Preface

We appreciate very much for your purchasing of Shihlin's servo products. This manual will be a helpful instruction to install, wire, inspect, and operate your Shihlin servo driver and motor. Before using the servo driver and motor, please read this user manual to prevent from electric shock, fire, and injury.

In this manual, the safety instruction levels are classified into "DANGER" and "CAUTION".

⚠ DANGER	It indicates that incorrect operation may cause hazardous conditions, resulting in death or injury.
⚠ CAUTION	It indicates that incorrect operation may cause hazards, resulting in injury to person or damage to the product.

125

Note that the CAUTION level may lead to a serious consequence by cases. Be sure to follow the instructions of both levels to keep personnel safety well.

What must not be done and what must be done are indicated by the following marks:

⃠ : It indicates what must not be done. For example, "No Fire" is marked as  .

● : It indicates what must be done. For example, grounding is marked as  .

In this manual, instructions at a lower level than the above, instructions for other functions, and so on are classified into "NOTE".

After reading this user manual , always keep it accessible to the operator.

1. To prevent electric shock, please confirm the following:

⚠ DANGER

- Operate the power switches with dry hand to prevent an electric shock.
- Before wiring or inspection, switch power off and wait for more than 10 minutes. Then, confirm if the power indicator is off or the voltage is safe with voltage meter. Otherwise, you may get an electric shock.
- Connect the servo driver and motor to ground.
- Do not attempt to wire the servo driver and motor until they have been installed. Otherwise, you may get an electric shock.
- The cables should not be damaged, stressed, loaded, or pinched. Otherwise, you may get an electric shock.

2. To prevent fire, note the following:

⚠ CAUTION

- Install the servo driver, motor and regenerative brake resistor in a clean and dry location free from corrosive and inflammable gases or liquids. Otherwise a fire may be caused.
- Don’t try to operate the servo driver or motor which has become faulty. Otherwise, a large current flow may cause a fire.
- Do not connect a commercial power supply to the U, V, W terminals of driver. Otherwise a fire may be caused and the servo drive will be damaged.
- When an external regenerative brake resistor is used, check the specification recommended. Otherwise, a regenerative brake transistor fault or the like may overheat the regenerative brake resistor, causing a fire.

3. To prevent injury, note the following:

⚠ CAUTION

- The proper voltage specified in this manual should be applied to each terminal, Otherwise, a burst, damage, etc. may occur.
- Connect the terminals correctly to prevent a burst, damage, etc.
- Ensure that polarity (＋,－) is correct. Otherwise, a burst, damage, etc. may occur.
- Ensure that all screws, connectors and wire terminations are fixed on the power supply, servo drive and motor to prevent from a burst, damage, or personal injury.
- Don’t touch either the drive heat sink or the motor during operation because they may become hot and cause personnel burnt.
- Don’t approach or touch any rotating parts (e.g. shaft) as the motor is running. Otherwise, it may cause serious personnel injury.

4. Other instructions

The following instructions should also be fully noted. Improper operation may cause a damage, fault, injury or electric shock, etc.

(1) Delivering and installation

⚠ CAUTION
• Delivery the products correctly according to their weights. • It is not allowed to stack the products in excess of the specified layers. • Do not carry the motor by the cables, shaft or encoder. • Do not hold the front cover to transport the driver. Otherwise, it may be dropped. • The servo driver and motor must be installed in the specified direction. • Inside control box, preserve enough space between the servo driver and other equipment. • Provide adequate protection to prevent screws and other conductive matter, oil and other combustible matter from entering the servo driver. • Do not drop or strike servo driver or servo motor. Keep from all impact loads. • Use the servo driver and servo motor under the specified environmental conditions. • Firmly attach the servo motor. Otherwise, it may come off during operation. • For safety of personnel, always cover the rotating and moving parts. • Never impact the servo motor or shaft, especially when coupling the servo motor to the machine. The encoder may become faulty. • Do not subject the servo motor shaft to more than the permissible load. Otherwise, the shaft may be broken. • When the equipment has been stored for an long period time, consult Shihlin.

(2) Wiring

⚠ CAUTION
• In order to prevent from fire or other accidents, please use the cable specified in this user manual to wire the servo equipment. • Wire the servo driver correctly and firmly. Otherwise, the motor will run improperly. • Do not install a power capacitor, surge absorber or noise filter between the servo motor and servo driver. • Do not connect AC power directly to the servo motor. Otherwise, it results in damage of servo motor. • The surge absorbing diode installed on the DC output signal relay must be wired in the specified direction. Otherwise, the emergency stop and other protective circuits may not operate.

(3) Trial run

⚠ CAUTION

- The initial trial run for servo motor should be operated under idle conditions (separate the motor from its couplings and belts).
- Before trial run, check if the parameters are set properly. Otherwise it will cause some unexpected operation.
- The parameter settings must not be changed excessively. To adjust the parameters setting gradually to meet your demand operation.
- Ensure to perform trial run before your normal operation to prevent unexpected accident.

(4) Duty operation

⚠ CAUTION

- Set an external emergency stop circuit. It could stop operation immediately as unexpected accidents occurred.
- Before resetting an alarm, make sure that the run signal is off to prevent a sudden restart.
- Use a noise filter to minimize the influence of electromagnetic interference, which may be caused by electronic equipment used near the servo driver.
- Do not mismatch the servo driver and motor in capacity.
- The electromagnetic brake on the servo motor is designed to hold the motor shaft and should not be used for ordinary braking.
- For heavy duty case (e.g. where a huge load inertia or short acceleration/deceleration time setting), the external regenerated brake resistor is necessary.

(5) Maintenance and Inspection

⚠ CAUTION

- Ensure that the power indicator is off before maintenance or inspection performed.
- Only personnel who have been trained should conduct maintenance and inspection.
- Do not try to disassemble the servo drive or motor which any fault occurred.
- Do not connect or disconnect the servo driver with motor while power is still applied.
- As power is still applied, not to touch any internal or exposed parts of servo drive and servo motor to prevent electrical shock.
- Some parts inside the servo driver are consumable and should be replaced periodically. For parts replacement, please consult Shihlin.

NOTE : This manual may be revised without prior notice. Please consult our agent or download the most updated version at ***http://www.seec.com.tw/en/*** **.**

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. The are 3 control types for single mode: position control, speed control, torque control. There are 3 types for hybrid mode: position control/speed control, position control/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 both RS-232 and RS-485 serial communication. The Shihlin communication software will help the user to perform parameters setting, trial run, monitoring, gain value adjustment.

The Shihlin servo is also equipped with the automatic tuning function. The control gain of the driver will be adjusted by the inner algorithm according to 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

To prevent the negligence of transport or human factor, please check the following items.

- Check if there are any loosened screws on the motor or the driver.
- Check the nameplate of product 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 our 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) The 3-pin(R/S/T) quick plug-in terminal.
(3) The 3-pin(P/D/C) quick plug-in terminal.
(4) The 3-pin(U/V/W) quick plug-in terminal.
(5) An installation manual.
(6) An user manual of the Shihlin servo.(It could be download on Shihlin website)

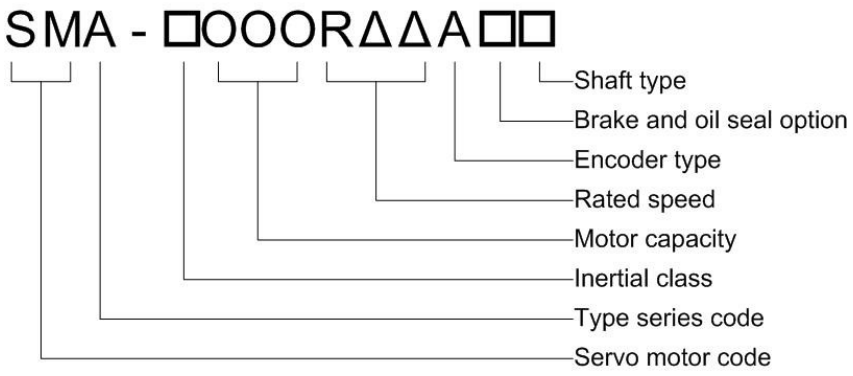
The following options also could be purchased through our agent or consult Shihlin.

(1) The motor power cable.(4 wires: U, V, W and ground)
(2) The encoder cable. One end is for the CN2 of driver, the other end for servo motor.
(3) The RS-232/RS-485 communication cable.
(4) The 44-pin socket connector for CN1 of servo driver.

Reference for product type

Coding rule for Shihlin servo motor

(1) Coding method



(2) Description for coded items

a. Servo motor code: SM denotes servo motor.

b. Type series code: A series.

c. Inertia class: Codes are classified by motor inertia and frame size as follows.

Code	Class
L	Low inertia
M	Medium inertia

d. 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. Some examples:
020 denotes: 02(1/10)=0.2kW=200W*
075 denotes: 07(1/10)=0.7kW=750W*

e. Rated speed: 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.

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

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

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

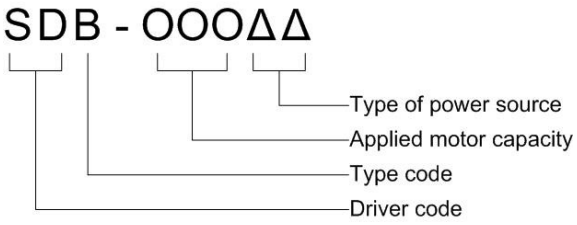
h. Shaft type: It describes the shape of motor shaft; "K" denotes a "keyway" type.

(3) Coding example

Example: 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*

Coding rule for Shihlin servo driver

(1) Coding method



(2) Description for code items

a. Driver code: SD denotes “servo driver”.

b. Type code: B series.

c. Applied motor capacity: The coding examples are described as follows.

010 denotes: 01(1/10)=0.1kW=100W*

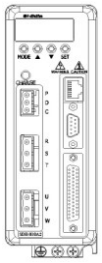
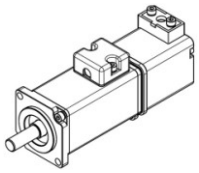
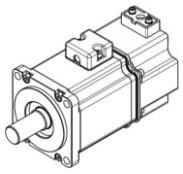
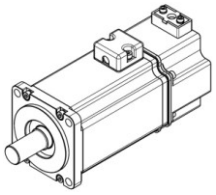
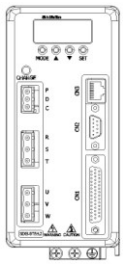
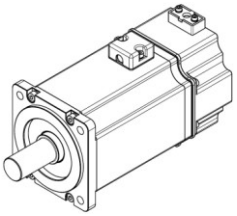
020 denotes: 02(1/10)=0.2kW=2000W*

045 denotes: 04(1/10)=0.4kW=400W*

075 denotes: 07(1/10)=0.7kW→750W*

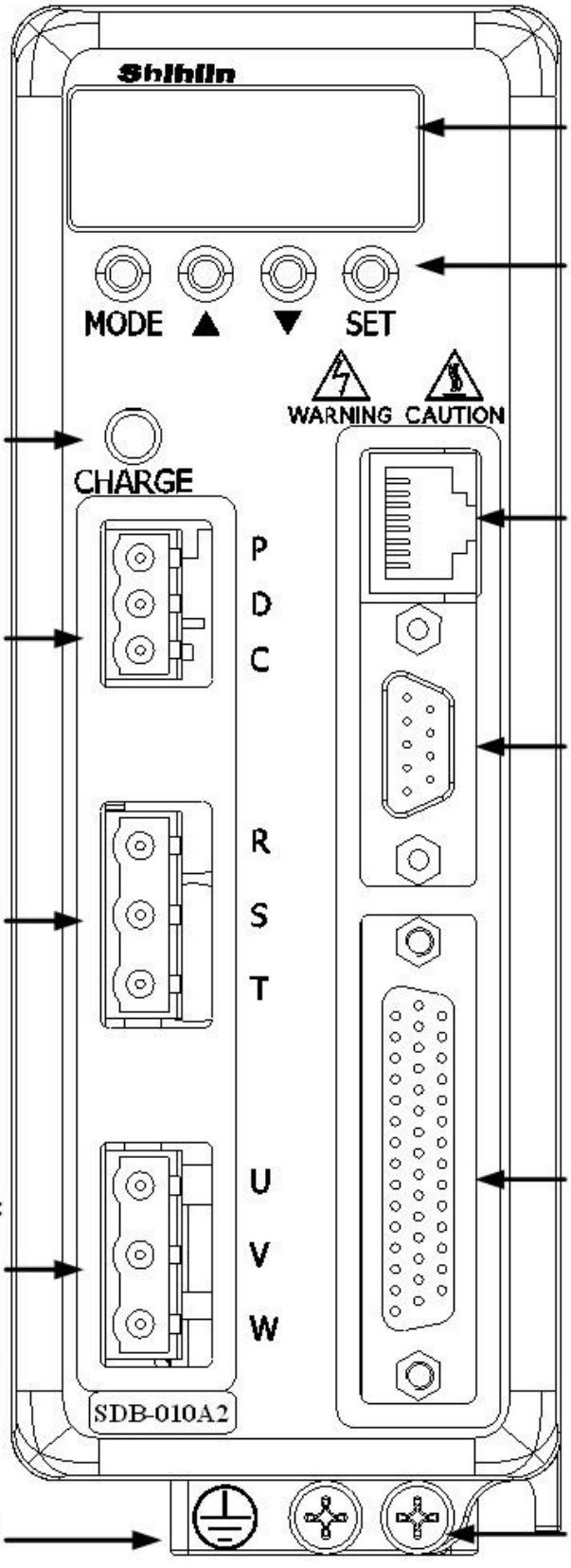
d. Type of power source: Specification of input power. “A2” means the 220V applied power.

Reference table for servo drivers and motors

	Servo driver		Servo motor(matched)	
100W		SDB-010A2 SDB-010A2-S01(*)		SMA-L010R30A☐☐
200W		SDB-020A2 SDB-020A2-S01(*)		SMA-L020R30A☐☐
400W		SDB-040A2 SDB-040A2-S01(*)		SMA-L040R30A☐☐
750W		SDB-075A2 SDB-075A2-S01(*)		SMA-L075R30A☐☐

(*): S01 is an additional code which means that servo driver is without inner regenerated brake resistor.

1.3.Servo driver appearance and panel descriptions



Display:
A 5-digit 7-segment LED to show the alarm、status、parameters, etc.

Operation keys:
To switch the function of control mode , monitor, parameters adjustment.
MODE：mode selection
▲: +1 incremental key
▼:-1 decreased key
SET：confirm key

Power indicator：
It lights to denote the driver "power on" .
It goes out to denote the driver "power off" .

RS-232/RS-485 port:
To connect this port with PC or supervisory controller.

Brake resistor:
(A) Connect the P/C with external resistor, and make P/D open.
(B) As build-in resistor applied, make P/C open and P/D short.

Encoder socket:
It is connected with the encoder cable of servo motor.

Power input terminals:
Connect R/S/T to AC 3 phase commercial power of 200~230Vac with 50/60 Hz.

44-pin DI/DO connector:
A integration I/O signal port. It provides various input/output signals for user to operate the advanced application.

Motor power terminals:
Connect the U/V/W terminal with the power cable of servo motor. Do not confuse U/V/W with R/S/T, it cause damages.

Heat sink:
A frame to cool down and for the installation.

Ground terminal

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	Position control (terminal input)	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.
	Speed control	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.
	Torque control	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.
		S-T	S/T is switched mutually via the LOP signal of DI.

If the default value of PA01 is applied, set the PA01 value as “1☐☐☐”.

NOTE :

1. Modify the PA01 value to define the application of mode switch. The PA01 modification works after the “Power on” restart.
2. If the default value of PA01 is applied, set the PA01 value as “1☐☐☐”.
3. The abbreviation for the control modes in this manual are explained as below.
   Pt : Position control mode(terminal input)
   S : Speed control mode
   T : Torque control mode

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
SDB-010A2	5A	5A
SDB-020A2	5A	5A
SDB-040A2	20A	10A
SDB-075A2	20A	10A

2. Installation

2.1. Precautions 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.
- 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. Environment conditions of installation

Installation place with good ventilation or air conditioner is necessary. It is recommended to place the driver in an environment where its temperature below 45℃ to ensure the reliability. If the product is installed in a distributor, confirm its size and ventilation condition. In addition, the usage of Shihlin servo should meet the following criteria.

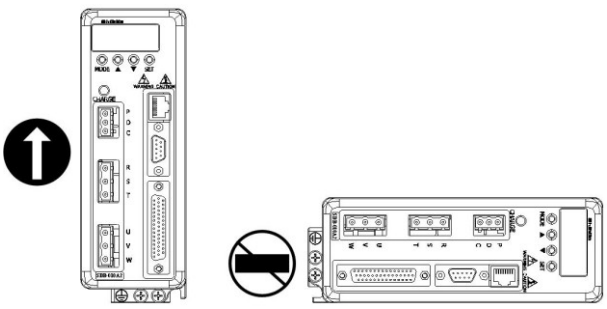
- Locations without high-heating devices.
- Locations without floating dust and metal particles.
- Locations without corrosive, inflammable gas and liquid.
- Locations without water drops, steam, dust or oil dust.
- Locations without electromagnetic interference.
- Select a solid, vibration-free location.

2.3. Installation direction and clearance

NOTE:

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.

The recommended installation direction inside a distributor is plotted below.

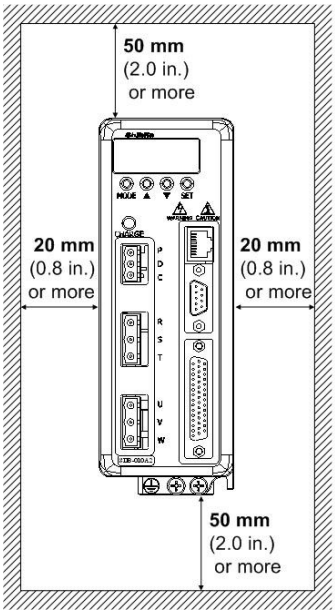


Installation diagram:

To achieve a lower wind resistance of the heat-dissipation fan for a more effective heat removal, follow the clearance recommended to install one or multiple AD servo drivers.

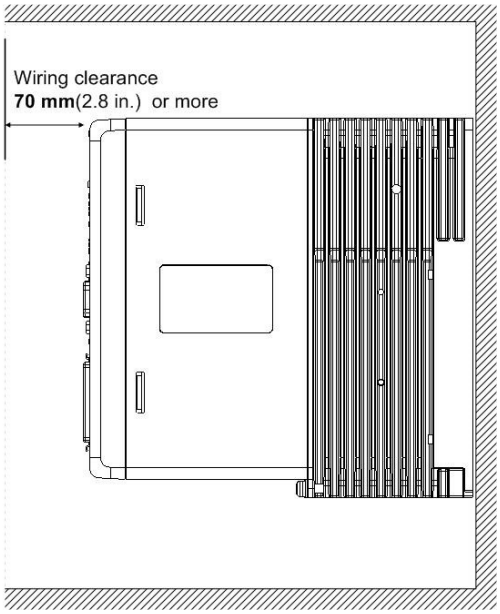
(1) Single driver installed

Control box



Front view

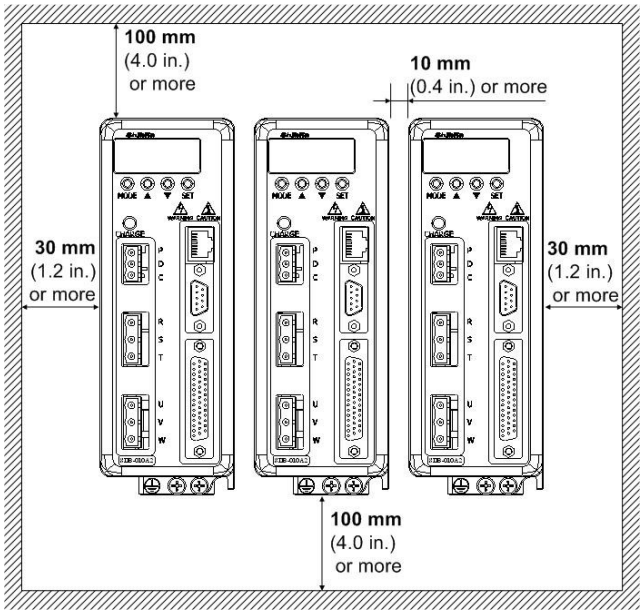
Control box



Side view

(2) Multiple driver installed

Control box

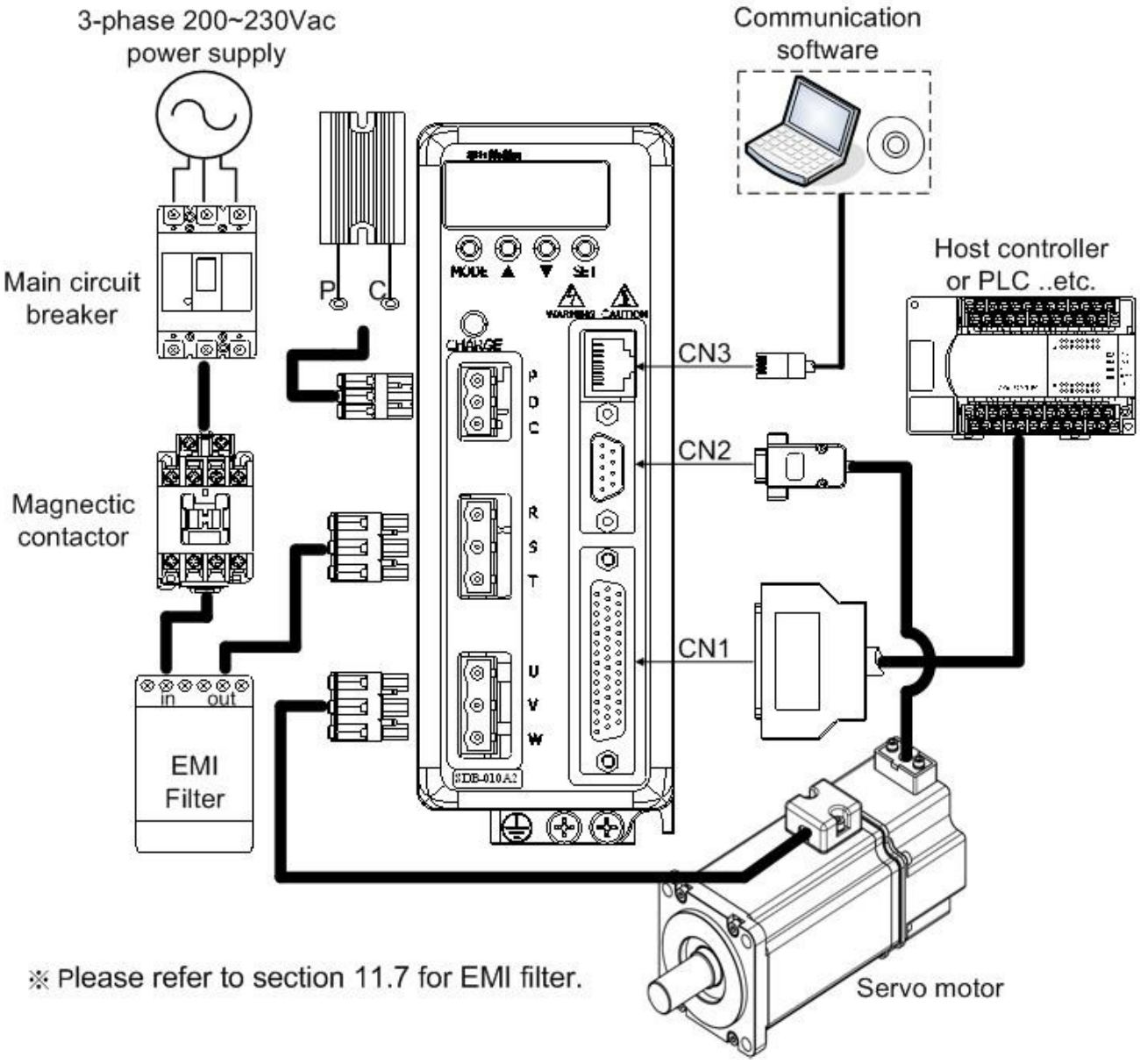


3. Wiring and signals

This chapter illustrate various wiring diagrams and signals of Shihlin servo driver.

3.1. Connections between main power source and peripheral devices

3.1.1. Wiring diagram of peripheral devices



NOTE :

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

3.1.2. Descriptions of connectors and terminals

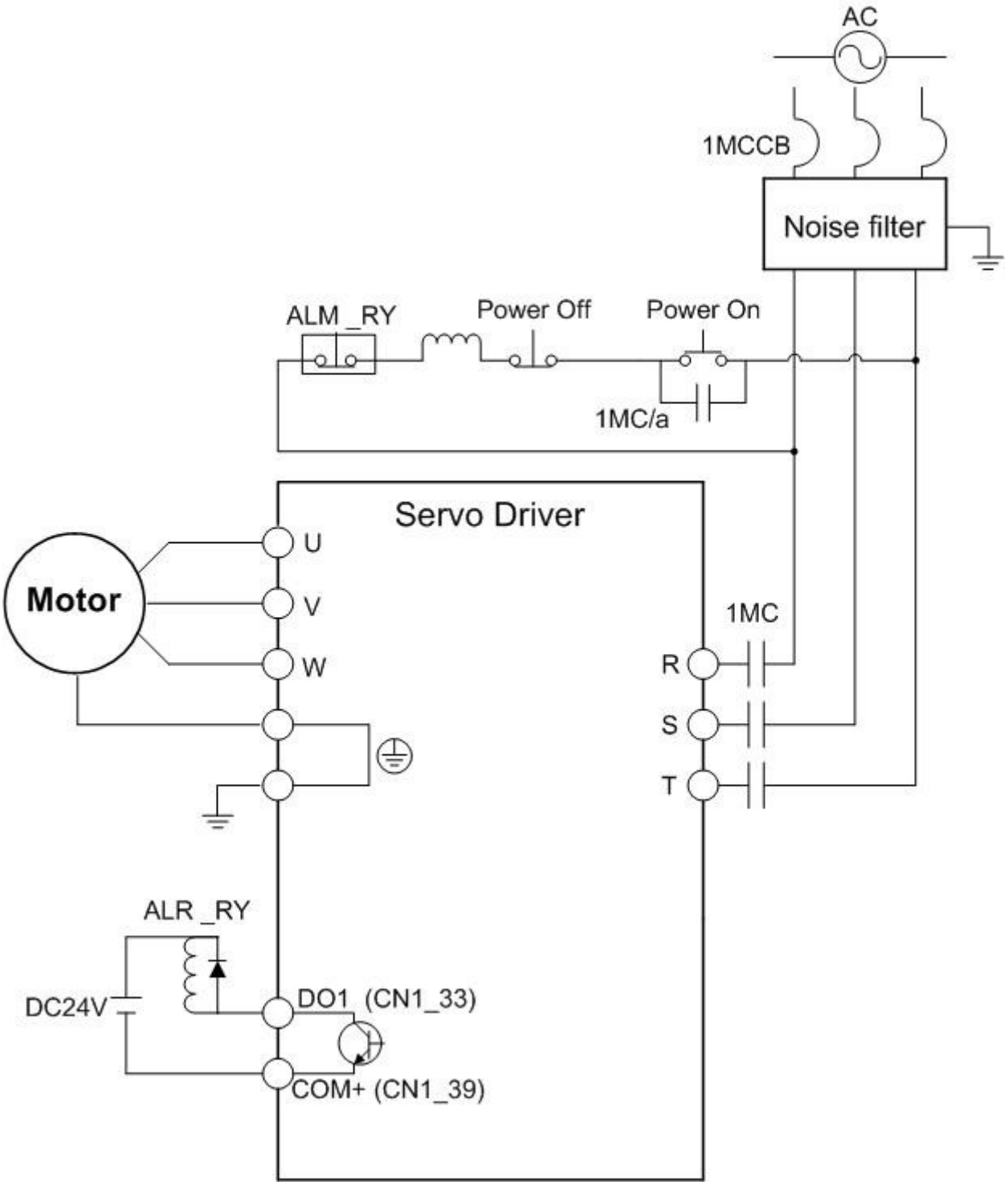
<table>
<tr><th>Name</th><th>Code</th><th>Description</th></tr>
<tr><td>Main power input terminal</td><td>R、S、T</td><td>Connects to 3-phase AC power source</td></tr>
<tr><td>Power output terminal for motor</td><td>U、V、
W、PE</td><td><table><tr><th>Terminal code</th><th>Wire color</th></tr><tr><td>U</td><td>Red</td></tr><tr><td>V</td><td>White</td></tr><tr><td>W</td><td>Black</td></tr><tr><td>PE</td><td>Green</td></tr></table></td></tr>
<tr><td>Brake resistor terminal</td><td>P、D、C</td><td><table><tr><td>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></td></tr>
<tr><td>Ground terminal</td><td>  </td><td>To connect the power ground with the motor ground.</td></tr>
<tr><td>P：main circuit【+】terminal
N：main circuit【-】terminal</td><td>P、N</td><td>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.</td></tr>
<tr><td>DI/DO connector</td><td>CN1</td><td>Connect to the host controller.</td></tr>
<tr><td>Encoder socket</td><td>CN2</td><td>Connect to the encoder cable of servo motor.</td></tr>
<tr><td>RS-232/RS-485 port</td><td>CN3</td><td>Connect to the COM port of PC.</td></tr>
</table>

NOTE :

1. Keep power lines R/S/T and U/V/W away from other signal lines at least 30 cm.
2. 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.

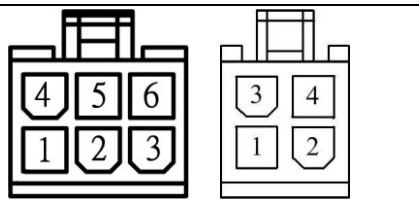
3.1.3. Wires of power source

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.



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

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

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

with brake without brake

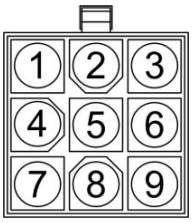
The lead wire signs of low inertia motor U,V,W terminal connector are listed as follows:

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)

3.1.5. Lead wire connector specifications of encoder

Servo motor side: (female type)

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

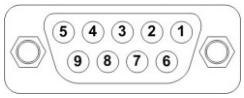
Driver capacity	Motor type	
100W	SMA－L010R30A□□	
200W	SMA－L020R30A□□	
400W	SMA－L040R30A□□	
750W	SMA－L075R30A□□	

The content of pin NO. are described as follows.

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			

Servo driver side: (female type)

Pin allocation of CN2



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

3.1.6. Selection of wiring materials

Please follow the recommendations below then use the proper specification.

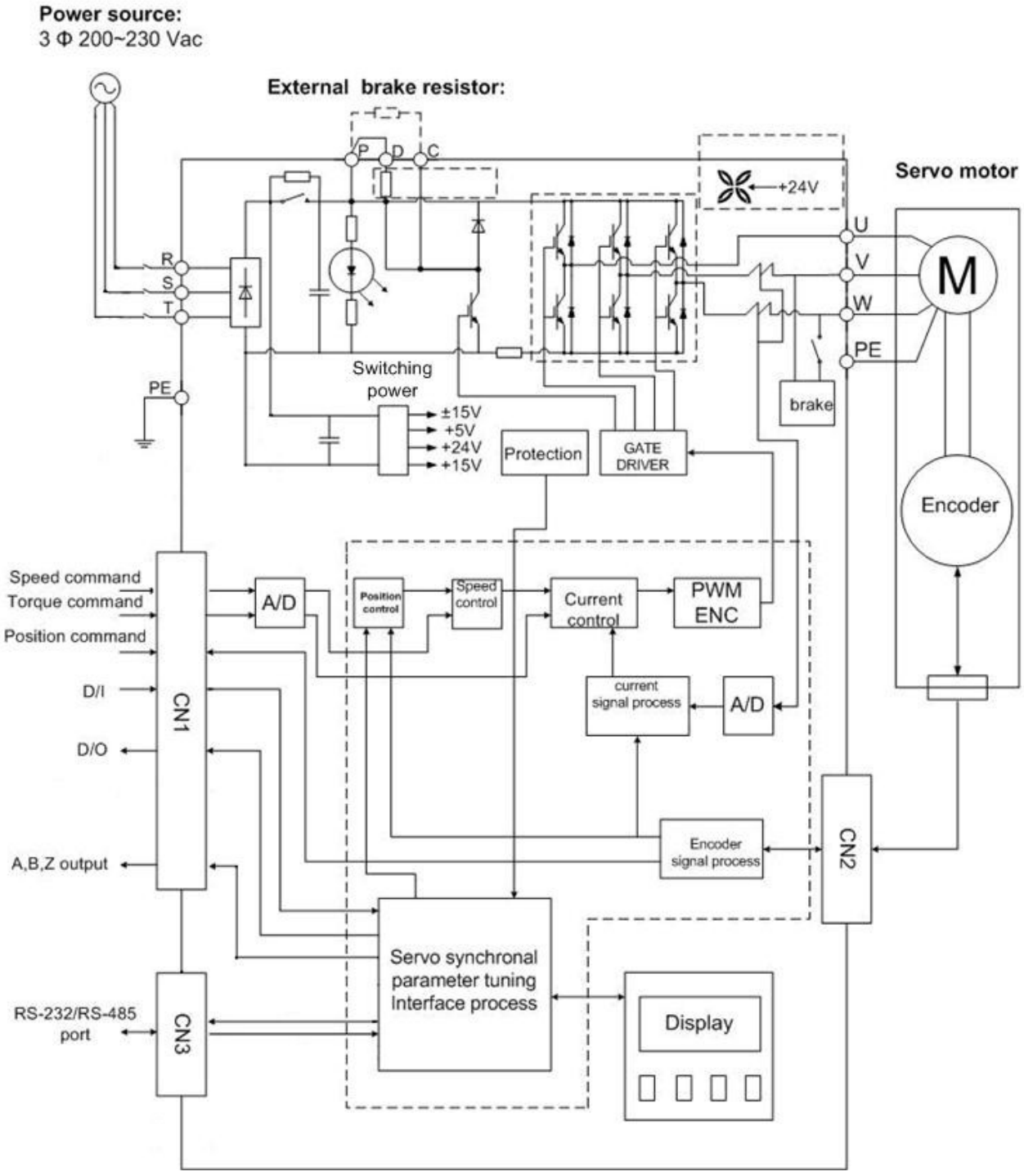
Driver type	Motor type	Specification for power wiring(AWG)			
		U、V、W	R、S、T	L1、L2	P、D、C
SDA－010A2	SMA－L010R30A□□	AWG14	AWG14	AWG16	AWG14
SDA－020A2	SMA－L020R30A□□	AWG14	AWG14	AWG16	AWG14
SDA－040A2	SMA－L040R30A□□	AWG14	AWG14	AWG16	AWG14
SDA－075A2	SMA－L075R30A□□	AWG14	AWG14	AWG16	AWG14

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－075A2	SMA－L075R30A□□	UL1332	2m	10	AWG26

NOTE :

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

3.2. Functional block diagram of Shihlin servo

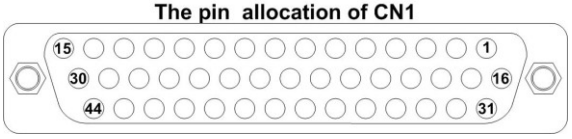


3.3.CN1 I/O signal wires instruction

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 DO 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:

The pin allocation of CN1



No	Pin name	Signal name	No	Pin name	Signal name
1	OPC	Open collector power	23	EMG	External emergency stop signal
2	SG	Signal ground of digital I/O	24	SG	Signal ground of digital I/O
3	DI1	Digital input 1~4	25	LG	Signal ground of analog input/output
4	DI2		26	LZ	Encoder Z-phase pulse
5	DI3		27	LB	Encoder B-phase pulse
6	DI4		28	LA	Encoder A-phase pulse
7	COM+	Digital power source midway	29	+12Vcc	+12V power supply output
8	COM+		30	TC/TLA	Torque analog command/limit
9	SG	Signal ground of digital I/O	31	PG	Forward/reverse rotation pulse train
10	LG	Signal ground of analog input/output	32	PP	
11	$\overline{LZR}$	Encoder /Z-phase pulse	33	DO1	Digital output 1~5
12	$\overline{LBR}$	Encoder /B-phase pulse	34	DO2	
13	$\overline{LAR}$	Encoder /A-phase pulse	35	DO3	
14	+12Vcc	+12V power supply output	36	DO4	
15	VC/VLA	Speed analog command/limit	37	DO5	
16	NG	Forward/reverse rotation pulse train	38	ALM	Alarm signal output
17	NP		39	SG	Signal ground of digital I/O
18	SG	Signal ground of digital I/O	40	LG	Signal ground of analog input/output
19	DI5	Digital input 5~8	41	OP	Phase Z pulse of encoder (open collector)
20	DI6		42	LG	Signal ground of analog input/output
21	DI7		43	LG	
22	DI8		44	LG	

NOTE :

NC is no effect terminal which is used for inner circuit of the driver. Do not connect it, or it will result in damage

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 44 pins in CN1 terminal. Every pin function will be described as below:

Signal name	Sign	Pin NO	Function description	Control mode
+12V power supply output	+12Vcc	CN1_14 CN1_29	A DC 15V output between +12Vcc and LG. It could be use as power source of TC, TLA, VC and VLA.	ALL
Speed analog command/limit	VC/VLA	CN1_15	Apply a voltage in ±10V range on VC-LG under the speed mode, the motor will rotate the proportional speed linearly of PC12 value at ±10V range. Apply a voltage in ±10V range on VLA-LG under the torque mode, the motor will rotate the proportional speed linearly of PC12 value at ±10V range.	S,T
Signal ground of analog input/output	LG	CN1_10 CN1_25 CN1_40 CN1_42 CN1_43 CN1_44	The common ground of TLA, TC, VC, VLA, OP, +12Vcc. Each pin inside the driver is connected together.	ALL
Forward/reverse rotation pulse train	NG	CN1-16	Open collector type:（Max. frequency 200Kpps） To apply signals on PP-SG means “forward command”. To apply signals on NP-SG means “reverse command”. 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”.	Pt
	NP	CN1-17		
	PP	CN1-32		
	PG	CN1-31		
Open collector power	OPC	CN1_1	As signals in open collector type; this pin provides 24V and SG is the ground.	ALL
Signal ground of digital I/O	SG	CN1_2 CN1_9 CN1_18 CN1_24 CN1_39	The common ground of SON, EMG, DI1, etc. digital input. Each pin inside the driver is connected together but separated from LG.	ALL
Torque analog command/limit	TC/TLA	CN1_30	Apply a voltage signal within ±10V on TC-LG, the motor torque generated will be linear proportional of PC13. As TLA is valid, motor generated torque will be limited according to proportion of rated torque to applied voltage. The range of applied voltage on TLA-SG is 0 ~ +10V.	Pt,S
Encoder A-phase pulse(differential line driver)	LA	CN1_28	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. The phase sequence of rotation and phase difference between phase A and phase B could be defined by the change of PA39 value.	ALL
	LAR	CN1_13		
Encoder B-phase pulse(differential line driver)	LB	CN1_27		
	LBR	CN1_12		

Signal name	Sign	Pin NO	Function description	Control mode
Encoder Z-phase pulse(differential line driver)	LZ	CN1_26	The servo driver transforms the OP signals into line driver(differential type).	ALL
	LZR	CN1_11		
Phase Z pulse of encoder (Open collector)	OP	CN1_41	The origin signal of encoder output. One pulse is output as the completion of one revolution for the servo motor.	ALL
Alarm signal output	ALM	CN1_38	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
External emergency stop signal	EMG	CN1_23	An external emergency stop signal input with higher priority to stop motor running immediately.	ALL
Digital power source midway	COM+	CN1-7 CN1-8	When external power is applied as the source of input signals, this pin should connected to external power.	ALL

2. I/O signal description of CN1 terminal

I/O Signals of CN1 terminal and their abbreviation reference table are presented below.

Abbr.	Signal name	Abbr.	Signal name
SON	Servo ON	COM +	Digital power source midway
LSP	Limit of forward rotation route	TLC	Torque limiting control
LSN	Limit of reverse rotation route	VLC	Speed limiting control
CR	Clear	RD	Servo 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	Phase Z pulse of encoder(Open collector)
TL	Torque limit option	LZ	Phase Z pulse of encoder (differential line driver)
RES	Reset	LZR	
EMG	External emergency stop	LA	Phase A pulse of encoder (differential line driver)
LOP	Control mode switch	LAR	
VC	Speed analog command	LB	Phase B pulse of encoder (differential line driver)
VLA	Speed analog limit	LBR	
RS1	Forward rotation option	SD	Shield
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		TLA	Torque analog limit
NG		TC	Torque analog command

3. DI and DO signals description

Input DI

Every DI pin is programmable. Each DI pin could be assigned to one of 18 functions by modifying the parameter PD02 to PD09. The value from 0x01 to 0x19 is defined as the function described below.(some values are reserved)

<table>
<tr><th>Signal function</th><th>Sign</th><th>Value</th><th>Functions/Applications description</th><th>Control mode</th></tr>
<tr><td>Servo ON</td><td>SON</td><td>0x01</td><td>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)</td><td>ALL</td></tr>
<tr><td>Reset</td><td>RES</td><td>0x02</td><td>A short-circuit duration over 50ms on RES-SG will recover from an abnormal alarm status. Some abnormal cases will not be recovered(refer to section 10.1). Set the PD20 as ☐☐☐1, the function of reset will not work.</td><td>ALL</td></tr>
<tr><td>Proportion control</td><td>PC</td><td>0x03</td><td>When PC-SG switches on, the speed algorithm will perform proportion control from proportion-integral control. When servo motor is in static, the driver keeps generating torque to resist the external disturbance. Even only 1 pulse interference, it will make servo motor revolute. Once the position is done, to prevent from unnecessary jitter of motor shaft, please switch to the proportion control.</td><td>Pt,S</td></tr>
<tr><td>Torque limit option</td><td>TL</td><td>0x04</td><td>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.</td><td>Pt,S</td></tr>
<tr><td>Inner torque limit option</td><td>TL1</td><td>0x05</td><td>Turn TL1-SG on to make inner torque limit 2 valid(PC25). For details, refer to section 6.3.4.</td><td>ALL</td></tr>
<tr><td>Speed option 1</td><td>SP1</td><td>0x06</td><td rowspan="3">＜Speed control mode＞
Used to select the speed command. Enable SP1, SP2, SP3 with PD02 to PD09.
<table>
<tr><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>
<tr><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>
</table>
＜Torque control mode＞
Used to select the speed limit. Enable SP1, SP2, SP3 with PD02 to PD09.
<table>
<tr><th colspan="3">Input signals</th><th rowspan="2">Speed command</th></tr>
<tr><th>SP3</th><th>SP2</th><th>SP1</th></tr>
<tr><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>
</table></td><td rowspan="3">S,T</td></tr>
<tr><td>Speed option 2</td><td>SP2</td><td>0x07</td></tr>
<tr><td>Speed option 3</td><td>SP3</td><td>0x08</td></tr>
</table>

<table>
<tr><td>Forward rotation activated</td><td>ST1</td><td>0x09</td><td rowspan="2">Used to start the servo motor in the following directions:
<table><tr><th colspan="2">Input signals</th><th rowspan="2">Servo motor starting direction</th></tr><tr><th>ST2</th><th>ST1</th></tr><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></table>If both ST1 and ST2 are switched on or off during operation, the motor will be decelerated to a stop according to PA28.</td><td rowspan="2">S</td></tr>
<tr><td>Reverse rotation activated</td><td>ST2</td><td>0x0A</td></tr>
<tr><td>Forward rotation option</td><td>RS1</td><td>0x0A</td><td rowspan="2">Used to select the following motor torque generated directions:
<table><tr><th colspan="2">Input signals</th><th rowspan="2">Torque generated direction</th></tr><tr><th>RS2</th><th>RS1</th></tr><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></table></td><td rowspan="2">T</td></tr>
<tr><td>Reverse rotation option</td><td>RS2</td><td>0x09</td></tr>
<tr><td>Origin position</td><td>ORGP</td><td>0x0B</td><td>In position control with inner registers, this signal activated will assigned current position to the origin.</td><td>Pr</td></tr>
<tr><td>Start Home moving</td><td>SHOM</td><td>0x0C</td><td>As this signal activated, driver runs motor to return the origin.</td><td>Pr</td></tr>
<tr><td>Electronic gear option 1</td><td>CM1</td><td>0x0D</td><td rowspan="2">Enable CM1, CM2 with PD02 to PD09. The combination of CM1 and CM2 gives a choice of 4 numerators. CM1 and CM2 cannot be used in the absolute position detection system.
<table><tr><th colspan="2">Input signals</th><th rowspan="2">Electronic gear molecule</th></tr><tr><th>CM2</th><th>CM1</th></tr><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></table></td><td rowspan="2">Pt</td></tr>
<tr><td>Electronic gear option 2</td><td>CM2</td><td>0x0E</td></tr>
<tr><td>Clear</td><td>CR</td><td>0x0F</td><td>Turn CR on to clear the position control counter droop pulses on its leading edge. The duration should be 10ms or longer. When the PD18 is ☐☐☐1, the pulses are cleared while CR is on.</td><td>Pt</td></tr>
<tr><td>Gain switch option</td><td>CDP</td><td>0x10</td><td>Enable this signal with PD02 to PD09. Turn CDP on to change the gain values into the multiplier of parameter PB14 to PB17.</td><td>ALL</td></tr>
<tr><td>Control mode switch</td><td>LOP</td><td>0x11</td><td>＜Hybrid mode of Position/Speed control＞
Used to select one of position mode and speed mode.
<table><tr><th>LOP</th><th>Control mode</th></tr><tr><td>0</td><td>Position</td></tr><tr><td>1</td><td>Speed</td></tr></table>＜Hybrid mode of Speed/Torque control＞
Used to select one of Speed mode and Torque mode.
<table><tr><th>LOP</th><th>Control mode</th></tr><tr><td>0</td><td>Speed</td></tr><tr><td>1</td><td>Torque</td></tr></table>＜Hybrid mode of Torque/Position control＞
Used to select one of Torque mode and Position mode.
<table><tr><th>LOP</th><th>Control mode</th></tr><tr><td>0</td><td>Torque</td></tr><tr><td>1</td><td>Position</td></tr></table></td><td>Refer to various App.</td></tr>
</table>

<table>
<tr><td>External emergency stop</td><td>EMG</td><td>0x12</td><td>Open EMG-SG to bring the driver to an emergency stop state, in which the electromagnetic brake is on. Short-circuit EMG-SG to reset the emergency stop state.
Set the PD01 as 1☐☐☐, this signal will be normal on.</td><td>ALL</td></tr>
<tr><td>Limit of forward rotation route</td><td>LSP</td><td>0x18</td><td rowspan="2">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. As the value of PD17 is ☐☐☐1, the motor decelerate by the time of deceleration and then stop.
Set the Parameter PD01 as follows to get a virtual short-circuit without a physical wiring.(normal “ON”)
<table>
<tr><th>PD01</th><th>Normal “ON”</th></tr>
<tr><td>xx1x</td><td>LSP</td></tr>
<tr><td>x1xx</td><td>LSN</td></tr>
</table>
<table>
<tr><th colspan="2">Signal status(*)</th><th colspan="2">Rotary direction</th></tr>
<tr><th>LSP</th><th>LSN</th><th>CCW</th><th>CW</th></tr>
<tr><td>1</td><td>1</td><td>○</td><td>○</td></tr>
<tr><td>0</td><td>1</td><td></td><td>○</td></tr>
<tr><td>1</td><td>0</td><td>○</td><td></td></tr>
<tr><td>0</td><td>0</td><td></td><td></td></tr>
</table></td><td rowspan="2">Pt,S</td></tr>
<tr><td>Limit of reverse rotation route</td><td>LSN</td><td>0x19</td></tr>
</table>

NOTE :

1. When setting the PA01 to run speed mode or torque mode, the DI definition of ST1/RS2 and ST2/RS1 will be switched mutually and automatically.
2. To program the DI function, PA01 should be set as 0☐☐☐. If the PA01 is 1☐☐☐, the DI definition will be default.
3. The logic 1 of XXX signal means that XXX and SG are short-circuit. The logic 0 of XXX signal means that XXX and SG are open-circuit.

Output DO

Every DO pin is programmable. Each DO pin could be assigned to one of 9 functions by modifying the parameter PD02 to PD09. The value from 0x01 to 0x09 is defined as the function described below. (some values are reserved)

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 will 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
Speed attained	SA		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
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,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

NOTE :

1. When setting the PA01 to run speed mode or position mode, the DI definition of INP and SA will be switched mutually and automatically.
2. When setting the PA01 to run speed mode or position mode, the DI definition of TLC and VLC will be switched mutually and automatically.

There are 8 DI, 5 DO equipped in CN1. They afford user a flexible application. According to the specified modes, Shihlin servo driver will allot default signal function into 8 DI pins.

DI allocation according various modes

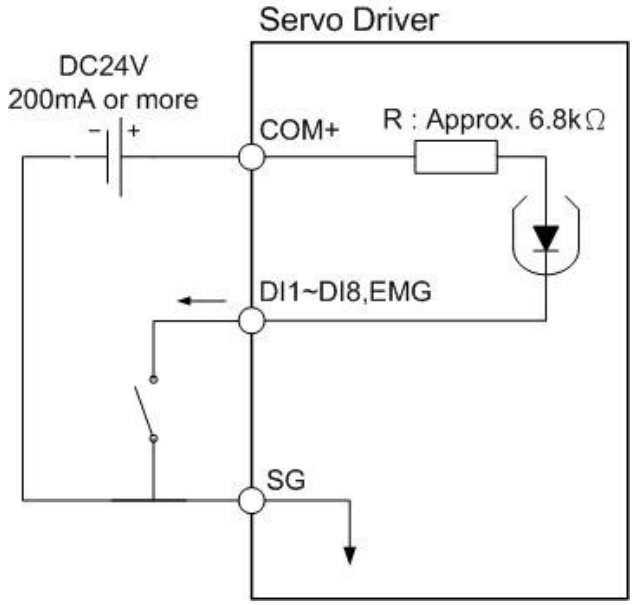
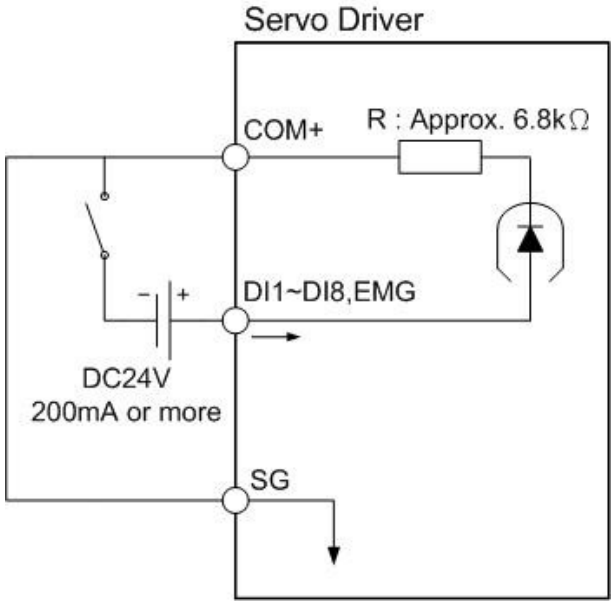
Value	Sign	Function	Pt	S	T	Pt-S	Pt-T	S-T
0x01	SON	Servo ON	DI1	DI1	DI1	DI1	DI1	DI1
0x02	RES	Reset	DI5	DI5	DI5	DI5	DI5	DI5
0x03	PC	Proportion control	DI3					
0x04	TL	Torque limit option	DI4					
0x05	TL1	Inner torque limit option						
0x06	SP1	Speed option 1		DI6	DI6			DI6
0x07	SP2	Speed option 2		DI2	DI2			
0x08	SP3	Speed option 3						
0x09	ST1	Forward rotation activated		DI3		DI3		
0x0A	ST2	Reverse rotation activated		DI4		DI4		
0x0A	RS1	Forward rotation option			DI4		DI4	DI4
0x09	RS2	Reverse rotation option			DI3		DI3	DI3
0x0D	CM1	Electronic gear option 1	DI2					
0x0E	CM2	Electronic gear option 2						
0x0F	CR	Clear	DI6			DI6	DI6	
0x10	CDP	Gain switch option						
0x11	LOP	Control mode switch				DI2	DI2	DI2
0x12	EMG	External emergency stop						
0x18	LSP	Limit of forward rotation route	DI7	DI7	DI7	DI7	DI7	DI7
0x19	LSN	Limit of reverse rotation route	DI8	DI8	DI8	DI8	DI8	DI8

DO allocation according various modes

Value	Sign	Function	Pt	S	T	Pt-S	Pt-T	S-T
0x01	RD	Ready	DO5	DO5	DO5	DO5	DO5	DO5
0x02	ALM	Trouble						
0x03	INP	In-position ready	DO1			DO1	DO1	
0x03	SA	Speed attained		DO1		DO1		DO1
0x05	TLC	Torque limiting control	DO4	DO4		DO4	DO4	DO4
0x05	VLC	Speed limiting control			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

3.3.3. Interface wiring diagram

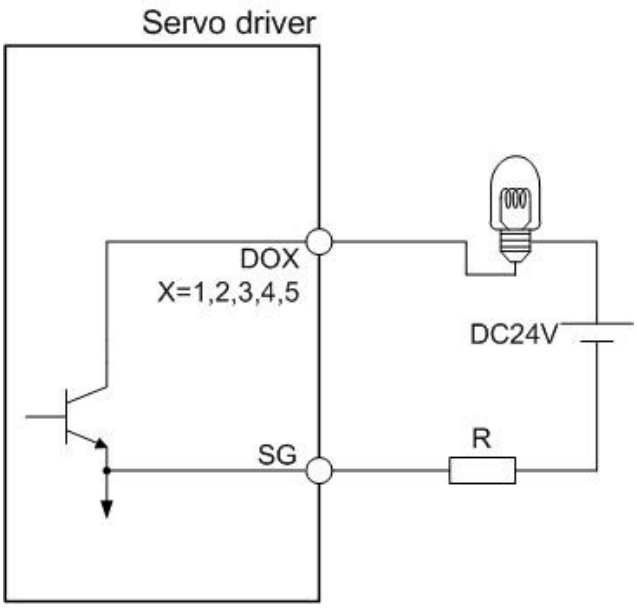
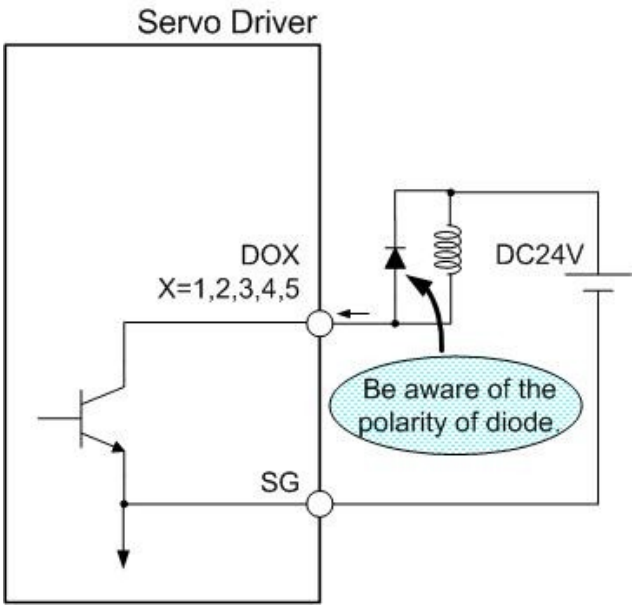
(1). DI wiring for **Sink** and **Source** type

Sink type	**Source** type
	

◆ Once a DI wiring is for Source type, then the others must be in Source type.

(2). DO wiring

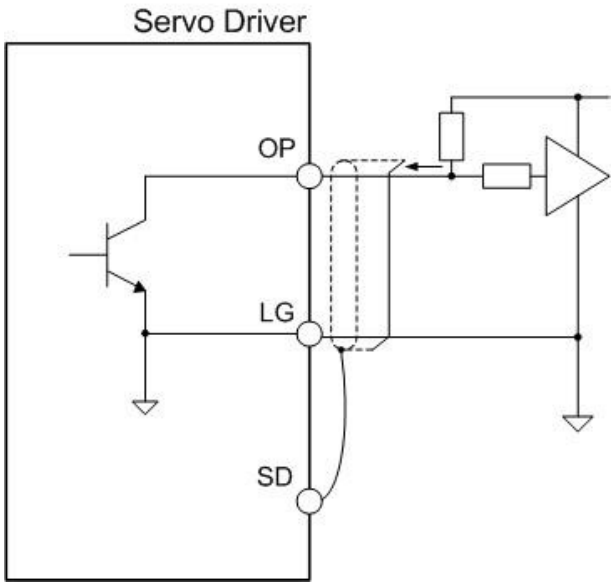
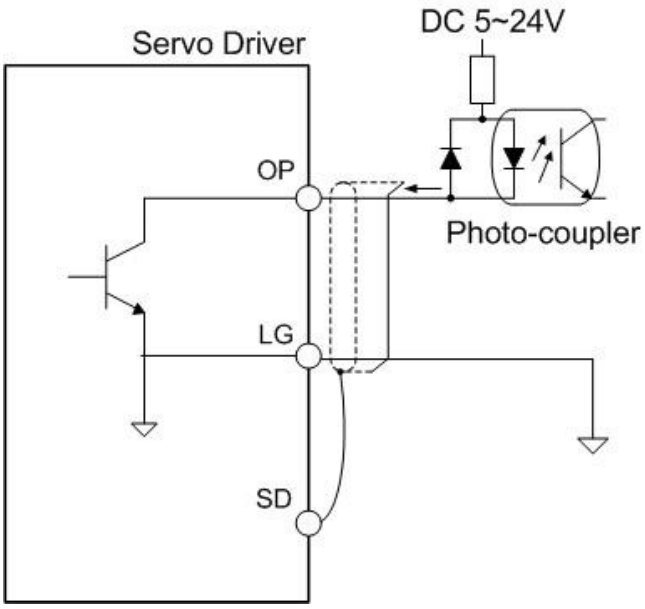
Provide a diode for an relay load, or an inrush current suppressing resistor for a lamp load. (Permissible current: 40mA or less, inrush current: 100mA or less)

Lamp load for DO wiring	**Relay load for DO wiring**
	

(3). Encoder pulse output

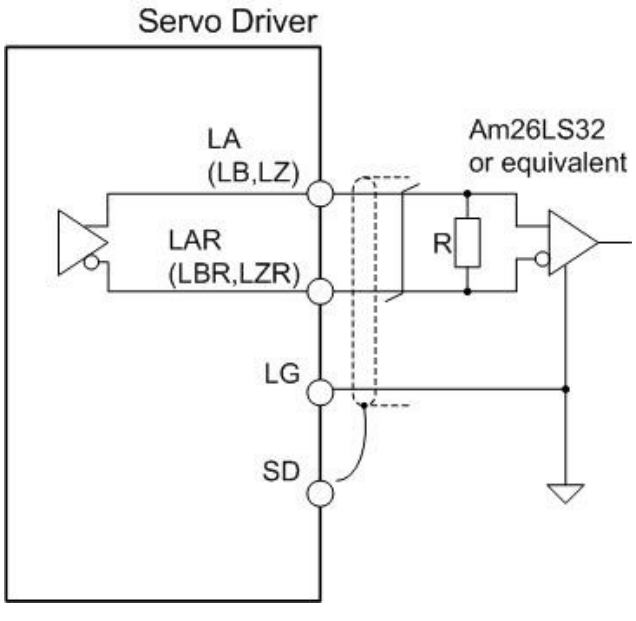
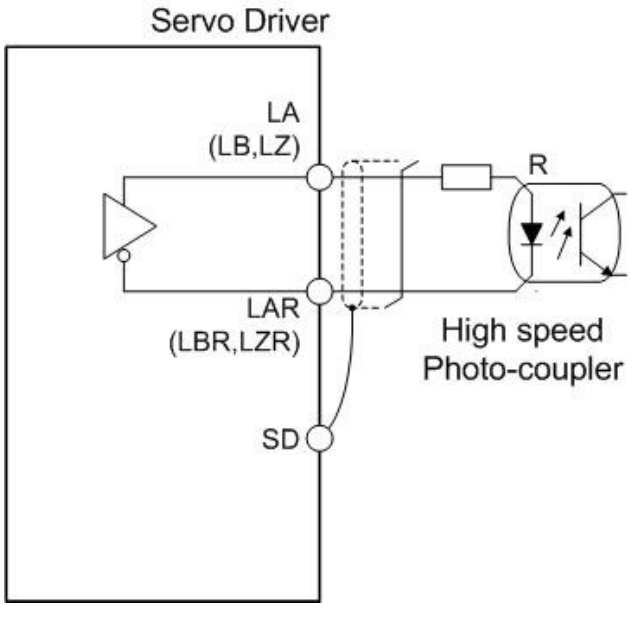
There are open collector type and differential line driver type. Open collector output could be obtained via the pin 41(OP) of CN1. The maximum output current is 35mA.

(a) Open collector type

Non-isolated output	Photo-coupler isolated output
	

(b) Differential line driver type

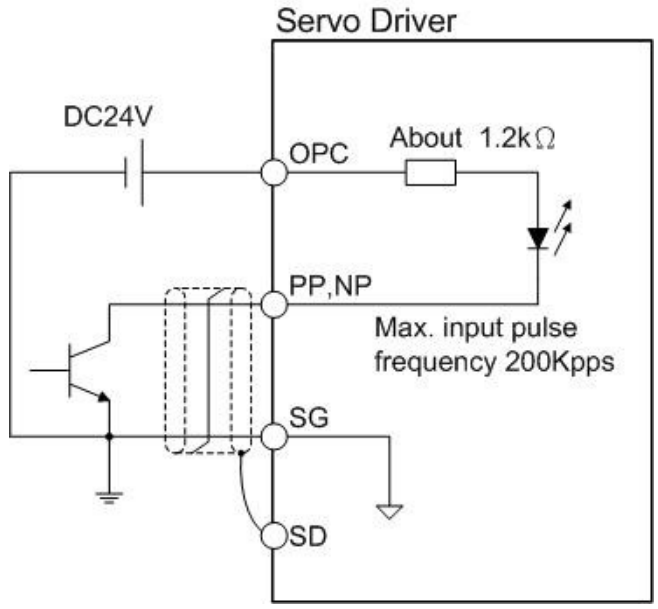
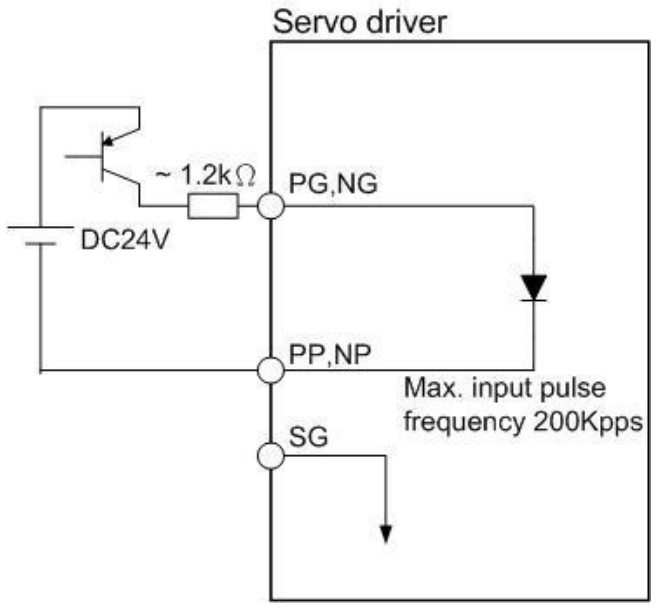
The maximum output current is 20mA.

Non-isolated LA/LAR output	Photo-coupler isolated LA/LAR output
	

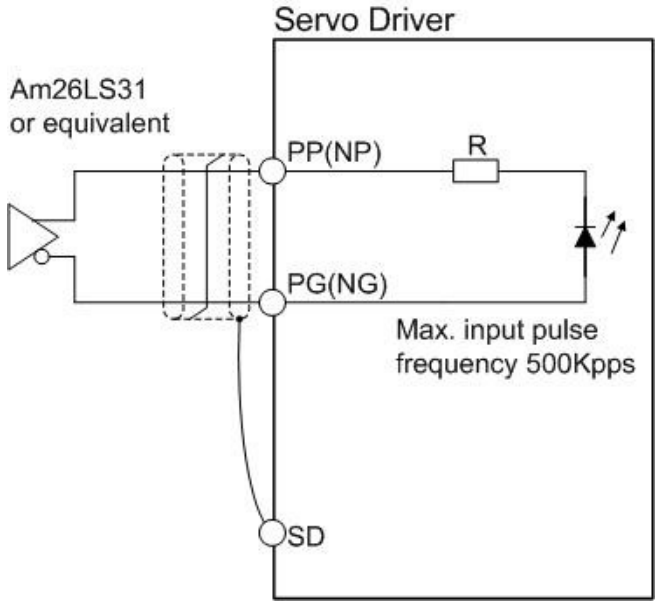
(4). Forward/reverse rotation pulse train input

Input forward/reverse rotation pulses in open collector type or differential line driver type. The maximum input pulse frequency is 500kpps for differential line driver and 200kpps for open collector type.

(a) Open collector type

NPN Open collector type	**PNP** Open collector type
	

(b) Differential line driver type

Differential line driver type


3.3.4. User definition of DI/DO

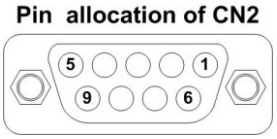
DI/DO default are suitable for position mode. If they are not suitable for user's application, please re-define the functions again. The functions of DI1 to DI8 are corresponding to the setting of parameter PD02 to PD09. Those DO1 to DO5 are corresponding to the PD10 to PD14. The following table describes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

Pin No.	Signal name	Relative Parameter	Pin No.	Signal name	Pin name
CN1_14	DI1	PD02	CN1_41	DO1	PD10
CN1_15	DI2	PD03	CN1_42	DO2	PD11
CN1_16	DI3	PD04	CN1_43	DO3	PD12
CN1_17	DI4	PD05	CN1_44	DO4	PD13
CN1_18	DI5	PD06	CN1_45	DO5	PD14
CN1_19	DI6	PD07			
CN1_20	DI7	PD08			
CN1_21	DI8	PD09			

3.4. CN2 Encoder signal wiring and description

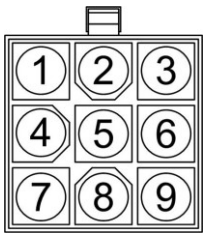
The resolution of Shihlin servo motor encoder is 2500ppr. After the digital signal process of 4 multiplied, that will be increased to 10,000ppr. There are 8 wires for Shihlin servo encoder, which are A,/A,B,/B,Z,/Z,+5V,GND. The appearance of CN2 connector is shown below.

Servo driver side



Servo motor side

Connector of encoder cable

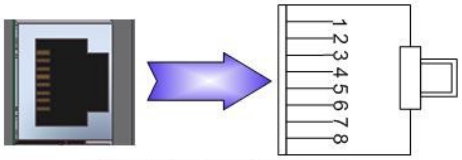


CN2 pin allocation and pin of encoder cable connector are listed below.

Driver side Pin NO.	Motor side Pin NO.	Signal name	Sign	Function description
2	6	Phase /Z	/Z	Phase /Z pulse train input/output(*) of encoder
3	5	Phase /B	/B	Phase /B pulse train input/output of encoder
4	4	Phase /A	/A	Phase /A pulse train input/output of encoder
5	7	Power	+5V	+5V power supply for encoder
6	3	Phase Z	Z	Phase Z pulse train input/output of encoder
7	2	Phase B	B	Phase B pulse train input/output of encoder
8	1	Phase A	A	Phase A pulse train input/output of encoder
9	8	Ground	GND	power ground
--	9	SHIELD	SHIELD	SHIELD

3.5. CN3 Communication signal wiring and description

The CN3 of Shihlin servo driver is for communication. With servo communication software, users could perform parameter setting, status monitoring, test operation, etc. on a personal computer. There are 2 format suitable for CN3: RS232 and RS485. Users could select one by setting 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.

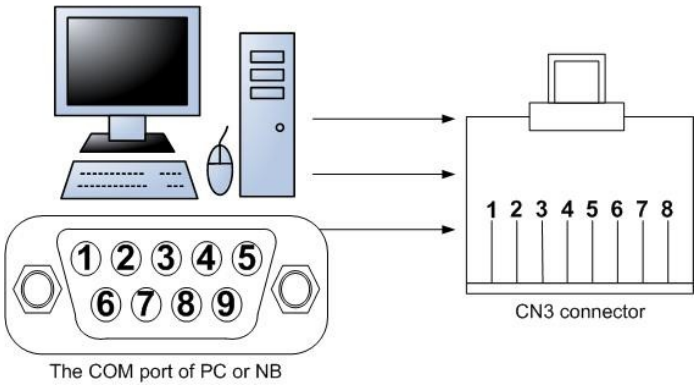


CN3 connector (female type)

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.

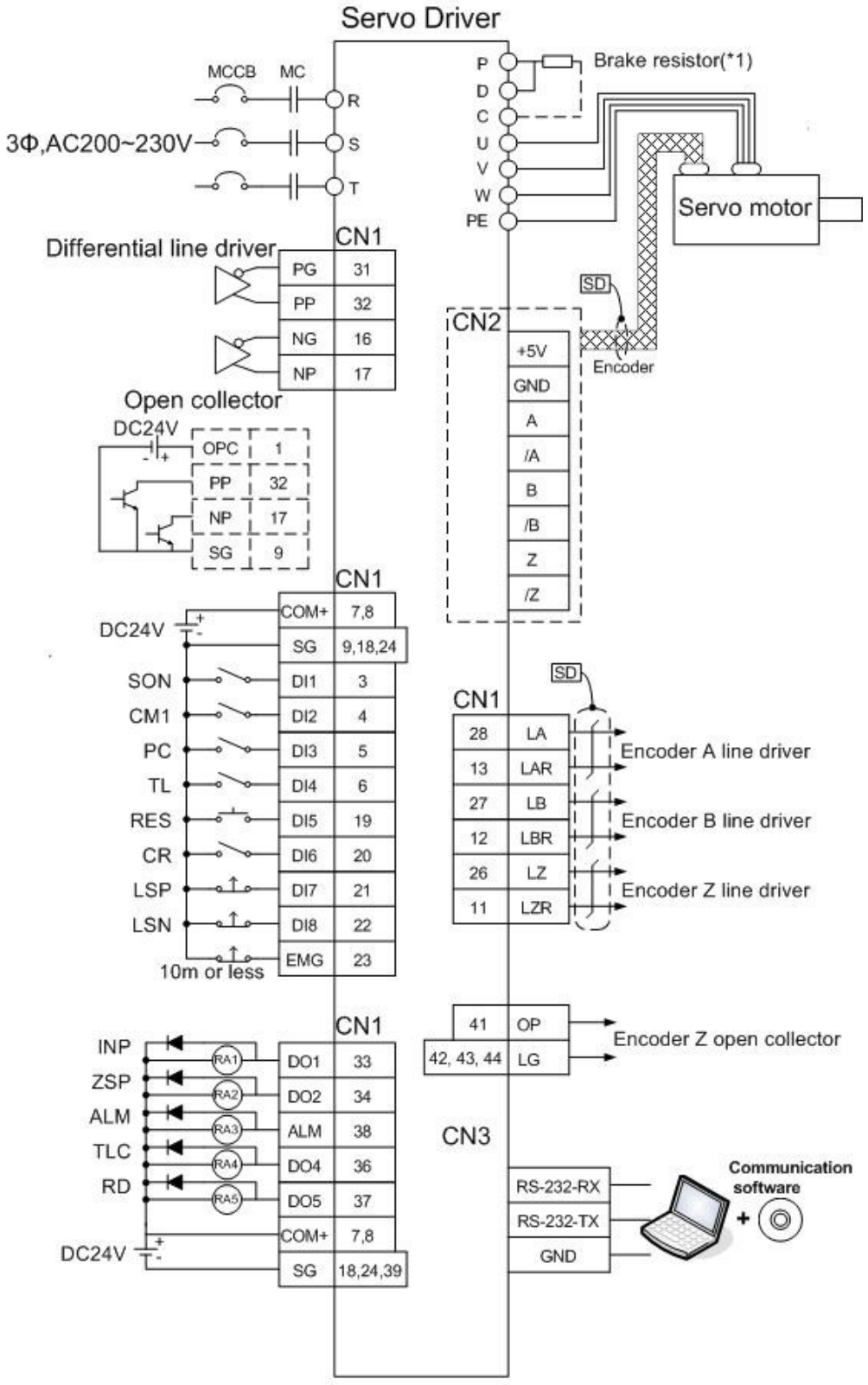
NOTE :

For RS-485 communication, please refer to section 8.1.



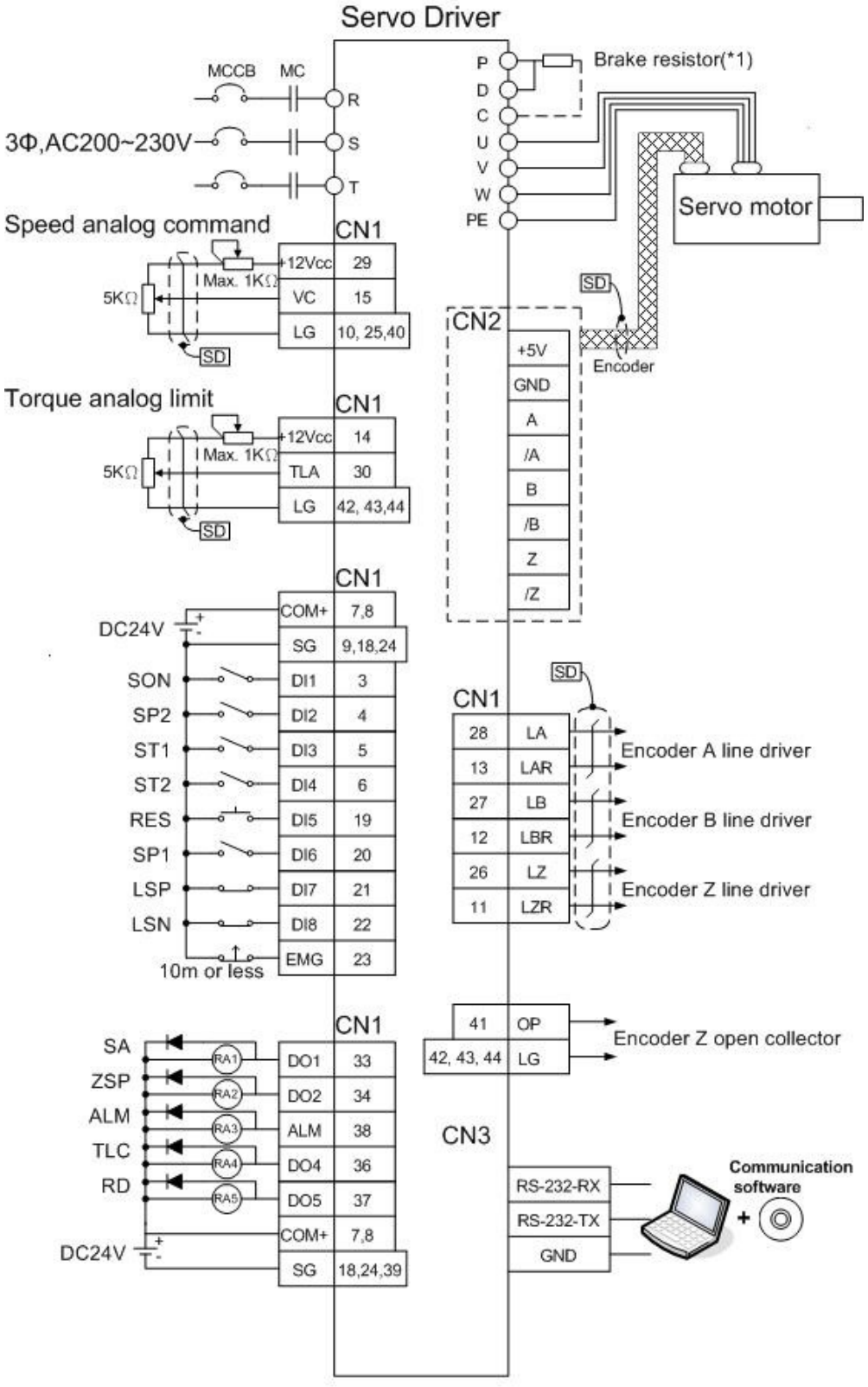
3.6.Wiring diagram

3.6.1. Position control mode(Pt)



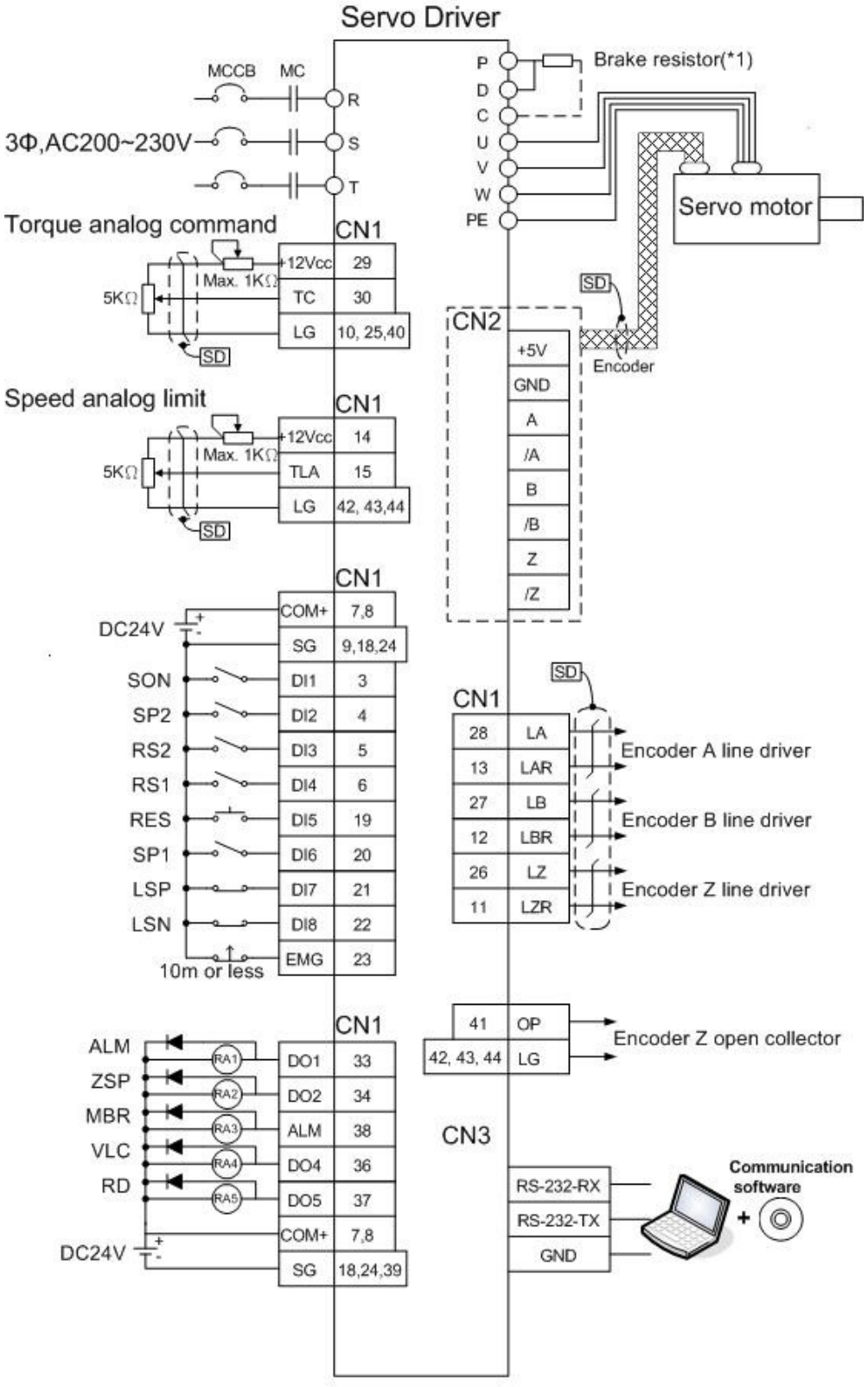
(*1): Refer to Section 3.1.2 for the wirings of Brake resistor

3.6.2. Speed control mode(S)



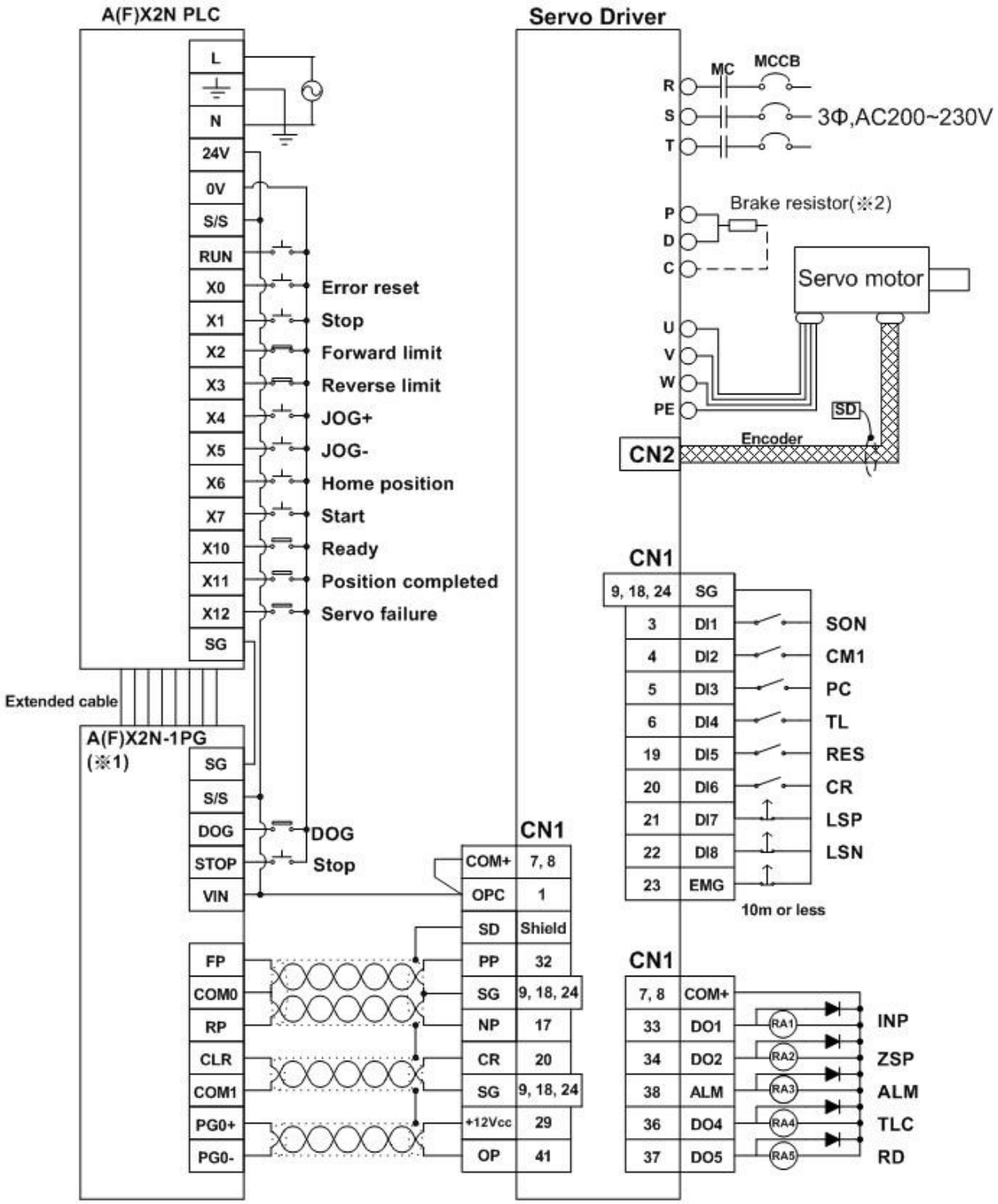
(*1): Refer to Section 3.1.2 for the wirings of Brake resistor

3.6.3. Torque control mode(T)



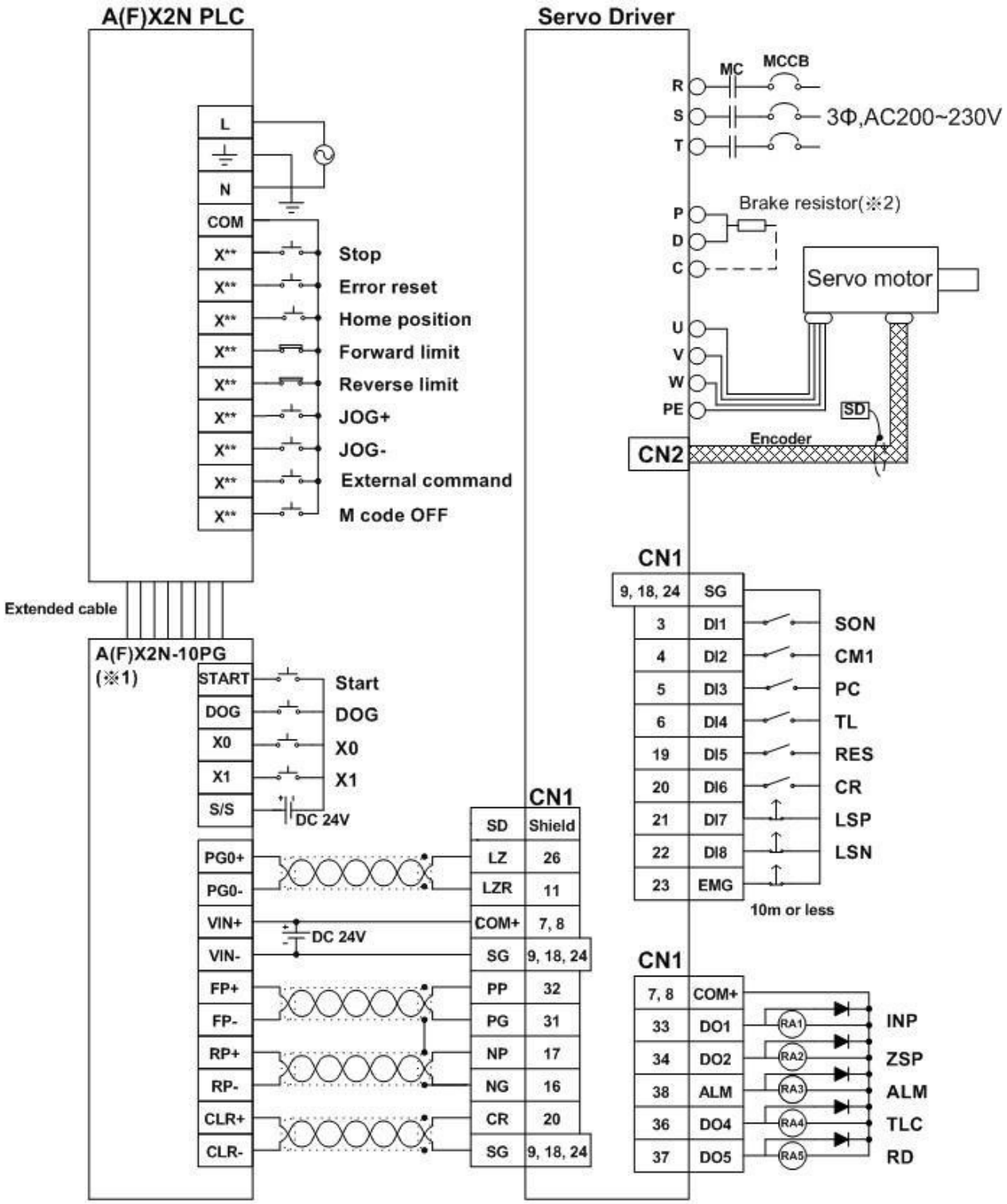
(*1): Refer to Section 3.1.2 for the wirings of Brake resistor

3.6.4. 1PG wiring diagram



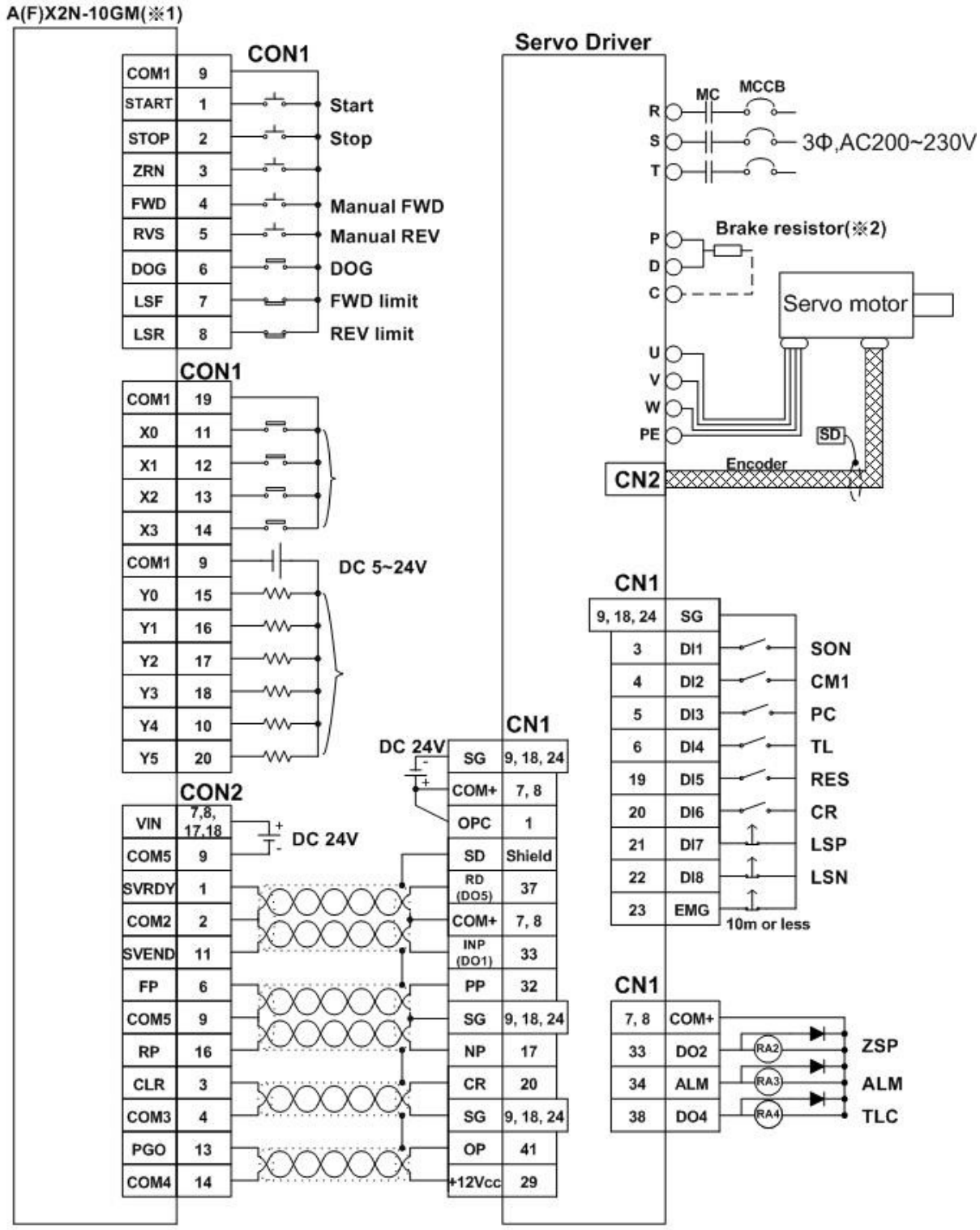
※1. A(F)X2N-1PG default is negative logic, forward/reverse rotation pulse train. The PA13 should be set as 0010h.
※2. See Section 3.1.2 for the wirings of brake resistor.

3.6.5. 10PG wiring diagram



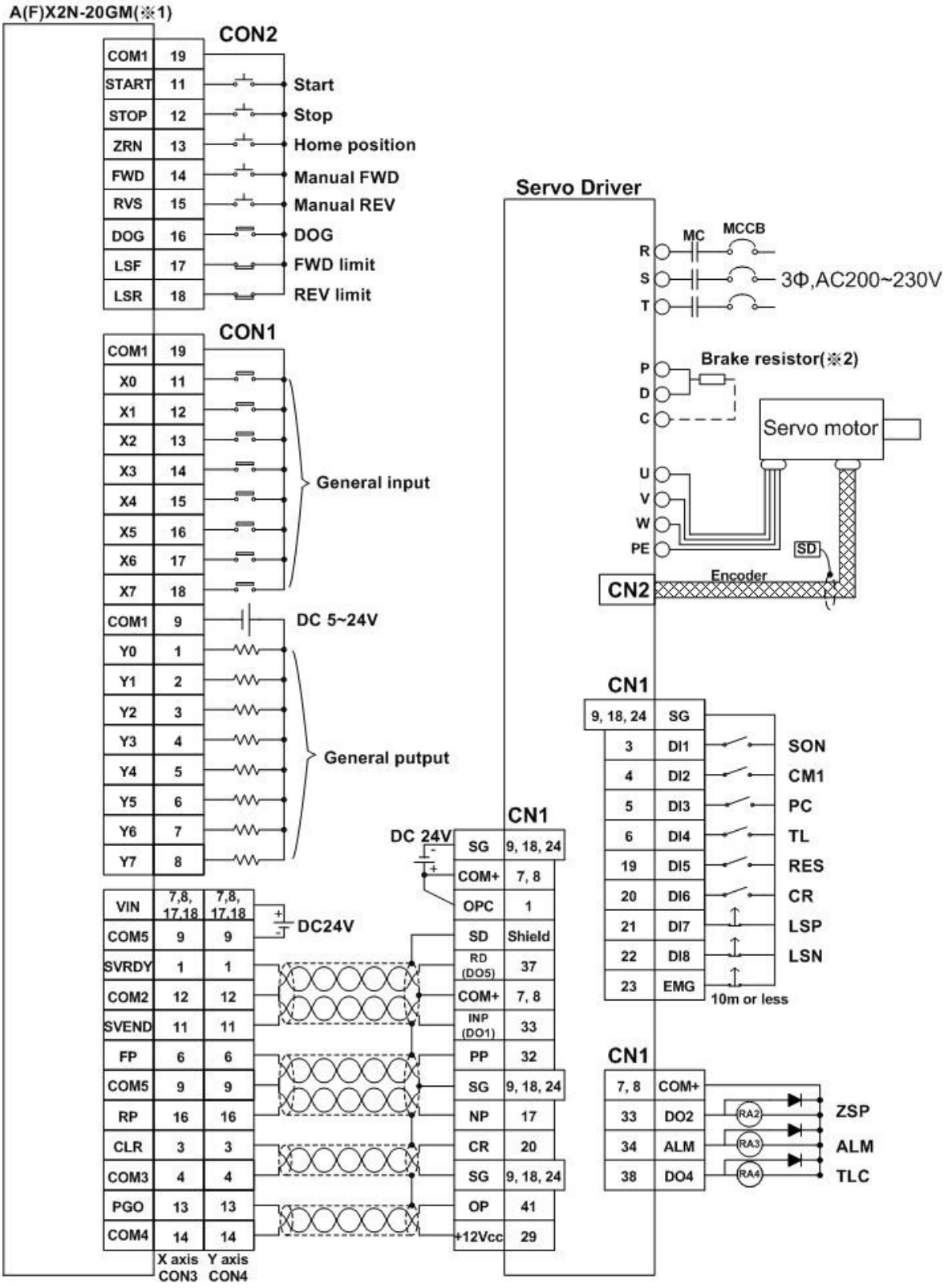
※1. A(F)X2N-10PG default is negative logic, forward/reverse rotation pulse train. The PA13 should be set as 0010h.
※2. See Section 3.1.2 for the wirings of brake resistor.

3.6.6. 10GM wiring diagram



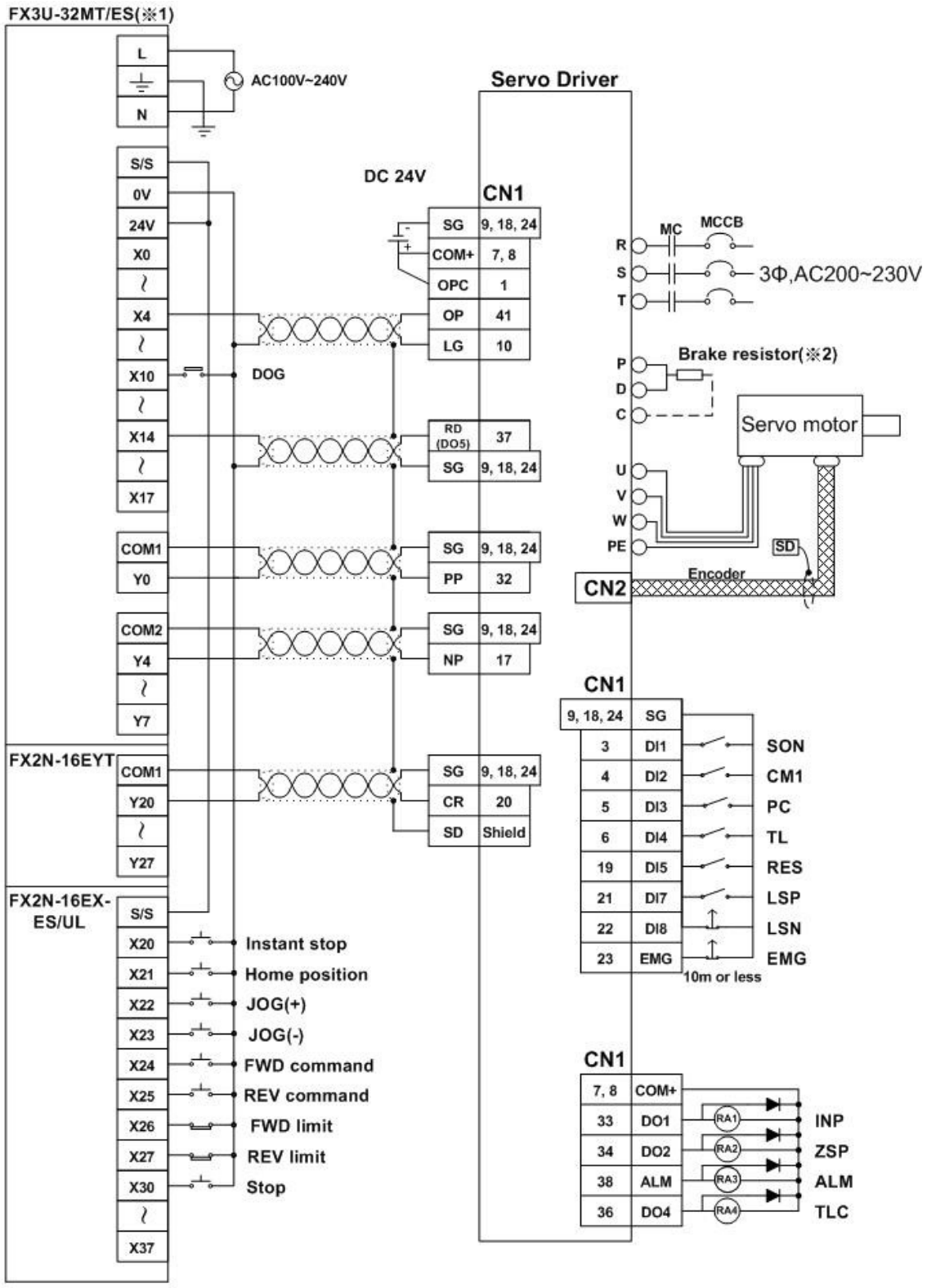
※1. A(F)X2N-10GM default is negative logic, forward/reverse rotation pulse train. The PA13 should be set as 0010h.
※2. See Section 3.1.2 for the wirings of brake resistor.

3.6.7. 20GM wiring diagram



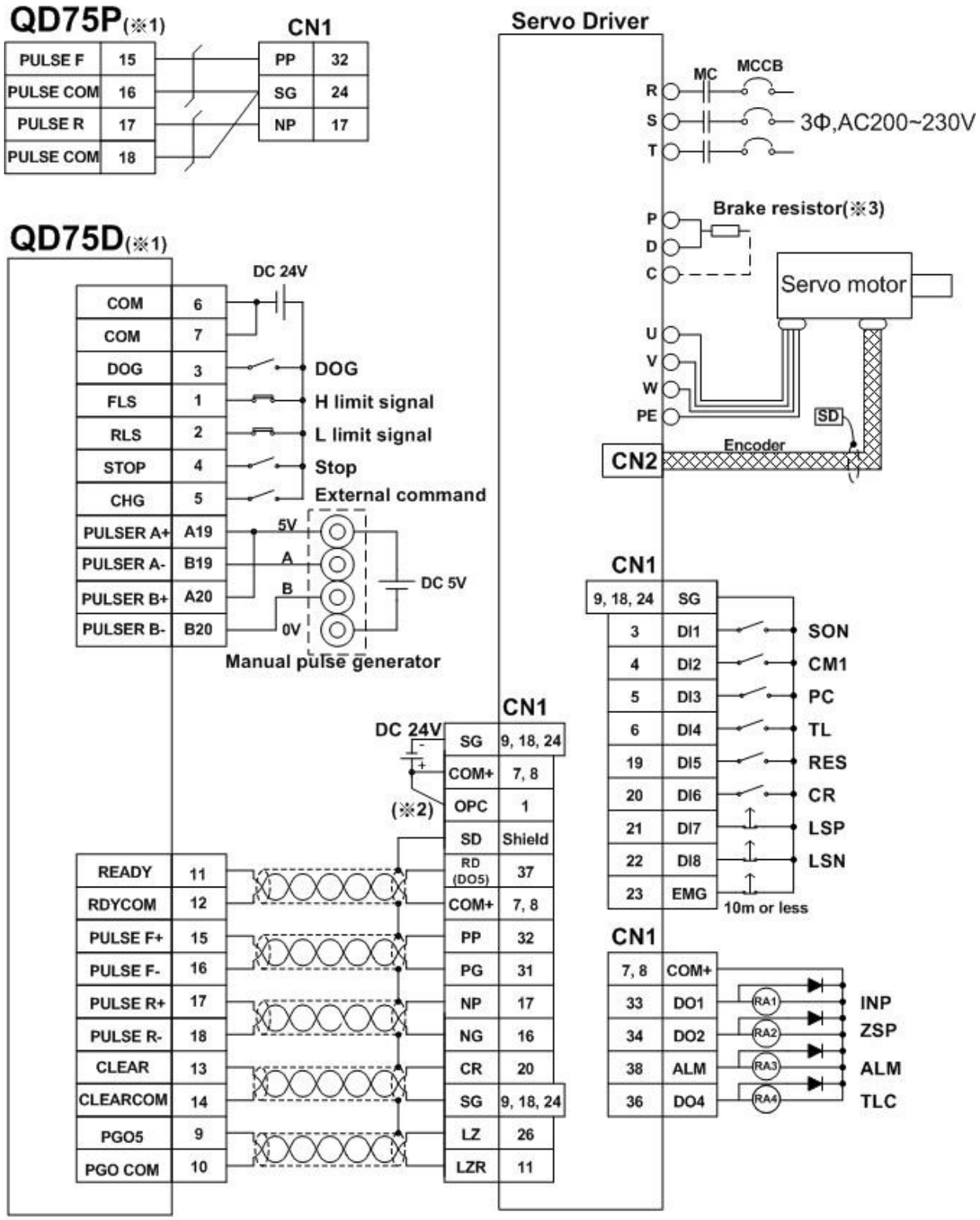
※1. A(F)X2N-20GM default is negative logic, forward/reverse rotation pulse train. The PA13 should be set as 0010h.
※2. See Section 3.1.2 for the wirings of brake resistor.

3.6.8. FX3U wiring diagram



※1. FX3U-MT default is negative logic/pulse train + sign. The PA13 should be set as 0010h.
(A(F)X-1N/2N-MT and FX3G-MT are in the same description mentioned above.)
※2. See Section 3.1.2 for the wirings of brake resistor.

3.6.9. QD75 wiring diagram

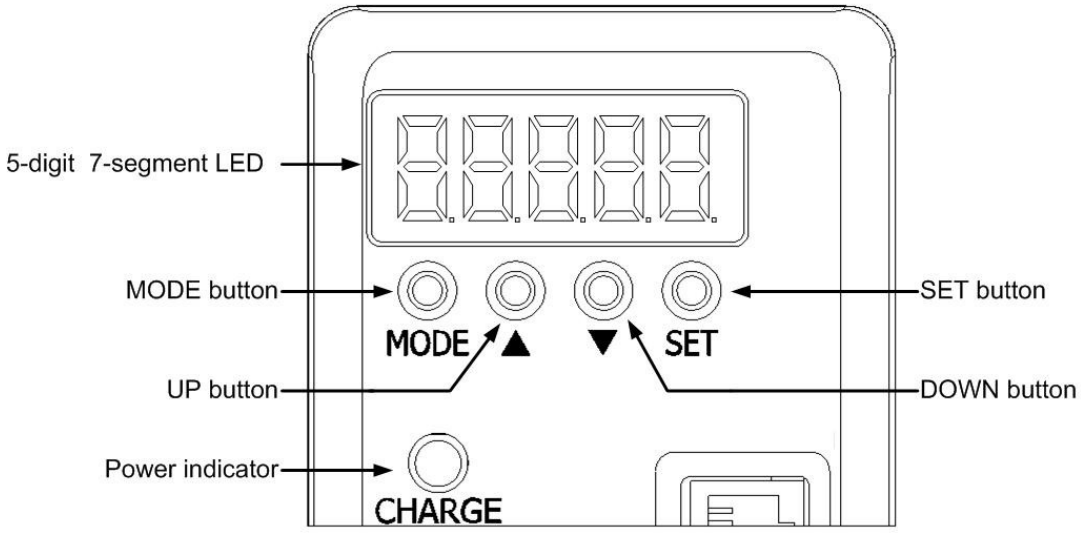


※1. When QD75D/QD75P default pulse command is used, The PA13 should be set as 0000h.
※2. When QD75D is applied, OPC is without providing power.
※3. See Section 3.1.2 for the wirings of brake resistor.

4. Display and operation

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

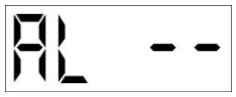
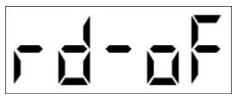
4.1.Summary



Name	Function description
5-digit 7-segment LED	Used to monitor the servo driver status, alarm, parameter setting, etc.
MODE button	1. To switch one display mode to others. 2. When parameter setting performed, this button is used as "shift" function.
UP button	Display or data scrolling.(Increasing)
DOWN button	Display or data scrolling.(Decreasing)
SET button	Display or data determination
Power indicator	To indicate the power source status.

4.2. Display flowchart

Press "MODE" button once to shift to next display. Refer to section 4.3 and later for related display. To read or set the extension parameters, make them valid with PA42.

Display process	Initial Screen	Function description	Reference
Status display		Servo status display. The initial message 「FbP 」is shown at power-on.(*)	Section 4.3
Alarm		Current alarm and history records are displayed.	Section 4.4
Diagnosis		Sequence display, external signal display, DO forced output, test operation, inertia estimation, VC automatic offset, software version display.	Section 4.5
Basic parameters		Display and setting of basic parameters.	Section 7.3
Gain/Filter parameters		Display and setting of Gain/Filter parameters.	
Extension parameters		Display and setting of extension parameters.	
I/O setting parameters		Display and setting of I/O setting parameters.	

MODE

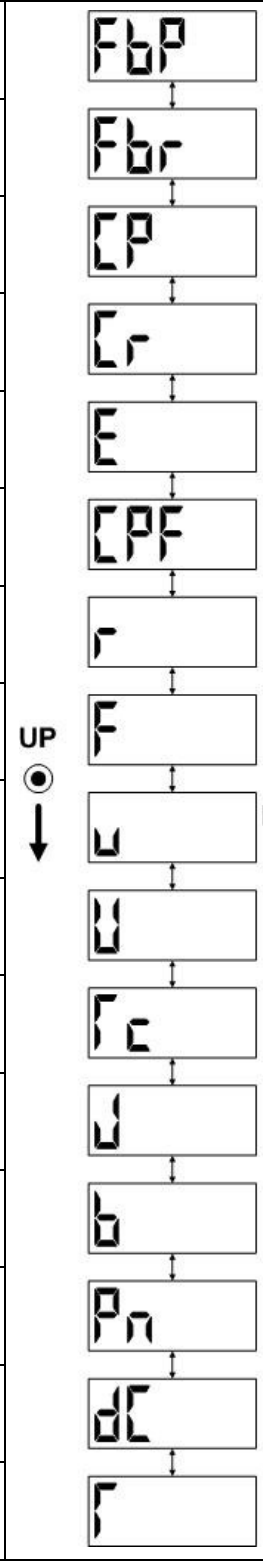
NOTE :

The initial message at power-on will be varied according to the setting of PA01.

4.3.Servo status display

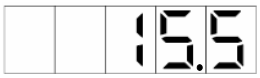
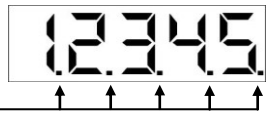
The servo status during operation is shown on the 5-digit, 7-segment LED . Press the "UP" or "DOWN" button to change display data. When the required data is selected, the specified symbol is displayed. Press the "SET" button to display the information.

⊡ List of status display

Status data	Display transition	Description	Range
Cumulative feedback pulses [pulse]		Feedback pulses from the motor encoder are counted and displayed.(cumulated value)	-9999 ~9999
Cumulative feedback turns [rev]		Feedback revolutions from the motor encoder are counted and displayed.(cumulated value)	-32767 ~32767
Cumulative command pulses [pulse]		The external command pulses are counted and displayed.	-9999 ~9999
Cumulative command turns [rev]		The external command turns are counted and displayed.	-32767 ~32767
Accumulative pulses error [pulse]		The difference between command pulses and cumulative feedback pulses.	-32767 ~32767
Command pulse frequency [Hz]		The frequency of external command pulse is displayed.	-800 ~800
Motor speed [rpm]		The speed of servo motor is displayed.	-6000 ~6000
Speed command voltage/ Speed limit voltage [V]		S : Speed analog command is displayed. T : Speed analog limit is displayed.	-10.00 ~10.00
Speed input command/ Speed input limit [rpm]		S : Speed input command is displayed. T : Speed input limit is displayed.	-6000 ~6000
Torque command voltage/ Torque limit voltage [V]		Pt,S : Torque analog limit is displayed. T : Torque analog command is displayed.	**0~ +10** **-10.~ +10**
Torque input command/ Torque input limit [rpm]		Pt,S : Torque input limit is displayed. T : Torque input command is displayed.	**0~ 300** **-300~ 300**
Effective load ratio [%]		Continuous effective load current relative to the rated current is displayed.	0~ 300
Peak load ratio [%]		The highest value in the past 15 seconds relative to the rated current is displayed.	0~ 300
DC bus voltage [V]		The P-N voltage of main circuit is displayed. “Lo-dC” is shown if voltage insufficient.	0~500
Load to motor inertia ratio [multiplier]		The ratio of load inertia to the servo motor shaft is displayed.	0.0 ~300.0
Instantaneous torque [%]		The Instantaneous torque value is displayed relative to the rated torque of 100%.。	0~100

⊡ Display examples

The following table lists the display examples.

Item	Status	Displayed data
Motor speed	Forward rotation at 2500r/min	
	Reverse rotation at 3000r/min	
Load to motor inertia ratio	15.5 times	
Cumulative feedback turns	11252 turns	
	-12345 turns	 To light the 5 decimal points if 「-」 symbol could not be displayed.
parameter setting accomplished	a successful EEPROM write-in	
parameter setting failed	a failed EEPROM write-in	

NOTE :

1. A negative value which occupies 5 digits is displayed by the 5 lit decimal points.
2. A negative value which occupies only 4 digits or less, the negative symbol "-" is displayed at the highest digit

⊡ Changing the status display screen

Change the PA01 setting, 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 below.

Control mode	Status display at power on
Position	Cumulative feedback pulses
Position/speed	Cumulative 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 / cumulative 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 04」.
		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:

(1) Any mode screen could display the current alarm.

(2) The other screen could be viewed during the occurrence of an alarm.

(3) Remove the cause of the alarm and clear it by one of the following methods:

(a) Switch the power OFF, then ON.

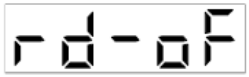
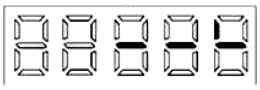
(b) Press the “SET” button on the current alarm screen.

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

(4) Move to the next screen 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. 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.
Test mode	JOG trial run		JOG trial run could be executed as no command from the external command device. For details, refer to section 5.2.1.
	Position trial run		Position trial run 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.
	Load inertia estimation		This operation could executed the estimation ratio of the motor shaft to the load or related gain values. 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 will be automatically adjusted to the offset voltage. Please follow the steps to operate: (1). Press the " SET" button once. (2). Press the "UP" or "DOWN" button and select 1. (3). Press the "SET" button.
Software version			Indicates the software version of the driver.

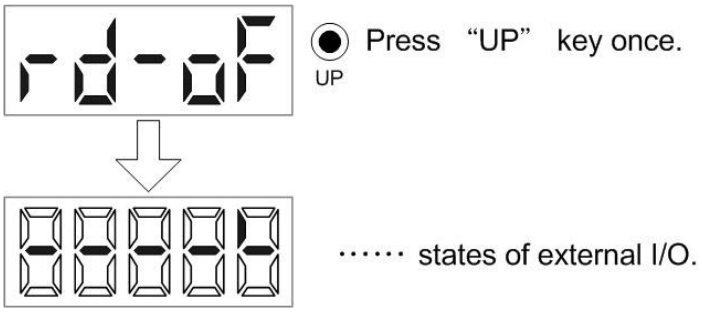
The applications of diagnostic display are described as follows.

4.5.1. Indication of external I/O signals

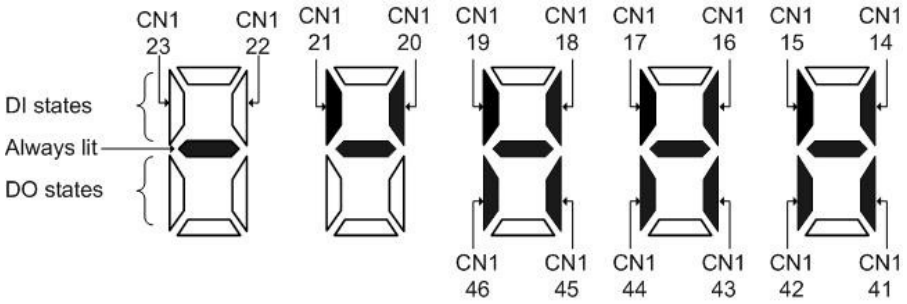
This display is used to verify the ON/OFF states of digital I/O signals connected to the driver.

(1) Operation

After power-on, to press " MODE" button to show the diagnostic screen.



(2) I/O signal status display



The 5-digit LED display indicates the ON/OFF status of DI and DO. The top segments indicate the input signal and the bottom segments indicate the output signal.

4.5.2. DO forced output

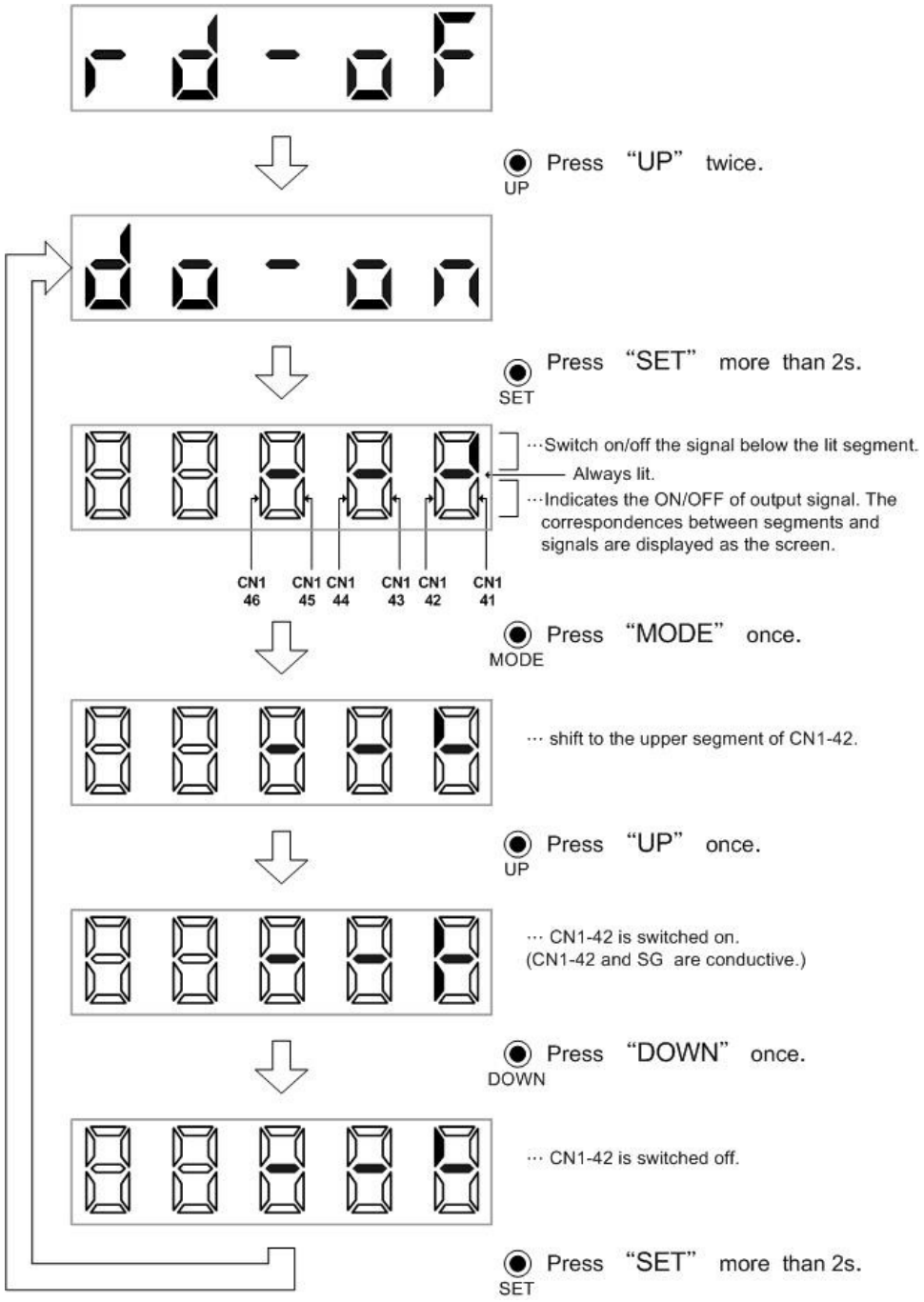
The output signals could be forced on/off and it does not affect the status of servo driver. This function is used for output signal wiring check, etc.

NOTE :

1. Without external command nor any alarm occurred, it could be executed.
2. Do not perform this operation until the driver turned off (SON-SG is off).

Operation

Call this screen after power-on. Press “MODE” button to show this diagnostic screen:

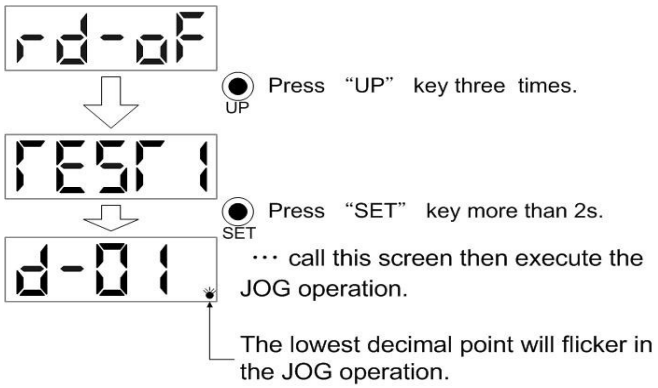


4.5.3. JOG trial run

NOTE :

1. Without external command nor any alarm occurred, it could be executed.
2. Do not perform this operation until the driver turned off (SON-SG is off).

Set JOG speed by the PC04, set acceleration time by the PC01, and set deceleration time by the PC02. Call the display screen after power-on, select JOG trial run, position trial run and load inertia estimation by the following steps.
Press “MODE” button to go to the diagnostic screen.



(1) Operation

Press “UP” or “DOWN” button to run. Release it to stop. Use the communication software to change the operation conditions. Initial conditions and setting ranges are listed below.

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

Icon functions are described as follows.

Icon	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 trial run by using the communication software, the servo motor will be decelerated to stop.

(2) Status display

Use “UP” and “DOWN” buttons to perform JOG operation. Each press of “MODE” button will show the next status screen. After an entire cycle, screen of JOG trial run ready is returned. More details related to the status display could be found in Section 6.2.

(3) JOG trial run completed

Power off or press "SET" button for more than 2 seconds to terminate the JOG trial run.

4.5.4. Position trial run

NOTE :

1. The Shihlin communication software is required to perform the position trial run.
2. Without external command nor alarm occurred, it could be executed.
3. Do not perform this operation until the driver turned off (SON-SG is off).
4. The motor will stop immediately if the communication cable is disconnected.

Operation

Press “Forward” or “Reverse” to rotate the motor which will then stop after moving the command route set by the user. The initial values and setting ranges are listed below.

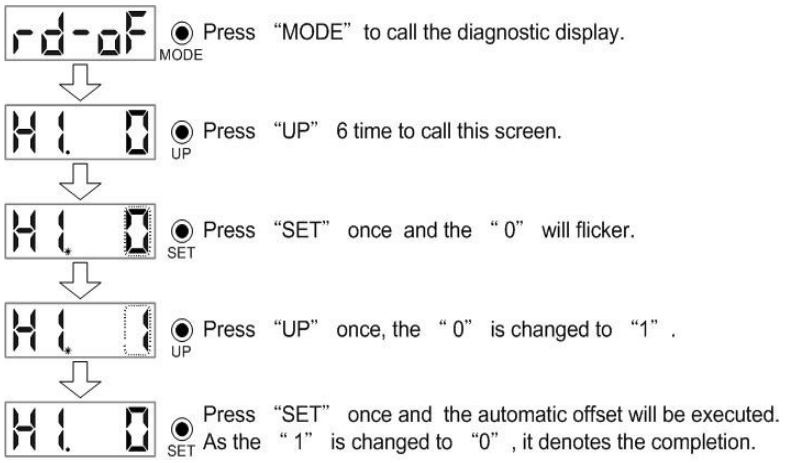
Operation item		Initial value	Setting range
Rotary speed [r/min]		200	0~6000
Acceleration/deceleration time constant [ms]		1000	0~20000
Command route	Revolution [rev]	10	0~30000
	pulse	0	0~9999

Description of the icon.

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

4.5.5. Automatic offset of analog command input

When the external speed analog command input is 0V, there may be a offset voltage which causes a slow motor rotation. The user could compensate this bias with automatic offset function in the diagnostic display mode.



After automatic offset completed, the compensation value is written into the PC26.

4.5.6. Load inertia estimation

NOTE :

1. The Shihlin communication software is required to perform load inertia estimation.
2. Without external command nor alarm occurred, it could be executed.
3. The PA02 should be set as 0000h.(manual gain tuning mode)

Operation

The relevant parameters are listed below.

(1) Make sure the motor is wired correctly before this load inertia estimation.

(2) Without alarm occurrence, enable “Auto tuning control panel”.

(3) Set acceleration/deceleration constant, S-pattern smoothing, JOG speed; if necessary.

(4) Press the “Servo ON” button and then the motor is magnetized.

(5) Press “JOG forward” or “JOG reverse” to run the servo motor in CCW or CW.

(6) Press “Position 1” and “Position 2” to set the proper route.(revolutions and pulses)

(7) Press “Start” to execute load inertia estimation. It takes several minutes to compute the load inertia and control gain. Then press “Stop” to quit this operation.

(8) Disable “Auto tuning control panel” and the estimation results would be saved.

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 calculates load to motor inertia ratio and the bandwidth of the system. 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,S,T
Position feed-forward gain	FFC	PB05	0~20000	0.0001	0	Pt
Load to motor inertia ratio	GD1	PB06	0~1200	0.1time	10	Pt,S
Position loop gain	PG1	PB07	4~1024	rad/s	35	Pt
Speed loop gain	VG1	PB08	40~4096	rad/s	817	Pt,S
Speed integral gain	VIC	PB09	1~1000	ms	48	Pt,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 load to motor inertia ratio, they could also set the bandwidth value desired to calculate the optimum value for controller.

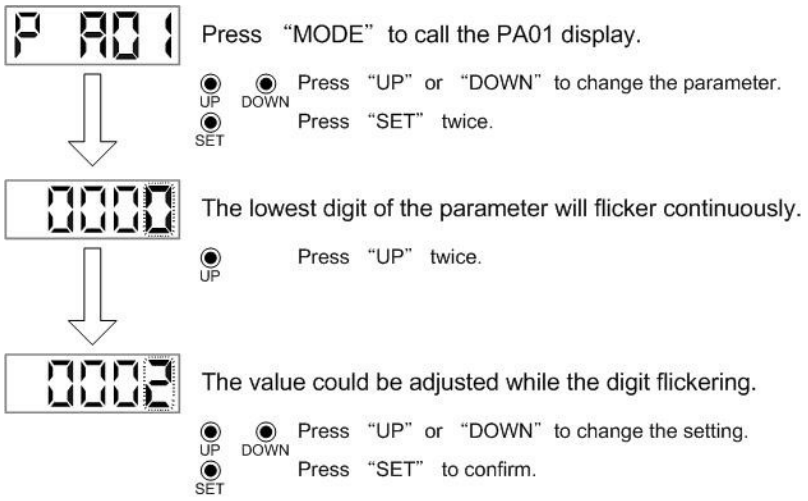
4.6.Parameter display

Some parameter modification are valid after driver power off once and power on again.

Operation

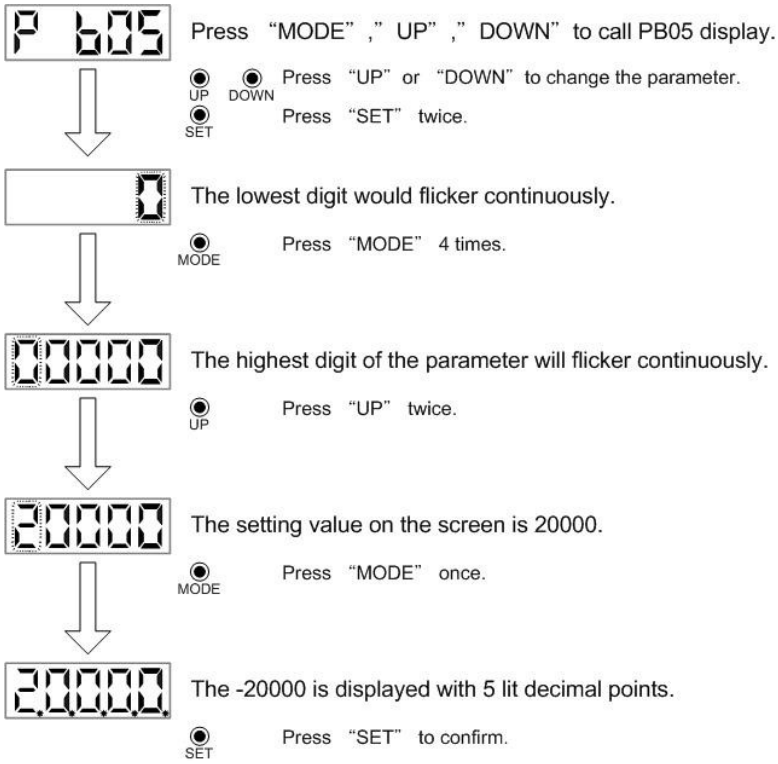
Here are 2 examples. One is the control mode(PA01) changed. The other is the usage of “MODE” button which is switched to “shift” function.

Example 1: Change the PA01 to speed control mode.



The change of PA01 setting is valid after power off once and power on again.

Example 2: Switch the usage of “MODE” button to the “shift” function.(PB05 as a case)



5. Operation

5.1. Checklist before operation

To avoid an electric shock or unexpected operation, please check the followings before starting the operation.

⚠ DANGER

- Operate the power switches with dry hand to prevent an electric shock.
- Do not attempt to wire the servo driver and motor until they have been installed. Otherwise, you may get an electric shock.

⚠ CAUTION

- Be sure that R/S/T power lines are wired correctly.
- The U/V/W terminals of motor and the U/V/W wires of servo driver need to be consistency.
- Make sure that there is no conductive or inflammable materials inside the driver or close to the driver.
- Make sure that 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 the top of servo driver or the wires.
- Use the twisted lines for the wiring of the regenerative resistor.
- Check if there is any apparent damage on the exterior of the driver.

5.2.Idle operation

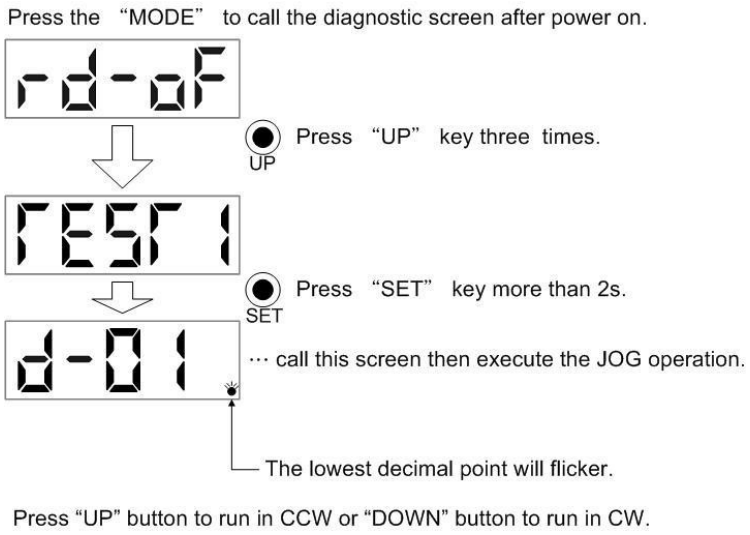
Please decouple the machinery load before this operation. Follow the regular instruction to run motor normally then couple with user's machine again. It is explained as follows.

5.2.1. JOG idle test

NOTE :

1. Without alarm nor warning occurred, this JOG idle test could be performed.
2. Be sure that SON-SG is open before this operation.
3. With panel operation or Shihlin communication software to perform this idle test.

To perform JOG idle test to check the speed and direction of the motor as expected. If speed command has to be changed, 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.



If Shihlin communication software is applied, some operation conditions could be changed.

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

The icon functions are described as follows.

Button name	Description
UP	Press to run servo motor in CCW rotation.
DOWN	Press to run servo motor CW rotation.
STOP	Press to stop servo motor running.
CLOSE	Quit this JOG idle test.

To terminate JOG idle test, please turn off the power or press "SET" button more than 2 seconds in 「d-01 .」screen.

5.2.2. Positioning idle test

To perform positioning idle test with 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 example, a route of 10.5 turns is composed of “10” revolutions and “5000” pulses. The operation steps are described below.

Step 1 : Wire the servo driver and motor correctly then turn on the power.
Step 2 : Connect PC and CN4 of servo driver with the standard mini USB cable. Execute Shihlin communication software and select the proper device number.
Step 3 : Select “TESTING/POSITIONING TESTING” to enter position trial run screen.
Step 4 : Set the revolution and pulse. Press “Forward” to run in CCW to complete the distance. Or press “Reverse” to run in CW to reach the target position.

The initial conditions and setting range are as follows.

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

The icon functions are described as follows.

Button name	Function description
FORWARD	Press to run positioning idle test in CCW until the command route done.
REVERSE	Press to run positioning idle 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 idle test.

Step 5 : When positioning idle test is completed, press “CLOSE” to return the last window of Shihlin communication software.

5.3. Gain tuning process

5.3.1. Abstract

With auto-gain tuning, the load inertia and control gain could be computed precisely. Manual tuning is applied to suit for user's special operation or mechanical system.

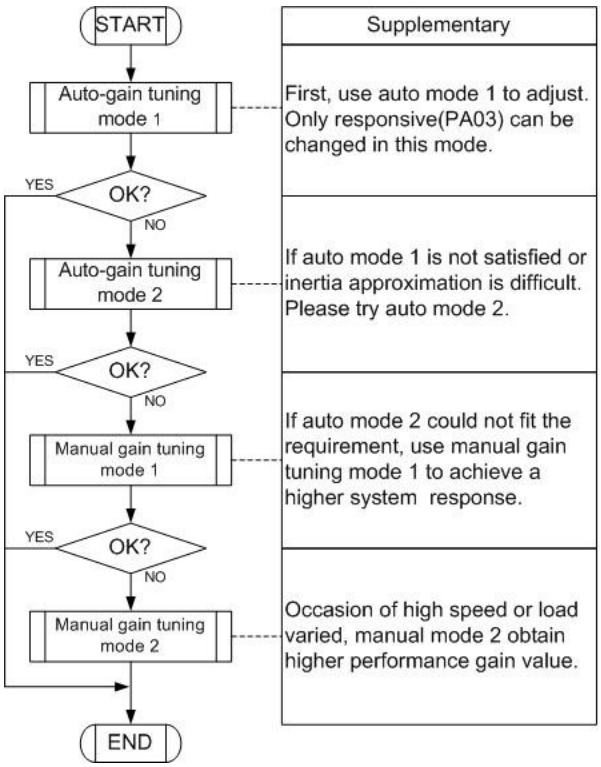
Gain tuning mode is explained in the following table.

Gain tuning mode	PA02 setting	Estimation rule	Automatically set parameter	Manually set parameter
Manual gain tuning mode 1 (PI control)	0000h	PB06 fixed		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	PB06 fixed	PG1 (PB07) VG1 (PB08) VIC (PB09)	ATUL(PA03) GD1(PB06)

NOTE :

1. The PA02 is not writable if SON-SG is conductive.
2. During manual gain tuning, reduce gain value if the mechanical system is instable. sure that SON-SG is open before this operation.

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



5.3.2. Auto-gain tuning mode

Auto-gain tuning mode could calculate the load to motor inertia ratio instantaneously. With this value, the optimum gain could be decided under the current mechanical condition. It is convenient to execute the auto-gain tuning function.

5.3.2.1. Auto-gain tuning function

(1) Auto-gain tuning mode 1

The default of PA02 is 0002h, the load inertia ratio is approximated continuously and the servo gain value is automatically set.

The relevant parameters and their settings are described below.

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

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

(a) The acceleration time from 0 to 2000rpm or the deceleration time from 2000rpm to 0 should be 1 second or less. If a 3000rpm case is applied, the acceleration and deceleration time should be 1.5 seconds or less.

(b) The speed command of the motor should be 300rpm or higher.

(c) The load to motor inertia ratio should be 100 times or less.

(d) The machinery system with a violent change of load inertia is not suitable.

(2) Auto-gain tuning mode 2

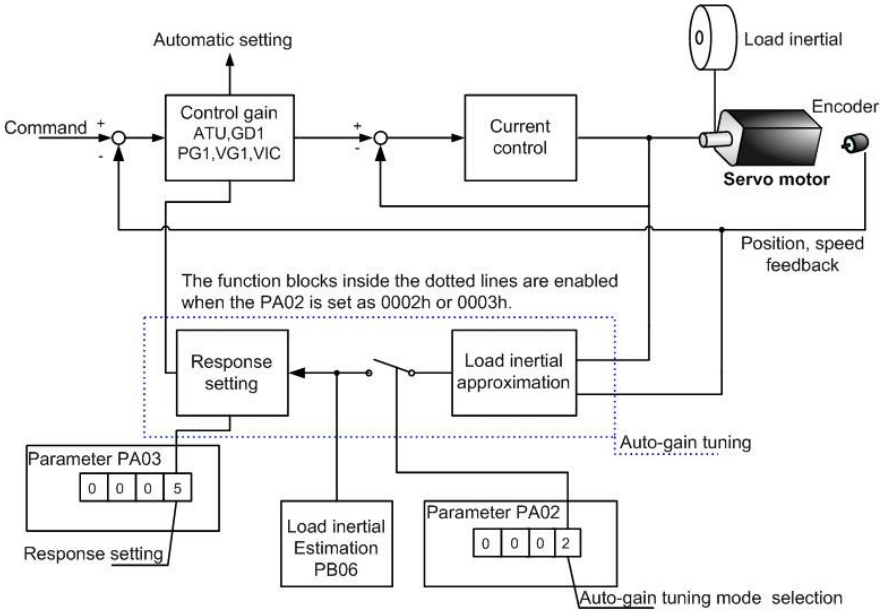
The value of PA02 is set as 0003h when auto-gain tuning mode 1 is not satisfied the accurate approximation of load inertia, the auto-gain tuning mode 2 is recommended. to perform this mode. During the tuning process, load to motor inertia ratio will not be approximated and users have to write manually the value into PB06 by themselves.

The relevant parameters and their settings are described below.

Parameter	Abbreviation	Parameter name	User adjustable or auto-presumed
PA03	ATUL	Auto-tuning response level setting	User adjustable
PB06	GD1	Load to motor inertia ratio	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. Flow of auto-gain tuning

The flow of auto-gain tuning mode is presented below.

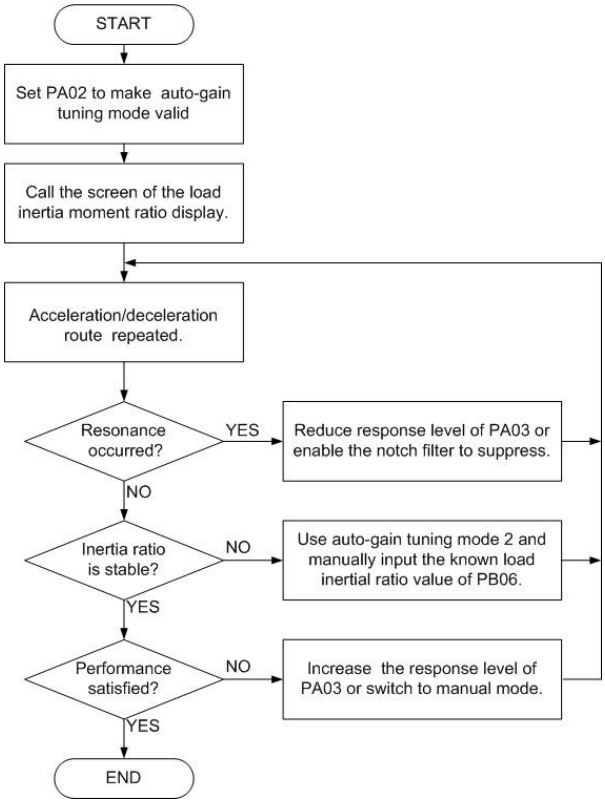


When auto-gain tuning mode is performed, the following steps should be satisfied.

(1) As mode 1 executed, run the acceleration/deceleration routes to approximate the load to motor inertia ratio. The PB06 will be updated a new value every 6 minutes.

(2) If the PB06 is known or proper gain cannot be made, please use mode 2 and manually set the known PB06. With this mode, the control gain estimation will still be computed.

(3) After setting load to motor inertia ratio and response level, the driver will find optimum gains during the acceleration/deceleration route. The result value will be updated into EEPROM. The saved new value will be used as the initial value for duty operation.

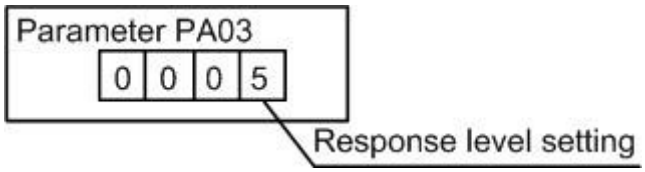


5.3.2.3. Response level setting

The PA03 is related to the response level of servo driver and motor. As the PA03 setting is increased, the traceability time and settling time decreased, but a too high level setting will generate vibration. Therefore, keep setting until the optimum response is obtained within the range without vibration.

If a response level setting which user desired causes 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 load to motor inertia ratio
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	

NOTE :

1. For the response level setting, it is recommended to increase the value gradually. It is probable to make resonance if the initial value is too high.
2. The applicable load to motor inertia ratio is a reference. The actual range is varied with the different mechanical systems.

5.3.3. Manual gain tuning mode

The manual gain tuning mode is applied as the result of auto-gain tuning is not suitable for the user's demand.

Adjustment of manual mode

For position control or speed control, bandwidth is highly related with machinery rigidity and structure. A machine tool with high precision required, higher response is necessary. However, a high response level setting could cause machine resonance easily. Therefore, occasions that require high response need a high rigidity machine to avoid resonance.

If users have no idea about response level setting, 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,S,T
Position feed-forward gain	FFC	PB05	0~20000	0.0001	0	Pt
Position loop gain	PG1	PB07	4~1024	rad/s	35	Pt
Speed loop gain	VG1	PB08	40~4096	rad/s	817	Pt,S
Speed integral gain	VIC	PB09	1~1000	ms	48	Pt,S
Speed feed-forward gain	VFG	PB10	0~20000	0.0001	0	Pt,S

- 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 will be increased. Thus, resonance suppression low-pass filter is used to eliminate the resonance. The higher setting value affords a better improvement about high frequency noises. But 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.

$$VIC\ setting\ value(mS) \geq \frac{3000\sim5000}{VG1\ setting\ value / (1+ GD1\ setting\ value \times 0.1)}$$

- Position feed-forward gain(FFC)

  Used to reduce position error and settling time, but a too large value will cause overshoots when a sudden acceleration or deceleration performed. Also, a too large electronic gear ratio will cause noises.

- Position loop gain(PG1)

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

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

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

- Speed loop gain(VG1)

  This parameter determines the response level of the speed loop. 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 will be occurred easily.

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

- Speed integral gain(VIC)

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

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

- Speed feed-forward gain(VFG)

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

5.4. Parameters and operation for position control mode

(1) Power on

Make SON-SG open after power on. The display panel will show  .

(2) Trial run

Confirm the running status of servo motor with JOG trial run.

(3) Parameters setting

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	Electronic gear numerator	1	Set the numerator as “1”
PA07	Electronic gear denominator	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 power of control board.(L1,L2)

(b) Make SON-SG short-circuit.

As SON is activated, the servo driver is ready to run and the motor shaft is not rotatable.

(5) Forward/Reverse rotation pulse train

If the position commands are open collector type, PP and NP are used as input terminal. If the line driver signals are applied, use PP-PG or NP-NG terminals. Auto-gain tuning function or controller gain manual input to run but avoid machine resonance. To adjust the PA03 to obtain the optimum speed response.

(6) Stop

One of the following steps will make servo motor stop running.

(a) Make SON-SG open-circuit

The shaft of motor becomes rotatable.

(b) Alarm occurrence

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

(c) EMG signal activated

Same actions mentioned above but the ALM message is displayed.

(d) LSP or LSN signal is off

If LSP or LSN signal is off, the servo motor stops running due to dynamic brake.

5.5. Parameters and operation for speed control mode

(1) Power on

Make SON-SG open after power on. The display panel will show  .

(2) Trial run

Confirm the running status of servo motor with JOG trial run.

(3) Parameters setting

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 power of control board.(L1,L2)

(b) Make SON-SG short-circuit.

As SON is activated, the servo driver is ready to run and the motor shaft is not rotatable.

(5) Start

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

External input signal		Speed command
SP2	SP1	
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 ST1 and ST2 signals. Options are listed 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 open-circuit with SG, “1” denotes short-circuit with SG. “-“ is servo locked.

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

(6) Stop

One of the following steps will make servo motor stop running.

(a) Make SON-SG open-circuit

The shaft of motor becomes rotatable.

(b) Alarm occurrence

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

(c) EMG signal activated

Same actions mentioned above but the ALM message is displayed.

(d) LSP or LSN signal is off

If LSP or LSN signal is off, the servo motor stops running due to dynamic brake.

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

5.6. Parameters and operation for torque control mode

(1) Power on

Make SON-SG open after power on. The display panel will show  .

(2) Trial run

Confirm the running status of servo motor with JOG trial run.

(3) Parameters setting

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 power of control board.(L1,L2)

(b) Make SON-SG short-circuit.

As SON is activated, the servo driver is ready to run and the motor shaft is not rotatable.

(5) Start

Choose the speed limit with SP1 and SP2 signals. RS1 activated makes the motor run in CCW. RS2 activated makes the motor run in CW. Use a low speed limit to prevent motor from accelerating suddenly at first. If the sequence is unexpected, check if the wirings is proper or not.

(6) Stop

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

(a) Make SON-SG open-circuit

The shaft of motor becomes rotatable.

(b) Alarm occurrence

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

(c) EMG signal activated

Same actions mentioned above but the ALM message is displayed.

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

6. Control function

6.1. Control mode option

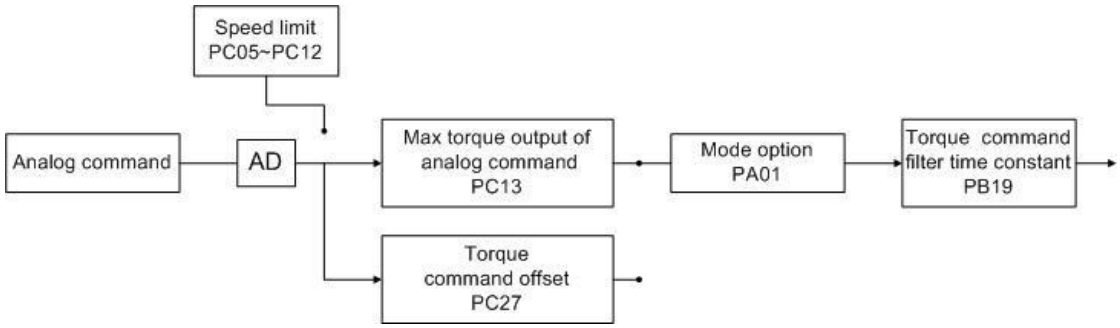
The are 3 single control mode for Shihlin servo driver : position control , speed control, torque control. The driver could be operated in single mode or hybrid mode. All control modes are described below.

Mode		Sign	PA01 setting	Description
Single mode	Position control	Pt	0000h	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
	Speed control	S	0002h	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	0004h	The driver receives the command to run the motor to generate the desired torque. The command source is the analog voltage.
Hybrid mode	Position/speed control	Pt-S	0001h	Pt/S is switched mutually via the LOP signal.
	Position/torque control	Pt-T	0005h	Pt/T is switched mutually via the LOP signal.
	Speed - torque control	S-T	0003h	S/T is switched mutually via the LOP signal.

(*)The modification of PA01 will 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 machines, etc. The torque command is analog voltage signals which control the output torque of servo motor. The torque control blocks are shown below.



Set the PA01 as 0004h to make torque control mode valid. The torque command is external analog voltage which range is ±10V. After A/D transformed, output limited, command offset process, the demand torque and speed will be outputted.

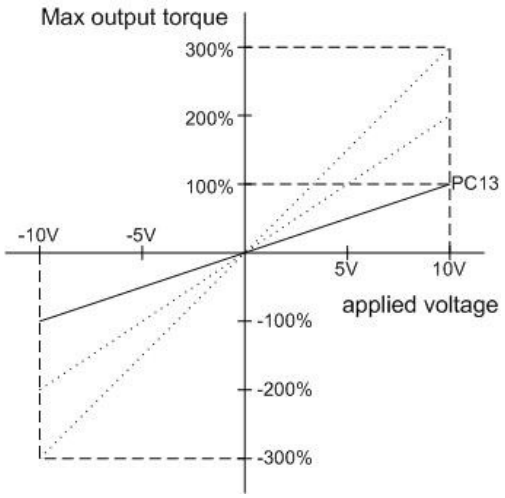
6.2.1. Output proportion of maximum torque analog command

It is a relationship of the applied torque voltage command and the torque generated.

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

Used to set the generated torque which its analog voltage command is at the maximum 10V.

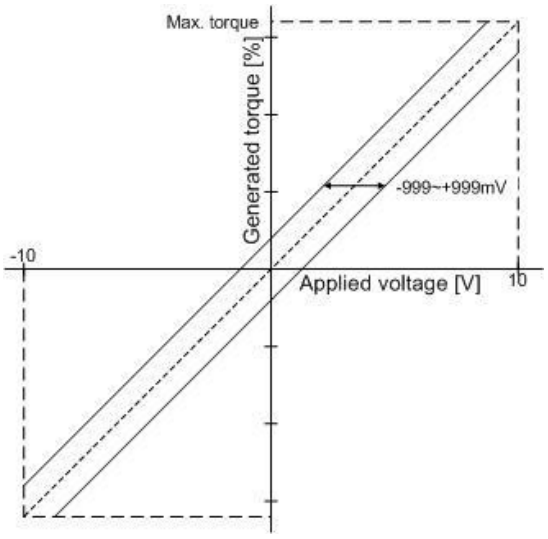
$$\textit{The generated torque(\%)} = \frac{\textit{applied voltage of torque command}}{10} \times \textit{the setting value of PC13}$$



6.2.2. Torque analog command offset

Compensates the bias to prevent servo motor jitter while the applied analog command is 0.

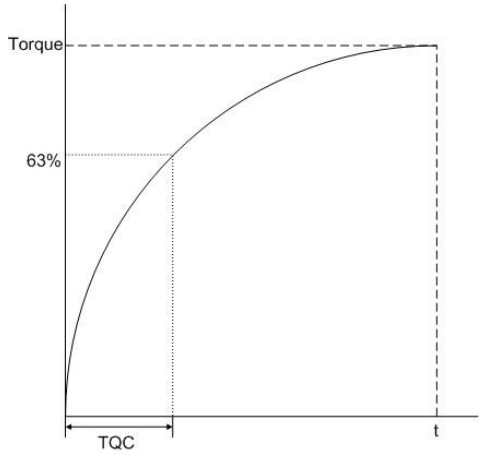
Name	Sign	Setting range	Unit	Initial value	Control mode
Torque analog command offset	PC27	-8000 ~8000	mV	0	S,T



6.2.3. Torque analog command smoothing

The servo motor could run smoothly when a violent changed torque command is applied.

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

PA 05, PC25 are used to limit the generated torque when torque control mode is performed.

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

The PC25 is usable only when one of 8 DI is set as 05h. There are 2 torque limit options.

DI signal status(*)	Description
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

When torque control mode is performed, various speed limits could be applied by the SP1, SP2, SP3 and the external analog signal. There are 8 combinations which are listed below.

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

NOTE :

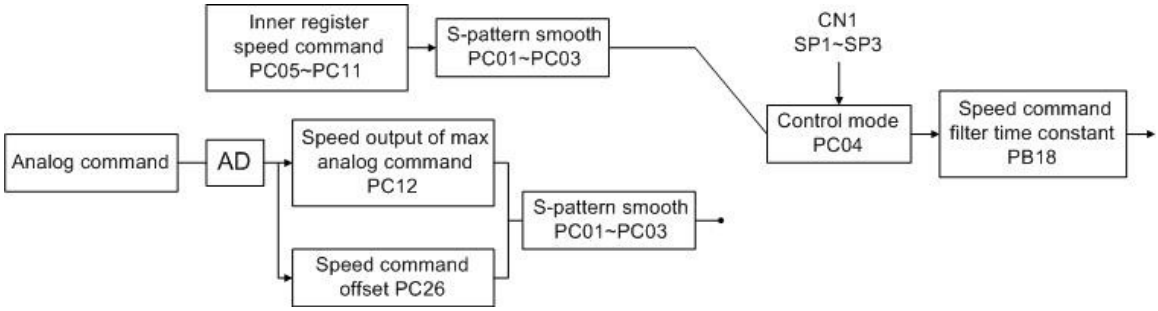
1. When external speed analog limit is applied, check the initial 0 voltage and PC12 value which are prohibited to exceed the motor's rated speed otherwise damages will be caused.
2. To make SP3 valid by setting PD02 to PD09 if the option SC4 to SC7 are used.

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 applied for occasions where is CNC machine, drilling machine, etc. Speed command is analog signal or inner command. The analog signal is the external voltage. The inner command is performed in 2 ways: (1)Use PC05 to PC11 for various commands and SP1, SP2, SP3 to change. (2)Use the communication software to modify speed command. The smooth S-pattern running prevents servo motor from discontinuity. The basic speed control blocks are shown as below.



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

6.3.1. Speed command option

There are 8 options for users to run servo motor in various speed commands.

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	-4500 ~ 4500	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	Related parameter
	VCM	0	0	0	Analog Command(VC)	±10V	PC12
	SC1	0	0	1	Inner speed command 1	-4500 ~ 4500	PC05
	SC2	0	1	0	Inner speed command 2		PC06
	SC3	0	1	1	Inner speed command 3		PC07
	SC4	1	0	0	Inner speed command 4		PC08
	SC5	1	0	1	Inner speed command 5		PC09
	SC6	1	1	0	Inner speed command 6		PC10
	SC7	1	1	1	Inner speed command 7		PC11

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

NOTE :

1. When external speed analog limit is applied, check the initial 0 voltage and PC12 value which are prohibited to exceed the motor's rated speed otherwise damages will be caused.
2. To make SP3 valid by setting PD02 to PD09 if the option SC4 to SC7 are used.

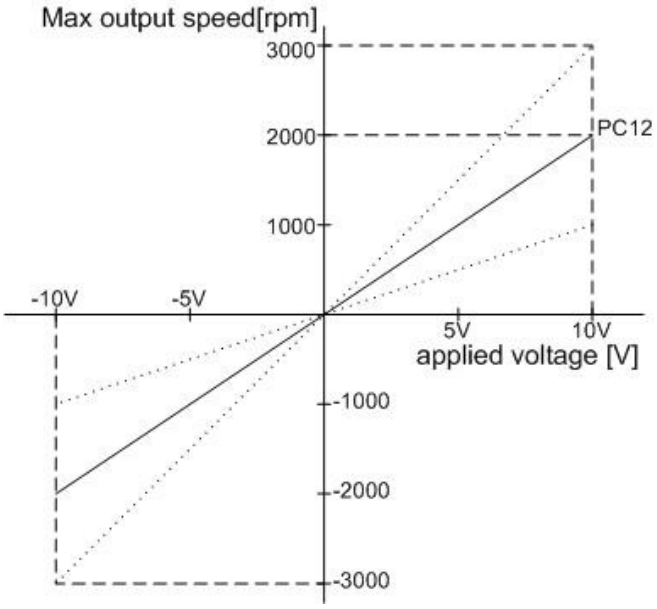
6.3.2. Output proportion of maximum torque analog command

It is a relationship of the applied speed voltage command and the output speed.

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

Used to set the output speed which its analog voltage command is the maximum 10V.

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



6.3.3. Speed analog command smoothing

If the speed command changed violently, vibration or noise or even overshoot may occurred. Users could use smoothing process to suppress those needless impacts. The acceleration time constant could be used to adjust the slope of speed pattern from static status to running status. The deceleration time constant could be used to adjust the slope from rotating state to static status. 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	S,T
Deceleration time constant [ms]	STB	PC02	0~20000	ms	200	S,T
S-pattern acc./dec. time constant [ms]	STC	PC03	0~20000	ms	0	S,T

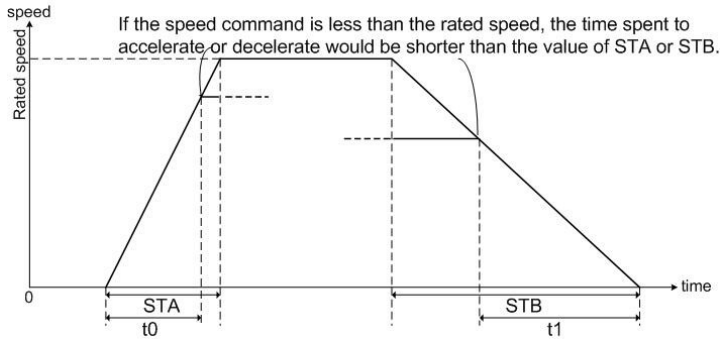
The relevant parameters will be described in detail as follows.

Acceleration time constant

Time spent for servo motor from 0 rpm to rated speed is called “acceleration time constant”. If motor rated speed is 3000 rpm and it is set as 3 seconds, motor accelerating from 0 rpm to 3000 rpm will take 3 seconds.

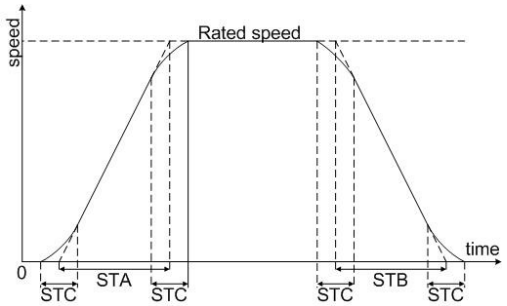
Deceleration time constant

Time spent for servo motor from rated speed to 0 rpm is called “deceleration time constant”. If motor rated speed is 2000 rpm and it is set as 4 seconds, motor decelerating from 1000 rpm to 0 rpm will take 2 seconds.



S-pattern acc./dec. time constant

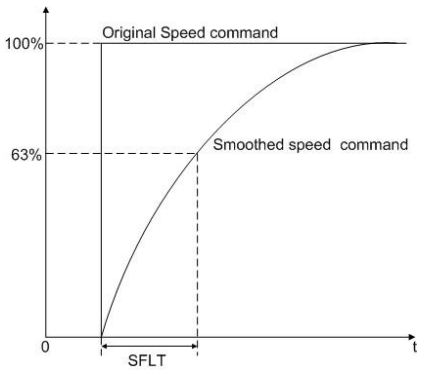
S-pattern acceleration/deceleration process is used to soothe vibration during starting or stopping the motor. Setting an appropriate STC could improve the stability of servo motor.



Low-pass filter smooth time constant

Larger value soothes speed command obviously but response slows down.

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



6.3.4. Torque limit of speed control mode

PA05 and PC25 are two relevant parameters for this torque limit function.

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

3 pin functions(1 analog voltage input and 2 DI inputs) are described below.

Pin/Signal name	Name Abbr.	Description	Control mode
Torque limit option	TL	TL is enabled by setting PD02~PD09. As TL-SG is open-circuit, inner torque limit 1(PA05) is valid, otherwise torque analog limit(TLA) is effective.	Pt,S
Torque analog limit	TLA	TL is enabled first then TLA is valid. As an analog voltage limit is applied, torque generated will be limited. The voltage range of TLA-SG is DC 0~10V. A maximum torque is generated at +10V.	Pt,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,S,T

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

DI signal status(*)		Valid torque limit value
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.

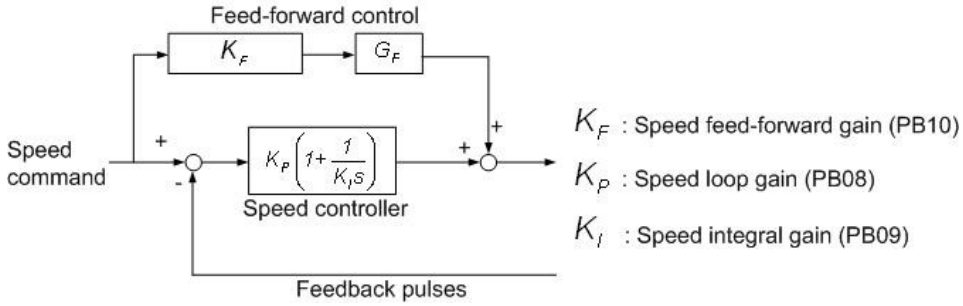
(*) 0: OFF(TL1-SG/TL-SG is open-circuit) ,1：ON(TL1-SG/TL-SG is short-circuit)

If torque generated fits the limit of PA05/PC25/TLA, DO signal TLC-SG is conductive.

DO signal name	Name Abbr.	Description	Control mode
Torque limiting control	TLC	TLC-SG is conductive when torque generated fits inner torque limit 1(PA05), or inner torque limit 2(PC25), or torque analog limit (TLA). TLC-SG is open-circuit when SON is off.	Pt,S

6.3.5. Speed control gain adjustment

There are some parameters related to inner speed control loop for users to adjust. Set the PA02 to use auto-gain tuning or manual-gain tuning. If auto-gain tuning is performed, the load inertia ratio will be approximated continuously and the control gain value will be set automatically. If manual-gain gain tuning is performed, users have to enter the proper load inertia ratio value and control gain value. The flow diagram is presented as follows.



Parameters and settings related of this mode are listed below.

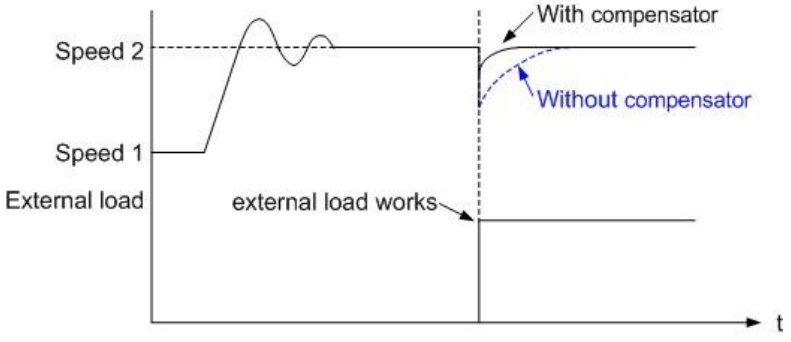
Name	Name Abbr.	Sign	Setting range	Unit	Initial value	Control mode
Gain tuning mode option	ATUM	PA02	0000h ~0003h	---	0002h	Pt,S
Auto-tuning response level setting	ATUL	PA03	0001h ~000Fh	---	0005h	Pt,S
Speed loop gain	VG1	PB08	40 ~4096	rad/s	817	Pt,S
Speed integral gain	VIC	PB09	1 ~1000	ms	48	Pt,S
Speed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

Auto-gain tuning mode

The proper gains will be tunes during acceleration/deceleration route. See section 5.3.2 .

Manual-gain tuning mode

Speed loop gain/speed integral gain/speed feed-forward gain are set manually to obtain a better operation when auto-gain tuning could not fit. An compensator which to reduce torque ripple and speed ripple is enabled if PA02 is 0001h. Occasions which load inertia ratio is greater than 10 times are not suitable for this compensator. The flow diagram is as follows.



Parameters for manual-gain tuning mode

Speed loop gain

Increasing the PB08 value improves the bandwidth of speed control loop, but a too large one will cause mechanism vibration. Increase it gradually and avoid mechanism vibration.

Speed integral gain：

Decreasing the PB09 value improves the low-frequency rigidity and reduce speed stability errors. But a too small one will cause phase delay and make an instable system.

Speed feed-forward gain

Proper PB10 value reduces the phase lag errors and increase the traceability. If the PB10 value is near 1, the dynamic tracking error will be very small and the pre-compensation will be the most completed. If the setting value is too small, the improvement is not obvious. But a too large value will cause the system vibration easily.

6.3.6. Resonance suppression filter

If the low rigidity system occurs resonance and its structure could not be modified, Shihlin servo driver provides 2 resonance filter, 4 parameters and 1 suppression low-pass filter for users to make improvement. Parameters for resonance suppression are listed below.

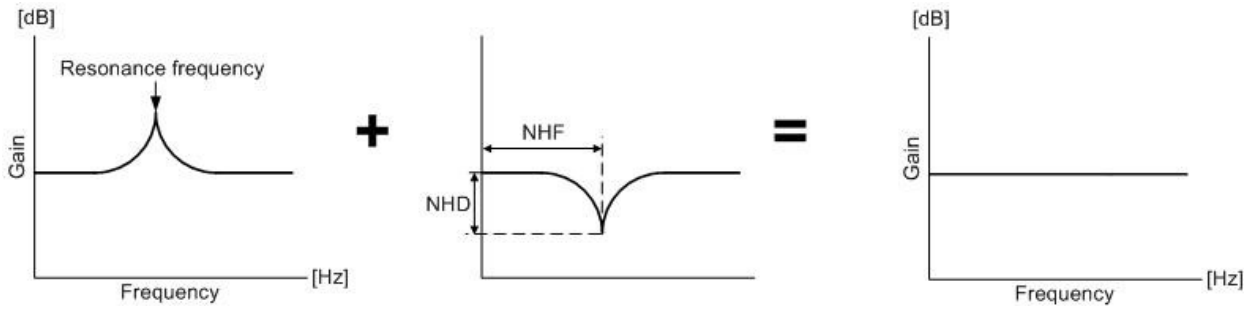
Name	Name Abbr.	Sign	Setting range	Unit	Initial value	Control mode
Machine resonance suppression filter 1	NHF1	PB01	50 ~1000	Hz	1000	Pt,S,T
Machine resonance suppression attenuation 1	NHD1	PB02	0 ~32	dB	0	Pt,S,T
Machine resonance suppression filter 2	NHF2	PB21	50 ~1000	Hz	1000	Pt,S,T
Machine resonance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

Machine resonance suppression filter

A specified frequency with attenuated gain is used to suppress the mechanism resonance.

Machine resonance suppression attenuation

Attenuation ratio of particular frequency to suppress the mechanism resonance. Non-zero value denotes the suppression filter enabled. The effect is plotted below.

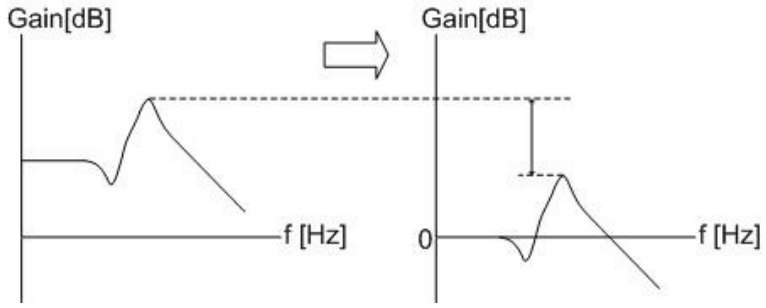


There is another resonance suppression low-pass filter and its function is described below.

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,S,T

Resonance suppression low-pass filter

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



It is obvious 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.

NOTE :

1. When this suppression filter is applied, to know the resonance frequency then to set the notch depth will make effect.
2. The improper frequency setting will not suppress resonance but amplify it.
3. If resonance frequencies are known, PB01/PB02/PB21/PB22 are recommended.
4. NLP is recommended when resonance frequency exceeds NHF setting range.

6.3.7. Control gain switch

Gain switch could be performed during the running or stop status of servo motor. The DI pins could be used as gain switch trigger. If this function is applied, the PA02 should be ”□□□0” or “□□□1”. Applicable occasions are listed below.

(1).The rotation noises of motor are loud due to the large gain value setting.

(2).The load to motor inertia ratio is changed violently during the running route.

(3).To improve the response or to shorten the settling time of the machinery system.

The relevant parameters and detail descriptions are described below.

Name	Name Abbr.	Sign	Setting range	Unit	Initial value	Control mode
Load to motor inertia ratio	GD1	PB06	0 ~1200	0.1time	10	Pt,S
Position loop gain	PG1	PB07	4 ~1024	rad/s	35	Pt
Speed loop gain	VG1	PB08	40 ~4096	rad/s	817	Pt,S
Speed integral gain	VIC	PB09	1 ~1000	ms	48	Pt,S
Gain switch option	CDP	PB11	0000h ~0004h	---	0000h	Pt,S
Gain switch condition value	CDS	PB12	0 ~6000	(*)	10	Pt,S
Gain switch time constant	CDT	PB13	0 ~1000	ms	1	Pt,S
Load to motor inertia ratio 2	GD2	PB14	0 ~1200	0.1time	70	Pt,S
Position loop gain change ratio	PG2	PB15	10 ~200	%	100	Pt
Speed loop gain change ratio	VG2	PB16	10 ~200	%	100	Pt,S
Speed integral gain change ratio	VIC2	PB17	10 ~200	%	100	Pt,S

(*) The unit (kpps, pulse, rpm) is depend on setting value of CDS.

Parameters related to gain switching are described below.

(1).GD1, PG1, VG1, VIC are changeable under this gain switch operation.

(2).Gain switch option CDP(PB11)

Enable the trigger condition at the lowest digit of PB11.

0	0	0	x

x=0：Invalid

x=1：CDP signal activated

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

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

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

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

PB11 setting value	Gain switch trigger condition	Unit
□□□2	Position command frequency is equal to higher than PB12 setting	kpps
□□□3	Position command pulse error is equal to higher than PB12 setting	pulse
□□□4	Motor speed is equal to higher than PB12 setting	rpm

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

Used to suppress motor vibration at the moment of gain switch.

(5).Load to motor inertia ratio 2 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 will be switched to the ratio values of PG2/VG2/VIC2 settings.

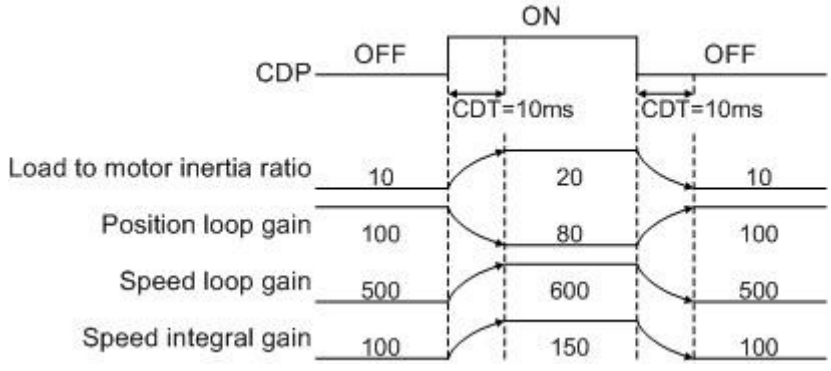
Some examples are shown below to explain the sequence of gain switch.

Example 1: CDP signal activated

①. Relevant parameters setting

Name	Name Abbr.	Sign	Setting value	Unit
Load to motor inertia ratio	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
Load to motor inertia ratio 2	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

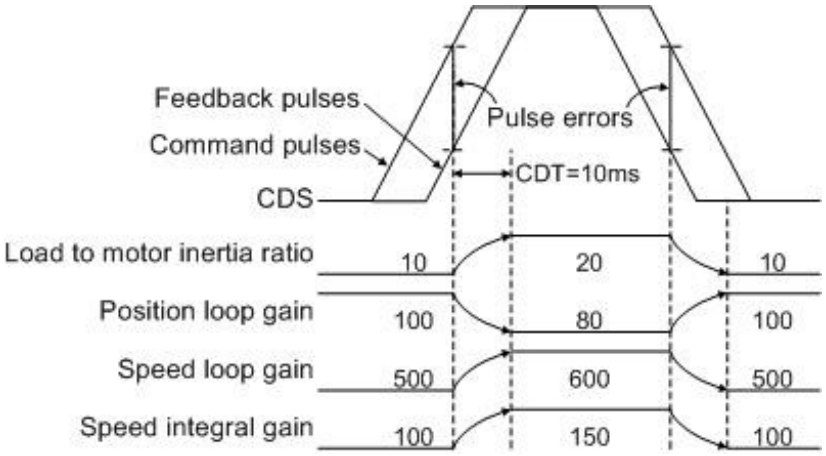


Example 2: Position command pulse error

①. Relevant parameters setting

Name	Name Abbr.	Sign	Setting value	Unit
Load to motor inertia ratio	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
Load to motor inertia ratio 2	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



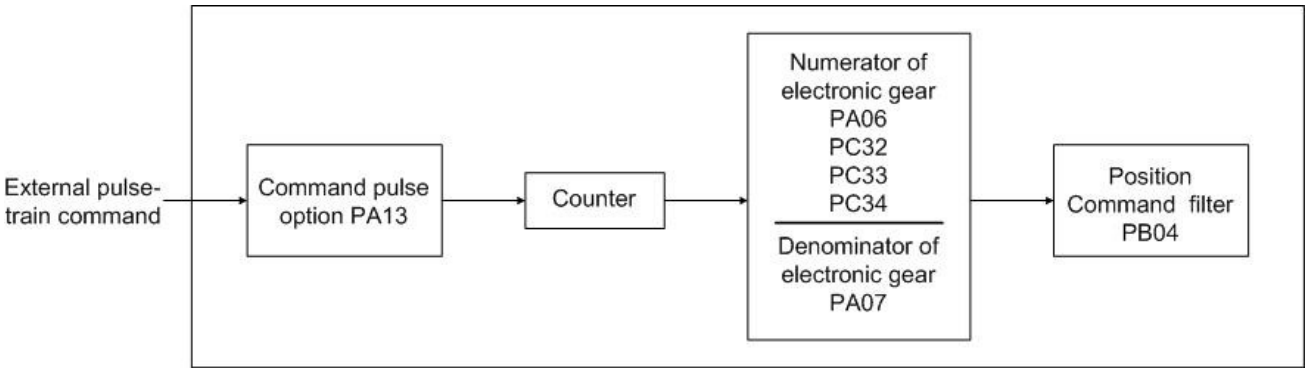
6.4.Position control mode

Occasions such as machine tools and CNC machines are suitable for this mode. Position commands from the host controller are composed of series pulses.

Name	Name abbr.	Sign	Control mode	Description
Control mode option	STY	PA01 (*)	ALL	Setting value of Control mode option: u z y x x: control mode select 0: position y: position command select 0: external input

(*)PA01 modification is valid by power off once and power on again.

The control flow and relevant parameters are shown below.



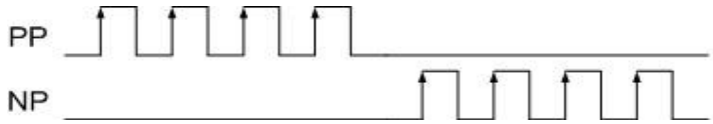
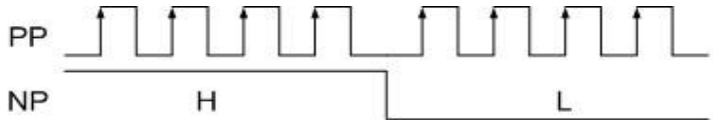
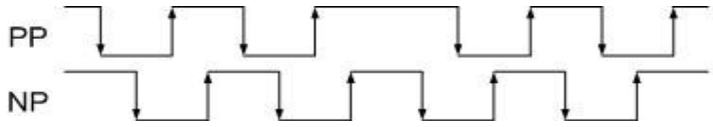
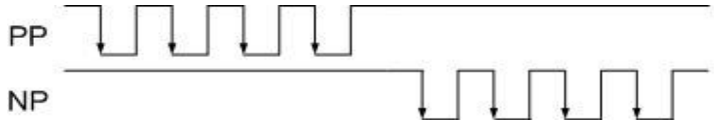
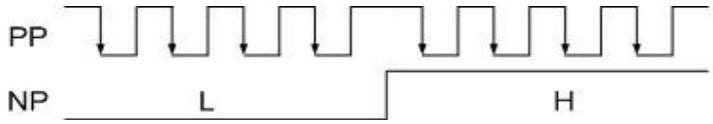
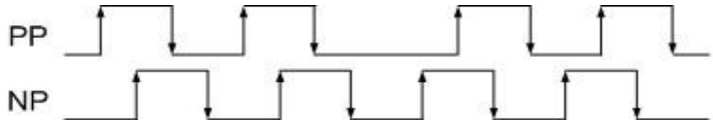
6.4.1. External pulse-train command(Pt mode)

There are 3 options for position command input. The commands are counted by positive or negative logic. Positive logic means the rising edge recognition. Negative logic means the falling edge recognition.

Name	Name abbr.	Sign	Control mode	Description
Command pulse option	PLSS	PA13 (*)	Pt	Setting value of Control mode option: 0 z y x x: pulse-train format select 0: forward/reverse rotation pulse train 1: pulse train + sign 2: A/B phase pulse train y: acknowledged logic 0: positive logic 1: negative logic

(*)PA13 modification is valid by power off once and power on again.

The 3 formats of position command are described below.

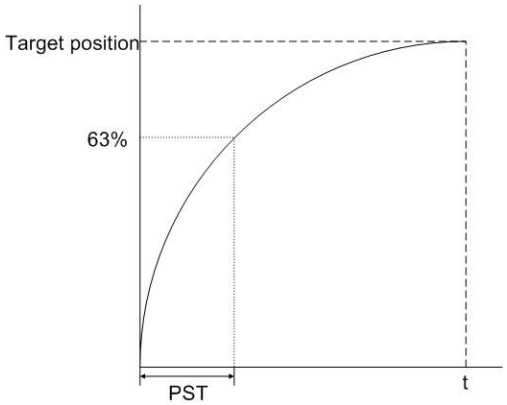
Pulse-train form		PA13 Setting	Forward command / Reverse command
Positive Logic	Forward/reverse rotation pulse train	□□00h	
	Pulse train + sign	□□01h	
	A/B phase pulse train	□□02h	
Negative Logic	Forward/reverse rotation pulse train	□□10h	
	pulse train + sign	□□11h	
	A/B phase pulse train	□□12h	

Permissible line driver command is max. 500Kpps. Open collector type is max. 200Kpps.

6.4.2. Position command smoothing

It is used to smooth motor running when the violent command changes are applied.

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



6.4.3. Electronic gear ratio

Arbitrary distance moving of servo motor is done by various electronic gear ratio.

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

The permissible range of electronic gear ratio is $\frac{1}{50} \le \frac{CMX}{CDV}(electronic\ gear\ ratio) \le 200$.

4 different electronic gear numerators could be switched by enabling CM1 and CM2 switch.

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

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

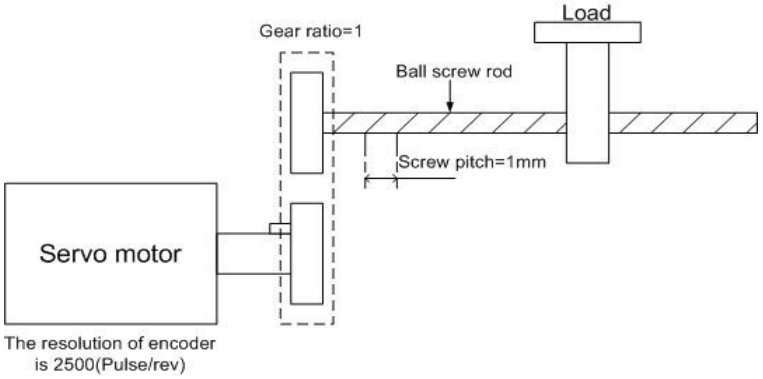
Calculation of electronic gear ratio

Use the following equation to calculate the electronic gear ratio.

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

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

As the plot below, how to set the electronic gear ratio to move a 5um per pulse?



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

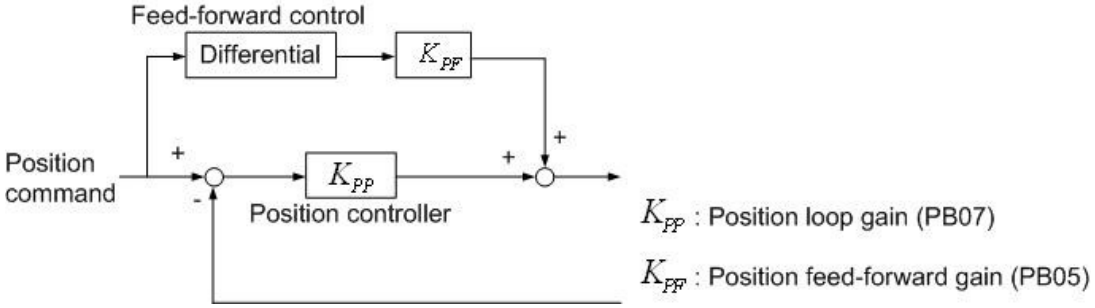
It is known that electronic gear numerator is 10000 and electronic gear denominator is 200, then the ball screw rod will shift a 5-μm distance after one pulse command applied.

6.4.4. Torque limit of position control mode

See section 6.3.4. for details.

6.4.5. Position loop gain

If users need to use manual-gain tuning for position loop, to adjust speed loop is priority since position loop is a dependence on speed loop. Usually, position gain is 1/4~1/6 of the speed loop gain. Position loop block diagram and relevant parameters are presented below.



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

If position loop gain PG1(PB07) is set too large, the motor will 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, 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 adjustment of position feed-forward gain should be increased gradually. Theoretically, 1 is the best value. The improper value will 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 3 hybrid modes of Shihlin servo driver could satisfy users who need to change varied modes frequently. The PA01 could be changed for the setting of hybrid mode.

Control mode		Abbr.	PA01 setting	Description
Hybrid mode	Position with external command - speed	Pt-S	0001h	Use DI signal to switch Pt and S
	Position with external command - torque	Pt-T	0005h	Use DI signal to switch Pt and T
	Speed - torque	S-T	0003h	Use 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 use analog voltage signal as the speed/torque command and external pulse train signals as position command to reduce the demand of DI.

The LOP of DI should be enabled if 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 LOP(*) / Control mode 0 / position 1 / speed Option of speed/torque switched LOP(*) / Control mode 0 / speed 1 / torque Option of torque/position switched LOP(*) / Control mode 0 / torque 1 / position	Described by varied case

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

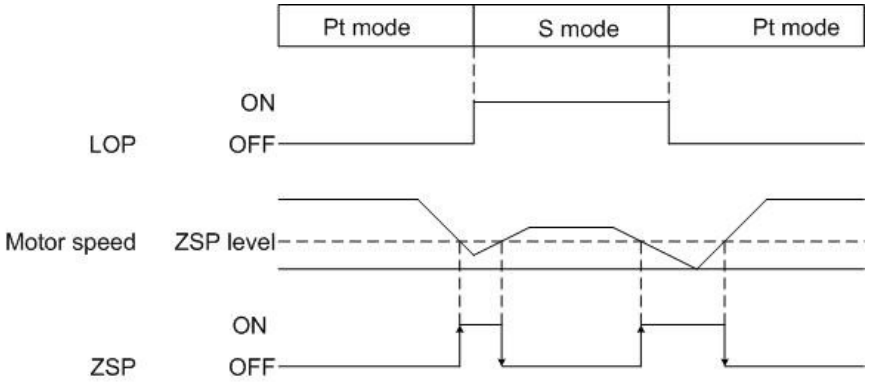
NOTE :

ST1 and RS2 are mutually inclusive, if speed/torque hybrid mode applied and LOP signal activated, ST1 function will have priority in speed mode and RS2 function will have priority in torque mode. Others such as POS1/SP2, PC/ST1, RS2/PC, TL/ST2, ST2/RS1, RS1/TL, CR/SP1 are defined mutually. Drivers will automatically recognize the corresponding DI function when 2 different modes are switched.

See Section 3.4.2 for more details.

6.5.1. Position/Speed hybrid mode

LOP is used to switch the position mode and speed mode. The sequence chart of mode switch is presented in the figure below.

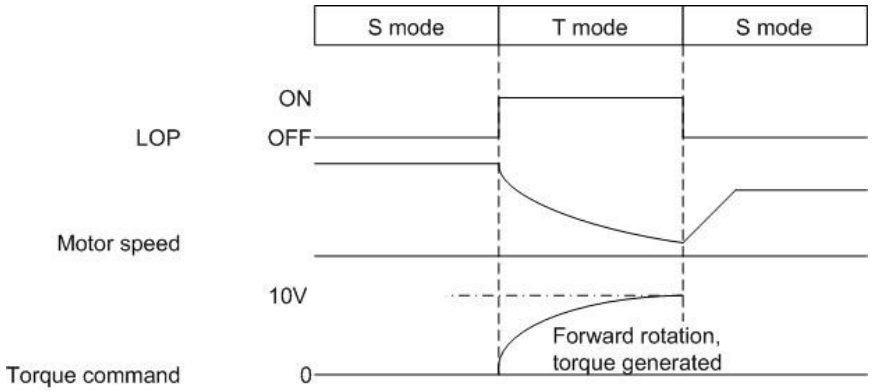


Control mode could not be switched if the motor is at a high speed rotation. It could be performed if zero speed detection output is ON. Yet it is recommended for users to switch control mode when the motor is stopped completely.

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 into torque mode. Because ST1(ST2) and RS2(RS1) are defined mutually, the rotary direction of motor will reverse while changing between the speed and torque modes.

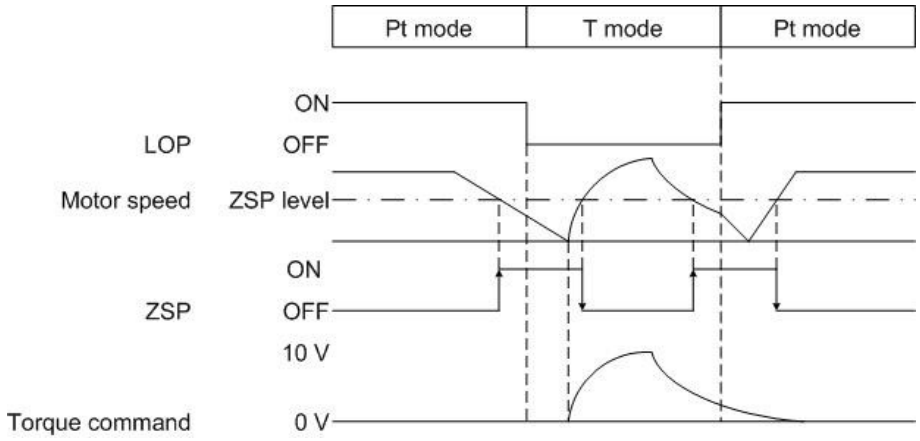
The sequence diagram of the speed/torque mode is presented below.



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

6.5.3. Torque/Position hybrid mode

Users could set the PA01 as 0005h to perform this hybrid mode. The switch is invalid if the motor is at a high speed rotation. It could be switched as the zero speed detection is ON. Users could use the LOP to switch these 2 modes. The sequence chart is presented in the figure below.



NOTE :

1. It is recommended that users switch position/torque mode after motor is static.
2. When ZSP is not turned on, the control mode is not switched even if LOP is turned on/off. After LOP is turned on/off, even if ZSP is turned on, the control mode is not switched.

6.6. Other functions

6.6.1. Selection of brake resistor

As the direction of motor generated torque is opposite to the rotary direction of motor, it becomes a power generator. The regenerative energy would be turned back to the servo driver. To prevent from P-N voltage exceeded, a voltage stabilized protection is necessary. The IGBT switch and brake resistors constitute this protection. Regenerative energy is consumed by the brake resistor.

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

Driver(W)	Built-in brake resistor specification		Minimum permissible resistance (Ω)	Consumption power of built-in resistor (W)
	resistor (Ω)	Capacity (W)		
100	100	20	100	10
200	100	20	100	10
400	100	20	100	10
750	40	40	40	20

◆ The average regenerative power that could be consumed is at 50% rated power of the built-in brake resistor. So as the external brake resistor.

If an external brake resistor is applied, the same resistance mentioned above is required. If serial or parallel wiring are applied to increase resistor's power, be sure that the resistance meets the minimum permissible specification. The brake resistor with a thermal switch or a cooling fan would be helpful to tell users that the capacity of brake resistor is insufficient or to reduce the temperature of brake resistor. Please contact the manufacturer of brake resistor to know the detail load characteristic.

In order to let users easily know how to calculate the power of external brake resistor, the calculations are described below.

(a) Without external load

If the motor is repeated running forward and reverse, the braking regenerative energy will return to the aluminum capacitors of servo driver. When the P-N voltage exceeds a certain value, the brake IGBT switch is turn on and the brake resistor will dissipate the regenerative energy. The following statement and table provide the calculation of regenerative power.

The Es and Ec of various driver capacity are listed below.

Driver(W)	Rotor inertia, J(x10^{-4}kg·m^2)	Regenerative power which from rated speed to stop without load Es(joule)	Regenerative-energy of capacitor, Ec(joule)
100	0.055	0.27	8.98
200	0.204	1.03	8.98
400	0.335	1.65	11.02
750	1.203	5.92	11.02

The capacity of brake resistor is calculated as follows:

$$P_{BR} = 2 \times ((N+1) \times E_S - E_C) / T$$

Where:

P_{BR} *: Power of brake resistor*

N : The ratio of load inertia to motor shaft

T : Duty cycle (Defined by users)

If the ratio of load inertia to motor shaft is N, deceleration from the rated speed to stop; the regenerative energy is (N +1) × Es. The brake resistor consumption is (N +1)× Es - Ec joules. Assuming the duty cycle is T second, then the recommend power of brake resistor is 2 × ((N +1) × Es-Ec) / T. The calculation procedure is as follows.

Step	Item	Calculation or procedure
1	Choose the duty cycle T	With user's application to decide the repeat operation cycle.
2	Set motor speed wr	Panel operation to read/write this value.
3	Set load to motor inertia ratio N	Panel operation to read/write this value.(PA02=0002h)
4	Compute the Es	Refer to the previous table or calculation Es = J × Wr^2 / 182
5	Compute the Ec	Refer to the previous table
6	Compute the P_{BR}	2 x ((N+1) x E_S-E_C)/T

Example 1

The driver's capacity is 400W, duty cycle T is 0.5 second, revolution speed is 3000 rpm, load to motor inertia ratio is 7, then the necessary power of brake resistor = 2 x ((7 + 1) x 1.65 -11.02) / 0.5 = 8.72W. Since these are less than the capacity(20W) of 400W servo driver's built-in brake resistor, users could directly use the built-in brake resistor to consume the regenerative energy.

Note: Due to 3000rpm is the rate speed of 400W servo driver, we could find the Es on the previous table is 1.65.

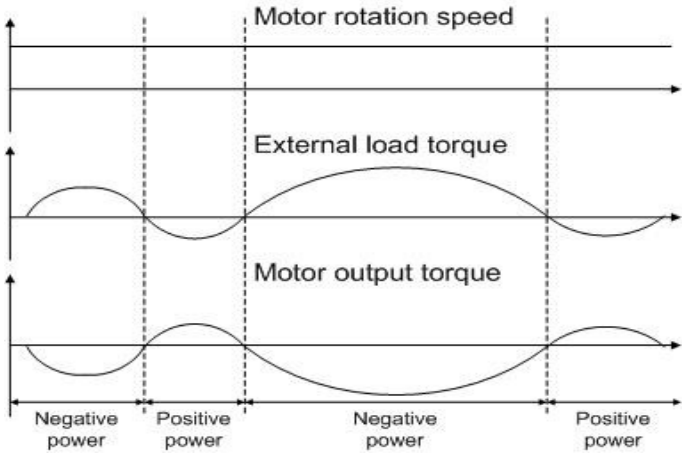
Example 2

The driver's capacity is 750W, duty cycle T is 1 second, revolution speed is 2000 rpm, load to motor inertia ratio is 20. Since the revolution speed 2000rpm is less than the rated speed (3000rpm), we need to compute E_S , E_S =1.203 x 10^{-4} x 2000^2/182 = 2.64, then the required power of brake resistor = 2 x ((20 + 1) x 2.64 -11.02) /1 = 88.84W. An external brake resistor of 200W is recommended.

Generally, if the load to motor inertia ratio is small(N<=5), the built-in brake resistor is sufficient. If the capacity of brake resistor is too small, the heat accumulated is growing easily and the temperature of brake resistor rises soon. When the temperature is higher than a certain value, the brake resistor will be burn out.

(b) With external load

When the external load torque is greater than motor torque, it make the servo motor output torque direction is opposite to the rotary direction of servo motor. In this case, the external energy is delivered to the servo driver through the servo motor. The following figure is an example that the motor runs in CCW rotation at constant speed when a sudden external load torque change.



Power of the external load torque : $P_L = T_L \times \omega$

Where:

P_L is the power of external load torque

T_L is the external load torque. (unit : Nt-m)

ω is the motor rotation speed. (unit : rad/s)

For example :

If an load torque of +50% rated torque is applied and the servo motor speed is 3000rpm, the servo drive is 400W capacity(rated torque: 1.27Nt-m), then the users need to connect a external brake resistor which power is 2 x (0.5 x 1.27) x (3000 x 2 x π/ 60) = 399W, 100Ω.

Note : 1rpm = 2π/60 (rad/s)

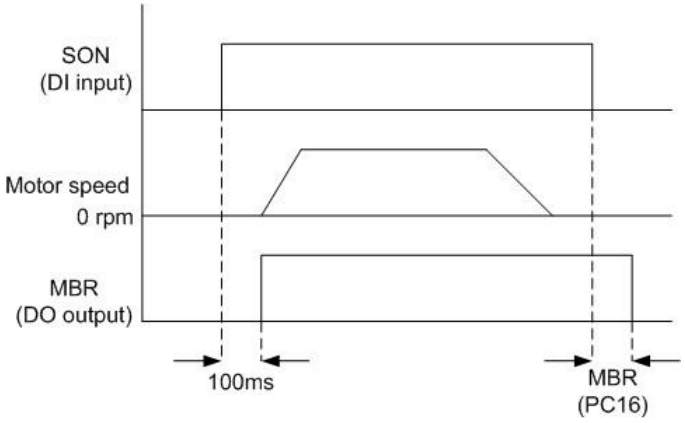
6.6.2. Operation of electromagnetic brake

The electromagnetic brake signal is described: (1)As MBR is OFF，the electromagnetic brake is disabled and motor shaft is locked. (2)As MBR is ON，the electromagnetic brake is enabled and motor shaft is rotatable. The PC16 could be used to decide the delay time of SON signal off to MBR signal activated. The electromagnetic brake is usually applied on the Z axis(vertical axis) to prevent from load falling.

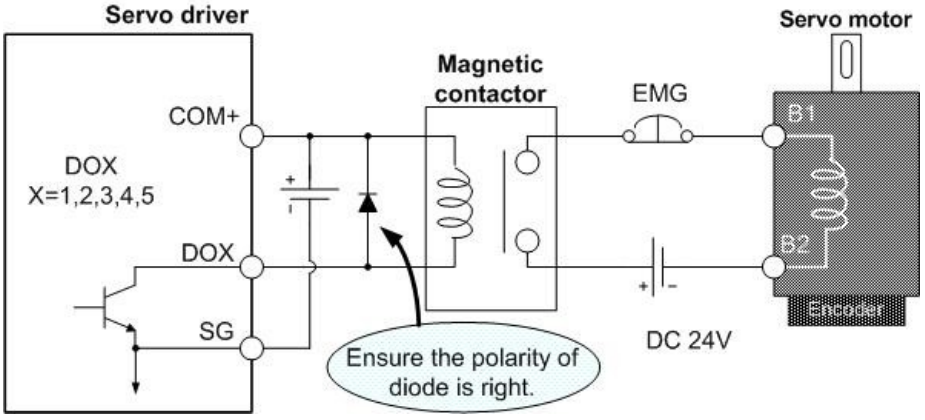
NOTE :

1. MBR enables/disables electromagnetic contactor to release/lock the motor shaft.
2. The coil of electromagnetic brake is without polarity.
3. If users control the electromagnetic brake without MBR, please refer to the operation sequence.

The operation sequence of electromagnetic brake is plotted below.



Wiring diagram of electromagnetic brake.



Specification of electromagnetic brake

Motor type	SMA series			
	L010B	L020B	L040B	L075B
Brake type	Spring brake (Normal locked)			
Rated voltage (V)	DC 24V			
Rated power (W)	6.3	7.9		8.6
Rated current (A)	0.24	0.32		0.35
Friction Tq (N・m)	0.3	1.3		2.4

7. Parameters

7.1.Parameter definition

Shihlin servo driver parameters are classified into basic parameters, gain values, filters, expansion parameters and I/O parameters. When an advance adjustment is required, change the parameter PA42 setting to make the expansion parameters write-enabled.
Here are some notes for reading this parameter chapter.

1. **Parameter classification**
   Functional lists are described at section 7.2. Detail lists are described at section 7.3.
2. **Special symbol of parameter**
   (★) denotes the change is valid by power off once and power on again.
   (▲) denotes the invalid change if Servo ON status is activated.
   There are 2 ways to make Servo ON status off.
   (1)Turn off the SON signal of DI.
   (2)Set PD16 as 1 and the driver will be at Servo OFF status. But remember to recover it after parameter modified completion.

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	Position control (terminal input)	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.
	Speed control	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.
	Torque control	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.
		S-T	S/T is switched mutually via the LOP signal of DI.

7.2.Parameter list

(1) Basic parameters

NO	Abbr.	Name	Initial value	Unit	Control mode		
					Pt	S	T
PA01(★)	STY	Control mode option	1000h	-	○	○	○
PA02(▲)	ATUM	Gain tuning mode option	0002h	-	○	○	
PA03	ATUL	Auto-tuning response level setting	0005h	-	○	○	
PA05	TL1	Inner torque limit 1	100	%	○	○	○
PA06	CMX	Electronic gear numerator	1	-	○		
PA07(▲)	CDV	Electronic gear denominator	1	-	○		
PA12	INP	In-position range	100	Pulse	○		
PA13(★)	PLSS	Command pulse option	0000h	-	○		
PA14(★)	ENR	Encoder output pulses	10000	pulse/rev	○	○	○
PA39(★)	POL	Motor rotary direction option	0000h	-	○	○	○
PA40(▲)	SPW	Special parameter write-enable	0000h	-	○	○	○
PA42(★)	BLK	Parameter write-inhibit	0000h	-	○	○	○
PA43	OVPE	Output of position error excess	3000	10 pulse	○		

(2) Gain, filter parameters

NO	Abbr.	Name	Initial value	Unit	Control mode		
					Pt	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	0.0001	○		
PB06	GD1	Load to motor inertia ratio	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	(*)	○	○	
PB13	CDT	Gain switch time constant	1	ms	○	○	
PB14	GD2	Load to motor inertia ratio 2	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	-	○	○	

(*) The unit of PB12 is a dependence of gain switch condition.(kpps,pulse,rpm)

(3) Expansion parameters

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

(4) I/O setting parameters

NO	Abbr.	Name	Initial value	Unit	Control mode		
					Pt	S	T
PD01(★)	DIA1	Digital input signal auto-ON option	0000h	-	○	○	○
PD02(★)	DI1	Digital input 1 option	0001h	-	○	○	○
PD03(★)	DI2	Digital input 2 option	0007h	-	○	○	○
PD04(★)	DI3	Digital input 3 option	0009h	-	○	○	○
PD05(★)	DI4	Digital input 4 option	000Ah	-	○	○	○
PD06(★)	DI5	Digital input 5 option	0002h	-	○	○	○
PD07(★)	DI6	Digital input 6 option	0006h	-	○	○	○
PD08(★)	DI7	Digital input 7 option	0018h	-	○	○	○
PD09(★)	DI8	Digital input 8 option	0019h	-	○	○	○
PD10(★)	DO1	Digital output 1 option	0003h	-	○	○	○
PD11(★)	DO2	Digital output 2 option	0008h	-	○	○	○
PD12(★)	DO3	Digital output 3 option	0007h	-	○	○	○
PD13(★)	DO4	Digital output 4 option	0005h	-	○	○	○
PD14(★)	DO5	Digital output 5 option	0001h	-	○	○	○
PD15(★)	DIF	Digital input filter time option	0002h	-	○	○	○
PD16(★)	IOS	Digital input on/off state control option	0000h	-	○	○	○
PD17(★)	DOP1	LSP/LSN triggered stop option	0000h	-	○	○	
PD18(★)	DOP2	CR signal clear option	0000h	-	○		
PD19(★)	DOP3	Alarm code output option	0000h	-	○	○	○
PD20(★)	DOP4	Alarm reset triggered process	0000h	-	○	○	○
PD21(★)	DIA2	Digital input signal auto-ON option 2	0000h	-	○	○	○

Some 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	**S**	**T**
PA01(★)	STY	Control mode option	1000h	-	○	○	○
PA05	TL1	Inner torque limit 1	100	%	○	○	○
PC05	SC1	Inner speed command/limit 1	100	rpm		○	○
PC06	SC2	Inner speed command/limit 2	500	rpm		○	○
PC07	SC3	Inner speed command/limit 3	1000	rpm		○	○
PC08	SC4	Inner speed command/limit 4	200	rpm		○	○
PC09	SC5	Inner speed command/limit 5	300	rpm		○	○
PC10	SC6	Inner speed command/limit 6	500	rpm		○	○
PC11	SC7	Inner speed command/limit 7	800	rpm		○	○
PC12(▲)	VCM	Output speed of maximum analog command	3000	rpm		○	○
PC13(▲)	TLC	Torque generated of maximum analog command	100	%	○	○	○
PC25	TL2	Inner torque limit 2	100	%	○	○	○
PC26	VCO	Speed analog command/limit offset	0	mV		○	○
PC27	TLO	Torque analog command/limit offset	0	mV		○	○

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

Position control related parameters							
NO	**Abbr.**	**Name**	**Initial value**	**Unit**	**Control mode**		
					Pt	**S**	**T**
PA01(★)	STY	Control mode option	1000h	-	○	○	○
PA04	HMOV	Home moving option	0000h	-			
PA05	TL1	Inner torque limit 1	100	%	○	○	○
PA06	CMX	Electronic gear numerator	1	-	○		
PA07(▲)	CDV	Electronic gear denominator	1	-	○		
PA13(★)	PLSS	Command pulse option	0000h	-	○		
PA14(★)	ENR	Encoder output pulses	10000	pulse/rev	○	○	○
PA39(★)	POL	Motor rotary direction option	0000h	-	○	○	○
PA43	OVPE	Output of position error excess	3000	10 pulse	○		
PC25	TL2	Inner torque limit 2	100	%	○	○	○
PC32	CMX2	Electronic gear numerator 2	1	-	○		
PC33	CMX3	Electronic gear numerator 3	1	-	○		
PC34	CMX4	Electronic gear numerator 4	1	-	○		

Smoothing filter and resonance suppression related parameters							
NO	**Abbr.**	**Name**	**Initial value**	**Unit**	**Control mode**		
					Pt	**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	○		
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	-	○		
PC01	STA	Acceleration time constant	200	ms		○	○
PC02	STB	Deceleration time constant	200	ms		○	○
PC03	STC	S-pattern acc./dec. time constant	0	ms		○	○
PD17(★)	DOP1	LSP/LSN triggered stop option	0000h	-	○	○	

Control gain and gain switch related parameters							
NO	**Abbr.**	**Name**	**Initial value**	**Unit**	**Control mode**		
					Pt	**S**	**T**
PA02(▲)	ATUM	Gain tuning mode option	0002h	-	○	○	
PA03	ATUL	Auto-tuning response level setting	0005h	-	○	○	
PB05	FFC	Position feed-forward gain	0	0.0001	○		
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	(*)	○	○	
PB13	CDT	Gain switch time constant	1	ms	○	○	
PB14	GD2	Load to motor inertia ratio 2	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	%	○	○	
PB24	VDC	Speed differential compensation	980	-	○	○	

(*) The unit of PB12 is a dependence of gain switch condition.(kpps,pulse,rpm)

Communication related parameters							
NO	**Abbr.**	**Name**	**Initial value**	**Unit**	**Control mode**		
					Pt	**S**	**T**
PC20(★)	SNO	Communication device number	1	-	○	○	○
PC21(★)	CMS	Communication mode option	0010h	-	○	○	○
PC22(★)	BPS	Communication protocol option	0010h	-	○	○	○
PC23	SIC	Communication time-out process option	0	s	○	○	○

Digital I/O settings related parameters							
NO	**Abbr.**	**Name**	**Initial value**	**Unit**	**Control mode**		
					Pt	**S**	**T**
PA12	INP	In-position range	100	Pulse	○		
PC16	MBR	Electromagnetic brake output delay time	100	ms	○	○	○
PC17	ZSP	Zero speed acknowledged range	50	rpm	○	○	○
PD01(★)	DIA1	Digital input signal auto-ON option	0000h	-	○	○	○
PD02(★)	DI1	Digital input 1 option(CN1-14)	0001h	-	○	○	○
PD03(★)	DI2	Digital input 2 option(CN1-15)	000Dh	-	○	○	○
PD04(★)	DI3	Digital input 3 option(CN1-16)	0003h	-	○	○	○
PD05(★)	DI4	Digital input 4 option(CN1-17)	0004h	-	○	○	○
PD06(★)	DI5	Digital input 5 option(CN1-18)	0002h	-	○	○	○
PD07(★)	DI6	Digital input 6 option(CN1-19)	000Fh	-	○	○	○
PD08(★)	DI7	Digital input 7 option(CN1-20)	0018h	-	○	○	○
PD09(★)	DI8	Digital input 8 option(CN1-21)	0019h	-	○	○	○
PD10(★)	DO1	Digital output 1 option(CN1-41)	0003h	-	○	○	○
PD11(★)	DO2	Digital output 2 option(CN1-42)	0008h	-	○	○	○
PD12(★)	DO3	Digital output 3 option(CN1-43)	0007h	-	○	○	○
PD13(★)	DO4	Digital output 4 option(CN1-44)	0005h	-	○	○	○
PD14(★)	DO5	Digital output 5 option(CN1-45)	0001h	-	○	○	○
PD15(★)	DIF	Digital input filter time option	0002h	-	○	○	○
PD16(★)	IOS	Digital input on/off state control option	0000h	-	○	○	○
PD17(★)	DOP1	LSP/LSN triggered stop option	0000h	-	○	○	
PD18(★)	DOP2	CR signal clear option	0000h	-	○		
PD19(★)	DOP3	Alarm code output option	0000h	-	○	○	○
PD20(★)	DOP4	Alarm reset triggered process	0000h	-	○	○	○
PD21(★)	DIA2	Digital input signal auto-ON option 2	0000h	-	○	○	○

Other functions related parameters							
NO	**Abbr.**	**Name**	**Initial value**	**Unit**	**Control mode**		
					Pt	**S**	**T**
PA40(▲)	SPW	Special parameter write-enable	0000h	-	○	○	○
PA42(★)	BLK	Parameter write-inhibit	0000h	-	○	○	○
PB06	GD1	Load to motor inertia ratio	10	0.1time	○	○	
PB14	GD2	Load to motor inertia ratio 2	70	0.1time	○	○	
PC18(★)	COP1	Stop and power interruption restart option	0010h	-	○	○	○
PC19(★)	COP2	Alarm history clear option	0000h	-	○	○	○
PD20(★)	DOP4	Alarm reset triggered process	0000h	-	○	○	○

7.3.Parameter details list

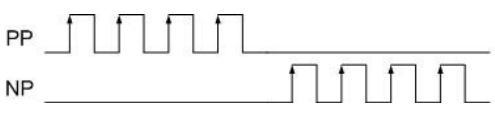
<table>
<tr><th>No</th><th>Abbr.</th><th>Function description</th><th>Control mode</th><th>Setting range</th><th>Unit</th></tr>
<tr><td>PA01</td><td>STY</td><td>Setting value of Control mode option:
u | z | y | x
x: control mode select
0: position
1: position/speed
2: speed
3: speed/torque
4: torque
5: torque/position

y: position command select
0: external input

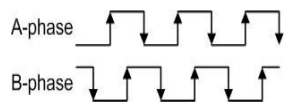
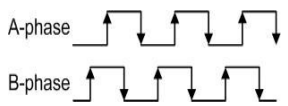
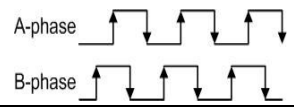
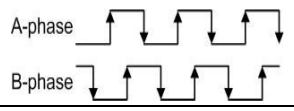
z: electromagnetic brake enabled option
0: disabled
1: enabled. (Motor with electromagnetic brake applied)

u: DI/DO setting option
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.</td><td>Pt,S,T</td><td>0000h
~1125h</td><td>-</td></tr>
<tr><td>PA02</td><td>ATUM</td><td>Gain tuning mode option:
0 | 0 | 0 | x
x: gain tuning mode option
0: manual-gain tuning(PI control)
1: manual-gain tuning(PI control + interference compensator)
2: Auto-gain tuning(load inertia ratio and bandwidth estimated)
3: Auto-gain tuning(fixed load inertia ratio)</td><td>Pt,S</td><td>0000h
~0003h</td><td>-</td></tr>
<tr><td>PA03</td><td>ATUL</td><td>Auto-tuning response level setting:
0 | 0 | 0 | x
x: response level setting

<table>
<tr><th>Response level</th><th>Rigidity</th><th>Response frequency</th></tr>
<tr><td>1</td><td rowspan="4">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 rowspan="5">middle</td><td>30 Hz</td></tr>
<tr><td>6</td><td>40 Hz</td></tr>
<tr><td>7</td><td>55 Hz</td></tr>
<tr><td>8</td><td>70 Hz</td></tr>
<tr><td>9</td><td>85 Hz</td></tr>
<tr><td>A</td><td rowspan="6">high</td><td>100 Hz</td></tr>
<tr><td>B</td><td>130 Hz</td></tr>
<tr><td>C</td><td>160 Hz</td></tr>
<tr><td>D</td><td>200 Hz</td></tr>
<tr><td>E</td><td>250 Hz</td></tr>
<tr><td>F</td><td>300 Hz</td></tr>
</table>
</td><td>Pt,T</td><td>0001h
~000Fh</td><td>-</td></tr>
</table>

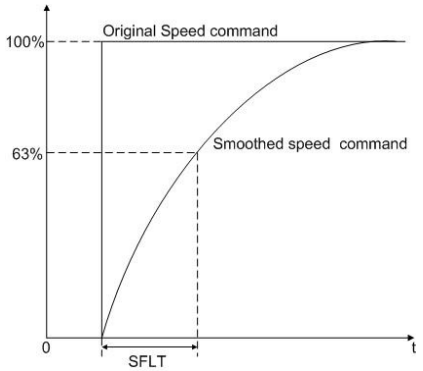
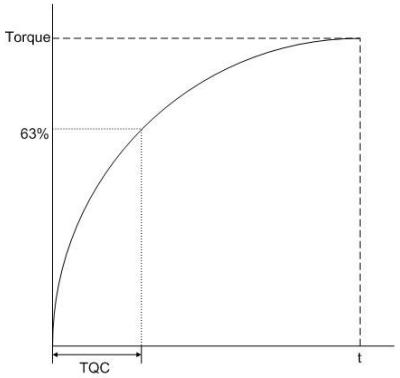
<table>
<tr><th>No</th><th>Abbr.</th><th>Function description</th><th>Control mode</th><th>Setting range</th><th>Unit</th></tr>
<tr><td>PA05</td><td>TL1</td><td>Inner torque limit 1:
Motor generated torque is restricted by this parameter which unit is %. The generated torque is calculated as below.
Torque limit value = maximum torque *PA05
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:
<table>
<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>
If the TL1 and SG are short-circuit, the valid torque limit is:
<table>
<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></td><td>Pt,S,T</td><td>0000h
~0003h</td><td>-</td></tr>
<tr><td>PA06</td><td>CMX</td><td>Electronic gear numerator
See section 6.4.4 for more details.</td><td>Pt</td><td>1
~32767</td><td>-</td></tr>
<tr><td>PA07</td><td>CDV</td><td>Electronic gear denominator
The proper range setting is:
$\frac{1}{50} \le \frac{CMX}{CDV}$ (electronic gear ratio) ≤ 200</td><td>Pt</td><td>1
~32767</td><td>-</td></tr>
<tr><td>PA12</td><td>INP</td><td>In-position range
To define the permissible pulse error range of position pulse commands. As positioning done, the INP signal will output.</td><td>Pt</td><td>0
~10000</td><td>pulse</td></tr>
<tr><td>PA13</td><td>PLSS</td><td>Setting value of Control mode option:
<table>
<tr><td>0</td><td>z</td><td>y</td><td>x</td></tr>
</table>
x: pulse-train format select
0: forward/reverse rotation pulse train
1: pulse train + sign
2: A/B phase pulse train
y: acknowledged logic
0: positive logic
1: negative logic
z: permissible pulse frequency option
0: 500kpps or less
1: 200kpps or less
Here is an example.
<table>
<tr><th colspan="2">Pulse format</th><th>Forward</th><th>Reverse</th></tr>
<tr><td>y=0</td><td>x=0</td><td colspan="2"> 
</td></tr>
</table>
To see section 6.4.1 for more details.</td><td>Pt</td><td>0000h
~0112h</td><td>-</td></tr>
</table>

<table>
<tr><th>No</th><th>Abbr.</th><th>Function description</th><th>Control mode</th><th>Setting range</th><th>Unit</th></tr>
<tr><td>PA14</td><td>ENR</td><td>Encoder output pulses
Use the PA14 to set A/B-phase pulses encoder output. Use the PA39 to choose 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. Maximum output frequency is 500kpps. (after multiplication by 4). Use this parameter within this range.
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.

For output division ratio setting
Set " □1□□ " in parameter PA39.
Set the output division ratio(PA14) per motor revolution.
$Output\ pulses = \frac{Resolution\ per\ motor\ revolution}{PA14\ setting\ value}$
At the setting of 2, for example, the actually output pulses per motor revolution is (10000/2)=5000.</td><td>Pt,S,T</td><td>1
~10000</td><td>pulse/rev</td></tr>
<tr><td>PA39</td><td>POL</td><td>Motor rotary direction option
The relation among motor rotary direction and input command pulse-train direction and encoder output pulse direction is described below.
0 | z | y | x
x: input pulse-train and motor rotary direction option
<table><tr><td rowspan="2">x</td><td colspan="2">motor rotary direction</td></tr><tr><td>forward pulse-train input</td><td>reverse pulse-train input</td></tr><tr><td>0</td><td>CCW</td><td>CW</td></tr><tr><td>1</td><td>CW</td><td>CCW</td></tr></table>y: motor rotary direction and encoder pulse output option
<table><tr><td>y</td><td>motor CCW rotation</td><td>motor CW rotation</td></tr><tr><td>0</td><td>  </td><td>  </td></tr><tr><td>1</td><td>  </td><td>  </td></tr></table>z: encoder output option
0: output pulse
1: output division ratio</td><td>Pt,S,T</td><td>0000h
~0111h</td><td>-</td></tr>
</table>

<table>
<tr><th>No</th><th>Abbr.</th><th>Function description</th><th>Control mode</th><th>Setting range</th><th>Unit</th></tr>
<tr><td>PA40</td><td>SPW</td><td>Special parameter write-enable
As this PA40 is set as 0088h, the driver will take 2 seconds to recover factory-set. This change is valid by power off once and power on again.</td><td>S,T</td><td>0000h
~00FFh</td><td>-</td></tr>
<tr><td>PA42</td><td>BLK</td><td>Parameter read/write inhibit option
<table>
<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="5">R/W enable</td><td rowspan="2">R/W enable</td><td rowspan="2">R/W enable</td><td>R/W enable</td></tr>
<tr><td>0001h</td><td rowspan="3">R/W inhibit</td></tr>
<tr><td>0002h</td><td rowspan="2">R/W enable</td><td rowspan="2">R/W inhibit</td></tr>
<tr><td>0003h</td><td>R/W inhibit</td></tr>
<tr><td>0004h</td><td colspan="3" rowspan="2">R enable
W inhibit</td></tr>
<tr><td>0005h</td><td rowspan="2">R enable
W inhibit(*)</td></tr>
<tr><td>0006h</td><td colspan="3">R/W inhibit</td></tr>
</table>
(*) PA42 is excepted, it is write-able.</td><td>Pt,S,T</td><td>0000h
~0006h</td><td>-</td></tr>
<tr><td>PA43</td><td>OVPE</td><td>Output of position error excess
When the position error is over this PA43 setting value, servo driver would output the alarm of position error excess.(AL08)</td><td>Pt</td><td>0
~32767</td><td>10 pulse</td></tr>
</table>

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,S,T	50 ~1000	Hz
PB02	NHD1	Machine resonance suppression attenuation 1 To set the attenuation at PB01 frequency. The setting of “0” value denotes the disabled of this notch filter.	Pt,S,T	0 ~32	dB
PB03	NLP	Resonance suppression low-pass filter To set low-pass filter time constant to suppress resonance.	Pt,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	0 ~20000	ms
PB05	FFC	Position feed-forward gain To reduce the position error and settling time, but a too large setting may cause system vibration or overshoots.	Pt	0 ~20000	0.0001
PB06	GD1	Load to motor inertia ratio See section 5.3.3 for more details.	Pt,S	0 ~1200	0.1time
PB07	PG1	Position loop gain Increasing PG1 improves traceability, but a too high value makes overshooting or vibration occurred. When auto-gain tuning mode is applied, PB07 will be set according to the result of inertia estimation.	Pt	4 ~1024	rad/s
PB08	VG1	Speed loop gain Increasing VG1 improves traceability, but a too high value will make machine resonance. When auto-gain tuning is applied, PB08 will be set according to the result of gain tuning.	Pt,S	40 ~4096	rad/s
PB09	VIC	Speed integral gain The PB09 is used to eliminate stationary deviation against a command.	Pt,S	1 ~1000	ms
PB10	VFG	Speed feed-forward gain Proper gain will reduce tracking error of speed command. Also, a too big value will cause overshoots during a sudden acceleration/deceleration command.	S	0 ~20000	0.0001
PB11	CDP	Gain switch option 0 0 0 x x : changing condition 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.	Pt,S	0000h ~0004h	-
PB12	CDS	Gain switch condition value The unit of CDS value is varied(kpps,pulse,rpm) according to the settings of CDP.	Pt,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,S	0 ~1000	ms
PB14	GD2	Load to motor inertia ratio 2 Set the demand ratio of load inertia to motor shaft after switching. This value is valid as gain switch function preformed.	Pt,S	0 ~1200	0.1time
PB15	PG2	Position loop gain change ratio The gain values will be changed as: *gain after switched = (PG1 or VG1 or VIC) x PB15(%)* These changes are valid only if auto-gain tuning disabled.	Pt	10 ~200	%
PB16	VG2	Speed loop gain change ratio	Pt,S	10 ~200	%
PB17	VIC2	Speed integral gain change ratio	Pt,S	10 ~200	%
PB18	SFLT	Speed low-pass filter smooth time constant Larger value will make the response slow down obviously. If it is set as zero, this function is disabled.  The required time to catch the command is 5-time of SELT.	S,T	0 ~1000	ms
PB19	TQC	Torque command filter time constant Larger value will make the response slow down obviously. If it is set as zero, this function is disabled.  The required time to catch the command is 5-time of TQC.	T	0 ~5000	ms

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,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,S,T	50 ~1000	Hz
PB22	NHD2	Machine resonance suppression 2 The secondary option of notch filter attenuation.	Pt,S,T	0 ~32	dB
PB23	MVS	Micro-vibration suppression option 0 0 0 x x: option 0: default 1: micro-vibration suppression enabled 2: micro-vibration suppression disabled	Pt	0000h ~0002h	-
PB24	VDC	Speed differential compensation	Pt,S	0 ~1000	-

No	Abbr.	Function description	Control mode	Setting range	Unit
PC01	STA	Acceleration time constant Time spent to accelerate from 0 rpm to rated speed is called “acceleration time constant”.	S,T	0 ~20000	ms
PC02	STB	Deceleration time constant Time spent to decelerate from rated speed to 0 rpm is called “deceleration time constant”.	S,T	0 ~20000	ms
PC03	STC	S-pattern acceleration/deceleration time constant It is to employ a three-step curve of acceleration/deceleration to soothe the vibration during starting or stopping the motor.	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,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 1.	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 2.	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 3.	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 4.	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 5.	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 6.	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 7.	S,T	-4500 ~+4500	rpm
PC12	VCM	Output speed of maximum analog command This value decides the output speed while the maximum permissible voltage is applied. $output\ speed = \frac{applied\ voltage\ of\ speed\ command}{10} \times PC12$ See section 6.3.2 for more details.	S	0 ~30000	rpm
		When torque mode is applied, this parameter will become speed limit as the maximum permissible voltage applied. $speed\ limit = \frac{applied\ voltage\ of\ torque\ command}{10} \times PC12$ See section 6.2.5 for more details.	T	0 ~30000	

No	Abbr.	Function description	Control mode	Setting range	Unit
PC13	TLC	Torque generated of maximum analog command $The\ torque\ generated = \frac{applied\ voltage\ of\ torque\ command}{10} \times PC13$ When position or speed control mode applied, it is torque limit. See section 6.2.1 for more details.	Pt,S,T	0 ~2000	%
PC15	SVZR	Speed analog zero voltage acknowledged range Treat the applied voltage which is less than PC15 as zero.	S,T	0 ~1000	mV
PC16	MBR	Electromagnetic brake output delay time The 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,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 will treat it as zero speed and the ZSP of DO will be outputted.	Pt,S,T	0 ~10000	rpm
PC18	COP1	Stop option and power interruption restart option The voltage level drop will cause driver to alarm and stop. Auto-restart function could be applied by the setting of PC18. 0 0 y x x: power interruption restart option 0: invalid 1: valid y: motor stop option 0: stops instantaneously 1: decelerates to stop	Pt,S,T	0000h ~0011h	-
PC19	COP2	Alarm history clear option 0 0 0 x x=0: does not clear x=1: to clear the histories after power off once and restart	Pt,S,T	0000h ~0001h	-
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,S,T	1 ~32	-
PC21	CMS	Communication mode option 0 0 y x x: mode option 0: RS-232C 1: RS-485 y: communication reply delay time 0: reply within 1 ms 1: reply after 1 ms	Pt,S,T	0000h ~0011h	-
PC22	BPS	Communication protocol option See section 8.2 for more details.	Pt,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,S,T	0 ~60	s

No	Abbr.	Function description	Control mode	Setting range	Unit
PC24	DMD	Status display option 0 0 y x x: display option after power on 0: Cumulative feedback pulses 1: Cumulative feedback turns 2: Cumulative command pulses 3: Cumulative command turns 4: Accumulative pulses error 5: Command pulse frequency 6: Motor speed 7: Speed command voltage/Speed limit voltage 8: Speed input command/Speed input limit 9: Torque command voltage/Torque limit voltage A: Torque input command/Torque input limit B: Effective load ratio C: Peak load ratio D: DC bus voltage E: Load to motor inertia ratio F: Instantaneous torque y: assigned display after power on 0: display option according varied control modes 1: display option according the x-digit of PC24 See section 4.3 for more details.	Pt,S,T	0000h ~001Fh	-
PC25	TL2	Inner torque limit 2 Refer to description of PA05.	Pt,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
PC32	CMX2	Electronic gear numerator 2 Refer to the description of PA06.	Pt	1 ~32767	-
PC33	CMX3	Electronic gear numerator 3 Refer to the description of PA06.	Pt	1 ~32767	-
PC34	CMX4	Electronic gear numerator 4 Refer to the description of PA06.	Pt	1 ~32767	-

No	Abbr.	Function description	Control mode	Setting range	Unit
PD01	DIA1	Digital input signal auto-ON option u z y x x:SON open/short option 0:controlled by external actual wiring 1:SON-SG is short-circuit without actual wiring y:LSP open/short option 0:controlled by external actual wiring 1:LSP-SG is short-circuit without actual wiring z:LSN open/short option 0:controlled by external actual wiring 1:LSN-SG is short-circuit without actual wiring u:EMG open/short option 0:controlled by external actual wiring 1:EMG-SG is short-circuit without actual wiring	Pt,S,T	0000h ~1111h	-
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,S,T	0000h ~001Fh	-
PD03	DI2	Digital input 2 option	Pt,S,T	0000h ~001Fh	-
PD04	DI3	Digital input 3 option	Pt,S,T	0000h ~001Fh	-
PD05	DI4	Digital input 4 option	Pt,S,T	0000h ~001Fh	-
PD06	DI5	Digital input 5 option	Pt,S,T	0000h ~001Fh	-
PD07	DI6	Digital input 6 option	Pt,S,T	0000h ~001Fh	-
PD08	DI7	Digital input 7 option	Pt,S,T	0000h ~001Fh	-
PD09	DI8	Digital input 8 option	Pt,S,T	0000h ~001Fh	-
PD10	DO1	Digital output 1 option 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.	Pt,S,T	0000h ~000Fh	-
PD11	DO2	Digital output 2 option	Pt,S,T	0000h ~000Fh	-
PD12	DO3	Digital output 3 option	Pt,S,T	0000h ~000Fh	-
PD13	DO4	Digital output 4 option	Pt,S,T	0000h ~000Fh	-
PD14	DO5	Digital output 5 option	Pt,S,T	0000h ~000Fh	-

No	Abbr.	Function description	Control mode	Setting range	Unit
PD15	DIF	Digital input filter time option 0 0 0 x x: filter time constant 0: invalid 1: 2ms 2: 4ms 3: 6ms	Pt,S,T	0000h ~0003h	-
PD16	IOS	Digital input on/off state control option 0 0 0 x x: state control option 0: controlled by external input signals 1: controlled by communication software	Pt,S,T	0000h ~0001h	-
PD17	DOP1	LSP/LSN triggered stop option 0 0 0 x x: motor stop option 0: stops immediately 1: decelerates to stop according to PC02,PC03	Pt,S,T	0000h ~0001h	-
PD18	DOP2	CR signal clear option As CR signal is activated, the deference between position pulses and motor feedback pulses will be cleared. 0 0 0 x x: clear option 0: CR rising edge trigger 1: keeps clearing while CR-SG is conductive.	Pt	0000h ~0001h	-
PD19	DPP3	Alarm code output option CN1-41/CN1-42/CN1-45 could be composed to express alarm codes according to their output states. 0 0 0 x x: clear option 0: original pins defined by the setting value of PD10 to PD14 1: to show alarm codes while alarms occurred See section 10.1 for more details.	Pt,S,T	0000h ~0001h	-
PD20	DOP4	Alarm reset triggered process 0 0 0 x x: clear option 0: PWM signal off(If the motor is running, it will coast to stop. If the motor is shaft-lock, it will become rotatable.) 1: invalid	Pt,S,T	0000h ~0001h	-
PD21	DIA2	Digital input signal auto-ON option 2 0 0 y x x: TL open/short option 0: controlled by external actual wiring 1: TL-SG is short-circuit without actual wiring y: SP1 open/short option 0: controlled by external actual wiring 1: SP1-SG is short-circuit without actual wiring	Pt,Pr S,T	0000h ~0011h	-

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 will stop running if Pr mode is applied.
LSP	0x18	Limit of forward rotation route
LSN	0x19	Limit of reverse rotation route

Digital output(DO) function definition

Sign	Setting Value	Functions/Applications description
RD	0x01	As the driver is ready to be operated, RD-SG will 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 will 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.
CMDOK	0x09	CMDOK-SG is conductive as the inner position command is completed or stopped.

8. Communication functions

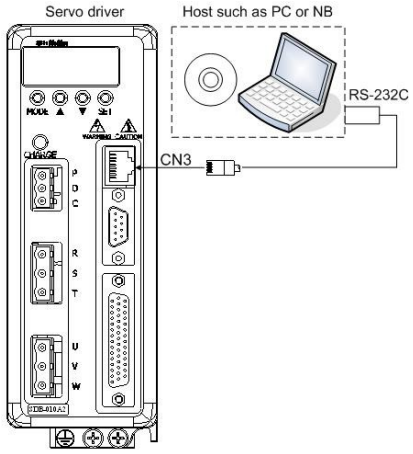
8.1. Communication interface and wirings

The Shihlin servo drive equips RS-232C and RS-485 serial communication functions which are used for servo operation, parameter changing, monitor function, etc. However, RS-232C and RS-485 communication could not be used simultaneously. Use the PC21 to select one of RS-232C and RS-485. The wiring is demonstrated below.

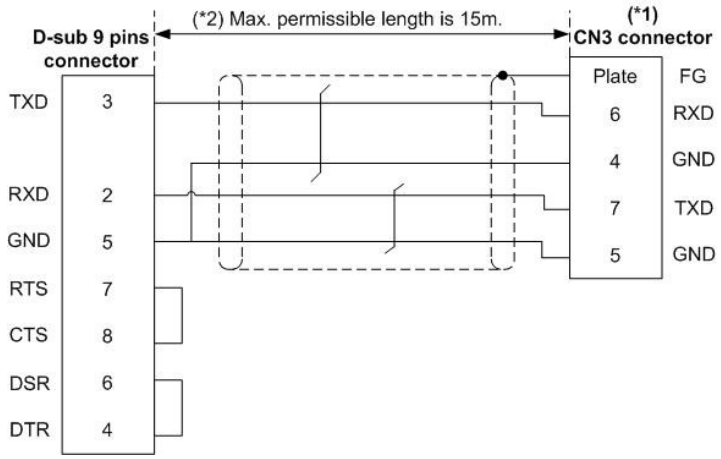
RS-232C

(1) Outline:

One device applied



(2) Wiring diagram:



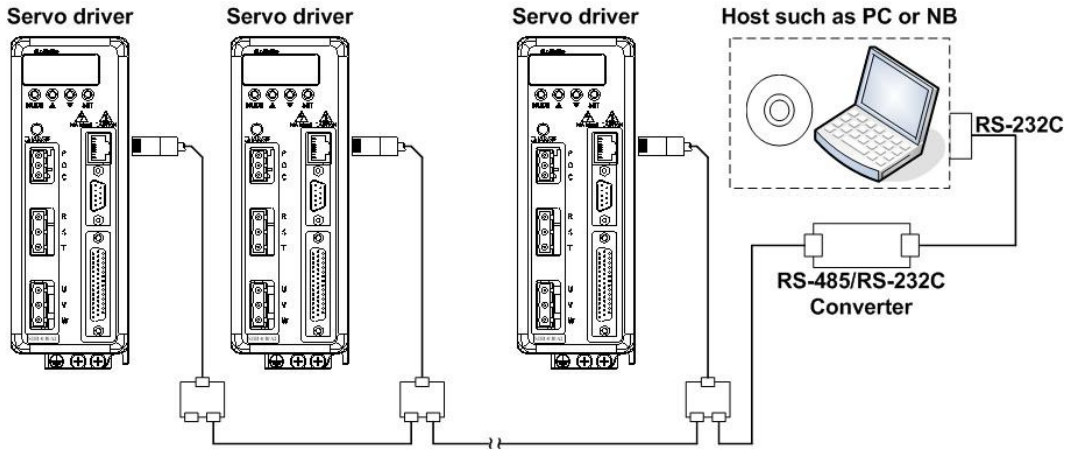
(*1) CN3 connector is the RJ-45 type.

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

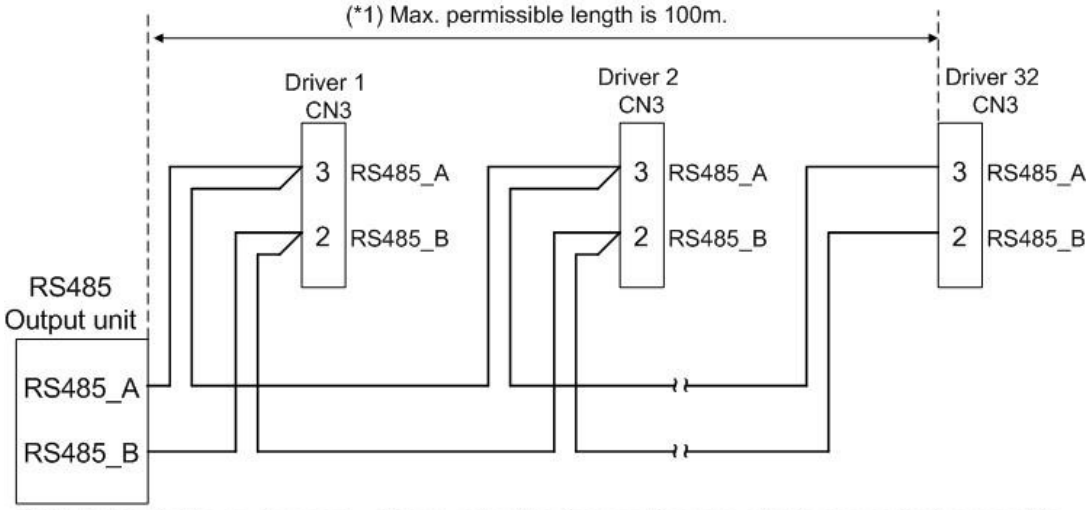
RS-485

(1) Outline:

Up to 32 servo drivers from station 1 to station 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 pin of CN3 could reduce communication failure if necessary.

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.

PC20 modification is valid by power off servo driver once and power on again.

(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) Communication speed option(PC22)

0	0	y	0

0: 4800 bps

1: 9600 bps

2: 19200 bps

3: 38400 bps

4: 57600 bps

5: 115200 bps

8.3. Modbus protocol

Device number is an identification that the host could communicate with several slaves. The host could control the particular slave according to its device number. Shihlin servo protocol is Modbus including two modes : ASCII (American Standard Code for information interchange) and RTU (Remote Terminal Unit), users could change the mode by setting the PC22 value.

A. ASCII mode

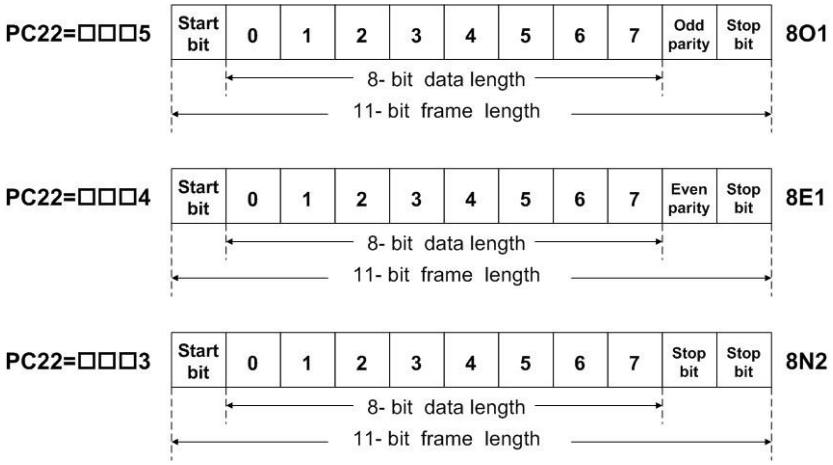
(a) Coding signification

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

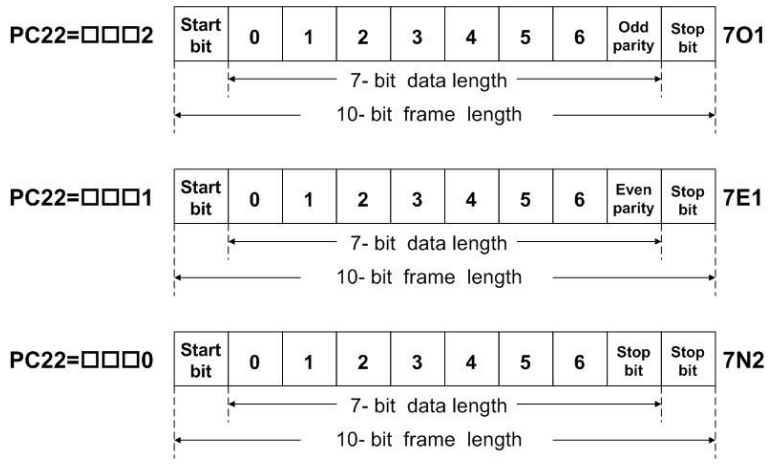
Character	‘0’	‘1’	‘2’	‘3’	‘4’	‘5’	‘6’	‘7’
ASCII code	30h	31h	32h	33h	34h	35h	36h	37h
Character	‘8’	‘9’	‘A’	‘B’	‘C’	‘D’	‘E’	‘F’
ASCII code	38h	39h	41h	42h	43h	44h	45h	46h

(b) frame signification

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



10-bit frame(suitable for 7-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 range 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 is as an example described below.

Command code: 03h, read data

Command(host):

STX		:
ADR		‘0’
		‘1’
CMD		‘0’
		‘3’
DATA	**start address**	‘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	**byte length**	‘0’
		‘4’
	content of address 0100h	‘0’
		‘1’
		‘0’
		‘2’
	content of address 0101h	‘1’
		‘2’
		‘2’
		‘1’
LRC		‘C’
		‘2’
End1		0Dh
End0		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

LRC(Longitudinal Redundancy Check) is used 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: 1. To compute the sum of ADR code to last data code. *11h+06h+C1h+2Ah+00h+64h=166h* 2. If the sum is byte-overflow, neglect the overflow part. *166h=66h* 3. Compute the 2's complement. *100h-66h=9Ah* 4. ”9Ah” is the LRC detection value.
	‘1’	
CMD	‘0’	
	‘6’	
DATA **start address**	‘C’	
	‘1’	
	‘2’	
	‘A’	
DATA **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

A 8-bit data is 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

Communication data formats are described below.

Start

To keep an idle more than 6 ms.

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

To read 2 words which start address is 0200h from device number 1 is described below.

Command(host):

ADR		01h
CMD		03h
DATA	**start address**	02h
		00h
	word length	00h
		02h
CRC_L		C5h
CRC_H		B3h

Response(slave):

ADR		01h
CMD		03h
DATA	**byte length**	04h
	address 0200h content	00h
		B1h
	address 0201h content	1Fh
		40h
CRC_L		A3h
CRC_H		D4h

Command code: 06h, write data

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

CRC(Cyclical Redundancy Check) is used to detect errors. The method is described below.

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

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

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

Step 4: Repeat step 3 until 8 shifts have been performed. When this is done, a complete 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.

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

Reading 2 words from address 0101h of the drive address 01H, the CRC is 3794H, the messages are shown. It should be noticed 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 6 ms.

CRC calculation example：
An CRC generator using C language is listed below. This code uses two variables and returns the CRC value as unsigned integer type.

```
unsigned char* data;
unsigned char length

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
06h	write

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

06h denotes data writing, a word length writing.

08h denotes the diagnostic mode which could check if communication normal or not.

Wrong commands, wrong address, over-range will cause the exception response.

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

01h denotes wrong command code transmitted from the host.

02h denotes wrong parameter address transmitted from the host.

03h denotes the over-range parameter setting request.

If the received data are wrong, the driver will send back the original command which but 80h is added to.

(a)ASCII mode

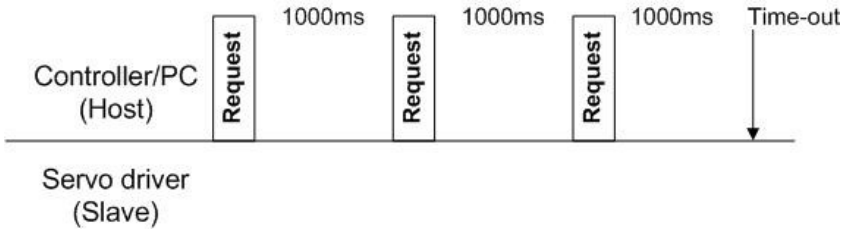
STX	':'
ADR	'0'
	'1'
CMD	'8'
	'6'
ECP	'0'
	'2'
LRC	'7'
	'7'
End1	CR
End0	LF

(b)RTU mode

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

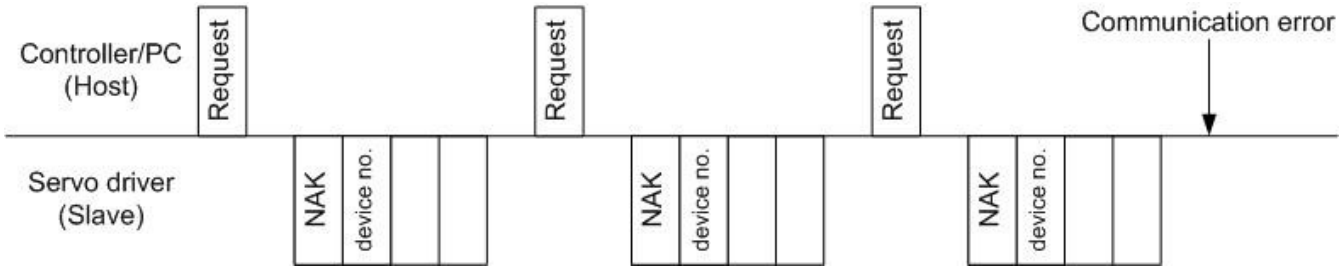
C. Time-out process

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



D. Retry process

If a communication fault occurs, the driver will response a exception code. In such case, host will retransmit same request which caused the last fault. An error will occur if the above operation is repeated and results in the same error three consecutive times.



8.4. Communication parameter write-in and read-out

(1) Status monitor (read only)

Address	Content	Data length
0000h	Cumulative feedback pulses [pulse]	1 word
0001h	Cumulative feedback turns [rev]	1 word
0002h	Cumulative command pulses [pulse]	1 word
0003h	Cumulative command turns [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 command voltage/Speed limit voltage [V]	1 word
0008h	Speed input command/Speed input limit [rpm]	1 word
0009h	Torque command voltage/Torque limit voltage [V]	1 word
000Ah	Torque input command/Torque input limit [N-m]	1 word
000Bh	Effective load ratio [%]	1 word
000Ch	Peak load ratio [%]	1 word
000Dh	DC bus voltage [V]	1 word
000Eh	Load to motor inertia ratio [times]	1 word
000Fh	Instantaneous torque [%]	1 word

(2) Digital IO monitor (read only)

(a) I/O 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) I/O 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**(*1)**				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**(*2)**					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					

(*1),(*2) : 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) 3: **S** mode 4: **T** mode	1 word

note 1: DO function option

Setting value	01h	02h	03h	-	05h	06h	07h	08h	-
Function sign	RD	ALM	INP/SA	-	TLC/VLC	MBR	WNG	ZSP	-

note 2: DI function option

Setting value	01h	02h	03h	04h	05h	06h	07h	08h
Function sign	SON	RES	PC	TL	TL1	SP1	SP2	SP3
Setting value	09h	0Ah	-	0Dh	0Eh	0Fh	10h	11h
Function sign	ST1/RS2	ST2/RS1	-	CM1	CM2	CR	CDP	LOP
Setting value	12h	-	18h	19h	-	-	-	-
Function sign	EMG	-	LSP	LSN	-	-	-	-

(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): PA04, PA08~PA11, PA15~PA38,PA41,PA44~PA45 are reserved parameters.

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

(*3): PC28~PC31, PC35~PB45 are reserved parameters.

(*4): PD22~PB30 are reserved parameters.

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

Address	Content	Data length
0621h	All parameters will 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	Reserved
DI signal	DI1	DI2	DI3	DI4	DI5	DI6	DI7	DI8	LSP	LSN	bit value must be “0”

NOTE : (DO forced output, JOG trial run, Position trial run)

1. No alarm occurred nor Servo ON activated, test mode could be performed.
2. If communication is interrupted over 1 second, the host could repeatedly read-out at address 0900h 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: Reserved 0002h: DO forced output 0003h: JOG trial run 0004h: Position trial run	1 word

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

To control DO status by particular written data. It is described as follows.

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 writing 0000h at address 0901h.

(9) JOG trial run (readable and writable)

Step 1: To write-in 0003h at address 0901h to perform this mode.

Step 2: To set acceleration/deceleration time constant of JOG trial run.

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

Step 3: JOG speed command(suitable for position trial run)

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

Step 4: 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 5: To quit this mode by writing 0000h at address 0901h.

(10) Positioning trial run (readable and writable)

Step 1: To write-in 0004h at address 0901h to perform this position trial run.

Step 2: To set the acceleration/deceleration time constant of position trial run.

Step 3: To set speed command of position trial run.(Refer to JOG trial run mentioned above)

Step 4: To set the revolution of position trial run.

Address	Content	Data length
0905h	Revolution of position trial run [rev] Setting range: 0~30000	1 word

Step 5: To set the pulse of position trial run.

Address	Content	Data length
0906h	Pulse of position trial run [pulse] Setting range: 0~9999	1 word

Step 6: Position trial run 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 7: To quit this mode by 0000h written at address “0901h”.

9. Inspection and maintenance

9.1. Basic inspection

It is recommended to inspect the following items periodically. Operate the inspection after the driver is power off and charge indicator is off.

- Inspect the screws of drive, terminal blocks 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 will 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 in maintenance.

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

9.3. Life of consumable components

Some components inside servo driver are consumable and must be replaced periodically. The life of consumable components are varied, which depend 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 will 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~ 30.000 hrs	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. Life of consumable components

The driver will display alarm or warning if some faults occurred during operation. If any alarm or 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	○		
	AL02	0	0	1	Low voltage	○	○	○
	AL03	0	1	1	Over current	○		
	AL04	0	1	0	Abnormal regeneration	○	○	○
	AL05	1	0	0	Overload 1	○	○	○
	AL06	1	0	1	Over speed	○	○	○
	AL07	1	0	1	Pulse command abnormal	○	○	○
	AL08	1	0	1	Position error excessive	○	○	○
	AL09	0	0	0	Communication abnormal	○	○	○
	AL0A	0	0	0	Communication time-out	○	○	○
	AL0B	1	1	0	Encoder error 1	○		
	AL0C	1	1	0	Encoder error 2	○		
	AL0D	1	1	0	Fan error	○		
	AL0E	0	0	0	IGBT overheat	○		
	AL0F	0	0	0	Memory error	○		
	AL10	0	0	0	Overload 2	○		
	AL11	1	1	1	Motor mismatched	○		
Warning	AL12				Emergency stop	Removing the cause will 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：The motor current has exceeded the allowance range of current of servo driver.

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.

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 command is too high.

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.

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 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 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 PC23 setting.	Check if PC23 setting is proper.	Set PC23 correctly.

AL0B Encoder error 1

Definition：Encoder pulse signals abnormal

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：Encoder pulse signals abnormal

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：Cooling fan of servo driver abnormal

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

AL0E IGBT overheat

Definition：IGBT power device of servo driver overheat

Cause	Inspection	Remedy
Operate the driver in over-rate duty continuously.	Check if mechanism is overload or motor current is huge.	Reduce load, or upgrade servo driver and motor a larger level.
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 parameter recovery or power on reset to check if it still null.	Contact agent for proper service.

AL10 Over load 2

Definition：Maximum current output duration 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. Manually adjust gain values.
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：Servo driver and motor match improperly.

Cause	Inspection	Remedy
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：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：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 driver

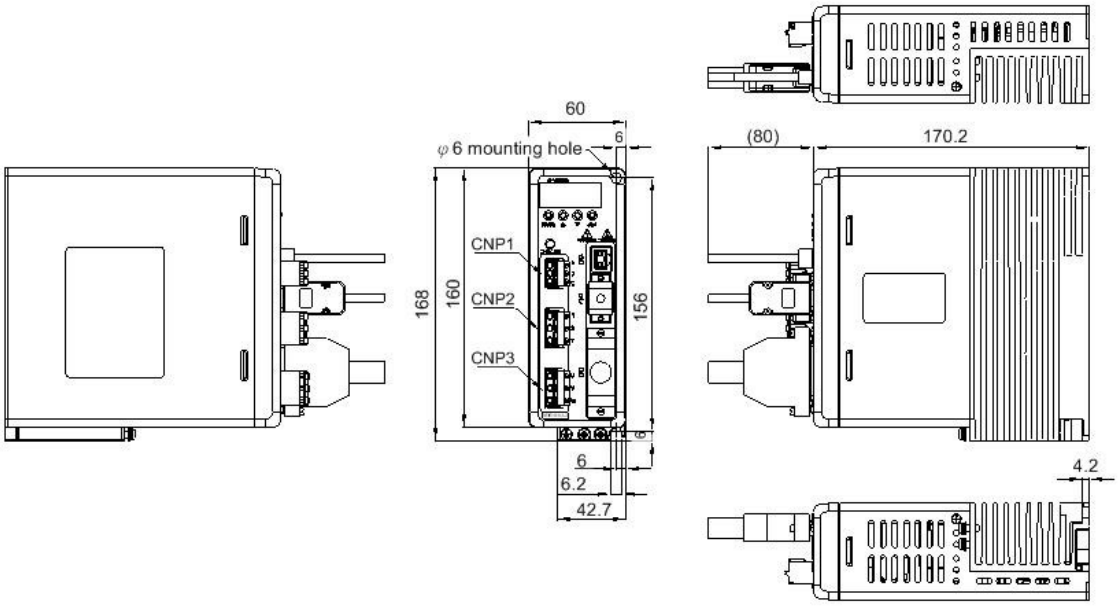
SDB-□□□A2			010	020	040	075
SMA-□□□□			L010	L020	L040	L075
Motor power			100W	200W	400W	750W
Main power	Voltage/Frequency	3φ	200~230VAC 50/60Hz			
		1φ	230VAC 50/60Hz			
	Voltage range	3φ	170~253VAC 50/60Hz			
		1φ	207~253VAC 50/60Hz			
	Allowable frequency range		Maximum ±5%			
Control mode			3φ full-wave rectification, IGBT-PWM control (SVPWM)			
Protection			Over current, over voltage, overload, fan fault, 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 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			
	Command smoothing		Low-pass filter			
	Electronic gear ratio		Electronic gear ratio A/B; 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%			
Speed 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/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℃~55℃; 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)			

SDB-□□□A2			010	020	040	075
SMA-□□□□			L010	L020	L040	L075
Motor power			100W	200W	400W	750W
I/O signal	Digital input(DI)		Servo ON, forward and reverse rotation limit switch, pulse error clear, torque direction option, speed command option, position command option, forward and reverse rotation command, proportional control switched, torque limit switched, abnormal reset, emergency stop, control mode option, 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			
Cooling method(structure)			Nature air convention(IP20)			Fan cooling(IP20)
Environment	Temperature	operating	0~55℃ (If it is above 45℃ forced cooling will be required)			
		storage	-20~65℃ (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 or flammable gas, no oil mist or dust			
	Altitude		Max.1000m (3280ft) or lower above sea level			
	Vibration		Maximum 59m/s^2			
Weight(kg)			1.4			1.7
Reference dimension figure			Page 132			Page 132
Approval			IEC/EN 61800-5-1			

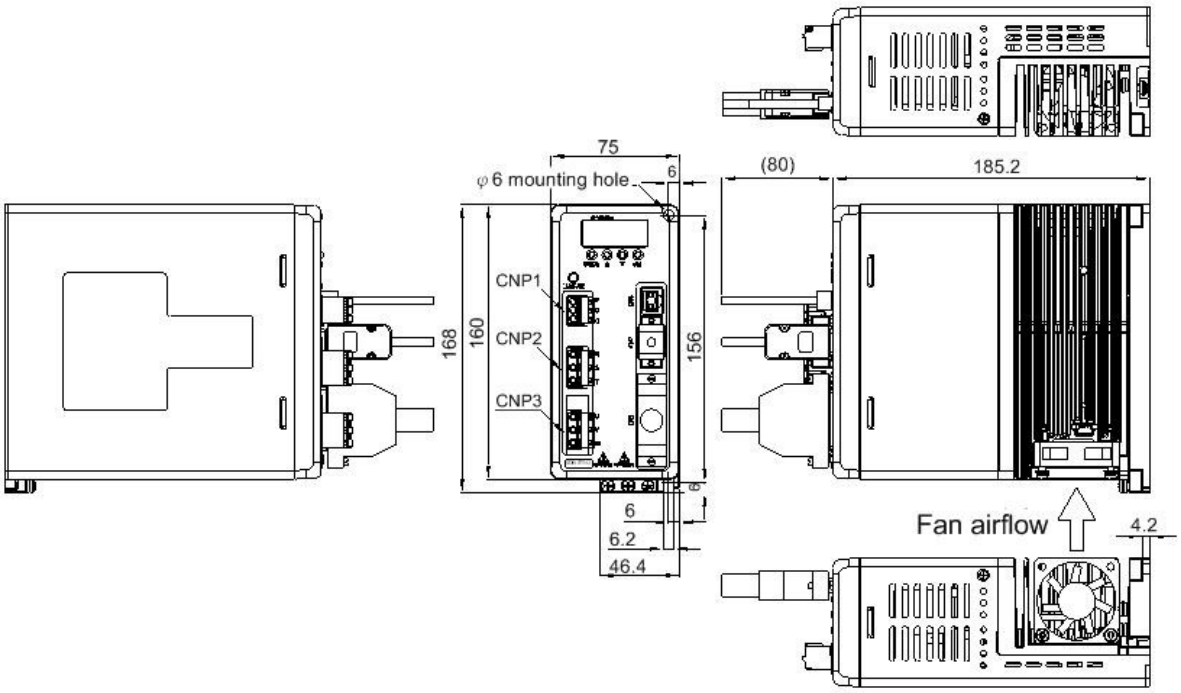
11.2. Dimensions of servo driver

SDB-010A2、SDB-020A2、SDB-040A2 (100W~400W)

unit : mm



SDB-075A2 (750W)



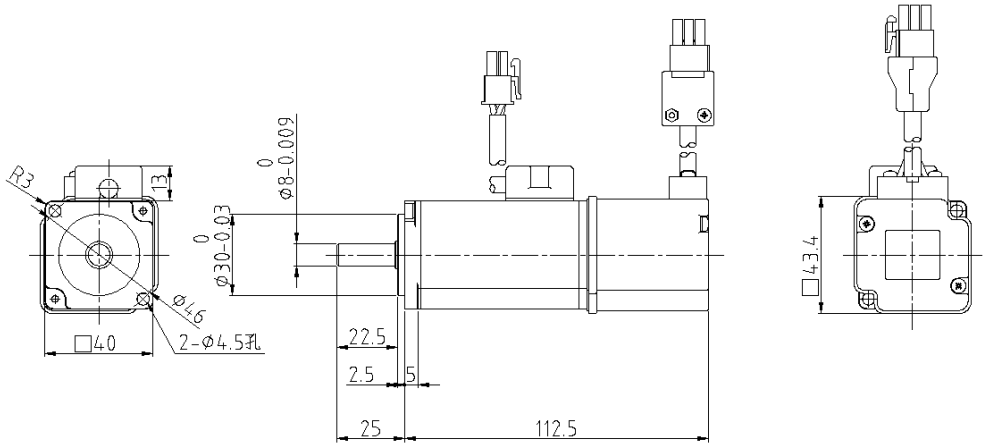
Dimensions of the servo drive may be revised without prior notice.

11.3. Specifications of low inertia motor SMA－L□□□R30A series

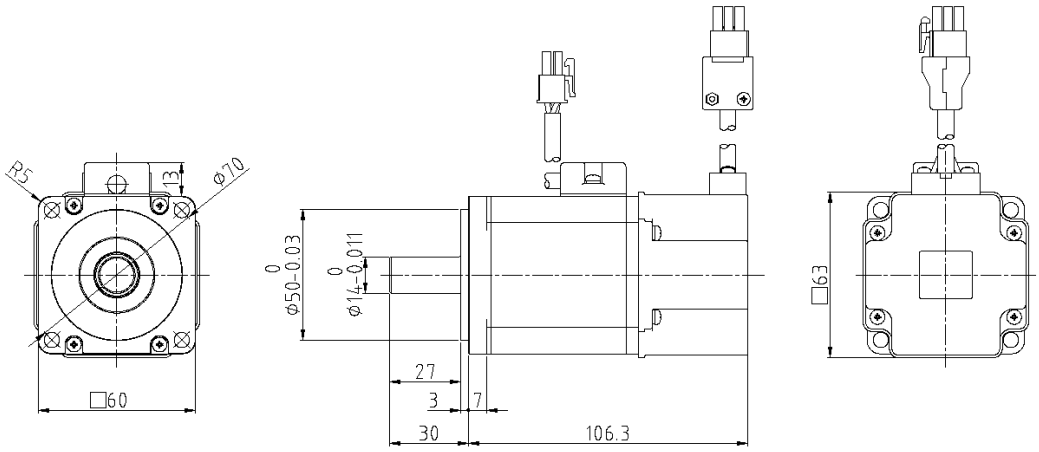
SMA-L□□□			010	020	040	075
Capacity of power supply (kVA)			0.3	0.5	0.9	1.3
Rated output power (W)			100	200	400	750
Rated torque (N-m)			0.32	0.64	1.27	2.40
Maximum torque (N-m)			0.96	1.92	3.81	7.20
Rated speed (r/min)			3000			
Maximum speed (r/min)			4500			
Instantaneous allowable speed (r/min)			5175			
Power rating (kW/S)			18.29	19.69	46.08	47.21
Rated current (A)			0.93	1.32	2.44	4.80
Max. instantaneous current (A)			2.79	3.96	7.32	14.70
Rotor inertia J ($x10^{-4}kg.m^2$)			0.056	0.208	0.350	1.380
Torque constant K_T (N-m/A)			0.344	0.485	0.521	0.490
Voltage constant K_E (mV/(r/min))			39.97	54.53	56.60	56.25
Armature resistance R_a(Ohm)			41.75	11.70	5.66	1.38
Armature inductance L_a(mH)			29.13	42.87	24.00	10.02
Mechanical constant (ms)			1.780	0.964	0.704	0.640
Electric constant (ms)			0.70	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℃			
		storage	-15~70℃			
	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) [ ] with electromagnetic brake			0.55 [0.75]	1.01 [1.44]	1.46 [1.89]	2.89 [3.63]
Approval			CE			

11.4. Dimensions of low inertia motor

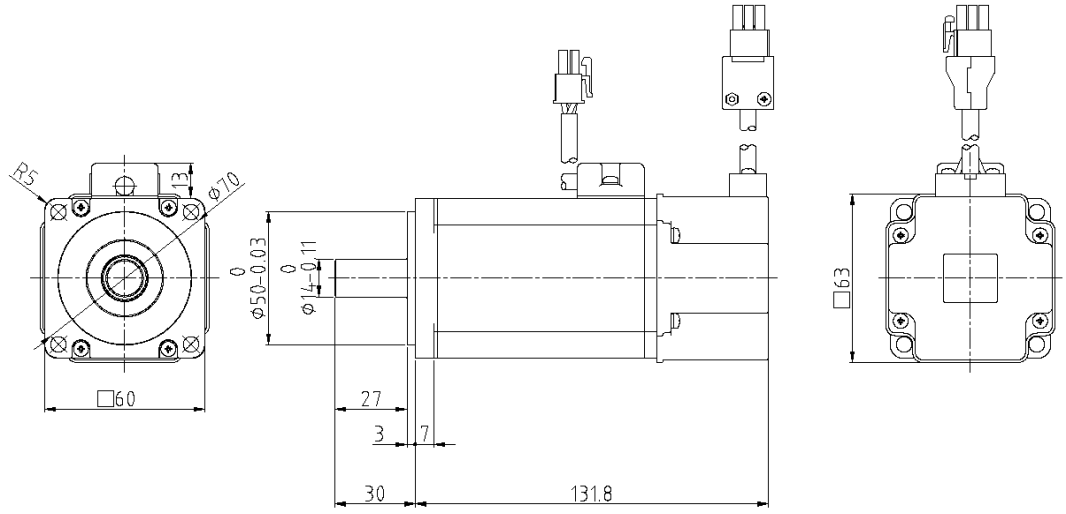
【SMA-L010】



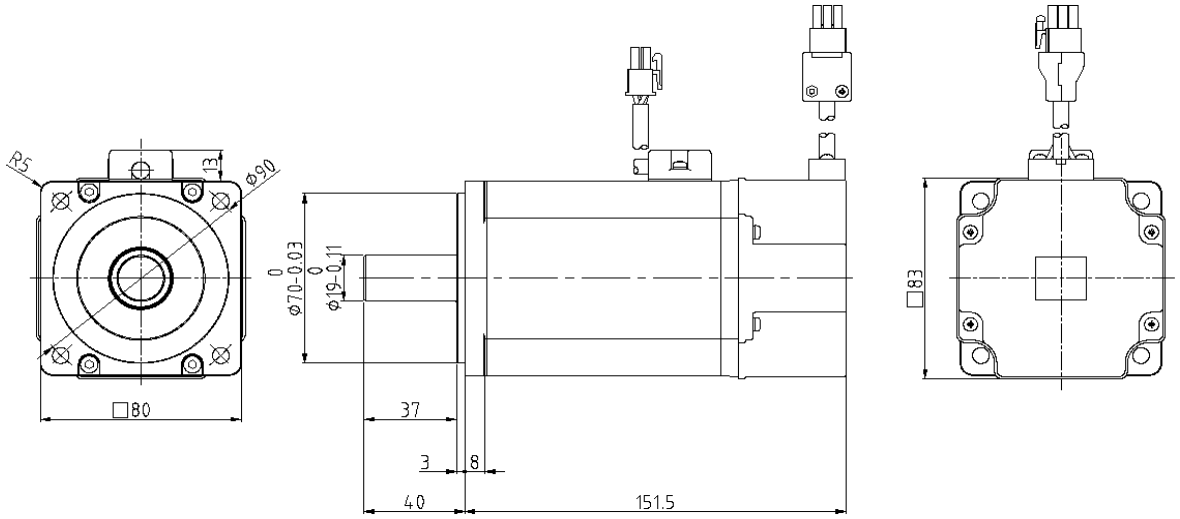
【SMA-L020】



【SMA-L040】

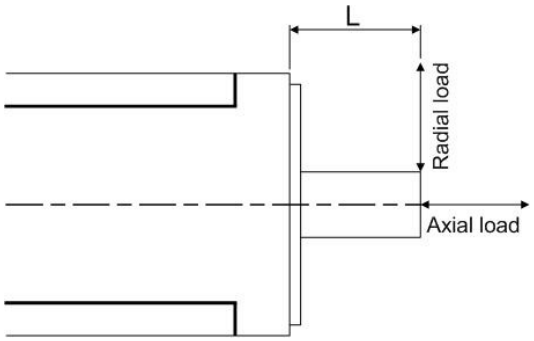


【SMA-L075】



11.5. Permissible shaft load of low inertia motor

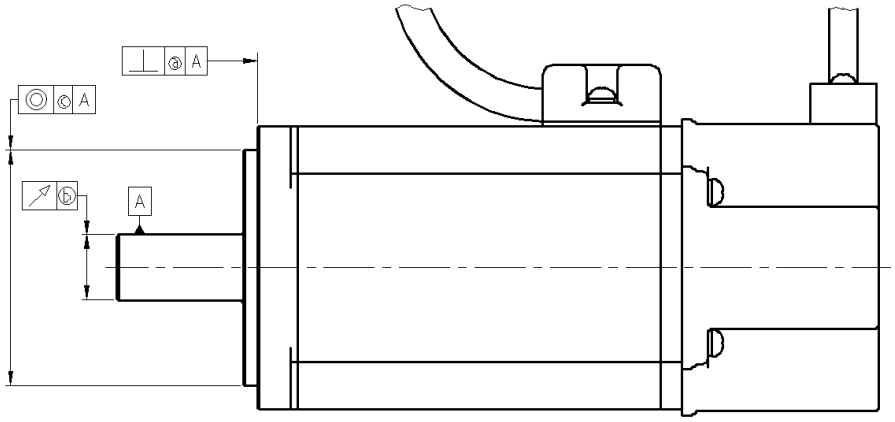
Motor type	SMA-M050	SMA-M100	SMA-M150	SMA-M200	SMA-M350
L (mm)	55	55	55	79	79
Permissible load in radial direction N(kgf)	490(50)	490(50)	490(50)	980(100)	980(100)
Permissible load in axial direction N(kgf)	196(20)	196(20)	196(20)	392(40)	392(40)



11.6. 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	ⓐ	0.05	0.06	0.08
Shaft deflection degree	ⓑ	0.02	0.02	0.03
Concentric grade of outer diameter to shaft	ⓒ	0.04	0.04	0.06



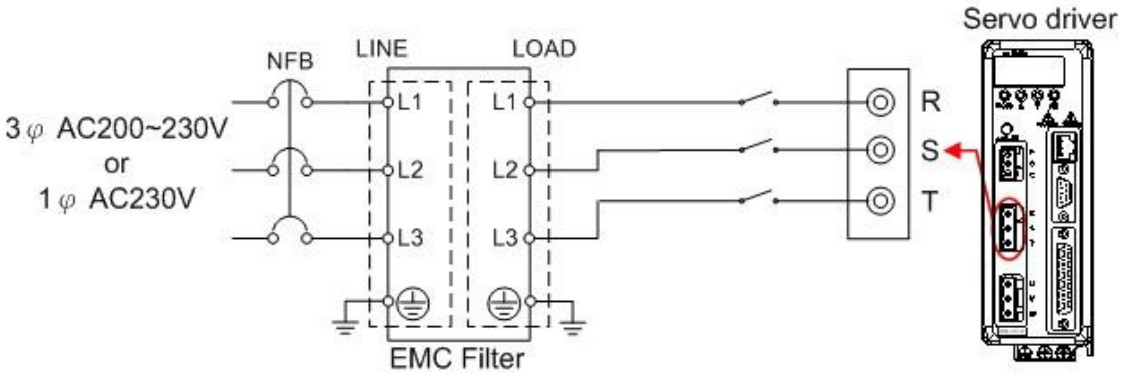
11.7. Electromagnetic compatible filter(EMC Filer)

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-075A2	750W	FN3258-16-45

◆ The filters are optional devices which are recommended to use if some EMI existed.

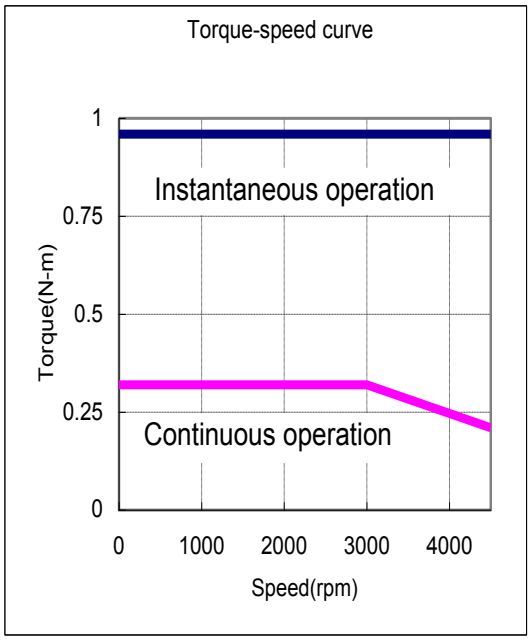
The wiring diagram for filter application is described below.



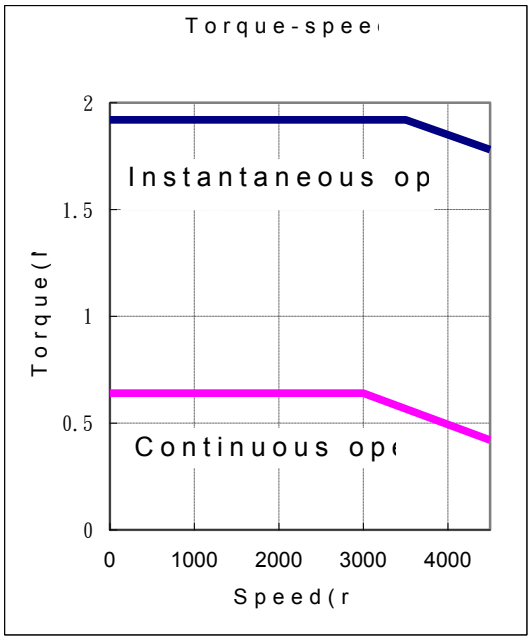
12. Motor characteristic

12.1. Speed-torque curves of low inertia motor

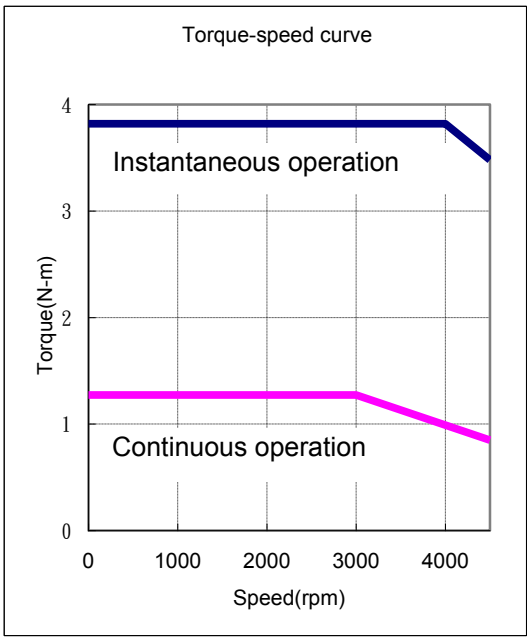
【SMA-L010】



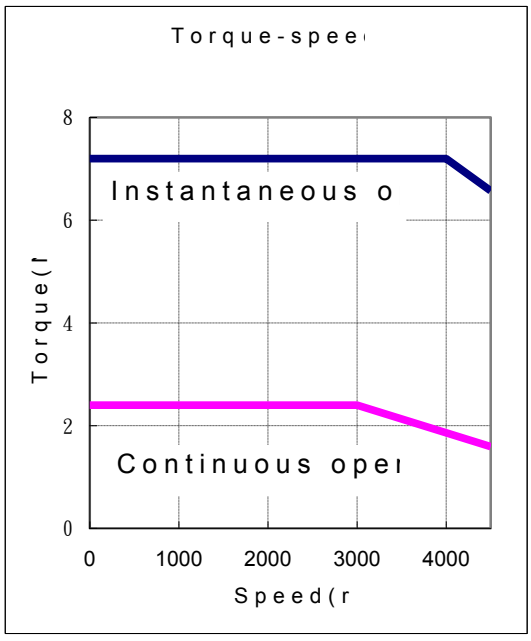
【SMA-L020】



【SMA-L040】



【SMA-L075】

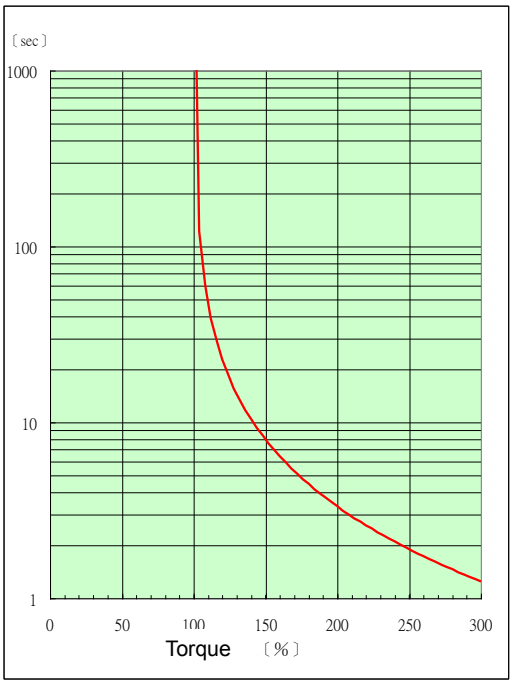


These characteristic curves are plotted with AC 3φ 200~230V power applied.

12.2. Overload protection

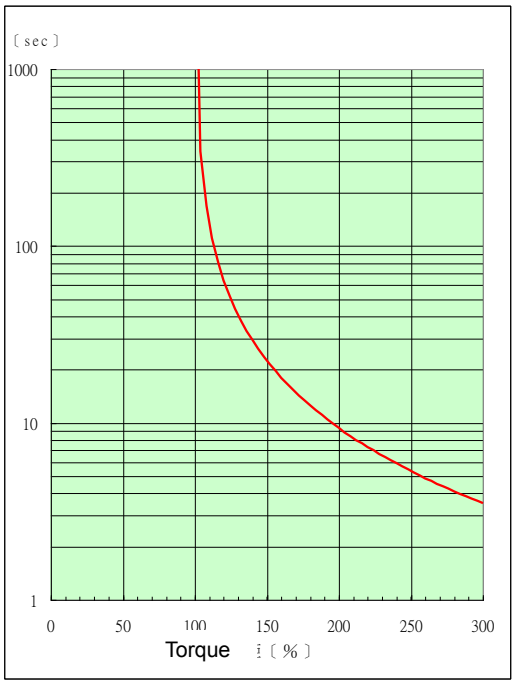
To prevent servo motor from damage while instantaneous over rated operation.
Some cases are described as follows.
(1) The load to motor inertia ratio is too large.
(2) During acceleration or deceleration process, the time constant is set too small.
(3) The operating time which torque generated over rated torque is too long.
(4) Mechanism vibration 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.

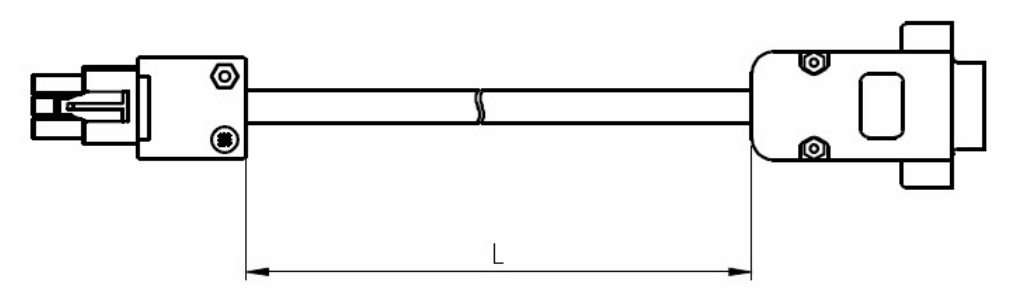
Appendix A: Accessories

Encoder connector

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

Encoder connector

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

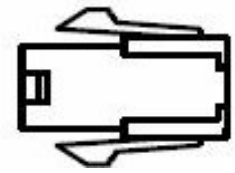


Type	Part number	L (mm)
2M low inertia encoder cable	SDA-ENLCBL2M-L	2000±100
5M low inertia encoder cable	SDA-ENLCBL5M-L	5000±100
10M low inertia encoder cable	SDA-ENLCBL10M-L	10000±100

Power connector

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

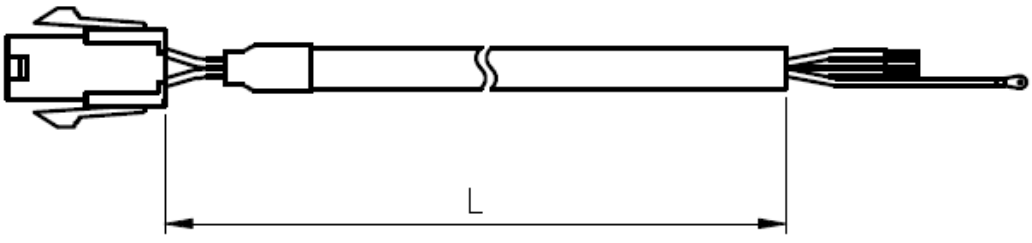
SDA-PWCNL2 (100W, 200W, 400W, 750W with electromagnetic brake)



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

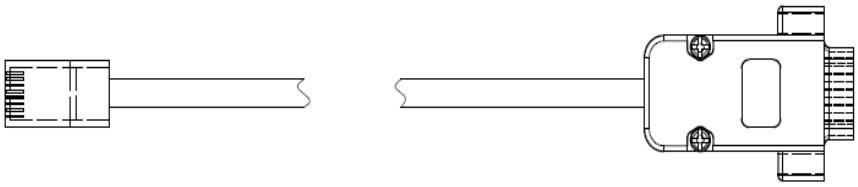


Power line specification table:

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

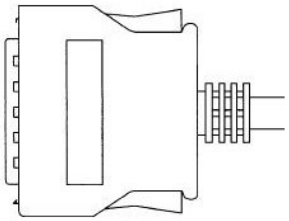
Shihlin part number: SDA-RJ45-3M



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

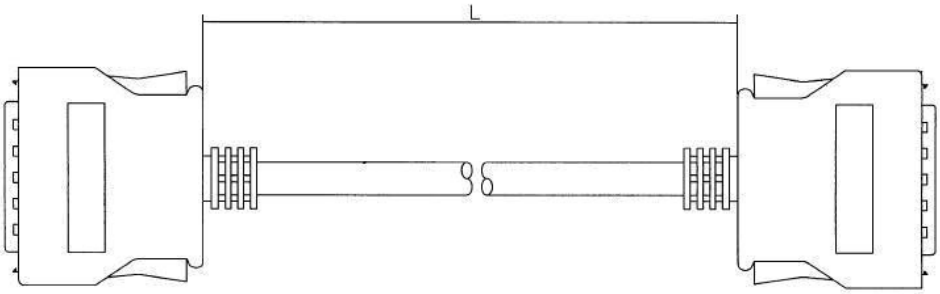
CN1 I/O connector

Shihlin part number: SDA-CN1



CN1 I/O control cable

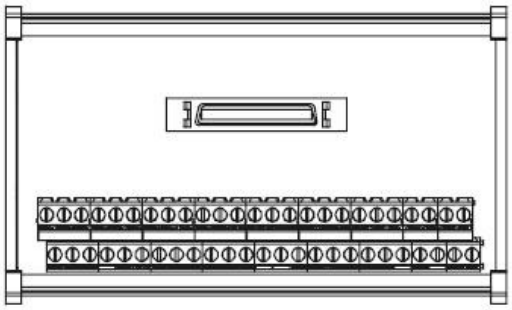
Shihlin part number: SDA-TBL05M, SDA-TBL1M, SDA-TBL2M



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)	
SDB-010A2	100	20	***100***	500	ABR-500W100
SDB-020A2	100	20	***100***	500	
SDB-040A2	100	20	***100***	500	
SDB-075A2	40	40	***40***	1000	ABR-1000W40

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

Appendix B: Parameter address

The address is expressed in hexadecimal.

PA group:

NO	Address	NO	Address	NO	Address	NO	Address	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	PA42	0329
PA07	0306	PA16	030F	PA25	0318	PA34	0321	PA43	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	NO	Address	NO	Address	NO	Address	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	NO	Address	NO	Address	NO	Address	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	NO	Address	NO	Address	NO	Address	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

Appendix C: Version information

Version: V1.08
Issue date: Aug. 2014
Proofreader: Yaochou Shu