Shihlin Electric

www.seec.com.tw

AC Servo System
SDA Series User Manual

ISO 14001 BSMI REGISTERED

ISO 9001 BSMI REGISTERED

CE

Contents

1. Product Inspection and Model Descriptions

1.1 Summary

The control models for Shihlin Multipurpose AC Servo can be classified into the single model or the combined model. There are for modes for the single model: the position mode (terminal input), the position mode (internal register), the speed mode, and the torque mode. The combined model has five modes: the position mode (terminal input) / the speed mode, the positioning mode (terminal input) / the torque mode, the position mode (internal register) / the speed mode, the position mode (internal register) / the torque mode, and the speed mode / the torque mode.

Therefore the models are suitable for the general mechanery industry that requires a high precision and a smooth speed control, or places that requires machine tools and tension control.

Shihlin servo not only has RS-232 and RS-485 serial communication function but also is equipped with USB communication functions that are the most convenieint ond on the communication market. A computer with Shihlin communication software is available for installation and quick parameter setups, test operation, conditioning monitoring, and gain control adjustment.

Shihlin servo is also equipped with automatic tuning functions; the gain servo (Gain) can perform automatic adjustment functions in coordination with machanary. For the encorder, the encoder of Shihlin servo has a 2500 pulse/rev resolution (or 10,000 pulse/rev after four-fold encoding) and offers a high precision control.

1.2 Product Inspection

Please review he following item to avoid product transport or human caused negligence.

- Do the motors and controllers have any loosening or untightened screws?
- Check product serial number on the name tag of the motor and the actuator to determine whether they are the intened product of the purchase. The serial number are listed in the serial number reference table provided in the following chapter.
- Check if there is any scratch or damage on the appearance of the motor and the actuator.

- Turn the motor axis by hand. A smooth turning indicates a normal motor axis.If the motor has an attached electromagnetic brake, then the motor axis will not be turned smoothly by hand.

Please contact the agent for solutions if any of the above issue happens.

A complete original set of servo components from the manufacturer should include:

(1) A servo actuator and a servo motor.

(2) A UVW motor power line with one side the three UVW line connected to the UVW master block of the actuator while the other side connected to the UVW master block on the motor. The green ground wire should be locked to the ground of the actuator(An item for purchase).

(3) A communication control wire for the encoder; one side attached to CN2 of the controller while the other side attached to the encoder master block of the motor(An item for purchase).

(4) The RS232 wire of communication; one side attached to CN3 of the actuator while the other side attached to the COM PORT of the computer(An item for purchase).

(5) The USB wire of communication; one side attached to CN4 of the actuator while the other side attached to the USB PORT of the computer(An item for purchase).

(6) 50 PIN connector for CN1(An item for purchase).

(7) 5 PIN quick connection terminal; for 1 KW servos (R, S, T, L1, and L2).

(8) 3 PIN quick connection terminal; for 1KW servos (P, D, and C).

(9) 5 PIN quick connection terminal; for 1.5 KW servos (P, N, R, S, and T).

(10) 5 PIN quick connection terminal; for servos 1.5KW or above (P, N, R, S, and T).

(11) 3 PIN quick connection terminal (U, V, W).

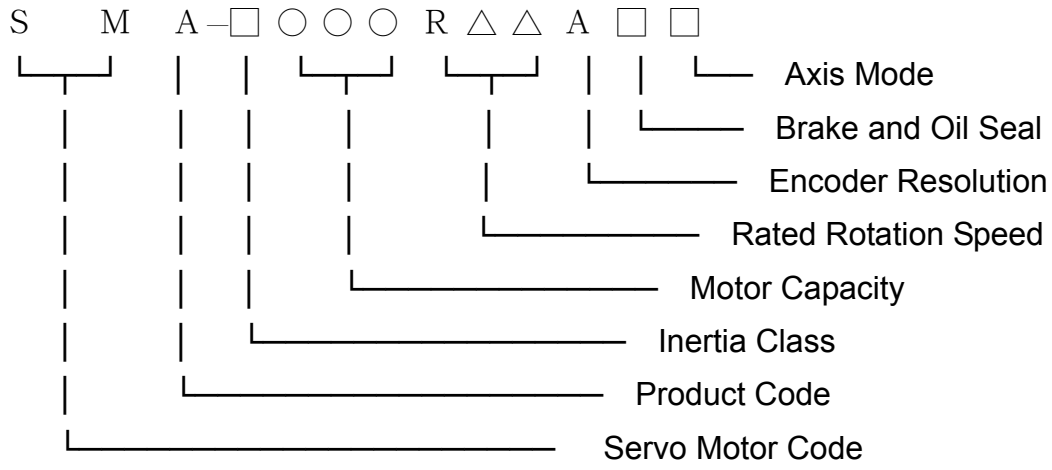
(12) Installation manual.

(13) Shihlin User Manual (an electronic verision can be downlowed online).(An item for purchase).

A Reference for Product Serial Number

Coding Rules for Shihlin Servo Motor Serial Number

(一) Coding Method



(二) Descriptions on Coded Items

(1) Servo Motor Code: SM denotes servo motor.

(2) Product Code: A.

(3) Inertia Class: The codes are assigned according motor inertia and frame size:

Code	Class
L	Low Inertia
M	Medium Inertia

(4) Motor Capacity: Motor Output Power.Three digits are used to represent the the motor's output power multiplied by 1/10: For products with power above 10,000W, a letter K is assigned to be the third digit, representing 1,000W.

For example: 020 denotes 200W;
150 denotes 1,500W;
350 denotes 3500W,
and so forth.

(5) Rated Rotation Speed: The rated output speed of the motor. Three-digit Coding: The first digit is represented by R, the second digit is represented by 20 (for 2,000rpm) or 30 (for 3,000rpm).

For example, R20 denotes for a 2000rpm of amotor's rated rotation speed.

(6) Encoder Resolution: It is represented by a capital letter A. The encoder resolution of Shihlin Motor Encoder is an incremental type of 2,500ppr.

(7) Brake and Oil Seal: Whether a motor has an included brake and oil seal is denoted by the following codings:

Item \ Coded	A	(B)	(C)	(D)
Brake	No	Yes	No	Yes
Oil Seal	No	No	Yes	Yes

(8) Shaft Mode: It describes the style of the motor shaft; K denotes the inclusion of a slot whereas no mark denotes the absence of a slot.

(三) Coding Example:

Example 1: The serial number for a 200W motor with low inertia, rated rotation speed 3000rpm, no brake, no oil seal, and no slot for the axis would be:

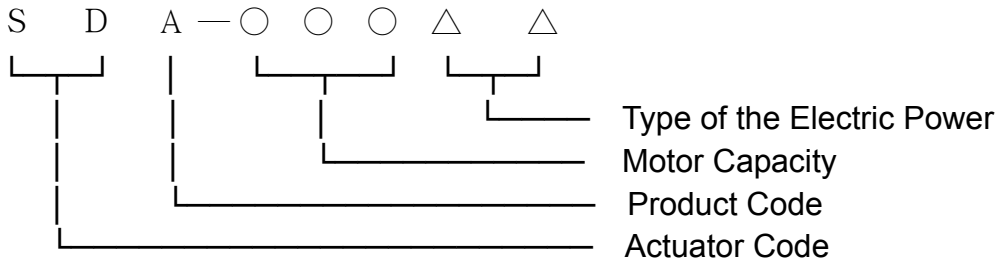
SMA－L020R30AA

Example 2: The serial number for a 1500W motor with medium inertia, 2000rpm, brake included, no oil seal, and has an axis with slot would be:

SMA－M150R20ABK

The Coding Rules for Servo Actuator Serial Number

(一) Coding Method



(二) Descriptions on Coded Items

(1) Actuator Code: SD represents the servo actuator.

(2) Product Code: A.

(3) Motor Capacity: Motor Output Power.Three digits are used to represent the the motor's output power multiplied by 1/10: For products with power above 10,000W, a letter K is assigned to be the third digit, representing 1,000W.

For example: 020 denotes 200W;
150 denotes 1,500W;
350 denotes 3500W,
and so forth.

(4) Power Specifications: Input power specifications

A2：3-phase，220V

(三) Examples:

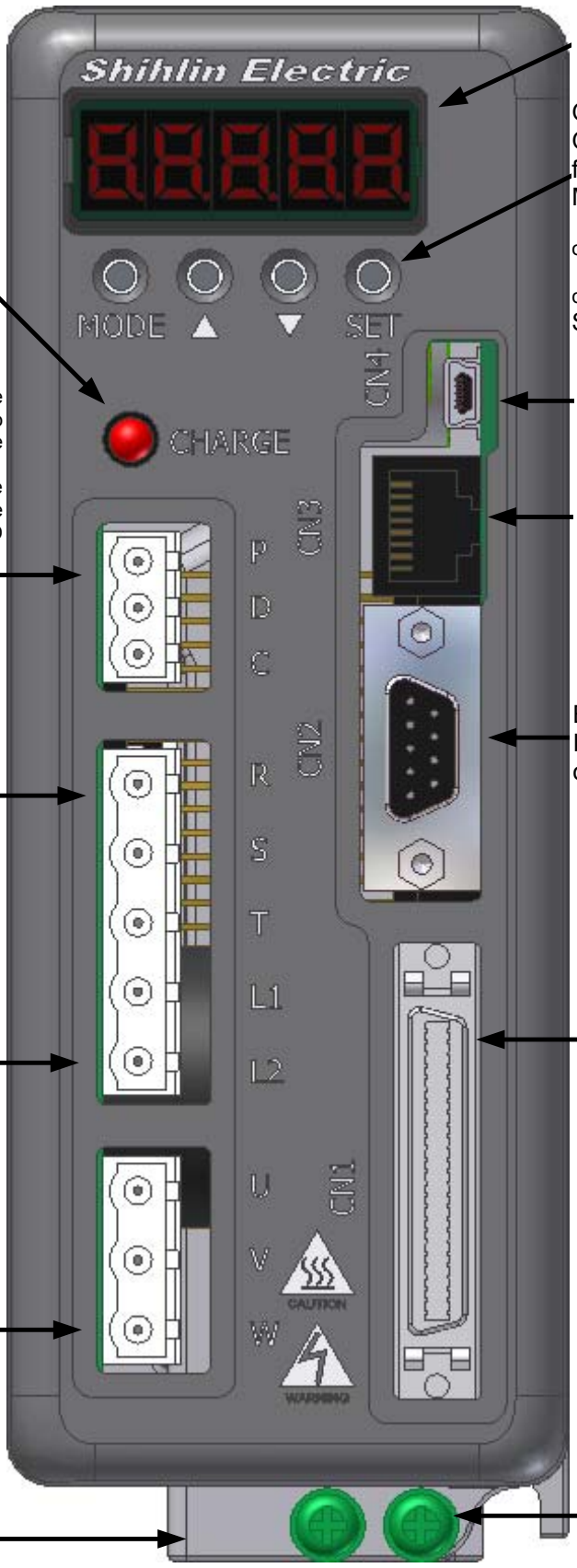
Example 1: The code given to a 200W motor for actuator that needs a three-phase 200V electric power would be:

SDA－020A2

The Reference Table for Servo Actuator and Motor Models

	Servo Actuator		Corresponding Servo Motor	
100W		SDA－010A2		SMA－L010R30AB
200W		SDA－020A2		SMA－L020R30AB
400W		SDA－040A2		SMA－L040R30AB
500W		SDA－050A2		SMA－M050R20AD
750W		SDA－075A2		SMA－L075R30AB
1000W		SDA－100A2		SMA－M100R20AD
1500W		SDA－150A2		SMA－M150R20AD
2000W		SDA－200A2		SMA－M200R20AD
3500W		SDA－350A2		SMA－M350R20AD

1.3 Servo Actuator Appearance and Panel Descriptions



Display Section:
5-digit, 7-way LED displaying alarms, server status, parameters, etc.

Operation Section:
Operation status includes setups for function, parameter, etc.
MODE: Mode options
▲: Add one unit to the value displayed on the display panel
▼: Subtract one unit from the value displayed on the display panel
Set: The confirm button

Power Indicator Light:
If the light is on, it indicates that the server actuator still has a high voltage.

USB connector:
Connect to PC and controller.

Internal/External Regenerative Resistor:

a) When using the external regenerative resistor, connect P and C terminals to the resistor, and make P and D the open circuits.
b) When using the internal regenerative resistor, make P and C terminals the open circuits, and make P and D terminals the short circuits.

RS-232 / RS-485 Connector:
Connect to PC and controllers

Main Circuit Power:
Connect R, S, and T to commercial electrical power of AC200 – 230V and 50/60Hz.

Encoder connector:
It is to connect to the encoder of server motor.

Control Panel Circuit Power:
L1 and L2 for single-phase 200 – 230 Vac, 50/60 Hz Power Source

Connector Control:
Can be connected to the external control I/O connector or to the program controller.

Server Motor Output:
Connect to U, V, and W ports of the motor power. Cannot be connected to the main circuit power. Wrong connection can cause servere actuator damages.

Ground

Cooling Pad:
Fix the server and cool down the temperature.

1.4 An Overview of the Servo Actuator Operation Modes

Shihlin Actuator provides multiple operation mode for the users to select. More detailed descriptions are listed as follows:

Mode		Code	Description
Single Mode	Position Mode (Internal Register)	Pt	The actuator accepts position commands for controlling the motor to reach the target position. Position commands are inputted by the terminal block, and the signals are in the form of pulse waves.
	Position Mode Internal Register	Pr	The actuator accepts position commands for controlling the motor to reach the target position. Position commands are given by the internal register (eight sets of registers). The user can use DI signals to select the register code.
	Speed Mode	S	The actuator accepts speed commands for controlling the motor to reach the target rotation speed. DI signals can be used to select the speed command to be analog voltage command or internal speed command (seven sets of register).
	Torque Mode	T	The actuator accepts torque commands for controlling the motor to reach the target torque. Torque commands are provided by analog voltage commands.
Combined Model		Pt-S	The switch for Pt to S or *vice versa* is carried out by DI signals.
		Pt-T	The switch for Pt to S or *vice versa* is carried out by DI signals.
		Pr-S	The switch for Pt to S or *vice versa* is carried out by DI signals.
		Pr-T	The switch for Pt to S or *vice versa* is carried out by DI signals.
		S-T	The switch for S to T or *vice versa* is carried out by DI signals.

Mode selection can be completed by setting up the parameter PA 01. After modifying the parameter PA01, restart the electric power to complete the modification.

1.5 Circuit Breaker and Fuse Specifications and Recommendations

Circuit breaker and fuse specifications for Shihlin servo actuator:

Actuator Serial No.	Fuse	Circuit Breaker
SDA－010A1	5A	5A
SDA－020A1	5A	5A
SDA－040A1	20A	10A
SDA－050A1	20A	10A
SDA－075A1	20A	10A
SDA－100A1	25A	15A
SDA－150A1	40A	20A
SDA－200A1	60A	30A
SDA－350A1	80A	30A

2. Installation

2.1. Notices and Storage Methods

- Do not install the product on inflammable matters or close to inflammable matters.
- Do not over tighten the wire between the actuator and the motor.
- Do not place heavy objects on top of the actuator.
- Be sure to tighly lock the fixing spots of the actuator when fastening the actuator.
- Install the actuator at a location that can bearthe weight of the actuator.
- Align the axle of the motor and the axle of the device.
- No oil-like inflammable objects or conductive bjects such as metal pieces or screws are allowed inside the actuator.
- Thicken thicken the wire between U, V, W and the encoder if the wiring between the actuator and the motor is more than 20 m.
- Do not clogged the vent of the actuator, or breakdowns may happen.
- Do not drop or clash the actuator.
- Do not run the actuator if the actuator has been damaged.
- Please refer to Section 11.1 and 11.3 for actuator and motor storage details.

2.2. Installation Environment Conditions

The ambient temperature for Shihlin actuator is between 0℃ and 55℃. If the operation environment is higher than 45℃, place the actuator in a place with good air circulation or with air conditioning.For a long-term operation, place the product in an environment with temperature below 45℃ to ensure the reliability of the product.If the product is installed inside an electric box, make sure that the size and the ventilation of the electric box can prevent over-heating of the electronic components inside the electric box.Make sure that machine vibration will not affect the electronic devices of the electric box.In addition, meet the following criteria for using Shihlin servo:

- Avoid locations with inflammable or high-heat devices.
- Avoid locations with floating dust or metal particles.
- Avoid locations with corrosive, inflammable gases and liquids.
- Avoid locations with water drops, steam, dust, or oily dust.

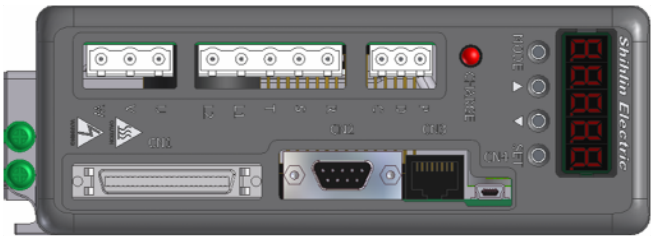
- Avoid locations with electromagnetic interference.
- Select solid, vibration-free locations.

2.3. Installation Direction and Spacing

Note:

Follow the regulations for installation direction to avoid causing servo breakdowns.Provide a good circulation cooling by keeping sufficient space between Shihlin AD servo actuator and objects or baffle board/walls when installing Shihlin AD servo actuator to avoid breakdowns.Do not seal the suction and the ventilation opening or place the AD servo actuator upside down during the installation to avoid breakdowns.

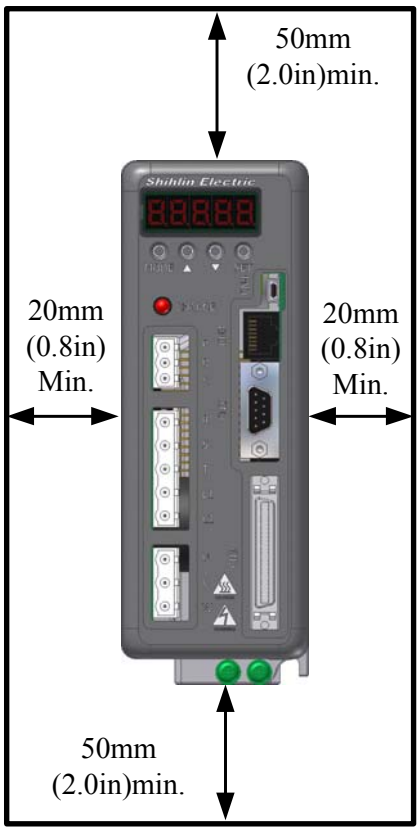
correct



incorrect

Installation Diagram:

To achieve a lower wind resistance of the heat-dissipation fan for a more effective heat removal, follow the spacing recommendation for installing one or multiple AD servo actuator (See the fiure below).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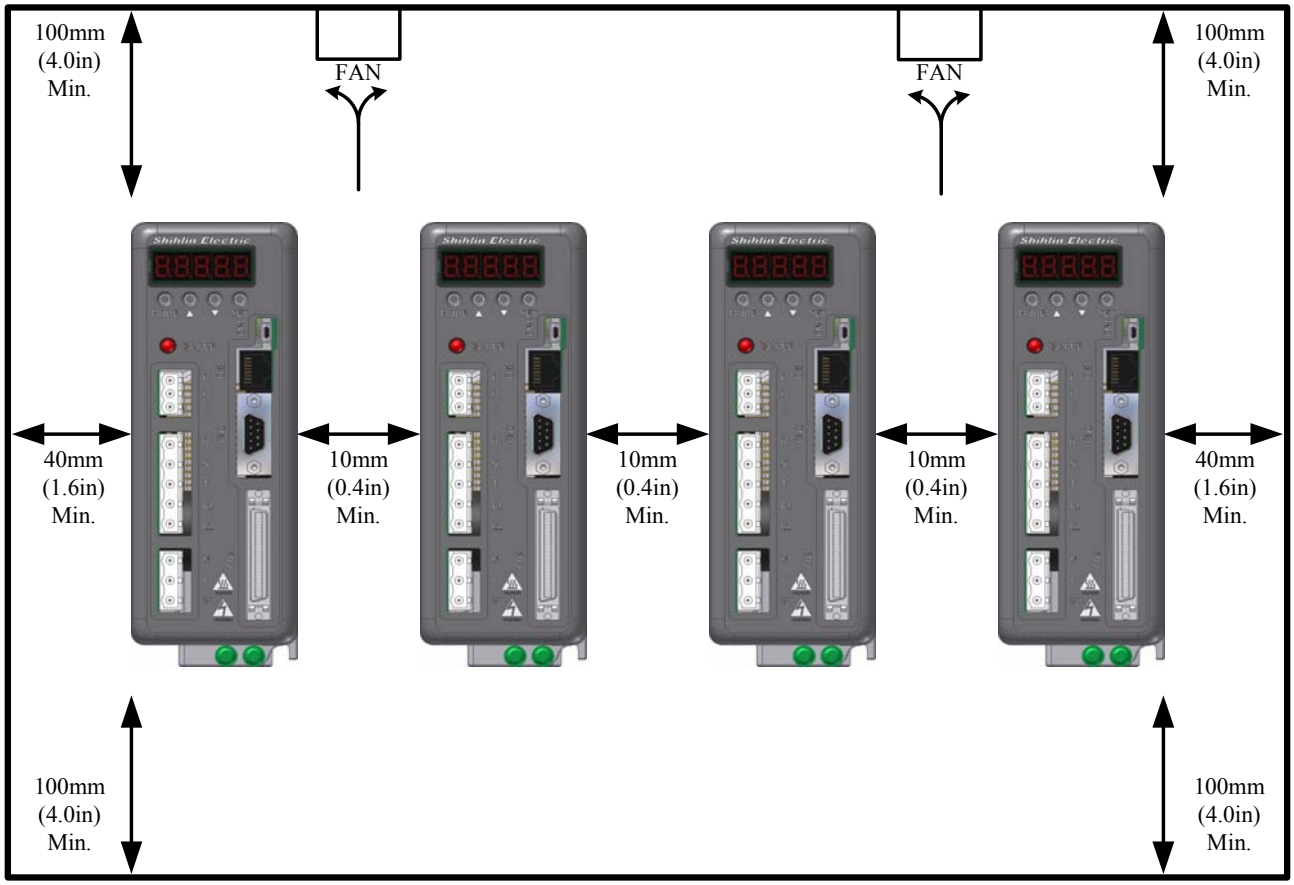
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40mm
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100mm
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100mm
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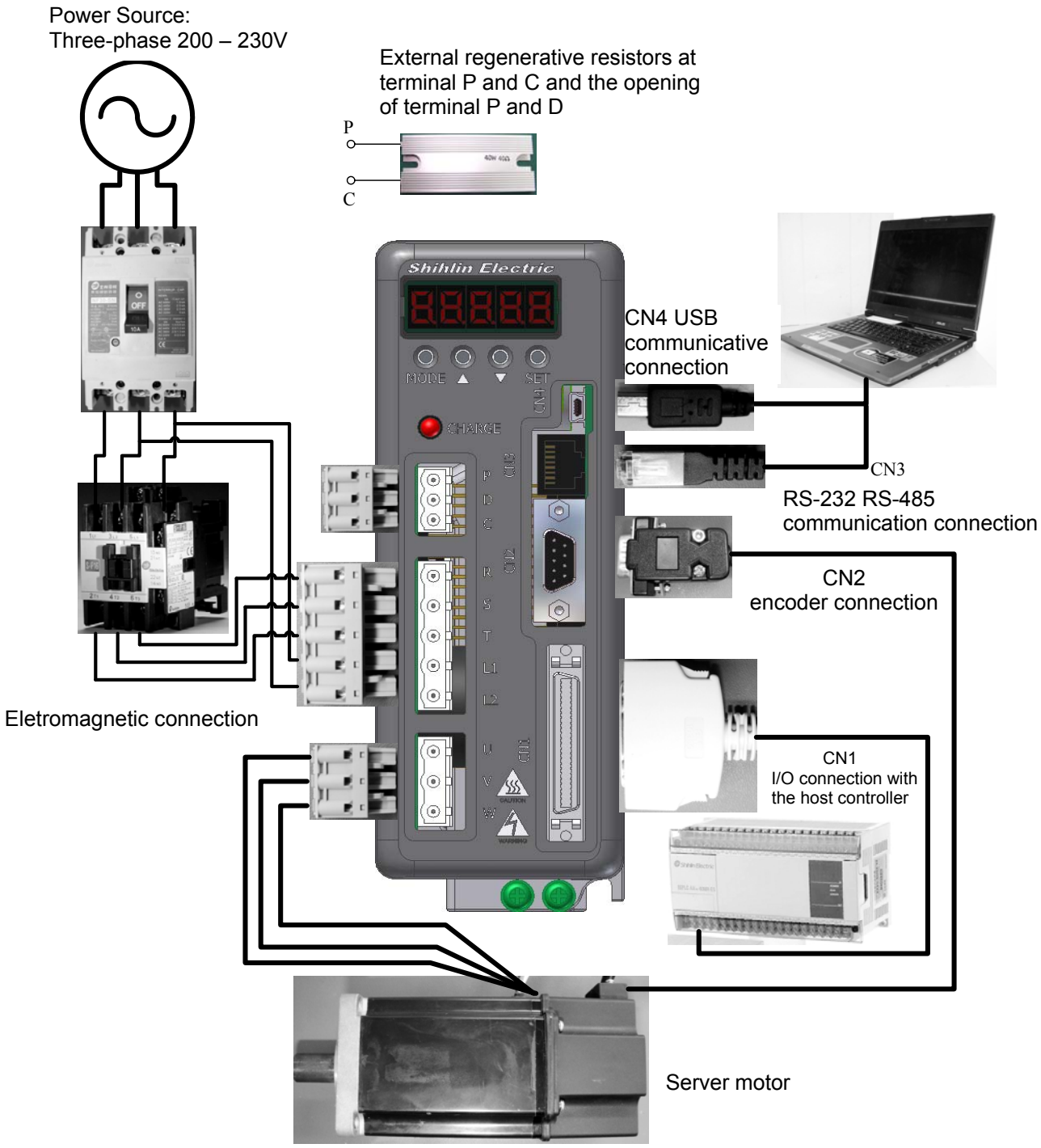
3. Signals and Wiring

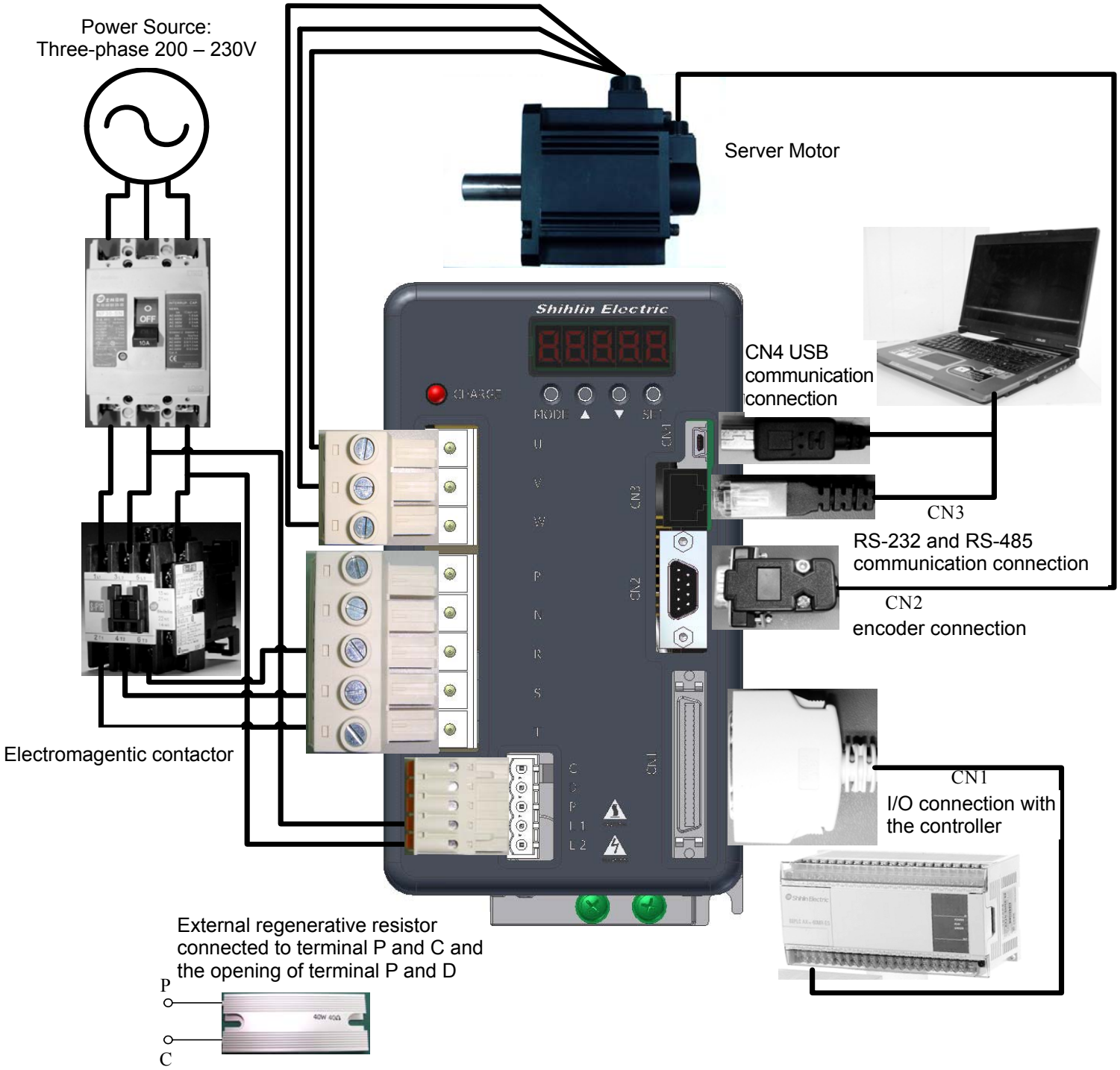
This chapter provides definitions of the wiring and signals of Shihlin servo actuator and the standard wiring diagrams for all the models.

3.1. Main Circuit Power Source and Peripheral Device Connections

3.1.1. Peripheral Device Connection Wiring (Under 1KW)



3.1.2. Peripheral Device Connection Wiring (Above 1.5KW)



🕮 Installation Note:

①Make sure that the terminal wiring of servo motor output U, V, Q is correct, or the motor will rotate randomly or be unrotatable.

②If external brake resistors are used, be sure to connect the open circuit resistor and the external brake resistor of P and D terminals to the P and C terminals. If built-in brake resistors are used, be sure to make the P and D terminals short circuits while the P and C open circuits.Be sure that the brake resistor is connected when wiring the servo.

③Check whether the power source and the wiring of R, S, T, L1 and L2 are correct. Wrong short circuits may blow up the machine.

3.1.3. Descriptions of Actuator Connectors and Terminals

<table>
<tr><th>Name</th><th>Terminal Code</th><th>Description</th></tr>
<tr><td>Main Circuit Power Source Input Terminal</td><td>R、S、T</td><td>Connect to three-phase AC.</td></tr>
<tr><td>Power Source Input Terminal</td><td>L1、L2</td><td>Connect to single-phase AC.</td></tr>
<tr><td>Motor Power Input Terminal</td><td>U、V、W、PE</td><td>
<table>
<tr><th>Terminal Code</th><th>Wire Color</th></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>Brake Resistor Terminal</td><td>P、D、C</td><td>
<table>
<tr><td>Using external resistors</td><td>Connect the resistor to the P and C terminals while making the P and D terminals the open circuits.</td></tr>
<tr><td>Using built-in resistors</td><td>Make the P and D terminal short circuits while the P and C terminals open circuits.</td></tr>
</table>
</td></tr>
<tr><td>Ground Terminals</td><td>⏚</td><td>Connect it to the ground terminal of the power source and of the motor (the green screws at the exterior of the controller.</td></tr>
</table>

P: Main Circuit “+” Terminal N: Main Circuit “-” Terminal	P、N	Select brake modules for models greater than 1.5kW. When selecting a brake module, be sure to connect the “+” terminal to the P terminal of the actuator servo and the “-“ to the N terminal of the actuator servo. Commonly, there is no need to connect to an optionalbrake module. If connection is required, it is because an enormous amount of regenerative power produced by the negative work of the servo motor can be offset by the brake module.
I/O Connector	CN1	Connect to the upper controller.
Encoder Connector	CN2	Connect to the motor encoder.
RS-232 and RS-485 Connectors	CN3	Connect to the COM PORT of the computer.
USB Connector	CN4	Connect to the USB slot of the computer.

Pay attention to the following issue when wiring:

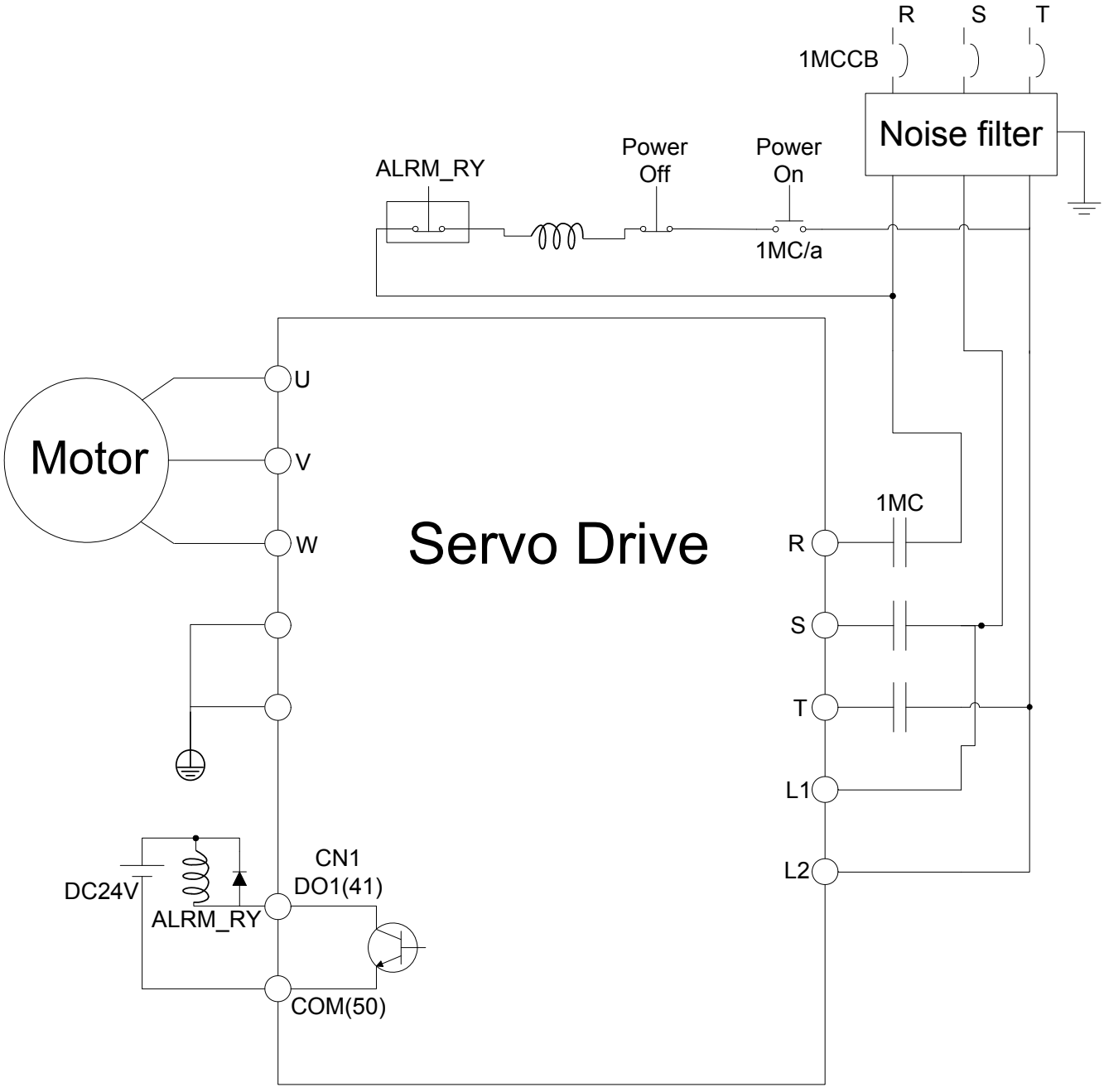
① Keep the six major power lines R, S, T, U, V and W away from other signal lines for at least 30 cm.

②Do not touch R, S, T, U, V and W this six major power line when shutting down the power; there is a large amount of electric charge in the large capacitor inside the actuator.Contact the lines only until the charging light goes off.

③ To elongate the encoder connecting line, be sure to use grounded and shield twisted pair signal line.Do not exceed 20 m (65.62 feet). Be sure to use a signal line with doubled diameter for length greater than 20 m to avoid losing the signals.

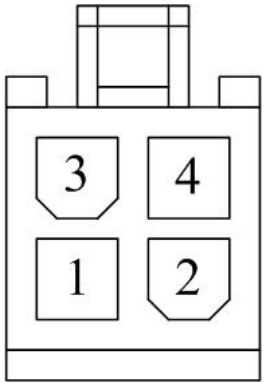
3.1.4. Power Source Wiring

The power source wiring of Shihlin servo actuator is a three-phase power source. In the figure below, Power ON is for connecting point a and OFF and Alarm Processing is for connecting point b.1MC/a is the self-sustaning power source, and 1MC is the electromagnetic contactor.



3.1.5. Connector Specifications of the Leadout Wire of Motor U, V &W

Connector specifications (female connectors) of U, V &W wiring of Shihlin Low Inertia Motor:

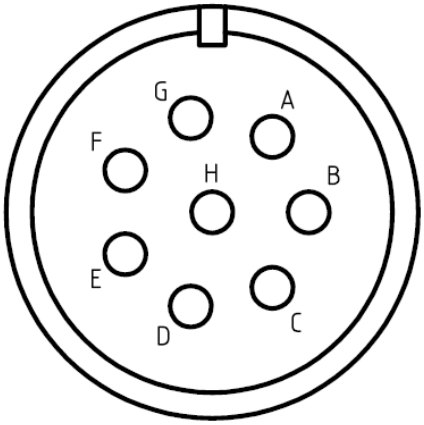
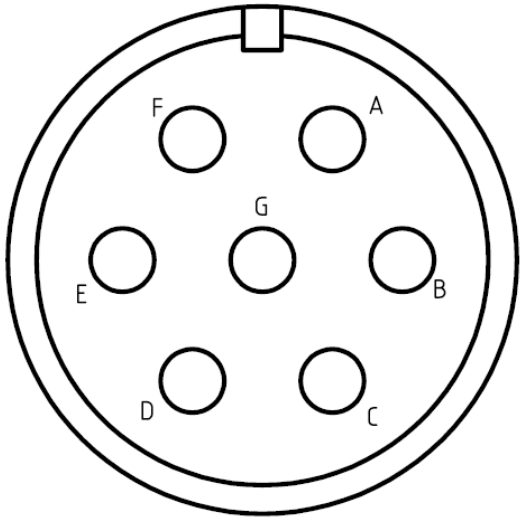
Actuator Capacity	Motor Type	
100W	SMA－L010R30AB	
200W	SMA－L020R30AB	
400W	SMA－L040R30AB	
750W	SMA－L075R30AB	

Signals of U, V &W lead-out wire connectors of the low inertia motor:

PIN	Signal	Wire Color
1	U	Red
2	V	White
3	W	Black
4	PE	Green (background) / yello

★ Note: The above-mentioend wiring are connected to the connector of the motor itsel.

Connector specifications (male connectors) of U, V &W wiring of Shihlin Low Inertia Motor:

Actuator Capacity	Motor Type	
500W	SMA－M050R20AD	
1KW	SMA－M100R20AD	
1.5KW	SMA－M150R20AD	
Actuator Capacity	Motor Type	
2KW	SMA－M200R20AD	
3.5KW	SMA－M350R20AD	

Signals of U, V &W lead-out wire connectors of the low inertia motor:

PIN	Signal
A	NC
B	U
C	V
D	W
E	PE
F	NC (Using the motor of the electromagnetic brake)
G	NC (Using the motor of the electromagnetic brake)
H	NC

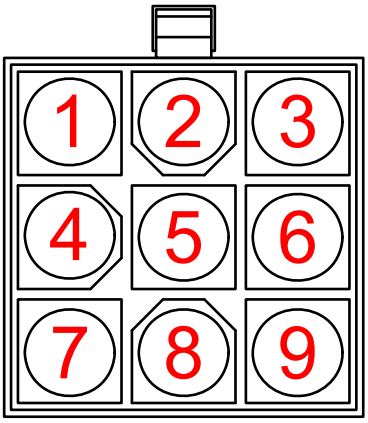
★ Note: The above-mentioend wiring are connected to the connector of the motor itsel.

3.1.6. Connector Specifications of the Lead-out Wire of the Encoder

Connectors of the encoder wiring of Shihlin low-inertia servo are described as follows:

Motor terminal: female connector

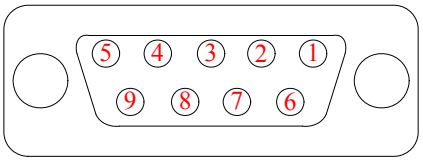
Shihline servo actuator capacity applicable connetors are presented in the table below:

Actuator Capacity	Motor Type	
100W	SMA－L010R30AB	
200W	SMA－L020R30AB	
400W	SMA－L040R30AB	
750W	SMA－L075R30AB	

Pin No.	Wire Color	Signal Content
1	Blue	A
2	Green	(B)
3	Yellow	Z
4	Blue-blake	/A
5	Green-blake	(B)
6	Yellow-blake	/Z
7	Red	5V
8	Black	GND
9	NC	SHELD

★ Note: The above-mentioend wiring are connected to the connector of the motor itself.

Actuator Terminal: 9 PIN Female Connector



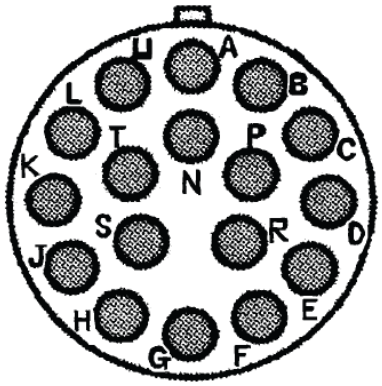
Pin	1	2	3	4	5	6	7	8	9
Pin Name	NC	/Z	/B	/A	5V	Z	(B)	A	GND

Connectors of the encoder wiring of Shihlin low-inertia servo are described as follows:

Motor terminal: female connector

Shihline servo actuator capacity applicable military-standard connetors are presented in the table below:

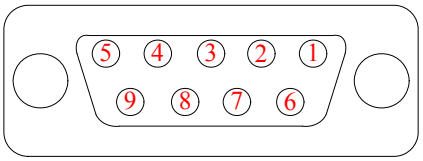
Actuator Capacity	Motor Type
500W	SMA－M050R20AD
1KW	SMA－M100R20AD
1.5KW	SMA－M150R20AD
2KW	SMA－M200R20AD
3.5KW	SMA－M350R20AD



Pin	A	B	D	E	G	H	S	P	L
Pin Name	A	/A	B	/B	Z	/Z	5V	GND	SHIELD

★ Note: The above-mentioend wiring are connected to the connector of the motor itself.

Actuator Terminal: 9 PIN Female Connector



Pin	1	2	3	4	5	6	7	8	9
Pin Name	NC	/Z	/B	/A	5V	Z	B	A	GND

3.1.7. Wiring Materials

The users have to do the wiring before using Shihlin actuator. Here are some recommended wiring:

Actuator Model	Motor Model	Power Source related wiring (AWG)			
		U、V、W	R、S、T	L1、L2	P、D、C
SDA－010A2	SMA－L010R30AB	AWG14	AWG14	AWG16	AWG14
SDA－020A2	SMA－L020R30AB	AWG14	AWG14	AWG16	AWG14
SDA－040A2	SMA－L040R30AB	AWG14	AWG14	AWG16	AWG14
SDA－050A2	SMA－M050R20AD	AWG14	AWG14	AWG16	AWG14
SDA－075A2	SMA－L075R30AB	AWG14	AWG14	AWG16	AWG14
SDA－100A2	SMA－M100R20AD	AWG14	AWG14	AWG16	AWG14
SDA－150A2	SMA－M150R20AD	AWG14	AWG14	AWG16	AWG14
SDA－200A2	SMA－M200R20AD	AWG12	AWG12	AWG16	AWG14
SDA－350A2	SMA－M350R20AD	AWG12	AWG12	AWG16	AWG14

Actuator Model	Motor Model	Encoder Wiring (AWG)			
		Wire Gauge	Standard Length of the Wiring	Number of Conductors	Conductor Gauge
SDA－010A2	SMA－L010R30AB	UL1332	2 M	10	AWG26
SDA－020A2	SMA－L020R30AB	UL1332	2 M	10	AWG26
SDA－040A2	SMA－L040R30AB	UL1332	2 M	10	AWG26
SDA－050A2	SMA－M050R20AD	UL1332	2 M	10	AWG26
SDA－075A2	SMA－L075R30AB	UL1332	2 M	10	AWG26
SDA－100A2	SMA－M100R20AD	UL1332	2 M	10	AWG26
SDA－150A2	SMA－M150R20AD	UL1332	2 M	10	AWG26
SDA－200A2	SMA－M200R20AD	UL1332	2 M	10	AWG26
SDA－350A2	SMA－M350R20AD	UL1332	2 M	10	AWG26

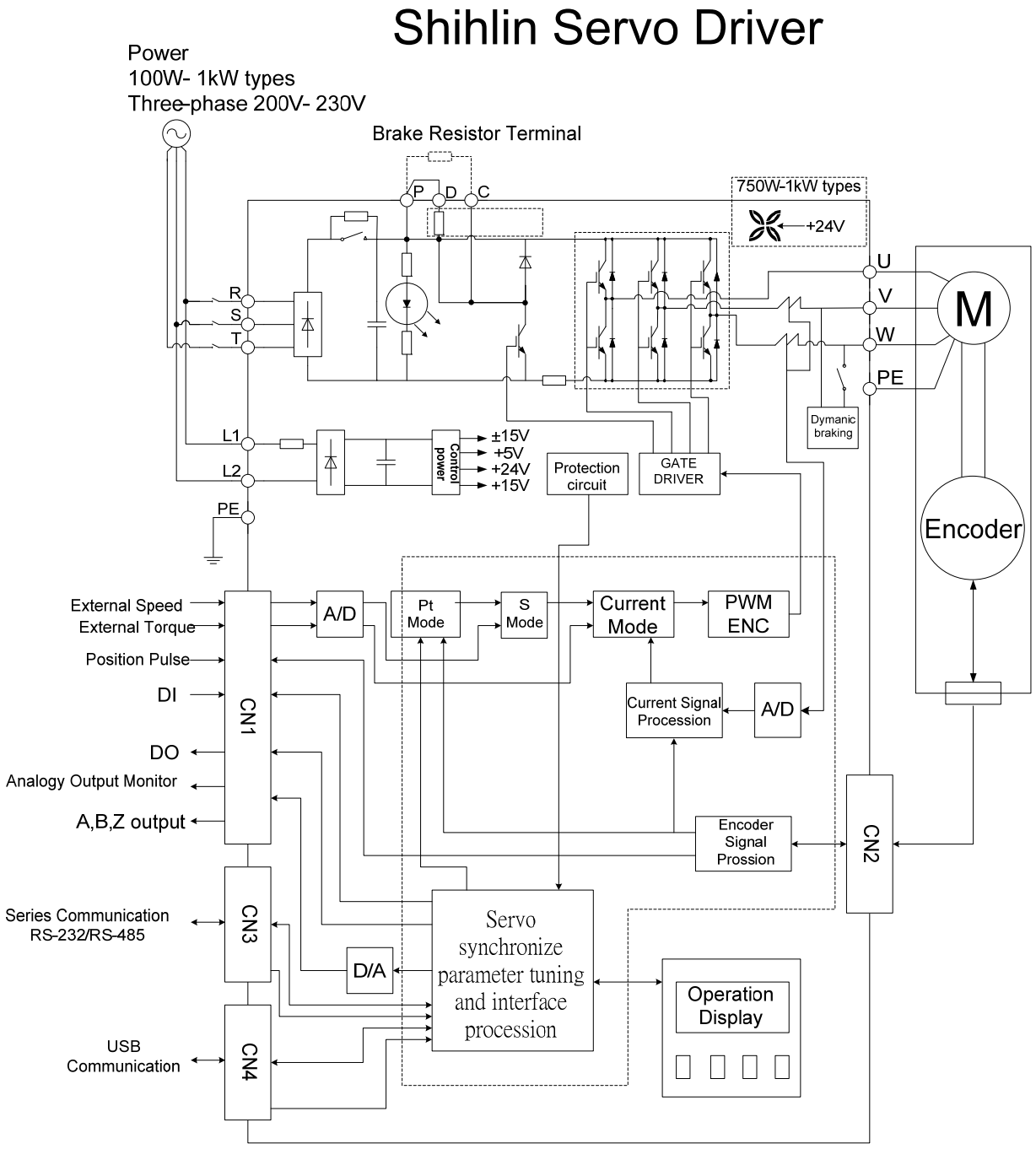
★ Please carry out the wiring according to the above table or adopting a larger gauge to avoid dangers.

★ The SHIELD terminal of the shield net has to be connected to the ground.

★ Use a shielded twisted pair cable for encoder wiring to reduce noise interference.

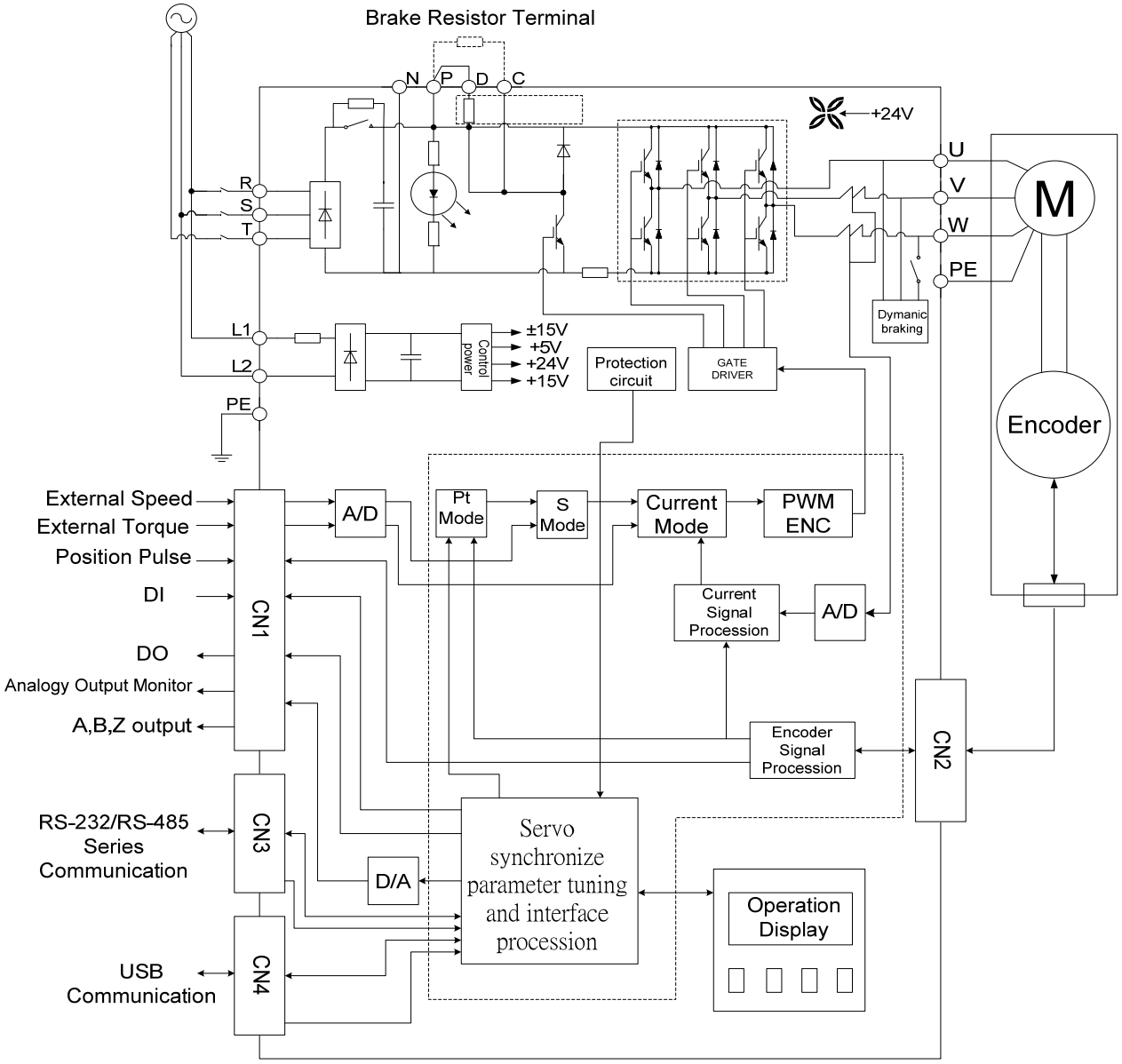
★ American Wire Gauge (AWG) is the standard American wire diameters.

3.2. Servo System Functional Block Diagram



Shihlin Servo Driver

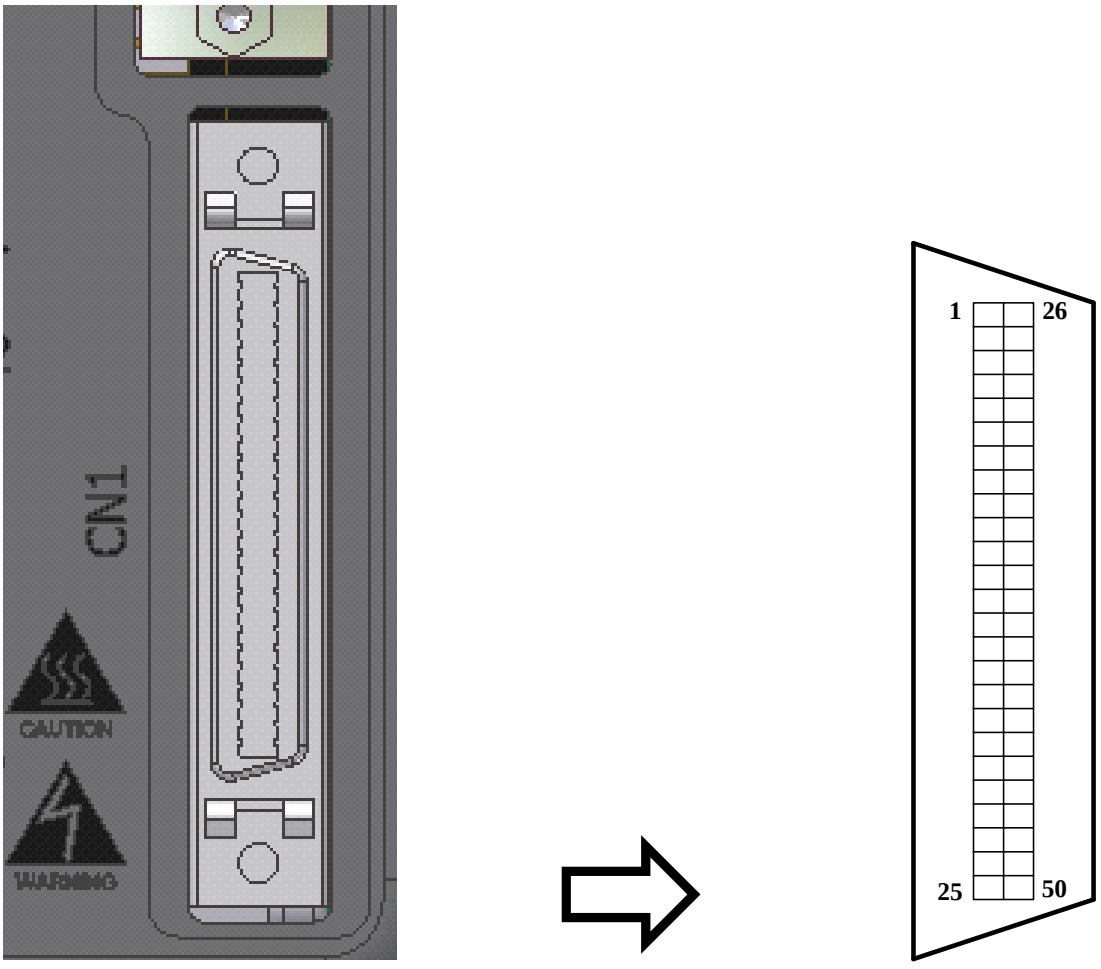
Power
1.5kW~3.5kW types
Three-phase 200V~230V



3.3. CN1 I/O Signal Wiring and Descriptions

3.3.1. CN1 Terminal Layout

Shihlin servo actuator provides eight sets of DI input and five sets of DO output for the user to arrange by themselves, which makes the application and intercommunication from connecting to the host controller more flexible.The eight input DI parameters for the users to set up by themselves are PD02 to PD09, and the output DI parameters are PD10 to PD14.In addition, signals of encoder A+, A-, B+, B-, Z+ and Z- of differential output, analog torque command input, and analog speed command input are provided.The pin diagram is presented as follows:



Pin	Code	Function	Pin	Code	Function	Pin	Code	Function	Pin	Code	Function
1	Vcc (15V)	+15 Power source output (For analog ommand)	2	VC/VLA	Analog speed command / restriction	26	Vcc (15V)	+15 Power source output (For analog ommand)	27	TC/TLA	Analog Torque Command / Restriction
3	LG	Analog input signal ground	4	NC	No Effect	28	LG	Analog input signal ground	29	LG	Analog input signal ground
5	NG	Input pulse train	6	NP	Input pulse train	30	MON 1	Analog Monitor 1	31	LG	Analog input signal ground
7	OPC	Open collector power input	8	PP	Input pulse train	32	MON 2	Analog Monitor 2	33	LA	Encoder phase A pulse
9	PG	Input pulse train	10	LG	Analog input signal ground	34	LAR	Encoder phase A pulse	35	LB	Encoder phase B pulse
11	LG	Analog input signal ground	12	NC	No Effect	36	LBR	Encoder phase B pulse	37	LZ	Encoder phase Z pulse
13	NC	No Effect	14	DI1	Digital Input 1	38	LZR	Encoder phase Z pulse	39	OP	Encoder phase Z pulse (Open collector)
15	DI2	Digital Input 2	16	DI3	Digital Input 3	40	NC	No Effect	41	DO1	Digital Output 1
17	DI4	Digital Input 4	18	DI5	Digital Input 5	42	DO2	Digital Output 2	43	DO3	Digital Output 3
19	DI6	Digital Input 6	20	DI7	Digital Input 7	44	DO4	Digital Output 4	45	DO5	Digital Output 5
21	DI8	Digital Input 8	22	LSP	Upper limit for Forward rotation route	46	ALM	Breakdow n	47	COM+	Digital power source
23	LSN	Upper limit for Reverse rotation route	24	SG	Digital power source	48	Vdd (24V)	Built-in power source +24V output	49	COM+	Digital power source
25	SG	Digital power source				50	SG	Digital power source			

🕮 Note:

1. NC stands for No Connection. This terminal is used by built-in components of the actuatorm. Do not connect to it to cause damages.
2. Although CN1-22, CN1-23 and CN1-45 are pins of digital output DI and DO, the users cannot use them for parameter planning or other functions.

3.3.2. CN1 Terminal Signal Descriptions

Signals listed in the above section are explained in more details here:

1. CN1 Terminal Signals

CN1 has a total of 50 pins, and their signals are described as follows:
Marks for the control modes in the table below are explained as below:

Pt: Position control mode and position mode (terminal input)
Pr: Position control mode and position mode (built-in registers)
S：Speed Control mode
T: Torque control mode

Siganl Name	Code	Pin NO	Function	Control Mode
+15 Power Output (For analog Commands)	Vcc (15V)	CN1-1 CN1-26	DC15V Output from VCC-LG. Can be used as TC, TLA, VC and VLA power source.	ALL
Analog speed command / restriction	VC/ VLA	CN1-2	Add a votage of DC -10V to +10V between VC-LG. At this speed mode, rotation speed set up by PC12 will be outputted at ±10V. Add a votage of DC 10V to +10V between VLA-LG. At this speed mode, rotation speed set up by PC12 will be outputted at ±10V.	S, T
Analog input signal ground	LG	CN1-3 CN1-10 CN1-11 CN1-28 CN1-31	The shared terminal of TLA, TC, VC, VLA, OP, MO1, MO2, VCC. Each pin has been connected at the inside.	ALL
Forward Rotation Pulse Train Reverse	NG	CN1-5	Enter the pulse train command. When using the open collector (maximum input frequency 200Kpps) A forward rotation pulse train between PP and SG.	Pt
	NP	CN1-6		
	PP	CN1-8		
	PG	CN1-9		

<table>
<tr><td>Rotation Pulse Train</td><td></td><td></td><td>A reverse pulse train between NP and SG.
When using the differential receiving method (maximum input frequency 500 Kpps).
A forward rotation pulse train between PG and PP.
A reverse pulse train between NG and NP.
The format of pulse train commands can be changed according to PA13.</td><td></td></tr>
<tr><td>Open collector power input</td><td>OPC</td><td>CN1-7</td><td>When using open collection for pulse train input, this terminal is the positive terminal providing DC 24V.</td><td>ALL</td></tr>
<tr><td rowspan="2">Upper limit for forward rotation route

Upper limit for reverse rotation route</td><td>LSP</td><td>CN1-22</td><td rowspan="2">Make a short circuit between LSP and SG and between LSN and SC during the rotation. When cutting the short circuit, make a emergency stop and lock the servo. When setting up the parameter as xxx1, it will be stopped from deceleration.
Set up the parameter PD01 as follows to change to internal automatic ON (i.e., stay on for a long time).

<table><tr><td colspan="2">Parameter PD01</td><td colspan="2">Automatic ON</td></tr><tr><td colspan="2">xx1x</td><td colspan="2">LSP</td></tr><tr><td colspan="2">x1xx</td><td colspan="2">LSN</td></tr><tr><td colspan="2">(Note) Input signal</td><td colspan="2">Operation</td></tr><tr><td>LSP</td><td>LSN</td><td>CCW direction</td><td>CW direction</td></tr><tr><td>1</td><td>1</td><td>○</td><td>○</td></tr><tr><td>0</td><td>1</td><td></td><td>○</td></tr><tr><td>1</td><td>0</td><td>○</td><td></td></tr><tr><td>0</td><td>0</td><td></td><td></td></tr></table>
Note: OFF (Open between SG)
1: ON (Short circuit between SG)</td><td rowspan="2">Pt、Pr、S</td></tr>
<tr><td>LSN</td><td>CN1-23</td></tr>
<tr><td>Digital power source ground</td><td>SG</td><td>CN1-24
CN1-25
CN1-50</td><td>The shared terminal for input signals of SON and EMG.Each PIN has already been connected and separated from LG.</td><td>ALL</td></tr>
<tr><td>Analog Torque</td><td>TC/ TLA</td><td>CN1-27</td><td>The servo motor output torques are under a global restriction.</td><td>Pt, Pr, S</td></tr>
</table>

Command / Restriction			Add a votage of DC -10V to +10V between TC-LG. Generate the maximum torque at ±10V. (The torque from inputting ±10V can be modified by parameter PC13.) An effective TLA will globally restrict the torque when the servo motor outputting the torques. Add a voltage of DC0 – 10V between TLA and LG. When TLA is connected to the positive end of the power source, a maximum torque will be generated at +10V.	
Analog Monitor 1	MON1	CN1-30	Data from setting parameter PC14 will be outputted from the voltage between MO2 and LG.	ALL
Analog Monitor 2	MON2	CN1-32	Data from setting parameter PC14 will be outputted from the voltage between MO2 and LG).	ALL
Phase A Pulse Differential Line Driver Detector	LA	CN1-33	The number of pulses outputted from every rotation by the servo motor set up by parameter PA14 is outputted by differential line driver. Phase B pulse of the detector has a π/2 delay compare to Phase A pulse of the encoder. (When servo motor rotates in CCW direction.) Phase differences and rotation detection of phase A pluse and phase B pulse can be determined by parameter PA39.	ALL
	LAR	CN1-34		
Phase B Pulse Differential Line Driver Detector	LB	CN1-35		ALL
	LBR	CN1-36		
Phase Z Pulse Differential Line Driver Detector	LZ	CN1-37	OP signal is outputted by differential line driver.	ALL
	LZR	CN1-38		
Encoder phase Z pulse (Open collector)	OP	CN1-39	Output the zero signal of the encoder.One pulse wave is outputted by each servo motor rotation.	ALL
Breakdown	ALM	CN1-46	ALM-SG will not become conductive when the power is off or when the main circuit is interrupted	ALL

			by activating the circuit protection.When there is no alarm, ALM-SG becomes conductive one second after turning on the power.	
Digital power source	COM+	CN1-47 CN1-49	Input DC24V for the input interface.Connect to the positive of DC 24V external power source.	ALL
Built-in power source +24V output	VDD (24V)	CN1-48	+24V ± 10% is outputted between VDD-SG.for connecting the digital interface power source at use to COM+.	ALL

Digital input and output signals are described in details below.

2. Shihlin Servo CN1 I/O

The names and abbreviation reference table for Shihlin servo CN1 I/O and digital input and output is presented below:

Abbreviation	Siganl Name	Abbreviation	Siganl Name
SON	Servo ON	CTRG	Triggering the position command
LSP	Upper limit for forward rotation route	TLC	Torque restricted
LSN	Upper limit for reverse rotation route	VLC	Speed restricted
CR	Clear	RD	Ready
SP1	Speed option 1	ZSP	Zero speed detection
SP2	Speed option 2	INP	Position ready
PC	Proportion control	SA	Speed attained
ST1	Forward rotation activated	ALM	The Z phase pulse fault detector (open collector)
ST2	Reverse rotation activation	OP	
TL	Torque restriction option	LZ	Z phase pulse detector (differential receiving)
RES	Reset	LZR	

EMG	External emergency stop	LA	A phase pulse detector (differential receiving)
LOP	Control mode switch	LAR	
VC	Analog speed command	LB	B phase pulse detector (differential receiving)
VLA	Analog speed restrictoin	LBR	
TLA	Analog torque restriction	VCC	The positive end of 15V power source output
TC	Analog torque command	VDD	The positive end of 24V internal power source output
RS1	Forward rotation option	COM+	The positive end of 24V external power source output
Abbreviation	Siganl Name	Abbreviation	Siganl Name
RS2	Reverse rotation option	SG	24V power source GND
PP	Forward and reverse rotation pulse train	OPC	Open collector power input
NP		LG	15V power source GND
PG		MON1	External analog monitoring output 1
NG		MON2	External analog monitoring output 2
POS1	Position command option 1	SD	Shield
POS2	Position command option 2		
POS3	Position command option 3		

3. DI and DO Signal Descriptions

Input DI

A total of 23 sets of digital input DI functions from 0x01 to 0x17 are available for the user to edit parameter PD02 to PD09. See the table below:

Siganl Name	Code	Value	Function	Control Mode
Servo ON	SON	0x01	SON-SG short circuit; include power source into the basic circuit for rotatable state (i.e., the servo is ON). Break the short circuit and the loop will result in the servo motor at a free run state (i.e., servo OFF). It becomes an internal automatic ON (i.e., ON all the time) from setting up parameter PD01 as XXX1.	ALL
Reset	RES	0x02	Abnormal alarm reset can be carried out when the short circuit between RES-SG is greater than 50ms. But sometimes the reset signal cannot lift the abrnomal alarm (refer to Section 10.1). If parameter PD20 is set to be XXX1, the loop will not be broken.	ALL
Proportion control	PC	0x03	A short circuit between PC-SG will make the speed controller switch from a proportional integral type to a proportion type.When the servo motor is at a stop state, torque will be generated to offset position shifting caused by even one pulse rotation induced by external factors.Once the positioning is done (and stops) and the axle of the machine is locked up, make the proportion control signal ON enables the user to suppress unnecessary torques that are to be corrected. For a long-term locking, turn on the torque control signal (TL) at the same time as making the proportion control signal. Use analog torque restriction to make it under the rated torque.	Pt, Pr, S
Torque restriction option	TL	0x04	TLA is valid at short circuit when the open internal torque restriction is one between TL and SG.Please refer to Chapter 6.3.4 for more details.	Pt, Pr, S
Internal torque restriction option	TL1	0x05	Internal torque restriction 2 (parameter PC25) is valid when TL1-SG is opened.Please refer to Chapter 6.3.4 for more details.	ALL

<table>
<tr>
<td>Speed option 1</td>
<td>SP1</td>
<td>0x06</td>
<td>At the speed control mode, select command return speed during rotation.
When using SP3, set up parameter PD02 – PD09 to make it possible to be used.
<table><tr><td rowspan="2">The setup of parameter PD02 – PD09</td><td colspan="3">(Note) Input signal</td><td rowspan="2">Speed Command</td></tr><tr><td>SP3</td><td>SP2</td><td>SP1</td></tr><tr><td rowspan="4">Speed option (SP3) when not in use (initial state)</td><td></td><td>0</td><td>0</td><td>Analog speed command (VC)</td></tr><tr><td></td><td>0</td><td>1</td><td>Internal speed command 1 (parameter PC05)</td></tr><tr><td></td><td>1</td><td>0</td><td>Internal speed command 2 (parameter PC06)</td></tr><tr><td></td><td>1</td><td>1</td><td>Internal speed command 3 (parameter PC07)</td></tr><tr><td rowspan="8">Speed option (SP3) in use</td><td>0</td><td>0</td><td>0</td><td>Analog speed command (VC)</td></tr><tr><td>0</td><td>0</td><td>1</td><td>Internal speed command 1 (parameter PC05)</td></tr><tr><td>0</td><td>1</td><td>0</td><td>Internal speed command 2 (parameter PC06)</td></tr><tr><td>0</td><td>1</td><td>1</td><td>Internal speed command 3 (parameter PC07)</td></tr><tr><td>1</td><td>0</td><td>0</td><td>Internal speed command 4 (parameter PC08)</td></tr><tr><td>1</td><td>0</td><td>1</td><td>Internal speed command 5 (parameter PC09)</td></tr><tr><td>1</td><td>1</td><td>0</td><td>Internal speed command 6 (parameter PC010)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>Internal speed command 7 (parameter PC011)</td></tr></table>
Note: OFF (Open between SG)
1: ON (Short circuit between SG)

Torque Control Mode: Select the return speed restriction during operation; parameter PD02 – PD09
<table><tr><td rowspan="2">set up</td><td colspan="3">(Note) Input signal</td><td rowspan="2">Speed Command</td></tr><tr><td>SP3</td><td>SP2</td><td>SP1</td></tr><tr><td rowspan="4">Speed option (SP3) when not in use (initial state)</td><td></td><td>0</td><td>0</td><td>Analog speed restrictoin</td></tr><tr><td></td><td>0</td><td>1</td><td>Internal speed command 1 (parameter PC05)</td></tr><tr><td></td><td>1</td><td>0</td><td>Internal speed command 2 (parameter PC06)</td></tr><tr><td></td><td>1</td><td>1</td><td>Internal speed command 3 (parameter PC07)</td></tr><tr><td rowspan="2">Speed option (SP3) when valid</td><td>0</td><td>0</td><td>0</td><td>Analog speed restrictoin</td></tr><tr><td>0</td><td>0</td><td>1</td><td>Internal speed command 1 (parameter PC05)</td></tr></table></td>
<td>S, T</td>
</tr>
<tr>
<td>Speed option 2</td>
<td>SP2</td>
<td>0x07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed option 3</td>
<td>SP3</td>
<td>0x08</td>
<td></td>
<td></td>
</tr>
</table>

<table>
<tr><td></td><td></td><td></td><td>
<table>
<tr><td></td><td>0</td><td>1</td><td>0</td><td>Internal speed command 2 (parameter PC06)</td></tr>
<tr><td></td><td>0</td><td>1</td><td>1</td><td>Internal speed command 3 (parameter PC07)</td></tr>
<tr><td></td><td>1</td><td>0</td><td>0</td><td>Internal speed command 4 (parameter PC08)</td></tr>
<tr><td></td><td>1</td><td>0</td><td>1</td><td>Internal speed command 5 (parameter PC09)</td></tr>
<tr><td></td><td>1</td><td>1</td><td>0</td><td>Internal speed command 6 (parameter PC010)</td></tr>
<tr><td></td><td>1</td><td>1</td><td>1</td><td>Internal speed command 7 (parameter PC011)</td></tr>
</table>
Note: OFF (Open between SG)
1: ON (Short circuit between SG)
</td><td></td></tr>
<tr><td>Forward rotation activated</td><td>ST1</td><td>0x09</td><td rowspan="2">After activating the servo motor, the directions of rotation are:
<table>
<tr><td colspan="2">(Note) Input signal</td><td rowspan="2">Servo Motor Activation Direction</td></tr>
<tr><td>ST2</td><td>ST1</td></tr>
<tr><td>0</td><td>0</td><td>Unlock the servo</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>Unlock the servo</td></tr>
</table>
Note: OFF (Open between SG)
1: ON (Short circuit between SG)
The ON and OFF of ST1 and ST2 during the operation will be stopped by deceleration according to parameter PA28, and the servo will be locked.The activation of analog speed commands (VC) at 0V will not produce torques locked by the servo.</td><td>S</td></tr>
<tr><td>Reverse rotation activation</td><td>ST2</td><td>0x0A</td><td></td></tr>
<tr><td>Forward rotation option</td><td>RS1</td><td>0x0A</td><td rowspan="2">Select the direction generated by the torques of the servo motor.
The directions are:
<table>
<tr><td>RS2</td><td>RS1</td><td></td></tr>
<tr><td>0</td><td>0</td><td>No torque</td></tr>
<tr><td>0</td><td>1</td><td>Forward rotation torque, reverse rotation regineration</td></tr>
<tr><td>1</td><td>0</td><td>Reverse rotation torque, positive rotation regeneration</td></tr>
<tr><td>1</td><td>1</td><td>No torque</td></tr>
</table>
Note: OFF (Open between SG)
1: ON (Short circuit between SG)</td><td>T</td></tr>
<tr><td>Reverse rotation option</td><td>RS2</td><td>0x09</td><td></td></tr>
</table>

<table>
<tr><td>Return to the Origin</td><td>ORGP</td><td>0x0B</td><td>When searching the original point at the built-in position register mode, the servo will treat the location of this point as the origin after receiving the signal.Origin return action will be intitiated when SHOM is ON.</td><td>Pr</td></tr>
<tr><td>Origin Search</td><td>SHOM</td><td>0x0C</td><td>When searching the original point at the built-in position register mode, origin search action will be activated once the signal is received.</td><td>Pr</td></tr>
<tr><td>Electronic Gear Option 1</td><td>CM1</td><td>0x0D</td><td rowspan="2">When applying CM1 and CM2, the setup of PD02 – PD09 enables the user to use the combination between CM1 – SG and CM2 – SG. Numerators of four types of gear ratios can be set up by the parameters.The absolute position detector system, CM1, and CM2 cannot be used.<table><tr><td colspan="2">(Note) Input signal</td><td rowspan="2">The numerator of electronic gear ratio</td></tr><tr><td>CM2</td><td>CM1</td></tr><tr><td>0</td><td>0</td><td>Parameter PA07 setup (CMX)</td></tr><tr><td>0</td><td>1</td><td>Parameter PC32 setup (CMX2)</td></tr><tr><td>1</td><td>0</td><td>Parameter PC33 setup (CMX3)</td></tr><tr><td>1</td><td>1</td><td>Parameter PC34 setup (CMX4)</td></tr></table>Note 0: OFF (SG opened); 1: ON(SG short circuit)</td><td rowspan="2">Pt、Pr</td></tr>
<tr><td>Electronic Gear Option 2</td><td>CM2</td><td>0x0E</td></tr>
<tr><td>Clear</td><td>CR</td><td>0x0F</td><td>For CR-SG short circuit, the slip pulse of the position control counter can be removed at the rising edge. The width of the pulse wave should be greater than 10 ms.The setup of parameter PD18 is xxx1 (often cleared for CR-SG short circuit).</td><td>Pt、Pr</td></tr>
<tr><td>Switch Gain Signal</td><td>CDP</td><td>0x10</td><td>When using the signal, set up parameter PD02 – PD09 for use. At CDP-SG short circuit, switch all the gain value to the product of PB14 – PB17 that are set up by the parameter.</td><td>ALL</td></tr>
<tr><td>Control Switch</td><td>LOP</td><td>0x11</td><td>Select the control mode at the position/speed control switch mode.<table><tr><td>(Note) LOP</td><td>Control Mode</td></tr><tr><td>0</td><td>Position</td></tr><tr><td>1</td><td>Speed</td></tr></table></td><td>Descriptions vary depending on the</td></tr>
</table>

<table>
<tr><td></td><td></td><td></td><td>Select the control mode at the position/speed control switch mode.
<table><tr><td>(Note) LOP</td><td>Control Mode</td></tr><tr><td>0</td><td>Speed</td></tr><tr><td>1</td><td>Torque</td></tr></table>Select the control mode at the position/speed control switch mode.
<table><tr><td>(Note) LOP</td><td>Control Mode</td></tr><tr><td>0</td><td>Torque</td></tr><tr><td>1</td><td>Position</td></tr></table>Note 0: OFF (SG opened); 1: ON(SG short circuit)</td><td>control mode.</td></tr>
<tr><td>External emergency stop</td><td>EMG</td><td>0x12</td><td>Opening EMG-SG will result in an emergency state, causing the shut off of the servo and the activation of the brake. Making EMG-SG a short circuit at an emergency state can lift the emergency stop.</td><td>ALL</td></tr>
<tr><td>Position command option 1</td><td>POS1</td><td>0x13</td><td rowspan="3"><table><tr><td>Position Command</td><td>POS1</td><td>POS2</td><td>POS3</td><td>CTRG</td><td>Corresponding Parameter</td></tr><tr><td>P1</td><td>0</td><td>0</td><td>0</td><td>↑</td><td>PA15,PA16, PA31</td></tr><tr><td>P2</td><td>1</td><td>0</td><td>0</td><td>↑</td><td>PA17,PA18, PA32</td></tr><tr><td>P3</td><td>0</td><td>1</td><td>0</td><td>↑</td><td>PA19,PA20, PA33</td></tr><tr><td>4</td><td>1</td><td>1</td><td>0</td><td>↑</td><td>PA21,PA22, PA34</td></tr><tr><td>P5</td><td>0</td><td>0</td><td>1</td><td>↑</td><td>PA23,PA24, PA35</td></tr><tr><td>P6</td><td>1</td><td>0</td><td>1</td><td>↑</td><td>PA25,PA26, PA36</td></tr><tr><td>P7</td><td>0</td><td>1</td><td>1</td><td>↑</td><td>PA27,PA28, PA37</td></tr><tr><td>P8</td><td>1</td><td>1</td><td>1</td><td>↑</td><td>PA29,PA30, PA38</td></tr></table></td><td rowspan="3">Pr 、Pr-S 、Pr-T</td></tr>
<tr><td>Position command option 2</td><td>POS2</td><td>0x14</td></tr>
<tr><td>Position command option 3</td><td>POS3</td><td>0x15</td></tr>
<tr><td>Triggering the position command</td><td>CTRG</td><td>0x16</td><td>At the position register input mode (the Pr mode), read the position command of POS1 – 3 into the controller at the moment when CTRO becomes conductive (the rising edge).</td><td>Pr 、Pr-S 、Pr-T</td></tr>
<tr><td>Internal Position Control Command Suspended</td><td>HOLD</td><td>0x17</td><td>At the internal position register mode, the signal connection will cuase the motor to stop the rotation.</td><td>Pr 、Pr-S 、Pr-T</td></tr>
</table>

Note:

1. When setting up parameter PA01 for the speed mode (STQ) or the torque mode (RS2), ST1/RS2 and ST2/RS1 will automatically switch the signal themselves.
2. The users have to arrange the terminals themselves. Set up PA01 as 0□□□ in order to plan the terminal setup. If PA01 is set as 1□□□, the set value will be theDI/DO digital input function recommended set value.

Output DO

A total of 9 sets of digital input DO functions from 0x01 to 0x9 are available for the users to edit parameter PD10 to PD14. See the table below:

Siganl Name	Code	Value	Function	Control Mode
Ready	RD	0x01	When Servo ON is at a rotatable state, RD-SG becomes conductive.	ALL
Breakdown	ALM	0x02	ALM-SG will be inconductive when the power is off or when the main circuit is interrupted by the activation of the circuit protection.When there is no alarm, ALM-SG becomes conductive one second after turning on the power.	ALL
Positioning Completed	INP	0x 03	INP-SG is conductive at the positioning range set up by slip differential.The range can be adjusted by parameter PA12.When a large range is set, there may be a frequent conductive state a low rotation speed.	Pt、Pr
Speed attained	SA	0x 03	SA-SG will become conductive when the rotation speed of the servo motor gets close to the setup speed. Speed set up under 50r/min will result in a frequent conductive state.	S
Return to Origin	HOME	0x 04	HOME-SG become conductive after completing the return to the origin.	Pr
Torque restricted	TLC	0x 05	When torque reaches set value of the internal torque restriction 1 (parameter	Pt, Pr, S

			PA05) or the analog torque restriction (TLA), TLC-SG will be come conductive. But when SON signal is OFF, TLC-SG will become inconductive.	
Speed restricted	VLC	0x 05	When controlling the torque through internal speed command 1 – 7 (parameter PC05 – PC07 and PC08 – PC11) or analog speed control (VLA), the reach of the speed limit will make VLA-SG conductive.But when SON signal is OFF<, VLA-SG is inconductive.	T
Electromagnetic Brake Interlock	MBR	0x06	Set up parameter PA91 as □1□□ when using the signal. MBR-SG is inconductive when servo OFF or at aabnormal alarm.The inconductive state during abnormal alarm has nothing to do with the main loop condition.	ALL
Alarm	WNG	0x 07	WNG-SG is inconductive when alarm happens.WNG-SG is conductive when there is no abnormal alarm.	ALL
Zero speed detection	ZSP	0x 08	ZSP-SG becomes conductive when the servo motor rotation speed is under zero speed (50 r/min).The range of zero speed can be adjusted by parameter PC17.	ALL
Internal Position Command Output Completed	CMDOK	0x 09	CMDOK-SG is conductive when the internal position command is completed stopped.	Pr

Note:

INP and SA will automatically switch the signal when setting up parameter PA01 at the speed mode or the position model.

TLC and VLC will automatically switch the signal when setting up parameter PA01 at the speed mode or the position model.

The eight sets of digital input (parameter PD02 – PD09) and five sets of digital output (parameter PD10 – PD14) of Shihlin servo are arranged at the CN1 terminal to provide a more flexibility for the user to set up according to their requirement.

The connector signal function differs according to the type of the control mode. See the table below.

Recommended Set Value for DI Digital Input Function

Di Code	Code	Function	Pt	Pr	S	T	Pt-S	Pt-T	Pr-S	Pr-T	S-T
0x 01	SON	Servo ON	DI1	DI1	DI1	DI1	DI1	DI1	DI1	DI1	DI1
0x 02	RES	Reset	DI5	DI5	DI5	DI5	DI5	DI5	DI5	DI5	DI5
0x 03	PC	Proportion control	DI3								
0x 04	TL	Torque restriction option	DI4								
0x 05	TL1	Internal torque restriction option									
0x 06	SP1	Speed option 1			DI6	DI6	DI2	DI2			DI6
0x 07	SP2	Speed option 2			DI2	DI2					DI2
0x 08	SP3	Speed option 3									
0x 09	ST1	Forward rotation activated			DI3		DI3		DI3		
0x0A	ST2	Reverse rotation activation			DI4		DI4		DI6		
0x0A	RS1	Forward rotation option				DI4		DI4		DI6	DI4
0x09	RS2	Reverse rotation option				DI3		DI3		DI3	DI3
0x0B	ORGP	Return to the Origin									

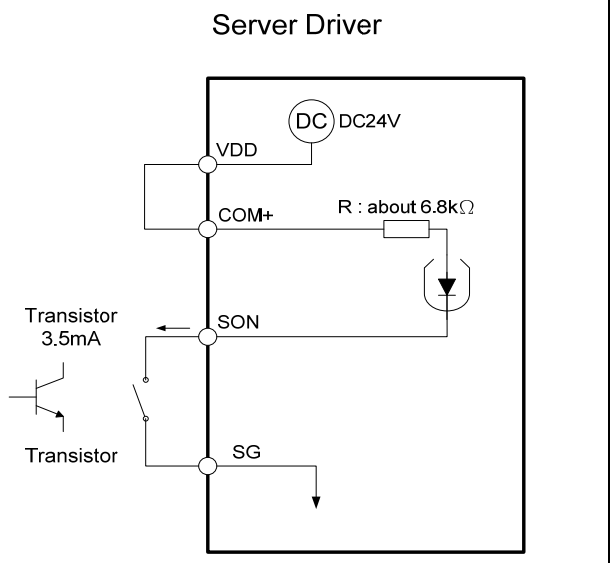
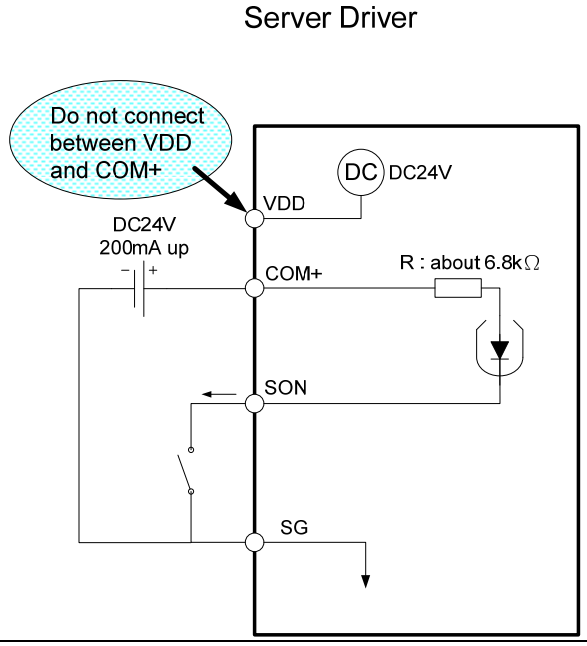
0x0C	SHOM	Origin Search									
0x0D	CM1	Electronic Gear Option 1	DI2								
0x0E	CM2	Electronic Gear Option 2									
0x0F	CR	Clear	DI6	DI6			DI6	DI6			
0x10	CDP	Switch Gain Signal									
0x11	LOP	Control Switch	DI8		DI8	DI8	DI8	DI8	DI8	DI8	DI8
0x12	EMG	External emergency stop	DI7	DI7	DI7	DI7	DI7	DI7	DI7	DI7	DI7
0x13	POS1	Position command option 1		DI2					DI2	DI2	
0x14	POS2	Position command option 2		DI3							
0x15	POS3	Position command option 3									
0x16	CTRG	Triggering the position command		DI4					DI4	DI4	
0x17	HOLD	Internal Position Control Command Suspended		DI8							

Recommended Set Value for DI Digital Output Function

DO Code	Code	Function	Pt	Pr	S	T	Pt-S	Pt-T	Pr-S	Pr-T	S-T
0x01	RD	Ready	DO5	DO5	DO5	DO5	DO5	DO5	DO5	DO5	DO5
0x02	ALM	Breakdown									
0x03	INP	Positioning Completed	DO1	DO1			DO1	DO1	DO1	DO1	
0x03	SA	Speed attained			DO1		DO1		DO1		DO1
0x04	HOME	Return to Origin									
0x05	TLC	Torque restricted	DO4	DO4	DO4		DO4	DO4	DO4	DO4	DO4
0x05	VLC	Speed restricted				DO4		DO4		DO4	DO4
0x06	MBR	Electromagnetic Brake Interlock			DO3	DO3					DO3
0x07	WNG	Alarm	DO3			DO1	DO3	DO3			
0x08	ZSP	Zero speed detection	DO2	DO2	DO2	DO2	DO2	DO2	DO2	DO2	DO2
0x09	CMDOK	Internal Position Command Output Completed		DO3					DO3	DO3	

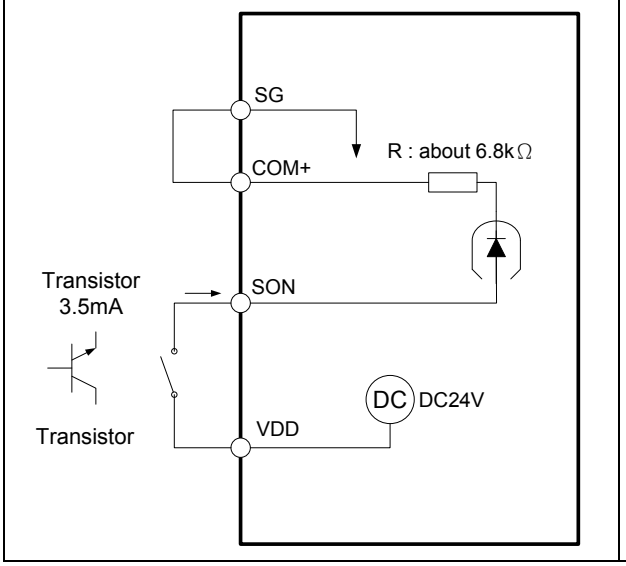
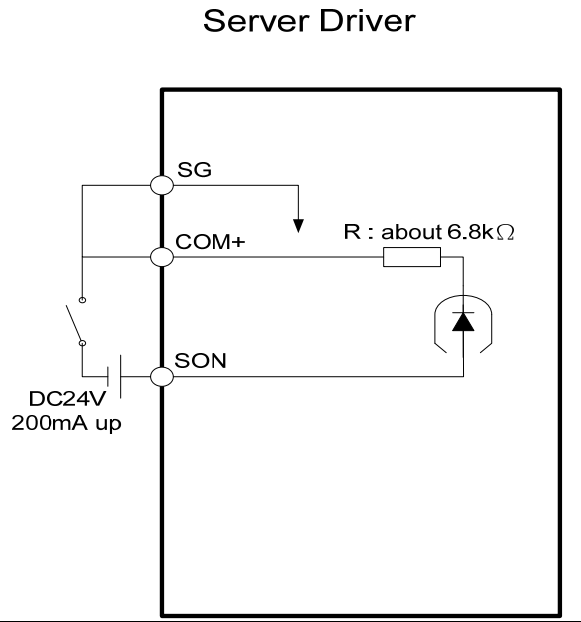
3.3.3. Interface Wiring Diagram

(1). Digital Input DI

Using built-in power source	Using external power source
	

(2). Digital input DI using source mode

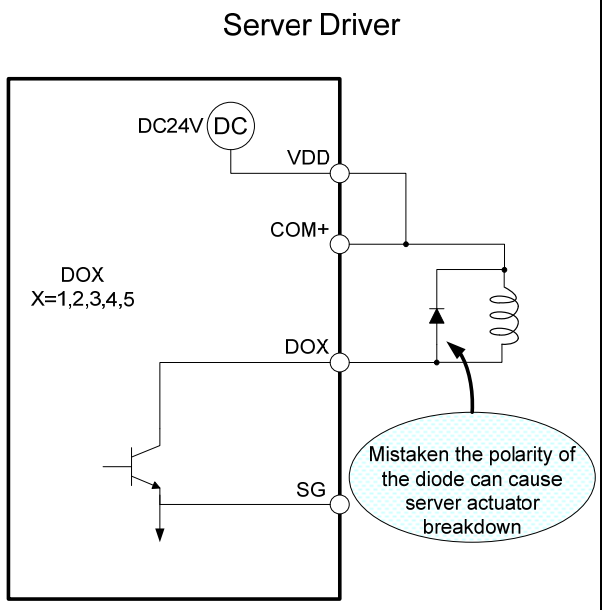
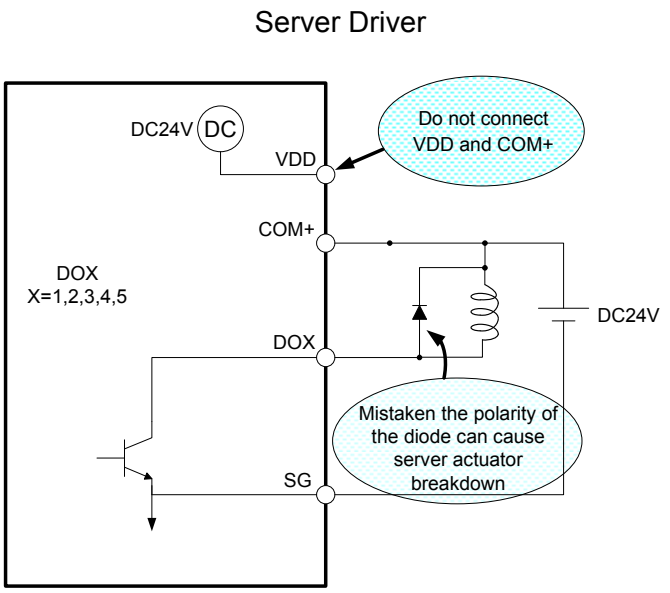
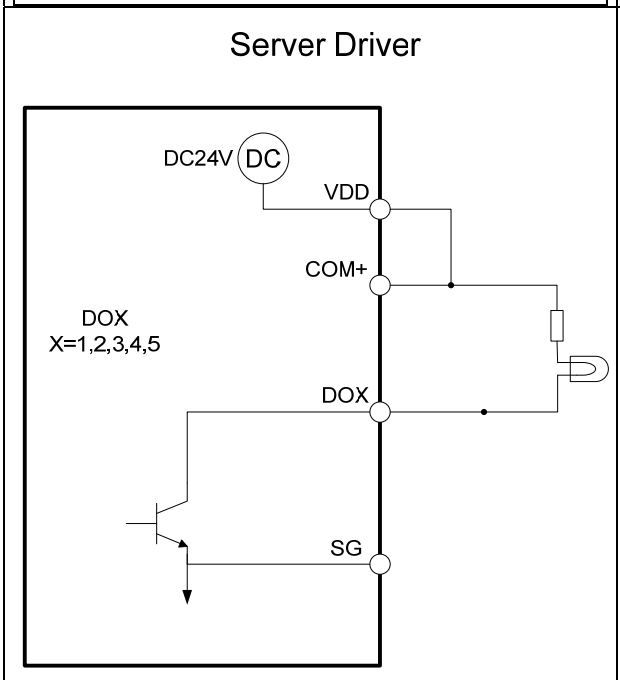
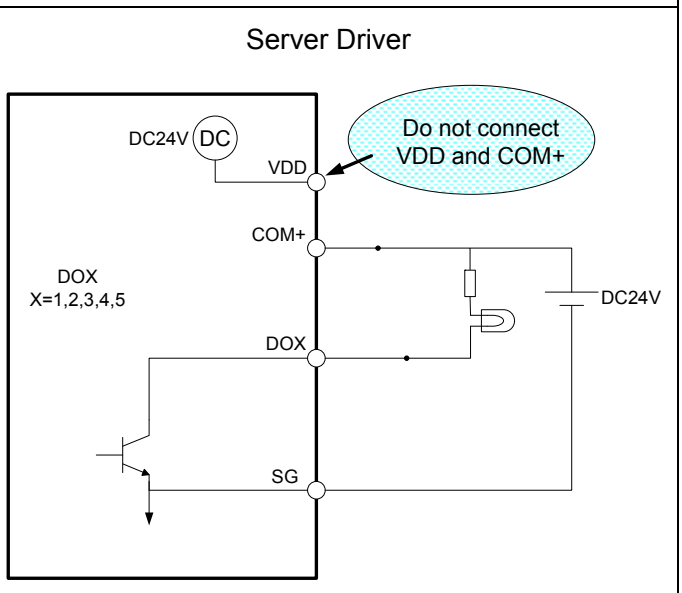
A digital input DI wired in source mode will be followed by all DI. When any digital input DI applied source mode, source cannot be outputted.

Using built-in power source	Using external power source
	

(3). Digital Output DO

It can drive lamp, relay, and photo-couple.

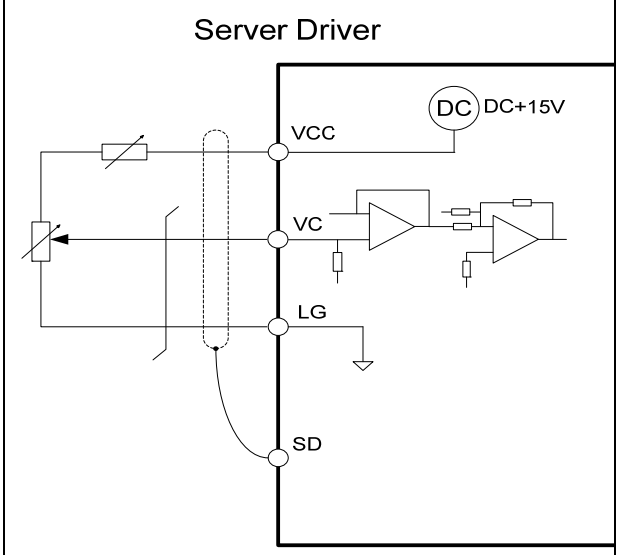
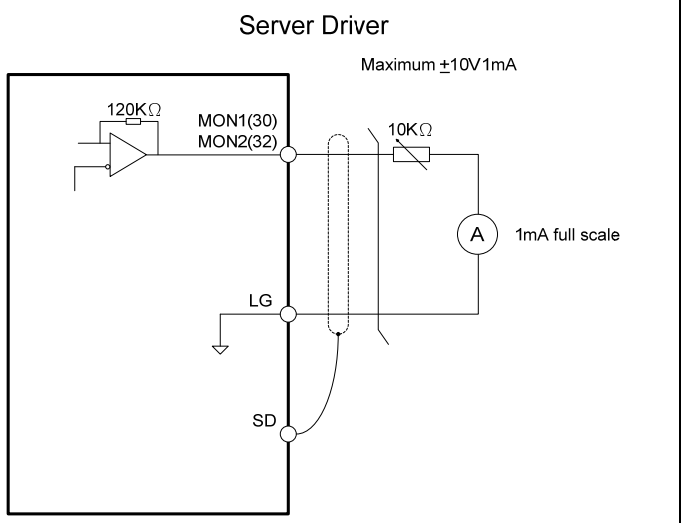
(Allowable current: under 40mA; Inrush current: under 100mA)

Relay negative load using internal power source	Relay negative load using external power source
	
Lamp negative load using internal power source	Lamp negative load using external power source
	

(4). Speed, torque analog input and MON1 and MON2 analog monitored output

Speed and torque analog input's input resistance are between 10Ω and 12KΩ.

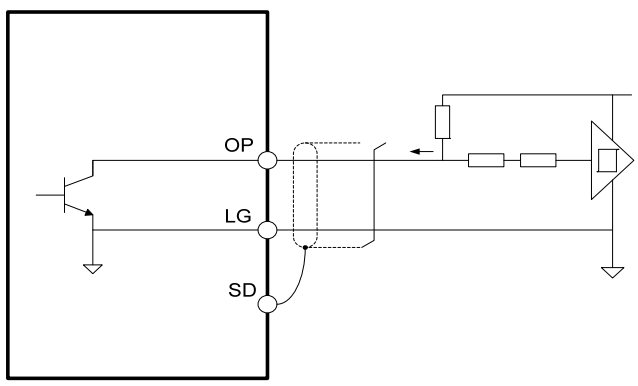
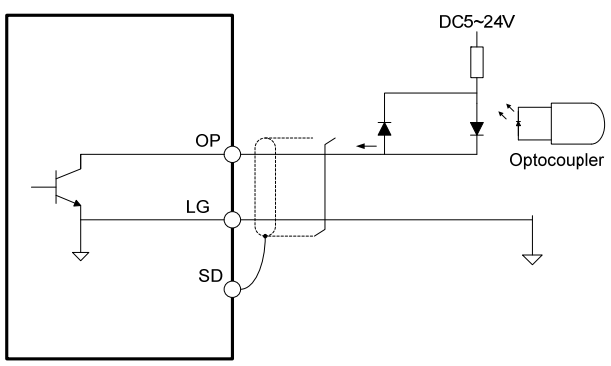
The output voltage of MON1 and MON2 analog monitored output is ±10V.

Speed and torque analog input	MON1 and MON2 analog monitored output
	

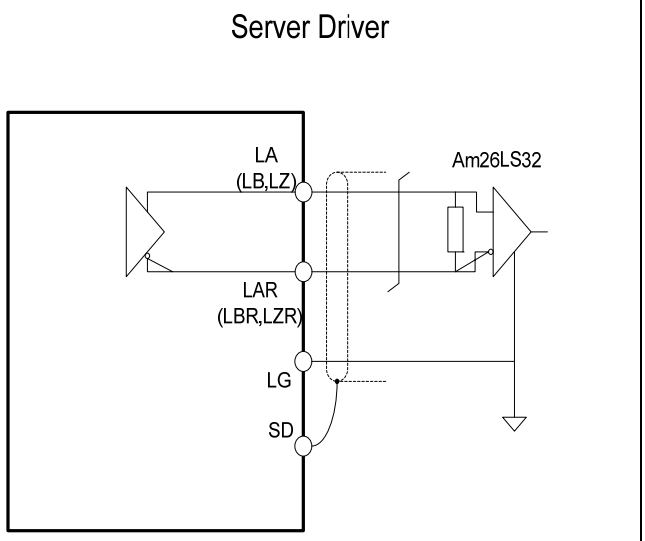
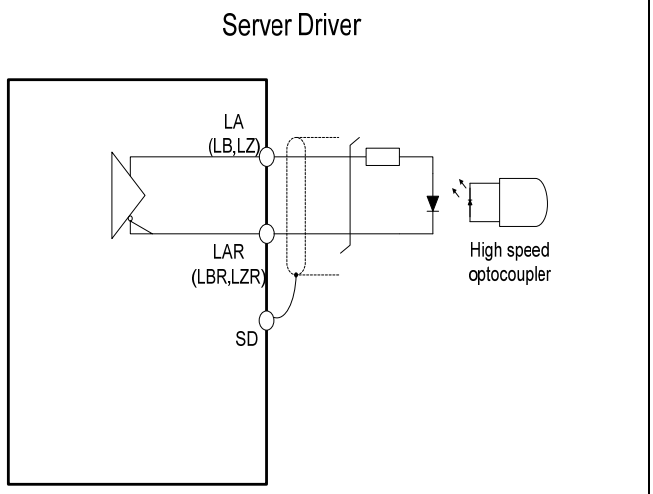
★ The upper limit of VC and TC input voltage is 10V. The built-in transistor can be burnt if the voltage is too high.

(5). Encoder position output

The output of encoder can be divided into open collector and line driver. The open collector output can be applied by CN1-39 (OP) only. The maximum current for open collector encoder's pulse detection circuit is 35mA.

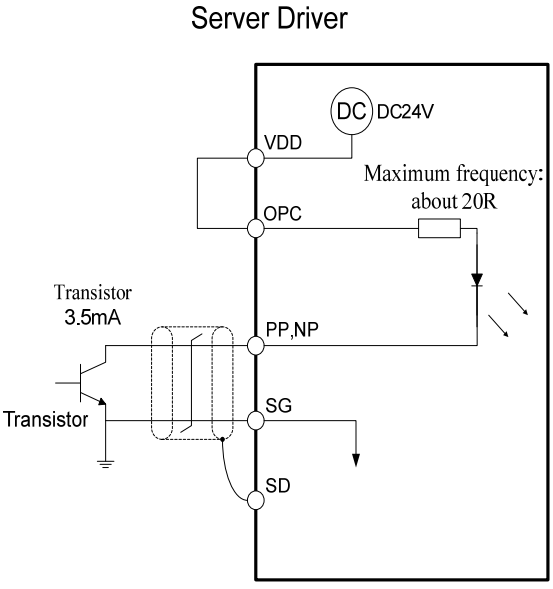
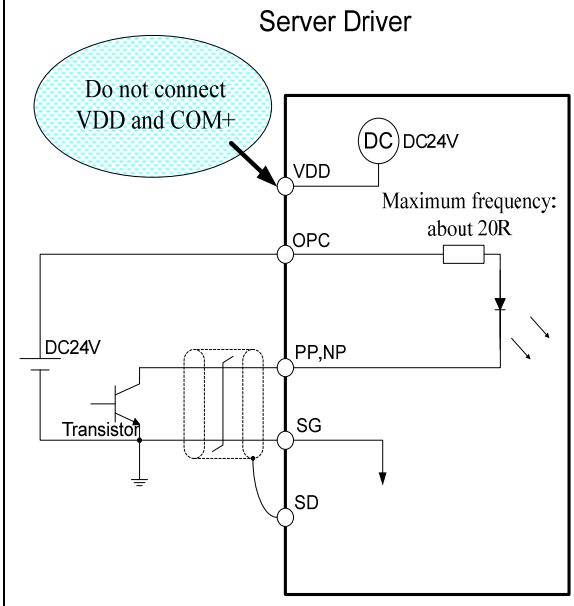
Open collector OP output encoder location	Open collector photo-couple output encoder location
	

The maximum line driver encoder pulse detection circuit is 20mA.

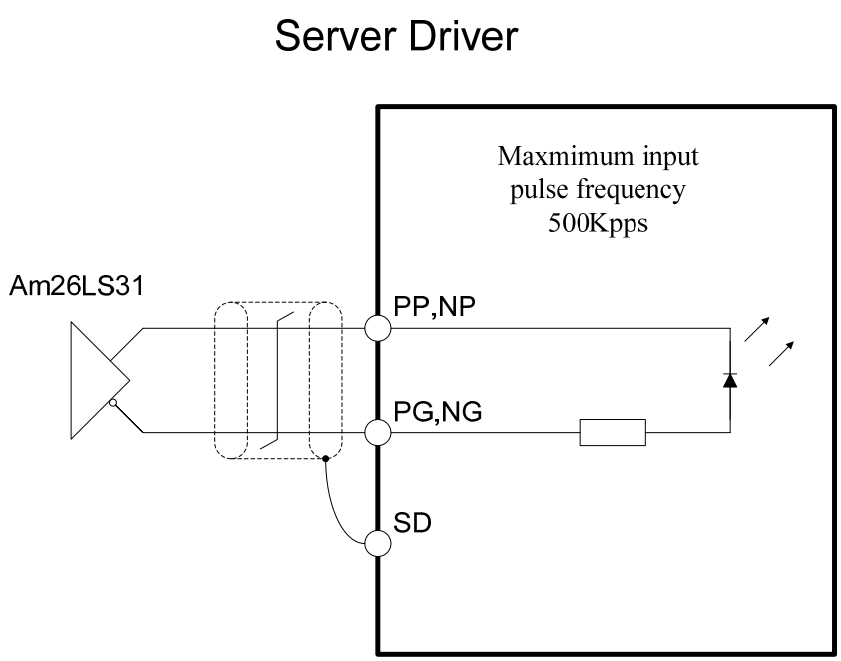
Line driver OP output encoder location	Line driver OP output encoder location
	

(6). Pulse command input

Pulse commands can be inputted by open collector or line driver. Line driver's maximum pulse input is 500kpps. Open collector's maximum pulse input is 200kpps.

The open collector approach uses the internal power source	The open collector approach uses the external power source
	

Line driver approach



3.3.4. DI and DO Signals Assigned by the Users

The default DI and DO signals of Shihlin servo are signals of the position mode. If clients need to change the default DI and DO signals, they can change the setup of parameter PA01 to alter the operation mode. Be sure to reset DI/DO signals; DI1 – DI8 and DO1 – DO5 signal functions are determined by parameters PD-02 – PD-09 and parameters PD-10 – PD-14.Enter DI code or DO code in the corresponding parameters to set up the function of DI/DO.The following table provide DI/DO signal corresponding CN1 Pin and parameters.

CN1 Pin	Siganl Name	Corresponding Parameter
CN-14	DI1	PD 02
CN-15	DI2	PD 03
CN-16	DI3	PD 04
CN-17	DI4	PD 05
CN-18	DI5	PD 06
CN-19	DI6	PD 07
CN-20	DI7	PD 08
CN-21	DI8	PD 09

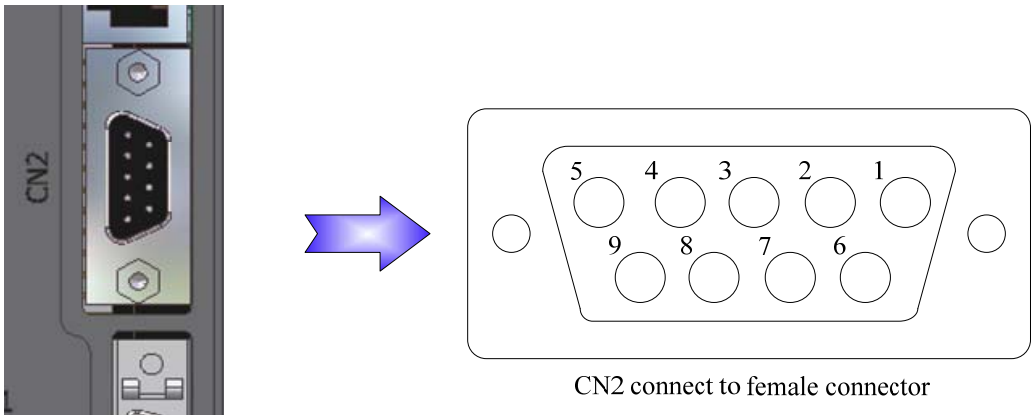
CN1 Pin	Siganl Name	Corresponding Parameter
CN-41	DO1	PD 10
CN-42	DO2	PD 11
CN-43	DO3	PD 12
CN-44	DO4	PD 13
CN-45	DO5	PD 14

3.4. CN2 Encoder Signal Wiring and Descriptions

The resolution of the included encoder in Shihlin servo motor is 2500ppr. After the signal been four-fold decoded by the servo actuator, A and B signal will be increased to 10000ppr. There are eight wires for Shihline servo encoder, which are A, /A, B, ./B, Z, /B, +5V and GND.

The pin number of the connector and the appearance of the external connector are shown below:

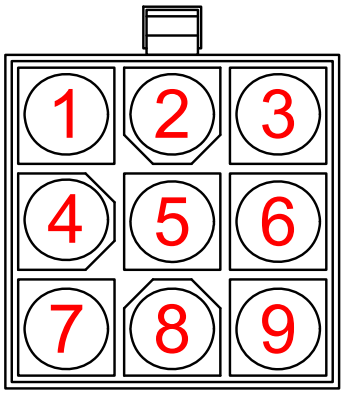
The actuator side



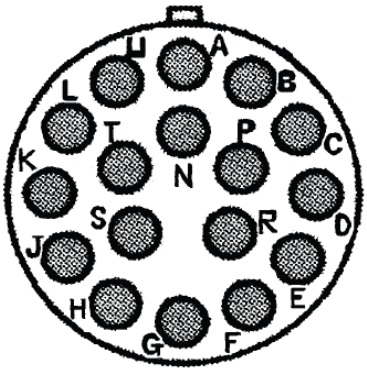
CN2 connect to female connector

The motor side

Low Inertia



Medium Inertia



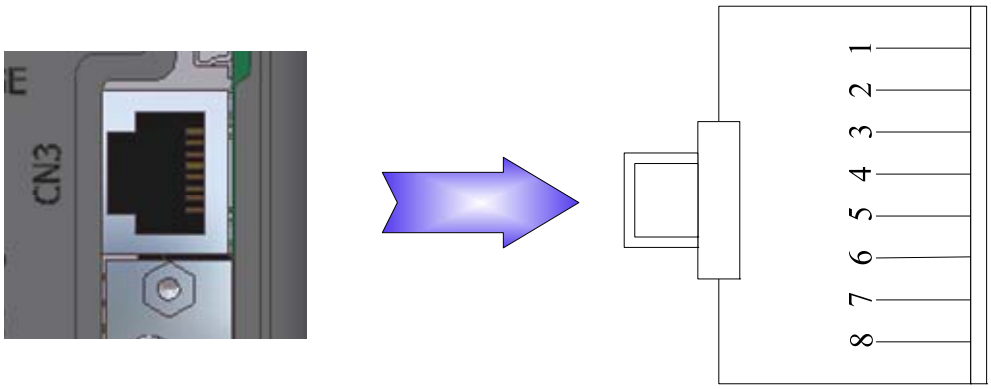
The corresponding signal pin position of the actuator terminal connector and the motor terminal connector and their functions are presented below:

The actuator side Pin NO	Quick connector Pin NO	Military-standard connector Pin NO	Siganl Name	Terminal mark	Functions
2	6	H	/Z phase input	/Z	Encoder /Z phase output
3	5	E	/B phase input	/B	Encoder /B phase output
4	4	B	/A phase input	/A	Encoder /A phase output
5	7	S	Encoder power source	+5V	5V power source used by the encoder
6	3	G	Z phase input	Z	Encoder Z phase output
7	2	D	B phase input	B	Encoder B phase output
8	1	A	A phase input	A	Encoder A phase output
9	8	P	Encoder ground	GND	Encoder ground terminal
	9	L	SHIELD	SHIELD	SHIELD

◆ Unlisted pin positions are NC (not in use) pin positions.

3.5. CN3 Communication Port Signal Wiring and Descriptions

Shihlin CN3 is the port for RS-232 and RS-485. The user can connect to the actuator and the computer and then Shihlin servo communication software willl set up the parameters, the state monitoring, and operation tests, etc. CN3 provides two types of communication approaches: RS232 communication and RS485 communication.The use can select RS232 or RS-485 communication by setting up parameter PC21.RS-232 is more common and its maximum communicaton distance is 15 m.If RS485 is chosen, it will provide a larger communication distance and support concurrent connection to several actuators.

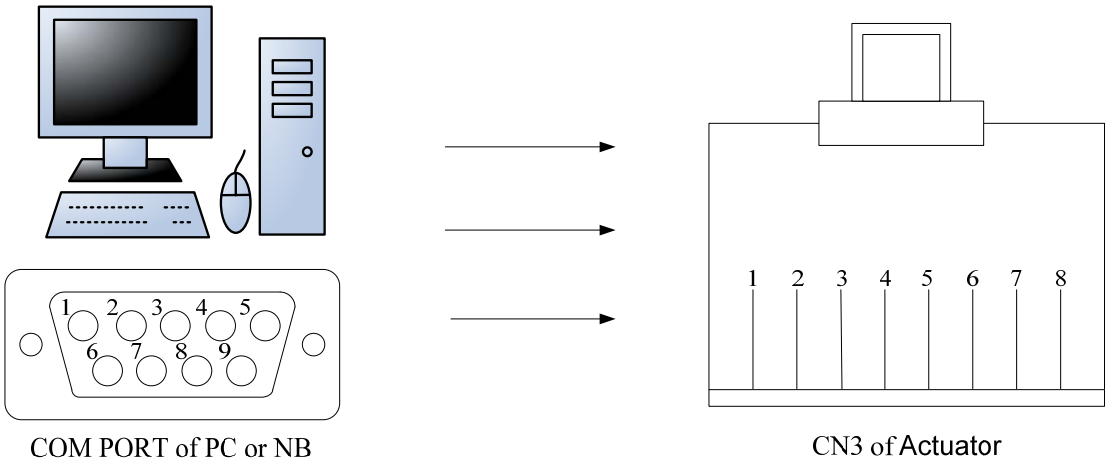


Pin of CN3

CN3 Pin NO	Terminal mark	Functions
2	RS-485-B	Actuator data are transmitted by line driver. Line driver B
3	RS-485-A	Actuator data are transmitted by line driver. Line driver A
6	RS-232-RX	Actuator data transmission It is connected to RS-232-TX terminal of the computer.
7	RS-232-TX	Actuator data receiving It is connected to RS-232-RX terminal of the computer.
4、5	GND	Signal ground terminal

Note:

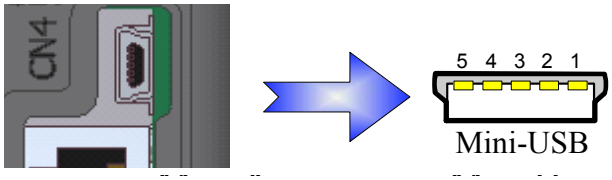
For RS-485 communication approach, please refer to Section 8.1.



3.6. CN4 USB Communication Port

Shihlin servo actuator provides USB communication terminal slot that is designed to allow a quick use of UBS after its insertion and therefore provides conveniences to the users.Similar to RS-232 and RS-485 of CN3, CN4 ues general mini-USB connected to the computer. Then Shihlin communication software will carry out parameter setup, state monitoring, and operation tests, etc.

The use of Mini-USB provide conveniences to the uses because of its easy access.

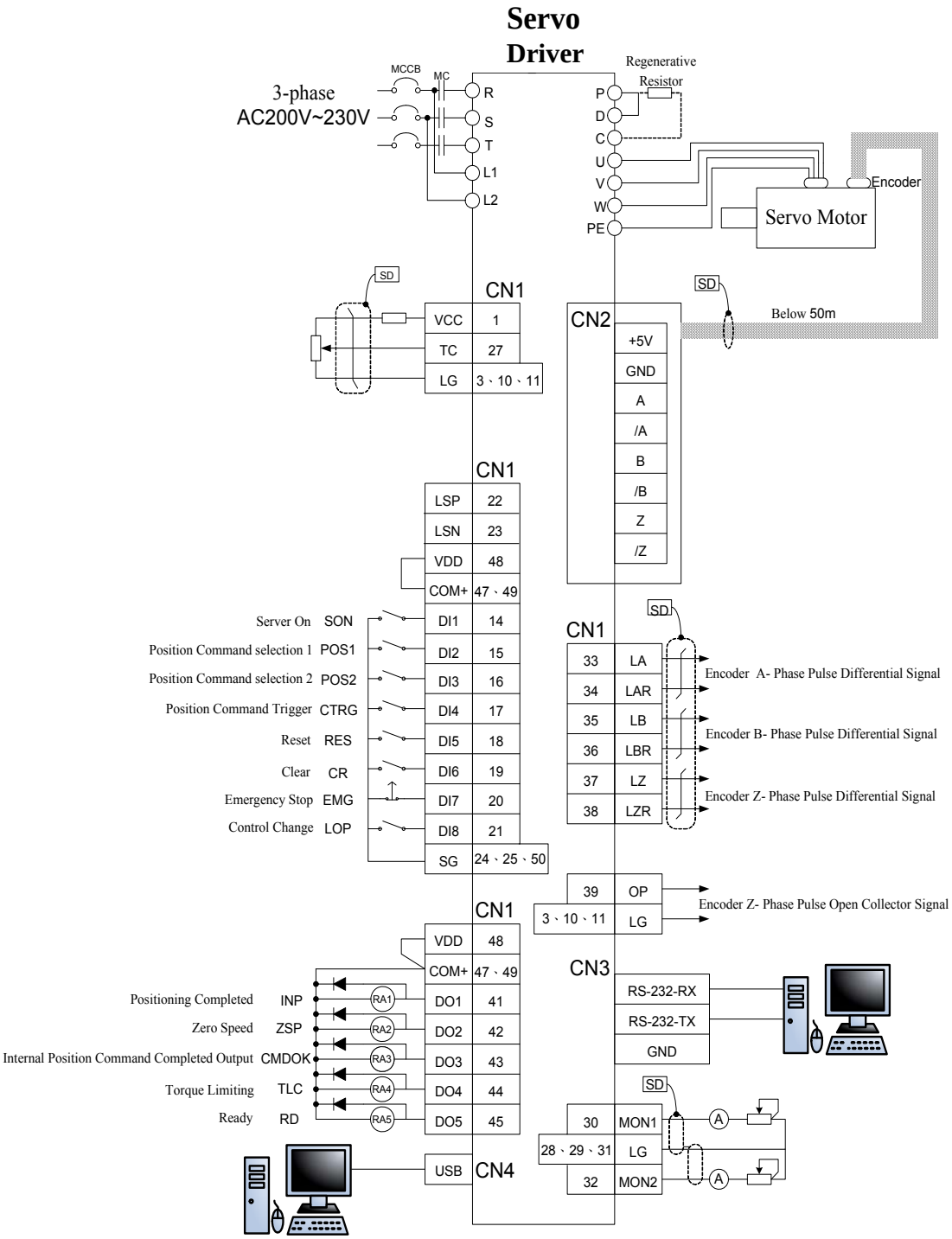


The following table describes the standard terminal specifications of mini-USB.

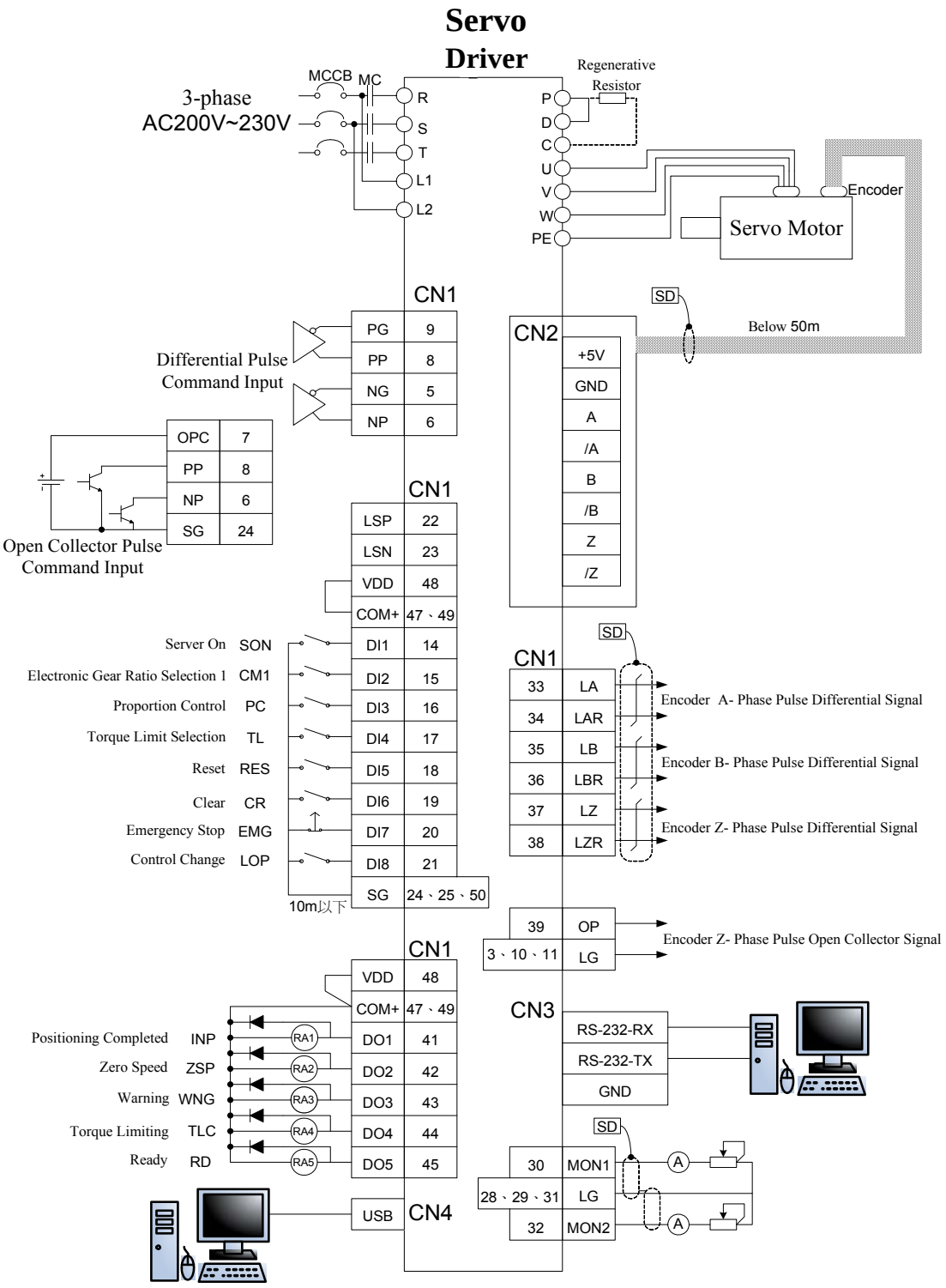
Pin NO	Terminal Function
1	+5V
2	D-
3	D+
4	NC
5	GND

3.7. Standard Wiring Method

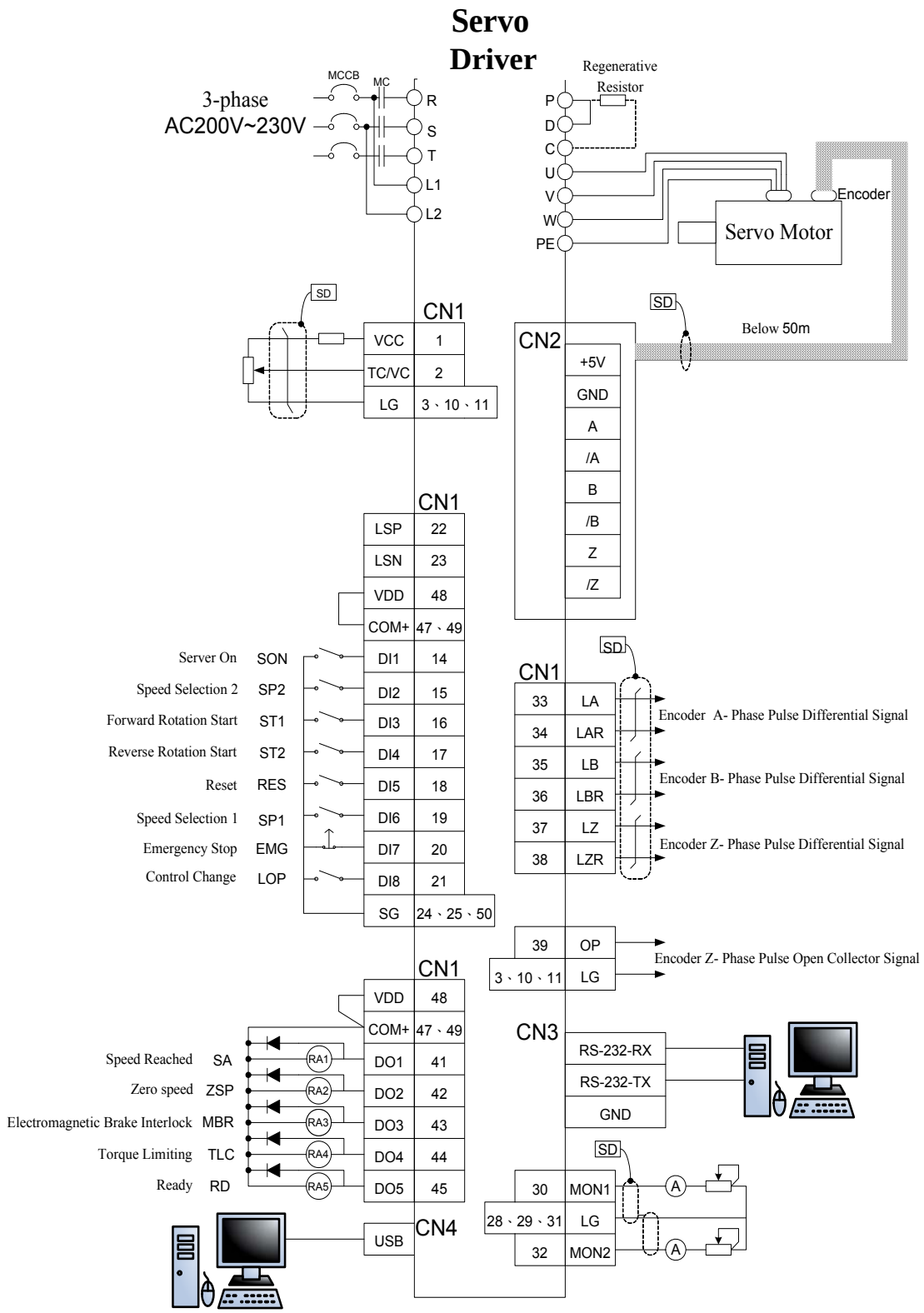
3.7.1. Built-in single-axis Position Control (PR)



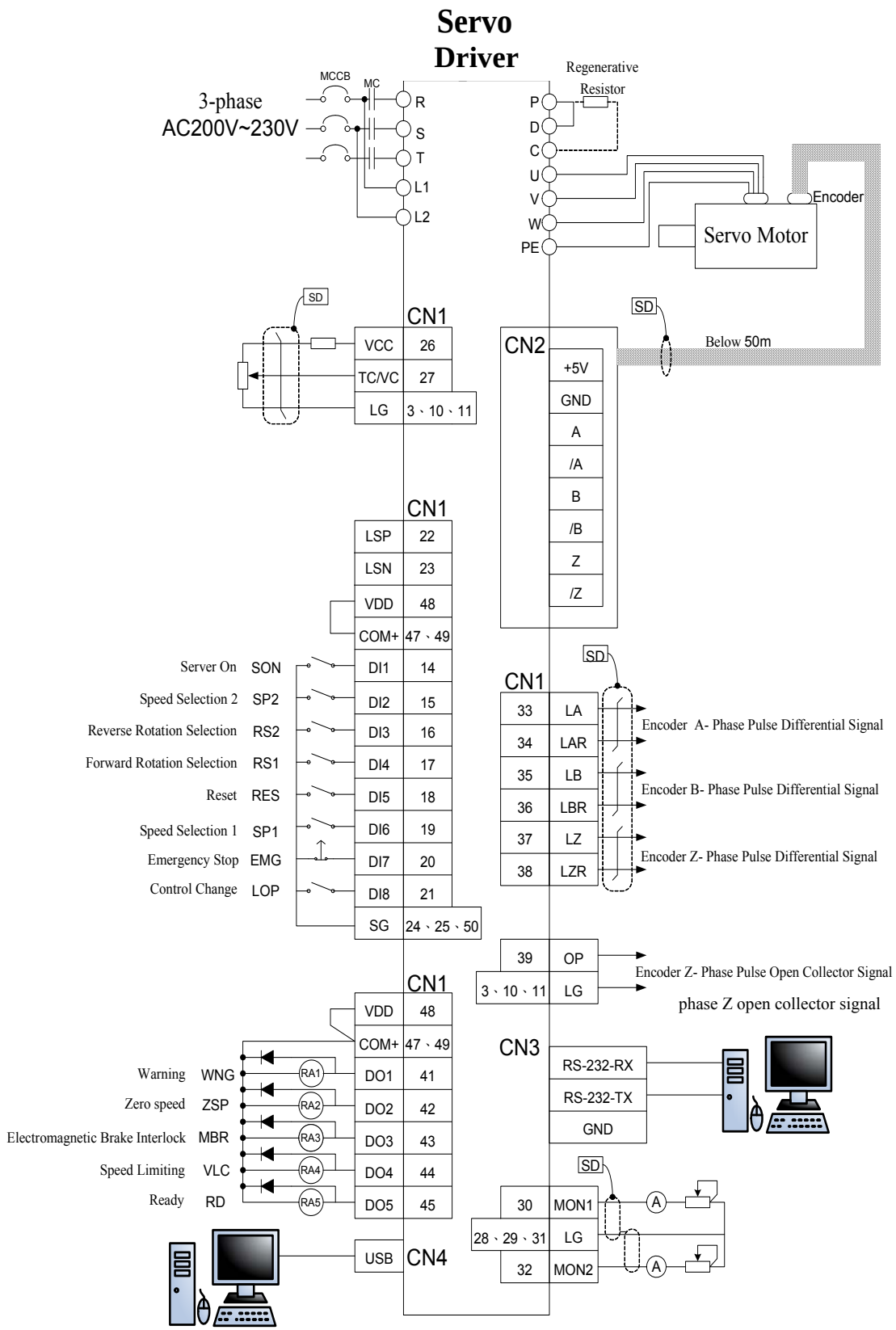
3.7.2. Position control (Pt Mode) Wiring



3.7.3. Speed Control (S Mode) Wiring



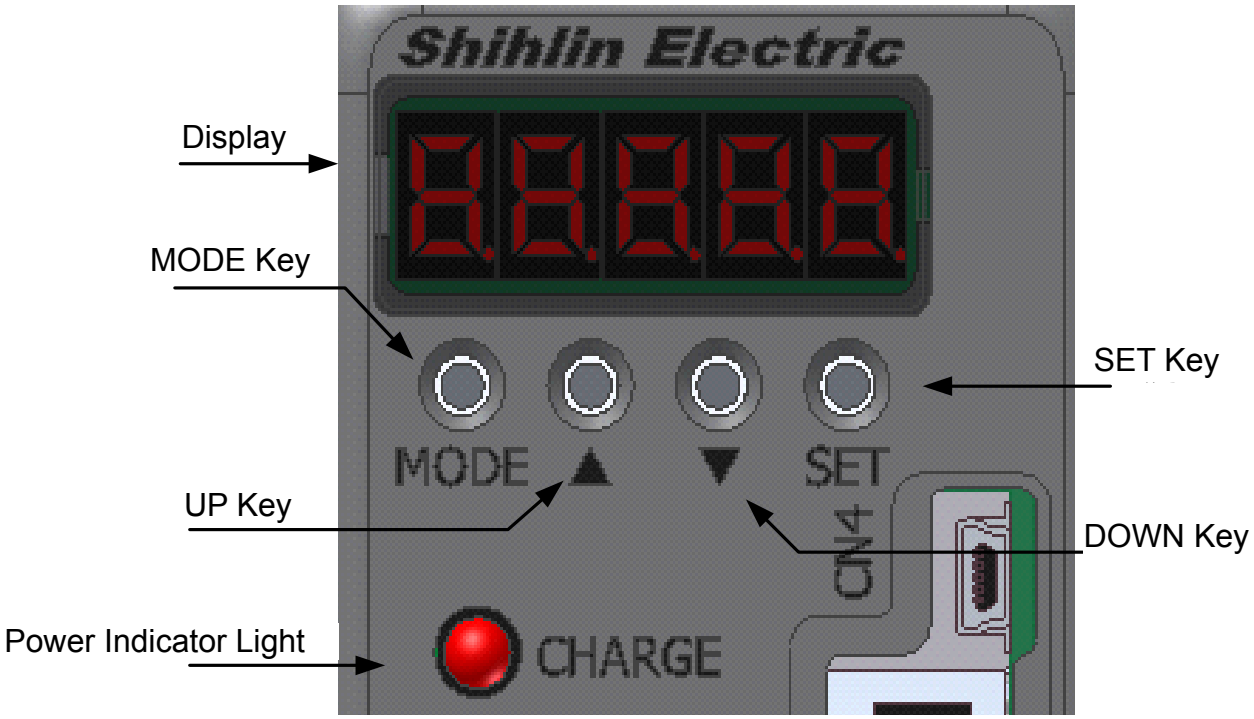
3.7.4. Torque Control (T Mode) Wiring



4. Panel Display and Operation

This chapter describes the conditions of Shihlin servo actuator ‘s panel and all the operation procedures for using the panel.

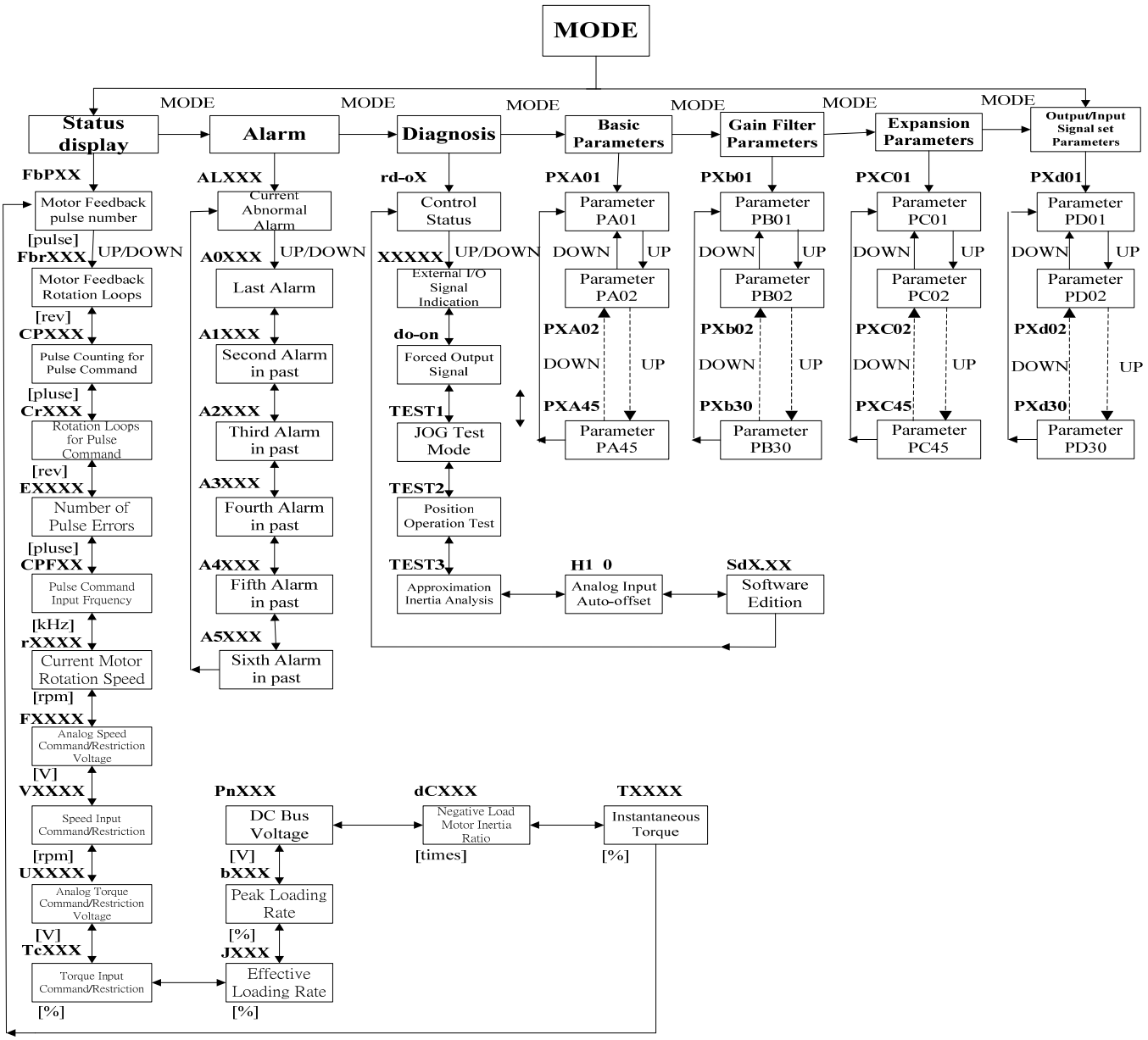
4.1. Panel Components



Name	Function
Display	There are five sets of seven levels LED for diplaying the monitoring value, the parameter value, and the set values.
MODE Key	For entering, leaving, or setting up the parameter mode, the abnormal alarm mode, and the monitoring mode. This key has the *shift* key function when writing functions for the parameters.
UP Key	Shift the parameter code or the set value one level up.
DOWN Key	Shift the parameter code or the set value one level up.
SET Key	Display and save the set values.
Power Indicator Light	Display power recharge of the capacity of the main power source circuit.

4.2. Flow Process Display

The users can use the display section at the front of SERVO AMP to carry out actions such as displaying the status and modifying the parameters.Verify the parameter setup, abnormal breakdown diagnosis, external control confirmation and operation condition before carrying out the operation.Press *MODE, UP and DOWN* these buttons once to move to the next screen.Setting up parameter PA42 is required for the references and operation of parameters to be valid.

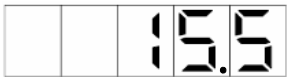


4.3. Status Display

- Operation status of the servo can be displayed at the five-digit, seven-level LED display section.
- Press the *UP* and *DOWN* buttons to change the content arbitrarily.
- When turning on the power, the user can select symbols for display and press the *SET* butoon to display the information.
- The seven-level LED diplay section can exhibit the last five digits of the data of 18 items, including the rotation speed of the motor.
- If the displayed value has five digits, the negative values is expressed by lighting up five dicemal point lights of the seven-level display.When less than four digits are displayed, the negative value will be expressed by the “-" at the left end of the seven-level display.

⊡ Examples

Examples are displayed as follows:

Items	Status	Display Approach Seven-level LED Display
Motor Rotation Speed	Forward rotation @ 2500r/min	
	Reverse rotation @ 2500r/min	
Negative Load Motor Inertia Ratio	15.5-fold	
Number of Motor Feedback Loop	11252 loops	
	-12566 loops	 The negative number has the decimal points lighted up at the seven-level display.
Completing Parameter Write-in	Write-in successfully	
Failure of Parameter Write-in	Failure to write in the servo activation (SON on).	 Turn off the SON and rewritte again.

▣ Status Display Summery

Servo status can be displayed in the following abbreviations.

Status Display	Abbreviation	Unit	Content	Range
Motor Feedback pulse number (the absolute value)	FbP	pulse	It indicates the number of feedback pulse of the servo motor detector.	－9999～999
Motor Feedback Rotation Loops (the absolute value)	Fbr	rev	It indicates the number of feedback loops of the servo motor detector (the accumulated value).	－32767～32767
Pulse Counting for External Pulse Command	CP	pulse	Represent the number of input pulse number of pulse commands.	－9999～9999
External Rotation Loops of External Pulse Command	Cr	rev	Represent the number of input rotation loops of pulse commands.	－32767～32767
Number of Pulse Errors	E	pulse	Control the number of pulse error of command pulses and feedback commandpulses	－32767～32767
Pulse Command Input Frequency	CPF	kHz	The input frequency of external pulse command.	－800~800
Current Motor Rotation Speed	r	rpm	Display the current motor feedback rotation speed.	－6000~6000
Analog Speed Command / Restriction Voltage	F	V	(1) Speed control mode indicates the input voltage of analog speed command. (2) Torque control mode indicates the input voltage of analog speed restriction.	－10.00~+10.00
Speed Input Command / Restriction	V	rpm	(1) Speed control mode indicates the analog input speed command. (2) Torque control mode indicates the analog input speed restriction.	－6000~6000
Analog Torque Command / Restriction Voltage	U	V	(1) Position control mode and speed control mode Indicates the voltage of TLA.	0 ~ +10.00
			(2) Torque control mode indicates the voltage of analog torque command.	－10.00~10.00
Torque Input Command / Restriction	TC	%	(1) Position control mode and speed control mode indicates analog torque restriction and is expressed as the commands / restrictions of rated torque commands.	0~ 300
			(2) Torque control mode indicates analog torque command.	－300~300

Status Display	Abbreviation	Unit	Content	Range
Effective Loading Rate	J	%	It indicates the loading rate of continuous torque. Express the effective loading rate by assuming the rated torque as 100%	0~ 300
Peak Loadind Rate	(b)	%	It indicates the largest torque peak value. The highest value from the past 15 seconds is expressed by assuming the rated torque as 100%.	0~ 300
DC Bus Voltage	Pn	V	It indicates the voltage of the main circuit of P-N. If the P-N voltage is less than the normal operation voltage of the servo, “Lo-dC" will be displayed on the panel.	0~500
Negative Load Motor Inertia Ratio	dC	times	It indicates the negative / servo motor inertia ratio.	0.0~300.0
Instantaneous Torque	T	%	It indicates the torque happened instantaneously. The happened torque is expressed in real time by assuming the rated torque as 100%.	0~100

⊡ Changing the Status Display Panel

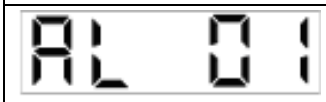
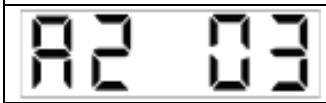
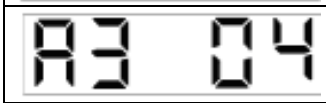
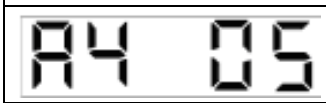
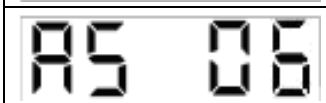
Changing parameter PA01 enables the user to modify the status display items of the seven-level LED when the power is on. The initial status display item can be modified according to the control mode.

Control Mode	Display Item
Position	Motor feedback pulse number
Position / Speed	Motor feedback pulse number / motor current rotation speed
Speed	Current Motor Rotation Speed
Speed / Torque	Current motor rotation speed / Analog torque command restriction voltage
Torque	Analog Torque command restriction voltage
Torque / Position	Analog torque command restriction voltage / motor feedback pulse number

4.4. Abnormal Alarm Mode

It displays the current abnormal alarms and the abnormal alarm record.

The last two digits display the occurred abnormal alarm number.

Name	Display	Content
Current Abnormal Alarm		No abnormal alarm
		Occurred voltage (AL01) Screen flickers when abnormal alarm happens.
Abnormal Alarm Record		Voltage of the previously happened alarm (AL01)
		Low voltage of the previously happened alarm (AL02)
		Current of the previously happened alarm (AL03)
		Abnormal rebound from the last abnormal alarm (AL04)
		Overload of the last abnormal alarm (AL 05)
		Speed of the last abnormal alarm (AL06)

Functions when abnormal alarm occurs:

A. Currently occurred abnormal alarm can be expressed by the screen of all modes.

B. Other screens can be read at the time when abnormal alarm happens.

C. Remove the cause of the alarm and lift the alarm by one of the following approach:

(a) Switch the power from OFF to ON.

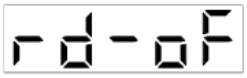
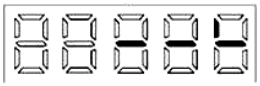
(b) Press the “SET” button on the current alarm screen.

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

D. Move to the next record by “UP” or “DOWN”.

4.5. The Diagnostic Mode

The following table provides information related to the operation of Shih servo diagnostic mode:

Name	Display	Content
Control Status		Not ready yet Either initialization incompleted or alarms have already occurred.
		Ready Initialization completed; ready for operation
External I/O Signal Indication		It indicates the ON/OFF status of the external I/O signal. The upper part corresponds to the input sigals; the lower part corresponds the the output signals I/O signals can be modified by PD02 – PD09.
Forced output signal		Digital output signals can force ON/OFF. Refer to Section 4.5.2 for more details.
Operation Test Mode		There is no command from external device. JOG operation can be executed. Refer to Section 5.2.1 for more details.
Position Operation Test		There is no command from external device. One-time positioning operation can be executed.This function cannot be carried out by the panel. To carry outthe function, please connect the communication software via RS-232/USB and test the function.
Approximation Inertia Analysis Operation Test		This function can be used to carry out negative load inertia ratio auto-presumption and relevant gain value auto-presumption.This function cannot be carried out by the panel. To carry outthe function, please connect the communication software via RS-232/USB and test the function.
Analog Input Auto-offset		This function is to set up analog speed command or analog speed restriction by adjusting the external analog loop voltage to 0V. The motor will still rotate slowly. It will automatically set up the offset. When using this function, parameter PC26 will be written into the value for auto-adjustment. Please operate by following the order presented below: (1). Enter into the automatic offset screen of the diagnostic mode. (2). Press the SET button. (3). Press the UP or DOWN buttons and select 1. (4). Press the SET button.
Software Edition		It indicates the version of the SERVO software.

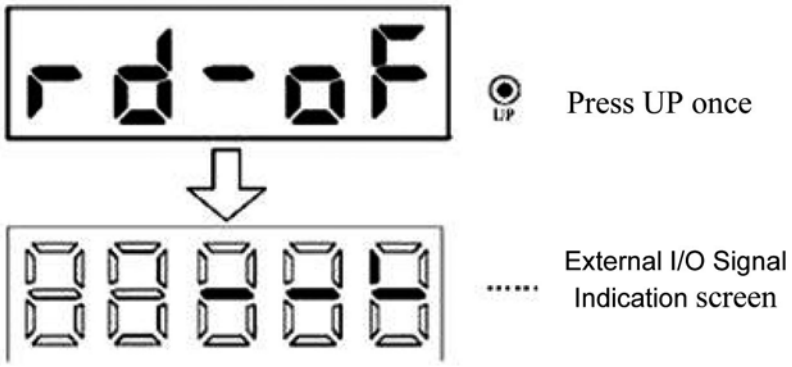
Approaches for using the diagnostic mode are described in details below.

4.5.1. External I/O Signal Indication

To verify and continue the ON/OFF state of digital I/O signal of SERVO AMP.

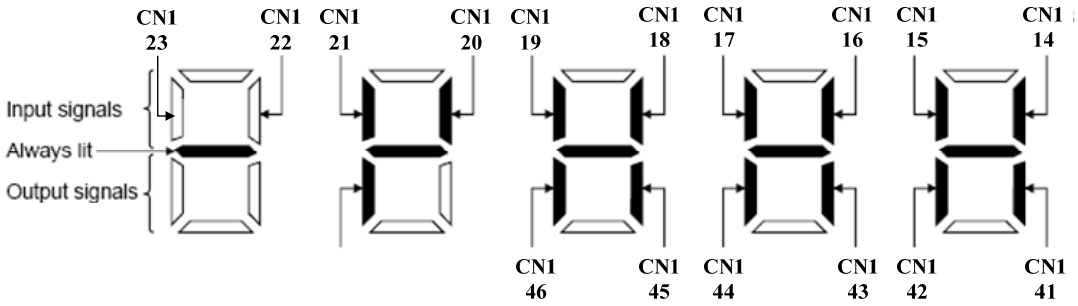
(1) Operation

It indicates the display screen after turning on the power.Use the MODE button to switchto the diagnostic screen.



(2) Content

It corresponds to the position and PIN of the seven-level LED.



ON/OFF is expressed by the seven-level LED.The upper part is the input sigals; the lower part is the the output signals

4.5.2. Forced Output of Output Signals (DO Forced Output)

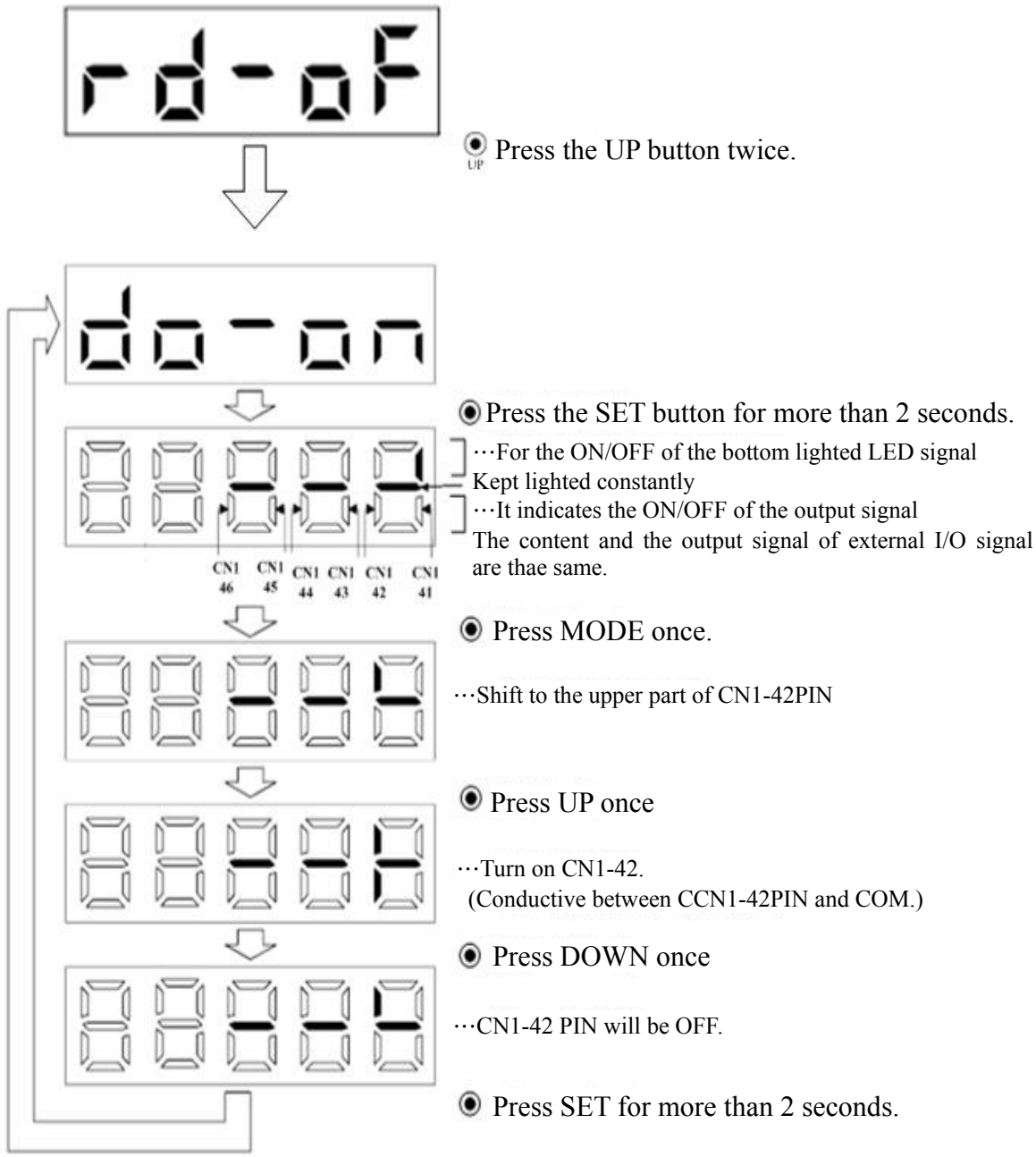
The user can force ON/OFF of output signals that do not affect the status of SERVO.It can be apply for wiring test of output signals.

★ Positioning operation can be tested after verifying that there is no external command device and no abnormal messages from the servo.

★ Make sure of the open contact of SON and SG from the test.

Operation

It indicates the display screen after turning on the power.Use the MODE button to switch to the diagnostic screen.

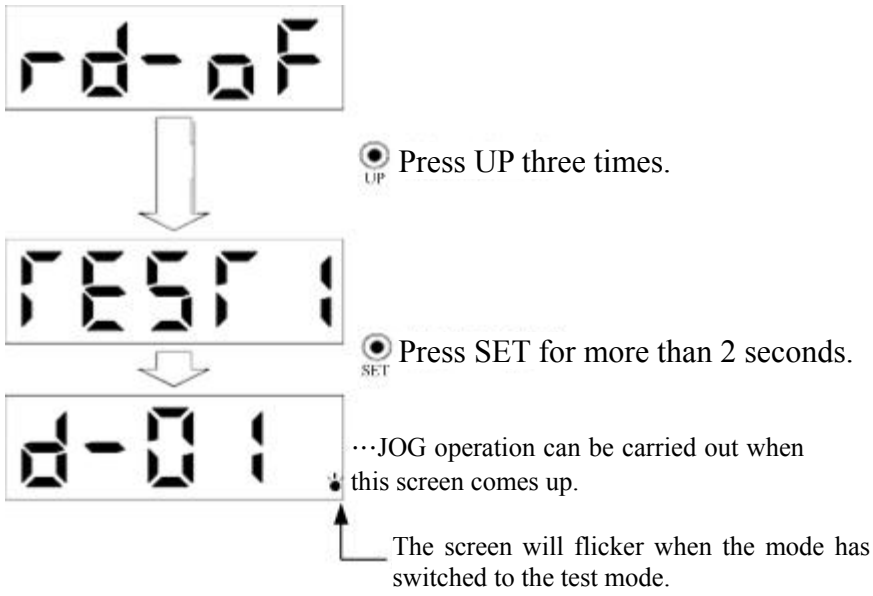


4.5.3. JOG Operation

- ★ JOG operation can be carried out once the user is certain that there is no abnormal alarm or alarma messages from the servo.
- ★ Make sure of the open contact of SON and SG from the test.

For the display screen after turning on the power, employ the following operation order: JOG operation, position testing operation, and inertia approximation analysis operation.

Use the MODE button to switch to the diagnostic screen.



(2) Operation

When carrying out the JOG operation, please connect VDD-COM+ if internal power source is used for EMG-SG.Press the UP and DOWN buttons for the servo motor to rotate. Release the button to stop motor rotation.Use the communication software to change the operation criteria.The initia criteria and set range for the operation are presented below:

Items	Initial Set Value	Set Range
Rotation Speed (r/min)	200	0 to instantaneous allowable rotation speed
Acceleration and Deceleration Time Constant	1000	0~2000

Button Functions:

Button	Content
UP	Press the button for CCW direction rotation. Release the button to stop the rotation.
DOWN	Press the button for CCW direction rotation. Release the button to stop the rotation.

When using the communication software for JOG operation, the servo motor decelerates until stop if the communication wire comes out during the operation.

(2) Status Display

It is used to ensure the SERVO status during JOG operation.

Press the MODE button to display the status screen during the status ready for JOG operation.Carry out the JOG operation in this status screen using UP and DOWN.Each press of the MODE button will shift the screen to the next one. JOG operation screen will come back after going through the entire cycle by pressing the button.More details related ot the status display can be found in Section 6.2.

The “UP” and “DOWN” buttons cannot be used for chaning the status screen at the JOG operation mode.

(2) JOG operation Completed

Turn off the power or press the SET button at the operation testing screen for more than 2 seconds to terminate the JOG operation mode.

4.5.4. Position Operation Test

- ★ Connect RS-232 or USB to Shihlin communication software to carry out the position operation test.
- ★ Positioning operation can be tested after verifying that there is no external command device and no abnormal messages from the servo.
- ★ Make sure of the open contact of SON and SG from the test.

Operation

Make sure that the motor is correctly wired when testing the positioning operation.Select positioning operation testing from Shihlin communication software. Press “FORWARD” or “REVERSE” for the motor to rotate according to the number of loops and pulses set up by the user and then to stop. Rotation criteria can be modified using Shihlin communication software.The initial value and set range for testing positioning operation are provided in the table below:

Name	Initial Value	Set Range
Motor Rotation Speed (rpm)	200	0~6000
Acceleration and Deceleraton Time (ms)	1000	0~20000
Loops (10kpulse)	10	0~30000
Number of Pulses (pulse)	0	0~9999

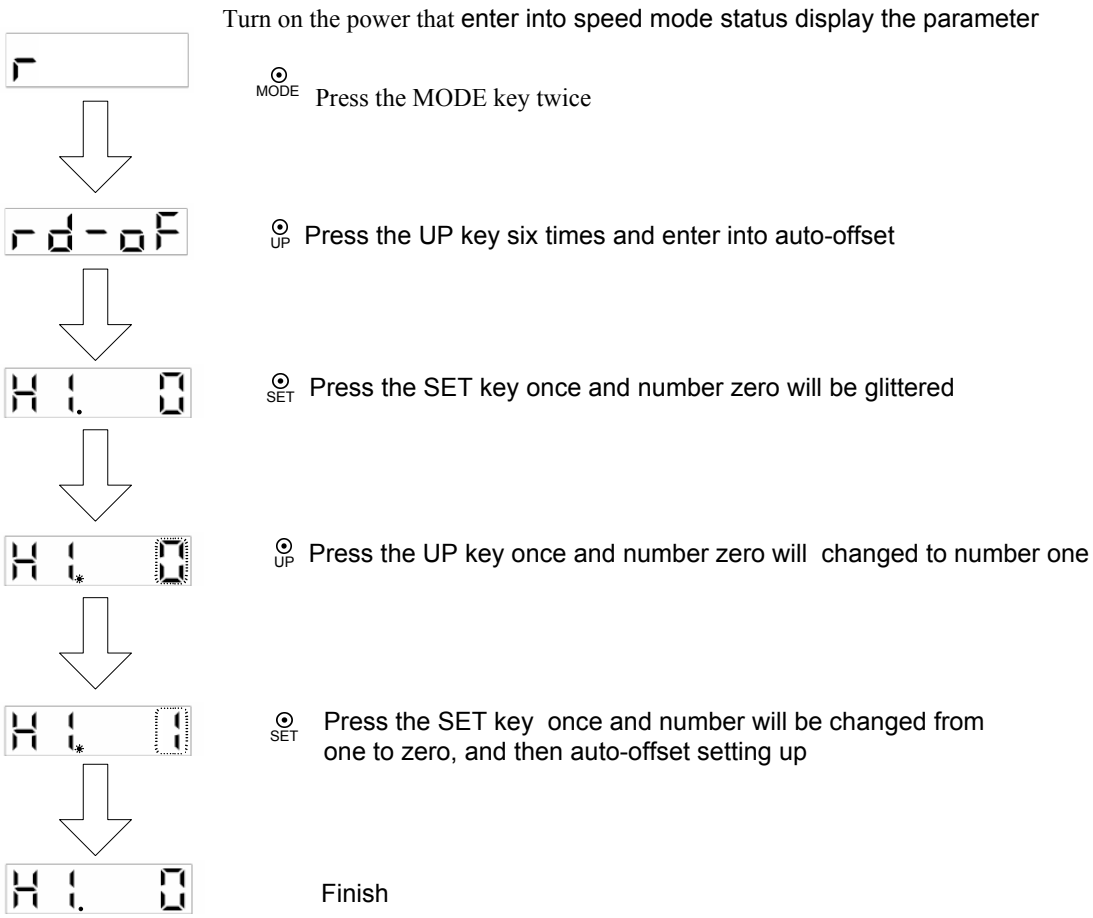
Descriptions of the operation buttons:

Button Name	Function
Forward Rotation	Press the button for the motor to carry out positioning operation by forward rotation.
Reverse Rotation	Press the button for the motor to carry out positioning operation by reverse rotation.
Suspend	Press SUSPEND for the motor to stop running. To start again from the remaining distance, press the same rotation button again.If this button has been pressed twice when the motor is running, the remaining distance will be cleared out.
Close	Terminate the positioning operation function testing.

- ★ Have an emergency stop for the motor if the communication wire goes off during the operation.

4.5.5. Analog Input Auto-offset

When the external analog speed command input is 0V, the motor may still have offset, which can cause a slow motor rotation. The user can enter into the diagnostic mode and then select analog input auto-offset function to have the voltage offset adjusted automatically.Follow the following method for setting up the analog input auto-offset.



After setting up the auto-offet function, the parameter will be written into PC26.

4.5.6. Inertia Approximation Analysis Operation

- ★ Connect RS-232 or USB to Shihlin communication software to carry out the position operation test.
- ★ Positioning operation can be tested after verifying that there is no external command device and no abnormal messages from the servo.
- ★ Set up the value for auto-adjustement at the manual operation mode.

Operation

Make sure that the motor is wired correctedly when using inertia approximation analysis operation.Select inertia approximation analysis operation from Shihlin communication software. Press the INERTIA RATIO AUTO-DETECTION button is there is no abnormal alarm. Press SERVO ACTIVATION button and motor magnatization happens at this point. After setting up the acceleration and deceleration constant, JOG speed, and constant speed time, pres the SETUP button. Then press the START button for the inertia approximation analysis operation to begin.Here are the parameter table used for the operation:

Name	Initial Value	Set Range
Acceleration and Deceleration Constant	200	1~1000
JOG Speed	300	300~2000
Constant Speed Time	1000	100~50000

When carrying out aceleraton or deceleration actions, the machine will automatically calculate the load inertia ratio and the frequency width of the system. After the values become more stable, press AUTO-GAIN CALCULATION and the controller's parameter auto-calculation will be listed in at the left of the table. Relevant calculation parameters are presented below:

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
Resonance Suppression of Low-pass Filter	NLP	PB03	0~10000	0.1ms	0	Pt、Pr、S、T
Position Feedforward Gain Value	FFC	PB 05	0~20000	0.0001	0	Pt、Pr

Load Inertia Ratio of the Servo Motor	GD1	PB 06	0~1200	0.1time	10	Pt、Pr、S
Position Loop Gain Value	PG1	PB07	4~1024	rad/s	35	Pt、Pr
Speed Loop Gain	VG1	PB08	40~4096	rad/s	817	Pt、Pr、S
Speed Integral Gain Value	VIC	PB 09	1~1000	ms	48	Pt、Pr、S

After completing the calculation, must turn off the INERTIA RATIO AUTO-DETECTION before parameter write-in.If the users already know about the low frequency gain and inertia ratio of the system, they can also enter the to be achieved frequency width for a direct calculation of the best controller parameter set value.

4.6. The Parameter Mode

The users have to switch the power off and aon after modifying certain parameter to make the modification effective.

(1) Operation

Here are some examples. One is for the operation method after restarting the machine for changing the control mode (parameter PA01) to the speed mode.

The second example is about the switching the function of the MODE key to the SHIFT function and the use the SHIFT function to change the number of rotation for the internal position command 1 to -20000.

Example 1: Change from the control mode (parameter PA01) to the speed control mode

Use the MODE button to jump to the screen of parameter PA01.

It denotes parameter PA01.

UP DOWN Press the UP or DOWN button to change the parameter.

SET Press the SET key twice.

The parameter at the far right will flicker continuously.

UP Press the UP button twice.

The set value can be adjusted when the screen is flickering.

UP DOWN Use “UP DOWN” to alter the setup.

SET Press the SET key for confirmation.

Press the UP DOWN button to move to the next parameter.

After modifying parameter PA01, be sure to restart the machine after setting up the new values.

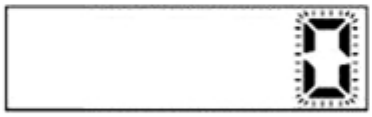
Example 2: When setting up the parameters, the MODE key will be used for the function of the SHIFT.(Take parameter PA15 as an example.)

Use the MODE key and the UP and DOWN buttons to jump to the screen of PA15.

It denotes parameter PA15.

UP DOWN Press UP or DOWN to change the parameter.

SET Press the SET button twice.



The far right parameter will flicker continuously.

MODE Press the MODE key four times.

The far left of the seven-level monitor will flicker continuously.

UP Press the UP key twice.

This value indicates a positive 200000.

MODE Press the MODE key once again.

The decimal point at the bottom of each seve-level monitor indicates a negative number.

SET Press the SET key again for confirmation.

- The range of PA15 is ±30000, and the display of the negative value is done by lightening up the decimal point of each digit at the bottom of the seven-level monitor.If the parameter has a four-digit range, for example, PC05 has a range ±4500, the set value of -2000 rotation will be displayed as -2000 by the seven-level monitor. See the figure below.

When the parameter range has less than four digits, the negative sign will be displayed by adding a "—"sign at the front of the number.

5. Operation

5.1. Checklist before Operation

Befire running the motor, conduct a detailed check on the following items to avoide motor damage when running.

- Whether the power source terminals (R, S, T, L1, L2) of the servo actuactor are correctly wired.
- The power terminals of the servo motor (U, V, W) and the U, V, W wire on the servo actuactor have to have consistent phases.
- Make sure whether the ground terminal of the servo actuactor is correctly grounded.
- Make sure there is no conductive or inflammable materials in the actuator or close to the actuactor.
- Make sure the voltage level of external power source of the actuator is correct.
- Make sure that the control switch is off.
- Do not put heavy objects on top of the actuator or the wires.
- Use twisted line for the wiring of the regenerative resistor.
- Check if there is any apparent damage on the exterior of the actuator.

5.2. No-load Test

Remove all the loads (e.g., the coupler and other devices of the machine or the servo motor axle) connected to the servo motor before conducting a no-load test.After removing all the loads connected to the servo motor, follow the regular operation procedure to start the servo motor, and then connect the servo motor to the servo motor.Motor's no-load test is explained below.

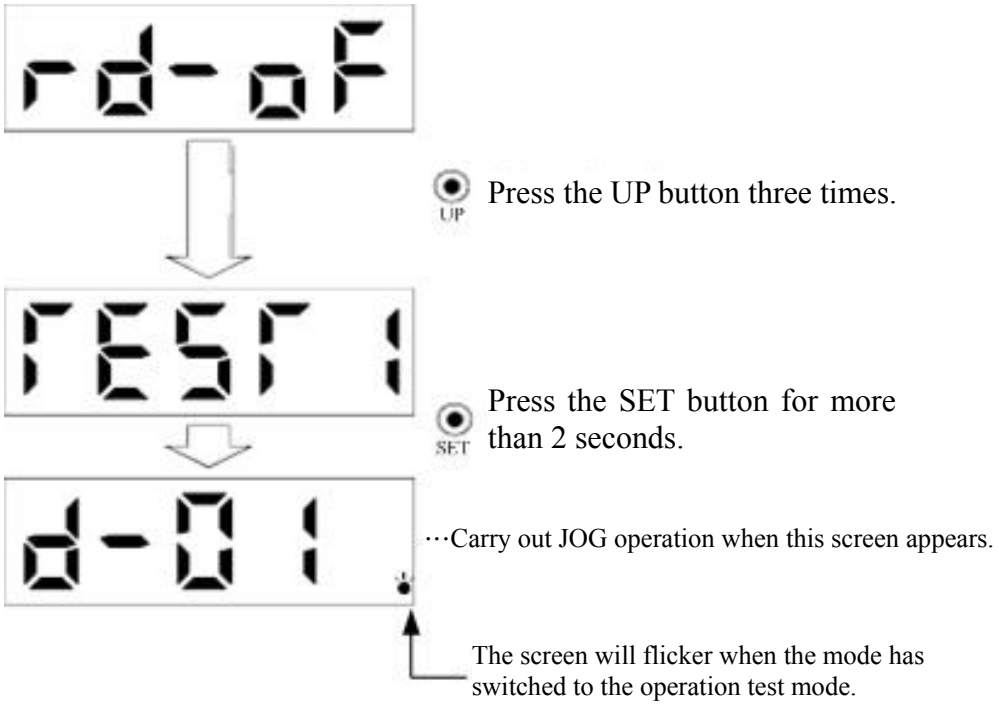
5.2.1. No-load Test

- ★ JOG operation can be carried out once the user is certain that there is no abnormal alarm or alarma messages from the servo.
- ★ Make sure of the open contact of SON and SG from the test.

To make sure that the rotation speed and direction of the motor is as expected, no-load JOG operation can be operated by the panel of the actuator and the connection to Shihlin's communication software.Motor rotation speed canno be modified when using the panel for operating JOG operation. If the motor rotation speed has to be modified for the JOG operation, please connect RS-232 or USB to Shihlin communication software to carry out JOG operation and rotation speed modification. Note, it is recommended for JOG operation to be conducted under a low speed.The use of JOG operation using the panel operation mode is described as follows:

Step 1 Correctly connect the servo actuator to the servo motor and turn on the power of the servo actuator.

Step 2 Use the MODE button on the panel to move the screen to the diagnosis screen. Press the UP key three times to go to TEST 1 (the JOG mode). Press the SET key continuously for 2 seconds so the screen will jump to d-o1 (the JOG operation screen).



Step 3 When conducting the JOG operation, press the UP button for the motor to rotate toward the CCW direction, or press the DOWN button for the motor to rotate toward the CW direction. The motor will stop once the button is released.Use the communication software to change the operation criteria.The initia criteria and set range for the operation are presented below:

Items	Initial Set Value	Set Range
Rotation Speed (r/min)	200	0 to instantaneous allowable rotation speed
Acceleration and Deceleration Time Constant	1000	0~2000

When using the communication software for JOG operation, the servo motor decelerates until stop if the communication wire comes out during the operation.

Button Functions:

Button	Content
Forward Rotation	Press the button for CCW direction rotation.
Reverse Rotation	Press the button for CCW direction rotation.
Stop	Press the button to stop the motor.
Close	Terminate the JOG test.

Step 4 At the end of the JOG operation, shut down the power or press the SET button at the operation testing screen (d-01) for more than 2 seconds to terminate the JOG operation mode.

★ Refer to the usage setup in the help file of Shihlin communication software if Shihlin communication software is employed to test JOG operation.

5.2.2. No-load Positioning Test

To make sure that the rotation speed and direction of the motor is as expected, connect to Shihlin communication softare via RS-232 and USB for no-load positioning operation. It is recommended to conduct positioning operation under low speed.The number of rotation loops and the number of rotation pulse have to be set up for positioning rotation. For example, for the motor to rotate 10 and 1/2 circules, the use have to set up the number of rotation as 10 and the pulse

Step 1 Correctly connect the servo actuator to the servo motor and turn on the power of the servo actuator.

Step 2 Use standard Mini USB line to connect the computer to the CN4 terminal of the servo actuator. When connecting to Shihlin communication software, select USB communication and correct number device number.

Step 3 Select “TESTING/POSITIONING TESTING” on the upper part of the communication software to enter into the positioning testing screen.

Step 4 When conducting positioning operation, first set up the number of rotation and the number of rotation pulses. Press “FORWARD ROTATION” for the servo motor to rotate toward CCW direction and to achieve the target number of rotation and or pules. Or press “REVERSE ROTATION” for the servo motor to rotate toward CW direction and to reach the target number of rotation and pulses.The initia criteria and set range for the operation are presented below:

Items	Initial Set Value	Set Range
Shifting Quantity; Number of rotation	10	0~30000
Shifting Quantity; Number of Pulses	0	0~9999
Rotation Speed (r/min)	200	0 to instantaneous allowable rotation speed
Acceleration and Deceleration Time Constant	1000	0~2000

Button Functions:

Button	Content
UP	Press the button to have the motor rotate toward CCW direction until reaching the target number of rotation and of pulses.
DOWN	Press the button to have the motor rotate toward CW direction until reaching the target number of rotation and of pulses.
Suspend	Press the button once to suspend the motor temporarily if the motor has not yet reached the target number of rotation or of the pulses. If the same rotation button is pressed for a second time, the motor will rotate to finishe the remaining number of rotation and of pulses. If the button is pressed twice, the remaining number of roation or of pulses will be cleared.
Close	Complete the positioning testing.

Step 5 Press the CLOSE button to jump out the positioning operation mode when positioning operation is completed.

5.3. Tunning Process

5.3.1. Tunning Methods and Types

The use can quickly and precise approximate the load inertia by using the auto-gain tunning function. The user can also use it to carry out a quick search of appropriate servo gain according of the motor under various loads.The use can manually tune the mode to attain the requirement if auto-gain tuning mode cannot satisfy the requirement.

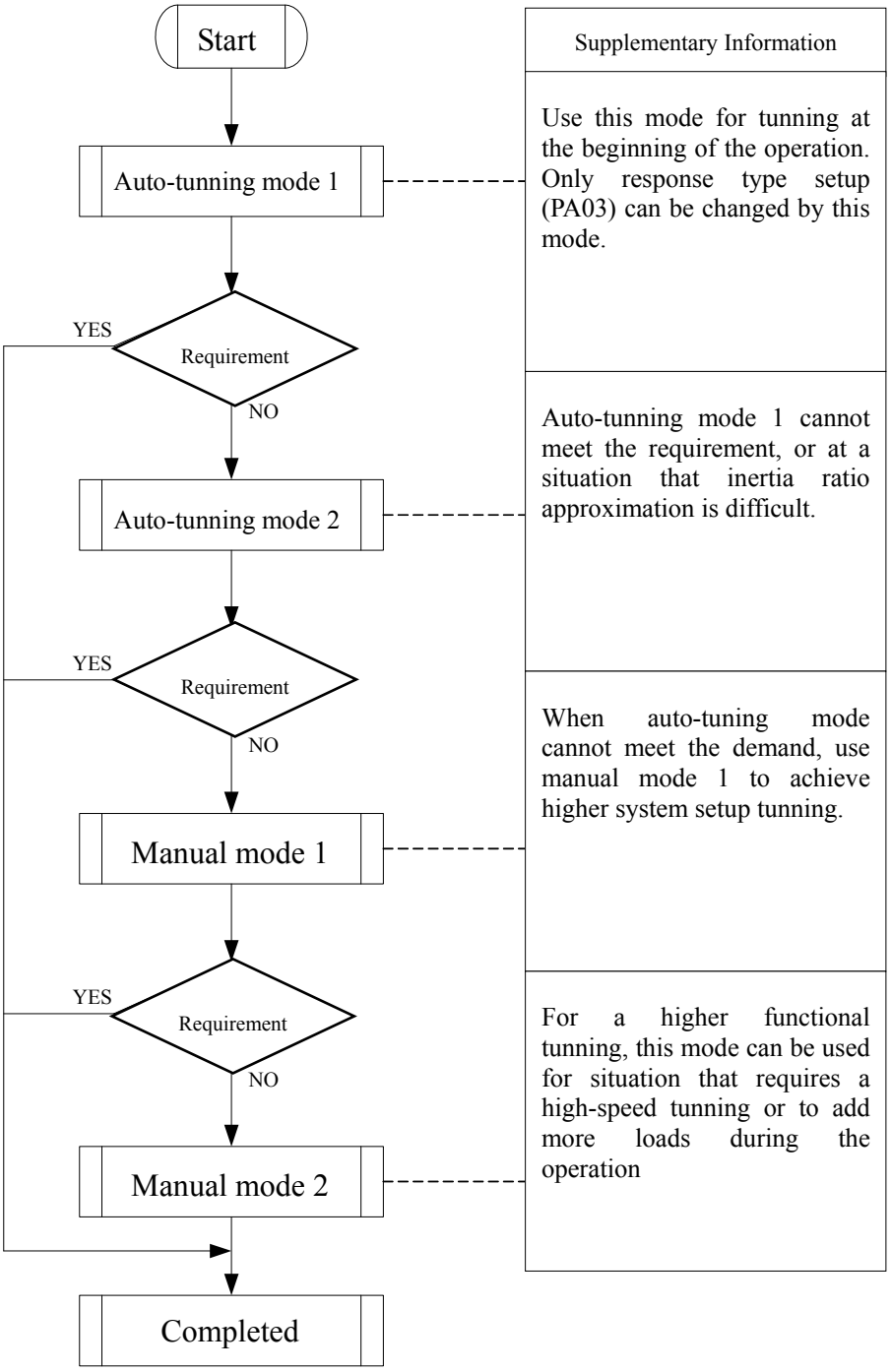
Gain tunning mode is explained by the following table:

Tunning Mode	Parameter PA02 Setup	Load Inertia Approximation Approach	Auto-Approximation Parameter	Parameters Set up by the Users
Manual Gain Tuning Mode (PI Control)	0000	A fixed parameter PB06 value		GD1 (Parameter PB06) PG1 (Parameter PB07) VG1 (Parameter PB08) VIC (Parameter PB09)
Manual Gain Tunning Mode (PI + Interference Compensator)	0001			GD1 (Parameter PB06) PG1 (Parameter PB07) VG1 (Parameter PB08) VIC (Parameter PB09)
Auto-Gain Tuning Mode 1	0002	Continuous approximation	GD1 (Parameter PB06) PG1 (Parameter PB07) VG1 (Parameter PB08) VIC (Parameter PB09)	ATUL (Parameter PA03)
Auto-Gain Tuning Mode 2	0003	A fixed parameter PB06 value	PG1 (Parameter PB07) VG1 (Parameter PB08) VIC (Parameter PB09)	ATUL (Parameter PA03) GD1 (Parameter PB06)

★ Parameter PA02 cannot be written in when SON-SG is conductive. Make sure to make SON-SG an open circuit before setting up the values.

Manual gain tunning mode (PI + interference compensator) can be employed at the position mode. The gain value can be adjusted according to the condition. For example, reduce the gain if the system is unstable.

For tunning, follow the table below for tunning order and modes.



If the servo erection condition is used for the first time, be sure to test the operation at the JOG mode. If there is no abnormality, then use the auto-tunning function.When running the auto-tunning mode, make sure to have the servo generate many acceleration/deceleration commands. Wait until the inertia ratio approximation becomes more stable to attain the purpose of inertia ratio approximation and frequency width search.

5.3.2. Auto-Tunning Mode

The auto-tunning function can carry out instantaneous approximation of the load inertia ratio of servo motor's rotor inertia for the servo actuator. Also, this value will be used for automatically for setting up the best gain under the current environment (GAIN value).Use auto-tunning function for simple and quick execution of gain tuning for the servo actuator.

5.3.2.1. Auto-tuning Function

(a) Auto-Gain Tuning Mode 1

This mode is the default value of the servo from the factory. If this function (PA02=0002) is set up for the servo, load inertia will be approximated continuously, and the servo gain value wil be set up automatically. The users can modify only the the response setup related parameters (PA03).

For the parameters and setup of this mode are presented below:

Parameter NO	Parameter Abbreviation	Parameter Name	User-adjusted parameters or Auto-approximated Parameters
PA 03	ATUL	Auto-tunning responsiveness setup	Can be modified by the users
PB 06	GD1	Load Inertia Ratio of the Servo Motor	Auto-approximation
PB 07	PG1	Position Loop Gain Value	Auto-approximation
PB 08	VG1	Speed Loop Gain	Auto-approximation
PB 09	VIC	Speed Integral Gain Value	Auto-approximation

The following criteria have to be met when the servo is set at the auto-gain tuning mode 1.The following criteria have to be met when the servo is set at the auto-gain tunning

①.When reaching 2000rpm, the acceleration/deceleration time has to be under 1 second. When reaching 3000rpm, the acceleration/deceleration time has to be under 1.5 seconds.

②.Motor rotation speed has to be higher than 300rpm.

③Load inertia cannot be greater than the 100-fold of the motor rotor inertia.

④Environment with external force or fierce inertia ratio change is not suitable for this mode.

⑤The inertia approximation value will not be written into EEPROM. For it to be written into EEPROM, use the manual setup.

(b) Auto-Gain Tuning Mode 2

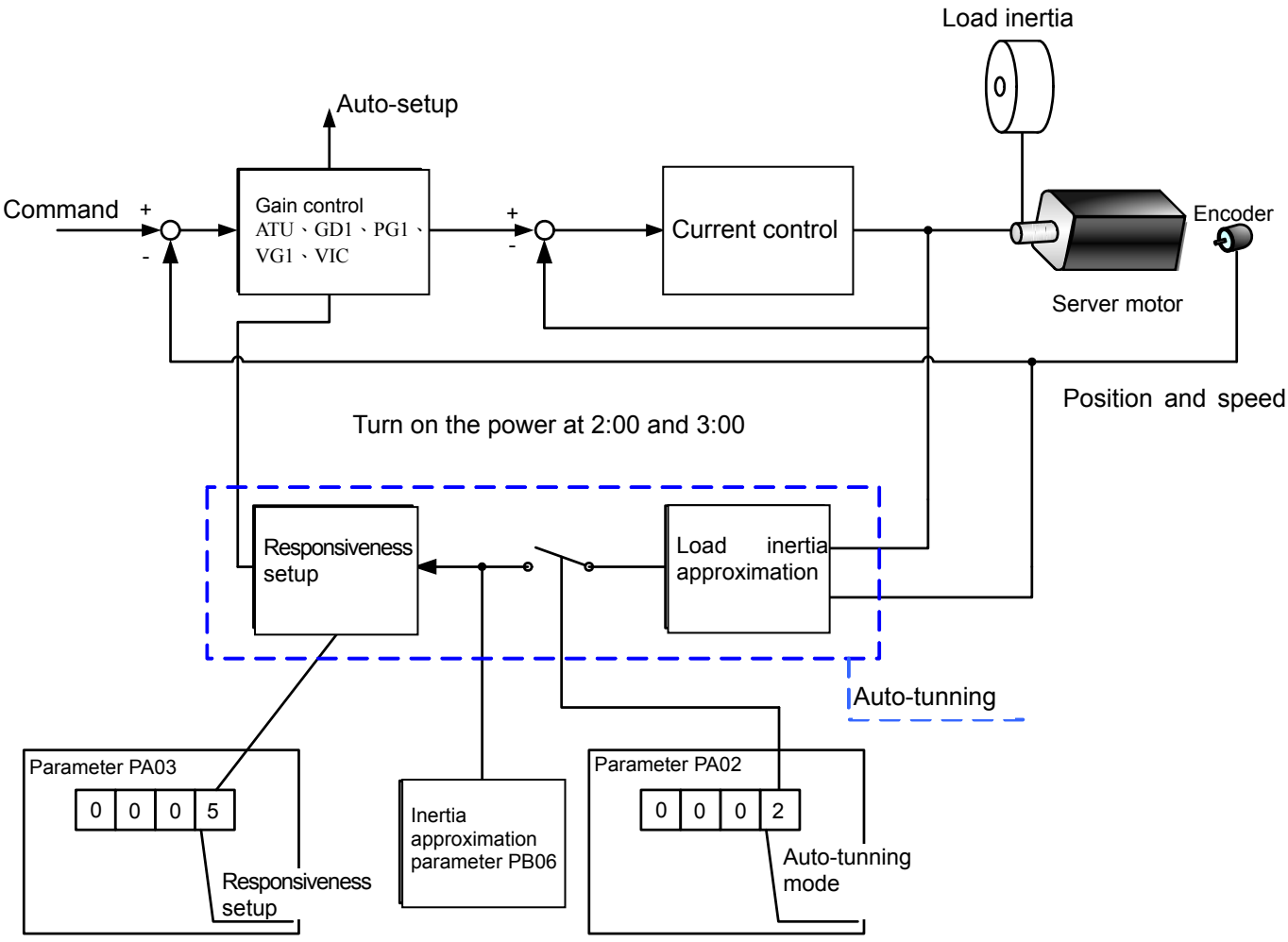
Use auto-gain tunning mode 2 for tunning action if auto-gain tunning mode 1 cannot properly approximate accurate inertia.At this mode, the servo parameter setup (PA02=003) will not make load inertia to be automatically approximated. The users have to know the value of the correct load inertia ratio and to wirte the value into parameter PB06 themselves.

For the parameters and setup of this mode are presented below:

Parameter NO	Parameter Abbreviation	Parameter Name	User-adjusted parameters or Auto-approximated Parameters
PA 03	ATUL	Auto-tunning responsiveness setup	Can be modified by the users
PB 06	GD1	Load Inertia Ratio of the Servo Motor	Can be modified by the users
PB 07	PG1	Position Loop Gain Value	Auto-approximation
PB 08	VG1	Speed Loop Gain	Auto-approximation
PB 09	VIC	Speed Integral Gain Value	Auto-approximation

5.3.2.2. Auto-tunning Action Flow Process

When the user is setting up the auto-tunning, actions of the servo can be expressed by the block diagram below:



Keep in mind the following points to carry out the actions of the auto-gain tuning mode:

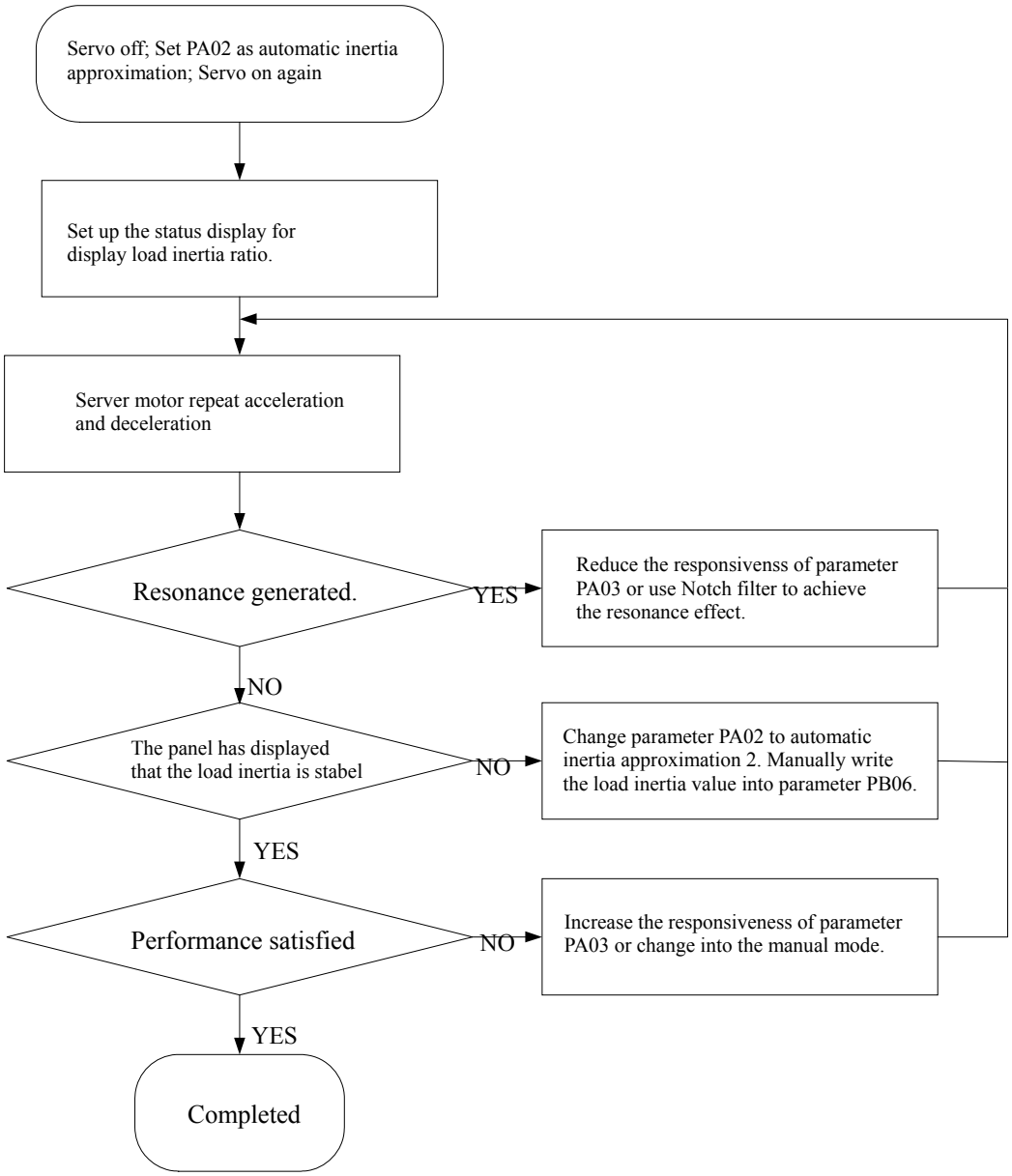
①. When the mode is set to be the auto-gain tunning mode 1, first carry out acceleration/deceleration motor rotation, and inertia ratio will approximate the inertia according to the current and speed of the motor. At this stage, the newly approximated inertia value of the servo motor will be obtained but will not be written into EEPROM. The default value will come back one the machine is restarted.

②. When the inertia ratio of the load to the motor is already known or in case where inertia ratio cannot be approximated accurately (e.g., a situation with servoe

change in inertia ratio), the user can set up parameter PA02 as the auto-gain tunning mode 2 and write the known inertia ratio into parameter PB06. At this stage, an action for searching the gain value will be carried out still.

③. The servo actuator will carry out the best controller gain tunning during the acceleration/deceleration rotation through the value of the inertia ratio and the responsiveness value.The searched gain result will be written into EEPROM every six minutes after turning on the power.After the power is turned on, the saved controller gain value by the EEPROM at the moment will be used as the initial tunning value for the auto-gain tunning mode.

Shihlin servo has set the auto-gain tunning mode 1 as the default mode at the factory. By letting the motor run acceleration/deceleration rotation, the best controller gain will be set automatically.The users only need to set up the required responsiveness to complete the entire procedure. The order is presented in the following figure.

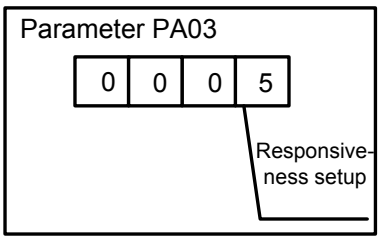


5.3.2.3. Auto-tunning Responsivenss

Parameter PA03 (responsiveness setup) is for setting up the overall responsiveness of the servo, and responsiveness will affect the bandwidth of the entire system.When setting up a higher responsiveness, the tracebility and setting time for the commands will be shorter. If the range is set to be too large, vibration can be generated by the system. Therefore, when setting up the responsivness, make sure that the range will not cause system vibration.

If the desired bandwidth can cause the machine to produce resonance, the user can employ machine resonance suppression filter (parameter PB01, PB02, PB21, PB22) and the resonance suppression low-pass filter (parameter PB03) to effectively suppress the resonance effect.And then, a higher responsiveness may be set sometimes.

Refer to Section 6.3.6 for more information on machine resonance suppression filter and resonance suppression low-pass filter.



Responsiveness Setup	Responsiveness	Speed loop responsiveness frequency	Appropriate load inertia ratio
1	Low responsiveness	5Hz	More than 30-fold of rotor inertia
2		10 Hz	
3		15 Hz	
4		20 Hz	
5	Medium responsiveness	30 Hz	10- to 30-fold of rotor inertia
6		40 Hz	
7		55 Hz	5- to 10-fold of rotor inertia
8		70 Hz	
9		85 Hz	
A	High responsiveness	100 Hz	Less than 5-fold of rotor inertia
B		130 Hz	
C		160 Hz	
D		200 Hz	
E		250 Hz	
F		300 Hz	

- For responsiveness setup, it is recommended to start the adjustment from low responsiveness and to high responsiveness gradually. It is more likely to produce resonance if the initial value is set to high.
- The *Appropriate Load Inertia Ratio* is a reference number. The applicable range would vary depending on the system environment of the servo erection.

5.3.3. Manual-Tunning Mode

The users can use the manual-tunning mode to adjust the gain parameter to the desired value if the auto-tunning function cannot meet the requirement of the users.

The manual-tunning mode

Bandwidth, machine rigidity, and environment have a great impact at the position or the speed mode. For machine requires a high precision, a high bandwidth system response is required. Neverthless, a high responsiveness can cause the machine to produce resonance easily.Therefore, a high rigidity machine should be used for occasions that require a high responsiveness to avoid machine resonance.

If the users have no idea about the permitted frequency responsiveness of the machine, adopt a smaller gain value at first and then gradually increase the gain value until resonance is produced by the machine. Then the user can reduce the gain value accordingly.Reference parameter values for users to adjust according to the position and the speed are presented in the following table:

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
Resonance Suppression of Low-pass Filter	NLP	PB03	0~10000	0.1ms	0	Pt、Pr、S、T
Position Feedforward Gain Value	FFC	PB 05	0~20000	0.0001	0	Pt、Pr
Position Loop Gain Value	PG1	PB07	4~1024	rad/s	35	Pt、Pr
Speed Loop Gain	VG1	PB08	40~4096	rad/s	817	Pt、Pr、S
Speed Integral Gain Value	VIC	PB 09	1~1000	ms	48	Pt、Pr、S
Speed Feedforward Gain Value	VFG	PB 10	0~20000	0.0001	0	S

- Position Loop Gain Value (PG1)

  This parameter determines the responsiveness of the position loop. The larger the PG1 is, the higher the responsiveness frequency of the position loop is. It well follows the great position commands, requires a short setting time, and reduces position errors. Nevertheless, setting up an over-large value can cause vibration or overshoot of the machine. The equation for determining the value is as follows:

$$\text{PG1 set value} \leq \frac{\text{VG2 set value}}{1+\text{load inertia ratio}} \times \frac{1}{4}$$

$$\text{PG1 set value} \approx \text{Speed loop bandwidth} \times \frac{1}{4}$$

- Speed Loop Gain (VG1)

  This parameter determines the responsiveness of the speed loop; the larger the VG1 set value is, the higher the frequency of the loop responsiveness bandwidth is. It well follows the speed commands. A too big set value can cause the machine to produce resonance easily.When setting up the speed loop gain, the value is normally about 4- to 6-fold of the position loop gain. When the position loop gain is greater than the speed loop gain, the machine will produce resonance or overshoot. The speed loop gain is calculated by the following equation:

$$\text{Speed loop responsiveness frequency (Hz)} \quad \frac{\text{VG1 set value}}{(1+\text{corresponding motor load inertia ratio}) \times 2\pi}$$

- Speed Integral Gain Value (VIC)

  This parameter is to clear up fixed deviations of corresponding commands.The smaller the speed integral gain set value is, the better the clear capability for the fixed deviations is. But for large load inertia and the existence of elements causing machine vibration, setting a too small value can cause resonance. The following equation can be used for determing the value:

$$\text{VIC Set value (ms)} \geq \frac{3000 \sim 5000}{[\text{VG1 set value} / (1 + \text{GD1 set value} \times 0.1)]}$$

- Resonance Suppression of Low-pass Filter (NLP)

  The larger the load inertia is, the lower the system bandwidth is. To maintain a relatively high bandwidth, higher gain value may be required. But for the machine, an increased gain value can also increase the probability of resonance. At this point, resonance suppression low-pass filter parameter can be used to remove the resonance.The higher the set value is, the better the improvement on high-frequency noises is. But a too large set value can also cause the entire system to be unstable. It is because the larger the set value, the servoer the drop behind the phase. An equation for calculating the set value is provided below:

$$\text{Filter cycle number (Hz)} = \frac{\text{VG1 set value x 10}}{2\pi \times (1 + \text{GD1 set value x 1})}$$

- Position Feedforward Gain Value (FFC)

  The user can reduce position error and shorten the position setting time, but if the value is set too large, a sudden acceleration or deceleration may cause overshoots. Also, a too large electronic gear ratio can produce noises.

- Speed Feedforward Gain Value (VFG)

  Setting up speed feedforward gain can shorten the speed command follow time, but if the value is set too large, overshooting can happen with sudden acceleration/deceleration.

5.4. Parameter Setup and Operation of the Position Mode

(1) Servo Actuator Power Transmission

The SON signal of digital inpu DI of the servo will be modified to the OFF state after the servo actuator is turned on.The panel of the servo actuator will automatically display “SERVO MOTOR ROTATION SPEED” after two seconds.

(2) Operation Testing

The JOG rotation method operation testing will be used to check whether the servo motor is operated normally.

(3) Parameter Setup

After wiring the position control mode, the following parameters have to be set for basic position control

Parameter	Name	Value	Content
PA01 (Note 1)	Control mode option	□□□0	Position control mode
PA02 (Note 2)	Auto-tunning	0002	Auto-tunning mode 1
PA 03	Auto-tunning responsiveness setup	0005	Medium responsiveness
PA06	The numerator of the electronic gear ratio	1	Set the numerator of the electronic gear ratio as one.
PA07	The denumerator of the electronic gear ratio	1	Set the denumerator of the electronic gear ratio as one.
PD15 (Note 1)	External input terminal filter time option	□□□2	The filter time constant of the external terminal is 4 ms.

Note 1: Switch the power from OFF to ON after modifying the parameter for the set parameter to be effective.

Note 2: The parameter cannot be set when SON-SG is conductive.

(4) Servo ON

Please execute SERVO ON according to the following procedures:

(a) Turn on the control power of the servo motor.

(b) Turn on the servo ON signal (SON) (short circuit between SONG-SG).

When the servo is ON, it is ready for operation. The servo motor will immediately become SERVO LOCK.

(5) Input the Command Pulse Train

At first make the servo motor rotate at a low speed. Make sure that the rotation and the direction are correct before inputting the command pulse train.PP and NP are the forward and reverse rotation inputted pulse signals at open collector input. If line drive signals are sued, make the input signal received by PG-PP or NG-NP. The user can use auto-tunning function or set up the controller parameter, but be careful of the resonance phenomenon generated by the machine. The user can adjust PA03 to obtain a better effect from the servo motor’s speed responsiveness.

(6) Return to Origin

The return to origin action is to make sure the correctness of the direction and the correctness of the return to origin position. Return to origin can be carried out if necessary.

(7) Stop

Take the following steps to stop the rotation of the motor.

(a) Turn off the servo ON signal (SON).

Turn off the base for the servo to be at a free run state (Turn off the base for the servo to be at a free run state.)

(b) Abnormal Alarm Occurrence

When abnormal occur, turn off the base and take the dynamic brake action for an emergency stop of the servo motor.

(c) Turn off the emergency Stop (EMG).

Turn off the base, and the dynamic brake action will cause an emergency stop of the servo motor. Abnormal alarm signal (ALM) will be displayed.

(d) Turn off the travel limit (LSP, LSN).

If LSP is on, the motor can have a forward rotation. If LSN is on, the motor can have a reverse rotation. If it is turned off and the motor has an emergency stop, the servo will be locked.

5.5. Parameter Setup and Operation of the Speed Mode

(1) Servo Actuator Power Transmission

The SON signal of digital inpu DI of the servo will be modified to the OFF state after the servo actuator is turned on.The panel of the servo actuator will automatically display “SERVO MOTOR ROTATION SPEED” after two seconds.

(2) Operation Testing

The JOG rotation method operation testing will be used to check whether the servo motor is operated normally.

(3) Parameter Setup

After wiring the speed control mode, the following parameters have to be set for basic position control

Parameter	Name	Value	Content
PA01 (Note 1)	Control mode option	□□□2	Speed control mode
PC 05	Internal speed command 1	1000	Set as 1000 rpm
PC 06	Internal speed command 2	1500	Set as 1500 rpm
PC 07	Internal speed command 3	2000	Set as 2000 rpm
PC 01	Acceleration time constant	1000	Set as 1000 ms
PC 02	Deceleration time constant	500	Set as 500 ms
PC 03	S-shape acceleration/deceleration time constant	0	Unapplicable
PD15 (Note 1)	External input terminal filter time option	□□□2	The filter time constant of the external terminal is 4 ms.

Note: Switch the power from OFF to ON after modifying the parameter for the set parameter to be effective.

(4) Servo ON

Please execute SERVO ON according to the following procedures:

(a) Turn on the control power of the servo motor.

(b) Turn on the servo ON signal (SON) (short circuit between SONG-SG).

When the servo is ON, it is ready for operation. The servo motor will immediately become SERVO LOCK.

(5) Activation

Select motor roation speed using speed selection signal 1 (SP1) and speed selection signal 2 (SP2). Options are presented in the following table.

(Note) External Input Signal		Rotation Speed Command Value
SP2	SP1	
0	0	Analog speed command (VC)
0	1	Internal speed command 1 (parameter PC05)
1	0	Internal speed command 2 (parameter PC06)
1	1	Internal speed command 3 (parameter PC07)

After selecting the speed, turning on the activaton signal (ST1 or ST2) to have the servo motor start the rotation. Methods for forward and reverse rotation are presented in the following table:

(Note) External Input Rotation Direction		Rotation Direction			
ST2	ST1	Analog speed command (VC)			Internal speed command 1
		+ polarity	0V	- polarity	
0	0	Stop (Servo locked)	Stop (Servo locked)	Stop (Servo locked)	Stop (Servo locked)
0	1	CCW	Stop (Servo locked)	CW	CCW
1	0	CW		CCW	CW
1	1	Stop (Servo locked)	Stop (Servo locked)	Stop (Servo locked)	Stop (Servo locked)

Note 0: OFF (SG opened); 1: ON(SG short circuit)

First employ a low rotation speed to verify the rotation direction. If the rotation is incorrect, then check the input signal.Display the screen by the status to verify the rotation speed of the servo motor, the number of command pulses, the loading ratio, etc.

The user can use auto-tunning function or set up the controller parameter, but be careful of the resonance phenomenon generated by the machine. The user can adjust PA03 to obtain a better effect from the servo motor’s speed responsiveness.

(6) Stop

Take the following steps to stop the rotation of the motor.

(a) Turn off the servo ON signal (SON).
Turn off the base for the servo to be at a free run state (Turn off the base for the servo to be at a free run state.)

(b) Abnormal Alarm Occurrence
When abnormal occur, turn off the base and take the dynamic brake action for an emergency stop of the servo motor.

(c) Turn off the emergency Stop (EMG).
Turn off the base, and the dynamic brake action will cause an emergency stop of the servo motor. Abnormal alarm signal (ALM) will be displayed.

(d) Turn off the travel limit (LSP, LSN).
If LSP is on, the motor can have a forward rotation. If LSN is on, the motor can have a reverse rotation. If it is turned off and the motor has an emergency stop, the servo will be locked.

(e) If the forward rotation activation signal (ST1) and the reverse rotation activation signal (ST2) are both ON or both OFF, the servo motor will be stopped through deceleration.

5.6. Parameter Setup and Operation of the Torque Mode

(1) Servo Actuator Power Transmission

The SON signal of digital inpu DI of the servo will be modified to the OFF state after the servo actuator is turned on.The panel of the servo actuator will automatically display U (torque command voltage) after two seconds.

(2) Operation Testing

The JOG rotation method operation testing will be used to check whether the servo motor is operated normally.

(3) Parameter Setup

After wiring the torque control mode, the following parameters have to be set for basic position control

Parameter	Name	Value	Content
PA01 (Note 1)	Control mode option	□□□4	Torque control mode
PC 05	Internal speed restriction 1	1000	Set as 1000 rpm
PC 06	Internal speed restriction 2	1500	Set as 1500 rpm
PC 07	Internal speed restriction 3	2000	Set as 2000 rpm
PC 01	Acceleration time constant	1000	Set as 1000 ms
PC 02	Deceleration time constant	500	Set as 500 ms
PC 03	S-shape acceleration/deceleration time constant	0	Unapplicable
PD15	External input terminal filter time option	□□□2	The filter time constant of the external terminal is 4 ms.
PA 05	Internal torque restriction 1	50	50% of the maximum torque as the output restriction

(4) Servo ON

Please execute SERVO ON according to the following procedures:

(a) Turn on the control power of the servo motor.

(b) Turn on the servo ON signal (SON) (short circuit between SONG-SG).

When the servo is ON, it is ready for operation. The servo motor will immediately become SERVO LOCK.

(5) Activation

Select rotation speed restriction value by speed selection signal 1 (SP1) and speed selection signal 2 (SP2). When forward rotation selection (RS1) is ON, the motor will have a forward rotation. When reverse rotation selection (RS2) is ON, the motor will have a reverse rotation. Torque will be generated. At the initial roation, use a low speed rotation to make sure if the rotation direction is correct. If the rotation direction is different from the expection, check whether the input signal is correct.

(6) Stop

Take the following steps to stop the rotation of the motor.

Turn off the servo ON signal (SON).

Turn off the base for the servo to be at a free run state (Turn off the base for the servo to be at a free run state.)

Abnormal Alarm Occurrence

When abnormal occur, turn off the base and take the dynamic brake action for an emergency stop of the servo motor.

Turn off the emergency Stop (EMG).

Turn off the base, and the dynamic brake action will cause an emergency stop of the servo motor. Abnormal alarm signal (ALM) will be displayed.

(d) If the forward rotation activation (RS1) signal and the reverse rotation activation (RS2) signal are both ON or both OFF, the servo motor will be at a free run state.

6. Control Function

6.1. Control Mode Option

Shihlin servo actuator has four basic operation modes, which are the position (terminal input) mode, the postion (internal register input) mode, the speed mode, and the torque mode. The actuator can employ either a single control mode, that is, to be controlled by a fixed mode, or a combined control mode, that is, to be controlled by mixed modes. All the operation modes and descriptions are provided below:

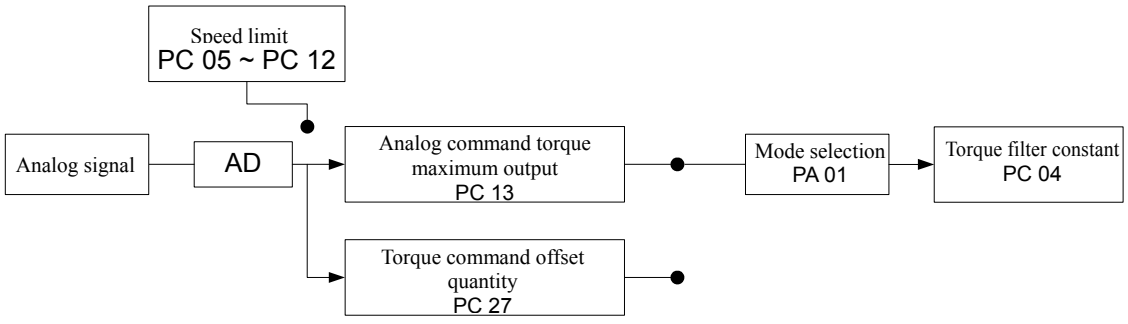
Mode		Code	Parameter PA01 Setup	Description
Single Mode	Position Mode (terminal input)	Pt	0000	The actuator accepts position commands for controlling the motor to reach the target position. Position commands are inputted by the terminal block, and the signals are in the form of pulse waves.
	Position Mode (Internal Register)	Pr	0010	The actuator accepts position commands for controlling the motor to reach the target position. Position commands are given by the internal register (eight sets of registers). The user can use DI signals to select the register code.
	Speed Mode	S	0002	The actuator accepts speed commands for controlling the motor to reach the target rotation speed. DI signals can be used to select the speed command to be analog voltage command or internal speed command (seven sets of register).
	Torque Mode	T	0004	The actuator accepts torque commands for controlling the motor to reach the target torque. Torque commands are provided by analog voltage commands.

Combined Model	Position mode (Termina input) – Speed mode	Pt-S	0001	The switch for Pt to S or *vice versa* is carried out by DI signals.
	Position mode (Termina input) – Torque mode	Pt-T	0005	The switch for Pt to S or *vice versa* is carried out by DI signals.
	Position mode (Internal register) – Speed mode	Pr-S	0011	The switch for Pt to S or *vice versa* is carried out by DI signals (LOP).
	Position mode (Internal register) – Speed mode	Pr-T	0015	The switch for Pt to T or *vice versa* is carried out by DI signals (LOP).
	Speed mode – Torque mode	S-T	0003	The switch for S to T or *vice versa* is carried out by DI (LOP) signals.

✦ Make sure to restart fhe machine after modifying parameter PA01 to have the set value effective.

6.2. Torque control mode

Torque mode is often applied for occasion when torque control is required; for example, winding machines, printing press, injection molding machines, etc.Shihlin servo's torque control is analog input and motor's torque is controlled by external voltage.Basic torque control framework is shown in the figure below:



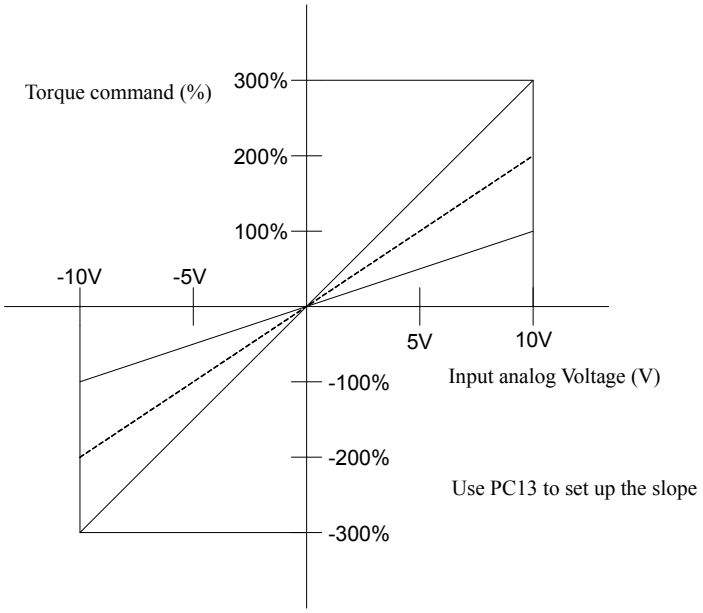
First, select the torque mode from the mode options.Torque mode uses external analog voltage ±10V as the torque command. After A/D process and the user send analog commands for maximum torque output and torque restricted shift quantity via parameters, the expected torque and speed will be outputted.

6.2.1. Analog Torque Command Proportioner

Analog torque propotioner is the analog command torque maximum output. The content is presented in the following table:

Name	Parameter Code	Set Range	Unit	Default Value	Control Mode
Analog Command Torque Maximum Output	PC 13	0~300	%	100	Pt, Pr, S, T

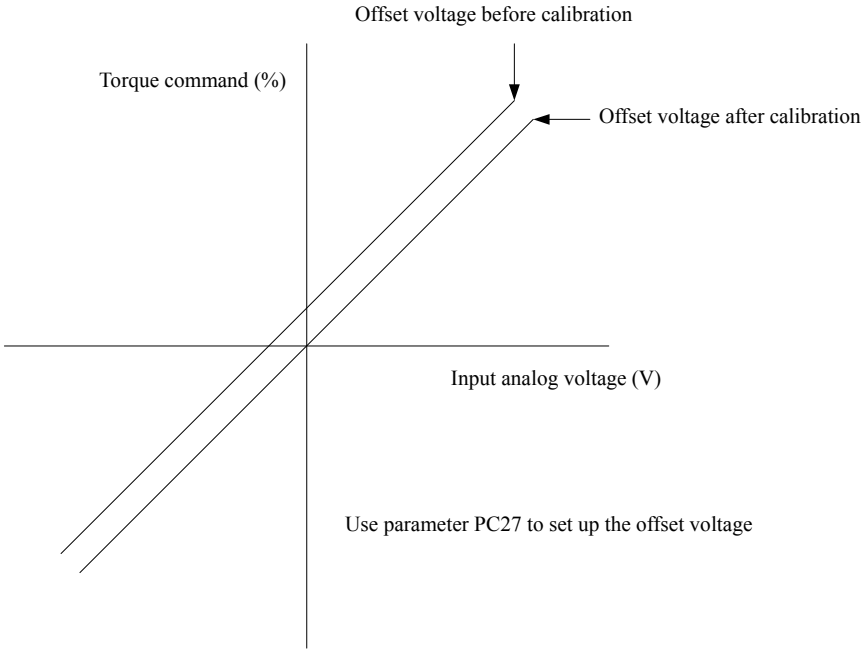
Set up the analog torque command as the torque at the maximum input voltage (10V).If parameter PC13 is set as 100, then when the input voltage is 10V, the torque command will be 100% of the maximum torque. If the input voltage is 5V, the torque command will be 50% of the maximum torque.The conversion is presented as follows:
Torque command = input voltage / 10 x the parameter set value



6.2.2. Analog Torque Command Offset Adjustment

When the analog torque command of servo actuator provides 0V, the motor can still rotate slowly.The abovementioned situation is mainly because external analog voltage may cause minor voltage offset, causing the input command voltage different from the actual voltage.In this case, the users can use parameter PC27 to correct the shifted voltage.Parameter content is presented in the following table:

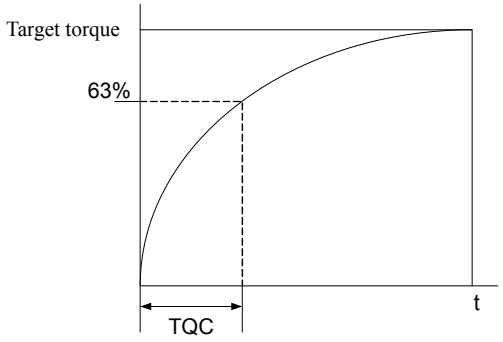
Name	Parameter Code	Set Range	Unit	Default Value	Control Mode
Analog Torque Command / Restricted Shifted Quantity	PC 27	-999~999	mV	0	S, T



6.2.3. Smoothing the Torque Commands

The filter time constant for setting up the torque command can make motor operation smoother when the sever actuator experience sudden and severe change from the torque commands if this parameter is appropriately set.Parameter content is presented in the following table:

Name	Parameter Code	Set Range	Unit	Default Value	Control Mode
Torque Command Filter Time Constant	PB19	0~5000	ms	0	T



6.2.4. Torque Restriction of the Torque Mode

When using the torque mode, the function of torque restriction has two major parameters, PA05 and PC25, which are explained in the following table.

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
Internal torque restriction 1	TL1	PA 05	0~100	%	100	Pt, Pr, S, T
Internal torque restriction 2	TL2	PC 25	0~100	%	100	Pt, Pr, S, T

Relevant input CN1 terminal TL1 is presented in the following table:

Name	Parameter Abbreviation	Description	Control Mode
Internal torque restriction option	TL1	When using the signal, make parameters PD-2 – PD09 usable first. Then when TL1-SG is opened, internal torque restriction 2 (parameter PC25) becomes effective.	Pt, Pr, S, T

When parameter PD02 – PD09 are set up for internal torque restriction selections (TL1) to be usable, internal torque restriction 2 (parameter PC25) can then be selected. TL1 switch according to digital input DI will generate two different types of situations.

(Note) Digital Input signal	Effective Torque Restriction Value
TL1	
0	The setup of parameter PA05
1	Parameter setup PC25 > Parameter setup PA05 > Parameter setup PA05 Parameter setup PC25 < Parameter setup PA05 => Parameter setup PC25

Note 0: OFF (SG opened); 1: ON(SG short circuit)

6.2.5. Speed Restriction of the Torque Mode

At the torque control mode, the contact of motor speed restriction can be changed internally by SP1, SP2 and SP3, as well as externally by the analog commands.Internal restriction plus external analog restriction provide a total of eight speed restrictions for the user to select and arrange.Speed restriction methods are provided in the following table:

Digital input DI Selection	Speed restriction code	(Note) Input signal		Speed Limit	Restriction Range	Relevant Parameters
		SP2	SP1			
Speed option (SP3) Unapplicable (Initial condition)	VCM	0	0	Analog speed restriction (VC)	±10V	PC 12
	SC1	0	1	Internal speed restriction 1	-4500 ~ +4500	PC 05
	SC2	1	0	Internal speed restriction 2	-4500 ~ 4500	PC 06
	SC3	1	1	Internal speed restriction 3	-4500 ~ 4500	PC 07

Speed option (SP3) Set to be usable	Speed command code	SP3	SP2	SP1	Speed Limit	Range	Relevant Parameters
	VCM	0	0	0	Analog speed restriction (VC)	¡Ó10V	PC 12
	SC1	0	0	1	Internal speed restriction 1	-4500 ~ 4500	PC 05
	SC2	0	1	0	Internal speed restriction 2	-4500 ~ 4500	PC 06
	SC3	0	1	1	Internal speed restriction 3	-4500 ~ 4500	PC 07
	SC4	1	0	0	Internal speed restriction 4	-4500 ~ 4500	PC 08
	SC5	1	0	1	Internal speed restriction 5	-4500 ~ 4500	PC 09
	SC6	1	1	0	Internal speed restriction 6	-4500 ~ 4500	PC 10
	SC7	1	1	1	Internal speed restriction 7	-4500 ~ 4500	PC 11

Note 0: OFF (SG opened); 1: ON(SG short circuit)

- When the users select to use external input analog speed commands, make sure to set the voltage to 0V and parameter PC12 in advance. Try to have a base not exceeding the motor's rated rotation speed or motor and structural damages can be caused.
- To use function SC4 – SC7, use parameters PD02 – PD09 to make SP3 pin of digital input DI usable.

Parameters for internal rotation speed restriction are presented in the table below:

Name	Parameter Code	Set Range	Unit	Default Value	Control Mode
Internal speed restriction 1	PC 05	0 ~ Instantaneous permissible rotation speed	rpm	100	T
Internal speed restriction 2	PC 06	0 ~ Instantaneous permissible rotation speed	rpm	500	T
Internal speed restriction 3	PC 07	0 ~ Instantaneous permissible rotation speed	rpm	1000	T
Internal speed restriction 4	PC 08	0 ~ Instantaneous permissible rotation speed	rpm	200	T
Internal speed restriction 5	PC 09	0 ~ Instantaneous permissible rotation speed	rpm	300	T
Internal speed restriction 6	PC 10	0 ~ Instantaneous permissible rotation speed	rpm	500	T
Internal speed restriction 7	PC 11	0 ~ Instantaneous permissible rotation speed	rpm	800	T

6.3. Speed control mode

Speed control mode is often applied for occasions where highly accurate speed control is required; for example, CNC machine, drilling machine, etc.There are two modes for Shihlin servo speed command input: (1) analog input, and (2) register input.

Analog command input can control motor rotation speed via external voltage.

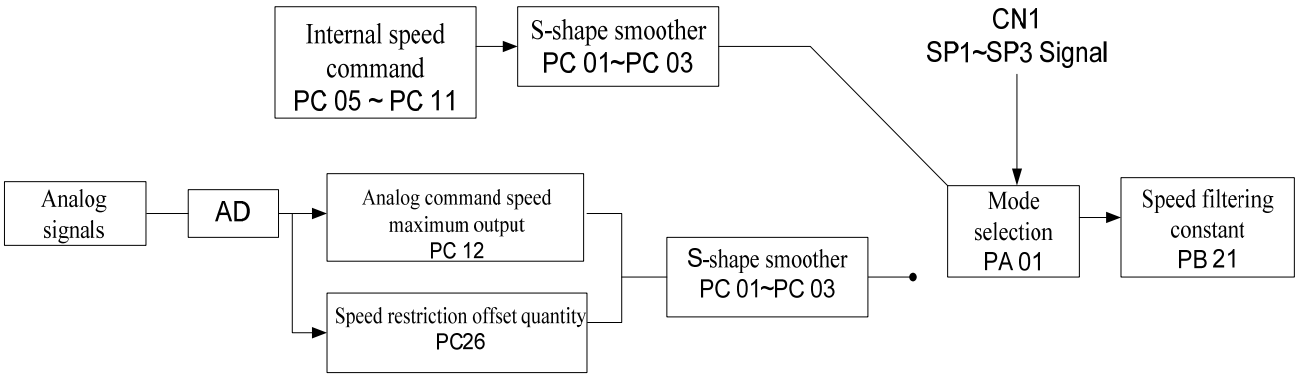
There are two application methods for register input:

The first type is to set the seven rotation speeds required by the user at seven command registers (PC05-PC11) in advance. Then use any three pin (SP1, SP2, SP3) of the digital input DI in the set CN1 to carry out the switching.

The second type is to use RS-232 or USB to connect to Shihlin communication software and then use a communication approach to change the value of the speed command register.

To avoid discontinuity produced by switching between command registers, Shihlin servo also provides an S-shape curve planning to achieve a smooth motor running when the user switches between different speeds.At the close loop system, this device adopts gain and accumulative integration mode (PI) controller.Two types of control modes (manual and automatic) are available for the users.

The manual gain mode enables the user to set up all the parameters while all the automatic or facilitative functions were shut off. The automatic gain mode provides a general approximation of the load inertia and functions for adjusting the actuator parameters. In this case, the parameters set by the users are treated as the initial values. The simple mode is especially designed to provide the users strong and powerful system functions, which is different from the automatic control mode that requires longer learning time for adaptation.The simple control mode can instantaneously suppress external load interference and machine resonance, as well as tolerate load inertia changes.



The upper part of the figure is the internal speed command. That is, the size of the speed command is switched by the user writing into the parameters and then the digital input terminal DI carries out the switching. The lower part of the figure is the ±10V of external analog input. It is treated by A/D and then the maximum output of analog commands (proportioner) and the voltage offset are calculated and outputted.

The users are recommended to use the S-shape smoother and low-pass filter when operating the speed mode to effectively make the motor running smoother.

6.3.1. Speed Command Options

Shihlin servo input speed command provides two methods: One is to use the internal parameters to set up the seven speed commands. The other is to use external inputted ±10V analog voltage commands. A total of eight speed commands are available for the users.

Digital input DI Selection	Speed command code	(Note) Input signal		Speed Command	Range	Relevant Parameters
		SP2	SP1			
Speed option (SP3) Unapplicable (Initial condition)	VCM	0	0	Analog speed command (VC)	¡Ó10V	PC 12
	SC1	0	1	Internal speed command 1	-4500 ~ 4500	PC 05
	SC2	1	0	Internal speed command 2	-4500 ~ 4500	PC 06
	SC3	1	1	Internal speed command 3	-4500 ~ 4500	PC 07

Speed option (SP3) Set to be usable	Speed command code	SP3	SP2	SP1	Speed Command	Range	Relevant Parameters
	VCM	0	0	0	Analog speed command (VC)	¡Ó10V	PC 12
	SC1	0	0	1	Internal speed command 1	-4500 ~ 4500	PC 05
	SC2	0	1	0	Internal speed command 2	-4500 ~ 4500	PC 06
	SC3	0	1	1	Internal speed command 3	-4500 ~ 4500	PC 07
	SC4	1	0	0	Internal speed command 4	-4500 ~ 4500	PC 08
	SC5	1	0	1	Internal speed command 5	-4500 ~ 4500	PC 09
	SC6	1	1	0	Internal speed command 6	-4500 ~ 4500	PC 10
	SC7	1	1	1	Internal speed command 7	-4500 ~ 4500	PC 11

Note 0: OFF (SG opened); 1: ON(SG short circuit)

- When the users select to use external input analog speed commands, make sure to set the voltage to 0V and parameter PC12 in advance. Try to have a base not exceeding the motor's rated rotation speed or motor and structural damages can be caused.
- To use function SC4 – SC7, use parameters PD02 – PD09 to make SP3 pin of digital input DI usable.

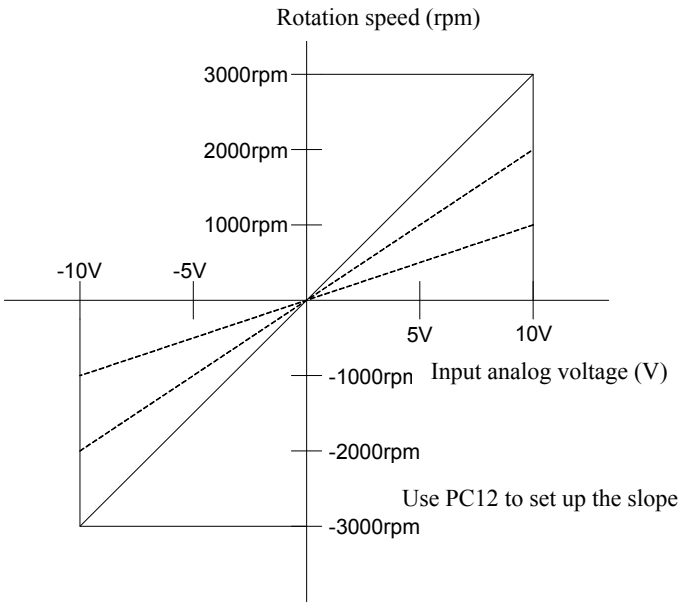
6.3.2. Analog Torque Command Proportioner

Analog torque propotioner is the analog command torque maximum output. The content is presented in the following table:

Name	Parameter Code	Set Range	Unit	Default Value	Control Mode
Analog Command Speed Maximum Rotation Speed	PC 12	0 ~10000	rpm	3000	S, T

Set up the analog torque command as the torque at the maximum input voltage (10V).If parameter PC12 is set as 3000, then the input voltage will be 10V and the servo motor rotation speed will be 3000 rpm. If the input voltage is 5V, the servo motor rotation speed will be 1500 rpm.The conversion is presented as follows:

Speed Command = Parameter set value x voltage input / 10



6.3.3. Smoothing the Torque Commands

If the motor's input command is changed greatly and quickly, vibration, noises, or even overshoot may be generated by the motor.The user can set up the parameters related to smoothing operation provided by Shihlin servo and thus suppress those negative impacts induced by sudden and quick changes from input commands.First, the acceleration time constant can be used to adjust the slope of the speed when the motor starts to rotate to the rotation speed set by the user. The deceleration time constant can be used to adjust the slope from the motor start to run to the time when the motor stops. The S-shape acceleration/deceleration time constant can be used to adjust the stability when starting or terminating the motor.

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
Acceleration time constant	STA	PC 01	0~20000	ms	200	R、S、T
Deceleration time constant	STB	PC 02	0~20000	ms	200	R、S、T
S-shape acceleration/deceleration time constant	STC	PC 03	0~10000	ms	0	Pr, S, T

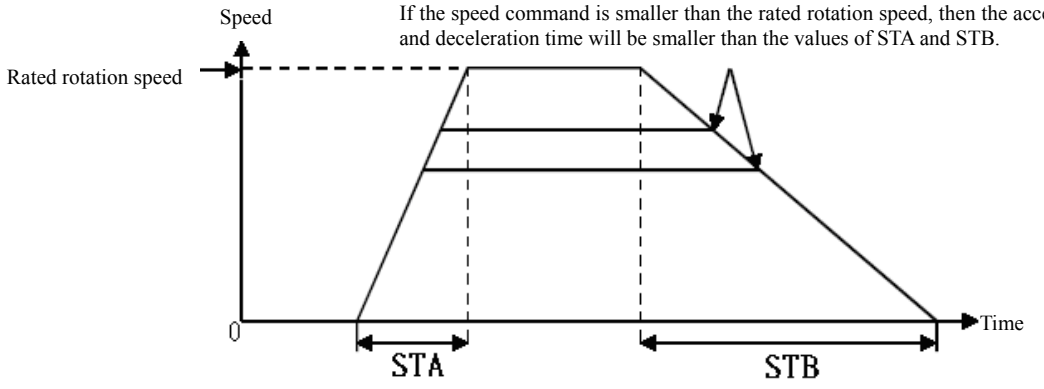
These three parameters are explained in more details below:

Acceleration time constant

This parameter is the acceleration time required for the rotation of the motor from 0 rpm to the rated rotation speed, and it is set as the acceleration time constant.For example, if the rated rotation speed of the servo motor is 3000 rpm, this parameter will be set as 3000 (3s). In this case, for the motor to accelerate from 0 rpm to 3000 rpm would take three seconds.When the speed command is set as 1000 rpm, then to accelerate the speed of the motor from 0 rpm to 1000 rpm would take 1 second.

Deceleration time constant

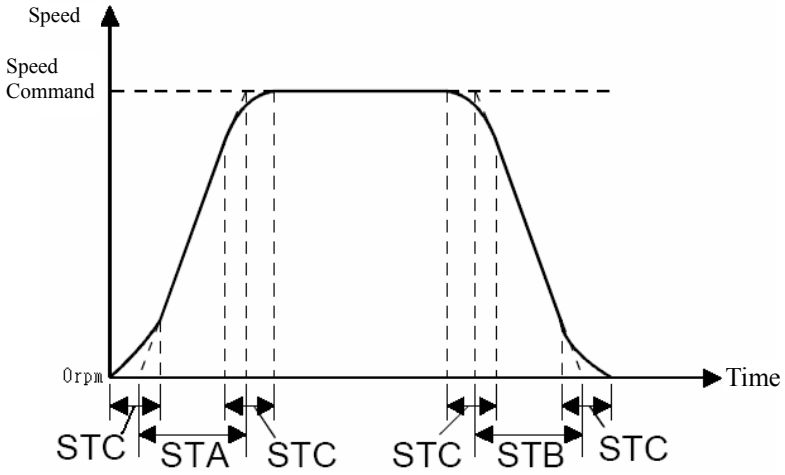
The deceleration time required for the motor rotation speed to reduce from a rated rotation speed to 0 rpm is defined as the deceleration time constant.For example, if the rated rotation speed of the servo motor is 3000 rpm, this parameter will be set as 3000 (3s). In this case, for the motor to decelerate from 3000 rpm to 0 rpm would take three seconds.When the motor rotates at 1000 rpm, then for the motor to decelerate from 1000 rpm to 0 rpm would take 1 second.



S-shape acceleration/deceleration time constant

The S-shape acceleration/deceleration constant design method is to employ a three-level acceleration/deceleration curve during the acceleration/deceleration process in

order to smooth the starting and stopping of the motor.Setting up an appropriate STC can improve the stability of the motor during activation and stop.The beginning S-shape acceleration/deceleration constant is set as 0 second.The users are recommended to open this function when using the speed mode.

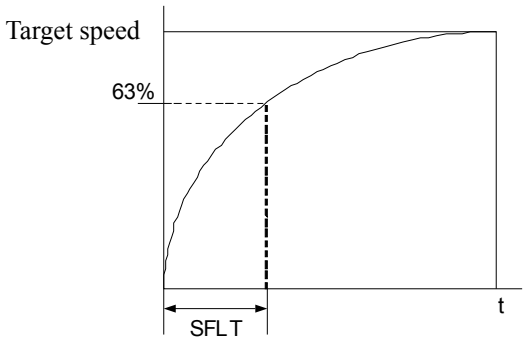


- These parameters can all provide protective function during acceleration and deceleration, regardless whether it is at an internal speed condition or an analog input condition command.
- STA, STB and STC can be set independently. Even if STC is set as zero, there is still a trapezoidal acceleration and deceleration planning.

Speed command low-pass smooth filter time constant

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
Speed command low-pass smooth filter time constant	SFLT	PB 18	0~1000	ms	0	S, T

The larger the parameter function value is, the smoother the command curve is. Nevertheless, the responsiveness will slow down as well. If it is set as zero, then this function cannot be applied.



6.3.4. Torque Restriction of the Speed Mode

When using the speed mode, the function of torque restriction has two major parameters, PA05 and PC25, which are explained in the following table.

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
Internal torque restriction 1	TL1	PA 05	0~100	%	100	Pt, Pr, S, T
Internal torque restriction 2	TL2	PC 25	0~100	%	100	Pt, Pr, S, T

There are three CN1 terminals; one analog voltage signal input and two digital input signal DI. They are described below:

Name	Parameter Abbreviation	Description	Control Mode
Analog torque restriction	TLA	When this signal is used for the speed control mode, parameter PD02 – PD09 have to set TL as usable condition.When TLA is effective, it will restrict the torque at the entire torque output domain by the servo motor.Add a voltage of DC0 – 10V between TLA and LG.When TLA is connected to the positive polarity of the power source, a maximum torque will be generated at +10V.	Pt, Pr, S

Name	Parameter Abbreviation	Description	Control Mode
Torque restriction option	TL	When using the signal, set parameter PD02 – PD09 to usable, make the internal torque restriction 1 (parameter PA05) effective when TL-SG is opened, and make the analog torque restriction (TLA) effective at short circuit.	Pt, Pr, S
Internal torque restriction option	TL1	When using the signal, make parameters PD-2 – PD09 usable first. Then when TL1-SG is opened, internal torque restriction 2 (parameter PC25) becomes effective.	Pt, Pr, S, T

When parameter PD02 – PD09 are set to have internal torque restriction selections (TL1) usable, internal torque restriction 2 (parameter PC25) can then be selected. Bur four different situations are generated according to digital input DI combination between TLand TL1.

Restrictions on using torque restriction value (TL), internal torque restriction option (TL1) and analog torque restriction (TLA) are presented in the following table:

(Note) Digital Input signal		Effective Torque Restriction Value
TL1	TL	
0	0	The setup of parameter PA05
0	1	TLA > Parameter setupPA05 => Parameter setup 05 TLA < Parameter setup PA05 => TLA
1	0	Parameter setup PC25 > Parameter setup PA05 => Parameter setup PA05 Parameter setup PC25 < Parameter setup PA05 => Parameter setup PC25
1	1	TLA > Parameter setup PC05 => Parameter setup PC25 TLA < Parameter setup PA05 => TLA

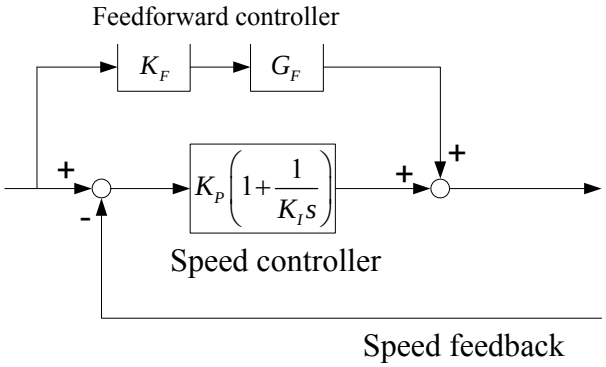
Note 0: OFF (SG opened); 1: ON(SG short circuit)

TLC-SG becomes conductive when servo motor produces torques at parameter setup PA05 and PC25, or when analog torque restricted torque is reached.TLC is a digital output DO signal.

Name	Parameter Abbreviation	Description	Control Mode
Torque restricted	TLC	When torque reaches set value of the internal torque restriction 1 (parameter PA05) or the analog torque restriction (TLA), TLC-SG will be come conductive. But when SON signal is OFF, TLC-SG will become inconductive.	Pt, Pr, S

6.3.5. Speed Loop Gain

There are many gains in the speed loop for the user to make adjustment. Methods to adjust gains can be carried out by setting parameter PA02 as auto-adjustment or manual-adjustment. If auto-adjustment is selected, the inertia ratio and gains will be continuously presumed.If manual-adjustment is selected, the users have to correctly enter the load inertia and gain of the system. Meanwhile, all the automatic or auxiliary functions will be shut off.Speed loop structural block diagram is presented as follows:



K_F : Speed feedforward gain value (PB10)

K_P : Speed loop gain value (PB08)

K_I : Speed loop gain value (PB09)

Some parameters related to gain adjustment in the speed control loop is presented below:

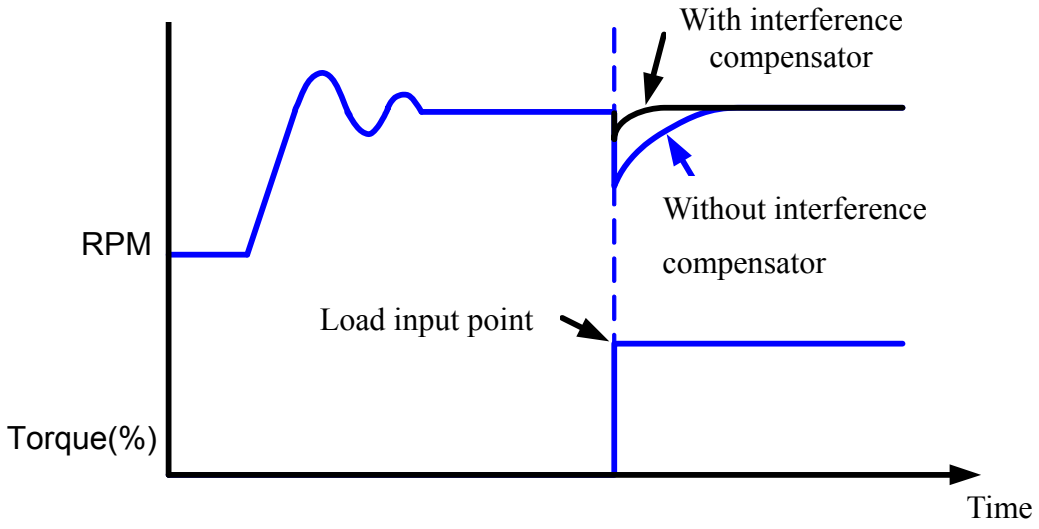
Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
Auto-tunning mode 1	ATUM	PA02	0000h~0003h	No	0002h	Pt, Pr, S
Auto-tunning responsiveness setup	ATUL	PA03	0001h~000Fh	No	0005h	Pt, Pr, S
Speed Loop Gain	VG1	PB08	40~4096	rad/s	817	Pt, Pr, S
Speed Integral Gain Value	VIC	PB 09	1~1000	ms	48	Pt, Pr, S
Speed Feedforward Gain Value	VFG	PB 10	0~20000	0.0001	0	S

Auto-mode:

During the acceleration and deceleration process, the servo actuator will adopt the best controller gain for adjustment. For more details please refer to Section 5.3.2.

Manual-mode:

When parameter PA02 is set as 0000 or 0001, the major gains include speed loop gain (PB08), speed integral gain (PB09), and speed feedforward gain (PB10).When PA02 is set as 0001, servo will automatically add an interference compensator function. This function can reduce torque ripple, overshoot, and speed change rate, and it is suitable for systems with frequent load changes. Nevertheless, the users should avoid apply it on systems with load inertia greater than 10-fold. Other gain values have to be adjusted according to the condition during the application.A schematic diagram is presented below:



Manual-mode parameter setup

Speed Loop Gain

Increase the value of this parameter will increase the bandwidth of high-speed loop, but a too large value will cause system vibration. Therefore, it is recommended to first approximate the base values using the auto-mode. If these values cannot satisfy the requirement, increase the values slowly until the system produces vibration and then return to the previous set value.

Speed Integral Gain Value:

Reduce the value of this parameter will increase the low-frequency rigidity of the high-speed loop in order to reduce stability errors.On the other hand, if the value is set too low, phase delay may be more serious, causing an unstable system.

Speed feedforward gain:

Speed feedfoward can reduce phase delay errors, and increase the capability to follow command trajectory. If the set value is close to one hour, dynamic track error will be very small and the pre-compensation will be most complete.If the value is set too low, system improvement effect will not be apparent, but if the value is set too high, the system will vibrate easily.

6.3.6. Resonance Suppression Filter

When the rigidity of the machine is too low, the structure may generate resonance, either because the bandwidth is too large or the rigidity of the control system of the actuator is too large. If the control gain of the machine can no longer be adjusted, Shihlin servo provides two sets of resonance suppression filters, four types of resonance suppression filter parameters, and one resonance suppression low-pass filter for the user to make the adjustment.Some parameters related to resonance suppression filter are introduced below:

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
Frequency of Machine Resonance Suppression Filter 1	NHF1	PB 01	50~1000	Hz	1000	Pt, Pr, S, T

Decay Rate of Machine Resonance Suppression Filter 1	NHD1	PB 02	0~32	dB	0	Pt、Pr、S、T
Frequency of Machine Resonance Suppression Filter 2	NHF2	PB 21	50~1000	Hz	1000	Pt、Pr、S、T
Decay Rate of Machine Resonance Suppression Filter 2	NHD2	PB 22	0~32	dB	0	Pt、Pr、S、T

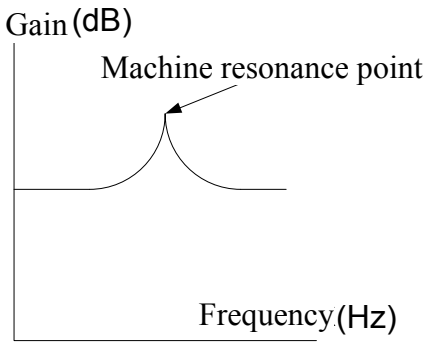
Frequency of Machine Resonance Suppression Filter

The user can set the frequency for resonance decay of machine resonance suppression filter.

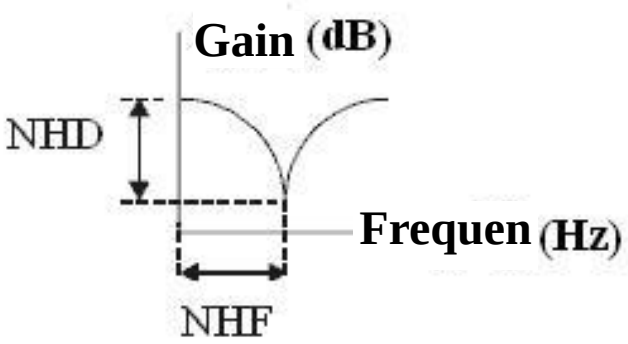
Decay Rate of Machine Resonance Suppression Filter

The user can set up the decay rate of machine resonance suppression filter, which can be used in coordination with PB01 (PB21). For parameter PB02 (PB22), 0 denotes shut off the notch filter function.

Machine system resonance is presented in the following schematic diagram:



The occurrence of resonance will cause a too large machine device resonance. In this case, by adjusting parameter PB01 (PB21) and PB02 (PB22) the controller will create corresponding commands to offset the resonance point.See figure below:

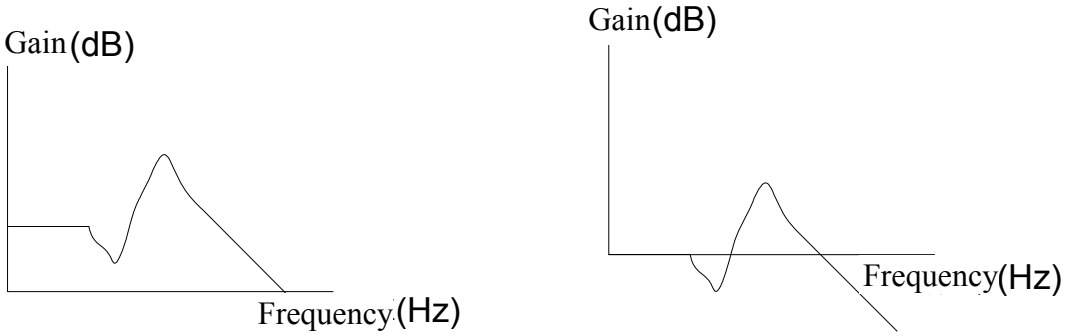


Shihlin servo also has a resonance suppression low-pass filter, and the function is presented below:

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
Resonance Suppression of Low-pass Filter	NLP	PB 03	0~10000	0.1ms	0	Pt, Pr, S, T

Resonance Suppression of Low-pass Filter

Set up the resonance suppression low-pass filter time constant.



It can be found from the above figure that the adjustment of resonance suppression low-pass filter can suppress the resonance point, but at the same time, the system bandwidth is reduced and the phase is delayed.

- When using machine resonance suppression function, the user have to know the frequency generated by the system resonance point before setting up the depth in order to achieve the resonance suppression function.
- If machine resonance suppression frequency is incorrect set, it cannot suppress resonance and may cause the machine to produce more resonance.
- If the user knows about the resonance frequency, Notch Filter (PB01, PB02, PB21, PB22) is a better choice than the resonance filter.
- If the resonance frequency exceeds the range of PB01 (PB21), PB02 (PB22), use resonance suppression low-pass filter (PB 03) to suppress machine resonance.

6.3.7. Gain Switch Function

The gain switching function of Shihlin servo can carry out gain switching on operating or suspended servo motor. Digital input DI pin can be set for gain switching actionIf the user uses gain switching option, make sure to set the auto-adjustment set value (parameter PA02) to the manual mode (□□□0, □□□1). If auto-adjustment mode is selected, gain switching function will be disabled.

Applicable occasions are listed below:

(1). If the set servo gain is too large, the servo rotation noises will be too large. In this case, use gain switching to reduce system gain.
(2). If there is a large change in the load inertia during the route, use gain switching to change the inertia ratio or the gain to ensure the stability of the servo system.
(3). For the servo system to have a higher responsiveness or a shorten setting time, use gain switching to enhance the gain.

When using the gain switching function, relevant parameters and details are provided below:

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
Load Inertia Ratio of the Servo Motor	GD1	PB 06	0~1200	0.1-fold	10	Pt, Pr, S

Position Loop Gain Value	PG1	PB07	4~1024	rad/s	35	Pt、Pr
Speed Loop Gain	VG1	PB08	40~4096	rad/s	817	Pt, Pr, S
Speed Integral Gain Value	VIC	PB09	1~1000	ms	48	Pt, Pr, S
Gain Switch Selection Criteria	CDP	PB11	0000h~ 0004h	No	0000H	Pt, Pr, S
Gain Switching Criteria Value	CDS	PB12	0~6000	Parameter Setup	10	Pt, Pr, S
Gain Switch Time Constant	CDT	PB13	0~1000	ms	1	Pt, Pr, S
Load Inertia Ratio of the Servo Motor	GD2	PB14	0~1200	0.1-fold	70	Pt, Pr, S
Change Rate of Position Gain at Gain Switching	PG2	PB15	10~200	%	100	Pt、Pr
Change Rate of Position Gain at Gain Switching	VG2	PB16	10~200	%	100	Pt, Pr, S
Change Rate of Position Integral Gain at Gain Switching	VIC2	PB17	10~200	%	100	Pt, Pr, S

Parameters related to gain switching are described below:

(1). Sever motor's load inertia ratio, position, speed loop gain, speed integral gain (GD1), PG1, VG1, VTC (PB06-PB09).

The method to adjust the four above-mentioned parameters is the same as that of manual-mode parameters. But during gain switching action, the value can be modified.

(2). Gain Switch Selection Criteria CDP (PB11)

This parameter is the criteria for setting gain switching. Change the first digit of

the parameter to carry out criteria selection. The selection for carrying out gain switching action can have the external digit input (DI) signal as the triggering source.The external digit input (DI) signal can become a gain switching function by setting parameter PD02 – PD09.

0	0	0	x

X =): Turn of the gain switch.

X = 1: Switching is carried out when the gain switching signal CPD (digital input DI) is ON.

X = 2: Switching is carried out when the position command frequency is larger than the setup of parameter CDS.

X = 2: Switching is carried out when the position error pulse is larger than the setup of parameter CDS.

X = 4: Switching is carried out when servo motor's rotation speed is equal to the setup of parameter CDS.

(3). Gain Switching Criteria Value CDS (PB12)

The value for gain switching criteria (kpps, pulse, rpm) is set according to the setup of CDP (PB11). When the setup is □□□2, the parameter is the frequency (kpps). When the setup is □□□3, the parameter is pulse number. When the setup is □□□4, the parameter is rpm. The unit of the set value varies depending on the item of the switching criteria.

PB12 Setting	Switching Criteria	Unit
□□□2	Position command frequency	kpps
□□□3	Position error pulse	pulse
□□□4	Motor rotation	rpm

(4). Gain Switch Time Constant CDT (PB13)

Switching time constant is often used to change smooth gain and to set up the time constant for CDP and CDS criteria switching. Under gain switching condition, this parameter setup can reduce machine vibration if the gain is set too large.

(5). Load Inertia Ratio of the Servo Motor is 2GD2 (PB14).

This parameter can be set to the load motor inertia ratio for the switching. If the load inertia ratio stays the same during the routine, set the value of GD1 (PB06) as the parameter.

(6). The change rates of position gain 2, speed gain 2, speed integral gain at gain switching are PG2, VG2, VIC2 (PB15 – PB17).

During gain switching action, the original servo gain value will be corrected by percentage and become the percent set by PG2, VG2, and VIC to conduct the gain switching action.

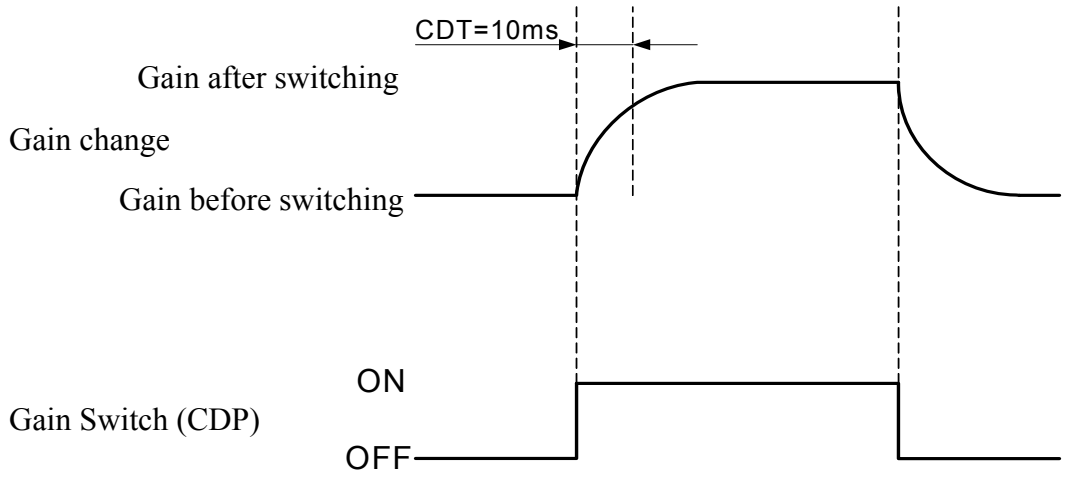
Some examples are provided below for gain switching action:

Example 1: When the user select digital input signal as the switching source:

①. The parameter to be set:

Name	Parameter Abbreviation	Parameter Code	Value	Unit
Load Inertia Ratio of the Servo Motor	GD1	PB 06	10	0.1-fold
Position Loop Gain Value	PG1	PB07	100	rad/s
Speed Loop Gain	VG1	PB08	500	rad/s
Speed Integral Gain Value	VIC	PB09	100	ms
Gain Switch Selection Criteria	CDP	PB11	0001	No
Gain Switch Time Constant	CDT	PB13	10	ms
Load Inertia Ratio of the Servo Motor	GD2	PB14	20	0.1-fold
Change Rate of Position Gain at Gain Switching	PG2	PB15	80	%
Change Rate of Position Gain at Gain Switching	VG2	PB16	120	%
Change Rate of Position Integral Gain at Gain Switching	VIC2	PB17	150	%

②. Switching action diagram



③. Parameter Change Condition

Name	CDP OFF		CDP ON		CDP OFF
Load Inertia Ratio of the Servo Motor	10	→	20	→	10
Position Loop Gain Value	100	→	80	→	100
Speed Loop Gain	500	→	600	→	500
Speed Integral Gain Value	100	→	150	→	100

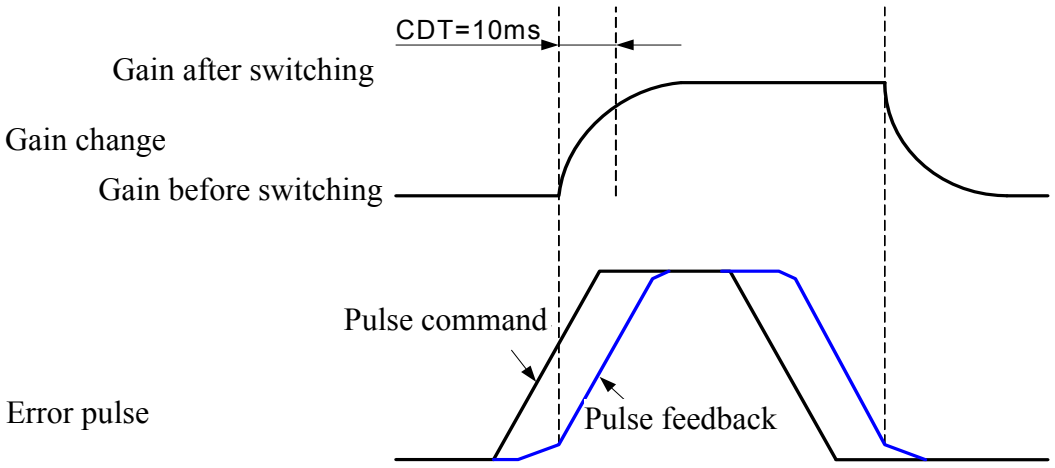
Example 2: The user select error pulse as the switching source.

①. The parameter to be set:

Name	Parameter Abbreviation	Parameter Code	Value	Unit
Load Inertia Ratio of the Servo Motor	GD1	PB 06	10	0.1-fold
Position Loop Gain Value	PG1	PB07	100	rad/s
Speed Loop Gain	VG1	PB08	500	rad/s
Speed Integral Gain Value	VIC	PB09	100	ms
Gain Switch Selection Criteria	CDP	PB11	0003	No

Gain Switching Criteria Value	CDS	PB12	100	pulse
Gain Switch Time Constant	CDT	PB13	10	ms
Load Inertia Ratio of the Servo Motor	GD2	PB14	20	0.1-fold
Change Rate of Position Gain at Gain Switching	PG2	PB15	80	%
Change Rate of Position Gain at Gain Switching	VG2	PB16	120	%
Change Rate of Position Integral Gain at Gain Switching	VIC2	PB17	150	%

②. Switching action diagram



③. Parameter Change Condition

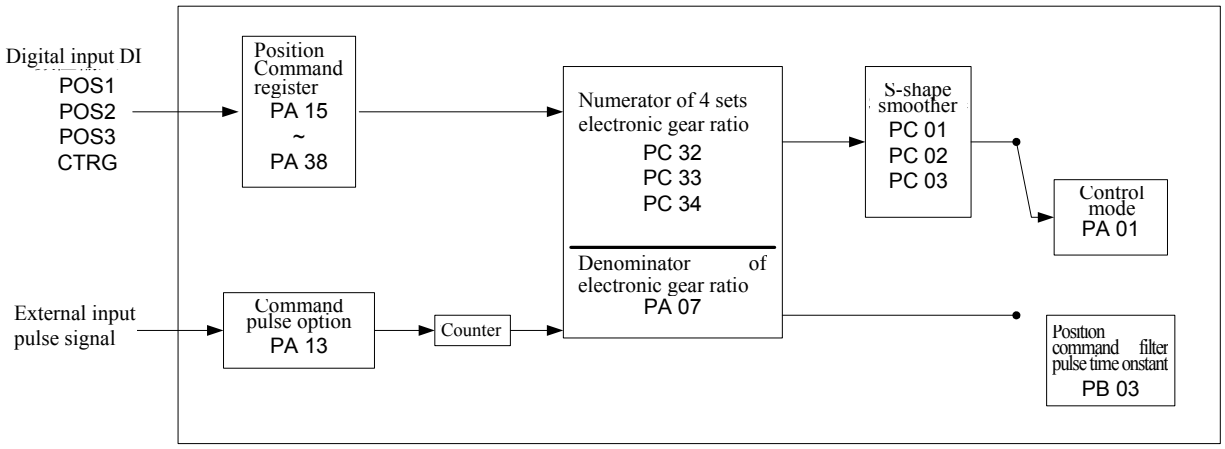
Name	CDP OFF		CDP ON		CDP OFF
Load Inertia Ratio of the Servo Motor	10	→	20	→	10
Position Loop Gain Value	100	→	80	→	100
Speed Loop Gain	500	→	600	→	500
Speed Integral Gain Value	100	→	150	→	100

6.4. Position control mode

Position control mode can be used at occasions that require highly accurate positioning; for example, industrial machinery, processing machines, etc.There are two ways of command input of Shinlin servo position control mode: one is terminal input mode, and the other is internal register input mode.The terminal input mode uses receiving the host controller's pulse commands to control the servo motor's position. The internal register input mode enables the users to set up the eight sets position commands (PA15 – PA30) and then set up the digital input contact DI's PO1 – PO3 to change the corresponding position command.The following table explains the setup of terminal input and internal register input:

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode	Description
Control Mode Set Value	STY	PA 01 (*)	0000h ~ 1125h	No	0000h	ALL	Control Mode Set Value u z y x X: Control mode setup X=0: Position Mode Y: Position control command input options y=0: Terminal input y=1: Internal register input (the absolute type) y=2: Internal register input (the incremental type)

For the set value to be effective, restart the machine after setting up parameter PA01.



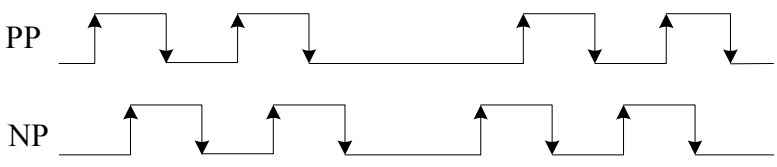
- The S-shape smoother cannot be used when using the external input pulse signal function.

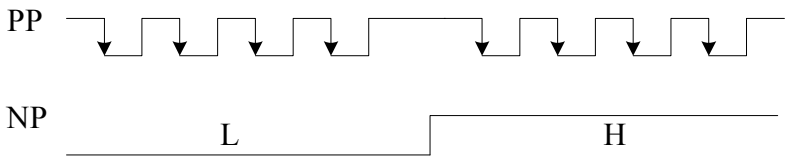
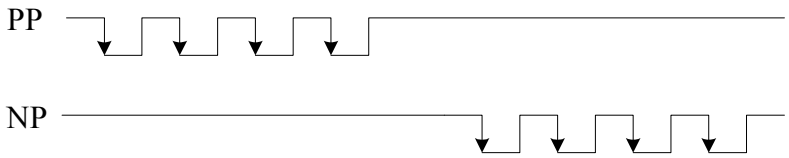
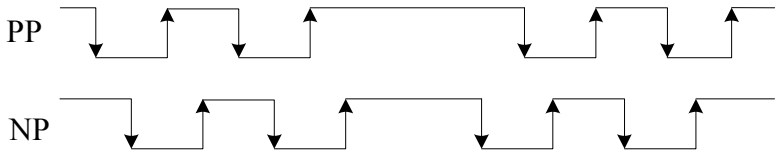
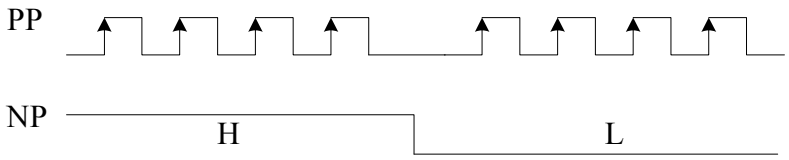
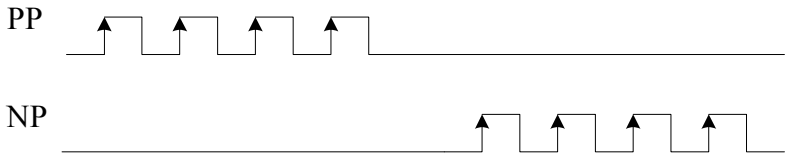
6.4.1. External Pulse Command (Pt Command)

The pulse command of this mode is to be provided by external devices. When using this mode, set parameter PA01 to 0000H and then restart the machine.There are three input wave types for this mode that can be used by the user. The pulse trigger type can be arranged into positive logic or negative logic. Positive logic indicates the controller determines the pulse as the upper edge trigger. On the other hand, negative logic indicates the lower edge trigger.Relevant setup parameters and setup approaches can be found in the table below:

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode	Description
Functional Selection 3 (Command pulse selection)	PLSS	PA 13	0000h ~ 0112h	No	0000h	Pt	Setting up external type of input pulse 0 z y x x: Select the type of input pulse train x=0: Forward/reverse rotation pulse train; x = 1: pulse train + symbol x = 2: AB phase pulse train y: Select input pulse train logic y=0: Positive logic; y=1: negative logic

At Servo On, this parameter cannot be set. After setting up the parameter, restart the machine to have the parameter setup effective.

Pulse Logic and Type		Forward Rotation	Reverse Rotation
Negative Logic	AB phase pulse train		

	Pulse Train + Sign	
	Forward Rotation Pulse Train Reverse Rotation Pulse Train	
Positive Logic	AB phase pulse train	
	Pulse Train + Sign	
	Forward Rotation Pulse Train Reverse Rotation Pulse Train	

If pulse input is line drive input, the highest input frequency is 500Kpps. If the pulse input is open collector input, the highest input frequency is 200Kpps.

6.4.2. Internal Position Command (Pr Command)

The internal position command of Shihlin servo has eight sets of registers (parameter PA15 – parameter PA 30). The users have to set POS1 – POS3 of digital input DI to be usable. These eight sets of position commands have their corresponding position command shift speed parameter (PA31 – PA38). See the table below:

Position Command	POS3	POS2	POS1	CTRG	Position Command Parameter		Speed Parameter
P1	0	0	0	↑	Loops	PA 15	PA 31
					Number of Pulses	PA 16	
P2	0	0	1	↑	Loops	PA 17	PA 32

					Number of Pulses	PA 18	
P3	0	1	0	↑	Loops	PA 19	PA 33
					Number of Pulses	PA 20	
P4	0	1	1	↑	Loops	PA 21	PA 34
					Number of Pulses	PA 22	
P5	1	0	0	↑	Loops	PA 23	PA 35
					Number of pulses	PA 24	
P6	1	0	1	↑	Loops	PA 25	PA 36
					Number of pulses	PA 26	
P7	1	1	0	↑	Loops	PA 27	PA 37
					Number of pulses	PA 28	
P8	1	1	1	↑	Loops	PA 29	PA38
					Number of pulses	PA 30	

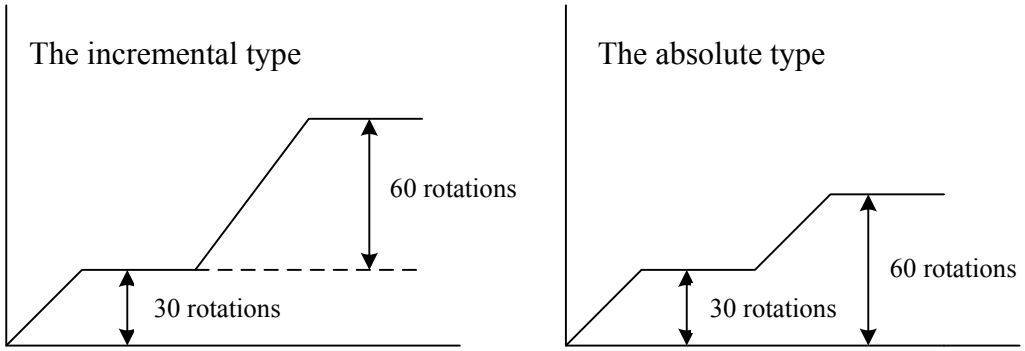
- CTRG ↑ suggests that the contact has been changed from an open circuit to a short circuit.
- State 0 of POS1 – POS3 denotes an open circuit; State 1 denotes a short circuit.
- Please set up a least one set of POS1 for digital input DI pin.

Absolute position control and incremental position control:

There are many applications for the absolute and the incremental type of position control. The users have to set up parameter PA01 before using these two modes.See the table below for parameter setup:

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode	Description
Control Mode Set Value	STY	PA 01	0000h ~ 1125h	No	0000h	ALL	u z y x X=0: Position Mode y=1: Internal register input (the absolute type) y=2: Internal register input (the incremental type)

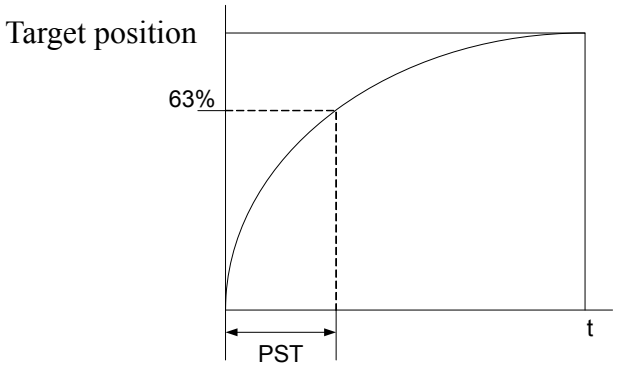
For example, if input position registers P1 and P2 are set as 30-rotation and 60-rotation commands respectively. P1 command is sent before P2 command. Differences between the absolute type and the incremental type of position control are displayed in the figure below:



6.4.3. Smoothing the Position Commands

The filter time constant for setting up the position command can make motor operation smoother when the sever actuator experience sudden and severe change from the position commands if this parameter is appropriately set.

Name	Parameter Code	Set Range	Unit	Default Value	Control Mode
Position Command Filter Time Constant	PB 04	0~20000	ms	3	Pt、Pr



Also, the users can use the speed smoothing treatment of acceleration and deceleration to make the servo motor operation smoother.See the table below for

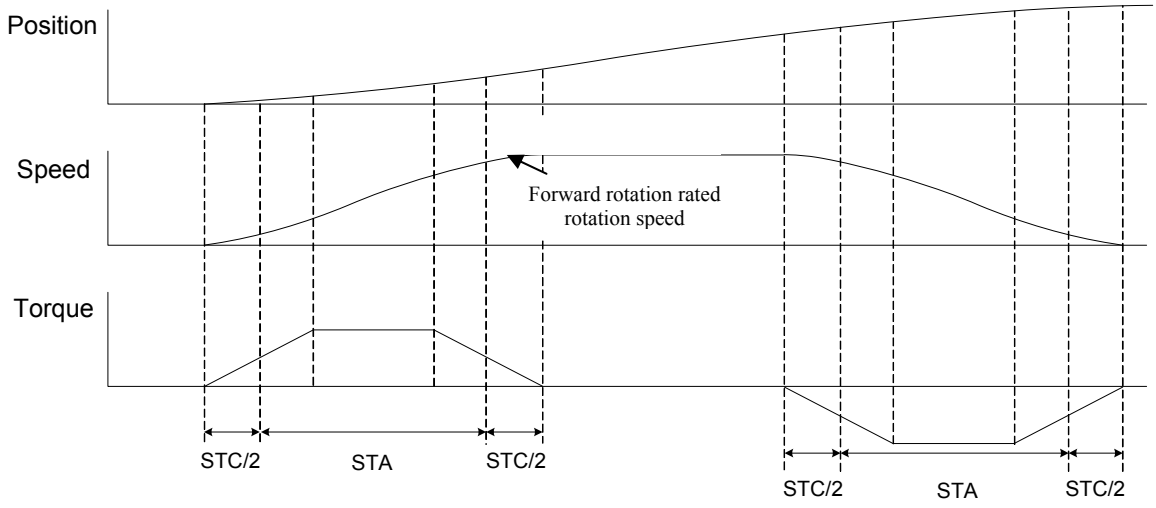
parameters related to the speed smoothing treatment of position acceleration / deceleration:

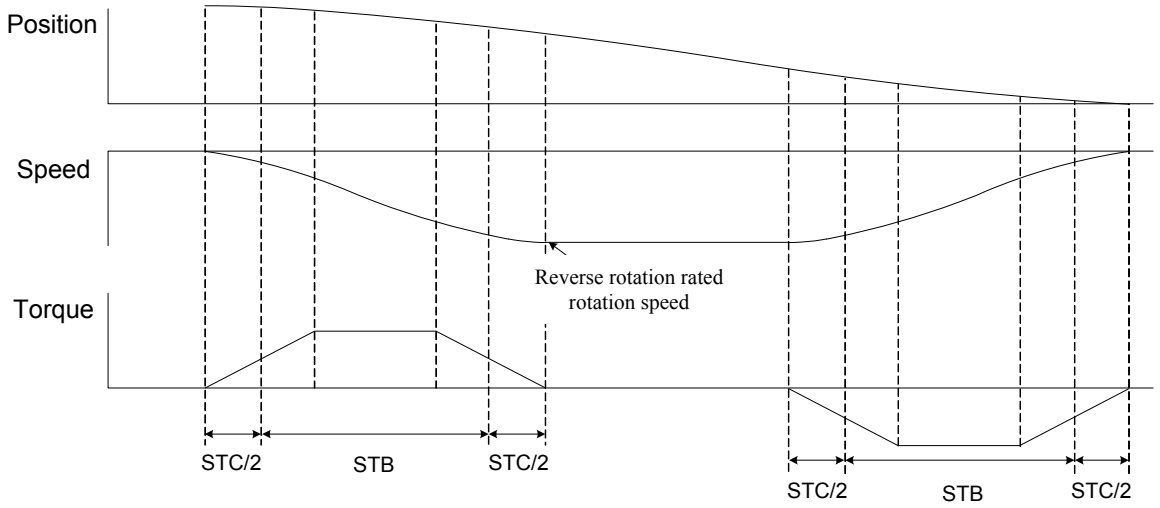
Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
Acceleration time constant	STA	PC 01	0~20000	ms	200	Pt, Pr, S, T
Deceleration time constant	STB	PC 02	0~20000	ms	200	Pt, Pr, S, T
S-shape acceleration/deceleration time constant	STC	PC 03	0~10000	ms	0	Pt, Pr, S, T

◆ It is recommended for the user to turn on PC03 function during the operation.

Using speed smoothing treatment of acceleration / deceleration can effectively improve motor's acceleration / deceleration characteristics.Having an increase of motor load terminal inertia or at an occasion with apparent inertia change may cause bumpy motor operation due to inertia or fraction. In this case, the user can increase parameters STA (PC01), STB (PC02), STC (PC03) to effectively enhance the unsmooth motor operation.

When the position command is under an external pulse signal input state, parameter STA (PC01), STB (PC02), STC (PC03) would become invalid because the continuity of speed and angular acceleration of external inputted pulse command have been determined by the host controller.





It can be found from the figure above that when position command sends a forward rotation command, the acceleration / deceleration times are controlled by the speed acceleration time constant (PC01). On the other hand, when the position command sends a reverse rotation commend, the acceleration / deceleration time will be controlled by the speed deceleration time constant (PC02).

When using internal register as a position command, it is recommended that the users arrange the acceleration / deceleration time and the time for the S-shape acceleration / deceleration time constant (PC01 – PC03) to make motor operation smoother.

6.4.4. Electronic Gear Ratio

The users can set different electronic gear ratio to enable the transmission gear to shift different distance. Relevant parameters are presented below:

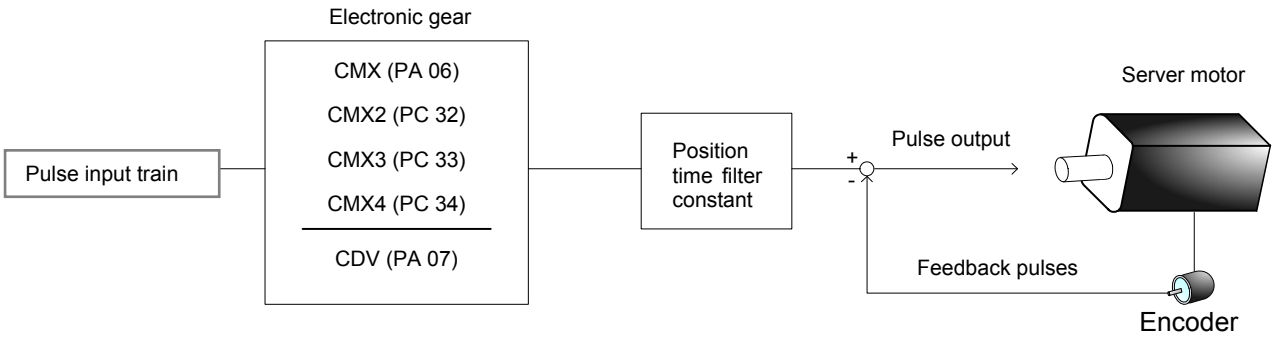
Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
The numerator of the electronic gear ratio	CMX	PA06	1~32767	No	1	Pt、Pr
The denumerator of the electronic gear ratio	CDV	PA07	1~32767	No	1	Pt、Pr
Numerator of the Second Set Electronic Gear Ratio	CMX2	PC 32	1~32767	No	1	Pt、Pr

Numerator of the Third Set Electronic Gear Ratio	CMX3	PC 33	1~32767	No	1	Pt、Pr
Numerator of the Fourth Set Electronic Gear Ratio	CMX4	PC 34	1~32767	No	1	Pt、Pr

When setting up electronic gear ratio, make sure to make the set up at SERVO OFF, or wrong setup can cause overshoot of the servo motor.

When setting up the electronic gear ratio, make sure that 1/50 ≤ electronic gear ratio ≤ 200, or otherwise the motor cannot run normally.

The relation among the numerator and the denominator of electronic gear and the commands are presented as follows:



Four sets of numerators of electronic gear are available for the user to select. Set two registers of the digital input DI as CM1 and CM2 to carry out the switching. See the table below:

Name	CM1	CM2	Control Mode
Electronic Gear Ratio Numerator 1 (PA06)	0	0	Pt、Pr
Electronic Gear Ratio Numerator 2 (PC32)	0	1	Pt、Pr
Electronic Gear Ratio Numerator 3 (PC33)	1	0	Pt、Pr
Electronic Gear Ratio Numerator 4 (PC34)	1	1	Pt、Pr

◆ State 0 of CM1 and CM2 denotes an open circuit; State 1 denotes a short circuit.

Electronic gear ratio calculation

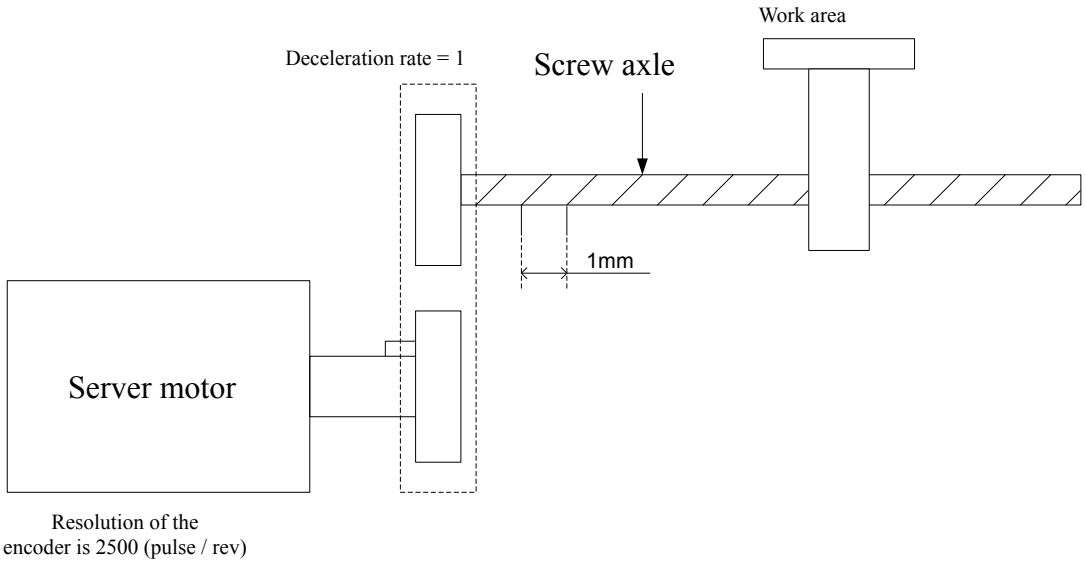
Before calculating the electronic gear ratio, the users have to understand system specifications such as the motor encoder's resolution is 2500 pulse /rev, the deceleration rate of the machine, and the gear ratio.

Use the following equation to calculate the electronic gear ratio:

$$\text{Electronic gear ratio} = \frac{\text{Motor encoder resolution} \times 4}{\text{shifted distance per load rotation (angle) / intended shifted distance of the pulse entered by the user}}$$

If there is a deceleration rate between the motor loads, multiply the above equation with the deceleration rate (i.e., the number of motor axle rotations / the number of load axle rotations).

The following example explains the method to set up the electronic gear ratio:



It can be found from the above figure that every one rotation of the load (screw shift) would shift a distance of 1 mm, and the motor resolution is 2500 pulse /rev. If the user needs the load axle to rotate 5 μm, place 5 μm into the electronic gear ratio equation:

$$\text{Electronic gear ratio} = \frac{2500\text{Pulse/rev} \times 4}{1\text{mm/rev} \div 5\mu\text{m/Pulse}} = \frac{10000}{200}$$

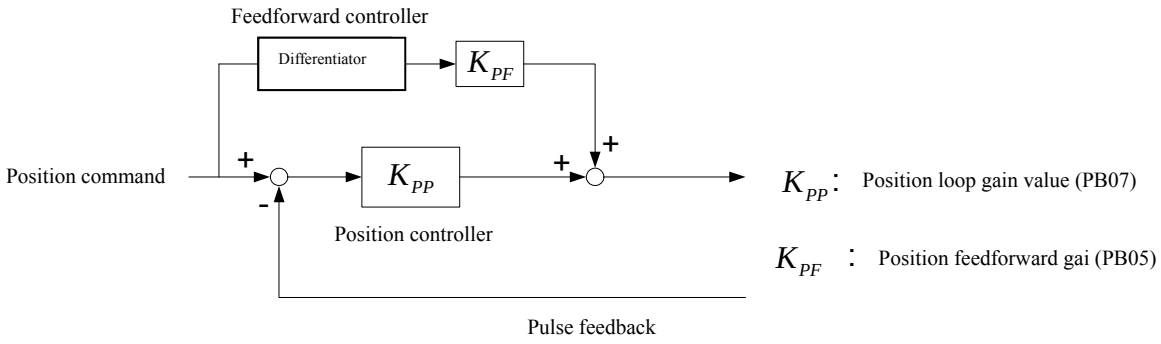
It can be found that by setting the numerator of electronic gear ratio as 10000 and the denominator of the electronic gear ratio as 200, then the screw shaft would shift 5μm after inputting the pulse.

6.4.5. Torque Restriction of the Position Loop

Same as Section 6.3.4

6.4.6. Position Loop Gain

Because the position loop includes the speed loop, set up speed gain relevant parameters (see Section 6.3.5) before setting the position loop if the user needs to use the manual mode for adjustment. Afterward the user can set up the position ratio gain and the position feedforward gain. For the position loop gain, the user can take 1/4 – 1/6 of the value of the speed loop gain.The user can also use the auto-tuning mode for automatically setting up the position and the speed related gain.Position circuit block diagram is presented below:



Parameters related to position gain adjustment are listed below:

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
Auto-tunning mode 1	ATUM	PA02	0000h~0003h	No	0002h	Pt, Pr, S
Auto-tunning responsiveness setup	ATUL	PA03	0001h~000Fh	No	0005h	Pt, Pr, S
Position Feedforward Gain Value	FFC	PB05	0~20000	0.0001	0	Pt、Pr

Position Loop Gain Value	PG1	PB07	4~1024	rad/s	35	Pt、Pr

If position loop gain PG1 (parameter PB07) is set too large, the motor will rotate back and forth and generate vibration even though the bandwidth and responsiveness are becoming faster. These phenomena are not permitted for occasions requiring an accurate position control. In this case, be sure to reduce PG1 value to prevent motor vibration.

If the bandwidth is restricted by the machine so the position feedback fails to track the position command and cannot satisfy the requirement for reasonable position errors. In this case, position feedfoward gain can be used to reduce the dynamic error of position tracking. In other words, the use of position feedfoward gain also relatively increases the position setting time.

The method for adjusting position feedfoward gain is carried out from the bottom to the top. Theoretically, one is best set value. If the value is set too large, machine may produce vibration easily. In this case, the users should reduce the position feedforward value to a level that does not generate vibration.

6.5. Combined Control Mode

Shihlin servo provide five types of combine mode for users who frequently need to change the control mode.Parameter PA01 can change the setup of the combine mode. See the table below:

Mode		Code	Parameter PA01 Setup	Description
Combined Model	External terminal position - speed	Pt-S	0001h	The switch for Pt to S or *vice versa* is carried out by DI signals.
	External terminal position - torque	Pt-T	0005h	The switch for Pt to T or *vice versa* is carried out by DI signals.
	Internal register position - speed	Pr-S	0011h	The switch for Pt to S or *vice versa* is carried out by DI signals.
	Internal register position - Torque	Pr-T	0015h	The switch for Pt to T or *vice versa* is carried out by DI signals.
	Speed - Torque	S-T	0003h	The switch for S to T or *vice versa* is carried out by DI signals.

The arrangement of digital input DI and output DO is critical when using the combine mode. To avoid insufficient DI/DO pins, the users can select external analog input for the speed and the torque at the speed / torque mode, or for the position mode, external input pulse can be used to reduce DI.

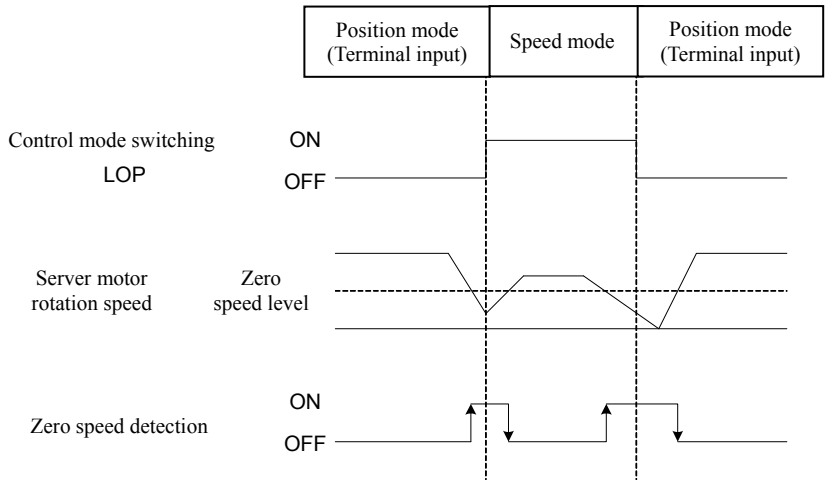
The digital input DI pin of the switching mode is the LOP pin. Please set DI to be LOP usable. See the following table:

<table>
<tr><th>Name</th><th>Parameter Code</th><th>I/O Classification</th><th>CN1 Arrangement</th><th>Description</th><th>Control Mode</th></tr>
<tr><td>Control Switch</td><td>LOP</td><td>DI</td><td>CN1-21 (default)</td><td>Select the control mode at the position/speed control switching mode.
<table>
<tr><td>(Note) LOP</td><td>Control Mode</td></tr>
<tr><td>0</td><td>Position</td></tr>
<tr><td>1</td><td>Speed</td></tr>
<tr><td>Select the control mode at the position/speed control switching mode.
(Note) LOP</td><td>Control Mode</td></tr>
<tr><td>0</td><td>Speed</td></tr>
<tr><td>1</td><td>Torque</td></tr>
<tr><td>Select the control mode at the position/speed control switching mode.
(Note) LOP</td><td>Control Mode</td></tr>
<tr><td>0</td><td>Torque</td></tr>
<tr><td>1</td><td>Position</td></tr>
</table>
Note 0: OFF (SG opened);
1: ON(SG short circuit)</td><td>Explained according to different control modes</td></tr>
</table>

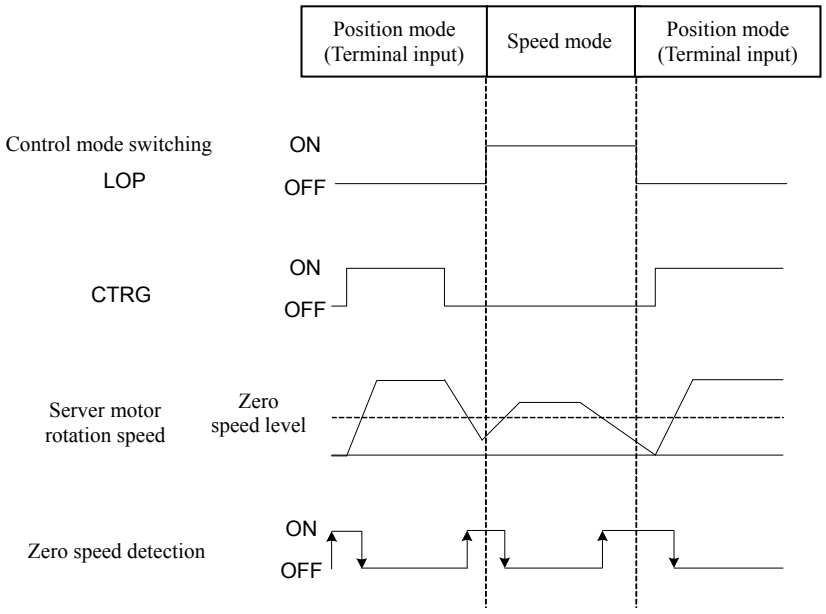
- ST1 and RS2 are assigned as for the same pin in DI. At the speed and torque combine mode, switching LOP to the stoped mode will induce automatic switching this pin to ST1 function. When LOP is changed to the torque mode,the pin will be changed automatically to the RS2 function. The rest such as POS1/SP2, PC/ST1, RS2/PC, TL/ST2, ST2/RS1, RS1/TL and CR/SP1 are also assigned to have the same DI input pin. At the actuator judgment mode, they will be changed to the corresponding functions automatically.See Section 3.4.2 for more details.

6.5.1. Position / Speed Combined Mode

The position / speed mode has two types: Pt / S and Pr / S. The users can make changes using the LOP terminal of the digital input DI pin.When parameter PA01 is set as the terminal input of the position mode or the internal register input, the order for changing with the speed mode is presented in the figure below:

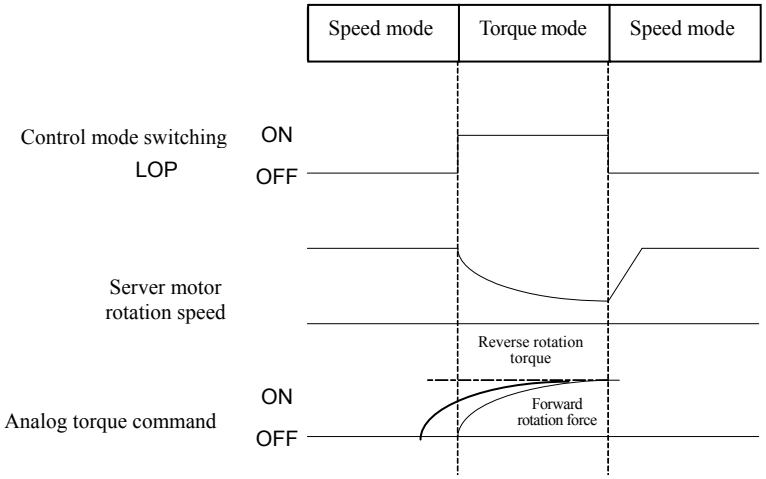


Modes cannot be changed if the motor is at a high speed rotation.Change of the control mode can be carried out at the zero speed output terminal (ZSP ON) of digital output (DO). Yet it is still recommended for the user to change mode when the motor is stopped completely.



6.5.2. Speed / Torque Combine Mode

Set parameter PA01 as 0003H before using the speed / torque combined mode. The users can use the LOP terminal of digital input DI pin to change the speed / torque mode.Because DI terminal ST1 (ST2) of the speed mode corresponds to RS2(RS1) of the torque mode, motor rotation will reverse when changing between the speed and the torque modes.The sequence diagram of the speed / torque mode is presented below:



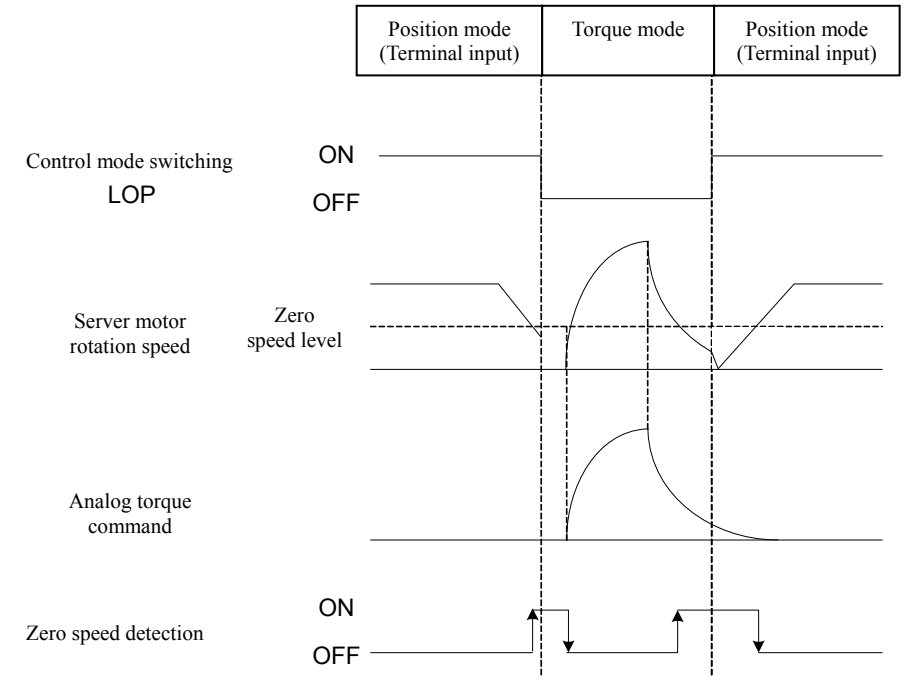
It is recommended that the users switch between the speed and the torque modes when the motor is stopped completely.

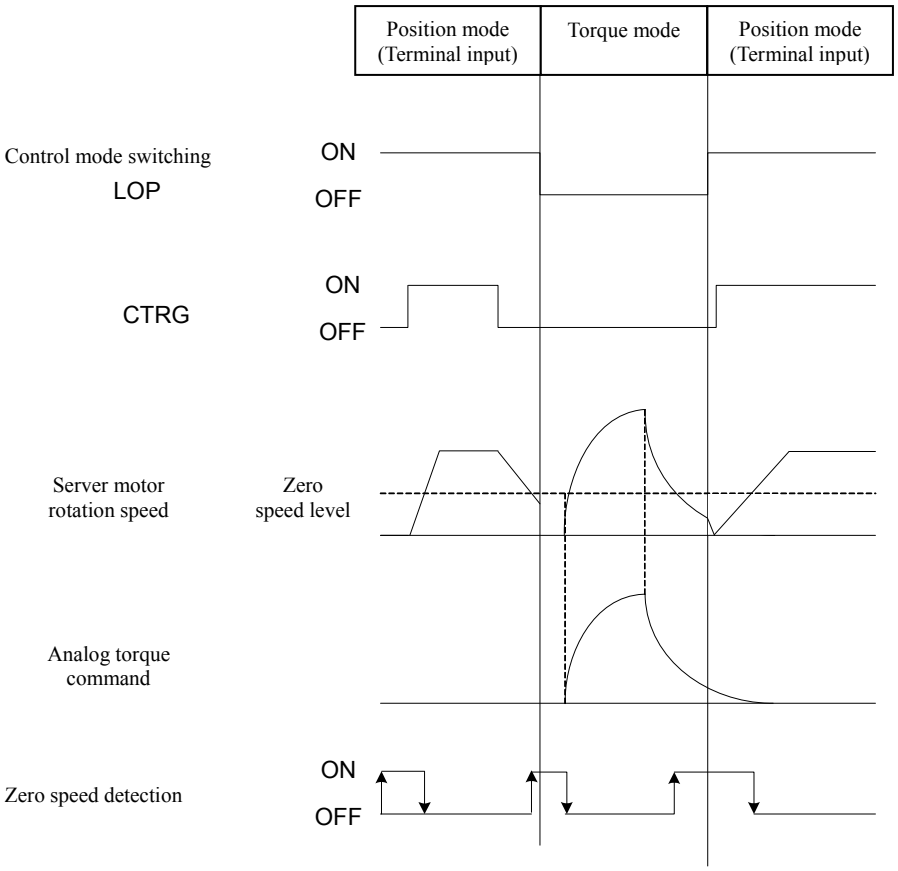
6.5.3. The Torque / Position Combined Mode

The torque / position combined mode has two types: T / Pt and T / Pr. The users can set parameter PA01 as 0005H (T/Pt mode) or 0015H (T/Pr mode).

Modes cannot be changed if the motor is at a high speed rotation.Control mode can be changed at the zero speed output terminal of digital output (DO).

The users can use the LOP terminal of digital input DI pin to switch between the torque / position combine mode. When changed to the position mode, the users have to switch the CTRG button from OFF to ON for the servo motor to carry out position control at the internal register mode. See the following sequence diagram for more details:





It is recommended that the users switch between the speed and the torque modes when the motor is stopped completely.

6.6. Othe Functions

6.6.1. Regenerative Resistor Selection

When the motor output direction is the opposite of the rotation direction, the motor will become a power generator from an electric machine. The energy will be transmitted back to the actuator from the load terminal. At this point, the PN terminal voltage will raise and requires a regenerative protection function to stabilized the safety voltage (within 370V) to prevent damaging the modules and the capacitance.IGBT and resistors constitute the major function. Regenerative energy is depleted by the resistors. Pay attention to the allowable energy volume of the resistor.Regenerative protection function is controlled by regenerative transistor. As a result, it is important to check the regenerative transistor. If the regenerative transistor is broken, make he motor stopped immediately to avoid energy continuously regenerated causing actuator damages.

There is a built-in regenerative resistor inside the actuator for the users. If the regenerative energy is too large, it is not recommended to use the built-in regenerative transistor. Instead, use external regenerative resistor to avoid overheating the built-in regenerative resistor or incapability to deplete the energy and thus damaging the actuator.

The external terminal PDC of actuator allows the user to select between the externally connected generative resistor or the built-in regenerative resistor. When using the built-in regenerative resistor, make sure that the PD terminal is a short circuit.When external regenerative resistor is required, make PD terminal the open circuit while the external resistor is connected to the PC terminal.

Built-in regenerative resistor specifications for assorted machine of Shihlin servo are described below:

Actuator (w)	Built-in regenerative resistor specification		The smallest permissive electric resistor value	Regenerative value treated by the internal regenerative resistor
	Resistor (Ω)	Volume (W)		
100	100	20	100	10
200	100	20	100	10
400	100	20	100	10
500	100	20	100	10

750	40	40	40	20
1000	40	40	40	20
1500	13	100	13	100
2000	13	100	13	100
3500	13	100	13	100

- The regenerative capacity of built-in regenerative resistor treatment is the average of the treatable regenerative capacity. This value is 50% of the rated capacity of the built-in regenerative resistor. It is the same for the external regenerative resistor's treatable regenerative capacity.

The user should connect it to external regenerative resistor if the regenerative capacity exceeds the regenerative capacity of built-in generative resistor.When making external connection, make sure to select regenerative resistor with same resistance. If serial and parallel connections are adopted to increase resistor power, be certain that the resistance qualifies the restriction criteria.Regenerative resistors adopting a thermal sensitive switch can effective help resistors to reduce temperature. Force cooling can also be applied to reduce temperature.Contact the manufacturers for load characteristics of resistors.

The following table provides regenerative and capacitor energy for users to use as a reference or to select the required regenerative resistors.

Actuator (w)	Rotor Inertia J ($x10^{-4}kg \cdot m^2$)	Regenerative Energy produced by a motor's sudden stop or switching of rotation direction (Es, joule)	Regenerative Energy of the Capacity (Joule)
100	0.086	0.4	10.83
200	0.207	1	10.83
400	0.303	1.5	10.83
500	6.51	14.3	10.83
750	1.519	7.5	18.85
1000	12.63	27.8	18.85

1500	18.75	41.2	40.9
2000	38	83.5	40.9
3500	76	167	54.5

Equation for energy calculation is provided below:

$$E_S = \frac{1}{2} J\omega^2 = \frac{1}{2}(J_L + J_M)\left(\frac{2\pi \times N_M}{60}\right)^2$$

$$E_C = \frac{1}{2} C\left(V_S{}^2 - V_C{}^2\right)$$

J_L: Load inertia; J_M: Rotor inertia; N_M: Rated rotation speed (rpm); V_C: capacitor voltage before regeneration; V_S: PN terminal voltage when regeneration is turned on

If there is an externally connected regenerative resistor, take the following steps to calculate regenerative resistor capacity:

1. Set up the action cycle T, which is defined by the user.
2. Set up the rotation speed N_M.
3. Set up the load inertia and the rotor inertia.
4. Calculate regenerative energy $E_S = \frac{1}{2} J\omega^2 = \frac{1}{2}(J_L + J_M)\left(\frac{2\pi \times N_M}{60}\right)^2$.
5. Calculate regenerative energy of the capacitor $E_C = \frac{1}{2} C\left(V_S{}^2 - V_C{}^2\right)$.
6. Calculate the capacity of the regenerative resistor $2 \times \left(\left(N+1\right) \times E_S - E_C\right)/T$.

If load inertia is N-fold of rotor inertia, then regenerative energy will be (N+1)×Es when the motor has a rotation brake and the speed dropped to 0 r/min.

If the selected regenerative resistor is too small, the accumulated energy will get bigger and the temperature will also get higher.AL04 will happen if the temperature exceeds a certain value.

6.6.2. Analog Monitoring Function

For the users to see the required analog voltage signals, Shihlin actuator provides two sets of analog output monitoring channels (MON1 and MON2), which are located at CN1-30 (MON1) and CN1-32 (MON2).The monitoring content and the setup of these two sets of analog output monitoring are provided in the table below:

Name	Parameter Abbreviation	Parameter Code	Set Range	Description	Default Value	Control Mode
Analog Control Output Monitoring	MOD	PC 14	0000h ~ 0707h	Analog monitoring output setup has two monitoring outputs:Ch1 and Ch2. 0 ch2 0 ch1 The set values of CH1 and CH2 and their corresponding output are presented below: 0: Motor rotation speed (±10V/2-fold of the rated rotation speed) 1: Motor torque (±10V/the maximum torque) 2: Speed command (±10V/2-fold of the rated rotation speed) 3: Effective loading rate (±10V/±300%) 4: Pulse command frequency (±10V/500k pules/s) 5: Current command (±10V/the maximum current command) 6: dc bus voltage (±10V/400V) 7: The number of error pulses (±10V/10000pulse)	0100h	ALL

Here is one example:

If analog output monitoring (PC14) is set as 0000, then the motor's rated rotation speed would be ±3000 rpm (± indicates forward or reverse rotation), and the current rotation speed of the motor would be 3000 rmp in forward rotation.The users can detect the

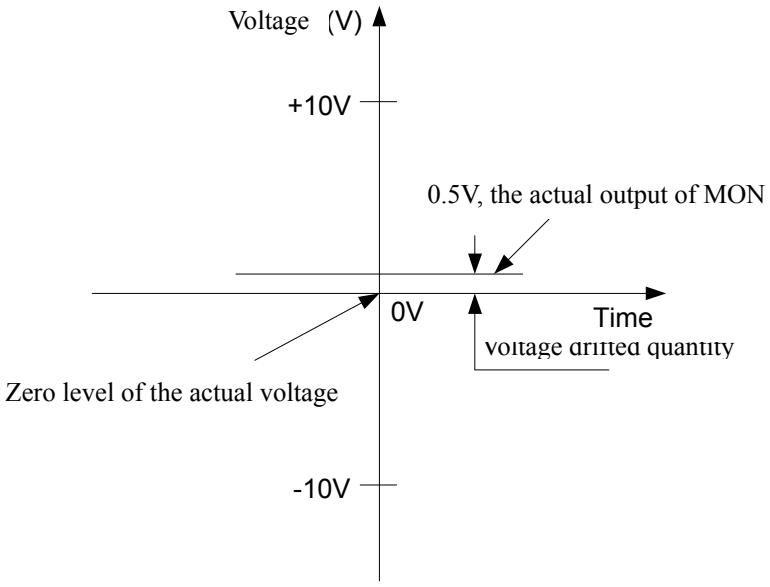
analog voltage output of +5V from CN1-30.In the example above, the analog voltage value is observed when the parameters of PC28 – PC31 are unadjusted.

Analog monitoring voltage drift

Analog monitoring voltage drift parameter enables the users to make calibration when the analog voltage shows a drift. Assuming that the zero electric potential of MON1 and MON2 are different from the actual voltage's zero electric potential, the users can adjust the analog monitoring voltage drift parameter. See the description below:

Name	Parameter Abbreviation	Parameter Code	Set Range	Description	Unit	Default Value	Control Mode
Voltage drift of Analog monitoring MO1	MO1	PC 28	-999 ~ 999	It is used to set up the voltage drift outputted by analog monitoring MON1	mV	0	ALL
Voltage Drift of Analog Monitoring MO2	MO2	PC 29	-999 ~ 999	It is used to set up the voltage drift outputted by analog monitoring MON2	mV	0	ALL

Here is one example:



Assuming that the rotation speed of the motor is 0 rpm, then the voltage displayed by the analog output monitoring (MOD) should be 0 V.

It can be found from the above that there is 0.5 V differences between MOD's output analog voltage and the actual voltage. In this case, the user can set PC28 or PC29 as -500 so the MOD analog voltage will be corrected to be the same as the actual voltage.If MOD analog voltage is smaller than the actual voltage, enter the correct value at PC28 or PC29.

Analog monitoring output ratio

The analog monitoring output ratios enable the users to set up the resolution of the analog voltage output to be viewed. Related parameters are presented in the table below:

Name	Parameter Abbreviation	Parameter Code	Set Range	Description	Unit	Default Value	Control Mode
Analog monitoring output ratio of MON1	MOG1	PC 30	0~100	Set the largest output ratio of analog monitoring 1	%	100	ALL
Analog monitoring output ratio of MON2	MOG2	PC 31	0~100	Set the largest output ratio of analog monitoring 2	%	100	ALL

If the motor's rated rotation speed is ±3000rpm, and the current rotation speed is +3000 rpm, the the voltage displayed by MON should be + 5V. If MOG1 or MOG2 are set as 50%, the analog voltage displayed by MON would be + 10V.

The equation is:

$$\text{MOD voltage output} \quad -\frac{\text{Current monitored value}}{\text{maximum monitored value}} \times 10\text{V} \div \text{MOG}$$

The unit of MOG1 and MOG2 is %.

7. Parameter Setup

7.1. Parameter Setup

Based on safety and usage frequency consideration, Shihlin actuator has the parameters divided into basic parameter, gain, filter parameter, expansion parameter, and input/output setup parameters. Modify the set value of parameter PA42 in order to modify the setup of expansion parameter f it is necessary to adjust the read and write permission.
Here are some notes from the parameter manual:

1. **Classification of Parameter Properties**

There is a parameter list that classifies parameters according to their functions for the users. Read Chapter to gain a better understanding the descriptions on parameters.

2. **Special Symbols for Parameter Coding**

Blue fonts in the text suggest uncertainty and will be modified later.

(*) suggests to restart the machine for the parameters to be effective: Take parameter PA01 for example.

(▲) suggests that the parameters cannot be set at Servo ON, e.g., PA07.There are two ways to turn off the Servo:

(1) Turn of the SON signal of DI.

(2) Make PD16 = 1 (change to the communication software contact mode), and the servo will be at Servo OFF state. But when the modification is completed, be sure to make PD16 = 0 in order to return to the initital external terminal mode.

Group classification is provided in the table below according to different functions.

Parameter Groups	Content
Basic Parameter Setup (No PA□□)	This is used for servo actuator's position control. Make sure to set up this basic parameter.
Gain, Filter Parameter (No PA□□)	Set up this parameter for using manual tunning gain for the adjustment.

Expansion Parameter Setup (No PA□□)	This is the speed mode of servo actuator. Set up this parameter when using the torque control mode.
Input/Output Parameter Setup (No PA□□)	It is used when changing the input / output signal of the servo actuator.

The control mode is explained below:

Mode		Code	Description
Single Mode	Position Mode (terminal input)	Pt	The actuator accepts position commands for controlling the motor to reach the target position. Position commands are inputted by the terminal block, and the signals are in the form of pulse waves.
	Position Mode (Internal Register)	Pr	The actuator accepts position commands for controlling the motor to reach the target position. Position commands are given by the internal register (eight sets of registers). The user can use DI signals to select the register code.
	Speed Mode	S	The actuator accepts speed commands for controlling the motor to reach the target rotation speed. DI signals can be used to select the speed command to be analog voltage command or internal speed command (seven sets of register).
	Torque Mode	T	The actuator accepts torque commands for controlling the motor to reach the target torque. Torque commands are provided by analog voltage commands.
Combined Model		Pt-S	The switch for Pt to S or *vice versa* is carried out by DI signals.
		Pt-T	The switch for Pt to T or *vice versa* is carried out by DI signals.
		Pr-S	The switch for Pt to S or *vice versa* is carried out by DI signals.
		Pr-T	The switch for Pt to T or *vice versa* is carried out by DI signals.
		S-T	The switch for S to T or *vice versa* is carried out by DI signals.

7.2. Parameter List

Shihlin servo parameters can be organized into four categories: PA, PB, PC and PD parameters groups.PA parameters are basic parameters, for example, control mode selection, auto-tuning, etc.PB parameters are gain filter parameters. PB parameter is set to adjust the servo motor to achieve a more stable running.PC parameters are expansion parameters. It includes parameters used for the speed mode and the torque mode, as well as analog-related parameters and communication setup parameters.PD parameters are input/output setup parameters. It enables the users to set up parameters for digital input DI and digital output DO.The following table lists all the parameters of Shihlin servo actuator for the users who look for parameter codes.

I. Basic Parameter Setup

NO	Abbreviation	Name	Initial Value	Unit	Control Mode			
					Pt	Pr	S	T
PA01	STY	Control Mode	0000h		○	○	○	○
PA02	ATUM	Auto-tuning mode setup	0002h		○	○	○	
PA03	ATUL	Auto-tuning responsiveness setup	0005h		○	○	○	
PA04	HMOV	Zero Return Mode	0000h			○		
PA05	TL1	Torque restriction 1	100	%	○	○	○	○
PA06	CMX	The numerator of the electronic gear ratio	1		○	○		
PA07	CDV	The denominator of the electronic gear ratio	1		○	○		
PA08	HSPD1	Level 1 high-speed return to the origin speed setup	1000	rpm		○		
PA09	HSPD2	Level 2 high-speed return to the origin speed setup	50	rpm		○		
PA10	HOF1	Return to origin offset loops	0	rev		○		
PA11	HOF2	The number of return to origin offset pulses	0	pulse		○		
PA12	INP	Range to reach the position	100	Pulse	○	○		
PA13	PLSS	Pulse command options	0000h		○			
PA14	*ENR	The number of encoder output pulses	10000	Pulse rev	○	○	○	○
PA15	PO1H	The setup of the number of position rotations of internal position command 1	0	rev		○		
PA16	PO1L	The setup of the number of position pulses of internal position command 1	0	pulse		○		
PA17	PO2H	The setup of the number of position rotations of internal position command 2	0	rev		○		

PA18	PO2L	The setup of the number of position pulses of internal position command 2	0	pulse		○		
PA19	PO3H	The setup of the number of position rotations of internal position command 3	0	rev		○		
PA20	PO3L	The setup of the number of position pulses of internal position command 3	0	pulse		○		
PA21	PO4H	The setup of the number of position rotations of internal position command 4	0	rev		○		
PA22	PO4L	The setup of the number of position pulses of internal position command 4	0	pulse		○		
PA23	PO5H	The setup of the number of position rotations of internal position command 5	0	rev		○		
PA24	PO5L	The setup of the number of position pulses of internal position command 5	0	pulse		○		
PA25	PO6H	The setup of the number of position rotations of internal position command 6	0	rev		○		
PA26	PO6L	The setup of the number of position pulses of internal position command 6	0	pulse		○		
PA27	PO7H	The setup of the number of position rotations of internal position command 7	0	rev		○		
PA28	PO7L	The setup of the number of position pulses of internal position command 7	0	pulse		○		
PA29	PO8H	The setup of the number of position rotations of internal position command 8	0	rev		○		
PA30	PO8L	The setup of the number of position pulses of internal position command 8	0	pulse		○		
PA31	POV1	The setup of the speed of internal position control 1	1000	rpm		○		
PA32	POV2	The setup of the speed of internal position control 2	1000	rpm		○		
PA33	POV3	The setup of the speed of internal position control 3	1000	rpm		○		
PA34	POV4	The setup of the speed of internal position control 4	1000	rpm		○		
PA35	POV5	The setup of the speed of internal position control 5	1000	rpm		○		
PA36	POV6	The setup of the speed of internal position control 6	1000	rpm		○		
PA37	POV7	The setup of the speed of internal position control 7	1000	rpm		○		
PA38	POV8	The setup of the speed of internal position control 8	1000	rpm		○		
PA39	*POL	Motor rotation direction options	0000h		○	○	○	○
PA40	▲SPW	Write-in of special parameters	0000h		○	○	○	○
PA41		Preparation						
PA42	*BLK	Parameter write-in prohibited	0000h		○	○	○	○
PA43		Preparation						
PA44		Preparation						
PA45		Preparation						

II. Gain and Filter Parameters

NO	Abbreviation	Name	Initial Value	Unit	Control Mode			
					Pt	Pr	S	T
PB01	NHF1	The frequency of machine resonance suppression filter 1	1000	Hz	○	○	○	○
PB02	NHD1	Decay rate of machine resonance suppression filter 1	0	dB	○	○	○	○
PB03	NLP	Resonance suppression of low-pass filter	0	0.1ms	○	○	○	○
PB04	PST	Position command filter time constant	3	ms	○	○		
PB05	FFC	Position feedforward gain value	0	%	○	○		
PB06	GD1	Load inertia ratio of the servo motor	10	0.1-fold	○	○	○	
PB07	PG1	Position loop gain	35	rad/s	○	○		
PB08	VG1	Speed loop gain	817	rad/s	○	○	○	
PB09	VIC	Speed integral gain value	48	ms	○	○	○	
PB10	VFG	Speed feedforward gain value	0	0.0001			○	
PB11	CDP	Gain change options	0000h	None	○	○	○	
PB12	CDS	Gain change criteria	10	pulse	○	○	○	
PB13	CDT	Gain change constant	1	ms	○	○	○	
PB14	GD2	Load inertia ratio 2 of the servo motor	70	0.1-fold	○	○	○	
PB15	PG2	Change rate of position gain at gain switching	100	%	○	○	○	
PB16	VG2	Change rate of position gain at gain switching	100	%	○	○	○	
PB17	VIC2	Change rate of position integral gain at gain switching	100	%	○	○	○	
PB18	SFLT	Speed command low-pass smooth filter time constant	0	ms			○	○
PB19	TQC	Torque command filter time constant	0	ms				○
PB20		Preparation						
PB21	NHF2	The frequency of machine resonance suppression filter 2	1000	Hz	○	○	○	○
PB22	NHD2	Decay rate of machine resonance suppression filter 2	0	dB	○	○	○	○
PB23		Preparation						
PB24	VDC	Speed differential compensation	980	None	○	○	○	
PB25								
PB26								
PB27								
PB28								
PB29								
PB30								

III. Expansion Parameters

NO	Abbreviation	Name	Initial Value	Unit	Control Mode			
					Pt	Pr	S	T
PC01	STA	Acceleration constant	200	ms		○	○	○
PC02	STB	Deceleration constant	200	ms		○	○	○
PC03	STC	S-shape acceleration/deceleration time constant	0	ms		○	○	○
PC04		Preparation						
PC05	SC1	Internal speed command 1	100	rpm			○	○
PC06	SC2	Internal speed command 2	500	rpm			○	○
PC07	SC3	Internal speed command 3	1000	rpm			○	○
PC08	SC4	Internal speed command 4	200	rpm			○	○
PC09	SC5	Internal speed command 5	300	rpm			○	○
PC10	SC6	Internal speed command 6	500	rpm			○	○
PC11	SC7	Internal speed command 7	800	rpm			○	○
PC12	VCM	The maximum rotation speed of analog command speed	3000	rpm			○	○
PC13	TLC	The maximum output analog command torque	100	%	○	○	○	○
PC14	MOD	Analog control output monitoring	0100h	None	○	○	○	○
PC15	*SVZR	Zero voltage range of analog speed voltage	10	mV			○	○
PC16	MBR	Electromagnetic brake sequence output time	100	ms	○	○	○	○
PC17	ZSP	Zero speed signal output range	50	rpm	○	○	○	○
PC18	*COP1	Setup the motor stop mode options and the restart of instantaneous stopped power option	0010h	None			○	
PC19	*COP2	Abnormal record clear option	0000h	None	○	○	○	○
PC20	*SNO	Servo actuator communication station number	1	None	○	○	○	○
PC21	*CMS	Communication mode setup	0010h	None	○	○	○	○
PC22	*BPS	Communication protocol setup	0010h	None	○	○	○	○
PC23	SIC	Serial communication overtime option	0	S	○	○	○	○
PC24	*DMD	Actuator state display setup	0000h	None	○	○	○	○
PC25	TL2	Internal torque restriction 2	100	%	○	○	○	○
PC26	VCO	Analog speed command drift quantity	0	mV			○	○
PC27	TLO	Analog Torque Command / Restricted drift quantity	0	mV			○	○
PC28	MO1	Voltage drift of analog monitoring MON1	0	mV	○	○	○	○
PC29	MO2	Voltage drift of analog monitoring MO2	0	mV	○	○	○	○
PC30	MOG1	Analog monitoring output ratio of MON1	100	%	○	○	○	○
PC31	MOG2	Analog monitoring output ratio of MON2	100	%	○	○	○	○
PC32	CMX2	Numerator of the second set electronic gear ratio	1	None	○	○		
PC33	CMX3	Numerator of the third set electronic gear ratio	1	None	○	○		
PC34	CMX4	Numerator of the fourth set electronic gear ratio	1	None	○	○		
PC35		Preparation						
PC36		Preparation						

PC37		Preparation						
PC38		Preparation						
PC39		Preparation						
PC40		Preparation						
PC41		Preparation						
PC42		Preparation						
PC43		Preparation						
PC44		Preparation						
PC45		Preparation						

IV. Input/Output Parameter Setup

NO	Abbreviation	Name	Initial Value	Unit	Control Mode			
					Pt	Pr	S	T
PD01	*DIA1	Input communication auto-ON option	0000h	None	○	○	○	○
PD02	DI1	Input signal option 1	0001h	None	○	○	○	○
PD03	DI2	Input signal option 2	0007h	None	○	○	○	○
PD04	DI3	Input signal option 3	0009h	None	○	○	○	○
PD05	DI4	Input signal option 4	000Ah	None	○	○	○	○
PD06	DI5	Input signal option 5	0002h	None	○	○	○	○
PD07	DI6	Input signal option 6	0006h	None	○	○	○	○
PD08	DI7	Input signal option 7	0012h	None	○	○	○	○
PD09	DI8	Input signal option 8	0011h	None	○	○	○	○
PD10	DO1	Input signal option 1	0003h	None	○	○	○	○
PD11	DO2	Input signal option 2	0008h	None	○	○	○	○
PD12	DO3	Input signal option 3	0006h	None	○	○	○	○
PD13	DO4	Input signal option 4	0005h	None	○	○	○	○
PD14	DO5	Input signal option 5	0001h	None	○	○	○	○
PD15	*DIF	Digital terminal input filter setup	0002h	None	○	○	○	○
PD16	IOS	Software input contact communication control	0000h	None	○	○	○	○
PD17	*DOP1	LSP and LSN stop mode	0000h	None	○	○	○	
PD18	*DOP2	The setup of CR communication clear method	0000h	None	○	○		
PD19	*DOP3	Export abnormal code option	0000h	None	○	○	○	○
PD20	*DOP4	Action option at abnormal reset signal short circuit	0000h	None	○	○	○	○
PD21		Preparation						
PD22		Preparation						
PD23		Preparation						
PD24		Preparation						
PD25		Preparation						
PD26		Preparation						
PD27		Preparation						
PD28		Preparation						
PD29		Preparation						
PD30		Preparation						

To help the users using parameters and setting up required parameters of Shihlin servo at different mode, relevant parameters of all categories are listed below:

Torque Control Relevant Parameters								
Parameter Code	Abbreviation	Parameter Function	Initial Value	Unit	Control Mode			
					Pt	Pr	S	T
PA01(*)	STY	Control mode set value	0000h	None	○	○	○	○
PA05	TL1	Internal torque restriction 1	100	%	○	○	○	○
PC05	SC1	Internal speed restriction 1	100	rpm			○	○
PC06	SC2	Internal speed restriction 2	500	rpm			○	○
PC07	SC3	Internal speed restriction 3	1000	rpm			○	○
PC08	SC4	Internal speed restriction 4	200	rpm			○	○
PC09	SC5	Internal speed restriction 5	300	rpm			○	○
PC10	SC6	Internal speed restriction 6	500	rpm			○	○
PC11	SC7	Internal speed restriction 7	800	rpm			○	○
PC12 (▲)	VCM	The maximum rotation speed of analog command speed	3000	rpm			○	○
PC13 (▲)	TLC	The maximum output of analog command torque	100	%	○	○	○	○
PC25	TL2	Internal torque restriction 2	100	%	○	○	○	○
PC26	VCO	Analog Torque Command / Restricted drift quantity	0	mV			○	○
PC27	TLO	Analog Torque Command / Restricted drift quantity	0	mV			○	○

Speed Control Parameters								
Parameter Code	Abbreviation	Parameter Function	Initial Value	Unit	Control Mode			
					Pt	Pr	S	T
PA01(*)	STY	Control mode set value	0000h	None	○	○	○	○
PA05	TL1	Internal torque restriction 1	100	%	○	○	○	○
PA14*	ENR	The number of encoder output pulses	10000	pulse	○	○	○	○
PB18	SFLT	Speed command low-pass smooth filter time constant	0	ms			○	○
PC05	SC1	Internal speed command 1	100	rpm			○	○
PC06	SC2	Internal speed command 2	500	rpm			○	○
PC07	SC3	Internal speed command 3	1000	rpm			○	○
PC08	SC4	Internal speed command 4	200	rpm			○	○
PC09	SC5	Internal speed command 5	300	rpm			○	○
PC10	SC6	Internal speed command 6	500	rpm			○	○
PC11	SC7	Internal speed command 7	800	rpm			○	○
PC12 (▲)	VCM	The maximum rotation speed of analog command speed	3000	rpm			○	○
PC25	TL2	Internal torque restriction 2	100	%	○	○	○	○
PC26	VCO	Analog speed command drift quantity	0	mV			○	○
PC27	TLO	Analog Torque Command / Restricted drift quantity	0	mV			○	○

Position Control Parameters								
Parameter Code	Abbreviation	Parameter Function	Initial Value	Unit	Control Mode			
					Pt	Pr	S	T
PA01(*)	STY	Control mode set value	0000h	None	○	○	○	○
PA04	HMOV	Zero Return Mode	0000h	None		○		
PA05	TL1	Internal torque restriction 1	100	%	○	○	○	○
PA06	CMX	The numerator of electronic gear (the numerator of command pulse multiplying power)	1	None	○	○		
PA07 (▲)	CDV	The denominator of electronic gear (the denominator of command pulse multiplying power)	1	None	○	○		
PA13 (*)	PLSS	Pulse command options	0000h	None	○	○	○	○
PA14 (*)	ENR	The number of encoder output pulses	10000	pulse	○	○	○	○
PA15	PO1H	The setup of the number of position pulses of internal position command 1	0	Rev		○		
PA16	PO1L	The setup of the number of position pulses of internal position command 1	0	Pulse		○		
PA17	PO2H	The setup of the number of position pulses of internal position command 2	0	Rev		○		
PA18	PO2L	The setup of the number of position pulses of internal position command 2	0	Pulse		○		
PA19	PO3H	The setup of the number of position pulses of internal position command 3	0	Rev		○		
PA20	PO3L	The setup of the number of position pulses of internal position command 3	0	Pulse		○		
PA21	PO4H	The setup of the number of position pulses of internal position command 4	0	Rev		○		

Position Control Parameters								
Parameter Code	Abbreviation	Parameter Function	Initial Value	Unit	Control Mode			
					Pt	Pr	S	T
PA22	PO4L	The setup of the number of position pulses of internal position command 4	0	Pulse		○		
PA23	PO5H	The setup of the number of position pulses of internal position command 5	0	Rev		○		
PA24	PO5L	The setup of the number of position pulses of internal position command 5	0	Pulse		○		
PA25	PO6H	The setup of the number of position pulses of internal position command 6	0	Rev		○		
PA26	PO6L	The setup of the number of position pulses of internal position command 6	0	Pulse		○		
PA27	PO7H	The setup of the number of position pulses of internal position command 7	0	Rev		○		
PA28	PO7L	The setup of the number of position pulses of internal position command 7	0	Pulse		○		
PA29	PO8H	The setup of the number of position pulses of internal position command 8	0	Rev		○		
PA30	PO8L	The setup of the number of position pulses of internal position command 8	0	Pulse		○		
PA39(*)	*POL	Motor rotation direction options	0000h	None	○	○		
PC25	TL2	Internal torque restriction 2	100	%	○	○	○	○
PC32	CMX2	Numerator 2 of electronic gear (the numerator of command pulse multiplying power)	1	None	○	○		
PC33	CMX3	Numerator 3 of electronic gear (the numerator of command pulse multiplying power)	1	None	○	○		
PC34	CMX4	Numerator 4 of electronic gear (the numerator of command pulse multiplying power)	1	None	○	○		

Position Control Parameters								
Parameter Code	Abbreviation	Parameter Function	Initial Value	Unit	Control Mode			
					Pt	Pr	S	T
PA31	POV1	The setup of the speed of internal position control 1	1000	rev		○		
PA32	POV2	The setup of the speed of internal position control 2	1000	rev		○		
PA33	POV3	The setup of the speed of internal position control 3	1000	rev		○		
PA34	POV4	The setup of the speed of internal position control 4	1000	rev		○		
PA35	POV5	The setup of the speed of internal position control 5	1000	rev		○		
PA36	POV6	The setup of the speed of internal position control 6	1000	rev		○		
PA37	POV7	The setup of the speed of internal position control 7	1000	rev		○		
PA38	POV8	The setup of the speed of internal position control 8	1000	rev		○		

Filter Smoothing and Resonance Suppression Parameters								
Parameter Code	Abbreviation	Parameter Function	Initial Value	Unit	Control Mode			
					Pt	Pr	S	T
PB01	NHF1	The frequency of machine resonance suppression filter 1	1000	Hz	○	○	○	○
PB02	NHD1	Decay rate of machine resonance suppression filter 1	0	dB	○	○	○	○
PB03	NLP	Resonance suppression of low-pass filter	0	0.1ms	○	○	○	○
PB04	PST	Position command filter time constant	3	ms	○	○		
PB19	TQC	Torque command filter time constant	0	ms				○
PB21	NHF2	The frequency of machine resonance suppression filter 2	1000	Hz	○	○	○	○
PB22	NHD2	Decay rate of machine resonance suppression filter 2	0	dB	○	○	○	○
PC01	STA	Acceleration constant	200	ms		○	○	○
PC02	STB	Deceleration constant	200	ms		○	○	○
PC03	STC	S-shape acceleration/deceleration time constant	0	ms		○	○	○
*PD17	*DOP1	LSP and LSN stop mode	0000h	None	○	○	○	

Gain and Switching Parameters								
Parameter Code	Abbreviation	Parameter Function	Initial Value	Unit	Control Mode			
					Pt	Pr	S	T
PA02	ATUM	Auto-tuning mode setup	0002h	None	○	○	○	
PA03	ATUL	Auto-tuning responsiveness setup	0005h	None	○	○	○	
PB05	FFC	Position feedforward gain value	0	%	○	○		
PB07	PG1	Position loop gain	35	rad/s	○	○		
PB08	VG1	Speed loop gain	817	rad/s	○	○	○	
PB09	VIC	Speed integral gain value	48	ms	○	○	○	
PB10	VFG	Speed feedforward gain value	0	0.0001			○	
*PB11	CDP	Gain change options	0000h	None	○	○	○	
PB12	CDS	Gain change criteria	10	pulse	○	○	○	
PB13	CDT	Gain change constant	1	ms	○	○	○	
PB14	GD2	Load inertia ratio 2 of the servo motor	70	0.1-fold	○	○	○	
PB15	PG2	Change rate of position gain at gain switching	100	%	○	○		
PB16	VG2	Change rate of position gain at gain switching	100	%	○	○	○	
PB17	VIC2	Change rate of position integral gain at gain switching	100	%	○	○	○	
PB24	VDC	Speed differential compensation	980	None	○	○	○	

Digital Output/Input Pin Setup and Output Setup Parameters								
Parameter Code	Abbreviation	Parameter Function	Initial Value	Unit	Control Mode			
					Pt	Pr	S	T
PA12	INP	Range to reach the position	100	pulse	○	○		
PC17	ZSP	Zero speed signal output range	50	rpm	○	○		
PC16	MBR	Electromagnetic brake sequence output time	100	ms	○	○	○	
*PD01	DIA1	Input communication auto-ON option	-{}-0001h	None	○	○	○	
*PD02	DI1	Input communication option 1 (CN1-14 Pin)	0007h	None	○	○	○	○
*PD03	DI2	Input communication option 2 (CN1-15 Pin)	0009h	None	○	○	○	○
*PD04	DI3	Input communication option 3 (CN1-16 Pin)	000Ah	None	○	○	○	○
*PD05	DI4	Input communication option 4 (CN1-17 Pin)	0002h	None	○	○	○	○
*PD06	DI5	Input communication option 5 (CN1-18 Pin)	0006h	None	○	○	○	○
*PD07	DI6	Input communication option 6 (CN1-19 Pin)	0012h	None	○	○	○	○
*PD08	DI7	Input communication option 7 (CN1-20 Pin)	0011h	None	○	○	○	○
*PD09	DI8	Input communication option 8 (CN1-21 Pin)	0003h	None	○	○	○	○
*PD10	DO1	Input communication option 1 (CN1-41 Pin)	0008h	None	○	○	○	○
*PD11	DO2	Input communication option 2 (CN1-42 Pin)	0006h	None	○	○	○	○
*PD12	DO3	Input communication option 3 (CN1-43 Pin)	0005h	None	○	○	○	○
*PD13	DO4	Input communication option 4 (CN1-44 Pin)	0001h	None	○	○	○	○
*PD14	DO5	Input communication option 5 (CN1-45 Pin)	0001h	None	○	○	○	○
*PD15	DIF	Digital terminal input filter setup	0002h	None	○	○	○	○
PD16	IOS	Software input contact communication control	0000h	None	○	○		
*PD17	DOP1	LSP and LSN stop mode	0000h	None	○	○	○	
*PD18	DOP2	The setup of CR communication clear method	0000h	None	○	○		
*PD19	DOP3	Export abnormal code option	0000h	None	○	○	○	○
*PD20	DOP4	Abnormal reset; action option at signal short circuit	0000h	None	○	○	○	○

Communication Setup Parameter								
Parameter Code	Abbreviation	Parameter Function	Initial Value	Unit	Control Mode			
					Pt	Pr	S	T
*PC20	SNO	Servo actuator communication station number	1	Station	○	○	○	○
*PC21	CMS	Communication mode setup	0000h	None	○	○	○	○
*PC22	BPS	Communication protocol setup	0010h	None	○	○	○	○
PC23	SIC	Serial communication overtime option	0	s	○	○	○	○

Monitoring and Status Display Setup Parameters								
Parameter Code	Abbreviation	Parameter Function	Initial Value	Unit	Control Mode			
					Pt	Pr	S	T
PC14	MOD	Analog control output monitoring	0100h	None	○	○	○	○
*PC24	DMD	Actuator state display setup	0000h	None	○	○	○	○
PC28	MO1	Voltage drift of analog monitoring MON1	0	mV	○	○	○	○
PC29	MO2	Voltage drift of analog monitoring MO2	0	mV	○	○	○	○
PC30	MOG1	Analog monitoring output ratio of MON1	100	mV	○	○	○	○
PC31	MOG2	Analog monitoring output ratio of MON2	100	mV	○	○	○	○

Other Parameters								
Parameter Code	Abbreviation	Parameter Function	Initial Value	Unit	Control Mode			
					Pt	Pr	S	T
PA42	BLK	Anti-write protection at parameters zones	0000h	None	○	○	○	○
PA40(▲)	SPW	Special parameter write-in	0000h	None	○	○	○	○
*PC18	COP1	Setup the motor stop mode options and the restart of instantaneous stopped power option	0010h	None			○	
PB06	GD1	Load inertia ratio of the servo motor	10	0.1-fold	○	○	○	
PB14	GD2	Load inertia ratio 2 of the servo motor	70	0.1-fold	○	○	○	
*PD20	DOP4	Abnormal reset short circuit action option	0000h	None	○	○	○	○
*PC19	COP2	Abnormal record clear option	0000h	None	○	○	○	○

7.3. Parameter Group Descriptions

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PA01	STY (*)	Control Mode Set Value u z y x X: Control mode setup x=0: Position mode; x=1: Position and speed combine model x=2: Speed mode; x=3: Speed and torque combine mode x=4: torque mode; x=5: Torque and position combined mode Y: Position control command input options y=0: Terminal input y=1: Internal register input (the absolute type) y=2: Internal register input (the incremental type) z: Electromagnetic brake function turn-on option This is the digital output function; use parameters PD10 – PD14 to set up the direction.This function has to work in corporation with the servo motor that has electromagnetic brake. z=0: No electromagnetic brake function Z=1: Turn on the electromagnetic brake function u: DI and DO set value control u=0: When switching the mode, keep DI and DO (PD02 – PD14) values the default value. Do not change these values with changes in the mode. DI and DO can be planned. u=1: When switching the mode, DI and DO values have corresponding set value depending on the type of the mode. DI and DO cannot be planned.	Pr.Pt S.T	0000h	0000h ~ 1125h	None
PA02	ATUM (▲)	Auto-tuning mode setup 0 0 0 x X: Auto gain-tuning mode setup X=0: Manual Gain-tuning mode (PI control) x=1 : Manual gain-tuning mode (PI + Interference Compensator) X=2: Auto gain-tuning mode 1 (load inertia ratio; bandwidth tuned continuously) X=3: Autogain-tuning mode 2 (load inertia ratio fixed; bandwidth adjustable)	Pt、Pr S	0002h	0000h ~ 0003h	None

<table>
<tr><th>No</th><th>Abbre viation</th><th>Parameter Function and Description</th><th>Control Mode</th><th>Initial Value</th><th>Range</th><th>Unit</th></tr>
<tr><td>PA03</td><td>ATUL</td><td>Auto-tuning responsiveness setup
0 | 0 | 0 | x

X: Auto-tuning mode responsiveness setup

<table>
<tr><th>Responsiveness Setup</th><th>Responsiveness</th><th>Speed loop responsiveness frequency</th></tr>
<tr><td>1</td><td rowspan="4">Low responsiveness</td><td>5Hz</td></tr>
<tr><td>2</td><td>10 Hz</td></tr>
<tr><td>3</td><td>15 Hz</td></tr>
<tr><td>4</td><td>20 Hz</td></tr>
<tr><td>5</td><td rowspan="5">Medium responsiveness</td><td>30 Hz</td></tr>
<tr><td>6</td><td>40 Hz</td></tr>
<tr><td>7</td><td>55 Hz</td></tr>
<tr><td>8</td><td>70 Hz</td></tr>
<tr><td>9</td><td>85 Hz</td></tr>
<tr><td>A</td><td rowspan="6">High responsiveness</td><td>100 Hz</td></tr>
<tr><td>B</td><td>130 Hz</td></tr>
<tr><td>C</td><td>160 Hz</td></tr>
<tr><td>D</td><td>200 Hz</td></tr>
<tr><td>E</td><td>250 Hz</td></tr>
<tr><td>F</td><td>300 Hz</td></tr>
</table>
</td><td>Pr. Pt.
S</td><td>0005h</td><td>0001h
~
000Fh</td><td>None</td></tr>
</table>

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PA04	HMOV	Zero Return Mode u x y z U: Origin point triggering activation mode 0: Turn off the return to the origin function 1: Automatically execute the return to the origin function when the power source is turned on. 2: Trigger the return to the origin function from SHOM input contact. X: The origin stop mode O: Decelerate the motor and pull back to the origin after the origin test. 1: Decelerate the motor forward till it stops after the origin test. Y: Set up the short distance movement method when reaching the origin. 0: Return and search for the Z pulse after returned to the origin. 1: Do not return but search for the Z pulse after returned to the origin. 2: Position it at the detector origin or the z pulse after returned to the origin. Z: Set up the type of the origin detector and the search direction. 0: Return to the origin for forward rotation; take ORGP as the origin of the return. 1: Return to the origin for reverse rotation; take ORGP as the origin of the return. 2: Forward rotation and directly search for the z pulse as the return origin. 3: Reverse rotation and directly search for the z pulse as the return origin.	Pr	0000h	0000h ～ 1125h	None

<table>
<tr><th>No</th><th>Abbre viation</th><th>Parameter Function and Description</th><th>Control Mode</th><th>Initial Value</th><th>Range</th><th>Unit</th></tr>
<tr><td>PA05</td><td>TL1</td><td>Internal torque restriction 1
The set up of this parameter can restrict the torque produced by the servo motor. The set value of the parameter has % as the unit, and the calculation equation is presented below:Torque restriction value = the maximum torque x the set value

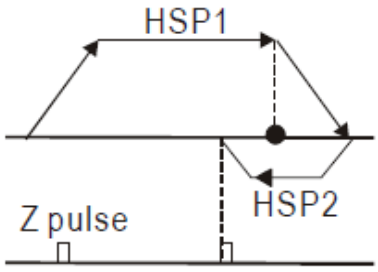
The input signal is used to select analog or internal parameter torque restriction. TL1 input signal can be used for selecting between internal parameter torque restriction 1 and 2.

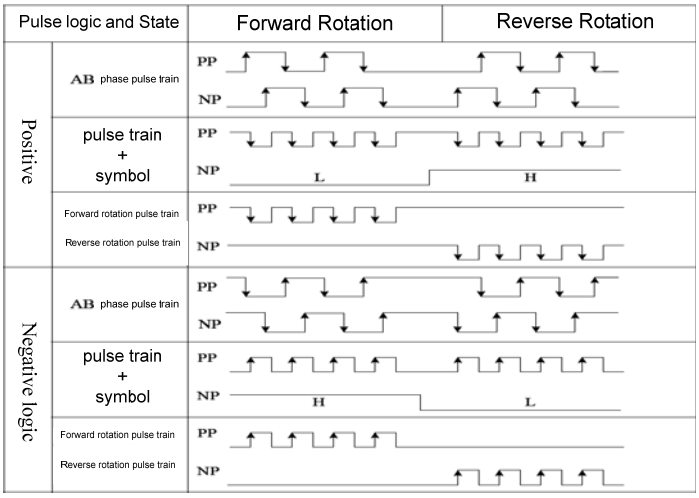
If the external input signals TL and SG are open circuit, options for torque restriction are presented below:

<table><tr><th>TL and SG</th><th>Torque Limit</th></tr><tr><td>Open circuit</td><td>Torque restriction = PA05</td></tr><tr><td>Short circuit</td><td>If TLA < PA05, then torque restriction = TLA.
If TLA > PA05, then torque restriction = PA05.</td></tr></table>
If the external input signals TL and SG are open circuit, options for torque restriction are presented below:

<table><tr><th>TL and SG</th><th>Torque Limit</th></tr><tr><td>Open circuit</td><td>If PC 25 < PA 05, then torque restriction = PC25.
If PC 25 > PA 05, then torque restriction = PA 25.</td></tr><tr><td>Short circuit</td><td>If PC 25 < TLA, then torque restriction = PC 25.
If PC 25 > TLA, then torque restriction = TLA.</td></tr></table></td><td>Pt、Pr S, T</td><td>100</td><td>0 ~ 100</td><td>%</td></tr>
<tr><td>PA06</td><td>CMX</td><td>The numerator of the electronic gear ratio</td><td>Pt、Pr</td><td>1</td><td>1 ~ 32767</td><td>None</td></tr>
<tr><td>PA07</td><td>CDV (▲)</td><td>The denominator of the electronic gear ratio
When setting up electronic gear ratio, make sure to make the set up at SERVO OFF, or wrong setup can cause overshoot of the servo motor.

Command pulse input ratio setup</td><td>Pt、Pr</td><td>1</td><td>1 ~ 32767</td><td>None</td></tr>
</table>

No	Abbre viation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
		Command pulse input f1 → [CMX / CDV] → Position command f2=f1 · CMX/CDV				
PA08	HSPD1	Level 1 high-speed return to the origin speed setup 	Pr	1000	1 ~ 2000	rpm
PA09	HSPD2	Level 2 high-speed return to the origin speed setup	Pr	50	1 ~ 500	rpm
PA10	HOF1	Return to origin offset loops	Pr	0	-30000 ~ 30000	rev
PA11	HOF2	The number of return to origin offset pulses When HOF1 and HOF2 are zero, the origin will be the Z pulse or ORGP according to PA04.If the set value is not equal to zero, add one pulse shift quantity to the above mentioned Z pulse or ORGP; Take HOF1 x 10000 + HOF2 as the new origin.	Pr	0	-9999 ~ 9999	pulse
PA12	INP	Range to reach the position At the position control mode, export terminal INP will send signals out when the phase difference between the position command and the actual motor position is less the set value of INP.	Pt、Pr	100	0 ~ 10000	pulse

No	Abbre viation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PA13	PLSS (*)	Pulse command options Set up the external pulse train input type 0 | z | y | x x: Select the type of input pulse train x=0: Forward/reverse rotation pulse train;x = 1: pulse train + symbol x = 2: AB phase pulse train y: Select input pulse train logic y=0: Positive logic; y=1: negative logic  Z: Input pulse filter setup If the highest frequency of the pulse input is 500KPPS, set the parameter as 00□□. If the highest frequency of the pulse input is 200KPPS, set the parameter as 01□□. After setting this parameter, anti-signal interference capability will be enhanced. z=0: Under 500KPPS z=0: Under 500KPPS	Pt	0000h	0000h ~ 0112h	None
PA14	ENR (*)	Detector output pulse number: Set the number of pulses of the actuator's output encoder (phase A and phase B).The number of output pulses differs depending on the selected output encoder pulse output setup of parameter PA 39. The set value are the four-fold frequency output of phase A and phase B. Actually, the single phase output pulse of phase A and phase B is 1/4 of the set value.	Pr.Pt S.T	10000	1 ~ 10000	Pulse/ rev

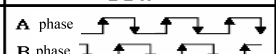
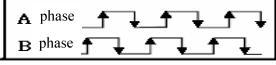
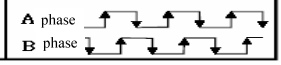
No	Abbre viation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
		Do not exceed this restricted range if the highest output frequency is 500KPPS (four-fold of the frequency). For the output pulse setup, the number of output pulses are as follows: Set parameter PA39 as □0□□ (initial value), and at this point, the set value of the parameter will be the outputted number of pulses of a rotation. Example: Assume PA 39 is set as 0000h, PA14 is set as 1024, then the outputted number of pulses of one rotation by the servo motor will be 1024 (pulse / rev). For the frequency divider setup, the number of output pulses are as follows: To set the output of frequency divider, the value will be the outputted number of pulses per rotation of the motor divided by the set value of PA 14. Outputted number of pulses = servo motor's number of pulses per rotation / the set value of PA14 Example: If PA 30 is set as 0100h, PA14 is set as 2, then 10000 / 2 = 5000 The outputted number of pulses of the motor per rotation would be 5000 (pulse /rev).				
PA15	PO1H	The setup of the number of position rotations of internal position command 1	Pr	0	±30000	rev
PA16	PO1L	The setup of the number of position pulses of internal position command 1 Internal position command 1 = Level 1 internal position number of rotation set value + level 1 internal position number of pulse set value	Pr	0	±9999	pulse
PA17	PO2H	The setup of the number of position rotations of internal position command 2	Pr	0	±30000	rev
PA18	PO2L	The setup of the number of position pulses of internal position command 2 Internal position command 2 = Level 2 internal position number of rotation set value + level 2 internal position number of pulse set value	Pr	0	±9999	pulse
PA19	PO3H	The setup of the number of position rotations of internal position command 3	Pr	0	±30000	rev

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PA20	PO3L	The setup of the number of position pulses of internal position command 3 Internal position command 3 = Level 3 internal position number of rotation set value + level 3 internal position number of pulse set value	Pr	0	±9999	pulse
PA21	PO4H	The setup of the number of position rotations of internal position command 4	Pr	0	±30000	rev
PA22	PO4L	The setup of the number of position pulses of internal position command 4 Internal position command 4 = Level 4 internal position number of rotation set value + level 4 internal position number of pulse set value	Pr	0	±9999	pulse
PA23	PO5H	The setup of the number of position rotations of internal position command 5	Pr	0	±30000	rev
PA24	PO5L	The setup of the number of position pulses of internal position command 5 Internal position command 5 = Level 5 internal position number of rotation set value + level 5 internal position number of pulse set value	Pr	0	±9999	pulse
PA25	PO6H	The setup of the number of position rotations of internal position command 6	Pr	0	±30000	rev
PA26	PO6L	The setup of the number of position pulses of internal position command 6 Internal position command 6 = Level 6 internal position number of rotation set value + level 6 internal position number of pulse set value	Pr	0	±9999	pulse
PA27	PO7H	The setup of the number of position rotations of internal position command 7	Pr	0	±30000	rev
PA28	PO7L	The setup of the number of position pulses of internal position command 7 Internal position command 7 = Level 7 internal position number of rotation set value + level 7 internal position number of pulse set value	Pr	0	±9999	pulse
PA29	PO8H	The setup of the number of position rotations of internal position command 8	Pr	0	±30000	rev
PA30	PO8L	The setup of the number of position pulses of internal position command 8 The internal position command 8 = Level eight internal position number of rotation se value + level eight internal position number of pulse set value	Pr	0	±9999	pulse

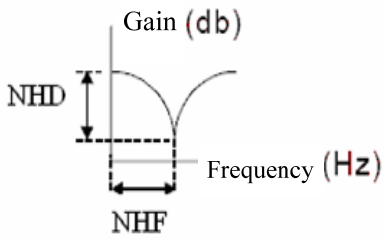
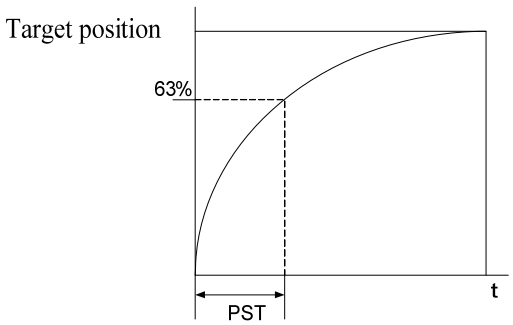
No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PA31	POV1	The setup of the speed of internal position control 1	Pr	1000	1-3000	rpm
PA32	POV2	The setup of the speed of internal position control 2	Pr	1000	1-3000	rpm
PA33	POV3	The setup of the speed of internal position control 3	Pr	1000	1-3000	rpm
PA34	POV4	The setup of the speed of internal position control 4	Pr	1000	1-3000	rpm
PA35	POV5	The setup of the speed of internal position control 5	Pr	1000	1-3000	rpm
PA36	POV6	The setup of the speed of internal position control 6	Pr	1000	1-3000	rpm
PA37	POV7	The setup of the speed of internal position control 7	Pr	1000	1-3000	rpm
PA38	POV8	The setup of the speed of internal position control 8	Pr	1000	1-3000	rpm

<table>
<tr><th>No</th><th>Abbre viation</th><th>Parameter Function and Description</th><th>Control Mode</th><th>Initial Value</th><th>Range</th><th>Unit</th></tr>
<tr><td>PA39</td><td>POL
(*)</td><td>Motor rotation direction options

The relation among the motor rotation direction, the input command pulse train rotation direction, and encoder output pulse direction.

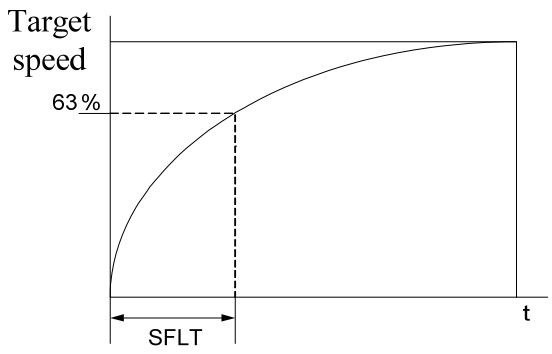
<table>
<tr><td>0</td><td>z</td><td>y</td><td>x</td></tr>
</table>
x：To set input pulse command relations with driver rotation direction
<table>
<tr><td rowspan="2">Set value</td><td colspan="2">Servo driver the rotation direction</td></tr>
<tr><td>rotation direction pulse train input</td><td>rotation direction pulse train input</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>
y：To set driver rotation direction relations with encoder output pulse
<table>
<tr><td>Set value</td><td>Server driver the rotation direction
CCW</td><td>Server driver the rotation direction
CW</td></tr>
<tr><td>0</td><td>  </td><td>  </td></tr>
<tr><td>1</td><td>  </td><td>  </td></tr>
</table>
z：To select output encoder pulse output to set
z=0：To set the output pulse
z=1：To set the frequency divider
The parameter relations with PA14</td><td>Pr.Pt
S.T</td><td>0000h</td><td>0000h
~
0111h</td><td>None</td></tr>
<tr><td>PA40</td><td>SPW
(▲)</td><td>Special parameter write-in:
When the parameter code is set as 0 x 0088, it will take two seconds to return to the default value set by the factory. Thereafter, restart the machine before running the actuator.</td><td>Pr.Pt
S.T</td><td>0000h</td><td>0000h
~
00FFh</td><td>None</td></tr>
<tr><td>PA41</td><td></td><td>Preparation</td><td></td><td></td><td></td><td></td></tr>
</table>

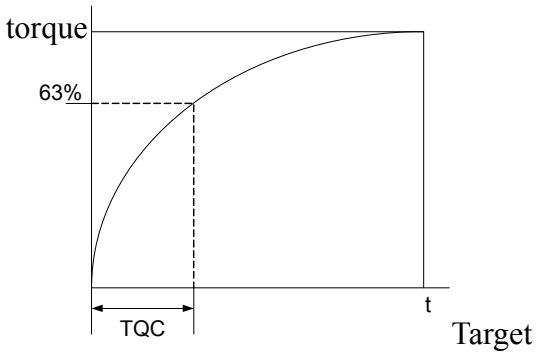
<table>
<tr><th>No</th><th>Abbreviation</th><th>Parameter Function and Description</th><th>Control Mode</th><th>Initial Value</th><th>Range</th><th>Unit</th></tr>
<tr><td>PA42</td><td>BLK
(*)</td><td>Anti-write protection at parameters zones
<table><tr><th>Value</th><th>Basic Setup Parameter No.PA□□</th><th>Gain; filter Parameter No.PA□□</th><th>Expansion Setup Parameter No.PA□□</th><th>Input/Output Parameter Setup No.PA□□</th></tr><tr><td>0000 Default Value</td><td>Read and write</td><td>Read and write</td><td>Read and write</td><td>Read and write</td></tr><tr><td>0001</td><td>Read and write</td><td>Read and write</td><td>Read and write</td><td>Non readable Non writable</td></tr><tr><td>0002</td><td>Read and write</td><td>Read and write</td><td>Non readable Non writable</td><td>Non readable Non writable</td></tr><tr><td>0003</td><td>Read and write</td><td>Non readable Non writable</td><td>Non readable Non writable</td><td>Non readable Non writable</td></tr><tr><td>0004</td><td>Read and write</td><td>Readable but non writable</td><td>Readable but non writable</td><td>Readable but non writable</td></tr><tr><td>0005</td><td>Readable but non writable PA 42 writable</td><td>Readable but non writable</td><td>Readable but non writable</td><td>Readable but non writable</td></tr><tr><td>0006</td><td>Readable but non writable PA 42 writable</td><td>Non readable Non writable</td><td>Non readable Non writable</td><td>Non readable Non writable</td></tr></table></td><td>Pr.Pt
S.T</td><td>0000h</td><td>0000h
~
0006h</td><td>None</td></tr>
</table>

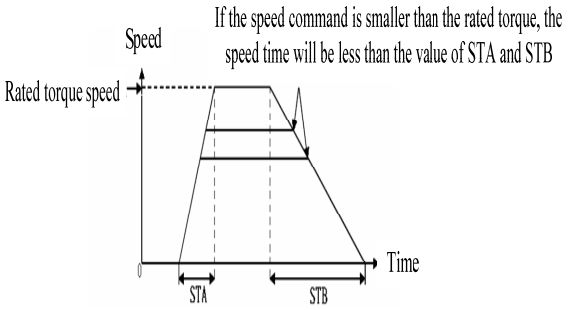
No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PB01	NHF1	The frequency of machine resonance suppression filter 1 The frequency of the machine resonance suppression filter can be set as follows: 	Pr.Pt S.T	1000	50 ~ 1000	Hz
PB02	NHD1	Decay rate of machine resonance suppression filter 1 The decay rate of the machine resonance suppression filter can be set and used with NHF1. 0 for turning of the Notch filter function.	Pr.Pt S.T	0	0 ~ 32	dB
PB03	NLP	Resonance suppression of low-pass filter Set up the resonance suppression low-pass filter time constant.	Pr.Pt S.T	0	0 ~ 10000	0.1ms
PB04	PST	Position command filter time constant The filter time constant for setting up the position command can make motor operation smoother when the sever actuator experience sudden and severe change from the position commands if this parameter is appropriately set.  The actual time catching the target position is about 5 folds of the PST.	Pt、Pr	3	0 ~ 20000	ms
PB05	FFC	Position feedforward gain value When the system has a smooth operation under the position control, feedfoward gain value can significantly improve the error of position tracking. If the system produces resonance under the position control, reduce the gain value	Pt、Pr	0	0 ~ 20000	0.0001

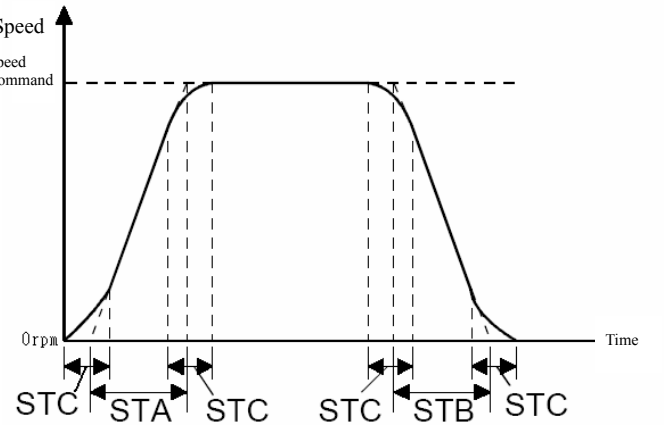
No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
		can decrease the operation vibration of the machine.				
PB06	GD1	Load inertia ratio of the servo motor Set up the ratio between load inertia and servo motor inertia.When the auto-tuning mode (PA02) is set as auto-gain tuning mode 1, the tuning result will be automatically set as the parameter.	Pt、Pr S	10	0 ~ 1200	0.1-fold
PB07	PG1	Position loop gain: Enlarge the position gain can improve the traceability of command responsiveness and minimize the position control error. But too large a value can cause the system to produce noises and vibration.When using the auto-tuning mode, the tuning result will be set as the parameter value automatically.	Pt、Pr	35	4 ~ 1024	rad/s
PB08	VG1	Speed Loop Gain Giving the parameter a larger value can improve the speed of responsiveness, but a value that is too large may cause system vibration and noises.When using the auto-tuning mode, the tuning result will be set as the parameter value automatically.	Pt、Pr S	817	40 ~ 4096	rad/s
PB09	VIC	Speed integral gain value: Set up the speed loop integral gain value (or the time constant).	Pt、Pr S	48	1 ~ 1000	ms
PB10	VFG	Speed feedforward gain value: When the system has a smooth operation under the position control, feedfoward gain value can significantly improve the error of speed tracking. If the system produces resonance under the speed control, reduce the gain value can decrease the	S	0	0 ~ 20000	0.0001

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
		operation vibration of the machine.				
PB11	CDP (*)	Gain switch selection criteria: 0 0 0 x X =): Turn of the gain switch. x=1：Switching when gain switch signal CDP is on. X = 2: Switching is carried out when the position command frequency is larger than the setup of parameter CDS. X = 2: Switching is carried out when the position error pulse is larger than the setup of parameter CDS. X = 4: Switching is carried out when servo motor's rotation speed is equal to the setup of parameter CDS.	Pt、Pr S	0000h	0000h ~ 0004h	None
PB12	CDS	Gain switch criteria value: The value of gain switch criteria (kpps, pulse, rpm) differs according to the setup of CDP. The unit of the set value differs according to the items of the switch criteria.	Pt、Pr S	10	0 ~ 6000	kpps pulse rpm
PB13	CDT	Gain switch time constant: Switch time constant is often used for changing the smooth gin. It is used to set up the time constant when switching the criteria of CDP and CDS.	Pt、Pr S	1	0 ~ 1000	ms
PB14	GD2	Servo motor and load inertia ratio 2: Set up the ratio between load inertia and servo motor inertia, and it will become effective only when switching the gain value.	Pt、Pr S	70	0 ~ 1200	0.1-fold
PB15	PG2	The change rate of position gain at gain switching: When setting up the change rate of position gain at gain switching, make sure to cancel auto-tuning in order to activate the function.	Pt、Pr	100	10 ~ 200	%

No	Abbre viation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PB16	VG2	The change rate of speed gain at gain switching: When setting up the change rate of speed gain at gain switching, make sure to cancel auto-tuning in order to activate the function.	Pt、Pr S	100	10 ~ 200	%
PB17	VIC2	Change rate of speed integral gain at switching gain: When setting up the change rate of speed integral gain at switching gain, make sure to cancel auto-tuning in order to activate the function.	Pt、Pr S	100	10 ~ 200	%
PB18	SFLT	Speed command low-pass smooth filter time constant: The larger the time constant is, the smoother the command curve is. Nevertheless, the responsiveness will slow down as well. If it is set as zero, then this function cannot be applied.  The actual time required to catch the speed command is about 5-fold SELT.	S, T	0	0 ~ 1000	ms

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PB19	TQC	Torque command filter time constant: The filter time constant for setting up the torque command can make motor operation smoother when the sever actuator experience sudden and severe change from the torque commands if this parameter is appropriately set.  The actual time required to catch the torque command is about 5-fold TQC.	T	0	0 ~ 5000	ms
PB20		Preparation				
PB21	NHF2	The frequency of machine resonance suppression filter 2 The frequency of machine resonance suppression filter can be set up. The setup approach is the same as the approach for setting up the frequency of machine resonance suppression filter 1.	Pr.Pt S.T	1000	50 ~ 1000	Hz
PB22	NHD2	Decay rate of machine resonance suppression filter 2 The decay rate of the machine resonance suppression filter can be set and used with NHF2. 0 for turning of the Notch filter function.	Pr.Pt S.T	0	0 ~ 32	dB
PB23		Preparation				
PB24	VDC	Speed differential compensation: The differentiation compensation setup becomes effective when the control signal of digital input terminal ratio is ON.	Pr.Pt S	980	0 ~ 1000	None

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PC01	STA	Acceleration time constant: This parameter is the acceleration time required for the rotation of the motor from 0 rpm to the rated rotation speed, and it is set as the acceleration time constant.For example, if the servo motor's rated rotation speed is 3000 rpm, this parameter will be set as 3000 (3s). If the speed command is set as 1000 rpm, it would take 1 second for the motor to accelerate from 0 rpm to 1000 rpm.Refer to Section 6.4.3 for setting up the internal position mode (Pr mode). (Figure below) Rated torque speed, speed If the speed command is smaller than the rated torque, the speed time will be less than the value of STA andSTB.  	Pr S.T	200	0 ~ 20000	ms
PC02	STB	Deceleration time constant: The deceleration time required for the motor rotation speed to reduce from a rated rotation speed to 0 rpm is defined as the deceleration time constant.Refer to Section 6.4.3 for setting up the internal position mode (Pr mode).	Pr S.T	200	0 ~ 20000	ms
PC03	STC	S-shape acceleration/deceleration time constant During the acceleration / deceleration process, the acceleration / deceleration curve is planned in three stages in order to provide a smooth movement.Setting up an appropriate STC can improve the stability of the motor during activation and stop.	Pr S.T	0	0 ~ 10000	ms

No	Abbre viation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
		 To make the command curve smoother, S-curve is added. Some errors may exist in the acceleration / deceleration time. The time required for the motor to accelerate to the speed command time = STA + STC The time required for the motor to decelerate from speed command to 0 = STB + STC.				
PC04		Preparation				
PC05	SC1	Internal speed command 1 (Restriction 1): At the speed control mode, the parameter has the setup for speed command 1.At the torque control mode, the parameter has the setup for speed command 1. The maximum value of internal speed command is the highest rotation speed of the motor.	S.T	100	-4500 ~ 4500	rpm
PC06	SC2	Internal speed command 2 (Restriction 2): At the speed control mode, the parameter has the setup for speed command 2.At the torque control mode, the parameter has the setup for speed command 2. The maximum value of internal speed command is the highest rotation speed of the motor.	S.T	500	-4500 ~ 4500	rpm

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PC07	SC3	Internal speed command 3 (Restriction 3): At the speed control mode, the parameter has the setup for speed command 3.At the torque control mode, the parameter has the setup for speed command 3. The maximum value of internal speed command is the highest rotation speed of the motor.	S.T	1000	-4500 ~ 4500	rpm
PC08	SC4	Internal speed command 4 (Restriction 4): At the speed control mode, the parameter is internal speed command 4. At the torque control mode, the parameter is speed restriction 4. The maximum value of internal speed command is the highest rotation speed of the motor.	S.T	200	-4500 ~ 4500	rpm
PC09	SC5	Internal speed command 5 (Restriction 5): At the speed control mode, the parameter is internal speed command 5. At the torque control mode, the parameter is speed restriction 5. The maximum value of internal speed command is the highest rotation speed of the motor.	S.T	300	-4500 ~ 4500	rpm
PC10	SC6	Internal speed command 6 (Restriction 6): At the speed control mode, the parameter is internal speed command 6. At the torque control mode, the parameter is speed restriction 6. The maximum value of internal speed command is the highest rotation speed of the motor.	S.T	500	-4500 ~ 4500	rpm
PC11	SC7	Internal speed command 7 (Restriction 7): At the speed control mode, the parameter is internal speed command 7. At the torque control mode, the parameter is speed restriction 7. The maximum value of internal speed command is the highest rotation speed of the motor.	S.T	800	-4500 ~ 4500	rpm

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PC12	VCM (▲)	Analog command speed maximum rotation speed: Set up the speed command as the rotation speed at the maximum input voltage (10V).Assuming the parameter is set as 2000, then the external input voltage would be 10V, suggesting that the speed control command is 2000 rpm. If the input voltage is 5V, then the speed command is 1000 rpm.The conversion relation is presented as follows: Speed Command = Parameter set value x voltage input / 10	S	3000	0 ~ 10000	rpm
		The above description is used at the speed control mode.At the torque control mode, the setup of this parameter is the restricted value of the torque when the input voltage is at the maximum.The conversion is presented as follows: Speed restriction command = Parameter set value x voltage input / 10	T	3000	0 ~ 10000	rpm
PC13	TLC (▲)	The maximum output of analog torque command: Set up the analog torque command as the torque at the maximum input voltage (10V).If parameter is set as 100, then when the input voltage is 10V, the torque command will be 100% of the maximum torque. If the input voltage is 5V, the torque command will be 50% of the maximum torque.The conversion relation is presented as follows: Torque command = input voltage / 10 x the parameter set value	T Pr.Pt S	100	0 ~ 300	%

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PC14	MOD	Analog output monitoring: Analog monitoring output setup has two monitoring outputs:Ch1 and Ch2. 0 ch2 0 ch1 The set values of CH1 and CH2 and their corresponding output are presented below: 0: Motor rotation speed (±10V/2-fold of the rated rotation speed) 1: Motor torque (±10V/the maximum torque) 2: Speed command (±10V/2-fold of the rated rotation speed) 3: Effective loading rate (±10V/±300%) 4: Pulse command frequency (±10V/500k pules/s) 5: Current command (±10V/the maximum current command) 6: dc bus voltage (±10V/400V) 7: The number of error pulses (±10V/10000pulse)	Pr.Pt S.T	0100h	0000h ~ 0707h	None
PC15	SVZR (*)	Zero voltage range of analog speed voltage Set the analog speed voltage within the set range, and the analog commanda are treated as 0V.	S.T	10	0~1000	mv
PC16	MBR	Electromagnetic brake sequence output time: Set the delay time between turning off the SON signal and turning off the electromagnetic brake interlock signal (MBR).	Pr.Pt S.T	100	0 ~ 1000	ms
PC17	ZSP	Zero speed signal output range: Set the speed range of the zero speed signal output.In other words, when the motor's forward / reverse rotation speed is lower than the set value of the parameter, the zero speed signal pin will output signals.	Pr.Pt S.T	50	0 ~ 10000	rpm

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PC18	COP1 (*)	Setup the motor stop mode options and the restart of instantaneous stopped power option 0 0 y x X: Power source instantaneous restart option At the speed control mode, when the power source is too low, abnormal alarm will go off due to insufficient voltage, and the servo motor will be stopped.When the power source return to the normal state, there is no need to reset the abnormal alarm before restarting the servo motor. 0: Invalid; 1: valid Y: Moroe stop mode optionsFor the serve stop operation mode at the speed control mode, set the parameter to lock the servo rotation axle and keep the motor stop. Y = 1: Stop the motor instantaneously. Y = 0: Stop according to the deceleration time.	S	0010h	0000h ~ 0011h	None
PC19	*COP2 (*)	Select the action for clearing the abnormal alarm record. 0 0 0 x X=0: Do not clear the abnormal alarm record; x=1: Clear the abnormal alarm record When set to clear the record, clearing will be carried out when the power is restarted next time. After clearing the record, it will be set as 0 automatically	Pr.Pt S.T	0000h	0000h ~ 0001h	None
PC20	SNO (*)	Servo actuator communication station number: During the communication, different servo actuator has to have different station number. Communication cannot be conducted when two servo actuators have the same station number.	Pr.Pt S.T	1	1 ~ 32	Station

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PC21	CMS (*)	Communication mode setup 0 0 y x Y: Communication reply delay time (the changed parameter become valid after restarting the machine.) Y=0: delay within 1ms; y=1: delay 1ms after reply X: Communication mode options X=0: use RS-232C; x=1: use RS-485	Pr.Pt S.T	0010h	0000h ~ 0011h	None
PC22	BPS (*)	Communication protocol setup 0 0 y x Y : RS-485 or RS-232C transmission speed setup y=0：4800bps y=1：9600bps y=2：19200bps y=3：38400bps y=4：57600bps y=5：115200bps X: Communication transmission protocol x=0：7,N,2（Modbus, ASCII） x=1：7,E,1（Modbus, ASCII） x=2：7,O,1（Modbus, ASCII） x=3：8,N,2（Modbus, ASCII） x=4：8,E,1（Modbus, ASCII） x=5：8,O,1（Modbus, ASCII） x=6：8,N,2（Modbus, RTU） x=7：8,E,1（Modbus, RTU） x=8：8,O,1（Modbus, RTU）	Pr.Pt S.T	0010h	0000h ~ 0058h	None
PC23	SIC	Serial communication overtime option: Communication protocol overtime can be set between 1 and 60 seconds.If it is set to 0, then the communication protocol will not conduct overtime inspection.	Pr.Pt S.T	0	0 ~ 60	s

<table>
<tr><th>No</th><th>Abbrev iation</th><th>Parameter Function and Description</th><th>Control Mode</th><th>Initial Value</th><th>Range</th><th>Unit</th></tr>
<tr><td>PC24</td><td>DMD
(*)</td><td>Actuator state display setup:

<table>
<tr><td>0</td><td>0</td><td>y</td><td>x</td></tr>
</table>

X: Set the status display after turning on the power.
X=0: Accumulate the motor feedback pulse number.
X=1: Accumulte the motor feedback rotation number.
X=2: Pulse Counting for Pulse Command
X=3: Number of rotations of pulse command
X=4: Number of pulse errors
X=5: Pulse command input frequency
X=6: Current motor rotation speed
X=7: Analog speed command voltage / resrtricted voltage
X=8: Speed input command / restriction
X=9: Analog torque command voltage / resrtricted voltage
x=A：Torque Input Command / Restriction
X=B: Effective loading rate
X=C: Peak loadind rate
X=D: DC Bus voltage
X=E: Load motor inertia ratio
x=F: Instantaneous torque

Y: Display corresponding states according to the control mode after the power is turned on.
y=1: Display actuator state according the set value of parameter x.
Y=0: Display actuator condition according to the control mode. The displayed state differs according to the control mode. See the table below:

<table>
<tr><td>Control Mode</td><td>The state displayed by the actuator after the power is turned on.</td></tr>
<tr><td>Position</td><td>Accumulated feedback pulses</td></tr>
<tr><td>Position / Speed Combined Mode</td><td>Accumulated feedback pulses / motor roation speed</td></tr>
<tr><td>Speed</td><td>Motor rotation</td></tr>
<tr><td>Speed / Torque Combine Mode</td><td>Motor rotation speed / analog torque command voltage</td></tr>
<tr><td>Torque</td><td>Analog torque command voltage</td></tr>
<tr><td>The Torque / Position Combined Mode</td><td>Analog torque command voltage / accumulated feedback pulses</td></tr>
</table></td><td>Pr.Pt
S.T</td><td>0000h</td><td>0000h
~
001Fh</td><td>無</td></tr>
</table>

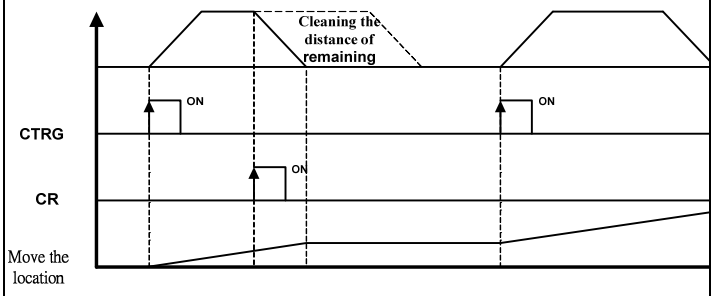
No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PC25	TL2	Internal torque restriction 2 The setup description is the same as the one for PA05.Also, the use of internal parameter torque restriction jn concert with external input signal TL and TL1 can select different torque restriction. See the description for PA05.	Pr.Pt S.T	100	0 ~ 100	%
PC26	VCO	Analog speed command / restricted drift quantity: The speed control mode can be used to correct the voltage driaft quantity of analog speed command (VC).The speed control mode can be used to correct the voltage driaft quantity of analog speed command (VLA).	S.T	0	-999 ~ 999	mV
PC27	TLO	Analog torque command / restricted drift quantity: The speed control mode can be used to correct the voltage drift quantity of analog torque command (TC).The speed control mode can be used to correct the voltage driaft quantity of analog torque command (TLA).	S.T	0	-999 ~ 999	mV
PC28	MO1	Voltage drift of analog monitoring MON1: It is used to set up the voltage drift outputted by analog monitoring MON1	Pr.Pt S.T	0	-999 ~ 999	mV
PC29	MO2	Voltage drift of analog monitoring MO2: It is used to set up the voltage drift outputted by analog monitoring MON2	Pr.Pt S.T	0	-999 ~ 999	mV
PC30	MOG1	Analog monitoring output ratio of MON1: Set the output rated rotation speed of analog monitoring 1 as 3000 rpm and MOG1 as 50 suggests that when the speed reach 3000rpm, the output voltage of analog monitoring 1 will be the maximum.	Pr.Pt S.T	100	0~100	%
PC31	MOG2	Analog monitoring output ratio of MON2: Set the largest output ratio of analog monitoring 2; the function is similr to PC30.	Pr.Pt S.T	100	0~100	%

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PC32	CMX2	The numerator of the second set electronic gear ratio: Set the numerator of the second set of electronic gear ratio.	Pt、Pr	1	1 ~ 32767	None
PC33	CMX3	The numerator of the third set electronic gear ratio: Set the numerator of the third set of electronic gear ratio.	Pt、Pr	1	1 ~ 32767	None
PC34	CMX4	The numerator of the fourth set electronic gear ratio: Set the numerator of the fourth set of electronic gear ratio.	Pt、Pr	1	1 ~ 32767	None
PD01	DIA1 (*)	Input the communication automatic turn on option: 0 z y x x=0: The open circuit and short circuit of Son and SG are controlled by the actuator's external wiring. X=1: Auto-SON and SG short ciruit of the actuator do not require to be controlled by external wiring. y=0: The open circuit and short circuit of LSP and SG are controlled by the actuator's external wiring. y=1: Auto-LSP and SG short ciruit of the actuator do not require to be controlled by external wiring. z=0: The open circuit and short circuit of LSNand SG are controlled by the actuator's external wiring. z=1: Auto-LSN and SG short ciruit of the actuator do not require to be controlled by external wiring.	Pr.Pt S.T	0000h	0000h ~ 0111h	None
PD02	DI1 (*)	Input signal option 1 Input signal CN1-14 pin function program 1At different control mode, the input signals are not completedly the same. By setting up the parameter, the users can select the input signal represented by the pin position of CN1-14 at different mode.	Pr.Pt S.T	0001h	0000h ~ 001Fh	None

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PD03	DI2 (*)	Input signal option 2 Input signal CN1-15 pin function program 2CN1-15 can be assigned to any input signal. The parameter setup method is the same as the one for PD02. Refer to PD02 for the setup.	Pr.Pt S.T	000Dh	0000h ~ 001Fh	None
PD04	DI3 (*)	Input signal option 3 Input signal CN1-16 pin function program 3CN1-16 can be assigned to any input signal. The parameter setup method is the same as the one for PD02. Refer to PD02 for the setup.	Pr.Pt S.T	0003h	0000h ~ 001Fh	None
PD05	DI4 (*)	Input signal option 4 Input signal CN1-17 pin function program 4CN1-17 can be assigned to any input signal. The parameter setup method is the same as the one for PD02. Refer to PD02 for the setup.	Pr.Pt S.T	0004h	0000h ~ 001Fh	None
PD06	DI5 (*)	Input signal option 5 Input signal CN1-18 pin function program 5CN1-18 can be assigned to any input signal. The parameter setup method is the same as the one for PD02. Refer to PD02 for the setup.	Pr.Pt S.T	0002h	0000h ~ 001Fh	None
PD07	DI6 (*)	Input signal option 6 Input signal CN1-19 pin function program 6CN1-19 can be assigned to any input signal. The parameter setup method is the same as the one for PD02. Refer to PD02 for the setup.	Pr.Pt S.T	000Fh	0000h ~ 001Fh	None
PD08	DI7 (*)	Input signal option 7 nal CN1-20 pin function planning 7CN1-20 can be assigned to any input signal. The parameter setup method is the same as the one for PD02. Refer to PD02 for the setup.	Pr.Pt S.T	0012h	0000h ~ 001Fh	None

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PD09	DI8 (*)	Input signal option 8 nal CN1-21 pin function program 8CN1-21 can be assigned to any input signal. The parameter setup method is the same as the one for PD02. Refer to PD02 for the setup.	Pr.Pt S.T	0011h	0000h ~ 001Fh	None
PD10	DO1 (*)	Output signal option 1: Output signal CN1-41 pin function planning 1At different control mode, the input signals are not completedly the same. By setting up the parameter, the users can select the input signal represented by the pin position of CN1-41 at different mode.	Pr.Pt S.T	0003h	0000h ~ 000Fh	None
PD11	DO2 (*)	Output signal option 2: Output signal CN1-42 pin function planning 2CN1-42 can be assigned to any input signal. The parameter setup method is the same as the one for PD10. Refer to PD10 for the setup.	Pr.Pt S.T	0008h	0000h ~ 000Fh	None
PD12	DO3 (*)	Output signal option 3: Output signal CN1-43 pin function planning 3CN1-43 can be assigned to any input signal. The parameter setup method is the same as the one for PD10. Refer to PD10 for the setup.	Pr.Pt S.T	0004h	0000h ~ 000Fh	None
PD13	DO4 (*)	Output signal option 4: Output signal CN1-44 pin function planning 4CN1-44 can be assigned to any input signal. The parameter setup method is the same as the one for PD10. Refer to PD10 for the setup.	Pr.Pt S.T	0005h	0000h ~ 000Fh	None
PD14	DO5 (*)	Output signal option 5: Output signal CN1-45 pin function planning 5CN1-45 can be assigned to any input signal. The parameter setup method is the same as the one for PD10. Refer to PD10 for the setup.	Pr.Pt S.T	0001h	0000h ~ 000Fh	None

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PD15	DIF (*)	Digital input terminal filter time option 0 0 0 x X =0: None; X=1: 2ms; x=2：4 ms ; x=3：6 ms	Pr.Pt S.T	0002h	0000h ~ 0003h	None
PD16	IOS	Software input contact communication control 0: Denotes that the digital input contact is controlled by external terminal. 1: Denotes that the digital input contact is controlled by communication software.	Pr.Pt S.T	0000h	0000h ~ 0001h	None
PD17	*DOP1 (*)	When LSN or LSP signal is OFF, the mode is at the servo operation emergency stop mode. 0 0 0 x X: The emergency stop treating mode can be selected. X=0: Stop instantaneously. X=1: Servo operation is based on the deceleration time constant of the parameter setup. It will decelerates until stop.The time required for the servo motor to decelerate until stop is based on parameter STB, STC (parameter PC02 and parameter PC03).	Pt、Pr S	0000h	0000h ~ 0001h	None
PD18	DOP2 (*)	Set up the CR communication clear method. 0 0 0 x X=0: Clear the position pulse command and feedback pulse error (the Pt mode). When CR and SG are at the upper edge triggering, the position pulse command of the actuator and the feedback pulse error will be cleared to 0. X=1: Clear the position pulse command and the feedback pulse error (the Pt mode). When CR and SG are	Pt、Pr	0000h	0000h ~ 0002h	None

No	Abbrev iation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
		short circuit, the position pulse command of the actuator and the feedback pulse error will be cleared continuously to 0. X=2: Set to stop the positioning. When CR and SG upper edge are conductive, the motor will decelerate to stop according to the deceleration time.The incompleted remaining pulses will be neglected. When CTRG and SG are short circuit again, pulse number command will be sent and executed (the Pr mode)  				

<table>
<tr><th>No</th><th>Abbrev iation</th><th>Parameter Function and Description</th><th>Control Mode</th><th>Initial Value</th><th>Range</th><th>Unit</th></tr>
<tr><td>PD19</td><td>DOP3 (*)</td><td>Export abnormal code option

<table>
<tr><td>0</td><td>0</td><td>0</td><td>x</td></tr>
</table>

<table>
<tr><td>Value x</td><td colspan="3">Pin Content</td></tr>
<tr><td></td><td>CN1-41</td><td>CN1-42</td><td>CN1-45</td></tr>
<tr><td>0</td><td>According to the function setup</td><td>According to the function setup</td><td>According to the function setup</td></tr>
<tr><td>1</td><td colspan="3">Output abnormal alarm code when abnormal alarm goes off.</td></tr>
</table>
Note: On the basis of function setup means on the basis of the setup of PD10 – PD14.

<table>
<tr><td colspan="3">(Note) Abnormal Alarm Code</td><td rowspan="2">Abnormal Alarm Display</td><td rowspan="2">Name</td></tr>
<tr><td>CN1 -41</td><td>CN1 -42</td><td>CN1 -45</td></tr>
<tr><td rowspan="5">0</td><td rowspan="5">0</td><td rowspan="5">0</td><td>AL. 09</td><td>Abnormal seriel communication</td></tr>
<tr><td>AL. 0A</td><td>Serial communication overtime</td></tr>
<tr><td>AL. 0E</td><td>Transistore execution overtime</td></tr>
<tr><td>AL. 0F</td><td>Abnormal memory</td></tr>
<tr><td>AL. 10</td><td>Abnormal power transistor</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>AL. 02</td><td>Low voltage</td></tr>
<tr><td rowspan="2">0</td><td rowspan="2">1</td><td rowspan="2">0</td><td>AL. 01</td><td>Overvoltage</td></tr>
<tr><td>AL. 04</td><td>Abnormal regeneration</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>AL. 03</td><td>Overcurrent</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>Overspeed</td></tr>
<tr><td>AL. 07</td><td>Abnormal pulse control command</td></tr>
<tr><td>AL. 08</td><td>Over-large position control command</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">1</td><td rowspan="2">0</td><td>AL. 0B</td><td>Position detector abnormal 1</td></tr>
<tr><td>AL. 0C</td><td>Position detector abnormal 2</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>AL. 11</td><td>Abnormal motor matching</td></tr>
</table>
Note: 0：OFF; 1：ON</td><td>Pr.Pt
S.T</td><td>0000h</td><td>0000h
~
0001h</td><td>None</td></tr>
</table>

No	Abbreviation	Parameter Function and Description	Control Mode	Initial Value	Range	Unit
PD20	DOP4 (*)	Action option at abnormal reset signal short circuit 0 0 0 x X=0: Base power off (motor excitation) X=0: Base power off (no motor excitation)	Pr.Pt S.T	0000h	0000h ~ 0001h	None

Digital Input (DI) Functional Definition

Abbreviation	Value	Digital Input (DI) Functional Description
SON	0x01	Turn on the servo when this signal is connected.
RES	0x02	When abnormal alarm occurs, connect to this signal to clear some of the abnormal alarm.
PC	0x03	Connect to the signal will make the speed controller switch from a proportional integral type to a proportional type.
TL	0x 04	When this signal is connected, analog torque restriction will be valid; when this signal is not connected, internal torque restriction 1 is valid.
TL1	0x 05	When this signal is connected, internal torque resticition 2 is valid.
SP1	0x 06	Speed control option terminal 1
SP2	0x 07	Speed control option terminal 2
SP3	0x 08	Speed control option terminal 3
ST1/RS2	0x 09	When the signal is connected at the speed mode, the speed command will be activated for forward rotation. When the signal is connected at the torque mode, torque command for reverse roation will be activated,
ST2/RS1	0x0A	When the signal is connected at the speed mode, the speed command will be activated for reverse rotation. When the signal is connected at the torque mode, torque command for forward roation will be activated,
ORGP	0x0B	When searching for the original point at the built-in position register mode, the servo will treat the location of this point as the origin after receiving the signal.
SHOM	0x0C	When searching the original point at the built-in position register mode, origin search action will be activated once the signal is received.
CM1	0x0D	Set option terminal 1 of the numerator of gear ratio at the position mode.
CM2	0x0E	Set option terminal 2 of the numerator of gear ratio at the position mode.
CR	0x0F	When the signal is connected, the slip pulse of the position control counter can be removed at the rising edge.The width of the pulse wave should be greater than 10 ms.

Abbreviation	Value	Digital Input (DI) Functional Description
CDP	0x10	When the signal is connected, the gain values will be switched to the product of the parameters PB14 – PB17.
LOP	0x11	It is used to switch different control mode at the combined mode.
EMG	0x12	When the signal is opened, the servo will be at an emergency status. When this signal is connected, the emergency status can be lifted.
POS1	0x13	Position command option terminal 1 of the internal position resister mode
POS2	0x14	Position command option terminal 2 of the internal position resister mode
POS3	0x15	Position command option terminal 3 of the internal position resister mode
CTRG	0x16	The connection to the signal will trigger the operation command of the internal position register mode.
HOLD	0x17	At the internal position register mode, the signal connection will cuase the motor to stop the rotation.

Digital Output (DO) Functional Definition

Abbreviation	Value	Digital Output (DI) Functional Description
RD	0x01	When Servo ON is at a rotatable state, RD-SG becomes conductive.
ALM	0x02	ALM-SG will be inconductive when the power is off or when the main circuit is interrupted by the activation of the circuit protection.When there is no alarm, ALM-SG becomes conductive one second after turning on the power.
INP/SA	0x 03	INP-SG is conductive at the positioning range set up by slip differential at the position mode. SA-SG will become conductive when the rotation speed of the servo motor gets close to the setup speed at the speed mode.
HOME	0x 04	This signal will be ouptted when return to origin is completed.

Abbreviation	Value	Digital Output (DI) Functional Description
TLC/VLC	0x 05	When torque reaches the set value of internal torque restriction 1 (parameter PA05) or the torque set by the analog torque restriction (TLA) at the position and the speed mode, TLC-SG will be come conductive. But when SON signal is OFF, TLC-SG will become inconductive. When controlling the torque and the internal speed command 1 – 7 or the analog speed control reaches the speed limit, VLA-SG conductive.But when SON signal is OFF<, VLA-SG is inconductive.
MBR	0x06	Set up parameter PA91 as □□□1 so when using the signal, MBR-SG is inconductive when servo OFF or at abnormal alarm.The inconductive state during abnormal alarm has nothing to do with the main loop condition.
WNG	0x 07	When using this signal, set up assign the pin of parameter PD18. Siganls received before the setup cannot be used.WNG-SG is inconductive when abnormal alarm happens.When there is no abnormal alarm, WNG-SG will be inconductive after the power is turned on for 1 second.
ZSP	0x 08	ZSP-SG becomes conductive when the servo motor rotation speed is below zero.
CMDOK	0x 09	This signal will be outputted when the internal position command is completed or stopped.

8. Communication Function

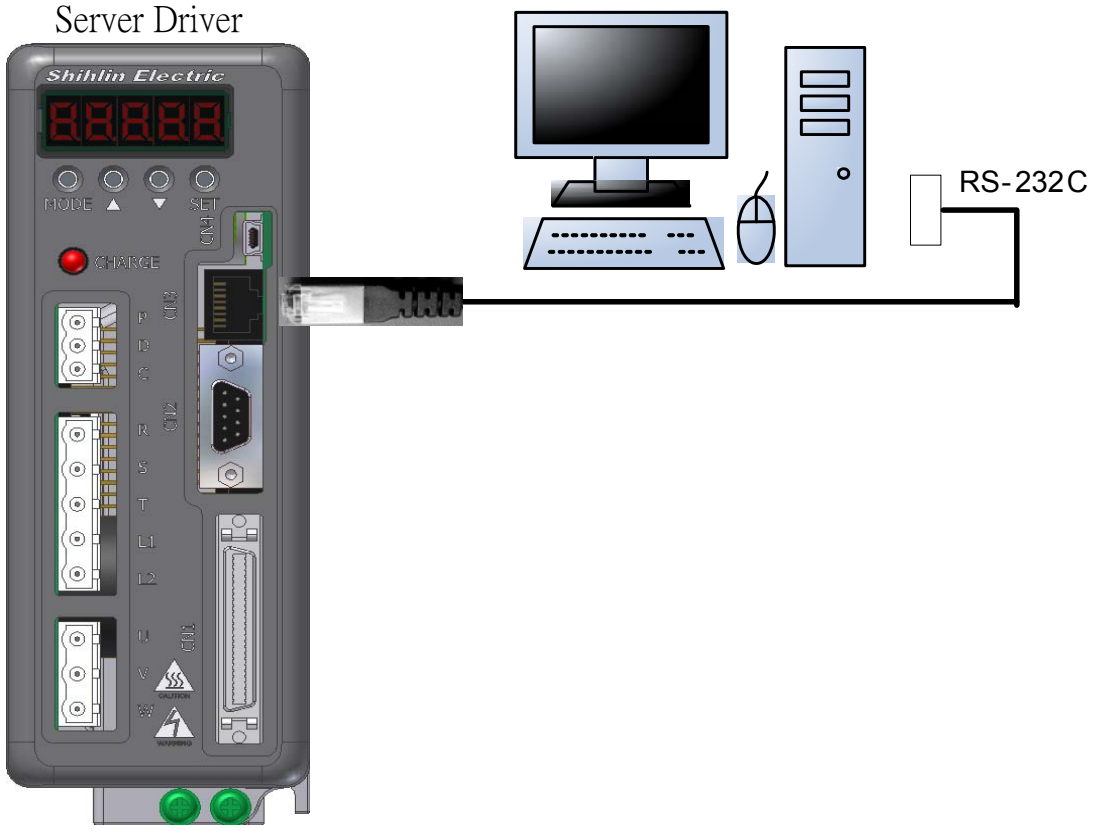
8.1. Communication Hardware Interface and Wiring

This servo actuator has serial commonunication function of plug and play USB and RS-232C as well as RS-485. This function carries out various tasks include drive the servo system, change parameters, and monitor condition of the servo system.But RS-232C, RS485, and USB communication function cannot be employed simultaneously. For RS232C/485, use parameter PC21 for selection.The wiring is demonstrated below:

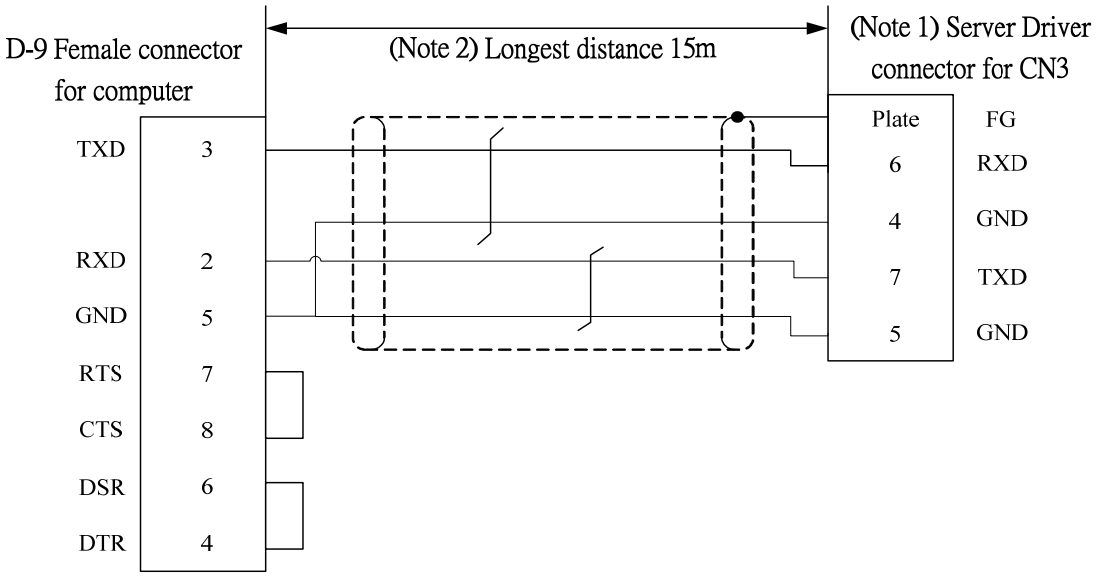
RS-232C

(1) External Thumbnail Graph:

Servo driver of operation for 1 axle



(2) The wiring diagram:



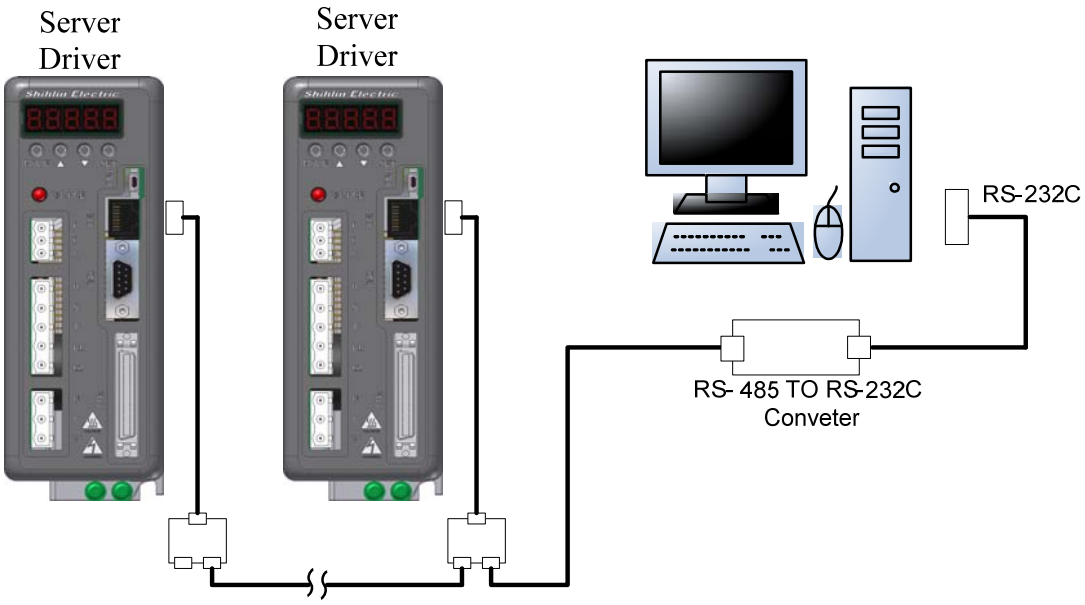
Note 1: CN3's connector is RJ-45.

Note 2: The lengh of wire for an environment with little noises is less than 15 m. But if the transmission speed is greater than 38400 bps, use wire less than 3 m.

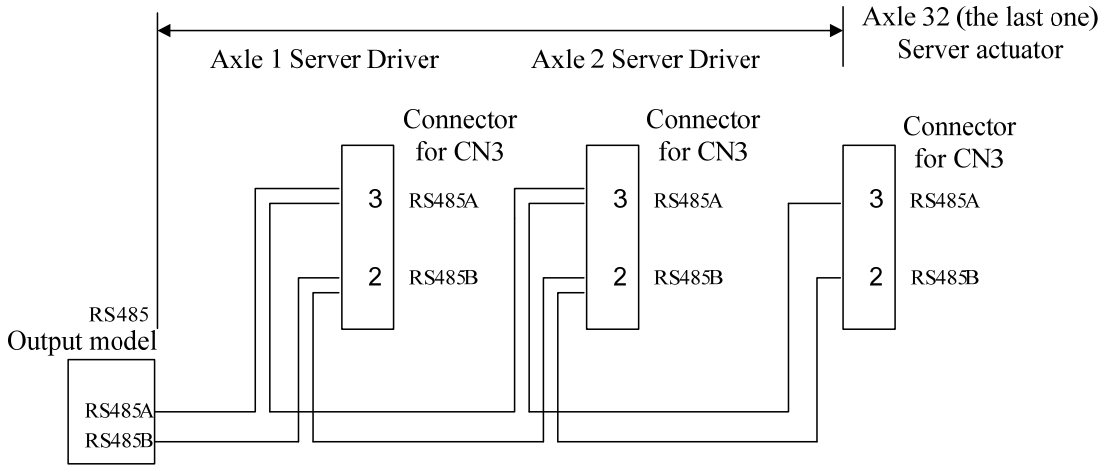
RS-485

(1) External Thumbnail Graph:

For station 1-32, as many as 32 servo actuator axles can be operated on the same bus.



(2) The wiring diagram:

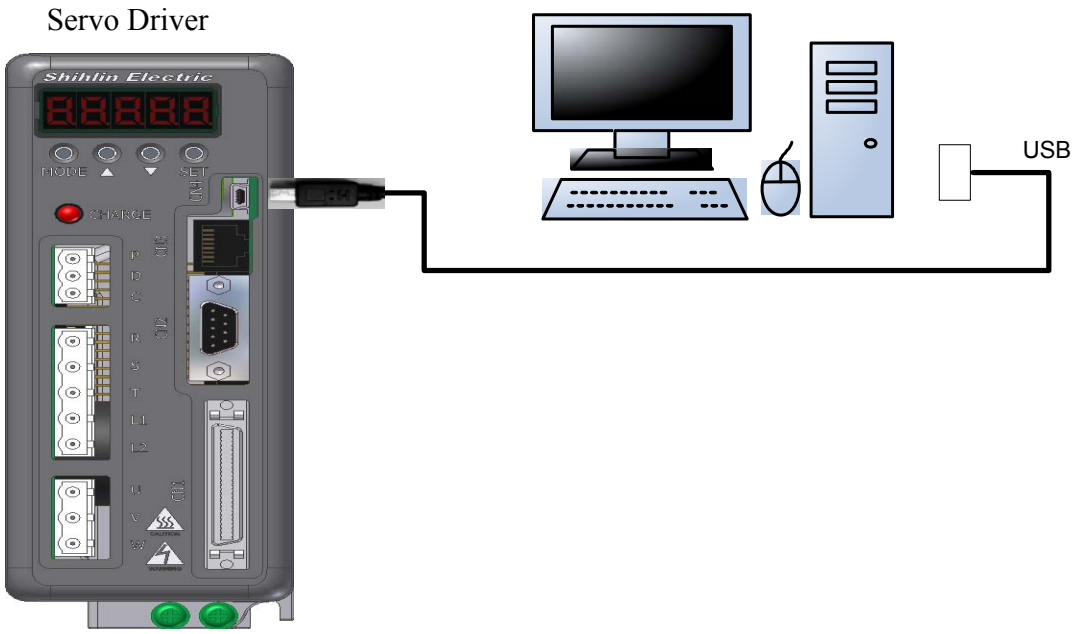


Note 1: For environment with fewer noises, the wire can be less than 100m long. For transmission speed above 38400bps, use a wire less than 15m long to ensure transmission accuracy.

Recommendation: if communication is conducted under an easily interfered environment, the user can make GND of RS-485 and RS-232 converter (or other utility terminal with similar communication protocol such as HMI) and GND of servo controller CN3 short circuit to reduce communication failures.

USB

(1) External Thumbnail Graph: Use standard mini-USB cable for USB cable.



8.2. Communication Setup Parameter

SERVO AMP communication setup specifications for using RS-232C/RS-485 communication function for servo actuator operation are provided below:

1. Station setup (PC20)

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode	Description
Servo actuator communication station number	SNO	PC 20	1~32	Station	1	ALL	During the communication, different servo actuator has to have different station number. Communication cannot be conducted when two servo actuators have the same station number.

◆ Restart the machine after completing the setup of parameter PC20.

2. RS-232C/485 communication interface selection and reply delay time setup (PC21)

0	0	y	x

X=0: use RS-232C; x=1: use RS-485

(2) Communication reply delay time (PC21)

0	0	y	x

y=0：Delay within 1ms; Y=1: Reply after 1ms delay;

(4) Communication transmission protocol (PC22)

0	0	y	x

x=0：7 data bit，No parity，2 Stop bit (Modbus，ASCII Mode)
x=1：7 data bit，Even parity，1 Stop bit (Modbus，ASCII Mode)
x=2：7 data bit，Odd parity，1 Stop bit (Modbus，ASCII Mode)
x=3：8 data bit，No parity，2 Stop bit (Modbus，ASCII Mode)
x=4：8 data bit，Even parity，1 Stop bit (Modbus，ASCII Mode)
x=5：8 data bit，Odd parity，1 Stop bit (Modbus，ASCII Mode)
x=6：8 data bit，No parity，2 Stop bit (Modbus，RTU Mode)
x=7：8 data bit，Even parity，1 Stop bit (Modbus，RTU Mode)
x=8：8 data bit，Odd parity，1 Stop bit (Modbus，RTU Mode)

(5) Communication transmission speed (PC22)

0	0	y	x

y=0：4800bps， y=1：9600bps， y=2：19200bps
y=3：38400bps， y=4：57600bps， y=5：115200bps

Note:

(1). When using USB communication, Shihlin communication software can be connected by setting up correct station number.

8.3. MODBUS Communication Protocol

For communication with the computer, each servo actuator has to have its station number set in parameter PC20. Then the computer can control each servo actuator according its station number. MODBUS networks communication is the communication method. Two types of MODBUS can be employed: ASCII (American Standard Code for information interchange) mode and RTU (Remote Terminal Unit) mode. The users can change the communication mode through parameter PC22.

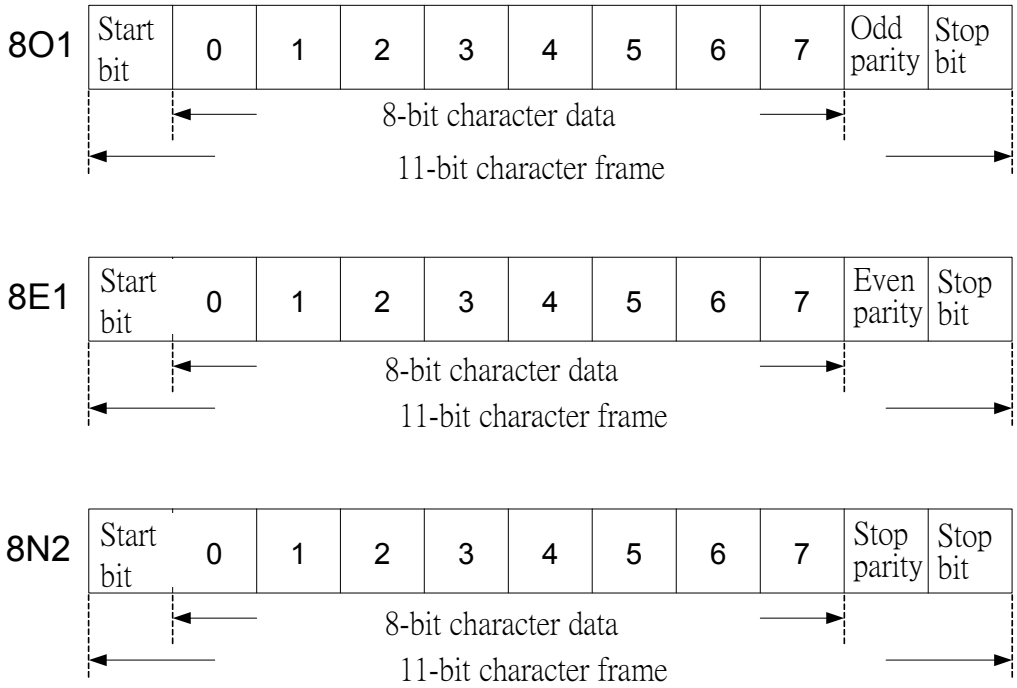
A. ASCII Mode

(a) Coding

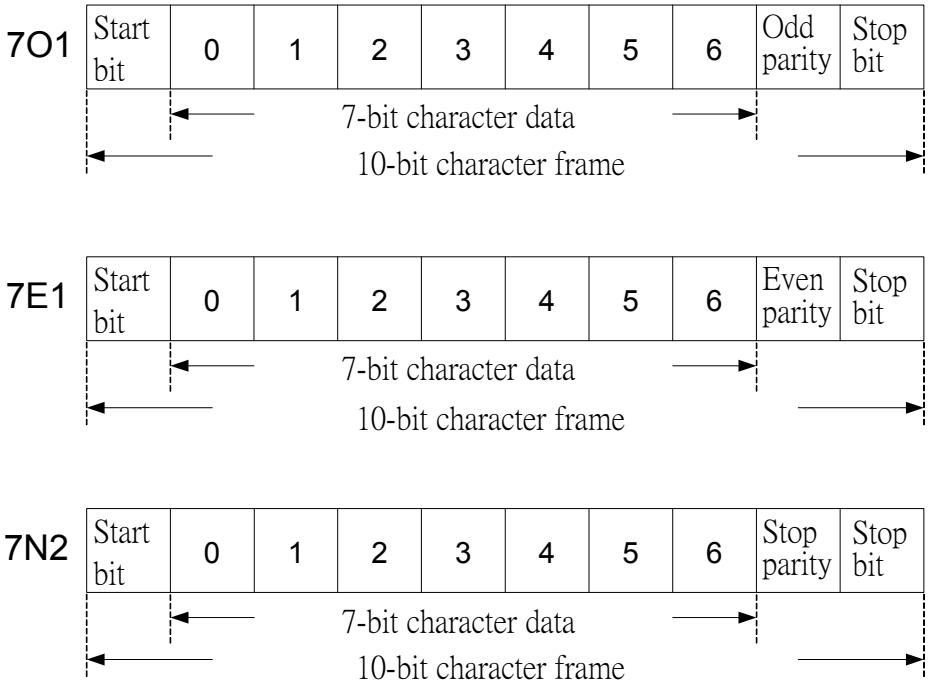
Each 8-bit datum comprises two ASCII characters.For example, a one-byte datum of 75H (hexadecimal expression) is expressed by 75 of ASCII, which includes the ASCII code for 7 (37H) and the ASCII code for 5 (35H).

(b) Character structure

11-bit character framework (used for 8-bit):



10-bit character framework (used for 7-bit):



(3) Communication data structure

Bit Code	Name	Content
STX	Start character	“ : ”(3AH of ASCII)
ADR	Communication address	Two ASCII code per 1-byte
CMD	Command code	Two ASCII code per 1-byte
DATA(n-1)	Data content	n-word = 2n-byte; includes 4n x ASCII code (n<=29)
……		
DATA(0)		
LRC	Command code	Two ASCII code per 1-byte
End1	End code 1	0DH (CR) of ASCII
End0	End code 0	0AH (LF) of ASCII

Communication data format and details of the items are described below:

STX (Communication start)

“ : Character

ADR (Communication address)

Communication location ranges between 1 and 32. For example, for communication with servo actuator of station No. 18 (hexadecimal 12H):

ADR= “1”，“2” =>“1”=31H， “2”=32H

CMD (command) and Data (data character)

The format of data character is determined by the command code.Those commonly applied command codes are described below:

Command code: 03H, read N words

N ≤ 20; for example, read two words continuously from the starting address 0100H of the servo actuator of station No. 01H.

Command message (the mainframe):

STX	:
ADR	0
	1
CMD	0
	3
Starting data address	0
	1
	0
	0
Data quantity	0
	0
	0
	2
LRC error detection	F
	9
End1	0DH(CR)
End0	0AH(LF)

STX	:
ADR	0
	1
CMD	0
	3
Data number (byte)	0
	4
Starting data address 0100H data	0
	1
	0
	2
Content of the second data 0101H data	1
	2
	2
	1
LRC error detection	D
	2
End1	0DH(CR)
End0	0AH(LF)

Command code: 06H; write 1 word

For example, write 100 (0064h) into the starting address 0100h of servo actuator station No. 01H.

Command message (the mainframe):

STX	:
ADR	0
	1
CMD	0
	6
Starting data address	0
	1
	0
	0
Data content	0
	1
	4
	5
LRC error detection	B
	2
End1	0DH(CR)
End0	0AH(LF)

Response message (slave machine):

STX	:
ADR	0
	1
CMD	0
	6
Starting data address	0
	1
	0
	0
Data content	0
	1
	4
	5
LRC error detection	B
	2
End1	0DH(CR)
End0	0AH(LF)

LRC error detection equation (ASCII mode):

ASCII mode use LRC (LONGITUDINAL Redundancy Check) check sum. The calculation of LRC check sum is add the ADR to the last data and the result is divided by 256. The remainder is removed (for example, the results of footing to get the 128H hexadecimal only take 28H), then to calculate the two's complement, the result is obtained after the LRC check sum.

For example: Reading two word form 0104h address for servo driver that device number is 01h

01H+03H+01H+04H+00H+02H=0BH

Take the two's complement of 08H the number is F8H, it to know LRC as "F", "5".

STX	:
ADR	0
	1
CMD	0
	6
Starting data address	0
	1
	0
	4
Data quantity	0
	0
	0
	2
LRC error detection	F
	5
End1	0DH(CR)
End0	0AH(LF)

End1、**End0**（Communication ended）

Use (0DH) as the character '\r' (carriage return) and (0AH) as the character '\n' (new line) to denote the end of the communication.

B. The RTU mode

(a) Coding

Each 8-bit data comprises two 4-bit hexadecimal characters.For example, 1-byte datum 62H

(b) Communication data structure

Communication data format and details of the items are described below:

Bit Code	Name	Content
STX	Start character	Still time for more than 6 ms
ADR	Communication address	1 byte
CMD	Command code	1 byte
DATA(n-1)	Data content	n-word = 2n-byte，n<=29
……		
DATA(0)		
CRC	Command code	1 byte
End	End code	Still time for more than 6 ms

STX (Communication start)

Still time for more than 6 ms

ADR (Communication address)

Communication location ranges between 1 and 32. For example, for communication with servo actuator of station No. 18 (hexadecimal 12H):

ADR=12H

CMD (command) and Data (data character)

The format of data character is determined by the command code.Those commonly applied command codes are described below:

Command code: 03H, read N words

N ≤ 20; for example, read two words continuously from the starting address 0100H of the servo actuator of station No. 01H.

Command message (the mainframe):

ADR	01H
CMD	03H
Starting data address	02H (High byte)
	00H (Low byte)
Data number (Counted by word)	00H
	02H
CRC low byte error detection	C5H (Low byte)
CRC high byte error detection	B3H (High byte)

Response message (slave machine):

ADR	01H
CMD	03H
Data number (Counted by byte)	04H
Starting data address 0100H content	00H (High byte)
	B1H (Low byte)
Second data address 0101H content	1FH (high byte)
	40H (Low byte)
CRC low-byte error detection	A3H (low byte)
CRC high-byte error detection	D4h (high byte)

Command code: 06H; write 1 word

For example, write 100 (0064h) into the starting address 0200h of servo actuator station No. 01H.

Command message (the mainframe):

ADR	01H
CMD	06H
Starting data address	02H (High byte)
	00H (Low byte)
Data content	00H (High byte)
	64H (Low byte)
CRC low-byte error detection	89H (Low byte)
CRC high-byte error detection	99H (High byte)

Response message (slave machine):

ADR	01H
CMD	06H
Starting data address	02H (High byte)
	00H (Low byte)
Data content	00H (High byte)
	64H (Low byte)
CRC low-byte error detection	89H (Low byte)
CRC high-byte error detection	99H (High byte)

CRC (RTU mode) error detection calculation:

The RTU mode adopts CRC (Cyclical Redundancy Check) to detect error.
CRC error detection calculation is explained as follows:

Step1: Load a 16-bit register with FFFFH content and name it as the CRC register.
Carry out Exclusive OR operation for the first byte of the command message and the 16-bit CRC register.

Save the result into the CRC register.

Step 3: Check the lowest bit (LSB) of CRC register. If the bit is 0, shift one bit to the right. If this bit is 1,

then shift the CR register value one bit to the right and carry out Exclusive OR computation with A001H.

Step 4: Return to step 3. Repeat this eight times before moving to step 5.
Step 5: Repeat step 2 to step 4 for the next bit of the command message until all bytes are handled.

At this point, the content of CRC register is the error detection value of CRC.

Note: After calculating CRC error detection value, fill in the low bit of CRC in the command meesage befor fill in the high bit of CRC.
Here is one example:

Read two words from the 0101H address of the servo actuator station No. 01H.The last content of CRC register obtained from the calculation of the last bit of ADR to datanumber is 3794H. The command message is presented below. Please note that 94H is transmitted before 37H.

ADR	01H
CMD	03H
Starting data address	99H (High byte)
	40H (Low byte)
Data number	00H (High byte)
	02H (Low byte)
CRC low-byte error detection	94H (Low byte)
CRC high-byte error detection	37H (High byte)

End1、**End0**（Communication ended）

Communication ends when the still period lasts for more than 6 ms.

CRC program example:

CRC value in the following example is produced by C programming language.This function requires two parameters:

unsigned char* data;

unsigned char length

Transmit this function to CRC value of the unsigned integer type.

```
unsigned int crc_chk(unsigned char* data, unsigned char length)
{
    int j;
    unsigned int reg_crc=0xFFFF;
    while( length-- )
    {
        reg_crc^= *data++;
        for (j=0; j<8; j++ )
        {
            if( reg_crc & 0x01 )            /*LSB(bit 0 ) = 1 */
                reg_crc = (reg_crc >> 1)^0xA001;
            else
                reg_crc = (reg_crc>>1);
        }
    }
    return reg_crc;
}
```

(c) Function code and error code

Shihlin servo actuator ‘s definition of function code and error code.

Function code	Description
03	Reading the parameter
06	Writing the parameter

Function code 03H denotes parameter reading (as many as 29 per reading).
Function code 06H denotes one set of data writing.
Function code 08H is the diagnoistic mode for judging whether the communication is normal or not.

Error code	Description
01	Function code error
02	Parameter address error
03	Parameter range error

Error code 01H denotes the received function code is wrong.
Error code 02H denotes the received parameter address is wrong.
Error code 03H denotes the received parameter value range is wrong.

When the received data is wrong, 0x80 will be added to the function code, denoting the occurrence of error. This information will be transmitted back to the following packet.

(a) The ASCII mode

STX	‘:’
Address	‘0’
	‘1’
Function	‘6’
	‘3’
Exception code	‘0’
	‘2’
LRC CHK	‘7’
	‘7’
END	CR
	LF

(b) The RTU mode

Address	01H
Function	86H
Exception code	02H
CRC CHK Low	C3H
CRC CHK High	A1H

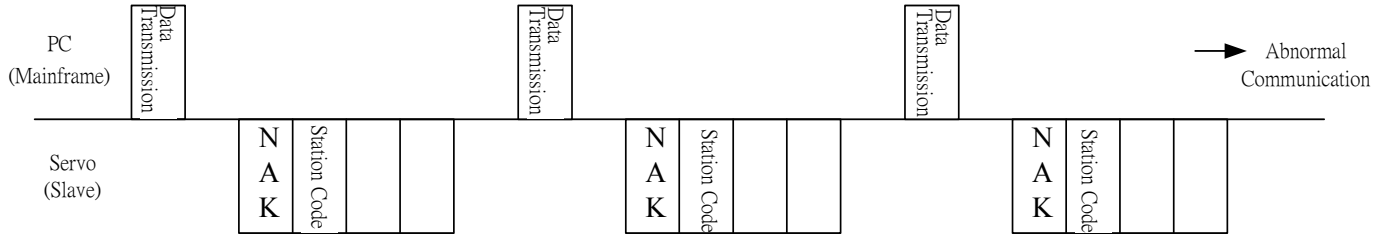
C. Overtime action

When the PC communication action ends, if no servo reply action is received after 1000 ms, data will be sent again. Overtime happens if the transmission has been carried out three times but not servo replay hhahs been received (communication abnormal).

Controller (Main Station)	Data transmission	Data transmission	Data transmission	Communication overtime
Actuator (Vice station)				

D. Retry action

When PC continuous receives error message from Servo, PC will resend the data to Servo. Communication abnormal happens if the computer receives error message sent by Servo three times consecutively.



8.4. Communication Parameter Writing and Reading

(1) Condition monitoring (read only)

Status expression command code

Communication address	Display Item	Data Length
0x0000	Motor Feedback pulse number (the absolute value) [pulse]	1word
0x0001	Motor Feedback Rotation Loops (the absolute value) [rev]	1word
0x0002	Pulse Counting for Pulse Command [pulse]	1word
0x0003	Number of rotations of pulse command [rev]	1word
0x0004	Number of Pulse Errors [pulse]	1word
0x0005	Pulse Command Input Frequency [kHz]	1word
0x0006	Current Motor Rotation Speed [rpm]	1word
0x0007	Analog speed voltage [V] (display two decimal points)	1word
0x0008	Speed input command [rpm]	1word
0x0009	Analog torque voltage [V] (display two decimal points)	1word
0x000A	Torque input command [Nt-m]	1word
0x000B	Effective Loading Rate [%]	1word
0x000C	Peak Loadind Rate [%]	1word
0x000D	DC Bus Voltage [V]	1word
0x000E	Load motor inertia ratio [times] (Display 1 decimal point)	1word
0x000F	Instantaneous Torque [%]	1word

(2) Digital IO monitoring (Read only)

(a) IO pin status

Communication address	Content	Data Length
0x0203	For digital input and output termal status (ON / OFF), the pin is arranged as follows:	1word

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	No. of Bit
CN1-21	CN1-20	CN1-19	CN1-18	CN1-17	CN1-16	CN1-15	CN1-14	Pin code
DI8	DI7	DI6	DI5	DI4	DI3	DI2	DI1	Siganl Name

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
CN1-46	CN1-45	CN1-44	CN1-43	CN1-42	CN1-41	CN1-23	CN1-22
ALM	DO5	DO4	DO3	DO2	DO1	LSN	LSP

(b) IO pin function

Communication address	Content	Data Length
0x0204~0x0207	For planning the display of the current digital input and output terminal function, make the following pin arrangement.	1word

Address : 0x0204

Bit12~Bit15	Bit8~Bit11	Bit4～Bit7	Bit0～bit3	No. of Bit
CN1-45(DO5)	CN1-44(DO4)	CN1-43(DO3)	CN1-42(DO2)	Pin code
0x00~0x09 (Note 1)	0x00~0x09 (Note 1)	0x00~0x09 (Note 1)	0x00~0x09 (Note 1)	Function option

Address : 0x0205

Bit10~Bit15	Bit5～Bit9	Bit0～bit4	No. of Bit
CN1-41(DO1)	CN1-21(DI8)	CN1-20(DI7)	Pin code
0x00~0x09 (Note 1)	0x00~0x17 (Note 2)	0x00~0x17 (Note 2)	Function option

Address : 0x0206

Bit10~Bit15	Bit5～Bit9	Bit0～bit4	No. of Bit
CN1-19(DI6)	CN1-18(DI5)	CN1-17(DI4)	Pin code
0x00~0x17 (Note 2)	0x00~0x17 (Note 2)	0x00~0x17 (Note 2)	Function option

Address : 0x0207

Bit10~Bit15	Bit5～Bit9	Bit0～bit4	No. of Bit
CN1-16(DI3)	CN1-15(DI2)	CN1-14(DI1)	Pin code
0x00~0x17 (Note 2)	0x00~0x17 (Note 2)	0x00~0x17 (Note 2)	Function option

(c) The current control mode

Communication address	Content	Data Length
0x0208	Display the current actuator control mode 0: Pt position mode; 1: Absolute Pr mode; 2: Incremental Pr mode 3: Speed control mode; 4: Torque control mode	1word

Note 1: DO function option definition

0x05	0x04	0x03	0x02	0x01	0x00	Function option code
TLC/VLC	**HOME**	**INP/SA**	**ALM**	**RD**	**None**	Representing signal
		0x09	0x08	0x07	0x06	Function option code
		CMDOK	**ZSP**	**WNG**	**MBR**	Representing signal

Note 2: DI function option definition

0x07	0x06	0x05	0x04	0x03	0x02	0x01	0x00	Function option code
SP2	**SP1**	**TL1**	**TL**	**PC**	**RES**	**SON**	**NONE**	Representing signal
0x0F	0x0E	0x0D	0x0C	0x0B	0x0A	0x09	0x08	Function option code
CR	**CM2**	**CM1**	**SHOM**	**ORGP**	**ST2/RS1**	**ST1/RS2**	**SP3**	Representing signal
0x17	0x16	0x15	0x14	0x13	0x12	0x11	0x10	Function option code
HOLD	**CTRG**	**POS3**	**POS2**	**POS1**	**EMG**	**LOP**	**CDP**	Representing signal

(3) Abnormal alarm information (Read only)

Communication address	Content	Data Length
0x0100	Current abnormal alarm	1word
0x0101	The preceding abnormal alarm record	1word
0x0102	The two preceding abnormal alarm records	1word
0x0103	The three preceding abnormal alarm records	1word
0x0104	The four preceding abnormal alarm records	1word
0x0105	The five preceding abnormal alarm records	1word
0x0106	The six preceding abnormal alarm records	1word

(4) Clearing the abnormal information (readable and writable)

Communication address	Content	Data Length
0x0130	Clear the current abnormal alarm if the written information is 0x1EA5. Transmit the current abnormal alarm back if read this address data.	1word
0x0131	Clear the current abnormal alarm if the written information is 0x1EA5. Transmit the preceding abnormal alarm record when this address data is read.	1word

(5) Parameter reading and writing (readable and writable)

Communication address	Content	Data Length
0x0300 ~ 0x0395	Parameters in the parameter group: PA group has a total of 45 parameters (communication address: 0x0300~0x032C) PB group has a total of 30 parameters (communication address: 0x032D~0x034A) PC group has a total of 45 parameters (communication address: 0x034B~0x0377) PD group has a total of 30 parameters (communication address: 0x0378~0x0395)	1word ~ As many as 29 words per reading

(g) Reset to the factory default value (Readable and writable)

Communication address	Content	Data Length
0x0621	Reset all the parameters from the PA – PD groups to the default value one second After the write-in of data 0x1EA5. Reading this parameter that if return 1 stand for Servo writing EEPROM parameter yet, on the contrary, if return 0 stand for writing EEPROM state finish.	1word

(7) Software input contact control (Readable and Writable)

Step 1: Select communication contact input mode (write-in data 0x0001).

Communication address	Content	Data Length
0x0387	0：External terminal input mode; 1: Communication contact input mode	1word

Step 2: Write-in digital input termal status (ON/OFF)

Communication address	Content	Data Length
0x0201	Write-in digital input termal status (ON/OFF)	1word

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	No. of Bit
CN1-21	CN1-20	CN1-19	CN1-18	CN1-17	CN1-16	CN1-15	CN1-14	Pin code
DI8	DI7	DI6	DI5	DI4	DI3	DI2	DI1	Siganl Name

Bit10~Bit15	Bit9	Bit8
Please set the value of these bit to zero.	CN1-23	CN1-22
	LSN	LSP

(8) Terminal force output control (Readable and writable)

Step 1: Read abnormal alarm and Servo On information from the following list of communication address. Make sure that there is no abnormal alaram at present.

Also, make sure that the Servo is off in order to enter the testing mode.

Communication address	Content	Data Length
0x0900 (read only)	For OxOUVW, UV denotes the abnormal alarm information; W=1 denotes Servo On; W=0 denotes Servo Off.	1word

Step 2: Enter the Forced DO mode, and write in Data 0X0001. The communication address setup has the following meanings:

Communication address	Content	Set Range	Data Length
0x0901	Switch of the operation mode 0000: Leave the testing mode 0001: Keep 0002: DO forced output (output signal forced output) 0003: JOG operation 0004: Positioning operation	0000~0004	1word

Step 3: Write-in digital output terminal status

Communication address	Content	Data Length
0x0202	See below for write-in digital input termal status (ON/OFF).	1word

Bit6~Bit15	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	No. of Bit
Please set the value of these bit to zero.	CN1-46	CN1-45	CN1-44	CN1-43	CN1-42	CN1-41	Pin code
	ALM	DO5	DO4	DO3	DO2	DO1	Siganl Name

Step 4: Leaving Forced DO mode: Write data 0x000 for the communication address 0x0901

(9) JOT testing (Readable and Writable)

Step 1: Read abnormal alarm and Servo On information from the following list of communication address. Make sure that there is no abnormal alaram at present. Also, make sure that the Servo is off in order to enter the testing mode.

Communication address	Content	Data Length
0x0900 (Read only)	For OxOUVW, UV denotes the abnormal alarm information; W=1 denotes Servo On; W=0 denotes Servo Off	1word

Step 2: Entering the JOG mode: Write data 0x003 for the communication address 0x0901

Step 3: Set the acceleration and deceleration time constant of JOG

Communication address	Content	Data Length
0x0902	The acceleration and deceleration time constant of JOG and positioning mode (Range 0 – 20000) (Unit: ms)	1word

Step 4: Set the speed command and activation of JOG

Communication address	Content	Data Length
0x0903	Enter the speed command of JOG and positioning mode (Range 0 – 6000) (Unit: rpm)	1word

Step 5: Set the command for testing JOG operation

Communication address	Content	Data Length
0x0904	When the write-in data is 0, JOG operation stops. When the write-in data is 1, JOG operation has a forward rotation. When the write-in data is 2, JOG operation has a reverse rotation.	1word

Step 6: Leaving the JOG mode: Write data 0x000 for the communication address 0x0901

(10) Positioning testing (Readable and writable)

Step 1: Read abnormal alarm and Servo On information from the following list of communication address. Make sure that there is no abnormal alaram at present.

Also, make sure that the Servo is off in order to enter the testing mode.

Communication address	Content	Data Length
0x0900 (read only)	For OxOUVW, UV denotes the abnormal alarm information; W=1 denotes Servo On; W=0 denotes Servo Off	1word

Step 2: Entering the positioning mode: Write data 0x004 for the communication address 0x0901

Step 3: Set the acceleration and deceleration time constant

Communication address	Content	Data Length
0x0902	The acceleration and deceleration time constant of JOG and positioning mode (Range 0 – 20000) (Unit: ms)	1word

Step 4: Set positioning speed command

Communication address	Content	Data Length
0x0903	Enter the speed command of JOG and positioning mode (Range 0 – 3000) (Unit: rpm)	1word

Step 5: Set the shifting number of rotations for the positioning mode

Communication address	Content	Data Length
0x0905	Set the shifting number of rotations for the positioning mode (Range 0 – 30000) (Unit: rev)	1word

Step 6: Set the shifting pulse number of the positioning mode

Communication address	Content	Data Length
0x0906	Number of shifting pulses of the position mode (Range 0 – 9999) (Unit: pulse)	1word

Step 7: Set the the testing positioning rotation command

Communication address	Content	Data Length
0x0907	A write-in data 0 denotes suspending /stopping the positioning operation (suspended if commanded during the operation; stopped after the command is given for a second time). When the write-in data is 1, positioning operation has a forward rotation. When the write-in data is 2, positioning operation has a reverse rotation.	1word

Step 8: Leaving the positioning mode: Write data 0x000 for the communication address 0x0901

9. Basic Check and Maintenance

9.1. Basic Check

It is recommended for the user to conduct the following check regularly. Make sure that the servo actuator has stopped power transmission. Carry out the inspection only when the recharging light is off.

- Check if there are loose screws at the connection between the machine and the terminal block, the installation part of the servo actuator, and the servo motor. Be sure to tighten any loose screws.
- Avoid placing the controller at a location with harmful gases.
- Avoid having conductable objects placed nexet to the actuator and the wiring of the actuator.
- Avoid having a too long skinned wire or damaged, broken wire for the servo motor.
- Well insulate the cable connecting point of the wiring terminal.
- Make sure that the voltage level of external AC220V is correct.
- Make sure that the operation control switch is off.
- Check if the wiring of self-made power source wiring and encoder wiring are correct.

9.2. Maintenance

The clients should not disassemble the servo actuator when conducting maintenance.Conduct the maintenance as follows:

- Regularly wipe the servo motor and the serer actuator to avoid dust.
- Do not operate the machin under harsh environment for a long time.
- Keep the vent of the servo actuator clean to avoid dust accumulation.

9.3. Component Service Life

Component service life varies depending on the operating environment. Replace the component instantly if any abnormality is found. Contact Shihlin agents for component replacement. The service life of components are listed below:

Component Name	Approximate Life	Description
Rely	100,000 times	Power capacity can affect the service life. The switch can be used for about 100,000 time accumulatedly.
Cooling fan	1 – 30,000 hours (2 – 3 years)	Continuous operation or place the servo actuator at place with harmful gases would short the service life of the fan. The approximate service life is about 2 – 3 years. Fan should be replaced if abnormal noises are produced during operation.
Smooth capacitor	10 years	If the smooth capacitor is affected by the ripple current, its property will deteriorate. The service life of capacitor is affected by the surrounding temperature and the usage criteria. If the operation environment is a regular environment with air conditioing, the service life is about 10 years.

10. Abnormal Alarm Troubleshooting

10.1. The Abnormal Alarm List and the Resolution

Display alarms or warning if breakdowns happen during the operation process.Handle alarms or warnings according to the methods given presented in Chapter 2. When parameter PD19 is set as xxxx1, alarm codes can be outputted.

Alarm codes are outputted by the ON/OFF between each PIN and SG. Warnings (AL12 – AL13) are not coded.

The alarm codes in the following table are outputted when alarm occurs.Under normal condition, they are the signals before setting the output alarm signal.

(CN1-41：DO1，CN1-42：DO2，CN1-45：DO5)

	Display	Alarm Code			Abnormal Alarm Name	Alarm Cleared		
		CN1 41	CN1 42	CN1 46		Power OFF→ON	Press SET at the current alarm screen	Alarm reset (RES) signal
Alarm	AL.01	0	1	0	Overvoltage	○		
	AL.02	0	0	1	Low voltage	○	○	○
	AL.03	0	1	1	Overcurrent	○		
	AL.04	0	1	0	Abnormal regeneration	○	○	○
	AL.05	1	0	0	Overload	○	○	○
	AL.06	1	0	1	Overspeed	○	○	○
	AL.07	1	0	1	Abnormal pulse control command	○	○	○
	AL.08	1	0	1	Over-large position control command	○	○	○
	AL.09	0	0	0	Abnormal seriel communication	○	○	○
	AL.0A	0	0	0	Serial communication overtime	○	○	○
	AL.0B	1	1	0	Position detector abnormal 1	○		
	AL.0C	1	1	0	Position detector abnormal 2	○		
	AL.0D	1	1	0	Abnormal fan	○		
	AL.0E	0	0	0	Over heated IGBT	○		
	AL.0F	0	0	0	Abnormal memory	○		
	AL.10	0	0	0	Overload 2	○		
	AL.11	1	1	1	Abnormal motor matching	○		
Alarm	AL.12				Emergency stop	Alarm cleared after eliminating possible causes		
	AL.13				Forward / reverse rotation limit abnormal			

10.2. Abnormal Causes and Handling

AL.01 Overvoltage

Abnormal action content:

Action when the main loop voltage is greater than the specification.

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Main loop input voltage is higher than the rated permissive voltage	Use a voltmeter to measure if the main loop input voltage is within the rated permissive voltage value.	Use a correct voltage source or a serial voltage stabilizer.
Power source input error (incorrect power source system)	Use a voltmeter to assess if the power source system meets the specification.	Use a correct voltage source or a serial voltage stabilizer.
Actuator hardware breakdown	Use a voltmeter to measure if the main loop input voltage is within the rated permissive voltage value while errors still occur.	Return the machine to the agent or the factory for repairmen.

AL.02 Low voltage

Abnormal action content: Action when the main loop voltage is lower than the specification.

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Main loop input voltage is lower than the rated permissive voltage	Check if the main loop input voltage wiring is normal.	Reconfirm the voltage wiring.
Main loop input voltage has no input voltage source	Use a voltmeter to check if the main loop voltage is normal.	Reconfirm the power source switch.
Power source input error (incorrect power source system)	Use a voltmeter to assess if the power source system meets the specification.	Use a correct voltage source or a serial voltage stabilizer.

AL.03 Overcurrent

Abnormal alarm action content: Action taken when the main loop current value exceeds 1.5-fold of the instantaneous maximum current of the motor.

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Abnormal motor wiring	Check if wiring sequence from the motor to the actuator.	Rewire by following sequence provided by the manual.
Actuator output short circuit	Check if the wiring or the wires between the motor and the actuator is short circuit.	Remove the short circuit and prevent the exposure of the metal conductor.
IGBT abnormal	Abnormal heat sink temperature	Return the machine to the agent or the factory for repairmen.
Abnormal control parameter setup	Check if the set value is greater than the factory default value.	Reset to the factory default value and make correction gradually.

AL.04 Abnormal regeneration

Abnormal alarm action content: Action taken for abnormal regeneration control

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Invalid regeneration transistor switch	Check if the regeneration transistor switch is short circuit.	Return the machine to the agent or the factory for repairmen.
Unconnected regenerative resistor	Check the connection of the regenerative resistor.	Reconnect to the regenerative resistor.
Parameter setup error	Check the set value of the regenerative resistor parameter and the regenerative resistor specifications	Reset the values.

AL.05 Overload

Abnormal alarm action content: Action taken for motor and actuator overload

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Continue usage when exceeding the actuator rated load	Check if the overload is too large.	Increase the motor capacity or decrease the load.
Control system parameter setup	Check if there is any machine vibration.	Make acceleration / deceleration auto-tuning.
Unstable system	The set acceleration / deceleration constant is too fast.	Slow down the acceleration / deceleration set time.
Position encoder, motor wiring error	Check the wiring of U, V, W, and position encoder.	Making correct wiring.

AL.06 Overspeed

Abnormal alarm action content:

Action taken when motorl control speed exceeds the normal speed.

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Over high input frequency of the pulse command	Check if the input frequency of the pulse command is too high.	Correctly set the pulse frequency.
Incorrect setup of the acceleration / deceleration time parameter	Check if the acceleration / deceleration time constant is too small.	Increase the acceleration / deceleration time constant.
A too large overshoot caused by unstable servo system	Obsserve if the system vibrate constantly.	1. Adjust the gain to a suitable value. 2. If adjusting the gain value is not effective, use the following method. (a) Minimize the load inertia. (b) Change the acceleration / deceleration time constant.

AL.07 Abnormal pulse control command

Abnormal alarm action content: Action taken when the input frequency of the pulse command exceeds the permitted value.

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Pulse command frequency higher than the rated input frequency	Use pulse frequency measurer to assess the input frequency.	Correctly set the pulse frequency.
Input pulse command device breakdowns	Change the input pulse command device.	

AL.08 Over-large position control command

Abnormal action content: Action taken when the position control error is larger than the set permissive value.

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Incorrect setup of the acceleration / deceleration time parameter	Check if the acceleration / deceleration time constant is too small.	Increase the acceleration / deceleration time constant.
Inproper torque restriction setup	Check if the torque restriction parameter (PA05) is too small.	Elevate the torque restriction.
Too small gain value setup	Make sure if the position control gain value (PB07) is too small.	Enlarge the position control gain.
Too big external load	Check external load.	Reduce the external load or re-evaluate the motor capacity.

AL.09 Abnormal seriel communication

Abnormal alarm action content: Action taken if RS-232 / 485 communication is abnormal.

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Communication protocol setup error	Check if the communication protocol set value matches.	Set the communication parameter value correctly.

Communication address incorrect	Check the communication address.	Set the communication parameter address correctly.
Communication data incorrect	Check the access values.	Set the values correctly.

AL.0A Serial communication overtime

Abnormal alarm action content: Action taken when RS-232 / 485 communication overtime.

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Did not receive communication commands for a long time	Check if the communication line if broken or loosen.	Change or renew the connection.
Inproper setup of the overtime constant	Check the setup of the overtime constant.	Set the values correctly.

AL. 08 Position detector abnormal 1

Abnormal alarm action content: Action taken when the pulse signal is abnormal

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Position encoder wiring error	Make sure that he wiring follows the recommendation from the manual.	Making correct wiring.
Loosen position encoder	Check if the position of the encoder connector.	Re-installation
Position encoder damaged	Abnormal motor	Motor replacement
Poor position encoder wiring	Check if the wiring has been loosen.	Reconnect the wiring.

AL.0C Abnormal position encoder 2

Abnormal alarm action content: Action taken when the pulse signal is abnormal

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Initial magnetic field error of the encoder	Make the motor axle roate before restarting the machine. If there is no improvement, return the machine to the agent or the factory.	

AL.0D Abnormal actuator fan

Abnormal action content: Action taken if the actuator fan is abnormal.

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Actuator fan stop operation	Turn off the power source. Change the fan by the clients or return the product to the agent or the factory.	

AL.0E Over heated IGBT

Abnormal alarm action content:

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Continuous using the machine with exceeded actuator rated load, or if the actuator has a short circuit	Check if the overload is too large or the motor current is too large. Check the output wiring of the actuator.	Reduce the actuator load or select an actuator with larger capacity.

AL.0F Abnormal memory

Abnormal alarm action content: Action taken for abnormal EEPROM acess

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Abnormal memory data access	Reset the parameters or the power.	If it is still abnormal after the reset, send the machine back to the agent or the factory for repairmen.

AL.10 Overload 2

Abnormal action content: When maximum current is outtpued continuously for more than 1 second under mechanical impacts.

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Mechnical impacts	Check if the route planning is problematic.	Correct the movement curve or add a limit switch.
Motor connection error	Check motor connection	Make correct wiring.
System operated under vibration	Check if the machine has high frequency noises.	Reduce the rigid setting or change to the manual adjustment.
Enconder breakdown	Check if the encoder is normal.	Replace the servo motor.

AL.11 Abnormal motor matching

Abnormal alarm action content: the serial number of the actuator does not match to the motor.

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
THe capacity of the motor and the actuator does not match well	Check if the motor and the actuator is well matched.	Make a correct match between the motor and the actuator.

Al.12 Emergency stop

Abnormal alarm action content: The action of pressing the emergency switch.

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Press the switch for an emergency stop	Make sure the switch location.	Activate the emergency stop switch.

AL.13 Forward / reverse rotation limit abnormal

Abnormal alarm action content: The action of pressing the button for forward limit.

Abnormal Alarm Cause	Abnormal Inspection Method	Abnormal Handling Method
Press the forward limit switch	Make sure the switch location.	Activate the forward limit switch.
Press the reverse limit button	Make sure the switch location.	Turn on the reverse limit switch.

11. Product Specifications

11.1. Servo Actuator Specifications

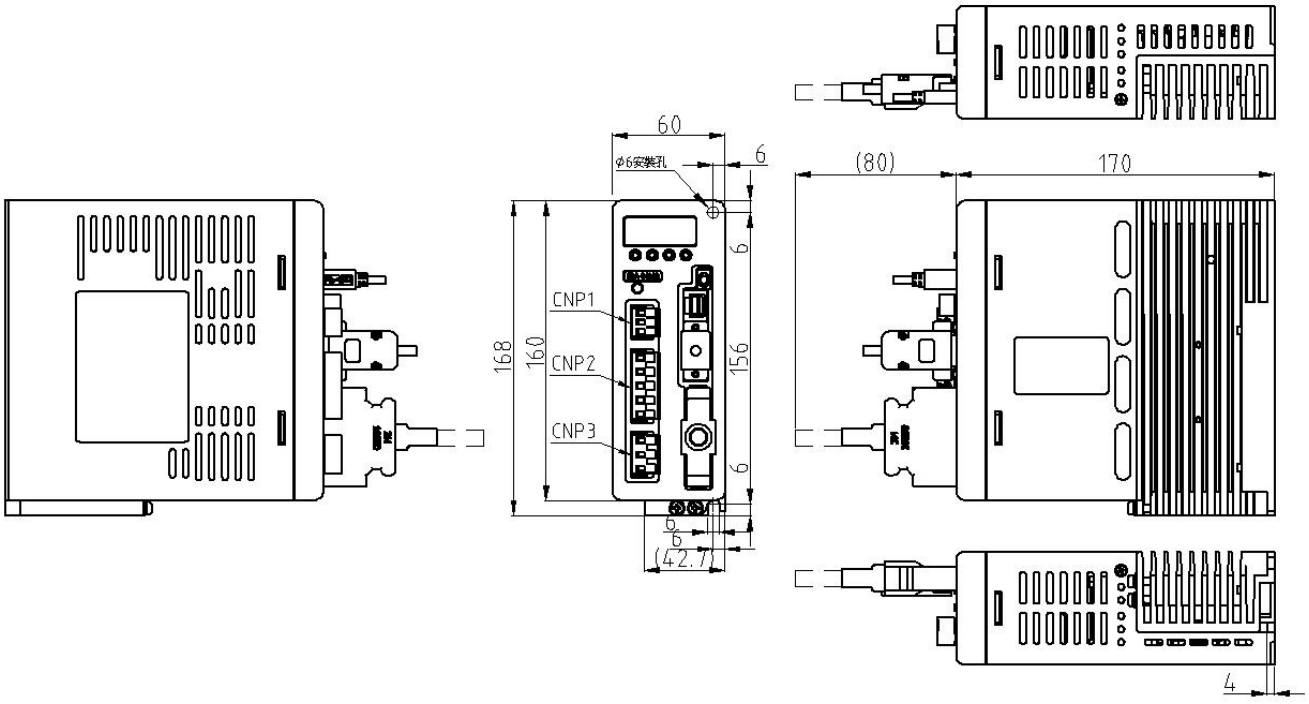
Actuator MOdel SDA-□□□A2		010	020	040	050	075	100	150	200	350
Recommend Servo Motor Model SMA-□□□□ SMA-□□□□		L010	L020	L040	M050	L075	M100	M150	M200	M350
Corresponding Motor Power		100W	200W	400W	500W	750W	1KW	1.5KW	2KW	3.5KW
Major Circuit Power	Voltage / Frequency (Note 1)	Three-phase 200～230VAC 50/60Hz or Single-phase 230VAC 50/60Hz					Three-phase 200～230VAC 50/60Hz or			
	Permitted Voltage Changes	Three-phase 170～230VAC 50/60Hz or Single-phase 207～253VAC 50/60Hz					Three-phase 170～253VAC 50/60Hz or			
	Permitted Frequency Changes	Maximum ± 5%								
Control Circuit Power	Voltage / Frequency	Single-phase 200～230VAC 50/60Hz								
	Permitted Voltage Changes	Single-phase 170～253VAC 50/60Hz								
	Permitted Frequency Changes	Maximum ± 5%								
	Power Consumption (W)	30								
Control Method		Three-phase whole wave rectify, IGBT-PWM controlled (SVPWM actuated)								
Dynamic Brake		Built-in								
Security Function		Overcurrent, regenerative overvoltage, overload (accumulated electronic heat), fan failure protection, output short circuilt protection, abnormal encoder protection, abnormal regeneration protection, Low voltage / instantaneous outages protection, overspeed protection, against over-large error protection								
Encoder Feedback		2500ppr (10000 resultion) incremental encoder								
Communication Interface		RS232/RS485(MODBUS)、USB								
Position Control Mode	Maximum Output Pulse Frequency	500kpps (Differential Transmission)，200kpps (Open Collector Transmission)								
	Pulse Command	CCW Pulse train+CW Pulse train； Pulse train + Symbols；A-, B-phase pulse train								
	Command Control	External puse control / Internal register setup								
	Commend Smoothing	Low-pass filter smoothing / Linear smoothing / PS curve smoothing								
	Pulse Command Power	Electronic gear ratio A/B-fold (A：1～32767, B：1～32767) 1/50 < A/B < 200								
	Pulse Width Setting for Completed Positioning	0～±10000pulses								
	Over-large Error	±3 Rotation								
	Torque Limit	Internal parameter setup or external analog Input setup (0～+10VDC/Maximum torque)								
	Feedforward Compensation	Internal parameter setup 0～200%								

Actuator Model SDA-□□□A2		010	020	040	050	075	100	150	200	350
Recommend Servo Motor Model SMA-□□□□ SMA-□□□□		L010	L020	L040	M050	L075	M100	M150	M200	M350
Corresponding Motor Power		100W	200W	400W	500W	750W	1KW	1.5KW	2KW	3.5KW
Speed Control Mode	Speed Control Range	Analogue speed command 1:2000; Internal speed command 1:5000								
	Command Control	External analog voltage input / Interanl register setup								
	Commend Smoothing	Low-pass filter smoothing / Linear acceleration and desceleration curve smoothing / S curve smoothing								
	Analog Speed Command Input	0～±10VDC/Rated speed (Resistor Input 10～12kΩ)								
	Speed Change Rate (Note 2)	Load change; 0～100% maximum ±10%, Power source change ±10% maximum 0.5%, Ambient temperature 0℃~55℃：Maximum ± 0.5% （Analog speed command）								
	Torque Limit	Internal parameter setup or external analog Input setup (0～+10VDC/Maximum torque)								
	Bandwidth	Maximum 450Hz								
Torque Limitation Mode	Command Control	External analog voltage input								
	Commend Smoothing	Low-pass filter smoothing								
	Analog Torque Command Input	0～±10VDC/Maximum torque (Resistor Input 10～12kΩ)								
	Speed Limit	Internal parameter setup or external analog Input setup (0～+10VDC/Maximum speed)								
Input and Output Signals	Digital Input	Servo activation, forward and backward rotation limits, pulse error clearing, torque direction options, speed command options, positioning command options, forward and backward rotation direction activation, ratio control switching, torque limit switching, abnormal alarm reset, emergency stop, control mode switching, electric gear ratio options, booster switching								
	Digital Output	Torque limit attended, speed limit attended, preparatory signal, zero speed attained, position attained, speed attained, alarm signal, Zero return completed								
	Analog Input	Analog speed command limit, analog torque command limit								
	Analog Output	Command pulse frequency, pulse error, current command, DC bus voltage, servo motor speed, torque size								
Cooling Method		Natural cooling, open (IP20)				Fan cooling, open (IP20)				
Environment	Temperature	0℃ ~ 55℃ Force air circulation in the surrounding area if the temperature goes beyond 45 ℃; Storage: -20～65℃ (Not at the freezing point)								
	Temperature	Maximum 90% RH (not at the dew point); Storage： Below 90RH (Not at the dew point)								
	Installation Location	Indoor (avoid direct sun light); no erosive gas, no flammable gas, no oil mist or dust								
	Altitude	Between sea level and 1000 m								
	Vibration	Maximum 59 m/s^2(Note 2)								
Weight (Kg) (Note 2)		1.4	1.4	1.4	1.4	1.7	1.7	2.6	2.6	
Reference size chart		P198				P199		P200		

11.2. Actuator Appearance and Dimensions

SDA-010A2、SDA-020A2、SDA-040A2、SDA-050A2 (100W~500W)

Unit: mm

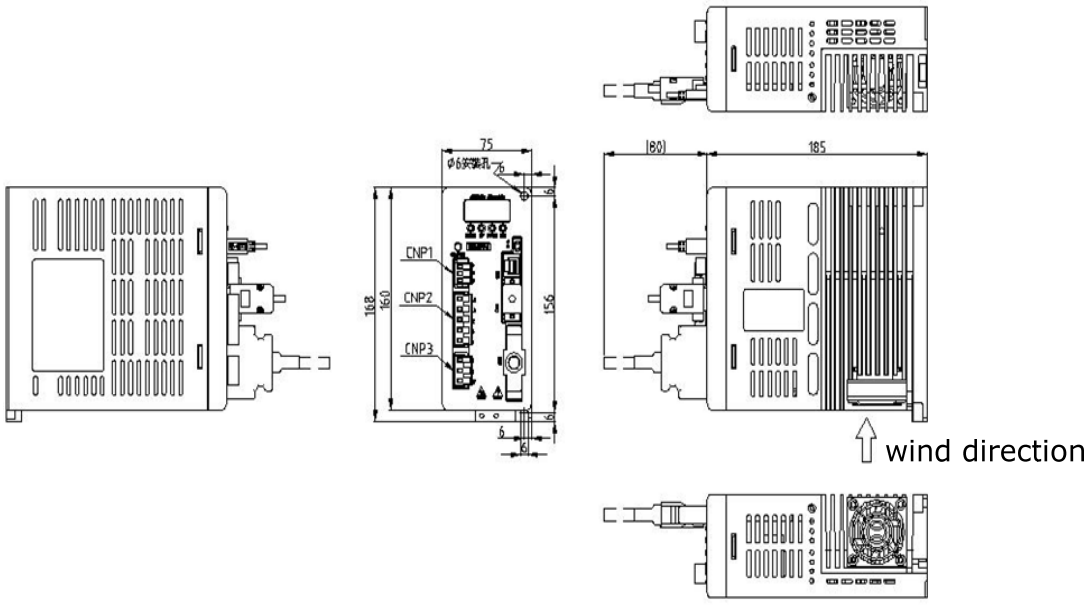


PE terminal

★ The company will not inform the clients for any dimension change of the machine.

SDA-075A2、SDA-100A2 (750W、1KW)

Unit: mm

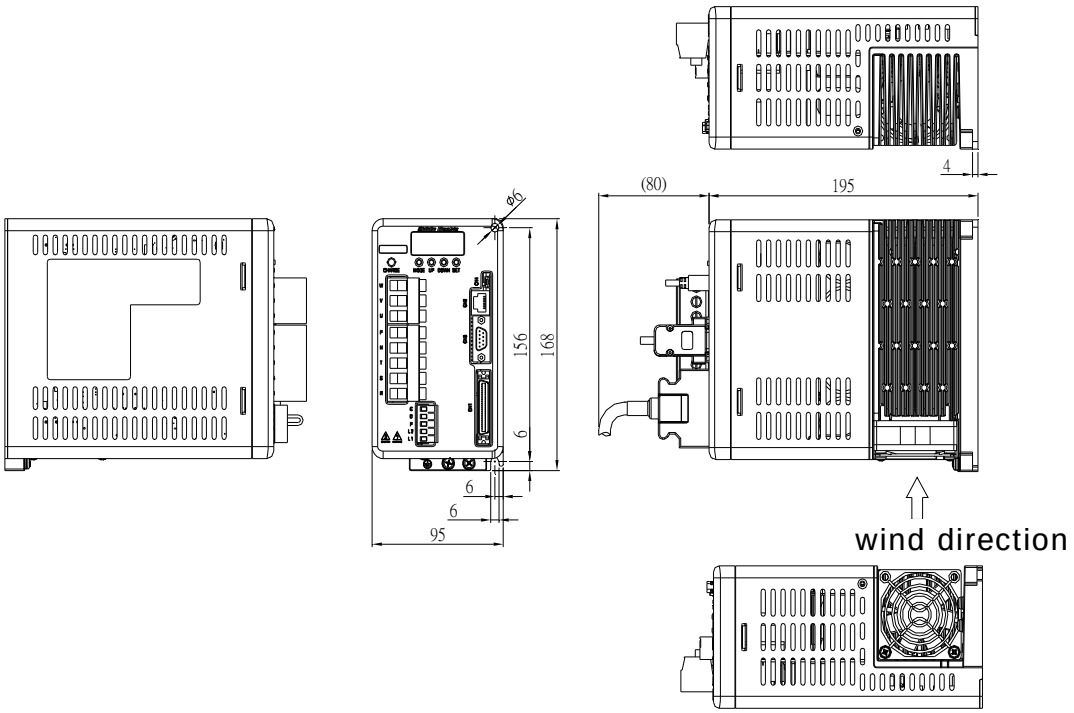


PE terminal

★ The company will not inform the clients for any dimension change of the machine.

SDA-150A2、SDA-200A2、SDA-350A2 (1.5KW~3KW)

Unit: mm



PE terminal

★ The company will not inform the clients for any dimension change of the machine.

11.3. Low Inertia Servo Motor Standard Specifications SMA – L□□□R30A Series

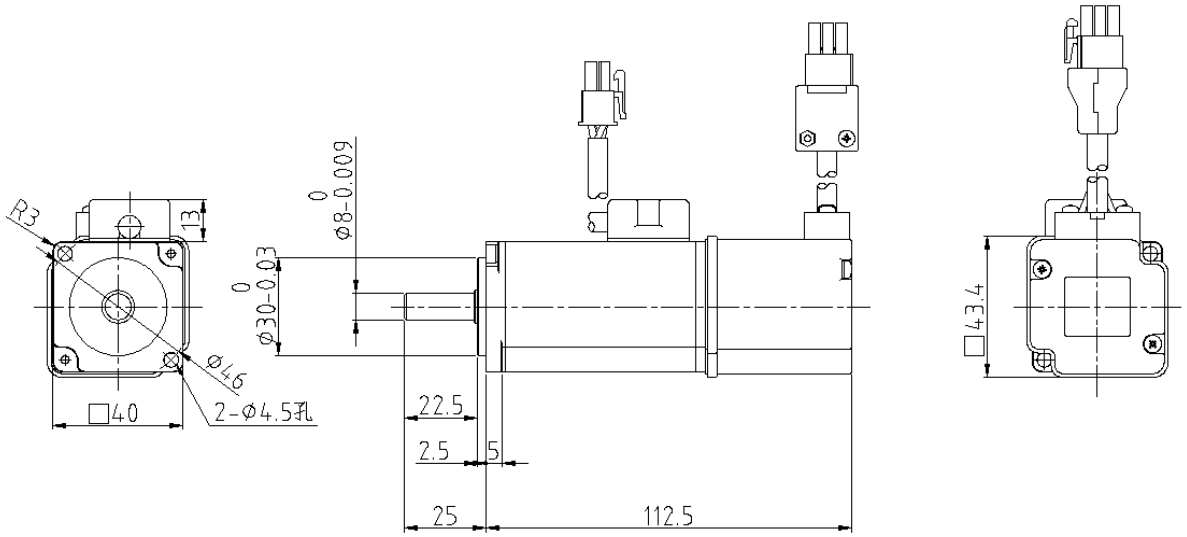
Model: SMA-		010	020	040	075
Power Device Capacity (kVA)		0.3	0.5	0.9	1.3
Rated Output Capacity (W)		100	200	400	750
Rated Torque (N • m)		0.32	0.64	1.27	2.4
Maximum Torque (N • m)		0.96	1.92	3.81	7.2
Rated Rotation Speed (r/min)		3000			
Maximum Rotation Speed (r/min)		4500			
Momentary Permitted Rotation Speed (r/min)		5175			
Continuous Rated Torque and Power Ratio (kW/s)		18.29	19.69	46.08	47.21
Rated Current (A)		0.93	1.32	2.44	4.8
Maximum Current (A)		2.79	3.96	7.32	14.7
Inertia J ($x10^{-4}$kg • m^2)		0.056	0.208	0.350	1.38
Torque Constant K_T (N · m/A)		0.344	0.485	0.5205	0.490
Voltage Constant K_E (V/Kmin^{-1})		39.97	54.53	56.6	56.25
Winding Inpedance R_a(Ohm)		41.75	11.70	5.66	1.38
Winding Inductance L_a(mH)		29.13	42.87	24	10.02
Mechanical Time Constant (ms)		1.780	0.964	0.704	0.640
Electrical Time Constant (ms)		0.7	3.66	4.24	7.26
Insulation Level		F			
Insulation Resistance		100MΩ,DC500V			
Insulance		AC1500V,60Hz,60sec			
Speed and Position Detector		2500ppr			
Surrounding Environment Specifications	Protection structure (IP)	65			
	Working Temperature	0～40℃			
	Surrounding Humidity	Under 80%Rh (No condensation)			
	StorageTemperature	-15～70℃			
	Storage Humidity	Under 90%Rh (No condensation)			
	Vibration Level	V-15			
	Vibration Resistance	x, y : 49 m/s^2			
Weight (Kg)		0.551	1.01	1.455	2.89
Safety Certification		CE			

11.4. Medium Inertia Servo Motor Standard Specifications SMA－M□□□R20 Series

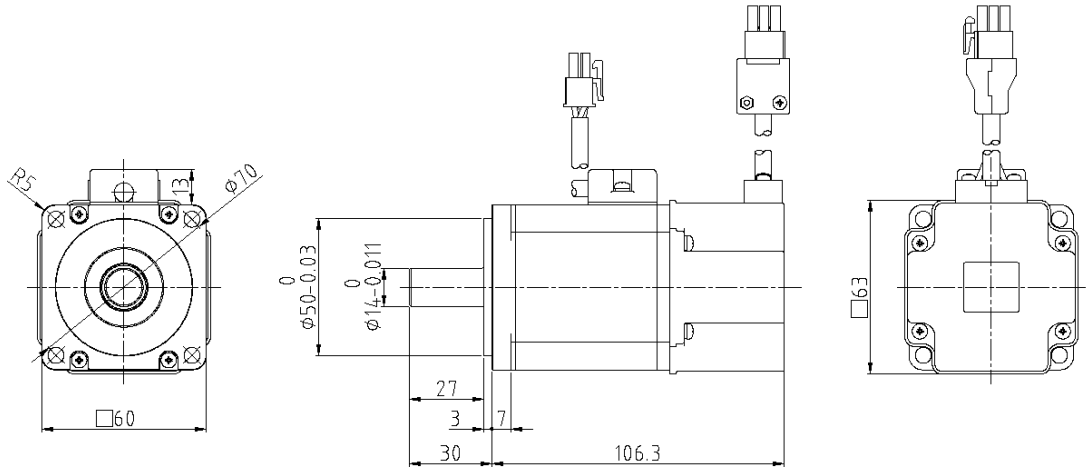
Mode: SMA-		050	100	150	200	350
Power Device Capacity (kVA)		1.0	1.7	2.5	3.5	5.5
Rated Output Capacity (W)		0.5	1.0	1.5	2.0	3.5
Rated Torque (N・m)		2.39	4.78	7.16	9.55	16.7
Maximum Torque (N・m)		7.16	14.4	21.6	28.5	50.1
Rated Rotation Speed (r/min)		2000				
Maximum Rotation Speed (r/min)		3000		2500		
Momentary Permitted Rotation Speed (r/min)		3450		2850		
Continuous Rated Torque and Power Ratio (kW/s)		8.6	18.2	27.7	23.5	37.3
Rated Current (A)		3.0	5.8	8.5	10	16
Maximum Current (A)		9.0	16.8	25.5	31.5	48
Inertia J ($x10^{-4}$kg・m^2)		6.59	12.56	18.52	38.8	74.8
Torque Constant K_T (N・m/A)		0.912	0.941	0.948	1.141	1.175
Voltage Constant K_E (V/Kmin^{-1})		95.34	98.48	99.32	119.49	123.18
Winding Inpedance R_a(Ohm)		3.77	1.48	0.885	0.758	0.311
Winding Inductance L_a(mH)		19.2	9.12	5.79	8.17	3.99
Mechanical Time Constant (ms)		2.988	2.094	1.824	2.262	1.690
Electrical Time Constant (ms)		5.091	6.179	6.542	10.751	12.788
Insulation Level		F				
Insulation Resistance		100MΩ,DC500V				
Insulance		AC1500V,60Hz,60sec				
Speed and Position Detector		2500ppr				
Surrounding Environment Specifications	Protection structure (IP)	65				
	Working Temperature	0～40℃				
	Surrounding Humidity	Under 80%Rh (No condensation)				
	StorageTemperature	-15～70℃				
	Storage Humidity	Under 90%Rh (No condensation)				
	Vibration Level	V-15				
	Vibration Resistance	x, y : 24.5 m/s^2				
Weight (Kg)		5.0	7.0	9.0	12.0	19
Safety Certification		CE				

11.5. Low Inertia Servo Motor Appearance and Dimension

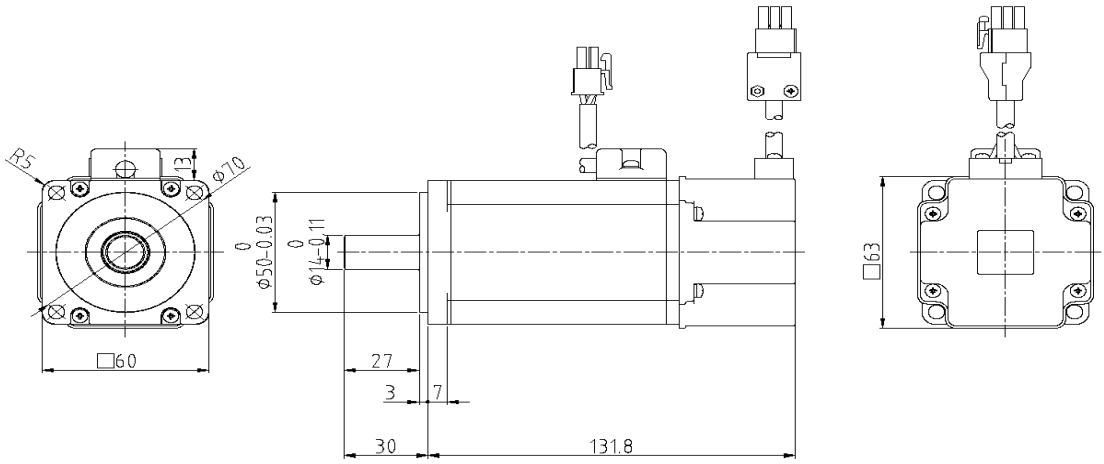
【SMA-L010】



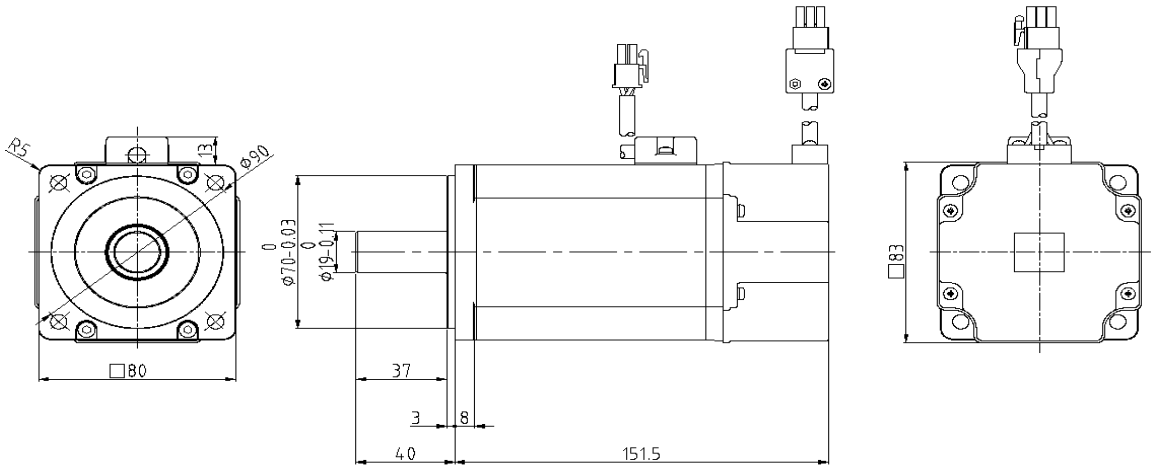
【SMA-L020】



【SMA-L040】

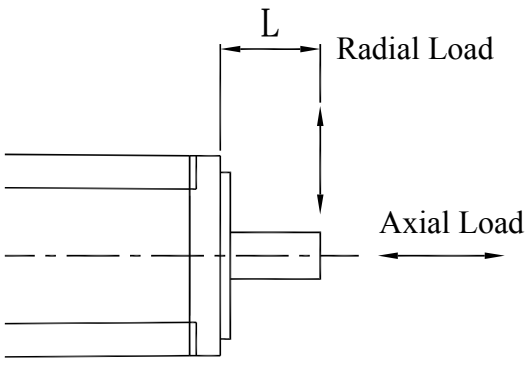


【SMA-L075】



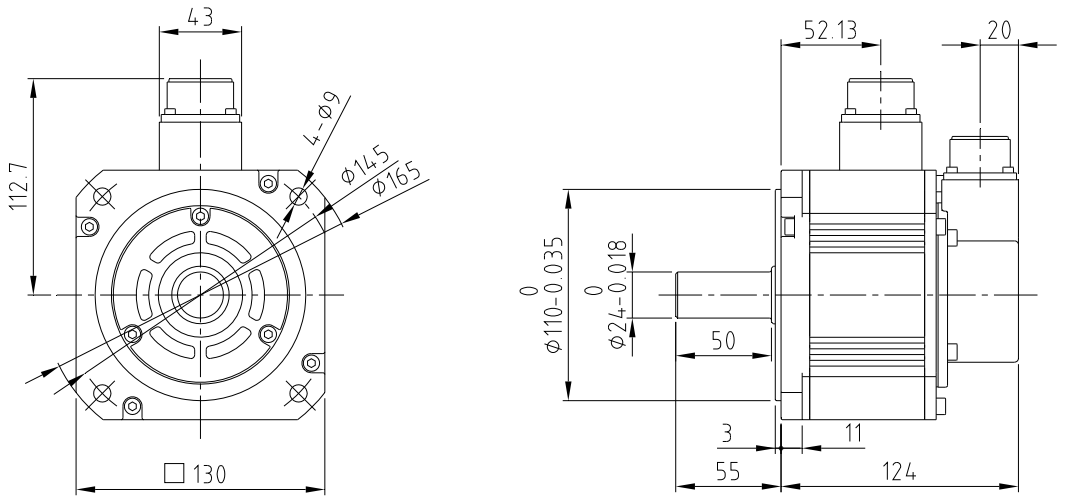
11.6. Permissive Load of Low Inertia Servo Motor Outputted Axle

Motor Model	【SMA-L010】	【SMA-L020】	【SMA-L040】	SMA-L075
L (mm)	25	30	30	40
Permissive Radial Load N(kgf)	78(8)	216(22)	245(25)	432(44)
Permissive Axial Load N(kgf)	34(3.5)	39(4)	68(7)	196(20)

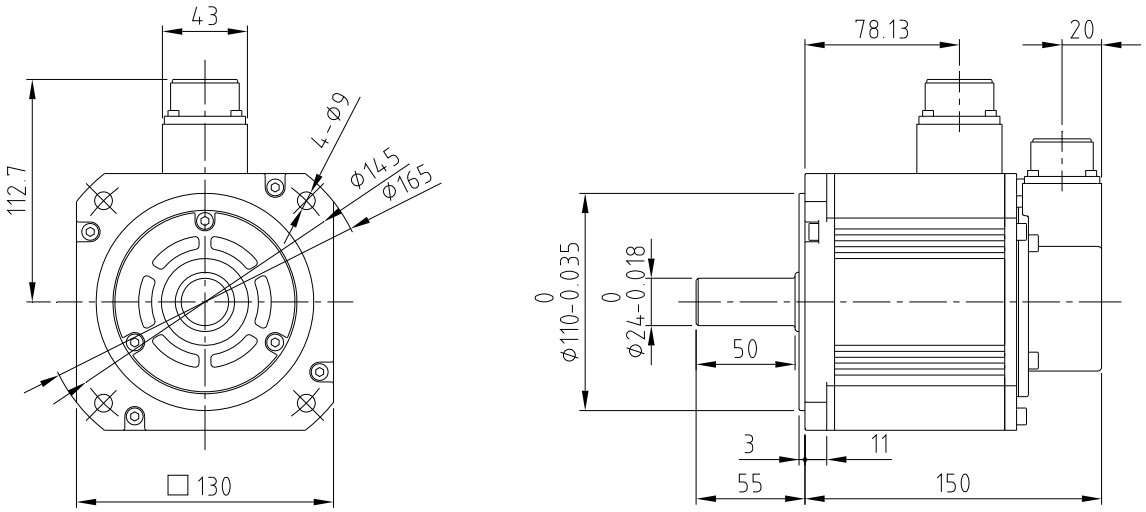


11.7. Medium Inertia Servo Motor Appearance and Dimension

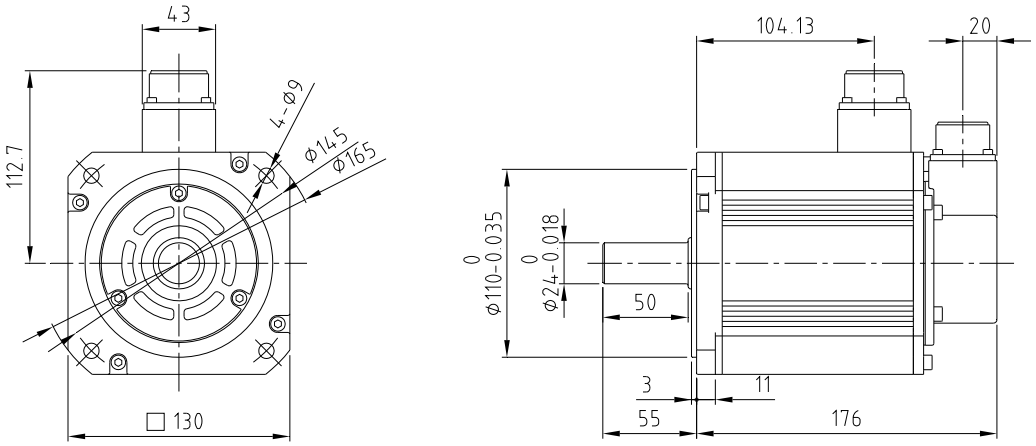
【SMA-L050】



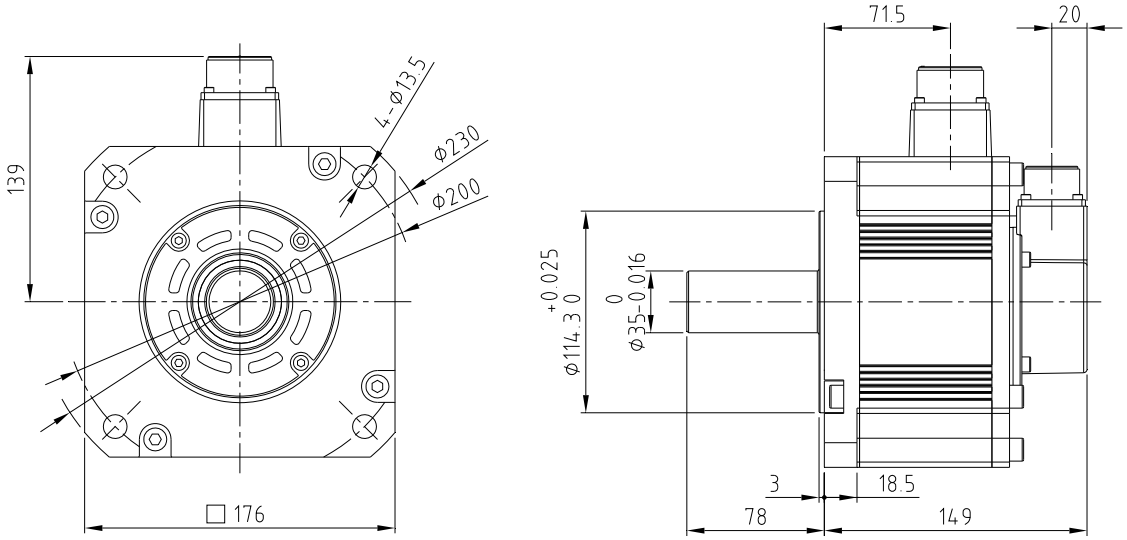
【SMA-M100】

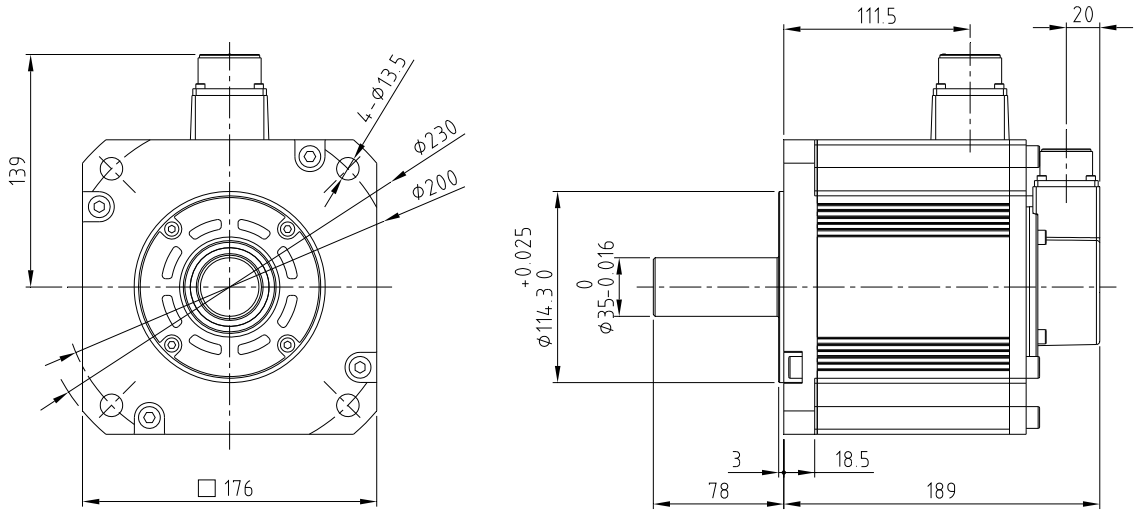


【SMA-M150】



【SMA-M200】

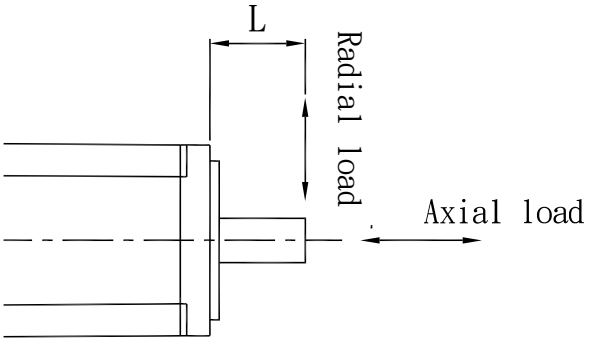




- ★ Marks and dimension vary according to the design of the motor.Also, dimension of the electromagnetic brake would vary, too.
- ★ The unit of machine dimension is mm.
- ★ The company will not inform the clients for any change in the dimension of the machine.

11.8. Permissive Load of Medium Inertia Servo Motor Outputted Axle

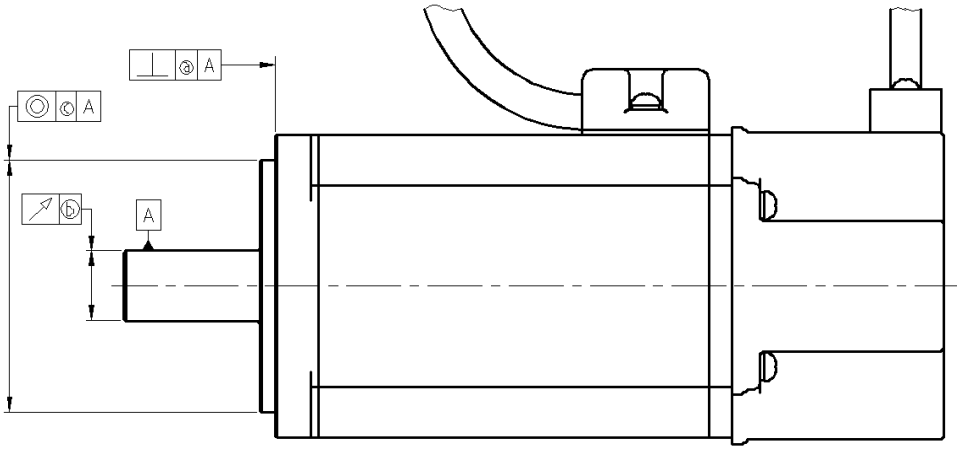
Motor Model	SMA-M050	SMA-M100	SMA-M150	SMA-M200	SMA-M350
L (mm)	55	55	55	79	79
Permissive Radial Load N(kgf)	667(68)	991(101)	1295(132)	1001(102)	1333(136)
Permissive axial Load N(kgf)	441(45)	333(34)	235(24)	608(62)	284(29)



11.9. Axial Precision

Precision level of motor shaft varies depending on the dimension such as the straight angle, the deflection degree, the concentricity, etc. The table below provides more details.

Precision (mm)		Motor Mounting Flange Dimensions		
		Less than □100	□130	□176
The straight angle of flange facing the output shaft	ⓐ	0.05	0.06	0.08
The deflection angle of the output shaft	ⓑ	0.02	0.02	0.03
Concentricity of the mounting outer diameter to the output shaft	ⓒ	0.04	0.04	0.06



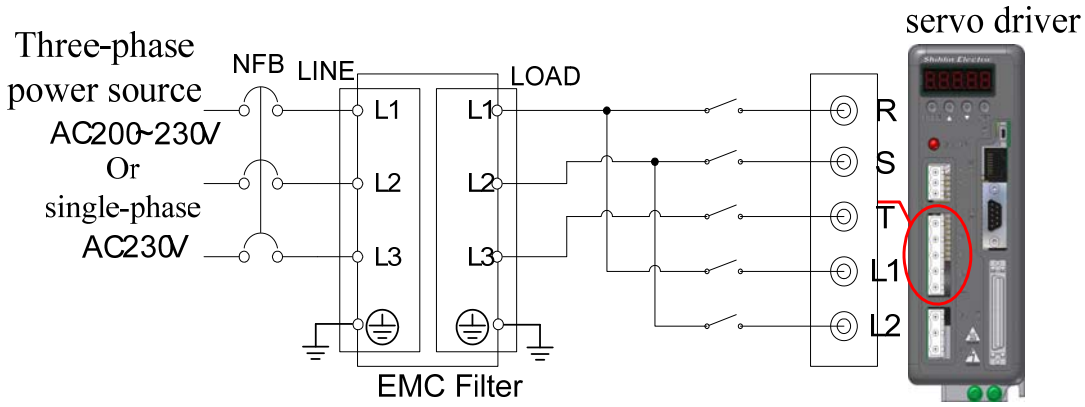
11.10. Electromagnetic Compatibility Filter (EMC Filter)

It is recommended to employ the following filters for EMC command corresponding to EN specifications:

Servo Actuator	Power	Recommended Filter
SDA－010A2	100W	FN3258-7-45
SDA－020A2	200W	
SDA－040A2	400W	
SDA－050A2	500W	
SDA－075A2	750W	FN3258-16-45
SDA－100A2	1KW	
SDA－150A2	1.5KW	FN3258-30-47
SDA－200A2	2KW	
SDA－350A2	3.5KW	

★ The filter, an option for purchase, is manufactured by SCHAFFNER.

The schematic diagram for connecting the actuator to an EMC filter and then to a three-phase power is presented below:



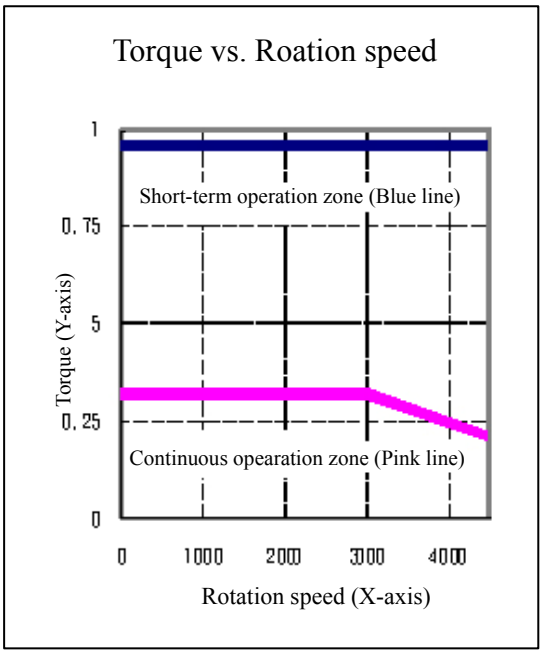
★ There is no T terminal if the power supply side is single-phase.

★ Ground the EMC filter ground connection.

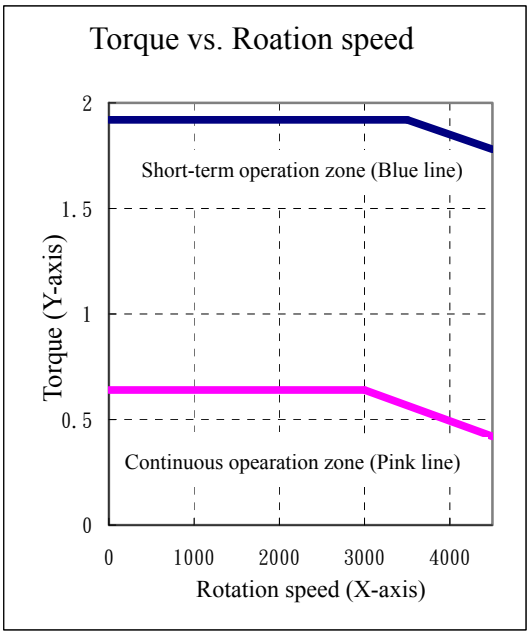
12. Features

12.1. Low Inertia Torque Features

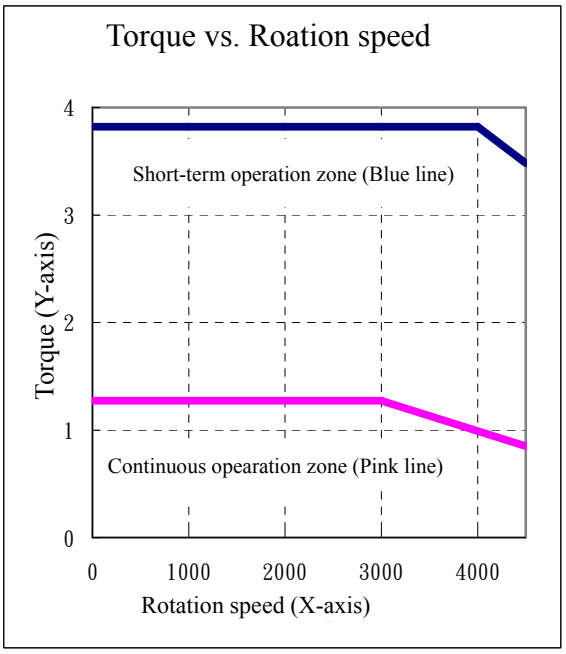
【SMA-L010】



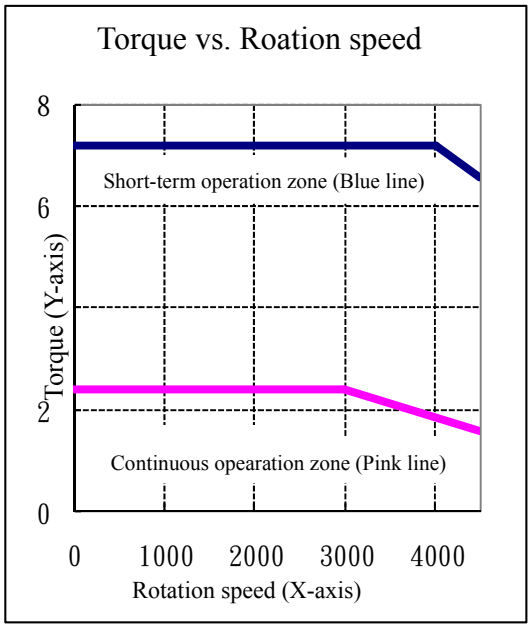
【SMA-L020】



【SMA-L040】



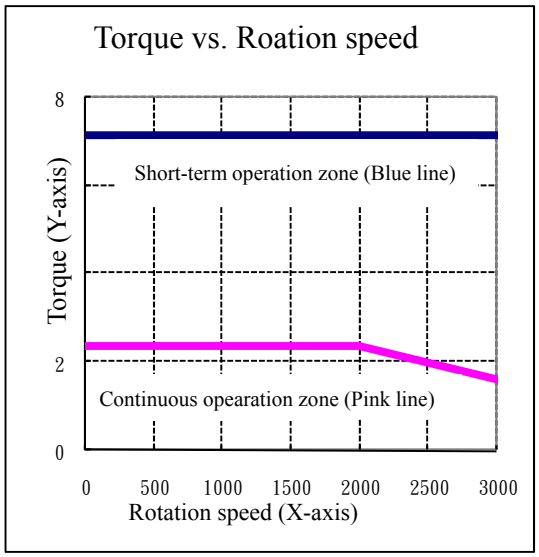
【SMA-L075】



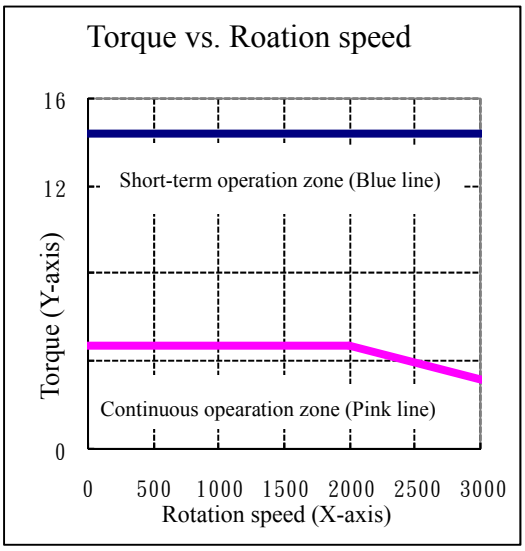
★ The power supply of this feature is three-phase 220 – 230V.

12.2. Medium Inertia Torque Features

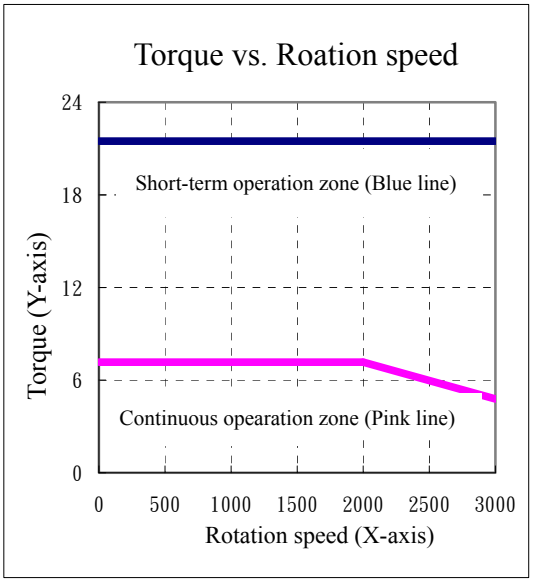
【SMA-M050】



【SMA-M100】

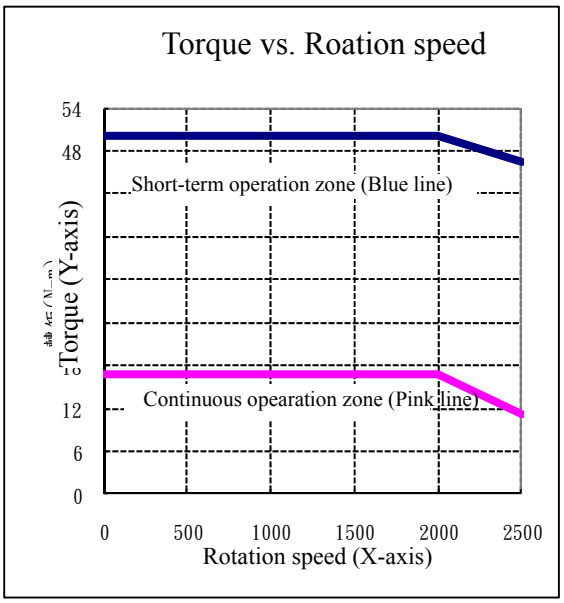


【SMA-M150】

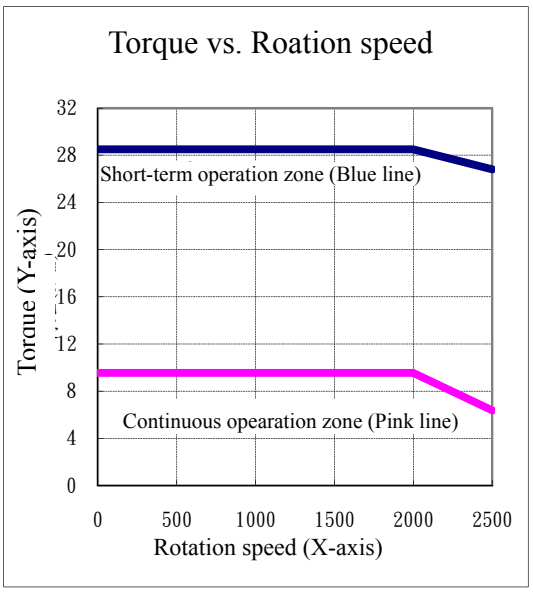


★ The power supply of this feature is three-phase 220 – 230V.

【SMA-M200】



【SMA-M350】



★ The power supply of this feature is three-phase 220 – 230V.

12.3. Overload Protection Features

Overload protection is to prevent the servo motor operates when overloaded.

Causes for producing overload can be summarized into the following points:

(1). The inertia ratio is too large.

(2). Theoretically when acceleration / deceleration time cannot be reached when loading.

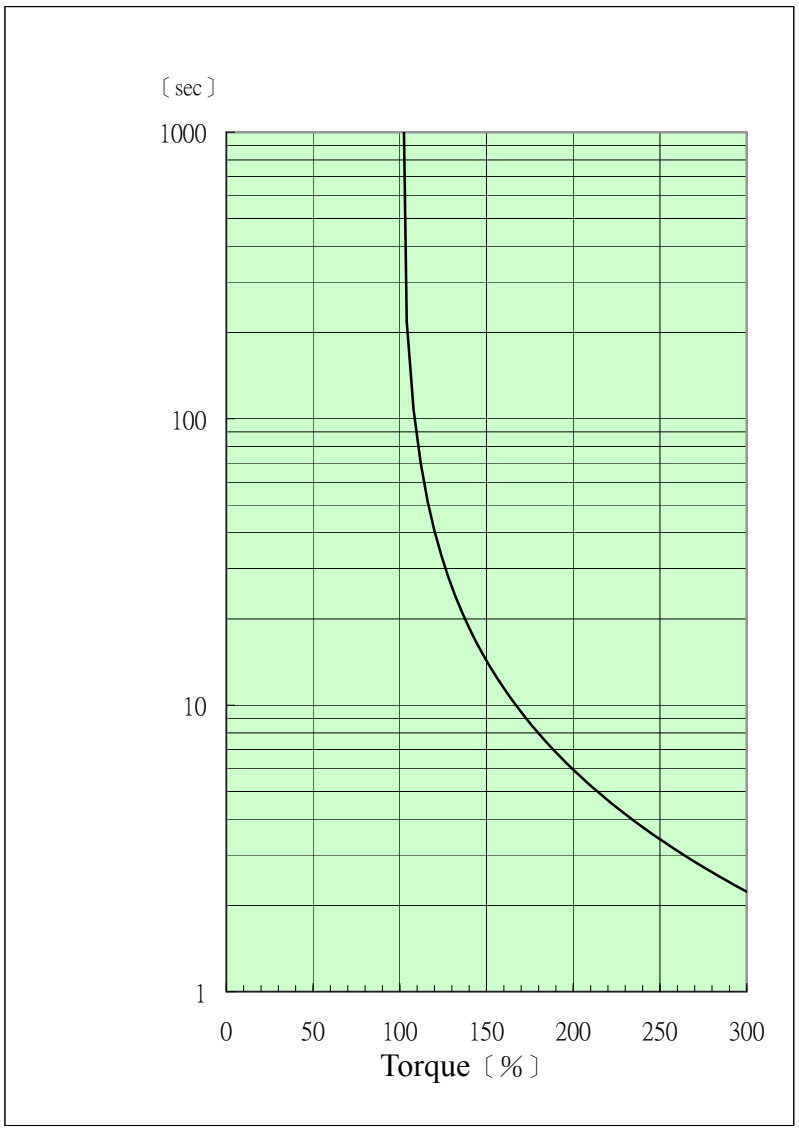
(3). If the maching is run too long, the rated torque will be exceeded during the operation.

(4). The machine produces vibration because the servo gain is too large but is still operated.

(5). The wiring of the motor power line to the encoder line is incorrect.

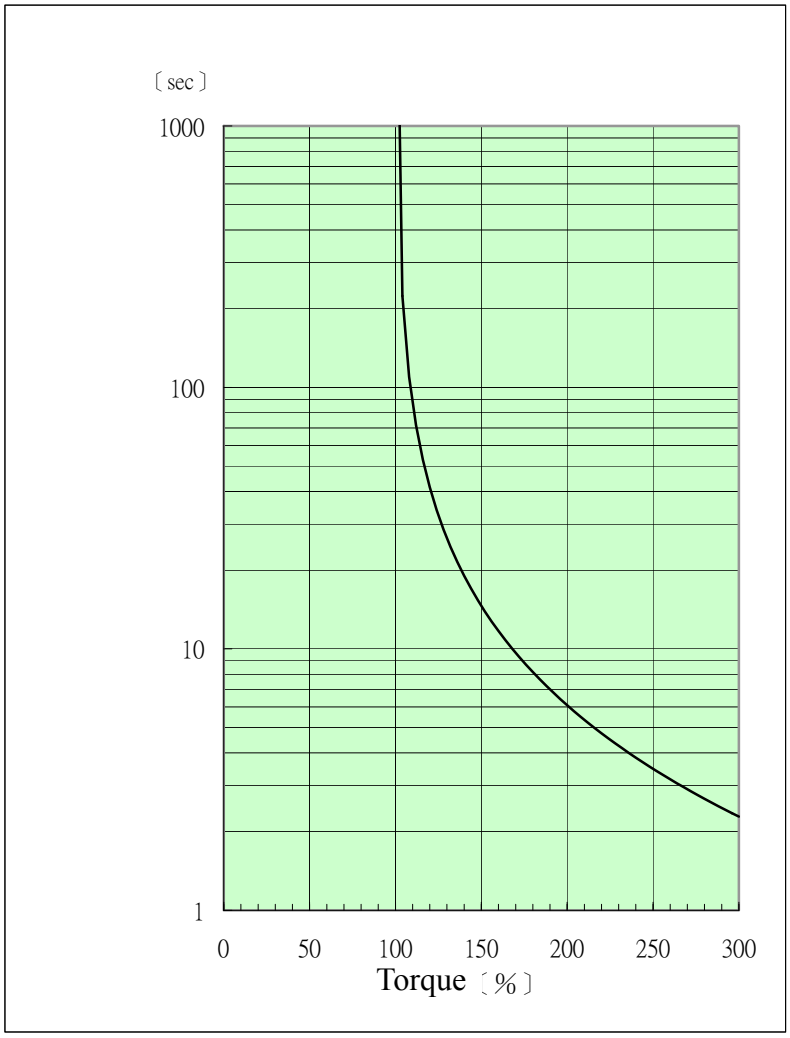
Please refer to the load ratio vs. operation time diagram if the rated torque may be exceeded during the servo motor operation.

Low Inertia Motor



When the load reaches 300%, the operation time will be 2.23 seconds.

Medium Inertia Motor



When the load reaches 300%, the operation time will be 2.28 seconds.

13. Production Application Examples

13.1. Internal positioning Mode Example

Shihlin servo actuator provides eight sets of internal positioning function, which can be categorized into the relative type positionining and the absolute type positioning method for the users to select.Relevant parameter settings are listed below:

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
Control mode set value	STY	PA01	0000H~1125H	None	0000H	Pt、Pr、S、T
The setup of the number of position rotations of internal position command 1	PO1H	PA15	±30000	rev	0	Pr
The setup of the number of position pulses of internal position command 1	PO1L	PA16	±9999	pulse	0	Pr
The setup of the number of position rotations of internal position command 2	PO2H	PA17	±30000	rev	0	Pr
The setup of the number of position pulses of internal position command 2	PO2L	PA18	±9999	pulse	0	Pr
The setup of the number of position rotations of internal position command 3	PO3H	PA19	±30000	rev	0	Pr
The setup of the number of position pulses of internal position command 3	PO3L	PA20	±9999	pulse	0	Pr
The setup of the number of position rotations of internal position command 4	PO4H	PA21	±30000	rev	0	Pr
The setup of the number of position pulses of internal position command 4	PO4L	PA22	±9999	pulse	0	Pr

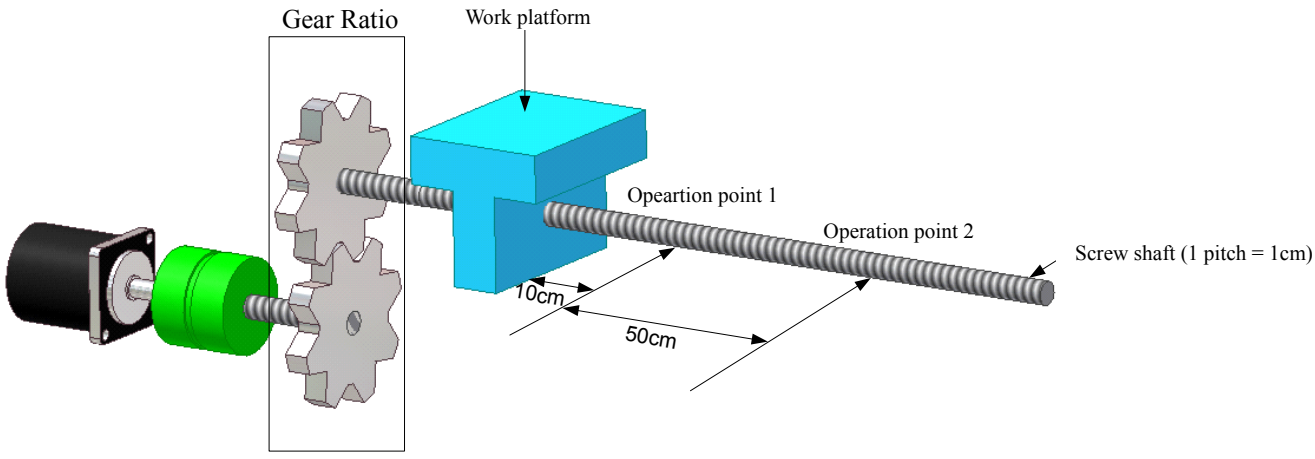
Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
The setup of the number of position rotations of internal position command 5	PO5H	PA23	±30000	rev	0	Pr
The setup of the number of position pulses of internal position command 5	PO5L	PA24	±9999	pulse	0	Pr
The setup of the number of position rotations of internal position command 6	PO6H	PA25	±30000	rev	0	Pr
The setup of the number of position pulses of internal position command 6	PO6L	PA26	±9999	pulse	0	Pr
The setup of the number of position rotations of internal position command 7	PO7H	PA27	±30000	rev	0	Pr
The setup of the number of position pulses of internal position command 7	PO7L	PA28	±9999	pulse	0	Pr
The setup of the number of position rotations of internal position command 8	PO8H	PA29	±30000	rev	0	Pr
The setup of the number of position pulses of internal position command 8	PO8L	PA30	±9999	pulse	0	Pr
The setup of the speed of internal position control 1	POV1	PA31	1~3000	rpm	1000	Pr
The setup of the speed of internal position control 2	POV2	PA32	1~3000	rpm	1000	Pr
The setup of the speed of internal position control 3	POV3	PA33	1~3000	rpm	1000	Pr
The setup of the speed of internal position control 4	POV4	PA34	1~3000	rpm	1000	Pr

Name	Parameter Abbreviation	Parameter Code	Set Range	Unit	Default Value	Control Mode
The setup of the speed of internal position control 5	POV5	PA35	1~3000	rpm	1000	Pr
The setup of the speed of internal position control 6	POV6	PA36	1~3000	rpm	1000	Pr
The setup of the speed of internal position control 7	POV7	PA37	1~3000	rpm	1000	Pr
The setup of the speed of internal position control 8	POV8	PA38	1~3000	rpm	1000	Pr
Acceleration time constant	STA	PC01	0~20000	ms	200	Pr, S, T
Deceleration time constant	STB	PC02	0~20000	ms	200	Pr, S, T
S-shape acceleration/deceleration time constant	STC	PC03	0~10000	ms	0	Pr, S, T

The following examples explain the applications of the internal positioning mode.

Exampel 1:

During the routein, the motor will carry out grrfomh at two fixed spots.See the schematic diagram below:



It can be found from the diagram above that positioning has to be conducted twice for one routine. One pitch of the screw shaft is one cm, and one rotation of the motor is exactly one pitch. Both the absolute type of positioning and the relative type of positioning can achieve this type of routine. At here, we assume that the absolute type of positioning is adopted for planning the routine. Parameters can be set with the criteria above.

Name	Parameter Abbreviation	Parameter Code	Value	Unit
Control mode set value	STY	PA01	1010	None
The setup of the number of position rotations of internal position command 1	PO1H	PA15	10	rev
The setup of the number of position rotations of internal position command 2	PO2H	PA17	60	rev
The setup of the number of position pulses of internal position command 1	PO1L	PA16	0	pulse
The setup of the number of position pulses of internal position command 2	PO2L	PA18	0	pulse

★ Restart the servo after correcting PA01.

After setting up the parameters and under the condition when the motor experiences no abnormal alarm, turn on the digital input terminal SON. Once motor excitation happens, use digital input terminal POS1 OFF and POS2 OFF to set the desired target position (PO1H). Next, turn on the digital input terminal CTRG and the motor will move to the first operating point.

Then set POS1 ON and POS2 OFF for the desired target position (PO2H), followed by turning on digital input terminal CTRG. The motor will move to the second operating point.

13.2. Return to Origin

Parameters related to the return to origin:

Z Pulse or ORGP (Outer sensor) can be used for the return to origin function.The users can also set the return to origin for forward and reverse rotation. Relevant parameter settings are listed below:

Parameter Code	Set Range	Default Value	Description	Control Mode
PA 04	0000h ~ 2123h	0000h	Zero Return Mode u x y z U: Origin point triggering activation mode X: The origin stop mode Y: Set up the short distance movement method when reaching the origin. Z: Set up the type of the origin detector and the search direction.	Pr
PA 08	1~2000	1000	Level 1 high-speed return to the origin speed setup	Pr
PA 09	1~500	50	Level 2 high-speed return to the origin speed setup	Pr
PA 10	-30000 ~ 30000	0	Return to origin offset loops	Pr
PA 11	-10000 ~ 10000	0	The number of return to origin offset pulses	Pr
PC 01	0 ~ 20000	200	Acceleration time constant	ALL
PC 02	0 ~ 20000	200	Deceleration time constant	ALL
PC 03	0 ~ 10000	0	S-shape acceleration/deceleration time constant	ALL

Description of the Zero Return Mode:

u. Origin point triggering activation mode

The code is set to determine whether to activate the return to origin function. The return to origin function can be categorized into two major classes: the automatic return to origin when starting the machine and the contact triggered return to origin.

0: Turn off the return to the origin function.

When u is set as 0, the return to origin function cannot be carried out.

u=1: Automatically execute the return to the origin function when the power source is turned on.

When u is set to 1, the function is valid only when the power supply and the servo are turned on.This setting can abe used if the servo operation requires only one return to origin function.This setting can save one digital input DI contact.

u = 2: Trigger the return to the origin function from SHOM input contact.

When u is set to 2, parameter PD02 – PD09 requires one SHOM trigerred return to origin function for the digital input DI contact.SHOM contact can be triggered when the servo is at running to activate the return to origin function.

X: The origin stop mode

X=0: Decelerate the motor and pull back to the origin after the origin test.

When x is to 0, motor will obtain the origin test signal at the second speed level. The motor will decelerate to stop according to the set deceleration time. When the motor stops, it will move to the mechanical origin position (the position of the origin test signal).

x=1: Decelerate the motor forward till it stops after the origin test.

When x is set to one, the motor will obtain the origin test signal at the second speed level and decelerate to stop.After the motor stops, the overshoot from exceeding the origin will not be corrected anymore. At this point, the mechanical origin position will not change according to the position overshoot.

y. Set up the short distance movement method when reaching the origin.

y=0: Return and search for the Z pulse after returned to the origin.

When y is set to 0, the motor will search for the reference origin using the first level speed operation. Next, the motor will search for a nearby Z pulse using the second speed level to be the mechanical origin.

y = 1: Do not return but search for the Z pulse after returned to the origin.

When y is set to 1, the motor will search for the reference origin using the first level speed operation. The motor will not search for a nearby Z pulse using the second speed level to be the mechanical origin.

y = 2: Position it at the detector origin or the z pulse after return to the origin.

Determine the z value when y is set to 2.If z is set to 0 or 1, the motor will search for the upper edge of ORGP and then start to decelerate to stop. If z is set to 2 or 3, the motor will search for the z pulse and then decelerate to stop.

Do not set y to 2 if z is set to 2 or 3, or the motor will not move.

Z: Set up the type of the origin detector and the search direction.

The origin detector can have an outer connection to a sensor (e.g., a proximity type or an optical type of sensor switch), and the sensor will act as an ORGP reference origin.If the servo motor rotate within one loop only, z pulse can be set as the reference origin.

z=0: Return to the origin for forward rotation; take ORGP as the return origin.

When z is set to 0, the motor will search for the origin via level one speed and in forward rotation. ORGP (outer sensor input point) will be taken as a reference point of the origin.A more percised mechanical origin can be achieved by setting up the backward search of the Z pulse (y=0) or the forward search of the z pulse (y=1).If the users do not wish to be positioned at the z pulse, actions for positioning at ORGP can be done by setting y = 2.

z=1: Return to the origin for reverse rotation; take ORGP as the return origin.

When z is set to 1, the motor will search for the origin via level one speed and in reverse rotation. ORGP (outer sensor input point) will be taken as a reference point of the origin.A more percised mechanical origin can be achieved by setting up the backward search of the Z pulse (y=0) or the

forward search of the z pulse (y=1).If the users do not wish to be positioned at the z pulse, actions for positioning at ORGP can be done by setting y = 2.

z=2: Forward rotation and directly search for the z pulse as the return origin.

When z is set to 2, the servo motor will search for a nearby z pulse in forward rotation. The z pulse will be treated as a mechanical origin. This function is often used as a movement control for servo motor rotates less than one loop.No outer sensor switch can be connected if this mode is set.

z=3: Reverse rotation and directly search for the z pulse as the return origin.

When z is set to 3, the servo motor will search for a nearby z pulse in reverse rotation. The z pulse will be treated as a mechanical origin. This function is often used as a movement control for servo motor rotates less than one loop.No outer sensor switch can be connected if this mode is set.

A recommendation table for the return to origin mode setup:

The users can set the u and x value depending on the requirement. Next, refer to the following table for setting up different y and z:

y \ z	0	1	2	3
0	✓	✓	✕	✕
1	✓	✓	✕	✕
2	✓	✓	✓	✓

★ ✓ denotes normal return to origin action; ✕ denotes return to origin action will not be carried out.

The number of shifts of the return to origin mode:

The user can change parameter PA10 and PA11 to set up the number of return to origin offset laps / pulses. When the motor get the mechanical origin according to the setup of PA04, it will reposition a new origin according to parameter PA10 (the number of return to origin offset laps) and PA11 (the number of return to origin offset pulses).The equation:

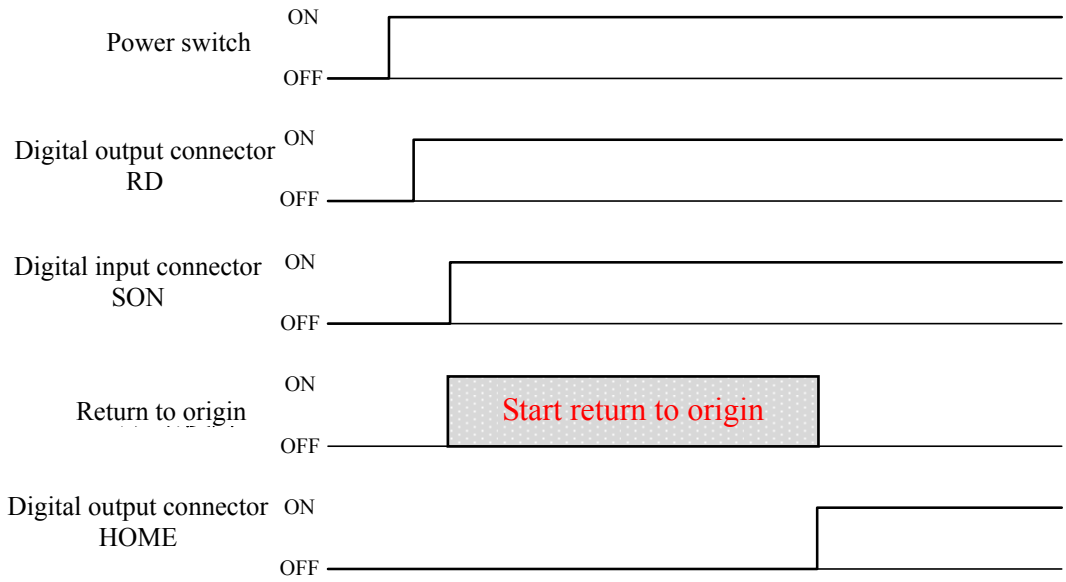
Parameter PA 10×10000 + Parameter PA 11 (Unit: pulse)

A sequence diagram for the return to origin activation mode:

During the return to origin operation, the operation will be stopped and the return completion of digital output contact (HOME) will have deliver action if the servo activation digital input contact (SON) action is cancelled or any abnormal alarm goes off.

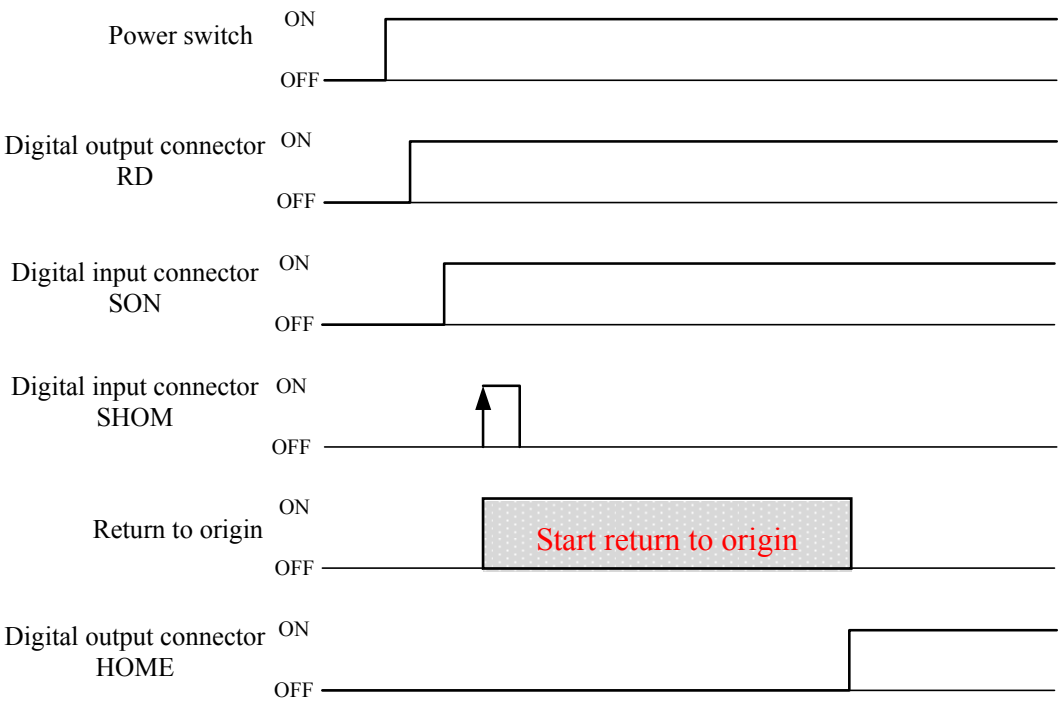
1. Automatically execute the return to the origin function when the power supply is turned on (u = 1).

When using the return to origin function, make one of the digital output DO pin (PD10 – PD 14) to be the HOME function (0 x 04). After the return to origin function is completed, high electrical potential will be outputted by HOME.



2. Trigger the return to the origin function from SHOM input contact (u = 2).

When using SHOM input contact triggered return to origin function, make one of the digital input DI pin (PD02 – PD09) to be the SHOM function.



The sequence diagram of the return to origin speed vs. position:

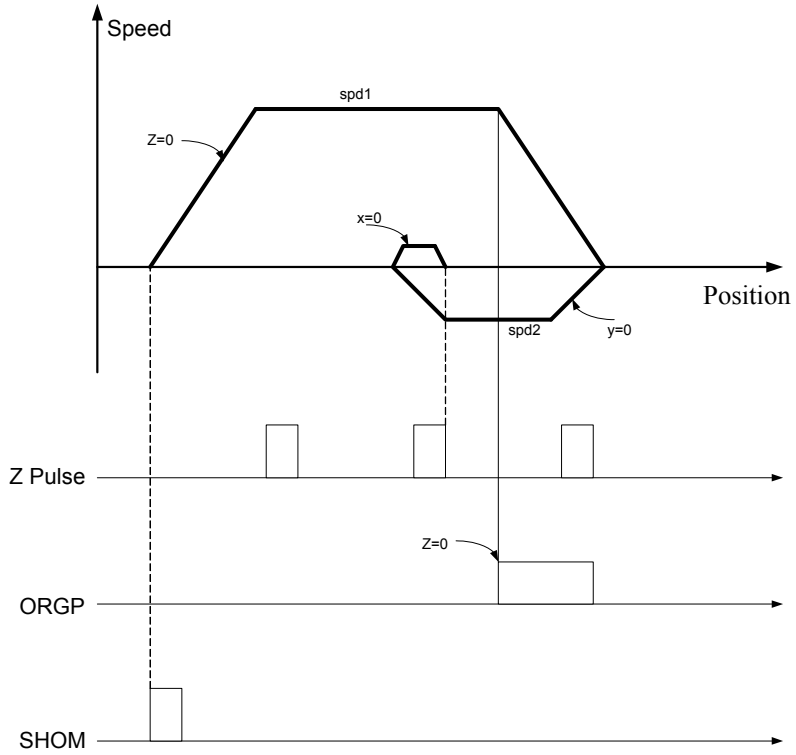
The following sequence diagram of the return to origin triggered activation mode is set to have SHOM input contact triggering the return to origin function (u = 2). After completing the origin testing, the motor will decelerate and pull back to the origin (x = 0). For the remaing, the servo motor will carry out the return to origin state. More details are provided below:

The following table lists the eight settings of return to origin corresponding to the speed and position sequence diagram:

y \ z	0	1	2	3
0	Figure (1)	Figure (2)	×	×
1	Figure (3)	Figure (4)	×	×
2	Figure (5)	Figure (6)	Figure (7)	Figure (8)

(1). y=0: Return and search for the Z pulse after returned to the origin.

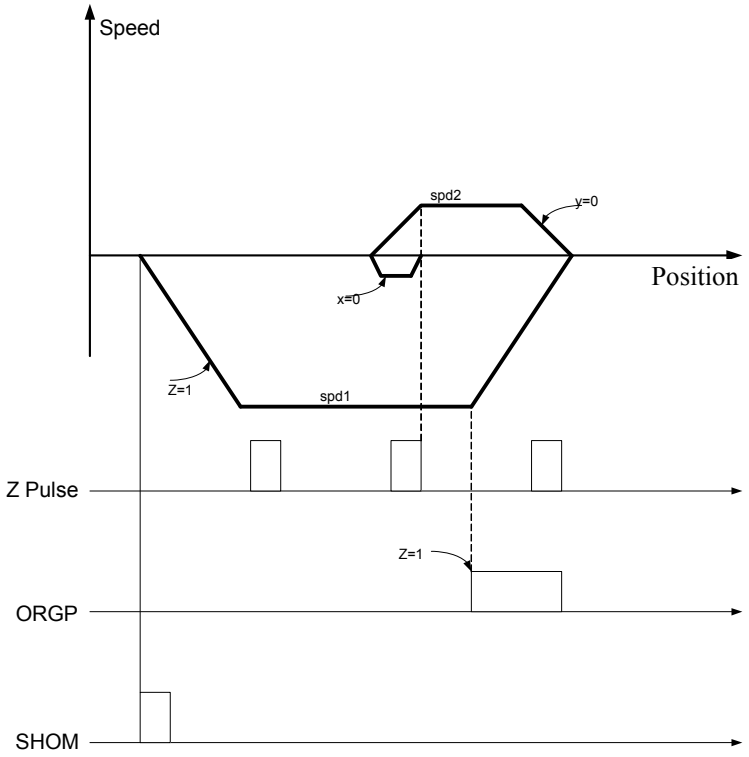
z=0: Return to the origin for forward rotation; take ORGP as the return origin.



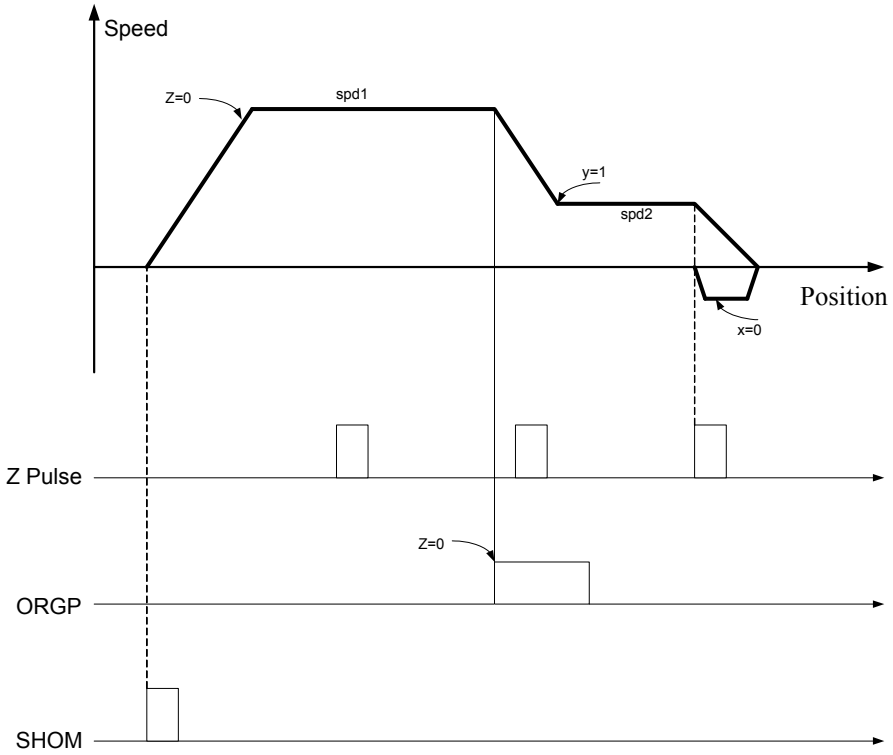
★ SPD1 in the fiture is the set value of parameter PA08; SPD2 is the set value of parameter PA09.

(2). y=0: Return and search for the Z pulse after returned to the origin.

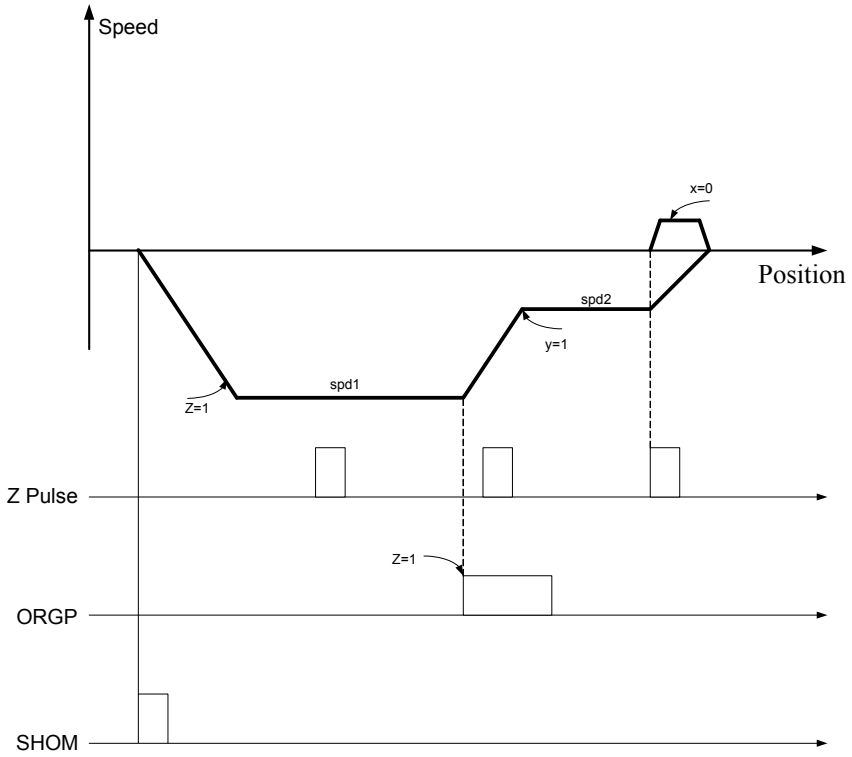
z=1: Return to the origin for reverse rotation; take ORGP as the return origin.



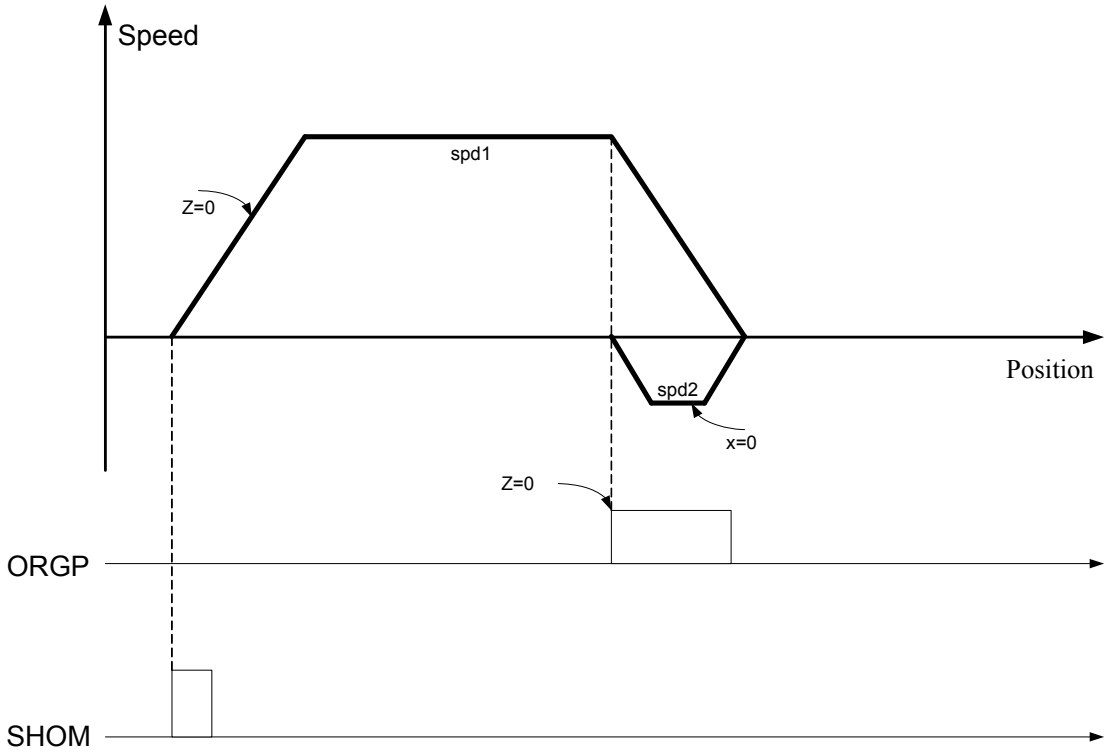
(3) y = 1: Do not return but search for the Z pulse after returned to the origin.
z=0: Return to the origin for forward rotation; take ORGP as the return origin.



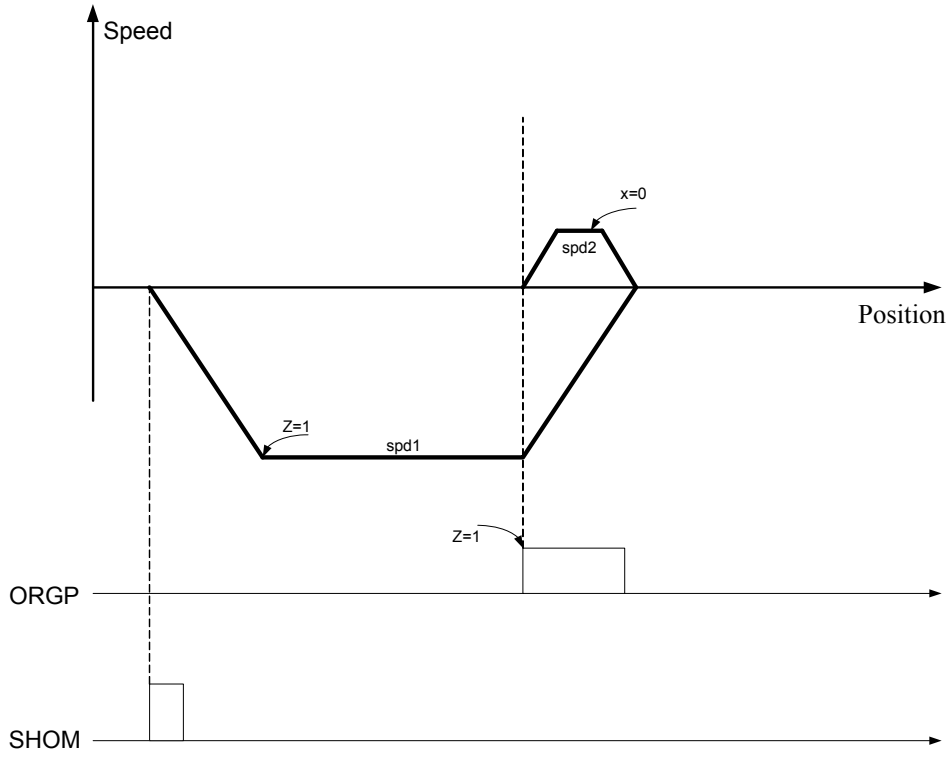
(4) y = 1: Do not return but search for the Z pulse after returned to the origin.
z=1: Return to the origin for reverse rotation; take ORGP as the return origin.



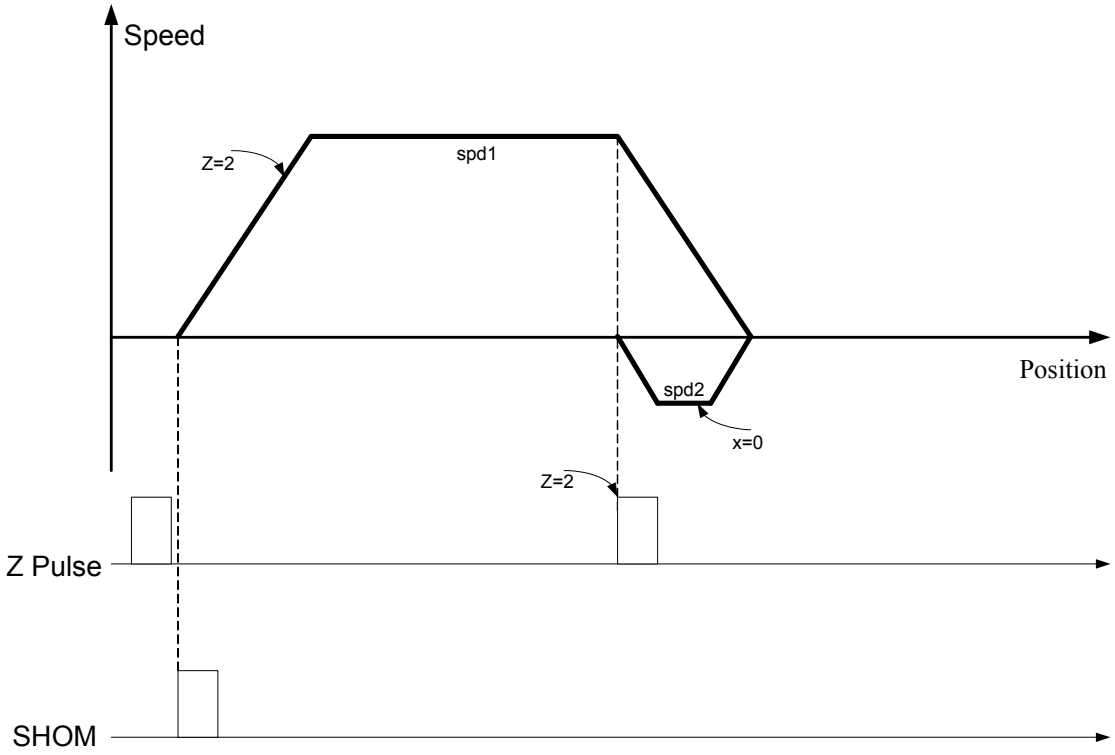
(5) y = 2: Position it at the detector origin or the z pulse after return to the origin.
z=0: Return to the origin for forward rotation; take ORGP as the return origin.



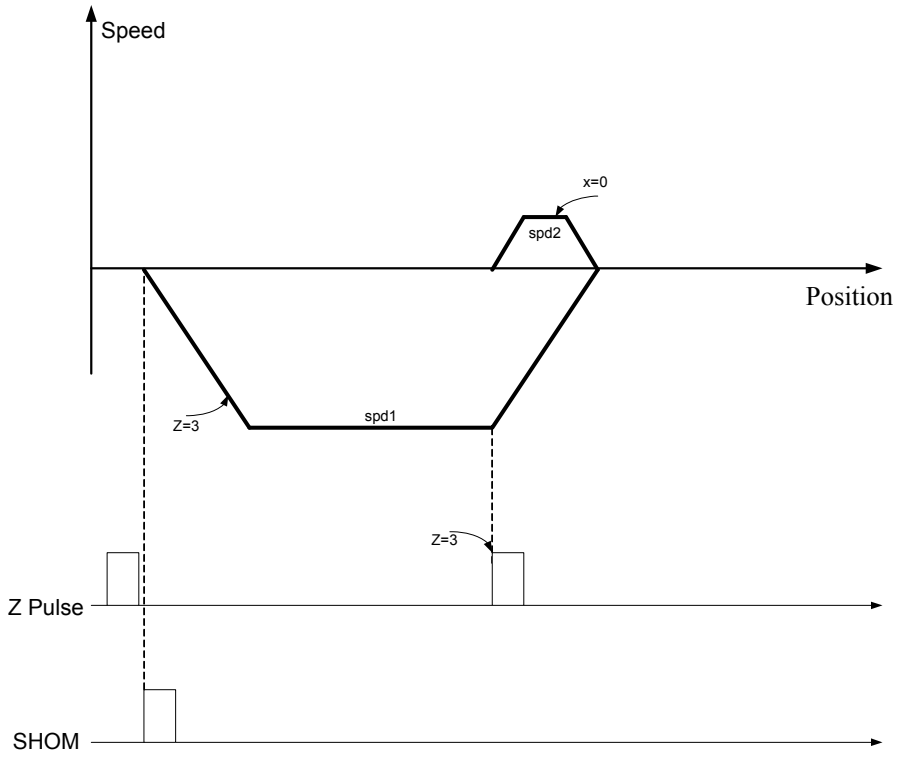
(6) y = 2: Position it at the detector origin or the z pulse after return to the origin.
z=1: Return to the origin for reverse rotation; take ORGP as the return origin.



(7) y = 2: Position it at the detector origin or the z pulse after return to the origin.
z=2: Forward rotation and directly search for the z pulse as the return origin.



(8) y = 2: Position it at the detector origin or the z pulse after return to the origin.
z=3: Reverse rotation and directly search for the z pulse as the return origin.



14. Appendix A Accessories

❖ Encoder connectors

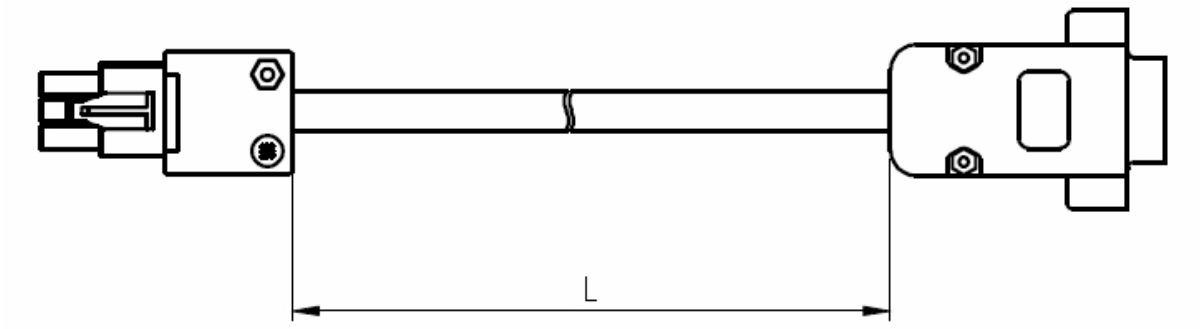
Shihlin serial number: SDA-ENCNL (for low inertia motor)

Shihlin serial number: SDA-ENCNM (for medium inertia motor)

❖ Encoder cable

Shihlin serial number：

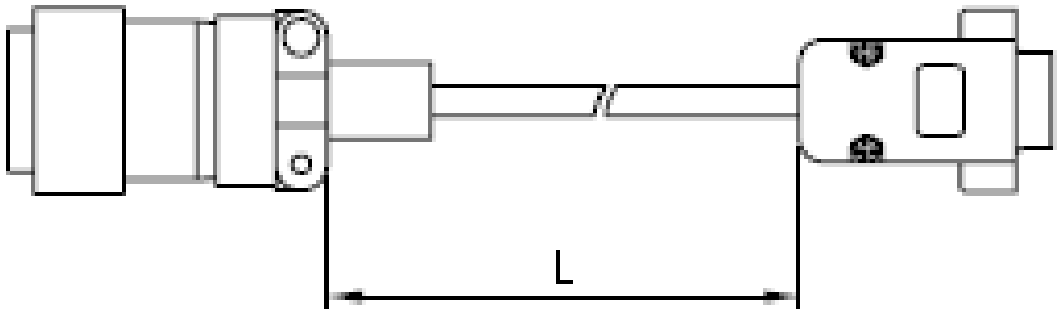
SDA-ENLCBL2ML, SDA-ENLCBL5ML, SDA-ENLCBL10ML



Types	Serial Number	Length (L, mm)
Low inertia encoder cable 1	SDA-ENLCBL2ML	2000±100
Low inertia encoder cable 2	SDA-ENLCBL5ML	5000±100
Low inertia encoder cable 3	SDA-ENLCBL10ML	10000±100

Shihlin serial number：

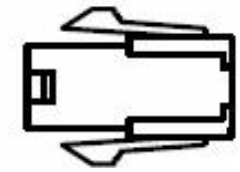
SDA-ENLCBL2ML, SDA-ENLCBL5ML, SDA-ENLCBL10ML



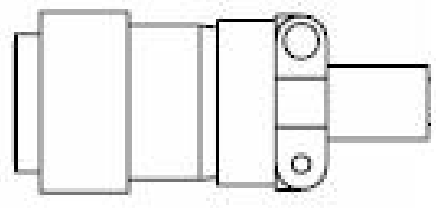
Types	Serial Number	Length (L, mm)
Medium inertia encoder cable 1	SDA-ENMCBL2ML	2000±100
Medium inertia encoder cable 2	SDA-ENMCBL5ML	5000±100
Medium inertia encoder cable 3	SDA-ENMCBL10ML	10000±100

❖ Power connectors

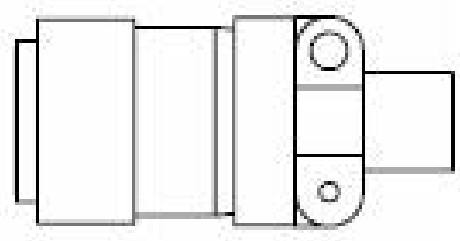
Shihlin serial number：SDA-PWCNL1 (for 100W, 200W, 400W, 750W)



Shihlin serial number：SDA-PWCNM1 (for 500W, 1KW, 1.5KW)

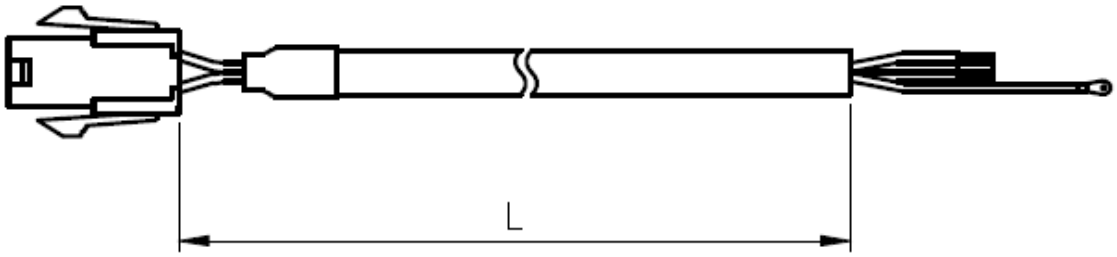


Shihlin serial number：SDA-PWCNM2 (for 2KW, 3.5KW)



❖ Power line

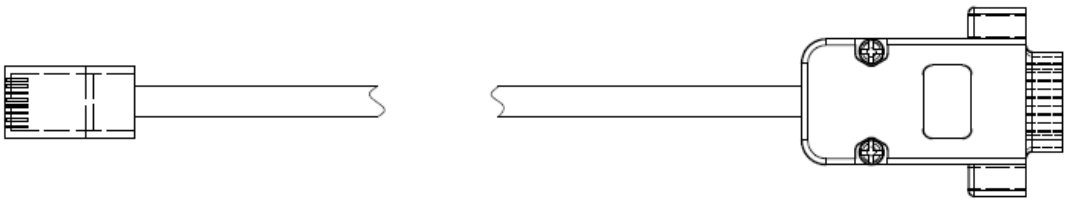
Shihlin serial number：SDA-PWCNL1-2.5M, SDA-PWCNL1-10M



Types	Serial Number	Length (mm)
Low inertia power line 1	SDA-PWCNL1-2.5M	2500±100
Low inertia power line 2	SDA-PWCNL1-10M	10000±100

❖ RS232/RS485 communication cable for the actuator and the computer.

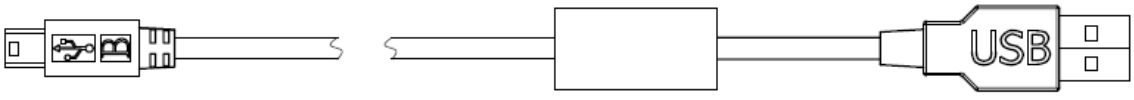
Shihlin serial number：SDA-RJ45-3M



Types	Serial Number	Length (mm)
RS232/RS485 Communication line	SDA-RJ45-3M	3000±10

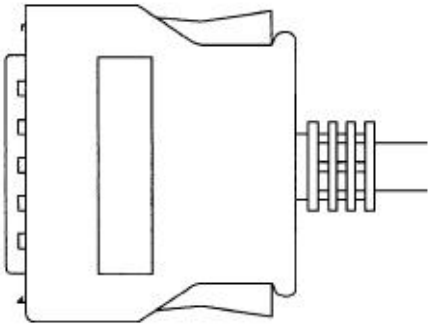
❖ USB communication cable for the actuator and the computer.

Shihlin serial number：SDA-USB3M



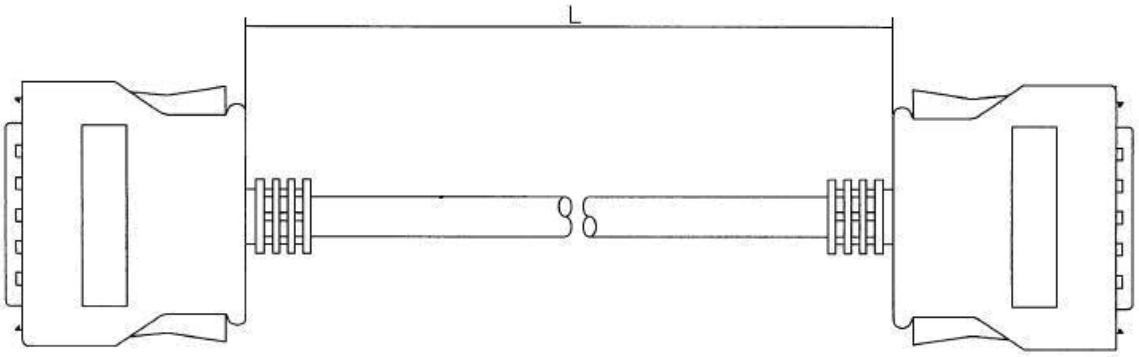
❖ I/O connector terminal

Shihlin serial number：SDA-CN1



❖ I/O connector terminal cable

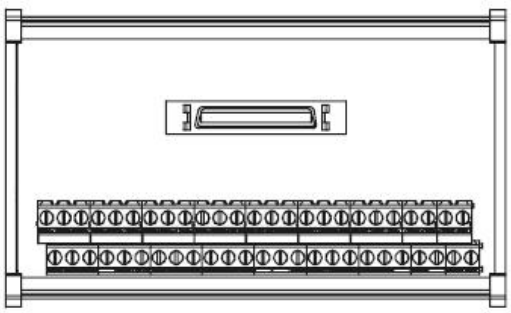
Shihlin serial number：SDA-TBL05T, SDA-TBL1T, SDA-TBL2T



Types	Serial Number	Length (L, mm)
I/O connector terminal cable 1	SDA-TBL05T	500±10
I/O connector terminal cable 2	SDA-TBL1T	1000±10
I/O connector terminal cable 3	SDA-TBL2T	2000±10

❖ I/O connector terminal block

Shihlin serial number：SDA-TB50T



❖ Regenerative resistor

Shihlin serial number：ABR100W100, ABR200W100, ABR400W100, ABR500W100, ABR750W40, ABR1000W40, ABR1500W13, ABR2000W13, ABR3500W13

Actuator (w)	Built-in renegerataive resistor specification		Recommended external resistor specifications	The smallest permissive electric resistor value
	Resistor (Ω)	Volume (W)		
100	100	20	100W(ABR100W100)	100
200	100	20	200W(ABR200W100)	100
400	100	20	400W(ABR400W100)	100
500	100	20	500W(ABR500W100)	100
750	40	40	750W(ABR750W40)	40
1000	40	40	1KW(ABR1000W40)	40
1500	13	100	1KW(ABR1500W13)	13
2000	13	100	1KW(ABR2000W13)	13
3500	13	100	1KW(ABR3500W13)	13

Shihlin Electric
Factory Automation Products

Human Machine Interface

Temperature Controller

Servo motor and drive

Inverter

Shihlin Electric & Engineering Corporation

Head Office:
16F, No. 88, Sec. 6, ChungShan N. Rd.., Taipei, Taiwan, 111
TEL:+886-2-2834-2662 FAX:+886-2-2836-6187
HsinFun Factory (Taiwan):
No.234, Chung Lun, Hsin Fun, HsinChu, Taiwan, 304
TEL:+886-3-599-5111 FAX:+886-3-5907173
SuZhou Factory(China):
No.22, HuoJu Rd., SuZhou Tech. District, JiangSu, China. 215009
TEL:+86-512-6843-2662 FAX: +86-512-6843-2669

Area Distributor