OEMAX™ CONTROLS

Maximum Value for OEMs℠

CSDJ Plus Servo Drive

User Manual

- Thank you for purchasing Rockwell Automation Korea 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

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 Chapter 5, Parameter Table.

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

General Precautions

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.

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**.

: When handled incorrectly, dangerous situations may happen.
May cause severe or slight injuries, or cause only a product damage.

: When handled incorrectly, dangerous situation (electro caution) may occur.
May cause death or severe injury.

- Even if the content is defined as 

, serious result may occur depending on the situation. Make sure to follow the manual.

Checking Product Status

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.

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℃.
- Overheating may cause fire or other accidents.

Precautions when Wiring

Operate only after checking that input power is off.
- There may be electric shock or fire.

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.

Cooling fin and electric discharge resistor overheats, so do not touch with hands.
- It may cause burns.

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

This servo drive has high voltage terminal, thus it is very dangerous.
Do not touch it.
- There may be electric shock.

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.

Control board uses C-MOS. Be aware when handling it.
- When touching with hand, the product may be damaged due to static electricity.

During being energized, do not exchange the wire or remove the connector and etc.
- There may be injuries or damage in products.

Do not modify the production.
- There may be electric shock or injuries.

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Chapter 1

Summary and Specifications

Chapter 1 explains about the basic information on complete composition and standard specifications of CSDJ Plus Servo Drive.

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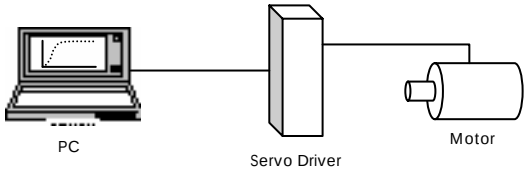
1.1 Main Features of the Product

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. Normal Incremental (15 lines), Brief incremental (11,9 lines) and Absolute (15 lines) Encoder are added to this product for easier system design.
- 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.



Warning 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.

1.2 Preparation for Servo Operation

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

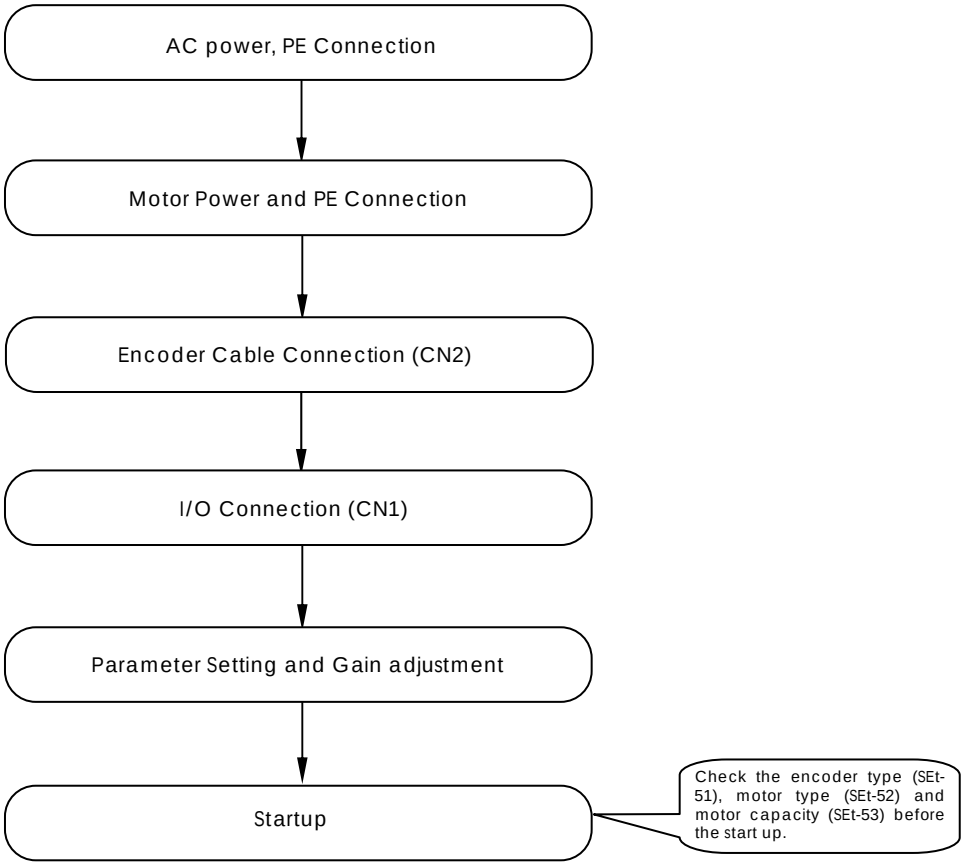


Fig 1.1 Preparation for Operation

1.3 External View

CSDJ-A3C,A5C,01B, 02B, 04B

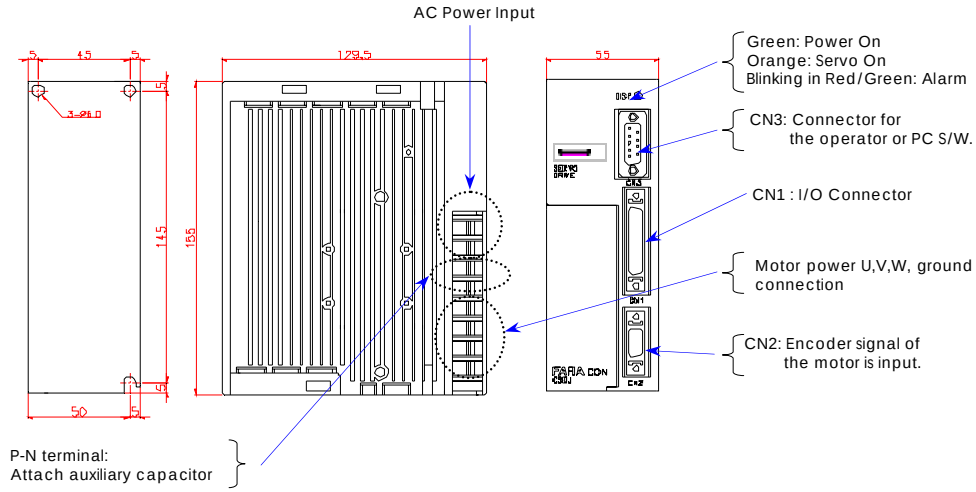


Fig 1.2 Outline Dimension (CSDJ-A3C,A5C,01B,02B,04B)

CSDJ-02C,06B,10B

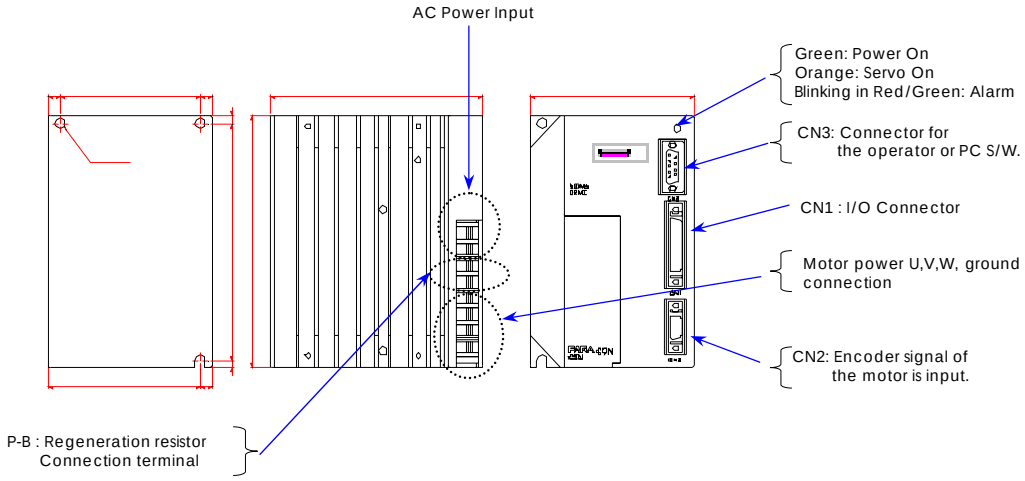


Fig 1.3 Outline Dimension (CSDJ-02C,06B,10B)

☞Refer to the Table 2.1 for types and capacity of the motor for each drive.

1.4 Standard Specifications

Table 1.1 Standard Specifications of CSDJ Plus Servo Drive

Basic Specification	**Power Source** ※1		Single phase 220V + 10, -15% 50/60Hz	24VDC ±10%
	Control Method		PWM control using IPM	
	Encoder ※2		2000/2048/2500/10000 P/R etc.(Incremental or Absolute type)	
	Operating Temperature/ Humidity		0℃~+55℃ / 90% or less(non-condensing)	
	Storing temperature/ Humidity		-20℃~+80℃ / 90% or less (non-condensing)	
	Vibration/Shock Resistance		Vibration 0.5G / Below shock 2G (1G = the acceleration of gravity. : 9.8m/s²)	
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	

※ 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.)

※ 2) Refer to 「7.6 Setting of encoder type」

※ 3) Number of pulse greater than the number of encoder pulse cannot be output in one rotation of the motor.

※ 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 「7.4 B. Allowable load inertia」

Table 1.2 Control Specifications

Speed Control	Speed Input	Speed Control Range *1		1:3,000
		Speed Variation*2	Load Variation	0 ~ 100% : Below 0.01% (At rated speed)
			Line voltage Variation	220VAC +10, -15% 50/60Hz : 0.01%
			Temperature Variation	25 ± 25℃ : Below ±0.01% (At rated speed)
		Frequency Band width		250Hz ($J_L = J_M$)
		Acceleration/Deceleration Time Setting		0 ~ 60 sec
	Speed/Torque Input	Speed	Rated Speed Command	±10VDC (Set to 6V from the rated speed when delivered)
			Input Impedance	Approximately 50 kΩ
			Circuit time constant	Approximately 35 μs
		Torque	Rated Torque Command	±10VDC (Set to 3V in rated torque when delivered)
			Input Impedance	Approximately 50 kΩ
			Circuit time constant	Approximately 35 μs
Position Control	Feed Forward Compensation			0 ~ 100% (Set Resolution : 1%)
	Input Signal	Command Pulse	Type	- Sign + Pulse train - 90° Phase difference 2 phase pulse (A phase + B phase) - CCW Pulse + CW Pulse
			Pulse Type	Line drive (+5V), Open collector (+5V, +12V, 24V)
			Pulse Frequency	0 ~ 450 kpps ; Line driver, 0 ~ 200 kpps ; open collector
Mounting Method				Base mounted
Others				Torque Control, Multi Step Speed Control, Zero-Clamp Speed Control, Speed/Speed Limit Torque Control Position/Torque Control, Position/Speed Control Torque Limit Speed Control, Speed/Multi Step Speed Control, Soft-Start/Stop Speed Setting, Brake Control JOG Operation, Auto Tuning, Reverse Operation and etc.

Caution

※ 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.

$$\text{Speed variation rate} = \frac{\text{No load speed} - \text{Total load speed}}{\text{Rated Speed}} \times 100\ (\%)$$

- 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.

3) This is a speed/torque/position control built-in type drive.

4) In case of CSM/MQ/MZ motor, maximum allowable load inertia can be up to 30 times, when below 200W, and up to 20 times, when below 1kW.
In case of CSMD/F/S/H motor, it's up to 10 times that of rotor inertia.
Be careful not to exceed the maximum allowable inertia of the motor.

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Chapter 2

Installation and Wiring

Chapter 2 contains general information on cautions in installing the product, installation method, and ways to handle the noise in wiring.

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2.1 Check Items upon the 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.

Warning

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

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

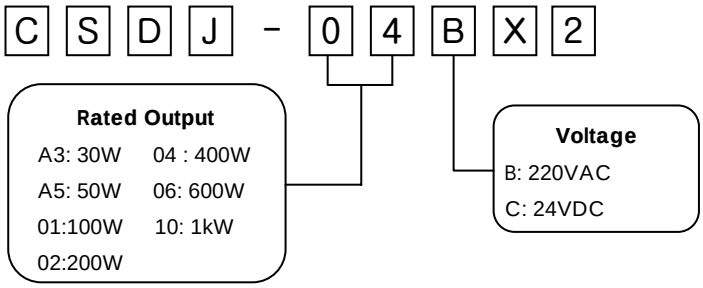


Fig 2.1 Drive Display

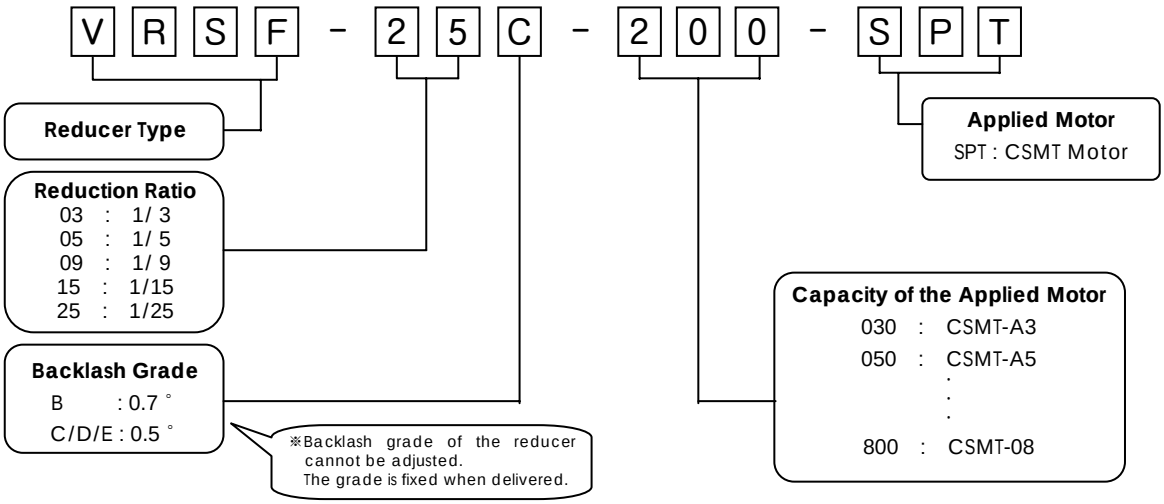


Fig 2.2 Reducer Display

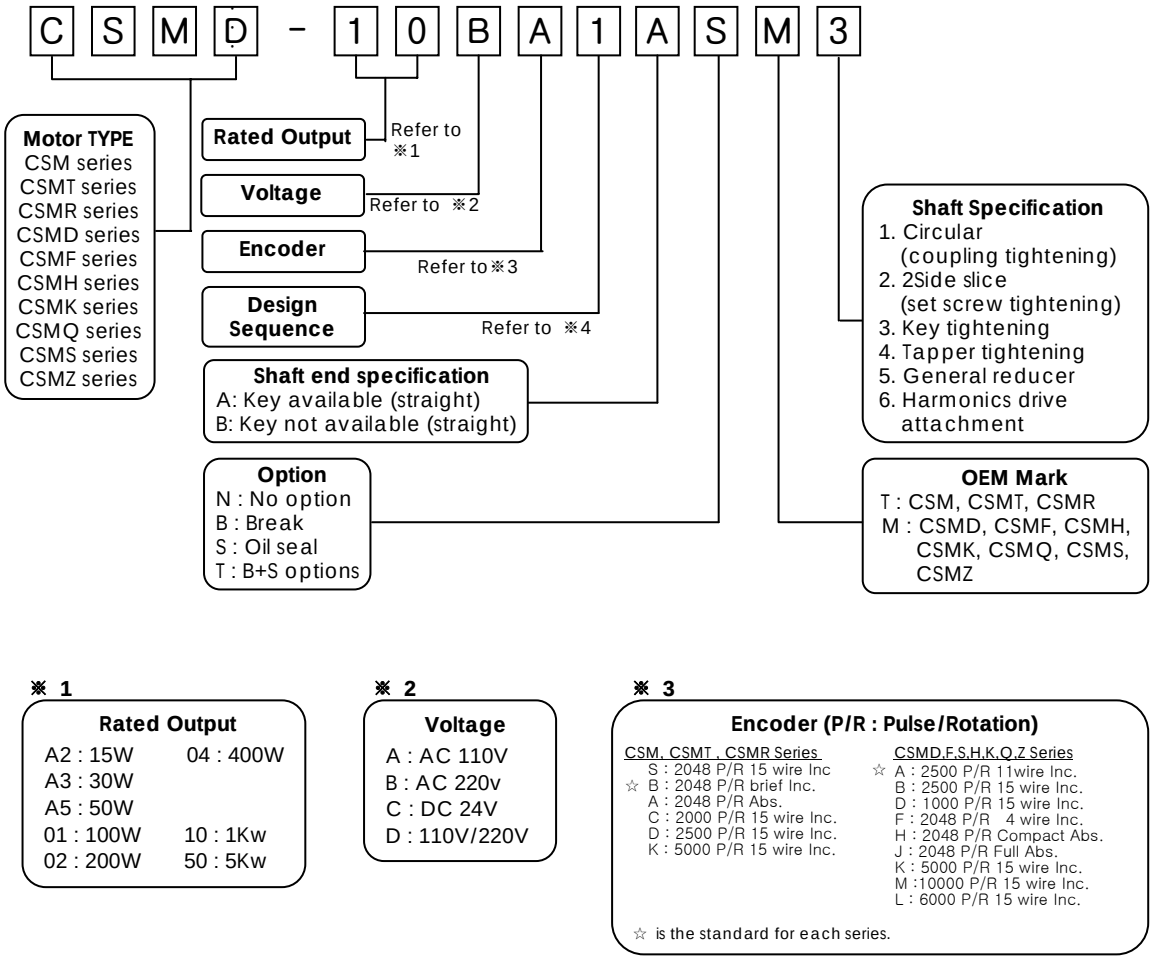
- **Types of reducer for the CSM & CSMT motor**

Deceleration Rate	1/3	1/5	1/9	1/15	1/25
Reducer	VRSF-3B- 50-SPT VRSF-3B-100-SPT VRSF-3B-200-SPT VRSF-3B-400-SPT VRSF-3C-600-SPT VRSF-3C-800-SPT	VRSF- 5B- 50-SPT VRSF- 5B-100-SPT VRSF- 5B-200-SPT VRSF- 5C-400-SPT VRSF- 5C-600-SPT VRSF- 5C-800-SPT	VRSF-S9B- 50-SPT VRSF-S9B-100-SPT VRSF-S9C-200-SPT VRSF-S9C-400-SPT VRSF- 9B-600-SPT VRSF- 9B-800-SPT	VRSF-15B- 50-SPT VRSF-15B-100-SPT VRSF-15C-200-SPT VRSF-15C-400-SPT VRSF-15D-600-SPT VRSF-15D-800-SPT	VRSF-25B- 50-SPT VRSF-25C-100-SPT VRSF-25C-200-SPT VRSF-25D-400-SPT VRSF-25E-600-SPT VRSF-25E-800-SPT

※All reducers are only available for CSM or CSMT motors

Table 2.1 CSDJ Plus Rated Output and Applicable Motor

Motor / Rated Output	CSM CSMT	CSMP CSMR	CSMQ	CSMZ	CSMD	CSMS	CSMF	CSMH	CSMN	CSMX	CSMK
CSDJ-A3CX2	30W										
CSDJ-A5CX2	50W										
CSDJ-02CX2	100W 200W										
CSDJ-01BX2	30W 50W 100W	100W	100W	30W, 50W 100W	*	*	*	*	*	*	*
CSDJ-02BX2	200W	200W	200W	200W	*	*	*	*	300W	200W 300W	300W
CSDJ-04BX2	400W	400W	400W	400W	*	*	*	*	*	*	*
CSDJ-06BX2	600W	*	*	*	*	*	400W	500W	600W	500W	600W
CSDJ-10BX2	800W 1kW	*	800W	800W	750W 1kW	1kW	750W	1kW	900W	850W	900W



※4 The design sequence is "2" only for the CSM 400W motor.

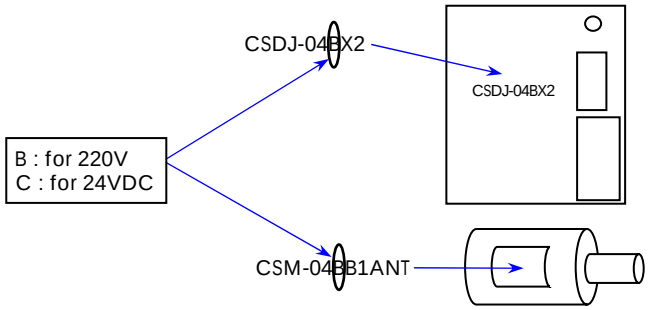
Fig 2.3 Motor Type Display

Note : Examples of Standard Model

CSMT -01BB1ANT3	CSMT -01BB1ABT3
CSMZ-01BA1ANM3	CSMZ-01BA1ABM3
CSMQ-01BA1ANM3	CSMQ-01BA1ABM3
CSMD-10BA1ASM3	CSMD-10BA1ATM3
CSMF-10BA1ASM3	CSMF-10BA1ATM3
CSMH-10BA1ASM3	CSMH-10BA1ATM3
CSMS-10BA1ASM3	CSMS-10BA1ATM3
CSMK-09BM1ASM3	CSMK-09BM1ATM3

2.2 Precautions during Installation

Power voltage is available for 220VAC & 24VDC.



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

A. Installing the 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.

1) Prior to the 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 2.4 AC Servo Motor

2) 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℃
- Storing temperature: -20 ~ +80℃
- 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.

3) 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.

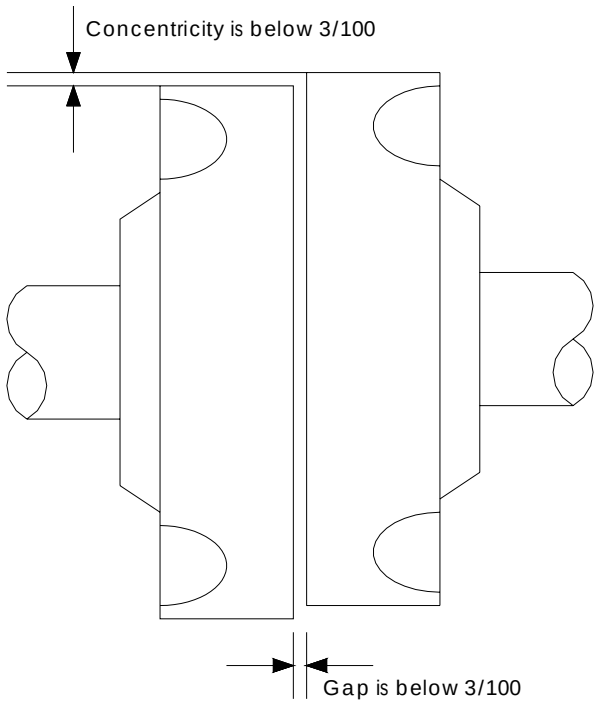


Fig 2.5 Coupling

- 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.

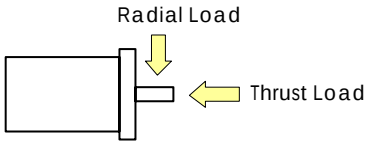


Table 2.2 Allowable Load of the Motor

Motor Type	Allowable Radial Load during Operation [kg f]	Allowable Thrust Load during Operation [kg f]	Motor Type	Allowable Radial Load during Operation [kg f]	Allowable Thrust Load during Operation [kg f]
CSM-A2A	2	2	CSMH-40B	80	35
CSM-A3A	8	4	CSMH-50B	80	35
CSM-A5A	8	4	CSMQ-01A	7	6
CSM-01A	8	4	CSMQ-02A	25	10
CSM-02A	20	7	CSMQ-04A	25	10
CSM-04A	20	7	CSMQ-04B	25	10
CSM-A3B	8	4	CSMQ-01B	7	6
CSM-A5B	8	4	CSMQ-02B	25	10
CSM-01B	8	4	CSMQ-08B	40	15
CSM-02B	20	7	CSMS-10B	40	15
CSM-04B	20	7	CSMS-15B	50	20
CSM-06B	35	10	CSMS-20B	50	20
CSM-08B	35	10	CSMS-25B	50	20
CSM-10B	35	10	CSMS-30B	80	35
CSMD-08B	40	15	CSMS-35B	80	35
CSMD-10B	50	20	CSMS-40B	80	35
CSMD-15B	50	20	CSMS-45B	80	35
CSMD-20B	50	20	CSMS-50B	80	35
CSMD-25B	80	35	CSMZ-A3D	5	3
CSMD-30B	80	35	CSMZ-A5D	7	6
CSMD-35B	80	35	CSMZ-01A	7	6
CSMD-40B	80	35	CSMZ-02A	25	10
CSMD-45A	80	35	CSMZ-04A	25	10
CSMD-50B	80	35	CSMZ-01B	7	6
CSMF-04B	40	15	CSMZ-02B	25	10
CSMF-08B	50	20	CSMZ-04B	25	10
CSMF-15B	50	20	CSMZ-08B	40	15
CSMF-25B	80	30	CSMK-03B	50	20
CSMF-35B	80	30	CSMK-06B	50	20
CSMF-45B	80	30	CSMK-09B	50	20
CSMH-05B	50	20	CSMK-12B	80	35
CSMH-10B	50	20	CSMK-20B	80	35
CSMH-15B	50	20	CSMK-30B	80	35
CSMH-20B	80	35	CSMK-45B	120	50
CSMH-30B	80	35	CSMK-60B	120	50

B. Installing the Servo Drive

1) 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.

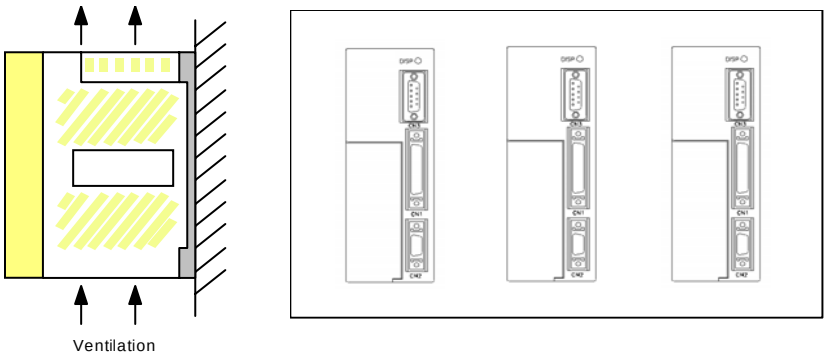
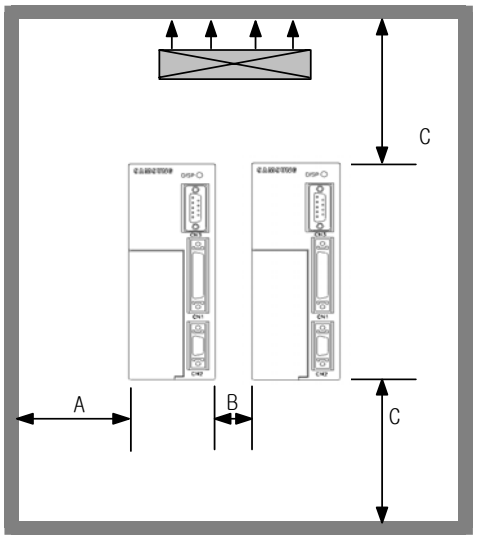


Fig 2.6 Installation of Servo Drive (Wall mounting type)

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℃). Ambient temperature is closely related to the life span of the product. Use it in low temperature if possible.



A	B	C
30mm or more	10mm or more	50mm or more

Fig 2.7 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.

2) 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℃
- Storing temperature: -20 ~ +80℃
- Humidity: 20 ~ 80% (non-condensing)
- Vibration: 0.5G (4.9m/s^2) 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.

3) 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 2.7 and lower the temperature of the servo drive.

2.3 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 +,- : 24VDC ±10%, 30Amax(200W)
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.

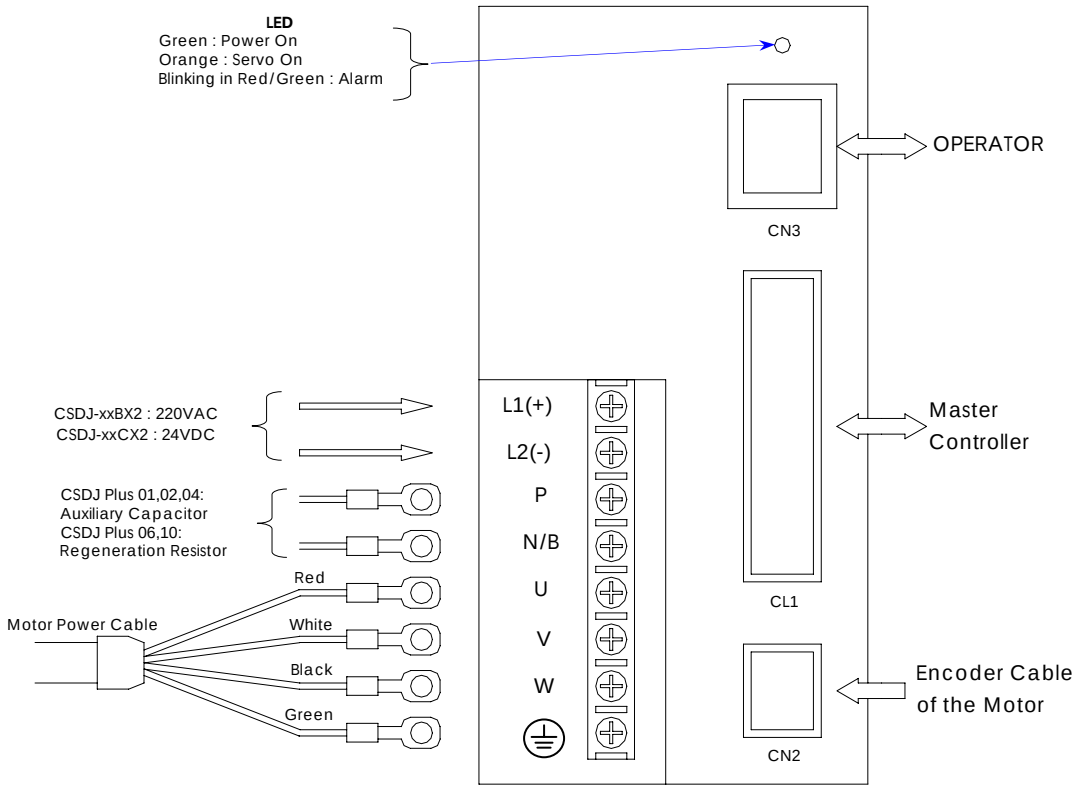


Fig 2.8 Connection of External Terminal Block

2.4 Wiring

A. Precautions when Wiring

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 **2.6 Noise Protection**.

5. The heat sink of the servo drive can rise up to around 80℃. 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.

B. Wiring

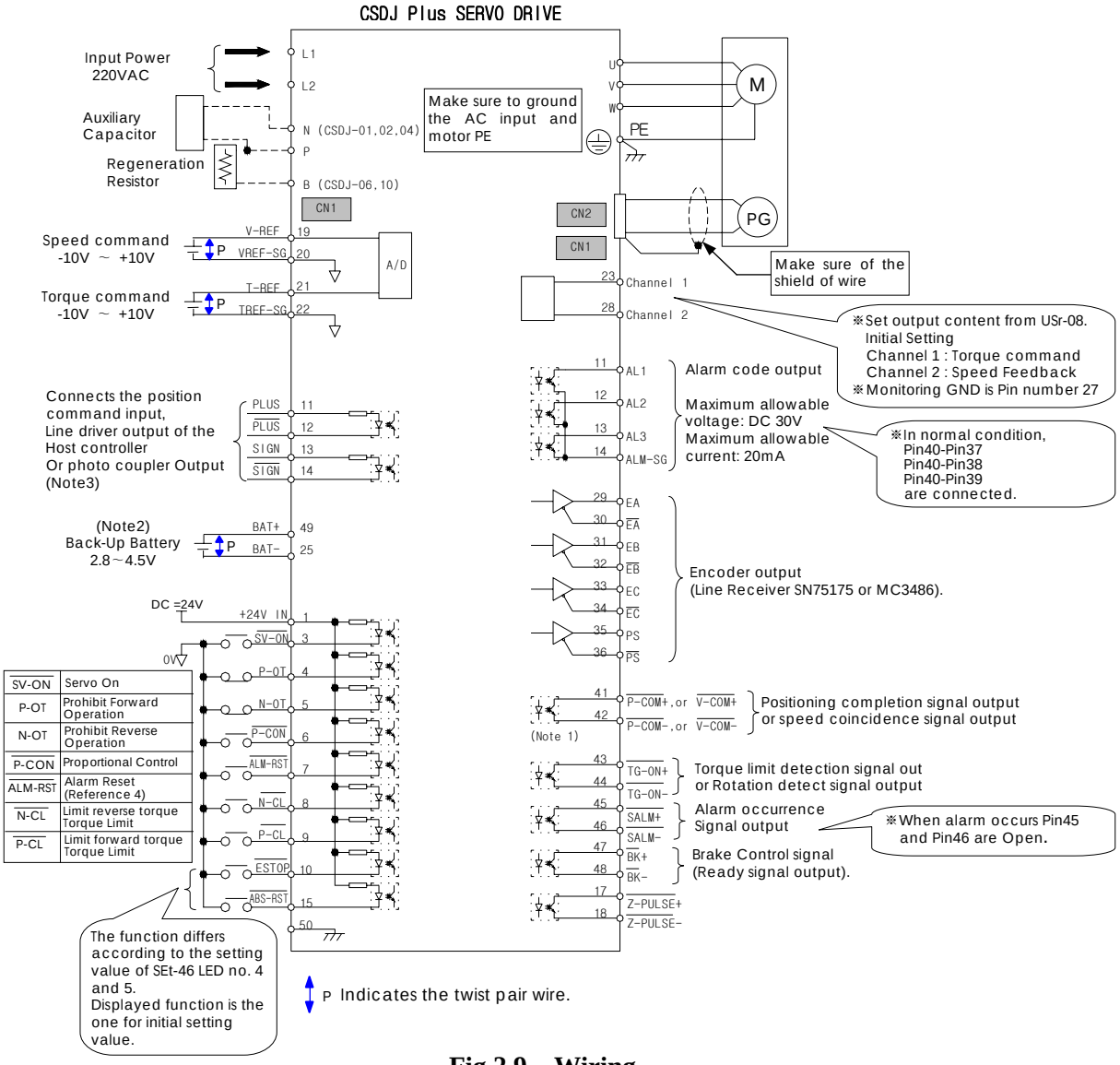


Fig 2.9 Wiring

Note 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 "6.5 A. 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 **5.1 SEt-46 in User Parameter List**.

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

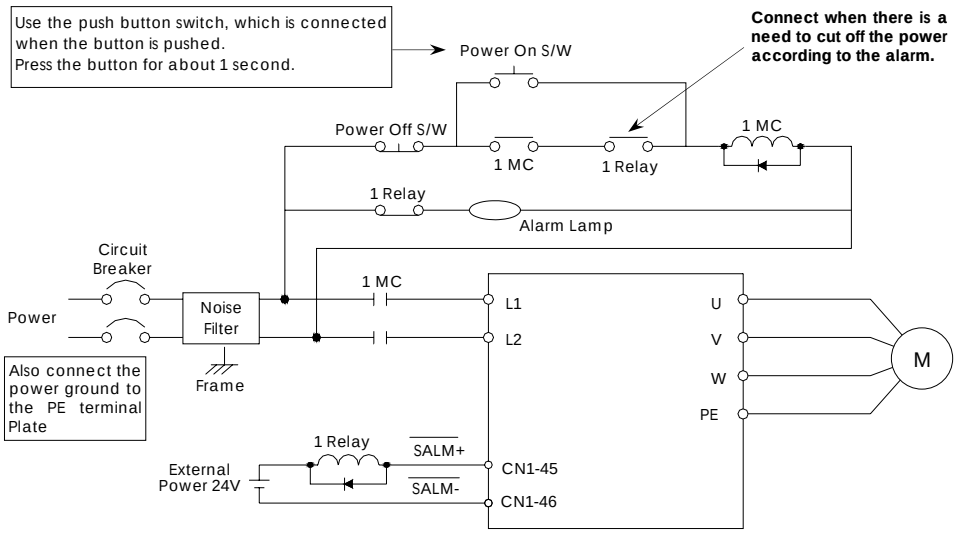


Fig 2.10 Example of Wiring in Main Circuit

Warning

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.

2.5 I/O Specification

A. 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	Yellw		27	SG-OV	Orange 3Point	SG(GND)
3	$\overline{\text{SV-ON}}$	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	$\overline{\text{EA}}$	Yellow 4Point	Encoder $\overline{\text{A}}$ phase output
6	$\overline{\text{P-CON}}$	Orange	Proportional control	31	EB	Blue 4Point	Encoder B phase output
7	$\overline{\text{ALM-RST}}$	Gray	Alarm reset	32	$\overline{\text{EB}}$	White 4Point	Encoder $\overline{\text{B}}$ phase output
8	$\overline{\text{N-CL}}$	Red 1Point	Reverse direction current limit input	33	EC	Pink 4Point	Encoder C phase output
9	$\overline{\text{P-CL}}$	Yellow 1Point	Forward direction current Limit input	34	$\overline{\text{EC}}$	Orange 4Point	Encoder $\overline{\text{C}}$ phase output
10	$\overline{\text{E-STOP}}$	Blue 1Point	Emergency stop	35	PS	Gray 4Point	Absolute encoder position DATA output
11	PULS+	White 1Point	Position pulse train input(+)	36	$\overline{\text{PS}}$	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	$\overline{\text{ABS-RST}}$	Red 2Point	Absolute encoder reset input	40	ALM-SG	Pink/ Line	Alarm code signal ground
16		Yellow 2Point	-	41	$\overline{\text{P-COM+}}$ $\overline{\text{V-COM+}}$	Orange/ Line	Positioning completion signal output (position control) Speed coincidence signal output(speed control)
17	Z-PULSE+	Blue 2Point	ENCODER Z phase open Collector output(+)	42	$\overline{\text{P-COM-}}$ $\overline{\text{V-COM-}}$	Gray/ Line	Positioning completion signal output GND Speed coincidence signal output GND.
18	Z-PULSE-	White 2Point	ENCODER $\overline{\text{Z}}$ phase open collector output(-)	43	$\overline{\text{TG-ON+}}$	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	$\overline{\text{TG-ON-}}$	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 bottery+ (3.6V)
25	BAT-	White 3Point	Absolute encoder battery-	50	PE	Geen (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 in section 5.1.

$\overline{\text{P-CON}}$, $\overline{\text{P-CL}}$, and $\overline{\text{N-CL}}$ 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

<table>
<tr><th colspan="2">CN1 Pin No.</th><th>8</th><th>9</th><th>6</th></tr>
<tr><th colspan="2">Signal</th><th>$\overline{\text{N-CL}}$</th><th>$\overline{\text{P-CL}}$</th><th>$\overline{\text{P-CON}}$</th></tr>
<tr><td rowspan="12">Control Mode</td><td>Speed Control
(SEt-41 = 10)</td><td rowspan="3">Reverse Rotation
Current Limit
Command</td><td rowspan="3">Forward Rotation
Current Limit
Command</td><td>ON : Reverse Rotation
OFF : Forward Rotation</td></tr>
<tr><td>Manual Zero-Clamp
Speed Control
(SEt-41 = 4)</td><td>ON : Zero-clamp
Operation
OFF : Zero-clamp not
Counted</td></tr>
<tr><td>Automatic Zero-Clamp
Speed Control
(SEt-41 = 5)</td><td>ON : P Control
OFF : PI Control</td></tr>
<tr><td>Multi-step Speed
Control
(SEt-41 = 3)</td><td colspan="2">Multi-step Speed Command
<table><tr><th>Speed Command</th><th>$\overline{\text{P-CL}}$</th><th>$\overline{\text{N-CL}}$</th><th>CN1 No. 10 PIN
or
CN1 No.15 PIN</th></tr><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></table></td><td>ON : Reverse Rotation
OFF : Forward Rotation

※4th Step Speed
→See P6-10</td></tr>
<tr><td>Torque Control
(SEt-41 = 2)</td><td rowspan="3">Reverse Rotation
Current Limit
Command</td><td rowspan="3">Forward Rotation
Current Limit
Command</td><td>-</td></tr>
<tr><td>Speed/Speed Limit
Torque Control
(SEt-41 = 6)</td><td>ON : Speed Control
OFF :Torque Control
with Speed limit</td></tr>
<tr><td>Position Control
(SEt-41 = 0)</td><td>ON : P Control
OFF : PI Control</td></tr>
<tr><td>Speed/Multi-step
Speed Control
(SEt-41 = 14)</td><td colspan="2">Multi-step Speed Command
<table><tr><th>Speed Command</th><th>$\overline{\text{P-CL}}$</th><th>$\overline{\text{N-CL}}$</th><th>CN1 No. 10 PIN
or
CN1 No.15 PIN</th></tr><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></table></td><td>ON : Speed Control
OFF : Multi-step
Speed Control

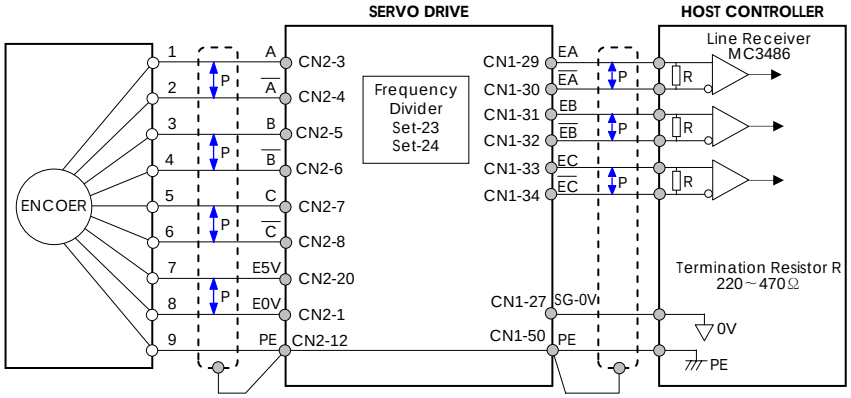
※4th Step Speed
→See P6-10</td></tr>
<tr><td>Position/Speed Control
(SEt-41 = 8)</td><td rowspan="3">Reverse Rotation
Current Limit
Command</td><td rowspan="3">Forward Rotation
Current limit
Command</td><td>ON : Speed Control
OFF: Position Control</td></tr>
<tr><td>Position/Torque Control
(SEt-41 = 7)</td><td>ON : Torque Control
OFF : Position Control</td></tr>
<tr><td>Analog Torque Limit
Speed Control
(SEt-41 = 12)</td><td>ON : Analog Torque Limit
Enable
OFF : Analog Torque Limit
Disable</td></tr>
</table>

B. CN2 (Connector for Encoder Connection)

Table 2.6 Connection of Encoder Connector

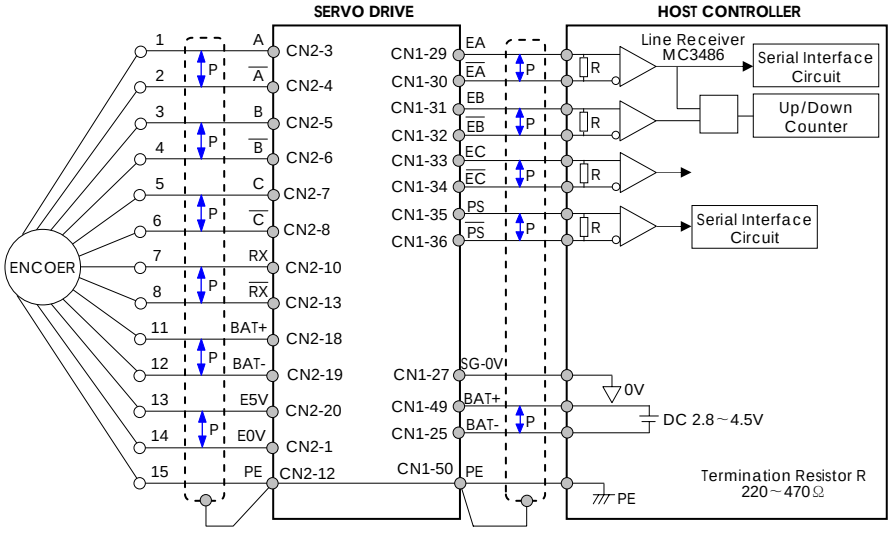
DRIVE		MOTOR								
Pin No.	Function	CSM/CSMG/CSMP CSMT/CSMR			CSMD,CSMF CSMH,CSMS CSMQ 800W	CSMZ,CSMQ 400W or less	CSMD,CSMF CSMH,CSMS CSMN,CSMX		CSMZ CSMQ	CSMK
		Incremental		ABS	Incremental 11 wire		INC 15wire	ABS	ABS	INC 15wire
		9 Wire	15 Wire							
1	E0V	8	14	14	G	11	G	G	14	G
2										
3	A	1	1	1	A	1	A	A	1	A
4	$\overline{A}$	2	2	2	B	2	B	B	2	B
5	B	3	3	3	C	3	C	C	3	C
6	$\overline{B}$	4	4	4	D	4	D	D	4	D
7	C	5	5	5	E	5	E	E	5	E
8	$\overline{C}$	6	6	6	F	6	F	F	6	F
9										
10	U/RX		7	7	P	8	K	K	11	K
11	RST			9				R	9	
12	PE	9	15	10,15	J	12	J	J	10,15	J
13	$\overline{U/RX}$		8	8	R	9	L	L	12	L
14	V		9				M			M
15	$\overline{V}$		10				N			N
16	W		11				P			P
17	$\overline{W}$		12				R			R
18	BAT+			11				T	7	
19	BAT-			12				S	8	
20	E5V	7	13	13	H	10	H	H	13	H

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



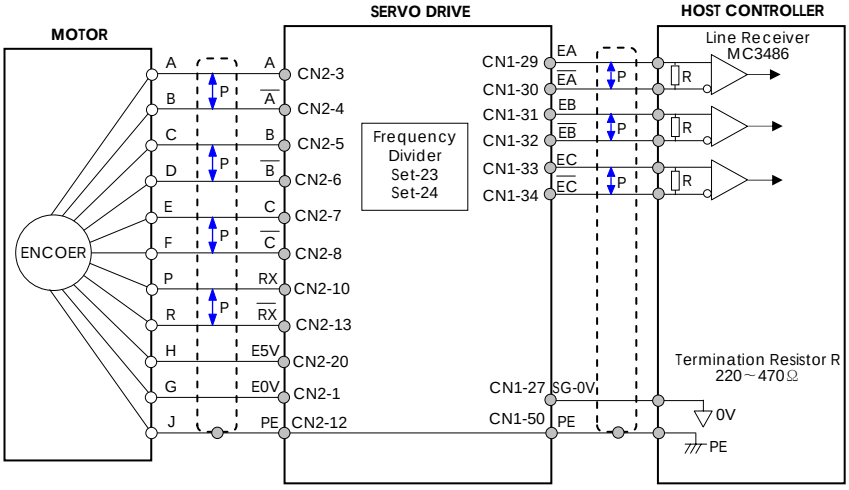
Do not connect the PE of the servo drive to the host controller when signal GND of the host controller and PE are connected, or when there isn't a separate PE.

Fig 2.11 9 Wire Incremental Encoder Connection Method of CSM/CSMG,P,T,R Motor (Setting Value of SEt-51 = 1, refer to 7.6)



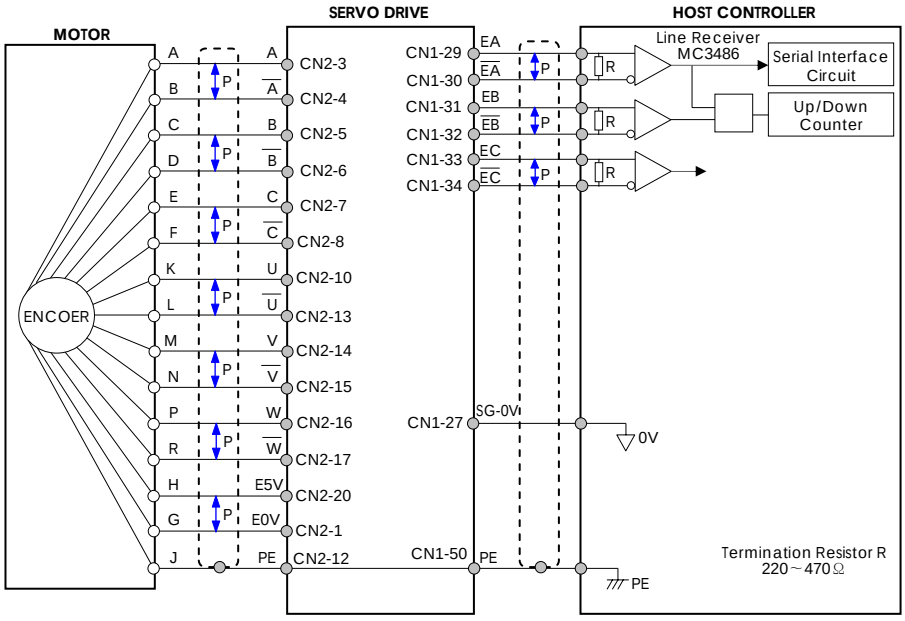
Do not connect the PE of the servo drive to the host controller when signal GND of the host controller and PE are connected, or when there isn't a separate PE.

Fig 2.12 Absolute Encoder Connection Method of CSM/CSMG,P,T,R Motor (Setting Value of SEt-51 = 2, refer to 7.6)



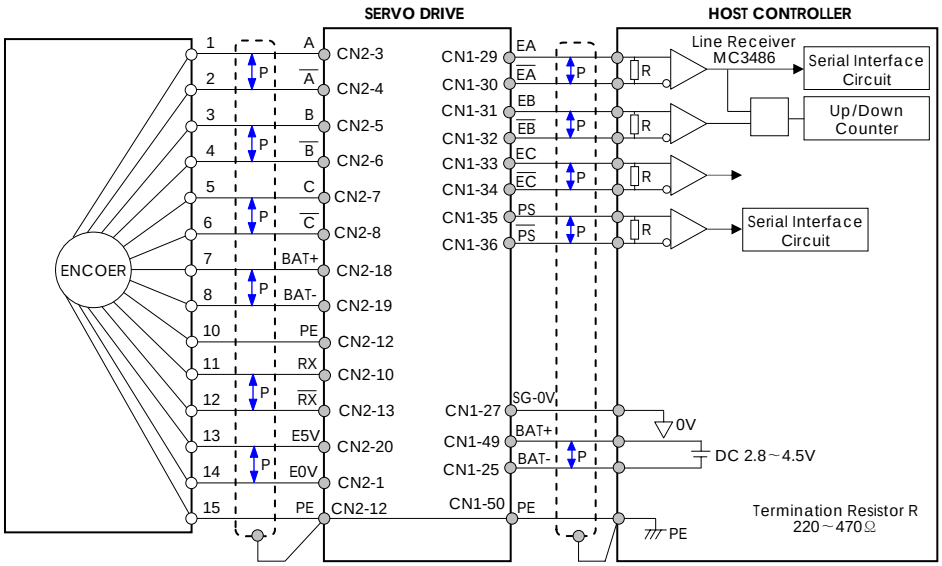
Do not connect the PE of the servo drive to the host controller when signal GND of the host controller and PE are connected, or when there isn't a separate PE.

Fig 2.13 CSMD/F/H/S Motor and 11 Wire Incremental Encoder Connection Method
(When the Setting Value of SEt-51 is 100)



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 2.14 CSMD/F/S/H/N/X/K Motor and 15 Wire Incremental Encoder Connection Method
(When the Setting Value of SEt-51 is 101, 102, 106, 300~307)



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 2.15 Absolute Encoder Connection Method of CSMQ/Z Motor (Setting value of SEt-51= 104, 105 Refer to 7.6)

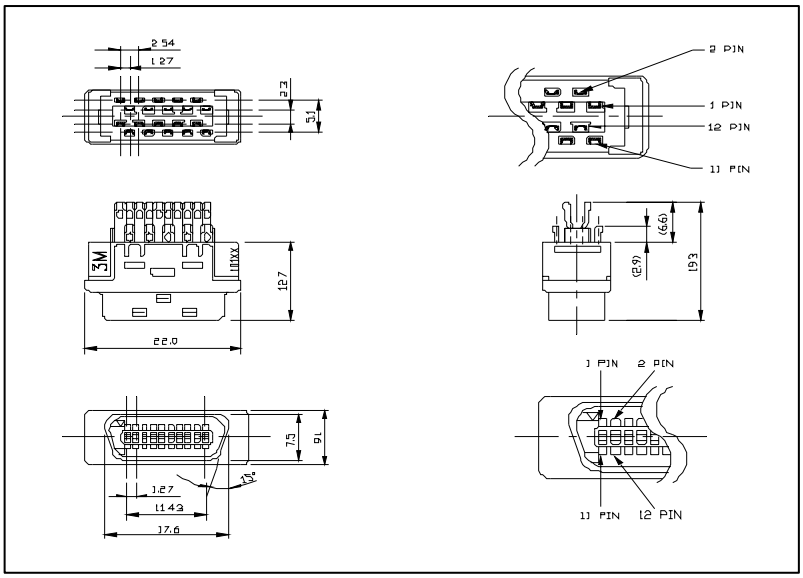


Fig 2.16 Shape and PIN Number of CN2(Encoder Connector)

2.6 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.

A. Precautions when Wiring

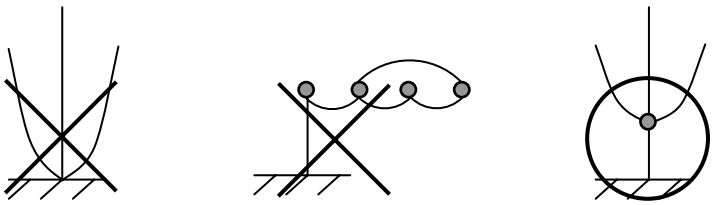
Use the specified cables for encoder cable and command input.

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 $mm^{2)}$

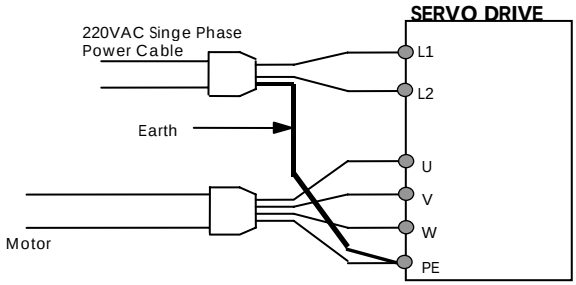
Class 3 grounding (grounding resistance is lower than 100Ω) is recommended.
One point grounding must be done. In other words, do not make the loops.

Warning



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.

Warning

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

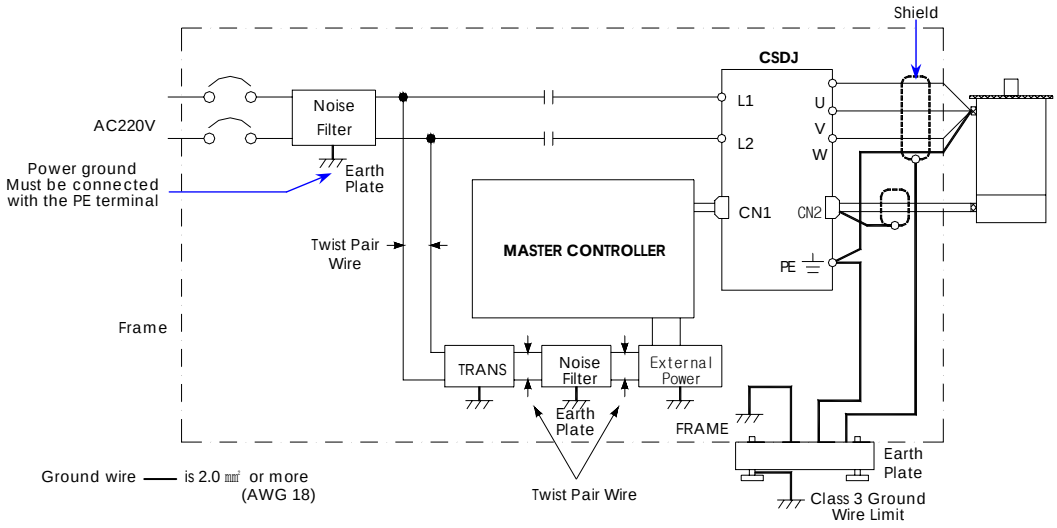
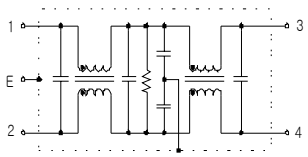
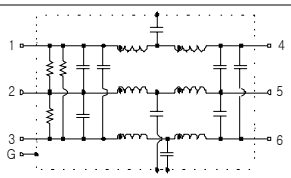


Fig 2.17 Grounding and Noise Filter for Noise Reduction

B. 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

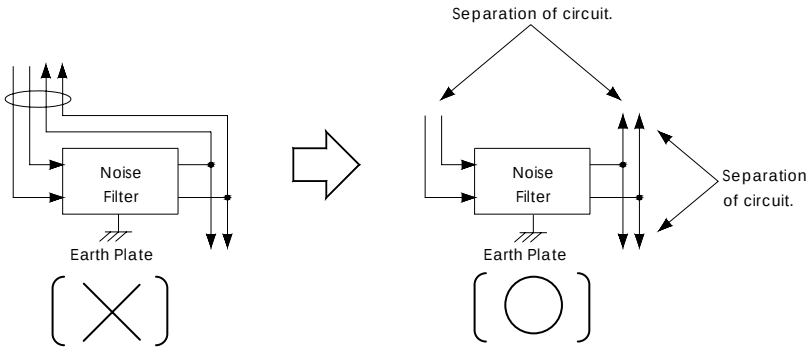
Power Supply	Servo Drive	Recommended Noise Filter	Recommended Noise Filter	
			Model Name	Noise Filter Spec.
Single Phase 220VAC	CSDJ-01～02B		NFR-205TS	250V/5A
	CSDJ-04～06B		NFR-210TS	250V/10A
	CSDJ-10B		NFR-220TS	250V/20A
3 Phase 220VAC	CSDP-08～15B		NFZ-4030SG	250V/15A
	CSDP-20~30B		NFZ-4030SG	250V/30A
	CSDP-35~50B		NFZ-4040SG	250V/40A

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.

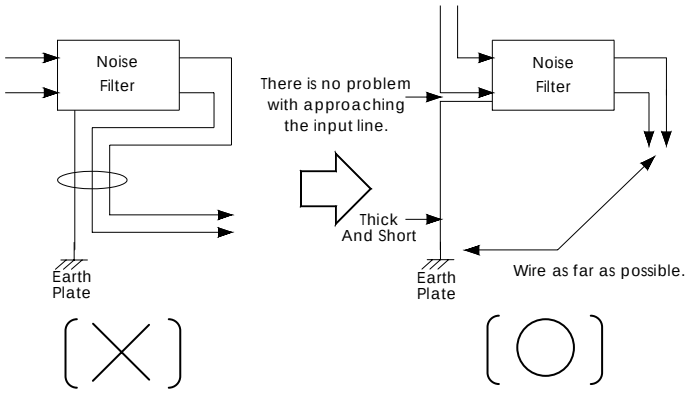
※ Samil Components Co., Ltd Tel. 82-2-478-6800~4
Fax. 82-2-476-3200
http://www.samilemc.com

• **Wiring Noise Filter**

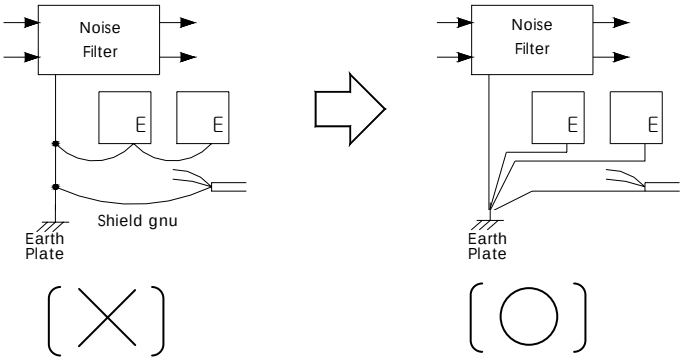
- Separate the input and output wiring.
- Do not put input and output wires in a same duct.



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



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



2.7 Circuit Breaker for Wiring

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.

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℃) : Over 200%/2sec, over 700%/0.01sec.
3. DAERYUK DCP-50BH Series(UL).
   http://www.dacb.co.kr

MEMO


MEMO

Chapter 3

Startup and Adjustment

Chapter 3 explains about items for startup and autotuning for gain adjustment and test.


MEMO

3.1 Check up Items prior to Startup

A. 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.

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

B. Servo Drive

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

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±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.

3.2 Startup

Warning

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.

A. Power 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.

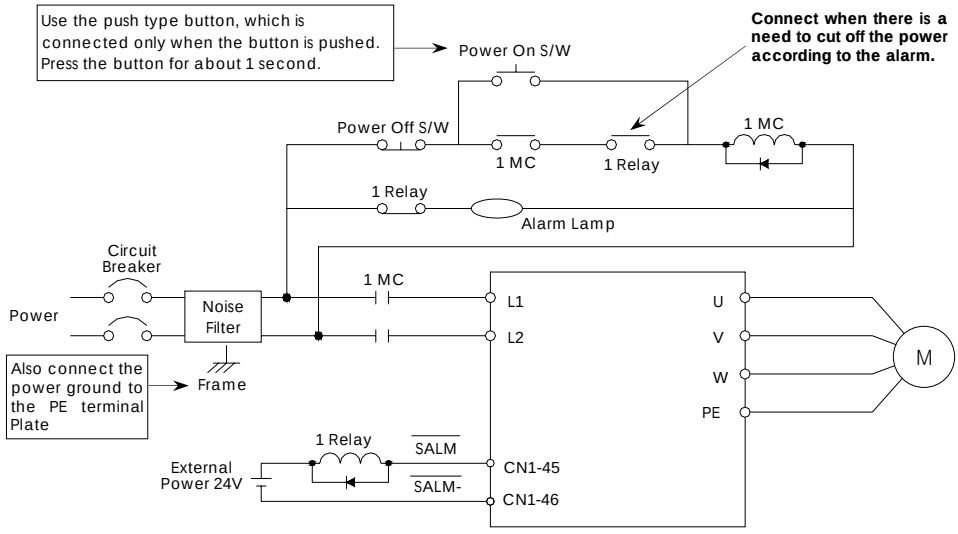


Fig 3.1 Example of Power ON and OFF

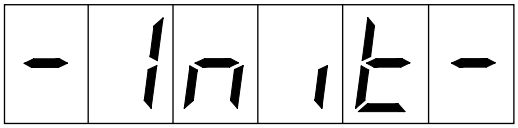
- **LED Display**

Table 3.1 LED Color and Description

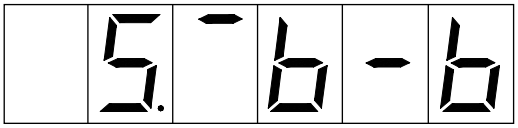
Color	Servo Drive Status
Green	Servo Power ON
Orange	Servo ON
Red/Green	Alarm (Flickers in green and red every 0.2 seconds.)

• Initial Display of the Operator

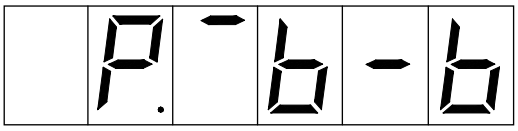
When the power is supplied normally, the initial display flickers "-Init-" three times. (Operator is initializing.)



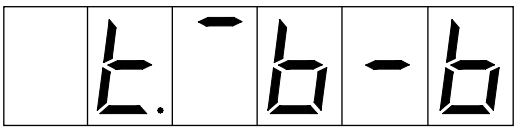
After displaying "-Init-", the operator displays the following.



Speed control mode



Position control mode
(Factory setting)



Torque control mode

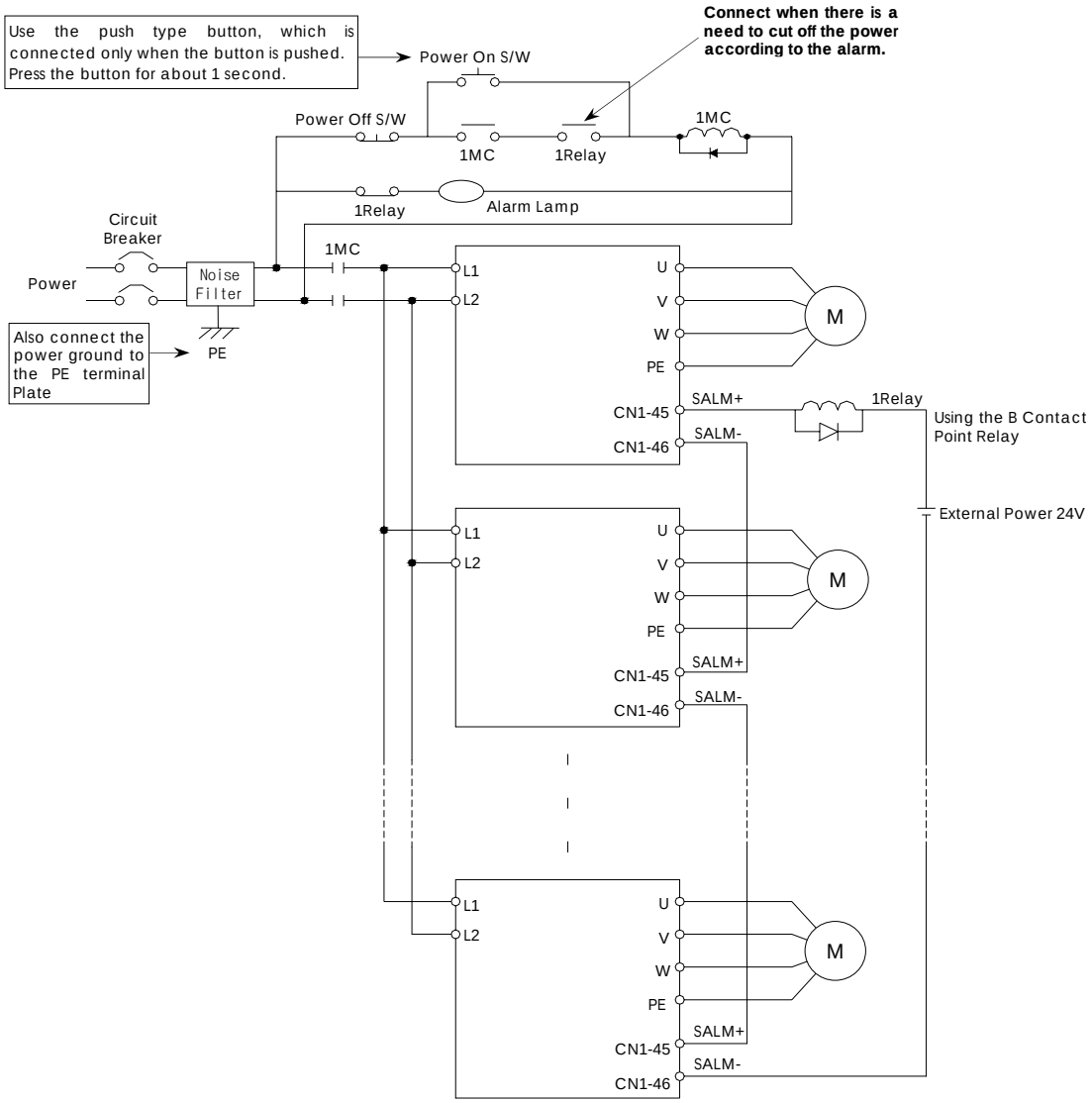
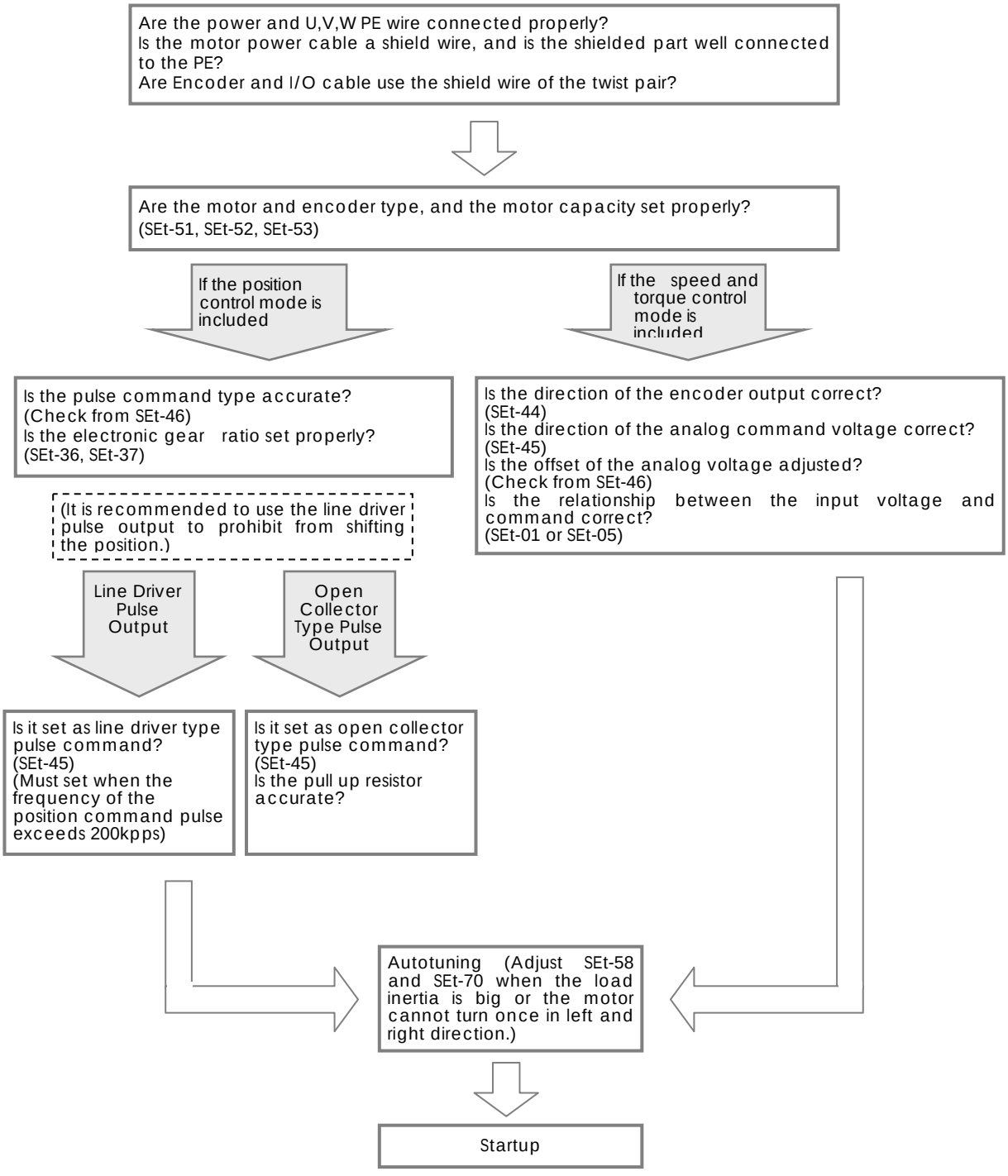
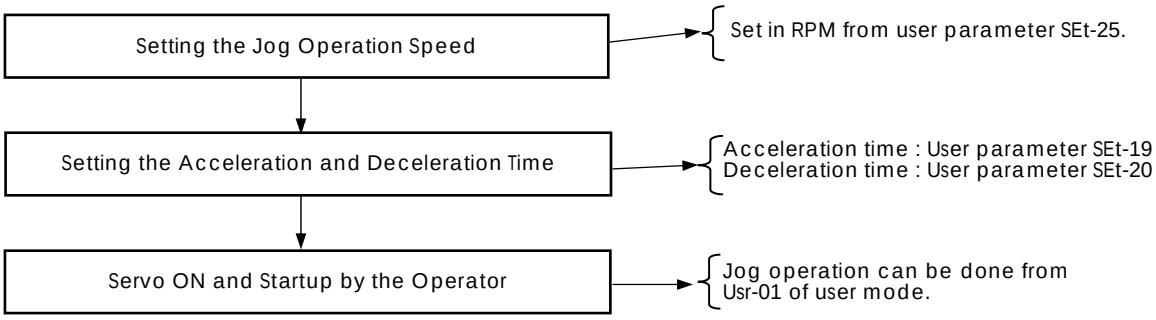


Fig 3.2 Power Supply Method for Multi-Servo Drive Connection

B. Check up Items prior to Startup



C. Startup by the Operator



- **Setting the Jog Operation Speed**

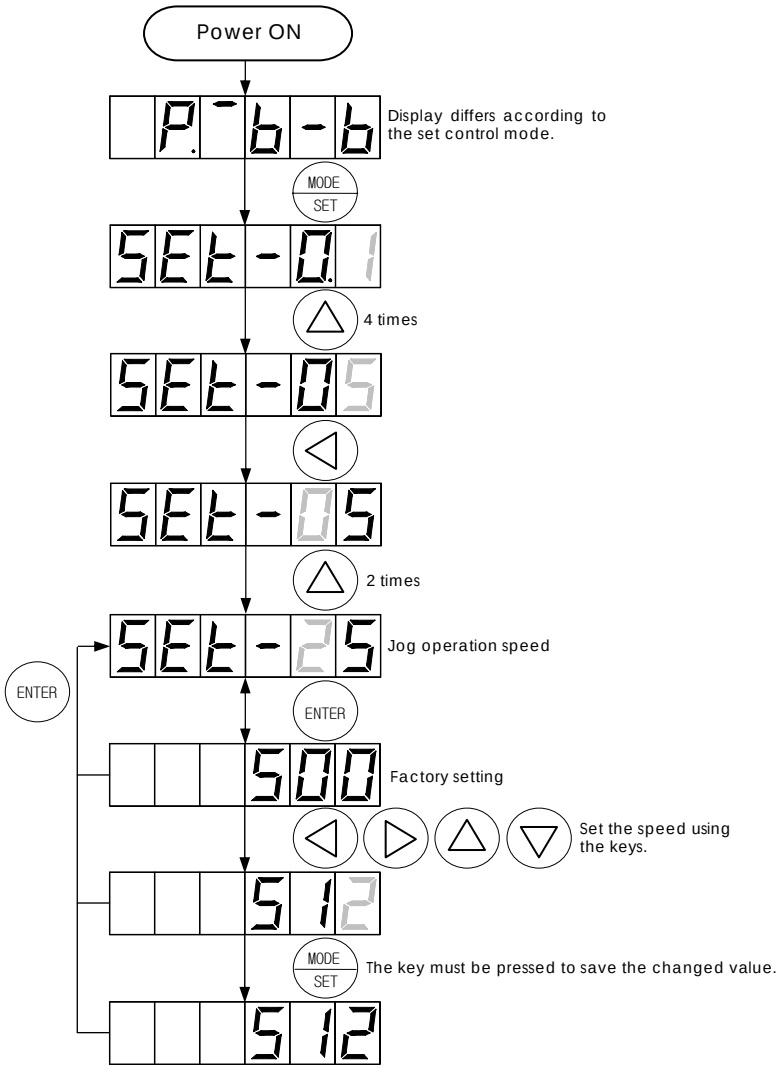


Fig 3.3 Setting the Jog Operation Speed

• Setting Acceleration and Deceleration Time in Startup by the Operator

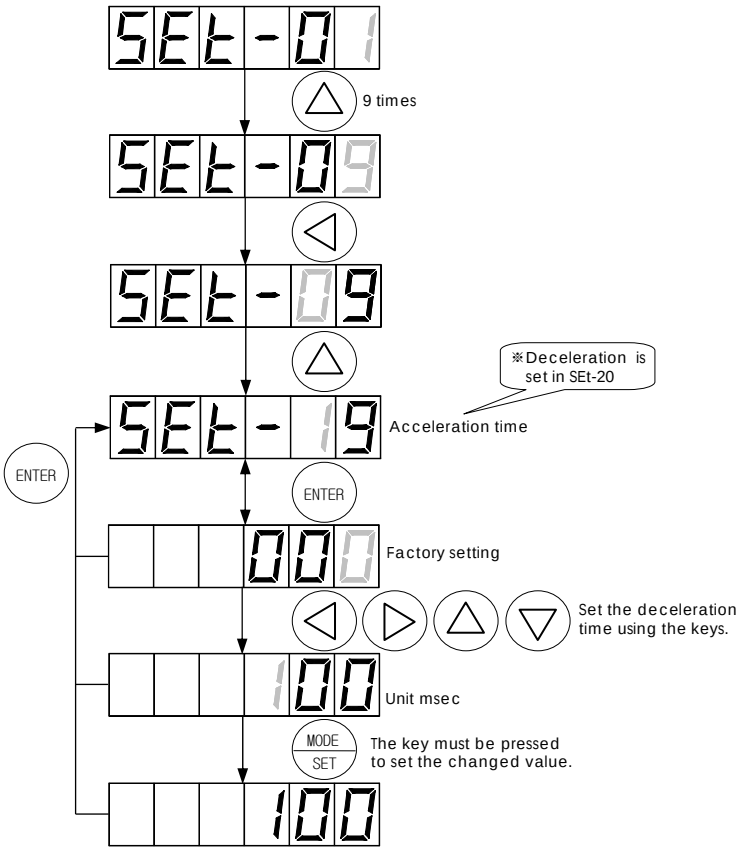


Fig 3.4 Setting Acceleration and Deceleration Time

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

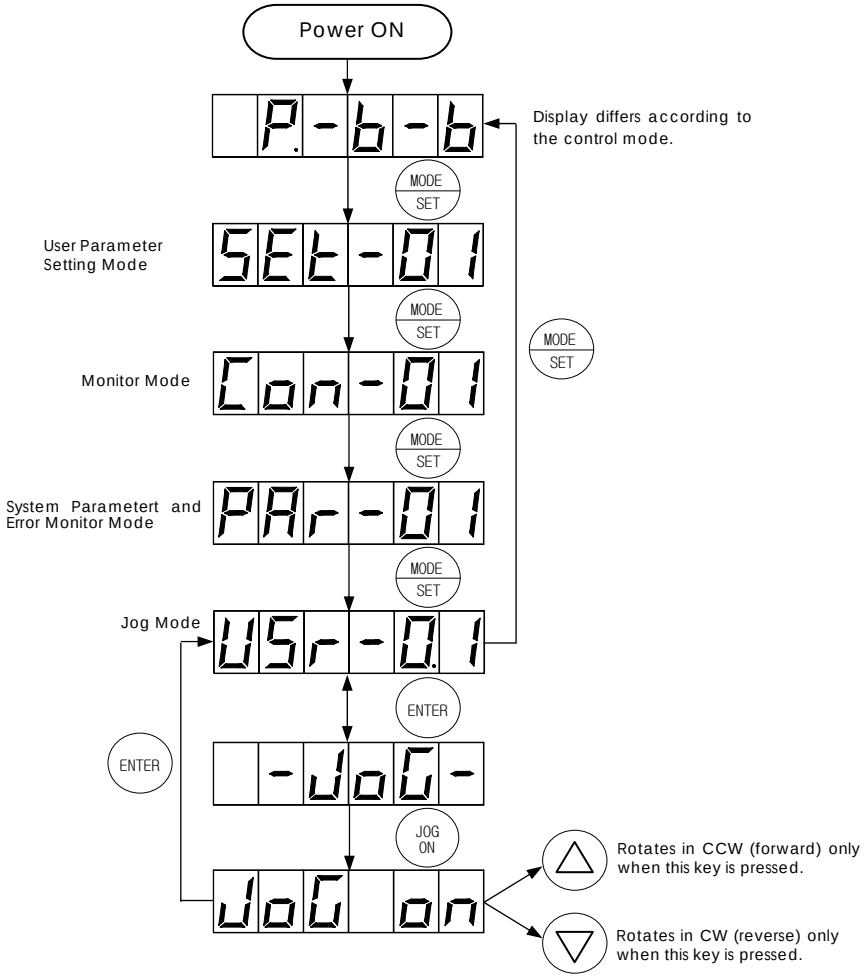
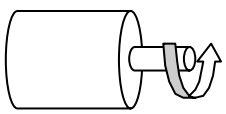


Fig 3.5 Startup by the Operator

- **Definition of Forward Rotation**

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



Warning

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.

D. 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 $\overline{\text{SV-ON}}$ (CN1 pin number 3).

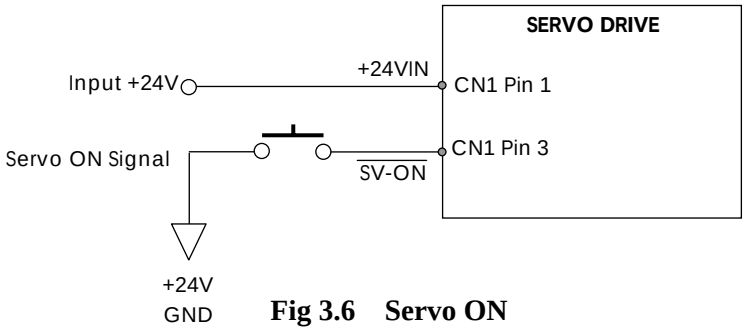
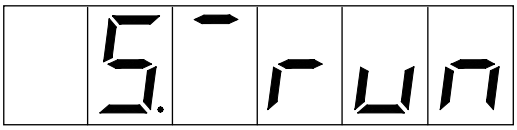


Fig 3.6 Servo ON

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.

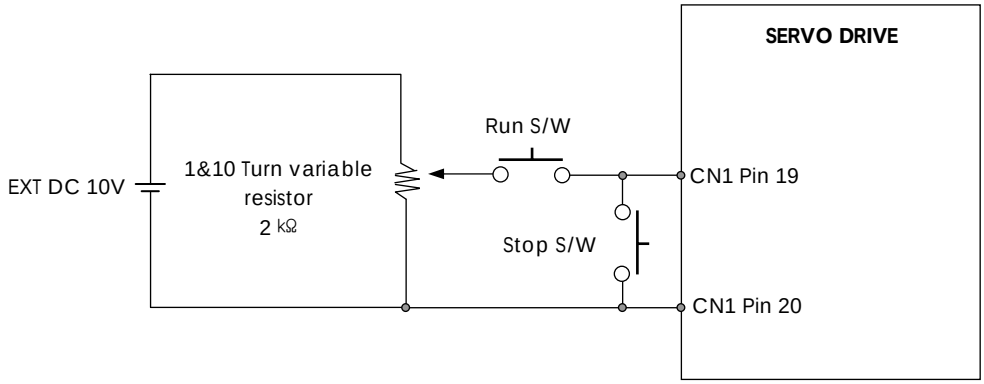


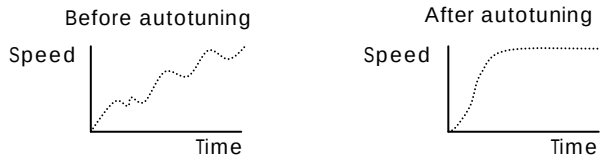
Fig 3.7 Speed Command Analog Input

- 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] × Input Voltage[V]
  Initial value of SEt-01=500.
  Thus, when inputting 6V, revolution takes place in 3000[RPM].
- Input voltage is ±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 6.1 A. Speed Command)

3.3 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 (1st Low Pass Filter Cutoff Frequency of Torque Command)
SEt-40 (1st Low Pass Filter Cutoff Frequency of Speed Command)

- **Autotuning Procedure**

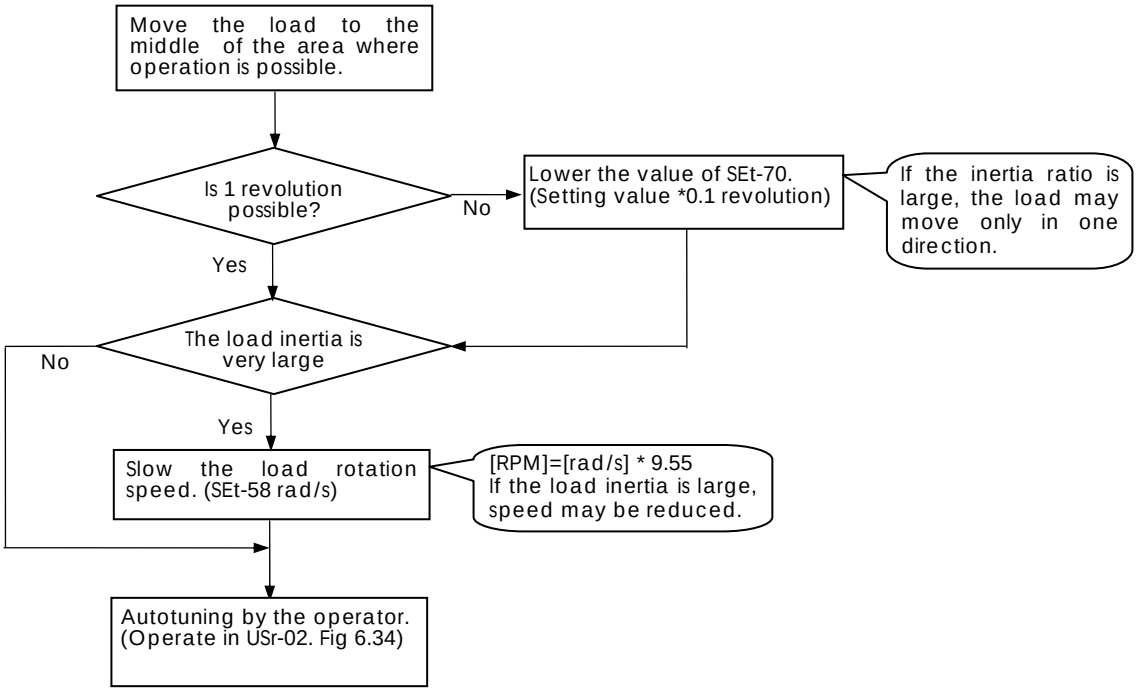


Fig 3.8 Autotuning Procedure

Warning

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.

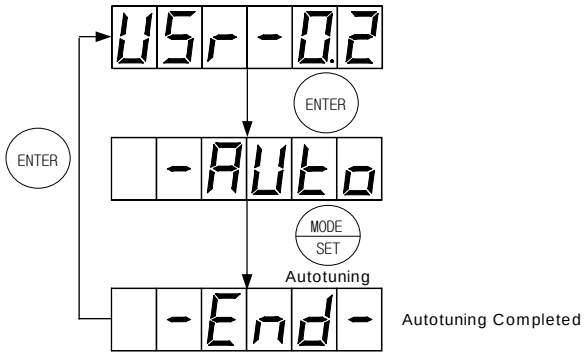


Fig 3.9 Example of Autotuning by the Operator

- **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.

3.4 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 MODE SET key. Repeat until it is stopped. 1 cycle time is 14 sec.

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

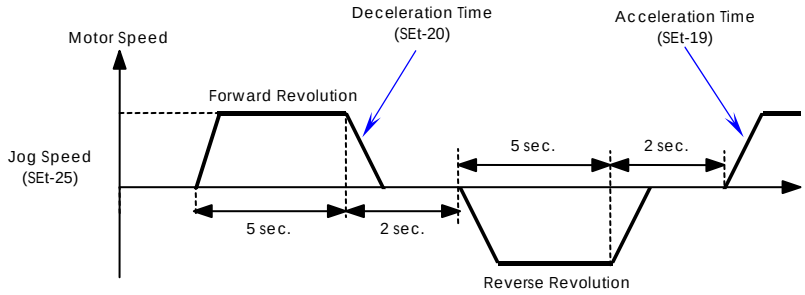


Fig 3.10 Operation Pattern of the Test Run

Warning

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.

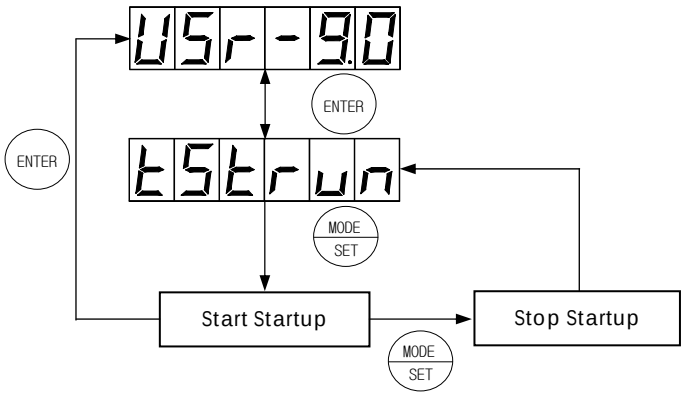


Fig 3.11 Test Run Using the Operator

MEMO

Chapter 4

Using the Operator

Chapter 4 explains the method of using the operator prior to handling the system.

MEMO

4.1 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.)

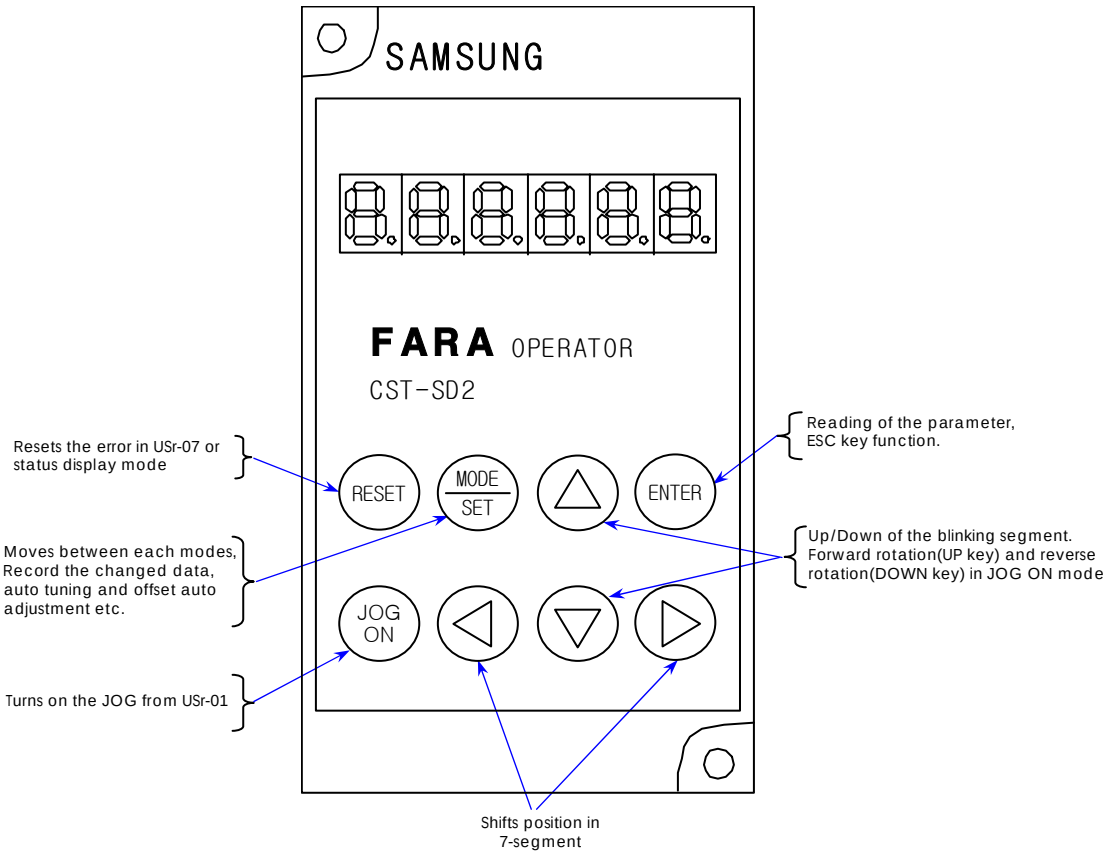
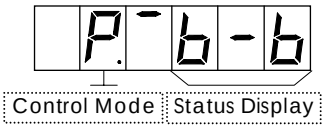
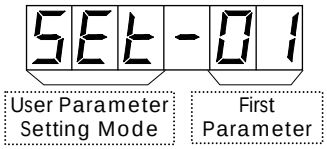
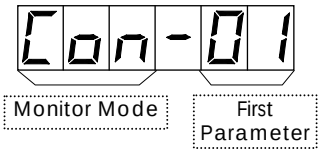
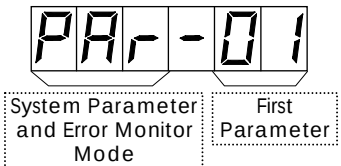


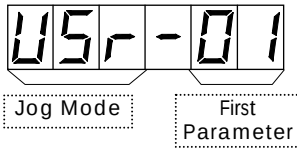
Fig 4.1 Operator

4.2 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 4.3) - Base Block - During operation - Error and Warning
User Parameter Setting Mode		Refer to 5.1 User Parameter Table
Monitor Mode		**Various Monitors** 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		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**

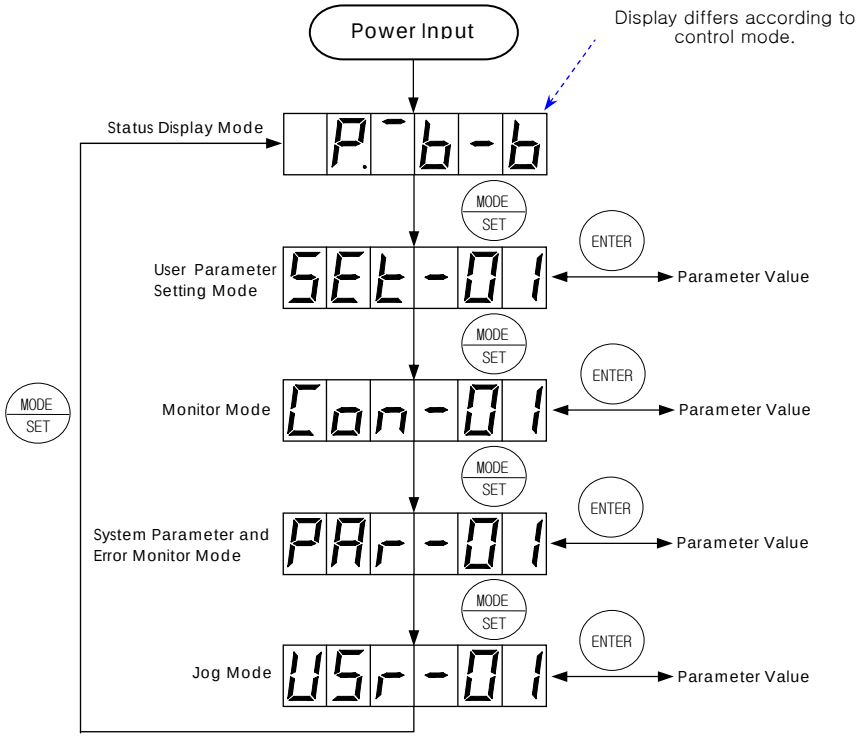


Fig 4.2 Mode Switching

4.3 Status Display Mode

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

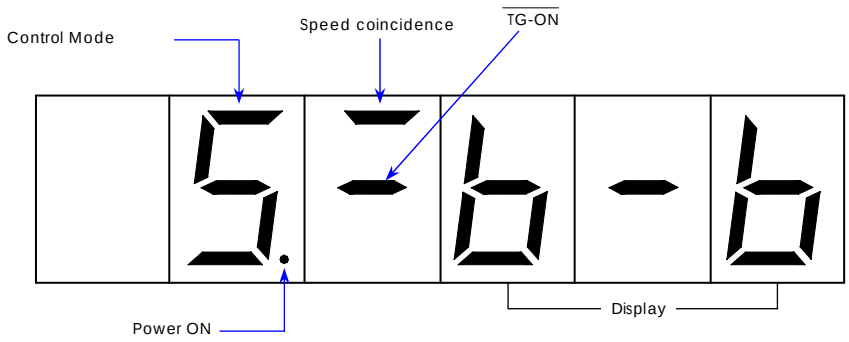


Fig 4.3 Status Display Mode

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.
$\overline{\text{TG-ON}}$	0	Light on when the motor rotation speed is higher than $\overline{\text{TG-ON}}$ 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	-	**S** : Speed Control Mode **t** : Torque Control Mode **P** : Position Control Mode

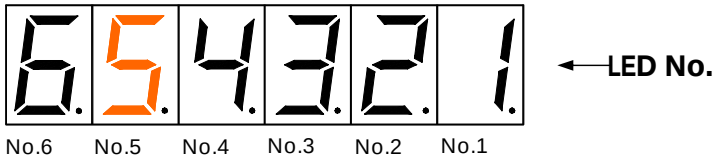
Table 4.3 Signal and Servo Status

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	

4.4 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.

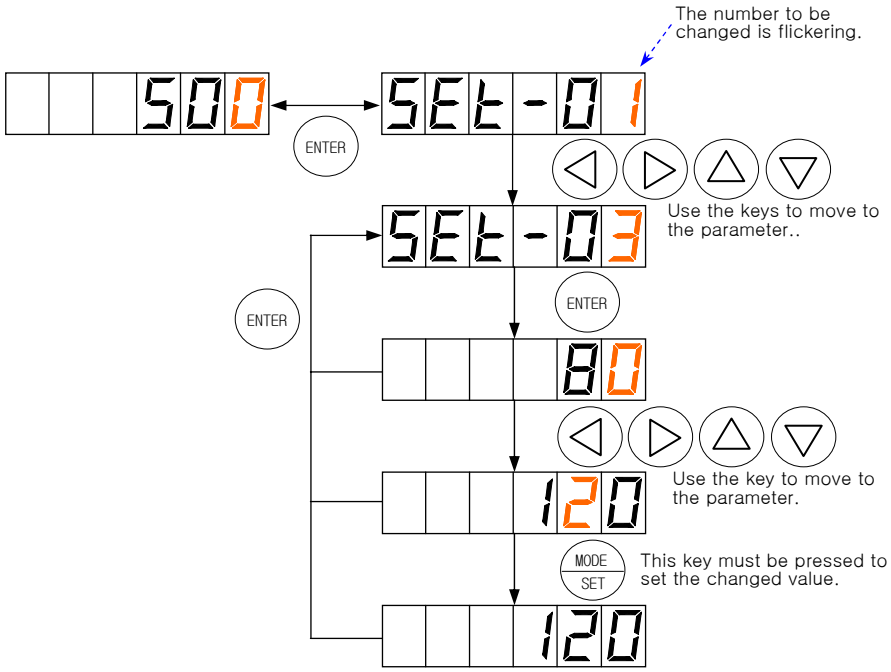


Fig 4.4 Example of Setting User Parameter

※Refer to chapter 5 for the list of the user parameters.

Note) The parameter which can be used differs partially according to the ROM version.

Refer to the Parameter list in the chapter 5.

4.5 Monitoring Mode

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

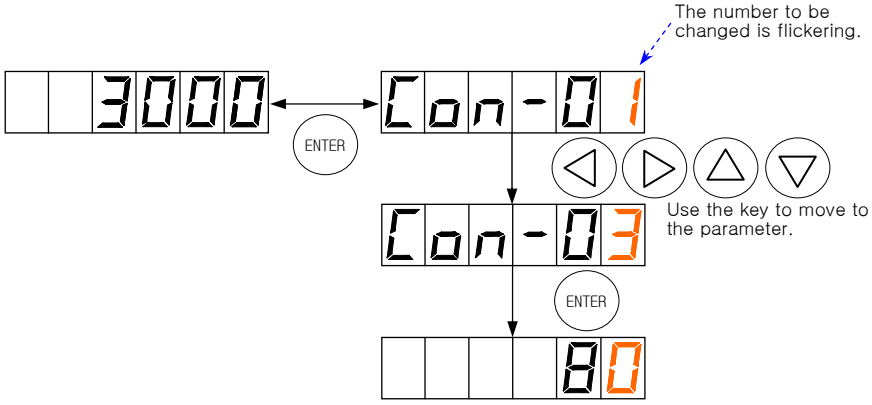


Fig 4.5 Example of Parameter of Monitoring Mode

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

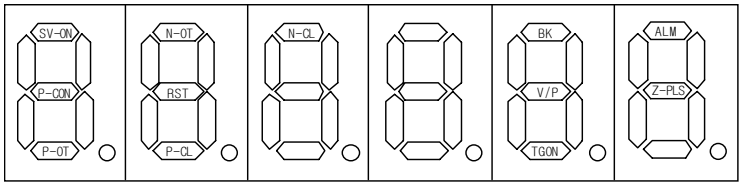


Fig 4.6 Display of Con-12
(V/P: Speed/Positioning Completion Signal CN1 Pin 41-42)

4.6 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.

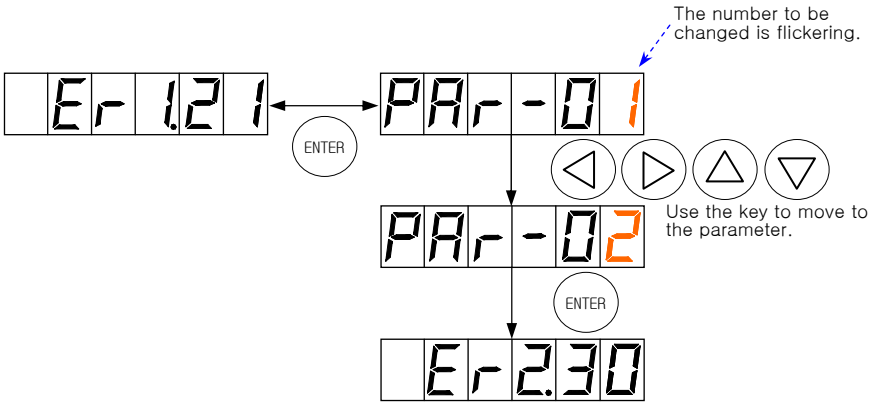


Fig 4.7 Example of Error

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 

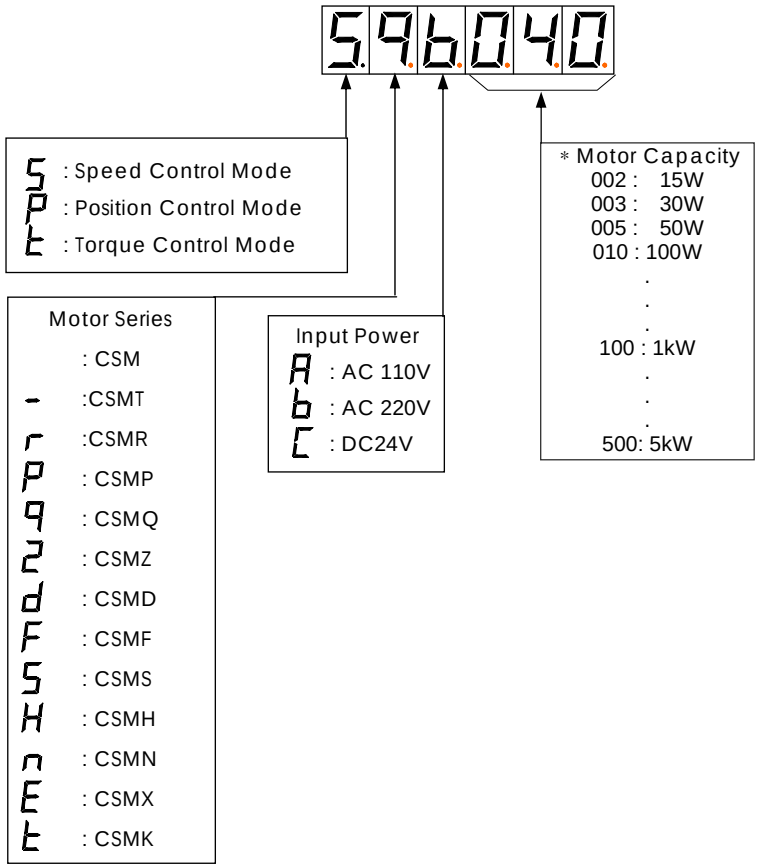
Parameter	Content
PAr-12	Controller type check 

Table 4.6 Error Display of Operator and Trace Back Table

Alarm Code		Alarm Content
Number	Letter	
10	SC	Motor over-current ※If it cannot be cancelled even if it's not over-current, it's overheat.
11	oC	Motor over-current
12	oH	Operation error due to motor overheat 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

4.7 Jog Mode

Table 4.7 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

A. Operation by the Operator

Refer to C in section 3.2.

B. Autotuning

Refer to Section 3.3.

C. 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].

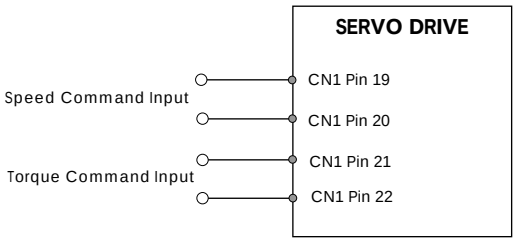


Fig 4.8 Speed/Torque Command Input

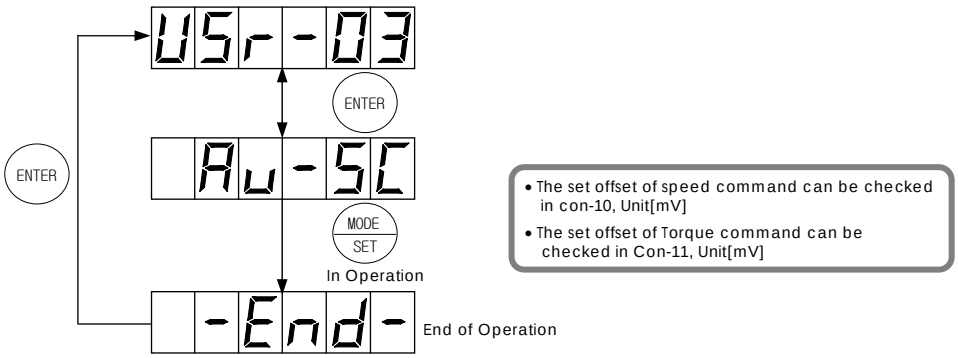


Fig 4.9 Auto Adjustment of Speed Command Offset
(In case of auto adjustment of torque command offset, "Au-tC" is displayed.)

Warning

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.)

D. 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].

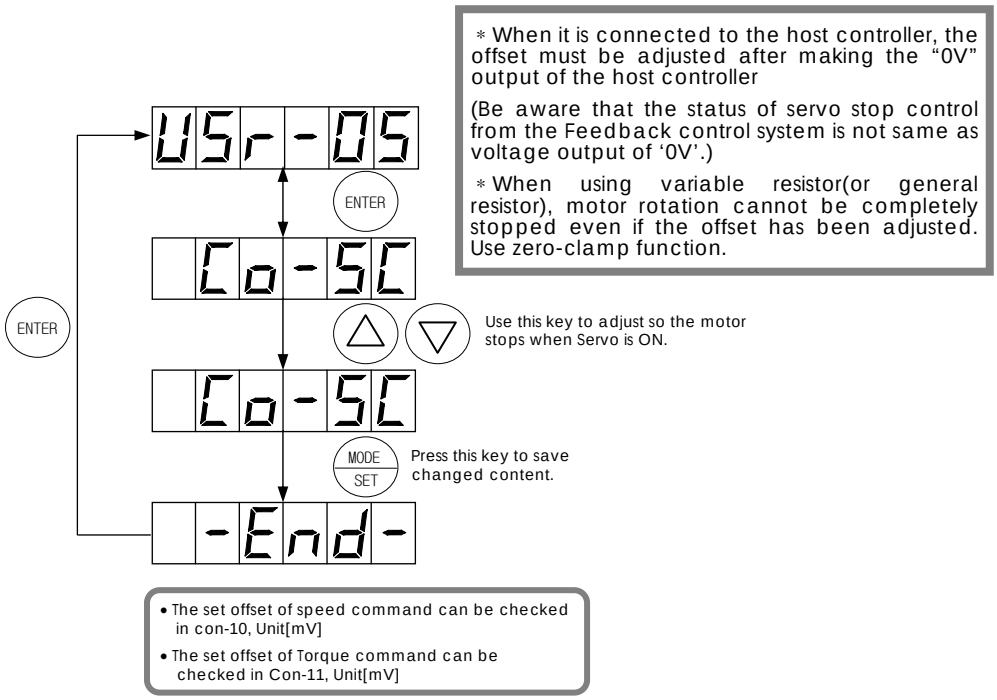


Fig 4.10 Manual Adjustment of Speed Command Offset
(In case of the manual adjustment of torque command offset , " Co-tC" is displayed.)

E. Alarm Reset

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

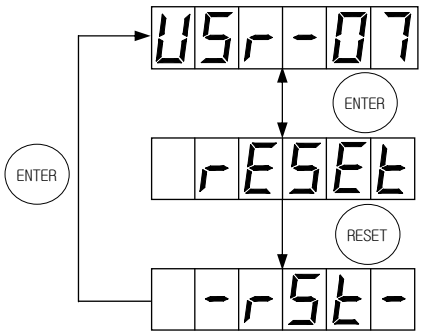


Fig 4.11 Alarm Reset

F. 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 torque×0.5)	Setting value of ±1V / SEt-09 [%], Max.±10V
27	GND	DA output signal GND

Table 4.8 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	

Warning

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.

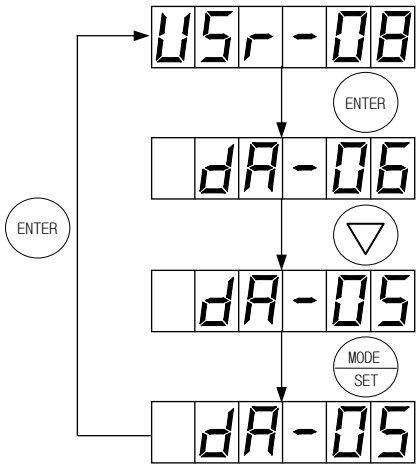


Fig 4.12 Example of Selecting the D/A Channel Output Content

G. Output Adjustment Method of D/A Converter Channel

Table 4.9 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	Adjuststt 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

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 4.9.

- **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 - Measured Output Voltage [mV] of channel 1*0.1
(Output voltage measured in servo OFF status)
SEt-73 = 100 - 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]/Actual output voltage of channel 1 [V] (Voltage output when the motor is in normal operation status)
SEt-74 = 100 * 5[V]/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].

H. 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.

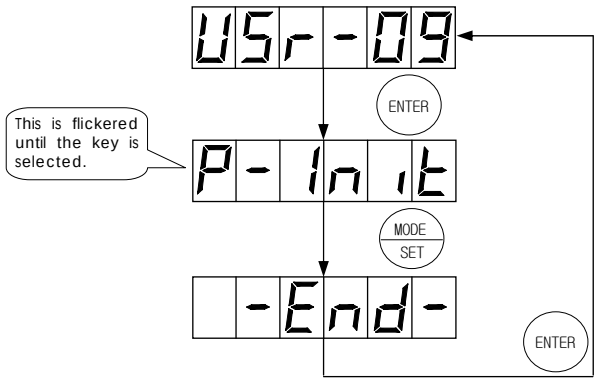


Fig 4.13 Initialization of User Parameter

Warning

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.

I. 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.

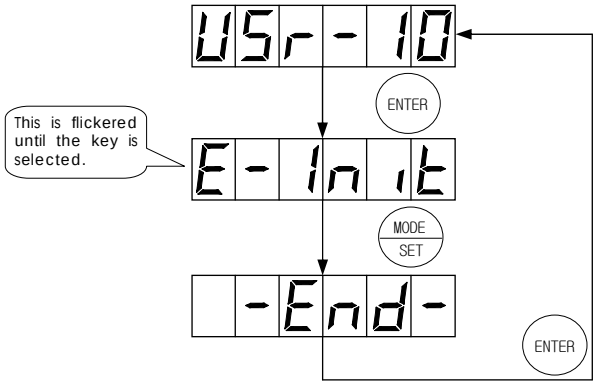


Fig 4.14 Error History Clear

J. Test Run

Refer to Section 3.4 Test Run

MEMO

MEMO

Chapter 5

Parameter List

Chapter 5 includes lists of various parameters of the servo drive and explains the setting.

MEMO

5.1 User Parameter

A. 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			CSMD/CSMF/CSMH/CSMS /CSMQ/CSMZ/CSMK			CSMN/CSMX		
Set	Encoder Type	Pulse	Set	Encoder Type	Pulse	Set	Encoder Type	Pulse
0	15 wire Incremental	2048	**100**	**11 wire Incremental**	**2500**	**300**	**15 wire Incremental**	**6000**
1	**9 wire Incremental**	**2048**	101	15 wire Incremental	2500	301	15 wire Incremental	5000
2	Absolute	2048	102	15 wire Incremental	1000	302	15 wire Incremental	2500
3	15 wire Incremental	2500	104	COMPACT Absolute	2048	303	15 wire Incremental	4000
4	15 wire Incremental	2000	105	FULL Absolute	2048	304	15 wire Incremental	1500
5	15 wire Incremental	5000	106	15 wire Incremental	10000	305	15 wire Incremental	1000
						306	15 wire Incremental	3000
						307	15 wire Incremental	2000
						308	FULL Absolute	2048

※Bold letters are the encoders installed as a basic and the rest are optional specifications.

Table 5.2 Motor Types Setting (SEt-52)

MOTOR	CSM	CSMP	CSMT	CSMR	CSMQ	CSMZ
DC24V	1010	*	1040	*	*	*
110V	1011	*	*	*	2111	2211
220V	1012	1022	1042	1062	2112	2212

MOTOR	CSMS	CSMD	CSMH	CSMF	CSMK	CSMN	CSMX
DC24V	*	*	*	*	*	*	*
110V	*	*	*	*	*	*	*
220V	2222	2312	2322	2332	2342	3412	3422

Caution: Parameter with ' * ' are affective after setting and then turn off and on the power.

220V Input Voltage, CSM Motor Setting Value

MOTOR	101	102	104	106	211	221	222	231	232	233	234	341	342
	CSM	CSMP	CSMT	CSMR	CSMQ	CSMZ	CSMS	CSMD	CSMH	CSMF	CSMK	CSMN	CSMX
	CSMG												

Input Voltage	
0	DC24V
1	110V
2	220V

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	24VDC				220VAC							
	30W	50W	100W	200W	30W	50W	100W	200W	400W	600W	800W	1kW
CSM CSMT	3	5	10	20	3	5	10	20	40	60	80	100
CSMP CSMR	*	*	*	*	*	*	10	20	40	*	*	*
CSMQ	*	*	*	*	*	*	10	20	40	*	*	*
CSMZ	*	*	*	*	3	5	10	20	40	*	80	*

Capacity / Motor Type	220VAC										
	200W	300W	400W	450W	500W	600W	750W	800W	850W	900W	1kW
CSMD	*	*	*	*	*	*	75	*	*	*	100
CSMS	*	*	*	*	*	*	*	*	*	*	100
CSMF	*	*	40	*	*	*	75	*	*	*	*
CSMH	*	*	*	*	50	*	*	*	*	*	100
CSMN	*	30	*	*		60	*	*	*	90	*
CSMX	20	30	*	*	50	*	*	*	85	*	*
CSMK	*	30	*	*	*	60	*	*	*	90	*

B. Control Mode Setting

Control Type		Control Mode	* SEt-41	Description
Single Type	Position Control	Position Mode	0	Factory Setting Value ※Refer to 6.5 Position Control
	Speed Control	Speed Mode	1	※Refer to 6.1 Speed Control
		Multi Step Speed Mode	3	3 Step Speed control by input terminal (P-CL, N-CL, P-CON) ※Refer to 6.1 B. 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 6.1 D. Manual Zero-Clamp Speed Mode
		Auto Zero Clamp Speed Mode	5	Refer to 6.1 E. Auto Zero-clamp Speed 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 6.9 Torque Control
Complex Type	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 6.9 Torque Control
	Position/Torque Control Conversion	Position + Torque Mode	7	P-CON ON: Torque Control Mode P-CON OFF: Position Control Mode ※Refer 6.9 D. Position/Torque Control Mode
	Position/Speed Control Conversion	Position + Speed Mode	8	P-CON ON: Speed Control Mode P-CON OFF: Position Control Mode ※Refer to 6.5 G. Position/Speed Control Mode
	Speed Control	Speed + Multi Step Speed Mode	14	P-CON ON: Multi step speed Control Mode P-CON OFF: Speed Control Mode ※Refer to 6.1 C. Speed/Multi Step Speed Control Mode

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

C. Parameter Setting Related to Autotuning

Parameter	Name	Description	Unit	Setting Range	Factory Setting
SEt-58	Autotuning Speed	- Autotuning speed (RPM): Setting value (rad/s)/2PI*60 Ex) Setting value:100 → 955RPM - The inertia ratio calculated may not be accurate if it is set too low compared to the load. - 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. - When setting this parameter high when the load is big, error can occur. Reduce the setting for the operation. ※Refer to 3.3 Autotuning	rad/s	20~100	100
SEt-70	Motor Rotation Angle During Autotuning	- 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. ※Refer to 3.3 Autotuning	0.1 Rotation	1~30	10
SEt-66	User Set Inertia	- The load inertia ratio can be set by the user. - The Con-13 changes upon the change in setting. - Load inertia ratio measured in autotuning is set. - 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.	0.1times	0~1000	30
SEt-42	System Gain	- Speed Response Frequency - When setting this parameter, the basic gain (SEt-02, 03, 04, 05, 40) changes in reference to SEt-66. ※Refer to 6.10 Setting of Servo Drive Gain	Hz	0~100	20

D. Parameter Setting Related to Gain

Parameter	Name	Description	Unit	Setting Range	Factory Setting
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 6.10 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 6.10 Setting of Servo Drive Gain.	$N.m.s^2$	0~10000	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 6.10 Setting of Servo Drive Gain.	1/s	0~500	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 6.10 Setting of Servo Drive Gain.	Hz	0~100	20

<table>
<tr><th>Parameter</th><th>Name</th><th>Description</th><th>Unit</th><th>Setting Range</th><th>Factory Setting</th></tr>
<tr><td>+ SEt-47</td><td>Notch Filter Cutoff Frequency</td><td>- Suppresses the torque command of frequency band set.
- Notch filter function is ineffective when setting "0".
- Resonant frequency may differ according to the load. Appropriate setting of resonant frequency can raise the system gain.
- Vibration or noise can occur if the frequency different from resonant frequency of load is set. Belt system:100~200Hz
The setting to be changed in servo OFF is effective.</td><td>Hz</td><td>0~10000</td><td>0</td></tr>
<tr><td>+ SEt-49</td><td>2nd Torque Filter Cutoff Frequency</td><td>- 2nd Low pass filter cutoff frequency of torque command.
- Effectively suppress high frequency term than first filter (SEt-06).
- Setting to be changed is effective in servo OFF.
If the setting has been changed during servo ON, operate servo OFF and re-save.</td><td>Hz</td><td>0~10000</td><td>1000</td></tr>
<tr><td>SEt-54</td><td>Selection of Auto Adjustment on Speed Integration Value</td><td>Limits the integration value of speed error and suppresses speed overshoot. Thus, in case of position control, the positioning completion speeds up.
<table>
<tr><th>Setting</th><th>Content</th></tr>
<tr><td>0</td><td>Invalid</td></tr>
<tr><td>1</td><td>Automatically adjustments the integration value with the setting value of SEt-55 as a standard</td></tr>
<tr><td>2</td><td>Automatically adjustments 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>
</table></td><td></td><td></td><td>2</td></tr>
<tr><td>SEt-55</td><td>Auto Adjustment on the Basis of Torque command</td><td>- If the torque command [%] becomes greater than the setting value [%], speed integration gain is automatically adjusted.
- This mode is effective with loading round plate load.
• Caution:
- When the torque [%] is greater than the setting value [%] in rated speed operation, in other words, when rated speed torque value [%] > SEt-55 [%], speed error may occur.
- Please set so the setting value [%] is greater than torque [%] in stop state. Torque value[%] can be checked in Con-03.
※Refer to 6.1 Speed Control.</td><td>%</td><td>0~300</td><td>100</td></tr>
<tr><td>SEt-56</td><td>Auto Adjustment on the Basis of Speed Command</td><td>- If the motor speed [RPM] is greater than the setting value [RPM], speed integration gain is automatically adjusted.
- In case of load with frictions, except for round plate load, it is effective.
• Caution:
- If the value of SEt-56 [%] is too low, speed error could occur in the speed [RPM], which exceeds SEt-56.
※Refer to 6.1 Speed Control.</td><td>RPM</td><td>0~3000</td><td>100</td></tr>
<tr><td>SEt-57</td><td>Auto Adjustment on the Basis of Position Error Amount</td><td>- If a position error exceeds the setting value [PULSE], speed integration gain is automatically adjusted.
- In case of load with frictions, except for round plate load, it is effective.
※Refer to 6.1 Speed Control..</td><td>PULSE</td><td>0~10000</td><td>100</td></tr>
<tr><td colspan="2">Cautions</td><td colspan="4">In gain setting, latest set value has the priority.
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.</td></tr>
</table>

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

E. Parameter Setting Related to Servo Control

Parameter	Name	Description	Unit	Setting Range	Factory Setting
SEt-16	TG-ON Speed Level	- Sets the speed level which turns on the TG-ON output signal - 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)	RPM	1~5000	20
SEt-17	Zero-Clamp Level	- Sets the stopping speed when operating in zero clamp mode (SEt-41 = 4 or 5) - If the analog speed command value is less than the setting value, it decelerates to stop and the Servo is ON. - 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. ※Refer to 6.1 D.E Zero-Clamp Speed Control Mode	RPM	1~5000	10
SEt-18	Output Range of Speed (position) Coincidence signal	- Sets the error range of speed (position), which turns on the P-COM output signal - P-COM is output when speed (position) error value reaches within the setting value. (Output: CN1 41,42) ※Refer to 6.5 E. Position Completion Output Signal	RPM (PULSE)	0~1000	10
* SEt-23	Number of Encoder Output Pulse per One Rotation	- Number of output pulse of servo drive per one rotation of the motor. ※Refer to 6.6 Using Encoder Output	PULSE	1~65535	2048
* SEt-24	Number of Motor Encoder Pulse	- Number of motor encoder pulse per one rotation ※Refer to 6.6 Using Encoder Output	PULSE	1~65535	2048
SEt-25	Jog Operation Speed (Multi Step Speed 4)	- Sets speed command when JOG operation, Test run and step 4 speed.	RPM	0~5000	500
SEt-67	Over Speed Level	- The over speed level is set by the user. - 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. - When setting "0", over speed level internally becomes 105% of the maximum motor speed. - 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.	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 6.11 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 6.11 Using rotation prohibition function.	0	N-OT signal is reverse rotation prohibition signal	1	
			1	Reverse rotation is always permitted		
	* 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.		

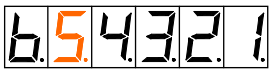
Parameter	LED No	Name	Setting Value	Description	Factory Setting	Note
SEt-44	* 1	Selection of Stop Method ※Refer to 6.4 Selection of stop method	0	Stops the motor with dynamic brake (DB)	0	Turn the power off and on after changing setting value in Servo OFF State
			1	Stops after free run		
	* 2	Selection of Operation after DB Stop ※Refer to 6.4 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 6.4 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.		
	* 4	Setting of Encoder Output Pulse Direction ※Refer to 6.6 Using encoder output	0	Output as the standard (B phase proceed in 90° in forward rotation (CCW)). ※Refer to Fig 6.25 Encoder output pulse form	0	
			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 1st torque command filter	0	
			1	Use 2nd torque command filter		
			2	Use both torque command filter (1st &2nd)		
		∗ 4	0	CCW Operation (Forward Operation)	• **Speed and torque control** (Definition of motor rotation direction according to the positive input of speed and torque voltage.)	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.



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

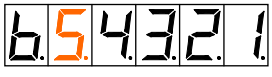
Caution: 1. Parameter with ' ∗ ' are effective after setting and turn off and on the power.

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.

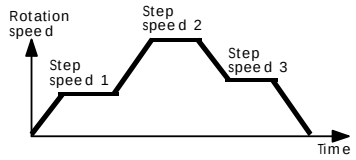


No.6 No.5 No.4 No.3 No.2 No.1

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.

F. Parameter Setting Related to Speed Control

<table>
<tr><th>Parameter</th><th>Name</th><th>Description</th><th>Unit</th><th>Setting Range</th><th>Factory Setting</th></tr>
<tr><td>SEt-01</td><td>External speed command gain</td><td>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.</td><td>RPM/V
(RPM/10V)</td><td>10～6000</td><td>500</td></tr>
<tr><td>USr-03</td><td>Auto adjustment of speed command offset</td><td colspan="4">※Refer to 4.7 C. Auto adjustment of speed/Torque command offset</td></tr>
<tr><td>Usr-05</td><td>Manual adjustment of speed command offset</td><td colspan="4">※Refer to 4.7 D. Manual adjustment of speed/Torque command offset</td></tr>
<tr><td>SEt-19</td><td>Acceleration time</td><td>Sets acceleration time from the zero speed to rated speed.
※Refer to 6.3 Acceleration/ deceleration time and S-curve operation</td><td>ms</td><td>0～60000</td><td>0</td></tr>
<tr><td>SEt-20</td><td>Deceleration time</td><td>Sets deceleration time from the rated speed to the zero speed.
※Refer to 6.3 Acceleration/ deceleration time and S-curve operation</td><td>ms</td><td>0～60000</td><td>0</td></tr>
<tr><td>SEt-21</td><td>S-curve operation time</td><td>Sets the S-curve time for during acceleration/deceleration.
※Refer to 6.3 Acceleration/ deceleration time and S-curve operation</td><td>ms</td><td>0～5000</td><td>10</td></tr>
<tr><td>SEt-26</td><td>Multi step speed 1</td><td>- Sets speed commands when using multi step speed control mode (SEt-41=3)
 

- Select speed command according to the input terminal P-CL(CN1 9), N-CL(CN1 8), as shown below
<table>
<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>
- Select forward and reverse rotation operation command with P-CON (CN1 4) input terminal.
<table>
<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>
※Refer to 6.1 B. Multi step speed control mode</td><td>RPM</td><td>0～5000</td><td>100</td></tr>
<tr><td>SEt-27</td><td>Multi step speed 2</td><td>Sets multi step speed 2</td><td>RPM</td><td>0～5000</td><td>200</td></tr>
<tr><td>SEt-28</td><td>Multi step speed 3</td><td>Sets multi step speed 3</td><td>RPM</td><td>0～5000</td><td>300</td></tr>
</table>

SEt-25	Multi step speed 4	Sets multi step speed 4 ※Refer to 6.1 C. Speed/Multi step speed control mode.	RPM	0～5000	500

G. Parameter Setting Related to Position Control

Parameter	Name	Description	Unit	Setting Range	Factory Setting
SEt-07	Position FF Filter Cutoff frequency	- Use filter to smooth feed-forward compensation value, which is differentiated position command. Cutoff frequency of this filter can be adjusted. - 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". ※Also refer to Fig 6.29 Block diagram of electronic gear	rad/s	0～2500	0
SEt-33	Overflow Level	- An overflow alarm occurs if the difference between position command and actual motor position is greater than the setting value. - Alarm CODE=33(Output alarm code in CN2 37,38, 39)	PULSE	0～65535	8000
SEt-34	Position Feedforward Gain	- Inputs feed-forward gain about speed value, which is differentiated position command. - 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. - Feed-forward function is ineffective when setting "0" ※Also refer to Fig 6.29 Block diagram of electronic gear.	%	0～100	0
SEt-35	Position Command Filter Cutoff Frequency	Setting low pass filter cutoff frequency of position command ※Also refer to Fig 6.29 Block diagram of electronic gear	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 6.7 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 6.7 Electronic gear	PULSE	1～65535	2048
SEt-69	Friction Compensation Torque	- Compensate the friction to reduce positioning completion time - Setting excessive value creates vibration in stopping operation. - Ball Screw direct system:2%	%	0～100	0

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

H. 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 6.9 B. Torque command	%/3V	0～100	100
USr-04	Auto Adjustment of Torque Command Offset	※Refer to 4.7 C. Auto adjustment of speed/torque command offset			
Usr-06	Manual Adjustment of Torque Command Offset	※Refer to 4.7 D. Manual adjustment of speed/torque command offset			

I. 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 ------ 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
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 6.4 D. Emergency stop	%	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 ------ 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
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 **Note**: 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. **Note**: When using with SEt-64, SEt-65 can not be non-zero when SEt-64 is also non-zero.	%	0～100	0

J. 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 7.2 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 7.2 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 7.2 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 7.2 Brake control	10ms	0～100	0

K. Parameter Setting Related to D/A Output

Parameter	Name	Description	Unit	Setting Range	Factory Setting
USr-08	DA Channel Output Value Selection	※Refer to 4.7 F. 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 4.7 F. 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 4.7 F. 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 4.7 G. 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 4.7 G. 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

5.2 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

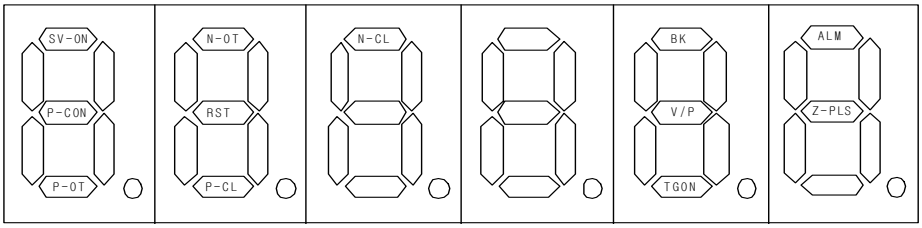


Fig 5.1 I/O Status of Con-12
(V/P: Speed/Position Completion Signal CN1 pin 41-42)

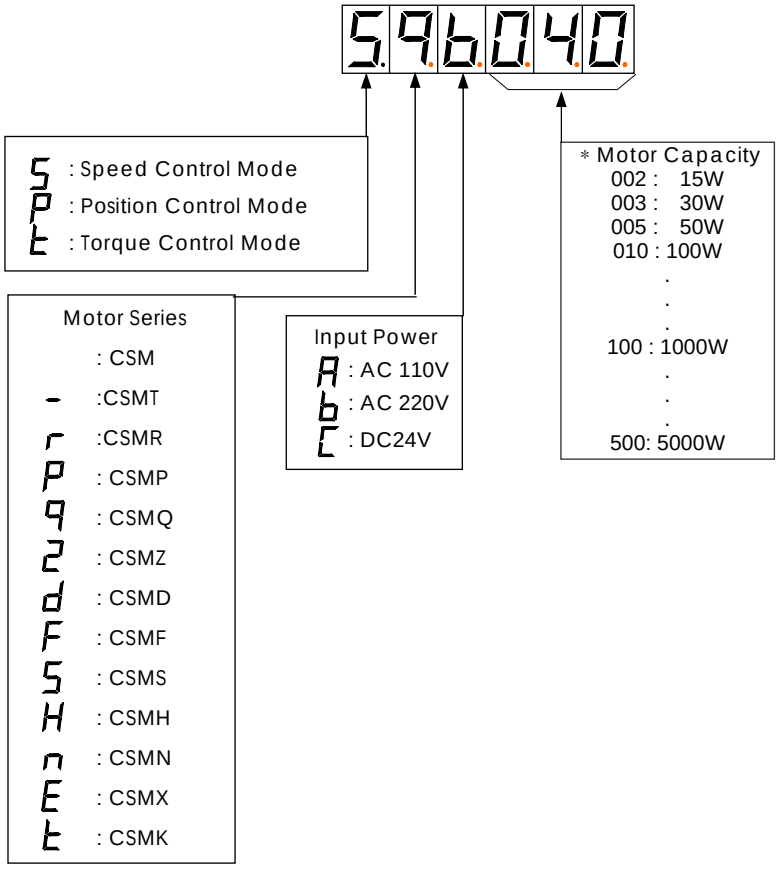
5.3 Jog Mode Parameter List

Table 5.5 Jog Mode Parameter List

<table>
<tr><th>Parameter</th><th>Description</th><th>Reference</th></tr>
<tr><td>USr-01</td><td>JOG (Servo ON by Operator)
※Refer to start up by Operator</td><td>3.2 B.</td></tr>
<tr><td>USr-02</td><td>AutoTuning</td><td>3.3</td></tr>
<tr><td>USr-03</td><td>Auto Adjustment of Speed Command Offset</td><td rowspan="2">4.7 C.</td></tr>
<tr><td>USr-04</td><td>Auto Adjustment of Torque Command Offset</td></tr>
<tr><td>USr-05</td><td>Manual Adjustment of Speed Command Offset</td><td rowspan="2">4.7 D.</td></tr>
<tr><td>USr-06</td><td>Manual Adjustment of Torque Command Offset</td></tr>
<tr><td>USr-07</td><td>Alarm Reset (Error Data Reset)</td><td>4.7 E.</td></tr>
<tr><td>USr-08</td><td>Uses D/A Converter Channel
<table>
<tr><th>Pin / Setting</th><th>Channel1 CN1 pin 23</th><th>Channel2 CN1 pin 28</th><th>CN1 pin 27</th></tr>
<tr><td>dA-03</td><td>Torque Command</td><td>Torque Feedback</td><td>GND</td></tr>
<tr><td>dA-04</td><td>Position command</td><td>Position Feedback</td><td>GND</td></tr>
<tr><td>dA-05</td><td>Speed Command</td><td>Speed Feedback</td><td>GND</td></tr>
<tr><td>dA-06</td><td>Speed Command</td><td>Torque Command</td><td>GND</td></tr>
<tr><td>dA-07 (Factory Setting)</td><td>Torque Command</td><td>Speed Feedback</td><td>GND</td></tr>
</table></td><td>4.7 F.
4.7 G.</td></tr>
<tr><td>USr-09</td><td>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</td><td>4.7 H.</td></tr>
<tr><td>USr-10</td><td>Error History Clear
Clears all of PAr-01 ~ PAr-10 contents to "0".</td><td>4.7 I.</td></tr>
<tr><td>USr-90</td><td>Test run
Test run/Stop by SET key</td><td>3.4</td></tr>
</table>

5.4 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 

MEMO

Chapter 6

Basic Functions

Chapter 6 Explains about basic functions of servo drive.

6.1 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	- P-CON OFF : PI control - P-CON ON : P control
		10	General Speed Control	The direction of rotation is selected by P-CON - P-CON OFF : Forward Rotation - P-CON ON : Reverse Rotation
		4	Manual Zero-Clamp Speed Control	- P/PI control conversion not possible. - P-CON ON : Zero-Clamp speed control mode - P-CON OFF: General speed control mode - Zero-Clamp operation : Ignores speed command below zero-clamp level (SEt-17)and motor decelerates to a stop (Zero Speed)
		5	Auto Zero-Clamp Speed Control	- P-CON OFF : PI control - P-CON ON : P control - Always ignores speed command below zero-clamp level (SEt-17) and motor decelerates to a stop (Zero Speed)
		3	Multi step Speed Control	- P/PI control conversion not possible - Step 3 speed control by input terminal (P-CL, N-CL, P-CON) P-CL , N-CL : Multi step speed command selection P-CON : Forward rotation/Reverse rotation operation command - Set the speed command value in SEt-26～28
		12	Analog Torque Limit Speed Control	- Torque limit by analog torque input voltage value(Torque value set in SEt-05) during speed control P-CON On : Analog torque limit effective P-CON Off : Analog torque limit ineffective
		14	Speed/Multi step Speed Control	P-CON Off : Speed control mode P-CON On : Multi step speed control mode

Warning

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 $\overline{\text{P-CON}}$ Input Signal**

$\overline{\text{P-CON}}$ function differs according to the control mode.

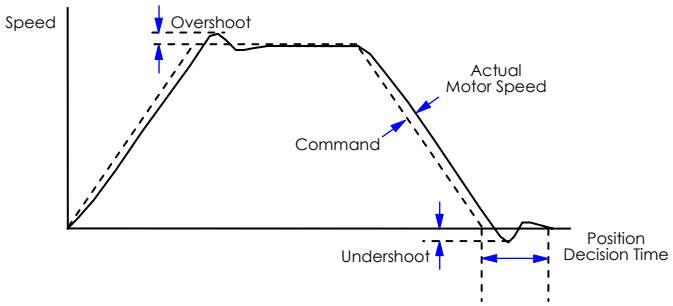
Control Mode	$\overline{\text{P-CON}}$ function
SEt-41=0, 1, 5	P/PI Control Conversion
SEt-41=4	Zero-Clamp On/Off
SEt-41=6	Speed/Speed Limit Torque Control Mode Conversion
SEt-41=3, 10	Selecting the direction of rotation
SEt-41=14	Speed/Multi-Step Speed Control Mode Conversion
SEt-41=8	Position/Speed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

Table 6.2 Using the $\overline{\text{P-CON}}$ Signal

- **P/PI Control Conversion**

P/PI control conversion by $\overline{\text{P-CON}}$ 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.



Warning

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 **4.7 F. D/A Converter channel selection**)
Do not use when there is less or no overshoot/undershoot.

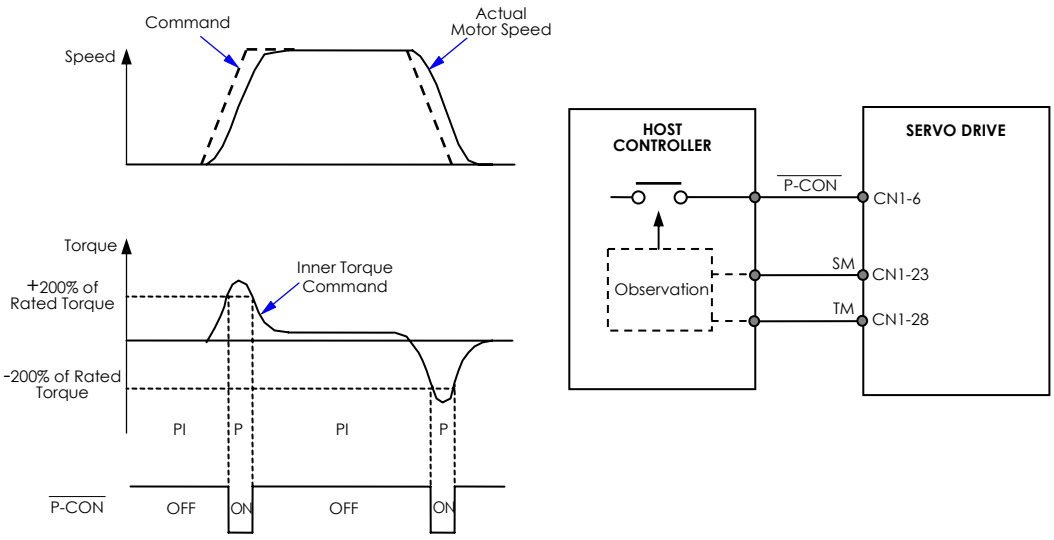


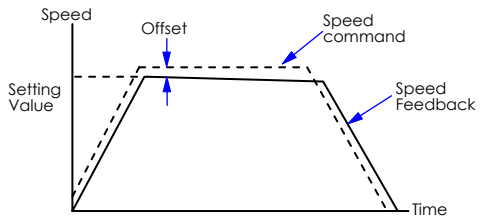
Fig 6.2 Example of P/PI Control Conversion Usage

- **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.)

<table>
<tr><th>Parameter</th><th>Parameter Name</th><th>Factory Setting</th><th>Unit</th><th>Description</th></tr>
<tr><td>SEt-54</td><td>Selection of Auto Adjustment on Speed Integration Value</td><td>2</td><td></td><td>Suppresses speed overshoot/undershoot while automatically adjusting the speed integration value. Thus, in case of position control, position completion time is shortened.
<table>
<tr><th>Setting</th><th>Description</th></tr>
<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>
</table></td></tr>
<tr><td>SEt-55</td><td>Auto Adjustment on the basis of Torque Command</td><td>100</td><td>%</td><td>- Automatically adjusts the speed Integration value on the basis of torque command.
- Set little lower value than maximum usage torque.</td></tr>
<tr><td>SEt-56</td><td>Auto Adjustment on the basis of Speed Command</td><td>100</td><td>RPM</td><td>- Automatically adjusts the speed integration value on the basis of speed command.
- Speed offset may occur above the setting value.
 
</td></tr>
<tr><td>SEt-57</td><td>Auto Adjustment on the basis of Position Error Amount</td><td>100</td><td>PULSE</td><td>- Automatically adjusts the speed Integration value on the basis of position error amount.</td></tr>
</table>

A. 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**

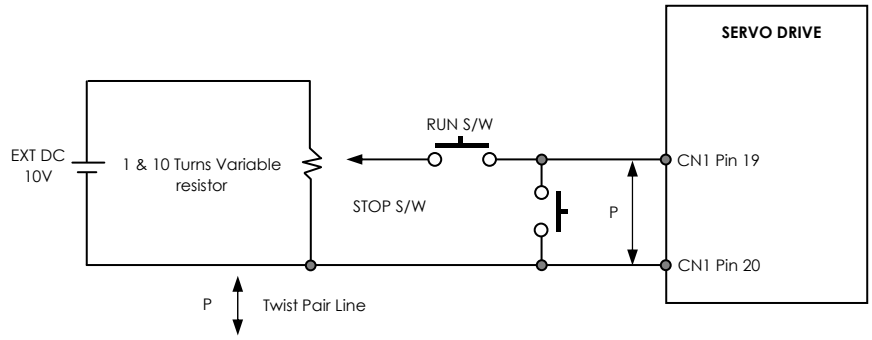


Fig 6.3 Analog Speed Command Input Circuit

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

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

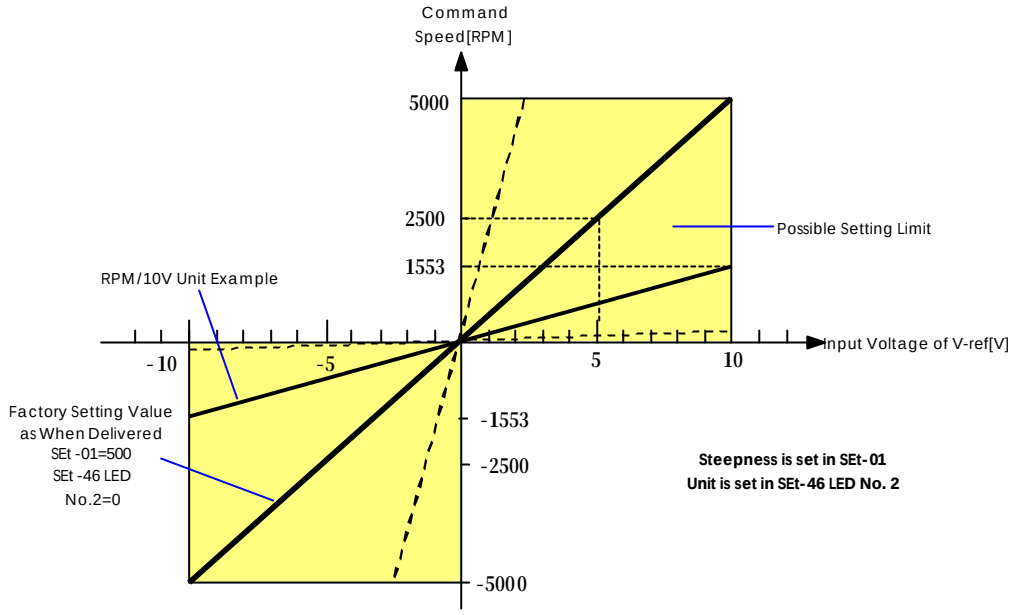


Fig 6.4 Analog Input Voltage and Speed

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

Speed Command [RPM] = Setting value of SEt-01[RPM/V] or [RPM/10V] ×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/V] × 10[V] Thus when setting 10V, motor rotates in 3000RPM.		[RPM] = 2439[RPM/10V] × 10[V] Thus when setting 10V, motor rotates in 2439RPM.	

B. Multi Step Speed Control Mode

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

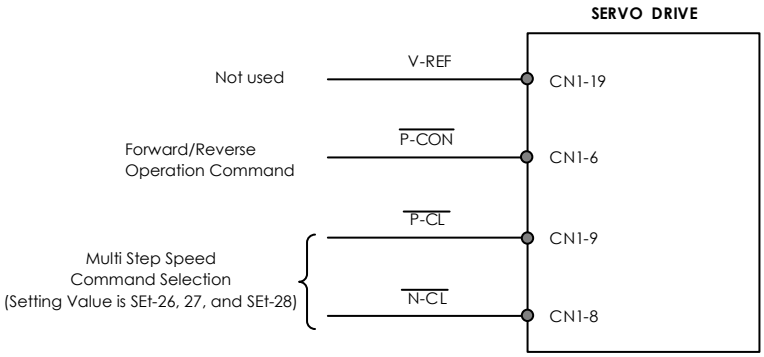
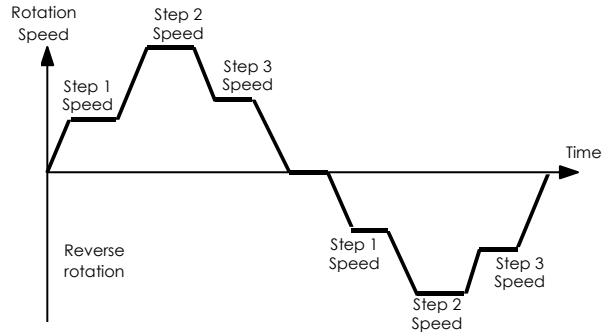


Fig 6.5 Multi Step Speed Control Circuit

Table 6.3 Multi Step Speed Control Mode Setting

Multi Step Speed Control Mode Setting	Setting Value of SEt-41 = 3
Speed Value Setting	Setting Value of SEt-26, SEt-27, and SEt-28[RPM]
Speed Command Selection	$\overline{\text{P-CL}}$ (CN1 Pin 9), $\overline{\text{N-CL}}$ (CN1 Pin 8)
Forward/Reverse Command	$\overline{\text{P-CON}}$ Terminal (CN1 Pin 6)
Acceleration Time Setting	Setting Value of SEt-19[msec]
Deceleration Time Setting	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.



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

Fig 6.6 Multi Step Speed Operation

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

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.

C. Speed/Multi Step Speed Control Mode

It may be converted to speed/multi step speed control mode by ON/OFF of $\overline{\text{P-CON}}$ input terminal.

Table 6.4 Speed/Multi Step Speed Control Mode Setting

<table>
<tr><th>Item</th><th>Description</th><th>Note</th></tr>
<tr><td>Mode Setting Parameter</td><td>SEt-41 = 14</td><td>Setting value is effective after Power ON/OFF.</td></tr>
<tr><td>Control Mode Conversion</td><td>$\overline{\text{P-CON}}$ Input Terminal
OFF → Speed Control Mode
ON → Multi Step Speed Control Mode</td><td></td></tr>
<tr><td>Multi Step Selection Speed</td><td>Selection by $\overline{\text{P-CL}}$, $\overline{\text{N-CL}}$ Input Terminal
<table>
<tr><th>Item</th><th>$\overline{\text{P-CL}}$</th><th>$\overline{\text{N-CL}}$</th><th>Speed Value</th></tr>
<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>
</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)</td><td></td></tr>
<tr><td>Acceleration and Deceleration time in mode Conversion</td><td>Acceleration time: Setting value of Set-19
Deceleration Time: Setting value of SEt-20
Unit: msec
Caution : 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.</td><td></td></tr>
</table>

※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**

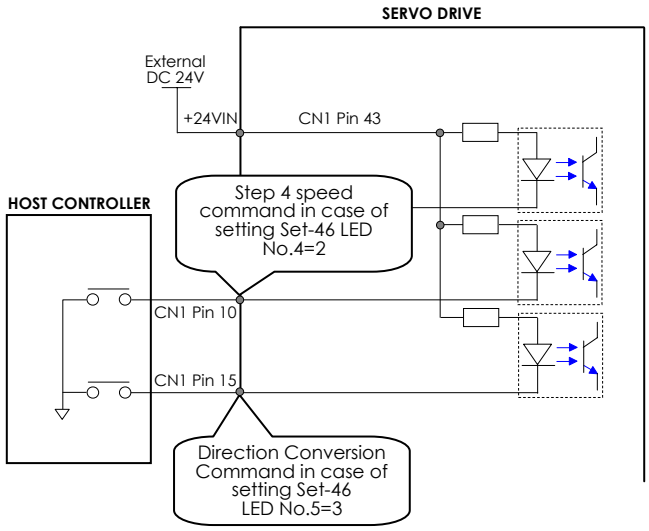


Fig 6.7 Using the Step 4 Speed

- 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 $\overline{\text{P-CON}}$ 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	
Step 4 Speed Command Selection	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
Direction Conversion Command Selection	/P-CON	SEt-46 LED No.5=3 Pin 15 of CN1	SEt-46 LED No.4=3 Pin 10 of CN1
Step 4 Speed Command Setting	Setting of SEt-25 [RPM]		

- **Example of Step 4 Speed Command 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'

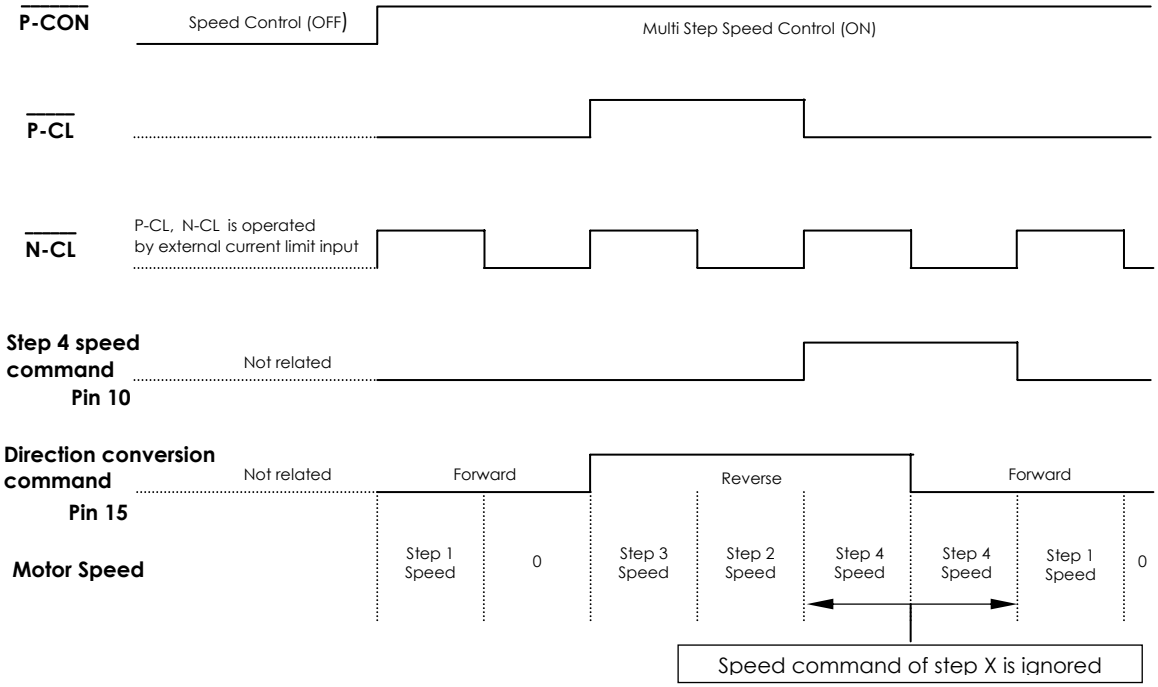


Fig 6.8 Example of Step 4 Speed Command Usage

D. 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.

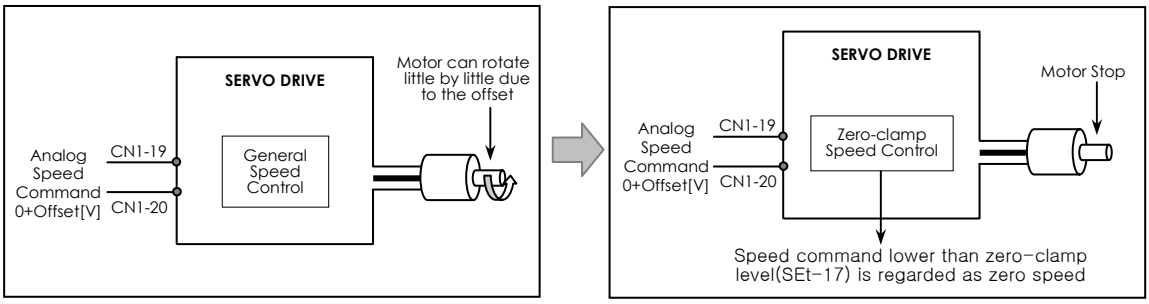


Fig 6.9 Using the Zero-Clamp Speed Control

Warning

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
$\overline{\text{P-CON}}$ (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

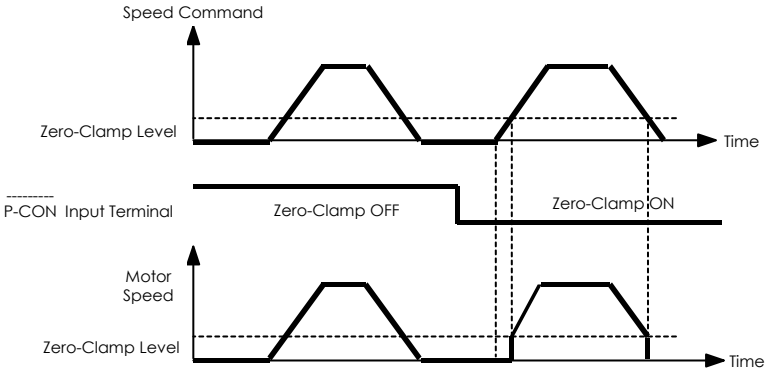


Fig 6.10 Zero-Clamp Operation

E. 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.

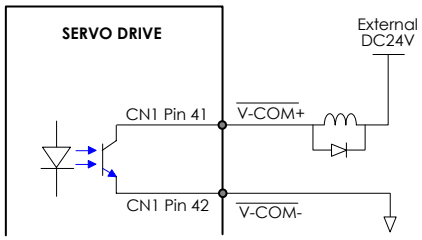
Table 6.7 Auto Zero-Clamp Speed Control Mode Setting

	Setting	Description
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
P-CON (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

F. Speed Coincidence Output Signal

This is an output signal which shows that the actual motor speed Matches up to command speed.



Parameter	Name	Setting Range	Unit	Factory Setting	Note
SEt-18	Output Width of Speed (Position) Coincidence Signal	0~1000	RPM (PULSE)	10	- Speed Control Mode: Width of speed coincidence output signal - Position Control Mode: Position Completion Range (PULSE)

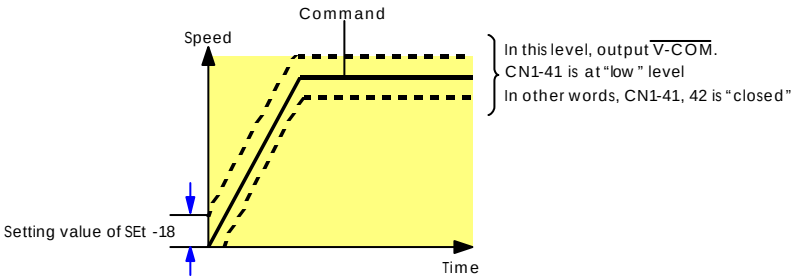


Fig 6.11 Width of Speed Coincidence Output Signal

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

- **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
		1	Output is opposite to the standard

6.3 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.

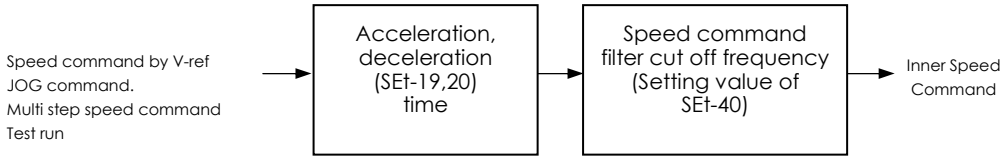


Fig 6.12 Inner Speed Command Generation

Parameter	Name	Unit	Setting Range	Factory Setting Value
SEt-19	Acceleration Time	msec	0～60000	0
SEt-20	Deceleration Time			
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 Time: Time it takes to accelerate from stop status to motor's rated speed.

  Deceleration Time: Time it takes to decelerates from motor's rated speed to a stop status.

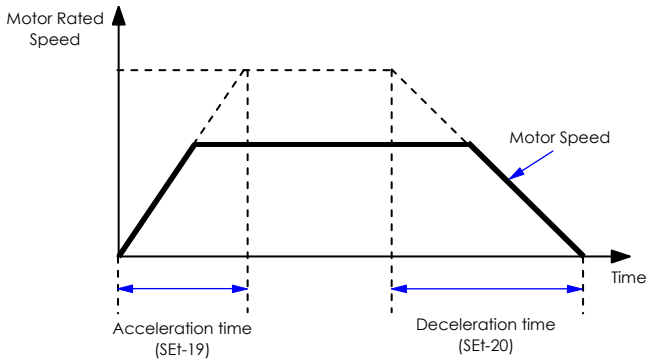
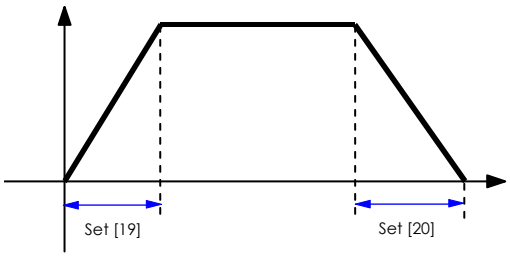
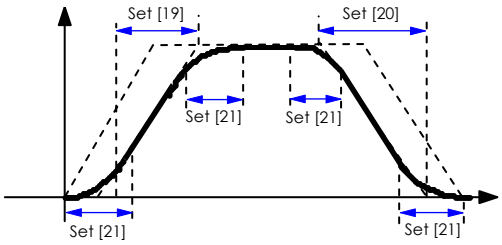


Fig 6.13 Definition of Acceleration/Deceleration Time

- **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		

6.4 Selection of Stop Method

A. 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 form 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 **Chapter 4 Usage Method of Operator.**

B. 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)

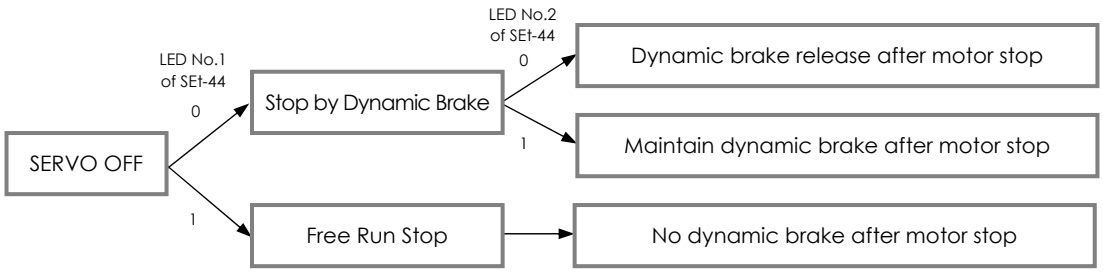


Fig 6.14 Selection of Stop Method

C. 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 **6.1 D. Manual Zero-Clamp Speed Control Mode**.

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

SEt-44 LED No.5	$\overline{\text{E-STOP}}$ 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

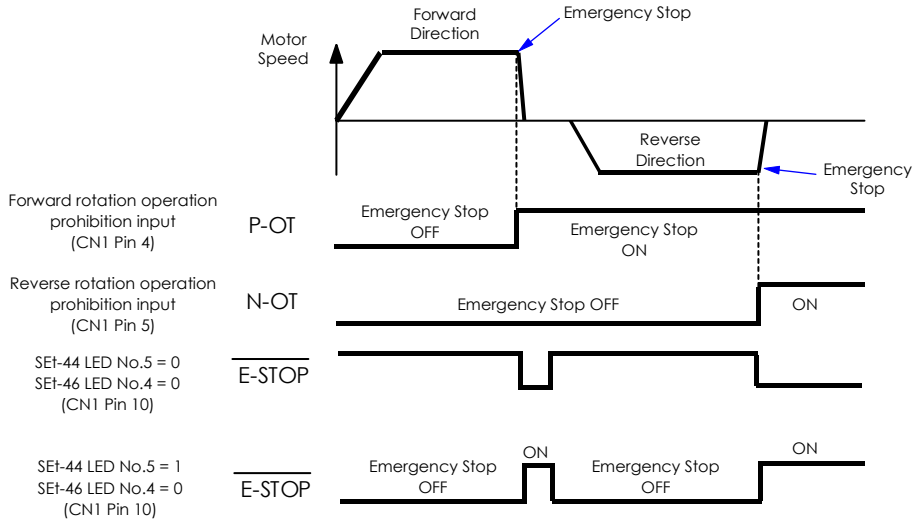


Fig 6.15 Emergency Stop

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

Parameter	LED No.	Setting	Stopping Method
SEt-44	3	0	Rotation Direction: Forward — Stop by torque value set in SEt-14 Rotation Direction: 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.

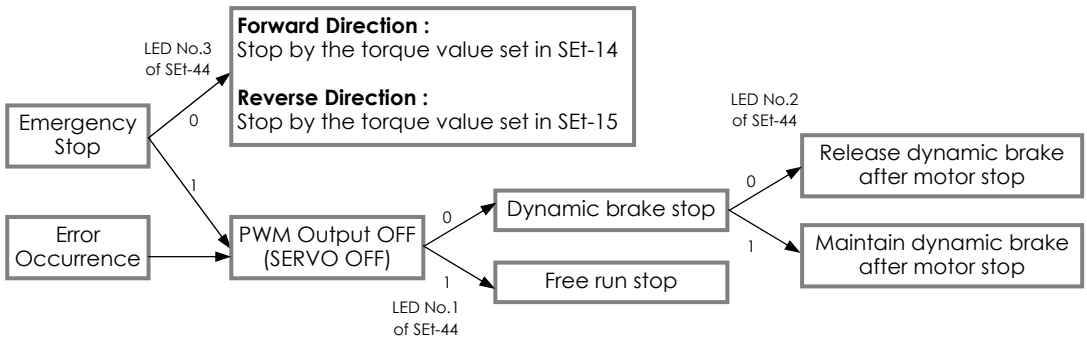
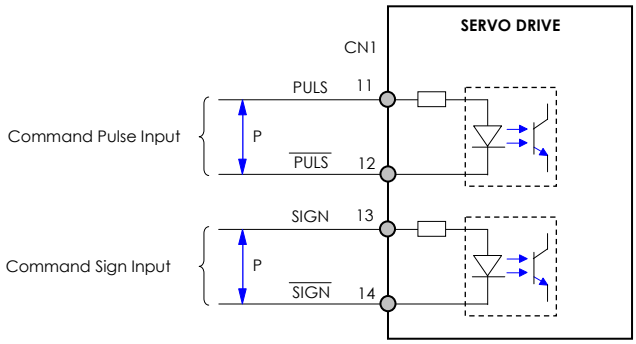


Fig 6.16 Selection of Stopping Method by Emergency Stop and Error Occurrence

6.5 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"



P: Represents twisted-pair cables.

Fig 6.17 Position Command Input Terminal

A. 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.

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

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..

SEt-37	Motor Speed	Command Pulse Frequency
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**

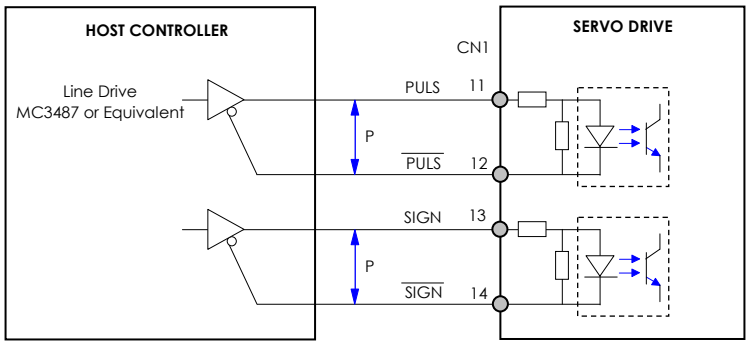


Fig 6.18 Wiring for Position Command of Line Drive Output

• **In Case of Open Collector**

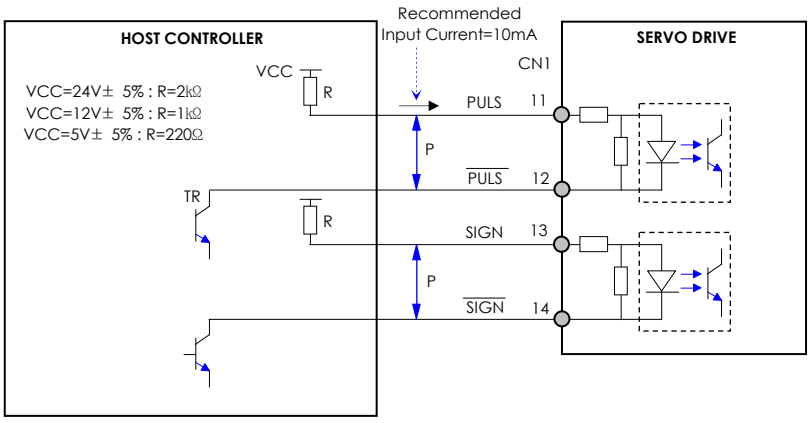


Fig 6.19 Wiring for Position Command of Open Collector Output

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.

Warning

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

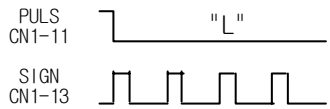
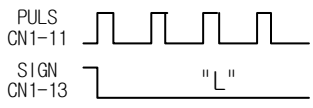
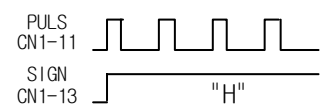
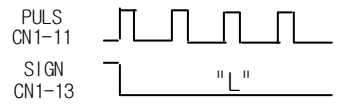
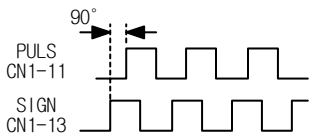
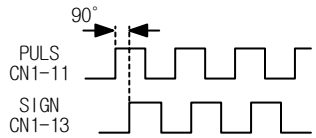
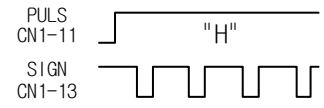
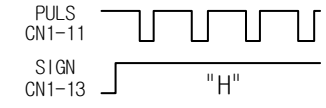
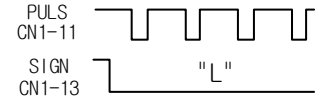
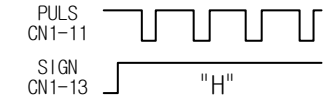
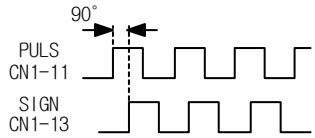
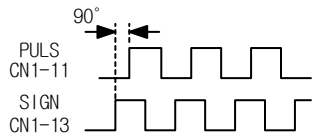
I/O cable length is restricted as follows

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

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

B. Position Command Pulse Form

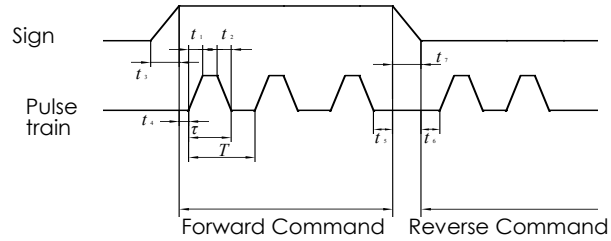
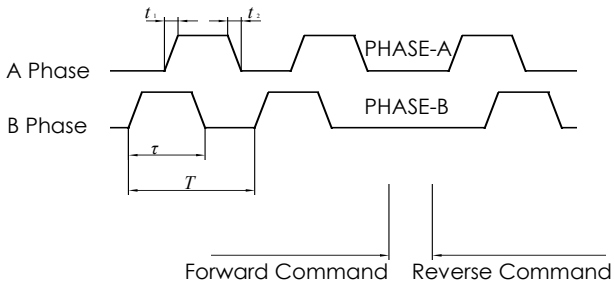
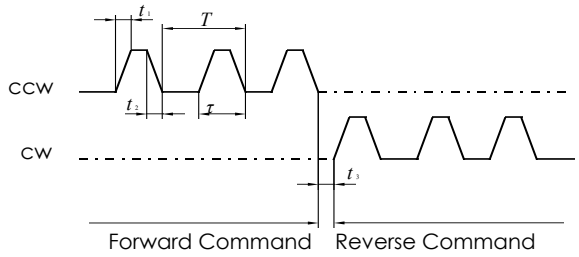
Table 6.9 Position Command Pulse Form (Set in SEt-46 LED No.1)

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

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 "**C. Electrical Specifications of Command Pulse**". In case of which the timing is inappropriate, position shift may occur.

C. Electrical Specifications of Command Pulse

Table 6.10 Electrical Specifications of Position Command Pulse

Command Pulse Form	Electrical Specifications	Note
Pulse train + Sign	 $t_1, t_2 \le 0.1\mu s \quad \tau \ge 1.1\mu s$ $t_3, t_7 \le 0.1\mu s$ $t_4, t_5, t_6 \rangle 3\mu s$	Sign Forward : High level Reverse: Low level Maximum Command Frequency : 450Kpps
2 Phase pulse train of 90° Difference (A,B Phase)	 $t_1, t_2 \le 0.1\mu s \quad \tau \ge 1.1\mu s$ $\frac{\tau}{T} \times 100 \le 50\%$	Maximum Command Frequency 1Multiplication: 450Kpps 2 Multiplication: 400Kpps 4 Multiplication: 200Kpps
CW + CCW	 $t_1, t_2 \le 0.1\mu s \quad \tau \ge 1.1\mu s$ $t_3 \rangle 3\mu s \quad \frac{\tau}{T} \times 100 \le 50\%$	Maximum Command Frequency : 450Kpps

D. Position Counter Clear

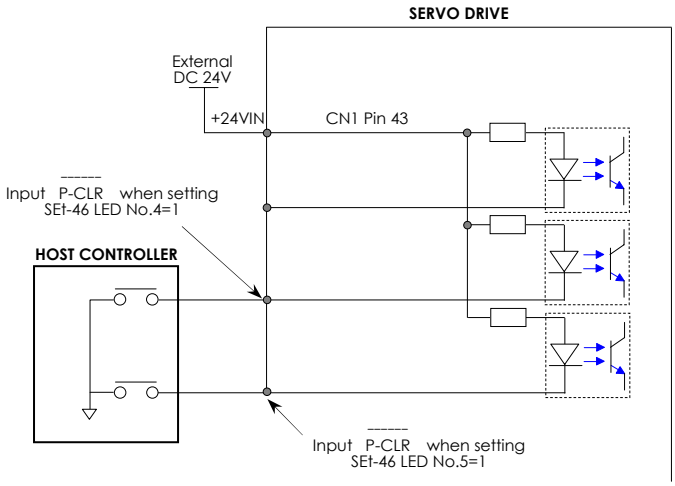


Fig 6.20 $\overline{\text{P-CLR}}$ Signal Usage

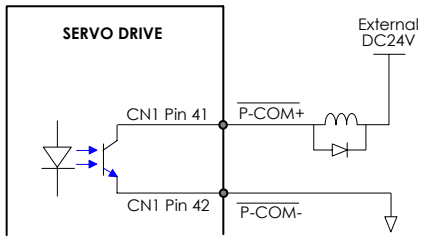
- In position control mode, set 1 in SEt-46 LED No. 4 or 5 in order to use CN1 pin 10 or 15 as position counter clear pin.
- During the position control operation, if $\overline{\text{P-CLR}}$ function is on, make the position command and position error 0(Con-09=Con-06=0), and stop with zero speed command.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

E. 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)

This output signal indicates that motor operation is complete during position control.



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

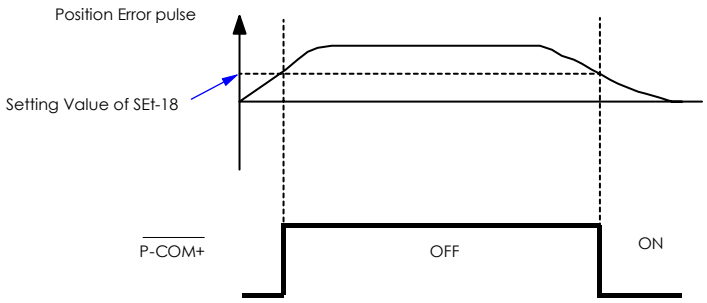


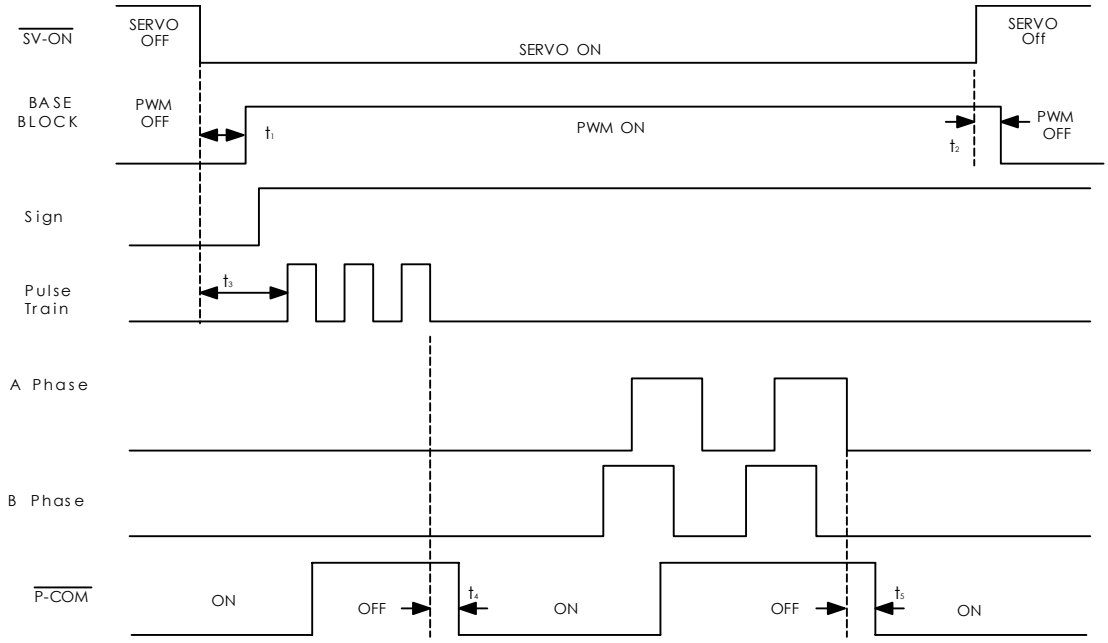
Fig 6.21 Output Width of Position Completion Signal

Warning

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.

F. I/O Signal Timing



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

Fig 6.22 I/O Signal Timing Chart

G. Position/Speed Control Mode

Input terminal $\overline{\text{P-CON}}$ 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	$\overline{\text{P-CON}}$ 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. P-CON terminal is ON.	**Caution 1 :** If those three conditions are not satisfied, cannot be changed to speed control mode. **Caution 2 :** 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. **Caution 3 :** 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. P-CON Terminal is OFF.	**Caution 1 :** 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. **Caution 2 :** 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.

6.6 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.

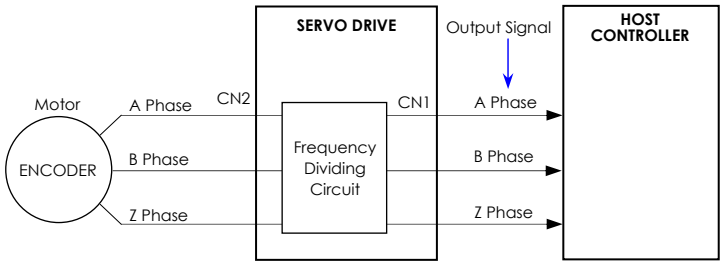


Fig 6.23 Using the Encoder Output Signal

- 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

Warning

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

If it does not satisfy the condition above, Phase difference of A and B phase does not become 90 ° .

It is not related to electronic gear ratio.

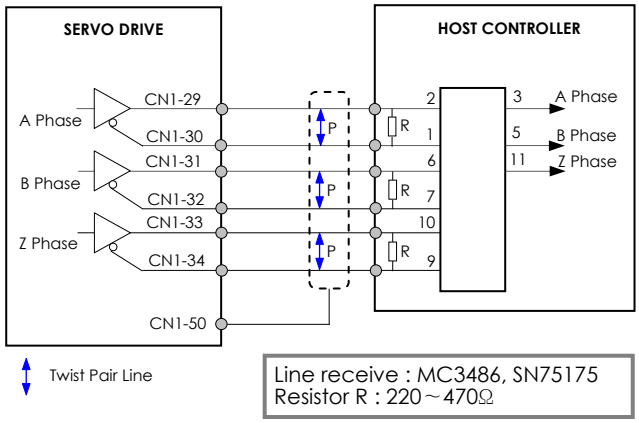


Fig 6.24 Example of Wiring between Incremental Encoder Output and Host Controller

Warning

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**

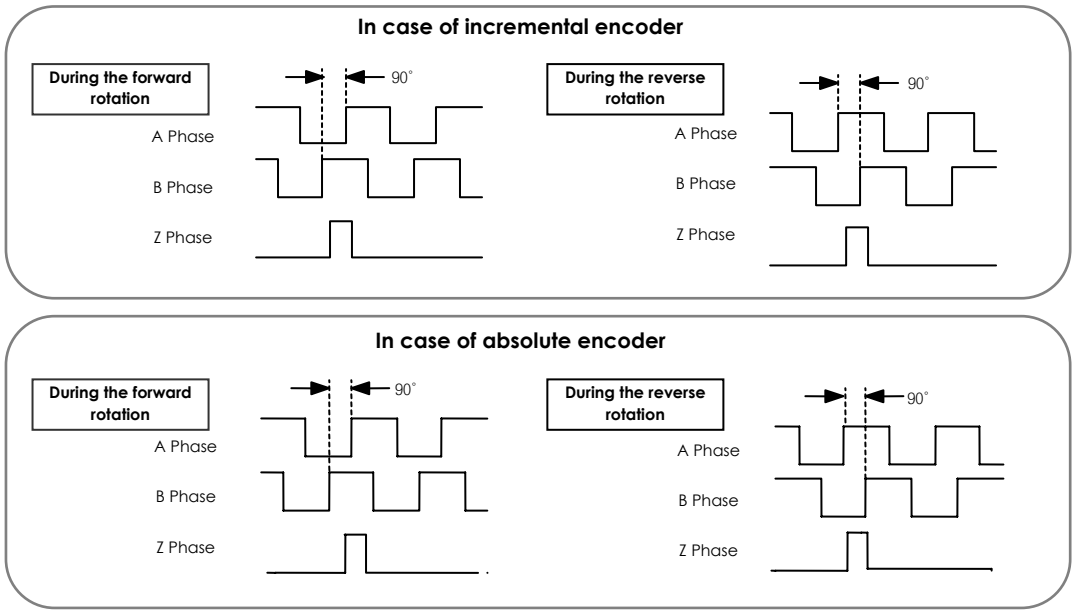


Fig 6.25 Encoder Output Pulse Form

- **I/O**

I/O	Pin No.	Description	Output type
EA	CN1 Pin 29	Encoder A phase output	Line Driver MC3487
$\overline{EA}$	CN1 Pin 30	Encoder $\overline{A}$ phase output	
EB	CN1 Pin 31	Encoder B phase output	
$\overline{EB}$	CN1 Pin 32	Encoder $\overline{B}$ phase output	
EC	CN1 Pin 33	Encoder C phase output	
$\overline{EC}$	CN1 Pin 34	Encoder $\overline{C}$ 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
$\overline{PS}$	CN1 Pin 36		
$\overline{Z\text{-PULSE}}$+	CN1 Pin 17	Encoder $\overline{Z\text{-PULSE}}$ output	Open Collector
$\overline{Z\text{-PULSE}}$-	CN1 Pin 18		

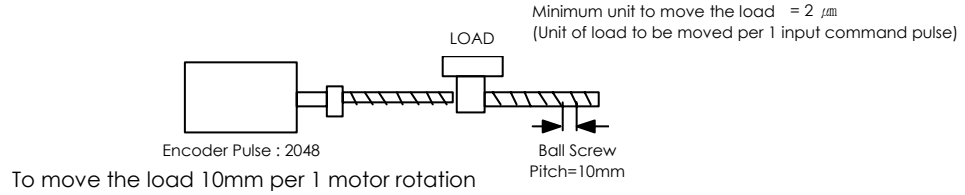
6.7 Electronic Gear

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 ×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.

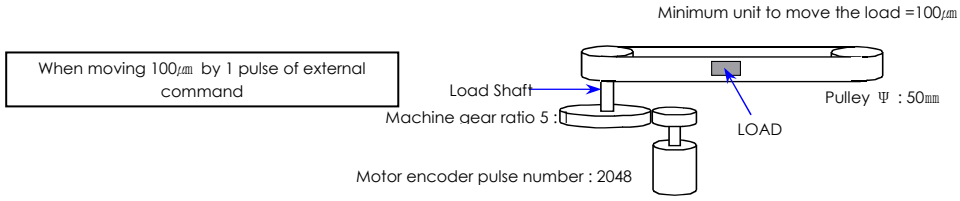


To move the load 10mm per 1 motor rotation

$$\frac{10\text{㎜}}{2\ \text{㎛}} = 5000\ \text{Pulse}$$

Thus, setting value for electronic gear is SEt-36 = 2048 (Number of pulse per 1 motor rotation), SEt-37 = 5000.

Fig 6.26 Example of Electronic Gear Setting (Ball Screw)

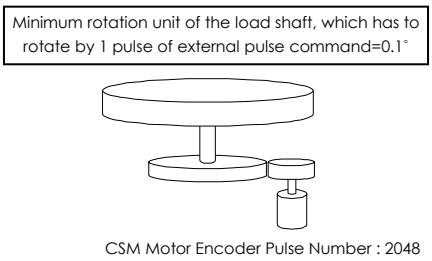


$$\text{Command Unit} = \frac{\text{Load movement amount per 1 load shaft rotation}}{\text{Minimum movement unit of load}} = \frac{3.14\times 50\text{㎜}}{100\text{㎛}} = 1570$$

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 (Belt+Pulley)



$$\text{Command Unit} = \frac{\text{Load movement amount per 1 load shaft rotation}}{\text{Minimum rotation unit of load}} = \frac{360^\circ}{0.1^\circ} = 3600$$

Electronic gear ratio setting :

$$\frac{2048\times3}{3600} = \frac{6144}{3600} = \frac{\text{Setting value of SEt-36}}{\text{Setting value of SEt-37}}$$

Fig 6.28 Example of Electronic Gear Setting (Turn Table)

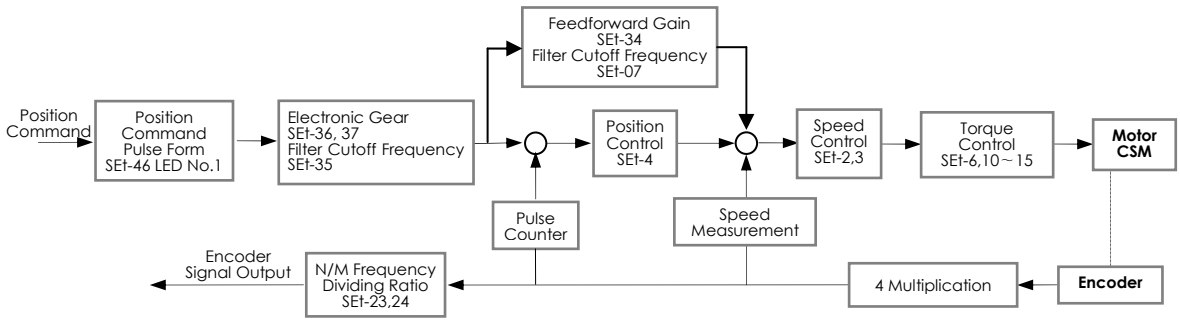


Fig 6.29 Block Diagram of Electronic Gear

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

[Number of pulse per 1 motor rotation] × [Machine gear ratio of load and motor shaft] × 4 ≥ [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 ×4 pulses per 1 motor rotation

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

Warning

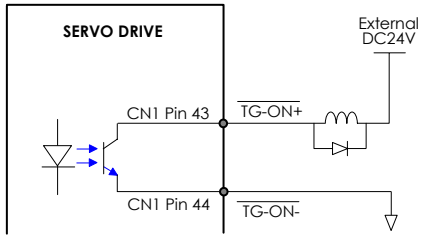
The position control resolution of CSDJ Plus Servo Drive is ±1 pulse.
In fig 6.23, SEt-36=2048 and the maximum value that can be obtained of SEt-37 is 2048 × 4=8192. Thus, minimum unit which moves by 1 command pulse can be calculated as shown below.

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

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

6.8 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 $\overline{\text{TG-ON}}$ Output Signal Function	0 (Factory setting)	0,1	-	Uses $\overline{\text{TG-ON}}$ as a Rotation detection output signal.
SEt-16	$\overline{\text{TG-ON}}$ Speed Level	20 (Factory setting)	0~1000	RPM	

Operate in all control modes.
When SEt-43 LED No.4 = 1, $\overline{\text{TG-ON}}$ signal operates as other function (Uses $\overline{\text{TG-ON}}$ as a torque limit output signal.)

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

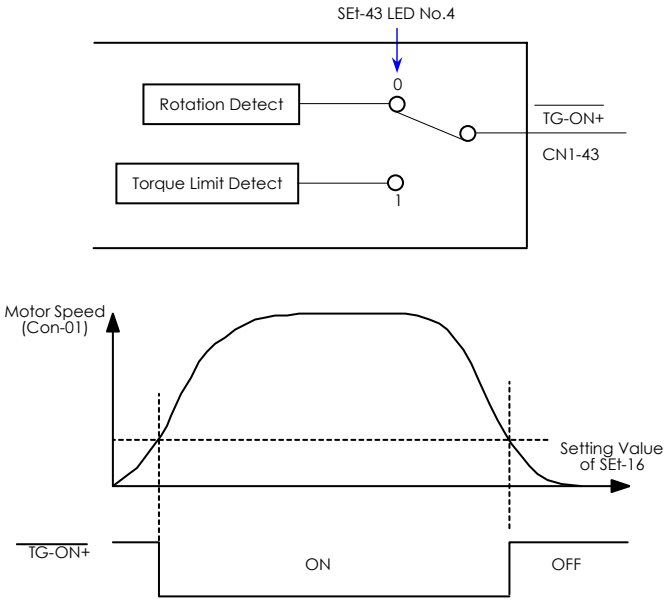
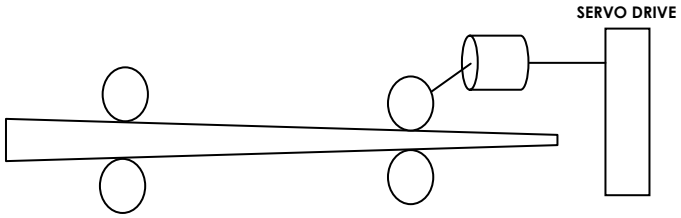


Fig 6.30 Rotation Detection Output Signal

6.9 Torque Control

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



A. 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) _____ P-CON: ON – Speed control mode; OFF – Torque control mode with speed limit
		7	Position/Torque Control _____ P-CON: ON – Torque control mode; 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)

B. 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)

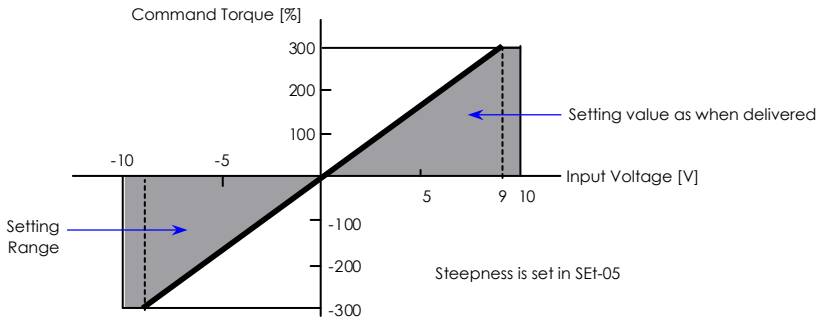


Fig 6.31 Input Voltage and Command Torque

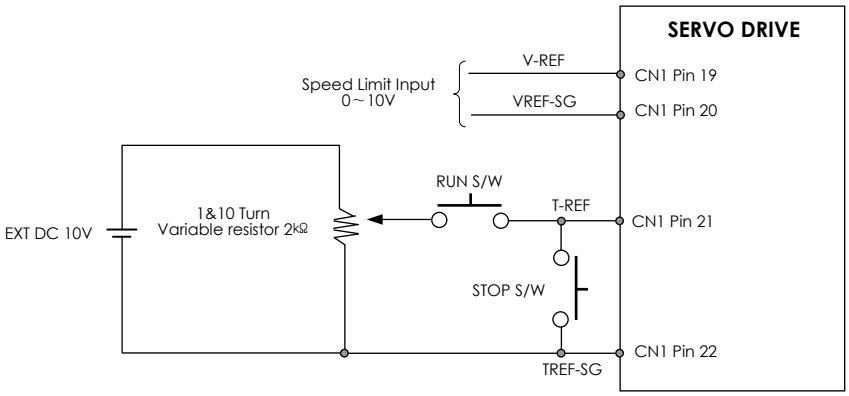


Fig 6.32 Torque Command Input Circuit

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

C. Limiting the Speed during the Torque Control

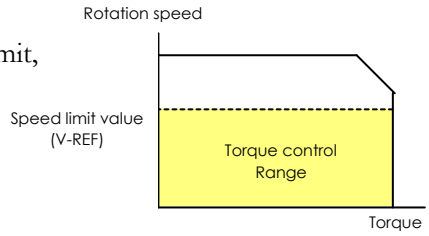
In order to limit the motor rotation speed during the torque control, first, control mode must be set in speed/torque control mode with speed limit.

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

D. Position/Torque Control Mode

Conversion to position/torque control mode is possible through ON/OFF of $\overline{\text{P-CON}}$ input terminal.

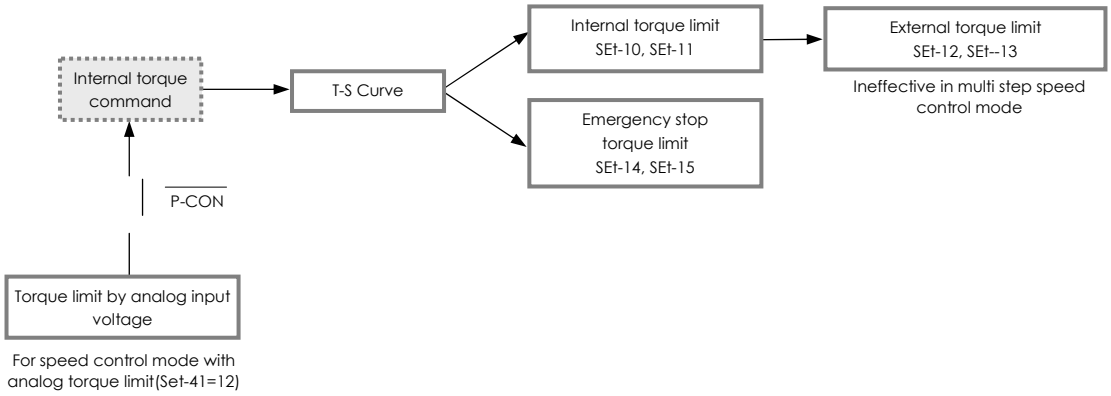
Table 6.13 Position/Torque Control Mode Setting

Content	Description	Note
Mode Setting Parameter	SEt-41 = 7	Setting value is effective after power OFF/ON
Control Mode Conversion	$\overline{\text{P-CON}}$ 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. $\overline{\text{P-CON}}$ Terminal on.	**Caution 1 :** If those three conditions are not satisfied, it cannot be changed to torque control mode. **Caution 2 :** 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. $\overline{\text{P-CON}}$ Terminal OFF.	**Caution 1 :** 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.

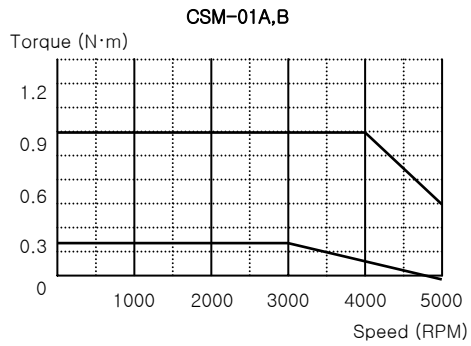
Caution: Operate autotuning in position control mode. When autotuning is operated in torque control mode, position/speed gain may not be set automatically.

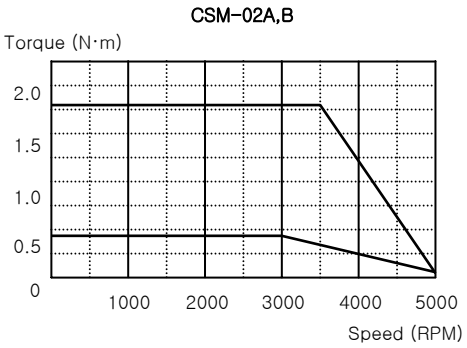
E. Torque Limit

- **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 I/O: _____ P-CON; Condition: OFF → Control Mode: Speed Control → Analog Torque Limit: Ineffective; Condition: ON → Control Mode: Speed Control → Analog Torque Limit: Effective	Power OFF/ON
SEt-05	External Torque Command Gain	- Sets limit torque per 3V input voltage at % unit. - Torque limit value is recognized as absolute value.	

- **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.

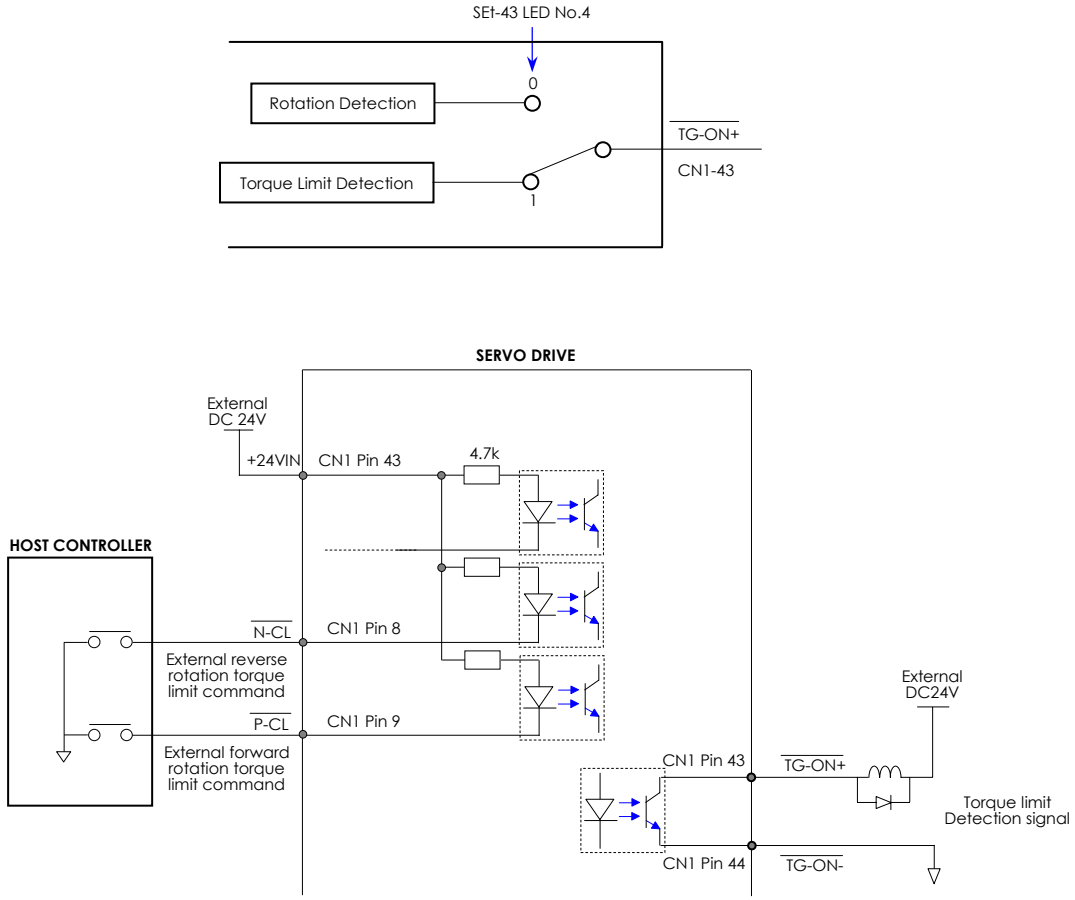


Fig 6.33 External Torque Limit Command and Torque Limit Detection Output Signal

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

6.10 Setting of Servo Drive Gain

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

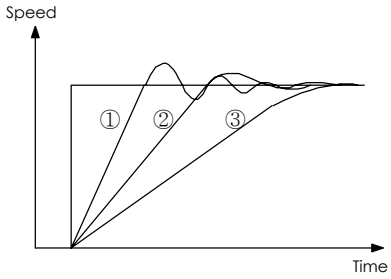
CSDJ Plus Servo Drive can set the following gain.

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	- This is a parameter which decides on response performance of the speed control. - 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. - Set the value high if the load inertia increases.	Speed/ Position
SEt-03	Speed Loop Integration Gain	0~10000	Non-load Gain	- If the value is set highly, transient response performance is better and speed error in steady state reduces. - If the value is too high, overshoot or undershoot increases in transient state. It must be used in appropriate range.	Speed/ Position
SEt-04	Position Loop Proportion Gain	0~500	50	- A parameter, which decides on response performance of position control. - 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. - In case of which the gain is too high, vibration occurs and machine parts has noises.	Position
SEt-34	Position FF Gain	0~100	0	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.	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/Integration Gain Value**



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.

- **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 the 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.

Warning

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,

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	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. 10 Low Rigidity : : 20 Medium Rigidity : : 50 High Rigidity : : - 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. - The following parameter changes on the basis of the setting value Set-42. SEt-02: Speed Loop Proportion Gain SEt-03: Speed Loop Integration Gain SEt-04: Position Loop Proportion Gain (During position control) SEt-06: Torque Command 1 Filter Cut-off Frequency SEt-40: Speed Command 1 Filter Cut-off Frequency (During position control)	0～100	20

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

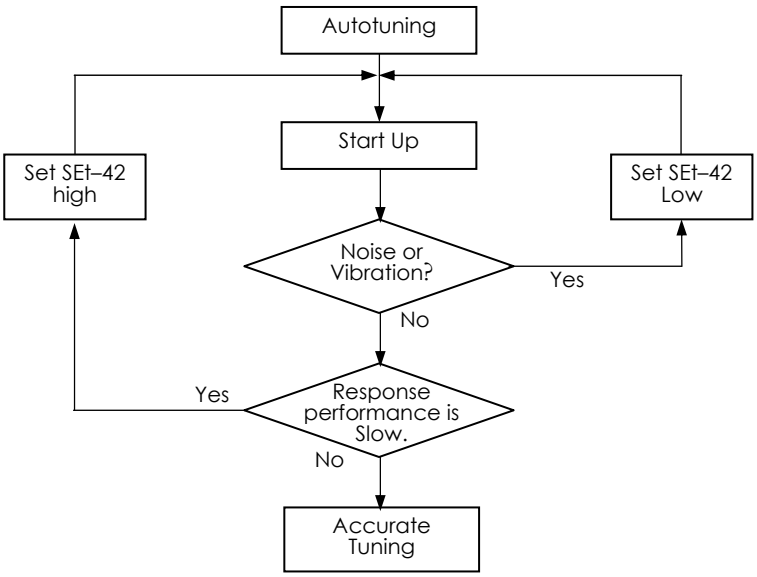


Fig 6.34 Gain Tuning

6.11 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.)

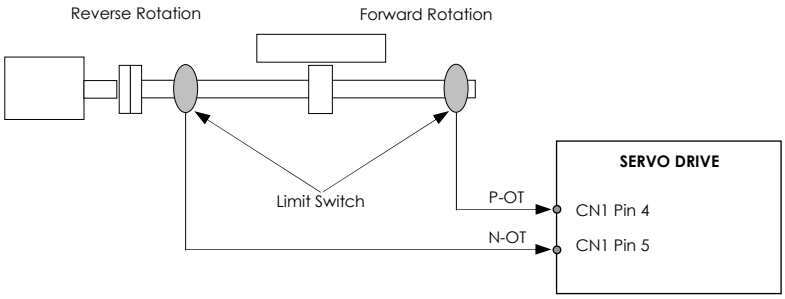


Fig 6.35 Using the Rotation Prohibition Input Signal

Warning 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).

MEMO

Chapter 7

Application of Other Functions

MEMO

7.1 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.

Dynamic Brake (DB) stops the motor by short-circuiting the circuit of the servo motor.

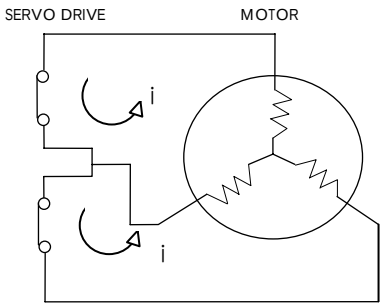


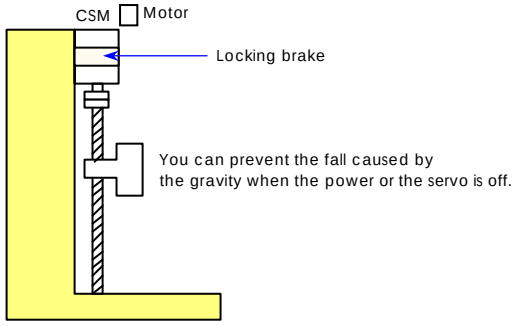
Fig 7.1 Dynamic Brake

- 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) $\overline{\text{E-STOP}}$ signal is on and when SEt-44 LED No.1 = 0

※Refer to 6.4 Selection of stop method.

7.2 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.



Warning

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.

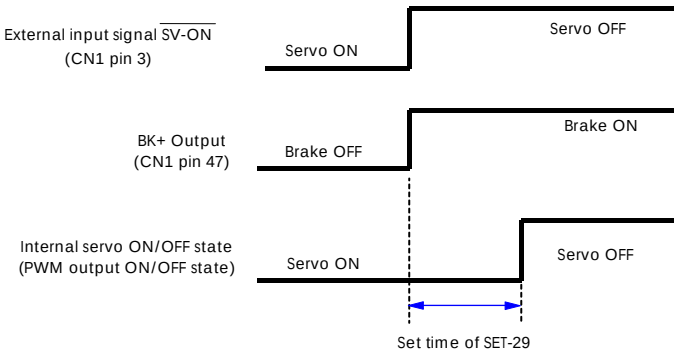


Fig 7.2 Timing Chart of Servo OFF Input Signal and Brake Control Output Signal

- **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

Adjust by watching the operation of motor.

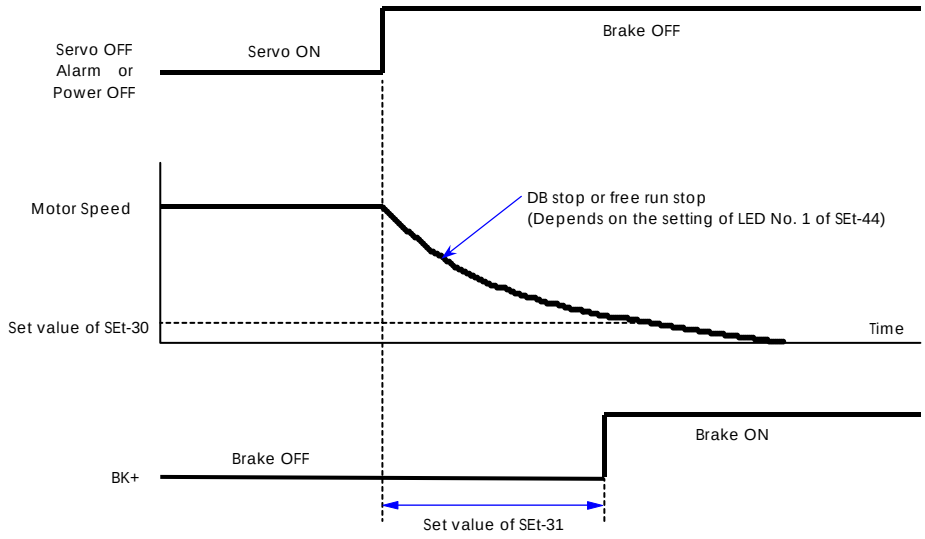


Fig 7.3 Timing Chart of Brake Control Signal when the Motor is Stopped during the Rotation

- **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 cause an error in the operation of the servo drive.

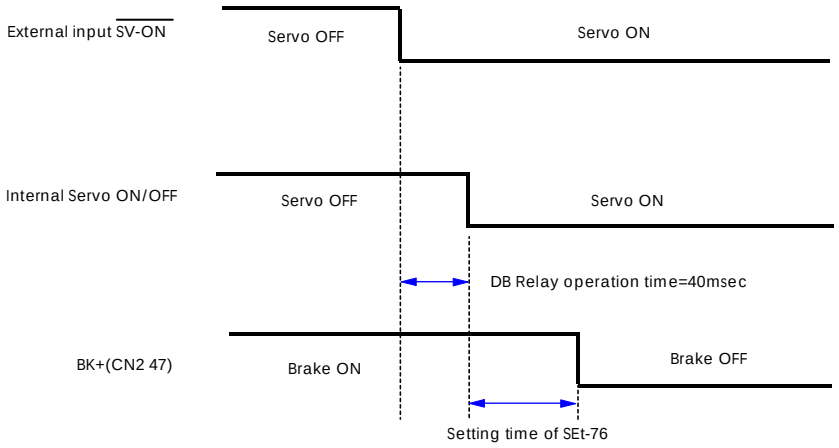


Fig 7.4 Timing Chart of Brake Control Signal at Servo ON

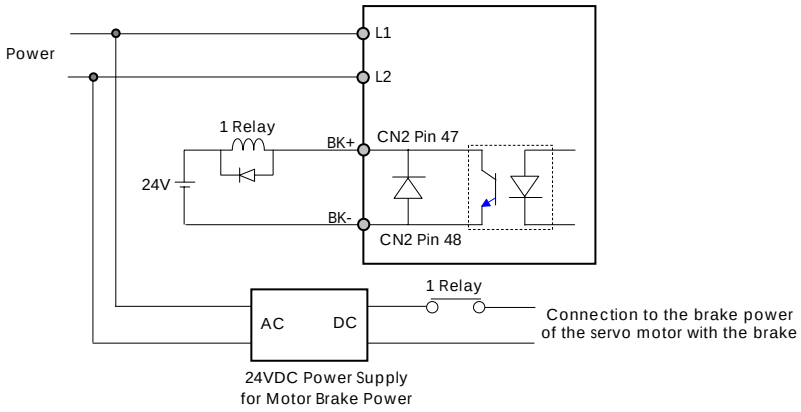
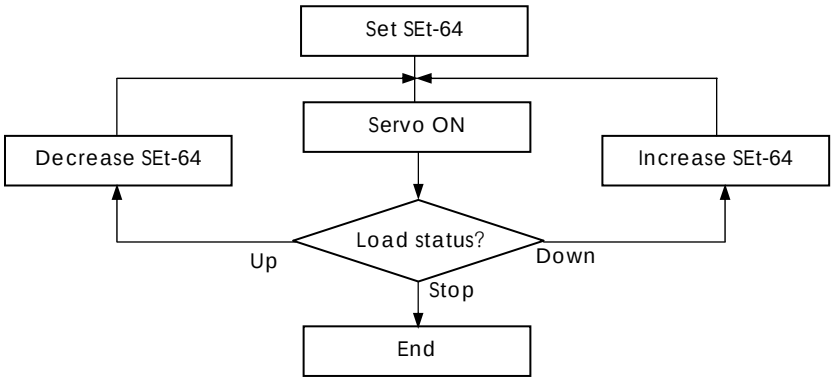


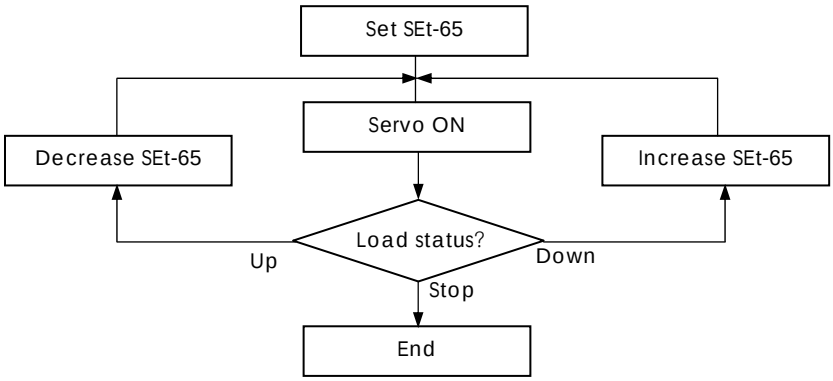
Fig 7.5 Using Brake Relay

- **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.



7.3 Using an Absolute Encoder

A. Absolute Encoder Data Transmitting by Serial Interface

Provide an external battery for the **'Absolute Encoder '** to remember the position information even when power is off. If the absolute encoder is used, it is possible to make a system in the host controller, which can operate automatically without the [origin point return], after turning on the power.

Prepare a battery on the host controller side as shown in the figure below.

Warning

Be sure to connect the battery in order to prevent the bad contact due to the environmental change.

Keep the minimum voltage of 2.8V and if necessary, prepare a voltage drop detecting circuit..

Standard wiring of 'Absolute Encoder attached in servo motor is as shown below.

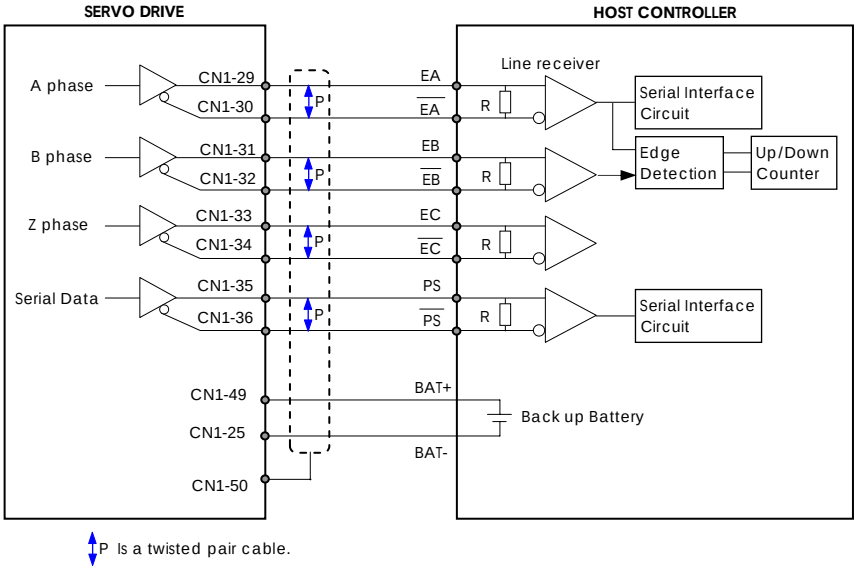
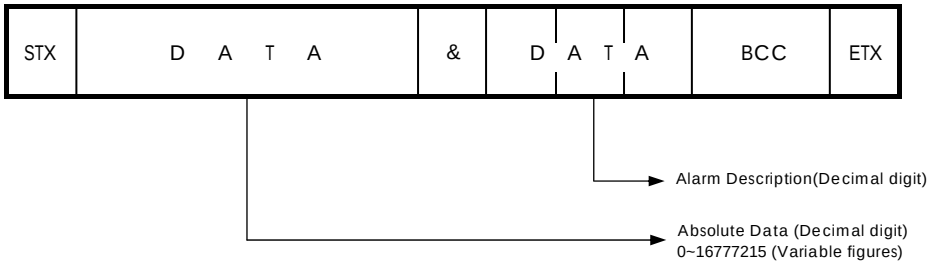


Fig 7.6 Wiring with the Host Controller when Absolute Encoder is used

- **Basic Structure of Data Frame for communication with host controller**
  - Baud rate ; 9600 bps
  - Parity ; None
  - Start Bit ; 1 bit
  - Stop Bit ; 1 bit
  - Character Code ; ASCII Code
  - Data Format ; 8 ~ 15 character(including STX,ETX)



  - Content of Data: Among the 24bit absolute data, the lower 11 bit are the data within one revolution and the upper 13 bit are the multi-revolution data.
    (24bit in maximum by converting decimal digit to hexadecimal digit.)
  - Transmission Period of Data: Transmits in every 50msec.
  - Recommended Usage: In Servo OFF status, read the data and write it to the position counter in the host controller.
  - Transmission character

Table 7.2 Transmission Character of Absolute Encoder

Name	Character	ASCII	Description
Packet Start	STX	02H	Indicates the start of packet at the first of message.
Packet End	ETX	03H	Indicates the end of packet at the end of message.

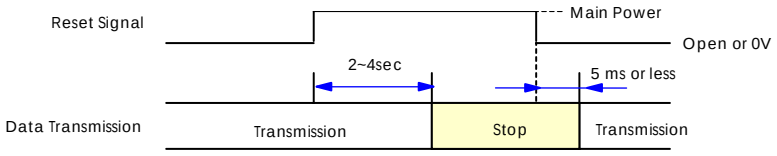
B. Absolute Encoder Reset

- By setting SEt-46 LED No.5=4, set the CN1 pin 15 to $\overline{\text{ABS\_RST}}$ input terminal. (Factory setting)
  To set the CN1 pin 10 to $\overline{\text{ABS\_RST}}$ input terminal, set to SEt-46 LED No.4=4.

Case 1. Alarm Reset using the $\overline{\text{ABS\_RST}}$ input terminal (CN1 15)

(1) When turning on the $\overline{\text{ABS\_RST}}$ input terminal for more than 4 seconds, counter overflow, battery error, over speed, multi rotation data are reset.

(2) Once the reset is ON, data transmission from the encoder to servo drive is stopped. Timing is as follows.



(3) Reset operation is only effective when the encoder power is on.
Do not reset during blackout operation (main power is cut off and battery is connected).

Case 2. Absolute Encoder Reset Using the Operator

(1) When E.35(low voltage of the capacitor inside the absolute encoder) and E37(excessive speed in case of black out of absolute encoder) occur, operate alarm reset (refer to 4.7 E. Alarm Reset) using the operator to reset overflow, battery error, over speed, multi rotation data.

(2) Reset operation is only effective when main power is on.
Do not reset the encoder during operating in blackout (main power is cut off and the battery is connected).

C. Absolute Encoder Data Transmitting by switching of I/O port

• Parameter Setting

- To use pin 10 or 15 of CN1 as the Absolute Encoder Data Transmitting Mode signal input, Set '5' in SEt-46 LED no.4 or 5

	LED no.	Value	Function
SEt-46	4	5	Pin 10 of CN1 is used for Absolute Encoder Data Transmitting Mode signal input
	5	5	Pin 15 of CN1 is used for Absolute Encoder Data Transmitting Mode signal input

- In SEt-77, set a value relevant to 1 rotation of motor. For example, In case of SEt-77=2048, the transmitted absolute encoder data including 1 rotation data increase or decrease by 2048 whenever motor rotate once. If the motor rotates three times and a half, the data increase or decrease by 7168 over that of last data.
- **The setting data must be 2^n**. Otherwise, the rotation data cannot be calculated

	Function	Initial Value	Range
SEt-77	Set a value relevant to 1 rotation of motor	2048	0 ~ 8192

• Absolute Encoder Data Reset

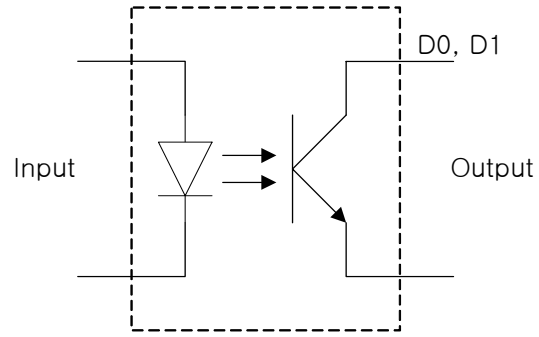
Absolute Encoder Data Reset makes the number of rotation data '0', But the data within 1 rotation remain. Therefore, the absolute encoder data is within 0~(SEt-77 value – 1) after reset operation.

• Description of Signal Output Port

- To transmit absolute encoder data by switching of I/O port, use the following I/O port.
- Absolute Encoder Data Transmitting Mode(AEDTM) is available only when AEDTM signal input is on. If AEDTM signal input is off, the I/O port turns back to the default function.

Signal Name	Code	Pin No.	Function when AEDTM is off	I/O
Absolute Encoder Data Transmitting Mode	AEDTM	CN1-10 or 15	-	I
Absolute Encoder Data Request	AR	CN1-06	/P-CON	I
Absolute Encoder Data Bit 0	D0	CN1-38	AL2	O
Absolute Encoder Data Bit 1	D1	CN1-39	AL3	O
Send Data Ready	SDR	CN1-37	AL1	O

• **Definition of On/Off switching**



Output	Condition	Bit(D0, D1)
On	LED is On	1
Off	LED is Off	0

※Emitters of AL1, AL2, AL3 Output Photo TRs are common. Refer to 2-14 in Chapter 2

Warning

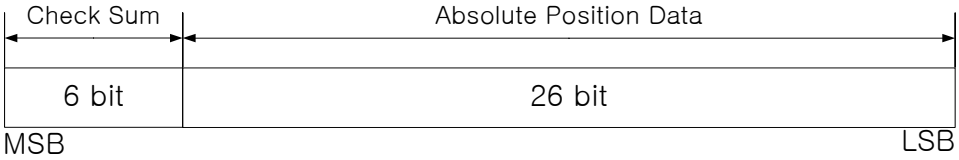
The number of rotation data range is within 0 ~ 8191

1 rotation data is within 0~(SEt-77 value – 1). Thus the total rotation data is within 0 ~ (8192*SEt-77 value – 1).

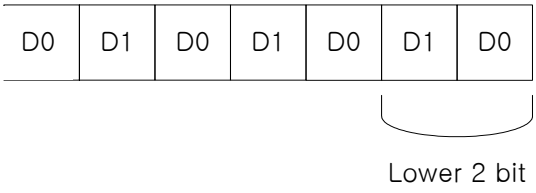
The absolute Encoder data is not negative value. For example, In case of SEt-77=8192, the absolute encoder data is within 0 ~ 67108863. When motor keep on rotating forward, the data change likely as 0, 1, …, 67108863, 0, 1, …

• **Operation**

The following 32 bit data packet is transmitted to a master controller. The Data transmitting is progressed without regard to Servo-On/Off status



- Every 2 bit from LSB to MSB is transmitted by D0, D1.



-Check Sum

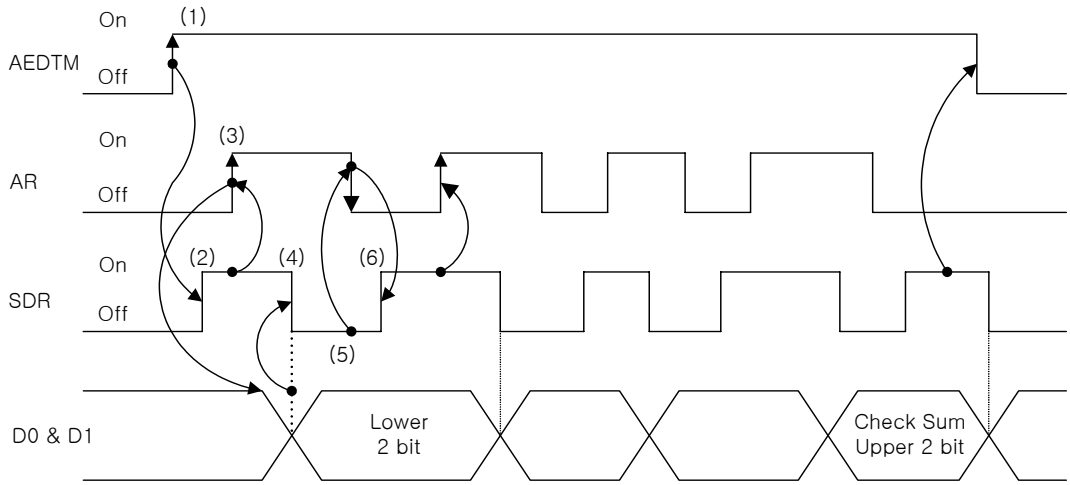
The sum of absolute position data bit becomes check sum bit

Ex) If Absolute Position Data is 22864, The hexadecimal code is 5950h.

5950h = 0101 1001 0101 0000

Then, 00 + 00 + 01 + 01 + 01 + 10 + 01 + 01 = 111

Thus, The check sum 6 bits is 000111



(1) If AEDTM signal input is on, the servo drive recognizes the AEDTM and makes the data to transmit to a master controller by reading the data from absolute encoder. The SDR signal is off then.

(2) The SDR signal turns on.

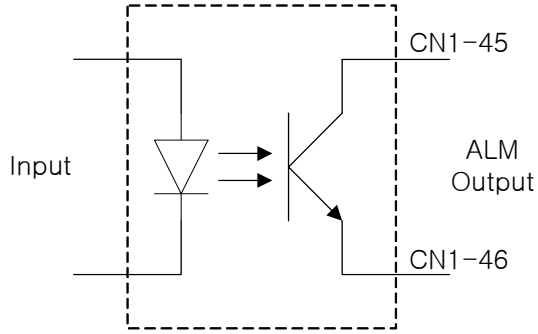
(3) When the SDR signal stays on and the AR signal input is on, the data is transmitted by D0, D1 at the rising edge of the AR signal.

(4) The SDR signal turns off.

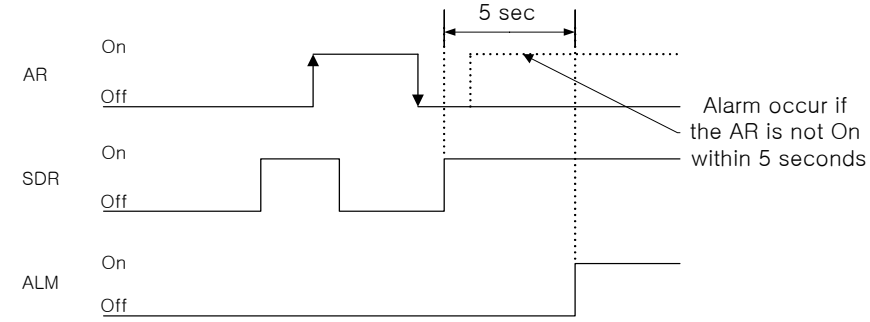
(5) After master controller reads the absolute encoder data, turns the AR signal off.

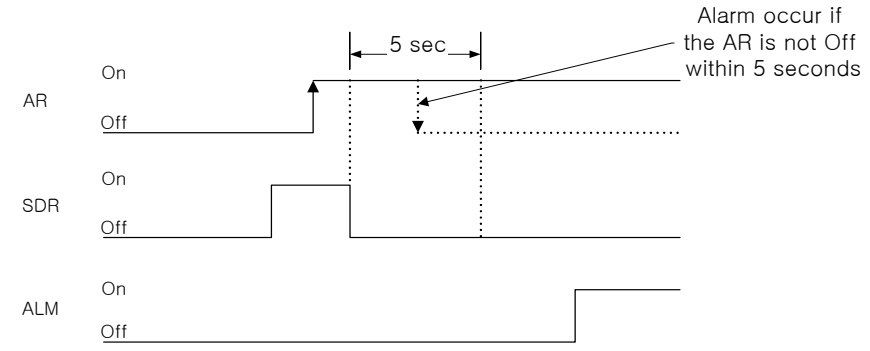
(6) The SDR signal turns on when the servo drive recognizes the falling edge of the AR signal.

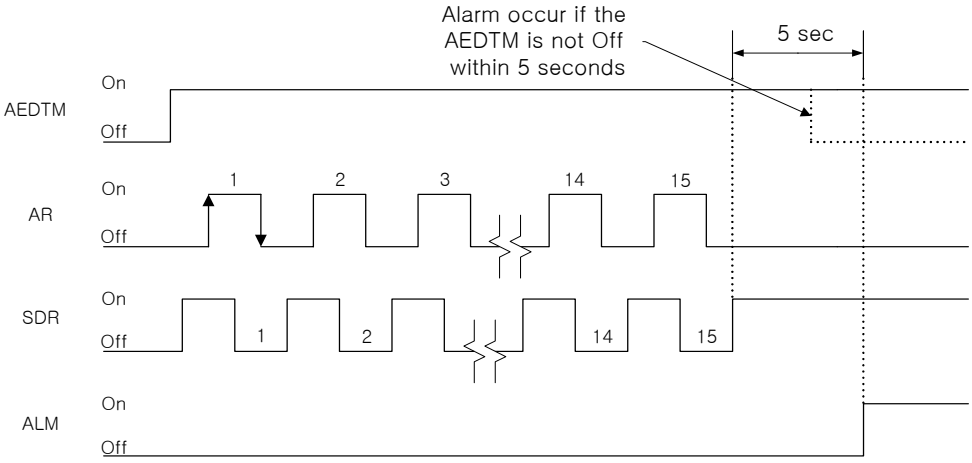
• **Error Processing**



Condition	ALM output
LED is On	On
LED is Off	Off

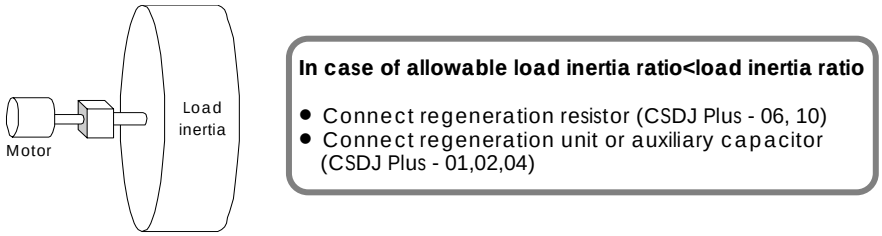






7.4 Regeneration

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 (refer to the table 7.3). 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.

A. 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.

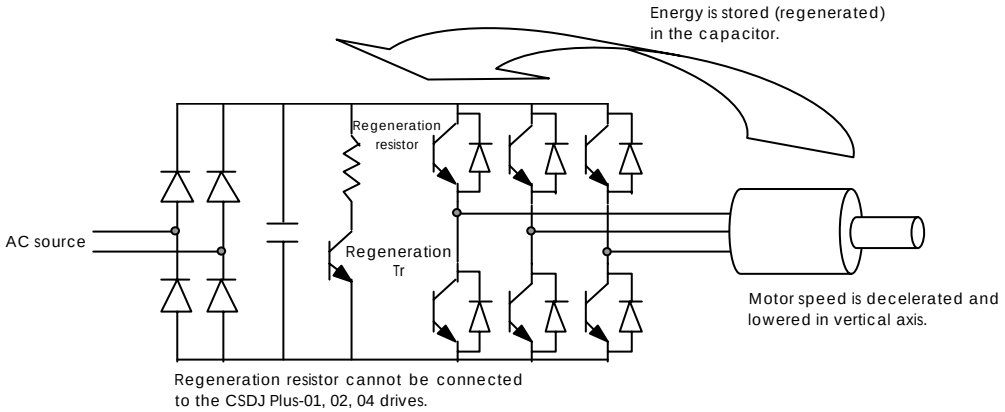


Fig 7.7 Regenerative Energy

B. 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 check in Con-13 after autotuning.

Table 7.3 Allowable Load Inertia Ratio
(When regeneration resistor is not connected and when operated at a rated speed)

Motor	220V								110V					
	A3B 30W	A5B 50W	01B 100W	02B 200W	04B 400W	06B 600W	08B 800W	10B 1kW	A2A 15W	A3A 30W	A5A 50W	01A 100W	02A 200W	04A 400W
CSM	30	30	30	23	12	7	6	3.5	30	30	30	30	30	30
CSMP	-	-	26	10	5	-	-	-	-	-	-	-	-	-
CSMQ	-	-	27	12	6	-	-	-	-	-	-	30	27	24
CSMZ	30	30	30	30	28	12	5	-	-	30	30	30	30	30
	200W	300W	400W	450W	500W	600W	750W	850W	900W	1kW				
CSMD	-	-	-	-	-	-	5.5	-	-	2				
CSMS	-	-	-	-	-	-	-	-	-	5				
CSMF	-	-	7	-	-	-	Ref 1)	-	-	-				
CSMH	-	-	-	-	Ref 1)	-	-	-	-	Ref 1)				
CSMN	-	5	-	-	-	4	-	-	1.5	-				
CSMX	26	13	-	-	-	2.5	-	-	Ref 1)	-				

Reference 1)
The inertia ratio is below 1.
Use regeneration resist or regeneration unit or auxiliary capacitor.

Warning

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 condition Refer to [C. Vertical Load].

Warning

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.

C. 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.

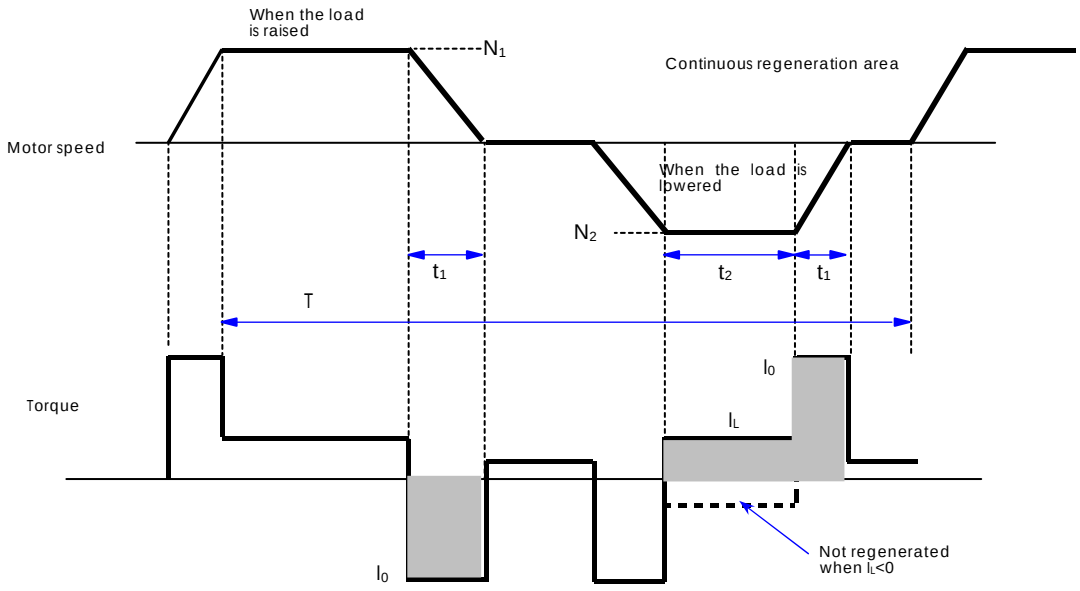


Fig 7.8 Operation Pattern of Vertical Load

D. Regeneration Resistor

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 50Ω, 150W as a standard. Contract the agencies for more information.

Table 7.4 Regeneration Resistor

Model	Regeneration Resistor
Capacity	0.6~1kW
Internal resistor	-
External resistor	50Ω 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

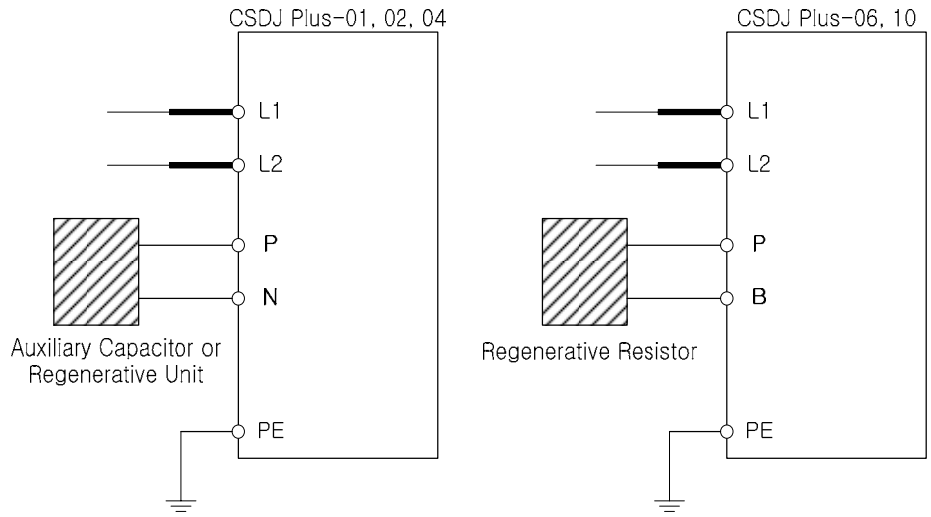


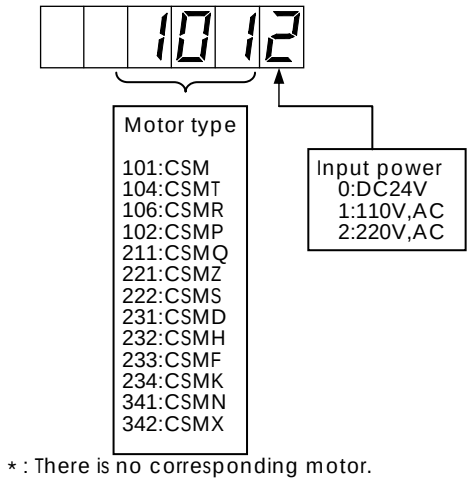
Fig 7.9 Regeneration Resistor and Regeneration Unit Connection

7.5 Setting of Motor Type and Capacity

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.

- **Setting of Motor Type**



Motor Type	DC24V	110V	220V
CSM	1010	1011	1012
CSMT	1040	*	1042
CSMR	*	*	1062
CSMP	*	*	1022
CSMQ	*	2111	2112
CSMZ	*	2211	2212
CSMS	*	*	2222
CSMD	*	*	2312
CSMH	*	*	2322
CSMF	*	*	2332
CSMK	*	*	2342
CSMN	*	*	3412
CSMX	*	*	3422

Fig 7.10 Setting of Motor Type (SEt-52)

- **Setting the Motor Capacity**

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

Table 7.5 Setting of CSM/P/Q/Z Motor Capacity (SEt-53)

Motor type	24VDC				220V							
	30W	50W	100W	200W	30W	50W	100W	200W	400W	600W	800W	1kW
CSM CSMT	3	5	10	20	3	5	10	20	40	60	80	100
CSMP CSMR	*	*	*	*	*	*	10	20	40	*	*	*
CSMQ	*	*	*	*	*	*	10	20	40	*	80	*
CSMZ	*	*	*	*	3	5	10	20	40	*	80	*

*: There is no corresponding motor.

Table 7.6 Setting of CSMD/S/F/H/N/X/K Motor Capacity (SEt-53)

Capacity / Motor type	200W	300W	400W	450W	500W	600W	750W	850W	900W	1kW
CSMD	*	*	*	*	*	*	75	*	*	100
CSMS	*	*	*	*	*	*	*	*	*	100
CSMF	*	*	40	*	*	*	75	*	*	*
CSMH	*	*	*	*	50	*	*	*	*	100
CSMN	*	30	*	*	*	60	*	*	90	*
CSMX	20	30	*	*	50	*	*	85	*	*
CSMK	*	30	*	*	*	60	*	*	90	*

* : There is no corresponding motor.

7.6 Setting of Encoder Type (SEt-51)

Table 7.7 Setting of Encoder Type

CSM,CSMP,CSMT,CSMR		CSMD/S/F/H/Q/Z/K		CSMN/X	
Setting	**Encoder Type**	**Setting**	**Encoder Type**	**Setting**	**Encoder Type**
0	15 wire incremental 2048 pulse	100	11 wire incremental 2500 pulse	300	15 wire incremental 6000 pulse
1	9 wire incremental 2048 pulse	101	11 wire incremental 2500 pulse	301	15 wire incremental 5000 pulse
2	Absolute 2048 pulse	102	11 wire incremental 2500 pulse	302	15 wire incremental 2500 pulse
3	15 wire incremental 2500 pulse	104	Compact Absolute 2048 pulse	303	15 wire incremental 4000 pulse
4	15 wire incremental 2000 pulse	105	Full Absolute 2048 pulse	304	15 wire incremental 1500 pulse
5	15 wire incremental 5000 pulse	106	11 wire incremental 10000 pulse	305	15 wire incremental 1000 pulse
				307	15 wire incremental 2000 pulse
				308	Full Absolute 2048 pulse

* 「xx wire」 includes PE. (Refer to the table 2.6)
* Refer to the Figure 2-3, ※3.

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Chapter 8

Error Display and Troubleshooting

CSDJ Plus Servo Drive has various protection functions to prevent the damage, which may occur in the driver and motor.

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8.1 Error Occurrence

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

- **CSDJ Plus**

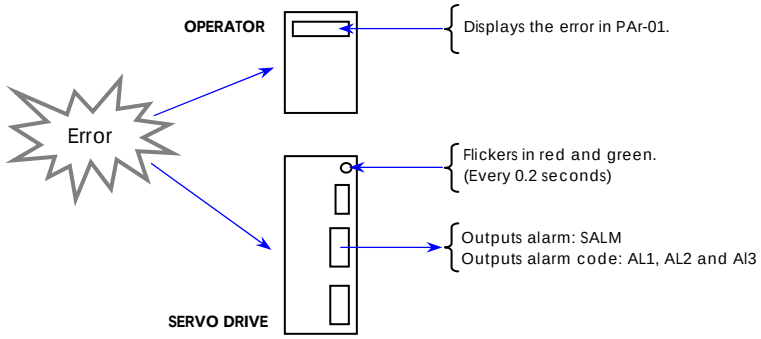

Fig 8.1 Error Occurrence

8.2 Alarm Output Signal

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

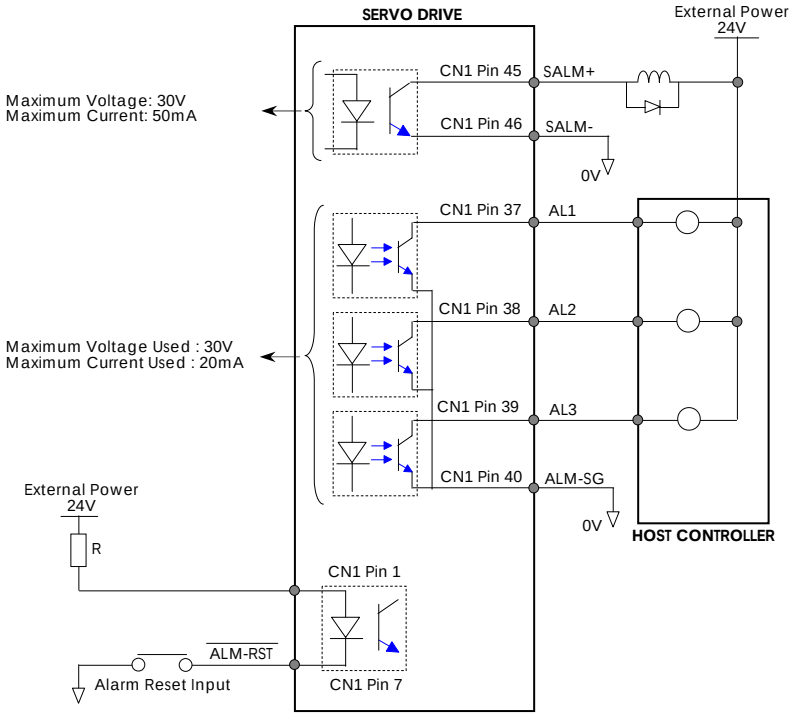

Fig 8.2 Connection Diagram of Alarm Related Output Signal

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. (Normally each terminal always maintains low level.)
AL2	CN1 pin 38	
AL3	CN1 pin 39	
ALM-SG	CN1 pin 40	0V
$\overline{\text{ALM-RST}}$	CN1 pin 7	Alarm Reset Input. - When alarm occurs, eliminate the cause and turn ON the input signal $\overline{\text{ALM-RST}}$ to reset the alarm. - Reset the alarm only when terminal is Open → Closed. (Operate not in LEVEL but EDGE.)

8.3 Alarm Code and Troubleshooting

Table 8.2 Alarm Detect Type

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.
Over heating					E12("oH")	In case of which the servo drive reaches the over heating status. Incorrect operation due to the noise.
Over load	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 error	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 **※1)** 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)

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 Error Display and Troubleshooting

Display	Status When Displayed	Cause	Troubleshooting
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℃ - 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℃
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)

Display	Status when displayed	Cause	Troubleshooting
Overvoltage E50(" oV")	Displays during deceleration	- Load GD^2 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 **Reference)** 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 Communi-cation Error	- Operator key does not operate - Operator LED flickers.	Communication error occurs by noise.	Un-attach and re-attach the operator.

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Chapter 9

Repair and Checking

Chapter 9 explains about repairing and checking of servo drive and servo motor.

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9.1 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 Check, Repair and Cleaning Method

Check and Repair Item	Period	Check and Repairing 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 10 MΩ	Contact our office if less than 10 MΩ
OIL SEAL	Every 5000 Hours	OIL SEAL replacement	
Overall Check	20000 Hours/5 Years	Contact our company	Disassembly and replacement of consumables

9.2 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 Maintaining, Repair, and Check Method of Servo Motor

Symptom	Cause	Checking Method	Troubleshooting
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℃.	Make the ambient temperature lower than 40℃.
	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.

9.3 Troubleshooting due to the Incorrect External Wiring

Symptom	Check Place and Items	Troubleshooting
- MCCB Trip at the same time of power distribution and servo ON - Motor does not rotate after speed command.	- Check of the main circuit wiring motor earth and motor line short. - Alarm Check - Speed Command Check - External Input - Input Power Check - LED Display Check	- Check and repair the wiring - Check causes of alarm, LED display - Check input power line - Check of reference voltage

9.4 Troubleshooting due to the Incorrect Setting

Symptom	Check Place and Items	Troubleshooting
- Motor rotate in speed command 0V.	Speed Zero Offset was not adjusted.	Input 0V in speed command and adjust speed offset.
- Motor vibrates. - Overshoot is big when accelerated or decelerated.	The gain of speed P (SEt-02), I(SEt-03) is too high or not correct.	Adjust gain value . (Adjust after autotuning)

9.5 Items to be Checked Prior to Asking for the Service

Symptom	Troubleshooting
- E80, E81, E82 occur continuously in status display mode.	- 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. - Check motor capacity, motor type setting, and encoder type setting. - After the data initialization, operate power OFF → on to change to position control mode.
- E36 occurs continuously in status display mode.	- Check the setting of encoder type (SEt-51) and motor type (SEt-52). - Check if the encoder cable is disconnected.
- Pulse is transmitted in unexpected way to the Host controller	- Refer to chapter 5, user parameter table, SEt-44 and SEt-46 and check if it is set in appropriate pulse.

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Appendix

Appendix A. Motor Specification

A.1 CSM Motor Specification

- **General Specification**

Table A.1 CSM Motor Specification

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

Content \ CSM Motor		A3B	A5B	01B	02B	04B	06B	08B	10B
Applied to	CSDJ-__BX2	A3	A5	01	02	04	06	10	10
Rated Voltage	V	220							
Rated Output	W	30	50	100	200	400	600	800	1000
Rated Torque	Kgf·cm	0.97	1.62	3.25	6.5	13	19.5	26	30.8
	N·m	0.095	0.16	0.32	0.64	1.27	1.91	2.55	3.02
Instantaneous Max. Torque	Kgf·cm	2.9	4.9	9.7	19.5	39	58.5	78	97.5
	N·m	0.29	0.48	0.95	1.91	3.82	5.73	7.64	9.55
Rated Speed	RPM	3000							
Max. Speed	RPM	5000							3500
Rotor Inertia	$gf \cdot cm \cdot s^2$	0.013	0.023	0.043	0.2	0.37	1.02	1.33	1.65
	$Kg \cdot m^2 \cdot 10^{-4}$	0.013	0.023	0.042	0.2	0.36	1.00	1.30	1.62
Rotor Inertia (with Brake)	$gf \cdot cm \cdot s^2$	0.021	0.031	0.051	0.29	0.46	1.38	1.69	2.01
	$Kg \cdot m^2 \cdot 10^{-4}$	0.021	0.031	0.050	0.29	0.45	1.36	1.66	1.98
Power Rate	kW/s	7.09	11.2	24.1	20.7	44.8	36.5	49.8	62.7
Mechanical Time Constant	ms	1.3	0.9	0.7		0.5	0.6	0.5	
Electrical Time Constant	ms	0.9	1.2	1.4	3.5	3.8	6.4	7.3	7.5
Shaft Friction Torque	Kgf·cm MAX	0.3			0.4		1.0		
Rated Current	A(rms)	0.3	0.5	0.9	1.4	2.7	4.2	4.6	4.4
Instantaneous Max. Currnet	A(rms)	0.9	1.5	2.7	4.2	8.1	12.6	13.8	13.2
Axial Play	mm MAX	0.04							

Content \ CSM Motor		A3B	A5B	01B	02B	04B	06B	08B	10B
Allowable Thrust Load	Kgf MAX	4	4	4	7	7	10		
Allowable Radial Load	Kgf MAX	8			20		35		
Weight (with Brake)	Kg	0.3	0.4	0.5	1.1	1.6	2.6	3.2	3.8
Rotation Direction		U →V →W							
Color		Black							
Oil Seal		Option							

Warning

When using as a rated torque, install on attach aluminum heat sink of 2000×200×6(mm) on the motor. Then, the temperature of the motor is 40℃.

All values are measured in surrounding temperature, 20℃～30℃.

Each values are typical value.

When seal is installed to the motor, allowable derating factor due to friction torque increase during the motor operation is as follows.

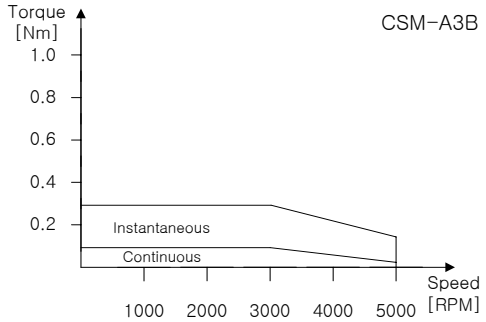
CSM-MODEL NAME	A3A	A5A	01A,02A	04A
Derating factor rate(%)	70	80	90	95

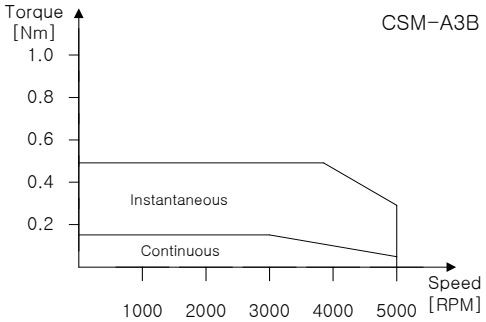
Table A.2 CSM Motor Brake Specification

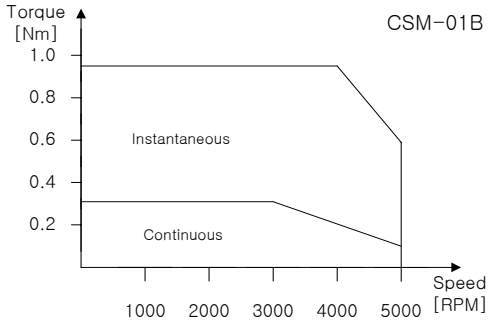
Content \ CSMT Motor		A3B	A5B	01B	02B	04B	06B	08B	10B
Raged Voltage	V	24							
Static Friction Torque	N·m Kgf·cm	3.25			13		26		
Power Dissipation	W	6			8		9		
Brake Pull-in Time	ms MAX	20			30		50		
Brake Release Time	ms MAX	40			50		80		

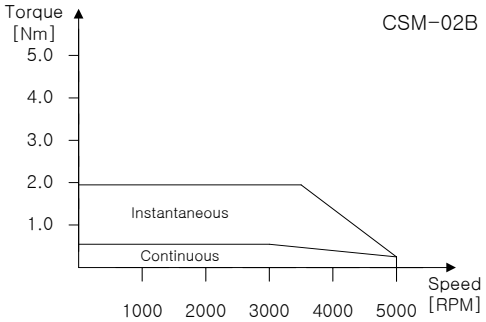
Caution: Total inertia may improve when using brake.

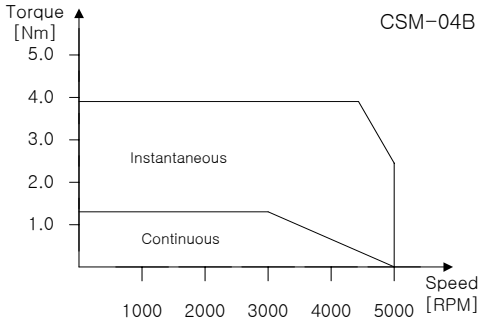
- **Speed-Torque Curve**

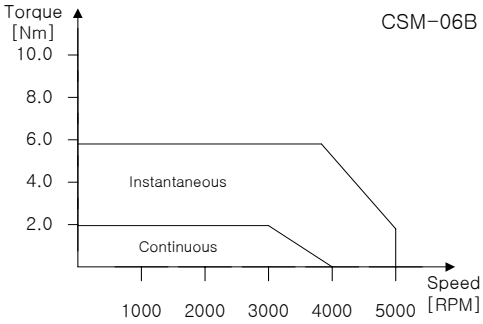


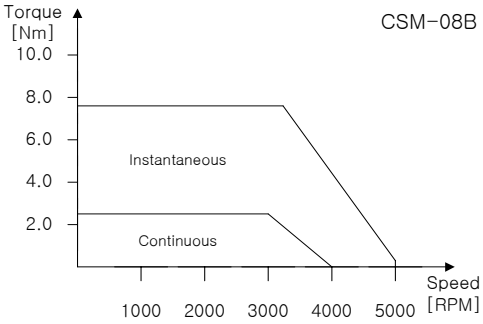


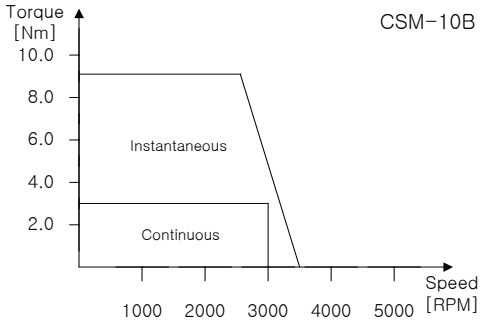












C. CSM Motor Specification When Reducer is Attached

- Motor Part Specification

  Standard specification is same as that of CSM Motor.

Table A.3 CSM Motor Specification (When reducer is attached)

Motor Part <Reducer Input>				Reducer Specification								
Model	Output (W)	Rotation Speed (r/min)	Rated Torque (N · m)	Backlash Spec.	Reduction Ratio	Rotation Speed (r/min)	Rated Torque (N · m)	Instantaneous Max Torque (N · m)	Allowable Radial Load[*2] (N)	Allowable Thrust Load (N)	Inertia on input shaft $kg \cdot m^2 \times 10^{-4}(GD^2/4)$	Reducer Weight (kg)
CSM-A5	50	3000	0.159	B	1/3	1000	0.25	0.78	392	196	0.058	0.58
					1/5	600	0.51	1.47	490	245	0.040	0.58
					1/9	333	0.92	2.74	588	294	0.048	0.73
					1/15	200	1.67	5.00	784	392	0.035	0.73
					1/25	120	2.74	8.33	882	441	0.033	0.73
CSM-01	100	3000	0.318	B	1/3	1000	0.72	2.06	392	196	0.058	0.58
					1/5	600	1.18	3.72	490	245	0.040	0.58
					1/9	333	2.25	6.84	588	294	0.048	0.73
					1/15	200	3.72	11.4	784	392	0.035	0.73
				C	1/25	120	6.27	19.0	1666	833	0.038	1.8
CSM-02	200	3000	0.64	B	1/3	1000	1.47	4.51	392	196	0.145	0.73
					1/5	600	2.65	8.04	490	245	0.125	0.73
				C	1/9	333	3.72	11.3	1176	588	0.400	2.3
					1/15	200	6.27	18.8	1470	735	0.300	2.3
					1/25	120	11.1	33.3	1666	833	0.288	2.3
CSM-04	400	3000	1.27	B	1/3	1000	3.43	10.3	392	196	0.145	0.73
				C	1/5	600	5.39	16.2	980	490	0.363	1.9
					1/9	333	9.51	28.5	1176	588	0.400	2.3
					1/15	200	15.8	47.5	1470	735	0.300	2.3
				D	1/25	120	26.4	79.2	2058	1029	0.300	3.2
CSM-06	600	3000	1.91	C	1/3	1000	5.00	15.0	784	392	0.913	2.2
					1/5	600	8.33	24.9	980	490	0.713	2.2
				D	1/9	333	13.9	41.8	1470	735	0.988	3.8
					1/15	200	23.2	69.6	1764	882	0.700	3.8
CSM-08	800	3000	2.55	C	1/3	1000	6.86	20.6	784	392	0.913	2.2
					1/5	600	11.5	34.3	980	490	0.713	2.2
				D	1/9	333	19.5	58.5	1470	735	0.988	3.8
					1/15	200	32.7	97.4	1764	882	0.700	3.8
				E	1/25	120	50.7	152	2650	1320	0.700	7.2

- Reducer Specification

  1. Above performance is typical value from the operation of 3,000[RPM], ambient temperature 20℃.
  2. Load position is the value from the center of the axis.
  3. Rotation direction of output axis is designed to match with the motor rotation direction.
  4. Backlash, in case of type B, is 0.7° , and in case of type C/D/E, is 0.5° .
  5. Life span : 1) Start/Stop repeat operation: More than 10^5times.
     2) Rated torque continuous operation.
     (Operating 3,000RPM) : more than 10,000 hours.

A.2 CSMT Motor Specification

Standard Speficication

Table A.4 CSMT Motor Specification

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

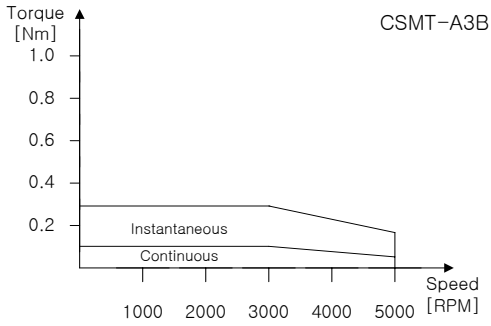
Content \ CSMT Motor		A3B	A5B	01B	02B	04B	06B	08B	10B
Applied to	CSDJ-__BX2	01	01	01	02	04	06	10	10
Rated Voltage	V	220							
Rated Output	W	30	50	100	200	400	600	750	950
Rated Torque	Kgf·cm	0.97	1.62	3.25	6.5	13.0	19.5	24.4	30.9
	N·m	0.095	0.159	0.318	0.64	1.27	1.91	2.39	3.0
Instantaneous Max. Torque	Kgf·cm	2.9	4.9	9.7	19.5	39	58.5	73	92.6
	N·m	0.29	0.48	0.95	1.91	3.82	5.73	7.16	9.1
Rated Speed	RPM	3000							
Max. Speed	RPM	5000							
Rotor Inertia	gf·cm·s^2	0.01	0.02	0.03	0.18	0.34	1.00	1.10	1.56
	Kg·m^2·10^{-4}	0.01	0.02	0.03	0.18	0.34	0.98	1.08	1.53
Rotor Inertia (with Brake)	gf·cm·s^2	0.04	0.05	0.06	0.28	0.44	1.24	1.34	1.66
	Kg·m^2·10^{-4}	0.04	0.05	0.06	0.28	0.44	1.22	1.32	1.63
Power Rate	kW/s	9.2	12.9	34.5	23.0	48.7	37.3	51.3	56.4
Mechanical Time Constant	ms	1.1	0.9	0.6	0.9	0.7	0.6	0.6	0.6
Electrical Time Constant	ms	0.8	1.1	1.6	3.2	3.5	6.0	4.8	5.6
Shaft Friction Torque	Kgf·cm MAX	0.2		0.4		0.8		1.5	
Rated Current	A(rms)	0.3	0.6	1.1	1.7	3.3	4.4	5.0	5.4
Instantaneous Max. Currnet	A(rms)	0.9	1.5	3.0	4.9	3.2	9.6	14.1	15.3
Axial Play	mm MAX	0.2				0.5			

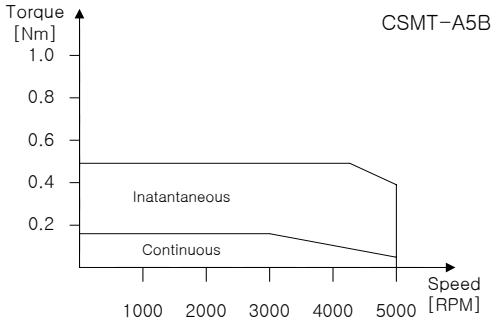
Content \ CSMT Motor		A3B	A5B	01B	02B	04B	06B	08B	10B
Allowable Thrust Load	Kgf MAX	4			7		10		
Allowable Radial Load	Kgf MAX	8			20		35		
Weight (with Brake)	Kg	0.3 0.5	0.4 0.6	0.5 0.7	0.9 1.4	1.3 1.8	2.2 3.1	2.5 3.4	3.7 4.5
Rotation Direction		U →V →W : CCW							
Oil Seal		Option							

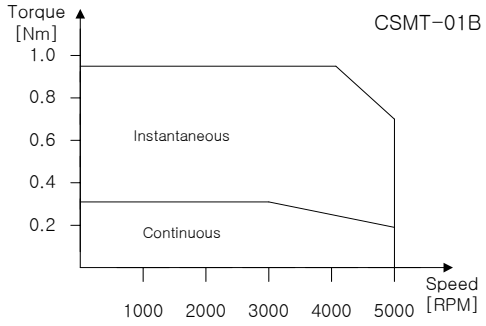
Table A.5 CSMT Motor Brake Specification

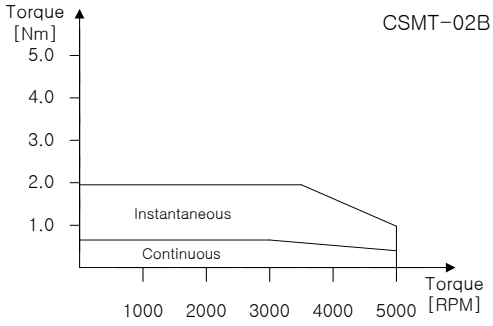
Content \ CSMT Motor		A3B	A5B	01B	02B	04B	06B	08B	10B
Raged Voltage	V	24 ± 10%							
Static Friction Torque	N·m Kgf·cm	0.32 3.25			1.27 13		2.55 26		
Power Dissipation	W	5			9		9.5		
Brake Pull-in Time	ms MAX	20					50		
Brake Release Time	ms MAX	40			50		80		

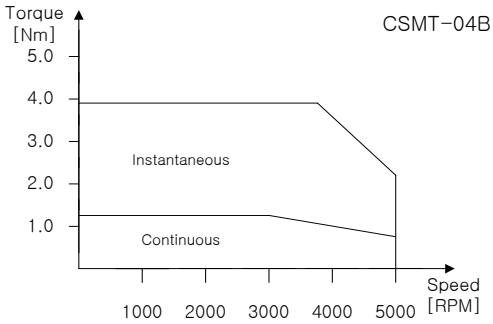
Speed-Torque Curve







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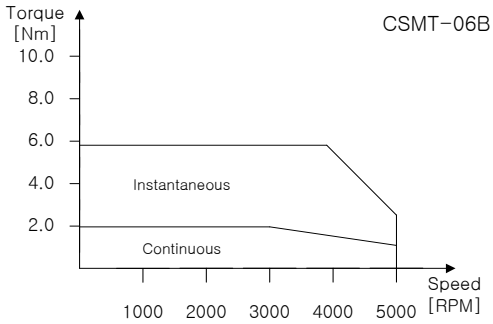
3.0
2.0
1.0
Instantaneous
Continuous
1000
2000
3000
4000
5000
Speed
[RPM]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Torque
[Nm]
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6.0
4.0
2.0
Instantaneous
Continuous
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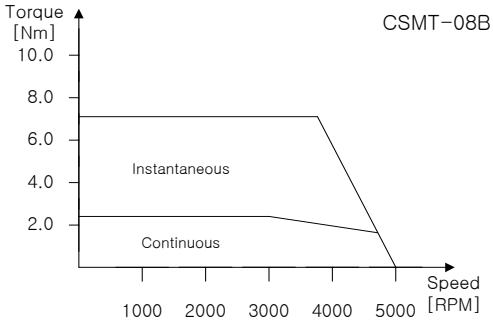
2000
3000
4000
5000
Speed
[RPM]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2.0
Instantaneous
Continuous
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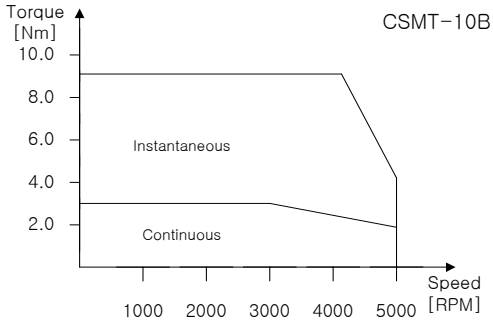
2000
3000
4000
5000
Speed
[RPM]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6.0
4.0
2.0
Instantaneous
Continuous
1000
2000
3000
4000
5000
Speed
[RPM]

A.3 CSMR Motor specification

Standard Speficication

Table A.6 CSMR Motor Specification

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

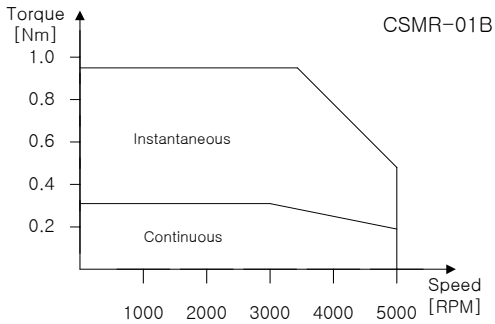
Content \ CSMR Motor		01B	02B	04B
Applied to	CSDJ-__BX2	01	02	04
Rated Voltage	V	220		
Rated Output	W	100	200	400
Rated Torque	Kgf·cm N·m	3.25 0.318	6.5 0.64	13.0 1.27
Instantaneous Max. Torque	Kgf·cm N·m	9.7 0.95	19.5 1.91	39 3.82
Rated Speed	RPM	3000		
Max. Speed	RPM	5000		
Rotor Inertia	gf·cm·s^2 Kg·m^2·10^{-4}	0.09 0.09	0.30 0.30	0.57 0.56
Rotor Inertia (with Brake)	gf·cm·s^2 Kg·m^2·10^{-4}	0.19 0.19	0.53 0.53	0.80 0.79
Power Rate	kW/s	11.5	13.8	29.1
Mechanical Time Constant	ms	1.2	1.0	0.6
Electrical Time Constant	ms	2.5	3.2	4.8
Shaft Friction Torque	Kgf·cm MAX	0.2	0.6	
Rated Current	A(rms)	0.9	1.5	2.7
Instantaneous Max. Currnet	A(rms)	2.5	4.2	7.8
Axial Play	mm MAX	0.2		
Allowable Thrust Load	Kgf MAX	4	7	
Allowable Radial Load	Kgf MAX	8	20	

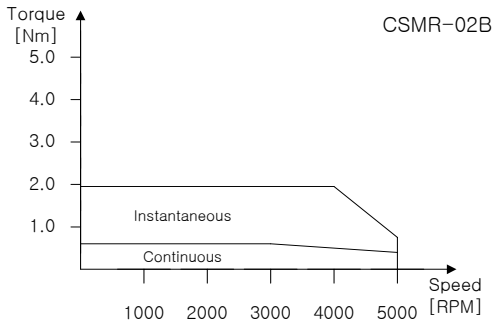
Content \ CSMR Motor		01B	02B	04B
Weight (with Brake)	Kg	0.6 0.9	1.1 1.9	1.6 2.4
Rotation Direction		U →V →W : CCW		
Color		Black		
Oil Seal		Option		

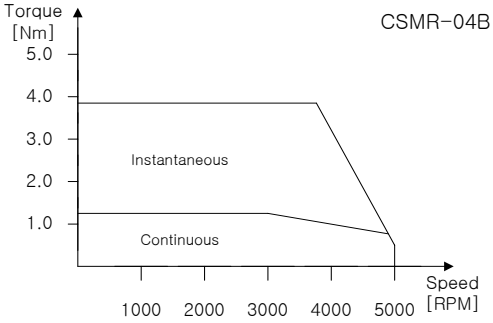
Table A.7 CSMR Motor Brake Specification

Content \ CSMR 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







A.4 CSMQ Motor Specification

Standard Specification

Table A.8 CSMQ Motor Specification

Content	Specification	Content	Specification
Connection Method	Y connection	Time Rating	Continuous
Operating Temperature	0 ~ +40℃	Insulation	Class B
Storing Temperature	-10 ~ +80℃	Dielectric Strength	1500VAC 60sec 1800VAC 1sec
Insulation Resistance	500VDC 20 MΩ	Excitation Method	Permanent Magnet
Pole	8 poles	Installation Method	FLANGE
Vibration	49 m/s²	Operating Humidity	85% or less

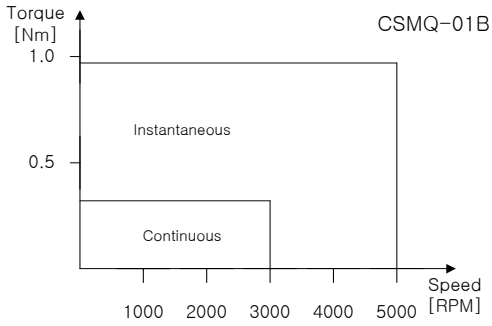
Content \ CSMQ Motor		01B	02B	04B	08B	15B
Applied to	CSDJ-__BX2	01	02	04	10	
Rated Voltage	V	220				
Rated Output	kW	0.1	0.2	0.4	0.75	1.5
Rated Torque	Kgf·cm N·m	3.24 0.318	6.5 0.637	13 1.274	24.3 2.4	48.7 4.77
Instantaneous Max. Torque	Kgf·cm N·m	9.7 0.95	19.5 1.911	39 3.822	78 7.64	126 12.3
Rated Speed	RPM	3000				
Max. Speed	RPM	5000			4500	
Rotor Inertia	gf·cm·s² Kg·m²·10⁻⁴	0.09 0.09	0.35 0.34	0.65 0.64	1.43 1.40	2.87 2.81
Rotor Inertia (with Brake)	gf·cm·s² Kg·m²·10⁻⁴	0.12 0.12	0.43 0.42	0.73 0.72	1.74 1.71	3.18 3.12
Power Rate	kW/s	11.4	11.8	25.5	40.5	81.0
Mechanical Time Constant	ms	0.95	0.79	0.59	0.64	0.55
Electrical Time Constant	ms	2.9	5.6	6.6	11.6	15.3
Rated Current	A(rms)	1.0	1.6	2.5	4.3	9.4
Instantaneous Max. Currnet	A(rms)	3.04	4.80	7.42	13.37	30.69
Axial Play	mm MAX	0.3				

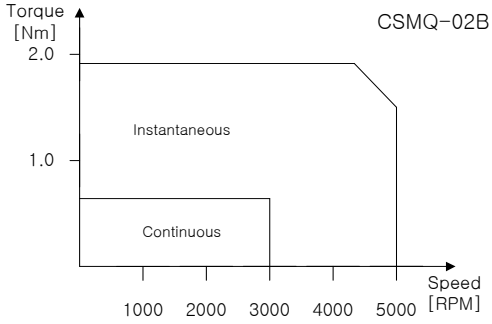
Content \ CSMQ Motor		01B	02B	04B	08B	15B
Allowable Thrust Load	Kgf MAX	6	10		15	
Allowable Radial Load	Kgf MAX	7	25		40	
Weight	Kg	0.65	1.3	1.8	3.4	4.8
Rotation Direction		U →V →W : CCW				
Color		Black				
Oil Seal		Option				

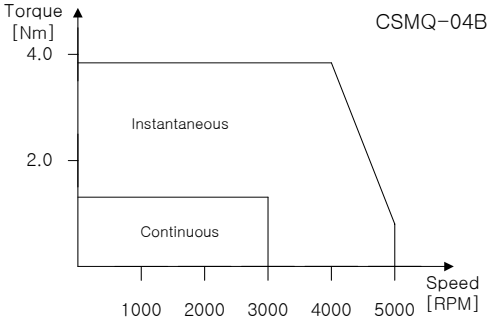
Table A.9 CSMQ Motor Brake Specification

Contents \ CSMQ Motor		01B	02B 04B	08B	15B
Static Friction Torque	N·m Kgf·cm	0.29 3	1.27 13	2.45 25	4.9 50
Rotor inertia	$kg \cdot m^2 \times 10^{-4}$ $gf \cdot cm \cdot s^2$	0.03 0.03	0.09 0.09	0.33 0.33	
Brake Pull-in Time	Ms	50	60		
Brake Release Time	ms	15		20	
Release Voltage	VDC	1 or more			
Rated Voltage	VDC	24 ± 2.4			
Rated Current	A	0.29	0.41	0.86	
Allowable Braking Energy	J Kgf·m	137 14	196 20	392 40	
Total Allowable Braking Energy	J Kgf·m	44.1×10^3 4500	147×10^3 15000	490×10^3 50000	

• **Speed-Torque Curve**







A.3 CSMZ Motor Specification

- **Standard Specification**

Table A.10 CSMZ Motor Specification

Content	Specification	Content	Specification
Connection Method	Y connection	Time Rating	Continuous
Operating Temperature	0 ~ +40℃	Insulation	Class B
Storing Temperature	-10 ~ +80℃	Dielectric Strength	1500VAC 60sec 1800VAC 1sec
Insulation Resistance	500VDC 20 MΩ	Excitation Method	Permanent Magnet
Pole	8 poles	Installation Method	FLANGE
Vibration	49 m/s²	Operating Humidity	85% or less

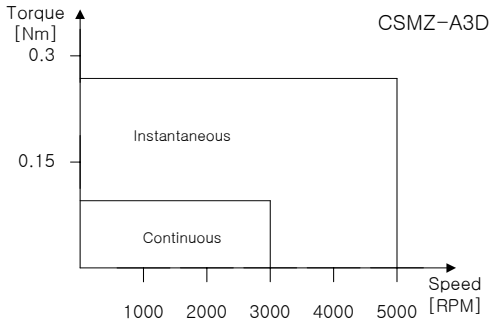
Content \ CSMZ Motor		A3D	A5D	01B	02B	04B	08B
Applied to	CSDJ-__BX2	A3	A5	01	02	04	10
Rated Voltage	V	110/220		220			
Rated Output	W	30	50	100	200	400	750
Rated Torque	Kgf·cm	0.97	1.62	3.24	6.5	13	24.3
	N·m	0.095	0.159	0.318	0.637	1.274	2.38
Instantaneous Max. Torque	Kgf·cm	2.9	4.9	9.7	19.5	39	73
	N·m	0.284	0.48	0.95	1.911	3.822	7.154
Rated Speed	RPM	3000					
Max. Speed	RPM	5000					4500
Rotor Inertia	gf·cm·s²	0.016	0.026	0.063	0.17	0.37	1.34
	Kg·m²·10⁻⁴	0.016	0.025	0.062	0.17	0.36	1.31
Rotor Inertia (with Brake)	gf·cm·s²	0.020	0.031	0.067	0.20	0.40	1.42
	Kg·m²·10⁻⁴	0.020	0.030	0.066	0.20	0.39	1.39
Power Rate	kW/s	5.8	9.9	16.3	24.4	44.8	43.2
Mechanical Time Constant	ms	1.8	1.2	0.77	0.63	0.54	0.45
Electrical Time Constant	ms	0.6	0.67	0.88	3.4	3.5	7.4
Rated Current	A(rms)	1.0	1.0	1.0	1.6	2.5	4.3
Instantaneous Max. Currnet	A(rms)	3.04	3.04	3.04	4.87	7.42	12.93
Axial Play	mm MAX	0.3					

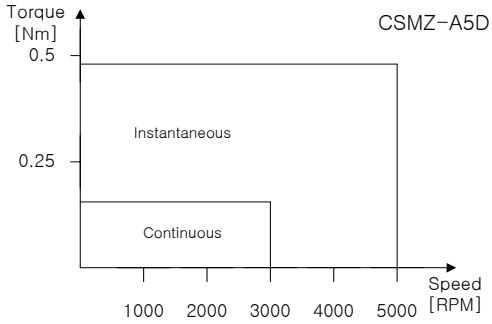
Content \ CSMZ Motor		A3D	A5D	01B	02B	04B	08B
Allowable Thrust Load	Kgf MAX	3	6		10		15
Allowable Radial Load	Kgf MAX	5	7		25		40
Weight	Kg	0.27	0.34	0.56	1.0	1.6	3.2
Rotation Direction		U →V →W : CCW					
Color		Black					
Oil Seal		Option					

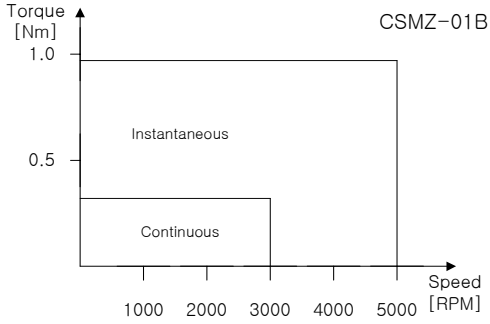
Table A.11 CSMZ Motor Brake Specification

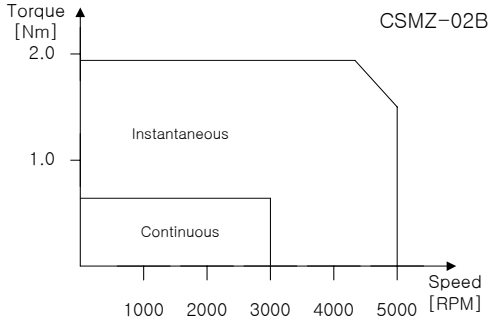
Content \ CSMZ Motor		A3D	A5D	01B	02B	04B	08B
Static Friction Torque	N·m Kgf·cm	0.29 3			1.27 13		2.45 25
Rotor inertia	$kg \cdot m^2 \times 10^{-4}$	0.003			0.03		0.09
Brake Pull-in Time	ms	25			50		60
Brake Release Time	ms	20			15		15
Release Voltage	VDC	1 or more					
Rated Voltage	VDC	24 ± 2.4					
Rated Current	A	0.26			0.36		0.43
Allowable Braking Energy	J Kgf·m	39.2 4			137 14		196 20
Total Allowable Braking Energy	J Kgf·m	4.9×10^3 500			44.1×10^3 4500		147×10^3 15000

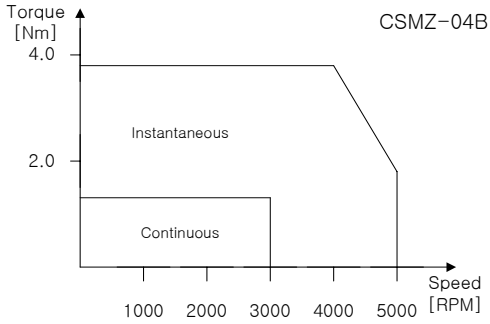
- **Speed-Torque Curve**

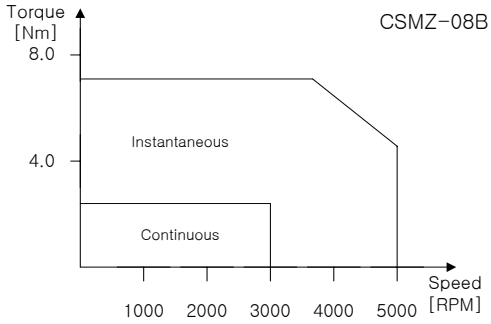












A.4 CSMD Motor Specification

- **Standard Specification**

Table A.12 CSMD Motor Specification

Content	Specification	Content	Specification
Connection Method	Y connection	Time Rating	Continuous
Operating Temperature	0 ~ +40℃	Insulation	Class B
Storing Temperature	-10 ~ +80℃	Dielectric Strength (With Brake)	1500VAC 60sec 1200VAC 60sec
Insulation Resistance	500VDC 20 MΩ		
Pole	8 poles	Excitation Method	Permanent Magnet
Vibration	49 m/s²	Installation Method	FLANGE
Shock	98 m/s²	Operating Humidity	85% or less

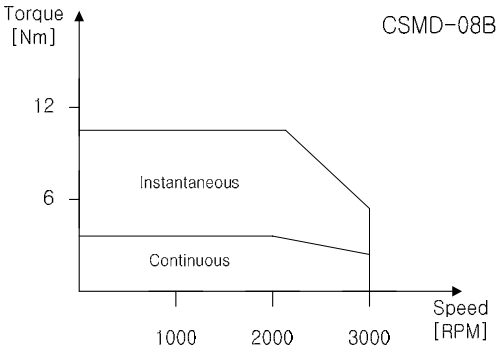
Content \ CSMD Motor		08B	10B	15B	20B	25B	30B	35B	40B	45B	50B
Applied to CSDJ-__BX2		10	10								
Rated Voltage	V	220									
Rated Output	kW	0.75	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Rated Torque	Kgf·cm	36.4	49	73	97.4	121	146	169	192	219	243
	N·m	3.57	4.8	7.15	9.54	11.86	14.3	16.6	18.8	21.4	23.8
Instantaneous Max. Torque	Kgf·cm	109	147	219	292	363	438	510	576	657	729
	N·m	10.7	14.4	21.5	28.5	35.6	42.9	50.0	56.4	64.3	71.4
Rated Speed	RPM	2000									
Max. Speed	RPM	3000									
Rotor Inertia	gf·cm·s²	2.88	6.30	11.4	15.5	19.6	22.8	36.6	43.4	51.6	61.9
	Kg·m²·10⁻⁴	2.82	6.17	11.2	15.2	19.2	22.3	35.9	42.5	50.6	60.7
Rotor Inertia (with Brake)	gf·cm·s²	3.19	6.93	12.6	17.0	21.5	25.1	41.0	47.8	56.7	68.1
	Kg·m²·10⁻⁴	3.13	6.17	12.3	16.7	21.1	24.6	40.2	46.8	55.6	66.7
Power Rate	kW/s	45.1	37.3	45.8	60.0	73.2	91.6	76	83.2	91.1	93.5
Mechanical Time Constant	ms	0.5	0.7	0.81	0.75	0.72		1.0			0.9
Electrical Time Constant	ms	15.7	18	19	21		20	24		30	32
Rated Current	A(rms)	5.0	5.6	9.4	12.3	14	17.8	18.7	23.4	26.2	28
Instantaneous Max. Currnet	A(rms)	15	16.8	28.2	36.9	42	53.4	56.1	70.2	78.6	84
Axial Play	mm MAX	0.3									

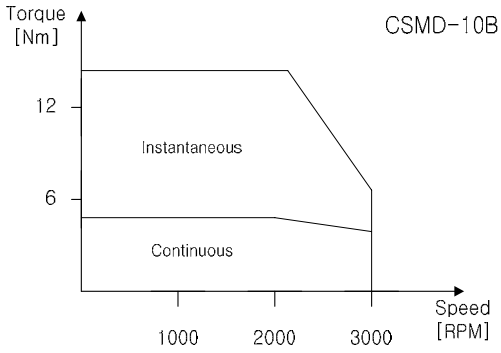
Content \ CSMD Motor		08B	10B	15B	20B	25B	30B	35B	40B	45B	50B
Allowable Thrust Load during operation	Kgf MAX	15	20			35					
Allowable Radial Load during operation	Kgf MAX	40	50			80					
Allowable Thrust Load when coupled	Kgf MAX	40	60					80			
Allowable Radial Load when coupled	Kgf MAX	70	100					170			
Weight (with Brake	Kg	4.8 6.5	6.8 8.7	8.5 10.1	10.6 12.5	12.8 14.7	14.6 16.5	16.2 18.7	18.8 21.3	21.5 25	25 28.5
Rotation Direction		U →V →W									
Color		Black									
Oil Seal		Option									

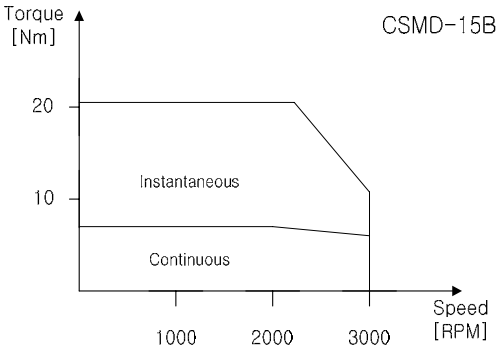
Table A.13 CSMD Motor Brake Specification

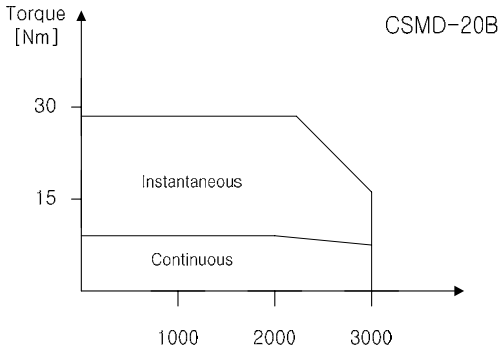
Content \ CSMD Motor		08B	10B	15B 20B	25B 30B	35B 40B	45B 50B
Static Friction Torque	N·m Kgf·cm	7.84 80	4.9 50	13.7 140	16.1 165	21.5 220	24.5 250
Rotor inertia	$kg \cdot m^2 \times 10^{-4}$ $Kgf \cdot cm \cdot s^2$	0.33 0.34	1.35 1.38			4.25 4.34	9.0 9.18
Brake Pull-in Time	ms	50	80	100	110	90	80
Brake Release Time	ms	15	70	50		35	25
Release Voltage	VDC	2 or more					
Rated Voltage	VDC	24 ± 2.4					
Rated Current	[A]±10%	0.81	0.59	0.79	0.90	1.1±10	1.3±10
Allowable Braking Energy	J Kgf·m	392 40	588 60	1176 120	1470 150	1078 110	1372 140
Total Allowable Braking Energy	J Kgf·m	4.9×10^5 5×10^4	7.8×10^5 8×10^4	1.5×10^6 1.5×10^5	2×10^6 2.2×10^5	2.4×10^6 2.5×10^5	2.9×10^6 3×10^5

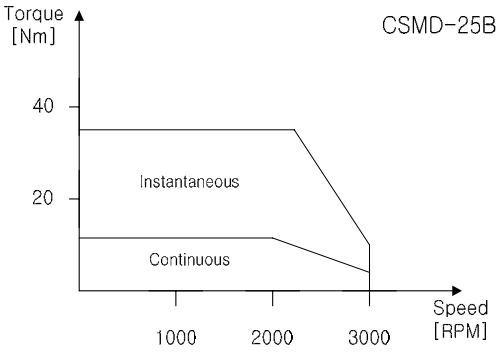
- **Speed-Torque Curve**

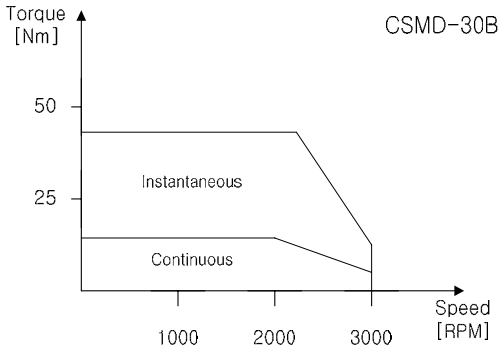


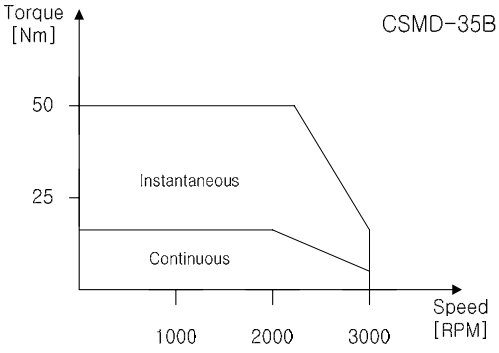


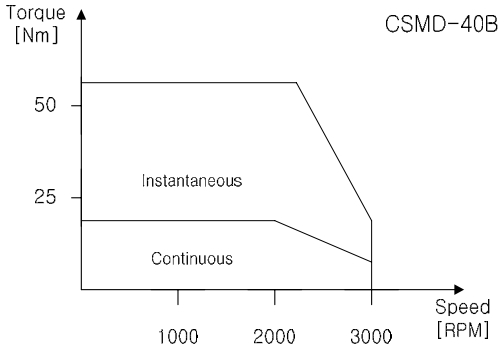


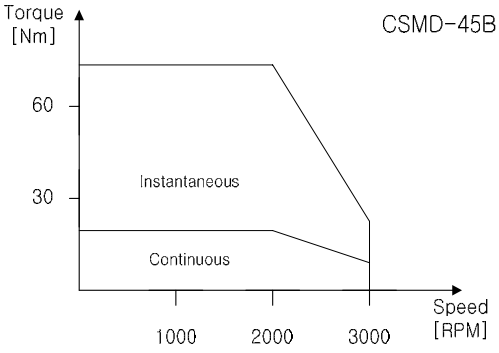








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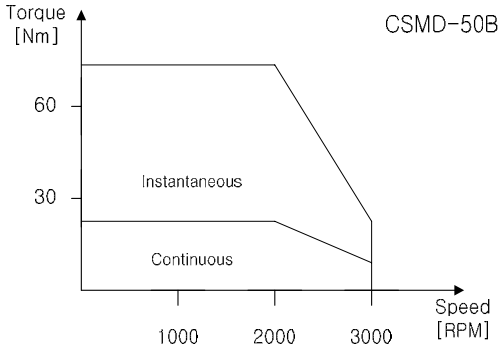
[Nm]
CSMD-45B
60
30
Instantaneous
Continuous
1000
2000
3000
Speed
[RPM]


Torque
[Nm]
CSMD-50B
60
30
Instantaneous
Continuous
1000
2000
3000
Speed
[RPM]

A.5 CSMF Motor Specification

- Standard Specification

Table A.14 CSMF Motor Specification

Content	Specification	Content	Specification
Connection Method	Y connection	**Time Rating**	Continuous Use
Operating Temperature	0～+40℃	**Insulation**	Class F
Storing Temperature	-20～+80℃	**Dielectric Strength**	AC 1500V(60sec)
Insulation Resistance	DC 500V 20MΩ	**Dielectric Strength (With Brake)**	AC 1200V(60sec)
Motor Pole	8 Pole	**Excitation Method**	Permanent Magnet
Vibration	49m/s² (When stopped,24,5)	**Installation Method**	Flange
Shock	48m/s² Three times	**Operation Humidity**	~85%(No Condensing)

Content \ CSMF Motor		04B	08B	15B	25B	35B	45B
Applied Drive	CSDJ-__BX2	06	10				
	CSDP-__BX1	08	08	15	25	35	45
Rated Output	kW	0.4	0.75	1.5	2.5	3.5	4.5
Rated Torque	Kgf · cm	19.5	36.4	73	121	169	219
	N m	1.91	3.57	7.15	11.86	16.56	21.46
Instantaneous max. Torque	Kgf · cm	58.5	109	219	310	450	560
	N m	5.3	10.68	21.46	30.38	44.1	54.88
Rated Rotation Speed	RPM	2000					
Maximum Rotation Speed	RPM	3000					
Rotor Inertia	gf · cm · s²	2.50	10.3	20.5	42.1	52.7	73.8
	Kgm² × 10⁻⁴	2.45	10.1	20.1	41.3	51.6	72.3
Rotor Inertia (With Brake)	gf · cm · s²	2.8	11.1	21.9	46.2	56.8	80.1
	Kgm² × 10⁻⁴	2.7	10.9	21.5	45.3	55.7	78.5
Power Rate	kW/s	14.9	12.6	25.5	34	53.1	63.7
Mechanic Time Constant	ms	1.2	1.9	1.4	1.3	1.06	0.88
Electrical Time constant	ms	14	21	25	35	41	41
Axial Play	mm Max.	0.3					
Allowable Thrust Load During Operation	Kgf	15	20		30		
Allowable Radial Load During Operation	Kgf	40	50		80		
Allowable Thrust Load Being Coupled	Kgf	60			70		
Allowable Rodial Load Being Coupled	Kgf	100			190		
Rotation Direction		U→V→W					
Weight	Kg	4.7	8.6	11	14.8	15.5	19.9
Weight (With Brake)	Kg	6.7	10.6	14	17.5	19.2	24.3
Color		Black					
Oil Seal		Basic Loading					

Content \ CSMF Motor	04B	08B	15B	25B	35B	45B
Rated Current A(rms)	2.8	5.0	9.5	13.4	20	23.5
Instantaneous Maximum Current A(rms)	8.4	15	28.5	40.2	60	70.5
Torque Constart Kt Kgf-cm/A(rms)±10%	6.79	7.35	7.78	9.05	8.63	9.33
Excitation Voltage Constant Keϕ (V(rms)/RPM)×10^{-3}±10%	24	25	26	31	30	32
Phase Resistance Ra Ω±10%	0.73	0.32	0.13	0.08	0.049	0.0034
Phase inductance La mH±30%	10.3	6.7	3.2	2.8	2.0	1.4

Warning

When using as rated torque, install an aluminum heat sink of 4:275×260×15, 08～15:380×350×20, 25～45:470×440×30(mm) on the motor. Here, motor temperature is 40℃.

All values were measured in 20℃.

All values are typical value.

IP 55.

This specification is guaranteed after combining and adjusting with the drive.

Table A.15 CSMF Motor Brake Specification

Item	Unit	Applied Motor			
		CSMF-04B	CSMF-08B CSMF-15B	CSMF-25B CSMF-35B	CSMF-45B
Static Friction Torque	N · m	4.9 or more (50)	7.8 or more (80)	21.6 or more (220)	31.4 or more (320)
Rotor Inertia	kg · m^2 10^{-4}	1.35 (1.38gf · cm · s^2)	4.7 (9.2gf · cm · s^2)	8.75 (8.9gf · cm · s^2)	8.75 (8.9gf · cm · s^2)
Brake Pull-In Time	ms	80 or less		150 or less	
Brake Release Time	ms	※2 70 or less	※1 35 or less	※2 100 or less	
Release Voltage (DC)	DC,V	2 or more			
Rated Voltage (DC)	DC,V	24±2.4			
Rated Current (DC)	A	0.59±10%	0.83±10%	0.75±10%	
Allowable Braking Energy(1 Time each)	J(kgf · m)	588(60)	1372(140)	1470(150)	
All Allowable Braking Energy	J(kgf · m)	7.8×10^5 (8×10^4)	2.9×10^6(3×10^5)	1.5×10^6(1.5×10^5)	2.2×10^6(2.2×10^5)

Warning

※1 by Thyristor G-5A2 20℃
※2 by Varistor TNR9G820K

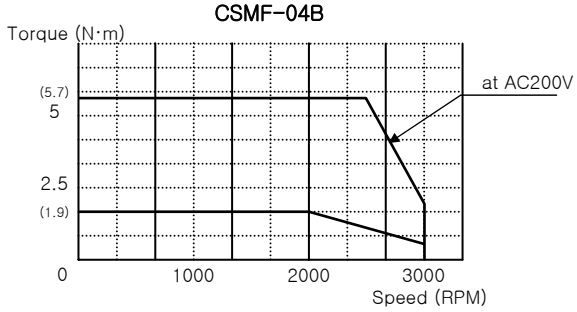
All Values are typical value.
(Except for static friction torque and release time)

All values were measured in 20℃.

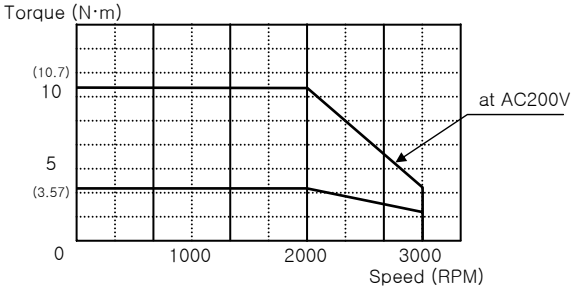
When using as rated torque.

- **Speed-Torque Curve**

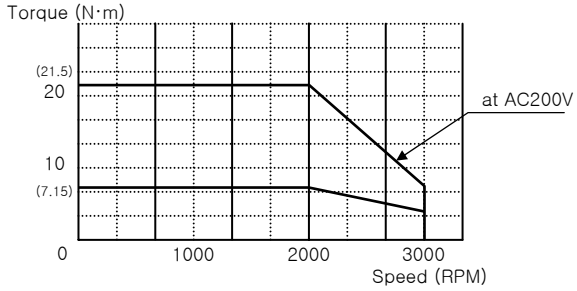
CSMF-04B



CSMF-08B



CSMF-15B



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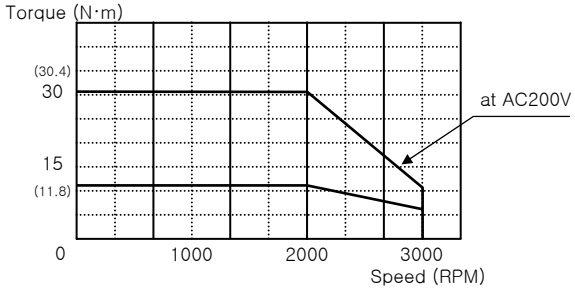

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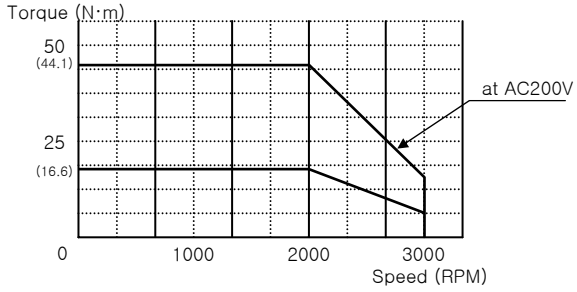

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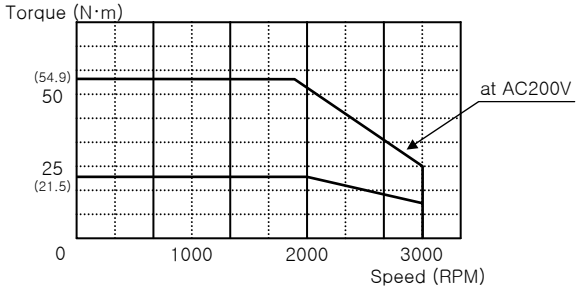


A.6 CSMS Motor Specification

- **Standard Specification**

Table A.16 CSMS Motor Specification

Content	Specification	Content	Specification
Connection Method	Y Connection	**Time Rating**	Continuous Use
Operating Temperature	0～+40℃	**Insulation**	Class F
Storing Temperature	-20～+80℃	**Dielectric Strength**	AC 1500V(60sec)
Insulation Resistance	DC 500V 20MΩ	**Dielectric Strength (With Brake)**	AC 1200V(60sec)
Motor Pole	8 Pole	**Excitation Method**	Permanent Magnet
Vibration	49m/s² (When stopped,24,5)	**Installation Method**	Flange
Shock	98m/s² Three times	**Operation Humidity**	~85%(No Condensing)

Content \ CSMS Motor		10B	15B	20B	25B	30B	35B	40B	45B	50B
Applied Drive	**CSDJ-__BX2**	10								
	CSDP-__BX1	10	15	20	25	30	35	40	45	50
Rated Output	**kW**	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Rated Torque	**Kgf·cm**	32.4	48.7	64.9	81	97.3	113	129	146	162
	N m	3.18	4.77	6.36	7.94	9.54	11.07	12.64	14.31	15.88
Momentary Max. Torque	**Kgf·cm**	97	146	195	243	292	339	387	438	486
	N m	9.51	14.31	19.11	23.81	28.62	33.22	37.93	42.92	47.63
Rated Rotation Speed	**RPM**	3000						3000		
Maximum Rotation speed	**RPM**	5000						4500		
Rotor Inertia	**gf·cm·s²**	1.72	2.64	3.53	4.40	6.91	8.06	13.0	15.6	18.2
	Kgm²×10⁻⁴	1.69	2.59	3.46	4.31	6.77	7.90	12.7	15.3	17.8
Rotor Inertia (With Brake)	**gf·cm·s²**	1.92	2.90	3.89	4.84	7.60	8.88	14.4	17.3	20.1
	Kgm²×10⁻⁴	1.88	2.84	3.81	4.74	7.45	8.69	14.1	17.0	19.7
Power Rate	**kW/s**	60	88	117	146	134	155	125	134	140
Mechanical Time constant	**ms**	0.78	0.54	0.53	0.52	0.46	0.45	0.51	0.45	0.46
Electric Time Constant	**ms**	6.7	10	10.8	11	17	20	20	20	20
Axial Play	**mm Max.**	0.3								
Allowable Thrust Load During Operation	**Kgf**	15	20			35				
Allowable Radial Load During Operation	**Kgf**	40	50			80				
Allowable Thrust Load Being Coupled	**Kgf**	40	60							
Allowable Radial Load Being Coupled	**Kgf**	70	100							
Rotation Direction		U→V→W								
Weight	**Kg**	4.5	5.1	6.5	7.5	9.3	10.9	12.9	15.1	17.3
Weight (With Brake)	**Kg**	5.1	6.5	7.9	8.9	11.0	12.6	14.8	17.0	19.2
Color		Black								
Oil Seal		Basically Installed								

Content \ CSMS Motor	10B	15B	20B	25B	30B	35B	40B	45B	50B
Rated Current A(rms)	7.2	9.4	13	15.9	18.6	21.6	24.7	28	28.5
Instantaneous Maximum Current A(rms)	21.6	28.2	39	47.7	55.8	64.8	74.1	84	85.5
Torque Current Kt Kgf-cm/A(rms)±10%	4.53	5.23	4.95	5.09	5.23				5.80
Excitation Voltage Constant KeΦ(V(rms)/RPM)×10⁻³±10%	15.6	17.97	17.02	17.49	17.97				19.86
Phase Resistance Ra Ω±10%	0.27	0.18	0.12	0.10	0.06	0.05	0.035	0.026	0.028
Phase inductance La mH±30%	1.8		1.3	1.1	1.0		0.7	0.52	0.56

Warning

When using as rated torque, install an aluminum heat sink of 4:275×160×12, 15～25:320×300×20, 30～50:380×30(mm) on the motor. Here, motor temperature is 40℃.

All values were measured in 20℃.

All values are typical value.

IP 55.

This specification is guaranteed after connecting and adjusting with the drive.

Table A.17 CSMS Motor Brake Specification

Item	Unit	Applied Motor			
		CSMS-10B	CSMS-15B CSMS-25B	CSMS-30B CSMS-35B	CSMS-40B CSMS-50B
Forward Friction Torque	N · m	4.9 or more (50)	7.8 or more (80)	11.8 or more (120)	16.1 or more (165)
Rotor Inertia	kg · m²10⁻⁴	0.25 (0.26gf · cm · s²)	0.33 (0.33gf · cm · s²)	1.35 (1.38gf · cm · s²)	
Brake Pull-In Time	ms	50 or less		80 or less	110 or less
Brake Release Time	ms	※1 15 or less			※2 50 or less
Release Voltage (DC)	DC,V	2 or more			
Rated Voltage (DC)	DC,V	24±2.4			
Rated Current(DC)	A	0.74±10%	0.81±10%		0.90±10%
Allowable Braking Energy (1 Time each)	J(kgf · m)	392(40)			1470(150)
All Allowable Braking Energy	J(kgf · m)	2.0×10⁵ (2×10⁴)	4.9×10⁵(5×10⁴)	4.9×10⁶(5×10⁵)	2×10⁶(2.2×10⁵)

Warning

※1 by Thyristor G-5A2 20℃

※2 by Varistor TNR9G820K

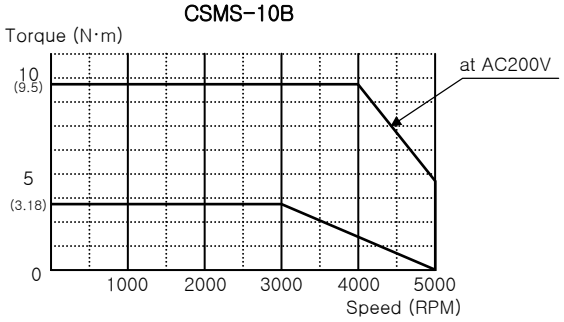
All Values are typical value.
(Except for static friction torque and release time)

All values were measured in 20℃.

When using as rated torque.

- **Speed-Torque Curve**

CSMS-10B



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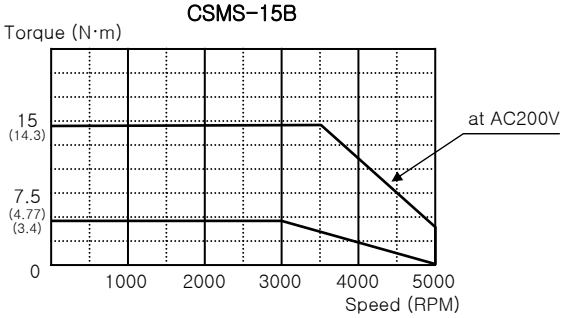
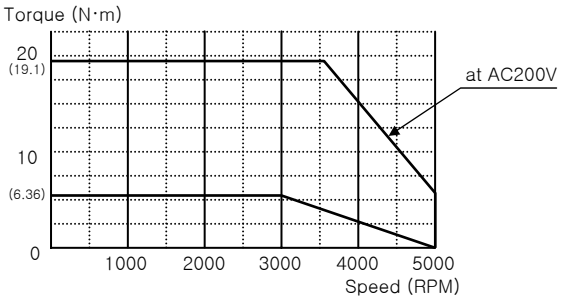
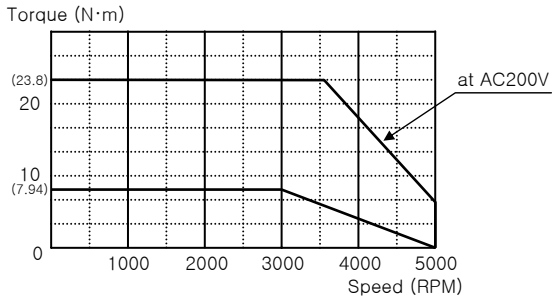


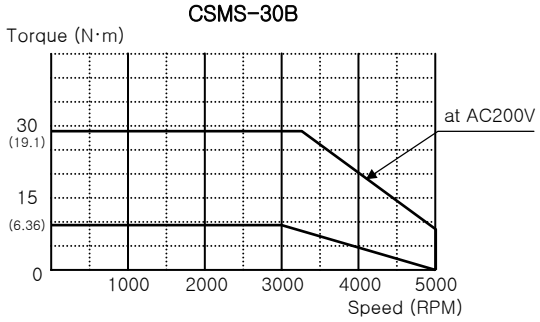
CSMS-20B



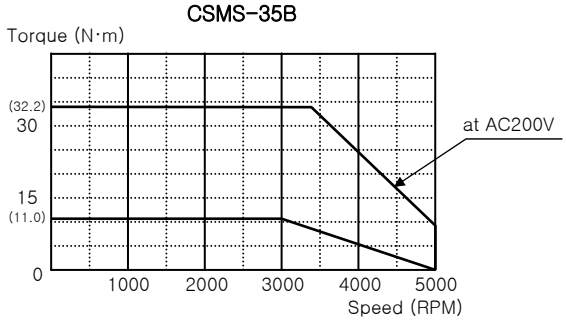
CSMS-25B



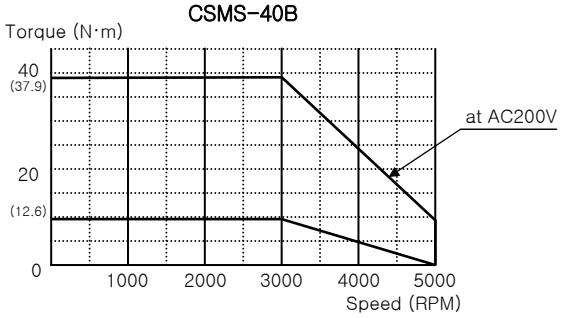
CSMS-30B



CSMS-35B



CSMS-40B



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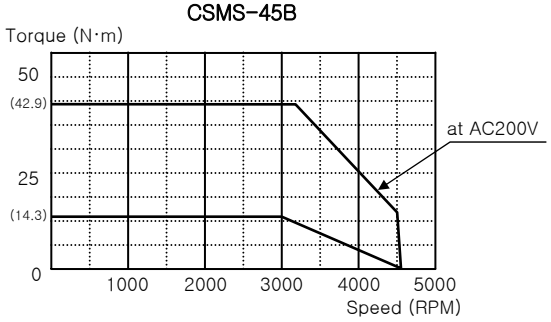
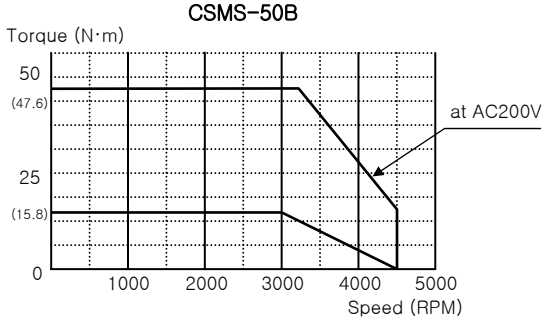


CSMS-50B



A.7 CSMH Motor Specification

- **Standard Specification**

Table A.18 CSMH Motor Specification

Content	Specification	Content	Specification
Connection Method	Y Connection	**Time Rating**	Continuous Use
Operating Temperature	0～+40℃	**Insulation**	Class F
Storing Temperature	-20～+80℃	**Dielectric Strength**	AC 1500V(60sec)
Insulation Resistance	DC 500V 20MΩ	**Dielectric Strength (With Brake)**	AC 1200V(60sec)
Motor Pole	8 Pole	**Excitation Method**	Permanent Magnet
Vibration	49m/s² (When stopped,24,5)	**Installation Method**	Flange
Shock	98m/s² Three times	**Operation Humidity**	~85%(No Condensing)

Content \ CSMH Motor		05B	10B	15B	20B	30B	40B	50B
Applied Drive	**CSDJ-__BX2**	06	10					
	CSDP-__BX1	08	10	15	20	30	40	50
Rated Output	**kW**	0.5	1	1.5	2.0	3.0	4.0	5.0
Rated Torque	**Kgf · cm** **N m**	24.3 2.38	49 4.8	73 7.15	97.4 9.54	146 14.31	192 18.8	243 23.8
Instantaneous Max. Torque	**Kgf · cm** **N m**	61.0 6.0	147 14.4	219 21.5	292 28.5	438 42.9	576 56.4	729 71.4
Rated Rotation Speed	**RPM**	2000						
Maximum Rotation Speed	**RPM**	3000						
Rotor Inertia	**gf · cm · s²** **Kgm² × 10⁻⁴**	14.3 14.0	26.5 26.0	43.8 42.9	63.3 62.0	96.0 94.1	122.4 120.0	173.5 170.0
Rotor Inertia (With Brake)	**gf · cm · s²** **Kgm² × 10⁻⁴**	15.5 15.2	27.8 27.2	45.0 44.1	69.3 67.9	102 100.0	128.6 126.0	179.6 176.0
Power Rate	**kW/s**	4.0	8.9	11.9	14.7	21.8	29.5	33.4
Mechanical Timel Constant	**ms**	4	2.9	3.1	2.1	2.5	2.2	2.3
Electric Timel Constant	**ms**	15	18	19	26	26	30	31
Axial Play	**mm Max.**	0.3						
Allowable Thrust Load During Operation	**Kgf**	20			35			
Allowable Radial Load During Operation	**Kgf**	50			80			
Allowable Thrust Load Being Coupled	**Kgf**	60			80			
Allowable Radial Load Being Coupled	**Kgf**	100			170			
Rotation Direction		U→V→W						
Weight	**Kg**	5.3	8.9	10.0	16.0	18.2	22.0	26.7
Weight (With Brake)	**Kg**	6.9	9.5	11.6	19.5	21.7	25.5	30.2
Color		Black						
Oil Seal		Basically Installed						

Content \ CSM Motor	05B	10B	15B	20B	30B	40B	50B
Rated Current A(rms)	3.2	5.6	9.4	12.3	17.8	23.4	28.0
Instantaneous Maximum Current A(rms)	8.1	16.8	28.0	36.7	53.6	70.2	84.0
Torque Parameter Kt Kgf·cm/A(rms)±10%	7.50	8.77	7.78	7.92	8.20	8.20	8.63
Excitation Voltage Constant keΦ (V(rms)/RPM)×10^{-3}±10%	25.77	30.26	26.48	27.42	28.37	28.37	29.79
Phase Resistance Ra Ω±10%	0.52	0.28	0.14	0.07	0.057	0.04	0.032
Phase inductance La mH±30%	7.8	5.0	2.6	1.8	1.5	1.2	1.0

Warning

When using as rated torque, install an aluminum heat sink of 4:275×260×15, 08～15:380×350×30, 25～45:470×440×30(mm).

Here, the temperature is 40℃.

All values were measured in 20℃.

All values are typical value.

IP 55.

This specification is guaranteed after connecting and adjusting with the drive.

Table A.19 CSMH Motor Brake Specification

Item	Unit	Applied Motor		
		CSMH-05B, CSMH-10B	CSMH-15B	CSMH-20B, CSMH-30B CSMH-40B, CSMH-50B
Static Friction Torque	N · m	4.9 or more (50)	13.7 or more (140)	24.5 or more (250)
Rotor inertia	kg · m^2 10^{-4}	1.35 (1.38gf · cm · s^2)		9.0 (9.18gf · cm · s^2)
Brake Pull-In Time	ms	80 or less	100 or less	80 or less
Brake Release Time	ms	※2 70 or less	※1 50 or less	※2 25 or less
Release Voltage (DC)	DC,V	2 or more		
Rated Voltage (DC)	DC,V	24±2.4		
Rated Current (DC)	A	0.59±10%	0.79±10%	1.3±10%
Allowable Braking Energy (1 Time each)	J(kgf · m)	588(60)	1176(120)	1372(140)
All Allowable Braking Energy	J(kgf · m)	7.8×10^5 (8×10^4)	1.5×10^6(3×10^5)	2.9×10^6(1.5×10^5)

Warning

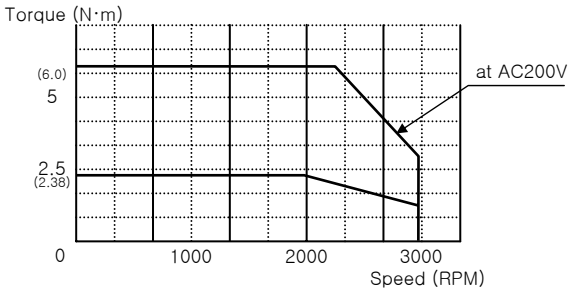
※1 by Thyristor G-5A2 20℃

※2 by Varistor TNR9G820K

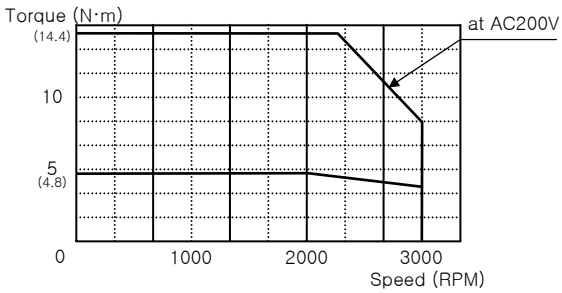
All Values are typical value.
(Except for Static friction torque, Release time)

- **Speed-Torque Curve**

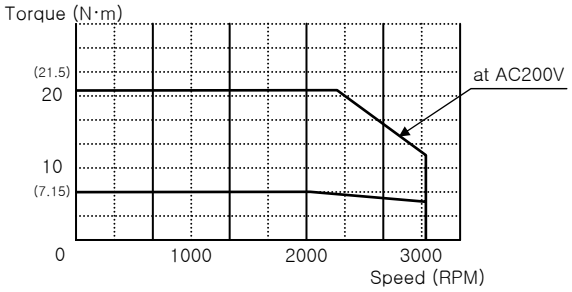
CSMH-05B



CSMH-10B



CSMH-15B



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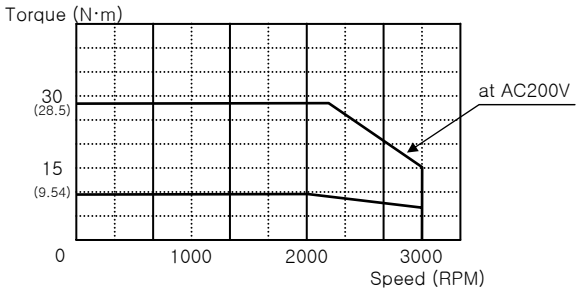

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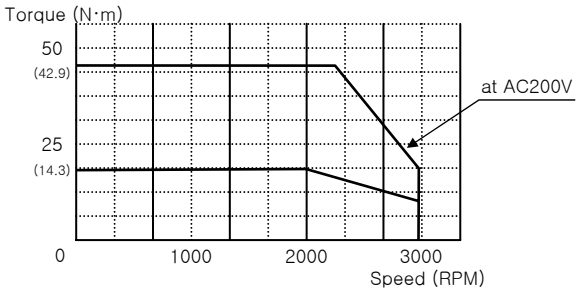

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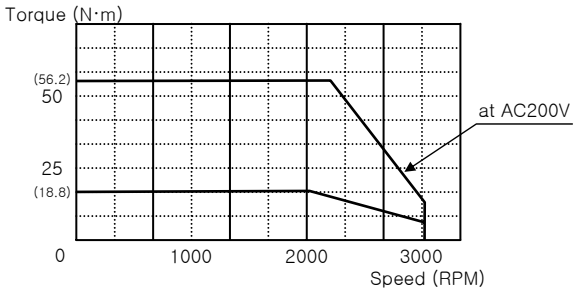
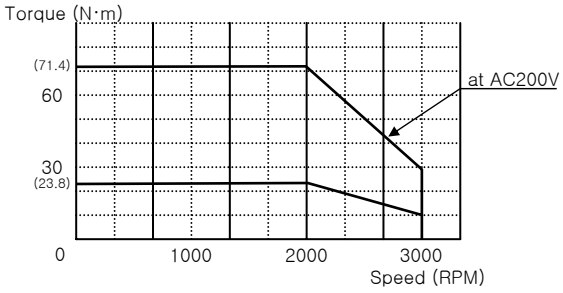


CSMH-50B



A.8 CSMK Motor Specification

- **Standard Specification**

Table A.20 CSMK Motor Specification

Content	Specification	Content	Specification
Operating Temperature	0~+40℃	Insulation	Class F
Storing Temperature	-20~+80℃	Dielectric Strength	AC 1500V (60sec) AC 1800V (1sec)
		Dielectric Strength (With Brake)	AC 1200V (60sec)
Insulation Resistance	DC 500V 20MΩ	Allowable maximum Rotation speed	120% of maximum speed
Vibration	Below 49m/s²	Installation Method	Flange
Shock	98m/s² Three times	Operation Humidity	~85%(No Condensing)

Content \ CSMK Motor		03B	06B	09B	12B	20B	30B	45B	60B
Applied Drive	CSDJ-__BX2	02	06	10					
	CSDP-__BX1	08	08	10	15	25	30	45	50
Rated Output (㎾)		0.3	0.6	0.9	1.2	2.0	3.0	4.5	6.0
Rated Torque	Kgf·cm	28.9	58.1	87.9	117.2	195	289.5	437.4	583.2
	N·m	2.84	5.7	8.62	11.5	19.1	28.4	42.9	57.2
Instantaneous Maximum Torque	Kgf·cm	64.3	146.8	196.8	285.5	448.6	649.5	1091	1320
	N·m	6.3	14.4	19.3	28.0	44.0	63.7	107	129
Rotor Inertia ($\times 10^{-4}$kg㎡)	No Brake	3.9	6.17	11.2	30.4	35.5	55.7	80.9	99
	With Brake	5.1	7.45	12.3	36.2	41.4	61.7	89.2	108
Rotation Speed (r/min)	Rated	1000							
	Maximum	2000							
Encoder		15 wire type Incremental 10,000 P/R							
Poles		8							
Power Rate kW/s	No Brake	20.7	52.7	66.3	43.3	103	145	228	331
	With Brake	15.8	43.6	60.4	36.3	88.3	131	207	304
Mechanical Time Constant ms	No Brake	1.4	0.81	0.88	1	0.97	0.74	0.70	0.9
	With Brake	1.8	0.98	0.96	1.2	1.1	0.82	0.78	0.98
Electric Time Constant ms		14	17	20	26	25	30	31	33
Axial Play mm MAX		0.3							
Rated Current A(rms)		3	5.7	7.6	11.6	18.5	24	33	47
Instantaneous Maximum Current A(o-p)		11	21	24	40	60	80	118	155
Torque Constant N·m/A(rms)		0.95	1	1.13	1	1	1.1	1.3	1.22
Phaser Resistance Ω		1.08	0.44	0.33	0.12	0.082	0.053	0.048	0.045
Phase Inductance mH		14.8	7.4	6.8	3.1	2.4	2	1.8	1.5
Color		Black							
Weight kg	No brake	5.1	6.8	8.5	15.5	17.5	25	34	41
	With Brake	6.7	8.4	10	19	21	28.5	39.5	46.5

Warning

All values were measured in 20℃.

All values are typical value.

IP 65

This specification is guaranteed after connecting and adjusting with the drive.

Table A.21 CSMK Motor Brake Specification

Applied Motor / Content	CSMK-03B	CSMK-06B CSMK-09B	CSMK-12B CSMK-20B	CSMK-30B CSMK-45B CSMK-60B
Static Friction Torque N · m	4.9 or more (50kgf · cm)	11.8 or more (120kgf · cm)	24.5 or more (250kgf · cm)	58.8 or more (600gf · cm)
Rotary Part Inertia	1.35 (1.38gf · cm · s^2)	←	4.7 (4.80gf · cm · s^2)	4.7 (4.80gf · cm · s^2)
Armature Pull-In Time	80 or less	80 or less	80 or less	150 or less
Armature Release Time	※1 70 or less	※2 15 or less	※2 25 or less	※3 50 or less
Releace Voltage (DC)	2 or more	←	←	2 or more
Rated Voltage (DC)	24±2.4	←	←	24±2.4
Rated Current (DC)	0.59±10%	0.81±10%	1.3±10%	1.4±10%
Allowable Braking Energy (1 Time each)	60	40	140	140
All Allowable Braking Energy	8×10^4	5×10^4	3×10^5	3×10^4

Warning

※1 by varistor TNR9G820K (MARCON Electronics)
※2 by silistor G-5A2 or varistor Z15D151(Ishizuka Electronics)
※3 by silistor G-5A3 or varistor Z15D151(Ishizuka Electronics)

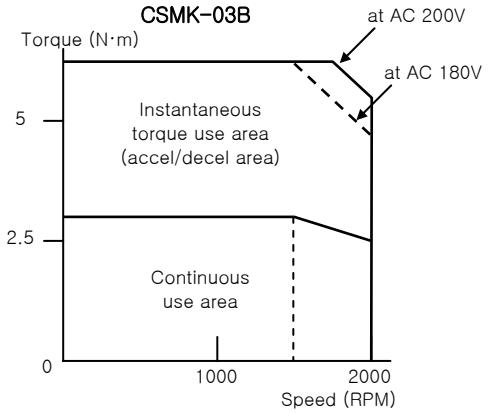
These values represents typical characteristics.
(Except for static friction torque, release voltage, excitation voltage)

When motor has been forwarded, backlash of brake is below ±1.0°.

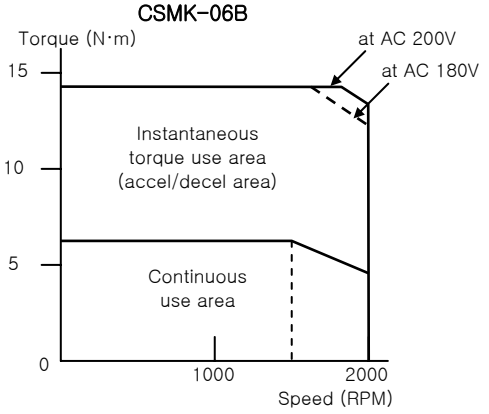
User should provide the power supply device of motor brake.

- **Speed-Torque Curve**

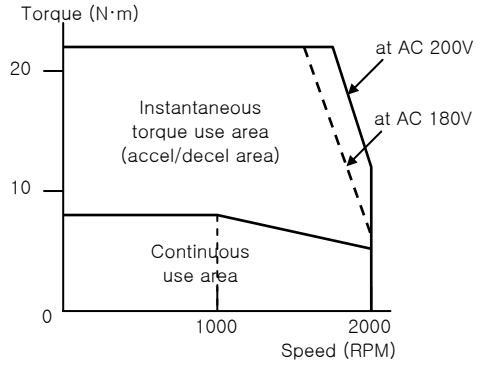
CSMK-03B



CSMK-06B



CSMK-09B



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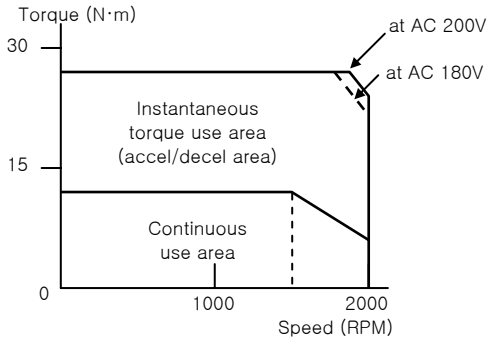
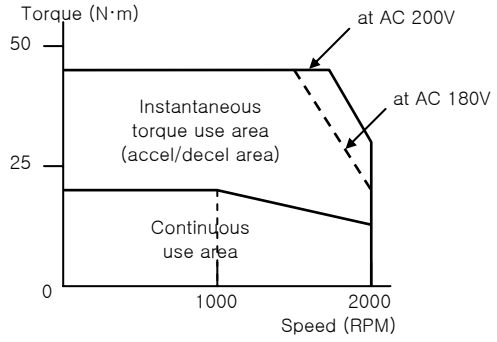
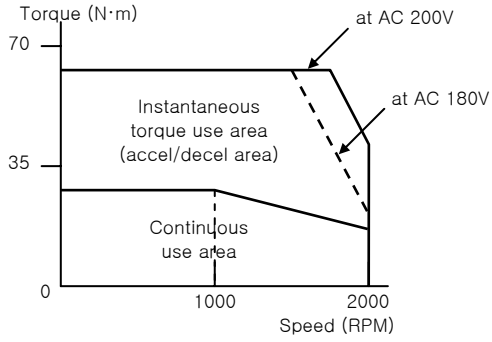


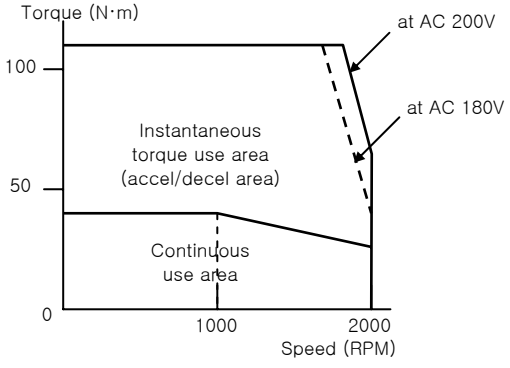
CSMK-20B



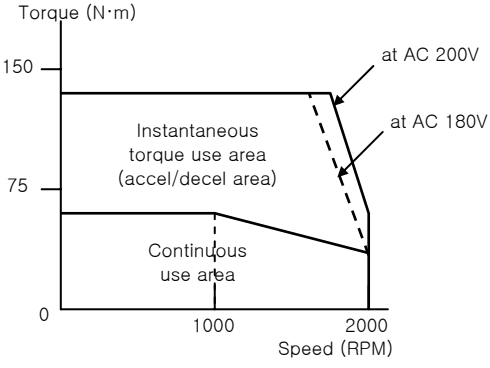
CSMK-30B



CSMK-45B



CSMK-60B



A.9 Main Features of Each Motors

Motor	Capacity	Inertal	Torque	Form
CSM **CSMT**	110V: 15kW ~ 400W 220V: 30W ~ 1kW	Low	Middle	Cylinder
CSMR	220V: 100W ~ 400W	Low	Middle	Pan Cake
CSMQ	110V: 100W ~ 400W 220V: 100W ~ 1.5kW	Low	Middle	Pan Cake
CSMZ	110V: 30W ~ 400W 220V: 30W ~ 800W	Low	Middle	Cylinder
CSMD	220V: 750W ~ 5kW	Middle	High	Cylinder
CSMS	220V: 1kW ~ 5kW	Low	Middle	Cylinder
CSMF	220V: 400W ~ 4.5kW	High	High	Pan Cake
CSMH	220V: 500W ~ 5kW	Highest	High	Cylinder
CSMK	220V: 300W ~ 6kW	High	Highest	Cylinder

MEMO

Appendix B. External dimension of the Motor

B.1 CSM Motor

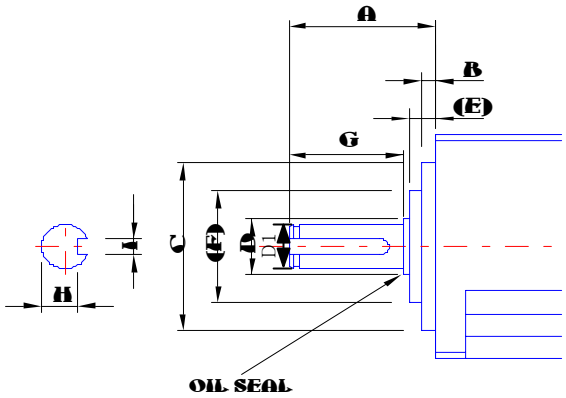
• **Shaft Specification**

1) External Size

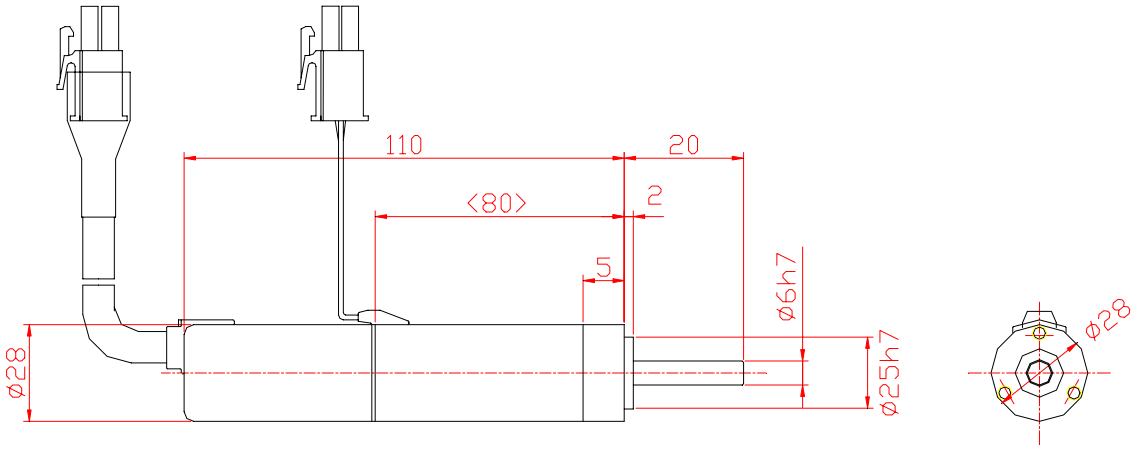
Motor Capacity	Size of Each Area(mm)										Key Specification
	A	B	C	D	D1	E	F	G	H	I	
30,50,100W	25±0.5	2.5	Φ30h7$_{-0.021}$	Φ9	Φ8	(4.5)	(Φ20)	20	6.2$_{-0.2}$	3P9$_{-0.031}$	3×3×16
200,400W	30±0.5	3	Φ50h7$_{-0.025}$	Φ14	Φ12	(7)	(Φ27)	22	4P9$_{-0.042}$	4P9$_{-0.042}$	4×4×20
600,800,950W	35±0.5	3	Φ70h7$_{-0.025}$	Φ20	Φ16	(7)	(Φ34)	27	5P9$_{-0.042}$	5P9$_{-0.042}$	5×5×25

※ When oil-sea is included if D is added.
(Standard specification has a area for oil seal but it is not attached.)

2) External Diagram

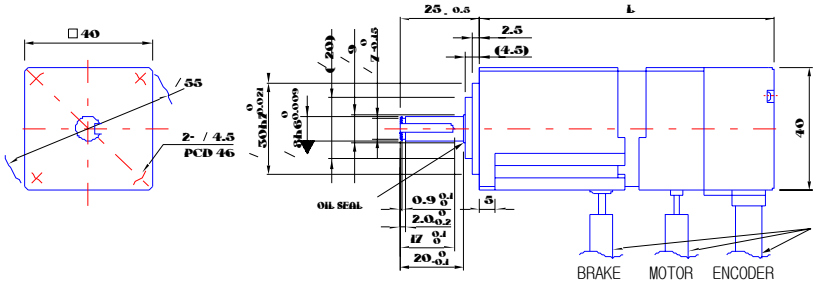


3) 15W Motor External Size



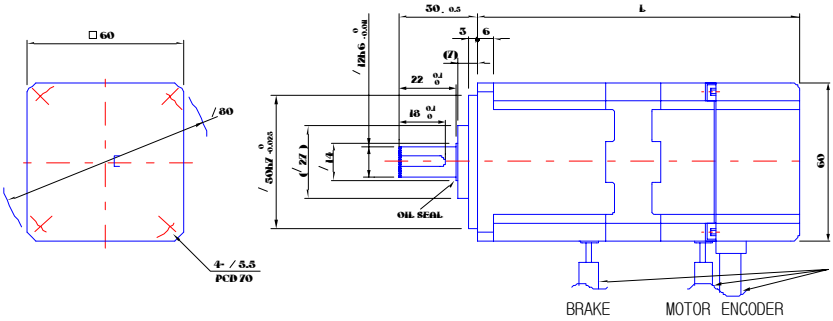
• Motor Diagram

1) CSM-A3/A5/01 (30, 50, 100W)



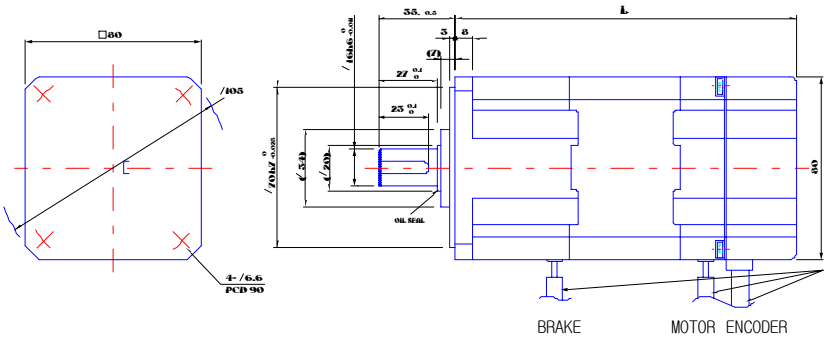
Output	Model	L (mm)	
		No Brake	With Brake
30W	CSM-A3	61.5	92.5
50W	CSM-A5	70.5	101.5
100W	CSM-01	88.5	119.5

2) CSM-02/04 (200,400W)



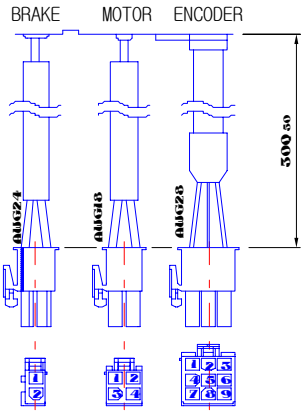
Output	Model	L (mm)	
		No Brake	With Brake
200W	CSM-02	93	122.5
400W	CSM-04	121	150.5

3) CSM-06/08/10 (600, 800 , 950W)



Output	Model	L (mm)	
		No Brake	With Brake
600W	CSM-06	125	156
800W	CSM-08	142	173
950W	CSM-10	163	194

• Motor Cable Specification



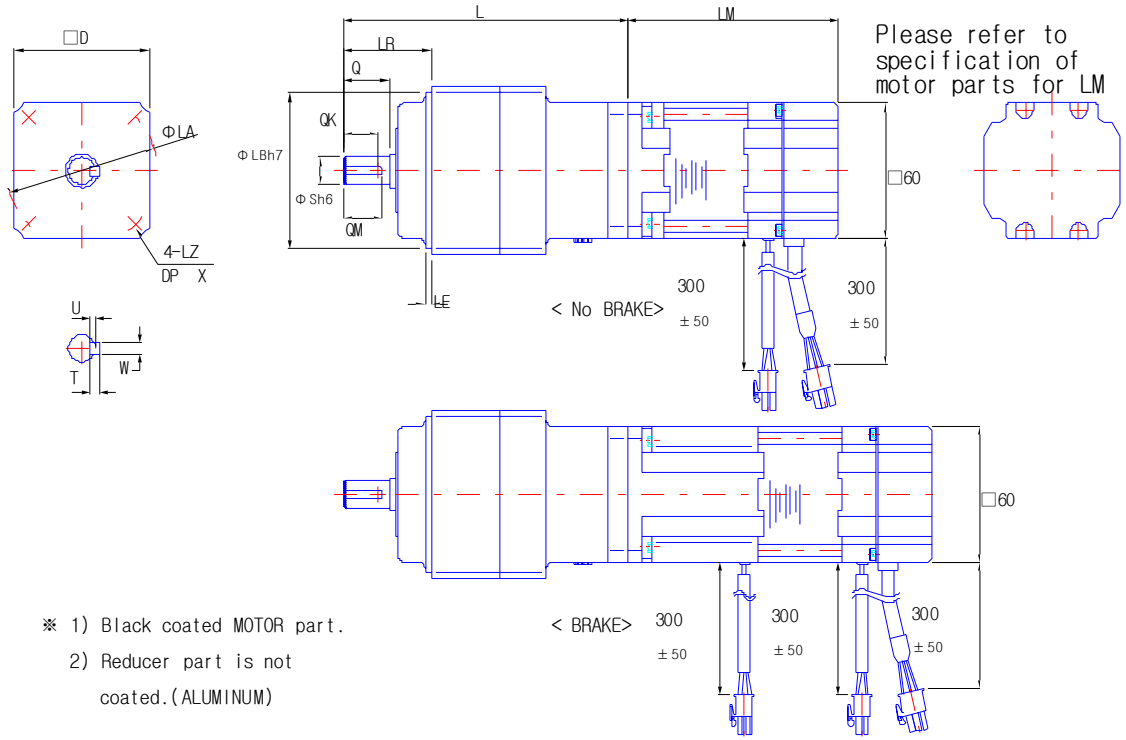
ENCODER CONNECTION											
Pin No	9 Wire INC.	11Wire INC.	15Wir INC.	CSM ABS.	CSMQ/Z ABS.	Pin No	9 Wire INC.	11Wire INC.	15Wir INC.	CSM ABS.	CSMQ/Z ABS.
1	A	A	A	A	A	9	SH	$\overline{Rx}$	V	RST	RST
2	$\overline{A}$	$\overline{A}$	$\overline{A}$	$\overline{A}$	$\overline{A}$	10		VCC	$\overline{V}$	FG	PE
3	B	B	B	B	B	11		GND	W	BAT+	Rx
4	$\overline{B}$	$\overline{B}$	$\overline{B}$	$\overline{B}$	$\overline{B}$	12		PE	$\overline{W}$	BAT-	$\overline{Rx}$
5	C	C	C	C	C	13			VCC	VCC	VCC
6	$\overline{C}$	$\overline{C}$	$\overline{C}$	$\overline{C}$	$\overline{C}$	14			GND	GND	GND
7	VCC		U	Rx	BAT+	15			PE	PE	PE
8	GND	Rx	$\overline{U}$	$\overline{Rx}$	BAT-						

BRAKE CONNECTION		
PIN No	FUNCTION	COLOR
1	BK+	Yellow
2	BK-	Yellow

※ Brake Power Source : DC 24V

MOTOR CONNECTION		
PIN No	FUNCTION	COLOR
1	U	Red
2	V	White
3	W	Black
4	PE	Green

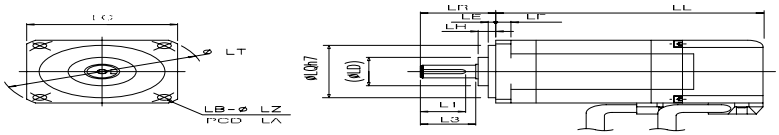
• When Attaching Reducer



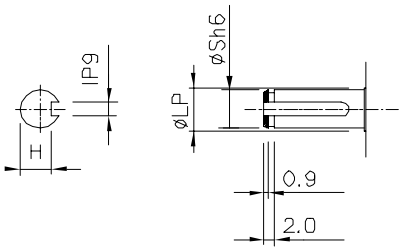
※ 1) Black coated MOTOR part.
2) Reducer part is not coated.(ALUMINUM)

Model			Length(mm)		Output Axis(mm)						FLANGE(mm)					
Model Name		Reduction Rate	L	LR	Q	QM	QK	S	W×U	T	LB	LA	LE	LZ	D	X
CSM-A5	B	1/3	99.5	32	20	18	16	12	4×2.5	4	50	60	3	M5	52	12
		1/5														
		1/9	110													
		1/15														
		1/25														
CSM-01	B	1/3	99.5	32	20	18	16	12	4×2.5	4	50	60	3	M5	52	12
		1/5														
		1/9	110													
		1/15														
	C	1/25	142	50	30	26	22	19	6×3.5	6	70	90	3	M6	78	20
CSM-02	B	1/3	104.5	32	20	18	16	12	4×2.5	4	50	60	3	M5	52	12
		1/5														
	C	1/9	150	50	30	26	22	19	6×3.5	6	70	90	3	M6	78	20
		1/15														
		1/25														
CSM-04	B	1/3	104.5	32	20	18	16	12	4×2.5	4	50	60	3	M5	52	12
	C	1/5	139.5	50	30	26	22	19	6×3.5	6	70	90	3	M6	78	20
		1/9	150													
		1/15														
	D	1/25	165	61	40	35	30	24	8×4	7	90	115	5	M8	96	20
CSM-06	C	1/3	143.5	50	30	26	22	19	6×3.5	6	70	90	3	M6	78	20
		1/5														
	D	1/9	171	61	40	35	30	24	8×4	7	90	115	5	M8	96	20
		1/15														
CSM-08	C	1/3	143.5	50	30	26	22	19	6×3.5	6	70	90	3	M6	78	20
		1/5														
	D	1/9	171	61	40	35	30	24	8×4	7	90	115	5	M8	96	20
		1/15														
	E	1/25	210	75	55	52	45	32	10×5	8	110	135	5	M10	125	20

B.2 CSMT Motor

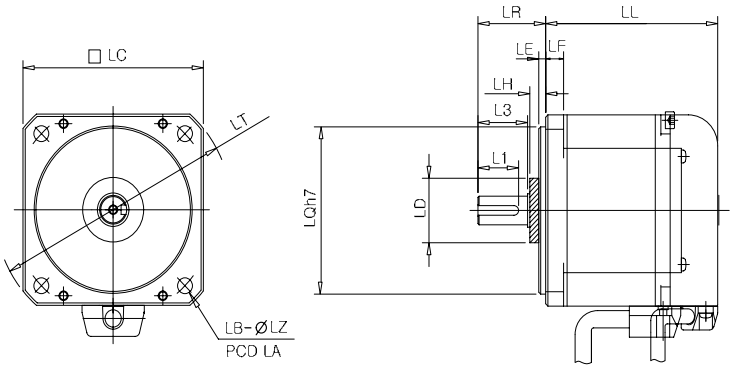


Model / Dimension		A3B	A5B	01B	02B	04B	06B	08B	10B
LL	No BRAKE	53.5	59.5	73.5	76.1	98.1	99.7	108.7	144.2
	With BRAKE	89.1	95.1	109.1	110.7	132.7	136.3	145.3	167.2
LR		25			30		35		35
LE		2.5			3		3		3
LF		5			6		8		8
LH		4.5			7		7		7
LQ		30			50		70		80
LD		20			27		34		34
L1		17			18		23		23
L3		20			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

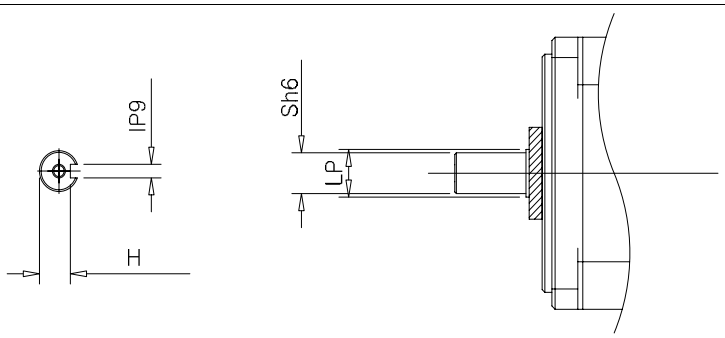


Model / Dimension	A3B	A5B	01B	02B	04B	06B	08B	10B
LP	8.9			14		19.8		
S	8			12		16		
H	6.2			9.5		13		
I	3			4		5		

B.3 CSMR Motor



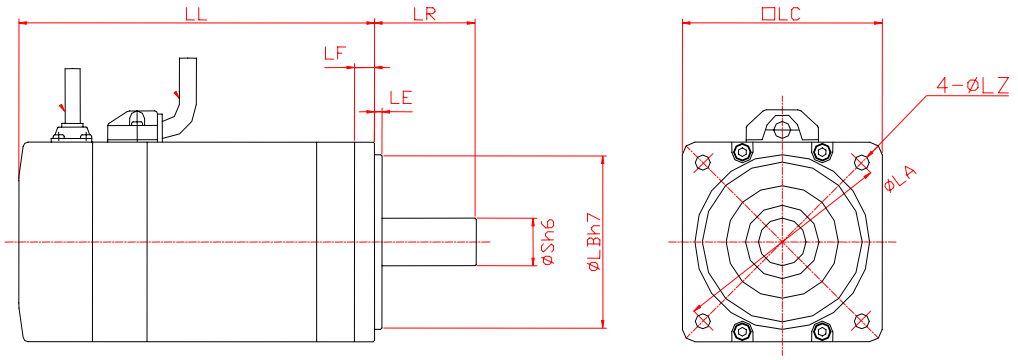
Dimension \ Model		01B	02B	04B
LL	No BRAKE	62.5	64.3	76.3
	With BRAKE	86.5	95.3	107.3
LR		30	30	
LE		3	3	
LF		6	8	
LH		7	7	
LQ		50	70	
LD		27	27	
L1		18	18	
L3		22	22	
LC		60	80	
LT		80	105	
LB		4	4	
LZ		5.5	6.6	
LA		70	90	



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

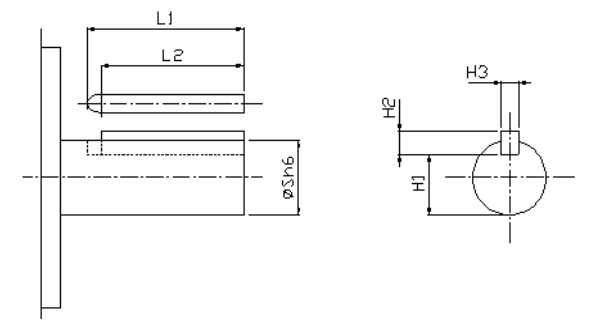
B.4 CSMQ Motor

• External diagram



Rated Output(W)		100W	200W	400W
LL	No Break	60	67	82
	With Break	84	99.5	114.5
LR		25	30	30
S		8	11	14
LA		70	90	90
LB		50	70	70
LC		60	80	80
LD		Not in SPEC. Diagonal Length = LC × SQRT(2) – (Corner cutting length × 2)		
LE		3	5	5
LF		7	8	8
LZ		4.5	5.5	5.5

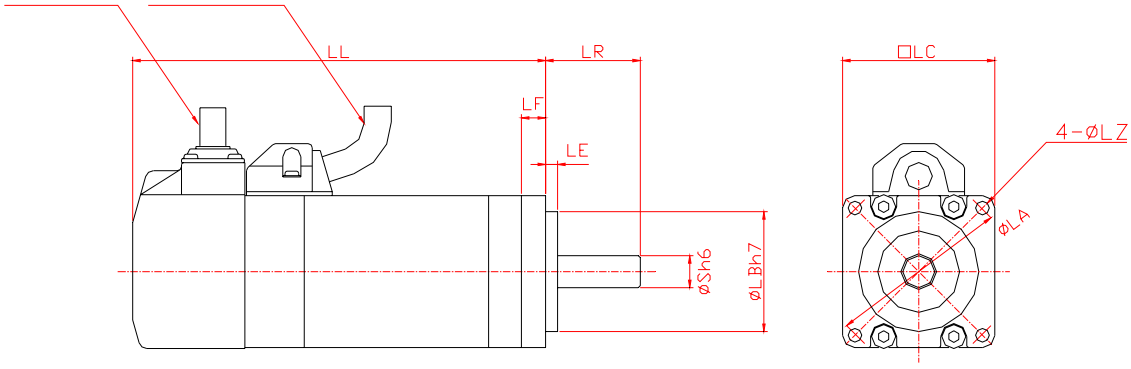
• Shaft Specification



Rated Output(W)	100W	200W	400W
L1	14	20	25
L2	12.5	18	22.5
H1	6.2	8.5	11
H2	3	4	5
H3	3	4	5
S	8	11	14

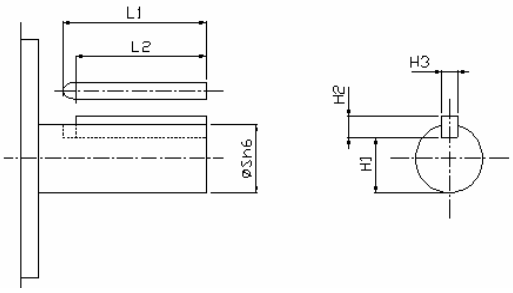
B.5 CSMZ Motor

• External diagram



Rated Output(W)		30W	50W	100W	200W	400W	750W
LL	No Break	65	73	103	94	123.5	142.5
	With Break	97	105	135	127	156.5	177.5
LR		25	25	25	30	30	35
S		7	8	8	11	14	19
LA		45	45	45	70	70	90
LB		30	30	30	50	50	70
LC		38	38	38	60	60	80
LE		3	3	3	3	3	3
LF		6	6	6	7	7	8
LZ		3.4	3.4	3.4	4.5	4.5	6

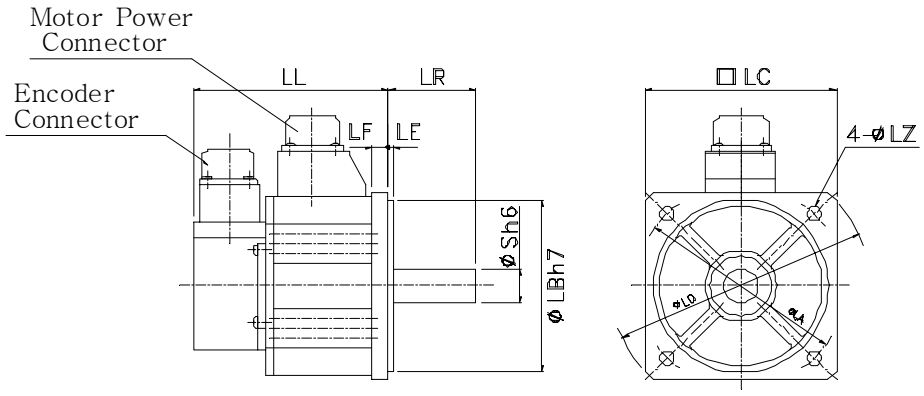
• Shaft Specification



Rated Output(W)	30W	50W	100W	200W	400W	750W
L1	13	14		20	25	25
L2	12	12.5		18	22.5	22
H1	5.8	6.2		8.5	11	15.5
H2	2	3		4	5	6
H3	2	3		4	5	6
S	7	8		11	14	19

B.6 CSMD/F/S/H/ Motor

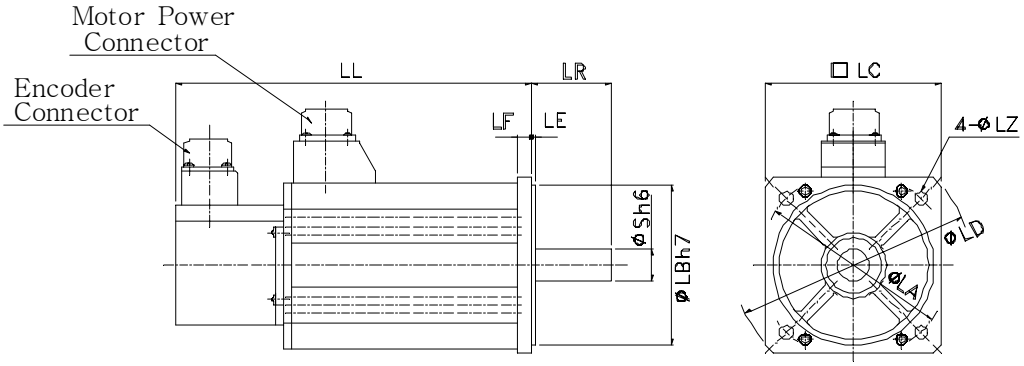
• CSMD-Series Motor External Diagram



Unit : mm

Rated Output (kW)		0.75	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
LL	Incremental/No Brake	144	147	172	197	222	247	229	249	202	222
	Incremental/With Brake	169	172	197	222	247	272	254	274	227	247
	Absolute/No Brake	173	176	201	226	251	276	258	278	231	251
	Absolute/With Brake	198	201	226	251	276	301	283	303	256	276
LR		55	55	55	55	65	65	65	65	70	70
S		19	22	22	22	24	24	28	28	35	35
LA		130/145	145	145	145	145	145	165	165	200	200
LB		110	110	110	110	110	110	130	130	114.3	114.3
LC		120	130	130	130	130	130	150	150	180	180
LD		162	165	165	165	165	165	190	190	233	233
LE		3	6	6	6	6	6	3.2	3.2	3.2	3.2
LF		10	12	12	12	12	12	18	18	18	18
LZ		9	9	9	9	9	9	11	11	13.5	13.5
Weight (kg)	No Brake	4.8	6.8	8.5	10.6	12.8	14.6	16.2	18.8	21.5	25.0
	With Brake	6.5	8.7	10.1	12.5	14.7	16.5	18.7	21.3	25.0	28.5

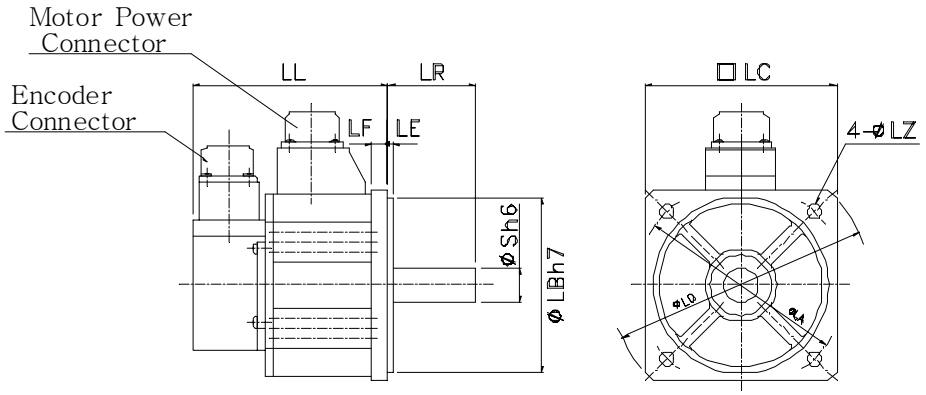
• **CSMS/H-Series Motor External Diagram**



Unit : mm

Motor Series		CSMS-Series Servo Motor									CSMH-Series Servo Motor						
Rated Output (kW)		1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0
LL	INC. / No Brake	172	177	202	227	214	234	237	257	277	147	172	197	187	202	227	252
	INC. / With Brake	197	202	227	252	239	259	262	282	302	172	197	222	212	227	252	277
	ABS. / No Brake	201	206	231	256	243	263	266	286	306	176	201	226	231	231	256	281
	ABS. / With Brake	226	231	256	281	268	288	291	311	331	201	226	251	241	256	281	306
LR		55	55	55	55	55	55	65	65	65	70	70	70	80	80	80	80
S		19	19	19	19	22	22	24	24	24	22	22	22	35	35	35	35
LA		100	115	115	115	130 145	130 145	145	145	145	145	145	145	200	200	200	200
LB		80	95	95	95	110	110	10	110	110	110	110	110	114.3	114.3	114.3	114.3
LC		90	100	00	100	120	120	130	130	130	130	130	130	180	180	180	180
LD		120	135	135	135	162	162	165	165	165	165	165	165	233	233	233	233
LE		3	3	3	3	3	3	6	6	6	6	6	6	3.2	3.2	3.2	3.2
LF		7	10	10	10	10	10	12	12	12	12	12	12	18	18	18	18
LZ		6.6	9	9	9	9	9	9	9	9	9	9	9	13.5	13.5	13.5	13.5
Weight (kg)	No Brake	4.5	5.1	6.5	7.5	9.3	10.9	12.9	15.1	17.3	5.3	8.9	10.0	16	18.2	22	26.7
	With Brake	5.1	6.5	7.9	8.9	11.0	12.6	14.8	17.0	19.2	6.9	9.5	11.6	19.5	21.7	25.5	30.2

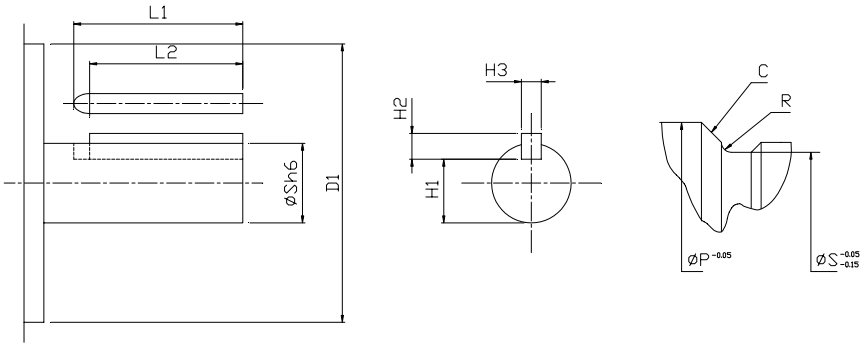
• CSMF-Series Motor External Diagram



Unit : mm

Rated Output (kW)		0.4	0.75	1.5	2.5	3.5	4.5
LL	INC. / No Brake	117	122	142	136	144	160
	INC. / With Brake	142	147	167	163	171	191
	ABS./ No Brake	146	151	171	165	173	189
	ABS. / With Brake	171	176	196	192	200	220
LR		55	55	65	65	65	70
S		19	22	35	35	35	35
LA		145	200	200	235	235	235
LB		110	114.3	114.3	200	200	200
LC		130	180	180	220	220	220
LD		165	233	233	268	268	268
LE		6	3.2	3.2	4	4	4
LF		12	18	18	16	16	16
LZ		9	13.5	13.5	13.5	13.5	13.5
Weight (kg)	No Brake	4.7	8.6	11.0	14.8	15.5	19.9
	With Brake	6.7	10.6	14.0	17.5	19.2	24.3

• CSMD/F/S/H Motor Shaft End Specification

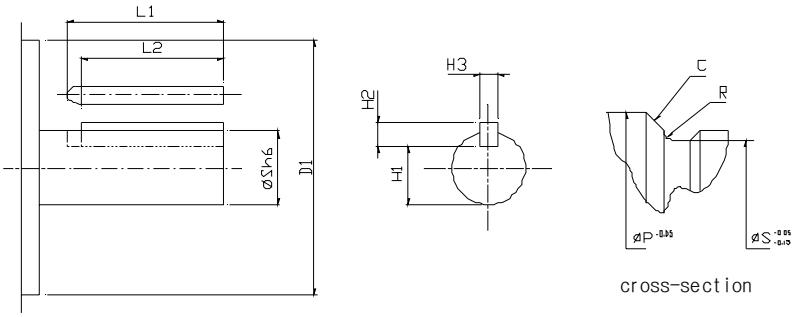


Unit : mm

MOTOR Type/Capacity	L1	L2	D1	H1	H2	H3	C	R	ΦP	ΦS
CSMS-10	45	42	Φ80h7	15.5	6	6h9	C0.3	R0.6～1.1	Φ19.8	Φ19
CSMS-15 ~ CSMS-25			Φ95h7							
CSMS-30 ~ CSMS-35 CSMD-10 ~ CSMS-20 CSMH-05 ~ CSMH-15	45	41	Φ110h7	18.0	7	8h9	C0.5		Φ24.0	Φ22
CSMS-40 ~ CSMS-50 CSMD-25 ~ CSMD-30	55	51		20.0	7	8h9			No Step	Φ24
CSMF-04 CSMD-08	45	42		15.5	6	6h9			Φ24.0	Φ19
CSMF-08	45	41	Φ114.3h7	18.0	7	8h9	C2.5		Φ39.8	Φ22
CSMF-15 CSMD-45 ~ CSMD-50 CSMH-20 ~ CSMH-50	55	50	Φ114.3h7	30.0	8	10h9	C0.5		Φ39.8	Φ35
CSMF-25 ~ CSMF-45	55	50	Φ200h7	30.0	8	10h9	C1.5～C2.5	R1.5	Φ37.9	Φ35
CSMD-35 ~ CSMD-40	55	51	Φ130h7	24.0	7	8h9	C0.5	R0.6～1.1	Φ29.8	Φ28

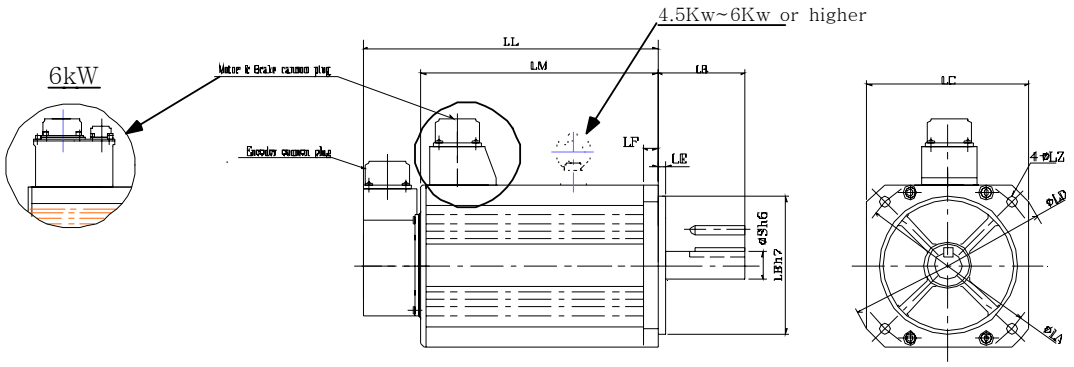
B.7 CSMK Motor

• Shaft End Specification



Motor Capacity	Size of Each Area(mm)									
	L1	L2	D1	H1	H2	H3	C	R	ϕP	ϕS
CSMK-03～09	45	41	ϕ110h7	18	7	8h9	C0.5	R0.6～1.1	ϕ24	ϕ22
CSMK-12～30	55	50	ϕ114.3h7	30	8	10	C0.5	R0.6～1.1	ϕ39.8	ϕ35
CSMK-45～60	96	90	ϕ114.3h7	37	8	12h9	No Step			ϕ42

• External of Diagram



Unit : mm

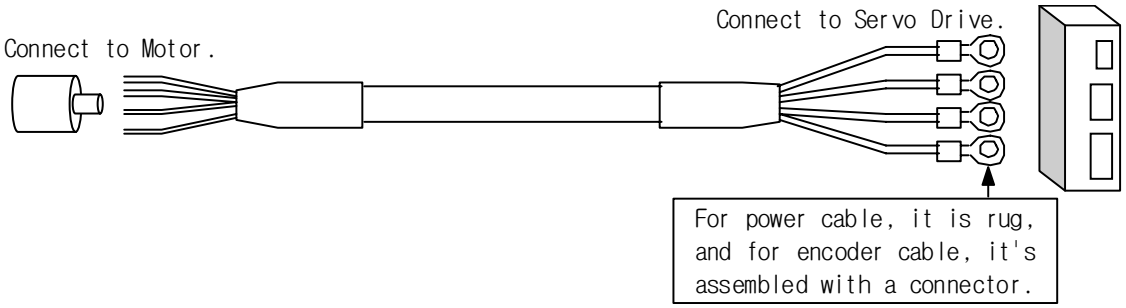
Rated Output(W)		0.3	0.6	0.9	1.2	2.0	3.0	4.5	6.0
LL	Incremental/ No Break	133	158	183	170	190	230	308.5	348.5
	Incremental/ With Break	158	183	208	195	162	208	353.5	393.5
LR		70	70	70	80	80	80	113	113
S		22	22	22	35	35	35	42	42
LA		145	145	145	200	200	200	200	200
LB		110	110	110	114.3	114.3	114.3	114.3	114.3
LC		130	130	130	176	176	176	176	176
LD		165	165	165	233	233	233	233	233
LE		6	6	6	3.2	3.2	3.2	3.2	3.2
LF		12	12	12	18	18	18	24	24
LZ		9	9	9	13.5	13.5	13.5	13.5	13.5
Weight	No Brake	5.1	6.8	8.5	15.5	17.5	25	34	41
	With Brake	6.7	8.4	10	19	21	28.5	39.5	46.5

MEMO

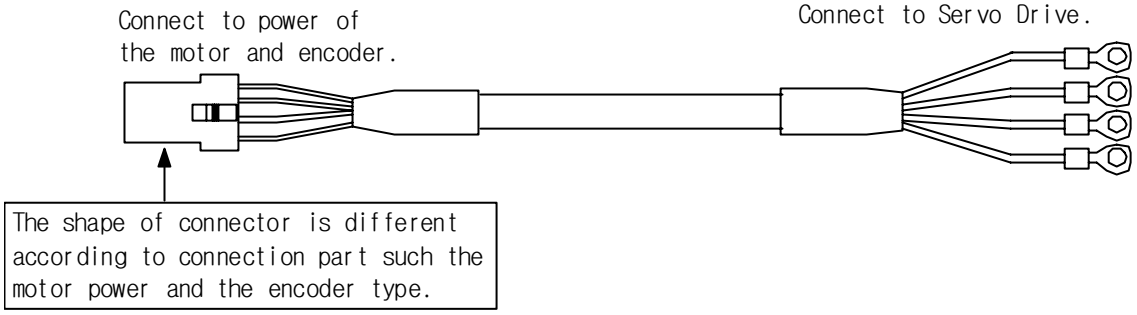
Appendix C. Cable

C.1 Term Explanation

- **Cable** : Cable which the connector is not assembled on the motor side.
  Power cable of CSMD/S/F/H/N/X/K motor is as fallows

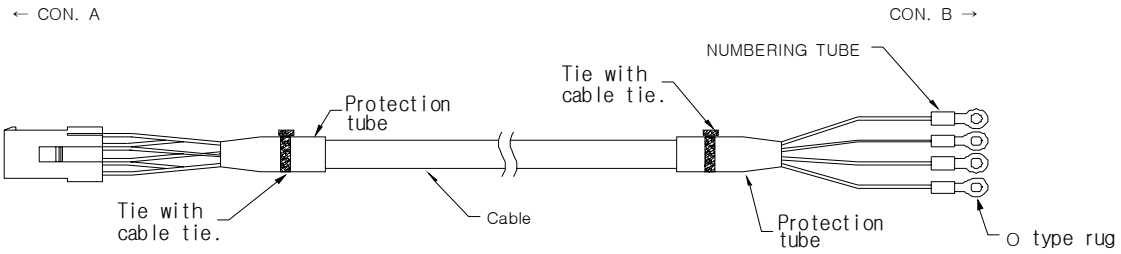


- **Cable Assembly**: Cable which the connection connector is assembled on the motor side.
  End of connector type display is marked in. A



Motor Type	Power Cable	Encoder Cable
CSM/P/Q/Z	Cable Assembly	Cable Assembly
CSMD/S/F/S/H/N/X/K	Cable	Cable Assembly

C.2 Motor 3Phase Power Cable (CSM,CSMT/R/Z/Q)

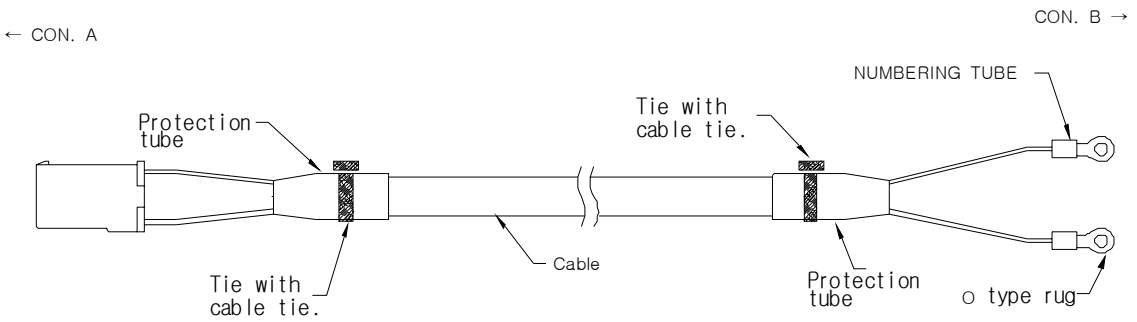


Marking	Cable Color	Remark
U	Red of 3 Point Cable	
V	White of 3 Point Cable	
W	Gray of 3 Point Cable	
P.E	P.E Wire (green background/yellow stripe)	Weld and connect the to 3 point cable of the shield

- **Order Number and Product Name**

Length(mm)±10%	Order Number		Product Name
	Fixed Type	Flexible Type	
3,000	POW SL03P010FA	POW SL03P010MA	3 Phase Motor Power Cable Assembly
5,000	POW SL05P010FA	POW SL05P010MA	
10,000	POW SL10P010FA	POW SL10P010MA	
15,000	POW SL15P010FA	POW SL15P010MA	
20,000	POW SL20P010FA	POW SL20P010MA	

C.3 Motor Brake Cable(CSM,CSMT/R/Z/Q)

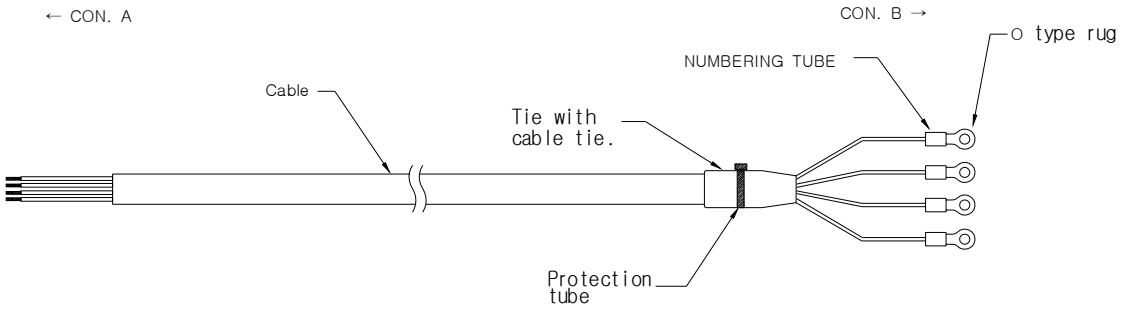


Marking	Cable Color	Remark
BK +	White of 2 Point Cable	
BK -	Gray of 2 Point Cable	

- **Order Number and Product Name**

Length(mm)±10%	Order Number		Product Name
	Fixed Type	Flexible Type	
3,000	BRK SL03BRAKFA	BRK SL03BRAKMA	Motor broke cable Assembly
5,000	BRK SL05BRAKFA	BRK SL05BRAKMA	
10,000	BRK SL10BRAKFA	BRK SL10BRAKMA	
15,000	BRK SL15BRAKFA	BRK SL15BRAKMA	
20,000	BRK SL20BRAKFA	BRK SL20BRAKMA	

C.4 Motor 3 Phase Power Cable (CSMD/F/H/S/K)

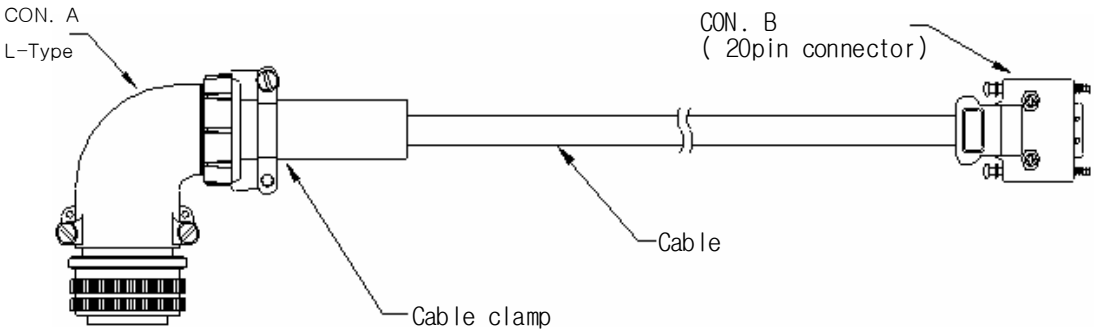


Marking	Cable Color	Remark
U	Red of 3 Point Cable	
V	White of 3 Point Cable	
W	Gray of 3 Point Cable	
P.E	P.E Wire (green background/yellow stripe)	Weld and connect the to 3 point cable of the shield

• **Order Number and Product Name**

Type	Length (m)	Order Number					Product Name
		600W	800W	3.5KW	5KW	6KW	
Fixed Type	3	POW SH03P006F	POW SH03P008F	POW SH03P035F	POW SH03P050F	POW SH03P060F	Motor 3 phase power cable
	5	POW SH05P006F	POW SH05P008F	POW SH05P035F	POW SH05P050F	POW SH05P060F	
	10	POW SH10P006F	POW SH10P008F	POW SH10P035F	POW SH10P050F	POW SH10P060F	
	15	POW SH15P006F	POW SH15P008F	POW SH15P035F	POW SH15P050F	POW SH15P060F	
	20	POW SH20P006F	POW SH20P008F	POW SH20P035F	POW SH20P050F	POW SH20P060F	
Flexible Type	3	POW SH03P006M	POW SH03P008M	POW SH03P035M	POW SH03P050M	POW SH03P060M	
	5	POW SH05P006M	POW SH05P008M	POW SH05P035M	POW SH05P050M	POW SH05P060M	
	10	POW SH10P006M	POW SH10P008M	POW SH10P035M	POW SH10P050M	POW SH10P060M	
	15	POW SH15P006M	POW SH15P008M	POW SH15P035M	POW SH15P050M	POW SH15P060M	
	20	POW SH20P006M	POW SH20P008M	POW SH20P035M	POW SH20P050M	POW SH20P060M	

C.5 11 Wire Incremental Encoder Cable(CSMD/F/H/S)



• 11 Wire Incremental Encoder Connector (CON.A ↔ CON.B) Connection Specification

CON.A	CON.B	Wire Color	Function
A	3	1P(White/Blue)-Blue	A
B	4	1P(White/Blue)-White	* A
C	5	2P(White/Blue)-Blue	B
D	6	2P(White/Blue)-White	* B
E	7	3P(White/Green)-White	C
F	8	3P(White/Green)-blue	* C
G	1	4P(White/Red)-White	GND
H	20	4P(White/Red)-Red	+5V
J	12/SH	Shield	FG
P	10	5P(White/Purple)-Purple	RX
R	13	5P(White/Purple)-White	* RX

• Order Number and Product Name of L-Type Plug

Length(mm)±10%	Order Number		Product Name
	Fixed Type	Flexible Type	
3,000	ENC SH03ECNLFA	ENC SH03ECNLMA	L-Type 11 Wire Incremental Encoder Cable Assembly
5,000	ENC SH05ECNLFA	ENC SH05ECNLMA	
10,000	ENC SH10ECNLFA	ENC SH10ECNLMA	
15,000	ENC SH15ECNLFA	ENC SH15ECNLMA	
20,000	ENC SH20ECNLFA	ENC SH20ECNLMA	

C.6 Absolute Encoder Cable Assembly (CSMD/F/H/S)

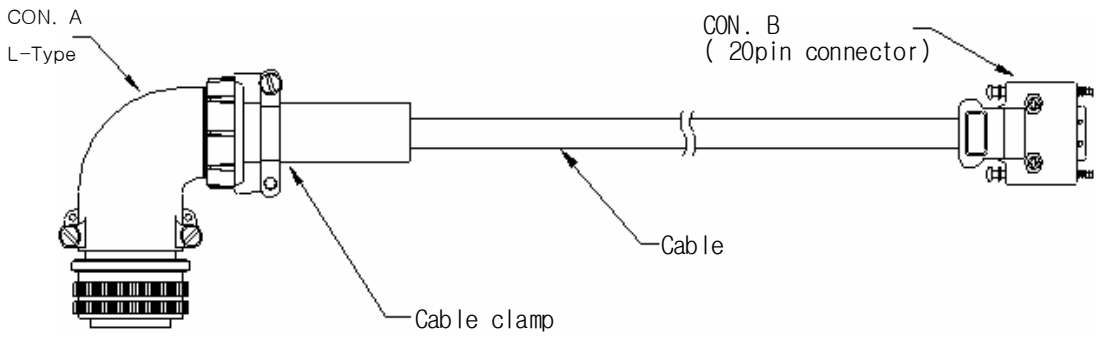
• **15 wire Absolute Encoder Connector (CON.A ↔ CON.B) Connection Specification**

CON.A	CON.B	Wire Color	Function
A	3	1P(White/blue)-blue	A
B	4	1P(White/blue)-White	* A
C	5	2P(White/Yellow)-Yellow	B
D	6	2P(White/Yellow)-White	* B
E	7	3P(White/Green)-Green	C
F	8	3P(White/Green)-White	* C
G	1	4P(White/Red)-White	GND
H	20	4P(White/Red)-Red	+5V
J	12/SH	Shield	FG
K	10	5P(White/Purple)-Purple	RX
L	13	5P(White/Purple)-White	* RX
R	11	6P(Brown/Blue)-Blue	RST
	15		Not Used
S	19	7P(Brown/Yellow)-Yellow	BAT-
T	18	7P(Brown/Yellow)-Brown	BAT+

• **Order Number and Product Name of L-Type Plug**

Length(mm)±10%	Order Number		Product Name
	Fixed Type	Flexible Type	
3,000	ENC SH03EABLFA	ENC SH03EABLMA	L-Type 15 wire Absolute Encoder Cable Assembly
5,000	ENC SH05EABLFA	ENC SH05EABLMA	
10,000	ENC SH10EABLFA	ENC SH10EABLMA	
15,000	ENC SH15EABLFA	ENC SH15EABLMA	
20,000	ENC SH20EABLFA	ENC SH20EABLMA	

C.7 15 Wire Incremental Encoder Cable(CSMD/F/H/S/K)



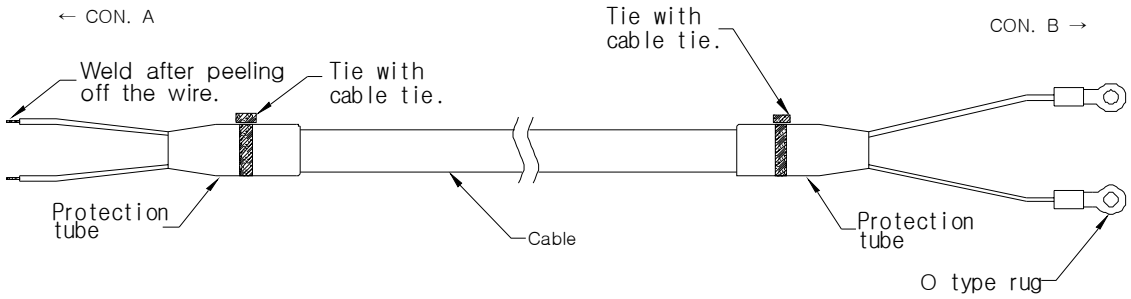
• 15 Wire Incremental Encoder Connector (CON.A ↔ CON.B) Connection Specification

CON.A	CON.B	Wire Color	Function
A	3	1P(White/blue)-blue	A
B	4	1P(White/blue)-White	* A
C	5	2P(White/Yellow)-Yellow	B
D	6	2P(White/Yellow)-White	* B
E	7	3P(White/Green)-Green	C
F	8	3P(White/Green)-White	* C
G	1	4P(White/Red)-White	GND
H	20	4P(White/Red)-Red	+5V
J	12/SH	Shield	FG
K	10	5P(White/Purple)-Purple	U
L	13	5P(White/Purple)-White	* U
M	14	6P(Brown/Blue)-Blue	V
N	15	6P(Brown/Blue)-Brown	* V
P	16	7P(Brown/Yellow)-Yellow	W
R	17	7P(Brown/Yellow)-Brown	* W

• Order Number and Product Name of L-Type Plug

Length(mm)±10%	Order Number		Product Name
	Fixed Type	Flexible Type	
3,000	ENC SH03ESNLFA	ENC SH03ESNLMA	L-TYPE 15 wire Incremental Encoder Cable Assembly
5,000	ENC SH05ESNLFA	ENC SH05ESNLMA	
10,000	ENC SH10ESNLFA	ENC SH10ESNLMA	
15,000	ENC SH15ESNLFA	ENC SH15ESNLMA	
20,000	ENC SH20ESNLFA	ENC SH20ESNLMA	

C.8 Motor Brake Cable(CSMD/F/H/S/K)

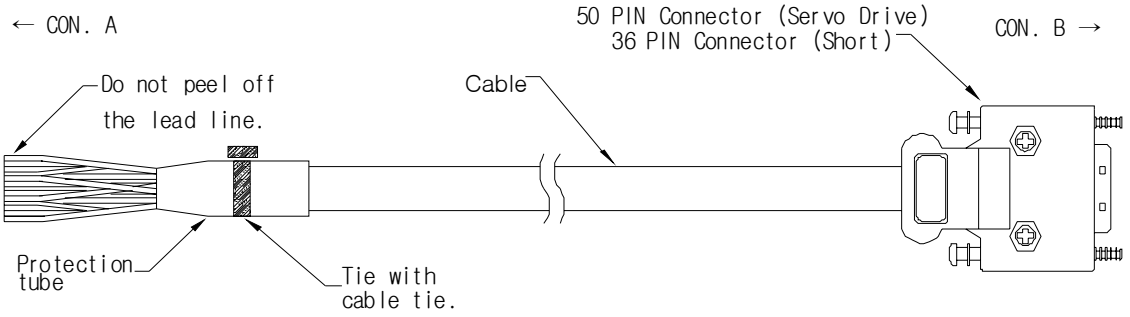


Marking	Cable Color	Remark
BK +	White of 2 Point Cable	
BK -	Gray of 2 Point Cable	

- **Order Number and Product Name**

Length(mm)±10%	Order Number		Product Name
	Fixed Type	Flexible Type	
3,000	BRK SH03BRAKFA	BRK SH03BRAKMA	Motor brake cable
5,000	BRK SH05BRAKFA	BRK SH05BRAKMA	
10,000	BRK SH10BRAKFA	BRK SH10BRAKMA	
15,000	BRK SH15BRAKFA	BRK SH15BRAKMA	
20,000	BRK SH20BRAKFA	BRK SH20BRAKMA	

C.9 User I/O Cable



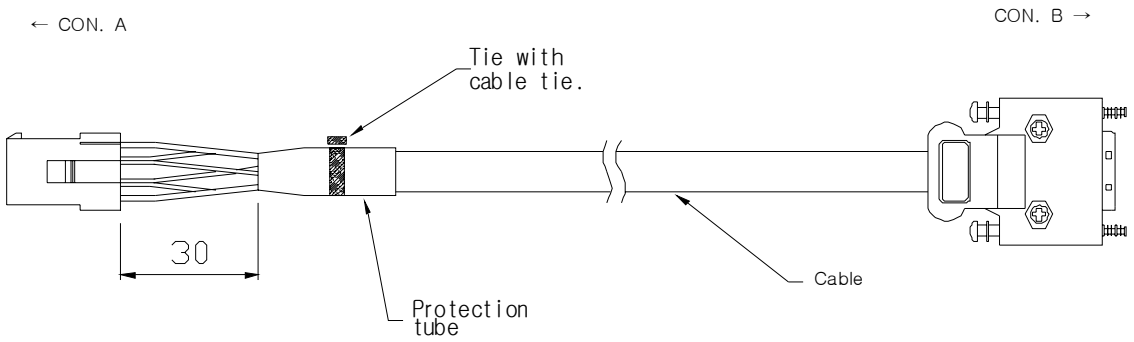
• **I/O Cable Connection Specification (Servo Drive)**

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 Number 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	

C.10 Compact Incremental Encoder Cable(CSM,CSMT/R/Z/Q)



• **9 Wire Incremental Encoder Connector (CON.A ↔ CON.B)**

Connection Specification - For CSM Motor

CON.A	CON.B	Wire Color	Function
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

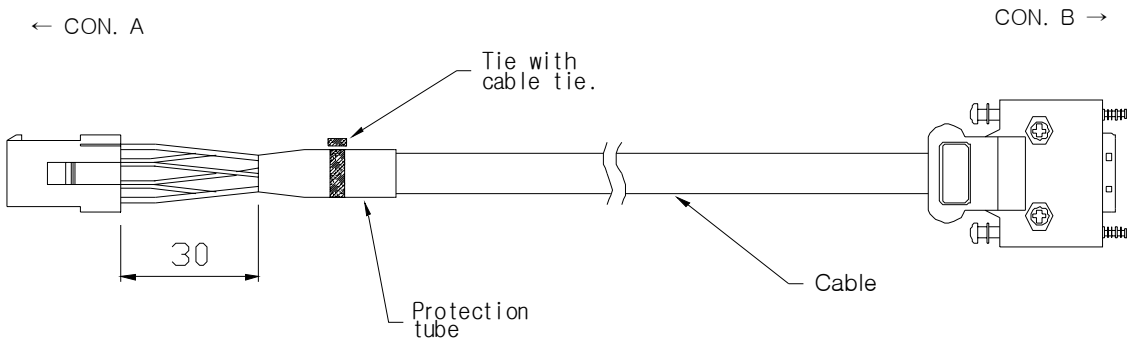
- **11 Wire Incremental Encoder Connector (CON.A ↔ CON.B)**
  Connection Specification - For CSMZ/Q Motor

CON.A	CON.B	Wire Color	Function
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**

Length (mm)±10%	Order Number (9 wire type, CSM Motor)		Order Number (11wire type, CSMZ/Q Motor)		Product Name
	Fixed Type	Flexible Type	Fixed Type	Flexible Type	
3,000	ENC SL03ECNSFA	ENC SL03ECNSMA	ENC SL03ECLSFA	ENC SL03ECLSMA	Incremental Encoder Cable Assembly
5,000	ENC SL05ECNSFA	ENC SL05ECNSMA	ENC SL05ECLSFA	ENC SL05ECLSMA	
10,000	ENC SL10ECNSFA	ENC SL10ECNSMA	ENC SL10ECLSFA	ENC SL10ECLSMA	
15,000	ENC SL15ECNSFA	ENC SL15ECNSMA	ENC SL15ECLSFA	ENC SL15ECLSMA	
20,000	ENC SL20ECNSFA	ENC SL20ECNSMA	ENC SL20ECLSFA	ENC SL20ECLSMA	

C.11 Absolute Encoder Cable Assembly (CSM,CSMZ,CSMQ)



• **15 Wire Absolute Encoder Connector (CON.A ↔ CON.B)**

Connection Specification - For CSM Motor

CON.A	CON.B	Wire Color	Function
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	10	5P(White/Purple)-Purple	RX
8	13	5P(White/Purple)-White	* RX
9	11	6P(Brown/Blue)-Blue	RST
10	12	Shield	FG
11	18	7P(Brown/Yellow)-Yellow	BAT+
12	19	7P(Brown/Yellow)-Brown	BAT-
13	20	4P(White/Red)-Red	VCC
14	1	4P(White/Red)-White	GND
15	12	Shield	P.E

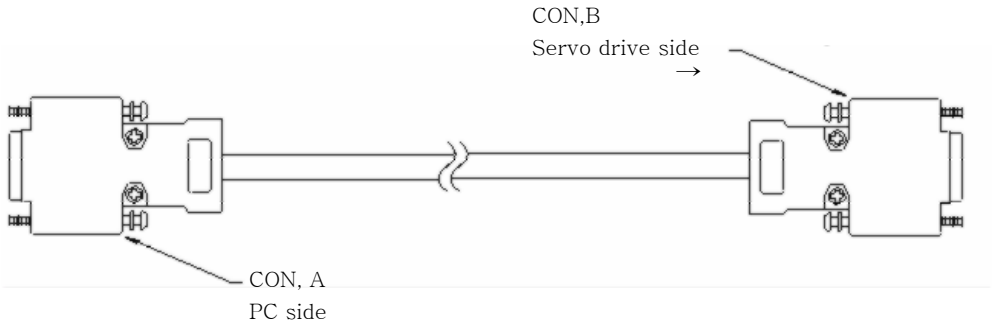
• **15 Wire Absolute Encoder Connector (CON.A ↔ CON.B)**
Connection specification - For CSMZ/Q Motor

CON.A	CON.B	Wire Color	Function
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	18	7P(Brown/Yellow)-Yellow	BAT+
8	19	7P(Brown/Yellow)-Brown	BAT-
9	11	6P(Brown/Blue)-Blue	RST
10	12	Shield	FG
11	10	5P(White/Purple)-Purple	RX
12	13	5P(White/Purple)-White	* RX
13	20	4P(White/Red)-Red	VCC
14	1	4P(White/Red)-White	GND
15	12	Shield	P.E

• **Order Number and Product Name**

Length (mm)±10%	Order Number (CSM Motor)		Order Number (CSMZ/Q Motor)		Product Name
	FIXED TYPE	Flexible TYPE	FIXED TYPE	Flexible TYPE	
3,000	ENC SL03EABSFA	ENC SL03EABSMA	ENC SL03EACSFA	ENC SL03EACSMA	Absolute Encoder Cable Assembly
5,000	ENC SL05EABSFA	ENC SL05EABSMA	ENC SL05EACSFA	ENC SL05EACSMA	
10,000	ENC SL10EABSFA	ENC SL10EABSMA	ENC SL10EACSFA	ENC SL10EACSMA	
15,000	ENC SL15EABSFA	ENC SL15EABSMA	ENC SL15EACSFA	ENC SL15EACSMA	
20,000	ENC SL20EABSFA	ENC SL20EABSMA	ENC SL20EACSFA	ENC SL20EACSMA	

C.12 Communication Cable

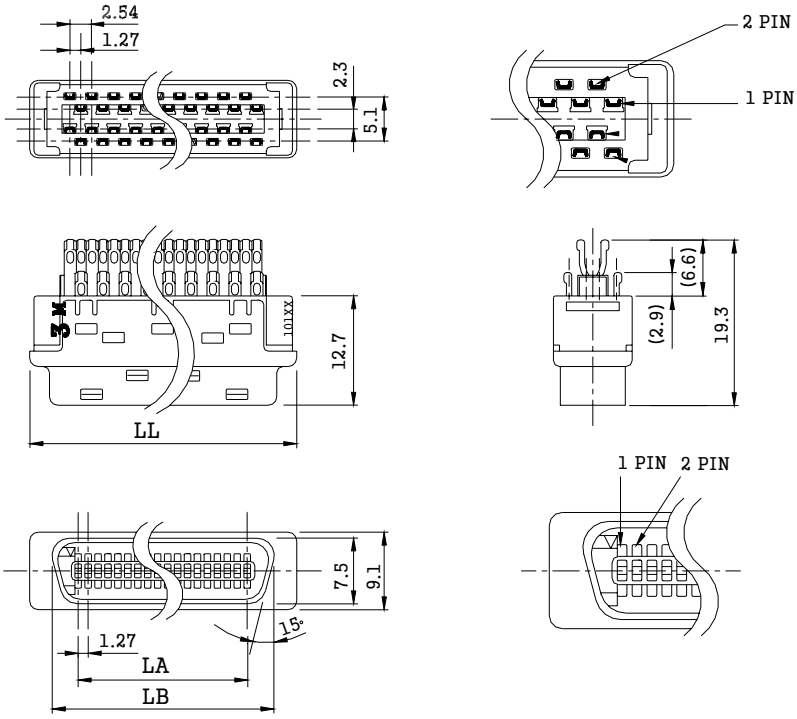


• **Communication Cable (CON.A ↔ CON.B) Connection Specification**

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	N.C		GND
N.C	N.C		GND
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

C.13 Connector Specification of Cable



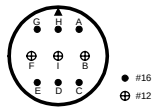
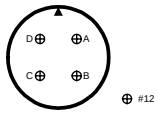
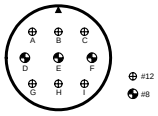
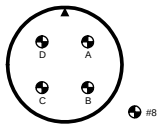
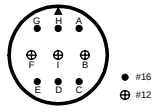
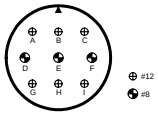
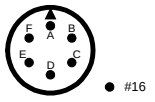
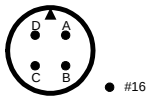
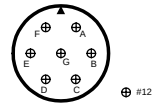
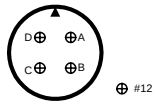
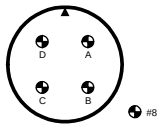
- **Order Number**
  - Encoder Connector(20Pin) : CON-SCONN20PEN
  - I/O Connector(36Pin) : CON-SCONN36PIN
  - I/O Connector(50Pin) : CON-SCONN50PIN

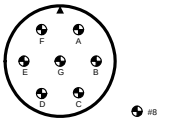
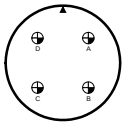
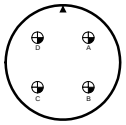
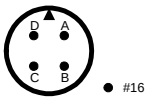
C.14 Ordering Part Number

<table>
<tr><th>Motor Type</th><th>Power Cable</th><th>Encoder Cable</th></tr>
<tr><td>CSM</td><td rowspan="2">POW-SL | 20 | P010 | F | A
▌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
▌Function
F: Fixed type
M: Flexible type</td><td>ENC-SL | 03 | E | CN | S | F | A
▌Cable length
Same as left
▌Function
Same as left
▌Encoder type
AB : 15 wire Absolute
CN : 9 wire Incremental
SN : 15 wire Incremental</td></tr>
<tr><td>CSMQ
CSMZ</td><td>ENC-SL | 03 | E | CL | S | F | A
▌Cable length
Same as left
▌Function
Same as left
▌Encoder type
AC : 15 wire Absolute
CL : 11 wire Incremental</td></tr>
<tr><td>CSMD
CSMS
CSMF
CSMH
CSMK</td><td>ENC-SL | 03 | E | CL | F
▌Cable length
Same as above
▌Function
Same as above
▌Capacity
006 : 600W or less
008 : 800W or less
035 : 3.5kW or less
050 : 5kW or less
060 : 6kW or less</td><td>ENC-SL | 03 | E | CL | L | F | A
▌Cable length
Same as left
▌Function
Same as left
▌Encoder type
AB : 15 wire Absolute
CN : 11 wire Incremental
SN : 15 wire Incremental
▌Connector type
L : L shape</td></tr>
<tr><td>All Motors</td><td>-</td><td>(When ordering only 20 PIN encoder Connector)
CON-SCONN | 20 | PEN</td></tr>
</table>

<table>
<tr><th>Motor Type</th><th>I/O Cable</th><th>Communication Cable</th></tr>
<tr><td rowspan="2">All Motors</td><td>ENC-SL | 03 | U50CNA
▌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</td><td>ENC-SL | 03 | C | PC | NNA
▌Cable type
JG : For JOG Operator
PC : For PC connection</td></tr>
<tr><td>(When ordering only 50PIN I/O Connector)
CON-SCONN | 50 | PIN</td><td></td></tr>
</table>

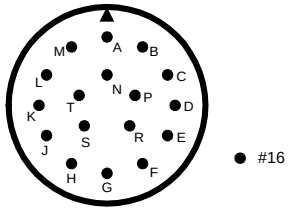
Appendix D. Motor Connector

Motor Type	Brake	Part No.	Pin Specification										External View
CSMD 08~CSMD-25 CSMS-10~CSMS-25 CSMH-05~CSMH-15 CSMK-03~CSMK-09	Yes	20-18P DMS 3102A	Pin	G	H	A	F	I	B	E	D	C	
			Function	BR	BR		U	V	W	P.E	P.E		
	No	20-4P DMS 3102A	Pin	A	B	C	D						
			Function	U	V	W	P.E						
CSMD-30~CSMD-50 CSMS-30~CSMS-50 CSMH-20~CSMH-50	Yes	24-11P DMS 3102A	Pin	A	B	C	D	E	F	G	H	I	
			Function	BR	BR		U	V	W	P.E	P.E		
	No	22-22P DMS 3202A	Pin	A	B	C	D						
			Function	U	V	W	P.E						
CSMF-04~CSMF-15	Yes	20-18P DMS 3102A	Pin	G	H	A	F	I	B	E	D	C	
			Function	BR	BR		U	V	W	P.E	P.E		
	No		Pin	G	H	A	F	I	B	E	D	C	
			Function				U	V	W	P.E	P.E		
CSMF-20~CSMF-45 CSMK-12~CSMK-45	Yes	24-11P DMS 3102A	Pin	A	B	C	D	E	F	G	H	I	
			Function	BR	BR		U	V	W	P.E	P.E		
CSMF-20~CSMF-45	No		Pin	A	B	C	D	E	F	G	H	I	
			Function				U	V	W	P.E	P.E		
CSMX-02~CSMX-03	Yes	14S-2P DMS 3102A	Pin	A	B	C	D	E	F				
			Function	U	V	W	BR	BR	P.E				
	No	14S-6P DMS 3102A	Pin	A	B	C	D						
			Function	U	V	W	P.E						
CSMN-03~CSMN-09 CSMX-05~CSMX-13	Yes	20-15P DMS 3102A	Pin	A	B	C	D	E	F				
			Function	U	V	W	P.E	BR	BR				
	No	18-10P DMS 3102A	Pin	A	B	C	D						
			Function	U	V	W	P.E						
CSMN-12~CSMN-30 CSMX-20~CSMX-44 CSMK-12~CSMK-45	No	22-22P DMS 3102A	Pin	A	B	C	D						
			Function	U	V	W	P.E						

Motor Type	Brake	Part No.	Pin Specification										External View
CSMN-12~CSMN-30 CSMX-20~CSMX-44	Yes	24-10P DMS 3102A	Pin	A	B	C	D	E	F				
			Function	U	V	W	BR	BR	P.E				
CSMN-44~CSMN-60	No	32-17P DMS 3102A	Pin	A	B	C	D						
			Function	U	V	W	P.E						
CSMK-60	Motor	32-17P DMS 3102A	Pin	A	B	C	D						
			Function	U	V	W	P.E						
	Barke	14S-2P DMS 3102A	Pin	A	B	C	D						
			Function	BR	BR								

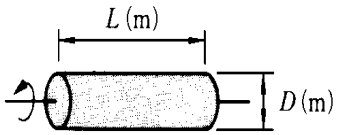
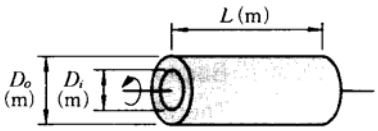
- Motor Connector (DDK) Detailed Specification/External View.
- CON A. Specification (DDK Connector) for Encoder Cable

  1) Connector External Design (CSMD/F/S/H/N/X/K)

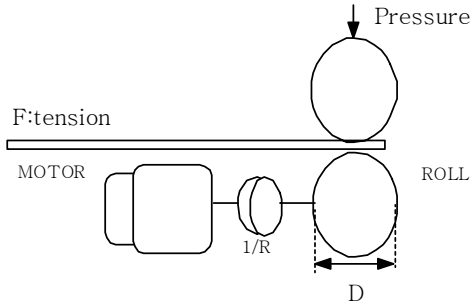
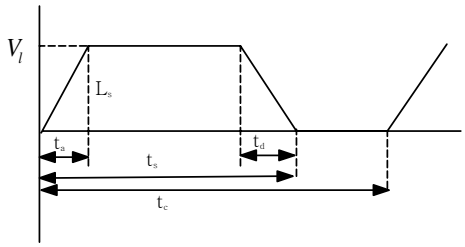
Connector (DDK)		External View of the Receptacle
Receptacle	DMS 3102B20-29P	
Cable Clamp	DMS 305712A	
L Type Plug	DMS 3108B20-29S	
Straight Type Plug	DMS 3106B20-29S	
Order Part No.	L Type Plug	CON-SHP17LN
	Straight type Plug	CON-SHP17SN

Appendix E. Load Calculation of the Mechanical Part

E.1 The Moment of Inertia Calculation

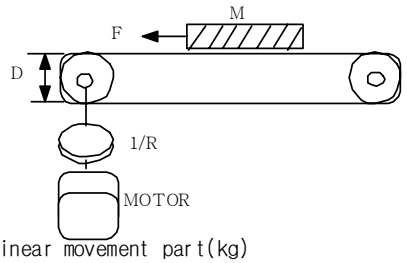
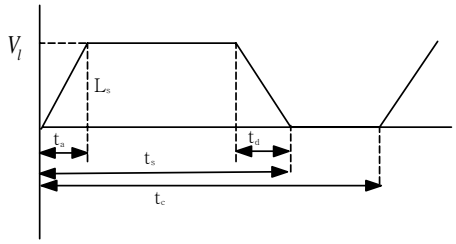
Solid Cylinder		$J = \frac{1}{8} M \times D^2 = \frac{\pi}{32} \rho \times L \times D^4$ Here, M = Weight (kg), ρ = density (kg/m3) Iron : ρ = 7.87×10³(kg/m³) Aluminum : ρ = 2.70×10³(kg/m³)
Hollow Cylinder		$J_K = \frac{1}{8} M_K (D_o^2 - D_i^2) = \frac{\pi}{32} \rho \bullet L (D_o^4 - D_i^4)$ Here, M = Weight (kg), ρ= density (kg/m3) Iron : ρ = 7.87×10³(kg/m³) Aluminum : ρ = 2.70×10³(kg/m³)

E.2 Roll Load

Mechanical Configuration	 F : Tension (N) P : Pressure V_l : Load speed (m/min) D : Roll diameter(m) $1/R$: Reduction Ratio μ : The coefficient of friction η : Mechanical efficiency
Speed Diagram	
Motion per Cycle m	$L_s = \frac{V_l}{60} \times \frac{2t_s - t_a - t_d}{2}$ $if \quad t_a = t_d, \qquad L_s = \frac{V_l}{60}(t_s - t_a)$
Motor shaft rotation speed r/min	$N_M = \frac{RV_l}{\pi D}$
Load Torque (Motor shaft) (Nm)	$T_L = \frac{(\mu P + F)D}{2R\eta}$
Load Inertia Moment kg · m²	$J_L = J_G + \frac{1}{R^2} J_R$ J_R : Roll(load part) inertia, J_G : Gear, coupling inertia
Minimum Acceleration Time s	$t_{am} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} - T_L)}$ J_M : motor inertia, T_{PM} : Motor maximum torque
Minimum Deceleration Time s	$t_{dm} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} + T_L)}$ J_M : Motor inertia, T_{PM} : Motor maximum torque
Load Operation Power w	$P_o = \frac{2\pi \times N_M \times T_L}{60}$
Load Acceleration Power w	$P_a = (\frac{2\pi \times N_M}{60})^2 \frac{J_L}{t_a} \qquad (t_a \leq t_{am})$

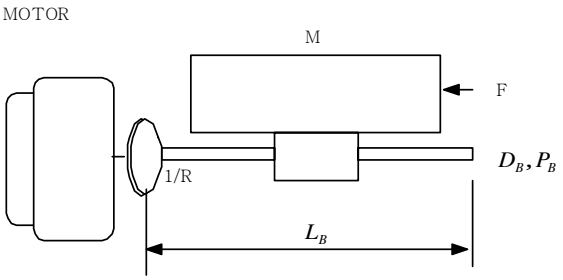
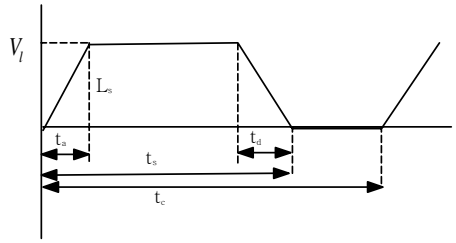
Acceleration Torque Used N m	$T_p = \frac{2\pi \times N_M (J_M + J_L)}{60 t_a} + T_L \quad (t_a \leq t_{am})$
Deceleration Torque Used N·m	$T_S = \frac{2\pi \cdot N_M (J_M + J_L)}{60 t_d} - T_L \quad (t_a \leq t_{dm})$
Torque RMS Value N·m	$T_{rms} = \sqrt{\frac{T_p^2 \times t_a \times T_L^2 \times (t_s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

E.3 Timing Belt Load

Mechanical Configuration	 M : Load mass of linear movement part(kg) V_l : load speed (m/min) F : Thrust Force(N) $1/R$: Reduction Ratio D : Pulley Diameter(m) μ : The coefficient of friction η : Mechanical efficiency
Speed Diagram	
Motion per Cycle m	$L_s = \frac{V_l}{60} \times \frac{2t_s - t_a - t_d}{2}$ $if \quad t_a = t_d, \qquad L_s = \frac{V_l}{60}(t_s - t_a)$
Motor shaft rotation speed r/min	$N_M = \frac{RV_l}{\pi D}$
Load torque (motor shaft) (Nm)	$T_L = \frac{(9.8\mu M + F)D}{2R\eta}$
Load Inertia Moment kg · m²	$J_L = J_W + J_G + \frac{J_P}{R^2}$ J_W : Direct operation part (load) inertia, , J_G : Gear, Coupling inertia, J_P : Pulley part inertia $J_W = M(\frac{D}{2R})^2$
Minimum Acceleration Time s	$t_{am} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} - T_L)}$ J_M : Load Inertia T_{PM} : Maximum Motor Torque
Minimum Deceleration Time s	$t_{dm} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} + T_L)}$ J_M : Motor Inertia, T_{PM} : Maximum Motor Torque
Load Operational Power w	$P_o = \frac{2\pi \times N_M \times T_L}{60}$

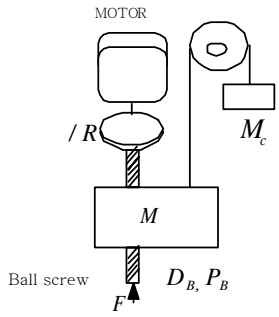
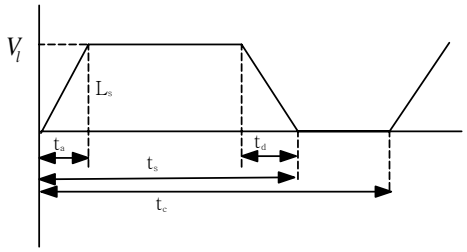
Load Acceleration Power w	$P_a = (\frac{2\pi \times N_M}{60})^2 \frac{J_L}{t_a}$ $(t_a \leq t_{am})$
Acceleration Torque Used N m	$T_p = \frac{2\pi \times N_M (J_M + J_L)}{60 t_a} + T_L$ $(t_a \leq t_{am})$
Deceleration Torque Used N m	$T_S = \frac{2\pi \cdot N_M (J_M + J_L)}{60 t_d} - T_L$ $(t_a \leq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

E.4 Ball Screw Load(Horizontal Axis)

Mechanical Configuration	 V_l : Load Speed (m/min) F : Thrust Force(N) $1/R$: Reduction Ratio P_B : Ball Screw Lead(m) L_B : Ball Screw Length(m) D_B : Ball Screw Diameter(m) μ : The Coefficient of Friction η : Mechanical Efficieney M : Load Mass of Linear movement Part
Speed Diagram	
Motion per Cycle m	$L_s = \frac{V_l}{60} \times \frac{2t_s - t_a - t_d}{2}$ $if \quad t_a = t_d, \qquad L_s = \frac{V_l}{60}(t_s - t_a)$
Motor Shaft Rotation Speed r/min	$N_M = \frac{RV_l}{P_B}$
Load Torque (Motor Shaft) (Nm)	$T_L = \frac{(9.8\mu M + F)P_B}{2\pi R\eta}$
Load Inertia Moment $kg \cdot m^2$	$J_. = J_W + J_G + \frac{J_B}{R^2}$ J_W : Direct operational part (load) inertia, J_G : gear part inertia, J_B : Ball Screw inertia $J_W = M(\frac{P_B}{2\pi R})^2$, $J_B = \frac{1}{8}M_B \times P_D{}^2 = \frac{\pi}{32}\rho \times P_L \times P_D{}^4$ here, M_B : Ball Screw weight(kg) ρ : density (kg/m^3) · · · · · Iron ρ = $7.87 \times 10^3 (kg/m^3)$ · · · · · Aluminum ρ = $2.70 \times 10^3 (kg/m^3)$
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

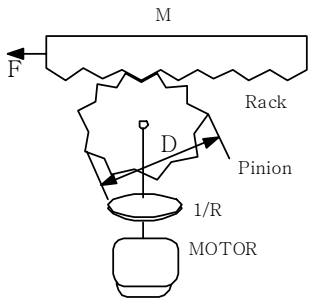
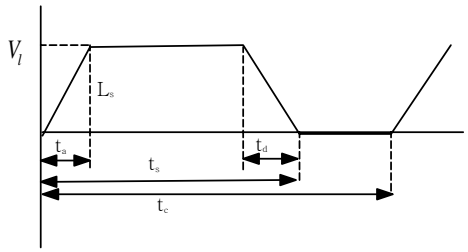
Minimum Deceleration Time s	$t_{dm} = \frac{2\pi \times N_M (J_M + J_L)}{60(T_{PM} + T_L)}$ Here J_M : motor inertia, T_{PM} : motor maximum torque
Load Operational Power w	$P_o = \frac{2\pi \times N_M \times T_L}{60}$
Load Acceleration Power w	$P_a = (\frac{2\pi \times N_M}{60})^2 \frac{J_L}{t_a}$ $(t_a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

E.5 Ball Screw Load(Vertical Axis)

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

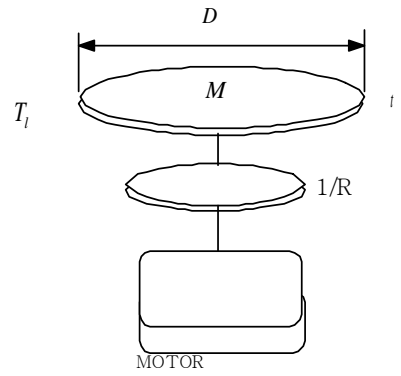
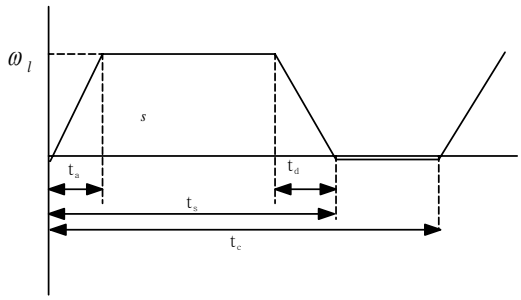
Load Inertia Moment kg·m²	$J_L = J_W + J_G + \frac{J_B}{R^2}$ Here J_W : Load Inertia of Linear Movement part J_G : Gear, Coupling Part Inertia, J_B : Ball Screw Inertia $J_W = (M + M_C)(\frac{P_B}{2\pi R})^2$, $J_B = \frac{1}{8} M_B \times P_D{}^2 = \frac{\pi}{32} \rho \times P_L \times P_D{}^4$ Here M_B : Ball Screw Mass (kg) ρ : Density (kg/m³) ····· Iron ρ = 7.87×10³(kg/m³) ····· Aluminum ρ = 2.70×10³(kg/m³)
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	$P_a = (\frac{2\pi \times N_M}{60})^2 \frac{J_L}{t_a}$ ($t_a \leq t_{am}$)
Acceleration torque used N·m	$T_p = \frac{2\pi \times N_M (J_M + J_L)}{60 t_a} + T_L$ ($t_a \leq t_{am}$)
Deceleration Torque used N·m	$T_S = \frac{2\pi \cdot N_M (J_M + J_L)}{60 t_d} - T_L$ ($t_a \leq t_{dm}$)
Torque RMS Value N·m	$T_{RMS} = \sqrt{\frac{T_p^2 \times t_a \times T_L^2 \times (t_s - t_a - t_d) + T_s^2 \times t_d}{t_c}}$

E.6 Rack & Pinion Load

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

Load Inertia Moment kg ㎡	$J_L = J_W + J_G + \frac{J_P}{R^2}$ Here J_W : Load Inertia of Linear Movement Part J_G : Gear, Coupling Part Inertia, J_P : Pinion Inertia $J_W = M(\frac{D}{2R})^2$, $J_P = \frac{1}{8} M_P \times D^2 = \frac{\pi}{32} \rho \times t \times D^4$ Here, M_P : Pinion Density(kg) ρ : Density (kg/㎥) ····· Iron ρ = 7.87×10^3(kg/㎥) ····· Aluminum ρ = 2.70×10^3(kg/㎥)
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	$P_a = (\frac{2\pi \times N_M}{60})^2 \frac{J_L}{t_a}$ ($t_a \leq t_{am}$)
Acceleration Torque Used N m	$T_p = \frac{2\pi \times N_M (J_M + J_L)}{60 t_a} + T_L$ ($t_a \leq t_{am}$)
Deceleration Torque Used N m	$T_S = \frac{2\pi \cdot N_M (J_M + J_L)}{60 t_d} - T_L$ ($t_a \leq t_{dm}$)
Torque RMS Value N m	$T_{RMS} = \sqrt{\frac{T_p^2 \times t_a \times T_L^2 \times (t_s - t_a - t_d) + T_s^2 \times t_d}{t_c}}$

E.7 Round Plate Load

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

Load Inertia Moment kg·m²	$J_L = J_G + \frac{J_W}{R^2}$ Here, J_W : Load Inertia of Round Plate J_G : Gear, Coupling Part Inertia $J_W = \frac{1}{8}M \times D^2 = \frac{\pi}{32}\rho \times t \times D^4$ Here, ρ : Density (kg/m³)····· Iron ρ = 7.87×10³(kg/m³) ····· Aluminum ρ = 2.70×10³(kg/m³)
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	$P_a = (\frac{2\pi \times N_M}{60})^2 \frac{J_L}{t_a}$ ($t_a \leq t_{am}$)
Acceleration Torque Used N·m	$T_p = \frac{2\pi \times N_M (J_M + J_L)}{60 t_a} + T_L$ ($t_a \leq t_{am}$)
Deceleration Torque Used N·m	$T_S = \frac{2\pi \cdot N_M (J_M + J_L)}{60 t_d} - T_L$ ($t_a \leq t_{dm}$)
Torque RMS Value N·m	$T_{RMS} = \sqrt{\frac{T_p^2 \times t_a \times T_L^2 \times (t_s - t_a - t_d) + T_s^2 \times t_d}{t_c}}$

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Appendix F. Conversion Table of SI Unit and Conventional Unit

Table F.1 Unit Conversion

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 = 0.10197kfg · m 1kgf · m = 9.80665N · m
The Moment of Inertia $J = \frac{GD^2}{4}$	Kg · m^2	gf · cm · S^2	1kgf · m^2 = 1.0197×10^4gf · cm · s^2 1gf · cm · s^2 = 0.980665 × 10^{-4}kg · m^2

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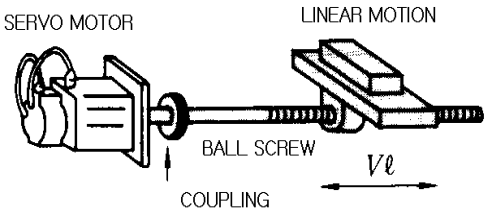
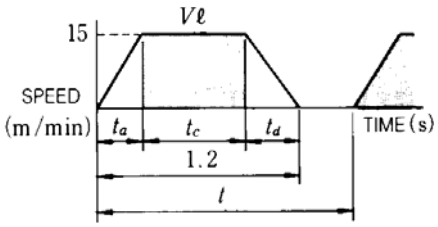
Appendix G. Motor Capacity Selection

• **This is an example of speed control**



·Load Speed : ℓ =15m/min
·Mass of the linear movernent part : M = 500kg
·Length of the ball screw : L_B = 1.4m
·Diameter of the ball screw : D_B = 0.04m
·Ball Screw Lead : P_B = 0.01m
·Mass of the coupling : M_K = 1kg
·Outer diameter of the coupling : D_K =0.06m
·The number of times of transfer : n = 40/min
·Transfer distance : λ = 0.275m
·Transfer time : t_m = 1.2s or less
·The coefficient of friction : μ = 0.2
·Mechanical efficiency : η = 0.9

(1) Speed Diagram



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

Here $t_a = t_d$

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

(2) Rotation Speed

·Load axis rotation speed $N\ell = \frac{V\ell}{P_B} = \frac{15}{0.01} = 1500(r/\min)$

·Motor rotation speed. This is direct coupling, Reduction ratio is 1/R = 1

Thus, $N_M = N\ell \cdot R = 1500 \times 1 = 1500(r/\min)$

(3) Load Torque

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

(4) Load Inertia

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

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

· Coupling $J_C = \frac{1}{8} M_C \times D_C{}^2 = \frac{1}{8} \times 0.06^2 = 4.5 \times 10^{-4} (kg \cdot m^2)$

· Motor shaft Load Inertia $J_L = J_{L1} + J_B + J_C = 44.9 \times 10^{-4} (kg \cdot m^2)$

(5) Load Operational Power

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

(6) Load Acceleration Power

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

(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) × 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 : 6.17×10^{-4} (kg·m^2)
- Allowable inertia of servo pack : 61.7×10^{-4} (kg·m^2)

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

(a) Load moment of inertia for motor side J_L

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

(b) Required operational torque (Consumed acceleration torque T_P)

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

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

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

(d) Torque RMS (Average value)

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

(e) Power

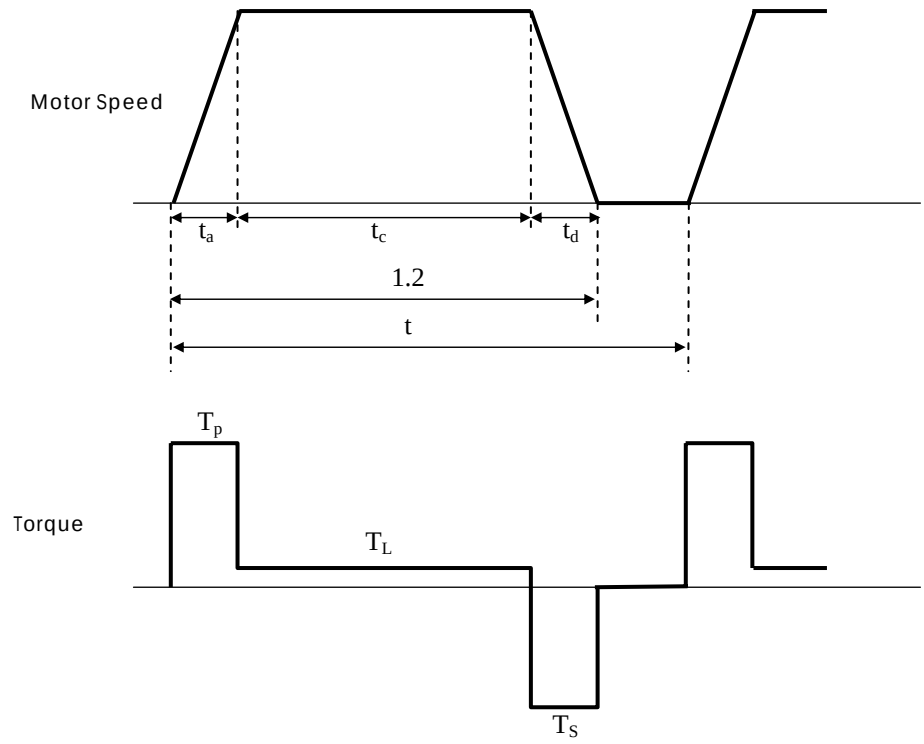
$P_a + P_o = 1108 + 272 = 1380W$ < Rated output of the motor 1000W ×(1～2)

(f) Rotation speed

$Nm = 1500RPM$ < 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.



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Appendix H. Revision Profile

Date of Publication	Revision No.	Content
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

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CSDJ Plus Servo Drive User Manual

www.oemax.co.kr
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