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1. Production inspection and model descriptions

1.1 Summary

The control modes for Shihlin multi-purpose AC servo could be classified into the single mode and hybrid mode. There are 4 control types for single mode: position control with terminals input, position control with inner registers, speed control, torque control. There are 5 types for hybrid mode: position control (terminals input) /speed control, position control (terminals input) /torque control, position control (inner registers) /speed control, position control (inner registers) /torque control and speed control/torque control.

Therefore, the Shihlin servo are suitable for the general industry machinery that require the high precision and smooth speed control, or machine tools, or tension control.

The Shihlin servo is equipped not only RS-232/RS-485 serial communication but also the most convenient equipment “USB” which is the most popular application. The PC with the Shihlin communication software would help the user to adjust the parameters, to operate the servo for test and to monitor the status of the driver.

The Shihlin servo is also equipped with the automatic tuning function. The control gain of the driver would be adjusted by the inner algorithm according to the instant dynamic change of the user’s machinery. The specification of the Shihlin servo encoder is the 2500 pulses per revolution. (or 10000 pulses/rev after the 4-multiplication signal process) It offers a high precision control.

1.2 Inspection

Please check following items carefully to prevent the negligence of transport or human factor.

- ◆ Check if there are any loosened screws on the motor or the driver.
- ◆ Check the specification nameplate of motor/driver to confirm the consistency of your demand.
- ◆ Check if there are any scratch and damage on the motor/driver.
- ◆ Manually turn the shaft of servo motor. A smooth turn indicates a normal motor. If the motor is with an electromagnetic brake, the motor will not be turn easy by hand.

Please contact your agent for solutions if any of above issues occurs.

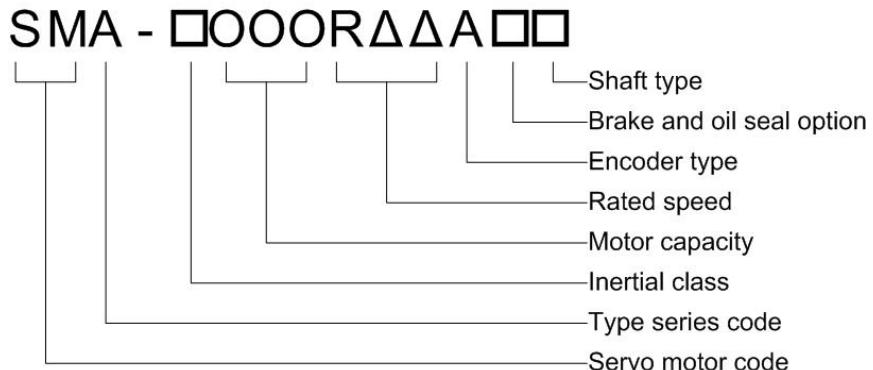
A complete set of the Shihlin servo should include :

- (1) A servo driver and a servo motor.
- (2) A 50-pin connector of CN1.
- (3) An encoder signal cable. One end is for the CN2 of driver, the other end for servo motor.
- (4) The 5-pin(R/S/T/L1/L2) quick plug-in terminal which applicable to 1kW driver or below.
- (5) The 3-pin(P/D/C) quick plug-in terminal which applicable to 1kW driver or below.
- (6) The 5-pin(P/N/R/S/T) quick plug-in terminal which applicable to 1.5kW driver or above.
- (7) The 5-pin(P/D/C/L1/L2) quick plug-in terminal which applicable to 1.5kW driver or above.
- (8) The 3-pin(U/V/W) quick plug-in terminal.
- (9) The RS-232 cable.(option)
- (10)The USB cable.(option)
- (11) A U-V-W power cable. (option)
- (12) An installation manual.
- (13) An user manual of the Shihlin servo.(It could be download on Shihlin website)

Reference for product type

Coding rule for Shihlin servo motor.

(1) Coding method



(2) Description for coded items

- Servo motor code: SM denotes servo motor.
- Type series code: A series.
- Inertial class: Codes are classified by motor inertial and frame size as follows.

Code	Class
L	Low inertial
M	Medium inertial

- Motor capacity: The first 2 digits are used to represent the motor's output power multiplied by 1/10 and a default unit "kW". If the third digit is a "K", the capacity is the first 2 digits multiplied by 1 kW. Here are some examples.

020 denotes: $02*(1/10)=0.2\text{ kW}=200\text{ W}$

150 denotes: $15*(1/10)=1.5\text{ kW}=1500\text{ W}$

350 denotes: $35*(1/10)=3.5\text{ kW}=3500\text{ W}$

11k denotes: $11*1\text{ kW}=11\text{ kW}\dots$ and so on.

- Rated speed: Rated speed of servo motor. It is denoted by 3 digits. First digit is represented by R, second 2 digits is represented by 20(2000rpm) or 30(3000rpm).

R20 represents the rated speed is 2000rpm.

R30 represents the rated speed is 3000rpm.

- Encoder type: It is represented by a capital "A". The resolution is 2,500ppr incremental type.

- Brake and oil seal: Motors with/without brake or oil seal are presented below.

item \ code	A	B	C	D
brake	without	with	without	with
oil seal	without	without	with	with

- Shaft type: It describes the shape of the motor shaft; K denotes the inclusion of a keyway.

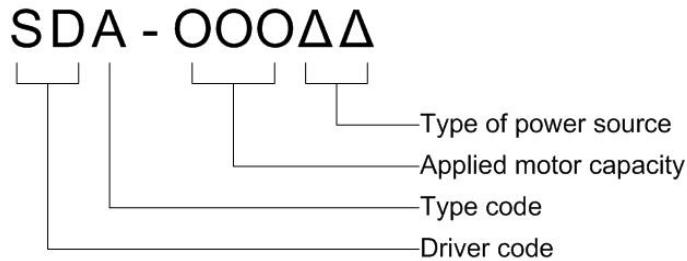
(3) Coding example:

Example 1: If a 200W low inertia motor, 3,000rpm rated speed, no brake, no oil seal, and no keyway, its name code should be: *SMA -L020R30AA*

Example 2: If a 1500W medium inertia motor, 2,000rpm, with brake, no oil seal, and with keyway, its name code should be: *SMA -M150R20ABK*

Coding rule for Shihlin servo driver:

(1) Coding method



(2) Description for coded items

- Driver code: SD denotes “servo driver”.
- Type code: A series.
- Applied motor capacity.

There are 3 digits to represent the capacity of servo driver. The first 2 digits are used to represent the driver's output power multiplied by 1/10. If the third digit is a "K", the capacity is the first 2 digits multiplied by 1kW. Here are some coding examples.

020 denotes: $02*(1/10)=0.2\text{kW}=200\text{W}$;

350 denotes: $35*(1/10)=3.5\text{kW}=3500\text{W}$

75k denotes: $75*1\text{kW}=75\text{kW}... \text{and so no.}$

- Driver code: SD denotes “servo driver”.
- Type code: A series.
- Applied motor capacity.
- Type of power source: Specification of input power. “A2” denotes the applied power is 220V.

(3) Coding example:

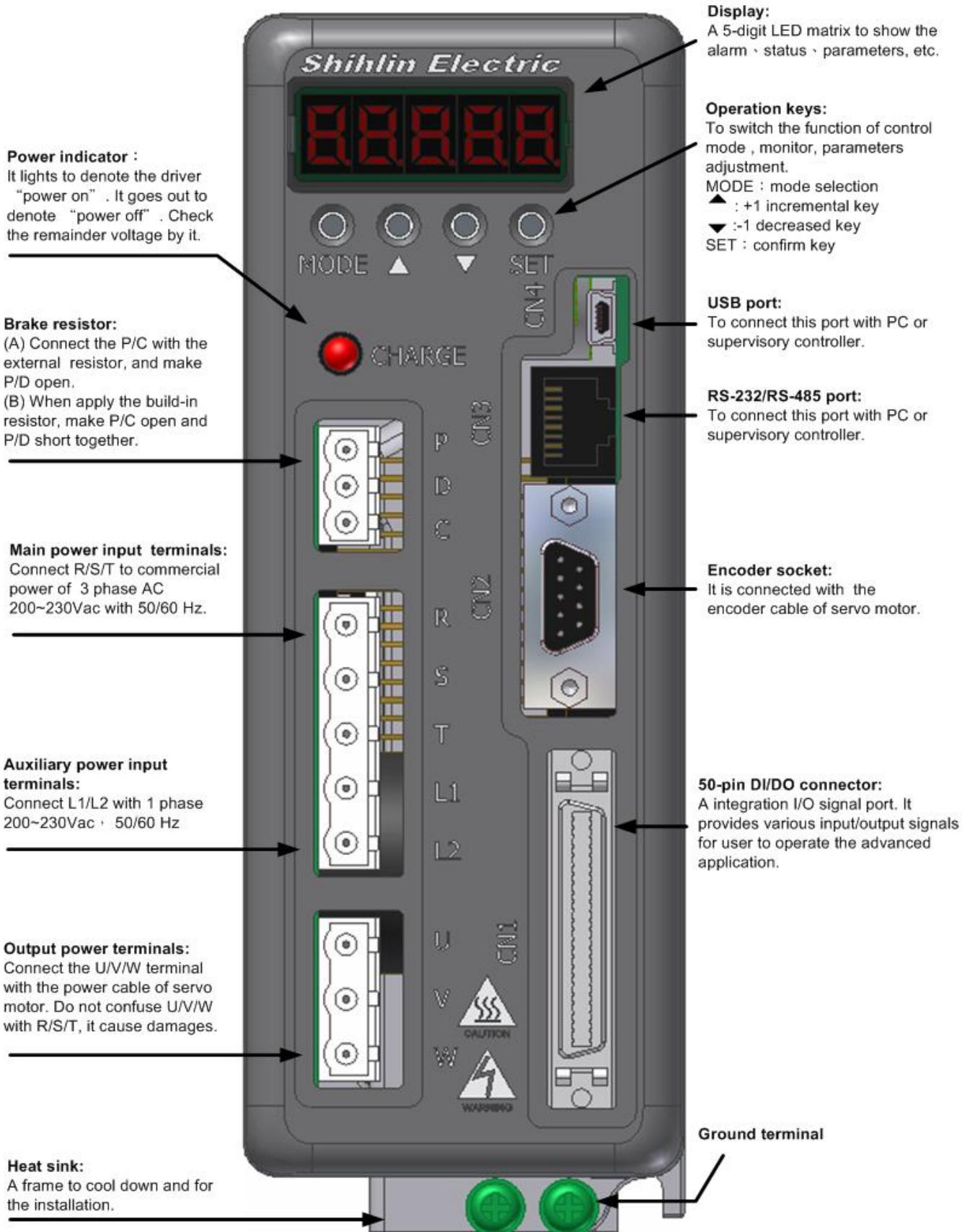
Example: If a 200W driver applied a 3-phase 220V power source, its name code should be:

SDA -020A2

Reference table for servo drivers and motors

	Servo driver	Servo motor (matched)	
100W		SDA-010A2	 SMA-L010R30A□□
200W		SDA-020A2	 SMA-L020R30A□□
400W		SDA-040A2	 SMA-L040R30A□□
500W		SDA-050A2	 SMA-M050R20A□□
750W		SDA-075A2	 SMA-L075R30A□□
1000W		SDA-100A2	 SMA-M100R20A□□
1500W		SDA-150A2	 SMA-M150R20A□□
2000W		SDA-200A2	 SMA-M200R20A□□
3500W		SDA-350A2	 SMA-M350R20A□□

1.3 Servo driver appearance and panel descriptions



1.4 Overview of servo driver operation modes

The Shihlin servo drivers provide multiple operation modes for users to select.

Mode	Sign	Description
Single mode	Pt	Driver runs motor to reach the goal according to the external commands which are received through the CN1 and are in the form of pulse trains.
	Pr	Driver runs motor to reach the goal according to the inner commands which are from inner 8 registers that could be switched by DI signals.
	S	Driver runs motor to attain the target speed. The command type which is an analog voltage or the inner registers could be switched by DI.
	T	The driver receives the commands to run the motor to generate the demanded torque. The command source is the analog voltage.
Hybrid mode	Pt-S	Pt/S is switched mutually via the LOP signal of DI.
	Pt-T	Pt/T is switched mutually via the LOP signal of DI.
	Pr-S	Pr/S is switched mutually via the LOP signal of DI.
	Pr-T	Pr/T is switched mutually via the LOP signal of DI.
	S-T	S/T is switched mutually via the LOP signal of DI.

- ★ Modify the PA01 value to define the application of mode switch. The PA01 modification works after the “Power on” restart.
- ★ If the default value of PA01 is applied, set the PA01 value as “1□□□”.

1.5 Recommended specifications for circuit breaker and fuse

Specifications of circuit breaker and fuse applicable to Shihlin servo driver.

Driver type	Fuse capacity	Circuit breaker capacity
SDA-010A2	5A	5A
SDA-020A2	5A	5A
SDA-040A2	20A	10A
SDA-050A2	20A	10A
SDA-075A2	20A	10A
SDA-100A2	25A	15A
SDA-150A2	40A	20A
SDA-200A2	60A	30A
SDA-350A2	80A	30A

2. Installation

2.1 Cautions and storage methods

- ◆ Do not install the product on inflammable matters or close to inflammable matters.
- ◆ Do not over tighten the wire between the driver and the motor.
- ◆ Do not place heavy objects on the top of the driver.
- ◆ Be sure to tight lock every screw when fixed the driver.
- ◆ Install the driver at a location where could bear the weight of the driver.
- ◆ Align the axle of the motor and the axle of the machinery device.
- ◆ Inflammable objects or conductive objects are not allowed inside the driver.
- ◆ Upgrade the diameter of the U/V/W wires and the encoder cable if the length between the driver and the motor is over 20m.
- ◆ Do not clog up the vent of the driver or breakdown may be occurred.
- ◆ Do not drop or clash the driver.
- ◆ Not try to run the driver which something has been damaged.
- ◆ Please refer to section 11.1 and 11.3 for driver and motor storage details.

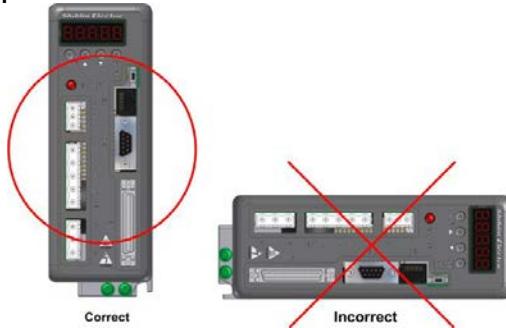
2.2 The environment conditions of installation

The ambient temperature suitable for Shihlin driver is between 0°C and 55°C. If the ambient temperature is higher than 45°C, the installation place with good ventilation or air conditioner is necessary. For a long-time operation, place the driver in an environment with temperature below 45°C to ensure the reliability of the driver. If the product is installed in a distributor, make sure that its size and ventilation condition. To prevent from over-heat of the electronic components inside it. Make sure that mechanical vibration will not affect the electronic devices of the distributor. In addition, the use of Shihlin servo shall meet the following criteria:

- ◆ Locations without high-heating devices.
- ◆ Locations without floating dust and metal particles.
- ◆ Locations without corrosive, inflammable gas and liquid.
- ◆ Locations without water drops, steam, dust or oil dust.
- ◆ Locations without electromagnetic interference.
- ◆ Select a solid, vibration-free location.

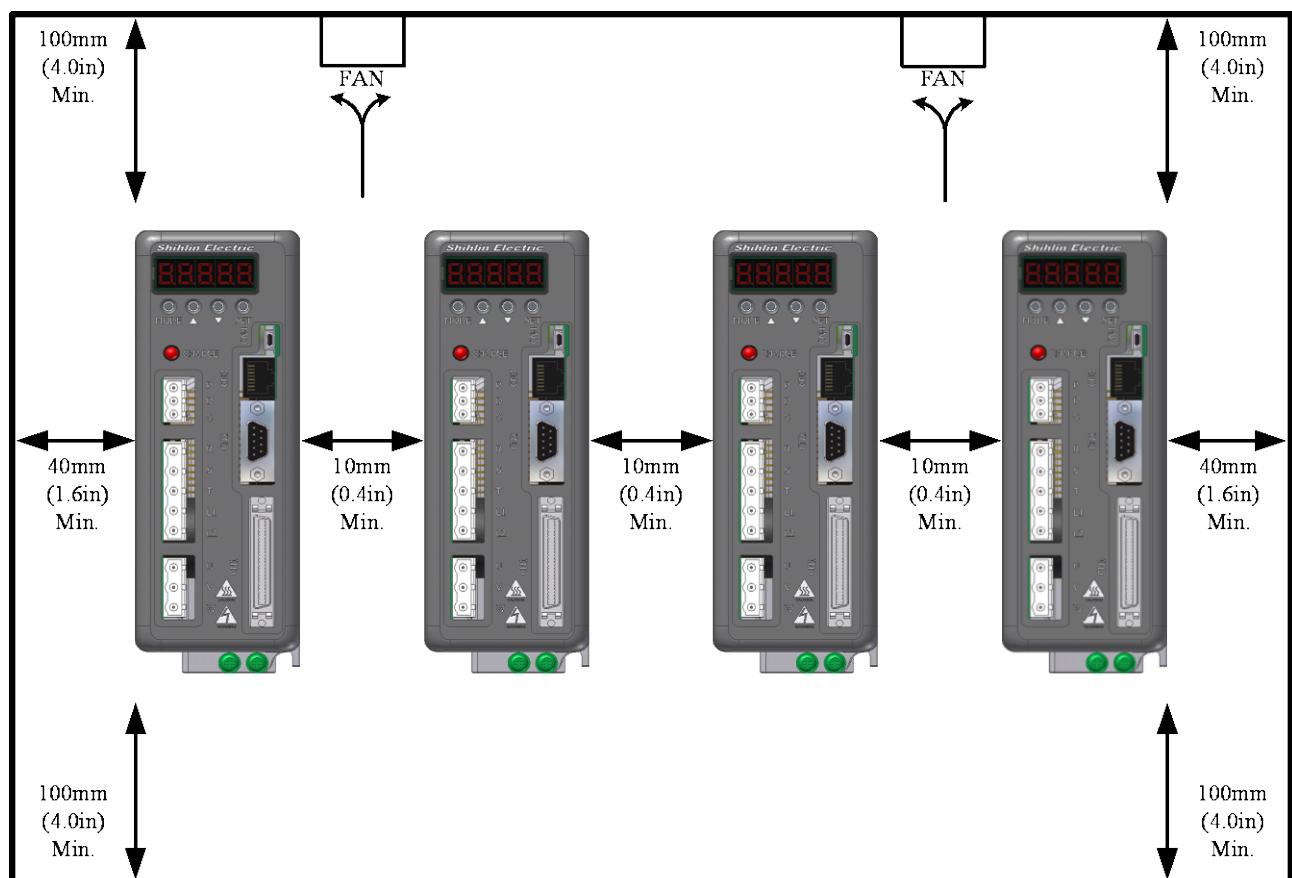
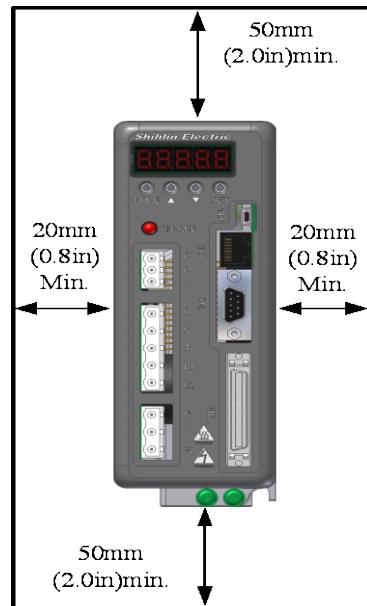
2.3 Installation direction and space

Follow the instruction of installation direction avoid the breakdown of driver. To provide a good ventilation by keeping sufficient space between the driver and other objects to avoid breakdown. Do not seal the vent of the driver or make the driver upside down during the installation to avoid breakdown.



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 drivers. (See the figure below).

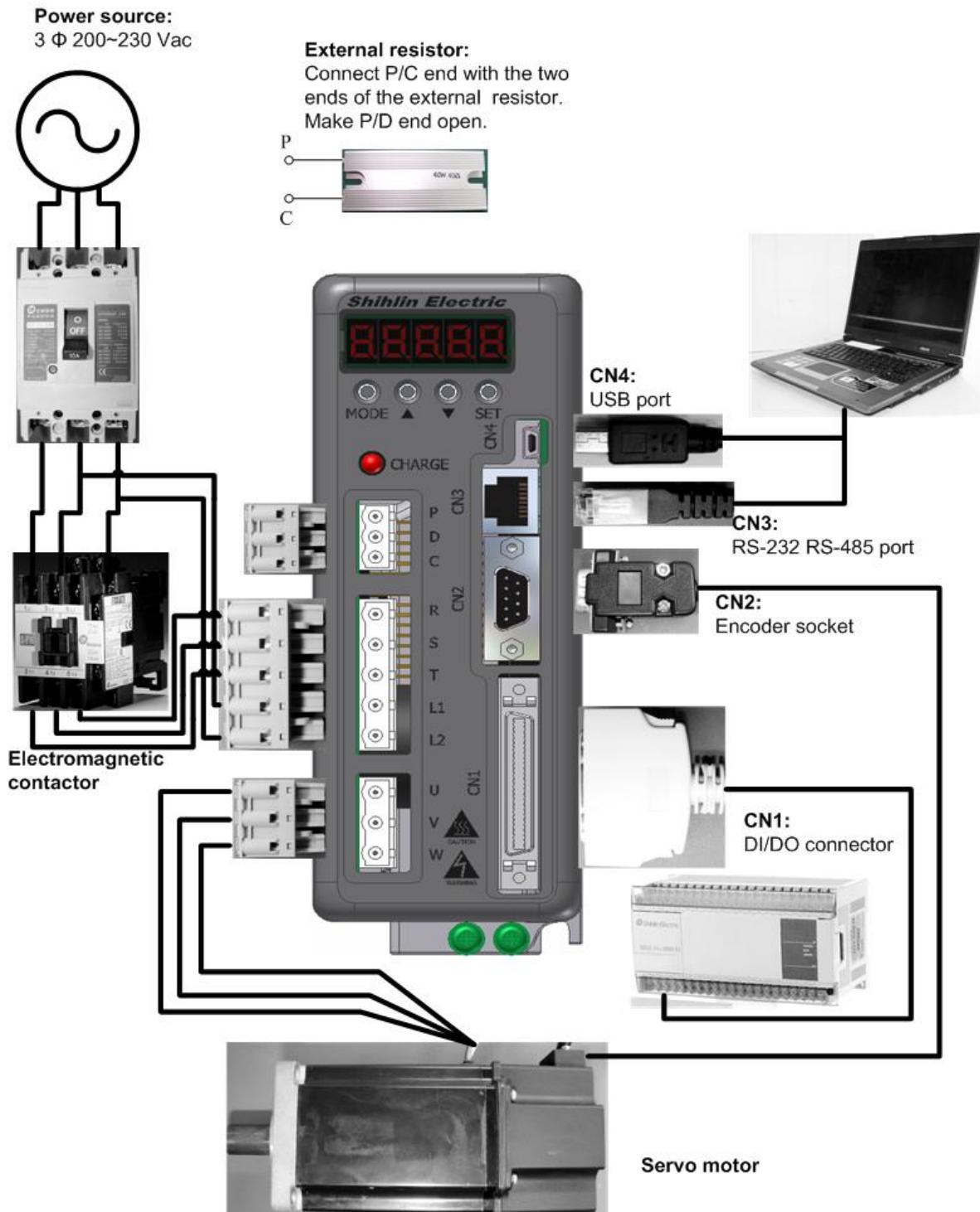


3. Wiring and signals

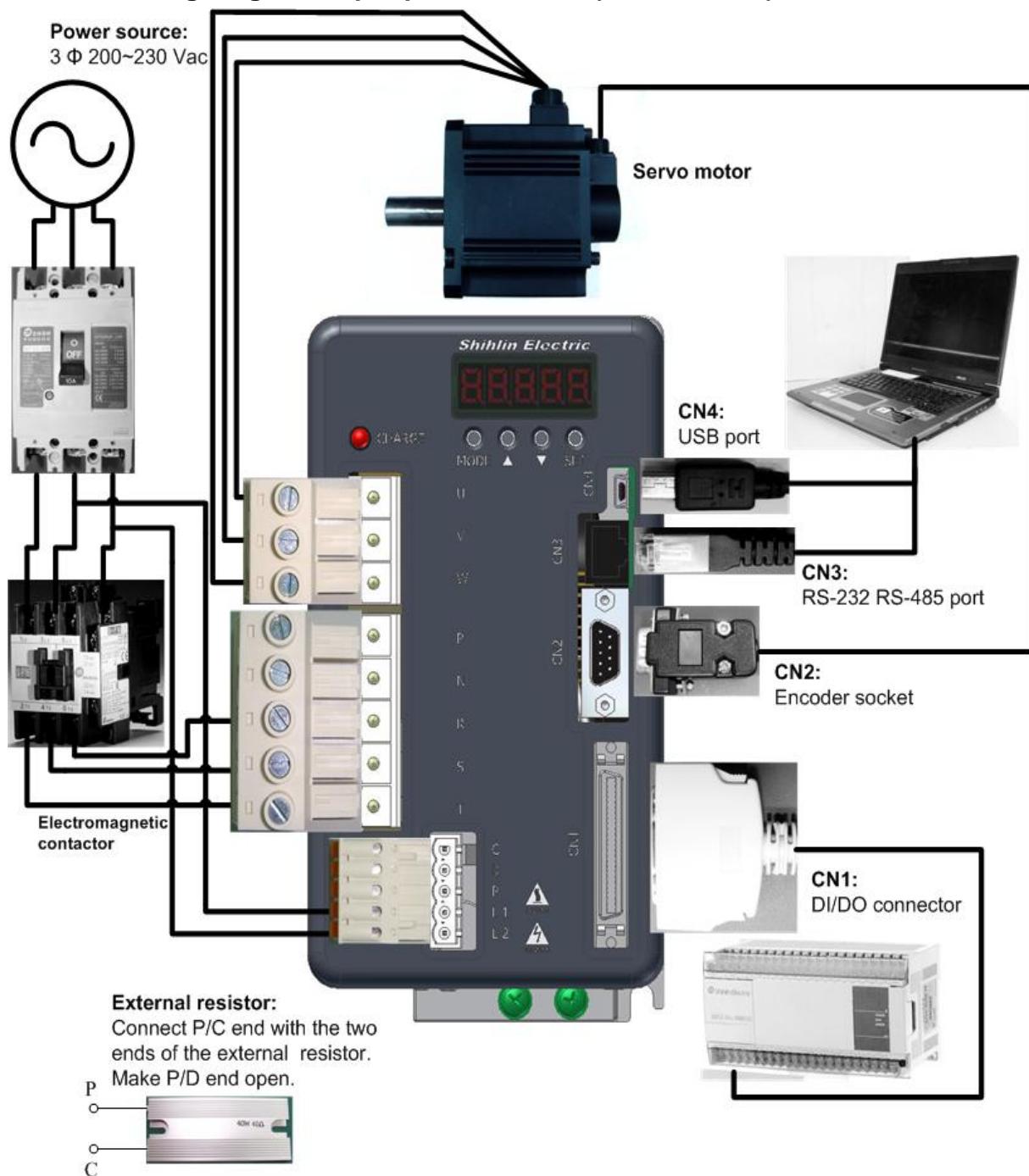
This chapter defines the wiring diagrams for operation and the signals of the Shihlin servo driver.

3.1.Connections between main power source and peripheral devices

3.1.1. Wiring diagram of peripheral devices(below 1kW)



3.1.2. Wiring diagram of peripheral devices(above 1.5kW)



NOTE Installation instruction:

- ① Make sure that servo motor output terminals U/V/W are wired correctly.
- ② When external brake resistor are used, make P/D ends open and connect the P/C ends to the external brake resistor. If the built-in one applied, make P/D ends short and P/C ends open. Be sure that the brake resistor is connected with the driver in operation.
- ③ Do not confuse U/V/W with R/S/T or L1/L2 or it causes the damage of servo.

3.1.3. Descriptions for driver's connectors and terminals

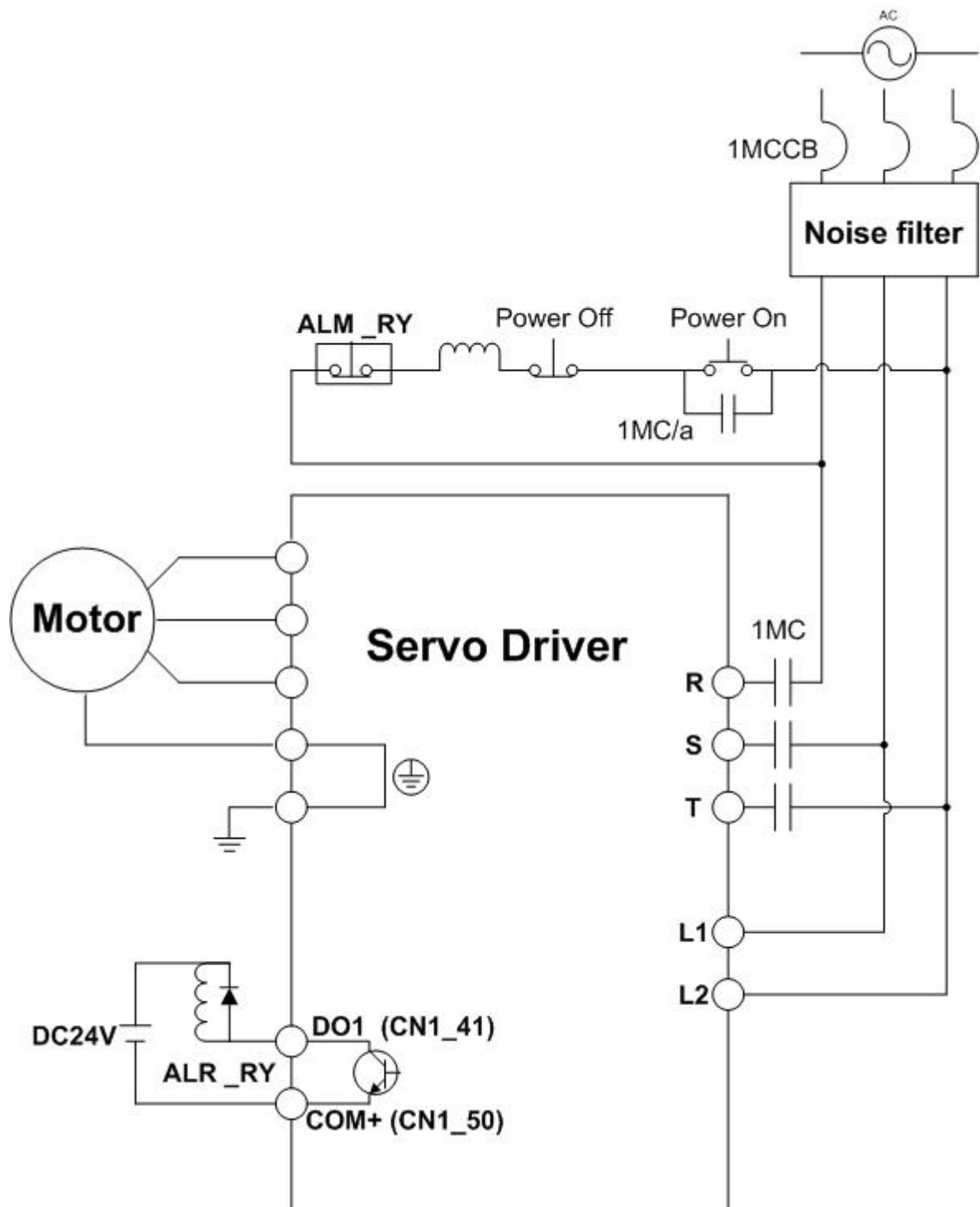
Name	Code	Description											
Main power input terminal	R, S, T	Connects to 3-phase AC power source											
Control power input terminal	L1, L2	Connects to single phase AC power source											
Power output terminal for motor	U , V , W, PE	<table border="1"> <thead> <tr> <th>Terminal code</th><th>Wire color</th></tr> </thead> <tbody> <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> </tbody> </table>		Terminal code	Wire color	U	Red	V	White	W	Black	PE	Green
Terminal code	Wire color												
U	Red												
V	White												
W	Black												
PE	Green												
Brake resistor terminal	P, D, C	<table border="1"> <tr> <td>External resistor</td><td>P/C ends connected to resistor and P/D ends open.</td></tr> <tr> <td>Built-in resistor</td><td>P/D ends short together and P/C ends open</td></tr> </table>		External resistor	P/C ends connected to resistor and P/D ends open.	Built-in resistor	P/D ends short together and P/C ends open						
External resistor	P/C ends connected to resistor and P/D ends open.												
Built-in resistor	P/D ends short together and P/C ends open												
Ground terminal		To connect the power ground with the motor ground.											
P:main circuit 【+】 terminal N:main circuit 【-】 terminal	P, N	When an active brake device is used for 1.5kW or above, please connect the 【+】 terminal of it to the driver's 【P】 terminal, the 【-】 terminal to the driver's 【N】 terminal. The active brake device is usually applied when the huge regenerative power produced by the servo motor in heavy duty.											
DI/DO connector	CN1	Connect to the host controller.											
Encoder socket	CN2	Connect to the encoder cable of servo motor.											
RS-232/RS-485 port	CN3	Connect to the COM port of PC.											
USB port	CN4	Connect to the USB port of PC.											

Confirm the items as follows when wiring:

- ① Keep the major power lines R/S/T and U/V/W away from other signal lines at least 30cm.
- ② Do not touch the major power lines until the charge indicator goes out. When "power off", there is still a large amount of electric charge in the aluminum capacitors inside the servo driver.
- ③ If a longer encoder cable is required, uses the twisted pairs cable and not to exceed 20m. Be sure to upgrade the diameter of wires to avoid signals attenuated when the wire's length greater than 20m.

3.1.4. Wiring method of power source

The Shihlin servo driver is connected to a three-phase power source. In the figure below, Power ON is contact a and alarm processing is contact b. 1MC/a is the self-maintained power source, and 1MC is the electromagnetic contactor.



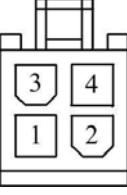
Note: The terminal P and N of servo driver 1.5kW above could not connected to ground.

3.1.5. Lead wire connector specifications of motor U,V,W terminals

Connector specifications (female type) of U/V/W terminals of the low inertia servo motor:

Driver capacity	Motor type		
100W	SMA—L010R30A□□		
200W	SMA—L020R30A□□		
400W	SMA—L040R30A□□		
750W	SMA—L075R30A□□		


with brake


without brake

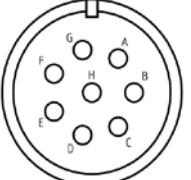
The lead wire signs of low inertia motor U,V,W terminal connector are listed as follows:

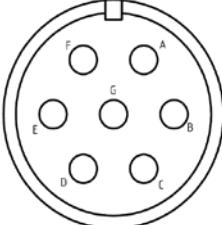
PIN	Sign	Wire color
1	U	Red
2	V	white
3	W	Black
4	PE	Green(background)/Yellow
5	NC	Black(with electromagnetic brake)
6	NC	Black(with electromagnetic brake)

★ Note: The aforesaid wires are connected to the connectors of the motor.

Connector specifications (male type) of U/V/W terminals of the medium inertia servo motor:

Driver capacity	Motor type	
500W	SMA—M050R20A□□	
1KW	SMA—M100R20A□□	
1.5KW	SMA—M150R20A□□	
2KW	SMA—M200R20A□□	
3.5KW	SMA—M350R20A□□	





The lead wire signs of medium inertia motor U,V,W terminal connector are listed as follows:

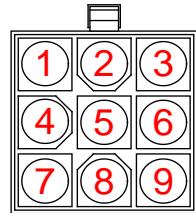
PIN	Sign
A	NC
B	U
C	V
D	W
E	PE
F	NC(with electromagnetic brake)
G	NC(with electromagnetic brake)
H	NC

3.1.6. Lead wire connector specifications of encoder

Encoder connector specifications (female type) of the low inertia servo motor:

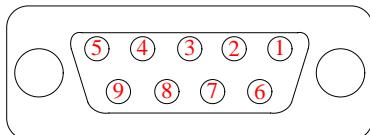
The suitable connector for various capacity of the Shihlin servo motor are listed as follows:

Driver capacity	Motor type	
100W	SMA—L010R30A□□	
200W	SMA—L020R30A□□	
400W	SMA—L040R30A□□	
750W	SMA—L075R30A□□	



Pin No.	Wire color	Sign	Pin No.	Wire color	Sign
1	blue	A	6	Yellow/black	/Z
2	green	B	7	red	5V
3	yellow	Z	8	black	GND
4	Blue/black	/A	9	NC	SHELD
5	Green/black	/B			

Driver socket: 9-pin female connector(suitable for the low and medium inertial motors)

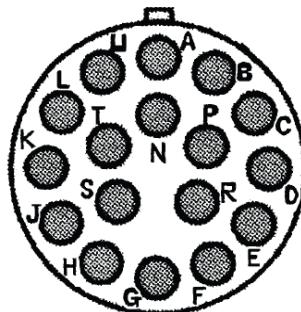


Pin No.	1	2	3	4	5	6	7	8	9
Sign	NC	/Z	/B	/A	5V	Z	B	A	GND

Encoder connector specifications (male type) of the medium inertia servo motor:

The suitable connector for various capacity of the Shihlin servo motor are listed as follows:

Driver capacity	Motor type	
500W	SMA—M050R20A□□	
1KW	SMA—M100R20A□□	
1.5KW	SMA—M150R20A□□	
2KW	SMA—M200R20A□□	
3.5KW	SMA—M350R20A□□	



Pin No.	A	B	D	E	G	H	S	P	L
Sign	A	/A	B	/B	Z	/Z	5V	GND	SHIELD

3.1.7. Selection of wiring materials

Please follow the following recommendations and then use the proper specification.

Driver type	Motor type	Specification for power wiring(AWG)			
		U、V、W	R、S、T	L1、L2	P、D、C
SDA-010A2	SMA-L010R30A□□	AWG14	AWG14	AWG16	AWG14
SDA-020A2	SMA-L020R30A□□	AWG14	AWG14	AWG16	AWG14
SDA-040A2	SMA-L040R30A□□	AWG14	AWG14	AWG16	AWG14
SDA-050A2	SMA-M050R20A□□	AWG14	AWG14	AWG16	AWG14
SDA-075A2	SMA-L075R30A□□	AWG14	AWG14	AWG16	AWG14
SDA-100A2	SMA-M100R20A□□	AWG14	AWG14	AWG16	AWG14
SDA-150A2	SMA-M150R20A□□	AWG14	AWG14	AWG16	AWG14
SDA-200A2	SMA-M200R20A□□	AWG12	AWG12	AWG16	AWG14
SDA-350A2	SMA-M350R20A□□	AWG12	AWG12	AWG16	AWG14

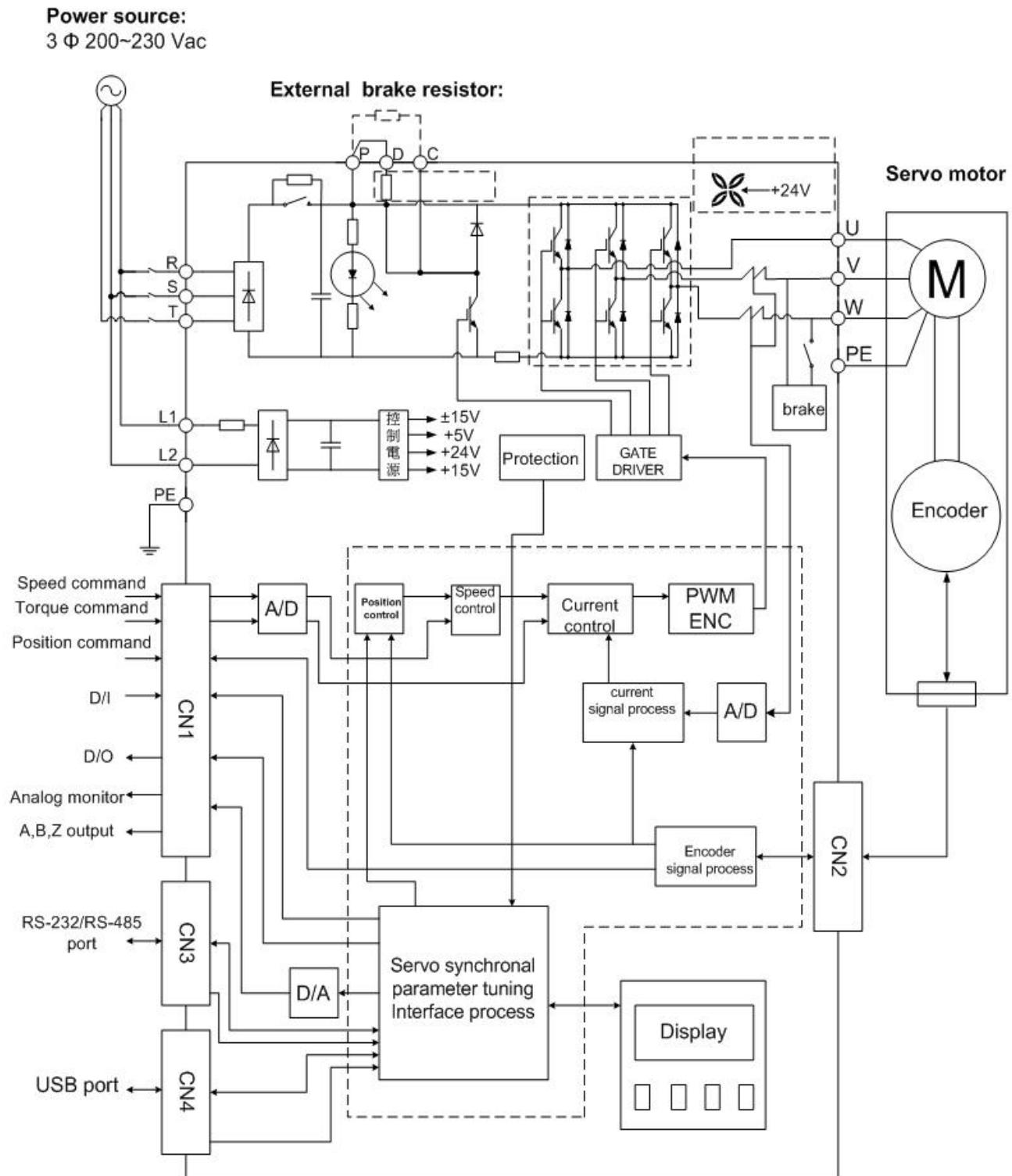
Driver type	Motor type	Specification for encoder wiring (AWG)			
		Wire gauge	Length	Core number	Core gauge
SDA-010A2	SMA-L010R30A□□	UL1332	2m	10	AWG26
SDA-020A2	SMA-L020R30A□□	UL1332	2m	10	AWG26
SDA-040A2	SMA-L040R30A□□	UL1332	2m	10	AWG26
SDA-050A2	SMA-M050R20A□□	UL1332	2m	10	AWG26
SDA-075A2	SMA-L075R30A□□	UL1332	2m	10	AWG26
SDA-100A2	SMA-M100R20A□□	UL1332	2m	10	AWG26
SDA-150A2	SMA-M150R20A□□	UL1332	2m	10	AWG26
SDA-200A2	SMA-M200R20A□□	UL1332	2m	10	AWG26
SDA-350A2	SMA-M350R20A□□	UL1332	2m	10	AWG26

- ★ Please follow the recommended list above or a larger specification to complete the wiring job.
- ★ The SHIELD terminal of the shield cable has to be connected to the power ground.
- ★ Use a shield twisted pairs cable for the wiring of encoder to reduce noise interference.
- ★ America Wire Gauge (AWG) is the standard wire diameter gauge of America.

3.2. Functional block diagram of Shihlin servo

100W~1kW:

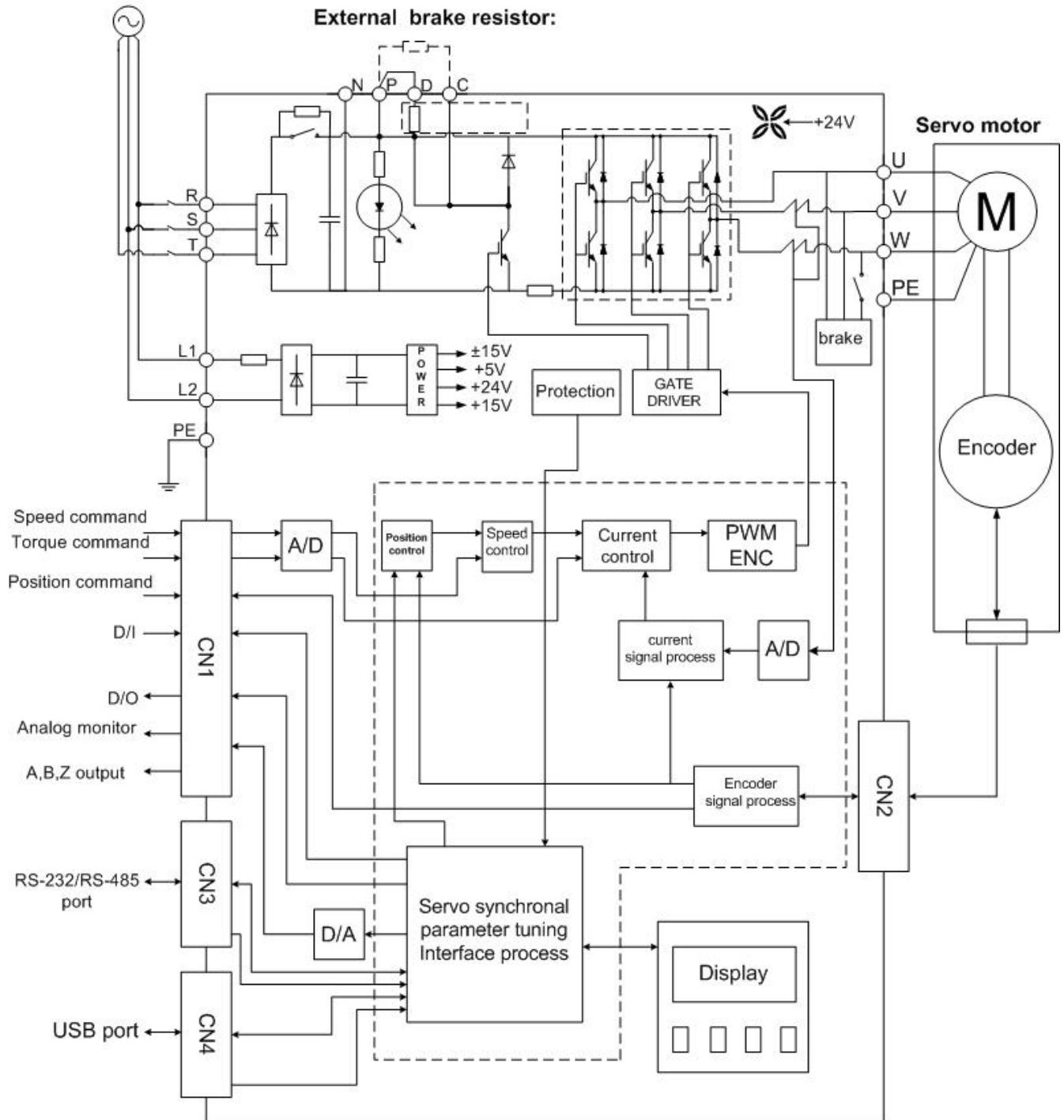
Shihlin servo driver



1.5kW~3.5kW:

Shihlin servo driver

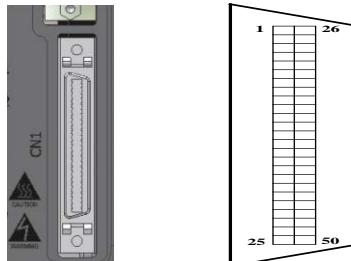
Power source:
3 Φ 200~230 Vac



3.3. CN1 I/O signal wires instruction

3.3.1. CN1 terminal layout

Shihlin servo driver provides 8 sets of DI inputs and 5 sets of DO outputs for users to program, which makes the application with the host controller more flexible. The 8 input DI parameters for users are PD02 to PD09, and the output DI parameters are PD10 to PD14. In addition, it affords encoder differential output signals, torque analog command input, speed analog command input. The CN1 pin diagram is presented as follows:



No	Pin name	Signal name	No	Pin name	Signal name
1	+15Vcc	+15V power supply output	26	+15Vcc	+15V power supply output
2	VC/VLA	Speed analog command/limit	27	TC/TLA	Torque analog command/limit
3	LG	Signal ground of analog input/output	28	LG	Signal ground of analog input/output
4	NC	No effect	29	LG	Signal ground of analog input/output
5	NG	Forward/reverse rotation pulse train	30	MON1	Analog monitor output 1
6	NP		31	LG	Signal ground of analog input/output
7	OPC	Open collector power	32	MON2	Analog monitor output 2
8	PP	Forward/reverse rotation pulse train	33	LA	Encoder A-phase pulse (differential line driver)
9	PG		34	LAR	
10	LG	Signal ground of analog input/output	35	LB	Encoder B-phase pulse (differential line driver)
11	LG	Signal ground of analog input/output	36	LBR	
12	NC	No effect	37	LZ	Encoder Z-phase pulse (differential line driver)
13	NC	No effect	38	LZR	
14	DI1	Digital input 1	39	OP	Phase Z pulse of encoder (open collector)
15	DI2	Digital input 2	40	NC	No effect
16	DI3	Digital input 31	41	DO1	Digital output 1
17	DI4	Digital input 41	42	DO2	Digital output 2
18	DI5	Digital input 51	43	DO3	Digital output 3
19	DI6	Digital input 6	44	DO4	Digital output 4
20	DI7	Digital input 7	45	DO5	Digital output 5
21	DI8	Digital input 8	46	ALM	Trouble
22	LSP	Limit of forward rotation route	47	COM+	Digital power source midway
23	LSN	Limit of reverse rotation route	48	+24Vdd	+24V built-in power
24	SG	Signal ground of digital I/O	49	COM+	Digital power source midway
25	SG	Signal ground of digital I/O	50	SG	Signal ground of digital I/O



NOTE:

1. NC stand for no effect terminal which is used for inner circuit of the driver. Do not connect it, or it would result in damage!
2. Although CN1-22 and CN1-23 are digital input pins but they are not programmable. CN1-46 is also the unique function output pin.

3.3.2. Signal description of CN1 terminal

Signals listed in aforesaid section will be described in detail in this section.

1. CN1 terminal signal description

There are 50 pins in CN1 terminal. Every pin function would be described as below:

The abbreviation for the control modes in the table below are explained as below:

Pt : Position control mode(terminal input)

Pr : Position control mode(inner register)

S : Speed control mode

T : Torque control mode

Signal name	Sign	Pin NO	Function description	Control mode
+15V power supply output	+15Vcc	CN1_1, CN1_26	DC 15V between +15Vcc and LG. It could be use as power source of TC, TLA, VC and VLA.	ALL
Speed analog command/limit	VC/VLA	CN1_2	<p>Apply a voltage in $\pm 10V$ range on VC-LG under the speed mode, the motor will rotate the proportional speed linearly of PC12 value at $\pm 10V$ range.</p> <p>Apply a voltage in $\pm 10V$ range on VLA-LG under the torque mode, the motor will rotate the proportional speed linearly of PC12 value at $\pm 10V$ range.</p>	S,T
Signal ground of analog input/output	LG	CN1_3 CN1_10 CN1_11 CN1_28 CN1_31	The common ground of TLA, LA, TC, VC, VLA, OP, MO1, MO2, VCC. Each pin inside the driver is connected together.	ALL
Forward/reverse rotation pulse train	NG NP PP PG	CN1_5 CN1_6 CN1_8 CN1_9	<p>Open collector type: (Max. frequency 200Kpps) To apply signals on PP-SG means "forward command". To apply signals on NP-SG means "reverse command".</p> <p>Signal in differential type: (Max. frequency 500Kpps) To apply signals on PG-PP means "forward command". To apply signals on NG-NP means "reverse command".</p>	Pt
Open collector power	OPC	CN1_7	As signals in open collector type; this pin provides 24V and SG is the ground.	ALL

Limit of forward rotation route	LSP	CN1_22	<p>Please make both LSP-SG and LSN-SG short-circuit when you operate the servo. An emergency stop occurred and the motor locked when something makes LSP-SG or LSN-SG open circuit.</p> <p>As the value of PD17 is xxx1, the motor decelerate by the time of deceleration and then stop.</p> <p>Set the Parameter PD01 as follows to get a virtual short-circuit without a physical wiring.(normal "ON")</p> <table border="1"> <thead> <tr> <th colspan="2">PD01</th><th colspan="2">Normal "ON"</th></tr> </thead> <tbody> <tr> <td>xx1x</td><td></td><td colspan="2">LSP</td></tr> <tr> <td>x1xx</td><td></td><td colspan="2">LSN</td></tr> <tr> <td colspan="2">Signal status(*)</td><td colspan="2">運轉</td></tr> <tr> <td>LSP</td><td>LSN</td><td>CCW</td><td>CW</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> </tbody> </table> <p>(*) 0:OFF (LSP-SG/LSN-SG open-circuit) 1:ON (LSP-SG/LSN-SG short-circuit)</p>	PD01		Normal "ON"		xx1x		LSP		x1xx		LSN		Signal status(*)		運轉		LSP	LSN	CCW	CW	1	1	○	○	0	1	---	○	1	0	○	---	0	0	---	---	Pt,Pr,S
PD01		Normal "ON"																																						
xx1x		LSP																																						
x1xx		LSN																																						
Signal status(*)		運轉																																						
LSP	LSN	CCW	CW																																					
1	1	○	○																																					
0	1	---	○																																					
1	0	○	---																																					
0	0	---	---																																					
Limit of reverse rotation route	LSN	CN1_23																																						
Signal ground of digital I/O	SG	CN1_24 CN1_25 CN1_50	The common ground of SON, EMG digital input. Each pin inside the driver is connected together but separated from LG.	ALL																																				
Torque analog command/limit	TC/TLA	CN1_2	<p>Apply a voltage signal within ±10V on TC-LG, the motor torque generated would be linear proportional of PC13.</p> <p>As TLA is valid, motor generated torque would be limited according to proportion of rated torque to applied voltage. The range of applied voltage on TLA-SG is 0 ~ +10V.</p>	Pt,Pr,S																																				
Analog monitor output 1	MON1	CN1_30	The proportional voltage signal according to the value of PC14 outputs on MO1-LG.	ALL																																				
Analog monitor output 2	MON2	CN1_32	The proportional voltage signal according to the value of PC14 outputs on MO2-LG.	ALL																																				
Encoder A-phase pulse(differential line driver)	LA	CN1_33	The value of PA14 decides how many pulses output in one turn. The output signals are in line driver type. There is a π/2 delay between phase A and B.	ALL																																				
Encoder B-phase pulse(differential line driver)	LAR	CN1_34																																						
Encoder Z-phase pulse(differential line driver)	LB	CN1_35	The phase sequence of rotation and phase difference between phase A and phase B could be defined by the change of PA39 value.	ALL																																				
Encoder Z-phase pulse(differential line driver)	LBR	CN1_36																																						
Phase Z pulse of encoder (Open collector)	LZ	CN1_37	The driver transforms the OP signals into line driver.	ALL																																				
Phase Z pulse of encoder (Open collector)	LZR	CN1_38																																						
Alarm signal output	ALM	CN1_46	ALM-SG is open-circuit when the power is off, or the protection of the driver is activated. In normal case, the ALM-SG is conductive one second after "power on".	ALL																																				
Digital power source midway	COM+	CN1_47 CN1_49	When +24V built-in power is applied as the source of input signals, this pin should be connected to +24Vdd.	ALL																																				
+24V built-in power	+24Vdd	CN1_48	There is a +24V±10% power source on +24Vdd - SG.	ALL																																				

2. I/O signal description of CN1 terminal

Some signals and their abbreviation reference table for the I/O signals of CN1 are presented below:

Abbr.	Signal name	Abbr.	Signal name
SON	Servo ON	CTRG	Trigger of the position command
LSP	Limit of forward rotation route	TLC	Torque limiting control
LSN	Limit of reverse rotation route	VLC	Speed limiting control
CR	Clear	RD	Ready
SP1	Speed option 1	ZSP	Zero speed detection
SP2	Speed option 2	INP	In-position ready
PC	Proportion control	SA	Speed attained
ST1	Forward rotation activated	ALM	Alarm signal output
ST2	Reverse rotation activated	OP	Encoder output pulse (Open collector)
TL	Torque limit option	LZ	Encoder Z-phase pulse(differential line driver)
RES	Reset	LZR	
EMG	External emergency stop	LA	Encoder A-phase pulse(differential line driver)
LOP	Control mode switch	LAR	
VC	Speed analog command	LB	Encoder B-phase pulse(differential line driver)
VLA	Speed analog limit	LBR	
TLA	Torque analog limit	+15Vcc	+15V power supply output
TC	Torque analog command	+24Vdd	+24V built-in power
RS1	Forward rotation option	COM +	Digital power source midway
RS2	Reverse rotation option	SG	Signal ground of digital I/O
PP	Forward/reverse rotation pulse train	OPC	Open collector power
NP		LG	Signal ground of analog input/output
PG		MON1	Analog monitor output 1
NG		MON2	Analog monitor output 2
POS1	Position command option 1	SD	Shield
POS2	Position command option 2		
POS3	Position command option 3		

3. DI and DO signal description

Input DI

Every DI pin is programmable. There are 23 signal functions could be assigned to the particular DI pin by the modification of parameter PD02 to PD09. The value from 0x01 to 0x17 is defined as the function described below:

Signal function	Sign	Value	Functions/Applications description	Control mode
Servo ON	SON	0x01	Power on the driver and make SON-SG short-circuit to ready (the shaft is locked). Make SON-SG open-circuit to release (the shaft is rotatable). A virtual “Servo ON” could be achieved by the PD01 set as □□□1.(Normal ON)	ALL
Reset	RES	0x02	A short-circuit duration over 50mS on RES-SG would recover from an abnormal alarm status. Some abnormal cases would not be recovered(refer to section 10.1). Set the PD20 as □□□1, the function of reset would not work.	ALL
Proportion control	PC	0x03	A short-circuit on PC-SG would switch the proportion-integral controller to the proportion controller (speed control) . When motor in static, it outputs torque to resist the external disturbance which even only 1 pulse revolution. Once the position is done, to prevent from unnecessary jitter of motor shaft, please switch to the proportion controller.	Pt,Pr,S
Torque limit option	TL	0x04	Open TL-SG to make inner torque limit 1 valid(PA05), or turn TL-SG on to make analog torque limit(TLA) valid. For details, refer to section 6.3.4.	Pt,Pr,S
Inner torque limit option	TL1	0x05	Turn TL1-SG on to make inner torque limit 2 valid(PC25). For details, refer to section 6.3.4.	ALL

Speed option 1	SP1	0x06	<p><Speed control mode> Used to select the speed command. When using SP3, make it usable by making the setting of PD02~PD09.</p> <table border="1"> <thead> <tr> <th rowspan="2">Setting of PD02~PD09</th><th colspan="3">(Note)Input signals</th><th rowspan="2">Speed command</th></tr> <tr> <th>SP3</th><th>SP2</th><th>SP1</th></tr> </thead> <tbody> <tr> <td rowspan="4">When speed option (SP3) is not used. (initial status)</td><td>/</td><td>0</td><td>0</td><td>Speed analog command (VC)</td></tr> <tr> <td>/</td><td>0</td><td>1</td><td>Inner speed command 1 (PC05)</td></tr> <tr> <td>/</td><td>1</td><td>0</td><td>Inner speed command 2 (PC06)</td></tr> <tr> <td>/</td><td>1</td><td>1</td><td>Inner speed command 3 (PC07)</td></tr> <tr> <td rowspan="9">When speed option (SP3) is made valid.</td><td>0</td><td>0</td><td>0</td><td>Speed analog command (VC)</td></tr> <tr> <td>0</td><td>0</td><td>1</td><td>Inner speed command 1 (PC05)</td></tr> <tr> <td>0</td><td>1</td><td>0</td><td>Inner speed command 2 (PC06)</td></tr> <tr> <td>0</td><td>1</td><td>1</td><td>Inner speed command 3 (PC07)</td></tr> <tr> <td>1</td><td>0</td><td>0</td><td>Inner speed command 4 (PC08)</td></tr> <tr> <td>1</td><td>0</td><td>1</td><td>Inner speed command 5 (PC09)</td></tr> <tr> <td>1</td><td>1</td><td>0</td><td>Inner speed command 6 (PC10)</td></tr> <tr> <td>1</td><td>1</td><td>1</td><td>Inner speed command 7 (PC11)</td></tr> </tbody> </table> <p>Note. 0:off (with SG) 1:on (with SG)</p>	Setting of PD02~PD09	(Note)Input signals			Speed command	SP3	SP2	SP1	When speed option (SP3) is not used. (initial status)	/	0	0	Speed analog command (VC)	/	0	1	Inner speed command 1 (PC05)	/	1	0	Inner speed command 2 (PC06)	/	1	1	Inner speed command 3 (PC07)	When speed option (SP3) is made valid.	0	0	0	Speed analog command (VC)	0	0	1	Inner speed command 1 (PC05)	0	1	0	Inner speed command 2 (PC06)	0	1	1	Inner speed command 3 (PC07)	1	0	0	Inner speed command 4 (PC08)	1	0	1	Inner speed command 5 (PC09)	1	1	0	Inner speed command 6 (PC10)	1	1	1	Inner speed command 7 (PC11)	S,T
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Forward rotation activated	ST1	0x09	Used to start the servo motor in the following directions:	<table border="1"> <thead> <tr> <th colspan="2">(Note)Input signals</th><th>Servo motor starting direction</th></tr> <tr> <th>ST2</th><th>ST1</th><th></th></tr> </thead> <tbody> <tr> <td>0</td><td>0</td><td>Stop(servo lock)</td></tr> <tr> <td>0</td><td>1</td><td>CCW</td></tr> <tr> <td>1</td><td>0</td><td>CW</td></tr> <tr> <td>1</td><td>1</td><td>Stop(servo lock)</td></tr> </tbody> </table>	(Note)Input signals		Servo motor starting direction	ST2	ST1		0	0	Stop(servo lock)	0	1	CCW	1	0	CW	1	1	Stop(servo lock)	S																																							
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1	1	Stop(servo lock)																																																												
Reverse rotation activated	ST2	0x0A	<p>Note. 0:off (with SG) 1:on (with SG)</p> <p>If both ST1 and ST2 are switched on or off during operation, the servo will be decelerated to a stop according to the value of PA28, and the motor will be locked. The activation of analog speed commands (VC) at 0V will not servo lock.</p>																																																											

Forward rotation option	RS1	0x0A	<p>Used to select any of the following servo motor torque generation directions:</p> <table border="1"> <thead> <tr> <th colspan="2">Input signals (Note)</th> <th>Torque generation direction</th> </tr> <tr> <th>RS2</th> <th>RS1</th> <td></td> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>Torque is not generated.</td> </tr> <tr> <td>0</td> <td>1</td> <td>Forward rotation torque, reverse rotation regeneration</td> </tr> <tr> <td>1</td> <td>0</td> <td>Reverse rotation torque, forward rotation regeneration</td> </tr> <tr> <td>1</td> <td>1</td> <td>Torque is not generated.</td> </tr> </tbody> </table> <p>Note. 0:off (with SG), 1:on (with SG)</p>	Input signals (Note)		Torque generation direction	RS2	RS1		0	0	Torque is not generated.	0	1	Forward rotation torque, reverse rotation regeneration	1	0	Reverse rotation torque, forward rotation regeneration	1	1	Torque is not generated.	T
Input signals (Note)		Torque generation direction																				
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0	1	Forward rotation torque, reverse rotation regeneration																				
1	0	Reverse rotation torque, forward rotation regeneration																				
1	1	Torque is not generated.																				
Reverse rotation option	RS2	0x09																				
Origin position	ORGP	0x0B	In position control with inner registers, this signal activated would assigned current position to the origin.	Pr																		
Start Home moving	SHOM	0x0C	As this signal activated, driver runs motor to return the origin.	Pr																		
Electronic gear option 1	CM1	0x0D	When using CM1 and CM2, make them usable by the setting of PD02~PD09. The combination of CM1 and CM2 gives you a choice of 4 numerators. CM1 and CM2 cannot be used in the absolute position detection system.	Pt,Pr																		
Electronic gear option 2	CM2	0x0E	<table border="1"> <thead> <tr> <th colspan="2">Input signals (Note)</th> <th>Electronic gear molecule</th> </tr> <tr> <th>CM2</th> <th>CM1</th> <td></td> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>The value of parameter PA07 (CMX)</td> </tr> <tr> <td>0</td> <td>1</td> <td>The value of parameter PC32(CMX2)</td> </tr> <tr> <td>1</td> <td>0</td> <td>The value of parameter PC33(CMX3)</td> </tr> <tr> <td>1</td> <td>1</td> <td>The value of parameter PC34(CMX4)</td> </tr> </tbody> </table> <p>Note. 0:off (with SG), 1:on (with SG)</p>		Input signals (Note)		Electronic gear molecule	CM2	CM1		0	0	The value of parameter PA07 (CMX)	0	1	The value of parameter PC32(CMX2)	1	0	The value of parameter PC33(CMX3)	1	1	The value of parameter PC34(CMX4)
Input signals (Note)		Electronic gear molecule																				
CM2	CM1																					
0	0	The value of parameter PA07 (CMX)																				
0	1	The value of parameter PC32(CMX2)																				
1	0	The value of parameter PC33(CMX3)																				
1	1	The value of parameter PC34(CMX4)																				
Clear	CR	0x0F	Turn CR on to clear the position control counter droop pulses on its leading edge. The pulse width should be 10mS or longer. When the PD18 setting is □□□1, the pulse are always cleared while CR is on.	Pt,Pr																		
Gain switch option	CDP	0x10	When using this signal, make it usable by the setting of PD02~PD09. Turn CDP on to change the gain values into the multiplier of parameter PB14 to PB17.	ALL																		
Control mode switch	LOP	0x11	<p><Position/Speed control switch mode> Used to select the control mode in the position/speed control switch mode.</p> <table border="1"> <thead> <tr> <th>(Note) LOP</th> <th>Control mode</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Position</td> </tr> <tr> <td>1</td> <td>Speed</td> </tr> </tbody> </table> <p><Speed/Torque control switch mode> Used to select the control mode in the Speed/Torque control switch mode.</p> <table border="1"> <thead> <tr> <th>(Note) LOP</th> <th>Control mode</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Speed</td> </tr> <tr> <td>1</td> <td>Torque</td> </tr> </tbody> </table> <p><Torque/Position control switch mode> Used to select the control mode in the Torque/Position control switch mode.</p> <table border="1"> <thead> <tr> <th>(Note) LOP</th> <th>Control mode</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Torque</td> </tr> <tr> <td>1</td> <td>Position</td> </tr> </tbody> </table> <p>Note. 0:off (with SG), 1:on (with SG)</p>	(Note) LOP	Control mode	0	Position	1	Speed	(Note) LOP	Control mode	0	Speed	1	Torque	(Note) LOP	Control mode	0	Torque	1	Position	Refer to Functions/ Applications
(Note) LOP	Control mode																					
0	Position																					
1	Speed																					
(Note) LOP	Control mode																					
0	Speed																					
1	Torque																					
(Note) LOP	Control mode																					
0	Torque																					
1	Position																					

External emergency stop	EMG	0x12	Turn EMG off (open EMG-SG) to bring the motor to an emergency stop state, in which the electromagnetic brake is on. Turn EMG on (short EMG-SG) in the emergency stop state to reset that state. To set the value of PD01 as 1□□□, this signal would be normal on.	ALL
Position command option 1	POS1	0x13		
Position command option 2	POS2	0x14		
Position command option 3	POS3	0x15		
Position command trigger	CTRG	0x16	In position control with inner 8 registers(Pr mode), the combination of POS1/POS2/POS3 gives you a choice of 8 position commands when the CTRG is activated.	Pr,Pr-S ,Pr-T
Inner position command halt	HOLD	0x17	In position control with inner 8 registers(Pr mode), the motor would stop running as this signal activated.	Pr,Pr-S ,Pr-T



NOTE:

1. When setting the parameter PA01 in speed mode or torque mode, the function ST1/RS2 and ST2/RS1 would be defined mutually because of the same values.
2. To use the custom definition of input signal, the value of PA01 should be as 0XXX. If the value of PA01 is 1□□□, the function definition of signals should be a default.

Output DO

Every DO pin is programmable. There are 9 output functions could be assigned to the particular DO pin by the modification of parameter PD10 to PD14. The value from 0x01 to 0x09 is defined as the function described below:

Signal function	Sign	Value	Functions/Applications description	Control mode
Ready	RD	0x01	It is on as power is turned on and driver is ready to operate.	ALL
Alarm signal output	ALM	0x02	ALM-SG is isolated as power off or protection activated to cut off the main circuit. Without alarm occurring, ALM-SG would turn on after power on 1 second latter.	ALL
In-position ready	INP	0x03	INP turn on when the number of droop pulses is in the preset in-position range. The in-position range could be change using parameter PA12. When the in-position range is increased, INP may be kept conductive during low-speed rotation.	Pt,Pr
Speed attained			SA turns on when the speed has nearly reached the preset command. When the preset command is 50r/min or less, SA always turns on.	S
Home moving completion	HOME	0x04	It turns on after the completion of home moving.	Pr
Torque limiting control	TLC	0x05	TLC-SG is on as motor generated torque reaches inner torque limit or torque analog limit. TLC-SG is off when SON signal is turned off.	Pt,Pr,S
Speed limiting control	VLC		In torque mode, VLC-SG is on as motor speed reaches inner speed limit or speed analog limit. VLC-SG is off when SON signal is turned off.	T
Electromagnetic brake interlock	MBR	0x06	When using this signal, make it usable by setting parameter PA01 as □1□□. MBR is off as the power is turned off or any alarm occurred.	ALL
Warning	WNG	0x07	WNG-SG is conductive as any warning occurred. Without warning occurring, WNG-SG is isolated.	ALL
Zero speed detection	ZSP	0x08	When the speed is under the preset of zero speed(50r/min), ZSP-SG keeps conductive. The zero speed range could be changed by PC17.	ALL
Inner position command output completed	CDMOK	0x09	CMDOK-SG is conductive as the inner position command is completed or stopped.	Pr



NOTE:

1. When setting the parameter PA01 in speed mode or torque mode, the function INP and SA would be defined mutually because of the same values.
2. When setting the parameter PA01 in speed mode or torque mode, the function TLC and VLC would be defined mutually because of the same values.

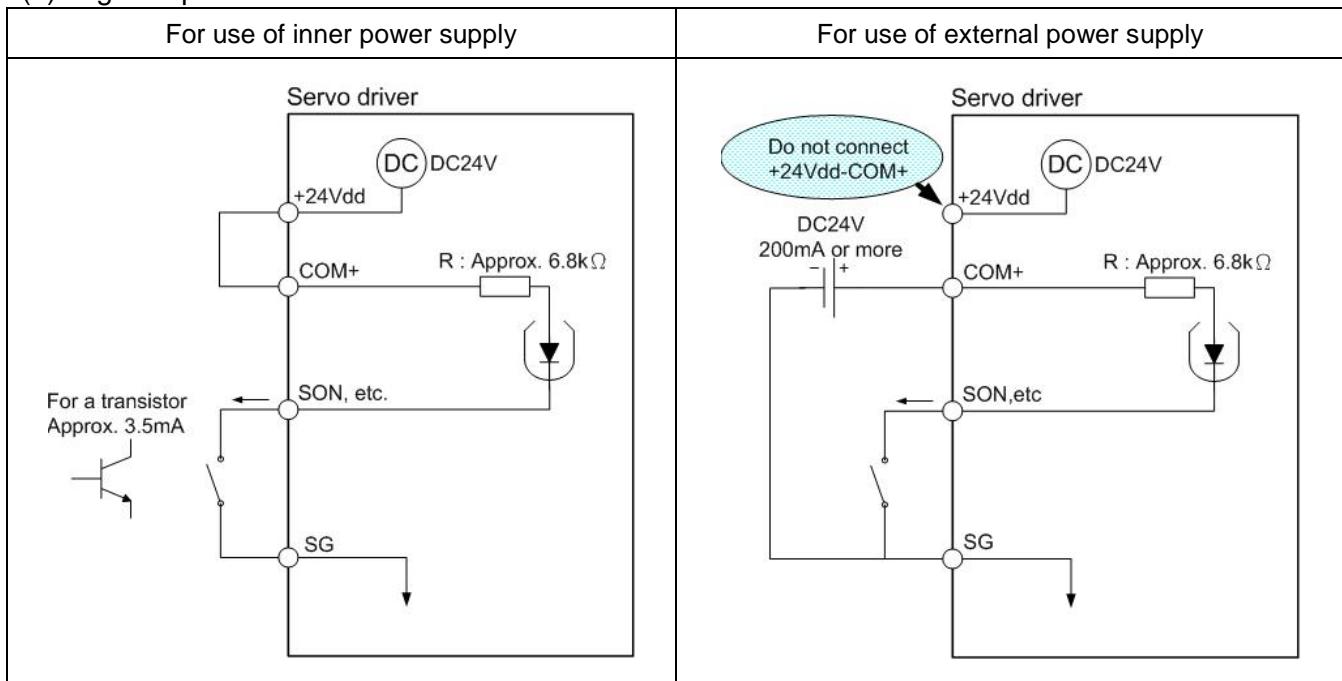
There are 8 DI and 5 DO equipped in CN1. They afford user a flexible application. See as follows.

Value	Sign	Function	Pt	Pr	S	T	Pt-S	Pt-T	Pr-S	Pr-T	S-T
0x01	SON	Servo ON	DI1	DI1	DI1	DI1	DI1	DI1	DI1	DI1	DI1
0x02	RES	Reset	DI5	DI5	DI5	DI5	DI5	DI5	DI5	DI5	DI5
0x03	PC	Proportion control	DI3								
0x04	TL	Torque limit option	DI4								
0x05	TL1	Inner torque limit option									
0x06	SP1	Speed option 1			DI6	DI6	DI2	DI2			DI6
0x07	SP2	Speed option 2			DI2	DI2					DI2
0x08	SP3	Speed option 3									
0x09	ST1	Forward rotation activated			DI3		DI3		DI3		
0x0A	ST2	Reverse rotation activated			DI4		DI4		DI6		
0x0A	RS1	Forward rotation option				DI4		DI4		DI6	DI4
0x09	RS2	Reverse rotation option				DI3		DI3		DI3	DI3
0x0B	ORGP	Origin positioned									
0x0C	SHOM	Start Home moving									
0x0D	CM1	Electronic gear option 1	DI2								
0x0E	CM2	Electronic gear option 2									
0x0F	CR	Clear	DI6	DI6			DI6	DI6			
0x10	CDP	Gain switch option									
0x11	LOP	Control mode 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	Position command trigger		DI4					DI4	DI4	
0x17	HOLD	Inner position command halt		DI8							

Value	Sign	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	Trouble									
0x03	INP	In-position ready	DO1	DO1			DO1	DO1	DO1	DO1	
0x03	SA	Speed attained			DO1		DO1		DO1		DO1
0x04	HOME	Home return									
0x05	TLC	Torque limiting control	DO4	DO4	DO4		DO4	DO4	DO4	DO4	DO4
0x05	VLC	Speed limiting control				DO4		DO4		DO4	DO4
0x06	MBR	Electromagnetic brake interlock			DO3	DO3					DO3
0x07	WNG	Warning	DO3			DO1	DO3	DO3			
0x08	ZSP	Zero speed detection	DO2	DO2	DO2	DO2	DO2	DO2	DO2	DO2	DO2
0x09	CDMOK	Inner position command output completed		DO3					DO3	DO3	

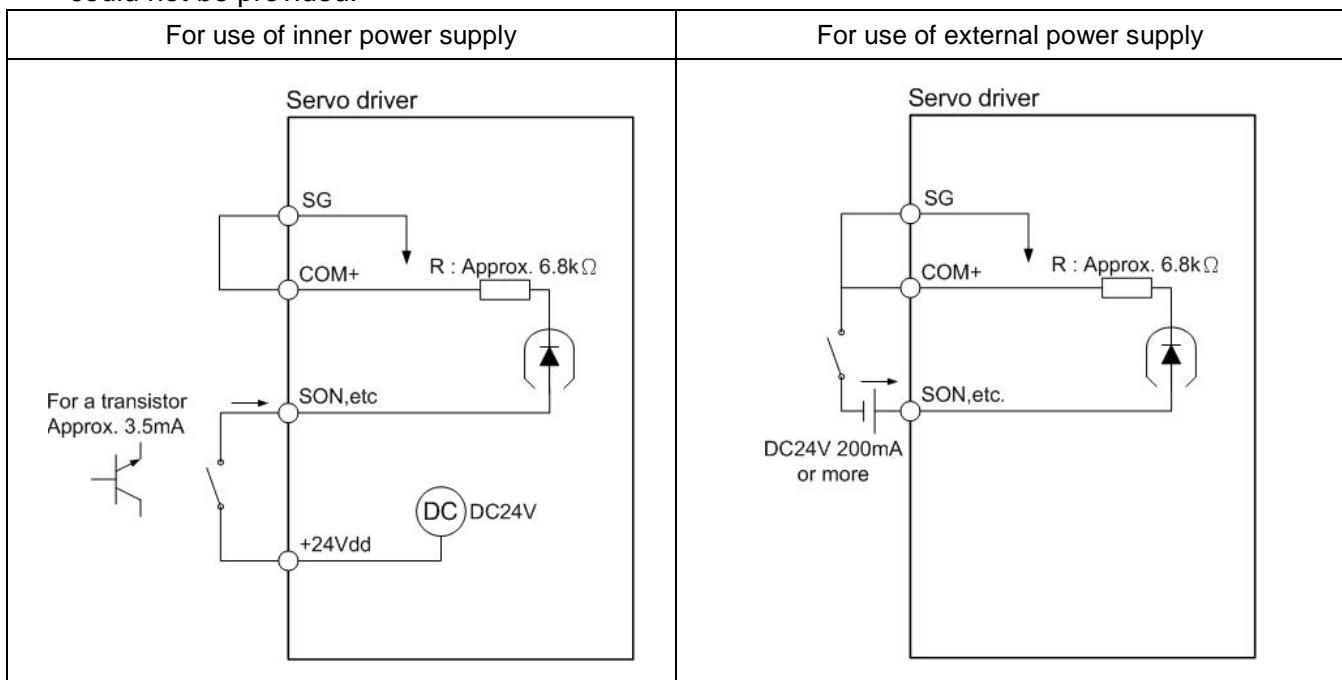
3.3.3. Interface wiring diagram

(1). Digital input interface DI



(2). Source input interface DI

When using the input interface of source type, all DI input signals are of source type. Source output could not be provided.



(3). Digital output interface DO

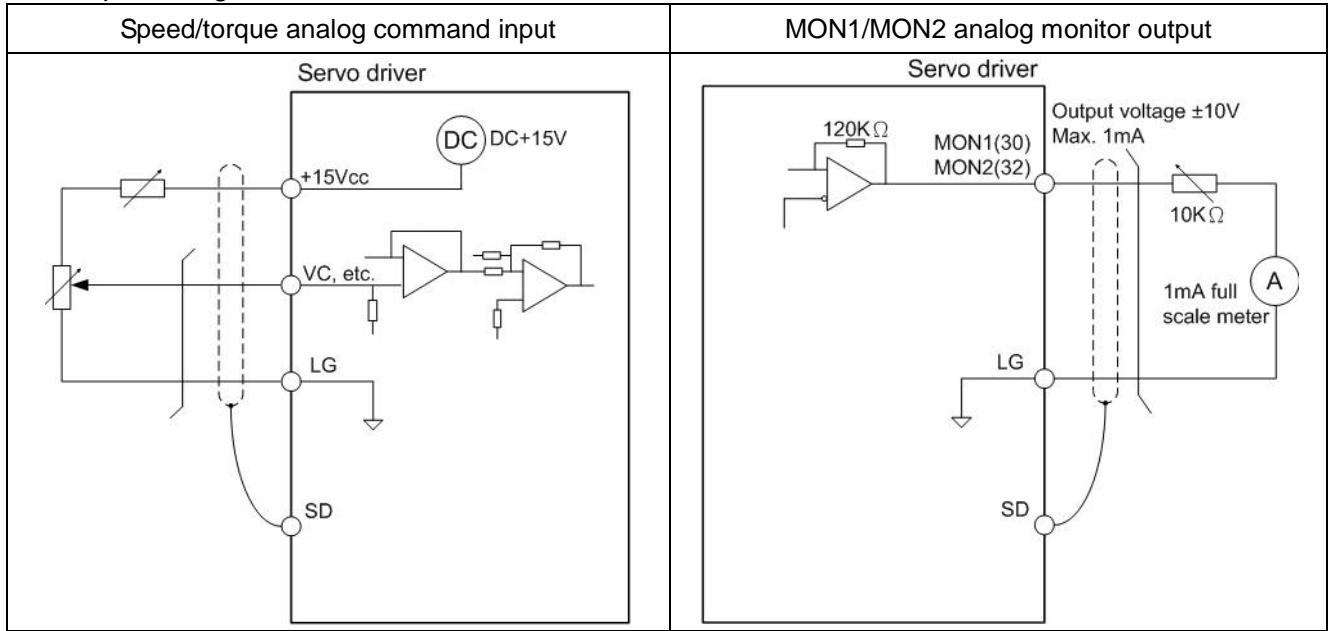
A lamp, relay or photo coupler could be driven. Provide a diode for an relay load, or an inrush current suppressing resistor for a lamp load. (Permissible current: 40mA or less, inrush current: 100mA or less)

Relay load for use of inner power supply	Relay load for use of external power supply
<p>Servo driver</p> <p>DC24V (DC) +24Vdd</p> <p>COM+</p> <p>DOX X=1,2,3,4,5</p> <p>SG</p> <p>If the polarity of diode is wrong, the driver will be damaged.</p>	<p>Servo driver</p> <p>DC24V (DC) +24Vdd</p> <p>COM+</p> <p>DOX X=1,2,3,4,5</p> <p>SG</p> <p>If the polarity of diode is wrong, the driver will be damaged.</p> <p>Do not connect +24Vdd-COM+</p> <p>DC24V</p>
Lamp load for use of inner power supply	Lamp load for use of external power supply
<p>Servo driver</p> <p>DC24V (DC) +24Vdd</p> <p>COM+</p> <p>DOX X=1,2,3,4,5</p> <p>SG</p> <p>R</p> <p>lamp</p>	<p>Servo driver</p> <p>DC24V (DC) +24Vdd</p> <p>COM+</p> <p>DOX X=1,2,3,4,5</p> <p>SG</p> <p>R</p> <p>lamp</p> <p>DC24V</p> <p>Do not connect +24Vdd-COM+</p>

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

Input impedance 10KΩ to 12KΩ.

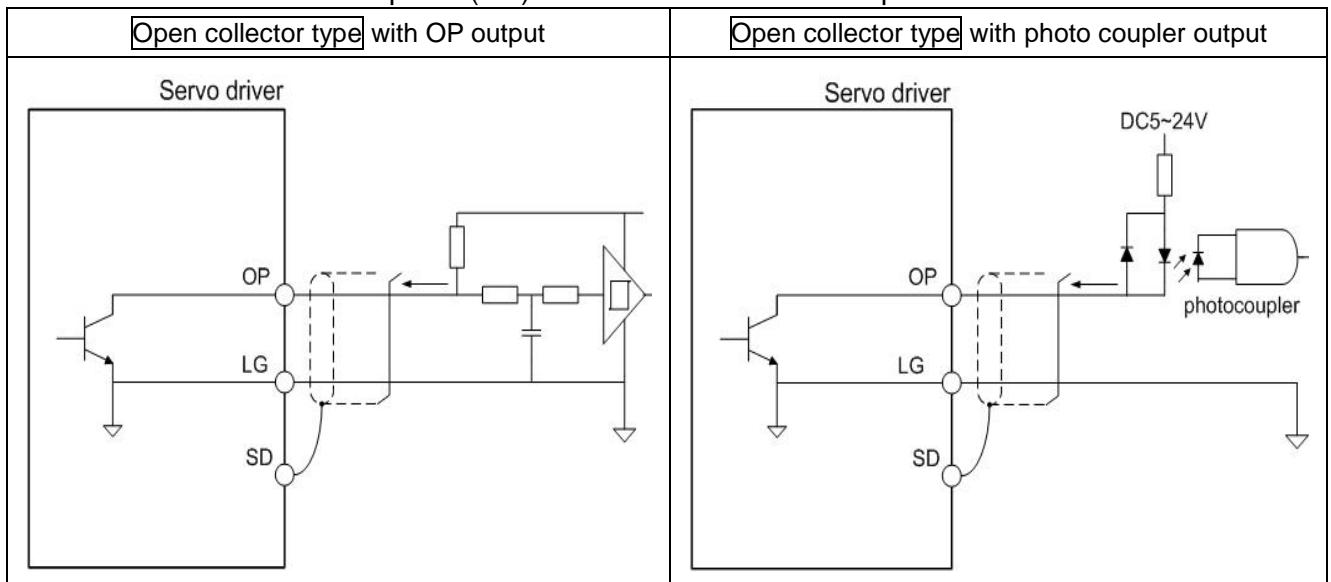
Output voltage $\pm 10V$.



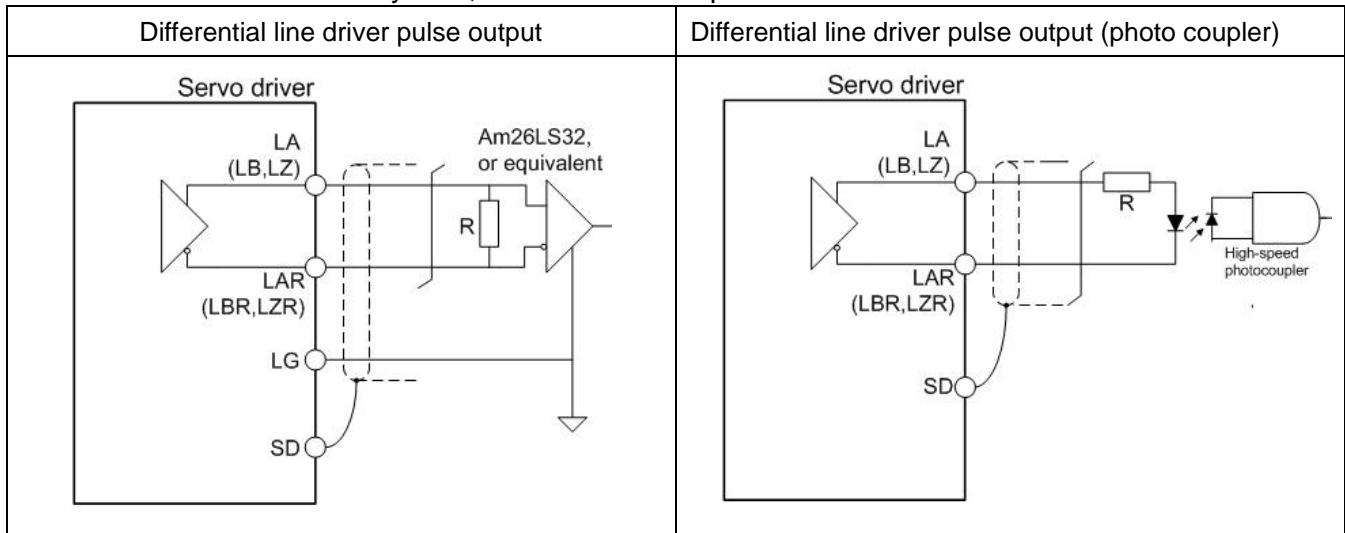
- ★ The maximum tolerance of VC and TC is 10V, a higher voltage would make the transistor inside the driver damaged.

(5). Encoder output pulse

Output a pulse train signal in the open collector or differential line driver type. Open collector output could be obtained via the pin 39(OP) of CN1. The maximum output current is 35mA.

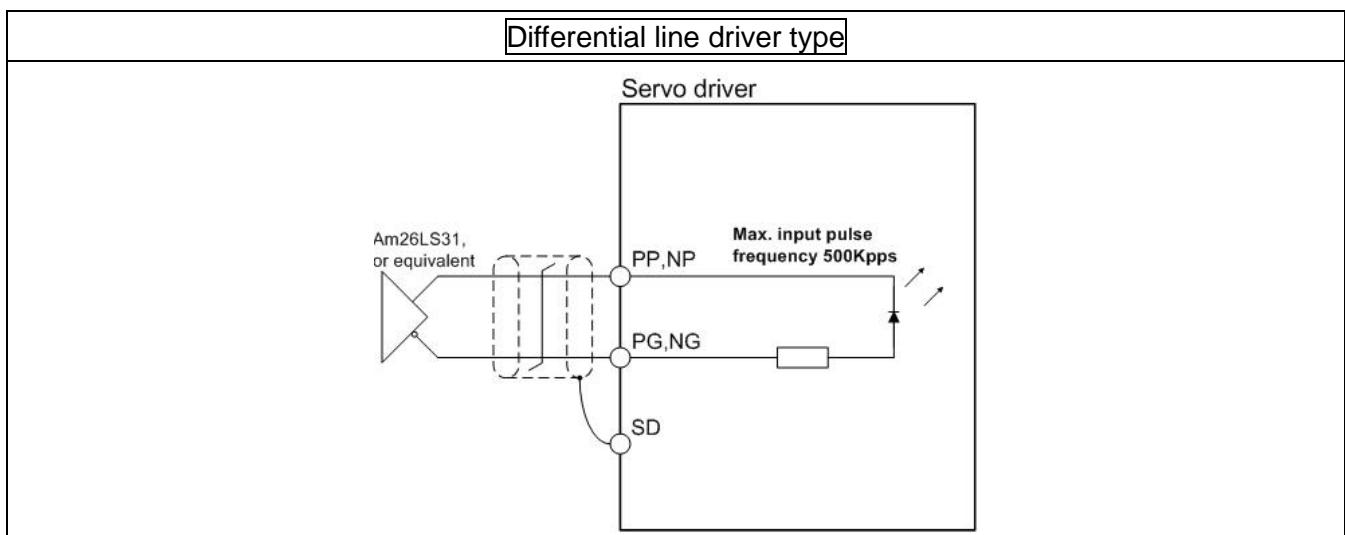
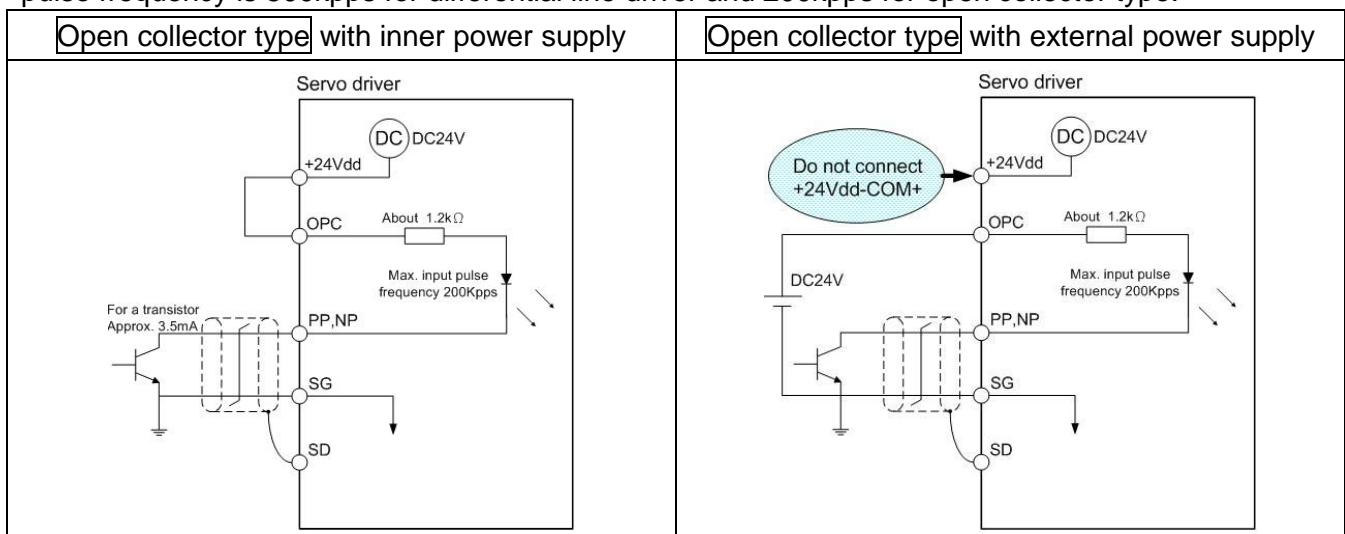


For a differential line driver system, the maximum output current is 20mA.



(6). Forward/reverse rotation pulse train input

Input a pulse train signal in the open collector or differential line driver type. The maximum input pulse frequency is 500kpps for differential line driver and 200kpps for open collector type.



3.3.4. User definition of DI/DO

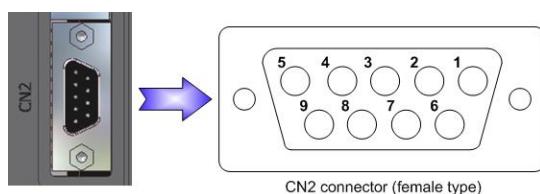
The DI/DO default functions are suitable for position mode. If they are not suitable for user's application, please define the functions of DI/DO again. The functions of DI1 to DI8 are corresponding to the setting of parameters PD02 to PD09. Those DO1 to DO5 are corresponding to the ones of PD10 to PD14. The following table describes the DI/DO pins of CN1 terminal and the relative parameters.

Pin No.	Pin name	Parameter	Pin No.	Pin name	Parameter
CN1_14	DI1	PD02	CN_41	DO1	PD10
CN1_15	DI2	PD03	CN_42	DO2	PD11
CN1_16	DI3	PD04	CN_43	DO3	PD12
CN1_17	DI4	PD05	CN_44	DO4	PD13
CN1_18	DI5	PD06	CN_45	DO5	PD14
CN1_19	DI6	PD07			
CN1_20	DI7	PD08			
CN1_21	DI8	PD09			

3.4. CN2 Encoder signal wiring and description

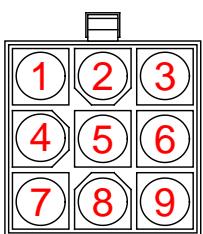
The resolution of Shihlin servo motor encoder is 2500ppr. After the digital signal process of 4 multiplied by the servo driver, that would be increased to 10,000ppr. There are 8 wires for Shihlin servo encoder, which are A,/A,B,/B,Z,/Z,+5V,GND. The appearance of CN2 connector is shown below:

The end of driver

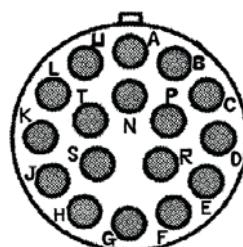


The end of servo motor

Low inertial : (Type A)



Medium inertial : (Type B)



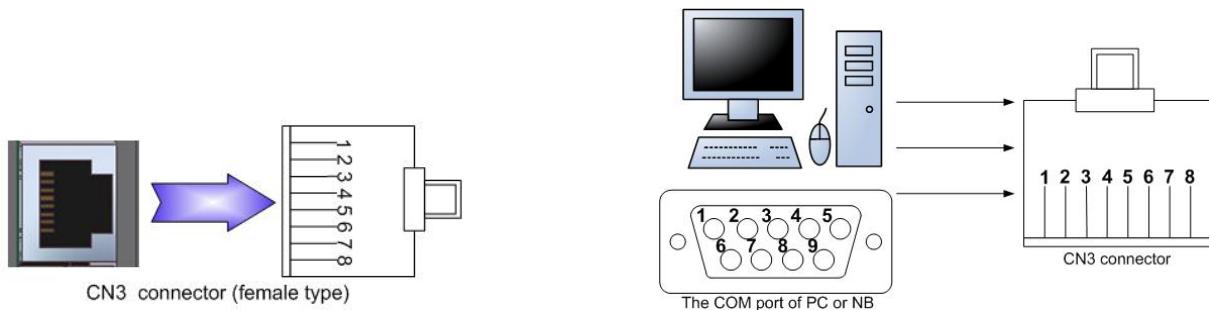
The pin names and descriptions are listed below:

(*): A~/Z input for driver end.

Driver	Type A	Type B	Signal name	Sign	Function description
2	6	H	Phase /Z	/Z	Phase /Z pulse train input/output(*) of encoder
3	5	E	Phase /B	/B	Phase /B pulse train input/output of encoder
4	4	B	Phase /A	/A	Phase /A pulse train input/output of encoder
5	7	S	Power	+5V	+5V power supply for encoder
6	3	G	Phase Z	Z	Phase Z pulse train input/output of encoder
7	2	D	Phase B	B	Phase B pulse train input/output of encoder
8	1	A	Phase A	A	Phase A pulse train input/output of encoder
9	8	P	Ground	GND	power ground
--	9	L	SHIELD	SHIELD	SHIELD

3.5.CN3 communication port signal wiring and description

Shihlin servo driver CN3 port is for RS-232 and RS-485 communication. Via the Shihlin servo software for communication, users could connect it to the computer then set parameters, monitor the status, operate and test, etc. There are 2 format suitable for CN3: RS232 and RS485. Users could select one by setting the parameter PC21. RS-232 format has its maximum communication distance 15m. The other format RS485, it provides a longer communication distance and multiple drivers communication.



Pin NO	Sign	Function description
CN3_2	RS-485-B	Data are transmitted in differential line driver format. Line driver B.
CN3_3	RS-485-A	Data are transmitted in differential line driver format. Line driver A.
CN3_6	RS-232-RX	Data transmission, it is connected to RS-232-TX end of computer.
CN3_7	RS-232-TX	Data receiving, it is connected to RS-232-RX end of computer.
CN3_4, CN3_5	GND	signal ground.



For RS-485 communication, please refer to section 8.1

3.6.CN4 USB communication port

For the plug-and-play usage, Shihlin servo driver provides the USB port (CN4). Similar to RS232 and RS485 of CN3, CN4 in Mini-USB type, users could connect it to the computer then set parameters, monitor the status, operate and test, etc.

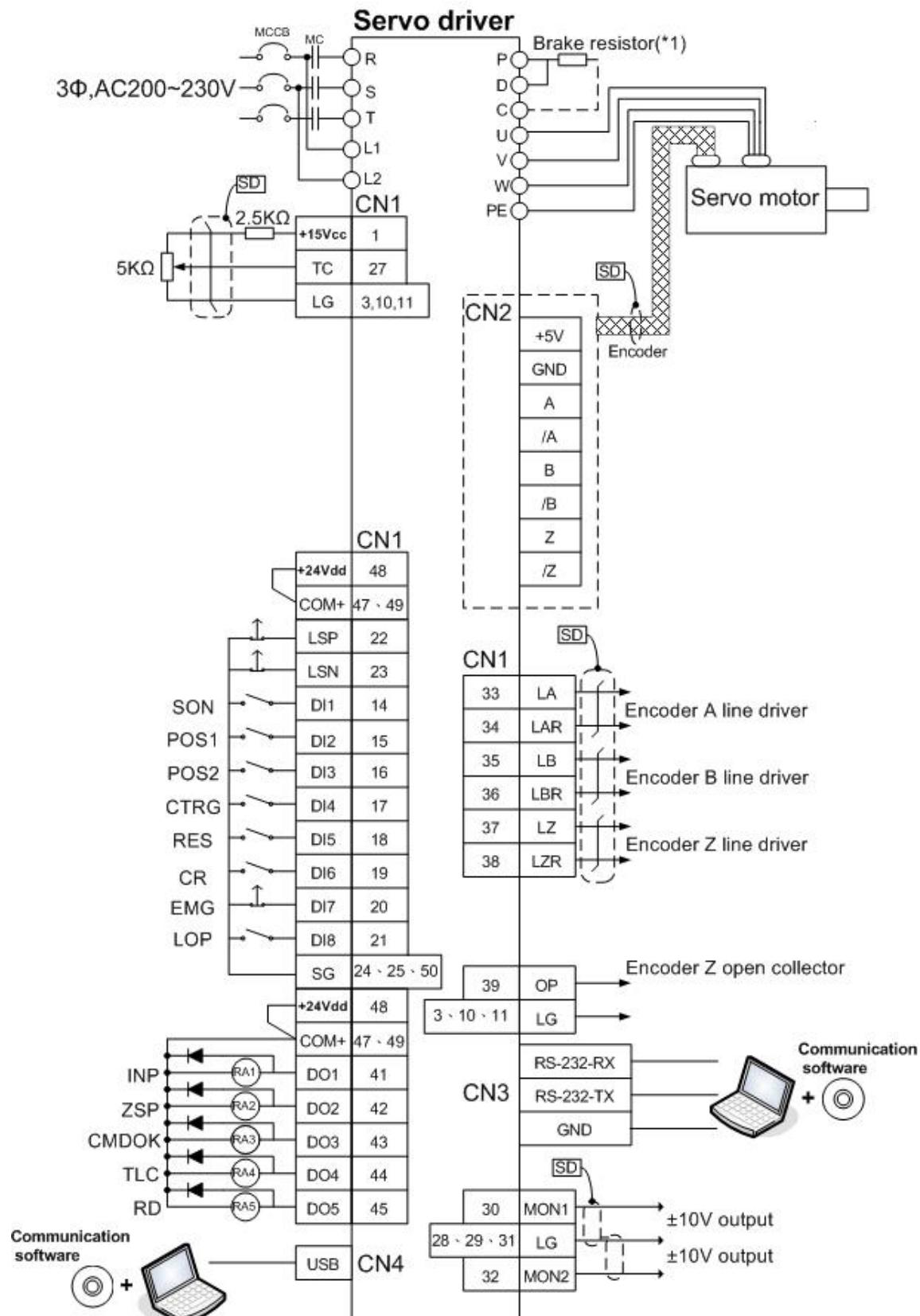


The following table describes the standard terminal specification of mini-USB:

Pin No.	Function description
1	+5V
2	D-
3	D+
4	NC
5	GND

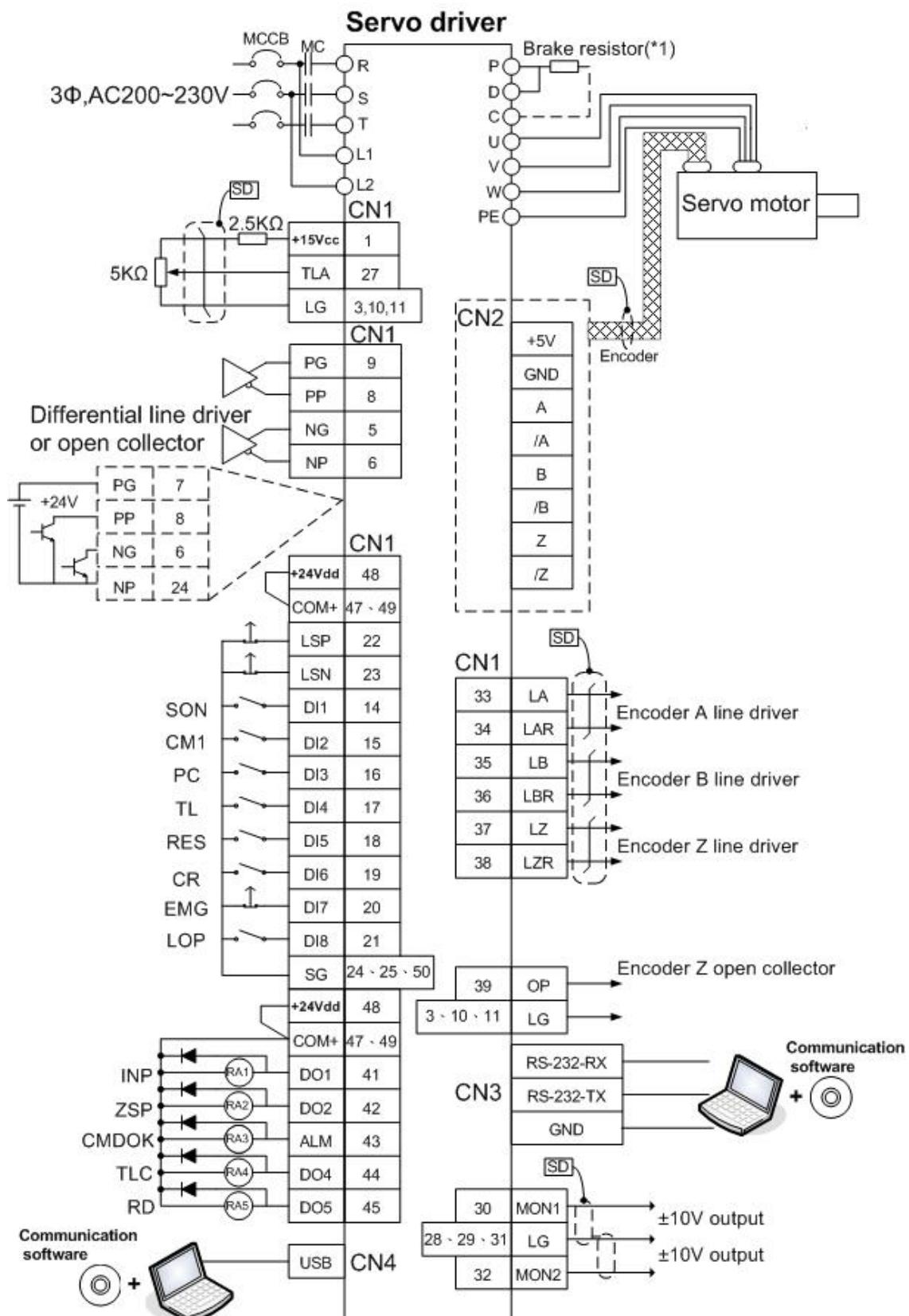
3.7. Standard wiring method

3.7.1. Wiring diagram of position control(Pr Mode)



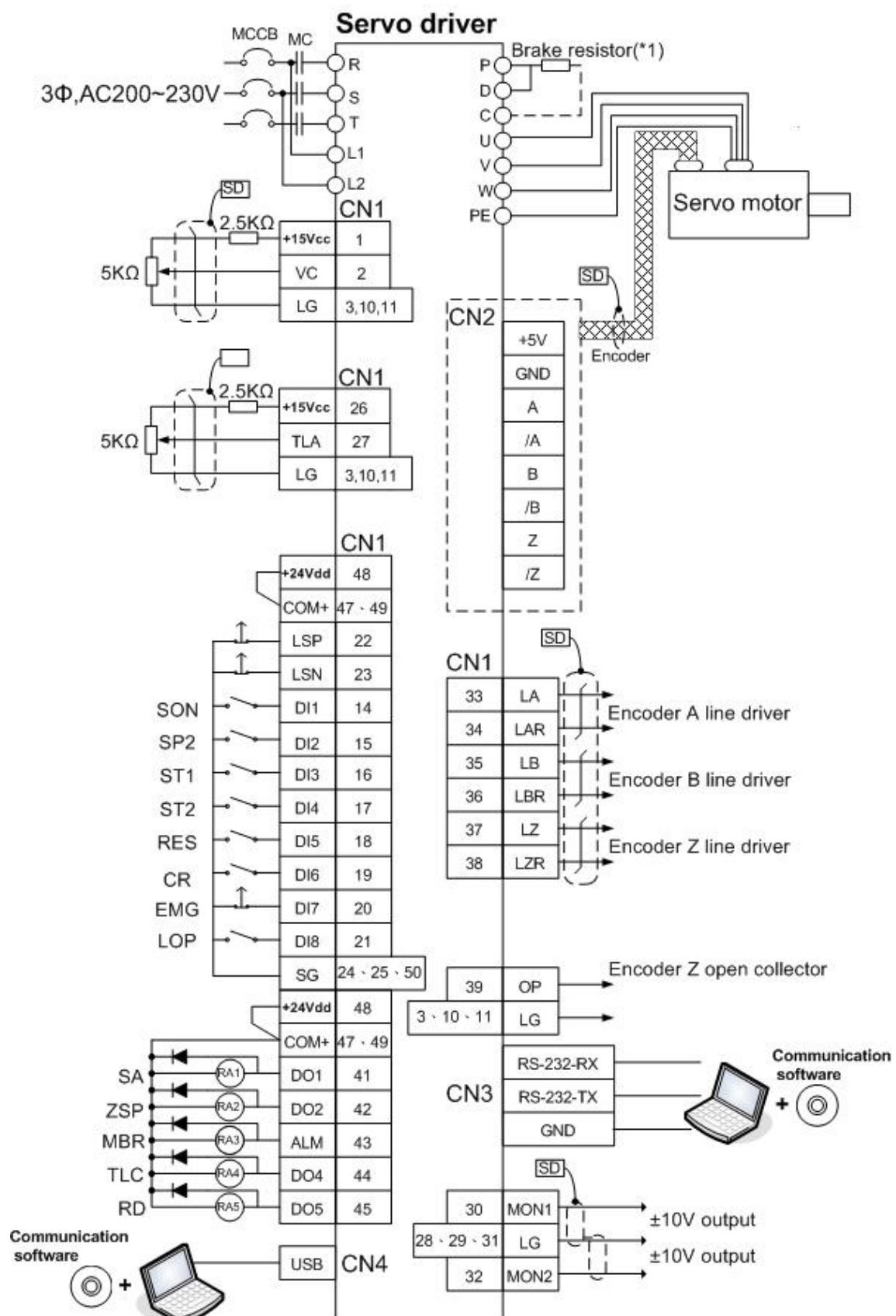
- ◆ Note: 1. If the external power is applied, do not connect +24Vdd and COM+.
- 2. See section 3.1.3 for the wirings of brake resistor.

3.7.2. Wiring diagram of position control(Pt Mode)



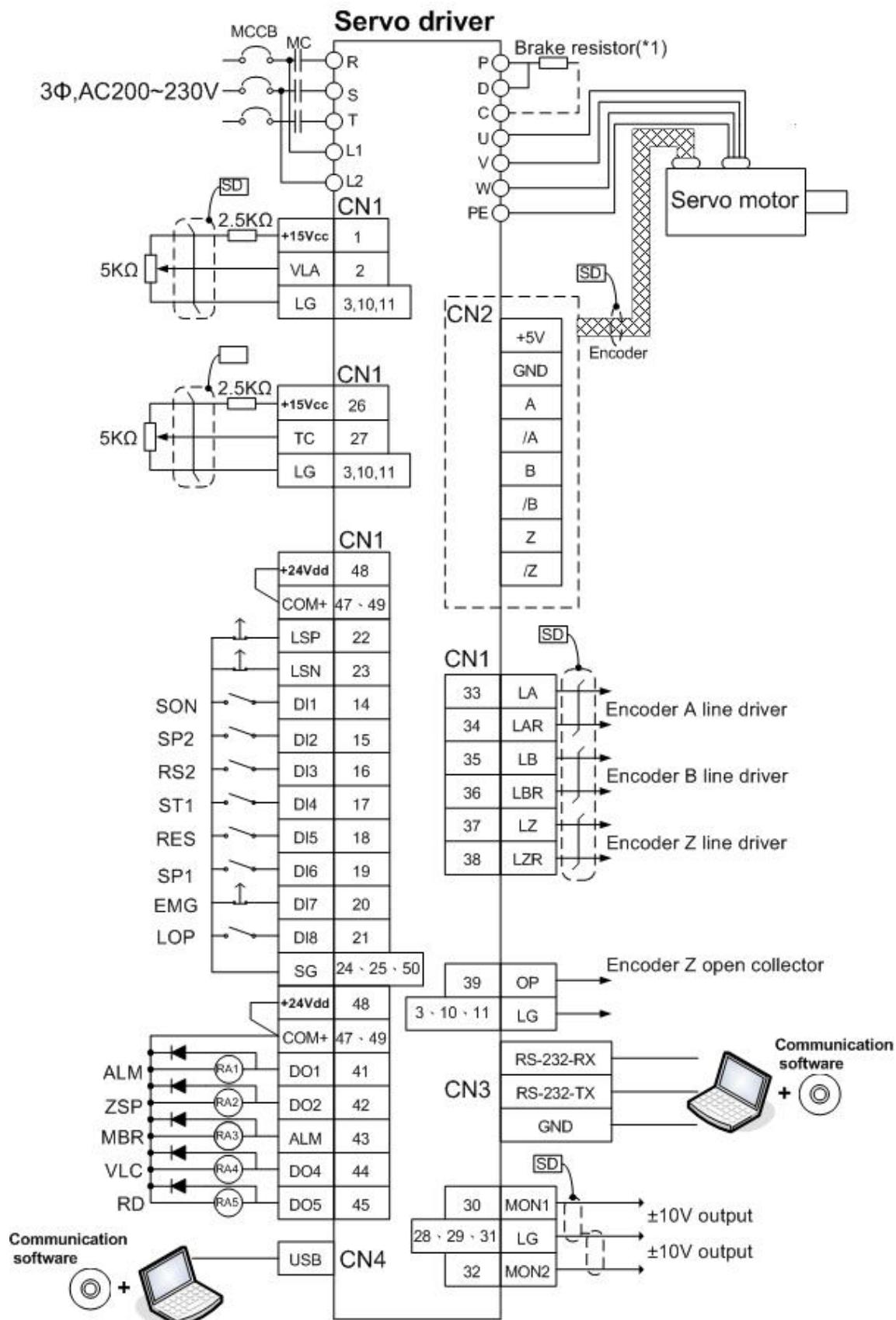
- ◆ Note: 1. If the external power is applied, do not connect +24Vdd and COM+.
- 2. See section 3.1.3 for the wirings of brake resistor.

3.7.3. Wiring diagram of speed control(S Mode)



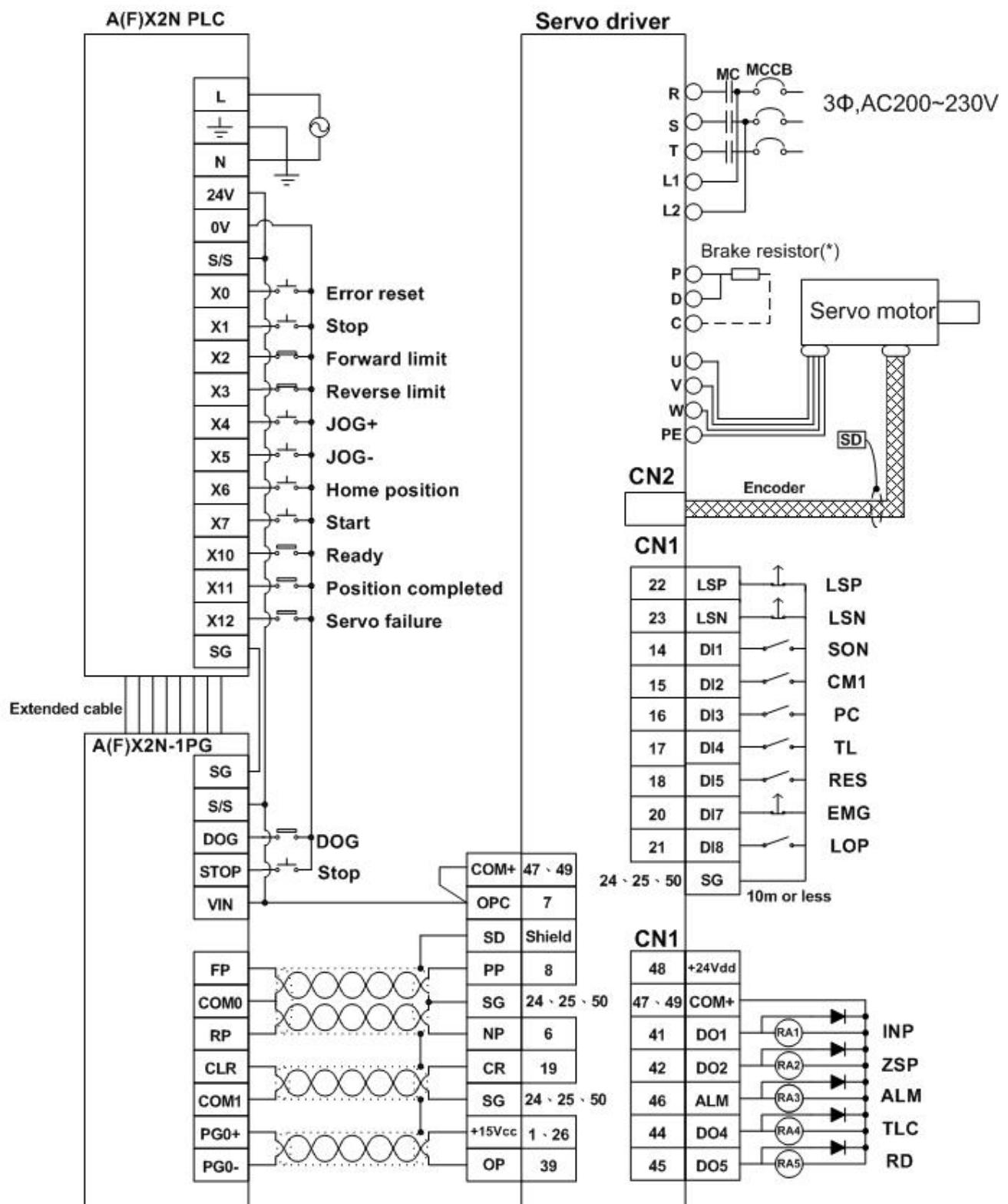
- ◆ Note: 1. If the external power is applied, do not connect +24Vdd and COM+.
- 2. See section 3.1.3 for the wirings of brake resistor.

3.7.4. Wiring diagram of torque control(T Mode)

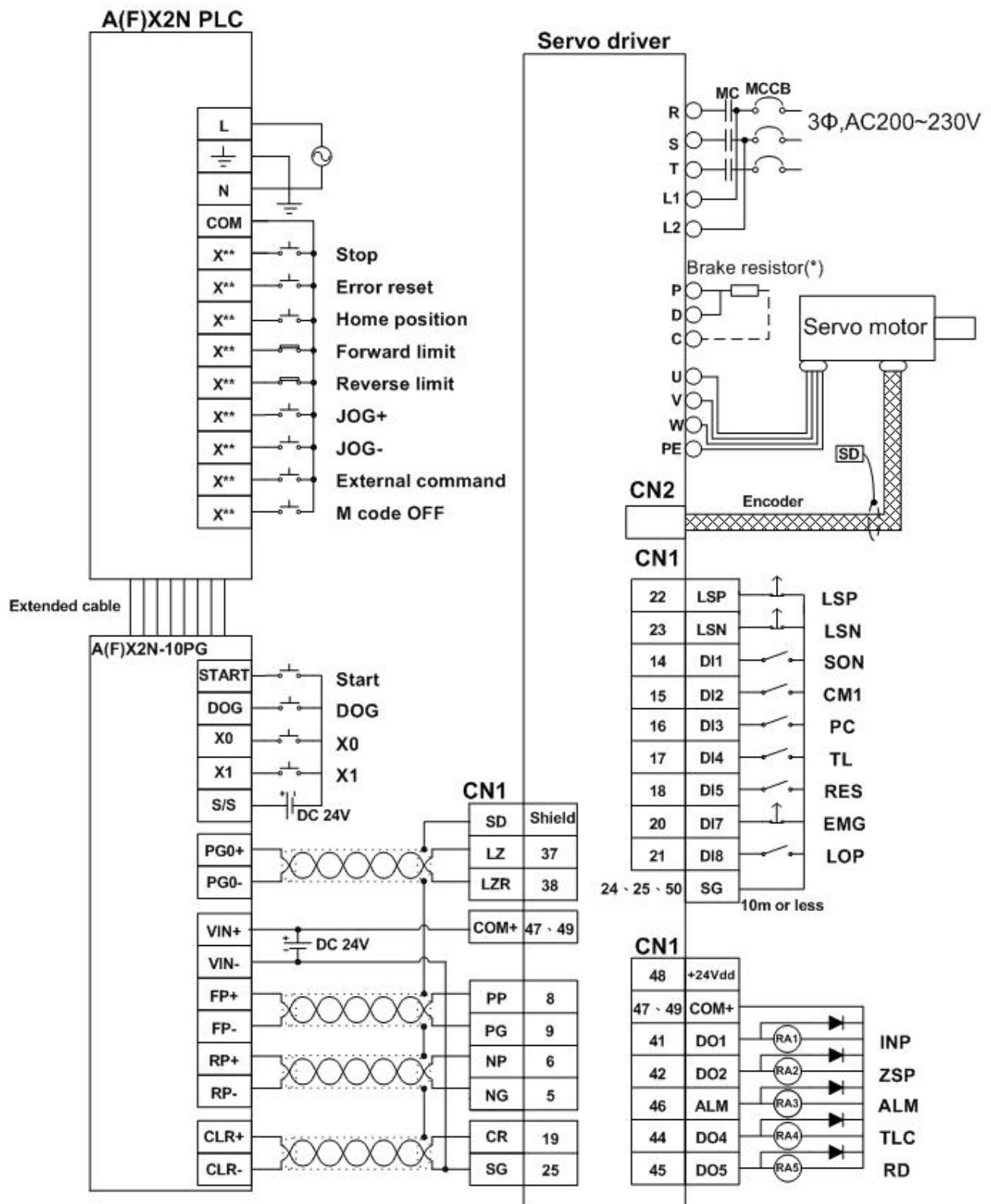


◆ Note: 1. If the external power is applied, do not connect +24Vdd and COM+.
2. See section 3.1.3 for the wirings of brake resistor.

3.7.5. Wiring diagram with 1PG



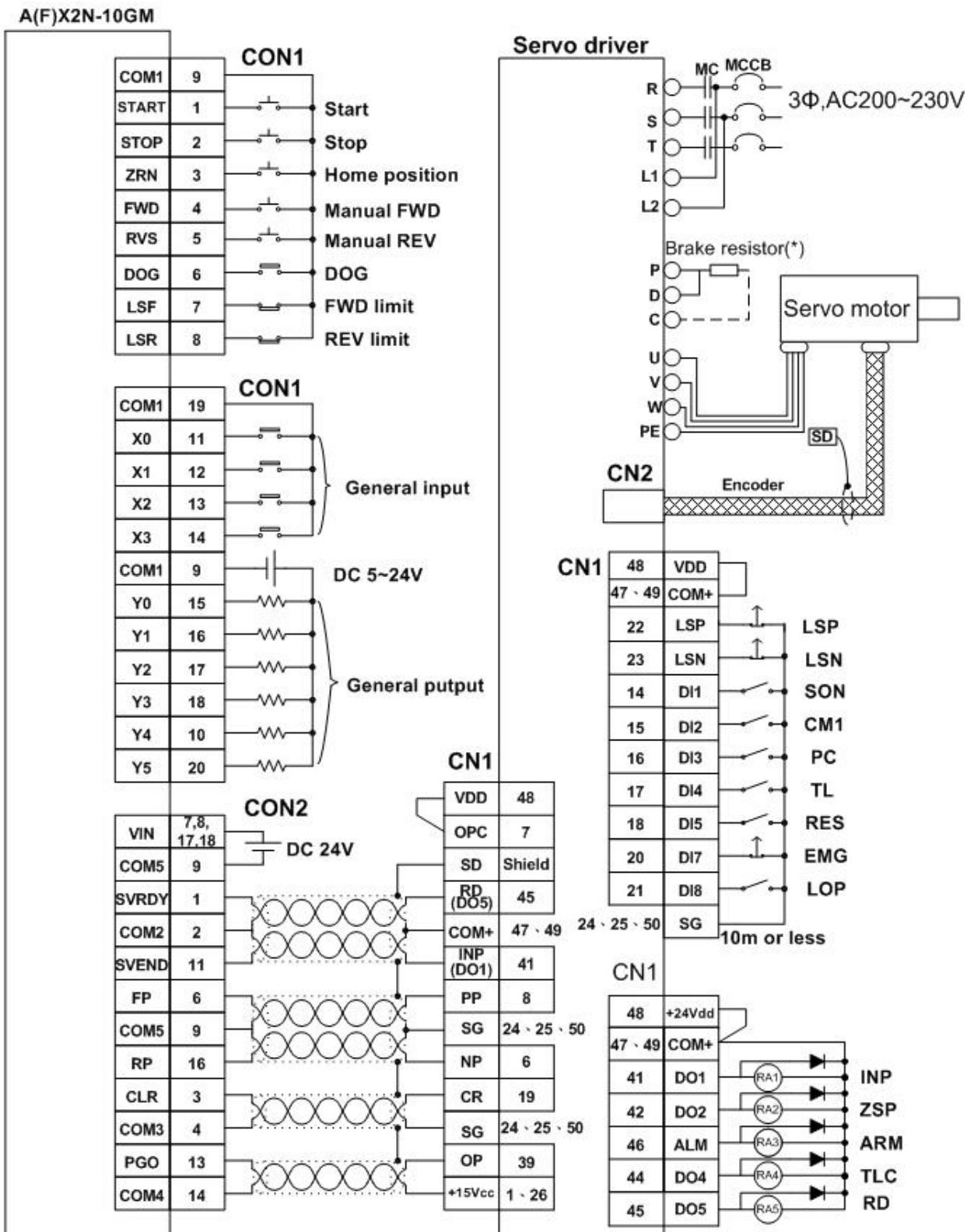
3.7.6. Wiring diagram with 10PG



※1. If DC24V is from PLC, do not connect +24Vdd and COM+.

※2. A(F)X2N-10G default type is negative logic, forward/reverse rotation pulse train. The PA13 should be set as 0010h.
※3. See section 3.1.3 for the wirings of brake resistor.

3.7.7. Wiring diagram with 10GM

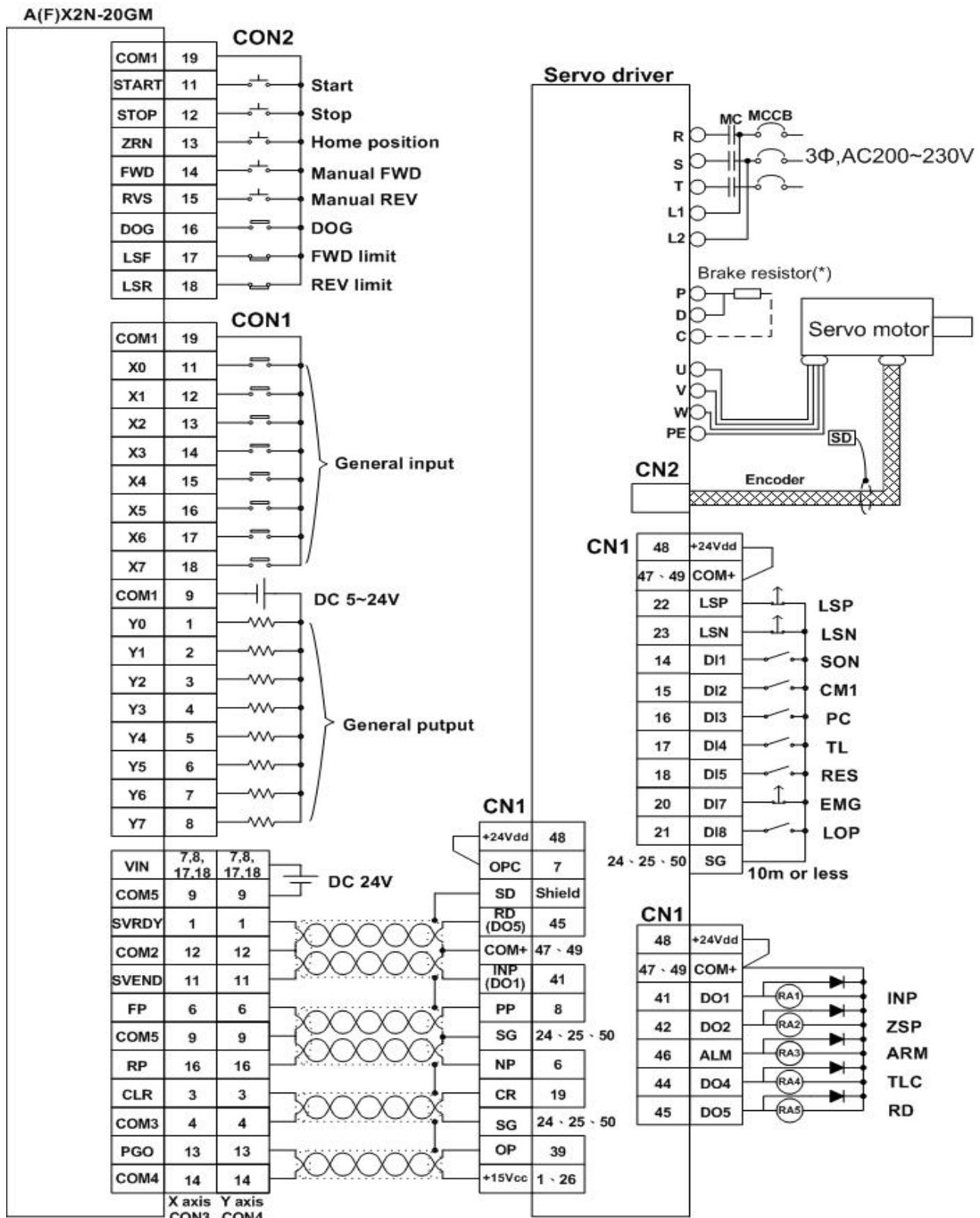


*1. If DC24V is from , do not connect +24Vdd and COM+.

*2. A(F)X2N-10GM default type is negative logic, forward/reverse rotation pulse train. The PA13 should be as 0010h.

*3. See section 3.1.3 for the wirings of brake resistor..

3.7.8. Wiring diagram with 20GM

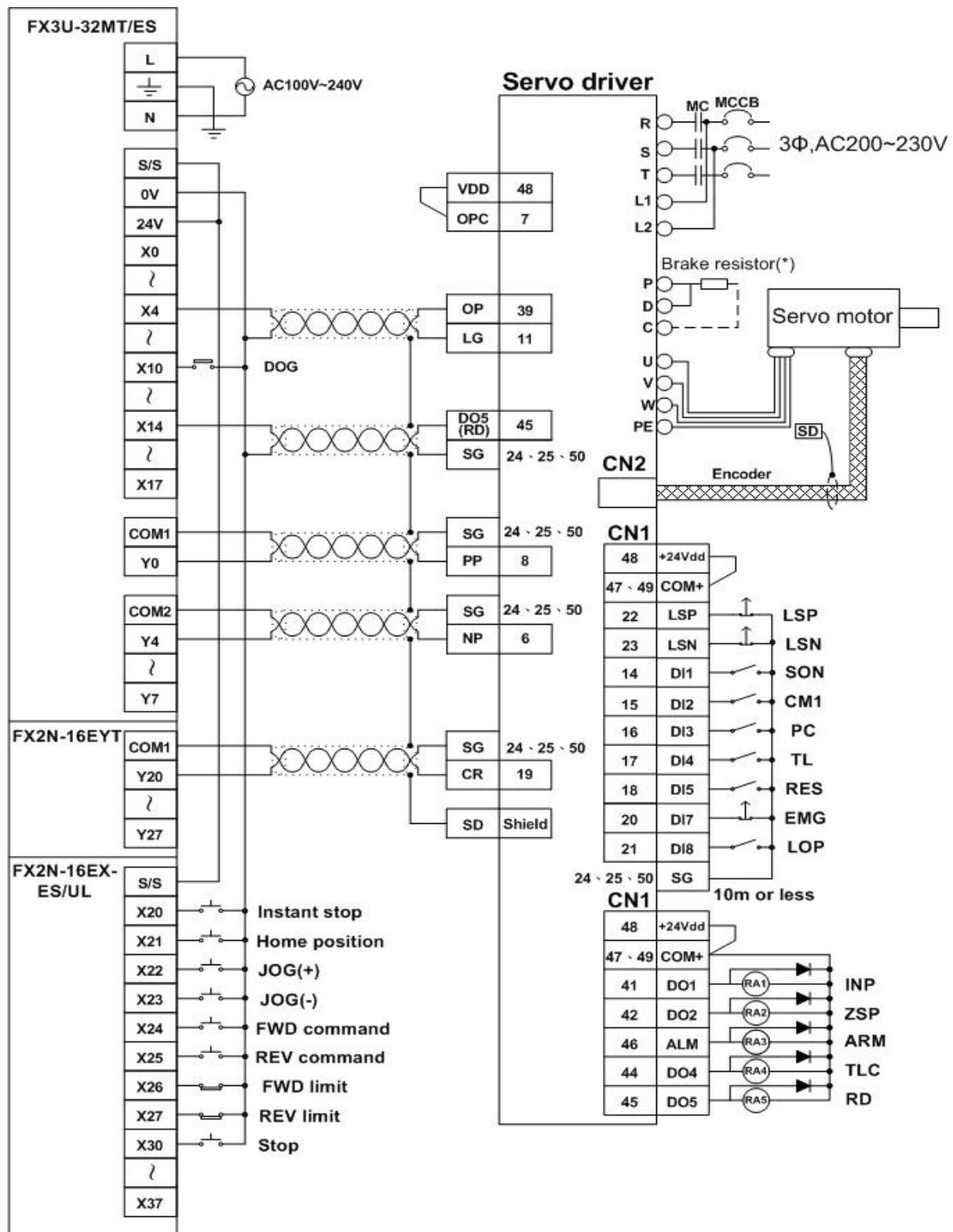


*1. If DC24V is from PLC, do not connect +24Vdd and COM+.

*2. A(F)X2N-20GM default type is negative logic, forward/reverse rotation pulse train. The PA13 should be as 0010h.

*3. See section 3.1.3 for the wirings of brake resistor.

3.7.9. Wiring diagram with FX3U

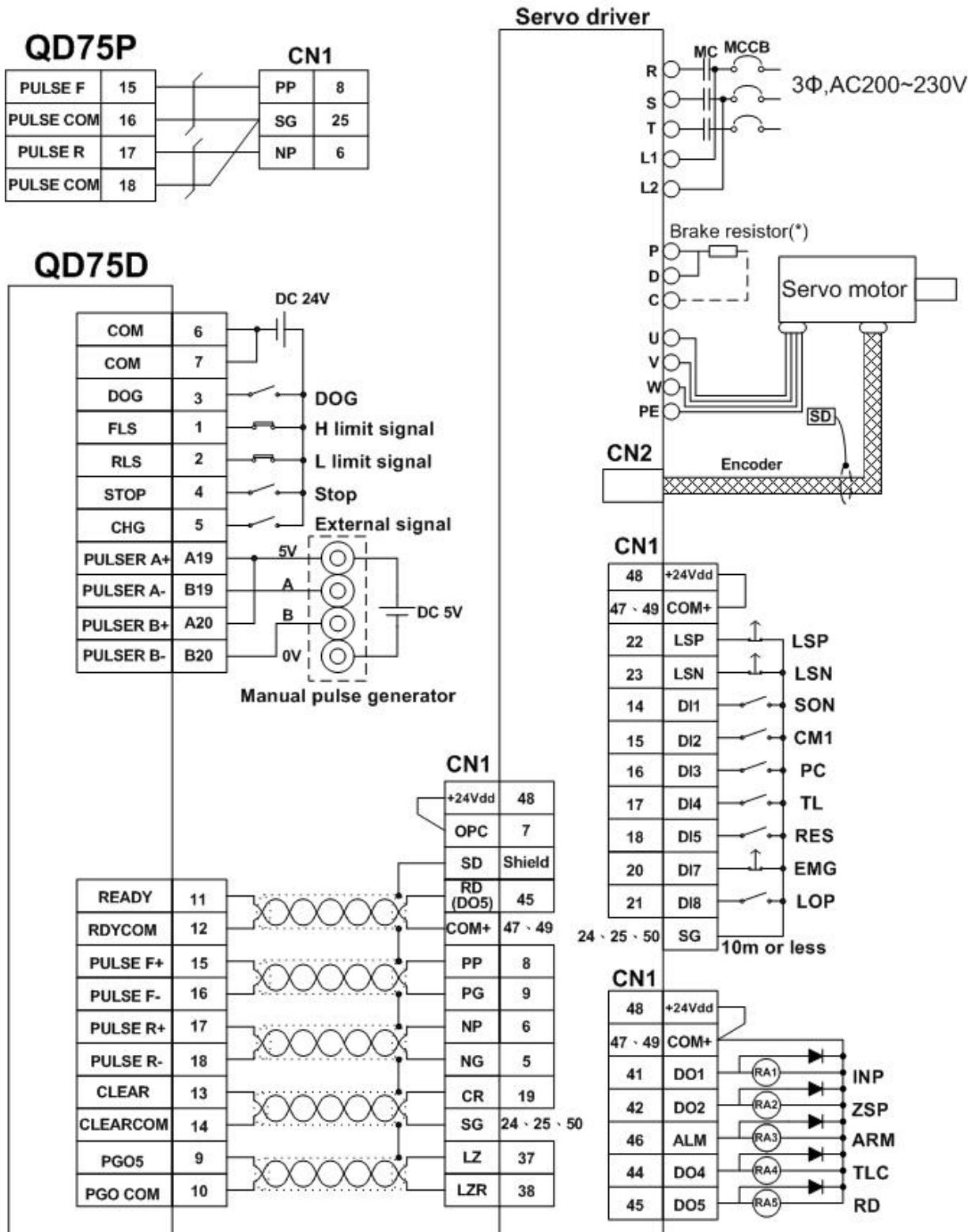


*1. If DC24V is from PLC, do not connect +24Vdd and COM+.

*2. FX3U-MT default pulse command type is negative logic, pulse train + sign. The PA13 should be set as 0011h. (A(F)X-1N/2N-MT and FX3G-MT are in the same description mentioned above.)

*3. See section 3.1.3 for the wirings of brake resistor.

3.7.10. Wiring diagram with QD75



*1. If DC24V is from PLC, do not connect +24Vdd and COM+.

*2. AS QD75D/QD75P default pulse command type is used, the PA13 should be set as 0000h.

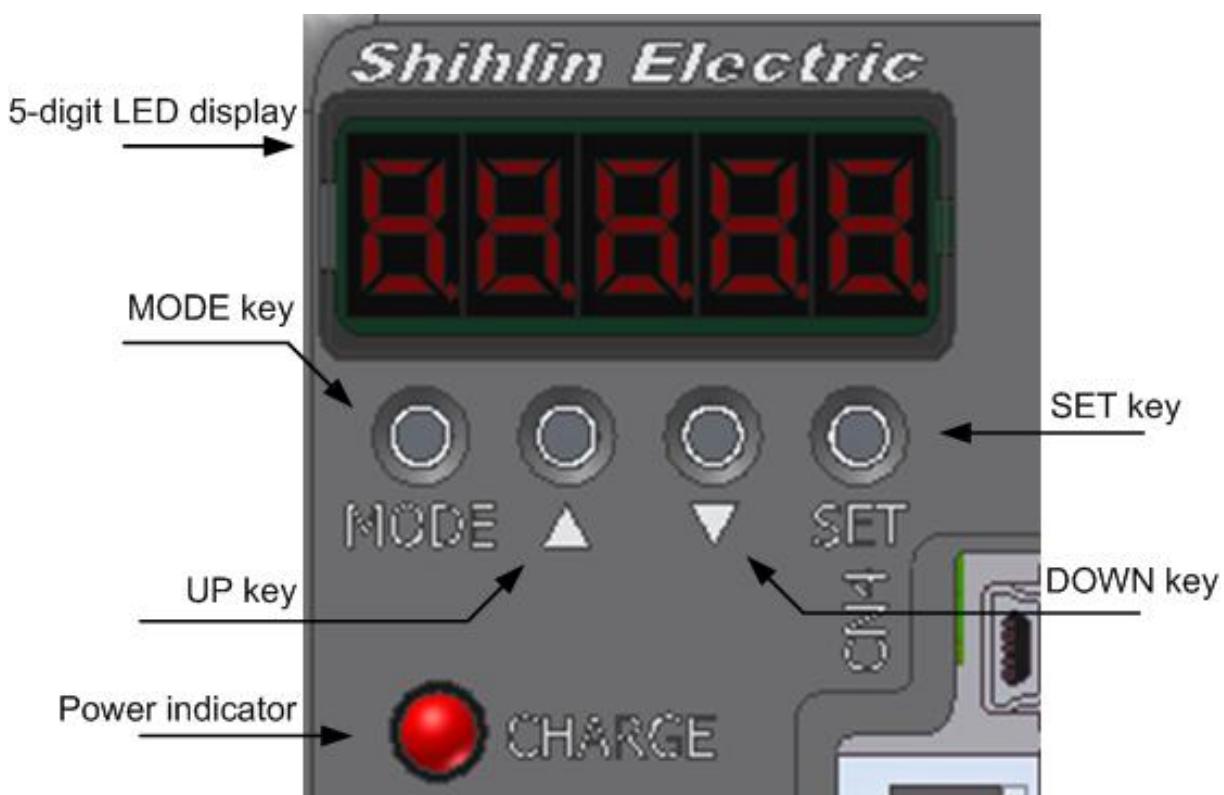
*3. When QD75D is applied, OPC is without providing power.

*4. See section 3.1.3 for the wirings of brake resistor.

4. Panel display and operation

This chapter describes the conditions of Shihlin servo driver's panel and all operation.

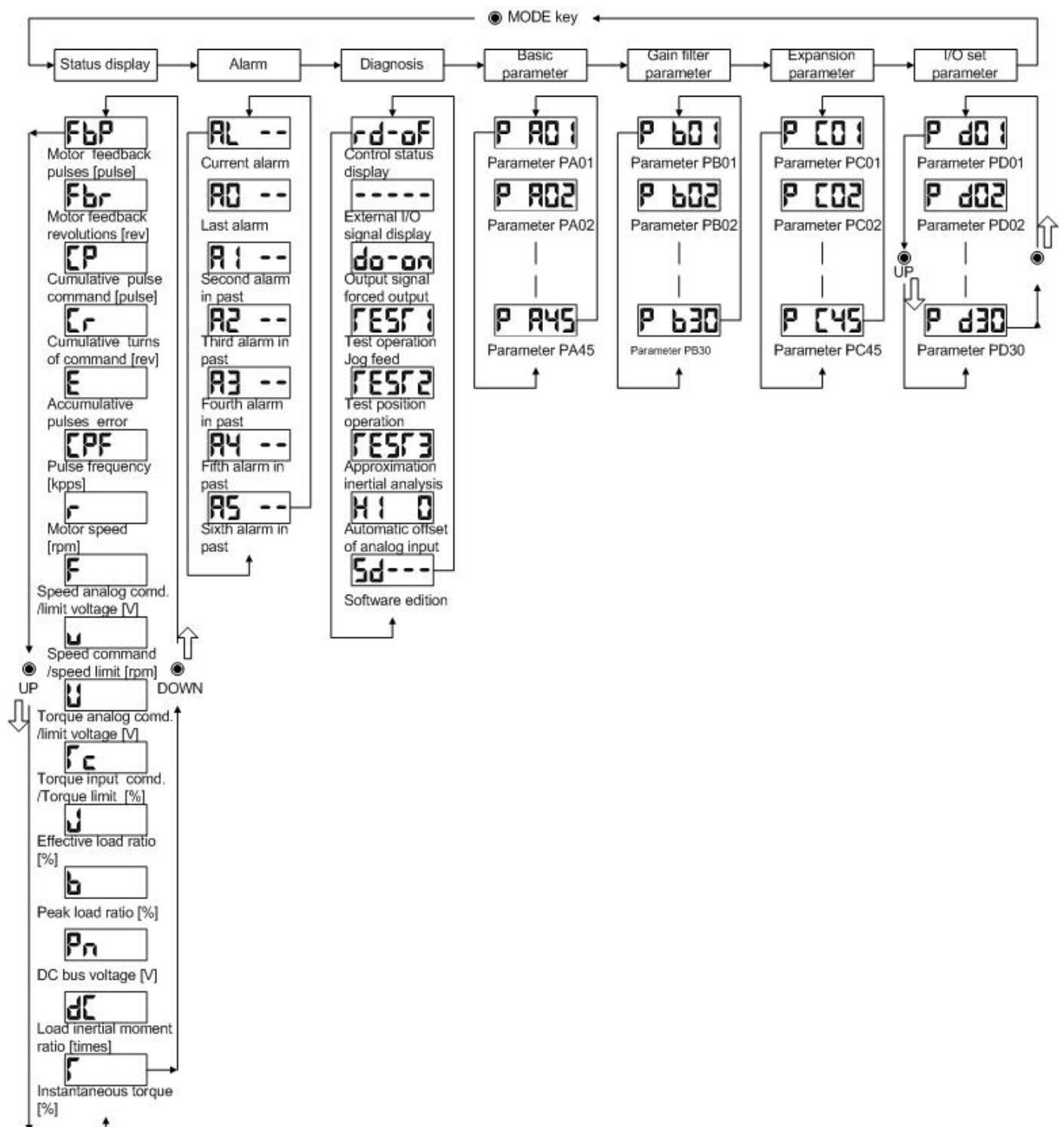
4.1. Panel components



Name	Function description
5-digit LED display	This display with 7-segment LED of 5 digits, is used to monitor the states of servo and the value of parameters, and set modification value.
MODE key	To switch one display mode to the others. Shihlin servo driver has parameter display mode, alarm history mode, status monitor mode, etc.
UP Key	1. To increase the value which denoted parameter or set value. 2. To move to the next screen as this key is pushed once.
DOWN key	1. To decrease the value which denoted parameter or set value. 2. To move to the last screen as this key is pushed once.
SET key	To show or save the value which is operated.
Power indicator	To indicate the power status.

4.2. Display flowchart

Use the display on the front side of servo driver for status display, parameter setting, etc. Set the parameter before operation, diagnose an alarm, confirm external sequences, and confirm the operation status. To refer to or set the expansion parameter, make them valid with PA42.

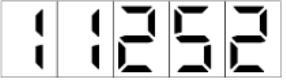


4.3.Status display

- ◆ The operation status of Shihlin servo could be displayed on the 5-digit LED display.
- ◆ Press the “UP” or “DOWN” key to change the display data as desired.
- ◆ When the required data is selected, the corresponding symbol appears. Press the “SET” key to display the information.
- ◆ The status display shows the lower 5 digits of 18 items such as the servo motor speed.
- ◆ A negative value which occupies 5 digits is displayed by the 5 lit decimal points. If a negative value which occupies only 4 digits or less, the negative symbol “-“ is displayed at the highest digit.

□ Examples

The following table lists the display examples:

Item	Status	Display device
		5-digit LED
Motor rotation speed	Forward rotation at 2500r/min	
	Reverse rotation at 3000r/min	
The ratio of load inertial to motor shaft	15.5 times	
Motor feedback revolution	11252 turns	
	-12566 turns	
parameter setting accomplished	a successful EEPROM write-in	
parameter setting failed	a failed EEPROM write-in	

List of status display

The servo statuses which may be shown are listed in the following table:

Status display	Sign	unit	Description	Range
Motor feedback pulses (absolute value)	FbP	pulse	Feedback pulses from the motor encoder are counted and displayed.(cumulated value)	-9999~9999
Motor feedback revolutions (absolute value)	Fbr	rev	Feedback revolutions from the motor encoder are counted and displayed.(cumulated value)	-32767~32767
Cumulative pulses of command	CP	pulse	The external command pulses are counted and displayed.	-9999~9999
Cumulative turns of command	Cr	rev	The external command turns are counted and displayed.	-32767~32767
Accumulative pulses error	E	pulse	The difference between command pulses and motor feedback pulses.	-32767~32767
Command pulse frequency	CPF	kHz	The frequency of external command pulse is displayed.	-800~800
Motor speed	r	rpm	The speed of servo motor is displayed.	-6000~6000
Speed analog command /limit voltage	F	V	Speed control mode: Speed analog command voltage is displayed. Torque control mode: Speed analog limit voltage is displayed.	-10.00~+10.00
Speed input command/limit	V	rpm	Speed control mode: Speed input command is displayed. Torque control mode: Speed input limit is displayed.	-6000~6000
Torque analog command /limit voltage	U	V	Position control mode, speed control mode: Torque analog limit voltage(TLA) is displayed. Torque control mode: Torque analog command voltage is displayed.	0 ~ +10.00 -10.00~10.00
Torque input command/limit	TC	%	Position control mode, speed control mode: Torque input limit is displayed in percentage. Torque control mode: Torque command is displayed in percentage.	0~300 -300~300
Effective load ratio	J	%	The continuous and effective load torque is displayed relative to the rated torque of 100%.	0~300
Peak load ratio	b	%	The highest value in the past 15 seconds is displayed relative to the rated torque of 100%.	0~300

Status display	Sign	unit	Description	Range
DC bus voltage	Pn	V	The P-N voltage of main circuit is displayed. “Lo-dC” is shown if it less than normal value.	0~500
The ratio of load inertial to motor shaft	dC	times	The ratio of load inertial to motor shaft is displayed.	0.0~300.0
Instantaneous torque	T	%	The Instantaneous torque value is displayed relative to the rated torque of 100%..	0~100

Changing the status display screen

Changing the parameter PA01, the status item of the servo driver at power on could be changed. The item displayed in the initial status changes with the control mode as follows:

Control mode	Status display at power on
Position	Motor feedback pulses
Position/speed	Motor feedback pulses/ Motor speed
Speed	Motor speed
Speed/torque	Motor speed / Torque analog command voltage
Torque	Torque analog command voltage
Torque/position	Torque analog command voltage / Motor feedback pulses

4.4. Alarm display

It displays the current alarm and the alarm history record.

The lower two digits display the abnormal alarm number which has occurred.

Name	Display	Description
Current alarm		No alarm occurred.
		Over voltage(AL 01) occurred, the screen flickers synchronously.
Alarm history		Indicates that the last alarm is over voltage(AL 01).
		Indicates that the 2nd alarm in the past is low voltage(AL 02).
		Indicates that the 3rd alarm in the past is over current(AL 03).
		Indicates that the 4th alarm in the past is regenerative error(AL 03).
		Indicates that the 5th alarm in the past is over load(AL 05).
		Indicates that the 6th alarm in the past is over speed(AL 06).

Functions when abnormal alarm occurred:

- A. Any mode screen could display the current alarm.
- B. The other screen could be read during the occurrence of an alarm.
- C. Remove the cause of the alarm and clear it by one of the following methods:
 - (a) Switch the power OFF, then ON.
 - (b) Press the “SET” key on the current alarm screen.
 - (c) Turn on the abnormal alarm reset signal (RES).
- A. D. Move to the next record by pressing “UP” or “DOWN”.

4.5. Diagnostic display

The following table provides information related to the operation of diagnostic display:

Name	Display	Description
Control status		Not ready yet. The driver is being initialized or an alarm has occurred.
		Ready. Initialization completed; ready for operation.
External I/O signal display		Indicates the ON/OFF states of the external I/O signals. The upper segments correspond to the input signals and the lower ones to the output signals. The I/O signals could be changed by the modification of PD02~PD09.
Output signal forced output		Digital output signals could force ON/OFF. For more information, refer to Section 4.5.2.
JOG test		JOG test could be executed as no command from the external command device. For details, refer to section 5.2.1.
Positioning test		Positioning test could be executed once when there is no command from the external command device. The PC communication software via RS-232/USB is required. This operation could not be performed from the display panel.
Inertia estimation		This operation could be executed once when there is no command from the external command device. The PC communication software via RS-232/USB is required. This operation cannot be performed from the display panel.
Automatic offset of analog input		If offset voltages in the analog circuits inside and outside the driver cause the motor to rotate slowly at the speed analog command or speed analog limit of 0V, this function automatically makes zero-adjustment of offset voltages. When using this function, the parameter PC26 would be automatically adjusted to the offset voltage. Please follow the steps to operate: (1). Press the "SET" key once. (2). Press the "UP" or "DOWN" key and select 1. (3). Press the "SET" key.
Software version		Indicates the software version of the driver.

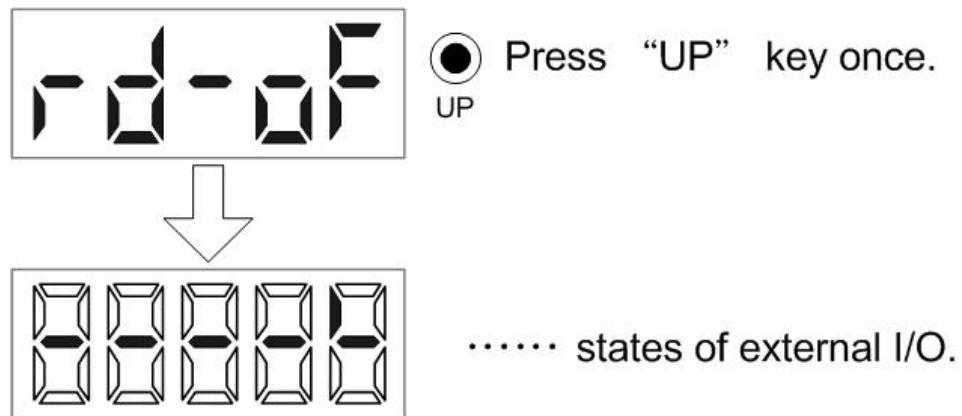
The applications of diagnostic display are described below:

4.5.1. Indication of external I/O signals

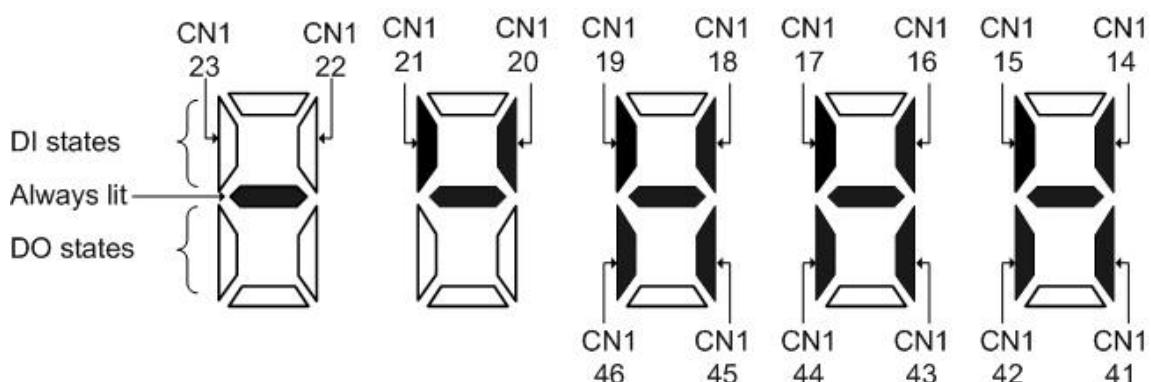
This display is used to verify the ON/OFF states of digital I/O signals connected to the driver.

(1) Operation

Call the display screen after power on. Press the “MODE” key to show the diagnostic screen:



(2) The display of I/O pin definition



The 5-digit 7-segment LED shown above indicates the ON/OFF states of DI and DO.

The top segments indicate the input signals and the bottom segments indicate the output signal.

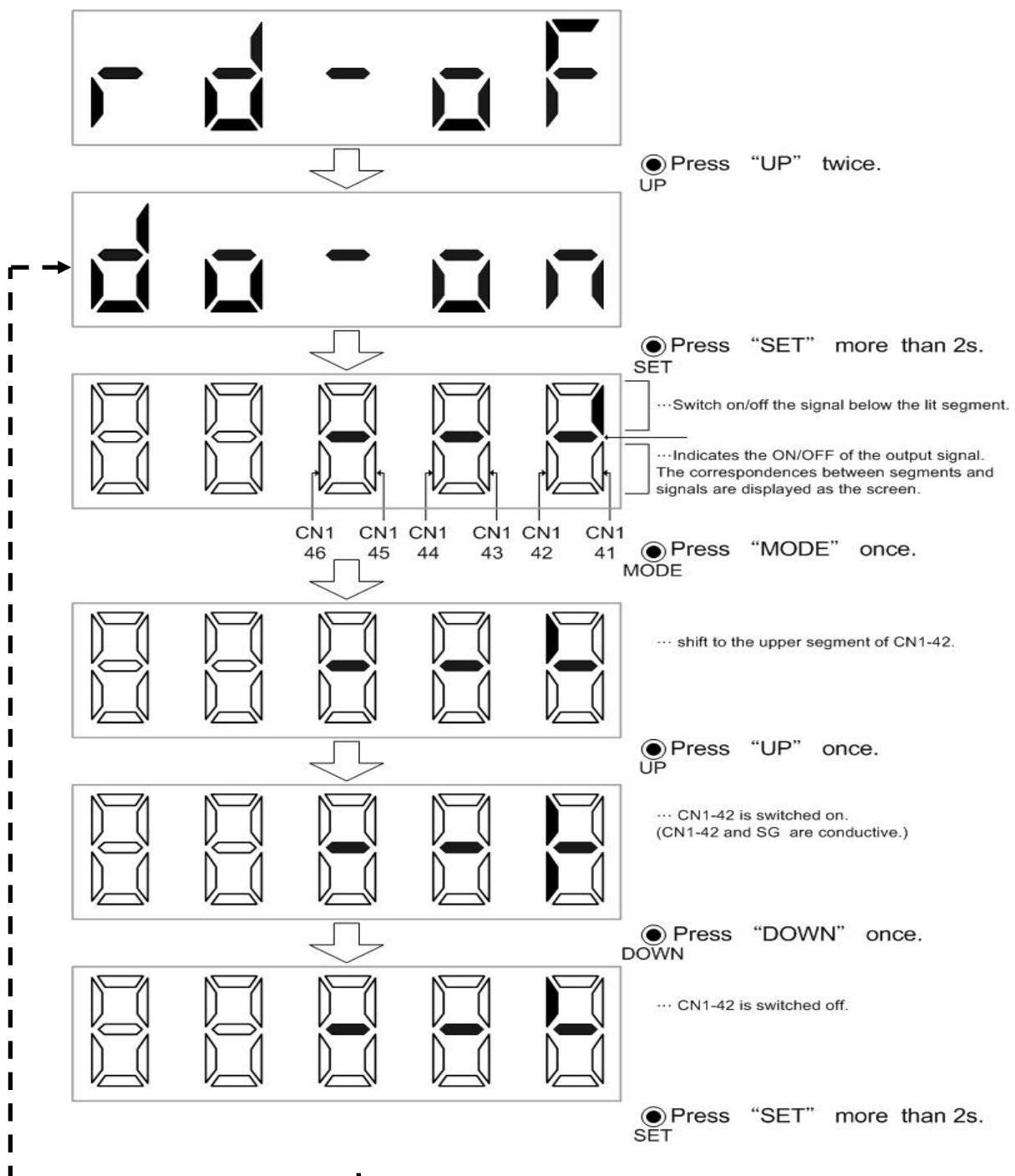
4.5.2. DO forced output

The output signals could be forced on/off and do not affect the status of the servo driver. This function is used for output signal wiring check, etc.

- ★ As no external command nor any alarm occurred, DO forced output operation could be executed.
- ★ Do not execute this operation until the driver turned off (SON signal off).

Operation

Call the display screen after power on. Press the “MODE” key to show the diagnostic screen:

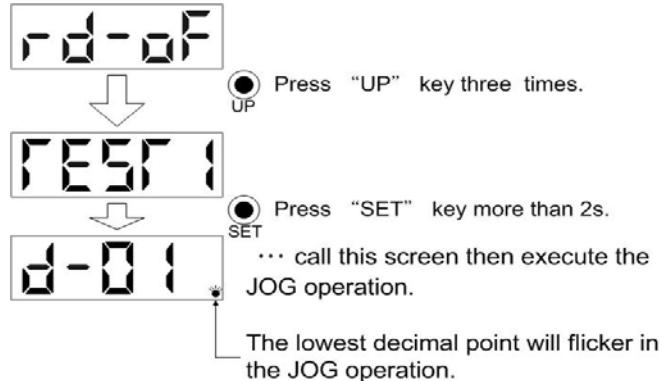


4.5.3. JOG test

- ★ As no external command nor any alarm occurred, JOG test could be executed.
- ★ Do not execute this operation until the contact between SON and SG is open.

Set the speed command of JOG by the PC04, set the acceleration time by the PC01, and set the deceleration time by the PC02. Call the display screen after power on, select JOG test, positioning test and approximate inertia operation by the following steps:

Press the MODE key to go to the diagnostic screen.



(1) Operation

As the JOG test is executed, connect +24Vdd with COM+ if the inner power is applied on EMG-SG. Press the “UP” or “DOWN” key to run the motor. Release the key to stop. Use the communication software to change the operation conditions. The initial conditions and setting ranges for the operation are presented below:

Item	Initial setting	Setting range
Rotary speed [r/min]	300	-4500~4500
Acceleration/deceleration time constant [mS]	200	0~20000

Key functions are described as follows:

Key	Description
UP	Press to run CCW rotation. Release to stop.
DOWN	Press to run CCW rotation. Release to stop.

If the communication cable is disconnected during JOG test by using the communication software, the servo motor will be decelerated to a stop.

(2) Status display

Users could check the servo status during JOG test.

Press the “MODE” key to show the status display during the ready of JOG test. Perform the JOG test in this status screen with “UP” and “DOWN” keys. Each press of “MODE” key will show the next status screen. After an entire cycle, the ready of JOG test is returned. More details related to the status display could be found in Section 6.2.

(3) JOG test completed

Turn off the power or press the "SET" key in operation test mode for more than 2 seconds to terminate the JOG test.



4.5.4. Positioning test

- ★ The Shihlin communication software is required to execute the positioning test.
- ★ As no external command nor any alarm occurred, positioning test could be executed.
- ★ Before this operation, make sure that the contact between SON and SG is open.

Operation

Make sure that the motor is correctly wired before this test performed. Select operation testing via the Shihlin communication software. Press “Forward” or “Reverse” to rotate the motor which will then stop after moving the command route set by the user. Operation conductions could be modified with the Shihlin communication software. The initial values and setting ranges are listed in the table below:

Name	Initial value	Setting range
Rotary speed [r/min]	200	0~6000
Acceleration/deceleration time constant [mS]	1000	0~20000
Command route	Revolution [10000/turn]	10
	pulse	0

Description of the buttons:

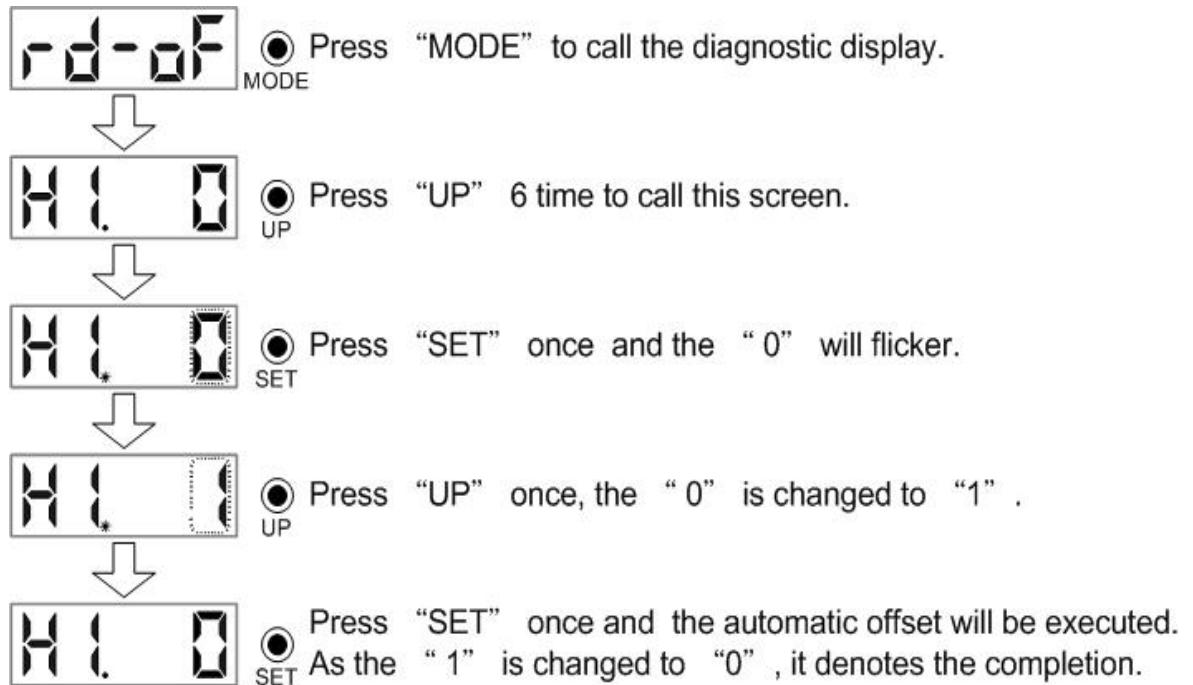
Button name	Function description
Forward	Press to run positioning test in CCW.
Reverse	Press to run positioning test in CW.
Pause	Press “Pause” button during operation to make a temporary stop. To press the same button which was pressed to finish the remaining route. Otherwise, to press "Pause" button again to erases the remaining route.
Close	Terminate this test.

- ★ The motor will stop immediately if the communication cable is disconnected during operation.

4.5.5. Automatic offset of analog command input

When the external speed analog command input is 0V, there may be still a offset voltage which will

cause a slow motor rotation inside the servo driver. The user could “erase” this bias with the automatic offset function in the diagnostic display mode. Follow the steps to execute automatic offset operation of analog input:



After the automatic offset completed, the bias value will be written into the PC26.

4.5.6. Inertia estimation

- ★ The Shihlin communication software is required to execute the inertial estimation.

- ★ As no external command nor any alarm occurred, the inertial estimation could be executed.
- ★ When this operation is performed, the PA02 should be set as 0x00.(manual tuning mode)

Operation

1. Make sure that the motor is wired correctly before operating this inertia estimation.
2. Under the Shihlin communication window, choose the “auto gain tuning” item.
3. Enable the “Auto tuning control panel”.
4. The acceleration/deceleration time constant, JOG speed could be adjusted if necessary.
5. Press the “Servo ON” button and then the motor would be magnetized.
6. The JOG button could be used to run the motor in CCW or CW.
7. Set the proper route command (revolutions and pulses).
8. Press the “Start” button to execute this inertia estimation.

The relevant parameters are listed below:

Name	Initial value	Setting range
acceleration/deceleration time constant [mS]	200	0~10000
JOG speed [r/min]	300	1~3000

During the acceleration or deceleration process, the servo driver would calculate the ratio of load inertial to motor shaft and the bandwidth of the system. After the values getting more stable, press the “Auto gain calculation” button, the relevant control parameters would be record.

The relevant parameters are listed below:

Name	Abbr.	Sign	Setting range	unit	Initial value	Control mode
Resonance suppression low-pass filter	NLP	PB03	0~10000	0.1mS	0	Pt,Pr,S,T
Position feed-forward gain	FFC	PB05	0~20000	0.0001	0	Pt,Pr
The ratio of load inertial to motor shaft	GD1	PB06	0~1200	0.1time	10	Pt,Pr,S
Position loop gain	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	VIC	PB09	1~1000	mS	48	Pt,Pr,S

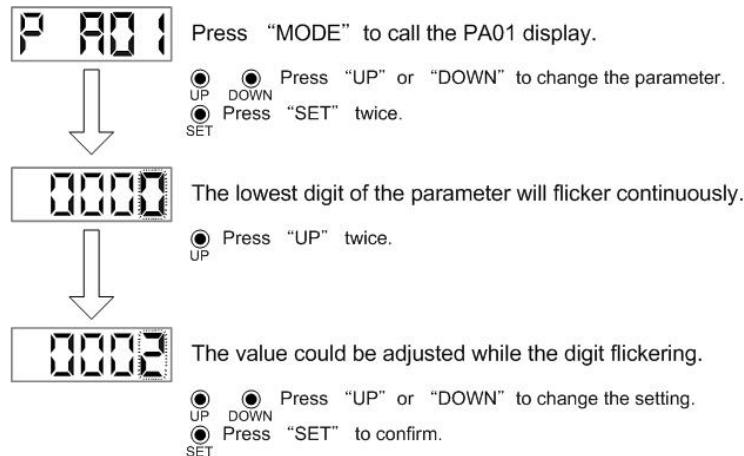
After the calculation completed, users must terminate the “Auto tuning control panel” in order to record the relevant parameters. If users already know the low frequency gain and inertia ratio of the system, they could also set the bandwidth value desired to calculate the optimum value for controller.

4.6.Parameter display

Some parameter modification would be valid by power off once and power on again.

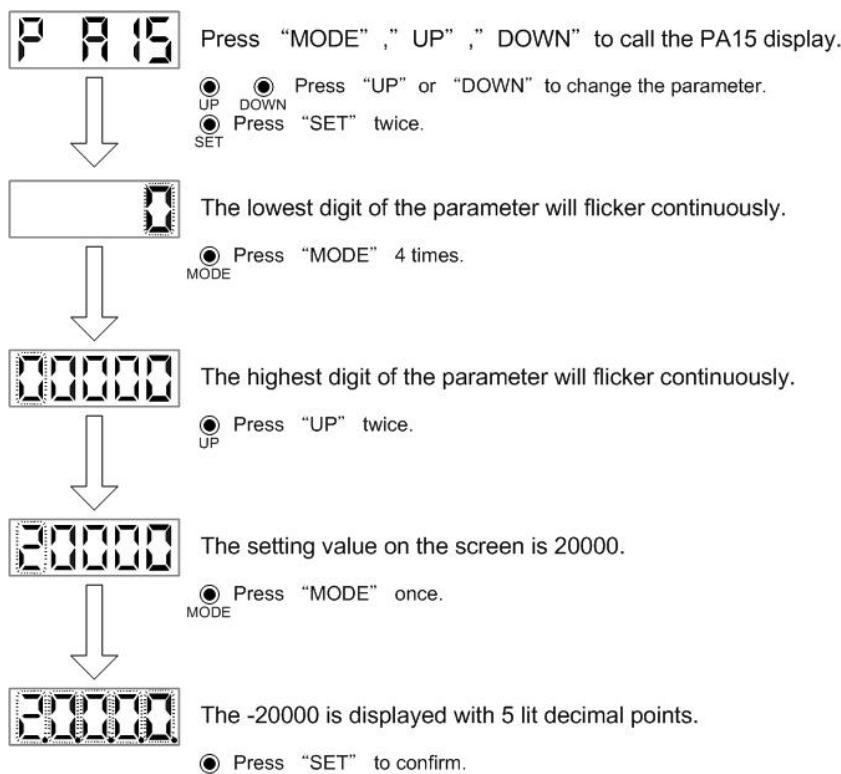
Here are 2 examples. One is the control mode(PA01) changed. The other is the usage changed of the “MODE” key. It is switched to the “shift” function to modify the revolutions.

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

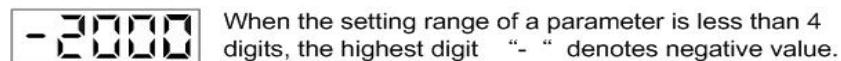


The change of this parameter setting is valid after power off once and power on again.

Example 2: Switch the usage of “MODE” key to the “shift” function.(PA15 as a case)



◆ Another way to display a negative value which only occupies 4 digits or less is shown below:



5. Operation

5.1. Checklist before operation

To avoid the damage, before starting the operation, please check the following:

- ◆ Whether the power source terminals (R,S,T,L1,L2) of the servo driver are correctly wired.
- ◆ The terminals(U,V,W) of the motor and the U, V, W wires on the driver need to be consistency.
- ◆ Make sure if the ground terminal of the servo driver is correctly grounded.
- ◆ Make sure there is no conductive or inflammable materials inside the driver or close to the driver.
- ◆ Make sure the voltage level of external power source of the driver is proper.
- ◆ Make sure that the control switch is off.
- ◆ Do not put heavy objects on top of the driver 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 driver.

5.2. Idle operation

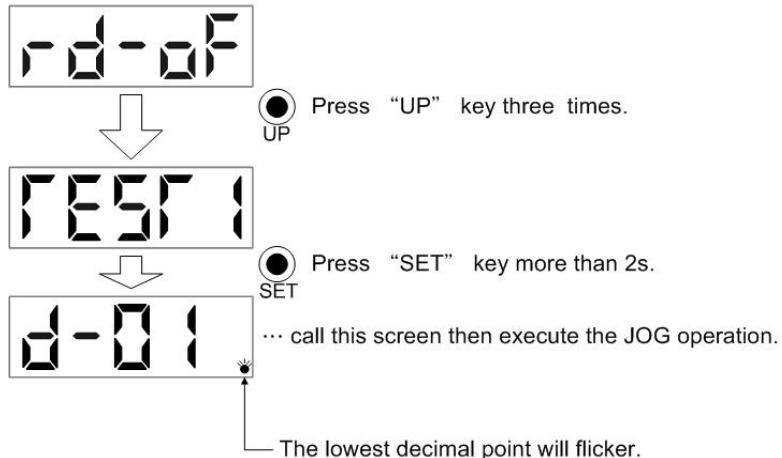
Please decouple the load(e.g., any coupler between the servo motor shaft and user's machine) before an idle operation. To follow the regular instruction to start the servo motor and then couple the servo motor with user's machine again. The idle operation is explained as below.

5.2.1. Idle JOG test

- ★ This operation could be performed only if there is not alarm nor warning on the driver.
- ★ To confirm an open contact between SON and SG before this operation.

The idle JOG test could be executed with the driver's panel or the Shihlin communication software in order to check if the speed and direction of the motor is as expected or not. The motor speed could not be modified with the driver's panel. If the rotation speed has to be modified, please use the Shihlin communication software to modify. The low speed command is recommended when this operation performed. The panel operation is described as follows:

Press the "MODE" to call the diagnostic screen after power on.



- Press the "UP" key to run the motor in CCW or the "DOWN" key to run the motor in CW.

The initial conditions and setting ranges are presented below:

Item	Initial setting	Setting range
Rotary speed [r/min]	300	-4500~4500
Acceleration/deceleration time constant [mS]	200	0~20000

If the communication cable is disconnected during this operation with the communication software, the motor will be decelerated to a stop. Key functions are described as follows:

Key	Description
UP	Press to run CCW rotation. Release to stop.
DOWN	Press to run CCW rotation. Release to stop.

To terminate the idle JOG test, turn off the power or press the "SET" key more than 2 seconds in the display of "d-01" screen.

- ★ If the Shihlin communication software are applied to perform the idle JOG test, please refer to the instruction of the help file for more detail.

5.2.2. Idle positioning test

The idle positioning test could be executed with the Shihlin communication software to check if the speed and direction of the motor is as expected. The low speed command is recommended when this operation performed. The route which is composed of revolutions and pulses should be set for this positioning test. For example, a route of 10.5 turns for the servo motor, the number of revolution should be set as "10" and the number of pulse should be set as "5000". The operation steps are described below:

Step 1 : Wire the driver and the motor correctly then turn on the power.

Step 2 : Connect the PC and the CN4 port of the driver with the standard mini USB cable. Execute the USB communication function of the Shihlin communication software and select the proper device number.

Step 3 : Select "TESTING/POSITIONING TESTING" to enter positioning test screen.

Step 4 : Set the numbers of revolution and pulse. Press "Forward" to run the motor CCW to complete the distance. Or press "Reverse" to run the motor CW to reach the target position.

The initial conditions and setting range are listed below:

Name		Initial value	Setting range
Command route	Revolution [10000/turn]	10	0~30000
	Pulse	0	0~9999
Rotary speed [r/min]		200	0 to the max allowable speed
Acceleration/deceleration time constant [mS]		1000	0~20000

Description of the buttons :

Button name	Function description
Forward	Press to run positioning test in CCW until the command route done.
Reverse	Press to run positioning test in CW until the command route done.
Pause	Press "Pause" button during operation to make a temporary stop. To press the same button which was pressed to finish the remaining route. Otherwise, to press "Pause" button again to erases the remaining route.
Close	Terminate the positioning test.

Step 5 : When the positioning test is completed, press "Close" to return the last window of the Shihlin communication software.

5.3.Tuning process

5.3.1. Abstract

With the auto-gain tuning function, the mechanical load inertia could be approximated precisely. The appropriate gain value of controller parameter also could be fitted for the servo motor under the various load conditions. The manual tuning function is executed as the result of auto-gain tuning function is not suitable for the user's mechanical system.

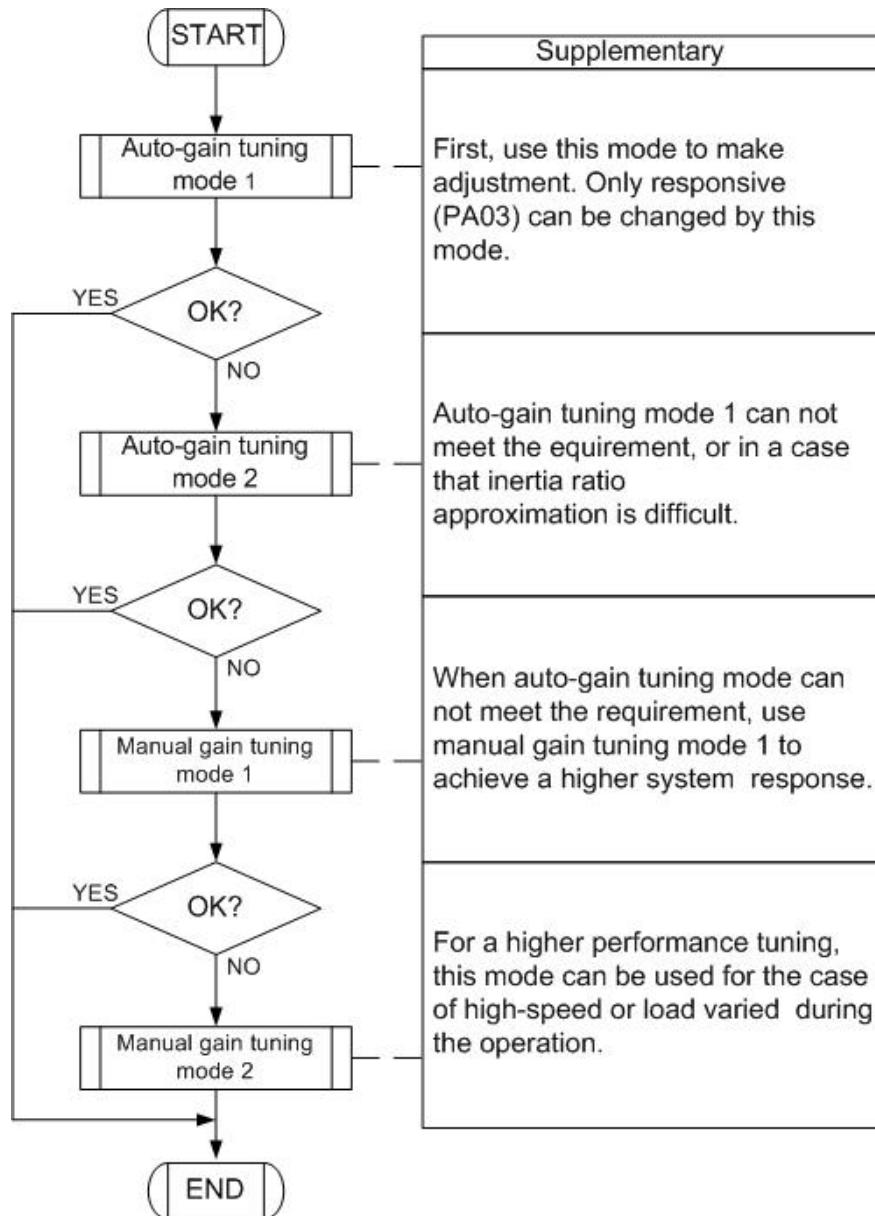
Gain tuning mode is explained in the following table:

Gain tuning mode	PA02 setting	Estimation rule	Automatically set parameter	Manually set parameter
Manual gain tuning mode 1 (PI control)	0000h	A fixed PB06.		GD1(PB06) PG1 (PB07) VG1 (PB08) VIC (PB09)
Manual gain tuning mode 2 (PI control + interference compensator)	0001h			GD1(PB06) PG1 (PB07) VG1 (PB08) VIC (PB09)
Auto-gain tuning mode 1	0002h	Always estimated.	GD1(PB06) PG1 (PB07) VG1 (PB08) VIC (PB09)	ATUL(PA03)
Auto-gain tuning mode 2	0003h	A fixed PB06.	PG1 (PB07) VG1 (PB08) VIC (PB09)	ATUL(PA03) GD1(PB06)

★ The PA02 is not writable as SON-SG is conductive. Make it open circuit then setting the values.

When the position control mode is performed, the manual gain tuning mode (PI control + interference compensator) is recommended. The value of gain setting is various according to the different load conditions. For example, reduce the gain value if the mechanical system is instable.

Follow the steps listed below to tune the proper gain value of user's mechanical application.



If the mechanical system which being tuned is a new set up, please use the JOG test at first. As no abnormal alarm occurred then use the auto-gain tuning function. During the auto-gain tuning function operated, several routes of acceleration and deceleration are necessary to make the ratio of load inertial to motor shaft be getting stable. Finally, the proper gain and response would be set.

5.3.2. Auto-gain tuning mode

The auto-gain tuning of the driver could calculate the ratio of load inertia to motor shaft instantaneously. With this value, the optimum gain could be decided under the current mechanical condition. It is convenient to execute the adjustment of gain value with the auto-gain tuning function.

5.3.2.1. Auto-gain tuning function

(a) Auto-gain tuning mode 1

This mode is the default mode of the servo driver. If the parameter PA02 is set as “0002h”, the load inertia ratio would be approximated continuously and the servo gain value will be set automatically. The variable parameter for users is only PA03 which the response setting related.

Parameters and settings related of this mode are presented below:

Parameter	Abbreviation	Parameter name	User adjustable or auto-presumed
PA03	ATUL	Auto-tuning response level setting	User adjustable
PB06	GD1	The ratio of load inertial to motor shaft	auto-approximated
PB07	PG1	Position loop gain	auto-approximated
PB08	VG1	Speed loop gain	auto-approximated
PB09	VIC	Speed integral gain	auto-approximated

When the function of auto-gain tuning mode 1 is applied, some conditions must be met.

- ①. The acceleration time from 0rpm to 2000rpm or the deceleration time from 2000rpm to 0rpm should be 1 second or less. If a 3000rpm case is applied, the acceleration and deceleration time should be 1.5 seconds or less.
- ②. The speed command of the motor should be 300rpm or higher.
- ③. The ratio of machinery load inertial to motor shaft should be 100 times or less.
- ④. The machinery system with a violent change of load inertial is not suitable.

(b) Auto-gain tuning mode 2

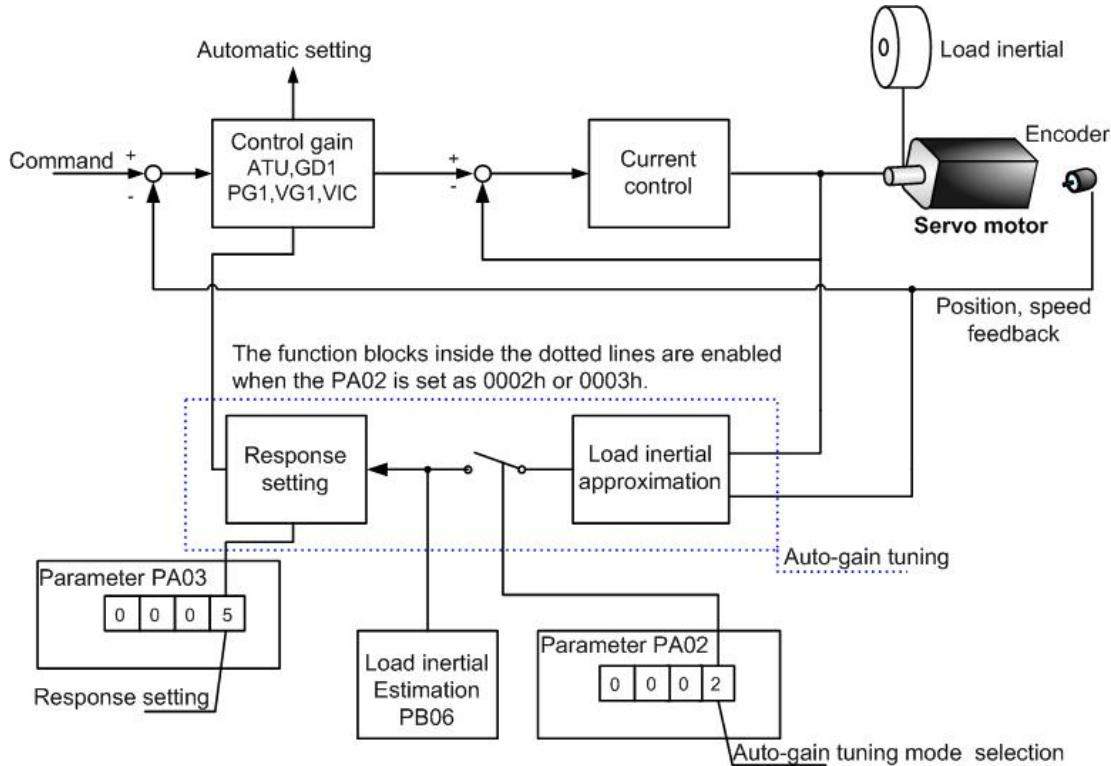
When auto-gain tuning mode 1 is not satisfied the accurate approximation of load inertial, the auto-gain tuning mode 2 is recommended. The parameter PA02 should be set as “0003h” to perform this mode. During the tuning process, the load inertia ratio would not be approximated and the users have to write manually the value into PA06 by themselves.

Parameters and settings related of this mode are presented below:

Parameter	Abbreviation	Parameter name	User adjustable or auto-presumed
PA03	ATUL	Auto-tuning response level setting	User adjustable
PB06	GD1	The ratio of load inertial to motor shaft	User adjustable
PB07	PG1	Position loop gain	auto-approximated
PB08	VG1	Speed loop gain	auto-approximated
PB09	VIC	Speed integral gain	auto-approximated

5.3.2.2. The flow of auto-gain tuning mode

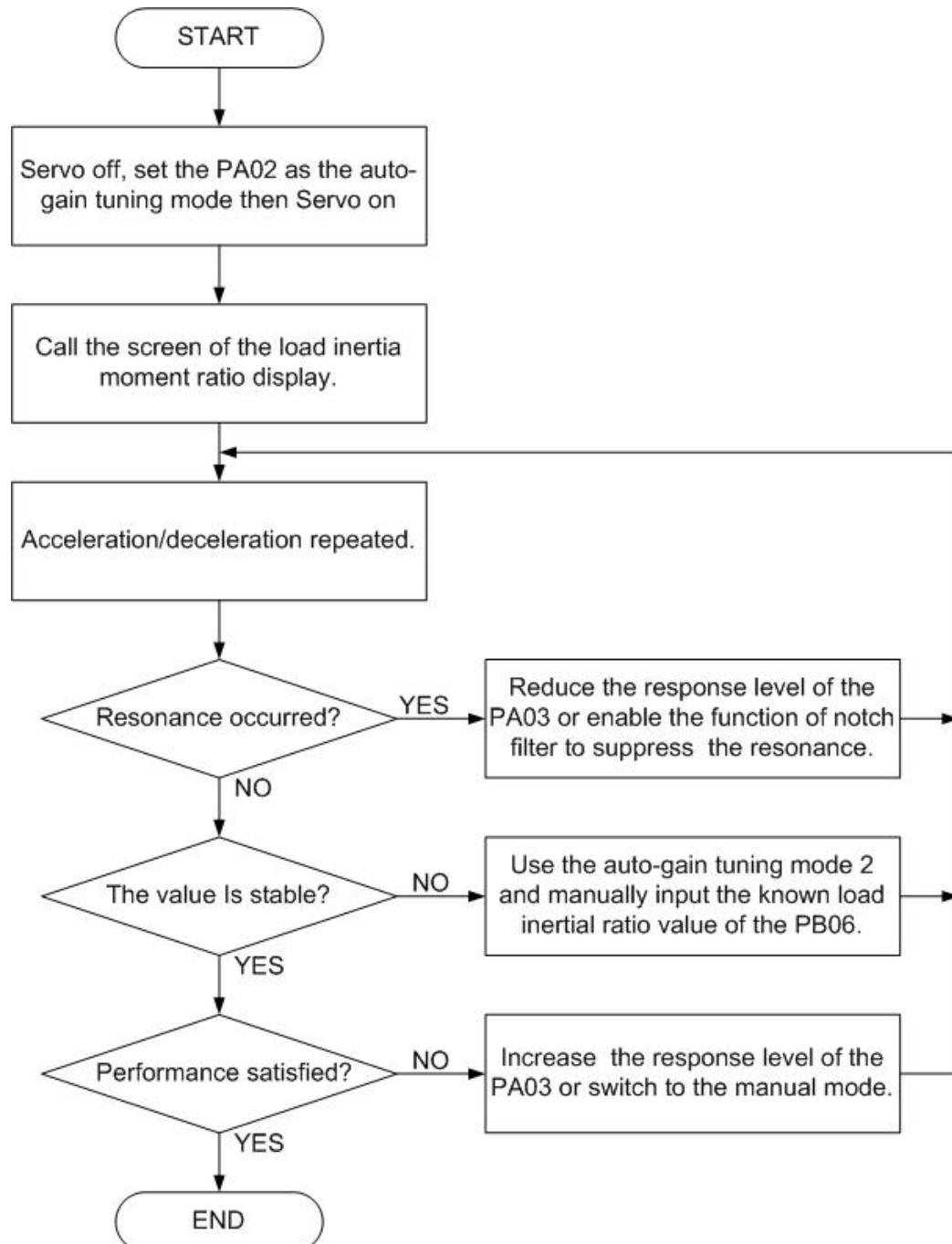
The flow of auto-gain tuning mode for the servo driver could be presented below:



When the auto-gain tuning mode is performed, the following conditions should be satisfied.

- ① As the mode 1 operated, at first execute the acceleration/deceleration routes of the motor, the ratio of load inertia to motor shaft would be approximated according to the current and speed. The PB06 would be updated(EEPROM) with the new approximated value every 6 minutes.
- ② If the PB06 is known or the proper gain cannot be made by the auto-gain tuning mode 1, please use the auto-gain tuning mode 2 by the setting of PA02 and manually set the known value of PB06. Under this mode, the estimation of control gain would still compute.
- ③ With the settings of the inertial ratio and the response, the servo driver would tune the optimum gains during the acceleration/deceleration route. The result value of gain tuning would be written into EEPROM every 6 minutes. After power on of the driver, the saved value of the controller gain in the EEPROM would be used as the initial value for the operation of auto-gain tuning mode.

Since the auto-gain tuning mode 1 is made valid as the default from the factory, simply running the acceleration/deceleration route of the motor would automatically obtain the optimum gains that match the machine. Merely changing the response level setting value as required completes the adjustment. The adjustment procedure is as follows.

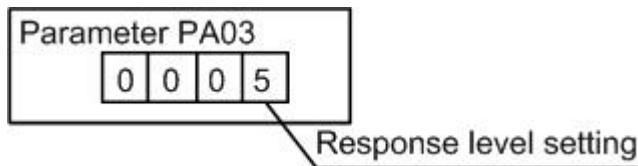


5.3.2.3. Response level setting of the auto-gain tuning mode

The parameter PA03(response level setting) is related to the response of the whole servo system. As the response level setting is increased, the traceability and settling time for a command decreases, but a too high response level setting would generate vibration. Therefore, keep setting until the optimum response is obtained within the range without vibration.

If the response level setting which user desired would cause machine resonance, the machine resonance suppression filter(PB01,PB02,PB21,PB22) and the resonance suppression low-pass filter(PB03) could be employed to suppress machine resonance. Suppressing machine resonance may allow the response level setting to be higher.

Refer to section 6.3.6 for more detail about suppressing machine resonance.



Response level setting	Machine rigidity	Speed loop response frequency	Applicable ratio of load inertial to motor shaft
1	Low	5Hz	30 times or more
2		10 Hz	
3		15 Hz	
4		20 Hz	
5	Middle	30 Hz	10~30 times
6		40 Hz	
7		55 Hz	5~10 times
8		70 Hz	
9		85 Hz	
A	High	100 Hz	5 times or less
B		130 Hz	
C		160 Hz	
D		200 Hz	
E		250 Hz	
F		300 Hz	

- ◆ For the response level setting, it is recommended to use the level value from low response to high response gradually. It is probably to make resonance if the initial value is too high.
- ◆ The applicable ratio of load inertia to motor shaft is a reference. The actual range would vary with the different mechanical systems.

5.3.3. Manual gain tuning mode

The manual gain tuning mode is executed as the result of auto-gain tuning function is not suitable for the user's desired.

Adjustment of manual mode

For the applications of position control or speed control, the bandwidth is highly related with the machinery rigidity and environment. For machine tools which the high precision required, a high bandwidth system response is necessary. However, a high response level setting could cause the machine resonance easily. Therefore, a high rigidity machine should be used for occasions that require a high response to avoid machine resonance.

If users have no idea about the permissible response of the machine, they should adopt a smaller gain value at first and then gradually increase the gain values until machine resonance occurred. Then users could reduce the gain values accordingly. Reference parameter values for users to adjust are listed in the following table:

Name	Name Abbr.	Sign	Setting range	Unit	Initial value	Control mode
Resonance suppression low-pass filter	NLP	PB03	0~10000	0.1mS	0	Pt,Pr,S,T
Position feed-forward gain value	FFC	PB05	0~20000	0.0001	0	Pt,Pr,
Position loop gain	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	VIC	PB09	1~1000	mS	48	Pt,Pr,S
Speed feed-forward gain	VFG	PB10	0~20000	0.0001	0	Pt,Pr,S

➤ Position loop gain(PG1)

This parameter determines the response level of the position loop. Increasing PG1 improves traceability, settling time and position error to a position command but a too high value will make overshooting or vibration to occur.

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

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

➤ Speed loop gain(VG1)

This parameter determines the response level of the speed loop. Increasing VG1 improves traceability to a speed command but a too high value will make machine resonance. The Speed loop gain is usually 4~6 times bigger than the position loop gain. As the position loop gain is greater than the speed loop gain, machine resonance or overshoot would be occurred easily.

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

➤ Speed integral gain(VIC)

This parameter is to eliminate stationary deviation against a command. The smaller it is, the better capability for the driver to eliminate stationary deviation. However, the machine with a large load inertia ratio or any vibration causing, the small value would cause vibration easily.

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

➤ Resonance suppression low-pass filter(NLP)

The larger the load inertia ratio is, the lower the system bandwidth is. To keep a relatively high bandwidth, a higher gain value may be required. Also the probability of resonance for the same machine would be increased. Thus the resonance suppression low-pass filter could be applied to eliminate the resonance. The higher setting value affords a better improvement about high frequency noises. Also a too large value could probably cause the entire system to be instable. It is because the higher setting value cause a larger phase lag of the servo driver.

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

➤ Position feed-forward gain(FFC)

To reduce the position error and position settling time, but if the value is set too large, a sudden acceleration or deceleration may cause overshoots. Also, a too large electronic gear ratio would cause noises.

➤ Speed feed-forward gain(VFG)

To set the proper gain value would reduce the tracking time of speed command. Also, a too big value would cause overshoots during the sudden acceleration/deceleration command.

5.4.Parameter setting and operation for position control mode

(1) Power on

To switch off the SON signal of DI after the servo driver has turned on. The panel of the driver would show  2 second latter.

(2) Test operation

Confirm the state of the servo motor with the JOG test.

(3) Parameter setting

After wiring for position control, the following parameters should be set for this operation.

Parameter	Name	Setting value	Description
PA01	Control mode option	□□□0	Position control mode
PA02	Gain tuning mode option	0002	Auto-gain tuning mode 1
PA03	Response level setting	0005	Middle rigidity
PA06	Numerator of the electronic gear ratio	1	Set the numerator as "1"
PA07	Denominator of the electronic gear ratio	1	Set the denominator as "1"
PD15	Digital input filter time option	□□□2	Filter time constant is "4mS"

(4) Servo on

(a)Turn on the control power(L1,L2) of the servo driver.

(b)Turn on the SON signal(SON-SG short circuit).

When the SON is activated, the driver is ready to run. The servo motor would immediately be magnetized and switched to the "SERVO LOCK" state.

(5) Forward/reverse rotation pulse train

At first make the servo motor run at a low speed and confirm the operation and rotary direction of the motor. If the pulse train commands are open collector type, PP and NP are used as input terminal. When the line driver signals applied, please use the PG-PP or NG-NP wiring. Use auto-gain tuning function or manually input the controller parameter and avoid the machine resonance. To adjust the PA03 to obtain the optimum speed response.

(6)Searching home

Before this function being performed, check if there is the proper rotary direction and origin. Searching home could be executed if necessary.

(7)Stop

Take one of the following steps to stop running the motor.

(a)SON signal off :

The shaft of servo motor is become rotatable.

(b)Alarm has occurred :

The dynamic brake works and the servo motor suddenly stop running.

(c)EMG is activated :

The same actions as above but the ALM message is displayed.

(d)LSP/LSN signal off :

LSP on is rotatable in CCW. LSN on is rotatable in CW. If it is off, the dynamic brake works.

5.5.Parameter setting and operation for speed control mode

(1) Power on

To switch off the SON signal of DI after the servo driver has turned on. The panel of the driver would show  2 second latter.

(2) Test operation

Check if the state of the servo motor normal or not with the JOG test.

(3) Parameter setting

After wiring for speed control, the following parameters should be set for this operation.

Parameter	Name	Setting value	Description
PA01	Control mode option	□□□2	Speed control mode
PC05	Inner speed command 1 [rpm]	1000	Speed command 1 is 1000rpm
PC06	Inner speed command 2 [rpm]	1500	Speed command 1 is 1500rpm
PC07	Inner speed command 3 [rpm]	2000	Speed command 1 is 2000rpm
PC01	Acceleration time constant [mS]	1000	Set as 1000mS
PC02	Deceleration time constant [mS]	500	Set as 500mS
PC03	S-curve acceleration/deceleration pattern	0	Disabled
PD15	Digital input filter time option	□□□2	Filter time constant is "4mS".

(4) Servo on

(a)Turn on the control power(L1,L2) of the servo driver.

(b)Turn on the SON signal(SON-SG short circuit).

When the SON is activated, the driver is ready to run. The servo motor would immediately be magnetized and switched to the "SERVO LOCK" state.

(5) Start

Choose the speed command with the SP1 and SP2 signals. Options are listed as below.

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

The rotary direction is decided with the ST1 and ST2 signals. Options are listed as below.

External input signal		Speed command			
SP2	SP1	Speed analog command(VC)			Inner command
		+ polarity	0V	- polarity	
0	0	-	-	-	-
0	1	CCW	-	CW	CCW
1	0	CW	-	CCW	CW
1	1	-	-	-	-

"0" denotes the open circuit with SG, "1" denotes the short circuit with SG. "-" is servo locked.

At first make the servo motor run at a low speed and check if the sequence correct or not. With the status display, user could check the motor speed, cumulative pulses of command, effective load ratio, etc. Use auto-gain tuning function or manually input the controller parameters and avoid the machine resonance. To adjust the PA03 to obtain the optimum speed response.

(6)Stop

Take one of the following steps to stop running the motor.

(a)SON signal off :

The shaft of servo motor is become rotatable.

(b)Alarm has occurred :

The dynamic brake works and the servo motor suddenly stop running.

(c)EMG is activated :

The same actions as above but the ALM message is displayed.

(d)LSP/LSN signal off :

LSP on is rotatable in CCW. LSN on is rotatable in CW. If it is off, the dynamic brake works.

(e)If ST1 and ST2 are both on or both off, the motor would decelerate to stop.

5.6.Parameter setting and operation for torque control mode

(1) Power on

To switch off the SON signal of DI after the servo driver has turned on. The panel of the driver would show  2 second latter.

(2) Test operation

Confirm the state of the servo motor with the JOG test.

(3) Parameter setting

After wiring for torque control, the following parameters should be set for this operation.

Parameter	Name	Setting value	Description
PA01	Control mode option	□□□4	Torque control mode
PC05	Inner speed limit 1 [rpm]	1000	Speed command 1 is 1000rpm
PC06	Inner speed limit 2 [rpm]	1500	Speed command 1 is 1500rpm
PC07	Inner speed limit 3 [rpm]	2000	Speed command 1 is 2000rpm
PC01	Acceleration time constant [mS]	1000	Set as 1000mS
PC02	Deceleration time constant [mS]	500	Set as 500mS
PC03	S-curve acceleration/deceleration pattern	0	Disabled
PD15	Digital input filter time option	□□□2	Filter time constant is "4mS".
PA05	Inner torque limit 1 [%]	50	50% of maximum torque as a limit

(4) Servo on

(a)Turn on the control power(L1,L2) of the servo driver.

(b)Turn on the SON signal(SON-SG short circuit).

When the SON is activated, the driver is ready to run. The servo motor would immediately be magnetized and switched to the "SERVO LOCK" state.

(5) Start

Choose the speed limit with the SP1 and SP2 signals. The motor runs in CCW as the SP1 activated. The motor runs in CW as the SP2 activated. At first to run the servo motor at a low speed to check if the sequence correct or not. If the sequence is unexpected, check whether the input signal is proper.

(6)Stop

Take one of the following steps to stop running the motor.

(a)SON signal off :

The shaft of servo motor is become rotatable.

(b)Alarm has occurred :

The dynamic brake works and the servo motor suddenly stop running.

(c)EMG is activated :

The same actions as above but the ALM message is displayed.

(d)LSP/LSN signal off :

LSP on is rotatable in CCW. LSN on is rotatable in CW. If it is off, the dynamic brake works.

(e)If ST1 and ST2 are both on or both off, the shaft of servo motor is become rotatable.

6. Control function

6.1. Control mode option

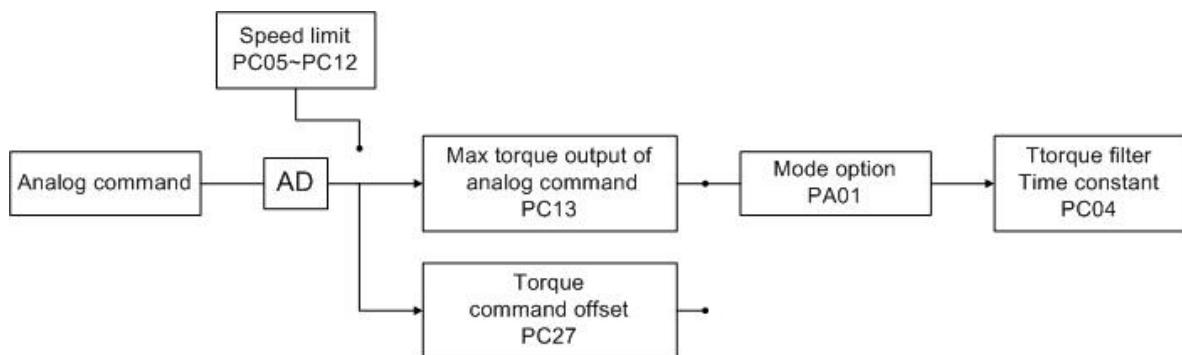
There are 4 basic operation modes for Shihlin servo driver: position control with terminals input, position control with inner registers, speed control, torque control. The driver could be operated in single mode or hybrid mode. All operation modes are described as below.

	Mode	Sign	PA01 setting	Description
Single mode	Position control (terminal input)	Pt	0000	The driver receives the command to run the motor to approach the goal. The command is received via the terminals and is in the form of pulse trains
	Position control (inner register)	Pr	0010	The driver receives the command to run the motor to approach the goal. The command source is the inner register which could be assigned by DI signals.
	Speed control	S	0002	The driver runs the motor to the target speed. The command source which is an analog voltage or the inner register could be switched by DI signals.
	Torque control	T	0004	The driver receives the command to run the motor to generate the desired torque. The command source is the analog voltage.
Hybrid mode	Position control (terminal input) - speed	Pt-S	0001	Pt/S is switched mutually via the LOP signal.
	Position control (terminal input) - torque	Pt-T	0005	Pt/T is switched mutually via the LOP signal.
	Position control (inner register) - speed	Pr-S	0011	Pr/S is switched mutually via the LOP signal.
	Position control (inner register) - torque	Pr-T	0015	Pr/T is switched mutually via the LOP signal.
	Speed - torque control	S-T	0003	S/T is switched mutually via the LOP signal.

◆ The modification of PA01 would be valid by power off once and power on again.

6.2.Torque control mode

Torque control mode is often applied for such occasions: winding machines, printing press, injection molding machines, etc. The torque command is analog voltage signals which control the output torque of the servo motor. The basic torque control blocks are shown as below.



The input command for torque control is an analog $\pm 10V$ voltage. After A/D process, torque output command and torque command offset process, the expected torque and speed will be output.

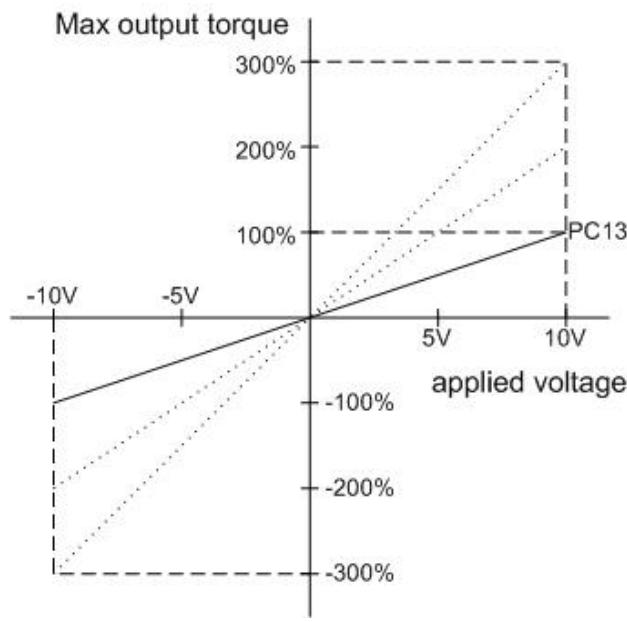
6.2.1. Output proportion of maximum torque analog command

Output proportion is the relationship between the applied voltage of the torque analog command and the torque generated by the servo motor.

Name	Sign	Setting range	Unit	Initial value	Control mode
Torque generated of maximum analog command	PC13	0~2000	%	100	Pt,Pr,S,T

If the setting value of PC13 is 100%, the 100% rated torque of servo motor would be generated when the applied voltage of torque command is 10V. If the applied voltage of torque command is 5V, the generated torque would be the 50% rated torque. The conversion is listed as follows.

$$\text{The generated torque}(\%) = \frac{\text{applied voltage of torque command}}{10} \times \text{the setting value of PC13}$$

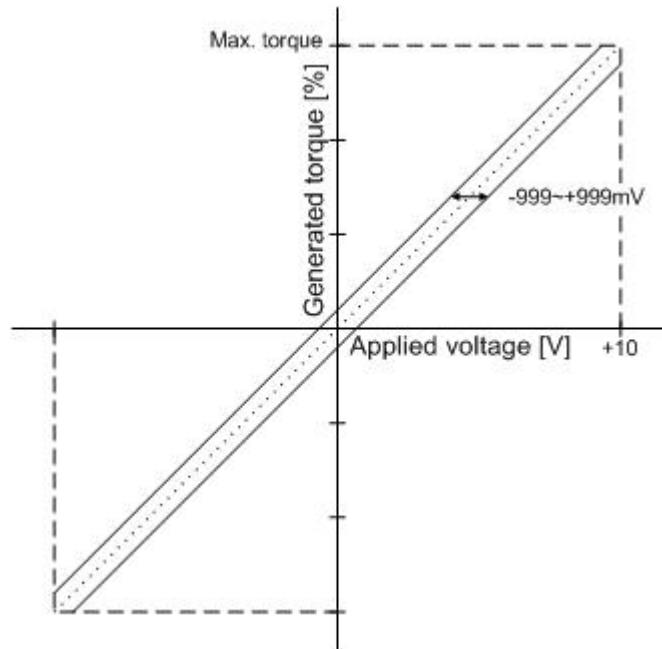


6.2.2. Torque analog command offset

When the torque analog command input is 0V, there may be still a offset voltage which will cause a slow motor rotation. In such case, the user could use the parameter PC27 to correct the bias voltage.

The parameter description is as follows.

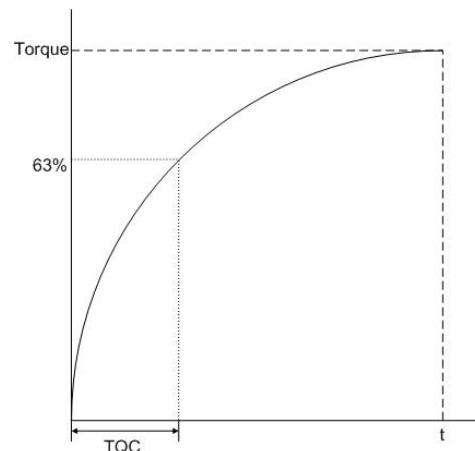
Name	Sign	Setting range	Unit	Initial value	Control mode
Torque analog command offset	PC27	-999~999	mV	0	S,T



6.2.3. Torque analog command smoothing

By setting the filter time constant of torque analog command, the user could run the servo motor smoothly in response to a sudden torque command. The parameter description is as follows.

Name	Sign	Setting range	Unit	Initial value	Control mode
Torque command filter time constant	PB19	0~5000	mS	0	T



6.2.4. Torque limit of torque control mode

The parameter PA05 and PC25 are used to limit the generated torque of the servo motor when the torque control mode is performed. The description is as follows.

Name	Name Abbr.	Sign	Setting range	Unit	Initial value	Control mode
Inner torque limit 1 [%]	TL1	PA05	0~100	%	100	Pt,Pr,S,T
Inner torque limit 2 [%]	TL2	PC25	0~100	%	100	Pt,Pr,S,T

The TL1 signal function of CN1 is also described again as follows.

Name	Name Abbr.	Description	Control mode
Inner torque limit option	TL1	When this signal is applied, make the PD02 to PD09 usable at first. Open TL1-SG to make inner torque limit 2 valid(PC25).	Pt,Pr,S,T

There are two different result which is chosen by the switch status of DI.

DI signal status(*)	The valid value of torque limit
TL1	
0	The setting value of PA05
1	If the PC25 is greater than the PA05, the PA05 is valid. If the PC25 is less than the PA05, the PC25 is valid.

(*) 0: OFF(TL1-SG is open-circuit) 1:ON(TL1-SG is short-circuit)

6.2.5. Speed limit of torque control mode

Under the torque control mode, the various speed limits could be applied by the SP1, SP2, SP3 and the external analog signal. There are 8 combinations which are listed below for user to choose.

DI status	Valid option	DI signal status(*)		Speed limit	Limit range	Related parameter	
		SP2	SP1				
SP3 is invalid (default value)	VCM	0	0	Speed analog limit(VC)	±10V	PC12	
	SC1	0	1	Inner speed limit 1	-4500 ~ 4500	PC05	
	SC2	1	0	Inner speed limit 2		PC06	
	SC3	1	1	Inner speed limit 3		PC07	
SP3 is valid	Valid option	SP3	SP2	SP1	Speed limit	Limit range	Related parameter
	VCM	0	0	0	Speed analog limit(VC)	±10V	PC12
	SC1	0	0	1	Inner speed limit 1	-4500 ~ 4500	PC05
	SC2	0	1	0	Inner speed limit 2		PC06
	SC3	0	1	1	Inner speed limit 3		PC07
	SC4	1	0	0	Inner speed limit 4		PC08
	SC5	1	0	1	Inner speed limit 5		PC09
	SC6	1	1	0	Inner speed limit 6		PC10
	SC7	1	1	1	Inner speed limit 7		PC11

(*) 0: OFF(SPx-SG is open-circuit) 1:ON(SPx-SG is short-circuit) x=1,2,3

- ◆ When the external speed analog limit is applied, check the initial 0 voltage and PC12 value which are not permissible to exceed the motor's rated speed otherwise damages would be caused.
- ◆ To make the SP3 of DI valid by setting PD02 to PD09 if the option SC4 to SC7 are used.

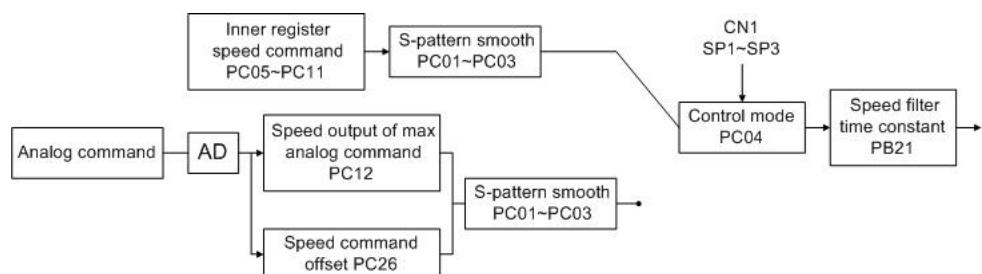
The parameters related to the function of inner speed limit are described below.

Name	Sign	Setting range	Initial value	Control mode
Inner speed limit 1 [rpm]	PC05	0 ~ instant permissible speed	100	T
Inner speed limit 2 [rpm]	PC06		500	
Inner speed limit 3 [rpm]	PC07		1000	
Inner speed limit 4 [rpm]	PC08		200	
Inner speed limit 5 [rpm]	PC09		300	
Inner speed limit 6 [rpm]	PC10		500	
Inner speed limit 7 [rpm]	PC11		800	

6.3. Speed control mode

Speed control is often applied for occasions where is CNC machine, drilling machine, etc. The command source is analog signal or inner register. The analog signal is the external voltage signal. The inner command could be performed by the following 2 ways: (1)Use the inner registers (PC05 to PC11) to set the various commands then switch SP1, SP2, and SP3 to change the demand speed. (2)Use the communication software to modify the value of speed command register.

To avoid the discontinuity, the drivers afford users the smooth S-pattern running. There are 2 control modes (manual and automatic) available. The manual mode enables users to set all related parameters while the automatic mode provides an estimation of load inertia ratio and parameters adjusted. In addition, an simple mode is designed to provide users a robust control which could instantaneously suppress external load interference. The basic speed control blocks are shown as below.



The S-pattern smooth process and speed filter are recommended to suppress the discontinuity.

6.3.1. Selection of speed command

There are 8 combinations which are listed below for user to choose.

DI status	Valid option	DI signal status(*)		Speed command	Setting range	Related parameter
		SP2	SP1			
SP3 is invalid (default value)	VCM	0	0	Analog Command(VC)	±10V	PC12
	SC1	0	1	Inner speed command 1		PC05
	SC2	1	0	Inner speed command 2		PC06
	SC3	1	1	Inner speed command 3		PC07
SP3 is valid	Valid option	SP3	SP2	SP1	Speed command	Setting range
	VCM	0	0	0	Analog Command(VC)	±10V
	SC1	0	0	1	Inner speed command 1	
	SC2	0	1	0	Inner speed command 2	
	SC3	0	1	1	Inner speed command 3	
	SC4	1	0	0	Inner speed command 4	
	SC5	1	0	1	Inner speed command 5	
	SC6	1	1	0	Inner speed command 6	
	SC7	1	1	1	Inner speed command 7	

(*) 0: OFF(SCx-SG is open-circuit) 1:ON(SCx-SG is short-circuit) x=1~7

- ◆ As the external speed analog command is applied, check the commands which are not permissible to exceed the motor's rated speed otherwise damages would be caused.
- ◆ To make the SP3 valid by setting PD02 to PD09 if the option SC4 to SC7 are used.

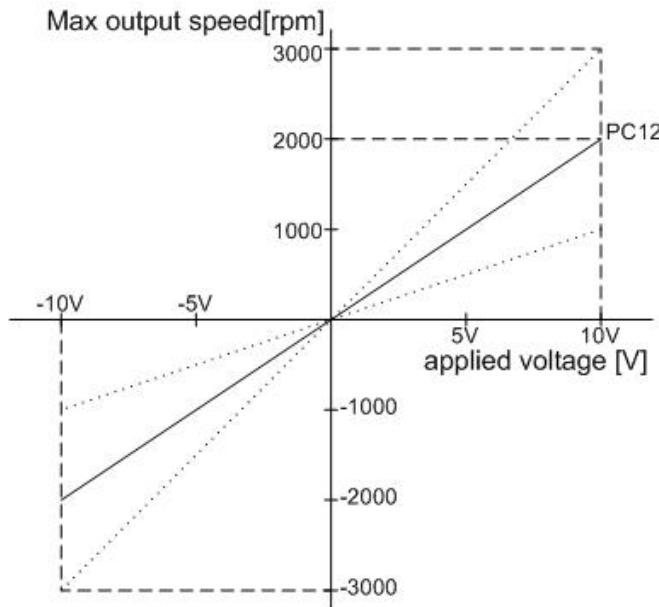
6.3.2. Output speed of maximum speed analog command

The relationship between the applied voltage of the speed analog command and the output speed is described below.

Name	Sign	Setting range	Unit	Initial value	Control mode
Output speed of maximum analog voltage command	PC12	0~30000	rpm	3000	S,T

This value decides the output speed while the maximum permissible voltage is applied. If the PC12 is 3000, the motor would rotate at 3000rpm when the applied voltage of speed command is 10V. If the applied voltage of speed command is 5V, the rotary speed would be 1500rpm. The conversion is listed as follows.

$$\text{The output speed[rpm]} = \frac{\text{applied voltage of speed command}}{10} \times \text{the setting value of PC12}$$



6.3.3. Speed analog command smoothing

If the speed command changed violently, vibration or noise or even overshoot may be occurred by the motor. Users could use related parameters for smoothing process to suppress those needless impacts. The acceleration time constant could be used to adjust the slope of speed pattern from static state to the speed command set by the user. The deceleration time constant could be used to adjust the slope from the rotary state to the static state. The S-pattern acceleration/deceleration time constant could be used to adjust the stability when starting or stopping the motor.

Name	Name Abbr.	Sign	Setting range	Unit	Initial value	Control mode
Acceleration time constant [mS]	STA	PC01	0~20000	mS	200	Pr,S,T
Deceleration time constant [mS]	STB	PC02	0~20000	mS	200	Pr,S,T
S-pattern acc./dec. time constant [mS]	STC	PC03	0~20000	mS	0	Pr,S,T

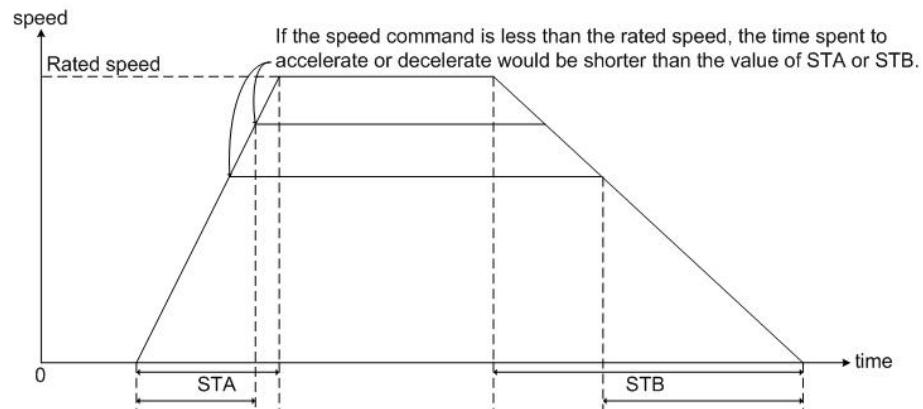
The 3 parameters will be described in detail as follows.

Acceleration time constant

This parameter is the time spent for the motor from 0 rpm to the rated speed and it is defined as “acceleration time constant”. For example, if the rated speed of the servo motor is 3000 rpm and this parameter is set as 3000 (3s). In such case, the motor accelerating from 0 rpm to 3000 rpm would take 3 seconds. When the speed command is set as 1000 rpm, the motor take 1 second to accelerate from 0 rpm to 1000 rpm.

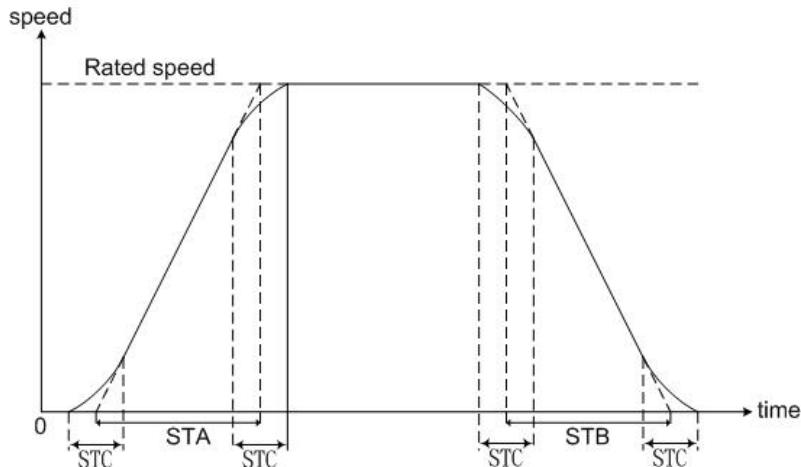
Deceleration time constant

The time spent for the motor to decelerate from the rated speed to 0 rpm is called “deceleration time constant”. For example, if the current speed of the servo motor is 2000 rpm and this parameter is set as 4000 (4s). In such case, the motor decelerating from 2000 rpm to 0 rpm would take 0.5 second. When the running speed is 4000 rpm, the motor take 1 second to decelerate from 4000 rpm to 0 rpm.



S-pattern acc./dec. time constant

The method of S-pattern acceleration/deceleration time constants is to employ a three-step curve during the acceleration or deceleration process in order to soothe the vibration during starting or stopping the motor. Setting an appropriate STC could improve the stability of the motor during startup and stop. The initial S-pattern acceleration/deceleration constants are set as 0 second. Users are recommended to enable this function when the speed control mode is performed.

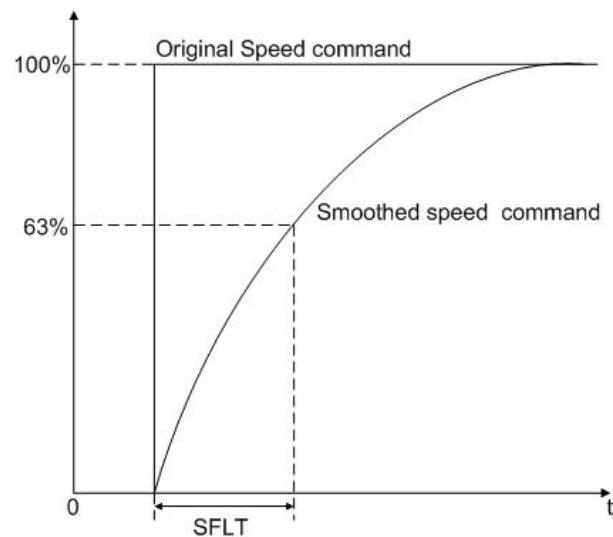


- ◆ Protection during acceleration/deceleration is occupied in the speed control mode.
- ◆ STA,STB,STC could be set independently. Even if STC is “0”, a trapezoidal-pattern is provided.

Low-pass filter smooth time constant

Name	Name Abbr.	Sign	Setting range	Unit	Initial value	Control mode
Speed low-pass filter smooth time constant[mS]	SFLT	PB18	0~1000	mS	0	S,T

A larger parameter value would soothe the speed command more obviously. However, the response would slow down as well. If it is set as zero, this function is disabled.



6.3.4. Torque limit of speed control mode

When this mode is applied, there are two major parameters: PA05 and PC25 which are related to the torque limit function. They are explained in the following table.

Name	Name Abbr.	Sign	Setting range	Unit	Initial value	Control mode
Inner torque limit 1 [%]	TL1	PA05	0~100	%	100	Pt,Pr,S,T
Inner torque limit 2 [%]	TL2	PC25	0~100	%	100	Pt,Pr,S,T

Here are 3 pin functions of CN1: 1 analog voltage input and 2 DI inputs which are described below:

Pin/Signal name	Name Abbr.	Description		Control mode
Torque analog limit	TLA	This signal is valid by the setting of PD02~PD09 to make TL enable. As TLA is valid, the torque output would be limited. When TLA is connected to the positive polarity of the power source , a maximum torque will be generated at +10V.		Pt,Pr,S
Torque limit option	TL	Set the PD02~PD09 parameter to enable this signal. As TL-SG is open circuit, the inner torque limit 1(PA05) is valid. In case of short circuit, the torque analog limitation(TLA) effective.		Pt,Pr,S
Inner torque limit option	TL1	Set the PD02~PD09 parameter to enable this signal. As TL1-SG is short circuit, the Inner torque limit 2(PC25) effective.		Pt,Pr,S,T

There are 4 combinations which are decided by the signal state of TL and TL1.

DI signal status(*)		The valid value of torque limit
TL1	TL	
0	0	The setting value of PA05
0	1	If TLA is less than PA05, then TLA is valid. If TLA is greater than PA05 then PA05 is valid.
1	0	If PC25 is less than PA05, then PC25 is valid. If PC25 is greater than PA05, then PA05 is valid.
1	1	If PC25 is less than TLA, then PC25 is valid. If PC25 is greater than TLA, then TLA is valid.

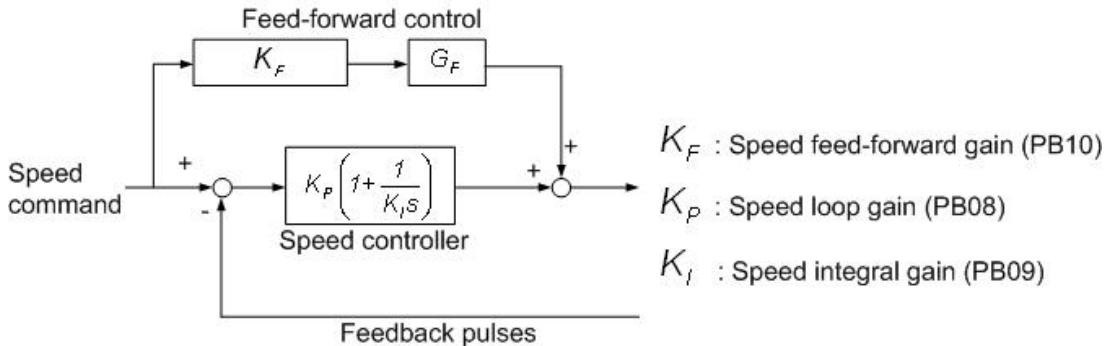
(*) 0: OFF(TL1-SG or TL-SG is open-circuit) ,1:ON(TL1-SG or TL-SG is short-circuit)

If the generated torque suits the value of PA05 or PC25 or torque analog limit, the TLC of DO signal becomes conductive with SG.

Pin/Signal name	Name Abbr.	Description		Control mode
Torque limiting control	TLC	TLC-SG is conductive as the generated torque reaches the inner torque limit 1(PA05), or the torque analog limit (TLA).TLC-SG is isolated when SERVO ON(SON) is off.		Pt,Pr,S

6.3.5. Adjustment of speed loop gain

There are some parameters related to inner speed control loop for users to adjust. Set the value of the PA02 to use the auto-gain tuning function or manual-gain tuning function. If auto-gain tuning function is performed, the load inertia ratio would be approximated continuously and the control gain value would be set automatically. If manual-gain gain tuning is performed, users have to enter the proper value of the load inertia ratio and control gain value. At this time, all automatic or auxiliary functions about inner speed control loop would be disabled. The block diagram of inner speed control loop is presented as follows:



Parameters and settings related of this mode are presented below.

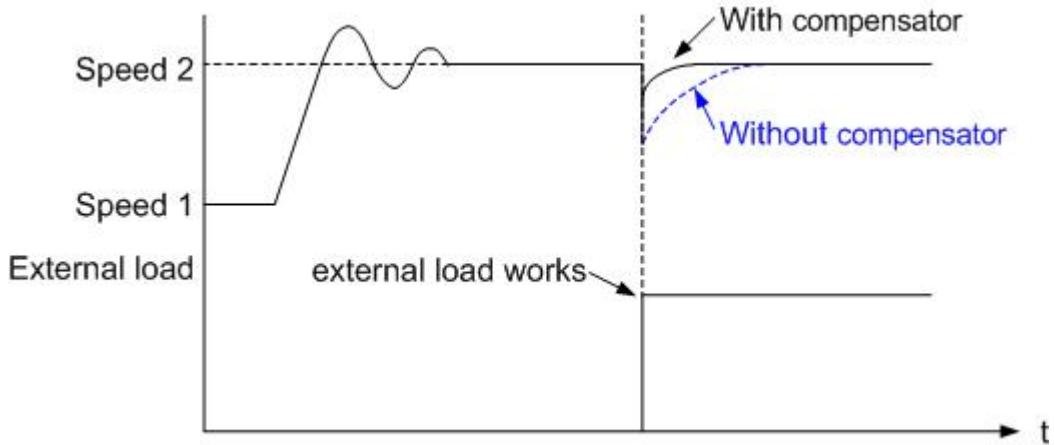
Name	Name Abbr.	Sign	Setting range	Unit	Initial value	Control mode
Gain tuning mode option	ATUM	PA02	0000h ~0003h	---	0002h	Pt,Pr,S
Auto-tuning response level setting	ATUL	PA03	0001h ~000Fh	---	0005h	Pt,Pr,S
Speed loop gain	VG1	PB08	40 ~4096	rad/s	817	Pt,Pr,S
Speed integral gain	VIC	PB09	1 ~1000	mS	48	Pt,Pr,S
Speed feed-forward gain	VFG	PB10	0 ~20000	0.0001	0	S

Auto-gain tuning mode

The driver would tune the optimum gains during the acceleration/deceleration route. Refer to section 5.3.2 for further details.

Manual-gain tuning mode

When the PA02 value is 0000h or 0001h, the effective parameters are: speed loop gain(PB08), speed integral gain(PB09) and speed feed-forward gain (PB10). When PA02 is set as 0001, the servo driver would automatically enable an interference compensator. This function could reduce torque ripple, overshoot and speed ripple. It is suitable for systems with load changed violently. Besides, users should avoid applying this compensator on the system which the ratio of load inertia to motor shaft is greater than 10 times. If necessary, the related parameters should be adjusted according to the various cases. The schematic diagram is as follows.



Parameters for manual-gain tuning mode

Speed loop gain:

Increasing this parameter would improve the bandwidth of speed control loop, but a too large value would cause the mechanism vibration. Therefore, it is recommended to operate the auto-gain tuning mode to approximate a proper values at first. If the value could not satisfy the requirement, to increase this value gradually until the mechanism vibration occurred.

Speed integral gain:

Decreasing this parameter would improve the low-frequency rigidity of speed control loop and reduce the speed stability errors. On the other hand, a too small value would cause the phase delay to make an unstable system.

Speed feed-forward gain value:

The speed feed-forward gain could reduce the phase lag errors, and increase the traceability. If the setting value is near 1, the dynamic tracking error would be very small and the pre-compensation will be the most completed. If the setting value is too low, the improvement would not obvious. But a too high value would cause the system vibration easily.

6.3.6. Resonance suppression filter

When the mechanism with low rigidity generates resonance by reason of the large bandwidth or the large rigidity setting value of the servo driver. If the mechanism factors could not be adjusted, the Shihlin servo driver provides 2 resonance filter frequencies, 4 related parameters of this function and 1 resonance suppression low-pass filter for users to make adjustment. Some parameters related to resonance suppression filter are introduced below.

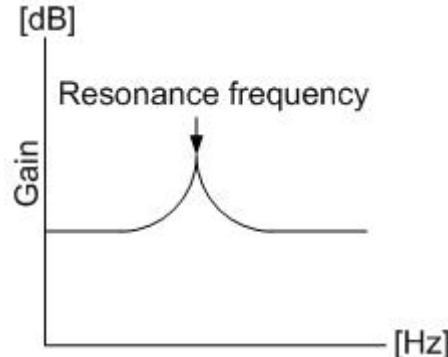
Name	Name Abbr.	Sign	Setting range	Unit	Initial value	Control mode
Machine resonance suppression filter 1	NHF1	PB01	50 ~1000	Hz	1000	Pt,Pr,S,T
Machine resonance suppression attenuation 1	NHD1	PB02	0 ~-32	dB	0	Pt,Pr,S,T
Machine resonance suppression filter 2	NHF2	PB21	50 ~1000	Hz	1000	Pt,Pr,S,T
Machine resonance suppression attenuation 2	NHD2	PB22	0 ~-32	dB	0	Pt,Pr,S,T

Machine resonance suppression filter

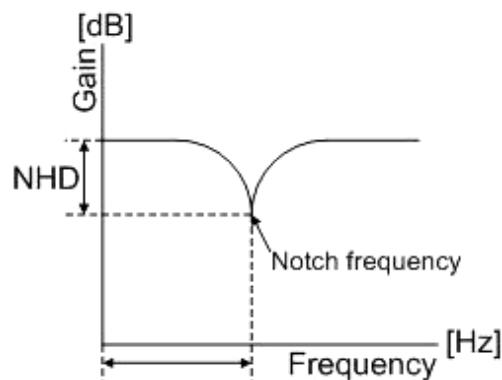
To set a specific frequency which the gain is decreased to suppress the mechanism resonance.

Machine resonance suppression attenuation

To set the attenuation of machine resonance suppression filter with the PB01/PB21. The value “0”denotes the disabled of the notch filter. The mechanism resonance is presented as follows.



The resonance would cause a violent mechanism vibration. In this case, to set the proper PB01/PB21 and PB02/PB22 for the servo driver to eliminate the resonance phenomenon. See the figure below.

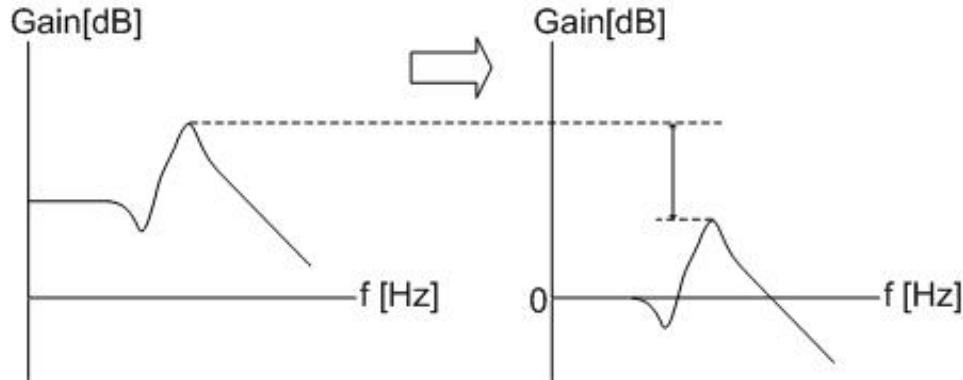


There is an additional resonance suppression low-pass filter and its function is presented below.

Name	Name Abbr.	Sign	Setting range	Unit	Initial value	Control mode
Resonance suppression low-pass filter[mS]	NLP	PB03	0 ~10000	0.1mS	0	Pt,Pr,S,T

Resonance suppression low-pass filter

To set the resonance suppression low-pass filter time constant to eliminate DC gain.



It could be found above that the employ of resonance suppression low-pass filter could suppress the resonance magnitude , but also the system bandwidth is reduced and the phase is lagged.

- ◆ As this resonance suppression filter is applied, it is necessary to know the frequency which resonance occurred then to set the notch depth to make effect.
- ◆ The improper frequency setting would not suppress resonance but amplify it.
- ◆ The effect of the machine resonance suppression filter(PB01,PB02,PB21,PB22) is better than that of resonance suppression low-pass filter if the frequency which resonance occurred is known.
- ◆ If the actual resonance frequency exceeds the setting range of PB01(PB21), use the resonance suppression low-pass filter(PB03) to suppress mechanism resonance.

6.3.7. Gain switch function

The gain switch could be performed for the driver during the running or stop status of the motor. The programmable DI pins could be set as the function of gain switch. If this function is applied, the gain tuning mode option(PA02) should be set as "□□□0" or "□□□1". The gain switch function is invalid under the auto-gain tuning mode option.

Applicable occasions are listed below.

- (1). The rotation noises of motor are loud due to the large gain value setting..
- (2). The load inertial ratio of mechanism is changed violently during the route.
- (3). To improve the response or to shorten the settling time of the machinery system.

The relevant parameters and the detail descriptions are listed below.

Name	Name Abbr.	Sign	Setting range	Unit	Initial value	Control mode
The ratio of load inertial to motor shaft	GD1	PB06	0 ~1200	0.1time	10	Pt,Pr,S
Position loop gain	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	VIC	PB09	1 ~1000	mS	48	Pt,Pr,S
Gain switch option	CDP	PB11	0000h ~0004h	---	0000h	Pt,Pr,S
Gain switch condition value	CDS	PB12	0 ~6000	(*)	10	Pt,Pr,S
Gain switch time constant	CDT	PB13	0 ~1000	mS	1	Pt,Pr,S
The ratio 2 of load inertial to motor shaft	GD2	PB14	0 ~1200	0.1time	70	Pt,Pr,S
Position loop gain change ratio	PG2	PB15	10 ~200	%	100	Pt,Pr
Speed loop gain change ratio	VG2	PB16	10 ~200	%	100	Pt,Pr,S
Speed integral gain change ratio	VIC2	PB17	10 ~200	%	100	Pt,Pr,S

Parameters related to gain switching are described below.

- (1). The method of gain tuning for GD1,PG1,VG1,VIC(PB06~PB09) parameters is the same as manual-gain tuning mode, but they are changeable under this gain switch operation.
- (2). Gain switch option CDP(PB11)

Used to set the gain changing condition. Enable the changing condition in the lowest digit. If users set "1" here, they could use the CDP signal of DI for gain changing. The CDP signal could be assigned to any one of the 8 DI pins using parameters PD02 to PD09.

0	0	0	x
---	---	---	---

x=0: Invalid

x=1: The external CDP signal of DI is ON

x=2: Position command frequency is equal to higher than parameter CDS(PB12) setting

x=3: Position command pulse error is equal to higher than parameter CDS(PB12) setting

x=4: Motor speed is equal to higher than parameter CDS(PB12) setting

(3). Gain switch condition value CDS(PB12)

As users selected "position command frequency", " position command pulse error" or " motor speed" in gain switch option(PB11), set the corresponding gain switch condition.

(*)The setting unit is as follows.

PB11 setting value	Gain switch condition	Unit
□□□2	Position command frequency	kpps
□□□3	Position command pulse error	pulse
□□□4	Motor speed	rpm

(4). Gain switch time constant CDT(PB13)

Used to smooth the motor running at gain switching moment to suppress vibration given to the machine if the gain difference is large.

(5). The ratio 2 of load inertial to motor shaft GD2(PB14)

Set the demand ratio of load inertia to motor shaft after switching. If the load inertia ratio does not change, set it to the same value as GD1(PB06).

(6). The change ratio of PG1/VG1/VIC after gain switching. The original gain values would be switched to the ratio values of PG2/VG2/VIC2 settings.

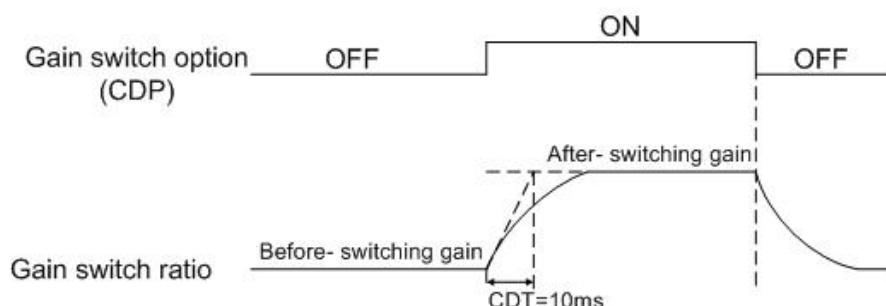
Some examples are described below for the sequence of gain switch function.

Example 1: The external DI signal as the switch option.

①. Relevant parameters setting

Name	Name Abbr.	Sign	Setting value	Unit
The ratio of load inertial to motor shaft	GD1	PB06	10	0.1 time
Position loop gain	PG1	PB07	100	rad/s
Speed loop gain	VG1	PB08	500	rad/s
Speed integral gain	VIC	PB09	100	mS
Gain switch option	CDP	PB11	0001h	---
Gain switch time constant	CDT	PB13	10	mS
The ratio 2 of load inertial to motor shaft	GD2	PB14	20	0.1 time
Position loop gain change ratio	PG2	PB15	80	%
Speed loop gain change ratio	VG2	PB16	120	%
Speed integral gain change ratio	VIC2	PB17	150	%

②. The sequence of gain switch



③. The states of parameters change

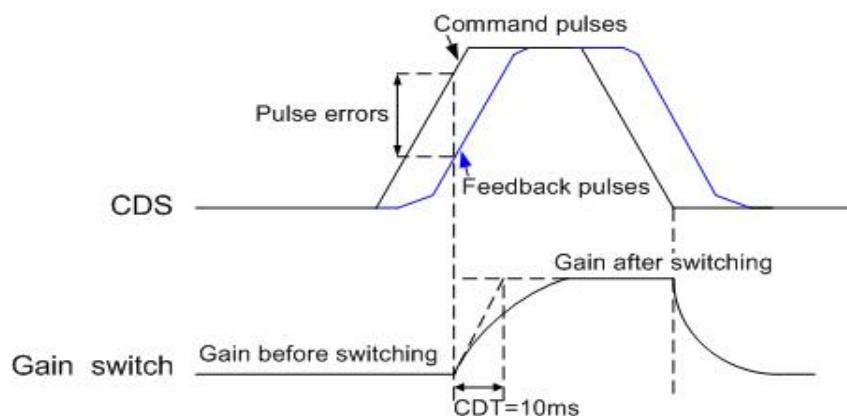
Name	CDP OFF	CDP ON	CDP OFF
The ratio of load inertial to motor shaft	10 → 20	→ 10	
Position loop gain	100 → 80	→ 100	
Speed loop gain	500 → 600	→ 500	
Speed integral gain	100 → 150	→ 100	

Example 2: Trigger condition of position command pulse error.

①. Relevant parameters setting

Name	Name Abbr.	Sign	Setting value	Unit
The ratio of load inertial to motor shaft	GD1	PB06	10	0.1 time
Position loop gain	PG1	PB07	100	rad/s
Speed loop gain	VG1	PB08	500	rad/s
Speed integral gain	VIC	PB09	100	mS
Gain switch option	CDP	PB11	0003h	---
Gain switch condition value	CDS	PB12	100	pulse
Gain switch time constant	CDT	PB13	10	mS
The ratio 2 of load inertial to motor shaft	GD2	PB14	20	0.1 time
Position loop gain change ratio	PG2	PB15	80	%
Speed loop gain change ratio	VG2	PB16	120	%
Speed integral gain change ratio	VIC2	PB17	150	%

②. The sequence of gain switch



③. The states of parameters change

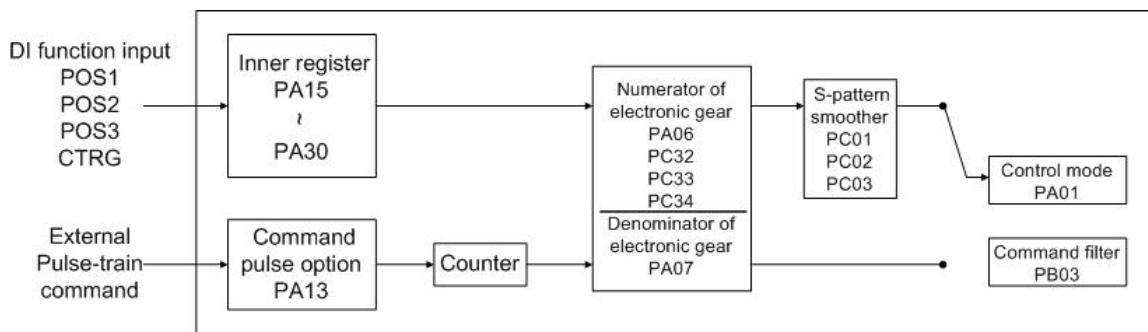
Name	CDP OFF	CDP ON	CDP OFF
The ratio of load inertial to motor shaft	10 → 20	→ 10	
Position loop gain	100 → 80	→ 100	
Speed loop gain	500 → 600	→ 500	
Speed integral gain	100 → 150	→ 100	

6.4. Position control mode

This mode is used at occasions, for example, machine tool, CNC processing, where require highly accurate positioning. There are two ways for position command: one is the external input and the other is internal register input. The external input is to receive the external pulse-train commands. The inner register input enables users to use the inner 8 sets of registers(PA15 to PA30) as the position commands and then set the DI function of POS1 to PO3 to switch the corresponding position command. The following table explains the settings of the external input and inner register input.

Name	Name abbr.	Sign	Control mode	說明				
Control mode option	STY	PA01 (*)	ALL	<p>Setting value of Control mode option: <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>u</td> <td>z</td> <td>y</td> <td>x</td> </tr> </table> <u>x:control mode select</u> 0:position <u>y:position command select</u> 0:external input 1:inner register(absolute type) 2:inner register(incremental type) </p>	u	z	y	x
u	z	y	x					

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



- The S-pattern smooth is invalid as the external pulse-train commands are applied.

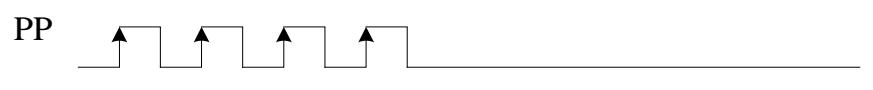
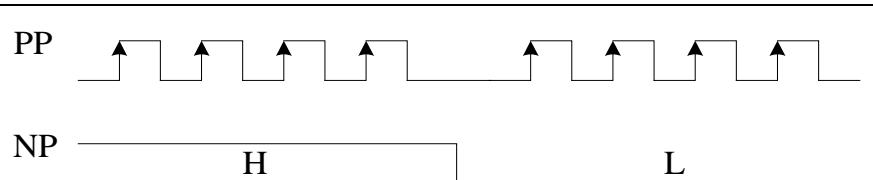
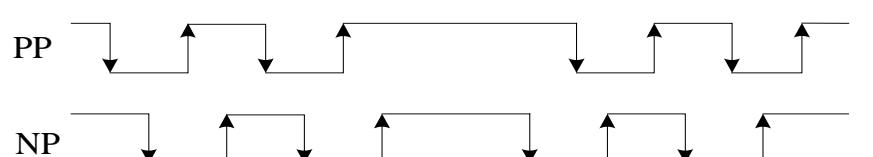
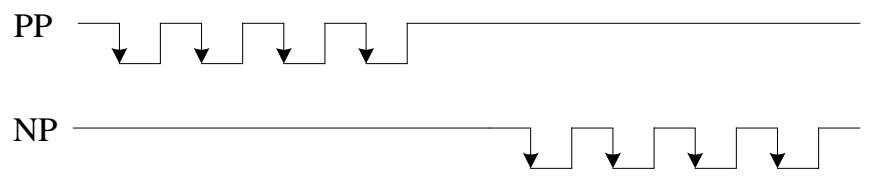
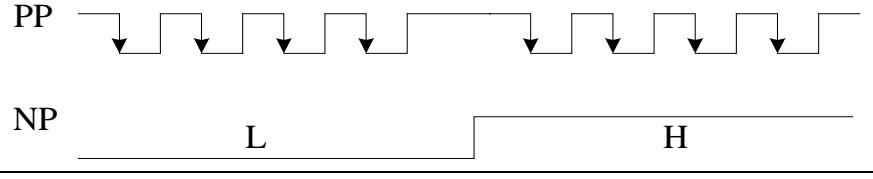
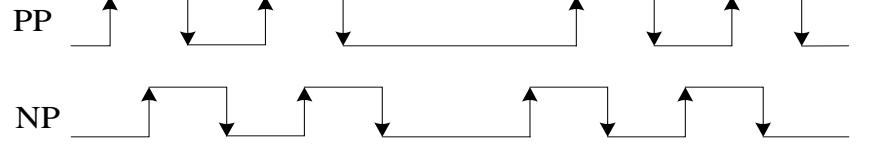
6.4.1. External pulse-train command(Pt mode)

The position commands are provided by external devices. When this mode applied, set the PA01 as 0000h. There are 3 formats which could be used by users. The pulse trigger could be assigned into positive or negative logic. Positive logic means that the driver recognizes the pulse valid by the rising edge. On the other hand, negative logic means the falling edge. Related parameter is listed below.

Name	Name abbr.	Sign	Control mode	Description				
Command pulse option	PLSS	PA13	Pt	<p>Setting value of Control mode option: <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>0</td> <td>z</td> <td>y</td> <td>x</td> </tr> </table> <u>x:pulse-train format select</u> 0:forward/reverse rotation pulse train 1:pulse train + sign 2:A/B phase pulse train <u>y:acknowledged logic</u> 0:positive logic 1:negative logic </p>	0	z	y	x
0	z	y	x					

The PA13 would not be changed as SON on and be valid by power off once and power on again.

The following table is the description of the pulse format and acknowledged logic.

Pulse-train form	Forward	Reverse
Positive logic	Forward/reverse rotation pulse train PP 	
	Pulse train + sign PP 	
	A/B phase pulse train PP 	
Negative logic	Forward/reverse rotation pulse train PP 	
	pulse train + sign PP 	
	A/B phase pulse train PP 	

If pulse train is line driver type, the highest permissible frequency is 500Kpps. If pulse train is open collector type, the highest permissible frequency is 200Kpps.

6.4.2. Inner register command(Pr mode)

The following table explains the combinations of POS1,POS2,POS3,CTRG and speed settings.

Command	POS3	POS2	POS1	CTRG	Position command register		Speed setting
P1	0	0	0	↑	Revolutions	PA15	PA31
					pulses	PA16	
P2	0	0	1	↑	Revolutions	PA17	PA32
					pulses	PA18	
P3	0	1	0	↑	Revolutions	PA19	PA33
					pulses	PA20	
P4	0	1	1	↑	Revolutions	PA21	PA34
					pulses	PA22	
P5	1	0	0	↑	Revolutions	PA23	PA35
					pulses	PA24	
P6	1	0	1	↑	Revolutions	PA25	PA36
					pulses	PA26	
P7	1	1	0	↑	Revolutions	PA27	PA37
					pulses	PA28	
P8	1	1	1	↑	Revolutions	PA29	PA38
					pulses	PA30	

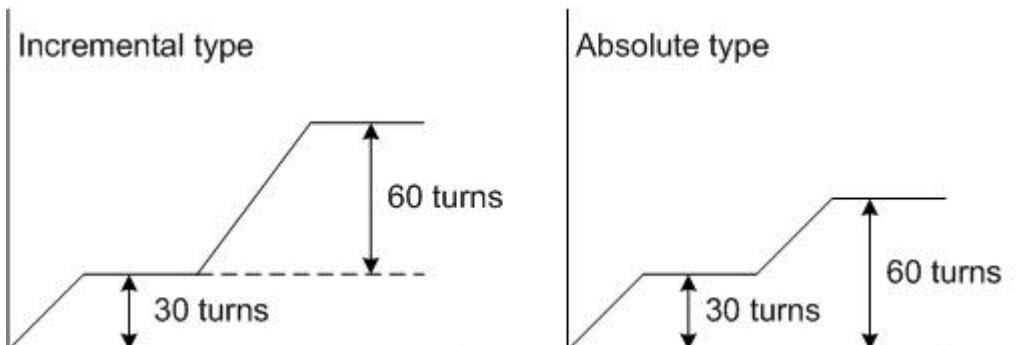
- ◆ The state “↑” of CTRG means the transient of open-circuit to short-circuit.
- ◆ 0: OFF(POSx-SG is open-circuit), 1:ON(POSx-SG is short-circuit), x=1~3
- ◆ To enable the least one of POS1 to POS3 is necessary.

Absolute/incremental position command

The applications of absolute/incremental command are common. Users have to make PA01 valid then use these two types. See the table below for parameter setup.

Name	Name abbr.	Sign	Control mode	説明				
Control mode option	STY	PA01	ALL	Setting value of Control mode option: <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>u</td> <td>z</td> <td>y</td> <td>x</td> </tr> </table> x=0: position control mode y=1: inner register(absolute type) y=2: inner register(incremental type)	u	z	y	x
u	z	y	x					

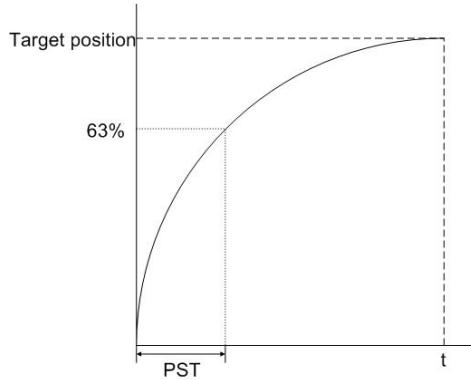
The results of absolute and incremental type even the same sequent of commands are listed.



6.4.3. Position command smoothing

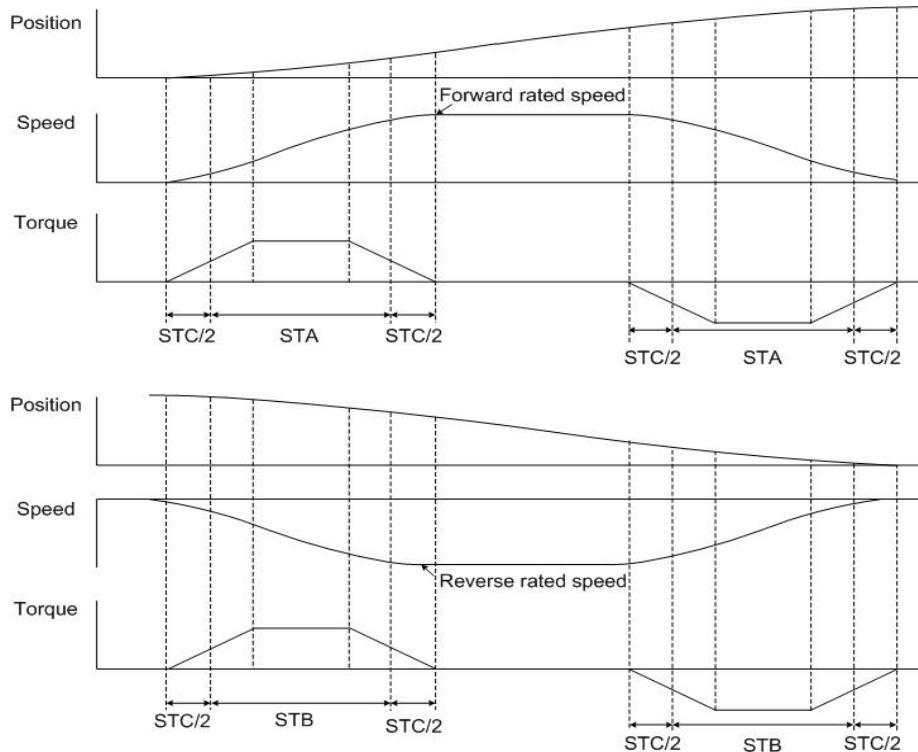
This is used to smooth the running of motor as a violent position command change is applied.

Name	Sign	Setting range	Unit	Initial value	Control mode
Position command filter time constant	PB04	0~20000	mS	3	Pt,Pr



To use the S-pattern smoothing could improve the acceleration/deceleration vibration. The load inertial ratio increased or occasion with huge inertia change may cause a motor rough running. In this case, users could use the STA(PC01), STB(PC02), STC(PC03) to improve the phenomenon.

When the external pulse-train position command is applied, the STA(PC01), STB(PC02), STC(PC03) would be invalid.



As a forward rotation due to position command is done, the acceleration/deceleration time is decided by the PC01. On the other hand, the acceleration/deceleration time of a reverse rotation due to other position command is controlled by the PC02.

As the inner register command is applied, it is recommended to use the S-pattern smoothing.

6.4.4. Electronic gear ratio

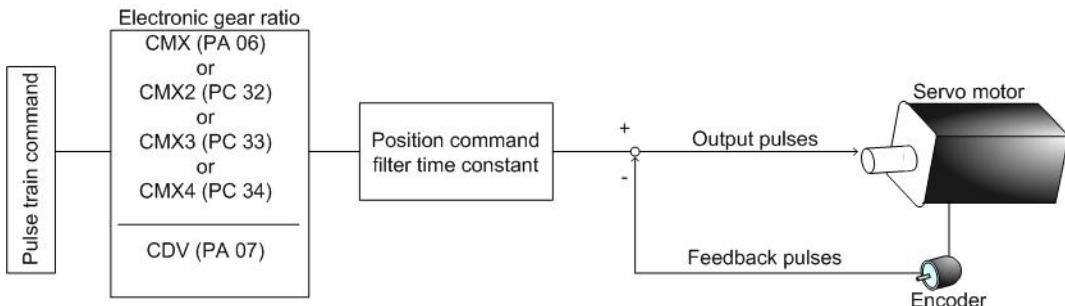
Users could set different electronic gear ratios to enable the transmission mechanism to move different distances. Relevant parameters are presented below.

Name	Name Abbr.	Sign	Setting range	Unit	Initial value	Control mode
Electronic gear numerator	CMX	PA06	1 ~32767			
Electronic gear denominator	CDV	PA07	1 ~32767			
Electronic gear numerator 2	CMX2	PC32	1 ~32767	-	1	Pt,Pr
Electronic gear numerator 3	CMX3	PC33	1 ~32767			
Electronic gear numerator 4	CMX4	PC34	1 ~32767			

The improper setting could lead to unexpected fast rotation so make sure to set them in the state of SERVO OFF. The range of the electronic gear ratio is $\frac{1}{50} \leq \frac{CMX}{CDV}$ (electronic gear ratio) ≤ 200 .

If the setting value is outside this range, the operation of motor may not be performed.

The relationship of electronic gear numerator and electronic gear denominator is plotted below.



4 electronic gear numerators are available for users to select. Enable the function CM1 and CM2 of DI to switch. See the table below.

Name	CM1	CM2	Control mode
Electronic gear numerator (PA06)	0	0	
Electronic gear numerator 2(PC32)	1	0	
Electronic gear numerator 3(PC33)	0	1	
Electronic gear numerator 4(PC34)	1	1	Pt,Pr

◆ 0: OFF(CMx-SG is open-circuit), 1:ON(CMx-SG is short-circuit), x=1,2

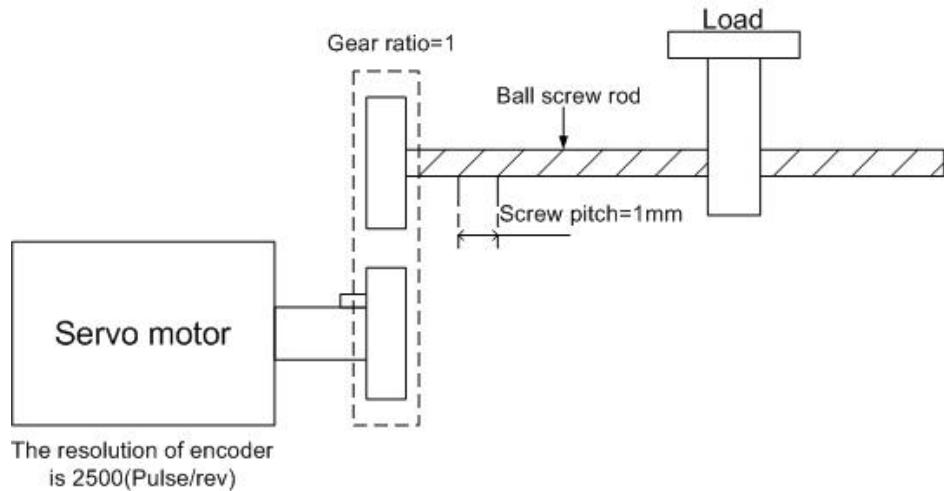
Calculation of electronic gear ratio

Before calculating the value, users have to know the specifications such as the resolution of motor encoder(2500ppr), the deceleration rate, the gear ratio of the machine. Use the following equation to calculate the electronic gear ratio.

$$\text{Encoder resolution} \times 4 \\ \text{Electronic gear ratio} = \frac{\text{Encoder resolution} \times 4}{\text{Load distance per revolution(angle)} / \text{Distance pulses to be shifted entered by user}}$$

If a gear ratio between motor and loads existed, to multiply the factor : $\frac{\text{a turn of motor shaft}}{\text{mechanism turns}}$.

The following example explains the method for setting the electronic gear ratio.



Load distance per revolution is 1mm, the resolution of motor encoder is 2500ppr, the gear ratio of load mechanism to motor shaft is 1, if the demand distance is 5μm, the calculation is listed below.

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

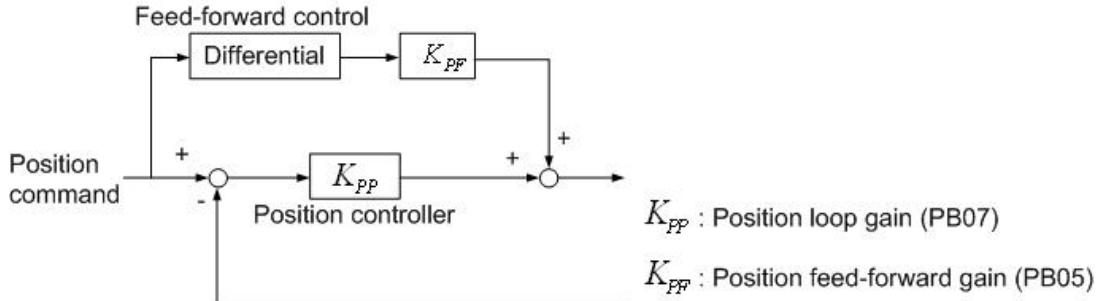
From above, it could be known that by setting the electronic gear numerator as 10000 and the electronic gear denominator as 200, then the ball screw rod would be shift a 5-μm distance after a position pulse command.

6.4.5. Torque limit of position control mode

See section 6.3.4. for details.

6.4.6. Position loop gain

If users need to use manual-gain tuning for position loop, to set parameters of speed loop(see Section 6.3.5) is priority since position loop is outside control of speed loop. Then users could set proportion gain and feed-forward gain of position loop. Usually, position gain is 1/4~1/6 value of the speed loop gain. Users could also use auto-gain tuning mode to set the gains of position and speed loop automatically. Position loop block diagram is presented below.



Parameters related to position gain adjustment are listed below.

Name	Name Abbr.	Sign	Setting range	Unit	Initial value	Control mode
Gain tuning mode option	ATUM	PA02	0000h ~0003h	-	0002h	Pt,Pr,S
Auto-tuning response level setting	ATUL	PA03	0001h ~000Fh	-	0005h	
Position feed-forward gain	FFC	PB05	0 ~20000	0.0001	0	Pt,Pr
Position loop gain	PG1	PB07	4 ~1024	rad/s	35	

If position loop gain PG1(PB07) is set too large, the motor would rotate back and forth and generate vibration even though the bandwidth and response 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 limited due to mechanism factors causes a bad traceability to perform position errors could not be ignored, position feed-forward gain could be used to reduce the dynamic error of position tracking. On the other hand, the usage of feed-forward control also relatively increases the position settling time.

The method for adjusting position feed-forward gain is to increase the value gradually. Theoretically, 1 is the best setting value. The improper value would cause machine vibration easily. In such case, users should decrease the position feed-forward gain to meet a vibration-free situation.

6.5.Hybrid control mode

The 5 hybrid modes of servo driver could satisfy users who need to change varied modes frequently. The parameter PA01 could be changed for the setting of hybrid mode. See the table below.

Control mode		Abbr.	PA01 setting	Description
Hybrid mode	Position with external command - speed	Pt-S	0001h	Via DI signal to switch Pt and S
	Position with external command - torque	Pt-T	0005h	Via DI signal to switch Pt and T
	Position with inner register command - speed	Pr-S	0011h	Via DI signal to switch Pr and S
	Position with inner register command - torque	Pr-T	0015h	Via DI signal to switch Pr and T
	Speed - torque	S-T	0003h	Via DI signal to switch S and T

The arrangement of DI and DO is critical when the hybrid mode is applied. To avoid DI/DO pins insufficient, users could apply external analog voltage signal as the command of speed/torque mode and external pulse train command for position mode so that could reduce the demand of DI.

The function LOP of DI should be made valid as the hybrid mode applied. See the following table.

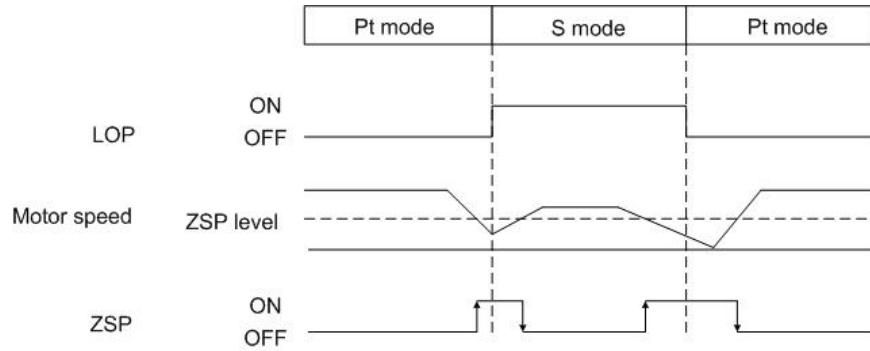
Name	Sign	I/O	CN1 No.	Description	Control mode																		
Control mode switch	LOP	DI	CN1-21 (default)	Option of position/speed switched <table border="1"> <tr><td>LOP(*)</td><td>Control mode</td></tr> <tr><td>0</td><td>position</td></tr> <tr><td>1</td><td>speed</td></tr> </table> Option of speed/torque switched <table border="1"> <tr><td>LOP(*)</td><td>Control mode</td></tr> <tr><td>0</td><td>speed</td></tr> <tr><td>1</td><td>torque</td></tr> </table> Option of torque/position switched <table border="1"> <tr><td>LOP(*)</td><td>Control mode</td></tr> <tr><td>0</td><td>torque</td></tr> <tr><td>1</td><td>position</td></tr> </table>	LOP(*)	Control mode	0	position	1	speed	LOP(*)	Control mode	0	speed	1	torque	LOP(*)	Control mode	0	torque	1	position	Described by varied case
LOP(*)	Control mode																						
0	position																						
1	speed																						
LOP(*)	Control mode																						
0	speed																						
1	torque																						
LOP(*)	Control mode																						
0	torque																						
1	position																						

(*) 0: OFF(LOP-SG is open-circuit), 1: ON(LOP-SG is short-circuit)

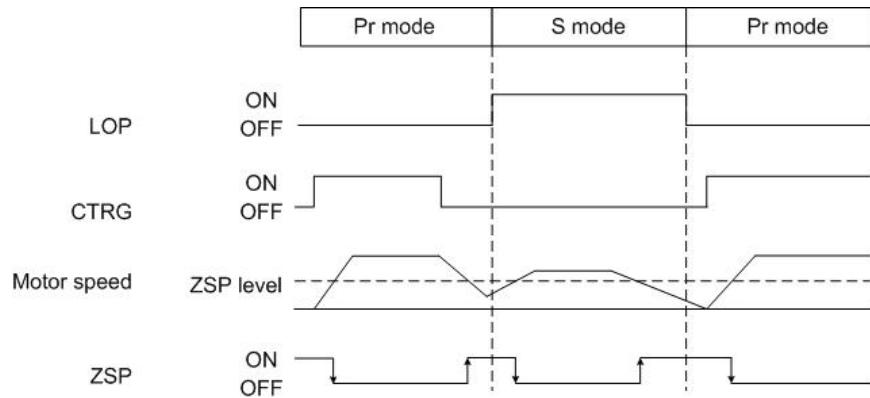
- ◆ The pin function setting of ST1 and RS2 are the same value, as speed/torque hybrid mode is applied and the LOP signal activated, the ST1 function would have priority in speed control mode and the RS2 function would have priority in torque control mode. Others such as POS1/SP2, PC/ST1, RS2/PC, TL/ST2, ST2/RS1, RS1/TL, CR/SP1 are defined mutually. The driver would automatically recognize the corresponding DI pin function when 2 different modes are switched. See Section 3.4.2 for more details.

6.5.1. Position/speed hybrid mode

This hybrid mode is divided into 2 types in detail., i.e. Pt/S and Pr/S. The sequence chart of mode switch is presented in the figure below.



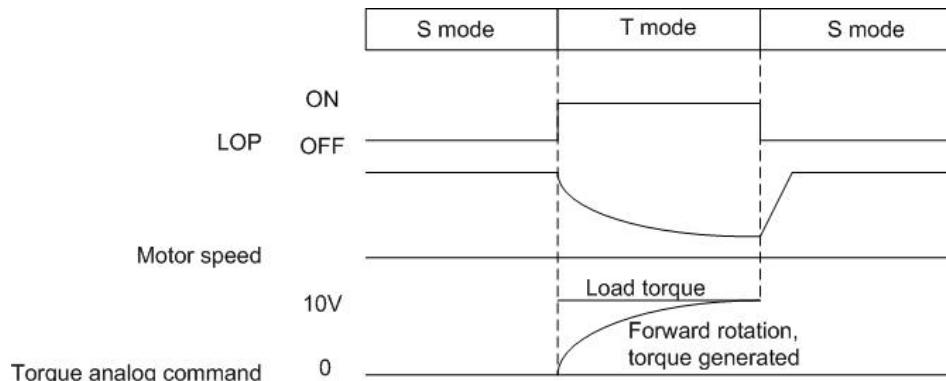
Control mode could not be switched if the motor is at a high speed rotation. It could be performed as the zero speed detection output signal is ON. Yet it is recommended for users to switch control mode when the motor is stopped completely.



6.5.2. Speed/torque hybrid mode

Set the PA01 as 0003h before this hybrid mode performed. Users could use LOP signal to switch speed mode and torque mode. Because pin function ST1(ST2) and RS2(RS1) are defined mutually, the rotation direction of motor would reverse while changing between the speed and torque modes.

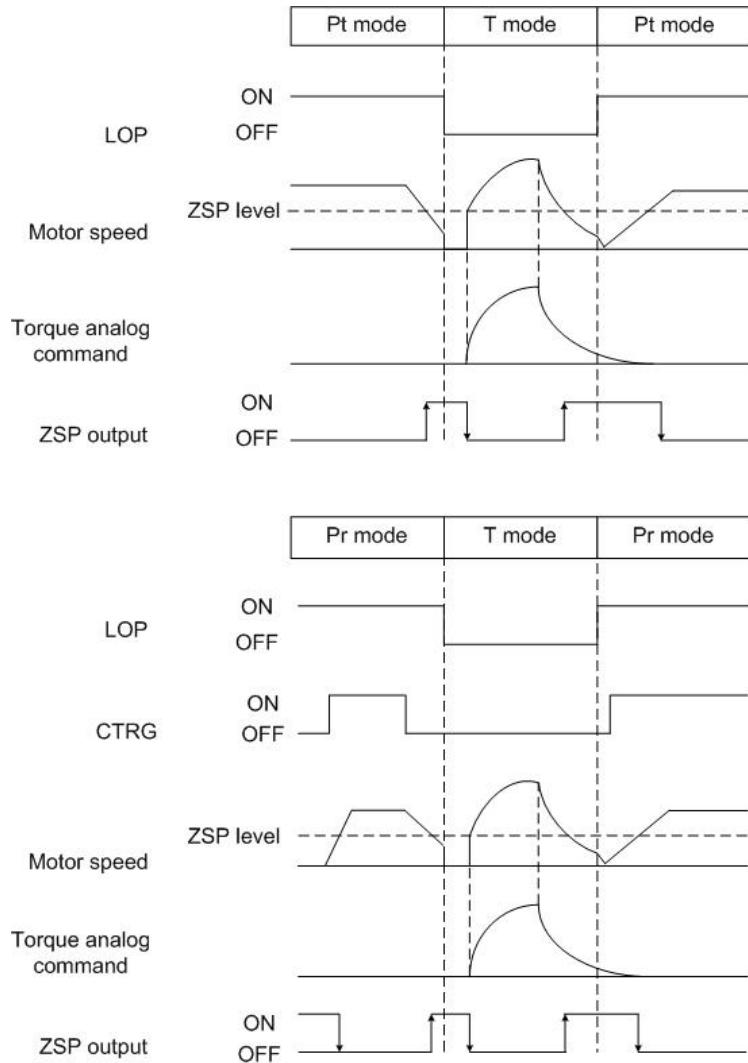
The sequence diagram of the speed / torque mode is presented below.



It is recommended that users switch the speed to torque mode after the motor is static.

6.5.3. Torque/Position hybrid mode

This hybrid mode is divided into 2 types in detail., i.e. T/Pt and T/Pr. Users could use the PA01 as 0005h(T/Pt mode) or 0015h(T/Pr mode). The switch could not be performed if the motor is at a high speed rotation. It could be switched as the zero speed detection output signal is ON. Users could use the pin function LOP of DI to switch these 2 modes. When the position mode with inner register command is wanted, the state of CTRG signal must be turned on. The sequence chart is presented in the figure below.



It is recommended that users switch torque to position mode after the motor is static.

6.6. Other functions

6.6.1. Selection of brake resistor

As the generated torque of motor is opposite to the rotation of motor, the motor would become a power generator. The energy will be transmitted back to the driver then the DC bus(P-N) voltage would raise so a protection to stabilized the safety voltage(within 370V) is necessary. The IGBT switch and resistors constitute this protection. Regenerative energy is consumed by the brake resistor.

There is a built-in brake resistor inside the driver. If the regenerative energy is too large, it is not recommended to use the one. Instead, use an external brake resistor to avoid overheating. When using the built-in brake resistor, make sure that the P/D terminals is short-circuit. As external brake resistor is applied, make P/D terminals open while the external resistor is connected to the P/C terminals.

Built-in brake resistor specifications for the Shihlin servo driver are described below.

Driver(W)	Built-in brake resistor specification		Minimum permissible (Ω)	Consumption power of built-in resistor
	resistor (Ω)	Capacity (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 consumption power is an 50% average value of the rated power of built-in resistor. So as the external brake resistor.

As external brake resistor is applied, the same resistance value mentioned above is required. If serial or and parallel wiring are adopted to increase resistor power, be certain that the resistance meets the minimum permissible condition. Brake resistor with a thermal switch or fan cooling would be helpful to reduce the temperature of brake resistor. Contact the manufacturers for load character of resistors.

The following table is a reference for the opinion of brake resistor chosen.

Driver(W)	Rotor inertial, J($\times 10^{-4}$ kg·m 2)	Motor sudden stop or rotation changed, Es(joule)	Regenerative-energy of capacitor, Ec(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

Energy is calculated as follows:

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

$$E_C = \frac{1}{2} C (V_s^2 - V_c^2)$$

Where:

J_L : Load inertial

J_M : Rotor inertial

N_M : Rated speed(rpm)

V_c : DC bus mormal voltage

V_s : DC bus regenerative voltage as protection trigled

If an external resistor is applied, take the following steps to calculate the capacity of it:

1. Set the duty cycle T which is defined by users.
2. Set the rotation speed N_M .
3. Set the load inertial and the rotor inertial.
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 the regenerative energy of capacitor $E_C = \frac{1}{2} C (V_s^2 - V_c^2)$.
6. Calculate the capacity of the regenerative resistor $2 \times ((N+1) \times E_s - E_C) / T$

If the load is N times inertial of the rotor, the regenerative energy would be $(N+1) \times E_s$ when the motor brakes and the speed drops to 0 rpm. If the capacity of external brake resistor is too small, the accumulated energy will cause the temperature higher. AL04 would be occurred if the temperature exceeds a certain value.

6.6.2. Analog monitor output

There are 2 analog monitor channels provided for users to check the required signals. The contents and settings of monitor output are described in the table below.

Name	Abbr.	Sign	Setting range	Description				
Analog monitor output	MOD	PC14	0000h ~0707h	<p>There are 2 monitor outputs, ch1 and ch2. <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>0</td> <td>ch2</td> <td>0</td> <td>ch1</td> </tr> </table> </p> <p>The setting values and their corresponding output are listed below.</p> <ul style="list-style-type: none"> 0: Motor speed (scale: $\pm 10V/(double\ rated\ speed)$) 1: Generated torque (scale: $\pm 10V/max.torque$) 2: Speed command (scale: $\pm 10V/(double\ rated\ speed)$) 3: Effective load ratio (scale: $\pm 10V/\pm 300\%$) 4: Pulse command frequency (scale: $\pm 10V/500kpps$) 5: Current command (scale: $\pm 10V/max.current\ command$) 6: DC Bus voltage (scale: $\pm 10V/400V$) 7: Pulse command error (scale: $\pm 10V/10000pulse$) 	0	ch2	0	ch1
0	ch2	0	ch1					

Example:

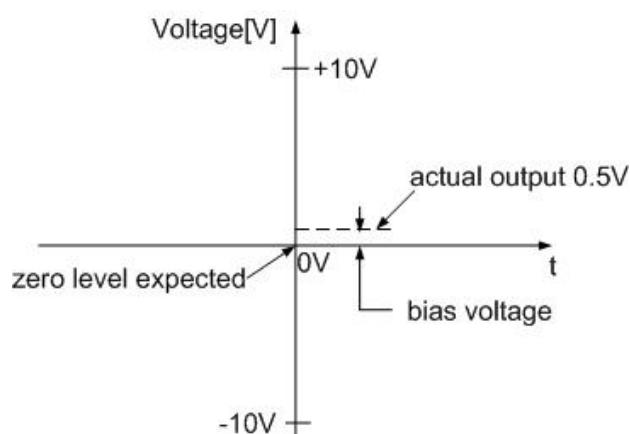
If the PC14 is set as 0000h and the current speed of motor is forward rotation 3000 rpm, a +5V signal would be measured on CN1-30 and LG. On the other hand, a -5V signal would be detected if the speed of motor is reverse rotation -3000 rpm. The mentioned example above is without any adjustment of PC28 to PC31.

Voltage offset of analog monitor

The parameter PC28 and PC29 are used to set the compensation to eliminate the bias voltages of analog monitor output MON1 and MON2.

Name	Abbr.	Sign	Setting range	Description	Unit	Initial value
Analog monitor ch1 offset	MO1	PC28	-999 ~999	Used to set the offset voltage of the analog monitor ch1 output.	mV	0
Analog monitor ch2 offset	MO2	PC29	-999 ~999	Used to set the offset voltage of the analog monitor ch2 output.	mV	0

Here is an example.



It assumes that the motor speed is 0 rpm, then the analog monitor voltage output should be 0 V. This difference above is 0.5 V, which could be compensated by setting PC28 or PC29 as -500mV so the MOD analog voltage would be corrected.

Output proportion of analog monitor

The output proportion of analog monitor enables users to set the ratio of the analog voltage output to be viewed. Relevant parameters are presented in the table below.

Name	Abbr.	Sign	Setting range	Description	Unit	Initial value
Analog monitor ch1 output proportion	MOG1	PC30	0 ~100	Set the output proportion of analog monitor ch1.	%	100
Analog monitor ch2 output proportion	MOG2	PC31	0 ~100	Set the output proportion of analog monitor ch2.	%	100

If the current rotation speed is +3000 rpm and monitor scale is $\pm 10V$ (double rated speed), the analog output should be +5V if MOG1 or MOG2 is set as initial value(100%). So, the analog monitor output voltage by MON should be +10V in case of 50% setting value applied.

The equation is:

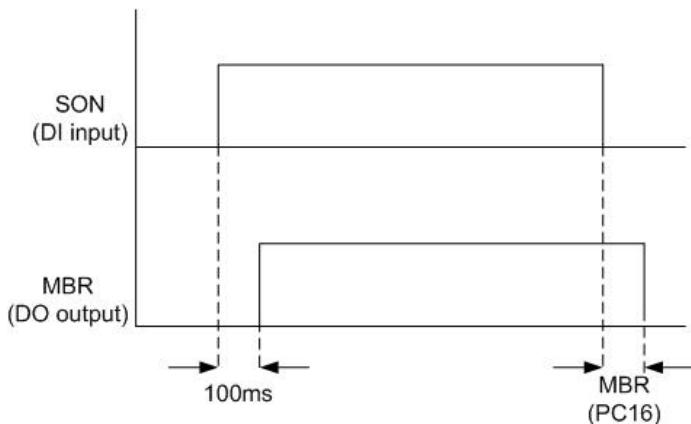
$$\text{Monitor output} = \text{monitoring value} \times \langle \text{monitor scale} \rangle \div \text{MOG}$$

6.6.3. Operation of electromagnetic brake

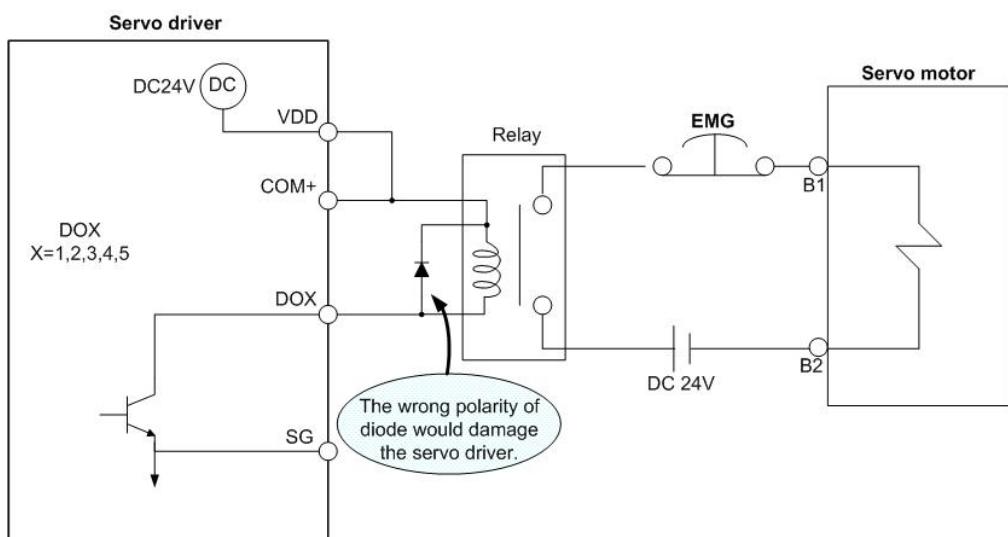
The operation of electromagnetic brake is described: (1)As MBR is OFF, the electromagnetic brake has not been magnetized yet and motor shaft is locked. (2)As MBR is ON, the electromagnetic brake has been magnetized and motor shaft is rotatable. The parameter PC16 could be used to decide the delay time of the SON signal off to the MBR signal activated. Usually the electromagnetic brake is applied on the Z axis(vertical axis) application to reduces torque generated of servo driver. For the proper operation done, the electromagnetic brake must be activated after turning off the servo driver. If users operate the electromagnetic brake by themselves, it should be enabled in deceleration process of servo motor so that the braking torque generated by electromagnetic brake and that by servo motor are in the same direction. As a result, the driver would work normally because the less interference from the electromagnetic brake. If it is activated in the acceleration or constant speed, the driver would generate a higher current to overcome the torque generated by the electromagnetic brae and may cause the alarm due to overload.

- ◆ MBR signal controls the open/short state of electromagnetic brake relay and provides the power to magnetize the electromagnetic brake to release the motor shaft.
- ◆ The coil of electromagnetic brake is without polarity.
- ◆ Do not connect the brake to power source (VDD) of the control signal.

The operation sequence of electromagnetic brake is plotted below.



Wiring diagram of electromagnetic brake.



7. Parameters

7.1. Parameter definition

In this Shihlin SDA servo driver, its parameters are classified into the basic parameters, gain values, filters, expansion parameters and I/O parameters according to their safety aspects and frequencies of use. When an advance adjustment is required, change the parameter PA42 setting to make the expansion parameters write-enabled.

Here are some notes for reading of parameter manual.

1. Parameter classification

There is a parameter list which is classified due to the functions for user to consult conveniently. Refer to section 7.3 for more details.

2. Special symbol of parameter sign

(★) denotes the change is valid by power off once and power on again. The PA01 is an example.

(▲) denotes the invalid change as the Servo ON activated. The PA07 is another example.

There are 2 ways to make Servo ON disabled.

(1) Turn off the SON signal of DI.

(2) Set the PD16 as 1 and the driver would be at Servo OFF state. But remember to recover it after the completion of modification.

Group classification according to different functions is listed below.

Group	Description
Basic parameter (No PA□□□)	Used to perform the position control. Please set this parameter group.
Gain, filter (No PB□□□)	Used to perform the manual-gain tuning. Please set this parameter group.
Expansion (No PC□□□)	As speed or torque control is required, please set this parameter group.
I/O settings (No PD□□□)	Used to change the states of I/O signal. Please set this parameter group.

The control mode is described as follows.

Mode	Sign	Description
Single mode	Pt	Driver runs motor to reach the goal according to the external commands which are received through the CN1 and are in the form of pulse trains.
	Pr	Driver runs motor to reach the goal according to the inner commands which are from inner 8 registers that could be switched by DI signals.
	S	Driver runs motor to attain the target speed. The command type which is an analog voltage or the inner registers could be switched by DI.
	T	The driver receives the commands to run the motor to generate the demanded torque. The command source is the analog voltage.
Hybrid mode	Pt-S	Pt/S is switched mutually via the LOP signal of DI.
	Pt-T	Pt/T is switched mutually via the LOP signal of DI.
	Pr-S	Pr/S is switched mutually via the LOP signal of DI.
	Pr-T	Pr/T is switched mutually via the LOP signal of DI.
	S-T	S/T is switched mutually via the LOP signal of DI.

7.2. Parameter list

The parameters of Shihlin servo driver could be classify into 4 groups. The PA group is basic for control mode option, auto-tuning, etc. The PB group is for gain and filter functions. The PC group is an expansion one which includes parameters related to speed/torque control mode and analog-related and communication parameters. The PD group is for I/O parameters which enables users to set parameters for DI and DO. The following table is the parameter list for users to consult.

(1) Basic parameters

NO	Abbr.	Name	Initial value	Unit	Control mode			
					Pt	Pr	S	T
PA01(★)	STY	Control mode option	1000h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PA02(▲)	ATUM	Gain tuning mode option	0002h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
PA03	ATUL	Auto-tuning response level setting	0005h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
PA04	HMOV	Home moving option	0000h	-		<input type="radio"/>		
PA05	TL1	Torque limit 1	100	%	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PA06	CMX	Electronic gear numerator	1	-	<input type="radio"/>	<input type="radio"/>		
PA07(▲)	CDV	Electronic gear denominator	1	-	<input type="radio"/>	<input type="radio"/>		
PA08	HSPD1	Home moving high speed option 1	1000	rpm		<input type="radio"/>		
PA09	HSPD2	Home moving high speed option 2	50	rpm		<input type="radio"/>		
PA10	HOF1	Home moving revolution offset	0	rev		<input type="radio"/>		
PA11	HOF2	Home moving pulse offset	0	pulse		<input type="radio"/>		
PA12	INP	In-position range	100	Pulse	<input type="radio"/>	<input type="radio"/>		
PA13(★)	PLSS	Command pulse option	0000h	-	<input type="radio"/>			
PA14(★)	ENR	Encoder output pulses	10000	pulse/rev	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PA15	PO1H	Revolution of inner position command 1	0	rev		<input type="radio"/>		
PA16	PO1L	Pulse of inner position command 1	0	pulse		<input type="radio"/>		
PA17	PO2H	Revolution of inner position command 2	0	rev		<input type="radio"/>		
PA18	PO2L	Pulse of inner position command 2	0	pulse		<input type="radio"/>		
PA19	PO3H	Revolution of inner position command 3	0	rev		<input type="radio"/>		
PA20	PO3L	Pulse of inner position command 3	0	pulse		<input type="radio"/>		
PA21	PO4H	Revolution of inner position command 4	0	rev		<input type="radio"/>		
PA22	PO4L	Pulse of inner position command 4	0	pulse		<input type="radio"/>		
PA23	PO5H	Revolution of inner position command 5	0	rev		<input type="radio"/>		
PA24	PO5L	Pulse of inner position command 5	0	pulse		<input type="radio"/>		
PA25	PO6H	Revolution of inner position command 6	0	rev		<input type="radio"/>		
PA26	PO6L	Pulse of inner position command 6	0	pulse		<input type="radio"/>		
PA27	PO7H	Revolution of inner position command 7	0	rev		<input type="radio"/>		
PA28	PO7L	Pulse of inner position command 7	0	pulse		<input type="radio"/>		
PA29	PO8H	Revolution of inner position command 8	0	rev		<input type="radio"/>		
PA30	PO8L	Pulse of inner position command 8	0	pulse		<input type="radio"/>		

PA31	POV1	Moving speed of inner position command 1	1000	rpm		○		
PA32	POV2	Moving speed of inner position command 2	1000	rpm		○		
PA33	POV3	Moving speed of inner position command 3	1000	rpm		○		
PA34	POV4	Moving speed of inner position command 4	1000	rpm		○		
PA35	POV5	Moving speed of inner position command 5	1000	rpm		○		
PA36	POV6	Moving speed of inner position command 6	1000	rpm		○		
PA37	POV7	Moving speed of inner position command 7	1000	rpm		○		
PA38	POV8	Moving speed of inner position command 8	1000	rpm		○		
PA39(★)	POL	Motor rotary direction option	0000h	-	○	○	○	○
PA40(▲)	SPW	Special parameter write-enable	0000h	-	○	○	○	○
PA42(★)	BLK	Parameter write-inhibit	0000h	-	○	○	○	○

(2)Gain, filter parameters

NO	Abbr.	Name	Initial value	Unit	Control mode			
					Pt	Pr	S	T
PB01	NHF1	Machine resonance suppression filter 1	1000	Hz	○	○	○	○
PB02	NHD1	Machine resonance suppression attenuation 1	0	dB	○	○	○	○
PB03	NLP	Resonance suppression low-pass filter	0	0.1mS	○	○	○	○
PB04	PST	Position command filter time constant	3	mS	○	○		
PB05	FFC	Position feed-forward gain	0	%	○	○		
PB06	GD1	The ratio of load inertial to motor shaft	10	0.1time	○	○	○	
PB07	PG1	Position loop gain	35	rad/s	○	○		
PB08	VG1	Speed loop gain	817	rad/s	○	○	○	
PB09	VIC	Speed integral gain	48	mS	○	○	○	
PB10	VFG	Speed feed-forward gain	0	0.0001			○	
PB11(★)	CDP	Gain switch condition	0000h	-	○	○	○	
PB12	CDS	Gain switch condition value	10	pulse	○	○	○	
PB13	CDT	Gain switch time constant	1	mS	○	○	○	
PB14	GD2	The ratio 2 of load inertial to motor shaft	70	0.1time	○	○	○	
PB15	PG2	Position loop gain change ratio	100	%	○	○	○	
PB16	VG2	Speed loop gain change ratio	100	%	○	○	○	
PB17	VIC2	Speed integral gain change ratio	100	%	○	○	○	
PB18	SFLT	Speed low-pass filter smooth time constant	0	mS			○	○
PB19	TQC	Torque command filter time constant	0	mS				○
PB20	SJIT	Speed feedback filter time constant	0	0.1mS	○	○	○	○
PB21	NHF2	Machine resonance suppression filter 2	1000	Hz	○	○	○	○
PB22	NHD2	Machine resonance suppression attenuation 2	0	dB	○	○	○	○
PB23	MVS	Micro-vibration suppression option	0000h	-	○	○		
PB24	VDC	Speed differential compensation	980	-	○	○	○	

(3) Expansion parameters

NO	Abbr.	Name	Initial value	Unit	Control mode			
					Pt	Pr	S	T
PC01	STA	Acceleration time constant	200	mS		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC02	STB	Deceleration time constant	200	mS		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC03	STC	S-pattern acc./dec. time constant	0	mS		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC04	JOG	JOG speed command	300	rpm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC05	SC1	Inner speed command/limit 1	100	rpm		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC06	SC2	Inner speed command/limit 2	500	rpm		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC07	SC3	Inner speed command/limit 3	1000	rpm		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC08	SC4	Inner speed command/limit 4	200	rpm		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC09	SC5	Inner speed command/limit 5	300	rpm		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC10	SC6	Inner speed command/limit 6	500	rpm		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC11	SC7	Inner speed command/limit 7	800	rpm		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC12(▲)	VCM	Output speed of maximum analog command	3000	rpm		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC13(▲)	TLC	Torque generated of maximum analog command	100	%	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC14	MOD	Analog monitor output	0100h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC15(★)	SVZR	Speed analog zero voltage acknowledged range	10	mV		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC16	MBR	Electromagnetic brake output delay time	100	mS	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC17	ZSP	Zero speed acknowledged range	50	rpm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC18(★)	COP1	Stop option and power interruption restart option	0010h	-		<input type="radio"/>		
PC19(★)	COP2	Alarm history clear option	0000h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC20(★)	SNO	Communication device number	1	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC21(★)	CMS	Communication mode option	0010h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC22(★)	BPS	Communication protocol option	0010h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC23	SIC	Communication time-out process option	0	S	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC24(★)	DMD	Status display option	0000h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC25	TL2	Inner torque limit 2	100	%	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC26	VCO	Speed analog command/limit offset	0	mV		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC27	TLO	Torque analog command/limit offset	0	mV		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC28	MO1	Analog monitor ch1 offset	0	mV	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC29	MO2	Analog monitor ch2 offset	0	mV	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC30	MOG1	Analog monitor ch1 output proportion	100	%	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC31	MOG2	Analog monitor ch2 output proportion	100	%	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC32	CMX2	Electronic gear numerator 2	1	-	<input type="radio"/>	<input type="radio"/>		
PC33	CMX3	Electronic gear numerator 3	1	-	<input type="radio"/>	<input type="radio"/>		
PC34	CMX4	Electronic gear numerator 4	1	-	<input type="radio"/>	<input type="radio"/>		
PC35(★)	VCL	VC voltage limit	0	mV		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(4) I/O setting parameters

NO	Abbr.	Name	Initial value	Unit	Control mode			
					Pt	Pr	S	T
PD01(★)	DIA1	Digital input signal auto-ON option	0000h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD02(★)	DI1	Digital input 1 option	0001h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD03(★)	DI2	Digital input 2 option	0007h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD04(★)	DI3	Digital input 3 option	0009h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD05(★)	DI4	Digital input 4 option	000Ah	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD06(★)	DI5	Digital input 5 option	0002h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD07(★)	DI6	Digital input 6 option	0006h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD08(★)	DI7	Digital input 7 option	0012h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD09(★)	DI8	Digital input 8 option	0011h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD10(★)	DO1	Digital output 1 option	0003h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD11(★)	DO2	Digital output 2 option	0008h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD12(★)	DO3	Digital output 3 option	0006h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD13(★)	DO4	Digital output 4 option	0005h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD14(★)	DO5	Digital output 5 option	0001h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD15(★)	DIF	Digital input filter time option	0002h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD16(★)	IOS	Digital input on/off state control option	0000h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD17(★)	DOP1	LSP/LSN triggered stop option	0000h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD18(★)	DOP2	CR signal clear option	0000h	-	<input type="radio"/>	<input type="radio"/>		
PD19(★)	DOP3	Alarm code output option	0000h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD20(★)	DOP4	Alarm reset triggered process	0000h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Some parameter categories which are helpful to operate varied control mode are listed below.

Torque control related parameters							
NO	Abbr.	Name	Initial value	Unit	Control mode		
					Pt	Pr	S
PA01(★)	STY	Control mode option	1000h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PA05	TL1	Torque limit 1	100	%	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC05	SC1	Inner speed command/limit 1	100	rpm			<input type="radio"/>
PC06	SC2	Inner speed command/limit 2	500	rpm			<input type="radio"/>
PC07	SC3	Inner speed command/limit 3	1000	rpm			<input type="radio"/>
PC08	SC4	Inner speed command/limit 4	200	rpm			<input type="radio"/>
PC09	SC5	Inner speed command/limit 5	300	rpm			<input type="radio"/>
PC10	SC6	Inner speed command/limit 6	500	rpm			<input type="radio"/>
PC11	SC7	Inner speed command/limit 7	800	rpm			<input type="radio"/>
PC12(▲)	VCM	Output speed of maximum analog command	3000	rpm			<input type="radio"/>
PC13(▲)	TLC	Torque generated of maximum analog command	100	%	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC25	TL2	Inner torque limit 2	100	%	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC26	VCO	Speed analog command/limit offset	0	mV			<input type="radio"/>
PC27	TLO	Torque analog command/limit offset	0	mV			<input type="radio"/>
PC35(★)	VCL	VC voltage limit	0	mV			<input type="radio"/>

Speed control related parameters							
NO	Abbr.	Name	Initial value	Unit	Control mode		
					Pt	Pr	S
PA01(★)	STY	Control mode option	1000h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PA05	TL1	Torque limit 1	100	%	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PA14(★)	ENR	Encoder output pulses	10000	pulse/rev	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PB18	SFLT	Speed low-pass filter smooth time constant	0	mS			<input type="radio"/>
PC05	SC1	Inner speed command/limit 1	100	rpm			<input type="radio"/>
PC06	SC2	Inner speed command/limit 2	500	rpm			<input type="radio"/>
PC07	SC3	Inner speed command/limit 3	1000	rpm			<input type="radio"/>
PC08	SC4	Inner speed command/limit 4	200	rpm			<input type="radio"/>
PC09	SC5	Inner speed command/limit 5	300	rpm			<input type="radio"/>
PC10	SC6	Inner speed command/limit 6	500	rpm			<input type="radio"/>
PC11	SC7	Inner speed command/limit 7	800	rpm			<input type="radio"/>
PC12(▲)	VCM	Output speed of maximum analog command	3000	rpm			<input type="radio"/>
PC25	TL2	Inner torque limit 2	100	%	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC26	VCO	Speed analog command/limit offset	0	mV			<input type="radio"/>
PC27	TLO	Torque analog command/limit offset	0	mV			<input type="radio"/>

Position control related parameters						
NO	Abbr.	Name	Initial value	Unit	Control mode	
					Pt	Pr
PA01(★)	STY	Control mode option	1000h	-	<input type="radio"/>	<input type="radio"/>
PA04	HMOV	Home moving option	0000h	-	<input type="radio"/>	
PA05	TL1	Torque limit 1	100	%	<input type="radio"/>	<input type="radio"/>
PA06	CMX	Electronic gear numerator	1	-	<input type="radio"/>	<input type="radio"/>
PA07(▲)	CDV	Electronic gear denominator	1	-	<input type="radio"/>	<input type="radio"/>
PA13(★)	PLSS	Command pulse option	0000h	-	<input type="radio"/>	
PA14(★)	ENR	Encoder output pulses	10000	pulse/rev	<input type="radio"/>	<input type="radio"/>
PA15	PO1H	Revolution of inner position command 1	0	rev	<input type="radio"/>	
PA16	PO1L	Pulse of inner position command 1	0	pulse	<input type="radio"/>	
PA17	PO2H	Revolution of inner position command 2	0	rev	<input type="radio"/>	
PA18	PO2L	Pulse of inner position command 2	0	pulse	<input type="radio"/>	
PA19	PO3H	Revolution of inner position command 3	0	rev	<input type="radio"/>	
PA20	PO3L	Pulse of inner position command 3	0	pulse	<input type="radio"/>	
PA21	PO4H	Revolution of inner position command 4	0	rev	<input type="radio"/>	
PA22	PO4L	Pulse of inner position command 4	0	pulse	<input type="radio"/>	
PA23	PO5H	Revolution of inner position command 5	0	rev	<input type="radio"/>	
PA24	PO5L	Pulse of inner position command 5	0	pulse	<input type="radio"/>	
PA25	PO6H	Revolution of inner position command 6	0	rev	<input type="radio"/>	
PA26	PO6L	Pulse of inner position command 6	0	pulse	<input type="radio"/>	
PA27	PO7H	Revolution of inner position command 7	0	rev	<input type="radio"/>	
PA28	PO7L	Pulse of inner position command 7	0	pulse	<input type="radio"/>	
PA29	PO8H	Revolution of inner position command 8	0	rev	<input type="radio"/>	
PA30	PO8L	Pulse of inner position command 8	0	pulse	<input type="radio"/>	
PA31	POV1	Moving speed of inner position command 1	1000	rpm	<input type="radio"/>	
PA32	POV2	Moving speed of inner position command 2	1000	rpm	<input type="radio"/>	
PA33	POV3	Moving speed of inner position command 3	1000	rpm	<input type="radio"/>	
PA34	POV4	Moving speed of inner position command 4	1000	rpm	<input type="radio"/>	
PA35	POV5	Moving speed of inner position command 5	1000	rpm	<input type="radio"/>	
PA36	POV6	Moving speed of inner position command 6	1000	rpm	<input type="radio"/>	
PA37	POV7	Moving speed of inner position command 7	1000	rpm	<input type="radio"/>	
PA38	POV8	Moving speed of inner position command 8	1000	rpm	<input type="radio"/>	
PA39(★)	POL	Motor rotary direction option	0000h	-	<input type="radio"/>	<input type="radio"/>
PC25	TL2	Inner torque limit 2	100	%	<input type="radio"/>	<input type="radio"/>
PC32	CMX2	Electronic gear numerator 2	1	-	<input type="radio"/>	<input type="radio"/>
PC33	CMX3	Electronic gear numerator 3	1	-	<input type="radio"/>	<input type="radio"/>
PC34	CMX4	Electronic gear numerator 4	1	-	<input type="radio"/>	<input type="radio"/>

Smoothing filter and resonance suppression related parameters						
NO	Abbr.	Name	Initial value	Unit	Control mode	
					Pt	Pr
PB01	NHF1	Machine resonance suppression filter 1	1000	Hz	<input type="radio"/>	<input type="radio"/>
PB02	NHD1	Machine resonance suppression attenuation 1	0	dB	<input type="radio"/>	<input type="radio"/>
PB03	NLP	Resonance suppression low-pass filter	0	0.1mS	<input type="radio"/>	<input type="radio"/>
PB04	PST	Position command filter time constant	3	mS	<input type="radio"/>	<input type="radio"/>
PB19	TQC	Torque command filter time constant	0	mS		
PB21	NHF2	Machine resonance suppression filter 2	1000	Hz	<input type="radio"/>	<input type="radio"/>
PB22	NHD2	Machine resonance suppression attenuation 2	0	dB	<input type="radio"/>	<input type="radio"/>
PC01	STA	Acceleration time constant	200	mS		<input type="radio"/>
PC02	STB	Deceleration time constant	200	mS		<input type="radio"/>
PC03	STC	S-pattern acc./dec. time constant	0	mS		<input type="radio"/>
PD17(★)	DOP1	LSP/LSN triggered stop option	0000h	-	<input type="radio"/>	<input type="radio"/>

Control gain and gain switch related parameters						
NO	Abbr.	Name	Initial value	Unit	Control mode	
					Pt	Pr
PA02(▲)	ATUM	Gain tuning mode option	0002h	-	<input type="radio"/>	<input type="radio"/>
PA03	ATUL	Auto-tuning response level setting	0005h	-	<input type="radio"/>	<input type="radio"/>
PB05	FFC	Position feed-forward gain	0	%	<input type="radio"/>	<input type="radio"/>
PB07	PG1	Position loop gain	35	rad/s	<input type="radio"/>	<input type="radio"/>
PB08	VG1	Speed loop gain	817	rad/s	<input type="radio"/>	<input type="radio"/>
PB09	VIC	Speed integral gain	48	mS	<input type="radio"/>	<input type="radio"/>
PB10	VFG	Speed feed-forward gain	0	0.0001		<input type="radio"/>
PB11(★)	CDP	Gain switch condition	0000h	-	<input type="radio"/>	<input type="radio"/>
PB12	CDS	Gain switch condition value	10	pulse	<input type="radio"/>	<input type="radio"/>
PB13	CDT	Gain switch time constant	1	mS	<input type="radio"/>	<input type="radio"/>
PB14	GD2	The ratio 2 of load inertial to motor shaft	70	0.1time	<input type="radio"/>	<input type="radio"/>
PB15	PG2	Position loop gain change ratio	100	%	<input type="radio"/>	<input type="radio"/>
PB16	VG2	Speed loop gain change ratio	100	%	<input type="radio"/>	<input type="radio"/>
PB17	VIC2	Speed integral gain change ratio	100	%	<input type="radio"/>	<input type="radio"/>
PB24	VDC	Speed differential compensation	980	-	<input type="radio"/>	<input type="radio"/>

Digital I/O settings related parameters						
NO	Abbr.	Name	Initial value	Unit	Control mode	
					Pt	Pr
PA12	INP	In-position range	100	Pulse	<input type="radio"/>	<input type="radio"/>
PC16	MBR	Electromagnetic brake output delay time	100	mS	<input type="radio"/>	<input type="radio"/>
PC17	ZSP	Zero speed acknowledged range	50	rpm	<input type="radio"/>	<input type="radio"/>
PD01(★)	DIA1	Digital input signal auto-ON option	0000h	-	<input type="radio"/>	<input type="radio"/>
PD02(★)	DI1	Digital input 1 option(CN1-14)	0001h	-	<input type="radio"/>	<input type="radio"/>
PD03(★)	DI2	Digital input 2 option(CN1-15)	0007h	-	<input type="radio"/>	<input type="radio"/>
PD04(★)	DI3	Digital input 3 option(CN1-16)	0009h	-	<input type="radio"/>	<input type="radio"/>
PD05(★)	DI4	Digital input 4 option(CN1-17)	000Ah	-	<input type="radio"/>	<input type="radio"/>
PD06(★)	DI5	Digital input 5 option(CN1-18)	0002h	-	<input type="radio"/>	<input type="radio"/>
PD07(★)	DI6	Digital input 6 option(CN1-19)	0006h	-	<input type="radio"/>	<input type="radio"/>
PD08(★)	DI7	Digital input 7 option(CN1-20)	0012h	-	<input type="radio"/>	<input type="radio"/>
PD09(★)	DI8	Digital input 8 option(CN1-21)	0011h	-	<input type="radio"/>	<input type="radio"/>
PD10(★)	DO1	Digital output 1 option(CN1-41)	0003h	-	<input type="radio"/>	<input type="radio"/>
PD11(★)	DO2	Digital output 2 option(CN1-42)	0008h	-	<input type="radio"/>	<input type="radio"/>
PD12(★)	DO3	Digital output 3 option(CN1-43)	0006h	-	<input type="radio"/>	<input type="radio"/>
PD13(★)	DO4	Digital output 4 option(CN1-44)	0005h	-	<input type="radio"/>	<input type="radio"/>
PD14(★)	DO5	Digital output 5 option(CN1-45)	0001h	-	<input type="radio"/>	<input type="radio"/>
PD15(★)	DIF	Digital input filter time option	0002h	-	<input type="radio"/>	<input type="radio"/>
PD16(★)	IOS	Digital input on/off state control option	0000h	-	<input type="radio"/>	<input type="radio"/>
PD17(★)	DOP1	LSP/LSN triggered stop option	0000h	-	<input type="radio"/>	<input type="radio"/>
PD18(★)	DOP2	CR signal clear option	0000h	-	<input type="radio"/>	<input type="radio"/>
PD19(★)	DOP3	Alarm code output option	0000h	-	<input type="radio"/>	<input type="radio"/>
PD20(★)	DOP4	Alarm reset triggered process	0000h	-	<input type="radio"/>	<input type="radio"/>

Communication related parameters						
NO	Abbr.	Name	Initial value	Unit	Control mode	
					Pt	Pr
PC20(★)	SNO	Communication device number	1	-	<input type="radio"/>	<input type="radio"/>
PC21(★)	CMS	Communication mode option	0010h	-	<input type="radio"/>	<input type="radio"/>
PC22(★)	BPS	Communication protocol option	0010h	-	<input type="radio"/>	<input type="radio"/>
PC23	SIC	Communication time-out process option	0	S	<input type="radio"/>	<input type="radio"/>

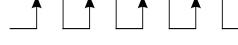
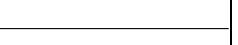
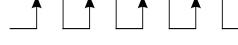
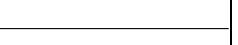
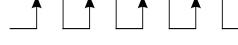
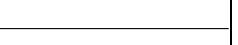
Monitor and status display related parameters							
NO	Abbr.	Name	Initial value	Unit	Control mode		
					Pt	Pr	S
PC14	MOD	Analog monitor output	0100h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC24(★)	DMD	Status display option	0000h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC28	MO1	Analog monitor ch1 offset	0	mV	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC29	MO2	Analog monitor ch2 offset	0	mV	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC30	MOG1	Analog monitor ch1 output proportion	100	%	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC31	MOG2	Analog monitor ch2 output proportion	100	%	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other functions related parameters							
NO	Abbr.	Name	Initial value	Unit	Control mode		
					Pt	Pr	S
PA40(▲)	SPW	Special parameter write-enable	0000h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PA42(★)	BLK	Parameter write-inhibit	0000h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PB06	GD1	The ratio of load inertial to motor shaft	10	0.1time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PB14	GD2	The ratio 2 of load inertial to motor shaft	70	0.1time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PC18(★)	COP1	Stop option and power interruption restart option	0010h	-			<input type="radio"/>
PC19(★)	COP2	Alarm history clear option	0000h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PD20(★)	DOP4	Alarm reset triggered process	0000h	-	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7.3.Parameter details list

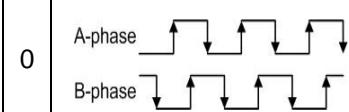
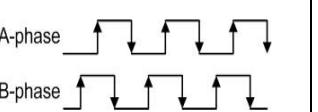
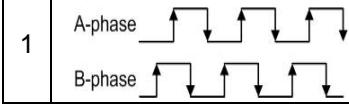
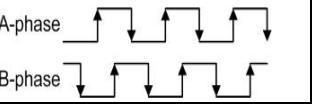
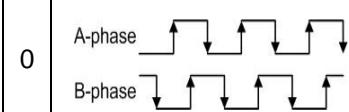
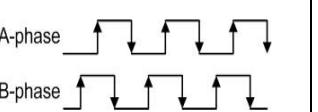
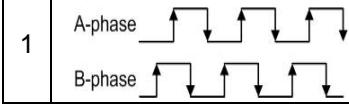
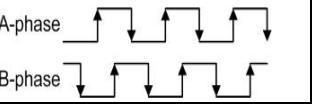
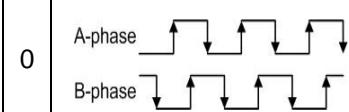
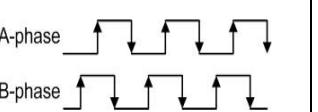
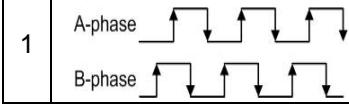
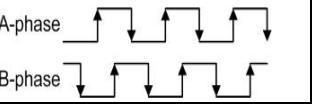
No	Abbr.	Function description	Control mode	Setting range	Unit																																									
PA01	STY	<p>Setting value of Control mode option:</p> <table border="1" style="margin-left: 20px;"> <tr><td>u</td><td>z</td><td>y</td><td>x</td></tr> </table> <p><u>x:control mode select</u></p> <p>0:position 1:position/speed 2:speed 3:speed/torque 4:torque 5:torque/position</p> <p><u>y:position command select</u></p> <p>0:external input 1:inner register(absolute type) 2:inner register(incremental type)</p> <p><u>z:electromagnetic brake enabled option</u></p> <p>0:disabled 1:enabled. (Motor with electromagnetic brake applied)</p> <p><u>u:DI/DO setting option</u></p> <p>0:Functions of DI/DO are fixed as user defined no matter what control mode switched. 1:Functions of DI/DO are changed as control mode switched. Pin functions are decided by servo driver automatically.</p>	u	z	y	x	Pt,Pr S,T	0000h ~1125h	-																																					
u	z	y	x																																											
PA02	ATUM	<p>Gain tuning mode option:</p> <table border="1" style="margin-left: 20px;"> <tr><td>0</td><td>0</td><td>0</td><td>x</td></tr> </table> <p><u>x:gain tuning mode option</u></p> <p>0:manual-gain tuning(PI control) 1: manual-gain tuning(PI control + interference compensator) 2: Auto-gain tuning(load inertial ratio and bandwidth estimated) 3: Auto-gain tuning(fixed load inertial ratio)</p>	0	0	0	x	Pt,Pr S	0000h ~0003h	-																																					
0	0	0	x																																											
PA03	ATUL	<p>Auto-tuning response level setting:</p> <table border="1" style="margin-left: 20px;"> <tr><td>0</td><td>0</td><td>0</td><td>x</td></tr> </table> <p><u>x:response level setting</u></p> <table border="1" style="margin-left: 20px; width: fit-content;"> <thead> <tr> <th>Response level</th> <th>Rigidity</th> <th>Response frequency</th> </tr> </thead> <tbody> <tr><td>1</td><td rowspan="5">low</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>30 Hz</td></tr> <tr><td>6</td><td rowspan="4">middle</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="5">high</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></td><td>300 Hz</td></tr> </tbody> </table>	0	0	0	x	Response level	Rigidity	Response frequency	1	low	5Hz	2	10 Hz	3	15 Hz	4	20 Hz	5	30 Hz	6	middle	40 Hz	7	55 Hz	8	70 Hz	9	85 Hz	A	high	100 Hz	B	130 Hz	C	160 Hz	D	200 Hz	E	250 Hz	F		300 Hz	Pt,Pr S,T	0001h ~000Fh	-
0	0	0	x																																											
Response level	Rigidity	Response frequency																																												
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2		10 Hz																																												
3		15 Hz																																												
4		20 Hz																																												
5		30 Hz																																												
6	middle	40 Hz																																												
7		55 Hz																																												
8		70 Hz																																												
9		85 Hz																																												
A	high	100 Hz																																												
B		130 Hz																																												
C		160 Hz																																												
D		200 Hz																																												
E		250 Hz																																												
F		300 Hz																																												

No	Abbr.	Function description	Control mode	Setting range	Unit												
PA04	HMOV	<p>Home moving option:</p> <table border="1" style="margin-left: 20px;"> <tr><td>u</td><td>z</td><td>y</td><td>x</td></tr> </table> <p><u>x:origin detector and rotation option</u> 0:ORGP detector in CCW rotation 1:ORGP detector in CW rotation 2:Encoder Z pulse detector in CCW rotation 3:Encoder Z pulse detector in CW rotation</p> <p><u>y:origin attained shortcut moving option</u> 0:motor turns back to last Z pulse to attain 1:motor goes ahead to next Z pulse to attain 2:origin recognized right away</p> <p><u>z:origin recognized completion option</u> 0:motor decelerates to stop then return to the mechanism origin 1:motor decelerates to stop</p> <p><u>u:trigger option</u> 0:home moving function disabled 1:automatically executes after power on 2:SHOM signal as the trigger source</p>	u	z	y	x	Pr	0000h ~2123h	-								
u	z	y	x														
PA05	TL1	<p>Inner torque limit 1: Motor generated torque is restricted by this parameter which unit is %. The generated torque is calculated as below. $Torque\ limit\ value = maximum\ torque * PA05$</p> <p>TL signal is used to select PA05 or analog TLA as limit value. TL1 signal enables the PC25 to compare with PA05 or TLA. If the TL1 and SG are open-circuit, the valid torque limit is:</p> <table border="1" style="margin-left: 20px;"> <tr><th>TL-SG</th><th>The valid torque limit</th></tr> <tr><td>open-circuit</td><td>PA05</td></tr> <tr><td>short-circuit</td><td>If TLA < PA05, limit value=TLA If TLA > PA05, limit value=PA05</td></tr> </table> <p>If the TL1 and SG are short-circuit, the valid torque limit is:</p> <table border="1" style="margin-left: 20px;"> <tr><th>TL-SG</th><th>The valid torque limit</th></tr> <tr><td>open-circuit</td><td>If PC25 < PA05, limit value=PC25 If PC25 > PA05, limit value=PA05</td></tr> <tr><td>short-circuit</td><td>If PC25 < TLA, limit value=PC25 If PC25 > TLA, limit value=TLA</td></tr> </table>	TL-SG	The valid torque limit	open-circuit	PA05	short-circuit	If TLA < PA05, limit value=TLA If TLA > PA05, limit value=PA05	TL-SG	The valid torque limit	open-circuit	If PC25 < PA05, limit value=PC25 If PC25 > PA05, limit value=PA05	short-circuit	If PC25 < TLA, limit value=PC25 If PC25 > TLA, limit value=TLA	Pt,Pr S	0000h ~0003h	-
TL-SG	The valid torque limit																
open-circuit	PA05																
short-circuit	If TLA < PA05, limit value=TLA If TLA > PA05, limit value=PA05																
TL-SG	The valid torque limit																
open-circuit	If PC25 < PA05, limit value=PC25 If PC25 > PA05, limit value=PA05																
short-circuit	If PC25 < TLA, limit value=PC25 If PC25 > TLA, limit value=TLA																
PA06	CMX	Electronic gear numerator See section 6.4.4 for more details.	Pt,Pr	1 ~32767	-												
PA07	CDV	<p>Electronic gear denominator The improper setting could lead to unexpected fast rotation so make sure to set them in the state of SERVO OFF. The proper range setting is:</p> $\frac{1}{50} \leq \frac{CMX}{CDV} \text{ (electronic gear ratio)} \leq 200$	Pt,Pr	1 ~32767	-												

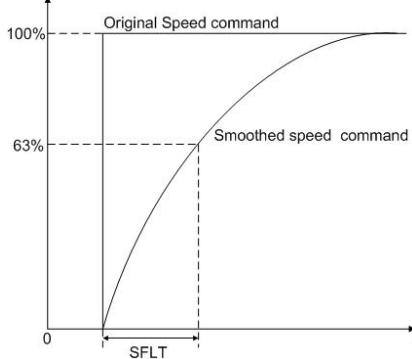
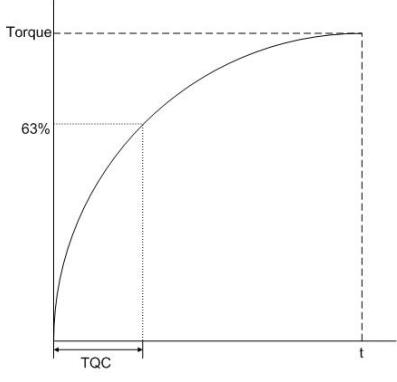
No	Abbr.	Function description	Control mode	Setting range	Unit												
PA08	HSPD1	Home moving high speed option 1 As home moving action is triggered, motor runs at the PA08 speed to search the origin. See section 13.2 for more details.	Pr	1 ~2000	rpm												
PA09	HSPD2	Home moving high speed option 2 As the origin is acknowledged, motor would keep running or turns back at the PA09 speed to search the Z phase pulse. See section 13.2 for more details.	Pr	1 ~500	rpm												
PA10	HOF1	Home moving revolution offset If this value is not zero, the origin would be acknowledged after two conditions satisfied: 1. ORGP or Z pulse attained. 2. PA10 offset value attained.	Pr	-30000 ~+30000	rev												
PA11	HOF2	Home moving pulse offset If PA10 and PA11 are not zero, The total offset pulses are : $(HOF1 \times 10000) + HOF2 \text{ pulses}$ After ORGP or Z phase pulse attained, this offset value should be attained then the origin would be acknowledged.	Pr	-30000 ~+30000	rev												
PA12	INP	In-position range To define the permissible pulse error range of position pulse commands. As positioning operation done, the INP signal of DO would output.	Pt,Pr	0 ~10000	pulse												
PA13	PLSS	Setting value of Control mode option: <table border="1" style="margin-left: 10px;"> <tr> <td>0</td> <td>z</td> <td>y</td> <td>x</td> </tr> </table> <u>x:pulse-train format select</u> 0:forward/reverse rotation pulse train 1:pulse train + sign 2:A/B phase pulse train <u>y:acknowledged logic</u> 0:positive logic 1:negative logic <u>z:permissible pulse frequency option</u> 0:500kpps or less 1:200kpps or less Here is an example. <table border="1" style="margin-left: 10px; width: fit-content;"> <tr> <th colspan="2">Pulse format</th> <th>Forward</th> <th>Reverse</th> </tr> <tr> <td>y=0</td> <td>x=0</td> <td>PP </td> <td>NP </td> </tr> </table> To see section 6.4.1 for more details.	0	z	y	x	Pulse format		Forward	Reverse	y=0	x=0	PP 	NP 			
0	z	y	x														
Pulse format		Forward	Reverse														
y=0	x=0	PP 	NP 														

No	Abbr.	Function description	Control mode	Setting range	Unit
PA14	ENR	<p>Encoder output pulses Used to set the A/B-phase pulses encoder output by the driver. Users could use parameter PA39 to choose the output pulse setting or output division ratio setting. Set the value 4 times greater than the A-phase or B-phase pulses. The number of A/B-phase pulses actually output is 1/4 times greater than the preset number of pulses. The maximum output frequency is 500kpps. (after multiplication by 4). Use this parameter within this range.</p> <p>For output pulse setting Set " □0□□ " (initial value) in parameter PA39. Set the number of pulses per servo motor revolution. At the setting of 1024, for example, the actually output pulses per motor revolution is 1024.</p> <p>For output division ratio setting Set " □1□□ " in parameter PA39. Set the output division ratio(PA14) per motor revolution. $\text{Output pulses} = \frac{\text{Resolution per motor revolution}}{\text{PA14 setting value}}$ At the setting of 2, for example, the actually output pulses per motor revolution is (10000/2)=5000.</p>	Pt,Pr S,T	~10000	1 pulse/rev
PA15	PO1H	Revolution of inner position command 1 There are 8 sets of inner register position command. Every set is composed of revolution and pulse. As PA15 and PA16 are applied, for example, the total pulses of inner position command is: $(PA15 \times 10000) + PA16 \text{ pulses}$	Pr	-30000 ~+30000	rev
PA16	PO1L	Pulse of inner position command 1	Pr	-9999 ~+9999	pulse
PA17	PO2H	Revolution of inner position command 2	Pr	-30000 ~+30000	rev
PA18	PO2L	Pulse of inner position command 2	Pr	-9999 ~+9999	pulse
PA19	PO3H	Revolution of inner position command 3	Pr	-30000 ~+30000	rev
PA20	PO3L	Pulse of inner position command 3	Pr	-9999 ~+9999	pulse
PA21	PO4H	Revolution of inner position command 4	Pr	-30000 ~+30000	rev
PA22	PO4L	Pulse of inner position command 4	Pr	-9999 ~+9999	pulse

No	Abbr.	Function description	Control mode	Setting range	Unit
PA23	PO5H	Revolution of inner position command 5	Pr	-30000 ~+30000	rev
PA24	PO5L	Pulse of inner position command 5	Pr	-9999 ~+9999	pulse
PA25	PO6H	Revolution of inner position command 6	Pr	-30000 ~+30000	rev
PA26	PO6L	Pulse of inner position command 6	Pr	-9999 ~+9999	pulse
PA27	PO7H	Revolution of inner position command 7	Pr	-30000 ~+30000	rev
PA28	PO7L	Pulse of inner position command 7	Pr	-9999 ~+9999	pulse
PA29	PO8H	Revolution of inner position command 8	Pr	-30000 ~+30000	rev
PA30	PO8L	Pulse of inner position command 8	Pr	-9999 ~+9999	pulse
PA31	POV1	Moving speed of inner position command 1 There are 8 sets of inner register position command. Every set has its speed command to approach the goal position.	Pr	1 ~3000	rpm
PA32	POV2	Moving speed of inner position command 2	Pr	1 ~3000	rpm
PA33	POV3	Moving speed of inner position command 3	Pr	1 ~3000	rpm
PA34	POV4	Moving speed of inner position command 4	Pr	1 ~3000	rpm
PA35	POV5	Moving speed of inner position command 5	Pr	1 ~3000	rpm
PA36	POV6	Moving speed of inner position command 6	Pr	1 ~3000	rpm
PA37	POV7	Moving speed of inner position command 7	Pr	1 ~3000	rpm
PA38	POV8	Moving speed of inner position command 8	Pr	1 ~3000	rpm

No	Abbr.	Function description	Control mode	Setting range	Unit																																
PA39	POL	<p>Motor rotary direction option The relation among motor rotary direction and input command pulse-train direction and encoder output pulse direction is described below.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>0</td><td>z</td><td>y</td><td>x</td></tr> </table> <p><u>x:input pulse-train and motor rotary direction option</u></p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td rowspan="2">x</td> <th colspan="2">motor rotary direction</th> </tr> <tr> <th>forward pulse-train input</th> <th>reverse pulse-train input</th> </tr> <tr> <td>0</td> <td>CCW</td> <td>CW</td> </tr> <tr> <td>1</td> <td>CW</td> <td>CCW</td> </tr> </table> <p><u>y: motor rotary direction and encoder pulse output option</u></p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td rowspan="2">y</td> <th>motor CCW rotation</th> <th>motor CW rotation</th> </tr> <tr> <td>A-phase B-phase</td> <td>A-phase B-phase</td> </tr> <tr> <td>0</td> <td></td> <td></td> </tr> <tr> <td>1</td> <td></td> <td></td> </tr> </table> <p><u>z: encoder output option</u> 0:output pulse 1:output division ratio</p>	0	z	y	x	x	motor rotary direction		forward pulse-train input	reverse pulse-train input	0	CCW	CW	1	CW	CCW	y	motor CCW rotation	motor CW rotation	A-phase B-phase	A-phase B-phase	0			1			Pt S,T	0000h ~0111h	-						
0	z	y	x																																		
x	motor rotary direction																																				
	forward pulse-train input	reverse pulse-train input																																			
0	CCW	CW																																			
1	CW	CCW																																			
y	motor CCW rotation	motor CW rotation																																			
	A-phase B-phase	A-phase B-phase																																			
0																																					
1																																					
PA40	SPW	Special parameter write-enable As this parameter is set as 0088h, the driver would take 2 seconds to recover factory-set. This change is valid by power off once and power on again.	Pr	0000h ~00FFh	-																																
PA42	BLK	<p>Parameter read/write inhibit option</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <th rowspan="2">PA42</th> <th colspan="4">Parameter group</th> </tr> <tr> <th>PA□□</th> <th>PB□□</th> <th>PC□□</th> <th>PD□□</th> </tr> <tr> <td>0000h</td> <td rowspan="6" style="text-align: center;">R/W enable</td> <td rowspan="2" style="text-align: center;">R/W enable</td> <td rowspan="2" style="text-align: center;">R/W enable</td> <td>R/W enable</td> </tr> <tr> <td>0001h</td> <td>R/W inhibit</td> </tr> <tr> <td>0002h</td> <td rowspan="2" style="text-align: center;">R/W inhibit</td> <td rowspan="2" style="text-align: center;">R/W inhibit</td> <td>R/W inhibit</td> </tr> <tr> <td>0003h</td> <td>R/W enable</td> </tr> <tr> <td>0004h</td> <td rowspan="3" style="text-align: center;">R enable W inhibit(*)</td> <td colspan="2" style="text-align: center;">R enable W inhibit</td> </tr> <tr> <td>0005h</td> <td colspan="2" style="text-align: center;">R/W inhibit</td> </tr> <tr> <td>0006h</td> <td colspan="2" style="text-align: center;">R/W inhibit</td> </tr> </table> <p>(*) PA42 is excepted, it is writeable.</p>	PA42	Parameter group				PA□□	PB□□	PC□□	PD□□	0000h	R/W enable	R/W enable	R/W enable	R/W enable	0001h	R/W inhibit	0002h	R/W inhibit	R/W inhibit	R/W inhibit	0003h	R/W enable	0004h	R enable W inhibit(*)	R enable W inhibit		0005h	R/W inhibit		0006h	R/W inhibit		Pt,Pr S,T	0000h ~0006h	-
PA42	Parameter group																																				
	PA□□	PB□□	PC□□	PD□□																																	
0000h	R/W enable	R/W enable	R/W enable	R/W enable																																	
0001h				R/W inhibit																																	
0002h		R/W inhibit	R/W inhibit	R/W inhibit																																	
0003h				R/W enable																																	
0004h		R enable W inhibit(*)	R enable W inhibit																																		
0005h			R/W inhibit																																		
0006h	R/W inhibit																																				

No	Abbr.	Function description	Control mode	Setting range	Unit				
PB01	NHF1	Machine resonance suppression filter 1 To set a specific frequency which the control gain is decreased to suppress the mechanism resonance. See section 6.3.6 for more details.	Pt,Pr S,T	50 ~1000	Hz				
PB02	NHD1	Machine resonance suppression attenuation 1 To set the attenuation at the frequency of PB01 setting. The setting of "0" value denotes the disabled of this notch filter.	Pt,Pr S,T	0 ~32	dB				
PB03	NLP	Resonance suppression low-pass filter To set low-pass filter time constant to suppress resonance.	Pt,Pr S,T	0 ~10000	0.1mS				
PB04	PST	Position command filter time constant Used to smooth the running of motor in position control mode. See section 6.4.3 for more details.	Pt,Pr	0 ~20000	mS				
PB05	FFC	Position feed-forward gain To reduce the position error and position settling time, but if the value is set too large, a sudden acceleration or deceleration may cause overshoots.	Pt,Pr	0 ~20000	0.0001				
PB06	GD1	The ratio of load inertial to motor shaft (load inertia ratio) See section 5.3.3 for more details.	Pt,Pr S	0 ~1200	0.1time				
PB07	PG1	Position loop gain Used to decide response level of position loop. Increasing PG1 improves traceability, but a too high value makes overshooting or vibration occurred. When auto-gain tuning mode is applied, PB07 would be set according to the result of inertial estimation.	Pt,Pr	4 ~1024	rad/s				
PB08	VG1	Speed loop gain Increasing VG1 improves traceability to a speed command but a too high value will make machine resonance. When auto-gain tuning mode is applied, PB08 would be set according to the result of gain tuning.	Pt,Pr S	40 ~4096	rad/s				
PB09	VIC	Speed integral gain The PB09 is used to eliminate stationary deviation against a command.	Pt,Pr S	1 ~1000	mS				
PB10	VFG	Speed feed-forward gain To set the proper gain would reduce the tracking time of speed command. Also, a too big value would cause overshoots during the sudden acceleration/deceleration command.	Pt,Pr S	0 ~20000	0.0001				
PB11	CDP	Gain switch option <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>0</td> <td>0</td> <td>0</td> <td>x</td> </tr> </table> <u>x: changing condition</u> 0: Invalid 1: Gain switched as the CDP signal of DI is ON 2: Position command frequency >= CDS(PB12) setting 3: Position command pulse error >= CDS(PB12) setting 4: Motor speed >= CDS(PB12) setting See section 6.3.7 for more details.	0	0	0	x	Pt,Pr S	0000h ~0004h	-
0	0	0	x						
PB12	CDS	Gain switch condition value The unit of CDS value is varied(kpps,pulse,rpm) according to the settings of CDP.	Pt,Pr S	0 ~60000	depends				

No	Abbr.	Function description	Control mode	Setting range	Unit
PB13	CDT	Gain switch time constant Used to smooth the motor running at gain switching moment to suppress vibration if the gain difference is large.	Pt,Pr S	0 ~1000	mS
PB14	GD2	The ratio 2 of load inertial to motor shaft Set the demand ratio of load inertia to motor shaft after switching. This value is valid as gain switch function preformed.	Pt,Pr S	0 ~1200	0.1time
PB15	PG2	Position loop gain change ratio The gain values would be changed as: $gain\ after\ switched = (PG1\ or\ VG1\ or\ VIC) \times PB15(\%)$ These changes are valid only if auto-gain tuning disabled.	Pt,Pr S	10 ~200	%
PB16	VG2	Speed loop gain change ratio	Pt,Pr S	10 ~200	%
PB17	VIC2	Speed integral gain change ratio	Pt,Pr S	10 ~200	%
PB18	SFLT	Speed low-pass filter smooth time constant Larger value would make the response slow down obviously. If it is set as zero, this function is disabled. 	S,T	0 ~1000	mS
The required time to catch the command is 5-time of SELT.					
PB19	TQC	Torque command filter time constant Larger value would make the response slow down obviously. If it is set as zero, this function is disabled. 	T	0 ~5000	mS
The required time to catch the command is 5-time of TQC.					

No	Abbr.	Function description	Control mode	Setting range	Unit				
PB20	SJIT	Speed feedback filter time constant Used to set the filter time constant of motor speed feedback.	Pt,Pr S,T	0 ~1000	0.1mS				
PB21	NHF2	Machine resonance suppression filter 2 The secondary option of notch filter frequency to suppress the mechanism resonance. See section 6.3.6 for more details.	Pt,Pr S,T	50 ~1000	Hz				
PB22	NHD2	Machine resonance suppression 2 The secondary option of notch filter attenuation.	Pt,Pr	0 ~-32	dB				
PB23	MVS	Micro-vibration suppression option <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>0</td> <td>0</td> <td>0</td> <td>x</td> </tr> </table> <u>x</u> :option 0 : default 1 : micro-vibration suppression enabled 2: micro-vibration suppression disabled	0	0	0	x	Pt,Pr S	0000h ~0002h	-
0	0	0	x						
PB24	VDC	Speed differential compensation	Pt,Pr S	0 ~1000	-				

No	Abbr.	Function description	Control mode	Setting range	Unit
PC01	STA	Acceleration time constant This parameter is the time spent for the motor from 0 rpm to the rated speed and it is defined as “acceleration time constant”. See section 6.3.3 for more details.	Pr S,T	0 ~20000	mS
PC02	STB	Deceleration time constant The time spent for the motor to decelerate from the rated speed to 0 rpm is called “deceleration time constant”.	Pr S,T	0 ~20000	mS
PC03	STC	S-pattern acceleration/deceleration time constant The S-pattern acceleration/deceleration function is to employ a three-step curve of acceleration or deceleration moving to soothe the vibration during starting or stopping the motor.	Pr S,T	0 ~10000	mS
PC04	JOG	JOG speed command As JOG mode applied, this PC04 is used as speed command. See section 4.5.3 for more details.	Pt,Pr S,T	0 ~4500	rpm
PC05	SC1	Inner speed command/limit 1 For speed control, PC05 is used as inner speed command 1. For torque control, PC05 is the speed limit and directionless.	S,T	-4500 ~+4500	rpm
PC06	SC2	Inner speed command/limit 2 For speed control, PC06 is used as inner speed command 2. For torque control, PC06 is the speed limit and directionless.	S,T	-4500 ~+4500	rpm
PC07	SC3	Inner speed command/limit 3 For speed control, PC07 is used as inner speed command 3. For torque control, PC07 is the speed limit and directionless.	S,T	-4500 ~+4500	rpm
PC08	SC4	Inner speed command/limit 4 For speed control, PC08 is used as inner speed command 4. For torque control, PC08 is the speed limit and directionless.	S,T	-4500 ~+4500	rpm
PC09	SC5	Inner speed command/limit 5 For speed control, PC09 is used as inner speed command 5. For torque control, PC09 is the speed limit and directionless.	S,T	-4500 ~+4500	rpm
PC10	SC6	Inner speed command/limit 6 For speed control, PC10 is used as inner speed command 6. For torque control, PC10 is the speed limit and directionless.	S,T	-4500 ~+4500	rpm
PC11	SC7	Inner speed command/limit 7 For speed control, PC11 is used as inner speed command 7. For torque control, PC11 is the speed limit and directionless.	S,T	-4500 ~+4500	rpm

No	Abbr.	Function description	Control mode	Setting range	Unit				
PC12	VCM	Output speed of maximum analog command This value decides the output speed while the maximum permissible voltage is applied. $\text{output speed} = \frac{\text{applied voltage of speed command}}{10} \times \text{PC12}$ See section 6.3.2 for more details.	S	0 ~30000	rpm				
		When torque mode is applied, this parameter would become speed limit as the maximum permissible voltage applied. $\text{speed limit} = \frac{\text{applied voltage of torque command}}{10} \times \text{PC12}$ See section 6.2.5 for more details.							
PC13	TLC	Torque generated of maximum analog command See section 6.2.1 for more details.	S,T	0 ~2000	%				
PC14	MOD	Analog monitor output There are 2 channels of analog monitor provided for users to check the required signals, see section 6.6.2 for more details.	Pt,Pr S,T	0000h ~0707h	-				
PC15	SVZR	Speed analog zero voltage acknowledged range Treat the applied voltage which is less than PC15 as zero speed command.	S,T	0 ~1000	mV				
PC16	MBR	Electromagnetic brake output delay time The parameter PC16 could be used to decide the delay time of the SON signal off to the MBR signal activated. See section 6.6.3 for more details.	Pt,Pr S,T	0 ~1000	mS				
PC17	ZSP	Zero speed acknowledged range As motor feedback speed is less than the setting value of PC17, the servo driver would treat it as zero speed and the ZSP of DO would be outputted.	Pt,Pr S,T	0 ~10000	rpm				
PC18	COP1	Stop option and power interruption restart option The voltage level drop would cause driver to alarm and stop. Auto-restart function could be applied by the setting of PC18. <table border="1"><tr><td>0</td><td>0</td><td>y</td><td>x</td></tr></table> <u>x:power interruption restart option</u> 0:invalid 1:valid <u>y:motor stop option</u> 0:stops instantaneously 1:decelerates to stop	0	0	y	x	Pt,Pr S,T	0000h ~0011h	-
0	0	y	x						
PC19	COP2	Alarm history clear option <table border="1"><tr><td>0</td><td>0</td><td>0</td><td>x</td></tr></table> x=0:does not clear x=1:to clear the histories after power off once and restart	0	0	0	x	Pt,Pr S,T	0000h ~0001h	-
0	0	0	x						

No	Abbr.	Function description	Control mode	Setting range	Unit														
PC20	SNO	Communication device number To set different device number for varied devices is necessary. If two drivers occupy the same number, the communication could not be performed.	Pt,Pr S,T	1 ~32	station														
PC21	CMS	Communication mode option <table border="1" style="margin-left: 20px;"> <tr><td>0</td><td>0</td><td>y</td><td>x</td></tr> </table> <u>x: mode option</u> 0:RS-232C 1:RS-485 <u>y: communication reply delay time</u> 0:reply within 1 mS 1:reply after 1 mS	0	0	y	x	Pt,Pr S,T	0000h ~0011h	-										
0	0	y	x																
PC22	BPS	Communication protocol option See section 8.2 for more details.	Pt,Pr S,T	0000h ~0058h	-														
PC23	SIC	Communication time-out process option Time-out inspection could be set from 1 to 60 seconds. If it is set as 0, the inspection function is invalid.	Pt,Pr S,T	0 ~60	s														
PC24	DMD	Status display option <table border="1" style="margin-left: 20px;"> <tr><td>0</td><td>0</td><td>y</td><td>x</td></tr> </table> <u>x: display option after power on</u> 0: Motor feedback pulse 1: Motor feedback revolution 2: Cumulative pulses of command 3: Cumulative turns of command 4: Accumulative pulses error 5: Command pulse frequency 6: Motor speed 7: Speed analog command/limit voltage 8: Speed input command/limit 9: Torque analog command/limit voltage A: Torque input command/limit B: Effective load ratio C: Peak load ratio D: DC bus voltage E: The ratio of load inertial to motor shaft F: Instantaneous torque <u>y: assigned display after power on</u> 0: display option according varied control modes 1: display option according the x-digit of PC24	0	0	y	x	Pt,Pr S,T	0000h ~001Fh	-										
0	0	y	x																
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px;">Control mode</td> <td style="padding: 2px;">Initial display after power on</td> </tr> <tr> <td style="padding: 2px;">position</td> <td style="padding: 2px;">motor feedback pulse</td> </tr> <tr> <td style="padding: 2px;">position/speed</td> <td style="padding: 2px;">motor feedback pulses/motor speed</td> </tr> <tr> <td style="padding: 2px;">speed</td> <td style="padding: 2px;">motor speed</td> </tr> <tr> <td style="padding: 2px;">speed/torque</td> <td style="padding: 2px;">motor speed / torque analog command</td> </tr> <tr> <td style="padding: 2px;">torque</td> <td style="padding: 2px;">torque analog command</td> </tr> <tr> <td style="padding: 2px;">torque/position</td> <td style="padding: 2px;">torque analog command/motor feedback pulse</td> </tr> </table>						Control mode	Initial display after power on	position	motor feedback pulse	position/speed	motor feedback pulses/motor speed	speed	motor speed	speed/torque	motor speed / torque analog command	torque	torque analog command	torque/position	torque analog command/motor feedback pulse
Control mode	Initial display after power on																		
position	motor feedback pulse																		
position/speed	motor feedback pulses/motor speed																		
speed	motor speed																		
speed/torque	motor speed / torque analog command																		
torque	torque analog command																		
torque/position	torque analog command/motor feedback pulse																		

No	Abbr.	Function description	Control mode	Setting range	Unit
PC25	TL2	Inner torque limit 2 Refer to description of PA05.	Pt,Pr S,T	0 ~100	%
PC26	VCO	Speed analog command/limit offset Used to "compensate" the analog offset for a zero command. Speed analog command(VC) is corrected for speed control. Speed analog limit(VLA) is corrected for torque control mode. Refer to section 4.5.5 for more details.	S,T	-8000 ~+8000	mV
PC27	TLO	Torque analog command/limit offset Used to "compensate" the analog offset for a zero command. Torque analog command(TC) is corrected for torque control mode. Torque output analog limit(TLA) is corrected for speed control mode. Refer to section 4.5.5 for more details.	S,T	-8000 ~+8000	mV
PC28	MO1	Analog monitor ch1 offset See section 6.6.2 for more details.	Pt,Pr S,T	-999 ~+999	mV
PC29	MO2	Analog monitor ch2 offset See section 6.6.2 for more details.	Pt,Pr S,T	-999 ~+999	mV
PC30	MOG1	Analog monitor ch1 output proportion Used to set output ratio of monitor signal to be viewed. See section 6.6.2 for more details.	Pt,Pr S,T	0 ~100	%
PC31	MOG2	Analog monitor ch2 output proportion	Pt,Pr S,T	0 ~100	%
PC32	CMX2	Electronic gear numerator 2 Refer to the description of PA06.	Pt,Pr	1 ~32767	-
PC33	CMX3	Electronic gear numerator 3	Pt,Pr	1 ~32767	-
PC34	CMX4	Electronic gear numerator 4	Pt,Pr	1 ~32767	-
PC35	VCL	VC input voltage limit Used to limit the range of speed analog command(VC). "0" denotes no limit. A 5000 setting of PC35 as an example: even the actual analog command is 10V, the driver would recognize that the maximum input voltage is only 5V.	S,T	0 ~20000	mV

No	Abbr.	Function description	Control mode	Setting range	Unit				
PD01	DIA1	<p>Digital input signal auto-ON option</p> <table border="1" style="margin-left: 20px;"> <tr><td>u</td><td>z</td><td>y</td><td>x</td></tr> </table> <p><u>x:SON open/short option</u> 0: controlled by external actual wiring 1: SON-SG is short-circuit without actual wiring</p> <p><u>y:LSP open/short option</u> 0: controlled by external actual wiring 1: LSP-SG is short-circuit without actual wiring</p> <p><u>z:LSN open/short option</u> 0: controlled by external actual wiring 1: LSN-SG is short-circuit without actual wiring</p> <p><u>u:EMG open/short option</u> 0: controlled by external actual wiring 1: EMG-SG is short-circuit without actual wiring</p>	u	z	y	x	Pt,Pr S,T	0000h ~1111h	-
u	z	y	x						
PD02	DI1	Digital input 1 option The 8 DI input pins of CN1 are programmable. The preset pin functions are different corresponding to varied control modes. See section 3.3.2 for more details.	Pt,Pr S,T	0000h ~001Fh	-				
PD03	DI2	Digital input 2 option	Pt,Pr S,T	0000h ~001Fh	-				
PD04	DI3	Digital input 3 option	Pt,Pr S,T	0000h ~001Fh	-				
PD05	DI4	Digital input 4 option	Pt,Pr S,T	0000h ~001Fh	-				
PD06	DI5	Digital input 5 option	Pt,Pr S,T	0000h ~001Fh	-				
PD07	DI6	Digital input 6 option	Pt,Pr S,T	0000h ~001Fh	-				
PD08	DI7	Digital input 7 option	Pt,Pr S,T	0000h ~001Fh	-				
PD09	DI8	Digital input 8 option	Pt,Pr S,T	0000h ~001Fh	-				
PD10	DO1	<p>Digital output 1 option</p> <p>The 5 DO output pins of CN1 are programmable. The preset pin functions are different corresponding to varied control modes. See section 3.3.2 for more details.</p>	Pt,Pr S,T	0000h ~000Fh	-				
PD11	DO2	Digital output 2 option	Pt,Pr S,T	0000h ~000Fh	-				
PD12	DO3	Digital output 3 option	Pt,Pr S,T	0000h ~000Fh	-				
PD13	DO4	Digital output 4 option	Pt,Pr S,T	0000h ~000Fh	-				
PD14	DO5	Digital output 5 option	Pt,Pr S,T	0000h ~000Fh	-				

No	Abbr.	Function description	Control mode	Setting range	Unit				
PD15	DIF	<p>Digital input filter time option</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>0</td><td>0</td><td>0</td><td>x</td></tr> </table> <p><u>x:filter time constant</u></p> <p>0:invalid 1:2mS 2:4mS 3:6mS</p>	0	0	0	x	Pt,Pr S,T	0000h ~0003h	-
0	0	0	x						
PD16	IOS	<p>Digital input on/off state control option</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>0</td><td>0</td><td>0</td><td>x</td></tr> </table> <p><u>x:state control option</u></p> <p>0:controlled by external input signals 1:controlled by communication software</p>	0	0	0	x	Pt,Pr S,T	0000h ~0001h	-
0	0	0	x						
PD17	DOP1	<p>LSP/LSN triggered stop option</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>0</td><td>0</td><td>0</td><td>x</td></tr> </table> <p><u>x:motor stop option</u></p> <p>0:stops immediately 1:decelerates to stop according to PC02,PC03</p>	0	0	0	x	Pt,Pr S	0000h ~0001h	-
0	0	0	x						
PD18	DOP2	<p>CR signal clear option</p> <p>As CR signal is activated, the deference between position pulses and motor feedback pulses would be cleared.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>0</td><td>0</td><td>0</td><td>x</td></tr> </table> <p><u>x:clear option</u></p> <p>0:CR rising edge trigger 1:keeps clearing while CR=1 2:As CR is triggered, the motor would decelerate to stop. The remainder of pulse commands would be neglected. If CTRG signal triggered, the present commands would be executed. Here is the process chart.</p> <p style="text-align: center;">Clear remainder</p>	0	0	0	x	Pt,Pr	0000h ~0002h	-
0	0	0	x						

No	Abbr.	Function description	Control mode	Setting range	Unit																																																																				
PD19	DPP3	<p>Alarm code output option CN1-41/CN1-42/CN1-45 could be composed to express alarm codes according to their output states.</p> <table border="1" style="margin-left: 20px;"> <tr><td>0</td><td>0</td><td>0</td><td>x</td></tr> </table> <p><u>x:clear option</u></p> <p>0:original pins defined by the setting value of PD10 to PD14 1:to show alarm codes while alarms occurred</p> <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th colspan="3">Alarm code(*)</th> <th rowspan="2">Sign</th> <th rowspan="2">Name</th> </tr> <tr> <th>CN1-41</th> <th>CN1-42</th> <th>CN1-45</th> </tr> </thead> <tbody> <tr><td rowspan="5">0</td><td rowspan="5">0</td><td rowspan="5">0</td><td>AL09</td><td>communication abnormal</td></tr> <tr><td>AL0A</td><td>communication time-out</td></tr> <tr><td>AL0E</td><td>IGBT overheat</td></tr> <tr><td>AL0F</td><td>memory error</td></tr> <tr><td>AL10</td><td>overload 2</td></tr> <tr><td>0</td><td>0</td><td>1</td><td>AL02</td><td>low voltage</td></tr> <tr><td rowspan="2">0</td><td rowspan="2">1</td><td rowspan="2">0</td><td>AL01</td><td>over voltage</td></tr> <tr><td>AL04</td><td>Abnormal regeneration</td></tr> <tr><td>0</td><td>1</td><td>1</td><td>AL03</td><td>over current</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>AL05</td><td>overload 1</td></tr> <tr><td rowspan="3">1</td><td rowspan="3">0</td><td rowspan="3">1</td><td>AL06</td><td>over speed</td></tr> <tr><td>AL07</td><td>Pulse command abnormal</td></tr> <tr><td>AL08</td><td>position error excessive</td></tr> <tr><td rowspan="2">1</td><td rowspan="2">1</td><td rowspan="2">0</td><td>AL0B</td><td>encoder error 1</td></tr> <tr><td>AL0C</td><td>encoder error 2</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>AL11</td><td>Motor mismatched</td></tr> </tbody> </table> <p>(*)0: Pin-SG off (open) 1: Pin-SG on (short)</p>	0	0	0	x	Alarm code(*)			Sign	Name	CN1-41	CN1-42	CN1-45	0	0	0	AL09	communication abnormal	AL0A	communication time-out	AL0E	IGBT overheat	AL0F	memory error	AL10	overload 2	0	0	1	AL02	low voltage	0	1	0	AL01	over voltage	AL04	Abnormal regeneration	0	1	1	AL03	over current	1	0	0	AL05	overload 1	1	0	1	AL06	over speed	AL07	Pulse command abnormal	AL08	position error excessive	1	1	0	AL0B	encoder error 1	AL0C	encoder error 2	1	1	1	AL11	Motor mismatched	Pt,Pr S,T	0000h ~001Fh	-
0	0	0	x																																																																						
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1	1	1	AL11	Motor mismatched																																																																					
PD20	DOP4	<p>Alarm reset triggered process</p> <table border="1" style="margin-left: 20px;"> <tr><td>0</td><td>0</td><td>0</td><td>x</td></tr> </table> <p><u>x:clear option</u></p> <p>0:PWM signal off(If the motor is running, it would coast to stop. If the motor is shaft-lock, it would become rotatable.) 1:invalid</p>	0	0	0	x	Pt,Pr S,T	0000h ~001Fh	-																																																																
0	0	0	x																																																																						

Digital input(DI) function definition

Sign	Setting Value	Functions/Applications description
SON	0x01	As this signal is on, the servo driver is ready to be operated.
RES	0x02	As particular alarm occurred, this signal recover from an abnormal status.
PC	0x03	This signal could switch proportion-integral speed control to proportion one.
TL	0x04	This signal could switch torque limit from inner limit 1 to external analog limit.
TL1	0x05	Turn TL1-SG on to make inner torque limit 2 valid.
SP1	0x06	Speed command/limit option 1.
SP2	0x07	Speed command/limit option 2.
SP3	0x08	Speed command/limit option 3.
ST1/RS2	0x09	In speed control mode, driver will rotate “forward” when the signal activated. In torque control mode, driver will rotate “reverse” when the signal activated.
ST2/RS1	0x0A	In speed control mode, driver will rotate “ reverse” when the signal activated. In torque control mode, driver will rotate “ forward” when the signal activated.
ORGP	0x0B	In position control with inner registers, the arbitrary position could be assigned as the origin when this signal activated.
SHOM	0x0C	As this signal activated, the driver runs motor to return the present origin.
CM1	0x0D	Electronic gear numerator option 1
CM2	0x0E	Electronic gear numerator option 2
CR	0x0F	Used to clear the position command pulse errors on its rising edge.
CDP	0x10	Turn CDP on to change the gain into the multiplier of PB14 to PB17.
LOP	0x11	It is used to switch varied mode as hybrid control mode applied.
EMG	0x12	Turn it off to bring to an emergency stop and turn it on to reset that state.
POS1	0x13	Position command option 1
POS2	0x14	Position command option 2
POS3	0x15	Position command option 3
CTRG	0x16	Used to switch the 8 inner register position commands.
HOLD	0x17	As this signal activated, the motor would stop running when the Pr mode is applied.

Digital output(DO) function definition

Sign	Setting Value	Functions/Applications description
RD	0x01	As the driver is ready to be operated, RD-SG would become conductive.
ALM	0x02	ALM-SG is isolated as power off or protection activated to cut off the main circuit. Without alarm occurring, ALM-SG would turn on after power on 1 second latter.
INP/SA	0x03	In position mode, INP-SG is conductive as position errors is under permissible range. In speed mode, SA-SG is conductive as the motor speed has nearly attained.
HOME	0x04	HOME-SG is on after the completion of home moving.
TLC/VLC	0x05	In speed mode, TLC-SG is on as motor generated torque reaches inner torque limit or torque analog limit. TLC-SG is off when SON signal is turned off. In torque mode, VLC-SG is on as motor speed reaches inner speed limit or speed analog limit. VLC-SG is off when SON signal is turned off.
MBR	0x06	When using this signal, make it usable by setting parameter PA01 as □1□□. MBR is off as the power is turned off or any alarm occurred.
WNG	0x07	WNG-SG is conductive as any warning occurred. Without warning occurring, WNG-SG is isolated.
ZSP	0x08	When motor speed is under the preset of zero speed, ZSP-SG keeps conductive.
CMDOCK	0x09	CMDOCK-SG is conductive as the inner position command is completed or stopped.

8. Communication functions

8.1. Communication interface and wiring

The Shihlin servo drive equips the RS-232C, RS-485 and plug-play USB serial communication functions. These functions could be used to perform servo operation, parameter changing, monitor function, etc. However, the RS-232C and RS-485 communication could not be used simultaneously. Use the parameter PC21 to select between RS-232C and RS-485. The wiring is demonstrated below.

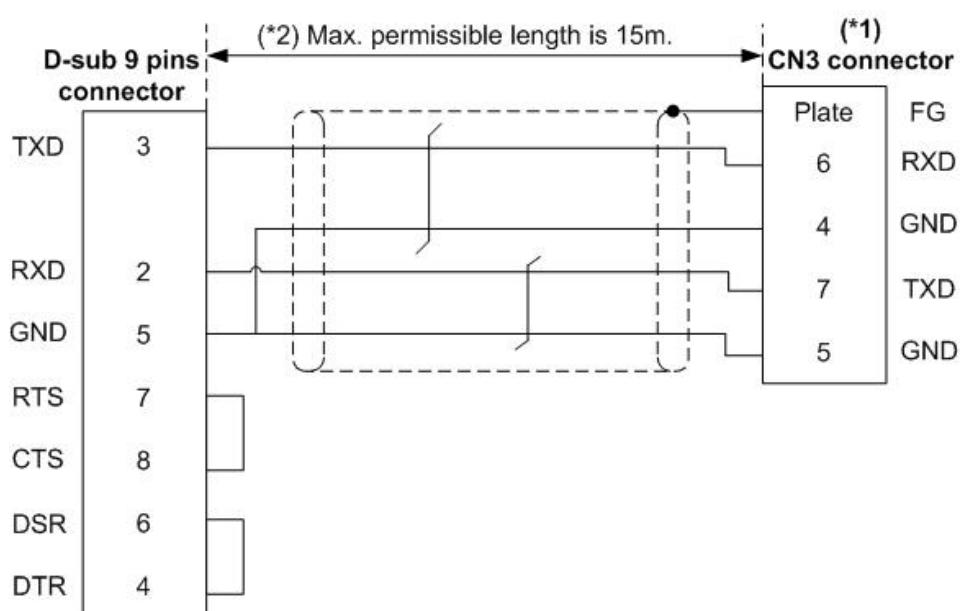
RS-232C

(1) Outline:

One device applied.



(2) Wiring diagram:



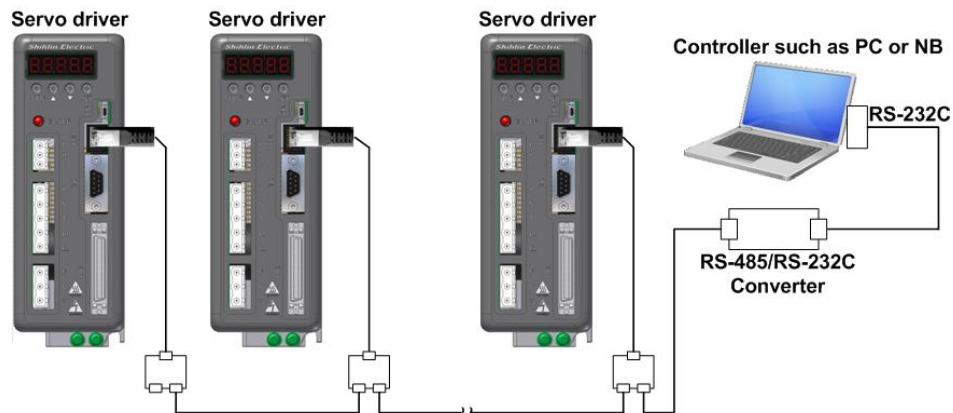
(*1): CN3 connector is the RJ-45 type.

(*2): Suitable for the environment with less noise interference. If communication transmission speed is higher than 38400bps, use the wires shorter than 3m.

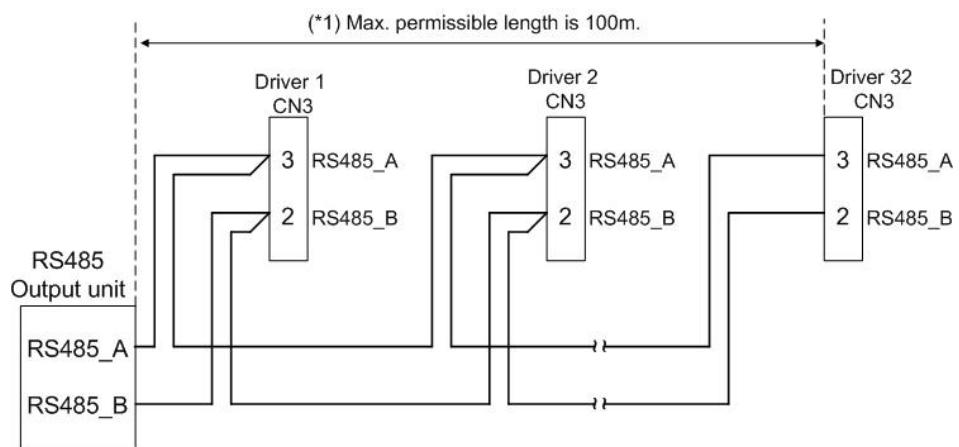
RS-485

(1) Outline:

Up to 32 devices of servo drivers from stations 1 to 32 could be operated on the same bus.



(2) Wiring diagram:



(*1) Suitable for the environment with less noise interference. If communication transmission speed is higher than 38400bps, use the wires shorter than 15m.

Recommendation: To connect ground terminal of RS-485/RS-232 converter and GND(pin4,pin5) of CN3 could reduce communication failure if necessary.

USB

(1) Outline:

Use the standard Mini-USB cable to perform.



8.2.Relevant parameters of communication

As RS-232C/RS-485 communication is performed, the related settings are described below.

(1) Communication device number(PC20)

Name	Abbr.	Sign	Setting range	Description
Communication device number	SNO	PC20	1 ~32	If two drivers occupy the same device number, the communication could not be performed.

(2) Mode option(PC21)

0	0	0	x
---	---	---	---

0:RS-232C

1:RS-485

(3) Communication reply time delay(PC21)

0	0	y	0
---	---	---	---

0:replay within 1mS

1:replay after 1mS

(4) Communication protocol option(PC22)

0	0	0	x
---	---	---	---

0:**7** data bit, **No** parity, **2** stop bit (Modbus, ASCII Mode)

1:**7** data bit, **Even** parity, **1** stop bit (Modbus, ASCII Mode)

2:**7** data bit, **Odd** parity, **1** stop bit (Modbus, ASCII Mode)

3:**8** data bit, **No** parity, **2** stop bit (Modbus, ASCII Mode)

4:**8** data bit, **Even** parity, **1** stop bit (Modbus, ASCII Mode)

5:**8** data bit, **Odd** parity, **1** stop bit (Modbus, ASCII Mode)

6:**8** data bit, **No** parity, **2** stop bit (Modbus, RTU Mode)

7:**8** data bit, **Even** parity, **1** stop bit (Modbus, RTU Mode)

8:**8** data bit, **Odd** parity, **1** stop bit (Modbus, RTU Mode)

(5) 通訊傳輸速率(PC22)

0	0	y	0
---	---	---	---

0: 4800 bps

1: 9600 bps

2: 19200 bps

3: 38400 bps

4: 57600 bps

5:115200 bps



NOTE:

As USB communication function is applied, it would work only to set the proper device number.

8.3.Modbus protocol

When communication between a computer and several drivers is going to be performed, every driver should have its device number of PC20 setting. Then the computer could control individual driver according to its device number. The protocol of Shihlin driver is Modbus protocol. There are two modes : ASCII(American Standard Code for information interchange) mode and RTU (Remote Terminal Unit) mode, users could change the mode by setting the PC22 value.

A. ASCII mode

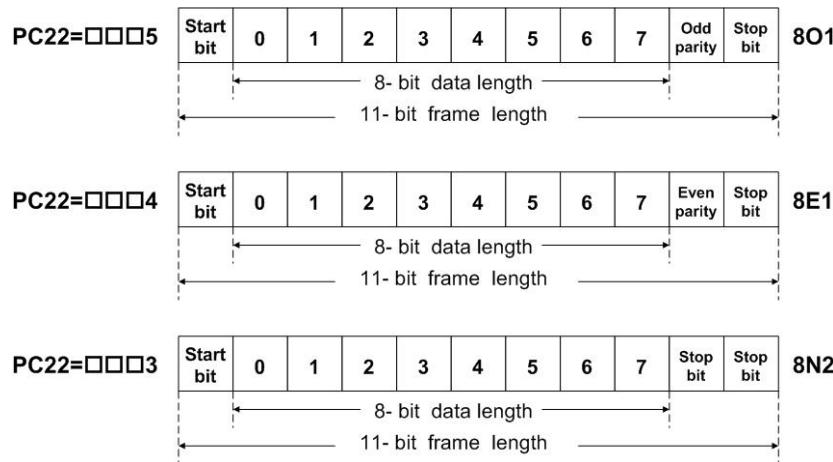
(a) Coding signification

A 8-bit data(a byte) is expressed with 2 ASCII character. For example, 75h is expressed with ASCII code “37h” and ASCII code “35h”.The ASCII codes ‘0’ to ‘9’ and ‘A’ to ‘F’ are listed below.

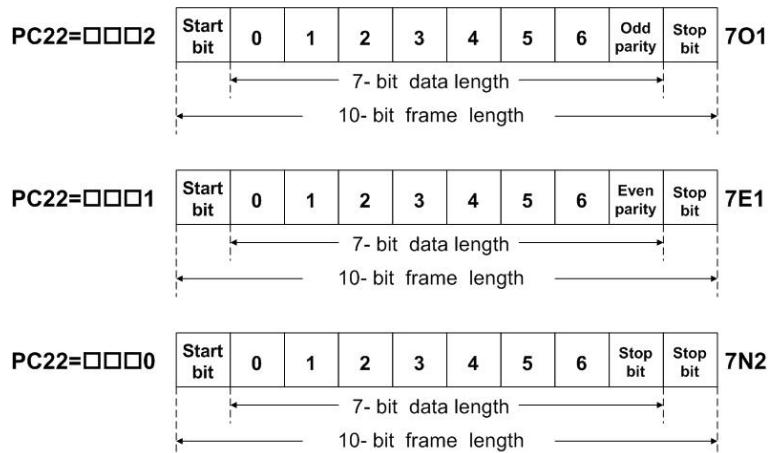
Character	‘0’	‘1’	‘2’	‘3’	‘4’	‘5’	‘6’	‘7’
ASCII code	30h	31h	32h	33h	34h	35h	36h	37h
Character	‘8’	‘9’	‘A’	‘B’	‘C’	‘D’	‘E’	‘F’
ASCII code	38h	39h	41h	42h	43h	44h	45h	46h

(b) frame signification

11-bit frame(suitable for 8-bit data length)



10-bit frame(suitable for 8-bit data length)



(c) Data packet structure

Byte sign	Name	Description
STX	Start code	":"(ASCII code 3Ah)
ADR	Device number	1 byte is composed of 2 ASCII code bytes.
CMD	Command code	1 byte is composed of 2 ASCII code bytes.
DATA(n-1)	Data code	The length of n words is equal to the one of 2n bytes.(n<=29) So, there are 4n ASCII code bytes.
.....		
DATA(0)		
LRC	LRC check value	1 byte is composed of 2 ASCII code bytes.
End1	End code 1	"CR"(ASCII code 0Dh)
End0	End code 0	"LF"(ASCII code 0Ah)

Communication data formats are described below.

STX

" :" character

ADR

The address code is from 1 to 32. For example, the expression of number 18(hexadecimal 12h) is divided into "1" and "2" in ASCII code. The address code 18 is expressed as 31h and 32h.

CMD and DATA

The DATA are varied according to different Command codes. To read 2 words which start address is 0100h from device number 1 as an example is described below.

Command code: 03h, read data

Command(host):

STX	:
ADR	'0'
	'1'
CMD	'0'
	'3'
DATA	'0'
	'1'
	'0'
	'0'
word length	'0'
	'0'
	'0'
	'2'
LRC	'F'
	'9'
End1	0Dh
End0	0Ah

Response(slave):

STX	:
ADR	'0'
	'1'
CMD	'0'
	'3'
DATA	'0'
	'4'
	'0'
	'1'
content of address 0100h	'0'
	'2'
	'1'
	'2'
content of address 0101h	'2'
	'1'
	'1'
	'C'
LRC	'2'
	0Dh
End1	0Ah

Command code: 06h, write data

To write "100"(0064h) into the driver which device number is 17 and start address is 0150h.

Command(host):

STX	:
ADR	'1'
	'1'
CMD	'0'
	'6'
DATA start address	'0'
	'1'
	'5'
	'0'
written data (word)	'0'
	'0'
	'6'
	'4'
LRC	'3'
	'4'
End1	0Dh
End0	0Ah

Response(slave):

STX	:
ADR	'1'
	'1'
CMD	'0'
	'6'
DATA start address	'0'
	'1'
	'5'
	'0'
written data (word)	'0'
	'0'
	'6'
	'4'
LRC	'3'
	'4'
End1	0Dh
End0	0Ah

LRC calculation:

ASCII mode uses LRC(Longitudinal Redundancy Check) to detect errors. LRC method computes the 2's complement of the sum from ADR code to the last data code. The 2's complement is a byte value which the overflow part neglected. Here is an case to describe the rule.

ADR	'1'	Calculation of LRC detection value:
CMD	'1'	
start address	'0'	
	'6'	
DATA	'C'	
	'1'	
	'2'	
	'A'	
data written (word)	'0'	
	'0'	
	'6'	
	'4'	
LRC	'9'	
	'A'	

End1,End0 (data packet ended):

Use "0Dh" and "0Ah" to denote the end of communication data packet.

B. RTU mode

(a) Coding signification

Data are expressed in hexadecimal characters. For example, “168” is expressed as A8h, “99” is expressed as 63h.

(b) Data packet structure

Byte sign	Name	Description
Start	-	To keep an idle more than 6mS
ADR	Device number	1 byte
CMD	Command code	1 byte
DATA(n-1)	Data code	n words is equal to 2n bytes.(n<=29)
.....		
DATA(0)		
CRC_L	CRC value low byte	Low byte of CRC check code
CRC_H	CRC value high byte	High byte of CRC check code
End	-	To keep an idle more than 6mS

Start

To keep an idle more than 6mS.

ADR

The address code is from 1 to 32. For example, number “17” is expressed as 11h.

CMD and DATA

The DATA are varied according to different Command codes.

Command code: 03h, read data

For example, to read 2 words which start address is 0200h from device number 1 is described below.

Command(host) :

ADR	01h
CMD	03h
DATA	02h
	00h
	00h
	02h
CRC_L	C5h
CRC_H	B3h

Response(slave) :

ADR	01h
CMD	03h
DATA	04h
	00h
DATA	B1h
	1Fh
CRC_L	40h
CRC_H	D4h

Command code: 06h, write data

For example, to write “100”(0064H) into the driver which device number 1 and start address 0200h.

Command(host):

ADR	01h
CMD	06h
DATA start address	02h
	00h
written data	00h
	64h
CRC_L	89h
CRC_H	99h

Response(slave):

ADR	01h
CMD	06h
DATA start address	02h
	00h
written data	00h
	64h
CRC_L	89h
CRC_H	99h

CRC calculation:

RTU mode uses CRC(Cyclical Redundancy Check) to detect errors.

CRC method to decide the check value is described below.

Step 1: Load a 16-bit register (called CRC register) with FFFFh.

Step 2: Exclusive OR the first 8-bit byte of the command message with the lower byte of CRC register, putting the result in the CRC register.

Step 3: Check the LSB of CRC register. If it is 0, shift the CRC register one bit to the right. If it is 1, shift the CRC register one bit to the right then Exclusive OR the CRC register with A001h.

Step 4: Repeat step 3 until eight shifts have been performed. When this is done, a complete 8-bit byte will have been processed, then perform step 5.

Step 5: Repeat step 2 to step 4 for the next 8-bit byte of the command message.

Continue doing this until all bytes have been processed. The final contents of the CRC register are the CRC value. It should be noticed that the low-byte should be transmitted before high-byte.

For example, reading 2 words from address 0101h of the drive with address 01H. The final content of the CRC register from ADR to last data character is 3794H, then the command message is shown as follows. What should be noticed is that 94H have to be transmitted before 37H.

ADR	01h
CMD	03h
DATA start address	01h
	01h
written data	00h
	02h
CRC_L	94h
CRC_H	37h

End:

To keep an idle more than 6mS.

CRC calculation example:

The following is an example of CRC generation using C language. The function takes two variables.

unsigned char* data;

unsigned char length

This function returns the CRC value as 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. Command code and exception code

The Command code and exception code of Shihlin servo driver are described below.

Command code	Description
03h	read data
06h	write data

Command code 03h denotes data reading, the maximum permissible length is 29 words.

Command code 06H denotes data writing, a word length writing.

Command code 08H denotes the diagnostic mode which could check if communication normal or not.

When the communication is performed between a host and the servo drivers, wrong commands or wrong address or over-range would cause the exception response with particular format.

Exception code (ECP)	Description
01h	Command code error
02h	Parameter address error
03h	Parameter range error

Exception code 01h denotes wrong Command code transmitted from the host computer.

Exception code 02H denotes wrong parameter address transmitted from the host computer.

Exception code 03H denotes the over-range parameter setting request.

If the received data are wrong, the driver would send back the Command code which is the original one added to 80h.

(a)ASCII mode

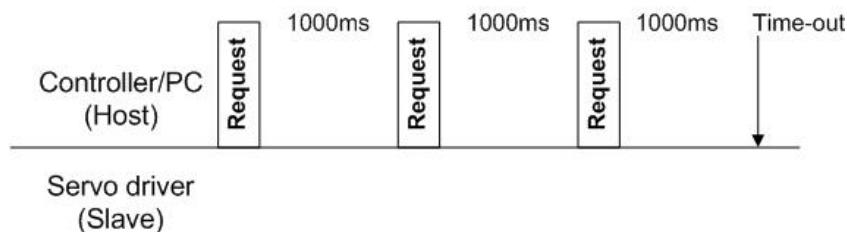
STX	:
ADR	'0'
	'1'
CMD	'8'
	'6'
ECP	'0'
	'2'
LRC	'7'
	'7'
End1	CR
End0	LF

(b)RTU mode

ADR	01h
CMD	86h
ECP	02h
CRC_L	C3h
CRC_H	A1h

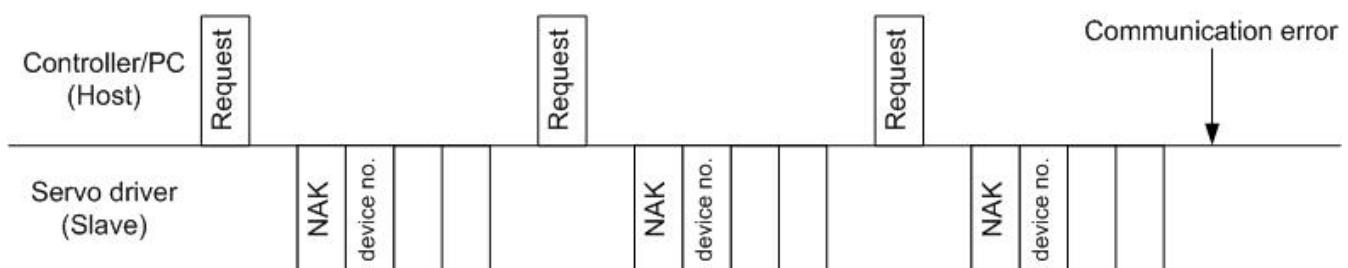
D. Time-out process

After the PC has transmitted the request and 1000mS took, if there still was no response replied from the servo driver, the PC would retransmit the request again. Time-out would occur if the driver does not answer after the PC has performed the above operation three times.



E. Retry process

When a communication fault occurs between the PC and drivers, the response data from the driver is a exception code. In this case, the PC retransmits the same request which caused the last fault. A communication error would occur if the above operation is repeated and results in the error three consecutive times.



8.4. Communication parameter write-in and read-out

(1) Status monitor (read only)

Address	Content	Data length
0000h	Motor feedback pulse (absolute value) [pulse]	1 word
0001h	Motor feedback revolution (absolute value) [rev]	1 word
0002h	Cumulative pulses of command [pulse]	1 word
0003h	Cumulative revolutions of command [rev]	1 word
0004h	Accumulative pulses error [pulse]	1 word
0005h	Command pulse frequency [kHz]	1 word
0006h	Motor speed [rpm]	1 word
0007h	Speed analog command voltage [V]	1 word
0008h	Speed command [rpm]	1 word
0009h	Torque analog command voltage [V]	1 word
000Ah	Torque command [N-m]	1 word
000Bh	Effective load ratio [%]	1 word
000Ch	Peak load ratio [%]	1 word
000Dh	DC bus voltage [V]	1 word
000Eh	The ratio of load inertial to motor shaft [times]	1 word
000Fh	Instantaneous torque [%]	1 word

(2) Digital IO monitor (read only)

(a) IO pin status

Address	Content	Data length
0203h	The ON/OFF status of DI and DO. The pin location is as follows.	1 word

bit No.	b0	b1	b2	b3	b4	b5	b6	b7
pin No.	CN1_14	CN1_15	CN1_16	CN1_17	CN1_18	CN1_19	CN1_20	CN1_21
Signal name	DI1	DI2	DI3	DI4	DI5	DI6	DI7	DI8

bit No.	b8	b9	b10	b11	b12	b13	b14	b15
pin No.	CN1_22	CN1_23	CN1_41	CN1_42	CN1_43	CN1_44	CN1_45	CN1_46
Signal name	LSP	LSN	DO1	DO2	DO3	DO4	DO5	ALM

(b) IO pin function

Address	Content	Data length
0204h ~0207h	To display the pin function programmed of DI and DO.	1 word

Address : 0x0204

bit No.	b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
pin No	CN1_42(DO2)				CN1_43(DO3)				CN1_44(DO4)				CN1_45(DO5)			
Function	00h to 09h(*)					00h to 09h					00h to 09h					

Address : 0x0205

bit No.	b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
pin No	CN1_20(DI7)					CN1_21(DI8)					CN1_41(DO1)					
Function	00 to 17h(**)					00h to 17h					00h to 09h					

Address : 0x0206

bit No.	b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
pin No	CN1_17(DI4)					CN1_18(DI5)					CN1_19(DI6)					
Function	00h to 17h					00h to 17h					00h to 17h					

Address : 0x0207

bit No.	b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
pin No	CN1_14(DI1)					CN1_15(DI2)					CN1_16(DI3)					
Function	00h to 17h					00h to 17h					00h to 17h					

(*),(**) : Refer to section 3.3.2 for more details.

(c) Current control mode

Address	Content	Data length
0208h	To display current control mode of servo driver. 0: Pt mode(external pulse-train command) 1: Pr mode(inner register command in <i>absolute</i> type) 2: Pr mode(inner register command in <i>incremental</i> type) 3: S mode 4: T mode	1 word

(3) Alarm information (read only)

Address	Content	Data length
0100h	Current alarm.	1 word
0101h	The last alarm.	1 word
0102h	The 2nd alarm in the past.	1 word
0103h	The 3rd alarm in the past.	1 word
0104h	The 4th alarm in the past.	1 word
0105h	The 5th alarm in the past.	1 word
0106h	The 6th alarm in the past.	1 word

(4) Alarm clear (readable and writable)

Address	Content	Data length
0130h	Clear current alarm if “1EA5h” is written into this address. Transmit current alarm code back if this address is read.	1 word
0131h	Clear all alarm histories if “1EA5h” written data is address. Transmit last alarm back if this address is read.	1 word

(5) Parameter write-in and read-out (readable and writable)

Address	Content	Data length
0300h ~0395h	Parameter group: PA□□: 45 parameters which address 0300h to 032Ch.(*1) PB□□: 30 parameters which address 032Dh to 034Ah.(*2) PC□□: 45 parameters which address 034Bh to 0377h.(*3) PD□□: 30 parameters which address 0378h to 0395h.(*4)	1 word ~ 29 words

(*1): PA41,PA43~PA45 are preserved parameters.

(*2): PB25~PB30 are preserved parameters.

(*3): PC35~PB45 are preserved parameters.

(*4): PD21~PB30 are preserved parameters.

(6) Factory-set recovery (readable and writable)

Address	Content	Data length
0621h	All parameters would be recover factory-set as 1 second latter after “1EA5h” being written. To read this address, the result of “1” means the recovery is processing. “0” means the completion of recovery.	1 word

(7) DI contact control (readable and writable)

Step 1: Select DI contact control option(write-in 0001h)

Address	Content	Data length
0387h	0: according to actual input state 1: controlled by communication command	1 word

Step 2: Write-in command to control ON/OFF state of each DI pin

Address	Content	Data length
0201h	Use bit value to control DI contact. Details are described below. Bit value 0 denotes OFF state. Bit value 1 denotes ON state.	1 word

bit No.	b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	preserved
DI signal	DI1	DI2	DI3	DI4	DI5	DI6	DI7	DI8	LSP	LSN	bit value must be "0"

Note: Consideration of test mode(DO forced output, JOG test, Positioning test)

As test mode is performed, check the following items or servo driver could not be operated normally.

1. As no alarm occurred nor Servo ON activated, test mode could be performed.
2. If communication is interrupted over 1 second during test mode, driver would quit this test mode. The host could repeatedly read-out at “0900h” address to keep a continuous communication.

(8) DO forced output (readable and writable)

Step 1: To check if alarm occurred or Servo ON activated by reading at address “0900h”.

Address	Content	Data length
0900h	0 z y x x=0 Servo OFF, x=1 Servo ON; zy:Alarm code	1 word

Step 2: To write-in 0002h at address “0901h” to perform this test.

Address	Content	Data length
0901h	0000h: To quit the test mode 0001h: Preserved 0002h: DO forced output 0003h: JOG test 0004h: Positioning test	1 word

Step 3: To write in test data at address “0202h” to enforce output.

Address	Content	Data length
0202h	To control DO status by the written data. It is described as follows.	1 word

bit No.	b0	b1	b2	b3	b4	b5	preserved
DI signal	DO1	DO2	DO3	DO4	DO5	ALM	bit value must be "0"

Step 4: To quit this mode by 0000h written at “0901h” address.

(9) JOG test (readable and writable)

Step 1: To check the driver without alarm occurred nor Servo ON activated.

Step 2: To write-in 0003h at address “0901h” to perform this mode.

Step 3: To set acceleration/deceleration time constant of JOG test(suitable for positioning test).

Address	Content	Data length
0902h	Acceleration/deceleration time constant [mS] Setting range: 0~20000	1 word

Step 4: JOG speed command(suitable for positioning test)

Address	Content	Data length
0903h	JOG speed command [rpm] Setting range: 0~6000	1 word

Step 5: JOG Forward/Reverse/Stop command

Address	Content	Data length
0904h	0: Written 0 to stop motor running. 1: Written 1 to make motor run forward rotation.(CCW) 2: Written 2 to make motor run reverse rotation.(CW)	1 word

Step 6: To quit this mode by 0000h written at address “0901h”.

(10) Positioning test (readable and writable)

Step 1: To check the driver without alarm occurred nor Servo ON activated.

Step 2: To write-in 0004h at address “0901h” to perform this positioning test.

Step 3: To set the acceleration/deceleration time constant of positioning test.

Step 4: To set speed command of positioning test.(Refer to JOG test mentioned above)

Step 5: To set the revolution of positioning test.

Address	Content	Data length
0905h	Revolution of positioning test [rev] Setting range: 0~30000	1 word

Step 6: To set the pulse of positioning test.

Address	Content	Data length
0906h	Pulse of positioning test [pulse] Setting range: 0~9999	1 word

Step 7: Positioning test Forward/Reverse/Stop command

Address	Content	Data length
0904h	0: Written 0 to pause/stop motor running.(twice pause command to stop motor running) 1: Written 1 to make motor run forward rotation.(CCW) 2: Written 2 to make motor run reverse rotation.(CW)	1 word

Step 8: To quit this mode by 0000h written at address “0901h”.

9. Inspection and Maintenance

9.1. Basic Inspection

It is recommended for users to inspect the following items periodically. Operate the inspection after the driver is power off and charge light of driver is off.

- ◆ Inspect the screws of the drive, terminal block and the connection to mechanical system.
Tighten screws as necessary as they may be loosen.
- ◆ Do not install the driver at location where closes to inflammable matters.
- ◆ Ensure that oil, water, metallic particles or any foreign objects do not fall inside the drive. As these would cause damage.
- ◆ Avoid any naked wires or damaged, broken wires applied for the servo motor.
- ◆ Ensure that all wiring terminals are correctly insulated.
- ◆ Ensure that the external applied power voltage is AC 220V.
- ◆ Ensure that all wiring instructions and recommendations are followed, otherwise damage to the drive and or motor may result.

9.2. Maintenance

Users should not disassemble the servo driver or motor as maintenance performing.

- ◆ Periodically clean the surface of servo driver and motor.
- ◆ Operate the servo driver and motor within the specified environmental condition range.
- ◆ Clean off any dust and dirt that accumulated on the ventilation holes of servo driver.

9.3. Life of consumable components

Some components inside the servo driver is consumable and must be replaced periodically. The life of consumable components are varied, which depends on operating methods and environmental conditions. For parts replacement, please contact your sales agent. The life of particular components are listed below.

Component	Life guideline	Description
Relay	100,000 times	The contact would wear due to switching currents. Relays reach the end of its life at cumulative 100,000 switching times, which depends on the power supply capacity.
Cooling fan	10.000~30.000hrs	The cooling fan bearings reach the end of their life in 10,000 to 30,000 hours. It should be replaced if noise is found during inspection.
Aluminum capacitor	10 years	Affected by ripple currents and deteriorates in characteristic. Its life greatly depends on ambient temperature and operating conditions. The capacitor will reach the end of its life in 10 years of continuous operation in normal air-conditioned environment.

10. Troubleshooting

10.1. Alarm list

The driver would display alarm or warning if some faults occurred during operation. As a alarm or a warning occurred, please remedy the fault according to the instruction mentioned in section 10.2. When parameter PD19 is set as □□□1, alarm codes could be output with the ON/OFF states of DO1(CN1_41), DO2(CN1_42), DO5(CN1_45) terminals.

Sign	Alarm code			Name	Clear		
	CN1_41	CN1_42	CN1_45		Power OFF→ON	Press "SET" on current alarm screen.	RES signal
Alarm	AL01	0	1	0	Over voltage	<input type="radio"/>	
	AL02	0	0	1	Low voltage	<input type="radio"/>	<input type="radio"/>
	AL03	0	1	1	Over current	<input type="radio"/>	
	AL04	0	1	0	Abnormal regeneration	<input type="radio"/>	<input type="radio"/>
	AL05	1	0	0	Overload 1	<input type="radio"/>	<input type="radio"/>
	AL06	1	0	1	Over speed	<input type="radio"/>	<input type="radio"/>
	AL07	1	0	1	Pulse command abnormal	<input type="radio"/>	<input type="radio"/>
	AL08	1	0	1	Position error excessive	<input type="radio"/>	<input type="radio"/>
	AL09	0	0	0	Communication abnormal	<input type="radio"/>	<input type="radio"/>
	AL0A	0	0	0	Communication time-out	<input type="radio"/>	<input type="radio"/>
	AL0B	1	1	0	Encoder error 1	<input type="radio"/>	
	AL0C	1	1	0	Encoder error 2	<input type="radio"/>	
	AL0D	1	1	0	Fan error	<input type="radio"/>	
Warning	AL0E	0	0	0	IGBT overheat	<input type="radio"/>	
	AL0F	0	0	0	Memory error	<input type="radio"/>	
	AL10	0	0	0	Overload 2	<input type="radio"/>	
	AL11	1	1	1	Motor mismatched	<input type="radio"/>	
	AL12				Emergency stop	Removing the cause would clear the warning automatically.	
	AL13				LSP/LSN activated		

10.2. Alarm cause and remedy

AL01 Over voltage

Definition: Main circuit bus voltage has exceeded its maximum allowable value.

Cause	Inspection	Remedy
Power supply voltage high.	Review the power supply.	Use proper power source.
Input power error (incorrect power).	Review the power supply.	Use proper power source.
Driver hardware damaged.	Use voltmeter to check if the power voltage is within rated voltage while error still occurred.	Contact agent for proper service.
Lead of built-in regenerative brake resistor or regenerative brake option is disconnected.	Check the P,D terminals connected well or not. Check built-in regenerative brake resistor or regenerative brake option is disconnected well.	Connect correctly.
Built-in regenerative brake resistor or regenerative brake option is damaged.	Check if it is burn out or damaged.	Change the built-in resistor or option.
Capacity of built-in regenerative brake resistor or regenerative brake option is insufficient.	Refer to section 6.6.1 to check if the capacity insufficient.	Add regenerative brake option or increase capacity.

AL02 Low voltage

Definition: Main circuit bus voltage is lower than its allowable value.

Cause	Inspection	Remedy
Input voltage of main circuit is lower than permissible value.	Review the power supply.	Use proper power source.
Capacity of power supply is insufficient.	Check if it occurred as motor torque regenerated huge.	Increase power supply capacity.
Input power error (incorrect power).	Review the power supply.	Use proper power source.

AL03 Over current

Definition: Main circuit current has exceeded 1.5 times maximum instantaneous current of motor.

Cause	Inspection	Remedy
Improper motor wirings.	Check the wirings.	Correct the wirings.
Short occurred in driver output phases U, V and W.	Check if the connection between driver and motor is short.	Correct the wirings to prevent from short-circuit or cable naked.
IGBT of servo driver faulty.	AL03 occurs if power is switched on after U,V and W are disconnected.	Contact agent for proper service.
Improper parameters setting.	Check relevant parameters which have modified.	Recover factory-set then re-define user's demand.

AL04 Regenerative alarm

Definition: Regenerative energy suppression circuit faults.

Cause	Inspection	Remedy
Regenerative transistor fault.	AL04 occurs even after removal of built-in regenerative brake resistor or regenerative brake option.	Contact agent for proper service.
Built-in regenerative brake resistor or regenerative brake option is disconnected.	Check the wirings.	Correct the wirings.

AL05 Overload 1

Definition: Load exceeded overload protection characteristic of servo driver.

Cause	Inspection	Remedy
Operate the servo driver in heavy duty continually.	Check if mechanism load is huge.	Upgrade the capability of servo or reduce the duty.
Improper gain values setting.	Check if vibration of mechanism is occurred.	Re-operate the auto-gain tuning job to obtain the proper gain value.
Servo system is instable.	Check if acceleration/deceleration time constant are proper.	Extend these setting values.
Wrong connection of servo motor.	Check the wirings.	Correct the wirings.
Encoder faulty.	As motor shaft is rotated slowly with Servo OFF, the pulses feedback should vary in proportion to rotary angle. If the indication skips or returns midway, it is faulty.	Contact agent for proper service.

AL06 Over speed

Definition: Speed has exceeded the instantaneous permissible speed.

Cause	Inspection	Remedy
Input command pulse frequency exceeded the permissible instantaneous speed frequency.	Check if frequency of input pulse is over the permissible speed range.	Set pulses frequency correctly.
Improper acceleration/deceleration time constant settings.	Check if these values are too small.	Increase acceleration/deceleration time constant.
Servo system is instable to cause overshoot.	Observe if the mechanism is with vibration.	1. Re-set proper servo gain value. 2. If gain could not be set to proper: 1) Reduce load inertia ratio; or 2) Set acceleration/deceleration time constant to proper value.
Electronic gear ratio is large	Check if the settings are proper.	Set correctly.

AL07 Pulse command abnormal

Definition: Input pulse frequency of the command pulse is too high.

Cause	Inspection	Remedy
Pulse frequency of the command pulse is too high.	Check if input pulse frequency is over range with frequency detector.	1. Set the command pulse frequency to a proper value. 2. After RD output signal activated, the host starts to send command.
Command device failure.	Check if the command device is normal or not.	Change the command device.

AL08 Position error excessive

Definition: Position error has exceeded the permissible error range.

Cause	Inspection	Remedy
Improper acceleration/deceleration time constant settings.	Check if these values are too small.	Increase acceleration/deceleration time constant.
Improper torque limit setting.	Check if PA05 setting is too small.	Increase the torque limit value.
Position loop gain value is small.	Check if PB07 setting is too small.	Increase the gain value and adjust to ensure proper operation.
Mechanism load is huge.	Check if mechanism load is huge.	Reduce load, or to use servo driver and motor provide larger output.

AL09 Communication abnormal

Definition: RS-232/485 communication error occurred between host device and servo driver.

Cause	Inspection	Remedy
Improper protocol setting.	Check if the protocol is matched.	Set the protocol correctly.
Improper address setting.	Check the communication address.	Set the address correctly.
Improper data content transmitted.	Check the value accessed.	Correct the data content accessed.

AL0A Communication time-out

Definition: RS-232/485 communication stopped for longer time exceeded the permissible range.

Cause	Inspection	Remedy
Cable broken or loosen.	Check if cable broken or loosen.	Replace or re-connect the cable.
Communication cycle is longer than parameter PC23 setting.	Check if PC23 setting is proper.	Set the PC23 correctly.

AL0B Encoder error 1

Definition: Pulse signals abnormal between servo motor and servo driver.

Cause	Inspection	Remedy
Wirings are in wrong sequence.	Check if wirings sequence is correct or not.	Correct the wirings.
CN2 connector is loosen or disconnected.	Check if CN2 connector is loosen or disconnected.	Re-connect CN2 connector.
Encoder faulty	Check the encoder feedback pulses continuity of motor while Servo OFF	Contact agent for proper service.

AL0C Encoder error 2

Definition: Pulse signals abnormal between servo motor and servo driver.

Cause	Inspection	Remedy
Initial magnetic polarity of encoder is in wrong position	Rotate the motor shaft forward and backward then re-power on the driver. If there is still no improvement, contact agent for proper service.	
CN2 connector is loosen or disconnected.	Check if CN2 connector is loosen or disconnected.	Re-connect CN2 connector.

AL0D Fan error

Definition: Abnormal operation of cooling fan.

Cause	Inspection	Remedy
Cooling fan stops working.	Change the fan by user or contact agent for proper service.	

AL0E IGBT overheat

Definition: Main circuit device overheat or fault.

Cause	Inspection	Remedy
Operate the driver in over-rate duty continuously.	Check if mechanism is overload or motor current is huge.	Reduce load, or to use servo driver and motor provide larger output.
Servo driver fault.	Check the output of servo driver.	Contact agent for proper service.

AL0F Memory error

Definition: EEPROM fault.

Cause	Inspection	Remedy
Data read-out/write-in abnormally.	To execute the parameter recovery or power on reset and check if it still null.	Contact agent for proper service.

AL10 Overload 2

Definition: The output duration of maximum current is over 1 second while mechanical impact.

Cause	Inspection	Remedy
Mechanical impact	Check if the moving route is proper.	1. Correct the moving route. 2. Install limit switches.
Wrong connection of servo motor.	Check the wirings.	Correct the wirings.
Mechanism vibration.	Check if mechanism is instable and humming.	1. Change response level setting. 2. Make gain adjustment manually.
Encoder faulty.	To rotate motor shaft and check the continuity of encoder feedback pulses while Servo OFF.	Contact agent for proper service.

AL11 Motor mismatch

Definition: The servo driver and servo motor match improperly.

Cause	Inspection	Remedy
The capacity of driver and motor are not compatible.	Check if they match for each other in capacity.	Use the proper combination.

AL12 Emergency stop warning

Definition: The EMG signal of DI is activated.

Cause	Inspection	Remedy
EMG signal is activated.	Check if EMG signal is applied and triggered.	Release the trigger after removal of some emergency conditions.

AL13 Limit switch activated warning

Definition: The LSP or LSN signal of DI is activated.

Cause	Inspection	Remedy
LSP activated.	Check if the limit switch is activated.	Release the activated cause of limit switch.
LSN activated.		

11. Specifications

11.1. Specifications of servo drivers

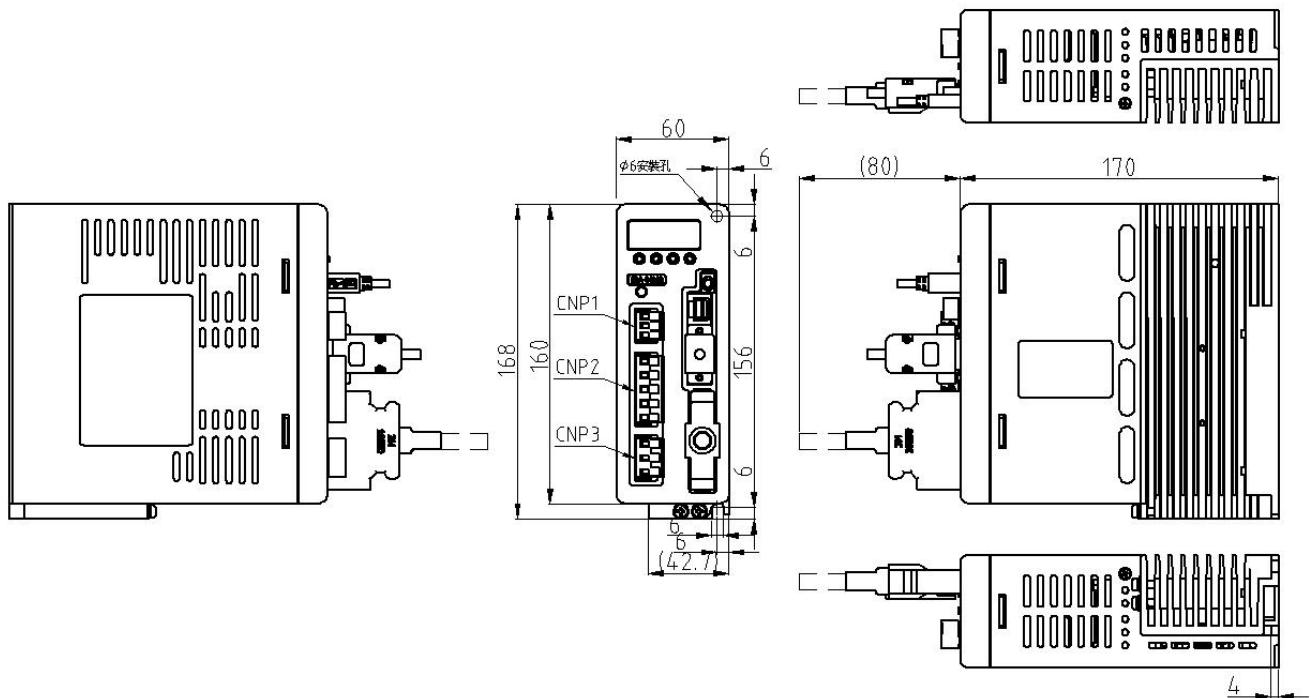
SDA-□□□A2	010	020	040	050	075	100	150	200	350											
SMA-□□□□ (matched motor)	L010	L020	L040	M050	L075	M100	M150	M200	M350											
Motor power	100W	200W	400W	500W	750W	1KW	1.5KW	2KW	3.5KW											
Main circuit power	Voltage/Frequency	3φ AC200~230V 50/60Hz or 1φ AC230V 50/60Hz					3φ AC200~230V 50/60Hz													
	Allowable voltage Range	3φ AC200~230V AC:170 to 253VAC 1φ AC230V AC: 207 to 253VAC					3φ AC170~253V 50/60Hz													
	Allowable frequency Range	Maximum ±5%																		
Control circuit power	Voltage/Frequency	1φ AC200~230V 50/60Hz																		
	Allowable voltage Range	AC:170 to 253VAC																		
	Allowable frequency Range	Maximum ±5%																		
	Power consumption(W)	30																		
Control mode	3φ full-wave rectification, IGBT-PWM control (SVPWM)																			
Dynamic brake	Built-in																			
Protection	Over current, over voltage, overload, fan failure protection, output short-circuit protection, abnormal encoder protection, abnormal regeneration protection, low voltage/power interruption protection, over speed protection, error excessive																			
Encoder type	2500ppr(10000 resolution) incremental type																			
Communication interface	RS232/RS485, USB (Modbus protocol)																			
Position control mode	Input pulse frequency	Max. 500Kpps(Line driver), Max. 200Kpps(Open collector)																		
	Command pulse type	Pulse + Direction, A phase + B phase, CCW pulse + CW pulse																		
	Command source	External pulse train input/Inner register																		
	Command smoothing	Low-pass filter/Linear acceleration and deceleration pattern/S-pattern smoothing																		
	Electronic gear ratio	Electronic gear ratio A/B-time A: 1~32767; B:1~32767 1/50 < A/B < 200																		
	In-position range setting	0~±10000pulses																		
	Position error excessive	±3 revolutions																		
	Torque limit	Inner limit or torque analog limit (0~+10Vdc/Maximum torque)																		
	Feed-forward function	Internal parameter setting: 0~200%																		

SDA-□□□A2		010	020	040	050	075	100	150	200	350					
SMA-□□□□ (matched motor)		L010	L020	L040	M050	L075	M100	M150	M200	M350					
Motor power		100W	200W	400W	500W	750W	1KW	1.5KW	2KW	3.5KW					
Speed control mode	Speed control range	Speed analog command 1:2000; Inner speed command 1:5000													
	Command source	Speed analog voltage input/ Inner register command													
	Command smoothing	Low-pass filter/Linear acceleration and deceleration pattern/S-pattern smoothing													
	Speed analog input	0~±10Vdc/Rated speed (Input impedance: 10~12kΩ)													
	Speed change rate	Load change: 0~100% ; maximum ±10%, Power source change: ±10%; maximum 0.5%, Ambient temperature 0°C ~55°C; Maximum ± 0.5% (Speed analog command)													
	Torque limit	Inner limit or torque analog limit (0~+10Vdc/Maximum torque)													
	Bandwidth	Maximum 450Hz													
Torque mode	Command source	Torque analog voltage input													
	Command smoothing	Low-pass filter													
	Torque analog input	0~±10Vdc/Max torque generated(Input impedance: 10~12kΩ)													
	Speed limit	Inner limit or speed analog limit (0~+10Vdc/Maximum speed)													
Digital input/output signal	Digital input(DI)	Servo ON, forward and reverse rotation limit switch, pulse error clearing, torque direction option, speed command option, position command option, forward and reverse rotation command, proportional control switched, torque limit switched, abnormal alarm reset, emergency stop, control mode switching, electric gear ratio options, gain switching													
	Digital output(DO)	Torque limit attain, speed limit attain, ready signal, zero speed attained, position attained, speed attained, alarm signal, home moving completed													
	Analog input	Speed analog command/limit, Torque analog command/limit,													
	Analog output	Command pulse frequency, pulse error, current command, DC bus voltage, motor speed, generated torque													
Cooling method(structure)			Nature air convention(IP20)				Fan force-cooling(IP20)								
Environment	Temperature	operating	0°C~ 55°C(If it is above 45°C forced cooling would be required)												
		storage	-20~65°C(non-freezing)												
	humidity	operating	90%RH or less (non-condensing)												
		storage	90%RH or less (non-condensing)												
	Installation site		Indoor(no direct sunlight), no corrosive gas, no oil mist or dust, no flammable gas												
	Altitude		Max.1000m (3280ft) or lower above sea level												
Vibration			Maximum 59m/s ²												
Weight(kg)			1.4	1.4	1.4	1.4	1.7	1.7	2.6	2.6	2.6				
Reference dimension figure			Page 158				Page 158		Page 159						
Approval			IEC/EN 61800-5-1												

11.2. Dimensions of servo drivers

SDA-010A2, SDA-020A2, SDA-040A2, SDA-050A2 (100W~500W)

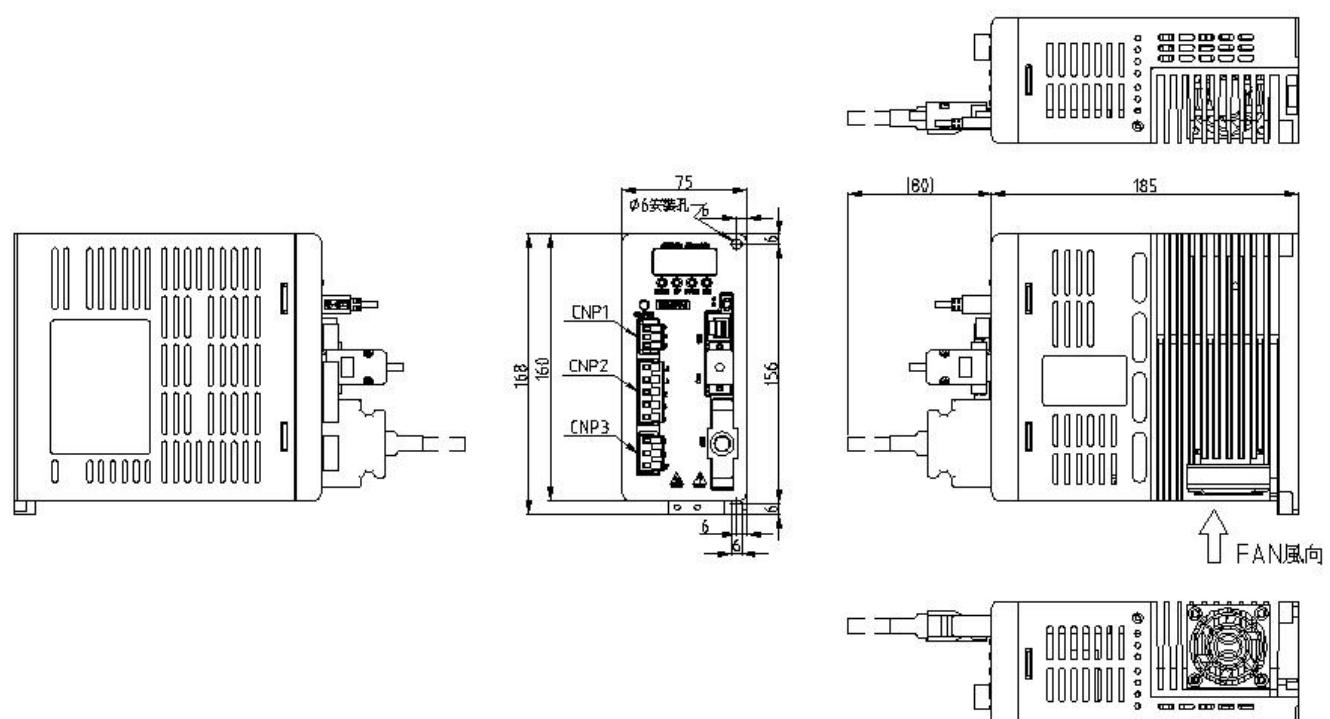
unit[mm]



★ Dimensions of the servo drive may be revised without prior notice.

SDA-075A2, SDA-100A2 (750W, 1KW)

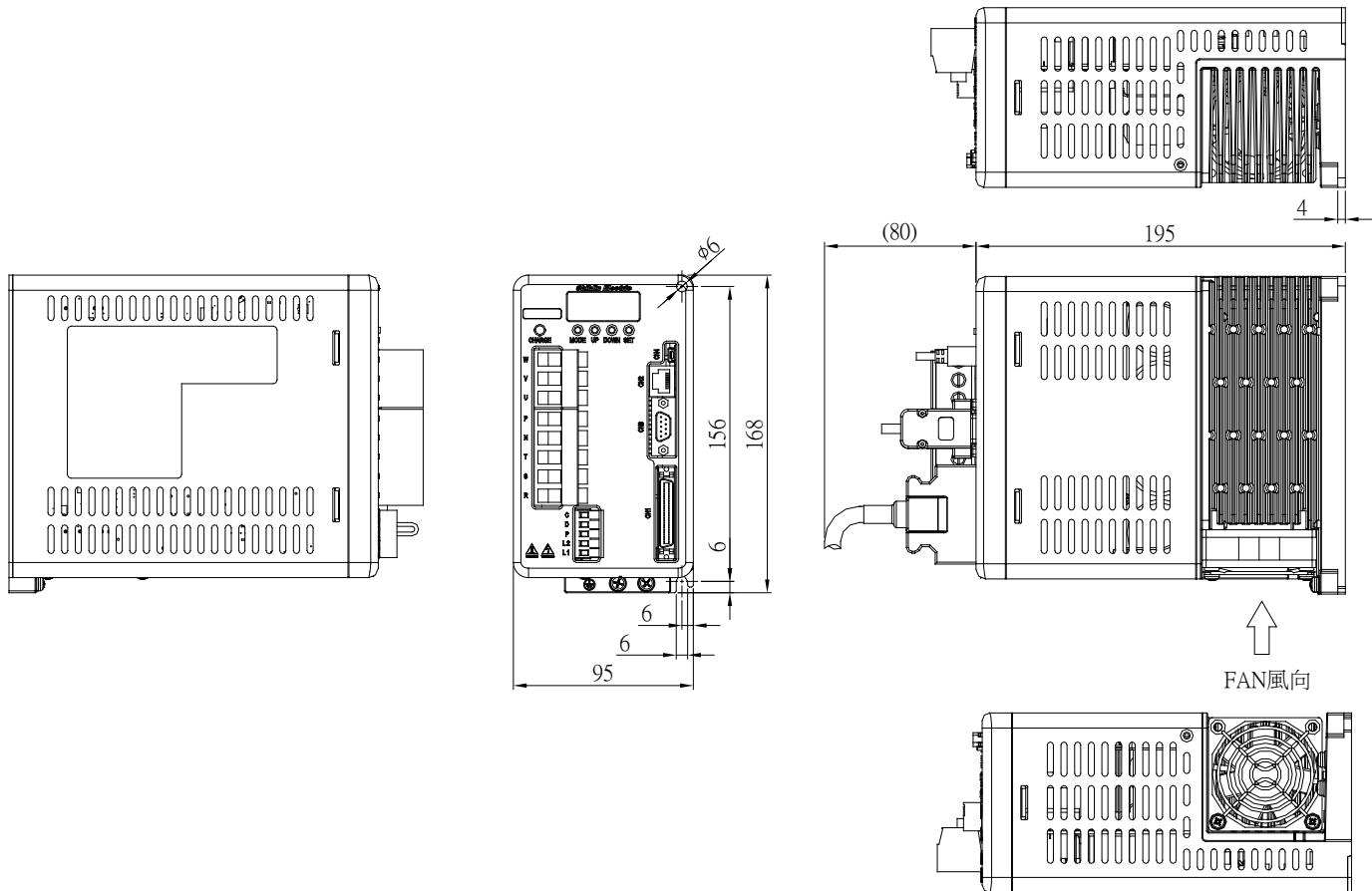
unit[mm]



★ Dimensions of the servo drive may be revised without prior notice.

SDA-150A2, SDA-200A2, SDA-350A2 (1.5KW~3KW)

unit[mm]



- ★ Dimensions of the servo drive may be revised without prior notice.

11.3. Specifications of low inertial motors SMA-L□□□R30A series

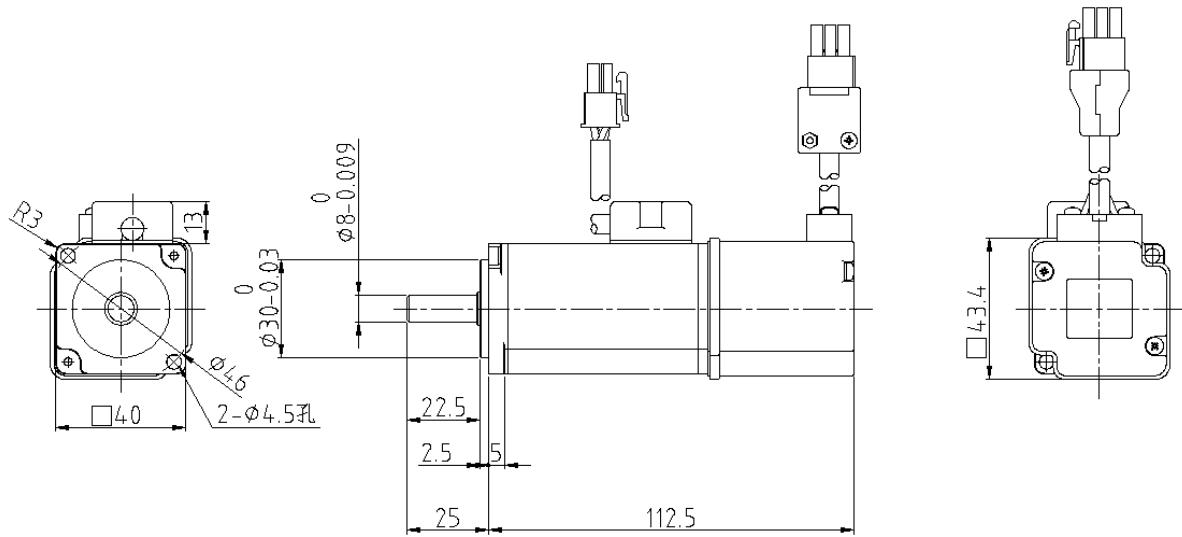
SMA-L□□□	010	020	040	075
Capacity of power supply (kVA)	0.3	0.5	0.9	1.3
Rated output power (W)	100	200	400	750
Rated torque (N·m)	0.32	0.64	1.27	2.4
Maximum torque (N·m)	0.96	1.92	3.81	7.2
Rated speed (r/min)		3000		
Maximum speed (r/min)		4500		
Instantaneous allowable speed (r/min)		5175		
Power rating (kW/S)	18.29	19.69	46.08	47.21
Rated current (A)	0.93	1.32	2.44	4.8
Max. instantaneous current (A)	2.79	3.96	7.32	14.7
Rotor inertia J ($\times 10^{-4}$ 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 (mV/(r/min))	39.97	54.53	56.6	56.25
Armature resistance R_a (Ohm)	41.75	11.70	5.66	1.38
Armature inductance L_a (mH)	29.13	42.87	24	10.02
Mechanical constant (mS)	1.780	0.964	0.704	0.640
Electric constant (mS)	0.7	3.66	4.24	7.26
Insulation class		F		
Insulation resistance		100MΩ,DC500V		
Insulation strength		AC1500V,60Hz,60sec		
Encoder		2500ppr		
Environment	Protection structure (IP)		65	
	Temperature	operating	0~40°C	
		storage	-15~70°C	
	Humidity	operating	80%RH or less (non-condensing)	
		storage	90%RH or less (non-condensing)	
	Vibration grade (μm)		15	
	Vibration capacity		x,y direction: 49 m/ S ²	
Weight (kg)	0.55	1.01	1.46	2.89
[] with electromagnetic brake	[0.75]	[1.44]	[1.89]	[3.63]
Approval		CE		

11.4. Specifications of medium inertial motors SMA—M□□□R20A series

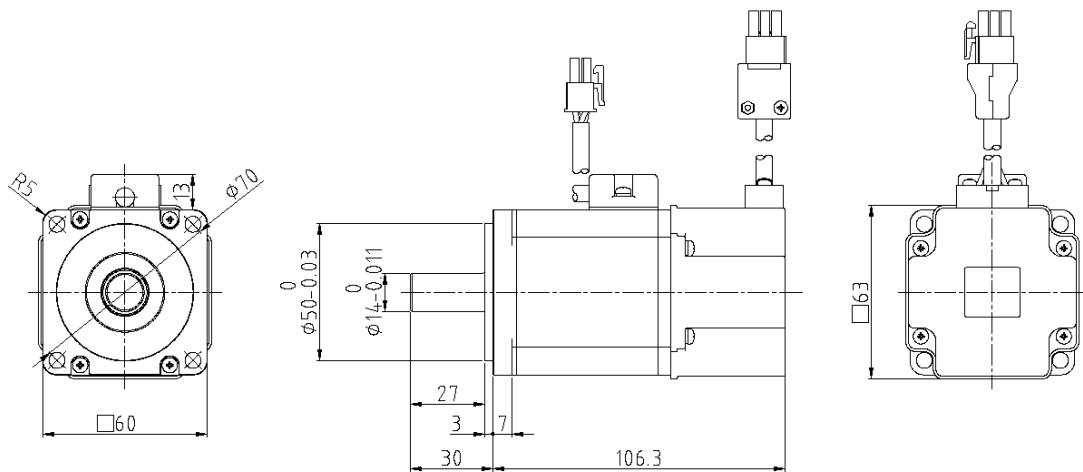
SMA-M□□□	050	100	150	200	350
Capacity of power supply (kVA)	1.0	1.7	2.5	3.5	5.5
Rated output power (W)	0.5	1.0	1.5	2.0	3.5
Rated torque (N·m)	2.39	4.78	7.16	9.55	16.7
Maximum torque (N·m)	7.16	14.4	21.6	28.5	50.1
Rated speed (r/min)		2000			
Maximum speed (r/min)		3000		2500	
Instantaneous allowable speed (r/min)		3450		2850	
Power rating (kW/S)	8.6	18.2	27.7	23.5	37.3
Rated current (A)	3.0	5.8	8.5	10	16
Max. instantaneous current (A)	9.0	16.8	25.5	31.5	48
Rotor inertia J ($\times 10^{-4}$ 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 (mV/(r/min))	95.34	98.48	99.32	119.49	123.18
Armature resistance R_a (Ohm)	3.77	1.48	0.885	0.758	0.311
Armature inductance L_a (mH)	19.2	9.12	5.79	8.17	3.99
Mechanical constant (mS)	2.988	2.094	1.824	2.262	1.690
Electric constant (mS)	5.091	6.179	6.542	10.751	12.788
Insulation class		F			
Insulation resistance		100MΩ,DC500V			
Insulation strength		AC1500V,60Hz,60sec			
Encoder		2500ppr			
Environment	Protection structure (IP)		65		
	Temperature	operating	0~40°C		
		storage	-15~70°C		
	Humidity	operating	80%RH or less (non-condensing)		
		storage	90%RH or less (non-condensing)		
	Vibration grade (μm)		15		
	Vibration capacity		x, y : 24.5 m/s 2		
Weight (kg)	4.8	6.9	9.0	11.6	17.7
[] with electromagnetic brake	(6.6)	(8.7)	(10.8)	(16.9)	(23)
Approval		CE			

11.5. Dimensions of low inertial motor

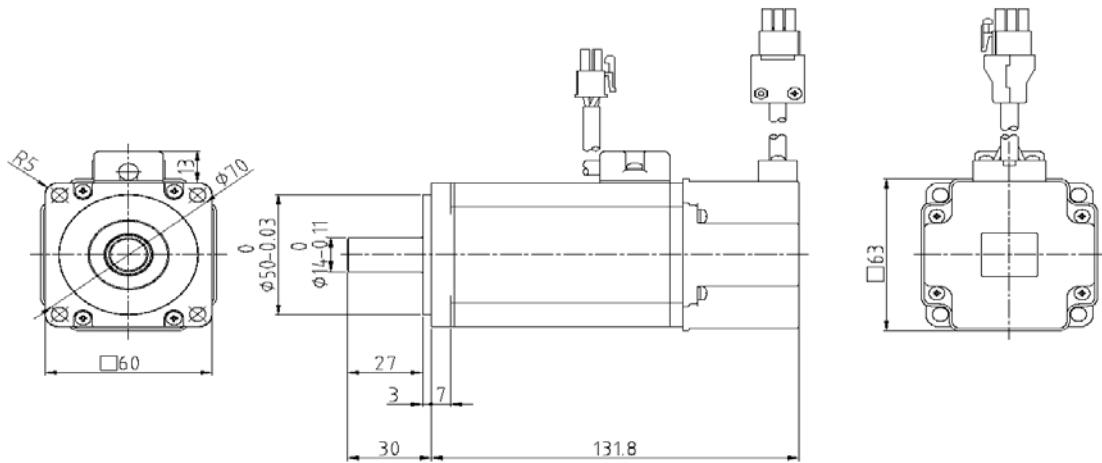
【SMA-L010】



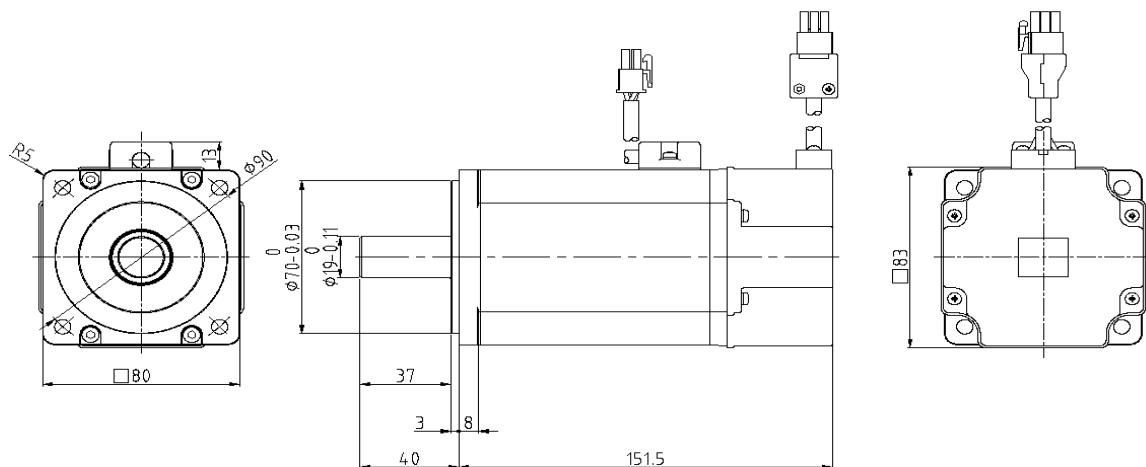
【SMA-L020】



SMA-L040

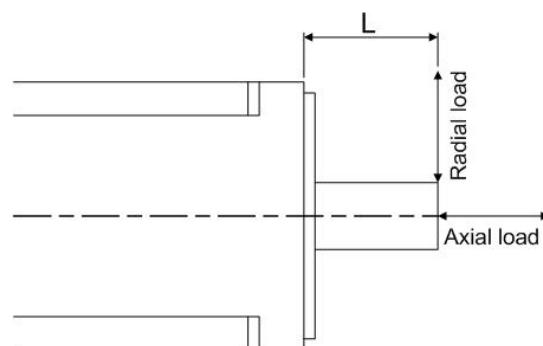


SMA-L075



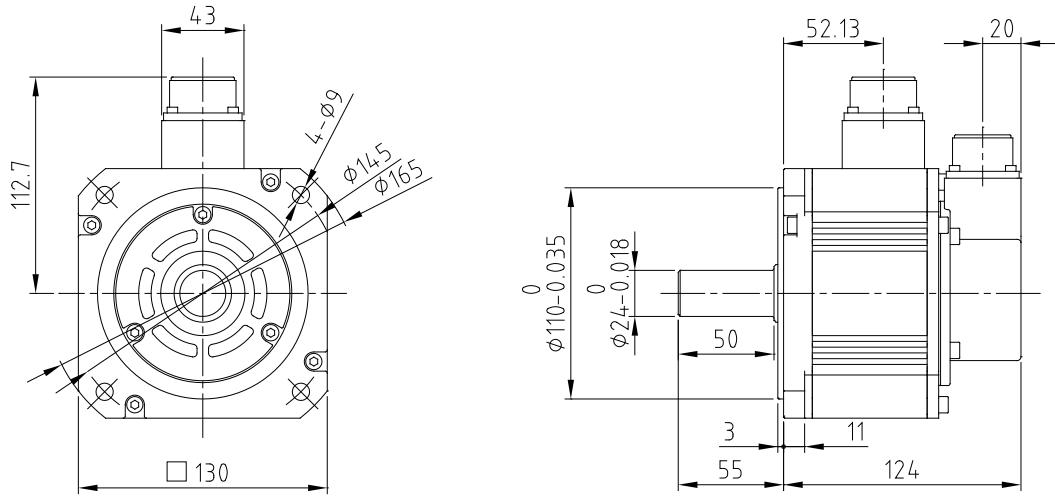
11.6. Permissible shaft load of low inertial motor

Motor type	SMA-L010	SMA-L020	SMA-L040	SMA-L075
L (mm)	25	30	30	40
Permissible load in radial direction N(kgf)	68.6(7)	245(25)	245(25)	392(40)
Permissible load in axial direction N(kgf)	39.2(4)	98(10)	98(10)	147(15)

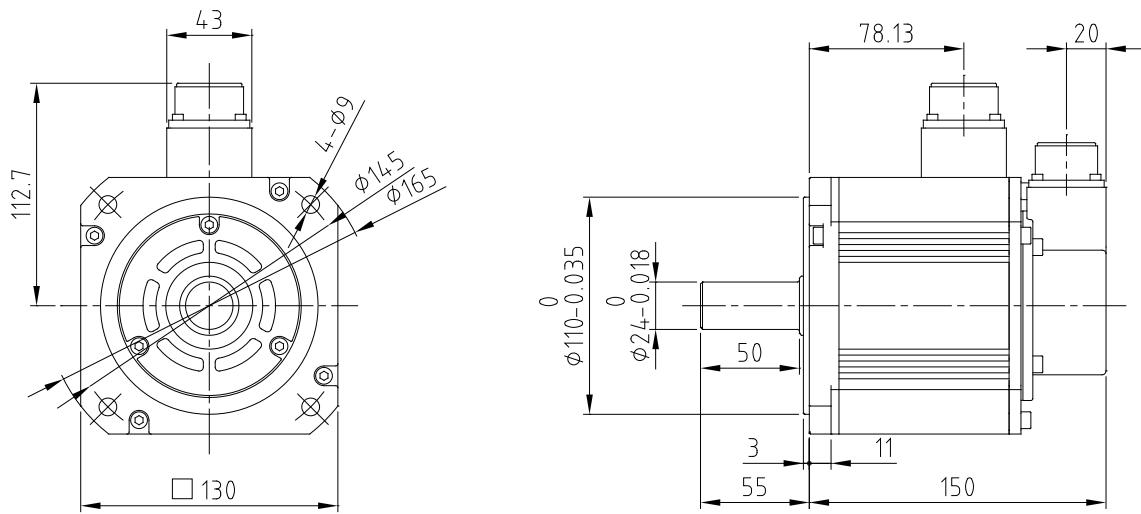


11.7. Dimensions of medium inertial motors

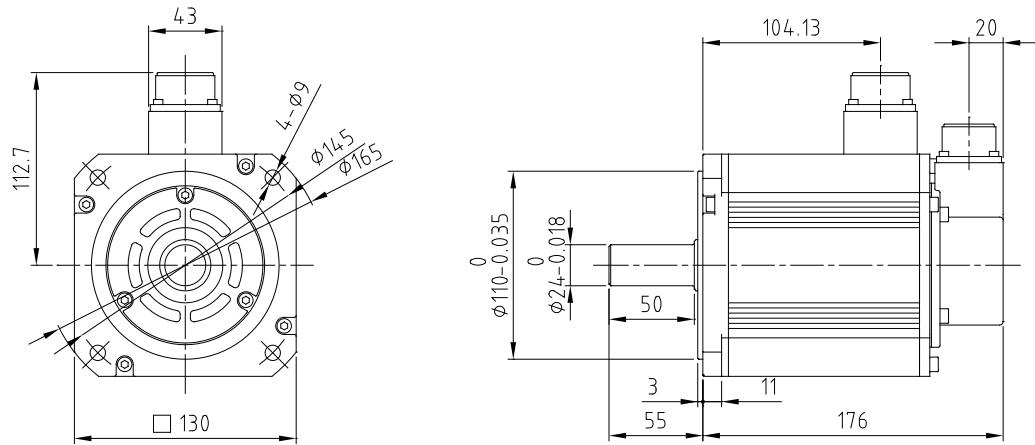
【SMA-M050】



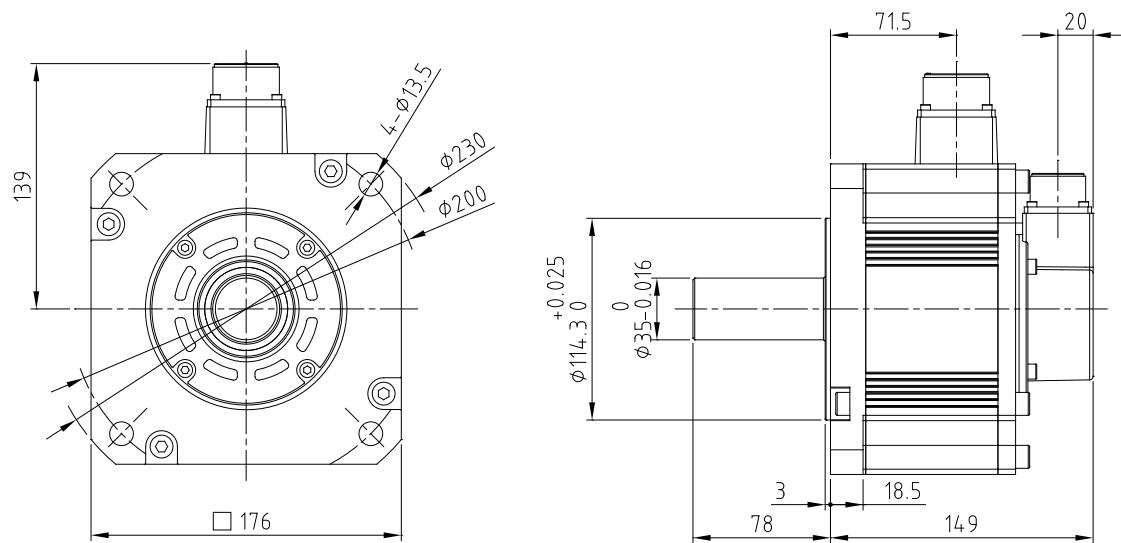
【SMA-M100】



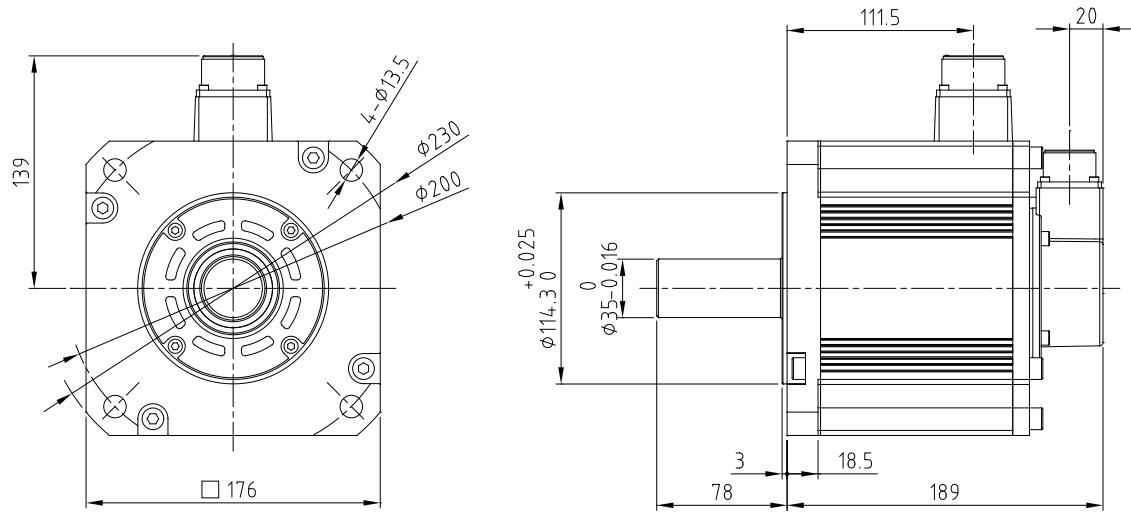
【SMA-M150】



【SMA-M200】



【SMA-M350】

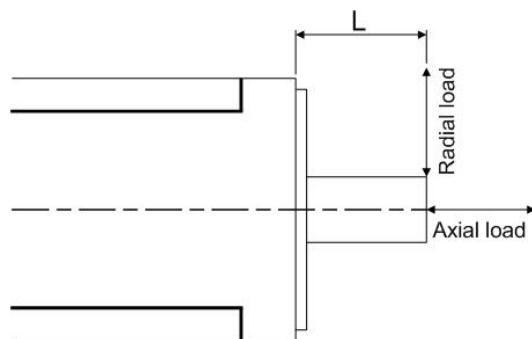


★ unit [mm]

★ Dimensions of servo motors may be revised without prior notice.

11.8. Permissible shaft load of medium inertial motor

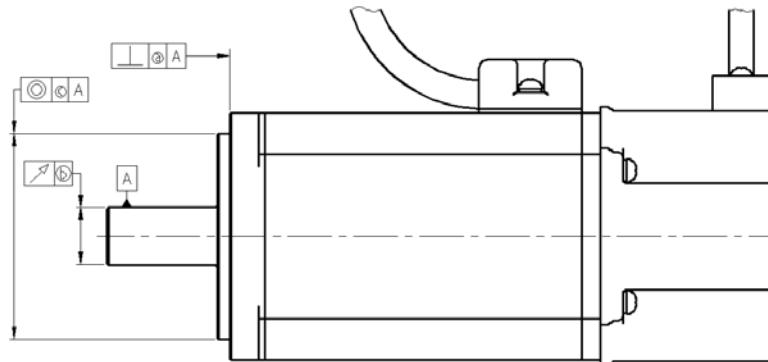
Motor type	SMA-M050	SMA-M100	SMA-M150	SMA-M200	SMA-M350
L (mm)	55	55	55	79	79
Permissible load in radial direction N(kgf)	490(50)	490(50)	490(50)	980(100)	980(100)
Permissible load in axial direction N(kgf)	196(20)	196(20)	196(20)	392(40)	392(40)



11.9. Precision of motor shaft

Precision of motor shaft varies with the dimensions such as right angle grade, deflection degree, concentric grade, etc. The table below provides more details.

Precision (mm)	Motor frame size		
	□ 100 or less	□ 130	□ 176
Right angle grade of frame to shaft	(a)	0.05	0.06
Shaft deflection degree	(b)	0.02	0.02
Concentric grade of outer diameter to shaft	(c)	0.04	0.04
			0.06

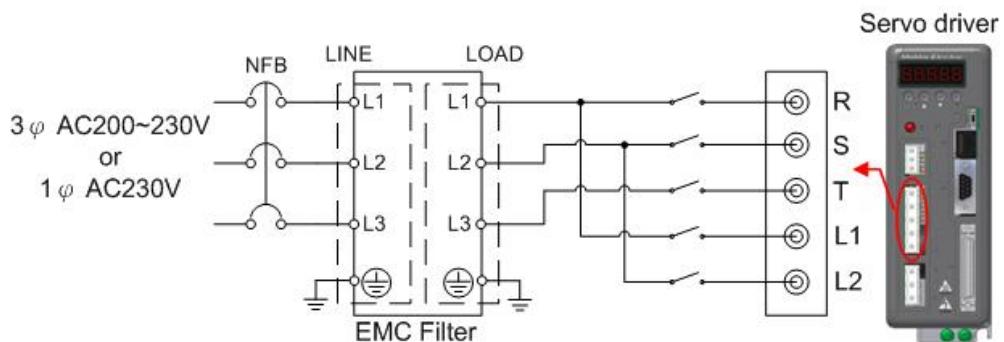


11.10. Electromagnetic compatible filter (EMC Filter)

If the driver and motor need to comply with EN/EMC rules, filters are recommended.

Driver	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	
SDA-200A2	2KW	FN3258-30-47
SDA-350A2	3.5KW	

- ★ The filter is option.
- ★ As an operating servo driver or motor interfere with peripheral equipment by radiation or conduction, it is recommended to use the filter. Here is a wiring diagram for the filter application.

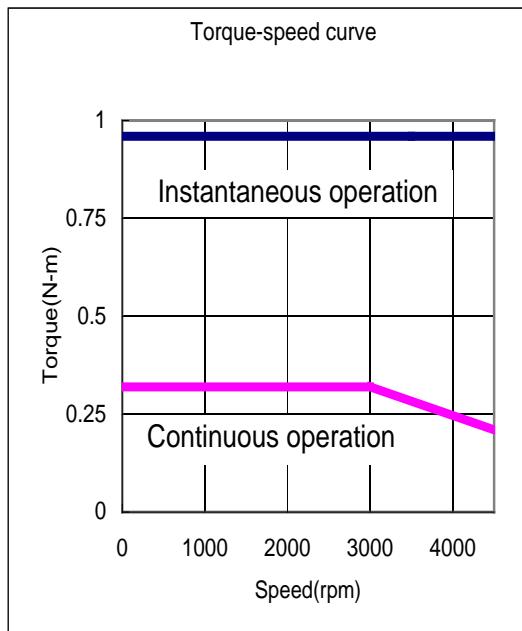


- ★ If the single phase power is applied, T terminal of driver is idle.

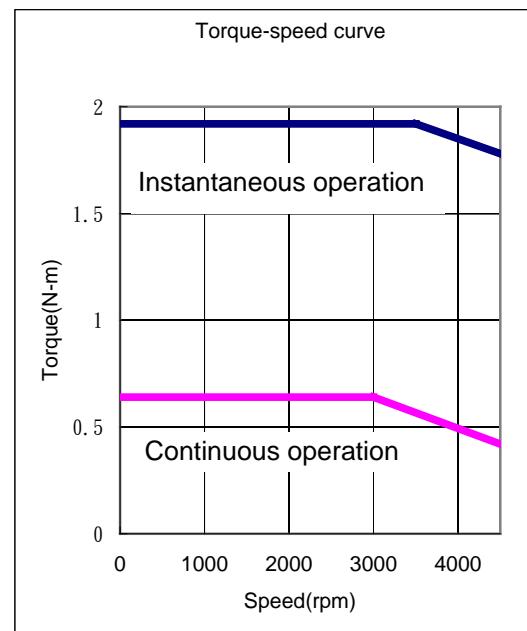
12. Motor characteristic

12.1. Speed-torque curves of low inertial motor

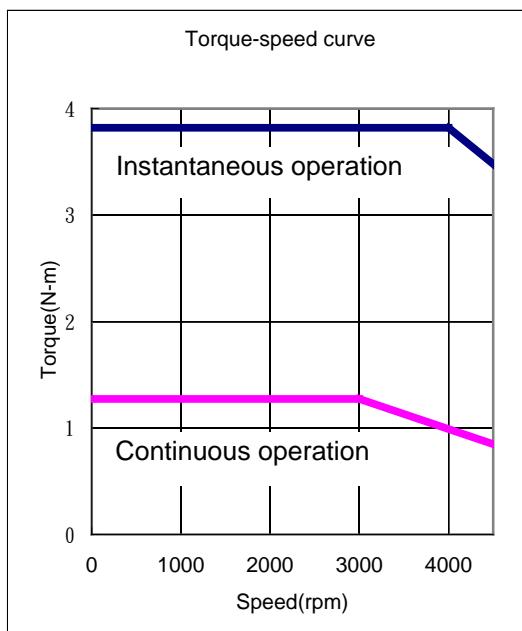
【SMA-L010】



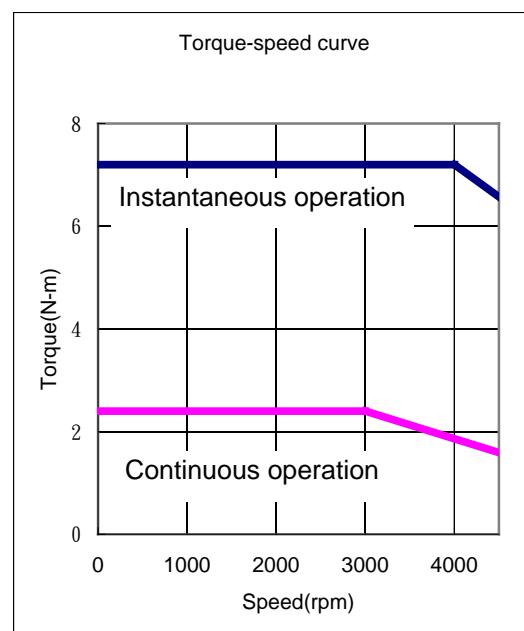
【SMA-L020】



【SMA-L040】



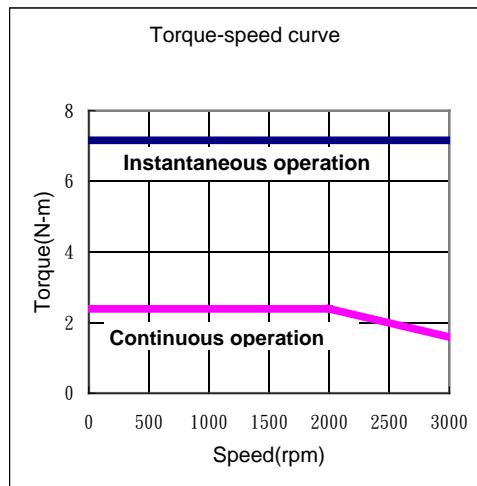
【SMA-L075】



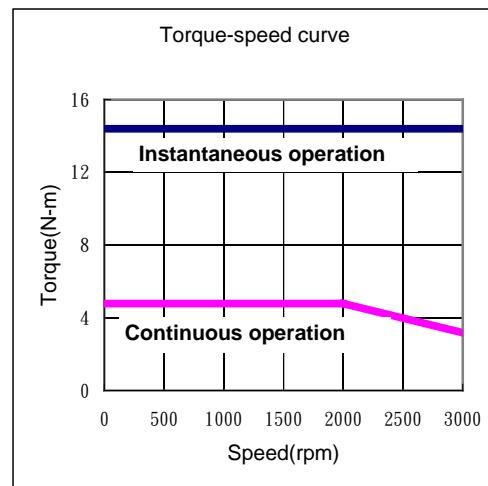
★ These characteristic curves are plotted with AC 3φ 200~230V power applied.

12.2. Speed-torque curves of medium inertial motor

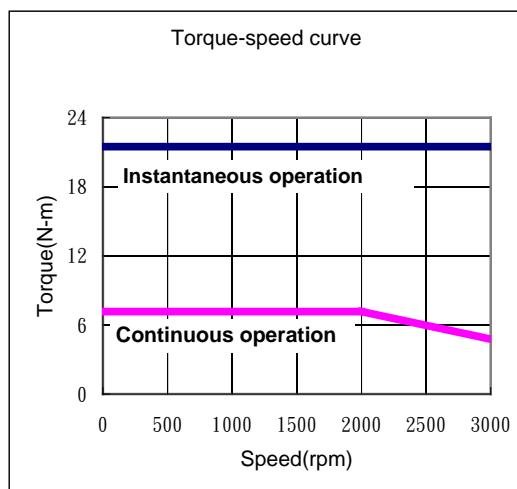
【SMA-M050】



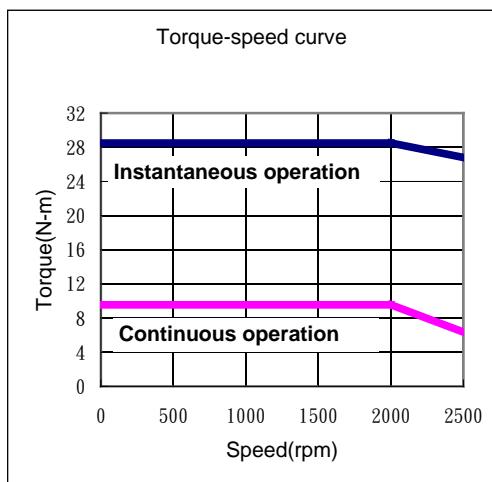
【SMA-M100】



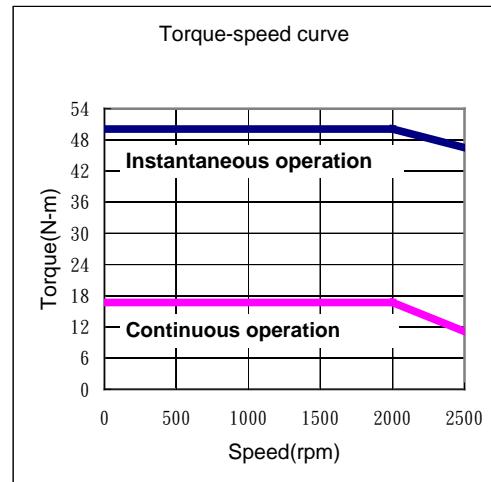
【SMA-M150】



【SMA-M200】



【SMA-M350】



- ★ These characteristic curves are plotted with AC 3φ 200~230V power applied

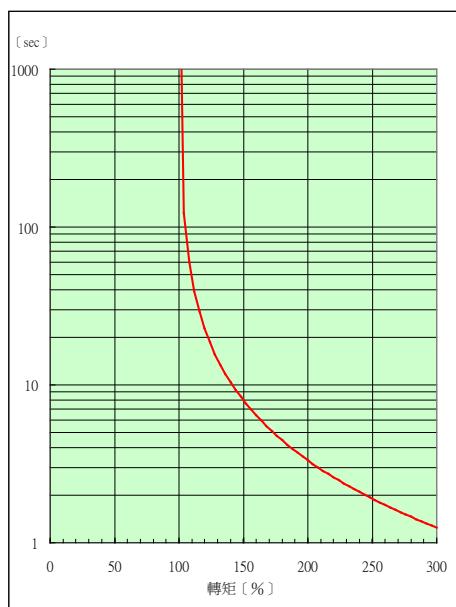
12.3. Overload protection

Overload protection is to prevent motor from damage during instantaneous over rated operation. Some cases are described as follows.

- (1) The ratio of load inertia to motor shaft is too large.
- (2) During acceleration or deceleration process, the time constant is set too small.
- (3) The operating time which torque generated is over rated torque is too long.
- (4) Mechanism vibration occurred due to improper gain is ignored but the motor is still performed.
- (5) Wrong connection between driver and motor, or the encoder is faulty.

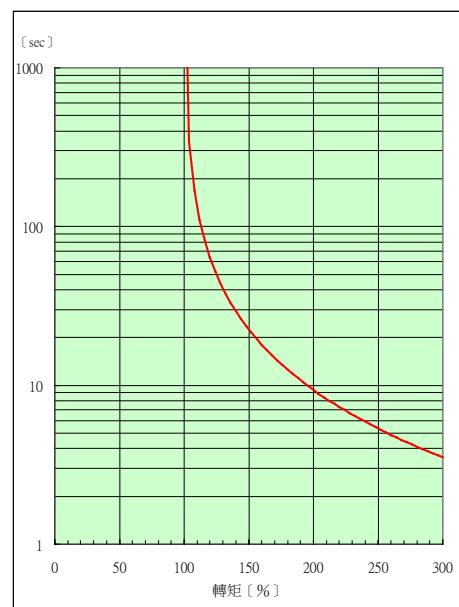
If case mentioned above met, the permissible operating time is plotted below.

【SMA-L010】



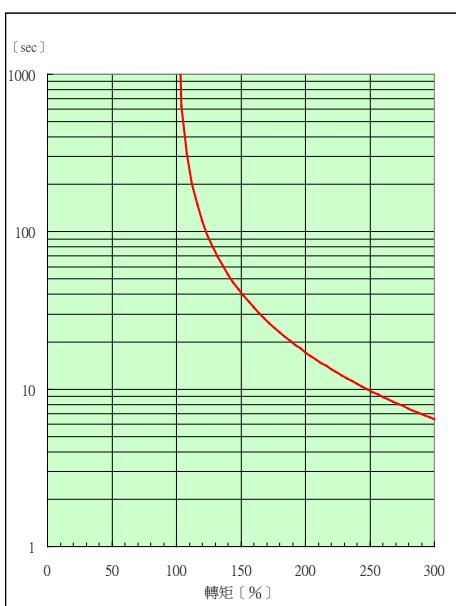
As load torque is 300%, operating time is 1.25S.

【SMA-L020/L040/L075】



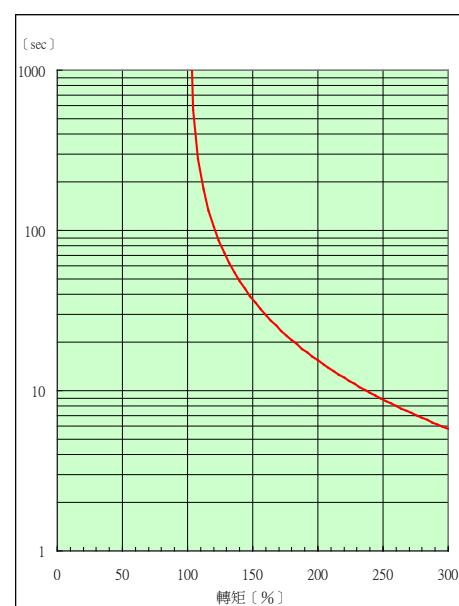
As load torque is 300%, operating time is 3.51S.

【SMA-M050/M100/M150】



As load torque is 300%, operating time is 6.43S.

【SMA-M200/M350】



As load torque is 300%, operating time is 5.79S.

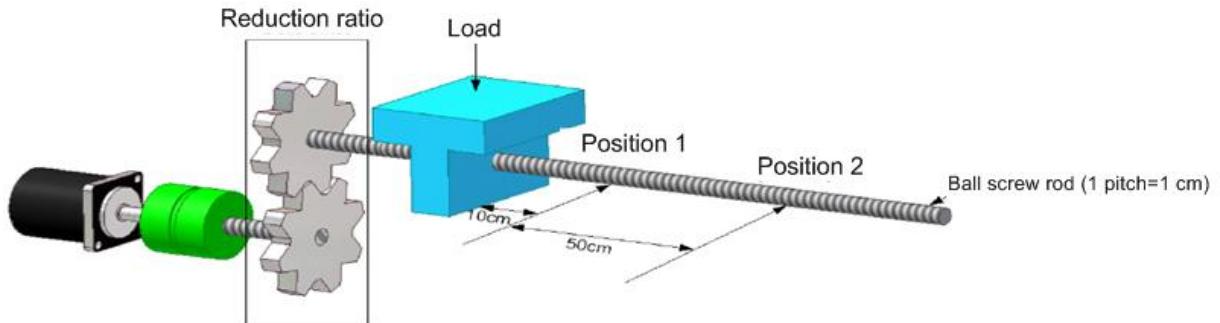
13. Application examples

13.1. Position control example with inner registers

There are 8 sets of inner registers related to position control. The positioning operation could be categorized into relative type and absolute type. The relevant parameter settings are listed below.

Name	Name Abbr.	Sign	Setting range	Initial value	Unit
Control mode option	STY	PA01	0000h~1125h	1000h	-
Revolution of inner position command 1	PO1H	PA15	-30000~+30000	0	rev
Pulse of inner position command 1	PO1L	PA16	-9999~+9999	0	pulse
Revolution of inner position command 2	PO2H	PA17	-30000~+30000	0	rev
Pulse of inner position command 2	PO2L	PA18	-9999~+9999	0	pulse
Revolution of inner position command 3	PO3H	PA19	-30000~+30000	0	rev
Pulse of inner position command 3	PO3L	PA20	-9999~+9999	0	pulse
Revolution of inner position command 4	PO4H	PA21	-30000~+30000	0	rev
Pulse of inner position command 4	PO4L	PA22	-9999~+9999	0	pulse
Revolution of inner position command 5	PO5H	PA23	-30000~+30000	0	rev
Pulse of inner position command 5	PO5L	PA24	-9999~+9999	0	pulse
Revolution of inner position command 6	PO6H	PA25	-30000~+30000	0	rev
Pulse of inner position command 6	PO6L	PA26	-9999~+9999	0	pulse
Revolution of inner position command 7	PO7H	PA27	-30000~+30000	0	rev
Pulse of inner position command 7	PO7L	PA28	-9999~+9999	0	pulse
Revolution of inner position command 8	PO8H	PA29	-30000~+30000	0	rev
Pulse of inner position command 8	PO8L	PA30	-9999~+9999	0	pulse
Moving speed of inner position command 1	POV1	PA31	1~3000	1000	rpm
Moving speed of inner position command 2	POV2	PA32	1~3000	1000	rpm
Moving speed of inner position command 3	POV3	PA33	1~3000	1000	rpm
Moving speed of inner position command 4	POV4	PA34	1~3000	1000	rpm
Moving speed of inner position command 5	POV5	PA35	1~3000	1000	rpm
Moving speed of inner position command 6	POV6	PA36	1~3000	1000	rpm
Moving speed of inner position command 7	POV7	PA37	1~3000	1000	rpm
Moving speed of inner position command 8	POV8	PA38	1~3000	1000	rpm
Acceleration time constant	STA	PC01	0~20000	200	mS
Deceleration time constant	STB	PC02	0~20000	200	mS
S-pattern acc/dec time constant	STC	PC03	0~10000	0	mS

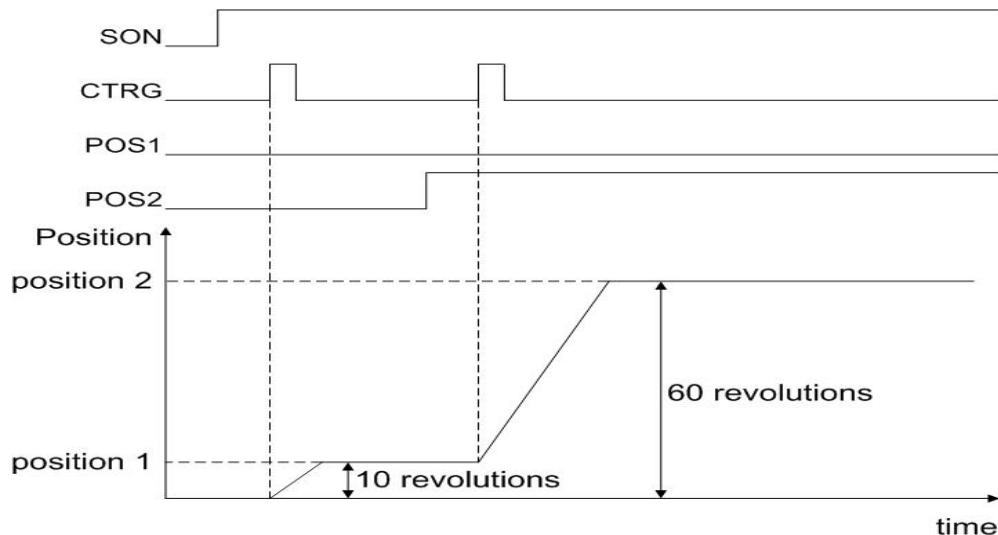
The following example describes the application of position mode with inner registers. During a route, the load will stop at two fixed locations then return. See the schematic diagram below.



It is known that 2 position commands are necessary. And the ball screw rod could transform one revolution into one centimeter moving. Both absolute type and relative type could achieve this route. We assume that absolute type is performed and relevant parameters could be set as follows.

Name	Name Abbr.	Sign	Setting value	Unit
Control mode option	STY	PA01	1010	-
Revolution of inner position command 1	PO1H	PA15	10	rev
Revolution of inner position command 2	PO2H	PA17	60	rev
Pulse of inner position command 1	PO1L	PA16	0	pulse
Pulse of inner position command 2	PO2L	PA18	0	pulse

As the parameter setting is completed and there is no alarm occurred, turn on SON signal. The following steps are plotted sequentially for users to understand easily.



13.2. Home moving examples

Relevant parameters of home moving function

As home moving function is performed, the origin position could be determined when the encoder Z phase pulse or ORGP signal activated. Also, the rotary direction of motor is related to this function.

Sign	Abbr.	Function description	Control mode	Setting range	Unit
PA04	HMOV	Home moving option: u z y x x:origin detector and rotation option y:origin attained shortcut moving option z:origin recognized completion option u:trigger option	Pr	0000h ~2123h	-
PA08	HSPD1	Home moving high speed option 1	Pr	1 ~2000	rpm
PA09	HSPD2	Home moving high speed option 2	Pr	1 ~500	rpm
PA10	HOF1	Home moving revolution offset	Pr	-30000 ~+30000	rev
PA11	HOF2	Home moving pulse offset	Pr	-30000 ~+30000	rev
PC01	STA	Acceleration time constant	Pr S,T	0 ~20000	mS
PC02	STB	Deceleration time constant	Pr S,T	0 ~20000	mS
PC03	STC	S-pattern acceleration/deceleration time constant	Pr S,T	0 ~10000	mS

Description of home moving function

x. Origin detector and rotation option

Origin detector could be assigned to ORGP signal which is connect to the output signal of a sensor(e.g., proximity switch or optical sensor). If the positioning range is within a servo motor revolution, the encoder Z pulse could be used as origin detector.

x = 0:ORGP detector in CCW rotation

The driver runs motor counterclockwise to detect the ORGP signal at PA08 speed.

x = 1:ORGP detector in CW rotation

The driver runs motor clockwise to detect the ORGP signal at PA08 speed.

x = 2:Encoder Z pulse detector in CCW rotation

The driver runs motor counterclockwise to detect the encoder Z pulse at PA08 speed. In this case, external sensor is not necessary.

x = 3:Encoder Z pulse detector in CW rotation

The driver runs motor clockwise to detect the encoder Z pulse at PA08 speed. In this case, external sensor is not necessary.

y. Origin attained shortcut moving option

y = 0: Motor turns back to last Z pulse to attain

Once the ORGP signal or encoder Z pulse is obtained, motor would turn back at PA09 speed to search for last Z pulse as the mechanism origin.

y = 1: Motor goes ahead to next Z pulse to attain

Once the ORGP signal or encoder Z pulse is obtained, motor keeps going ahead at PA09 speed to search for next Z pulse as the mechanism origin.

y = 2: Origin recognized right away

Once the ORGP signal or encoder Z pulse is obtained, motor would decelerate to stop and recognize current position as the mechanism origin.

If x is set as 2 or 3, y should be set as 2 or the servo motor would not work.

z. Origin recognized completion option

z = 0: Motor decelerates to stop then return to the mechanism origin

As the next Z pulse or the last Z pulse is obtained, motor would decelerate to stop and return to the mechanism origin.

z = 1: Motor decelerates to stop

As the next Z pulse or the last Z pulse is obtained, motor would decelerate to stop and there are position overshoot between current position and the mechanism origin.

No matter z is 0 or 1, it does not affect the inner counts of the mechanism origin.

u. Trigger option

This code is to determine if home moving function enabled or not. As this function is enabled, there are 2 modes which are “power on auto-execution” and “ SHOM signal triggered” could be selected.

u = 0: Home moving function disabled

While u is set as 0, the home moving function is disabled.

u = 1: Automatically executed after power on

While u is set as 1, the home moving function would be executed automatically after power on. If users operate their mechanism which only one time home position reset required, this option is helpful to save a DI contact.

u = 2: SHOM signal as the trigger source

While u is set as 2, the SHOM function should be assigned to one of 8 DI by the setting of PD02 to PD09. As SHOM signal is activated, home moving function would be executed.

A table recommended for using the home moving function

Users could set u and z according to requirement, but refer to the combinations of x and y.

y \ x	0	1	2	3
0	○	○	×	×
1	○	○	×	×
2	○	○	○	○

★ ○ denotes home moving function valid, × denotes a invalid setting.

Offset value of home moving

Users could use parameter PA10 and PA11 to set the recognized origin offset values. After the completion of origin positioning, a new origin could be redefine to the nonzero settings of parameter PA10 and PA11. The equation is as follows:

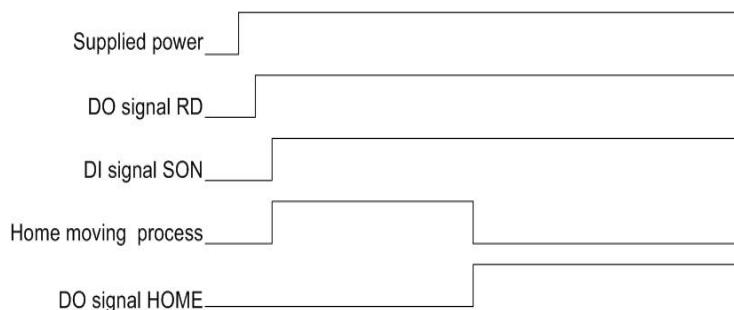
$$\text{New origin counts} = \text{Primary origin counts} + (\text{PA10} \times 10000 + \text{PA11}) [\text{pulse}]$$

Sequence diagram of home moving operation

During home moving operation, if SON signal is off or any alarm occurred, the home moving sequence would be interrupted and the HOME output signal would not work.

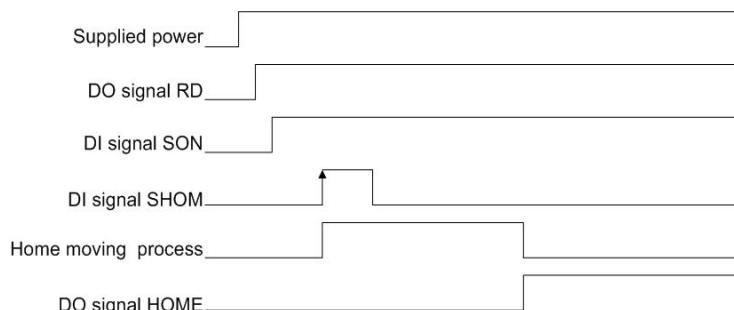
1. Automatically executed after power on ($u = 1$)

Set one of DO pins as HOME signal output by the setting of PD10 to PD14. After the completion of home moving, HOME signal would turn on.



2. SHOM signal as the trigger source ($u = 2$)

Set one of DI pins as SHOM signal input by the setting of PD02 to PD09.

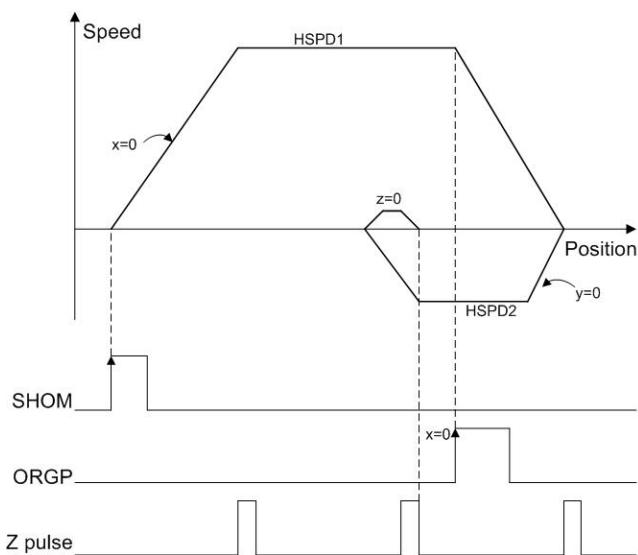


Sequence diagram of home moving speed vs. position

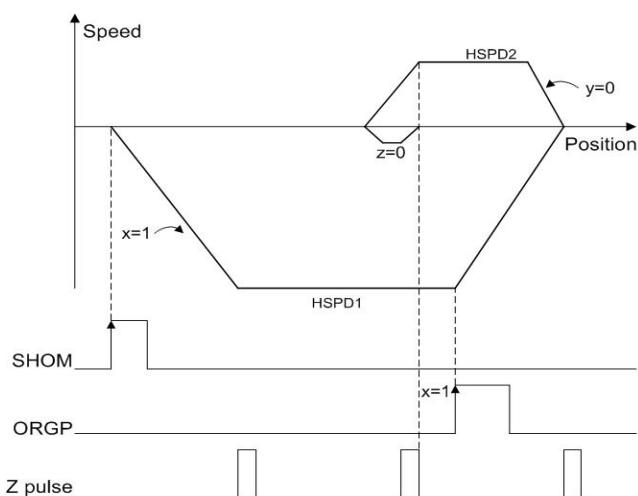
The same conditions of following sequence diagram are “SHOM signal as the trigger source($u=2$)” and “Motor decelerates to stop then return to the origin($z=0$)”. The combinations of x and y and their corresponded sequence diagrams are described as follows.

$y \backslash x$	0	1	2	3
0	Plot(1)	Plot (2)	×	×
1	Plot (3)	Plot (4)	×	×
2	Plot (5)	Plot (6)	Plot (7)	Plot (8)

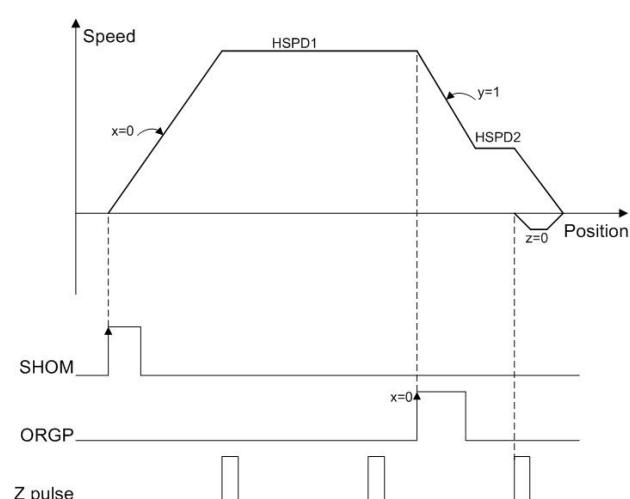
Plot(1) $x = 0$: ORGP detector in CCW rotation
 $y = 0$: Motor turns back to last Z pulse to attain



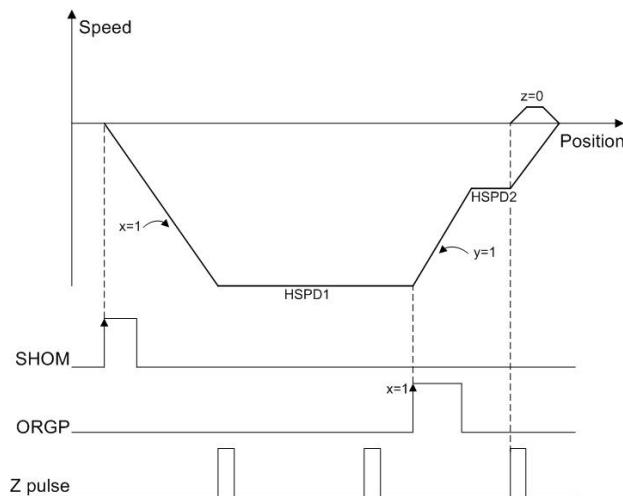
Plot(2) $x = 1$: ORGP detector in CW rotation
 $y = 0$: Motor turns back to last Z pulse to attain



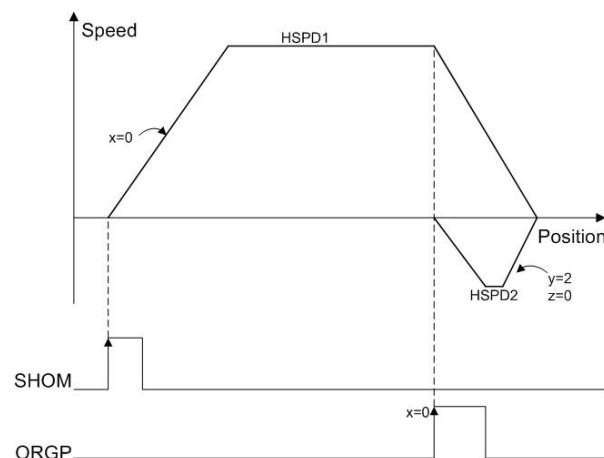
Plot(3) $x = 0$: ORGP detector in CCW rotation
 $y = 1$: Motor goes ahead to next Z pulse to attain



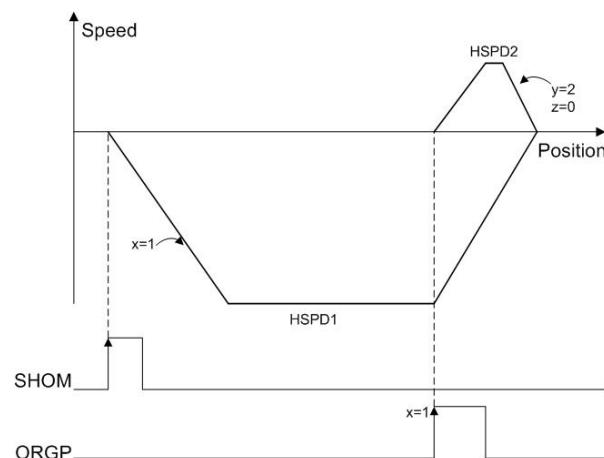
Plot(4) $x = 1$: ORGP detector in CW rotation
 $y = 1$: Motor goes ahead to next Z pulse to attain



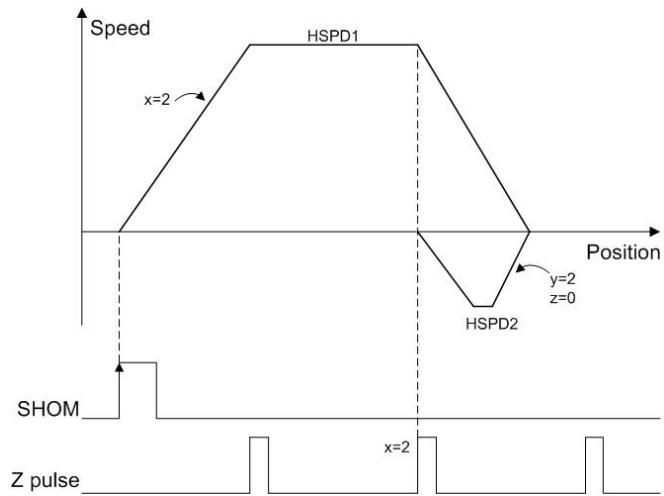
Plot(5) $x = 0$: ORGP detector in CCW rotation
 $y = 2$: Origin recognized right away



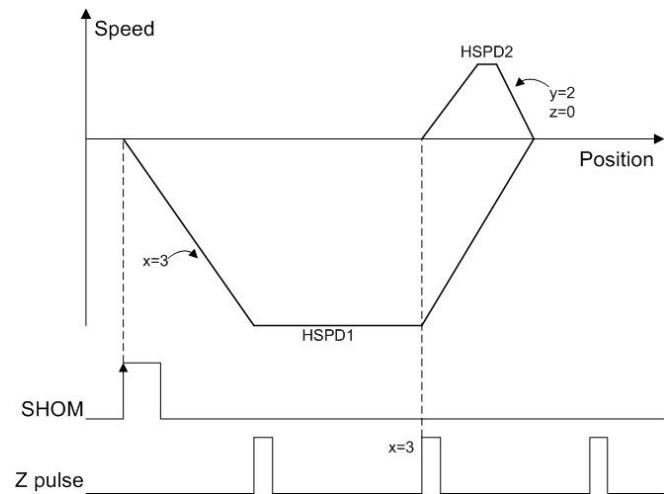
Plot(6) $x = 1$: ORGP detector in CW rotation
 $y = 2$: Origin recognized right away



Plot(7) $x = 2$: Encoder Z pulse detector in CCW rotation
 $y = 2$: Origin recognized right away



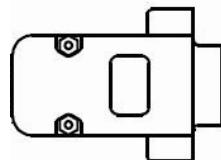
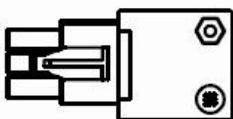
Plot(8) $x = 3$: Encoder Z pulse detector in CW rotation
 $y = 2$: Origin recognized right away



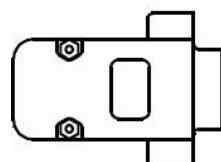
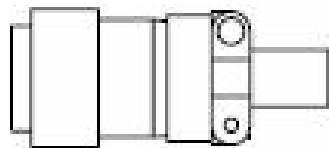
14. Appendix A: Accessories

- ❖ Encoder connectors

Shihlin part number: SDA-ENCNL (for low inertia motor)

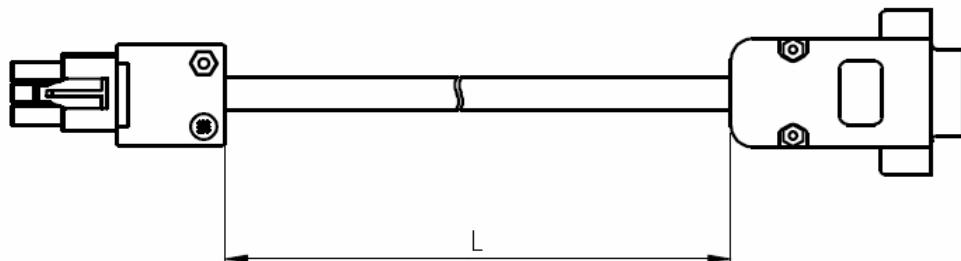


Shihlin part number: SDA-ENCMN (for medium inertia motor)



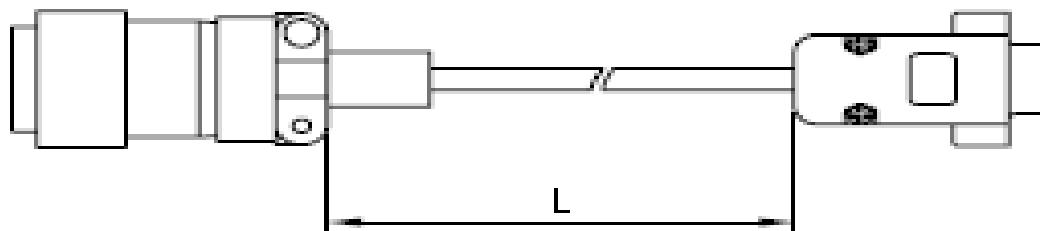
- ❖ Encoder cable

Shihlin part number: SDA-ENLCBL2M-L, SDA-ENLCBL5M-L, SDA-ENLCBL10M-L



Type	Part number	L (mm)
2M low inertia encoder cable	SDA-ENLCBL2M-L	2000±100
5M low inertia encoder cable	SDA-ENLCBL5M-L	5000±100
10M low inertia encoder cable	SDA-ENLCBL10M-L	10000±100

Shihlin part number: SDA-ENMCBL2M-L, SDA-ENMCBL5M-L, SDA-ENMCBL10M-L

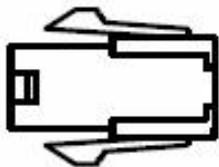


Type	Part number	L (mm)
2M medium inertia encoder cable	SDA-ENMCBL2M-L	2000±100
5M medium inertia encoder cable	SDA-ENMCBL5M-L	5000±100
10M medium inertia encoder cable	SDA-ENMCBL10M-L	10000±100

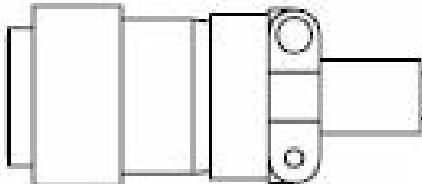
❖ Power connectors

Shihlin part number: SDA-PWCNL1 (for 100W, 200W, 400W, 750W)

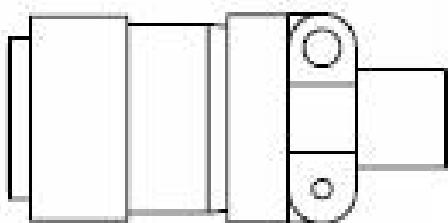
SDA-PWCNL2 (for 100W, 200W, 400W, 750W with electromagnetic brake)



Shihlin part number: SDA-PWCNM1 (for 500W, 1KW, 1.5KW)



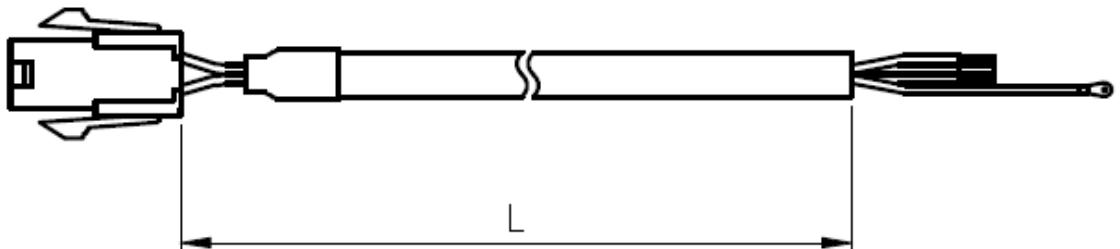
Shihlin part number: SDA-PWCNM2 (for 2KW, 3.5KW)



❖ Power line

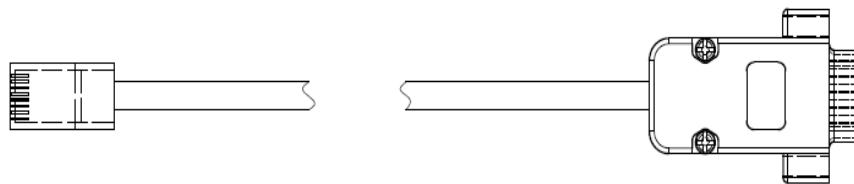
Shihlin part number: SDA-PWCNL1-2M-L, SDA-PWCNL1-5M-L, SDA-PWCNL1-10M-L

SDA-PWCNL2-2M-L, SDA-PWCNL2-5M-L, SDA-PWCNL2-10M-L



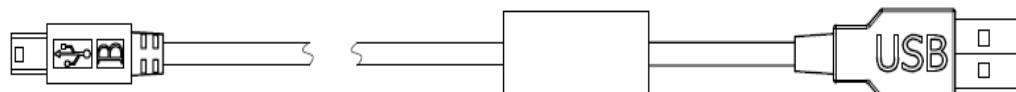
Type	Part number	L (mm)
Low inertia power line 1 (without electromagnetic brake)	SDA-PWCNL1-2M-L	2000±100
Low inertia power line 2 (without electromagnetic brake)	SDA-PWCNL1-5M-L	5000±100
Low inertia power line 3 (without electromagnetic brake)	SDA-PWCNL1-10M-L	10000±100
Low inertia power line 1 (with electromagnetic brake)	SDA-PWCNL2-2M-L	2000±100
Low inertia power line 2 (with electromagnetic brake)	SDA-PWCNL2-5M-L	5000±100
Low inertia power line 3 (with electromagnetic brake)	SDA-PWCNL2-10M-L	10000±100

- ❖ RS232/RS485 communication cable
Shihlin part number: SDA-RJ45-3M

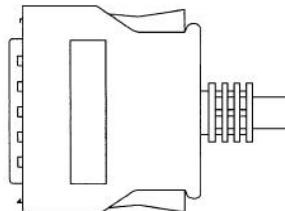


Type	Part number	L (mm)
RS232/RS485 communication cable	SDA-RJ45-3M	3000±10

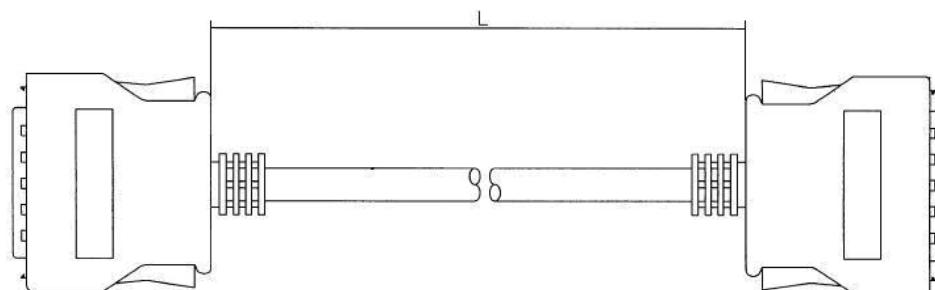
- ❖ USB communication cable
Shihlin part number: SDA-USB3M



- ❖ CN1 I/O connector
Shihlin part number: SDA-CN1

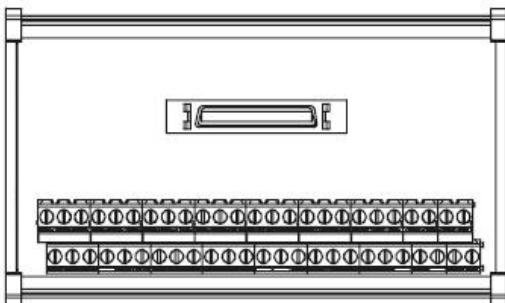


- ❖ CN1 I/O control cable
Shihlin part number: SDA-TBL05M, SDA-TBL1M, SDA-TBL2M



Type	Part number	L (mm)
CN1 I/O control cable 1	SDA-TBL05M	500±10
CN1 I/O control cable 2	SDA-TBL1M	1000±10
CN1 I/O control cable 3	SDA-TBL2M	2000±10

- ❖ CN1 I/O terminal block
Shihlin part number: SDA-TB50



- ❖ Regenerative energy consumption resistor

Driver type	Built-in resistor		External option resistor (recommended)		Part number
	Resistance(Ω)	Capacity(W)	Permissible Min. resistance(Ω)	Capacity(W)	
SDA-010A2	100	20	100	500	ABR-500W100
SDA-020A2	100	20	100	500	ABR-500W100
SDA-040A2	100	20	100	500	ABR-500W100
SDA-050A2	100	20	100	500	ABR-500W100
SDA-075A2	40	40	40	1000	ABR-1000W40
SDA-100A2	40	40	40	1000	ABR-1000W40
SDA-150A2	13	100	13	1000	ABR-1000W13
SDA-200A2	13	100	13	1000	ABR-1000W13
SDA-350A2	13	100	13	1000	ABR-1000W13

★ As an external resistor option is applied, an open circuit between P and D should be made.

15. Appendix B: Parameters communication address

The address is expressed in hexadecimal.

PA group:

NO	Address								
PA01	0300	PA10	0309	PA19	0312	PA28	031B	PA37	0324
PA02	0301	PA11	030A	PA20	0313	PA29	031C	PA38	0325
PA03	0302	PA12	030B	PA21	0314	PA30	031D	PA39	0326
PA04	0303	PA13	030C	PA22	0315	PA31	031E	PA40	0327
PA05	0304	PA14	030D	PA23	0316	PA32	031F	PA41	0328
PA06	0305	PA15	030E	PA24	0317	PA33	0320	PA41	0329
PA07	0306	PA16	030F	PA25	0318	PA34	0321	PA42	032A
PA08	0307	PA17	0310	PA26	0319	PA35	0322	PA44	032B
PA09	0308	PA18	0311	PA27	031A	PA36	0323	PA45	032C

PB group:

NO	Address								
PB01	032D	PB07	0333	PB13	0339	PB19	033F	PB25	0345
PB02	032E	PB08	0334	PB14	033A	PB20	0340	PB26	0346
PB03	032F	PB09	0335	PB15	033B	PB21	0341	PB27	0347
PB04	0330	PB10	0336	PB16	033C	PB22	0342	PB28	0348
PB05	0331	PB11	0337	PB17	033D	PB23	0343	PB29	0349
PB06	0332	PB12	0338	PB18	033E	PB24	0344	PB30	034A

PC group:

NO	Address								
PC01	034B	PC10	0354	PC19	035D	PC28	0366	PC37	036F
PC02	034C	PC11	0355	PC20	035E	PC29	0367	PC38	0370
PC03	034D	PC12	0356	PC21	035F	PC30	0368	PC39	0371
PC04	034E	PC13	0357	PC22	0360	PC31	0369	PC40	0372
PC05	034F	PC14	0358	PC23	0361	PC32	036A	PC41	0373
PC06	0350	PC15	0359	PC24	0362	PC33	036B	PC42	0374
PC07	0351	PC16	035A	PC25	0363	PC34	036C	PC43	0375
PC08	0352	PC17	035B	PC26	0364	PC35	036D	PC44	0376
PC09	0353	PC18	035C	PC27	0365	PC36	036E	PC45	0377

PD group:

NO	Address								
PD01	0378	PD07	037E	PD13	0384	PD19	038A	PD25	0390
PD02	0379	PD08	037F	PD14	0385	PD20	038B	PD26	0391
PD03	037A	PD09	0380	PD15	0386	PD21	038C	PD27	0392
PD04	037B	PD10	0381	PD16	0387	PD22	038D	PD28	0393
PD05	037C	PD11	0382	PD17	0388	PD23	038E	PD29	0394
PD06	037D	PD12	0383	PD18	0389	PD24	038F	PD30	0395

16. Appendix C: Version information

Version: V1.15

Issue date: Aug. 2013

Proofreader: Yaochou Shu