RS OEMax

CSD7 Servo Drive

(Pulse/Analog type)

User Manual

Catalog Number(s): CSD7-**BX1,
CSD7-**BXF1

RS Reliable & Smart Automation

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. There are some important differences between solid state equipment and hard-wired electromechanical devices. 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.

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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 which may lead to serious personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTEN-	Identifies information about proactives or circumstances that can lead to minor personal injury, property damage, economic loss, or product malfunction. However, depending on the situation, failure to follow the directions accompanying this symbol may also lead to serious consequences.

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Preface

Read this preface to familiarize you with the rest of the manual.

- Who Should Use This Manual
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Who Should Use This Manual

This manual is intended for engineers or technicians directly involved in the installation and wiring of the CSD7 servo drive, and programmers directly involved in the operation, field maintenance, and integration of the CSD7 servo drive with a Motion Card.

If you do not have a basic understanding of the CSD7 servo drive, contact your local RS Automation sales representative before using this product, for information on available training courses.

About This Publication

This manual provides detailed installation instructions for mounting, wiring, and troubleshooting your CSD7 servo drive, and system integration for your drive/motor combination with a Motion Card.

Additional Resources

The following documents contain additional information concerning related CSD7 servo drive products.You can view or download publications at www.rsautomation.biz To order paper copies of technical documentation, contact your local RS Automation Korea distributor or sales representative.

www.rsautomation.co.kr

For	Read This Document
Information on the installation of your CSD7 servo drive	CSD7 Servo Drive Installation Instructions
Information on the installation and operation of motors used together with CSD7 servo drive	Servo Motor User Manual

Conventions Used in This Manual

The conventions starting below are used throughout this manual.

- Bulleted lists such as this one provide information, not procedural steps.
- Numbered lists provide sequential steps or hierarchical information.

Table for Parameter Setting

This manual uses the following table for parameter description.

Example of Parameter Setting

Parameter (Ft-0.02)	 
Parameter Name	Motor Forward Direction
Description	You can choose the rotational direction of the motor
Setting Value	• 0: CW direction is set as forward rotation. • 1: CCW direction is set as forward rotation.
Initial Value	0
Applicable Mode	All
Others	Servo-OFF > Setting > End

Table Description

Parameter: at the top-left side shows the parameter being described. The setting window on the right of the parameter, is entered when the ENTER key is pressed. The parameter must be set from the digit in black color and the initial value shows the initial value of the parameter.

It is classified into a parameter selected among already set values (“selected parameter”) and a parameter, which the users give appropriate value. The selected parameter, as shown in the example above, displays both parameter and setting window, and the latter parameter displays only the parameter and not eh setting window.

Parameter Name: describes the value selectable by the user and the selected value.

Description: describes the function and usage of parameter.

Setting Value: describes the value selectable by the user and the selected value.

Initial Value: Initial Value displayed when the parameter is selected.

Applicable Mode: alphabetically displays the corresponding control mode in setting parameter, and displays (ALL) if all are included.

Mode	Position Control Mode	Speed Control Mode	Torque Control Mode	Contact Speed Control
Symbol	F	S	C	P

Combinational control mode indicates the alphabets of two modes, combined in a row.
ex) speed + position mode (SF), torque-speed mode (CS).

Others: normally, as described in an example of automobile, the driver cannot manipulate parking brake of a running automobile, and the servo drive also should be divided into Servo-ON status and Servo-OFF status when setting the parameter.

Other Symbols	**Description**
Setting > End	Set regardless of the drive status.
Servo-OFF > Setting > End	Set it in Servo-OFF status.
Servo-OFF > Setting > Power Off&On > End	Set it in Servo-OFF status, and apply the power again

Terminology

The following describes terminologies used in this manual.

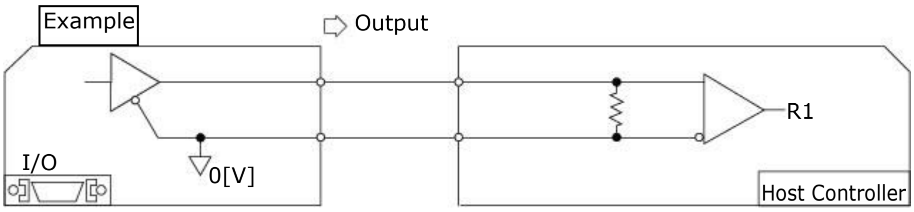
- Servo Drive or Drive: Refer to the CSD7 Servo Drive
- Servo Motor or Motor: Refer to the servo motor exclusively for the CSD7 drive.
- Host Controller: Refers to a controller or a device that gives command to the drive and controls it.
- Initial Value: Refer to the value set at the factory before the shipment.
- Setting Value: Refers to the initial value or the value changed and set by the users.
- User's Manual: Simply indicated as 'manual'.

Notation Description

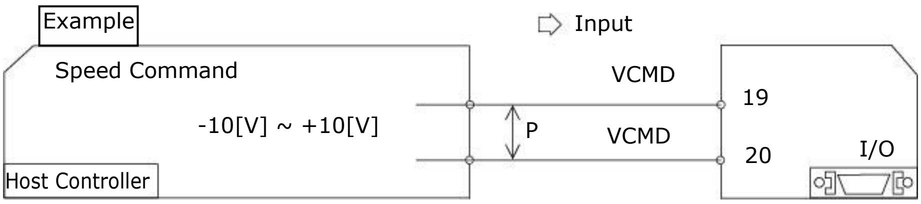
Within the sentences of this manual, the following is expressed as shown below. Be fully aware of them when using the servo drive.

1. Use '/' in front of Active Low signal.

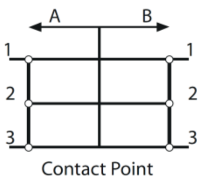
2. A figure box with both the top corners cut off diagonally represents a circuit diagram. If I/O for I/O signal or a connector attached to the servo driver is on the left, it is the output of I/O or servo drive.



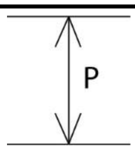
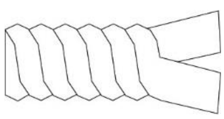
3. If I/O for I/O signal or a connector attached to servo driver is on the right, it is the input from the host controller to I/O or servo drive.



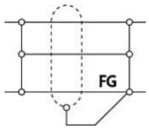
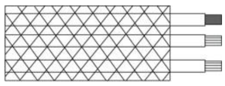
4. The following shows the symbols used on the circuit diagram.

Signal	Description
	• The figure represents the pin number of the connector, which can be marked with alphabets tather than the nummbers. • The contact is the connection between the side A and B with the connector.

5. The following figure shows a symbol used to show a twist pair wires to prevent the noise generation.

Signal	Figure	Description
		Shield the wires where this symbol is located for the noise prevention.

6. The following figure shows a symbol used to show a shield pair wire to prevent the noise generation.

Signal	Figure	Description
		Shield the wires where this symbol is located for the noise prevention.

Manual Description Order

This manual is described in the view of users from the purchase to operation.

1. Describes things to know before using the product.
2. Describes the outline of product and marking.
3. Describes precautions upon product installation.
4. Describes wiring with the host controller and peripheral equipment.
5. Describes the operator for various settings.
6. Describes brief functions of the product.
7. Describes the basic settings that users should set.
8. Describes the function of the product for each control modes.
9. Describes the tuning to implement optimum performance of load system.
10. Describes simple supplementary functions.
11. Describes the protective function, fault diagnosis and troubleshooting.
12. Describes items corresponding to various numerical data in the Appendix.

Others

Each chapter or paragraph has a page called before you begin before description. For easier understanding of this manual, be fully aware of the contents of this page called before you begin in advance.

Safety Precautions

This is CSD7 User Manual describes safety matters using the following marks. Safety marks deals with the important matters. If the following marks and contents of each mark are indicated in the contents of this user's manual, you must be fully aware of them and follow them.

Usage

CAUTION

- Do not touch the inside of servo drive.
- Make sure that the servo drive and the motor are fully grounded.
- Completely discharged before handling after power off.
- Do not put excessive stress on the motor power and encoder cable.
- Never touch the revolving part of the motor during operation.

WARNING

- Avoid using the product near wet places or corrosive and inflammable materials.
- Operate the system with no load during pilot operation.
- Never touch the heat sink directly.

Storage

WARNING

- Do not store the product near wet places, rain, toxic gas or fluid.
- Keep the product out of the direct rays of the sun and store it within the storage temperature and humidity ranges.
- Avoid overloading if the product is stored in a warehouse.

Transportation

WARNING

Do not carry the product by holding the cable and the motor shaft

Installation and Wiring

WARNING

- Install a cooling fan to prevent excessive temperature increase. (Refer to the Chapter 2)
- Be careful not to wiring cables around the heat sink.

CAUTION

- Install drives with regular space (at least 10 mm) between them.
- Pay attention to the heat sink when wiring. (Refer to Chapter 2)

Maintenance and Repair

WARNING

- Do not disassemble or remodel the product. Any damage caused after the user disassembles or remodels the product will be excluded from the company's warranty.
- The company bears no responsibility for injuries or physical damage caused by remodeling of this product.
- Life-limited Parts by mechanical friction or heat requires regular. Refer to the Chapter 8.
- In case of a failure that cannot be dealt with, please contact the company’s technical support team or after-sales service center.

Certification

Standards Applied

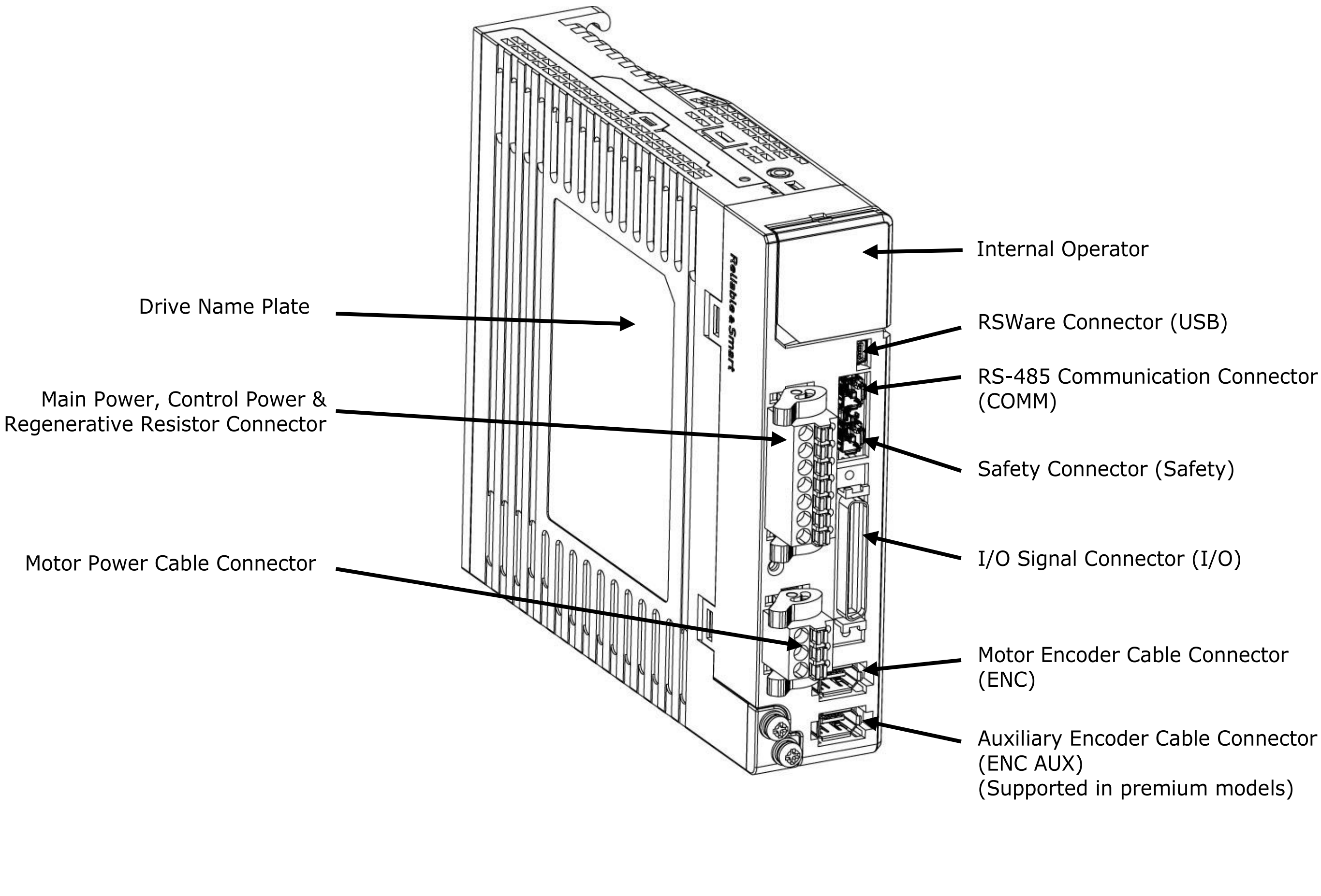
		Servo Drive
EC Directive	EMC Directive	**EMC Directive:201430/EU, KN** EN61800_3, KC61800_3 EN61000_4_2, KN61000_4_2 EN61000_4_3, KN61000_4_3 EN61000_4_4, KN61000_4_4 EN61000_4_5, KN61000_4_5 EN61000_4_6, KN61000_4_6
	LVD Low Voltage Directive	EN61000_5_1
USA Standards	NRTL	UL508C
Canada Standards	NRTL/C	C22.2No.14_10

Before Using the CSD7 Servo Drive

This chapter describes the general matters and optional specifications that you should know before using the CSD7 SERVO DRIVE.

Product Type and Each Part Name

The following figure introduces the name of each part of the servo drive.



TIP For more detail information about Operator, please refer to "Chapter 4 Operator, Basic Setting and Startup".

Model Number of the Drive

The following figure describes the model name on the nameplate of the servo drive.

- The nameplate is attached on the side of the drive case. Check the model name on the nameplate, and check if it orresponds to the product ordered.
- The drive type is RS Automation Servo Drive CSD7 Series.
- The serial number is included on the nameplate. Be careful not to erase the serial number during the use.

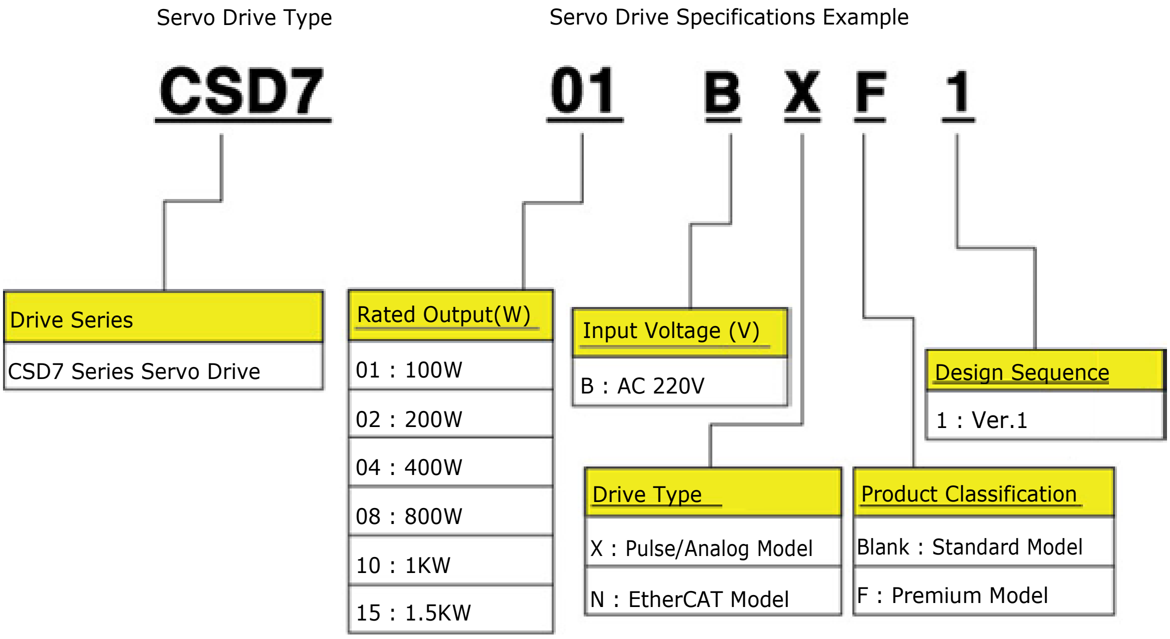


Table 1.1 Servo Drive Indications

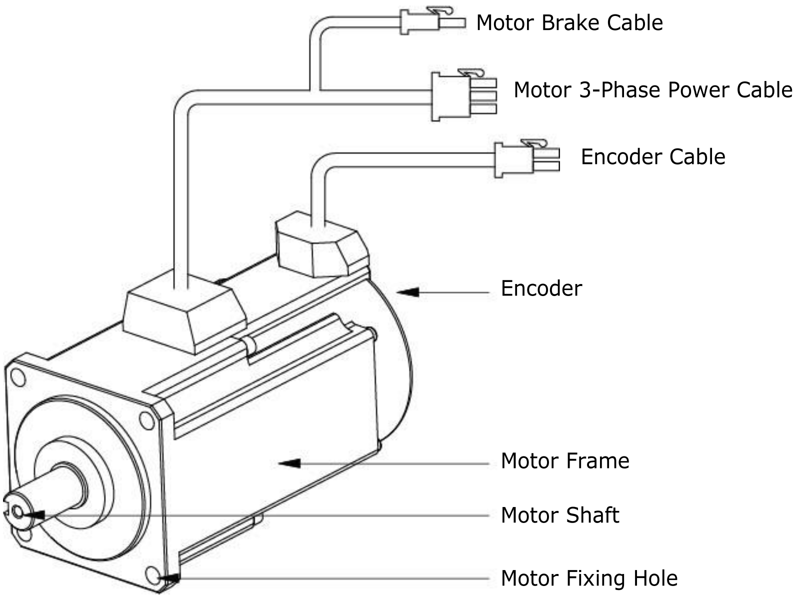
	Controllable Mode	Special Functions
Basic Type	Position control, multi-speed control, multi-speed-position control and index	-
Premium Type	Position control, speed control, torque control, speed-position control, torque-position control, torque-speed control, multi-speed control, multi-speed-position control, multi-speed-torque control, and index	Full Closed Loop Control, STO (Safety Torque off) function.

Name of Each Motor Part

The following figure shows the name of each more part.

A motor without a brake does not have a brake cable. The name of each motor part may differ from the following figure according to the motor type.

TIP For more detailed information about Servo Motor, please refer to "Servo Motor Manual".

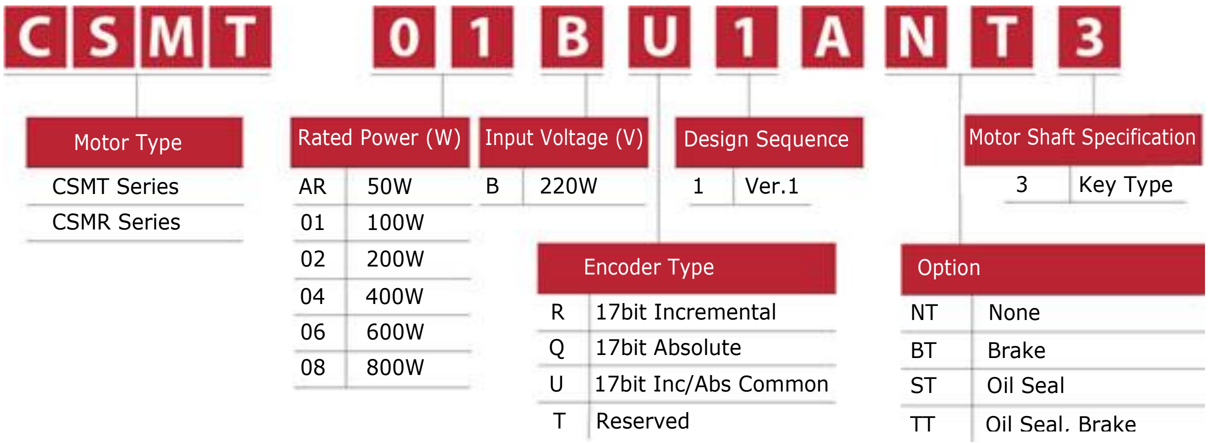


RS Automation does not provide cables. For more information about specification and order code of cables below, refer to "Servo Motor Manual (Publication SMOTOR-UM002)".

- Motor 3 phase Power Cable
- Encoder Cable
- Motor Break Cable
- I/O Cable
- Communication Cable

Model Number of the Motor

The following figure describes the model name of the motor on Motor the nameplate.



For more detailed information about each motor name plate items, refer to Servo Motor Manual (Publication SMOTOR-UM002).

Installation

This chapter describes matters to consider when installing the servo drive and the motor. Refer to the ‘Appendix B’ for numerical data on the drive, motor, and various peripheral equipment necessary for the installation.

Servo Drive Installation

Precautions

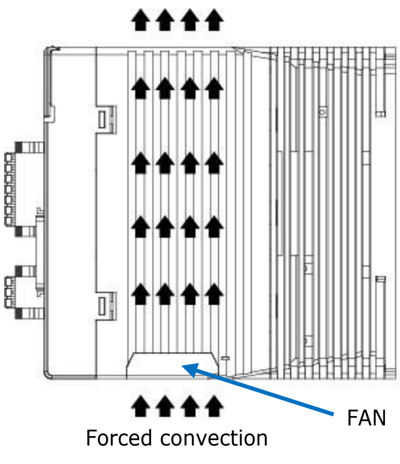
Refer to the following figures when installing the servo drive.

The most important thing to consider when installing the drive is the ambient temperature. Follow the operational temperature and mount the servo drive vertically. Be sure to install the product vertically.

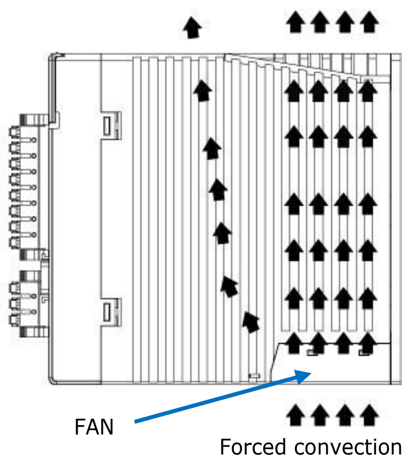
Install the Servo Drive Vertically

The CSD7 series servo drive adopts a forced cooling method using the fan installed inside the product. To increase cooling efficiency, be sure to install the product vertically.

As the servo drive includes electronic parts which are sensitive to static electricity, install the product in an environment in which static electricity is not generated.



< Less than 400W>

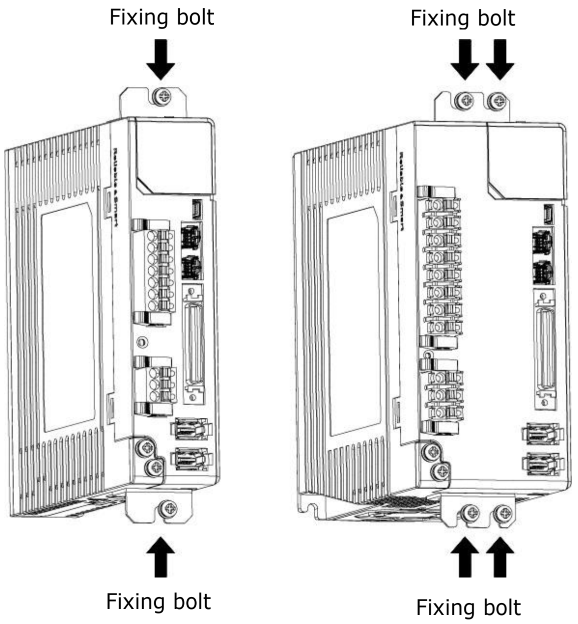


< 800W or above>

< RACK MOUNT >

Fixing Bolt

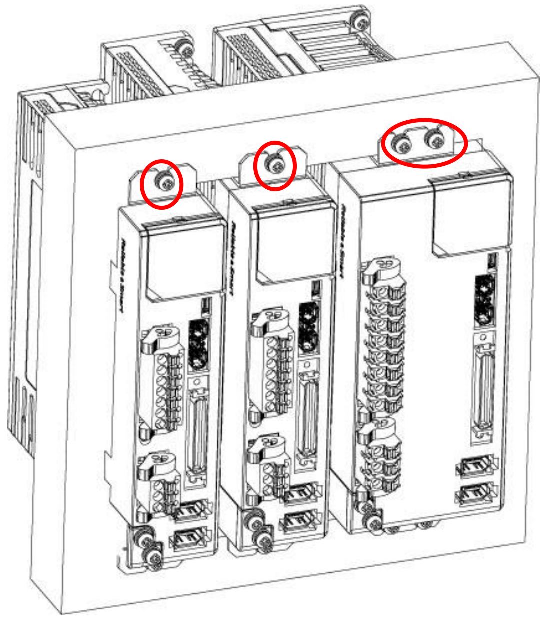
- Less than 400W : One M4xL10 bolt for top and bottom
- 800 W or above : Two M4xL10 bolt for top and bottom



Fixing Bolt

- Apply M4 bolts to both top and bottom

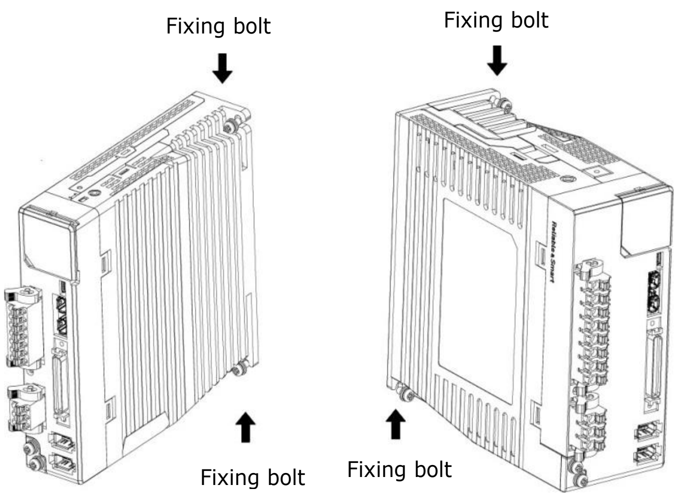
(See “Drive Size and Exterial View” in the page B-4)



< WALL MOUNT >

Fixing Bolt

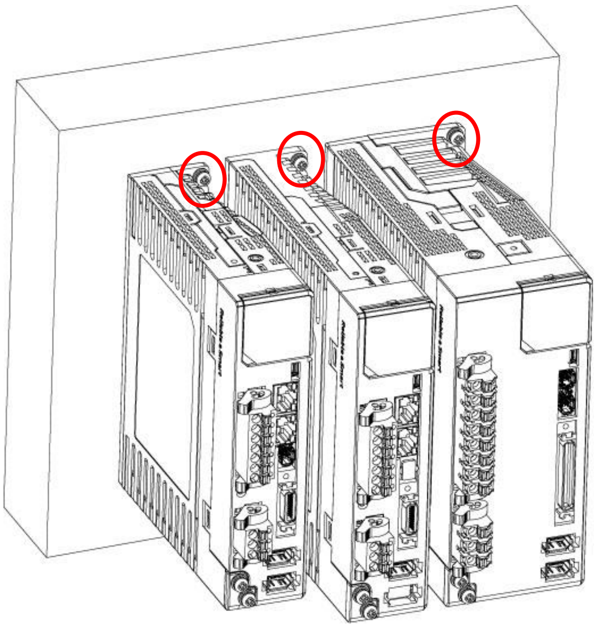
- All model : one M4xL10 bolt for top and bottom



Fixing Bolt

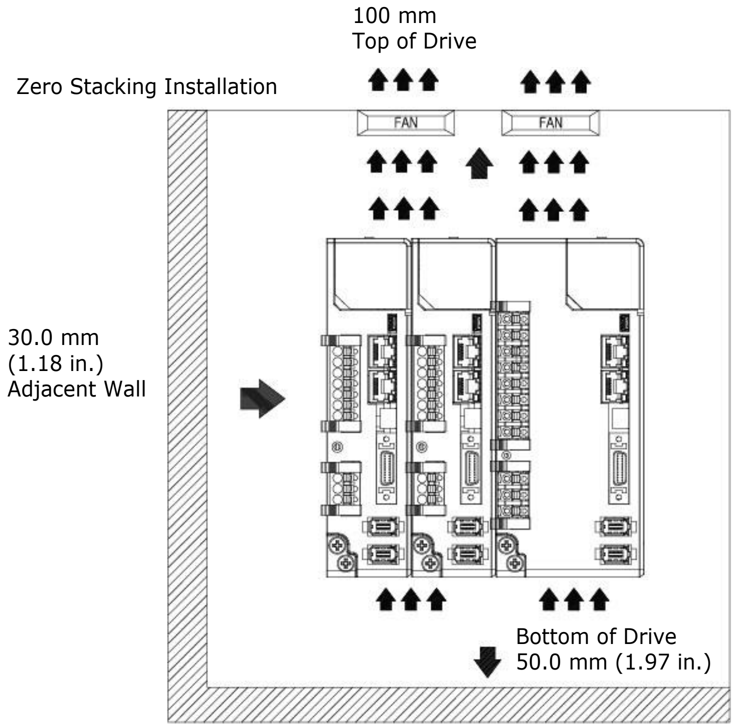
- Apply M4 bolts to both top and bottom

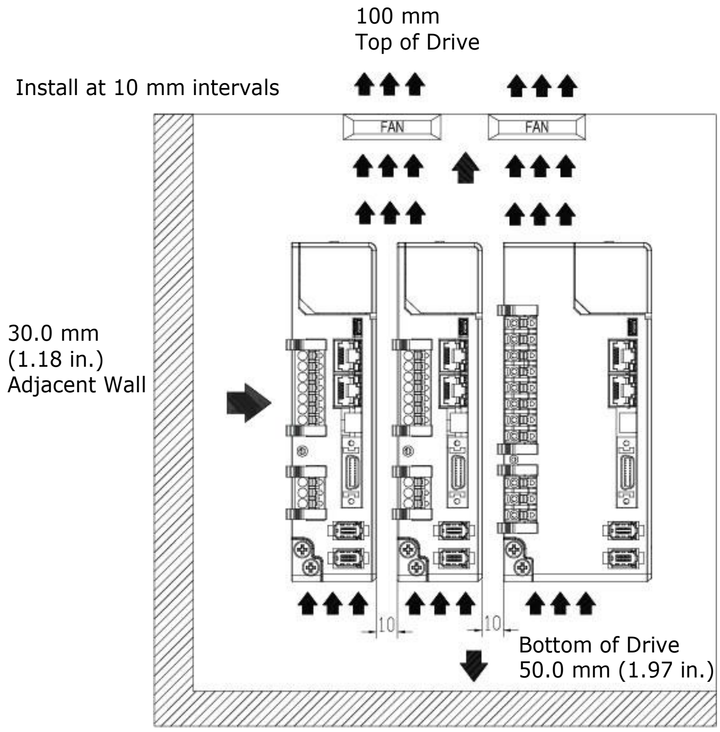
(See “Drive Size and Exterial View” in the page B-4)

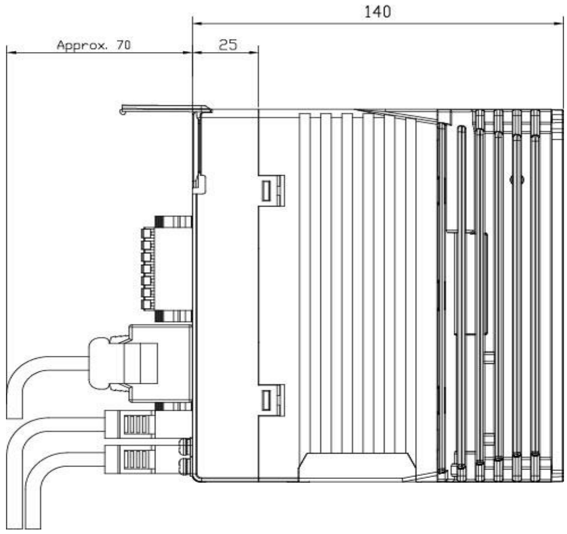


When installing several drives, you must the following criteria.

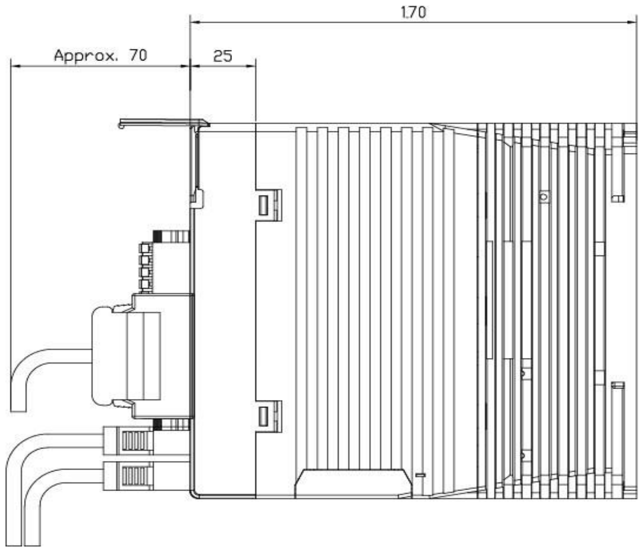
- Basically, keep 10 mm distance between products.
- In case of zero stacking installation, attach an external fan to keep the ambient temperature of the products below 40 degrees Celsius.



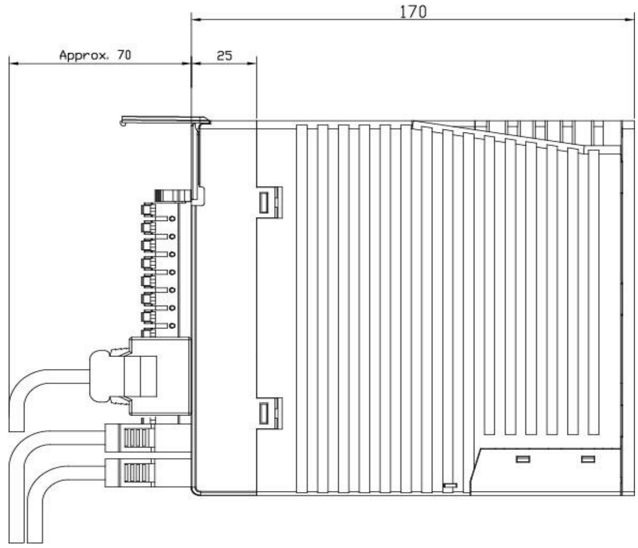




< 100W, 200W>



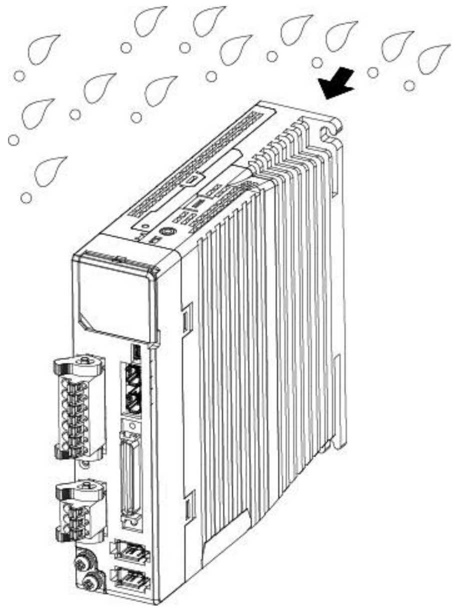
< 400W>



< 800W>

Use the drive in a clean environment where there is no dust or humidity.

The installation environment for CSD7 Servo Drive is the pollution level 2 specified in the IEC-60664-1, and this product should be used per IP2x, so use the product in a clean environment without dust or humidity.

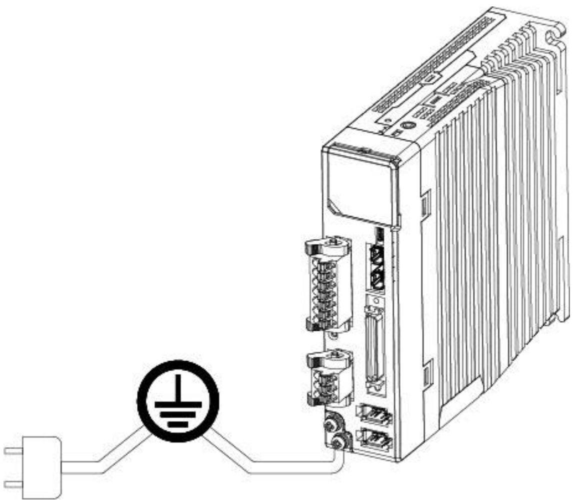


Ground Product

There is a grounding terminal at the bottom of the heat sink.

- 100w to 1.5Kw full capacity : two M4 bolts
  (for input power supply & motor power grounding)

If not grounded, it may reduce the performance. Be sure to connect the ground of input power and motor power to the grounding terminal of drive.

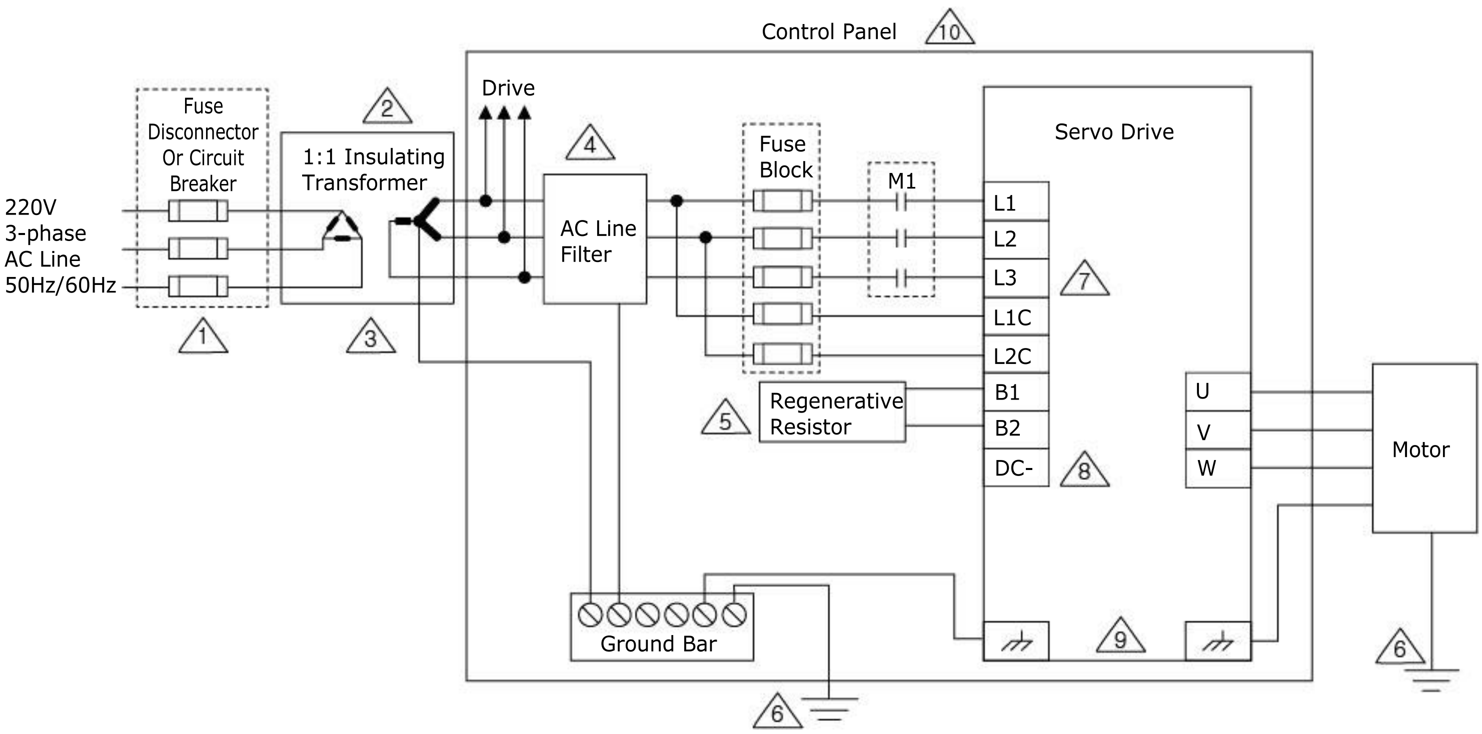


Installation Environment

CSD7 Servo Drive installation environment is like below.

Table 2.1 CSD7 Servo Drive Installation Environment

Item	Installation Conditions
Storing Temperature	-25 to 85°C
Operational Temperature	0 to 50°C
Operational Humidity	5 to 95 % RH at a place without condensations.
Vibration	5-55Hz @ 0.35mm(0.014") double amplitude, continuous displacement, 55-500Hz @ 2g peak constant acceleration.
Operational Location	Installation environment must meet the follwoing conditions (IP2X, Pollution level 2) : • Indoors • Well ventilation • Easy checkup • Without explosive gas



(IP2x, Pollution level 2)

1. Power cut-off device is required for maintenance and safety purposes. Local regulations should be observed.
2. When using the transformer, the voltage between phase voltage and neutral point/ground should not exceed the rated input.
3. Use of insulating transformer is optional. If used, the secondary ground in a transformer should be used.
4. To enhance the electromagnetic compatibility (EMC) and satisfy the European EMC directive, the AC power input filter and shielded motor cable are used; and the ferrite core should be used in the AC power, motor (power & signaling line), input/output and communication (USB & RS485) cable. As the AC power input filter has a large leakage current, discharge time is required upon removing the power supply. The wiring between drive and filter should be kept as short as possible. The common ground bar should be installed close to the drive to the maximum extent possible.
5. The regenerative circuit is available only for the product of 400 W (CSD7_04Bxx1 - CSD7_15Bxx1) or above. For the product of 200 W or below (CSD7)01Bxx1, CSD7_02Bxx1), the B1 and B2 terminal should be kept with nothing connected.
6. For the high-frequency ground, a thick braided wire is connected among the product, equipment enclosure, machine frame and motor.
7. The product of 400 W or below supports only a single-phase AC input, so there is no L3 terminal. Connect power only to L1 and L2.
8. It is a DC voltage connection terminal. Connect the DC power supply which has the circuit limiting the initial charging input current to the B1 and DC terminal.
9. The radiator panel has two ground screws for motor and power ground respectively. The ground terminal should be tightened to 1.25 Nm (11 lbs-in) torque.
10. As for the installation environment, the product should be installed in the environment with pollution level 1 or 2 as specified in an IEC-60664-1. Install on the control panel which satisfies the IP54 protection.

Noise Filter and Ferrite Core

Table 2.2 Noise Filter and Ferrite Core

	CSD7-					
CSD7 Drive	01BX1	02BX1	04BX1	08BX1	10BX1	15BX1
AC Power Filter	2090-XXLF-TC116(Tesch NF310/16)			2090-XXLF-TC318(Tesch NF210/16) 2090-XXLF-TC116(008xx1 , if single-phase applied)		
Ferrite Core	Wire for AC Power, Motor (Power and Signal line) : OP14.2x28.5-6.8H Wire for input/output, communication (USE & RS485): OP12x20-5.6H					

IMPORTANT

- To maintain reliability for a long time, use it within to 0 to 35 °C.
- Install a separate cooling device at a place with high ambient temperature and use it within the operational temperature.

Servo Motor Installation

NOTE

For numerical data related to the installation of the servo motor, please refer to Servo Motor User Manual (Publication SMOTOR-UM002).

Wiring

This chapter describes the information on motor, host controller and other wiring connected to the servo drive, along with the circuit diagram.

Before You Begin

Pay attention to the following precautions when wiring.

CAUTION

- Wiring should be done only by the qualified personal.
- High voltage remains in the drive even through the power is off. Therefore, do not inspect components unless inside Charge lamp is off.
- Pay attention to the polarity when wiring.
- The heat sink of the drive generates high heat. Pay attention to the heat sink when wiring.

In this chapter, the circuit is divided into electric circuit and signal circuit for easier and convenient explanation. Be fully aware of the names of each terminal when reading this user's manual.

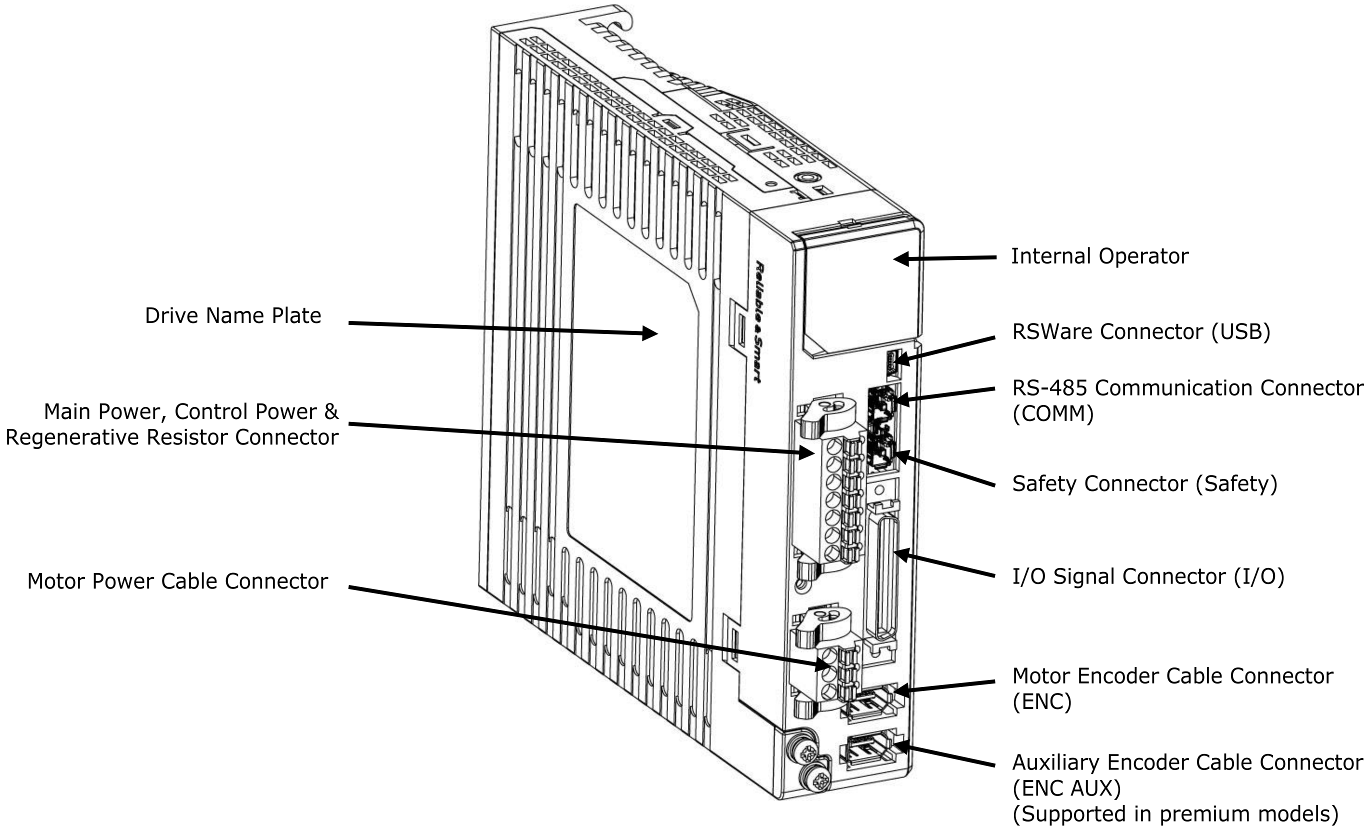
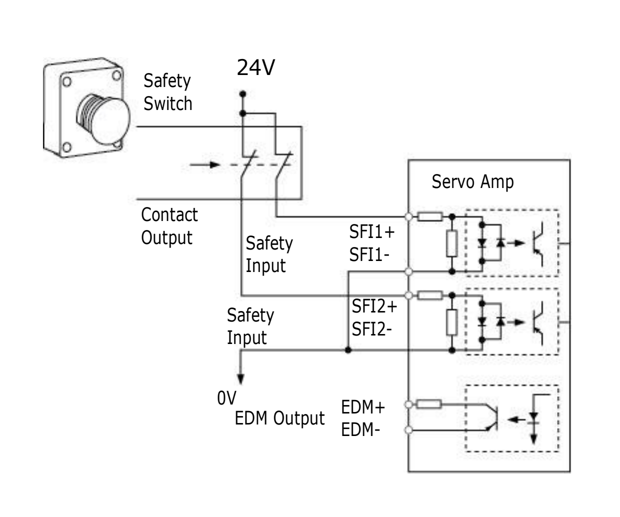


Table 3.1

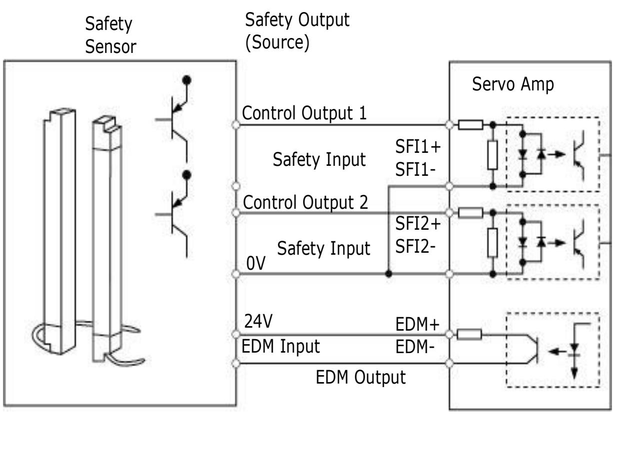
No	Item	Function description
1	Internal Operator	Composed of 6 7-segments, and 4 buttons. Functions available - Parameter Editing, Status Display, Monitoring and Run Function
2	USB	Connects the PC software, RSWare
3	COMM	Connects the Modbus-RTU (RS-485) communication
4	Safety	Provides the functional safety function, STO
5	I/O	Input/output function composed of 50 pins. See each wiring diagrams for the wiring methods. - Position Control Mode - Velocity Control Mode - Torque Control Mode - Multi-step Speed Mode
6	ENC	Input the serial encoder signal of the motor used. (17 bit Serial, BiSS)
7	ENC^{AUX}	Used for inputting the position value of the external linear scale which is used for the full closed function.

The input/output signal connector (I/O) and encoder cable connector (ENC) are discussed in the signal circuit description while the USB, RS-485 and safety connectors are discussed in the Appendix C, Cable Specifications.

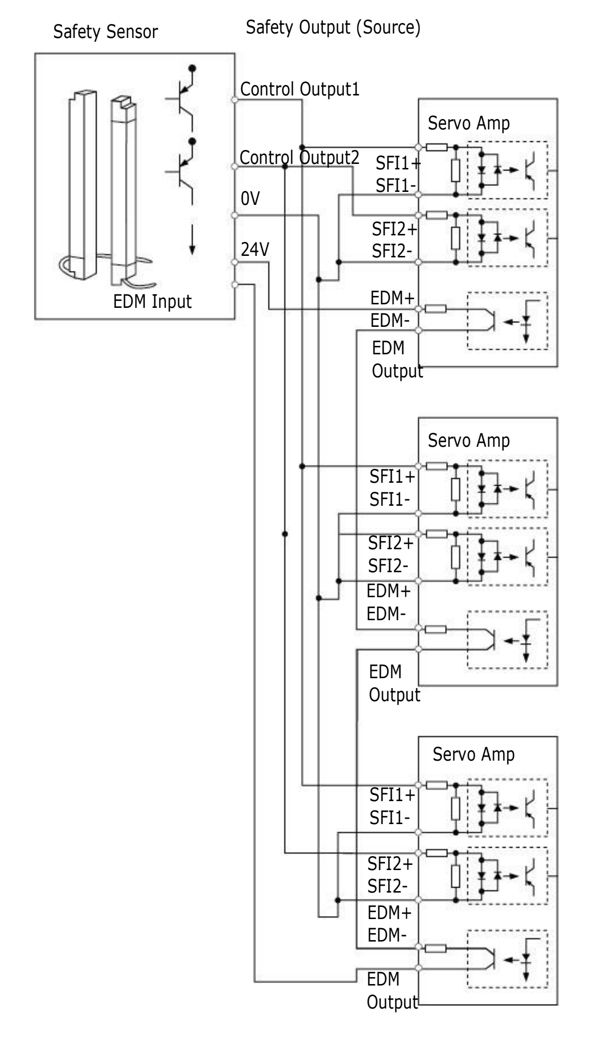
To use the Safe Torque Off (STO) feature available only in a premium model, external wiring using connectors as shown in the figure below is required; if not, the dummy connector included in the product should inserted to allow normal operation.



When Using a Safety Switch



When Using a Safety Sensor.



When Multiple Drives are Connected to a Single Safety Sensor.

Electric Circuit Name and Function

Electric Circuit Name and Function

The names of each electric circuits are printed on the front of the drive.

Perform wiring for the drive after thoroughly reading through the table below.

Table 3.2 Electric Circuit

Terminal	Symbol	Purpose	
AC Main Power Input Terminal	L1, L2	400W or lower	Single-phase 200-230V (50/60 Hz)
	L1, L2, L3	800W or higher	3-phase 200 - 230V (50/60 Hz) (Sigle-phase is available at 800 W)
Control Power Terminal	L1C, L2C	Use of Full Capacity	Single-phase 200-230V (50/60 Hz)
Motor Power Cable Connection Terminal	U, V, W	Connect to the 3-phase power (U,V,W) cable of motor	
Grounding Terminal (Heat Sink)	⏚	Connect the power and motor cable to the grounding terminal.	
Regenerative Register Connection Terminal	B1, B2	200W or lower	As the function for regenerative energy consumption is not required, the regenerative resistor does not have to be mounted.
		400W or higher	If the capacity of the mounted regenerative resistor is insufficient, connect an external resistor with a larger capacity in a parallel manner to the regenerative resistor connection terminal (B1 and B2). You should not connect the resistor with the resistor value smaller than the existing resistor value. For the value of the external regenerative resistor to be added, contact RS Automation before changing it.
External Condenser Connection Terminal	B1 DC-	It is the terminal where external condenser is connected if the condenser capacity of the servo drive is insufficient. Connect the condenser + polarity to the B1 terminal; and N polarity to the DC- terminal. If it is necessary to connect an external condenser, be sure to contact RS Automation for advice.	

AC Power Terminal (L1, L2, L3) and Control Power Terminal (L1C, L2C)

As the main power input and control power input can be connected to the drive separately, a user can configure the peripheral circuit so that the drive itself can cut off only the power selectively after determining if something is normal or not.

If the drive independently checks the status and only the main power is cut off, but not the control power, the drive can display the cause of cut-off of the main power. The user can take appropriate action after identifying the cause of cut-off of the main power.

Refer to the 3-6 page "Electric Circuit Diagram" for the Electric Circuit Diagram of the power separation.

Motor Power Cable Connection Terminal (U, V, W)

WARNING

The motor power cable connection terminals (U, V, W) are output terminals. Do not connect the input power. It may cause of the drive damage.

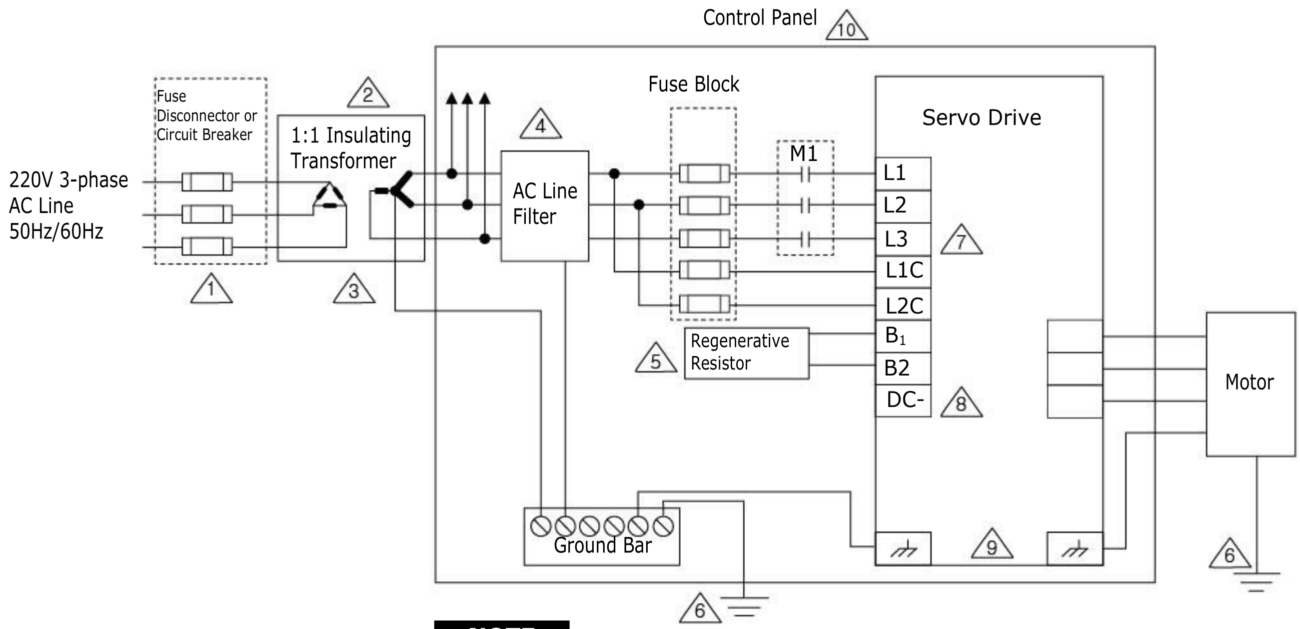
Regenerative Resistor Connector

Refer to the 7-11 page "Reneration Resistor" for details of the Regeneration Resistor Connection.

CAUTION

- When wiring the wiring socket, be careful not to expose the core wire. It may cause an electric shock.
- Completely discharged before handling after power off.

Electric Circuit Diagram



NOTE

Power cut

1. Power cut-off device is required for maintenance and safety purpose. The local regulations should be observed.
2. When using the transformer, the voltage between phase voltage and neutral point/ground should not exceed the rated input.
3. Use of insulating transformer is optional. If used, the secondary ground in a transformer should be used.
4. To enhance the electromagnetic compatibility (EMC) and satisfy the European EMC directive, the AC power input filter and shielded motor cable are used; and the ferrite core should be used in the AC power, motor (power & signal line), input/output and communication (USB & RS485) cable. As the AC power input filter has a large leakage current, discharge time is required upon removing the power supply. The wiring between drive and filter should be kept as short as possible. The common ground bar should be installed close to the drive to the maximum extent possible.
5. The regenerative circuit is available only for the product with 400 W (CSD7_04Bxx1 - CSD7_15Bxx1) or above.
   For the product of 200 W or below (CSD7)01Bxx1, CSD7_02Bxx1), the B1 and B2 terminal should be kept with nothing connected.
6. For the high-frequency ground, a thick braided wire is connected among the product, equipment enclosure, machine frame and motor.
7. The product of 400 W or below supports only a single-phase AC input, so there is no L3 terminal. Connect power only to L1 and L2.
8. It is a DC voltage connection terminal. Connect the DC power supply which has the circuit limiting the initial charging input current to the B1 and DC terminal.

9. The radiator panel has two ground screws for motor and power ground respectively. The ground terminal should be tightened to 1.25 Nm (11 lbs-in) torque.
10. As for the installation environment, the product should be installed in the environment with pollution level 1 or 2 as specified in the IEC-60664-1. Install on the control panel which satisfies the IP54 protection.

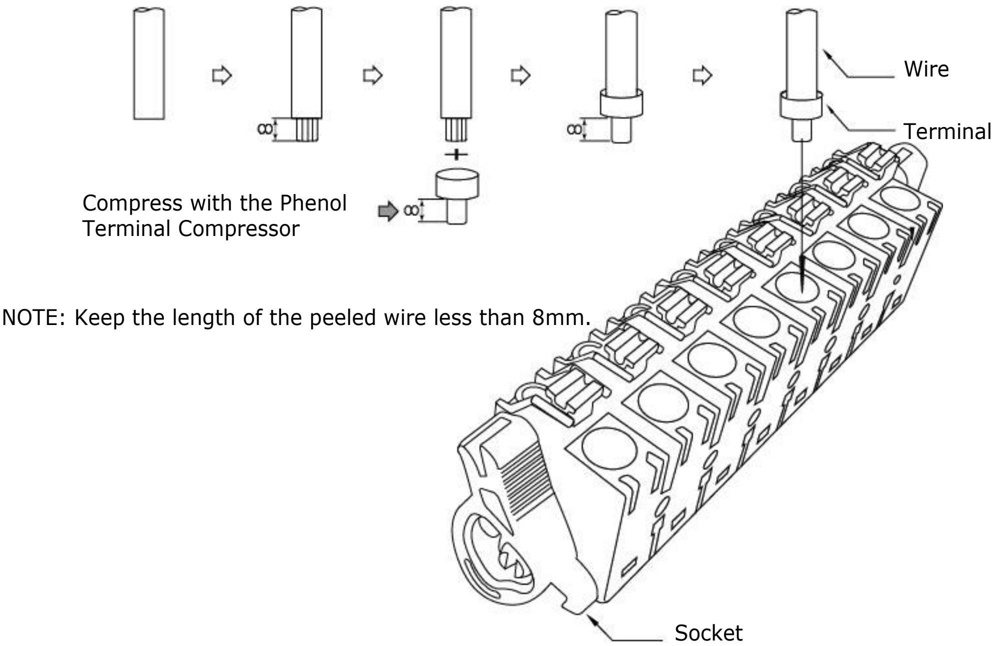
CAUTION

Use single-phase power in servo drive whose rated output (capacity) is 400 [W] or lower.

Using the Socket and Lever

This section describes the usage of wiring socket and lever provided with servo drive.

- Connect only one wire at wire inlet of the socket. If the wire is pulled accidentally with an excessive force, rewire it properly.
- The peeled wire can be used. (Keep the length of the peeled core wire less than 8 [mm].)
- The use of phenol terminal is recommended for the reliability of wiring.
- After connecting the wire, pull it slightly to check if the connection between the socket and wire is normal.
- You can disconnect the wire by pressing the button at the top of the socket.



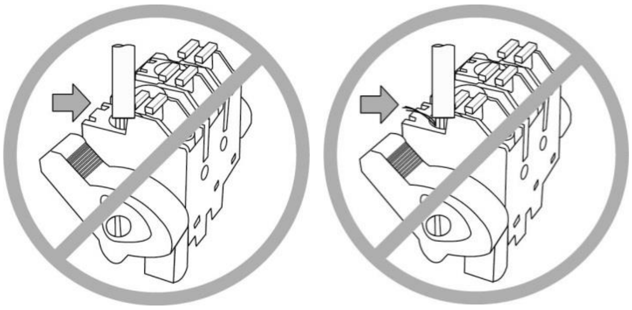
The thickness of wire allowed by the socket is shown below.

Table 3.3

Capacity	Wire Thickness
400W or less	AWG26 to AWG14 (Twisted Pair)
800 W or above	AWG20 to AWG14 (Twisted Pair)

CAUTION

Insert the wire completely. If peeled core wire is exposed, it may cause an electric shock.



I/O Signal (I/O)

I/O Connection Diagram

This is the circuit diagram of a connector for I/O signal. It is divided into input on the left and output on the right.

The Backup battery for absolute value encoder does not have the separate terminal. It must be connected to motor encoder cable.

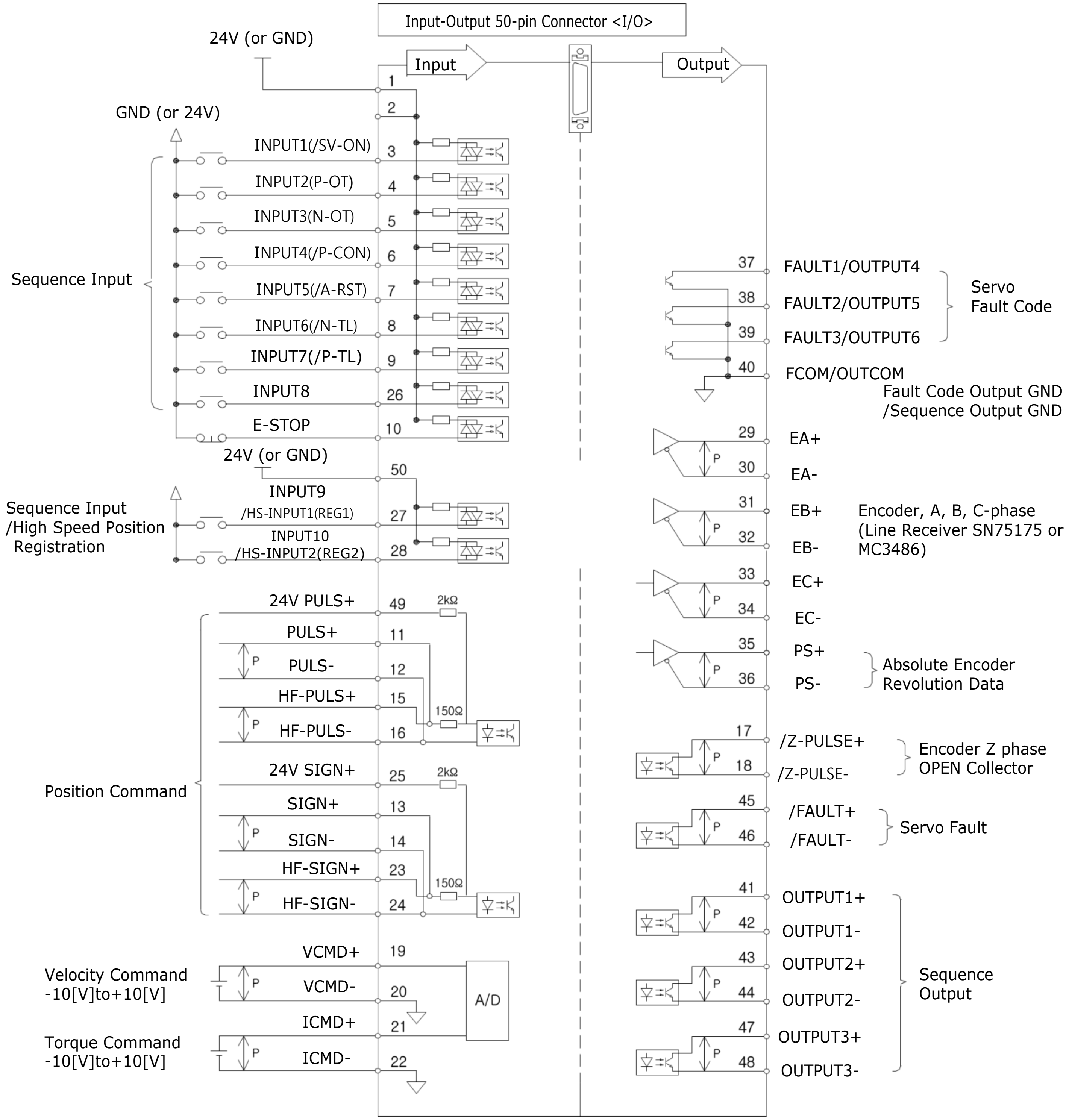


Table 3.4 (I/O) Pin Arrangement for host controller connections

Pin	Symbol	Description	Pin	Symbol	Description
1	+24V IN	24V Power Input (Input No 3~10, 26~28 Common)	26	INPUT8	Digital Input 8
2	+24V IN	24V Power Input (Input No 3~10, 26~28 Common)	27	HS-INPUT1 (REG1) / INPUT 9	High Speed Position Recognition 1 (for registration) / Digital INPUT 9
3	INPUT1	Digital Input 1 (SV-ON)(1)	28	HS-INPUT2 (REG2) / INPUT 10	High Speed Position Recognition 2 (for registration) / Digital INPUT 10
4	INPUT2	Digital Input 2 (P-OT)(1)	29	EA+	Encoder Signal Output A+
5	INPUT3	Digital Input 3 (N-OT)(1)	30	EA-	Encoder Signal Output A-
6	INPUT4	Digital Input 4 (/P-CON)(1)	31	EB+	Encoder Signal Output B+
7	INPUT5	Digital Input 5 (/A-RST)(1)	32	EB-	Encoder Signal Output B-
8	INPUT6	Digital Input 6 (/N-TL)(1)	33	EC+	Encoder Signal Output Z+
9	INPUT7	Digital Input 7 (/P-TL)(1)	34	EC-	Encoder Signal Output Z-
10	E-STOP	Emergency Stop (Default: Disable)	35	PS+	Absolute Encoder Position Data Output +
11	PULS+	Position Command Pulse Input+	36	PS-	Absolute Encoder Position Data Output -
12	PULS-	Position Command Pulse Input-	37	FAULT1/ OUTPUT4	Fault Code Output 1/Digital Output 4
13	SIGN+	Position Command Sign Input+	38	FAULT2/ OUTPUT5	Fault Code Output 2/Digital Output 5
14	SIGN-	Position Command Sign Input-	39	FAULT3/ OUTPUT6	Fault Code Output 3/Digital Output 6
15	HF-PULS+	High Speed Position Command Pulse Input+	40	FCOM/ OUTCOM	Fault Code Output Ground/Digital Output 4-6 Ground
16	HF-PULS-	High Speed Position Command Pulse Input-	41	OUTPUT 1+	Digital Output 1 +(P_COM+)(1)
17	Z-PULSE+	Encoder Z-Pulse Output (Open Collector)	42	OUTPUT 1-	Digital Output 1 –(P_COM-)(1)
18	Z-PULSE-	Encoder Z-Pulse Output (Open Collector)	43	OUTPUT 2+	Digital Output 2 +(TG_ON+)(1)
19	VCMD+	Speed Command Input+	44	OUTPUT 2-	Digital Output 2 –(TG_ON-)(1)
20	VCMD-	Speed Command Input-	45	/FAULT+	Fault Generation Signal Output +
21	ICMD+	Current Command Input+	46	/FAULT-	Fault Generation Signal Output -
22	ICMD-	Current Command Input-	47	OUTPUT 3+	Digital Output 3 +(BK+)(1)
23	HF-SIGN+	High Speed Position Command Code Input+	48	OUTPUT 3-	Digital Output 3 –(BK-)(1)
24	HF-SIGN-	High Speed Position Command Code Input-	49	24V-PULS+	Open Collector Pulse Input + for 24 [V] Level
25	24V-SIGN+	24V level Open Collector Code Input+	50	HS-INPUT COM	24 V Power Input (Input 27 and 28 common)

(3) Factory default values

(I/O) Input Signal

Sequence Input Signal (Allocation)

Refer to the 5-3 page "Sequence I/O (Input/Output) Signal" for details of sequence input signal.

Table 3.5 I/O Sequence Input Signal

Type	Description	Mode	Reference
</SV-ON>Servo-ON	When the servo is set to ON, voltage is applied to the servo motor; when it is set to OFF, voltage is cut off.	All	4-1 page
<A-RST> Fault Reset	It disables the Servo's Fault.	All	7-41 page
</G-SEL> Gain Group Conversion	Use 2-group gain where it is set to ON and use current gain where it is set to OFF. It converts gain of 2 groups.	All	6-37 page
</P-TL> Forward Torque Limit	When it is set to ON, limit the forward torque by the set value [Ft-4.09].	All	5-45 page
</N-TL> Reverse Torque Limit	When it is set to ON, limit the reverse torque by the set value [Ft-4.10].	All	5-45 page
<P-OT> Prohibit Forward Rotation	It prohibits the motor from rotating forward when the load device reaches the limit of the available section.	All	7-2 page
<N-OT> Prohibit Reverse Rotation	It prohibits the motor from rotating reversely when the load device reaches the limit of the available section.	All	7-2 page
</P-CON> P Control Conversion	It converts the Seed Controller from PI type controller to P type controller. It is used to suppress the overshoot of the excessive response and complete a faster response.	F,S,P,I	6-30 page
</C-SEL> Control Mode Conversion	It is used to convert Control Mode when using it as Combination Control Mode.	Combinational Control Mode Only	5-56 page
</C-DIR> Multi-step Speed Direction </C-SP1> </C-SP2> </C-SP3> </C-SP4> Multi-step Speed Command	At the Multi-step Speed Control Mode, these input combinations decide the rotation direction of the motor </C-DIR> and the rotation speed </C-SP1 to /C-SP4>. The rotation speed for </C-SP1 to /C-SP3> input is set in [Ft-2.09 to Ft-2.11]. The analogue speed command voltage decides the rotation speed for </C-SP4>. </C-DIR> is used to change the motor rotation direction in Velocity Control Mode.	P	5-50 page
</Z-CLP> Zero Clamp	Ignores the input value in the Velocity control when the command value is lower than the value set in the Speed Zero Clamp Level [Ft-2.20].	S	5-35 page
</INHIBT> Inhibit Pulse Command	Inhibits the position command pulse where it is ON.	F	5-27 page
</ABS-DT> Absolute Encoder Data Transmission	In the absolute position transmission mode using the photo coupler, the absolute position data is transmitted through synchronization with the Signal On.	All	7-42 page
</PCLR> Position Error Clear	Clears position command, position feedback, and position error.	F,I	5-27 page
</START> Start	Set to start or stop the motor rotation by using the contact signal in Velocity/Multi-step speed Control Mode.	S,P	5-38 page

Table 3.6 I/O Sequence Input Signal

<table>
<tr><th>Types</th><th>Description</th><th>Relevant Mode</th><th>Details</th></tr>
<tr><td></R-ABS>Absolute Encoder Multi-rotation Data Reset</td><td>Erases the multi-rotation data of the absolute motor.</td><td>All</td><td>7-30 page</td></tr>
<tr><td></BANK_SEL>Gain Bank Select</td><td>Uses the 3^{rd} and the 4^{th} Gain Bank when it is set to ON.</td><td>All</td><td>6-36 page</td></tr>
<tr><td></A-CL>Analog Torque Limit</td><td>Current Limit Function is activated by the analogue torque command input values when it is set to ON.</td><td>S, P</td><td></td></tr>
<tr><td></HOM_SEN>Home Sensor</td><td>When activated, the sensor indicates the Return to Home sequence that is detected.</td><td>I</td><td></td></tr>
<tr><td></I-HSTART>Start Homing</td><td>When activated, the system starts returning to home.</td><td>I</td><td></td></tr>
<tr><td></I-PAUSE>Index Pause</td><td>When activated, it decelerates until stop and pause the index sequence. It decides whether to stop or to continue the motion by constantly monitoring the input status.</td><td>I</td><td></td></tr>
<tr><td></I-STOP>Index Stop</td><td>When activated, index movement ends.</td><td>I</td><td></td></tr>
<tr><td></I-SEL0-IN>
Index Selection 0 Input
</I-SEL1-IN>
Index Selection 1 Input
</I-SEL2-IN>
Index Selection 2 Input
</I-SEL3-IN>
Index Selection 3 Input
</I-SEL4-IN>
Index Selection 4 Input
</I-SEL5-IN>
Index Selection 5 Input</td><td>Used for the combinations to allocate indexes.</td><td>I</td><td></td></tr>
<tr><td></I-HSTOP>Homing Stop</td><td>Stops Homing operation when it is set to ON.</td><td>I</td><td></td></tr>
<tr><td></I-START>Start Indexing</td><td>Starts Indexing when it is set to ON.</td><td>I</td><td></td></tr>
<tr><td></ABS-MD>Absolute Position Data Transmission Mode</td><td>When the signal is turned on, the absolute data is transmitted to the higher level through the photo coupler output.</td><td>F</td><td></td></tr>
<tr><td></I-JOG></td><td>Jog operation starts at an index mode, and Jog turns on</td><td>I</td><td></td></tr>
<tr><td></I-JOG-FW>
Index Jog Forward</td><td>When turned on in an index jog mode, it rotates to the forward direction.</td><td>I</td><td></td></tr>
<tr><td></I-JOG-BW>
Index Jog Reverse</td><td>When turned on in an index jog mode, it rotates to the reverse direction.</td><td>I</td><td></td></tr>
<tr><td></E-GEAR1>
2^{nd} Electronic Gear Ratio Selection

</E-GEAR2>
3^{rd} Electronic Gear Ratio Selection</td><td><table><tr><th>/E-GEAR2</th><th>/E-GEAR1</th><th>Electronic gear Selection</th></tr><tr><td>OFF</td><td>OFF</td><td>1^{st} electronic gear
(Ft-3.05, Ft-3.06)</td></tr><tr><td>OFF</td><td>ON</td><td>2^{nd} electronic gear
(Ft-3.07, Ft-3.08)</td></tr><tr><td>ON</td><td>OFF</td><td>3^{rd} electronic gear
(Ft-3.09, Ft-3.10)</td></tr></table></td><td>F</td><td></td></tr>
</table>

General Input Signal (Fixed)

Power

Table 3.7 Power Input Signal

Signal Name	Symbol	Function	Mode	Reference
External power input	+24V IN	As control power input for contact point signal, +24 [V] power should be prepared by users. Power Specifications: 21.6 to 26.4V, 210Ma	All	50 pin I/O connector 3~10 pin, 26~28 pin common

Emergency Stop

Table 3.8 Emergency Stop Input Signal

Signal Name	Symbol	Function	Mode	Reference
Emergency Stop	E-STOP	Connect and use an extra emergency stop switch to quickly act upon emergency situation, users can select whether to use in [Ft-0.05] [D3] (0:Disable, 1: Enable) constant.	All	3-22 page

Position Command, Velocity Command, Torque Command

Table 3.9 Position command input signal

Signal Name	Symbol	Function	Mode	Reference
Pulse Command	PULS+ PULS- SIGN+ SIGN-	Receives position command by pulse input. Can respond to line drive or 5V open collector output of the host controller. When 5V open collector is used, however, 180 ohm resistor should be added externally. (Line drive, less than 900 kpps)	F	5-10 page (Position Control Mode)
High Frequency Pulse Command	HF-PULSE+ HF-PULSE- HF-SIGN+ HF-SIGN-	Connect the high frequency pulse input to this terminal. (High speed line Drive, less than 4Mpps)	F	5-10 page (Position Control Mode)
Open ollector(24[V]) Pulse Command	24V-PULSE+ PULS- 24V-SIGN+ SIGN-	For Open Collector 24V pulse input, connect to this terminal without a pull-up resistor. (Open collector, less than 250 kpps)	F	5-10 page (Position Control Mode)
Velocity Command	VCMD+ VCMD-	Receives analog speed command. (-10V to +10V)	S	5-32 page (Velocity Control Mode)
Torque Command	ICMD+ ICMD-	Receives analog torque command. (-10V to +10V)	C	5-42 page (Torque Control Mode)

I/O Output Signal

Sequence Output Signal (Allocation)

Refer to the 5-1 page "Sequence I/O (Input/Output) Signal" for details of sequence output signal.

Table 3.10 I/O Sequence Output Signal

Type	Description	Applicable Mode	Details
</P-COM (+, -)> Position Completion Detection	Turns to ON, when the position error is within the set value of the position completion range [Ft-3.18].	F	5-28 Page
</NEAR (+, -)> Position Proximity Detection	Turns to ON, when the position error is within the set value of the position completion range [Ft-3.19].	F	5-28 Page
</V-COM (+, -)> Speed Match Detection	Turns to ON when the deviation between the speed command and the motor rotation speed is within the set value of the speed match decision range [Ft-2.18].	F, S, C	5-39 Page
</TG-ON (+, -)> Rotation Detection	Turns to ON when the motor is rotating above the set value of the rotation detection level [Ft-2.19].	All	5-40 Page
</T-LMT (+, -)> Torque Limit Detection	Turns to ON when torque reaches the set value of the torque limit.	All	5-58 Page
</V-LMT (+, -)> Speed Limit Detection	Turns to ON when speed reaches the set value of the speed limit.	All	5-41 Page
</BK (+, -)> Brake Control	It is the signal for the brake control installed inside or outside of the servo motor.	All	7-6 Page
</WARN (+, -)> Warning Detection	Turns to ON when a Servo warning is detected.	All	8-3 Page
</A-VLD> Absolute Position Valid	Turns to ON when the absolute position data is valid while using the absolute motor.	All	-
</RDY> Drive Ready	Means getting the operation ready while in the Servo-OFF status.	All	-
</I-HOM> In homing	Homing sequency is in progress.	I	5-8 page (Table 5.7)
</I-HOMC (+,-)> Axis Homing completion	When activated, it shows the completion of the Homing operation.	I	5-8 page (Table 5.7)
</I-MO (+,-)> In Motion	Turns to ON when in motion.	I	5-8 page (Table 5.7)
</I-DW> In Dwell	When activated, it indicates that the motor is on the hold position in the index movement and on stand-by for the dwell time assigned.	I	5-8 page (Table 5.7)
</I-SEL0-OUT> Index Selection 0 Input </I-SEL1-OUT > Index Selection 1 Input </I-SEL2-OUT > Index Selection 2 Input </I-SEL3-OUT > Index Selection 3 Input </I-SEL4-OUT > Index Selection 4 Input </I-SEL5-OUT > Index Selection 5 Input	Used to output the index number in use in the selected indexing operation.	I	5-8 page (Table 5.7)
</I-ESEQ> Sequence Operation Completion	Turns to ON when the index movement is complete.	I	5-8 page (Table 5.7)

Type	Description	Applicable Mode	Details
</RMS-CLT1> Effective Load Ratio Output 1	Effective Load Ratio Output 1	All	5-8 page (Table 5.7)
</RMS-CLT2> Effective Load Ratio Output 2	Effective Load Ratio Output 2	All	5-8 page (Table 5.7)

NOTE In this manual, < > is applied to the names of sequence I/O signal.
ex) </SV-ON>, </P-COM>

General Output Signal (Fixed)

Fault Code

Table 3.11 Fault Code Output Signal

Signal Name	Symbol	Function	Mode	Reference
Fault	/FAULT (+, -) Fault	Outputs when Servo Fault sets off.	F	8-5 Page
Fault code	FAULT 1/OUTPUT 4 (Fault 1/Digital output 4) FAULT 2/OUTPUT 5 (Fault 2/Digital output 5) FAULT 3/OUTPUT 6 (Fault 3/Digital output 6)	Upon servo fault generation, it outputs the types of the servo fault with the 3-bit. (Refer to the table below) Maximum rating of open collector: DC 30 [V], 20 [mA]	All	8-3 Page

Fault group	Fault code output status			Fault code
	Fault3	Fault2	Fault1	
0	ON	ON	ON	No fault
1	ON	ON	OFF	E.005 IPM Error E.054 Current Feedback Offset E.057 PWM Hardware Error E.079 Regenerative Over Current Protection E.114 Motor Phase Over current
2	ON	OFF	ON	E.022 모터 연속 전류 과부하 E.023 Drive Overload E.036 Drive Overheat E.075 Regenerative Overload Protection E.101 Motor Power Cable Open E.102 Motor instantaneous current overload E.103 Motor Mismatch Fault
3	ON	OFF	OFF	E.028 Encoder Date Range Error E.030 Encoder Cable Open E.031 Encoder Data Parameter Error E.083 Battery Low Voltage Error of Absolute Encoder E.084 Absolute Encoder Over Speed E.085 Absolute Encoder Multi-turn Count Error

				E.106 Encoder Communication Error
4	OFF	ON	ON	E.006 FAN fault E.009 BUS Low Voltage E.010 BUS Over Voltage E.037 AC line Loss
5	OFF	ON	OFF	E.018 Motor Over-speed E.019 Position Error Limit Exceeded E.024 Absolute Data Transmission Timeout E.056 Watchdog Timeout E.108 Position Command Frequency error E.111 Safety Torque Off Input Error E.112 Emergency Stop
6	OFF	OFF	ON	E.053 User Parameter Initialization Error E.055 User Parameter Checksum Error E.058 User Parameter Range Error E.107 Serial Communication Error E.113 Index Position Range Overflow
7	OFF	OFF	OFF	E.012 Home Searching Failed E.027 Homing Incomplete E.060 Drive Initialization Error

NOTE If one or more of Fault code (FAULT1, FAULT2, and FAULT3) set to Digital output (Sequence output), Fault code does not output.

Encoder Signal

Table 3.12 Encoder Signal

Signal Name	Symbol	Function	Mode	Reference
Encoder Signal Output	EA+	Displays multiplied encoder signal A, B, C pulse in the form of line drive. According to the parameter setting, the drive can logically invert output of A, B pulse.	All	7-21 Page
	EA-			
	EB+			
	EB-			
	EC+			
	EC-			
Absolute Encoder Position S pulse	PS+	Outputs the number of rotation by serial data when the absolute encoder is used.	All	7-21 Page
	PS-			

Servo Fault

Table 3.13 Servo Fault Output Signal

Signal Name	Symbol	Function	Mode	Reference
Servo Fault Monitor Output	FAULT+	It is displayed if the servo fault is generated.	All	7-24 Page
	FAULT-			

Encoder Z-pulse Display

Table 3.14 Encoder Z-pulse Output Signal

Signal Name	Symbol	Function	Mode	Reference
Encoder Z-pulse	Z-PULSE+	It is displayed if Z-Pulse of the encoder is detected.	All	-
	Z-PULSE-			

(I/O) Input Circuit and Interface

Describes the connection circuit for input from the host controller to the servo drive.

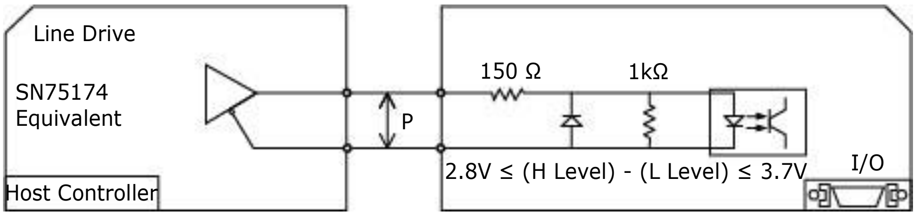
Pulse Command Input Circuit

The drive receives the pulse output of host controller by position command in position control mode.

Host controller can output pulse in line drive or open collector type. Select one of the two output types. Refer to the 5-11 page "Position Control Mode" for the servo drive setting according to the selection.

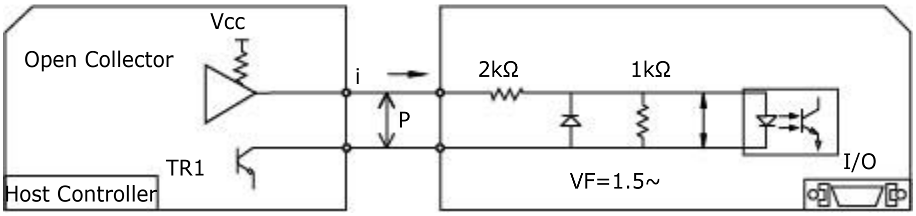
Line drive - Maximum allowable frequency 900 [kpps](Duty ratio: 50:50)

- Input pin number
  - H-PULS+, H-PULS- (11, 12)
  - SIGN+, SIGN- (13, 14)



Open Collector (24 [V]) - Maximum Allowable Frequency 250 [kpps]

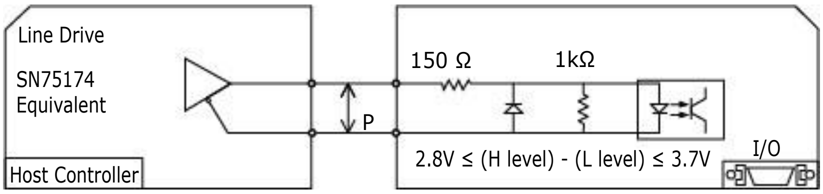
- Input pin number
  - 24V-PULS+, PULS- (49, 12)
  - 24V-SIGN+, SIGN- (25, 14)



NOTE For Open Collector 24 [V] input, it does not need the external resistor.

High Frequency Line Drive - Maximum Allowable Frequency 4Mpps

- Input pin number
  - HF-PULS+, HF-PULS- (15,16)
  - HF-SIGN+, HF-SIGN- (23, 24)



NOTE

Maximum allowable frequency of host controller's pulse command is

- 900 kpps for the line drive
- 4 Mpps for high speed line drive
- 250 kpps for the open collector

If the maximum allowable frequency is exceeded, 'E.CdFrE' servo fault of position command pulse is generated. Make sure the output of host controller does not exceed the maximum allowable frequency.

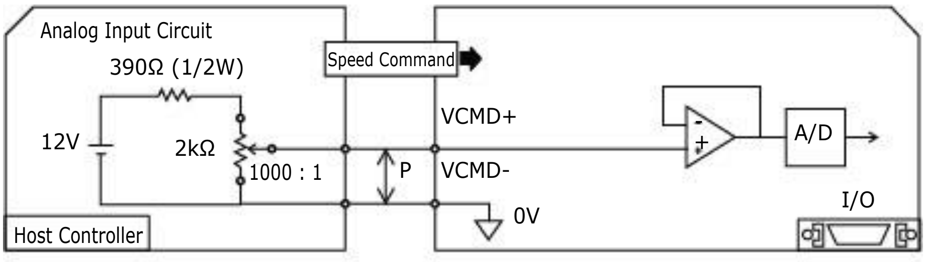
Analog Voltage Input Circuit

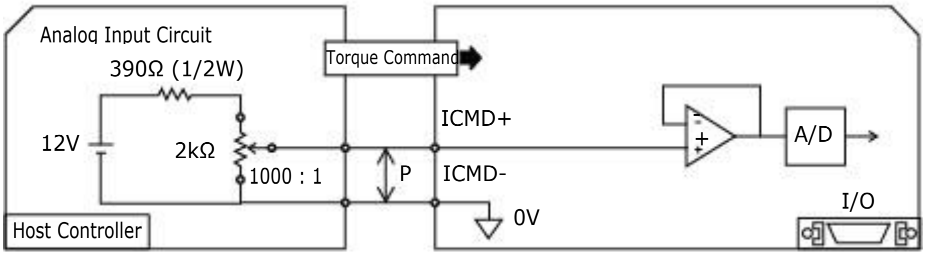
The drive receives analog voltage output of the host controller with speed, speed of torque control mode and torque command.

- Input impedance of speed and torque commands is about 10 kΩ.
- Maximum allowable voltage range of input signal is -10V to +10 V.

Input pin of I/O that uses analog voltage output of the host controller:

- Speed Command: VCMD+ (19), VCMD- (20)
- Torque Command: ICMD+ (21), ICMD- (22)

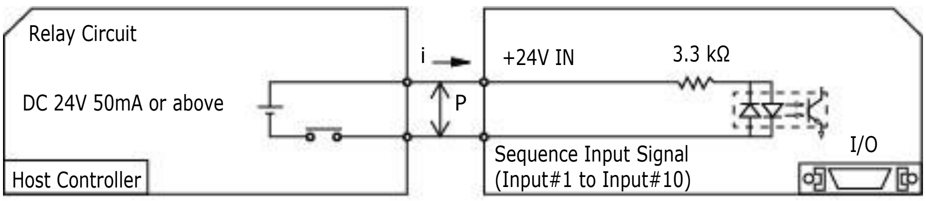


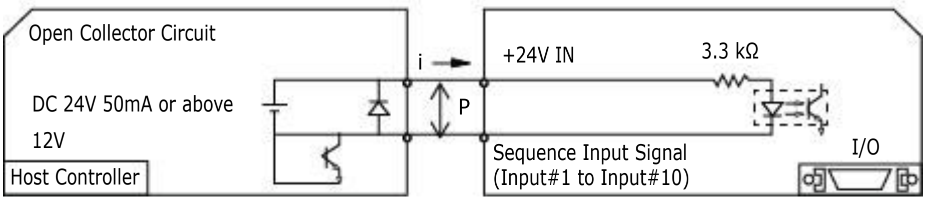


Sequence Input Circuit

Relay or open collector output of the host controller is used for the sequence input circuit.

Make sure that the input current i is within 7 mA to 15 mA.





Emergency Stop Signal

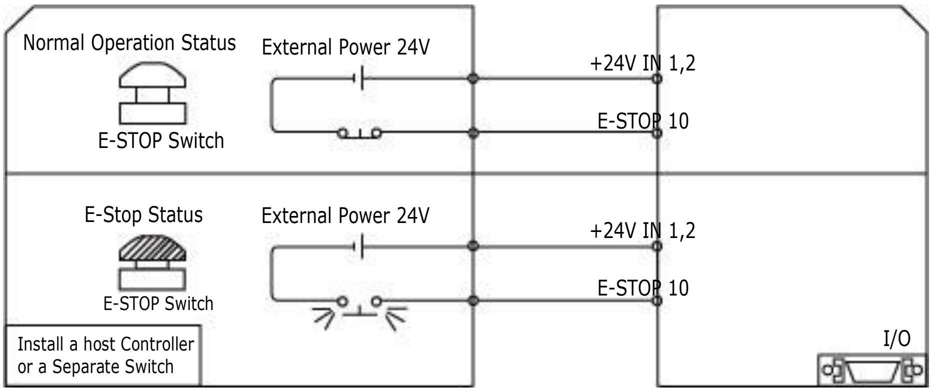
This drive has a built-in circuit for the emergency stop situation.

To quickly respond to the equipment failure or dangerous situation, it receives the emergency stop signal from #10 pin of I/O.

Emergency stop input can be done by the relay contact output of host controller and installing a separate switch.

Whether to use the emergency stop input can be set by the parameter [Ft-0.05][D3]; the initial value(Factory value: [Ft-0.05][D3] = 0) is set as not to use.

#10 pin of I/O assigned below is used as the input pin only for the emergency stop.



NOTE

- If the emergency stop signal is input, [E.EStoP] servo fault is generated.
- Refer to the 8-3 page "Protection Function" more information on the servo fault.
- If the emergency stop is released, reset the fault by referring to the 7-41 page "Fault Reset (run-08)".
- You can check the status of emergency stop signal through the monitor mode describe in the 7-45 page "Monitor Mode Function".

(I/O) Output Circuit and Interface

There are 2 types for the servo drive output circuits. Design the input circuit at the host controller suitable for the each output circuit.

- Line Drive Output
- Photo-Coupler output

Line Drive Output

Output signal (EA+, EA-, EB+, EB-) that converted the encoder serial data into 2 phase (A phase and B phase) pulse, zero point pulse signal (EC+, EC-) and S phase rotation amount signal (PS+, PS-), are output to line drive circuit. It is used to configure the position control loop from the host controller. Receive the pulse signal with the line receiver circuit in the host controller.

Set R1 value to 330 Ω.

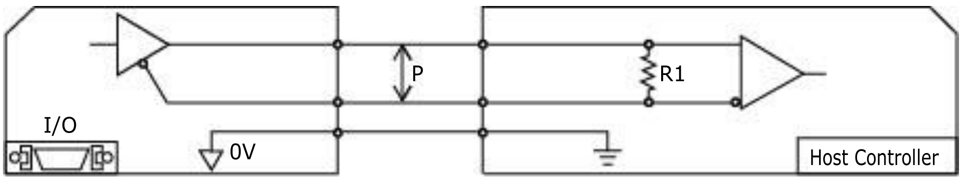
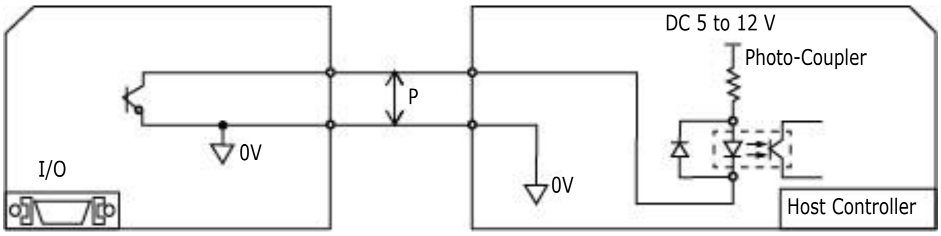


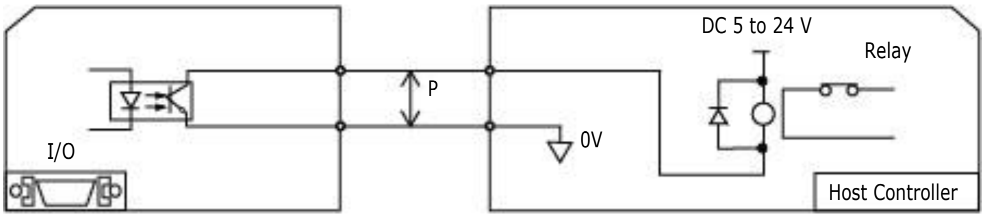
Photo-Coupler Output

Servo Fault, sequence output signal and encoder Z-pulse signal output are the photo coupler output circuits.

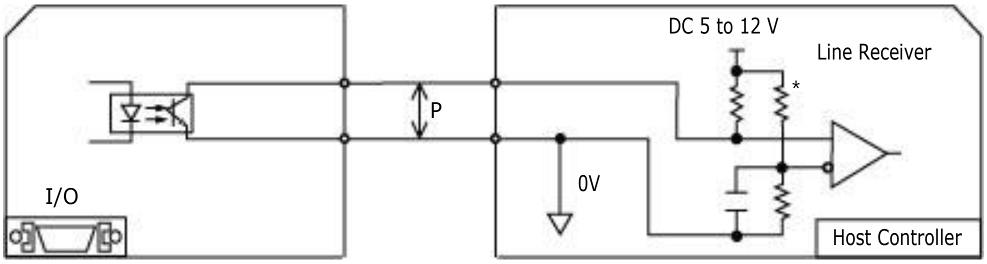
Connect to the photo-coupler circuit of the host controller:



Connect to the relay circuit of the host controller:



Connect to the line receiver circuit of the host controller:



* The terminating resistance should be processed.

STO Related Specifications (Safe Torque Off)

This drive adopts the STO function, which is technology used to prevent safety-related accident at the site and secure the safety of the user, facilities and production system. This section describes the STO function which reduces the maintenance time, and minimizes the production interruption to increase productivity and save cost for greater enhancing the value added at the industrial site.

STO Input /Output Terminal Specifications

Table 3.15 STO Input/Output Terminal Specifications

Signal	Description	Pin	Item
SFI1+	Safety Status Input 1 (blocks the top operation) • Safe status: P/C connected to terminal is turned on. • Non Safe status: P/C connected to terminal is turned off.	4	Input
SFI1-		3	Input
SFI2+	Safety Status Input 2 (blocks the bottom operation) • Safe status: P/C connected to terminal is turned on. • Non Safe status: P/C connected to terminal is turned off.	6	Input
SFI2-		5	Input
EDM+	Safety Circuit Status Output (Open Collector) • Safe status: It is turned on between two pins. • Non Safe status: It is turned off between two pins.	8	Input
EDM-		7	Input

STO Input /Output Electric Specifications

Table 3.16 Input Signal Specifications

Internal Impedance	Operation Voltage	Maximum Delay Time
1.5KOhm	+12V to +24V	1msec

Table 3.17 Output Signal Specifications

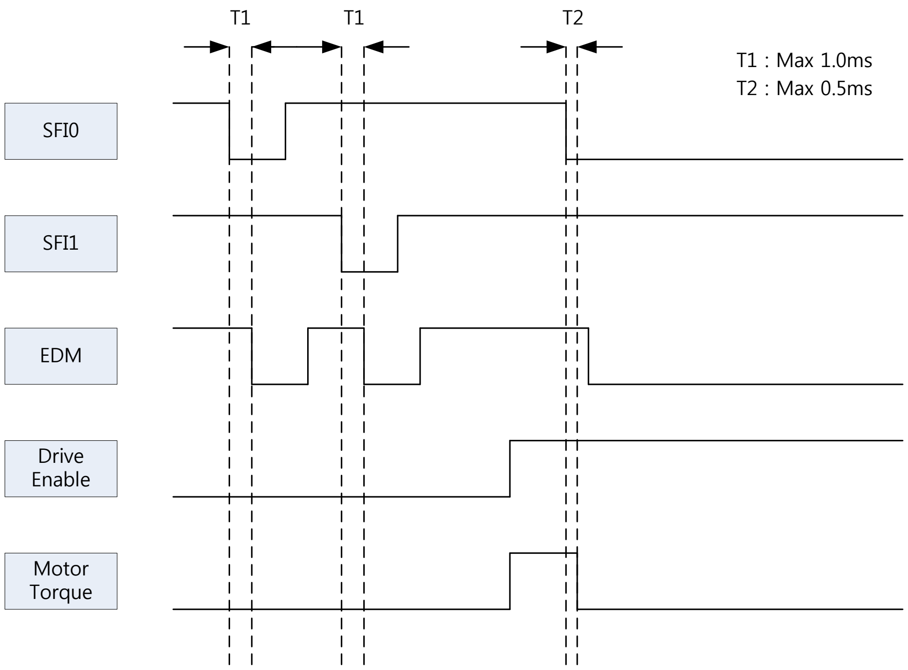
Maximum Voltage Allowed	Maximum Current Allowed	Maximum Voltage Drop
26.4V	30mA	1V

Table 3.18 EDM Output Signal Logic

Signal	Safe Status	Non-safe Status		
SFI1	ON	OFF	ON	OFF
SFI2	ON	ON	OFF	OFF
EDM	ON	OFF	OFF	OFF

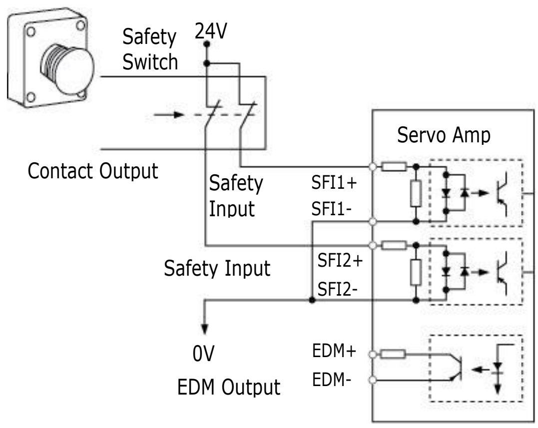
Timing Chart

When a safe state is switched to an unsafe state as shown in the figure, the time (T1) taken until this state applies to the safety circuit state output is maximum 1 msec, and the time (T2) taken until the torque is lost is maximum 0.5 ms.

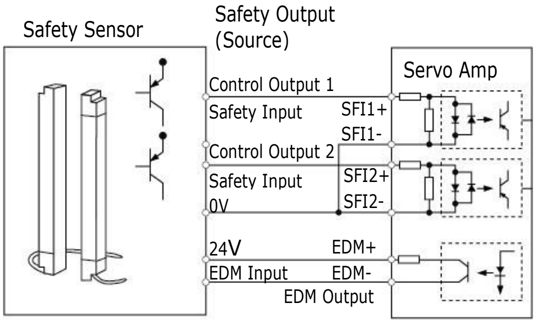


STO Wiring

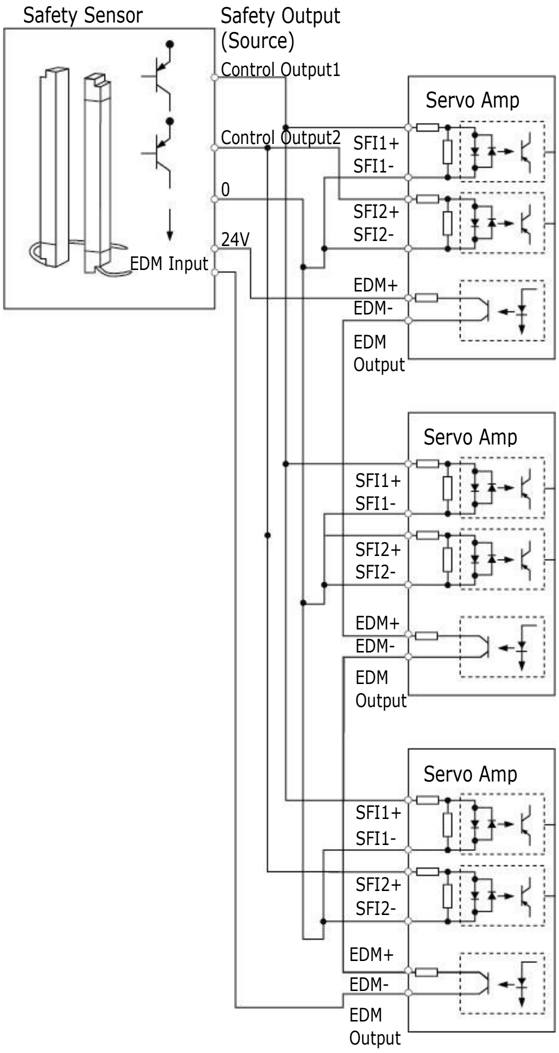
Connecting to Safety Switch



Connecting to Safety Switch



Connecting Multiple Drives to a Single Safety Sensor



Encoder Wiring (Motor Feedback)

Pin Arrangement of Motor Feedback

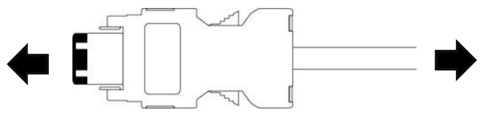
The table below shows the pin arrangement for each encoder.

Table 3.19 Pin Arrangement for Encoder C onnector (Motor Feedback)

Drive		CSMT, CSMR	Remarks
ENC pin No.	Function	17bit	
1	SD+	4	Twisted pair
2	SD-	5	
3	VCC(5V)	7	-
4	COM(0V)	8	-
5	N.C	-	-
6	N.C	-	-
FG		3	-

Terminal Type

The table below shows the terminal type and specifications of the encoder cable.



Connector CON A for connection to Motor Feedback of servo drive : One type regardless of motor model and encoder.

Table 3.20 Terminal Type

Model Number	Manufacturer
3E206-0100KV (Connector) 3E306-3200-008 (Assembly)	3M

Connector CON B for connection to the encoder cable of servo motor:

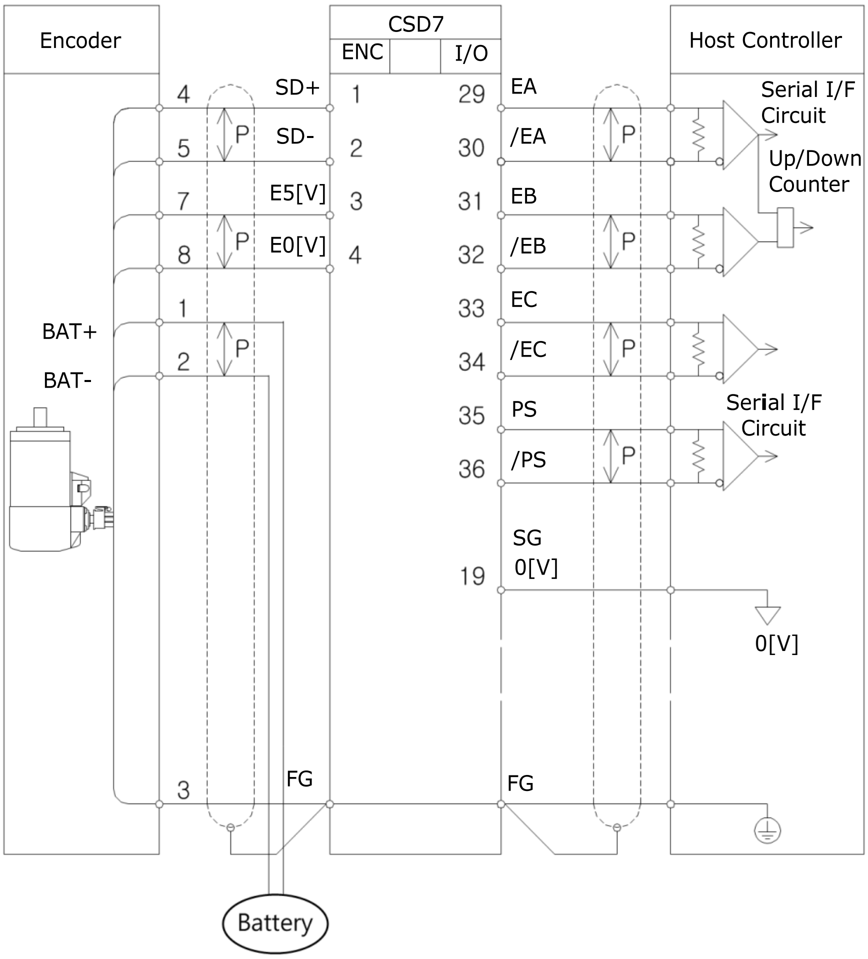
Table 3.21

Motor	Type	Housing	Terminal	Manufacturer
CSMT, CSMR	Serial absolute value Serial Inc	172161-1	170361-1 Or 70365-1	AMP

Power cable connector for large capacity motor packed with the motor.

NOTE	Do not connect FG of servo drive to host controller if GND and FG are common, or if there is no separate FG.

Encoder Signal Process



* Connection for the Use of Absolute Encoders

General Articles Wiring

This part describes wiring to implement optimum performance of the servo drive in wiring and noise.

Precautions

Electric Circuit

- Use a thick wire as earth wire if possible.
- Class 3 grounding is recommended. (Recommendation: grounding resistance lower than 100 [Ω])
- Only 1 point must be grounded.
- Select ground phase and ground point considering the power conditions of installation area. If the power is supplied by the ground phase, wire it so that L2 of AC main power input terminal (L1, L2, and L3) becomes the ground phase.
- Use noise filter for the main power and control power.
- Electric circuit wiring and signal circuit wiring should be apart as much as possible. (30 [cm] or more)
- Do not use same power with the electric ARC welding machine or discharge processor equipment.
- The earth wire of the servo motor must be connected to the grounding terminal of the drive. In addition, ground the grounding terminal of the drive.
- If the wiring is inside the metal pipe, ground the pipe with class 1 1grounding.

Signal Circuit

- The host controller should be installed as closely as possible to the drive, and the noise filter must be used.
- I/O (I/O signal connector) and Motor Feedback (encoder cable) should be twist pair wire and batch shield wire.
- Note that the signal circuit wire is very thin, thus pay attention when handling it.
- If the noise is generated at command input cable, ground 0 [V] line (SG) of the input line before the usage.

NOTE

Refer to the servo motor manual (Publication SMOTOR-UM002) more information on the following cable Specifications and order code.

- Motor 3 phase power cable
- Encoder cable
- Motor brake cable
- I/O cable
- Communication cable

Others

- Use the breaker or fuse for wiring to protect the servo drive.
- Make sure there is no continuous bending and stress to the wire.
- Use noise filter in radio noise.
- If used around residential area or the radio disturbance is concerned, install a noise filter on the input side of power line.
- As the drive is for industrial use, there are no measures for radio disturbance.
- Attach a surge absorption circuit to the relay, solenoid, and coil of the magnetic contactor.

Capacity of the Drive and Fuse

The table below shows the capacity of servo drive and fuse.

Table 3.22 Fuse Specifications

Drive	Capacity	Power Capacity per 1 Drive [kVA]	MCCB or fuse Power Capacity [Amps]
CSD7_01BX1	100 W	0.23	4
CSD7_02BX1	200 W	0.45	4
CSD7_04BX1	400 W	0.89	8
CSD7_08BX1	800 W	1.71	10
CSD7_10BX1	1 kW	2.40	10
CSD7_15BX1	1.5 kW	3.46	15

The fuse capacity is the value when 100 [%] load is applied. When selecting the MCCB (breaker for wiring) or fuse capacity, select the fuse capacity considering the load ratio.

Cut-off features: 200 [%]- 2 seconds or more. 700 [%] - 0.01 second or more

CAUTION

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

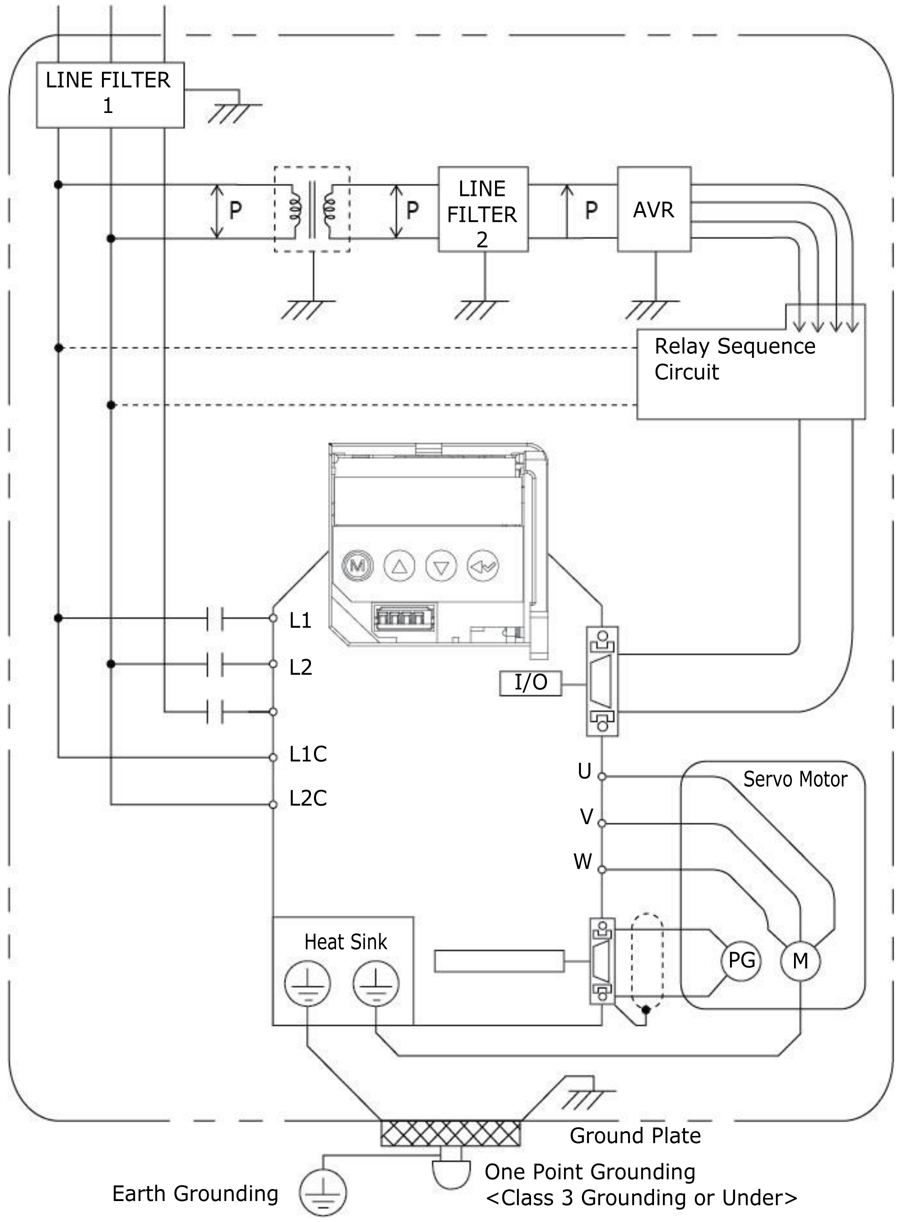
Noise Protection

The high-speed switching device and microprocessor are used at the main circuit of the CSD7 servo drive. Thus, switching noise is affected by the connection and grounding methods. Use the proper wiring and grounding method to prevent any affects from the noise.

CAUTION

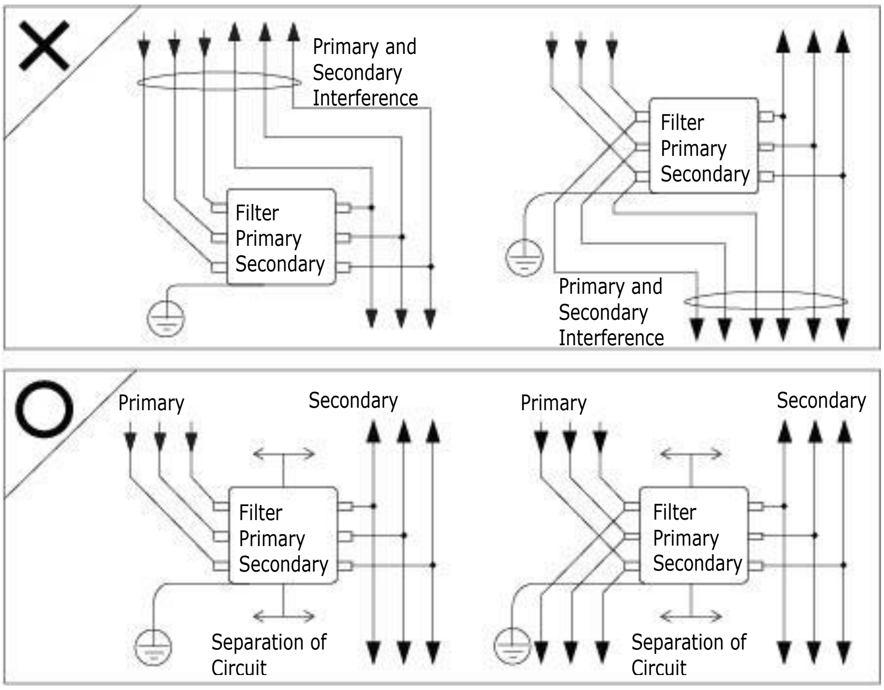
Use a wire of 3.5 [mm^2] or thicker for the earth wire.
Separate the signal and power wiring.

3-phase AC 200 to 230V <50/60Hz>

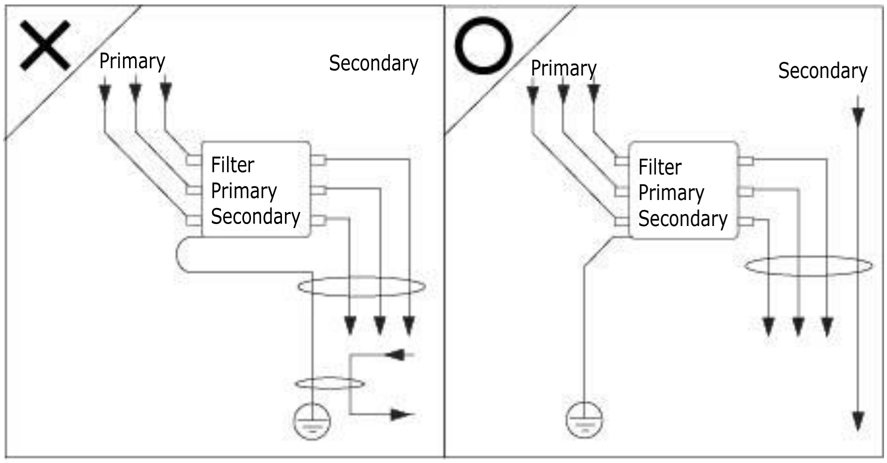


Extra caution is required when wiring the noise filter. The following figure describes precautions when wiring the noise filter. If the wiring is wrong, the performance of the noise filter falls.

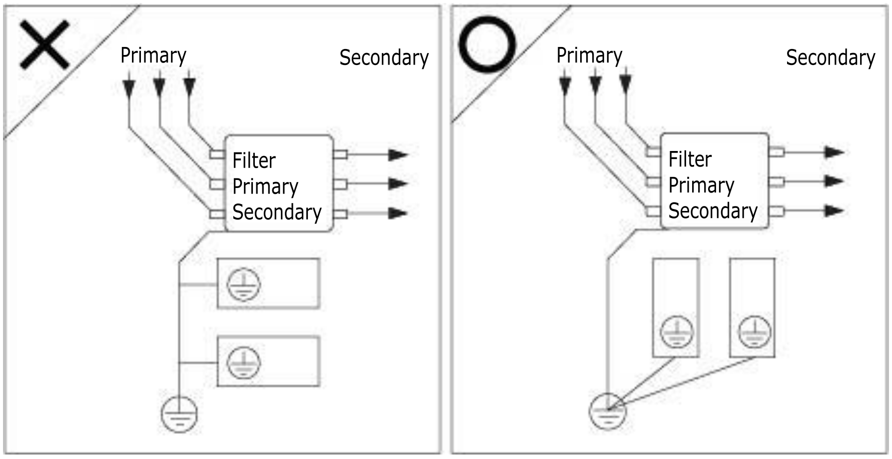
Separate the input and output wiring of the noise filter and do not tie up them together.



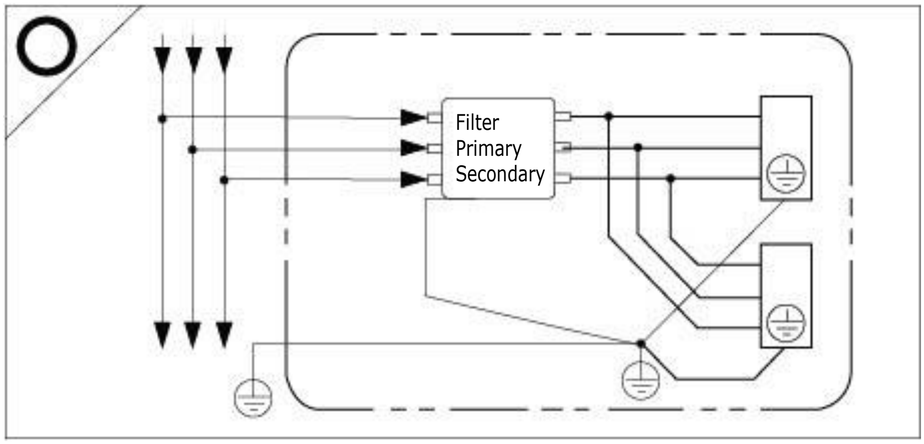
Earth wire of the noise filter should be wired in distance to the output wire and do not put other signal lines and earth wire in a same duct and tie up them together.



Earth wire of noise filter should be solely attached in the earth plate. Do not connect the earth wire of the noise filter to other earth wire together.



If there is noise filter inside the case (panel), connect all of the earth wires and earth wires of other equipment inside of the case to the grounding plate. And then, ground them.

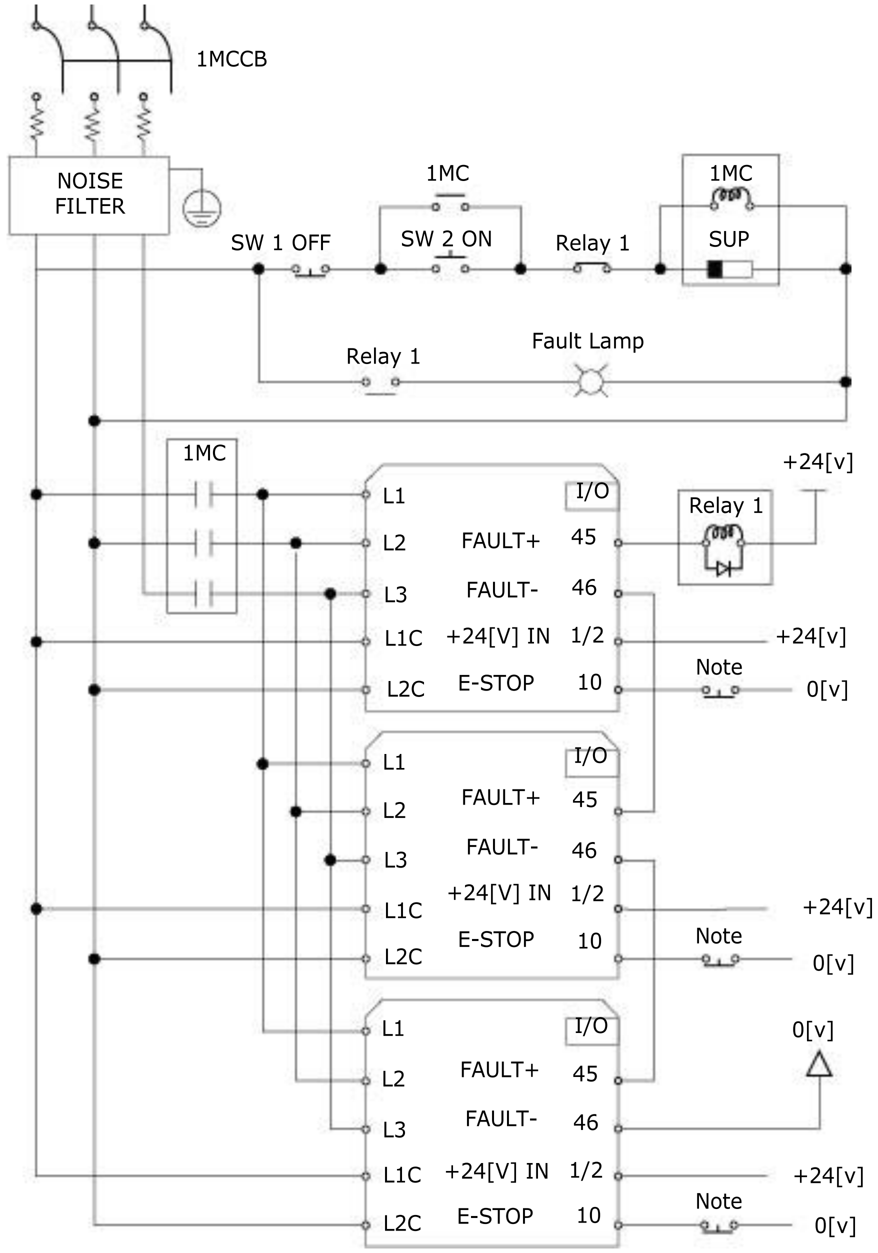


Wiring when Using Several Drives

This is an example of wiring when connecting several drives.

Connect the fault output </FAULT> signal of each servo drive in a series and run Relay 1 to detect the fault. Normally, FAULT+ and FAULT- are interconnected, and with 24 [V] supplied to Relay1, the servo drive runs normally.

If the servo fault is generated, 24 [V] supplied to Relay1 is cut off.



NOTE Whether to use the emergency stop input can be set by the parameter ([Ft-0.05][D3]=0); the initial value is set as not to use. Do not wiring when it does not using the emergency stop.

Operator, Basic Setting and Startup

This chapter introduces the operator mounted on the servo drive. In addition, it describes the basic setting of servo drive, and also an example for simple startup.

Before You Begin

About Servo-ON Signal

This part describes Servo-ON signal for the control of the servo drive.

What is Servo-ON?

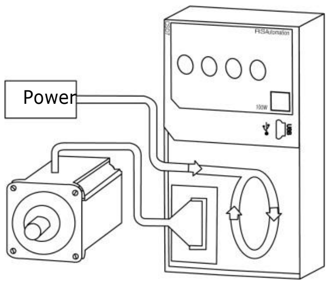
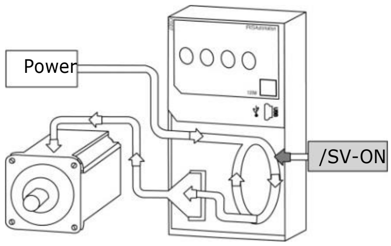
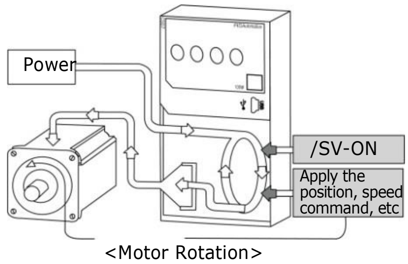
Audio or TV can select and play music and display channel that the users want from the moment the power switch is on.

However, the servo drive cannot run servo motor by simple applying the power. To complete load the system and use the servo drive, Servo-ON signal from the host controller is required.

Servo-ON signal should be applied and maintained from the host controller for the servo drive to run the motor. In servo-OFF status, it cannot run the motor.

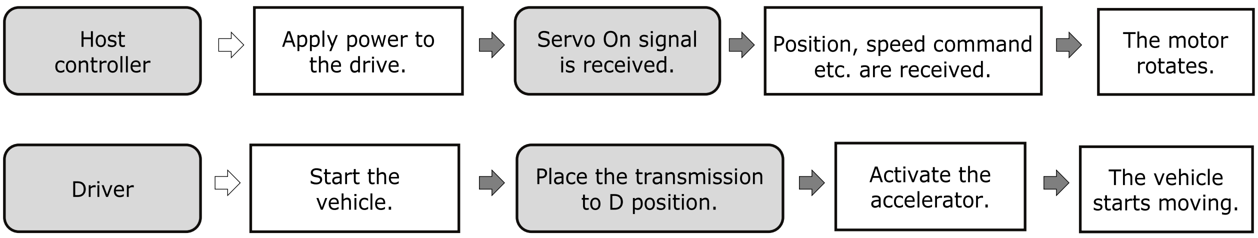
Servo-OFF and Servo-ON

Table 4.1 Servo-OFF and Servo-ON

Servo-ff State	**Servo-On State**	**Apply the position, speed command etc. for the servo-on state and motor operation**
• If the servo-ON signal is not applied after the power application, it is same as the servo driver and motor being separated completely. • This is a ready status to run the motor.	• If the servo-ON signal is applied from the host controller, the drive starts to apply voltage to the motor. At this time, if there is no motor run command, the drive maintains the motor stopped.	• If the motor run command is input while the servo-ON signal of the host controller is maintained, the drive can run the motor according to the command.
		

Servo-ON Signal of the Host Controller and Running the Automobile

The following describes the servo drive in relation to the transmission of the automobile.



As the transmission of the automobile should be positioned at 'D' to start the automobile, the drive can be run only when the servo-ON of the host controller is maintained.

Commands to run the motor such as the position, speed of host controller are invalid in Servo-OFF status.

Servo-ON/OFF Signal Indication

In this manual, the Servo-ON signal is indicated as shown below.

Table 4.2 Servo-ON/OFF Signal Indication

Servo-ON, </SV-ON>	Servo-OFF

Servo-ON Signal Input

Servo-ON signal from host controller is received through the sequence input signal of I/O. Refer to the 5-1 page “Sequence I/O (Input/Output) Signal” for the sequence I/O signals.

Servo Drive’s Own Servo-ON

If the servo drive runs the motor without a command from the host controller as in the operation mode (run-00), (run-01), the drive makes itself Servo-ON for the operation.

NOTE

- Refer to the 7-36 page “Operation Mode Function” for the operation mode (run-00) to (run-02). In addition, the operation mode (run-00) is described in the 4-16 page “Startup”.
- (run-00), (run-01), (run-08), (run-10), (run-12) are not operated in Servo-ON status.

Fault Occurrence and Servo-ON Status

If servo fault is occurred by the self-diagnosis function of the drive while the Servo-ON signal is applied to the drive, the drive make itself Servo-OFF to stop the motor and displays the contents of servo fault. Users should inspect the contents of servo fault, take necessary action, and reset the fault (Refer to the7-41 page “Fault Reset (run-08)”. At this time, if an appropriate action against the servo fault is taken and the servo-ON signal of host controller is maintained, the drive returns to servo-ON status at the moment that fault is reset.

Refer to the 8-3 page “Servo Warning” for the information of the servo fault.

NOTE

- All parameter setting after Chapter 4 should be done for the Servo-ON status and Servo-OFF status.
- In this manual, ‘the servo drive status’ means whether the servo drive is in servo-ON status or servo-OFF status.

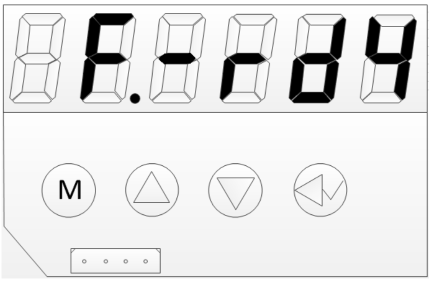
Operator

Name and Function of Each Part

The servo drive has a built-in operator for various status displays, parameter setting, operation command, and monitoring.

- Displays various contents with six 7-segment LED display. Provides all key manipulation function without a separate external operator.

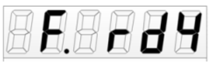
The following figure shows the front side of the operator on the servo drive.



Icons for the Key Buttons

Icon is used in description throughout the manual. Thus, be fully aware of the shape, name and function of icons.

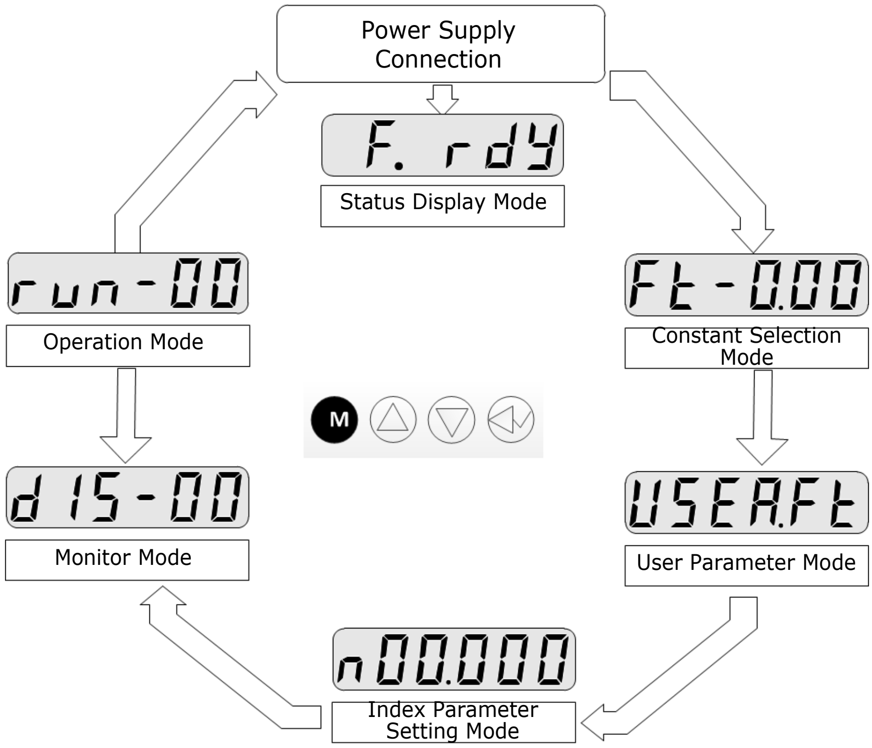
Table 4.3 Icons for the Key Buttons

Key	Name	Function	Remark
	7-segment LED Indicator	Displays the status with 6-digit 7-segment LED display, sets parameter, commands operation and displays monitoring.	For more information, refer to the status display mode.
	Set/ Mode	Key for switching display mode, editing parameter, and running an operation mode • Initial Screen>Ft>Dis>Run switching • In a Set mode, used for applying the setting value	Same as the Set/Mode key of existing CSD3/5
	Up	The value or parameter is increased by 1 from the cursor position; for bit field, fixed to max. value of each bit. Generally, if the Up key is pressed at 9, carry applies. Long-pressing speeds up the increase in value.	
	Down	The value or parameter is decreased by 1 from the cursor position; for bit field, fixed to min. value of each bit. Generally, if the Down key is pressed at 0, borrow applies. Long-pressing speeds up the decrease in value.	
	Enter/Shift(<)	Used to apply a parameter, enter a function or move to the left digit. 1. Moves to the left digit. 2. Enters a parameter modification mode or function (when pressed 2+ seconds). 3. As the Set mode, exits without apply the changed value.	It is the combination of the Enter and Left key of the existing CSD3/5.

Structure of the Entire Mode

As shown in the figure below, the servo drive is divided into 6 types of control modes:

The mode displayed after the power ON is the status display mode. Mode is changed whenever the MODE/SET key is pressed. Be fully aware of the following 6 types of modes and read the following.



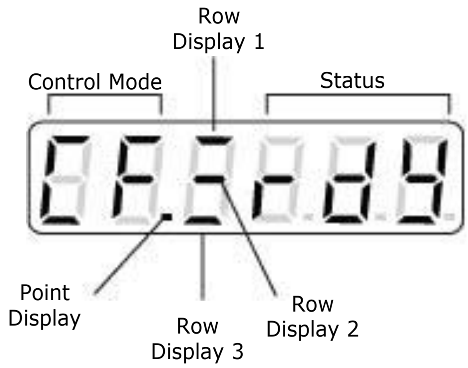
The displayed values in the above figure are the initial value of each mode.

If the value is changed in a mode and then returned, the changed value is shown instead of the initial value.

Status Display Mode

This section describes contents of the status display mode.

The figure below is an example of display for the description of the status mode. Refer to the table below for the meaning of each display.



Control Mode (Ft-0.00)

Displays control mode in use. In combinational control mode, the display of the control mode flickers.

Table 4.4 Status Display Modes - Control Mode

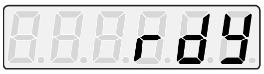
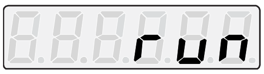
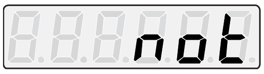
	Display	Description
Basic Control Mode	F	Position mode
	S	Speed mode
	C	Torque mode
	P	Multi-step speed mode
	I	Index mode
Combinational Control Mode	SF	Speed + position mode
	CS	Torque + speed mode
	CF	Torque + position mode
	PF	Multi-step speed + position mode
	PS	Multi-step speed + speed mode
	PC	Multi-step speed + torque mode

In combinational control mode, it performs two types of selected mode simultaneously for the operation. And at this time, the display of the current mode is flickered. If the mode is changed, the display of new mode flickers, and the previous mode does not.

Status

Displays corresponding character upon servo warning. Refer to the 8-3 page "Servo Warning" for details of the servo warning.

Table 4.5 Status Display Mode - Status

Display	Description
	It means the preparation for the operation in Servo-OFF status.
	Displays that it is running.
	Displayed when forward operation prohibiting signal is input.
	Displayed when reverse operation prohibiting signal is input.

Point Display

It is on if internal DC BUS voltage is charged after the power is applied.

Row Display

Refer to the reference pages on the right for more information on the row display.

Table 4.6 Status Display Mode -Row Display

	Description	Reference
Row Display 1	When using as a position mode, if the difference between load position and position command is smaller than [Ft-3.18] value, the servo drive can display (</P-COM> position completion detection) signal. It is on when </P-COM> signal is displayed.	Page 5-28
	When using as a speed mode, if the difference between motor speed and speed command is smaller than [Ft-2.18] value, the servo drive can display (</V-COM> speed coincidence detection) signal. It is on when </V-COM> signal is displayed.	Page 5-39
Row Display 2	When the rotation speed of the motor is higher than the setting value of rotation detection level [Ft-2.19], the servo drive can display (</TG-ON> rotation detection) signal. It is on when </ TG-ON > signal is displayed.	Page 5-40
Row Display 3	It is on when Z-pulse output of the encoder is detected. In case of linear motor, it is illuminated when the first hall U signal is detected.	-

Overview of the Parameter Setting Mode

This section includes brief explanation of the parameters in parameter setting mode.

The Parameter sets and saves various functions to make drive suitable for equipment.

There is a parameter that can be always set regardless of the status of the drive, and those that must be in certain status of the drive when setting them.

The contents related to parameter setting are described in details in the Appendix along with the functional description of the servo drive.

The table below is to aid the understanding of parameter group.

Parameter range:

From 

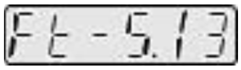
to 

Table 4.7 Parameter Group

Parameter Group		Parameter Group Description
Group 0	Ft-0.00 to Ft-0.32	User parameter related to basic setting and I/O signal
Group 1	Ft-1.00 to Ft-1.22	User parameter related to gain and gain tuning
Group 2	Ft-2.00 to Ft-2.24	User parameter related to velocity control mode
Group 3	Ft-3.00 to Ft-3.21	User parameter related to position control mode
Group 4	Ft-4.00 to Ft-4.25	User parameter related to torque control mode
Group 5	Ft-5.00 to Ft-5.13	User parameter related to supplementary function

Overview of the User-Defined Parameter

The user-defined parameter setting mode is a group of parameters which a user changes frequently.

User-defined parameters are as follows. Even when the name of a parameter differs, if the number indication is the same, it is treated as the same parameter and saved as the same one.
E.g.) UF-0.03 is the same as Ft-0.03

The parameter settings will be described in detail later and in the Appendix together with the functions of the servo drive.

Table 4.8 User-Defined Parameter Group

Parameter Group	Description of Parameter Group	Same Parameter
UF-0.03	Off-line Auto Tuning Function Selection	Ft-0.03
UF-1.01	System Gain	Ft-1.01
UF-1.02	Primary Speed Loop Proportional Gain	Ft-1.02
UF-1.03	Primary Speed Loop Integral Gain	Ft-1.03
UF-1.07	Primary Position Loop Proportional Gain	Ft-1.07
UF-4.02	1st Current Command Filter Bandwidth	Ft-4.02
UF-3.02	Position Feed Forward Gain	Ft-3.02
UF-1.04	P/PI Control Switching Mode	Ft-1.04
UF-1.05	P/PI Control Switching Reference Value	Ft-1.05
UF-4.06	Current Loop Gain Setting	Ft-4.06
UF-3.04	Position Movement Average Filter	Ft-3.04

Overview of the Monitor Mode

This section includes brief explanation of the parameters in monitor mode.

Displays several numerical data generated as the motor is controlled by the drive. The contents of the monitor mode can be checked regardless of the status of the drive. Be fully aware of the numbers and units displayed in monitor mode shown in the table below and refer to it when using the servo drive.

The table below shows the brief contents of each item in the monitor mode.

Monitor Mode Range:

From 

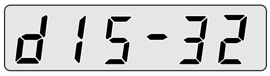
to 

Table 4.9 Monitor Mode

Item	Monitor Contents [Unit]
dIS-00	Speed feedback [rpm or mm/sec]
dIS-01	Speed command [rpm or mm/sec]
dIS-02	Speed error [rpm or mm/sec]
dIS-03	Torque command [%]
dIS-04	Position feedback [pulse]
dIS-05	Position command [pulse]
dIS-06	Position error [pulse]
dIS-07	Position command pulse frequency [kpps]
dIS-08	Electrical angle [°]
dIS-09	Mechanical angle [°]
dIS-10	Accumulated load rate of regenerative resistor [%]
dIS-11	DC Link voltage [V]
dIS-12	The number of rotation data of absolute encoder
dIS-13	Speed command offset [mV]
dIS-14	Torque command offset [mV]
dIS-15	I/O status
dIS-16	Fault history
dIS-17	Firmware version
dIS-18	Motor & Encoder Type
dIS-19	Analog speed command vol [V]
dIS-20	Analog torque command voltage [V]
dIS-21	Drive rated output
dIS-22	Absolute encoder 1-time rotation data
dIS-23	Encoder feedback counter
dIS-24	Current Command Max. Value [%]
dIS-31	Effective Torque Load Ratio [%] (Rated Torque=100%)
dIS-32	Effective Torque Max. Load Ratio [%] (Rated Torque=100%)

The items like Position feedback, Potion Command, and Encoder Feedback Counter of the monitor mode Position feedback, whose value is more than 6 digits, is not displayed at once by the 6-digit 7-segment LED display. Therefore, it is displayed separately by left and right key. Refer to the 7-45 page “Monitor Mode Function” for details on how to check such items.

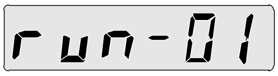
Overview of the Operation Mode

This section includes brief explanation of the parameters in operation mode.

The motor can be run in operation mode. Each item provides a special function, which can be used. Just as in the parameter setting mode, there is a status where the operation is possible/impossible according to the status of the servo drive, during the use of the operation mode. Refer to the 7-36 page “Operation Mode Function” for details of operation mode.

The table below shows the brief functions of each item in the operation mode.

Operation Mode Range:

From 

to 

Table 4.10 Operation Mode

Item	Operation	Modbus Address
Run-00	Jog Operation	2000
Run-01	Off-line Auto Tuning	2001
Run-03	Speed Command Offset Auto Adjustment	2003
Run-04	Torque Command Offset Auto Adjustment	2004
Run-08	Fault Reset	2008
Run-10	Absolute Encoder Data Reset	2010
Run-11	2-Group Gain Storing	2011
Run-12	Constant Initialization	2012

Refer to the 7-37 page “Operation Mode Function” for details of operation mode and key button manipulation.

Basic Setting

This section includes the introduction of the control mode and the basic setting.

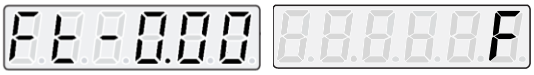
Overview of the Basic Setting

Basic setting must be done before using the servo drive.

- Other parameters can be set after the basic setting.
- The basic setting is possible only after connecting the control power of the servo drive.
- After all setting three types of basic setting, reapply the power.
- The values of the basic setting are not changed even if the power is cut off after editing parameter or parameter is initialized by [run-12] function of the operation mode.
- To change basic setting value, change it directly from corresponding parameter and reapply the power.

As shown below, the basic setting uses two parameters to set 2 types.

Table 4.11 Basic Setting

	Basic Setting Parameter	Setting
1 (Ft-0.00)		Control mode (Optional) setting
2	-	Motor Setting • Motor setting is done automatically.

The key button manipulation flow chart is provided in the description of thebasic setting to aid the understanding of the key buttons. While performing the basic setting, get accustomed to key button manipulation. Key button manipulation flowchart is not described after Chapter 5.

Control Mode Setting

Control Mode Type

As in the table below, there are 5 kinds of basic control modes and 6 kinds of associated control modes. The table below shows the control mode types. Refer to the Chapter 5 for function for each control mode.

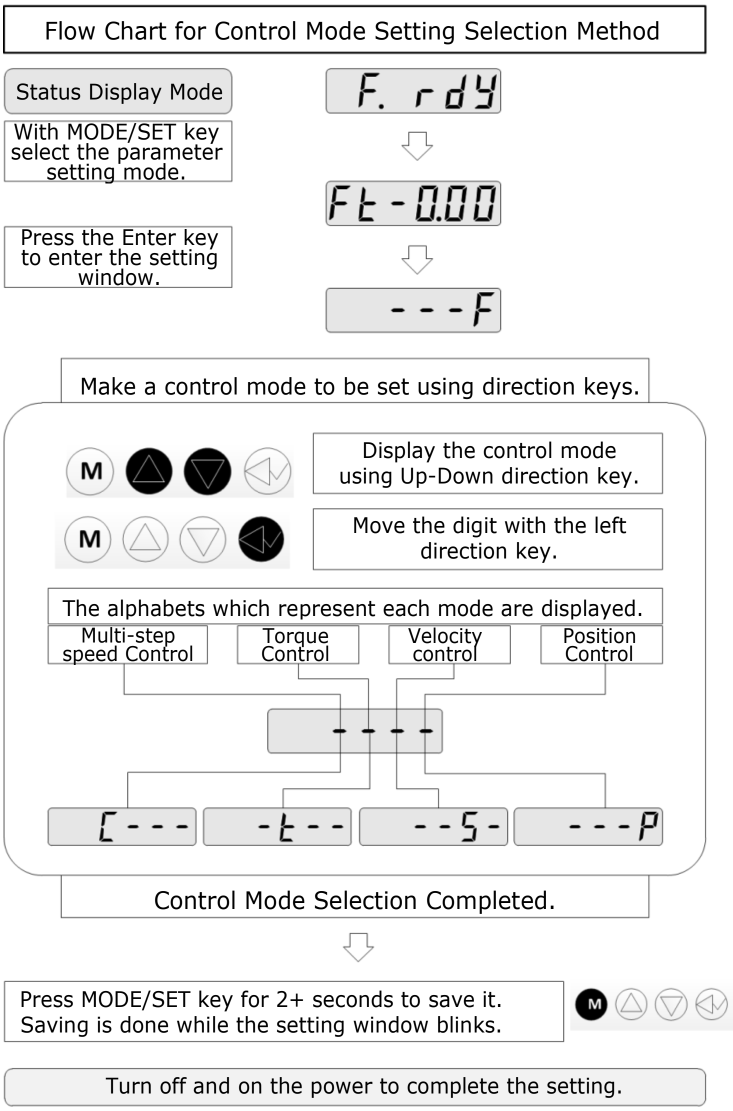
Table 4.12 Types of Control Mode

	Display	Description
Basic Control Mode	F	Position mode
	S	Speed mode
	C	Torque mode
	P	Multi-step mode
	I	Index mode
Associated Control Mode	SF	Speed + position mode
	CS	Torque + speed mode
	CF	Torque+ position mode
	PF	Multi-step speed + position mode
	PS	Multi-step speed + speed mode
	PC	Multi-step speed + torque mode

Control Mode Setting Method

Describes control mode setting method focusing on the key button manipulation.

Apply the power and set it as shown in the flowchart below.



Combinational Control Mode Setting

Combinational control mode should be set as below.

Table 4.13 Combinational Control Mode

Associated Control Mode	Setting Window Display
Speed + position control	SF
Torque + velocity control	CS
Torque + position control	CF
Multi-step speed + position control	PF
Multi-step speed + velocity control	PS
Multi-step speed +Torque control	PC

CAUTION

The following are the precautions in setting associated control mode.

- Combinational control mode cannot be used by combining more than 3 types. Make sure to combine two types only.
- If the setting is correctly entered, the setting window blinks once when MODE/SET key is used to save the data. However, if wrong setting is entered, it does not blink nor is saved.

Startup

Before Startup

1. Please be aware of wiring in Chapter 3 and connect main power and control power normally. In addition, by configuring emergency stop input circuit, clear the emergency stop status.
2. Connect the motor and encoder properly.
3. Pereform basic setting in reference to the 4-12 page “Basic Setting”.
4. Do not connect the load to the motor for safety purposes. If the motor is mounted on the equipment, remove coupling of the motor shaft so that load may not move.

CAUTION

Cautions when Startup

- To prevent the injury, check the operation range of the motor shaft or load upon operation, and keep it away from the drive.
- Run the drive after preparing the E-stop circuit. Then, you can cope quickly with an emergency situation.
- Refer to the 3-18 page “Emergency Stop Signal” for E-stop information.

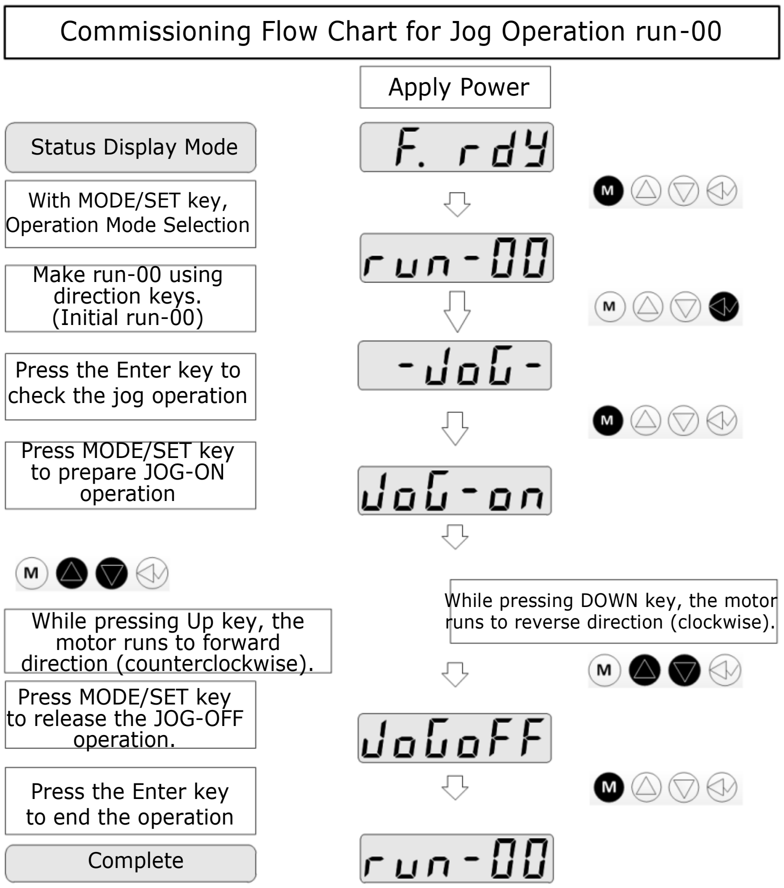
Startup

Start up 1: Start up the Drive by Using Jog Operation Function.

The jog operation is possible in Servo-OFF status. Remove the wiring between the drive and the host controller, or apply Servo-OFF signal from the host controller.

The speed of the motor can be set from the drive for the jog operation. The initial value of the jog operation speed is 50 [rpm]. At startup 1, runs the drive at the factory setting speed, 50 [rpm].

Start up the drive according to the following flowchart.

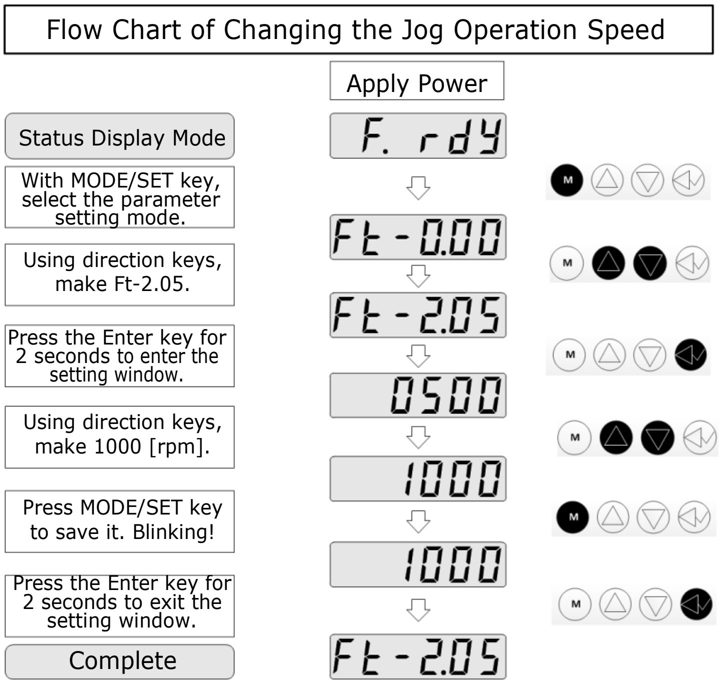


Start up 2: Start Up the Drive by Changing the Speed

Start up the drive by changing the speed from the initial value, 50 [rpm] to 1000 [rpm].

The change of Jog operation speed should be done at [Ft-2.05]. The speed set here is not related to other operation, and applied only upon the Jog operation. Setting range is 0 to 6000 [rpm]. Initial value is 50 [rpm].

Change the Jog operation speed by according to the following flowchart.



If setting is wrong, the setting window does not blink when saving it by pressing the MODE/SET key. If setting is completed normally, retry the Jog operation [run-00]. You can see that the speed is changed from 50 [rpm] to 1000 [rpm].

- At first, the drive is not tuned suitable for the load or motor.
- If you start commissioning after performing the off-line auto tuning operation as described in the “Off-line Auto Tuning Operation (run-01)” on page 7-37, then you can operate the motor more smoothly and reliably.

Functions for Control Mode

This chapter describes the sequence input/output function of I/O signal connector and the function for each control mode.

Sequence I/O (Input/Output) Signal

What is Sequence I/O Signal?

To provide the optimum performance that is suitable for user's equipment, 50 pin connector of I/O is used to allow the drive can input/output signals that have various functions.

Input provides 25 functions and you can freely allocate input signal of each function with 10 pins.

Output provides 16 functions and you can freely allocate output signal of each function with three pairs of pins such as (41, 42), (43, 44), (47, 48) and pin (37~40) of I/O.

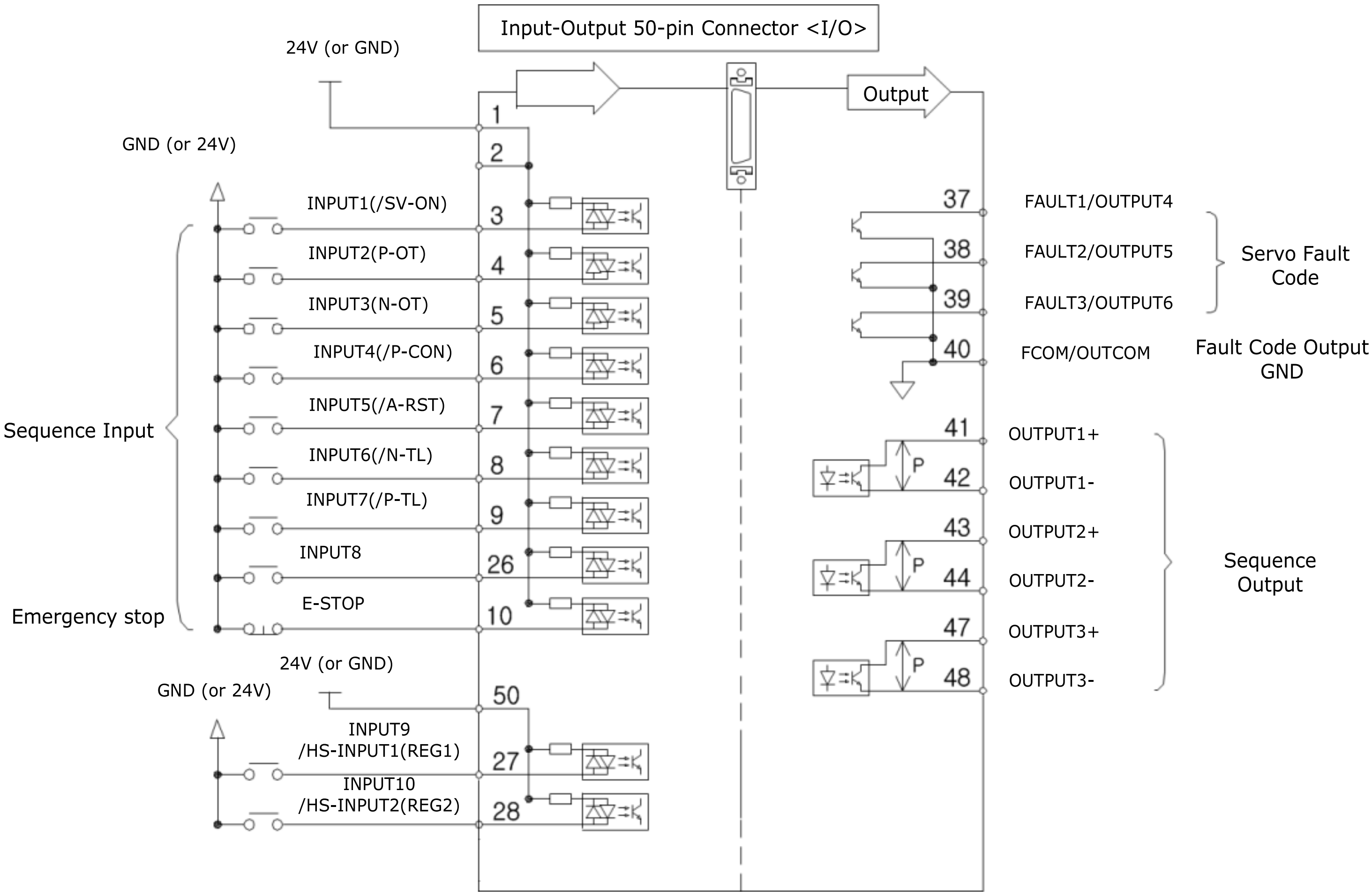
Sequence I/O signal means the I/O signal of various functions that are required for servo drive control by the host controller.

Sequence I/O signal is not to process input or output signal with the designated pin of I/O, but to select the function that the user equires in terms of circuit design of host controller and to directly allocate the selected functions to the designated pin.

Therefore, the host controller can do the sequential control that fits to the equipment to operate servo drive.

The following figure is sequence I/O part among 50 pins of I/O

- Sequence Input is indicated as (INPUT#1) to (INPUT#10).
  (Digital Input Channel)
- Sequence Output (OUTPUT#1) to (OUTPUT#6).
  (Digital Output Channel)


Input-Output 50-pin Connector <I/O>
24V (or GND)
GND (or 24V)
Output
1
2
INPUT1(/SV-ON)
3
INPUT2(P-OT)
4
INPUT3(N-OT)
5
INPUT4(/P-CON)
6
INPUT5(/A-RST)
7
INPUT6(/N-TL)
8
INPUT7(/P-TL)
9
INPUT8
26
E-STOP
10
Sequence Input
Emergency stop
24V (or GND)
GND (or 24V)
50
INPUT9
/HS-INPUT1(REG1)
27
INPUT10
/HS-INPUT2(REG2)
28
37
FAULT1/OUTPUT4
38
FAULT2/OUTPUT5
39
FAULT3/OUTPUT6
Servo Fault
Code
40
FCOM/OUTCOM
Fault Code Output
GND
41
OUTPUT1+
42
OUTPUT1-
43
OUTPUT2+
44
OUTPUT2-
47
OUTPUT3+
48
OUTPUT3-
Sequence
Output
P

Function of Input Signal

The following is the brief explanation on 40 functions of sequence input signal. Details for each signal are explained in the reference pages listed on the right side of the table.

Table 5.1 I/O Sequence Input Signal

Type	Description	Mode	Reference
</SV-ON>Servo-ON	When input is ON, voltage is applied to the servo motor and when input is off, the voltage is cut off.	-	Page 4-1
<A-RST> Fault Reset	It releases the servo fault.	ALL	Page 7-42
</G-SEL> Gain Group Conversion	Use 2 group gain for the section where input is on, and current gain for the section where input is OFF. It converts gain of 2 groups.	All	Page 6-37
</P-TL> Forward Torque Limit	When a signal is on, it limits forward torque by the setting value [Ft-4.09].	All	Page 5-49
</N-TL> Reverse Torque Limit	When a signal is on, it limits reverse torque by the setting value [Ft-4.10].	All	Page 5-49
<P-OT> Prohibit Forward Revolution	It prohibits a motor from rotating forward when the load part reaches to the limit of available section.	All	Page 7-.2
<N-OT> Prohibit Reverse Revolution	It prohibits a motor from rotating to the reverse direction when the load part reaches to the limit of available section.	All	Page 7-2
</P-CON> Conversion to P Control	It converts the Seed Controller from PI type controller to P type controller. It is used to suppress the overshoot of the excessive response and complete a faster response.	E, S, P,I	Page 6-31
</C-SEL> Control Mode Conversion	Used to convert the control mode when using the combinational control mode.	For Combinational Control Mode only	Page 5-58
</C-DIR> Multi-step Speed Direction </C-SP1> </C-SP2> </C-SP3> </C-SP4> Multi-step Speed Command	The rotation direction</C-DIR> and rotation speed </C-SP1 to /C-SP4> of the motor are determined by the combination of these inputs in Multi-step Speed control mode. The rotation speed of </C-SP1~/C-SP3> is set to [Ft-2.09~Ft-2.15] Rotation speed of </C-SP4> is set by analog speed command voltage. <C-DIR> is used to reverse the motor rotation direction in a Velocity Control Mode.	P	Page 5-54
</Z-CLP> Zero Clamp	When the analog command value in a velocity control is lower than the setting value of speed zero clamp level [Ft-2.20], the input value is ignored.	S	Page 5-37
</INHIBIT> Inhibit Pulse Command	It ignores position command pulse in the section where the signal is on.		Page 5-29
</ABS-DT> Absolute Encoder Data Transmission	In the absolute position transmission mode using the photo coupler, the absolute position data is transmitted through synchronization with the Signal On.	F, I	Page 7-42
</PCLR> Position Error Clear	Clears the position command, position feedback, and position error.	F, I	Page 5-29
</START> Start	It is set to control the start and stop of motor rotation using the contact signal in a Velocity Control / Multi-step speed Control mode.	S, P	Page 5-40
</R-ABS>Absolute Encoder Multi-rotation Data Reset	Erases the multi-rotation data of the absolute motor.	All	Page 7-31
</BANK_SEL>Gain Bank Select	If the input is on, the 3rd and 4th gain bank are used. If the input is off, the 1st and 2nd gain bank are used.	All	Page 6-39
</A-CL>Analog Torque Limit	If the input is on, the current limit function is activated by the analog torque command input value.	S, P	-

<table>
<tr><th>Type</th><th>Description</th><th>Mode</th><th>Reference</th></tr>
<tr><td></HOM_SEN>Home Sensor</td><td>When activated, the sensor indicates the homing sequence that is detected.</td><td>I</td><td>-</td></tr>
<tr><td></I-HSTART>Start Homing</td><td>When activated, the system starts returning to home.</td><td>I</td><td>-</td></tr>
<tr><td></I-PAUSE>Index Pause</td><td>When activated, it decelerates until stop and pause the index sequence. It decides whether to stop or to continue the motion by constantly monitoring the input status.</td><td>I</td><td>-</td></tr>
<tr><td></I-STOP>Index Stop</td><td>When activated, index movement ends.</td><td>I</td><td>-</td></tr>
<tr><td></I-SEL0-IN>
Index Selection 0 Input
</I-SEL1-IN>
Index Selection 1 Input
</I-SEL2-IN>
Index Selection 2 Input
</I-SEL3-IN>
Index Selection 3 Input
</I-SEL4-IN>
Index Selection 4 Input
</I-SEL5-IN>
Index Selection 5 Input</td><td>Used for the combinations to allocate indexes.</td><td>I</td><td>-</td></tr>
<tr><td></I-HSTOP>Homing Stop</td><td>Stops the homing operation when it is set to ON.</td><td>I</td><td>-</td></tr>
<tr><td></I-START>Start Indexing</td><td>Starts the homing operation when it is set to ON.</td><td>I</td><td>-</td></tr>
<tr><td></ABS-MD>Absolute Position Data Transmission Mode</td><td>When the signal is turned on, the absolute data is transmitted to the higher level through the photo coupler output.</td><td>F</td><td>-</td></tr>
<tr><td></I-JOG></td><td>Jog operation starts at an index mode, and Jog is turned on.</td><td>I</td><td>-</td></tr>
<tr><td></I-JOG-FW>
Index Jog Forward</td><td>When turned on in an index jog mode, it rotates to the forward direction.</td><td>I</td><td>-</td></tr>
<tr><td></I-JOG-BW>
Index Jog Reverse</td><td>When turned on in an index jog mode, it rotates to the backward direction.</td><td>I</td><td>-</td></tr>
<tr><td></E-GEAR1>
2nd Electronic Gear Ratio Selection

</E-GEAR2>
3rd Electronic Gear Ratio Selection</td><td><table>
<tr><th>/E-GEAR2</th><th>/E-GEAR1</th><th>Electronic gear Selection</th></tr>
<tr><td>OFF</td><td>OFF</td><td>1st electronic gear
(Ft-3.05, Ft-3.06)</td></tr>
<tr><td>OFF</td><td>ON</td><td>2nd electronic gear
(Ft-3.07, Ft-3.08)</td></tr>
<tr><td>ON</td><td>OFF</td><td>3rd electronic gear
(Ft-3.09, Ft-3.10)</td></tr>
</table></td><td>F</td><td></td></tr>
</table>

Function of Output Signal

The following is the brief explanation on 23 functions of sequence output signal. Details for each signal is explained in the pages listed on the right side of the table.

Table 5.2 I/O Sequence Output Signal

Type	Description	Mode	Reference
</P-COM (+, -)> Positioning completion detection	It is on when the position error is within the output width of position completion signal [Ft-3.18].	F	5-30 Page
</NEAR (+, -)> Positioning approach detection	It is on when the position error is within the output width of position approach signal [Ft-3.19].	F	5-30 Page
</V-COM (+, -)> Speed coincidence detection	It is on when the speed difference between command speed and the rotation speed are within the output width of speed coincidence signal [Ft-2.18].	F, S, C	5-41 Page
</TG-ON (+, -)> Rotation detection	It is ON when the motor rotates with the speed more than the setting value of rotation detection level [Ft-2.19].	All	5-42 Page
</T-LMT (+, -)> Torque limit detection	It is on when motor torque is reached the setting value of torque limit.	All	5-47 Page
</V-LMT (+, -)> Speed limit detection	It is on when motor speed is reached the setting value of speed limit.	All	5-43 Page
</BK (+, -)> Breaker control	It is the signal for control of the brake that is mounted inside and outside of the servo motor.	All	7-6 Page
</WARN (+, -)> Warning Detection	If a servo warning is detected, it is turned on.	All	8-3 Page
</A-VLD> Absolute position valid	Turns to ON when the absolute position data is valid while using the absolute motor.	All	
</RDY> Drive ready	Means getting the operation ready while in the Servo-OFF status.	All	
</I-HOM> In homing	Homing sequency is in progress.	I	
</I-HOMC(+,-)> Axis homing completion	When activated, it shows the completion of the Homing operation.	I	
</I-MO (+,-)> In motion	Turns to ON when in motion.	I	
</I-DW> In dwell	When activated, it indicates that the motor is on the hold position in the index movement and on stand-by for the dwell time assigned.	I	
</I-SEL0-OUT> Index Selection 0 Input </I-SEL1-OUT > Index Selection 1 Input </I-SEL2-OUT > Index Selection 2 Input </I-SEL3-OUT > Index Selection 3 Input </I-SEL4-OUT > Index Selection 4 Input </I-SEL5-OUT > Index Selection 5 Input	Used to output the index number in use in the selected indexing operation.	I	
</I-ESEQ> Sequence operation completion	Turns to ON when the index movement is complete.	I	
</RMS-CLT1> Effective Load Ratio Output 1	Effective Load Ratio Output 1	All	
</RMS-CLT2> Effective Load Ratio Output 2	Effective Load Ratio Output 2	All	

NOTE	The sequence I/O signal name is indicated by < > in this manual. Ex) </SV-ON>, </P-COM>

Input Signal Allocation Method

Refer to the table below to allocate to I/O pin by searching the function that is suitable for your condition.

As shown in the table below, the related function is already allocated to the sequence input parameter and its position in the setting window and it means that you use the related function as setting certain value among '1 to A' except '0' to the setting position.

For example, if you want to put certain function to I/O No. 5 pin, you can find the related parameter of that signal and the position in the setting window according to the table below and enter '3' as the setting value.

Enter '0' when the function of input signal is not used. If you want to make input signal 'ON' all the time regardless of the wiring, set as 'b'.

Table 5.3 I/O Input Signal Allocation

Setting Value	b	A	9	8	7	6	5	4	3	2	1	0
Input Channel No.	Always valid	INPUT #10	INPUT #9	INPUT #8	INPUT #7	INPUT #6	INPUT #5	INPUT #4	INPUT #3	INPUT #2	INPUT #1	Always invalid
I/O Pin No.		28	27	26	9	8	7	6	5	4	3	

The following table is to arrange the parameter for each function and 7-segment number position in the setting window. Set so that the related parameter of each signal and the number position in the setting window is not in the wrong.

Table 5.4 7-Segment Number Position of Input Signal Parameter

Parameter	7-Segment Position 3	2	1	0
(Ft-0.10)	</P-CON> Initial value: 4	<N-OT> Initial value: b	<P-OT> Initial value: b	</SV-ON> Initial value: 1
(Ft-0.11)	</C-SEL>	</P-TL> Initial value: 7	</N-TL> Initial value: 6	</A-RST> Initial value: 5
(Ft-0.12)	</C-SP3>	</C-SP2>	</C-SP1>	</C-DIR>
(Ft-0.13)	</PCLR>	</G-SEL>	</INHIBIT>	</Z-CLP>
(Ft-0.14)	</I-JOG>	</C-SP4>	</START>	</ABS-DT>
(Ft-0.15)	</ABS-MD>	</A-CL>	</BANK-SEL>	</R-ABS>
(Ft-0.16)	</I-PAUSE>	</I-STOP>	</I-HSTART>	</HOM-SEN>
(Ft-0.17)	</I-SEL3-IN>	</I-SEL2-IN>	</I-SEL1-IN>	</I-SEL0-IN>
(Ft-0.18)	</I-START>	</I-HSTOP>	</I-SEL5-IN>	</I-SEL4-IN>
(Ft-0.19)	<I-JOGBW>	<I-JOGFW>	</E-GEAR2>	</E-GEAR1>

The table below is the example to allocate sequence input signal.

Table 5.5

Example			
(Ft-0.10)	Enter '7' in setting window of the parameter [Ft-0.10][D3]. The [Ft-0.10][D3] is intended to allocate the </P-CON> input function. As 7 was allocated here, It means that the "INPUT 7" (I/O connector #9 pin) is used as </P-CON> input.		
Applicable Models	All	Other Details	Servo off>Configuration>Completed

Output Signal Allocation Method

Refer to the table below to allocate to I/O pin after searching the function that is suitable for your condition.

Set the setting value as '0' when the output of the related signal is not used.

Sequence output is displayed when situation that is meets the condition of each ouput in drive was produced.

Table 5.6 I/O Output Signal Allocation

Setting Value	6	5	4	3	2	1	0
Input Channel No.	OUTPUT #6	OUTPUT #5	OUTPUT #4	OUTPUT #3	OUTPUT #2	OUTPUT #1	Always Invalid
I/O Pin No.	39, 40	38, 40	37, 40	47, 48	43, 44	41, 42	

The following table is to arrange the parameter for each function and 7-segment number position in the setting window. Set so that the related parameter of each signal and the number position in the setting window is not in the wrong.

Table 5.7 7-Segment Number Position of Output Signal Parameter

	7-segment Position			
Parameter	**3**	**2**	**1**	**0**
Ft-0.22 (Ft-0.22)	</V-COM>	</BK> Initial value: 3	</TG-ON> Initial value: 2	</P-COM> Initial value: 1
Ft-0.23 (Ft-0.23)	</WARN>	</NEAR>	</V-LMT>	</T-LMT>
Ft-0.24 (Ft-0.24)	Reserved	<I-HOM>	</RDY>	</A-VLD>
Ft-0.25 (Ft-0.25)	</I-SEL0-OUT>	</HOMC>	</I-DW>	</IMO>
Ft-0.26 (Ft-0.26)	</I-SEL4-OUT>	</I-SEL3-OUT>	</I-SEL2-OUT>	</I-SEL1-OUT>
Ft-0.27 (Ft-0.27)	</RMS-CLT2>	</RMS-CLT1>	</I-ESEQ>	</I-SEL5-OUT>

The table below is the example to allocate sequence output signal.

Table 5.8

Example			
 (Ft-0.23)		Set '3' in the 3st position in setting window of the parameter [Ft-0.23][D3]. The [Ft-0.23][D3] is intended to allocate the </WARN> output function. As 3 was allocated here, It means that the "OUTPUT3" (I/O connector #47 and #48 pin) is used as </WARN> output.	
Applicable Models	All	Other Details	Servo off>Configuration>Completed

Notice for Signal Allocation

When you allocate the different functions to the same pin of I/O as shown below, the drive indicates servo warning in the status mode.

Table 5.9

 (Ft-0.11)	Set '4' in the 2nd position in setting window of the parameter [Ft-0.11][D1]. It is set to use </N-TL>function and it means that I/O No. INPUT#4 pin is used as an input pin
 (Ft-0.13)	Set '4' in the 2nd position in setting window of the parameter [Ft-0.13][D1]. It is set to use </INHIBIT> function and it means that I/O No. INPUT#4 pin is used as an input pin.

When you allocate more than two signals to the same pin as described above, the servo warning is indicated.

Table 5.10

Status Display Mode 	In this case, when you reapply the power after completing the input allocation, the status display mode indicates servo warning (Pin). Check if you allocate more than two signals to the same pin of I/O.

TIP

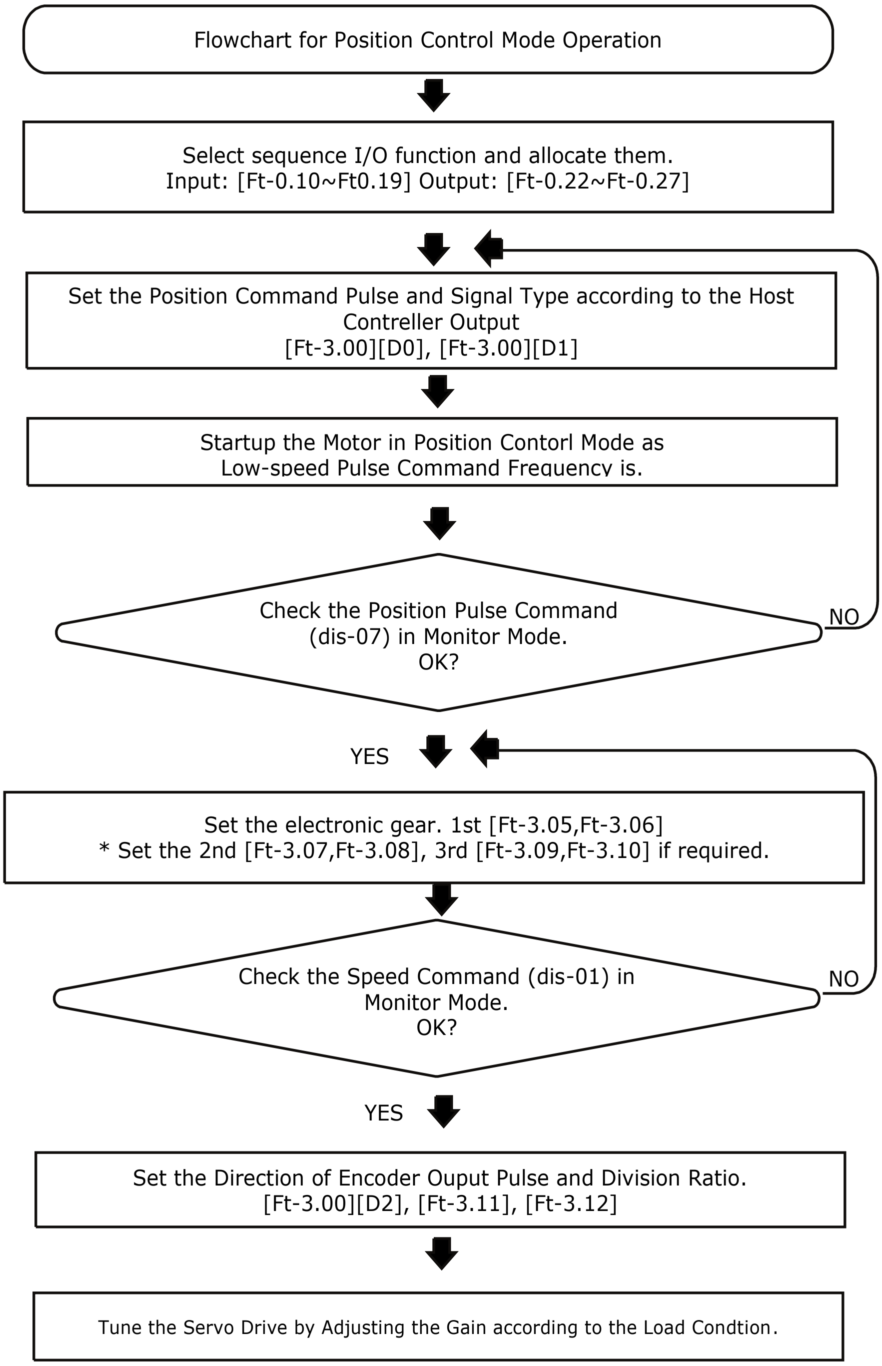
- Through monitor mode in the 7-45 page "Monitor Mode Function", you can check if the sequence I/O signal is input.
- Unlike the sequence input by allocation, the E-STOP (Emergency Stop) signal uses the I/O fixed input pin (I/O connector #10 pin).
- Servo drive has self-diagnostic function.
- The (servo fault) and (servo warning) is divided according to the importance of error diagnostic. For the details, see Chapter 8.

Position Control Mode

Overview

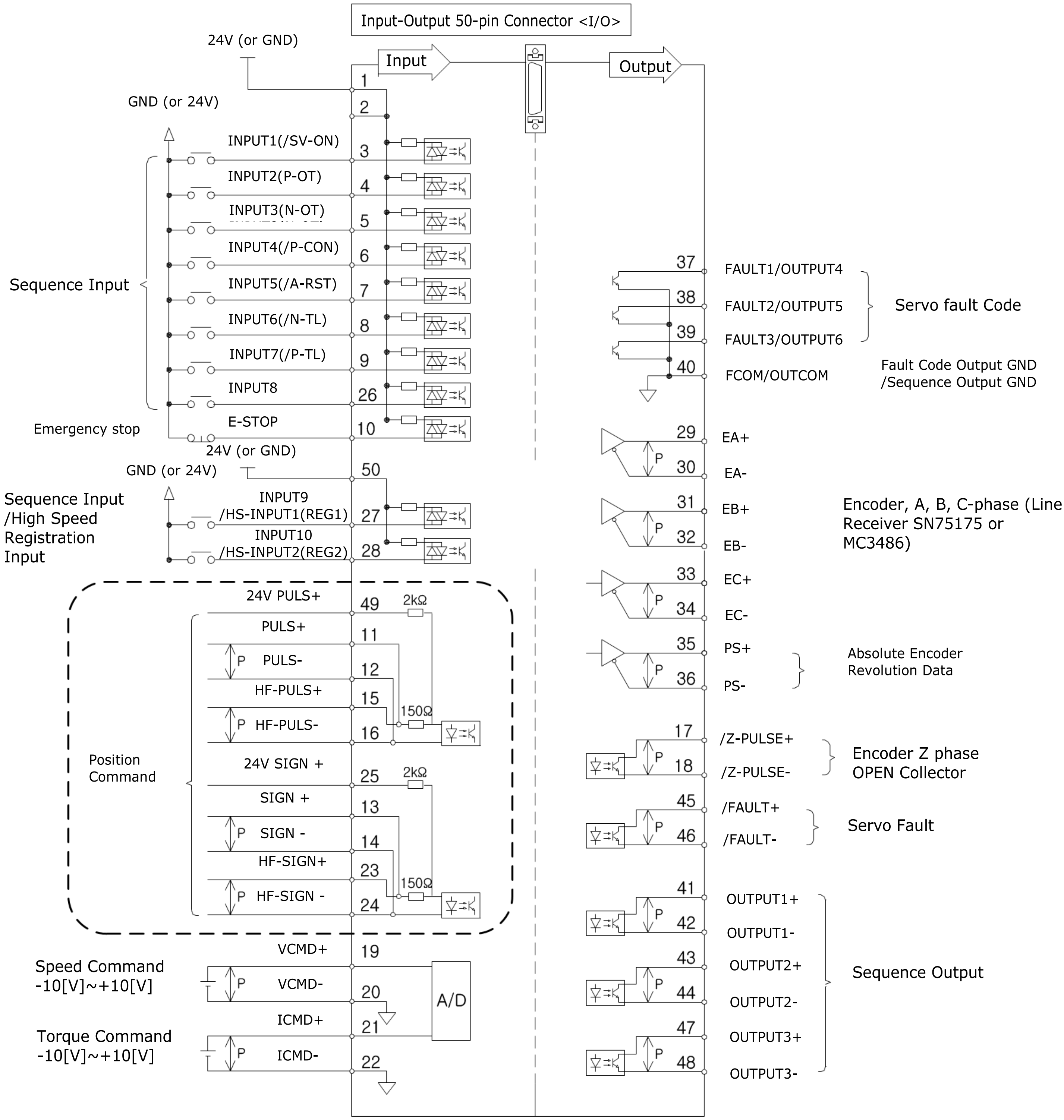
The position control mode is used when the position command pulse is received from the host controller to move the load to a target position.

To operate the servo drive in position control mode, connect the position command pulse signal to PULS and SIGN input pins, connect other necessary input signals and set as followsv.



Standard Wiring Example

The following figure illustrates the standard wiring example of position control mode. You can set the sequence input/output signal, as you want if it is necessary for the system configuration.



Position Command Pulse

10 pins of I/O receive 3 kinds of commands related to the position control mode.

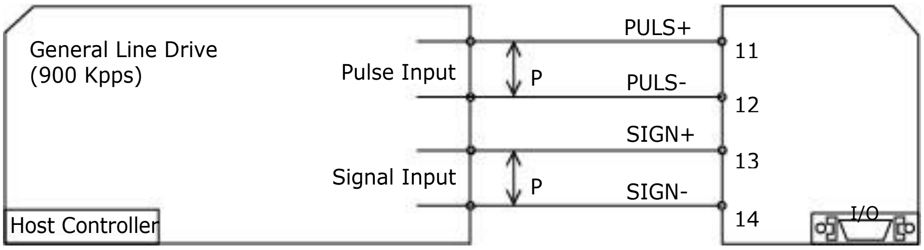
Host controller sends the position command with the pulse input and sign input.

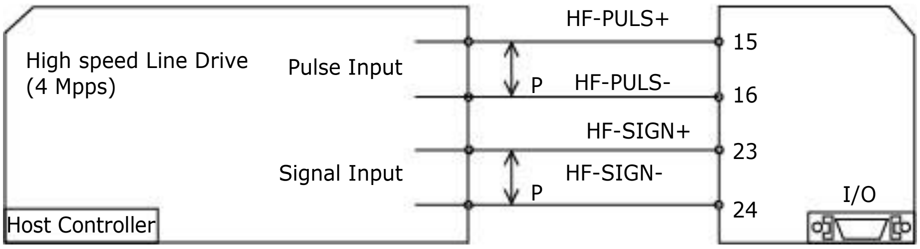
When the position control mode is used, there are line drive method, high speed line drive and open collector method as the input types of the host controller. The CSD7 servo drive supports three types of input.

When It is Line Drive Output

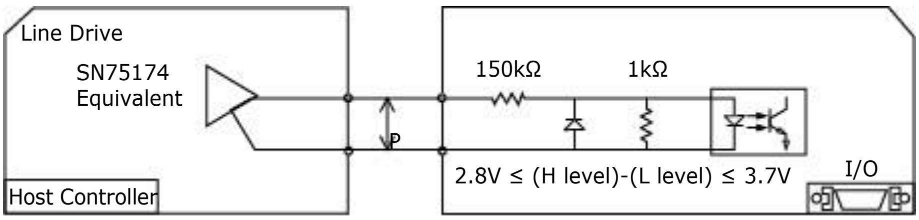
Maximum allowable frequency

- For the line drive output : 900 [kpps]
- For the high speed line drive output : 4 [Mpps]



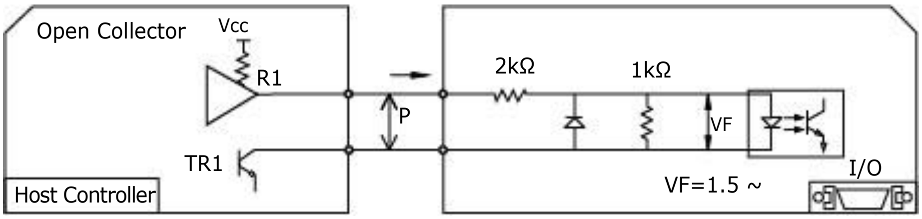


Following circuit shows above figure.



When It is Open Collector Output

Maximum allowable frequency: 250 [kpps]



- 5[V] open collectors, connect the pull up resistor (R1, 180 Ohm) in the middle of the general line drive input (Pin No. 11, 12, 13 and 14).
- For the 24 [V] open collector, directly connect it to PULS+/- (Pin No. 49, 12), SIGN+/- (Pin No. 25, 14) without the pull up resistor R1.

IMPORTANT

Caution is needed on the highest allowed frequency. (When the duty ratio for Pulse is 50:50).

- For the general line drive input: 900 [kpps]
- For the high-speed line drive input: 4 [Mpps]
- For the open collector input: 250 [kpps]

CAUTION

In the figure above, when it is open collector method and TR1 of host controller is ON, the servo drive identifies as low level input logic and if TR1 is OFF, the servo drive identifies as high level input logic.

In addition, set the Pull Up resistor R1 value to be within 6 [mA] to 12 [mA] by referring to the application example below.

Table 5.11

Vcc of Host Controller	R1 (External resister)
24[V] ± 5[%]	Do not need external resister
5 [V] ± 5 [%]	180 [Ω]

NOTE

- When you use open collector method for the output of host controller, it is recommended to use 24 [V] for Vcc. In doing so, the operation is stable even in the environment with serious noise problem.
- When input voltage of 12, 14, 16and 24 of I/O is not exactly low level (less than 0.6 [V]) or R1 value is higher than the suggested value, an error can occur. Therefore, use 24 [V] for Vcc of the host controller.
- Position command wiring length
  - Line Drive : 5 [m] or less
  - Open Collector: 1 [m] or less

Set the Position Command Pulse Type for the Host Controller

Refer to table below to set position command pulse of host controller.

Table 5.12

Parameter [Ft-3.00][D1]	
Parameter Name	Receving method of Position Command from host controller
Setting Value	• 0: Use the line drive output of the host controller • 1: Use the open collector output of the host controller • 2: Use the high speed line drive output of the host controller
Initial Value	0
Applicable Mode	F (Position Control Mode)
Others	Servo-OFF > Setting > End

IMPORTANT

Maximum allowable frequency of pulse command of host controller is

- For the general line drive: 900 [kpps]
- For the high-speed line drive: 4 [Mpps]
- For the open collector: 250 [kpps]

If it exceeds the maximum allowable frequency, excessive position command pulse [E.OvPUL] fault occurs. Please be careful not to exceed the maximum allowable frequency.

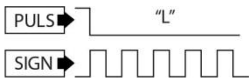
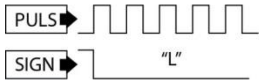
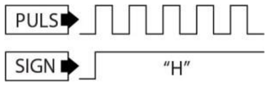
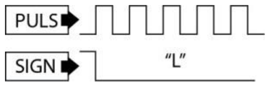
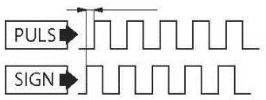
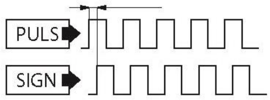
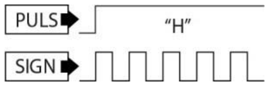
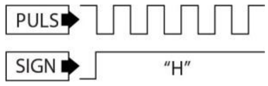
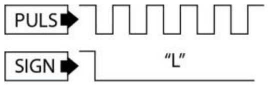
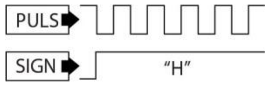
Position Command Pulse Setting

The position command supports 7 types as shown below. Check the applicable specification with reference to electric specification of the command pulse. If the electric specification such as timing is not appropriate, a position error can occur.

Table 5.13

Parameter [Ft-3.00][D0]	 
Parameter Name	Position Command Pulse From Selection
Settomg Value	0~6: Refer to the table 5.14 below
Initial Value	0
Applicable Mode	F (Position Control Mode)
Others	Servo-OFF > Setting > End

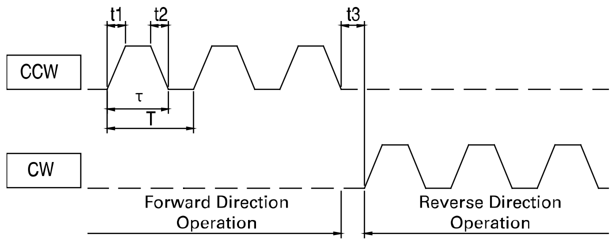
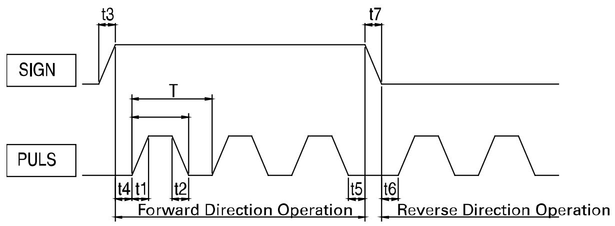
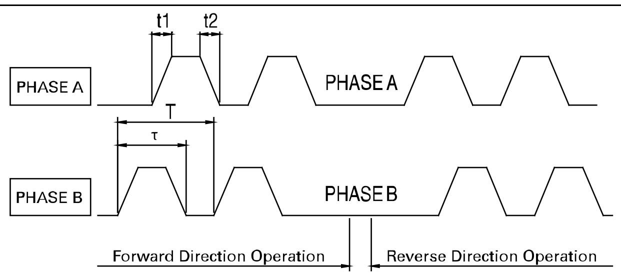
Table 5.14

Setting Value	Logic	Command Pulse Form	Forward Direction Operation	Reverse Direction Operation	Input Muliplication
0	Positive Logic	CW + CCW			-
2		Pulse Train+ Sign			-
4		Phase A+ Phase B			1
5					Duple
6					Quadruple
1	Negative Logic	CW + CCW			-
3		Pulse Train+ Sign			-

NOTE You can verify the data related to the position through monitor mode in the 7-45 page “Monitor Mode Function”.

Electrical Specifications of Position Command Pulse

Table 5.15 Electrical Specifications of Position Command Pulse

Command Pulse Form	Electrical Specification	Maximum Allowable Frequency
CW + CCW	 • t1, t2 ≤0.1 us • τ ≥1.1 us • t3 > 3 us • τ/T x100 ≤50 %	Line Drive: 900 [kpps] High Speed Line Drive: 4 [Mpps] Open Collector: 250 [kpps] (Duty ratio should be 50:50)
Pulse Train+ Sign	 • t1, t2, t3, t7 ≤0.1 us • t4, t5, t6 > 3 us • τ ≥1.1 us	
2 Phase Pulse Train of 90 Difference A Phase + B Phase	 • t1, t2 ≤0.1 us • τ ≥1.1 us • τ/T x100 ≤50 %	

Electronic Gear

Electronic Gear

The electronic gear is to set the amount of load movement per input command pulse.

The following is the example of encoder that generates 32768 pulses per rotation (Resolution 131072).

- (Resolution 131072) per rotation.
  Encoder that the number of pulse is 32768 rotates once when the host controller transfers 131072 pulses to the drive. Then, is it possible to make a motor rotate once as transferring 1000 pulse (or other number of pulses)?
  → Yes, it can
- Let's suppose that the ball screw load is operated by the pitch (Unit of load to be moved per rotation) with 15 [mm]. When the host controller transfers 131072 pulses, the load moves 15 [mm]. For easier calculation, is it possible to move one pitch (15 [mm]) with 1500 pulses? → Yes, it can
- When you want to control the accurate angle using the servo drive, and if you control 360 degree with 131072 pulses, the number of pulse and the moving unit of the last echanical part are different. So it is difficult to calculate. Therefore, the electronic gear is set for easier calculation of the input pulse of the host controller in respect to the distance or angle that is the moving unit of last mechanical part.
- When you use the electronic gear, the host controller can control without considering the number of pulse of the encoder or the reduction gear ratio of mechanical part.

Before Setting the Electronic Gear

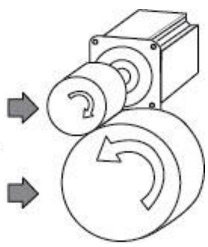
The following table explains the contents that you should know before setting the electronic gear.

- Motor : Check the number of pulse of the encoder used.
- Load : Check the reduction gear ratio applied from shaft to the mechanical part.

Reduction gear ratio

For the reduction gear ratio that is mentioned in electronic gear setting, refer to the explanation below

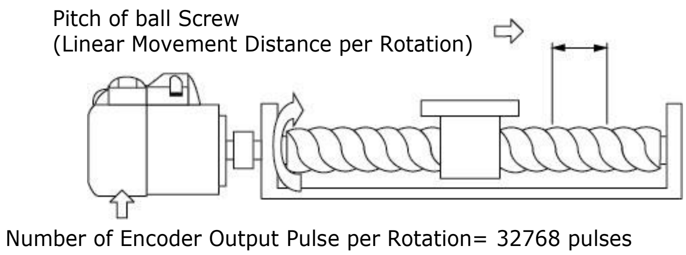
$$\text{Reduction gear ratio} = \frac{\text{Number of Motor Rotation}}{\text{Rotation Number of the End Mechanical Part}}$$



When the mechanical part rotates once while the motor rotates 5 times, then the reduction gear ratio is ‘5’. When the device part rotates 5 times while the motor rotates once, then the reduction gear ratio is ‘0.2’.

Example 1 of Electronic Gear Setting

The following example on ball screw will help you to understand the electronic gear.



Boll screw is applied to the load above and the pitch is 10 [mm].

When we suppose that the number of pulse of the encoder is 32768 [pulse] (Resolution 131072), the reduction gear ratio is ‘1’ because it is 1:1.

Electronic Gear Setting Numerator

- Electronic gear setting numerator parameter :

- Electronic gear setting numerator parameter is as follows.
  Resolution of Encoder × Reduction gear ratio
  Therefore, it is 131072 (resolution)× 1 so that setting value is 131072.

Electronical Gear Setting Denominator

- Electronic gear setting denominator parameter

- Enter the number of pulse to make a motor rotate once
- If you want to rotate a motor once by the host controller sending 1000 pulse to the servo drive, enter 1000 as a setting value. As a result, the boll screw rotates once with 1000 pulses, so the ball screw with the movement pitch of 10 [mm] moves 10 [µm].
- If you want to rotate a motor once by the host controller sending 100000 pulses to the servo drive, enter 100000 as a setting value. As a result, the ball screw rotates once with 100000 pulse, so the ball screw with the movement pitch of 10 [mm] moves 0.1 [µm].

CAUTION

When you set up the denominator as 100000, the ball screw moves 0.1 [μm] per pulse of the host controller so that it shows better resolution than set with 1000.

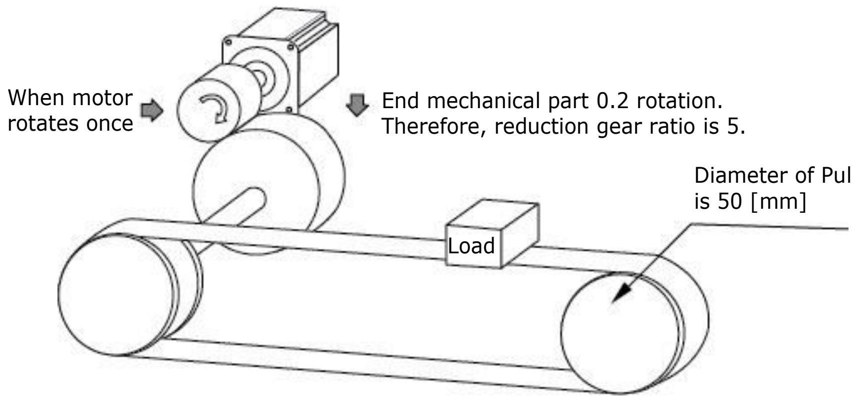
If so, can you realize much better the resolution is if the denominator is set as 200000? No, you cannot. The resolution of the encoder that is selected is 131072. So the electronic gear has to satisfy the following formula because it is set according to the selected encoder.

The number of encoder resolution × Reduction gear ratio ≥ Setting Value of [Ft-3.06]
(The number of encoder resolution = the number of encoder pulse x 4)

Therefore, the host controller can rotate a motor one revolution with maximum of 131072 pulses in the above example. In other words, the denominator value of the electronic gear cannot exceed maximum resolution of the encoder used.

Example 2 of Electronic Gear Setting

This chapter explains the electronic gear setting for a belt load with the reduction gear ratio.



For the ball screw in the example 1, you can easily recognize the pitch through the ball screw specification, but you cannot find the load pitch that consists of belt and pulley. Therefore, let's suppose that the distance we want to move is 100 [μm] per pulse from the host controller.

Let's suppose that the number of pulse of the encoder is 32768 pulses and the reduction gear ratio is '5'.

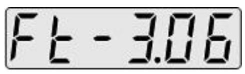
Electronic Gear Setting Numerator:

- Electronic gear setting numerator parameter:

- Electronic gear setting numerator parameter is as follows.
  Encoder resolution (The number of Encoder pulse × 4) × Reduction gear ratio
  Therefore, it is 32768 × 4 × 5 so that setting value is 655360.

Electronic Gear Setting Denominator:

- Electronic gear setting denominator parameter:



- Rotate the pulley of the final mechanical part once with the 1570 pulses from the host controller. In this case, the linear moving distance of the final load per pulse from host controller is 100 [μm].

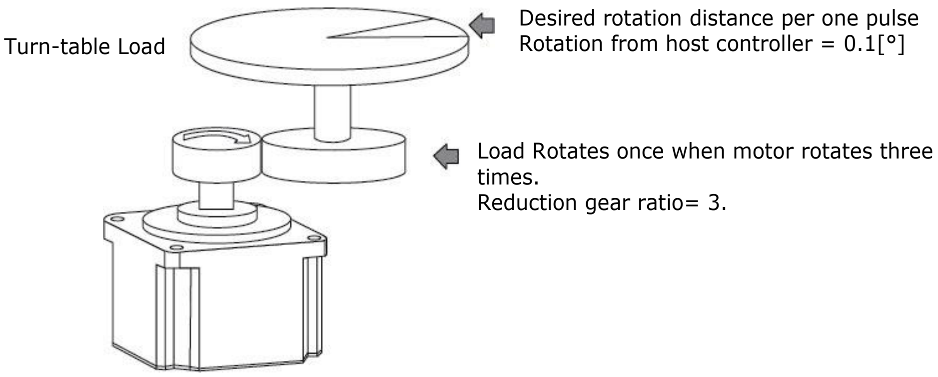
$$\frac{\text{Load moving distance per revolution}}{\text{Moviement Amout by 1 Pulse} \atop \textit{from the host Controller}} = \frac{3.14 \times 50 \times 1000[um]}{100\ [um]} = 1570$$

- You can enter the numerator and denominator by reduction of fraction as the following.

$$\frac{\text{Electronic Gear Setting Numerator} \atop \text{Ft}-3.05}{\text{Electronic Gear Setting Denominator} \atop \text{Ft}-3.06} = \frac{655360}{1570} = \frac{65536}{157}$$

Example 3 of Electronic Gear Setting

The following explains the electronic gear setting when it is a turn- table load with the reduction gear ratio.



Let's suppose the distance we want to rotate per command pulse from the host controller is 0.1 [°].

Let's suppose that the number of pulse of the encoder 32768 pulse (Resolution 131072) and the reduction gear ratio is '3'.

Electronic Gear Setting Numerator

- Electronic gear setting numerator parameter:

- The numerator value of the Electronic gear is as follows.
  The Number of Encoder Pulse × 4 × Reduction gear ratio
  Therefore, it is 32768 × 4 × 3 so that setting value is 393216.

Electronic Gear Setting Denominator:

- Electronic gear setting denominator parameter:

- Rotate the turntable load of the end mechanical part once with the 3600 pulses from the host controller. In this case, the rotation angle of the final load per pulse from host controller is 0.1 [°].

$$\frac{\text{Load Movement Amount per } 1\ \textit{Load Shaft Rotation}}{\text{Movement Angle by 1 Pulse from the Host Controller}} = \frac{360°}{0.1°} = 3600$$

NOTE

- The electronic gear is applied only when the position control mode is used.
- You can easily adjust the distance or the angle of pulse command and load from the host controller by setting the electronic gear.
- You should check two things below when setting the electronic gear.
  1. Check the number of pulse of encoder.
  2. Check the reduction gear ratio that is applied from shaft to the end mechanical part.

Electronic Gear Setting

Set the electronic gear to the parameter below.

Table 5.16

Parameter (Ft-3.05)	Ft-3.05
Parameter Name	1st Electronic gear setting (Numerator)
Description	Pulse of Encoder× 4 (Resolution) × Reduction gear ratio
Setting Value	1~8388608
Initial Value	4
Unit	pulse
Applicable Mode	F (Position control mode)
Others	Servo-OFF > Setting > End

Table 5.17

Parameter (Ft-3.06)	Ft-3.06
Parameter Name	1st Electronic Gear Setting (Denominator)
Description	The number of position command pulses of the host controller to rotate the load (load shaft) once.
Setting Value	1~8388608
Initial Value	1
Unit	pulse
Applicable Mode	F
Others	Servo-OFF > Setting > End

Table 5.18

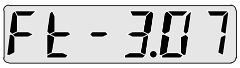
Parameter (Ft-3.07)	
Parameter Name	2nd Electronic Gear Setting (Numerator)
Description	The number of position command pulses of the host controller to rotate the load (load shaft) once.
Setting Value	1~8388608
Initial Value	4
Unit	pulse
Applicable Mode	F
Others	Servo-OFF > Setting > End

Table 5.19

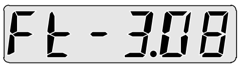
Parameter (Ft-3.08)	
Parameter Name	2nd Electronic Gear Setting (Denominator)
Description	The number of position command pulses of the host controller to rotate the load (load shaft) once.
Setting Value	1~8388608
Initial Value	1
Unit	pulse
Applicable Mode	F
Others	Servo-OFF > Setting > End

Table 5.20

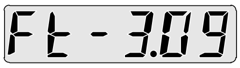
Parameter (Ft-3.09)	
Parameter Name	3rd Electronic Gear Setting (Numerator)
Description	The number of position command pulses of the host controller to rotate the load (load shaft) once.
Setting Value	1~8388608
Initial Value	4
Unit	pulse
Applicable Mode	F
Others	Servo-OFF > Setting > End

Table 5.21

Parameter (Ft-3.10)	Ft-3.10
Parameter Name	3rd Electronic Gear Setting (Denominator)
Description	The number of position command pulses of the host controller to rotate the load (load shaft) once.
Setting Value	1~8388608
Initial Value	1
Unit	pulse
Applicable Mode	F
Others	Servo-OFF > Setting > End

NOTE

The Initial value of the electronic gear parameter is automatically set as the number of pulse of related encoder at the same time when the parameter is initialized [run-12].

Precautions and Other Specifications

Setting value of the electronic gear should satisfy the following relationship. If the relationship below is not formed, you can use it as pulse command but the resolution is not guaranteed.

Encoder Resolution per 1 Rotation of Motor × Reduction gear ratio ≥ Denominator value of the electronic gear (Ft-3.06, Ft-3.08, Ft-3.10)

Maximum resolution is 1 / (Encoder Resolution per 1 Rotation of Motor × Reduction gear ratio).

If the denominator value of electronic gear does not satisfy the relationship above,

- Reduce the distance or angle needs to be moved with one command pulse. (= Reduce the resolution.)
- Use the high-resolution encoder, which outputs the number of pulse higher than the denominator value of the electronic gear divided by 4, or increase the reduction gear ratio.

NOTE

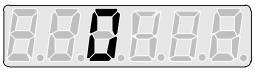
- Position control resolution of CSD7 Servo drive is ± 1 pulse.
- In the example 1 on ball screw load, [Ft-3.05]=131072 and the maximum value for [Ft-3.06] is 32768 × 4=131072. Therefore, the minimum unit which moved by 1 command is 10 [mm] / 131072 ≒ 0.076[μm].
- When actually applying, design with sufficient amount more than the minimum unit.
- Servo drive can output the encoder by the host controller.
- Refer to the 7-21 page "Position Feedback to the Host Controller" (position feedback with the host controller) with the understanding of the electronic gear setting.

Expansion of Electronic Gear Setting

When the electronic gear ratio needs to be changed in position control mode during the operation, you can change the electronic gear parameters, immediately.

You can change the electronic gear parameters – Ft-3.05, Ft-3.06, Ft-3.07, Ft-3.08, Ft-3.09 and Ft-3.10 - only when Servo Off. The parameters shown below are changeable regardless of the Servo On/Off Status.

Table 5.22

Parameter (Ft-3.00)(D3)	 
Parameter Name	Change the setting method of electronic gear parameters [Ft-3.05], [Ft-3.06], [Ft-3.07], [Ft-3.08], [Ft-3.09], [Ft-3.10]
Setting Value	• 0 - Change electronic gear parameters only when Servo-OFF • 1 - Change electronic gear parameters no matter what Servo-OFF or Servo-ON
Initial Value	0
Applicable Mode	F
Others	Servo-OFF > Setting > End

Use of Electronic Gear (1st, 2nd and 3rd Electronic Gear)

During operation in a position control mode, you can switch to another electronic gear ratio in the following way.

Table 5.23

/E-GEAR2	/E-GEAR1	Electronic Gear Selection
OFF	OFF	1st electronic gear (Ft-3.05, Ft-3.06)
OFF	ON	2nd electronic gear (Ft-3.07, Ft-3.08)
ON	OFF	3rd electronic gear (Ft-3.09, Ft-3.10)

Table 5.24

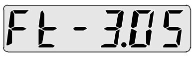
Parameter (Ft-3.05) (Ft-3.07) (Ft-3.09)	  
Parameter Name	1st, 2nd and 3rd Electronic Gear Setting (Numerator)
Description	Equation: Encoder Pulse Count × 4 (Resolution) × Reduction gear ratio
Set value	1~8388608
Initial value	4
Unit	Pulse
Relevant Mode	F
Others	Servo-OFF > Setting > End

Table 5.25

Parameter (Ft-3.06) (Ft-3.08) (Ft-3.10)	Ft-3.06 Ft-3.08 Ft-3.10
Parameter Name	1st, 2nd and 3rd Electronic Gear Setting (Denominator)
Description	The number of position command pulses of the host controller to rotate the load (load shaft) once.
Set value	1~8388608
Initial value	1
Unit	Pulse
Relevant Mode	F
Others	Servo-OFF > Setting > End

CAUTION

If the gear ratio is changed frequently or if the change in gear ratio is large, severe machine vibration due to rapid acceleration/deceleration may occur in Servo ON state.

Position Error Clear </PCLR>

If this signal is inputted, the position command, the position feedback, the position error, and encoder feedback counter (dIS-23) are cleared to '0'. If the position command pulse is not inputted any more, the motor can be stopped from the current state.

It can be stop instantly when it receive signal during operation, so stop the motor before operating.

Position error clear input signal is assigned to sequence input, and the parameter is set in [Ft-0.13][D3].

It clears just once at a falling edge of the position error clear signal.

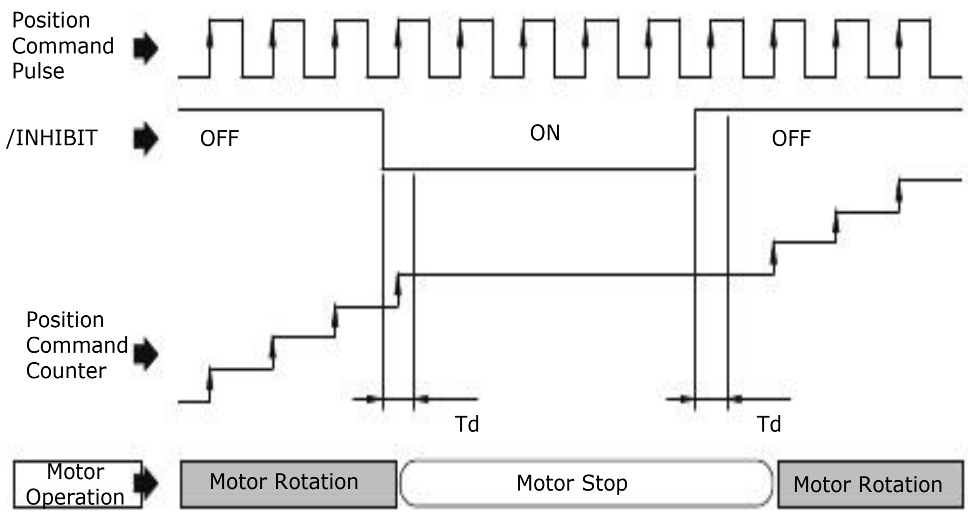
Pulse Command Inhibition</INHIBIT> Input

The position command counter can be stopped in the position control mode by setting the pulse command inhibition</INHIBIT> by the sequence input signal.

While </INHIBIT> input is ON, it is ignored even though the host controller sends the position command pulse to the servo drive. Therefore, it locks the servo status in the current position.

If </INHIBIT> signal is ON/OFF while the host controller continuously sends the position commands, the following operation occurs according to the </INHIBIT> signal status.

In the figure below, Td is about 10 [msec].



</INHIBIT> is a sequence input signal. To use the </INHIBIT> signal, allocate the </INHIBIT> signal with the reference to the sequence input/output signal in the 5-1 page “Sequence I/O (Input/Output) Signal”.

CAUTION

The setting value 'b', as shown in "Input Signal Allocation Method" in the 5-6 page, cannot apply to </INHIBIT>.

Position Completion Signal Detection </P-COM>, Approach Signal Detection </NEAR> Output

Position Completion Signal Detection </P-COM>

The position completion signal detection</P-COM> can be output with sequence output signal.

When you set the position command completion time to Servo drive that receives the position command from host controller, and the difference between position feedback and position command is less than Setting value, the position completion signal detection </P-COM> can be output.

Setting the Output Width of Position Completion Signal

Set the output width of position completion signal (Standard) to output the </P-COM> signal to the parameter below.

Table 5.26

Parameter (Ft-3.18)	Ft-3.18
Parameter Name	Output width of position completion signal
Description	When the number of position error pulse is within the value above, position completion signal detection </P-COM> signal is generated.
Setting Value	0~2500
Initial Value	10
Unit	Pulse
Applicable Mode	F (Position control mode)
Others	Setting > End

Position Approach Signal Detection </NEAR>

The position approach signal detection </NEAR> signal can be output with sequence output signal.

When setting the position command approach signal time to the servo drive that receives position command from the host controller, and the difference between the position feedback and position command is less than setting value, the position approach signal detection </NEAR> signal can be output.

Setting the Output Width of Position Approach Signal

Set up output width of position approach signal (Standard) to generate </NEAR> signal to the parameter below.

Table 5.27

Parameter (Ft-3.19)	
Parameter Name	Output Width of Position Approach Signal
Description	When the number of position error pulse is within the value above, position Approach Signal detection </NEAR> signal is generated.
Setting Value	0~2500
Initial Value	20
Unit	Pulse
Applicable Mode	F (Position control mode)
Others	Setting > End

Other Explanation

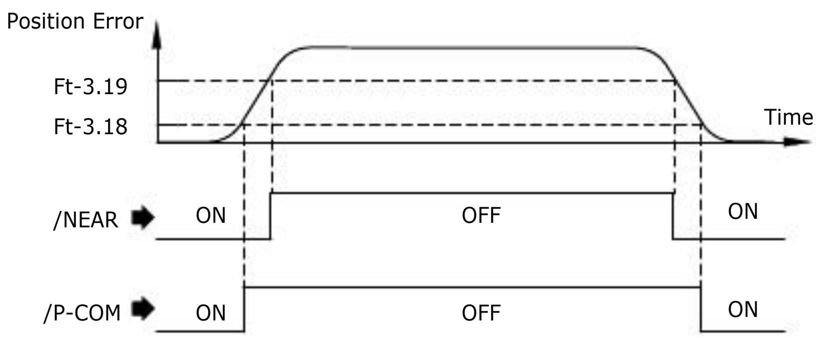
Position approach signal detection </NEAR> signal with position completion signal detection </P-COM> signal is useful to reduce the necessary operation at the position completion signal time. First, check the approach signal and preparing the next sequence before the host controller verifies the position completion signal detection signal. The setting of these parameters above do not influence on the accuracy of final position decision.

Therefore, you can adjust timing to output </P-COM> signal and </ NEAR> signal by adjusting the number of position error pulse of [Ft 3.18] and [Ft-3.19].

If the position completion signal detection, </P-COM> signal, is detected, the segment LED in line indication 1 of status indication mode is on. However, </NEAR> signal is not on.

Figure Explanation

Sequence output </P-COM> and </NEAR> signal output as shown below.



Thus, </P-COM> and </NEAR> output are ON when satisfying the following conditions. However, the position pulse command frequency should be 100 [pps] and less.

- Position Error < Setting valuen of [Ft-3.18]: /P-COM Output
- Position Error < Setting valuen of [Ft-3.19]: /NEAR Output

CAUTION

When [Ft-3.18] is set with high value during the low-speed operation (less 100 [pps]), </P-COM> output signal remains ON.

NOTE

- </P-COM> and </NEAR> are sequence output signal. To use </P-COM> and </NEAR> function, allocate </P-COM> and </NEAR> signal and refer to sequence input/output signal in the 5-1 page “Sequence I/O (Input/Output) Signal”.
- You can use </P-COM> and </NEAR> signal as the reference signal for the next operation of the system with </V-COM> of Velocity Control Mode.
- When the position completion signal detection </P-COM> signal is output, the servo drive turns line indication on to allow verification of </P-COM> signal output.
- For status indication mode, refer to the 4-6 page “Status Display Mode”.

Output Width of Allowable Position Error

Set allowable position error limit.

Table 5.28

Parameter (Ft-3.20)	Ft-3.20
Parameter Name	Output width of allowable position error
Description	If position error is bigger than setting value, the position error overflow servo fault [E.PoSEr] occurs.
Setting Value	0~2147483647
Initial Value	99999
Unit	Pulse
Applicable Mode	F (Position control mode)
Others	Setting > End

Input/Output Signal Timing Diagram

The figure below is a timing diagram of Input/Output signal in position control mode.

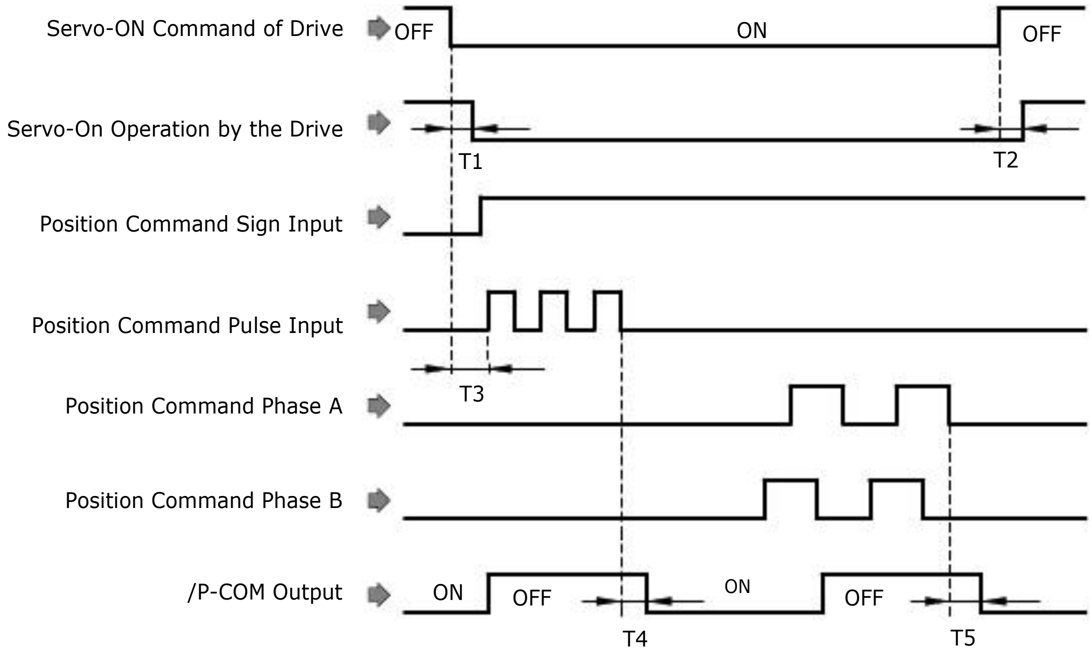


Table 5.23

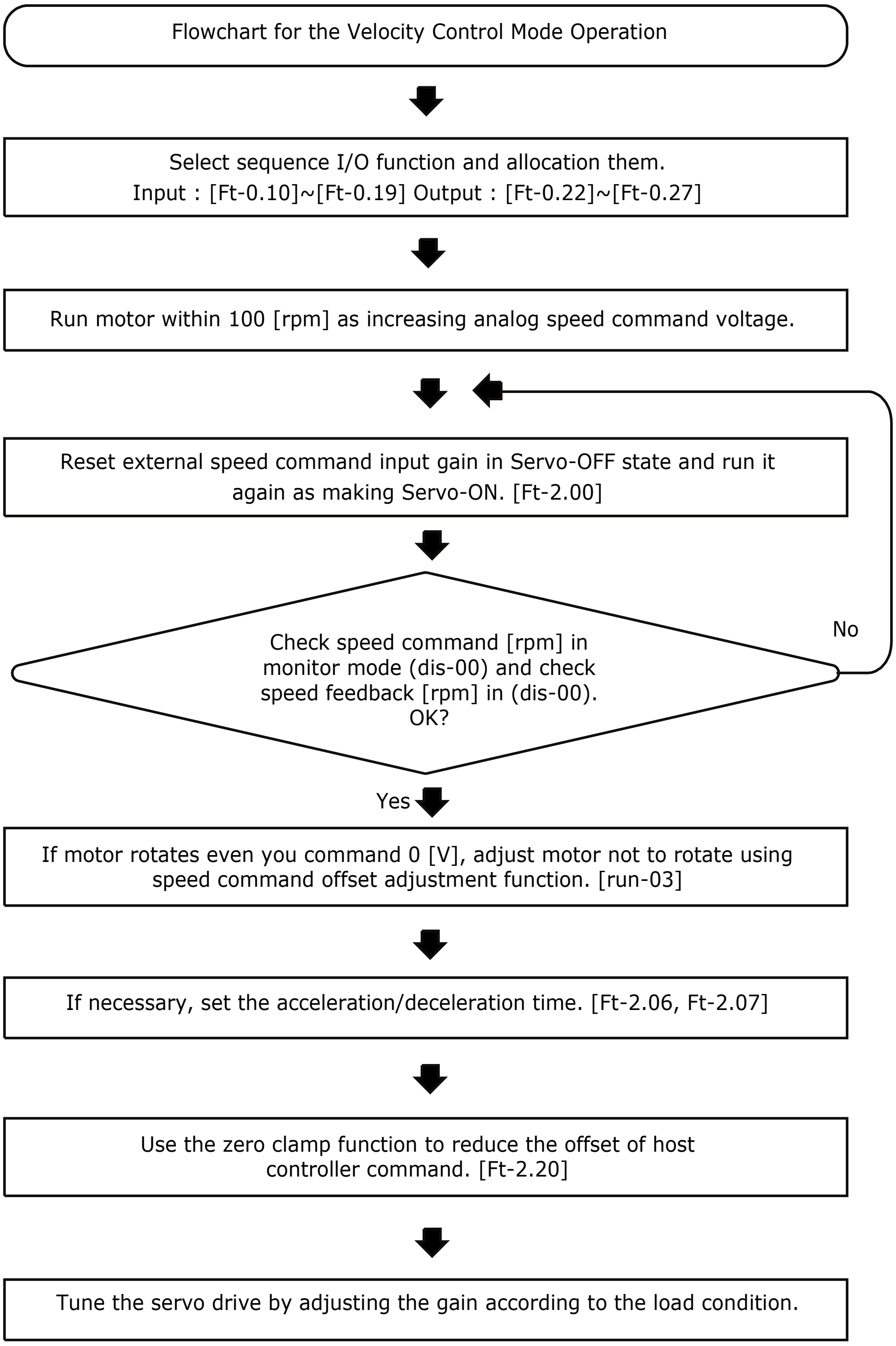
T1	T2	T3	T4	T5
Max. 40 ms	Max. 6 ms	Min. 40 ms	Min. 2 ms	Min. 2 ms

Velocity Control Mode

Overview

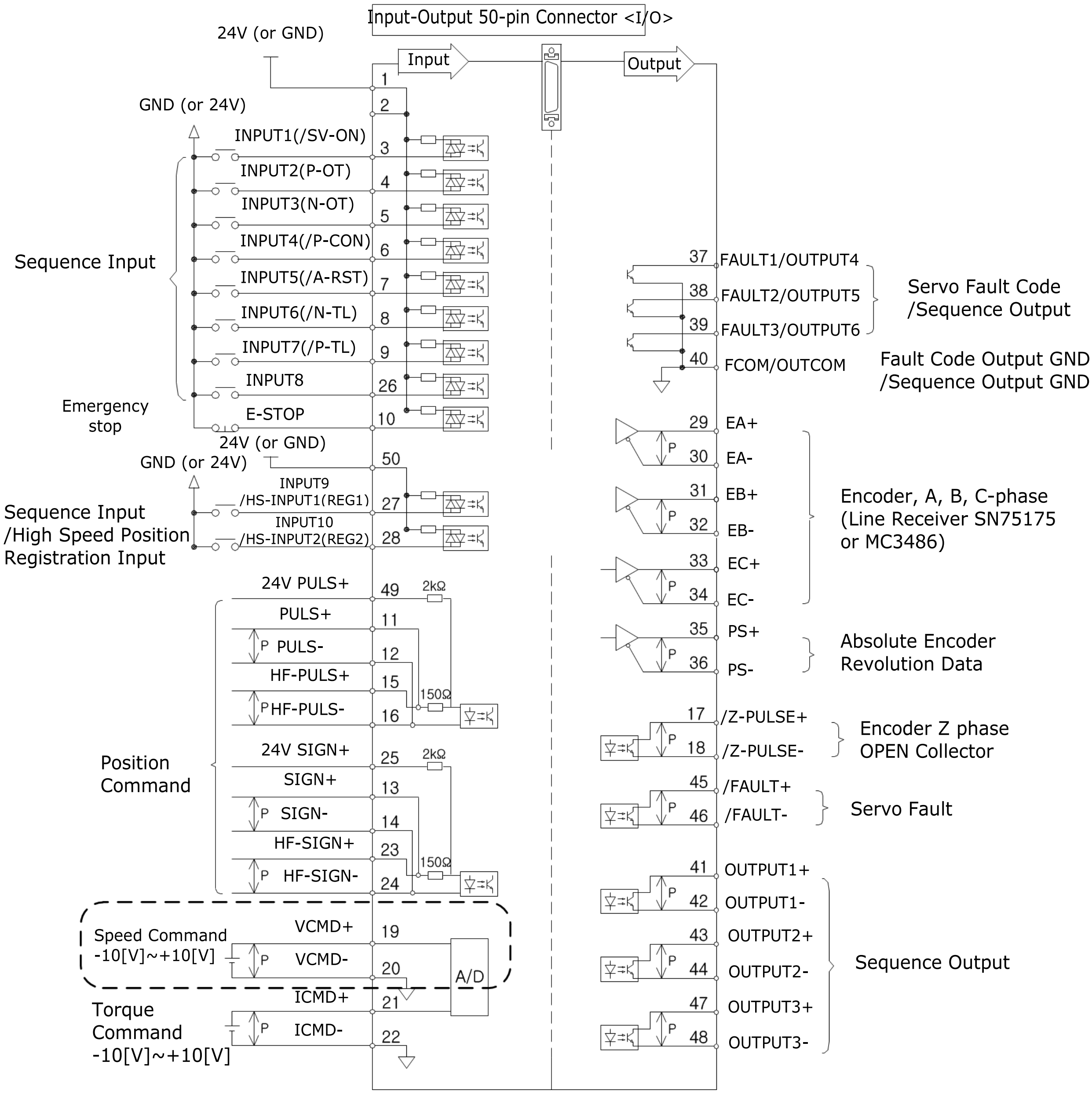
The Velocity Control Mode is used to control the speed as inputting speed command of analogue voltage type that is generated by the host controller to servo drive even if the position control loop is formed in the host controller or not.

In order to operate servo drive in Velocity Control Mode, connect the analog speed command to the related input pin and set as the following.



Standard Wiring Example

The following figure illustrates the standard wiring example of the Velocity Control Mode. You can set sequence input/output signal, as you want if it is necessary for system configuration.



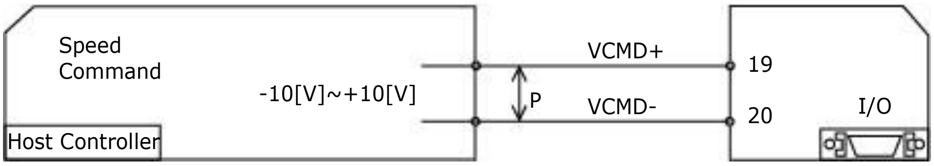
NOTE	Whether to use the emergency stop input(E-STOP) can be set by the parameter ([Ft-0.05][D3] = 0); the initial value is set as not to use.

Speed Command Input

Speed Command

Two pins of I/O (19, 20) receive one command related to the Velocity Control Mode.

Host controller sends the voltage command of analog type.



Speed Command Input Ratio Setting

Set the relationship between the analog speed command voltage and the speed to the parameter below.

Table 5.24

Parameter (Ft-2.00)	
Parameter Name	External speed command Input Ratio
Description	Set of speed command gain value [rpm] related to the analogue voltage 1 [V]. This setting is used as external speed limit function if the servo drive is not used in Velocity Control Mode. For speed limit function, refer to the 7-18 page.
Setting Value	10.0~2000.0
Initial Value	500.0
Unit	rpm/V, For rotary motor
Applicable Mode	S (Velocity control mode)
Others	Servo-OFF > Setting > End

Speed command is given according to the following relationship.

Speed Command (rpm) = Setting Value of [Ft-2.00](rpm/V) * Input Voltage(V) Therefore, If input voltage 6 [V] according to initial value, motor rotates 3000 [rpm] as the rated speed of motor, If input voltage 10 [V], motor rotates 5000 [rpm] as the maximum speed of motor

NOTE

- Maximum allowable voltage of speed command input is DC -10 [V] to +10 [V].
- If analog speed command voltage is more than the maximum speed of set motor, over speed command servo warning ("OSC") occurs.
- Motor can rotate even though the velocity command from external device is not input or the host controller outputs velocity command as 0 [V]. It is because of the voltage offset between the host controller and the drive.
- The rotation of the motor can be prevented by voltage offset using the automatic adjustment of velocity command offset (Run-03). Refer to the 7-36 page "Operation Mode Function" for the automatic (manual) adjustment of the velocity command offset.

Zero Clamp </Z-CLP> Input

Even though the analog speed command of the host controller is 0 [V], some offset voltage can exist in servo drive input, resulting in slow rotation of the motor. In this case, prevent the subtle rotation of motor according to offset voltage using the zero clamp function.

</Z-CLP> is a sequence input signal. To use </Z-CLP> function, allocate </Z-CLP> by referring to the sequence input/output signal in the 5-1 page "Sequence I/O (Input/Output) Signal".

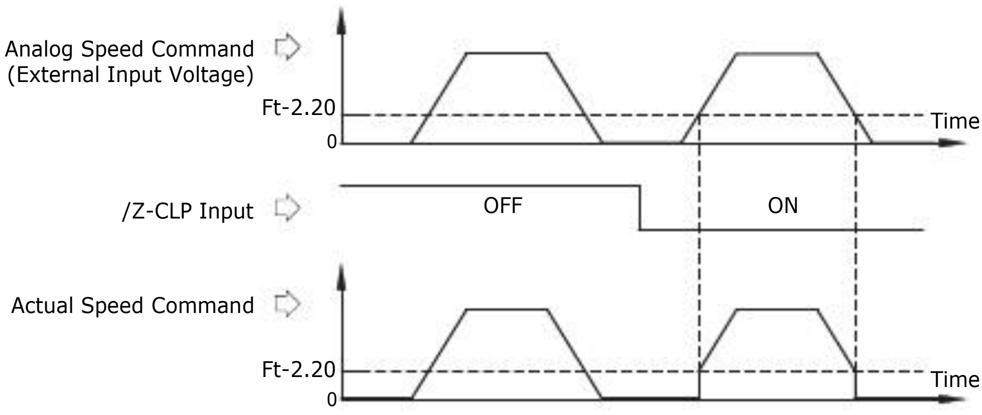
Set speed zero clamp level to the parameter below.

Table 5.25

Parameter (Ft-2.20)	Ft-2.20
Parameter Name	Speed sero clamp level
Description	Speed command that is below the value is ignored.
Setting Value	0~5000
Initial Value	0
Unit	rpm
Applicable Mode	S (Velocity control mode)
Others	Setting > End

If you turn the signal on or off to the pin of I/O where the zero clamp function is allocated, the velocity command less than the zero clamp level [Ft-2.20] or lower is ignored. When the speed command value is higher than this level, the motor is accelerated to the command value.

In addition, if you set the sequence input as 'b' with the reference of the input signal allocation method in the 5-6 page "Input Signal Allocation Method", the zero clamp function is always valid and if it is set as '0', the zero clamp function is not processed.

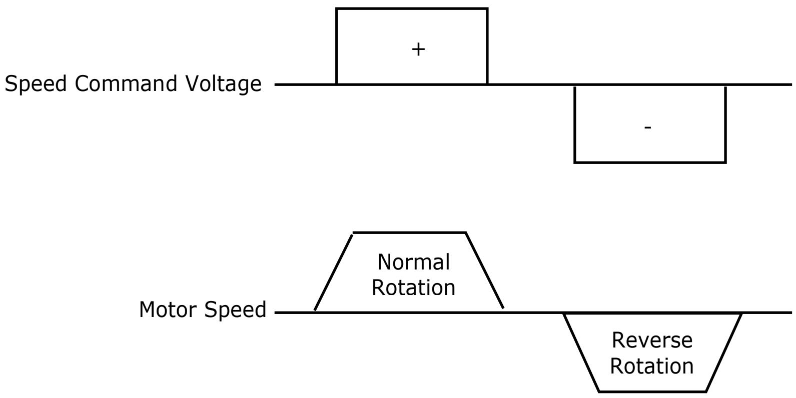


CAUTION

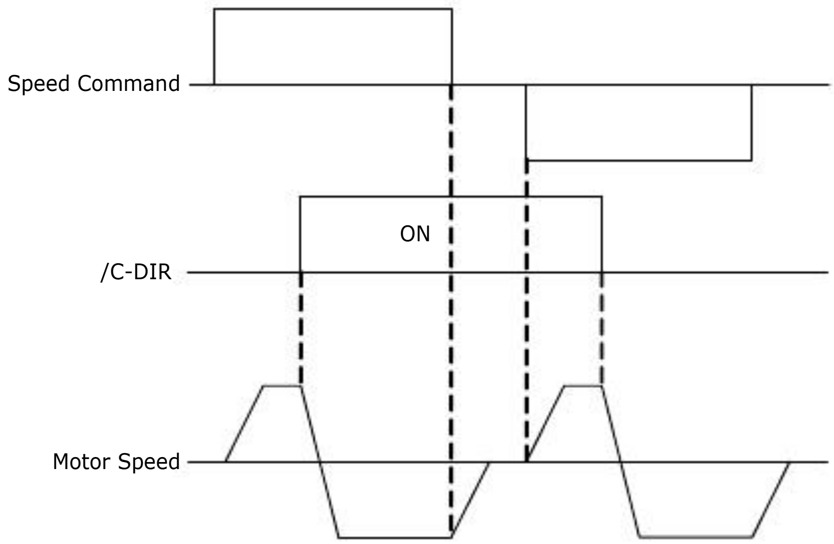
- Although /Z-CLP input is not allocated, the drive automatically clamps the speed command as '0' in case any value is in Ft-2.20 except '0'.
- Do not use when you configure position control loop by host controller.
- The position loop may malfunction. In this case, set the acceleration and deceleration of Ft-2.06 and Ft-2.07 to a high value.

Rotation Direction Switch Input </C-DIR>

Typically the direction of motor rotation in Velocity Control Mode is changed according to the analog voltage polarity as shown below.



You can control the rotation direction using input </C-DIR>, which is also used in Multi-step Speed Control Mode. When input </C-DIR> is ON, the rotational direction of the motor will be inverted.

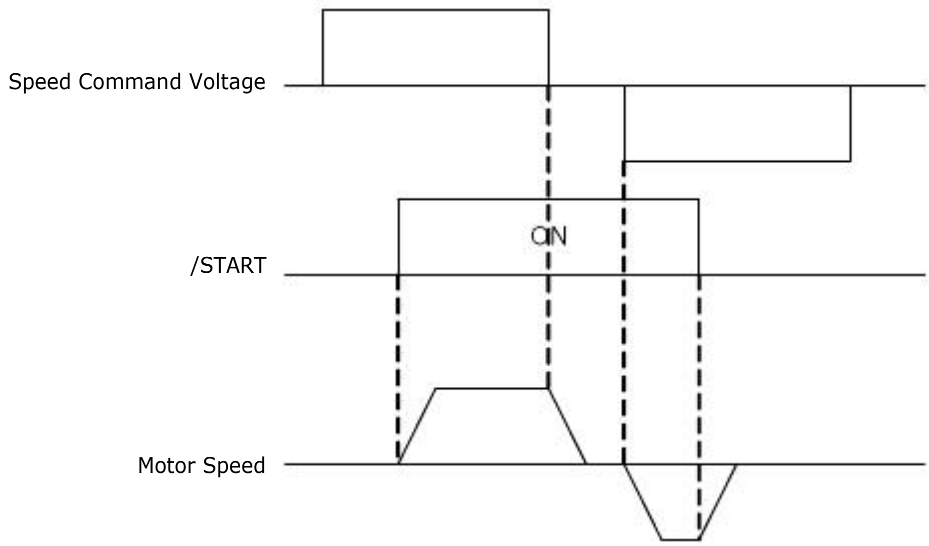


Motor Rotation Start/Stop Input </START>

Generally, the motor begins to rotate when the speed command is entered after Servo-ON in the Velocity Control Mode. You can control the motor rotation srat and stop using contact point input signal with setting </START>input.

If the </START> input is assigned to an input pin, the </START> contact point input acts as an enable and can be used to control motor rotation start or stop.

Control mode can be applied: Speed Contorl Mode, Multi-step speed mode



Speed Coincidence Output Signal </V-COM>

The speed coincidence detection output is to indicate that the actual motor speed matches up to command speed within the allowable error. Like position completion output signal </P-COM> in position control mode, you can use it as an inter-lock signal in the host controller.

</V-COM> is a sequence output signal. To use </V-COM> function, allocate </V-COM> signal by referring to the sequence input/output signal described in the 5-1 page “Sequence I/O (Input/Output) Signal”.

Set output width of speed coincidence signal to the parameter below.

Table 5.26

Parameter (Ft-2.18)	Ft-2.18
Parameter Name	Output width of speed coincidence signal
Description	If speed error is within setting value, speed coincidence detection </V-COM> signal is generated.
Setting Value	0~1000
Initial Value	10
Unit	rpm
Applicable Mode	All
Other	Setting > End

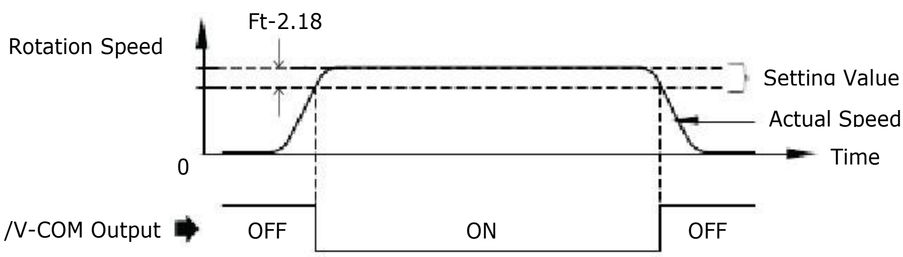
Speed coincidence detection </V-COM> output is ON when the following conditions are satisfied.

Speed Error < Setting Value of [Ft-2.18]: /V-COM Output

Therefore, you can adjust the timing to generate </V-COM> signal by adjusting the difference between the speed command and actual rotation speed to output width of speed coincidence signal [Ft-2.18].

Output width of speed coincidence signal [Ft-2.18] setting does not have influence on the final velocity control.

Sequence output </V-COM> signal is generated as shown in the figure below.



NOTE	
	• </V-COM> is ON to the allocated sequence output channel when the output width of speed coincidence signal is Ft-2.18 = 100, the speed command is 2000 [rpm], and the actual rotation speed is in 1900~2100 =100 [rpm]. • When speed coincidence output signal </V-COM> is generated, the servo drive turns line indication 1 of status indication mode, on to allow verification of the output of the </V-COM> signal. For status indication mode, refer to the 4-6 page “Status Display Mode”.

Rotation Detection </TG-ON> Output

It indicates that the servo motor rotates at a speed higher than the set speed. It can be used as one condition to check the motor status when you change the control mode in mixed control mode, or before you change one sequence to other sequence among sequences.

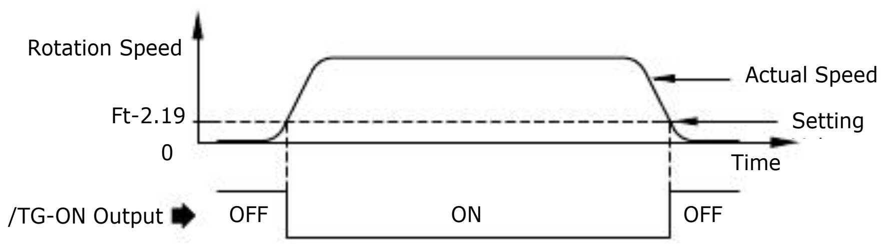
</TG-ON>is a sequence output signal.To use </TG-ON> function, allocate </TG-ON> signal by referring to the sequence input/output signal in the 5-1 page “Sequence I/O (Input/Output) Signal”.

Set rotation detection level in order to set the appropriate constant to satisfy the purpose such as control mode change or sequence conversion.

Table 5.27

Parameter (Ft-2.19)	Ft-2.19
Parameter Name	Rotation Detection Level
Description	</TG-ON> signal is output if the motor rotates at a speed higher than the set value.
Setting Value	1 to 5000
Initial Value	20
Unit	rpm
Applicable Mode	All
Others	Setting > End

Sequence output </TG-ON> signal is output as shown below.



NOTE	
	If you set ration detection level [Ft-2.19] too low, </TG-ON> signal can be output even with small vibration.

Speed Limit Function and Speed Limit Detection </V-LMT> Output

You can limit the speed of servo motor within a set speed in order to avoid the excessive operation of the load. Initial value is limited to 5000 [rpm] and you can change the speed limit according to the parameter setting below.

Set speed level that you want to limit to the parameter below.

Table 5.28

Parameter (Ft-2.16)	Ft-2.16
Parameter Name	Speed Limit
Description	It limits the rotation speed of motor to keep below the speed of set value
Setting Value	1 to 6000
Initial Value	5000
Unit	rpm
Applicable Mode	All
Others	Setting > Completed

Even though you set the speed limit [Ft-2.16] as 1500 [rpm] and send analog speed command related to 1500 [rpm] from the host controller, servo motor runs in 1000 [rpm].

On this occasion, if the speed of motor reaches to speed limit as allocating sequence output function speed limit detection </V-LMT>, you can generate </V-LMT> signal to the allocated output pin.

</V-LMT> is sequence output signal. To use </V-LMT> function, allocate </V-LMT> signal with reference to sequence input/output signal in the 5-1 page "Sequence I/O (Input/Output) Signal".

Speed limit detection </V-LMT> output is ON when the following conditions are satisfied.

Rotation Speed ≥ Setting value of [Ft-2.16]: /V-LMT Output.

NOTE

- Initial value of speed limit is automatically set as maximum speed of set motor at the same time when motor type is set in the basic setting in the 4-12 page "Basic Setting".
- Set speed limit [Ft-2.16] to maximum speed of motor if there is no excessive load. If the set value is too small, response performance is reduced.
- Except the speed limit method by setting of speed limit [Ft-2.16], you can also limit the speed by the velocity command(analog signal) from the host controller.
- Among two methods, you can select how to limit speed by speed limit selection [Ft-2.17].
- If you do not select the method by [Ft-2.16] in speed limit selection [Ft-2.17], setting value of speed limit [Ft-2.16] becomes invalid.
- For details on speed limit, refer to the 7-18 page "Speed Limiting Function".

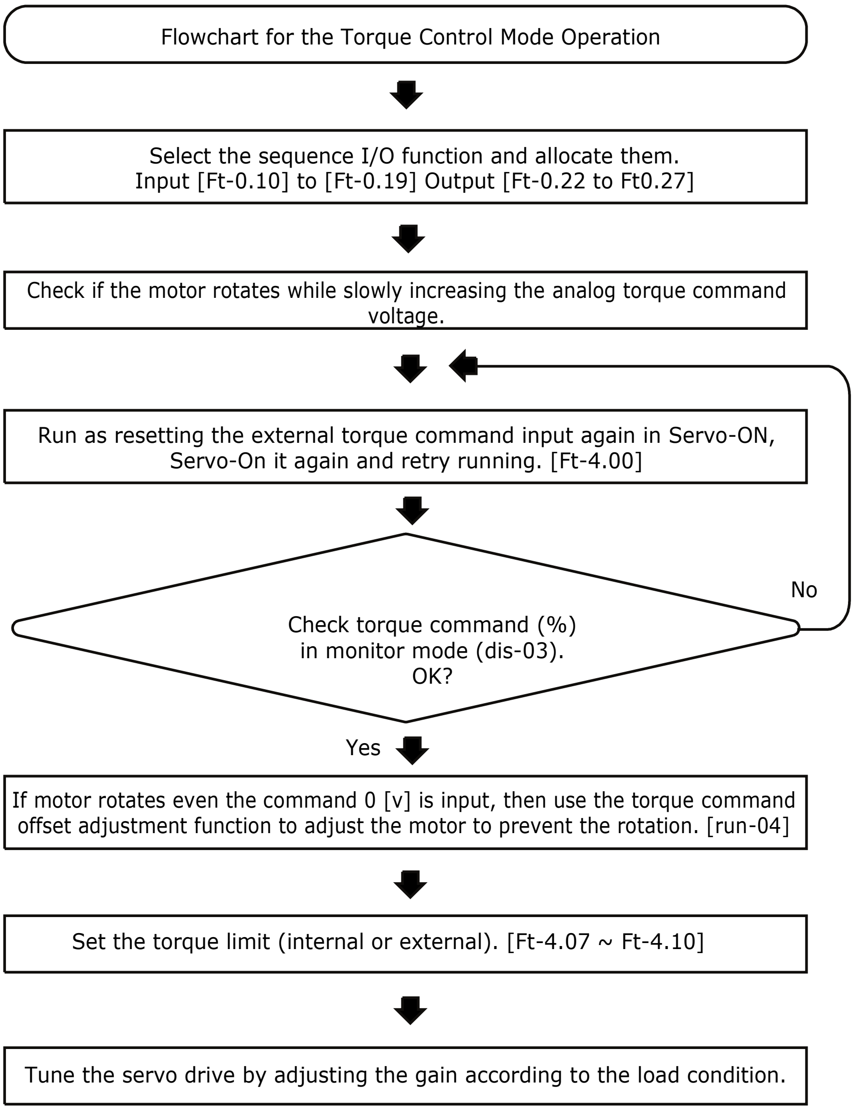
Torque Control Mode

Overview

The torque control mode is used to control the tension or the pressure of the mechanical part by using the servo drive.

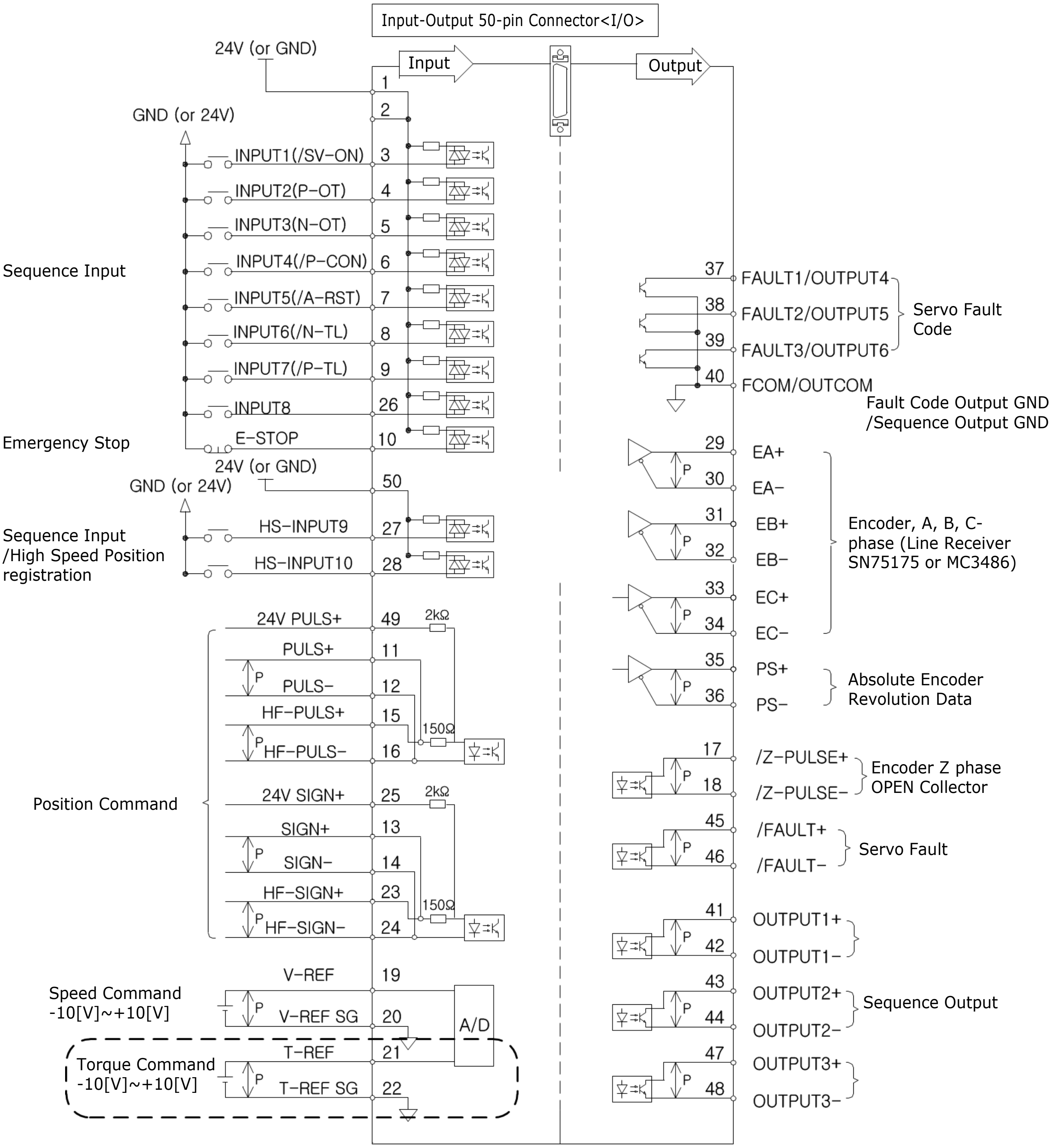
Enter the voltage related to the desired torque from the host controller. Various setting values related to operation torque limit of motor are generally applied to the position or the Velocity Control Mode.

In order to operate the servo drive in a torque control mode, connect the analog torque command to the related input pin and set the required process as shown bellow.



Standard Wiring Example

The following figure illustrates the standard wiring example of the torque control mode. The sequence input/output signal can be set according to needs if it is necessary for the system configuration.



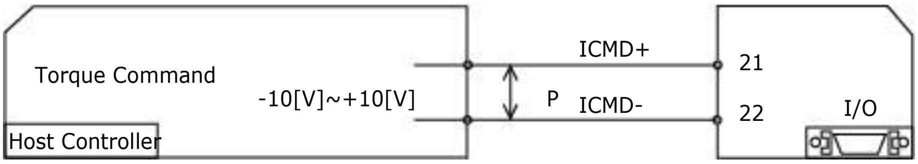
NOTE	Whether to use the emergency stop input can be set by the parameter [Ft-0.05][D3] = 0 ; the initial value is set as not to use.

Torque Command Input

Torque Command

Two pins of I/O (21, 22) receive one command related to torque control mode.

Host controller outputs the voltage command of the analog type.



External Torque Command Input Ratio Setting

Set the relationship between the analog voltage value and torque command value to the parameter below.

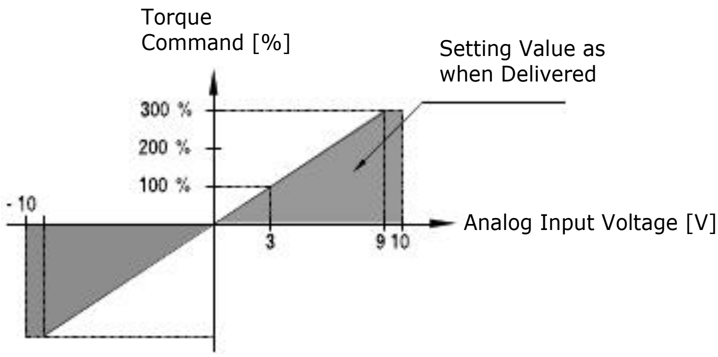
Table 5.29

Parameter (Ft-4.00)	
Parameter Name	External Torque Command Input Ratio
Description	Set the gain of torque command value [%] related to analog voltage 1 [V].
Setting Value	0.0~100.0
Initial Value	33.3
Unit	%/V
Applicable Mode	C (Torque control mode)
Others	Servo-OFF > Setting > End

Speed command is given according to the following relationship.

$$\mathrm{Torque[Nm]} = \frac{\mathrm{Ft} - 4.00[\%/\mathrm{V}] \times \mathrm{Input\ Voltage[V]} \times \mathrm{Rated\ Torque[Nm]}}{100}$$

Therefore, according to the Initial value, when the input voltage is 3 [V], 100 [%] torque that is rated torque of motor occurs. In addition, when input voltage is 9 [V], 300 [%] torque that is maximum torque of motor occurs.
(Rated torque and maximum torque can be different according to motor type.)



NOTE

- Maximum allowable torque command is DC -10 [V] to +10 [V].
- If the input reference voltage is changed, the torque command can be changed together.
- If you want a precise torque adjustment, it is recommended to use multi-turn variable resistor more than 10-turn (rotation).
- If analog torque command is over maximum torque of set motor, over (external) torque command warning, Servo warning ("OTC") occurs.
- Motor can rotate even though torque command is not approved or the host controller outputs the torque command as 0 [V]. It is because of the voltage offset between the host controller and the drive.
- The rotation of motor due to offset can be prevented using automatic adjustment of torque command offset (Run-04) function. For the automatic (manual) adjustment of the torque command offset, refer to the 7-36 page "Operation Mode Function".

Torque Limit and Torque Limit Detection </T-LMT> Output

It can limit the torque of servo motor and can set separately in forward (reverse) direction.

Internal Limit

It means the drive limits itself according to the parameter setting regardless of the external signal.

External Limit

It receives the external sequence input signal. In addition, it sets up the limit value to the parameter that is different from internal limit, and torque is limited according to sequence input signal.

If the internal torque limit is set, the limit value is always valid. However, external torque limit setting is not always valid because it is controlled according to sequence input signal. It can be difference between internal torque limit and external torque limit.

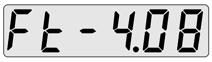
Internal torque limit setting

Set the following two parameters for the internal torque limit.

Table 5.30

Parameter (Ft-4.07)	
Parameter Name	Forward Rotation Torque Limit (Internal Limit))
Description	It limits positive torque in [%] unit related to rated torque.
Setting Value	0~500
Initial Value	350
Unit	[%]
Applicable Mode	All
Others	Setting > End

Table 5.31

Parameter (Ft-4.08)	
Parameter Name	Reverse Rotation Torque Limit (Internal Limit)
Description	It limits negative torque in [%] unit related to rated torque.
Setting Value	0~500
Initial Value	350
Unit	[%]
Applicable Mode	All
Others	Setting > End

External torque limit setting

Set the following two parameters for the external torque limit.

Table 5.32

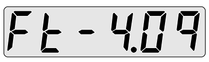
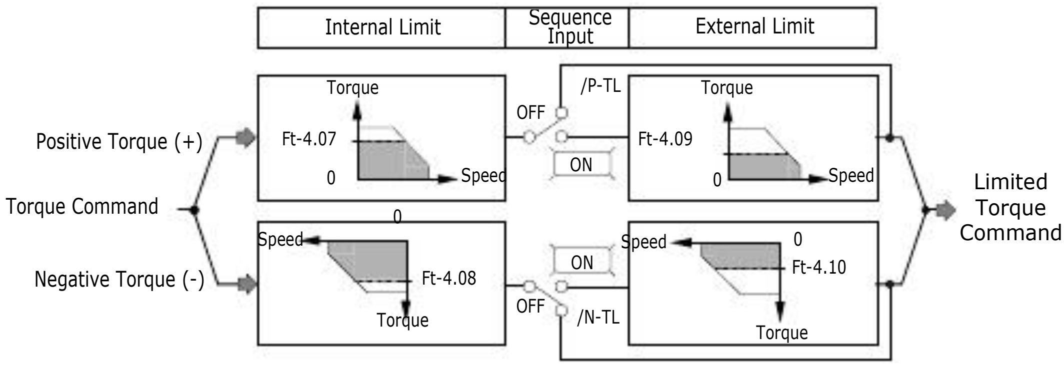
Parameter (Ft-4.09)	
Parameter Name	External Torque Limit of Reverse Rotation </P-TL>
Description	If </P-TL> is ON, it limits positive torque in [%] unit related to rated torque.
Setting Value	0~500
Initial Value	100
Unit	[%]
Applicable Mode	All
Others	Setting > End

Table 5.33

Parameter (Ft-4.10)	Ft-4.10
Parameter Name	External Forward Rotation Torque Limit </N-TL>
Description	If </N-TL> is ON, it limits negative torque in [%] unit related to rated torque.
Setting Value	0~500
Initial Value	100
Unit	[%]
Applicable Mode	All
Others	Setting > End

Relationship between the internal and external torque limit



Cautions

</P-TL> and </N-TL> are sequence input signals. To use </P-TL> and </N-TL> functions, allocate </P-TL> and </N-TL> signals by referring to the sequence input/output signal in the 5-1 page "Sequence I/O (Input/Output) Signal".

External limit of positive torque uses </P-TL> signal and that of negative torque uses </N-TL> signal.

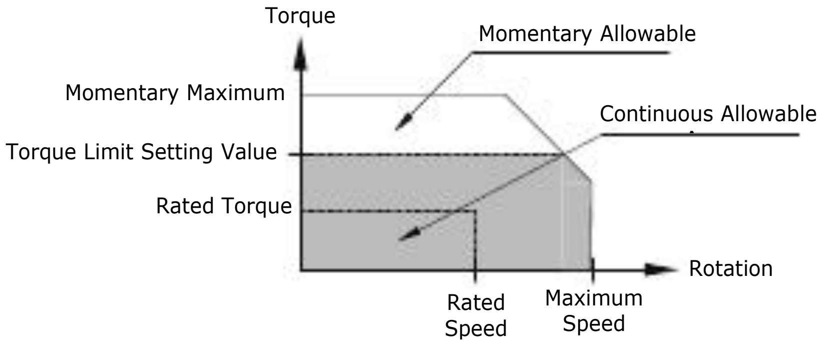
Torque limit by internal limit [Ft-4.07] and [Ft-4.08] are prior to external torque limit </P-TL> and </N-TL> signal.

More Explanation

Internal limit is used to limit maximum value of operation torque of motor (or output torque) within set range to protect the load system or the object on work.

Generally, the allowable torque limit of motor is as shown in the figure below.

Therefore, torque limit in the speed over rated speed is achieved within the momentary operation range as shown in the figure. In high speed range, torque limit according to current motor speed is automatically processed inside Servo drive. If the values of [Ft-4.07] and [Ft-4.08] are set as shown in the following figure, torque of motor is limited as the lined area in the figure.



NOTE	Depending on the motor type, there is a maximum instantaneous torque that is less than 300 [%]. If you set [Ft-4.07] and [Ft-4.08] to the value over maximum torque that motor allows, it is limited to maximum torque value as ignoring setting value.

Torque Limit when Over Travel Occurs

When over travel occurs except external and internal torque limits described above, you can limit torque as setting separate parameter.

For over travel, refer to the 7-2 page “OverTravel <P-OT>, <N-OT>”.

Set torque limit value when over travel occurs to the following parameter. Same setting value is applied both to positive and negative torque as being different from the internal and external torque limits.

Table 5.34

Parameter (Ft-4.11)	Ft-4.11
Parameter Name	Rotation Prohibition Torque Limit <P-OT>, <N-OT>
Description	Both forward and reverse rotation are limited by the same setting value.
Setting Value	0~500
Initial Value	350
Unit	%
Applicable Mode	All
Others	Setting > End

NOTE	Internal torque limit is always valid. So if setting values of external torque limit and rotation prohibition torque limit are bigger than the setting value of internal torque limit, setting value of external torque limit and rotation prohibition torque is meaningless. So be careful of setting.

Torque Limit Detection </T-LMT> Output

As described before, torque that is added to motor can be limited by various setting. The state that torque is limited by setting value can be generated to host controller by sequence output. That output is torque limit detection </T-LMT> signal.

</T-LMT> is sequence output signal. To use </T-LMT> function, allocate </T-LMT> signal with reference to sequence input/output signal in the 5-1 page “Sequence I/O Input/Output) Signal”.

Torque limit detection </T-LMT> output is ON when satisfying the following conditions.

Servo Motor Torque	≥	Internal Torque Limit ; [Ft-4.07], [Ft-4.08] External Torque Limit ; [Ft-4.09], [Ft-4.10] Revolution Disable Torque Limit ; [Ft-4.11]	→	/T-LMT Output

NOTE

Internal and external torque limits can be set separately when the rotation direction of the motor is forward and reverse.

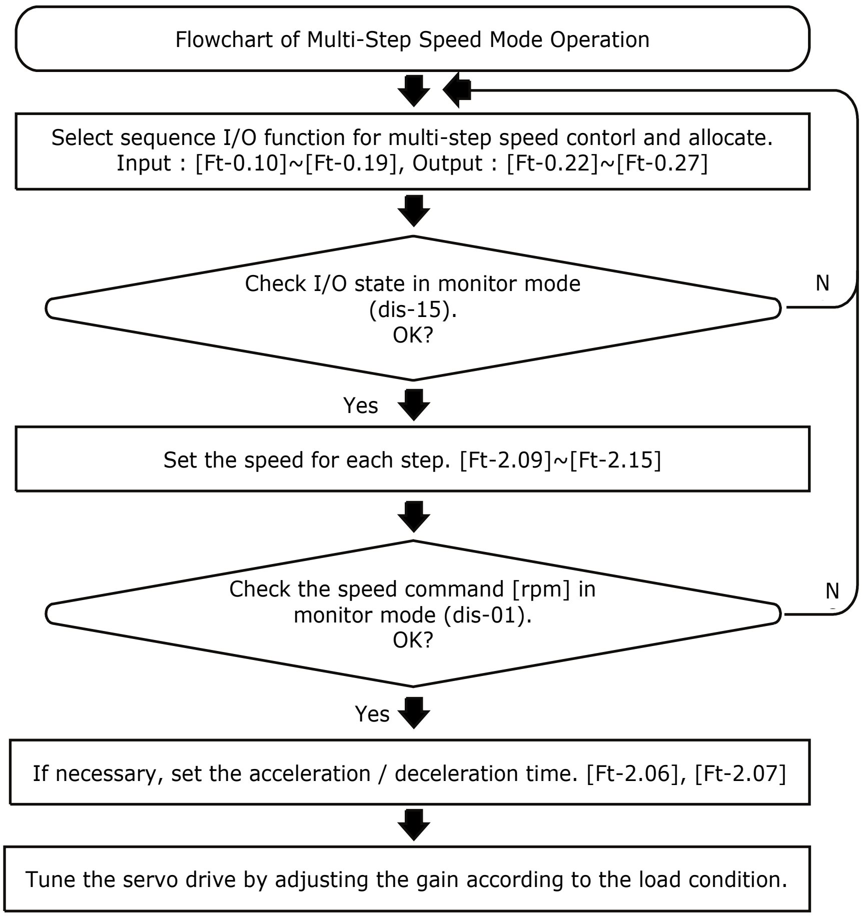
However, for torque limit by over travel </P-OT> and </N-OT> signal input, torque is limited by one setting value of rotation prohibition torque limit [Ft-4.11] regardless of rotation direction of motor.

Multi-Step Speed Mode

Overview

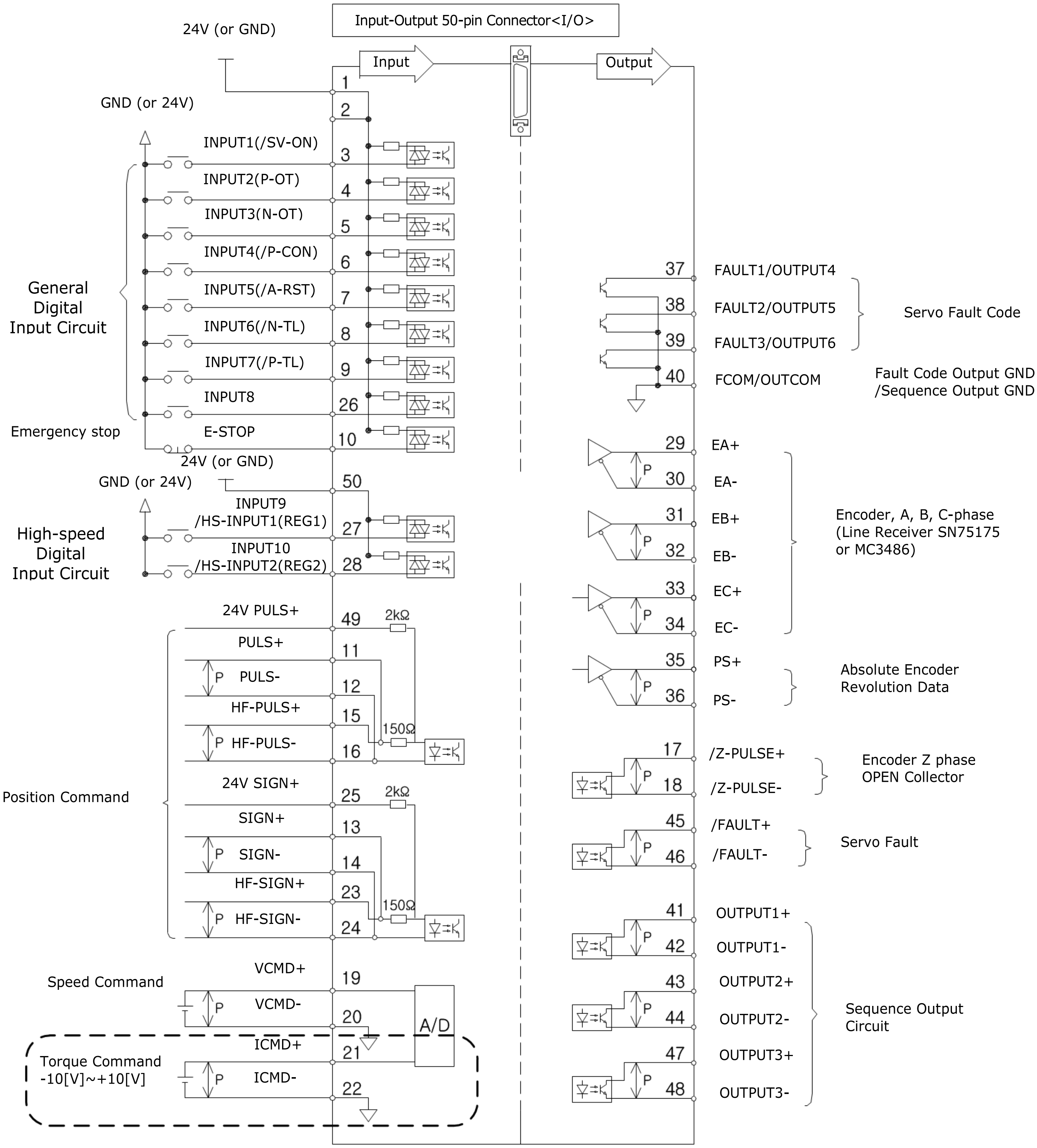
Multi-step speed mode is one of velocity control method. It is to operate according to sequence input after setting operation speed in advance by parameter setting. It does not require separate speed command input or offset adjustment because it operates only with parameter and sequence input.

To operate servo drive as multi-step control mode, set the required process as follows.



Standard Wiring Example

The following figure illustrates the standard wiring example of multi-step speed control mode. The sequence input/output signal can be set according to needs if it is necessary for the system configuration.



NOTE	Whether to use the emergency stop input can be set by the parameter ([Ft-0.05][D3] = 0) ; the initial value is set as not to use.

Multi-Step Speed Command Setting

Multi-step speed control mode does not have external signal input pin for each control mode unlike position, speed and torque control mode and can be operated only by sequence input. Therefore, sequence input signal has input signal that is exclusive for multi-step control mode and exclusive input signals are as follows.

- /C-DIR (Multi-step Speed Direction)
- /C-SP1 (Multi-step Speed Command 1)
- /C-SP2 (Multi-step Speed Command 2)
- /C-SP3 (Multi-step Speed Command 3)
- /C-SP4 (Multi-step Speed Command 4, Analog velocity command selection)

</C-DIR>

It is input signal to determine rotation direction of motor. If </C-DIR> signal is OFF, motor rotates forward, and if it is ON, motor rotates reverse.

Table 5.35 </C-DIR> Signal to Determine Rotation Direction of Motor

	</C-DIR> Signal		Motor Rotation Direction
1	OFF	0	Forward Rotation
2	ON	1	Reverse Rotation

</C-SP1>, </C-SP2>, </C-SP3>

3 kinds of input signal can make 8 kinds of number and each number can set the rotation speed. In addition, parameter to set speed for each number is already designated. Refer to the following table.

Table 5.36 Rotation Speed According to </C-SP1>, </C-SP2>, </C-SP3> Signal

Multi-step speed	Speed Setting Parameter	Initial Value (rpm)	</C-SP3>	</C-SP2>	</C-SP1>
Stop Command	0 (rpm)		0	0	0
Speed Command 1 (Ft-2.09)	Ft-2.09	0000	0	0	1
Speed Command 2 (Ft-2.10)	Ft-2.10	0000	0	1	0
Speed Command 3 (Ft-2.11)	Ft-2.11	0000	0	1	1
Speed Command 4 (Ft-2.12)	Ft-2.12	0000	1	0	0
Speed Command 5 (Ft-2.13)	Ft-2.13	0000	1	0	1
Speed Command 6 (Ft-2.14)	Ft-2.14	0000	1	1	0
Speed Command 7 (Ft-2.15)	Ft-2.15	0000	1	1	1

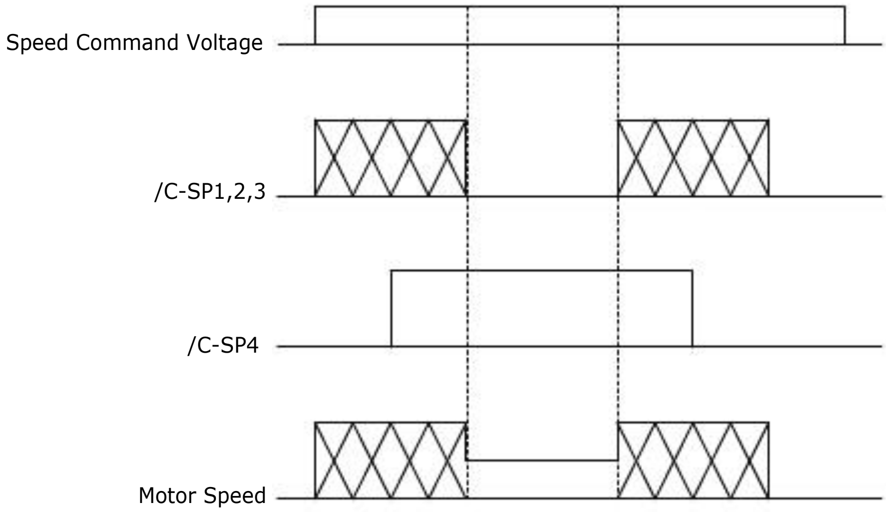
Table 5.37 </C-SP1>, </C-SP2>, </C-SP3> Parameter Data

Setting Value	-6000~6000
Initial Value	0
Unit	rpm
Applicable Mode	P (Multi-step speed mode)
Others	Setting > End

You can control the rotation direction of motor differently to forward and reverse as approving </C-DIR> sequence input for each speed that is designated to each speed parameter.

</C-SP4>

In Multi-step Speed Mode (Ft-0.00 = C), </C-SP4> can be used to change the motor speed using analog speed input voltage without changing the control mode. When </C-SP4> is ON and <C-SP1>, <C-SP2>, and <C-SP3> are all OFF, the motor speed is controlled by analog speed input. The </Z-CLP> input and zero clamp function are all available. If the </C-SP4> input is ON and any one of <C-SP1>, <C-SP2>, and <C-SP3> inputs is ON at the same time, the motor speed is controlled by the corresponding contact inputs.



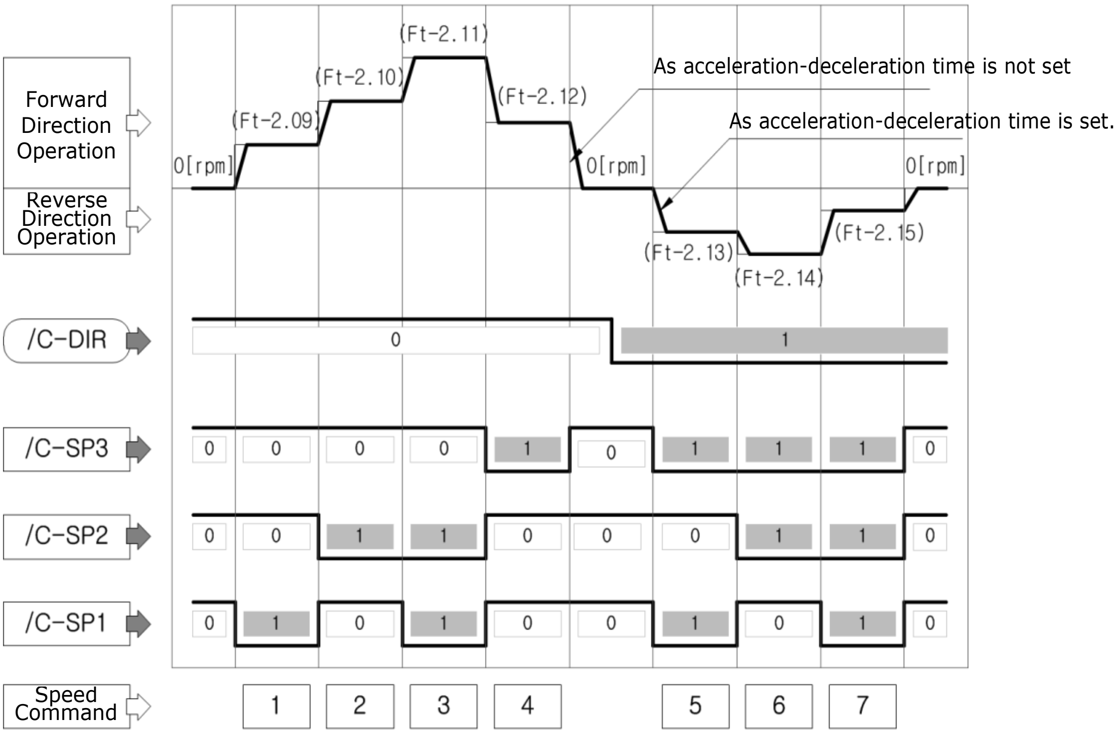
To use sequence input signal </C-DIR>, </C-SP1>, </C-SP2>, </C-SP3>, or </C-SP4> function, allocate signal with reference to sequence input/output signal in the 5-1 page "Sequence I/O (Input/Output) Signal".

NOTE

- If you do not change the rotation direction, you do not need to use </C-DIR> input.
- In addition, you do not need to use all </C-SP1>, </C-SP2> and </C-SP3>, and can adjust change level using only </C-SP1> or both </C-SP1> and </C-SP2> according to your needs.
- If you set up 'b' when you allocate sequence input signal as described in sequence input/output signal in the 5-1 page "Sequence I/O (Input/Output) Signal".
- The setting value 'b', as shown in "Input Signal Allocation Method" in the 5-6 page, cannot apply to </C-DIR>, </C-SP1>, </C-SP2>, </C-SP3> and </C-SP4>.
- </START> input can be used.

Multi-step Speed Mode

The following figure is to help you understand motor operation according to sequence input signal in multi-step control mode.



NOTE	• Set sufficient acceleration/deceleration time within the limit that does not disturb the response performance of the system in order to alleviate the impact when the speed is changed. • For acceleration/deceleration time setting, refer to the 7-15 page “Setting for Smooth Operation”.

Mixed Control Mode and </C-SEL> Function

Position control mode, Velocity Control Mode, torque control mode and multi-step speed control mode described are called the basic control modes. The servo drive provides combinational control mode function to combine basic control modes to meet the user's condition.

Combinational control mode uses two basic control modes.

Setting of Combinational Control Mode

Set combinational control mode to meet your condition with reference to the 4-13 page "Control Mode Setting".

Convert Two Control Modes by Sequence Input </C-SEL> Signal.

</C-SEL> is sequence input signal. To use </C-SEL> function, allocate </C-SEL> signal with reference to sequence input/output signal in the 5-1 page "Sequence I/O (Input/Output) Signal".

If you set combinational control mode, you should use sequence input </C-SEL>. When you use combinational control mode, control mode is determined by </C-SEL> input signal. The following table is the relationship between </C-SEL> input signal and control mode conversion.

Table 5.38 Relationship Between </C-SEL> Input Signal and Control Mode Conversion

Mixed Control Mode Set in [Ft-0.00]		Control Mode & Display </C-SEL> = OFF	</C-SEL> = ON
SF	Speed-Position	SF	SF
CS	Torque-Speed	CS	CS
CF	Torque-Position	CF	CF
PF	Multi-Step Speed+Position	PF	PF
PS	Multi-Step Speed+Speed	PS	PS
PC	Multi-Step Speed+Torque	PC	PC

Each basic control mode is already described before. If Servo is ON, the current control mode is flashed and if the control mode is converted by </C-SEL> signal, the alphabet of the control mode is flashed.

</C-SEL> is sequence input that is used only for combinational control mode. If you set combinational control mode in [Ft-0.00] and do not allocate </C-SEL> to sequence input, Servo drive indicate Servo warning "PIN" in state indication mode.

Precautions

Caution is needed when changing the control mode in the combination control mode.

If the control mode is changed by solely using the </C-SEL> signal in the combination control mode, the operation of the servo drive can become unstable or the load can be damaged under certain circumstances.

While programming a higher control device, be sure to change the control mode using </C-SEL> input signal after the sequence input/output conditions are properly met as the table below.

Table 5.39 Condition for Control Mode Convention

Current Control Mode	Condition for Control Mode Convention
Position Control Mode	1. </P-COM> Output = ON
Velocity Control Mode	1. < /V-COM> Output = ON 2. </TG-ON> Output = OFF
Torque Control Mode	1. </TG-ON> Output = OFF
Multi-step Speed Mode	1. </C-SP1>~</C-SP3> Input = All OFF 2. </TG-ON> Output = OFF

As described before, mixed control mode uses two basic control modes. If you use two-control mode and one mode is working, other control mode input is ignored.

For example, when the Velocity Control Mode is used, position command pulse or analog torque command is ignored and only when the control mode is converted by </C-SEL> signal, the related input will be valid.

NOTE

Some parameter functions are valid in special control mode.

For example, acceleration/deceleration time setting [Ft-2.06] and [Ft-2.07], S-Curve Operation time setting [Ft-2.08] are valid in Velocity Control Mode but invalid in position or torque control mode.

Be careful when converting the control mode.

Tuning by Gain Setting

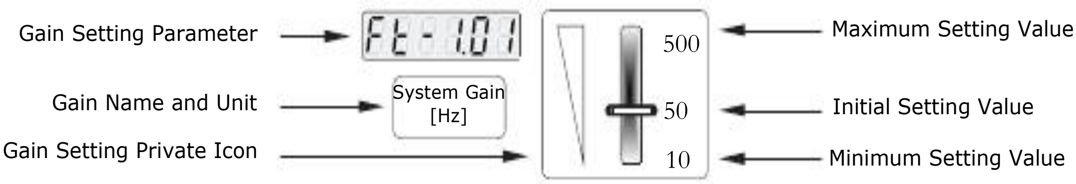
This chapter explains the servo drive setting that can achieve its optimum performance to satisfy different load system as controlling servo motor.

Before You Begin

Mark Description

The following icon is used for tuning.

<Tuning Icon>



Gain Introduction

As the audio system has equalizer to adjust the audio quality, the drive also requires adjustment to achieve the optimum performance for each load. Equalizer adjustment is not essential for the audio system, but the adjustment is important fact that is directly connected to performance for servo drive.

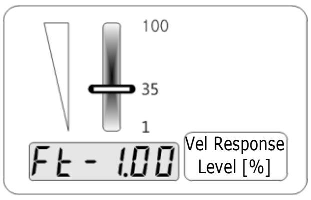
You should adjust servo drive to satisfy load condition in order to achieve optimum performance for each control.

In addition, the adjustment made to the motor that is connected to drive, to achieve the optimum performance through gain setting, is called Tuning.

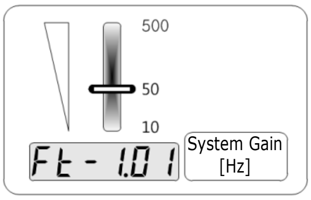
Servo Drive Gain

What kind of drive gains are there that acts like equalizers of audio system? Parameter group 1 has gain setting parameter for tuning and it is classified as follows.

Velocity Response Level



System Gain



System Gain[Hz] = Maximum bandwidth[Hz] x Velocity Response Level[%]

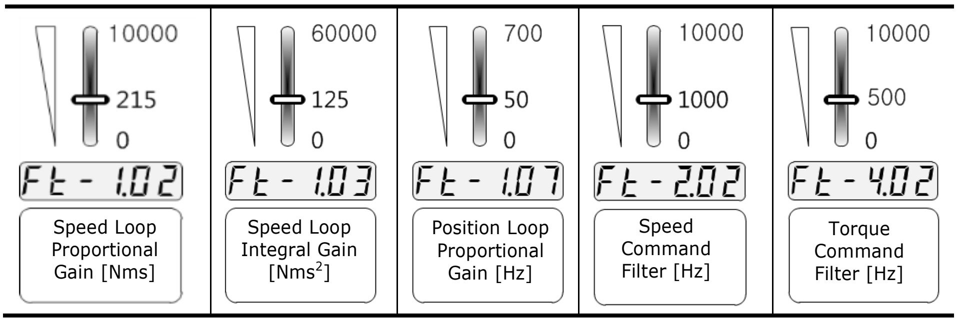
(Maximum bandwidth is decided depend on Ft-0.04)

It is the same as the Bandwidth of overall velocity control loop of the servo drive.

It can adjust five basic gains at the same time.

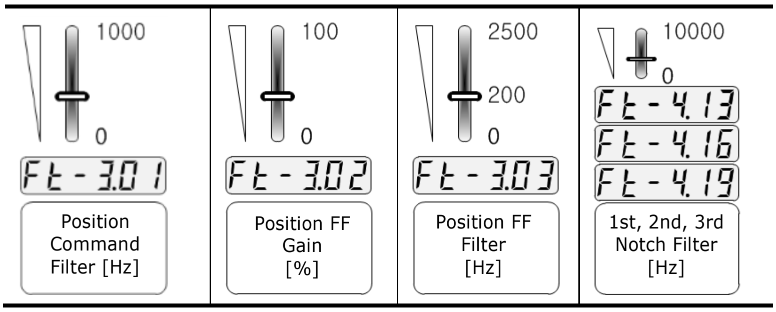
Basic Gain

They are five fundamental gains for tuning.



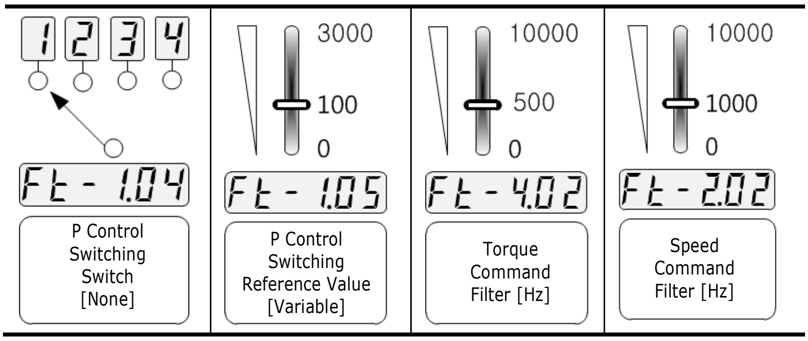
Applicable Gain

They are four gains that with separate functions.


1000
0
Ft-3.01
Position Command Filter [Hz]
100
0
Ft-3.02
Position FF Gain [%]
2500
200
0
Ft-3.03
Position FF Filter [Hz]
10000
0
Ft-4.13
Ft-4.16
Ft-4.19
1st, 2nd, 3rd Notch Filter [Hz]

Others

They are four parameters with supplementary function that is required for tuning.



As mentioned above, gains in parameter group 1 and 13 parameters related to gain are explained and the details are explained hereinafter.

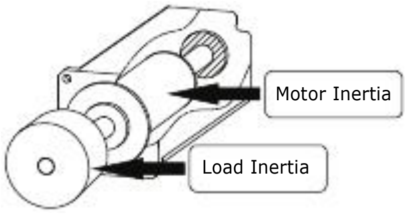
Parameter That is Most Important for Tuning, Inertia Ratio

The parameter that is considered to make motor, that is connected to servo drive achieve the optimum performance in tuning, is the inertia ratio setting parameter. First of all, you should understand that inertia ratio and gain settings are interlocked, and refer to the explanation hereinafter.

Inertia Ratio

What is Inertia Ratio?

The following figure explains the inertia ratio.



It shows the ratio of load inertia compared to the motor (rotor) inertia.

If the motor (rotor) inertia is 3 [gfcms²] and the load inertia is 30 [gfcms²], the inertia ratio is 10 [times]. For the motor inertia table, refer to the motor specification in the appendix.

Setting Unit

Setting value of Inertia Ratio uses the unit, [times]. For example, if the motor inertia is same as the load inertia, the Inertia Ratio is 1 [time] and the setting value is 1.00.

The setting value of the Inertia Ratio is determined by the following formula.

$$\text{Inertia Ratio [times]} = \frac{\text{Load Inertia}}{\text{Motor Rotor Inertia}}$$

Setting Parameter

Set the Inertia Ratio to the following parameter.

Table 6.1

Parameter (Ft-0.04)	
Parameter Name	Inertia Ratio
Descirption	• If the inertia ratio is know, you can set the value directly, but usually it is measured automatically through offline auto tuning. (See "Off-line Auto Tuning Operation (run-01)" on page 7-37.) • If the inertia ratio is changed by auto tuning or manually, the proper system gain (Ft-1.01) is set, and the 5 basic gains [Ft-1.02], [Ft-1.03], [Ft-1.07], [Ft-2.02] and [Ft-4.02] are also changed automatically accordingly.
Setting Value	0.00 to 60.00
Initial Value	1.00
Unit	Times
Applicable Mode	All
Others	Setting > End

IMPORTANT Based on the motor type and the rated output, the maximum allowed inertia ratio is as below. When the allowed inertia ratio exceeds the maximum, you cannot expect a fast response.

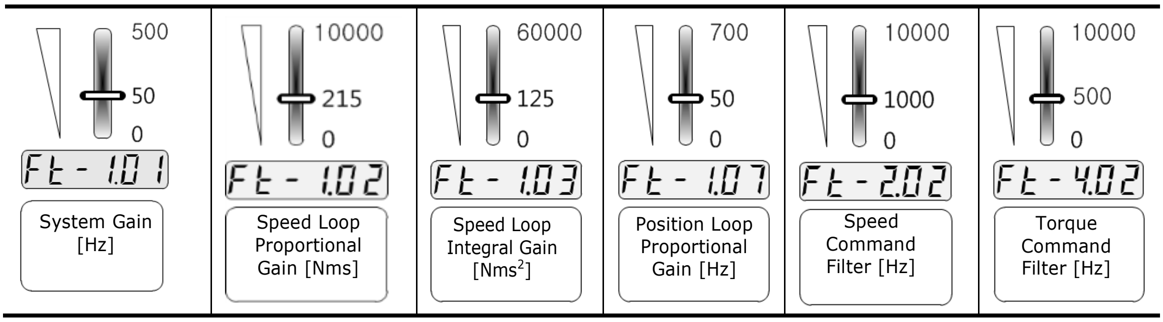
Table 6.2

Motor	Capacity	Maximum Allowble Inertia Rotation
CSMT/R	less 100 [W]	30[Times]
	less 1 [kW]	20[Times]
	1 [kW]	10[Times]

Inertia Ratio and Gain

If the Inertia Ratio is adjusted by certain reason, it automatically changes the following system gain and five basic gains at the same time with the adjustment. Therefore, the Inertia Ratio setting means gain setting, so that you should be careful when adjusting or setting the Inertia Ratio.

System gain and five basic gains that are changed according to the adjustment of Inertia Ratio.



Gain Setting Configuration

This chapter explains the overall configuration (Position, Speed, and Torque) related to the gain setting.

The following diagram will help you understand the gain configuration related to position, speed and torque.

Table 6.3

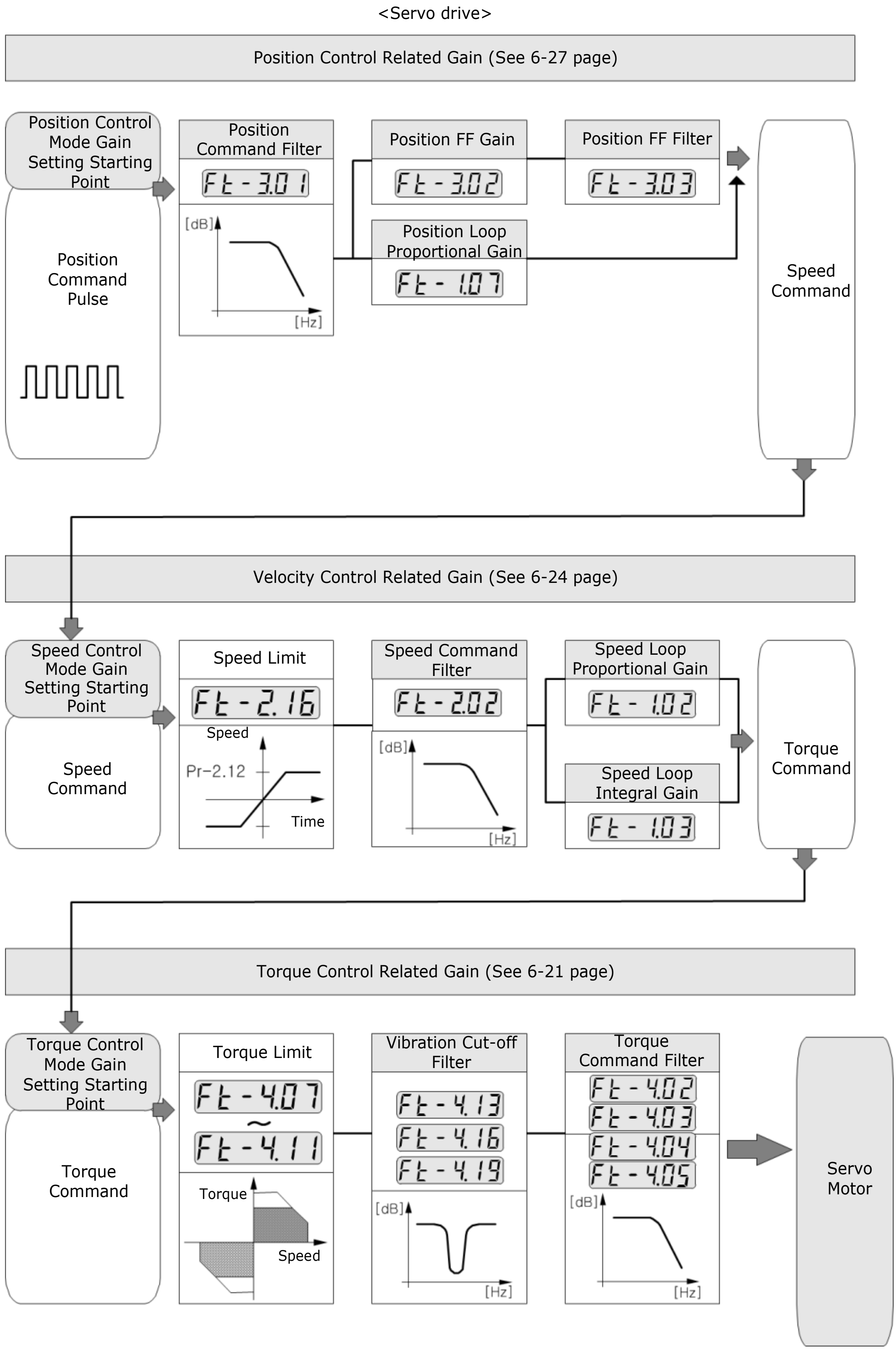
Starting point for position mode gain setting	Position mode using the position pulse command of host controller includes all gains related to speed and torque from starting point to the servo motor as shown in the figure below. Servo drive first generates the speed command using the position command of the host controller, speed command generates the torque command and finally, it transfers the torque command to the servo motor. Therefore, when you use the position mode, the gain can be set properly. If gain related to position control is set properly but the gain related to torque or speed is not set properly, the optimum tuning cannot be achieved.
Starting point for speed mode gain setting	Speed mode using speed command of the host controller includes all gains related to torque from starting point to the servo motor as shown in the figure below. Servo drive first generates torque command using speed command of the host controller and finally, it transfers the torque command to the servo motor. Therefore, when you use the speed mode, the gains related to speed and torque can be set properly. If gain related to velocity control is set properly but gain related to torque is not set properly, the optimum tuning cannot be achieved.
Starting point for torque mode gain setting	Torque mode using torque command of host controller includes all gains related to torque from starting point to servo motor as shown in the figure below. You can adjust gains related to torque in torque mode.

NOTE

If gains related to position are set in the condition that response quality is not sufficiently guaranteed through gain settings related to velocity control, system becomes unstable. Therefore, firstly you should sufficiently secure the response quality of velocity control loop to make the response quality of whole position control system good.

For speed limit details, refer to the 7-18 page “Speed Limiting Function”.

For torque details, refer to the 5-42 page “Torque Control Mode”.


<Servo drive>
Position Control Related Gain (See 6-27 page)
Position Control Mode Gain Setting Starting Point
Position Command Pulse
Position Command Filter
Ft-3.01
[dB]
[Hz]
Position FF Gain
Ft-3.02
Position FF Filter
Ft-3.03
Position Loop Proportional Gain
Ft-1.07
Speed Command
Velocity Control Related Gain (See 6-24 page)
Speed Control Mode Gain Setting Starting Point
Speed Command
Speed Limit
Ft-2.16
Speed
Pr-2.12
Time
Speed Command Filter
Ft-2.02
[dB]
[Hz]
Speed Loop Proportional Gain
Ft-1.02
Speed Loop Integral Gain
Ft-1.03
Torque Command
Torque Control Related Gain (See 6-21 page)
Torque Control Mode Gain Setting Starting Point
Torque Command
Torque Limit
Ft-4.07
~
Ft-4.11
Torque
Speed
Vibration Cut-off Filter
Ft-4.13
Ft-4.16
Ft-4.19
[dB]
[Hz]
Torque Command Filter
Ft-4.02
Ft-4.03
Ft-4.04
Ft-4.05
[dB]
[Hz]
Servo Motor

Auto Gain Setting

Auto Tuning

There are two functions, which automatically detects the load status inside servo drive.

- Off-line auto-tuning
- ANF(Adaptive Notch Filter) Function

Off-line Auto Tuning

Tuning Function

System gain(Ft-1.01) and five basic gains are automatically set based on the calculated inetia ratio(Ft-0.04) after off-line auto tuning.

Tuning Mode

There are inertial identification mode, inertia identification and resonance frequency detection mode, and resonance frequency detection mode.

The tuning mode determins the operation mode of run-01 is set by the Auto tuning Mode Setting [Ft-0.03][D0]. When Off-Line Auto Tuning Mode Setting [Ft-0.03][DO] = 2 (Resonance Frequency Detection). This is a function that looks for only the resonance frequency of the system in a stationary position unlike the inertia moment identification function. This function is for the users who are interested in finding only the resonance frequency, unlike [Ft-0.03][D0] = 1(inertia identification and resonance frequency detection). However, as this function also requires the system's inertia for an accurate operation, it can be useful when the vibration suppression filter needs to be corrected once more by feeling the vibration after performing [Ft-0.03] [D0]= 0 (inertia moment identification) or [Ft-0.03][D0]= 1 (inertia moment identification and resonance frequency detection).

Operation (Tuning) Method

For Operation method for off-line auto tuning, refer to Off-line Auto Tuning Operation (run-01) on page 7-37 "Off-line Auto Tuning Operation (run-01)".

Speed Response Level [Ft-1.00]

The actually available maximum bandwidth is determined based on the inertia ratio measured by auto tuning (run-01), and it is used to set the system gain [Ft-1.01] automatically. That is, the maximum bandwidth is determined based on the calculated inertia ratio [Ft-0.04] after tuning; and the system gain [Ft-1.01] to be actually used is set by the user-defined [Ft-1.00] value.

System Gain (Ft-1.01) [Hz]

= Max. Bandwidth [Hz] * Speed Response Level (Ft-1.00) [%]

Table 6.4

Parameter (Ft-1.00)	
Parameter Name	Speed response level
Description	Define the reflection ratio of the maximum bandwidth recommended by the drive on the basis of the inertia ratio measured after auto tuning.
Setting Value	1 to 100
Initial Value	35
Unit	%
Applicable Mode	All
Others	Setting > End

This parameter is to define the reflection ratio of the maximum system gain recommended by the drive after performing the "inertial identification" or "inertia identification and resonance frequency measurement" as defined in [Ft-0.03][D0]. For example, if the "maximum bandwidth" of a system after auto tuning is "200Hz", the system gain [Ft-1.01] is defined to be 70 Hz per initial value (35%) of Ft-[1.00].

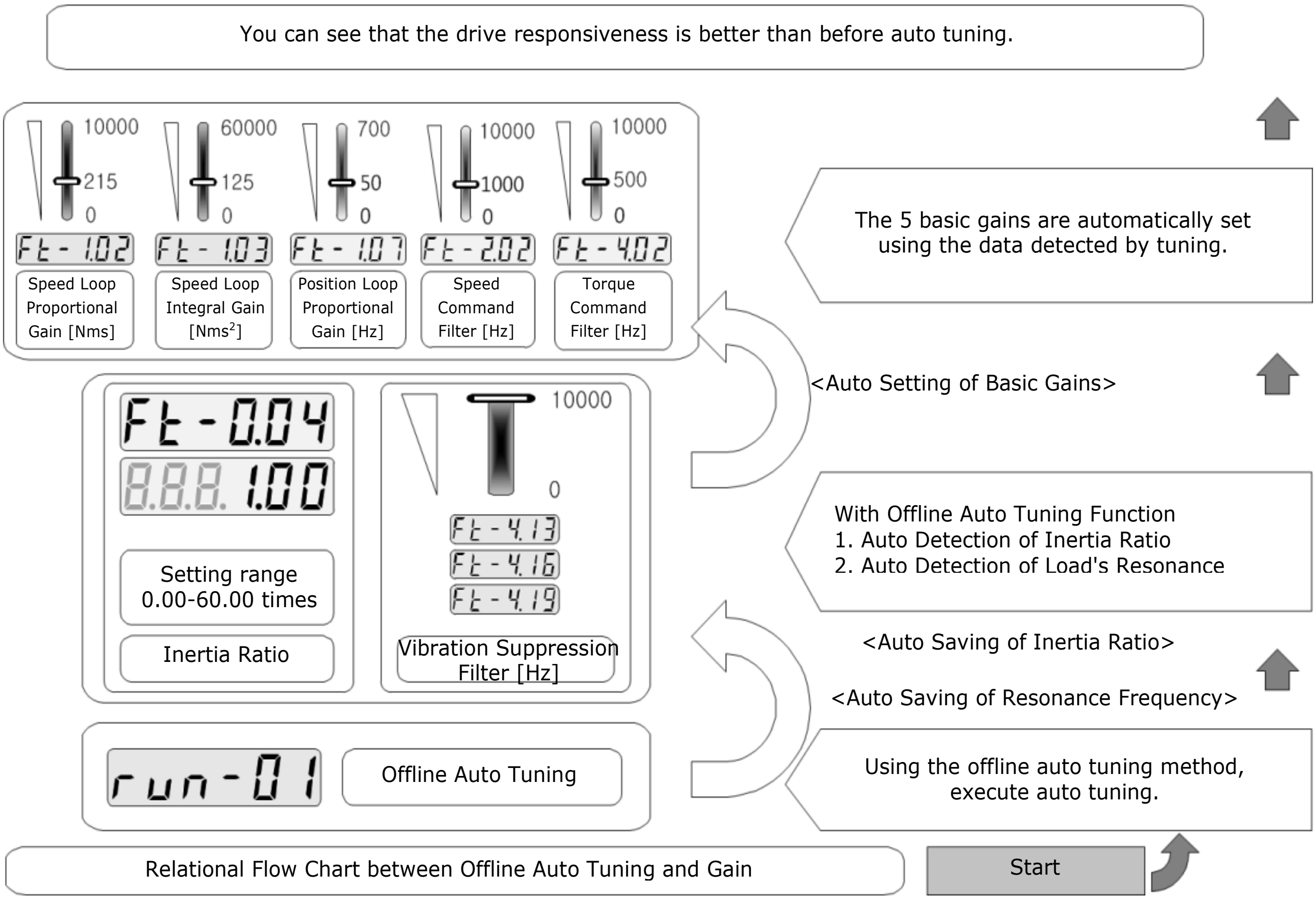
As the "maximum bandwidth" is based on the estimated inertia ratio, it is not always available, but determined depending on the system features.

Therefore, the initial value of the speed response level [Ft-1.00] is set to 35%; and when this value is modified, the values of the system gain and five basic gains are set by proper values automatically.

Explanation of the Relationship Flow between Off-line Auto Tuning and Gain

When you run off-line auto tuning, drive automatically Inertia Ratio [Ft-0.04] of load system and automatically set system gain and five basic gains as being suitable for Inertia Ratio. Therefore, it is recognized that the response quality of servomotor is improved at the same time.

In addition, load system sometimes does resonant (vibration) in the specific frequency range because of vibration noise. For those situations, it intercepts vibration of load system using resonant frequency that is automatically detected by auto tuning. Resonant frequency of load system becomes the setting value for resonance suppression filter [Ft-4.13], [Ft-4.16] and [Ft-4.19] and if you know the exact resonant frequency of the load, you can set it directly.



NOTE

- Only as operating off-line auto tuning, you can prevent vibration and noise caused by resonant frequency of the system, because basic five gains and resonance suppression filters are automatically set by auto-tuning.
- In case of [Ft-0.03][D0]=1, off-line auto tuning automatically sets Inertia Ratio [Ft-0.04] and resonant suppression filter [Ft-4.13], [Ft-4.16] and [Ft-4.19], but when you know exactly each value, you can directly set.
- However, if the value set directly is not accurate, the response quality is degraded and becomes the reason of resonant noise. Therefore, be careful when setting it directly.

ANF (Adaptive Notch Filter) function

Overview

CSD7 provides two methods of removing resonance as follows:

- RFD (Resonant Frequency Detection) : The resonance frequency is identified by the frequency obtained during off-line tuning as described in the previous page. ([Ft-0.03][D0] = set to 1 or 2)
- ANF (Adaptive Notch Filter): This is the method to remove resonance from the equipment by setting the resonance frequency through detecting the resonance point in real time when resonance occurs during operation.

How to Use ANF

You can use the ANF function in the steps below.

- Apply power to the servo drive, and prepare the general conditions for such operation.
- Find the inertia ration suitable for the external load connected to the servo motor by performing the offline auto tuning. (As soon as the inertia ratio is found, the system gain, speed proportional gain, speed integral gain, position proportional gain, torque command filter value, etc. are set automatically.)
- Here, if the offline auto tuning mode is set to the default setting Inertia Moment Estimation and Resonant Frequency Detection (for built-in, set to [Ft-0.03][D0]=1), the resonance frequency is also found together with the inertia ratio to set the resonance frequency automatically.

	Autotuning		
0.03 D2	Off-Line Auto Tuning Speed	700	RPM
0.03 D0	Off-Line Auto Tuning Mode	Inertia Moment Estimation and Resonant Frequency Detection	

- As shown below, there may be the resonance frequency value which is found after performing offline auto tuning.

	Main Current Regulator Gains		
4.06	Main Current Regulator Gain	Medium	
4.02	1st Current Command LPF Bandwidth	700	Hz
4.13	1st Resonant Frequency Suppression Filter	765	Hz
4.14	1st Resonant Frequency Suppression Filter Wid	10	
4.15	1st Resonant Frequency Suppression Filter De	100	
4.16	2nd Resonant Frequency Suppression Filter	10000	Hz
4.17	2nd Resonant Frequency Suppression Filter Wi	10	
4.18	2nd Resonant Frequency Suppression Filter De	100	
4.19	3rd Resonant Frequency Suppression Filter	10000	Hz
4.20	3rd Resonant Frequency Suppression Filter Wi	10	
4.21	3rd Resonant Frequency Suppression Filter De	100	

- Next, as shown below, set Adaptive Notch Filter(ANF) Enable to 'Enable'. After setting to 'Enable', if resonance occurs during motor operation, the ANF function runs to detect the resonance in real time and set the proper resonance frequency accordingly, thereby removing the resonance.

⊟		**Adaptive Notch Filter(ANF) Setting**	
	4.22 D0	Adaptive Notch Filter(ANF) Enable	Enable
	4.22 D1	ANF HPF Cutoff Frequency Selection	High
	4.22 D2	ANF Estimation Frequency Initial Value Selection	High
	4.22 D3	ANF Detect Level	Middle

- If a fast enough response is not obtained by the gain value from offline auto tuning, you can speed up the response through tuning with increased system gain (One parameter tuning method). As shown below, if the system gain is 70Hz as a result of offline auto tuning, try operation at that value; if vibration or resonance does not occur, increase the system gain to 70Hz → 80Hz → 90Hz → 100Hz, etc. one by one.
- If you increase the system gain incrementally when Adaptive Notch Filter(ANF) Enable functio is set to 'Enable' (e.g., the jog mode operation of RSWare or the operation by position movement command from the host controller), sometimes the device resonance occurs; at this point, you can see that the ANF starts working to update the resonance frequency so as to remove the resonance.

RSWare : Drive - Tuning

Ft Number	Parameter	Value	Units
1.00	Velocity Regulator Response Level	35	%
1.01	System Gain	70	Hz
	Main Velocity Regulator Gains		
1.02	1st Velocity Regulator P Gain	314	
1.03	1st Velocity Regulator I Gain	245	
1.04	Velocity Regulator I Gain Mode	Always On	
1.05	Velocity Regulator I Gain Disable Threshold	100	
1.06	Velocity Regulator D Gain	0	
2.04	Velocity Regulator Kff Gain	0	
2.03	Velocity Error Filter Bandwidth	30	Hz
	Main Position Regulator Gains		
1.07	1st Position Regulator Kp Gain	70	Hz
3.02	Position Regulator Kff Gain	0	%
3.03	Position Regulator Kff LPF Bandwidth	200	Hz
3.01	Position Command LPF Bandwidth	0	Hz
3.04	Moving Average Filter	320	0.125ms
	Main Current Regulator Gains		
4.06	Main Current Regulator Gain	Medium	
4.02	1st Current Command LPF Bandwidth	700	Hz
4.13	1st Resonant Frequency Suppression Filter	765	Hz
4.14	1st Resonant Frequency Suppression Filter Width	10	
4.15	1st Resonant Frequency Suppression Filter Depth	100	
4.16	2nd Resonant Frequency Suppression Filter	10000	Hz
4.17	2nd Resonant Frequency Suppression Filter Width	10	
4.18	2nd Resonant Frequency Suppression Filter Depth	100	
4.19	3rd Resonant Frequency Suppression Filter	10000	Hz
4.20	3rd Resonant Frequency Suppression Filter Width	10	
4.21	3rd Resonant Frequency Suppression Filter Depth	100	
	Autotuning		
0.03 D2	Off-Line Auto Tuning Velocity	700	RPM
0.03 D0	Off-Line Auto Tuning Mode	Inertia Moment Estimation and Resonant Frequency Detection	

RSWare : Drive - Resonant Suppression

	Adaptive Notch Filter(ANF) Setting	
4.22 D0	Adaptive Notch Filter(ANF) Enable	Enable
4.22 D1	ANF HPF Cutoff Frequency Selection	High
4.22 D2	ANF Estimation Frequency Initial Value Selection	High
4.22 D3	ANF Detect Level	Middle

- For the load with many resonance points, everything is updated up to the 3rd resonance frequency sometimes.
- In CSD7, you can set 3 resonance frequencies (1st, 2nd and 3rd). In a rare case where a complex device has 4-5 resonance points, the resonance frequencies which, out of the 4-5 resonance points, have the great impact on the system are set automatically in the order of impact.
- There are three options used to change the conditions of ANF function: ANF HPF Cutoff Frequency Selection, ANF Estimation Frequency Initial Value Selection, and ANF Detect Level.

  A. The ANF HPF Cutoff Frequency Selection is to set the HPF frequency which is used to estimate the resonance frequency; if High is selected, it is internally set to 500Hz; Low to 300Hz. (The default setting is High. Generally, it is recommended to select High for the load (e.g., ball screw load) with high resonance point; and Low for the load (e.g., belt load) with low frequency resonance point under 500Hz.)

B. The ANF Estimation Frequency Initial Value Selection is the initial frequency value for the frequency estimation. As the actual resonance frequency is found by starting from this value, if this initial value is closer to the actual resonance frequency, the resonance frequency can be estimated in a faster way. (The default setting is High. If High is selected, it is internally set to 800Hz; if Low, to 300Hz.) In general, it is recommended for the system with high rigidity such as ball screw has high frequency resonance point to set this value to High; the belt load to Low.)

C. Literally, the ANF Detect Level is the parameter which can be used to detect the level of resonance frequency at AFN. (The default setting is Middle. If it is set to High, the detection level is increased; Low, decreased. Therefore, in most of the systems, the resonance point is found well with Middle setting. If, however, the ANF cannot detect the resonance well even when there exists resonance, set this level to Low and try operation. To the contrary, if the user does not want to update the resonance frequency because resonance does not occur, set this level to High.)

	Adaptive Notch Filter(ANF) Setting	
4.22 D0	Adaptive Notch Filter(ANF) Enable	Enable
4.22 D1	ANF HPF Cutoff Frequency Selection	High
4.22 D2	ANF Estimation Frequency Initial Value Selection	High
4.22 D3	ANF Detect Level	Middle

- The Notch Filter Reset function shown in the figure below can be used to reset (reset the all the 1st - 3rd resonance frequencies to default value 10000) the measured resonance filter value due to any reason.

- The “Notch Filter Reset” above is useful to reset and re-find the resonance frequency found by offline auto tuning only by ANF; or to detect the 1st to 3rd resonance frequency again due to potential change in device resonance features even when the resonance frequency was found by ANF.
- If a satisfactory system gain was set by the procedure above, and the resonance frequency value was updated by the ANF under these conditions, change the Adaptive Notch Filter (ANF) Enable setting to Disable. Of course the ANF can be always on for operation, but it is recommended to set to Disable for safety purpose.

	Adaptive Notch Filter(ANF) Setting	
4.22 D0	Adaptive Notch Filter(ANF) Enable	Disable
4.22 D1	ANF HPF Cutoff Frequency Selection	High
4.22 D2	ANF Estimation Frequency Initial Value Selection	High
4.22 D3	ANF Detect Level	Middle

NOTE

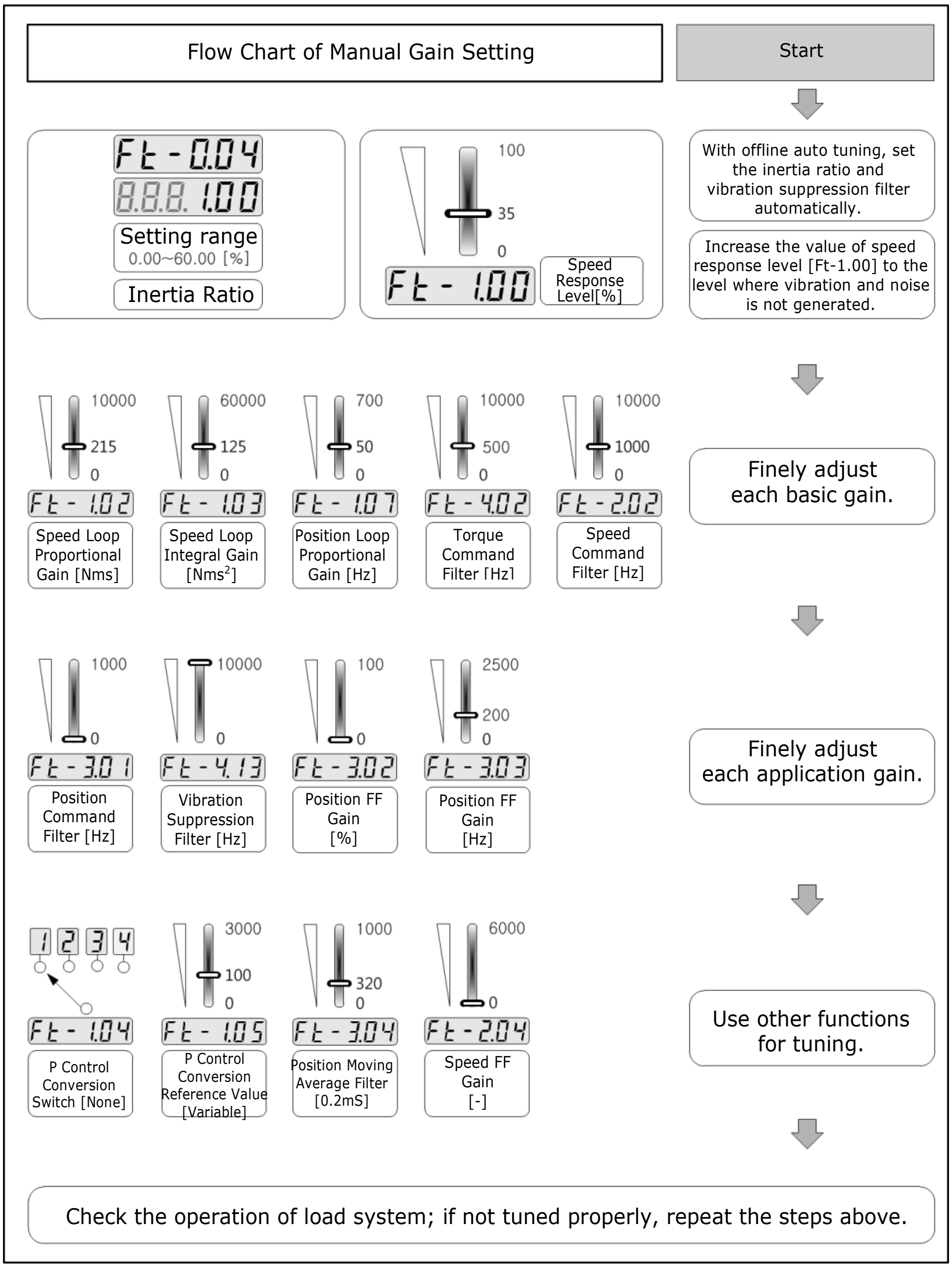
Cautions and Notes When using ANF Function

- When trying to find the resonance frequency using the ANF, do not operate it at excessively low speed with operation RPM below 50 rpm. (If rpm is too low, the ANF may not find the resonance point well.) Excessively high rpm is not desirable, so operation at 200 - 600 rpm is recommended.)
- When finding a resonance frequency using ANF, abrupt acceleration/deceleration should be avoided.
- When, after enabling the ANF, detecting the resonance frequency by increasing the system gain, if you set the torque command filter value to 1000 Hz, you can detect the resonance point even at a lower system gain.
- When the resonance frequency is near to the operation area below 300 Hz and if it is excessively low, such resonance frequency may not be detected well.
- The resonance frequency band which can be detected by the ANF is between 200 Hz and 3 kHz.
- If multiple (3 to 4) resonance points occur simultaneously, the resonance frequency may be detected erroneously.
- If the maximum value of the resonance frequency is low, or the control gain is too low for the resonance to influence the motor speed, the resonance may not be detected well.
- If the motor speed changes due to non-linear factors such backlash including high harmonic content, the resonance may not be detected well.

Manual Gain Setting

Gain Setting Flowchart

The following figure illustrates whole structure and procedure of Manual Gain Setting.



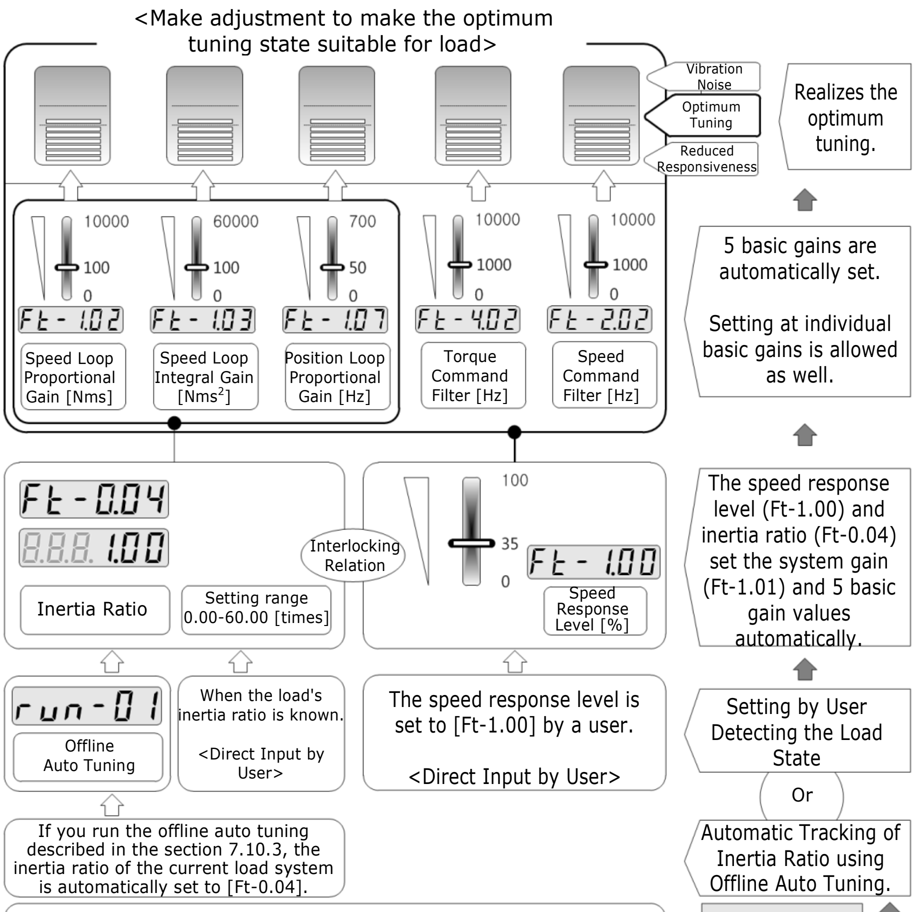
Basic Gain Setting

The following explains five Basic Gain Settings for Tuning.

Speed Response Level (Ft-1.00) Basic Gain Setting by System Gain and Inertia Ratio

- Firstly, execute the Off-line Auto Tuning for automatic setting of Inertia Ratio [Ft-0.04].
- Speed Response Level (Ft-1.00) Set system gain to optimum Tuning level. If vibration noise occurs in load system, reduce tuning level to prevent vibration noise.
- Adjust in each basic gain in detail.
- If the tuning is not sufficient, set again from the Off-line Auto Tuning.

The following figure illustrates the flowchart that Inertia Ratio and Velocity Response Level set the basic gain as being interlocked. Adjust to make the optimum tuning as making Inertia Ratio and Velocity Response Level refer to each other whenever Inertia Ratio is changed or the Velocity Response Level is adjusted.



Basic Gain Setting Flow Chart

If response performance is decreased after Off-line Auto Tuning, increase the value of speed response leve [Ft-1.00], and do Off-line Auto Tuning again. We recommend securing the maximum response quality as increasing the value of speed response level [Ft-1.00] until noise or vibration occurs.

When maximum response quality is guaranteed in the condition that the value of Inertia Ratio [Ft-0.04] is accurately set and there is no vibration noise in load system, (When you set the value of speed response level [Ft-1.00] as high as you can), it becomes bandwidth of whole velocity control loop.

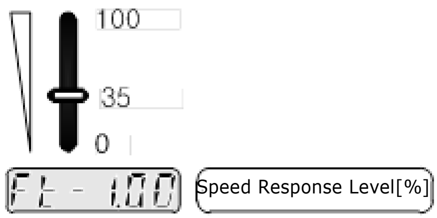
As described above, as exactly set Inertia Ratio [Ft-0.04] and set basic gains using speed response level [Ft-1.00], you can get response quality.

The following table is for Inertia Ratio and system gain setting.

Table 6.5

Parameter (Ft-0.04)	
Parameter Name	Inertia Ratio
Description	A parameter used to set the load inertia ratio for the motor's own inertia. If you change this value, the proper system gain (Ft-1.01) suitable for this inertia ratio is set, and the 5 basic gains [Ft-1.02], [Ft-1.03], [Ft-1.07], [Ft-2.02] and [Ft-4.02] are also changed automatically accordingly.
Setting Value	0.00 to 60.00
Initial Value	1.00
Unit	times
Applicable Mode	All
Others	Setting > End

Table 6.6

Parameter (Ft-1.00)	
Parameter Name	Speed Response Level
Description	The actually available maximum bandwidth is determined based on the inertia ratio (Ft-0.04) measured by auto tuning (run-01); and the system gain (Ft-1.01) is generated by applying the ratio which is set in the speed response level (Ft-1.00). That is, it can be defined by the equation below. Ft-1.01[Hz] = Maximum bandwidth [Hz] specified during auto tuning * Ft-1.00[%] The system gain (Ft-1.01) generated in this way is the bandwidth for the entire velocity control loop; if this value is changed, the 5 basic gains [Ft-1.02], [Ft-1.03], [Ft-1.07], [Ft-2.02] and [Ft-4.02] are changed automatically. If the speed response level (Ft-1.00) is set to higher value, the

	values of the basic gains are increased, and the responsiveness is enhanced. If, however, the value is excessively high when compared to the load condition, it may cause vibration or noise. ※ You may change the 5 basic gains by directly changing the system gain. For system safety, however, it is recommended to change the system gain and basic gains by changing the speed response level (Ft-1.00) parameter.
Applicable Mode	All
Others	Setting > End

For improvement of over response characteristics, we will explain gain setting related to torque, speed and position. Refer to the page 6-22 “Position, Speed, Torque Related Gain Setting”.

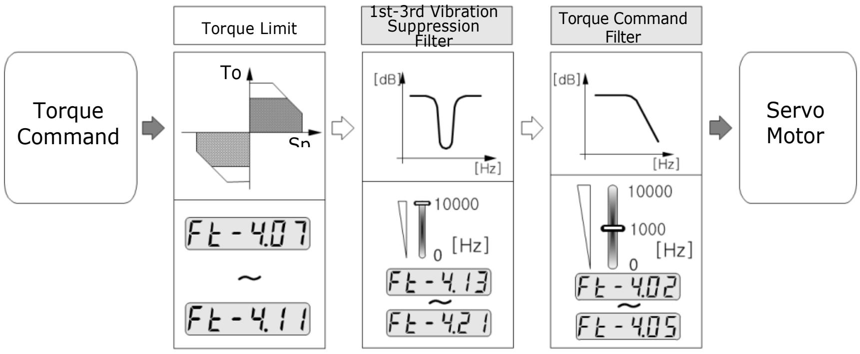
In addition, refer to the page 6-30 “Tip to get fast response” for more explanation about various functions to acquire fast response quality in gain setting.

Position, Speed, Torque Related Gain Setting

Torque Control Related Gain

There are resonance suppression filter and torque command filter gains related to torque related gain. The following figure is related to torque in Gain Setting Diagram.

Torque Control Related Gain



1st-3rd Vibration Suppression Filter

If the vibration suppression filter is used in a ball screw or a belt system, it can suppress the mechanical vibration by decreasing the specific frequency that generates resonance. The frequency, depth, and width of the vibration suppression filter can be adjusted. The vibration suppression filter works the same way as a general notch filter.

The depth and width of the vibration suppression filter is as below

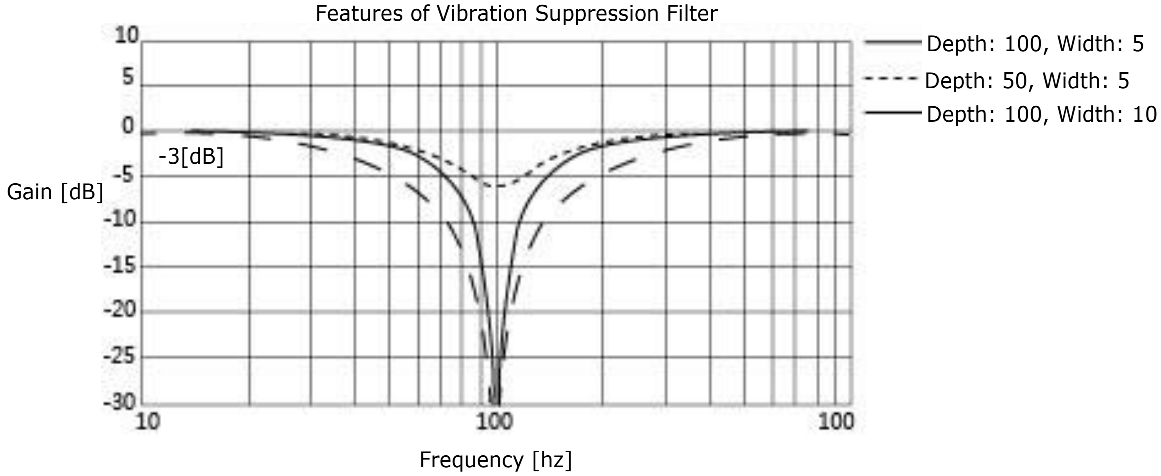
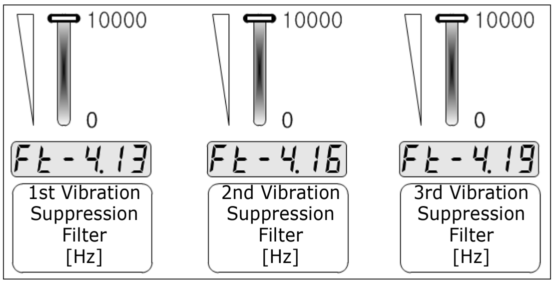


Table 6.7

Parameter	
Parameter Name	1st, 2nd, 3rd Vibration Suppression Filter [Ft-4.13], [Ft-4.16], [Ft-4.19]
Description	The width and depth of the 1st, 2nd and 3rd Resonance Suppression Filter can be set respectively. The width range for the filter is 1 to 20, the depth is 0 to 100. When the load system causes resonance in a specific frequency band, it suppresses the vibration caused by the resonance of the load. If properly set, it allows other gains to be raised, so that the stability and responsiveness of the overall system are improved enormously. But if it is set in a wrong way, it can cause vibration or noise.
Applicable Mode	All
Others	Setting > End

NOTE

Resonance frequency of load= resonance suppression filter [Ft-4.13], [Ft-4.16] and [Ft-4.19].

It is setting value of Resonance Suppression Filter [Ft-4.13], [Ft-4.16] and [Ft-4.19] automatically find out resonance frequency and set the value by itself when you execute Off-line Auto Tuning.

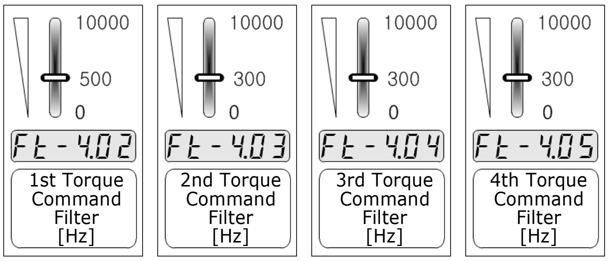
For Off-line Auto Tuning, refer to the 6-10 page Off-line Auto Tuning.

If you know exactly mechanical resonance frequency range of load, you can directly enter the value.

Torque Command Filter

It suppresses high frequency factor that is included in torque command.

Table 6.8

Parameter	
Parameter Name	Torque Command Filter
Description	It suppresses high frequency factor that is included in torque command. It makes torque command itself smooth as suppressing high frequency overset frequency, so it can reduce vibration or noise. The more the value is, the better the response quality is, but if you set too high, vibration can occur. If you reduce this value in the condition that the load rigidity is high, you can suppress oscillation. Do not set too small more than necessary because it is a delay factor. The load system can be unstable.
Applicable Mode	All
Others	Setting > End

If load system uses belt or chain, rigidity is low so that you cannot expect the fast response. In addition, if you excessively increase velocity control or position control related gains, it can be oscillated. For those loads, it is difficult to set the value of torque command filter [Ft-4.02], [Ft-4.03], [Ft-4.04] and [Ft-4.05] within about 100 [Hz].

NOTE

For torque mode that host controller directly approves torque command through I/O of servo drive, you can indirectly adjust gain of whole control loop as adjusting external torque command input gain [Ft-4.00]. That is to say, if you increase [Ft-4.00], it has the same effect as increasing gain. And if you reduce [Ft-4.00], it has the same effect as reducing gain.

For external torque command input gain [Ft-4.00], refer to the "Torque Command Input" on page 5-44.

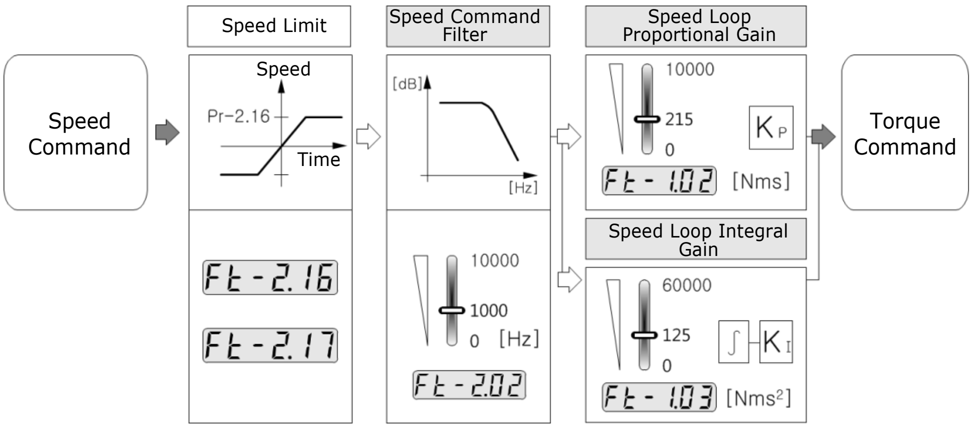
For torque limit, refer to the "Torque Control Mode" on page 5-42.

Velocity Control Related Gain

Speed related gain includes speed command filter, speed loop proportional gain and speed loop integration gain.

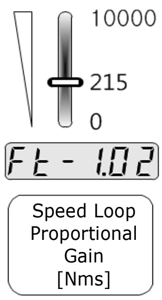
The following figure is related to speed in Gain Setting Diagram.

Velocity Control Related Gain



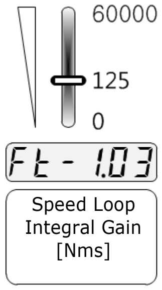
Speed Loop Proportion Gain

Table 6.9

Parameter	
Parameter Name	Speed Loop Proportion Gain
Description	The higher the value is set, the better response of velocity control loop is. Set as high as you can within the limit that vibration does not occur.
Applicable Mode	All
Others	Setting > End

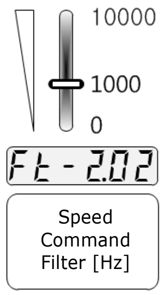
Speed Loop Integration Gain

Table 6.10

Parameter (Ft-1.03)	
Parameter Name	Speed Loop Integration Gain
Description	It is to remove error in normal state as responding to very small input. The higher the value is set, the better response is and completion time is reduced. Set this value to low level in the environment that load inertia is big or vibration can easily occur.
Applicable Mode	All
Others	Setting > End

Speed Command Filter

Table 6.11

Parameter (Ft-2.02)	
Parameter Name	Speed Command Filter
Description	It makes speed command itself smooth as suppressing high frequency that is included in speed command. If this value is ’0’, speed command filter is not used.
Applicable Mode	S (Velocity control mode), P (Multi-step speed mode)
Others	Setting > End

Velocity Control Related Gain Setting Procedure

- Increase speed loop proportional gain [Ft-1.02] to the limit that vibration noise does not occur.
- Confirm [Ft-1.02] as the value of 80 to 90 [%] of maximum setting value.
- Increase speed loop proportional gain [Ft-1.03] as checking over response (overshoot, completion time, whether vibration or noise occurs). If you set it too low, response quality is degraded and if you set too high, vibration or noise can occur. Maximum setting value of [Ft-1.03] is as the following formula.

  [Ft-1.03] ≤ 300 × $[\text{Ft-1.02}]^2$ × Inertia of applied motor

- If position control related gain of host controller is set high more than necessary or in the environment where the noise is too big, reduce the value of speed command filter [Ft-2.02].
- It is better to set the value of torque command filter [Ft-4.02] as long as there is no vibration in load side.
- As repeating over response state, adjust gain in detail.

NOTE

[Value of [Ft-1.02] and [Ft-1.03] is scaled based on inertia value of motor.

Therefore, if Inertia Ratio [Ft-0.04] for 100 [W] motor or 1 [kW] motor is same as 10 [times], the appropriate gain of [Ft-1.02] and [Ft-1.03] becomes the same.

For speed mode that host controller directly approves speed command through I/O of servo drive, you can indirectly adjust gain of whole control loop as adjusting external speed command input ratio [Ft-2.00]. That is to say, if you increase [Ft-2.00], it has the same effect as increasing gain. And if you reduce [Ft-2.00], it has the same effect as reducing gain.

For details about External Speed Command Input Ratio [Ft-2.00], see the "Speed Command Input" on page 5-34.

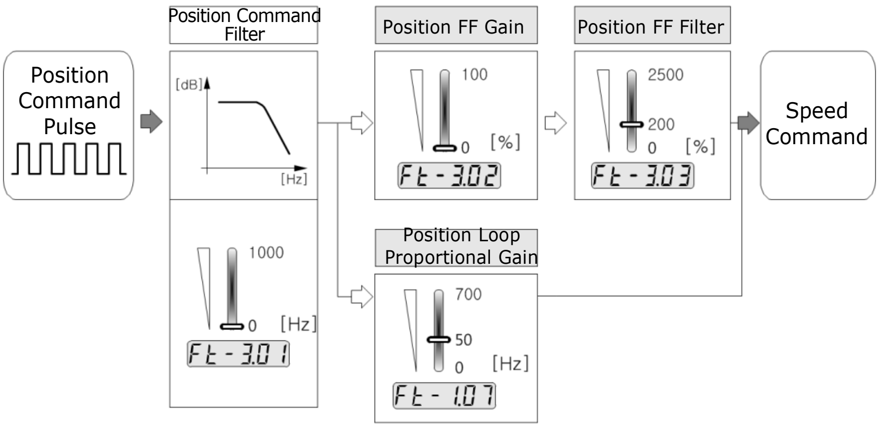
For the description of speed limit, see the "Speed Limit Function" on page 7-18 and "Speed Limiting Function and Speed Limit Detection </V-LMT> Output" on page 5-41.

Position Control Related Gain

Position related gain includes position FF gain, position FF filter and position loop proportional gain.

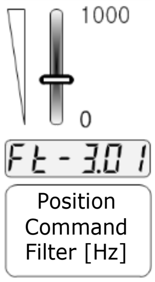
The following figure is related to position in Gain Setting Diagram.

Position Control Related Gain



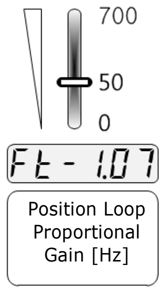
Position Command Filter

Table 6.12

Parameter (Ft-3.01)	
Parameter Name	Position Command Filter
Description	It makes position command itself smooth as suppressing high frequency that is included in position command. If this value is ’0’, position command filter is not used. Max value is ’1000’.
Applicable Mode	F (Position control mode)
Others	Setting > End

Position Command Filter

Table 6.13

Parameter (Ft-1.07)	
Parameter Name	Position Loop Proportion Gain
Description	The higher the value is set, the better position control response is.
Applicable Mode	F (Position control mode)
Others	Setting > End

Position Control Related Gain Setting Procedure

- Increase the value of speed loop proportional gain [Ft-1.02] gradually in the condition while the initial value of position loop proportional gain [Ft-1.07] is set.
- If there is vibration noise in load, reduce the value of [Ft-1.02] as 80 to 90[%] of that moment.
- Increase the value of [Ft-1.07] again up to the level that vibration noise does not occur in over response.
- Increase speed loop integration gain [Ft-1.03] as checking over response (overshoot, completion time, whether vibration or noise occurs). If you set too low, response quality is degraded and if you set too high, vibration or noise can occur. Maximum setting value of [Ft-1.03] is as the following formula.

  $[\text{Ft-1.03}] \leq 300 \times [\text{Ft-1.02}]^2 \times$ Inertia of applied motor (Appendix)

- If necessary, you can suppress the excessive change of position command as reducing the value of position command filter [Ft-3.01].
- It is better to set torque command filter [Ft-4.02] as high as possible until vibration does not occur in load side.
- As repeating over response state, adjust gain in detail.

NOTE	Position FF gain, position FF filter and speed bias function are explained in the 6-32 page “Tip to get fast response”.

Tip to get fast response

Feedforward function

For position feed forward (FF) diagram, refer to the “Position Control Related Gain” on page 6-28. Position FF makes differentiation factor on position command in position control mode approved in speed command through feed forward method. Therefore, over response characteristics is improved so that you can reduce position output time.

The related parameter to set is as follows.

Table 6.14

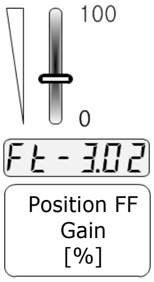
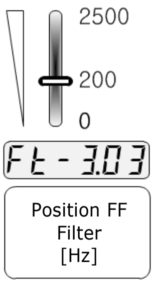
Parameter (Ft-3.02)	
Parameter Name	Position Feed forward Gain
Description	The higher the value is set, the better position control response performance.
Applicable Mode	All
Others	Setting > End

Table 6.15

Parameter (Ft-3.03)	
Parameter Name	Position Feed forward Filter
Description	It makes position command itself smooth as suppressing high frequency that is included in position command. If torque command filter [Ft-3.02] is not ‘0’, it is valid. If this value is ‘0’, position FF filter is not used.
Applicable Mode	F
Others	Setting > End

If you use position FF function, speed command increases or reduces much as responding to increase or reduction of position command. Therefore, if position command is entered as the type to be significantly changed (that is to say, in case of high acceleration or high deceleration), position FF has overshoot.

At this moment, if you want to reduce position output time, find out appropriate value as slowly increasing the value of [Ft-1.07] as checking over response.

In addition, it is good method to suppress high frequency factor of position FF using speed command filter [Ft-2.02] or making position command itself smooth using position command filter [Ft-3.01].

P/PI Mode Setting Function

When you control speed or position, if you set speed loop integration gain [Ft-1.03], it responds to the delicate command so that you can accurately control and make the error in the normal state '0'.

However, if you increase speed loop integration [Ft-1.03] to increase response quality, overshoot occurs in speed response as over response and as a result, position completion time can be increased. Therefore, you can reduce position completion time as setting instantly integration gain as '0' and suppressing overshoot if necessary. In that case, velocity control loop is changed from 'PI controller' type to 'P controller' type.

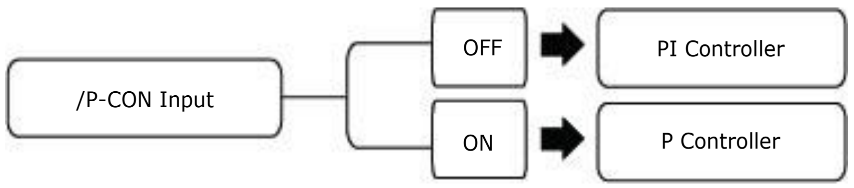
There are two methods to change velocity control loop from 'PI controller' type to 'P controller' type.

- Control by sequence input P control conversion </P-CON> signal.
- Method to use P/PI mode switching function by parameter setting.

Control by sequence input P control conversion </P-CON> signal

</P-CON> is sequence input signal. To use </P-CON>, allocate </P-CON>with reference to sequence input/output signal in the Chapter 5-1 page “Sequence I/O (Input/Output) Signal”.

</P-CON> signal is allocated and velocity controller is determined as following type according to allocated input channel signal.



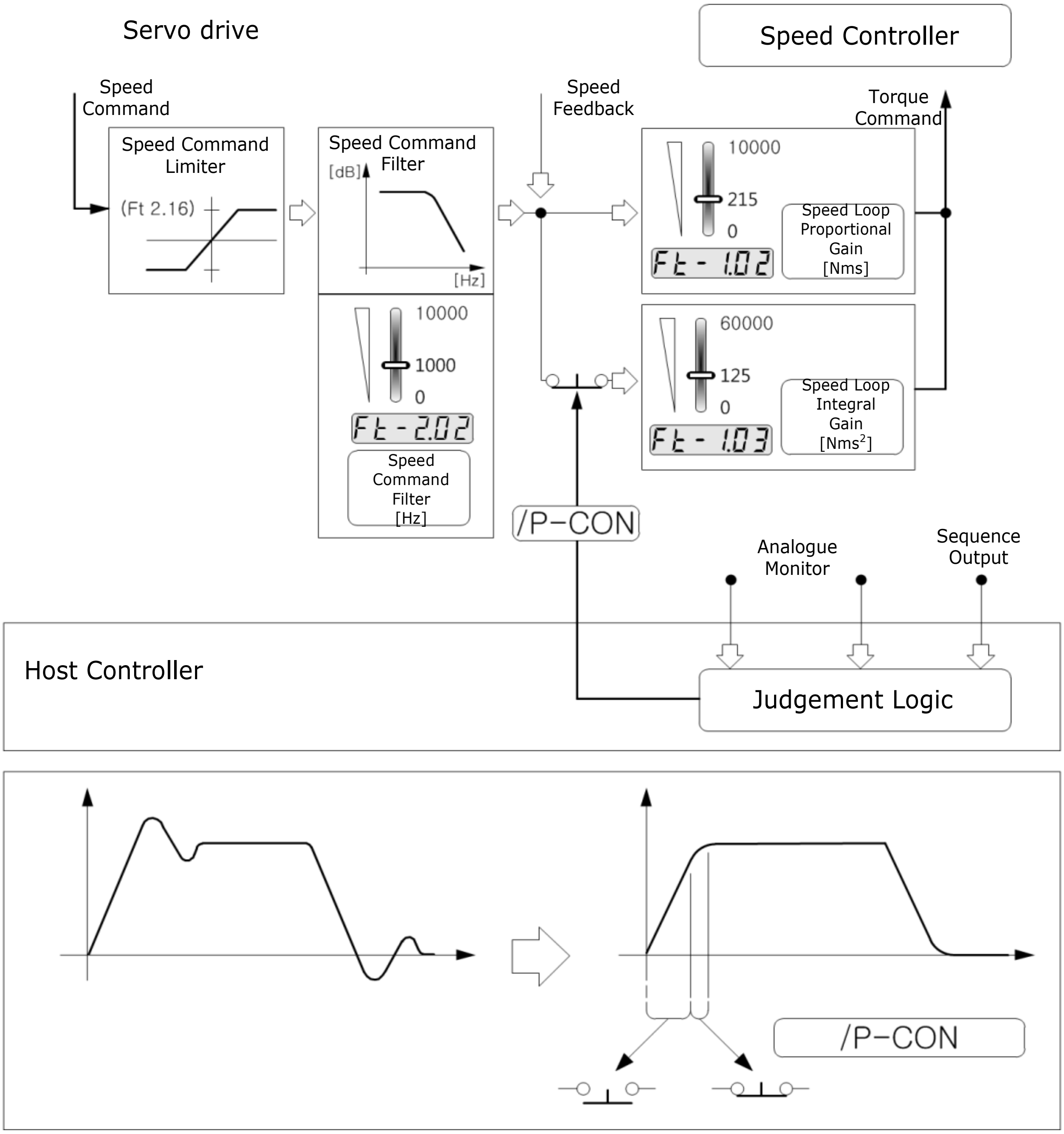
Therefore, host controller checks analog output such as speed or torque of servo drive and sequence output such as </P-COM>, </V-COM>, </TG-ON> and programs logics to convert controller from ‘PI controller’ type to ‘P controller’ type.

CAUTION

Do not use this function when overshoot occurs.

If some offset is included in speed command when you use speed mode, if you use ‘P controller’ type, motor does not respond to the offset related to ‘0’ speed command and remains without moving.

The following figure illustrates the conversion of ‘PI controller’ and ‘P controller’ using </P-CON> input in velocity control loop (velocity controller).



Method to Use P/PI Mode Switching Function by Parameter Setting

Meanwhile, you can operate velocity controller as 'P controller' type by parameter setting without allocation external sequence input. According to parameter setting, you can change velocity controller to 'P controller' type.

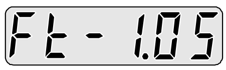
- When internal torque command is bigger than certain value [%].
- When speed command exceeds certain value [rpm].
- When position error is bigger than certain value [pulse].

For setting related to cases above, use the following parameter.

Table 6.16

Parameter (Ft-1.04)	
Parameter Name	P control conversion switch
Description	• 0 : P/PI mode conversion is not used. • 1 : If torque command is more than setting value of [Ft-1.05], PI -> P Control. • 2 : If speed command is more than setting value of [Ft-1.05], PI -> P Control. • 3 : If position error is more than setting value of [Ft-1.50], PI -> P Control. • 4 : Reserved
Applicable Mode	F, S, P
Others	Servo-OFF> Setting > End

Table 6.17

Parameter (Ft-1.05)	
Parameter Name	P control conversion standard value
Setting Value	0 to 3,000
Description	Setting the P control conversion standard value is depending on the setting value of [Ft-1.04].
Initial Value	100
Unit	Variable
Applicable Mode	F, S, P
Others	Setting > End

Unit of P control conversion standard value [Ft-1.05] follow the unit of command that is selected in selected parameter of P control conversion switch [Ft-1.04].

- Position Error : [pulse]
- Speed Command : [rpm]
- Torque Command : [%]

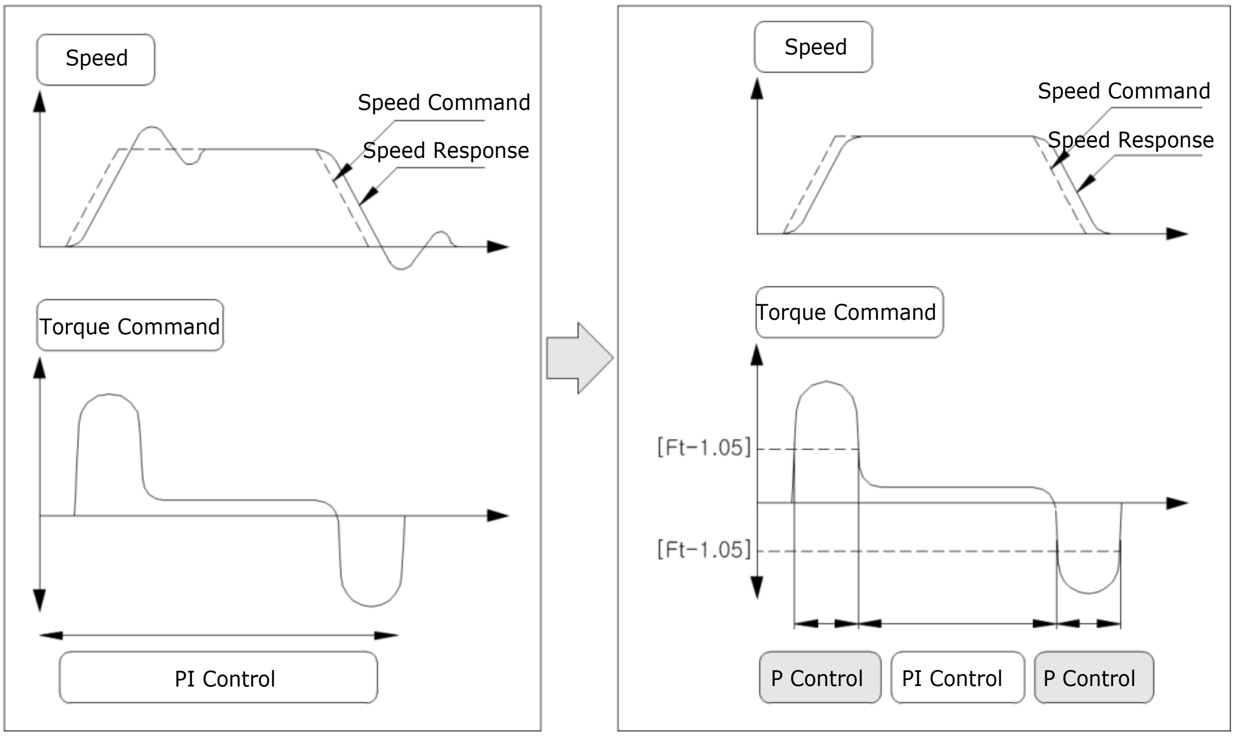
CAUTION

Sequence input </P-CON> signal is converted prior to setting of [Ft-1.04] and [Ft-1.05]. That is to say, if </P-CON> is ON regardless of current motor condition or setting of motor value, velocity controller is converted to 'P controller'.

To reduce overshoot of speed response or position completion time using this function, you should set appropriate value to [Ft-1.04] and [Ft-1.05]. For optimum setting, check carefully speed, torque, and position and be careful for setting.

The following figure is example of speed response when velocity controller is converted from '1 controller' type to 'P controller' type in the over response condition.

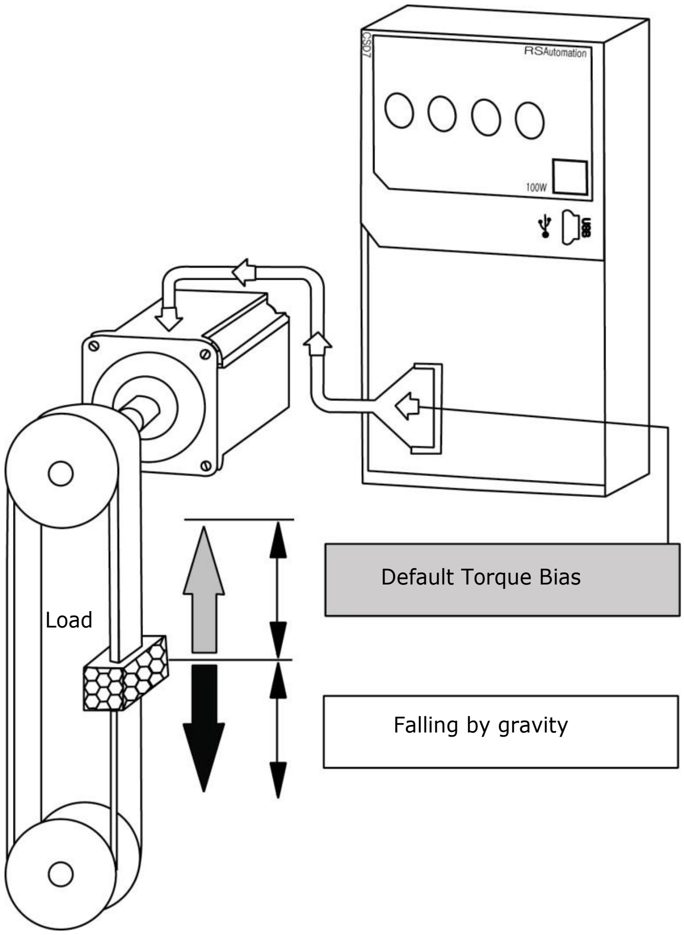
In the over response condition in acceleration-deceleration section, if torque command is higher than setting value of P/PI mode conversion standard value [Ft-1.05], it becomes 'P controller' type and the other section becomes 'PI controller' type.



Initial Torque Bias

It provides downturn by gravity of vertical shaft load during initial operation.

Downturn of Load by Gravity and Initial Torque Bias



If you approve Servo-ON signal to operate motor in the condition that load is vertical as shown in the figure, downturn of load by gravity can occur.

In addition, when you change from Servo-On to Servo-OFF, you need to hold or release motor brake. If you do not appropriately adjust the timing, instantly load drops and vibration occurs in the device.

As characteristics of those vertical shaft load, speed overshoot occurs in motor control and position output time is delayed. In addition, if you try to operate motor as holding the brake, it can be the reason of Servo fault.

Initial torque bias approves motor toward the direction against initial torque that relates to downturn when approving initial Servo-ON signal in order to prevent downturn by gravity when controlling vertical shaft load.

If you set initial torque bias appropriately against the strength that load drops, you can prevent the downturn of vertical load during initial operation.

Initial Torque Bias Setting Procedure

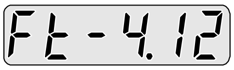
Set the appropriate value following the procedure below.

1. Check motor rotation direction (forward/reverse) and load direction (up/down).
2. Stop load in the special position using ‘0’ velocity control or fixed location control.
3. If it remains without moving, check torque command value in (dis-03) of the Chapter 7-45 page “Monitor Mode Function” and set that value to [Ft-4.12] below. Set positive value if the direction that the load goes up is forward direction of motor and negative value if the direction that the load goes up is reverse direction of motor. For definition on forward and reverse rotation, refer to the Chapter 7-10 page “Change the Motor Rotation Direction”.
4. Do detailed adjustment on the basis of current setting value as checking torque, speed, position response of motor.

Initial Torque Bias Setting

Set initial torque bias to the following parameter.

Table 6.18

Parameter (Ft-4.12)	
Parameter Name	Initial Torque Bias
Setting Value	-100 to 100
Description	started and the value of torque command is started from Setting value of parameter. Since torque to maintain the current state occurs from the beginning, you can prevent the phenomenon that the load drops. Therefore, you can suppress overshoot of speed response so that you can reduce position completion time.
Initial Value	0
Unit	%
Applicable Mode	All
Others	Setting > End

NOTE

For another method of brake control, see the “Motor Brake Control” on page 7-6.

You can prevent the instantaneous drop of load just by setting the brake control timing at the “Motor Brake Control” on page 7-6.

WARNING

If you set value of initial torque bias [Ft-4.12] too high, load can temporarily goes up.

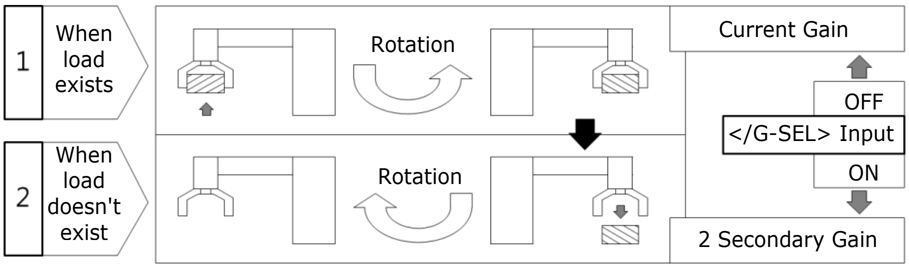
Be careful to make appropriate setting.

</G-SEL> Function

As shown in the figure below, two different conditions of load can be repeated. For example, robot moves a object to other position and return to the original position without any load after laying a object down.

If those movements are repeated too fast, On-line Auto Tuning is not smoothly performed. In addition, if you operate different load condition with the same gain, the response quality in one side is degraded.

In this case, you can effectively use sequence input </G-SEL> function.



The following details per step is to use </G-SEL> function.

1. Set the optimum gain to fit for No. 2 condition in the figure above.
2. Save gain in No. 2 condition using gain storage function (run-11). At this moment, saved gains is 2nd group gain. Corresponding gain [Ft-1.02], [Ft-1.03], [Ft-1.07], [Ft-4.02] excluded is stored in 2nd group gain. (For run-11 function, refer to the Chapter 7-36 page “Operation Mode Function”.)
3. Set the optimum gain to fit for No. 1 condition in the figure above. (current gain)
4. Allocate the input pin for sequence input </G-SEL> with reference to the Chapter 5-1 page “Sequence I/O (Input/Output) Signal”.
5. Use as matching </G-SEL> signal with the repeated movement No. 1 and No. 2.

Therefore, if you use as dividing different loads into current gain and 2nd group gain, you can satisfy the response quality of both different load conditions.

</G-SEL> is sequence input signal. To use </G-SEL> function, allocate </G-SEL> signal with reference to sequence I/O signal in the Chapter 5-1 page “Sequence I/O (Input/Output) Signal”.

CAUTION

When you use </G-SEL> function, you cannot use On-line Auto Tuning.

Gain Switching Function

CSD7 Servo Drive offers the following 4 gain groups to apply various movements.

Table 6.19 1 Group Gain

No.	Name
Ft-1.02	The 1st Speed Loop Proportional Gain
Ft-1.03	The 1st Speed Loop Integral Gain
Ft-1.07	Primary Position Loop Proportional Gain
Ft-4.02	The 1st Torque Command Filter

Table 6.20 2 Group Gain

No.	Name
Ft-1.14	The 2nd Speed Loop Proportional Gain
Ft-1.15	The 2nd Speed Loop Integral Gain
Ft-1.16	The 2nd Position Loop Proportional Gain
Ft-4.03	The 2nd Torque Command Filter

Table 6.21 3 Group Gain

No.	Name
Ft-1.17	The 3rd Speed Loop Proportional Gain
Ft-1.18	The 3rd Speed Loop Integral Gain
Ft-1.19	The 3rd Position Loop Proportional Gain
Ft-4.04	The 3rd Torque Command Filter

Table 6.22 4 Group Gain

No.	Name
Ft-1.20	The 4th Speed Loop Proportional Gain
Ft-1.21	The 4th Speed Loop Integral Gain
Ft-1.22	The 4th Position Loop Proportional Gain
Ft-4.05	The 4th Torque Command Filter

</BANK_SEL> Function

Four gain groups are selectable for use through </BANK_SEL>(Gain BankSelection).

</BANK_SEL> is set in [Ft-0.15] [D1]. When the set value is '0', Gain Bank 1 (1, 2 group gain), when the set value is '1', Gain Bank 2 (3, 4 group gain) is selected.

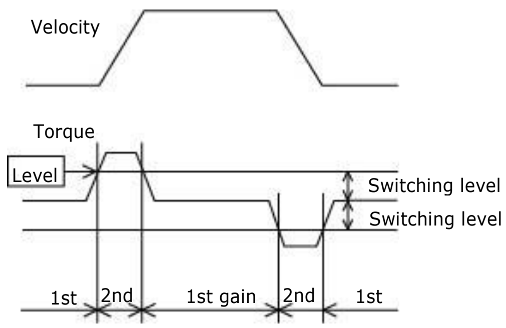
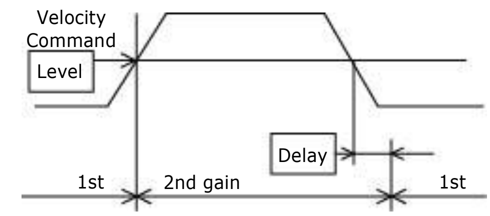
Table 6.23

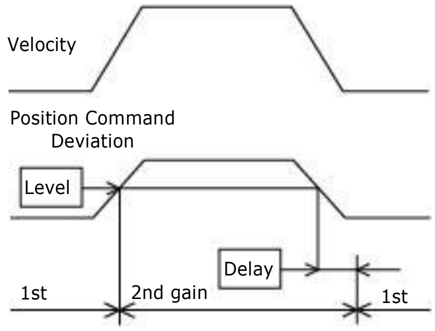
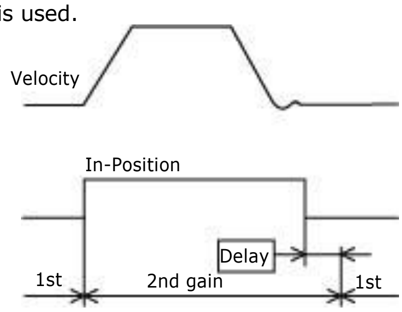
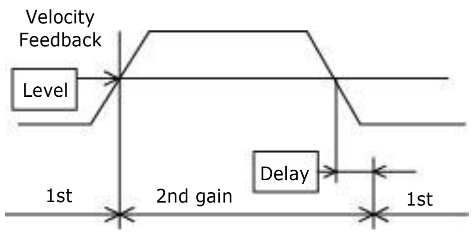
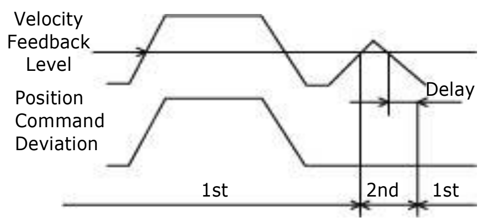
[Ft-0.15][D1]	0	Gain Bank 1 (1, 2 group gain)
	1	Gain Bank 2 (3, 4 group gain)

Gain Switching Mode

Gain Switching Mode can be chosen in [Ft-0.06] D2.

Table 6.24

<table>
<tr><td>Ft-0.06[D2]</td><td colspan="2">Gain Switching Mode</td></tr>
<tr><td>Category</td><td>Parameta</td><td>Description</td></tr>
<tr><td></td><td>0</td><td>The 1st gain value is fixed (1, 3 group gain).</td></tr>
<tr><td></td><td>1</td><td>The 2nd gain value is fixed (2, 4 group gain).</td></tr>
<tr><td></td><td>2</td><td>When the set external signal </G-SEL> is input, the 2nd gain value is used.</td></tr>
<tr><td></td><td>3</td><td>When the torque command value is higher than the set value, the 2nd gain value is used.

</td></tr>
<tr><td></td><td>4</td><td>When the speed command value is higher than the set value, the 2nd gain value is used.

</td></tr>
<tr><td></td><td>5</td><td>When the position error is higher than the set value, the 2nd gain value is used.</td></tr>
</table>

<table>
<tr><td></td><td></td><td>
</td></tr>
<tr><td></td><td>6</td><td>When the speed command value is higher than the set value, the 2nd gain value is used.</td></tr>
<tr><td></td><td>7</td><td>Before the completion of In-position the 2nd gain value is used.

</td></tr>
<tr><td></td><td>8</td><td>When the motor speed value is higher than the set value, the 2nd gain value is used.

</td></tr>
<tr><td></td><td>9</td><td>When the motor speed value is lower than the set value without any speed command, the 2nd gain value is used.

</td></tr>
</table>

NOTE

Gain Switching function uses the existing </G-SEL> function to enable the gain change in the 2 gain group change function, and by adding 3, 4 group gains, allows to choose between Gain Bank 1 (1, 2 group gain) and Gain Bank 2 (3, 4 group gain) through </BANK_SEL>.

The gain value after the auto tuning is saved only in the 1 gain group same as before, and it can be manually copied to other groups and used after a fine tuning.

Chapter 7

Application

This chapter describes the contents that the users should know in terms of fragmentary application function, operation mode and monitor mode when using the servo drive.

Motor Suspension

Overview

The general overview on the each situation when the motor is stopped is explained.

With the exception of motor suspended by the normal operation, the servo drive suspend its operation when the below situation occurs and result in suspension of the motor.

- Servo Fault Occurrence
- Over Travel Occurrence

The motor can be stopped by 2 above factors in normal operation of the drive, and the method of stopping the motor for each suspension factors may be set in several forms.

The method to suspend the motors by the servo drive is classified as belo

- Suspended by Using Dynamic Brake Function
- Suspended by Torque Control Consistent with Normal Operation

Servo Fault

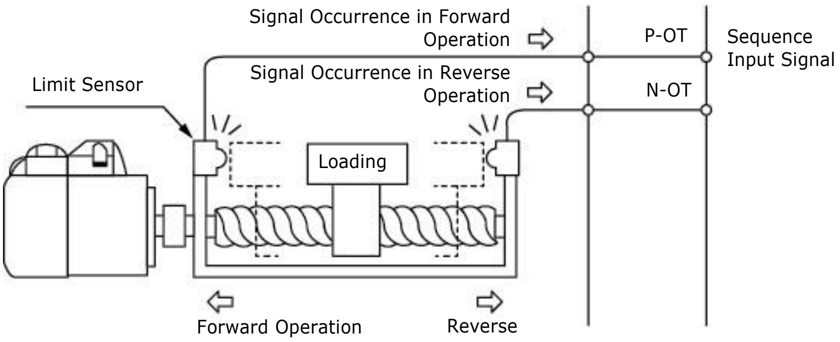
The content on servo fault is described in detail in the Chapter 8-5.

OverTravel <P-OT>, <N-OT>

OverTravel(OT)

When the load exceeds the operation range while running, the load system may be damaged. To respond to this situation, the sensor is installed at the edge of the operation range as shown in the figure below to prevent the damages to the load system.

Allow the operation within the range so that the loading does not reach the sensor during the operation. The servo drive stops the motor to protect the load system when the signal from the sensor occurs due to the loading exceeding the operation range by a certain error. At this time, the signal occurring in forward rotation of the motor is called <P-OT> signal and the signal occurring in reverse rotation is called <N-OT> signal.



Rotation Prohibition Signal In Over Travel Occurrence

The rotation prohibition signal in overtravel occurrence is the sequence input signal and is classified as below.

Table 7.1

Display	Signal Name	Description
<P-OT>	Inhibit Forward Revolution	The signal which occurs during forward revolution.
<N-OT>	Inhibit Reverse Revolution	The signal which occurs during reverse revolution.

Overtravel Signal Input

<P-OT> and <N-OT> are the sequence input signals. In order to use the <P-OT> and <N-OT> functions, refer to the sequence input & output signal in Chapter 5-1 page "Sequence I/O (Input/Output) Signal" and allocated the <P-OT> and <N-OT> signals.

The No. 4 pin of I/O has the <P-OT> signal, and the No. 5 pin of I/O has the <N-OT> signal allocation as a factory setting.

NOTE

The over travel signal is not the servo fault signal but it is a signal for the protection of the load system.

When the over travel signal is inputted, the drive status display mode shows the characters that the signal is inputted. Refer to the content of status display mode in the Chapter 4-6 page "Status Display Mode".

Selection of Stop Method in Overtravel Occurrence

Select the overtravel stop method from the below parameter. The information on dynamic brake is described in the following section.

Table 7.2

Parameter (Ft-0.02)(D1)	 
Parameter Name	Selection of an over travel stop method
Setting Value	0 : Stop the motor while continuing the normal torque control. Refer to the Chapter 5-45 page "Torque Limit and Torque Limit Detection </T-LMT> Output" for the torque limit in an overtravel occurrence. 1 : Stop the motor depend on the selection of the table 7.3 in the page 7-5.
Initial Value	0
Applicable Mode	All
Others	Servo OFF > Setting > Completed

NOTE

In case of an over travel incident, when the stop method N1 of [Ft-0.02][D1] is set to '0' to stop through the normal torque control, the servo drive can limit the torque transmitted to the motor. Refer to the Chapter 5-45 page "Torque Limit and Torque Limit Detection </T-LMT> Output" for the torque limit in an over travel occurrence.

Dynamic Brake

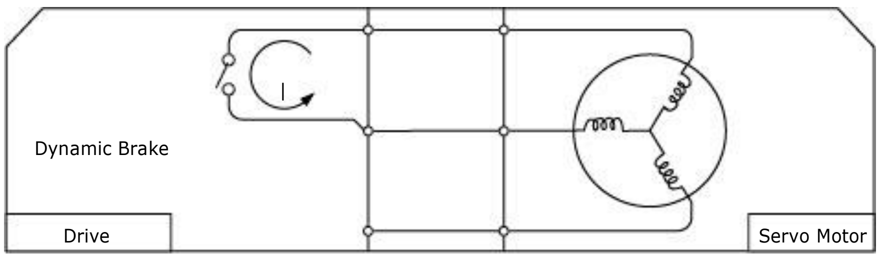
The CSD7 servo drive has the dynamic brake circuit.

Dynamic Brake

When the motor cable (U, V, and W) of the servo motor is all short circuited and the motor shaft is rotated with hands, it is easy to find out that there is much more loading in the rotation than when not short circuited. The drive uses such characteristic of the motor when stopping the motor. This is referred to as a dynamic brake (DB).

The following figure shows the internal DB circuit of the servo drive.

If the motor cable is connected to the servo drive and if the power is not supplied to the servo drive, the switch in the below figure is short-circuited. This indicates that the DB is in operation. Also, the servo drive controls the DB switch according to the parameter setting for the DB operation.



CAUTION

The DB cannot be used while stopping the motor with normal torque control. The normal torque control is done in servo-ON, but the DB is only operated in servo-OFF.

DB Stop

DB Stop is operating the DB to stop the motor during the run.

Free Run Stop

Free Run Stop is stopping the motor during the run by the friction of the load only.

DB Stop Method Setting

Set the DB stop method on the below parameter.

Table 7.3

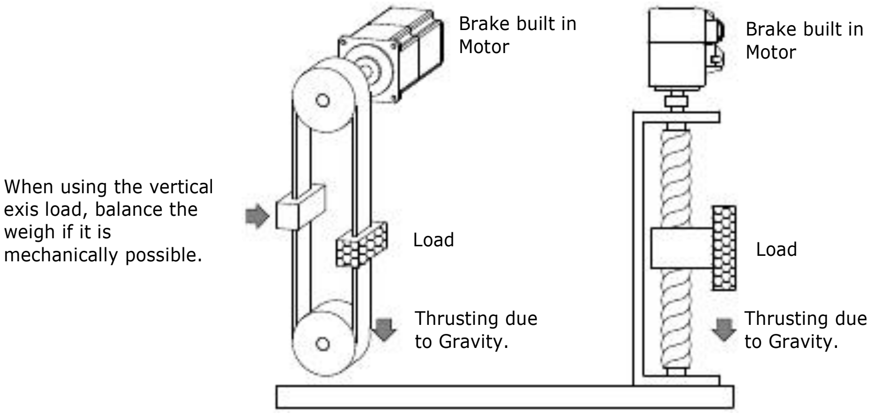
Parameter (Ft-0.02)(D0)	 
Parameter Name	Selection of DB Stop Method
Description	Set the stop method in an overtravel occurrence
Setting Value	• 0: DB Stop. DB stop is maintained even after the complete stop. • 1: DB Stop. DB operation is released after the complete stop. • 2: The DB is not used, but free run stop. • 3: Free Run stop. DB operation is maintained after the complete stop.
Applicable Mode	All
Others	Servo-OFF > Setting > Completed

Motor Brake Contorl

Motor Brake

This function is used when the motor is equipped with the mechanical brake.

- If the load is movable by the gravity (e.g.: When applied in the vertical axis control)
- The fall can be prevented when the power is off or the drive servo is off.



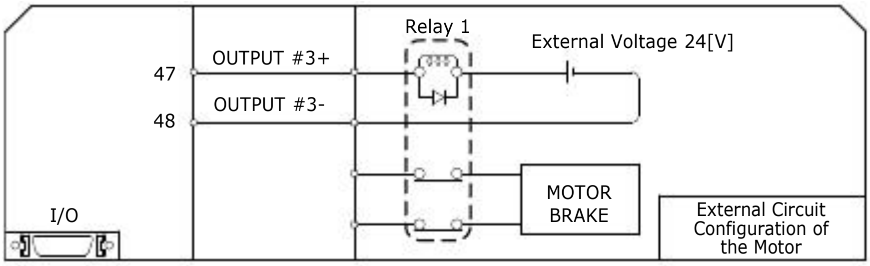
Sequence Signal Allocation

In order to use the motor brake, refer to the sequence input & output signal in the Chapter 5-1 page “Sequence I/O (Input/Output) Signal” first and allocate the <BK> sequence output signal. The signal for brake control is outputted with the allotted pin. The factory setting is OUTPUT#3 (No. 47 and No. 48 pins of I/O).

Circuit Configuration

The drive cannot use the high voltage and current that can directly control the motor brake. Therefore, the motor brake cannot be connected directly to the drive and used. And it is possible to control the brake indirectly by configuring the external relay circuit. Refer to the indirect control circuit hrough the relay shown below.

The output channel of I/O can be adjusted by the user according to the condition since the sequence output signal is used. The example below is based on a factory setting.



Motor Brake Control Setting

After the allocation of the brake output signal, the detailed setting on the brake control can be made in the below parameter. Set appropriately by observing the motion of the load.

Table 7.4

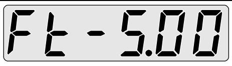
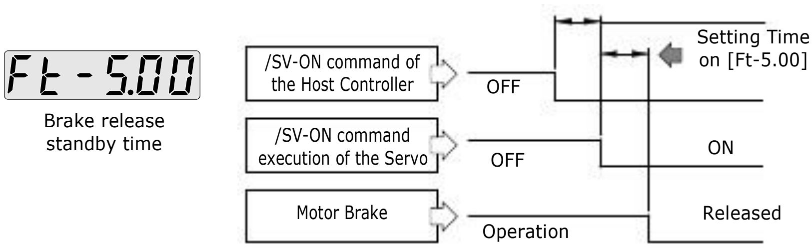
Parameter (Ft-5.00)	
Parameter Name	Delay Time of Brake Output Signal after Servo ON
Description	Set delay time of brake ouput signal after servo on. The motor brake has to be released first if the motor brake is in operation when the drive is about to start the motor. At this time, if the brake is released before servo-ON (or simultaneously), the vertical load will immediately fall. The drive has to be servo-on first and to prevent the fall of the vertical load, then release the brake. This setting is used to secure the time from the servo drive becomes servo-ON to the release of the motor brake. 
Setting Value	0 to 10000
Initial Value	0
Unit	ms
Applicable Mode	All
Others	Servo-OFF > Setting > Completed

Table 7.5

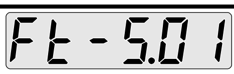
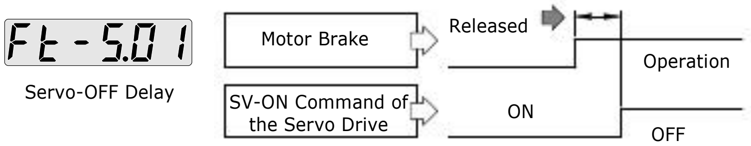
Parameter (Ft-5.01)	
Parameter Name	Servo-OFF Delay Time
Description	Set Servo-OFF dely time. The time between the receiving the servo-off command from the host controller to the actual servo-off by the drive can be set. This setting is used in securing the time for operating the motor brake while the host controller commanded the servo-off. 
Setting Value	0 to 10000
Initial Value	0
Unit	ms
Applicable Mode	All
Others	Servo-OFF > Setting > Completed

Table 7.6

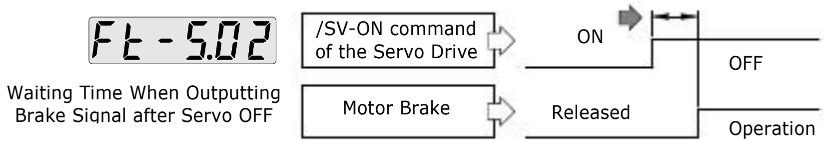
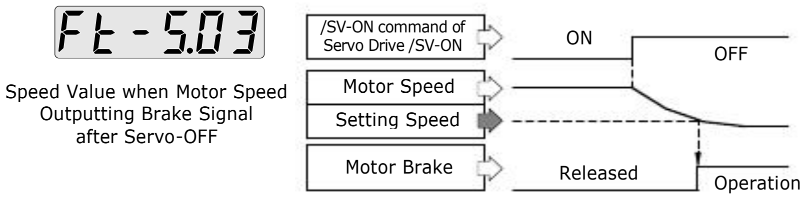
<table>
<tr><td>Parameter
(Ft-5.02)</td><td>Ft-5.02</td></tr>
<tr><td>Parameter Name</td><td>Waiting Time When Outputting Brake Signal after Servo OFF</td></tr>
<tr><td>Description</td><td>Set saiting time when outputting brake signal after Servo OFF.
In order to stop the motor from the host controller, the servo-off command is outputted from the drive. At this time, the actual time when the motor brake is operated, can be set.

</td></tr>
<tr><td>Setting Value</td><td>0 to 10000</td></tr>
<tr><td>Initial Value</td><td>500</td></tr>
<tr><td>Unit</td><td>ms</td></tr>
<tr><td>Applicable Mode</td><td>All</td></tr>
<tr><td>Others</td><td>Servo-OFF > Setting > Completed</td></tr>
</table>

Table 7.7

<table>
<tr><td>Parameter
(Ft-5.03)</td><td>Ft-5.03</td></tr>
<tr><td>Parameter Name</td><td>Speed Value When Outputting Brake Signal after Servo OFF</td></tr>
<tr><td>Description</td><td>Set speed value when outputting brake signal after Servo OFF.
Host Controller outputs the Servo-OFF command to drvice to stop the motor. The motor speed when the motor brake is operated, can be set.

</td></tr>
<tr><td>Setting Value</td><td>0 to 1000</td></tr>
<tr><td>Initial Value</td><td>100</td></tr>
<tr><td>Unit</td><td>Rotary Motor [rpm], Linear Motor [mm/sec]</td></tr>
<tr><td>Applicable Mode</td><td>All</td></tr>
<tr><td>Others</td><td>Servo-OFF > Setting > Completed</td></tr>
</table>

CAUTION

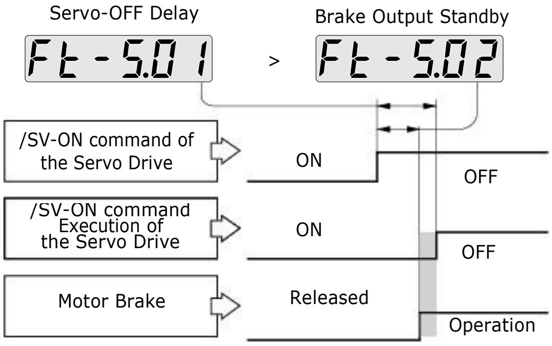
The brake attached to the motor should not be used to stop the running motor. Use it to maintain the stop status of the motor immediately before or after the stop.

Precautions when Setting

The below are the precautions when setting the time in Servo-ON andServo-OFF.

As shown on the right column, if the brake operates after the actual servo-off is completed, it will temporarily be descended by the gravity in case of vertical load. As shown on the left column, lowering of the load is prevented by operating the motor brake early, before the actual Servo-OFF. In order to prevent the fall by the gravity, set the time properly.

Table 7.8

<table>
<tr><th>O</th><th>X</th></tr>
<tr><td>


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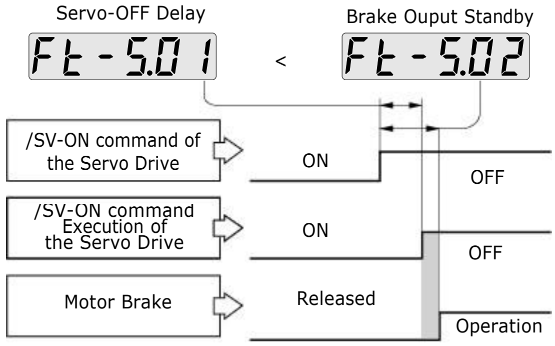


</td></tr>
</table>

Brake signal is outputted according to the priority among [Ft-5.02] and [Ft-5.03].

Other

Even when the brake attached to the motor is not used, a separate brake may be manufactured and installed by the user. When controlling the extra manufactured brake, it can be controlled by the signal from the servo drive.

NOTE

- Sequence output signal <BK> that is to control the motor brake is allocated at the time of the shipment.
- When not using the motor brake, allocate and use other output signal needed.
- The detailed contents on the sequence input and output is described in the Chapter 5-1 page "Sequence I/O (Input/Output) Signal".

Change the Motor Rotation Direction

Overview

When the rotation direction of the motor is wired differently than the intent of user by the pulse input, the rotation direction of the motor can be reversed by the below parameter setting without the separate wiring.

When the movement direction of the final mechanical part on loading side is operated to the opposite direction of the setting, the motor rotation direction can be easily converted.

Definition of Forward Rotation - CW (Clock Wise)

If the motor shaft rotates in clockwise when the motor is viewed from the load, it is rotating in forward direction.

Definition of Reverse Rotation - CCW (Counter Clock Wise)

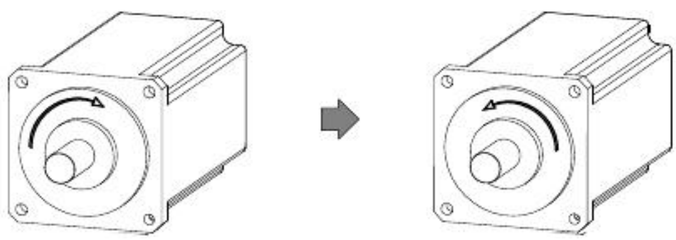
If the motor shaft rotates in counterclockwise when the motor is viewed from the load, then it is rotating in reverse direction.

Rotation Direction Setting

Set the direction of the rotation in the below parameter.

Table 7.9

Parameter (Ft-0.02)(D2)	 
Parameter Name	Selection of Rotation Direction for External Command
Description	Set the rotation direction
Setting Value	• 0: Forward rotation is set as the CW direction. • 1: Forward rotation is set as the CCW direction.
Initial Value	0
Applicable Mode	All
Others	Servo-OFF > Setting > Completed



Forward Revolution Reverse Revolution

Regeneration Resister

Regeneration Resister

Regeneration Energy

When stopping the running motor, the motor operates like a generator and the resulting energy is called the regeneration energy.

Regeneration Resistor

The regeneration energy occurring when the motor is stopped is absorbed by the servo drive in some degree, but if the energy exceeds the capacity, a separate device is needed to consume the regeneration energy. The regenerative resistor is mounted on the exterior of servo drive in order to consume the regeneration energy.

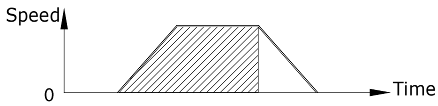
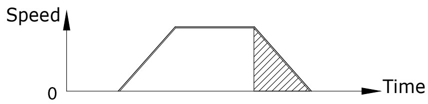
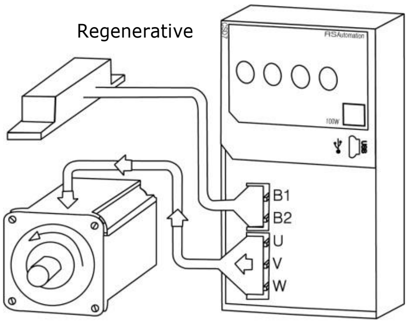
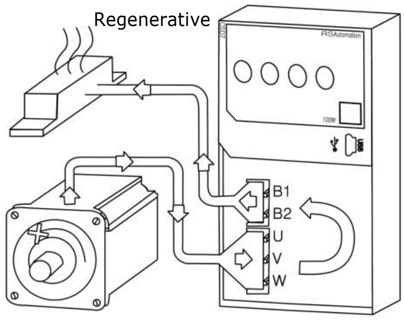
If there is excessive regeneration energy that causes the damage to the Servo Drive, but the Servo Drive is equipped with the protective circuit to shield off such phenomenon.

Regeneration Energy Generating Condition

- When the speed is decelerating
- When the motor is continuously rotated by the strength of the load for example (-loading condition) or (When of operating the vertical axis loading)

Precaution

Regenerative resistor equipped on the servo drive is designed to consume the regeneration energy in relatively short period of time such as in between the stops. It is not appropriate to the case when the regeneration energy is generated too much, like the cases of minus loading condition and vertical load that rotates the servo motor with the gravity. However, when the rated power of regenerative resistor that is calculated by referring to the 7- 13 page "Regenerative Resistor Selection Standard" is smaller than the regenerative resistor attached at the time of shipment, the internal regenerative resistor can be used as is without any special actions.

Acceleration and Constant Speed	Deceleration
	
	

Specification of Regenerative Resistor Mounted on the Drive

The allowable power is 25 [%] of the rated power of the regenerative resistor mounted on the drive. But it is 50 [%] when using a cooling fan.

Table 7.10 Specification of regenerative resistor mounted on the drive

Servo Drive	Resistor (Ω)	Rated Power (W)	Allowble Power (W)	Cooling Fan
200W or less	-	-	-	X
400W	50	30	7.5	X
800W	30	70	35	O
1 kW	30	70	35	O
1.5 kW	30	70	35	O

External Regenerative Resistor

The regenerative resistor that the user connects to the outside for load is called external regenerative resistor. The following is the description when using the external regenerative resistor.

General Specifications

The user may consume the regeneration energy generated in the load system by increasing the rated power of regenerative resistor and installing the external regenerative resistor if the rated power of mounted regenerative resistor consumes small regeneration energy.

In order to increase the allowable power of regenerative resistor, the mounted regenerative resistor and external regenerative resistor are connected in parallel. Another way is to remove the internal regenerative resistor and install the separate external regenerative resistor.

Precautions

When the rated power is increased for regenerative resistor on the above two methods, the following conditions have to be satisfied.

CAUTION

- The resistor of the total regenerative resistor has to be 30 to 50 [Ω].
- When used in parallel with the internal resistor, install the external regenerative resistor with resistor value 60 Ω or higher (capacity 15W or higher) for 400W drive, or the one with resistor value 180 Ω or higher (capacity 10W or higher) for 800W or higher drive.
- The regenerative resistor can be risen to 200 degree or higher of the temperature on the rated load condition. When the separate cooling fan is not used, the temperature of the regenerative resistor may increase excessively. Therefore, user should lower it to 25 [%] of the rated power.
- The contents relating to the regenerative resistor is important. When the rated power of regenerative resistor is increased, make sure to keep the above two contents.

Regenerative Resistor Selection Standard

Regenerative resistor selection standard through the allowable number of repetition

The regenerative resistor has to be selected with the specification that meets the load system of the user. One of the selection standards may be the selection of optimal regenerative resistor that satisfies the load system by calculating the frequency of repeated motion of the motor.

The repeated frequency means the frequency of operation that the motor rotates and stops regardless of the rotation direction of the motor. The permitted repetition frequency means the maximum repetition frequency per minute.

The motor regenerative resistor selection by the repetitive frequency is limited to the loading operated in the horizontal direction.

Refer to the below formula to calculate the maximum allowable repetition frequency of the load system.

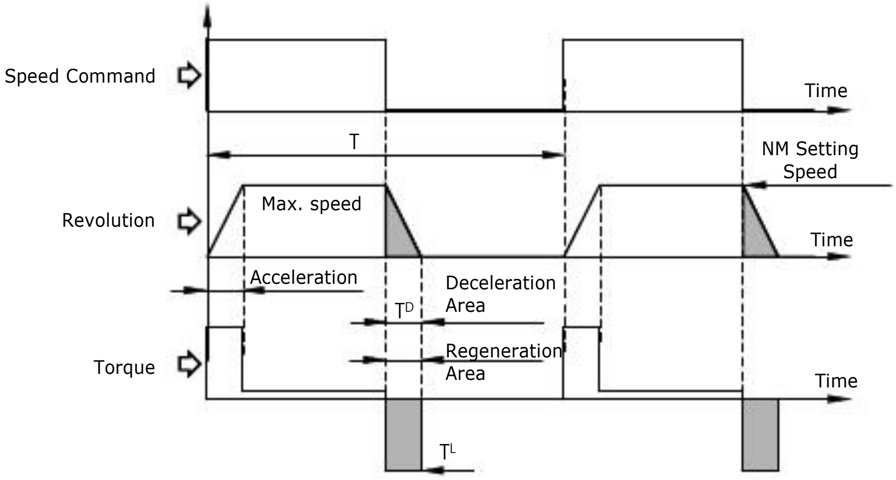
$$\text{Allowable Repetition Frequency} = \frac{\text{Allowble Repection } \textit{Frequencty in without load}}{1+n} \times \left(\frac{\text{Maximum Speed}}{\text{Setting Speed}}\right)^2 \quad [\text{Cycles/Min}]$$

- Contents necessary in calculation shall be referred to the below.
- n is the inertia ratio.
- The maximum speed of motor shall be referred to the motor specifications.

CAUTION

Make sure to use the actual repetition Frequency of the motor smaller than the permitted repetition frequency calculated on the above formula.

It shows the acceleration and deceleration of the motor in certain operation cycle in horizontal axis.



$$\text{Repetition Frequency} = \frac{1}{T} \times 60 \text{ [Cycles/Min]}$$

It shows the allowable repetition frequency per minute when operated without the load. It is left as blank if there is no applicable capacity of the motor type.

Table 7.11 Allowble Repetition Frequency in Without Load [Cycles/Min]

Motor	400W	600W	750W	950W	1000W	1500W
CSMR	50	-	-	-	-	-
CSMR(Brake)	35	-	-	-	-	-
CSMT	85	94	85	60	-	-
CSMT(Brake)	66	75	70	56	-	-
CSMA	-	-	-	-	50	37
CSMA(Brake)	-	-	-	-	42	32

When the repetition frequency of actual motor is larger than the allowable repetition frequency, perform as the following.

- Lower the possible setting speed.
- Refer to the Chapter 7-15 page "Setting for Smooth Operation" to set the possible deceleration time in long period of time.
- Refer to The Chapter 5-45 page "Torque Limit and Torque Limit Detection </T-LMT> Output" and limit the possible torque.
- Make the inertia of load system small.

Setting for Smooth Operation

Overview

By setting the acceleration/deceleration time and S-curve operation time on the servo drive, the impact that may occur in acceleration or deceleration can be reduced to result in smoother operation.

Definition of Acceleration

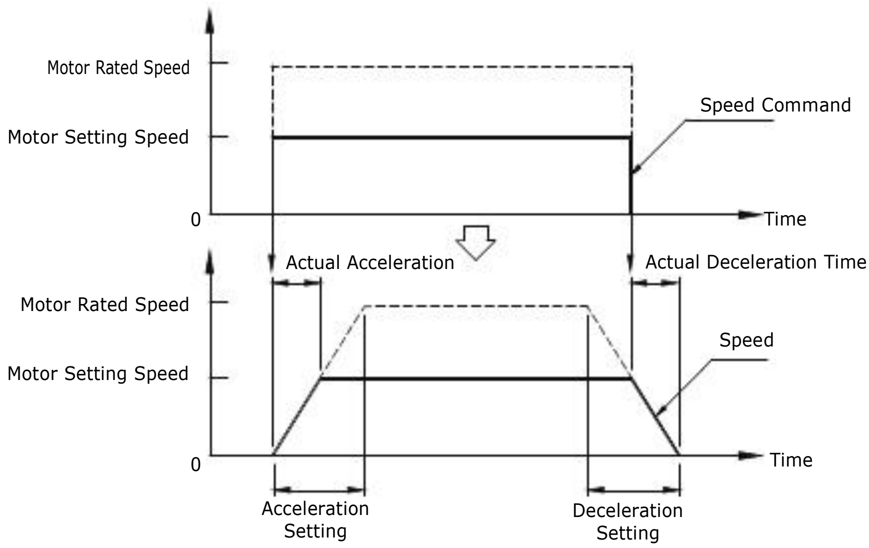
Acceleration is the rate of change in speed from stop to the motor's rated speed.

Definition of Deceleration

Deceleration is the rate of change in speed from the motor's rated speed to a stop.

Speed Command and Acceleration/Deceleration

The figure below shows the implementation of the speed command by the Servo drive after the Acceleration/Deceleration speed is set. It shows that the longer the deceleration time is, the longer the time for the implementation of the command becomes.



Acceleration/Deceleration Setting

Set the acceleration/deceleration on the below parameter.

Table 7.12

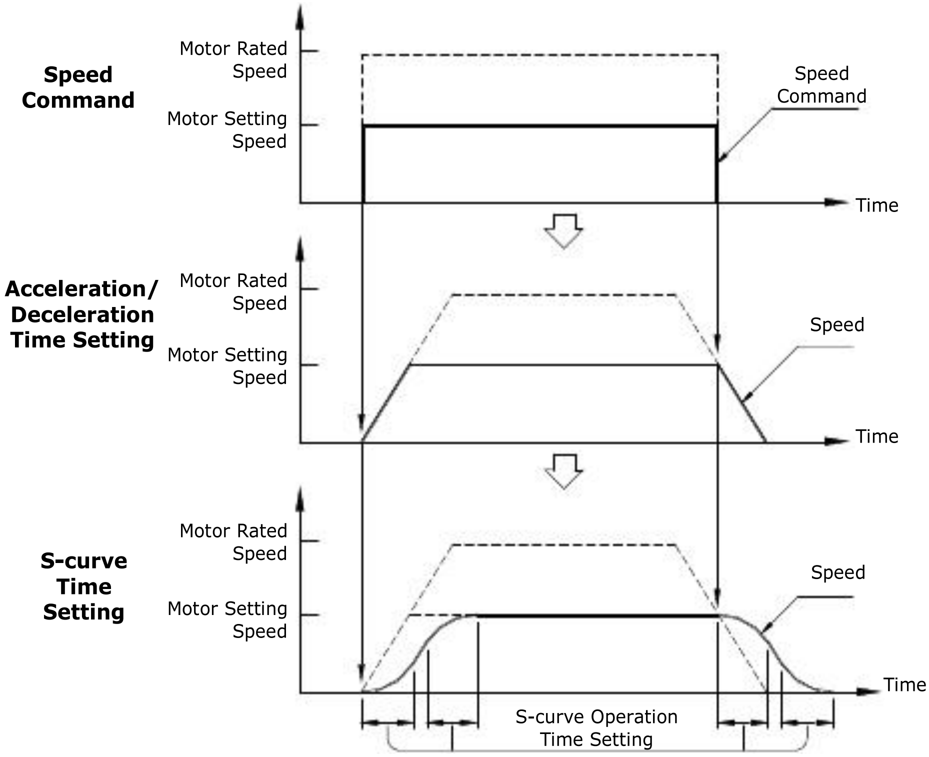
Parameter (Ft-2.06)	Ft-2.06
Parameter Area	Acceleration
Description	Set motor acceleration speed
Setting Value	1 to 2,147,483,647
Initial Value	41667
Unit	Rotary Motor [10^{-2} x Rev/sec^{2}]
Applicable Mode	All
Others	Setting > Completed

Table 7.13

Parameter (Ft-2.06)	Ft-2.07
Parameter Area	Deceleration
Description	Set motor deceleration speed
Setting Value	1 to 2,147,483,647
Initial Value	41667
Unit	Rotary Motor [10^{-2} x Rev/sec^{2}]
Applicable Mode	All
Others	Setting > Completed

Definition of S Curve Operation

As shown in the below figure, by performing the S-curve command at the conversion point of acceleration/deceleration, more smooth operation can be had.



S Curve Operation Time Setting

Set the S-curve operation time on the below parameter.

Table 7.14

Parameter (Ft-2.08)	Ft-2.08
Parameter Area	S-Curve Operation Time
Description	Set motor accelecation time.
Setting Value	0 to 5000
Initial Value	0
Unit	ms
Applicable Mode	All
Others	Setting > Completed

Caution

The total command performance time differs by the acceleration-deceleration and S-curve operation time.

If the total consumed time for initial speed command is 10 seconds, the total time of speed command time after the acceleration-deceleration time setting is (10 seconds + [Ft-2.07]). Also, the total time (10 seconds + [Ft-2.07] + [Ft-2.08]) of speed command performance after the S-curve operation time setting.

CAUTION	If the S-curve operation setting value is set as '0', the S-curve operation is not used. Also, without the setting of acceleration/deceleration, the S-curve operation alone shall not be used. For the use of S-curve operation, first set the acceleration/deceleration that is appropriate to the user's situation.

Speed Limiting Function

It describes the function to limit the rotation speed of the motor.

2 Ways to Limit the Speed

There are 2 ways to limit the speed as below.

- Limit the speed through the independent setting of the servo drive (Internal speed limit).
- Limit the speed through the command from the host controller (External speed limit).

Internal Speed Limit

Internal speed limit is operated by the value set by the user on the below parameter. Therefore, when the faster speed command than the setting value of below from the host controller, the servo drive is limited to the setting value and operated.

Table 7.15

Parameter (Ft-2.16)	Ft-2.16
Paramter Name	Speed Limit Setting Value
Description	It limits the rotation speed of the motor to operate under the setting value. Initial value is automatically set with the maximum speed of the motor applicable together with the setting the motor model at the basis setting of the Chapter 4-12 page "Basic Setting".
Setting Value	1 to 6000
Initial Value	5000
Unit	rpm

Applicable Mode	All
Other	Setting > Completed

External Speed Limit Value

The below figure is the input of function to allow the servo drive to make the velocity control by permitting the analog speed command at the host controller when the servo drive is used as the speed mode.

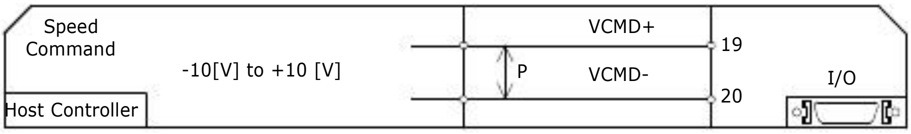
Refer to the speed mode in the Chapter 5-32 page "Velocity Control Mode".

If, the user does not use the speed mode and operate with other control mode (position, torque, multi-step speed), the below input can be used as the function limiting the speed. The speed limit utilizing the speed command input pin is referred to as external speed limit.

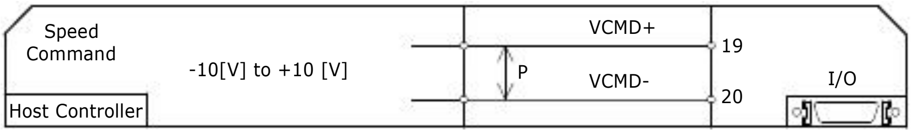
When it is used as speed mode, the external speed limit function may not be used and the speed may be limited by the internal speed limit.

The speed may be limited to a speed equivalent to the analog voltage command inputted from the host controller.

When operated in Speed mode, the analog speed command of host controller is



When operated in Speed mode, the analog speed command of host controller is executed.



External Speed Limit Value

The parameter below is the parameter setting the relationship between the analog speed command voltage and the speed when operating with speed mode. When it is not used as the speed mode, the speed is limited to the applicable speed at the below parameter setting.

Select the analog command voltage and speed to be limited, and set the external speed limit value of the below parameter.

Table 7.16

Paramter (Ft-2.00)	Ft-2.00
Parameter Name	Anlaog Speed Command Input Ratio Setting
Description	Set the speed command value [rpm] on analog voltage 1 [V], and limit it with the set speed.
Setting Value	10.0 to 2000.0
Initial Value	500.0
Unit	[rpm/V]

Applicable Mode	S
Other	Servo-OFF > Setting > Completed

External speed limit value is given by the following relationship.

External Speed Limit (rpm) = Speed Command Gain(rpm/V) × Input Voltage(V)

Accordingly, when the input voltage is 6 [V] following the initial value, it is limited to the rated speed of motor, 3000 [rpm], and limited to 5000 [rpm], the maximum speed of motor when the input voltage is 10 [V].

The Voltage Command of Host Controller and External Speed Limit

When the speed mode is used with VCMD (No. 19 pin of I/O) and VCMD- (No. 20 pin of I/O) of servo drive, the motor is rotated to the forward direction in the + voltage. And the motor is rotated to the reverse direction in the - voltage when permitting the analog speed command of -10 [V] to +10 [V] range. However, when of using it as external speed limit function, the classification of + and- voltage is not made.

For example, when +1 [V] is permitted at the host controller and set with 500 for [Ft-2.00], the external speed limit value becomes 500 [rpm], and it is limited in all forward and reverse directions. Also, if -1 [V] is permitted, both forward and reverse directions are limited to 500 [rpm].

Speed Limit Selection

Select how to make the speed limit at the below parameter.

Table 7.17

Paramter (Ft-2.17)	Ft-2.17
Parameter Name	Speed Limit Selection
Description	Select the method of speed limit
Setting Value	• 0: The speed limit function is not used. • 1: It is limited by the internal speed limit [Ft-2.16]. • 2: It is limited by the external speed limit. (Except for Analog Velocity Control Mode) • 3: Compare the internal speed limit [Ft-2.16] and external speed limit to limit in small value.
Initial Value	0
Unit	All
Applicable Mode	Setting > Completed

Position Feedback to the Host Controller

Overview

Servo drive controls the servo motor by using several information received from the encoder. Also, the servo drive has the function to output the encoder information to host controller. In this the chapter, it describes the output function of encoder information.

Types of Output Sent to Host Controller

The total of 5 below encoder signals is outputted to the host controller.

Table 7.18 Encorder signal which is outputted to the host contoller

Function	Function	Type
EA+, EA-	Output on Encoder A+, A-	Line drive
EB+, EB-	Output on Encoder B+, B-	Line drive
EC+, EC-	Output on Encoder C+, C-	Line drive
PS+ PS-	Absolute Encoder Position Data Output	Line drive
/Z-PULSE+ /Z-PULSE-	Open Collector Output of Encoder Z+, Z-	Open Collector

Example of Wiring with Host Controller

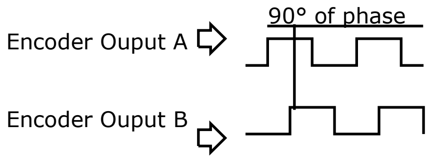
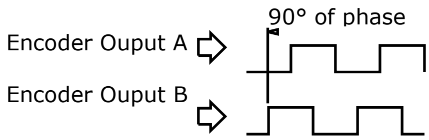
Refer to the Chapter 3-27 page “Encoder Wiring (Motor Feedback)” for the example of wiring of the host controller and servo drive.

Direction Change of Output Pulse ([Ft-3.00][D2])

The direction of encoder pulse outputted to the host controller is converted.

Set the below parameter to convert the direction of output pulse.

Table 7.19

Parameter (Ft-3.00)(D2)	Ft-3.00 0
Parameter Name	Encoder Output Pulse Direction
Description	Set the direction of output pulse
Setting Value	• 0: In forward rotation, the encoder output A phase have a lead of 90°over A phase.  • 1: In forward rotation, the encoder output A phase have a lead of 90°over B phase. 
Initial Value	0
Applicable Mode	All
Other	Servo-OFF > Setting > Completed

Pulse Dividing Circuit

Overview

Servo drive may adjust the number of pulse of encoder through the dividing circuit function before outputting to the host controller through the input received from the encoder.

Adjustment calculation formula for pulse number

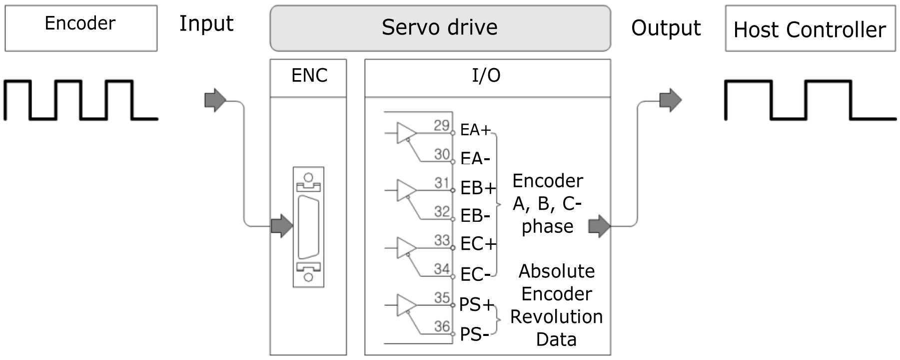
The number of output pulse is adjusted by the formula below.

([Ft-3.11]/[Ft-3.12]) × Number of Encoder Pulse= Ouput to Host Controller

When the type of encoder connected to the drive is outputted 32768 pulses per 1 revolution, and output 1000 pulses per 1 revolution with the host controller. Set the numerator [Ft-3.11] to 1000 and denominator [Ft-3.12] to 32768 as shown below.

$$(1000/32768) \times 32768 = 1000$$

Servo drive receives 32768 pulse per 1 revolution from the encoder, but outputs 1000 pulse to the host controller.



Setting

Set the pulse dividing circuit numerator and denominator from the below parameter.

Table 7.20

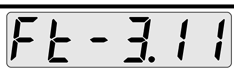
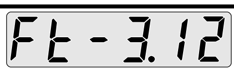
Parameter (Ft-3.11)	
Parameter Name	Position Output Pulse Adjustment (Numerator)
Description	Set the numerator of position output pulse adjustment value of dividing circuit. Generally, enter the the number of pulse per revelution to be outputted to an host controller.
Setting Value	1 to 8388608
Initial Value	1
Unit	pulse
Applicable Mode	All
Other	Servo-OFF > Setting > Completed

Table 7.21

Parameter (Ft-3.12)	
Parameter Name	Position Output Pulse Adjustment (Denominator)
Description	Set the denominator value of position output pulse adjustment value of dividing circuit . Set the denominator of the position output pulse adjustment value of a division circuit. Usually enter the encoder value for 1 rotation of a motor.
Setting Value	1 to 8388608
Initial Value	1
Unit	pulse
Applicable Mode	All
Other	Servo-OFF > Setting > Completed

The initial value of dividing circuit is automatically set the number of encoder pulse value applicable to the encoder type which is set simulaeously with the running of run-12.

Even when the motor rotates at a fixed speed, the encoder output pulse may have jittering of 33 [μs] depending on the rotation speed.

CAUTION

Make sure to comply with the following condition in the setting of alternative circuit. Therefore, numerator [Ft-3.11] should be same or less than denominator [Ft-3.12].

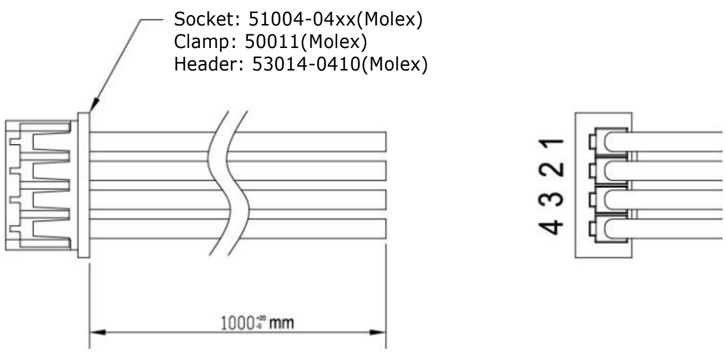
Analog Monitor Output

Overview

The drive includes two analog outputs that a user can allocate for the variables of the internal drive. A 4-pin connector, 53014_0410A, is provided for two analog outputs.

See the pin arrangement of analog monitor connector, as bleow.

Analogue Monitor Cable



The figure above shows when the connector is installed from the front; the pin numbers are from the pins in the connector.

Table 7.22

Pin	Description
1	Analog Output Ch1
2	Analog GND
3	Analog Output Ch2
4	Analog GND

Setting

Set the output type and range that the users want to confirm from the below parameter.

Table 7.23

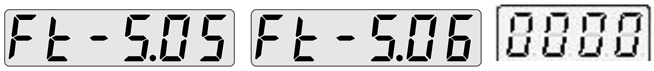
Parameter (Ft-5.05), (Ft-5.06)	
Parameter Name	Analog Monitor Output CH1, CH2 Selection
Setting Value	0 to 46
Initial Value	0, 1
ApplicableMode	All
Other	Setting > Completed

Table 7.24

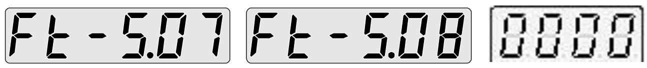
Parameter (Ft-5.07), (Ft-5.08)	
Parameter Name	Analog Monitor Output CH1, CH2 Scaling
Description	Amplitude of the Channel 1 and 2 input signal to be displayed on oscilloscope
Setting Value	1 to 99999
Initial Value	500
ApplicableMode	All
Other	Setting > Completed

Table 7.25 Types and Unit of Analog Monitor Ouput

Ft-5.05(CH1) Ft-5.06(CH2) Selection No.	Type	Unit	Ft-5.07(CH1) Ft-5.08(CH2) Range
0	Speed Feedback	rpm	1 to 99999
1	Speed Command	rpm	1 to 99999
2	Speed Error	rpm	1 to 99999
3	Torque Command	A	0.001 to 99.999
4	Position Feedback	pulse	1 to 99999
5	Position Command	pulse	1 to 99999
6	Position Error	pulse	1 to 99999
7	Position Pulse Command Frequency	kpps	0.1 to 9999.9
8	Electrical Angle	°	0.1 to 9999.9
9	Mechanical Angle	°	0.1 to 9999.9
10	Regenerative Accumulated Load Ratio	%	1 to 99999
11	DC Link Voltage	V	1 to 99999
12	Absolute Encoder Multi-revolution Data	turns	1 to 99999
13	Speed Command Offset	mV	0.1 to 9999.9
14	Torque Command Offset	mV	0.1 to 9999.9
16	U-phase Current	A	0.001 to 99.999
17	V-phase Current	A	0.001 to 99.999
18	W-phase Current	A	0.001 to 99.999
19	Motor Load Ratio	%	1 to 99999
20	Analog Speed Command Voltage	V	0.01 to 999.99
21	Analog Torque Command Voltage	V	0.01 to 999.99
22	Torque Feedback	A	0.001 to 99.999
24	Position Feedback	pulse	1 to 99999
27	Instantaneous Regenerative Energy	W	1 to 99999
28	Driver Load Ratio	%	1 to 99999
34	Absolute Encoder Single-revolution Data	pulse	1 to 99999
44	Average Torque Load Ratio	%	0.001 to 99.999
45	Maximum Torque Load Ratio	%	0.001 to 99.999

Monitoring Sample

The below figures are the monitoring samples.

Set the monitoring type and input the setting value applicable to 1 [V] output. The output range is -10 [V] to +10 [V].

<Monitoring Sample 1>

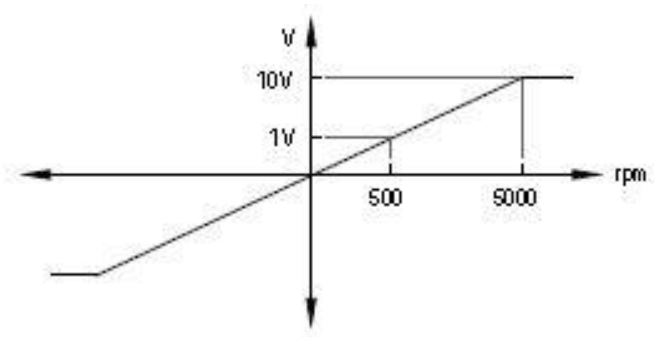
[Setting] Ft-5.05 = 1, Ft-5.07 = 500

[Meaning]

Confirm the speed command of host controller through the analog monitor output CH1.

[Description]

The speed command confirmation of host controller applicable to monitor output 1 [V] is 500 [rpm]. By outputting of maximum of 10 [V], the confirmation can be made up to 5000 [rpm]. Accordingly, the confirmation range of entire speed command is -5000 [rpm] to 5000 [rpm].



<Monitoring Example 2>

[Setting] Ft-5.05 = 34, Ft-5.07 = 10000

[Meaning] The Absolute Encoder Single-revolution Data value is outputted through CH1. At this time, 10000 pulses are outputted at 1 V.

<Monitoring Example 3>

[Setting] Ft-5.06 = 44, Ft-5.08 = 10.000

[Meaning] The Average Torque Load Ratio is outputted via CH2. At this time, 10% is outputted at 1 V.

Use of Absolute Encoder

It describes on the matters related to the absolute encoder, battery and other absolute encoder.

What is an Absolute Encoder?

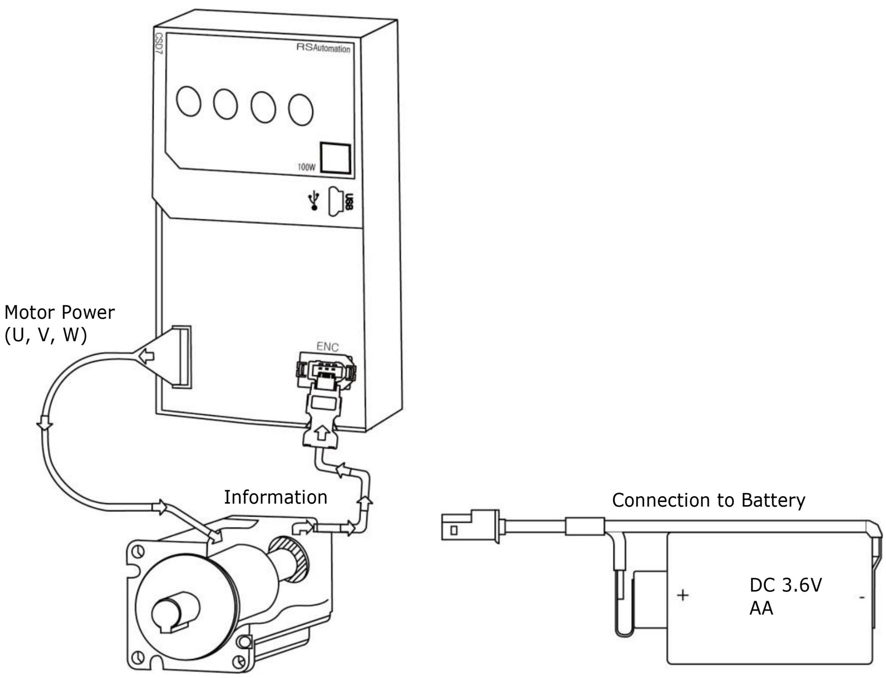
Absolute encoder is an encoder that can detect the absolute position of input. Absolute encoder can store and memorize the absolute position information of the load system by using the battery power if the power of servo drive is cut off. Absolute encoder does not accumulate the error by the noise during the signal transmission. Also, if the power is cut off as in the incremental encoder, there is no need to adjust again for initial load position, and the operation of equipment can immediately be executed by using the saved information.

When the host controller needs the absolute position of load system in the power cut off, the motor that is equipped with the absolute encoder has to be used.

Types of Absolute Encoder:

- Q type serial absolute encoder (17-bit serial·absolute encoder)

Drive Output and Encoder Information Flow:



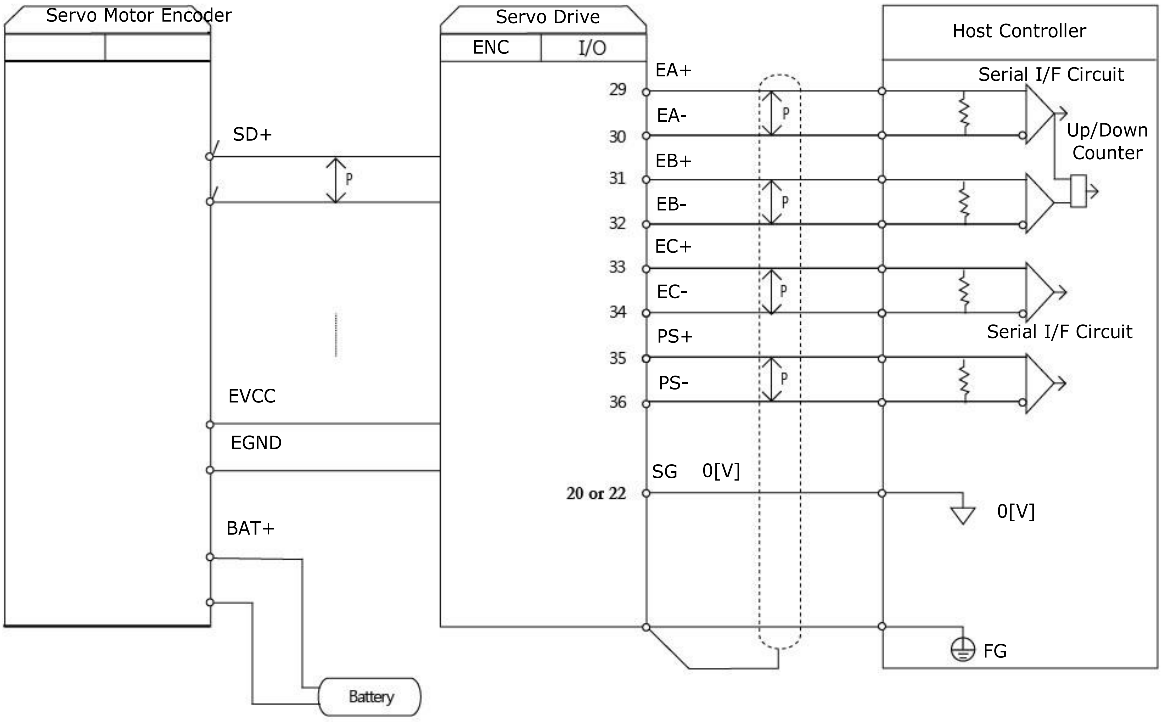
Absolute Encoder has to be connected with the Battery. The battery memorizes and maintains the absolute position of load system when the servodrive power cut off.

Contact with the Host Controller

When the motor equipped with the absolute encoder is used, the standard connection with the drive and host controller is as below figure.

For memorizing and maintaining the absolute position information, the absolute encoder shall be connected to a battery.

The battery may be connected to motor encoder cable.



Battery

Battery

It describes the battery for absolute encoder information preservation.

When the power of servo drive is cut off, the battery memorizes the absolute position of the load system and helps maintain it.

If the power of servo drive is cut off and discharged the battery power to lower than the standard, the saved information in absolute encoder may be damaged.

Battery specification : 3.6 [V]

The voltage of battery is not directly monitored from the drive but the error is checked indirectly through the encoder. Prepare the low voltage detection circuit as needed basis.

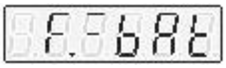
Battery Voltage Diagnosis

The voltage monitored with encoder is displayed for servo warning and fault depending on the following situation.

- Servo Warning

  When the voltage of battery for absolute encoder is 3.2 [V] or less, Absolute encoder battery low voltage warning. occurs. At this time, the below warning characters are displayed in the status display mode.

  Replace the battery before having 'Battery low voltage fault for absolute encoder' occurs with the battery low voltage in having the warning.



- Servo Fault

  When the voltage of encoder inside is detected about 2.7 [V] or less, the battery low voltage fault for absolute encoder occurs. At this time, the servo drive stops the operation.

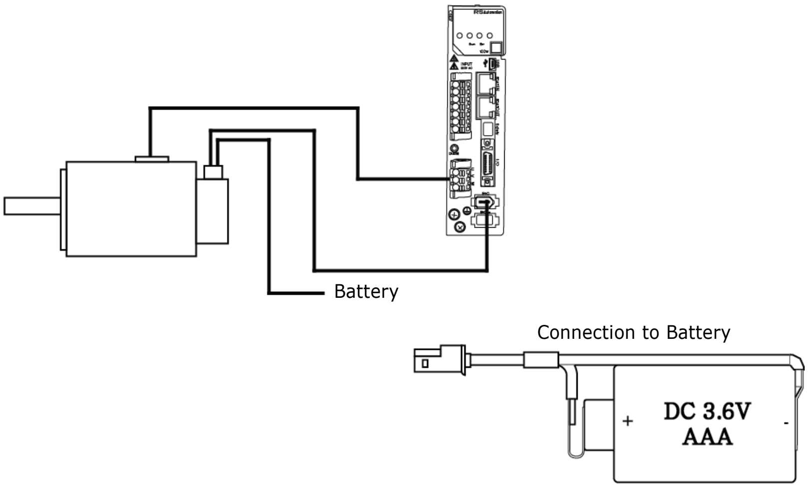
  When 'Battery low voltage fault for absolute encoder' occurs, the saved information on encoder may be damaged.

NOTE

- In case of the Q type 17-bit absolute encoder, when an absolute encoder batter low battery warning occurs, the warning is reset only by running the fault reset (run-08). At this time, both multi-turn and single-turn data are reset.

Connecting Battery to Encoder

The below figure is how to connect the battery to encoder of servo motor.



1. Prepare the proper battery for specification.
2. The polarity is consistent if the battery specification is complied.

Reset of Absolute Encoder

Implement the absolute encoder reset (run-10) in the following cases.

- For initial trial operation
- When separate the drive and encoder cable after cutting off the power and connected again.
- When wanting to reset the number of rotation data.

Caution has to be taken on the following;

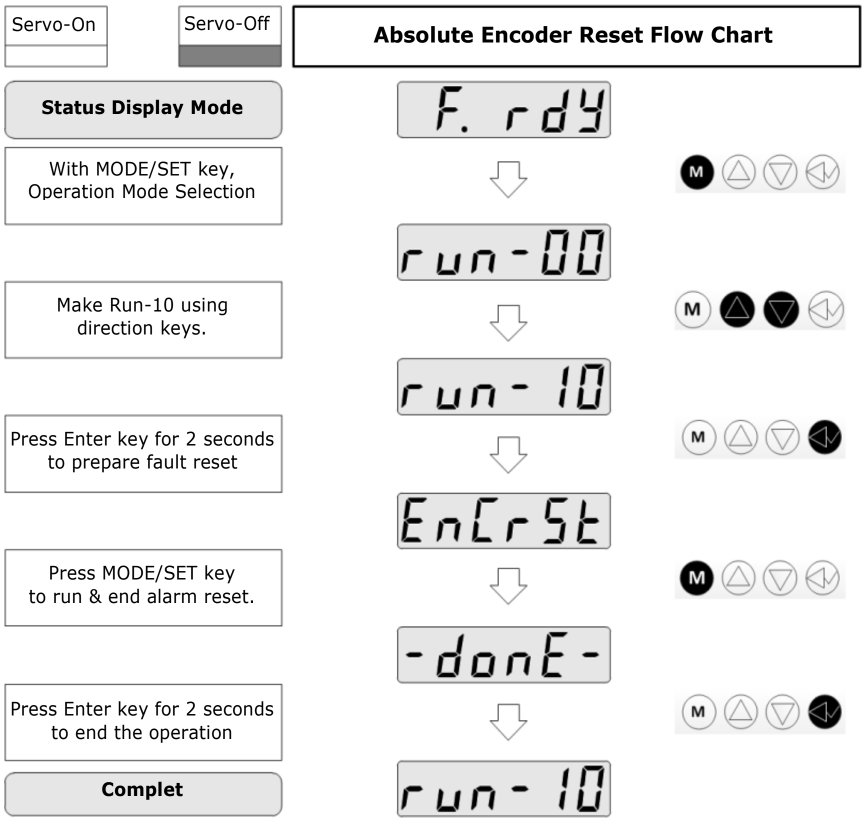
- The reset operation of absolute encoder is possible only in servo-OFF status.
- Performing the absolute encoder reset differs from performing the fault reset. Read carefully the following table 7.26 prior to use.

Table 7.26 Absolute Encoder Reset and Fault Reset per Encoder Type

Command	Q Type Encoder
Fault Reset (run-08)	• Fault Clear • Upon the following fault, the multi-turn data and single-turn data are reset. E.ABSOS(E.084) E.MTCOF(E.028) E.MTCER(E.085) E.ABSBE(E.083) • If the CNT warning is not removed automatically, the CNT warning is cleared.
Absolute Encoder Reset (run-10)	• Multi-turn data and single-turn data reset • If the CNT warning is not removed automatically, the CNT warning is cleared.

NOTE When using an absolute encoder, you must reset the absolute encoder in order to reset the multi-turn data.

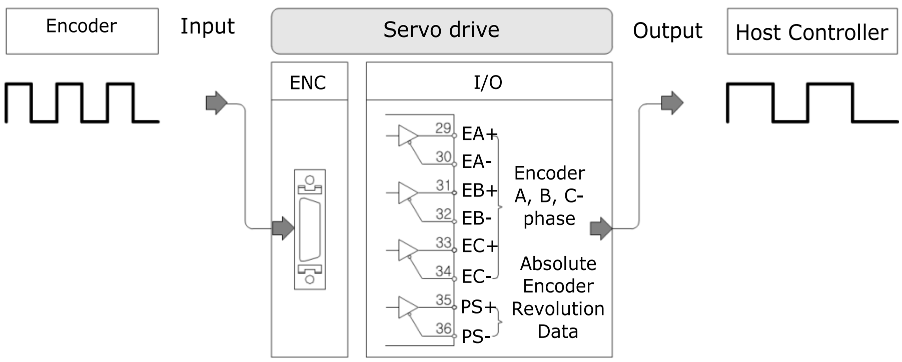
Refer to the below flow chart to make absolute encoder reset.



Data Transmission of Absolute Encoder

This Chapter describes the sequence of drive receiving the data of absolute encoder and sending it to the host controller. After sufficiently understand it, and then design the host controller.

As shown in the figure below, the drive is outputted for absolute information through the PS(+,-), EA(+,-), and EB(+,-) terminals.



PS (+, -) Serial Data Frame Structure

Through the PS output, the structure of transmission frame of data sending to host controller is as follows.

Data is structured with multi-rotation data, single-rotation data, and fault. The transmission size of data varies depending on the data.

Table 7.27 PS Output Data of Encoder

Absolute Encoder	Multi-rotation Data	Single-rotation Data	Transmission Cycle
Q Type Encoder	16 bits	17 bits	50 [ms]

Structure of transmission frame is like below.

Structure of transmission frame (Q type absolute encoder)

Table 7.28

<table>
<tr><td rowspan="2">STX</td><td colspan="3">Absolute Data (Variable digit)</td><td rowspan="2">&</td><td rowspan="2">Data (3bit)
(Fault Content)</td><td rowspan="2">BCC</td><td rowspan="2">ETX</td></tr>
<tr><td>Multi-RationData
(0 to 65535)</td><td>&</td><td>1 Rotation Data
(0 to 131071)</td></tr>
</table>

Table 7.29 Data Transmission Format

Item	Description
Data Transmission Method	Asynchronous
Baud rate	9600 [bps]
Start Bit	1 bit
Stop Bit	1 bit
Parity	None
Character Code	ASCII
Data Format	10 - 19 Characters

NOTE

Through the monitor mode (dIS-22) of the “Monitor Mode Function” on page 7-45 the multi-step rotation data of absolute encoder can be confirmed. Division ratio is applied to 1 rotation data sent to PS output.

Cautions

STX indicates the beginning of transmission packet, and is applicable to ASCII code 02H.

ETX indicated the end of transmission packet, and is applicable to ASCII code 03H.

Multi-step rotation data has the range of -32768 to +32767 and +/- indicates normal/reverse rotation direction .

Serial Data Standard for EA(+, -), EB(+, -)

For the host controller not receiving the serial data output using the PS (+, -), the data of absolute encoder is sent to the host controller in the form of incremental pulse form through the output of EA and EB, the incremental encoder output signal. At this time, the pulse ouputted at a speed of 1 [Mpps]. From the absolute dta, send the 1 rotation data first, and then send the multi-rotation data. The host controller multiplexes the received pulses by 4 times.

Sequence of receiving the absolute serial data through EA and EB.

1. Clear the Up/Down counter for incremental pulse counter to 0 and make it in the absolute encoder data receiving standby status.
2. The /ABS-DT signal inputted to drive is maintained in low level for 10 [ms] or more. (For Sequence Input Signal/ABS-DT Signal Distribution, refer to Chapter 5-1 page “equence I/O (Input/Output) Signal”.)
3. After 100 [ms] since /ABS -DT OFF is off, receive the multi-ration data transmitted from the drive.
4. Receive multi-rotation data , and receive the 1 rotation data transmitted after 100 [ms].
5. EA and EB of drive are operated in normal incremental encoder output signal after the lapse of about 50 [ms] after thransmitting the 1 rotation data to which division ratiro is applied.

PAO Serial data reception sequence

For the meaing of each signal, refer to table below.

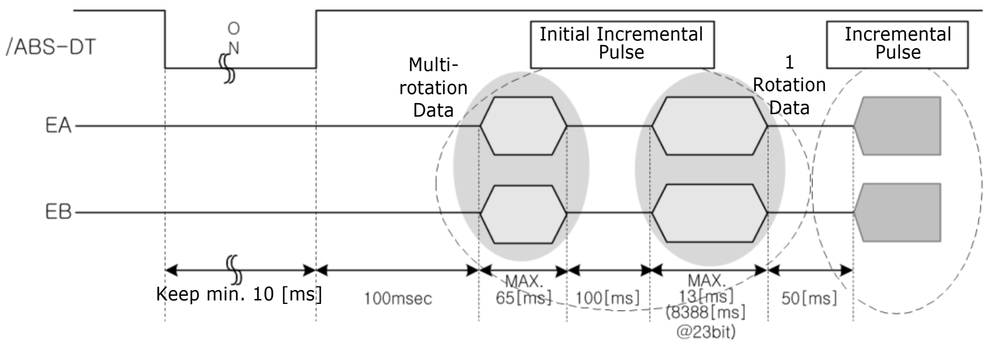


Table 7.30 Content of Each Signal

Signal	Status	Puls
EA (+,-)	When initialize it by turning on the power	Initial incremental pulse
	In normal operation after the initialization	Incremental pulse
EB (+,-)	In normal operation after the initialization	Initial incremental pulse
	In normal operation after the initialization	Incremental pulse
EC (+,-)	Always	Original Pulse
PS (+,-)	Always	Serial data of absolute encoder

When Using the Absolute Encoder Without a Battery

A, H Type Absolute Encoder can be used without a bettery.

1. When the power is connected initially, the battery low voltage fault (E.AbSbE) of the absolute encoder will occur.
2. After waiting the time long enough to fully charge the internal capacitor of the encoder, run the absolute encoder reset (run-10, multi-rotation data reset) and then run the fault reset (run-08) again.
3. After a normal reset without battery, the battery low voltage warnnig will occur continuously, however the servo drive can be operated.

NOTE

- While operating, if the power cut-off time is prolonged until the internal capacitor of the encoder totally discharges, [E.AbSbE] will go off again. In this case, repeat the above process
- The internal multi-rotation data of the encoder may be damaged when the power is cut off while operating without a backup battery.

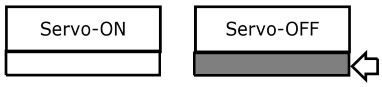
The serial absolute encoder (Q type) checks if the battery is connected and sends the data to the drive; [E.AbSbE] error will continue if there is no a battery. At this time, adjusting the parameter so the serial absolute encoder can be recognized as a serial incremental encoder will enable the operation of the motor.

Operation Mode Function

Things to Know First

First understand the below content before reading the description of the operation mode.

- From the flow chart content, the content of display of status display mode may be different from the actual condition.
- The content displayed in the flow chart and the key operation sequence is the same with the actual condition.
- The black part of key button mark on the right means to press.
- The upper left side with servo-ON, servo-OFF means the status of servo drives status in setting.
- It describes to the order from (run-00) to (run-12).
- Before using the functions of operation mode, the content of each functions and flow chart shall sufficiently understand and operate it. Adjust or operate in the black display status.



When the status of drive is not maintained, the following content is displayed during the performance or storage of each operation ode.

Jog Operation (run-00)

Function Description

By using the direction key of the operator, the motor can be made for forward rotation or reverse rotation.

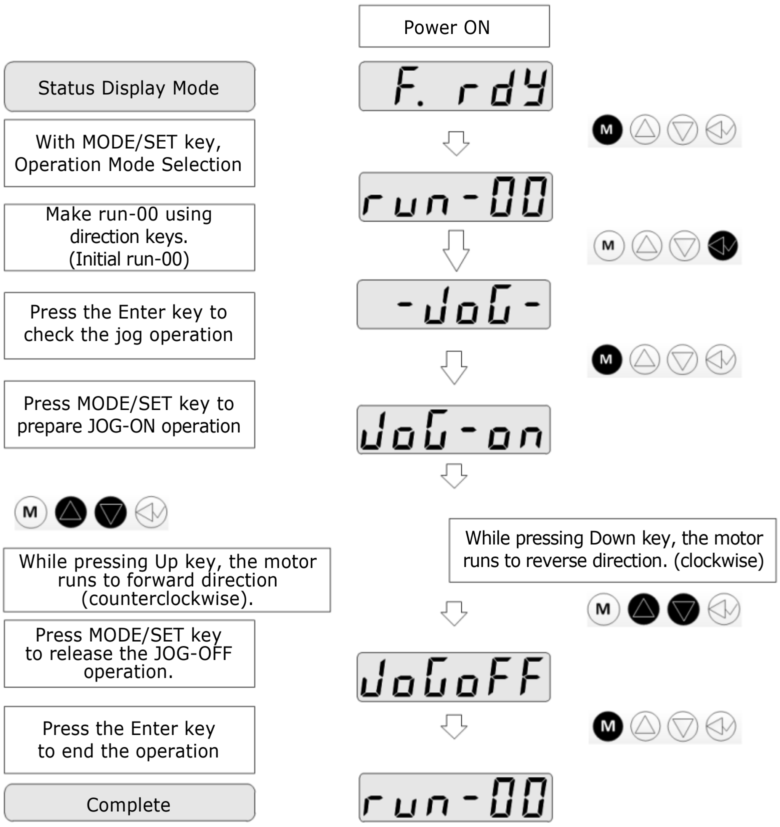
It is an appropriate function when the trial operation of equipment or simple operation is required.

The speed of the motor is determined with the setting value of [Ft-2.05]. Confirm the setting value of [Ft-2.05] in advance before operation and adjust it for situation. The operation can be possible in the range of 0 to 6000 [rpm]and the initial setting speed is 50 [rpm].

How to Operate

Refer the flow chart of the below and operate.

Commissioning Flow Chart for Jog Operation run-00



Off-line Auto Tuning Operation (run-01)

Function Description

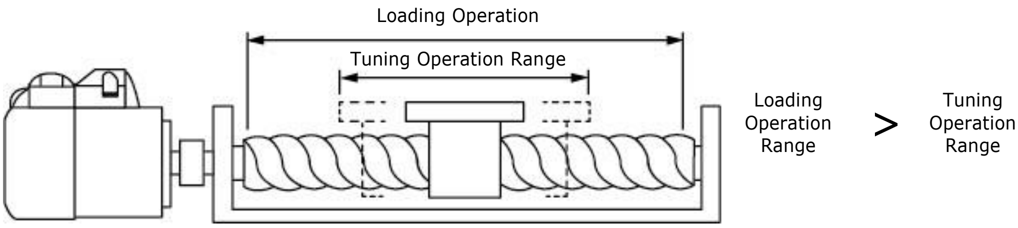
Refer the Chapter 6-9 page "Auto Gain Setting" for detailed description on off-line auto tuning.

Caution

The following shall be carefully reviewed before operation.

CAUTION

- With the jog operation of the Chapter 7-36 page "Jog Operation (run-00)".
- The motor rotates 3 times in 360° forward and reverse direction.
- Confirm the loading not to exceed the operation range during tuning.



How to Operate

Refer to the below flow chart to operate.

Flow Chart of Off-line Auto Tuning Operation

Servo-On | Servo-Off

Status Display Mode	F. rdY
With MODE/SET key, Operation Mode Selection	run-00
Make run-01 using direction keys.	run-01
Press Enter key for 2 seconds to prepare auto tuning.	-AUto-
Press MODE/SET key to run auto tuning.	
Motor Rotation! The optimum tuning suitable for load is done. The setting values are saved automatically after tuning.	
Auto Tuning Complete	-donE-
Press Enter key for 2 secs to end the operation	
Complete	run-01

Auto Adjustment of Speed Command Offset (run-03)

When of operating the speed mode by the host controller or combination control mode related to the speed, it is a function to automatically adjust with the offset voltage of the speed command.

Function Description

When the analog speed voltage command is made to 0 [V], the motor has to stop. But there is such a case that the motor slowly rotates. This is because of the phenomenon that the small amount of voltage offset by the host controller or external circuit. This function automatically adjusts such an offset voltage.

Operation Sequence

Connect the host controller to the I/O and the speed voltage command is made to 0 [V].

At this time, if the motor is not rotating, it can be said that there is no offset voltage. However, if the motor is slowly rotating, there is an offset voltage occurring.

Make automatic offset adjustment. The drive reads the voltage of adjustment as 0 [V] and stops the motor.

Others

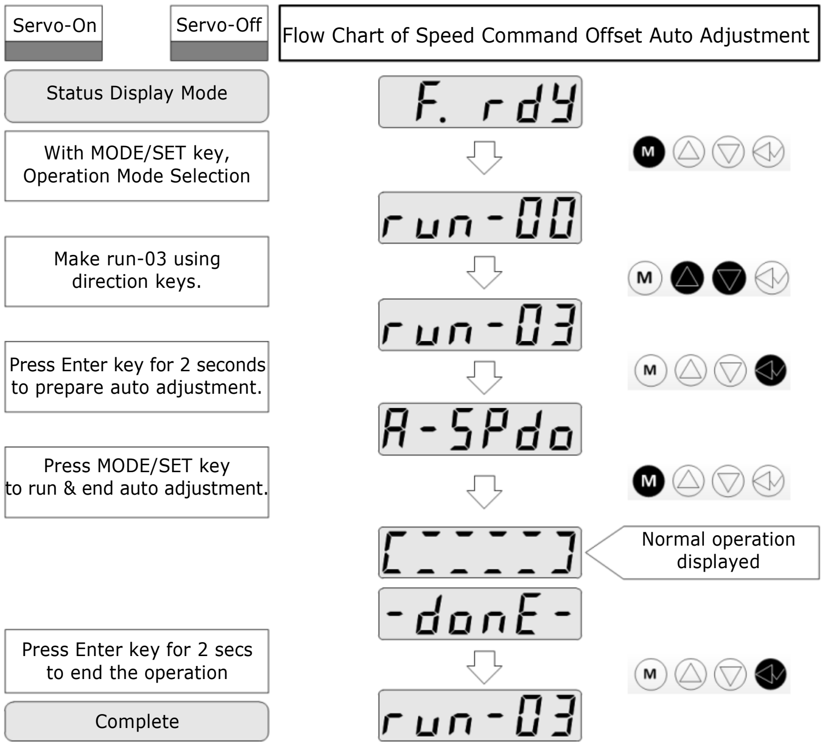
The voltage range that is possible for offset adjustment is .1 [V] to +1 [V]. The voltage exceeding the range cannot be adjusted, and there is no showing in the display during the normal operation in the below figure.

The actual size of offset voltage can be confirmed in [dis-14] of The Chapter 7-45 page “Monitor Mode Function”.

Understand the speed zero-clamp function of velocity control mode of the Chapter 5-35 page “Zero Clamp </Z-CLP> Input” together.

How to Operate

Refer the below flow chart and operate.



Auto Adjustment of Torque Command Offset (run-04)

When the operation is made with torque control mode from the host controller or combination control mode related to torque, it is a function to automatically adjust with the offset voltage of the torque command.

Function Description

When the analog torque voltage command is made to 0 [V], the motor has to stop. But there is such a case that the motor slowly rotates. This is because of the phenomenon that the small amount of voltage offset by the host controller or external circuit. This function automatically adjusts such an offset voltage.

Operation Sequence

Connect the host controller to the I/O and the torque voltage command is made to 0 [V].

At this time, if the motor is not rotating, it can be said that there is no offset voltage. However, if the motor is slowly rotating, there is an offset voltage occurring.

Make offset automatic adjustment. The drive reads the voltage of adjustment as 0 [V] and stops the motor.

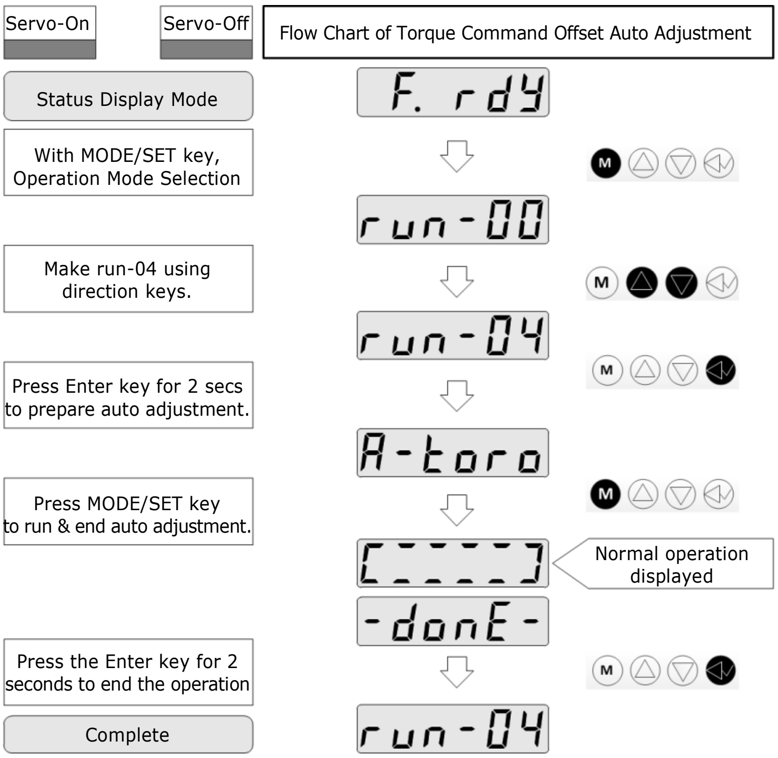
Others

The voltage range that is possible for offset adjustment is -1 [V] to +1 [V]. The voltage exceeding the range cannot be adjusted, and there is no showing in the display during the normal operation in the below figure.

The size of actually offset voltage can be confirmed in [dis-13] of the Chapter 7-45 page “Monitor Mode Function”.

How to Operate

Refer the below flow chart and operate.



Fault Reset (run-08)

Servo drive may reset the servo fault detected by the independent error diagnostic function.

Function Description

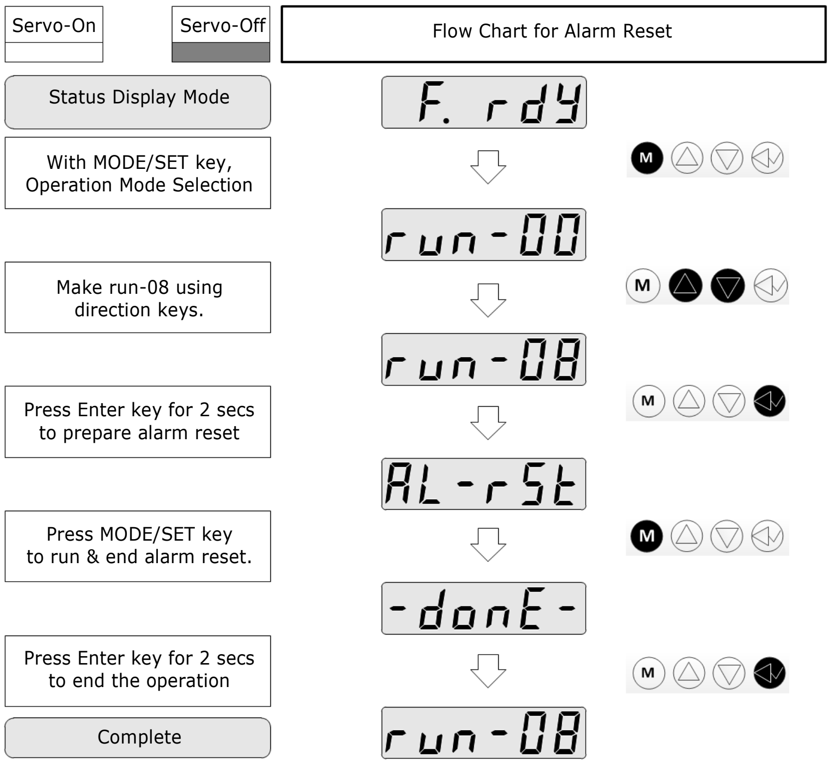
The drive monitor the system with the independent error diagnosis function from the moment the power is connected. At this time, if there is an error in the servo drive, it displays the servo fault.

User has to understand the content of fault and resolve the causes of fault for a normal use of the drive. If an fault occurs, find out the content of fault and resolve it. After that, reset it through the fault-reset operation. When the content of fault is resolved with no further problems, the occurred fault is no longer displayed.

Even if the reset is made, if the action taken is not sufficient or other error occurs, the drive continuously displays the fault content.

How to operate

Refer to the flow chart below and operate.



Fault Reset by Sequence Input </A-RST> Signal

There is another way to reset the fault by using the sequence input signal </A-RST>. Refer to the Chapter 5-1 page "Sequence I/O (Input/Output) Signal".

Chapter #8 describes the detailed content relating to servo fault.

Also, the history of fault occurred from the beginning to this point can be inquired through the monitor mode. (Refer to the 7-45 page "Monitor Mode Function".)

Absolute Encoder Reset (run-10)

For details on the absolute encoder reset, refer to "Absolute Encoder Reset (run-10)" on page 7-42.

2-Group Gain Storing (run-11)

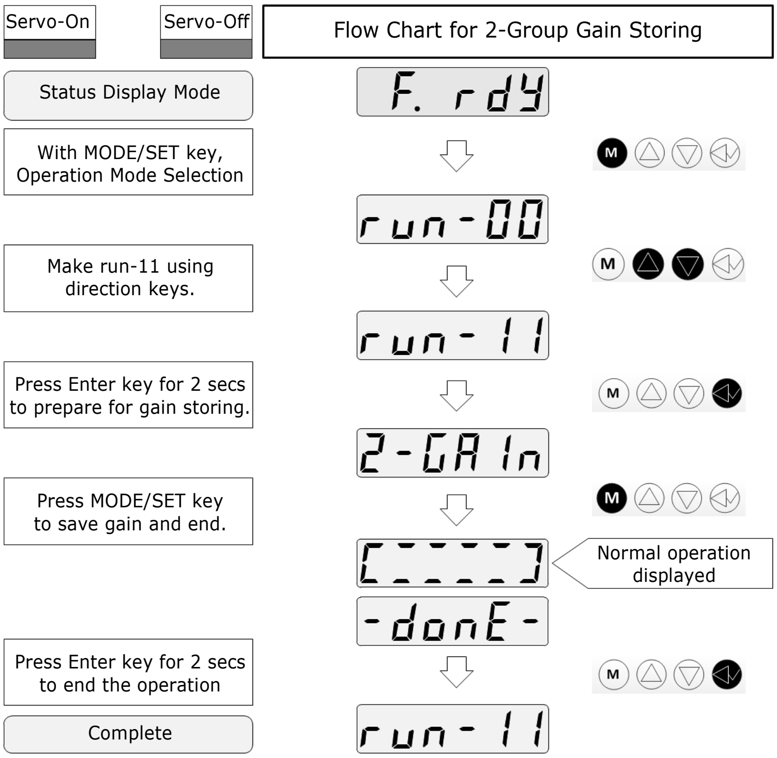
Function Description

Understand the content of the Chapter 6-37 page “</G-SEL> Function” first.

When the optimal tuning that is appropriate to the load system is made, it is stored.

How to Operate

Refer to the flow chart below and operate.



NOTE

When the </G-SEL> function of the Chapter 6-37 page “</G-SEL> Function” is not used, the main storage function meaningless. Understand the contents of the 6-37 page “</G-SEL> Function” first.

Parameter Initialization (run-12)

This function is to initialize the user parameter to the same status as the factory setting values.

General Matter

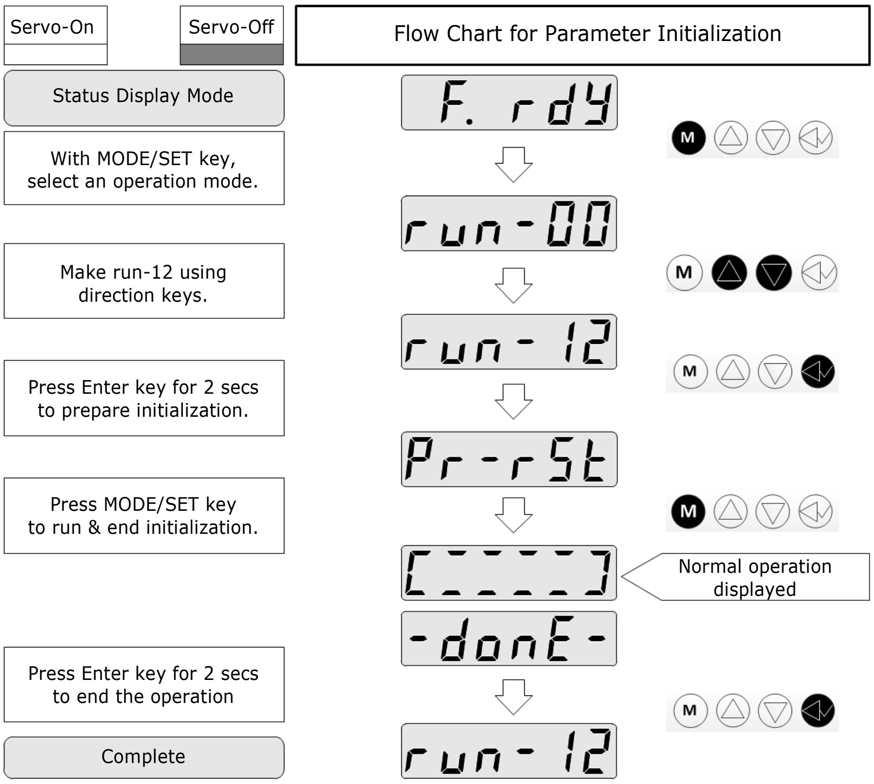
The initialization of parameter is operated carefully. After initializing parameter, the parameter has to be reset in meeting the load.

The below parameters are not changed after initializing parameter. For changing the below parameters, change them manually.

- [Ft-0.00] Control mode setting (optional)
- [Ft-0.06] Auxillary function selection 2
- [Ft-2.01] Analog velocity command offset
- [Ft-4.01] Torque command offset

How to Operate

Refer to the flow chart below and operate.



Monitor Mode Function

Monitor Mode Function

The below chart describes the function expressed in each monitor.

Table 7.31 Monitor Mode

Monitor Mode Item	Name	Unit
(dis-00)	Speed Feedback	rpm
(dis-01)	Speed Command	rpm
(dis-02)	Speed Error	rpm
(dis-03)	Torque Command	%
(dis-04)	Position Feedback	pulse
(dis-05)	Position Command	pulse

The [dis-04] and [dis-05] are displayed each upper and lower digits (5 digits each, total 10 digits) separately by left and right key in case of overflowing count data.

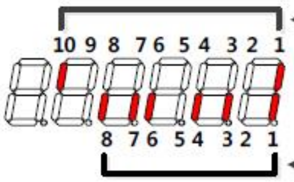
Table 7.32 Monitor Mode

Monitor Mode Item	Name	Unit
(dis-06)	Position Error	pulse
(dis-07)	Position Pulse Command Frequence	kpps
(dis-08)	Electronic Angle	°
(dis-09)	Mechanical Angle	°

(dis-10)	Regeneration Accumulation Loading Rate	%
(dis-11)	DC Link Voltage	V
(dis-12)	Multi-rotation Data of Absolute Encoder	-
(dis-13)	Speed Command Offset	mV
(dis-14)	Torque Command Offset	mV
(dis-15)	Input & Output Status	-

< Monitor mode dis-15 >

When the sequence input & output, emergency stop and servo fault signal are on, the applicable displays of each position are lit.



Digital input status : 1 ~ 10

1. LED is turned on, when digital input is ON.

The status of digital output, E-STOP and Fault

2. 1st digit : Drive fault (LED is turned on while no fault occurs.)
3. 2nd digit : Digital output 1 (LED is turned on while signal is output.)
4. 3rd digit : Digital output 2 (LED is turned on while signal is output.)
5. 4th digit : Digital output 3 (LED is turned on while signal is output.)
6. 5th digit : E-STOP (LED is turned on if Ft-0.05[D3]=1 and E-STOP signal is input)
7. 6~8th digit : Fault code / Digital output 4~6

   7.1 Using fault code

   - Three LED are turned on while no fault occurs.
   - If fault occurs, three LED are turned on according to fault group (1: ON(0)-ON(0)-OFF(1) ~ 7: OFF(1)-OFF(1)-OFF(1))

   7.2 Using Digital output (It should be allocated as sequence output.)

   - 6th digit : Digital output 4 (LED is turned on while signal is output)
   - 7th digit : Digital output 5 (LED is turned on while signal is output)

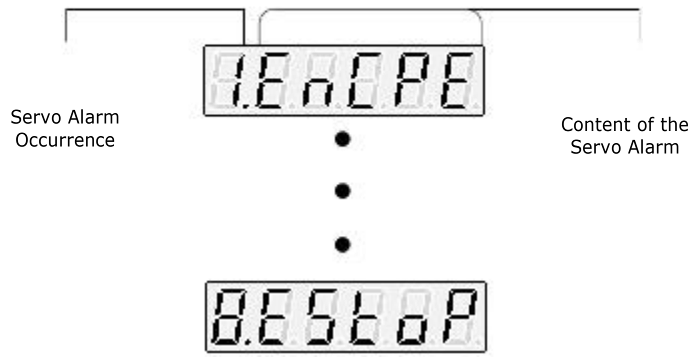
- 8th digit : Digital output 6 (LED is turned on when signal is output)

Table 7.33 Monitor Mode

Monitor Mode Item	Name	Unit
(dis-16)	Up to 8 Servo faults are stored.	

The fault that occurs most recently is the number 1 servo fault occurrence. If all 8 faults are stored, the fault occurring thereafter is stored as number with the earliest fault (No. 8 fault) is deleted.

Refer the Chapter 8-3 page "Servo Warning".



(dis-17)	It displays the software version of servo drive. Example of Version Display:
(dis-18)	Motor and Encoder Type

Example of CSMT-04BQ1ANT3 (CSMT motor, 400W, 17bit absolute encoder)

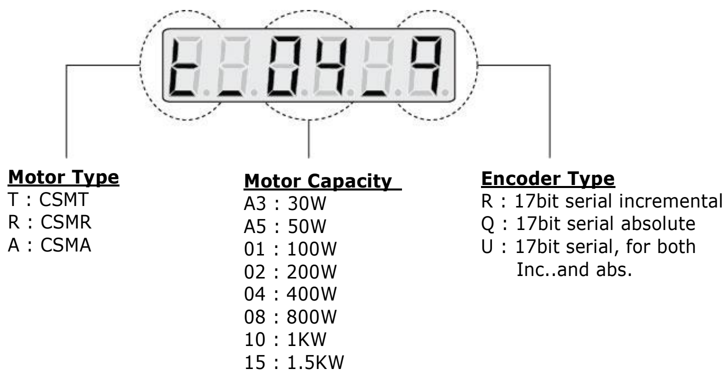


Table 7.34 Monitor Mode

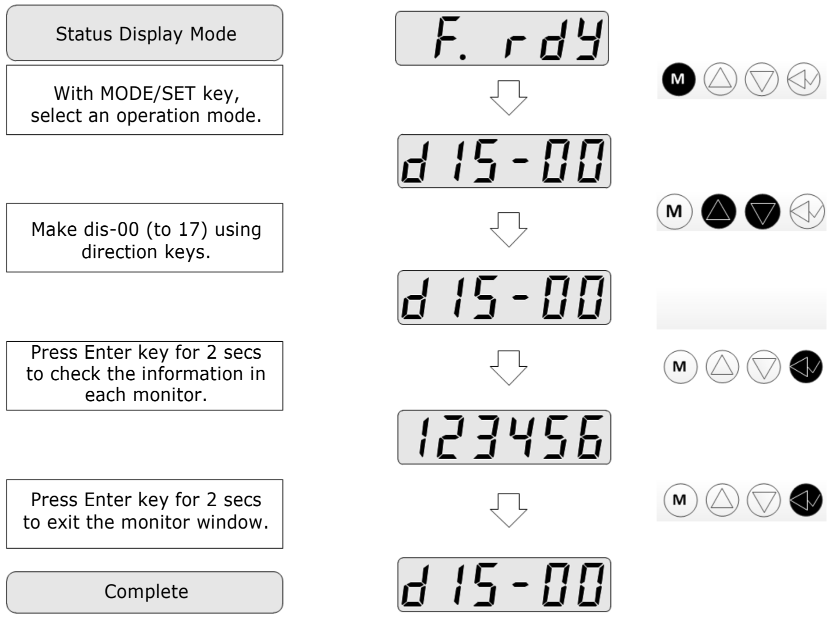
Monitor Mode Item	Name	Unit
 (dis-19)	Analog Speed Command Voltage	V
 (dis-20)	Analog Torque Command Voltage	V
 (dis-21)	Drive Rated Output	-
 (dis-22)	Absolute Encoder 1 Rotation Data	
 (dis-23)	Encoder Feedback Data	pulse
 (dis-24)	Current Command Max. Value	%
 (dis-31)	Effective Torque Load Ratio	Current Command Max. Value [%]
 (dis-32)	Effective Torque Max. Load Ratio	Effective Torque Load Ratio

Key Button Operation

It describes the key button operation of monitor mode.

The content of monitor mode can be confirmed regardless of servo drive status. Refer to the below flow chart to confirm the content of each monitor item. Use the upper and lower direction key to confirm the fault history [dis-16].

Flow Chart for Monitor Mode Key Button Operation



Inspection and Protection Functions

In this chapter, the inspection and the protective function of servo drive are described.

Inspection

It describes the basic inspection, abnormality diagnosis and how to take action of servo motor and drive. Also, it describes the protection function of drive and action to take in times of fault occurs as well as any action to take in times of breakdown following the fault code.

Inspection of Motor

Servo motor does not have a brush that causes mechanically abrasive part. A simple inspection is sufficient as follow. By considering the use environment, determine the appropriate inspection time.

Table 8.1 Motor Inspection

Check List	Check Period	How to check and repair	Action
Vibration and Noise	Daily Check	Determine with Sense and Hearing	It shall not be larger than normal times
Presence of Eternal Foreign Substance	In Occurrence	Cleaning with Vacuum Cleaner	
Insulation Resistor	1 Year	Measure with Insulation resistor meter 500 [V] 10 [MΩ]	Inquiry to the company if the measuring value is 10 [MΩ] or less
Oil Seal	5000 Hours	Oil Seal Replacement	Only for motor that has oil seal
Overall Inspection	20000Hours(5 Years)	Inquiry to the Company	Disassembly and worn-out part replacement

CAUTION

In the event of disassemble the servo motor for repair or inspection; a care shall be taken for A/S not available.

Inspection of Servo Drive

Servo drive is equipped with electronic circuit. The dust and foreign substance may cause the breakdown or malfunction that the dust shall be cleaned and tighten the nuts on a regular basis (1-year).

Table 8.2 Servo Drive Inspection

Item	Period	Inspection and Repair	Action
Cleaning of Main Body and Board	Once or more per year	Do not have dust or oil	Clean with compressed air or fabric
Socket, Connector, Nut	Once or more per year	Do not allow loosening of\ socket, connector, nut and others	Do not allow loosening
Abnormal Part on Main Body and Board	Once or more per year	There is no discoloration by heat, damage or open circuit	Inquiry to the company

CAUTION

In the event of disassemble the servo drive for repair or inspection; a care shall be taken for A/S not available.

Part Inspection

The part below may have mechanical abrasion or material degradation.
A regular inspection is needed for prevention and preservation.

When the annual average ambient temperature is 30°C or less, the load rate is 80% or less, and the operation rate is 20 hours or less a day, the life of key products is as follows.

Table 8.3 Servo Dirve's parts life

Parts	Use Period
Capacitor	5 Yeas
Cable	3 Years(based on flexible cable)
Power Device	3 Yeas
Regeneration Resister	2 Yeas
Dynamic Break Resister	2 Yeas
Fan	2 Yeas
Cooling Fan	8 Yeas
Fuse	10 Yeas

Battery Inspection for Absolute Encoder

Refer to Chapter 7-30 page "Battery" for absolute encoder battery.

Protection Function

It describes the equipped protection function and actions taken in times of abnormal operation in order to protect the servo drive and load system. The protection function is classified into two types depending on the importance.

- Servo warning: It displays a minimal abnormality that does not require the suspension of operation when occurred.
- Servo fault: It displays the very serious abnormality that requires the suspension of operation when occurred.

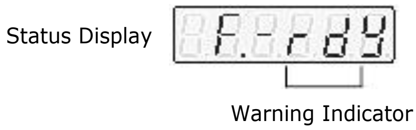
It is classified depending on the importance, but when an abnormality occurs, remove the cause immediately and use the servo drive in normal conditio.

Servo Warning

There is a servo warning that displays a minimal abnormality as the protection function by the self-diagnosis.

Servo Warning Indication

It displays the mark that is applicable to a warning through the Status Display Mode.



The warning is displayed on the 3 digit of 7-segment as shown on the left. The character displayed the normal operation status does not flicker, but once the abnormality applicable for servo warning is sensed, the applicable character is displayed and flickers.

Servo Warning Types

Servo drive displays the warning characters for the following 7 ituations.

Table 8.4 Causes and Actions for Servo Warning

Indicator	Cause	Action
[Cnt] AbsoluteEncoder Counter Overflow	In the event the Q Type Absolute Encoder is rotated forward or reverses over 32768 revolutions, it is displayed.	• Reset the multi turn data of absolute encoder.
[bAt] Low Voltage of Absolute Encoder Battery	It occurs when the voltage of battery or external power supply of absolute encoder is 3.2 [V] or less.	• Replace the battery or external power supply to make sure. [1]
[FAS] Abnormal Initial Status of Encoder	During the drive motor for moving the control power has been applied. Abnormal initial value of incremental encoder after power on	• After making sure that the motor stops turning off the control power.
[oCC] Over (external) Current Command	Analog current scale setting Inadequate.	• Check if the scale constant is suitable for range of the analog signal.
	The system does not support the motion profile.	• Check the speed loop tuning. • Check the capacity of the system.
	Current limit setting is inappropriate.	• Check if the current limit lower than the current limited capacity of the system.
[oSC] Over(external) Speed Command	Analog current scale setting inadequate.	• Check if the scale constant is suitable for range of the analog signal.
	The system does not support the motion profile.	• Check the position loop tuning. • Check the capacity of the system.
[Pin] Allocation Error of Sequence Input and Output	Digital input or output of the allocation is inappropriate.	• When working in the preset mode, check if it is allocated for preset. • When working in the normal / override mode, check if it is allocated for override function.
[CAP] Over Motor Capacity	It occurs when motor power is set higher than the drive rated output.	• Use a motor suitable to the drive or set the torque limit below the drive capacity.

[1] When replacing a battery, absolute position is lost. Homing may be required.

Servo Fault

For protection function by the self-diagnosis, there is the servo fault that displays the important errors.

Table 8.5 Servo Fault Types

Fault Code	Text Message	Cause	Action
E.005 IPM Error	E.IPMFt	Motor cable shorted	• Check if the motor power cable and theconnector are not shorted.
		Occurs when the winding wire of the motor is shorted internally.	• Disconnect the motor power cable from the motor. If the motor will not be rotated by hand, a replacement may be needed.
		Occurs when exceeding the continuous power rating while operating.	• Check if the ambient temperature is too high. • Operate within the continuous power rating. • Decrease the acceleration rate.
		Occurs when an unsuitable IPM output, short circuit or over current exist in the drive.	• Check the wiring connections that go from DC U, V, and W motor terminals to the DC BUS after disconnecting the power and the motor. If the connections are normal, check the wires between terminals or have the drive repaired.
		Occurs when the IPM operation power of drive is low	• Check if the IP16V power of the power board is 15 V or above.
E.006 FAN fault	E.FAn	Fan attached on servo drive work abnormally.	• Check whether there are foreign substance on the fan blade, and remove it. • Check wheterh the fan cable is connected to the servo drive properly.
E.009 BUS Low Voltage	E.UdvtG	AC line/AC power input is low.	• Check the voltage level of the incoming • Check the noise pulse of the AC power or for a voltage drop. • Install an Uninterruptible Power Supply (UPS) to the AC input.
		Attempted to activate the drive without turning on the main power.	• Before activating the drive, turn on the main power.
E.010 BUS Over Voltage	E.ovvtG	Occurs when the power regeneration is excessive. That is, the drive generates an error to protect itself from the overload when its main power supply regenerates excessive peak energy while the motor is run by the external mechanical power.	• Check the regenerative circuit. • Adjust the motion profile and keep theregeneration resistor within the limit. • Replace the regenerative transistor. • Replace the drive.
		Excessive AC input voltage	• Confirm the input value.

Fault Code	Text Message	Cause	Action
E.012 Home Searching Failed	E.HFAIL	Homing is incomplete within the time assigned in Homing Time Limit (IN-01.11).	• Increase the time assigned in Homing TimeLimit (IN-01.11). • Set the value other than '0' in Homing Speed (IN-01.02) and Creep Velocity (IN-01.03). • Check for an obstruction in homing. • Check the homing related parameter setting and mechanical parts.
E.018 Motor Over-speed	E.ovSPd	Motor speed exceeds the maximum.	• Check the wiring of the encoder. • Retune the drive system. • Check the input gain of the torque command or the external speed command. (Ft-2.00, Ft-4.00).
E.019 Position Error Limit Exceeded	E.PoSEr	Occurs when the position error exceeds the allowed value.	• Increase the Following Error Limit value. • Check the position loop tuning.
E.022 Motor Continuous Current Overload	E.ConoL	Occurs when the internal filter that protects the motor from overheating trips.	• Decrease the acceleration rate. • Decrease the duty cycle (ON/OFF) of the motion assigned. • Increase the time for the motion allowed. • Use a drive or motor with bigger capacity. • Check the tuning.
E.023 Drive Overload	E.drvoL	Occurs when the drive average current exceeding the rated capacity is needed for the motion application.	• Decrease the acceleration rate. • Decrease the duty cycle (ON/OFF) of the motion assigned. • Increase the time for the motion allowed. • Use a drive or motor with bigger capacity. • Check the tuning.
E.024 Absolute Data Transmission Timeout	E.AbSto	/ABS-DT input is not turned on within 5s from Absolute Position Transfer Ready-On during Absolute Position Transfer Mode using photo coupler output.	• Verify the sequential timing of Absolute PositionTransmission Ready & /ABS-DT, Absolute PositionTransmission Mode input. • Check if the I/O cable and connector is disconnected.
		/ABS-DT input is not turned off within 5s from Absolute Position Transfer Ready-Off during Absolute Position Transfer Mode using photo coupler output.	
		Absolute Position Transfer Mode input is not turned off within 5s after absolute data transfer completion.	
E.027 Homing Incomplete	E.notHM	Occurs when an axis didn't return to home before the drive can operate an absolute coordinate index.	-
E.028 Encoder Date Range Error	E.MtCoF	Occurs when the encoder is not properly programmed.	• Replace the motor.
		Occurs when the memory of the encoder is damaged.	

Fault Code	Text Message	Cause	Action
E.030 Encoder Cable Open	E.EnCoP	Occurs when the communication with the interactive encoder cannot be established.	• Check the motor selected. • Check whether the motor supports an auto detection. • Check the wiring of the encoder.
		Hall Error	
E.031 Encoder Data Parameter Error	E.EnCPE	Occurs when the encoder is not properly programmed.	• Replace the motor.
		Occurs when the memory of the encoder is damaged.	
E.036 Drive Overheat	E.drVot	Occurs when the drive overheats.	• Check if the cooling pan is working • Check the tuning. • Decrease the acceleration rate. • Decrease the duty cycle (ON/OFF) of the motion assigned. • Increase the time for the motion allowed. • Use a drive or motor with bigger capacity.
E.037 AC line Loss	E.ACoFF	Occurs when the power is low.	• Increase the instant outage compensation time.
		Attempted to activate the drive without turning on the main power.	• Before activating the drive, turn on the main power.
		A phase is not connected.	• Disconnect the power and check all • mechanical connections.
		The fault delay parameter is set too short.	• Increase the Fault delay parameter value.
E.053 User Parameter Initialization Error	E.PInIt	An error exists in the parameter saved in the memory.	• Initialize the parameter. • Reset the values of the drive to the factory.
E.054 Current Feedback Offset	E.oFSEt	Defective Hardware	• Replace the drive.
E.055 User Parameter Checksum Error	E.CHSUM	Checksum Error	• Check the parameter and reset. • Reset the values of the drive to the factory settings.
E.056 Watchdog Timeout	E.CPUFt	Excessive System Noise	• Check the wiring and the installation method.
		Defective Hardware	• Replace the drive.
E.057 PWM Hardware Error	E.HWArE	Defective Hardware	• Contact your nearest dealer.
E.058 User Parameter Range Error	E.rAnGE	Parameter range is invalid.	• Input the parameter within the range. • Reset the values of the drive to the factory settings.

Fault Code	Text Message	Cause	Action
E.060 Drive Initialization Error	E.dInIt	Hardware Error	• Replace the drive.
E.075 Regenerative Overload Protection	E.SHtoL	Exceeds the value allowed by the voltage of the regeneration resistor.	• Adjust the motion profile and keep the regeneration resistor within the limit.
		Regeneration resistor is separated or damaged.	• Check the connection of the regeneration resistor. • Check the values of the regeneration resistor.
E.079 Regenerative Over Current Protection	E.SHtoC	The regenerative current exceeds the allowable instant value.	• Check if the regeneration resistor is shorted or damaged. • Check if the overload energy is excessive while decelerating.
E.083 Battery Low Voltage Error of Absolute Encoder	E.AbSbE	The parameter of the encoder backup battery is set as 'installed,' but the battery is not installed.	• Set the constant of the encoder backup battery as 'not installed.'
		The battery voltage is detected under 2.7 [V] DC.	• Check the battery voltage and the connections. • Replace the battery.
E.084 Absolute Encoder Over Speed	E.AbSoS	The encoder rotates mechanically at high speed while turning off the drive, when it is powered by the battery.	• Remove the motor from the system. • Turn off and on the drive and reset the Warning.
E.085 Absolute Encoder Multi-turn Count Error	E.MtCEr	Noise from Encoder	• Turn off and on the drive and reset the Warning.
		Defective Encoder Multi rotation data is abnormal	• Replace the motor.
E.101 Motor Power Cable Open	E.CAbLE	The motor cable is not connected.	• Check the power connection between the motor and the drive.
E.102 Motor instantaneous current overload	E.InSoL	The motion profile requires peak current over 300% for a few second.	• Check the wiring of the motor. • Adjustthe cceleration/deceleration time. • Check if the motor selected is suitable.
		There is a defect in the current feedback detection.	• Check the phase current.
E.103 Motor Mismatch Fault	E.MAtCH	The dynamic control current of the selected motor exceeds double the value of the drive peak current rating.	• Install a different motor.
E.106 Encoder Communication Error	E.EnCCE	The wiring between the drive and the encoder is cut off or problematic. Or encoder signals are interrupted by the EMI (noise).	• Check the wiring of the encoder. • Contact your nearest dealer.
E.107 Serial Communication Error	E.SErCE	Communication error between the host and the drive (noise)	• Check the serial communication cable. • Check the noise of the serial communication interface.

Fault Code	Text Message	Cause	Action
E.108 Position Command Frequency error	E.CdFrE	The input frequency value exceeds that limit.	• Check if the hardware type selected in the rive matches the physical hardware. • Change from an open collector to a line dive. • Decrease the maximum speed. • Manipulate the gear.
E.111 Safety Torque Off Input Error	E.StoIn	The Safety Torque Off input is open. (Normal Close input condition)	• The signal was inputted by STO input. Set the release condition. • Check the STO connection. • Check the connection of the dummy connector provided with the product.
E.112 Emergency Stop	E.EStoP	Emergency Stop (E-STOP) is detected.	• Remove the emergency stop condition. • Erase E-STOP signal.
E.113 Index Position Range Overflow	E.IrAnG	The constant of the index position deviate the range.	• Use a value in the range between • -2,147,483,647 to +2,147,483,647.
E.114 Motor Phase Over current	E.ovCUr	• When the error occurs while turning on the power, there is a problem in the control or main power circuit. • When this error occurs while in operation over current exists. (Current that is 300 [%] over the rated current is supplied to the motor at more than 250 [ms]).	• Check the wiring and the power. • Check the power and set or adjust the acceleration/deceleration time.

Confirmation before Requesting for A/S

In the event an error occurs in servo fault that is not displayed, it describes the cause and action.

If the main circuit power is allowed in a cause investigation, it is dangerous. After the power shall be disconnected to completely turn out thedischarge-confirming lamp, take action on it. In the event the error is not resolved after taking an action, promptly request for A/S to the company.

The chart below shows the diagnosis on errors when the fault does not occur.

Table 8.6 Diagnosis on errors when the fault does not occur

Errors	Cause	Inspection and Action
The motor does not run.	The power is not inputted.	Make correction after confirming the power wiring.
	Motor and encoder wiring is erroneously made.	Make corrections after confirming the wiring.
	External command and position command is not inputted.	Confirm the wiring of input terminal and input it correctly.
	Servo-ON is not made.	The allotted parameter of sequence input signal (Ft-0.10)[D0] shall be confirmed for setting.
	The selection of command pulse is wrong.	Refer to Chapter 5-10 page "Position Control Mode" and correctly set it.
	Over trouble input is turned off.	P-OT, N-OT input signal is made to ON.
	Over trouble input is turned off.	P-OT, N-OT input signal is made to ON.
	Servo fault occurs.	Remove the cause for fault and implement the fault reset then re-start it.
Motor vibrates or has large overshoot in accelerating or decelerating.	The speed loop integration gain of servo is too high.	Lower the system gain [Ft-1.00]. Heighten the speed loop integration gain [Ft-1.03].
The motor rotates at the speed command '0'.	The speed command offset adjustment is erroneously made.	In put '0' to the speed command and redo the offset adjustment.
The encoder type setting error or encoder circuit fault occurs.	The setting of motor and encoder is erroneous.	Check if the motor setting [Dis-18] is correct.
	Motor and encoder wiring is erroneous.	Refer to the wiring in Chapter 3 and make a correction.
Strange noise is made.	Mechanical installation condition is bad.	Confirm the installation condition (coupling, nut tightening) and adjust.
Motor or drive is overheated.	The ambient temperature is high.	Lower the ambient temperature. (under 50 [°C])
	It is in overloaded condition.	Release the overload condition and operate it.

Parameter Group

Parameters control CSD7 Servo drive operations. They are grouped by the type of drive, Standard or Indexing, and the settings they define.

Parameter Description

Standard Group 0

Parameter No	Name	Digit No.	Range	Initial Value	Note
Ft-0.00	Operation Mode	N/A	1~12	1(Position control mode)	-
Ft-0.01	Reserved	-	-	-	-
Ft-0.02	Selection of Basic Mode	-	-	-	Bit Field
	Fault and Disable Braking	D0	0~3	0(Brake and Hold)	
	Over Travel stop method	D1	0~1	0(Current Control)	1:Dynamic Brake
	Command Polarity	D2	0~1	0(Normal)	Reverse
	AC Line Loss Detection	D3	0~2	0(Enable)	-
Ft-0.03	Selection of Auto Tuning Function	-	-	-	Bit Field
	Off-line Tuning Mode Setting	D0	0~2	1(Inertia Moment and RFD)	-
	Reserved	D1			-
	Auto Tuning Speed	D2	2~9	7(700RPM)	Value*100RPM
	Reserved	D3	0~0	0	-
Ft-0.04	Inertia Ratio	N/A	0.00~60.00	1.00	[times]
Ft-0.05	Auxiliary Function Selection 1	-		-	Bit Field
	Encoder Backup Battery	D0	0~1	1(Not installed)	
	Selection of Speed Observer	D1			
	Gain Change Enable	D2	0~1	0(Disable)	-
	Emergency Stop Input	D3	0~1	0(Disable)	-
Ft-0.06	Auxiliary Function Selection 2	-	-	-	Bit Field
	Reserved	D0			
	Reserved	D1			
	Gain Switching Mode	D2	0~9	0(Fixed to 1st Gain)	-
	Absolute Position Transmission Type	D3	0~2	0	-
Ft-0.07	Servo ID	N/A	0~247	1	-

Parameter No	Name	Digit No.	Range	Initial Value	Note
Ft-0.08	Reserved				
Ft-0.09	Modbus Communication Setting	-		-	Bit Field
	Baud Rate	D0	0~5	5(75600bps)	-
	Data bits, Parity, Stop bit	D1	0~5	0(8bits, No parity, 1 stop)	-
	Modbus Availability Setting	D2	0~1	0(disable)	
	Reserved	D3	0~0	0	
Ft-0.10	Allocation of Input Signal 1	-			Bit Field
	Servo-ON (/SV-ON)	D0	0 : ~ 0xb	1	-
	Forward Drive Disabled (P-OT)	D1	0 : ~ 0xb	B	-
	Reverse Drive Disabled (P-OT)	D2	0 : ~ 0xb	B	-
	P Control (/P-CON)	D3	0 : ~ 0xa	4	
Ft-0.11	Allocation of Input Signal 2	-			Bit Field
	Fault Reset (/A-RST)	D0	0 : ~ 0xa	5	-
	Reverse Current Limit (/N-TL)	D1	0 : ~ 0xa	6	-
	Forward Current Limit (/N-TL)	D2	0 : ~ 0xa	7	-
	Switch to Operation Mode (/C-SEL)	D3	0 : ~ 0xa	0	-
Ft-0.12	Allocation of Input Signal 3	-	-	-	Bit Field
	Multi-speed Control Direction (/C-DIR)	D0	0 : ~ 0xa	0	-
	Multi-speed Control Select 1 (/C-SP1)	D1	0 : ~ 0xa	0	-
	Multi-speed Control Select 2 (/C-SP2)	D2	0 : ~ 0xa	0	-
	Multi-speed Control Select 3 (/C-SP3)	D3	0 : ~ 0xa	0	-
Ft-0.13	Allocation of Input Signal 4	-			Bit Field
	Speed Zero Clamp (/Z-CLP)	D0	0 : ~ 0xa	0	-
	Pulse Command Inhibit (/INHIBIT)	D1	0 : ~ 0xa	0	-
	Gain Group Switching (/G-SEL)	D2	0 : ~ 0xa	0	-
	Position Clear (/PCLR)	D3	0 : ~ 0xa	0	-
Ft-0.14	Allocation of Input Signal 5	-		-	Bit Field
	Absolute Data Transmission (/ABS-DT)	D0	0 : ~ 0xa	0	-
	Start (/START)	D1	0 : ~ 0xa	0	-
	Multi-speed Select 4 (/C-SP4)	D2	0 : ~ 0xa	0	-
	Index Mode Jog Enable (/I-JOG)	D3	0 : ~ 0xa	0	-
Ft-0.15	Allocation of Input Signal 6	-		-	Bit Field
	Absolute Encoder Multi-revolution Data Reset (R-ABS)	D0	0 : ~ 0xa	0	V
	Gain Bank Select (BANK-SEL)	D1	0 : ~ 0xa	0	-
	Analog Torque Limit (/A-CL)	D2	0 : ~ 0xa	0	-
	Absolute Position Data Transmission Mode (/ABS-MD)	D3	0 : ~ 0xa	0	-
Ft-0.16	Allocation of Input Signal 7	-			Bit Field

Parameter No	Name	Digit No.	Range	Initial Value	Note
	Home Position Sensor (/HOM-SEN)	D0	0 : ~ 0xa	0	-
	Return to Home Start (/I-HSTART)	D1	0 : ~ 0xa	0	-
	Index Stop (/I-STOP)	D2	0 : ~ 0xa	0	-
	Index Pause (/I-PAUSE)	D3	0 : ~ 0xa	0	-
Ft-0.17	Allocation of Input Signal 8	-		-	Bit Field
	Index Selection 0 Input (/I-SEL0-IN)	D0	0 : ~ 0xa	0	-
	Index Selection 1 Input (/I-SEL1-IN)	D1	0 : ~ 0xa	0	-
	Index Selection 2 Input (/I-SEL2-IN)	D2	0 : ~ 0xa	0	-
	Index Selection 3 Input (/I-SEL3-IN)	D3	0 : ~ 0xa	0	-
Ft-0.18	Allocation of Input Signal 9	-		-	Bit Field
	Index Selection 4 Input (/I-SEL4-IN)	D0	0 : ~ 0xa	0	-
	Index Selection 5 Input (/I-SEL5-IN)	D1	0 : ~ 0xa	0	-
	Return to Home Stop (/I-HSTOP)	D2	0 : ~ 0xa	0	-
	Index Start (/I-START)	D3	0 : ~ 0xa	0	-
Ft-0.19	Input Signal Allocation 10		-	-	Bit Field
	Electronic Rear Ratio Select 1 (/E-GEAR1)	D0	0 : ~ 0xa	0	-
	Electronic Rear Ratio select 2 (/E-GEAR2)	D1	0 : ~ 0xa	0	-
	Index Forward Jog (I-JOGFW)	D2	0 : ~ 0xa	0	-
	Index Backward Jog (I-JOGFW)	D3	0 : ~ 0xa	0	-
Ft-0.22	Allocation of Input Signal 1			-	Bit Field
	Position Completion Detection (/P-COM)	D0	0 : ~ 0x6	1	-
	Revolution Detection (/TG-ON)	D1	0 : ~ 0x6	2	-
	Break Control (/BK)	D2	0 : ~ 0x6	3	
	Speed Match Detection (/V-COM)	D3	0 : ~ 0x6	0	
Ft-0.23	Allocation of Input Signal 2			-	Bit Field
	Torque Limit Detection (/T-LMT)	D0	0 : ~ 0x6	0	
	Speed Limit Detection (/V-LMT)	D1	0 : ~ 0x6	0	
	Position Proximity Detection (/NEAR)	D2	0 : ~ 0x6	0	-
	Warning Detection (/WARN)	D3	0 : ~ 0x6	0	-
Ft-0.24	Allocation of Input Signal 3			-	Bit Field
	Absolute Position Valid (/A-VLD)	D0	0 : ~ 0x6	0	-
	Servo Drive Ready (/RDY)	D1	0 : ~ 0x6	0	-
	Returning to Home (/I-HOM)	D2	0 : ~ 0x6	0	-
Ft-0.25	Allocation of Input Signal 4			-	Bit Field
	In Motion (/I-MO)	D0	0 : ~ 0x6	0	-
	In Dwell (/I-DW)	D1	0 : ~ 0x6	0	-
	Axis Homing Complete (/I-HOMC)	D2	0 : ~ 0x6	0	-

Parameter No	Name	Digit No.	Range	Initial Value	Note
	Index Selection 0 Output (/I-SEL0-OUT)	D3	0 : ~ 0x6	0	-
Ft-0.26	Allocation of Input Signal 5	-		-	Bit Field
	Index Selection 1 Output (/I-SEL1-OUT)	D0	0 : ~ 0x6	0	-
	Index Selection 2 Output (/I-SEL2-OUT)	D1	0 : ~ 0x6	0	-
	Index Selection 3 Output (/I-SEL3-OUT)	D2	0 : ~ 0x6	0	-
	Index Selection 4 Output (/I-SEL4-OUT)	D3	0 : ~ 0x6	0	-
Ft-0.27	Allocation of Input Signal 6			-	Bit Field
	Index Selection 5 Output (/I-SEL5-OUT)	D0	0 : ~ 0x6	0	-
	Sequence Operation Complete (/I-ESEQ)	D1	0 : ~ 0x6	0	-
	Effective Load Ratio Detection 1 Output (/RMS-CLT1)	D2	0 : ~ 0x6	0	-
	Effective Load Ratio Detection 2 Output (/RMS-CLT2)	D3	0 : ~ 0x6	0	-
Ft-0.32	Modbus I/O Control Authority				Bit Field
	Input Control by Modbus	D0	0~2	0	-
	Function Control by Modbus	D1	0~1	0	-
	Reserved	D2	-	-	-
	Reserved	D3	-	-	

Standard Group 1

Parameter No.	Name	Digit No.	Range	Initial Value	Note
Ft-1.00	Speed Response Level	N/A	1~100	35	%
Ft-1.01	System Gain	N/A	10~500	50	Hz
Ft-1.02	Primary Speed Loop Proportional Gain	N/A	0~10000	215	-
Ft-1.03	Primary Speed Loop Integral Gain	N/A	0~60000	125	-
Ft-1.04	P/PI Control Switching Mode	N/A	0~4	0	-
Ft-1.05	P/PI Control Switching Reference Value	N/A	0~3000	100	-
Ft-1.06	Speed Loop Derivative Gain	N/A	0~1000	0	-
Ft-1.07	Primary Position Loop Proportional Gain	N/A	0~700	50	Hz
Ft-1.08	Reserved				
Ft-1.09	Reserved				
Ft-1.10	Gain Switching Delay Time	N/A	0~10000	0	Value*0.125 msec
Ft-1.11	Gain Switching Reference Value	N/A	0~10000	0	Per the setting value of [Ft-0.06][D2]
Ft-1.12	Gain Switching Hysteresis Width	N/A	0~10000	0	Per the setting value of [Ft-0.06][D2]
Ft-1.13	Position Gain Switching Time	N/A	0~10000	0	Value*0.125 msec
Ft-1.14	Secondary Speed Loop Proportional Gain	N/A	0~10000	60	-
Ft-1.15	Secondary Speed Loop Integral Gain	N/A	0~60000	26	-
Ft-1.16	Secondary Position Loop Proportional Gain	N/A	0~700	20	Hz
Ft-1.17	Tertiary Speed Loop Proportional Gain	N/A	0~10000	60	-
Ft-1.18	Tertiary Speed Loop Integral Gain	N/A	0~60000	26	-
Ft-1.19	Tertiary Position Loop Proportional Gain	N/A	0~700	20	Hz
Ft-1.20	Quaternary Speed Loop Proportional Gain	N/A	0~10000	60	-
Ft-1.21	Quaternary Speed Loop Integral Gain	N/A	0~60000	26	-
Ft-1.22	Quaternary Position Loop Proportional Gain	N/A	0~700	20	Hz

Standard Group 2

<table>
<tr><th>Parameter No.</th><th>Name</th><th>Digit No.</th><th>Range</th><th>Initial Value</th><th>Note</th></tr>
<tr><td>Ft-2.00</td><td>Analog Speed Command Input Ratio Setting</td><td>N/A</td><td>10.0~2000.0</td><td>500.0</td><td>rpm/V(mm/sec/V)</td></tr>
<tr><td>Ft-2.01</td><td>Analog Speed Command Offset</td><td>N/A</td><td>-1000.0~1000.0</td><td>0</td><td>mV</td></tr>
<tr><td>Ft-2.02</td><td>Speed Command Field Bandwidth</td><td>N/A</td><td>0~10000</td><td>1000</td><td>Hz</td></tr>
<tr><td>Ft-2.03</td><td>Speed Tolerance Filter Bandwidth</td><td>N/A</td><td>0~2500</td><td>030</td><td>Hz</td></tr>
<tr><td>Ft-2.04</td><td>Speed Feed Forward Gain</td><td>N/A</td><td>0~6000</td><td>0</td><td>-</td></tr>
<tr><td>Ft-2.05</td><td>Jog Operation Speed</td><td>N/A</td><td>0~6000</td><td>50</td><td>rpm(mm/sec)</td></tr>
<tr><td>Ft-2.06</td><td>Acceleration</td><td>N/A</td><td>1~2147483647</td><td>41667</td><td>x0.01 Rev/sec^2</td></tr>
<tr><td>Ft-2.07</td><td>Deceleration</td><td>N/A</td><td>1~2147483647</td><td>41667</td><td>x0.01 Rev/sec^2</td></tr>
<tr><td>Ft-2.08</td><td>S-Curve Operation Time</td><td>N/A</td><td>0~5000</td><td>0</td><td>msec</td></tr>
<tr><td>Ft-2.09</td><td>Multi-step Speed Command 1</td><td>N/A</td><td>-6000~6000</td><td>0</td><td>rpm(mm/sec)</td></tr>
<tr><td>Ft-2.10</td><td>Multi-step Speed Command 2</td><td>N/A</td><td>-6000~6000</td><td>0</td><td>rpm(mm/sec)</td></tr>
<tr><td>Ft-2.11</td><td>Multi-step Speed Command 3</td><td>N/A</td><td>-6000~6000</td><td>0</td><td>rpm(mm/sec)</td></tr>
<tr><td>Ft-2.12</td><td>Multi-step Speed Command 4</td><td>N/A</td><td>-6000~6000</td><td>00</td><td>rpm(mm/sec)</td></tr>
<tr><td>Ft-2.13</td><td>Multi-step Speed Command 5</td><td>N/A</td><td>-6000~6000</td><td>0</td><td>rpm(mm/sec)</td></tr>
<tr><td>Ft-2.14</td><td>Multi-step Speed Command 6</td><td>N/A</td><td>-6000~6000</td><td>0</td><td>rpm(mm/sec)</td></tr>
<tr><td>Ft-2.15</td><td>Multi-step Speed Command 7</td><td>N/A</td><td>-6000~6000</td><td>0</td><td>rpm(mm/sec)</td></tr>
<tr><td>Ft-2.16</td><td>Speed Limit Setting Value</td><td>N/A</td><td>1~6000</td><td>5000</td><td>rpm(mm/sec)</td></tr>
<tr><td>Ft-2.17</td><td>Speed Limit Mode Selection</td><td>N/A</td><td>0~3</td><td>0</td><td>rpm(mm/sec)</td></tr>
<tr><td>Ft-2.18</td><td>Speed Window</td><td>N/A</td><td>0~1000</td><td>10</td><td>rpm(mm/sec)</td></tr>
<tr><td>Ft-2.19</td><td>Revolution Detection Level</td><td>N/A</td><td>1~5000</td><td>20</td><td>rpm(mm/sec)</td></tr>
<tr><td>Ft-2.20</td><td>Speed Zero Clamp Level</td><td>N/A</td><td>0~5000</td><td>0</td><td>rpm(mm/sec)</td></tr>
<tr><td rowspan="5">Ft-2.24</td><td>Adaptive Notch Test Run Setting</td><td>N/A</td><td></td><td></td><td>Bit Field</td></tr>
<tr><td>Adaptive Notch Test Run Setting</td><td>D0</td><td>0 ~ 1</td><td>0</td><td></td></tr>
<tr><td>Reserved</td><td>D1</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Reserved</td><td>D2</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Reserved</td><td>D3</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Standard Group 3

Parameter No.	Name	Digit No.	Range	Initial Value	Note
Ft-3.00	Position Command Pulse Specification	-	0 : 000~1 : 126	-	Bit Field
	Position Command Type	D0	0~6	0 (Step Up/Step Down)	-
	Position Command Pulse Type	D1	0~2	0 (Line drive)	-
	Encoder Output Pulse Direction	D2	0~1	0 (During forward revolution, A phase precedes by 90°.)	-
	Change the Electronic Gear Ratio	D3	0~1	0 (Changeable under servo off)	-
Ft-3.01	Position Command Filter Bandwidth	N/A	0~1000	0	Hz
Ft-3.02	Position Feed Forward Gain	N/A	0~100	0	Hz
Ft-3.03	Position Feed Forward Filter Bandwidth	N/A	0~2500	200	Hz
Ft-3.04	Position Movement Average Filter	N/A	0~1000	320	0.125ms
Ft-3.05	1st Electronic Gear Ratio (Numerator)	N/A	1~8388808	4	Pulse
Ft-3.06	1st Electronic Gear Ratio (Denominator)	N/A	1~8388808	1	Pulse
Ft-3.07	2nd Electronic Gear Ratio (Numerator)	N/A	1~8388808	4	Pulse
Ft-3.08	2nd Electronic Gear Ratio (Denominator)	N/A	1~8388808	1	Pulse
Ft-3.09	3rd Electronic Gear Ratio (Numerator)	N/A	1~8388808	4	Pulse
Ft-3.10	3rd Electronic Gear Ratio (Denominator)	N/A	1~8388808	1	Pulse
Ft-3.11	Position Output Pulse Adjustment (Numerator)	N/A	1~8388808	1	-
Ft-3.12	Position Output Pulse Adjustment (Denominator)	N/A	1~8388808	1	-
Ft-3.13	Position Command Pulse Filter Type Setting	-	0 : 000~0 : 333	-	Bit Field
	Line Driver Input Filter	D0	0~7	3	-
	Open Collector Input Filter	D1	0~7	6	
	High-speed Line Driver Input Filter	D2	0~7	0	-
	Position Command Filter On Duty	D3	0~2	1	-
Ft-3.14	1st Resonance Filter Cutoff Frequency	N/A	0~10000	0	*0.01Hz
Ft-3.15	1st Resonance Filter Damping Ratio	N/A	0~999	0	-
Ft-3.16	2ndt Resonance Filter Cutoff Frequency	N/A	0~10000	0	*0.01Hz
Ft-3.17	2nd Resonance Filter Damping Ratio	N/A	0~999	0	-
Ft-3.18	Position Completion Decision Range	N/A	0~2500	10	-
Ft-3.19	Near Position Size	N/A	0~2500	20	-
Ft-3.20	Position Deviation Tolerance Width	N/A	0~2147483647	655360	-

Stan dart Group 4

Parameter No.	Name	Digit No.	Range	Initial Value	Note
Ft-4.00	External Torque Command Input Ratio	N/A	0~1000	333	-
Ft-4.01	Current Command Offset	N/A	-10000~10000	0	-
Ft-4.02	1st Current Command Filter Bandwidth	N/A	0~10000	500	Hz
Ft-4.03	2nd Current Command Filter	N/A	0~10000	300	Hz
Ft-4.04	3rd Current Command Filter	N/A	0~10000	300	Hz
Ft-4.05	4th Current Command Filter	N/A	0~10000	300	Hz
Ft-4.06	Current Loop Gain Setting	N/A	0~2	1	-
Ft-4.07	Forward Torque Limit	N/A	0~500	300	-
Ft-4.08	Reverse Torque Limit	N/A	0~500	300	-
Ft-4.09	Forward External Torque Limits	N/A	0~500	100	-
Ft-4.10	Reverse External Torque Limits	N/A	0~500	100	-
Ft-4.11	Revolution Disable Torque Limit	N/A	0~500	350	-
Ft-4.12	Default Torque Bias	N/A	-100~100	0	%
Ft-4.13	1st Vibration Suppression Filter Frequency	N/A	0~10000	10000	Hz
Ft-4.14	1st Vibration Suppression Filter Width	N/A	1~20	10	-
Ft-4.15	1st Vibration Suppression Filter Depth	N/A	0~100	100	-
Ft-4.16	2nd Vibration Suppression Filter Frequency	N/A	0~10000	10000	Hz
Ft-4.17	2nd Vibration Suppression Filter Width	N/A	1~20	10	-
Ft-4.18	2nd Vibration Suppression Filter Depth	N/A	0~100	100	-
Ft-4.19	3rd Vibration Suppression Filter Frequency	N/A	0~10000	10000	Hz
Ft-4.20	3rd Vibration Suppression Filter Width	N/A	1~20	10	-
Ft-4.21	3rd Vibration Suppression Filter Depth	N/A	0~100	100	-
Ft-4.22	Adaptive Notch Filter Setting	-	-	-	Bit Field
	Adaptive Notch Filter Application Setting	D0	0~1	0	-
	High-Pass Filter Cut-off Frequency Setting	D1	0~1	1	-
	Tracking Frequency Initial Value Setting	D2	0~1	1	-
	Adaptive Notch Filter Detection Filter	D3	0~2	1	-
Ft-4.23	Effective Load Ratio Accumulated Time Setting	N/A	0~60	10	-
Ft-4.24	Effective Load Ratio Detection Value Setting 1	N/A	0~350	350	-
Ft-4.25	Effective Load Ratio Detection Value Setting 2	N/A	0~350	350	-

Standard Group 5

Parameter No.	Name	Digit No.	Range	Initial Value	Note
Ft-5.00	Brake Release Delay Time	N/A	0~10000	0	-
Ft-5.01	Servo Off Delay Time	N/A	0~10000	0	-
Ft-5.02	Brake Operation Delay Time	N/A	0~10000	500	-
Ft-5.03	Brake Operation Start Speed	N/A	0~1000	100	-
Ft-5.04	Instantaneous Power Fail Delay Time	N/A	20~2000	20	-
Ft-5.05	Analog Output CH1 Selection	N/A	0~45	0	See the table 7.25
Ft-5.06	Analog Output CH2 Selection	N/A	0~45	1	See the table 7.25
Ft-5.07	Analog Output CH1 Ratio Setting	N/A	1~99999	500	-
Ft-5.08	Analog Output CH2 Ratio Setting	N/A	1~99999	500	-
Ft-5.09	Motor Overload Detection Method Selection	N/A	0~1	0	-
Ft-5.10	Select Monitoring Function on Status Window	-	0 : ~ 1 : 099	0 : 000	Bit Field
	Monitoring Units Digit	D0	0~9	0	-
	Monitoring Tens Digit	D1	0~9	0	-
	Reserved	D2			-
	Status Window Monitoring Window Selection	D3	0~1	0	-
Ft-5.11	Main Power Cut-off Warning Selection	N/A	0~1	0	-
Ft-5.12	Torque Limit in SAG function	N/A	0~450	50	%
Ft-5.13	Duration time of Torque Limit in SAG function	N/A	0~3000	100	msec

Parameter Description

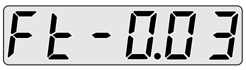
Standard Group 0

(Ft-0.00)	Operations Mode RSWare : Drive - Operation Modes (Main/Override)			
Description	Set control mode (Optional)			
Display (Value)	Value	Display	Operating Mode	RSWare Name
	1	F	Position Control Mode	Follower /None
	2	S	Velocity Control Mode	Analog Velocity Input/ None
	3	C	Torque Control Mode	Analog Current Input/ None
	4	SF	Velocity+Position Control Mode	Analog Velocity Input/ Follower
	5	CF	Torque+Position Control Mode	Analog Velocity Current/ Follower
	6	CS	Torque+Velocity Control Mode	Analog Current Input/Analog Velocity Input
	7	P	Multi-Step Speed Control Mode	Preset Velocity / None
	8	PF	Multi-Step Speed + Postion Contorl Mode	Preset Velocity / Follower
	9	PS	Multi-Step Speed + Velocity Contorl Mode	Preset Velocity/Analog Velocity Input
	10	PC	Multi-Step Speed + Torque Control Mode	Preset Velocity/Analog Current Input
	12	I	Index	Indexing / None
Init Value	1	F	Position Control Mode	Follower / None

(Ft-0.01)	RESERVED

(Ft-0.02)	Selection of 4 Basic Mode		
Applicable Operating Mode	All		
Data Size	4 digits		
Digit 0 [D0]	Fault and Disable Braking RSWare : Drive - Stopping Functions - Fault and Disable Braking		
Range	Value	Description	RSWare Name
	0	Keep DB after DB stop	Brake and hold
	1	DB is released after DB stop.	Brake and release
	2	Stop Free run (operation) without DB stop	Free Stop
	3	Keep DB after stop Free run	Free Stop and hold
Initial Value	0		

Digit 1 [D1]	Overtravel stop method RSWare : Drive - Stopping Functions - Over Travel Stop Method		
Range	Value	Description	RSWare Name
	0	Stop by normal torque contorl during overtravel. At this monent,can contorl torque by setting overtravel torque linit [Ft-4.11].	Current Control
	1	Stop by the method specified at the DB stop method selection in [Ft-0.02][D0] when overtravel occurs.	Dynamic Brake
Initial Value	0		
Digit 2 [D2]	External Command Rotation Direction Selection RSWare : Drive - Command Polarity		
Range	Value	Description	RSWare Name
	0	The command signal is not inverted so that a positive command value results in CW Rotation, (as viewed from shaft end).	None
	1	The command signal is inverted so that a positive command value results in CCW Rotation, (as viewed from shaft end).	Inverted
Initial Value	0		
Digit 3 [D3]	AC Line Loss Detection RSWare : Drive - AC Line Loss Check		
Range	Value	Description	RSWare Name
	0	Check input power 100W~400W Servo Drive: Enable single-phase open check 800W~1.5kW Servo Drive: 3-phase open check	Enable
	1	Do not check the input power	Disable
	2	Single-phase input	Single phase input
Initial Value	0		

 (Ft-0.03)	Selection of Auto Tuning Function		
Applicable Operating Mode	All		
Data Size	4 digits		
Digit 0 [D0]	Off-Line Tuning Mode Mode Setting RSWare : Drive - Tuning - Autotuning - Off-Line Auto Tuning Mode		
Range	Value	Descirption	RSWare Name
	0	Inertia Moment Estimation	Inertia Moment Estimation
	1	Inertia Moment Estimation and Resonant Frequency Detection	Inertia Moment Estimation and Resonant Frequency Detection
	2	Resonance frequency Detection	Resonant Frequency Detection
Initial Value	1		
Digit 1 [D1]	Reserved		
Digit 2 [D2]	Autotuning Speed		

	RSWare : Drive - Tuning - Autotuning - Autotuning Speed – Off-Line Auto Tuning Velocity		
Range	Value	Description	
	2-9	The larger the setting value, the higher speed.	
Initial Value	7		
Unit	Setting value* 100rpm		

(Ft-0.04)	Inertia Ratio RSWare : Drive - Motor - Inertia Ratio
Description	Inertial Ratio shows Load Inertia to Motor
Range	0.00 ~ 60.00
Initial Value	1.00
Unit	times

(Ft-0.05)	Auxiliary Function Selection 1		
Applicable Operation Mode	All		
Data Size	4 digits		
Digit 0 [D0]	Encoder Backup Battery RSWare : Drive - Encoder - Encoder Backup Battery		
Range	Value	Description	RSWare Name
	0	Backup Battery Installed	Installed
	1	Backup Battery Not Installed	Not Installed
Initial Value	1		
Digit 1 [D1]	Reserved		
Digit 2 [D2]	Gain Change Enable RSWare : Drive - Tuning - Gain Switching - Gain Change Enable		
Range	Value	Description	RSWare Name
	0	Disable	Disable
	1	Enable	Enable
Initial Value	0		
Digit 3 [D3]	Emergency Stop Input RSWare : Drive - Auxiliary Function Selection 1 - Emergency Stop Input		
Range	Value	Description	RSWare Name
	0	Disable	Disable
	1	Enable	Enable
Initial Value	0		

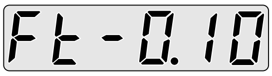
<table>
<tr><td>Ft-0.06
(Ft-0.06)</td><td colspan="3">Auxiliary function Selection 2</td></tr>
<tr><td>Applicable Operation Mode</td><td colspan="3">All</td></tr>
<tr><td>Data Size</td><td colspan="3"></td></tr>
<tr><td>Digit 0 [D0]</td><td colspan="3">Reserved</td></tr>
<tr><td>Digit 1 [D1]</td><td colspan="3">Reserved</td></tr>
<tr><td>Digit 2 [D2]</td><td colspan="3">Gain Change Enable
RSWare : Drive - Tuning - Gain Switching - Mode of Gain Switching</td></tr>
<tr><td rowspan="11">Range</td><td>Value</td><td>Description</td><td>RSWare Name</td></tr>
<tr><td>0</td><td>Fixed to the 1st gain.</td><td>1st Gain Fix</td></tr>
<tr><td>1</td><td>Fixed to 2nd gain.</td><td>2nd Gain Fix</td></tr>
<tr><td>2</td><td>2nd gain selection when the gain switching input is turned on.</td><td>Digital Input (G-SEL)</td></tr>
<tr><td>3</td><td>2nd gain selection when the toque command is larger than the setups (level of gain control switching and hysteresis of control switching).</td><td>Torque Command Deviation</td></tr>
<tr><td>4</td><td>2nd gain selection when the command speed is larger than the setups (level of gain control switching and hysteresis of control switching).</td><td>Velocity Command</td></tr>
<tr><td>5</td><td>2nd gain selection when the positional deviation is larger than the setups (level of gain control switching and hysteresis of control switching).</td><td>Position Error</td></tr>
<tr><td>6</td><td>2nd gain selection when more than one command pulse exists between 200usec.</td><td>Position Command</td></tr>
<tr><td>7</td><td>2nd gain selection when the positional deviation counter value exceeds the setup of Positioning completer range.</td><td>In-Position</td></tr>
<tr><td>8</td><td>2nd gain selection when the motor actual speed exceeds the setup.</td><td>Velocity</td></tr>
<tr><td>9</td><td>2nd gain selection when no position commands applied and the motor actual speed falls slower than the setup.</td><td>Position command and Velocity</td></tr>
<tr><td>Initial Value</td><td colspan="3">0</td></tr>
<tr><td>Digit 3 [D3]</td><td colspan="3">Absolute Position Transmission Type
RSWare : Drive - Encoders - Absolute Feedback Transfer Type</td></tr>
<tr><td rowspan="4">Range</td><td>Value</td><td>Description</td><td>RSWare Name</td></tr>
<tr><td>0</td><td>Same as Command Polarity</td><td>Same as Command Polarity</td></tr>
<tr><td>1</td><td>Always CCW</td><td>Always CCW</td></tr>
<tr><td>2</td><td>Always CW</td><td>Always CW</td></tr>
<tr><td>Initial value</td><td colspan="3">0</td></tr>
</table>

(Ft-0.07)	Servo ID RSWare : Drive - Modbus Communications - Drive Address
Applicable Operating Mode	All
Range	1-247
Initial Value	1

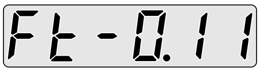
(Ft-0.08)	Reserved

(Ft-0.09)	Modbus Communication Setting RSWare : Drive - Modbus Communications		
Applicable Operating Mode	All		
Data Size	4 digits		
Digit 0 [D0]	Transmission Rate (Baud Rate) RSWare : Drive - Modbus Communications - Baudrate		
Range	Value	Descriptions	
	0	9600bps	
	1	14400bps	
	2	19200bps	
	3	38400bps	
	4	56000bps	
	5	57600bps	
Initial Value	5		
Digit 1 [D1]	Data bits, Parity, Stop Bit RSWare : Drive - Modbus Communications – Frame Frmat		
Range	Value	Descriptions	RSWare Name
	0	8, None, 1	8 Data, No Parity, 1 Stop bit
	1	8, Even, 1	8 Data, Even Parity, 1 Stop bit
	2	8, Odd, 1	8 Data, Odd Parity, 1 Stop bit
	3	8, None, 2	8 Data, No Parity, 2 Stop bit
	4	8, Even, 2	8 Data, Even Parity, 2 Stop bit
	5	8, Odd, 2	8 Data, Odd Parity, 2 Stop bit
Initial Value	0		
Digit 2 [D2]	Modbus Enable Setting RSWare : Drive - Modbus Communications - Modbus Enable		

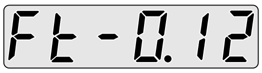
Range	Value	Description	RSWare Name
	0	Not used	Disable
	1	Used	Enable
Initial Value	0		
Digit 3 [D3]	Reserved		

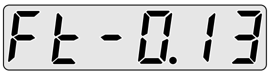


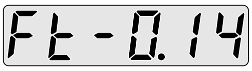
(Ft-0.10)	Allocation of Input Signals 1 RSWare : Drive - Digital Inputs			
Rage for All Digits	0-B, Where 0 is Off, B is On, and 1-A are digital input			
Data Size	4 digits			
Digit	Description	Initial Value	Unmapped IO Status	RSWare Name
D0	Drive Enable (/SV-ON)	1	ON	Drive Enable(/SV-ON)
D1	Positive Over-travel (P-OT)	b	ON	Overtravel - Positive(P-OT)
D2	Negative Over-travel (N-OT)	b	ON	Overtravel - Negative(N-OT)
D3	Integrator Inhibit (/P-CON)	4	OFF	Integrator Inhibit(/P-CON)
Applicable Operating Mode	All			

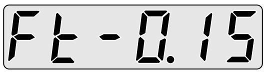


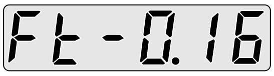
(Ft-0.11)	Allocation of Input Signals 2 RSWare : Drive - Digital Inputs			
Rage for All Digits	0-B, Where 0 is Off, B is On, and 1-A are digital input			
Data Size	4 digits			
Digit	Description	Initial Value	Unmapped IO Status	RSWare Name
D0	Fault Reset (/A-RST)	5	OFF	Fault Reset(/A-RST)
D1	Negative Current Limit (/N-TL)	6	OFF	Current Limit - Negative(/N-TL)
D2	Positive Current Limit (/P-TL)	7	OFF	Current Limit - Positive(/P-TL)
D3	Operation Mode Override (/C-SEL)	0	OFF	Operation Mode Override(/C-SEL)
Applicable Operating Mode	All			

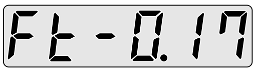
 (Ft-0.12)	Allocation of Input Signals 3 RSWare : Drive - Digital Inputs			
Range for All Digits	0-B, Where 0 is Off, B is On, and 1-A are digital input			
Data Size	4 digits			
Digit	Description	Initial Value	Unmapped IO Status	RSWare Name
D0	Preset Direction (/C-DIR)	0	OFF	Velocity Direction (/C-DIR)
D1	Preset Select 1 (/C-SP1)	0	OFF	Preset Select 1(/C-SP1)
D2	Preset Select 2 (/C-SP2)	0	OFF	Preset Select 2(/C-SP2)
D3	Preset Select 3 (/C-SP3)	0	OFF	Preset Select 3(/C-SP3)
Applicable Operating Mode	All			

 (Ft-0.13)	Allocation of Input Signals 4 RSWare : Drive - Digital Inputs			
Range for All Digits	0-B, Where 0 is Off, B is On, and 1-A are digital input			
Data Size	4 digits			
Digit	Description	Init	Unmapped IO Status	RSWare Name
D0	Zero Speed ClampEnable (/Z-CLP)	0	OFF	Zero Velocity Clamp Enable(/Z-CLP)
D1	Pause Follower (/INHIBIT)	0	OFF	Pause Follower(/INHIBIT)
D2	Alternate Gain Select (/G-SEL)	0	OFF	Alternate Gain Select(/G-SEL)
D3	Position clear (/PCLR)	0	OFF	Position Error Clear(/PCLR)
Applicable Operating Mode	All			

 (Ft-0.14)	Allocation of Input Signals 5 RSWare : Drive - Digital Inputs			
Range for All Digits	0-B, Where 0 is Off, B is On, and 1-A are digital input			
Data Size	4 digits			
Digit	Description	Init	Unmapped IO Status	RSWare Name
D0	Absolute Data Transmission (/ABS-DT)	0	OFF	Absolute Data Transmission(/ABS-DT)
D1	Start (/START)	0	OFF	Motor Moving Start(/START)
D2	Multi-speed Control Select 4 (/C-SP4)	0	OFF	Analog Veolcity Command Enable(/C-SP4)
D3	Index Mode Jog Operation (I-JOG)	0	OFF	Indexing Mode Jog Enable(/I-JOG)

 (Ft-0.15)	Allocation of Input Signals 6 RSWare : Drive - Digital Inputs			
Data Size	4 digits			
Digit	Description	Init	Unmapped IO Status	RSWare Name
D0	Reset multi-turn data of Absolute Encoder (/R-ABS)	0	OFF	Absolute Encoder Reset(/R-ABS)
D1	Gain Bank Select (/BANK-SEL)	0	OFF	Gain Bank Select(/BANK-SEL)
D2	Analog Current Limit Transmission Mode (/A-CL)	0	OFF	Analog Current Limit(/A-CL)
D3	Absolute Position Data Transmission Mode (/ABS-MD)	0	OFF	Absolute Position Transfer Mode(/ABS-MD)
Applicable Operating Mode	All			

 (Ft-0.16)	Allocation of Input Signals 7 RSWare : Drive - Digital Inputs			
Data Size	4 digits			
Digit	Description	Init	Unmapped IO Status	RSWare Name
D0	Home Sensor (/HOM-SEN)	0	OFF	Home Sensor(/HOM-SEN)
D1	Start Homing (/I-HSTART)	0	OFF	Start Homing(/I-HSTART)
D2	Start Indexing (/I-STOP)	0	OFF	Stop Indexing(/I-STOP)
D3	Pause Indexing (/PAUSE)	0	OFF	Pause Indexing(/I-PAUSE)
Applicable Operating Mode	I			

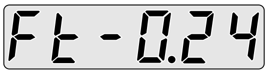
 (Ft-0.17)	Allocation of Input Signals 8 RSWare : Drive - Digital Inputs			
Data Size	4 digits			
Digit	Description	Init	Unmapped IO Status	RSWare Name
D0	Index Select 0 Input (/I-SEL0)	0	OFF	Indexing Select 0 Input(/I-SEL0-IN)
D1	Index Select 1 Input (/I-SEL1)	0	OFF	Indexing Select 1 Input(/I-SEL1-IN)
D2	Index Select 2 Input (/I-SEL2)	0	OFF	Indexing Select 2 Input(/I-SEL2-IN)
D3	Index Select 3 Input (/I-SEL3)	0	OFF	Indexing Select 3 Input(/I-SEL3-IN)
Applicable Operating Mode	I			

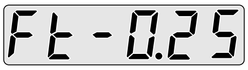
Ft-0.18 (Ft-0.18)	Allocation of Input Signals 9 RSWare : Drive - Digital Inputs			
Data Size	4 digits			
Digit	Description	Init	Unmapped IO Status	RSWare Name
D0	Index Select 4 Input (/I-SEL4)	0	OFF	Indexing Select 4 Input(/I-SEL4-IN)
D1	Index Select 5 Input (/I-SEL5)	0	OFF	Indexing Select 5 Input(/I-SEL5-IN)
D2	Stop Homing (/H-STOP)	0	OFF	Stop Homing(/I-HSTOP)
D3	Start Indexing (/START-I)	0	OFF	Start Indexing(/I-START)
Applicable Operating Mode	I			

Ft-0.19 (Ft-0.19)	Allocation of Input Signals 10 RSWare : Drive - Digital Inputs			
Data Size	4 digits			
Digit	Description	Init	Unmapped IO Status	RSWare Name
D0	Electronic Gear Ratio Select 1 (/E-GEAR1)	0	OFF	Electronic Gear Bank Select 1(/E-GEAR1)
D1	Electronic Gear Ratio Select 2 (/E-GEAR2)	0	OFF	Electronic Gear Bank Select 2(/E-GEAR2)
D2	Index Jog Operation Forward Direction (I-JOGFW)	0	OFF	Indexing Mode Jog Forward(/I-JOGFW)
D3	Index Jog Operation Reverse Direction (I-JOGBW)	0	OFF	Indexing Mode Jog Backward(/I-JOGBW)
Applicable Operating Mode	Reserved			

(Ft-0.22)	Allocation of Output Signals 1 RSWare : Drive - Digital Outputs		
Range for All Digits	0-3, Where 0 is Off, and 1-6 are digital output		
Data Size	4 digits		
Digit	Description	Initial Value	RSWare Name
D0	Position Completion Detection (/P-COM)	1	Within In-Position Window(/P-COM)
D1	Revolution Detection (/TG-ON)	2	Up to Velocity (/TG-ON)
D2	Break Control (/BK)	3	Brake Control(/BK)
D3	Speed Window Detection (/V-COM)	0	Within Speed Window (/V-COM)
Applicable Operating Mode	All		

(Ft-0.23)	Allocation of Output Signals 2 RSWare : Drive - Digital Outputs		
Range for All Digits	0-3, Where 0 is Off, and 1-6 are digital output		
Data Size	4 digits		
Digit	Description	Init	RSWare Name
D0	Current Limited (/T-LMT)	0	Current Limited (/T-LMT)
D1	Velocity Limited (/V-LMT)	0	Velocity Limited (/V-LMT)
D2	Within Near Window (/NEAR)	0	Within Near-Position Window (/NEAR)
D3	Warning (/WARN)	0	Warning(/WARN)
Applicable Operating Mode	All		

 (Ft-0.24)	Allocation of Output Signals 3 RSWare : Drive - Digital Outputs		
Range for All Digits	0-3, Where 0 is Off, and 1-6 are digital output		
Data Size	4 digits		
Digit	Description	Init	RSWare Name
D0	Absolute Position Valid (/A-VLD)	0	Absolute Position Valid(/A-VLD)
D1	Servo drive ready (/RDY)	0	Drive Ready(/RDY)
D2	Index Home Position Returning (/I-HOM)	0	In Homing(/I-HOM)
D3	Reserved		
Applicable Operating Mode	All		

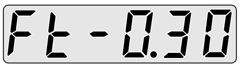
 (Ft-0.25)	Allocation of Output Signals 4 RSWare : Drive - Digital Outputs		
Range for All Digits	0-3, Where 0 is Off, and 1-6 are digital output		
Data Size	4 digits		
Digit	Description	Init	RSWare Name
D0	In Motion (/I-MO)	0	In Motion(/I-MO)
D1	In Dwell (/I-DW)	0	In Dwell(I-DW)
D2	Axis Homed (/I-HOMC)	0	Axis Homing Completed(/I-HOMC)
D3	Index Select 0 Out (/I-SEL0-OUT)	0	Index Select 0 Output(/I-SEL0-OUT)
Applicable Operating Mode	I		

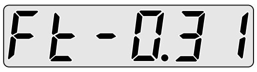
(Ft-0.26)	Allocation of Output Signals 5 RSWare : Drive - Digital Outputs		
Range for All Digits	0-3, Where 0 is Off, and 1-6 are digital output		
Data Size	4 digits		
Digit	Description	Init	RSWare Name
D0	Index Select 1 Out (/I-SEL1-OUT)	0	Index Select 1 Output(/I-SEL1-OUT)
D1	Index Select 2 Out (/I-SEL2-OUT)	1	Index Select 2 Output(/I-SEL2-OUT)
D2	Index Select 3 Out (/I-SEL3-OUT)	2	Index Select 3 Output(/I-SEL3-OUT)
D3	Index Select 4 Out (/I-SEL4-OUT)	3	Index Select 4 Output(/I-SEL4-OUT)
Applicable Operating Mode	I		

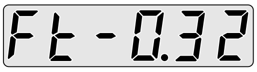
(Ft-0.27)	Allocation of Output Signals 6 RSWare : Drive - Digital Outputs		
Range for All Digits	0-3, Where 0 is Off, and 1-6 are digital output		
Data Size	4 digits		
Digit	Description	Init	RSWare Name
D0	Index Select 5 Out (/I-SEL5-OUT)	0	Index Select 5 Output(/I-SEL5-OUT)
D1	End of Sequence (/I-ESEQ)	0	End of Indexing Sequence(/I-ESEQ)
D2	Effective Load Ratio 1 Output (/RMS-CLT1)	0	RMS Current Load Factor Threshold Output 1(/RMS-CLT1)
D3	Effective Load Ratio 2 Output (/RMS-CLT2)	0	RMS Current Load Factor Threshold Output 2(/RMS-CLT2)
Applicable Operating Mode	I		

(Ft-0.28)	Reserved

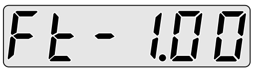
(Ft-0.29)	Reserved

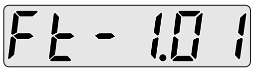
 (Ft-0.30)	Reserved

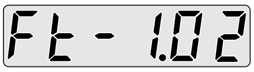
 (Ft-0.31)	Reserved

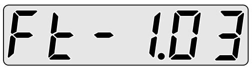
 (Ft-0.32)	I/O Control RSWare : Drive - Modbus Communications - Modbus Run Function Control
Description	Run & Input Control Selection It is used for selection of run-xx or Input function using Modbus. Input function on Hardware cannot be used in case that the input function is used by Modbus with this parameter. Run function cannot be used by key pad, similarly, if the run function is used by Modbus. • 0x00 - Both Run and Input function are not used, and only the Input function through hardware is used for Modbus. • 0x01 - Only Input function is used for Modbus. • 0x02 - Both Run and Input function are not used for Modbus; and Input function through hardware and Special function for Modbus are used. • 0x10 - Only Run function is used for Modbus, and only the input function through hardware is used. • 0x11 - Both Run and Input function are used for Modbus. • 0x12 - Run function, Input function through hardware and Special Function for Modbus are used.
Range	0x00, 0x01, 0x02, 0x10, 0x11, 0x12
Initial Value	0x00
Applicable Operation Mode	All

Standard Group 1

 (Ft-1.00)	Velocity Regulator Response level RSWare : Drive - Tuning - Velocity Regulator Response Level
Description	Set system gain in proportion to speed response level automatically by referring the estimated inertia ratio after auto tuning.
Range	1~100
Initial Value	35
Unit	%
Applicable Operating Mode	All

 (Ft-1.01)	System Gain RSWare : Drive - Tuning - System Gain
Description	• Refers to the bandwidth of the entire velocity control loop. • When this value is changed, basic gain values [Ft-1.02], [Ft-1.03], [Ft-1.07], [Ft-4.02] and [Ft-2.02] are set automatically according to the control mode while referring to the inertia ratio parameter [Ft-0.04]. • The lower limit is 10 [Hz]. • A higher value results in higher basic gain values and higher responsiveness. (However, excessive values can result in noise and vibrations) • Conversely, lower values result in smaller gain and lower responsiveness; however, the whole system's stability is increased. • The system gain can be changed directly by a user, but it is recommended to change the value by changing the speed response level (Ft-1.00) parameter for safety of the system.
Range	10~500
Initial Value	50
Unit	Hz
Applicable Operating Mode	All

 (Ft-1.02)	Primary Speed Loop Proportional Gain RSWare : Drive - Tuning - Main Velocity Regulator Gains - 1st Velocity Regulator P Gain
Description	• Parameter which determines the responsiveness of velocity control. • Value changed simultaneously with change of inertia ratio [Ft-0.04], speed response level [Ft-1.01] or system gain [Ft-1.01].
Range	0~10000
Initial Value	215
Unit	-
Applicable Operating Mode	F, S, P

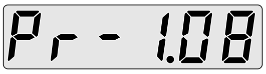
 (Ft-1.03)	Primary Speed Loop Integral Gain RSWare : Drive - Tuning - Main Velocity Regulator Gains - 1st Velocity Regulator I Gain
Description	• Removes steady state speed tolerance. • Overshoot in speed response can occur if set value is too large. • Value changed by change in inertia ratio [Ft-0.04] or system gain [Ft-1.00].
Range	0~60000
Initial Value	125
Unit	-
Applicable Operating Mode	F, S, P

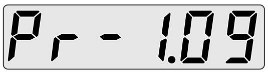
 (Ft-1.04)	P control shift switch RSWare : Drive - Tuning - Main Velocity Regulator Gains - Velocity Regulator I Gain Mode	
Description	During transient response, the Speed Response Overshoot can be suppressed by changing the velocity controller from Proportion Integration (PI) Controller into Proportion (P)Controller. This reduces Position completion time during Position Control.	
Range	Value	Description
	0	PI controller is always used.
	1	When the torque command exceeds the torque value in [Ft-1.05], the velocity controller is changed from PIController to P controller.
	2	When the speed command exceeds the speed value in [Ft-1.05], the Velocity controller is changed from PIController to P Controller.
	3	When the position error exceeds the position error value in [Ft-1.05], the Velocity controller is changed from PIController to P Controller.
	4	P and PI mode are changed automatically.
Initial value	0	
Applicable Operating Mode	All	

 (Ft-1.05)	P Control Switching Reference Value RSWare : Drive - Tuning - Main Velocity Regulator Gains - Velocity Regulator I Gain Disable Threshold
Description	If the speed torque command or the position tolerance exceeds the value set in this parameter, the velocity controller changes from PI type to P type.
Range	0~3000
Initial value	100
Applicable Operating Mode	All

 (Ft-1.06)	Speed Loop Derivative Gain RSWare : Drive - Tuning - Main Velocity Regulator Gains - Velocity Regulator D Gain
Description	Speed Loop Derivative Gain
Range	0~1000
Initial value	0
Applicable Operating Mode	All

 (Ft-1.07)	Primary Position Loop Proportional GainRSWare : Drive - Tuning - Main Position Regulator Gains - 1st Position Regulator Kp Gain
Description	• A parameter which determines the responsiveness of positioncontrol. • Change the setting value according to rigidity of load. • This value is changed simultaneously with change of inertia ratio (Ft-0.04), speed response level (Ft-1.00) or system gain (Ft-1.01) value.
Range	0~700
Initial value	50
Unit	Hz
Applicable Operating Mode	All

 (Ft-1.08)	Reserved

 (Ft-1.09)	Reserved

 (Ft-1.10)	Delay Time of Gain Switching RSWare : Drive - Tuning - Gain Switching - Delay Time of Gain Switching
Description	When gain value is switched from Second gain to first gain, you can set delay time.
Range	0~10000
Initial value	0
Unit	0.125msec
Applicable Operating Mode	All

 (Ft-1.11)	Gain Switching Reference Value RSWare : Drive - Tuning - Gain Switching - Level of Gain Switching
Description	Set standard value for gain switching. The specified value operates at the gain switching mode selected from [Ft-0.06][D2].
Range	0~10000
Initial value	0
Applicable Operating Mode	All

 (Ft-1.12)	Hysteresis of Gain Switching RSWare : Drive - Tuning - Gain Switching - Hysteresis of Gain Switching
Description	Operates Hysteresis based on operation level when gain switching. The setting value is for Gain Switching Mode [Ft-0.06][D2].
Range	0~10000
Initial value	0
Applicable Operating Mode	All

 (Ft-1.13)	Position Gain Switching Time RSWare : Drive - Tuning - Gain Switching - Position Gain Switching Time
Description	Adjust as Position Gain Switching Time step by step when switching gain value from first gain to second gain.
Range	0~10000
Initial value	0
Unit	0.125msec
Applicable Operating Mode	F, S, P

 (Ft-1.14)	2nd Velocity Regulator P Gain RSWare : Drive - Tuning - 2nd Regulator Gains - 2nd Velocity Regulator P Gain
Description	Parameter which determines the responsiveness of velocity control.
Range	0~10000
Initial value	60
Unit	-
Applicable Operating Mode	F, S, P

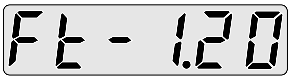
 (Ft-1.15)	2nd Velocity Regulator I Gain RSWare : Drive - Tuning - 2nd Regulator Gains - 2nd Velocity Regulator I Gain
Description	• Removes steady state speed tolerance. • Overshoot in speed response can occur if set value is too large.
Range	0~60000
Initial value	26
Unit	-
Applicable Operating Mode	F, S, P

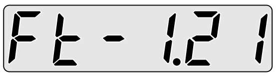
 (Ft-1.16)	2nd Position Regulator Kp Gain RSWare : Drive - Tuning - 2nd Regulator Gains - 2nd Position Regulator Kp Gain
Description	• Parameter which determines the responsiveness of positioncontrol. • Change set value according to rigidity of load.
Range	0~700
Initial value	20
Unit	Hz
Applicable Operating Mode	F

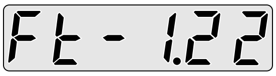
 (Ft-1.17)	3rd Velocity Regulator P Gain RSWare : Drive - Tuning - 3rd Regulator Gains - 3rd Velocity Regulator P Gain
Description	Parameter which determines the responsiveness of velocity control.
Range	0~10000
Initial value	60
Unit	-
Applicable Operating Mode	All

 (Ft-1.18)	3rd Velocity Regulator I Gain RSWare : Drive - Tuning - 3rd Regulator Gains - 3rd Velocity Regulator I Gain
Description	• Removes steady state speed tolerance. • Overshoot in speed response can occur if set value is too large.
Range	0~60000
Initial value	26
Unit	-
Applicable Operating Mode	All

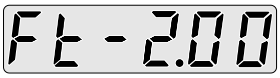
 (Ft-1.19)	3rd Position Regulator Kp Gain RSWare : Drive - Tuning - 3rd Regulator Gains - 3rd Position Regulator Kp Gain
Description	Parameter which determines the responsiveness of position control. Change set value according to rigidity of load.
Range	0~700
Initial value	20
Unit	Hz
Applicable Operating Mode	F

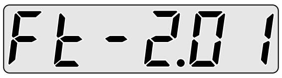
 (Ft-1.20)	4th Velocity Regulator P Gain RSWare : Drive - Tuning - 4th Regulator Gains - 4th Velocity Regulator P Gain
Description	Parameter which determines the responsiveness of velocity control.
Range	0~10000
Initial value	60
Unit	-
Applicable Operating Mode	F, S, P

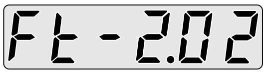
 (Ft-1.21)	4th Velocity Regulator I Gain RSWare : Drive - Tuning - 4th Regulator Gains - 4th Velocity Regulator I Gain
Description	Removes steady state speed tolerance. Overshoot in speed response can occur if set value is too large.
Range	0~60000
Initial value	26
Unit	-
Applicable Operating Mode	F, S, P

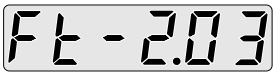
 (Ft-1.22)	4th Velocity Regulator P Gain RSWare : Drive - Tuning - 4th Regulator Gains - 4th Position Regulator Kp Gain
Description	A parameter which determines the responsiveness of position control. Change the setting value according to rigidity of load.
Range	0~700
Initial value	20
Unit	Hz
Applicable Operating Mode	F

Standard Group 2

 (Ft-2.00)	Set the analogue speed command input scale RSWare : Drive - Mode Configuration - Analog- Analog Velocity Command Scale
Description	• Sets the speed command value [rpm] for the analog speed command input pin (Pin 19 and 20 of I/O). • Speed command [rpm] = Ft-2.00 [rpm/V] × Input Voltage [V]
Range	10.0~2000.0
Initial value	500.0
Unit	Rotary Motor: [rpm/V], Linear Motor: [mm/sec/V]
Applicable Operating Mode	S

 (Ft-2.01)	Analogue Speed Command OffsetRSWare : Drive - Mode Configuration - Analog - Analog Velocity Command Offset
Description	Enter the analog velocity command offset
Range	-10000~10000
Initial value	0
Unit	mV
Applicable Operating Mode	S

 (Ft-2.02)	Speed Command Filter Bandwidth
Description	• Enter the speed command filter bandwidth. • This value changed simultaneously with change of inertia ratio (Ft-0.04), speed response level (Ft-1.00) or system gain (Ft-1.01) value.
Range	0~10000
Initial value	0
Unit	Hz
Applicable Operating Mode	All

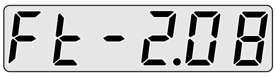
 (Ft-2.03)	Speed Error Filter Bandwidth RSWare : Drive - Tuning - Velocity Error Filter Bandwidth
Description	Speed Error Filter
Range	0~2500
Initial value	30
Unit	-
Applicable Operating Mode	S, P

 (Ft-2.04)	Speed feed forward gain RSWare : Drive - Tuning - Velocity Regulator Kff Gain
Description	Speed Feed Forward Gain
Range	0~6000
Initial value	0
Applicable Operating Mode	All

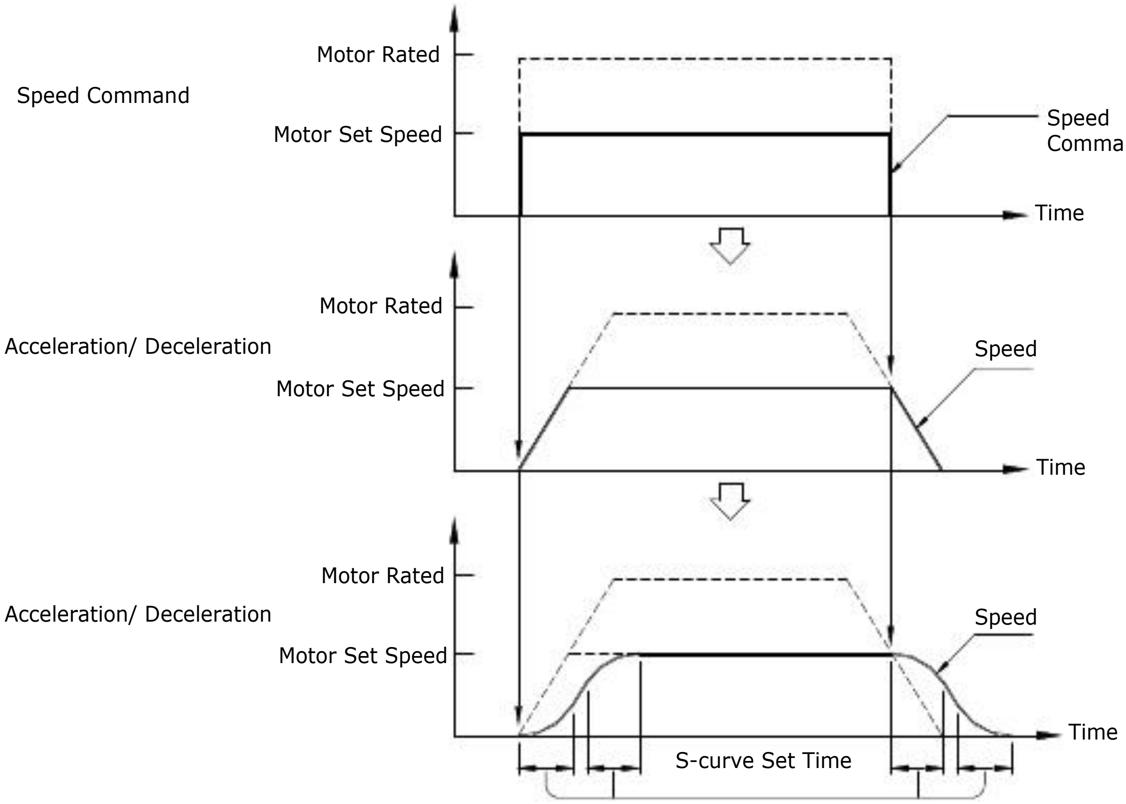
 (Ft-2.05)	Jog Operation Speed RSWare : Drive - Resonant Suppression - Test Run For ANF Settings - Jog Velocity Command
Description	Jog Operation Speed
Range	0~6000 rpm
Initial value	50
Applicable Operating Mode	All

 (Ft-2.06)	Acceleration RSWare : Drive - Acceleration Limits - Acceleration
Description	Acceleration means slope of the Speed Profile.
Range	1~2147483647
Initial value	41667; for rotary motor, 416.67 Rev/sec^2
Applicable Operating Mode	All

 (Ft-2.07)	Deceleration RSWare : Drive - Acceleration Limits - Deceleration
Description	Deceleration means slope of the Speed Profile.
Range	1~2147483647
Initial value	41667, Rotary Motor: 416.67 Rev/sec^2
Applicable Operating Mode	All

 (Ft-2.08)	S-Curve Operation Time RSWare : Drive - Acceleration Limits - S-Curve Time
Description	0~5,000
Range	0
Initial value	Ms
Applicable Operating Mode	All

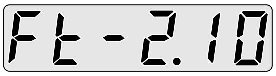
- Set the S-curve operation time for smooth operation.
- Applicable only when acceleration/deceleration time have been set. If value is set to ‘0’, S-curve operation is disabled; if a value other than ‘0’ is set, S-curve operation is enabled upon acceleration/ deceleration.

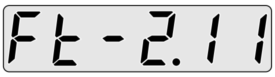


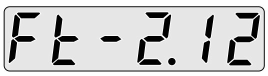
(Ft-2.09)	Preset Velocity 1 RSWare : Drive - Mode Configuration - Preset –Preset Velocity1
Description	• Sets each Multi-step Speed commands for Multi-step Speed control mode. • The operation speed should be entered in advance into the relevant parameters </C-SP1>, </C-SP2>, </C-SP3>. • According to combination of the sequence input signals </C-SP1>, </C-SP2>, </C-SP3>, operation at preset speed is possible. • In addition, sequence input signal </C-DIR> is used to change the rotation direction of each speed command. • To reduce impact of speed change, set the acceleration/deceleration time to a sufficient value which should not interfere with system responsiveness.
Range	-6000~6000
Initial value	0
Unit	Rotary Motor: [rpm], Linear Motor: [mm/sec]
Applicable Operating Mode	P

Table A.1 </C-SP1>, </C-SP2>, </C-SP3> Rotation Speed per Signal

Multi-step Speed	Speed Set Parameter	</C-SP3>	</C-SP2>	</C-SP1>
Halt Command	0 (rpm)	0	0	0
Speed Command 1	Ft-2.09	0	0	1
Speed Command 2	Ft-2.09	0	1	0
Speed Command 3	Ft-2.09	0	1	1
Speed Command 4	Ft-2.09	1	0	0
Speed Command 5	Ft-2.09	1	0	1
Speed Command 6	Ft-2.09	1	1	0
Speed Command 7	Ft-2.09	1	1	1

 (Ft-2.10)	Preset Velocity 2 RSWare : Drive - Mode Configuration - Preset – Preset Velocity2
Description	Refer to descriptions of [Ft-2.09]
Range	-6000~6000
Initial value	0
Unit	Rotary Motor: [rpm], Linear Motor: [mm/sec]
Applicable Operating Mode	All

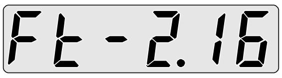
 (Ft-2.11)	Preset Velocity 3 RSWare : Drive - Mode Configuration - Preset – Preset Velocity3
Description	See the Ft-2.09 description.
Range	-6000~6000
Initial value	0
Unit	Rotary Motor: [rpm], Linear Motor: [mm/sec]
Applicable Operating Mode	P

 (Ft-2.12)	Preset Velocity 4 RSWare : Drive - Mode Configuration - Preset – Preset Velocity4
Description	See the Ft-2.09 description.
Range	-6000~6000
Initial value	0
Unit	Rotary Motor: [rpm], Linear Motor: [mm/sec]
Applicable Operating Mode	P

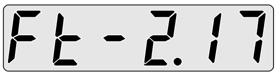
(Ft-2.13)	Preset Velocity 4 RSWare : Drive - Mode Configuration - Preset – Preset Velocity5
Description	See the Ft-2.09 description.
Range	-6000~6000
Initial value	0
Unit	Rotary Motor: [rpm], Linear Motor: [mm/sec]
Applicable Operating Mode	P

(Ft-2.14)	Preset Velocity 6 RSWare : Drive - Mode Configuration - Preset – Preset Velocity6
Description	See the Ft-2.09 description.
Range	-6000~6000
Initial value	0
Unit	Rotary Motor: [rpm], Linear Motor: [mm/sec]
Applicable Operating Mode	P

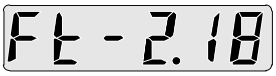
(Ft-2.15)	Preset Velocity 7 RSWare : Drive - Mode Configuration - Preset – Preset Velocity7
Description	See the Ft-2.09 description.
Range	-6000~6000
Initial value	0
Unit	Rotary Motor: [rpm], Linear Motor: [mm/sec]
Applicable Operating Mode	P

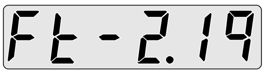
<table>
<tr><td>

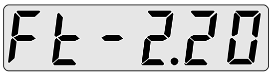
(Ft-2.16)</td><td>Manual Velocity Limit
RSWare : Drive - Velocity Limits - Manual Velocity limit</td></tr>
<tr><td>Description</td><td>• Limits the operation speed to below this set value in all control modes.
• There are two methods of speed limitation: limitation thorough this value and limitation through speed command of upper level controller. Configure by referring to speed limit method selection of [Ft-2.17].
• In addition, in torque control mode, the mode is changed automatically to velocity control mode if motor speed exceeds this value; velocity control is performed using limit speed command.
• If the analog speed command exceeds motor's maximum speed, the excessive speed command warning “OSC” is issued.
• If excessive speed command warning is issued, the speed command is automatically reduced to the motor’s maximum speed.</td></tr>
<tr><td>Range</td><td>1~6000</td></tr>
<tr><td>Initial value</td><td>5000</td></tr>
<tr><td>Unit</td><td>Rotary Motor: [rpm], Linear Motor: [mm/sec]</td></tr>
<tr><td>Applicable Operating Mode</td><td>F, S, P</td></tr>
</table>

<table>
<tr><td>

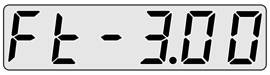
(Ft-2.17)</td><td colspan="3">Velocity Limit Mode
RSWare : Drive - Velocity Limits - Velocity Limit Mode</td></tr>
<tr><td>Description</td><td colspan="3">Select velocity limit mode.</td></tr>
<tr><td rowspan="5">Range</td><td>Value</td><td>Description</td><td>RSWare Name</td></tr>
<tr><td>0</td><td>Disabled</td><td>Disabled</td></tr>
<tr><td>1</td><td>Limited by [Ft-2.16].</td><td>Manual Limit</td></tr>
<tr><td>2</td><td>Limited by Analogue Speed Command Value. (except for Analog Velocity control Mode).</td><td>Analog Input</td></tr>
<tr><td>3</td><td>Limited by lesser one between [Ft-2.16] and Analogue Speed Command.</td><td>Manual and Analog</td></tr>
<tr><td>Initial value</td><td colspan="3">0</td></tr>
</table>

 (Ft-2.18)	Speed Window RSWare : Drive – Speed Functions – Speed Window
Description	If the speed error is smaller than the set value and Within Speed Window output signal is assigned, then the Within Speed Window output is turned ON.
Range	0~1000
Initial value	10
Unit	Rotary Motor: [rpm], Linear Motor: [mm/sec]
Applicable Operating Mode	F, S, P

 (Ft-2.19)	Revolution Detection Level RSWare : Drive - Speed Functions - Up to Velocity
Description	If the motor speed is greater than set value and motor rotation signal is assigned, then the motor rotation signal is turned ON.
Range	1~5000
Initial value	20
Unit	Rotary Motor: [rpm], Linear Motor: [mm/sec]
Applicable Operating Mode	All

 (Ft-2.20)	Speed Zero Clamp LevelRSWare : Drive - Speed Functions - Zero Clamp
Description	If the velocity control mode command is smaller than the set value, then the velocity control mode command is ignored and the motor command speed is set to zero
Range	0~5000
Initial value	0
Unit	Rotary Motor: [rpm], Linear Motor: [mm/sec]
Applicable Operating Mode	S (Velocity control mode)

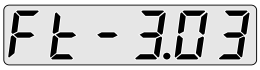
Standard Group 3

 (Ft-3.00)	Follower RSWare : Drive - Mode Configuration - Follower		
Data Size	4 digits		
Ditig 0 [D0]	Position Command Type RSWare : Drive - Mode Configuration - Follower - Command Type		
Range	Value	Description	RSWare Name
	0	Step Up/Step Down, Positive logic	Step Up/Step Down. Positive Logic
	1	Step Up/Step Down, Negative logic	Step Up/Step Down. Negative Logic
	2	Step/Direction, Positive Logic	Step/Direction. Positive Logic
	3	Step/Direction, Negative Logic	Step/Direction. Negative Logic
	4	A phase+B phase, x1	Auxiliary Encoder. x1ommand
	5	A phase+B phase, x2	Auxiliary Encoder. X2
	6	A phase+B phase, x4	Auxiliary Encoder. X4
Initial Value	0		
Applicable Operating Mode	F		
Digit 1 [D1]	Position Command Pulse Type RSWare : Drive - Mode Configuration - Follower - Controller Output Type		
Range	Value	Description	RSWare Name
	0	Use Low speed Line Drive Output in Host Controller for isolated electrical connection (Max.900 [kHz])	Line Drive
	1	Use Open Collector in Host Controller (Max. 250 [kHz])	Open Collector
	2	Use High Frequency Line Drive Output in Host Controller (Max. 4 [MHz])	High Speed Line Drive
Initial Value	0		
Applicable Operating Mode	F		
Digit 2 [D2]	Encoder Output Pulse Direction RSWare : Drive - Encoders - Encoder Output Forward Direction		
Range	Value	Description	RSWare Name
	0	During Forward Rotation, Encoder Output Phase A have a lead of 90° over Phase B.	A Leads B
	1	During Forward Rotation, Encoder Output Phase B have a lead of 90° over Phase A.	B Leads A
	0		
Initial Value	All		
Digit 3 [D3]	Change the Electronic Gear Ratio RSWare : Drive - Mode Configuration - Follower - Gear Ratio Change		
Range	Value	Description	RSWare Name
	0	Enable Only when Servo OFF	Enable Only on Drive Disabled

	1	Always Enable	Always Enable
Initial Value	0		
Applicable Operating Mode	F		

	Position Command Filter Bandwidth RSWare : Drive - Tuning - Main Position Regulator Gains - Position Command LPF Bandwidth
Description	Sets low pass cutoff frequency of speed command to suppress high frequency components.
Range	0~1000
Initial value	0
Unit	Hz
Applicable Operating Mode	All

 (Ft-3.02)	Position FF Gain RSWare : Drive - Tuning - Main Position Regulator Gains - Position Regulator Kff Gain
Description	• Larger values result in faster position completion and smallerposition error at transient response condition. • The value can differ depending load's type or rigidity; an excessively large value causes vibration.
Range	0~100
Initial value	0
Unit	%
Applicable Operating Mode	F

 (Ft-3.03)	Position FF Gain Filter RSWare : Drive - Tuning - Main Position Regulator Gains - Position Regulator Kff LPF Bandwidth
Description	• Valid if position FF gain Ft-3.02 is not '0'. • If a value other than '0' entered for Ft-3.02 results in overshoot or vibration, set this value to '0'.
Range	0~2500
Initial value	200
Unit	Hz
Applicable Operating Mode	F

(Ft-3.04)	Position Movement Command Filter RSWare : Drive - Tuning - Main Position Regulator Gains - Moving Average Filter
Description	• Set it when smooth operation is required. • The filter tends to reduce t he responsiveness.
Range	0~1000
Initial value	320
Unit	0.125ms
Applicable Operating Mode	F

(Ft-3.05)	1st Gear Ratio, Follower Numerator RSWare : Drive - Mode Configuration - Follower - 1st Gear Ratio
Description	• Numerator of Electronic gear. • By using the electronic gear function, the amount of motor rotation pr input command pulse can be set arbitrarily. • The following relationship has to be satisfied “No. of pulses per 1 motor rotation × Reduction gear ratio × 4 ≥ [Ft-3.06]”. • Maximum resolution = 1 / ([No. of pulses per 1 motor rotation] × [Reduction gear ratio] × 4)
Range	1~8388608
Initial value	4
Unit	Pulse
Applicable Operating Mode	F

(Ft-3.06)	1st Gear Ratio Denominator RSWare : Drive - Mode Configuration - Follower - 1st Gear Ratio
Description	Denominator of Electronic gear.
Range	1~8388608
Initial value	4
Unit	Pulse
Applicable Operating Mode	F

(Ft-3.07)	2nd Gear Ratio Numerator RSWare : Drive - Mode Configuration - Follower - 2st Gear Ratio
Description	Numerator of 2nd Electronic gear.
Range	1~8388608
Initial value	4
Unit	Pulse
Applicable Operating Mode	F

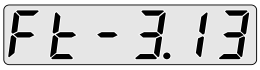
(Ft-3.08)	2nd Gear Ratio Denominator RSWare : Drive - Mode Configuration - Follower - 2st Gear Ratio
Description	Denominator of 2nd Gear Ratio.
Range	1~8388608
Initial value	4
Unit	Pulse
Applicable Operating Mode	F

(Ft-3.09)	3rd Electronic Gear Ratio Numerator RSWare : Drive - Mode Configuration - Follower - 3st Gear Ratio
Description	The numerator of the 3rd electronic gear ratio.
Range	1~8388608
Initial value	4
Unit	Pulse
Applicable Operating Mode	F

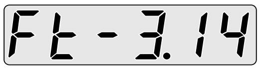
(Ft-3.10)	3rd Electronic Gear Ratio Denominator RSWare : Drive - Mode Configuration - Follower - 3st Gear Ratio
Description	The denominator of the 3rd electronic gear ratio.
Range	1~8388608
Initial value	4
Unit	Pulse
Applicable Operating Mode	F

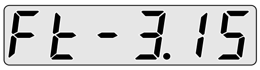
(Ft-3.11)	Position Output Pulse Adjustment Numerator RSWare : Drive - Encoder - Output Ratio
Description	• The numerator of position output pulse adjustment. • Set the number of pulses to be output through the servo drive's encoder signal output (EA+, EA-, EB+, EB-) per one motor rotation. • For [Ft-3.11], enter the numerator of the encoder's output division ratio. Generally, the number of pulses to be output per one motor rotation is entered. • For [Ft-3.12], enter the denominator of the encoder's output division ratio. Generally, the number of pulses of the encoder connected to the motor per one rotation is entered. • For the encoder output division ratio, the relationship [Ft-3.11] ≤ [Ft-3.12] should be satisfied. • Equation for adjusting the number of pulses outputted to the higher level controller: ([Ft-3.11]/[Ft-3.12]) × No. of encoder pulses = No. of output pulses
Range	1~8388608
Initial value	1
Unit	-
Applicable Operating Mode	F

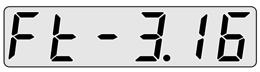
(Ft-3.12)	Position Output Pulse Adjustment (Denominator) RSWare : Drive - Encoder - Output Ratio
Description	The numerator of position output pulse adjustment.
Range	1~8388608
Initial value	1
Unit	-
Applicable Operating Mode	F

<table>
<tr><td>
(Ft-3.13)</td><td colspan="2">Position Command Pulse Filter Type
RSWare : Drive - Mode Configuration - Follower - Digital Filter Cut-off Frequency</td></tr>
<tr><td>Digit 0 [D0]</td><td colspan="2">Line Drive
RSWare : Drive - Mode Configuration - Follower - Digital Filter Cut-off Frequency - Low Speed Line Drive Input</td></tr>
<tr><td rowspan="9">Range</td><td>Value</td><td>Description</td></tr>
<tr><td>0</td><td>4.0 MHz</td></tr>
<tr><td>1</td><td>2.5 MHz</td></tr>
<tr><td>2</td><td>1.5 MHz</td></tr>
<tr><td>3</td><td>1.0 MHz</td></tr>
<tr><td>4</td><td>0.7 MHz</td></tr>
<tr><td>5</td><td>0.5 MHz</td></tr>
<tr><td>6</td><td>0.3 MHz</td></tr>
<tr><td>7</td><td>0.2 MHz</td></tr>
<tr><td>Initial value</td><td colspan="2">3</td></tr>
<tr><td>Applicable Operating Mode</td><td colspan="2">F</td></tr>
<tr><td>Digit 1 [D1]</td><td colspan="2">Open Collector
RSWare : Drive - Mode Configuration - Follower - Digital Filter Cut-off Frequency - Open Collector Input</td></tr>
<tr><td rowspan="9">Range</td><td>Value</td><td>Description</td></tr>
<tr><td>0</td><td>4.0 MHz</td></tr>
<tr><td>1</td><td>2.5 MHz</td></tr>
<tr><td>2</td><td>1.5 MHz</td></tr>
<tr><td>3</td><td>1.0 MHz</td></tr>
<tr><td>4</td><td>0.7 MHz</td></tr>
<tr><td>5</td><td>0.5 MHz</td></tr>
<tr><td>6</td><td>0.3 MHz</td></tr>
<tr><td>7</td><td>0.2 MHz</td></tr>
<tr><td>Initial value</td><td colspan="2">5</td></tr>
<tr><td>Applicable Operating Mode</td><td colspan="2">F</td></tr>
<tr><td>Digit 2 [D2]</td><td colspan="2">High Speed Line Drive
RSWare : Drive - Mode Configuration - Follower - Digital Filter Cut-off Frequency - High Speed Line Drive Input</td></tr>
<tr><td rowspan="8">Range</td><td>Value</td><td>Description</td></tr>
<tr><td>0</td><td>4.0 MHz</td></tr>
<tr><td>1</td><td>2.5 MHz</td></tr>
<tr><td>2</td><td>1.5 MHz</td></tr>
<tr><td>3</td><td>1.0 MHz</td></tr>
<tr><td>4</td><td>0.7 MHz</td></tr>
<tr><td>5</td><td>0.5 MHz</td></tr>
<tr><td>6</td><td>0.3 MHz</td></tr>
</table>

	7	0.2 MHz
Initial value	0	
Applicable Operating Mode	F	
Digit 3 [D3]	Position Command Pulse On Duty RSWare : Drive - Mode Configuration - Follower - Digital Filter Cut-off Frequency - Position Command Pulse On-Duty	
Range	Value	Description
	0	20 ~ 40%
	1	40 ~ 60%
	2	60 ~ 80%
Initial value	1	
Applicable Operating Mode	F	

 (Ft-3.14)	1st Vibration Suppression Filter Cutoff Frequency RSWare : Drive - Tuning - Vibration Suppression - 1st Damping Frequency
Description	1st Vibration Suppression Filter Cutoff Frequency
Range	0~10000
Initial value	0
Unit	*0.01Hz
Applicable Operating Mode	F

 (Ft-3.15)	1st Vibration Suppression Filter Damping Ratio RSWare : Drive - Tuning - Vibration Suppression - 1st Damping Ratio
Description	1st Vibration Suppression Filter Damping Ratio
Range	1~999
Initial value	0
Unit	-
Applicable Operating Mode	F

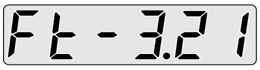
 (Ft-3.16)	2nd Vibration Suppression Filter Cutoff Frequency RSWare : Drive - Tuning - Vibration Suppression - 2st Damping Frequency
Description	2nd Vibration Suppression Filter Cutoff Frequency.
Range	1~10000
Initial value	0
Unit	*0.01Hz
Applicable Operating Mode	F

(Ft-3.17)	2nd Vibration Suppression Filter Damping Ratio RSWare : Drive - Tuning - Vibration Suppression - 2st Damping Ratio
Description	2nd Vibration Suppression Filter Damping Ratio
Range	1~999
Initial value	0
Unit	-
Applicable Operating Mode	F

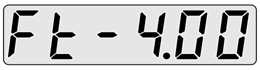
(Ft-3.18)	In Position Size RSWare : Drive - Position Functions - In Position Size
Description	If position error < In Position Size for 1 ms and the In PositionSize output signal is assigned, the In Position output is turned ON.
Range	0~2500
Initial value	10
Unit	pulse
Applicable Operating Mode	F

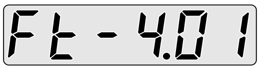
(Ft-3.19)	Near Position Size RSWare : Drive - Position Functions - Near Position Size
Description	If position error < Near Position Size and the Near Position output signal is assigned, the Near Position output is turned ON.
Range	0~2500
Initial value	20
Unit	pulse
Applicable Operating Mode	F

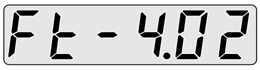
(Ft-3.20)	Following Error Limit RSWare : Drive - Faults - Following Error Limit
Description	A following error fault occurs when the difference between position command and actual position is greater than this parameter.
Range	0~2147483647
Initial value	655360
Unit	pulse
Applicable Operating Mode	F

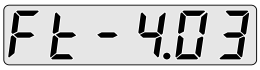
 (Ft-3.21)	Reserved

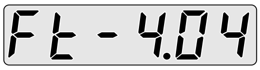
Standard Group 4

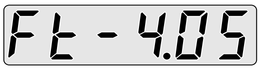
 (Ft-4.00)	External Torque Command Input Ratio RSWare : Drive - Mode Configuration - Analog - Analog Current Command Scale
Description	• Set the torque command value (%) for 10V on the analog torque command input (pin 21,22 of I/O). • Torque command (%) =Ft-4.00 (%/V) × Input voltage (V)
Range	0~1000
Initial value	333
Unit	% of rated continuous current/V/10
Applicable Operating Mode	C

 (Ft-4.01)	Current Command Offset RSWare : Drive - Mode Configuration - Analog - Analog Current Command Offset
Description	Current Command Offset
Range	-10000~10000
Initial value	0
Unit	mV
Applicable Operating Mode	C

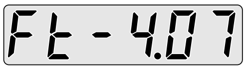
 (Ft-4.02)	1st Current Command Filter Bandwidth RSWare : Drive - Tuning - Main Current Regulator Gains - 1st Current Command LPF Bandwidth
Description	• Restrict the high-frequency elements of torque command. • This value is changed simultaneously with change of inertia ratio (Ft-0.04), speed response level (Ft-1.00) or system gain (Ft-1.01) value.
0-10000	0~10000
Initial value	500
Unit	Hz
Applicable Operating Mode	F

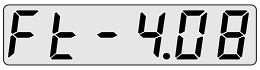
 (Ft-4.03)	2nd Current Command Filter Bandwidth RSWare : Drive - Tuning - 2nd Regulator Gains - 2nd Current Command LPF Bandwidth
Description	2nd Current Command Filter Bandwidth
Range	0~10000
Initial value	300
Unit	Hz
Applicable Operating Mode	All

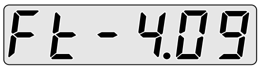
 (Ft-4.04)	3rd Current Command Filter Bandwidth
Description	3rd Current Command Filter Bandwidth
Range	0~10000
Initial value	300
Unit	*0.1Hz
Applicable Operating Mode	F

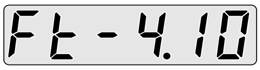
 (Ft-4.05)	4th Current Command Filter Bandwidth
Description	4th Current Command Filter Bandwidth.
Range	0~10000
Initial value	300
Unit	*0.1Hz
Applicable Operating Mode	F

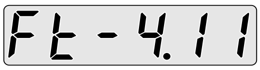
 (Ft-4.06)	Current Loop Gain Setting RSWare : Drive - Tuning - Main Current Regulator Gains - Main Current Regulator Gain	
Description	Current Loop Badnwidth	
Range	Value	Description
	0	High bandwidth
	1	Medium bandwidth
	2	Low bandwidth
Initial value	1	
Unit	-	
Applicable Operating Mode	All	

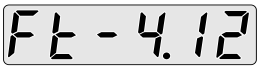
 (Ft-4.07)	Positive Internal Torque Limit RSWare : Drive - Current Limits - Positive Internal Current Limit
Description	Limits forward direction torque on motor separately. (internally limited)
Range	0~500
Initial value	350
Unit	%
Applicable Operating Mode	All

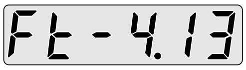
 (Ft-4.08)	Negative Internal Torque Limit RSWare : Drive - Current Limits - Negative Internal Current Limit
Description	Limits reverse direction torque on motor. (Internally limited)
Range	0~500
Initial value	350
Unit	%
Applicable Operating Mode	All

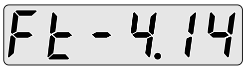
 (Ft-4.09)	Positive External Torque Limit RSWare : Drive - Current Limits - Positive External Current Limit
Description	• The torque imposed on the motor is internally limited automatically by the values set on [Ft-4.07], [Ft-4.08]. Additionally, it is also limited by the values set on [Ft-4.09], [Ft-4.10] when external </P-TL>,</N-TL> signals are input through sequence input. • The torque limit according to internal limit [Ft-4.07] and [Ft-4.08] takes precedence to external torque limit </P-TL> and </N-TL> signals.
Range	0~500
Initial value	100
Unit	%
Applicable Operating Mode	All

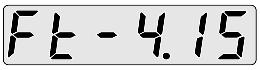
 (Ft-4.10)	Reverse External Torque Limits RSWare : Drive - Current Limits - Negative External Current Limit
Description	Reverse External Torque Limits
Range	0~500
Initial value	100
Unit	%
Applicable Operating Mode	All

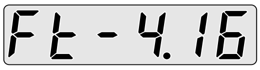
 (Ft-4.11)	Over-travel Torque Limit RSWare : Drive - Stopping Functions - Maximum Stopping Current
Description	• Limits the torque imposed on the motor if the motor is halted by overtravel (<P-OT>,<N-OT>) input signal during rotation. • Unlike external and internal torque limit, the torque limit value for overtravel input is same for forward and reverse direction.
Range	0~500
Initial value	350
Unit	%
Applicable Operating Mode	All

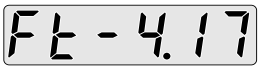
 (Ft-4.12)	Default Torque Bias RSWare : Drive - Stopping Functions - Maximum Stopping Current
Description	Initial torque value applied when the servo drive is activated. This is to keep the vertical axis load.
Range	-100 ~ 100
Initial value	0
Unit	%
Applicable Operating Mode	F

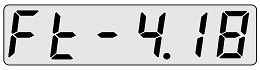
 (Ft-4.13)	1st Vibration Suppression Filter Frequency RSWare : Drive - Tuning - Main Current Regulator Gains - 1st Resonant Frequency Suppression Filter
Description	1st Vibration Suppression Filter Frequency
Range	0~10000
Initial value	10000
Unit	Hz
Applicable Operating Mode	All

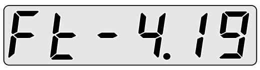
 (Ft-4.14)	1st Vibration Suppression Filter Width
Description	1st Vibration Suppression Filter Width.
Range	1~20
Initial value	10
Unit	-
Applicable Operating Mode	All

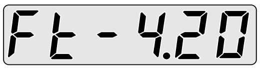
 (Ft-4.15)	1st Vibration Suppression Filter Depth RSWare : Drive - Tuning - Main Current Regulator Gains - 1st Resonant Frequency Suppression Filter Depth
Description	1st Vibration Suppression Filter Depth
Range	0~100
Initial value	100
Unit	-
Applicable Operating Mode	All

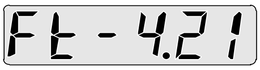
 (Ft-4.16)	2nd Vibration Suppression Filter Frequency RSWare : Drive - Tuning - Main Current Regulator Gains - 2nd Resonant Frequency Suppression Filter
Description	2nd Vibration Suppression Filter Frequency
Range	0~10000
Initial value	10000
Unit	Hz
Applicable Operating Mode	All

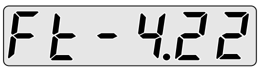
 (Ft-4.17)	2nd Vibration Suppression Filter Width RSWare : Drive - Tuning - Main Current Regulator Gains - 2nd Resonant Frequency Suppression Filter Width
2nd Vibration Suppression Filter Width	2nd Vibration Suppression Filter Width
Range	1~20
Initial value	10
Unit	-
Applicable Operating Mode	All

 (Ft-4.18)	2nd Vibration Suppression Filter Depth RSWare : Drive - Tuning - Main Current Regulator Gains - 2nd Resonant Frequency Suppression Filter Depth
Description	2nd Vibration Suppression Filter Depth
Range	0~100
Initial value	100
Unit	-
Applicable Operating Mode	All

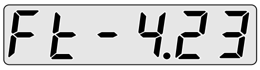
 (Ft-4.19)	3rd Vibration Suppression Filter Frequency
Description	3rd Vibration Suppression Filter Frequency
Range	0~10000
Initial value	10000
Unit	Hz
Applicable Operating Mode	All

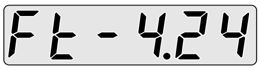
 (Ft-4.20)	3rd Vibration Suppression Filter Width
Description	3rd Vibration Suppression Filter Width.
Range	1~20
Initial value	10
Unit	-
Applicable Operating Mode	All

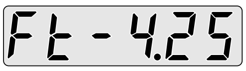
 (Ft-4.21)	3rd Vibration Suppression Filter Depth
Description	3rd Vibration Suppression Filter Depth
Range	0~100
Initial value	100
Unit	-
Applicable Operating Mode	All

 (Ft-4.22)	Adaptive Notch Filter Application Setting RSWare : Drive - Resonant Suppression - Adaptive Notch Filter Setting	
Description	Adaptive Notch Filter (ANF) Application Setting	
Digit 0 [D0]	Adaptive Notch Filter Application Setting	
Range	Value	Description
	0	Not used
	1	Used
Range	0~1	
Initial value	0	
Digit 1 [D1]	High-Pass Filter Cut-off Frequency Setting	
Range	Value	Description
	0	Low
	1	High
Range	0~1	
Initial value	1	
Digit 2 [D2]	Tracking Frequency Initial Value Setting	
Range	Value	Description
	0	Low
	1	High
Range	0~1	

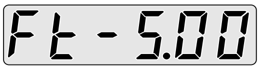
Initial value	High	
Digit 3 [D3]	Adaptive Notch Filter Detection Filter	
Range	Value	Description
	0	Low
	1	Middle
	2	High
Range	0~2	
Initial value	1	

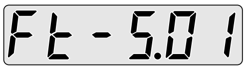
 (Ft-4.23)	Effective Load Ratio Accumulated Time Setting RSWare : Drive - RMS Current Load Factor Function - RMS Current Load Factor Cumulative Time Setting
Description	Set the effective load ratio accumulated time.
Range	0~60
Initial value	10
Unit	Sec
Applicable Operating Mode	All

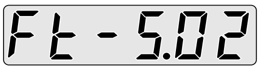
 (Ft-4.24)	Effective Load Ratio Detection Value Setting 1 RSWare : Drive - RMS Current Load Factor Function - RMS Current Load Factor Threshold Setting 1
Description	Effective Load Ratio Detection Value Setting 1
Range	0~350.000
Initial value	350
Unit	%
Applicable Operating Mode	All

 (Ft-4.25)	Effective Load Ratio Detection Value Setting 2 RSWare : Drive - RMS Current Load Factor Function - RMS Current Load Factor Threshold Setting 2
Description	Effective Load Ratio Detection Value Setting 2
Range	0~350.000
Initial value	350
Unit	%
Applicable Operating Mode	All

Standard Group 5

 (Ft-5.00)	Brake Inactive Delay RSWare : Drive - Stopping Functions - Brake Inactive Delay
Description	Set the time from when the drive is enabled to when the brake is released, after Servo-on
Range	0~10000
Initial value	0
Unit	ms
Applicable Operating Mode	All

 (Ft-5.01)	Servo-Off Delay Time RSWare : Drive - Stopping Functions - Disable Delay
Description	Set the actual servo-off time after the motor brake is activated.
Range	0~10000
Initial value	0
Unit	ms
Applicable Operating Mode	All

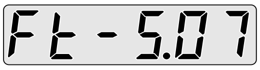
 (Ft-5.02)	Brake Active Delay RSWare : Drive - Stopping Functions - Brake Active Delay
Description	The Braking Application Speed is the feedback speed below which the motor break is engaged, after disabling the drive.
Range	0~10000
Initial value	500
Unit	ms
Applicable Operating Mode	All

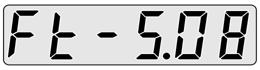
Ft-5.03 (Ft-5.03)	Disabled Braking Speed RSWare : Drive - Stopping Functions - Braking Application Velocity
Description	The Braking Application Speed is the feedback speed below which the motor break is engaged, after disabling the drive.
Range	0~1000
Initial value	100
Unit	Rpm
Applicable Operating Mode	All

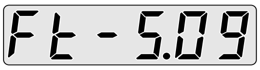
Ft-5.04 (Ft-5.04)	AC Line Loss Fault Delay RSWare : Drive - Faults - AC Line Loss Fault Delay
Description	Set the delay time prior to make an fault when temporary power down occurs.
Range	20~ 2000
Initial value	20
Unit	ms
Applicable Operating Mode	All

Ft-5.05 (Ft-5.05)	Analog Output CH1 Selection RSWare : Drive - Analog Output - Analog Output Ch1 Selection
Description	You can assign the drive internal control value to the analog signal for monitoring, using oscilloscope.
Range	0~ 45 (See the Table 7.25)
Initial value	1
Unit	
Applicable Operating Mode	All

Ft-5.06 (Ft-5.06)	Analog Output CH2 Selection RSWare : Drive - Analog Output - Analog Output Ch2 Selection
Description	The drive signal assigned to channel 2 from the Channel Setup dialog box in the Oscilloscope window.
Range	0~ 45 (Refer to Table 7.25)
Initial value	1
Unit	
Applicable Operating Mode	All

 (Ft-5.07)	Analog Output CH1 Scale RSWare : Drive - Analog Output - Analog Output Ch1 Scale
Description	The amplitude of the channel 1 input signal to be displayed by the oscilloscope.
Range	1 - 99999
Initial value	500
Unit	Units depend on the channel selection.
Applicable Operating Mode	All

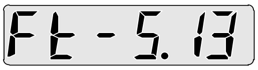
 (Ft-5.08)	Analog Output CH2 Scale RSWare : Drive - Analog Output - Analog Output Ch2 Scale
Description	The amplitude of the channel 2 input signal to be displayed by the oscilloscope.
Range	1 - 99999
Initial value	500
Unit	Units depend on the channel selection.
Applicable Operating Mode	All

 (Ft-5.09)	Motor Overload Detection Method Selection RSWare : Drive - Motor - Motor Overload Method Selection	
Description	Motor Overload Detection Method Selection	
Range	Value	Description
	0	Thermal Model Method
	1	I Square T Method
Initial value	0	
Unit	-	
Applicable Operating Mode	All	

(Ft-5.10)	Status Window Monitoring Window Change Setting RSWare : Drive - Display Monitoring Function	
Description	Status Window Monitoring Window Change Setting	
Digit 0 [D0]	Units digit of the variable number to monitor	
Range	0~9	
Digit 1 [D1]	Tens digit of the variable number to monitor	
Range	0~9	
Digit 2 [D2]	Reserved	
Digit 3 [D3]	Select a monitoring function from status window.	
Range	Value	Description
	0	Not used
	1	Used
Range	0~1	
Initial value	0	

(Ft-5.11)	Enable SAG function RSWare : Drive - Current Limits – Power Sag Warning Enable		
Description	Select whether to use SAG function when main power is cut off.		
Range	Value	Description	RSWare
	0	Not used	Disable
	1	Used	Enable
Initial value	0		
Unit	-		
Applicable Operating Mode	All		

(Ft-5.12)	Torque Limit in SAG function RSWare : Drive - Current Limits – Power Sag Current limit
Description	Torque limit Value while SAG function is working
Range	0 ~ 450
Initial value	50
Unit	%
Applicable Operating Mode	All

 (Ft-5.13)	Duration time of Torque Limit in SAG function RSWare : Drive - Current Limits – Power Sag Current limit release Time
Description	Duration time of torque limit while SAG function is working
Range	0 ~ 3000
Initial value	100
Unit	Msec
Applicable Operating Mode	All

Index Parameter Table

Index Group 0 - Index System

No.	Name	Modbus Address	Digit No.	Range	Initial Value	Note
 (n00.000)	Auto Start Indexing	5000	N/A	0~1	0	-
 (n00.001)	Abort Index Deceleration	5001~5002	N/A	1~2147483647	6250	Rotary Motor: 10-^{2}xRev/sec^{2}, Linear Motor: mm/sec^{2}
 (n00.002)	Positive Deceleration Distance	5003~5004	N/A	0~2147483647	0	pulse
 (n00.003)	Negative Deceleration Distance	5005~5006	N/A	0~2147483647	0	pulse
 (n00.004)	Enable Software Limits	5007	N/A	0~1	0	-
 (n00.005)	Positive Software Limit	5008~5009	N/A	2147483647 ~2147483647	2147483647	pulse
 (n00.006)	Negative Software Limit	5010~5011	N/A	2147483647 ~2147483647	- 2147483647	pulse
 (n00.007)	User-defined distance per one motor rotation	5012~5013	N/A	0~99999	0	-
 (n00.008)	Jog Speed Command	5014	N/A	1~6000	50	rpm
 (n00.009)	Jog Acceleration/Deceleration	5015 ~ 5016	N/A	1~2147483647	6250	Rotary Motor: 10^{-2}x rev/sec^{2}, Linear Motor: mm/sec^{2}

Index Group 1 - Homing

No.	Name	Modbus Address	Digit No.	Range	Initial Value	Note
(n01.000)	Homing Method	5400	N/A	0~10	1	
(n01.001)	Homing starts automatically upon Servo On	5401	N/A	0~2	2	
(n01.002)	Homing Velocity 1st	5402	N/A	-6000~6000	100	Rotary Motor: [rpm]
(n01.003)	Homing Velocity 2nd	5402	N/A	0~6000	20	Rotary Motor: [rpm]
(n01.004)	Homing Acceleration/ Deceleration	5404~5405	N/A	1~214748367	6250	rpm for rotary motor
(n01.005)	Offset Move Distance	5406~5407	N/A	-2147483647 ~2147483647	0	pulse
(n01.006)	Home Sensor Polarity	5408	N/A	0~1	0	-
(n01.007)	Home Position	5409~5410	N/A	-2147483647 ~2147483647	0	pulse
(n01.008)	Moving distance After Home Sensor	5411~5412	N/A	0~2147483647	0	pulse
(n01.009)	Stopper Recognition Torque	5413	N/A	1~250	100	%
(n01.010)	Stopper Recognition Time	5414	N/A	0~1000	0	ms
(n01.011)	Homing Time Limit	5415	N/A	0~65535	60	sec
(n01.012)	Stop Home Deceleration	5416~5417	N/A	1~2147483647	6250	Rotary Motor: 10^{-2} x Rev/sec^2 Linear Motor: mm/sec^2

Indexing Group 2 - Index Option

No.	Name	Modbus Address	Digit No.	Range	Initial Value	Note
(n02.000)	Index 0 Option	5800	0	0: Absolute 1: Incremental	0	-
			1	0: Stop 1: Start next index 2: Wait for Start	0	-
			2...3	Reserved		
(n02.001)	Index 1 Option	5801	0	0: Absolute 1: Incremental	0	-
			1	0: Stop 1: Start next index 2: Wait for Start	0	
			2...3	Reserved		
: : :	: : :	: : :	: : :	: : :	: : :	: : :
(n02.127)	Index 127 option	5927	0	0: Absolute 1: Incremental	0	-
			1	0: Stop 1: Start next index 2: Wait for Start	0	-
			2...3	Reserved		

Index Group 4 - Index Position / Distance

No.	Name	Modbus Address	Digit No.	Range	Initial Value	Note
(n04.000)	Index 0 Position/Distance	56600~6601	N/A	-2147483647 ~2147483647	0	pulse
(n04.001)	Index 1 Position/Distance	5602~6603	N/A	-2147483647 ~2147483647	0	pulse
(n04.127)	Index 127 Position/Distance	5854~6855	N/A	-2147483647 ~2147483647	0	pulse

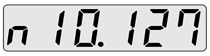
Index Group 7 - Index Dwell

No.	Name	Modbus Address	Digit No.	Range	Initial Value	Note
(n07.000)	Index 0 Dwell	7800	N/A	0~65535	0	ms
(n07.000)	Index 1 Dwell	7801	N/A	0~65535	0	ms
: : :	: : :	: : :	: : :	: : :	: : :	: : :
(n07.127)	Index 127 dwell	7927	N/A	0~65535	0	ms

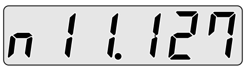
Indexing Gorup 8 - Index Velocity

No.	Name	Modbus Address	Digit No.	Range	Initial Value	Note
(n08.000)	Index 0 Velocity	8200	N/A	0~6000	750	Rotary Motor: rpm, Linear Motor: mm/sec
(n08.001)	Index 1 Velocity	8201	N/A	0~6000	750	Rotary Motor: rpm, Linear Motor: mm/sec
: :	:	: :	: :	: :	: :	: :
(n08.127)	Index 127 Velocity	8327	N/A	0~6000	750	Rotary Motor: rpm, Linear Motor: mm/sec

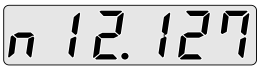
Index Group 10 - Index Acceleration

No.	Name	Modbus Address	Digit No.	Range	Initial Value	Note
 (n10.000)	Index 0 Acceleration	9000~9001	N/A	1~2147483647	6250	Rotary Motor: rpm, Linear Motor: mm/ sec
 (n11.001)	Index 1 Acceleration	9002~9003	N/A	1~2147483647	6250	Rotary Motor: rpm, Linear Motor: mm/ sec
: : :	: : :	: : :	: : :	: : :	: : :	: : :
 (n10.127)	Index 127 Acceleration	9254~9255	N/A	1~2147483647	6250	Rotary Motor: rpm, Linear Motor: mm/sec

Index Group 11 - Index Decelerat

No.	Name	Modbus Address	Digit No.	Range	Initial Value	Note
 (n11.000)	Index 0 Deceleration	9400~9401	N/A	1~2147483647	6250	Rotary Motor: 10^{-2}xRev/sec^2 Linear Motor: mm/sec^2
 (n11.001)	Index 1 Deceleration	9402~9403	N/A	1~2147483647	6250	Rotary Motor: 10^2xRev/sec^2, Linear Motor: mm/sec^2
: : :	: : :	: : :	: : :	: : :	: : :	: : :
 (n11.127)	Index 127 Deceleration	9654~9655	N/A	1~2147483647	6250	Rotary Motor: 10^2xRev/sec^2, Linear Motor: mm/sec^2

Indexing Gorup 12 - Index Deceleration

No.	Name	Modbus Address	Digit No.	Range	Initial Value	Note
 (n12.000)	Index 0 Next Index	9800	N/A	0~127	0	-
 (n12.001)	Index 1 Next Index	9801	N/A	0~127	0	-
: : :	: : :	: : :	: : :	: : :	: : :	: : :
 (n12.127)	Index 127 Next Index	9927	N/A	0~127	0	-

Indexing Parameter Gorup 0 - Indexing System

 (n00.000)	Auto Start Indexing RSWare : Drive - Mode Configuration- Indexing - Auto Start Indexing				
Description	When this field is set to "on", the drive will begin executing the selected index whenever the drive enables. • 0-Off • 1-On				
Range	0~1	Initial Value	0	Unit	N/A
Modbus Address	5000	Changeable Status	Always		
Applicable Operation Mode	I				

 (n00.001)	Abort Index Deceleration RSWare : Drive - Mode Configuration- Indexing - Abort Index Decel				
Description	The deceleration used to stop motion when the Stop Index input terminates an index move.				
Range	0~2147483647	Initial Value	6250	Unit	Rotary Motor: 10^{-2}xRev/sec^2, Linear Motor: mm/sec^2
Modbus Address	5001~5002	Changeable Status	Always	-	
Applicable Operation Mode	I				

 (n00.002)	Positive Deceleration Distance RSWare : Drive - Mode Configuration- Indexing - Positive Deceleration Distance				
Description	The stopping distance used when the drive encounters a positive overtravel limit.				
Range	0~2147483647	Initial Value	0	Unit	pulse
Modbus Address	5003~ 5004	Changeable Status	Always	-	
Applicable Operation Mode	I	-			

 (n00.003)	Negative Deceleration Distance RSWare : Drive - Mode Configuration- Indexing - Negative Deceleration Distance				
Description	The stopping distance used when the drive encounters a negative overtravel limit.				
Range	0~2147483647	Initial Value	0	Unit	pulse
Modbus Address	5003~ 5004	Changeable Status	Always	-	
Applicable Operation Mode	I	-			

n00.004 (n00.000)	Enable Software Limits RSWare : Drive - Mode Configuration- Indexing - Enable Software Limits				
Description	Select: • 0-Off: Turns off software limit checking • 1-On: Turns on software limit checking				
Range	0~1	Initial Value	0	Unit	N/A
Modbus Address	5007	Changeable Status	Servo-OFF	-	

n00.005 (n00.005)	Positive Software Limit RSWare : Drive - Mode Configuration- Indexing - Positive Software Limit				
Description	If the motor feedback position is greater than this value, the drive has exceeded the software overtravel limit.				
Range	-2147483647 ~2147483647	Initial Value	2,147,483,647	Unit	pulse
Modbus Address	5008~5009	Changeable Status	Servo-OFF	-	
Applicable Operation Mode	I	-			

n00.006 (n00.006)	Negative S/W Limit RSWare : Drive - Mode Configuration- Indexing - Negative Software Limit				
Description	If the motor feedback position is less than this value, the drive has exceeded the software overtravel limit.				
Range	-2147483647 ~2147483647	Initial Value	2,147,483,647	Unit	pulse
Modbus Address	5010~5011	Changeable Status	Servo-OFF	-	
Applicable Operation Mode	I	-			

n00.007 (n00.007)	User-defined distance per one motor rotation RSWare : Drive - Mode Configuration- Indexing - User Defined Distance Per Motor Revolution				
Description	Define the moving distance of a load system per one motor rotation.				
Range	0~99999	Initial value	0	Unit	User-defined
Modbus Address	5012~5013	Changeable Status	Always	-	
Applicable Operation Mode	I	-			

(n00.008)	Jog Speed Command RSWare : Drive - Mode Configuration- Indexing – Jog Velocity Command				
Description	Define the jog speed command in the index				
Range	1~6000	Initial value	50	Unit	rpm
Modbus Address		Changeable Status	Always	-	
Applicable Operation Mode	I	-			

(n00.009)	Jog Acceleration/Deceleration RSWare : Drive - Mode Configuration- Indexing – Jog Accel/Decel				
Description	Define in the index the acceleration/deceleration upon jog movement.				
Range	1~2147483647	Initial value	6250	Unit	Rotary Motor: 10^{-2} x Rev/sec^2, Linear Motor: mm/sec^2
Modbus Address		Changeable Status	Always	-	
Applicable Operation Mode	I	-			

Indexing Parameter Garoup 1 - Homing

(n01.000)	Homing Type RSWare : Drive - Mode Configuration- Homing - Homing Type				
Description	Select the type of homing operation the drive will perform. • 0-Home to Present Position • 1-To Home sensor/Back to Marker • 2-To Limit/Back to Marker • 3-To Home sensor/Fwd to Marker • 4- To Limit/Fwd to Marker • 5- Home to Current Value • 6-Home to Current Value/Back to Marker • 7-To Home sensor/Move/Back to Marker • 8-Home to Marker • 9-To Home Sensor • 10-To Limit Sensor				
Range	0~10	Initial Value	1	Unit	N/A
Modbus Address	5400	Changeable Status	Servo-OFF	-	
Applicable Operation Mode	I	-			

(n01.001)	Auto Start Homing on Enable RSWare : Drive - Mode Configuration- Homing - Auto Start Homing on Enable				
Description	Starts the homing procedure of the servo drive automatically when the servo is activated. • 0 - Run: Homing starts automatically whenever the drive servo is turned on. • 1 - Run only after reset: When the servo is not homed yet, homing starts automatically when the servo is turned on. • 2 - Disable				
Range	0~2	Initial Value	2	Unit	N/A
Modbus Address	5401	Changeable Status	Always (Setting applied upon power re-apply)		
Applicable Operation Mode	I	-			

(n10.002)	Homing Velocity 1st RSWare : Drive - Mode Configuration- Homing - Homing Velocity				
Description	The velocity until the sensor is found upon homing. The sign (+/-) of this value indicates the direction of homing motion.				
Range	-6000~6000	Initial Value	100	Unit	Rotary Motor: rpm, Linear Motor: mm/sec
Modbus Address	5402	Changeable Status	Servo-OFF	-	
Applicable Operation Mode	I	-			

 (n01.003)	Homing Velocity 2nd RSWare : Drive - Mode Configuration- Homing - Creep Velocity				
Description	The velocity until the encoder “Z” phase is found after detecting the sensor.				
Range	0~6000	Initial Value	20	Unit	Rotary Motor: rpm, Linear Motor: mm/sec
Modbus Address	5403	Changeable Status	Servo-OFF	-	
Applicable Operation Mode	I	-			

 (n01.004)	Homing Acceleration/Deceleration RSWare : Drive - Mode Configuration- Homing - Homing Accel/Decel				
Description	Acceleration and deceleration velocity used during homing.				
Range	1~2147483647	Initial Value	6250	Unit	Rotary Motor: 10^{-2}xRev/sec^2, Linear Motor: mm/sec^2
Modbus Address	5404, 5405	Changeable Status	Servo-OFF	-	
Applicable Operation Mode	I	-			

 (n01.005)	Offset Move Distance RSWare : Drive - Mode Configuration- Homing - Offset Move Distance				
Description	The distance of movement after the homing procedure is completed per the defined homing method.				
Range	-2147483647~ 2147483647	Initial Value	0	Unit	pulse
Modbus Address	5406, 5407	Changeable Status	Servo-OFF	-	
Applicable Operation Mode	I	-			

 (n01.006)	Home Sensor Polarity RSWare : Drive - Mode Configuration- Homing - Home Sensor Polarity				
Description	• 0-NORMAL CLOSE • 1-NORMAL OPEN				
Range	0~1	Initial Value	2	Unit	N/A
Modbus Address	5406, 5407	Changeable Status	Servo-OFF	-	
Applicable Operation Mode	I	-			

 (n01.007)	Home Position RSWare : Drive - Mode Configuration- Homing - Home Position				
Description	The home position when a homing procedure is completed.				
Range	-2147483647~ 2147483647	Initial Value	0	Unit	pulse
Modbus Address	5409, 5410	Changeable Status	Servo-OFF	-	
Applicable Operation Mode	I	-			

 (n01.008)	Moving distance After Home Sensor RSWare : Drive - Mode Configuration- Homing - Moving Distance After Home Sensor				
Description	This value is distance that the drive ignores the marker inputs after the home sensor is detected.				
Range	0~2147483647	Initial Value	0	Unit	pulse
Modbus Address	5411, 5412	Changeable Status	Servo-OFF	-	
Applicable Operation Mode	I	-			

 (n01.009)	Home Current RSWare : Drive - Mode Configuration - Homing - Home Current				
Description	Specifies the torque feedback at which the drive stops moving the motor at the Homing Velocity. Unit : Percentages of a motor rating torque				
Range	0~250	Initial Value	100	Unit	%
Modbus Address	5413	Changeable Status	Servo-OFF	-	
Applicable Operation Mode	I	-			

 (n01.010)	Home Current Time RSWare : Drive - Mode Configuration- Homing - Home Current Time				
Description	The time to when the torque feedback is more than the home current to when the drive detects stopper.				
Range	0~1000	Initial Value	0	Unit	ms
Modbus Address	5414	Changeable Status	Servo-OFF	-	
Applicable Operation Mode	I	-			

 (n01.011)	Homing Time Limit RSWare : Drive - Mode Configuration- Homing - Homing Timeout				
Description	Drive fault occurs when time for homing is over the homing time limit.				
Range	0~65535	Initial Value	60	Unit	s
Modbus Address	5415	Changeable Status	Servo-OFF	-	
Applicable Operation Mode	I	-			

(n01.012)	Deceleration Velocity Upon Canceling Homing RSWare : Drive - Mode Configuration- Homing - Stop Home Deceleration				
Description	The rate of drive deceleration used when homing is stopped.				
Range	1~2147483647	Initial Value	6250	Unit	Rotary Motor: 10^{-2}xRev/sec^2, Line
Modbus Address	5416, 5417	Changeable Status	Servo-OFF	-	
Applicable Operation Mode	I	-			

Indexing Parameter Group 2 - Indexing Options

(n02.000)	Digit 0 [D0]	Index 0~127 Types of indexing options RSWare : Drive - Mode Configuration- Indexing - Index 0 ~ 127 Setup - Mode			
Description	Index 0 ~7 Setup Mode: • 0-Absolute: moves from its starting position to the specified Position, below. • 1-Incremental: moves from its starting position the specified Distance, below. • Note: The axis must be homed before the drive can execute any index.				
Range	0~1	Initial Value	0	Unit	N/A
Modbus Address	5800~5927	Changeable Status	Always	-	
Applicable Operation Mode	I	-			

(n02.000)	Digit 1 [D1]	Index 0-63 Action When Complete RSWare : Drive - Mode Configuration- Indexing - Index 0 ~127 Setup – Action When Complete			
Description	• 0: Stop • 1: Start next index, immediatly • 2: Wait for Start				
Range	0~2	Initial Value	0	Unit	N/A
Modbus Address	5800~5927	Changeable Status	Always	-	
Applicable Operation Mode	I	-			

Indexing Parameter Group 4 - Index Position/Distance

 (n04.000)	Index 0-127 dwell RSWare : Drive - Mode Configuration- Indexing - Index 0 ~127 Setup – Distance or Position				
Description	• Position: For Absolute mode moves, the fixed position to which the motor will travel. • Distance: For Incremental and Registration mode moves, the relative distance the motor will travel.				
Range	-2147483647~ 2147483647	Initial Value	0	Unit	pulse
Modbus Address	6600~6855	Changeable Status	Always	-	
Applicable Operation Mode	I	-			

Indexing Parameter Group 7 - Index Dwell

 (n07.000)	Index 0-127 dwell RSWare : Drive - Mode Configuration- Indexing - Index 0 ~127 Setup - Dwell				
Description	Milliseconds to remain at current position before exec.				
Range	0~65535	Initial Value	0	Unit	ms
Modbus Address	7800~7925	Changeable Status	Always	-	
Applicable Operation Mode	I	-			

Indexing Parameter Group 8 - Index Velocity

 (n08.000)	Index 0-127 Velocity RSWare : Drive - Mode Configuration- Indexing - Index 0 ~127 Setup - Velocity				
Description	Maximum velocity while in motion.				
Range	0~6000	Initial Value	0	Unit	Rotary Motor: [rpm], Linear Motor: [mm/sec]
Modbus Address	8200~8327	Changeable Status	Always	-	
Applicable Operation Mode	I	-			

Indexing Parameter Group 10 - Index Acceleration

 (n10.000)	Index 0-127 Acceleration RSWare : Drive - Mode Configuration- Indexing - Index 0 ~127 Setup - Acceleration				
Description	Maximum acceleration while in motion.				
Range	1~2147483647	Initial Value	6250	Unit	Rotary Motor: 10^{-2}xRev/sec^2, Linear Motor: mm/sec^2
Modbus Address	9000~9255	Changeable Status	Always	-	
Applicable Operation Mode	I	-			

Indexing Parameter Group 11 - Index Deceleration

 (n11.000)	Index 0-127 Deceleration RSWare : Drive - Mode Configuration- Indexing - Index 0 ~127 Setup - Deceleration				
Description	Maximum deceleration while in motion.				
Range	1~2147483647	Initial Value	6250	Unit	Rotary Motor: 10^{-2}xRev/sec^2, Linear Motor: mm/sec^2
Modbus Address	9400~9655	Changeable Status	Always	-	
Applicable Operation Mode	I	-			

Indexing Parameter Group 12 - Index Next Index

 (n12.000)	Index 0-127 Next Index RSWare : Drive - Mode Configuration- Indexing - Index 0 ~127 Setup - Next Index				
Description	The number (0 - 63) of the next indexed move to execute when Action When Complete is not set to "Stop”.				
Range	0~127	Initial Value	6250	Unit	N/A
Modbus Address	9800~9927	Changeable Status	Always	-	
Applicable Operation Mode	I	-			

Run Parameter

Run	Name	Modbus Address
run-00	Jog Operation	2000
run-01	Off-Line Auto Tuning	2001
run-03	Auto Adjustment of Speed Command Offset	2003
run-04	Auto Adjustment of Current Command Offset	2004
run-08	Fault Reset	2008
run-10	Absolute Encoder Reset	2010
run-11	2-Group Gain Storing	2011
run-12	Parameter Initialization	2012

Display Parameter

Run	Name[Unit]	Modbus Address
dIS-00	Velocity Feedback [rpm or mm/sec]	0
dIS-01	Velocity Command [rpm or mm/sec]	1
dIS-02	Velocity Error [rpm or mm/sec]	2
dIS-03	Torque Command [%]	3
dIS-04	Position Feedback [pulse]	4~5
dIS-05	Position Command [pulse]	6~7
dIS-06	Position Error [pulse]	8~9
dIS-07	Pulse Command Frequency [kpps]	10
dIS-08	Electrical Angle [°]	11
dIS-09	Mechnical Angle [°]	12
dIS-10	Regeneration Load Ratio [%]	13
dIS-11	DC Link Voltage [V]	14
dIS-12	Multi-Turn Data of Absolute Encoder	15
dIS-13	Offset in Velocity Command [mV]	16~17
dIS-14	Torque Offset [mV]	18~19
dIS-15	Input/Output Signal Status	20~24
dIS-16	Fault History	25~32

Run	Name[Unit]	Modbus Address
dIS-17	Display Software Version	33
dIS-18	Motor Type and Encoder Type	34~35
dIS-19	Analog Velocity Command Voltage [V]	36
dIS-20	Analog Current Command Voltage [V]	37
dIS-21	Drive Rated Output Power	38
dIS-22	Absolute Single Turn Data	39~40
dIS-23	Encoder Feedback Counter	41~42
dIS-24	Current Command Max. Value [%]	43
dIS-31	Effective Torque Load Ratio [%] (Rated Torque=100%)	44
dIS-32	Effective Torque Max. Load Ratio [%] (Rated Torque=100%)	45

Specification and Exterior Size

Drive Specification

Product Type CSD7_		01BX1 01BXF1	02BX1 02BXF1	04BX1 04BXF1	08BX1 08BXF1	10BX1 10BXF1	15BX1 15BXF1
Product Output	Rated Current [Arms]	1.1	1.8	3.3	6.2	8.0	11.0
Main Power Specifications		Single-phase AC 200 to 230V 10% to -15%, 50/60Hz			3-phase AC 200 - 230V. 10% to -15%, 50/60Hz For 800W, the rated operation is possible with single phase.		
Control Power Specifications		Single-phase AC 200 to 230V, 10% to -15%, 50/60Hz					
Control Method		SVPWM control using IPM device					
Applicable Encoder		17Bit Serial Absolute/Incremental, 21Bit Biss					
Regenerative Circuit		-	-	30 W internal resistor	100 W internal resistor		
DB Function		Built-in circuit provided, motor 2-phase (U,W) short circuit					
Communication function	USB	Connected to PC; responding to RSWare software					
	RS-485	Support 1: N Multi-Drop function and 32-axis operation; set the axis number by a parameter					
Ambiance	Operating Temperature/Humidity	0°C to 50°C/below 90% RH (non condensing)					
	Storage Temperature/Humidity	-20°C to 85°C/below 90% RH (non condensing)					
	Vibration / Shock	Below vibration 2G and shock 15G (1G= acceleration of gravity 9.8m/s2)					
	IP Class/Pollution Level	IP20/Pollution Class 2					
	Allowed Altitude	Below 1000 m					
Input/Output Specifications	Encoder Output	A, B and Z-phase pulse output, Line Driver output, Division ratio: N/M(N,M≤32768); Absolute position can be sent by serial data.					
	Input	Applicable 8 points; fixed 1 point (emergency stop); input detection time: 6ms to 8ms					
		High speed allocable 2 points: function setting allowed, position registration, input detection time: 5us or under					
	Output	Allocable 6 points, Fixed 2 points(Encoder Z-pulse, Servo fault display)					

Product Type CSD7_		01BX1 01BXF1	02BX1 02BXF1	04BX1 04BXF1	08BX1 08BXF1	10BX1 10BXF1	15BX1 15BXF1
Built-in Operator		6 7-segment LED; 4 buttons for setting					
Protection Function		Over current, Motor Overload, Drive Overload, Regenerative Overload, Overvoltage, Low voltage, Overspeed, Overheat, CPU failure, Encoderfailure, Communication disruption, IPM failure, Abnormal motor speed setting, Over position error, Input voltage phase loss, Abnormal motor cabling, etc.					
Position Control	Position Command Type	CCW+CW pulse train, Sign+Pulse train, A+B pulse train (90˚phase difference)					
	Command Input Circuit	Line Driver(5V), Open Collector (5 V external resistor required)					
	Maximum Input Frequency	4Mpps (Line Driver), 250Kpps (Open Collector)					
	Electronic Gear	3 sets of electronic gears provided					
	Feedforward Compensation	0 - 100% (Setting units: 1%)					
	Aux Feedback	RSA 17Bit&23Bit Serial, 21Bit Biss type supported					
Velocity control	Command Type	Analog speed command, internal speed command					
	Range of Control	Internal speed command: 1:5000, Analog speed command: 1:2000					
	Speed Variation (Rated)	Input voltage variation (200 - 230Vac,+10%,-15%): 0%, :Load variation (0-100%):±0.01% Max, Temperature variation (25°C±25°C):±0.1%					
	Acceleration/Deceleration Setting Range	0 - 60 sec					
	Analog Speed Input	DC 0V - ± 10V(For initial value, 6 V is set as a rated speed.)					
Torque Control	Command Type	Analog Torque Command					
	Analog Torque Input	DC 0V - ± 10V(For initial value, 3 V is set as a rated torque.)					
Safety Function	Functions Available	STO(Safe Torque Off, IEC/EN 61800-5-2); a separate connector is provided.					
	Standards Applied	IEC/EN 61508 SIL2, EN ISO 13849-1 PL d					
Certification Standards	CE Standard	LVD:EN61800-5-1:2007, EMC:N61800-3:2004+A1:2012					
Product Structure		Forced cooling with a fan; open structure (IP20)					
Installation Specifications	Fitting Method	Base Mounted (standard), Rack Mounted (additional appliance required)					
	Close Fitting	Close fitting of the product is allowed.					

Fuse and Contactor Recommendations

	CSD7_				
Main Power Fuses1	01BX1 O1BXF1	02BX1 02BXF1	04BX1 04BXF1	08BX1, 10BX1 08BXF1, 10BXF1	15BX1 15BXF1
Recommended Fuse Group 1[2]	FNQ-R-7		FNQ-R-10	FNQ-R-20	FNQ-R-30
Recommended Fuse Group 2[3]	N/A			LPJ-20	LPJ-30
Control Power Fuses1					
Recommended Fuse Group 1[4]	FRS-R-2-1/2				
Recommended Fuse Group 2[2]	FNQ-R-7-1/2				
Recommended Fuse Group 3[3]	LPJ-6				
Contactor	100-M05N xy	100-M09N xy	100-M12N xy	100-C16xy	100-C23xy

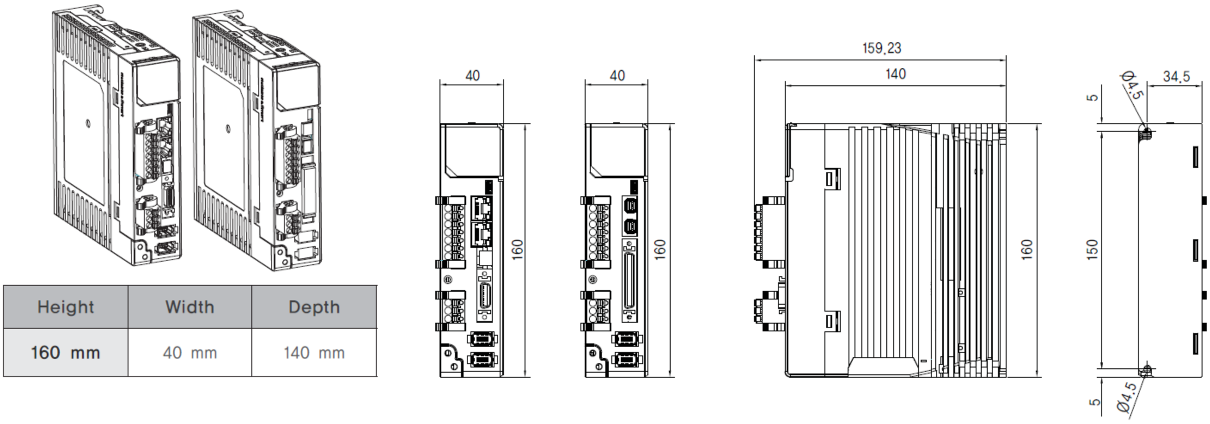
1 Fuses specified are Bussmann® fuses.
2 FNQ-R fuses are described as Time-Delay Fuses, Class CC.
3 LPJ fuses are described as Dual-Element Time-Delay Fuses, Class J.
4 FRS-R fuses are described as Dual-Element Time-Delay Fuses, Class RK5.
5 For contactors: x represents coil voltage, and y represents number of contacts.

Drive Size and Exterial View

Drive dimensions are shown in the following diagrams.

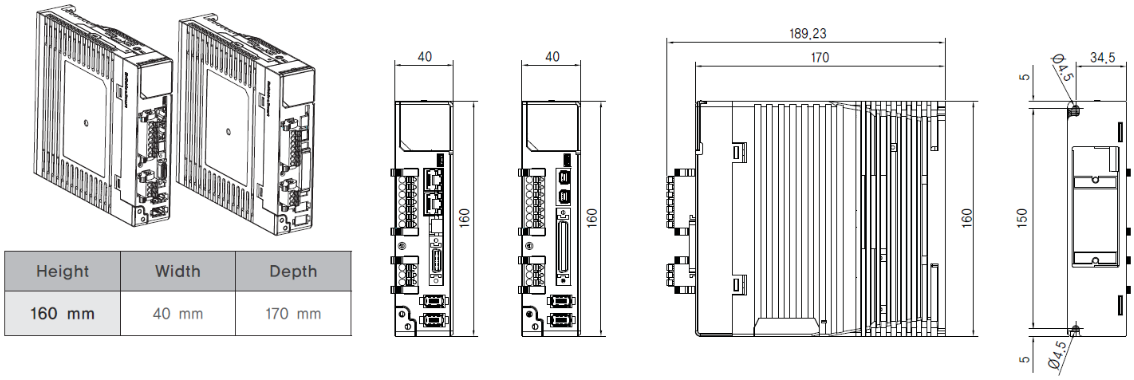
Servo Drive Exterior Dimensions for Wall Mounting

Figure B.1 CSD7_01BX1 and CSD7_02BX1 Size



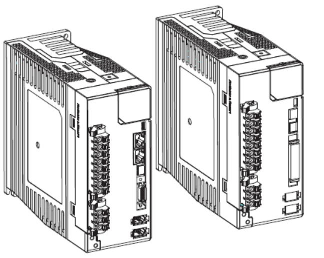
Height	Width	Depth
160 mm	40 mm	140 mm

Figure B.2 CSD7_04BX1 Size

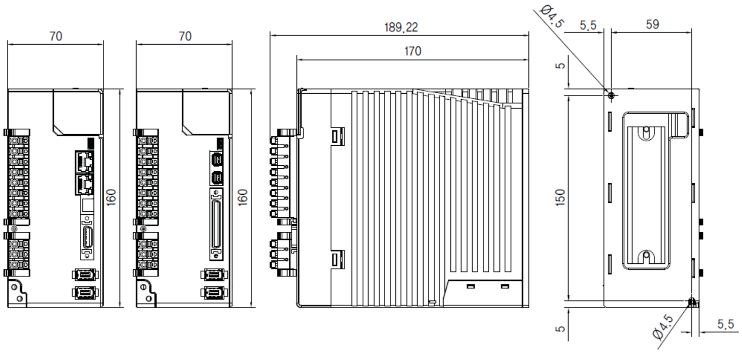


Height	Width	Depth
160 mm	40 mm	170 mm

Figure B.3 CSD7_08BX1, CSD7_10BX1 and CSD7_15BX1 Size



Height	Width	Depth
160 mm	70 mm	170 mm



Servo Drive Exterior Dimensions for Rack Mounting

Figure B.4 100W to 200W

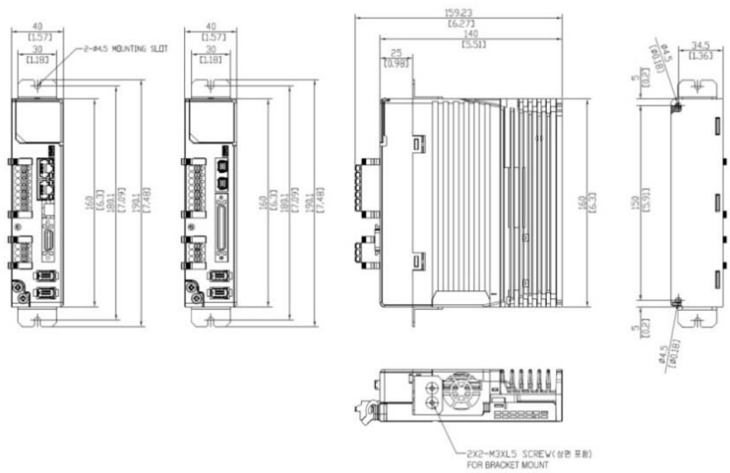


Figure B.5 400W

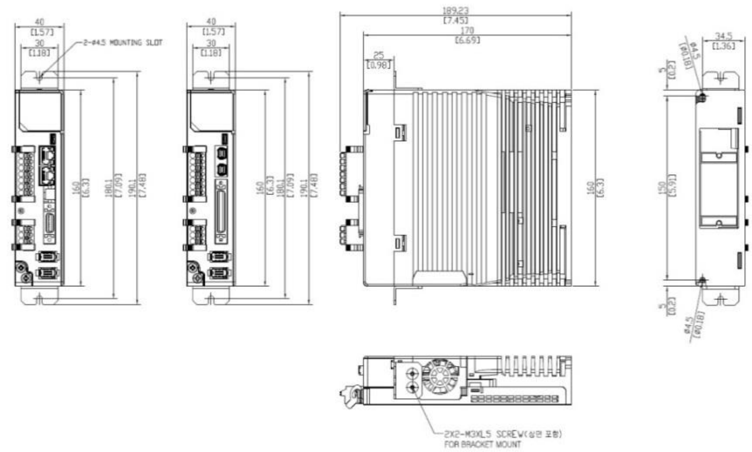
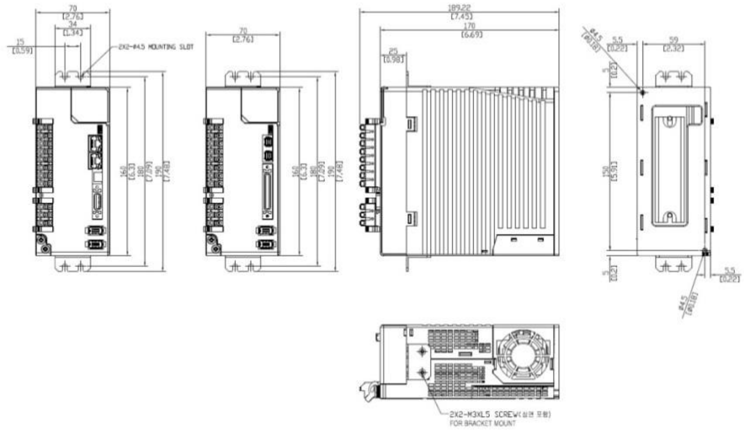
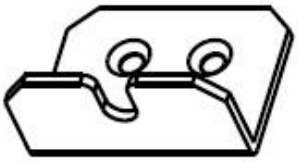


Figure B.6 800W to 1.5KW



Rack mount bracket for low capacity under 400 W



<table>
<tr><th colspan="2">Dimensions</th></tr>
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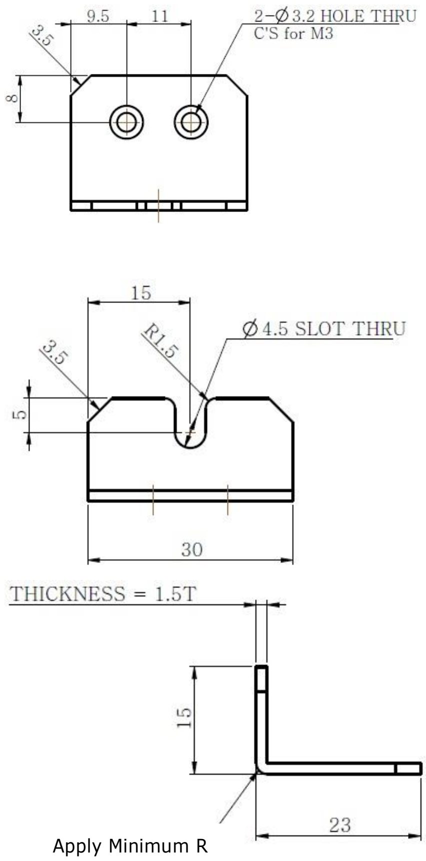
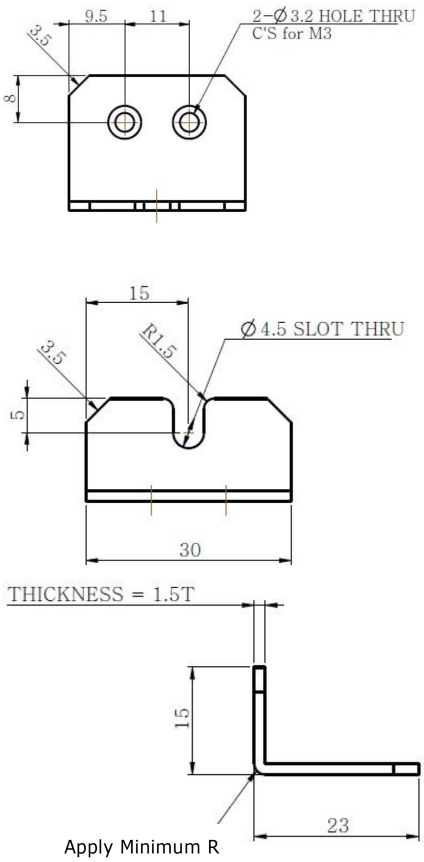
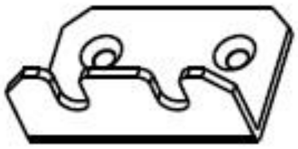
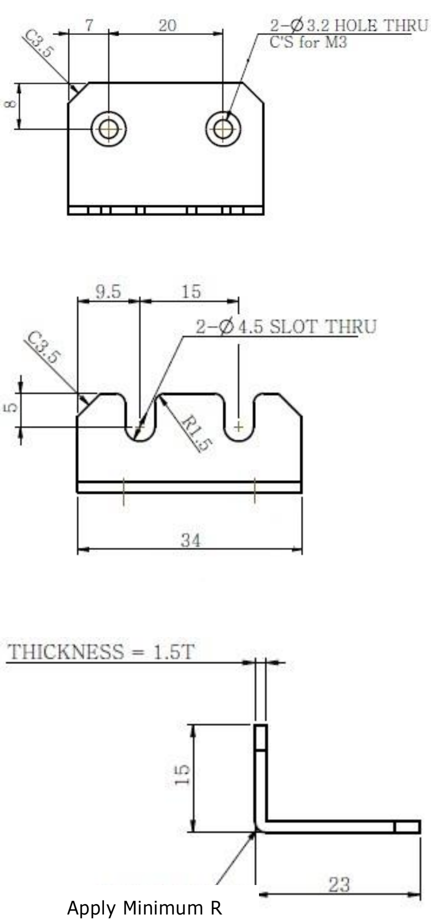
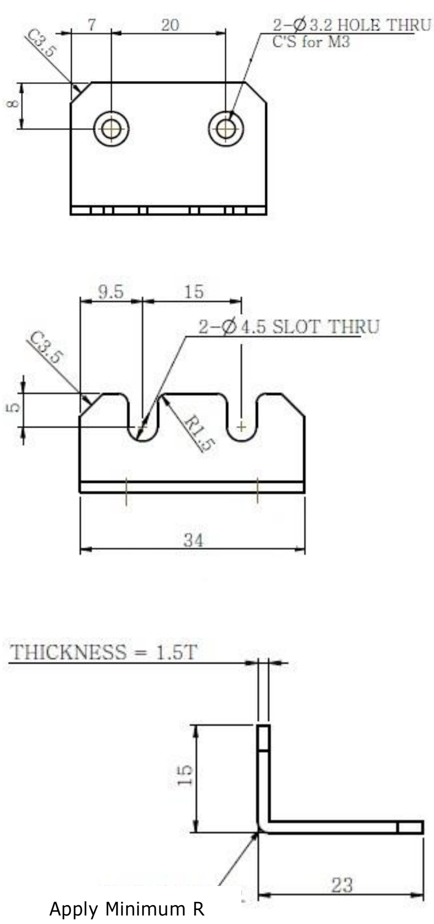
<tr><td>
</td><td>
</td></tr>
</table>

Rack mount bracket for large capacity above 800 W



Dimensions	
Top	**Bottom**
	

Cable & Connector Specification

USB Communication Cable

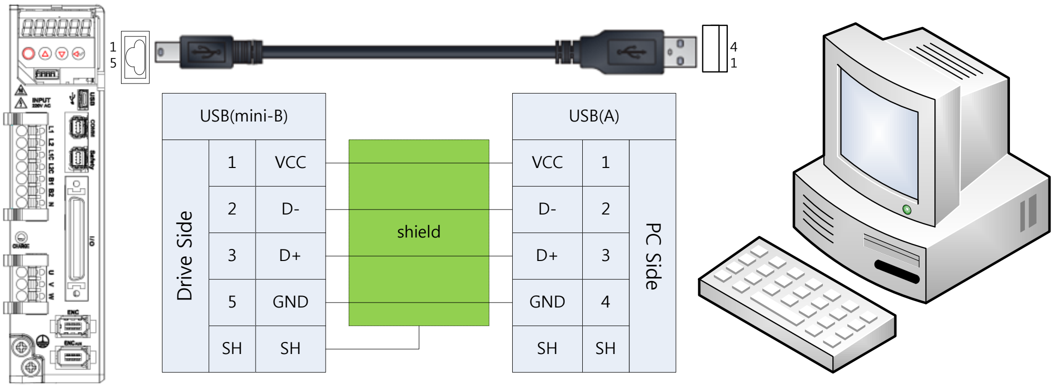
The figure below is the USB wiring diagram for PC communication cable assembly required for interface between CSD7 servo drive and host computer.

Figure C.1 CSD7 Servo Drive's USB PC Com Cable Specifications

The pin map of the connector is shown in the table below.

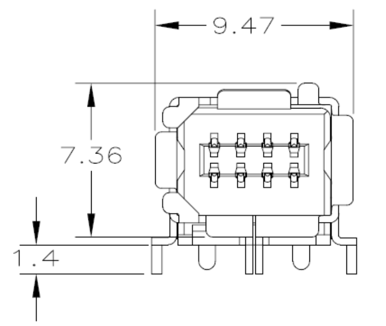
Pin	Signal	Description	Note
1	VBUS	-	Power
2	D-	Data Negative	Bi-Dir
3	D+	Data Positive	Bi-Dir
4	ID	-	Input
5	GND	Ground	Power
Case	-	Shield	-

A standard USB cable can be used as the PC connection cable. If, however, the communication environment is not good due to excessive noise, it is recommended to use a cable with a ferrite core or a cable in which the shield is attached to online one side (drive side) as shown in the figure below.



Safety Function Connector

The industrial mini IO type connector (Tyco, 2069552-1) shown below is installed to prevent motor operation under an unsafe situation; and the dummy connector (Tyco, 1971153-1) is provided by default for the users who do not have a separate safety function. To enable the safety function, connect it to the safety sensor switch or controller using the connector shown on the right side of the picture below.

	
Drive Side (Tyco, 1981080-1)	Cable side (Tyco, 2069577-1)

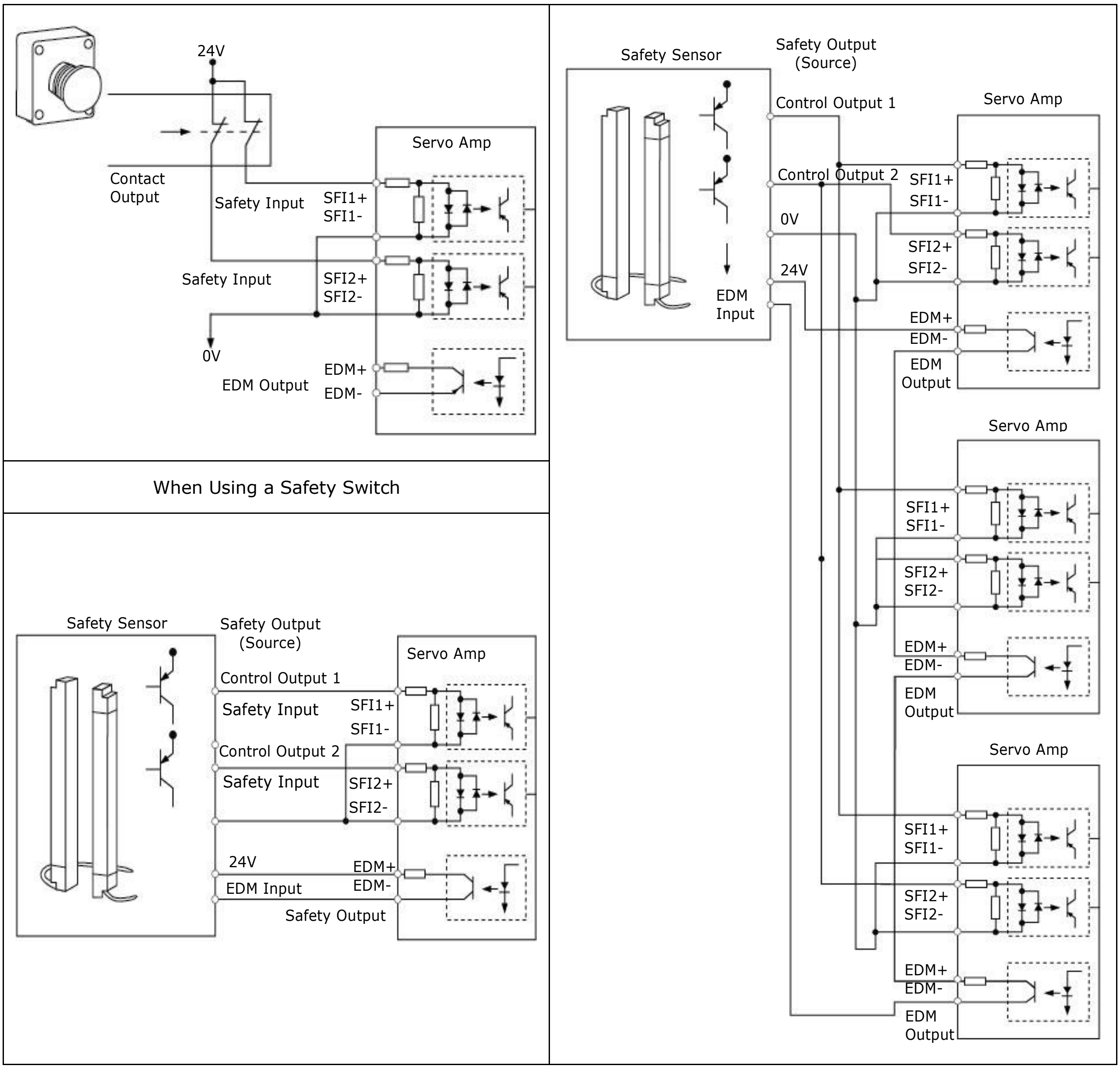
The table below shows the pin map of the safety connector. To enhance the safety standard, it consists of 2 independent input ports and 1 output port to monitor the product safety status.

Pin	Signal	Description	Note
1	N.C	-	-
2	N.C	-	-
3	SFI1-	Safety Input 1 -	Input

Pin	Signal	Description	Note
4	SFI1+	Safety Input 1 +	Input
5	SFI2-	Safety Input 2 -	Input
6	SFI2+	Safety Input 2 +	Input
7	EDM-	External Device Monitor -	Output
8	EDM+	External Device Monitor +	Output

The +/-12V output in the table above is the one for the users who do not use the safety function. A user must not use it arbitrarily because this may cause failure.

For the wiring for safety function, see the figure below.



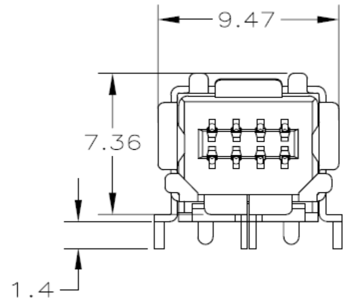
When Using a Safety Switch

When Using a Safety Sensor	When Multiple Drives are Connected to a Single Safety Sensor

RS 485 Communication Cable

For the RS-485 connector to be used for multi drop in the analog type drive, the 8-pin connector for industrial mini I/O from TYCO is used. Its part name is 1981386-1; and the power for the user's RS485 signaling line and termination processing is assigned to the connector pin.

Figure C.2 CSD7 Servo Drive RS485 PC Com Cable Specifications



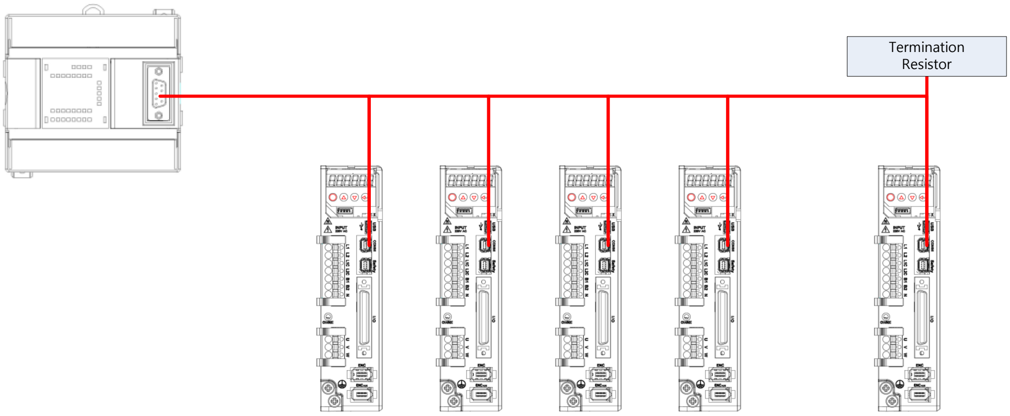
Drive Side (Tyco, 1981386-1) | Cable Side (Tyco, 2069578-1)

The pin map of the connector is shown on the table below. 5 V is outputted through the #2 pin so that the cable may process the terminal resistor.
A user must not use this 5 V arbitrarily because this may result in drive failure.

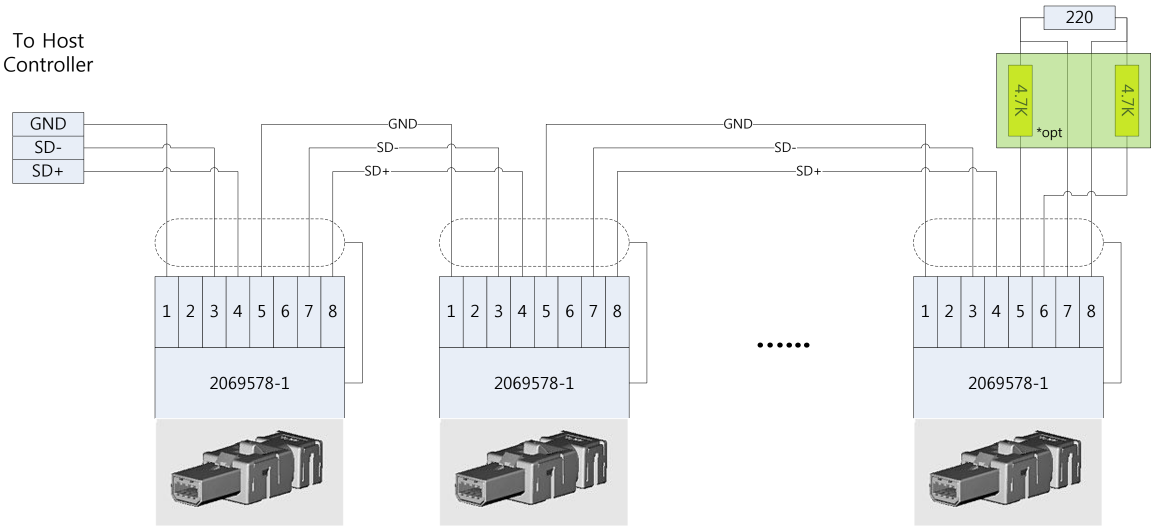
No	Name	Spec.	Property
1	GND	Signal Common	Power
2	5V	Internal 5V	Power
3	485-	Negative signal	Bi-Dir
4	485+	Positive signal	Bi-Dir
5	GND	Signal Common	Power
6	5V	Internal 5V	Power
7	485-	Negative signal	Bi-Dir
8	485+	Positive signal	Bi-Dir

The connector case should be connected to the frame ground

The multi drop method using RS485 port can be configured as shown in the figure below; note here that the terminal resistor should be processed by the cable.



In actual situation, make the cable referring to the sample cable drawing below.



In the figure above, you can see that the 220 ohm terminal resistor is connected to the drive furthest from the host controller. Two 4.7 Kohms in the opt box below are for the pull up and pull down resistor connection to the communication line; and this is effective when RS485 communication is not smooth due to exposure to excessive noise

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