RS OEMax

CSDP Plus Servo Drive

User Manual

Catalog Number(s): CSDP-xxBX2

RS Reliable & Smart Automation

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will RS Automation Co., Ltd. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, RS Automation Co., Ltd. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by RS Automation Co., Ltd. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING 	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION 	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence
WARNING 	Labels may be located on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
BURN HAZARD 	Labels may be located on or inside the equipment, for example, a drive or motor, to alert people that surfaces may be at dangerous temperatures.

Contents

A brief introduction to the manual is in this preface.
The following contents are included in the preface.

- User of the manual
- Purpose of the manual
- Reference
- Symbols and Notations

User of the manual

This user's manual explains the specifications, installation, wiring, operation, abnormal status assessment and troubleshooting, and maintenance of the CSDP Plus Servo Drive.
This manual is made for the engineers who want to install, wire, and operate the CSDP Plus Servo Drive or apply the CSDP Plus Servo Drive to a control system.

Those who do not have basic understanding of the CSDP Plus Servo Drive need to receive the product education provided by the before using the product.

The purpose of the manual

This manual explains the installation, configuration, operation, malfunction assessment, troubleshooting measures, and maintenance and repair of the CSDP Plus Servo Drive. The necessary wiring diagram and other installation guidelines are provided.

Symbols and Notations

The following symbols and notations are used in this manual.

- Bullet points are used to provide multiple kinds of information. They are not used for sequential procedures.
- Numbers are used to provide sequential procedures or hierarchical information.

Safety Instructions

Please read this manual and the related documentation thoroughly and familiarize yourself with product information, safety instructions and other directions before installing, operating, performing inspection and preventive maintenance. Make sure to follow the directions correctly to ensure normal operation of the product and your safety.

ATTENTION

- If this product is used in a situation that may cause personal injury and/or significant product damage, implement safe measures such as use of fault-safe equipment.
- Do not use this product under any conditions exposed to explosive gases. It may cause an explosion.

ATTENTION

- Make sure to use an external device when configuring the protective circuit breakers for emergencies or interlock circuits.
- Fasten the terminal screws tightly to ensure that the cable connection is secure. Incorrect cable connection may cause overheating and product malfunction.
- Operate and keep the product under the allowed conditions directed in product specifications.
  Otherwise it may cause overheating and product malfunction.
- Do not disassemble or remodel the product.
  Otherwise it may cause an electric shock or malfunction.
- Do not touch the terminals when the power is on.
  Otherwise it may cause an electric shock.

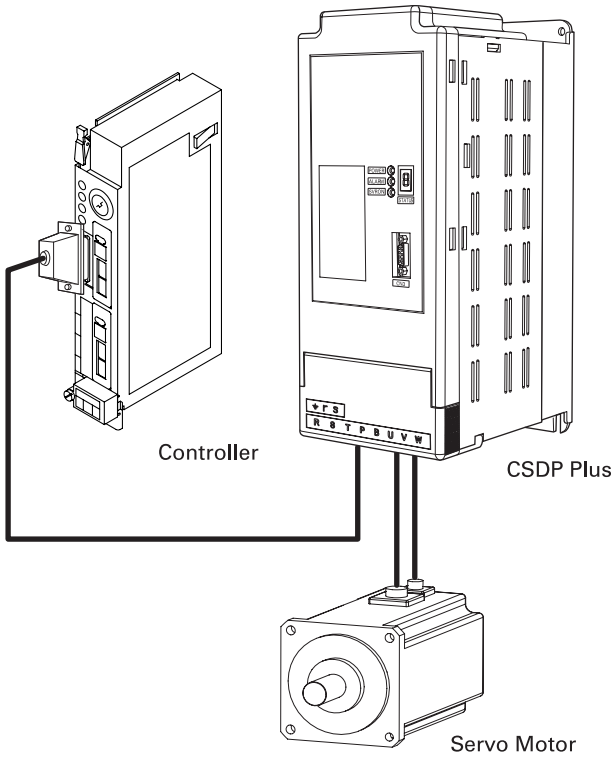
1

Introduction

Functionality

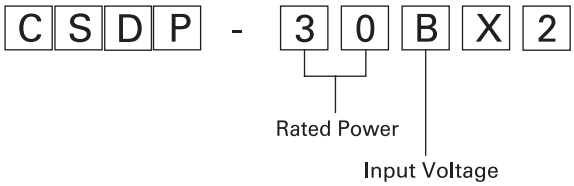
CSDP Plus is an AC servo motor drive adopting a 32-bit DSP that realizes high accuracy control. CSDP Plus supports standard incremental encoder, simple incremental encoder, and absolute encoder for the sake of convenient system design.

CSDP Plus-based servo system is usually configured as shown in the following diagram. The controller in the diagram is PLC, but various controllers can be used instead of PLC.



Servo System Configuration

CSDP Plus has five different products. Basic specifications of the products are displayed on the labels.



Servo Drive Label

Rated output of each product is described in the table below.

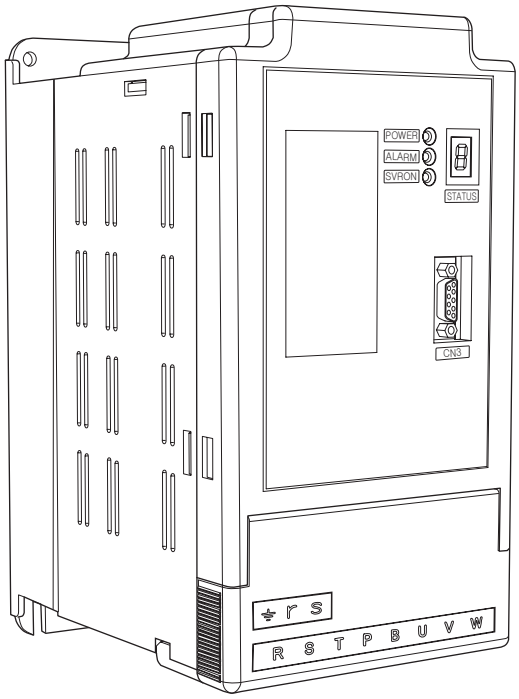
CSDP Plus Rated Output

Model Number	Rated Output
CSDP-15BX2	1.5 kW
CSDP-20BX2	2.0 kW
CSDP-30BX2	3.0 kW
CSDP-40BX2	4.0 kW
CSDP-50BX2	5.0 kW

Input Voltage B means 220V AC.

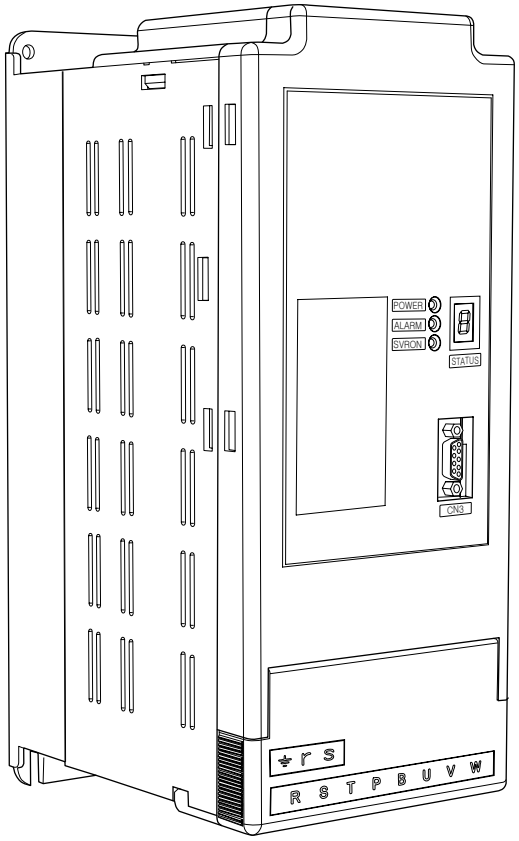
The models with the same appearance as that or the device in the diagram below are as follows.

- CSDP-15BX2
- CSDP-20BX2
- CSDP-30BX2



The models with the same appearance as that or the device in the diagram below are as follows.

- CSDP-40BX2
- CSDP-50BX2



Specifications

Servo Drive

The specifications of CSDP Plus models are as follows.

CSDP Plus Model Specifications

	CSDP-15BX2	CSDP-20BX2	CSDP-30BX2	CSDP-40BX2	CSDP-50BX2
Main Supply Voltage (Vrms)	3-phase 200 to 230V, +10% to -15%, 50/60 Hz				
Control Voltage (Vrms)	Single Phase 200 to 230V, +10% to -15%, 50/60 Hz				
Rated Input Current (Arms)	8.2	10.3	15.1	19.4	22.2
Input Power (kVA)	4.5	6	9	12	15
Output Voltage (Vrms)	200	200	200	200	200
Rated Output Current (Arms)	10	13	19	25	28.5
Peak Output Current (Arms)	30	39	57	75	85.5
Output Frequency	0 - 400 Hz				

Performance specifications of CSDP Plus are as follows.

The performance specifications of CSDP Plus

Classification	Item	Specifications
Basic Specifications	Control Method	PWM Control by IPM
	Feedback Type	1000/2048/2500/6000/10000 Inc./Abs Type, 17 bit Serial Inc./ Abs type
	Ambient Temperature/ Humidity in Operation	0 to 55°C/90% RH or less
	Ambient Temperature/ Humidity in Storage	-25 to 80°C/90% RH or less
	Mounting Type	Base Mounted Type
Speed/Torque Control Performance	Speed Control Range	1:5000
	Load Fluctuation Rate	± 0.01% or less at the Rated Speed and within the Load Range of 0 to 100%
	Voltage Fluctuation Rate	0% at the Rated Speed and Supply Voltage of 220V AC
	Temperature Fluctuation Rate	0.1% or less at the Rated Speed and Ambient Temperature of 25°C
	Speed Response Frequency	400 Hz
	Torque Control Accuracy	± 2%
	Acceleration/ Deceleration Time	0 to 60 sec.
Position Control Performance	Feed forward	0 to 100%
	Positioning Completion Range	0 to 250 pulse

The performance specifications of CSDP Plus

Classification	Item	Specifications
Position Control Command Input Signal	Command Pulse Type	CW + CCW, Pulse Train+ Signal Train, A Phase+ BPhase (90° phase difference)
	Command Input Type	Line drive - Voltage between levels 2.8 to 3.7 V
		Open collector - External Voltage 24 V, 12 V, 5 V
	Pulse Frequency	Line drive - Maximum 900 kpps
		Open collector - Maximum 250 kpps
	Control Signal	Position Error Clear Input (Set at one of input terminals)
Speed/Torque Command Input Signal	Command Voltage	±10 V DC (14 bit A/D conversion)
	Input Impedance	Approx. 8.3 MΩ
	Circuit Time Constant	35 μs or less
Multi-level Speed Command Input Signal	Revolving Direction	Used by assigning relevant functions to an input terminal
	Speed Selection	Used by assigning relevant functions to an input terminal
I/O Signal	Position Output Type	Line Drive Output: A, B, Z Phase, Absolute Encoder Data
		Open Collector Output: Z phase
	Input	Servo On, Alarm Reset, Gain Group Shift, Forward/Reverse Torque Limit, Forward/Reverse Revolution Prohibition, P/PI Control Shift, Control Mode Shift, Internal Speed Command, Zero Clamp, Position Command Pulse Inhibit, Absolute Encoder Data Transmission
	Output	Position Completion, Near Postion, In Speed, Revolution Detection, Torque Limit Detection, Speed Limit Detection, Brake Control Output, Servo Warning Detection
Dynamic Brake		When servo power supply is off, When alarm occurs, When over-travel occurs (depending on conditions)
Regenerative Resistance		Embedded in Drive
Protection Function		Over current, Over voltage, Overload, Over speed, Low Voltage, CPU Malfunction, Communication Malfunction, etc.
Monitoring		Position/Speed/Torque Command and Feedback, 2 Channel D/A Output for measuring position error

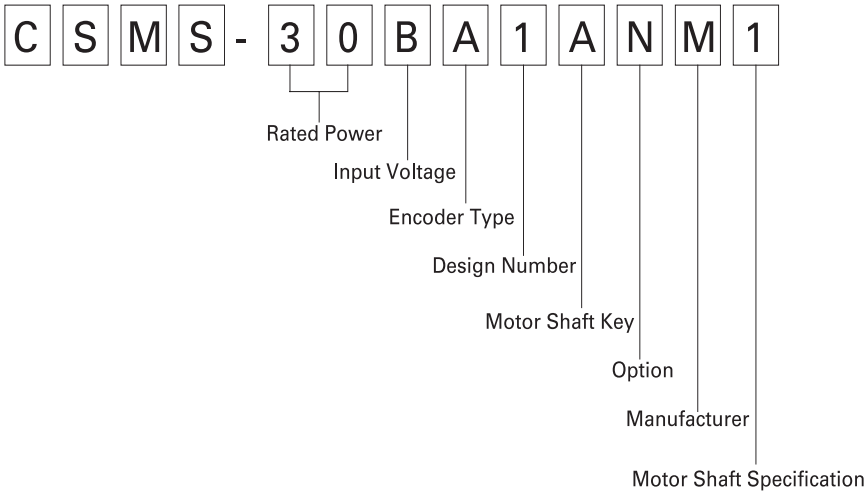
Servo Motor

Motors supported by CSDP Plus are as follows.

CSDP Plus-supported motors

CSDP-15BX2	CSDP-20BX2	CSDP-30BX2	CSDP-40BX2	CSDP-50BX2
CSMD-15	CSMD-20	CSMD-25/30	CSMD-35/40	CSMD-45/50
CSMF-15		CSMF-25	CSMF-35	CSMF-45
CSMH-15	CSMH-20	CSMH-30	CSMH-40	CSMH-50
CSMK-12	CSMK-20	CSMK-30		CSMK-45/60
CSMS-15	CSMS-20	CSMS-25/30	CSMS-35/40	CSMS-45/50
RSMD-15	RSMD-20	RSMD-25/30	RSMD-40	RSMD-45/50
RSMF-15		RSMF-25	RSMF-35	RSMF-45
RSMH-15	RSMH-20	RSMH-30	RSMH-40	RSMH-50
RSMK-12	RSMK-20	RSMK-30		RSMK-45/60
RSML-12	RSML-20	RSML-30		RSML-45/60
RSMN-12	RSMN-20	RSMN-30		
RSMS-15	RSMS-20	RSMS-25/30	RSMS-35/40	RSMS-45/50
RSMX-13	RSMX-20	RSMX-30		RSMX-45

General specifications of all the motors are displayed on each label of the motor.



Servo Motor Label

Rated Output is displayed as it is on servo drive.

Rated Output Display Method

	Rated Output
13	1.3 kW
15	1.5 kW
20	2.0 kW
25	2.5 kW
30	3.0 kW
35	3.5 kW
40	4.0 kW
45	4.5 kW
50	5.0 kW
60	6.0 kW

Input Voltage B stands for 220V AC.

Definitions of the remaining numbers are as follows.

Servo Motor Label Number

Item	No.	Specifications
Input Voltage	A	110V AC
	B	220V AC
	C	24V DC
	D	110/220V AC
Motor Shaft Key	A	Key Present
	B	Key Absent
Option	N	Option Absent
	B	Brake Present
	S	Oil Seal Present
	T	Brake and Oil Seal Present
Motor Shaft	1	Circular Type (Coupling Tightening)
	3	Key Tightening Type
	4	Taper Tightening Type

Encoder

CSDP Plus-supported encoders are as follows.

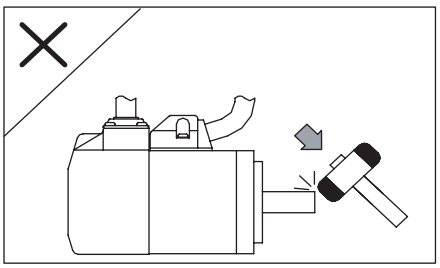
CSDP Plus-supported Encoders

Motor	Mode	Encoder Type	
CSMD, CSMF, CSMH, CSMK, CSMS	A	2500 P/R	11-wire type Inc.
	B	2500 P/R	15-wire type Inc.
	D	1000 P/R	15-wire type Inc.
	H	2048 P/R	Compact Abs.
	M	10000 P/R	15-wire type Inc.
RSMD, RSMF, RSMH, RSMK, RSML, RSMN, RSMS, RSMX	A	2500 P/R	9-wire type Inc.
	K	5000 P/R	15-wire type Inc.
	L	6000 P/R	15-wire type Inc.
	M	10000 P/R	15-wire type Inc.
	H	2048 P/R	Compact Abs.
	Q	17 Bit Serial Abs.	
	R	17 Bit Serial Inc.	

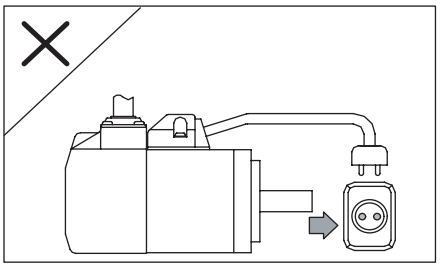
Installation

Servo Motor Installation

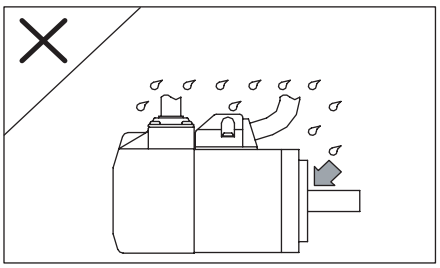
Please pay special attention to the following during motor installation.



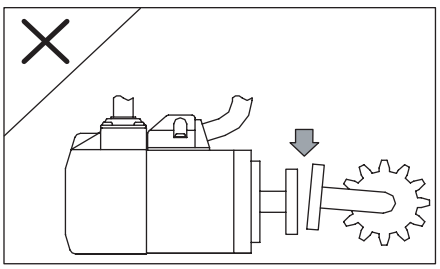
Impact is a major factor in lowering the motor's performance.



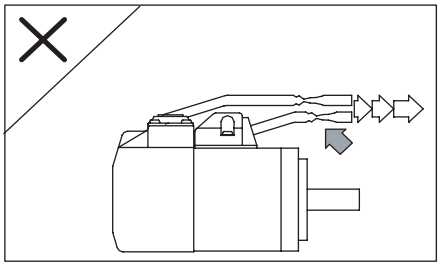
Please do not directly connect the motor to the power supply.



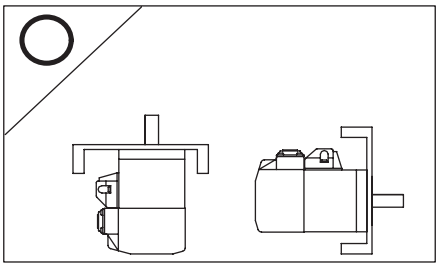
Please keep the motor away from water and oil.



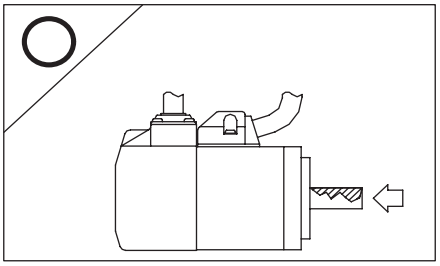
Please pay attention to the concentricity of the coupling that is linked to the load.



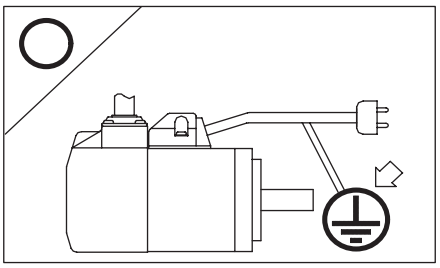
Please do not put stress on the electric wires.



Please mount the motor vertically or horizontally.

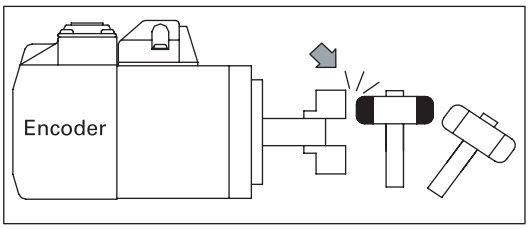


The shaft is oiled for corrosion prevention. Please remove it before installation.



Please connect the grounding line to the grounding connection terminal of the drive.

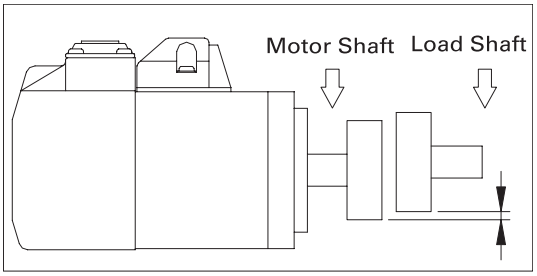
Coupling Assembly



Excessive impact during coupling assembly can damage the encoder.

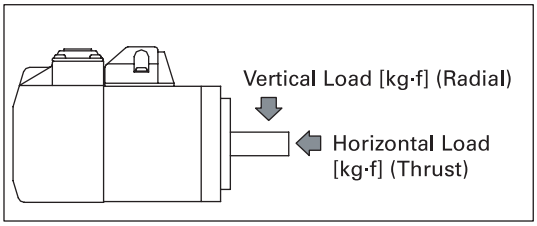
Please measure the concentricity of the motor shaft and load shaft after coupling assembly. Take four measurements by rotating each 90° and adjust the difference between the maximum value and the minimum value to be 0.03 mm or less.

Load Connection



If the center of the shaft does not match, it will lower the performance.

Allowed Load for Motor Shaft



Please make sure the load on the motor shaft doesn't exceed load allowance. Please refer to the motor specifications in the appendix for the allowed load for each motor.

Motor Installation Environment

Motor Installation Specifications

Item	Condition
Storage Temperature	-20 to 80°C
Operating Temperature	0 to 55°C
Operating Humidity	RH 90% or less, non-condensing.

Installation environment needs to meet the following conditions.

- Indoors.
- Good Ventilation.
- Easy to check and clean.
- No explosive gas.

Servo Drive Installation

Please check the following before installing CSDP Plus.

- Does the delivered product match the order?
- Does the servo motor match the specifications of the servo drive?
- Is the product broken?
- Does the product have any loosened or cracked parts?

The installation environment required for CSDP Plus is as below.

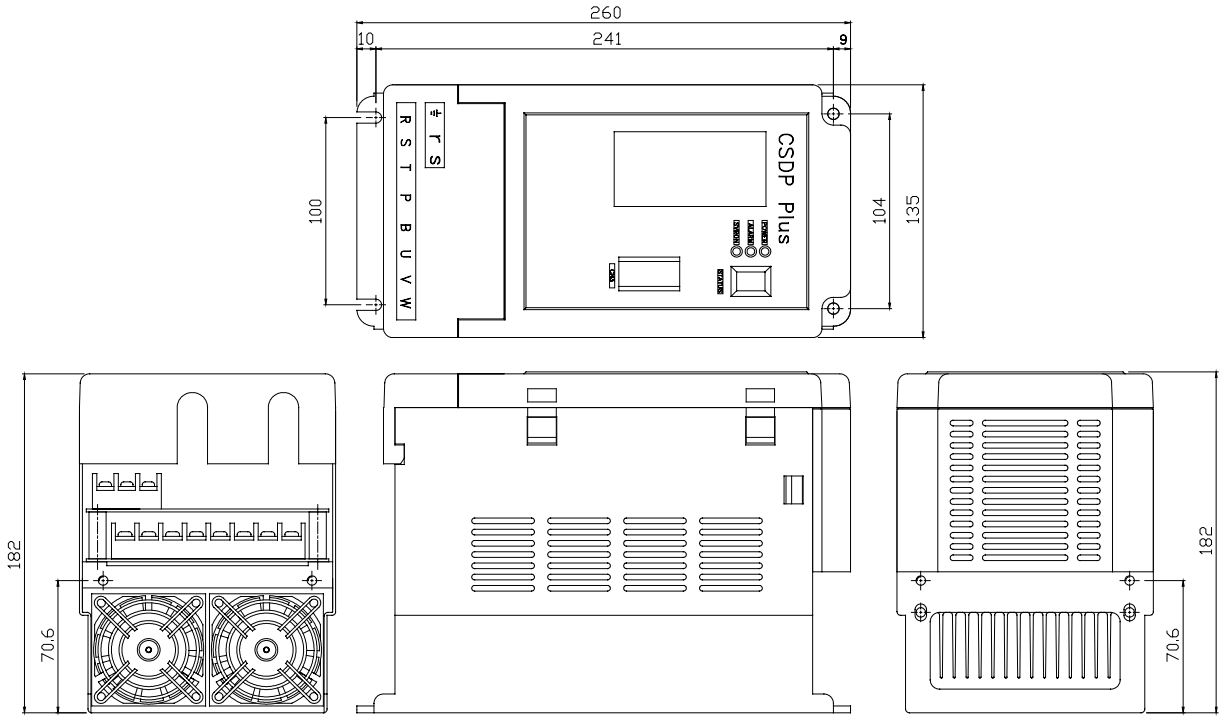
CSDP Plus Installation Specifications

Item	Condition
Storage Temperature	-20 to 80° C
Operating Temperature	0 to 55° C
Operating Humidity	RH 90% or less, non-condensing
Vibration	0.5g (4.9 m/S^2) or less

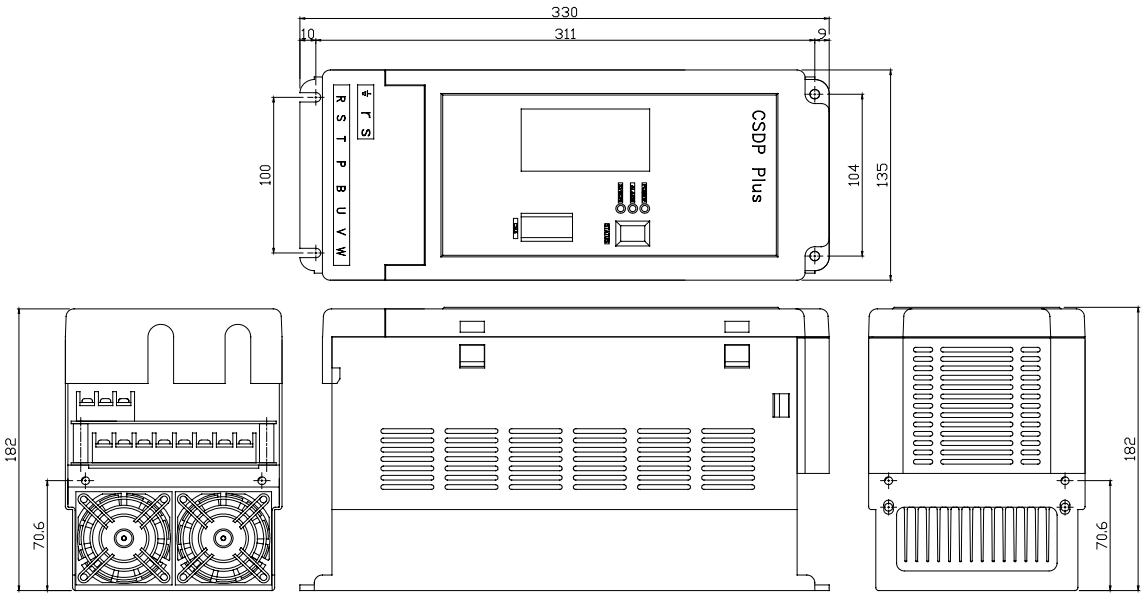
The installation environment needs to meet the following conditions.

- Indoors
- Good ventilation
- Easy to check
- No explosive gas.

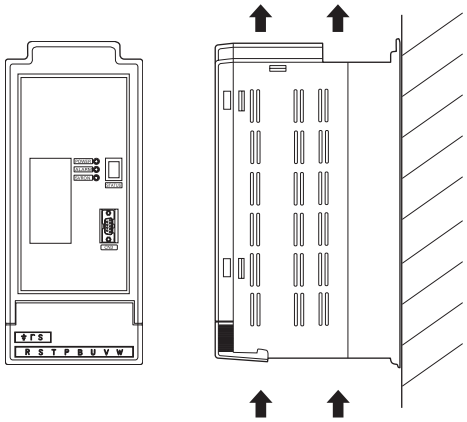
The sizes of CSDP-15BX2, CSDP-20BX2, CSDP-30BX2 are as below.



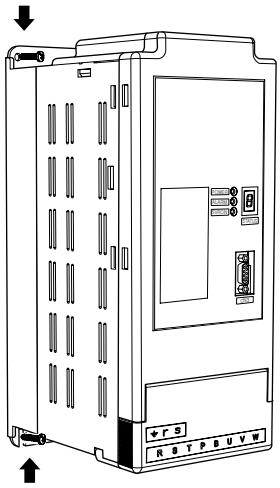
The sizes of CSDP-40BX2, CSDP-50BX2 are as below.



Please follow the command below to install the drive.

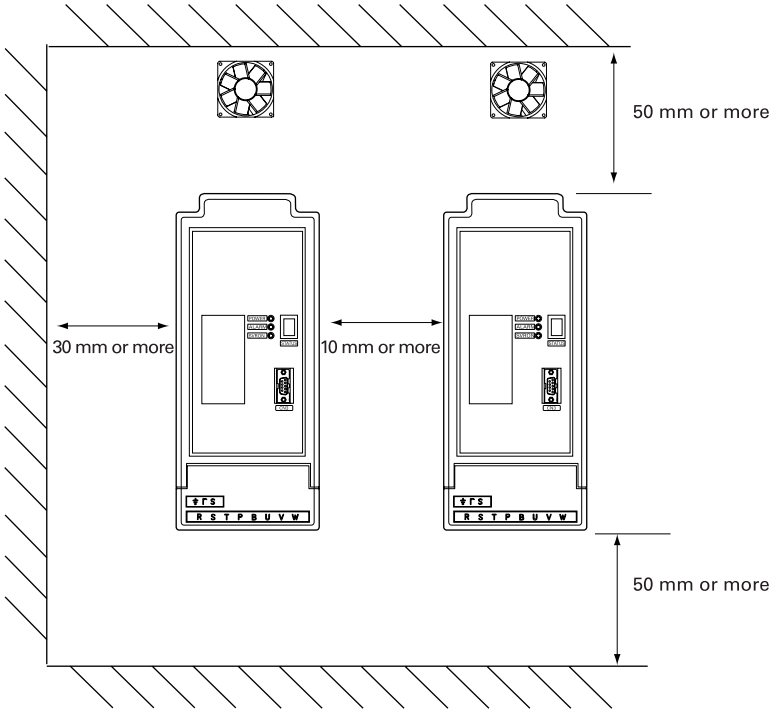


Please make sure that the drive is installed vertically for enhanced cooling efficiency.



Please attach the servo drive with a M5xL10 bolt.

When multiple drives are installed, please set up cooling fans to prevent excessive temperatures.



Wiring

Please follow the wiring command below according to the wiring specifications.

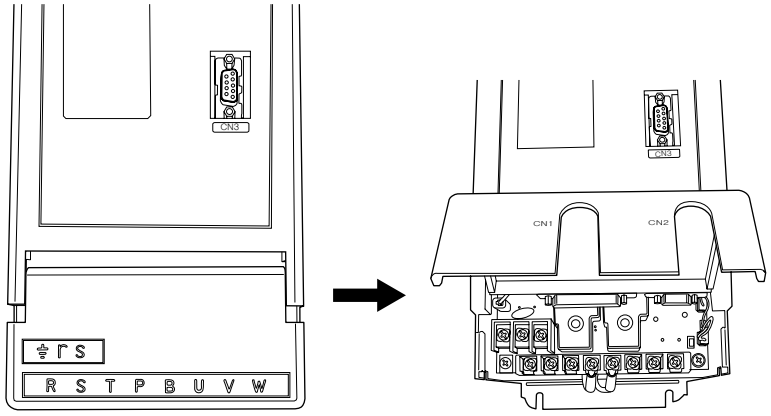
- Please install line filer, servo drive, motor, and input device as close as possible.
- Please attach surge-absorption circuit to relay, wiring breaker, and electric contacter.
- Please do not wire unused terminals. If unused terminals are wired, noise can be generated.
- If a cable should move, use a separate flexible cable.
- Please use a noise filter at a power supply.
- Signal line should be at least 30 cm away from the power supply line.
- All the grounding terminals should be grounded.

WARNING Signal line should be wired separately from the power supply line. Otherwise, noise or system error can occur.

Wiring Specifications

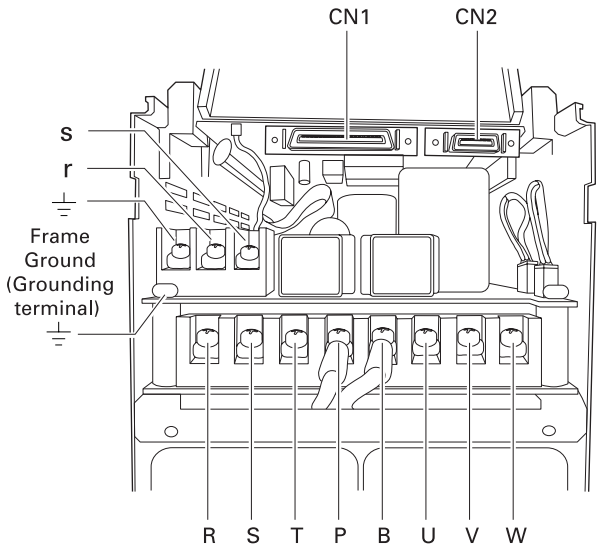
Item	Specifications
Signal line	Multi core, twisted pair, batch shielded cable as thick as AWG26 or more
Grounding Line	One-point grounding (100 Ω or less) with an electric wire as thick as 3.5 mm^2 or more
Input Power Cable Length	Max. 3 m
Encoder Cable Length	Max. 20 m
Motor Power Cable Length	Max. 20 m

Connection terminal and connector are inside the cover. The cover is at the lower end of the servo drive. Please pull it downward and draw it up to open the cover.



Servo Drive Cover

The letters on the cover represent the terminal number.

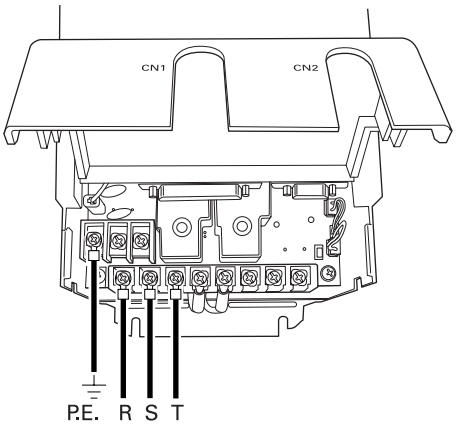


Terminal block

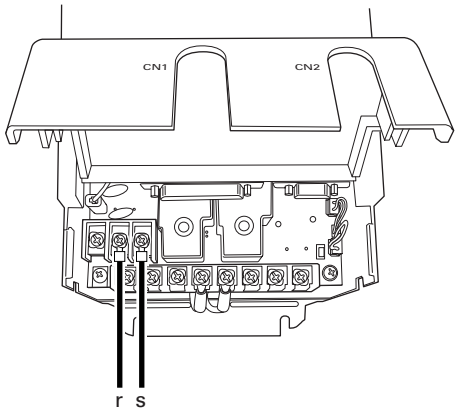
Power Supply Connection

Terminal block

Notation	Function
CN1	Cable Connection with Controller
CN2	Encoder Cable Connection
R	3-Phase 220V AC Main Power Supply Input Connection
S	3-Phase 220V AC Main Power Supply Input Connection
T	3-Phase 220V AC Main Power Supply Input Connection
P	Regenerative Resistance Connection (Regenerative Resistance Embedded)
B	Regenerative Resistance Connection (Regenerative Resistance Embedded)
U	Motor Power Cable Connection
V	Motor Power Cable Connection
W	Motor Power Cable Connection
r	Single-Phase 220V AC Circuit Power Supply Input Connection
s	Single-Phase 220V AC Circuit Power Supply Input Connection
⏚	Grounding Connection



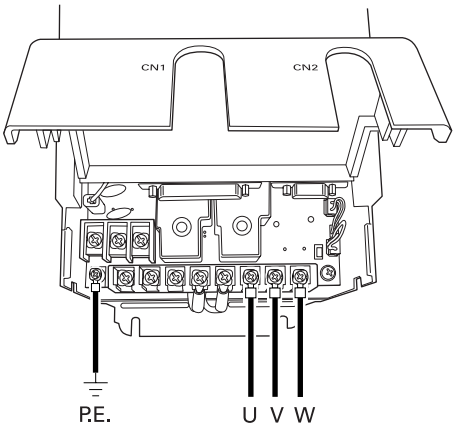
Connect the 3-phase voltage to R, S, and T terminals to supply power to the main system.



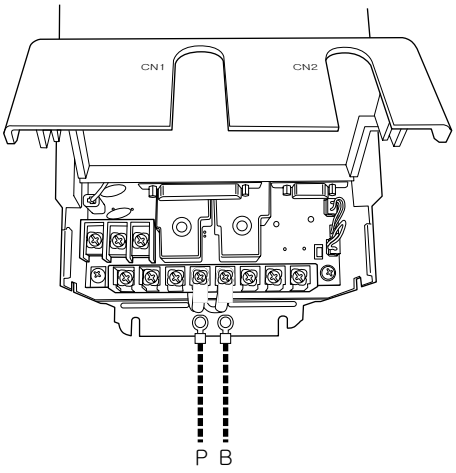
Connect the single-phase voltage to r and s terminals to supply power to the control circuit.

WARNING

Previous CSDP users need to be careful with the wiring since the terminal arrangement is different from CSDP.



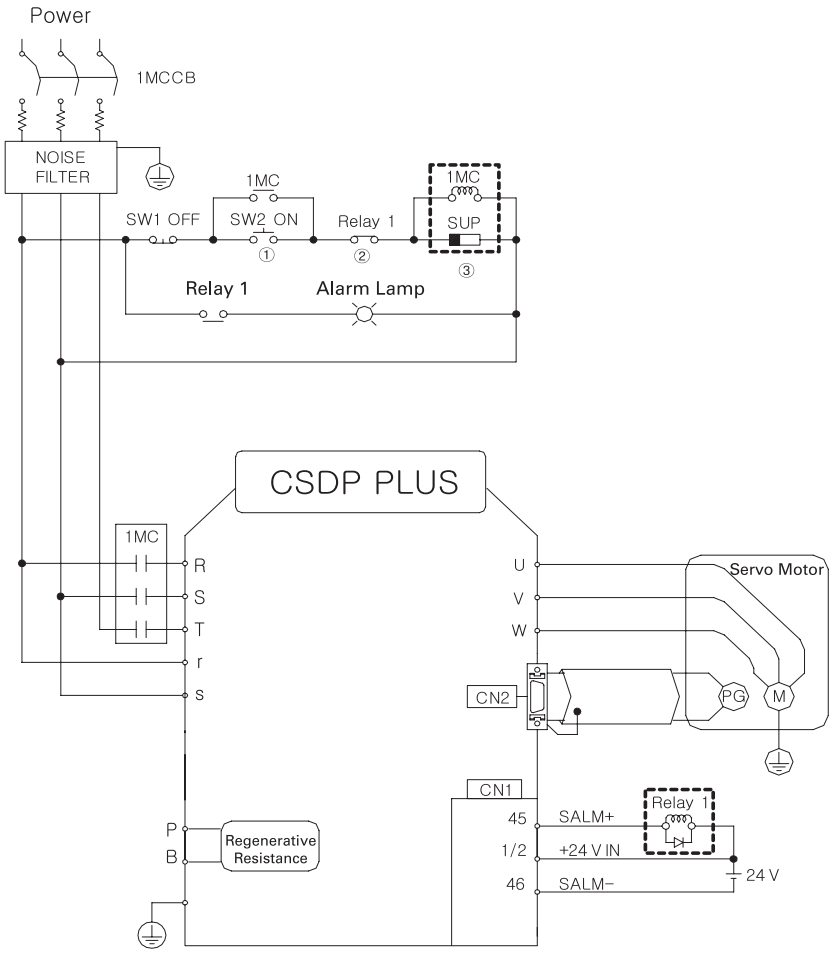
Connect the motor power supply cable to U, V, and W terminals.



CSDP Plus has its own low-capacity regenerative resistance.

WARNING

If an extra high-capacity regenerative resistance is needed, please remove the internal wiring of P and B terminals and connect the external regenerative resistance.

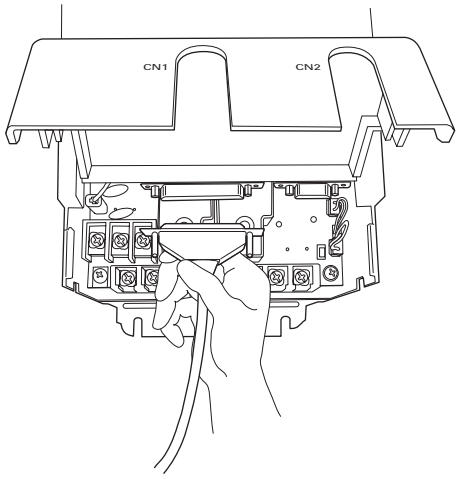


Power Supply Wiring

In the diagram above, MCCB stands for Molded Case Circuit Breaker and MC stands for Magnetic Conductor.

Please use a push-button switch that transmits electricity only when it is pushed at ① in the circuit. Please connect the relay at ② when the power needs to be shut down. Please attach a surge suppressor to the magnetic switch relay coil at ③.

Connection with Controller



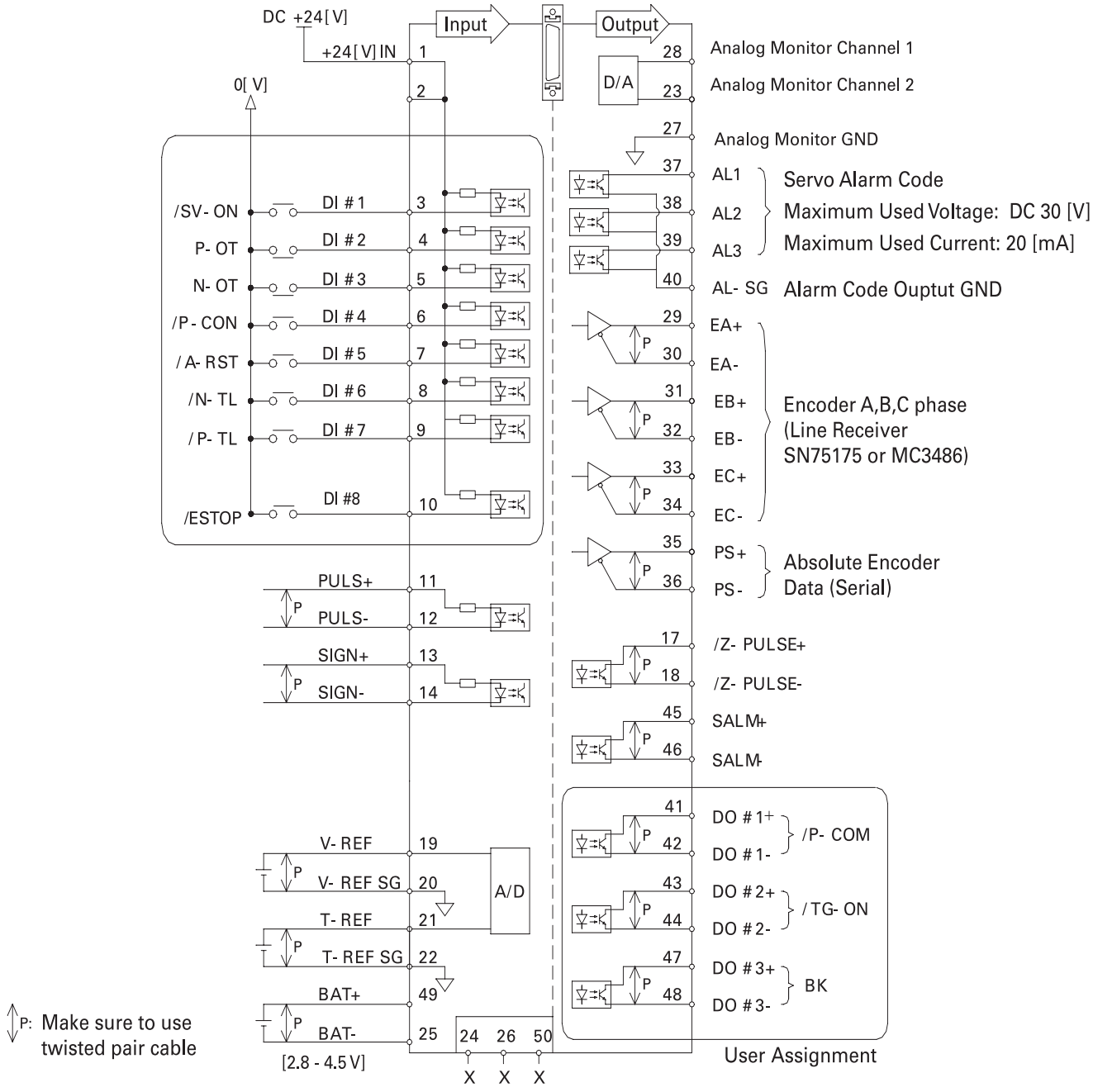
Connect the cable of controller to the CN1 connector.

Controller Connector (CN1) Pin

No.	Symbols	Wire Color	Usage
1	+24V IN	Red	External 24V Input
2	+24V IN	Yellow	External 24V Input
3	DI#1	Sky-blue	Input Signal Assignment (Default Value/SV-ON)
4	DI#2	White	Input Signal Assignment (Default Value/P-OT)
5	DI#3	Pink	Input Signal Assignment (Default Value/N-OT)
6	DI#4	Orange	Input Signal Assignment (Default Value/P-CON)
7	DI#5	Gray	Input Signal Assignment (Default Value/A-RST)
8	DI#6	Red 1 Dot	Input Signal Assignment (Default Value/N-TL)
9	DI#7	Yellow 1 Dot	Input Signal Assignment (Default Value/P-TL)
10	DI#8	Sky-blue 1 Dot	Input Signal Assignment (Default Value/ESTOP)
11	PULS+	White 1 Dot	Position Command Signal
12	PULS-	Pink 1 Dot	Position Command Signal
13	SIGN+	Orange 1 Dot	Position Command Signal
14	SIGN-	Gray 1 Dot	Position Command Signal
17	Z-PULSE+	Sky-blue 2 Dots	Encoder Z-PULSE Output
18	Z-PULSE-	White 2 Dots	Encoder Z-PULSE Output
19	V-REF	Pink 2 Dots	Analog Speed Command Signal
20	V-REF SG	Orange 2 Dots	Analog Speed Command Signal
21	T-REF	Gray 2 Dots Analog	Analog Torque Command Signal
22	T-REF SG	Red 3 Dots Analog	Analog Torque Command Signal
23	AM-CH2	Yellow 3 Dots	Analog Monitor Channel 2
24	-	Sky-blue 3 Dots	-
25	BAT-	White 3 Dots	Absolute Encoder Battery GND
26	-	Pink 3 Dots	-

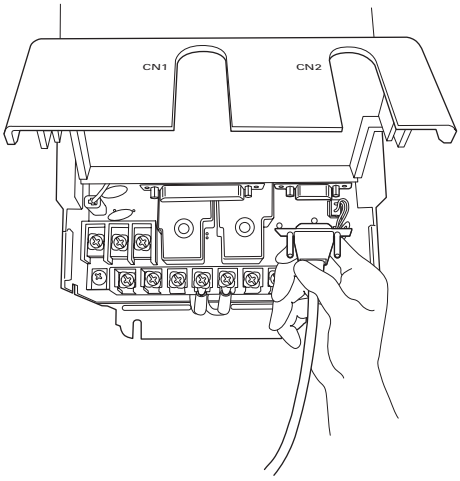
Controller Connector (CN1) Pin

No.	Symbols	Wire Color	Usage
27	AM-SG	Orange 3 Dots	Analog Monitor Output GND
28	AM-CH1	Gray 3 Dots	Analog Monitor Channel 1
29	EA+	Red 4 Dots	Encoder Signal (Line Drive) Output A
30	EA-	Yellow 4 Dots	Encoder Signal (Line Drive) Output/A
31	EB+	Sky-blue 4 Dots	Encoder Signal (Line Drive) Output B
32	EB-	White 4 Dots	Encoder Signal (Line Drive) Output/B
33	EC+	Pink 4 Dots	Encoder Signal (Line Drive) Output C
34	EC-	Orange 4 Dots	Encoder Signal (Line Drive) Output/C
35	PS+	Gray 4 Dots	Encoder Signal (Line Drive) Output
36	PS-	Red/Twisted Pair Wire	Encoder Signal (Line Drive) Output
37	AL1	Yellow/Twisted Pair Wire	Alarm Code 1 (Open Collector) Output
38	AL2	Sky-blue/Twisted Pair Wire	Alarm Code 2 (Open Collector) Output
39	AL3	White/Twisted Pair Wire	Alarm Code 3 (Open Collector) Output
40	AL-SG	Pink/Twisted Pair Wire	Alarm Code Output GND
41	DO#1+	Orange/Twisted Pair Wire	Output Signal Assignment (Default Value/ P-COM)
42	DO#1-	Gray/Twisted Pair Wire	Output Signal Assignment (Default Value/ P-COM)
43	DO#2+	Red/1 Line	Output Signal Assignment (Default Value/ TG-ON)
44	DO#2-	Yellow/1 Line	Output Signal Assignment (Default Value/ TG-ON)
45	SALM+	Sky-blue/1 Line	Servo Alarm Output
46	SALM-	White/1 Line	Servo Alarm Output
47	DO#3+	Pink/1 Line	Output Signal Assignment (Default Value/BK)
48	DO#3-	Orange/1 Line	Output Signal Assignment (Default Value/BK)
49	BAT+	Gray/1 Line	Absolute Encoder Battery Power Supply



Higher Control Connector (CN1) Circuit Diagram

Encoder Connection

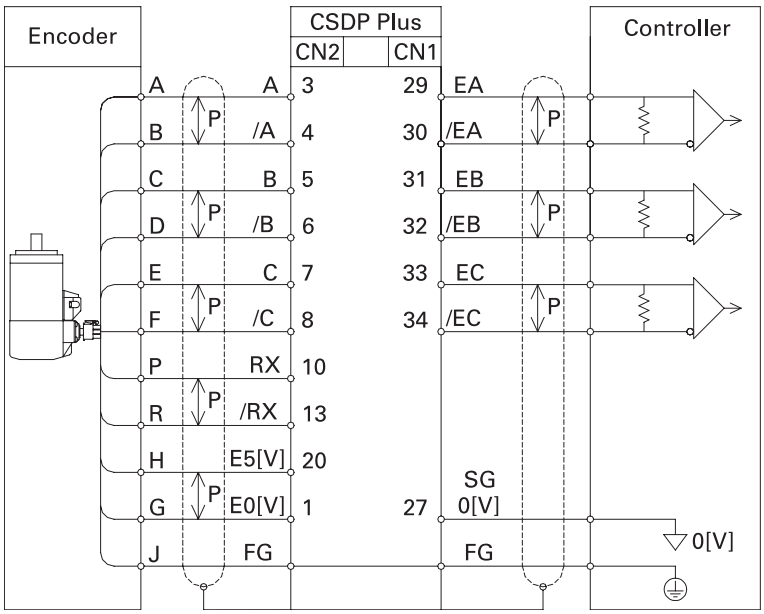


Connect the encoder cable to CN2 connector.

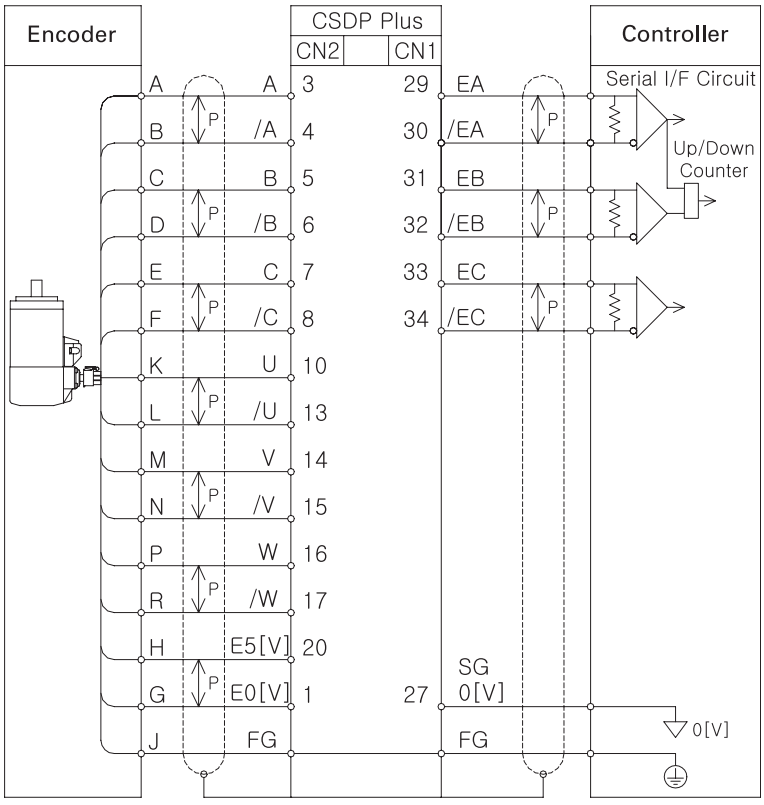
Encoder Connector (CN2) Pin

No.	Function	9-wire Inc.	11-wire Inc.	15-wire Inc.	Compact Abs.	Serial Abs.	Serial Inc.
1	EO [V]	G	G	G	G	G	G
2							
3	A	A	A	A	A		
4	A	B	B	B	B		
5	B	C	C	C	C		
6	B	D	D	D	D		
7	C	E	E	E	E		
8	C	F	F	F	F		
9							
10	U/SD+		P	K	K	K	K
11	RST (Abs)				R		
12							
13	/U/SD-		R	L	L	L	L
14	V			M			
15	V			N			
16	W			P			
17	W			R			
18	BAT+				T	T	
19	BAT-				S	S	
20	E5 [V]	H	H	H	H	H	H
FG		J	J	J	J	J	J

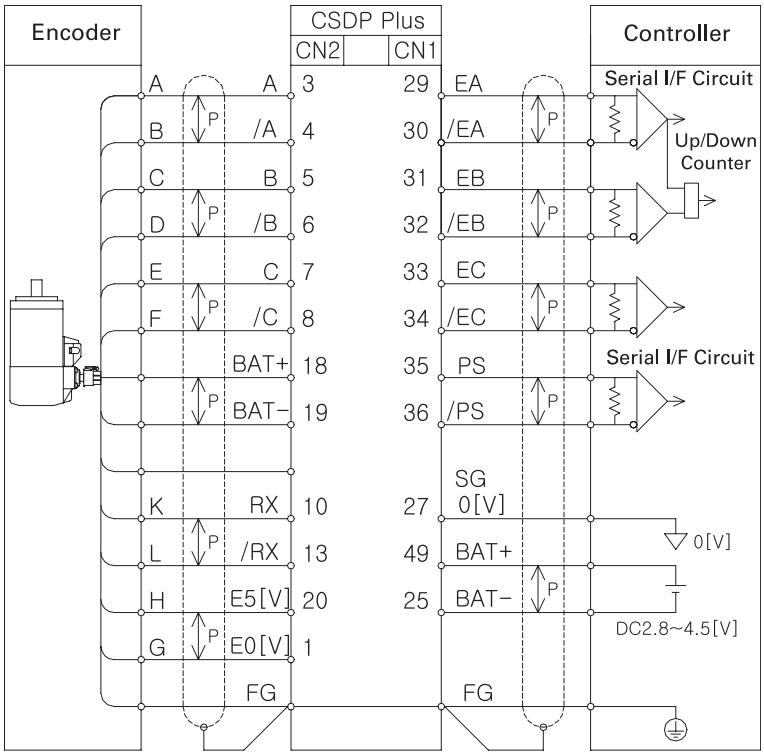
Please See *"Cable Specifications" in Appendix C* for further information about encoder cable, connector, and plug.



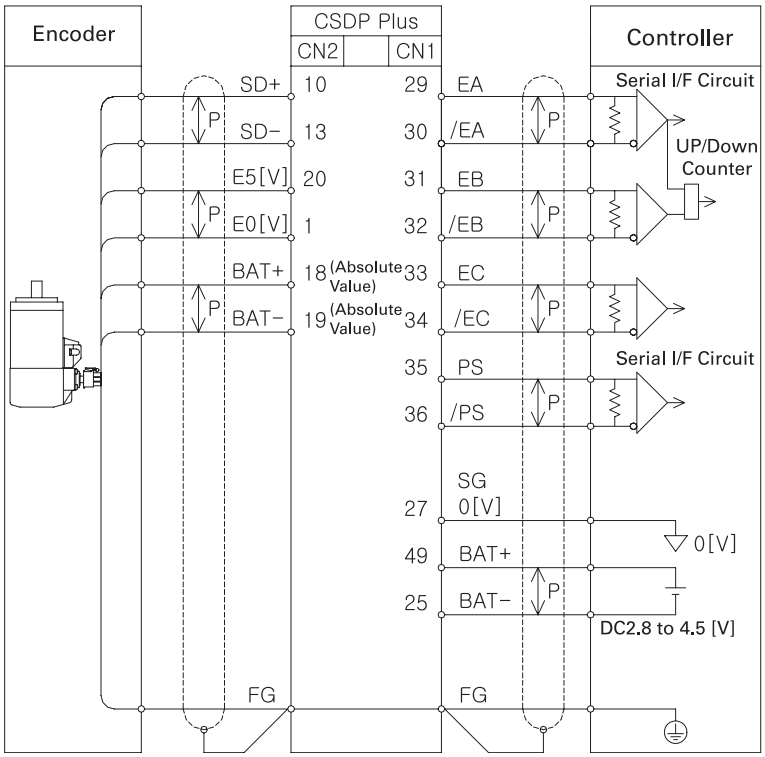
11-wire Incremental Encoder Wiring



15-wire Incremental Encoder Wiring



Compact Absolute Encoder Wiring



Serial Encoder Wiring

Encoder Connector Specifications

Motor	Types	Products
RSMD, RSMF, RSMH, RSMK, RSML, RSMN, RSMS, RSMX	9-wire Inc.	DMS3108B20-29S (or DMS3106B20-29S)
CSMD, CSMF, CSMH, CSMS	11-wire Inc.	DMS3108B20-29S (or DMS3106B20-29S)
CSMD, CSMF, CSMH, CSMS, CSMK, RSMD, RSMF, RSMH, RSMK, RSML, RSMN, RSMS, RSMX	15-wire Inc.	DMS3108B20-29S (or DMS3106B20-29S)
CSMD, CSMF, CSMH, CSMS, RSMD, RSMF, RSMH, RSMK, RSML, RSMN, RSMS, RSMX	Compact Abs.	DMS3108B20-29S (or DMS3106B20-29S)
RSMD, RSMF, RSMH, RSMK, RSML, RSMN, RSMS, RSMX	Serial Abs	DMS3108B20-29S (or DMS3106B20-29S)
RSMD, RSMF, RSMH, RSMK, RSML, RSMN, RSMS, RSMX	Serial Inc.	DMS3108B20-29S (or DMS3106B20-29S)

Fuse

Fuse capacity in the table below is the figure when the load is 100%. Please select a wiring breaker or fuse capacity after considering the load factor.

Fuse Specifications

	Input Power Supply Capacity	Fuse	NFB	Inrush current
CSDP-15BX2	4.6 kVA	16 A	30 A	50 A
CSDP-20BX2	6.1 kVA	21 A	30 A	50 A
CSDP-30BX2	9.1 kVA	31 A	40 A	50 A
CSDP-40BX2	12.1 kVA	41 A	50 A	50 A
CSDP-50BX2	15.2 kVA	52 A	60 A	50 A

ATTENTION

Using a high-speed fuse is not possible. As the power supply of the drive is a condenser input type, if a high-speed fuse is used, it can blow even under normal circumstances.

Anti-noise Measures

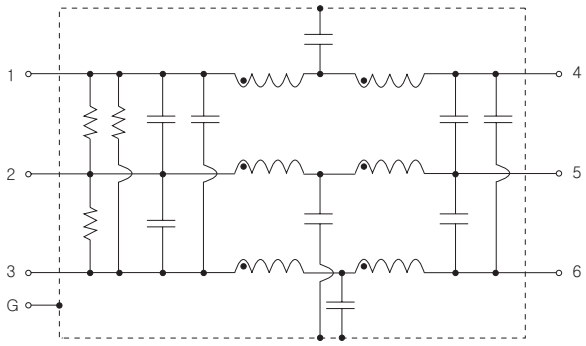
As CSDP Plus uses a high-speed switching device and microprocessor in its main circuit, it can be affected by the switching noise from the switching device depending on the methods of peripheral wiring and grounding.

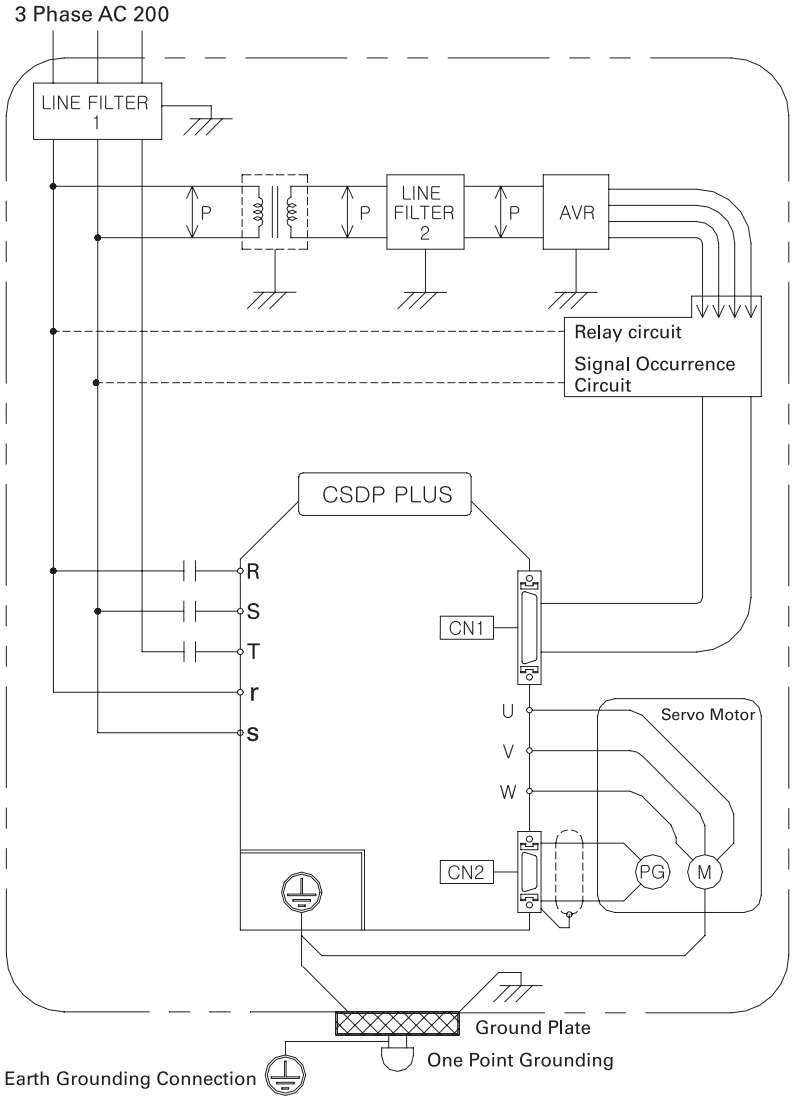
ATTENTION

Please use a thick line with the diameter 3.5 mm^2 or above for grounding. And, make sure that the signal line and the power supply line are separated.

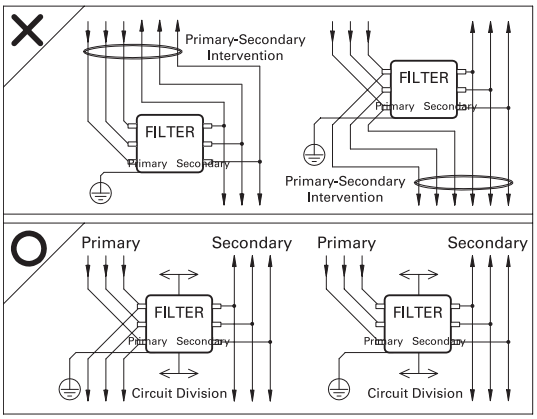
Noise Filter (3 phase AC)

3 Phase 220V AC Noise Filter

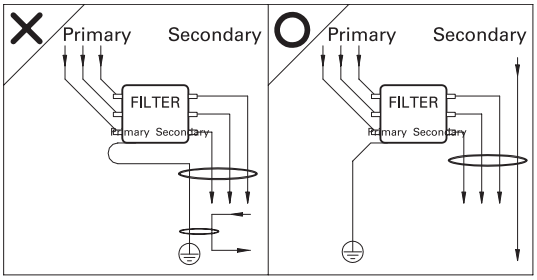
Servo Drive	Recommended Noise Filter	Mode	Specification
CSDP-15B		NFZ-4030SG	250V/15A
CSDP-20 - 30B		NFZ-4030SG	250V/30A
CSDP-40 - 50B		NFZ-4040SG	250V/40A



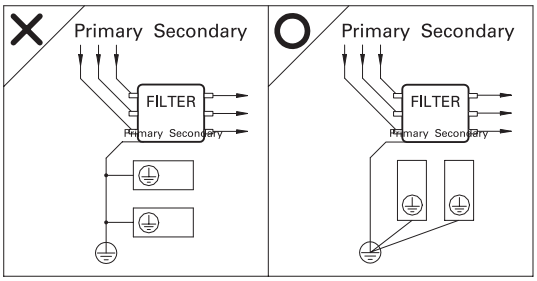
Grounding, Wiring



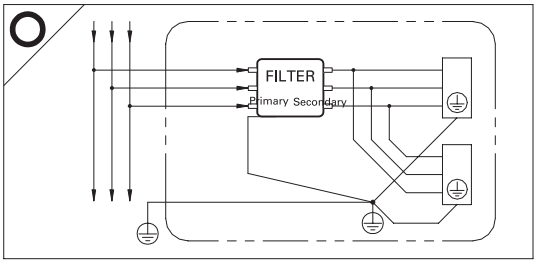
Please separate the input and output wires of the filter, and do not tie them together.



Please position the grounding line of the noise filter away from the output wiring and do not tie it with other signal lines in the same duct.



Connect the grounding line of the noise filter to the grounding frame separately. Please do not connect the grounding line of the noise filter to other grounding lines.



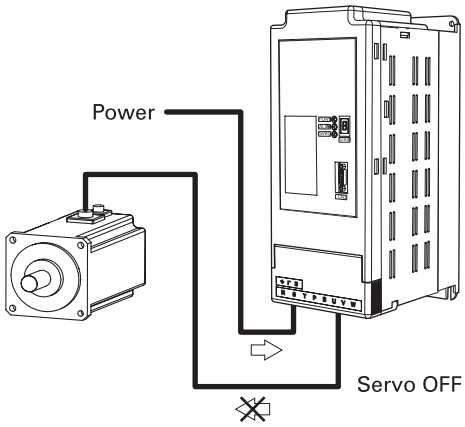
If the noise filter is inside the case, connect the grounding line of the noise filter and all other grounding lines of different devices to the grounding frame and finish the grounding.

3

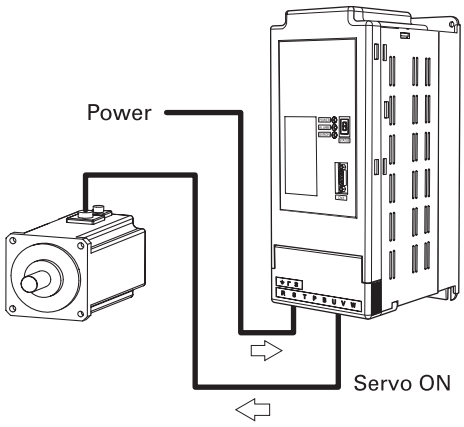
Operation

Overview

You can instantly use general electronic appliances like a television by just turning it on. But turning on a servo drive is not enough to operate a servo motor. To properly operate a servo drive, a servo-ON signal from a controller is required.



If the power supply is engaged but servo-ON signal is not issued, the servo drive and the motor are separated.

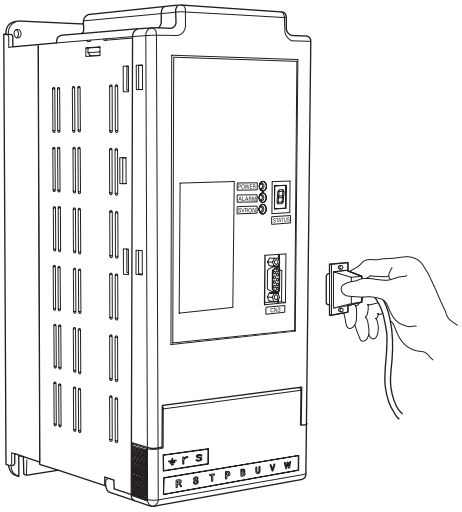


When the controller issues a servo-ON signal, the drive transmits voltage to the motor.

If the command for operating the motor is approved, then the drive can operate the motor according to the command.

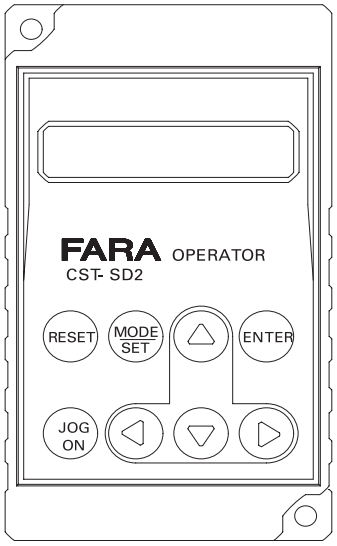
Operator

To set up a servo drive, operator needs to be connected to the servo drive.



Connect the operator cable to CN3 (9 pin) terminal.

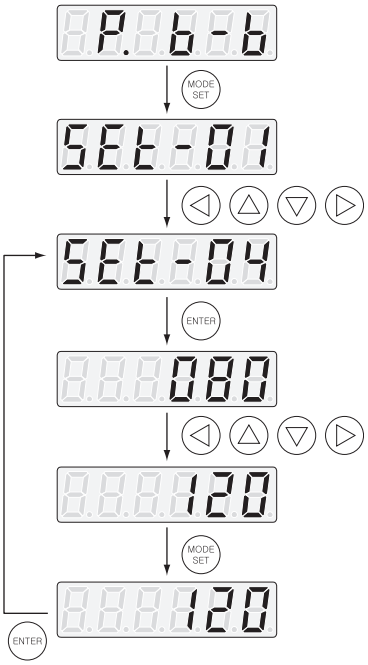
The operator used by for to CSDP Plus is CST-SD2.



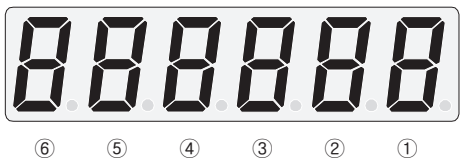
Operator

Please press the MODE/SET key to change mode or save the parameter. Press the ENTER key to select the parameter or escape to higher mode after selection. LED displays six digit numbers. Then press left or right keys to move to other decimal places while selecting the parameter. Press up or down keys at the current position and search the number or the value of the parameter you want.

For instance, if you want to set up a position regulator loop proportional gain, follow the command below.



Please press the MODE key until SEt-01 appears. When you see SEt-01, press the direction keys until you see Set-04, the parameter for the position regulator loop proportional gain. Then press the ENTER key and the position proportional gain parameter will be displayed. Press the direction keys to get the value you want and press the SET key to save it. Press the ENTER key to escape from the current level.



No. 1 digit is on the far right and the No. 6 digit is on the far left.

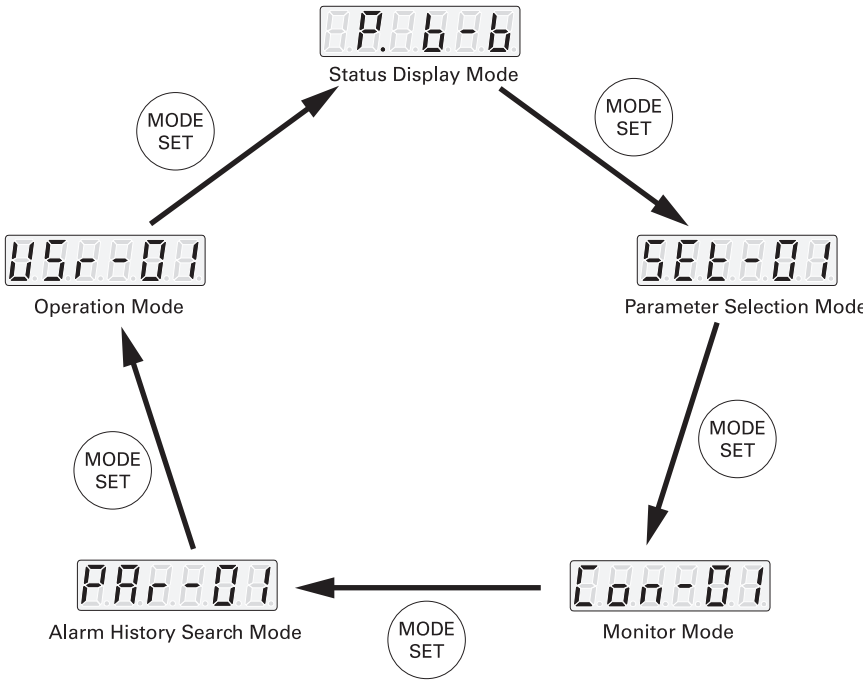
In the status display mode and parameter selection mode, a decimal place sometimes has a separate meaning of its own.

Mode

CSDP Plus has five operation modes.

- Status Display Mode
- Parameter Selection Mode
- Monitor Mode
- Alarm History Search Mode
- Operation Mode

When the power is turned on, the status display mode will start.



Please press the MODE key to change mode.

Please See *"Troubleshooting" in Chapter 7* for the alarm history search mode.

Status Display Mode

When the power is turned on, the dot on the right side of the fifth digit will be lit.

When the motor speed reaches the level of the speed command, the top line on the fourth digit will be lit as the diagram shows.

When the revolution detection signal is displayed, the middle line on the fourth digit will be lit.

If the revolution speed of the motor is faster than the revolution detection level (SEt-16), the servo drive can display the revolution detection signal (/TG-ON).

When the z-phase output of the encoder is detected, the bottom line on the fourth digit will be lit.

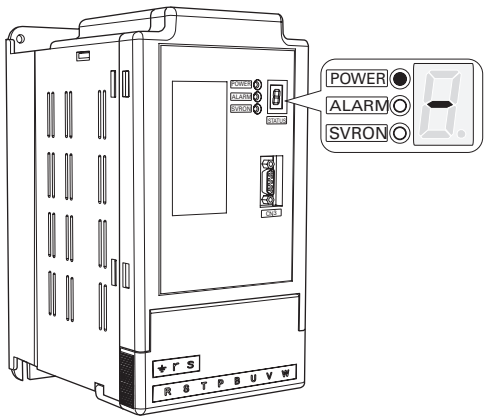
This indicates that the servo is off.

P. run indicates that the operation is in the position control mode.
S. run indicates that the operation is in speed control mode.
t.run indicates that the operation is in torque control mode.

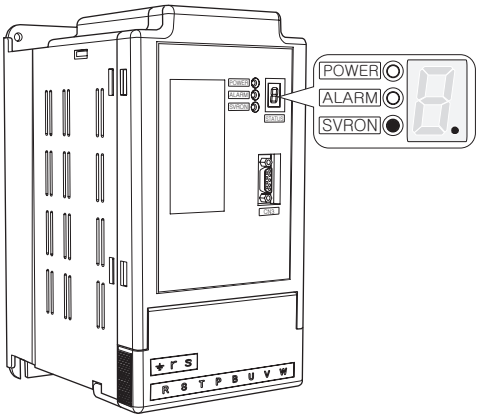
P. Pot indicates that a signal to stop forward revolution is received in the position control mode.
S. Pot indicates that a signal to stop forward revolution is received in the speed control mode.
t.Pot indicates that a signal to stop forward revolution is received in the torque control mode.

P. not indicates that a signal to stop reverse revolution is received in the position control mode.
S. not indicates that a signal to stop reverse revolution is received in the speed control mode.
t. not indicates that a signal to stop reverse revolution is received in the torque control mode.

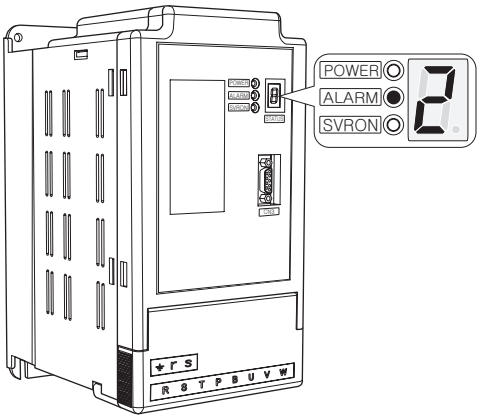
The display panel on the servo drive itself can indicate Power ON, Servo ON, and Alarm occurrence.



When the power is ON, the middle line will be lit. And the power light will be on.



When the Servo is ON, a dot will be lit. And SVRON light will be on.



If an alarm occurs, the first digit of the relevant number will be displayed. And the ALARM light will be on.

Parameter Selection Mode

Various operational conditions are allocated to the parameter. Please See *"Parameter" in Appendix A* for the functions of each parameter.

Monitor Mode

The monitor mode shows various data generated while the drive controls the motor.

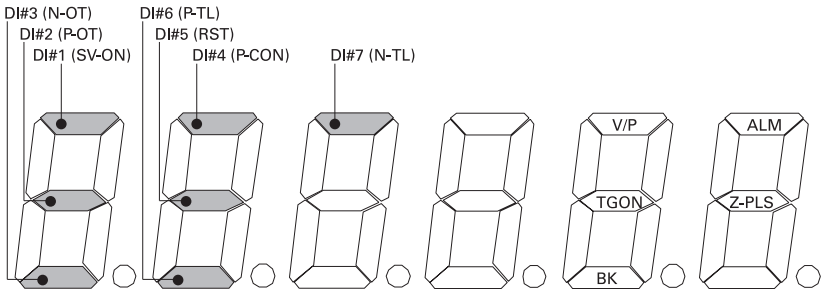
Monitor Number List

No.	Contents (Unit)
Con-01	Speed Feedback (RPM)
Con-02	Speed Command (RPM)
Con-03	Torque Command (%)
Con-04	Electrical Angle (°)
Con-05	Speed Error (RPM)
Con-06	Position Error (pulse)
Con-07	Mechanical Angle (°)
Con-08	Position Feedback (pulse)
Con-09	Position Command (pulse)
Con-10	Offset of Analog Speed Command
Con-11	Offset of Analog Torque Command
Con-12	In/Output Signal Status
Con-13	Load Inertia Ratio
Con-16	Frequency of the Position Command pulse (kHz)
Con-17	Analog Speed Input Voltage (10 mV)
Con-18	Analog Torque Input Voltage (10 mV)
Con-19	Maximum Torque Used Until Now
Con-20	Multi-revolution Position of the Absolute Encoder
Con-21	Maximum Position Error (pulse)
Con-22	Maximum Speed (RPM)
Con-23	Encoder Pulse Value After Servo ON
Con-24	One Revolution Position of the Absolute Encoder
Con-29	DC Voltage [V]
Con-30	Instant Output Power [W]
Con-32	Servo Drive Usage Rate [%]

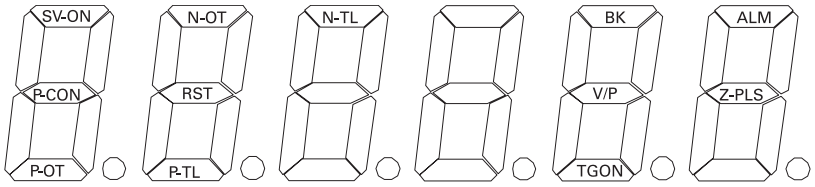
Con-12 Function

The in/output signal status display method can be set up on the second digit of SEt-50. To use the previous CSDP method for existing CSDP users, please set the parameter to 1. To use the original CSDP Plus display method, please set the parameter to 0.

When the second digit of SEt-50 is 0, the in/output signal status of Con-12 will be displayed as below.



When it is 1, the status will be displayed as below.

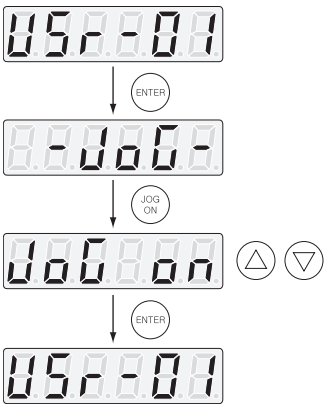


Operation Mode

Operation Number List

No.	Event
USr-01	Jog Operation
USr-02	Auto Tuning
USr-03	Auto Adjustment for Speed Command Offset/Adjustment for Current Offset
USr-04	Auto Adjustment for Torque Command Offset
USr-05	Manual Adjustment for Speed Command Offset
USr-06	Manual Adjustment for Torque Command Offset
USr-07	Alarm Reset
USr-09	Parameter Initialization
USr-10	Alarm History Initialization
USr-90	Pilot Operation

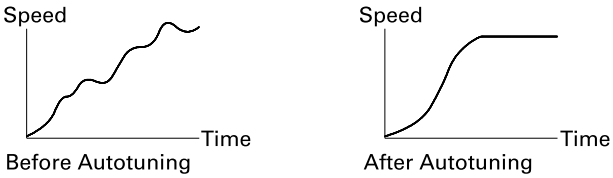
Jog Operation



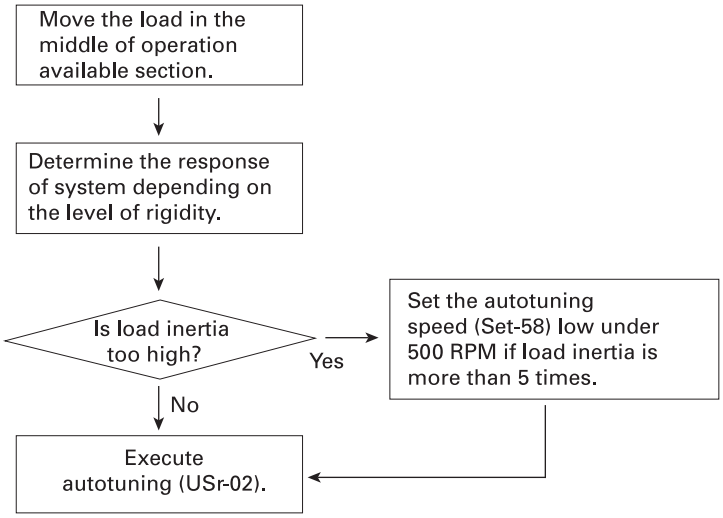
The revolution will continue in the forward direction (counterclockwise) only while the up button is pushed, and in the reverse direction (clockwise) only while the down button is pushed.

Auto Tuning

The gain of the servo drive is usually in proportion to inertia. If velocity speed regulator loop proportional gain and velocity speed regulator loop integral gain are not set properly, the operation characteristics of the servo drive can slow down.



The order of auto tuning is as follows.

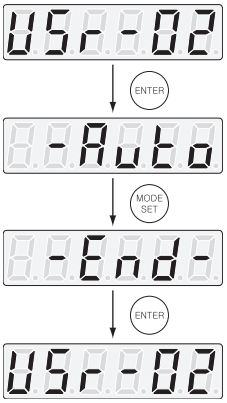


Auto Tuning Order

Please set SEt-69 by referring to the table below.

Set-69 Set Up

System Rigidity	SEt-69
Low Rigidity	20
Medium Rigidity	30
High Rigidity	45



During the process of auto tuning, the following parameter will be automatically set.

- Speed Loop Proportional Gain (SEt-02)
- Speed Loop Integral Gain (SEt-03)
- Position Loop Proportional Gain (SEt-04)
- Torque Command Filter (SEt-06)
- Speed Command Filter (SEt-40)
- System Gain (SEt-42)
- Inertia Ratio (SEt-66)

If auto tuning doesn't work well, please adjust the gain according to the command below.

1. First, set the speed integral gain (SEt-03) to its default value.
2. Raise the speed proportional gain (SEt-02) to the range that doesn't cause vibration in the system.
3. Raise the speed integral gain (SEt-03) to the range that doesn't cause vibration in the system.
4. Try jog operation or pilot operation.
5. If there is a serious vibration or noise, please reduce the speed proportional (SEt-02) or speed integral gain (SEt-03).

Please repeat the fourth and fifth steps until stabilization.

Quick response cannot be expected when the inertia of the load exceeds five times the inertia of the motor's rotor or when the load torque is higher than the motor torque. In these cases, please follow the command below for adjustment.

- Reduce the inertia of the system and load torque.
- Extend the time for acceleration and deceleration.
- Replace the motor with another one with higher rotor inertia.
- Use a motor with higher output torque.
- Lower the gain to reduce the response of the system.

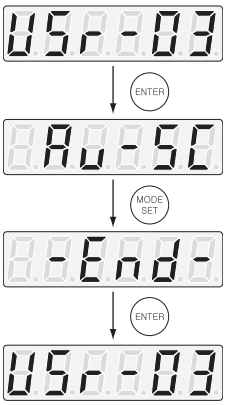
Current Offset Adjustment

To adjust the current offset, please set the second digit of SEt-45 to 1 or 2.

1: Current Adjustment when Servo is OFF
2: Current Offset Adjustment when Servo is ON

To run the auto adjustment for speed command offset, please change the preset value to 0.

Auto Adjustment for Speed Command Offset

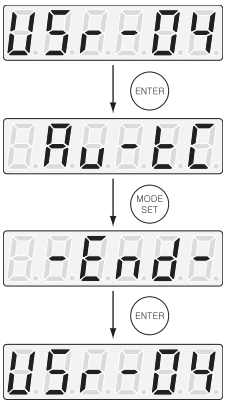


Auto adjustment for speed command offset can be done when the servo is either ON or OFF.

The voltage input of the current speed command is identified as 0V. Therefore, please adjust the voltage generated from the controller or a variable resistor to 0V.

The adjusted speed command offset can be checked with Con-10.

Auto Adjustment for Torque Command Offset



Auto adjustment for torque command offset can be done when the servo is either ON or OFF.

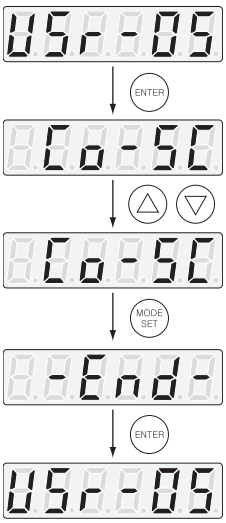
The voltage input of the current torque command will be identified as 0V. Therefore, please adjust the voltage output generated from the controller or a variable resistor to 0V.

The adjusted torque command offset can be checked with Con-11.

ATTENTION

Afterthought speed command offset or torque command offset is automatically adjusted, so themotor can move a little. This is because the power supply voltage has noise or fluctuates a little. To completely stop the motor by analog command, please operate the system in the zero clamp speed control mode.

Manual Adjustment for Speed Command Offset

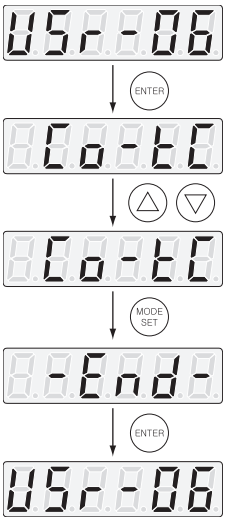


Manual adjustment for speed command offset should be done when the servo is ON.

If the UP key is pushed, offset will be added in the forward direction. If the DOWN key is pushed, offset will be added in the reverse direction.

The adjusted speed command offset can be checked with Con-10.

Manual Adjustment for Torque Command Offset

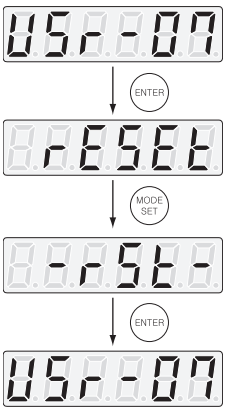


Manual adjustment for torque command offset can be done when the servo is ON.

If the UP key is pushed, offset will be added in the forward direction. If the DOWN key is pushed, offset will be added in the reverse direction.

The adjusted torque command offset can be checked with Con-11.

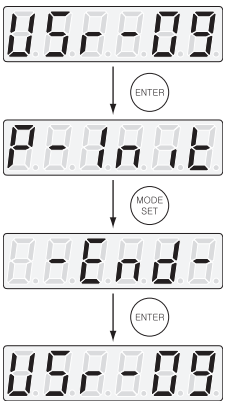
Alarm Reset



If an alarm (Error) occurs, it can be turned off by Usr-07 after the cause of the problem is dealt with.

Please See *"Troubleshooting" in Chapter 7* for further details about the alarm.

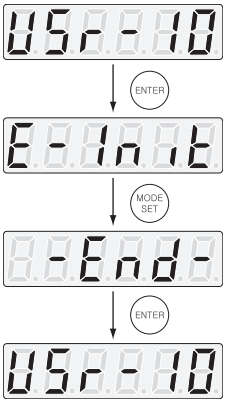
Parameter Initialization



To return the parameter to their default values, please use USr-09.

When USr-09 is implemented, in cases where the fourth digit of SEt-50 is 0, all the parameter except for those related to the system will be initialized and if the fourth digit of SEt-50 is 1, all the parameter will be initialized.

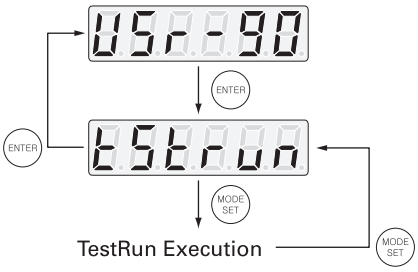
Alarm History Deletion



When an alarm occurs, the alarm code will be recorded in the order of PAr-01 to PAr-10. If USr-10 is implemented, all the values from PAr-01 to PAr-10 will be changed to 0.

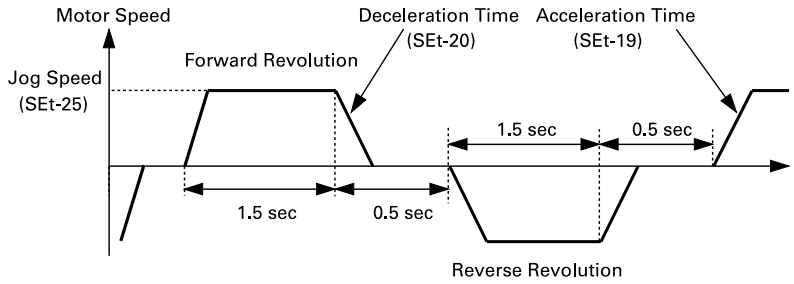
Please See *"Troubleshooting" in Chapter 7* for detailed information about alarm.

Pilot Operation



Pilot operation will be repeated in the same pattern until it is aborted. The 1 cycle is 14 seconds.

Parameter can be referred to or set during pilot operation.



Pilot Operation Pattern

Basic Set-up

There are basic parameter that should be set first before setting other parameter.

The parameter included in the basic set-up are listed in the table below.

Basic Parameter

Basic Parameter	Event
SEt-41	Control Mode
SEt-51	Encoder Type
SEt-52	Motor Type
SEt-53	Motor Capacity

Please turn off the power after basic set-up and then restart it.
Please set up the control mode at SEt-41.

SEt-41 Set-up Value

Setting	Control Mode	/C-SEL OFF	/C-SEL ON
0	Position Mode		
1	Speed Mode		
10	Direction Change Speed Mode		
12	Torque Limit Speed Mode		
5	Zero Clamp Mode		
2	Torque Mode		
3	Multi-level Speed Mode		
9	Speed Limit Torque Mode	Speed Limit Torque Mode	Torque Mode
6	Torque + Speed Mode	Torque Mode	Speed Mode
7	Position + Torque Mode	Position Mode	Torque Mode
8	Position + Speed Mode	Position Mode	Speed Mode
13	Position + Multi-level Speed Mode	Position Mode	Multi-level Speed Mode
14	Speed + Multi-level Speed Mode	Speed Mode	Multi-level Speed Mode
15	Torque + Multi-level Speed Mode	Torque Mode	Multi-level Speed Mode

Please select the encoder type at SEt-51.

SEt-51 Set-up Value

Motor	Mode		Encoder Type	Set-up(SEt-51)
CSMD, CSMF, CSMH, CSMK, CSMS	A	2500 P/R	Inc. (11-wire)	100
	B	2500 P/R	Inc. (15-wire)	101
	D	1000 P/R	Inc. (15-wire)	102
	H	2048 P/R	Compact Abs.	104
	M	10000 P/R	Inc. (15-wire)	106
RSMD, RSMF, RSMH, RSMK, RSML, RSMN,RSMS,RSMX	A	2500 P/R	Inc. (9 -wire)	107
	K	5000 P/R	Inc. (15 -wire)	103
	L	6000 P/R	Inc. (15 -wire)	105
	M	10000 P/R	Inc. (15 -wire)	106
	H	2048 P/R	Compact Abs.	104
	Q	17 Bit Serial Abs.		108
	R	17 Bit Serial Inc.		109

Please set the motor type at SEt-52.

SEt-52 Set-up Value

Motor	Set-up Value
CSMS	2222
CSMD	2312
CSMH	2322
CSMF	2332
CSMK	2342
RSMS	2402
RSMD	2412
RSMH	2422
RSMF	2432
RSMK	2442
RSML	2452
RSMN	2462
RSMX	2472

Please set the motor capacity at SEt-53.

SEt-53 Set-up Value

	1.2kW	1.3kW	1.5kW	2.0kW	2.5kW	3.0kW	3.5kW	4.0kW	4.5kW	5.0kW	6.0kW
CSMD	-	-	150	200	250	300	350	400	450	500	-
CSMF	-	-	150	-	250	-	350	-	450	-	-
CSMH	-	-	150	200	-	300	-	400	-	500	-
CSMK	120	-	-	200	-	300	-	-	450	-	600
CSMS	-	-	150	200	250	300	350	400	450	500	-
RSMD	-	-	150	200	250	300	350	400	450	500	-
RSMF	-	-	150	-	250	-	350	-	450	-	-
RSMH	-	-	150	200	-	300	-	400	-	500	-
RSMK	120	-	-	200	-	300	-	-	450	-	600
RSML	120	-	-	200	-	300	-	-	450	-	600
RSMN	120	-	-	200	-	300					
RSMS	-	-	150	200	250	300	350	400	450	500	-
RSMX	-	130	-	180	-	290	-	-	440	-	-

4

Control

Overview

Input signal is sent to servo drive from the controller, while the output is vice versa.

IMPORTANT Only A contact is used for CSDP Plus except for P-OT and N-OT. Therefore, ON means connection and OFF means interruption, excluding the cases of P-OT and N-OT. For example, when /C-DIR signal is ON, the terminal where /C-DIR signal is allocated will be connected and the electric current will flow, but when /C-DIR signal is OFF, the terminal will be interrupted so that the electricity will be shut off.

Input Signal

There are 20 different input signals. The functions of the signals are shown below.

Input Signal

Signal	Function	Application Control Mode
/SV-ON	Control Voltage for the servo motor.	All
/A-RST	Clear the servo alarm.	All
/G-SEL	Shifts the gains of the two groups.	All
/P-TL	Limits the forward torque within the preset value (SEt-12).	All
/N-TL	Limits the reverse torque within the preset value (SEt-13).	All
P-OT	Stops the forward movement of the load devices when they reach the mobility limit in the forward direction.	All
N-OT	Stops the reverse movement of the load when they reach the mobility limit in the reverse direction.	All
/P-CON	Changes the speed control method from PI control to P control.	Position, Speed, Multi-level Control
/C-SEL	Changes the control mode from the combination control.	Complex Control
/C-DIR	Determines the revolution direction of the motor in the multi-level speed control.	Multi-level Control
/C-SP1	Selects the revolution speed in the multi-level speed control.	Multi-level Control
/C-SP2	Selects the revolution speed in the multi-level speed control.	Multi-level Control
/C-SP3	Selects the revolution speed in the multi-level speed control.	Multi-level Control

Input Signal

Signal	Function	Application Control Mode
/Z-CLP	Ignores the input value if the value of analog command is lower than the speed zero clamp level (SEt-17) in the speed control.	analog command Speed Control
/INHIB	Ignores the position command pulse input.	Position Control
/ABS-DT	Sends absolute value data to the controller through EA, EB signals.	All
/A-TL	Limits the torque in the torque speed limit control mode through torque command.	Torque Speed Limit Control
/P-LCR	Clear the current position and position command.	Position Control
/EMG	Issues an emergency alarm.	All
/R-ENC	Resets the multi-revolution of the absolute encoder and the alarm.	All

Output Signal

There are eight different output signals. The functions of the signals are shown below.

Output Signal

Signal	Function	Application Control Mode
/P-COM	This signal will be displayed if the position error is within the range of position completion decision (SEt-18).	Position Control
/NEAR	This signal will be displayed if the position error is within the range of near position proximity decision (SEt-23).	Position Control
/V-COM	This signal will be displayed if the error between the speed command and the revolution speed of the motor is within the range of in speed (SEt-18).	Multi-level Control
/TG-ON	This signal will be displayed if the motor revolves at the revolution detection level value (SEt-17) or above.	All
/T-LMT	This signal will be displayed if the torque reaches the torque limit value.	All
/V-LMT	This signal will be displayed if the speed reaches the speed limit value.	All
/BK	Activates the brake of the servo motor.	All
/WARN	This signal will be displayed when a servo warning is detected.	All

Signal Assignment

The input signals should be allocated to the CN1 connector's input pins from DI#1 to DI#8.

Input Signal Assignment Table

Parameter	Fourth Digit	Third Digit	Second Digit	First Digit
SEt-59	/P-CON	N-OT	P-OT	/SV-ON
SEt-60	/C-SEL	/P-TL	/N-TL	/A-RST
SEt-61	/C-SP3	/C-SP2	/C-SP1	/C-DIR
SEt-62	/A-TL	/G-SEL	/INHIB	/Z-CLP
SEt-63	/P-CLR	/R-ENC	/EMG	/ABS-DT

For instance, put 7 in the fourth digit of SEt-59 to allocate the/P-CON signal to the DI#7 pin.

Put 3 in the second digit of SEt-62 to allocate the /INHIB signal to DI#3 pin.

When 9 is set, it is always valid and when 0 is set, it is always invalid. For instance, to keep SV-ON always valid when the power is on regardless of the wiring, put 9 in the first digit of SEt-59.

Output Signal Assignment Table

Parameter	Fourth digit	Third digit	Second digit	First digit
SEt-76	/V-COM	/BK	/TG-ON	/P-COM
SEt-77	/WARN	/NEAR	/V-LMT	/T-LMT

Put 1 in the first digit of SEt-76 to allocate /P-COM signal to the DO#1 pin.

Put 3 in the fourth digit of SEt-77 to use /WARN function through DO#3 pin.

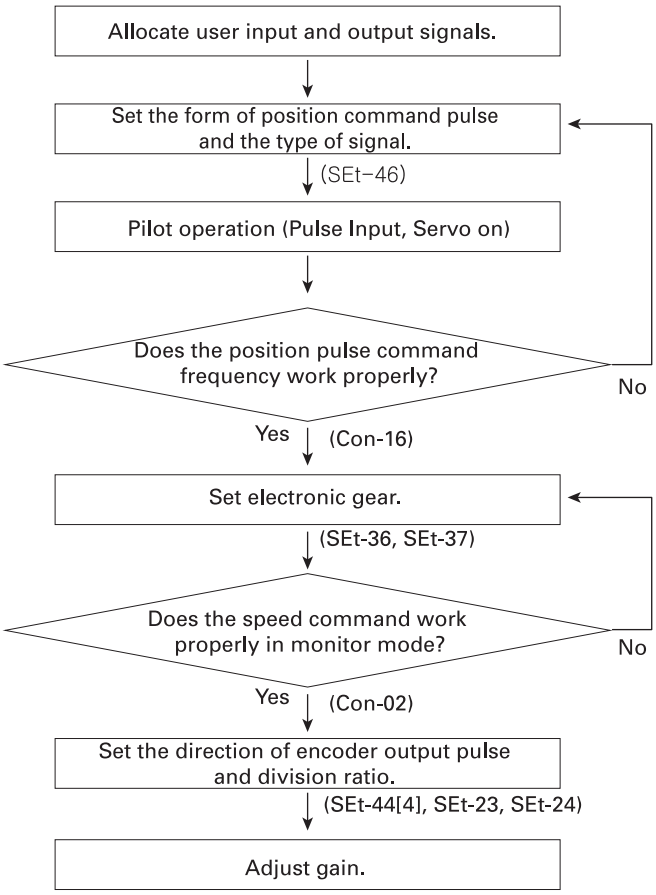
Setting 0 makes the system always invalid and there is no value to make the system always valid, which is different from the input case.

If the warning in the diagram is displayed, it means two or more signals were allocated to a single pin.

ATTENTION Restart servo drive after signal assignment.

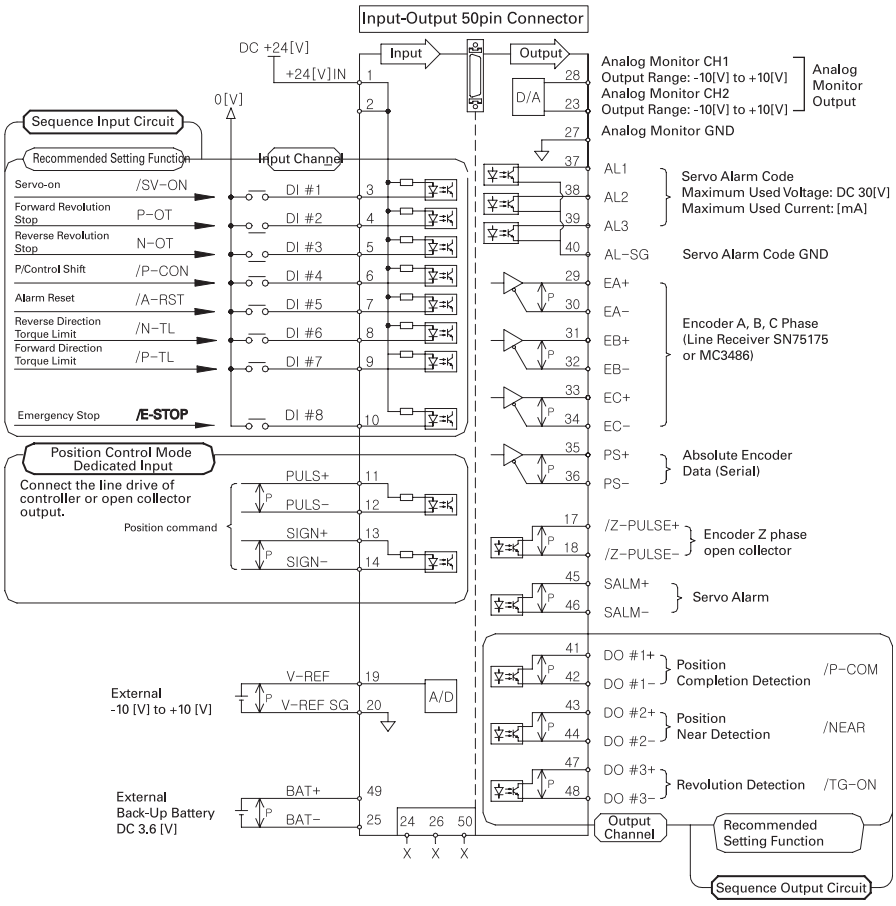
Position Control

Position control is moving the load to the position where the controller instructs. In order to carry out position control, please connect the command pulse signal to PULSE and SIGN input pins and connect other input signals as needed. And then please follow the command below for set-up.



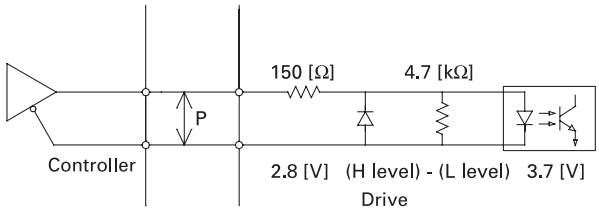
Position Control Set-up Sequence

Three types of command are inputed through the four pins of the controller connector (CN1).

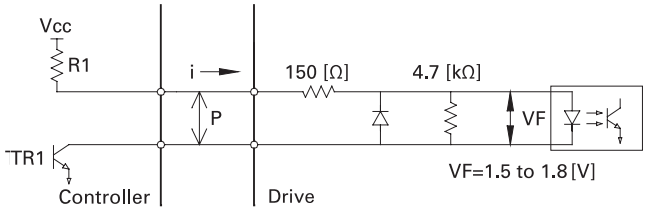


Position Control Wiring

In the position control mode, the controller can input position command in two ways. The first is line drive and the second is open collector.



Line Drive Input



Open Collector Input

The maximum frequency allowed in the line drive input is 900 kpps, and the maximum frequency allowed in the open collector input is 250 kpps.

In the open collector type, if TR1 is ON, the servo drive recognizes it as a low level input logic, and if TR1 is OFF, the servo drive recognizes it as a high level input logic. Please set the value of R1, so that the input electric current can be 7 to15 mA.

When the output of the controller is open collector type, it is desirable to set Vcc to 24V. It is because the system can be operated securely even in a noisy environment. At this time, please use 2.2 kΩ resistor at R1.

Resistance to Voltage

Voltage (Vcc)	Resistance (R1)
24 V ± 5 %	2.2 kΩ
12 V ± 5 %	1 kΩ
5 V ± 5 %	180 Ω

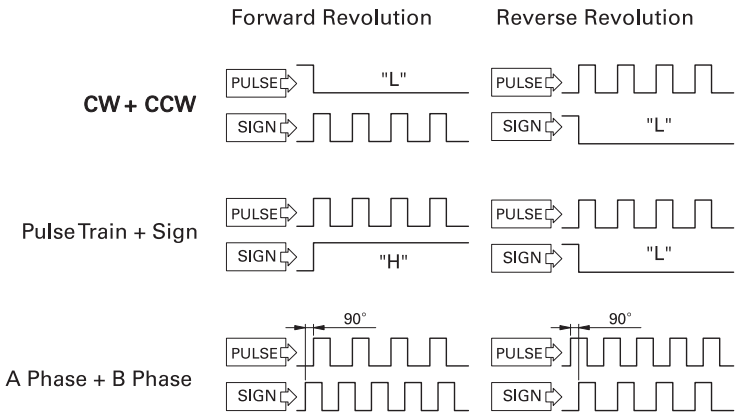
Set the control mode to position control by putting 0 at SEt-41.

Set up the type of position command on the first digit of SEt-46.

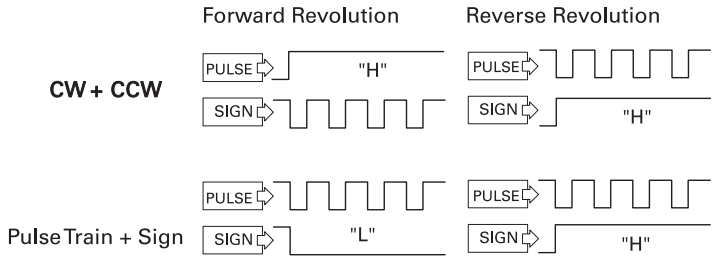
Position Command Type Set-up

Set value	Logic	Multiplication	Pulse Type
0	Positive	-	CW+CCW
1	Negation	-	CW+CCW
8	Positive	-	Pulse Train + Sign
9	Negation	-	Pulse Train + Sign
2	Positive	1 multiplications	A Phase + B Phase
4	Positive	2 multiplications	A Phase + B Phase
6	Positive	4 multiplications	A Phase + B Phase

Please select the position control type by referring to the diagram.

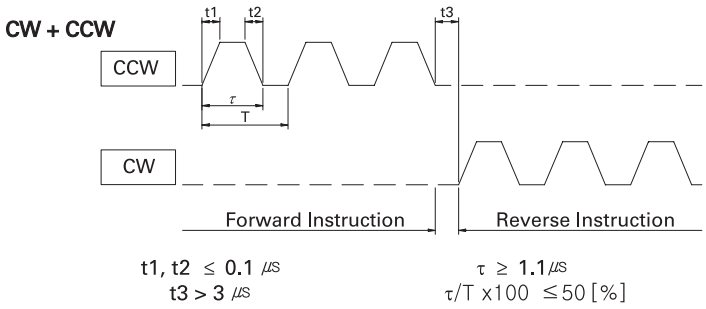


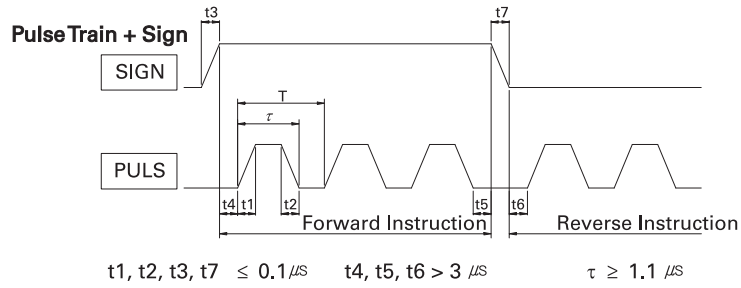
Positive Logic Pulse

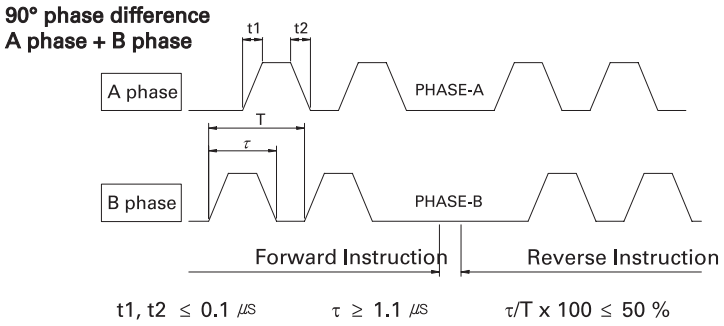


Negative Logic Pulse

Electric characteristics of the position command pulse are shown in the diagram.







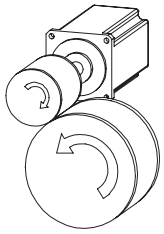
Electronic Gear

Electronic gear is a function to set the amount of load movement for each input command pulse.

An encoder generating 2048 pulses per revolution can make a complete revolution when the controller transmits 2048 pulses to the drive. If the electronic gear is used, only 1000 pulses can make the encoder finish a complete revolution.

In order to use an electronic gear, the speed reduction ratio from the motor shaft to the system is needed.

$$\text{Speed Reduction Ratio} = \frac{\text{Number of revolution of motor}}{\text{Number of revolution of system}}$$



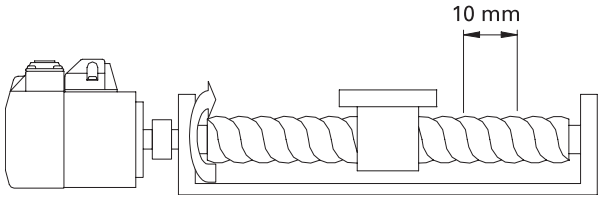
The speed reduction ratio is the ratio of revolutions of the system to the motor. If the system make one revolution when the motor makes five revolutions, the speed reduction ratio is 5. If the system make five revolutions when the motor revolves once, then the speed reduction ratio is 0.2.

The numerator and denominator of the electronic gear can be calculated as below.

(SEt-36) Numerator = Number of pulses of the encoder × Speed reduction ratio

(SEt-37) Denominator = Number of pulses per a revolution of the motor

In the case of a ball screw whose speed reduction ratio is 1 and the number of pulses of the encoder per one revolution is 5000, if the controller approves 1000 pulses for the servo drive to make the motor finish one revolution, the numerator of the electronic gear is 5000 and the denominator is 1000.



The ball screw finishes one revolution with 1000 pulses and thus a ball screw with 10 mm pitch can move 10 with one pulse command.

ATTENTION

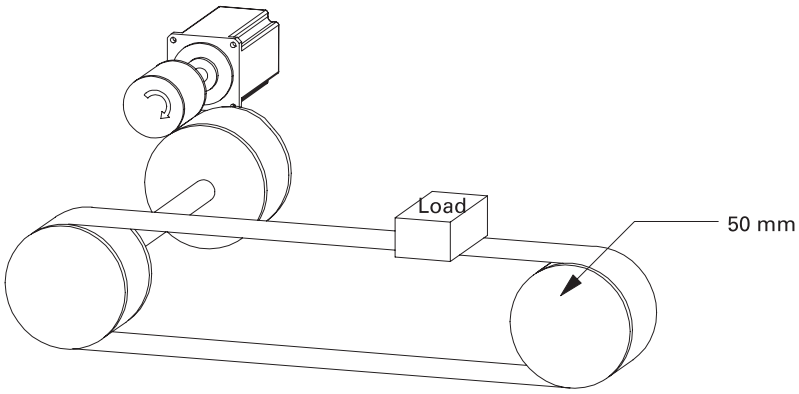
As the denominator increases, the resolution becomes higher. But the following expression should be satisfied.

Pulse of the encoder × Speed reduction ratio × 4 ≥ Denominator

In this case, the maximum denominator is 20000.

In the case of moving a belt 100 μm per one pulse, whose speed reduction ratio is 5 and the number of pulses of the encoder is 2048, the numerator of the electronic gear is 10240, and the denominator is calculated by the following method.

Denominator = Movement distance of the load per revolution/Distance to move by one pulse



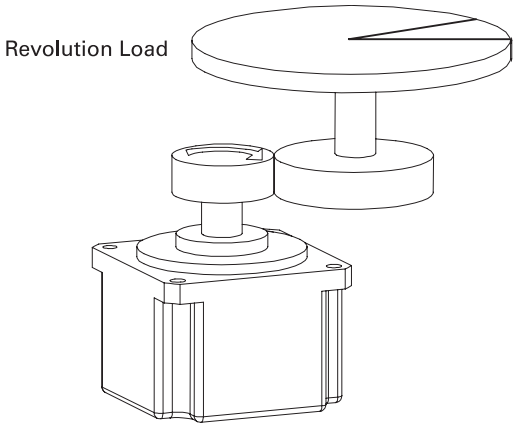
If the diameter of the pulley on the load side is 50 mm and the distance to move by one pulse of the controller is 100 μm, the denominator is 1570.

50π mm/100 μm = 1570

In this case, if 1570 pulses are approved by the controller, the pulley at the end devices makes one revolution and the straight moving distance of the end load is 100 μm.

In case of rotating a turntable 0.1° per pulse, whose speed reduction ratio is 3 and the number of pulses of the encoder is 2048, the numerator of the electronic gear is 6144 and the denominator can be calculated by the following method.

Denominator = Movement angle of the load per revolution/Angle to move with one pulse



If the distance to move with one pulse of the controller is 0.1°, the denominator is 3600.

360°/0.1° = 3600

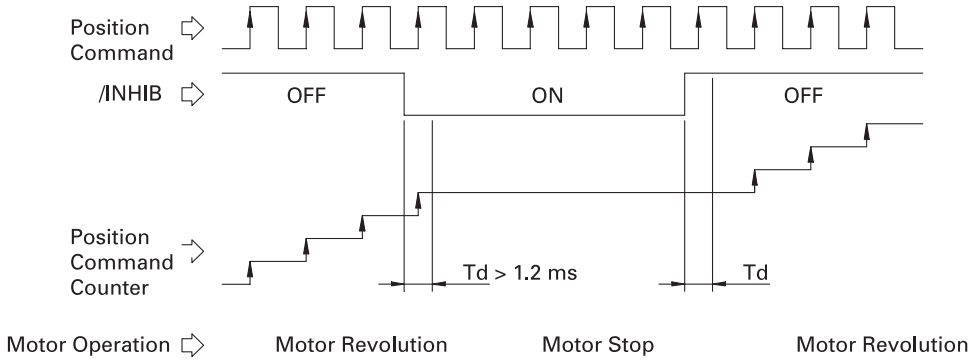
In this case, if the controller approves 3600 pulses, the rotational load of the end devices makes one revolution and the rotational angle of the end load per one pulse command becomes 0.1°.

Please set the numerator at SEt-36.

Please set the denominator at SEt-37.

Pulse Command Inhibit Function

Position command counter can be stopped by setting /INHIB input, which is the signal to ignore pulse command. While this input is ON, the position command pulse input from the controller to the servo drive is ignored. Therefore, the servo lock is maintained at the current position.



Position completion detection and in position detection

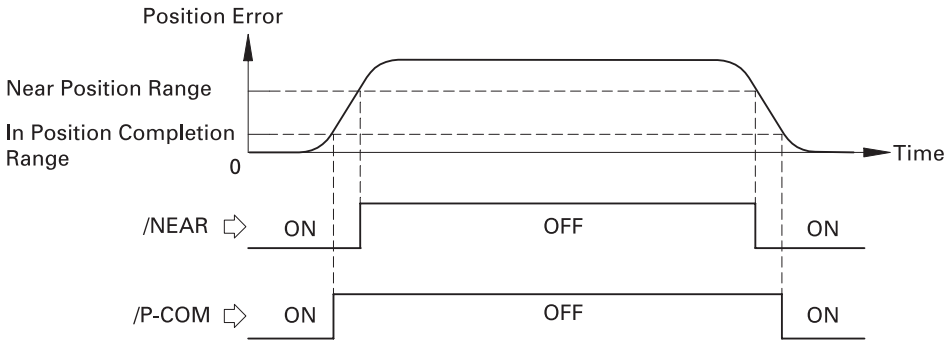
The user can set the timing for the position command completion at the servo drive that received a position command from the controller, and if the difference between the position of the load and the position command is smaller than the set value, the signal for position completion detection /P-COM can be displayed.

Set the decision range for displaying /P-COM signal at SEt-18. The display range is 0 to 1000 pulse and the default value is 10.

If the user sets the timing of the position command proximity at the servo drive that received the position command from the controller and the difference between the load position and the position command is smaller than the preset value, the in position detection signal /NEAR can be displayed.

Set the decision range for displaying /NEAR signal at SEt-22. The display range is 0 to 1000 pulse and the default value is 20.

The motions required at the moment of position completion can be shortened if /NEAR signal and /P-COM signal are used together, so that the controller can confirm the in position signal before position completion detection signal and prepare for the next sequence. Setting these parameter does not affect the accuracy of the final position decision.

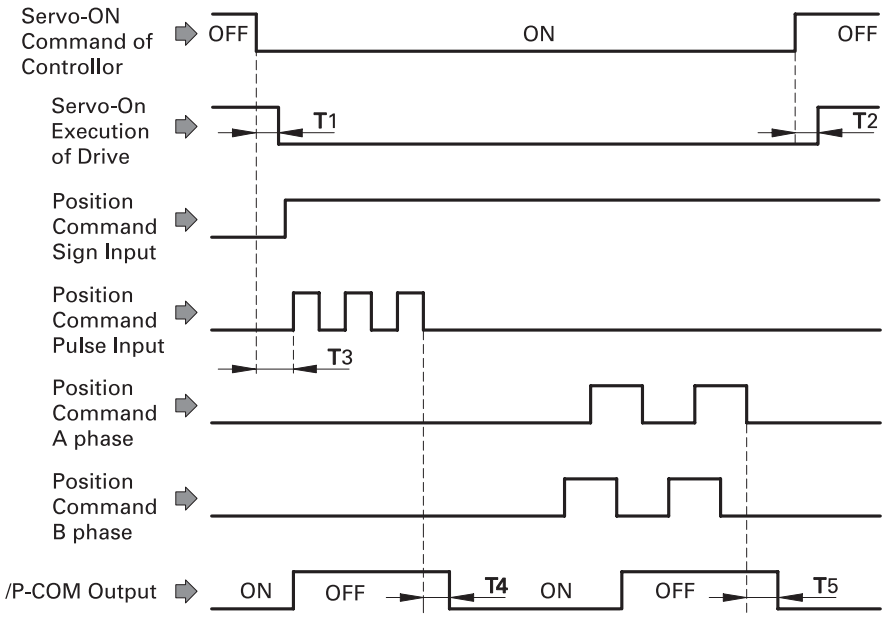


ATTENTION

If the position completion range is large while the system is operating at a low speed, /P-COM output signal can be kept ON.

Position Error Range

Set the position error range at SEt-33. The setting range is 0 to 65535 pulse and the default value is 25000. If the position error is bigger than the set value, the position error overflow servo alarm (E.33 PoF) will occur.

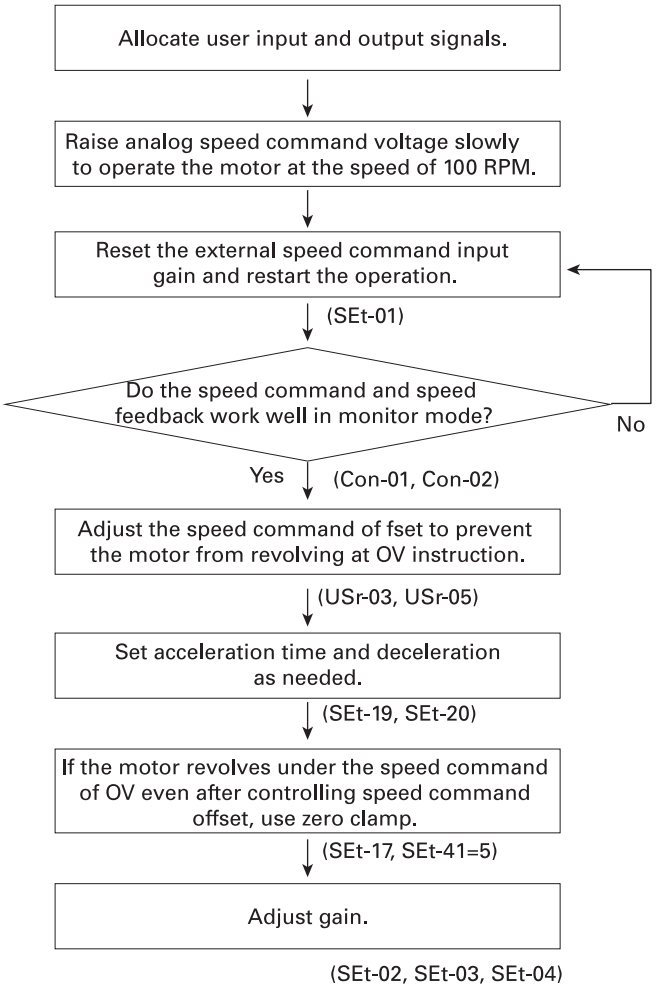


T1: Maximum 40 ms
T2: Maximum 6 ms
T3: Minimum 40 ms
T4: Minimum 10 ms
T5: Minimum 10 ms

Speed Control

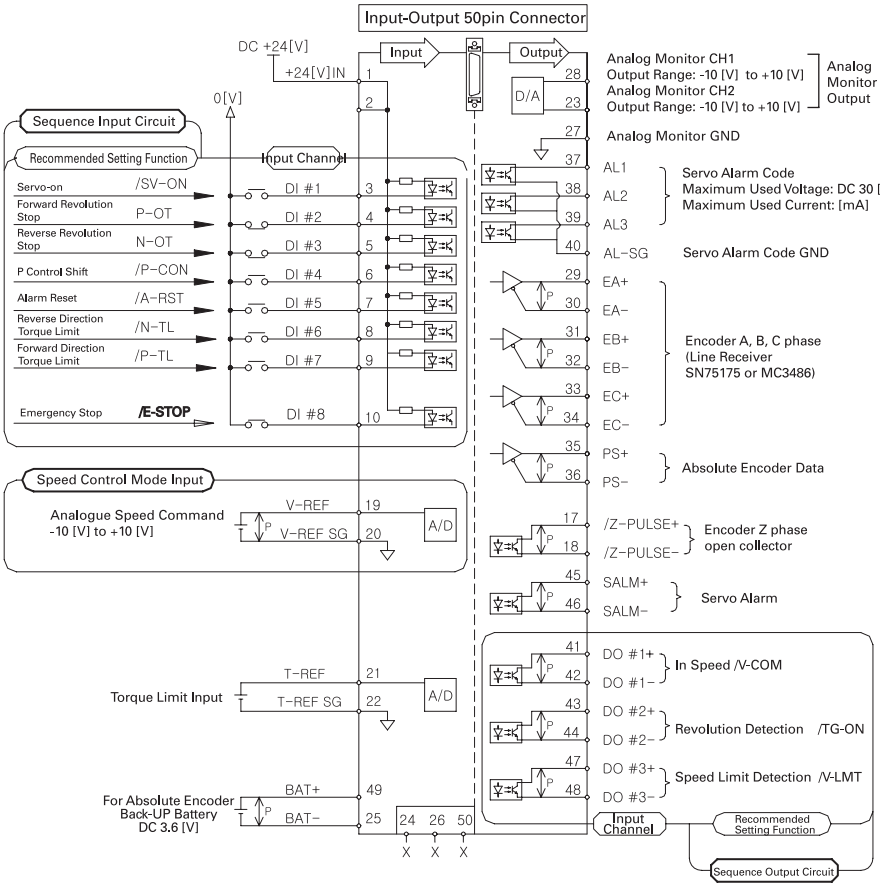
Speed control is used for the purpose of controlling speed by approving the speed command in the form of analog voltage from the controller to servo drive in both cases whether the position control loop is formed at the controller or not.

To carry out speed control, please follow the command below for set-up.



Speed Control Setting Sequence

Input and output signals can be set as needed in case they are required in configuring the system.



Speed Control Wiring

Speed Command

Set the speed command gain at SEt-01. The setting range is 10 to 6000 RPM/1V or RPM/10V. The default value is 500.

The unit setting of SEt-01 is set up on the second digit of SEt-46.

When the second digit of SEt-46 is 0

Speed Command (RPM) = Speed Gain (RPM/V) × Input Voltage (V) When the second digit of SEt-46 is 1

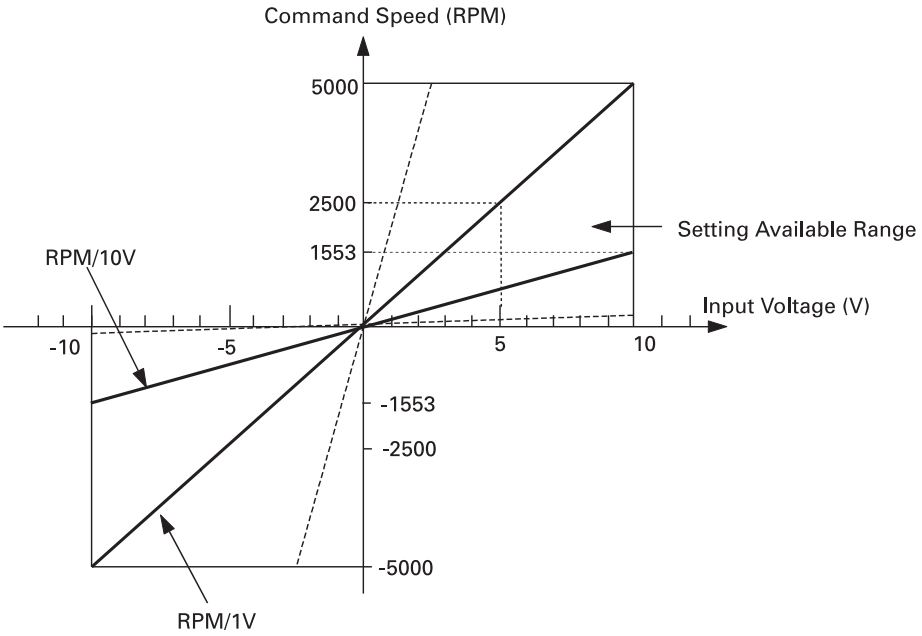
Speed Command (RPM) = Speed Gain (RPM/10V) × Input Voltage (V)

When the speed gain is 500 RPM/V and the input voltage is 6V, the motor revolves at the speed of 3000 RPM.

ATTENTION

The tolerated range of the input voltage is DC V. An error can occur if the input voltage is out of this range, and it cannot be recognized.

If torque command is higher than the preset maximum torque of the motor, a warning for excessive torque command (A.10 OSC) will occur.



Speed command gain determines the gradient of the graph.

The motor sometimes revolves in boths cases where the controller did not approve the speed command or it approved the speed command with 0V. This is because of the voltage offset between the controller and the drive.

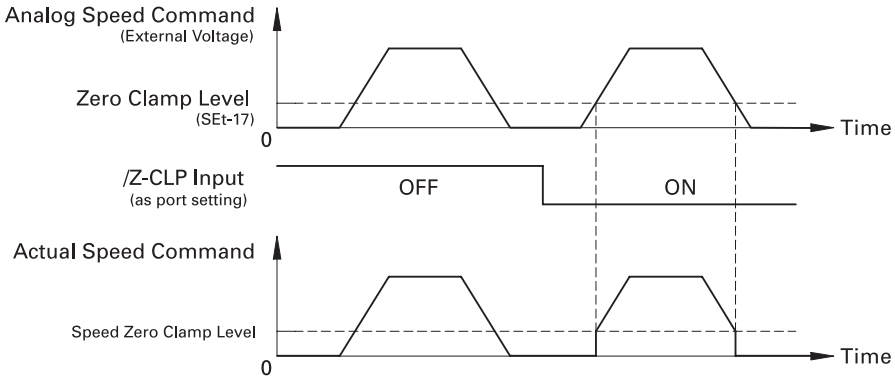
Zero Clamp

Even if the analog speed command of the controller is 0V at the speed command offset automatic adjustment, a little bit of offset voltage can exist at the servo drive input terminal, which may cause the motor to slowly rotate. In this case, using the zero clamp function can prevent the motor from revolving a small amount caused by the offset voltage.

To use zero clamp function, please set the control mode at 5. Once zero clamp input port is set, the zero clamp input terminal should be ON to activate it. If the port is not set, it will be automatically activated.

Please set the speed zero clamp level at SEt-17. The setting range is 0 to 5000 RPM and the default value is 0.

If the CN1 connector pins where the zero clamp function is allocated are ON, the voltage command below the level set at SEt-17 will be ignored. When the value of the speed command surpasses this level again, the motor will accelerate to the value of the command.

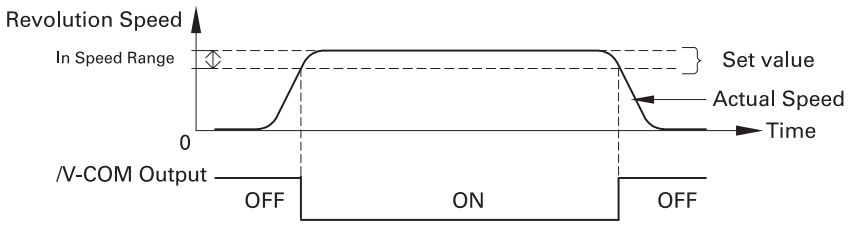


In Speed Function

/V-COM signal displays that the error between the motor revolution speed and the speed command value is kept within a certain range. This signal can be used as an interlock signal at the controller just as the position completion detection /P-COM signal at the position control mode can.

Please set the decision range for in speed match at SEt-18. The setting range is 0 to 1000 RPM and the default value is 10.

If the in speed is 100 and the speed command is 2000 RPM, /V-COM signal is ON and displayed when the actual revolution speed is 1900 RPM or higher and 2100 RPM or lower.

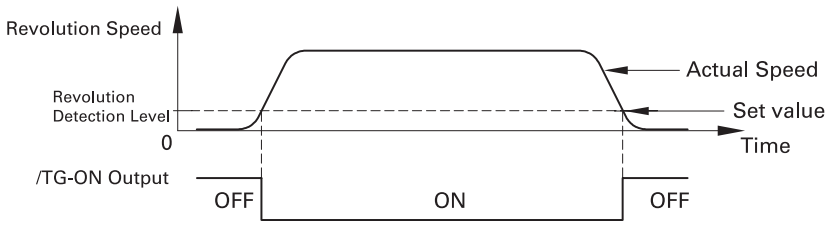


Revolution Detection

/TG-ON signal shows that the servo motor is revolving faster than a certain speed. This signal can be used as a condition to assess the status of the motor while changing the control mode from the combination control mode.

Please set the revolution detection level at SEt-16. The setting range is 1 to 5000 RPM and the default value is 20.

If the revolution detection level is set too low, a minute revolution can cause the /TG-ON signal to be displayed.



Speed Limit

To avoid excessive motions in the load, the servo motor can be used within a limited regular speed.

The speed limit is set by the user at SEt-67. Therefore, the servo drive operates under the preset limit even if the controller approves a speed command faster than the set value of the speed limit.

Please set the speed limit method at the third digit of SET-45.

The set values are as follows.

0: Motor Maximum Speed (default value)

1: SEt-67 Value (RPM)

2: Analog Speed command (Operates in all modes except the speed control mode)

3: The smaller value between the motor maximum speed and SEt-67

If setting value is bigger than the maximum speed of the motor, speed is limited to that maximum speed.

Please set the speed limit level at SEt-67.
The setting range is 1 to 5000 RPM and the default value is 5000.

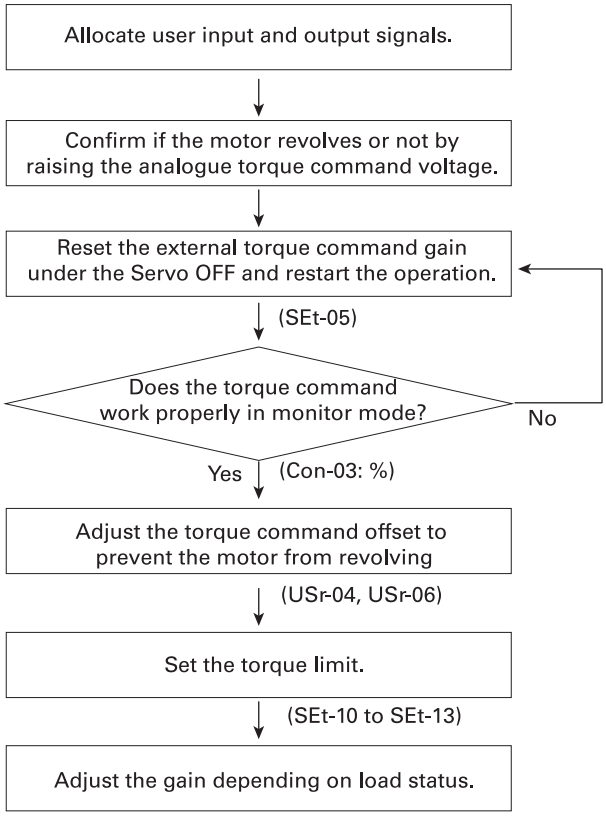
When the speed limit is set at 1000 RPM, even if the controller approves a speed command for 1500 RPM, the servo motor operates at the speed of 1000 RPM. In this case, the signal for speed limit detection /V-LMT can be allocated, so that the /V-LMT signal can be displayed when the motor speed is bound by the speed limit.

Torque Control

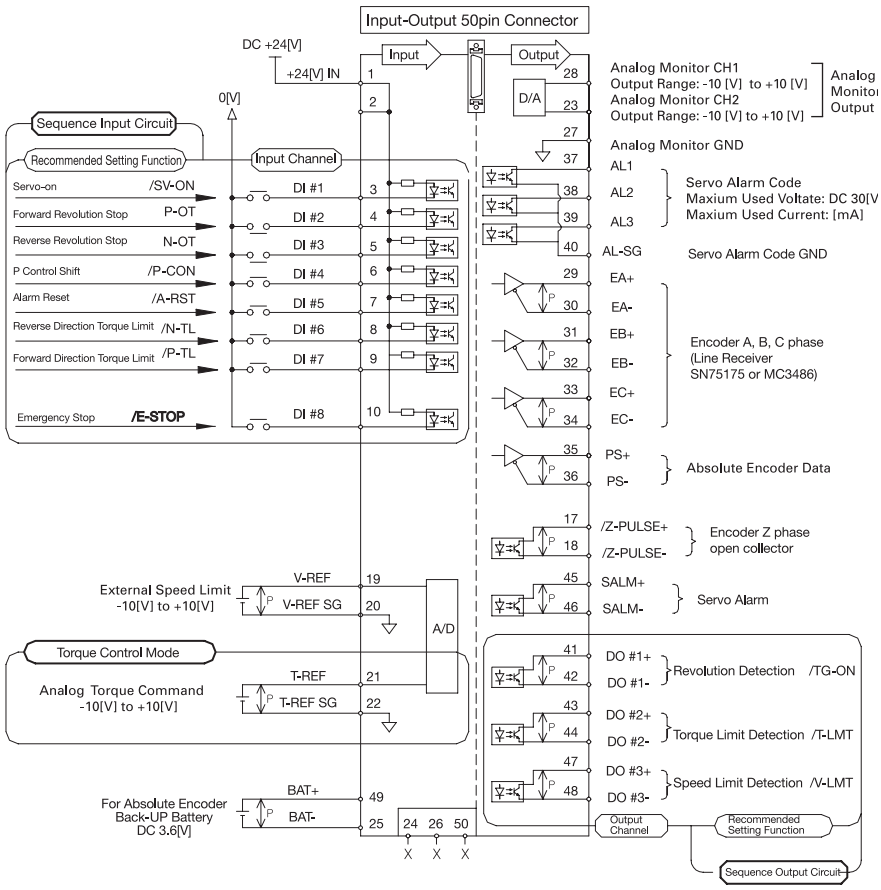
Torque control mode is used when the tension or pressure of the system should be controlled by using the servo drive.

Set the voltage appropriate for the required torque input from the controller. Various set-values for the motor's operating torque limit are commonly applicable to position or speed control mode.

To operate the servo drive in torque control mode, please connect analog torque command to corresponding input pins and follow the setting command.



Torque Control Setting Sequence



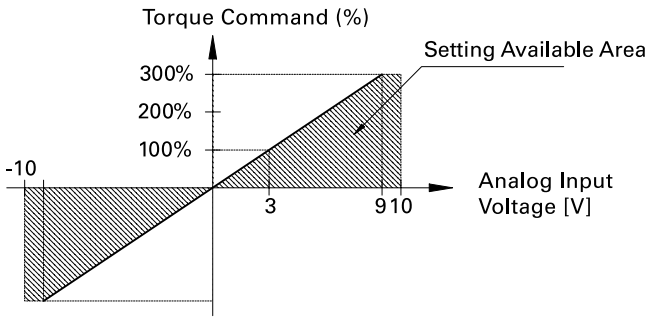
Torque Control Wiring

Torque Command

Please set torque command gain at SEt-05. The setting range is 0 to 100%/3V and the default value is 100.

Torque = (Torque Command Gain × Input Voltage × Rated Torque)/100

When torque command gain is 100%/3V and input voltage is 3V, 100% torque (rated torque) is generated.



If the torque command gain is 100%/3V and the input voltage is 9V, 300% torque, the maximum torque of the motor, will be generated.

ATTENTION

The maximum allowed voltage of the torque command input is DC ±10V.

If the standard voltage fluctuates, the torque command can also change together. Therefore, a power supply with high accuracy is needed.

If minute torque adjustment is required, please use a multi-revolution variable resistor which revolves over 10 times.

If the torque command is bigger than the preset maximum torque of the motor, an warning for excessive torque command (A.08 OtC) will be issued.

The motor sometimes revolves in both cases where the controller didn't approve a torque command at the offset automatic adjustment and where the controller approved the torque command with 0V. This is because of the voltage offset between the controller and the drive.

Torque Limit

The torque of the servo motor can be limited in either forward or reverse direction.

There are two methods to limit torque.

The first is internal limit. The internal limit is the limit of the drive itself by setting parameters regardless of external signals.

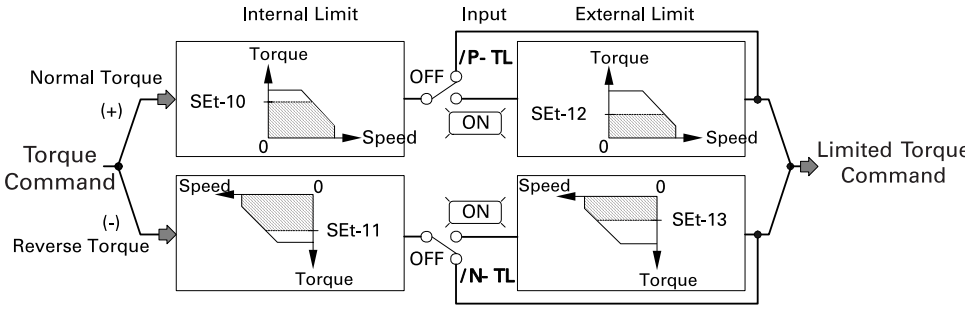
The second is external limit. The external limit is determined according to input signals.

Please set SEt-10 to limit the forward torque internally. The setting range is 0 to 300% and the default value is 300.

Please set SEt-11 to limit the reverse torque internally. The setting range is 0 to 300% and the default value is 300.

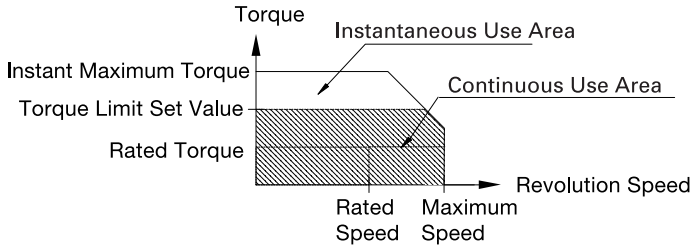
Please set SEt-12 to limit the forward torque externally. The setting range is 0 to 300% and the default value is 100.

Please set SEt-13 to limit the reverse torque externally. The setting range is 0 to 300% and the default value is 100.



/P-TL signal is used to externally limit the forward torque, and /N-TL signal is used to externally limit the reverse torque. These external torque limits have priority over internal torque limits. Internal limits are used to retrain the maximum value of the motor's operating torque (or output torque) within a fixed range so that the load system or operation targets can be protected.

Usual range of the motor's available torque is as follows.



Depending on the type of a motor, Instantaneous maximum torque can be 300% or less. If the torque limit is set higher than the maximum allowed torque of the motor, the limit will be set at the Instantaneous maximum torque of the motor and the preset limit will be ignored.

Please set SEt-14 and SEt-15 to limit the torque in case of an overtravel. Setting range 0 to 300%, 300.

Internal torque limit is always effective. Therefore, if the external torque limit and the torque limit to prohibit revolution are bigger than the preset value for limiting internal torque, the external torque limit and the torque limit to prohibit revolution become meaningless.

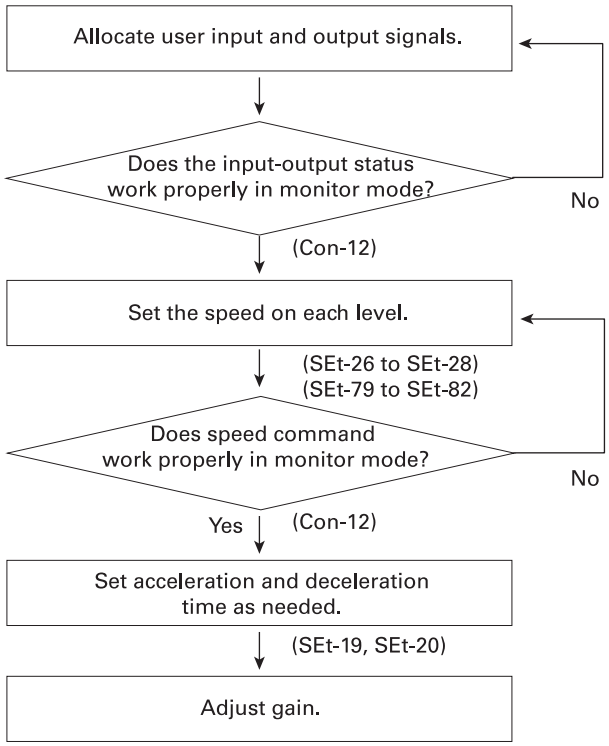
The status where torque is limited by the preset values can be displayed to the controller by using /T-LMT signal. If the motor's torque is the same as the preset torque limit, /T-LMT signal will be displayed.

If the third digit of SEt-44 is 0, the motor will stop by the torque set at SEt-14 and SEt-15, and if it is 1, the servo will be OFF.

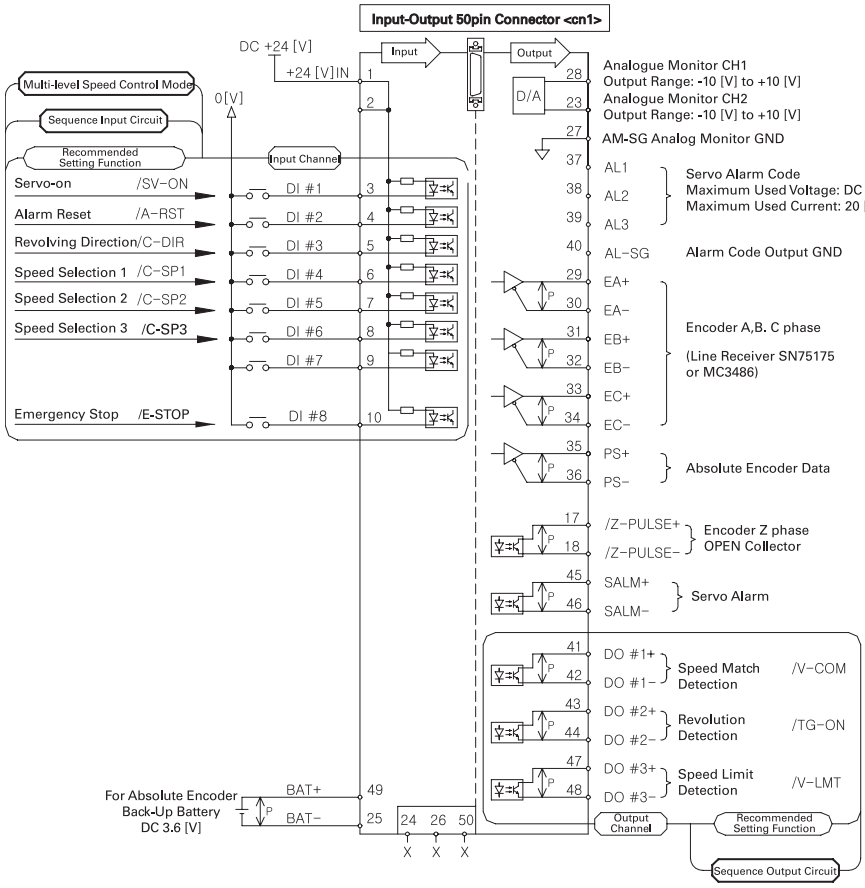
Multi-level Speed Control

Multi-level speed control is one of the ways to control speed. The operation speed is set in advance by the parameter setting, and the system is operated according to the input. Hence, speed command input or offset adjustment is unnecessary.

To operate the servo drive in the multi-level speed control mode, please follow the command below.



Multi-level Speed Control Set-up Sequence



Multi-level Speed Control Wiring

In the multi-level speed control mode, there is no external signal input pin for each control mode including position control, speed control, and torque control. The operation is carried out only by the external input signal. There are four different input signals dedicated to multi-level speed control.

- /C-DIR
- /C-SP1
- /C-SP2
- /C-SP3

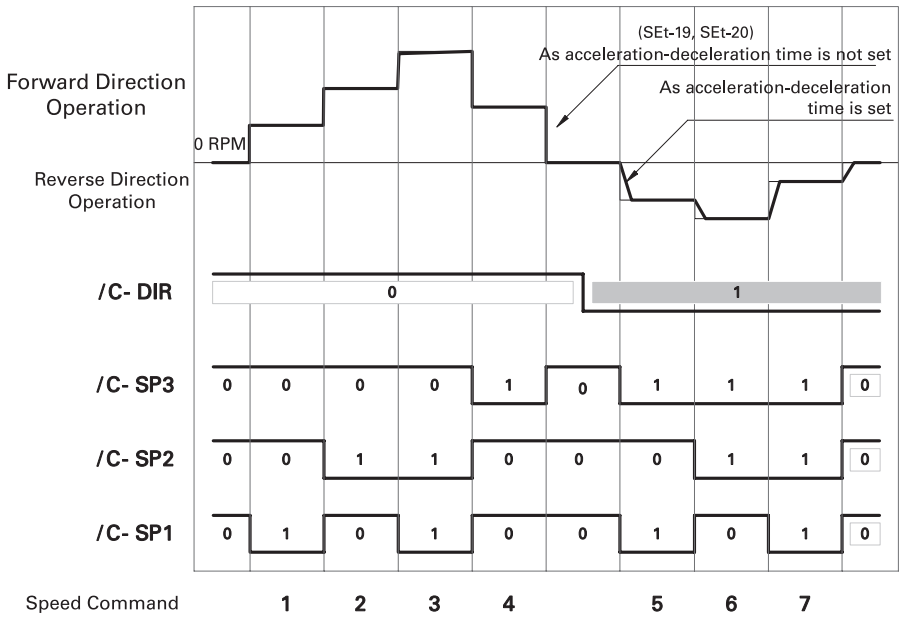
The revolution will be in the forward direction if /C-DIR signal is OFF and in the reverse direction if the signal is ON.

/C-SP1, /C-SP2, /C-SP3 signals can be combined in eight different ways for which revolution speed can be determined. The motor's revolving direction can be controlled separately by engaging /C-DIR input to each speed designated to each speed command.

Multi-level Speed

Speed	Parameter	Default value (RPM)	/C-SP3	/C-SP2	/C-SP1
Stop command		0	0	0	0
Internal Speed command 1	SEt-26	100	0	0	1
Internal Speed command 2	SEt-27	200	0	1	0
Internal Speed command 3	SEt-28	300	0	1	1
Internal Speed command 4	SEt-79	400	1	0	0
Internal Speed command 5	SEt-80	500	1	0	1
Internal Speed command 6	SEt-81	600	1	1	0
Internal Speed command 7	SEt-82	700	1	1	1

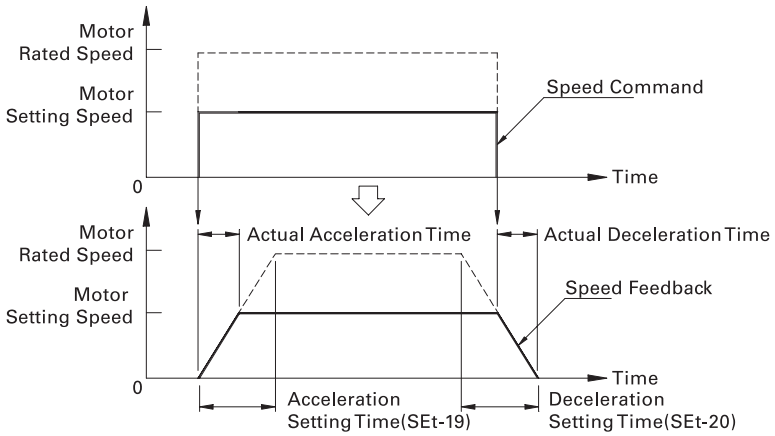
In the multilevel speed control mode, the motion of the motor changes according to the input signal.



Set the acceleration time and deceleration time within the range that won't undermine the response of the system in order to ease the impact of speed change.

Acceleration time is the time required for the motor to reach the rated speed from standstill.

Please set the acceleration time at SEt-19. The setting range is 0 to 60000 ms and the default value is 200.



The diagram shows that the time for execution compared to command was extended as much as the deceleration time.

Deceleration time is the time required for the motor to slow down to a halt from the rated speed.

Please set deceleration time at SEt-20. The setting range is 0 to 60000 ms and the default value is 200.

Combination Control

Position control, speed control, torque control, and multi-level speed control are the basic controls. Basic controls can be used in combination depending on the user's circumstances.

/C-SEL signal is used to shift control mode between the two modes that are combined. If the combination control mode is used, /C-SEL signal must be used.

Combination Control Mode List

Set-up (SEt-41)	Control Mode	/C-SEL OFF	/C-SEL ON
6	Torque + Speed Mode	Torque Mode	Speed Mode
7	Position + Torque Mode	Position Mode	Torque Mode
8	Position + Speed Mode	Position Mode	Speed Mode
13	Position + Multi-level Speed Mode	Position Mode	Multi-level Speed Mode
14	Speed + Multi-level Speed Mode	Speed Mode	Multi-level Speed Mode
15	Torque + Multi-level Speed Mode	Torque Mode	Multi-level Speed Mode

Please set the combination control mode at SEt-41

If the combination control mode is set at SEt-41 and /C-SEL signal is not allocated, a warning will be displayed as shown in the diagram.

When the system is in operation under one of the two control modes that are combined in the combination control mode, input for the other control mode will be ignored. For instance, when the system is in operation under the speed control mode, position command pulse or analog torque command will be ignored. The input for those command will be valid only when the control mode is changed by /C-SEL signal to the relevant control mode.

Caution is needed when changing the control mode under the combination control mode. In the case of changing the control mode just depending on /C-SEL signal, it can cause damage to load or unstability to servo drive in certain circumstance.

Combination control mode including position control is changed when the following conditions are met.

Control Mode Changing Condition

Control Mode (SEt-41)	/C-SEL OFF	/C-SEL ON
7	Torque Control → Position Control	Position Control → Torque Control
	Revolution Speed < SEt-16 set value or torque command < (10%* rated torque)	position command pulse input = 0 (position command_actual position) < SEt-18set value, continued for 16 ms
8	Speed Control → Position Control	Position Control → Speed Control
	Revolution Speed < SEt-16 set value	Position command pulse input = 0 (position command_actual position) < SEt-18set value, continued for 16 ms
13	Multi-level Speed Control → Position Control	Position Control → Multi-level Speed Control
	Revolution Speed < SEt16 set value	Position command pulse input = 0 (position command_actual position) < SEt-18set value, continued for 16 ms

5

Tuning By Gain Adjustment

Overview

Users need to adjust the servo drive depending on the status of the load in order to control different loads for the best performance. This is the gain adjustment. And tuning is making the motor connected to the drive perform its best through the gain adjustment.

Gains can be categorized as below.

- System Gain
- Basic Gain
- Applied Gain

System gain is changed according to the inertia of the system and is the same with the bandwidth of the servo drive's overall speed control loop. This gain can control the five basic gains at the same time.

- System Gain (SEt-42)

Basic gain is categorized in five items that are essential for tuning.

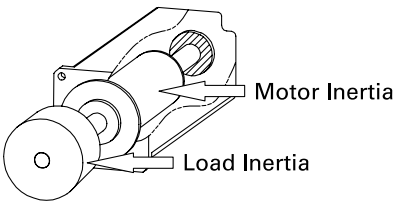
- Speed Loop Proportional Gain (Nms, SEt-02)
- Speed Loop Integral Gain (Nms^2, SEt-03)
- Position Loop Proportional Gain (rad/s, SEt-04)
- Torque Command Filter (rad/s, SEt-06)
- Speed Command Filter (rad/s, SEt-40)

Applied gains are categorized into four items with distinct functions.

- Position Command Filter (rad/s, SEt-35)
- Vibration Suppression Filter (Hz, SEt-47)
- Position Feedforward Gain (%, SEt-34)
- Position Feedforward Filter (rad/s, SEt-07)

And there are four parameter needed for tuning.

- P Control Shift Switch (SEt-54)
- P Control Shift Reference Value (SEt-55, SEt-56, SEt-57)
- Speed Bias Amount (RPM, SEt-38)
- Speed Bias Application Range (pulse, SEt-39)



In tuning, the inertia ratio should be considered first for the optimum performance of the servo drive system. The inertia ratio is the ratio of the inertia of the load to the that of the motor's rotor. If the rotor's inertia is 3 gf.cm.s^2 and the load's inertia is 30 gf.cm.s^2, the inertia ratio is 10.

Inertia Ratio = Inertia of the Load/Inertia of the Motor's Rotor

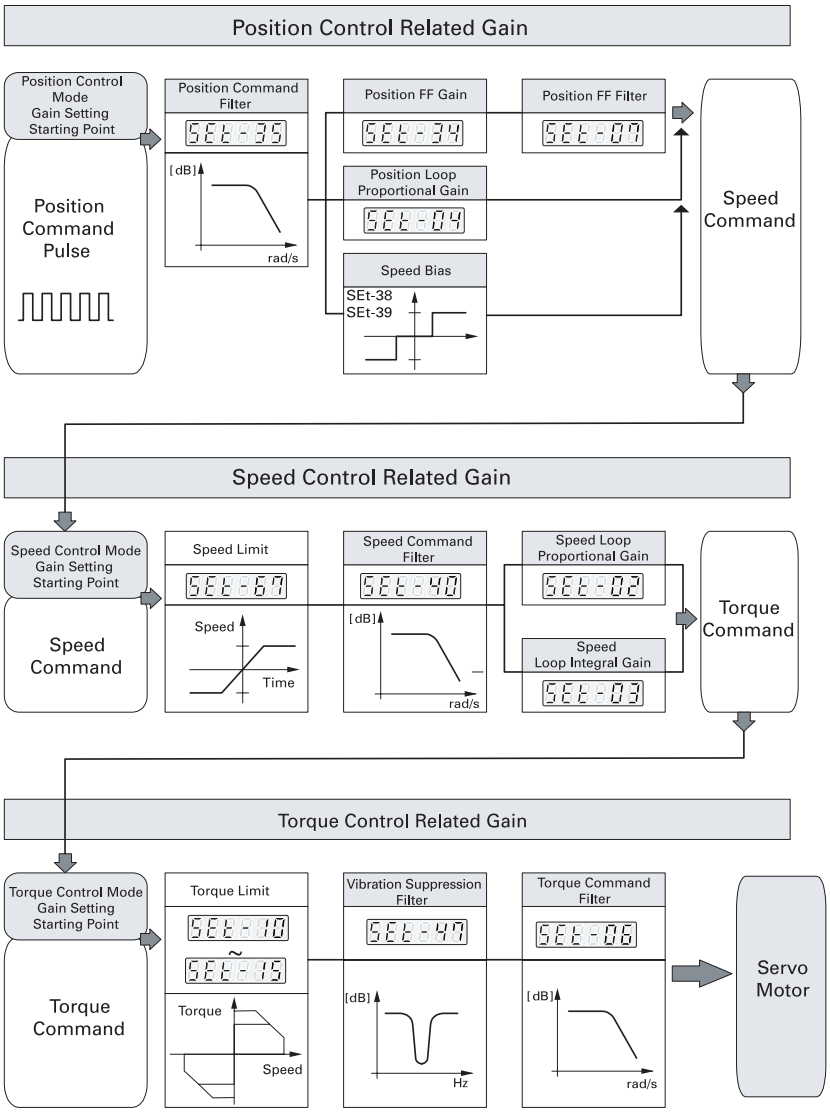
Please set inertia ratio at SEt-66. Setting range is 0 to 600 (0.1 times) and the default value is 30. The default value 30 indicates that the inertia ratio is 3.

ATTENTION

Once the inertia ratio is set, the servo drive adjusts basic gains according to the inertia ratio. Therefore, adjustment of the inertia ratio should be done carefully.

Set the system bandwidth.
If auto tuning or user changes the inertia ratio (SEt-66), it automatically set the system gain (SEt-42) and the basic gain based on this value.

The servo drive uses position command of the controller device to generate speed command, and the speed command generate torque command and transmit them to the servo motor. Thus all of the basic gains should be set properly in case of using position control mode. Even if the gains related to position control are appropriate, the best tuning cannot be carried out if the gains related to torque or speed are not properly set.



If position-related gains alone are adjusted when the response is not secured enough through setting the gains related to speed control, the system can be unstable. To improve the response of the overall position control system, please secure ample response of the speed control loop.

Gain Automatic Set-up

The servo drive has the following two functions to automatically detect the status of the load.

- Offline Auto Tuning
- Online Auto Tuning

Offline Auto Tuning

Offline Auto Tuning automatically detects inertia ratio, friction coefficient, and resonance frequency, and sets basic gains accordingly.

Please set SEt-69 as below according to the type of the system.

System Type	SEt-69
Low Rigidity (Belt)	20
Medium Stiffness	30
High Rigidity (Ball Screw)	45

The execution procedure of offline auto tuning is as below.

1. Offline autotuning (USr-02) is executed automatically.
2. Inertia ratio and system gain are automatically set.
3. 5 different basic gains are automatically set.
4. The response of drive will be improved.

The value set on the third digit of SEt-58 represents 100 RPM. For instance, if the set value is 8, it means 800 RPM.
Revolution speed can be set at offline auto tuning.

Inertia ratio (SEt-66) can be directly set by the user.

Online Auto Tuning

Online auto tuning is used when the load constantly changes during operation. It constantly changes the gain value according to the status of the load in order to maintain response of the system even if the status of the load changes.

In the following cases, offline auto tuning is better than online auto tuning.

- When the inertia ratio of the load changes minutely or rapidly during operation.
- When the inertia ratio of the load alternates between two values
- When a large torque is not generated during the operation because the acceleration or deceleration time is too long, or the maximum revolving speed limit or torque limit is set low.

Setting Tuning Coefficient on online

To use online auto tuning, set the coefficient at the fourth digit of SEt-58. Setting range is 0 to 9. If the fourth position is not 0, online auto tuning function will be used.
As the value is set higher, the system becomes more sensitive to load fluctuation.

ATTENTION

If the load fluctuates radiply, online auto tuning coefficient needs to be set high, but caution is needed because the system can be momentarily unstable in an environment where the load fluctuates excessively.

While online auto tuning is being used, please raise system gain (SEt-42) if the response of the control loop drops and lower it if the system makes noise or vibrates.

Gain Manual Set-up

To set up gains manually, please follow the command below.

1. Set the inertia ratio and system gain automatically executing offline auto tuning.

2. If the response of control loop is lowered, raise the system gain value. If the load system makes noise or vibrates, lower the set value until vibration or noise stops.

   If the load system is not composed of optimum combination by 1 and 2 above, adjust the gain minutely as 3, 4 and 5 hereunder.

3. Fine tune the value of each basic gain.
   (Speed loop proportional gain, Speed loop integral gain, Position loop proportional gain, Torque command Filter, Speed command Filter)

4. Fine tune the value of each applied gain.
   (Position command filter, Vibration suppression filter, Position feedforward gain, Position feedforward filter)

5. Set the four parameter required for tuning.
   (P control shift switch, P control shift reference value, Speed bias application range, Speed bias amount)

If the response drops after offline auto tuning, raise the system bandwidth (SEt-69) a little and run offline auto tuning again. Secure the maximum response by raising the system gain (Set-42) to the level before vibration or noise starts.

When the maximum response is secure while the inertia ratio (SEt-66) is set accurately and the load system has no vibration or noise, the system gain can be set as high as possible and becomes the bandwidth of the overall speed control loop.

If the system gain (SEt-42) is raised, the overall gains increase and the response improves. If this value is changed, the five basic gains change, and the inertia ratio is referred to in this process. If the value is set too high for the load condition, vibration or noise can be generated.

By setting SEt-42, basic gains are changed by referring to the inertia ratio (SEt-66). As the value is set higher, the response improves. But if the value is too high for the load condition, vibration or noise can be generated.

ATTENTION

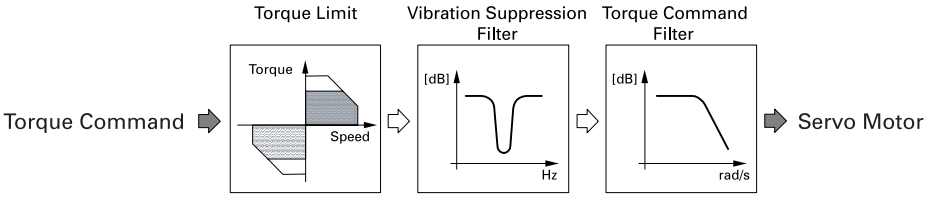
The value set last takes priority in the gain set-up. For instance, even after the speed loop proportional gain is changed by setting the system gain (SEt-42), if the speed loop proportional gain (SEt-02) is set again, this value is valid.

The function of the system bandwidth (SEt-69) is the same as the function of the system gain (SEt-42), but while the system gain changes according to the inertia ratio, the system bandwidth remains parameter even if the inertia ratio changes.

When the inertia ratio is changed by auto tuning or user, change the system and basic gain refering to SEt-69 and inertia ratio.

Torque Control Gain

Torque control gains include vibration suppression filter and torque command filter gain. The diagram below shows the application process of torque control-related gains.



Vibration suppression filter restrains the vibration caused by the load's resonance when the load system resonates in a certain frequency band. If properly set, it allows other gains to be raised, so that the stability and response of the overall system are improved greatly. But if it is set incorrectly, it can cause vibration or noise.

Set vibration suppression filter at SEt-47. The setting range is 0 to 10000 Hz, and the default value is 10000.

Torque command filter limits the high frequency element in the torque command. By limiting the high frequency element higher than the preset level, torque command itself can be softened to reduce vibration and noise.

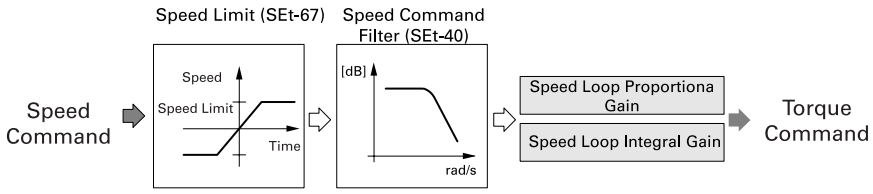
Please set torque command filter at SEt-06. The setting range is 0 to 60000 rad/s, and the default value is 1800.

As the value is higher, the response can improve. But if it is set too high, it can cause vibration. If the load is a belt or chain system, fast response is not expected because of the lowered stiffness.
If speed control or position control related gain is raised excessively when the value is set at lower torque command, it can oscillate. In the case of these loads, it is hard to set the torque command filter higher than 1000 rad/s. Please refer to the table below for set-up.

Load Type	SEt-06
Directly-coupled Disk	4000
Ball Screw Coupled directly	2000 to 3000
Belt	500 to 1000

Speed Control Gain

Speed control gains include speed loop proportional gain, speed loop integral gain, and speed command filter. The picture below shows the application process of the speed control-related gains.



Raising the speed loop proportional gain can improve the response of the speed control loop. Please set the value as high as possible within a range that won't cause vibration.

Speed loop integral gain can remove error at the steady state by responding to even very small input. Raising the speed loop integral gain can improve the response and reduce completion time. Please set it low in an environment where the inertia of the load is big or vibration can easily occur.

The speed command filter can limit the high frequency element in the speed command to soften the speed command itself. If its value is 0, speed command filter will not be used.

To set up the gains related to speed control, please follow the commands below.

1. Set the speed loop proportional gain at SEt-02. The setting range is 0 to 1500 Nms, and the default value is 80. Please raise the value as high as possible as long as it doesn't cause vibration or noise.

2. Set speed loop integral gain at SEt-03. The setting range is 0 to 20000 $Nms^2$and the default value is 200. Raise the value gradually while watching the responses in the excessive period such as overshoot, completion time, vibration or noise. If it is set too low, the response can drop. But if it is too high, vibration or noise can be generated.

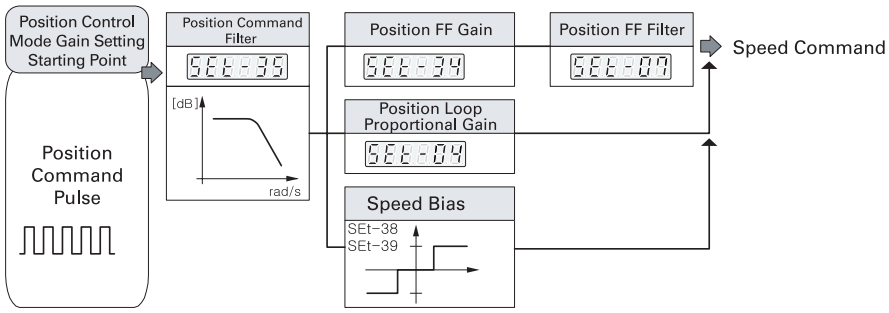
3. Please set speed command filter at SEt-40. The setting range is 0 to 4000 rad/s and the default value is 1000. Please lower the value in an environment where the position control-related gain of the higher control device is set too high or there is too much noise.

4. It is desirable to set the value of torque command filter (SEt-06) as high as possible as long as no vibration is generated from the load.

The values of the speed loop proportional gain and the speed loop integral gain are supposed to be scaled according to the inertia ratio. Therefore, if the load inertia ratios of a 100 W motor and a 1 KW motor are the same to be about 10 times, appropriate values of the speed loop integral gains are the same as well.

Position Control Gain

Position control gain includes feedforward gain, position feedforward filter, and position loop proportional gain.
The diagram below shows the application process of position control-related gains.



Position command filter can restrain the high frequency element in the position command to soften the position command itself. If its value is 0, position command filter will not be used.

Raising the value of position loop proportional gain improves the response of the position control.

To set up position control-related gains, please follow the commands below.

1. Set the default position loop proportional gain at SEt-04. The setting range is 0 to 500 rad/s and the default value is 60.

2. Slowly raise the value of speed loop proportional gain (SEt-02).

3. Lower the value of speed loop proportional gain to 80 to 90% if vibration or noise is generated from the load.

4. Raise the value of position loop proportion gain as high as possible in the transient period as long as no vibration or noise is generated.

5. Raise the value of speed loop integral gain (SEt-03) gradually while watching the responses in the transient period such as overshoot, completion time, vibration or noise. If it is set too low, the response can drop. But if it is too high, vibration or noise can be generated.

6. When necessary, the value of position command filter (SEt-35) can be lowered to restrain transient change of the position command.

7. It is desirable to set the value of torque command filter (SEt-06) as high as possible as long as no vibration is generated from the load.

Methods to Get Quick Responses

Position Feedforward Function

Position feedforward applies the differentiated element of the position command to speed command in the position control mode by way of feedforward. Consequently, transient response characteristics are improved and the position decision time is reduced.

Set the position feedforward gain at SEt-34. The setting range is 0 to 100% and the default value is 0. Setting the value high will improve the response of the position control.

Position feedforward filter restrains the high frequency element in the position command to soften the position command itself.

Set the feedforward filter at SEt-07. The setting range is 0 to 5000 rad/s and the default value is 0. If its value is 0, position feedforward filter will not be used. When the value of the torque command filter (SEt-06) is set high, if overshoot or excessive vibration occurs, please lower the value of the position feedforward filter.

When the position feedforward function is used, the speed command varies highly in response to the change of position command. Therefore, if the position command input fluctuates rapidly, in cases of rapid acceleration or deceleration, feedforward can cause overshoot. To reduce position command completion time in this case, raise the value of the torque command filter (SEt-06) slowly and locate the appropriate value. Or it may be desirable to restrain the high frequency element of the position feedforward by using the speed command filter (SEt-40) or soften the position command itself by using the position command filter (SEt-35).

ATTENTION Using online auto tuning and position feedforward function together can make the system unstable.

Speed Bias Function

In the position control mode, another way to reduce position completion time is to apply bias to speed command according to position error. When this function is used, position error can be reduced quickly as faster speed command is issued to reduce error at the area with large position error. This has the same effect as a relatively higher position proportional gain is applied to an area with large position error, and by doing so, the position completion time near the steady state can be reduced.

Please set the speed bias amount at SEt-38. The setting range is 0 to 450 RPM and the default value is 0. If the position error is bigger than the preset value of the speed bias application range (SEt-39), a faster speed command that includes the value of the speed command set here will be issued.

Please set the speed bias application range at SEt-39. The setting range is 0 to 250 pulse and the default value is 10. When the position error is bigger than the value set here, the speed bias amount (SEt-38) will be added to the speed command.

If the absolute value of position error is bigger than the preset value of the speed bias application range, the speed command equal to the preset value of the speed bias amount will be added to the position control output. Please adjust the speed bias amount and the speed bias application range alternately while watching transient response. If the speed bias amount is set too high or the speed bias application range is set too low, vibration can occur.

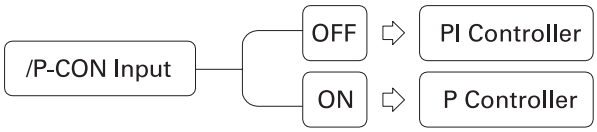
P/PI Mode Set-up Function

By setting the speed loop integral gain (SEt-03) in the speed control or position control mode, the system will be able to respond to subtle changes of the command and can be controlled accurately and the error at the steady state can be 0. If the speed loop integral gain is set too high in order to increase the response, overshoot may occur with the speed response in the transient status, which would increase position completion time. Therefore, position completion time can be reduced by setting the integral gain to 0 for an instant to restrain overshoot when necessary. In this case, the speed control loop is used in the form of a P controller after changing it from a PI controller.

There are two ways to use the speed control loop by changing it from PI controller type to P controller type.

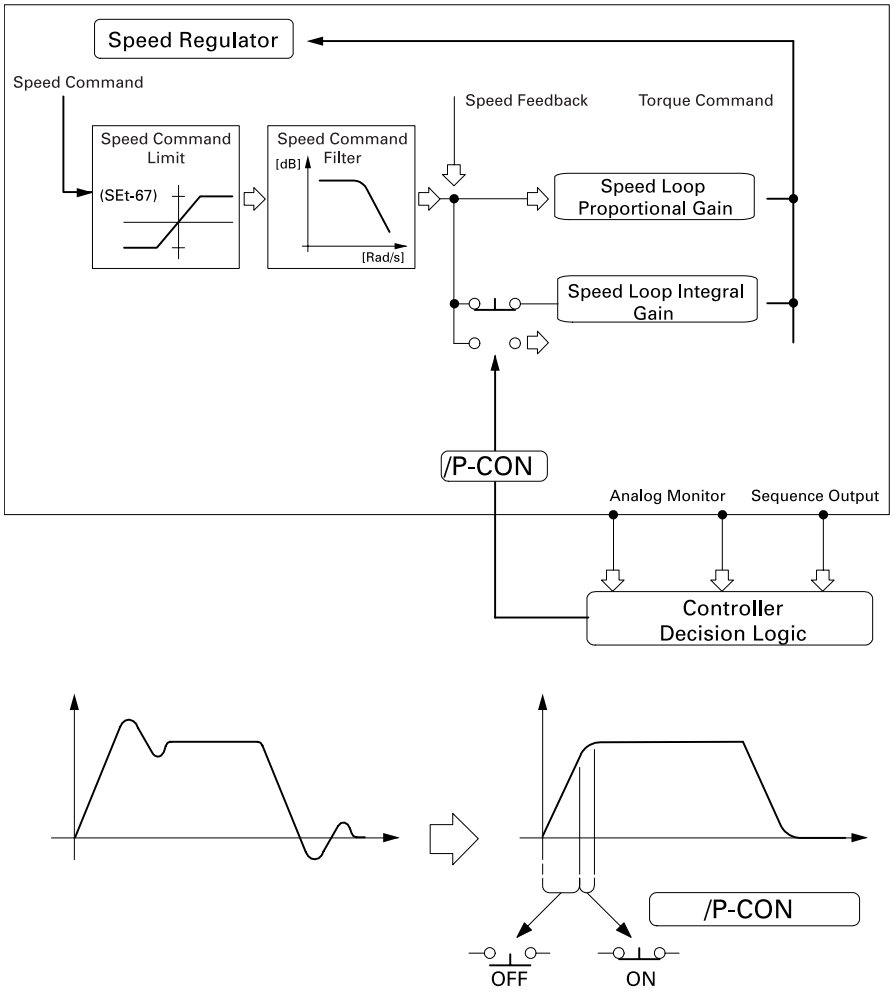
- Input P Control Shift Control by /P-CON Signal.
- P/PI Mode Shift by Parameter Set-up.

The type of the speed controller is determined in the following way according to the input channel signal after /P-CON. Signal is allocated to the input channel.



Therefore, at the controller, a program to shift the speed controller from PI controller type to P controller type can be made by assessing the analogue output such as the speed of the servo drive and torque and the output like /P-COM, /V-COM, /TG-ON.

Description on Second Digit of SEt-54



ATTENTION

If overshoot is small, do not use the control by the /P-CON signal.

When a small amount of offset is included in the speed command on the speed control mode, using the P controller type can cause the motor to not react to the offset set at 0 speed command and remain still.

P/PI mode shift function by the parameter set-up can be used in the following cases.

- When the internal torque command is bigger than a certain value (%)
- When the speed command is bigger than a certain value (RPM)
- When the position error is bigger than a certain value (pulse)

Set the P control shift switch at the first digit of SEt-54. The set-up can be done as shown in the table below.

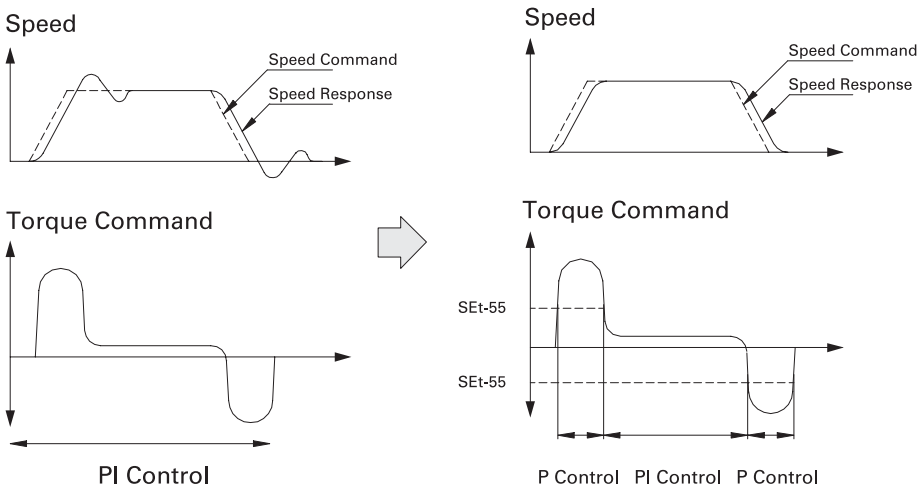
Set Value	Function
0	Do not use P/PI mode shift.
1	Shifts when the torque command is bigger than P control shift reference value (%).
2	Shifts when the speed command is bigger than P control shift reference value (RPM).
3	Shifts when the position error is bigger than P control shift reference (pulse).

Please set the P control shift reference for a torque command at SEt-55. The setting range is 0 to 300% and the default value is 100.

Please set the P control shift reference for a speed command at SEt-56. The setting range is 0 to 3000 RPM and the default value is 100.

Please set the P control shift reference for a position error at SEt-57. The setting range is 0 to 10000 pulse and the default value is 100.

The picture below shows the speed response when the speed regulator is changed from PI to P by torque command in the transient response status.
In the transient status of acceleration area or deceleration area, if the torque command is bigger than the P/PI mode shift reference, the speed regulator will be P type and PI controller type in other areas.



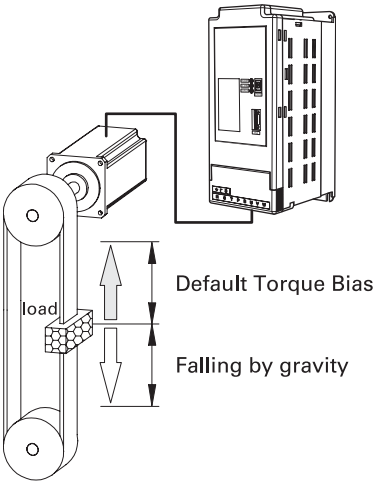
ATTENTION

/P-CON signal will be shifted prior to P control shift switch and the reference set-up. In other words, regardless of the current motor status and the set-up of these values, the speed regulator will be P controller type if /P-CON signal is ON.

To reduce the position completion time or overshoot of the speed response by using this function, P control shift switch and the reference should be set up properly. Please closely watch transient responses of speed, torque, and position for optimum set-up.

Default Torque Bias

Default torque bias prevents a fall due to gravity of the vertical load during the initial operation.



When the load is vertical and the servo ON signal is applied to activate the motor, the load can fall because of gravity. And when the servo ON, servo OFF signals are applied, the motor brake should be applied or released. If the timing is not properly adjusted, the load can fall momentarily, causing vibration in the machine. This characteristics of the vertical load causes overshoot and postpones position completion. Moreover, the servo alarm can go off as the system tries to activate the motor while the brake is applied.

Default torque bias is used to prevent the load from falling by gravity during the process of controlling the vertical load. The default torque equal to the falling load is applied to the motor in a reverse direction of the falling motion when the servo ON signal is applied. If default torque bias is properly set according to the falling force of the load, the falling of the vertical load can be prevented in the early stage of the operation.

By adjusting torque command offset (SEt-64 and SEt-65), revolution of the motor can be prevented.

ATTENTION

In case of controlling a vertical load, please use brake motor or install braking device to use the motor.

The set-up sequence of the default torque bias is as follows.

1. Check the revolving direction of the motor and the movement direction of the load.

2. Stop the load at a certain position by using 0 speed control or normal position control.

3. Check the torque command value while maintaining the system at a halt and set the value at SEt-64 if it is in the forward direction and at SEt-65 if it is in the reverse direction.

4. Fine tune the values with the current set values as standard while watching the torque of the motor, speed, and position response.

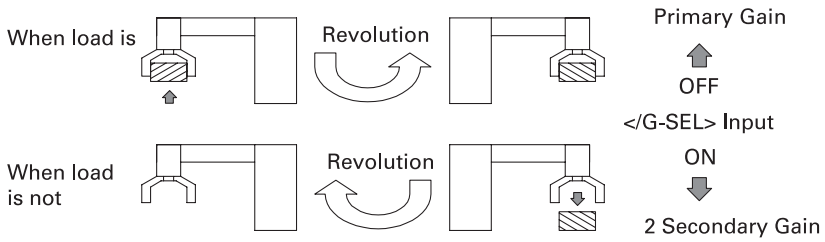
If the default torque bias is fixed at a certain value but not 0, the control begins at the moment of the servo ON and the value of the torque command begins from the set value of the parameter. Since the torque to maintain the motor at the current status is generated from the beginning, the temporary fall of the load can be prevented. Therefore, overshoot of the speed response can be restrained, and consequently the position completion time can be reduced.

ATTENTION

If the default torque bias is set too high, the load can temporarily rise at the moment of the servo ON.

Gain Alternation

In some cases, the load alternates between the two different statuses. For instance, a robot repeats a motion to lift up an object, carry it somewhere, leave it there and come back to the original position at no load status. If this kind of motion is repeated very quickly, online auto tuning cannot be done smoothly. And if the same gains are used to operate different load conditions, the response drops in a one-load situation. In this case, /G-SEL signal is helpful.



If all the different load conditions are categorized into two, the primary gains and the secondary gains, the response of different load conditions can be satisfied.

/To use /G-SEL signal, please set the optimum gain under the no-load condition. And then set the optimum gain in a situation with a load. And then let the /G-SEL signal be input in both conditions where a load exists or not.

ATTENTION

When the gain alternation function is used, online auto tuning cannot be carried out.

Application

Motor Stop

The servo drive aborts the operation and stops the motor under the following circumstances except for the case where the motor is stopped by normal operation.

- Servo Alarm Occurs
- Overtravel Occurs

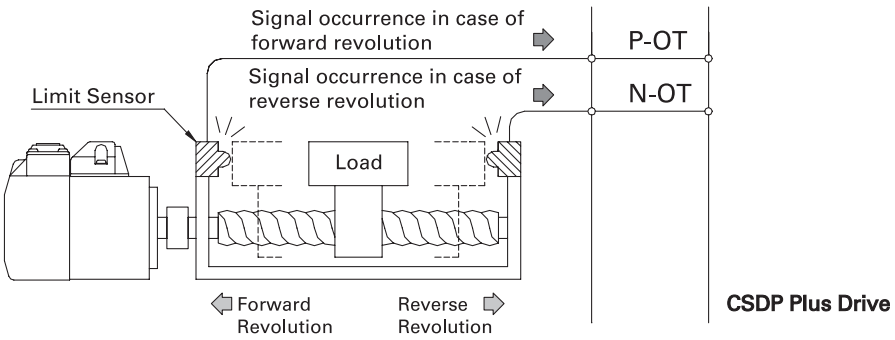
The methods to stop the motor can be set up depending on the reasons for the stoppage.

- Stop by dynamic brake
- Control stop as in normal operation

Overtravel

If the load moves out of the movement range during operation, the load system can be damaged. The breakage of the load system can be prevented by installing limit sensors at the end of the movement range.

Please make sure the load can move within the range that won't touch the sensors during operation. If the load moves out of the movement range and the sensor generates a signal because of an unknown error, the servo drive can stop the motor and protect the load system. The signal emitted from the limit sensors while the motor revolves in the forward direction is the P-OT signal, and is the N-OT signal while the motor revolves in the reverse direction.



The overtravel signal is not the servo alarm but a signal to protect the load system.

Please set the motor stop method in case of an overtravel on the third digit of SEt-44.

Overtravel Stop method

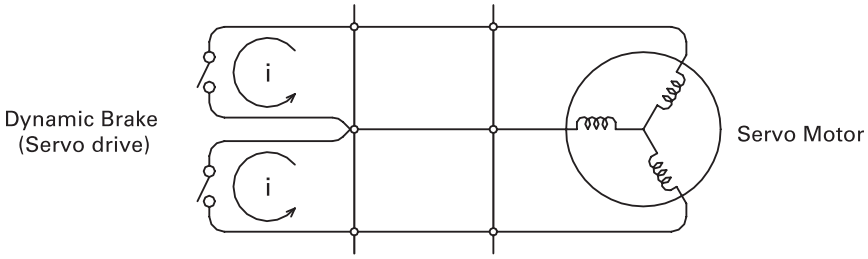
Set Value	Function
0	Stop the motor while controlling torque normally.
1	Servo OFF.

Dynamic Brake

If a motor shaft is revolved manually after short-circuiting all the motor cables (U, V, W) of the servo motor, the revolving load is bigger than when the cables are not short-circuited. The drive uses this feature to stop the motor. When the servo drive uses this feature to stop the motor, it is called dynamic brake.

CSDP Plus servo drive has internal dynamic brake circuit.

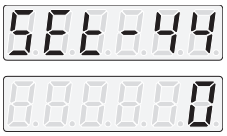
If the motor cable is connected to the servo drive and the servo drive is not enabled, the switch in the diagram below is short-circuited. This means dynamic brake is working. And the servo drive can activate dynamic brake by controlling the switch of dynamic brake according to the parameter setting.



ATTENTION

Dynamic brake cannot be used with the motor stop method which uses normal torque control.

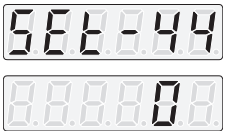
When the motor needs to stop during operation, if the dynamic brake stopped the motor, it is called dynamic brake stop. On the contrary, if the friction of the load stopped the motor by itself, it is called Free Run stop.



Please set the stop method of dynamic brake on the first digit of SEt-44.

Dynamic Brake Stop Method

Set Value	Function
0	Stops by dynamic brake.
1	Stops by free run.



Please determine whether to maintain the dynamic brake function after the motor has stopped on the second digit of SEt-44.

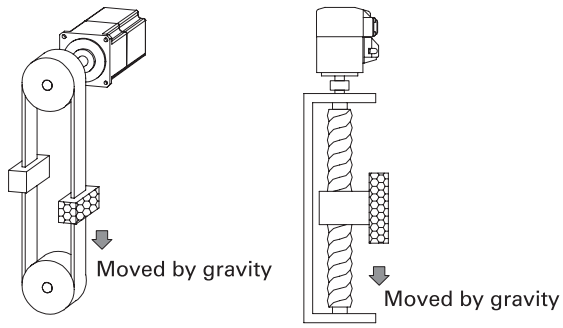
Dynamic Brake Function After Stoppage

Set Value	Function
0	Maintains the dynamic brake function after the dynamic brake stoppage
1	Releases the dynamic brake function after the dynamic brake stoppage

Motor Brake

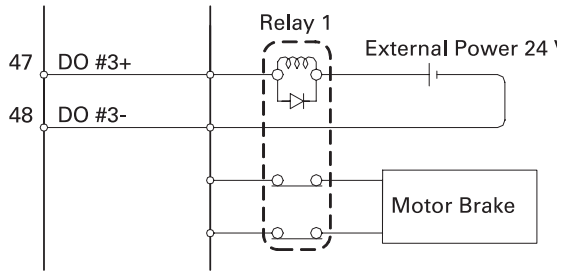
If a mechanical brake is mounted on the motor, it can be used in the following cases.

- When the load can move by gravity
- When the load should be kept from falling in case of power OFF or servo off.



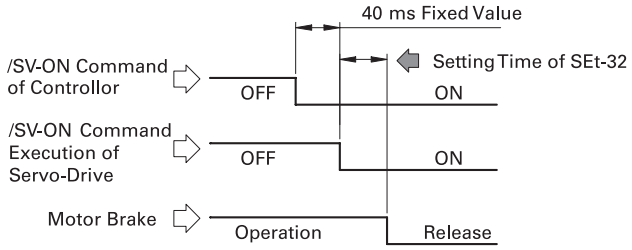
The drive cannot use voltage and current high enough to control the motor brake directly. Therefore, the motor brake cannot be directly connected to the drive. It can be controlled indirectly by building an external circuit through a relay.

The external circuit to control the motor brake is built as shown below.



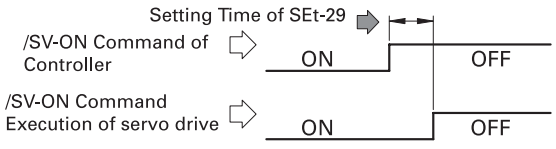
Please set the waiting time for brake release at SEt-32. The setting range is 0 to 10000 10 ms and the default value is 0.

If the motor brake is working at the moment when the drive activates the motor, it should be released first. In this case, if the brake is released before the servo is ON, the vertical load will drop for a moment. Therefore, the servo should be ON first so that the drive can control the vertical load so that it won't fall, and then the brake should be released. This configuration is to secure the time for the servo drive to release the motor brake from the moment the servo is ON.



Brake Inactive delay Time

Please set the servo OFF delay time at SEt-29. The setting range is 0 to 1000 [10 ms] and the default value is 0. This configuration is used to secure the time before the drive activates the motor brake after the controller delivered the servo OFF command.

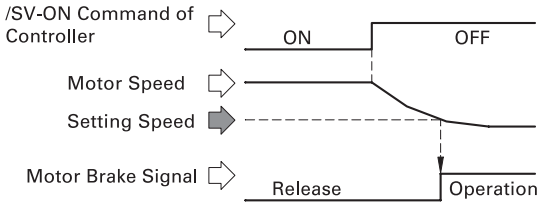


Servo Off Delay Time

Please set the brake output waiting time at SEt-31. The setting range is 0 to 1000 [10 ms] and the default value is 50. This configuration is used for the time for the motor brake to start working after the controller delivered the servo OFF command.

Brake Active Relay Time

Please set the brake output start speed at SEt-30. The setting range is 0 to 1000 RPM and the default value is 100.

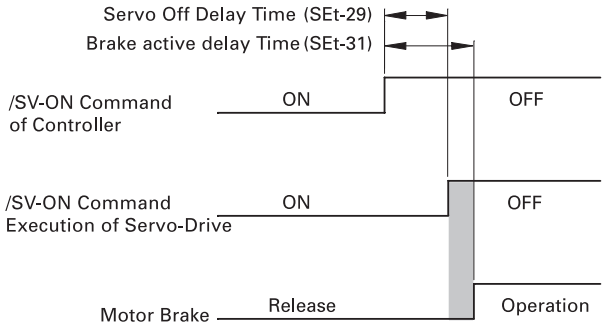


Braking Application Speed

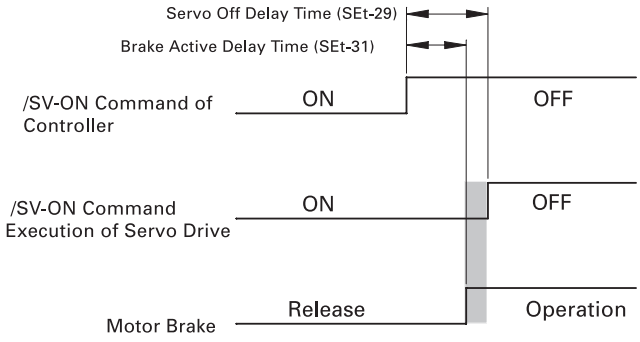
ATTENTION

The brake mounted on the motor cannot be used to stop the revolving motor. Please use it right before the stop or use it to keep the stopped motor at a standstill.

If the brake active delay time is longer than the servo OFF delay time, the brake works after the servo OFF is completed as shown below. Then the vertial load is bound to fall for a moment by gravity.



On the contrary, if the servo OFF delay time is longer than the brake active delay time, the brake on the motor starts working before the servo OFF is completed as shown below, preventing the fall of the vertical load.



Motor Revolving Direction

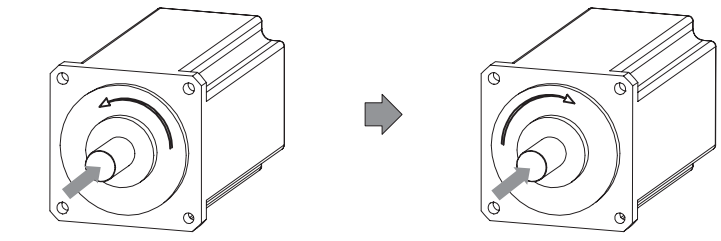
As for the controller and its wiring, even if the revolving direction of the motor determined by pulse input is wired in a different way from the user's intention, the revolving direction can be reversed by the parameter set-up with no need to modify the wiring.

Please set the motor's revolving direction at the fourth position of SEt-45.

Motor's Revolving Direction

Set Value	Function
0	Revolves in the forward direction.
1	Revolves in the reverse direction.

Forward direction is counterclockwise when the motor is looked at from the front. The reverse direction is clockwise when the motor is looked at from the front.



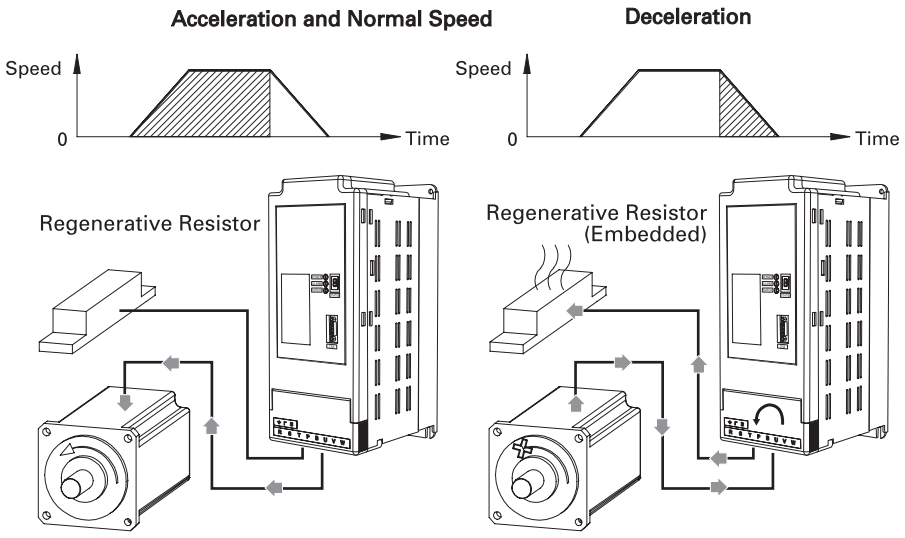
Forward Revolution Motion Reverse Revolution Motion

In the jog operation mode, the motor's revolving direction and the key button switch are fixed to each other. Therefore, this function cannot be used for jog operation.

Regenerative Resistor

When the operating motor is stopped, the motor works like the generator, which produces energy, regenerative energy.

The servo drive absorbs to some extent the regenerative energy produced while the motor stops. But if the amount of the regenerative energy exceeds the existing capacity, an additional device to consume the energy is required. If excessive regenerative energy overstrains the servo drive, it can cause damage to the system. To prevent this, the servo drive has its own internal protective circuit.



Regenerative Resistor

Regenerative energy is produced in the following cases.

- During deceleration.
- When the force of the load revolves the motor continuously. For instance, minus load condition or when the vertical load is operated.

Under the condition of minus load where load revolves servo motor with gravity and vertical load where continuing regenerative energy occurs excessively, excessive regenerative energy can occur. If regenerative energy is consumed, however, internal regenerative resistor is available without any measures.

Regenerative Resistor Specifications

Servo drive	Capacitor	Internal Regenerative Resistor
CSDP-15BX2	2010 μF	50Ω, 125 W
CSDP-20BX2	2010 μF	25Ω, 125 W
CSDP-30BX2	2010 μF	25Ω, 250 W
CSDP-40BX2	2800 μF	25Ω, 250 W
CSDP-50BX2	3900 μF	25Ω, 250 W

Allowed Inertia Ratio (Based on the 50% usage rate of the regenerative resistor)

	1.2kW	1.3kW	1.5kW	2kW	2.5kW	3kW	3.5kW	4kW	4.5kW	5kW	6kW
CSMD			8.0	5.0	6.0	5.0	3.0	3.0	2.0	1.5	
CSMS			16.0	11.0	9.0	8.0	7.0	4.0	4.0	3.0	
CSMF			6.0		2.0		2.0		1.0		
CSMH			2.0	1.0		0.5		0.3		0.0	
CSMK	13.0			10.0		6.0			7.0		5.0
RSMD			8.0	5.0	6.0	5.0	3.0	3.0	2.0	1.5	
RSMF			6.0		2.0		2.0		1.0		
RSMH			2.0	1.0		0.5		0.3		0.0	
RSMK	13.0			10.0		6.0			7.0		5.0
RSMX		5.0		3.0		1.0			1.0		
RSMN	8.0			4.5		2.0					
RSML	6.0			3.0		2.0			2.0		1.5

Allowed inertia ratio application condition

Setting acceleration time	200 ms
1cycle	2 sec.
Operation Speed	Rated Speed

A regenerative resistor that users connect to the outside according to the load is called the external regenerative resistor. The rated power of the regenerative resistor consumes the regenerative energy produced from the load system. If the produced energy is small enough, users can set up the external regenerative resistor and increase the rated power of the regenerative resistor, so that the regenerative energy produced from the load system can be consumed.

There are two ways to increase the allowed power of the regenerative resistor. The first is connecting the internal regenerative resistor and the external resistor in parallel, and the second is mounting an extra external regenerative resistor after removing the internal regenerative resistor.

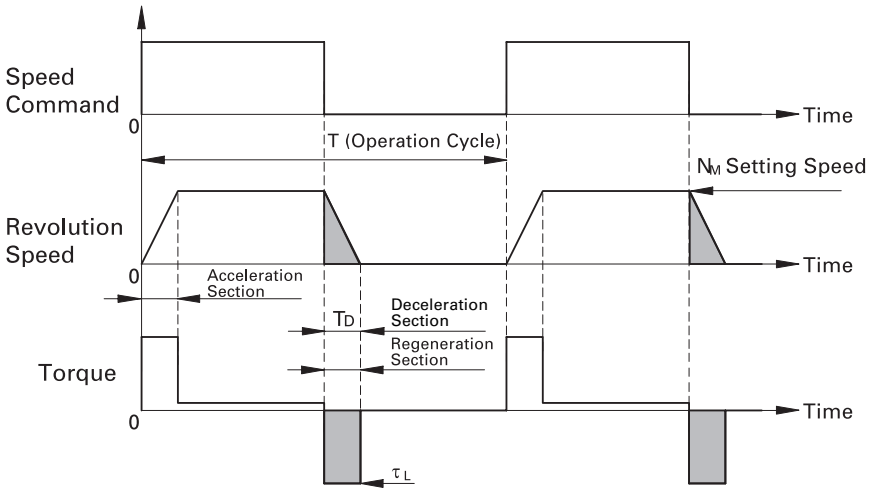
ATTENTION

In case of increasing the rated power of regenerative resistor, set the minimum resistor value according to capacity. (15Ω to 25Ω)

ATTENTION

The temperature of a resistance for the regenerative resistor can rise over 200° C under the rated load condition. Because without an extra cooling fan, the temperature of the regenerative resistor can go up excessively, please use 20% or less of the rated power of the regenerative resistor.

This picture shows the case where a motor repeats acceleration and deceleration on the horizontal basis with a fixed cycle.



$$\text{Number of Repetition} = \frac{1}{T} \times 60 \text{ cycles/min}$$

If the number of the motor's actual repetition is more than the allowed number of repetitions, please follow the command below.

- Lower the preset speed as much as possible.
- Set the deceleration time as long as possible.
- Limit the torque as much as possible.
- Make the inertia of the load system smaller.

The regenerative resistor should be selected among those that meet the specifications of the user's load system. As another way to select the regenerative resistor, calculating the rated power of the necessary regenerative resistor can help the user choose the optimum regenerative resistor for the load system.

The formula to get the rated power W_K of the regenerative resistor is as follows.

$$W_K = \frac{E_K}{0.2 \times T}$$

T stands for the operation cycle and 2means the 20% of the rated power.

The energy consumed by the regenerative resistor E_K can be calculated by the following formula.

$$E_K = E_M - (E_L + E_R + E_C)$$

E_M = Revolving energy of the servo motor

E_L = Energy consumed by the load in the deceleration section

E_R = Heat loss energy consumed by the coil resistance of the motor

E_C = Energy that can be absorbed by the servo drive

The revolving energy of the servo motor E_M can be calculated by the following formula.

$$E_M = \frac{J_M \times (1+n) \times N_M^2}{182}$$

N_M = Set Speed
J_M = Motor Inertia
n = Inertia Ratio

The energy consumed by the load in the deceleration section E_L can be calculated by the following formula.

$$E_L = \frac{\pi}{60}(N_M \times \tau_L \times T_D)$$

T_L = Motor Torque
T_D = Deceleration Time

If the energy consumed by the load is unknown, then calculate with E_L=0.

The heat loss energy consumed by the coil resistance of the motor E_R can be calculated as shown in the formula below.

$$E_R = \frac{3}{2} \times R_a \times \left(\frac{\tau_L}{K_T}\right)^2 \times T_D$$

R_a = Phase Resistance
K_T = Torque Parameter

ATTENTION

Please make sure the rated power of the regenerative resistor is calculated accurately. If the calculated rated power of the regenerative resistor is bigger than the rated power of the internal regenerative resistor, please remove the existing resistor and set up an external regenerative resistor.

The units used in the aforementioned formula are as follows.

Units used in the formula for the regenerative resistor

Item	Unit
Energy	E = Joules = kgm^2/s^2
Torque	τ = Nm
Inertia	J = kgm^2
Time	T = s = 1/60 Min
Speed	N = RPM = 60/2 π rad/s
Torque Constant	K_T = Nm/A

The regenerative energy produced when continuous regeneration sections occurred under the vertical load condition are called E_G and the selection standard of the regenerative resistor can be calculated as shown below.

$$E_K = E_M - (E_L + E_R + E_C) + E_G$$

E_M = Revolving energy of the servo motor

E_L = Energy consumed by the load in the deceleration section

E_R = Heat loss energy consumed by the coil resistance of the motor

E_C = Energy that can be absorbed by the servo drive

Regenerative energy produced in the continuous regeneration sections E_G can be calculated as shown below.

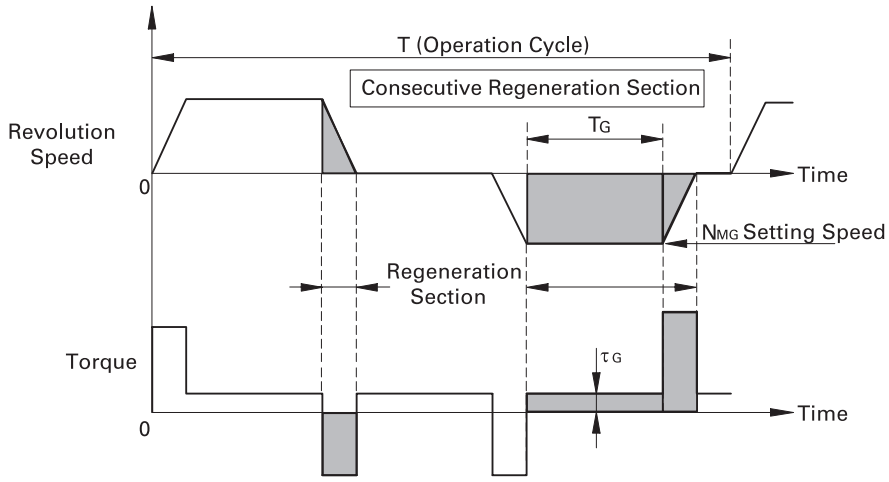
$$E_G = \frac{2\pi}{60}(N_{MG} \times \tau_G \times T_G)$$

N_{MG} = Preset speed in the continuous regeneration sections

τ_G = Torque in the continuous regeneration sections

T_G = Operation time in the continuous regeneration sections

This diagram shows the case where the motor repeats acceleration and deceleration on the vertical axis with a fixed cycle.

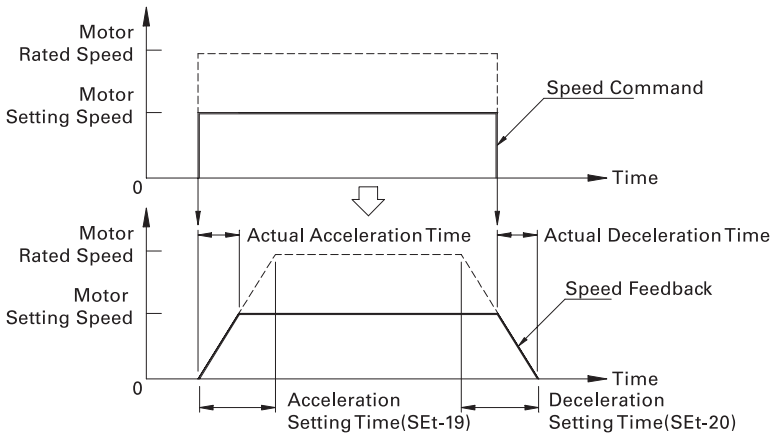


Set-up for Smooth Operation

By setting the acceleration/deceleration time and S operation time at the servo drive, the system can operate more smoothly by easing the possible impact from acceleration or deceleration.

Acceleration time is the time required for the motor to reach the rated speed from standstill.

Deceleration Time is the time required for the motor to slow down to a halt from the rated speed.

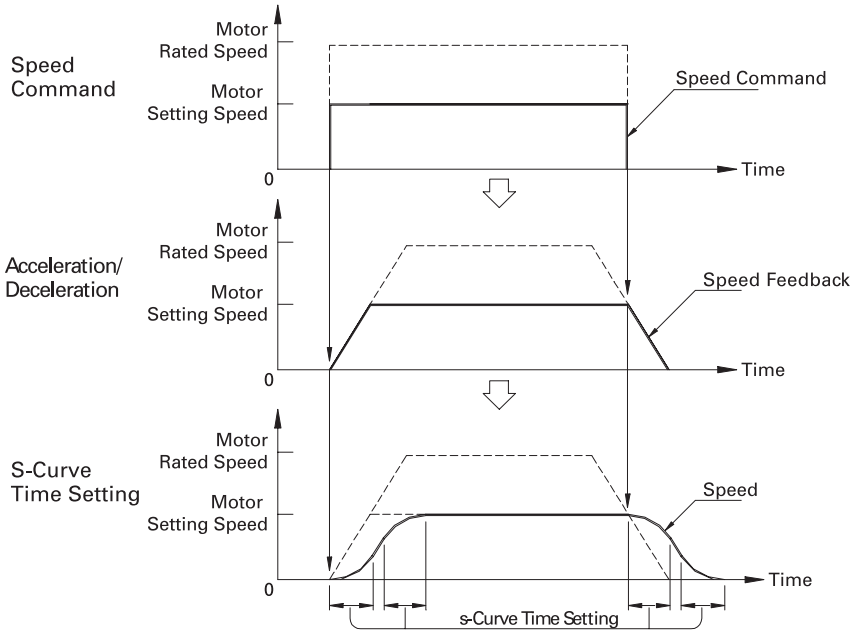


The diagram shows that the time for execution compared to command got extended as much as the deceleration time.

Please set the acceleration time at SEt-19. The setting range is 0 to 60000 ms and the default value is 200.

Please set the deceleration time at SEt-20. The setting range is 0 to 60000 ms and the default value is 200.

As shown below, executing command in the form of an S curve at the transitional points of acceleration or deceleration can make the operation smoother.



Please set S operation time at SEt-21. The setting range is 0 to 5000 ms and the default value is 0.

Assuming that the time required to execute the initial speed command is 10 seconds, the total time required to execute the speed command after setting acceleration/deceleration time will be 10 seconds + deceleration time. And the total time required to execute speed command after setting the S-curve operation time is 10 seconds + deceleration time + S-curve operation time.

ATTENTION

S operation alone cannot be used without setting acceleration/deceleration time. To use S operation, please set acceleration/deceleration time that corresponds to the user's situation.

What is different from CSDP is that 0 should be set at SEt-21 not to use the S operation. Setting other values besides 0 enables S operation.

Speed Limit

Speed limiting methods are internal speed limit and external speed limit.

- Internal Speed Limit: Limit the speed through the setting of the servo drive itself.
- External Speed Limit: Limit the speed through the command from the controller.

Internal Speed Limit

Internal speed limit works as the speed is limited by the value users set at SEt-67. Therefore, the servo drive operates under the preset limit even if the controller approves a speed command faster than the set value of the speed limit.

Please set the speed limit at SEt-67. The setting range is 1 to 5000 RPM and the default value is 5000.

External Speed Limit

If the user does not use the speed control mode and operates the system in one of the other control modes, the analog speed command input from external can be used to limit speed. If the speed control mode is used, the external speed limit function cannot be used and the speed can be limited by the internal speed limit.

Speed command gain (SEt-01) determines the relationship between the analog speed command voltage and the speed command in the speed control mode. When the speed control mode is not used, the speed limit is the speed set by the relationship between the speed command gain and the analog speed command voltage.

Please set the speed command gain at SEt-01. The setting range is 10 to 6000 RPM/V and the default value is 500.

The formula to get the external speed limit is as follows.

External speed limit (RPM) = Speed Command Gain (RPM/V) × Input Voltage (V)

When the speed command gain is 500 RPM/V and the input voltage is 6V, the motor speed is limited at 3000 RPM and when the input voltage is 10V, the speed limit is 5000 RPM.

Speed Limiting Method Selection

Please set the method to limit speed at the third digit of SEt-45.

Speed Limiting Method

Set Value	Function
0	Does not use the speed limit function.
1	Limits the speed by the internal speed limit (SEt-67).
2	Limits the speed by the analog speed command input from the outside.
3	Limits the speed under the smaller value between the motor's maximum speed and the value of SEt-67.

Position Feedback to the Controller.

The servo drive controls the servo motor by using various information from the encoder. And the servo drive can send the output of the encoder information to the controller.

The servo drive outputs five different encoder signals in total to the controller.

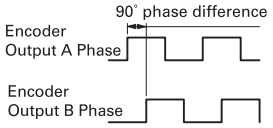
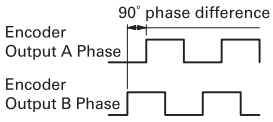
Encoder Signals Sent to the Controller.

Symbols	Function	Type
EA, /EA	Encoder A(/A) Phase Output	Line Drive
EB, /EB	Encoder B(/B) Phase Output	Line Drive
EC, /EC	Encoder C(/C) Phase Output	Line Drive
PS, /PS	Absolute encoder position Data output	Line Drive
/Z-PULSE+, /Z-PULSE-	Encoder Z (+/-) Phase Output	Open Collector

The direction of the encoder output pulse sent to the controller can be changed.

Please set the direction of the encoder output pulse at the first digit of SEt-46.

Direction of the Encoder Output Pulse

Set Value	Function
0	In the forward revolution, encoder output phase A is displayed 90 degress in advance. 
1	In the reverse revolution, encoder output phase B is displayed 90 degrees in advance. 

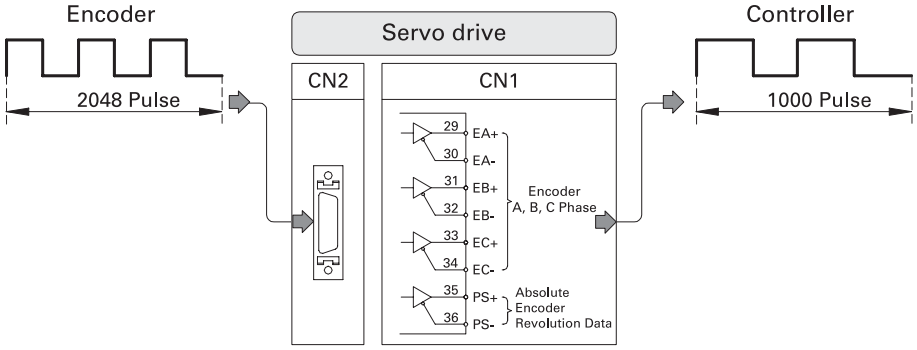
The servo drive can adjust the number of the encoder pulses through the dividing circuit function before sending the input from the encoder to the controller.

The formula to adjust the number of output pulse is as follows.

(Numerator/Denominator) × Number of Encoder Pulse = Output to the controller

If a certain type of encoder connected to the drive produces 2048 pulses per revolution and as many as 1000 pulses per revolution should be sent to the controller, the numerator can be set to 1000 and the denominator can be set to 2048.

(1000/2048) × 2048 = 1000



Please set the number of output pulses per revolution, which is the numerator, at SEt-23. The setting range is 1 to 65535 pulse and the default value is 2500.

Please set the number of encoder pulses per revolution, the denominator, at SEt-24. The setting range is 1 to 65535 pulse and the default value is 2500.

Even when the motor is revolving at a completely normal speed, jittering of about 33 μs can be generated at the encoder output pulse depending on the revolution speed.

ATTENTION

The servo drive cannot send more pulses than the number of input pulses from the encoder to the controller. Therefore, the numerator should always be the same as or smaller than the denominator.

Analog Monitor

The servo drive can display the analog monitor signals with which the user can check the actual control status through an oscilloscope.

Set the scale units of the analog monitor channel 1 and channel 2 at SEt-78.

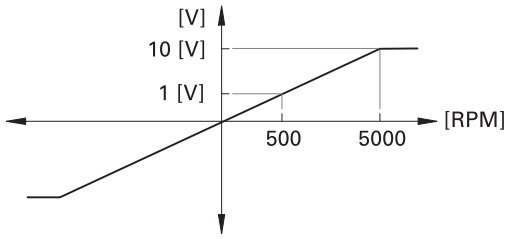
Analog Monitor Output Type

Chosen Number	Types	Setting Range (1V)
0	Speed Command	1 to 500 RPM
1	Torque Command	1 to 30%
2	Position Command	1 to 5000 pulse
3	Speed Feedback	1 to 500 RPM
4	Torque Feedback	1 to 30%
5	Position Feedback	1 to 5000 pulse
6	Position Error	1 to 2500 pulse
7	Speed Error	RPM
8	DC-link Voltage	V
9	$\ominus$ (theta_cnt) Electrical Angle	°
10	Pulse Command Frequency	kHz
11	Inertia Ratio	%
12	Q Axis Current	A
13	D Axis Current	A
14	U Phase Current	A
15	V Phase Current	A
16	W Phase Current	A

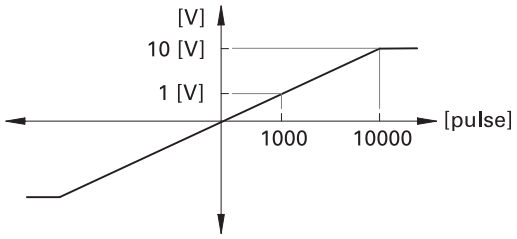
Please set the scale of the analog monitor channel 1 at SEt-08. The setting range is 1 to 65535 /V and the default value is 500.

Please set the scale of the analog monitor channel 2 at SEt-09. The setting range is 1 to 65535 /V and the default value is 500.

If the scale of the analog monitor channel 1 is set to 500 of the speed command (0), the speed command of the controller that corresponds to the monitor output 1V is 500 RPM. Since the maximum output is 10 V, the speed can be monitored up to 5000 RPM. Therefore, the monitoring range of the overall speed command is ±5000 RPM.

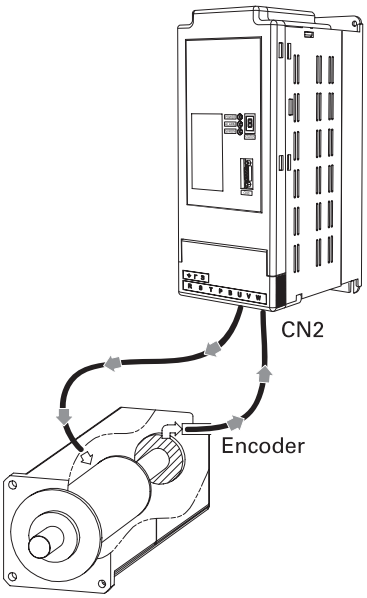


If the scale of the analog monitor channel 2 is 1000 of the position command (2), the position command of the controller that corresponds to the monitor output of 1V is 1000 pulses. As the maximum output is 10 V, the position command can be checked up to 10000 pulses. Therefore, the monitoring range of the overall position command is ±10000 pulses..

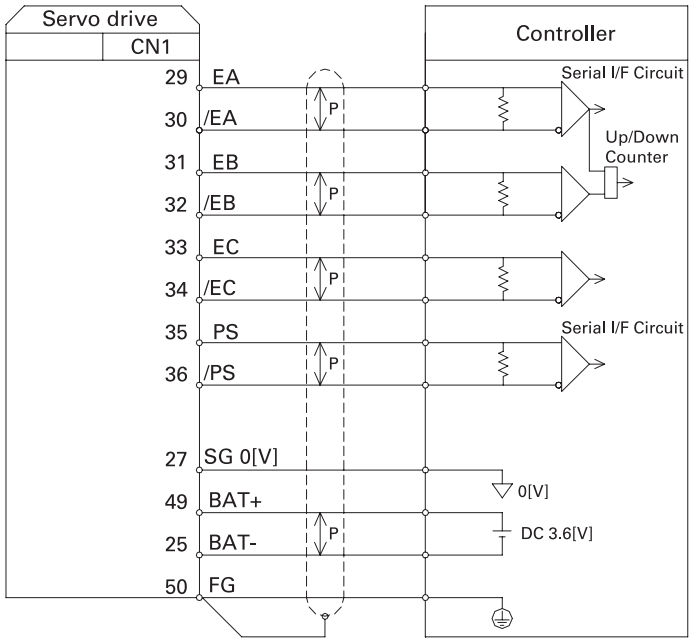


Absolute Encoder

An absolute encoder can detect the absolute position.



The absolute encoder uses external battery power to store and remember the position information of the load system if the power supply of the servo drive is cut. The error caused by the noise during signal transmission is not accumulated with the absolute encoder. And it doesn't require the default position of the load to be adjusted when the power supply is cut off, while the incremental encoder does require it. The absolute encoder can activate the equipment with the memory information. When the power supply is cut off and the absolute position of the load system is needed by the absolute encoder should be used.



Absolute Encoder Wiring

An absolute encoder should be connected to the external battery power. The battery enables the absolute encoder to remember and maintain the information of absolute position of the load system when the power supply of the servo drive is cut off. If the power supply to the servo drive is cut off and the battery power is discharged below the standard, the information memorized in the absolute encoder can be damaged. The drive does not monitor the battery voltage directly, but checks it indirectly through the encoder. When needed, please get the low-voltage detection circuit ready.

When the voltage of the absolute encoder battery becomes 3.2V or less, the low-voltage warning of the absolute encoder battery will occur. Please change your battery when this warning is seen.

When the internal condenser voltage of the encoder is about 2.8V or less, the absolute encoder internal low-voltage alarm will go off. When this alarm goes off, the memorized information in the encoder can disappear.

The drive transmits the absolute information through the PS, EA, EB terminals.

The data structure transmitted to the controller through the output is shown below.

PS output data of the encoder

Encoder	Multi-revolution Data	1 Revolution Data	Transmission Cycle
Absolute Value (Compact) H	13-bit	11-bit	Approx. 50 ms
Serial	16-bit	17-bit	Approx. 50 ms

STX	Absolute Data (Position variable)		&	Data (3bit) (Alarm Content)	BCC	ETX
	Multi-revolution Data (0 to 65535)	1 Revolution Data (1 to 131071)				

Transmission Frame Structure

Data Transmission Format

Item	Event
Data Transmission Method	Asynchronous
Baud-Rate	9600 bps
Start Bit	1 bit
STOP Bit	1 bit
Parity	N/A
Character Code	ASCII
Data Format	10 to 19 Character Array

STX represents the beginning of the transmission packet and corresponds to ASCII code 02H. ETX represents the end of the transmission packet and corresponds to ASCII code 03H. The range of the multi-revolution data is -32768 to +32767, and if it exceeds –32768, it becomes +32767, and if it exceeds +32767, it becomes -32768. The range of multi-revolution data of compact (H) type is -4096 to + 4095.

For the controller that can't receive the serial data output through PS terminal, the absolute encoder data is transmitted to the controller in the form of incremental pulses through the output of the EA and EB terminals, which are the incremental encoder output signals in the early stage. Among the absolute value data, 1 revolution data is transmitted after the multi-revolution data.

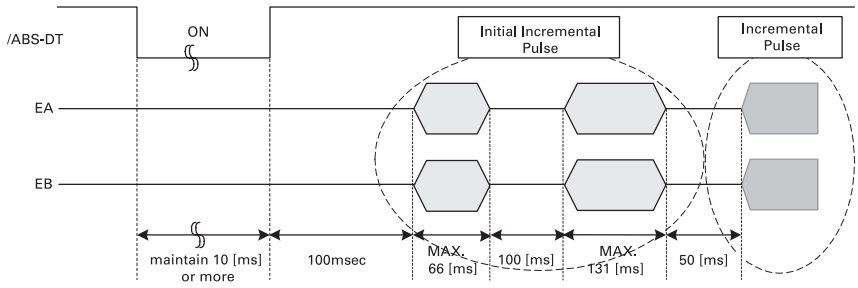
The serial data of the absolute value can be received through the EA and EB terminals in the following order.

1. Keep /ABS-DT signal at low level, 10 ms or more.

2. Clear the UP/DOWN counter that counts the incremental pulses to 0 so that it can be ready for the absolute encoder data reception.

3. Receive the multi-revolution data transmitted from the drive after 100 ms.

4. The EA and EB of the drive starts working with ordinary incremental encoder output signals 50 ms after they transmitted 1 revolution data.



Encoder Signal

Signal	Status	Pulse
EA	During initialization when the power is ON	Early Incremental Pulse
	During ordinary operation after initialization	Incremental Pulse
EB	During initialization when the power is ON	Early Incremental Pulse
	During ordinary operation after initialization	Incremental Pulse
EC	Always	Origin Pulse
PS	Always	Serial Data of absolute encoder

7

Troubleshooting

Check

Checking Motor

The following simple checks are enough as there is no mechanical part like a brush that is vulnerable to abrasion. Please choose when to check the system after considering the usage environment.

Motor Check

Item	Cycle	Maintenance
Vibration and Noise	Everyday	Adjust it to not be bigger than usual occasions.
Foreign Bodies	Instantly when found	Vacuum clean.
Insulation resistance	1 Year	Contact the company if it is lower than 10 mΩ after checking with insulation resistance measuring instrument.
Oil Seal	5000 Hours	Replace with a new oil seal.

Servo Drive Check

The servo drive has an embedded electronic circuit. Dust and other foreign bodies may cause malfunction. Please keep the system cleaned and serviced.

Servo Drive Check

Item	Cycle	Maintenance
Main Body	1 Year	Remove the dust and grease with compressed air and cloth.
Socket, Connector, Screw	1 Year	Tighten.
Circuit Board	1 Year	Contact the company in the case of discoloration, breakage or a broken wire.

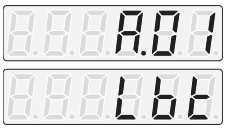
When the ambient temperature is an anual average of 30° C or less, the load rate is 80% or less, and the rate of operation is 20 hours a day or less, the lifespan of major products are as follows.

Parts life of the servo drive

Parts	Period of Use
Condenser	3 Years
Cable	3 Years (Based on Moving Cable)
Power Device	3 Years
Regenerative Resistance	2 Years
Dynamic Brake Resistance	2 Years
FAN	2 Years
Cooling Fan	4 to 5 Years
Fuse	10 Years

Servo Drive Failure

When a failure occurs at the servo drive, a servo warning or servo alarm will occur. A servo warning will occur when there is a minor failure that doesn't require the operation to stop. But a servo alarm means there is a serious failure and the operation should be stopped.



In case of a servo warning, the corresponding number and characters will be displayed alternately.

In case of a servo alarm, the corresponding number and characters will be displayed alternately.

Servo Warning

The servo drive can use /WARN signal to notify the controller of a servo warning.

Servo Warning List

No.	Event
A.01 Lbt	Absolute Encoder Battery Low Voltage
A.02 Cnt	Absolute Encoder Counter Overflow
A.04 PrE	Absolute Encoder Default Status Failure
A.08 OtC	Excessive Torque command
A.10 OSC	Excessive Speed command
A.20 Pin	Allocation Failure at Input Pin or Output Pin
A.40 CAP	When the capacity of driver is less than that of motor

If the voltage of the external battery of the absolute encoder is less than 3.1V, this warning will occur. Please replace the battery.

If the Q type absolute encoder revolves in either forward or reverse direction more than 32768 (4096 times for H type) times, this warning will occur. Reset the absolute encoder.

If the motor revolves faster than 100 RPM when the main power supply is engaged, this warning will occur. This warning will occur only when the serial absolute encoder is used. When the resolution of the 1 revolution data becomes 17-bit, the warning will be automatically canceled.

If the external torque command is over 300% of the rated torque, this warning will occur. Even if the torque command is more than 300% of the rated torque, the servo drive automatically limits it under 300%.

When the external torque command is lowered below 300%, this warning will automatically canceled.

If external speed command is input at more than the preset limit speed of drive, this warning will occur. If speed command is input at more than the limit speed, servo drive is limited to the automatically preset limit speed.
When the external speed command is lowered below the speed limit, the warning will be automatically canceled.

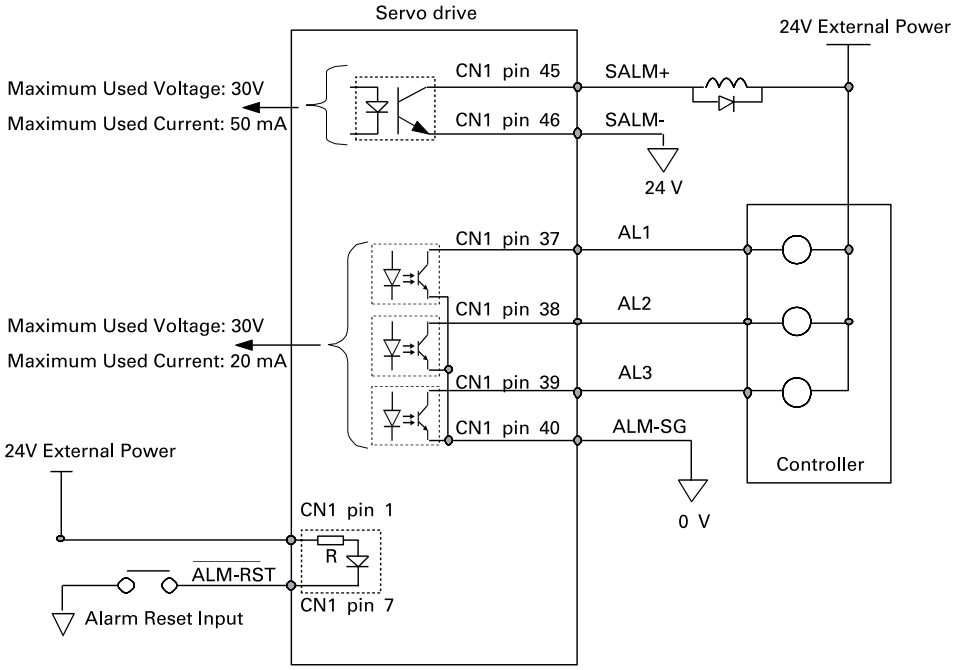
If input signal (or output signal) is allocated duplicately to the same input channel (or output channel), /C-SEL signal is not allocated while operated in combination control mode and /C-DIR, /C-SP1, /C-SP2, /C-SP2 signals are not allocated while operated in contact control mode, this warning will occur. Check the wiring and signal allocation and approve the power again.

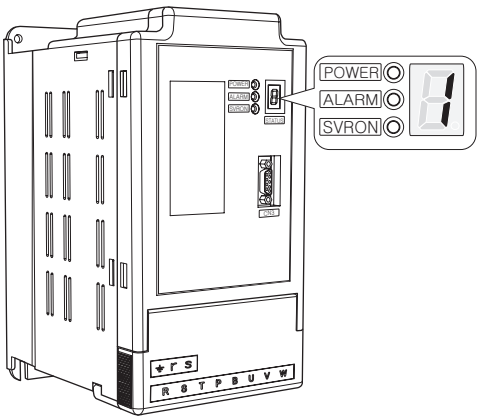
If the capacity of the motor is bigger than that of the servo drive, this warning will occur.
Please replace the servo drive with the one that fits the capacity of the motor.

If replacement is not available, limit the torque so that the servo drive won't be overstrained.

Servo Alarm

In case of a servo alarm, corresponding numbers and characters will be displayed and the operation will stop.





In case of a servo alarm, the LED of the servo drive will display the first number of the relevant alarm code.

ATTENTION

When a servo alarm occurs, please shut down the power and find the cause. After removing the cause and reseting the system, input the speed command to 0V and restart the operation.

The servo drive can notify the controller of the information about the alarm through AL1, AL2, and AL3 terminals.

At the alarm output terminal, 1 means that the secondary photocoupler transistor is OFF, and 0 means it is ON.

Servo Alarm List

No.	Event	AL3	AL2	AL1
E.10 SC	Servo Drive Internal Circuit Failure	0	0	1
E.11 oC	Motor Overcurrent (Hall Sensor)	0	0	1
E.12 oH	Device for Motor Operation Error (IPM H/W Fault)	0	0	1
E.22 FoI	Torque Instantaneous Overload	0	1	0
E.23 FOL	Torque Continuous Overload	0	1	0
E.24 HoH	Heatsink Overheat	0	1	0
E.25 PCO	Motor Cable Failure	0	1	0
E.26 POL	Output Capacity Overload	0	1	0
E.27 dOL	Drive Overload	0	1	0
E.30 EOP	Encoder Cable Wiring Open	0	1	1
E.31 AOS	Absolute Encoder Overspeed	0	1	1
E.32 AtE	Absolute Encoder Multi-revolution Data Error	0	1	1
E.33 PoF	Position Error Overflow	0	1	1
E.34 AdE	Absolute Value Data Error	0	1	1
E.35 EuU	Absolute Value Battery Failure	0	1	1
E.36 EoP	Encoder Type Set-up Error	0	1	1
E.37 ACE	Absolute Encoder Communication Failure	0	1	1
E.39 EPE	Serial Absolute Encoder Parameter Error	0	1	1
E.40 oS	Motor Overspeed	1	0	0
E.41 Est	Emergency Stop	1	0	0
E.42 OPC	Excessive Position Command Pulse	1	0	0
E.50 oU	Excessive Voltage of the Main Power Supply	1	0	1
E.51 uU	Low Voltage of the Main Power Supply	1	0	1
E.60 CPU	CPU error	1	1	0
E.62 COF	U Phase Offset Error	1	1	0
E.63 COF	W Phase Offset Error	1	1	0
E.70 PF	Main Power Supply Failure	1	1	1
E.80 CSE	Parameter Checksum Error	0	0	0
E.81 Pro	Out of Parameter Range	0	0	0
E.82 EtP	Motor or Encoder Type Set-up Error	0	0	0
E.83 SCE	Serial Communication Failure	0	0	0
E.84 FbE	Parameter Breakdown	0	0	0
E.85 CdE	Servo Drive Capacity Error	0	0	0

If a sudden excessive current flows through the servo drive or the main circuit fails, this alarm will occur.
Check the power supply and increase acceleration/ deceleration time.

If the over current flows through the servo drive or the main circuit fails, this alarm will occur.
Check the power supply and increase acceleration/ deceleration time.

If the ambient temperature is 55° C or higher, IPM unit failed, or the power supply is low voltage, this alarm can occur.
Check the power supply and lower the ambient temperature.

If the torque feedback continues with the maximum torque for several seconds, this alarm can occur.
Check the load condition, power supply and motor capacity, and increase acceleration /deceleration time.

If 115% or more torque feedback continues for several seconds, this alarm can occur.
Check the load condition, power supply and motor capacity, and increase acceleration /deceleration time.

If the temperature of heatsink plate of servo drive is over about 95±10° C, this alarm will occur.
Check the power supply and lower the ambient temperature.

If the power cable of the motor is not connected, this alarm will occur.
Connect the motor power cable to the motor and the servo drive properly.

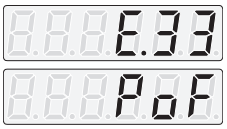
If drive capacity is exceeded, this alarm will occur .
Check the load condition of the power supply.

If the servo drive is overloaded, this alarm will occur.
Check the load condition of the servo drive.

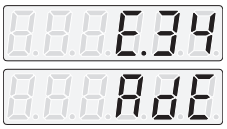
If the encoder cable is not connected, this alarm will occur. Connect the encoder cable to the encoder and the servo drive properly.

If the motor revolves quickly when the main power supply of the servo drive is shut down during normal operation and the encoder works with the external battery, this alarm can occur.

If the motor revolves quickly while the power is not supplied to the absolute encoder, the multi-revolution data of the absolute encoder will have an error and this alarm will occur. Set the multi-revolution data of the absolute encoder at 0.



If a pulse error exceeding the overflow Level (SEt-33) is made, gain is too low or the external load is too big, this alarm occurs. Lower the input frequency, and raise feed forward gain (SEt-34) and speed gain (SEt-02, SEt-03) and position gain (SEt-04).

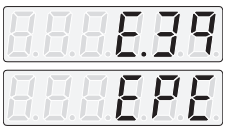


If the absolute encoder data has an error, this error occurs. Turn off and turn on the power again or reset the alarm.

If the main condenser of the absolute encoder is low voltage, this alarm occurs. Reset the system after one minute while the power is connected. Then the multi-revolution of the absolute encoder will be reset to be 0.

If the encoder power is disconnected or the encoder type set-up (SEt-51) is wrong, this alarm occurs.
Check the encoder power and set up the encoder type properly.

If there is a communication failure between the servo drive and the absolute encoder, this alarm occurs. Check the wiring of the encoder and if there is nothing wrong, replace the motor with the new one.



If the EEPROM of the encoder has an error, this alarm occurs.

If the encoder cable or the motor cable is not connected properly or there is an error with the position command, this alarm occurs.
Check the connection of the cable and adjust the electronic gears (SEt-36 and SEt-37).

If the emergency stop circuit is activated, this alarm occurs.
Clear the emergency stop and cancel the emergency stop input.

If the input pulse command frequency of the controller is high, this alarm occurs.
Check the type of the input pulse and the frequency. It should be 900 kpps or less for the line drive type and 250 kpps or less for the open collector type.

If the power is higher than the rated voltage range (405V), the regenerative resistor is short-circuited, the regenerative transistor failed, or the operation exceeds the regenerative capacity, this alarm occurs.

If the power supply voltage is normal and the load inertia is not excessive, replace the regenerative resistor.

If the main power voltage is lower than 200V, this alarm occurs.
Check the power supply voltage.

If there is an error with the CPU, this alarm will occur.

If there is an error with the U phase current offset, this alarm will occur.

If there is an error with the W phase current offset, this alarm will occur.

If there is an error with the main power supply, this alarm will occur.

If there is an error with the memory that stores the user parameter, this alarm will occur.
Check and reset the recently-set parameter and back up the remaining parameter.

If there is a parameter set-up out of the preset range, this alarm will occur.
Reset the parameter with the values within the preset range.

If the motor type or encoder type is incorrectly set, this alarm will occur.
Set the encoder type (SEt-51), motor type (SEt-52), and motor capacity (SEt-53) properly.

If there is a failure of the serial communication caused by noise or connecting cable failure, this alarm will occur.
Check the connection status of the cable and connect it in a noise-free environment.

If there is an error with the memory that stores parameter, this alarm will occur.
If this alarm occurs too often, replace the servo drive with a new one.

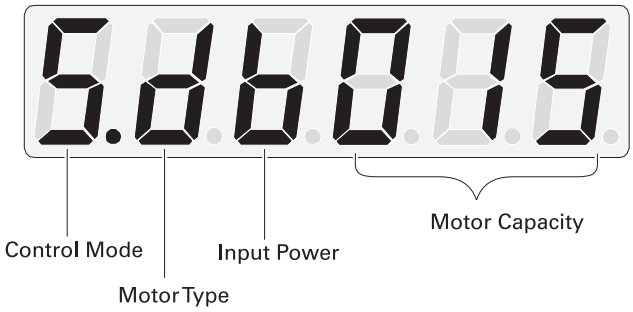
If the rated output of the servo drive is incorrectly set, this alarm will occur.

The servo drive can store a maximum of 10 alarm records in the order of occurrence. The alarm records can be deleted by using USr-10.

Servo Alarm Record List

No.	Event
PAr-01	The latest error
PAr-02	The error that occurred before 1 time
PAr-03	The error that occurred before 2 times
PAr-04	The error that occurred before 3 times
PAr-05	The error that occurred before 4 times
PAr-06	The error that occurred before 5 times
PAr-07	The error that occurred before 6 times
PAr-08	The error that occurred before 7 times
PAr-09	The error that occurred before 8 times
PAr-10	The error that occurred before 9 times
PAr-11	Software Version
PAr-12	Controller Type

The controller type of PAr-12 is displayed as shown below.



Appendix A

Parameter

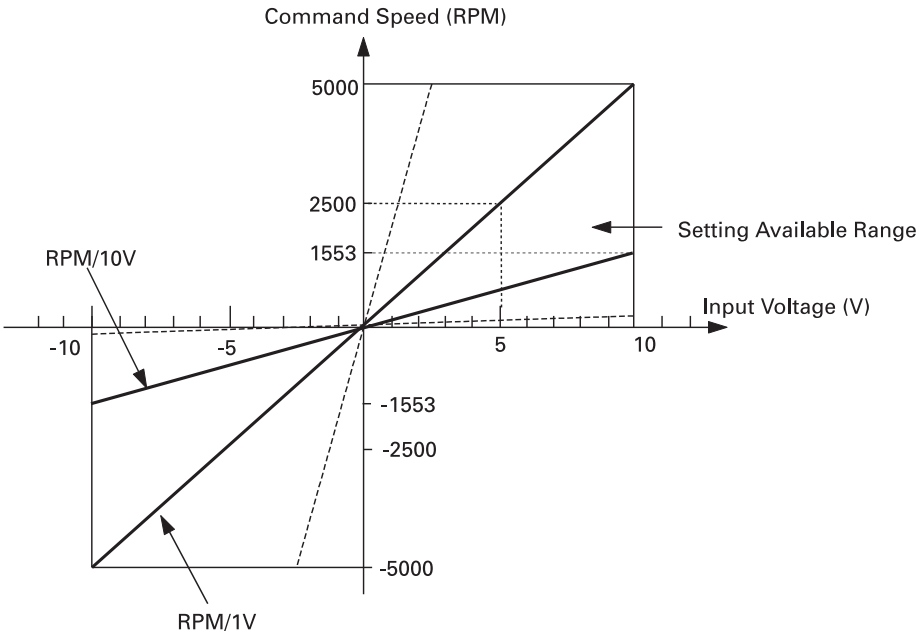
ATTENTION

To change the parameter that is unchangeable during operation, please make sure to change it after turning the servo OFF and turn the servo ON.

SEt-01 Speed Command Gain

- Setting range: 10 to 6000 RPM/1V, RPM/10V
- User Default: 500
- Changes anytime

The second digit of SEt-46 determines the preset unit of the parameter.



Speed command gain determines the gradient of the graph.

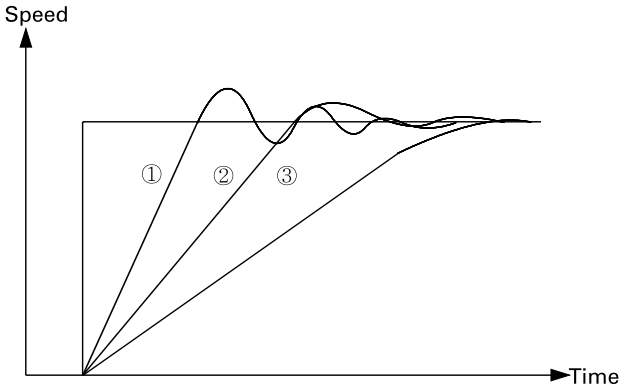
Speed command (RPM) = SEt-01 × Input Voltage (V)

SEt-02 Speed Loop Proportional Gain

- Setting range: 0 to 1500 N·m·s
- User Default: 80
- Changes anytime

Speed loop proportional gain determines the response of the speed control. Set the highest value as long as vibration does not occur at the system. The upper limit will be determined according to the natural frequency and rigidity of the system. If the inertia of the load grows, raise the value.

Speed loop proportional gain is scaled to the motor's rotor inertia. If load condition is equivalent to the operating condition, the gain value for the load inertia 10 times larger than that of a 1.5 kW motor is similar to the load inertia 10 times larger than that of a 3 kW motor.



If the proportional gain (P) is lowered while the integral gain (I) remains the same or the proportional gain is kept the same while the integral gain is lowered, the response changes in the order shown in the above diagram. The time to reach the target speed in the early stage is determined by the proportional gain and the time to catch up with the end target from the point past 50% of the target speed is determined by the integral gain. Since the characteristics of these two gains can't be regarded separately, tune the proportional gain first and then integral gain.

SEt-03 Speed Loop Integral Gain

- Setting range: 0 to 20000 $N \cdot m \cdot s^2$
- User Default: 200
- Changes anytime

Speed loop integral gain removes the speed error in the steady state. Raising the value can improve the transient response characteristics and reduce error in the steady state. But the value should be set within an appropriate range because overshoot or undershoot in an transient condition increases if the value is too high.

Speed integral gain is scaled to the rotor inertia of the motor. If load condition is equivalent to the operating condition, the gain value for the load inertia 10 times larger than that of a 1.5 kW motor is similar to the load inertia 10 times larger than that of a 3 kW motor.

SEt-04 Position Loop Proportional Gain

- Setting range: 0 to 500 rad/s
- User Default: 60
- Changes anytime

Position loop proportional gain determines the response of the position control. Raising this value improves the response and the set value changes according to the position decision load rigidity. The upper limit is determined by the natural frequency and the rigidity of the system. If the gain value is too high, vibration can be generated and there can be noise in the system.

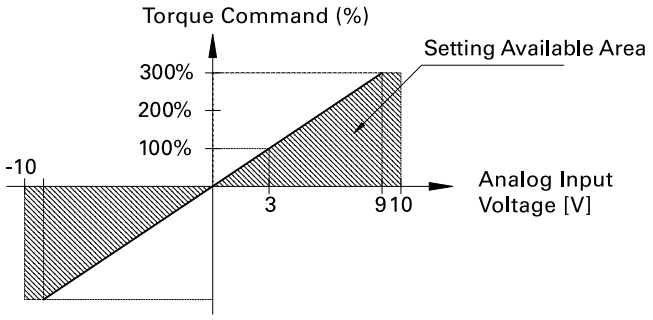
SEt-05 External Torque Command Gain

- Setting range: 0 to 100%/3V
- User Default: 100
- Changes anytime

This parameter is the torque ratio based on the rated torque of the motor.

Torque = (Torque Gain × Input Voltage × rated torque)/100

If the torque gain is 100%/3V and the input voltage is 3V, 100% torque, rated torque, will be generated.



If the torque command gain is 100%/3V and the input voltage is 9 V, 300% torque, the maximum torque of the motor, will be generated.

SEt-06 Torque Command Filter

- Setting range: 0 to 60000 rad/s
- User Default: 1800
- Changes anytime

This parameter limits the high frequency element of the torque command. The set value changes according to the rigidity of the load.

Torque filter cut-off frequency lowers the frequency depending on how many delay factors there were during the process of delivering the motor's torque to the load. In the case of a directly-coupled disk with no delay factor, a value that is too low can cause vibration. Contrastingly, if the value is set too high for a belt or chain with many delay factors, there can be a vibration. Finish the setting according to the type of the load by referring to the next table.

Torque Filter Cut-off Frequency

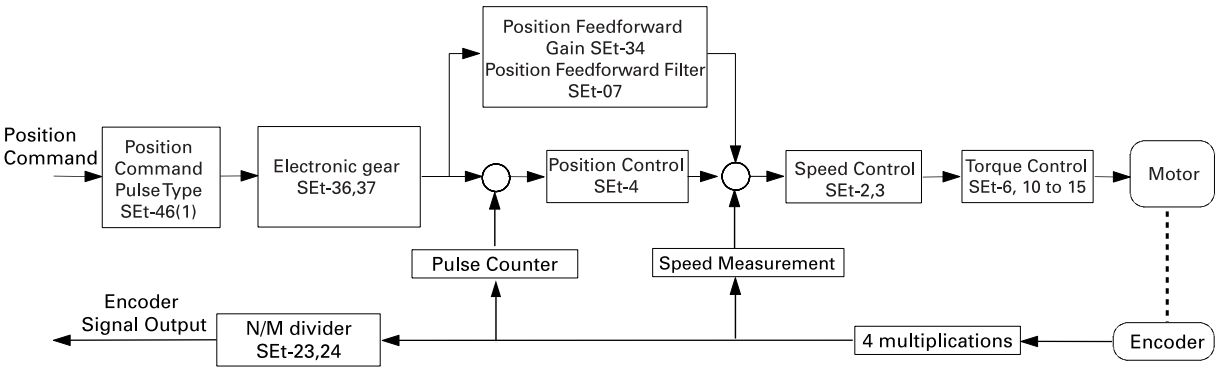
Load Type	Recommended Value
Directly-coupled Disk	4000
Ball Screw coupled directly	2000 to 3000
Belt or Chain	500 to 1000

SEt-07 Position Feedforward Filter

- Setting range: 0 to 5000 rad/s
- User Default: 0
- Changes anytime

The filter is used to feedforward the differentiated position command. This parameter is the cut-off frequency of the filter. If position feedforward gain (SEt-34) is 0, this parameter is not valid. In the case of an overshoot, please set the parameter to 0.

Please refer to the diagram below for the information about the usage and the setting position of SEt-07.



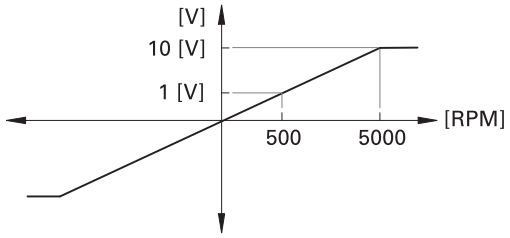
SEt-08 DA Monitor Channel 1 Scale

- Setting range: 1 to 65535/V
- User Default: 500
- Changes anytime

The servo drive can display the analog monitor signals with which the user can check the actual control status through an oscilloscope.

Set the scale unit of analog monitor channel 1 at SEt-08.

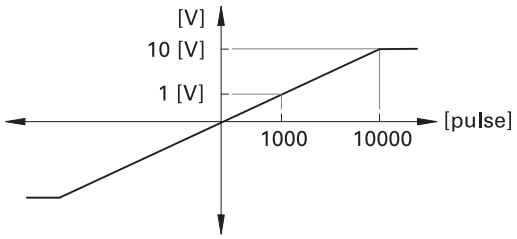
If the scale of the analog monitor channel 1 is set to 500 of the speed command (0), the speed command of the controller that corresponds to the monitor output 1V is 500 RPM. Since the maximum output is 10V, the speed can be monitored up to 5000 RPM. Therefore, the monitoring range of the overall speed command is ±5000 RPM.



SEt-09 DA Monitor Channel 2 Scale

- Setting range: 1 to 65535/V
- User Default: 500
- Changes anytime

If the scale of the analog monitor channel 2 is set to 1000 of the position command (2), the position command of the controller that corresponds to the monitor output 1V is 1000 pulse. Since the maximum output is 10V, the monitoring range is up to 10000 pulses. Therefore, the monitoring range of the overall position command is ± 10000 pulse.



SEt-10 Forward Internal Torque Limits

- Setting range: 0 to 300%
- User Default: 300
- Changes anytime

This parameter limits the torque in the forward direction.

SEt-11 Reverse Internal Torque Limits

- Setting range: 0 to 300%
- User Default: 300
- Changes anytime

This parameter limits the torque in the reverse direction.

SEt-12 Forward External Torque Limits

- Setting range: 0 to 300%
- User Default: 100
- Changes anytime

The torque in the forward direction is limited based on the set value of this parameter when /P-TL signal is received.

SEt-13 Reverse External Torque Limits

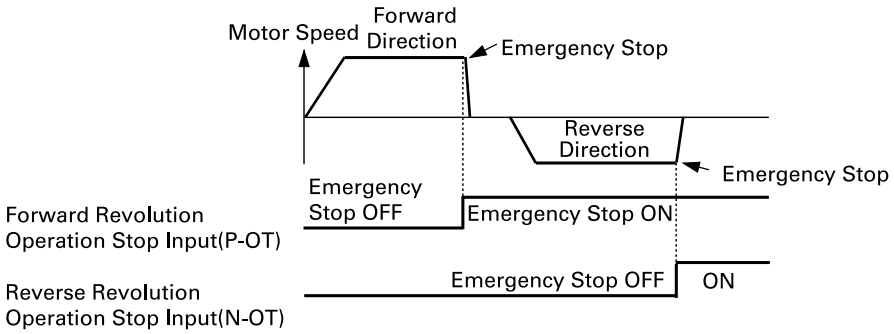
- Setting range: 0 to 300%
- User Default: 100
- Changes anytime

The torque in the reverse direction is limited based on the set value of this parameter when /N-TL signal is received.

SEt-14 Forward Emergency Stop Torque

- Setting range: 0 to 300%
- User Default: 300
- Changes anytime

When P-OT signal is set to the forward revolution limit signal (second digit of SEt-43) and the P-OT signal is received during the motor's forward revolution, the motor will stop in emergency. This parameter is the value of the torque at that time.



SEt-15 Reverse Emergency Stop Torque

- Setting range: 0 to 300%
- User Default: 300
- Changes anytime

When N-OT signal is the reverse revolution limit signal (third digit of SEt-43) and N-OT signal is received during the motor's reverse revolution, the motor stops in emergency. This parameter is the value of the torque at that time.

SEt-16 TG-ON Speed Level

- Setting range: 1 to 5000 RPM
- User Default: 20
- Changes anytime

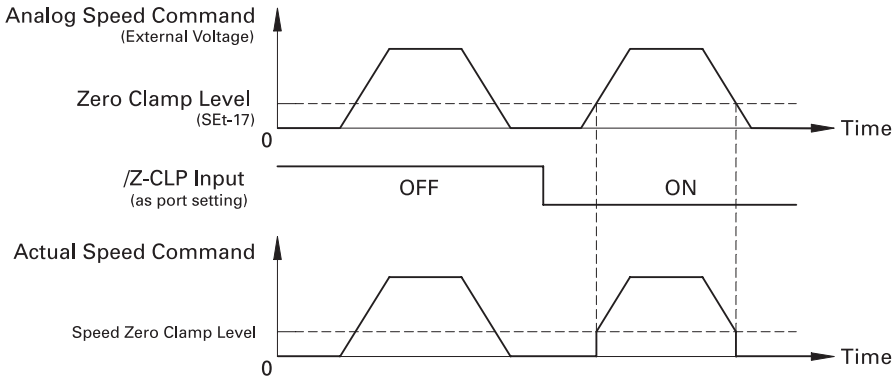
This parameter is the speed level that switches on the /TG-ON output. It is valid only when the TG-ON signal function (fourth digit of SEt-43) is set 0. If the motor speed exceeds the preset value of this parameter, /TG-ON signal will be ON.

SEt-17 Zero Clamp Level

- Setting range: 0 to 5000 RPM
- User Default: 0
- Changes anytime

This parameter is the stop speed level in the zero clamp control mode. If the analog speed command is below the preset value of this parameter, the motor will decelerate and stop.

Even if the analog speed command of the controller is 0V at the speed command offset auto adjustment, a little offset voltage can exist at the servo drive input terminal, which may cause the motor to revolve slowly. In this case, using the zero clamp function can prevent the motor from revolving a little caused by the offset voltage.



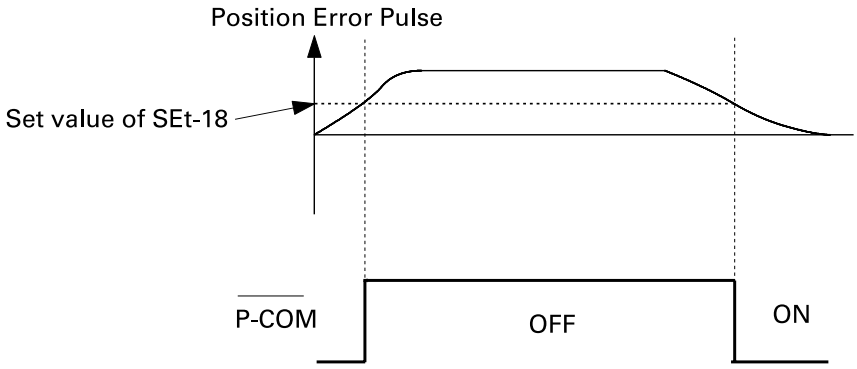
If the CN1 connector pins where the zero clamp function is allocated are ON, the voltage command below the level set at SEt-17 will be ignored. When the value of the speed command surpasses this level again, the motor will be accelerated to the value of the command.

If the input pins for zero clamp is not set, execute the clamp automatically.

SEt-18 In Speed/In Position Range

- Setting range: 0 to 1000 RPM/pulse
- User Default: 10
- Changes anytime

This parameter is the error range of the speed or position that turns ON the position completion signal (/P-COM). When the speed error or position error reaches within the preset range, /P-COM signal will be displayed.

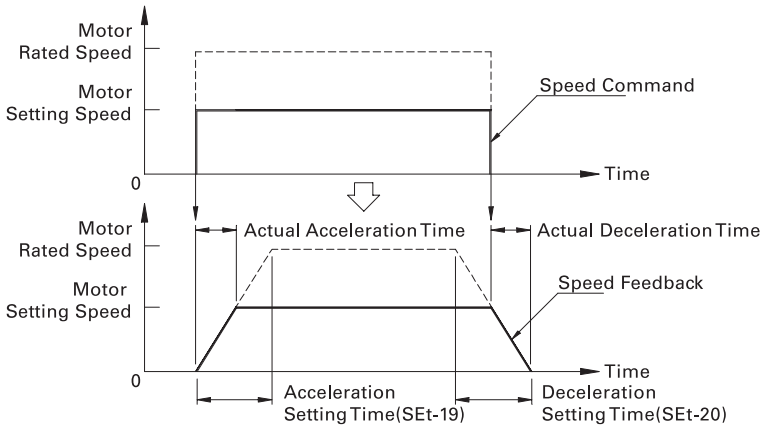


If this parameter is high in the low-speed operation, the position completion signal can be kept ON. This signal can usually be used as a reference signal for the next sequence of the operation.

SEt-19 Acceleration Time

- Setting range: 0 to 60000 ms
- User Default: 200
- Changes anytime

Acceleration time is the time required for the motor to reach the rated speed from standstill.



The diagram shows that the time for execution compared to command got extended as much as the deceleration time.

SEt-20 Deceleration Time

- Setting range: 0 to 60000 ms
- User Default: 200
- Changes anytime

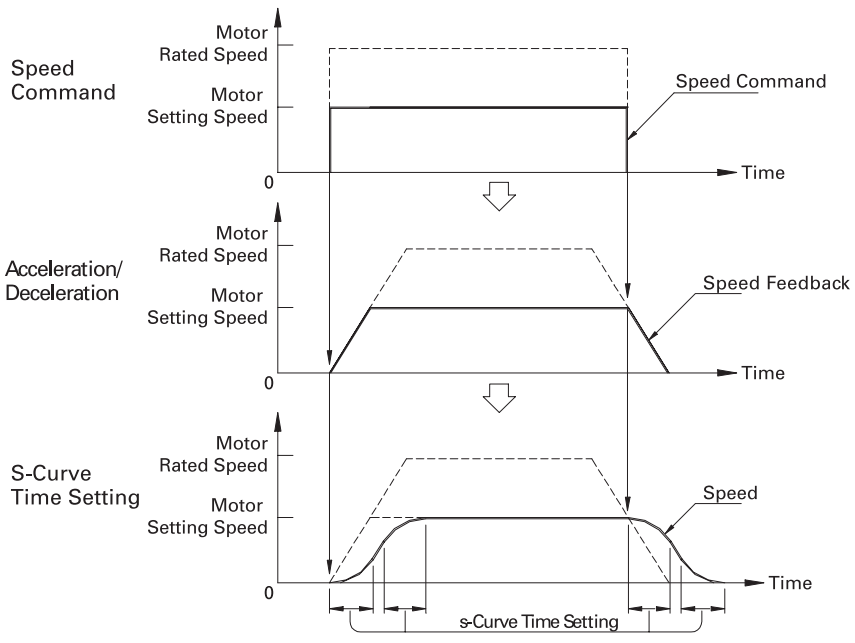
Deceleration Time is the time required for the motor to slow down to a halt from the rated speed.

SEt-21 S-Curve Operation Time

- Setting range: 0 to 5000 ms
- User Default: 0
- Changes anytime

This parameter is the time for the S-curve during acceleration/ deceleration operation.
As shown below, executing command in the S-curve form at transitional points of acceleration or deceleration can make the operation smoother.

Assuming that the time required to execute the initial speed command is 10 seconds, the total time required to execute the speed command after setting acceleration/deceleration time will be 10 seconds + deceleration time. And the total time required to execute speed command after setting the S-curve operation time is 10 seconds + deceleration time + S-curve operation time.



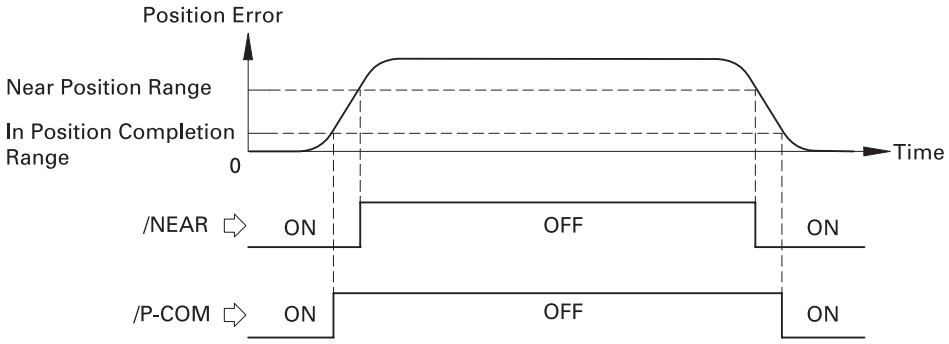
ATTENTION

Please select the set value carefully because the S-curve operation will be automatically run if this parameter is set higher than 0.

SEt-22 Near Position Range

- Setting range: 0 to 1000 pulse
- User Default: 20
- Changes anytime

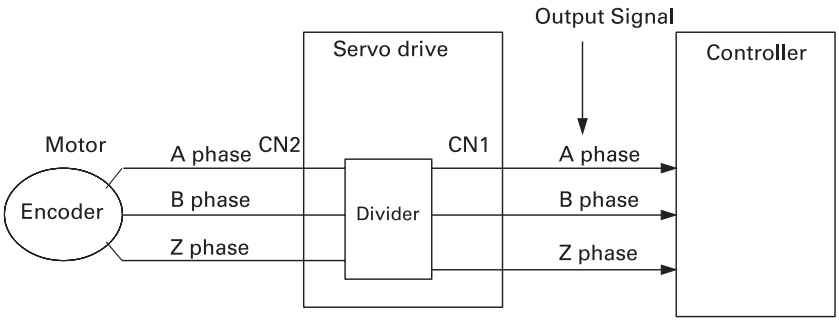
If the user sets the timing of the position command proximity at the servo drive that received the position command from the controller and the difference between the load position and the position command is smaller than the preset value, the position proximity detection signal /NEAR can be displayed.
The determination range to display the /NEAR signal is called near position range.



SEt-23 Encoder Output Ratio Numerator

- Setting range: 1 to 65535
- Factory Default: 2500
- Changes while the servo is disable

The signal can be displayed after dividing the encoder input inside the servo drive. This function can be used to make a position control loop at the controller.

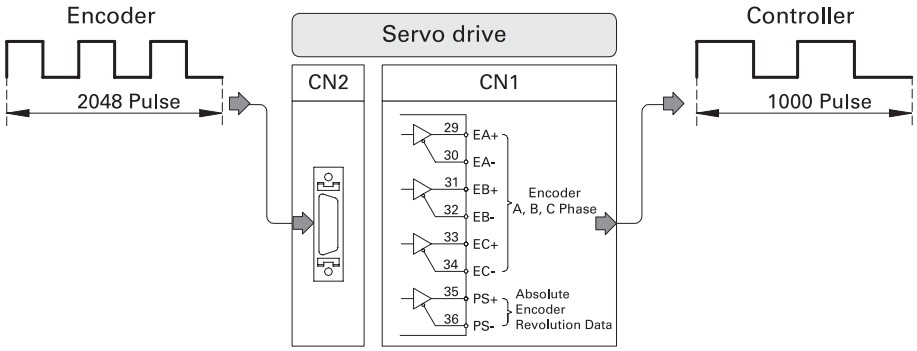


The formula to adjust the number of output pulses is as follows.

(Numerator/Denominator) × Number of Encoder Pulse = Output to the controller

If a certain type of the encoder connected to the drive produces 2048 pulses per revolution and as many as 1000 pulses per revolution should be sent to the controller, the numerator can be set to 1000 and the denominator can be set to 2048.

(1000/2048) × 2048 = 1000



SEt-24 Encoder Output Ratio Denominator

- Setting range: 1 to 65535 pulse
- Factory Default: 2500
- Changes while the servo is OFF

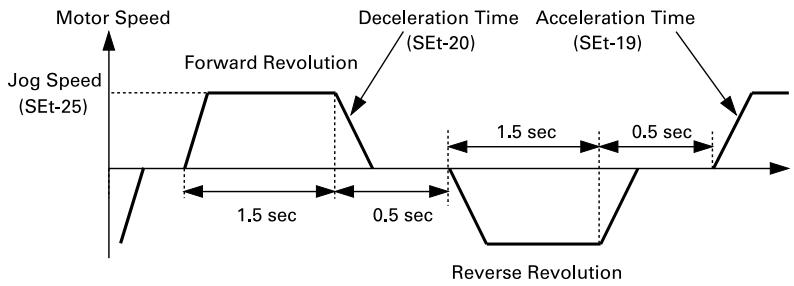
ATTENTION

The servo drive output pulse cannot output to the outside A and B phase pulses higher than the number of encoder pulses per the motor's revolution. If the motor-mounted encoder generates 2048 PPR, the pulse from the servo drive to the outside cannot exceed 2048 pulses per the motor's revolution.

SEt-25 Jog Command Speed

- Setting range: 0 to 5000 RPM
- User Default: 500
- Changes anytime

This parameter is the command speed for a jog operation or a pilot operation.



SEt-26 Internal Speed Command 1

Internal Speed Command 1

- Setting range: 0 to 5000 RPM
- User Default: 100
- Changes anytime

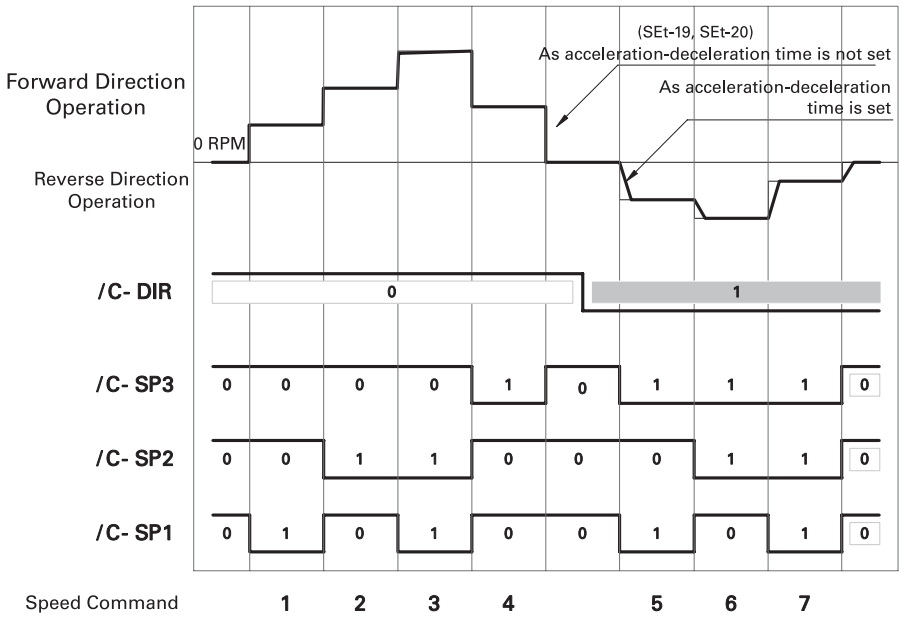
There are four different input signals dedicated to multi level speed control.

- /C-DIR
- /C-SP1
- /C-SP2
- /C-SP3

The revolution direction is forward direction when /C-DIR signal is OFF, reverse direction when it is ON.

/C-SP1, /C-SP2, /C-SP3 signals can be combined in eight different ways for which revolution speed can be determined. The motor's revolving direction can be controlled separately by engaging /C-DIR input to each speed designated to each speed command parameter.

In the multi level speed control mode, the motion of the motor changes according to the input signal.



Set the acceleration time and deceleration time within the range that won't undermine the response of the system in order to ease the impact of speed change.

SEt-27 Internal Speed Command 2

Internal Speed Command 2

- Setting range: 0 to 5000 RPM
- User Default: 200
- Changes anytime

SEt-28 Internal Speed Command 3

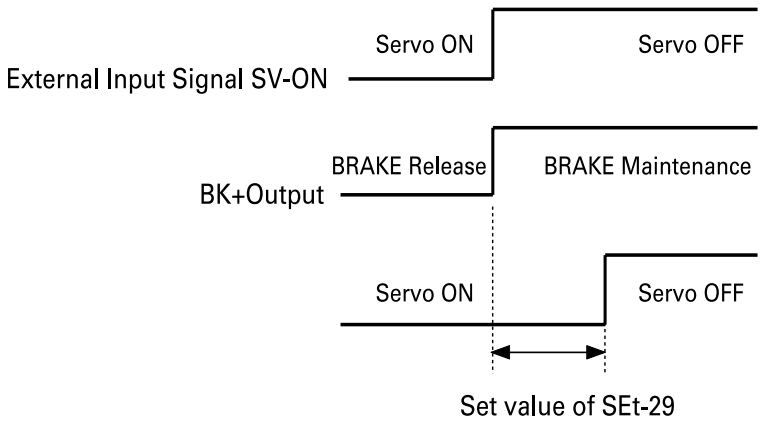
Internal Speed Command 3

- Setting range: 0 to 5000 RPM
- User Default: 300
- Changes anytime

SEt-29 Servo OFF Delay Time

- Setting range: 0 to 1000 10ms
- User Default: 0
- Changes while the servo is OFF

This parameter is the delay time from the moment of the servo OFF command to the point when the command is executed.



The parameter switches on the BK signal if the servo OFF signal is received when the motor stops, maintains the servo ON status internally for the time set at SEt-29 from the moment it receives the servo OFF signal, and switches the servo OFF after the preset time is passed.

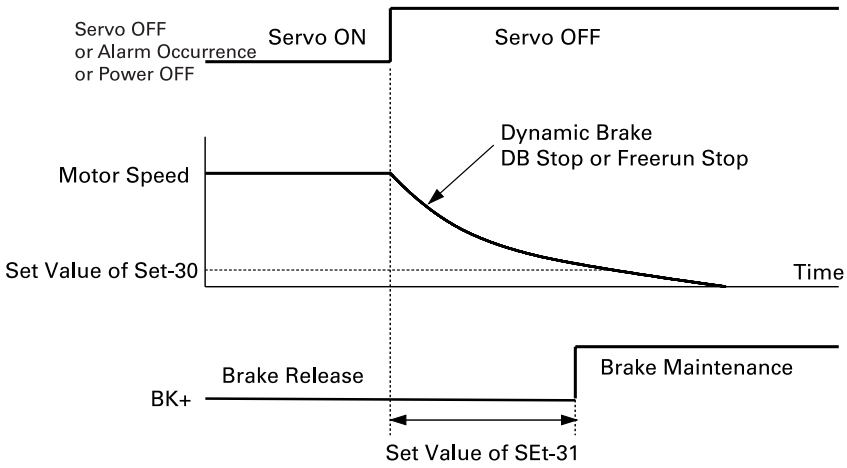
ATTENTION

The brake mounted on the motor cannot be used to actually stop the system. Use it only for the purpose of maintaining the stopped motor at a standstill.

SEt-30 Braking Application Speed After Servo OFF

- Setting range: 0 to 1000 RPM
- User Default: 100
- Changes while the servo is OFF

This parameter is the motor speed at the moment when the servo OFF command is received during revolution and the servo starts producing brake signals.



The brake signal will be produced if the motor speed is smaller than the set value of the parameter or the time set at SEt-31 passed after the servo is OFF.

SEt-31 Brake Active Delay Time After Servo OFF

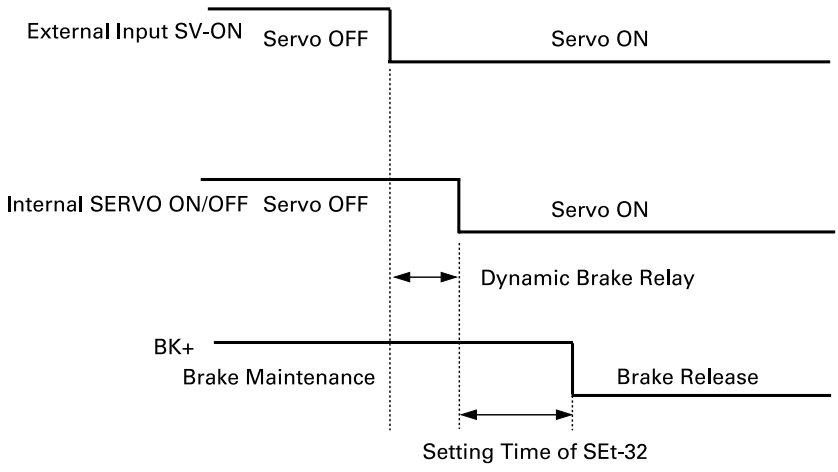
- Setting range: 0 to 1000 10ms
- User Default: 50
- Changes while the servo is OFF

This parameter is the time needed for the servo to produce a brake signal output from the moment servo OFF command is received during revolution. The brake signals will be produced if the motor speed is below the set value of the brake output starting speed (SEt-30) after the servo stopped, even if the time set at SEt-3 has not passed since the moment the servo was OFF.

SEt-32 Brake Inactive Delay Time After Servo ON

- Setting range: 0 to 1000 10ms
- User Default: 0
- Changes while the servo is OFF

When switching off the servo while the motor is stopped, if the load moves a little because of gravity set the delay time at this parameter from the moment when the servo OFF signal is received to the moment when the servo is actually switched OFF.



ATTENTION Excessive delay time can cause malfunction of the servo drive.

SEt-33 Following Error Level

- Setting range: 0 to 65535 pulse
- User Default: 25000
- Changes anytime

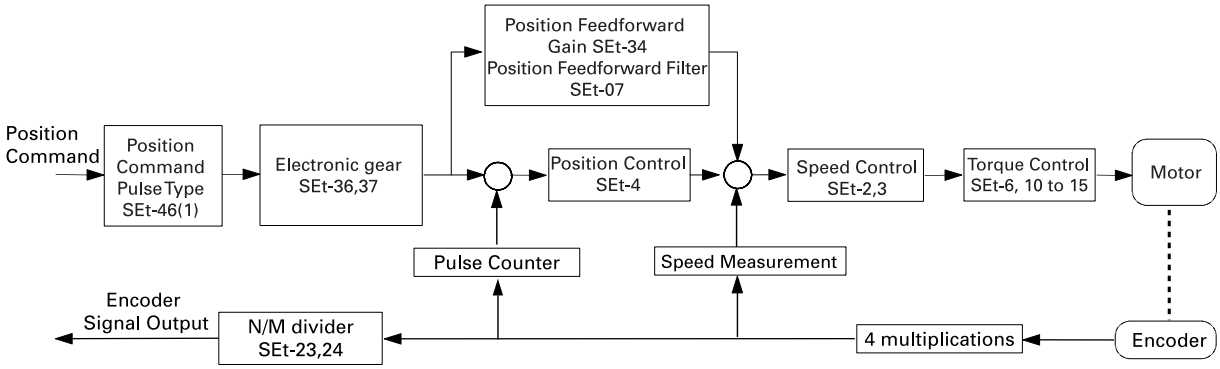
Following error (E.33) occurs when the difference between the position command and the actual movement position is higher than the set value of the parameter.

SEt-34 Position Feedforward Gain

- Setting range: 0 to 100%
- User Default: 0
- Changes anytime

This parameter is the feedforward ratio to the speed value, which is the differentiated position command.
If the set value is higher, position error gets lower and the position completion can be done quickly. But if the set value is too high, there can be vibration in the system. If 0 is set as the parameter, the feedforward function won't be activated.

Please refer to the diagram below for the usage and setting position of SEt-34.



SEt-35 Position Command Filter

- Setting range: 0 to 5000 rad/s
- User Default: 0
- Changes anytime

This parameter is the cut-off frequency of the position command in the low-frequency range.

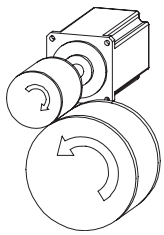
SEt-36 Electronic Gear Ratio Numerator

- Setting range: 1 to 65535 pulse
- Factory Default: 2500
- Changes while the servo is OFF

An encoder generating 2048 pulses per revolution can make a complete revolution when the controller transmits 2048 pulses to the drive. If the electronic gear is used, only 1000 pulses can make the encoder finish a complete revolution.

In order to use an electronic gear, the speed reduction ratio from the motor shaft to the system is needed.

$$\text{Speed Reduction Ratio} = \frac{\text{Number of revolution of motor}}{\text{Number of revolution of system}}$$

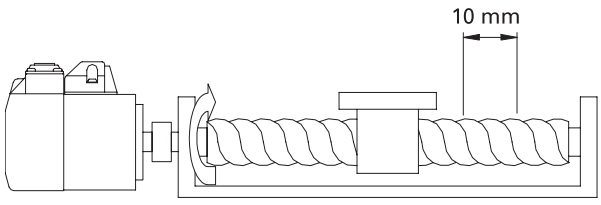


The speed reduction ratio is the ratio of revolutions of the system to the motor. If the system make one revolution when the motor makes five revolutions, the speed reduction ratio is 5. If the system make five revolutions when the motor revolves once, then the speed reduction ratio is 0.2.

The numerator and denominator of the electronic gear can be calculated as below.

Numerator = Number of pulses of the encoder × Speed reduction ratio
Denominator = Number of pulses per one revolution of the motor

In case of a ball screw whose speed reduction ratio is 1 and the number of pulses of the encoder per one revolution is 5000, if the controller approves 1000 pulses for the servo drive to make the motor finish one revolution, the numerator of the electronic gear is 5000 and the denominator is 1000.



The ball screw finishes one revolution with 1000 pulses and thus a ball screw with 10 mm pitch can move 10 μm with one pulse command.

SEt-37 Electronic Gear Ratio Denominator

- Setting range: 1 to 65535 pulse
- Factory Default: 2500
- Changes while the servo is OFF

ATTENTION

As the denominator increases, the resolution becomes higher. But the following expression should be satisfied.

Pulse of the encoder × Speed reduction ratio × 4 ≥ Denominator

In this case, the maximum denominator is 20000.

SEt-38 Speed Bias

- Setting range: 0 to 450 RPM
- User Default: 0
- Changes anytime

A method to reduce the position completion time in the position control mode by adding bias to speed command depending on the position error. When this function is used, position error can be reduced quickly as faster speed command are issued to reduce error at the area with large position error. This has the same effect as when a relatively higher position proportional gain is applied to an area with large position error, and by doing so, the position completion time near the steady state can be reduced.

SEt-39 Speed Bias Application Range

- Setting range: 0 to 250 pulse
- User Default: 10
- Changes anytime

If the absolute value of position error is higher than the preset value of the speed bias application range, the speed command equal to the preset value of the speed bias amount will be added to the position control output. Please adjust the speed bias amount and the speed bias application range alternately while watching transient response. If the speed bias amount is set too high or the speed bias application range is set too low, vibration can occur.

SEt-40 Speed Command Filter

- Setting range: 0 to 40000 rad/s
- User Default: 1000
- Changes anytime

The set value of this parameter suppress the high frequency element of the speed command.

SEt-41 Control Mode Selection

- Setting range: 0 to 15
- Factory Default: 0
- Change while the servo is OFF, and turn off the power and turn it back on

Control Mode List

Setting	Control Mode	/C-SEL OFF	/C-SEL ON
0	Position Mode		
1	Speed Mode		
10	Direction Change Speed Mode		
12	Torque Limit Speed Mode		
5	Zero Clamp Mode		
2	Torque Mode		
3	Multi-level Speed Mode		
9	Speed Limit Torque Mode	Speed Limit Torque Mode	Torque Mode
6	Torque + Speed Mode	Torque Mode	Speed Mode
7	Position + Torque Mode	Position Mode	Torque Mode
8	Position + Speed Mode	Position Mode	Speed Mode
13	Position + Multi-level Speed Mode	Position Mode	Multi-level Speed Mode
14	Speed + Multi-level Speed Mode	Speed Mode	Multi-level Speed Mode
15	Torque + Multi-level Speed Mode	Torque Mode	Multi-level Speed Mode

In the direction change speed mode /C-DIR signal changes the revolving direction of the motor.

SEt-42 System Gain

- Setting range: 0 to 300 Hz
- User Default: 40
- Changes anytime

System gain is the same with the bandwidth of the overall speed control loop of the servo drive. This gain can control the five basic gains at the same time.

Basic gain is categorized in five items that are essential for tuning.

- Speed Loop Proportional Gain (Nms, SEt-02)
- Speed Loop Integral Gain (Nms^2, SEt-03)
- Position Loop Proportional Gain (rad/s, SEt-04)
- Torque Command Filter (rad/s, SEt-06)
- Speed Command Filter (rad/s, SEt-40)

When this parameter is set, the values of the basic gain will change after referring to the inertia ratio (SEt-66).

ATTENTION

The value set last has the highest priority in the gain setting. For instance, even if the system gain (SEt-42) is set and the value of the speed loop proportional gain changed, setting new speed loop proportional gain (SEt-02) will make the new value valid.

As the valueis set higher, the response improves. But if the value is too high for the load condition, vibration or noise can be generated.

SEt-43(1) Servo Enable Method

- Setting range: 0 x 0 to 0 x 1
- User Default: 0 x 0
- Change while the servo is OFF, and turn off the power and turn it back on

The set values are as follows.

0: Servo ON by the external input signal (SV-ON)
1: Always Servo ON

SEt-43(2) P-OT Signal Function Selection

- Setting range: 0 x 0 to 0 x 1
- User Default: 0 x 1
- Change while the servo is OFF, and turn off the power and turn it back on

The set values are as follows.

0: Forbid forward revolution with P-OT signal
1: Always approve forward revolving operation

SEt-43(3) N-OT Signal Function Selection

- Setting range: 0 x 0 to 0 x 1
- User Default: 0 x 1
- Change while the servo is OFF, and turn off the power and turn it back on

The set values are as follows.

0: Forbid reverse revolution with N-OT signal.
1: Always approve reverse revolving operation

SEt-43(4) TG-ON Signal Function Selection

- Setting range: 0 x 0 to 0 x 1
- User Default: 0 x 0
- Change while the servo is OFF, and turn off the power and turn it back on

The set values are as follows.

0: ON when the speed is faster than the zero speed level (SEt-16)
1: ON when the current is higher than the current limit
(SEt-10, SEt-11, SEt-12, SEt-13)

SEt-44(1) Dynamic Brake

- Setting range: 0 x 0 to 0 x 1
- User Default: 0 x 0
- Changes while the servo is OFF

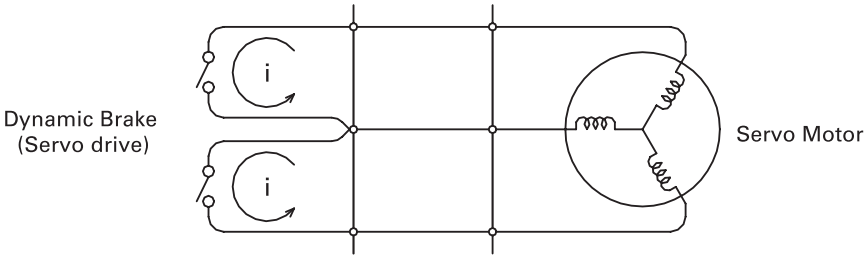
The set values are as follows.

0: Stop the motor with dynamic brake
1: Stop the motor with free run

If a motor shaft is revolved manually after short-circuiting all the motor cables (U, V, W) of the servo motor, the revolving load is higher than when the cables are not short-circuited. The drive uses this feature to stop the motor. When the servo drive uses this feature to stop the motor, it is called dynamic brake.

CSDP Plus servo drive has internal dynamic brake circuit.

If the motor cable is connected to the servo drive and the servo drive is not enabled, the switch in the diagram below is short-circuited. This means dynamic brake is working. And the servo drive can activate dynamic brake by controlling the switch of dynamic brake according to the parameter setting.



ATTENTION

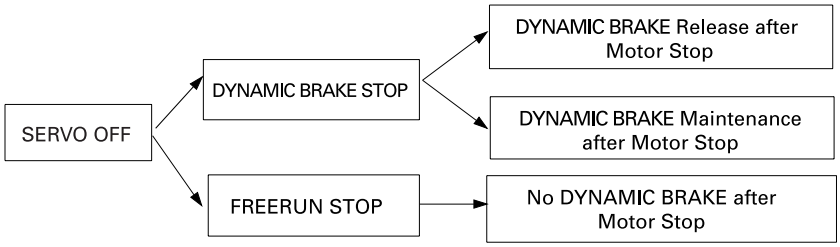
Dynamic brake cannot be used with the motor stop method which uses normal torque control.

SEt-44(2) Dynamic Brake After the Motor Stopped

- Setting range: 0 x 0 to 0 x 1
- User Default: 0 x 1
- Changes while the servo is OFF

The set values are as follows.

0: Disable the dynamic brake after the motor stopped
1: Keep the dynamic brake ON after the motor stopped



SEt-44(3) Emergency Stop Method

- Setting range: 0 x 0 to 0 x 1
- User Default: 0 x 0
- Changes while the servo is OFF

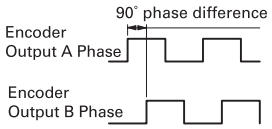
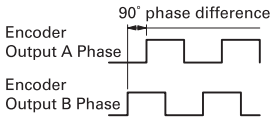
The set values are as follows.

0: Stop by emergency stop torque (SEt-14, SEt-15)
1: Stop by 0 torque (PWM OFF)

SEt-44(4) Encoder Output Pulse Direction

- Setting range: 0 x 0 to 0 x 1
- User Default: 0 x 0
- Changes while the servo is OFF

The set values are as follows.

Set Value	Function
0	In the forward revolution, encoder output A phase is produced 90 degress in advance. 
1	In the reverse revolution, encoder output B phase is produced 90 degrees in advance. 

SEt-45(1) Main Power Supply Type

- Setting range: 0 x 0 to 0 x 1
- User Default: 0 x 0
- Change while the servo is OFF, and turn off the power and turn it back on

The set values are as follows.

0: 3-phase Input
1: Single phase Input

SEt-45(2) Speed Command Offset Auto Adjustment

- Setting range: 0 x 0 to 0 x 1
- User Default: 0 x 0
- Changes while the servo is OFF

The set values are as follows.

0: Analog Speed Command Offset
1: Current Offset when the servo is OFF
2: Current Offset when the servo is ON

SEt-45(3) Speed Limit Method

- Setting range: 0 x 0 to 0 x 3
- User Default: 0 x 0
- Changes while the servo is OFF

The set values are as follows.

0: Motor Maximum Speed
1: SEt-67 Value
2: Analog Speed Command
3: The smaller value between the motor maximum speed and SEt-67

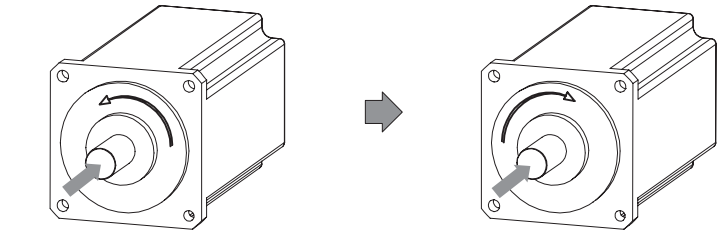
SEt-45(4) Motor Revolving Direction

- Setting range: 0 x 0 to 0 x 1
- User Default: 0 x 0
- Changes while the servo is OFF

This parameter determines the revolving direction of the motor. The set values are as follows.

0: Forward Direction
1: Reverse Direction

Forward direction is counterclockwise when the motor is looked at from the front. Reverse direction is clockwise when looked at from the front.



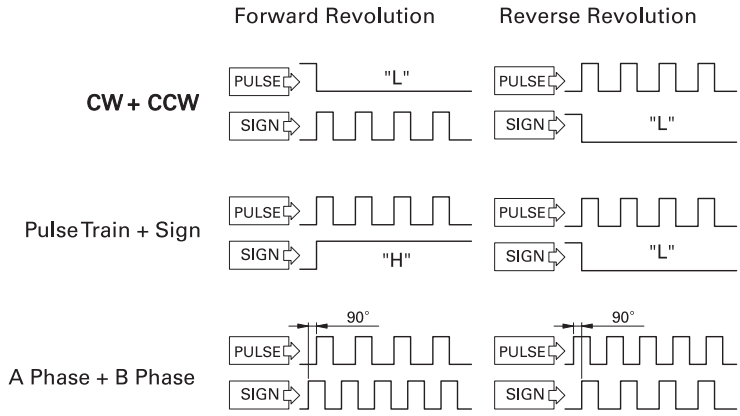
Forward Revolution Motion Reverse Revolution Motion

SEt-46(1) Position Command Pulse Type

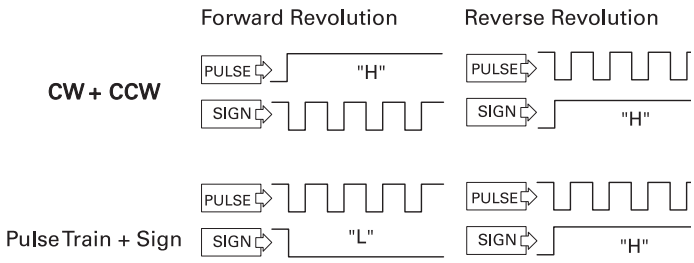
- Setting range: 0 x 0 to 0 x 9
- User Default: 0 x 0
- Changes while the servo is OFF

The set values are as follows.

0: Positive Logic CW + CCW
1: Negative Logic CW + CCW
2: Positive Logic A Phase + B Phase 1 Multiplication
4: Positive Logic A Phase + B Phase 2 Multiplication
6: Positive Logic A Phase + B Phase 4 Multiplication
8: Positive Logic Sign + Pulse
9: Negative Logic Sign + Pulse



Positive Logic Pulse



Negative Logic Pulse

SEt-46(2) Speed Command Unit

- Setting range: 0 x 0 to 0 x 1
- User Default: 0 x 0
- Changes while the servo is OFF

This parameter determines the unit for setting the speed command gain (SEt-01). The set values are as follows.

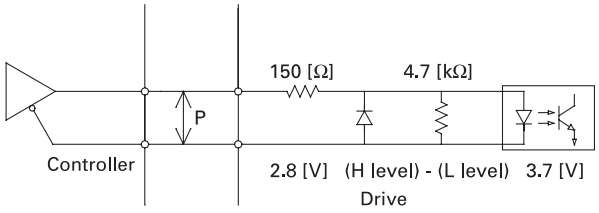
0: RPM/1V
1: RPM/10V

SEt-46(3) Position Command Input Circuit Type

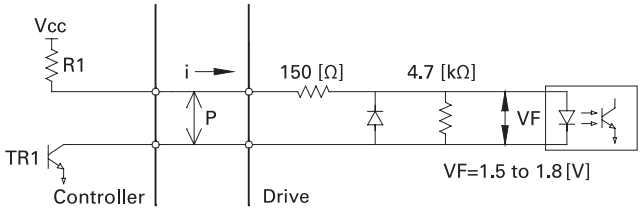
- Setting range: 0 x 0 to 0 x 1
- User Default: 0 x 0
- Changes while the servo is OFF

The set values are as follows.

0: Line Drive
1: Open Collector



Line Drive Input



Open Collector Input

SEt-46(4) Speed Observer Selection

- Setting range: 0 x 0 to 0 x 1
- User Default: 0 x 0
- Change while the servo is OFF, and turn off the power and turn it back on

The set values are as follows.

0: Use the embedded observation algorithm
1: Do not use the embedded observation algorithm

SEt-47 Notch Filter

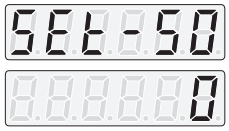
- Setting range: 0 to 10000 Hz
- User Default: 10000
- Changes anytime

This parameter suppress the torque command of setting frequency area and vibration caused by resonance. The resonance frequency can vary according to the load and if it is set properly, the system gain can be raised more. If the newly-set frequency is different from the resonance frequency of the load, vibration or noise can be generated.

SEt-48 Password

- Setting range: 0 to 9999
- User Default: 0
- Changes anytime

SEt-50 (1) Serial Encoder Type



- Setting range: 0 x 0 to 0 x 1
- Factory Default: 0 x 0
- Change while the servo is OFF, and turn off the power and turn it back on

The set values are as follows.

0: Serial Absolute Encoder
1: Serial Incremental Encoder

External battery should be equipped to use serial absolute encoder. This parameter can be used to use the serial absolute encoder without external battery.

SEt-50 (2) In/Output Signal Status Display

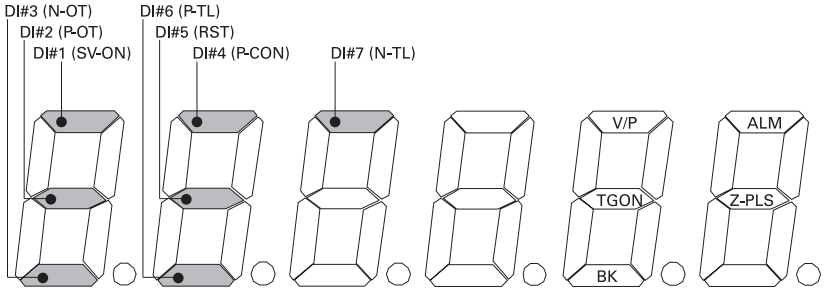
- Setting range: 0 x 0 to 0 x 1
- Factory Default: 0 x 0
- Change while the servo is OFF, and turn off the power and turn it back on

The set values are as follows.

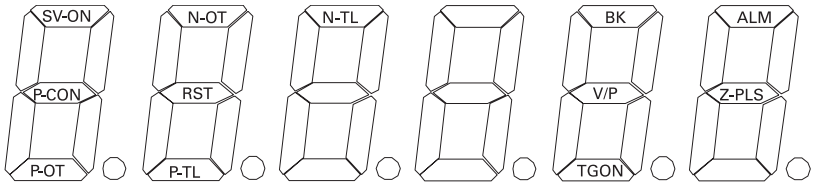
0: Display by the CSDP+ method
1: Display by the CSDP method

To choose the CSDP display method for previous CSDP users at Con-12 put 1 for the parameter. To choose the CSDP Plus method, put 0 for the parameter.

When the second digit of SEt-50 is set to 0, the in/output signal status of Con-12 will be displayed as below.



When the parameter is 1, it will be displayed as below.



SEt-50 (3) Parameter Fixiation

- Setting range: 0 x 0 to 0 x 1
- Factory Default: 0 x 0
- Change while the servo is OFF, and turn off the power and turn it back on

The set values are as follows.

0: Parameter Change Enabled
1: Parameter Change Disabled

SEt-50 (4) Parameter Initialization Type

- Setting range: 0 x 0 to 0 x 1
- Factory Default: 0 x 0
- Change while the servo is OFF, and turn off the power and turn it back on

The set values are as follows.

0: Initialize the user parameter and maintain the system related parameter
1: Initialize all the parameters

SEt-51 Encoder Type

- Setting range: 0 x 0 to 0 x 109
- Factory Default: 0 x 100
- Change while the servo is OFF, and turn off the power and turn it back on

Encoder Type Setting

Motor	Type		Encoder Type	setting
CSMD, CSMF, CSMH, CSMK, CSMS	A	2500 P/R	Inc. (11 -wire)	100
	B	2500 P/R	Inc. (15-wire)	101
	D	1000 P/R	Inc. (15-wire)	102
	H	2048 P/R	Compact Abs.	104
	M	10000 P/R	Inc. (15 -wire)	106
RSMD, RSMF, RSMH, RSMK, RSML, RSMN, RSMS, RSMX	A	2500 P/R	Inc. (9 -wire)	107
	K	5000 P/R	Inc. (15 -wire)	103
	L	6000 P/R	Inc. (15 -wire)	105
	M	10000 P/R	Inc. (15 -wire)	106
	H	2048 P/R	Compact Abs.	104
	Q	17 bit Serial Abs.		108
	R	17 bit Serial Inc.		109

SEt-52 Motor Type

- Setting range: 2222 to 2472
- Factory Default: 2312
- Change while the servo is OFF, and turn off the power and turn it back on

Motor Type Setting

Motor	setting
CSMS	2222
CSMD	2312
CSMH	2322
CSMF	2332
CSMK	2342
RSMS	2402
RSMD	2412
RSMH	2422
RSMF	2432
RSMK	2442
RSML	2452
RSMN	2462
RSMX	2472

SEt-53 Motor Capacity

- Setting range: 100 to 600 10W
- Factory Default: 150
- Change while the servo is OFF, and turn off the power and turn it back on

Motor Capacity Setting

	1.2kW	1.3kW	1.5kW	2.0kW	2.5kW	3.0kW	3.5kW	4.0kW	4.5kW	5.0kW	6.0kW
CSMD	-	-	150	200	250	300	350	400	450	500	-
CSMF	-	-	150	-	250	-	350	-	450	-	-
CSMH	-	-	150	200	-	300	-	400	-	500	-
CSMK	120	-	-	200	-	300	-	-	450	-	600
CSMS	-	-	150	200	250	300	350	400	450	500	-
RSMD	-	-	150	200	250	300	350	400	450	500	-
RSMF	-	-	150	-	250	-	350	-	450	-	-
RSMH	-	-	150	200	-	300	-	400	-	500	-
RSMK	120	-	-	200	-	300	-	-	450	-	600
RSML	120	-	-	200	-	300	-	-	450	-	600
RSMN	120	-	-	200	-	300					
RSMS	-	-	150	200	250	300	350	400	450	500	-
RSMX	-	130	-	180	-	290	-	-	440	-	-

SEt-54 Speed Integral Gain Auto Adjustment

- Setting range: 0 x 0 to 0 x 193
- User Default: 0 x 0
- Changes while the servo is OFF

When /P-CON is ON, this parameter limits the integral value of the speed error and suppress the speed overshoot. Therefore, position completition becomes fast in the position control.

The set value is displayed in three digits and the function of each decimal digit will be applied in combination.

Adjusting method will be set at the first digit. The set values are as follows.

0: Previous integral value Use
1: Auto adjustment by the reference of torque feedback value (SEt-55)
2: Auto adjustment by the reference of speed command value (SEt-56)
3: Auto adjustment by the reference of position error (SEt-57)

The value on the second digit is applied in the following way.

Value on the second digit x 0.1 x Speed integral gain

The set value on the third digit is shown below.

0: Previous Torque Command Use
1: Add Speed Command Feed Forward Value to Torque Command

SEt-55 Torque-Command for Speed Integral Gain Auto Adjustment

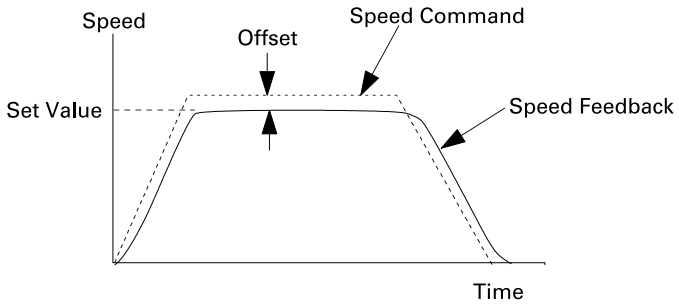
- Setting range: 0 to 300%
- User Default: 100
- Changes while the servo is OFF

If the torque feedback exceeds the set value of this parameter, speed integral gain will be automatically adjusted. This setting is effective when activating a frictionless disk load. But if the torque is higher than the set value of this parameter during normal speed operation, there can be speed error. Set this parameter higher than the torque when the motor stops.

SEt-56 Speed Command for Speed Integral Gain Auto Adjustment

- Setting range: 0 to 3000 RPM
- User Default: 100
- Changes while the servo is OFF

If the motor speed exceeds the set value of this parameter, speed integral gain will be automatically adjusted. This setting is effective for the load with friction.



The integral value will be automatically adjusted based on the set value of the speed command. There can be speed offset if the speed exceeds the set value.

SEt-57 Position Error for Speed Integral Gain Auto Adjustment

- Setting range: 0 to 10000 pulse
- User Default: 100
- Changes while the servo is OFF

If the position error exceeds the set value of this parameter, the speed integral gain will be automatically adjusted. This setting is effective for the load with friction.

SEt-58 Auto Tuning Speed

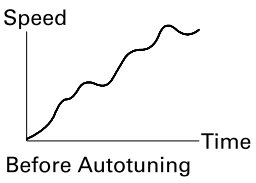
- Setting range: 0 x 0200 to 0 x 9900 RPM
- User Default: 0 x 0700
- Changes while the servo is OFF

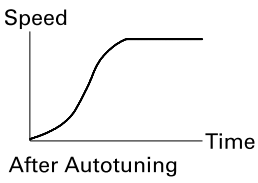
In the caseusing the online auto tuning, set the tuning coefficient on the fourth digit of SEt-58. Setting range is 0 x 0000 to 0 x 9000, initial value is 0x0. If the fourth digit is not 0, online auto tuning function will be used.
As the value is set higher, the system becomes more sensitive to load fluctuation.

ATTENTION

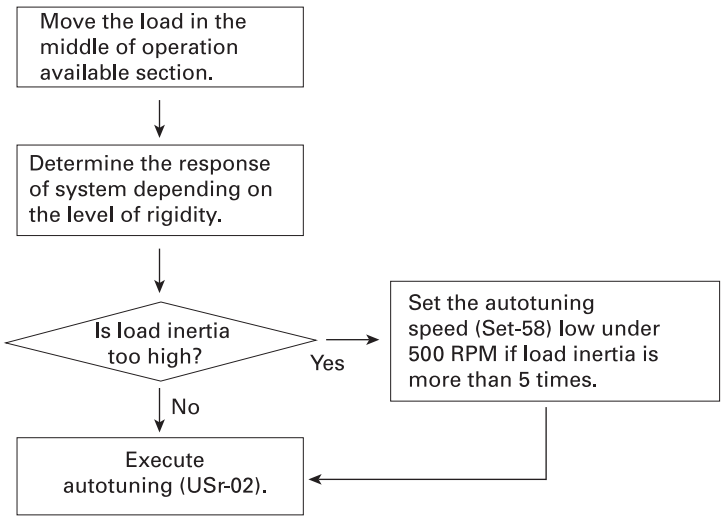
If the load fluctuates radiply, online auto tuning coefficient needs to be set high, but caution is needed because the system can be momentarily unstable in an environment where the load fluctuates excessively.

Set value on the third digit of SEt-58 is the revolution speed used in offline auto tuning. For instance, if the setting value is 8, it revolves forward and reverse 3 times when autotuned with 800 RPM.





Auto tuning is done in the following sequence.



If it is set too low compared to the load, the calculated inertia ratio can be inaccurate.

SEt-59 Input Signal Assignment 1

- Setting range: 0 x 0 to 0 x 9999
- User Default: 0 x 4321
- Change while the servo is OFF, and turn off the power and turn it back on

The input signals should be assigned to the CN1 connector's input pins from DI#1 to DI#8.

Input Signal Allocation Table

Parameter	Fourth Digit	Third Digit	Second Digit	First Digit
SEt-59	/P-CON	N-OT	P-OT	/SV-ON
SEt-60	/C-SEL	/P-TL	/N-TL	/A-RST
SEt-61	/C-SP3	/C-SP2	/C-SP1	/C-DIR
SEt-62	/A-TL	/G-SEL	/INHIB	/Z-CLP
SEt-63	/P-CLR	/R-ENC	/EMG	/ABS-DT

For instance, put 7 in the fourth digit of SEt-59 to allocate the /P-CON signal to the DI#7 pin.

Put 3 in the second digit of SEt-62 to allocate the /INHIB signal to DI#3 pin.

When 9 is set, it is always valid and when 0 is set, it is always invalid. For instance, to keep /SV-ON always valid when the power is on regardless of the wiring, put 9 in the first digit of SEt-59.

SEt-60 Input Signal Assignment 2

- Setting range: 0 x 0 to 0 x 9999
- User Default: 0 x 0765
- Change while the servo is OFF, and turn off the power and turn it back on

SEt-61 Input Signal Assignment 3

- Setting range: 0 x 0 to 0 x 9999
- User Default: 0 x 0000
- Change while the servo is OFF, and turn off the power and turn it back on

SEt-62 Input Signal Assignment 4

- Setting range: 0 x 0 to 0 x 9999
- User Default: 0 x 0000
- Change while the servo is OFF, and turn off the power and turn it back on

SEt-63 Input Signal Assignment 5

- Setting range: 0 x 0 to 0 x 9999
- User Default: 0 x 0080
- Change while the servo is OFF, and turn off the power and turn it back on

SEt-64 Forward Torque Offset

- Setting range: 0 to 100%
- User Default: 0
- Changes while the servo is OFF

Set this parameter in cases where the load moves upward vertically when the motor revolves in the forward direction. This can supplement the problem of a falling vertical load when the mechanical brake is released as the servo is ON.

SEt-65 Reverse Torque Offset

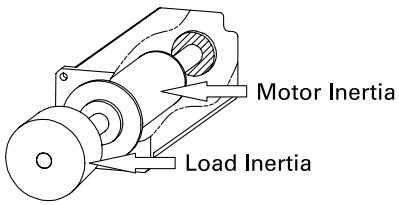
- Setting range: 0 to 100%
- User Default: 0
- Changes while the servo is OFF

Set this parameter in cases where the load increases when the load moves along the vertical axis and the motor revolves in the reverse direction. This can resolve the problem of a falling load when the mechanical brake is released after the servo is ON in case of a vertically operating load.

SEt-66 Load Inertia Ratio

- Setting range: 0 to 600 0.1 times
- User Default: 30
- Changes while the servo is OFF

The load inertia ratio estimated by auto tuning is set automatically.



In tuning, the inertia ratio should be considered first for the optimum performance of the motor connected to the servo drive. The inertia ratio is the ratio of the inertia of the load to that of the motor's rotor.

If the inertia of rotor is 3 gf.cm.s^2 and the inertia of load is 3 gf.cm.s^2, inertia ratio is 10 times.

Inertia Ratio = Inertia of the Load/Inertia of the Motor's Rotor

ATTENTION

If inertia ratio is set, servo drive changes system gain (SEt-42) and 5 basic gains according to inertia ratio. Therefore, adjustment of the inertia ratio should be done carefully.

SEt-67 Speed Limit

- Setting range: 1 to 5000 RPM
- User Default: 5000
- Changes while the servo is OFF

This parameter is the set value of internal speed limit. If this setting exceeds the maximum motor speed, it is automatically limited to maximum motor speed.

SEt-68 Maximum Torque Used

- Setting range: 0 to 1000%
- User Default: 500
- Changes anytime

The highest torque value of the torques used up to now is stored to this parameter. Even after the power is shut down, the value will remain.

SEt-69 System Bandwidth

- Setting range: 0 to 500
- Factory Default: 60
- Changes while the servo is OFF

If auto tuning is executed or user changes the inertia ratio, system gain and 5 basic gains changed after referring to the value of system bandwidth.

Basic gain is categorized in five items that are essential for tuning.

- Speed Loop Proportional Gain (Nms, SEt-02)
- Speed Loop Proportional Gain (Nms^2, SEt-03)
- Position Loop Proportional Gain (rad/s, SEt-04)
- Torque Command Filter (rad/s, SEt-06)
- Speed Command Filter (rad/s, SEt-40)

When this parameter is set, the values of the basic gain will change after referring to the inertia ratio (SEt-66).

- System Gain (SEt-42)

SEt-71 DA Monitor Channel 1 Offset

- Setting range: 0 to 1000, 10000 to 11000 mV
- Factory Default: 0
- Changes anytime

SEt-72 DA Monitor Channel 1 Output Gain

- Setting range: 0 to 1000, 10000 to 11000 mV
- Factory Default: 0
- Changes anytime

SEt-73 DA Monitor Channel 2 Offset

- Setting range: 0 to 1000, 10000 to 11000 mV
- Factory Default: 0
- Changes anytime

SEt-74 Monitor Channel 2 Output Gain

- Setting range: 0 to 1000, 10000 to 11000 mV
- Factory Default: 0
- Changes anytime

The setting of SEt-71 to 74 is used for the offset of analog monitor and the control of output gain.
As the values between 0 to 1000 mV are entered, it becomes +offset, in the case of the values between 10000 to 11000 mV, it becomes - offset. (1 on the fifth digit means '-'.)

SEt-75 Overload Curve Level

- Setting range: 50 to 300%
- User Default: 100
- Changes while the servo is OFF

The level of overload curves of driver can be controlled.

SEt-76 Output Signal Assignment 1

- Setting range: 0 x 0000 to 0 x 3333
- User Default: 0 x 0321
- Change while the servo is OFF, and turn off the power and turn it back on

Output signals to be used at the CN1 connector's output pins from DO#1 to DO#3 should be allocated.

Output Signal Allocation Table

Parameter	Fourth Digit	Third Digit	Second Digit	First Digit
SEt-76	/V-COM	/BK	/TG-ON	/P-COM
SEt-77	/WARN	/NEAR	/V-LMT	/T-LMT

Put 1 in the first digit of SEt-76 to allocate /P-COM signal to the DO#1 pin.

Put 3 in the fourth digit of SEt-77 to use /WARN function through DO#3 pin.

Setting 0 makes the system always invalid and there is no value to make the system always valid, which is different from the input case.

SEt-77 Output Signal Assignment 2

- Setting range: 0 x 0000 to 0 x 3333
- User Default: 0 x 0000
- Change while the servo is OFF, and turn off the power and turn it back on

SEt-78 DA Monitor Channel Selection

- Setting range: 0 to 2020
- User Default: 103
- Changes anytime

Set the units for the scales of the monitor channel 1 and channel 2.

Analog Monitor Output Type

Chosen Number	Types	Setting range
0	Speed Command	1 - 500 RPM
1	Torque Command	1 - 30 %
2	Position Command	1 - 5000 pulse
3	Speed Feedback	1 - 500 RPM
4	Torque Feedback	1 - 30 %
5	Position Feedback	1 - 5000 pulse
6	Position Error	1 - 2500 pulse
7	Speed Error	RPM
8	DC-link Voltage	
9	⊖ (theta_cnt) Electrical Angle	kHz
10	Pulse command Frequency	kHz
11	Inertia Ratio	%
12	Q Axis Current	A
13	D Axis Current	A
14	U Phase Current	A
15	V Phase Current	A
16	W Phase Current	A

SEt-79 Internal Speed Command 4

- Setting range: 0 to 5000 RPM
- User Default: 400
- Changes anytime

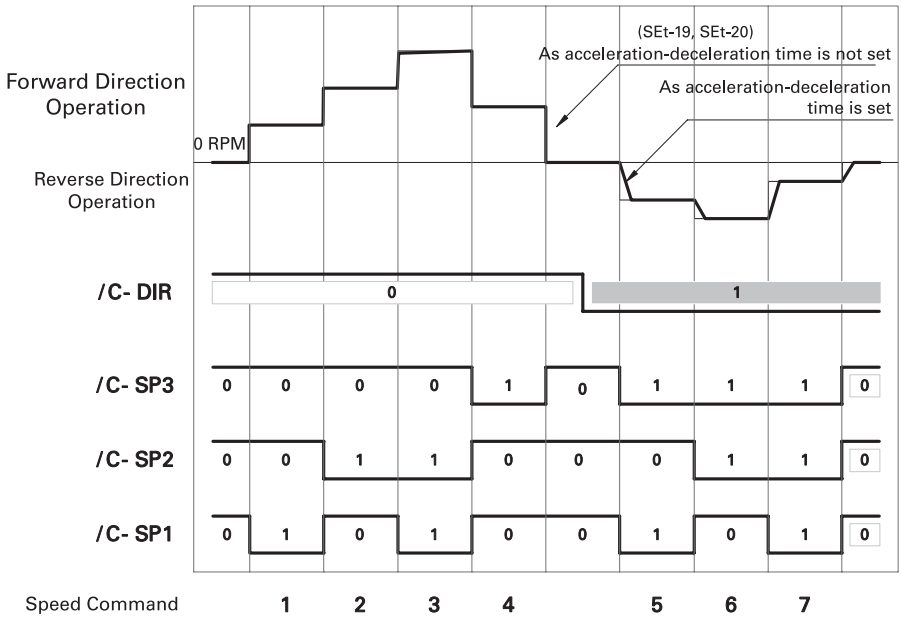
There are four different input signals dedicated to multilevel speed control.

- /C-DIR
- /C-SP1
- /C-SP2
- /C-SP3

The revolution will be in the forward direction if /C-DIR signal is OFF and in the reverse direction if the signal is ON.

/C-SP1, /C-SP2, /C-SP3 signals can be combined in eight different ways for which revolution speed can be determined. The motor's revolving direction can be controlled separately by engaging /C-DIR input to each speed designated to each speed command parameter.

In the multilevel speed control mode, the motion of the motor changes according to the input signal.



Set the acceleration time and deceleration time within the range that won't undermine the response of the system in order to ease the impact of speed change.

SEt-80 Internal Speed Command 5

- Setting range: 0 to 5000 RPM
- User Default: 500
- Changes anytime

SEt-81 Internal Speed Command 6

- Setting range: 0 to 5000 RPM
- User Default: 600
- Changes anytime

SEt-82 Internal Speed Command 7

- Setting range: 0 to 5000 RPM
- User Default: 700
- Changes anytime

Appendix B

Motor Specifications

CSMD Motor

Basic Specifications

Relevant Drive CSDP		15BX2	20BX2	30BX2		40BX2		50BX2	
Rated Voltage	V	220							
Rated Output	kW	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Rated Torque	Kgf· cm N: M	73 1.15	97.4 9.54	121 11.86	146 14.3	169 16.6	192 18.8	219 21.4	243 23.8
Maximum Instantaneous Torque	Kgf· cm N: M	219 21.5	292 28.5	363 35.6	438 42.9	510 50.0	576 56.4	657 64.3	729 71.4
Rated Speed	RPM	2000							
Maximum Speed	RPM	3000							
ROTOR INERTIA	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}§^3{\cdot}10^{-4}$	11.4 11.2	15.5 15.2	19.6 19.2	22.8 22.3	36.6 35.9	43.4 42.5	51.6 50.6	61.9 60.7
ROTOR INERTIA (When Brake is Attached)	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^2 10^{-4}$	13.6 12.3	17.0 16.7	21.5 21.1	25.1 24.6	41.0 40.2	47.8 46.8	56.7 55.6	68.1 66.7
POWER RATE	kW/s	45.8	60.0	73.2	91.6	76	83.2	91.1	93.5
Mechanical Time Parameter	ms	0.81	0.75	0.72		1.0			0.9
Electrical Time Parameter	ms	19	21		20	24		30	32
Rated Current	A (rms)	9.4	12.3	14	17.8	18.7	23.4	26.2	28
Maximum Instantaneous Current	A (rms)	28.2	36.9	42	53.4	56.1	70.2	78.6	84
Axial Play	mm MAX	0.3							
Allowed thrust load during operation	Kgf MAX	20		35					
Allowed Radial Load during Operation	Kgf MAX	50		80					

Relevant Drive CSDP-		15BX2	20BX2	30BX2		40BX2		50BX2	
Allowed Thrust Load while Coupling	Kgf MAX	60				80			
Allowed Radial Load while Coupling	Kgf MAX	100				170			
Weight (When Brake is Attached)	Kg	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
Revolving Direction		U → V → W							
Color		Black							
Oil Seal		Embedded							

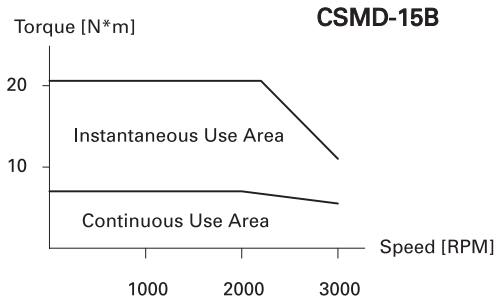
Item	Specifications	Item	Specifications
Wiring Method	Y Wiring	Time Rating	Continuous Use
Operating Temperature Range	0 to +40 °C	Insulation Grade	F Grade
Storage Temperature Range	-20 to +80 °C	Dielectric Voltage	1500V AC 60 sec.
Insulation resistance	500V DC 20MΩ	When Brake is Attached	1200V AC 60 sec.
Number of Poles	8-Pole	Excitation Method	Permanent Magnet
Vibration	49 m/s^2 (24.5 when stopped)	Mounting Method	FLANGE
Shock	98 m/s^2 3 Times	Operating Humidity	85% or less (Non-Condensing)

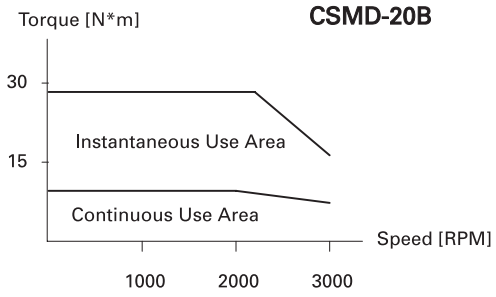
Brake Specifications

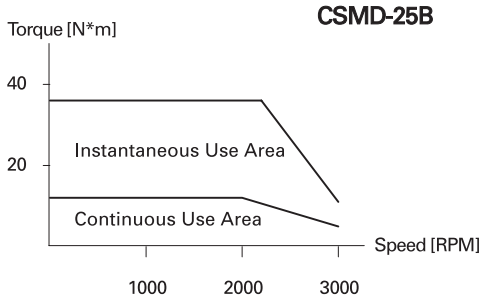
CSMD Motor Brake Specifications

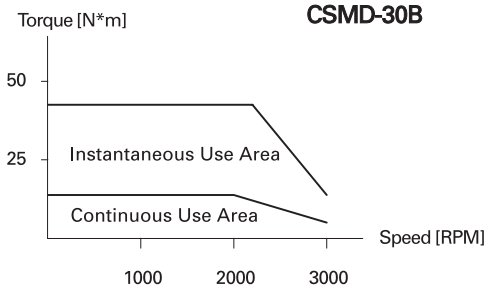
CSMD		15B, 20B	25B, 30B	35B, 40B	45B, 50B
Friction Torque	nm Kgf·cm	13.7 or more 140	16.1 or more 165	21.5 or more 220	24.5 or more 250
Rotor INERTIA	$Kg·m^2·10^{-4}$ $Kg·cm·s^2$	1.35 1.38		4.25 4.34	9.0 9.18
Brake Pull In Time	ms	100 or less	110 or less	90 or less	80 or less
Brake Release Time	ms	50 or less		35 or less	25 or less
Release Voltage	V DC	2 or more			
Rated Voltage	V DC	24±2.4			
Rated Current	A	0.79±10%	0.90±10%	1.1±10%	1.3±10%
Allowed BRAKE Energy: Once	J Kgf·m	1176 120	1470 150	1078 110	1372 140
Overall Allowed BRAKE Energy	J Kgf·m	$1.5*10^6$ $1.5*10^5$	$2*10^6$ $2.2*10^5$	$2.4*10^6$ $2.5*10^5$	$2.9*10^6$ $3*10^5$

Speed Torque Curve

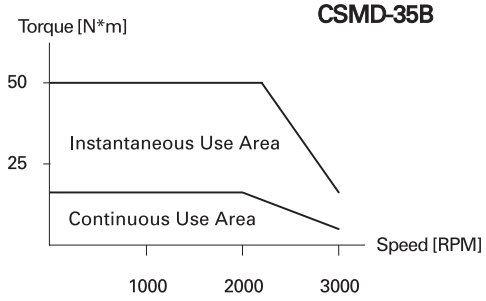




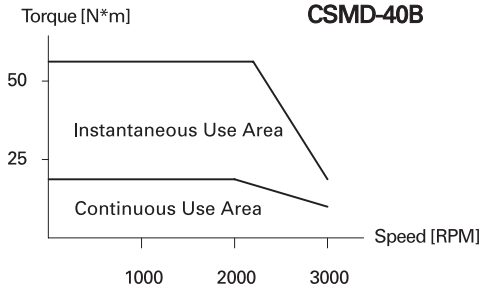




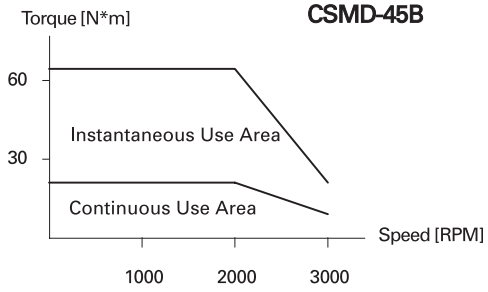
CSMD-35B



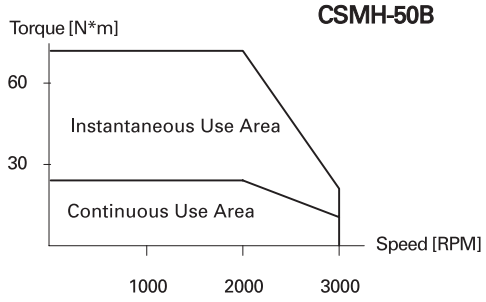
CSMD-40B



CSMD-45B



CSMH-50B



CSMS Motor

Basic Specifications

CSMS Motor Specifications

Relevant Drive CSDP-		15BX2	20BX2	30BX2		40BX2		50BX2	
Rated Voltage	V	220							
Rated Output	kW	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Rated Torque	Kgf·cm N:M	48.7 4.77	64.9 6.36	81 7.94	97.3 9.54	113 11.07	129 12.64	146 14.31	162 15.88
Maximum Instantaneous Torque	Kgf·cm N:M	146 14.31	195 19.11	243 23.81	292 28.62	339 33.22	387 37.93	483 42.92	486 47.63
Rated Speed	RPM	300							
Maximum Speed	RPM	5000					4500		
ROTOR INERTIA	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}§^3{\cdot}10^{-4}$	2.64 2.59	3.53 3.46	4.40 4.31	6.91 6.77	8.06 7.90	13.0 12.7	15.6 115.3	18.2 17.8
ROTOR INERTIA (When Brake is Attached)	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}§^3{\cdot}10^{-4}$	2.90 2.84	3.89 3.81	4.84 4.74	7.60 7.45	8.88 8.69	14.4 14.1	17.3 170	20.1 19.7
POWER RATE	kW/s	88	117	146	134	155	125	134	140
Mechanical Time Parameter	ms	0.54	0.53	0.52	0.46	0.45	0.51	0.45	0.46
Electrical Time Parameter	ms	10	10.8	11	17				
Rated Current	A (rms)	9.4	12	15.9	18.6	21.6	24.7	28	28.5
Maximum Instant Current	A (rms)	28.2	39	47.7	55.8	64.8	74.1	84	85.5
Axial Play	mm MAX	0.3							
Allowed THRUST Load during Operation	Kgf MAX	20			35				
Allowed RADIAL Load during Operation	Kgf MAX	50			80				
Alloed THRUST Load while Coupling	Kgf MAX	60							
Allowed RADIAL Load while Coupling	Kgf MAX	100							
Weight (WHEN BRAKE IS ATTACHED)	Kg	5.1 6.5	6.5 7.9	7.5 8.9	9.3 11.0	109 12.6	12.9 14.8	15.1 17.0	17.3 19.2
Revolving Direction		U → V → W							
Color		Black							
Oil Seal		Embedded							

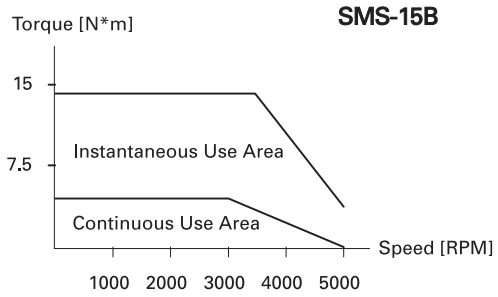
Item	Specifications	Item	Specifications
Wiring Method	Y Wiring	Time Rating	Continuous Use
Operating Temperature Range	0 to +40°C	Insulation Grade	F Grade
Storage Temperature Range	-20 to +80°C	Dielectric Voltage	1500V AC 60 sec.
Insulation resistance	500V DC 20 MΩ	When Brake is Attached	1200V AC 60 sec.
Number of Poles	8 Poles	Excitation Method	Permanent Magnet
Vibration	49 m/s^2 (When Stopped 24.5)	Mounting Method	FLANGE
Shock	98 m/s^2 3 Times	Operating Humidity	85% or less (Non-Condensing)

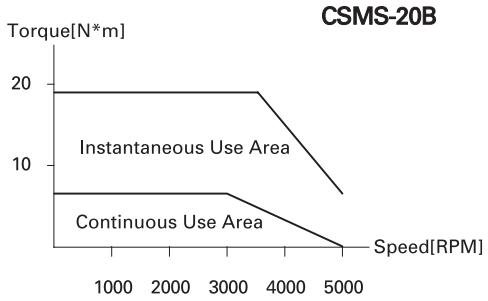
Brake Specifications

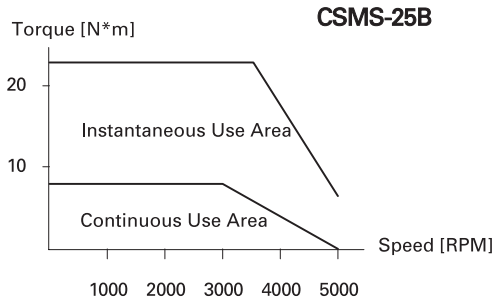
CSMS Motor Brake Specifications

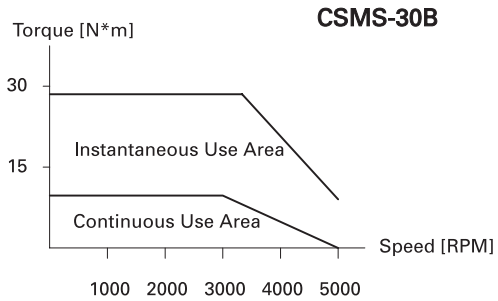
CSMS		15B to 25B	30B, 35B	40B to 50B
Friction Torque	nm Kgf·cm	7.8 or more 80	11.8 or more 120	16.1 or more 165
Rotor INERTIA	$Kg·m^2·10^{-4}$ $Kg·cm·s^2$	0.33 0.33	1.35 1.38	
Brake Pull In Time	ms	50 or less	80 or less	110 or less
Brake Release Time	ms	15 or less		50 or less
Release Voltage	V DC	2 or more		
Rated Voltage	V DC	24 ±2.4		
Rated Current	A	0.81 ±10%		0.90 ±10%
Allowed Brake Energy: Once	J Kgf·m	392 40		1470 150
Overall Allowed BRAKE Energy	J Kgf·m	$4.9*10^5$ $5*10^4$	$4.9*10^6$ $5*10^5$	$2*10^6$ $2.2*10^5$

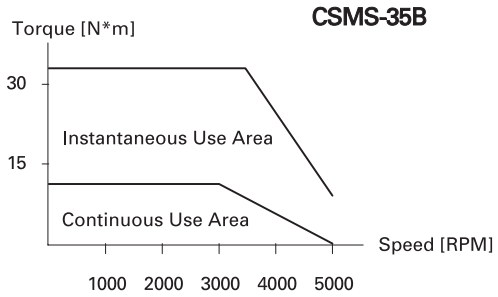
Speed Torque Curve

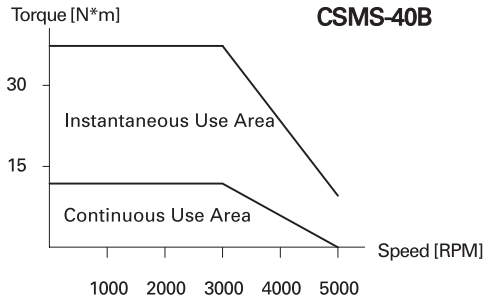


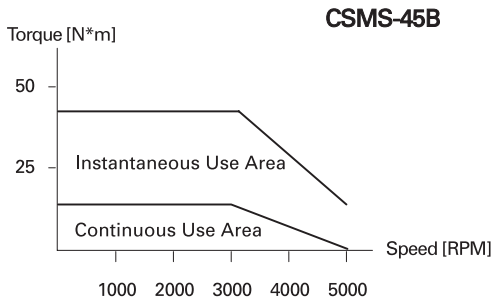


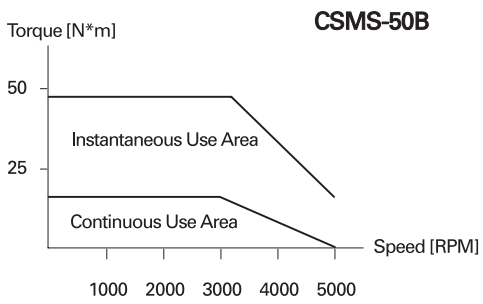





CSMS-35B
Torque [N*m]
30
15
Instantaneous Use Area
Continuous Use Area
Speed [RPM]
1000 2000 3000 4000 5000


CSMS-40B
Torque [N*m]
30
15
Instantaneous Use Area
Continuous Use Area
Speed [RPM]
1000 2000 3000 4000 5000


CSMS-45B
Torque [N*m]
50
25
Instantaneous Use Area
Continuous Use Area
Speed [RPM]
1000 2000 3000 4000 5000


CSMS-50B
Torque [N*m]
50
25
Instantaneous Use Area
Continuous Use Area
Speed [RPM]
1000 2000 3000 4000 5000

CSMH Motor

Basic Specifications

CSMH Motor Specifications

Relevant Drive CSDP-		15BX2	20BX2	30BX2	40BX2	50BX2
Rated Voltage	V	220				
Rated Power	kW	1.5	20	30	40	50
Rated Torque	Kgf· cm N:M	73 7.15	97.4 9.54	146 14.31	192 18.8	243 23.8
Maximum Instantaneous Torque	Kgf· cm N:M	219 21.5	292 28.5	483 42.9	576 56.4	729 71.4
Rated Revolving Speed	RPM	2000				
Maximum Revolving Speed	RPM	3000				
ROTOR INERTIA	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^2{\cdot}10^{-4}$	43.8 42.9	63.3 62.0	96.0 94.1	122.4 120.0	173.5 170.0
ROTOR INERTIA (WHEN BRAKE IS ATTACHED)	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^2{\cdot}10^{-4}$	45.0 44.1	69.3 67.9	102 100.0	128.6 126.0	179.6 176.0
POWER RATE	kW/s	11.9	14.7	21.8	29.5	33.4
Mechanical Time Parameter	ms	3.1	2.1	2.5	2.2	2.3
Electrical Time Parameter	ms	19	26		30	31
Rated Current	A (rms)	9.4	12.3	17.8	23.4	28.0
Maximum Instant Current	A (rms)	28.0	36.7	53.6	70.2	84.0
Axial Play	mm MAX					
Allowed Thrust Load during Operation	Kgf MAX	20	35			
Allowed Radial Load during Operation	Kgf MAX	50	80			
Allowed Thrust Load While Coupling	Kgf MAX	60	80			
Allowed Radial Load while Coupling	Kgf MAX	100	170			
Weight (WHEN BRAKE IS ATTACHED)	Kg	10.0 11.6	16.0 19.5	18.2 21.7	22.0 25.5	26.7 30.2
Revolving Direction		U → V → W				
Color		Black				
Oil Seal		Embedded				

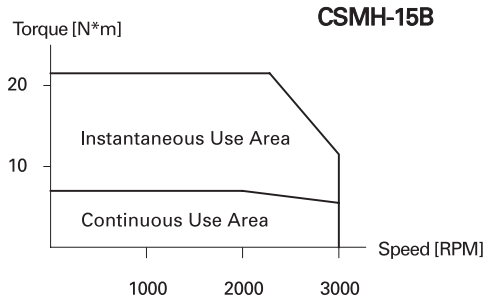
Item	Specifications	Item	Specifications
Wiring Method	Y Wiring	Time Rating	Continuous Use
Operating Temperature Range	0 to +40°C	Insulation Grade	F Grade
Storage Temperature Range	-20 to +80°C	Dielectric Voltage	1500V AC 60 sec.
Insulation resistance	500V DC 20 MΩ	When Brake is Attached	1200V AC 60 sec.
Number of Poles	8 Poles	Excitation Method	Permanent Magnet
Vibration	49 m/s^2(When Stopped 24.5)	Mounting Method	FLANGE
Shock	98 m/s^2 3 Times	Operating Humidity	85% or less (Non-Condensing)

Brake Specifications

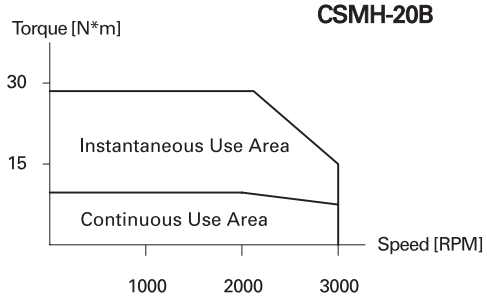
CSMH Brake Specifications

CSMH		15B	20B to 50B
Friction Torque	nm Kgf·cm	13.7 or more 140	24.5 250
Rotor INERTIA	$Kg·§^3·10^{-4}$ $Kg·cm·s^2$	1.35 1.38	9.0 9.18
Brake Pull In Time	ms	100 or less	80 or less
Brake Release Time	ms	50 or less	25 or less
Release Voltage	V DC	2 or more	
Rated Voltage	V DC	24±2.4	
Rated Current	A	0.79±10%	1.3±10%
Allowed Brake Energy: Once	J Kgf·m	1176 120	1372 140
Overall Allowed BRAKE Energy	J Kgf·m	$1.5*10^6$ $3*10^5$	$2.9*10^6$ $1.5*10^5$

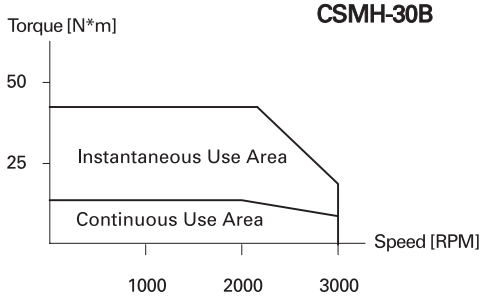
3.Speed-Torque Curve



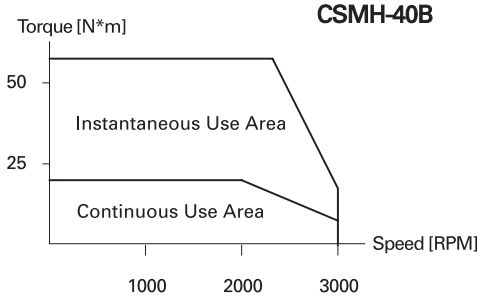
CSMH-20B



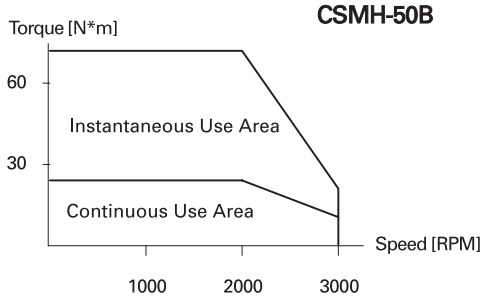
CSMH-30B



CSMH-40B



CSMH-50B



CSMF Motor

Basic Specifications

CSMF Motor Specifications

Relevant Drive CSDP-		15BX2	30BX2	40BX2	50BX2
Rated Voltage	V	220			
Rated Power	kW	1.5	2.5	3.5	4.5
Rated Torque	Kgf· cm N: M	73 7.15	121 11.86	169 16.56	219 21.46
Maximum Instantaneous Torque	Kgf· cm N: M	219 21.46	310 30.38	450 44.1	560 54.88
Rated Revolving Speed	RPM	2000			
Maximum Revolving Speed	RPM	3000			
ROTOR INERTIA	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^2{\cdot}10^{-4}$	20.5 20.1	42.1 41.3	52.7 51.6	73.8 72.3
ROTOR INERTIA (WHEN BRAKE IS ATTACHED)	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^2{\cdot}10^{-4}$	21.9 21.9	46.2 45.3	56.8 55.7	80.1 78.5
POWER RATE	kW/s	25.5	34	53.1	63.7
Mechanical Time Parameter	ms	1.4	1.3	1.06	0.88
Electrical Time Parameter	ms	25	35	41	
Rated Current	A (rms)	9.5	13.4	20	23.5
Maximum Instant Current	A (rms)	28.5	40.2	60	70.5
Axial Play	mm MAX	0.3			
Allowed Thrust Load During Operation	Kgf MAX	20	30		
Allowed Radial Load during Operation	Kgf MAX	50	80		
Allowed Thrust Load While Coupling	Kgf MAX	60	70		
Allowed Radial Load while Coupling	Kgf MAX	100	190		
Weight (WHEN BRAKE IS ATTACHED)	Kg	11 14	14.8 17.5	15.5 19.2	19.9 24.3
Revolving Direction		U → V → W			
Color		Black			
Oil Seal		Embedded			

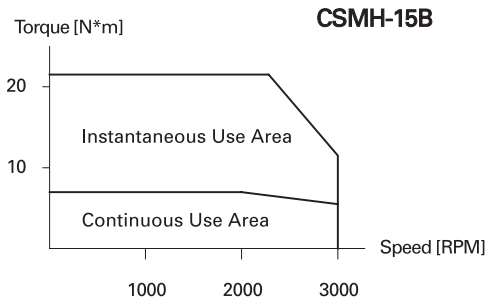
Item	Specifications	Item	Specifications
Wiring Method	Y Wiring	Time Rating	Continuous Use
Operating Temperature Range	0 to +40° C	Insulation Grade	F Grade
Storage Temperature Range	-20 to +80° C	Dielectric Voltage	1500V AC 60 sec.
Insulation resistance	500V DC 20 MΩ	When Brake is Attached	1200V AC 60 sec.
Number of Poles	8 Poles	Excitation Method	Permanent Magnet
Vibration	49 m/s^2(When Stopped 24.5)	Mounting Method	FLANGE
Shock	98 m/s^2 3 Times	Operating Humidity	85% or less (Non-Condensing)

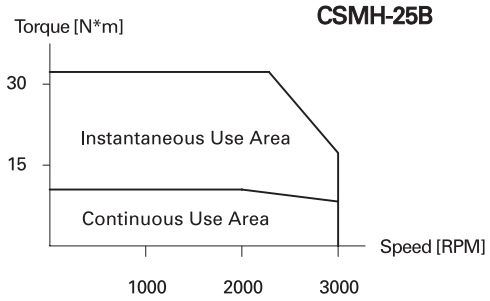
Brake Specifications

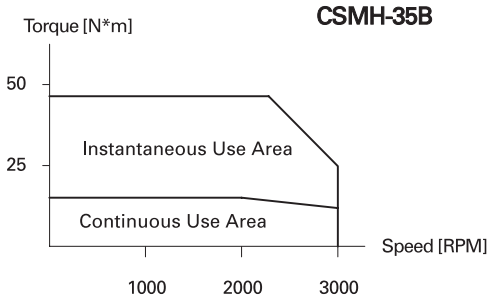
CSMF Motor Brake Specifications

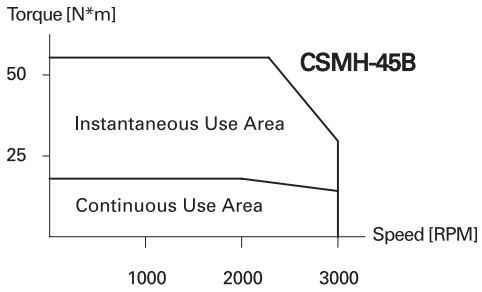
CSMF		15B	25B, 35B	45B
Friction Torque	nm Kgf·cm	7.8 or more 80	21.6D or more	31.4 or more 320
Rotor INERTIA	$Kg·m^2·10^{-4}$ $Kg·cm·s^2$	4.7 9.2	8.75 8.9	8.75 8.9
Brake Pull In Time	ms	80 or less	150 or less	
Brake Release Time	ms	35DLGK	100 or less	
Release Voltage	V DC	2 or more		
Rated Voltage	V DC	24±2.4		
Rated Current	A	0.83±10%	0.75±10%	
Allowed Brake Energy: Once	J Kgf·m	1372 140	1470 150	
Overall Allowed BRAKE Energy	J Kgf·m	$2.9*10^6$ $3*10^5$	$1.5*10^6$ $1.5*10^5$	$2.2*10^6$ $2.2*10^5$

Speed Torque Curve









CSMK Motor

Basic Specifications

CSMK Motor Specifications

Relevant Drive CSDP-		15BX2	20BX2	30BX2	50BX2	
Rated Voltage	V	220				
Rated Power	kW	1.2	2.0	3.0	4.5	6.0
Rated Torque	Kgf·cm N:M	117.2 11.5	195 19.1	289.5 28.4	437.4 42.9	583.2 57.2
Maximum Instantaneous Torque	Kgf·cm N:M	285.5 28.0	448.6 44.0	649.5 63.7	1091 107	1320 129
Rated Revolving Speed	RPM	1000				
Maximum Revolving Speed	RPM	2000				
ROTOR INERTIA (WHEN BRAKE IS ATTACHED)	$Kg \cdot §^{3} \cdot 10^{-4}$	30.4 36.2	35.5 41.4	55.7 61.7	80.9 89.2	99 108
POWER RATE (WHEN BRAKE IS ATTACHED)	kW/s	43.3 36.3	103 88.3	145 131	228 207	331 304
Mechanical Time Parameter (WHEN BRAKE IS ATTACHED)	ms	1 1.2	0.97 1.1	0.74 0.82	0.70 0.78	0.9 0.98
Electrical Time Parameter	ms	26	25	30	31	33
Rated Current	A (rms)	11.6	18.5	24	33	47
Maximum Instant Current	A (rms)	40	60	80	118	155
Axial Play	mm MAX	0.3				
Weight (WHEN BRAKE IS ATTACHED)	Kg	15.5 19	17.5 21	25 28.5	34 39.5	41 46.5
Color		Black				

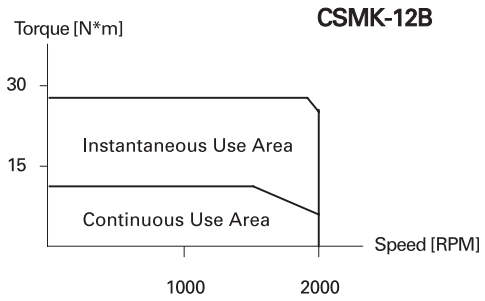
Item	Specifications	Item	Specifications
Wiring Method	Y Wiring	Time Rating	Continuous Use
Operating Temperature Range	0 to +40°C	Insulation Grade	F Grade
Storage Temperature Range	-20 to +80°C	Dielectric Voltage	1500V AC 60 sec.
Insulation resistance	500V DC 20 MΩ	When Brake is Attached	1200V AC 60 sec.
Number of Poles	8 Poles	Excitation Method	Permanent Magnet
Vibration	49 m/s^2(When Stopped 24.5)	Mounting Method	FLANGE
Shock	98 m/s^2 3 Times	Operating Humidity	85% or less (Non-Condensing)

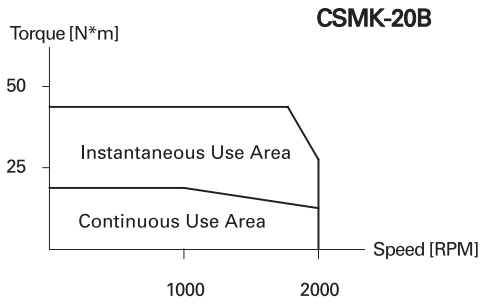
Brake Specifications

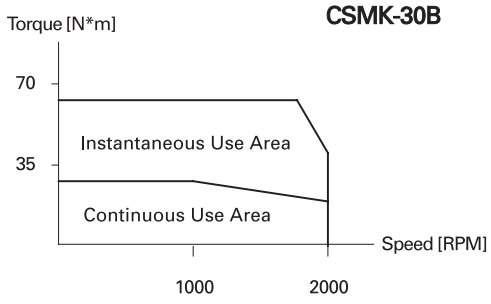
CSMK Motor Brake Specifications

CSMK		12B to 20B	30B to 60B
Friction Torque	nm Kgf·cm	24.5 or more 205	58.8 or more 600
Rotor INERTIA	Kg·§³.10^{-4}	4.7	
Brake Pull In Time	ms	80 or less	150 or less
Brake Release Time	ms	25 or less	50 or less
Release Voltage	V DC	2 or more	
Rated Voltage	V DC	24 ±2.4	
Rated Current	A	1.3 ±10%	1.4 ±10%
Allowed Brake Energy	J	140	
Overall Allowed Brake Energy	J	3* 10^5	3* 10^4

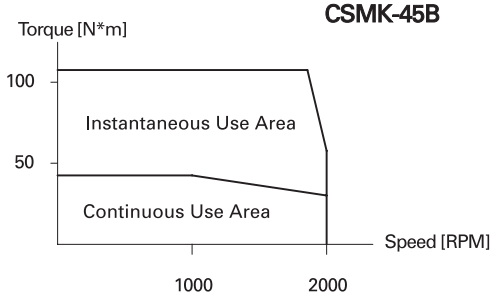
Speed Torque Curve



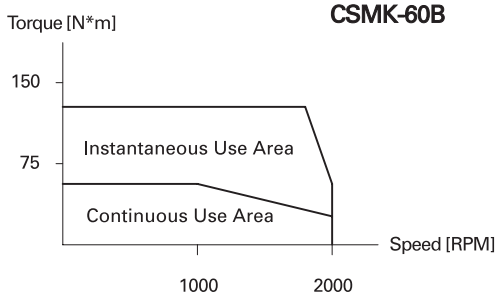




CSMK-45B



CSMK-60B



RSMD Motor

Basic Specifications

RSMD Motor Specification

Relevant Drive CSDP-		15BX2	20BX2	30BX2		40BX2	50BX2	
Rated Voltage	V	220						
Rated Power	kW	1.5	2.0	2.5	3.0	4.0	4.5	5.0
Rated Torque	Kgf· cm N: M	72.9 7.15	97.4 9.55	121 11.9	146 14.3	195 19.1	219 21.5	244 23.9
Maximum Instantaneous Torque	Kgf· cm N: M	219.2 21.5	292 28.5	363 35.5	437 42.9	576 56.4	657 64.3	729 71.4
Rated Revolving Speed	RPM	2000						
Maximum Revolving Speed	RPM	3000						
ROTOR INERTIA	gf·cm·s^{2}· Kg·m^{2}.10^{-4}	7.1 7.0	9.5 9.3	11.7 11.5	14.1 13.8	34.2 33.5	38.5 37.7	46.4 45.5
ROTOR INERTIA (WHEN BRAKE IS ATTACHED)	gf·cm·s^{2}· Kg·m^{2}.10^{-4}	8.5 8.3	10.7 10.5	13.1 12.8	15.3 15.0	38.5 37.7	43.8 42.9	51.7 50.7
POWER RATE	kW/s	74.7	100.0	124.9	151.2	111	124.8	128.3
Mechanical Time Parameter	ms	0.58	0.53	0.5	0.47	0.83	0.9	0.74
Electrical Time Parameter	ms	19	21	21	20	28	30	32
Rated Current	A (rms)	9.8	12.3	14	17.8	23.4	26.2	28
Maximum Instant Current	A (rms)	40	52.18	60	75.5	103	111	120
Axial Play	mm MAX	0.3						
Weight (WHEN BRAKE IS ATTACHED)	Kg	8.5 10.1	10.6 12.5	12.8 14.7	14.6 16.5	19.7 23.2	21.5 25.0	25.0 28.5
Revolving Direction		U → V → W: CW						
Color		Black						
Oil Seal		Embedded						

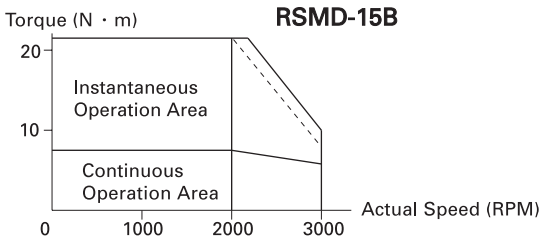
Item	Specifications	Item	Specifications
Wiring Method	Y Wiring	Time Rating	Continuous Use
Operating Temperature Range	0 to +40° C	Insulation Grade	B Grade
Storage Temperature Range	-20 to +80° C	Dielectric Voltage	1500V AC 60 sec. 1800V AC 1 sec.
Insulation resistance	500V DC 20 MΩ	Dielectric Voltage (Brake)	1200V AC 1 sec.
Number of Poles	8 Poles	Excitation Method	Permanent Magnet
Vibration	49 m/s^{2} When Stopped 24.5 m/s^{2} During Operation	Mounting Method	FLANGE
Shock	98 m/s^{2}	Operating Humidity	85% or less (Non-Condensing)

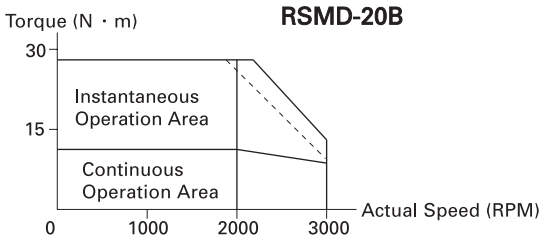
Brake Specifications

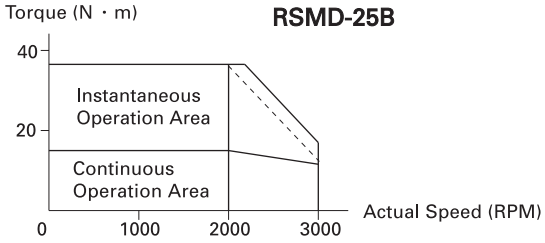
RSMD Motor Brake Specifications

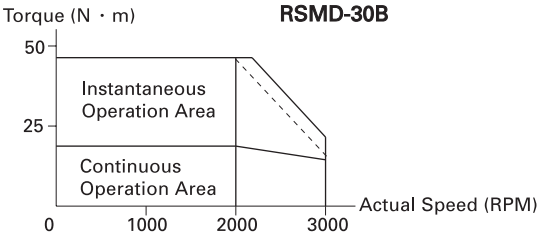
RSMD-		15B to 30B	40B	45B to 50B
Friction Torque	nm	16.5	25	45
Rotor INERTIA	$Kg \cdot §^3.10^{-4}$	1.2	4.7	11
Brake Pull In Time	ms	110	160	220
Brake Release Time	ms	50	75	100
Release Voltage	V DC	2 (at 20° C)		
Rated Voltage	V DC	24 ±2.4		
Rated Current	A	0.876	1.287	0.797
Allowed Brake Energy	J	1000	1800	2000
Overall Allowed Brake Energy	J	1.0×10^6	3.0×10^6	4.0×10^6

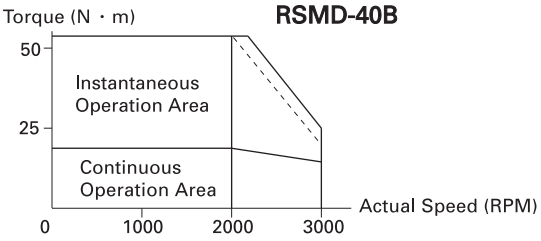
Speed Torque Curve

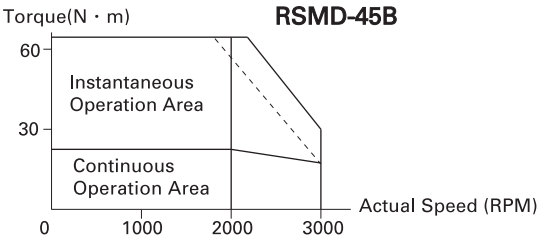


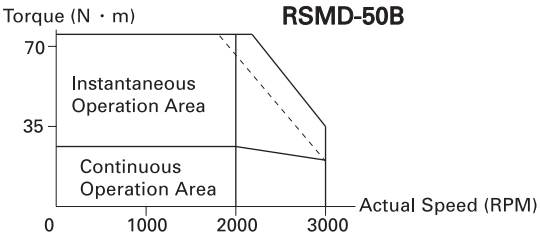





RSMD-30B
Torque (N・m)
50
25
Instantaneous
Operation Area
Continuous
Operation Area
0
1000
2000
3000
Actual Speed (RPM)


RSMD-40B
Torque (N・m)
50
25
Instantaneous
Operation Area
Continuous
Operation Area
0
1000
2000
3000
Actual Speed (RPM)


RSMD-45B
Torque(N・m)
60
30
Instantaneous
Operation Area
Continuous
Operation Area
0
1000
2000
3000
Actual Speed (RPM)


RSMD-50B
Torque (N・m)
70
35
Instantaneous
Operation Area
Continuous
Operation Area
0
1000
2000
3000
Actual Speed (RPM)

RSMS Motor

Basic Specifications

RSMS Motor Specifications

Relevant Drive CSDP-		30BX2	40BX2	50BX2	
Rated Voltage	V	220			
Rated Power	kW	3.0	4.0	4.5	5.0
Rated Torque	Kgf· cm N: M	97.3 9.54	129 12.7	146 14.3	162 15.9
Maximum Instantaneous Torque	Kgf· cm N: M	292 28.6	387 37.9	438 42.9	486 47.6
Rated Revolving Speed	RPM	3000			
Maximum Revolving Speed	RPM	4500			
ROTOR INERTIA	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^2{\cdot}10^{-4}$	9.42 9.24	12.7 12.4	13.9 13.6	16.3 16.0
ROTOR INERTIA (WHEN BRAKE IS ATTACHED)	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^2{\cdot}10^{-4}$	10.65 10.44	14.0 13.7	15.2 14.9	17.7 17.3
POWER RATE	kW/s	100.5	134	154	161
Mechanical Time Parameter	ms	0.54	0.58	0.47	0.48
Electrical Time Parameter	ms	21.4	20		
Rated Current	A (rms)	20.4	24.7	28.0	28.5
Maximum Instant Current	A (rms)	80	105	118	120
Axial Play	mm MAX	0.3			
Weight (WHEN BRAKE IS ATTACHED)	Kg	10.1 12	12.9 14.8	15.1 17.0	17.3 19.2
Revolving Direction		U → V → W: CW			
Color		Black			
Oil Seal		Embedded			

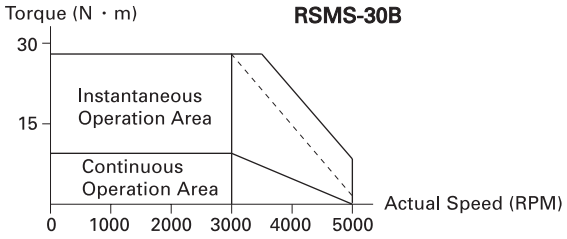
Item	Specifications	Item	Specifications
Wiring Method	Y Wiring	Time Rating	Continuous Use
Operating Temperature Range	0 to +40° C	Insulation Grade	B Grade
Storage Temperature Range	-20 to +80° C	Dielectric Voltage	1500V AC 60 sec. 1800V AC 1 sec.
Insulation resistance	500V DC 20 MΩ	Dielectric Voltage (Brake)	1200V AC 1 sec.
Number of Poles	8 Poles	Excitation Method	Permanent Magnet
Vibration	49 m/s^2 When Stopped 24.5 m/s^2 During Operation	Mounting Method	FLANGE
Shock	98 m/s^2	Operating Humidity	85% or less (Non-Condensing)

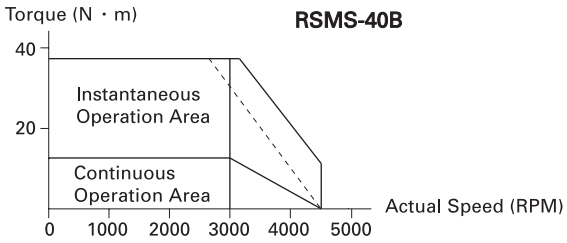
Brake Specifications

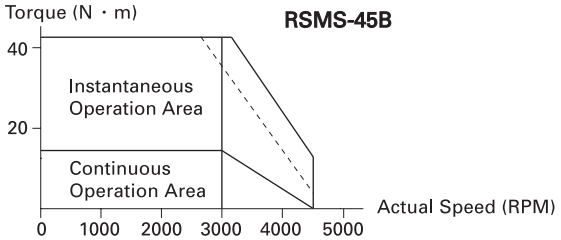
RSMS Motor Brake Specifications

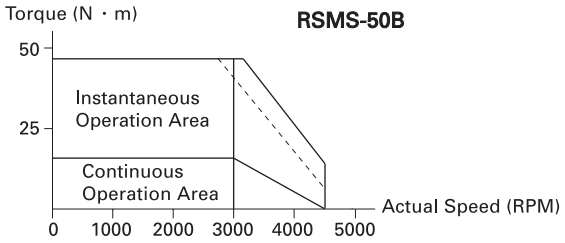
RSMS-		30B to 50B
Friction Torque	nm	16.5
Rotor INERTIA	$Kg \cdot §^3.10^{-4}$	1.2
Brake Pull In Time	ms	110
Brake Release Time	ms	50
Release Voltage	V DC	2 (at 20° C)
Rated Voltage	V DC	24 ±2.4
Rated Current	A	0.876
Allowed Brake Energy	J	1000
Overall Allowed Brake Energy	J	1.0×10^6

Speed Torque Curve









RSMH Motor

Basic Specifications

RSMH Motor Specifications

Relevant Drive CSDP-		15BX2	20BX2	30BX2	40BX2	50BX2
Rated Voltage	V	220				
Rated Power	kW	1.5	2.0	3.0	4.0	5.0
Rated Torque	Kgf· cm N: M	72.9 7.15	97.4 9.55	146 14.32	195 19.1	243 23.87
Maximum Instantaneous Torque	Kgf· cm N: M	219.2 21.5	291 28.5	437 42.9	576 56.4	729 71.4
Rated Revolving Speed	RPM	2000				
Maximum Revolving Speed	RPM	3000				
ROTOR INERTIA	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^{2}{\cdot}10^{-4}$	43.8 42.9	63.3 62.0	96.0 94.1	122.4 120.0	173.5 170.0
ROTOR INERTIA (WHEN BRAKE IS ATTACHED)	$gf{\cdot}cm{\cdot}s^{2}$ $Kg{\cdot}m^{2}{\cdot}10^{-4}$	45.0 44.1	69.3 67.9	102 100.0	128.6 126.0	179.6 176.0
POWER RATE	kW/s	12.2	15.0	22.2	31.1	34.1
Mechanical Time Parameter	ms	3.5	2.5	2.9	2.6	2.6
Electrical Time Parameter	ms	22	26	26	30	31
Rated Current	A (rms)	9.9	12.3	17.8	23.4	28.0
Maximum Instant Current	A (rms)	40	51.9	75.8	100	120
Axial Play	mm MAX	0.3				
Weight (WHEN BRAKE IS ATTACHED)	Kg	10 11.6	16 19.5	18.2 21.7	22 25.5	26.7 30.2
Revolving Direction		U → V → W: CW				
Color		Black				
Oil Seal		Embedded				

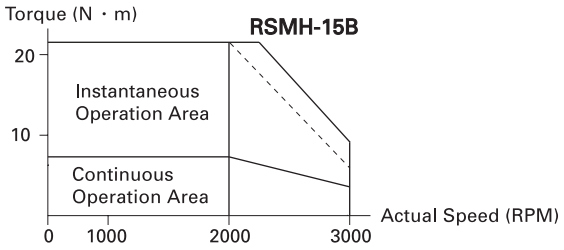
Item	Specifications	Item	Specifications
Wiring Method	Y Wiring	Time Rating	Continuous Use
Operating Temperature Range	0 to +40 °C	Insulation Grade	B Grade
Storage Temperature Range	-20 to +80 °C	Dielectric Voltage	1500V AC 60 sec. 1800V AC 1 sec.
Insulation resistance	500V DC 20 MΩ	Dielectric Voltage (Brake)	1200V AC 1 sec.
Number of Poles	8 Poles	Excitation Method	Permanent Magnet
Vibration	49 m/s^2 When Stopped 24.5 m/s^2 During Operation	Mounting Method	FLANGE
Shock	98 m/s^2	Operating Humidity	85% or less (Non-Condensing)

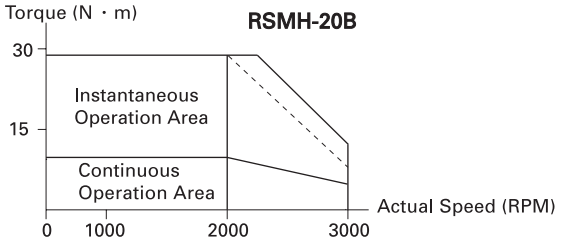
Brake

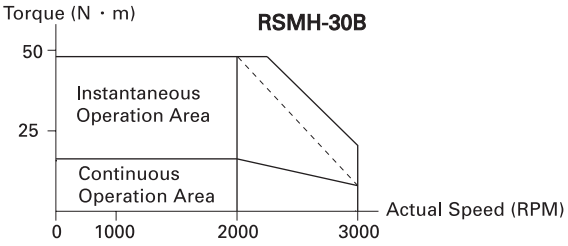
RSMH Motor Brake Specifications

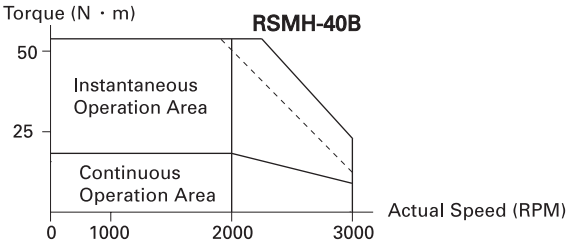
RSMH-		15B	20B to 50B
Friction Torque	nm	16.5	25
Rotor INERTIA	$Kg \cdot m^2.10^{-4}$	1.2	4.7
Brake Pull In Time	ms	110	160
Brake Release Time	ms	50	75
Release Voltage	V DC	2 (at 20° C)	
Rated Voltage	V DC	24 ±2.4	
Rated Current	A	0.876	1.287
Allowed Brake Energy	J	1000	1800
Overall Allowed Brake Energy	J	1.0×10^6	3.0×10^6

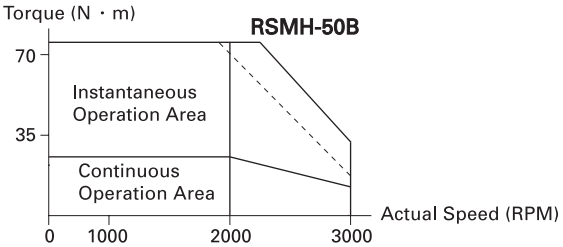
Speed-Torque Curve






Torque (N・m)
RSMH-30B
50
25
Instantaneous
Operation Area
Continuous
Operation Area
Actual Speed (RPM)
0
1000
2000
3000


Torque (N・m)
RSMH-40B
50
25
Instantaneous
Operation Area
Continuous
Operation Area
Actual Speed (RPM)
0
1000
2000
3000


Torque (N・m)
RSMH-50B
70
35
Instantaneous
Operation Area
Continuous
Operation Area
Actual Speed (RPM)
0
1000
2000
3000

RSMF Motor

Basic Specifications

RSMF Motor Specifications

Relevant Drive CSDP-		15BX2	30BX2	40BX2	50BX2
Rated Voltage	V	220			
Rated Power	kW	1.5	2.5	3.5	4.5
Rated Torque	Kgf·cm N:M	73.0 7.16	121 11.9	170 16.7	219 21.5
Maximum Instantaneous Torque	Kgf·cm N:M	219 21.5	310 30.4	450 44.1	560 54.9
Rated Revolving Speed	RPM	2000			
Maximum Revolving Speed	RPM	3000			
ROTOR INERTIA	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^2{\cdot}10^{-4}$	18.4 18.0	34.4 33.7	43.5 42.6	59.9 58.7
ROTOR INERTIA (WHEN BRAKE IS ATTACHED)	$gf{\cdot}cm{\cdot}s^{2\cdot}$ $Kg{\cdot}m^2{\cdot}10^{-4}$	23.7 23.2	46.2 45.3	55.4 54.3	71.7 70.3
POWER RATE	kW/s	29.0	42.6	66.5	80.1
Mechanical Time Parameter	ms	1.4	1.2	1.0	0.8
Electrical Time Parameter	ms	25	35	41	41
Rated Current	A (rms)	9.5	13.4	20.0	23.5
Maximum Instant Current	A (rms)	40.3	56.9	84	99.7
Axial Play	mm MAX	0.3			
Weight (WHEN BRAKE IS ATTACHED)	Kg	11.0 14.0	14.8 17.5	15.5 19.2	19.9 24.3
Revolving Direction		U → V → W: CW			
Color		Black			
Oil Seal		Embedded			

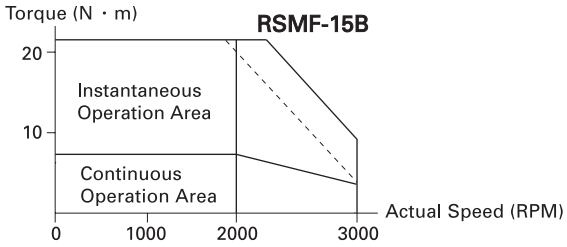
Item	Specifications	Item	Specifications
Wiring Method	Y Wiring	Time Rating	Continuous Use
Operating Temperature Range	0 to +40° C	Insulation Grade	B Grade
Storage Temperature Range	-20 to +80° C	Dielectric Voltage	1500V AC 60 sec. 1800V AC 1 sec.
Insulation resistance	500V DC 20 MΩ	Dielectric Voltage (Brake)	1200V AC 1 sec.
Number of Poles	8 Poles	Excitation Method	Permanent Magnet
Vibration	49 m/s^2 When Stopped 24.5 m/s^2 During Operation	Mounting Method	FLANGE
Shock	98 m/s^2	Operating Humidity	85% or less (Non-Condensing)

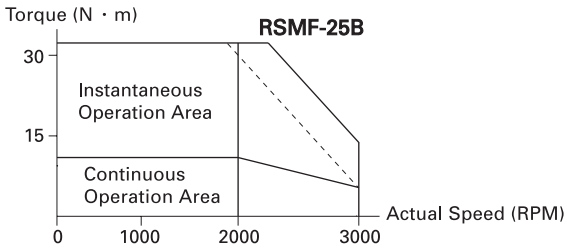
Brake Specifications

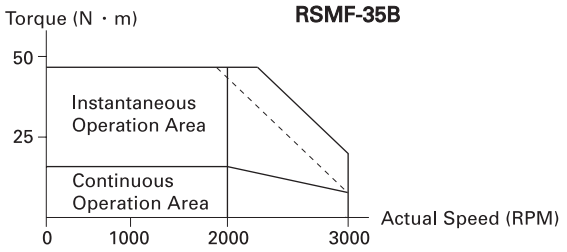
RSMF Motor Brake Specifications

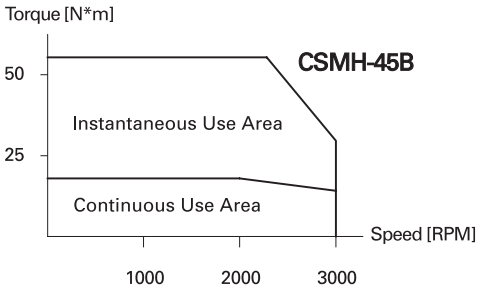
RSMF-		15B	25B to 45B
Friction Torque	nm	25	45
Rotor INERTIA	$Kg{\cdot}m^2.10^{-4}$	4.7	11
Brake Pull In Time	ms	160	220
Brake Release Time	ms	75	100
Release Voltage	V DC	2 (at 20° C)	
Rated Voltage	V DC	24 ±2.4	
Rated Current	A	1.287	0.797
Allowed Brake Energy	J	1800	2000
Overall Allowed Brake Energy	J	3.0×10^6	4.0×10^6

Speed Torque Curve








Torque [N*m]
CSMH-45B
50
Instantaneous Use Area
25
Continuous Use Area
Speed [RPM]
1000
2000
3000

RSMK Motor

Basic Specifications

RSMK Motor Specifications

Relevant Drive CSDP-		15BX2	20BX2	30BX2	50BX2	
Rated Voltage	V	220				
Rated Power	kW	1.2	2.0	3.0	4.5	6.0
Rated Torque	Kgf·cm N:M	117 11.5	198 19.1	290 28.4	437 42.9	583 57.2
Maximum Instantaneous Torque	Kgf·cm N:M	286 28	449 44	650 63.7	1091 107	1315 129
Rated Revolving Speed	RPM	1000				
Maximum Revolving Speed	RPM	2000				
ROTOR INERTIA	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^2{\cdot}10^{-4}$	31.0 30.4	36.2 35.5	56.8 55.7	82.6 80.9	101 99
ROTOR INERTIA (WHEN BRAKE IS ATTACHED)	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^2{\cdot}10^{-4}$	36.9 36.2	42.2 41.4	63.0 61.7	88.7 86.9	110 108
POWER RATE	kW/s	44	104	147	232	337
Mechanical Time Parameter	ms	0.94	0.85	0.72	0.71	0.63
Electrical Time Parameter	ms	31	30	39	42	44
Rated Current	A (rms)	11.6	18.5	24.0	33.0	47.0
Maximum Instant Current	A (rms)	40.0	60	80.0	118	155
Axial Play	mm MAX	0.3				
Weight (WHEN BRAKE IS ATTACHED)	Kg	15.5 19.0	17.5 21.0	25 29	34 39.5	41 47
Revolving Direction		U → V → W: CW				
Color		Black				
Oil Seal		Embedded				

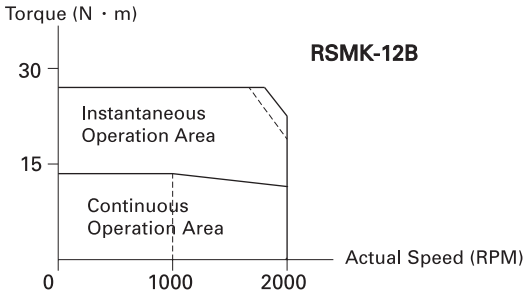
Item	Specifications	Item	Specifications
Wiring Method	Y Wiring	Time Rating	Continuous Use
Operating Temperature Range	0 to +40° C	Insulation Grade	B Grade
Storage Temperature Range	-20 to +80° C	Dielectric Voltage	1500V AC 60 sec. 1800V AC 1 sec.
Insulation resistance	500V DC 20 MΩ	Dielectric Voltage (Brake)	1200V AC 1 sec.
Number of Poles	8 Poles	Excitation Method	Permanent Magnet
Vibration	49 m/s^2 When Stopped 24.5 m/s^2 During Operation	Mounting Method	FLANGE
Shock	98 m/s^2	Operating Humidity	85% or less (Non-Condensing)

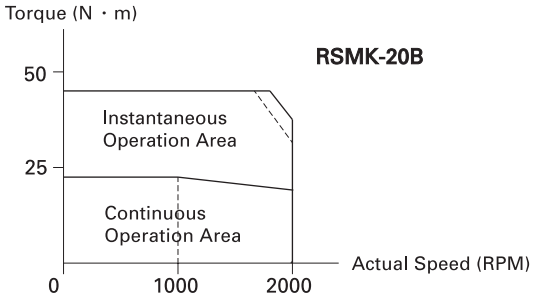
Brake Specifications

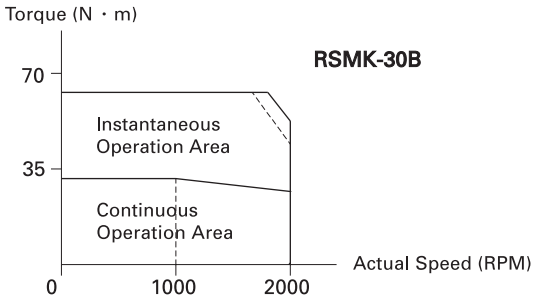
RSMK Motor Brake Specifications

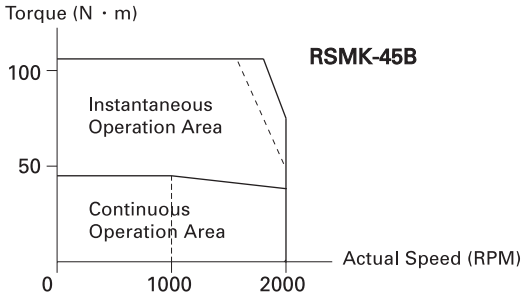
RSMK-		12B to 60B
Friction Torque	nm	25
Rotor INERTIA	$Kg \cdot m^2.10^{-4}$	4.7
Brake Pull In Time	ms	160
Brake Release Time	ms	75
Release Voltage	V DC	2 (at 20° C)
Rated Voltage	V DC	24 ±2.4
Rated Current	A	1.287
Allowed Brake Energy	J	1800
Overall Allowed Brake Energy	J	3.0×10^6

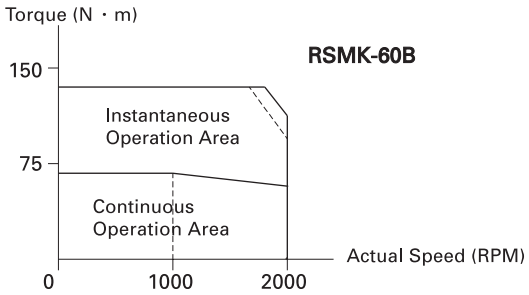
Speed Torque Curve








Torque (N・m)
RSMK-45B
100
50
Instantaneous
Operation Area
Continuous
Operation Area
Actual Speed (RPM)
0
1000
2000


Torque (N・m)
RSMK-60B
150
75
Instantaneous
Operation Area
Continuous
Operation Area
Actual Speed (RPM)
0
1000
2000

RSML Motor

Basic Specifications

RSML Motor Specifications

Relevant Drive CSDP-		15BX2	20BX2	30BX2	50BX2	
Rated Voltage	V	220				
Rated Power	kW	1.2	2.0	3.0	4.5	6.0
Rated Torque	Kgf·cm N:M	117 11.5	198 19.1	290 28.4	437 42.9	583 57.2
Maximum Instantaneous Torque	Kgf·cm N:M	286 28	449 44	650 63.7	1091 107	1315 129
Rated Revolving Speed	RPM	1000				
Maximum Revolving Speed	RPM	2000				
ROTOR INERTIA	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^2{\cdot}10^{-4}$	64.5 63.3	97.9 96.1	133.6 131.1	204.5 200.6	255.1 250.0
ROTOR INERTIA (WHEN BRAKE IS ATTACHED)	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^2{\cdot}10^{-4}$	70.4 69.1	103.9 102.0	139.8 137.1	210.6 206.6	261.2 256.0
POWER RATE	kW/s	21.3	38.8	62.8	94	133
Mechanical Time Parameter	ms	1.95	2.3	1.69	1.77	1.58
Electrical Time Parameter	ms	31	31	40	42	45
Rated Current	A (rms)	11.6	18.5	24.0	33.0	47.0
Maximum Instant Current	A (rms)	40.0	60	80.0	118	155
Axial Play	mm MAX	0.3				
Weight (WHEN BRAKE IS ATTACHED)	Kg	15.5 19.0	17.5 21.0	25 29	34 39.5	41 47
Revolving Direction		U → V → W: CW				
Color		Black				
Oil Seal		Embedded				

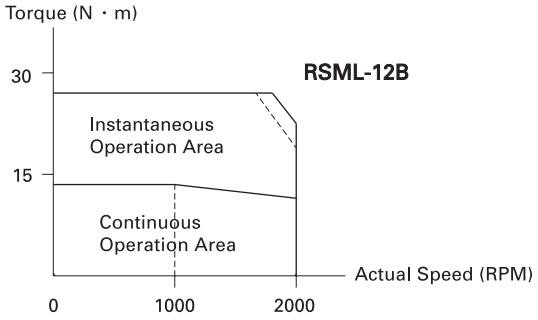
Item	Specifications	Item	Specifications
Wiring Method	Y Wiring	Time Rating	Continuous Use
Operating Temperature Range	0 to +40 °C	Insulation Grade	B Grade
Storage Temperature Range	-20 to +80 °C	Dielectric Voltage	1500V AC 60 sec. 1800V AC 1 sec.
Insulation resistance	500V DC 20 MΩ	Dielectric Voltage (Brake)	1200V AC 1 sec.
Number of Poles	8 Poles	Excitation Method	Permanent Magnet
Vibration	49 m/s^2 When Stopped 24.5 m/s^2 During Operation	Mounting Method	FLANGE
Shock	98 m/s^2	Operating Humidity	85% or less (Non-Condensing)

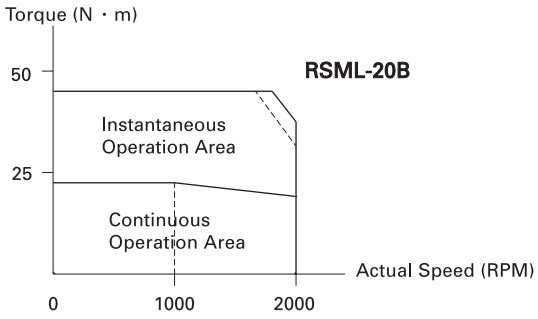
Brake Specifications

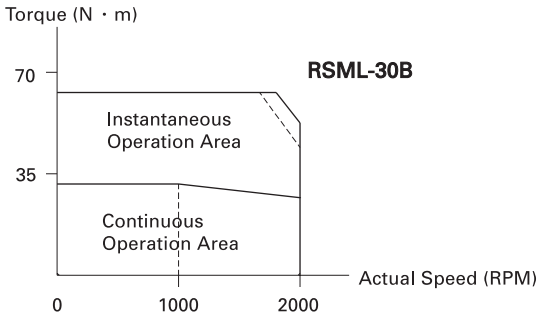
RSML Motor Brake Specifications

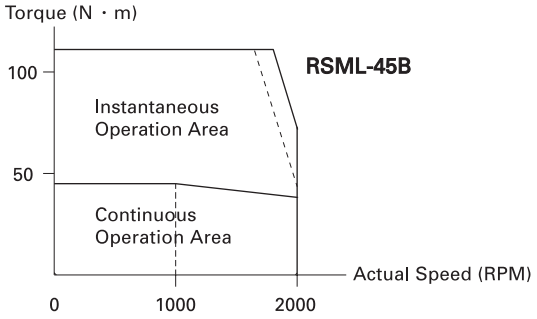
RSML-		12B to 60B
Friction Torque	nm	25
Rotor INERTIA	$Kg{\cdot}m^2.10^{-4}$	4.7
Brake Pull In Time	ms	160
Brake Release Time	ms	75
Release Voltage	V DC	2 (at 20° C)
Rated Voltage	V DC	24 ±2.4
Rated Current	A	1.287
Allowed Brake Energy	J	1800
Overall Allowed Brake Energy	J	3.0×10^6

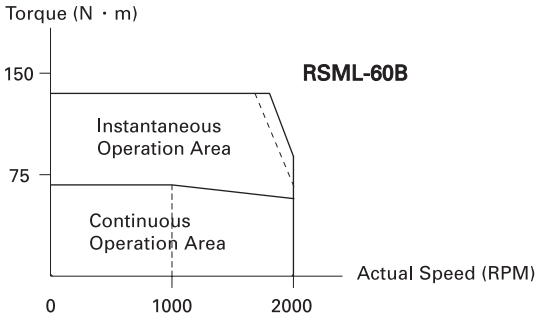
Speed Torque Curve








Torque (N・m)
RSML-45B
100
Instantaneous
Operation Area
50
Continuous
Operation Area
Actual Speed (RPM)
0
1000
2000


Torque (N・m)
RSML-60B
150
Instantaneous
Operation Area
75
Continuous
Operation Area
Actual Speed (RPM)
0
1000
2000

RSMN Motor

Basic Specifications

RSMN Motor Specifications

Relevant Drive CSDP-		15BX2	20BX2	30BX2
Rated Voltage	V	220		
Rated Power	kW	1.2	2.0	3.0
Rated Torque	Kgf·cm N:M	117 11.5	195 19.1	290 28.4
Maximum Instantaneous Torque	Kgf·cm N:M	286 28	449 44	650 63.7
Rated Revolving Speed	RPM	1000		
Maximum Revolving Speed	RPM	2000		
ROTOR INERTIA	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^2.10^{-4}$	56 55	89 87	140 137
ROTOR INERTIA (WHEN BRAKE IS ATTACHED)	$gf{\cdot}cm{\cdot}s^{2\cdot}$ $Kg{\cdot}m^2.10^{-4}$	64 63	98 96	149 146
POWER RATE	kW/s	24.4	42.9	60.2
Mechanical Time Parameter	ms	6.2	4.5	3.5
Electrical Time Parameter	ms	7	11.8	12.8
Rated Current	A (rms)	11.7	18.8	26
Maximum Instant Current	A (rms)	39.6	59.4	80
Axial Play	mm MAX	0.3		
Weight (WHEN BRAKE IS ATTACHED)	Kg	22 28	29 36	41 48
Revolving Direction		U → V → W: CW		
Color		Black		
Oil Seal		Embedded		

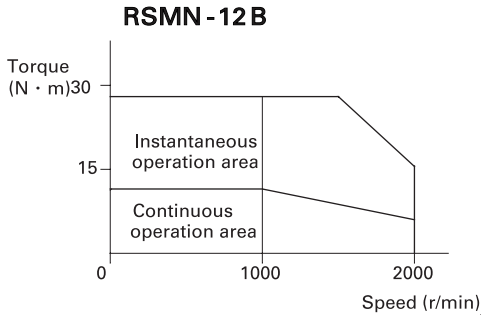
Item	Specifications	Item	Specifications
Wiring Method	Y Wiring	Time Rating	Continuous Use
Operating Temperature Range	0 to +40° C	Insulation Grade	B Grade
Storage Temperature Range	-20 to +80° C	Dielectric Voltage	1500V AC 60 sec. 1800V AC 1 sec.
Insulation resistance	500V DC 20 MΩ	Dielectric Voltage (Brake)	1200V AC 1 sec.
Number of Poles	8 Poles	Excitation Method	Permanent Magnet
Vibration	49 m/s^2 When Stopped 24.5 m/s^2 During Operation	Mounting Method	FLANGE
Shock	98 m/s^2	Operating Humidity	85% or less (Non-Condensing)

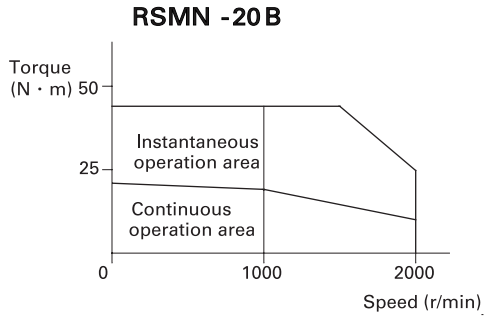
Brake Specifications

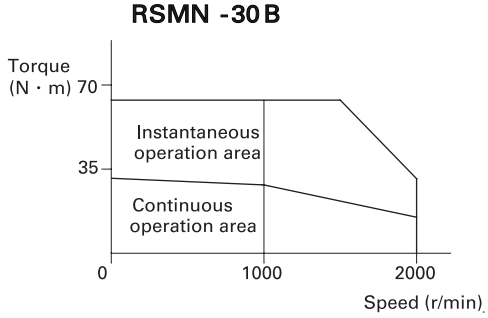
RSMN Motor Brake Specifications

RSMN-		12B to 30B
Friction Torque	nm	35.3
Rotor INERTIA	$Kg \cdot m^2.10^{-4}$	3
Brake Pull In Time	ms	60
Brake Release Time	ms	170
Release Voltage	V DC	2 (at 20° C)
Rated Voltage	V DC	24 ±2.4
Rated Current	A	0.34
Allowed Brake Energy	J	1372

Speed Torque Curve







RSMX Motor

Basic Specifications

RSMX Motor Specifications

Relevant Drive CSDP-		15BX2	20BX2	30BX2	50BX2
Rated Voltage	V	220			
Rated Power	kW	1.3	2.0	3.0	4.5
Rated Torque	Kgf·cm N:M	85 8.34	117 11.5	190 18.6	290 28.4
Maximum Instantaneous Torque	Kgf·cm N:M	252 24.7	347 34	552 54.1	778 76.2
Rated Revolving Speed	RPM	1500			
Maximum Revolving Speed	RPM	2500			
ROTOR INERTIA	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^{2}{\cdot}10^{-4}$	39.1 38.3	56 55	89 87	140 137
ROTOR INERTIA (WHEN BRAKE IS ATTACHED)	$gf{\cdot}cm{\cdot}s^2$ $Kg{\cdot}m^{2}{\cdot}10^{-4}$	40.2 39.4	64 63	98 96	149 146
POWER RATE	kW/s	18.5	24.4	40.7	60.2
Mechanical Time Parameter	ms	5.2	6.2	4.6	3.8
Electrical Time Parameter	ms	5.1	9.4	11.4	17.8
Rated Current	A (rms)	9.7	15	20	30
Maximum Instant Current	A (rms)	39	59.4	80	109
Axial Play	mm MAX	0.3			
Weight (WHEN BRAKE IS ATTACHED)	Kg	18 20.5	22 28	29 36	41 48
Revolving Direction		U → V → W: CW			
Color		Black			
Oil Seal		Embedded			

Item	Specifications	Item	Specifications
Wiring Method	Y Wiring	Time Rating	Continuous Use
Operating Temperature Range	0 to +40° C	Insulation Grade	B Grade
Storage Temperature Range	-20 to +80° C	Dielectric Voltage	1500V AC 60 sec. 1800V AC 1 sec.
Insulation resistance	500V DC 20 MΩ	Dielectric Voltage (Brake)	1200V AC 1 sec.
Number of Poles	8 Poles	Excitation Method	Permanent Magnet
Vibration	49 m/s^2 When Stopped 24.5 m/s^2 During Operation	Mounting Method	FLANGE
Shock	98 m/s^2	Operating Humidity	85% or less (Non-Condensing)

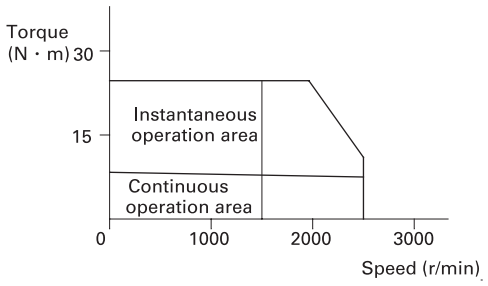
Brake Specifications

RSMX Motor Brake Specifications

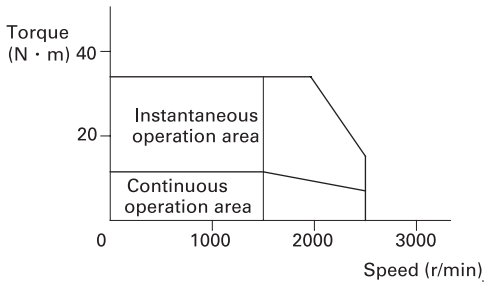
RSMX-		13B	20B to 45B
Friction Torque	nm	5.88	35.3
Rotor INERTIA	$Kg{\cdot}m^2.10^{-4}$	0.9	3
Brake Pull In Time	ms	40	60
Brake Release Time	ms	140	170
Release Voltage	V DC	2 (at 20° C)	
Rated Voltage	V DC	24 ±2.4	
Rated Current	A	0.2	0.34
Allowed Brake Energy	J	1470	1372

Speed Torque Curve

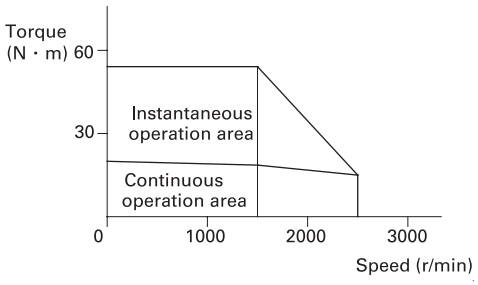
RSMX-13 B



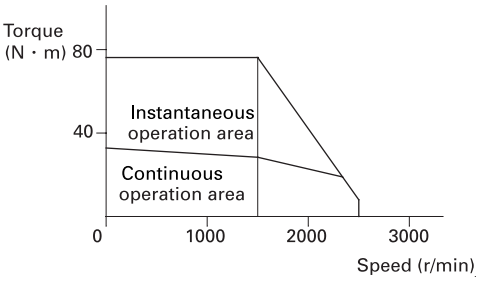
RSMX-20B



RSMX-30B



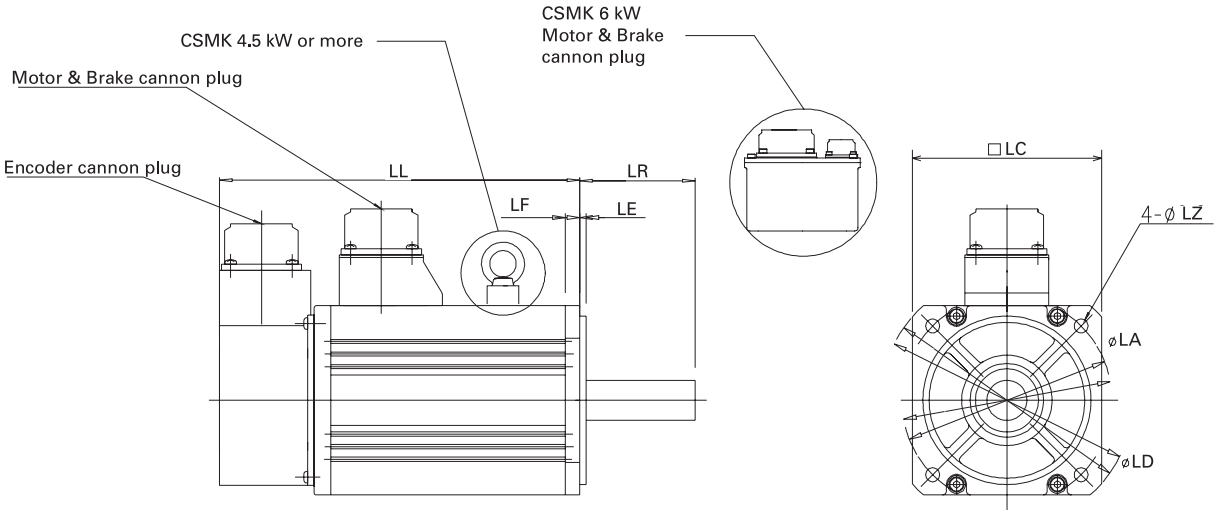
RSMX-45B



Motor Size

CSMD, CSMH, CSMK, CSMS Motor

CSMD, CSMH, CSMK, CSMS Motor Size

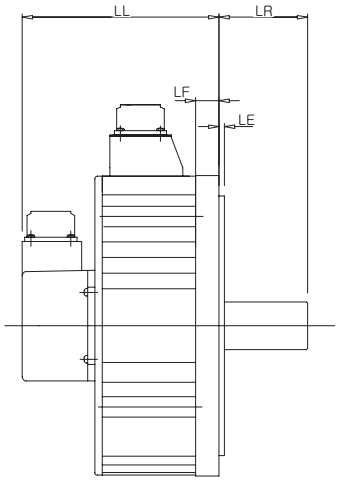


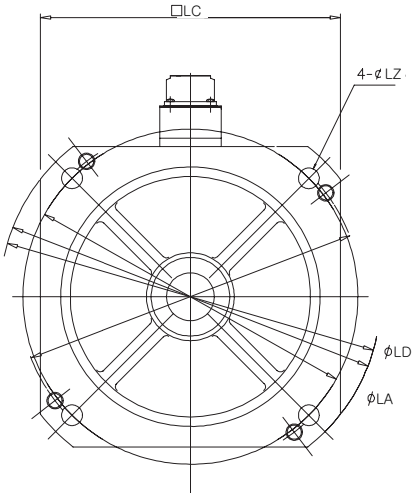
Model	LL				LR	LA	LC	LD	LE	LF	LZ
	Brake Present		Brake Absent								
	(Abs.)	Inc.	(Abs.)	Inc							
CSMD-15B	226	197	201	172	55	145	130	165	6	12	9
CSMD-20B	251	222	226	197	55	145	130	165	6	12	9
CSMD-25B	276	247	251	222	65	145	120	165	6	12	9
CSMD-30B	301	272	276	247	65	145	130	165	6	12	9
CSMD-35B	283	254	258	229	65	165	150	190	3.2	18	11
CSMD-40B	303	274	278	249	65	165	150	190	3.2	18	11
CSMD-45B	256	227	231	202	70	200	176	233	3.2	18	13.5
CSMD-50B	276	247	251	222	70	200	176	233	3.2	18	13.5
CSMS-15B	231	202	206	177	55	115	100	135	3	10	9
CSMS-20B	256	227	231	202	55	115	100	135	3	10	9
CSMS-25B	281	252	256	227	55	115	100	135	3	10	9
CSMS-30B	268	239	243	241	55	130/145	120	162	3	10	9
CSMS-35B	288	259	263	234	55	130/145	120	162	3	10	9
CSMS-40B	391	362	366	237	65	145	130	165	6	12	9
CSMS-45B	311	282	286	257	65	145	130	165	6	12	9
CSMS-50B	311	302	306	277	65	145	130	164	6	12	9
CHMH-15B	251	222	226	197	70	145	130	165	6	12	9
CHMH-20B	241	212	231	187	80	200	176	233	3.2	18	13.5
CHMH-30B	256	227	231	202	80	200	176	233	3.2	18	13.5

Model	LL				LR	LA	LC	LD	LE	LF	LZ
	Brake Present		Brake Absent								
	(Abs.)	Inc.	(Abs.)	Inc							
CHMH-40B	281	252	256	227	80	200	176	233	3.2	18	13.5
CHMH-50B	306	277	281	252	80	200	176	233	3.2	18	13.5
CSMK-12B		195		170	80	200	176	233	3.2	18	13.5
CSMK-20B		162		190	80	200	176	233	3.2	18	13.5
CSMK-30B		208		230	80	200	176	233	3.2	18	13.5
CSMK-45B		353.5		308.5	113	200	176	233	3.2	24	13.5
CSMK-60B		393.5		348.5	113	200	176	233	3.2	24	13.5

CSMF Motor

CSMF Motor Size

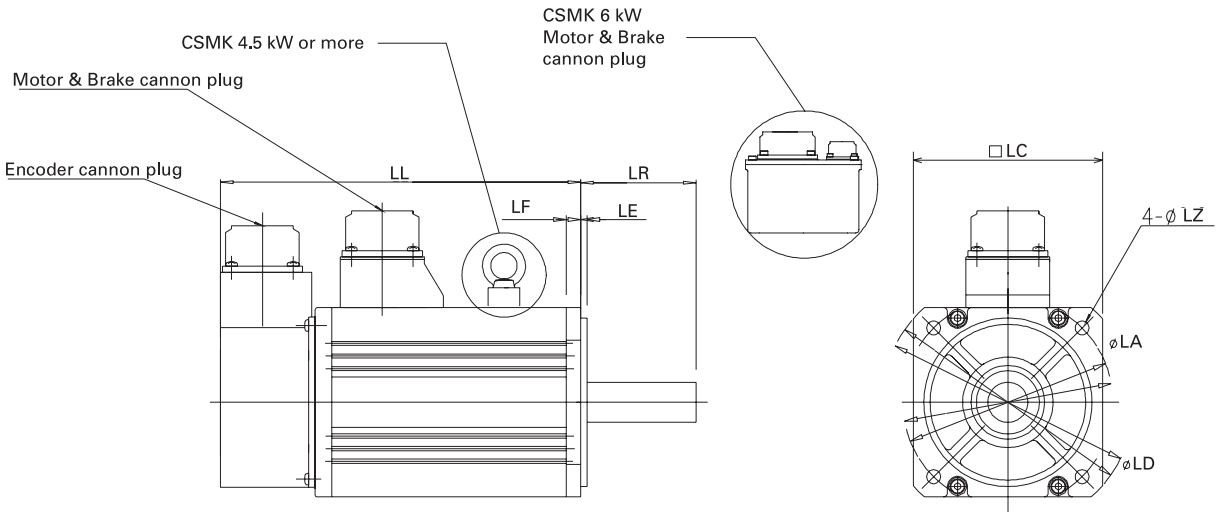




Model	LL				LR	LA	LC	LD	LE	LF	LZ
	BRAKE Present		BRAKE Absent								
	(Abs.)	Inc.	(Abs.)	Inc							
CSMF-15B	196	167	171	142	65	200	176	233	3.2	18	13.5
CSMF-25B	192	163	165	136	65	235	220	268	4	16	13.5
CSMF-35B	200	171	173	144	65	235	220	268	4	16	13.5
CSMF-45B	220	171	189	160	70	235	220	268	4	16	13.5

RSMD, RSMF, RSMH, RSMK, RSML, RSMS Motor

RSMD, RSMF, RSMH, RSMK, RSML, RSMS Motor Size

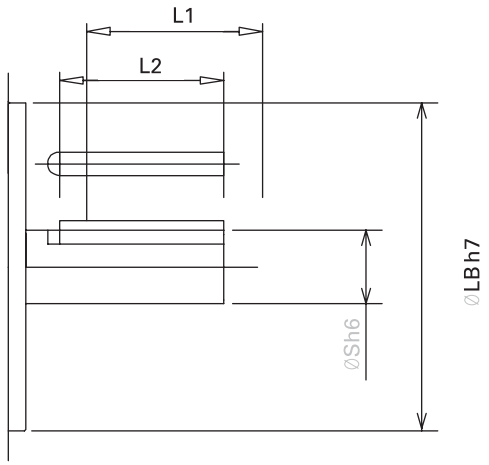


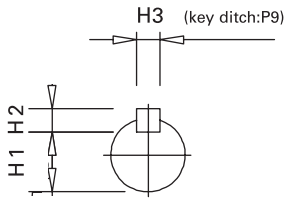
Model	LL		LR	LA	LC	LD	LE	LF	LZ
	Brake Present	Brake Absent							
RSMD-15	208	183	55	145	130	165	6	12	9
RSMD-20	233	208	55	145	130	165	6	12	9
RSMD-25	258	233	55	145	130	165	6	12	9
RSMD-30	283	258	65	145	130	165	6	12	9
RSMD-45	238	213	70	200	180	230	3.2	18	13.5
RSMD-50	258	233	70	200	180	230	3.2	18	13.5
RSMF-15	178	153	65	200	180	230	3.2	18	13.5
RSMF-25	177	146	65	235 250	220	268	4	16	12 13.5
RSMF-35	186	155	65	235 250	220	268	4	16	12 13.5
RSMF-45	202	171	70	235 250	220	268	4	16	12 13.5
RSMH-15	233	208	70	145	130	165	6	12	9
RSMH-20	225	200	80	200	180	230	3.2	18	13.5
RSMH-30	240	215	80	200	180	230	3.2	18	13.5
RSMH-40	255	230	80	200	180	230	3.2	18	13.5
RSMH-50	285	260	80	200	180	230	3.2	18	13.5
RSMK-12	208	183	80	200	180	230	3.2	18	13.5
RSMK-20	228	203	80	200	180	230	3.2	18	13.5
RSMK-30	268	243	80	200	180	230	3.2	18	13.5
RSMK-45	323	298	113	200	180	230	3.2	18	13.5
RSMK-60	368	343	113	200	180	230	3.2	18	13.5
RSML-12	238	213	80	200	180	230	3.2	18	13.5

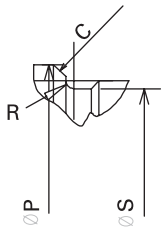
Model	LL		LR	LA	LC	LD	LE	LF	LZ
	Brake Present	Brake Absent							
RSML-20	258	233	80	200	180	230	3.2	18	13.5
RSML-30	298	273	80	200	180	230	3.2	18	13.5
RSML-45	353	328	113	200	180	230	3.2	18	13.5
RSML-60	398	373	113	200	180	230	3.2	18	13.5
RSMS-40	273	248	65	145	130	165	6	12	9
RSMS-45	263	268	65	145	130	165	6	12	9
RSMS-50	313	288	65	135	130	165	6	12	9

Shaft End Size

CSM Series Motor Shaft End Size



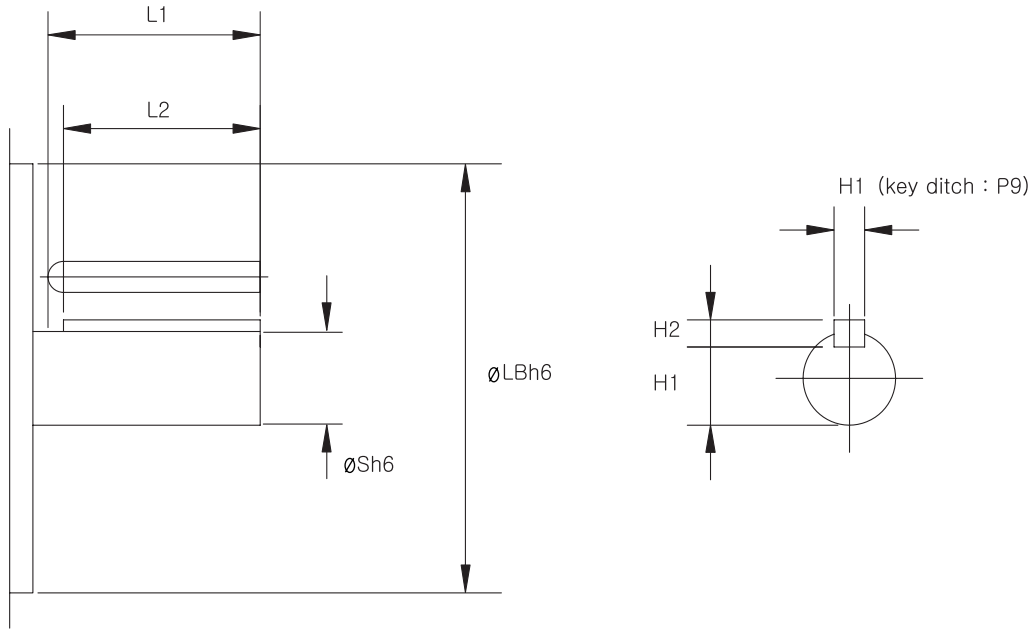




Shaft Part

Model	L1	L2	S	LB	H1	H2	H3	C	R	P
CSMS-15 to 25	45	42	19	95	15.5	6	6	0.3	0.6 to 1.1	19.8
CSMD-10 to 20 CSMH-15 CSMS-30 to 35	45	41	22	110	18	7	8	0.5	0.6 to 11	24
CSMD-25 to 30 CSMS-40 to 50	55	51	24	110	20	7	8	0.5	0.6 to 11	No Step
CSMD-45 to 50 CSMF-15 CSMH-20 to 50	55	50	35	114.3	30	8	10	0.5	0.6 to 11	39.8
CSMF-25 to 45	55	50	35	200	30	8	10	1.5 to 2.5	1.5	37.9
CSMD-35 to 40	55	51	28	130	24	7	8	0.5	0.6 to 11	29.8

RSM Series Motor Shaft End Size



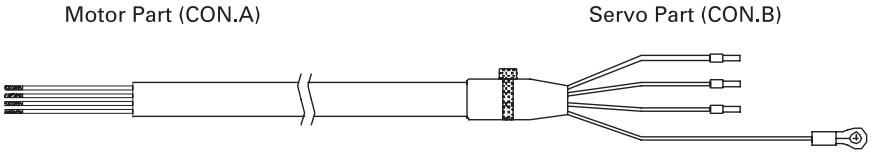
Model	L1	L2	S	LB	H1	H2	H3
RSMD-15, 20	45	41	22	110	18	7	8
RSMD-25, 30	55	51	24	110	20	7	8
RSMD-45, 50	55	50	35	114.3	30	8	10
RSMF-15	55	50	35	200	30	8	10
RSMF-25 to 45	55	50	35	200	30	8	10
RSMH-15	45	41	22	110	18	7	8
RSMH-20 to 50	55	50	35	114.3	30	8	10
RSMK-12 to 30	55	50	35	114.3	30	8	10
RSMK-45, 60	96	90	42	114.3	37	8	12
RSML-12 to 30	55	50	35	114.3	30	8	10
RSML-45, 60	96	90	42	114.3	37	8	12
RSMS-40 to 50	55	51	24	110	20	7	8

Appendix C

Cable Specifications

Motor 3-phase Power Supply Cable

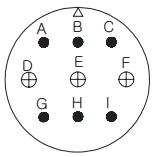
CSMD, CSMF, CSMH, CSMK, CSMS, RSMD, RSMF, RSMS, RSMH, RSMK, RSML, RSMN, RSMXmotors use the following power supply cables.



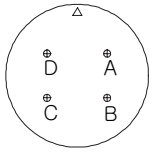
Motor 3-phase Cable

Symbol	Color	types
U	Red	3-core Cable
V	White	3-core Cable
W	Black	3-core Cable
FG	Yellow Striple on Green	Solder 3-core Cable on the shield

CSMD, CSMF, CSMH, CSMK, CSMS motors use MS3102A 24-11P or MS310A 22-4P power plugs.



MS3102A 24–11P



MS3102A 22–22P

MS3102A 24-11P is usually used for motors with brakes, MS3102A 22-4P is used for the motors with no brakes.

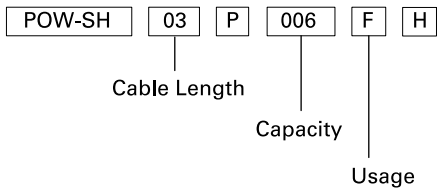
Power plugs are different from each other for each motor capacity, and are packaged inside the motor boxes for shipment.

Wire the pins of the motor power plugs as shown in the table below.

Pin fuctions of the motor power plugs

No.	MS3102A 24-11P	MS3102A 22-22P
A	BR	U
B	BR	V
C		W
D	U	FG
E	V	
F	W	
G	FG	
H	FG	
I		

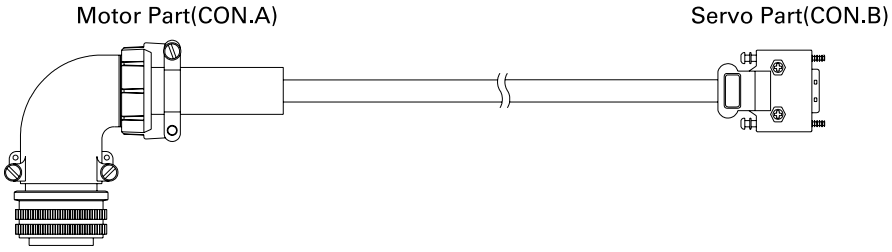
To order power cables, use the order code as shown below.



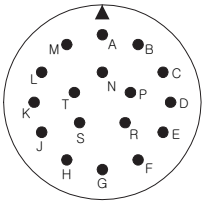
Write 1H5 to order a 1.5 m-long cable, 05 for a 5 m-long cable, and 40 for a 40 m-long cable. If 1.5 kw capacity is required, write 015.

Encoder Cable

CSMD, CSMF, CSMH, CSMK, CSMS, RSMD, RSMF, RSMS, RSMH, RSMK, RSML, RSMN, RSMX motors use the following encoder cables.



CSMD, CSMF, CSMH, CSMK, CSMS motors use MS3102A20 29P encoder plug.



MS3102A20 29P

Wire the pins of the encoder plug as shown in the table below.

11-wire Inc. Encoder

COMM. A	COMM. B	Color	Function
A	3	1P (Whie/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	VCC
J	12/SH	Shield	FG
P	10	5P (White/Purple)-Purple	RX
R	13	5P (White/Purple)-White	/RX

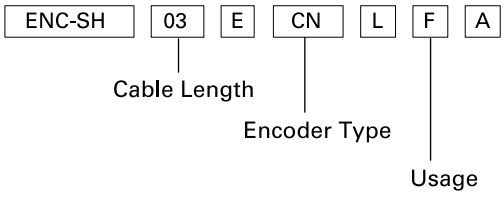
15-wire Inc. Encoder

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

(Abs.) Encoder

Con. A	Con. B	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)-Red	GND
H	20	4P(White/Red)-White	VCC
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		N.C
S	19	5P(Brown/Yellow)-Yellow	BAT-
T	18	5P(Brown/Yellow)-Brown	BAT+

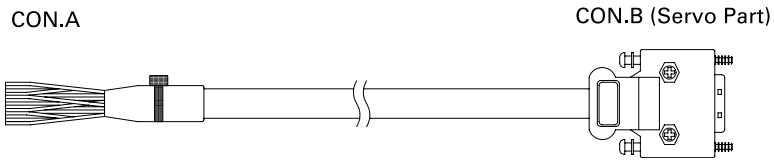
To order power cables, use the order code as shown below.



Write 1H5 to order a 1.5 m-long cable, 05 for a 5m-long cable, and 40 for a 40 m-long cable. Write CL if a 15-wire Abs type encoder is needed, CL for a 11-wire Inc type, and CH for a 17-bit Serial type encoder. Write F for a cable to fix up and M for a flexible cable.

I/O Cable

CON-SCONN50PIN cable is used for an I/O cable.



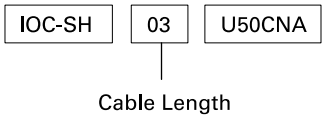
I/O Cable

CON.B	Color
1	Red
2	Yellow
3	Sky-blue
4	White
5	Pink
6	Orange
7	Gray
8	Red 1 Dot
9	Yellow 1 Dot
10	Sky-blue 1 Dot
11	White 1 Dot
12	Pink 1 Dot
13	Orange 1 Dot
14	Gray 1 Dot
15	Red 2 Dots
16	Yellow 2 Dots
17	Sky-blue 2 Dots
18	White 2 Dots
19	Pink 2 Dots
20	Orange 2 Dots
21	Gray 2 Dots
22	Red 3 Dots
23	Yellow 3 Dots
24	Sky-blue 3 Dots
25	White 3 Dots
26	Pink 3 Dots
27	Orange 3 Dots
28	Gray 3 Dots
29	Red 4 Dots
30	Yellow 4 Dots

I/O Cable

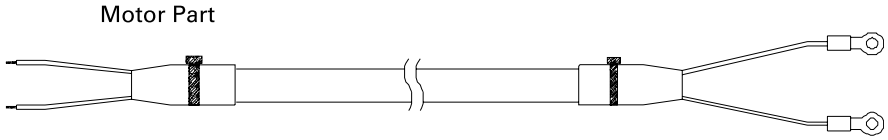
CON.B	Color
31	Sky-blue 4 Dots
32	White 4 Dots
33	Pink 4 Dots
34	Orange 4 Dots
35	Gray 4 Dots
36	Red/Twisted Pair Wire
37	Yellow/Twisted Pair Wire
38	Sky-blue/Twisted Pair Wire
39	White/Twisted Pair Wire
40	Pink/Twisted Pair Wire
41	Orange/Twisted Pair Wire
42	Gray/Twisted Pair Wire
43	Red/1 Line
44	Yellow/1 Line
45	Sky-blue/1 Line
46	White/1 Line
47	Pink/1 Line
48	Orange/1 Line
49	Gray/1 Line
50	Green(Shield)

To order I/O cables, use the order code as shown below.



Motor Brake Cable

CSMD, CSMF, CSMH, CSMK, CSMS motors use the following motor brake cables.

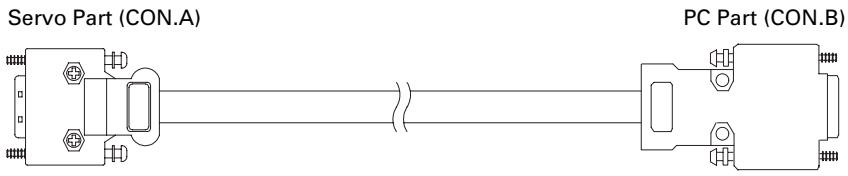


Motor Brake Cable

Symbol	Color	Types
BK+	White	2-core cable
BK-	Black	2-core cable

Communication Cable

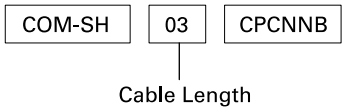
CON-SCONN20PIN cable is used for communication.



Communication Cable

Coh. A	Con. B	Color	Function
11	2	1P(Black/Blue)-Blue	RX
12	3	2P(Black/Yellow)-Yellow	TX
1	5	3P(Black/Green)-Green	GND
9	N.C.		FG

To order communication cables, use the order code as shown below.

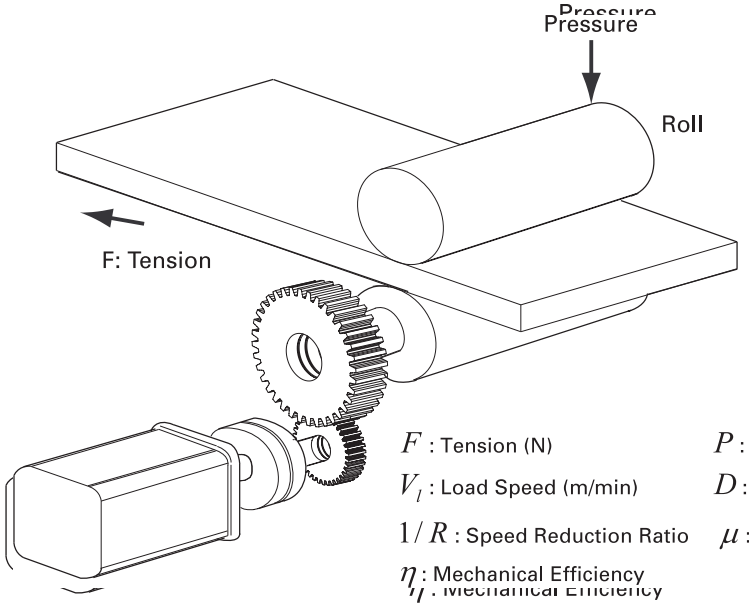


Appendix D

Load Calculation

ROLL Load

Mechanical Configuration



F : Tension (N)
P : Pressure
V_l : Load Speed (m/min)
D : Roll Diameter (m)
$1/R$: Speed Reduction Ratio
μ : Friction Coefficient
η : Mechanical Efficiency

Movement Amount (M)

$$L_s = \frac{V_l}{60} \times \frac{2t_s - t_a - t_d}{2}$$

$$if \quad t_a = t_d, \quad L_s = \frac{V_l}{60} \times (t_s - t_a)$$

Motor Shaft Revolving Speed (r/min)

$$N_M = \frac{RV_l}{\pi D}$$

Load Torque (N· m}

$$T_L = \frac{(\mu P + F)D}{2R\eta}$$

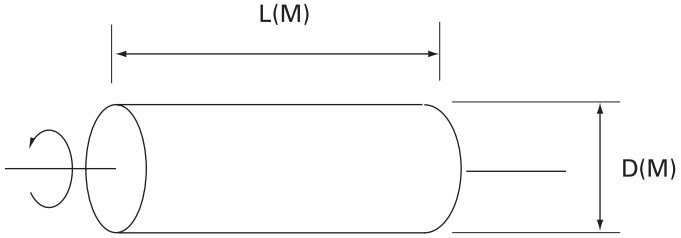
Load Inertia Moment (Kg· m^2)

$$J_L = J_G + \frac{J_R}{R^2}$$

J_R : Roll Inertia J_G : Gear, Coupling Inertia

J_R

< Solid Cylinder >



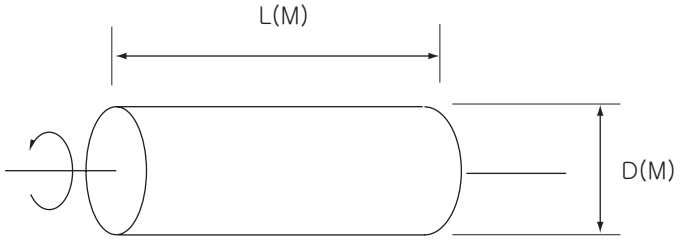
$$J_R = \frac{MD^2}{8} = \frac{\pi\rho LD^4}{32}$$

M : Mass[㎏], ρ : Density[㎏/㎥]

$\rho = 7.87 \times 10^3$ [㎏/㎥] : Iron

$\rho = 2.70 \times 10^3$ [㎏/㎥] : Aluminum

< Hollow Cylinder >



$$J_R = \frac{M(D_o^2 - D_i^2)}{8} = \frac{\pi\rho L(D_o^4 - D_i^4)}{32}$$

Minimum Acceleration Time (s)

$$t_{am} = \frac{2\pi N_M (J_M + J_L)}{60(T_{PM} - T_L)}$$

J_M : Motor Inertia, T_{PM} : Motor Maximum Torque

Minimum Deceleration Time (s)

$$t_{dm} = \frac{2\pi N_M (J_M + J_L)}{60(T_{PM} + T_L)}$$

Load Operation Power (W)

$$P_o = \frac{2\pi N_M T_L}{60}$$

Load Acceleration Power (W)

$$P_a = (\frac{2\pi N_M}{60})^2 \times \frac{J_L}{t_a}, \ (t_a \le t_{am})$$

Acceleration Torque Required (N· m}

$$T_P = \frac{2\pi N_M (J_M + J_L)}{60 t_a} + T_L, \ (t_a \le t_{am})$$

Deceleration Torque Required (N· m)

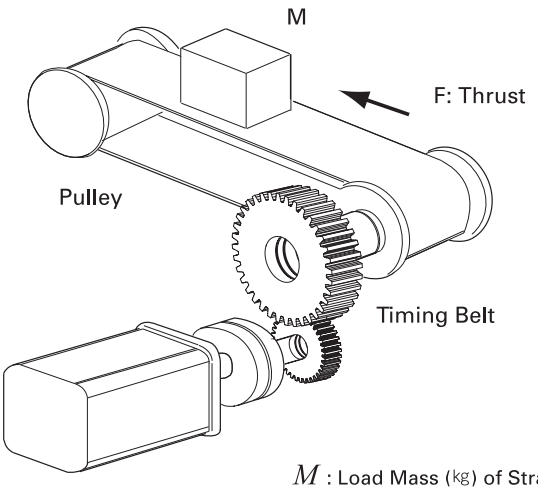
$$T_S = \frac{2\pi N_M (J_M + J_L)}{60 t_d} - T_L, \ (t_a \le t_{dm})$$

Torque Effective Value (N· m)

$$T_{rms} = \sqrt{\frac{T_p^2 t_a + T_L^2 (t_s - t_a - t_d) + T_s^2 t_d}{t_c}}$$

Timing Belt Load

Mechanical Configuration



M : Load Mass (kg) of Straight Movement Part
F : Thrust (N)
V_l : Load Speed (m/min)
D : Pulley (m)
$1/R$: Speed Reduction Ratio
μ : Friction Coefficient
η : Mechanical Efficiency

Movement Amount (m)

$$L_s = \frac{V_l}{60} \times \frac{2t_s - t_a - t_d}{2}$$

$$if \quad t_a = t_d, \quad L_s = \frac{V_l}{60} \times (t_s - t_a)$$

Motor Shaft Revolving Speed (r/min)

$$N_M = \frac{RV_l}{\pi D}$$

Load Torque (N· m)

$$T_L = \frac{(9.8\mu M + F)D}{2R\eta}$$

Load Inertia Moment (kg· m^2)

$$J_L = J_W + J_G + \frac{J_P}{R^2}$$

J_W : Load Inertia of Straight Movement Part J_P : Inertia of Pulley Part

J_G : Gear, Coupling Inertia

$$J_W = M(\frac{D}{2R})^2$$

Minimum Acceleration Time (s)

$$t_{am} = \frac{2\pi N_M (J_M + J_L)}{60(T_{PM} - T_L)}$$

J_M : Motor Inertia T_{PM} : Motor Maximum Torque

Minimum Deceleration Time (s)

$$t_{dm} = \frac{2\pi N_M (J_M + J_L)}{60(T_{PM} + T_L)}$$

Load Operation Power (W)

$$P_o = \frac{2\pi N_M T_L}{60}$$

Load Acceleration Power (W)

$$P_a = (\frac{2\pi N_M}{60})^2 \times \frac{J_L}{t_a}, \ (t_a \le t_{am})$$

Acceleration Torque Required (N· m)

$$T_P = \frac{2\pi N_M (J_M + J_L)}{60 t_a} + T_L \,, \quad (t_a \le t_{am})$$

Deceleration Torque Required (N· m)

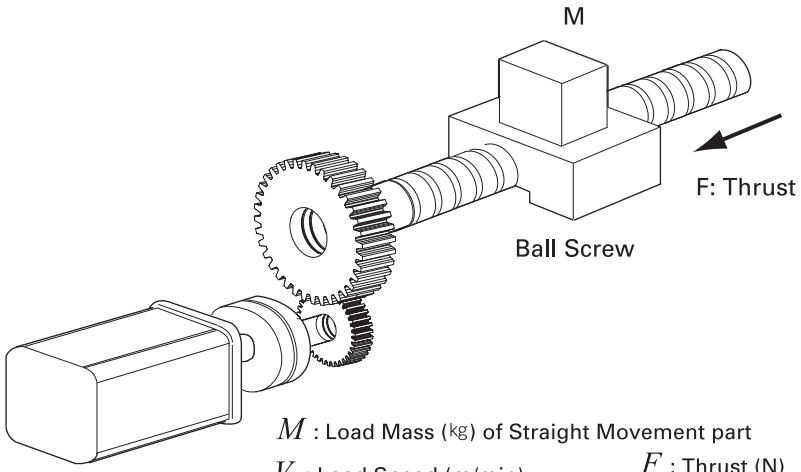
$$T_S = \frac{2\pi N_M (J_M + J_L)}{60 t_d} - T_L \,, \quad (t_a \le t_{dm})$$

Torque Effective Value (N· m)

$$T_{rms} = \sqrt{\frac{T_p^2 t_a + T_L^2 (t_s - t_a - t_d) + T_s^2 t_d}{t_c}}$$

Horizontal BALL SCREW Load

Mechanical Configuration



M : Load Mass (㎏) of Straight Movement part

V_l : Load Speed (m/min)

P_B : Ball Screw Lea

L_B : Ball Screw Length (m)

η : Mechanical Efficiency

F : Thrust (N)

D_B : Ball Screw

$1/R$: Speed Reduction Ratio

μ : Friction Coefficient

Movement Amount (m)

$$L_s = \frac{V_l}{60} \times \frac{2t_s - t_a - t_d}{2}$$

$$if \quad t_a = t_d, \quad L_s = \frac{V_l}{60} \times (t_s - t_a)$$

Motor Shaft Revolving Speed (r/min)

$$N_M = \frac{RV_l}{P_B}$$

Load Torque (N· m)

$$T_L = \frac{(9.8\mu M + F)P_B}{2\pi R\eta}$$

Load Inertia Moment (kg· m^2)

$$J_L = J_W + J_G + \frac{J_B}{R^2}$$

J_W : Load Inertia of Straight Movement Part J_B : Ball Screw Inertia

J_G : Gear, Coupling Inertia

$$J_W = M(\frac{P_B}{2\pi R})^2, \ J_B = \frac{M_B D_B{}^2}{8} = \frac{\pi\rho L_B D_B{}^4}{32}$$

M_B : Ball Screw Mass[㎏]

$\rho = 7.87 \times 10^3$ [㎏/㎥] ; Iron

$\rho = 2.70 \times 10^3$ [㎏/㎥] ; Aluminum

Minimum Acceleration Time (s)

$$t_{am} = \frac{2\pi N_M (J_M + J_L)}{60(T_{PM} - T_L)}$$

J_M : Motor Inertia, T_{PM} : Motor Maximum Torque

Minimum Deceleration Time (s)

$$t_{dm} = \frac{2\pi N_M (J_M + J_L)}{60(T_{PM} + T_L)}$$

Load Operation power (W)

$$P_o = \frac{2\pi N_M T_L}{60}$$

Load Acceleration Power (W)

$$P_a = (\frac{2\pi N_M}{60})^2 \times \frac{J_L}{t_a},\ (t_a \le t_{am})$$

Acceleration Torque Required (N· m)

$$T_P = \frac{2\pi N_M (J_M + J_L)}{60 t_a} + T_L,\ (t_a \le t_{am})$$

Deceleration Torque Required (N· m)

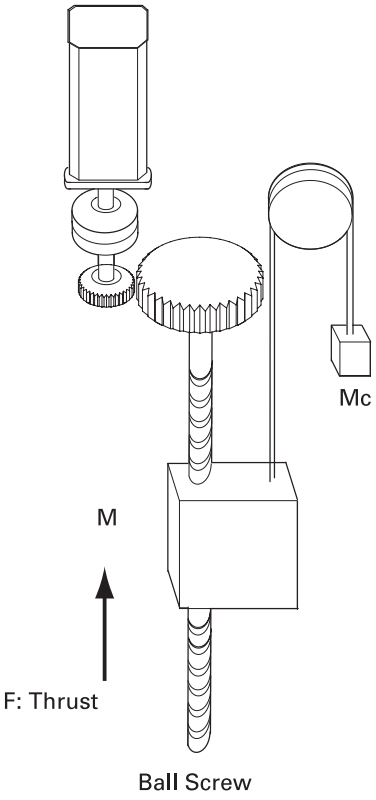
$$T_S = \frac{2\pi N_M (J_M + J_L)}{60 t_d} - T_L,\ (t_a \le t_{dm})$$

Torque Effective Value (N· m)

$$T_{rms} = \sqrt{\frac{T_p^2 t_a + T_L^2 (t_s - t_a - t_d) + T_s^2 t_d}{t_c}}$$

Vertical BALL SCREW Load

Mechanical Configuration



M : Load Mass (kg) of Straight Movement Part

V_l : Load Speed (m/min)

P_B : Ball Screw Lead (m)

L_B : Ball Screw Length (m)

η : Mechanical Efficiency

F : Thrust (N)

D_B : Ball Screw Diameter (m) Ball Screw

$1/R$: Speed Reduction Ratio

μ : Friction Coefficient

M_C : Mass of Counter (kg)

Movement Amount (m)

$$L_s = \frac{V_l}{60} \times \frac{2t_s - t_a - t_d}{2}$$

$$if \quad t_a = t_d, \quad L_s = \frac{V_l}{60} \times (t_s - t_a)$$

Motor Shaft Revolving Speed (r/min)

$$N_M = \frac{RV_l}{P_B}$$

Load Torque (N· m)

$$T_L = \frac{\{9.8\mu(M - M_C) + F\}P_B}{2\pi R\eta}$$

Load Inertia Moment (kg· m^2)

$$J_L = J_W + J_G + \frac{J_B}{R^2}$$

J_W : Load Inertia of Straight Movement Part, J_B : Ball Screw Inertia

J_G : Gear, Coupling Inertia

$$J_W = (M + M_C)(\frac{P_B}{2\pi R})^2$$

$$J_B = \frac{M_B D_B{}^2}{8} = \frac{\pi\rho L_B D_B{}^4}{32}$$

M_B :Ball Screw Mass[kg]

$\rho = 7.87 \times 10^3$ [kg/㎥] : Iron

$\rho = 2.70 \times 10^3$ [kg/㎥] : Aluminum

Minimum Acceleration Time (s)

$$t_{am} = \frac{2\pi N_M(J_M + J_L)}{60(T_{PM} - T_L)}$$

J_M : Motor Inertia, T_{PM} : Motor Maximum Torque

Minimum Deceleration Time (s)

$$t_{dm} = \frac{2\pi N_M(J_M + J_L)}{60(T_{PM} + T_L)}$$

Load Operation Power (W)

$$P_o = \frac{2\pi N_M T_L}{60}$$

Load Acceleration Power (W)

$$P_a = (\frac{2\pi N_M}{60})^2 \times \frac{J_L}{t_a}, \ (t_a \le t_{am})$$

Acceleration Torque Required (N· m)

$$T_P = \frac{2\pi N_M (J_M + J_L)}{60 t_a} + T_L, \ (t_a \le t_{am})$$

Deceleration Torque Required (N· m)

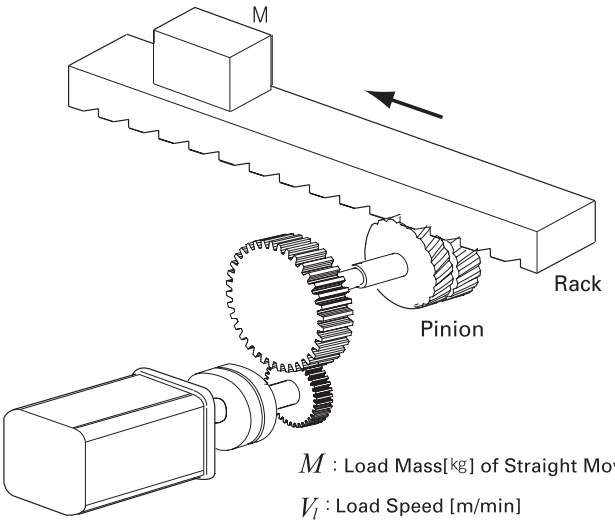
$$T_S = \frac{2\pi N_M (J_M + J_L)}{60 t_d} - T_L, \ (t_a \le t_{dm})$$

Torque Effective Value (N· m)

$$T_{rms} = \sqrt{\frac{T_p^2 t_a + T_L^2 (t_s - t_a - t_d) + T_s^2 t_d}{t_c}}$$

RACK & PINION Load

Mechanical Configuration



M : Load Mass[kg] of Straight Movement Part
F : Thrust [N]
V_l : Load Speed [m/min]
D : Pinion Diameter [m]
l/R : Speed Reduction Ratio
t : Pinion Thickness [m]
η : Mechanical Efficiency
μ : Friction Coefficient

Movement Amount (m)

$$L_s = \frac{V_l}{60} \times \frac{2t_s - t_a - t_d}{2}$$

$$if \quad t_a = t_d, \quad L_s = \frac{V_l}{60} \times (t_s - t_a)$$

Motor Shaft Revolving Speed (r/min)

$$N_M = \frac{RV_l}{P_B}$$

Load Torque (N· m)

$$T_L = \frac{(9.8\mu M + F)D}{2R\eta}$$

Load Inertia Moment (kg· m^2)

$$J_L = J_W + J_G + \frac{J_P}{R^2}$$

J_W : Load Inertia of Straight Movement Part J_P : Pinion Inertia

J_G : Gear, Coupling Inertia

$$J_W = M(\frac{D}{2R})^2,\ J_P = \frac{M_p D^2}{8} = \frac{\pi \rho t D^4}{32}$$

M_P : Pinion Mass[㎏]

$\rho = 7.87 \times 10^3$ [㎏/㎥] : Iron

$\rho = 2.70 \times 10^3$ [㎏/㎥] : Aluminum

Minimum Acceleration Time (s)

$$t_{am} = \frac{2\pi N_M (J_M + J_L)}{60(T_{PM} - T_L)}$$

J_M : Motor Inertia T_{PM} : Motor Maximum Torque

Minimum Deceleration Time (s)

$$t_{dm} = \frac{2\pi N_M (J_M + J_L)}{60(T_{PM} + T_L)}$$

Load Operation Power (W)

$$P_o = \frac{2\pi N_M T_L}{60}$$

Load Acceleration Power (W)

$$P_a = (\frac{2\pi N_M}{60})^2 \times \frac{J_L}{t_a},\ (t_a \le t_{am})$$

Acceleration Torque Required (N· m)

$$T_P = \frac{2\pi N_M (J_M + J_L)}{60 t_a} + T_L,\ (t_a \le t_{am})$$

Deceleration Torque Required (N· m)

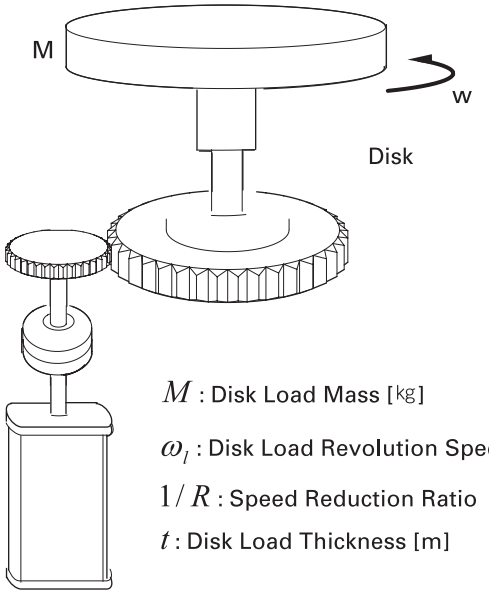
$$T_S = \frac{2\pi N_M (J_M + J_L)}{60 t_d} - T_L, \ (t_a \le t_{dm})$$

Torque Effective Value (N· m)

$$T_{rms} = \sqrt{\frac{T_p^2 t_a + T_L^2 (t_s - t_a - t_d) + T_s^2 t_d}{t_c}}$$

Disk Load

Mechanical Configuration



M : Disk Load Mass [kg]

T_l : Load Torque

ω_l : Disk Load Revolution Speed [rpm]

D : Disk Load Diameter [m]

$1/R$: Speed Reduction Ratio

η : Mechanical Efficiency

t : Disk Load Thickness [m]

Movement Amount (rad)

$$\theta_s = \frac{\omega_l}{60} \times \frac{2t_s - t_a - t_d}{2}$$

$$if \quad t_a = t_d, \quad \theta_s = \frac{\omega_l}{60} \times (t_s - t_a)$$

Motor Shaft Revolving Speed (r/min)

$$N_M = R\omega_l$$

Load Torque (N· m)

$$T_L = \frac{T_l}{R}$$

Load Inertia Moment (kg· m^2)

$$J_L = J_G + \frac{J_W}{R^2}$$

J_W : Disk Load Inertia, J_G : Gear, Coupling Inertia

$$J_R = \frac{MD^2}{8} = \frac{\pi\rho tD^4}{32}$$

$\rho = 7.87 \times 10^3$ [kg/㎥] ; Iron

$\rho = 2.70 \times 10^3$ [kg/㎥] ; Aluminum

Minimum Acceleration Time (s)

$$t_{am} = \frac{2\pi N_M (J_M + J_L)}{60(T_{PM} - T_L)}$$

J_M : Motor Inertia, T_{PM} : Motor Maximum Torque

Minimum Deceleration Time (s)

$$t_{dm} = \frac{2\pi N_M (J_M + J_L)}{60(T_{PM} + T_L)}$$

Load Operation Power (W)

$$P_o = \frac{2\pi N_M T_L}{60}$$

Load Acceleration Power (W)

$$P_a = (\frac{2\pi N_M}{60})^2 \times \frac{J_L}{t_a}, \ (t_a \le t_{am})$$

Acceleration Torque Required (N· m)

$$T_P = \frac{2\pi N_M (J_M + J_L)}{60 t_a} + T_L, \ (t_a \le t_{am})$$

Deceleration Torque Required (N· m)

$$T_S = \frac{2\pi N_M (J_M + J_L)}{60 t_d} - T_L, \ (t_a \le t_{dm})$$

Torque Effective Value (N· m)

$$T_{rms} = \sqrt{\frac{T_p^2 t_a + T_L^2 (t_s - t_a - t_d) + T_s^2 t_d}{t_c}}$$

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알에스오토메이션주식회사

www.rsautomation.co.kr

경기도 평택시 진위면 청호리 진위산업단지 348-2 알에스오토메이션빌딩 # 451-862

T 031-685-9300, F 031-685-9500

부산 지사 부산광역시 사상구 대동로 303 벽산디지털밸리 620호 #617-731
T 051-329-7870, F 051-329-7874

대구 지사 대구광역시 북구 산격2동 1665번지 전기재료관 다동 223호 #702-717
T 053-944-7783, F 053-944-7784

알에스오토메이션 서비스센터 전국 어디서나 **1588-5298**

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T 031-373-3744, F 031-372-6446

부산 센터 부산광역시 사상구 대동로 303 벽산디지털밸리 313호 #617-731
T 051-329-7802/3, F 051-329-7804

RS Automation Co., Ltd.

www.rsautomation.biz

RS Automation Building, 348-2, Jinwi Industrial Complex, Cheongho-ri, Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do, Korea, zip code : 451-862

T 82-31-685-9300, F 82-31-685-9500

RS Automation Global Business Support
rsagbs@rsautomation.biz

韩国京畿道平泽市振威面清湖里振威工业园348-2RS自动化大厦 邮编：451-862

T 82-31-685-9300, F 82-31-685-9500

RS自动化全球商户支持
rsagbs@rsautomation.biz