



Maximum Value for OEMs<sup>SM</sup>



## CSDJ plus servo

### User Manual

- Thank you for purchasing Rockwell Samsung Automation CSDJ Plus Servo Drive.
- This user's manual explains handling method, repair, inspection, error diagnosis, troubleshooting and, specifications of the CSDJ Plus Servo Drive.
- Use the CSDJ Plus after completely understanding this user's manual.

## Precautions during Initial Setup

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When setting up the product, select Encoder Type (SEt-51), Motor Type (SEt-52), Motor Capacity (SEt-53), Control Mode (SEt-41) such as position, speed, and etc. after supplying the power.

\* After the change, turn off and on the power.

\* For detailed information, refer to Parameter List.

Error such as Control Impossibility or Encoder Open Error may occur if the parameter selection is incorrectly set as stated above.

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## General Precautions

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This user's manual may be changed without notice in case of product improvement or specification change, or for better understanding of the manual.

Use the user's manual included in the product purchased.

When re-ordering the user's manual due to damage or loss, contact company agency or an agency closeby recorded on the back of this manual.

Do not disassemble the servo drive. A/S is not provided for any accidents or damages caused by the disassembly or modification of the servo drive by the user.

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## Other Safety Precautions

- Install, operate, check and repair the product after reading and completely understanding the user's manual.  
Also, use the product after sufficiently understanding the safety information or surrounding specifications.
- After reading, make sure to keep the manual at an easy to reach place for easy access.
- User's manual records contents of safety specifications by categories of **Warning** and **Caution**.

### ATTENTION

: When handled incorrectly, dangerous situations may happen.



May cause severe or slight injuries, or cause only a product damage

### CAUTION

: When handled incorrectly, dangerous situation (electro caution) may occur.



May cause death or severe injury.

### CAUTION

- Even if the content is defined as  , serious result may occur depending on the situation. Make sure to follow the manual.

## Checking Product Status

### ATTENTION

**Do not install the servo drive, which is damaged or has missing parts.**

- It may cause injuries.



## Precautions during Installation

### Be careful in moving the product.

- Dropping on the foot may cause injuries.

### ATTENTION

**Use nonflammable such as metals in locations to place servo drive.**

- There may be a fire.



**When installing several servos in one location, by installing cooling fans and etc so the surrounding temperature is below 55°C.**

- Overheating may cause fire or other accidents.

## Precautions when Wiring

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**Operate only after checking that input power is off.**

- There may be electric shock or fire.

**ATTENTION**



**Only the electrician should do the wiring.**

- There may be electric shock or fire.

**In case of wiring emergency stop circuit, check the operation after wiring (Wiring responsibility is on the user.)**

- There may be injuries.

**Be sure to make the earth of grounding terminal.  
(Class 3 grounding)**

- There may be electric shock or fire.
- 

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**Cooling fin and electric discharge resistor over-heats, so do not touch with hands.**

- It may cause burns.

**ATTENTION**



**It is easy to change the speed of servo drive from low to high, thus operate after checking the motor and mechanical allowable limit.**

- There may be injuries.

**Do not check signal during the operation.**

- The product may be damaged.

**Each gain of this servo drive is properly set upon the delivery for the non-load operation. When changing the setting, pay extra caution.**

- The product may be damaged.
-

## Precautions when repairing

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**This servo drive has high voltage terminal, thus it is very dangerous. Do not touch it.**

- There may be electric shock.

**CAUTION**



**Repair and check after sufficient amount of time has passed after cutting off the main circuit power.**

- It is dangerous because power flows in the capacitor.

**Except for the people appointed, do not repair, check, nor replace the parts.**

- Before the operation, remove the metals (watch, ring, etc) from the body. Operate after preparing the tools to handle insulation. There may be electric shock.
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**Control board uses C-MOS. Be aware when handling it.**

**CAUTION**



**During being energized, do not exchange the wire or remove the connector and etc.**

- There may be injuries or damage in products.
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**Do not modify the production.**

- There may be electric shock or injuries.
- 

**CAUTION**



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# Overview and Specifications

Chapter 1 explains the basic information on CSDJ Plus Servo Drive such as features and standard specifications.

## **Main Features**

## **Preparations for Operation**

## **Hardware Features**

## **Standard Specifications**

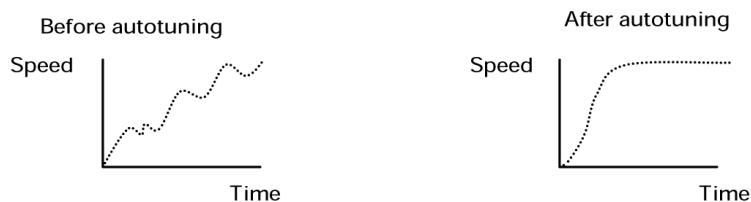


## Main Features

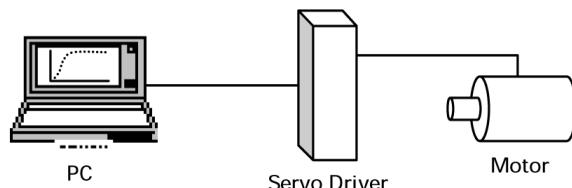
CSDJ Plus Servo Drive is an AC servo motor drive with full digital method, where high speed and precision control is possible, using 32 bit high speed DSP. Also, position control mode, speed control mode, torque control mode, and etc are provided so that the Drive can be used according to the needs and provides various types of I/O input and output. CSDJ Plus Servo Drive can provide the best control in its performance and function.

### Main features of the CSDJ Plus Servo Drive are as follows:

- Full digital control with high speed and accuracy is achieved by using the 32bit high speed DSP.
- Optimized the size by designing the servomotor to be 1/3 and the drive to be 1/5 of the previous model.
- It also includes the autotuning function, which allows the beginners to easily operate the system.



- The highly accurate control is possible with speed control range of 1:3000.
- With the various built-in functions such as compatibility with the PC S/W, it can be used in various ranges of applications.



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#### ATTENTION

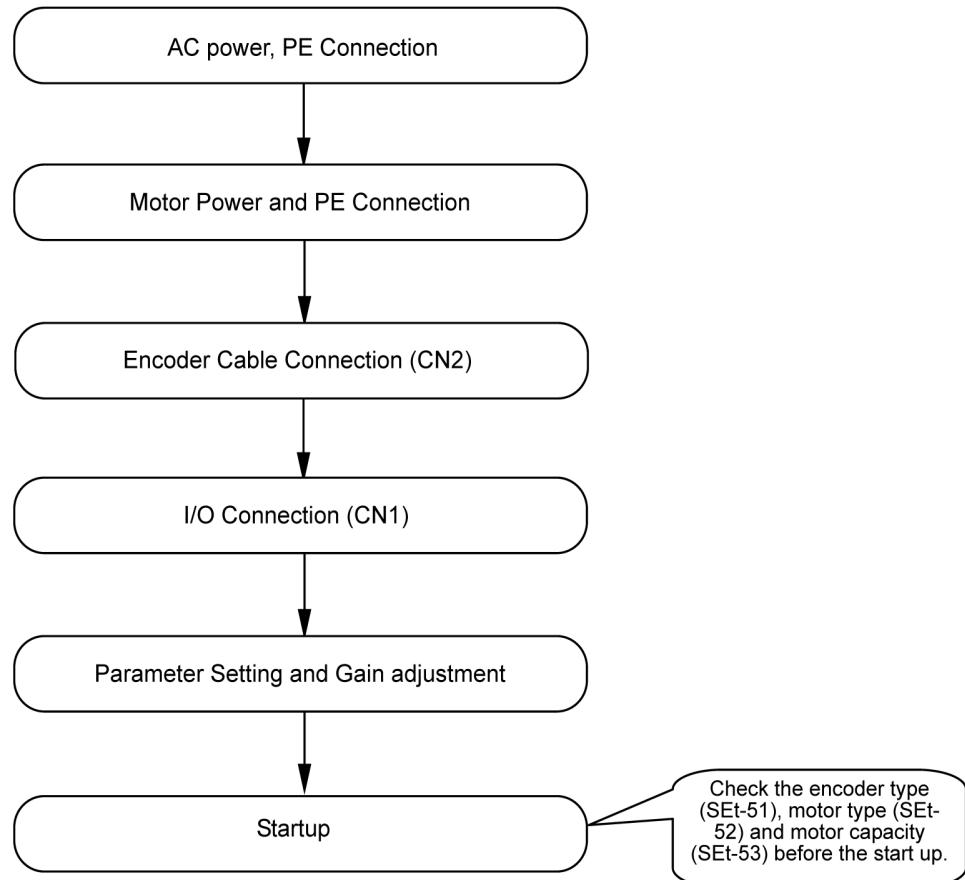


Do not disassemble the servo drive. A/S is not provided for any accidents or damages caused by the disassembly or modification of the servo drive by the user.

## Preparations for Operation

The block description below is the basic steps before operating the servo drive.

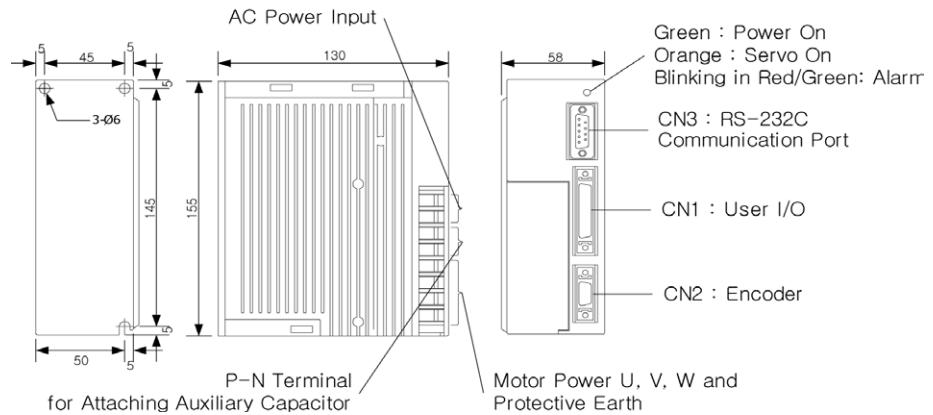
**Fig 1.1 Preparations for Operation**



## Hardware Features

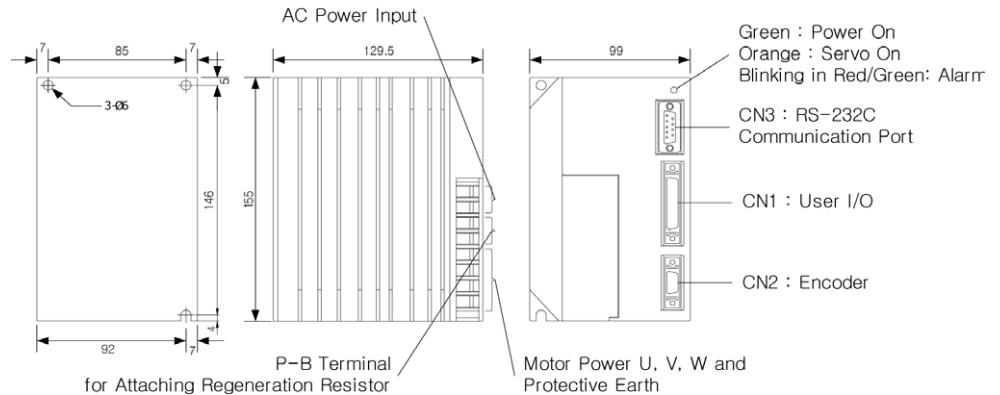
**Fig 1.2 Hardware Features (CSDJ-01B,02B,04B)**

CSDJ-01B, 02B, 04B



**Fig 1.3 Hardware Features (CSDJ-06B,10B)**

CSDJ-06B,10B



- \* Refer to the Table 2.1 for types and capacity of the motor for each drive.

# Standard Specifications

**Table 1.1 Standard Specifications of CSDJ Plus Servo Drive**

Basic Specification		Power Source *1	Single phase 220V + 10, -15% 50/60Hz	
Control Method		PWM control using IPM		
Encoder *2		2048 P/R (Incremental type)		
Operating Temperature/ Humidity		0°C~+55°C / 90% or less(non-condensing)		
Storing temperature/ Humidity		-20°C~+80°C / 90% or less (non-condensing)		
Vibration/Shock Resistance		Vibration 0.5G / Below shock 2G (1G = the acceleration of gravity. : 9.8m/s <sup>2</sup> )		
I/O Specification	Position	Output Spec.	Encoder A, B, Z pulse output (MC3487 line driver)	
		Freq. Dividing Ratio *3	N/M (N, M ≤ 8192)	
External Input		Servo On/Off, P control, Forward/Reverse rotation prohibition, Forward/Reverse rotation current limit, Alarm Reset.		
External Output		Brake control, Servo Alarm/Code(3bit), Speed Coincidence(Speed Control Mode), Position Completion(Position Control Mode), Z-Pulse(Open- Collector)		
Protection Function	Protection Function		Over-current, Overload, Over-voltage, Over speed, Inverter overheat, low voltage, CPU defect, Encoder defect, Communication error, and etc.	
	Dynamic Brake		Operating when Servo/Controller Off or Alarm (Built-in)	
	Regeneration *4		External auxiliary capacitor in case of 400W or less. External Regeneration resistor in case of 600W or more.(It can be connected if necessary)	
Monitoring	D/A Output	Speed	±1V/the value of SEt-08 [RPM] (max. ±10V)	
		Torque	±1V/ the value of SEt-09 [%] (max. ±10V)	
	External Display	LED	Power on, Servo run, Servo Alarm (applied in all models)	
	External Communication	Operator	Speed/Torque/Position command value, Electrical/Mechanical angle, Error value, Feedback value, Offset value, Load inertia ratio I/O status monitoring and etc.	
		PC-Software	All function of the operator	
<p>* 1) The Servo drive has the built- in DC power (300 V), thus separate DC power supply is not needed. (except the DC 24V power for external I/O.)</p> <p>* 2) Refer to Encoder Type Setting (SEt-51)</p> <p>* 3) Number of pulse greater than the number of encoder pulse cannot be output in one rotation of the motor.</p> <p>* 4) Regeneration energy is generated when motor decelerates. Regenerative energy, which can be absorbed just by the drive and the motor, differs according to the rotation speed and load inertia of the motor. Refer to Allowable Load Inertia</p>				

**Table 1.2 Control Specifications**

<b>Speed Control</b>	<b>Speed Input</b>	<b>Speed Control Range *1</b>		1:3,000			
		<b>Speed Variation *2</b>	<b>Load Variation</b>	0~100% : Below 0.01% (At rated speed)			
			<b>Line voltage Variation</b>	220VAC +10, -15% 50/60Hz : 0.01%			
		<b>Temperature Variation</b>	25 ± 25°C : Below ± 0.01% (At rated speed)				
		<b>Frequency Band width</b>	250Hz ( $J_L = J_M$ )				
		<b>Acceleration/Deceleration Time Setting</b>	0~60 sec				
<b>Monitoring</b>	<b>Speed/Torque Input</b>	<b>Speed</b>	<b>Rated Speed Command</b>	± 10VDC (Set to 6V from the rated speed when delivered)			
			<b>Input Impedance</b>	Approximately 50			
			<b>Circuit time constant</b>	Approximately 35			
		<b>Torque</b>	<b>Rated Torque Command</b>	± 10VDC (Set to 3V in rated torque when delivered)			
			<b>Input Impedance</b>	Approximately 50kΩ			
			<b>Circuit time constant</b>	Approximately 35μs			
<b>Feed Forward Compensation</b>			0~100% (Set Resolution : 1%)				
<b>Input Signal</b>	<b>Command Pulse</b>	<b>Type</b>	<ul style="list-style-type: none"> <li>- Sign + Pulse train</li> <li>- 90° Phase difference 2 phase pulse (A phase + B phase)</li> <li>- CCW Pulse + CW Pulse</li> </ul>				
			<b>Pulse Type</b>				
		<b>Pulse Frequency</b>	Line drive (+5V), Open collector (+5V, +12V, 24V)				
<b>Mounting Method</b>			Base mounted				
<b>Others</b>			Torque Control, Multi Step Speed Control, Zero-Clamp Speed Control, Speed/Speed Limit Torque ControlPosition/Torque Control, Position/Speed ControlTorque Limit Speed Control, Speed/Multi Step Speed Control, Soft-Start/Stop Speed Setting, Brake ControlJOG Operation, Auto Tuning, Reverse Operation and etc.				
<b>Caution</b>							
*1) In case of speed control, rotating in one direction at the lowest speed is possible.							
*2) Speed variation rate is defined as shown below.							
$\text{Speed variation rate} = \frac{\text{No load speed} - \text{Total load speed}}{\text{Rated Speed}} \times 100\%$							
<ul style="list-style-type: none"> <li>• Speed of the motor can vary depending on the control voltage variation or the voltage variation of the power amp caused by the temperature variation.</li> </ul>							
3) This is a speed/torque/position control built-in type drive.							
4) In case of motor, maximum allowable load inertia can be up to 30 times, when below 200W, and up to 20 times, when below 1kW. Be careful not to exceed the maximum allowable inertia of the motor.							



# Installation and Wiring

Chapter 2 explains installation precautions, how to install the product and how to handle noises when wiring.

## **Check Items upon Delivery of the Product**

### **External Terminal Block**

- Installing Servo Motor**
- Installation Location**

### **Wiring**

- Wiring Precautions**
- Wiring Diagram**

### **I/O Specification**

- CN1 (I/O Cable)**
- CN2 (Connector for Encoder Connection)**

### **Noise Protection**

- Wiring Precautions**
- Noise Filter**

### **Circuit Breaker**



## Check Items upon Delivery of the Product

Check the following items when the product is delivered.

1. Check if the correct product is delivered.  
(check with the specification table of servo motor and drive.)
2. Check if the product is damaged.
3. Check if the motor shaft rotates smoothly when turned by the hand.  
Check if it moves as if it's locked. (except for the motor with brake attached).
4. Check if the coupling part is loose.

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### ATTENTION

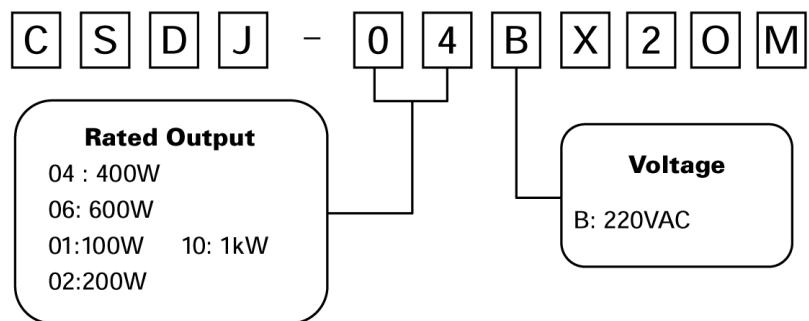


Contact the agency where you've purchased or the FA marketing department of Samsung Electronics for any problems.

Also, check if there is any loosening of various bolts or damage in lead wires or insulation materials.

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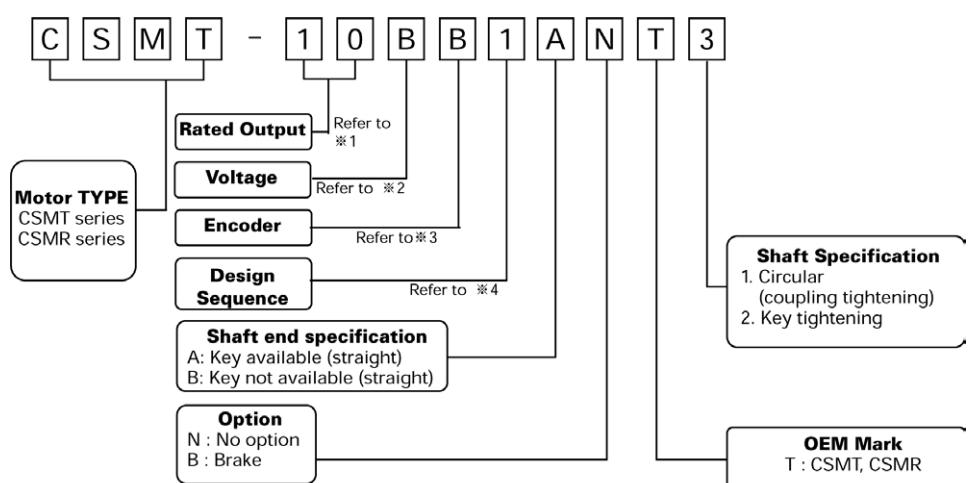
**Fig 2.1 Drive Display**



**Table 2.1 CSDJ Plus Rated Output and Applicable Motor**

<b>Motor Rated Output</b>	<b>CSMT</b>	<b>CSMR</b>
CSDJ-01BX2	30W 50W 100W	100W
CSDJ-02BX2	200W	200W
CSDJ-04BX2	400W	400W
CSDJ-06BX2	600W	*
CSDJ-10BX2	800W 1kW	*

**Fig 2.2 Motor Type Display**



**\* 1**  
**Rated Output**  
04 : 400W  
A5 : 50W  
01 : 100W 10 : 1Kw  
02 : 200W 50 : 5Kw

**\* 2**  
**Voltage**  
B : AC 220V

**\* 3**  
**Encoder (P/R : Pulse/Rotation)**  
CSMT, CSMR Series  
B : 2048 P/R brief Inc.

**IMPORTANT**

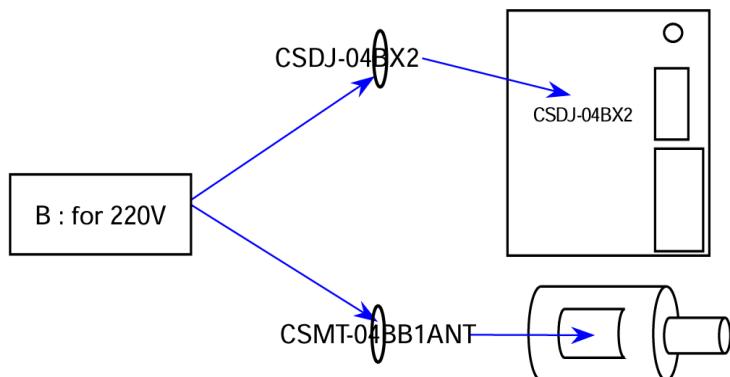
**Examples of Standard Model**

CSMT -01BB1ANT3

CSMT -01BB1ABT3

## Installation Precautions

Power voltage is available for 220VAC.



### CAUTION



Electricity remains in the product even if the power has been turned off. Operate 10 minutes after turning off the power.

## Installing Servo Motor

Installation of the AC servo motor is possible both horizontally and vertically. If the installation location or its environment is not appropriate, the life span of the motor may be reduced or may cause unexpected accidents. Install the system according to the procedures described below.

### Prior to Installation

- The rustproof paint is coated on the shaft end and the surface of the flange. Clean the paint using the thinner prior to the installation. To prevent the cover from peeling, be cautious the thinner is not applied to other parts. Be cautious when moving the motor because it may rust if the surface is scratched. Also, the encoder attached in the servo motor may be damaged from vibration or shock.

**Fig 2.3 AC Servo Motor**



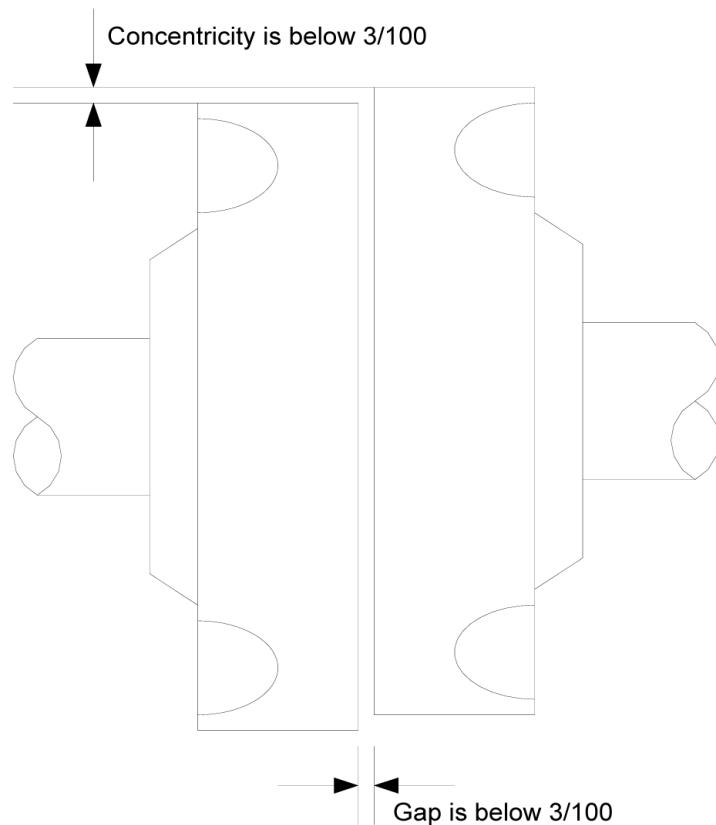
## Installation Location

- AC Servo motor is generally used in indoor. Operate the system under the following conditions.
  - Indoors where there is no corrosive or explosive gas.
  - Ambient temperature: 0 ~ +55 °C
  - Storing temperature: -20 ~ +80 °C
  - Humidity: 20 ~ 80% (non-condensing)
  - Place with good ventilation and no dust and humidity.
  - Place where maintenance and cleaning is easy.
- If there are water and oil drops in the surrounding, take appropriate action such as using cover etc.

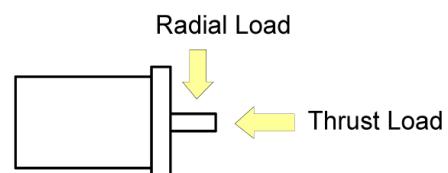
## Connection with load

- When connecting the load, user must align the motor shaft and the load axis. If the axes are not aligned, vibration and noise might occur and motor bearing can be damaged.

**Fig 2.4 Coupling**



- Excessive external shock can cause breakage of the bearing and the encoder of the motor. Use the key, which fits the key specifications and fix by using the standardized bolts.
- When operating by connecting directly to the load axis, use the flexible coupling.
- Make sure no excessive shock (below 50G) is given to the motor axis when using the gearbox, coupling, and pulley. When it is impossible to avoid such cases, be cautious not to exceed specified trust and radial load.



**Table 2.2 Allowable Load of the Motor**

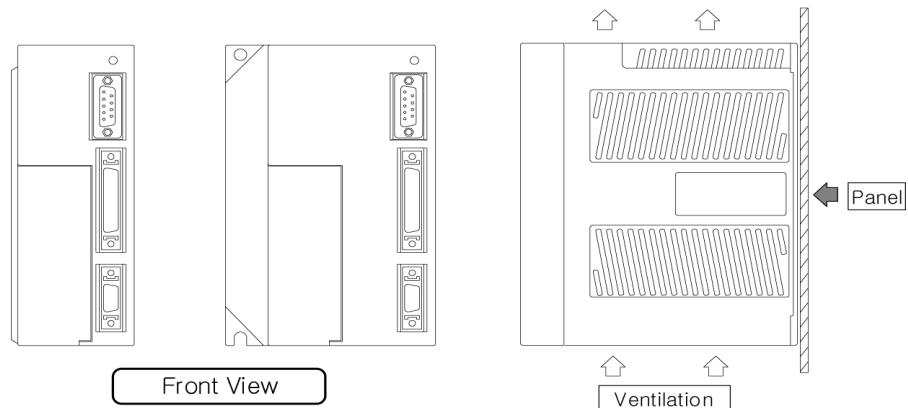
<b>Motor Type</b>	<b>Allowable Radial Load during Operation [kg f]</b>	<b>Allowable Thrust Load during Operation [kg f]</b>
CSMR-01A	8	4
CSMR-02A	20	7
CSMR-04A	20	7
CSMT-A3B	8	4
CSMT-A5B	8	4
CSMT-01B	8	4
CSMT-02B	20	7
CSMT-04B	20	7
CSMT-06B	35	10
CSMT-08B	35	10
CSMT-10B	35	10

## Installing Servo Drive

### Installation

- Servo drive is designed for base mounting type. For natural cooling effect, the vertical mounting is standard. Follow this mounting direction for cooling effect.

**Fig 2.5 Installation of Servo Drive (Wall mounting type)**



#### CAUTION

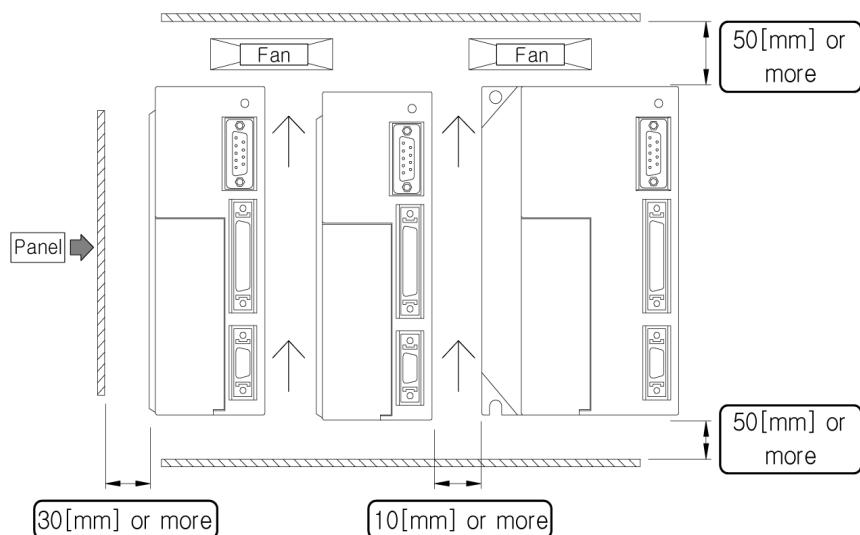


**Control board uses C-MOS. Be aware when handling it.**

- When touching with hand, the product may be damaged due to static electricity

- Also when installing the servo drive in rack or panel, if the ambient temperature is higher than the allowable limit, install the cooling fan and reconsider mechanical layout so it can be operated in allowable temperature (55 °C). Ambient temperature is closely related to the life span of the product. Use it in low temperature if possible.

**Fig 2.6 Installation of Servo Drive (Installing in the panel)**



- When the product must be installed at a location with vibrations, use the vibration-absorbing device, so it does not affect the servo drive directly.
- When corrosive gas exists in the surrounding, NFB, terminal block, and etc. may be rusted and connection defect may occur. This can be the cause of unexpected accidents. Avoid the usage in locations with high temperature, humidity, dust, iron, explosive gas, and etc.

## **Installation Environment**

- Install the product in the environment with the following specifications.
  - Indoors where there is no corrosive or explosive gas.
  - Ambient temperature: 0 ~ +55 °C
  - Storing temperature: -20 ~ +80 °C
  - Humidity: 20 ~ 80% (non-condensing)
  - Vibration: 0.5G (4.9m/s<sup>2</sup>) or less
  - Place with good ventilation and no dust and humidity.
  - Place where maintenance and cleaning is easy.
- If there are water and oil drops in the surrounding, take appropriate action such as using cover etc.

## **Other Precautions**

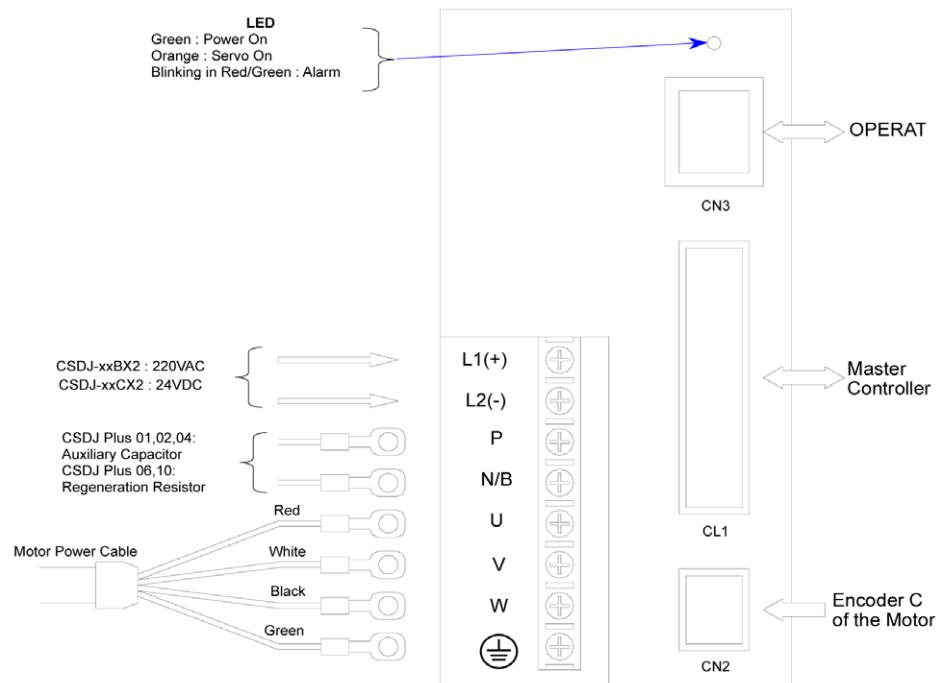
- Install the system with the following precautions.
  - Mount the product vertically on the wall using the bolt hole on the sides.
  - For the natural cooling effect, provide sufficient space around the system.
  - When series of servo drives are mounted in the panel, temperature distribution of the panel may not be uniform and this may cause the temperature rise.
- In such cases, install the cooling fan in the upper area of the panel as shown in Fig 2.6 and lower the temperature of the servo drive.

## External Terminal Block

**Table 2.3 Names of External Terminal Block of the CSDJ Plus**

Terminal Block		Function	Description
220VAC	24VDC		
L1	+	Main Power Input	L1,L2 : Single Phase 220VAC, -15% ~ +10%, 50/60Hz
L2	-		
P		P-N: Connection of Auxiliary Capacitor (In case of CSDJ Plus-01, 02, 04) P-B: Connection of External Regeneration Resistor (In case of CSDJ Plus-06, 10)	
B			
N			
U		Motor Power Cable	Red
V			White
W			Black
	Protective Earth		Connect to green/yellow motor cable and the power cable.

**Fig 2.7 Connection of External Terminal Block**



# **Wiring**

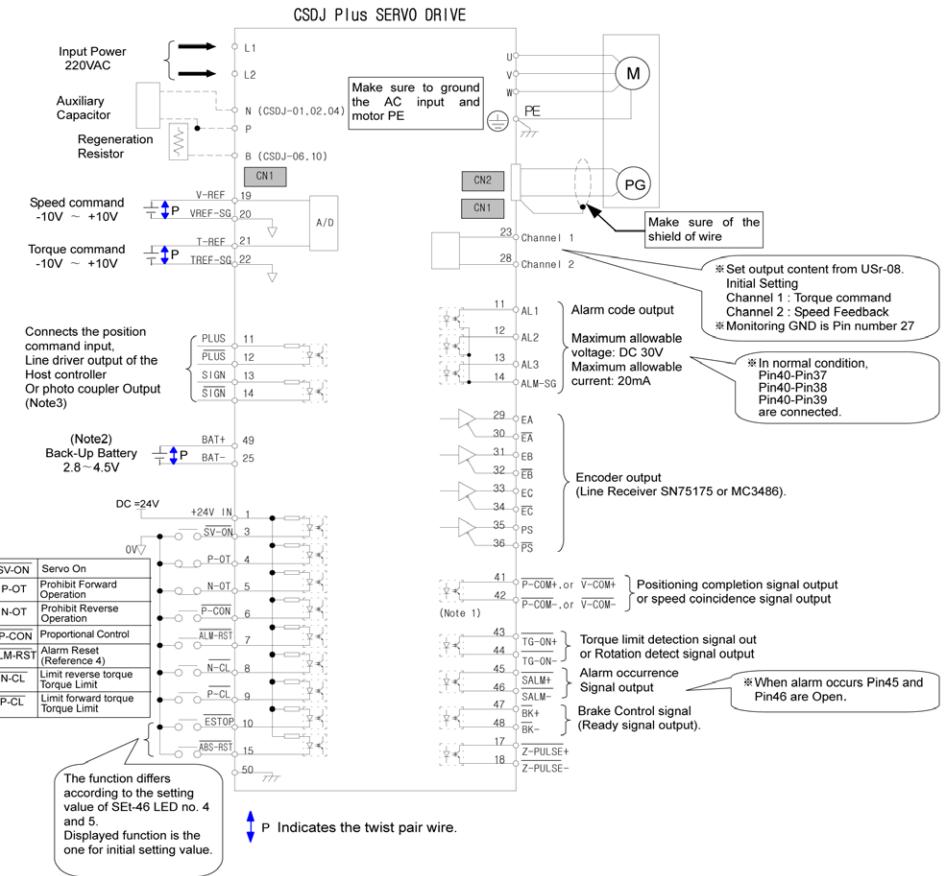
## **Wiring Precautions**

Using the high-speed controller with 3000:1 of precision, servo drive handles signals below small mV. Pay attention to the conditions listed below when wiring.

1. Multi-core twisted pair with overall wire shield must be used for the signal wire and position signal (CN1, CN2, CN3 connection wire). Thus use electric wire with the thickness of at least AWG26. Especially when the input of the position command in open collector method is provided by the host controller, multi-core twist pair shield wire must be used. Otherwise it may cause error in operations such as position shifting due to external noise.
2. If possible, use thick electrical wire for grounding and one point must be grounded. However, apply the class higher than 3 class. When isolating the motor and mechanical parts, ground the motor.
3. The maximum length of the wire for command input cable (CN1) is 3m and for the position sensor and motor power cable, its maximum length is 20m. Cut off excessive wires and use shortest wiring distance if possible.  
\* Contact the agency for long-distance wiring.
4. Pay attention to the following cases to prevent errors due to noise when operation the system.
  - Line filter, servo drive, motor, input devices should be installed as closely as possible.
  - Attach surge absorbing circuit for relay, wiring circuit breaker, electronic contactor, and etc. **Refer to Noise Protection.**
5. The heat sink of the servo drive can rise up to around 80°C Avoid the devices or wiring, which can be easily effected by the heat, from the servo drive.
6. Open unused signals and terminals. The system may be affected by the external noise if unused circuit is wired.
7. If the cable is not fixed in place and moves, utilize separate movable cable. The life span of the cable is around 2 years. Change the cable every 2 years.

# Wiring Diagram

**Fig 2.8 Wiring Diagram**

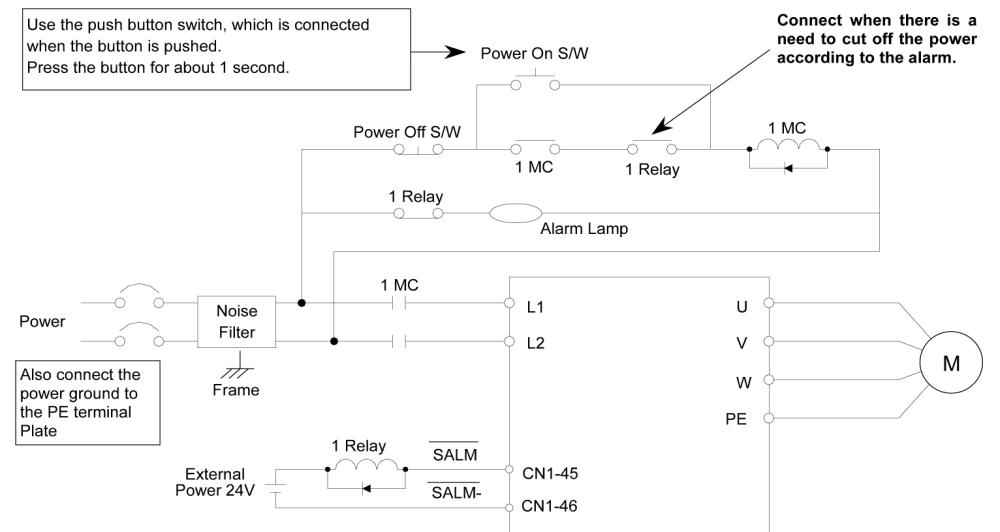


## IMPORTANT

1. Photo Coupler output capacity is below DC 30V 50mA.
2. Connect when utilizing absolute encoder.
3. When external power is above 5V, connect external resistor. System is tolerant to the noise if 24V power is used. (Refer to "Wiring"). Twisted pair shield wire must be used for position command pulse.
4. Alarm reset is effective only when the terminal is on. (This is Edge detection, not the Level.)
5. The function differs according to the setting value of SET-46 LED No.4 and 5. The image above represents the function according to the initial value set in SET-46 LED No.4 and 5. Refer to **User Parameter**.

The figure below is the example of wiring in main circuit of CSDJ Plus.

**Fig 2.9 Example of Wiring in Main Circuit**



ATTENTION



Do not turn on/off the power frequently. Because the servo drive has capacitor in the power part, large inrush current flows when the power is turned on. Thus, turning on/off the power frequently may cause the deterioration of the main power elements in the servo drive and may cause problems, such as reduced life span, and etc.

# I/O Specification

## CN1 (I/O Cable)

**Table 2.4 I/O Specification of CN1**

Pin No.	I/O Specification of CN1			Pin No.	I/O Specification of CN1		
	Signal	Color	Function		Signal	Color	Function
1	+24EXIT	Red	External 24V input	26	-	Pink 3Point	
2	+24EXIT	Yellow	SERVO ON/OFF input	27	SG-OV	Orange 3Point	SG(GND)
3	SV-ON	Blue	SERVO ON/OFF input	28	SM	Gray 2Point	Analog monitor channel 2
4	P-OT	White	Forward rotation prohibition	29	EA	Red 4Point	Encoder A Phase output
5	N-OT	Pink	Reverse rotation prohibition	30	EA	Yellow 4Point	Encoder $\bar{A}$ phase output
6	P-CON	Orange	Proportional control	31	EB	Blue 4Point	Encoder B phase output
7	ALM-RST	Gray	Alarm reset	32	$\bar{EB}$	White 4Point	Encoder $\bar{B}$ phase output
8	N-CL	Red 1Point	Reverse direction current limit input	33	EC	Pink 4Point	Encoder C phase output
9	P-CL	Yellow 1Point	Forward direction current Limit input	34	$\bar{EC}$	Orange 4Point	Encoder $\bar{C}$ phase output
10	E-STOP	Blue 1Point	Emergency stop	35	PS	Gray 4Point	Absolute encoder position DATA output
11	PULS+	White 1Point	Position pulse train input(+)	36	$\bar{PS}$	Red/ Line	Absolute encoder position DATA output
12	PULS-	Pink 1Point	Position pulse train input(-)	37	AL1	Yellow/ Line	Alarm code 1 output
13	SIGN+	Orange 1Point	Sign input(+)	38	AL2	Blue/ Line	Alarm code 2 output
14	SIGN-	Gray 1Point	Sign input(-)	39	AL3	White/ Line	Alarm code 3 output
15	ABS-RST	Red 2Point	Absolute encoder reset input	40	ALM-SG	Pink/ Line	Alarm code signal ground
16		Yellow 2Point	-	41	P-COM+ V-COM+	Orange/ Line	Positioning completion signal output (position control) Speed coincidence signal output(speed control)
17	Z-PULSE+	Blue 2Point	ENCODER $\bar{Z}$ phase open Collector output(+)	42	P-COM- V-COM-	Gray/ Line	Positioning completion signal output GND Speed coincidence signal output GND.
18	Z-PULSE-	White 2Point	ENCODER phase open collector output(-)	43	TG-ON+	Red/ Line1	Rotation detect (SET-43 LED No.4=0) Current limit detect (SET-43 LED No.4=1)
19	V-REF	Pink 2Point	Speed command input	44	TG-ON-	Yellow/ Line1	TG-ON GND
20	VREF-SG	Orange 2Point	Speed command input GND	45	SALM+	Blue/ Line1	Servo alarm occurrence signal output
21	T-REF	Gray 2Point	Torque command input	46	SALM-	White/ Line1	SERVO ALARM GND
22	TREF-SG	Red 3Point	Torque command input GND	47	BK+	Pink/ Line1	Brake control signal output (Ready signal output)
23	TM	Yellow 3Point	Analog monitor channel 1	48	BK-	Orange/ Line1	Brake control signal output GND (Ready signal output GND)
24		Blue 3Point	-	49	BAT+	Gray/ Line1	Absolute encoder battery+ (3.6V)
25	BAT-	White 3Point	Absolute encoder battery-	50	PE	Green (Shield)	PROTECTIVE EARTH

The color of I/O Cable wire can be changed

The functions of pin 10 and 15 of CN1 differ according to the setting value of SEt-46 No.4 and 5. Functions marked in the table above are the one based on initial value set in SEt-46 No.4 and 5. Refer to SEt-46 of user constant list.

P-CON P-CL and N-CL functions differ according to the control mode. Refer to the table shown below.

**Table 2.5 I/O With Different Functions for Each Control Mode**

CN1 Pin No.	8	9	6																						
Signal	N-CL	P-CL	P-CON																						
Control Mode	<b>Speed Control (SEt-41 = 10)</b>	Reverse Rotation Current Limit Command	ON : Reverse Rotation OFF : Forward Rotation																						
	<b>Manual Zero-Clamp Speed Control (SEt-41 = 4)</b>		ON : Zero-clamp Operation OFF : Zero-clamp not Counted																						
	<b>Automatic Zero-Clamp Speed Control (SEt-41 = 5)</b>		ON : P Control OFF : PI Control																						
	<b>Multi-step Speed Control (SEt-41 = 3)</b>	Multi-step Speed Command																							
	<table border="1"> <thead> <tr> <th>Speed Command</th> <th>P-CL</th> <th>N-CL</th> <th>CNI No.10 PIN or CNI No.15 PIN</th> </tr> </thead> <tbody> <tr> <td>1st Step Speed (setting value of SEt-26)</td> <td>OFF</td> <td>ON</td> <td>OFF</td> </tr> <tr> <td>2nd Step Speed (setting value of SEt-27)</td> <td>ON</td> <td>OFF</td> <td>OFF</td> </tr> <tr> <td>3rd Step Speed (setting value of SEt-28)</td> <td>ON</td> <td>ON</td> <td>OFF</td> </tr> <tr> <td>*4th Step Speed (setting value of SEt-25)</td> <td>-</td> <td>-</td> <td>ON</td> </tr> <tr> <td>Stop</td> <td>OFF</td> <td>OFF</td> <td>OFF</td> </tr> </tbody> </table>	Speed Command	P-CL	N-CL	CNI No.10 PIN or CNI No.15 PIN	1st Step Speed (setting value of SEt-26)	OFF	ON	OFF	2nd Step Speed (setting value of SEt-27)	ON	OFF	OFF	3rd Step Speed (setting value of SEt-28)	ON	ON	OFF	*4th Step Speed (setting value of SEt-25)	-	-	ON	Stop	OFF	OFF	OFF
Speed Command	P-CL	N-CL	CNI No.10 PIN or CNI No.15 PIN																						
1st Step Speed (setting value of SEt-26)	OFF	ON	OFF																						
2nd Step Speed (setting value of SEt-27)	ON	OFF	OFF																						
3rd Step Speed (setting value of SEt-28)	ON	ON	OFF																						
*4th Step Speed (setting value of SEt-25)	-	-	ON																						
Stop	OFF	OFF	OFF																						
<b>Torque Control (SEt-41 = 2)</b>	Reverse Rotation Current Limit Command	-																							
<b>Speed/Speed Limit Torque Control (SEt-41 = 6)</b>		ON : Speed Control OFF : Torque Control with Speed limit																							
<b>Position Control (SEt-41 = 0)</b>		ON : P Control OFF : PI Control																							
<b>Speed/Multi-step Speed Control (SEt-41 = 14)</b>	Multi-step Speed Command																								
<table border="1"> <thead> <tr> <th>Speed Command</th> <th>P-CL</th> <th>N-CL</th> <th>CNI No.10 PIN or CNI No.15 PIN</th> </tr> </thead> <tbody> <tr> <td>1st Step Speed (setting value of SEt-26)</td> <td>OFF</td> <td>ON</td> <td>OFF</td> </tr> <tr> <td>2nd Step Speed (setting value of SEt-27)</td> <td>ON</td> <td>OFF</td> <td>OFF</td> </tr> <tr> <td>3rd Step Speed (setting value of SEt-28)</td> <td>ON</td> <td>ON</td> <td>OFF</td> </tr> <tr> <td>*4th Step Speed (setting value of SEt-25)</td> <td>-</td> <td>-</td> <td>ON</td> </tr> <tr> <td>Stop</td> <td>OFF</td> <td>OFF</td> <td>OFF</td> </tr> </tbody> </table>	Speed Command	P-CL	N-CL	CNI No.10 PIN or CNI No.15 PIN	1st Step Speed (setting value of SEt-26)	OFF	ON	OFF	2nd Step Speed (setting value of SEt-27)	ON	OFF	OFF	3rd Step Speed (setting value of SEt-28)	ON	ON	OFF	*4th Step Speed (setting value of SEt-25)	-	-	ON	Stop	OFF	OFF	OFF	ON : Speed Control OFF : Multi-step Speed Control  *4th Step Speed → See P6-10
Speed Command	P-CL	N-CL	CNI No.10 PIN or CNI No.15 PIN																						
1st Step Speed (setting value of SEt-26)	OFF	ON	OFF																						
2nd Step Speed (setting value of SEt-27)	ON	OFF	OFF																						
3rd Step Speed (setting value of SEt-28)	ON	ON	OFF																						
*4th Step Speed (setting value of SEt-25)	-	-	ON																						
Stop	OFF	OFF	OFF																						
	<b>Position/Speed Control (SEt-41 = 8)</b>	Reverse Rotation Current Limit Command	ON : Speed Control OFF: Position Control																						
	<b>Position/Torque Control (SEt-41 = 7)</b>		ON : Torque Control OFF : Position Control																						
	<b>Analog Torque Limit Speed Control (SEt-41 = 12)</b>		ON : Analog Torque Limit Enable OFF : Analog Torque Limit Disable																						

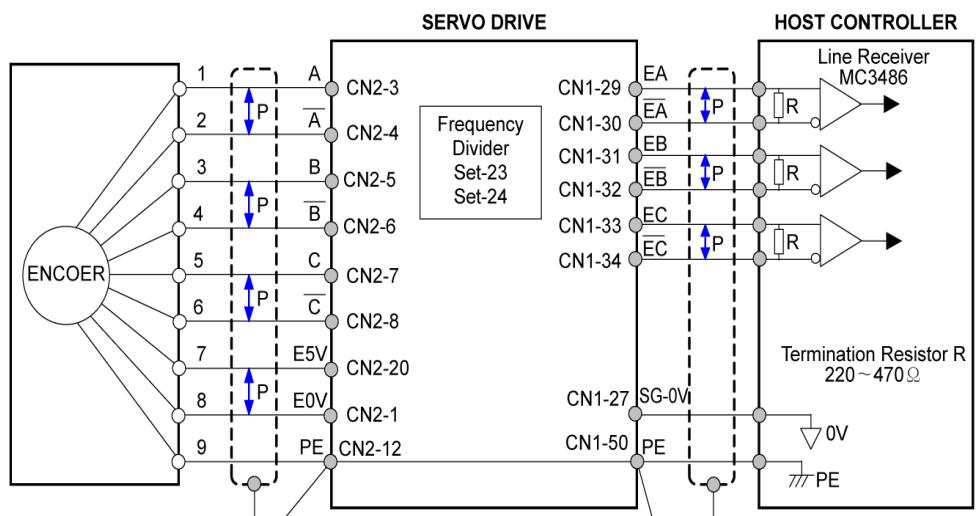
## CN2 (Connector for Encoder Connection)

**Table 2.6 Connection of Encoder Connector**

DRIVE		MOTOR
Pin No.	Function	CSMT/CSMR
		Incremental
		9 Wire
1	E0V	8
2		
3	A	1
4	$\bar{A}$	2
5	B	3
6	$\bar{B}$	4
7	C	5
8	$\bar{C}$	6
9		
10	U/RX	
11	RST	
12	PE	9
13	$\bar{U}/\bar{R}\bar{X}$	
14	V	
15	$\bar{V}$	
16	W	
17	$\bar{W}$	
18	BAT+	
19	BAT-	
20	E5V	7

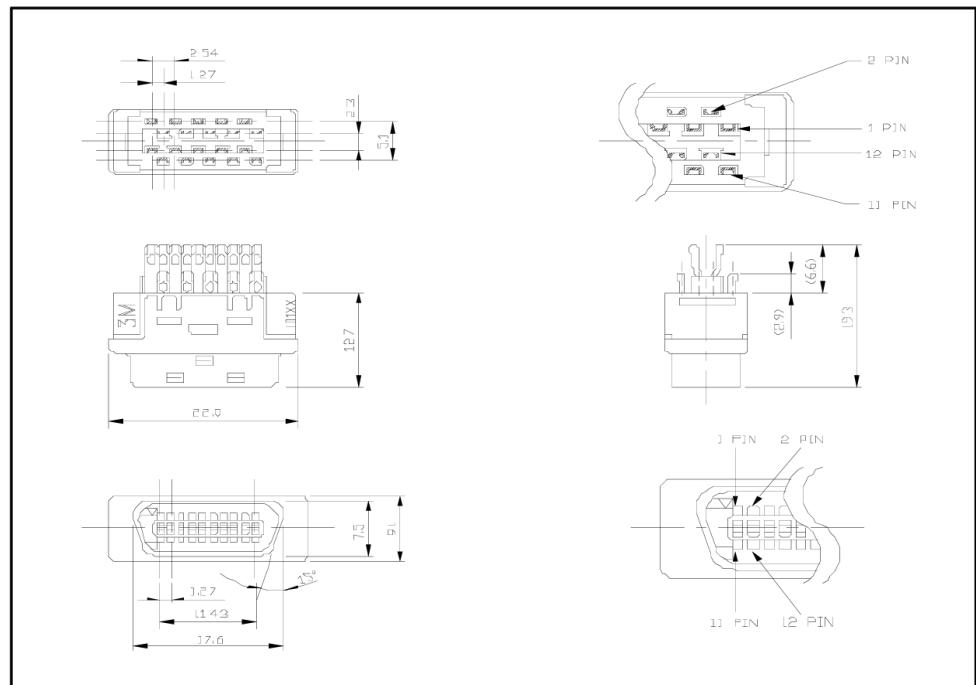
Do not connect the unused signal wire. Otherwise, it may cause error in operation or damage due to external noise.

**Fig 2.10 9 Wire Incremental Encoder Connection Method of Motor (Setting Value of SET-51 = 1, refer to 7.6)**



Do not connect the PE of the servo drive to the host controller when signal GND of the host controller and PE are connected, or when there isn't a separate PE.

**Fig 2.11 Shape and PIN Number of CN2(Encoder Connector)**



## Noise Protection

Inverter and SMPS in power part inside the servo drive operate the switching operation in high frequency during the operation. The  $di/dt, dv/dt$  (switching noise) which occurs by inverter operation, are seldom affected by the connection and grounding methods.

## Wiring Precautions

Use the specified cables for encoder cable and command input.

Keep the wiring distance as short as possible by cutting off the excessive wire.

Wiring for grounding must be done with thick wire if possible. (More than  $2.0\text{ mm}^2$ )

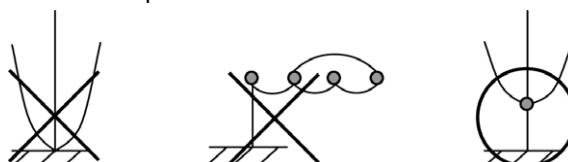


Class 3 grounding (grounding resistance is lower than  $100\Omega$ ) is recommended.

### ATTENTION

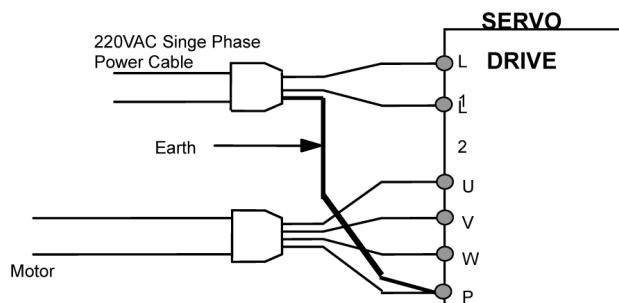


One point grounding must be done. In other words, do not make the loops.



Make sure there is no bending or tensions in the wire.

Make sure to connect the Earth terminal (PE) of the motor and the servo drive.



Do not connect the unused signal wire.

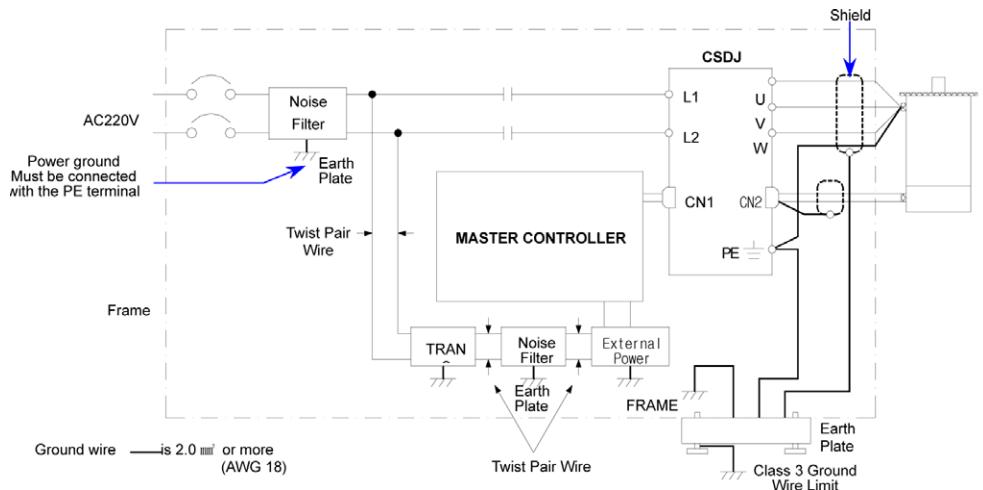
### ATTENTION



Use noise filter in radio noise.

Servo drive is for the industrial use and does not include the radio noise protection.

**Fig 2.12 Grounding and Noise Filter for Noise Reduction**



## Noise Filter

Noise filter should be located as close as possible to the drive. Make sure to check the current capacity of the noise filter. Recommended noise filter is shown in the following table.

**Table 2.7 Recommended Noise Filter**

Power Supply	Servo Drive	Recommended Noise Filter	Recommended Noise Filter	
			Model Name	Noise Filter Spec.
Single Phase 220VAC	CSDJ-0102B		NFR-205TS	250V/5A
	CSDJ-0406B		NFR-210TS	250V/10A
	CSDJ-10B		NFR-220TS	250V/20A

When using several servos, one noise filter could be shared.

However, utilize the noise filter with appropriate capacity, which fits the capacity for several servos.

\* Samil Components Co., Ltd

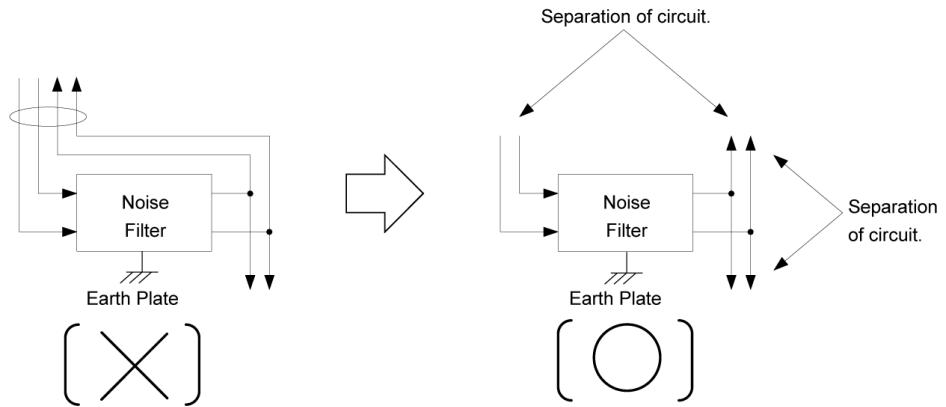
Tel. 82-2-478-6800~4

Fax. 82-2-476-3200

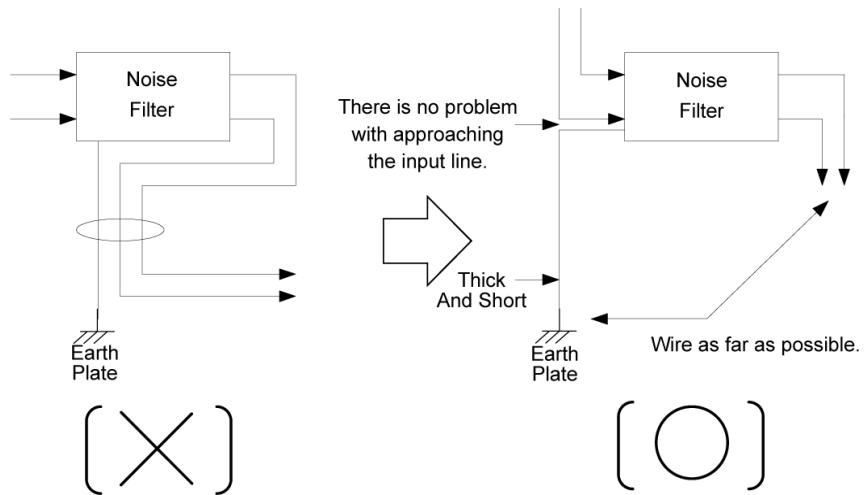
<http://www.samilemc.com>

### • Wiring Noise Filter

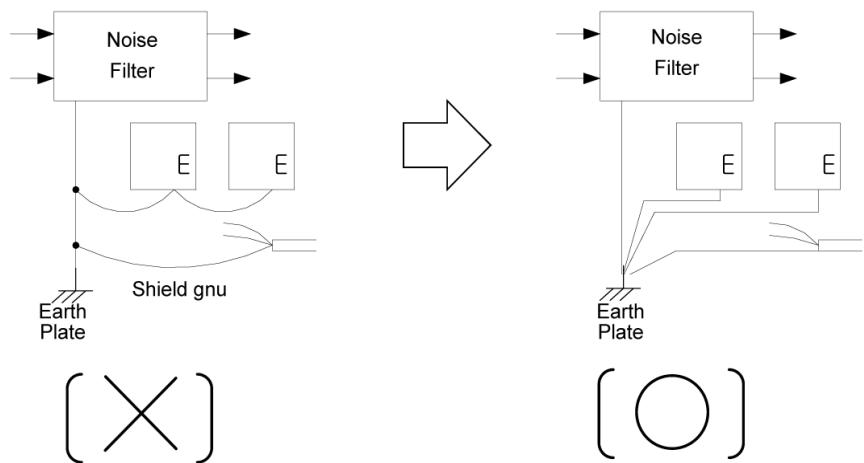
- Separate the input and output wiring.
- Do not put input and output wires in a same duct.



- Earth wire of the noise filter should be wired in distance to the output wire.



- Each wire of the filter should be solely attached in the earth panel.



## Circuit Breaker

CSDJ Plus Servo Drive uses general power source (Single phase 220VAC, 50/60Hz). For system protection from grounding accident, contact accident, electric leakage and the case of the fire, install the CP (Circuit Protector) or the fuse with capacity provided in the table below.

In case of using several servos, circuit breaker for wiring could be shared. The capacity of the circuit breaker should be set by the total amount of servo drive capacity.

### ATTENTION



Since the inrush current flows when the CSDJ Plus Servo Drive capacitor power is charged, do not use the high speed-break fuse.

Also, for checking up on an accidents, use NFB (No Fuse Breaker) in power input wire.

**Table 2.8 Capacity of Circuit Breaker and Fuse**

Power Supply	Servo Drive	Servo Drive Power Capacity (KVA)	MCCB/FUSE Current Capacity (A)	NFB Capacity	Inrush Current
220VAC	CSDJ-01BX2	0.286	220V/3A	30A	30A
	CSDJ-02BX2	0.44			
	CSDJ-04BX2	0.726	220V/6A		
	CSDJ-06BX2	1.54	220V/9A		
	CSDJ-10BX2	1.716	220V/14A		

1. Data in above table are the rated load capacity.
2. Over-current feature (25°C) : Over 200%/2sec, over 700%/0.01sec.
3. DAERYUK DCP-50BH Series(UL).

<http://www.dacb.co.kr>





## Startup and Adjustment

Chapter 3 explains startup, autotuning for gain adjustment, and test run.

### **Check Items prior to Startup**

**Servo Motor**

**Servo Drive**

### **Startup**

**Powering ON and OFF**

**Check Items prior to Startup**

**Startup by the Operator**

**Startup by I/O Input**

### **Autotuning**

### **Test Run**



## Check Items prior to Startup

### Servo Motor

Check the items listed below prior to the startup. When the system is unused for long period of time, check it according to the maintenance and check up list prior to the startup.

#### ATTENTION



Check if the connection, grounding, and conditions of the external equipment are done appropriately when connecting the drive with the servo motor.

Check if there is any loose parts

Check if the Oil Seal part has been damaged (for those with the oil seal attached). Check the condition of the oil and take appropriate action immediately in case of problem.

### Servo Drive

Check if the system is set properly according to the specification of applied servo motor.

#### ATTENTION



Check if the connection and wiring LEAD are properly connected to the terminal and if they are plugged into the connector properly.

Check if the sequence is set up so the power can be turned off by the Servo Alarm.

Check if the voltage supplied to the servo drive is actually supplied with an appropriate power. (Single phase 220VAC, +10, -15%, 50/60Hz)

Check if the polarity of DC voltage supplied to the servo drive is correct. (24VDC  $\pm$  10%)

Check if 0V is applied for speed command.

Check if the motor type, capacity and encoder type are set exactly. (They can be checked in SEt-51 ~ SEt-53).

For modification, turn the power off and on again, then initialize the parameter in USr-09.

Take appropriate action immediately if there are any problems in the above.

# Startup

## ATTENTION



In order to avoid unexpected accidents during startup, operate the servo motor without the load.

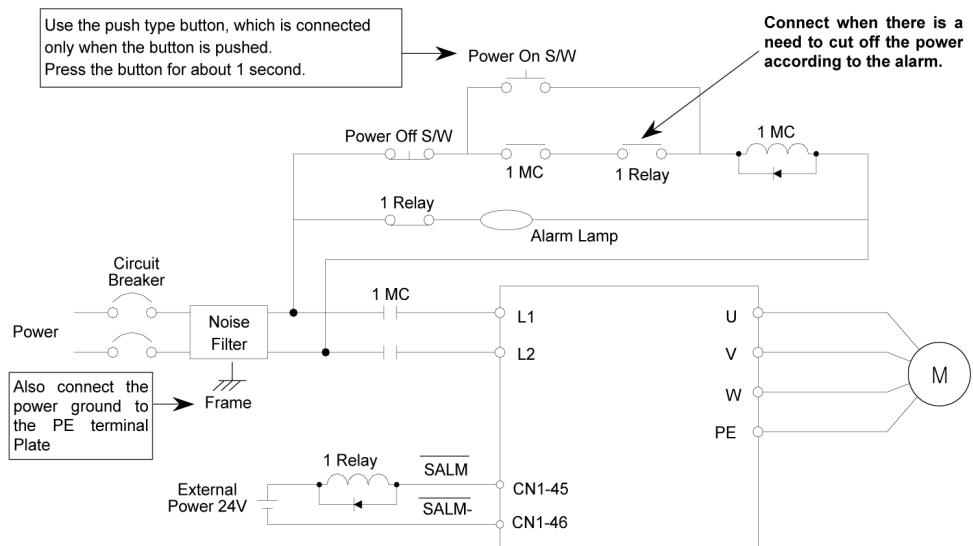
When startup is done with the load, then operate the servo motor after setting the system, so that the operation can be emergency stopped anytime.

When the load is connected and startup is done with the operator, set the acceleration and deceleration time properly in SET-19 and SET-20.

## Powering ON and OFF

When supplying the power with the power sequence made, the power is supplied to the push button switch, and the user must push the button for one second. Check the color of LED and proceed according to the procedure.

**Fig 3.1 Example of Power ON and OFF**



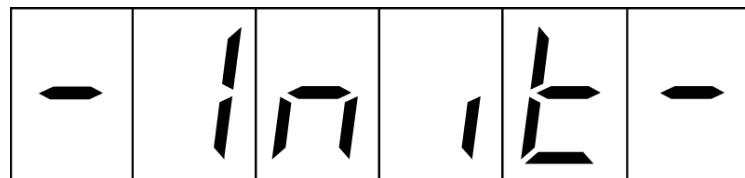
### • LED Display

**Table 3.1 LED Color and Description**

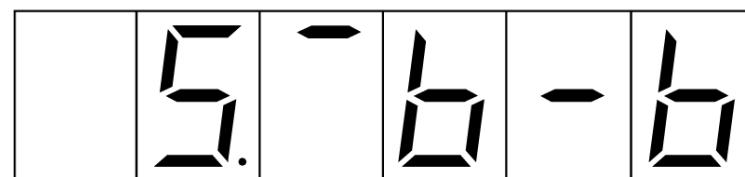
Color	Servo Drive Status
Green	Servo Power ON
Orange	Servo ON
Red/Green	Alarm (Flickers in green and red every 0.2 seconds.)

- **Initial Display of the Operator**

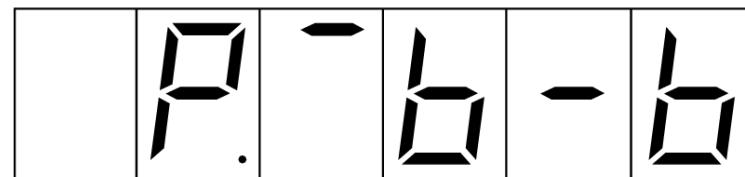
When the power is supplied normally, the initial display flickers "-Init-" three times. (Operator is initializing.)



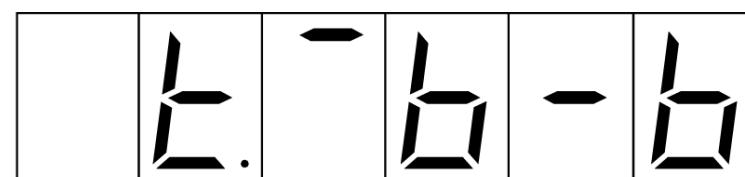
After displaying -Init-, the operator displays the following.



Speed control mode

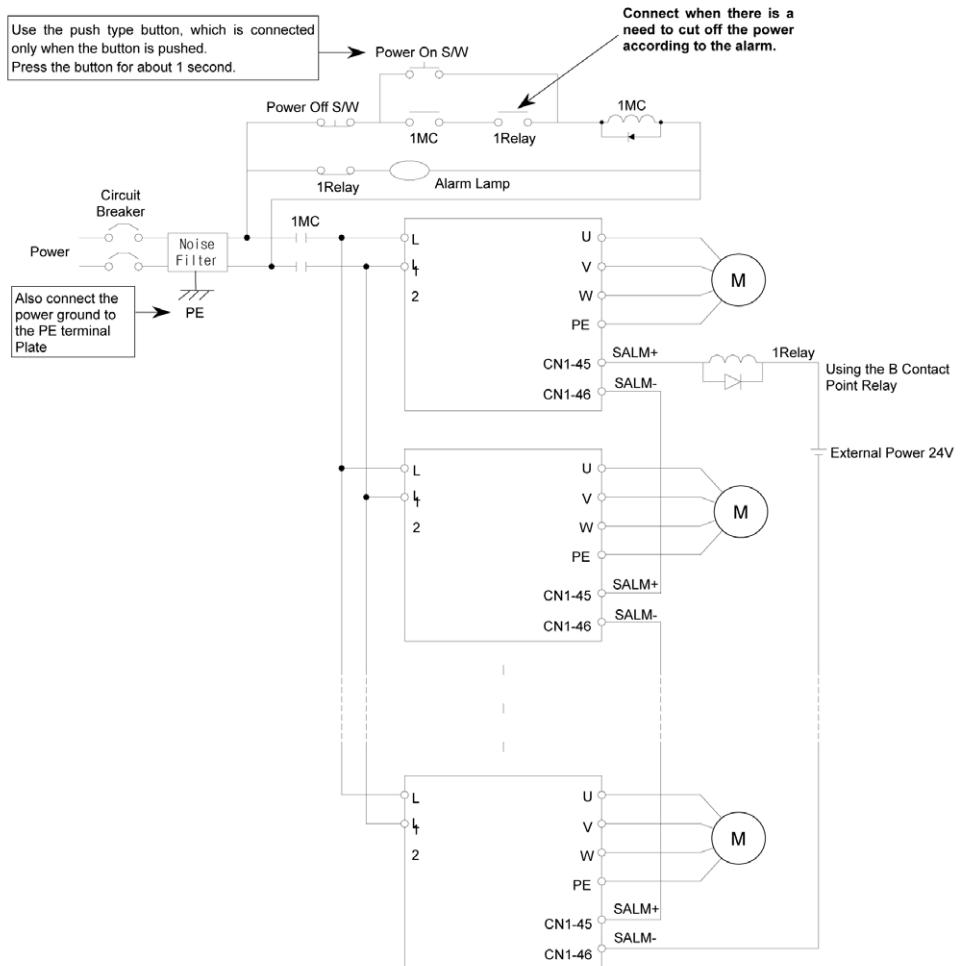


Position control mode  
(Factory setting)

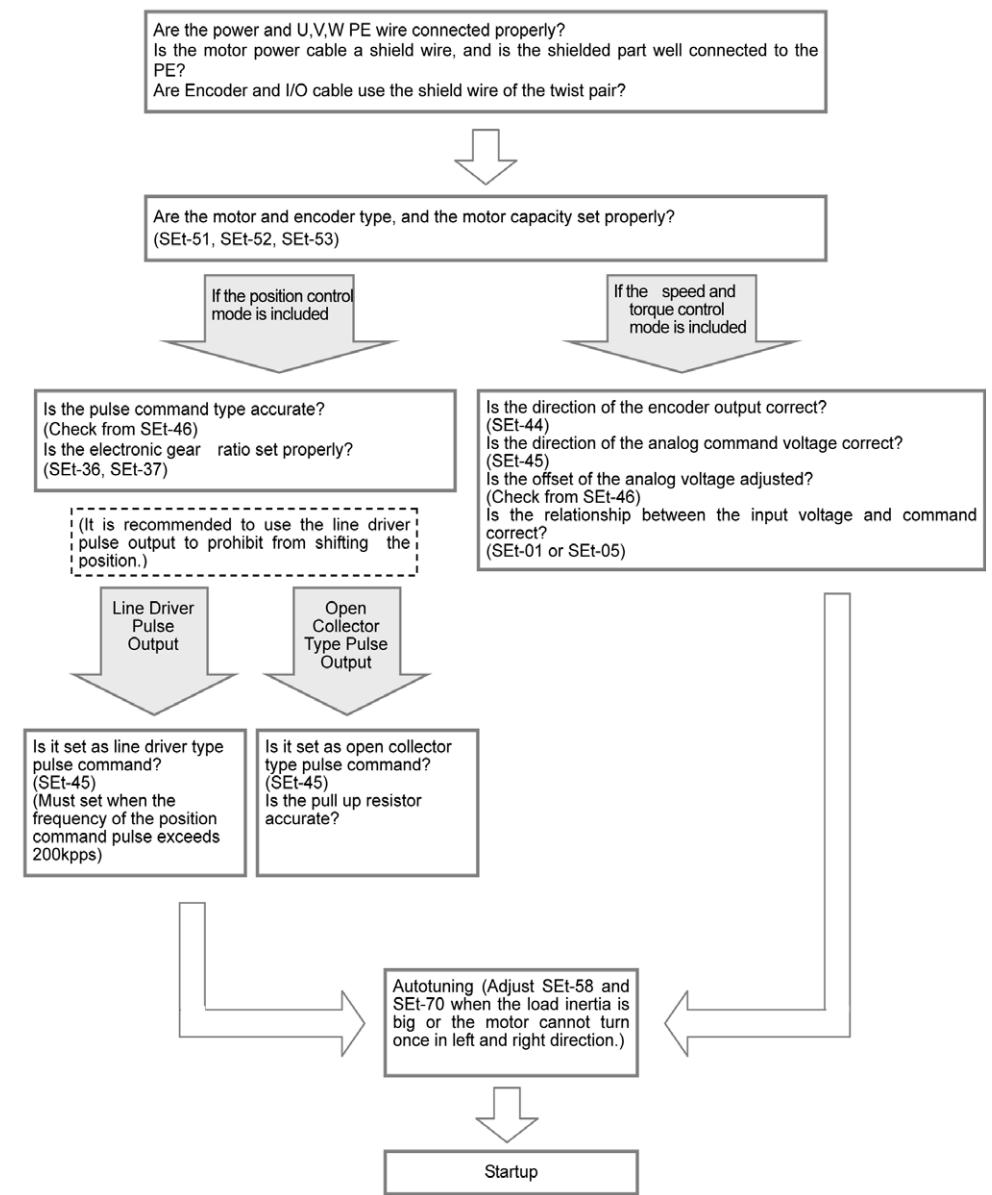


Torque control mode

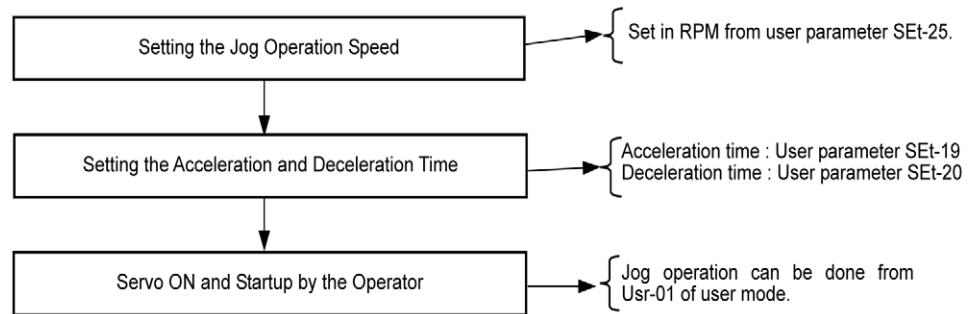
**Fig 3.2 Power Supply Method for Multi-Servo Drive Connection**



## Check Items prior to Startup

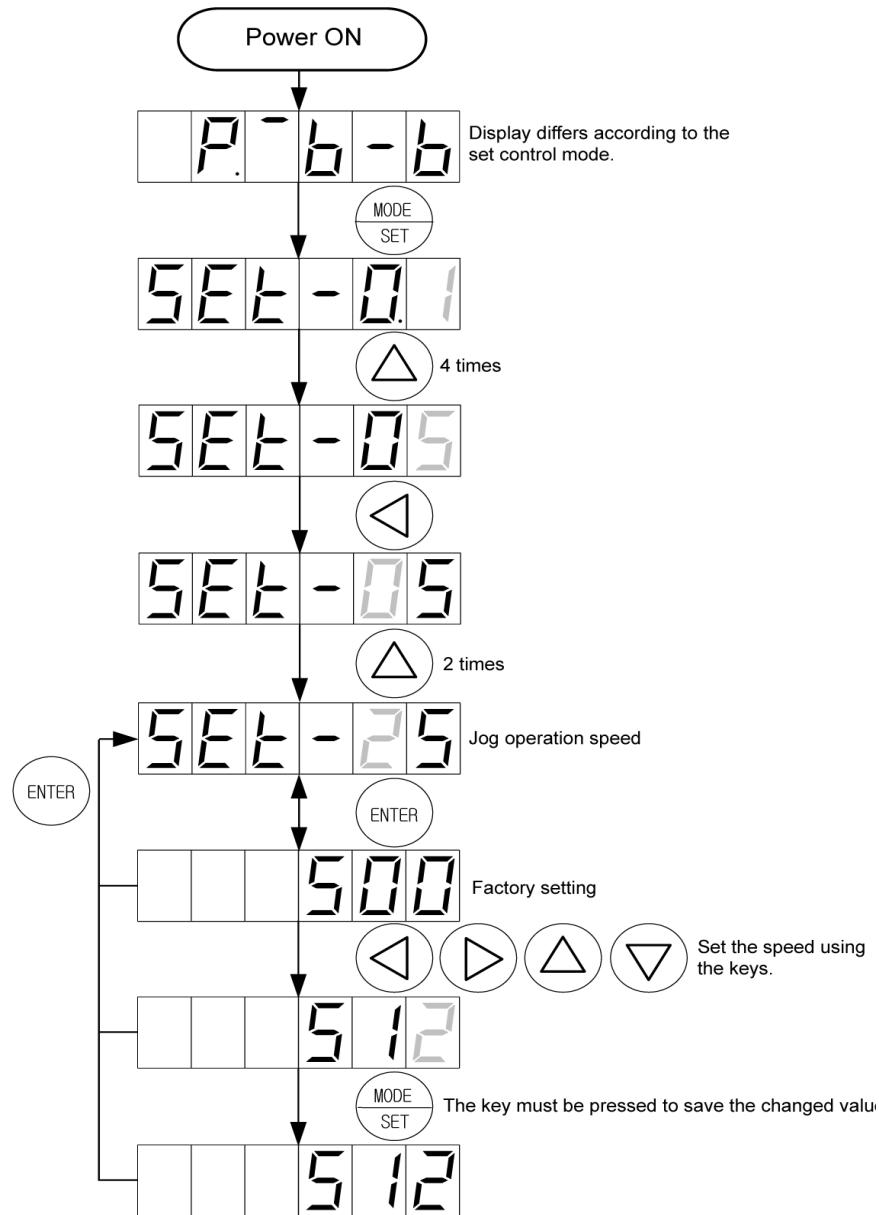


## Startup by the Operator



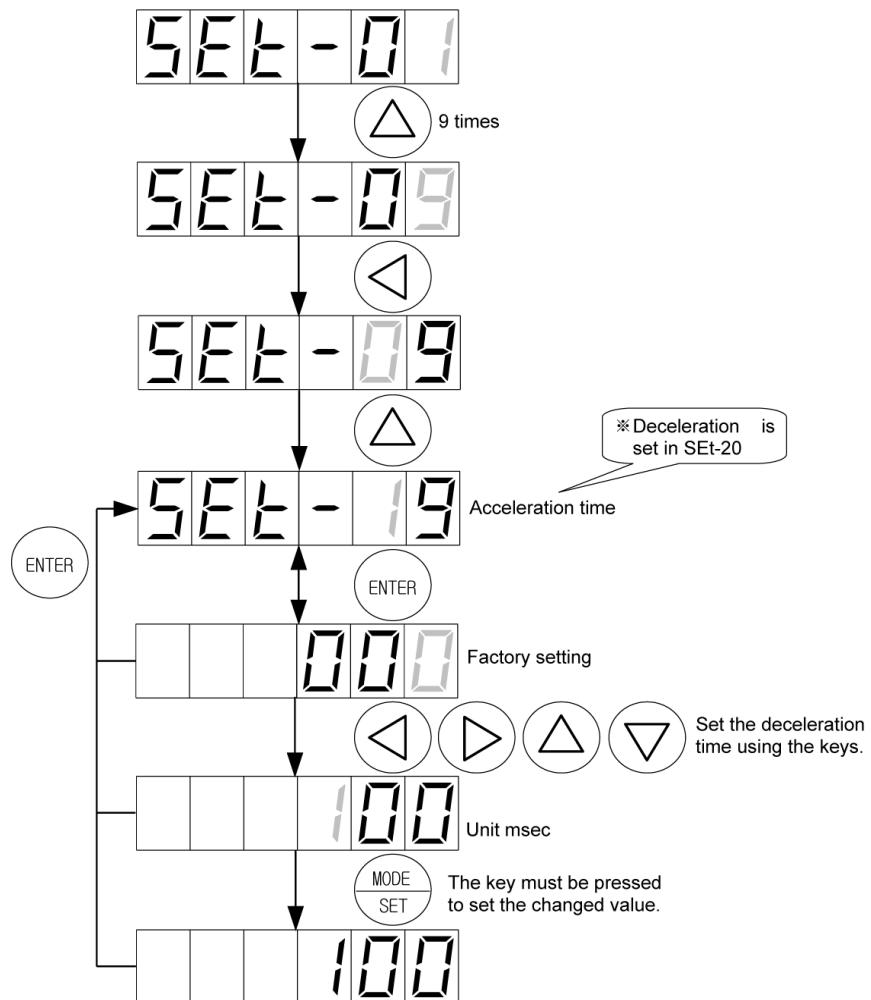
- Setting the Jog Operation Speed**

**Fig 3.3 Setting the Jog Operation Speed**



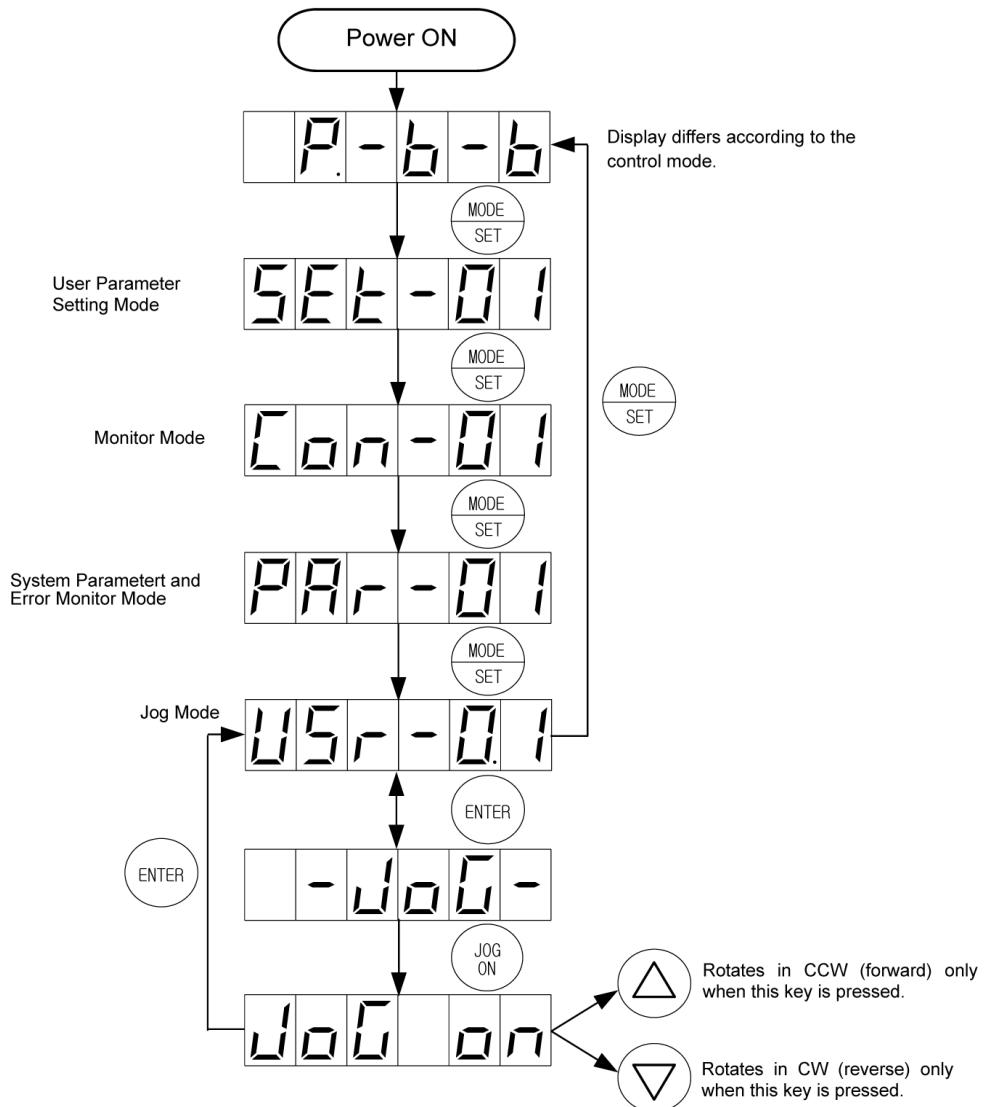
- **Setting Acceleration and Deceleration Time in Startup by the Operator**

**Fig 3.4 Setting Acceleration and Deceleration Time**



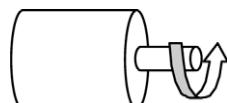
- Servo ON (Jog On) and Startup by the Operator

### **Fig 3.5 Startup by the Operator**



- **Definition of Forward Rotation**

Forward Rotation = Motor rotates in counterclockwise direction when viewed from the motor shaft. (CCW)



ATTENTION

Check if the AC voltage is supplied and output normally.

Check if there is any abnormal noise.

Check if the temperature of the servo drive case rises abnormally.



During the startup, under the influence of the mechanical load of motor and load, over load may occur.

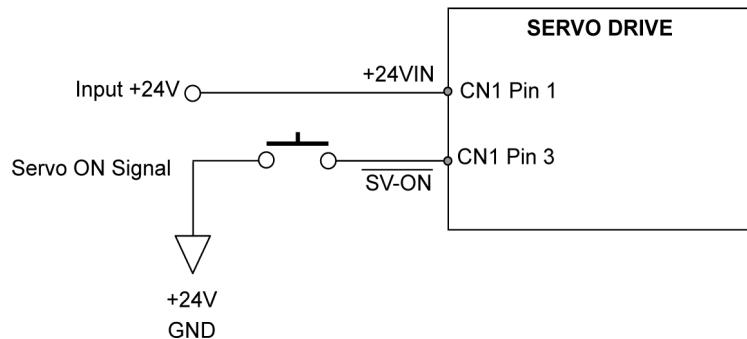
## Startup by I/O Input

This section describes the speed control mode operation by I/O input.

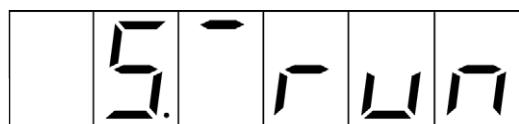
- **Servo ON by I/O input**

The Servo-ON status is made when inputting ON signal in SERVO ON/OFF input terminal  $\overline{SV\text{-}ON}$  (CN1 pin number 3).

**Fig 3.6 Servo ON**



Operator displays the following when the servo is ON from speed control mode.



(Different according to the control mode.)

- **Speed Control Mode**

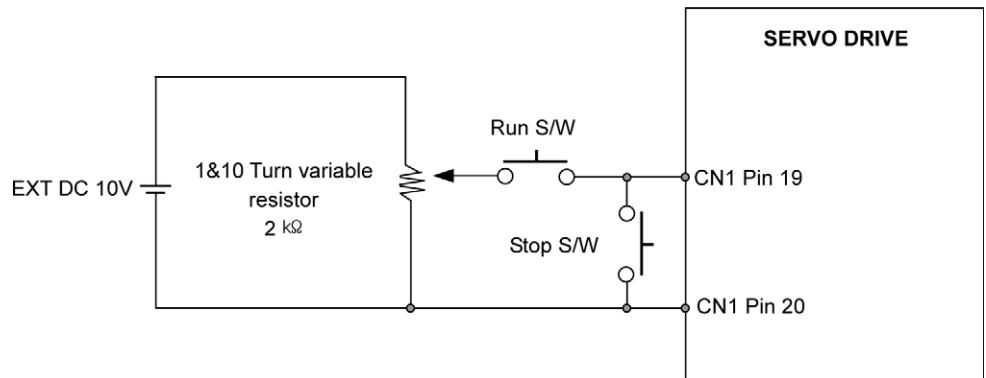
Setting of the speed control mode:

Setting value of SEt-41 = 1

- **Speed command**

Use pin number 19 and 20 of CN1 for speed command.

**Fig 3.7 Speed Command Analog Input**

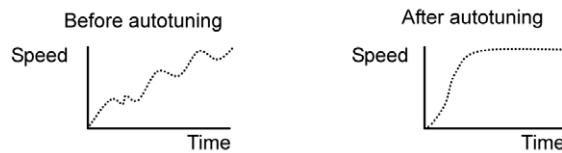


- Speed may change when the voltage changes, thus accurate external power must be used.
- Open the input terminal, which is not used during the speed control.
- Relationship between input voltage and speed command value
- Speed command value[RPM]=Setting value of SEt-01[RPM/V] x Input Voltage[V]  
Initial value of SEt-01=500.  
Thus, when inputting 6V, revolution takes place in 3000[RPM].
- Input voltage is  $\pm$  10V Maximum.
- When inputting the 0V using just the variable resistor, the input voltage cannot reach 0V, thus use the switch as shown above for 0V input. (In order to stop the motor completely when it has 0V, operate in Zero-Clamp speed control mode.)

\* When the speed command, which the user wants, is not a multiple of 10, set LED No.2=1 from SEt-46, to change the unit of SEt-01 as [RPM/10V]. Then, the motor rotates in 1552[RPM] for 10V speed command, if SEt-01=1553 is input. (Refer to Speed Control )

## Autotuning

Generally, the gain of the servo drive is in proportion to the inertia. If the Speed Loop Proportion Gain and Speed Loop Integration Gain are not set correctly, position decision may be slowed down.



CSDJ Plus Servo Drive has the [autotuning] function, which automatically finds the load inertia. When autotuning, the gain shown below is automatically set with the load inertia as the base.

SEt-02 (Speed Loop Proportion Gain)

SEt-03 (Speed Loop Integration Gain)

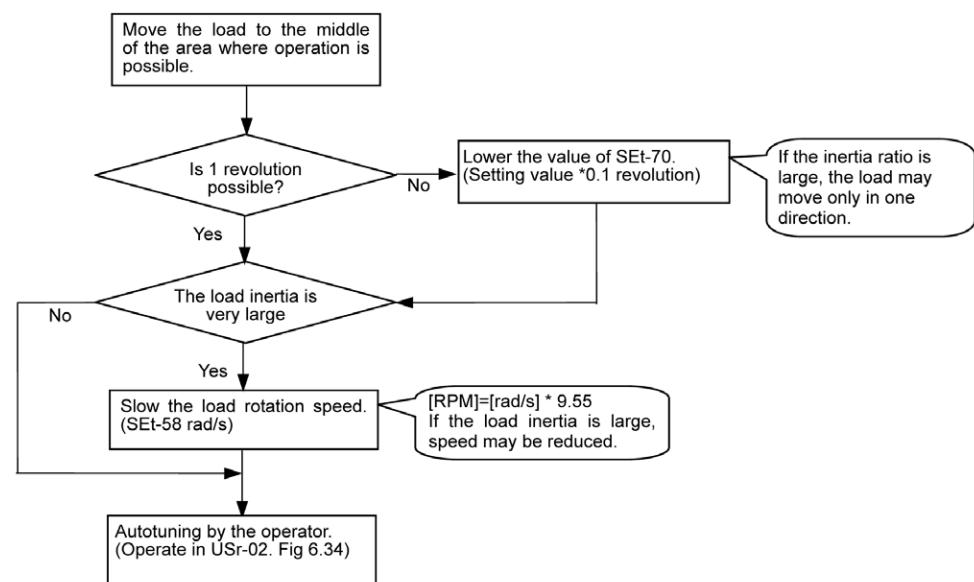
SEt-04 (Position Loop Proportion Gain)

SEt-06 (1<sup>st</sup> Low Pass Filter Cutoff Frequency of Torque Command)

SEt-40 (1<sup>st</sup> Low Pass Filter Cutoff Frequency of Speed Command)

### • Autotuning Procedure

**Fig 3.8 Autotuning Procedure**

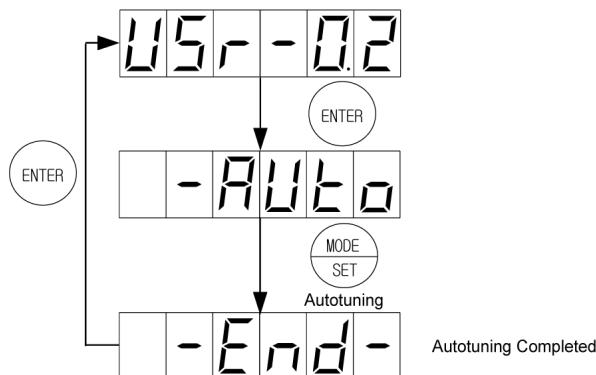


**ATTENTION**

During the autotuning, motor rotates in CW and CCW direction once, thus the system may be damaged due to collision of the moving part of the assembled structure against the mechanical border. Check if all moving parts of the system are in safe position, then perform autotuning.

When the moving part of the system is not in a safe position, move it to the safe position by using the JOG function

**Fig 3.9 Example of Autotuning by the Operator**



- **Setting the torque filter cut off frequency for the load**

**Table 3.2 Setting the Torque Filter Cutoff Frequency (SEt-06)**

Load Type	Setting Value of SEt-06
Direct coupled round plate	1000(Initial value when delivered)
Direct coupled Ball Screw	1000 ~ 2000
Belt and chain	300 ~ 600

Torque filter cutoff frequency lowers the frequency according to how much delay elements exists in the process of delivering the torque of the motor. When the value is set too low, it could cause vibration in the direct coupled round plate, where there is no delay element. On the contrary, vibration occurs in belt or chain, where there is many delay elements, when the frequency is set too high

\* Operating the autotuning when the value of SEt-42 is set to "0", the gain is adjusted in "20", the initial value of SEt-42. In other words, the gain value reflected by operating the autotuning in the condition where the setting of SEt-42 is "0" is same as the one operated in "20".

- **Checking the Load Inertia ratio**

Load inertia ratio gained in autotuning can be checked in Con-13, SEt-66.

Load inertia ratio is calculated as the following,

$$\text{Load Inertia Ratio} = \frac{\text{Load Inertia}}{\text{Motor Inertia}}$$

Displayed to the first decimal point.

\* Refer to Table 7.3 for allowable load inertia in operation of each motor in rated speed.

## Test Run

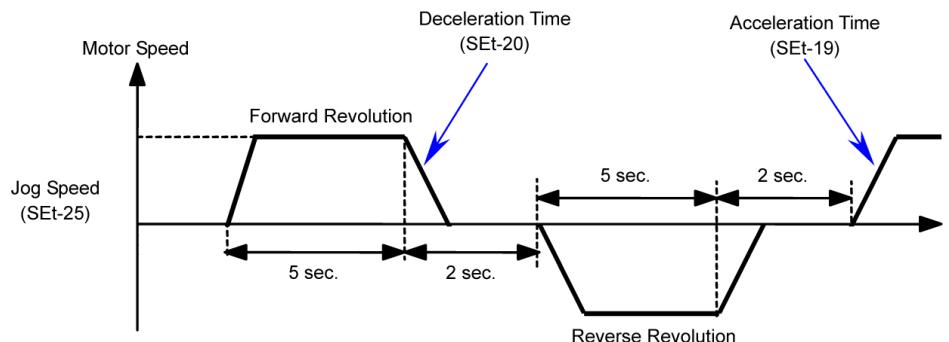
In the operator, test run can be done using the following operation pattern.

Operate in USr-90.

Starting and ending the test run can be done with  key. Repeat until it is stopped.  
1 cycle time is 14 sec.

**Fig 3.10 Operation Pattern of the Test Run**

During the test run, all of user parameter can be referred to or set using the operator.

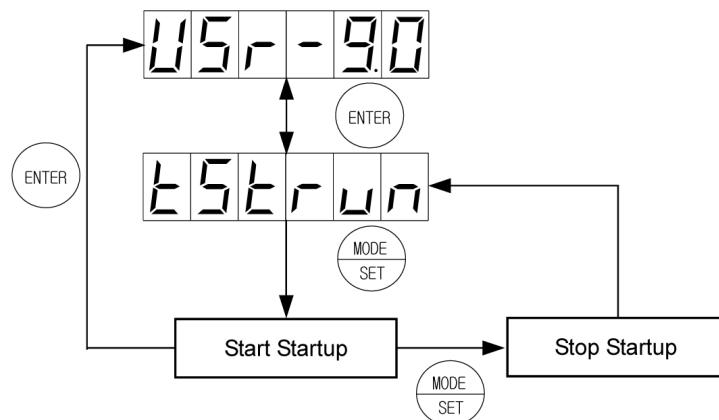


### ATTENTION



Operation time for the test run is already set. Be cautious when the load is connected. Test run only when the emergency stop is possible at any time.

**Fig 3.11 Test Run Using the Operator**







# Using the Operator

Chapter 4 explains how to use the operator, which you should know for proper handling of the product.

## **Operator**

### **Types of Mode and Mode Switching**

### **Status Display Mode**

### **User Parameter Setting Mode**

### **Monitoring Mode**

### **System Parameter and Error Monitoring Mode**

### **Jog Mode**

#### **Operation by the Operator**

#### **Autotuning**

#### **Auto Adjustment of Speed/Torque Command Offset**

#### **Manual Adjustment of Speed/Torque Command Offset**

#### **Alarm Reset**

#### **D/A Converter Channel Selection**

#### **Output Adjustment Method of D/A Converter Channel**

#### **Parameter Initialization**

#### **Error History Clear**

#### **Test Run**

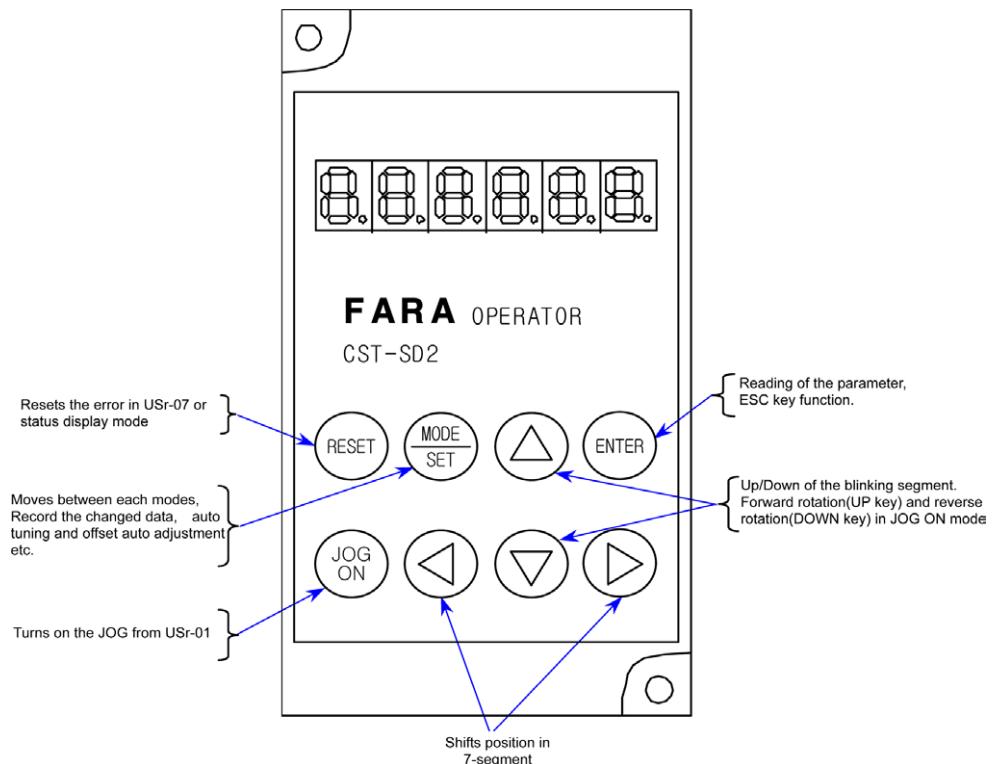


## Operator

Data set by the operator is saved in servo drive even if the power has been cut off.

More than last 10 contents of error are saved, thus the error can be checked when the problem occurs. (It's saved in parameter PAr-01 ~ PAr-10.)

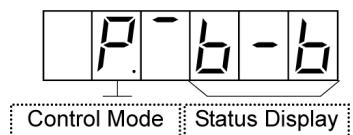
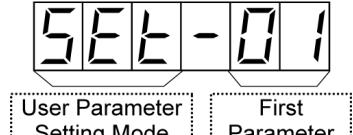
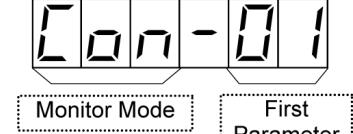
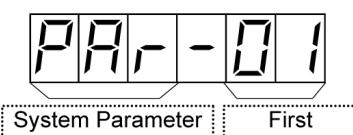
**Fig 4.1 Operator**



## Types of Mode and Mode Switching

- **Types of Modes**

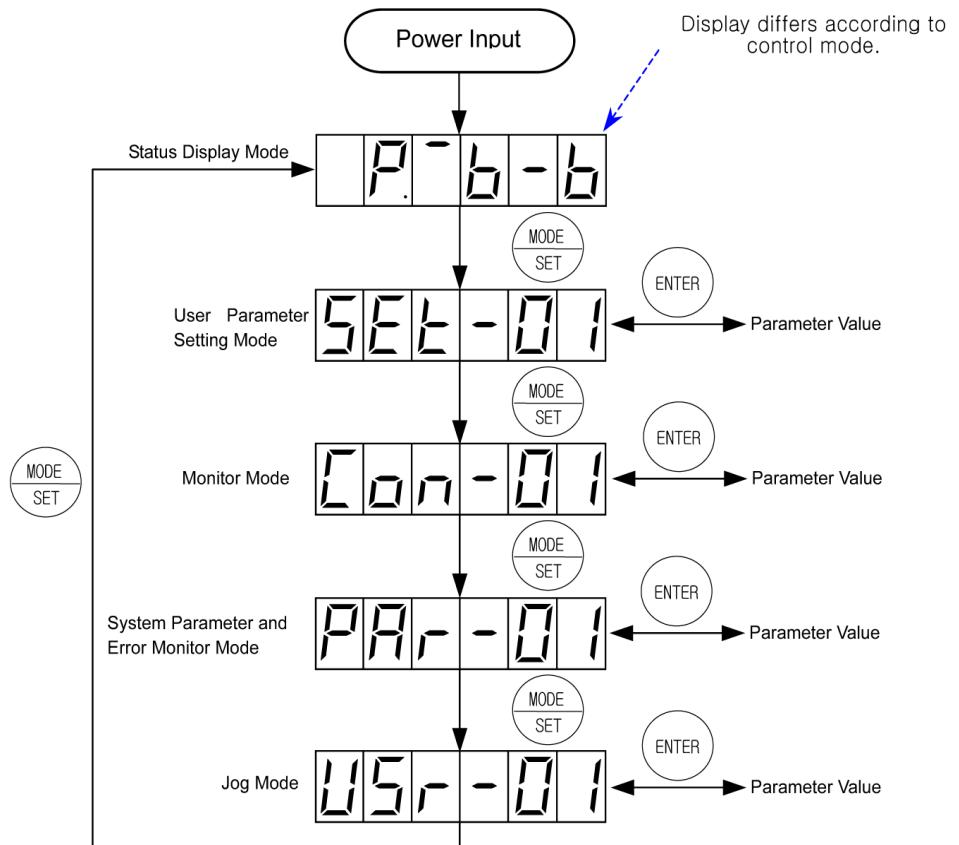
**Table 4.1 Types of Modes**

Mode Name	Display	Function
Status Display Mode	 Various status display (Refer to Status Display Mode) - Base Block - During operation - Error and Warning	
User Parameter Setting Mode	 Refer to User Parameter	
Monitor Mode	 <b>Various Monitors</b> 01. Feedback speed [RPM] 02. Speed command [RPM] 03. Torque command [%] 04. Electrical angle [DEGREE] 05. Speed error [RPM] 06. Position error [PULSE] 07. Mechanical angle [DEGREE] 08. Position feedback [PULSE] 09. Position command [PULSE] 10. Speed command offset [mV] 11. Torque command offset [mV] 12. I/O status 13. Load inertia ratio(=Load inertia/Motor inertia) 16. Input pulse frequency[kHz] 17. Speed command voltage[10mV] 18. Torque command voltage[10mV] 19. Maximum torque absolute value[%] 20. Multi rotation data of absolute encoder 21. Maximum position error absolute value[PULSE] 22. Maximum speed feedback absolute value[RPM] 23. Encoder counter 24. Data within 1 rotation of absolute encoder 25. Lower 5digits of position command in servo-off status[PULSE] 26. Upper 5digits of position command in servo-off status[PULSE] 27. Lower 5digits of position feedback in servo off status[PULSE] 28. Upper 5digits of position feedback in servo-off status[PULSE]	
System parameter and Error Monitor Mode	 01. Marks last error 02~10. Displays the past error. 11. S/W VERSION 12. Types of controller	

Mode Name	Display	Function
JOG Mode	<p>The digital display shows "JOG Mode" in the first two segments and "First Parameter" in the last two segments.</p>	01. JOG operation 02. Autotuning 03. Auto adjustment of speed command offset 04. Auto adjustment of torque command offset 05. Manual adjustment of speed command offset 06. Manual adjustment of torque command offset 07. Alarm Reset 08. D/A CHANNEL selection 09. Parameter initialization 10. Error History Clear 90. Test Run

### • Mode Switching

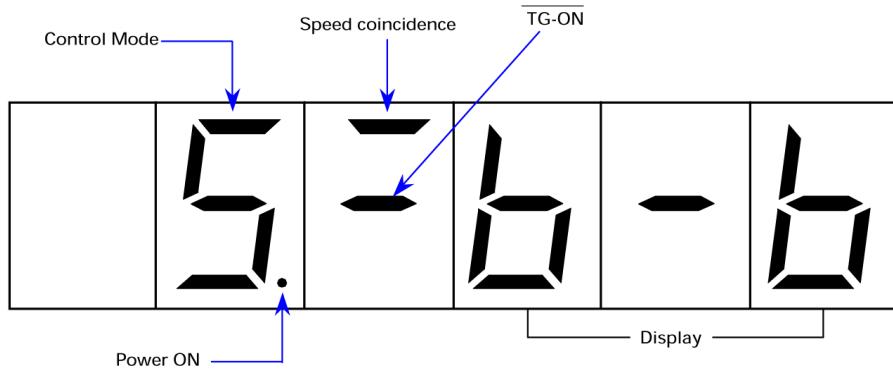
**Fig 4.2 Mode Switching**



## Status Display Mode

Servo drive status is displayed in bit as shown below when status display mode is set.

**Fig 4.3 Status Display Mode**



**Table 4.2 Content of Bit Data**

Bit Data	SEt-43 LED No.4	Content
Power ON	-	Light a bit when Power is ON.
Speed coincidence	-	Light on when the motor speed reached the speed command.
TG-ON	0	Light on when the motor rotation speed is higher than <u>TG-ON</u> speed level (setting value of SEt-16). (Initial value upon delivery)
	1	(Current Limit Detection) Light on when the torque command has reached current limit value (setting value of SEt-10 ~ SEt-13).
Control Mode	-	<b>S</b> : Speed Control Mode <b>t</b> : Torque Control Mode <b>P</b> : Position Control Mode

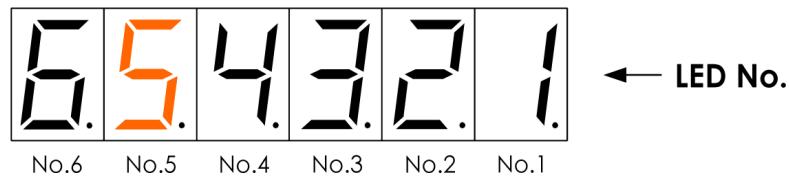
**Table 4.3 Signal and Servo Status**

Abbreviation	Status		Display priority
E.00~E.82	Alarm Display		1
b-b	Base Block(servo OFF)		2
run	Servo ON	Servo ON	3
Pot		Forward Rotation Prohibited	
not		Reverse Rotation Prohibited	

## User Parameter Setting Mode

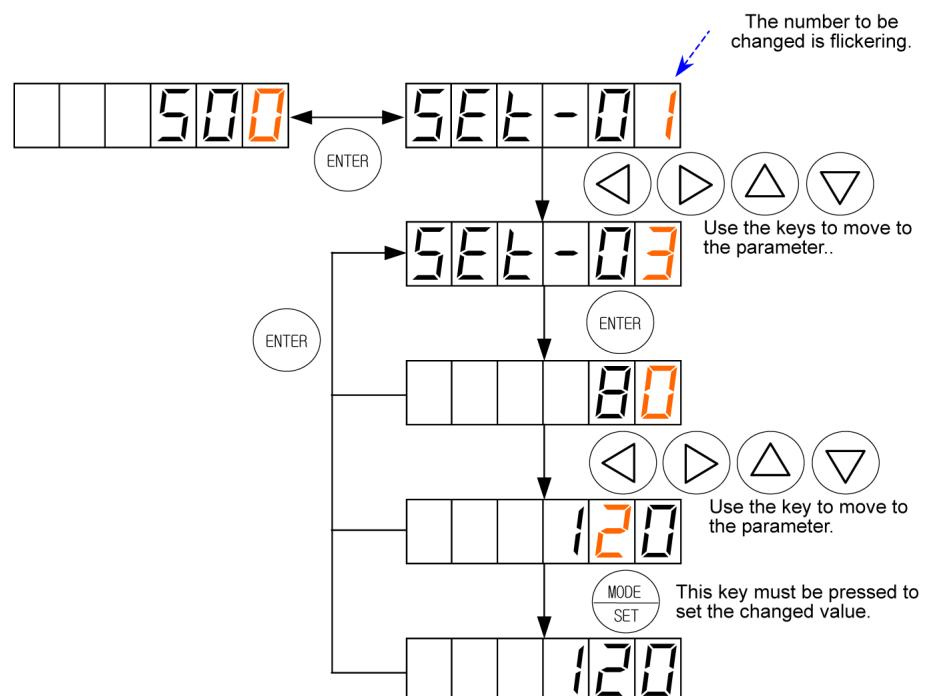
There are 76 user parameters in SEt-01 ~ SEt-76.(Note 1)

Each LED value (0 or 1) in parameter SEt-43 ~ SEt-46 has its own definition. LED No. are as follows.



The figure below is an example of setting SEt-03 from 80 to 120.

**Fig 4.4 Example of Setting User Parameter**



\* Refer to chapter 5 Parameter List.

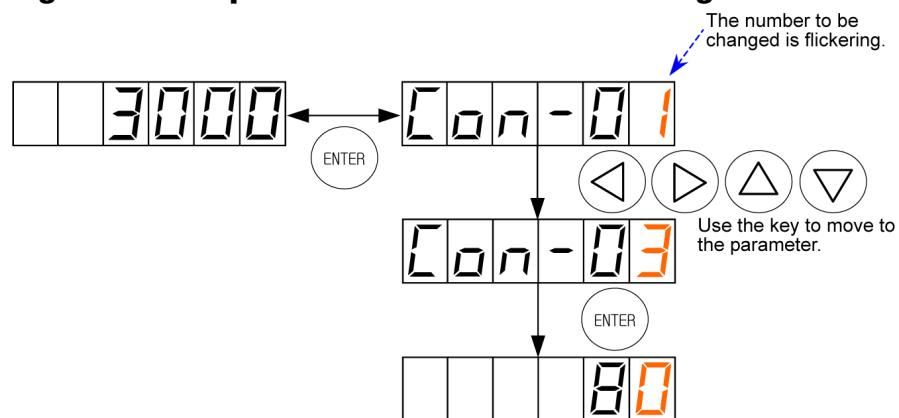
### IMPORTANT

The parameter which can be used differs partially according to the ROM version.  
Refer to the Using the Operator.

## Monitoring Mode

The operator speed and torque command is monitored in this mode. The figure below is an example of monitoring the torque command.

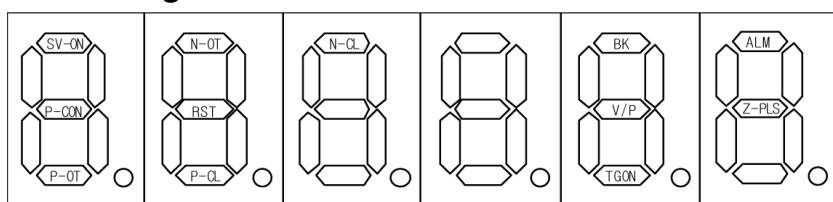
**Fig 4.5 Example of Parameter of Monitoring Mode**



**Table 4.4 Monitor type**

Monitor No.	Content	Unit	Monitor No.	Content	Unit
Con-01	Feedback Speed	RPM	Con-16	Input Pulse Frequency	-
Con-02	Speed Command	RPM	Con-17	Speed Command Voltage	kHz
Con-03	Torque Command	%	Con-18	Torque Command Voltage	10mV
Con-04	Electrical Angle	DEGREE	Con-19	Maximum Torque Absolute Value	10mV
Con-05	Speed Error	RPM	Con-20	Multi rotation data of absolute encoder	%
Con-06	Position Error	PULSE	Con-21	Absolute value of maximum position error	-
Con-07	Mechanical Angle	DEGREE	Con-22	Maximum speed feedback absolute value	PULSE
Con-08	Position Feedback	PULSE	Con-23	Encoder Counter	RPM
Con-09	Position Command	PULSE	Con-24	Data within 1 rotation of absolute encoder	-
Con-10	Speed command Offset	mV	Con-25	Lower 5digits of position command in servo-off status	PULSE
Con-11	Torque command Offset	mV	Con-26	Upper 5digits of position command in servo-off status	PULSE
Con-12	I/O Status Display (Refer to Fig 4.6)	-	Con-27	Lower 5digits of position feedback in servo-off status	PULSE
Con-13	Inertia ratio (=Load inertia/Motor inertia)	-	Con-28	Upper 5digits of position feedback in servo-off status	PULSE

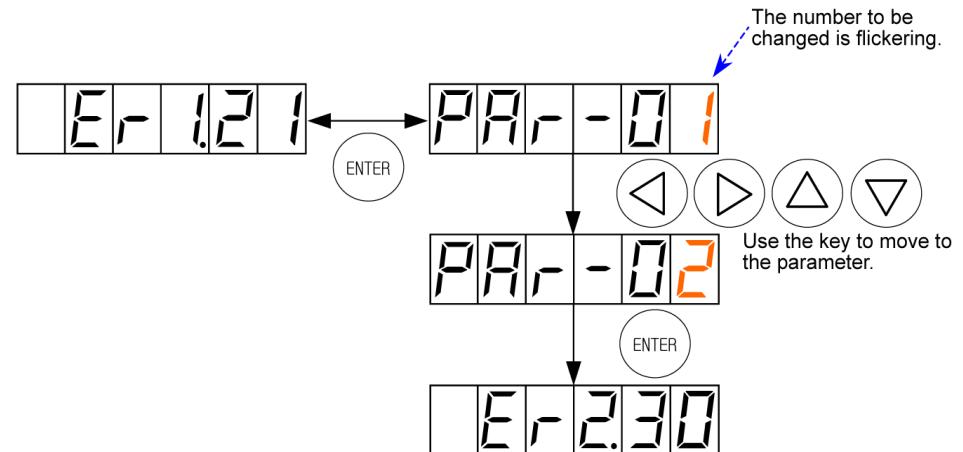
**Fig 4.6 Display of Con-12 (V/P: Speed/Positioning Completion Signal CN1 Pin 41-42)**



## System Parameter and Error Monitoring Mode

This mode displays information on previous errors and S/W version, along with controller type. Conservation capacity of error information is the last 10 contents of errors.

**Fig 4.7 Example of Error**



**Table 4.5 Types of Error Saving Parameter**

Parameter	Content
Par-01	Latest ERROR
Par-02	Second Last Error
Par-03	Third Last Error
Par-04	Fourth Last Error
Par-05	Fifth Last Error
Par-06	Sixth Last Error
Par-07	Seventh Last Error
Par-08	Eighth Last Error
Par-09	Ninth Last Error
Par-10	Tenth Last Error
Par-11	Software version can be checked 

Parameter	Content								
PAr-12	<p>Controller type check</p> <table border="1"> <tr> <td><b>S</b> : Speed Control Mode</td> <td><b>A</b> : Position Control Mode</td> <td><b>B</b> : Torque Control Mode</td> <td><b>D</b> : Motor Capacity 003 : 30W 005 : 50W 010 : 100W . . . 100 : 1kW</td> </tr> <tr> <td>Motor Series - :CSMT</td> <td>Input Power b : AC 220V</td> <td></td> <td></td> </tr> </table>	<b>S</b> : Speed Control Mode	<b>A</b> : Position Control Mode	<b>B</b> : Torque Control Mode	<b>D</b> : Motor Capacity 003 : 30W 005 : 50W 010 : 100W . . . 100 : 1kW	Motor Series - :CSMT	Input Power b : AC 220V		
<b>S</b> : Speed Control Mode	<b>A</b> : Position Control Mode	<b>B</b> : Torque Control Mode	<b>D</b> : Motor Capacity 003 : 30W 005 : 50W 010 : 100W . . . 100 : 1kW						
Motor Series - :CSMT	Input Power b : AC 220V								

**Table 4.1 Error Display of Operator and Trace Back Table**

<b>Alarm Code</b>		<b>Alarm Content</b>
<b>Number</b>	<b>Letter</b>	
10	SC	Motor over-current If it cannot be cancelled even if it's not over-current, it's overheated.
11	oC	Motor over-current
12	oH	Operation error due to motor overheating or noise
20	tol	Instantaneous over load of torque command
21	tOL	Continuous overload of torque command
22	Fol	Instantaneous overload of motor current
23	FOL	Continuous overload of motor current
30	EOP	Encoder open
33	PoF	Pulse error (difference between the pulse command and motor movement) overflow
35	EuV	Low voltage of inner capacitor of absolute encoder
36	EoP	Error in initializing encoder
37	Eos	Over-speed during electricity failure of absolute encoder
40	oS	Over-speed detection
41	EST	Emergency stop
50	oV	Over voltage
62	uOF	Offset trouble in current sensor U phase
63	UoF	Offset trouble in current sensor V phase
70	tuV	Momentary electricity failure
71	uV	Control power cut-off
80	CHE	Parameter damage
81	Pro	Parameter range check error
82	EtP	Motor setting or encoder setting error

## Jog Mode

**Table 4.2 Jog Mode Parameter**

Parameter	Contents
USr-01	JOG(Servo ON by operator) * Refer to startup by operator
USr-02	Autotuning
USr-03	Auto adjustment of speed command offset
USr-04	Auto adjustment of torque command offset
USr-05	Manual adjustment of speed command offset
USr-06	Manual adjustment of torque command offset
USr-07	ALARM RESET(ERROR DATA RESET) When resetting during the error related to absolute encoder, the multi rotation data of encoder also becomes 0.
USr-08	D/A CONVERTER Channel selection
USr-09	All parameter, except SEt-23, SEt-24, SEt-36, SEt-37, SEt-51 ~ SEt-53, SEt-71 ~ 74, are set to factory setting. In occurrence of E.80, initializing operation will change all user parameters into initial setting value. USr-09 → ENTER key → "P-init" on → MODE/SET key → Initialization
USr-10	ERROR HISTORY CLEAR Clears the content of PAr-01 ~ PAr-10 all into "0". USr-10 → ENTER key → "E-init" on → MODE/SET key → Clear
USr-90	Test run

## Operation by the Operator

Refer to C in Status Display Mode.

## Autotuning

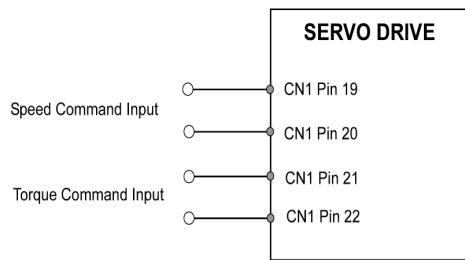
Refer to User Parameter Setting Mode.

## Auto Adjustment of Speed/Torque Command Offset

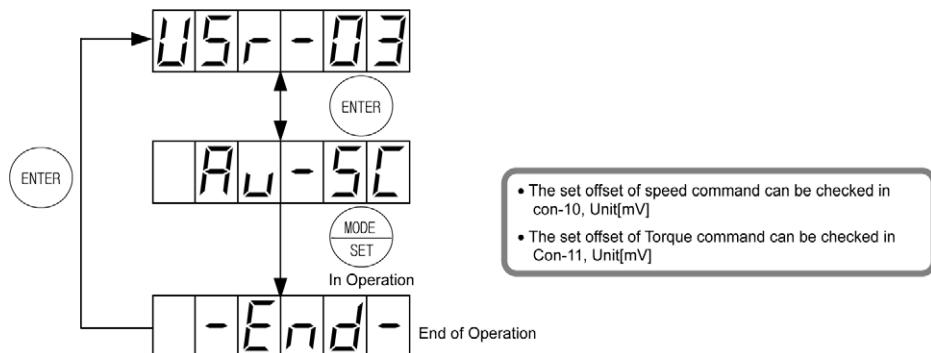
This is a mode, which automatically adjusts the speed/torque command offset, during the speed/torque control by I/O.

- The voltage, which is input into current speed/torque command, is recognized as 0V.
- Therefore, adjust it so that the size of the voltage output from the host controller or the variable resistor is 0V.
- It can be adjusted when SERVO is OFF .
- Tuned offset value can be checked in Con-10 and Con-11 and it is in [mV].

**Fig 4.13 Speed/Torque Command Input**



**Fig 4.14 Auto Adjustment of Speed Command Offset (In case of auto adjustment of torque command offset, "AutC" is displayed.)**



**ATTENTION**



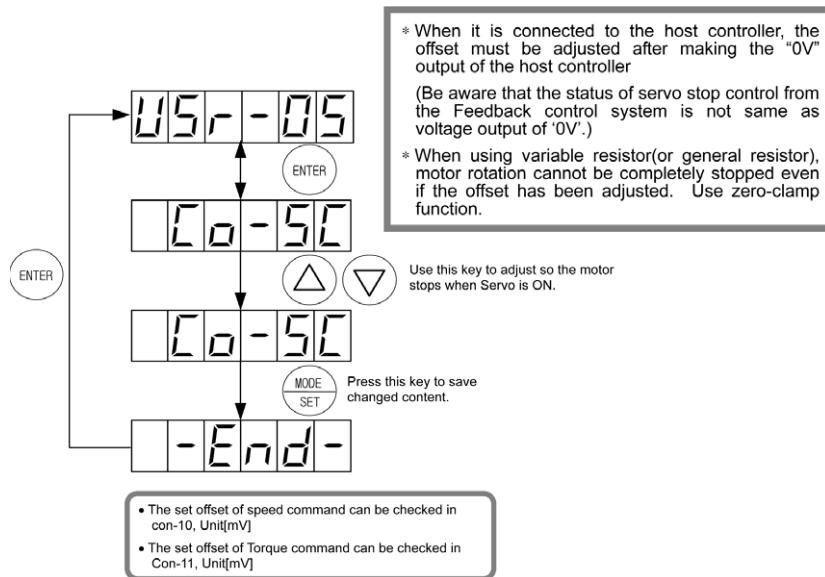
The motor can move a little even if the command offset has been automatically adjusted. This is because the noise in power voltage or the power voltage changes. In order to completely stop the motor in analog command, operate in Zero-Clamp Speed Control Mode.

(**Caution :** When using the servo drive in speed control mode, and when the position controller is used in host controller, do not use zero-clamp function. Motor may malfunction.)

## Manual Adjustment of Speed/Torque Command Offset

- Operate when Servo is ON.
- Up key operates the offset in forward rotation direction.
- DOWN key operates the offset in reverse rotation direction.
- Tuned offset value can be checked in Con-10 and Con-11 and it is in [mV].

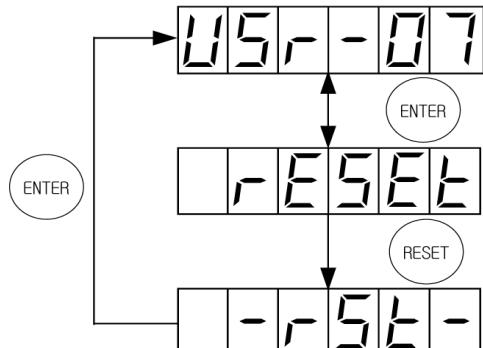
**Fig 4.15 Manual Adjustment of Speed Command Offset (In case of the manual adjustment of torque command offset , "Co-tC" is displayed.)**



## Alarm Reset

Error status can be reset in USr-07 of the jog mode. Resetting method is as follows.

**Fig 4.16 Alarm Reset**



## D/A Converter Channel Selection

CSDJ Plus prepares two of D/A output.

Output can be selected in USr-08.

CN1 pin No.	Initial setting	Content
28	Speed Feedback ±1V / 500[RPM]	Setting value of ±1V / SEt-08 [RPM], Max.±10V
23	Torque Command ±1V / (Rated torque0.5)	Setting value of ±1V / SEt-09 [%], Max.±10V
27	GND	DA output signal GND

**Table 4.3 Parameter Value and Content of D/A Converter (USr-08)**

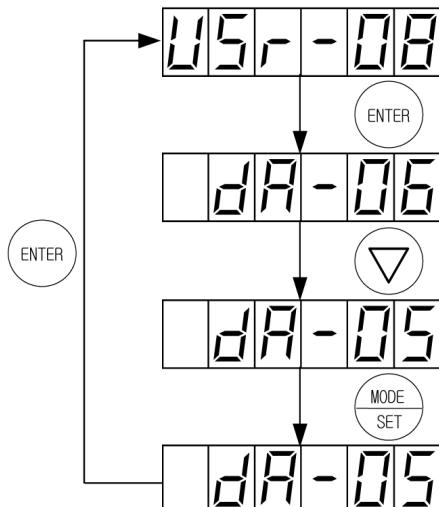
Pin no. Parameter	23	28	27
dA-03	Torque Command	Torque feedback	DA output signal GND
dA-04	Position Command	Position feedback	
dA-05	Speed command	Speed feedback	
dA-06	Speed command	Torque command	
dA-07(Initial Value)	Torque command	Speed feedback	
dA-08	Position Error	Position command in position control cycle	

### ATTENTION



SEt-08 and SEt-09 are parameters, which adjust the D/A output scale of each speed(position) and torque value. There is no direct relationship with the D/A output pin. Thus, when setting dA-07 in USr-08, reset SEt-09 in order to scale the D/A output (torque command) of pin 23.

**Fig 4.17 Example of Selecting the D/A Channel Output Content**



## Output Adjustment Method of D/A Converter Channel

**Table 4.4 Parameter Value and Content Related to D/A Converter Output**

Parameter	Name	Content	Initial Setting	Unit	Setting Range
USR-08	DA Channel Output Content Selection				
SEt-71	DA Channel 1 Offset Adjustment	Adjusts output offset of DA channel 1	100	10mV	0~200
SEt-72	DA Channel 1 Gain Adjustment	Adjustst output gain of DA channel 1	100	%	1~200
SEt-73	DA Channel 2 Offset Adjustment	Adjusts output offset of DA channel 2	100	10mV	0~200
SEt-74	DA Channel 2 Gain Adjustment	Adjusts output gain of DA channel 1	100	%	1~200

**ATTENTION**



Factory setting is appropriate. It cannot be initialized even if initialized with USR-09.

When error 80 (Check Sum Error) occurs, it is initialized to initial setting in Table 4.4.

• **Offset Adjustment Method**

1. Set dA-04 in USR-08 using the operator with SERVO OFF (motor is stopped). DA output is 0 Volt.
2. Measure output voltage of each channel.
3. Set SEt-71 and SEt-73 according to the calculation below.

When increasing the setting value with standard of 100, D/A output voltage rises in + voltage and when decreasing the setting value, it declines to - voltage. An accurate computation is as follows.

$$SEt-71 = 100 - \text{Measured Output Voltage [mV] of channel 1} * 0.1$$

(Output voltage measured in servo OFF status)

$$SEt-73 = 100 - \text{Measured Output Voltage [mV] of channel 2} * 0.1$$

(Output voltage measured in servo OFF status)

4. Or, as observing the output voltage, SEt-71 and SEt-73 can be set so the voltage is 0[V]. Reduce the setting if the voltage is greater than 0[V], and increase the setting if the voltage is less than 0[V].

- **Gain Adjustment Method**

1. Adjust the offset before adjusting the gain.
2. Set the dA-01 in USr-08 with the operator. DA is set to output 5V at this point.  
(However, when 5V is not output correctly, in other words, if the voltage is not output as set in SEt-08 and SEt-09, adjust with the following method.)
3. Measure output voltage of each channel.
4. Set SEt-72 and SEt-74 according to the calculation below.

Absolute value of D/A output voltage will increase when the setting is increased in the standard of 100, and it will decrease when decreasing the setting. Accurate calculation is as follows.

$SEt-72 = 100 * 5[V] / \text{Actual output voltage of channel 1 [V]}$  (Voltage output when the motor is in normal operation status)

$SEt-74 = 100 * 5[V] / \text{Actual output voltage of channel 2 [V]}$  (Voltage output when the motor is in normal operation status)

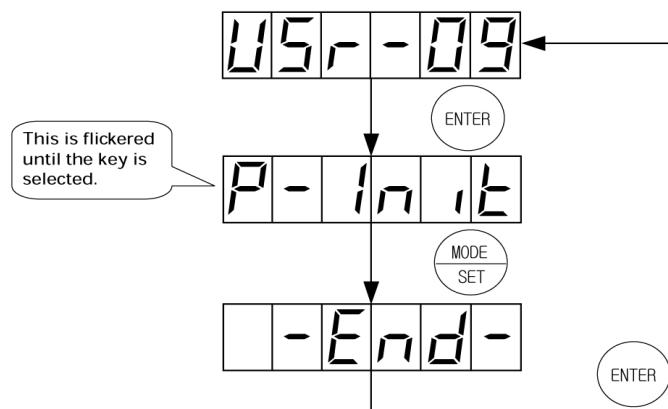
5. Or, by observing the output voltage, SEt-72 and SEt-74 can be set so the voltage is 5[V]. Reduce the setting if the voltage is greater than 5[V], or increase the setting if the voltage is less than 5[V].

## Parameter Initialization

All user parameter values except SEt-23, SEt-24, SEt-36, SEt-37, SEt-51 ~ 53, and SEt-71 ~ 74 can be reset to factory setting value in USr-09.

It takes around 4 seconds to initialize the data. Wait enough time before proceeding with the next step.

**Fig 4.18 Initialization of User Parameter**



**ATTENTION**

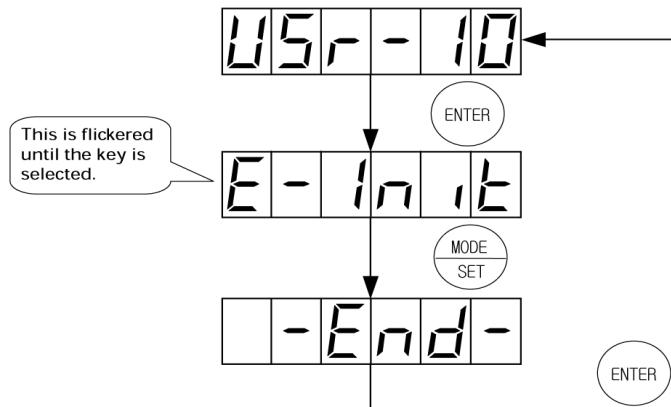
It takes around 4 seconds to initialize the data. Initialize after sometime between the procedures. When the power is turned off during the initialization, ALARM E.80 ~ E. 82 can be occurred. If initializing the data after Alarm E.80 occurs, all user parameter changes into initial setting value. Normal operation can be achieved by checking and resetting the part where the wrong user parameter value has been set.

## Error History Clear

PAr-01 ~ PAr-10 values can be cleared to "0" in USr-10.

It takes around 4 seconds to clear the error history. Wait enough time before proceeding with the next step.

**Fig 4.19 Error History Clear**



## Test Run

Refer to Section Test Run





# Parameter List

Chapter 5 shows lists of various servo drive parameters and their settings.

## User Parameter

- Motor and Encoder Setting**
- Control Mode Setting**
- Parameter Setting Related to Autotuning**
- Parameter Setting Related to Gain**
- Parameter Setting Related to Servo Control**
- Parameter Setting Related to Speed Control**
- Parameter Setting Related to Position Control**
- Parameter Setting Related to Torque Control**
- Parameter Setting Related to Torque Limit**
- Parameter Setting Related to Timing Control**
- Parameter Setting Related to D/A Output**

## Monitor Parameter List

## Jog Mode Parameter List

## Error Monitor and System Parameter List



# User Parameter

## Motor and Encoder Setting

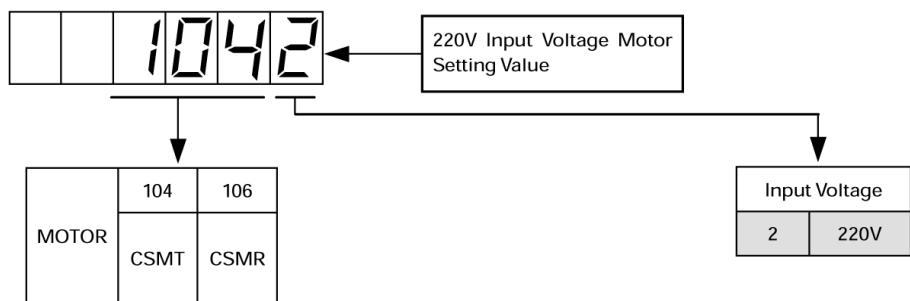
Parameter	Name	Description
*SEt-51	Encoder Type	Refer to Table 5.1
*SEt-52	Motor Type	Refer to Table 5.2
*SEt-53	Motor Capacity Setting	Refer to Table 5.3 A,B

**Table 5.1 Encoder Types Setting (SEt-51)**

CSM/CSMP/CSMT/CSMR		
Set	Encoder Type	Pulse
1	9 wire Incremental	2048

**Table 5.2 Motor Types Setting (SEt-52)**

MOTOR	CSMT	CSMR
DC24V	1040	*
110V	*	*
220V	1042	1062



### Caution:

The motor and encoder parameters are effective after setting and then turn off and on the power.

**Table 5.3 Motor Capacity Setting (SEt-53)**

Capacity Motor Type	220VAC							
	30W	50W	100W	200W	400W	600W	800W	1kW
<b>CSMT</b>	3	5	10	20	40	60	80	100
<b>CSMR</b>	*	*	10	20	40	*	*	*

## Control Mode Setting

Control Type		Control Mode	*SEt-41	Description
<b>Single Type</b>	Position Control	Position Mode	0	Factory Setting Value * Refer to Position Control
	Speed Control	Speed Mode	1	* Refer to Speed Control
		Multi Step Speed Mode	3	3 Step Speed control by input terminal (P-CL, N-CL, P-CON) * Refer to Multi Step Speed Control Mode
		Manual Zero-Clamp Speed Mode	4	P-CON ON: Zero-Clamp Speed Control Mode P-CON OFF: Speed Control Mode * Refer to Auto Zero-Clamp Speed Control Mode
		Auto Zero Clamp Speed Mode	5	Refer to Auto Zero-Clamp Speed Control Mode
		Speed Mode	10	Speed Command method is same with Set-41=1, but the direction of rotation is selected by P-CON P-CON ON: Reverse Rotation P-CON OFF: Forward Rotation
		Analog Torque Limit Speed Mode	12	Torque limit by analog torque input voltage value (Set torque value in SEt-05) during the speed control. P-CON ON: Analog torque limit effective P-CON OFF: Analog torque limit not counted
	Torque Control	Torque Mode	2	* Refer to Torque Control
<b>Complex Type</b>	Speed/Torque Control Conversion	Speed + Speed Limit Torque Mode	6	P-CON ON: Speed Control Mode P-CON OFF: Torque control with speed limit function * Refer to Torque Control
	Position/Torque Control Conversion	Position + Torque Mode	7	P-CON ON: Torque Control Mode P-CON OFF: Position Control Mode * Refer to Manual Zero-Clamp Speed Control Mode
	Position/Speed Control Conversion	Position + Speed Mode	8	P-CON ON: Speed Control Mode P-CON OFF: Position Control Mode * Refer to Offset Adjustment
	Speed Control	Speed + Multi Step Speed Mode	14	P-CON ON: Multi step speed Control Mode P-CON OFF: Speed Control Mode * Refer to Speed/Multi Step Speed Control Mode

### Caution:

Parameter with '\*' are effective after setting and then turn off and on the power

## Parameter Setting Related to Autotuning

Parameter	Name	Description	Unit	Setting Range	Factory Settings
SEt-58	Autotuning Speed	<ul style="list-style-type: none"> <li>- Autotuning speed (RPM): Setting value (rad/s)/2PI*60 Ex) Setting value:100 → 955PM</li> <li>- The inertia ratio calculated may not be accurate if it is set too low compared to the load.</li> <li>- When speed setting value is limited according to the load, if the motor rotation angle (SEt-70) is set to low, accurate inertia ratio can be obtained. If SEt-58=30, set in SEt-70=3.</li> <li>- When setting this parameter high when the load is big, error can occur. Reduce the setting for the operation.</li> </ul> <p>* Refer to Autotuning</p>	rad/s	20~100	100
SEt-70	Motor Rotation Angle During Autotuning	<ul style="list-style-type: none"> <li>- Motor rotates to the left and right once when setting it as 10 (Factory Setting value). However, it may differ according to the load condition.</li> </ul> <p>* Refer to Autotuning</p>	0.1 Rotation	1~30	10
SEt-66	User Set Inertia	<ul style="list-style-type: none"> <li>- The load inertia ratio can be set by the user.</li> <li>- The Con-13 changes upon the change in setting.</li> <li>- Load inertia ratio measured in autotuning is set.</li> <li>- Gain does not change immediately even if the value has been changed, and when changing and setting the SEt-42, basic gain (SEt-02, 03, 04, 06, 40) will be changed in reference to that setting.</li> </ul>	0.1 times	0~1000	30
SEt-42	System Gain	<ul style="list-style-type: none"> <li>- Speed Response Frequency</li> <li>- When setting this parameter, the basic gain (SEt-02, 03, 04, 05, 40) changes in reference to SEt-66.</li> </ul> <p>* Refer to Setting of Servo Drive Gain</p>	Hz	0~100	20

## Parameter Setting Related to Gain

Parameter	Name	Description	Unit	Setting Range	Factory Settings
SEt-02	Speed Loop Proportion Gain	Parameter, which decides the response performance of the speed control. Setting value differs according to load rigidity. * Refer to Setting of Servo Drive Gain	N.m.s	0~2000	40
SEt-03	Speed Loop Integration Gain	Eliminates speed error in steady state. * Refer to Setting of Servo Drive Gain	N.m.s <sup>2</sup>	1~30	130
SEt-04	Position Loop Proportion Gain	Parameter, which decides the response performance of position control. Setting value differs according to load rigidity. * Refer to Setting of Servo Drive Gain	1/s	0~1000	50
SEt-06	1st Torque Filter Cutoff Frequency	Suppresses high frequency term of torque command. Setting value differs according to load rigidity. * Refer to Table 3.2 Setting the Torque Filter Cutoff Frequency (SEt-06)	Rad/s	10~7000	1000
SEt-40	Speed Command Filter Cutoff Frequency	Suppresses high frequency term of speed command.	Rad/s	0~2000	200
SEt-42	System Gain	Basic gain (SEt-02, 03, 04, 06, 40) changes on the basis of inertia ratio(SEt-66) when changing this value. * Refer to Setting of Servo Drive Gain	Hz/s	0~100	20

Parameter	Name	Description	Unit	Setting Range	Factory Setting										
+ SEt-47	Notch Filter Cutoff Frequency	<ul style="list-style-type: none"> <li>- Suppresses the torque command of frequency band set.</li> <li>- Notch filter function is ineffective when setting "0".</li> <li>- Resonant frequency may differ according to the load. Appropriate setting of resonant frequency can raise the system gain.</li> <li>- Vibration or noise can occur if the frequency different from resonant frequency of load is set. Belt system:100~200Hz</li> <li>- The setting to be changed in servo OFF is effective.</li> </ul>	Hz	0~10000	0										
+ SEt-49	2nd Torque Filter Cutoff Frequency	<ul style="list-style-type: none"> <li>- 2<sup>nd</sup> Low pass filter cutoff frequency of torque command.</li> <li>- Effectively suppress high frequency term than first filter (SEt-06).</li> <li>- Setting to be changed is effective in servo OFF. If the setting has been changed during servo ON, operate servo OFF and re-save.</li> </ul>	Hz	0~10000	1000										
SEt-54	Selection of Auto Adjustment on Speed Integration Value	<p>Limits the integration value of speed error and suppresses speed overshoot. Thus, in case of position control, the positioning completion speeds up.</p> <table border="1"> <thead> <tr> <th>Setting</th><th>Content</th></tr> </thead> <tbody> <tr> <td>0</td><td>Invalid</td></tr> <tr> <td>1</td><td>Automatically adjusts the integration value with the setting value of SEt-55 as a standard</td></tr> <tr> <td>2</td><td>Automatically adjusts the integration value with the setting value of SEt-56 as a standard</td></tr> <tr> <td>3</td><td>Automatically adjustment integration value with the setting value of SEt-57 as a standard</td></tr> </tbody> </table>	Setting	Content	0	Invalid	1	Automatically adjusts the integration value with the setting value of SEt-55 as a standard	2	Automatically adjusts the integration value with the setting value of SEt-56 as a standard	3	Automatically adjustment integration value with the setting value of SEt-57 as a standard			2
Setting	Content														
0	Invalid														
1	Automatically adjusts the integration value with the setting value of SEt-55 as a standard														
2	Automatically adjusts the integration value with the setting value of SEt-56 as a standard														
3	Automatically adjustment integration value with the setting value of SEt-57 as a standard														
SEt-55	Auto Adjustment on the Basis of Torque command	<ul style="list-style-type: none"> <li>- If the torque command [%] becomes greater than the setting value [%], speed integration gain is automatically adjusted.</li> <li>- This mode is effective with loading round plate load.</li> </ul> <p><b>Caution:</b></p> <ul style="list-style-type: none"> <li>- When the torque [%] is greater than the setting value [%] in rated speed operation, in other words, when rated speed torque value [%] &gt; SEt-55 [%], speed error may occur.</li> <li>- Please set so the setting value [%] is greater than torque [%] in stop state. Torque value[%] can be checked in Con-03.</li> <li>* Refer to Speed Control .</li> </ul>	%	0~300	100										
SEt-56	Auto Adjustment on the Basis of Speed Command	<ul style="list-style-type: none"> <li>- If the motor speed [RPM] is greater than the setting value [RPM], speed integration gain is automatically adjusted.</li> <li>- In case of load with frictions, except for round plate load, it is effective.</li> </ul> <p><b>Caution:</b></p> <ul style="list-style-type: none"> <li>- If the value of SEt-56 [%] is too low, speed error could occur in the speed [RPM], which exceeds SEt-56.</li> <li>* Refer to Speed Control .</li> </ul>	RPM	0~3000	100										
SEt-57	Auto Adjustment on the Basis of Position Error Amount	<ul style="list-style-type: none"> <li>- If a position error exceeds the setting value [PULSE], speed integration gain is automatically adjusted.</li> <li>- In case of load with frictions, except for round plate load, it is effective.</li> <li>* Refer to Speed Control .</li> </ul>	PULSE	0~10000	100										
<b>Cautions</b>		<b>In gain setting, latest set value has the priority.</b> <b>In other words, even if SEt-02 is changed by setting SEt-42, if SEt-02 is reset, the new SEt-02 is applied to the servo gain.</b>													

### Caution:

Parameter with '+' are effective when it set in servo OFF.

## Parameter Setting Related to Servo Control

Parameter	Name	Description	Unit	Setting Range	Factory Setting
SEt-16	TG-ON Speed Level	<ul style="list-style-type: none"> <li>- Sets the speed level which turns on the TG-ON output signal</li> <li>- Effective when LED no.4=0 of SEt-43. If the motor speed is greater than the setting value, the TG-ON signal is turned On. (Output: CN1 43, 44)</li> </ul>	RPM	1~5000	20
SEt-17	Zero-Clamp Level	<ul style="list-style-type: none"> <li>- Sets the stopping speed when operating in zero clamp mode (SEt-41 = 4 or 5)</li> <li>- If the analog speed command value is less than the setting value, it decelerates to stop and the Servo is ON.</li> <li>- If the analog speed command value is less than the setting value, motor maintains stopped condition, and if the command value is greater than the setting value, motor is sped up to the command value.</li> <li>* Refer to Auto Zero-Clamp Speed Control Mode .</li> </ul>	RPM	1~5000	10
SEt-18	Output Range of Speed (position) Coincidence signal	<ul style="list-style-type: none"> <li>- Sets the error range of speed (position), which turns on the P-COM output signal</li> <li>- P-COM is output when speed (position) error value reaches within the setting value. (Output: CN1 41,42)</li> <li>* Refer to Speed Coincidence Output Signal.</li> </ul>	RPM (PULSE)	0~1000	10
*SEt-23	Number of Encoder Output Pulse per One Rotation	<ul style="list-style-type: none"> <li>- Number of output pulse of servo drive per one rotation of the motor.</li> <li>* Refer to Using Encoder Output.</li> </ul>	PULSE	1~65535	2048
*SEt-24	Number of Motor Encoder Pulse	<ul style="list-style-type: none"> <li>- Number of motor encoder pulse per one rotation</li> <li>* Refer to Using Encoder Output.</li> </ul>	PULSE	1~65535	2048
SEt-25	Jog Operation Speed (Multi Step Speed 4)	<ul style="list-style-type: none"> <li>- Sets speed command when JOG operation, Test run and step 4 speed.</li> </ul>	RPM	0~5000	500
SEt-67	Over Speed Level	<ul style="list-style-type: none"> <li>- The over speed level is set by the user.</li> <li>- When the user setting value [RPM] exceeds 105% of the maximum motor speed, over speed level is limited to 105% of maximum motor speed internally.</li> <li>- When setting "0", over speed level internally becomes 105% of the maximum motor speed.</li> <li>- Actual motor speed at the moment when over speed level error (E.40) has occurred may be a little greater than the over speed level, and may differ according to the inertia ratio or frictions.</li> </ul>	RPM	0~5500	0

**Caution:**

Parameter with ' \* ' are effective after setting and then turn off and on the power.

Parameter	LED No	Name	Setting Value	Description	Factory Setting	Note	
SEt-43	*1	Servo ON Method	0	ON/OFF by external input terminal(SV-ON)	0	Turn the power off and on after changing setting value in Servo OFF state	
			1	Always Servo ON			
	*2	Function Selection of P-OT Signal * Refer to Using Rotation Prohibition Function	0	P-OT Signal is forward rotation prohibition signal	1		
			1	Forward Rotation operation is always permitted			
	*3	Function Selection of N-OT Signal * Refer to Using Rotation Prohibition Function	0	N-OT signal is reverse rotation prohibition signal	1		
			1	Reverse rotation is always permitted			
SEt-44	*4	Function Selection of TG-ON Signal	0	ON when the speed is greater than TG-ON speed level (Setting value of SEt-16)	0		
			1	ON when the current value is greater than current limit value (Setting value of SEt-10~SEt-13)			
	*5	Blackout. Handle after RESET	0	Maintain alarm state when restored to normal state	1		
			1	Automatically the servo alarm state reset.			

Parameter	LED No	Name	Setting Value	Description	Factory Setting	Note	
SEt-44	*1	Selection of Stop Method * Refer to Selection of Stop Method	0	Stops the motor with dynamic brake (DB)	0	Turn the power off and on after changing setting value in Servo OFF state	
			1	Stops after free run			
	*2	Selection of Operation after DB Stop * Refer to Selection of Stop Method	0	Dynamic Brake is off after the stopping of motor	1		
			1	Dynamic Brake is continually on after the stopping of motor			
	*3	Selection of Operation in Emergency Stop * Refer to Selection of Stop Method	0	Stops by the torque set in SEt-14,15 in emergency stop.	0		
			1	Stops the motor with 0 torque in emergency stop(PWM OFF) → Stopping in torque control with 0 also.			
SEt-44	*4	Setting of Encoder Output Pulse Direction * Refer to Using Encoder Output	0	Output as the standard (B phase proceed in 90°) * Refer to Fif 6.25 Encoder Output Pulse Form	0	Servo OFF State	
			1	Output is opposite to the standard			
	+ 5	Selection of ON state of CN1 10 pin	0	Recognizes as ON state when CN1 10 pin is "closed".	0		
			1	Recognizes as ON state when CN1 10 pin is 'open'.			

### Caution:

1. Parameter with '\*' are effective after setting and then turn off and on the power.
2. Parameter with ' + ' are effective when it set in Servo OFF.

Parameter	Name	LED No.	Setting Value	Description	Factory Setting	Note	
SEt-45	Additional Function Selection	1	0	No Function.	0	Turn off and on the power after changing setting value in Servo OFF state  Parameter is set to factory setting if initialized from USr-09.	
			1	When absolute value of analog speed command is less than SEt-17[RPM], speed command is recognized as "0" (Setting is not counted in zero-clamp mode)			
		+ 2	0	Trapezoid Operation	0		
			1	S-Curve Operation			
		+ 3	0	Use 1 <sup>st</sup> torque command filter	0		
			1	Use 2 <sup>nd</sup> torque command filter			
			2	Use both torque command filter (1 <sup>st</sup> &2 <sup>nd</sup> )			
		*4	0	CCW Operation (Forward Operation)	0		
			1	CW Operation (Reverse Direction Operation)			
		*5	0	Position pulse command of line drive output circuit	0		
			1	Position pulse command of open collector output circuit			
		6	-	Reserved	-		

LED No. is specified as shown on the right.

6 5 4 3 2 1

No.6 No.5 No.4 No.3 No.2 No.1

### Caution:

1. Parameter with '\*' are effective after setting and turn off and on the power.
2. Parameter with '+' are effective when it set in Servo OFF.

Parameter	Name	LED No.	Setting Value	Description	Factory Setting	Note
SEt-46	Position Command Pulse Form Selection	1	0	CW + CCW (Positive Logic)	0	Turn off and on the power after changing setting value in Servo OFF state Parameter is set to Factory setting if initialized from USr-09.
			1	CW + CCW (Negative Logic)		
			2	Cannot be Used		
			3	Cannot be Used		
			4	Cannot be Used		
			5	Cannot be Used		
			6	A phase + B phase(X 4) (Positive Logic)		
			7	A phase + B phase(X 4) (Negative Logic)		
			8	Sign + Pulse train(Positive Logic)		
			9	Sign + Pulse train(Negative Logic)		
	SEt-01 Unit Conversion	2	0	Sets the unit of SEt-01 in RPM/V	0	Effective when it set in Servo OFF
	1	Sets the unit of SEt-01 in RPM/10V				
	Reserved	3		Reserved	0	
	Function Selection of CN1 10 Pin	4	0	Emergency Stop	0	Effective when it set in Servo OFF
			1	P-CLR(Position Counter Clear)		
			2	Multi Step Speed 4 Command (Multi Step Speed Mode)		
			3	Direction conversion command (Speed/Multi step Speed Mode)		
			4	Reset of absolute encoder		
			5	Absolute Encoder Data Transmitting mode		
	Function Selection of CN1 15 Pin	5	0	Emergency Stop	4	
			1	P-CLR(Position Counter Clear)		
			2	Multi Step Speed 4 Command (Multi Step Speed Mode)		
			3	Direction conversion Command (Speed/Multi Step Speed Mode)		
			4	Reset of absolute encoder		
			5	Absolute Encoder Data Transmitting mode		

Parameter	Name	Description	Unit	Setting Range	Factory Setting
SEt-77	1 rotation data during transmitting absolute encoder data	Refer to	-	0~8192	2048

LED No. is specified as shown on the right.

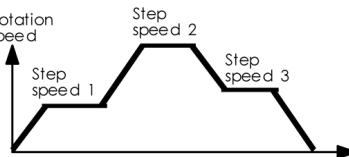
b|5|4|3|2|1

No.6 No.5 No.4 No.3 No.2 No.1

**Caution:**

1. Parameter with '\*' are effective after setting and turn off and on the power.
2. Parameter with ' + ' are effective when it set in Servo OFF.

## Parameter Setting Related to Speed Control

Parameter	Name	Description	Unit	Setting Range	Factory Setting																					
SEt-01	External speed command gain	Speed per external analog input voltage command (1V or 10V according to setting of SEt-46 LED No.2) * Refer to 6.1 A. Speed Command	RPM/V (RPM/10V)	10~6000	500																					
USr-03	Auto adjustment of speed command offset	* Refer to Auto Adjustment of Speed/Torque Command Offset.																								
Usr-05	Manual adjustment of speed command offset	* Refer to Manual Adjustment of Speed/Torque Command Offset																								
SEt-19	Acceleration time	Sets acceleration time from the zero speed to rated speed. * Refer to Acceleration/Deceleration Time and S-Curve Operation.	ms	0~60000	0																					
SEt-20	Deceleration time	Sets deceleration time from the rated speed to the zero speed. * Refer to Acceleration/Deceleration Time and S-Curve Operation.	ms	0~60000	0																					
SEt-21	S-curve operation time	Sets the S-curve time for during acceleration/deceleration. * Refer to Acceleration/Deceleration Time and S-Curve Operation.	ms	0~5000	10																					
SEt-26	Multi step speed 1	<ul style="list-style-type: none"> <li>- Sets speed commands when using multi step speed control mode (SEt-41=3)</li>  <li>- Select speed command according to the input terminal P-CL(CN1 9), N-CL(CN1 8), as shown below.-</li> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <th>Speed selection</th> <th>P-CL</th> <th>N-CL</th> </tr> <tr> <td>Multi step speed 1</td> <td>OFF</td> <td>ON</td> </tr> <tr> <td>Multi step speed 2</td> <td>ON</td> <td>OFF</td> </tr> <tr> <td>Multi step speed 3</td> <td>ON</td> <td>ON</td> </tr> <tr> <td>Stop</td> <td>OFF</td> <td>OFF</td> </tr> </table>   <p>Select forward and reverse rotation operation command with (CN1 4) input terminal</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <th>Rotation direction</th> <th>P-CON</th> </tr> <tr> <td>Forward direction</td> <td>OFF</td> </tr> <tr> <td>Reverse direction</td> <td>ON</td> </tr> </table> </ul>	Speed selection	P-CL	N-CL	Multi step speed 1	OFF	ON	Multi step speed 2	ON	OFF	Multi step speed 3	ON	ON	Stop	OFF	OFF	Rotation direction	P-CON	Forward direction	OFF	Reverse direction	ON	RPM	0~5000	100
Speed selection	P-CL	N-CL																								
Multi step speed 1	OFF	ON																								
Multi step speed 2	ON	OFF																								
Multi step speed 3	ON	ON																								
Stop	OFF	OFF																								
Rotation direction	P-CON																									
Forward direction	OFF																									
Reverse direction	ON																									
SEt-27	Multi step speed 2	Sets multi step speed 2	RPM	0~5000	200																					
SEt-28	Multi step speed 3	Sets multi step speed 3	RPM	0~5000	300																					
SEt-25	Multi step speed 4	<ul style="list-style-type: none"> <li>Sets multi step speed 4</li> <li>* Refer to Speed/Multi Step Speed Control Mode .</li> </ul>	RPM	0~5000	500																					

## Parameter Setting Related to Position Control

Parameter	Name	Description	Unit	Setting Range	Factory Setting
SEt-07	Position FF Filter Cutoff frequency	<ul style="list-style-type: none"> <li>- Use filter to smooth feed-forward compensation value, which is differentiated position command. Cutoff frequency of this filter can be adjusted.</li> <li>- Only effective when feed-forward compensation (FF) gain is not "0", and if overshoot takes place by inserting a value other than "0", set the SEt-07 to "0".</li> </ul> <p>* Also refer to Fig 6.29 Block Diagram of Electronic Gear.</p>	rad/s	0~2500	0
SEt-33	Overflow Level	<ul style="list-style-type: none"> <li>- An overflow alarm occurs if the difference between position command and actual motor position is greater than the setting value.</li> <li>- Alarm CODE=33(Output alarm code in CN2 37,38, 39)</li> </ul>	PULSE	0~65535	8000
SEt-34	Position Feedforward Gain	<ul style="list-style-type: none"> <li>- Inputs feed-forward gain about speed value, which is differentiated position command.</li> <li>- If the value is set high, it is possible to reduce delay term of the position controller and positioning completion speeds up, and position error is reduced during the operation. However, vibration may occur and performance of controller may be reduced according to load type or rigidity.</li> <li>- Feed-forward function is ineffective when setting "0"</li> </ul> <p>* Also refer to Fig 6.29 Block Diagram of Electronic Gear.</p>	%	0~100	0
SEt-35	Position Command Filter Cutoff Frequency	<p>Setting low pass filter cutoff frequency of position command</p> <p>* Also refer to Fig 6.29 Block diagram of electronic gear</p>	rad/s	0~2000	200
* SEt-36	Electronic Gear Ratio Numerator	(Number of pulse per 1 rotation of the motor) x(machine gear ratio of load and motor shaft) * Refer to Electronic Gear.	PULSE	1~65535	2048
* SEt-37	Electronic Gear Ratio Denominator	Number of position command pulse per 1 rotation of load shaft * Refer to Electronic Gear.	PULSE	1~65535	2048
SEt-69	Friction Compensation Torque	<ul style="list-style-type: none"> <li>- Compensate the friction to reduce positioning completion time</li> <li>- Setting excessive value creates vibration in stopping operation.</li> <li>- Ball Screw direct system:2%</li> </ul>	%	0~100	0

### **Caution:**

Parameter with '\*' are effective after setting and turn off and on the power.

## Parameter Setting Related to Torque Control

Parameter	Name	Description	Unit	Setting Value	Factory Setting
SEt-05	External Torque Command Gain	Sets how many percent (%) of motor rated torque per 3V input voltage will be the torque command (CN1 21-22) . 100% = Motor rated torque * Refer to Multi Step Speed Control Mode	%/3V	0~100	100
USr-04	Auto Adjustment of Torque Command Offset	* Refer to Auto Adjustment of Speed/Torque Command Offset			
Usr-06	Manual Adjustment of Torque Command Offset	* Refer to Manual Adjustment of Speed/Torque Command Offset			

## Parameter Setting Related to Torque Limit

Parameter	Name	Description	Unit	Setting Range	Factory Setting						
SEt-10	Forward Rotation Torque Limit	Limits the torque in set value.	%	0~300	300						
SEt-12	External Current Limit of Forward Rotation	100% : Rated torque of the motor <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="padding: 2px 10px;">----- P-CL (CN1 9)</td> <td style="padding: 2px 10px;">ON</td> <td style="padding: 2px 10px;">External current limit of forward rotation is effective.</td> </tr> <tr> <td></td> <td style="padding: 2px 10px;">OFF</td> <td style="padding: 2px 10px;">Setting value is ineffective. (Setting value of SEt10 is effective).</td> </tr> </table>	----- P-CL (CN1 9)	ON	External current limit of forward rotation is effective.		OFF	Setting value is ineffective. (Setting value of SEt10 is effective).	%	0~300	100
----- P-CL (CN1 9)	ON	External current limit of forward rotation is effective.									
	OFF	Setting value is ineffective. (Setting value of SEt10 is effective).									
SEt-14	Emergency Stop Torque of Forward Rotation	- P-OT is set in forward rotation prohibition signal (LED No.2=0 of SEt-43), and if the P-OT signal is input during the forward rotation of the motor, the motor is emergency stopped. This sets the emergency stop torque value at this moment.  - 100% : Rated torque of the motor * Refer to Auto Zero-Clamp Speed Control Mode .	%	0~300	300						
SEt-11	Reverse Rotation Torque Limit	Limits the torque according to the setting.	%	0~300	300						
SEt-13	External Current Limit of Reverse Rotation	100% : Rated torque of the motor <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="padding: 2px 10px;">----- N-CL (CN1 8)</td> <td style="padding: 2px 10px;">ON</td> <td style="padding: 2px 10px;">External current limit of reverse direction is effective.</td> </tr> <tr> <td></td> <td style="padding: 2px 10px;">OFF</td> <td style="padding: 2px 10px;">Setting value is ineffective. (Setting value of SEt11 is effective).</td> </tr> </table>	----- N-CL (CN1 8)	ON	External current limit of reverse direction is effective.		OFF	Setting value is ineffective. (Setting value of SEt11 is effective).	%	0~300	100
----- N-CL (CN1 8)	ON	External current limit of reverse direction is effective.									
	OFF	Setting value is ineffective. (Setting value of SEt11 is effective).									
SEt-15	Emergency Stop Torque of Reverse Rotation	- N-OT is set in reverse rotation prohibition signal(LED No.3=0 of SEt-43), and if N-OT signal is input during the reverse rotation of the motor, the motor is emergency stopped. This sets the emergency stop torque value at this moment.	%	0~300	300						
SEt-64	Forward Torque Offset	- Set when the load rise as the motor rotates forward towards the vertical axis of the load. - It is possible to make up for the problem which the load falls when unlocking the machine brake in servo on state, in the load which is operating to the vertical axis.  <b>Note:</b> When using with SEt-65, SEt-64 can not be non-zero when SEt-65 is also non-zero.	%	0~100	0						
SEt-65	Reverse Torque Offset	- Sets when the load rises when the motor rotates reverse towards vertical axis of load. - It is possible to make up the problem, which the load falls when unlocking the machine brake in servo on state, in the load which is operating to the vertical axis.  <b>Note:</b> When using with SEt-64, SEt-65 can not be non-zero when SEt-64 is also non-zero.	%	0~100	0						

## Parameter Setting Related to Timing Control

Parameter	Name	Description	Unit	Setting Value	Factory Setting
SEt-29	Servo OFF Delay Time	Delay time until the Servo OFF is operated inside actual servo drive from the point where Servo OFF command is input externally when the motor stopping. * Refer to Brake Control .	10ms	0~1000	0
SEt-30	Setting of motor speed value when outputting Brake Signal after Servo OFF	Sets the motor speed, which the servo output brake signal when inputting Servo OFF command during rotation. * Refer to Brake Control .	RPM	0~1000	100
SEt-31	Setting of waiting time when Outputting Brake Signal after Servo OFF	- Sets the time which servo sends out brake output signal (CN2 47, 48) from the point where Servo OFF command has been input during the rotation. - Output the brake signal if the motor speed is below the setting value in SEt-30, even if it does not reach time set in SEt-31 from the point where Servo OFF is done. * Refer to Brake Control .	10ms	0~1000	50
SEt-76	Delay Time of Brake signal output after Servo ON	Sets the time from external Servo ON signal to the point where brake output signal is output. * Refer to Brake Control .	10ms	0~100	0

## Parameter Setting Related to D/A Output

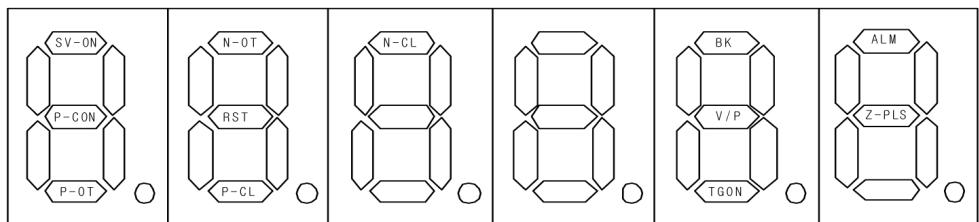
Parameter	Name	Description	Unit	Setting Range	Factory Setting
USR-08	DA Channel Output Value Selection	* Refer to D/A Converter Channel Selection.			
SEt-08	Adjustment of D/A output Related speed/ position	Speed(position) setting of D/A output 1V (+: forward rotation, -: reverse rotation) * Refer to D/A Converter Channel Selection.	RPM (PULSE)	1~65535	500
SEt-09	Adjustment of D/A output Related Toque	Torque setting of D/A output ±1V (+: forward rotation, -: reverse rotation) * Refer to D/A Converter Channel Selection.	%	1~300	50
SEt-71	Offset Adjustment of DA Channel 1	Adjusts output offset of DA channel 1 * Refer to Output Adjustment Method of D/A Converter Channel.	10mV	0~200	100
SEt-72	Gain Adjustment of DA Channel 1	Adjusts output gain of DA channel 1 * Refer to Output Adjustment Method of D/A Converter Channel.	%	1~200	100
SEt-73	Offset Adjustment of DA Channel 2	Adjusts output offset of DA channel 2	10mV	0~200	100
SEt-74	Gain Adjustment of DA Channel 2	Adjusts output gain of DA channel 1	%	1~200	100

## Monitor Parameter List

**Table 5.4 Monitor Parameter List**

Monitor No.	Description	Unit
Con-01	Feedback Speed	RPM
Con-02	Speed Command	RPM
Con-03	Torque Command	%
Con-04	Electrical Angle	DEGREE
Con-05	Speed Error	RPM
Con-06	Position Error	PULSE
Con-07	Mechanical angle	DEGREE
Con-08	Position Feedback	PULSE
Con-09	Position Command	PULSE
Con-10	Speed Offset	mV
Con-11	Torque Offset	mV
Con-12	I/O State Display (Refer to Fig 4.6 Display of Con-12)	
Con-13	Inertia Ratio (=Load Inertia/Motor Inertia)	-
Con-16	Input Pulse Frequency	kHz
Con-17	Speed Command Voltage	10mV
Con-18	Torque Command Voltage	10mV
Con-19	Maximum Torque Absolute Value	%
Con-20	Multi Rotation Data of Absolute Encoder	-
Con-21	Absolute Value of Maximum Position Error	PULSE
Con-22	Absolute Value of Maximum Speed Feedback	RPM
Con-23	Encoder Counter	PULSE
Con-24	Data within 1 Rotation of Absolute Encoder	-
Con-25	Lower 5digits of position command in servo-off status	PULSE
Con-26	Upper 5digits of position command in servo-off status	PULSE
Con-27	Lower 5digits of position feedback in servo-off status	PULSE
Con-28	Upper 5digits of position feedback in servo-off status	PULSE

**Fig 5.1 I/O Status of Con-12 (V/P: Speed/Position Completion Signal CN1 pin 41-42)**



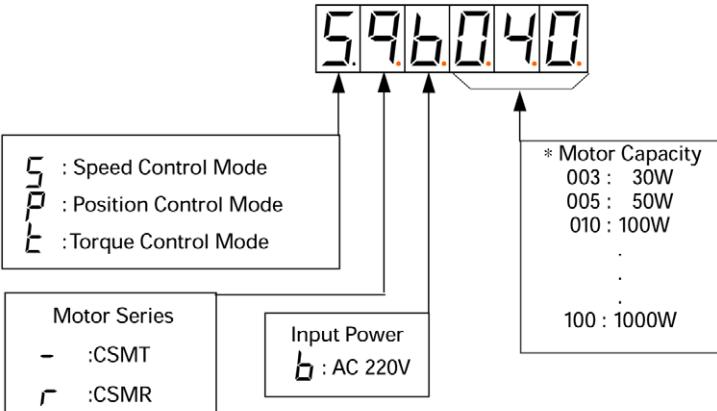
## Jog Mode Parameter List

**Table 5.5 Jog Mode Parameter List**

Parameter	Description				Reference																											
USR-01	JOG (Servo ON by Operator) * Refer to start up by Operator				3.2 B.																											
USR-02	AutoTuning				3.3																											
USR-03	Auto Adjustment of Speed Command Offset				4.7 C.																											
USR-04	Auto Adjustment of Torque Command Offset																															
USR-05	Manual Adjustment of Speed Command Offset				4.7 D.																											
USR-06	Manual Adjustment of Torque Command Offset																															
USR-07	Alarm Reset (Error Data Reset)				4.7 E.																											
USR-08	Uses D/A Converter Channel <table border="1"> <thead> <tr> <th>Setting</th> <th>Pin</th> <th>Channel1 CN1 pin 23</th> <th>Channel2 CN1 pin 28</th> <th>CN1 pin 27</th> </tr> </thead> <tbody> <tr> <td>dA-03</td> <td>Torque Command</td> <td>Torque Feedback</td> <td>GND</td> <td></td> </tr> <tr> <td>dA-04</td> <td>Position command</td> <td>Position Feedback</td> <td>GND</td> <td></td> </tr> <tr> <td>dA-05</td> <td>Speed Command</td> <td>Speed Feedback</td> <td>GND</td> <td></td> </tr> <tr> <td>dA-06</td> <td>Speed Command</td> <td>Torque Command</td> <td>GND</td> <td></td> </tr> <tr> <td>dA-07 (Factory Setting)</td> <td>Torque Command</td> <td>Speed Feedback</td> <td>GND</td> <td></td> </tr> </tbody> </table>	Setting	Pin	Channel1 CN1 pin 23	Channel2 CN1 pin 28	CN1 pin 27	dA-03	Torque Command	Torque Feedback	GND		dA-04	Position command	Position Feedback	GND		dA-05	Speed Command	Speed Feedback	GND		dA-06	Speed Command	Torque Command	GND		dA-07 (Factory Setting)	Torque Command	Speed Feedback	GND		4.7 F. 4.7 G.
Setting	Pin	Channel1 CN1 pin 23	Channel2 CN1 pin 28	CN1 pin 27																												
dA-03	Torque Command	Torque Feedback	GND																													
dA-04	Position command	Position Feedback	GND																													
dA-05	Speed Command	Speed Feedback	GND																													
dA-06	Speed Command	Torque Command	GND																													
dA-07 (Factory Setting)	Torque Command	Speed Feedback	GND																													
USR-09	All parameters except SEt-23, SEt-24, SEt-36, SEt-37, SEt-51 ~ SEt-53, SEt-71 ~ 74 are set to factory setting value. Initialization during the E.80 changes all user parameters to factory setting. USR-09 → ENTER Key → "P-init" blinks → MODE/SET Key → Initialization																															
USR-10	Error History Clear Clears all of PAr-01 ~ PAr-10 contents to "0".				4.7 I.																											
USR-90	Test run Test run/Stop by SET key				3.4																											

## Error Monitor and System Parameter List

**Table 5.6 Error Monitor and System Parameter List**

Parameter	Description
PAr-01	Last Error
PAr-02	Second Last Error
PAr-03	Third Last Error
PAr-04	Fourth Last Error
PAr-05	Fifth Last Error
PAr-06	Sixth Last Error
PAr-07	Seventh Last Error
PAr-08	Eighth last Error
PAr-09	Ninth Last Error
PAr-10	Tenth Last Error
PAr-11	Checks the software version 
PAr-12	Checks the controller type  <p>5 : Speed Control Mode 6 : Position Control Mode 0 : Torque Control Mode</p> <p>Motor Series - :CSMT 0 :CSMR</p> <p>Input Power b : AC 220V</p> <p>* Motor Capacity 003 : 30W 005 : 50W 010 : 100W ... 100 : 1000W</p>



# Basic Functions

Chapter 6 explains the basic functions of the servo drive.

## Speed Control

- Speed Command**
- Multi Step Speed Control Mode**
- Speed/Multi Step Speed Control Mode**
- Manual Zero-Clamp Speed Control Mode**
- Auto Zero-Clamp Speed Control Mode**
- Speed Coincidence Output Signal**

## Changing the Motor Rotation Direction

## Acceleration/Deceleration Time and S-Curve Operation

## Selection of Stop Method

- Offset Adjustment**
- Using the DB(Dynamic Brake)**
- Using Zero-Clamp Function**
- Emergency Stop**

## Position Control

- Wiring**
- Position Command Pulse Form**
- Electrical Specifications of Command Pulse**
- Position Counter Clear**
- Position Completion Output Signal (P-COM)**
- I/O Signal Timing**
- Position/Speed Control Mode**

## Using Encoder Output

**Electronic Gear**  
**Rotation Detection Output Signal**

**Torque Control**

**Setting**

**Torque Command**

**Limiting the Speed during the Torque Control**

**Position/Torque Control Mode**

**Torque Limit**

**Setting of Servo Drive Gain**

**Using Rotation Prohibition Function**

## Speed Control

There are 6 types of mode in speed control: general speed control, manual zero-clamp speed control, auto zero-clamp speed control, multi step speed control, speed control with analog torque limit, and speed/multi step speed control.

**Table 6.1 Setting the Speed Control Mode**

Parameter	Name	Setting	Control Mode	Description
SEt-41	Control Mode Setting	1	General Speed Control	<ul style="list-style-type: none"> <li>- <u>P-CON</u> OFF : PI control</li> <li>- <u>P-CON</u> ON : P control</li> </ul>
		10	General Speed Control	<p>The direction of rotation is selected by P-CON</p> <ul style="list-style-type: none"> <li>- <u>P-CON</u> OFF : Forward Rotation</li> <li>- <u>P-CON</u> ON : Reverse Rotation</li> </ul>
		4	Manual Zero-Clamp Speed Control	<ul style="list-style-type: none"> <li>- P/PI control conversion not possible.</li> <li>- <u>P-CON</u> ON : Zero-Clamp speed control mode</li> <li>- <u>P-CON</u> OFF: General speed control mode</li> <li>- Zero-Clamp operation : Ignores speed command below zero-clamp level (SEt-17)and motor decelerates to a stop (Zero Speed)</li> </ul>
		5	Auto Zero-Clamp Speed Control	<ul style="list-style-type: none"> <li>- <u>P-CON</u> OFF : PI control</li> <li>- <u>P-CON</u> ON : P control</li> <li>- Always ignores speed command below zero-clamp level (SEt-17) and motor decelerates to a stop (Zero Speed)</li> </ul>
		3	Multi step Speed Control	<ul style="list-style-type: none"> <li>- P/PI control conversion not possible</li> <li>- Step 3 speed control by input terminal (<u>P-CL</u>, <u>N-CL</u>, <u>P-CON</u>)</li> <li><u>P-CL</u>, <u>N-CL</u> : Multi step speed command selection</li> <li><u>P-CON</u> : Forward rotation/Reverse rotation operation command</li> <li>- Set the speed command value in SEt-26~28</li> </ul>
		12	Analog Torque Limit Speed Control	<ul style="list-style-type: none"> <li>- Torque limit by analog torque input voltage value(Torque value set in SEt-05) during speed control</li> <li><u>P-CON</u> On : Analog torque limit effective</li> <li><u>P-CON</u> Off : Analog torque limit ineffective</li> </ul>
		14	Speed/Multi step Speed Control	<ul style="list-style-type: none"> <li><u>P-CON</u> Off : Speed control mode</li> <li><u>P-CON</u> On : Multi step speed control mode</li> </ul>

**ATTENTION**



When controlling the feedback (position control) from the host controller, do not use zero-clamp mode. When controlling the feedback (position control) from the host controller, set the acceleration/deceleration time (SEt-19, SEt-20) to "0".

## • Using the P-CON Input Signal

P-CON function differs according to the control mode.

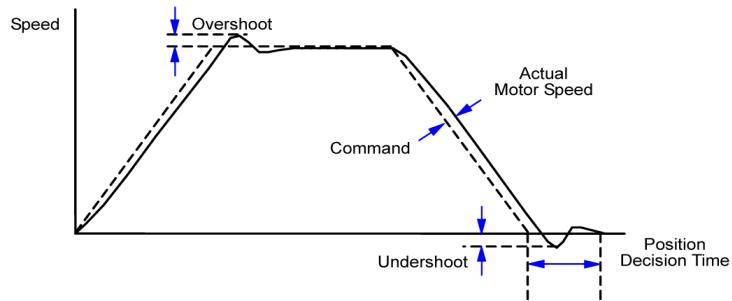
**Table 6.2 Using the P-CON Signal**

Control Mode	P-CON function
SEt-41=0, 1, 5	P/PI Control Conversion
SEt-41=4	Zero-Clamp On/Off
SEt-41=6	Speed/Speed Limit Torque Control Mode Conversion
SEt-41=3, 10	Selecting the direction of rotation
SEt-41=14	Speed/Multi-Step Speed Control Mode Conversion
SEt-41=8	Position/Speed Control Mode Conversion
SEt-41=7	Position/Torque Control Mode Conversion
SEt-41=12	Analogue Torque Limit On/Off

## • P/PI Control Conversion

P/PI control conversion by P-CON input terminal can be used in the following cases.

- (1) To block undershoot during the speed control.
- (2) To decide on the position within minimum time by blocking the undershoot during the position control.



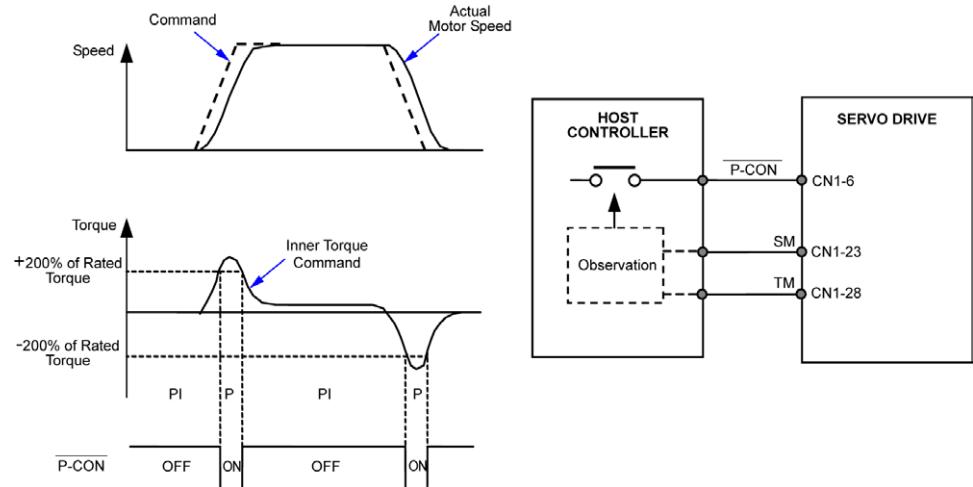
### ATTENTION



P/PI control conversion needs observations such as speed/torque curve so be cautious. Speed/torque curve can be observed through D/A output (CN1 pin 23, 28). (Refer to **D/A Converter Channel Selection**)

Do not use when there is less or no overshoot/undershoot.

**Fig 6.1 Example of P/PI Control Conversion Usage**



• **Auto Adjustment of Speed Integration Value (SEt-54)**

Purpose: used to reduce overshoot or undershoot in case of position and speed control.

Setting Parameter: SEt-54 and either one of SEt-55 ~ SEt-57.

(Similar operation as the P/PI conversion control described above is done.)

Parameter	Parameter Name	Factory Setting	Unit	Description										
SEt-54	Selection of Auto Adjustment on Speed Integration Value	2		<p>Suppresses speed overshoot/undershoot while automatically adjusting the speed integration value. Thus, in case of position control, position completion time is shortened.</p> <table border="1"> <thead> <tr> <th>Setting</th><th>Description</th></tr> </thead> <tbody> <tr> <td>0</td><td>Ineffective</td></tr> <tr> <td>1</td><td>Automatically adjusts the integration value on the basis of the setting value SEt-55.</td></tr> <tr> <td>2</td><td>Automatically adjusts the integration value on the basis of the setting value SEt-56.</td></tr> <tr> <td>3</td><td>Automatically adjusts the integration value on the basis of the setting value SEt-57.</td></tr> </tbody> </table>	Setting	Description	0	Ineffective	1	Automatically adjusts the integration value on the basis of the setting value SEt-55.	2	Automatically adjusts the integration value on the basis of the setting value SEt-56.	3	Automatically adjusts the integration value on the basis of the setting value SEt-57.
Setting	Description													
0	Ineffective													
1	Automatically adjusts the integration value on the basis of the setting value SEt-55.													
2	Automatically adjusts the integration value on the basis of the setting value SEt-56.													
3	Automatically adjusts the integration value on the basis of the setting value SEt-57.													
SEt-55	Auto Adjustment on the basis of Torque Command	100	%	<ul style="list-style-type: none"> <li>- Automatically adjusts the speed Integration value on the basis of torque command.</li> <li>- Set little lower value than maximum usage torque.</li> </ul>										
SEt-56	Auto Adjustment on the basis of Speed Command	100	RPM	<ul style="list-style-type: none"> <li>- Automatically adjusts the speed integration value on the basis of speed command.</li> <li>- Speed offset may occur above the setting value.</li> </ul> <p>The graph shows 'Speed' on the vertical axis and 'Time' on the horizontal axis. A solid line represents the 'Speed command', which rises from a 'Setting Value' to a peak and then falls. A dashed line represents the 'Speed Feedback', which follows the command but remains below it, creating an 'Offset' indicated by a double-headed arrow. Arrows point to the 'Speed command' and 'Speed Feedback' lines with labels.</p>										
SEt-57	Auto Adjustment on the basis of Position Error Amount	100	PULSE	<ul style="list-style-type: none"> <li>- Automatically adjusts the speed Integration value on the basis of position error amount.</li> </ul>										

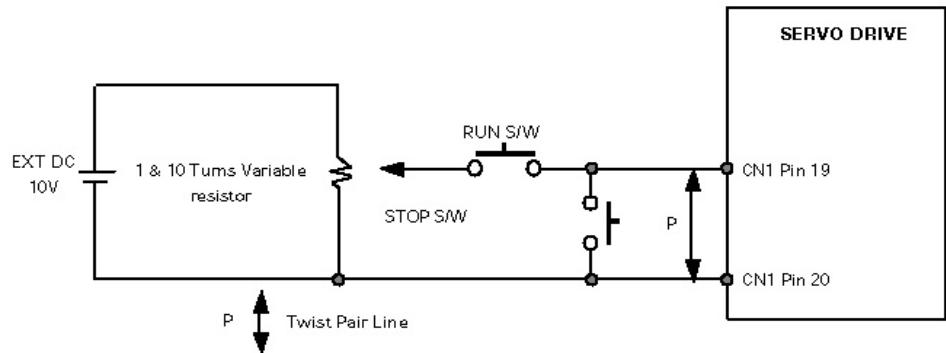
## Speed Command

In case of speed control, analog input voltage value of pin 19-20 of CN1 becomes the speed command value.

The relationship between the speed command value and input voltage is set in SEt-01.

- **Composition**

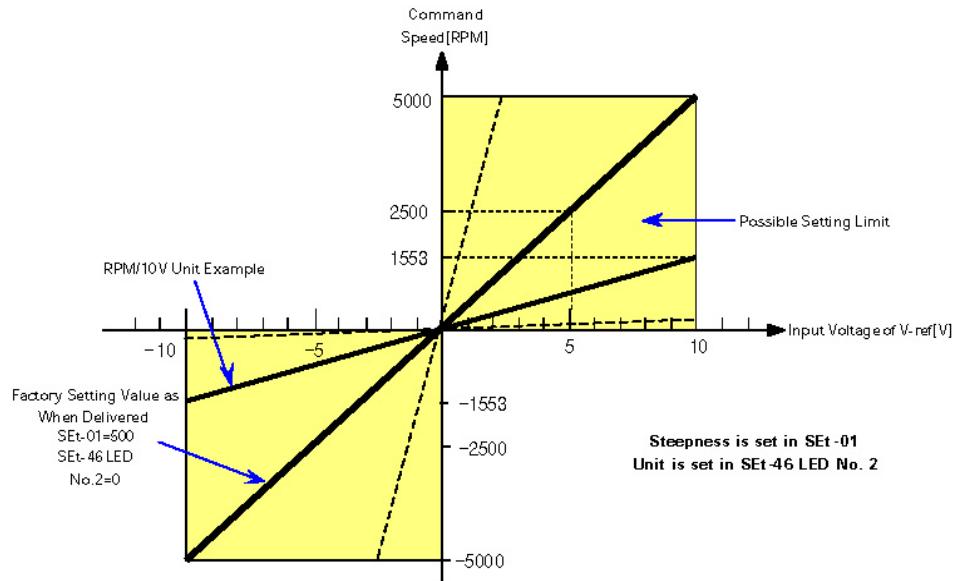
**Fig 6.2 Analog Speed Command Input Circuit**



- **Relationship Between the Input Voltage Value and Speed Command**

Controls the speed in proportion to input voltage V-ref.

**Fig 6.3 Analog Input Voltage and Speed**



Speed command can be changed in constant input voltage by changing the setting value of SEt-01.

$$\text{Speed Command [RPM]} = \text{Setting value of SEt-01[RPM/V]} \text{ or } [\text{RPM}/10\text{V}] \times \text{Input Voltage Value[V]}$$

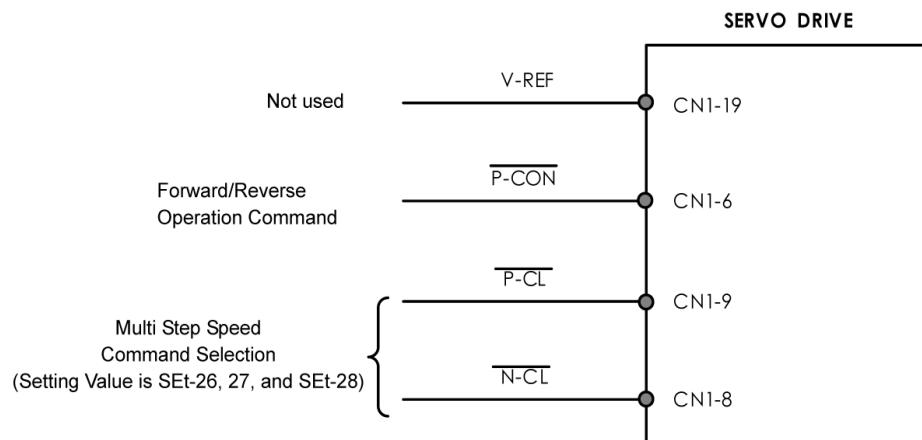
When the speed command desired by the user is not in the multiples of 10, set to LED No.2=1 of SEt-46 and change the unit of the value to [RPM/10V]. When setting SEt-01=1553, motor is rotated in 1553[RPM] with 10V speed command.

SEt-01	300	SEt-01	2439
SEt-46 LED No.2	0	SEt-46 LED No.2	1
[RPM] = 300[RPM/10V] x10[V]		[RPM] = 2439[RPM/10V] x10[V]	
Thus when setting 10V, motor rotates in 3000RPM.		Thus when setting 10V, motor rotates in 2439RPM.	

## Multi Step Speed Control Mode

Used when desired to operate the motor in the speed already set (forward/reverse 3 types of speed).

**Fig 6.4 Multi Step Speed Control Circuit**



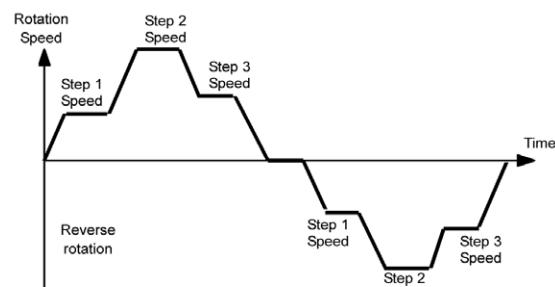
**Table 6.3 Multi Step Speed Control Mode Setting**

Multi Step Speed Control Mode Setting	Setting Value of SET-41 = 3
<b>Speed Value Setting</b>	Setting Value of SET-26, SET-27, and SET-28[RPM]
<b>Speed Command Selection</b>	P-CL(CN1 Pin 9), N-CL(CN1 Pin 8)
<b>Forward/Reverse Command</b>	P-CON Terminal (CN1 Pin 6)
<b>Acceleration Time Setting</b>	Setting Value of SEt-19[msec]
<b>Deceleration Time Setting</b>	Setting Value of SEt-20[msec]

\* Current limit function and P/PI control conversion function cannot be used here.

\* When using the acceleration/deceleration function. Shock on the system can be reduced during speed change.

**Fig 6.5 Multi Step Speed Operation**



\* Step 4 speed can be used.  
Refer to **page 6-10 for its usage.**

Speed	Setting	P-CON	P-CL	N-CL
Step 1 Speed	SEt-26	OFF	OFF	ON
Step 2 Speed	SEt-27		ON	OFF
Step 3 Speed	SEt-28		ON	ON
Reverse Rotation Step 1 Speed	SEt-26	ON	OFF	ON
Reverse Rotation Step 2 Speed	SEt-27		ON	OFF
Reverse Rotation Step 3 Speed	SEt-28		ON	ON
Stop	-	-	OFF	OFF

ON : The corresponding input terminal is connected to the input voltage GND(0V).

OFF : The corresponding input terminal is connected to +24VIN or not connected.

## Speed/Multi Step Speed Control Mode

It may be converted to speed/multi step speed control mode by ON/OFF of P-CON input terminal.

**Table 6.4 Speed/Multi Step Speed Control Mode Setting**

Item	Description	Note																				
Mode Setting Parameter	SEt-41 = 14	Setting value is effective after Power ON/OFF.																				
Control Mode Conversion	P-CON Input Terminal OFF → Speed Control Mode ON → Multi Step Speed Control Mode																					
Multi Step Selection Speed	Selection by P-CL, N-CL Input Terminal <table border="1" data-bbox="541 720 1107 1118"> <thead> <tr> <th>Item</th> <th>P-CL</th> <th>N-CL</th> <th>Speed Value</th> </tr> </thead> <tbody> <tr> <td>Step 1 speed</td> <td>OFF</td> <td>ON</td> <td>Setting value of SEt-26</td> </tr> <tr> <td>Step 2 speed</td> <td>ON</td> <td>OFF</td> <td>Setting value of SEt-27</td> </tr> <tr> <td>Step 3 speed</td> <td>ON</td> <td>ON</td> <td>Setting value of SEt-28</td> </tr> <tr> <td>Stop</td> <td>OFF</td> <td>OFF</td> <td>0</td> </tr> </tbody> </table> In order to set direction conversion command terminal with CN1 pin 10 or 15, set '3' in SEt-46 LED No. 4 or 5. Forward/Reverse direction command is operated through ON/OFF of set terminal (CN1. 10 or 15)	Item	P-CL	N-CL	Speed Value	Step 1 speed	OFF	ON	Setting value of SEt-26	Step 2 speed	ON	OFF	Setting value of SEt-27	Step 3 speed	ON	ON	Setting value of SEt-28	Stop	OFF	OFF	0	
Item	P-CL	N-CL	Speed Value																			
Step 1 speed	OFF	ON	Setting value of SEt-26																			
Step 2 speed	ON	OFF	Setting value of SEt-27																			
Step 3 speed	ON	ON	Setting value of SEt-28																			
Stop	OFF	OFF	0																			
Acceleration and Deceleration time in mode Conversion	Acceleration time: Setting value of Set-19 Deceleration Time: Setting value of SEt-20 Unit: msec <b>Caution :</b> Acceleration and deceleration time must be set. In case of which the acceleration and deceleration time is "0", it may be too harsh for the load during control mode conversion.																					

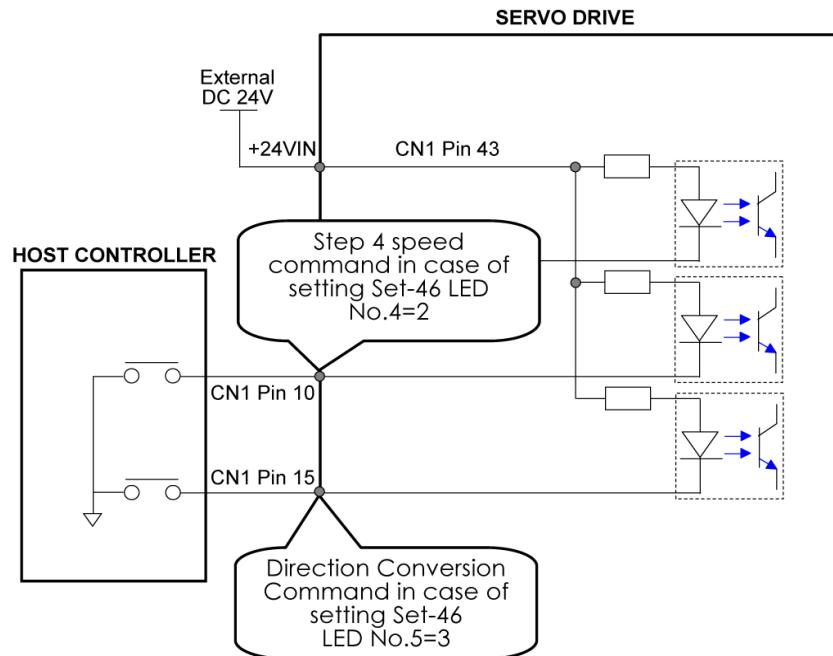
\* Step 4 speed can be used when selecting multi step speed control mode. Refer to **next page for its usage**.

ON: The corresponding input terminal is connected to input voltage GND(0V)

OFF: The corresponding input terminal is connected to +24VIN or not connected.

- **Using the Step 4 Speed**

**Fig 6.6 Using the Step 4 Speed**



- Step 4 speed command can be used in multi step speed control mode or speed/multi step speed control mode.
  - In order to use step 4 speed command, set '2' in SEt-46 LED No. 4 or 5 and set the pin 10 or 15 of CN1 as step 4 speed command.
  - If the step 4 speed command is on, ignore other step x speed command and rotates in the speed set in SEt-25.
- \* The rotation of direction is selected by pin 10 or 15 of CN1 in Speed/Multi step speed control mode(SEt-41=14). If you use pin 10 of CN1 as the step 4 speed command, you must use pin 15 of CN1 as the direction conversion command.  
In Multi step speed control mode(SEt-41=3), Use P-CON input terminal for changing the direction of rotation.

**Table 6.5 Step 4 Speed Usage Setting**

Control Mode Setting	SEt-41= 3 Multi-Step Speed Control mode	SEt-41=14 Speed/Multi Step Speed Control Mode	
<b>Step 4 Speed Command Selection</b>	SEt-46 LED No.4=3, Pin 10 of CN1 SEt-46 LED No.5=3, Pin 15 of CN1	SEt-46 LED No.4=2 Pin 10 of CN1	SEt-46 LED No.5=2 Pin 15 of CN1
<b>Direction Conversion Command Selection</b>	/P-CON	SEt-46 LED No.5=3 Pin 15 of CN1	SEt-46 LED No.4=3 Pin 10 of CN1
<b>Step 4 Speed Command Setting</b>	Setting of SEt-25 [RPM]		

- **Example of Step 4 Speed Cobmmmand Usage**

SEt-41=14

Sets to speed/multi step speed control mode

SEt-44 LED No.5 = 0(Factory setting)

Set into On status when CN1 pin 10 is 'Closed'

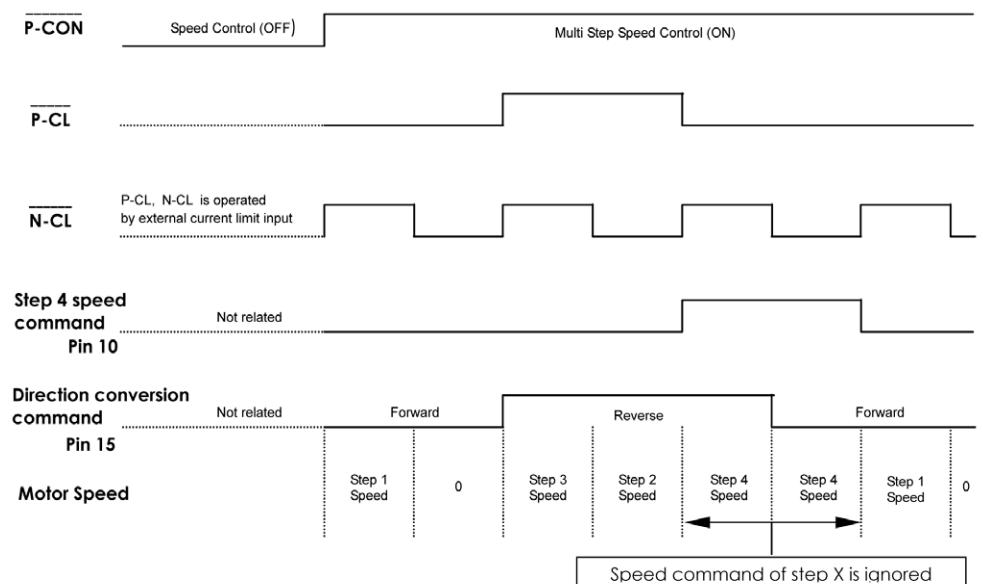
SEt-46 LED No.4 = 2

Set the CN1 pin 10 to input of 'step 4 speed command'

SEt-46 LDE No.5 = 3

Set the CN1 pin 15 to input of 'direction conversion command'

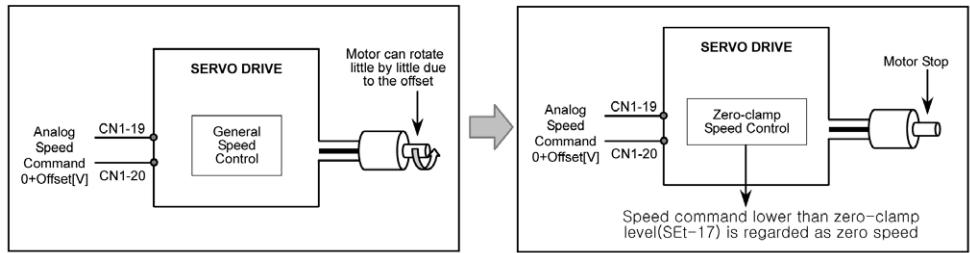
**Fig 6.7 Example of Step 4 Speed Command Usage**



## Manual Zero-Clamp Speed Control Mode

In case of which there is position control loop in host controller, it controls the position to stop the motor. But if the host controller does not control the position when using the servo drive only in speed control mode, speed command V-ref is not completely 0[V], and little offset may exist. Here, motor rotates little and uses this function to completely stop the motor rotation.

**Fig 6.8 Using the Zero-Clamp Speed Control**



### ATTENTION



In case of operating position control in the host controller, do not use zero-clamp control mode. Motor may not operate correctly.

Also, set acceleration/deceleration time to "0".

- Parameter and input terminal related to zero-clamp is as follows.

**Table 6.6 Manual Zero-Clamp Speed Control Setting**

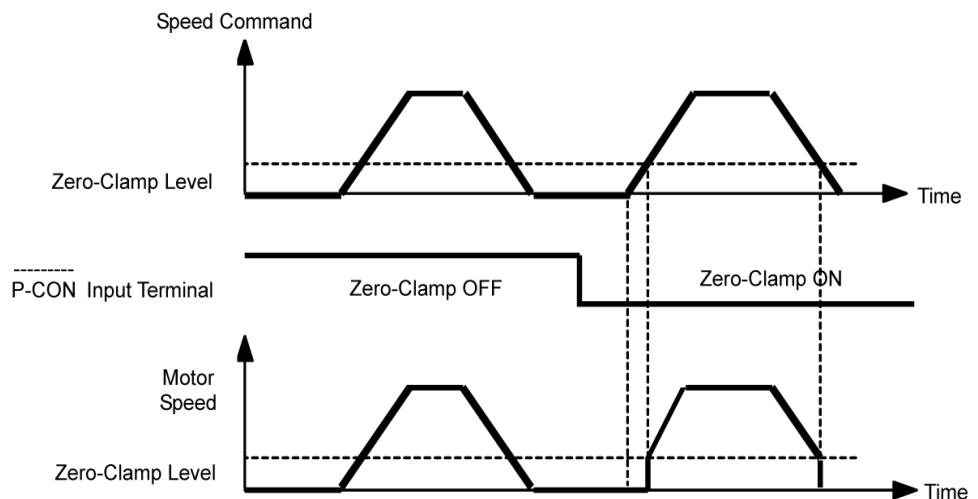
	Setting	Description
SEt-41	4	Manual Zero-Clamp speed control mode
SEt-17	1~5000[RPM]	Zero-Clamp Operation Level
V-ref (CN1 pin 19,20)	-10~10V	Speed command
P-CON (CN1 pin 6)	ON	Zero-Clamp ON
	OFF	Zero-Clamp OFF

\* P/PI control cannot be converted.

ON: The corresponding input terminal is connected to input voltage GND (0V)

OFF: The corresponding input terminal is connected to +24VIN it is not connected

**Fig 6.9 Zero-Clamp Operation**



### **Auto Zero-Clamp Speed Control Mode**

This is a control mode, which always operates zero-clamp function.  
 Other operations are same as manual zero-clamp speed control mode.

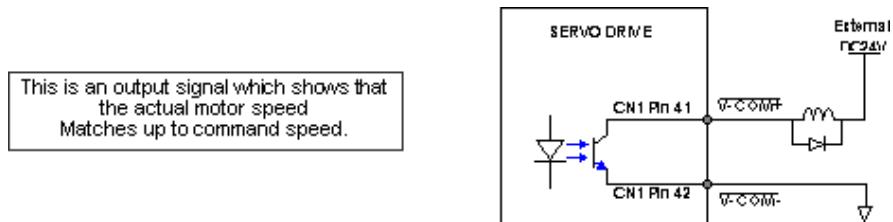
**Table 6.7 Auto Zero-Clamp Speed Control Mode Setting**

	<b>Setting</b>	<b>Description</b>
SEt-41	5	Auto zero-clamp speed control mode
SEt-17	1~5000[RPM]	Zero-Clamp Operation Level
V-ref (CN1 pin 19,20)	-10~10V	Speed command
<u>P-CON</u> (CN1 pin 6)	ON	P control
	OFF	PI control

ON: The corresponding input terminal is connected to input voltage GND(0V)

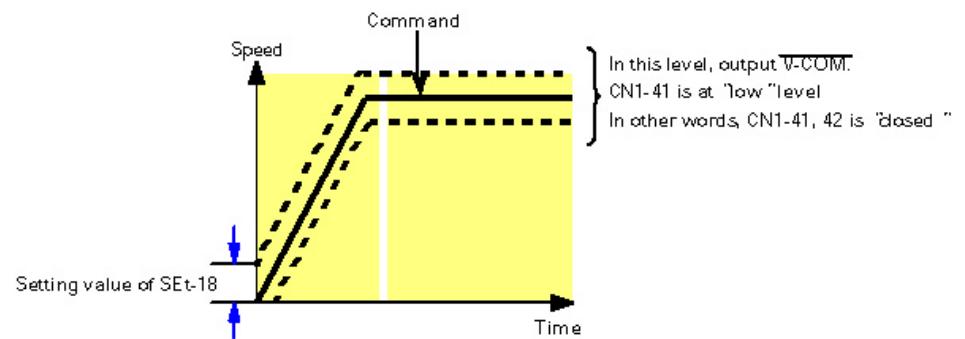
OFF: The corresponding input terminal is connected to +24VIN or it is not connected

## Speed Coincidence Output Signal



Parameter	Name	Setting Range	Unit	Factory Setting	Note
SEt-18	Output Width of Speed (Position) Coincidence Signal	0~1000	RPM (PULSE)	10	<ul style="list-style-type: none"> <li>- Speed Control Mode: Width of speed coincidence output signal</li> <li>- Position Control Mode: Position Completion Range (PULSE)</li> </ul>

**Fig 6.10 Width of Speed Coincidence Output Signal**



## Changing the Motor Rotation Direction

This function can be used for the speed/torque control mode.  
(Setting of control mode is done in SEt-41.)

- In Case of Speed/Torque Control Mode**

Parameter	LED No.	Setting Value	Description	Factory Setting
SEt-45	4	0	Forward rotation operation. During speed control mode, + voltage of V-ref terminal (CN1 pin 19) is forward direction operation During torque control mode, + voltage of T-ref terminal (CN1 pin 21) is forward direction operation	0
		1	Reverse Direction Operation During speed control mode, - voltage of V-ref terminal (CN1 pin 19) is forward direction operation During torque control mode, - voltage of T-ref terminal (CN1 pin 21) is forward direction operation	

- After changing the setting value, turn off the power, and turn it on again. It is only effective after rebooting.

**Table 6.8 Effective Boundary of SEt-45 LED No.4 Setting**

Control Mode	
Speed Control	
Zero-Clamp Speed Control	
Torque Control	Effective
Speed/Speed Limit Torque Control	
Auto Zero-Clamp Speed Control	
Multi Step Speed Control	
Position Control	Ineffective

- Encoder output for rotation direction follows the setting of SEt-44 LED No.4.**

Parameter	LED No.4	Setting	Description
SEt-44	4	0	Output as the standard( During the forward rotation (CCW) B phase advances for 90) Refer to Fig 6.22 I/O Signal Timing Chart.
		1	Output is opposite to the standard

## Acceleration/Deceleration Time and S-Curve Operation

- **Acceleration and Deceleration Time Setting**

This function can set the acceleration or deceleration time inside the drive when the step speed command is given externally.

**Fig 6.11 Inner Speed Command Generation**



Parameter	Name	Unit	Setting Range	Factory Setting Value
SEt-19	Acceleration Time	msec	0~60000	0
SEt-20				
SEt-21	S-curve Operation Conversion Time	msec	0~5000	10

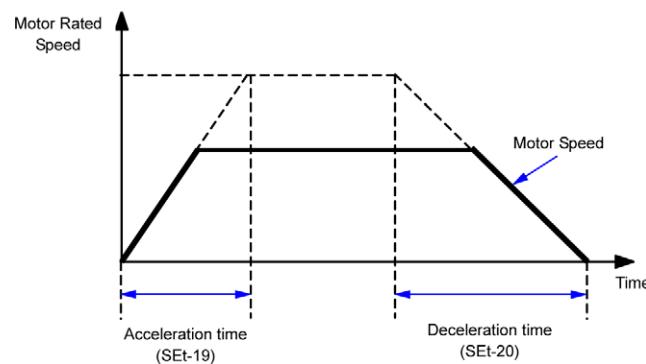
- Acceleration/Deceleration time is ineffective in position control, torque control, and autotuning.

- **Definition of Acceleration and Deceleration Time**

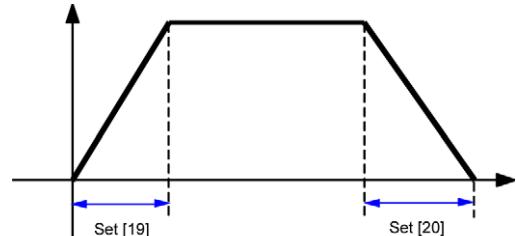
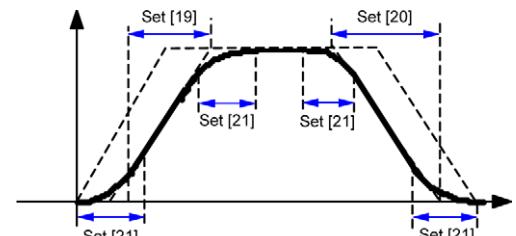
Acceleration's rated speed.

Deceleration Time: Time it takes to decelerate to a stop status.

**Fig 6.12 Definition of Acceleration/Deceleration Time**



- **Setting of S-Curve Operation**

Parameter	LED No.	Name	Setting	Description	Note
SEt-45	2	Selection of S-Curve Operation	0		Factory Setting value when delivered
			1		

## Selection of Stop Method

### Offset Adjustment

When 0V is specified as analog input voltage for speed/torque command, the motor may rotate at a very slow speed and fail to stop. This happens when analog input voltage from the host controller or external circuit has a slight voltage offset (in mV unit). If this offset is adjusted to 0V, the motor will stop.

	Manual Adjustment	Auto Adjustment
Speed Command	USR-05	USR-03
Torque Command	USR-06	USR-04

For detailed adjustment procedures, refer to **Using the Operator**.

### Using the DB(Dynamic Brake)

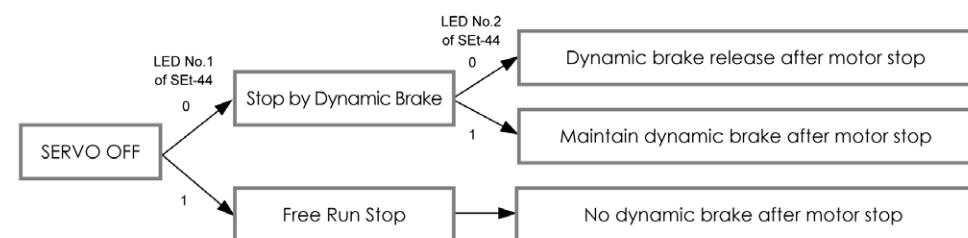
- Set motor stop method after the Servo OFF

	Setting	Description
SEt-44 LED No.1	0	Stop using dynamic brake. (Factory setting value)
	1	Stop after the free run.

- Set the operation after motor stop using the dynamic brake.

	Setting	Description
SEt-44 LED No.2	0	Dynamic brake is off after the motor stopping.
	1	Dynamic brake is on even after the motor stopping. (Factory setting value)

**Fig 6.13 Selection of Stop Method**



## Using Zero-Clamp Function

If the speed command is lower than zero-clamp level (setting value of SEt-17), ignore the speed command value and stop the motor by selected acceleration/deceleration time.

Refer to **Manual Zero-Clamp Speed Control Mode**.

## Emergency Stop

- **Emergency Stop Using P-OT, N-OT Input Terminal**

- According to motor rotation direction, in forward rotation, forward rotation operation prohibition input P-OT(CN1 pin 4), in reverse rotation operation, reverse rotation operation prohibition input N-OT(CN1 pin 5) can stop the motor in emergency state

Rotation Direction	Emergency Stop Input Terminal
Forward Rotation	P-OT (CN1 pin 4)
Reverse Rotation	N-OT (CN1 pin 5)

- **Emergency Stop Using E-STOP Input Terminal.**

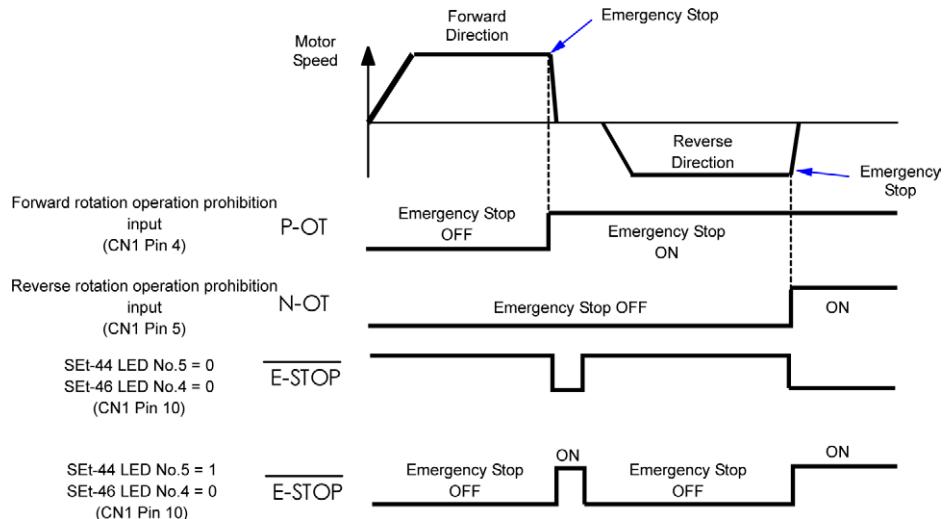
- Set SEt-46 LED No.4=0 and set CN1 pin 10 to E-STOP input terminal. (Factory Setting Value)  
In order to set CN1 pin 15 to E-STOP input terminal, set SEt-46 No.5=0.
- Regardless of motor rotation direction, using the Emergency Stop E-STOP input terminal (CN1 pin 10 or 15) to operate emergency stop.
- If the value of SEt-44 LED No.5 is "0", when E-STOP input terminal is closed, emergency stop is operated and if the value of SEt-44 LED No.5 is set to "1", if E-STOP input terminal is opened, emergency stop is operated.

SEt-44 LED No.5	E-STOP Input Terminal (CN1 pin 10)
0	ON
1	OFF

ON: The corresponding input terminal is connected to input voltage GND(0V)

OFF: The corresponding input terminal is connected to +24VIN or it is not connected

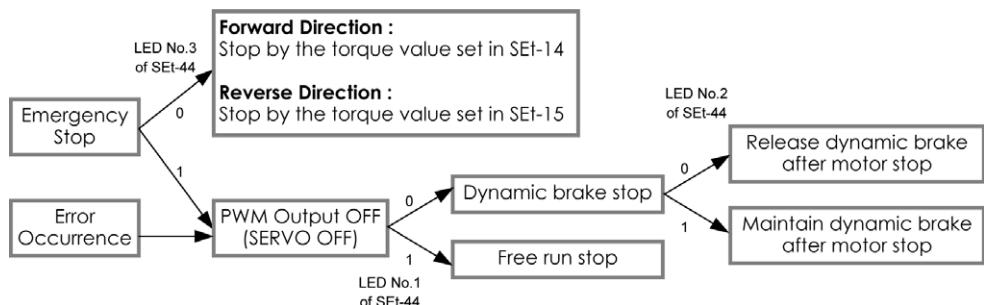
**Fig 6.14 Emergency Stop**



- Stopping method in emergency stop follows setting of SEt-44 LED No.3.

Parameter	LED No.	Setting	Stopping Method	
SEt-44	3	0	<b>Rotation Direction</b>	<b>Description</b>
		0	Forward	Stop by torque value set in SET-14
		1	Reverse	Stop by torque value set in SET-15
		1	Servo OFF (PWM OFF) Operation after the servo OFF follows the setting of SEt-44 LED No.1, No.2.	

**Fig 6.15 Selection of Stopping Method by Emergency Stop and Error Occurrence**



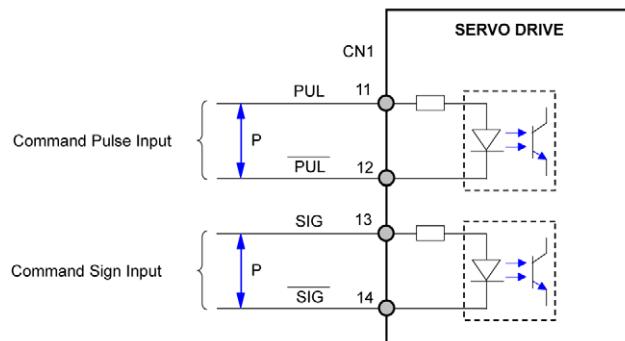
## Position Control

Selection of Position Control Mode: Set SEt-41 to "0" (Factory setting value).

After changing the SEt-41 setting value, always turn the power off, then ON. This makes the new setting value valid.

In order to move motor, input a position command by using input signal "Command pulse input" and "Command sign input"

**Fig 6.16 Position Command Input Terminal**



P: Represents twisted-pair cables.

## Wiring

- Position command can correspond to the following four types of output form.
  - Line Driver Output
  - +5V Open Collector Output
  - +12V Open Collector Output
  - +24V Open Collector Output
- Line drive output may correspond up to 450 kpps, and open collector output may correspond up to 200 kpps.
- The relationship between SEt-36, SEt-37, motor's maximum speed [RPM] and maximum frequency of position command is as follows.

Position Command Maximum Frequency =

$$\frac{\text{Setting value of SEt-37 X motor's maximum speed[RPM]}}{(\text{Setting value of SEt-36}/\text{Encoder pulse number per 1 motor rotation}) \times 60} \text{ [pps]}$$

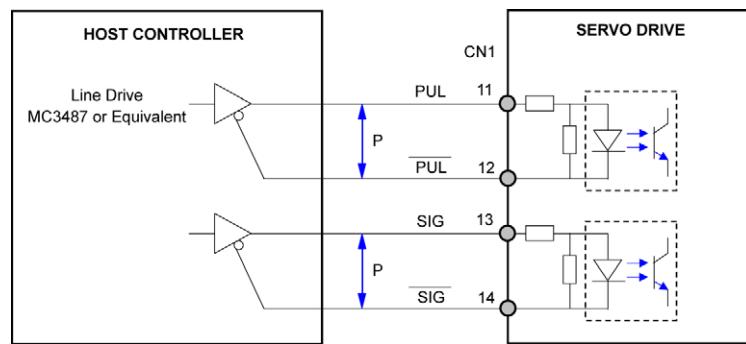
For example, if the setting value of SEt-36 is set to number of pulse for one rotation of the encoder, motor rotation speed according to command pulse frequency is as follows.

<b>SEt-37</b>	<b>Motor Speed</b>	<b>Command Pulse Frequency</b>
2048	3000 RPM	102.4 kpps
4000	3000 RPM	200 kpps
5000	3000 RPM	250 kpps
10000	3000 RPM	500 kpps

- When the command pulse form is A, B phase pulse train with 90° phase difference, motor rotation speed differs according to the command pulse multiplication.

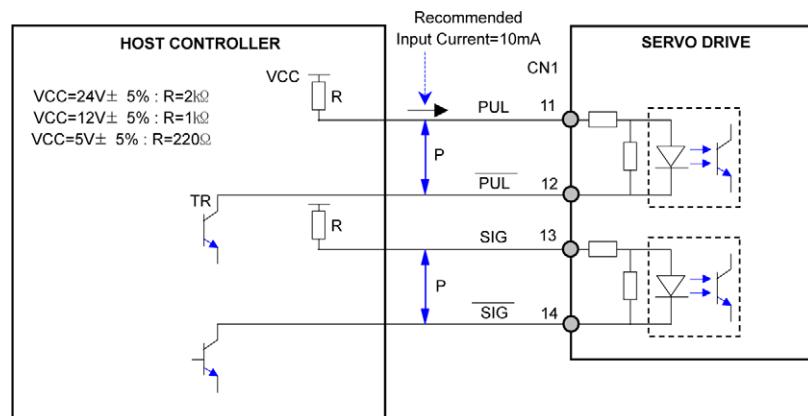
#### • In Case of Line Drive

**Fig 6.17 Wiring for Position Command of Line Drive Output**



#### • In Case of Open Collector

**Fig 6.18 Wiring for Position Command of Open Collector Output**



The signal logic for open collector output is as follows.

TR is ON	Equivalent to low level input.
TR is OFF	Equivalent to high level input.

### ATTENTION



When operating in 24V, operation is stable in a noise environment. In case of which input form of CN1 pin 12, 14 is not accurately Low (<0.6V), or if R is greater than the standard, position shift may occur. Thus, use 24VDC external power supply & Pull-Up Resistor 2kΩ I/O cable length is restricted as follows!

- Line Drive Output : under 5m
- Open Collector Output : under 1m

In case that the cable length is over restriction. Positioning error may occur.

## Position Command Pulse Form

**Table 6.9 Position Command Pulse Form (Set in SEt-46 LED No.1)**

Logic	Command Pulse Form	Forward Direction Operation	Reverse Direction Operation	Input Multipli-cation	SET-46 LED No.1
Positive Logic	CW + CCW	PULS CN1-11 "L" SIGN CN1-13	PULS CN1-11 "L" SIGN CN1-13	-	0 (Factory Setting)
	Pulse train + Sign	PULS CN1-11 "H" SIGN CN1-13	PULS CN1-11 "L" SIGN CN1-13	-	8
	A Phase + B Phase	PULS CN1-11 "H" SIGN CN1-13	PULS CN1-11 "H" SIGN CN1-13	4	6
Negative Logic	CW + CCW	PULS CN1-11 "H" SIGN CN1-13	PULS CN1-11 "H" SIGN CN1-13	-	1
	Pulse train + Sign	PULS CN1-11 "L" SIGN CN1-13	PULS CN1-11 "H" SIGN CN1-13	-	9
	A Phase + B Phase	PULS CN1-11 "L" SIGN CN1-13	PULS CN1-11 "H" SIGN CN1-13	4	7

### IMPORTANT

Note: If command pulse form is "Pulse train + Sign" (SET-46 LED No.1 = 8 or 9), consider pulse timing when motor rotation direction is changed. Refer to "Electrical Specifications of Command Pulse". In case of which the timing is inappropriate, position shift may occur.

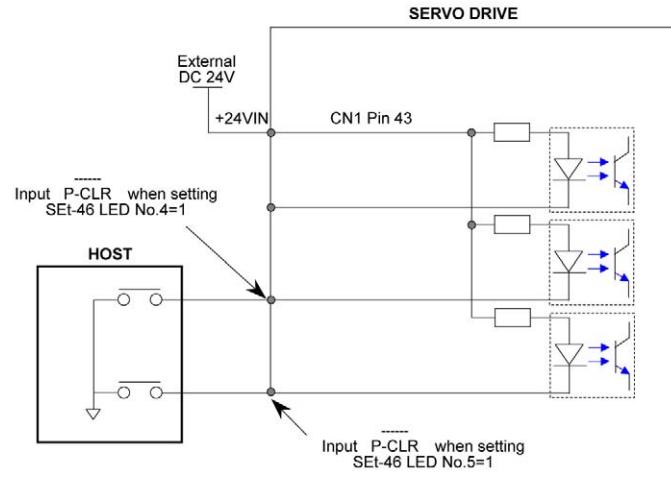
## Electrical Specifications of Command Pulse

**Table 6.10 Electrical Specifications of Position Command Pulse**

Command Pulse Form	Electrical Specifications	Note
Pulse train + Sign	<p style="text-align: center;">         Sign          Pulse train          Forward Command      Reverse Command       </p> $t_1, t_2 \leq 0.1\mu s \quad \tau \geq 1.1\mu s$ $t_3, t_7 \leq 0.1\mu s$ $t_4, t_5, t_6 \geq 3\mu s$	Sign Forward : High level Reverse: Low level Maximum Command Frequency: 450Kpps
2 Phase pulse train of 90° Difference (A,B Phase)	<p style="text-align: center;">         A Phase          B Phase          Forward Command      Reverse Command       </p> $t_1, t_2 \leq 0.1\mu s \quad \tau \geq 1.1\mu s$ $\frac{\tau}{T} \times 100 \leq 50\%$	Maximum Command Frequency 1Multiplication: 450Kpps 2 Multiplication: 400Kpps 4 Multiplication: 200Kpps
CW + CCW	<p style="text-align: center;">         CCW          CW          Forward Command      Reverse Command       </p> $t_1, t_2 \leq 0.1\mu s \quad \tau \geq 1.1\mu s$ $t_3 \geq 3\mu s \quad \frac{\tau}{T} \times 100 \leq 50\%$	Maximum Command Frequency : 450Kpps

## Position Counter Clear

**Fig 6.19 P-CLR Signal Usage**

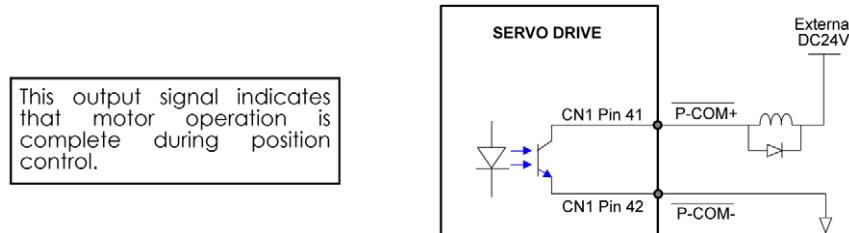


- In position control mode, set 1 in SET-46 LED No. 4 or 5 in order to use CN1 pin 10 or 15 as position counter clear pin.
- During the position control operation, if  $\overline{\text{P-CLR}}$  function is on, make the position command and position error 0(Con-09=Con-06=0), and stop with zero speed command.
- Time delay exists between the time where  $\overline{\text{P-CLR}}$  function is turned on and motor stopping time, thus accurate position control is impossible.

## Position Completion Output Signal (P-COM)

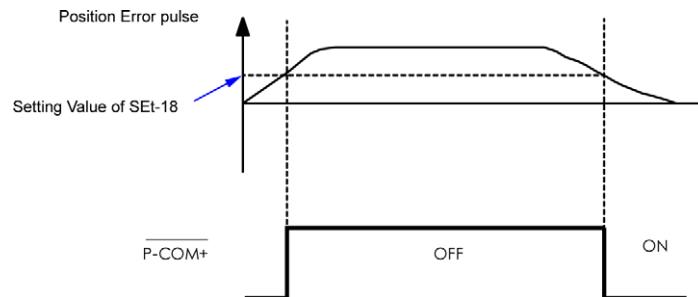
P-COM output signal is ON (CN1 pin41 is at low level)when satisfying the following conditions.

- Position Error < Positioning Completion Range (Setting value of SET-18)



Parameter	Name	Setting Range	Unit	Factory Setting	Note
SEt-18	Output Width of Speed (Position) Coincidence Signal	0~1000	PULSE (RPM)	10	<b>Speed Control Mode:</b> Output width of speed coincidence signal  <b>Position Control Mode:</b> Position completion range

**Fig 6.20 Output Width of Position Completion Signal**



### ATTENTION

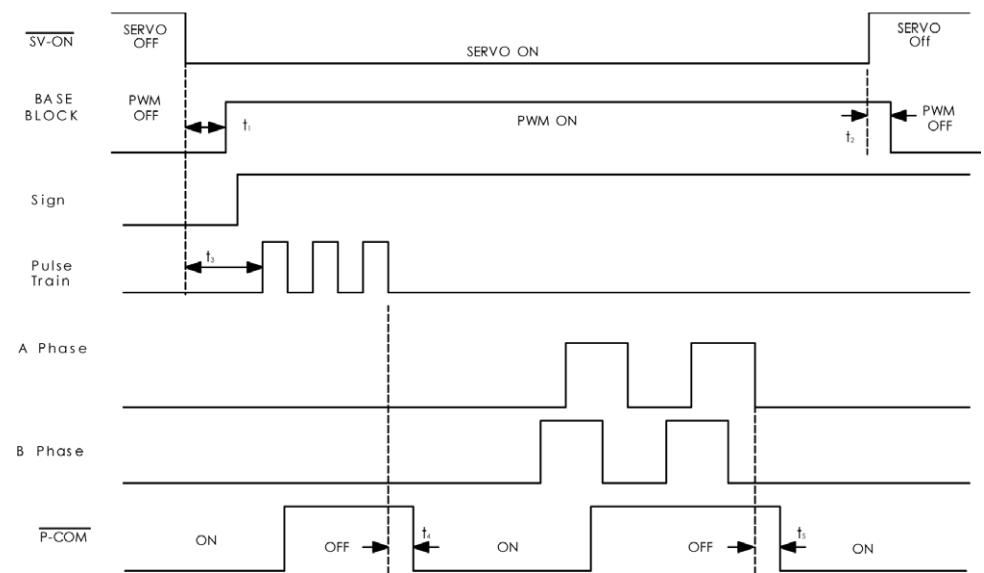


If position completion range (User parameter SET-18) is set in big value in low speed operation, it can be maintained in where position completion signal(P-COM) is ON(CN1 pin 41 is at "low" level, in other words,CN1 pin 41-42 are "Closed").

Generally, this signal can be used as a signal for next step operation of the system.

## I/O Signal Timing

**Fig 6.21 I/O Signal Timing Chart**



$t_1$	$t_2$	$t_3$	$t_4$	$t_5$
Maximum 40ms	Maximum 6ms	Minimum 40ms		Minimum 2ms

## Position/Speed Control Mode

Input terminal P-CON is used to switch between position control mode and speed control mode.

**Table 6.11 Setting of Position/Speed Control Mode**

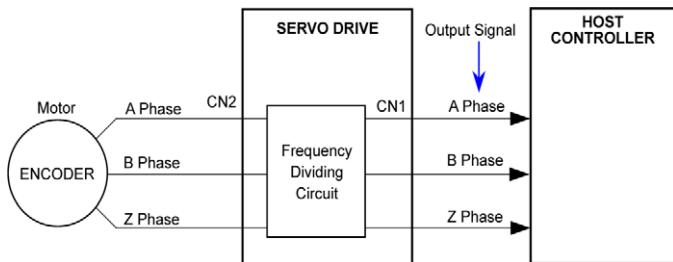
Content	Description	Note
Mode Setting Parameter	SEt-41 = 8	Setting value is effective after power OFF/ON
Control Mode Conversion	P-CON Terminal OFF → Position control mode ON → Speed control mode	Control mode display of the operator "P", "S" display.
Position Control → Speed Control Mode Conversion	Conversion conditions: 1. Position command pulse = 0; 2. (position command - actual position) < setting value of Set-18, maintain this conditions during minimum 10 msec. 3. <u>P-CON</u> terminal is ON.	<b>Caution 1 :</b> If those three conditions are not satisfied, cannot be changed to speed control mode. <b>Caution 2 :</b> Set the acceleration and deceleration time (SEt-19, SEt-20) in advance when operating in speed control mode. It may be harsh on the load when acceleration/deceleration time is 0. <b>Caution 3 :</b> Acceleration/deceleration time is only effective in speed control.
Speed Control → Position Control Mode Conversion	Conditions of conversion 1. Absolute value of rotation speed < SEt-16 2. <u>P-CON</u> Terminal is OFF.	<b>Caution 1 :</b> Position command pulse is ignored when operating in speed control mode. However, in the state of where command pulse is being continually output, changing to position control mode from speed control mode may create position overflow Error (Err-33) by much position command pulse. <b>Caution 2 :</b> SEt-16 is being used as TG-ON (rotation detect signal). When using this signal, consider sufficiently.
Analog Voltage Value and Motor Rotation Direction	When you want to make motor rotation direction according to the analog voltage speed command to be opposite, change the value of SEt-45 LED No.4. (For example, if "0", change to "1" and if "1" to "0")	Setting value is effective after power OFF/ON.

**Caution:** Autotuning must be operated in position control mode. When autotuning is operated in speed control mode, position gain may not be set automatically.

## Using Encoder Output

Encoder output signals divided inside the servo drive can be output externally. These signals can be used to form a position control loop in the host controller. Also, it can be used as position command pulse in the system operated at the same time.

**Fig 6.22 Using the Encoder Output Signal**



- Frequency Divining Ratio is set in SEt-23, SEt-24.  
SEt-23 : Number of servo drive output pulse per 1 motor rotation  
SEt-24 : Number of encoder pulse per 1 motor rotation

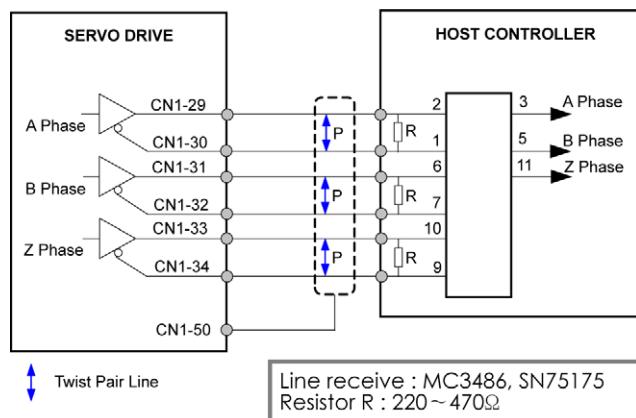
### ATTENTION



$$\frac{SEt-23}{SEt-24} = \frac{1}{2^N} \quad (N = 1, 2, 3, \dots)$$

If it does not satisfy the condition above, Phase difference of A and B phase does not become  $90^\circ$ .  
It is not related to electronic gear ratio.

**Fig 6.23 Example of Wiring between Incremental Encoder Output and Host Controller**



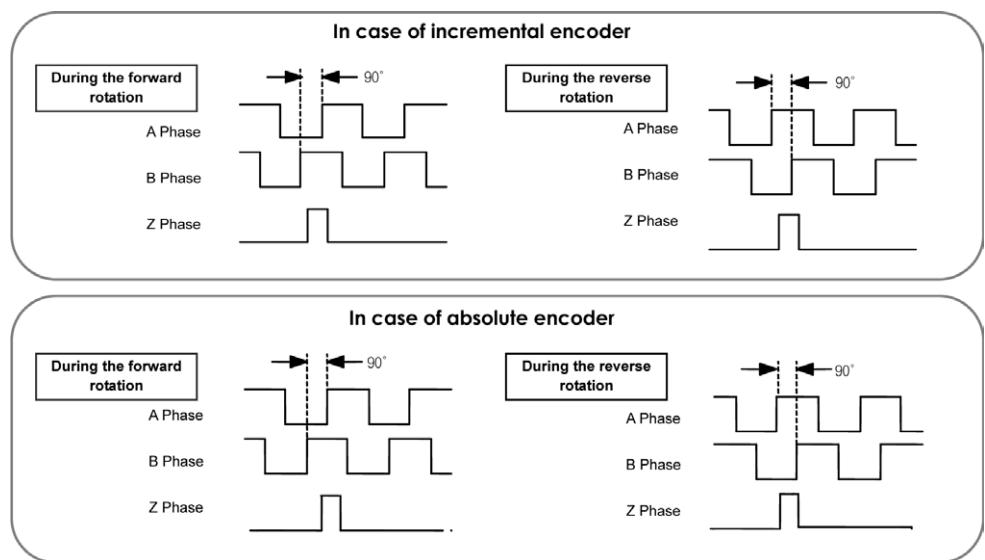
## ATTENTION



Servo drive output pulse may not output A, B phase pulse greater than encoder pulse per 1 motor rotation externally. In other words, if the pulse of encoder attached in the motor is 2048PPR, the pulse output to external side from the servo drive cannot exceed 2048 pulse per 1 motor rotation.

### • Output Pulse Form

**Fig 6.24 Encoder Output Pulse Form**



### • I/O

I/O	Pin No.	Description	Output type
EA	CN1 Pin 29	Encoder A phase output	Line Driver MC3487
$\bar{E}A$	CN1 Pin 30	Encoder $\bar{A}$ phase output	
EB	CN1 Pin 31	Encoder B phase output	
$\bar{E}B$	CN1 Pin 32	Encoder $\bar{B}$ phase output	
EC	CN1 Pin 33	Encoder C phase output	
$\bar{E}C$	CN1 Pin 34	Encoder $\bar{C}$ phase output	
GND	CN1 Pin 20, 22, 27	Analog GND	-
BAT+	CN1 Pin 49	In case of using absolute encoder, connect external back up battery.	-
BAT-	CN1 Pin 25		-
PS	CN1 Pin 35	In case of absolute encoder, outputs serial position data according to motor rotation.	Line Driver MC3487
$\bar{P}S$	CN1 Pin 36		
Z-PULSE+	CN1 Pin 17	Encoder $\bar{Z}$ -PULSE output	Open Collector
Z-PULSE-	CN1 Pin 18		

## Electronic Gear

Only apply in position control mode.

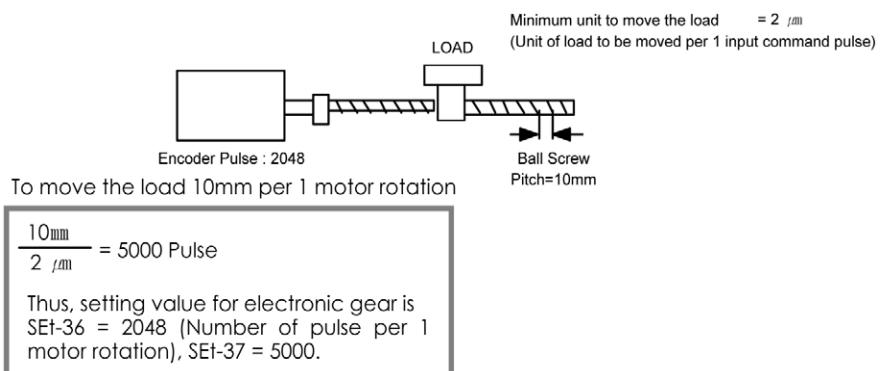
Outline and setting of electronic gear are as follow.

- The electronic gear function enables the motor travel distance per position input command pulse to be set to any value. It allows the host controller to perform control without having to consider the machine gear ratio and the number of encoder pulses. Electronic gear is set in SEt-36, SEt-37.

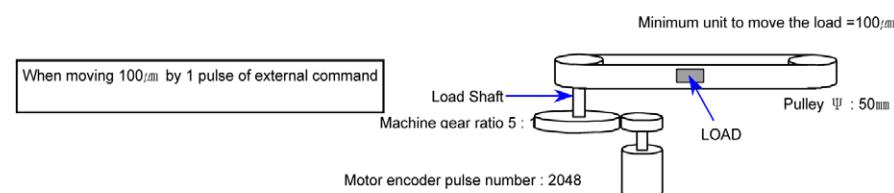
Parameter	Parameter Name	Setting Range	Description	Factory Setting
SEt-36	Electronic Gear Ratio Numerator	1~65535	Number of pulse per 1 motor rotation x Machine gear ratio of load and motor shaft.	2048
SEt-37	Electronic Gear Ratio Denominator		Number of position command pulse per 1 rotation of load shaft.	2048

- For example, if the machine gear ratio is 1:1 and setting value of SEt-36 and SEt-37 is the Factory setting value, the motor rotates once when host controller sends 2048 pulses. Here, if you want to rotate the motor once when host controller sends 1000 pulses. Set the Set-37 to 1000.

**Fig 6.25 Example of Electronic Gear Setting (Ball Screw)**



**Fig 6.26 Example of Electronic Gear Setting (Belt+Pulley)**

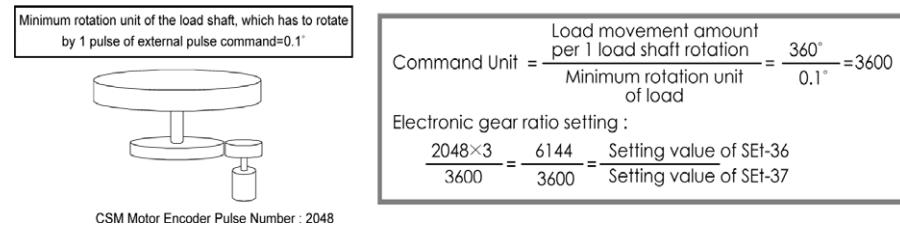


$$\text{Command Unit} = \frac{\text{Load movement amount per 1 load shaft rotation}}{\text{Minimum movement unit of load}} = \frac{3.14 \times 50 \text{mm}}{100 \mu\text{m}} = 1570$$

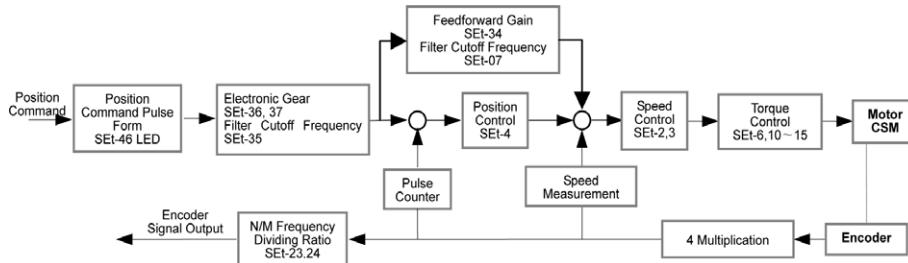
setting value of electric gear ratio is,

$$\frac{\text{Motor encoder pulse number} \times \text{Machine gear ratio}}{\text{Command Unit}} = \frac{2048 \times 5}{1570} = \frac{10240}{1570} = \frac{1024}{157} = \frac{\text{Setting value of SEt-36}}{\text{Setting value of SEt-37}}$$

**Fig 6.27 Example of Electronic Gear Setting (Turn Table)**



**Fig 6.28 Block Diagram of Electronic Gear**



Setting value of SET-36 and SET-37 should at least satisfy the following formula.

$$[\text{Number of pulse per 1 motor rotation}] \times [\text{Machine gear ratio of load and motor shaft}] \times 4 \geq [\text{Setting value of SET-37}]$$

In case of which the formula above is not satisfied, it can be used as a pulse command but resolution cannot be guaranteed.

$$\text{Maximum resolution} = \frac{1}{[\text{Number of pulse per 1 motor rotation}] \times [\text{Machine gear ratio of load and motor shaft}] \times 4}$$

If the setting value does not satisfy the relationship above, take care of the following:

First, increase the minimum unit desired to move with 1 command pulse.(Reduces the resolution.)

Second, use an encoder which outputs more than SET-37 setting value x 4 pulses per 1 motor rotation.

Third, increase the machine gear ratio or use small pitch of ball screw.

**ATTENTION**



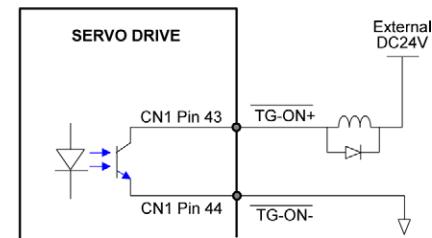
The position control resolution of CSDJ Plus Servo Drive is  $\pm 1$  pulse. In fig 6.23, SET-36=2048 and the maximum value that can be obtained of SET-37 is  $2048 \times 4 = 8192$ . Thus, minimum unit which moves by 1 command pulse can be calculated as shown below.

$$\text{Minimum distance moved by 1 pulse of position command} = \frac{10\text{mm}}{8192} = 1.22\mu\text{m}$$

When actually applying, design with sufficient amount more than minimum unit.

## Rotation Detection Output Signal

This is an output signal, which indicates that the motor is rotating



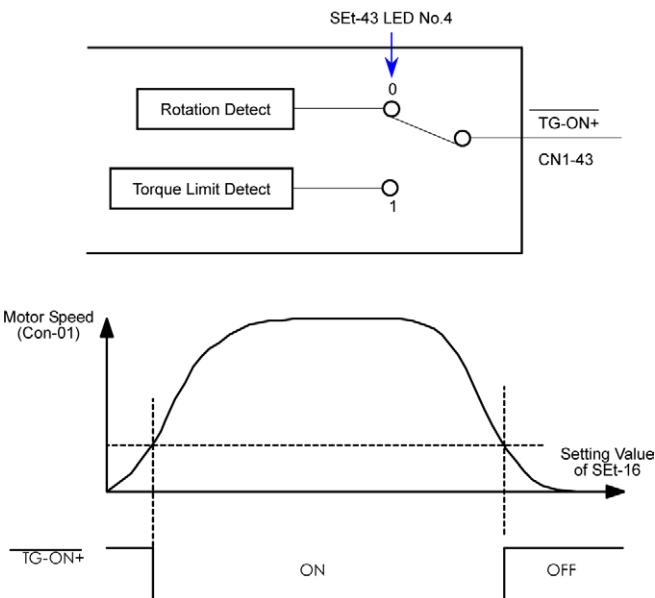
Parameter	Name	Setting Value	Setting Range	Unit	Description
SET-43 LED No.4	Selection of <u>TG-ON</u> Output Signal Function	0 (Factory setting)	0,1	-	Uses <u>TG-ON</u> as a Rotation detection output signal.
SET-16	<u>TG-ON</u> Speed Level	20 (Factory setting)	0-1000	RPM	

Operate in all control modes.

When SET-43 LED No.4 = 1, TG-ON signal operates as other function  
(Uses TG-ON as a torque limit output signal.)

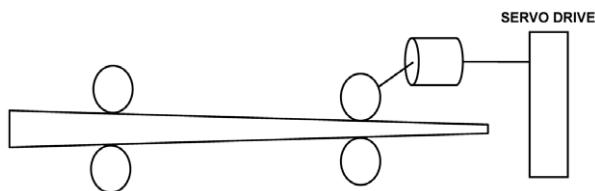
This signal can be used as reference signal of host controller.

**Fig 6.29 Rotation Detection Output Signal**



## Torque Control

Torque control, tension control or pressure control can be operated.



## Setting

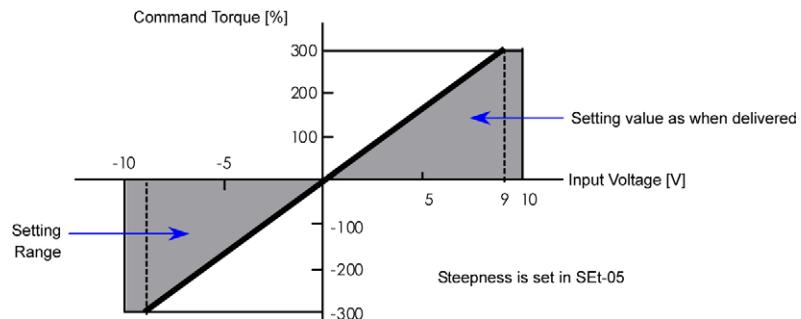
Parameter	Name	Setting	Description							
SEt-41	Control Mode Setting	2	Torque control(Only torque control is possible) T-REF : Torque command input V-REF : Ineffective							
		6	Speed + torque control (Torque control with speed limit function) T-REF : Torque Command V-REF : Speed Limit Command (Speed/Speed limit torque control conversion possible) <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="text-align: center;">-----</td> <td style="text-align: center;">ON</td> <td style="text-align: center;">Speed control mode</td> </tr> <tr> <td style="text-align: center;">P-CON</td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">-----</td> <td style="text-align: center;">OFF</td> <td style="text-align: center;">Torque control mode with speed limit</td> </tr> </table>	-----	ON	Speed control mode	P-CON			-----
-----	ON	Speed control mode								
P-CON										
-----	OFF	Torque control mode with speed limit								
7	Position/Torque Control <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="text-align: center;">-----</td> <td style="text-align: center;">ON</td> <td style="text-align: center;">Torque control mode</td> </tr> <tr> <td style="text-align: center;">P-CON</td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">-----</td> <td style="text-align: center;">OFF</td> <td style="text-align: center;">Position control mode</td> </tr> </table>	-----	ON	Torque control mode	P-CON			-----	OFF	Position control mode
-----	ON	Torque control mode								
P-CON										
-----	OFF	Position control mode								
SEt-05	Torque Command Gain	0~100	Sets how many % of rated torque per 3V input voltage will be the command torque. (Factory Setting value = 100)							

## Torque Command

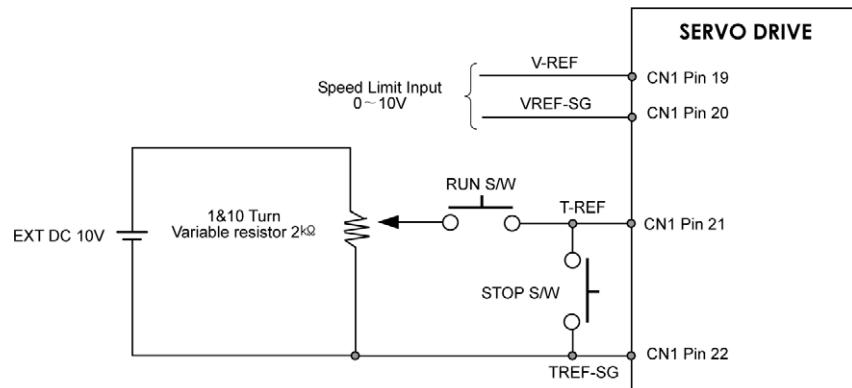
Table 6.12 Torque Command

Terminal	Function
T-REF (CN1 pin 21-22)	Torque command = $\frac{\text{Input voltage} \times \text{Rated torque} \times \text{Setting SEt-05}}{3 \times 100}$ Input voltage: -10V ~ 10V (Forward rotation to + voltage)

**Fig 6.30 Input Voltage and Command Torque**



**Fig 6.31 Torque Command Input Circuit**



- During the torque control, input terminal of unused command must be opened.

**ATTENTION**



- Torque may also change when the analog input voltage changes thus a precision power supply must be used.
- For accurate torque control, use multi turn precision variable resistor (10-Turn) and when accurate work is not required relatively, use general variable resistor (1-Turn).
- Command voltage from the host controller or external circuit has an offset in the vicinity of 0V. In such cases, operate "Torque Command Auto Offset Adjustment" (Torque Command Manual Offset Adjustment) from USr-04 (Usr-06).

## **Limiting the Speed during the Torque Control**

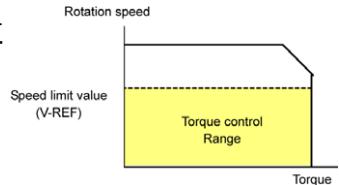
In order to limit the motor rotation speed during the torque control, first, control mode must be set in speed/torque control mode with speed limit.

**Setting of Speed/ Torque control mode with speed limit  
(Setting value of SEt-41 = 6 )**

Speed limit value is proportion to speed command value of V-REF input terminal (CN1 pin 19-20). Here, speed limit value is not related to polarity of V-REF input terminal. In other words, regardless of polarity of input voltage, it is depended on the absolute value.

The relationship between V-REF input voltage and speed limit value is same as in speed control mode.

- When selecting torque control mode with speed limit, set speed limit value by V-REF.
- Protects speed excessiveness during the torque control.



- **Conversion of Speed/ Torque Control Mode with Speed Limit**
  - User can change the speed/torque control with speed limit when not have reached the speed limit value

P-CON	ON	Speed control mode
	OFF	Torque control mode with speed limit

## Position/Torque Control Mode

Conversion to position/torque control mode is possible through ON/OFF of P-CON input terminal.

**Table 6.13 Position/Torque Control Mode Setting**

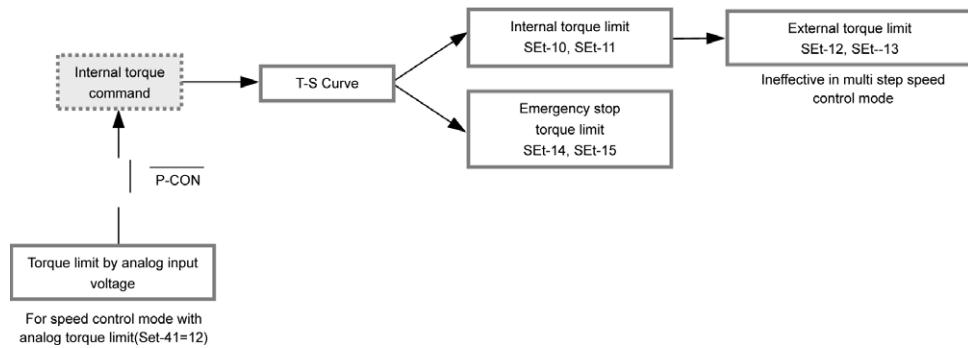
Content	Description	Note
Mode Setting Parameter	SEt-41 = 7	Setting value is effective after power OFF/ON
Control Mode Conversion	P-CON Terminal OFF → Position control mode ON → Torque control mode	Control mode display of the operator "P", "t" display.
Position Control → Torque Control Mode Conversion	Conversion condition: 1. Position command pulse = 0 2. (position command - actual position) ≤ Setting value of SEt-18 This condition is maintained for at least 10 msec. 3. P-CON Terminal on.	<b>Caution 1 :</b> If those three conditions are not satisfied, it cannot be changed to torque control mode. <b>Caution 2 :</b> Position command pulse is ignored when operating in Torque control mode.
Torque Control Position → Control Mode Conversion	Condition of conversion 1. Motor rotation speed is smaller than the setting value of SEt-16 or torque command is smaller than 10% of the rated torque. 2. P-CON Terminal OFF.	<b>Caution 1 :</b> When changing to position control mode from the torque control mode, user must satisfy the conversion conditions and input the command pulse. When inputting the position command pulse before hands, position overflow error (Err-33) may occur or may be harsh on the load.
Analog Voltage Torque Command and Motor Rotation Direction	To make motor rotation direction according to the analog voltage torque command to be opposite, change the value of SEt-LED No. 4. (for example, if 0, change to 1, and if 1, change to 0.)	Setting value is effective after power OFF/ON.

### Caution:

Operate autotuning in position control mode. When autotuning is operated in torque control mode, position/speed gain may not be set automatically.

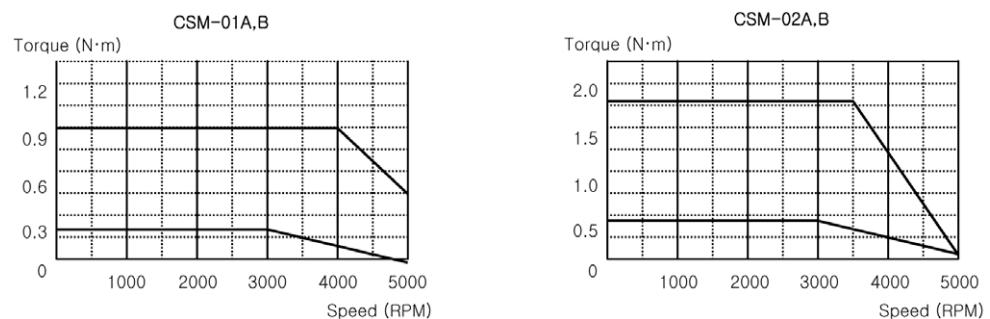
## Torque Limit

- **Block Diagram of Torque Limit**



- **T-S Curve**

- Allowable maximum torque differs according to the motor rotation speed. Here, limit the maximum torque according to motor rotation speed.
- For T-S Curve of the motor used, check the motor specification of the appendix.
- The examples of T-S Curve is as follows.



- **Internal Torque Limit**

Torque limit can be set using the user parameter.

In case of which the torque limit value is low, acceleration/deceleration time may increase.

Parameter	Name	Description	Setting Range	Factory Setting	Unit	Mode Used	Change during the Operation
SEt-10	Forward Rotation Torque Limit	Limits the torque in set value.	0~300	300	%	P/S/t	Possible
SEt-11	Reverse Rotation Torque Limit						

- **External Torque Limit**

- Torque limit can be set using external I/O terminal P-CL, N-CL.
- Cannot be used in multi step speed control mode.

Parameter	Name	Description	Setting Range	Factory Setting	Unit	Mode Used	Change during Operation
SEt-12	External forward rotation torque limit	Limits the torque in set value.	0~300	300	%	P/S/t	Possible
SEt-13	External reverse rotation torque limit						

- Used External I/O Terminal

Parameter	Name	Description	Mode Used	Note
P-CL	External forward rotation torque limit	Limits forward torque when input terminal ON.	P/S/t	Ineffective in multi step speed control mode
N-CL	External reverse rotation torque limit	Limits reverse torque when input terminal ON.		

- **Emergency Stop Torque Limit**

Parameter	Name	Description	Setting Range	Factory Setting	Unit	Mode Used	Change during Operation
SEt-14	Emergency stop torque limit during forward rotation	Limits the torque in set value.	0~300	300	%	P/S/t	Possible
SEt-15	Emergency stop torque limit during reverse rotation						

\* Only effective in emergency stop.

- **Torque Limit by Analog Input Voltage**

- Torque limit may be set in analog input voltage value during the speed control (speed control mode with analog torque limit). However, torque limit value is recognized in absolute value.

**Caution :**

1. When motor is in forward rotation, reverse torque, which is the strength of stopping the motor is not limited.
2. When the motor is in reverse rotation, forward torque, which is the strength of stopping the motor, is not limited.
3. When speed command is 0 by zero-clamp operation, both forward/reverse torque are limited.

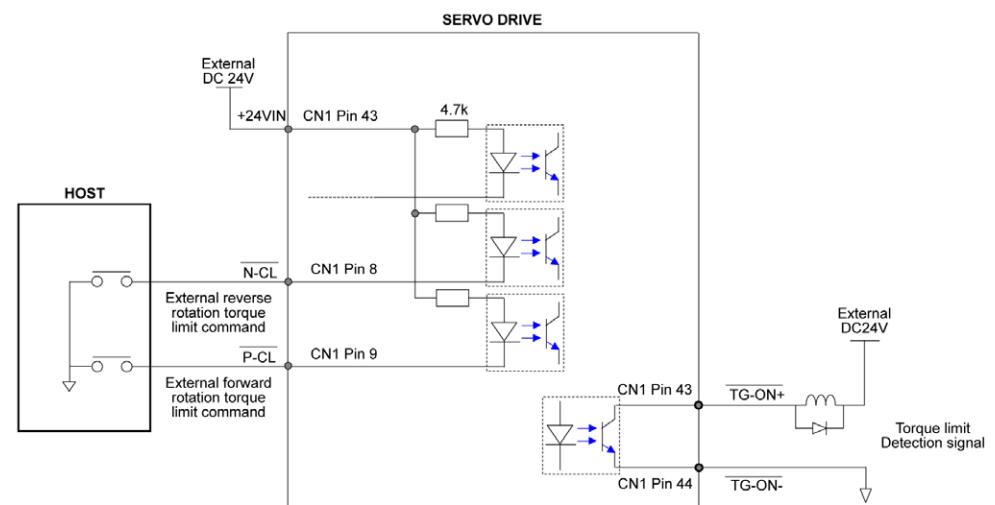
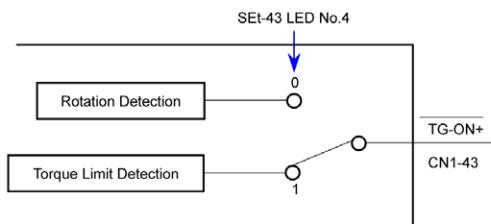
Parameter	Name	Description				Change															
SEt-41	Control Mode Selection	SEt-41=12 Speed/Speed control mode with analog torque limit																			
		<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>I/O</td> <td>Condition</td> <td>Control Mode</td> <td>AnalogTorque Limit</td> </tr> <tr> <td>-----</td> <td></td> <td></td> <td></td> </tr> <tr> <td>PCON</td> <td>OFF</td> <td>Speed Control</td> <td>Ineffective</td> </tr> <tr> <td></td> <td>ON</td> <td></td> <td>Effective</td> </tr> </table>				I/O	Condition	Control Mode	AnalogTorque Limit	-----				PCON	OFF	Speed Control	Ineffective		ON		Effective
I/O	Condition	Control Mode	AnalogTorque Limit																		
-----																					
PCON	OFF	Speed Control	Ineffective																		
	ON		Effective																		
SEt-05	External Torque Command Gain	<ul style="list-style-type: none"> <li>- Sets limit torque per 3V input voltage at % unit.</li> <li>- Torque limit value is recognized as absolute value.</li> </ul>																			

### • Torque Limit Detection Output Signal

In order to use  $\overline{\text{TG-ON+}}$  (CN1 pin 43) output signal as torque limit detection signal, SEt-43 LED No.4 must be set to "1".

Parameter	LED	Setting	Description
SEt-43	No. 4	0	$\overline{\text{TG-ON+}}$ Signal becomes motor rotation detection signal. (This signal is ON when motor speed is higher than zero-speed level.)
		1	$\overline{\text{TG-ON+}}$ Signal becomes torque(current)limit detection signal.

**Fig 6.32 External Torque Limit Command and Torque Limit Detection Output Signal**



<b>TG-ON+ is On</b>	CN1-43, 44 are closed CN1-43 is at "Low" Level	During the motor output torque limit, (Limit value is internal setting value)						
		<table border="1"> <thead> <tr> <th>I/O</th><th>Torque Limit Value</th></tr> </thead> <tbody> <tr> <td>---- P-CL ON</td><td>Setting value of SEt-12</td></tr> <tr> <td>---- N-CL ON</td><td>Setting value of SEt-13</td></tr> <tr> <td>---- P-CL OFF ---- N-CL OFF</td><td>           During forward rotation : Setting value of SEt-10            During reverse rotation : Setting value of SEt-11         </td></tr> </tbody> </table>	I/O	Torque Limit Value	---- P-CL ON	Setting value of SEt-12	---- N-CL ON	Setting value of SEt-13
I/O	Torque Limit Value							
---- P-CL ON	Setting value of SEt-12							
---- N-CL ON	Setting value of SEt-13							
---- P-CL OFF ---- N-CL OFF	During forward rotation : Setting value of SEt-10 During reverse rotation : Setting value of SEt-11							
<b>TG-ON+ is Off</b>	CN1-43, 44 are Open CN1-43 is at "High" Level	Motor Output Torque < Limit Value						

## Setting of Servo Drive Gain

Operate autotuning prior to manually adjusting the servo gain. Refer to 3.3 Autotuning.

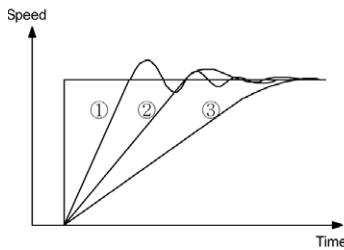
CSDJ Plus Servo Drive can set the following gain.

**Table 6.14 Setting of Servo Drive Gain**

Parameter	Name	Setting Range	Factory Setting	Description	Applied Control Mode
SEt-02	Speed Loop Proportion Gain	0~2000	Non-load Gain	<ul style="list-style-type: none"> <li>- This is a parameter which decides on response performance of the speed control.</li> <li>- Set in the maximum value where vibration does not occur in the machine part. Maximum of the value depends on the response performance or rigidity of the machine part.</li> <li>- Set the value high if the load inertia increases.</li> </ul>	Speed/ Position
SEt-03	Speed Loop Integration Gain	0~10000	Non-load Gain	<ul style="list-style-type: none"> <li>- If the value is set highly, transient response performance is better and speed error in steady state reduces.</li> <li>- If the value is too high, overshoot or undershoot increases in transient state. It must be used in appropriate range.</li> </ul>	Speed/ Position
SEt-04	Position Loop Proportion Gain	0~500	50	<ul style="list-style-type: none"> <li>- A parameter, which decides on response performance of position control.</li> <li>- If this value is set too high, response performance gets better, and position completion time reduces. However, maximum of that value differs according to response and rigidity of the machine part.</li> <li>- In case of which the gain is too high, vibration occurs and machine parts has noises.</li> </ul>	Position
SEt-34	Position FF Gain	0~100	0	<ul style="list-style-type: none"> <li>- If this value is high, position error value reduces during the position control and position completion can be speed up. However, if the value is too high, system may have vibration, thus be cautious when setting.</li> </ul>	Position

- \* Speed proportion gain and speed integration gain is scaled by motor load inertia. In other words, if the operation condition is similar to that of load condition, either the gain value about 10 multiple load inertia of 100W motor or the gain value about 10 multiple load inertia of 800W motor get similar value.

## • Speed Response Performance for Speed Proportion/



According to reducing the proportion gain (P) by constantly leaving the integration gain (I), or by reducing the integration gain by constantly leaving the proportion gain, response performance changes in the order of ①, ②, and ③. The time it takes to follow to the goal speed in the beginning is decided by P gain, and the time it takes to follow up to final goal from the location, above 50% of the goal speed is decided by I gain. It is hard to separate out these to gain features thus when tuning, first tune P gain and tune I gain. Best case is set by high value, the proportion gain and integration gain, but generally, use by setting appropriately.

## Integration Gain Value

### • When Autotuning is not operated well

In case the load rigidity is too low, the gain obtained by autotuning may not fit well. In such case, set the gain according to the procedure below.

- ① First, set the speed integration gain (SEt-03) to non-load gain value (Factory value as when delivered).
- ② Raise the speed proportion gain (SEt-02) to the limit where there is no vibration in the machine part.
- ③ Raise the speed integration gain (SEt-03) to the limit where there is no vibration in the machine part.
- ④ Operate jog operation or start up.
- ⑤ If there is big vibration or noise in the load, reduce the speed proportion gain (SEt-02) or speed integration gain (SEt-03).
- ⑥ Repeat ④ and ⑤ until appropriate operation can be done.

Typically, the system using the belt or chain cannot operate with fast response performance because of low rigidity of the machine. Set the SEt-06 value to 300 ~ 600.

In case of which the load inertia exceeds 5 times that of the motor or the load torque exceeds 5 times that of the motor, it is impossible to expect fast response. In such case,

### ATTENTION



Reduce the inertia of the mechanical part and load torque. Increase the acceleration/deceleration time.

Exchange to motor which gets high motor inertia.

Select the motor, which the output torque is higher.

Lower the system response performance.  
(Reduce the gain.)

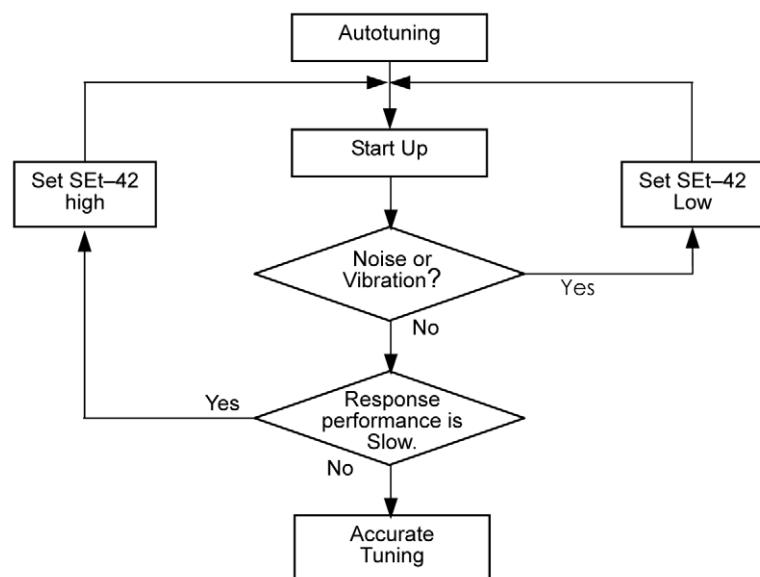
### • Gain Tuning Method

- Set the system response performance with SEt-42.

Parameter	Name	Description	Setting Range	Factory Setting
SEt-42	System Response Performance	<p>A response performance gets better as the value gets higher. If the value is big compared to the load condition, vibration or noise can occur.</p> <p>10 Low Rigidity : 20 Medium Rigidity : 50 High Rigidity :  <ul style="list-style-type: none"> <li>- In case of when vibrating with the load may create vibration or noise even if the value is low. In such case, you may set the vibration rejection frequency in SEt-47.</li> <li>- The following parameter changes on the basis of the setting value Set-42.           <ul style="list-style-type: none"> <li>SEt-02: Speed Loop Proportion Gain</li> <li>SEt-03: Speed Loop Integration Gain</li> <li>SEt-04: Position Loop Proportion Gain (During position control)</li> <li>SEt-06: Torque Command 1 Filter Cut-off Frequency</li> <li>SEt-40: Speed Command 1 Filter Cut-off Frequency (During position control)</li> </ul> </li> </ul> </p>	0~100	20

**Fig 6.33 Gain Tuning**

Until there is no vibration, SEt-42 can be set high.  
(Factory setting value of SEt-42 = 20)



## Using Rotation Prohibition Function

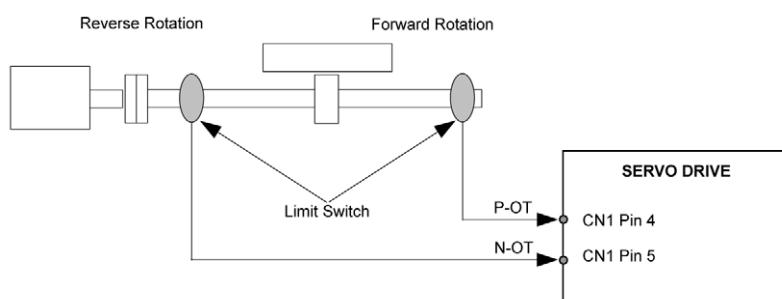
In such cases as linear machine, in order to protect from mechanical damage, it can be used by connecting the limit switch. Also, it can be also used so the motor rotates only in one direction.

Motor operates emergency stop when P-OT is on during the forward rotation.

Motor operates emergency stop when N-OT is on during the reverse operation.

Set the emergency stop method in SEt-44. (Refer to 6.4 D. Emergency Stop.)

**Fig 6.34 Using the Rotation Prohibition Input Signal**



### ATTENTION



If this input terminal is not used, it must be opened.

I/O	Pin No.	Description
P-OT	CN1 Pin 4	OFF: Forward Rotation Operation is Possible ON : Forward Rotation Operation is Impossible
N-OT	CN1 Pin 5	OFF: Reverse Rotation Operation is Possible ON : Reverse Rotation Operation is Impossible

ON : The corresponding input terminal is connected to +24VIN or not connected.

OFF : The corresponding input terminal is connected to the input voltage GND(0V).



# **Other Functions and Applications**

**Brake Control**

**Regeneration**

**Regenerative Energy**

**Allowable Load Inertia**

**Vertical Load**

**Regenerative Resistance**

**Motor Type and Capacity Setting**

**Encoder Type Setting (SEt-51)**

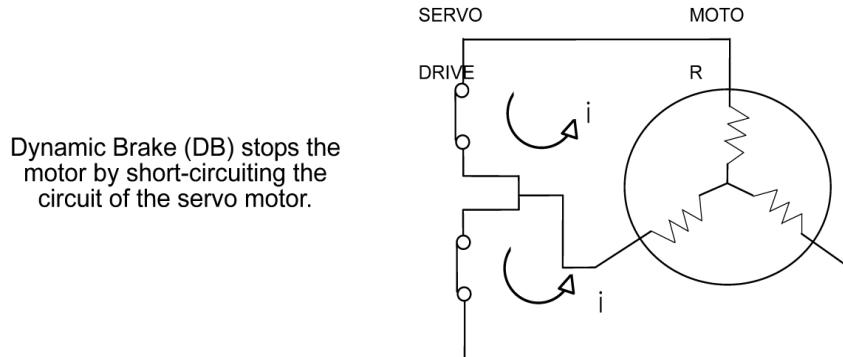


## Dynamic Brake

CSDJ Plus Servo Drive has a built-in dynamic brake, which can be used to emergency stop the motor.

Dynamic brake, an electrical brake, which is supported by CSDJ Plus is completely different from a mechanical brake.

**Fig 7.1 Dynamic Brake**

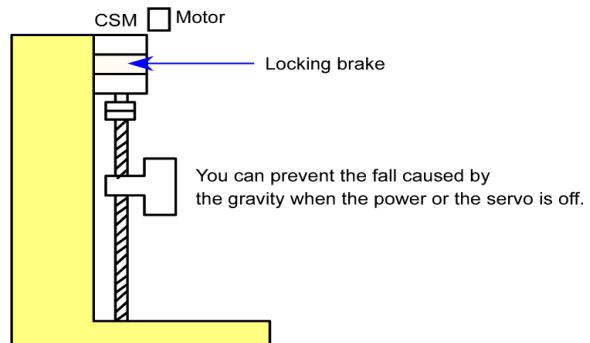


- Dynamic brake operates in the following circumstances.
- 1) When servo alarm occurs
  - 2) When servo status is changed from Servo ON to Servo OFF
  - 3) When power voltage is not supplied
  - 4) When excessive operation occurs
  - 5) P-OT signal is on during the forward rotation and when SET-44 LED No.1 = 0
  - 6) N-OT signal is on during the reverse rotation and when SET-44 LED No.1 = 0
  - 7) E-STOP signal is on and when SET-44 LED No.1 = 0
- \* Refer to Selection of Stop Method.

## Brake Control

Brake control is used when applying the servo drive to control of the vertical axis.

In motor stop status, use brake attachment motor so the load is not moved by gravity.



### ATTENTION



Brake attached to the motor cannot be used for stopping rotation. Just use it to lock the stopped motor in that status.

**Table 7.1 Brake Control Setting Parameter**

Parameter	Description	Unit	Setting Range	Factory Setting
SEt-29	Time it takes actually to turn the servo off inside from the point of time where servo OFF signal has been ON when the motor is stopped.	10msec	0 ~ 1000	0
SEt-30	Speed of the motor when the braking command is on when the Servo OFF signal has been input during the motor operation.	RPM	0 ~ 5000	100
SEt-31	Waiting time from the input of Servo OFF signal when the motor is operating, until the output of brake command.	10msec	0 ~ 1000	50
SEt-76	Time it takes for brake release signal is output from internal Servo ON signal.	10msec	0 ~ 1000	0

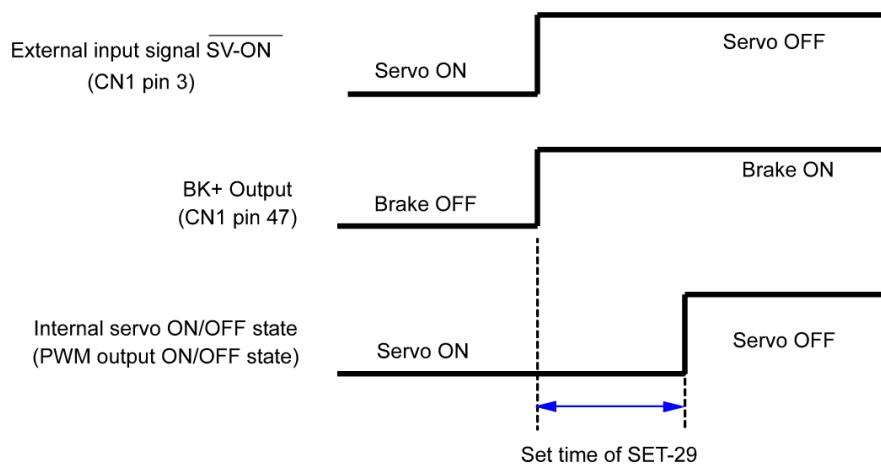
- **Servo Off and Brake Control Signal Timing When the Motor is Locked**

In case the load moves a little due to the gravity when the servo is turned OFF, set the delay time appropriately from the point where the servo off signal has been input in SEt-29 up to the actual point when the internal servo is OFF.

If Servo OFF signal is on when the motor is stopped, immediately turn ON the BK signal.

Maintain servo on status internally according to the time set in SEt-29 from the point when Servo OFF signal has been on. Then turn the Servo OFF when the set time is exceeded.

**Fig 7.2 Timing Chart of Servo OFF Input Signal and Brake Control Output Signal**



- **When motor stopped during the rotation, operate the brake.**

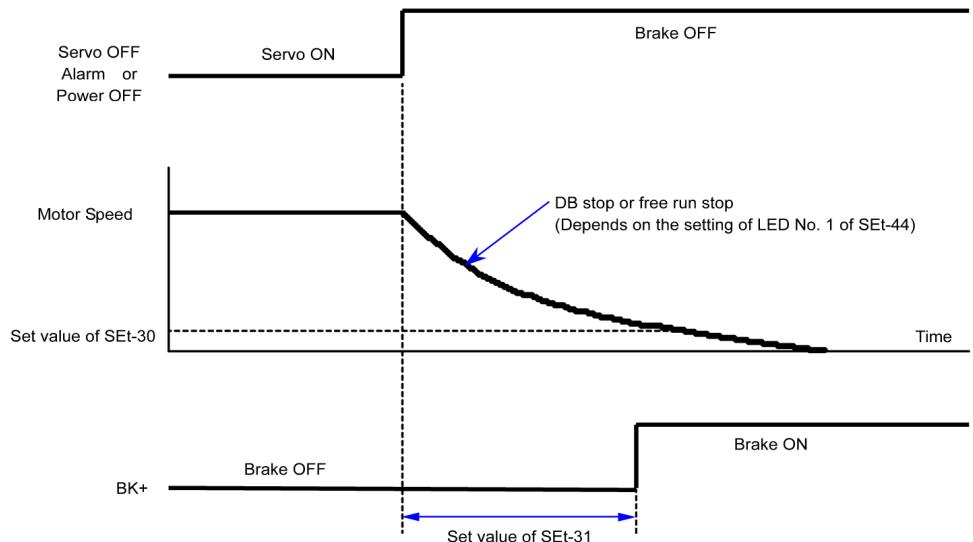
The brake signal will be output if and only if,

Motor Speed < Set value of SET-30

or

Exceeding time set in SET-31 after Servo OFF

**Fig 7.3 Timing Chart of Brake Control Signal when the Motor is Stopped during the Rotation**

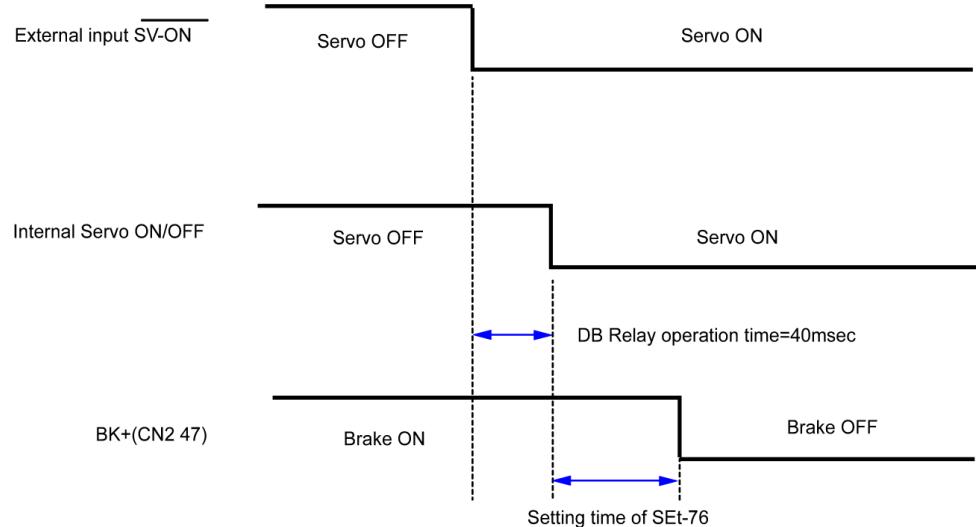


- **Timing of Servo ON and brake control signal when the motor is stopped.**

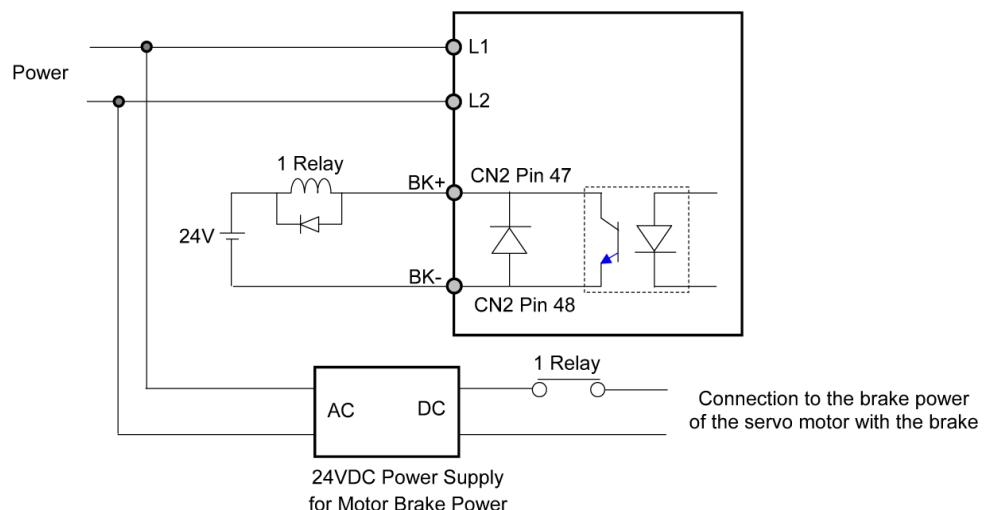
The load may move a little due to gravity if the servo is turned on when the motor is stopped. If then, adjust the delay time from the point when the internal Servo ON signal is inputted in SEt-76 up to the point when the brake releasing signal is outputted.

Excessive setting of delayed time may

**Fig 7.4 Timing Chart of Brake Control Signal at Servo ON**



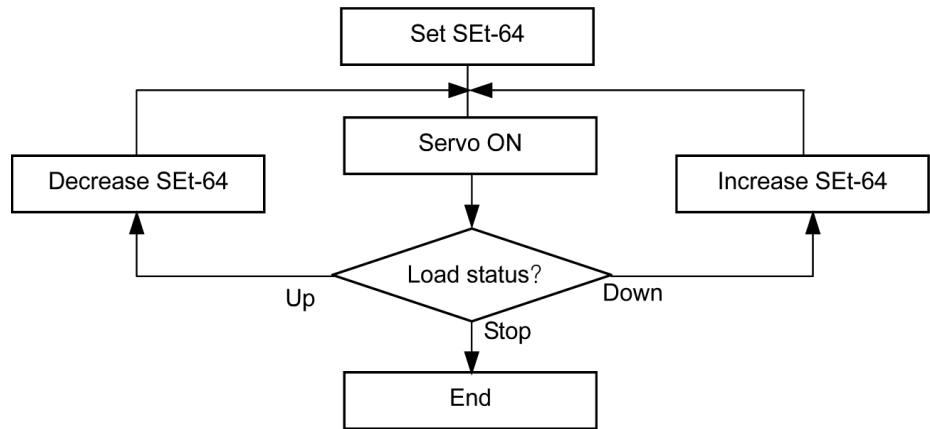
**Fig 7.5 Using Brake Relay**



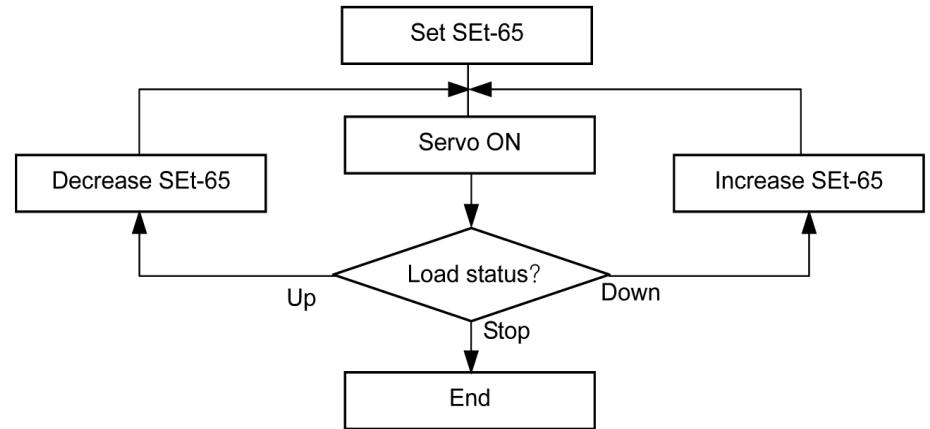
- **Reduces shift of the load when the servo status is on.**

- In case of vertical load, the load is shifted a little then restore the position when the servo is on. If that's the case, shift of the load can be reduced by SEt-64, SEt-65.
- It is effective in case of vertical load. Motor may rotate in one direction during the servo ON if applied in a horizontal load.
- SEt-64 and SEt-65 cannot be set other than "0" at the same time.
- Set as shown on the next page (case1 and case2).

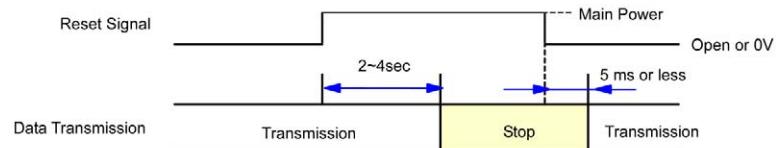
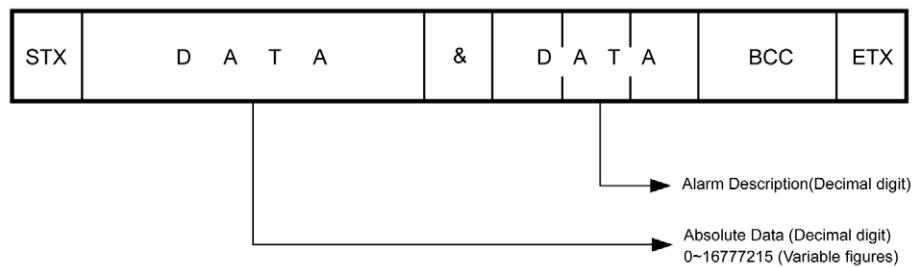
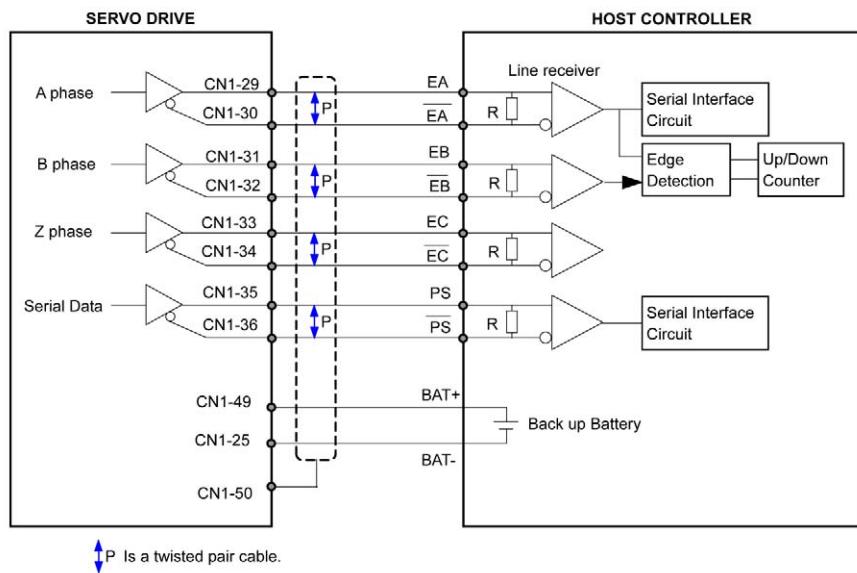
**Case 1:** If the load is raised when motor is rotated in forward direction.



**Case 2:** If the load is raised when the motor is rotated in reverse direction.

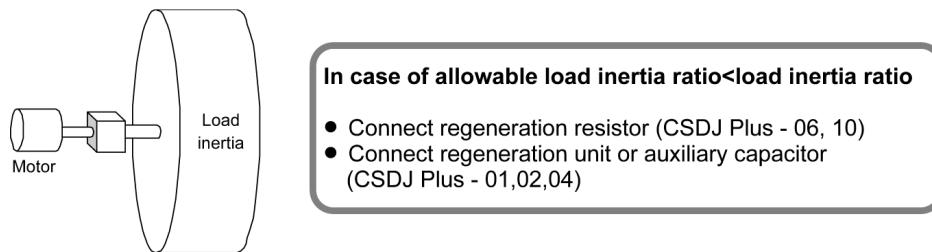


**Fig 7.6 Wiring with the Host Controller when Absolute Encoder is used**



## Regeneration

If the load inertia becomes larger, response of the load becomes slower. Use the servo motor in inertia lower than the allowable load inertia ratio of the motor. When using the load with inertia larger than allowable one, connect a regeneration resistor, a regeneration unit, or an auxiliary capacitor.



In order to operate excessive load inertia without error, handle as stated below.

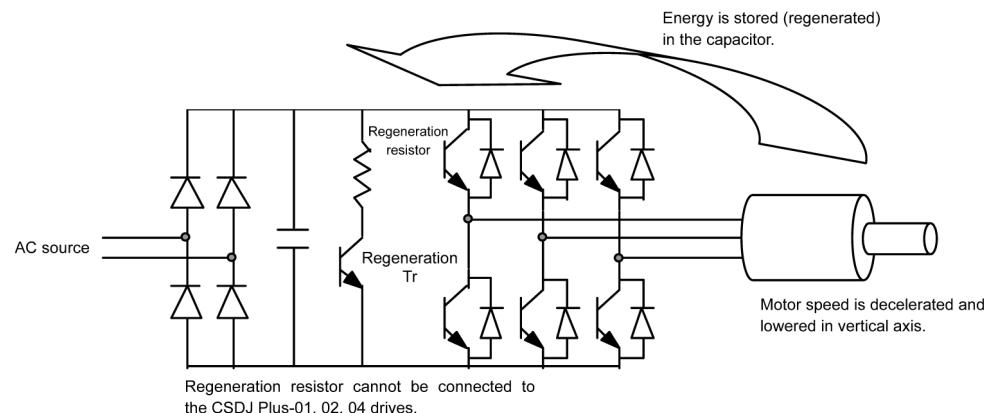
- Reduce the torque limit.
- Reduce the torque filter (SEt-06 value).
- Slow the acceleration and deceleration time.
- Reduce the motor speed.

## Regenerative Energy

When the servo motor and drive are used in the following condition, the energy may be transferred (regenerated) from the motor to the servo drive.

- 1) When load moves vertically.
- 2) When acceleration and deceleration is repeated frequently.
- 3) When the load inertia is much bigger than the motor inertia.
- 4) When the acceleration and deceleration time is short and rotating in high speed.

**Fig 7.7 Regenerative Energy**



## Allowable Load Inertia

- The table below displays the maximum inertia ratio (load inertia/motor inertia) of the load, which can be attached in each motor. It is based on the regenerative energy absorbable in the capacitor (during deceleration) at the horizontal load.
- When operating the load larger than the allowable load inertia, connect a regeneration resistor or auxiliary capacitor.

$$\text{Inertia ratio} = \frac{\text{Load inertia}}{\text{Rotor inertia of motor}}$$

Load inertia ratio can be checked in Con-13 after autotuning.



**Table 7.2 Allowable Load Inertia Ratio(When regeneration resistor is not connected and when operated at a rated speed)**

Motor	220V							
	A3B 30W	10B 1kW	A5B 50W	01B 100W	02B 200W	04B 400W	06B 600W	08B 800W
	30	3.5	30	30	23	12	7	6
	-	-	-	26	10	5	-	-
	-	-	-	27	12	6	-	-
	30	-	30	30	30	28	12	5

### ATTENTION



Above inertia is the maximum value thus use with sufficient allowance. When connecting a load larger than the allowable load inertia, connect a regeneration resistor, regeneration unit or auxiliary capacitor. When connecting a load larger than the allowable load inertia and using repeatedly, electrolytic capacitor may be damaged or the lifespan of the drive may be reduced.

---

The table above is for the horizontal load. When using in vertical load, allowable load inertia may be lowered according to the usage conditionRefer to [C. Vertical Load].

**ATTENTION**



The table above is load inertia when operating in rated speed. Supposing that there is no friction, energy the rotor generates is calculated as follows

$$1/2 \times (\text{Total rotor inertia}) \times \text{Speed}^2$$

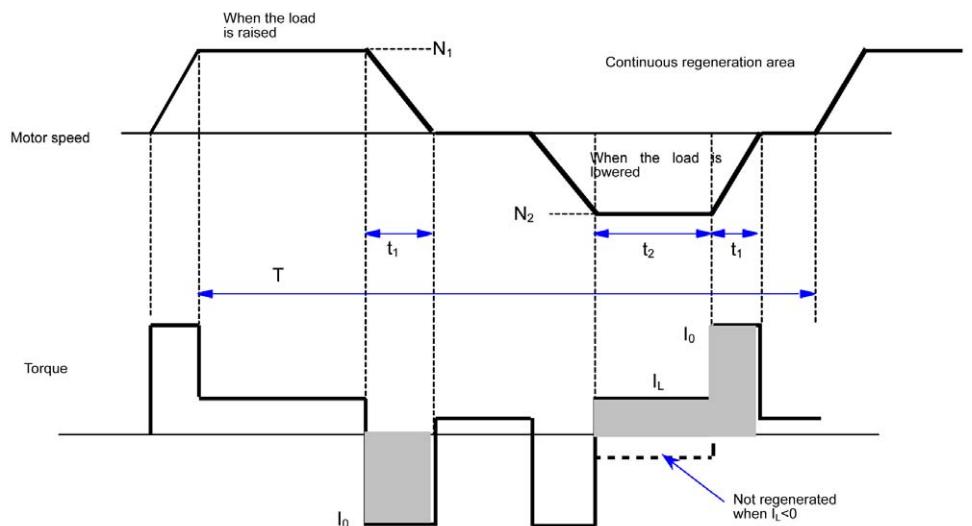
Thus, when operating above the maximum speed, the maximum allowable load inertia is remarkably lowered. Contact the agencies. On the contrary, if it is operated with lower than rated speed, it can correspond to greater load inertia than that of above table. In other words, if the speed is reduced to half, then the allowable load inertia gets 4 times bigger.

---

## Vertical Load

In case of vertical load operation, **continuous regeneration area** may occur when moving downward at a constant speed. Be cautious in regeneration when operating a vertical load. Motor speed or torque value can be checked in DA output (CN1 pin 23, 28) or PC S/W.

**Fig 7.8 Operation Pattern of Vertical Load**



## Regenerative Resistance

Energy is charged in the capacitor with the amount driven by multiplying the motor speed and torque when the motor is decelerated. By consuming the energy by the regeneration resistor, it protects the device of main circuit. Regeneration resistor may not be attached to the CSDJ Plus Servo Drive with 400W or lower. However, regeneration unit or auxiliary capacitor can be attached to the P-N terminal.

CSDJ Plus Servo Drive with 600W to 1kW has an regeneration circuit, which can consume the energy in regenerative operation of the motor. Thus, when external resistor is installed, the regeneration circuit is operated to consume the regenerative energy.

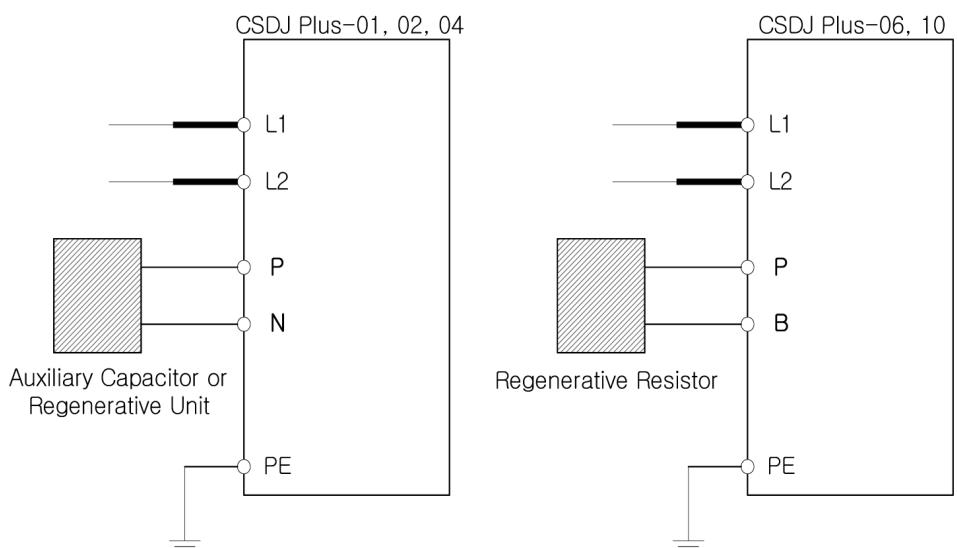
Regeneration resistor is  $50 \Omega$ , 150W as a standard. Contact the agencies for more information.

**Table 7.3 Regenerative Resistance**

Model	Regenerative Resistance
Capacity	0.6~1kW
Internal resistor	-
External resistor	$50 \Omega$ 150W

Drive	Regenerative Energy Management Method	Connecting Terminal
CSDJ Plus-01, 02, 04	Regenerative unit or auxiliary capacitor	P-N
CSDJ Plus-06, 10	External regeneration resistor	P-B

**Fig 7.9 Regeneration Resistor and Regeneration Unit Connection**



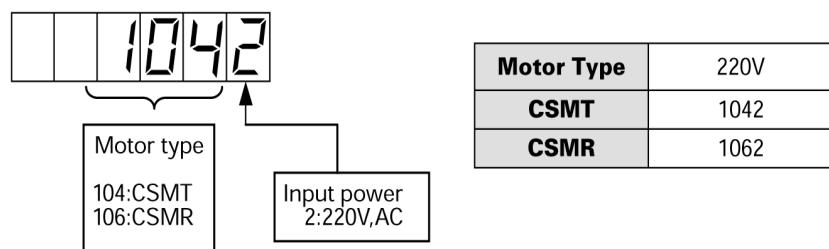
## Motor Type and Capacity Setting

Parameter	Description
Set-52	Setting of the motor type
Set-53	Setting of the motor capacity

- It is already set when delivered thus there is no need to reset it.
- Changed setting is effective only after turning off and on the power after the change. Also, initialize the data in USr-09 after the change.

- **Motor Type Settings**

**Fig 7.10 Motor Type Setting (SEt-52)**



\* : There is no corresponding motor.

- **Motor Capacity Setting**

Setting value of SEt-53 x 10 = Motor Capacity [W]

**Table 7.4 CSMT/MR Motor Capacity Settings (SEt-53)**

<b>Motor type</b>	<b>220V</b>							
	<b>30W</b>	<b>50W</b>	<b>100W</b>	<b>200W</b>	<b>400W</b>	<b>600W</b>	<b>800W</b>	<b>1kW</b>
<b>CSMT</b>	3	5	10	20	40	60	80	100
<b>CSMR</b>	*	*	10	20	40	*	*	*

\* There is no corresponding motor.

## **Encoder Type Setting (SEt-51)**

**Table 7.5 Encoder Type Settings**

CSMT,CSMR	
Setting	Encoder Type
1	9 wire incremental 2048 pulse



## Error Handling

CSDJ Plus Servo Drive has various protective functions to prevent faults and damages that may occur in the driver and motor.

### **Error Notification**

### **Alarm Output**

### **Alarm Codes Classification**

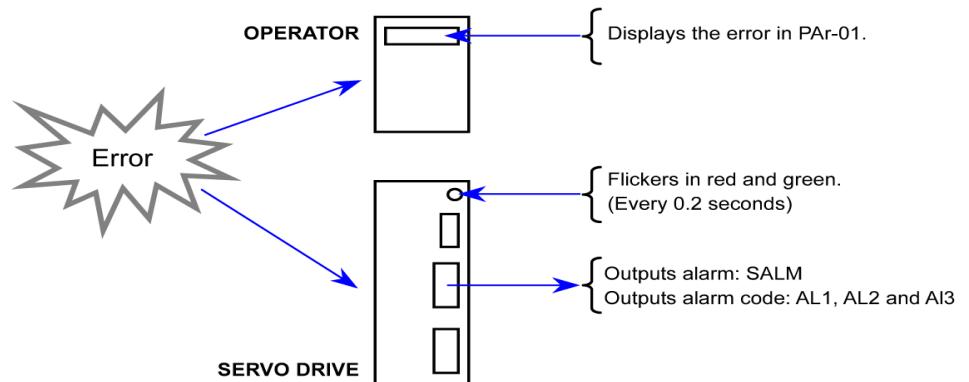


## Error Notification

CSDJ Plus Servo Drive displays error contents by output of operator, LED and alarm code when error occurs.

- **CSDJ Plus**

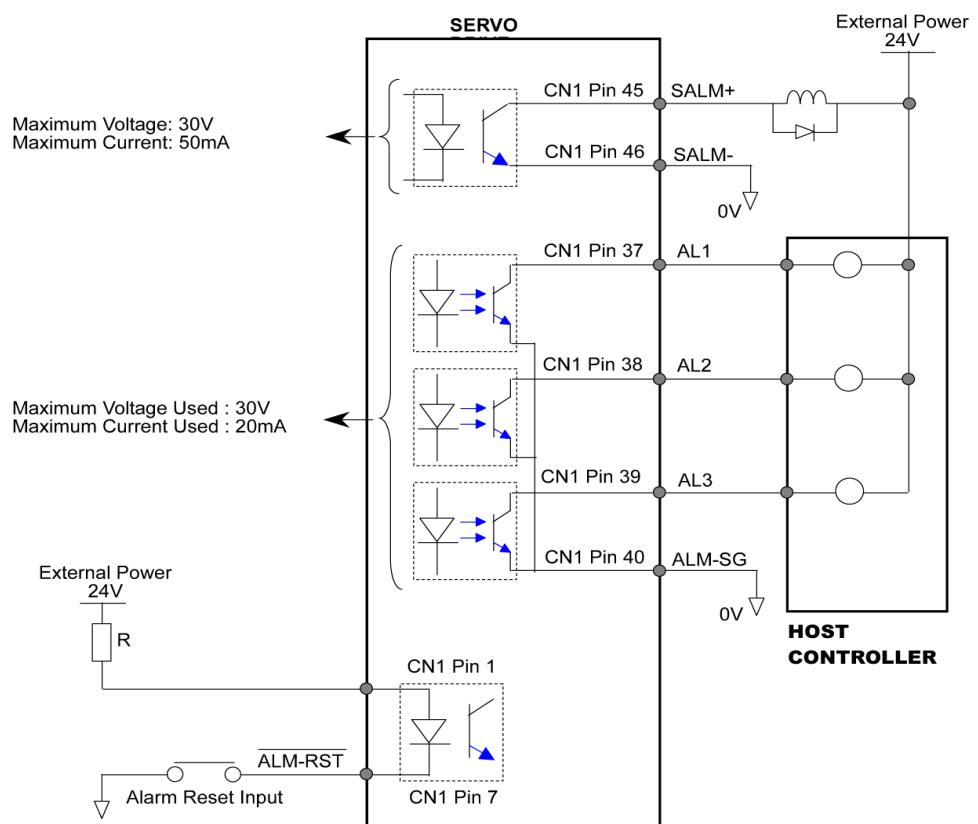
**Fig 8.1 Error Notification**



## Alarm Output

CSDJ Plus Servo Drive has output terminal SALM, AL1, AL2, AL3, which indicates the alarm occurrence to the external.

**Fig 8.2 Connection Diagram of Alarm Related Output Signal**



**Table 8.1 Alarm Related Input/Output Terminal**

Name	Pin No.	Description
SALM+	CN1 pin 45	ON when error occurs. (If the external power is 24V, pin 45-46 is 24V)
SALM-	CN1 pin 46	0V
AL1	CN1 pin 37	Alarm code occurrence output.
AL2	CN1 pin 38	(Normally each terminal always maintains low level.)
AL3	CN1 pin 39	
ALM-SG	CN1 pin 40	0V
ALM-RST	CN1 pin 7	Alarm Reset Input. - When alarm occurs, eliminate the cause and turn ON the input signal ALM-RST to reset the alarm. - Reset the alarm only when terminal is Open → Closed. (Operate not in LEVEL but EDGE.)

## Alarm Codes and Corrective Actions

**Table 8.2 Alarm Codes Classification**

Protective Function	Output Composition				Operator Display Composition	Description		
	SALM Output	Alarm Code Output						
		AL3	AL2	AL1				
Over current	1	0	0	1	E10(" SC") E11(" oC")	Detected if over current exists in main circuit.		
					E12("oH")	In case of which the servo drive reaches the over heating status. Incorrect operation due to the noise.		
Overload	1	0	1	0	E20("tol") E21("tOL") E22("Fol") E23("FOL")	Torque Command Momentary Overload Torque Command Continuous Overload Torque Feedback Momentary Overload Torque Feedback Continuous Overload		
Position detect erro	1	0	1	1	E30("EOP") E33("PoF") E35("EuU") E36("EoP") E37("EoS")	Encoder Open Occurs when position error exceeds the SEt-33 value Inner Capacitor Low Voltage of Absolute Encoder Initial Encoder Open(Initial Electric Angle Error) Over speed during black out of absolute encoder		
Over speed	1	1	0	0	E40("oS") E41("ESt")	In case of which the motor rotation number exceeds the maximum allowed speed Emergency Stop		
Over voltage	1	1	0	1	E50("oU")	Detected when main circuit DC voltage is higher than the standard voltage (Occur during speed reducing). Standard voltage 410V±5%		
Controller B/D error	1	1	1	0	E62("uOF") E63("UOF")	U phase current offset error V phase current offset error		
Low voltage of main power	1	1	1	1	E70("tuU") E71(" uU")	Momentary black out Main Power OFF		
Parameter error	1	0	0	0	E80("CSE") E81("Pro") E82("EtP")	EEPROM data error EEPROM data has data, which exceeds setting limit. Motor and Encoder type error		
Absolute encoder external battery low voltage	0	0	0	0	"Lbt" *1	Low Voltage of External Battery of Absolute Encoder  <b>*1</b> This is a warning message. "Lbt" is displayed on the operator and motor operation continues even if the red lamp is displayed every 1.5 seconds.		
No problem	0	0	0	0	-	-		

1: Data output (transistor OFF in photocoupler output)

0: Data output (transistor ON in photocoupler output)

**ATTENTION**



The alarm is displayed because there is a error in the servo drive. Investigate the cause and handle the problem properly, and reset. Re-operate according to the procedure.

When investigating the cause, it is dangerous if the voltage is supplied in the main circuit. You must turn off the NFB or the circuit breaker connector input for the investigation.

After eliminating the cause, in case of re-starting motor operation, use after inputting the speed command in 0V.

**Table 8.3 Alarm Codes and Corrective Actions**

<b>Alarm Code</b>	<b>Status</b>	<b>Cause</b>	<b>Corrective Action</b>
Over-Current E10(" SC")	After power ON or servo ON	- Control circuit error - Main circuit IPM Module error	After checking the line on motor power, call for A/S if normal
	During the operation, acceleration, or crash	- Extreme over current	- Check power voltage - Power Line Check - Increase acceleration/deceleration time
E11(" oC")	After power ON or servo ON	- Control circuit error- Main circuit IPM Module error	After line check of motor power, call for A/S.
	During the operation, acceleration, or crash	- Over current- Motor Line Short/Open	- Check power voltage - Increase acceleration/deceleration time
Over Heat E12(" oH")	When inserting the power	- Ambient temperature is over 55°C. - IPM Module error due to over current error previously occurred- - Low voltage of IPM - Motor line grounding	- Check power voltage - Check motor power line - Use in the environment where the temperature is below 55 °C.
Torque Command Momentary Overload E20("tol")	During the operation	- The torque command is operated for more than couple of seconds in maximum torque - Motor connection error	- Check load condition- Increase acceleration/deceleration time - Check the motor power cable - Check the motor capacity
Torque Feedback Momentary Overload E22("Fol")	During the operation	- The torque feedback is operated for more than couple of seconds in maximum torque - Motor connection error	
Torque Command Continuous Overload E21("tOL")	During the operation	- The operation proceeds for more than couple ~ tens of seconds by exceeded torque command - Motor connection error	- Check load condition - Increase accelerated and deceleration time - Check motor power cable - Check motor capacity
Torque Feedback Continuous Overload E23("FOL")	During the operation	- The operation proceeds for more than couple ~ tens of seconds by exceeded torque feedback - Motor connection error	
Over Speed E40(" oS")	Displays after high speed rotation after the speed command has been input	- Error in encoder cable wiring - Motor connection error - Position command error	- Check encoder connection status - Check motor connection status - Gain adjustment - SEt-36, SEt-37 Check
E-stop E41("EST")	E-stop signal is ON during power ON or run	- External e-stop circuit is activated due to alarm during run.	- Remove the cause of alarm and reset it.
		- CN1 No 10 pin is set to input e-stop and SEt-44 LED No.5=1	- Set SEt-44 LED No.5=0

(Continued)

<b>Alarm Code</b>	<b>Status</b>	<b>Cause</b>	<b>Corrective Action</b>
Overvoltage E50(" oV")	Displays during deceleration	- Load GD <sup>2</sup> is too big. - When there is regeneration resistor, regeneration resistor is open.	- Check load inertia - Check motor connection - Check regeneration resistor is open and increase regeneration resistor capacity
Encoder Error E30("EOP")	Displays after power input or during the operation	- Error in encoder connection or connector - No attached encoder - Encoder input part B'D error	- Check CN2 connection status - Turn OFF and reset alarm
Pulse Input Overflow E33("PoF")	During the Operation	- Pulse error, which exceeds user parameter SEt-33. - Gain is too low. - External load is too big.	- Check pulse input part connection status - Lower the input frequency - Raise Feed Forward gain of SEt-34. - Raise speed gain (SEt-2,3). - Raise position gain (SEt-4).
External Battery Low Voltage of Absolute Encoder Alarm "Lbt"	After power input or during the operation	Low voltage of external battery of absolute encoder	Battery exchange Check encoder cable  <b>Reference)</b> Motor continues to operate even if the alarm is displayed.
Absolute Encoder Low Voltage Error E35("EuU")	After power distribution	Internal main capacitor of absolute encoder is low voltage	In the status where the power has been connected, after about 1 minute, reset with operator or I/O. Here, multi rotation data of absolute encoder is also set as 0.
Initial Encoder OPEN E36("EoP")	Displays after power distribution	- When encoder power wire is not connected - SEt-51 setting error - Encoder error	- Check encoder power line - SEt-51 check - Encoder exchange
Over speed During Blackout of Absolute Encoder E37("EoS")	After power distribution	In case of which main power is not supplied in the encoder, motor axis rotates in high speed. In such case, there may be an error in multi rotation data of absolute encoder.	Multi rotation data is reset to 0 when resetting with operator or I/O.
HALL sensor offset Error E62("uOF") E63("UOF")	- Displays after power distribution - Occurred during the operation	- Error occurred in current feedback inside the servo - Motor error	- Check motor status - Ask for A/S
Control Power Error E70("tuU") E71(" uU")	During the operation or cut off main power	- Momentary black out occurs during the operation - Control power is cut off from the exterior	Eliminate momentary blackout function of user parameter SEt-43.
Initial Data Error E80("CHE")	Occurs during power distribution	EEPROM data error inside the servo	Operate parameter initialization in USr-09 and check the motor capacity and encoder type. And re-distribute the power.  * When initializing the data when ALARM E.80 occurs, all user parameter values change to initial setting value. In this case, the system can be operated normally if the setting is checked and reset properly without initialization.
Data Setting Limit Error E81("Pro")	During the power distribution	Data which has gone off the user setting limit is recorded.	
Encoder Type Setting Error E82("EtP")	During the power distribution	Not fit to motor and encoder type	Reset SEt-51,SEt-52,SEt-53.
Operator Communication Error	- Operator key does not operate - Operator LED flickers.	Communication error occurs by noise.	Un-attach and re-attach the operator.



# Troubleshooting

Chapter 9 explains how to troubleshoot the servo drive and the servo motor.

## **Servo Motor**

## **Servo Drive**

## **Troubleshooting Relating to Incorrect External Wiring**

## **Troubleshooting Relating to Incorrect Setting**

## **Items to Check Prior to Asking Service**



## Servo Motor

AC servo motor is composed of mechanical parts, which can not be consumed, thus only the simple check is required.

Never disassemble the motor.

**Table 9.1 Servo Motor Maintenance and Cleanin**

Check Item	Period	Method	Note
Vibration Noise	Everyday	Check by touch and hearing	Compared to normal situation
Foreign material adhesion	When Occurs	Clean by vacuum cleaner	
Insulation resistance	1 Year	Measure by insulation resistance measurer. Greater than 500V 10MΩ	Contact our office if less than 10MΩ
OIL SEAL	Every 5000 Hours	OIL SEAL replacement	
Overall Check	20000 Hours/5 Years	Contact our company	Disassembly and replacement of consumables

## Servo Drive

Since the servo drive is designed with the electronic circuit, foreign material or dust causes the malfunction. Thus, periodic (annual) cleaning and tightening of screw is required.

\* Replacement period of servo drive's each parts (on the basis of 20 hour operation per day)

Capacitor - 3 years	Cable - 3 years (Movable cable as standard)
Power element - 3 years	Regeneration resistor - 2 years
DB Resistor - 2 years	FAN - 2 years

**Table 9.2 Troubleshooting Servo Motor**

Symptom	Cause	Check Item	Action
Motor does not rotate	Motor defect	Measure the resistance for each wire of Motor U, V, W phase lead by resistance test.	If each line resistance of motor is different, replace the motor.
	Over-loaded	Operate with no load.	If the motor starts, make the load light or replace the motor with bigger capacity.
	Loose coupling between motor and mechanical contact part	Check the connection part.	Tighten the loosened part and replace the damaged part.
	System connection wiring open or short circuit	Check the connection of wire.	Correct it with reference to the connection diagram of manual.
Motor over heated	Ambient temperature high	Check whether the ambient temperature is lower than 40 °C.	Make the ambient temperature lower than 40°C.
	Over-loaded	Operate in non-load status.	Make the load light or replace the motor with bigger capacity.
	Motor surface is polluted with foreign material	Check whether motor surface is polluted with foreign material.	Clean the motor surface.
	Defect motor connection	Check the connection status of UVW phase of motor.	Replace the bad contact part and repair the damaged part.
Check the vibration or noise due to the motor trouble	Bad installation of machine	Mechanical part is loosened. Coupling is misaligned	Correct the screw and mechanical part to repair the misalignment of coupling for balancing.
	Bearing and gear trouble (motor side)	Check the bearing and gear status	If it is the motor bearing trouble, contact to our office.
	Mechanical vibration and noise of load side.	Check damage or error in mechanical parts of load axis.	Contact the machine maker.
	Motor bad contact	Check the U, V, W phase of motor.	Replace the bad contact and repair the damaged part.

## **Troubleshooting Relating to Incorrect External Wiring**

<b>Symptom</b>	<b>Check Item</b>	<b>Action</b>
<ul style="list-style-type: none"> <li>- MCCB Trip at the same time of power distribution and servo ON</li> <li>- Motor does not rotate after speed command.</li> </ul>	<ul style="list-style-type: none"> <li>- Check of the main circuit wiring motor earth and motor line short.</li> <li>- Alarm Check</li> <li>- Speed Command Check</li> <li>- External Input</li> <li>- Input Power Check</li> <li>- LED Display Check</li> </ul>	<ul style="list-style-type: none"> <li>- Check and repair the wiring</li> <li>- Check causes of alarm, LED display</li> <li>- Check input power line</li> <li>- Check of reference voltage</li> </ul>

## **Troubleshooting Relating to Incorrect Setting**

<b>Symptom</b>	<b>Cause</b>	<b>Action</b>
- Motor rotate in speed command 0V.	Speed Zero Offset was not adjusted.	Input 0V in speed command and adjust speed offset.
<ul style="list-style-type: none"> <li>- Motor vibrates.</li> <li>- Overshoot is big when accelerated or decelerated.</li> </ul>	<ul style="list-style-type: none"> <li>The gain of speed P (SEt-02), I(SEt-03) is too high or not correct.</li> </ul>	<ul style="list-style-type: none"> <li>Adjust gain value .</li> <li>(Adjust after autotuning)</li> </ul>

## **Items to Check Prior to Asking Service**

<b>Symptom</b>	<b>Action</b>
<ul style="list-style-type: none"> <li>- E80, E81, E82 occur continuously in status display mode.</li> </ul>	<ul style="list-style-type: none"> <li>- Initialize the data referring to 4.7 "H Data Initialization". During the initialization, do not operate other operation for 6 seconds and make sure the power does not go OFF.</li> <li>- Check motor capacity, motor type setting, and encoder type setting.</li> <li>- After the data initialization, operate power OFF → on to change to position control mode.</li> </ul>
<ul style="list-style-type: none"> <li>- E36 occurs continuously in status display mode.</li> </ul>	<ul style="list-style-type: none"> <li>- Check the setting of encoder type (SEt-51) and motor type (SEt-52).</li> <li>- Check if the encoder cable is disconnected.</li> </ul>
<ul style="list-style-type: none"> <li>- Pulse is transmitted in unexpected way to the Host controller</li> </ul>	<ul style="list-style-type: none"> <li>- Refer to chapter 5, user parameter table, SEt-44 and SEt-46 and check if it is set in appropriate pulse.</li> </ul>



# Apppendix

## **Appendix A. Motor Specification**

CSMT Motor Specification  
CSMR Motor specification

## **Appendix B. Motor Dimensions**

CSMT Motor  
CSMR Motor

## **Appendix C. Cable**

Motor Brake Cable Assembly (CSMT/MR)  
User I/O Cable  
9-Wire Incremental Encoder Cable Assembly (CSMT/MR)  
Communication Cable  
Controller Cable Connector Specification  
Cable Code Format

## **Appendix D. Load Calculation of the Mechanical Part**

The Moment of Inertia Calculation  
Roll Load  
Timing Belt Load  
Ball Screw Load(Horizontal Axis)  
Ball Screw Load(Vertical Axis)  
Rack & Pinion Load  
Round Plate Load

## **Appendix E. Conversion Table of SI to/from CGS**

## **Appendix F. Motor Capacity Selection**

## **Appendix G. Revision History**

# Appendix A. Motor Specification

## CSMT Motor Specification

Standard Specification

**Table A.1 CSMT Motor Specification**

Content	Specification	Content	Specification
<b>Connection Method</b>	Y connection	<b>Insulation</b>	Class B
<b>Operating Temperature</b>	0 ~ +40°C	<b>Dielectric Strength</b>	1500VAC 60sec
<b>Storing Temperature</b>	-10 ~ +85°C	<b>Excitation Method</b>	Permanent Magnet
<b>Insulation Resistance</b>	500VDC 100MΩ	<b>Installation Method</b>	FLANGE
<b>Pole</b>	8 poles	<b>Operating Humidity</b>	20 ~ 80%

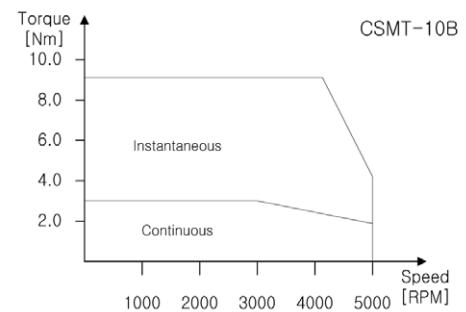
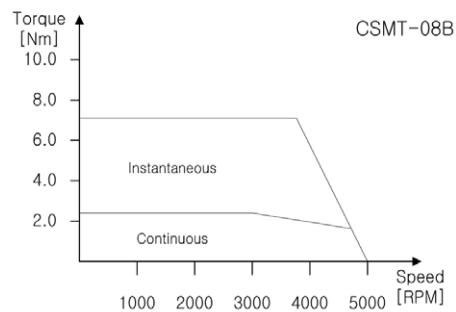
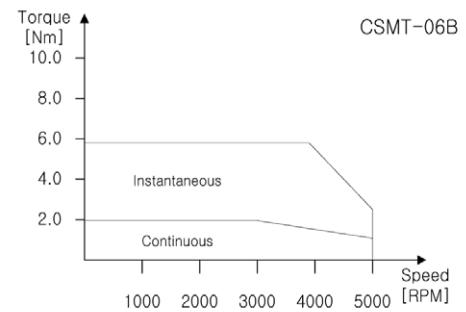
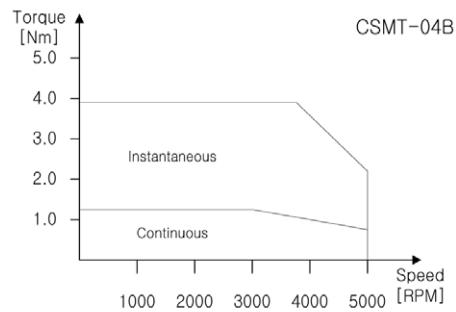
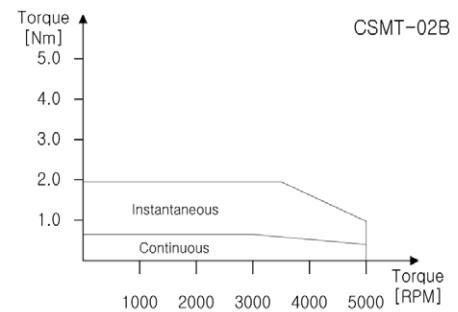
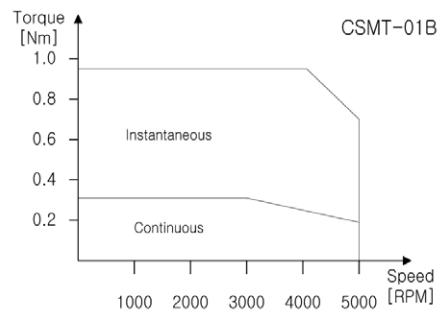
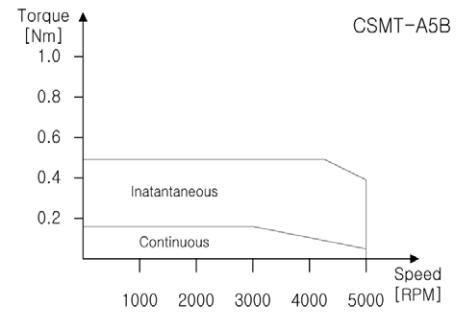
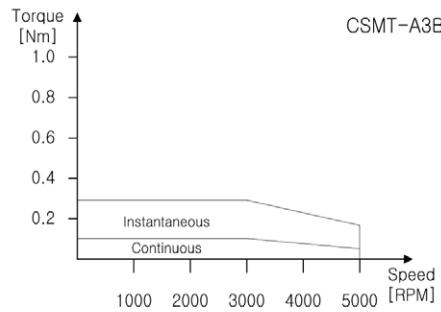
Content	CSMT Motor	A3B	A5B	01B	02B	04B	06B	08B	10B
<b>Applied to</b>	<b>CSDJ- BX2</b>	01	01	01	02	04	06	10	10
<b>Rated Voltage</b>	<b>V</b>				220				
<b>Rated Output</b>	<b>W</b>	30	50	100	200	400	600	750	950
<b>Rated Torque</b>	<b>Kgf·cm</b> <b>N·m</b>	0.97 0.095	1.62 0.159	3.25 0.318	6.5 0.64	13.0 1.27	19.5 1.91	24.4 2.39	30.9 3.0
<b>Instantaneous</b> <b>Max. Torque</b>	<b>Kgf·cm</b> <b>N·m</b>	2.9 0.29	4.9 0.48	9.7 0.95	19.5 1.91	39 3.82	58.5 5.73	73 7.16	92.6 9.1
<b>Rated Speed</b>	<b>RPM</b>				3000				
<b>Max. Speed</b>	<b>RPM</b>				5000				
<b>Rotor Inertia</b>	<b>gf·cm·s<sup>2</sup></b> <b>Kg·m<sup>2</sup>·10<sup>-4</sup></b>	0.01 0.01	0.02 0.02	0.03 0.03	0.18 0.18	0.34 0.34	1.00 0.98	1.10 1.08	1.56 1.53
<b>Rotor Inertia</b> <b>(with Brake)</b>	<b>gf·cm·s<sup>2</sup></b> <b>Kg·m<sup>2</sup>·10<sup>-4</sup></b>	0.04 0.04	0.05 0.05	0.06 0.06	0.28 0.28	0.44 0.44	1.24 1.22	1.34 1.32	1.66 1.63
<b>Power Rate</b>	<b>kW/s</b>	9.2	12.9	34.5	23.0	48.7	37.3	51.3	56.4
<b>Mechanical Time Constant</b>	<b>ms</b>	1.1	0.9	0.6	0.9	0.7	0.6	0.6	0.6
<b>Electrical Time Constant</b>	<b>ms</b>	0.8	1.1	1.6	3.2	3.5	6.0	4.8	5.6
<b>Shaft Friction Torque</b>	<b>Kgf·cm MAX</b>		0.2		0.4		0.8		1.5
<b>Rated Current</b>	<b>A(rms)</b>	0.3	0.6	1.1	1.7	3.3	4.4	5.0	5.4
<b>Instantaneous Max. Current</b>	<b>A(rms)</b>	0.9	1.5	3.0	4.9	3.2	9.6	14.1	15.3
<b>Axial Play</b>	<b>mm MAX</b>			0.2			0.5		

CSMT Motor Content		A3B	A5B	01B	02B	04B	06B	08B	10B
<b>Allowable Thrust Load</b>	<b>Kgf MAX</b>	4			7		10		
<b>Allowable Radial Load</b>	<b>Kgf MAX</b>	8			20		35		
<b>Weight (with Brake)</b>	<b>Kg</b>	0.3 0.5	0.4 0.6	0.5 0.7	0.9 1.4	1.3 1.8	2.2 3.1	2.5 3.4	3.7 4.5
<b>Rotation Direction</b>		U → V → W : CCW							
<b>Oil Seal</b>		Option							

**Table A.2 CSMT Motor Brake Specification**

CSMT Motor Content		A3B	A5B	01B	02B	04B	06B	08B	10B
<b>Raged Voltage</b>	<b>V</b>	24 ± 10%							
<b>Static Friction Torque</b>	<b>N·m Kgf·cm</b>	0.32			1.27		2.55		
<b>Power Dissipation</b>	<b>W</b>	3.25			13		26		
<b>Brake Pull-in Time</b>	<b>ms MAX</b>	5			9		9.5		
<b>Brake Release Time</b>	<b>ms MAX</b>	20			50		50		
		40			80		80		

## • Speed-Torque Curve



## CSMR Motor specification

- Standard Specification

**Table A.3 CSMR Motor Specification**

<b>Content</b>	<b>Specification</b>	<b>Content</b>	<b>Specification</b>
<b>Connection Method</b>	Y connection	<b>Insulation</b>	Class B
<b>Operating Temperature</b>	0 ~ +40 °C	<b>Dielectric Strength</b>	1500VAC 60sec
<b>Storing Temperature</b>	-10 ~ +85 °C	<b>Excitation Method</b>	Permanent Magnet
<b>Insulation Resistance</b>	500DVC 100MΩ	<b>Installation Method</b>	FLANGE
<b>Pole</b>	8 poles	<b>Operating Humidity</b>	20 ~ 80%

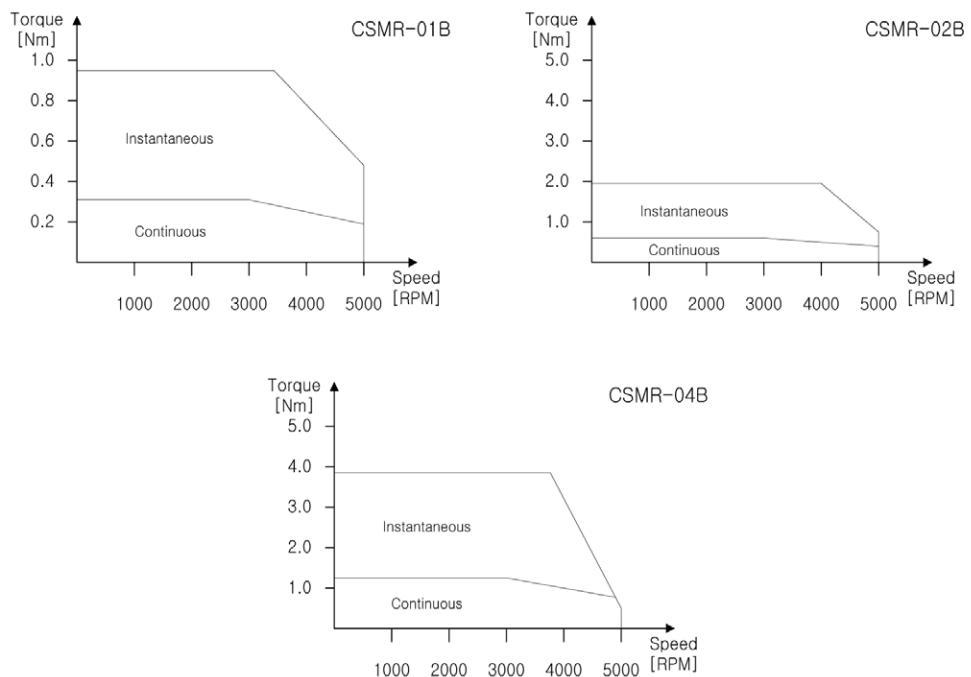
<b>CSMT Motor</b>		<b>01B</b>	<b>02B</b>	<b>04B</b>
<b>Content</b>				
<b>Applied to</b> <b>CSDJ-__BX2</b>		01	02	04
<b>Rated Voltage</b>	<b>V</b>	220		
<b>Rated Output</b>	<b>W</b>	100	200	400
<b>Rated Torque</b>	<b>Kgf·cm</b>	3.25	6.5	13.0
	<b>N·m</b>	0.318	0.64	1.27
<b>Instantaneous Max. Torque</b>	<b>Kgf·cm</b>	9.7	19.5	39
	<b>N·m</b>	0.95	1.91	3.82
<b>Rated Speed</b>	<b>RPM</b>	3000		
<b>Max. Speed</b>	<b>RPM</b>	5000		
<b>Rotor Inertia</b>	<b>gf·cm·s<sup>2</sup></b>	0.09	0.30	0.57
	<b>Kg·m<sup>2</sup>·10<sup>-4</sup></b>	0.09	0.30	0.56
<b>Rotor Inertia (with Brake)</b>	<b>gf·cm·s<sup>2</sup></b>	0.19	0.53	0.80
	<b>Kg·m<sup>2</sup>·10<sup>-4</sup></b>	0.19	0.53	0.79
<b>Power Rate</b>	<b>kW/s</b>	11.5	13.8	29.1
<b>Mechanical Time Constant</b>	<b>ms</b>	1.2	1.0	0.6
<b>Electrical Time Constant</b>	<b>ms</b>	2.5	3.2	4.8
<b>Shaft Friction Torque</b>	<b>Kgf·cm MAX</b>	0.2	0.6	
<b>Rated Current</b>	<b>A(rms)</b>	0.9	1.5	2.7
<b>Instantaneous Max. Currnet</b>	<b>A(rms)</b>	2.5	4.2	7.8
<b>Axial Play</b>	<b>mm MAX</b>	0.2		
<b>Allowable Thrust Load</b>	<b>Kgf MAX</b>	4		
<b>Allowable Radial Load</b>	<b>Kgf MAX</b>	8		

Content		CSMT Motor	01B	02B	04B
Weight (with Brake)	Kg		0.6 0.9	1.1 1.9	1.6 2.4
Rotation Direction		U → V → W : CCW			
Color		Black			
Oil Seal		Option			

**Table A.4 CSMR Motor Brake Specification**

Content		CSMT Motor	01B	02B	04B
Raged Voltage		V	24 ± 10%		
Static Friction Torque	N·m Kgf·cm		0.32 3.25	1.27 13	
Power Dissipation	W		9	9.5	
Brake Pull-in Time	ms MAX		20	50	
Brake Release Time	ms MAX		40	80	

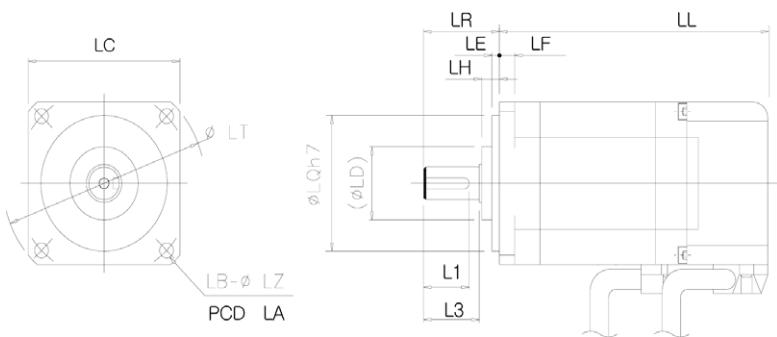
### • Speed-Torque Curve



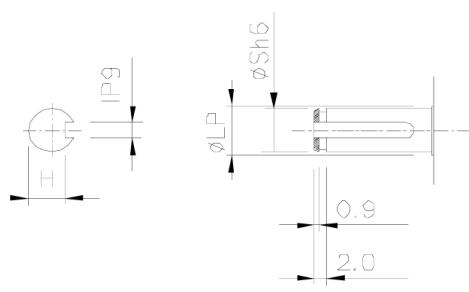


# Appendix B. Motor Dimensions

## CSMT Motor

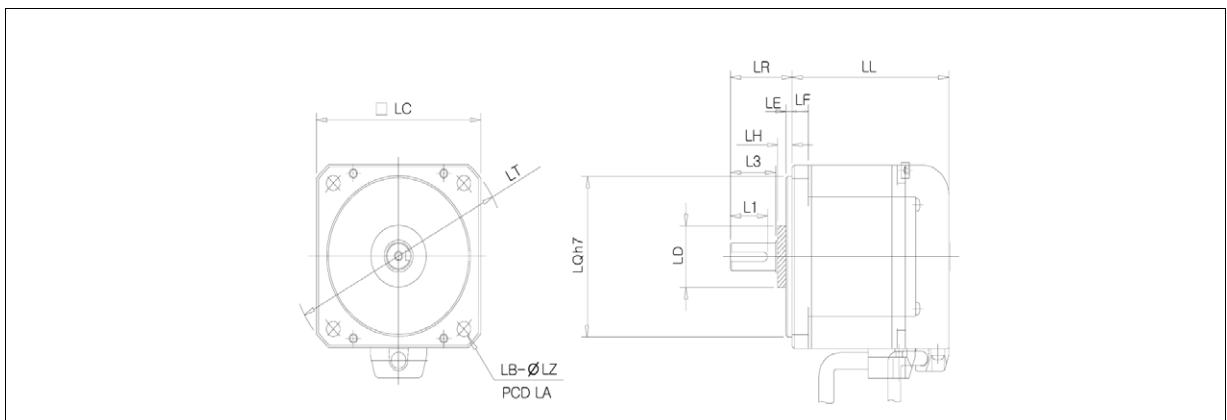


Dimension	Model	A3B	A5B	01B	02B	04B	06B	08B	10B
LL	No BRAKE	53.5	59.5	73.5	76.1	98.1	99.7	108.7	144.2
	With BRAKE	89.1	95.1	109.1	110.7	132.7	136.3	145.3	167.2
LR		25		30		35		35	
LE		2.5		3		3		3	
LF		5		6		8		8	
LH		4.5		7		7		7	
LQ		30		50		70		80	
LD		20		27		34		34	
L1		17		18		23		23	
L3		20		22		27		27	
LC		40		60		80		86	
LT		55		80		105		112	
LB		2		4		4		4	
LZ		4.5		5.5		6.6		6.6	
LA		46		70		90		100	



Dimension	Model	A3B	A5B	01B	02B	04B	06B	08B	10B
LP		8.9		14		19.8			
S		8		12		16			
H		6.2		9.5		13			
I		3		4		5			

## CSMR Motor



Dimension	Model	01B	02B	04B
LL	No BRAKE	62.5	64.3	76.3
	With BRAKE	86.5	95.3	107.3
LR		30	30	
LE		3	3	
LF		6	8	
LH		7	7	
LQ		50	70	
LD		27	27	
L1		18	18	
L3		22	22	
LC		60	80	
LT		80	105	
LB		4	4	
LZ		5.5	6.6	
LA		70	90	

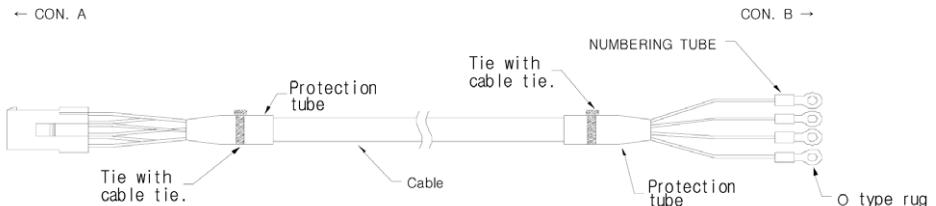
The image contains two technical drawings of the CSMR Motor. The left drawing shows dimension H. The right drawing shows dimensions Sh6, LP, and I.

Dimension	Model	01B	02B	04B
LP			14	
S			12	
H			9.5	
I			4	



# Appendix C. Cable

## Power Cable Assembly for 3-Phase Motor (CSMT/MR)

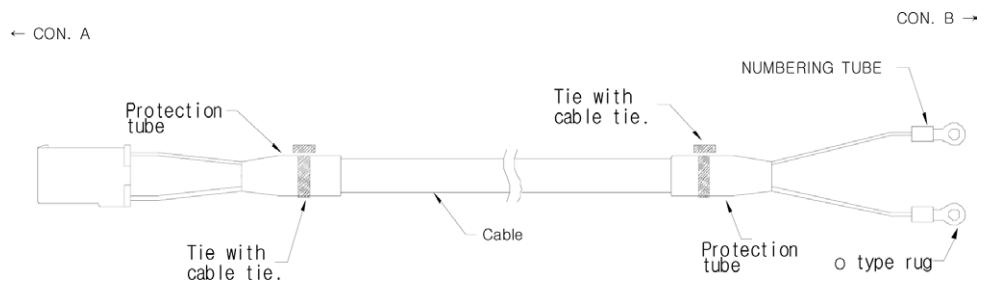


Marking	Cable Color	Remark
U	Red of 3 Point Cable	
V	White of 3 Point Cable	
W	Gray of 3 Point Cable	
PE	P.E Wire (green background/yellow stripe)	Weld and connect the to 3 point cable of the shield

### • Order Number and Product Name

Length(mm) ± 10%	Order Number	Product Name
3,000	POW SL03P010FA	3 Phase Motor Power Cable Assembly
5,000	POW SL05P010FA	

## Motor Brake Cable Assembly (CSMT/MR)

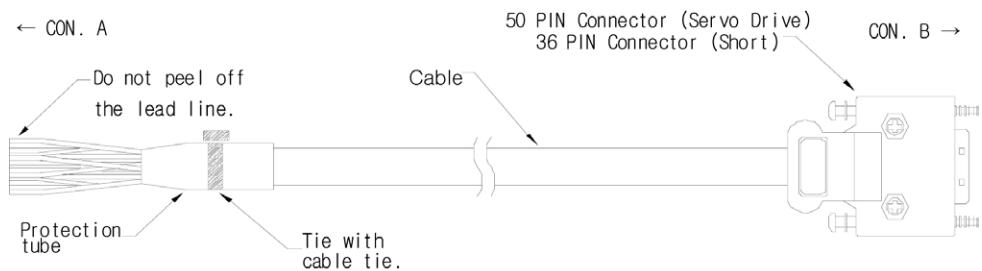


Marking	Cable Color	Remark
BK +	White of 2 Point Cable	
BK -	Gray of 2 Point Cable	

### • Order Number and Product Name

Length(mm) ± 10%	Order Number	Product Name
3,000	BRK SL03BRAKFA	Motor broke cable Assembly
5,000	BRK SL05BRAKFA	
10,000	BRK SL10BRAKFA	
15,000	BRK SL15BRAKFA	
20,000	BRK SL20BRAKFA	

## User I/O Cable



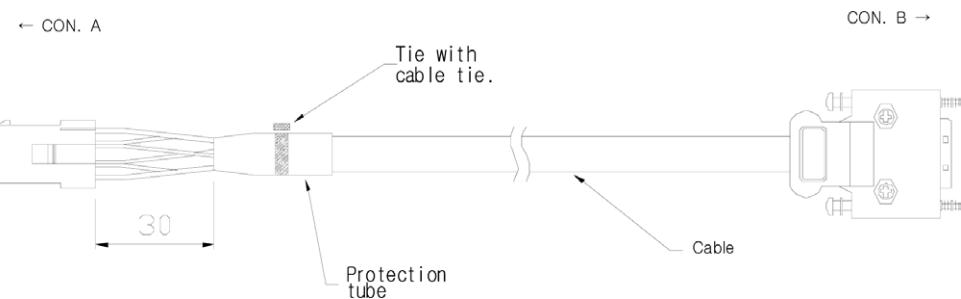
### • I/O Cable Connection Specification (Servo Drive)

con.b	Wire Color	con.b	Wire Color	con.b	Wire Color
1	Red	21	Gray/2Point	41	Orange/Light Line
2	Yellow	22	Red/3Point	42	Gray/Light Line
3	Sky Blue	23	Yellow/3Point	43	Red/1Line
4	White	24	Skyblue/3Point	44	Yellow/1Line
5	Pink	25	White/3Point	45	Skyblue/1Line
6	Orange	26	Pink/3Point	46	White/1Line
7	Gray	27	Orange/3Point	47	Pink/1Line
8	Red/1Point	28	Gray/3Point	48	Orange/1Line
9	Yellow/1Point	29	Red/4Point	49	Gray/1Line
10	Skyblue/1Point	30	Yellow/4Point	50	Shield(Green)
11	White/1Point	31	Skyblue/4Point		
12	Pink/1Point	32	White/4Point		
13	Orange/1Point	33	Pink/4Point		
14	Gray/1Point	34	Orange/4Point		
15	Red/2Point	35	Gray/4Point		
16	Yellow/2Point	36	Red/Light Line		
17	Skyblue/2Point	37	Yellow/Light Line		
18	White/2Point	38	White/Light Line		
19	Pink/2Point	39	White/Light Line		
20	Orange/2Point	40	Pink/Light line		

### • Order Numver and Product Name

Length(mm) ± 10%	Order Number	Product Name
3,000	IOC SH03U50CNA	Use I/O Cable
5,000	IOC SH05U50CNA	
10,000	IOC SH10U50CNA	
15,000	IOC SH15U50CNA	
20,000	IOC SH20U50CNA	

## 9-Wire Incremental Encoder Cable Assembly (CSMT/MR)



- **9 Wire Incremental Encoder Connector (CON.A ↔ CON.B)  
Connection Specification-For CSM Motor**

<b>CON.A</b>	<b>CON.B</b>	<b>Wire Color</b>	<b>Function</b>
1	3	1P(White/Blue)-Blue	A
2	4	1P(White/Blue)-White	*A
3	5	2P(White/Yellow)-Yellow	B
4	6	2P(White/Yellow)-White	*B
5	7	3P(White/Green)-Green	C
6	8	3P(White/Green)-White	*C
7	20	4P(White/Red)-White	VCC
8	1	4P(White/Red)-White	GND
9	12/SH	Shield	P.E

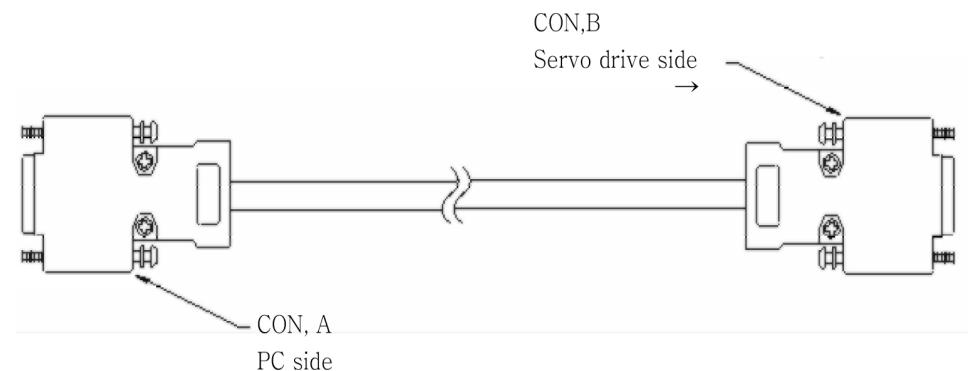
- **11 Wire Incremental Encoder Connector (CON.A ↔ CON.B)  
Connection Specification-For CSMZ/Q Motor**

<b>CON.A</b>	<b>CON.B</b>	<b>Wire Color</b>	<b>Function</b>
1	3	1P(White/Blue)-Blue	A
2	4	1P(White/Blue)-White	*A
3	5	2P(White/Yellow)-Yellow	B
4	6	2P(White/Yellow)-White	*B
5	7	3P(White/Green)-Green	C
6	8	3P(White/Green)-White	*C
7			
8	10	5P(White/Purple)-Purple	RX
9	13	5P(White/Purple)-White	*RX
10	20	4P(White/Red)-Red	VCC
11	1	4P(White/Red)-White	E0V
12	12	Shield	P.E

**• Order Number and Product Name**

<b>Length(mm) ± 10%</b>	<b>Order Number ( 9 wire type, CSM TMotor)</b>	<b>Product Name</b>
3,000	ENC SL03ECNSFA	Incremental Encoder Cable Assembly
5,000	ENC SL05ECNSFA	
10,000	ENC SL10ECNSFA	
15,000	ENC SL15ECNSFA	
20,000	ENC SL20ECNSFA	

## Communication Cable

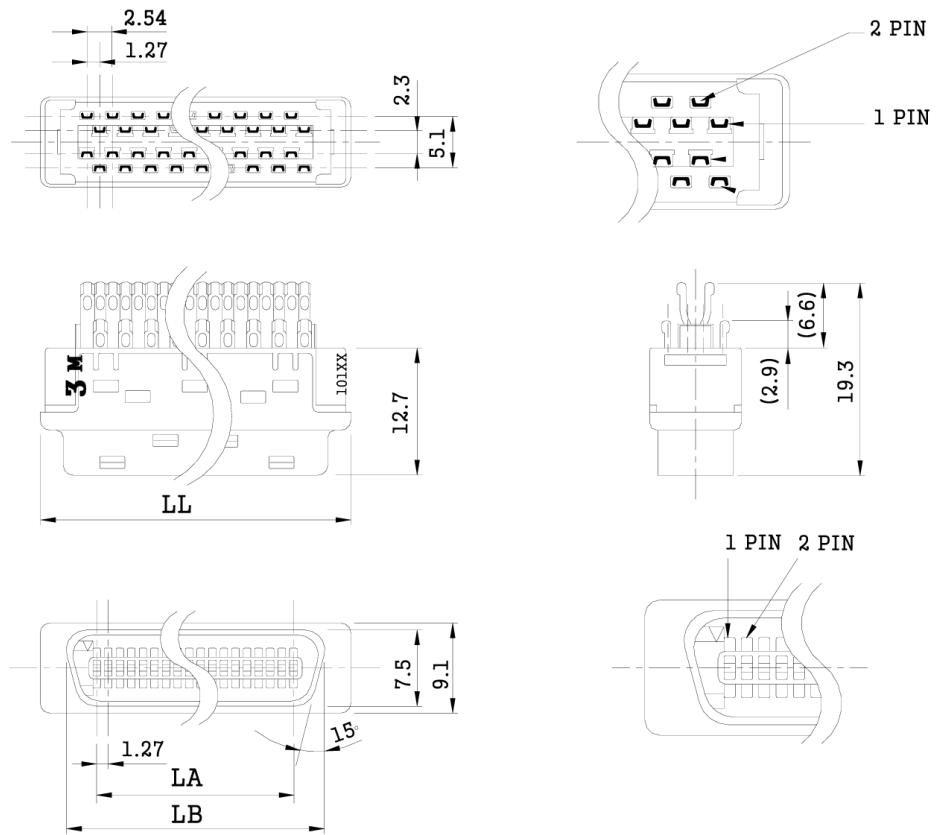


- **Communication Cable (CON.A ↔ CON.B) Connection Specification**

CON.A	CON.B	Wire Color	Function
5	5	Gray	OFF_CHK
3	2	Brown	RX
2	3	Red	TX
N.C	N.C		GND
N.C	9	Shield	P.E

Length(mm) ± 10%	Order Number	Product Name
3,000	COM-SH03CPCNNA	Servo Drive Communication cable

## Controller Cable Connector Specification



### • Order Number

- Encoder Connector(20Pin): CON-SCONN20OPEN
- I/O Connector(36Pin) : CON-SCONN36PIN
- I/O Connector(50Pin) : CON-SCONN50PIN

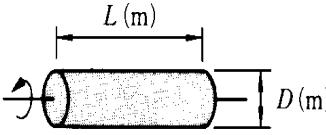
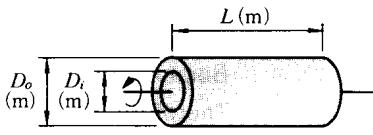
## Cable Code Format

<b>Motor Type</b>	<b>Power Cable</b>	<b>Encoder Cable</b>
<b>CSMT</b>	<p>POW-SL [20] P010 F A</p> <p>■ Cable length 0H : 0.5m 01 : 1m 1H : 1.5m 02 : 2m . 05 : 5m 10 : 10m 15 : 15m 20 : 20m 30 : 30m 40 : 40m 50 : 50m</p> <p>■ Function F: Fixed type</p>	<p>ENC-SL [03] E CN S F A</p> <p>■ Cable length Same as left</p> <p>■ Function Same as left</p> <p>■ Encoder type CN : 9 wire Incremental</p>
<b>All Motors</b>		<p>(When ordering only 20 PIN encoder Connector)</p> <p>CON-SCCONN [20] PEN</p>

<b>Motor Type</b>	<b>I/O Cable</b>	<b>Communication Cable</b>
<b>All Motors</b>	<p>ENC-SL [03] U50CNA</p> <p>■ Cable length 0H : 0.5m 01 : 1m 1H : 1.5m 02 : 2m . . 05 : 5m 10 : 10m 15 : 15m 20 : 20m 30 : 30m 40 : 40m 50 : 50m</p>	<p>ENC-SL [03] C PC NNA</p> <p>■ Cable type JG : For JOG Operator PC : For PC connection</p>
	<p>(When ordering only 50PIN I/O Connector)</p> <p>CON-SCCONN [50] PIN</p>	

# Appendix D. Load Calculation of the Mechanical Part

## The Moment of Inertia Calculation

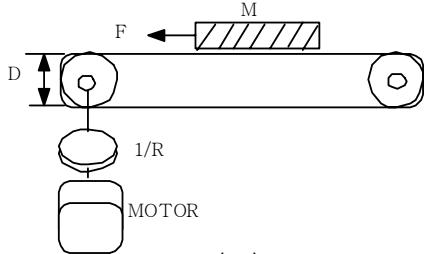
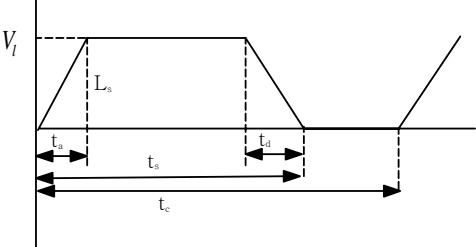
Solid Cylinder		$J = \frac{1}{8} M \times D^2 = \frac{\pi}{32} \rho \times L \times D^4$
Hollow Cylinder		$J_K = \frac{1}{8} M_K (D_o^2 - D_i^2) = \frac{\pi}{32} \rho \cdot L (D_o^4 - D_i^4)$

## Roll Load

<p>Mechanical Configuration</p>	<p>F : tension (N)      P : Pressure      V<sub>l</sub> : Load speed (m/min)      D : Roll diameter (m)      1/R : Reduction Ratio      <math>\mu</math> : The coefficient of friction  <math>\eta</math> : Mechanical efficiency</p>
<p>Speed Diagram</p>	
<p>Motion per Cycle m</p>	$L_s = \frac{V_l}{60} \times \frac{2t_s - t_a - t_d}{2}$ $\text{if } t_a = t_d, \quad L_s = \frac{V_l}{60} (t_s - t_a)$
<p>Motor shaft rotation speed r/min</p>	$N_M = \frac{RV_l}{\pi D}$
<p>Load Torque (Motor shaft) (Nm)</p>	$T_L = \frac{(\mu P + F)D}{2R\eta}$
<p>Load Inertia Moment kg · m<sup>2</sup></p>	$J_L = J_G + \frac{1}{R^2} J_R$ <p><math>J_R</math> : Roll (load part) inertia,      <math>J_G</math> : Gear, coupling inertia</p>
<p>Minimum Acceleration Time s</p>	$t_{am} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} - T_L)}$ <p><math>J_M</math> : motor inertia,      <math>T_{PM}</math> : Motor maximum torque</p>
<p>Minimum Deceleration Time s</p>	$t_{dm} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} + T_L)}$ <p><math>J_M</math> : Motor inertia,      <math>T_{PM}</math> : Motor maximum torque</p>
<p>Load Operation Power W</p>	$P_o = \frac{2\pi \times N_M \times T_L}{60}$
<p>Load Acceleration Power W</p>	$P_a = \left( \frac{2\pi \times N_M}{60} \right)^2 \frac{J_L}{t_a} \quad (t_a \leq t_{am})$

Acceleration Torque Used N·m	$T_p = \frac{2\pi \times N_m (J_M + J_L)}{60t_a} + T_L \quad (t_a \leq t_{am})$
Deceleration Torque Used N·m	$T_s = \frac{2\pi \cdot N_m (J_M + J_L)}{60t_d} - T_L \quad (t_a \leq t_{dm})$
Torque RMS Value N·m	$T_{rms} = \sqrt{\frac{T_p^2 \times t_a \times T_L^2 \times (t_s - t_a - t_d) + T_s^2 \times t_d}{t_c}}$

## Timing Belt Load

<p>Mechanical Configuration</p>	 <p><math>M</math> : Load mass of linear movement part(kg)  <math>V_l</math> : load speed (m/min)    <math>F</math> : Thrust Force(N)    <math>1/R</math> : Reduction Ratio  <math>D</math> : Pulley Diameter(m)    <math>\mu</math> : The coefficient of friction    <math>\eta</math> : Mechanical efficiency</p>
<p>Speed Diagram</p>	
<p>Motion per Cycle m</p>	$L_s = \frac{V_l}{60} \times \frac{2t_s - t_a - t_d}{2}$ $\text{if } t_a = t_d, \quad L_s = \frac{V_l}{60}(t_s - t_a)$
<p>Motor shaft rotation speed r/min</p>	$N_M = \frac{RV_l}{\pi D}$
<p>Load torque (motor shaft) (Nm)</p>	$T_L = \frac{(9.8\mu M + F)D}{2R\eta}$
<p>Load Inertia Moment <math>\text{kg} \cdot \text{m}^2</math></p>	$J_L = J_W + J_G + \frac{J_p}{R^2}$ <p><math>J_W</math> : Direct operation part (load) inertia, ,  <math>J_G</math> : Gear, Coupling inertia,    <math>J_p</math> : Pulley part inertia</p> $J_W = M(\frac{D}{2R})^2$
<p>Minimum Acceleration Time s</p>	$t_{am} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} - T_L)}$ <p><math>J_M</math> : Load Inertia    <math>T_{PM}</math> : Maximum Motor Torque</p>
<p>Minimum Deceleration Time s</p>	$t_{dm} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} + T_L)}$ <p><math>J_M</math> : Motor Inertia,    <math>T_{PM}</math> : Maximum Motor Torque</p>
<p>Load Operational Power W</p>	$P_o = \frac{2\pi \times N_M \times T_L}{60}$

Load Acceleration Power W	$P_a = \left(\frac{2\pi \times N_M}{60}\right)^2 \frac{J_L}{t_a} \quad (t_a \leq t_{am})$
Acceleration Torque Used N m	$T_p = \frac{2\pi \times N_M (J_M + J_L)}{60 t_a} + T_L \quad (t_a \leq t_{am})$
Deceleration Torque Used N m	$T_s = \frac{2\pi \cdot N_M (J_M + J_L)}{60 t_d} - T_L \quad (t_a \leq t_{dn})$
Torque RMS Value N m	$T_{\text{RMS}} = \sqrt{\frac{T_p^2 \times t_a \times T_L^2 \times (t_s - t_a - t_d) + T_s^2 \times t_d}{t_c}}$

## Ball Screw Load(Horizontal Axis)

<p>Mechanical Configuration</p>	<p> <math>V_l</math> : Load Speed (m/min)  <math>1/R</math> : Reduction Ratio  <math>L_B</math> : Ball Screw Length(m)  <math>\mu</math> : The Coefficient of Friction  <math>M</math> : Load Mass of Linear movement Part  <math>F</math> : Thrust Force(N)  <math>P_B</math> : Ball Screw Lead(m)  <math>D_B</math> : Ball Screw Diameter(m)  <math>\eta</math> : Mechanical Efficiency     </p>
<p>Speed Diagram</p>	
<p>Motion per Cycle m</p>	$L_s = \frac{V_l}{60} \times \frac{2t_s - t_a - t_d}{2}$ <p>if <math>t_a = t_d</math>, <math>L_s = \frac{V_l}{60} (t_s - t_a)</math></p>
<p>Motor Shaft Rotation Speed r/min</p>	$N_M = \frac{RV_l}{P_B}$
<p>Load Torque (Motor Shaft) (Nm)</p>	$T_L = \frac{(9.8\mu M + F)P_B}{2\pi R\eta}$
<p>Load Inertia Moment kg · m<sup>2</sup></p>	$J_L = J_w + J_g + \frac{J_B}{R^2}$ <p>여기서</p> <p> <math>J_w</math> : Direct operational part (load) inertia, <math>J_g</math> : gear part inertia,  <math>J_B</math> : Ball Screw inertia     </p> $J_w = M \left( \frac{P_B}{2\pi R} \right)^2, \quad J_B = \frac{1}{8} M_B \times P_D^2 = \frac{\pi}{32} \rho \times P_L \times P_D^4$ <p>here, <math>M_B</math> : Ball Screw weight(kg)</p> <p> <math>\rho</math> : density (kg/m<sup>3</sup>) . . . . . Iron <math>\rho = 7.87 \times 10^3</math> (kg/m<sup>3</sup>)  . . . . . Aluminum <math>\rho = 2.70 \times 10^3</math> (kg/m<sup>3</sup>)     </p>
<p>Minimum Acceleration Time s</p>	$t_{am} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} - T_L)}$ <p>Here, <math>J_M</math> : Motor Inertia, <math>T_{PM}</math> : Motor Maximum torque</p>

Minimum Deceleration Time s	$t_{dm} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} + T_L)}$ Here $J_M$ : motor inertia, $T_{PM}$ : motor maximum torque
Load Operational Power W	$P_o = \frac{2\pi \times N_M \times T_L}{60}$
Load Acceleration Power W	$P_a = \left(\frac{2\pi \times N_M}{60}\right)^2 \frac{J_L}{t_a} \quad (t_a \leq t_{dm})$
Acceleration Torque Used Nm	$T_p = \frac{2\pi \times N_M (J_M + J_L)}{60t_a} + T_L \quad (t_a \leq t_{dm})$
Deceleration Torque Used Nm	$T_s = \frac{2\pi \cdot N_M (J_M + J_L)}{60t_d} - T_L \quad (t_a \leq t_{dm})$
Torque RMS Value Nm	$T_{rms} = \sqrt{\frac{T_p^2 \times t_a \times T_L^2 \times (t_s - t_a - t_d) + T_s^2 \times t_d}{t_c}}$

## Ball Screw Load(Vertical Axis)

<p>Mechanical Configuration</p>	
	<p> <math>V_l</math> : Load Speed (m/min)      <math>F</math> : Thrust Force(N)  <math>1/R</math> : Reduction Ratio      <math>P_B</math> : Ball Screw Lead(m)  <math>L_B</math> : Ball Screw Length(m)      <math>D_B</math> : Ball Screw Diameter (m)  <math>M</math> : Load Mass of Linear Movement Part(kg)  <math>M_c</math> : Counter Part Mass (kg)      <math>\eta</math> : Mechanical Efficiency     </p>
<p>Speed Diagram</p>	
<p>Motion per Cycle</p>	$L_s = \frac{V_l}{60} \times \frac{2t_s - t_a - t_d}{2}$ <p>if <math>t_a = t_d</math>, <math>L_s = \frac{V_l}{60}(t_s - t_a)</math></p>
<p>Motor Axis Rotation Speed r/min</p>	$N_M = \frac{RV_l}{P_B}$
<p>Load Torque (Motor shaft) (Nm)</p>	$T_L = \frac{[9.8(M - M_c) + F]P_B}{2\pi R\eta}$

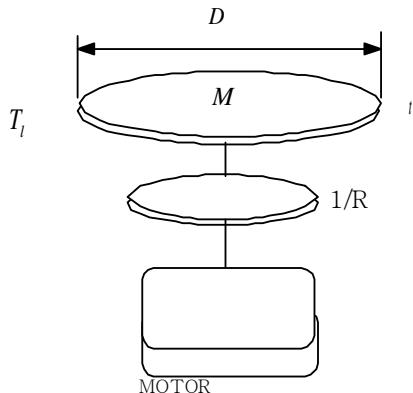
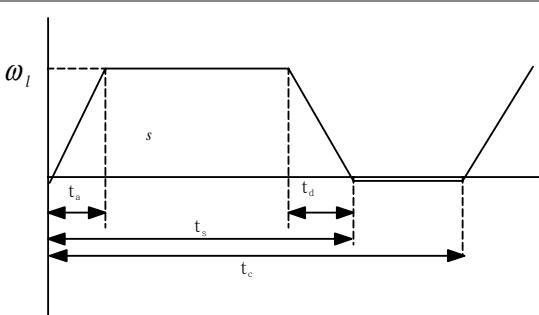
Load Inertia Moment  kg m <sup>2</sup>	$J_L = J_w + J_G + \frac{J_B}{R^2}$ <p>Here</p> $J_w : \text{Load Inertia of Linear Movement part} \quad J_G : \text{Gear, Coupling Part Inertia},$ $J_B : \text{Ball Screw Inertia}$ $J_w = (M + M_c) \left( \frac{P_B}{2\pi R} \right)^2, \quad J_B = \frac{1}{8} M_B \times P_d^2 = \frac{\pi}{32} \rho \times P_L \times P_d^4$ <p>Here <math>M_B</math> : Ball Screw Mass (kg)</p> <p><math>\rho</math> : Density (kg/m<sup>3</sup>) .... Iron <math>\rho = 7.87 \times 10^3</math> (kg/m<sup>3</sup>) .... Aluminum <math>\rho = 2.70 \times 10^3</math> (kg/m<sup>3</sup>)</p>
Minimum Acceleration Time  s	$t_{am} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} - T_L)}$ <p>Here <math>J_M</math> : Motor Inertia, <math>T_{PM}</math> : Motor maximum torque</p>
Minimum Deceleration Time  s	$t_{dm} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} + T_L)}$ <p>Here <math>J_M</math> : Motor Inertia, <math>T_{PM}</math> : Motor maximum torque</p>
Load operational Power  w	$P_o = \frac{2\pi \times N_M \times T_L}{60}$
Load Acceleration Power  w	$P_a = \left( \frac{2\pi \times N_M}{60} \right)^2 \frac{J_L}{t_a} \quad (t_a \leq t_{am})$
Acceleration torque used  N·m	$T_p = \frac{2\pi \times N_M (J_M + J_L)}{60 t_a} + T_L \quad (t_a \leq t_{am})$
Deceleration Torque used  N·m	$T_s = \frac{2\pi \times N_M (J_M + J_L)}{60 t_d} - T_L \quad (t_a \leq t_{dm})$
Torque RMS Value  N·m	$T_{\text{RMS}} = \sqrt{\frac{T_p^2 \times t_a \times T_L^2 \times (t_s - t_a - t_d) + T_s^2 \times t_d}{t_c}}$

## Rack & Pinion Load

Mechanical Configuration	<p>M : Load mass of linear movement part (kg)   <math>\mu</math> : The coefficient of friction  <math>V_l</math> : Load speed (m/min)   <math>F</math> : Thrust force (N)  <math>1/R</math> : Reduction ratio   <math>\eta</math> : Mechanical efficiency  <math>D</math> : Pinion diameter (m)   <math>t</math> : Pinion thickness(m)</p>
Speed Diagram	
Motion per Cycle	$L_s = \frac{V_l}{60} \times \frac{2t_s - t_a - t_d}{2}$ $\text{if } t_a = t_d, \quad L_s = \frac{V_l}{60}(t_s - t_a)$
Motor axis rotation speed r/min	$N_M = \frac{RV_l}{\pi D}$
Load torque (Motor Shaft) (Nm)	$T_L = \frac{(9.8\mu M + F)D}{2R\eta}$

	$J_L = J_W + J_G + \frac{J_p}{R^2}$
Load Inertia Moment kg m <sup>2</sup>	Here $J_W$ : Load Inertia of Linear Movement Part $J_G$ : Gear, Coupling Part Inertia, $J_p$ : Pinion Inertia $J_W = M \left( \frac{D}{2R} \right)^2, \quad J_p = \frac{1}{8} M_p \times D^2 = \frac{\pi}{32} \rho \times t \times D^4$ Here, $M_p$ : Pinion Density(kg) ρ : Density (kg/m <sup>3</sup> )    ··· Iron      ρ = 7.87 × 10 <sup>3</sup> (kg/m <sup>3</sup> ) ··· Aluminum      ρ = 2.70 × 10 <sup>3</sup> (kg/m <sup>3</sup> )
Minimum Acceleration Time s	$t_{am} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} - T_L)}$ Here $J_M$ : Motor Inertia, $T_{PM}$ : Motor maximum torque
Minimum Deceleration Time s	$t_{dm} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} + T_L)}$ Here $J_M$ : Motor Inertia, $T_{PM}$ : Motor maximum torque
Load Operational Power W	$P_o = \frac{2\pi \times N_M \times T_L}{60}$
Load Acceleration Power W	$P_a = \left( \frac{2\pi \times N_M}{60} \right)^2 \frac{J_L}{t_a} \quad (t_a \leq t_{am})$
Acceleration Torque Used Nm	$T_p = \frac{2\pi \times N_M (J_M + J_L)}{60t_a} + T_L \quad (t_a \leq t_{am})$
Deceleration Torque Used Nm	$T_s = \frac{2\pi \cdot N_M (J_M + J_L)}{60t_d} - T_L \quad (t_a \leq t_{dm})$
Torque RMS Value Nm	$T_{rms} = \sqrt{\frac{T_p^2 \times t_a \times T_L^2 \times (t_s - t_a - t_d) + T_s^2 \times t_d}{t_c}}$

## Round Plate Load

<p>Mechanical Configuration</p>	
	<p><math>M</math> : Load Mass of Round Plate(kg)      <math>1/R</math> : Reduction Ratio  <math>\omega_l</math> : Rotation Speed of Round Plate (rpm)      <math>T_l</math> : Load torque  <math>\eta</math> : Mechanical Efficiency      <math>D</math> : Diameter of Round Plate  <math>t</math> : Thickness of Round Plate</p>
<p>Speed Diagram</p>	
<p>Motion per Cycle (rad)</p>	$s = \frac{\omega_l}{60} \times \frac{2t_s - t_a - t_d}{2}$ $\text{if } t_a = t_d, \quad \theta_s = \frac{\omega_l}{60}(t_s - t_a)$
<p>Motor Shaft Rotation Speed (r/min)</p>	$N_M = R\omega_l$
<p>Load Torque (Motor shaft) (Nm)</p>	$T_L = \frac{T_l}{R}$

Load Inertia Moment  $\text{kg}\cdot\text{m}^2$	$J_L = J_G + \frac{J_W}{R^2}$ <p>Here,</p> $J_W : \text{Load Inertia of Round Plate} \quad J_G : \text{Gear, Coupling Part Inertia}$ $J_W = \frac{1}{8} M \times D^2 = \frac{\pi}{32} \rho \times t \times D^4$ <p>Here, <math>\rho</math> : Density (<math>\text{kg}/\text{m}^3</math>) ..... Iron <math>\rho = 7.87 \times 10^3 (\text{kg}/\text{m}^3)</math> ..... Aluminum <math>\rho = 2.70 \times 10^3 (\text{kg}/\text{m}^3)</math></p>
Minimum Acceleration Time  $\text{s}$	$t_{am} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} - T_L)}$ <p>Here <math>J_M</math> : Motor Inertia, <math>T_{PM}</math> : Motor maximum torque</p>
Minimum Deceleration Time  $\text{s}$	$t_{dm} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} + T_L)}$ <p>Here <math>J_M</math> : Motor Inertia, <math>T_{PM}</math> : Motor maximum torque</p>
Load Operational Power  $\text{W}$	$P_o = \frac{2\pi \times N_M \times T_L}{60}$
Load Acceleration Power  $\text{W}$	$P_a = \left( \frac{2\pi \times N_M}{60} \right)^2 \frac{J_L}{t_a} \quad (t_a \leq t_{am})$
Acceleration Torque Used  $\text{N}\cdot\text{m}$	$T_p = \frac{2\pi \times N_M (J_M + J_L)}{60 t_a} + T_L \quad (t_a \leq t_{am})$
Deceleration Torque Used  $\text{N}\cdot\text{m}$	$T_s = \frac{2\pi \times N_M (J_M + J_L)}{60 t_d} - T_L \quad (t_a \leq t_{dm})$
Torque RMS Value  $\text{N}\cdot\text{m}$	$T_{rm} = \sqrt{\frac{T_p^2 \times t_a \times T_L^2 \times (t_s - t_a - t_d) + T_s^2 \times t_d}{t_c}}$



# Appendix E. Conversion Table of SI to/from CGS

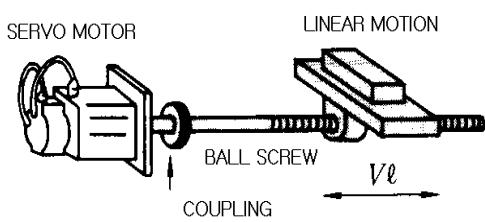
**Table F.1 Conversion Table of SI to/from CGS**

Item	Unit		Conversion Rate
	SI	CGS	
Force	N	Kgf	1N = 0.10197kgf 1kg = 9.80665N
Mass	Kg	Kgf	1kg = 1kgf
Torque	N · m	Kgf · m	1N · m = 0.10197kgf · m 1kgf · m = 9.80665N · m
The Moment of Inertia $J = \frac{GD^2}{4}$	Kg · m <sup>2</sup>	gf · cm · s <sup>2</sup>	1kgf · m <sup>2</sup> = 1.0197x10 <sup>4</sup> gf · cm · s <sup>2</sup> 1gf · cm · s <sup>2</sup> = 0.980665x10 <sup>-4</sup> kg · m <sup>2</sup>

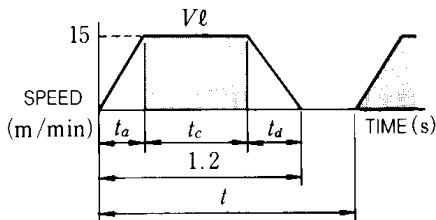


# Appendix F. Motor Capacity Selection

- This is an example of speed control



(1) Speed Diagram



- Load Speed:  $\ell = 15 \text{ m/min}$
- Mass of the linear movement part:  $M = 500 \text{ kg}$
- Length of the ball screw:  $L_B = 1.4 \text{ m}$
- Diameter of the ball screw:  $D_B = 0.04 \text{ m}$
- Ball Screw Lead:  $P_B = 0.01 \text{ m}$
- Mass of the coupling:  $M_K = 1 \text{ kg}$
- Outer diameter of the coupling:  $D_K = 0.06 \text{ m}$
- The number of times of transfer:  $n = 40/\text{min}$
- Transfer distance:  $\lambda = 0.275 \text{ m}$
- Transfer time:  $t_m = 1.2 \text{ s}$  or less
- The coefficient of friction:  $\mu = 0.2$
- Mechanical efficiency:  $\eta = 0.9$

$$t = \frac{60}{n} = \frac{60}{40} = 1.5 \text{ (sec)}$$

Here  $t_a = t_d$

$$t_a = t_m - \frac{60\ell}{V\ell} = 1.2 - \frac{60 \cdot 0.275}{15} = 0.1 \text{ (sec)}$$

(2) Rotation Speed

$$N\ell = \frac{V\ell}{P_B} = \frac{15}{0.01} = 1500 \text{ (r/min)}$$

• Load axis rotation speed

• Motor rotation speed. This is direct coupling, Reduction ratio is  $1/R = 1$   
Thus,  $N_M = N\ell \cdot R = 1500 \times 1 = 1500 \text{ (r/min)}$

(3) Load Torque

$$T_l = \frac{9.8\mu \cdot M \cdot P_B}{2\pi R \cdot \eta} = \frac{9.8 \times 0.2 \times 500 \times 0.01}{2\pi \times 1 \times 0.9} = 1.73 \text{ (N.m)}$$

(4) Load Inertia

$$\text{• linear movement Part } J_{L1} = M \times \left(\frac{P_B}{2\pi R}\right)^2 = 500 \left(\frac{0.01}{2\pi \times 1}\right) = 12.7 \cdot 10^{-4} \text{ (kg} \cdot \text{m}^2)$$

$$\text{• Ball Screw } J_B = \frac{\pi}{32} \rho \times L_B \times D_B^4 = \frac{\pi}{32} \times 7.87 \times 10^3 \times 1.4 \times 0.04^4 = 27.7 \times 10^{-4} \text{ (kg} \cdot \text{m}^2)$$

- Coupling  $J_c = \frac{1}{8} M_c \times D_c^2 = \frac{1}{8} \times 0.06^2 = 4.5 \times 10^{-4} (\text{kg} \cdot \text{m}^2)$
- Motor shaft Load Inertia  $J_L = J_M + J_B + J_C = 44.9 \times 10^{-4} (\text{kg} \cdot \text{m}^2)$

(5) Load Operational Power

$$P_o = \frac{2\pi \cdot N_M \cdot T_L}{60} = \frac{2\pi \times 1500 \times 1.73}{60} = 272(\text{W})$$

(6) Load Acceleration Power

$$P_a = \left( \frac{2\pi \times N_M}{60} \right)^2 \frac{J_L}{t_a} = \left( \frac{2\pi}{60} \times 1500 \right)^2 \times \frac{44.9 \times 10^{-4}}{0.1} = 1108(\text{W})$$

(7) Temporary selection of servo motor

Condition of Selection

- $J_L \leq$  Allowable load inertia of servo pack
- Consumed acceleration torque  $\leq$  Instantaneous maximum torque
- Consumed deceleration torque  $\leq$  Instantaneous maximum torque
- $T_{ms} \leq$  Rated torque of the motor
- $P_a + P_o = (1~2) \times$  Rated motor output
- $N_M \leq$  Rated rotation speed of the motor

Select the servo motor with the above condition.

<Servo Motor Specification>

- Rated output : CSMD-1000(W)
- Rated rotation speed : 2000(r/min)
- Rated torque : 14.4 (N · m)
- Motor inertia :  $6.17 \times 10^{-4}$  ( $\text{kg} \cdot \text{m}^2$ )
- Allowable inertia of servo pack :  $61.7 \times 10^{-4}$  ( $\text{kg} \cdot \text{m}^2$ )

(8) Check for selection condition of the temporarily selected servo motor

(a) Load moment of inertia for motor side  $J_L$

$$J_L = 44.9 \times 10^{-4} (\text{kg} \cdot \text{m}^2) > \text{Allowable inertia of servo pack } 61.7 \times 10^{-4} (\text{kg} \cdot \text{m}^2)$$

(b) Required operational torque (Consumed acceleration torque  $T_p$ )

$$T_p = \frac{2\pi N_M (J_M + J_L)}{60 t_a} + T_L = \frac{2\pi \times 1500 (6.17 + 44.9)}{60 \times 0.1} + 1.73 = 9.75(\text{N m}) \quad < \text{Instantaneous maximum torque of the motor}$$

( c ) Required stop torque (Consumed deceleration torque  $T_S$ )

$$T_S = \frac{2\pi N_M (J_M + J)}{60t_a} - T_L = \frac{2\pi \times 1500(6.17 + 44.9)}{60 \times 0.1} - 1.73 = 6.29(N\cdot m) < \text{Instantaneous maximum torque of the motor}$$

( d ) Torque RMS (Average value)

$$T_{rms} = \sqrt{\frac{T_p^2 \cdot t_a + T_L^2 \cdot t_c + T_S^2 \cdot t_d}{t}} = \sqrt{\frac{9.75^2 \times 0.1 + 1.73^2 \times 10 + 6.29^2 \times 0.1}{15}} = 3.31(N\cdot m) < \text{Rated torque of the motor}$$

( e ) Power

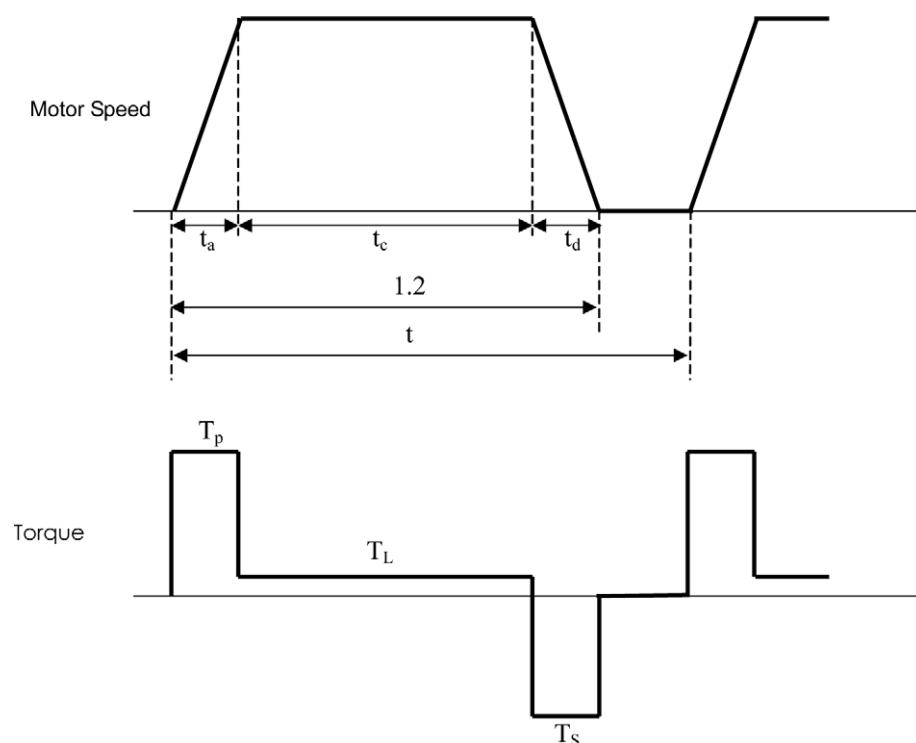
$$P_a + P_o = 1108 + 272 = 1380W < \text{Rated output of the motor } 1000W \times (1 \sim 2)$$

( f ) Rotation speed

$$Nm = 1500RPM < \text{Rated rotation speed of the motor } 2000RPM$$

### (9) Final servo motor selection

Temporarily selected servo motor, which satisfies the above conditions can be used. The selected AC servo motor generates the torque depending on the speed, as shown below.





## **Appendix G. Revision History**

<b>Publication Date</b>	<b>Revision No.</b>	<b>Content</b>
2001. 02	CSDJ-XXBX2 Ver 1.0	Initial version for modification
2001. 03	CSDJ Plus V 1.0	Authorized publication version ROM version 1.1
2001. 05	CSDJ Plus V 1.2	ROM version 1.2 function added - SEt-46 function - Torque limit sequence change
2002. 12	CSDJ Plus V 1.3	ROM version 1.3 function added - SEt-41=10 speed control function - Absolute Encoder Data Transmitting by switching of I/O port
2004.01	CSDJ Plus V 1.4	ROM version 1.4 function added - Support CSMT, CSMR motors - Monitoring Modes Con-25 ~ 28 added - DA monitor channel dA-08 added

