HITACHI AC SERVO DRIVES

With Programmable Functions

AD3 Series

Instruction Manual

Thank you very much for purchasing the HITACHI AC servo drives.
This instruction manual describes the handling, maintenance, and others of the HITACHI AD3 series servo drives with AC servo programmable functions. Please read this manual thoroughly before operating it so that installation, maintenance, inspection may be performed correctly. For the program function, read the instruction manual pertaining to the Programmable Function.
When using option products related to this servo drives, read the instruction manuals for the related products thoroughly.

Keep this manual handy for your quick reference.

HITACHI

NB258X

SAFETY

For the Best Results with **AD** Series servo drives, read this manual and all of the warning sign attached to the servo drive carefully before installing and operating it, and follow the instructions exactly. Keep this manual handy for your quick reference.

Definitions and Symbols

A safety instruction (message) is given with a hazard alert symbol and a signal word;
WARNING or **CAUTION**. Each signal word has the following meaning throughout this manual.

This symbol means hazardous high voltage. It used to call your attention to items or operations that could be dangerous to you or other persons operating this equipment.
Read these message and follow these instructions carefully.

This is the "Safety Alert Symbol" This symbol is used to call your attention to items or operations that could be dangerous to you or other persons operating this equipment.
Read these messages and follow these instructions carefully.

WARNING

WARNING

Indicates a potentially hazardous situation which, if not avoided, can result in serious injury or death.

CAUTION

CAUTION

Indicates a potentially hazardous situation which, if not avoided, can result in minor to moderate injury, or serious damage of product.
The matters described under ⚠ CAUTION may, if not avoided, lead to serious results depending on the situation. Important matters are described in **CAUTION** (as well as **WARNING**), so be sure to observe them.

NOTE

NOTE

Notes indicate an area or subject of special merit, emphasizing either the product's capabilities or common errors in operation or maintenance.

HAZARDOUS HIGH VOLTAGE

Motor control equipment and electronic controllers are connected to hazardous line voltages. When servicing drives and electronic controllers, there might be exposed components with cases or protrusions at or above line potential. Extreme care should be taken to product against shock.

Stand on an insulating pad and make it a habit to use only one hand when checking components. Always work with another person in case an emergency occurs. Disconnect power before checking controllers or performing maintenance. Be sure equipment is properly grounded. Wear safety glasses whenever working on an electronic controller or rotating electrical equipment.

PRECAUTION

⚠ **WARNING** **:** This is equipment should be installed, adjusted and serviced by qualified electrical maintenance personal familiar with the construction and operation of the equipment and the hazards involved. Failure to observe this precaution could results in bodily injury.

⚠ **WARNING** **:** The user is responsible for ensuring that all driven machinery, drive train mechanism not supplied by Hitachi, and process line material are capable of safe operation at an applied maximum speed to the AC servo motor. Failure to do so can result in destruction of equipment and injury to personnel should a single point failure occur.

⚠ **WARNING** **:** For protection, install an earth leakage breaker with a high frequency circuit capable of large currents to avoid an unnecessary operation. The ground fault protection circuit is not designed to protect personal injury.

⚠ **WARNING** **:** HAZARD OF ELECTRICAL SHOCK. DISCONNECT INCOMING POWER BEFORE WORKING ON THIS CONTROL.

⚠ **WARNING** **:** SEPARATE MOTOR OVERCURRENT, OVERLOAD AND OVERHEATING PROTECTION IS REQUIRED TO BE PROVIDED IN ACCORDANCE WITH THE SAFETY CODES REQUIRED BY JURISDICTIONAL AUTHORITIES.

⚠ **CAUTION** **:** These instructions should be read and clearly understood before working on AD series equipment.

⚠ **CAUTION** **:** Proper grounds, disconnecting devices and other safety devices and their location are the responsibility of the user and are not provided by Hitachi.

⚠ **CAUTION** **:** DANGEROUS VOLTAGE EXISTS UNTIL CHARGE LAMP IS OFF.

⚠ **CAUTION** **:** Rotating shafts and above ground electrical potentials can be hazardous. Therefore, it is strongly recommended that all electrical work conform to the National Electrical Codes and local regulations. Only qualified personnel should perform installation, alignment and maintenance. Factory recommended test procedures, included in the instruction manual, should be followed. Always disconnect electrical power before working on the unit.

NOTE : POLLUTION DEGREE 2

The servo drives must be used environment of the degree 2.
Typical constructions that reduce the possibility of conductive pollution are;

1) The use of an unventilated enclosure
2) The use of a filtered ventilated enclosure when the ventilation is fan forced that is, ventilation is accomplished by one or more blowers within the enclosure that provide a positive intake and exhaust.

SAFETY

Cautions for EMC (Electromagnetic Compatibility)

It is required to satisfy the EMC directive (89/336/EEC) when using AD series servo drives in EU country. To satisfy the EMC directive and to comply with standard (EN61800-3), the following should be kept.

⚠**WARNING** **:** This equipment should be installed, adjusted, and serviced by qualified personal familiar with construction and operation of the equipment and the hazards involved. Failure to observe this precaution could result in bodily injury.

1.The power supply to the drives must meet these specifications:

a. Voltage fluctuation +10%/-15% or less.

b. Voltage unbalance +/-3% or less.

c. Frequency variation +/-4% or less.

d. Voltage distortion THD = 10% or less.

2.Installation measure:

a. Use a filter designed for AD series servo drives.

3.Wiring

a. Shielded wire (screened cable) is required for motor wiring, and the length must be less than 30 meters.

b. Separate the main circuit from the signal/process circuit wiring.

4.Environmental conditions – when using a filter, follow these guidelines:

a. Ambient air temperature: 0 - +55 ºC.

b. Humidity: 20 to 90% RH (non-condensing)

c. Vibration: 5.9 m/sec^2 (0.6 G) 10 – 55Hz.

d. Location: 1000meters or less altitude, indoors (no corrosive gas or dust)

Conformity to the Low Voltage Directive (LVD)

The protective enclosure is required to satisfy the Low Voltage Directive (73/23/EEC).

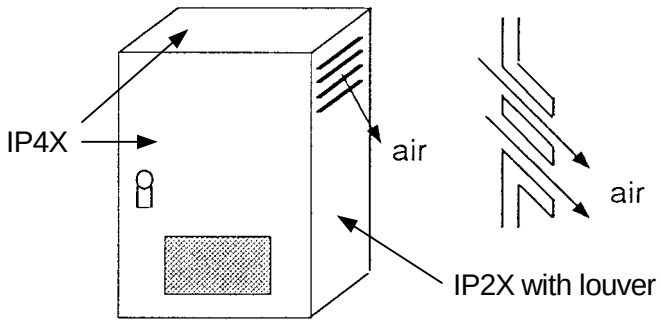
The drives can conform to the LVD and comply with standard (EN50178) by mounting into the following enclosure.

1.Enclosure

The drives must be installed into a enclosure which has the protection degree of Type IP2X (See EN60529). In addition the top surface or front surface of enclosure are easily accessible shall meet at least the requirements of the Protective Type IP4X.

2.Protection device

A double pole disconnection device must be fitted to the incoming mains supply close to the drive. Additionaly, a protection device meeting IEC947-1/IEC947-3 must be fitted at this point. (protection device data shown in page vii)



UL Warnings and Cautions Manual for AD series

This auxiliary instruction manual should be delivered to the end user.

1. Wiring Warnings for Electrical Practices and Wire Specifications

(1) ⚠ **WARNING** : "Use 60/75 ºC CU wire only" or equivalent.

(2) ⚠ **WARNING**: "Open Type Equipment."

(3) ⚠ **WARNING**: " Suitable for use on a circuit capable or delivering not more than 10,000 rms symmetrical amperes, 240 V maximum.

2.Tightening Torque and Wire Range

(1) ⚠ **WARNING** : Tightening torque and wire range for field wiring terminals are marked adjacent to the terminal or on the wiring diagram.

Model Name	Tightening Torque [N•m]	Wire Range (AWG)	
		Input	Output
ADAX3-01NSE	1.2	18	18
ADAX3-02NSE	1.2	18	18
ADAX3-04NSE	1.2	18	18
ADAX3-08NSE	1.2	16	18
ADAX3-15HPE	0.5~0.6	18	18
ADAX3-35HPE	0.5~0.6	14	14
ADAX3-70HPE	2.0	10	10

3. Fuse Size

(1) ⚠ **WARNING** : Distribution fuse size marking is included in the manual to indicate that the unit shall be connected with an UL Listed Class J fuse rated 600 V with the current ratings as shown in the table below.

Model Name	Input Phase	Fuse [A]
ADAX3-01NSE	1/3	3/3
ADAX3-02NSE	1/3	6/3
ADAX3-04NSE	1/3	10/6
ADAX3-08NSE	1/3	15/10
ADAX3-15HPE	3	10
ADAX3-35HPE	3	20
ADAX3-70HPE	3	50

4.Others

(1) ⚠ **WARNING** : "Field wiring connection must be made by an UL Listed and CSA Certified closed-loop terminal connector sized for the wire gauge involved. Connector must be fixed using the crimp tool specified by the connector manufacturer. ", or equivalent wording included in the manual.

(2) ⚠ **WARNING** : Use the transient voltage surge suppressors recognized in accordance with UL1449.

(3) ⚠ **WARNING** : “Solid state motor over load protection is provided in each model.”, or equivalent.

(4) ⚠ **WARNING** : “Maximum Surrounding Air Temperature 55°C.”

(5) ⚠ **WARNING** : “Not incorporating Over-speed Protection.” or an equivalent statement.

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CHAPTER 1 SAFETY PRECAUTIONS

Read this manual and all of the warning sign attached to the drives carefully before installing and operating it, and follow the instructions exactly. Keep this manual handy for your quick reference.

1.1 Installation

⚠ CAUTION

- Be sure to install the unit on flame resistant material such as metal.
  Otherwise, there is a danger of fire.
- Be sure not to place anything inflammable in the vicinity.
  Otherwise, there is a danger of fire.
- Do not carry unit by top cover, always carry by supporting base of unit.
  There is a risk of falling and injury.
- Be sure not to let the foreign matter enter such as cut wire refuse, spatter from welding, iron refuse, wire, dust, etc.
  Otherwise, there is a danger of fire.
- Be sure to install it in a place where can bear the weight according to the specifications in the text.
  Otherwise, it may fall and there is a danger of injury.
- Be sure to install the unit on a perpendicular wall where is not subject to vibration.
  Otherwise, it may fall and there is a danger of injury.
- Be sure not to install and operate AC servo drive which is damaged or parts of which are missing.
  Otherwise, there is a danger of injury.
- Be sure to install it in a room where is not exposed to direct sunlight and is well ventilated. Avoid environments which tend to be high in temperature, high in humidity or to have dew condensation, as well as places with dust, corrosive gas, explosive gas, inflammable gas, grinding-fluid mist, salt damage, etc.
  Otherwise, there is a danger of fire.

1.2 Wiring

⚠ WARNING

- Be sure to ground the unit.
  Otherwise, there is a danger of electric shock and/or fire.
- Wiring work shall be carried out by electrical experts.
  Otherwise, there is a danger of electric shock and/or fire.
- Implement wiring after checking that the power supply is off.
  It might incur electric shock and/or fire.
- After installing the main body, carry out wiring.
  Otherwise, there is a danger of electric shock and/or injury.

⚠ CAUTION

- Make sure that the input voltage is:
  Single phase 220 to 230V / Three phase 200 to 230V 50/60Hz
  (for models with suffix N)
  Three phase 380 to 480V 50/60Hz
  (for models with suffix H)
  Control power supply 200 to 240V 50/60Hz
  (for models with suffix H)
  Otherwise, there is a danger of fire.
- Be sure not to input a single phase for models with suffix H.
  Otherwise, there is a danger of fire.
- Be sure not to connect AC power supply to the output terminals(U, V, W).
  Otherwise, there is a danger of injury and/or fire.
- Be sure not to connect the resistor to DC terminals (+1,+ and –) directly.
  Otherwise, there is a danger of fire.
- As for motor leads, fuses and electromagnetic contactors, be sure to use the equivalent ones with the specified capacity (rated).
  Otherwise, there is a danger of fire.
- Fasten the screws with the specified fastening torque. Check so that there is no loosening of screws.
  Otherwise, there is a danger of fire.
- Connection to field wiring terminals must be reliably fixed having two independent means of support. Using terminal with cable support, cable gland or cable clamp etc.
  Otherwise, there is a danger of fire.

1.3 Control and operation

⚠ WARNING

- While the servo drive is energized, be sure not to touch the main terminal or to check the signal or put on/off wire and/or connector.
  Otherwise, there is a danger of electric shock.
- Be sure to turn on the input power supply after closing the terminal cover. While being energized, be sure not to open the terminal cover.
  Otherwise, there is a danger of electric shock.
- Be sure not to operate the switches with wet hands.
  Otherwise, there is a danger of electric shock.
- While the servo drive is energized, be sure not to touch the servo drive terminals even during stoppage.
  Otherwise, there is a danger of electric shock.
- It may suddenly restart after the incoming power failure. Be sure not to approach the machine. (Be sure to design the machine so that personnel safety will be secured even if it restarts.)
  Otherwise, there is a danger of injury.
- Even if the power supply is cut for a short period of time, it may restart operation after the power supply is recovered if the operation command is given. If it may incur danger to personnel, be sure to make a circuit so that it will not restart after power recovery.
  Otherwise, there is a danger of injury.
- After the operation command is given, if the alarm reset is conducted, it will restart suddenly. Be sure to set the alarm reset after checking the operation command is off.
  Otherwise, there is a danger of injury.
- Be sure not to touch the inside of the energized servo drive or to put a bar into it.
  Otherwise, there is a danger of electric shock and/or fire.

⚠ CAUTION

- Cooling fin will have high temperature. Be sure not to touch them.
  Otherwise, there is a danger of getting burned.
- Install external break system if needed.
  Otherwise, there is a danger of injury.

1.4 Maintenance, inspection and part replacement

⚠ WARNING

- After a lapse of more than 10 minutes after turning off the input power supply, perform the maintenance and inspection.
  Otherwise, there is a danger of electric shock.
- Make sure that only qualified persons will perform maintenance, inspection and part replacement. (Before starting the work, remove metallic objects from your body (wristwatch, bracelet, etc.)
  (Be sure to use tools protected with insulation.)
  Otherwise, there is a danger of electric shock and/or injury.

1.5 Others

⚠ WARNING

- Never modify the unit.
  Otherwise, there is a danger of electric shock and/or injury.

MEMO

CHAPTER 2 INTRODUCTION

This chapter explains the checking, warranty, and names of parts of the product that you purchased.

2.1 Inspection upon unpacking

2.1.1 Checking the product

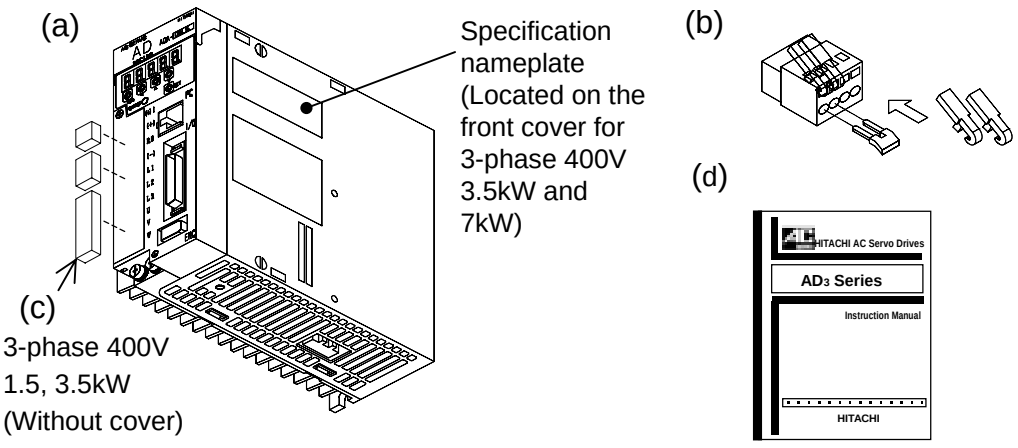
After unpacking, take out the servo drive and check the following items.
If you have any doubt or fault on the product, please contact your dealer.

(1) Make sure that there was no damage (injury, falling or dents in the body) of the product.
(2) After unpacking, make sure that the package contains the following articles.

Packed article	ADAX3-□□NSE (200V class)	ADAX3-□□HPE (400V class)		Remarks
		1.5, 3.5kW	7kW	
(a) Servo drive	1 unit	1 unit	1 unit	
(b) Control power supply connector	1 piece	Not provided	Not provided	With wire inserting jig With B1-B2 short bar
(c) Main power circuit / control power circuit connector	Not provided	3 pieces	Not provided	Main power circuit : 2 Control power circuit : 1
(d) Instruction manual	1 copy	1 copy	1 copy	Installation manual

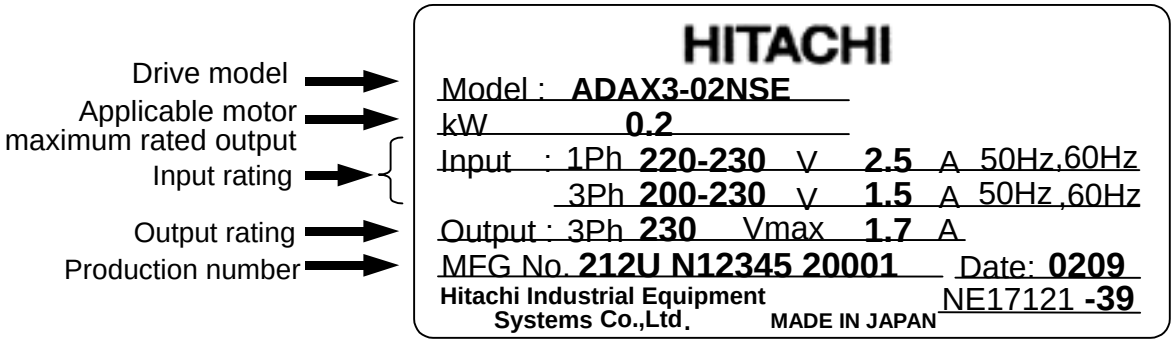
The attached manual with the servo drive is the simple one for installation, maintenance and inspection. This detailed manual is not attached.

(3) Check on the specification nameplate whether the product is as ordered or not.

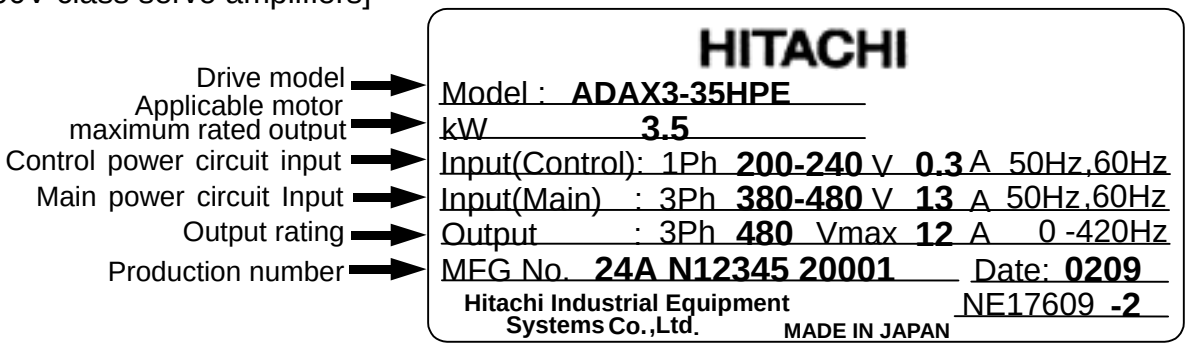


Specification nameplate position
(200V class and 400V 1.5kW)

[200V class servo amplifiers]



[400V class servo amplifiers]



Contents of Specification Nameplate

(4) When the 200V class servo motor with the serial incremental encoder (17bit / revolution) is different from the specification of the standard product, connect the encoder and then perform initialize processing. For the procedure, refer to Chapter 5, “Clearing the Trip Log and Performing Factory-setting”.

(5) In case that you use the motor with the serial absolute encoder (17bit / revolution), Absolute Battery Error (E90) occurs after connecting the backup battery and turning on the power supply. Clear the trip and then clear the encoder data. For the procedure, refer to Chapter 5, “Functions for Absolute Position Encoder”, (2) Clearing the absolute position.

Explanation of Drive model

AD AX3 – 08 N S E –

Series name
AD : AD series

Drive name
AX3 : Programmable function build-in
A3 : High performance (Standard)

Output rating

Voltage	200V class				400V class		
Symbol	01	02	04	08	15	35	70
kW	0.1	0.2	0.4	0.75	1.5	3.5	7

Input power supply
N: Single / Three phase 200V class
H: Three phase 400V class

Encoder type
S: 17bit / revolutionSerial encoder (Incremental, Absolute)
P: Wire-saving incremental encoder

I/O polarity
None : Sink type
E : Source type

Option
None : Standard
DN : DeviceNet
SC : SERCOS

2.1.2 Instruction manual

This instruction manual explains the detail of the Hitachi AD series servo.
Please read this manual thoroughly to operate the product correctly before operating it. Keep the manual in custody with care.
When using option products related to this servo drive, read the instruction manuals for the related products thoroughly.

2.2 Inquiry about the Product and Warranty

2.2.1 Notes for making an inquiry

If you have to make an inquiry about product damage, doubt, failure, etc., inform the dealer of the following items.

(1) Servo drive type and form (model No.)
(2) Production number (MFG. No.)
(3) Date of purchase
(4) Contents of your inquiry
- Damage position, status, etc.
- Doubtful item, contents, etc.

2.2.2 Product warranty

The product warranty period shall be one year after purchase.
In the following cases, however, the product is out of the warranty range and shall be repaired with charge even within the warranty period.

(1) The failure is due to an operation error or improper repair or modification.
(2) The failure is due to any other reason that is not related to your purchased product.
(3) The product was operated over the specification value range.
(4) The failure is due to a natural calamity, disaster, or secondary disaster.

The warranty herein referred to means the warranty of the delivered product proper. Any damage induced by a failure of the delivered product shall be excluded.

2.2.3 Charged repair

After the lapse of the warranty period (one year), any investigation and repair shall be performed with charge. In the warranty period, repair or investigation that is out of the above warranty range shall be undertaken with charge.
For asking for a charged repair, contact with the dealer.

2.3 Appearance and Names of Parts

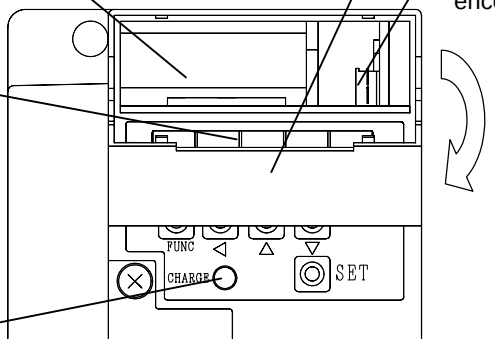
(The following drawings describe 200V class servo.)

Battery housing cover
A cover for the battery holder.

Battery holder
Houses the backup battery when the absolute encoder is used.

Battery connector
Used to connect the backup battery for the absolute encoder.

Panel display unit
Used to indicate the servo drive condition or parameter setting by using a 5-digit 7-segment LED.



Charge lamp
Lights up when the main circuit power supply is turned on. While the electric charge remains on the main circuit capacitor after the power supply is turned off, this lamp continues to light. Do not touch the servo drive during lighting.

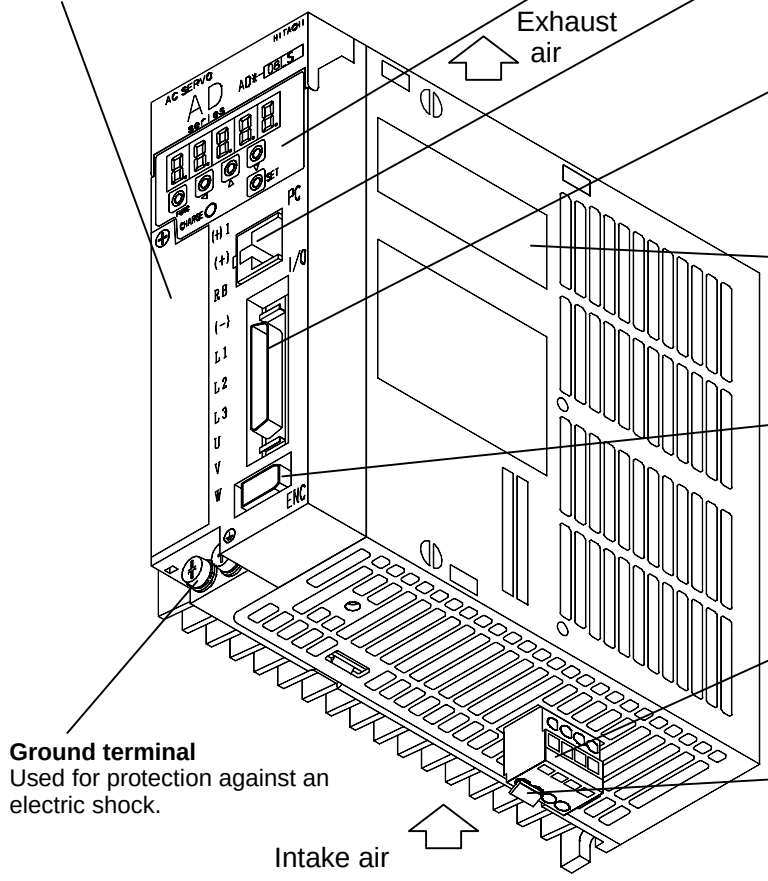
Digital operator
Used to set parameters.

Main circuit terminal block (TM1)
Connection terminals with the main circuit power supply, external regenerative resistor, and motor power cable.
This terminal block is covered with a cover.

Connector for connecting a PC (PC)
A connector for communication with a PC.

Exhaust air

Input/output signal connector (I/O)
A connector for command input signals and sequencer input signals.



Specification nameplate
Used to indicate the servo drive type and form and ratings.

Encoder connector (ENC)
Used to connect the encoder of the servo motor.

Control power supply connector (TM2)
A connector for connecting the control power supply.

B1-B2 short bar
Be sure to connect this short bar when using the internal braking resistor.

Ground terminal
Used for protection against an electric shock.

Intake air

CHAPTER 2 INSTRUCTION

2.4 Combination of servo amplifiers and servo motors

The applicable combination of servo amplifiers and servo motors is shown in the following table.

Phase / Voltage for main power circuit	Rated speed	Output (kW)	Servo amplifier Model code Note 1)	Applicable servo motor	
				With Incremental encoder	With Absolute encoder
Single-phase 220~230V /3-phase 200~230V	3000 (min^{-1})	0.1	ADA3-01NSE ADAX3-01NSE	ADMA-01SA□□□	ADMA-01SF□□□
		0.2	ADA3-02NSE ADAX3-02NSE	ADMA-02SA□□□	ADMA-02SF□□□
		0.4	ADA3-04NSE ADAX3-04NSE	ADMA-04SA□□□	ADMA-04SF□□□
		0.75	ADA3-08NSE ADAX3-08NSE	ADMA-08SA□□□	ADMA-08SF□□□
3-phase 380~480V	2000 (min^{-1})	0.5	Note 2) ADA3-15HPE ADAX3-15HPE	ADMG-05HP□□□	
		1.0		ADMG-10HP□□□	
		1.5		ADMG-15HP□□□	
		2.0	Note 2) ADA3-35HPE ADAX3-35HPE	ADMG-20HP□□□	
		3.5		ADMG-35HP□□□	
		4.5	Note 2) ADA3-70HPE ADAX3-70HPE	ADMG-45HP□□□	
		5.5		ADMG-55HP□□□	
		7.0		ADMG-70HP□□□	

Note 1) ADA3 describes the standard high performance type, and ADAX3 describe the programmable function built-in type.

Note 2) Single-phase 200 ~ 240V is needed for the control power circuit. Do not supply 3-phase

CHAPTER 3 INSTALLATION AND WIRING

This chapter explains the procedure for installing this product, main circuit wiring, and input/output signal wiring. Typical connection examples are shown.

CHAPTER 3 INSTALLATION AND WIRING

3.1 Installation

⚠ CAUTION

- Be sure to install the unit on flame resistant material such as metal.
  Otherwise, there is a danger of fire.

- Be sure not to place anything inflammable in the vicinity.
  Otherwise, there is a danger of fire.

- Do not carry unit by top cover, always carry by supporting base of unit.
  There is a risk of falling and injury.

- Be sure not to let the foreign matter enter such as cut wire refuse, spatter from welding, iron refuse, wire, dust, etc.
  Otherwise, there is a danger of fire.

- Be sure to install it in a place which can bear the weight according to the specifications in the text.
  Otherwise, it may fall and there is a danger of injury.

- Be sure to install the unit on a perpendicular wall which is not subject to vibration.
  Otherwise, it may fall and there is a danger of injury.

- Be sure not to install and operate AC servo drive which is damaged or parts of which are missing.
  Otherwise, there is a danger of injury.

- Be sure to install it in a room which is not exposed to direct sunlight and is well ventilated. Avoid environments which tend to be high in temperature, high in humidity or to have dew condensation, as well as places with dust, corrosive gas, explosive gas, inflammable gas, grinding-fluid mist, salt damage, etc.
  Otherwise, there is a danger of fire.
  A failure will be caused.

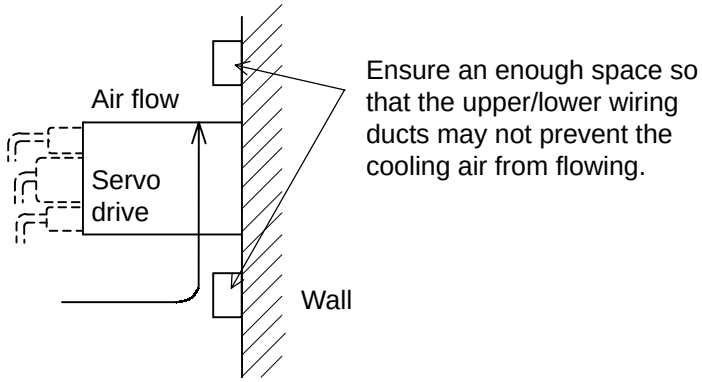
3.1.1 Precautions on installation

1) Precaution at transportation

The servo drive employs plastic parts. Handle it so that these plastic parts may not be damaged. In particular, do not carry the servo drive in such a way that force is applied to only the front surface cover and the terminal block cover. Falling may be caused.
If any part is damaged or missing, do not install and operate the servo drive.

2) Install the servo drive on an incombustible (metal) surface.

The servo drive goes to a high temperature. Install the servo drive on an incombustible vertical metal wall surface so as to avoid a fire.
Ensure an enough space around the installation place. In particular, if there is any heat generating device (braking resistor, reactor, etc.), keep the servo drive away from such a material.



3) Precaution about the ambient temperature

The ambient temperature in the installation place should not exceed the allowable operating temperature range (0 to 55°C) described in the standard specification.
Measure the ambient temperature at an about 50 mm position away from the lower center of the servo drive body, and make sure that it is within the allowable operating temperature range.
Operating the servo drive over the allowable operating temperature range may lead to its shorter life (especially, the life of the capacitor) or damage.

4) Do not install the servo drive in a high-temperature and high-humidity place that may easily cause condensation.

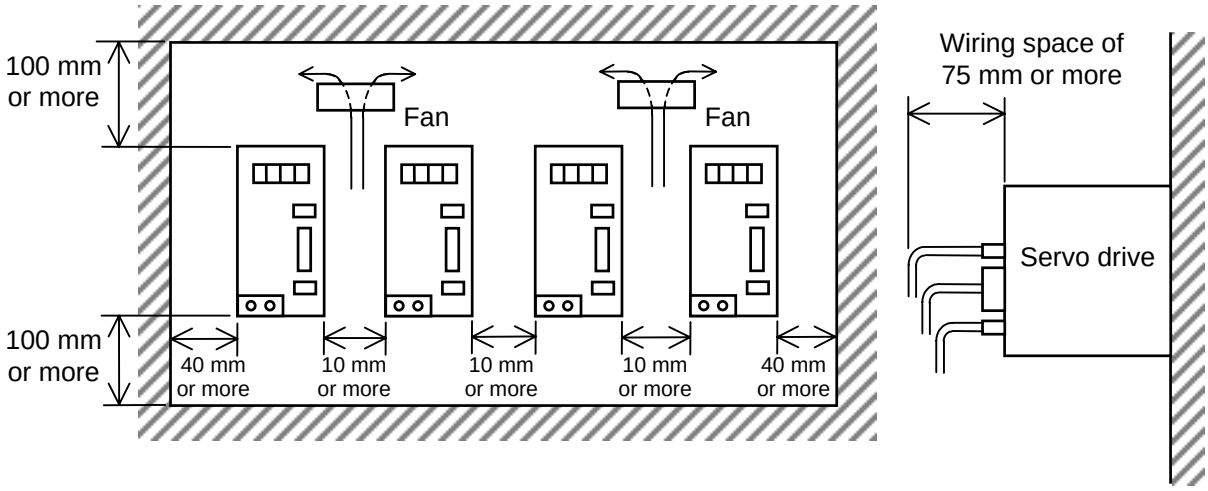
Operate the servo drive within the allowable operating humidity range (20 to 90%RH) described in the standard specification. In particular, operate it in a place free from condensation.
If water-drops are attached inside the servo drive by condensation, the section between electronic parts is shorted, resulting in a failure.
Avoid installing the servo drive in a place that is exposed to direct sunlight.

5) Precaution about the installing environment

Do not install the servo drive in a place where there is dust, corrosive gas, explosive gas, combustible gas, grinding lubricant mist, or injury from salt. Admitting foreign substances or dust inside the servo drive will result in a failure.
Therefore, if the servo drive must be operated in very dusty place, for example, house it in a sealed type box.

6) Precaution about the installing method and direction
Install the servo drive on a mounting surface that can withstand its weight, firmly and vertically without any screw or bolt looseness.
If the servo drive is not installed vertically on the wall surface, it may lower the cooling capacity with a result of trip or damage.

7) Precaution for housing servo drives in a box
When multiple servo drives are housed in a box and ventilation fans are equipped in the box, provide the fans in the following way so as to make the ambient temperature of each servo drive uniform.



In the case of boxes arranged in a row, install them at 40 mm or more from the wall surfaces with a space of 10 mm or more between servo drives and a clearance of 100 mm or more from the top or bottom.

3.2 Wiring

⚠ WARNING

- Be sure to ground the unit.
  Otherwise, there is a danger of electric shock and/or fire.

- Wiring work shall be carried out by electrical experts.
  Otherwise, there is a danger of electric shock and/or fire.

- Implement wiring after checking that the power supply is off.
  It might incur electric shock and/or fire.

- After installing the main body, carry out wiring.
  Otherwise, there is a danger of electric shock and/or injury.

⚠ CAUTION

- Make sure that the input voltage is:
  Single phase 220 to 230V / Three phase 200 to 230V 50/60Hz (for models with suffix N)
  Three phase 380 to 480V 50/60Hz (for models with suffix H)
  Control power supply 200 to 240V 50/60Hz (for models with suffix H)
  Otherwise, there is a danger of fire.

- Be sure not to input a single phase for models with suffix H.
  Otherwise, there is a danger of fire.

- Be sure not to connect AC power supply to the output terminals(U, V, W).
  Otherwise, there is a danger of injury and/or fire.

- Be sure not to connect the resistor to DC terminals (+1,+ and –) directly.
  Otherwise, there is a danger of fire.

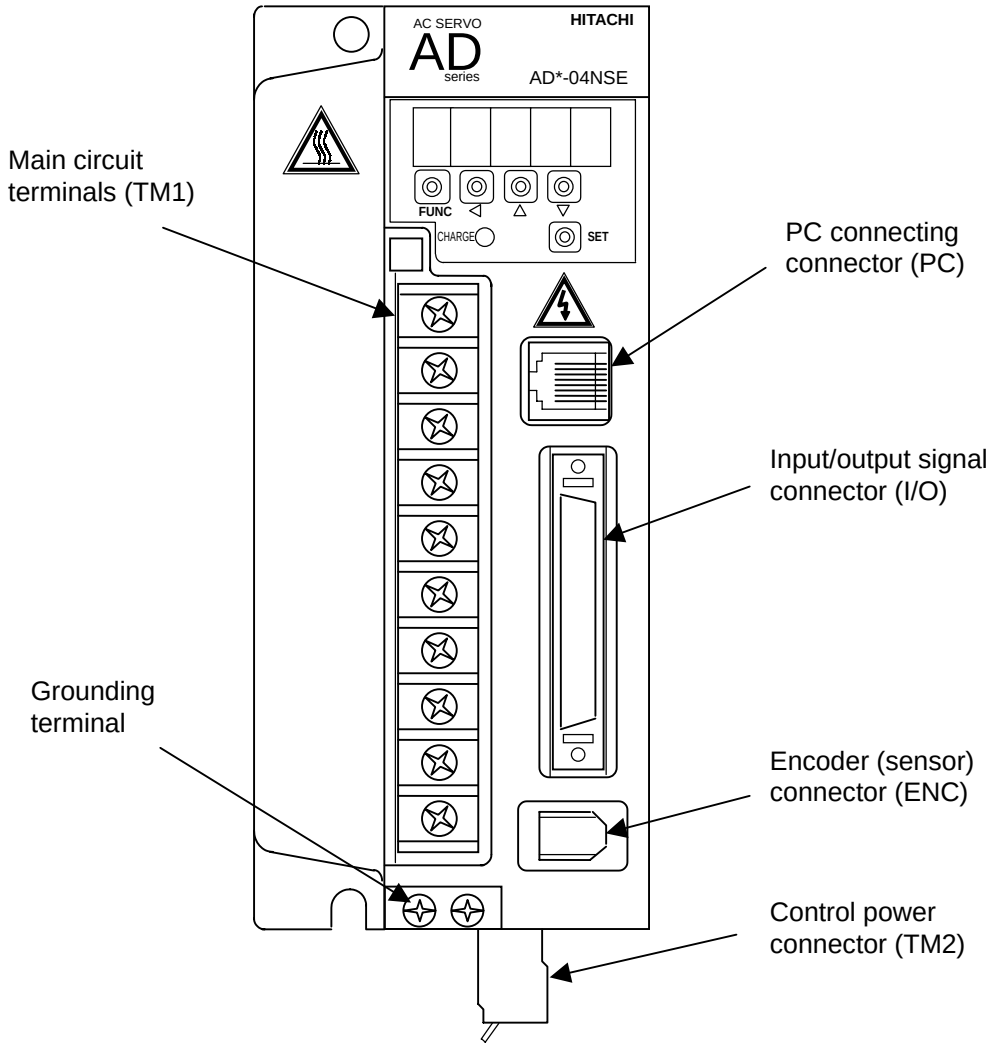
- As for motor leads, fuses and electromagnetic contactors, be sure to use the equivalent ones with the specified capacity (rated).
  Otherwise, there is a danger of fire.

- Fasten the screws with the specified fastening torque. Check so that there is no loosening of screws.
  Otherwise, there is a danger of fire.

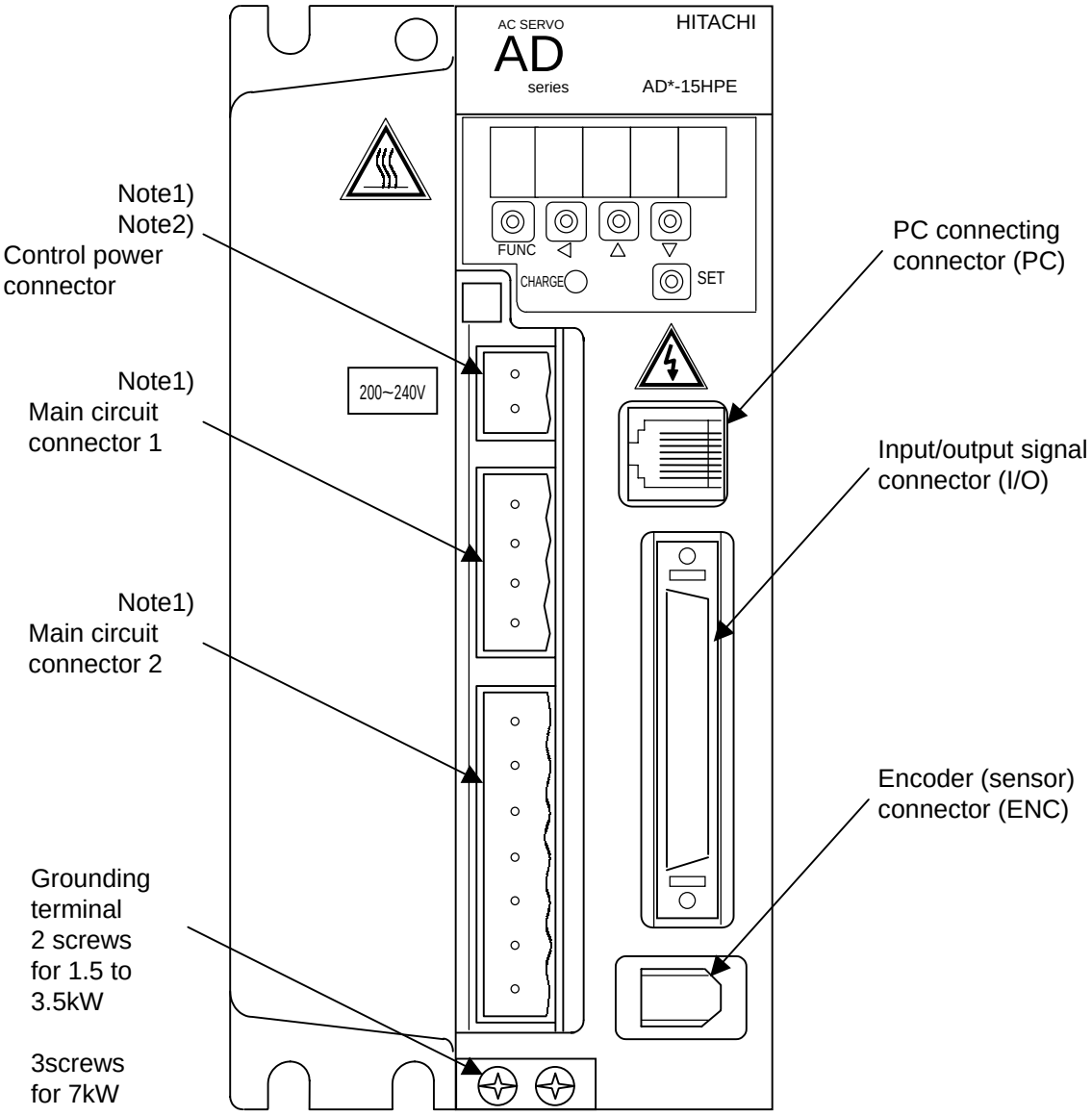
- Connection to field wiring terminals must be reliably fixed having two independent means of support. Using terminal with cable support, cable gland or cable clamp etc.
  Otherwise, there is a danger of fire.

3.2.1 Terminals and connectors

(1) 200V class



(2) 400V class



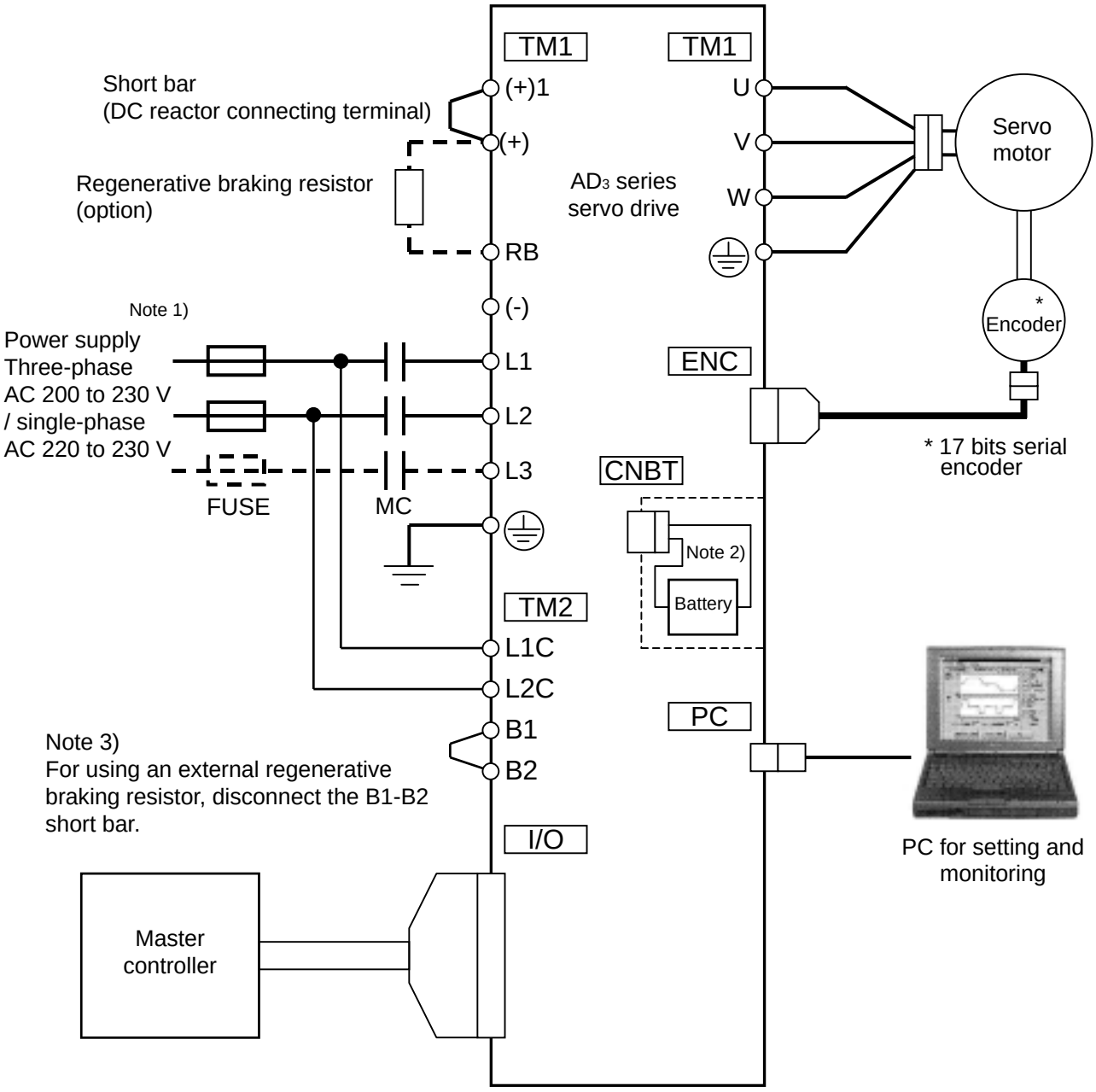
Note 1) 3.5 and 7kW drive is a different appearance.
For 7kW, the control power and main circuit connectors are a terminal block.

Note 2) The input voltage to the control power connector is AC 200 to 240V.
Do not input the main power supply voltage to the control power connector.

3.2.2 Main circuit wiring

(1) Terminal connection diagram

a) 200V class

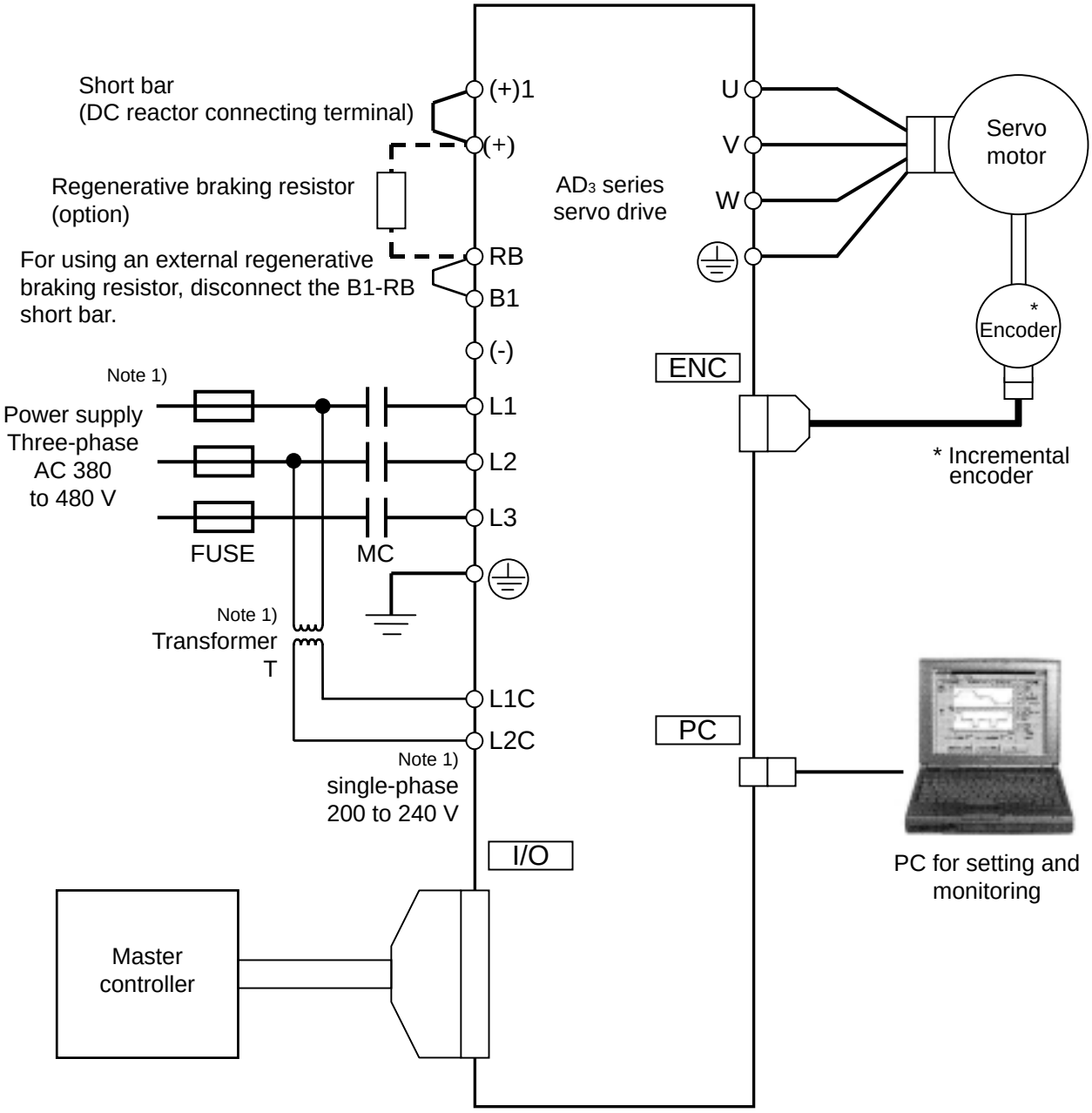


Note 1: For single-phase 220 to 230 V AC, connect only L1 and L2.
(For three phase connect L1, L2 and L3.)

Note 2: The battery is used only for the absolute encoder.

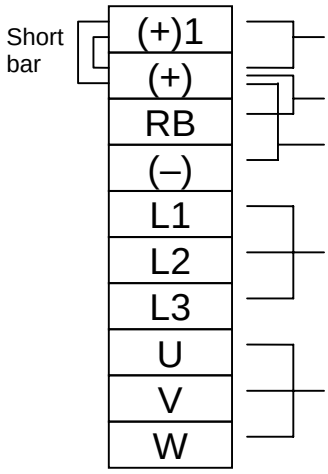
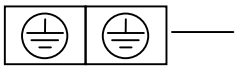
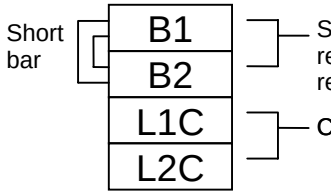
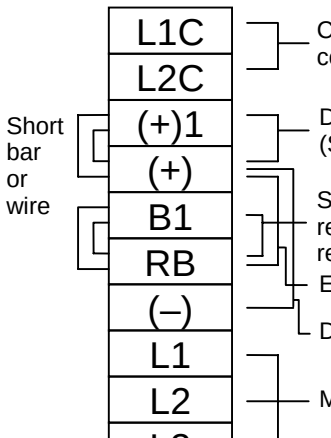
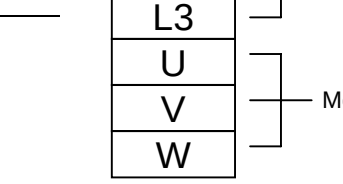
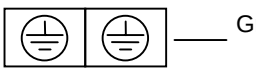
Note 3: The regenerative braking resistor is built in the model of class 200 V, 400 W and 750 W.

b) 400V class



Note 1: Connect three phase 380 to 480 V to L1, L2 and L3, and single phase 200 to 240 V to L1C and L2C. Do not input 380 to 480 V to L1C and L2C. Be sure to be the secondary voltage 200 to 240 V when the transformer is used.

(2) Terminal assignment

Type	Terminal name	Terminal assignment	Terminal screw size	Terminal width (mm)
200V class	Main circuit terminals (TM1)		M4	8.1
	Grounding terminal		M4	–
	Control power connector (TM2)	 Note: The figure shows a view of the servo drive seen from the lower side. Refer to 3.2.3 “Wiring for the control terminal”.	Applicable cable size: 0.5 mm^2 to 2.0 mm^2	
400V class 1.5 to 3.5 kW	Main circuit and control power connectors		M3	–
	Grounding terminal		M4	–
400V class 7 kW	Main circuit and control power terminals		M5	13
	Grounding terminal		M5	–

⚠ CAUTION

1. For the connectors, perform wiring after removing them from the servo drive.
   Otherwise, the servo drive way be broken.

2. When inserting the cable, take care not to bring the core whisker into contact with the other terminal.
   The servo drive may be broken.

3. If the cable core has not enough contact for any reason, strip it again and them connect the cable.
   The servo drive may be broken.

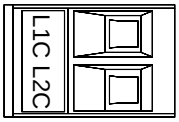
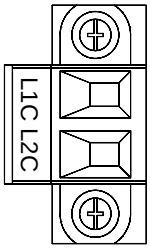
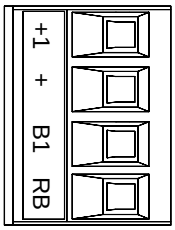
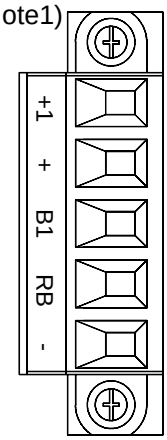
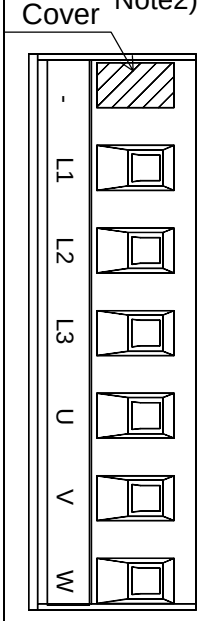
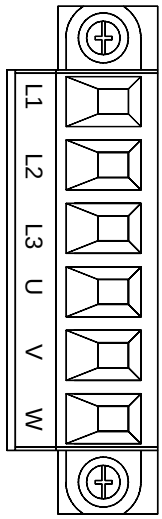
(2-1) 400V class main circuit and control power connectors

The front terminal of the servo drive separates as follows.

Model	200V class AD*3-☐☐NSE	400V class AD*3-☐☐HPE		
	100 to 750W	1.5kW	3.5kW	7kW
Terminal	Terminal	Connector	Connector	Terminal

The connectors of the front main circuit and control power are attached to the servo drive. The specification of the connectors of 400V class is shown in the following table.

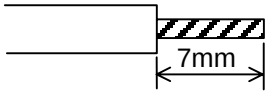
Specification of connectors

Model / Spec. / Connector name	AD*3-15HPE(1.5kW)		AD*3-35HPE(3.5kW)	
	Connector model	Assignment	Connector model	Assignment
Control power connector (L1C, L2C)	Model:MSTB2.5/2 -ST-5.08 Pin No. :2P Pin pitch:5.08mm Wire size:1.25 - 2.5mm^2/AWG16 - 12 Manufacture: PHOENIX CONTACT GMBH & CO.		Model:PC4/2 -STF-7.62 Pin No. :2P Pin pitch:7.62mm Wire size:1.25 - 4mm^2/AWG16 - 10 Manufacture: PHOENIX CONTACT GMBH & CO.	
Main circuit connector 1	Model:MSTB2.5/4 -ST-5.08 Pin No. :4P Pin pitch:5.08mm Wire size:1.25 - 2.5mm^2/AWG16 - 12 Manufacture: PHOENIX CONTACT GMBH & CO.	Note1) 	Model:PC4/5 -STF-7.62 Pin No. :5P Pin pitch:7.62mm Wire size:1.25 - 4mm^2/AWG16 - 10 Manufacture: PHOENIX CONTACT GMBH & CO.	Note1) 
Main circuit connector 2	Model:GMSTB2.5/7 -ST-7.62 Pin No. :7P Pin pitch:7.62mm Wire size:1.25 - 2.5mm^2/AWG16 - 12 Manufacture: PHOENIX CONTACT GMBH & CO.	Cover Note2) 	Model:PC4/6 -STF-7.62 Pin No. :6P Pin pitch:7.62mm Wire size:1.25 - 4mm^2/AWG16 - 10 Manufacture: PHOENIX CONTACT GMBH & CO.	

Note1) Short bars or wires are connected between +1 and +, B1 and RB.
Do not remove them except for the optional use.
Note2) This cove prevents a faulty wiring.
When (-) terminal is used, remove it.

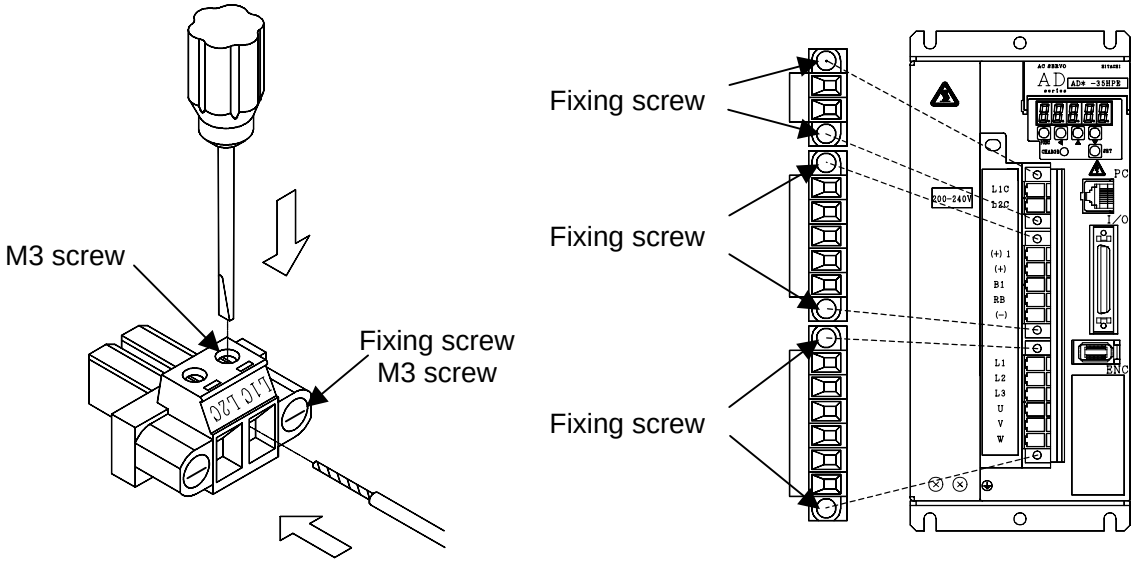
(2-2) 400V class cable terminal treatment for connectors

Strip the cable cover as follows. Then the cable can be used as it is.



(2-3) Connecting method

Insert the core the cable in the opening of the connector. Tighten the terminal screws with the specified torque. Insufficient tightening way result in a short cicuit or fire. Make sure not to remove the cable by pulling. For 3.5kW, tighten the screws of both sides of the connector after connecting it.



Connection procedure

(3) Precautions on wiring

Before starting wiring, make sure that the charge lamp is completely extinguished. Take care about the capacitor that is charged at a high voltage. In 10 minutes or more after shutting off the power supply, check with a tester that no residual voltage exists between (+) and (–) on the main circuit terminal block, and then start the wiring work.

(3-1)Main power supply input connecting terminal (L1, L2, L3)

- Use fuses for circuit (wiring) protection between the power supply and the main power supply terminal (L1, L2, or L3).
- Connect an electromagnetic contactor that shuts off the power supply of the servo drive to prevent a failure or accident from spreading when the protective function of the servo drive is actuated.
- Do not start or stop the servo drive by turning on or off each electromagnetic contactor provided on the primary side and secondary side of the servo drive.
- Do not input a single phase to the main power supply input of 400V class servo drive (AD*3-☐☐HPE).
- In the following cases, the converter module may be damaged.
  The unbalance of power supply voltage is 3% or more.
  The power supply capacity is 10 times as large as the servo drive capacity, or 500 kVA or more.
  A sudden power supply change occurs.
  (Example) Multiple servo drives are interconnection with a short bus.
- Turn on and off the power supply, at least, at intervals of 5 minutes per operation. Otherwise, the servo drive may be damaged.

(3-2)Motor cable connecting terminal (U, V, W)

- Perform wiring by using a thicker cable than applicable cable in order to suppress a voltage drop.

(3-3)DC reactor connecting terminal ((+) 1, (+))

- This terminal is used to connect the DC reactor (option) for improvement of power factor. A short bar or wire is connected between terminals (+) 1 and (+) at delivery from the factory. When connecting the DC reactor, disconnect it bar beforehand. When the DC reactor is not used, do not remove it.

(3-4)External braking resistor connecting terminal ((+), RB))

- The regenerative braking circuit and the braking resistor are built-in the servo drive. To enhance the braking capacity, connect the optional external braking resistor to this terminal. For using the external braking resistor, disconnect the short bar or wire between the terminals (B1 and B2 or RB) for internal braking resistor. The wiring length should be 5 m or less and perform wiring by twisting two wires without making inductance.
- Install a resistor exceeding the resistance value R_{BRmin} shown in the following table. Installing a resistor not exceeding the resistance value shown in the table will cause damage to the regenerative braking circuit.

Servo drive capacity		Built-in R_{BR}	Minimum resistance value R_{BRmin}
200 V class	100 W	Not provided	100Ω
	200 W	Not provided	100Ω
	400 W	50 W 50Ω (15 W, 0.5%)	50Ω
	750 W	50 W 50Ω (15 W, 0.5%)	40Ω
400 V class	1.5 kW	50 W 100Ω (27 W, 0.5%)	100Ω
	3.5 kW	120 W 50Ω (70 W, 0.5%)	50Ω
	7 kW	180 W 25Ω (120 W, 0.5%)	25Ω

Note: The power of the built-in braking resistor R_{BR} is the nominal power value. The values in parentheses are the available average power (W) and the allowable operating ratio (%).

(3-5)DC power supply input connecting terminal ((+), (–))

- To supply the DC power from an external converter, this terminal is used to connect the DC power supply. The DC power supply voltage should be 270 V DC to 310 V DC for 200V class, 510V DC to 650V DC for 400V class (+10%, –15%). Use a power supply of enough capacity.
- When supplying the DC power supply, do not connect anything to the main power supply input connecting terminals (L1, L2, L3).
- When supplying the DC power supply, set the PN power supply (FA-07) to Pn. If this is not set, a momentary power failure will be detected by mistake for 200 V class servo drive.

(3-6)Control power supply input connecting terminal (L1C, L2C)

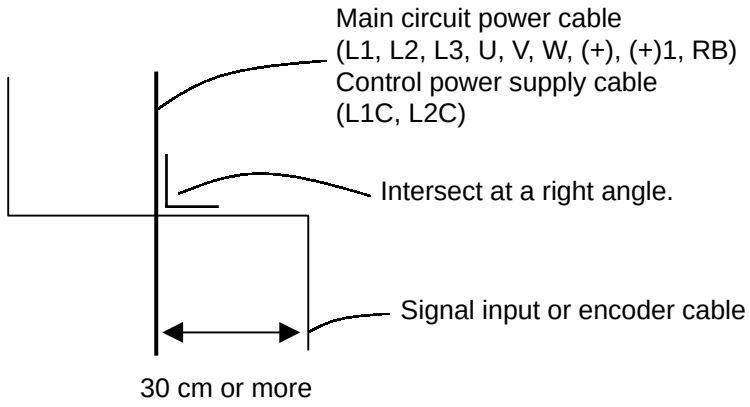
- This servo drive has to supply the control power supply apart from the main circuit power supply. Be sure to connect the single-phase AC power supply to the control power supply input terminal (L1C, L2C). For this power supply, use a fuse for circuit (wiring) protection.
- The control power supply of 400V class servo drive (AD*3-☐☐HPE) is AC 200 – 240 V.
- Turn on and off the power supply, at least, at intervals of 5 minutes per operation. Otherwise, the servo drive may be damaged.

(3-7)Grounding connecting terminal (⏚))

- For prevention against an electric shock, be sure to be grounded the servo drive and the servo motor as specified.
- Use a larger size than the applicable wire as the grounding conductor. It should be as short as possible.

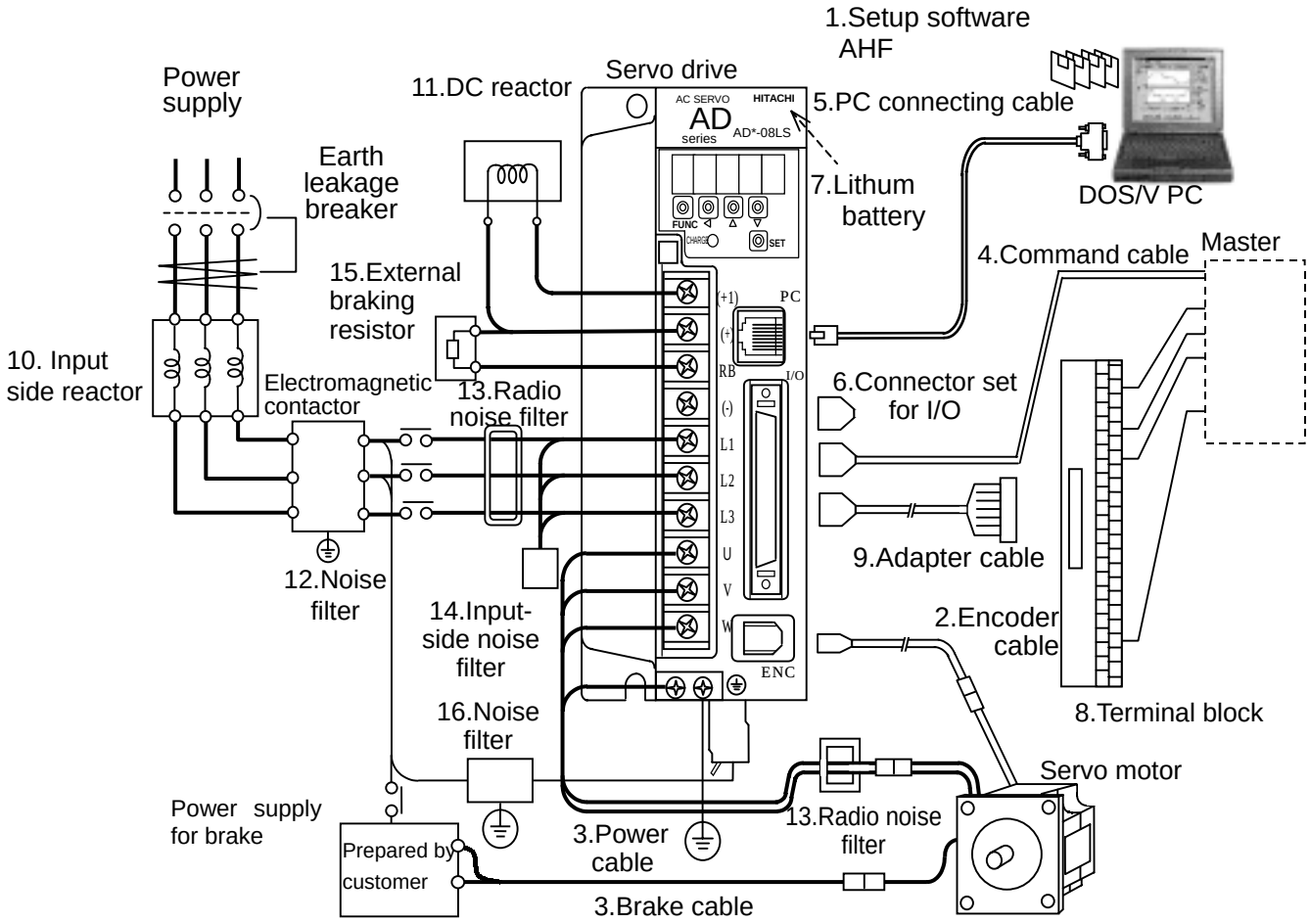
Note 1: For wiring to the terminals, use a solderless terminal conforming to the terminal screw size and terminal width. If a too wide solderless terminal width is used, this connection may not be made. In particular, take care about the terminal width in the following cases.
- 2 mm^2 or more cable is connected to the main circuit terminals of 200 V class.
- 8 mm^2 or more cable is connected to the main circuit terminals of 400 V class 7kW.

Note 2: Separate the servo drive signal input cable or encoder cable from the main circuit power cable or control power cable 30 cm or more from each other. If they must intersect each other, cause them to intersect at a right angle as shown in the following figure. If they are not separated enough, a malfunction may be caused.



(4) Wiring equipment, options

Name		Model	Function
1	Setup software AHF	AHF-P01,P02	Setting,monitoring and graphic display by PC
2	Encoder cable	ADCE-C---☐S,HP	-C:standard type, -CH:high flexure life type
3	Power cable (with or without brake)		Motor cable (Prepared by customer)
4	Command cable	ADCC-03	Cable with I/O connector
5	PC connecting cable	ADCH-AT2	Cable with DOS/V PC connector(D-SUB 9P)
6	Connector set for I/O	ADCC-CON	Connector and its cover
7	Lithium battery (for absolute encorder)	ADABS-BT	Encoder data are kept by battery at control power off for the absolute encoder use.
8	Terminal block	ADCC-TM	Terminal connection adapter for I/O connector with 1m or 2m cable
9	Above adapter cable	ADCC-T01,T02	
10	Input –side reactor	ALI-☐☐☐	Power factor improvement, power cooperation
11	DC reactor	DCL-☐☐☐	Power factor improvement
12	Noise filter	NF-☐☐☐	EMC noise filter
13	Radio noise filter (zero-phase reactor)	ZCL-B40,B75 ZCL-A	Reduction for radiating noise
14	Input-side noise filter	CFI-L,-H	Reduction for radiating noise
15	External braking resistor	RB☐,JRB---,SRB---	Braking power capacity improvement
16	Noise filter	SUP-E1H-EP	EMC noise filter for 400 V class control power



5) Recommended wire size and wiring equipment

- For the wire size and wiring equipment to be used for wiring to the servo drive, refer to the following table.
- For safety, use fuses.
- As the cable, use a 75°C copper electric cable.
- When the wiring length exceeds 20 m, the power cable must be larger.
- Tighten the terminal screw with the specified tightening torque. Insufficient tightening may result in a short circuit or fire.

(Tightening torque)

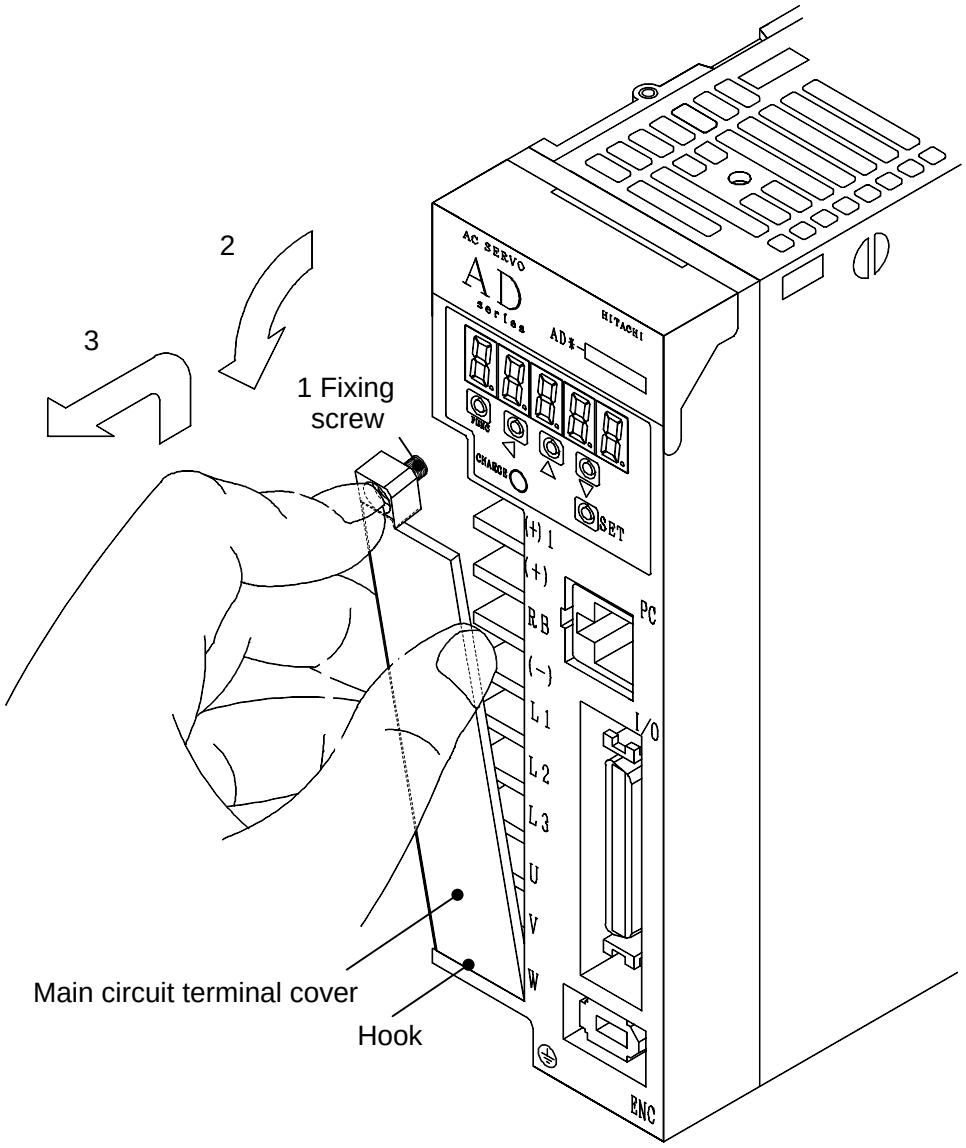
For up to 750W (M4 screw): 1.2 N.m(max.1.35N.m)
For 1.5kW, 3.5kW (M3 screw): 0.6 N.m(max.0.66N.m)
For 7kW (M5 screw): 2.0 N.m(max.2.2N.m)

Motor kW	Servo drive model	Main circuit power cable (L1, L2, L3) (+)1, (+), RB, (–)	Motor cable (U, V, W) Grounding cable	Control power cable (L1C, L2C)	Fuse (class J) rated 600 V	Electro-magnetic contactor (MC) (Note 1)
0.1	AD*3-01NSE	AWG 18 (1.25mm^2)	AWG 18 (1.25mm^2)	AWG 20 (0.5mm^2)	3A	H10C
0.2	AD*3-02NSE	AWG 18 (1.25mm^2)	AWG 18 (1.25mm^2)	AWG 20 (0.5mm^2)	6A (1 ph.) 3A (3 ph.)	H10C
0.4	AD*3-04NSE	AWG 18 (1.25mm^2)	AWG 18 (1.25mm^2)	AWG 20 (0.5mm^2)	10A (1 ph.) 6A (3 ph.)	H10C
0.75	AD*3-08NSE	AWG 16 (2mm^2)	AWG 18 (1.25mm^2)	AWG 20 (0.5mm^2)	15A (1 ph.) 10A (3 ph.)	H10C
~ 1.5	AD*3-15HPE	AWG 18 (1.25mm^2)	AWG 18 (1.25mm^2)	AWG 18 (1.25mm^2)	10A	H10C
~ 3.5	AD*3-35HPE	AWG 14 (2mm^2)	AWG 14 (2mm^2)	AWG 18 (1.25mm^2)	20A	H20
~ 7	AD*3-70HPE	AWG 10 (5.5mm^2)	AWG 10 (5.5mm^2)	AWG 18 (1.25mm^2)	50A	H20

Note 1 : The electromagnetic contactor are the model manufactured by Hitachi Industrial Equipment Systems Co., Ltd.

Note 2 : Field wiring connection must be made by a UL Listed and CSA Certified closed – loop terminal connect or sized wire gauge involved. Connector must be fixed using the crimp tool specified by the connector manufacturer.

(6) Opening the main circuit terminal block (TM1) cover (200 V class)
1- Loosen a fixing screw of the main circuit terminal cover.
2- Take the main circuit terminal cover on the body away from the front slowly.
3- Remove the cover from the hook.



3.2.3 Wiring for the control power connector (TM2) (200V class)

⚠ CAUTION
1. For the control power connector (TM2), perform wiring after removing it from the servo drive. Otherwise, the servo drive may be broken. 2. Insert one cable in one wiring hole of the control power connector (TM2). Otherwise, the servo drive may malfunction. 3. When inserting the cable, take care not to bring the core whisker into contact with the other terminal. The servo drive may be broken. 4. If the cable core has not enough contact for any reason, strip it again and then connect the cable. The servo drive may be broken.

(1) Cable terminal treatment

Strip the cable cover as shown in Fig. 1. Then, the cable can be used as it is. The applicable wire size is as follows.

Solid wire .....Wire size 0.5 to 2.0 mm^2
Stranded wire.....Wire size 0.5 to 2.0 mm^2

Fig. 1

(2) Connecting method

Insert the core of the cable in the opening of the control power connector (TM2) (Fig. 2) by using one of the methods shown in Fig. 3 and Fig. 4. Make sure that the cable cannot be pulled out.

1- Insert the cable by using an attached lever as shown in Fig. 3.
2- Insert the cable by using a bladed screwdriver as shown in Fig. 4.

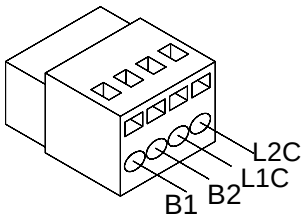


Fig. 2

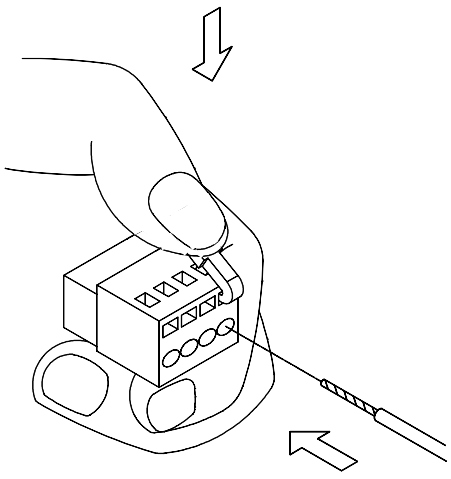


Fig. 3

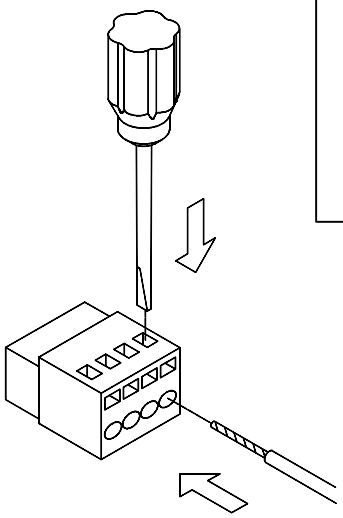


Fig. 4

3.2.4 Connecting the backup battery for absolute encoder

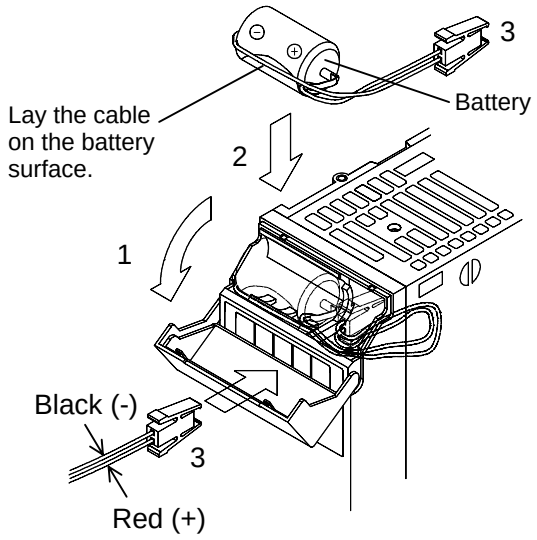


Fig. 1

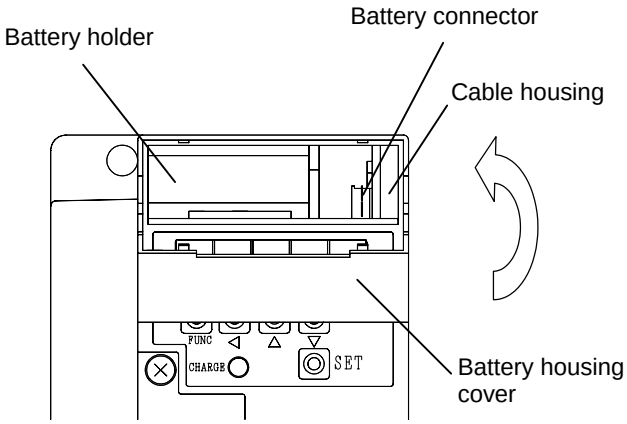


Fig. 2

1- Set the click in the groove on the top surface of the battery housing cover and then open the cover.
2- Set the battery in the battery housing with its positive side on the receptacle side as shown in Fig. 1.
3- Insert the connector in the receptacle firmly.
4- Lay the battery cable surely on the battery surface as shown in Fig. 1 and house the excessive cable in the cable housing.
5- Mount the battery housing cover on the front cover by pushing the upper part of the battery housing cover (Fig. 2) with a finger until a click is produced.

Note 1: After mounting the battery and connecting the encoder, turn on the power supply. At that time, an absolute battery error (E90) may occur. In this case, clear the encoder to zero. For the procedure, refer to Chapter 5, Function for absolute position encoder, (2) Clearing the absolute position.

If the following trip related to the absolute battery occurs, take one of the measures shown below.

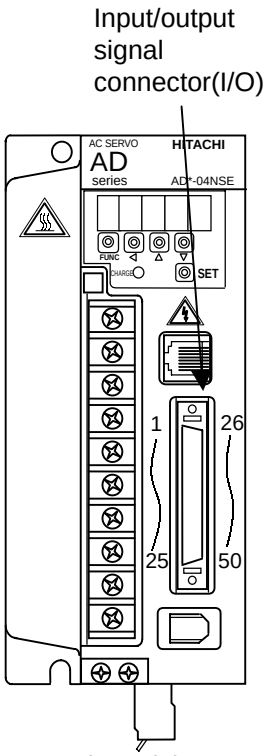
Trip name		Measure
Absolute battery error	E90	- Replace the battery after turning off the control and main power supply. - Clear the encoder to zero. Perform the system adjustment from the beginning.
Absolute battery alarm	E91	- Replace the battery with the control power supply (L1C, L2C) incoming after a lapse of more than 10 minutes after turning off the main power supply (L1, L2, L3). - Turn ON and OFF the alarm reset signal RS.

Note2: The absolute battery alarm (E91) occurs if the battery is removed with the control power supply incoming. In this case, take the above measure.

3.2.5 Input/output signal wiring

(1) Input/output signal connector

In the input/output signal connector, the upper left pin is pin no.1 when the servo drive is viewed from the front as shown in the figure. The signal assignment on the input/output signal connector (servo drive side) is shown in the following table.



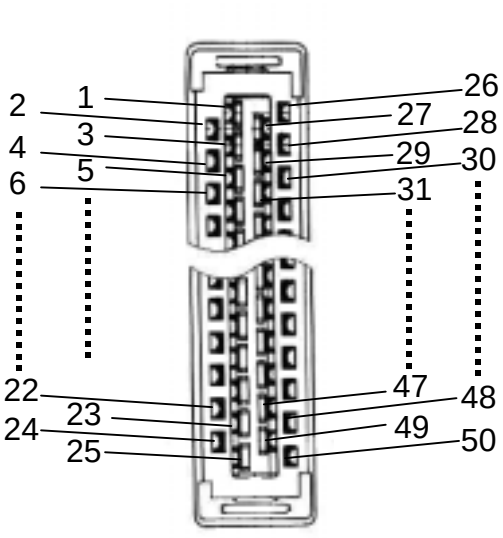
Front view of the 0.4 kW servo drive

Pin No.	Pin code	Signal name	Pin No.	Pin code	Signal name
1	P24	Interface power	26	SON	Servo ON
2	PLC	Intelligent input common	27	RS	Alarm reset
3	X(00)/ MOD	General input 0/ Control mode switch	28	X(02)/ FOT	General input 2/ Forward overtravel
4	X(01)/ TL	General input 1/ Torque limit	29	X(03)/ ROT	General input 3/ Reverse overtravel
5	X(04)/ SS1/ EGR2	General input 4/ Multistage speed 1/ Electronic gear switch	30	CM1	Interface power common
6	X(05)/ SS2/ ECLR	General input 5/ Multistage speed 2/ Encoder clear	31	X(06)/ PPI/ GCH	General input 6/ Proportional control/ Gain change
7	X(07)/ SRZ/ EOH	General input 7/ Zero speed clamp/ External trip	32	X(09)/ ORG	General input 9/ Homing
8	X(08)/ ORL	General input 8/ Home limit switch	33	X(10)/ PEN/ FWD	General input 10/ Pulse train input enable/ Forward command
9	X(11)/ CER/ REV	General input 11/ Position error clear/ Reverse command	34	CM2	Output common
10	CM1	Interface power common	35	Y(00)/ SRD	General output 0/ Servo ready
11	Y(01)/ ALM	General output 1/ Alarm	36	Y(03)/ SA/ AL1	General output 3/ Up to speed/ Alarm code 1
12	Y(02)/ INP	General output 2/ Positioning complete	37	Y(04)/ SZD	General output 4/ Zero speed detection
13	Y(05)/ BRK	General output 5/ Brake release	38	Y(07)/ OL1/ AL3	General output 7/ Overload notice/ Alarm code 3
14	Y(06)/ TLM/ AL2	General output 6/ Torque limiting/ Alarm code 2	39	CM2	Output common
15	PLSP	Position command pulse (P)	40	SIGP	Position command code (P)
16	PLSN	Position command pulse (N)	41	SIGN	Position command code (N)
17	L	Analog input /output common	42	–	
18	AI3	Analog input 3	43	AI4	Analog input 4
19	XA(0)/AI1	General/Analog input 1	44	XA(1)/AI2	General/Analog input 2
20	L	Analog input /output common	45	L	Analog input /output common
21	OAP	Phase A (P)	46	OBP	Phase B (P)
22	OAN	Phase A (N)	47	OBN	Phase B (N)
23	OZP	Phase Z (P)	48	OZ	Phase Z detection
24	OZN	Phase Z (N)	49	L	Phase Z detection common
25	AO1	Analog monitor 1	50	AO2	Analog monitor 2

In the connector (cable side) for connecting these input/output signals, the inner upper pin on the left side is pin no.1 when the connector is viewed from the solder side as shown in the following figure.

For connecting input/output signals (cable side), use the following connectors.

Connector name	Model	Manufacturer
Solder plug	10150-3000VE	Sumitomo 3M Ltd.
Non-shield shell kit	10350-52A0-008	Sumitomo 3M Ltd.

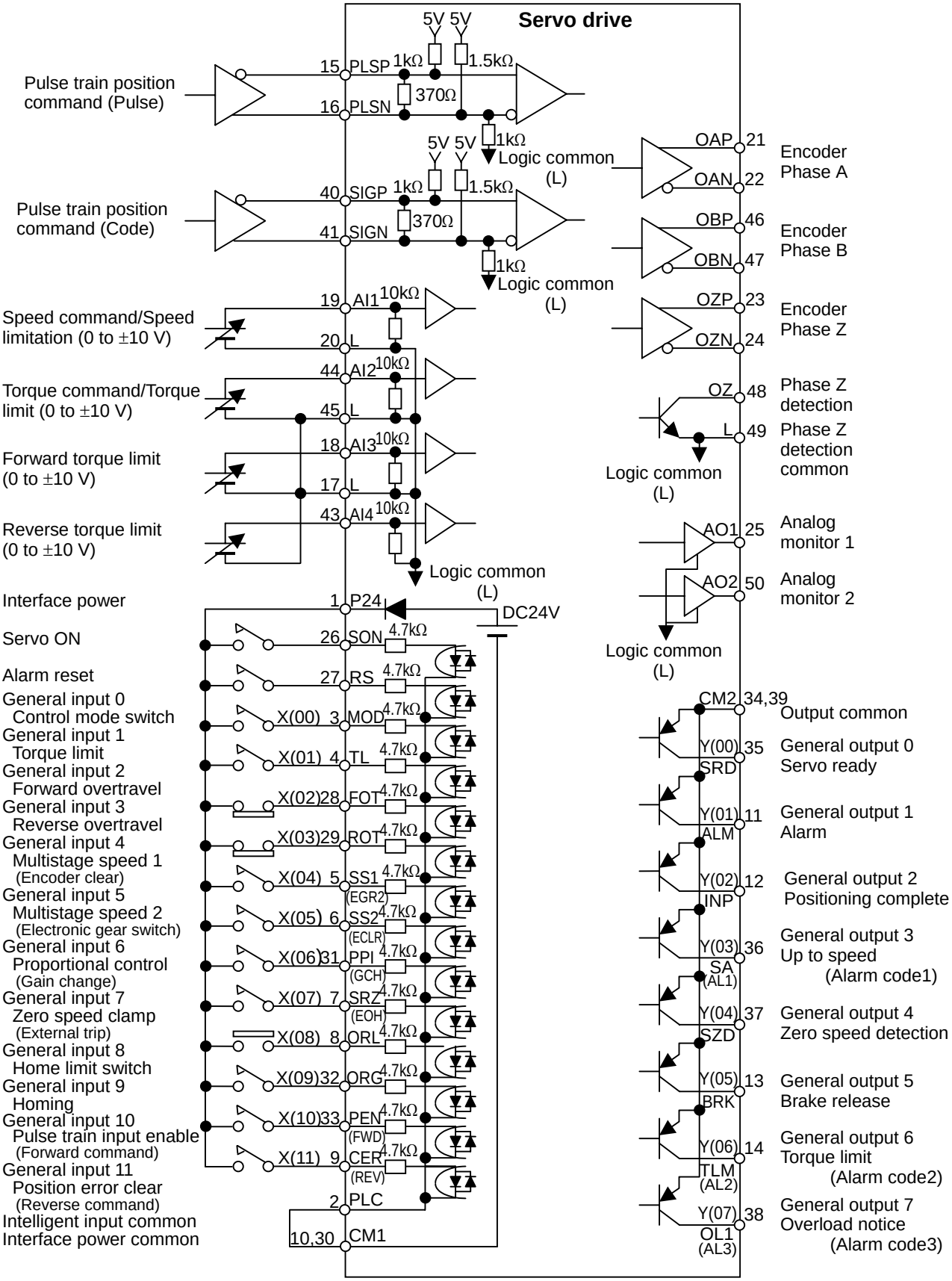


2	PLC	1	P24	27	RS	26	SON
4	X(01)/ TL	3	X(00)/ MOD	29	X(03)/ ROT	28	X(02)/ FOT
6	X(05)/ SS2/ ECLR	5	X(04)/ SS1/ EGR2	31	X(06)/ PPI/ GCH	30	CM1
8	X(08)/ ORL	7	X(07)/ SRZ/ EOH	33	X(10)/ PEN/ FWD	32	X(09)/ ORG
10	CM1	9	X(11)/ CER/ REV	35	Y(00)/ SRD	34	CM2
12	Y(02)/ INP	11	Y(01)/ ALM	37	Y(04)/ SZD	36	Y(03)/ SA/ AL1
14	Y(06)/ TLM/ AL2	13	Y(05)/ BRK	39	CM2	38	Y(07)/ OL1/ AL3
16	PLSN	15	PLSP	41	SIGN	40	SIGP
18	AI3	17	L	43	AI4	42	-
20	L	19	XA(0)/ AI1	45	L	44	XA(1) AI2
22	OAN	21	OAP	47	OBN	46	OBP
24	OZN	23	OZP	49	L	48	OZ
		25	AO1			50	AO2

Note : The command cable connected to the above connector is available as an option (ADCC-03).

(2) Input/output signal connection diagram

Standard input/output signal connections are shown in the following figure.



(3) Input/output signal functions

The input/output signal functions are summarized in the following table.

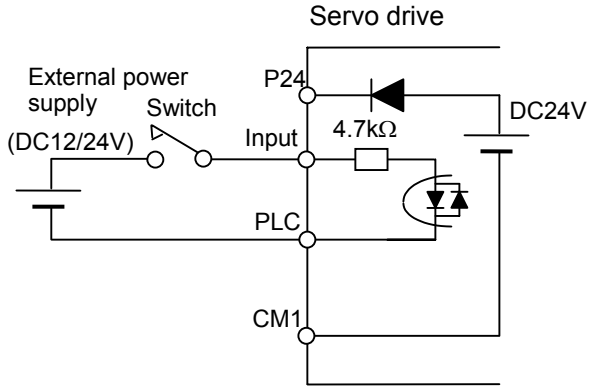
Type	Terminal symbol	Terminal name	Function	Electrical specification
Input signal	P24	Interface power	It is DC24V power for connection of input signal. Do not use for the other purpose.	DC+24 V ±10% Max 80 mA
	CM1	Interface power common	Common of the P24 power supply.	
	PLC	Intelligent input common	Select sink logic or source logic by connecting input common signal. It also connects the external power supply or the internal power supply (P24).	
	SON	Servo ON	Puts the servo drive into a servo ON status (powers the servo motor to put it under control).	Input impedance 4.7 kΩ 5 mA (at 24 V) per input
	RS	Alarm reset	In the trip status, the alarm status is cleared by inputting this signal. However, measure the cause of error before resetting, and turn off the Servo ON terminal.	
	X(00) ~ X(11)	General input 0~11	Changes to general input terminal at programmed operation. "0" : open " 1 " : close	
	MOD	Control mode switch	Switches the control mode depending on the status of this input. (Position/Speed, Speed/Torque, Torque/Position)	
	TL	Torque limit	Enables the torque limit when this signal is input.	
	FOT	Forward overtravel	When this signal is OFF, the servo drive does not operate in the forward direction. (Forward direction limit signal)	
	ROT	Reverse overtravel	When this signal is OFF, the servo drive does not operate in the reverse direction. (Reverse direction limit signal)	
	SS1	Multistage speed 1	A multistage speed of 3 steps is selected by combining these signal states, and a speed control operation is performed. When all of these signals are OFF, the operation is stopped.	
	SS2	Multistage speed 2		
	PPI	Proportional control	When this signal is ON, P (proportional) control is performed as speed control.	
	SRZ	Zero speed clamp	Fixes the speed command value to zero.	
	ORL	Home limit switch	Inputs the signal of the home limit switch to indicate the home area. This signal is used for a homing in the position control mode.	
	ORG	Homing	When this signal is input, a homing operation is started. This signal is used for a homing in the position control mode.	
	PEN	Pulse train input enable	While this signal is ON, the pulse train position command input is enabled.	
	CER	Position error clear	Clears the position error counter. (The position command value is regarded as the present position.)	
	FWD	Forward command	Operates the motor in the forward direction at multistage speed operation. (The 2nd function of the PEN signal)	
	REV	Reverse command	Operates the motor in the reverse direction at multistage speed operation. (The 2nd function of the CER signal)	
	GCH	Gain change	Changes the gain of the control loop. (The 2nd function of the PPI signal)	
	EGR2	Electronic gear switch	Changes from 1st gear ratio to 2nd gear ratio and clears the remaining pulses. (The 2nd function of the SS1 signal.)	
	ECLR	Encoder clear	Clears the multi-ration data of the absolute encoder with 4 second or more signal input. (The 2nd function of the SS2 signal.)	
	EOH	External trip	The drive trips and its output stops. Trip is reset by RS signal. (The 2nd function of the SRZ signal.)	

Type	Terminal symbol	Terminal name	Function	Electrical specification
Analog input	XA(0)/ AI1	General analog input 1/ Analog input 1	Changes to general analog input 1 at programmed operation. The signal has each function of speed command, speed bias, or speed limit depending on the control mode and parameter setting.	0 to ±10 V Input impedance: approx. 10 kΩ
	XA(1)/ AI2	General analog input 2/ Analog input 2	Changes to general analog input 2 at programmed operation. The signal has each function of torque command, torque bias, or torque limit depending on the control mode and parameter setting.	
	AI3	Analog input 3	The forward torque limit level depends on input voltage with TL signal ON.	
	AI4	Analog input 4	The reverse torque limit level depends on input voltage with TL signal ON.	
	L	Analog input/ output common	Common of the analog input signal.	
Output signal	Y(00) ~ Y(07)	General output 0~7	Changes to general output terminal at programmed operation. "0" : open " 1 " : close	Open collector signal output +30 V DC or less, 50 mA max. per output
	SRD	Servo ready	This signal is output when the servo drive can accept for the servo ON (when the main power supply is set up without any trip).	
	ALM	Alarm	The alarm signal is output in the trip status. (This signal is ON in the normal status and OFF in the trip status.)	
	INP	Positioning complete	This signal is output when the deviation between the command position and the current position is within the set positioning range.	
	SA	Up to speed	The signal is output when the speed detection value reaches the speed command value.	
	SZD	Zero speed detection	The signal indicates that the speed detection value is below the set zero speed detection value.	
	BRK (SOA)	Brake release	In the servo ON status, the brake release enable signal is output. When the brake waiting time is set to 0, the signal can be used as Servo ON Answer (SOA).	
	TLM	Torque limiting	The signal is output in the torque limit status (where the torque command value is limited by the torque limit value).	
	OL1	Overload notice	The signal is output when the overload detection amount reaches the set overload notice level.	
	AL1~3	Alarm code	The three bits – binary alarm signal is output for each error code.	
	CM2	Output common	Common of the output signal.	
Monitor output	AO1	Analog monitor 1	The speed detection value or torque command value monitors by analog voltage. The signal to be output can be set by parameter. Since these signals are for monitoring, do not use them for control.	0 to ±3.0 V Load impedance: 3 kΩ or more
	AO2	Analog monitor 2		
	L	Analog output common	Common for the Monitor signal.	
Position command	PLSP	Position command pulse (Pulse signal)	These are pulse train position command inputs. The following signal forms can be selected. 1-Command pulse + Direction signal 2- Forward pulse train + Reverse pulse train 3- Phase difference 2-phase pulse input	The line receiver signal input
	PLSN			
	SIGP	Position command pulse (Code signal)		
	SIGN			
Encoder monitor	OAP	Encoder Phase A	The monitor signal resulting from dividing the phase A signal of the enczoder is output.	Line driver signal output
	OAN			
	OBP	Encoder Phase B	The monitor signal resulting from dividing the phase B signal of the encoder is output.	
	OBN			
	OZP	Encoder Phase Z	The monitor signal of the phase Z signal of the encoder is output. The current position data is output as a serial signal by setting.	
	OZN			
	OZ	Phase Z detection	The monitor signal of the phase Z signal of the encoder is output.	Open collector output +30 V DC or less, 50 mA max.
	L	Phase Z detection common		

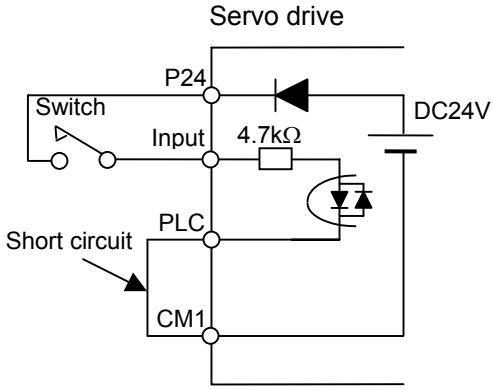
(4) Details of input/output signal wiring

(4-1) Contact input signal

• Contact signals of switches and relays are input. The following figures (a) and (b) show the wiring in the status where an external power supply is used or the internal interface power is used.

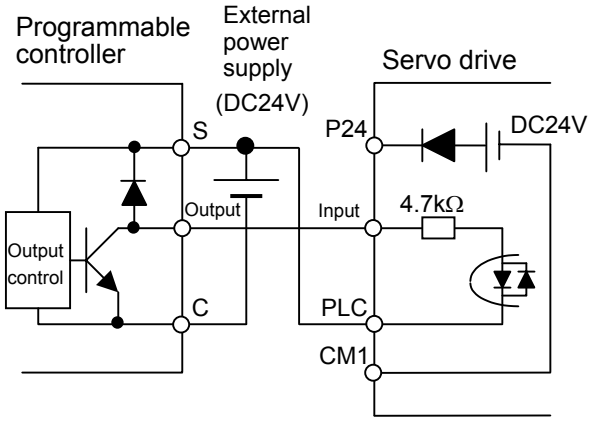


(a) When an external power supply is used.

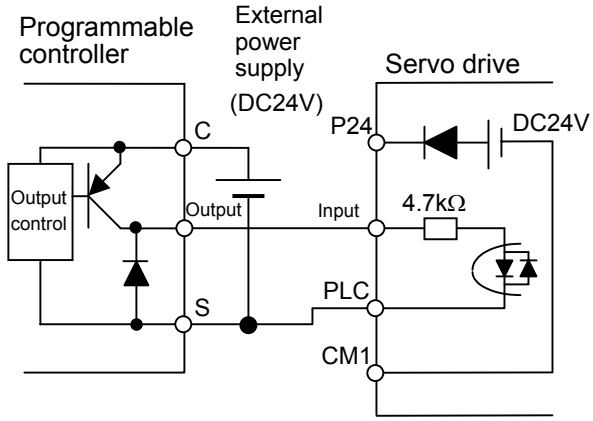


(b) When the internal power supply is used.

• When a device requiring a power supply for output control, for example, the output module of the programmable controller, use an external power supply. (Do not use the internal interface power of the servo drive.) The following figures (c) and (d) show examples of connection with the transistor output module (sink type, source type) of the programmable controller.

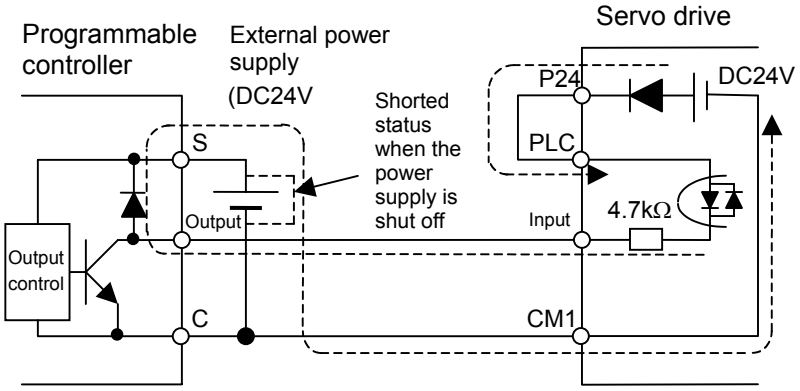


(c) For sink type output module



(d) For source type output module

• When using an external power supply, do not connect the internal interface power of the servo drive. When the external power supply is shut off, a current may flow as shown in the following figure (e), thereby turning on the input.



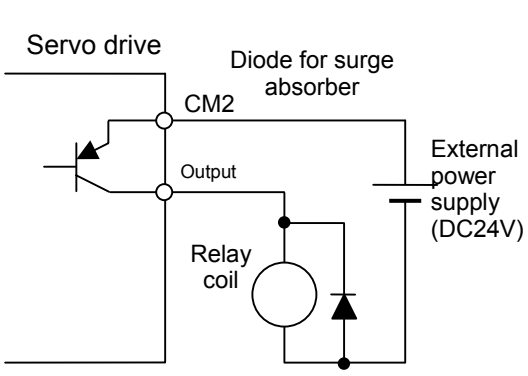
(e) Current when the external power supply is shut off

- When a switch contact or relay contact is used for a contact input signal, use a contact in which a contact defect may not be caused even by a very weak current or voltage , such as crossbar twin contacts, etc.
- Do not make a short circuit between the internal interface power P24 and CM1. The servo drive may fail.
- Electrical specifications of the input signal are shown in the following table.

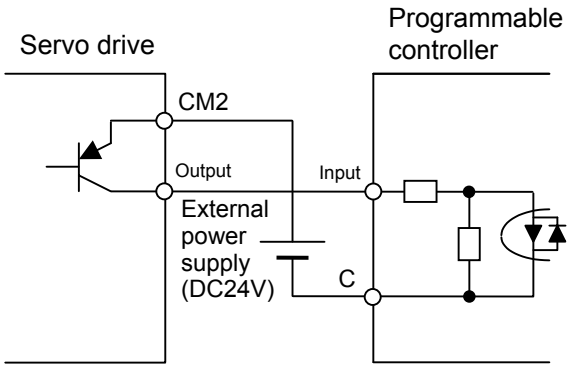
Item	Unit	Minimum	Maximum	Condition
Input impedance	kΩ	4.5	5.7	
Input current at OFF	mA	0	0.3	
Input current at ON	mA	3.0	5.2	Power supply voltage 24 V DC

(4-2) Open collector output signal

- The relay coil and the input module of the programmable controller is connected as shown in the figures (a) and (b). When using a relay, connect a diode for surge absorber in parallel with the coil. At this time, connect the diode as shown in the following figure (a) so that it may be in the opposite direction of the voltage applied to the coil.



(a) Connection of relay coil



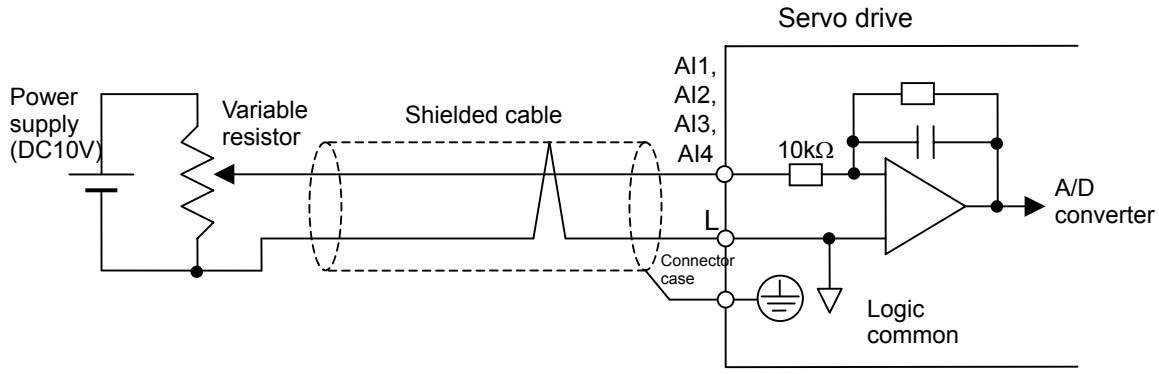
(b) Connection of programmable controller

- For the power supply for output signals, be sure to prepare an external power supply. Do not use the internal interface power (P24-CM1) of the servo drive. The servo drive may fail.
- The electrical specifications of the contact output signal are shown in the following table.

Item	Unit	Minimum	Maximum	Condition
Output power supply voltage	V	–	30	
Output current at ON	mA	–	50	
Leakage current at output OFF	mA	–	0.1	
Output saturation voltage at ON	V	0.5	1.5	Output current 50 mA

(4-3) Analog input signal

- The variable resistor and the analog output module of the programmable controller are connected as shown in the following figure (a). Prepare an external power supply for analog input. Each analog input signal cable should be a twisted pair cable with the analog common (L), being a shielded cable.
  Connect the cable shield to the ground (⏚) on the servo drive side. (The I/O connector case of the servo drive is internally connected to the ground.)



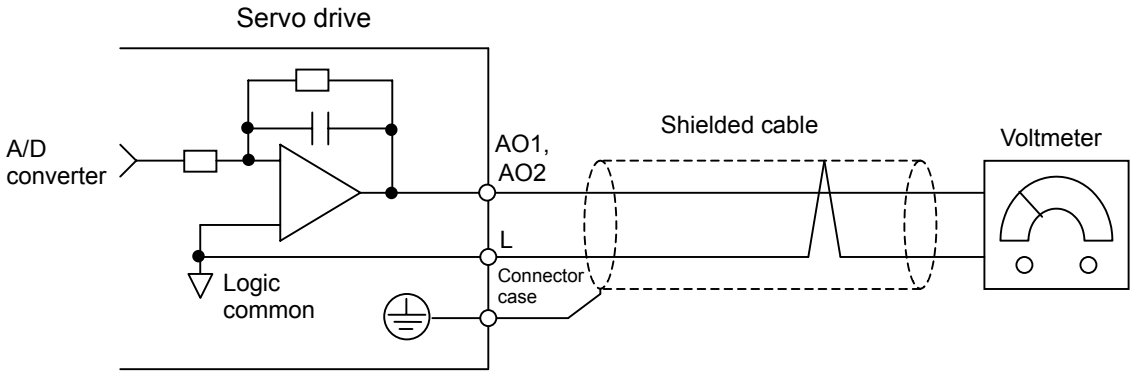
(a) Connection of analog input signal

- The cable length for analog signal should be 3 m or less. Perform wiring as apart as possible from the main circuit cable and relay control cable.
- Electrical specifications of the analog input signal are shown in the following table.

Item	Unit	Specification
Input voltage	V	0 to ±10
Allowable maximum input voltage	V	±16
Input impedance	kΩ	Approx. 10

(4-4) Monitor output signal

- The meter (voltmeter) or the recorder for monitoring speed detection values and torque command values is connected as shown in the following figure (a). Use this signal for only monitoring but not for commands of other control devices. (The output signal accuracy is about ±10%.) Each monitor output signal cable should be a twisted pair cable with the analog common (L--- connector pin No.17, 20, 45, 49), being a shielded cable.
  Connect the cable shield to the ground (⏚) on the servo drive side. (The I/O connector case of the servo drive is internally connected to the ground.)



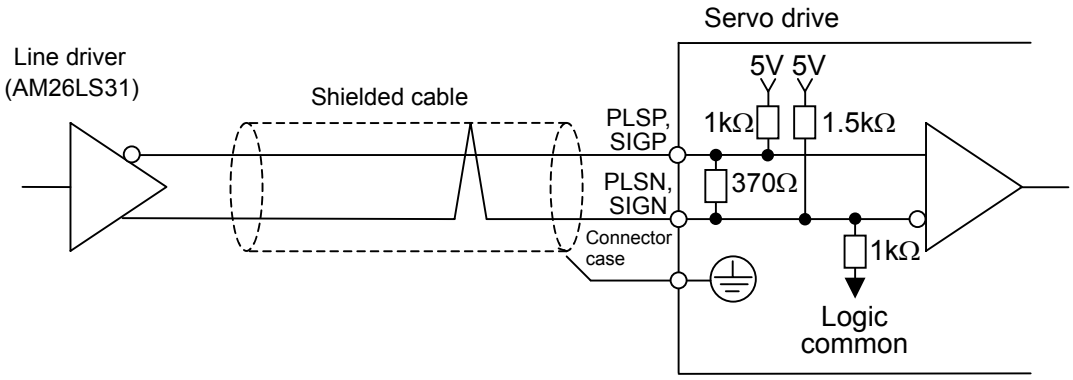
(a) Connection of monitor output signal

- The impedance of the load to be connected to this monitor signal should be 3 kΩ or more. Do not connect the monitor output signal (AO1, AO2) to the common (L) or another power supply. The servo drive may fail.
- The electrical specifications of the monitor output signal are shown in the following table.

Item	Unit	Specification
Output voltage	V	0 to ±3.0
Load impedance	kΩ	3.0 or more
Output voltage accuracy	%	±10 or more
Output signal delay time	ms	1.0 or less

(4-5) Position command signal

- The pulse train signal of a position command is connected as shown in the following figure for a line driver (AM26LS31 or equivalent). Position command signal cable should be a twisted pair cable, being a shielded cable. Connect the cable shield to the ground (⏚) on the servo drive side. (The I/O connector case of the servo drive is internally connected to the ground.)



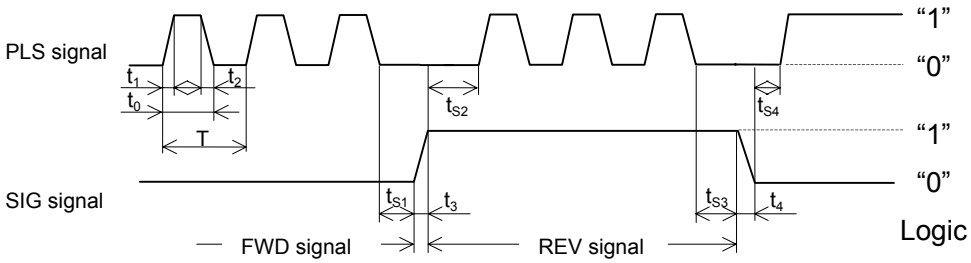
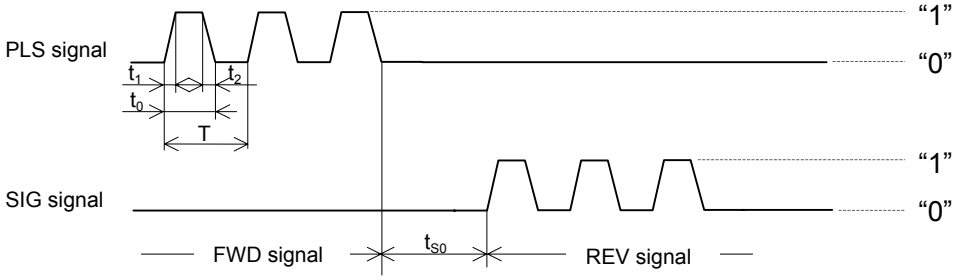
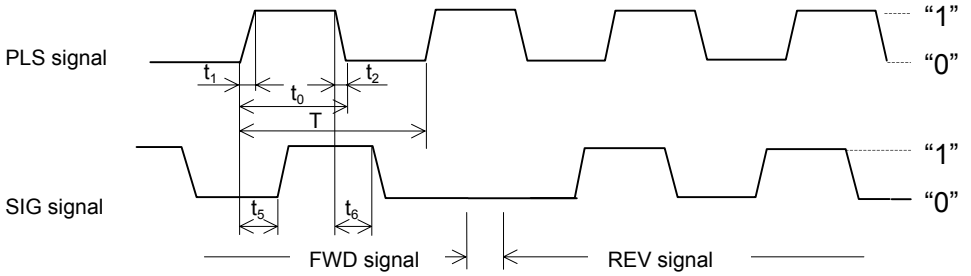
Connection of line driver signal

- The electrical specifications and timing chart of the position pulse signal are shown in the following table.

Electrical specifications

Item		Unit	Specification	Condition
Input current of logic 1		mA	8 to 15	
Maximum input pulse rate	FWD/REV pulse Pulse/ Direction signal	Pulses/s	2M	Line driver
	Phase difference 90° pulse	Pulses/s	500k	Open collector

Timing chart

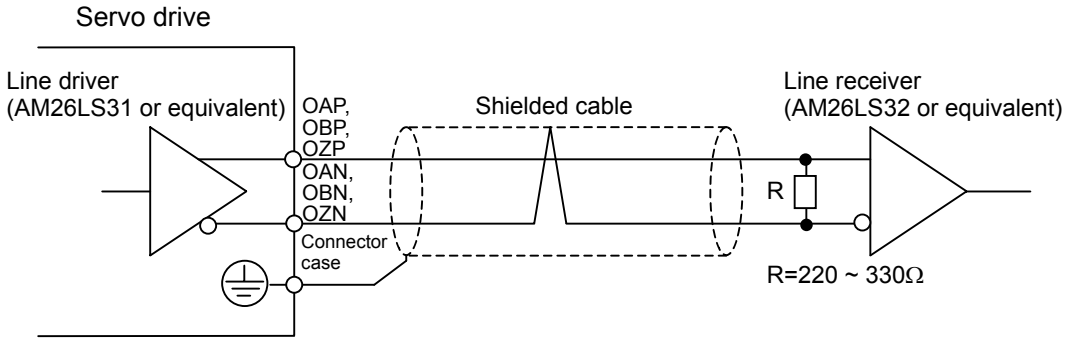
Signal form	Pulse train input timing chart
Pulse/Direction signal (Fig.1)	In case of FA-11=P-S(If FA-11=-P-S, SIG signal logic becomes in reverse.) 
FWD/REV pulse (Fig.2)	In case of FA-11=F-r(If FA-11=r-F, revolution signal becomes in reverse.) 
Phase difference signal (Fig.3)	In case of FA-11=A-b(If FA-11=b-A, revolution signal becomes in reverse.) 

Time of timing chart

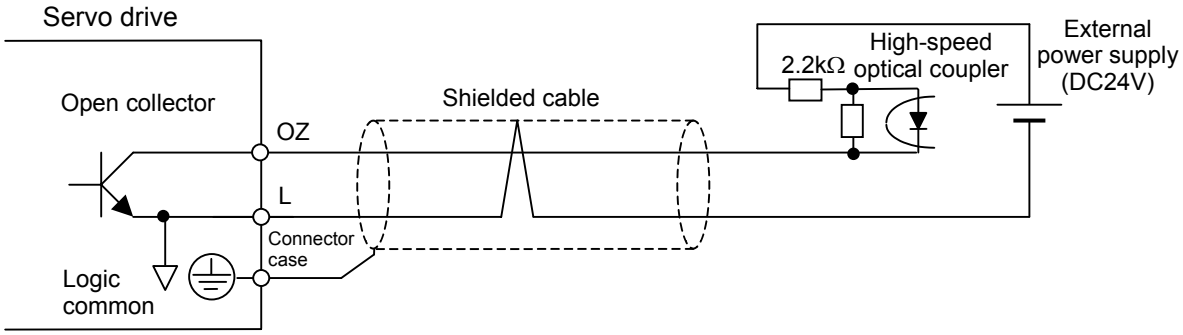
Signal form	Line driver signal	
	Fig.1,Fig2	Fig.3
Rise time :t_1,t_3	≤ 0.1 us	≤ 0.1 us
Fall time :t_2,t_4	≤ 0.1 us	≤ 0.1 us
Switching time:t_{S0},t_{S1},t_{S2},t_{S3},t_{S4}	3us or more	-
Phase difference:t_5,t_6	-	T/4 ± T/8
Pulse width :(t_0/T) x 100	50 ± 10%	50 ± 10%
Maximum pulse rate(pulses/s)	2M	500k

(4-6) Encoder monitor signal

- The encoder position signal is output as phase A, B, and Z signals. Regarding the line driver output signals (OAP-OAN, OBP-OBN, OZP-OZN), connect the line receiver (input impedance: 220 to 230 Ω) as shown in the following figure (a). For the open collector output signal (OZ-L), connect the input device as shown in the following figure (b). Each encoder monitor signal cable should be a twisted pair cable in each pair, being a shielded cable. Connect the cable shield to the ground ( ) on t servo drive side. (The I/O connector case of the servo drive is internally connected to the ground.)



(a) Connection of line driver output signal



(b) Connection of open collector output signal

- This signal becomes a high-speed signal (1 MHz or more max. for phase A or B signal) depending on the set value of resolution of the encoder monitor signal. Accordingly, the cable or the receiving circuit should be considered for the high-speed signal. In particular, when the open collector output of phase Z signal is received by optical coupler, use a high-speed optical coupler (1 MHz or more).
- The cable length for this signal should be 3 m or less. Perform this wiring as apart as possible from the main circuit cable and the relay control cable.
- Do not short between line driver output signals each other or connect them to another power supply. The servo drive may fail.

- When the absolute encoder is used, absolute position data can be output from the phase Z line driver output signal (OZP-OZN) as a serial signal. However, this data cannot be output from the phase Z detection signal of the open collector.
- The electrical specifications of the line driver signal output conform to those of line driver (AM26LS31 or equivalent). The electrical specifications of the Phase Z detection signal of the open collector are shown in the following table.

Item	Unit	Minimum	Maximum	Condition
Output power supply voltage	V	4	30	
Output current at ON	mA	0	50	
Leakage current at output OFF	mA	0	0.1	
Output saturation voltage at ON	V	0	0.4	Output current 50 mA

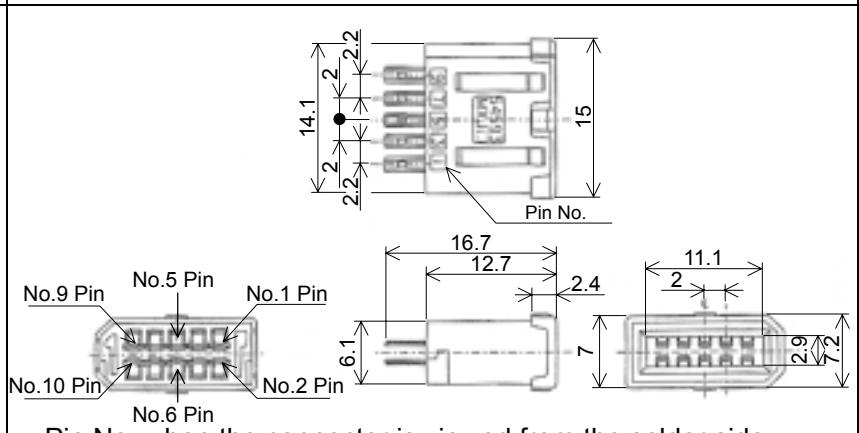
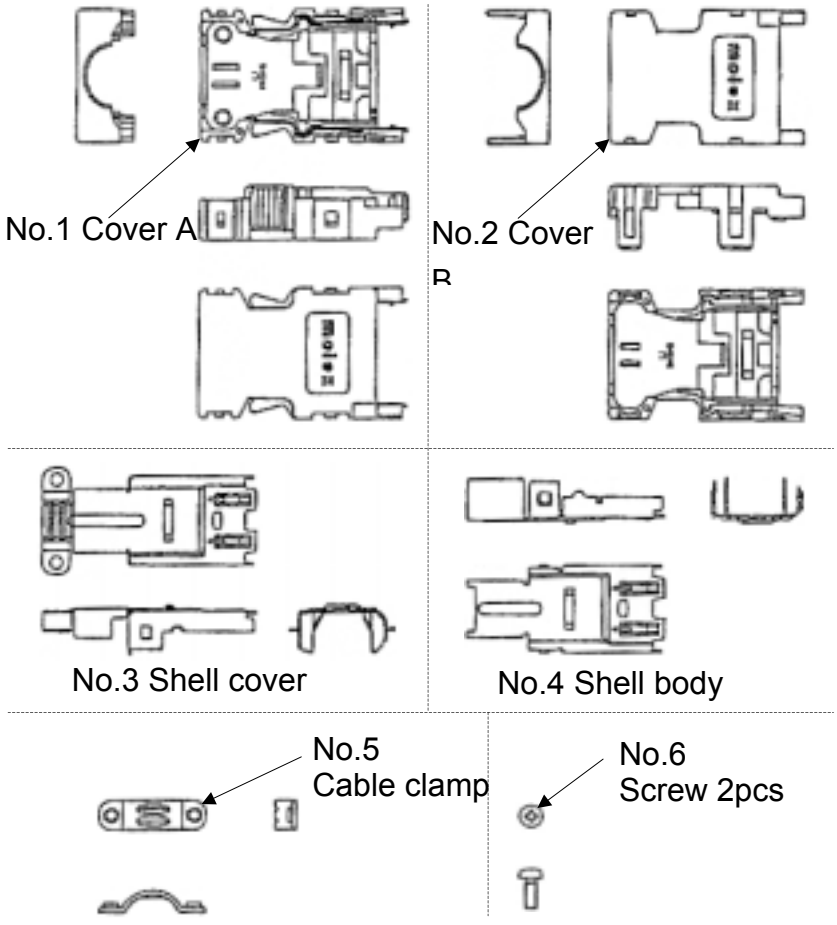
3.2.6 Wiring for encoder signals

(1) Encoder signal connector

The AD series servo drive is exclusively for a 17 bits/rev serial output encoder or incremental encoder mounted on the AD series servo motor. Connect this encoder signal to the connector ENC of the servo drive.

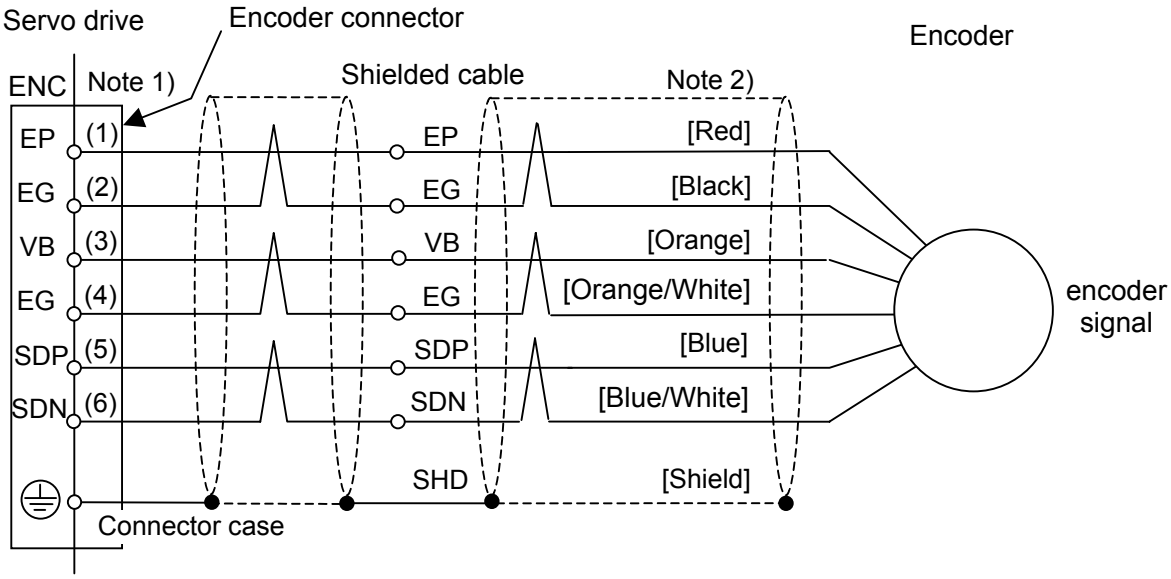
Use the following connector as this connector ENC in the following figure.

Encoder connector plug and cover

No.	Name/Model	Picture	Manufacture
1	Connector plug/ 54593-1011	 Pin No. when the connector is viewed from the solder side.	Molex-Japan Co., Ltd.
2	Cover/ 54599-1005 (Form No.1 to No.6 is necessary.)		

(2) Connection of encoder signal

1- The following figure shows a connection diagram of 17 bits / rev serial encoder signal.



Note 1) Number means the Pin No. of encoder connector.

Note 2) Color means the color of encoder cable from the motor.

The signal assignment is shown in the following table.

Pin No.	Terminal code	Signal name	Pin No.	Terminal code	Signal name
1	EP	Encoder power supply +	2	EG	Encoder power supply –
3	VB	Battery power supply +	4	EG	Battery power supply –
5	SDP	Serial signal (P)	6	SDN	Serial signal (N)
7	-	-	8	-	-
9	-	-	10	-	-

The battery power supply (VB-EG) is required only to use the absolute encoder. For using the incremental encoder, it is not necessary to connect the battery power supply signal.

Caution

a) Pull out the encoder cable when the control power supply has been turned off. If the power supply is turned on in the non-connection status and the encoder cable is connected, Encoder Error E39 will occur. In this case, turn on the power supply once again. (Take care that the absolute encoder may lose the position data without the control power supply.)

b) High-speed serial communication is performed between the servo drive and the encoder. Therefore, each encoder signal cable and the power cable should be twisted pair cables in each pair, being shielded cables. Connect the cable shield to the ground (⏚) on the servo drive side. (The I/O connector case of the servo drive is internally connected to the ground.)

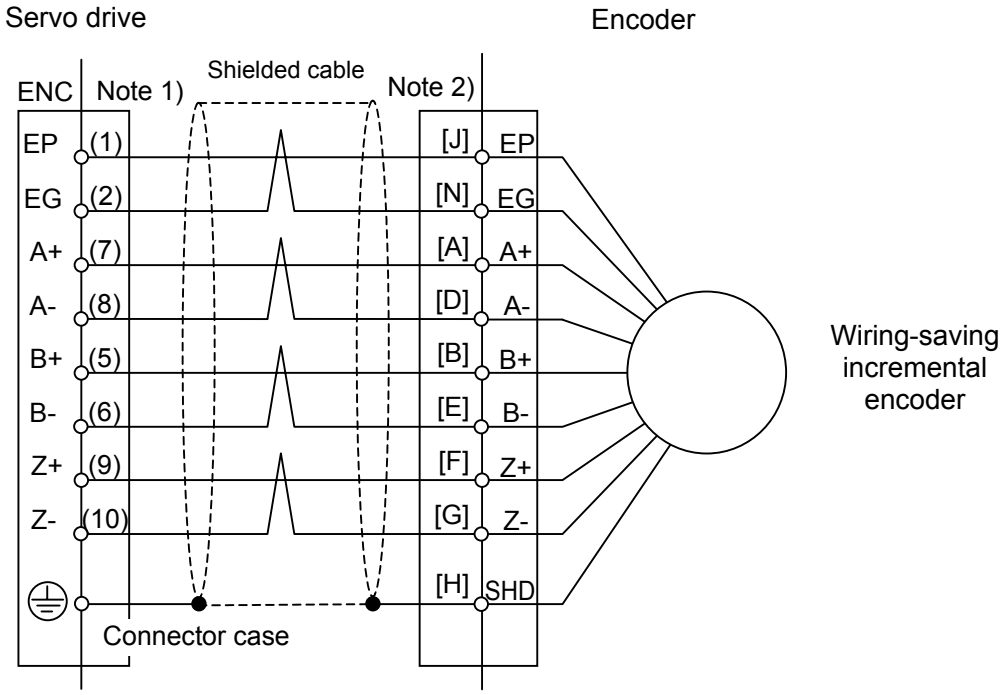
c) Do not short between serial signal cables or connect each serial signal cable to the power supply. The servo drive and the encoder may fail.

d) The following table shows the maximum value of current flowing on each power cable or signal cable, each allowable voltage drop (voltage drop at a forward/backward flow between the servo drive and the encoder), and allowable resistance value at a forward/backward flow. Select each cable length or wire size within these allowable values.

Power/signal name	Maximum current (mA)	Allowable voltage drop (V)	Allowable resistance value (Ω)
EP, EG	165	0.25	1.5
VB, EG	1	0.1	100
SDP, SDN	15	0.3	15

e) Separate the encoder cable from the main power cable and motor cable 30cm or more each other.

2- Connection of wiring-saving incremental encoder.



Note 1) The figure in parentheses indicates the pin No. of encoder connector to the servo drive.

Note 2) The character in parentheses indicates the pin code of encoder connector to the servo motor..

The signal assignment of ENC connector to the servo drive.

Pin No.	Terminal code	Signal name	Pin No.	Terminal code	Signal name
1	EP	Encoder power supply +	2	EG	Encoder power supply –
3	-	-	4	-	-
5	B+	Phase B (phase V) signal (P)	6	B-	Phase B (phase V) signal (N)
7	A+	Phase A (phase U) signal (P)	8	A-	Phase A (phase U) signal (N)
9	Z+	Phase Z (phase W) signal (P)	10	Z-	Phase Z (phase W) signal (N)

Caution

a) High-speed pulse signal is transmitted between the servo drive and the encoder. Therefore, each encoder signal cable and the power cable should be twisted pair cables in each pair, being shielded cables. Connect the cable shield to the ground (⏚) on the servo drive side. (The I/O connector case of the servo drive is internally connected to the ground.)

b) Do not short between serial signal cables or connect each serial signal cable to the power supply. The servo drive and the encoder may fail.

c) Pull out the encoder cable when the control power supply has been turned off. If the power supply is turned on in the non-connection status and the encoder cable is connected, Encoder Error E39 will occur. In this case, turn on the power supply once again.

d) Separate the encoder cable from the main power cable and motor cable 30cm or more each other.

MEMO

CHAPTER 4 OPERATION

This chapter explains typical examples of operation of this product and also a simple trial run method.

CHAPTER 4 OPERATION

4.1 Operating Method

⚠ WARNING

- While the servo drive is energized, be sure not to touch the main terminal or to check the signal or put on/off wire and/or connector.
  Otherwise, there is a danger of electric shock.

- Be sure to turn on the input power supply after closing the terminal cover.
  While being energized, be sure not to open the terminal cover.
  Otherwise, there is a danger of electric shock.

- Be sure not to operate the switches with wet hands.
  Otherwise, there is a danger of electric shock.

- While the servo drive is energized, be sure not to touch the servo drive terminals even during stoppage.
  Otherwise, there is a danger of electric shock.

- It may suddenly restart after the incoming power failure. Be sure not to approach the machine. (Be sure to design the machine so that personnel safety will be secured even if it restarts.)
  Otherwise, there is a danger of injury.

- Even if the power supply is cut for a short period of time, it may restart operation after the power supply is recovered if the operation command is given. If it may incur danger to personnel, be sure to make a circuit so that it will not restart after power recovery.
  Otherwise, there is a danger of injury.

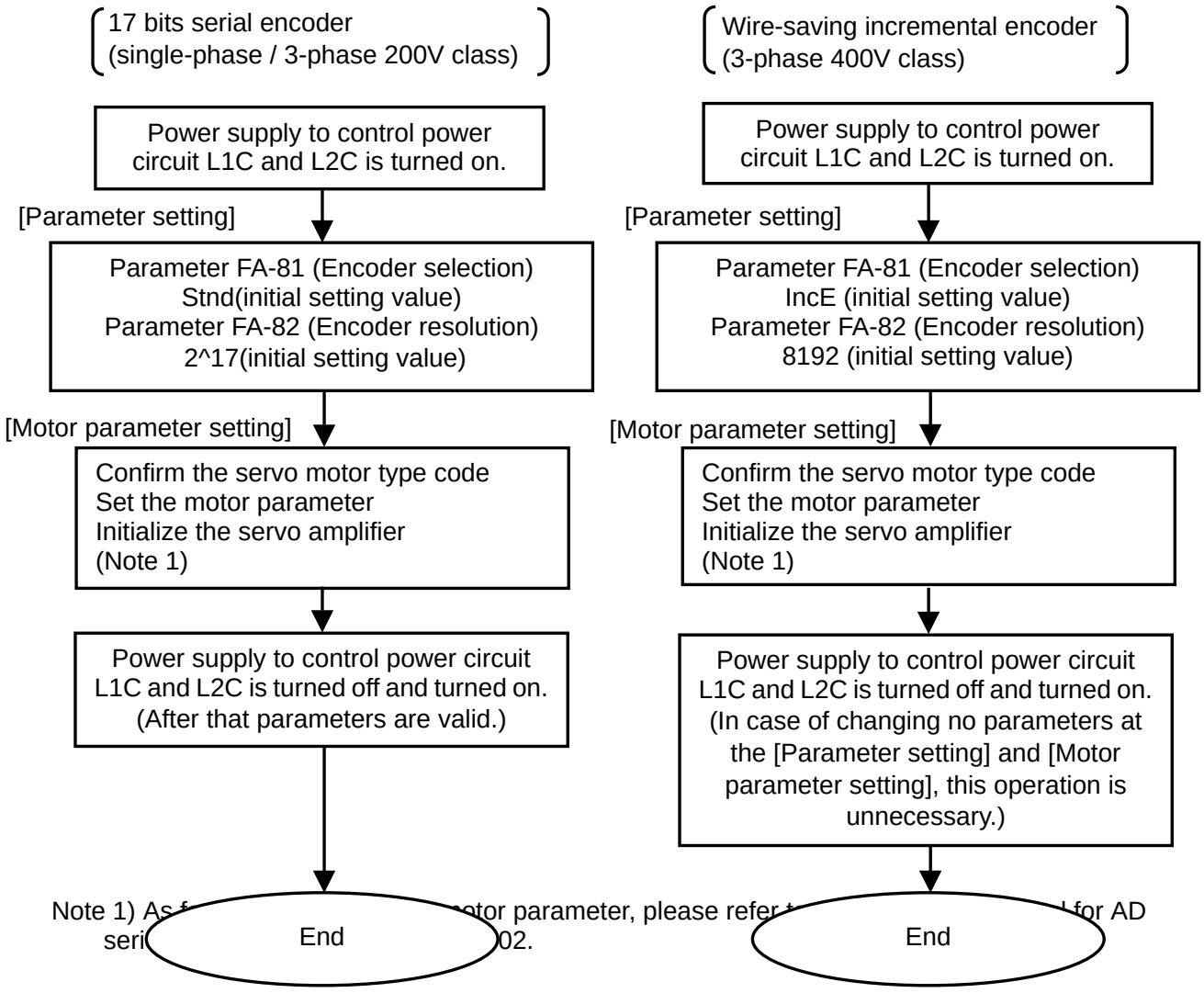
- After the operation command is given, if the alarm reset is conducted, it will restart suddenly. Be sure to set the alarm reset after checking the operation command is off.
  Otherwise, there is a danger of injury.

- Be sure not to touch the inside of the energized servo drive or to put a bar into it.
  Otherwise, there is a danger of electric shock and/or fire.

Before operating

Before operating AD series, be sure to choose a correct encoder type and parameter of AD3 servo motor by setup software “AHF” because there are two type encoders in AD3 according to voltage class (single-phase / 3-phase 200V class servo motor has 17 bits serial encoder and 3-phase 400V class servo motor has wire-saving incremental encoder.).

The flowchart of setting is shown as following.



Note 1) As f…otor parameter, please refer t… for AD seri… 02.

This servo drive has the control modes and operation patterns shown in the following figure.

Control mode	Operation pattern
Speed control	Analog input
	Multistage
Position control	Pulse train input
Torque control	Analog input

In the following, typical operation examples are shown.

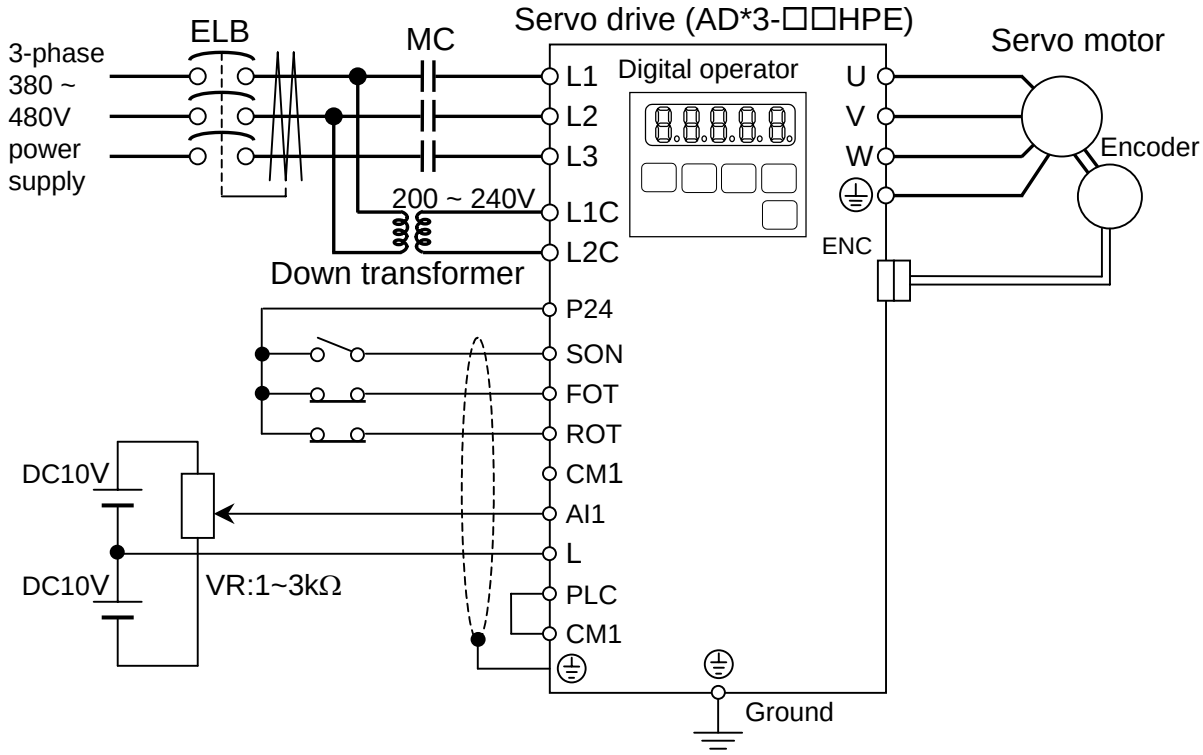
Refer to Chapter 6 (Details of Parameters) regarding the parameter setting.

4.1.1 Speed-control operation by analog input

In this method, the servo drive is operated by connecting an external signal (Speed command, Servo ON (SON)). The control mode (FA-00) is S-P initial setting.

1- Make connections as shown in the following figure and check if they are correct.
2- Turn on the ELB and then turn on the power supply to the servo drive.
The digital operator comes on and “d-00” is indicated. (This is a factory-set initial status.)
3- Set Analog input (A1) in the parameter Speed Command Selection (FA-21).
4- Set Speed Command (nrEF) in the parameter Analog input 1 Function Selection (FC-03) and adjust the AI1 input voltage to 0 [V].
5- Input the speed command. (You can make sure of the speed command by d-00.)
6- Turn on the FOT and ROT terminals.
7- Turn on MC for main power supply.
8- Turn on the SON terminal.
9- Input the AI1 speed reference voltage up to the desired speed.
10- At a stop, set speed reference voltage to 0 and check that the motor rotation has been stopped. After that, turn off the SON terminal.

<Items required for operation>
Servo ON (SON): Switch, relay, etc.
Speed Command (AI1): External signal (DC±10 V)



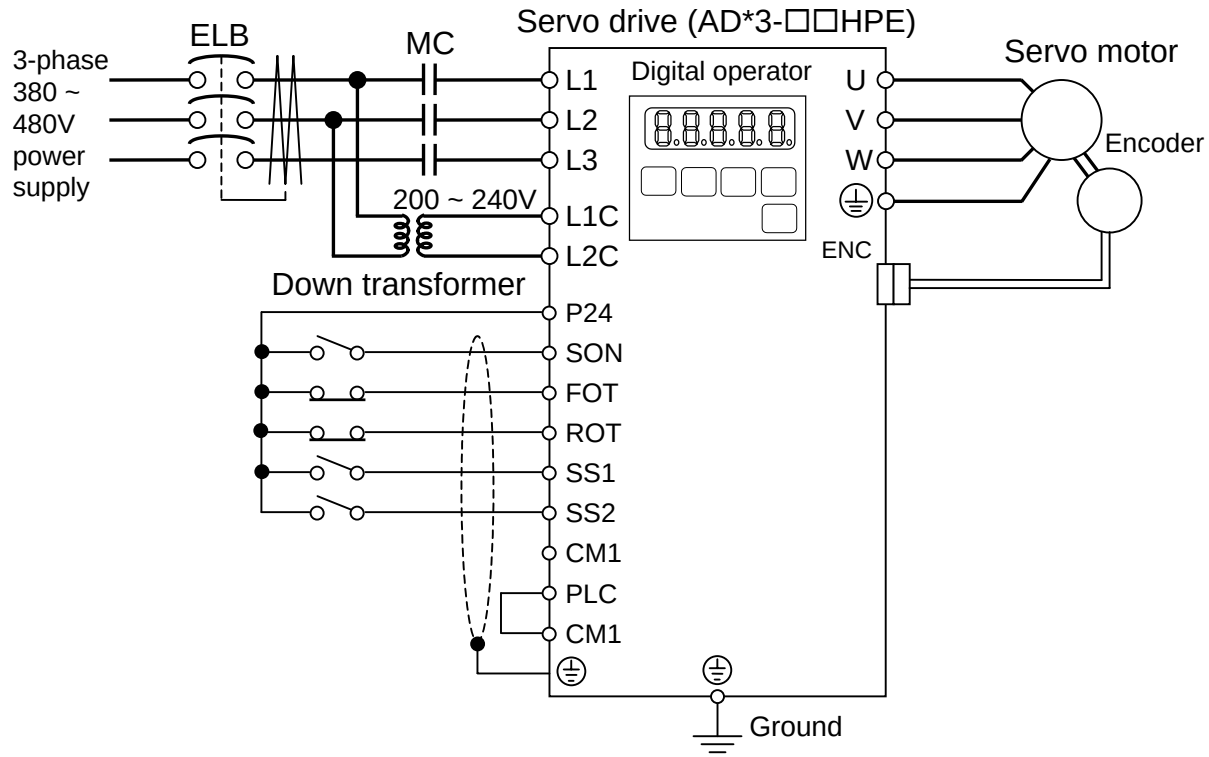
Note) The above picture is showing 3-phase 400V class servo drive.
Do not supply the control power circuit L1C and L2C with 400V power.
Be sure to supply the control power circuit L1C and L2C with 200 ~ 240V power.

4.1.2 Speed control operation by multistage speed

In this method, the servo drive is operated by contact input signal. The control mode (FA-00) is S-P initial setting.

1- Make connections as shown in the following figure and check if they are correct.
2- Turn on the ELB and then turn on the power supply to the servo drive.
The digital operator comes on and “d-00” is indicated. (This is a factory-set initial status.)
3- Set Multistage speed Input (CnS) in the parameter Speed Command Selection (FA-21).
4- Set multistage speed (Fb-00 to Fb-03).
5- Set the acceleration/deceleration time (Fb-04, Fb-05).(The initial value is 10s.)
6- Turn on the FOT and ROT terminals.
8- Check that the SS1 and SS2 terminals are OFF and turn on MC for main power supply.
7- Turn on the SON terminal.
9- Input the SS1 terminal and SS2 terminal to operate the servo motor. At SS1 = ON and SS2 = OFF, the Fb-00 setting is validated. Check the speed by d-01.)
10- To stop the motor, turn off the SS1 and SS2 terminals and check that the motor rotation has been stopped. After that, turn off the SON terminal.

<Items required for operation>
Servo ON (SON): Switch, relay, etc.
Multistage speed command (SS1, SS2): Switch, relay, etc.

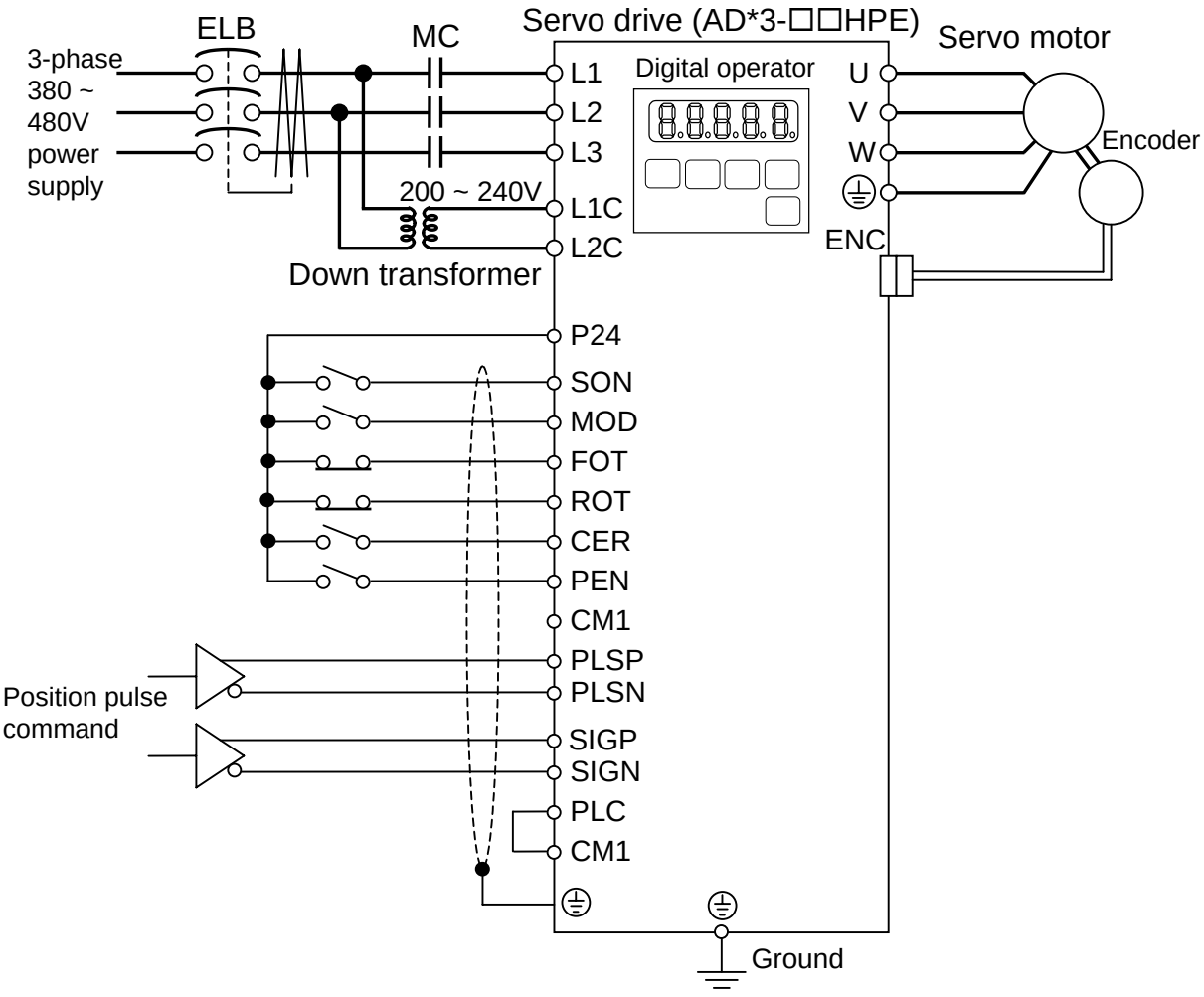


Note) The above picture is showing 3-phase 400V class servo drive.
Do not supply the control power circuit L1C and L2C with 400V power.
Be sure to supply the control power circuit L1C and L2C with 200 ~ 240V power.

4.1.3 Position control operation by pulse train input

In this method, the servo drive is operated by pulse train input signal.

1- Make connections as shown in the following figure and check if they are correct.
2- Turn on the ELB and then turn on the power supply to the servo drive.
The digital operator comes on and “d-00” is indicated. (This is a factory-set initial status.)
3- Set the parameter Pulse Train Input Mode (FA-11).
4- Set the parameter Electronic Gear (FA-12, FA-13).
5- Set “Speed control – Position control” (S-P) in the parameter Control Mode (FA-00).
6- Turn on the MOD terminal. (With this, the servo motor is put into position control operation.)
7- Turn on and off the CER terminal.
8- Turn on the FOT and ROT terminals.
9- Turn on MC for main power supply.
10- Turn on the SON terminal.
11- Turn on the PEN terminal and input the position pulse command. (With this, the motor is operated up to the commanded position.)
12- To stop the motor , turn off the PEN terminal after completing positioning. After checking that the motor rotation has been stopped, turn off the SON terminal.



Note) The above picture is showing 3-phase 400V class servo drive.
Do not supply the control power circuit L1C and L2C with 400V power.
Be sure to supply the control power circuit L1C and L2C with 200 ~ 240V power.

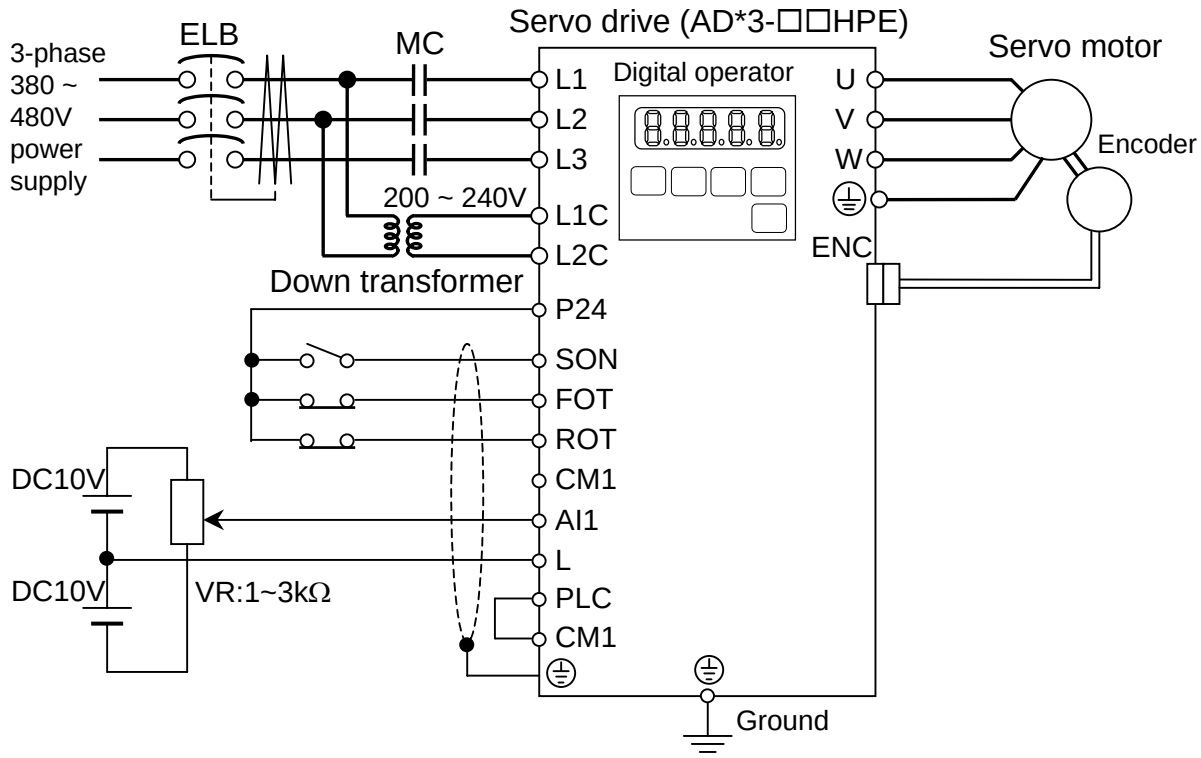
4.2 Test Run

The following is a comparatively simple test run method.

4.2.1 Test run by analog input

The control mode (FA-00) is S-P initial setting.

1- Make connections as shown in the following figure and check if they are correct.
2- Turn on the ELB and then turn on the power supply to the servo drive.
The digital operator comes on and “d-00” is indicated. (This is a factory-set initial status.)
3- Open d-00 and adjust (input 0 V) the speed command so that the speed command may be 0.
(When d-00 is indicated, press the FUNC key once. If any other value is indicated, press ▲ and ▼ several times.)
4- Turn on the FOT and ROT terminals.
5- Turn on MC for main power supply.
6- Turn on the SON terminal.
7- Input the speed command and check that the servo motor can be operated according to the speed command. (Check the speed by d-01.)
8- At a stop, set the speed command to 0 and check that the motor rotation has been stopped. After that, turn off the SON terminal.



Note) The above picture is showing 3-phase 400V class servo drive.
Do not supply the control power circuit L1C and L2C with 400V power.
Be sure to supply the control power circuit L1C and L2C with 200 ~ 240V power.

4.2.2 Test run by multistage speed

The control mode (FA-00) is S-P initial setting.

1- Make connections as shown in the following figure and check if they are correct.

2- Turn on the ELB and then turn on the power supply to the servo drive.
The digital operator comes on and “d-00” is indicated. (This is a factory-set initial status.)

3- Set Multi-speed Input (CnS) in the parameter Speed Command Selection (FA-21).
Press the ▲ and ▼ keys to change d-00 into FA---.
Press the FUNC key once to indicate FA-00.
Press the ▲ and ▼ keys to indicate FA-21.
Press the FUNC key once and then press the ▲ and ▼ keys to indicate CnS. Lastly, press SET to save the indication.

4 -Perform Multistage Speed Setting (Fb-00).
Press the FUNC key once to change FA-21into FA---.
Press the ▲ and ▼ keys to indicate Fb---.
Press the FUNC key once to indicate Fb-00.
Press the FUNC key to indicate the set data. Press the ◄ ▲, and ▼ keys and input the speed command value. Lastly, press SET to save the value.

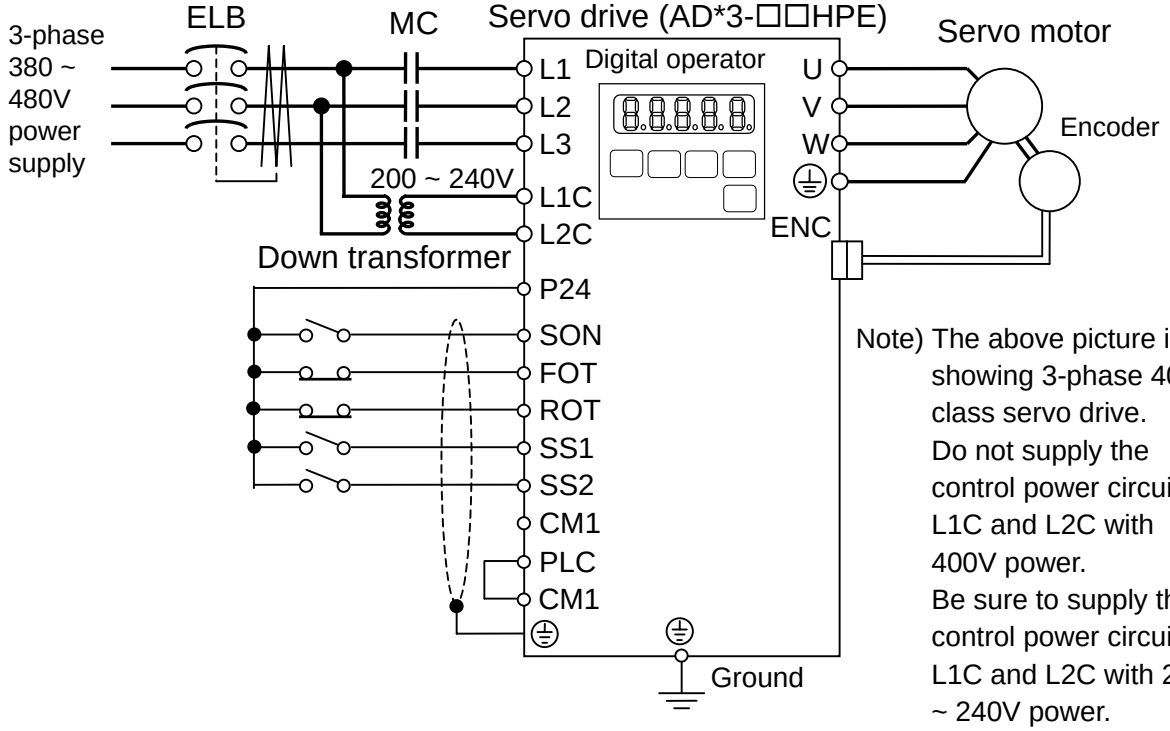
5- Input the acceleration/deceleration time (Fb-04, Fb-05).
(Since the initial value is 10.0 s, change this setting if you desire another value.

6- Turn on the FOT and ROT terminals.

7- Make sure that the SS1 and SS2 terminals are OFF and turn on MC, then turn on the SON terminal.

8- With the SS1 terminal ON and the SS2 terminal OFF, make sure that the motor can operate according to the speed command. (Check the speed by d-01.)

9- To stop the motor, turn off the SS1 and SS2 terminals and check that the motor rotation has been stopped. After that, turn off the SON terminal.

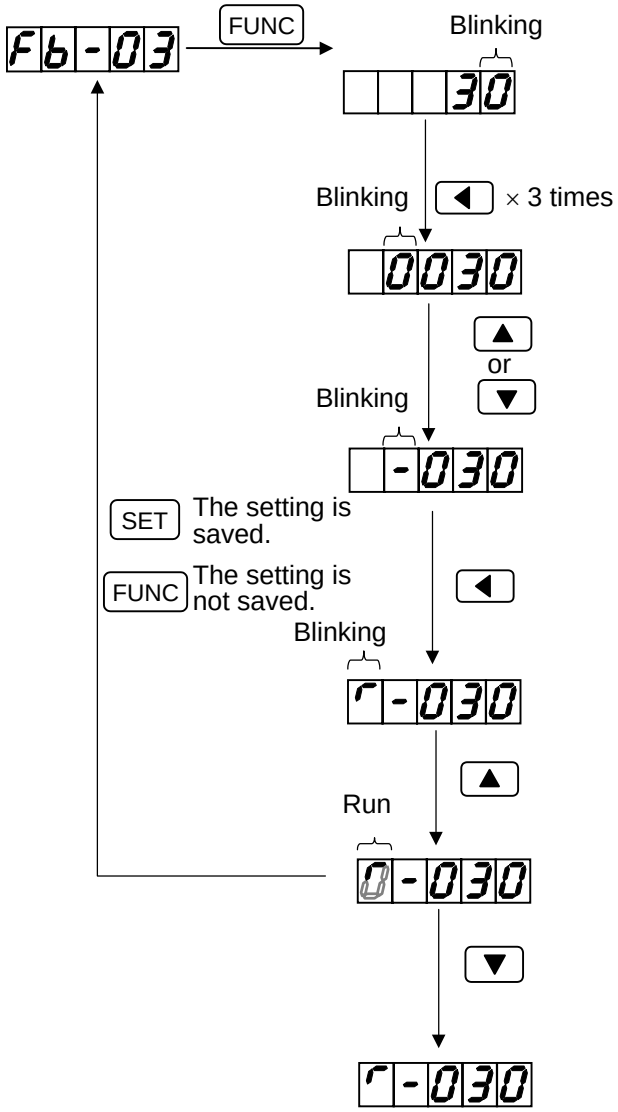


Note) The above picture is showing 3-phase 400V class servo drive.
Do not supply the control power circuit L1C and L2C with 400V power.
Be sure to supply the control power circuit L1C and L2C with 200 ~ 240V power.

4.2.3 Jogging operation and teaching operation from the digital operator

Jogging operation can be performed from the digital operator by using only the wiring of the servo motor, servo drive, and power supply. Also, operation by teaching function can be available in case program operation mode(FA-22 : set in Pro).
Using this test run method permits making wiring checks among the servo drive, servo motor, and power supply.

(1) Operations for jogging operation
When the SON terminal is OFF in the speed control mode, perform the following operations.



1- Operate the FUNC , ▲ and ▼ keys to indicate the set data of Jogging Speed Fb-03.

2- Set the operation speed by using the ◄ , ▲ and ▼ keys. (The example shown in the figure at left shows the operating procedure for changing only the direction of run.)
For the direction of reverse run, perform setting by negative speed. Input the code by the LED of the second digit from the left.

3- For jogging operation, adjust to the most significant digit by using the ◄ key.

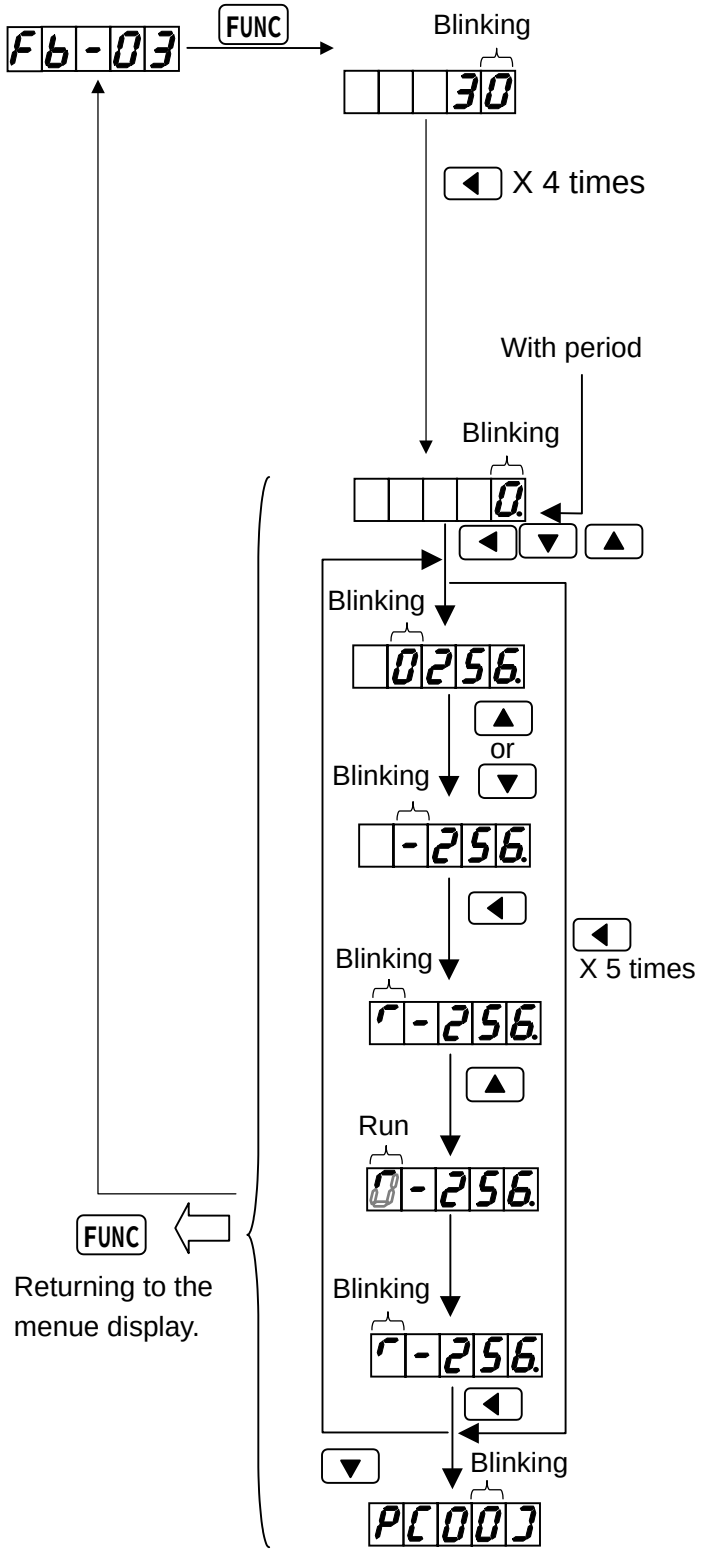
4- Press the ▲ key in the above status. With this operation, jogging operation is started and the servo motor starts to rotate.

5- Press the any of the following keys to stop the operation.

▼ key:	The contents of indication are continued.
SET key:	The set speed is saved.
FUNC key:	The set speed is not saved, returning to the menu display.

(2) Operations for teaching operation

When the SON terminal is OFF, perform the following operations.



1- Operate the FUNC , ▲ and ▼ keys to indicate the set date of jogging Speed Fb-03.

2- Set the operation speed by using ◄, ▼ and ▲ keys. In case the teaching operation, Set the absolute value as the run direction and movement are decided by the code and number of setting pulses (refer to 3-the following.). (The example shown in the figure at left shows the operating procedure not to change the speed.)

3- After confirming the period appearance, set the pulse numbers for movement by ◄, ▼ and ▲ keys. (1=1/32768 rotation)
(The example shown in the figure at left shows –256 pulses)
Only ◄ key press makes the transition to the setting of P() without movement value input.

4- Adjust to blink the LED of the most significant digit by using the ◄ key.

5- Press the ▲ key in the above status. Teaching operation is started, and the servo motor and LED circulation runs until movement pulses complete.

6- If the required movement is satisfied by teaching operation, For saving the movement value, adjust to the variable number P() of your choise by the ◄ key and save it by the SET key.

4.2.4 Test run by using the setup software AHF

Jogging operation can be started from a PC to perform a test run. At this jogging operation, wiring checks can be made for the servo drive, servo motor, and power supply because connections to I/O connectors from the outside are not required.

(1) Operations for jogging operation

Jogging is classified into two types: ordinary jogging in which operations are performed in the speed control mode and pulse train jogging in which a feed is made according to the number of pulses set in the position control mode.
Each of these types is explained below.

(a) Operations for jogging

In this jogging, the servo motor is operated at a constant speed by the given speed command until a stop command.

After the setup software AHF is started, jogging operation is performed by the following operations.
(For details, refer to the instruction manual for the setup software AHF.)

1- Click the Test Run and Adjustment buttons on the opening screen.
(Click the Jog & homing tags.)
2- Input the speed command for jogging operation.
3- After making a safety check, click the button of the direction in which operation is to be performed.
(With this, the motor will rotate in the desired direction.)
4- Click the Stop button to stop the operation.

Note 1: Do not input any signal from I/O connectors including the SON terminal during this operation. Otherwise, the operation is performed on the basis of the input terminal.
Note 2: In this jogging, the servo motor is operated when the acceleration/deceleration time is 0 s, and the current settings are used, for example, for control gain and speed limit.
Note 3: With this operation, the motor rotates. Perform operations making a safety check.

(b) Operations for pulse feed jogging

The servo motor is operated in the position control mode up to the commanded position by the given position command.

After the setup software AHF is started, jogging operation is performed by the following operations.
(For details, refer to the instruction manual for the setup software AHF.)

1- Click the Test Run and Adjustment buttons on the opening screen.
(Click the Jog & homing tags.)
2- Input the number of feed pulses. (The number of pulses should be regarded as 32768 per rotation.)
3- After making a safety check, click the forward feed or reverse feed button. (With this operation, the motor will rotate and positioning is performed at the command value.)
4- After positioning, the return to the initial screen.
In this status, the servo ON status is continued. So click the stop button.

Note 1: Do not input any signal from I/O connectors including the SON terminal during this operation. Otherwise, the operation is performed on the basis of the input terminal.
Note 2: In this jogging, the servo drive is operated when the acceleration/deceleration time is 0 s, and the current settings are used, for example, for control gain and speed limit.
Note 3: With this operation, the motor rotates. Perform operations making a safety check. To stop positioning, click the stop button.

CHAPTER 5 FUNCTIONS

This chapter explains the functions of the input/output signals of this product and its major control functions.

CHAPTER 5 FUNCTIONS

5.1 Terminal Functions List

In the following table, “Control mode” in the right column indicates control modes in which the servo drive is operated. The mark O denotes “operation”, the mark X denotes “non-operation” and the mark * denotes “Possible to assign”.

Type	Terminal symbol	Terminal name	Function	Control mode			
				Programmable	Position	Speed	Torque
Input signal	P24	Interface power	It is DC24V power for connection of input signal. When selecting source logic, it’s for connection with input common PLC terminal.	O	O	O	O
	CM1	Interface power common	Common of the P24 power supply.	O	O	O	O
	PLC	Intelligent input common	Select sink logic or source logic by connecting input common signal. It also connects the external power supply or the internal power supply (P24).	O	O	O	O
	SON	Servo ON	Puts the servo drive into a servo ON status (powers the servo motor to put it under control).	O	O	O	O
	RS	Alarm reset	In the trip status, the alarm status is cleared by inputting this signal. However, clear the cause of error before resetting, and turn off the SON terminal. This signal is used to terminate the auto tuning and exit from the mode.	O	O	O	O
	X(00) ~ X(11)	General input 0~11	Changes to general input terminal at programmed operation. “0” : open “ 1 “ : close	O	X	X	X
	MOD	Control mode switch	Switches the control mode depending on the status of this input. (Position/Speed, Speed/Torque, Torque/Position)	X	O	O	O
	TL	Torque limit	Enables the torque limit when this signal is input.	X	O	O	O
	FOT	Forward overtravel	When this signal is OFF, the servo drive does not operate in the forward direction. (Forward direction limit signal)	Selectable	O	O	O
	ROT	Reverse overtravel	When this signal is OFF, the servo drive does not operate in the reverse direction. (Reverse direction limit signal)		O	O	O
	SS1	Multistage speed 1	A multistage speed of 3 steps is selected by combining these signal states, and a speed control operation is performed. When all of these signals are OFF, the operation is stopped.	X	X	O	X
	SS2	Multistage speed 2					
	PPI	Proportional control	When this signal is ON, P (proportional) control is performed as speed control.	X	O	O	X
	SRZ	Zero speed clamp	Fixes the speed command value to zero.	X	X	O	X
	ORL	Home limit switch	Inputs the signal of the home limit switch to indicate the origin area. This signal is used for a homing in the position control mode.	Selectable	O	X	X
	ORG	Homing	When this signal is input, a homing operation is started. This signal is used for a homing in the position control mode.	Selectable	O	X	X
	PEN	Pulse train input enable	While this signal is ON, the pulse train position command input is enabled.	X	O	X	X
	CER	Position error clear	Clears the position error counter. (The position command value is regarded as the current position.)	X	O	X	X
	FWD	Forward command	Operates the motor in the forward direction at multistage speed operation. (The second function of the PEN signal)	X	X	O	X
	REV	Reverse command	Operates the motor in the reverse direction at multistage operation. (The second function of the CER signal)	X	X	O	X
	GCH	Gain change	Changes the gain of the control loop. (The second function of the PPI signal)	X	O	O	X
	EGR2	Electronic gear change	Changes to the second electronic gear when this signal is input. The surplus pulse is cleared. (The second function of the SS1 signal)	X	O	X	X
	ECLR	Absolute encoder clear	Clears multi-rotation data of absolute encoder when this signal is input during 4 s or more. (The second function of the SS2 signal)	X	O	O	O
	EOH	External error	When this signal is input, the error occurs. The alarm status is cleared by inputting RS signal. (The second function of the SRZ signal)	X	O	O	O

Note) For electrical specifications, refer to Chapter 3.

Type	Terminal symbol	Terminal name	Function	Control mode			
				Programmable	Position	Speed	Torque
Analog input	XA(0)/ AI1	General analog input 1/ Analog input 1	Changes to general analog input 1 at programmed operation. When the control mode and parameters are set, each function of speed command/speed bias/speed limit is available.	O	O	O	O
	XA(1)/ AI2	General analog input 2/ Analog input 2	Changes to general analog input 2 at programmed operation. When the control mode and parameters are set, each function of torque command/torque bias/torque limit is available.	O	O	O	O
	AI3	Analog input 3	The forward torque limit level depends on input voltage with TL signal ON.	X	O	O	O
	AI4	Analog input 4	The reverse torque limit level depends on input voltage with TL signal ON.	X	O	O	O
	L	Analog input/output common	Common of the analog input signal.	O	O	O	O
Output signal	Y(00) ~ Y(07)	General output 0~7	Changes to general output terminal at programmed operation. "0" : open " 1 " : close	O	X	X	X
	SRD	Servo ready	This signal is output when the servo drive can accept for the servo ON (when the main power supply is set up without any trip).	Selec table	O	O	O
	ALM	Alarm	The alarm signal is output in the trip status. (This signal is ON in the normal status and OFF in the trip status.)	Selec table	O	O	O
	INP	Positioning complete	This signal is output when the error between the command position and the current position is within the set positioning range.	Selec table	O	X	X
	SA	Up to speed	The signal is output when the speed detection value reaches the speed command value.	X	X	O	X
	SZD	Zero speed detection	The signal indicates that the speed detection value is below the set zero speed detection value.	X	O	O	O
	BRK (SOA)	Brake release	In the servo ON status, the brake release enable signal is output. When the brake waiting time is set to 0, the signal can be used as Servo ON Answer (SOA).	X	O	O	O
	TLM	Torque limiting	The signal is output in the torque limit status (where the torque command value is limited by the torque limit value).	X	O	O	X
	OL1	Overload notice	The signal is output when the overload detection amount reaches the set overload notice level.	X	O	O	O
	AL1~3	Alarm code	The three bits – binary alarm signal is output for each error code.	X	O	O	O
	CM2	Output common	Common terminal of the sink output signal.	O	O	O	O
Monitor output	AO1	Monitor output 1	0 to ± 3.0 V voltage output The speed detection value or torque command value monitors by analog voltage. The signal to be output can be set by parameter. Since these signals are for monitoring, do not use them for control.	O	O	O	O
	AO2	Monitor output 2					
	L	Analog output common	Common for the Monitor signal.	O	O	O	O
Position command	PLSP	Position command pulse (Pulse signal)	The position pulse train input function permits selecting (FA-11) among the following signal forms. 1- Pulse train/direction command 2- Forward/reverse pulse train 3- Phase difference two-phase pulse	O	O	X	X
	PLSN						
	SIGP	Position command pulse (Code signal)					
	SIGN						
Encoder monitor	OAP	Encoder Phase A	The monitor signal resulting from dividing (FC-09, FC-11) the Phase A signal of the encoder is output.	O	O	O	O
	OAN						
	OBP	Encoder Phase B	The monitor signal resulting from dividing (FC-09, FC-11) the Phase B signal of the encoder is output.	O	O	O	O
	OBN						
	OZP	Encoder Phase Z	The monitor signal of the Phase Z signal of the encoder is output. The current position data is output as a serial signal by setting (FC-12).	O	O	O	O
	OZN						
	OZ	Phase Z detection	The monitor signal of the phase Z signal of the encoder is output.	O	O	O	O
	L	Phase Z common					

* For electrical specifications, refer to Chapter 3.

5.2 Input Terminal Functions

Fourteen input signals are available as the following servo dedicated input signals.
Usually, when an input terminal is closed, the function is turned on. If Input Terminal Polarity Setting FC-01 is specified, the function is turned on when the input terminal is opened.

Servo ON (SON)

Related parameters
FA-16: DB operation selection
FC-01: Input terminal polarity setting

When this signal is turned on, the servo ON status (powered status) is provided.

- Only when the main circuit power supply is set up and the servo drive is not in the trip status (SRD ON), the Servo ON signal is accepted, providing a servo ON status. When the above condition is not satisfied, the servo drive remains in the non-powered status even if this signal is turned on.
- When the parameter DB Operation Selection (FA-16) is set to SoF (Servo OFF), the dynamic brake is actuated at Servo OFF, so that the motor is suddenly stopped.
- In the servo drive of 5 kW or more, the servo drive is not put into the servo ON status unless the motor speed is below 0.5% of the rated speed after the DB is started. To provide a servo ON status once again, turn on this signal after making sure that the motor rotation speed is below the above level.
- The time from inputting the Servo ON Signal till providing an operation enable status is about 20 ms.
- The servo ON status can also be provided when the input terminal is opened, by specifying the parameter Input Terminal Polarity Setting (FC-01).
- When the SON signal is turned off and on in the position control mode, the pulses accumulated at the OFF time are cleared.

Alarm Reset (RS)

Related parameters
FC-01: Input terminal polarity setting

This signal turns off the SON signal in the trip status. When this signal is turned on, the trip status is cleared and the servo drive is put into an operation enable status again.

- If this signal is turned on in a non-strip status, this is ignored.
- When the signal changes from OFF into ON in the trip status and the ON status is continued for 20 ms or more, the trip status is cleared.
- Even if the ON status of this signal is continued, a reset operation is performed only once.
- Alarm resetting can also be performed when the input terminal is opened, by specifying the parameter Input Terminal Polarity Setting (FC-01).
- For protection against E31, E39, E40, E90, E92 and E93, the trip status cannot be cleared by the RS terminal. (Regarding E31 for 200V class servo drive is possible to clear by the RS terminal. In case of clearing E90, E92 or E93, at first ECLR is input during 4 s or more. After that RS is input.) For the clearing method, refer to Chapter 9 Error Processing.

General input (X(00)~X(11))

Related parameters
FA-22 : Position command selection

When Pro in the position command selection (FA-22) is set, the input terminals except for SON, RS change to the general input. For the details, refer to the instruction manual pertaining to the programmable function.

Control Mode Switch (MOD)

A combination of available control modes is set by the parameter Control Mode (FA-00) and one of control modes is selected by this signal.

Related parameters
FA-00: Control mode
FC-01: Input terminal polarity setting

Control Mode (FA-00) and combinations of control mode switch are shown in the following table.

Parameter value of control mode setting	Control mode at MOD = OFF	Control mode at MOD = ON
S-P (initial setting)	Speed control	Position control
P-S	Position control	Speed control
S-t	Speed control	Torque control
t-S	Torque control	Speed control
t-P	Torque control	Position control
P-t	Position control	Torque control

- This signal can be switched even in the servo ON status.
- At mode switching, a slight switching shock may be caused. As a rule, perform switching when the motor stops.
- MOD can also be turned on when the input terminal is opened, by specifying the parameter Input Terminal Polarity Setting (FC-01).

Torque limit (TL)

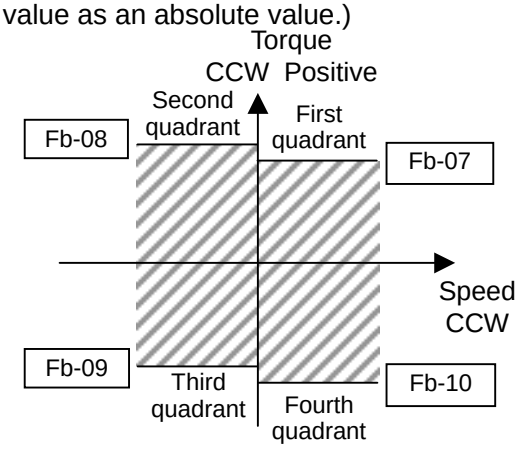
When this signal is turned on, torque limit becomes valid.
The torque limit value permits selecting a control mode by the parameter (FA-17) on the basis of the parameter (Fb-07 to Fb-10) or the torque limit input value (Al2, AI3 or AI4 input value).

Related parameters
FA-00: Control mode
FA-17: Torque limit mode
Fb-07 to 10: Torque limit value 1 to 4
FC-01: Input terminal polarity setting

- This signal is valid only in the speed control or position control mode.
- Torque limit can also be enabled when the input terminal is opened, by specifying the parameter Input Terminal Polarity Setting (FC-01).
- The parameters Fb-07 to Fb-10 perform torque limit for each quadrant as shown in the following figure.

(However, for parameter input, input the torque limit value as an absolute value.)

Note: The working direction of Fb-07 to Fb-10 is the same in spite of Motor Revolution Direction (FA-14) setting.



Forward/Reverse Overtravel (FOT, ROT)

The operating range limit switch is connected to this signal so that the servo drive may not deviate from the operating range.

Related parameters
FC-01: Input terminal polarity setting

- When this signal is turned on, drive is enabled.
- "Overtravel" means that the internal speed command limit value is 0 in the speed /position control mode, or that the internal torque command limit value is 0 in the torque control mode.
- Drive can also be enabled when the input terminal is opened, by specifying the parameter Input Terminal Polarity Setting (FA-01).
- When both FOT and ROT are activated (OFF) and the servo ON status is continued for 1 s or more, overtravel error (E25) occurs.

Multistage Speed 1, 2 (SS1, SS2)

One of the set 3 steps of multistage speed (Fb-00 to Fb-02) is selected by a combination of these signals and the servo drive is operated at this speed.
The relation between the status of this signal and multistage speeds is shown in the following table.

Related parameters
FA-21: Speed Command Selection
Fb-00 to Fb-02: Multistage speed 1 to 3
Fb-04: Speed Acceleration Time
Fb-05: Speed Deceleration Time
FC-01: Input terminal polarity setting

SS2	SS1	Selected speed
OFF	OFF	Zero Speed Command
OFF	ON	Multistage speed 1
ON	OFF	Multistage speed 2
ON	ON	Multistage speed 3

- This signal is valid only in the speed control mode but does not function in the other modes.
- When multi-speed is selected, the acceleration and deceleration time are the set value by Fb-04 and Fb-05.
- SS1 and SS2 can also be turned on when the input terminal is opened, by specifying the parameter Input Terminal Polarity Setting (FC-01).

Proportional Control (PPI)

While this signal is ON, the speed control system functions as P control (proportional control).

Related parameters
FC-01: Input terminal polarity setting
Fd-00: Moment of inertia
Fd-01: Speed control response frequency
Fd-02: Speed control proportional gain
Fd-03: Speed control integral gain
Fd-04: P control gain

- The parameters Proportional Gain (Fd-02) and Integral Gain (Fd-03) in PI control, and P control Gain (Fd-04) in P control can be set individually.
- This signal is valid in the position control mode and the speed control mode.
- P control can also be selected when the input terminal is opened, by specifying the parameter Input Terminal Polarity Setting (FC-01).

Zero Speed Clamp (SRZ)

While this signal is ON, the speed command value is fixed at 0.

- This signal functions only in the speed control mode but does not function in the other modes.
- Even when multistage speed is selected for operation, the speed command value becomes 0 if this signal is turned on. At this time, however, deceleration is performed according to the set parameter Speed Deceleration Time (Fb-05) and the command value becomes 0.
- The signal Zero speed clamp can also be validated when the input terminal is opened, by specifying the parameter Input Terminal Polarity Setting (FC-01).

Homing and Home Limit Switch (ORG, ORL)

This function makes the position return to the home position in case of the incremental encoder.
If the homing signal is turned on in the servo ON status in the position control mode, the servo drive is operated according to the set parameter Homing Mode (FA-23). Homing Mode includes the modes shown in the following table. Each of them will be explained in sequence.

Related parameters

FA-23: Homing mode
Fb-04: Speed acceleration time
Fb-05: Speed deceleration time
Fb-12: Homing speed 1
Fb-13: Homing speed 2
Fb-14: Homing position offset value (H)
Fb-15: Homing position offset value (L)
FC-01: Input terminal polarity setting

Set value	Homing mode
CP	Optional homing
L-F	Low-speed homing(forward run)
L-r	Low-speed homing (reverse run)
H1-F	High-speed homing 1 (forward run)
H1-r	High-speed homing 1 (reverse run)
H2-F	High-speed homing 2 (forward run)
H2-r	High-speed homing 2 (reverse run)

- The homing operation functions only in the position control mode. (The servo drive is operated in the position control mode.) It does not function in the other functions.
- The acceleration time and deceleration time of high-speed homing are the set parameters Speed Acceleration Time (Fb-04) and Speed Deceleration Time (Fb-05).
- The homing and home limit switch signals can also be validated when the input terminal is opened, by specifying the parameter Input Terminal Polarity Setting (FC-01).
- If the parameter Homing Speed 2 (Fb-13) at positioning is set a high value, the stop position may slightly deviate. In the range of 60 to 100 min^{-1}, the stop position becomes rather stable. Do not set the parameters Homing Speed (Fb-12 and Fb-13) to 0.

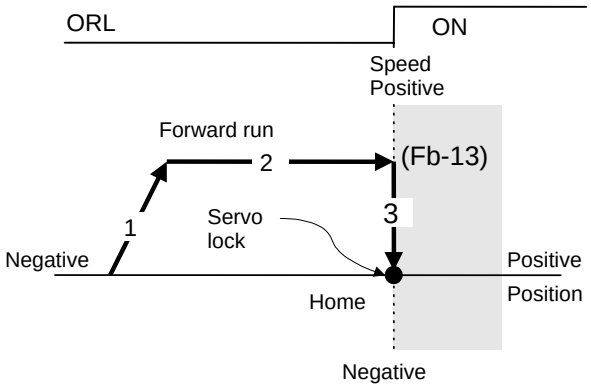
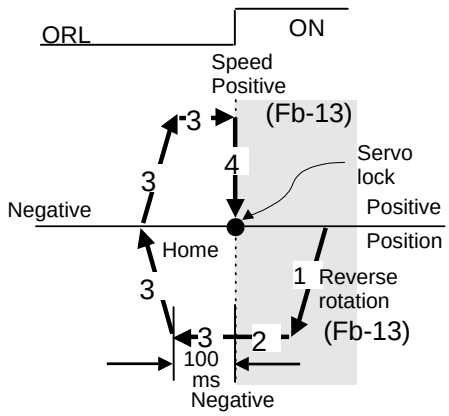
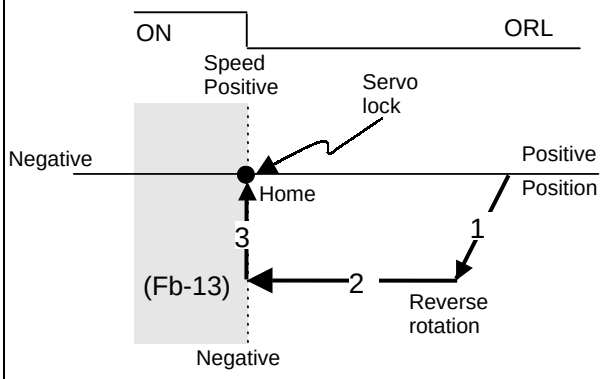
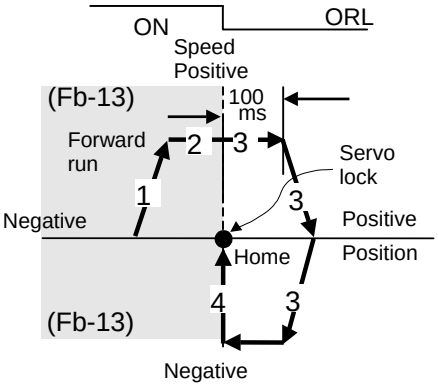
Note: The present position is set to the offset position of Fb-14 and Fb-15 by homing even if the encoder is the absolute type and Abs setting in FA-80.

(1) Optional Homing (CP)
The position where the ORL signal was turned on during homing in the servo ON status is regarded as the optional home position ,which is the offset position set in the parameters Fb-14 and Fb-15. However, this is valid only in the servo ON status.

(2) Low Speed Homing (L-F, L-r: ORL signal)
When the ORG signal is turned on, a homing is started and the servo motor is operated at a low speed. The operation is performed with the edge of OFF to ON of the ORL terminal as the home position.

- When no homing is performed, the position where power was supplied to the servo drive is regarded as the home position.
- When the ORG signal is turned off during the homing operation, this operation is immediately stopped. At this time, the homing remains incomplete.
- Upon completion of the homing, the positioning complete signal (INP) is output.
- The direction of homing operation is set to L-F: forward or L-r: reverse in the parameter Homing Mode (FA-23).

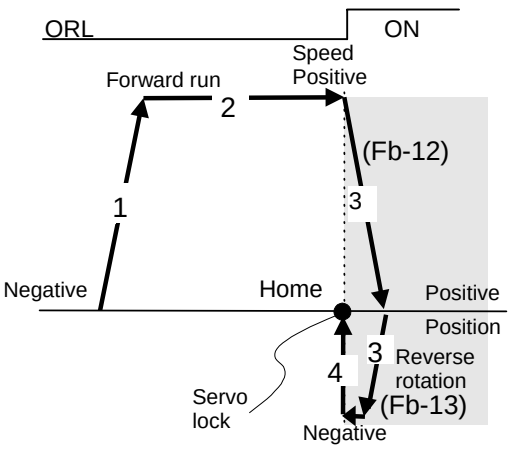
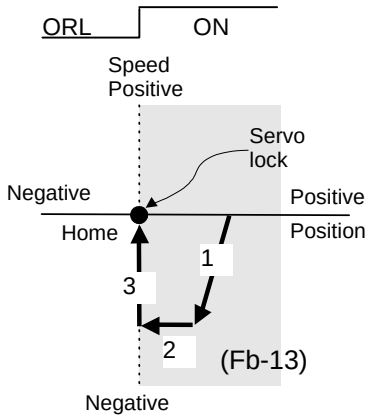
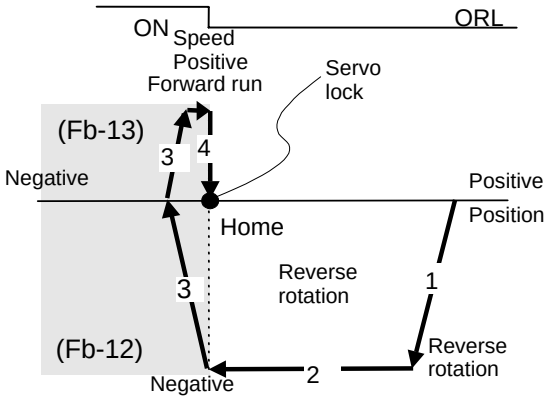
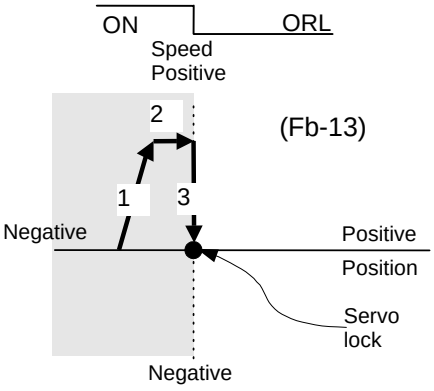
The following figure shows the operational procedure in each case.

<table>
<tr><td rowspan="2">FA-23</td><td colspan="2">ORL terminal at the start of low speed homing</td></tr>
<tr><td>OFF</td><td>ON</td></tr>
<tr><td>L-F</td><td> 
</td><td> 
</td></tr>
<tr><td>L-r</td><td> 
</td><td> 
</td></tr>
<tr><td>Operational procedure</td><td>1- When the ORG signal is turned on, a homing is started.
2- The operation is performed in the set direction of homing according to the parameter Homing Speed 2(Fb-13).
3- The operation is stopped at the position where the ORL signal was changed from OFF to ON. This position is regarded as the offset position (home) set in Fb-14 and Fb-15.</td><td>1- When the ORG signal is turned on, a homing is started.
2-The operation is performed in the opposite direction of the set home according to the parameter Homing Speed2(Fb-13).
3- The ORL signal is changed from ON to OFF. In about 100 ms, deceleration is performed and then reverse run is performed.
4- The operation is stopped at the position where the ORL signal was changed from OFF to ON. This position is regarded as the offset position (home) set in Fb-14 and Fb-15.</td></tr>
</table>

(3) High Speed Homing1 (H1-F, H1-r: ORL signal)
When the ORG signal is turned on, a homing is started and the servo motor is operated at a high speed. The operation is performed with the edge of OFF to ON of the ORL terminal as the home. When the direction of home is forward or reverse, set H1-F or H1-r. The following figure shows the operational procedure in each case.

- When no homing is performed, the position where power was supplied to the servo drive is regarded as the home.
- When the ORG signal is turned off during the homing operation, this operation is immediately stopped. At this time, the homing remains incomplete.
- Upon completion of the homing, the positioning complete signal (INP) is output.
- The direction of home for the homing operation is set to H1-F: forward or H1-r: reverse in the parameter Homing Mode (FA-23).

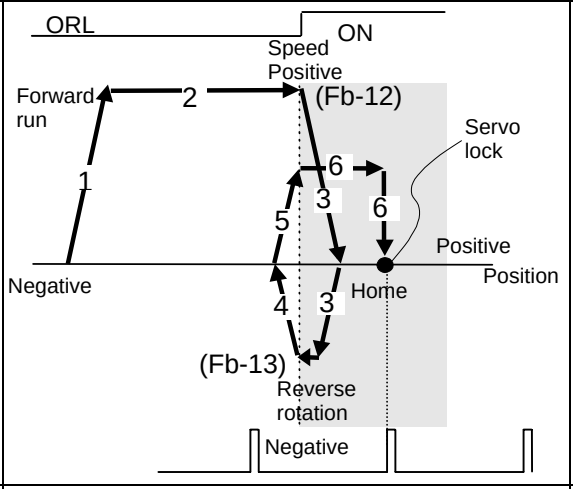
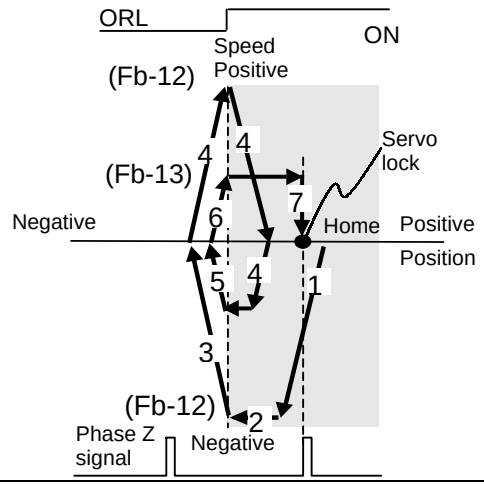
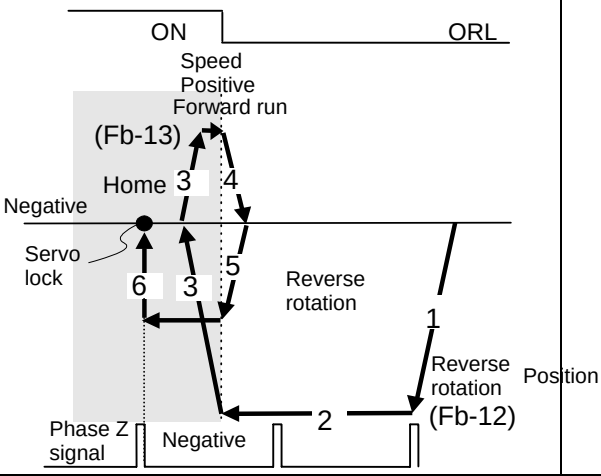
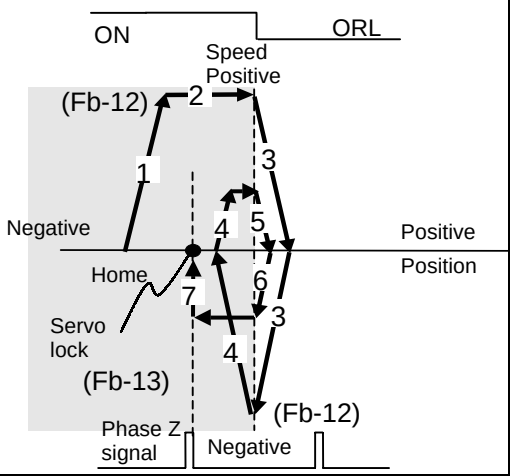
The following figure shows the operational procedure in each case.

<table>
<tr><td rowspan="2">FA-23</td><td colspan="2">ORL terminal at the start of high speed homing 1</td></tr>
<tr><td>OFF</td><td>ON</td></tr>
<tr><td>H1-F</td><td> 
</td><td> 
</td></tr>
<tr><td>H1-r</td><td> 
</td><td> 
</td></tr>
<tr><td>Opera-tional proce-dure</td><td>1- When the ORG signal is turned on, a homing is started.
2- The operation is performed in the set direction of home according to the parameter to Homing Speed 1(Fb-12).
3- Deceleration/stop is performed at the position where the ORL signal was changed from OFF to ON, and the operation is performed in the reverse direction.
4- The position where the ORL signal was changed from ON to OFF is regarded as the offset position (home) set in Fb-14 and Fb-15 and positioning is performed.</td><td>1- When the ORG signal is turned on, a homing is started.
2- The operation is performed in the opposite direction of the set home according to the parameter Homing Speed2 (Fb-13).
3- The position where the ORL signal was changed from ON to OFF is regarded as the offset position (home) set in Fb-14 and Fb-15 and positioning is performed.</td></tr>
</table>

Note: The travel time in the first direction of home for the homing start operation should be up to 30 minutes. If this value is exceeded, an incorrect operation or trip may be caused.

(4) High Speed Homing2 (H2-F, H2-r: Z signal input)

When the ORG signal is turned on, a homing is started and the servo motor is operated at a high speed. The first phase Z signal after the ORL terminal is turned on is taken as the home. When the direction of home is forward or reverse, set H2-F or H2-r. The following figure shows the operational procedure in each case.

<table>
<tr><td rowspan="2">FA-23</td><td colspan="2">ORL terminal at the start of high speed homing 2</td></tr>
<tr><td>OFF</td><td>ON</td></tr>
<tr><td>H2-F</td><td> 
</td><td> 
</td></tr>
<tr><td>H2-r</td><td> 
</td><td> 
</td></tr>
<tr><td>Operational procedure</td><td>1- When the ORG signal is turned on, a homing is started.
2- The operation is performed in the set direction of home according to the parameter Homing Speed1 (Fb-12).
3- Deceleration, stop, and reverse operation are started at the position where the ORL signal was changed from OFF to ON. The operation is performed according to the parameter Homing Speed 2(Fb-13).
4- Deceleration is started at the position where the ORL signal changed from ON to OFF.
5- The operation is performed according to the parameter Homing Speed2 (Fb-13) in the direction of origin.
6- The ORL signal changes from OFF to ON and the first Phase Z signal position is regarded as the offset position (home) set in Fb-14 and Fb-15. Then, positioning is performed.</td><td>1- When the ORG signal is turned on, a homing is started.
2- The operation is performed in the set direction of origin according to the parameter Homing Speed 1(Fb-12).
3- Deceleration, stop, and reverse operation are started at the position where the ORL signal changes from ON to OFF. The operation is performed according to the parameter Homing Speed 1 (Fb-12).
4- Deceleration, stop, and reverse operation are started at the position where the ORL signal was changed from OFF to ON. The operation is performed according to the parameter Homing Speed 2(Fb-13).
5- Deceleration is started at the position where the ORL signal changed from ON to OFF.
6- The operation is performed according to the parameter Homing Speed (Fb-13) in the direction of home.
7- The ORL signal changes from OFF to ON and the first phase Z signal position is regarded as the offset position (home) set in Fb-14 and Fb-15. Then, positioning is performed.</td></tr>
</table>

Note: The travel time in the first direction of home should be up to 30 minutes. If this value is exceeded, an incorrect operation or trip may be caused.

- If a homing is not performed, the position where the power supply to the servo drive is turned on is regarded as the home (0).
- If the ORG signal is turned off during a homing operation, this operation is immediately stopped. At this time, the homing remains incomplete.
- Upon completion of the homing, the positioning complete signal (INP) is output.
- The direction of home for the homing operation can be set in the parameter Homing Mode (FA-23).

The following figure (on the previous page) shows the operational procedure in each case.

Pulse Train Input Enable (PEN)

Only when this signal is ON, the position command pulse train input is valid.

Related parameters
FC-01: Input terminal polarity setting

- Only when the servo drive is in the position control mode and the position command is set to the parameter Pulse Train Input, this signal is valid.
- While this signal is turned on, the position command value can be updated according to pulse train input signal.
- The position pulse train input can also be validated when the input terminal is opened, by specifying the parameter Input Terminal Polarity Setting (FC-01).

Position Error Clear (CER)

The position error goes to 0 (for edge signal) by specifying the position command value as the current position in the position control mode.

Related parameters
FC-01: Input terminal polarity setting

- This signal is valid only in the position control mode. In the moment when this signal changes from OFF to ON, the position command value is made equal to the current position. This signal is of edge signal. Accordingly, even if the signal keeps ON, any counter clear operation is not performed. To clear the error counter again, turn off the signal once and then turn it on.
- The errror counter can also be validated when the input terminal is opened, by specifying the parameter Input Terminal Polarity Setting (FC-01).

Forward and Reverse Command (FWD, REV)

Usually, the multistage speed function using the SS1 and SS2 terminals does not permits specifying the direction of run. However, the direction of run can be specified by the second function terminal FWD/REV and the speed command value can be specified by the SS1 and SS2 terminals.

- The parameters Multistage Speed Setting (Fb-00 to Fb-02) are signed. Accordingly, if REV is specified, the reverse polarity of the set value is regarded as the speed command. The acceleration/deceleration time is based on the parameters Fb-04 and Fb-05 as ever. The following table shows the relation between each terminal and the speed command.

Related parameters

Fb-00 to Fb-02:	Multistage speed
Fb-04:	Acceleration time
Fb-05:	Deceleration time
Fb-01:	Input terminal polarity setting
Fb-40:	Input terminal function selection

SON	FWD	REV	SS1	SS2	Speed command	Remarks
OFF	*	*	*	*	No output power	
ON	OFF	OFF	*	*	0	Zero speed servo
	ON	ON	*	*		
	ON	OFF	OFF	OFF	0	Zero speed servo
			ON	OFF	(Fb-00)	1st speed
			OFF	ON	(Fb-01)	2nd speed
			ON	ON	(Fb-02)	3rd speed
	OFF	ON	OFF	OFF	0	Zero speed servo
			ON	OFF	–(Fb-00)	Reverse 1st speed
			OFF	ON	– (Fb-01)	Reverse 2nd steed
			ON	ON	– (Fb-02)	Reverse 3rd speed

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Gain Change (GCH)

When this signal is ON, the position/speed control gain is switched over to the second control gain.

- This signal is valid only in the position control mode.
- The gain switch function can also be validated when the input terminal is opened, by specifying the parameter Input Terminal Polarity Setting (FC-01). For the detail, refer to Chapter 5.13 ‘Gain Change Function’.

Related parameters

FC-01: Input terminal polarity setting
FC-40: Input terminal function selection
Fd-30: Gain change mode
Fd-31: Position error width for gain change
Fd-01: Speed control cut-off frequency
Fd-09: Position control cut-off frequency
Fd-32: 2nd position control cut-off frequency
Fd-34: 2nd speed control cut-off frequency
Fd-33: Gain change time constant
Fd-35: Speed control gain change time

Electronic gear change (EGR2)

When this signal is ON, the electronic gear is switched over to the second electronic gear.
For the detail, refer to (2) ‘Electronic Gear’ in Chapter 5.7 ‘Position Pulse Train Input Function’.

Related parameters

FA-12: Electronic gear numerator
FA-13: Electronic gear denominator
FA-32: Electronic gear 2 numerator
FA-33: Electronic gear 2 denominator
FC-01: Input terminal polarity setting
FC-40: Input terminal function selection

Absolute encoder clear (ECLR)

In case of using absolute encoder, when this signal is ON during 4s or more, the multi-rotation data of absolute encoder is cleared.
In case of clearing E90, E92 or E93, at first ECLR is input during 4s or more. After that RS is input.
For the detail, refer to (2) ‘Clear Encoder to Zero’ in Chapter 5.14 ‘Functions for Absolute Position Encoder’.

Related parameters

FC-01: Input terminal polarity setting
FC-40: Input terminal function selection

External error (EOH)

This signal is used with an external braking resistor or an external regenerative braking unit etc. which output alarm signal. When these units are overheated, the output signal from these units is input to EOH terminal in order to cause an error.

- When this signal is ON, E12 occurs and servo amplifier become 'error status'.
- The operation when error occurs is selectable (The dynamic brake is used or not used) in parameter FA-16.
- In case of clearing alarm, at first EOH is OFF. After that RS is input.
- If the electrical specification of output signal from external units is for high voltage circuit, be sure to change the signal to be for low voltage circuit by using relay at the high voltage circuit side, and input the signal to EOH terminal.

Related parameters

FC-01: Input terminal polarity setting
FC-40: Input terminal function selection
FA-16: DB operation selection

Second Terminal Function

There are 14 input terminals and one function is assigned to one terminal as a rule. However, the second function can be assigned to one terminal.
An assignment change can be set in the parameter Input Terminal Function Selection (FC-40).

Parameter	Function name	Contents of function and set point	Initial value
FC-40	Input terminal function selection	Select the first function side or the second function side of the input side to be validated. 0 = 1st function, 1 = 2nd function Setting range: 0 to 3FFF To validate FWD, REV, and GCH, set 3100 (hexadecimal) to turn on the bits corresponding to PEN, CER, and PPI.	0

5.3 Output Terminal Functions

8 output signals can be used as servo dedicated output signals that are shown below.
Usually, the output terminal is closed when the output function is ON. However, the output terminal can also be opened when the output function is ON, by specifying the parameter Output Terminal Polarity Setting (FC-02).

General output (Y(00)~Y(07))

When Pro in the position command selection (FA-22) is set, the output terminals change to the general output. For the details, refer to the instruction manual pertaining to the programmable function.

Related parameters
FA-22: Position command selection

Servo Ready (SRD)

When the main circuit power supply is set up and the servo drive is not in the trip status, this signal is output. While this signal is ON, the Servo ON signal is accepted. Otherwise, the Servo ON signal cannot be accepted.

Related parameters
FC-02: Output terminal polarity setting

- The output terminal can also be opened in the servo ready status by specifying the parameter Output Terminal Polarity Setting (FC-02).

Related parameters
FC-02: Output terminal polarity setting

Alarm (ALM)

This signal indicates an trip status and can be set to the a-contact (Normally Open) or b-contact (Normally Close) (initial setting: b-contact) by the parameter Setting (FC-02). The following table shows the relation between each contact specification and alarm output signal. When a trip status is indicated by this signal, clear the trip status by the Alarm Reset signal to return the signal to the normal status.

Contact specification	Power OFF	Normal status	Trip status
b-contact	OFF	ON	OFF
a-contact	OFF	OFF	ON

Positioning Complete (INP)

This signal indicates the positioning complete or the completion of a homing.

Related parameters
Fb-23: Positioning detection range
FC-02: Output terminal polarity setting

- This signal functions only in the position control mode, and turned off in the other control modes.
- When the homing signal is input, this signal is turned off to start a homing. Upon completion of the homing, this signal is turned on. While the homing signal is input, this signal is continuously output.
- When the position deviation is within the set parameter Positioning Detection Range (Fb-23), this signal is turned on.
- In the servo OFF status, this signal is turned off.
- The output terminal can also be opened when positioning is completed, by specifying the parameter Output Terminal Polarity Setting (FC-02).

Up to Speed (SA)

When the speed command value is constant and the speed detection value is within the range of (Speed command) ± (Up to speed detection range), this signal is turned on and output.

Related parameters
Fb-25: Up to speed detection range
FC-02: Output terminal polarity setting

- This signal functions only in the speed control mode and is turned off in the other control modes.
- When the speed command value is constant and the speed deviation between the speed command value and the speed detection value is within the width set in the parameter Up to speed Width (Fb-25), this signal is turned on.
- When the speed command value is analog and not constant because of noise, the signal may not be turned on and output.
- When hunting tends to be caused by reason of control gain or customer's load, this signal may cause chattering (repetition of ON and OFF). At this time, adjust the gain or increase the up to speed width (Fb-25).
- This signal is turned off in the servo OFF status.
- The output terminal can also be opened at the up to speed by specifying the parameter Output Terminal Polarity Setting (FC-02).

Zero Speed Detection (SZD)

When the speed detection value is within the zero speed detection value, this signal is output.

Related parameters
Fb-22: Zero speed detection value
FC-02: Output terminal polarity setting

- This signal functions regardless of any control mode, and is turned on when the speed detection value is within the Zero Speed Detection Value (Fb-22).
- The output terminal can also be opened at zero speed detection by the parameter Output Terminal Polarity Setting (FC-02).

Brake Release (BRK/SOA)

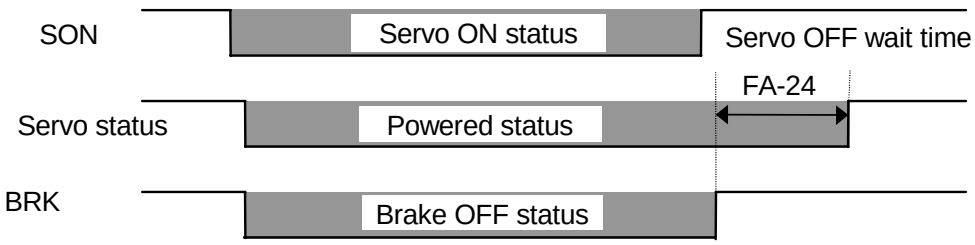
This signal is used to control the brake that is externally equipped. The signal functions regardless of any control mode. For the brake signal, the two output methods of motor stop and motor run can be selected by exclusive setting as shown in the following table. Each output method is explained below.

Related parameters
FA-24: Servo OFF wait time
FA-26: Brake operation start speed
FA-27: Brake operation start time
FC-02: Output terminal polarity setting

Setting parameter		(1) Brake signal during stop	(2) Brake signal during run
Servo OFF wait time	FA-24	Wait time setting	0
Brake operation start speed	FA-26	–	Start speed
Brake operation start time	FA-27	0	Start time

Unless the parameters are exclusively set as shown in the above table, the operation cannot be performed correctly.

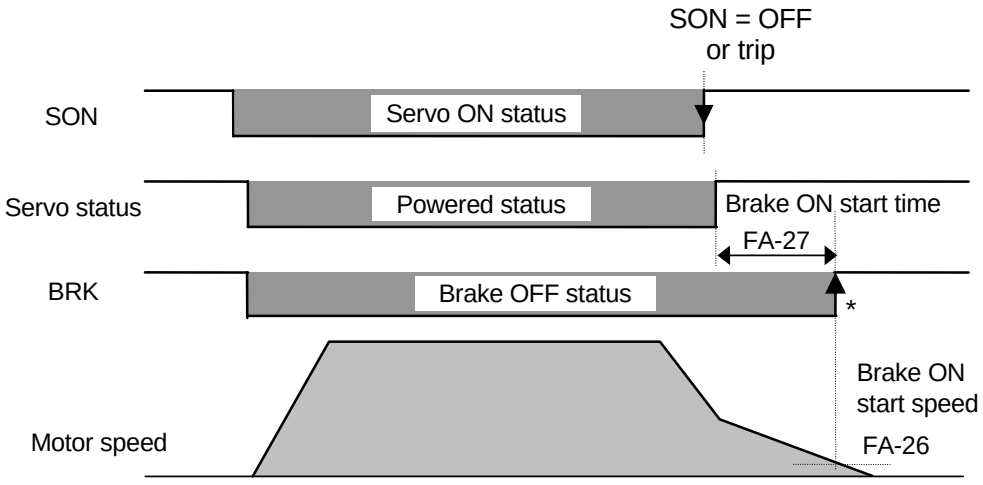
(1) Brake Signal during Motor Stop
This function can delay the servo OFF time by the delay time after the brake signal (BRK) is actuated, in consideration of a brake ON delay. Accordingly, use this signal when the motor stops, for example, after a positioning stop. If this signal is often used during motor run, the brake will be worn away abnormally.
- When the Servo ON signal is input, this signal is turned on simultaneously . As soon as the Servo OFF signal is input, this signal is turned off. After the lapse of the time set in the parameter Servo OFF Wait Time (FA-24), the servo drive is turned off. (Refer to the following figure.) Within this Servo OFF Wait Time, the speed command is forcibly caused to go 0.
- The Servo OFF Wait Time (FA-24) can be set in the range of 0 to 1.00 s by 10 ms steps. The operation may be delayed 1 ms max.
- When the Servo OFF Wait Time is set to 0, the SOA (Servo ON Answer) function is actuated.
- When a trip occurs, the servo drive is turned off simultaneously with this signal.
- This signal can also be turned off when the Servo ON signal is input , by specifying the parameter Output Terminal Polarity Setting (FC-02).
- For using this function, set the parameter Brake Operation Start Time (FA-27) to 0.



(2) Brake Signal during Motor Run

This function is used to apply the brake while the motor is rotating. Use the function for a use that permits obtaining sufficient deceleration, for example, for a case where the motor is put into a free run. If the function is used for a gravitational load, the brake operation may be relayed to invite a risk of falling.

- When the Servo ON signal is input, this signal is turned on simultaneously with a servo ON operation. With the Servo ON signal or in the trip status, the brake is actuated after the motor speed becomes below the Brake Operation Start Speed (FA-26) or after the Brake operation Start Time (FA-27) elapses after servo OFF. (Refer to the following figure.)
- The parameter Brake ON Start Time (FA-27) can be set in the range of 0 to 1.000 s by 4 ms steps and the operation may be delayed 4 ms max.
- This signal can also be turned off when the Servo ON signal is input, by specifying the parameter Output Terminal Polarity Setting (FC-02).
- For using this function, set the parameter Servo OFF Wait Time (FA-24) to 0.



* Operational conditions

FA-26 | Speed | or FA-27 Time elapsed

Torque Limit (TLM)

Related parameters

FC-02: Output terminal polarity setting

This signal is valid only in the position control mode or speed control mode and turned on when torque limit is in process.

- When the torque command value in the servo drive is limited to the momentary maximum torque limiter regardless of the TL terminal state, or the torque limit value by the torque limiting function, this signal is turned on.
- When hunting tends to be caused by reason of control gain or customer's load, this signal may provoke chattering (repetition of ON and OFF). In this case, adjust the control gain to prevent such hunting.
- This signal can also be turned off during torque limit by specifying the parameter Output Terminal Polarity Setting (FC-02).
- When the torque command value is higher than the limit level, this signal is turned on. Accordingly, the signal is also turned on even if no current flows and no torque is output with the motor cable open.

Overload Notice (OL1)

Related parameters
FA-09: Overload notice level
FC-02: Output terminal polarity setting

This signal is turned on when the integrated value of electronic thermal exceeds the overload notice level (FA-09).

- When hunting tends to be caused by reason of control gain or customer's load, this signal may provoke chattering (repetition of ON and OFF). In this case, adjust the notice level and the control gain.
- Once the signal is turned on, the ON output continues at least for 1 s.
- This can also be turned off at overload notice by specifying the parameter Output Terminal Polarity Setting (FC-02).

Alarm code (AL1~3)

Related parameters
FC-45: Alarm code output enable

This signal is available for all control mode (but not available when position command selection (FA-22) is set to "Pro").
The three bits – binary signal is output for each error code.

- The alarm signal is output to the general output terminal assigned to AL1, AL2 and AL3 when the parameter (FC-45) is set to ALC.
- The bit output can be changed to negative logic by the parameter output terminal polarity setting (FC-02).
- The following table shows the relation of error code and alarm signal.

The relation of error code and alarm signal

Error code	ALM	AL3 (OL1)	AL2 (TLM)	AL1 (SA)	Trip name
E08	0	0	0	0	Memory error
E11					CPU error 1
E22					CPU error 2
E40					Motor power unmatch
E42					Option error
E61					Duplicate MAC ID
E01		0	0	1	Overcurrent protection
E31					Power module protection
E14		0	1	0	Ground fault protection
E06		0	1	1	Braking resistor overload protection
E25					Overtravel error
E83					Position error fault
E84					Speed error fault
E89					Position monitoring timeout error
E07		1	0	0	Main power overvoltage protection
E09					Main power undervoltage protection
E16					Instantaneous power failure protection
E20					Control power undervoltage protection
E39		1	0	1	Encoder signal error
E60					DeviceNet communication error
E85					Overspeed error
E88					Driving range error
E90		1	1	0	Absolute encoder battery error / Position data error
E91					Absolute encoder battery alarm
E92					Absolute encoder counter overflow
E93					Absolute encoder error / Encoder failure
E05		1	1	1	Overload protection
E10					CT error
E21					Abnormal temperature
E36					DB overload error
E12					External error

5.4 Analog Input / Output Function

5.4.1 Analog Input Function

There are four analog inputs of AI1, AI2, AI3 and AI4 with the input voltage range of 0 to ±10 V. For each input signal, function assignment is set in the parameters Setting (FC-03 and FC-04) so that it may be used as the following function. The speed-related items are input from AI1 and the torque-related items are input from AI2. AI3 and AI4 are used by torque limit input only. The function assignment shown in the following table is performed according to each setting and MOD terminal status.

When the parameter position command selection (FA-22) is set to “Pro”, the general analog input 1, 2 (XA(0), XA(1)) are set. Refer to the instruction manual of programmable function.

(1) Function assignment of analog input AI1

Control status						
	Control mode FA-00	MOD terminal	AI1 function assignment FC-03	Speed limit mode FA-20	Speed command selection FA-21	Analog input AI1
Speed control	S-P	OFF	nrEF / niLit / nbiAS	–	A1	Speed command
	P-S	ON				
	S-t	OFF				
	t-S	ON				
Position control	P-S	OFF	nbiAS	–	–	Speed bias
	S-P	ON				
	P-t	OFF				
	t-P	ON				
Position control	P-S	OFF	nLit	A1	–	Speed limit
	S-P	ON				
	P-t	OFF				
	t-P	ON				
Torque control	t-S	OFF				
	S-t	ON				
	t-P	OFF				
	P-t	ON				
Other status and setting						Invalid

Note: – means no influence with the parameter setting.

(2) Function assignment of analog input AI2

Control status			Parameter setting				Operation of analog input terminal	
	Control mode FA-00	MOD terminal	AI2 function assignment FC-04	Torque limit mode FA-17	Torque bias mode FA-18	Torque command selection FA-19	AI2	AI3 AI4
Speed control	S-P	OFF	tLit	A2 A3 A4	–	–	Torque limit (Note 2)	Torque limit (Note 2)
	P-S	ON						
	S-t	OFF						
	t-S	ON						
Position control	P-S	OFF						
	S-P	ON						
	P-t	OFF						
	t-P	ON						
Speed control	S-P	OFF	tbiAS	–	A2	–	Torque bias	–
	P-S	ON						
	S-t	OFF						
	t-S	ON						
Position control	P-S	OFF						
	S-P	ON						
	P-t	OFF						
	t-P	ON						
Torque control	t-S	OFF	trEF (tLit tbiAS)	–	–	A2	Torque command	–
	S-t	ON						
	t-P	OFF						
	P-t	ON						
Other status and setting							Invalid	

Note 1: – means no influence with the parameter setting.

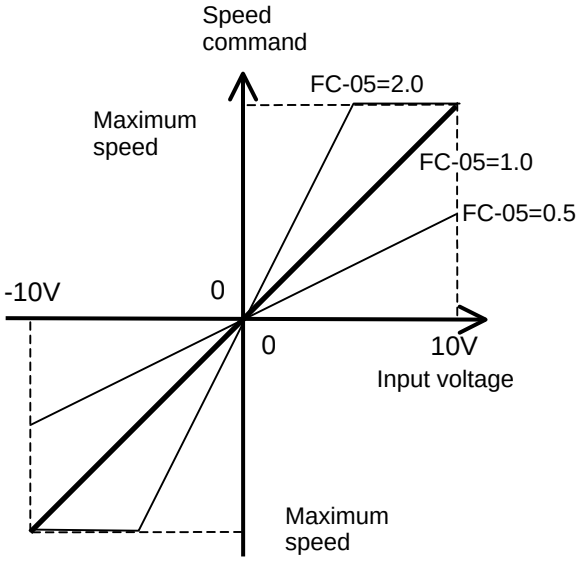
Note 2: AI2 input is the bipolar limit value of torque command, AI3 input is the positive limit value of torque command and AI4 input is the negative limit value of torque command.
As for the positive limit value, the smaller value is chosen among AI2 and AI3.
As for the negative limit value, the smaller value is chosen among AI2 and AI4.
For the detail of the process of torque limit value determination, refer to Section 5.4.1 (4).

(3) Functional Contents of Analog Input 1(AI1)

The contents of assignment of Analog Input 1 Setting (FC-03) are explained in sequence. The name in parentheses of each title is the FC-03 setting name.

(a) Speed Command (nrEF)

- This function is valid only in the speed control mode. The speed command value is input by analog voltage.
- This function is validated when Analog Input (A1: initial setting) is selected in Speed Command Selection (FA-21).
- The speed command value is validated when Multistage Speed is not selected, and –10 V to 0 V to +10 V corresponds to – maximum speed - zero speed - + maximum speed.



- Analog Input Gain can be set in the parameter (FC-05).
- Offset can be set in the parameter (FC-07).
- While the zero speed clamp (SRZ) or overtravel (FOT, ROT) terminal is input, the speed command value becomes 0 regardless of this input value.

(b) Speed Bias (nbiAS)

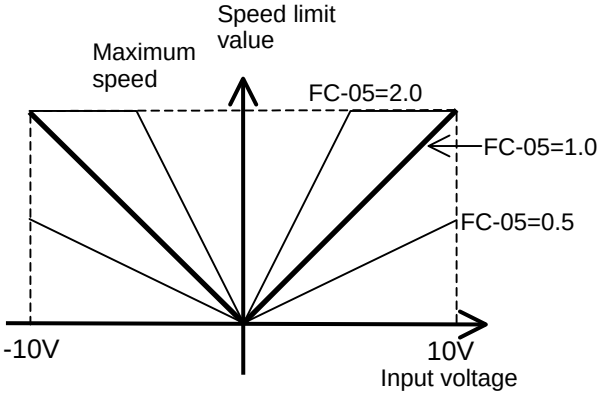
This function is valid only in the position control mode. Input the speed bias value by analog voltage. The speed bias value is obtained by adding a bias to the speed command value to be output in the position control mode, and can achieve the synchronous-control type control by applying positional correction while giving the speed command.

- –10 V , 0 V , +10 V corresponds to – maximum value , zero sped -,+ maximum speed.
- Analog Input Gain can be set in the parameter (FC-05).
- Offset can be set in the parameter (FC-07)

(c) Speed Limit (nLit)

This function is valid in the position control mode or torque control mode. The speed limit value is input by analog voltage.

- This function is validated when Analog Input 1 (A1) is selected in Speed Limit Mode (FA-20).
- The input value takes an absolute value and becomes a speed limit value common to 4 quadrants. (0 V - ± 10 V corresponds to zero speed - + maximum speed.)



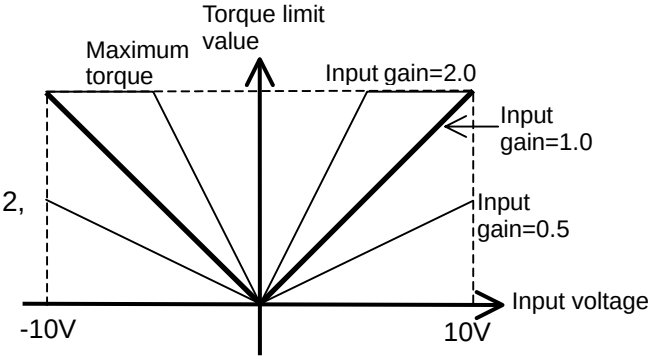
- Analog Input Gain can be set in the parameter (FC-05).
- Offset can be set in the parameter (FC-07).

(4) Functional Contents of Analog Input 2

Any of torque limit, torque bias and torque command can be assigned to AI2 in the parameter Analog Input 2 Function Selection (FC-04). In case that torque limit is assigned to AI2, analog input from AI2, AI3 and AI4 terminal is valid. The contents are explained below.

(a) Toque Limit (tLit)

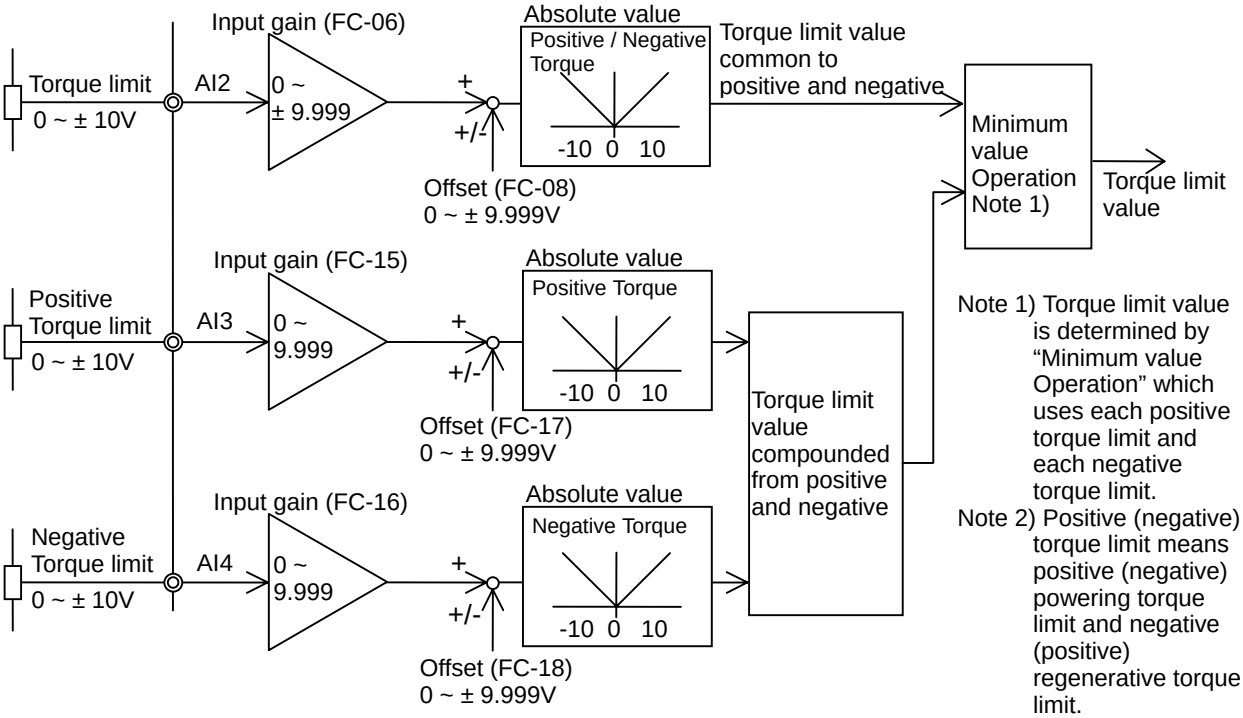
This function is valid in the position control mode or speed control mode. Input the torque limit value by analog voltage.



- Torque limit from analog input terminal AI2, AI3 and AI4 is valid when Analog Input 2 (A2) is selected in the parameter Torque Limit Mode (FA-17) and the torque limit signal (TL) is turned on.
- The input value from AI2 terminal takes an absolute value and becomes a torque limit value common to 4 quadrants. Be sure to use AI2 terminal when the same value is used at positive torque limit and negative torque limit.

Torque limit Analog input terminal	Parameter	
	Input gain	Offset
AI2	FC-06	FC-08
AI3	FC-15	FC-17
AI4	FC-16	FC-18

- The input value from AI3 terminal takes an absolute value and becomes a positive torque limit value. The input value from AI4 terminal takes an absolute value and becomes a negative torque limit value. Be sure to use AI3 and AI4 terminals when the different values are used at positive torque limit and negative torque limit.
- At AI2 terminal, 0 V ~ ± 10 V corresponds to zero torque ~ ± maximum torque. At AI3 terminal, 0 V ~ ± 10 V corresponds to zero torque ~ + maximum torque. At AI4 terminal, 0 V ~ ± 10 V corresponds to zero torque ~ - maximum torque.
- Analog Input Gain and Offset can be set with the parameter indicated in the top table.



Structure of the analog input terminal for torque limit

Example of setting

(1) In case that the same value is used at positive torque limit and negative torque limit

Be sure to use the analog input terminal AI2, and parameters FC-06 and FC-08.

Do not input anything into the analog input terminals AI3 and AI4.

Be sure to set parameters as follow.

Parameter	FC-15	FC-16	FC-17	FC-18
Setting value	0.000	0.000	9.999 or -9.999	9.999 or -9.999

(2) In case that the different values are used at positive torque limit and negative torque limit

Be sure to use the analog input terminals AI3 and AI4, and parameters FC-15, FC-16, FC-17 and FC-18.

Do not input anything into the analog input terminal AI2.

Be sure to set parameters as follow.

Parameter	FC-06	FC-08
Setting value	0.000	9.999 or -9.999

(b) Torque Bias (tbiAS)

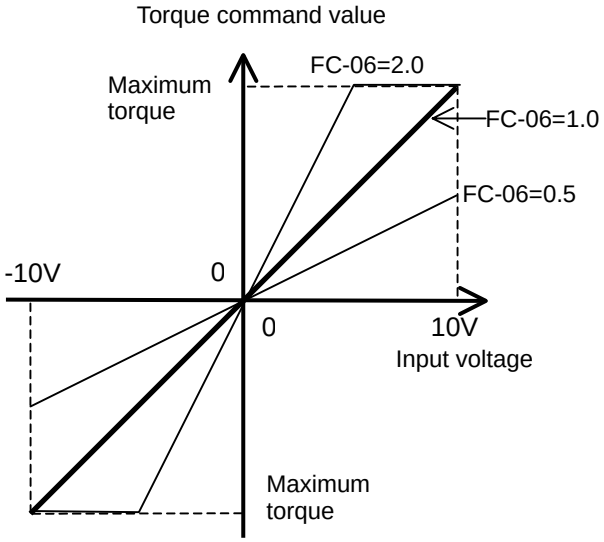
This function is valid in the position control mode or speed control mode. Input the torque bias value by analog voltage.

- This function is validated when analog input 2 (A2) is selected in the parameter Torque Bias Mode (FA-18).
- The value input by this signal becomes a signed torque bias value. (0 V - ± 10 V corresponds to zero torque - ± maximum torque.)
- Analog Input Gain can be set in the parameter (FC-06).
- Offset can be set in the parameter (FC-08).

(c) Torque Command (trEF)

Input the torque command value by analog voltage.

- This function is validated when Analog Input 2 (A2: initial setting) in the parameter Torque Command Selection (FA-19).
- The value input by this signal becomes a signed torque command value. (0 V - ± 10 V corresponds to zero torque - ± maximum torque.)
- Analog Input Gain can be set in the parameter (FC-06).
- Offset can be set in the parameter (FC-08).

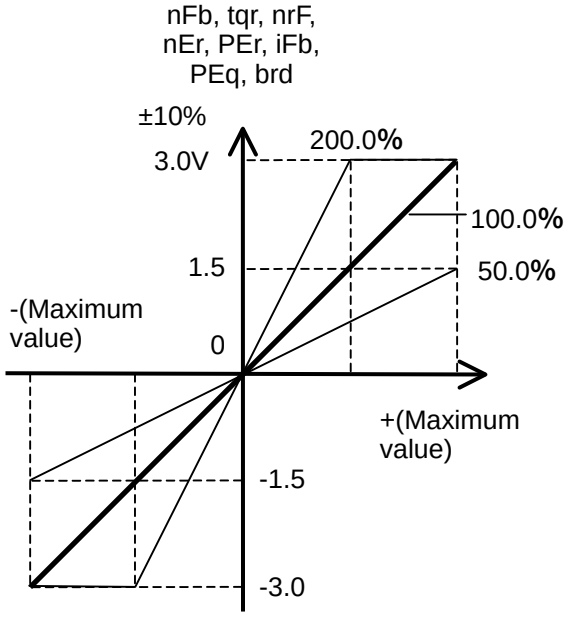


5.4.2 Analog Output Function

There are two analog outputs of AO1 and AO2 with the output voltage range of 0 to ±3.0 V. For each output signal (AO1 / AO2), function assignment is set in the parameters setting (FC-30 and FC-33). Selectable functions are eight ; Speed detection value(nFb), Torque command value(tqr), Speed command value(nrF), Speed deviation(nEr), Position deviation(PEr), Current value(iFb), Command pulse frequency(PFq) and Regenerative braking resistor operating ratio(brd). The output gain for each analog output is set in the parameters setting (FC-32 and FC-35). Signed(0 ~ ±3.0V) or unsigned / absolute(0 ~ +3.0V) for output signals is selectable in the parameters setting (FC-31) and (FC-34).

Analog monitor output function

Setting	Data name	Maximum output value (3.0V output value) (Note 1)	Initial setting		Range of gain setting [%] (FC-32) (FC-35)	Control mode (Note 2, 3)		
			AO1 (FC-30)	AO2 (FC-33)		Position	Speed	Torque
nFb	Speed detection value	Maximum speed	O		0 ~ 3000.0 Initial setting 100.0[%]	O	O	O
tqr	Torque command value	Maximum torque		O		O	O	O
nrF	Speed command value	Maximum speed				O	O	X
nEr	Speed deviation	Maximum speed				O	O	X
PEr	Position deviation	Five motor rotations				O	X	X
iFb	Current value	Maximum current				O	O	O
PFq	Command pulse frequency	Maximum speed				O	X	X
brd	Regenerative braking resistor operating ratio	Trip level (FA-08)				O	O	O



The gain setting for analog output

(FC-32), (FC-35)

Note 1) When the gain is set to 100.0[%], each maximum value mentioned in the top table is output as 3.0V.

Note 2) The sign 'O' means that the function is available at the control mode. The sign 'X' means that 0V is always output.
In case of the amplifier with programmable function, 'O' and 'X' are determined by its control commands.

Note 3) All functions except 'speed detection value' output 0V when an error occurs.
In case of encoder error (E39), 'speed detection value' is invalid.

Note 4) The output signals obtain accuracy of ±10%.

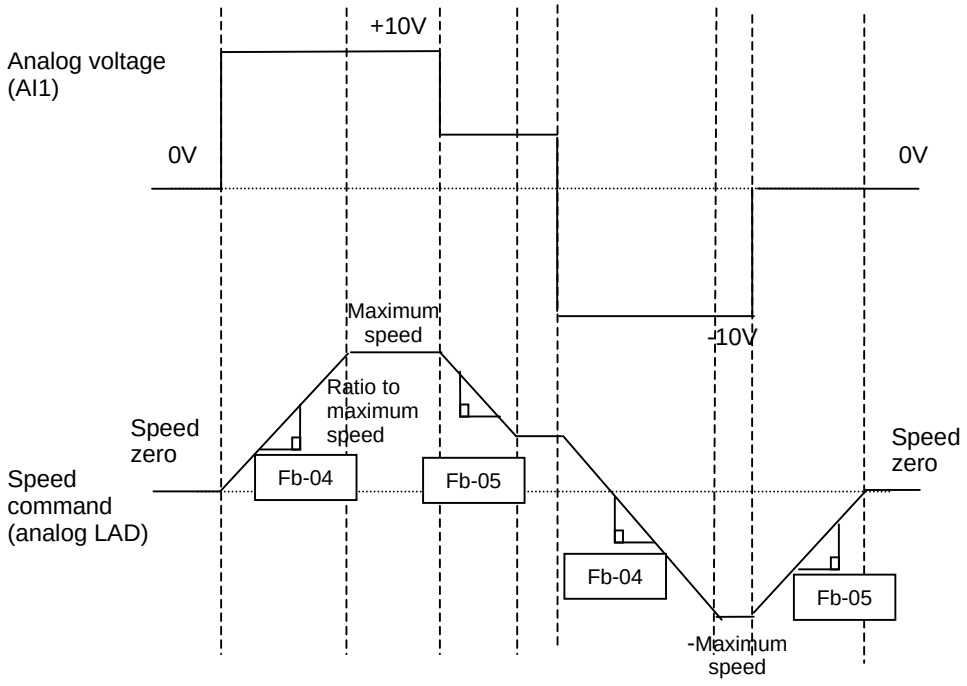
Note 5) Signed(0 ~ ±3.0V) or unsigned / absolute(0 ~ +3.0V) for output signals is selectable in the parameters setting (FC-31) and (FC-34). But functions 'PFq' and 'brd' are output as absolute values only.

5.5 Analog Input Acceleration/Deceleration Function

This function is valid only in the speed control mode. Acceleration/deceleration is performed for the specified acceleration/deceleration time (Fb-04, Fb-05) up to the speed command input by analog voltage.

- This function is validated when Input with Analog Acceleration/Deceleration Time 1 (AlS) is selected in the parameter Speed Command Selection (FA-21).
- Set the acceleration/ deceleration time by Acceleration Time (Fb-04) and Deceleration Time (Fb-05). This acceleration/deceleration time is set as the time from speed zero to the maximum speed.
- In the initial value of speed command value, -10 V - 0 V - +10 V corresponds to (– maximum speed) - (speed zero) - (+ maximum speed). Analog Input Gain can be set in the parameter (FC-05) and Offset can be set in the parameter (FC-07).
- While the zero speed clamp (SRZ) or overtravel (FOT, ROT) terminal is input, the speed command value becomes 0 regardless of the this input value.
- Analog voltage should be constant during acceleration/deceleration. If this varies, the acceleration/deceleration time may be different from the setting.

Parameter		Set point (initial value)
No.	Name	
FA-21	Speed command selection	To validate the function with analog acceleration/deceleration time, select A1S.
Fb-04	Acceleration time	0.0 to 99.99 (10.00)
Fb-05	Deceleration time	0.00 to 99.99 (10.00)

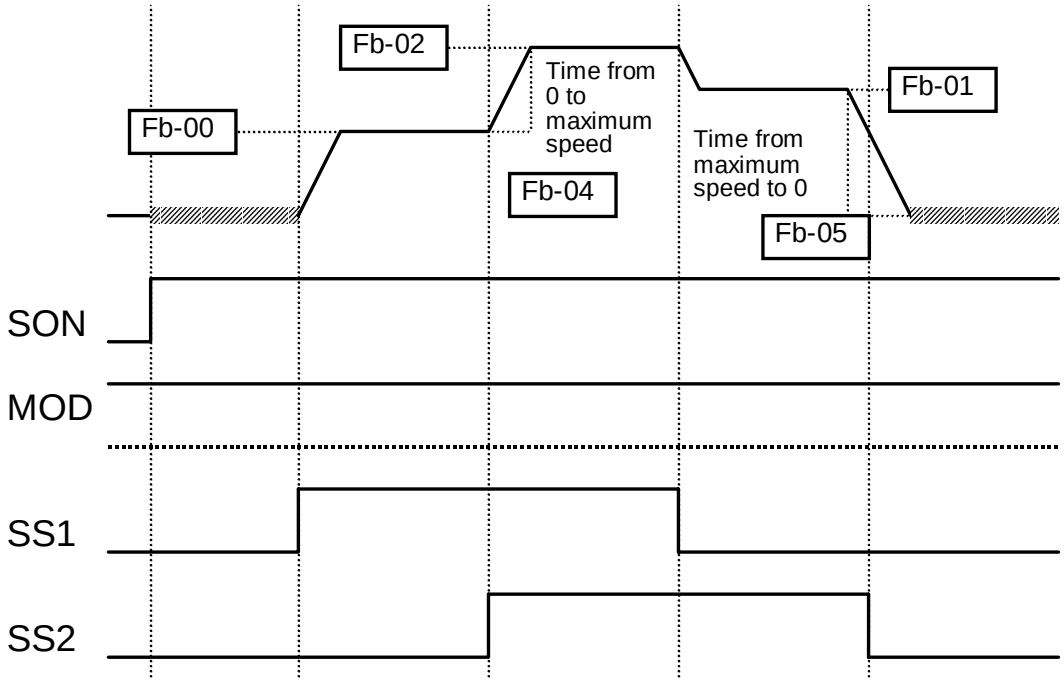


5.6 Multistage Speed Function

(1) Multistage speed terminals (SS1, SS2)

In the speed control status when the MOD terminal is ON and the parameter Control Mode (FA-00) is set to Speed Control, multistage speed operation can be performed by using the SS1 and SS2 terminals. Combining SS1 and SS2 provides speed commands shown in the following table. In this case, the acceleration/deceleration time is set in Fb-04 and Fb-05. Set this acceleration/deceleration time by the time from speed zero to the maximum motor run speed.

Parameter		Setting range	Initial value	Multistage speed terminals	
No.	Name			SS1	SS2
Fb-00	Multistage speed 1	0 to ±Maximum speed	0	ON	OFF
Fb-01	Multistage speed 2	0 to ±Maximum speed	0	OFF	ON
Fb-02	Multistage speed 3	0 to ±Maximum speed	0	ON	ON
–	–	–	0	OFF	OFF
Fb-04	Acceleration time	0.00 to 99.99	10.00	–	–
Fb-05	Deceleration time	0.00 to 99.99	10.00	–	–



(2) FWD/REV terminal

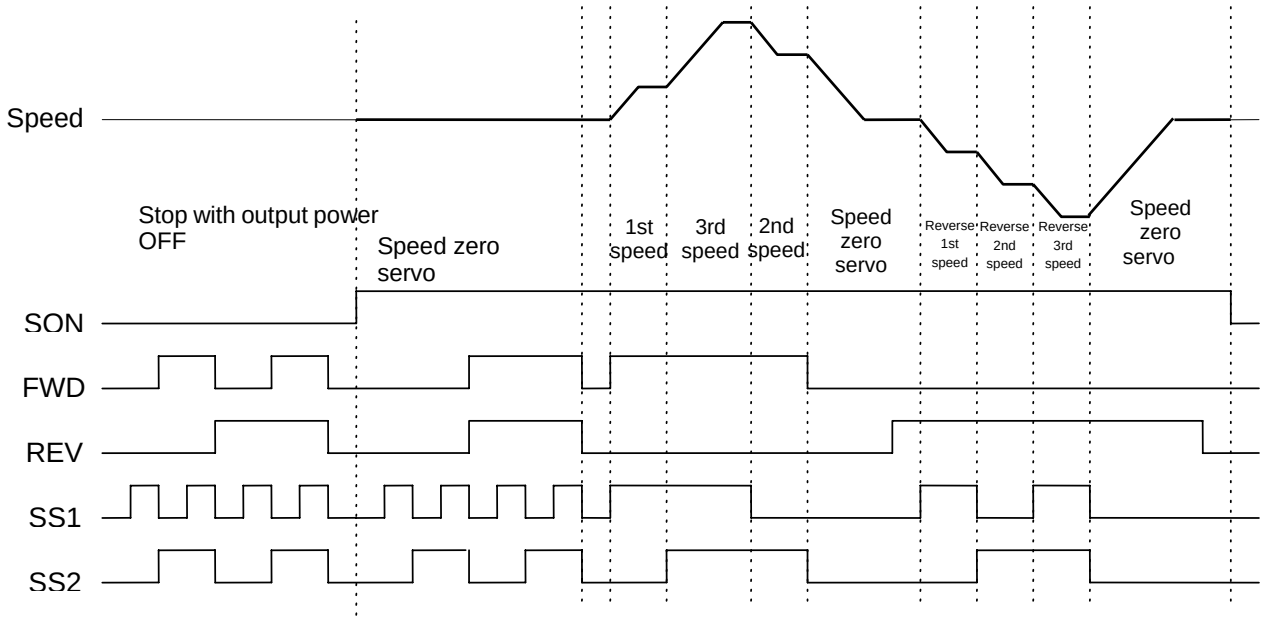
Usually, the multistage speed function using the SS1 and SS2 terminals cannot specify the direction of run. However, when the second function terminals FWD and REV are assigned, the direction of run and the speed command value can be specified by FWD/REV and SS1/SS2, respectively.

In this case, because the parameters Multistage Speed Setting (Fb-00 to Fb-02) are signed, the opposite polarity is specified as the speed command when REV is assigned. The acceleration/deceleration time is based on Fb-04 and Fb-05. The relation between terminals and speed commands are shown in the following table.

SON	FWD	REV	SS1	SS2	Speed command	Remarks
OFF	*	*	*	*	No output power	
ON	OFF	OFF	*	*	0	Zero speed servo
	ON	ON	*	*		
	ON	OFF	OFF	OFF	0	Zero speed servo
			ON	OFF	(Fb-00)	1st speed
			OFF	ON	(Fb-01)	2nd speed
			ON	ON	(Fb-02)	3rd speed
	OFF	ON	OFF	OFF	0	Zero speed servo
			ON	OFF	–(Fb-00)	Reverse 1st speed
			OFF	ON	– (Fb-01)	Reverse 2nd steed
			ON	ON	– (Fb-02)	Reverse 3rd speed

*: ALL Mighty

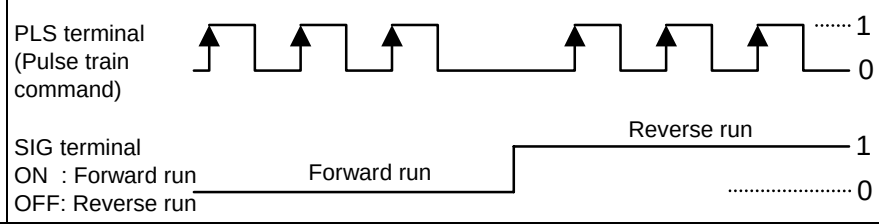
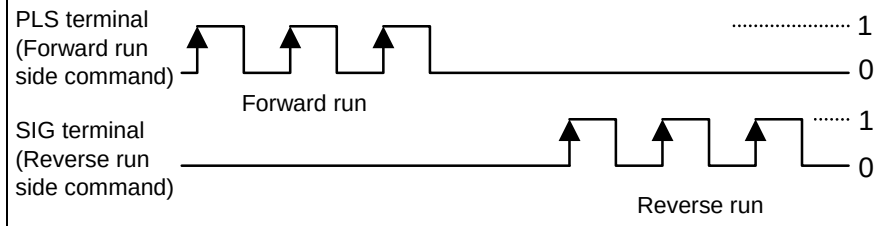
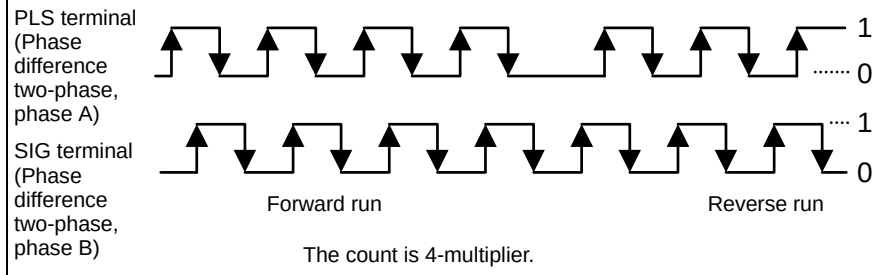
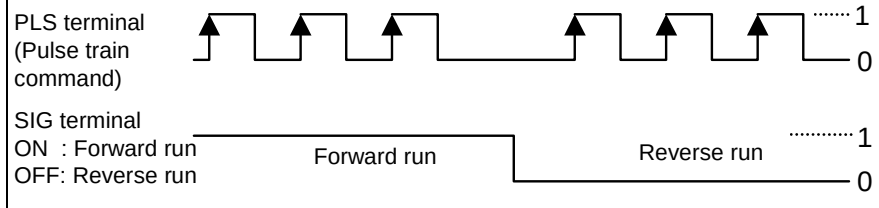
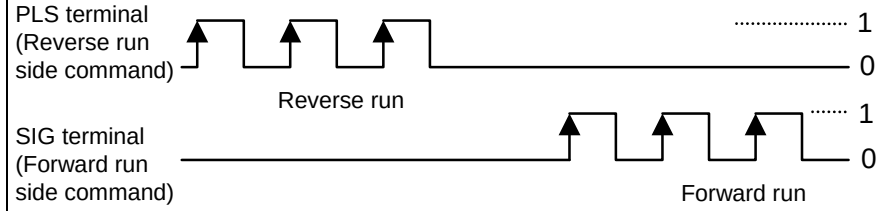
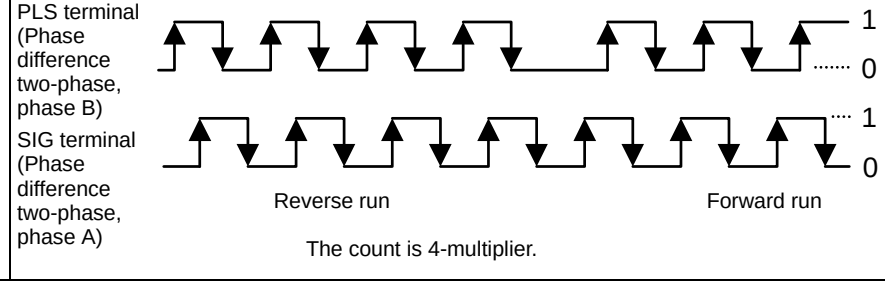
- Multistage command: Operations when (Fb-02) > (Fb-01) > (Fb-0) > 0



5.7 Position Pulse Train Input Function

(1) Position Pulse Train Input Form

The Position Command Pulse Train signal (PLS, SIG) is valid in the position control mode. Only when the pulse train input enable signal (PEN) is ON, the position command is counted with this signal. The 6 position command count modes shown in the following table can be set in the parameter (FA-11).

FA-11	Signal form name	Position pulse train input form
P-S (initial value)	Pulse train command	
F-r	Forward/Rev - erse run pulse	
A-b	Phase difference two-phase pulse	
-P-S	Reverse pulse train command	
r-F	Reverse/For ward run pulse	
b-A	Reverse phase difference two-phase pulse	

According to the command pulse frequency, command pulse filter time constant (FC-19) is selectable. (Those filters are composed by hardware in the pulse input circuit.)

Command pulse filter time constant FC-19	Filter time constant [μs]	Recommendation value of command pulse frequency
Lo	1	Under 200k pulse/s
Hi(Initial setting)	0.2	200k pulse/s or more

Note : In case of the phase difference two-phase pulse signal (A-phase and B-phase input), the recommendation value of command pulse frequency is set to one fourth of the values of the top table.

Note 1: These signals are line driver and open collector signals. The maximum rate of the pulse train input signal is as shown in the following table.

Signal method	Maximum rate	Remarks
Line driver signal	2M pulses/s	FWD/REV pulse Command pulse/ Direction signal

Note 2: The pulse train command signal counts at the leading edge when the signal changes from 0 to 1.

Note 3: The phase difference two-phase pulse signal counts as a 4-multiplier pulse input. But maximum rate is 500k pulses/s for line.

Note 4: The logic of each signal is shown in the following table.

Logic	Direction of current flow
0	PLSP→PLSN SIGP→SIGN
1	PLSP←PLSN SIGP←SIGN

(2) Electronic Gear

The position command value as the position command pulse train signal becomes a position command value through the electronic gear. This electronic gear creates a position command value by multiplying the input command value by (FA-12/FA-13) when EGR2 (Electronic gear change) is OFF. When EGR2 is ON, (FA-32/FA-33) is multiplied. This relation is shown in the following formula.

[EGR2:OFF]

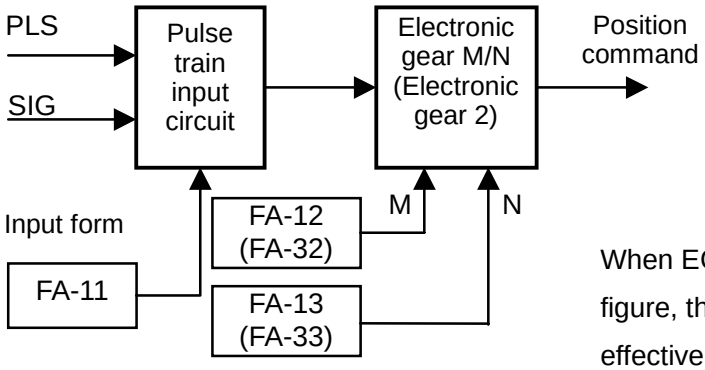
$$\text{(Position command value)} = \frac{\text{(Electronic Gear Numerator FA-12)}}{\text{(Electronic Gear Denominator FA-13)}} \times \text{(Pulse train input)}$$

[EGR2:ON]

$$\text{(Position command value)} = \frac{\text{(Electronic Gear Numerator FA-32)}}{\text{(Electronic Gear Denominator FA-33)}} \times \text{(Pulse train input)}$$

In this case, the number of pulses equivalent to one rotation, 15 bits (32768 pulses per rotation) is specified as one unit in the position command value. Any value of 1 to 65535 can be optionally set in FA-12, 13, 32 and 33 in the range of 1/20 <= M/N <= 50.

The relation of the above pulse train input signal is shown in the following figure.



When EGR2 is ON with the left figure, the parameter in () becomes effective.

[Setting method]

<Example> Suppose that a ball screw of 20 mm per rotation is mounted on the servo motor. Perform setting so that the ball screw may move 1 mm when 1000 is input in pulse train. The encoder counter is 32768 pulses per rotation (when EGR2 is OFF).

1- Set value of Electronic Gear Numerator (FA-12)

Input the count value of the encoder per rotation of the ball screw in the numerator (FA-12).

(FA-12) = 32768

2- Set value of Electronic Gear Denominator(FA-13)

Input the command value per rotation of the ball screw in the denominator (FA-13).

$(FA-13) = 1000_{Pulse} \times 20$ mm/rotation = 20000

$$\frac{1}{20} <= \frac{(FA-12)}{(FA-13)} = \frac{32768}{20000} = 1.6384 <= 50$$

With this, setting can be performed.

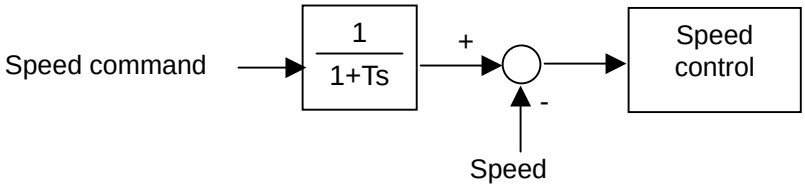
5.8 Smoothing Function

(1) Speed Command Filter

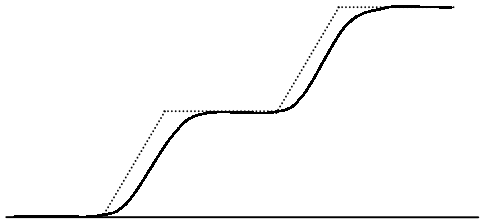
In the multistage speed operation using the SS1, SS2, FWD, and REV terminals, the edge is formed in switching between acceleration/deceleration and constant-speed operation. In combination with a machine with low rigidity, this edge appears as vibration. For prevention against vibration, a filter is added to the speed command to make the command smoother. The filter time constant setting can be changed by the parameter (Fb-20) and is invalidated at 0.

Parameter	Function name	Contents of function	Initial value
Fd-20	Speed command filter time constant	The speed command can be made smoother by adding a filter. 0 to 60000 ms 0 = Invalid	0

In this functional expansion, filtering is performed for the speed command in the position control mode or speed control mode, so a filter is inserted not only for multistage speed but also at all times. The control block is shown in the following figure.



Inserting a filter makes the speed command smoother, as shown in the following figure, to prevent vibration.



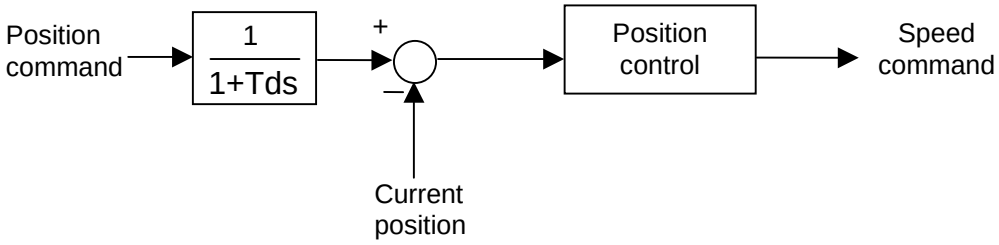
(2) Position Command Filter

In combination with a machine with low rigidity, vibration may be caused by the pulse rate of the position command. For prevention against this vibration, the command can be made smoother by adding a filter to the position command.

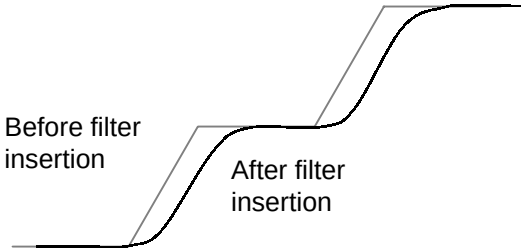
The filter time constant setting can be changed by the parameter (Fd-36) and is invalidated at 0 as shown in the following table.

Parameter	Function name	Contents of function	Initial value
Fd-36	Position command filter time constant	The position command can be made smoother by adding a filter. 0 to 60000 ms 0 = Invalid	0

This function is effective only in the position control. The control block is as shown in the following figure.

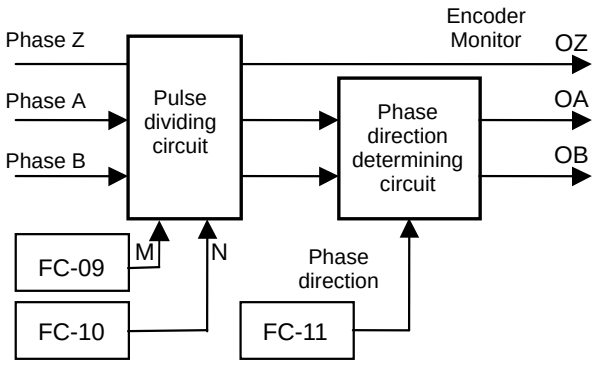


Inserting a filter makes the position command smoother, as shown in the following figure, to prevent vibration.



Note) Be sure to set to 0 when motor is rotating only one direction continuously in position control mode. Otherwise E83 (Position error fault) occurs.

5.9 Encoder Monitor Function



As the Encoder Monitor signal, a signal obtained by dividing the phase A signal and phase B signal being encoder signals is output to the line driver as OA and OB. The phase Z signal is directly output to the line driver and the open collector as OZ.

The Encoder Monitor signal is set in M/N pulse per rotation by parameters FC-09 (M) and FC-10 (N). Please note that the setting range M / N is limited according to the installed encoder. In case of the 17 bits serial encoder, the encoder monitor signal is set as M / 32768 (M = 16 to 8192).

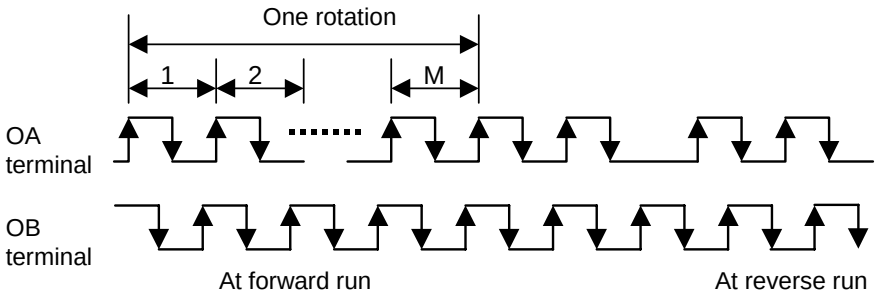
In case of the wire saving incremental encoder, it is set as 1 / N (N = 1 to 64), 2 / N (N= 3 to 64) or M / 8192 (M= 1 to 8192) (Note 3). If M and N are the invalid combinations showed in the following table, the encoder monitor signal is not output and E40 occurs.

As for Z phase, no frequency division is performed and one pulse is outputted at each revolution. In case of 17 bits serial encoder, the pulse width of OZ is the same as the one pulse width of OA or OB which is divided and outputted according to parameter FC-09. In case of the wire saving incremental encoder, Z phase pulse is outputted as it is through the pulse dividing circuit. Regarding the phase difference between phase A and phase B and the direction of motor run, normally, the phase of the phase A leads at forward run but can be reversed by the parameter setting (FC-11).

Encoder selection FA-81	Effective range M FC-09	Effective range N FC-10	Encoder monitor resolution	Invalid Combinations
Stnd AbSE1 AbSE2 AbSA2 AbSA4	16 ~ 8192	--- 32768 is set up internally	M / 32768	FC-09 = 1 ~ 15
inCE (Note 1)	1 (Note 2)	1 ~ 64	1 / N	FC-10 = 65 ~ 8192
	2 (Note 2)	3 ~ 64	2 / N	FC-10 = 1, 2, 65 ~ 8192
	1 ~ 8191	8192 (Note 2)	M / 8192	FC-09 = 8192 FC-10 = 1 ~ 8192

Note 1: Parameter FC-10 is valid only when FA-81 is set to inCE.

Note 2: Parameter FC-10 is set to 8192, the encoder monitor resolution is set to M / 8192 (M is set by parameter FC-09).
Parameter FC-10 is set to a number other than 8192, the encoder monitor resolution is set to 1/N or 2/N according to FC-09(N is set by parameter FC-10).



At setting FC-11=b in case of 17bits serial encoder (Initial setting)

Note 3: When the FC-09, FC-10 or FC-11 setting has been changed, turn on the control power again. Otherwise, a correct waveform cannot be output.

Note 4: The encoder monitor signal OAP, OAN, OBP, OBN, OZP, OZN and OZ are invalid during 3s after the control power is turned on. In case that those signals are monitored by master control device, be sure to wait for 3s or more after the control power is turned on and then start to monitor them.

The logic of each signal is shown in the following table.

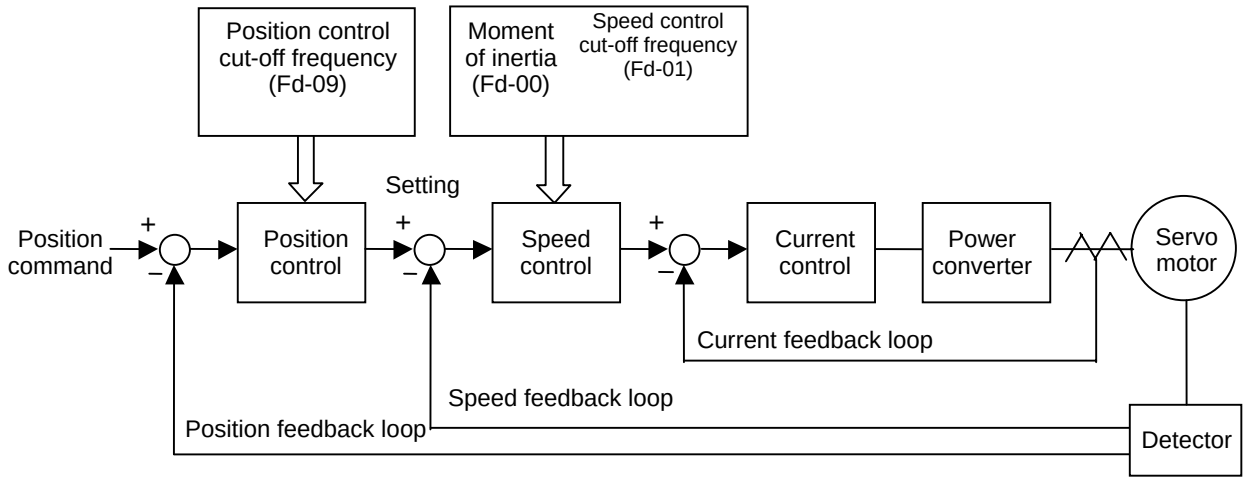
Logic	Direction of current flow of line driver (OAP,OAN,OBP,OBN,OZP,OZN)	Output of open collector transistor (OZ)
1	OAP→OAN OBP→OBN OZP→OZN	ON(Close)
0	OAP←OAN OBP←OBN OZP←OZN	OFF(Open)

5.10 Adjusting the Control Gain

This section explains how to adjust each control gain required to adjust the servo system. The main parameter constants that are adjusted on the customer side are as follows.

- Moment of inertia (Fd-00)
- Speed control cut-off frequency (Fd-01)
- Position control cut-off frequency (Fd-09)

The following figure shows a block diagram of the servo system.



5.10.1 Basic Rules of Gain Adjustment

(1) The servo system consists of 3 feedback loops, namely, position , speed , and current . For an inner loop, the response performance must be set to a higher level. The customer must adjust only the position feedback loop gain and the speed feedback gain. The current feedback loop gain, for which enough response performance is already secured, requires no adjustment.

(2) The position feedback loop and the speed feedback loop must be set to a well-balanced response. Basically, set the loop gain in the range that can hold the relation of “Position Control Cut-off Frequency (Fd-09) < Speed Control Cut-off Frequency (Fd-01)”.
As the standard setting, the Position Control Cut-off Frequency (Fd-09) should be 1/6 or less of the Speed Control Cut-off Frequency (Fd-01).

(3) When the response speed of the position feedback loop is set to a higher level, the mechanical system may oscillate. At this time, the gain must not be raised further. Generally, the response performance of the position control loop must not be higher than the natural oscillation frequency of the mechanical system. Set a loop gain suitable for the rigidity of the mechanical system. In the following, the rigidity and response setting of the mechanical system will be explained.

5.10.2 Rigidity and Response Setting of The Mechanical System

Set the response of the servo system according to the rigidity of the machine to be connected to the AC servo motor. If the Speed/Position Control Cut-off Frequency (Fd-01/09) is set to a high value, the response time and positioning time for the command value are shortened. However, when it is set to a too high value, vibration will be caused if the rigidity of the mechanical system is low.

Set the Speed/Position Control Cut-off Frequency (Fd-01/09) in the stable operation range. Table 5.10.2 shows the standard response setting based on the rigidity of the mechanical system. Note that this is only a standard and oscillation may occur even in this range.

Table 5.10.2

Rigidity of mechanical system	Corresponding machines	Recommended control cut-off frequency [Hz]	
		Position (Fd-09)	Speed (Fd-01)
Low	Machines to be driven by belt or chain - Conveyor	1 to 5	6 to 30
Medium	Machines to be driven by ball screw through a gear - General machine tool - Robot	5 to 10	30 to 60
High	Machines directly connected to a ball screw - Mounting machine - Bonding machine	10 or more	60 or more

In the following, the detailed procedures for adjusting the speed and position feedback loops will be explained.

5.10.3 Adjusting The Speed Feedback Loop

(1) Parameter Constants for Speed Control
The parameter constants to be used are explained below.

(a) Speed Control Cut-off Frequency (Fd-01)
This parameter constant determines the response performance of the speed feedback loop. Set it in the range in which the mechanical system does not oscillate. The larger the set point, the higher the response performance.
When the parameter Moment of Inertia (Fd-00) of the mechanical system (including the motor) is correctly set, the measured speed control cut-off frequency is almost equal to the set value of Fd-01.

(b) Speed Control Proportional Gain (Fd-02)
The speed control proportional gain is automatically determined by the parameter Speed Control Cut-off Frequency (Fd-01). However, if Fd-02 is set, the PI control proportional gain can be finely adjusted.

(c) Speed Control Integral Gain (Fd-03)
The speed control integral gain is automatically determined by the parameter Speed Control Cut-off Frequency (Fd-01). However, if Fd-03 is set, the PI control integral gain can be finely adjusted.

Note 1: For manual adjustment, the parameter Moment of Inertia (Fd-00) must be set on the customer side. However, if auto-tuning is performed, the value of moment of inertia assumed by the servo drive is automatically written in Fd-00, so that this parameter does not need to be set.
For details, refer to 5.11 Offline Auto-tuning Function and 5.12 Online Auto-tuning Function.

(2) Adjusting Method
1- Set the parameter Speed Control Cut-off Frequency (Fd-01) in a range in which no abnormal noise or oscillation occurs.

2- Lastly, perform speed step response to check the positioning characteristic and rotating condition. At this time, adjust Speed Control PI Gain (Fd-02 and Fd-03) finely to find out the best point.

5.10.4 Adjusting The Position Feedback Loop

(1) Parameter Constants for Position Control
The parameter constants to be used are explained below.

(a) Position Control Cut-off Frequency (Fd-09)
This parameter constant determines the response performance of the position feedback loop. When this parameter constant is set to a high value, the response performance is improved and the positioning time is reduced.

(b) Speed Control Cut-off Frequency (Fd-01)
This parameter constant determines the response performance of the speed control loop. Set it in the range in which the mechanical system does not oscillate. The larger the set point, the higher the response performance.
When the parameter Moment of Inertia (Fd-00) of the mechanical system (including the motor) is correctly set, the measured speed control response frequency is almost equal to the set point of Fd-01.

(c) Speed Control Proportional Gain (Fd-02)
The speed control proportional gain is automatically determined by the parameter Speed Control Cut-off Frequency (Fd-01). However, if Fd-02 is set, the speed control proportional gain can be finely adjusted.

(d) Speed Control Integral Gain (Fd-03)
The speed control integral gain is automatically determined by the parameter Speed Control Cut-off Frequency (Fd-01). However, if Fd-03 is set, the speed control integral gain can be finely adjusted.

Note 1: For manual adjustment, the parameter Moment of Inertia (Fd-00) must be set on the customer side. However, if auto-tuning is performed, the assumed value of moment of inertia is automatically written in Fd-00, so that this parameter does not need to be set.
For details, refer to 5.11 Offline Auto-tuning Function and 5.12 Online Auto-tuning Function.

(2) Adjusting Method
1- Set the parameter Position Control Cut-off Frequency (Fd-09) to a slightly low level. And set the parameter Speed Control Cut-off Frequency (Fd-01) in a range in which abnormal noise or oscillation does not occur.

2- Set the parameter Position Control Cut-off Frequency (Fd-09) to a larger value in a range in which overshooting or vibration does not occur. As the setting standard, the value should be 1/6 or less of Speed Control Cut-off Frequency (Fd-01).

3- Lastly, adjust Speed Control PI Gain (Fd-02 and Fd-03) finely to find out the best point while checking the positioning characteristic and rotating condition.

5.11 Offline Auto-tuning Function

This section explains the offline auto-tuning function. The offline auto-tuning function adjusts the gain of the servo system automatically in offline mode according to the set speed control response frequency.

The offline auto-tuning causes the servo motor to operate according to the predetermined operation pattern, estimates the value of moment of inertia, and sets the parameter Fd-00 correctly. With this, the control gain is automatically set from Speed Control Cut-off Frequency (Fd-01) that determines the response performance of the speed feedback loop.

Note 1: Perform auto-tuning in the same load condition as the actual operating condition by connecting the servo motor to the machine. Adjust the gain to the optimum status for the load.
Note 2: For auto-tuning, set the control mode of the speed control loop to “Speed PI control” beforehand.(The tuning can not be performed correctly to IP control.)
Note 3: When the setup software AHF is connected at offline auto-tuning, the set speed, torque data, and others can be checked graphically. Therefore, we recommend the customer to use the setup software AHF.

5.11.1 Offline Auto-tuning Method

(1) Parameter Constants for Offline Auto-tuning
The parameter constants to be used are explained below.

(a) Auto-tuning (FA-10)
This parameter constant gives permission to execute auto-tuning. For executing offline auto-tuning, set it to “oFL”.

(b) Speed Control Cut-off Frequency (Fd-01)
This parameter constant determines the response performance of the speed feedback loop. Set it in the range in which the mechanical system does not oscillate. The larger the set value, the higher the response performance.

(2) Offline Auto-tuning Operation
1- When the FOT and ROT terminals are turned on and the SON terminal is turned on, auto-tuning is started. LED indicator of the drive indicates “Auto”.

2- The motor is accelerated or decelerated around the auto-tuning start point with the tuning run speed in both forward and reverse directions. This is regarded as one cycle and up to 10 cycles are repeated. (Refer to Fig. 5.11.1.)
The initial value of tuning run speed is 1000 [min^{-1}] and can be changed by the setup software AHF.

3- The acceleration/deceleration time may be changed or the operation may be terminated within completing 10 cycles depending on the load condition.

4- After completion of auto-tuning, the estimated value of moment of inertia is written into Fd-00. When auto-tuning has been normally terminated, the LED indicator of the drive indicates “End”.

5- After completion of auto-tuning, turn ON and OFF the RS terminal to escape the auto-tuning mode.

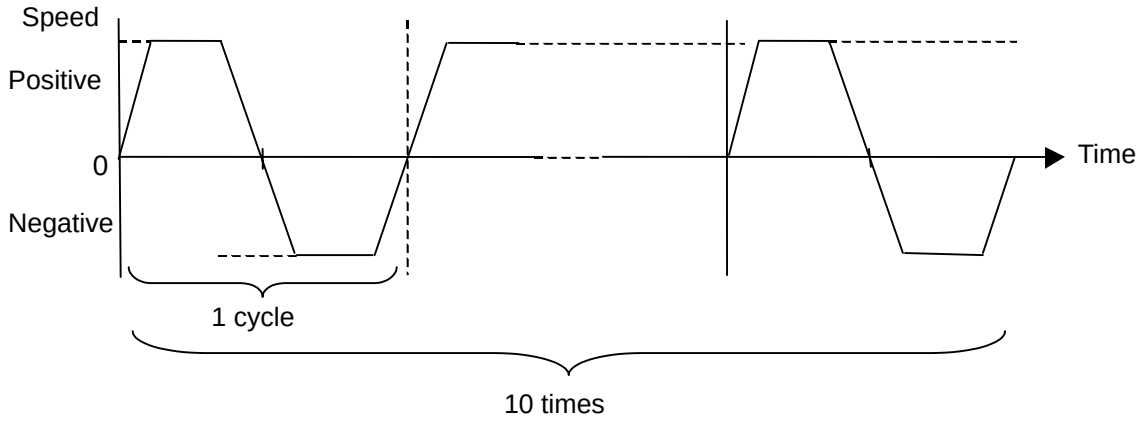


Fig. 5.11.1 Operation Pattern at Offline Auto-tuning

Note4 : This function is not applicable unless the following conditions are satisfied.
- The acceleration/deceleration torque should be 10% or more of the rated torque.
- The rigidity of the machine including the coupling with the motor should be high.
- Backlash in gears and others should be small.
- The application should be free from problem in safety and give no damage to the machine even in an oscillation status.
- The moment of inertia of load is less than 20 times of motor one. If it exceeds 20 times, adjust the gain by manual. (Refer to Chapter 5 clause 5.10.1 to 5.10.4 for adjustment.)
- An enough operating range should be provided in both forward and reverse directions.
- When the tuning speed is low, the speed should be increased to a degree that does not give damage to the machine.

Calculation of motor integrated revolution at offline auto-tuning

Tuning revolution : Va(min-1)
Accel./Decel. time : Δt(s)
Motor integrated revolution : S(rev.)

$S=(3xVa / 60) \times \Delta t$

As the right table shows the calculation example, make sure of the enough travel area to the result of calculation.

Each parameter can be adjusted by the setup software AHF through the PC as the following table.

Motor integrated revolution at offline auto-tuning

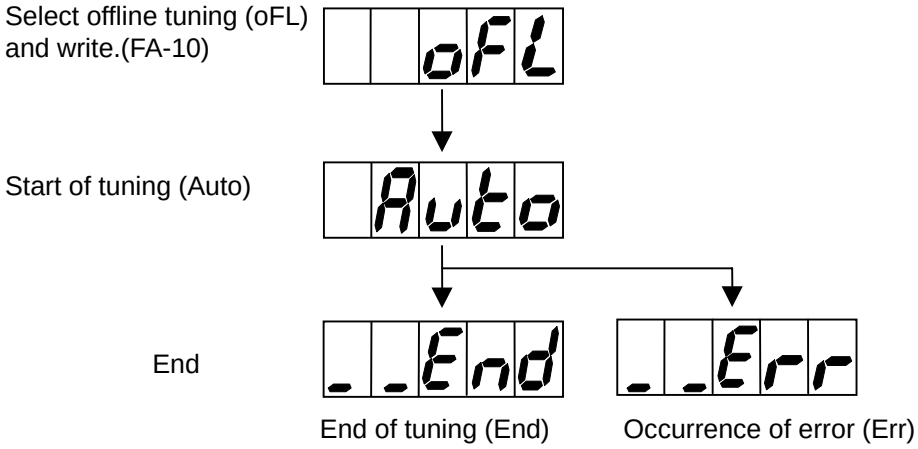
Tuning revolution Va(min^{-1})	Accel./ Decel. time Δt(s)	Motor integrated revolution S(rev.)
500	0.05 0.1	1.25 2.5
1000	0.05 0.1	2.5 5.0
1500	0.05 0.1	3.75 7.5

	Tuning revolution Va(min^{-1})	Accel/Decel timeΔt(s)
Digital operator	1000(Not adjustable)	0.05(Not adjustable)
Setup software AHF	Adjustable	Adjustable

Note)The Accel/Decel time corresponds to the time up to the tuning revolution at offline auto-tuning.

(3) Procedure in The Offline Auto-Tuning Mode

1-For executing offline auto-tuning, select Offline Tuning (oFL)in the parameter Auto-tuning (FA-10), and perform “Servo ON” after writing.



(a) When auto-tuning has been normally terminated
The estimated value of moment of inertia is written into (Fd-00).

(b) When an auto-tuning error has occurred
If the following status occurs during tuning, it results in a tuning error.

- An error has occurred.
- The SON terminal has been turned off during tuning.
- Tuning could not be successfully executed because of resonance.

2- After completion of tuning, turn off SON terminal , then turn ON and OFF the RS terminal to exit from the auto-tuning mode.

Note 5: If the acceleration/deceleration torque is below 10% of the rated torque, the tuning operation may not be normally terminated. At that time, set the initial value of acceleration/deceleration 50 [ms] to a smaller value by using the AD series setup software AHF.
If a tuning error occurs, each gain will go back to the value preceding the execution of tuning. Remove the cause of error. Because no trip is caused, take extreme care about the safety upon occurrence of resonance.

Note 6: After completion of tuning, set oFL in non in the parameter Auto-tuning (FA-10) unless the above item 2- is executed.

5.11.2 Offline Auto-tuning Using the AD series Setup Software AHF

When the AD series setup software AHF is used, offline auto-tuning can be performed in the full automatic mode or with each check of operation. The procedure is briefly explained below. For details, refer to the instruction manual for AD series setup software AHF.

(1) Procedure for Full Offline Auto-tuning

1- Click the Test run and Adjustment buttons on the opening screen.
(Click the offline tuning tag.)

2- Set the following parameters required for tuning.

(a) Cut-off frequency setting
Set the cut-off frequency of speed control for auto-tuning.
Set a value that does not cause hunting.

(b) Initial value of tuning moment of inertia
Set the moment of inertia at a start of auto-tuning. If this parameter is set when the approximate value of the moment of inertia is already known, tuning will be terminated more quickly.
If such a value is unclear, the moment of inertia will be estimated by this auto-tuning function without manual setting.

(c) Tuning speed
Input the speed for auto-tuning.
Input a speed that does not give damage to the machine connected to the motor.
If the speed is too low, tuning may fail. Set this parameter to a little larger value that does not give damage to the machine.

(d) Acceleration/Deceleration time
Set the acceleration/deceleration time of pattern operation for auto-tuning.
If the acceleration/deceleration torque is below 10% of the rated torque, set this parameter to a small value. (Refer to the torque data at pattern operation, which is indicated on the display.)

3- Click the [Continuous pattern tuning start] button.

4- Make sure of safety, turn on the FOT and ROT terminals, and turn on the SON terminal. With this, pattern operation is continuously performed to estimate the moment of inertia.

5- After completion of the moment of inertia estimation, download the operation waveform of the last pattern operation from the servo drive and display it.

6- After completion of tuning, turn on and off the RS terminal to exit from the auto-tuning mode.

Note 1: This function rewrites the set value of the moment of inertia Fd-00 automatically.
Note 2: If tuning is aborted halfway, turn on and off the RS terminal to exit from the auto-tuning mode.
Note 3: If auto-tuning has failed, refer to Note 4 and Note 5 in 5.11.1.

(2) Procedure for Offline Auto-tuning with Each Check of Operation

1- Click the Test run and Adjustment buttons on the opening screen.
The following screen appears. (Click the offline tuning tag.)

2- Set the following parameters required for tuning.

(a) Cut-off frequency setting
Set the cut-off frequency of speed control for auto-tuning.
Set a value that does not cause hunting.

(b) Initial Value of Tuning the moment of Inertia
Set the moment of inertia at a start of auto-tuning. If this parameter is set when the approximate value of the moment of inertia is already known, tuning will be terminated more quickly.
If such a value is unclear, the moment of inertia will be estimated by this auto-tuning function without manual setting.

(c) Tuning speed
Input the speed for auto-tuning.
Input a speed that does not give damage to the machine connected to the motor.
If the speed is too low, tuning may fail. Set this parameter to a little larger value that does not give damage to the machine.

(d) Acceleration/Deceleration time
Set the acceleration/deceleration time of pattern operation for auto-tuning.
If the acceleration/deceleration torque is below 10% of the rated torque, set this parameter to a small value. (Refer to the torque data at pattern operation, which is indicated on the display.)

3- Click the [1 pattern tuning start] button.

4- Make sure of safety, turn on the FOT and ROT terminals, and turn on the SON terminal. With this, one-pattern operation is performed to estimate the moment of inertia.

5- After completion of the moment of inertia estimation, download the operation waveform of the last pattern operation from the servo drive and display it.

6- Check if the waveform is enough. If necessary, click the [1 pattern tuning start] button once again. Consequently, one-pattern operation is performed to estimate the moment of inertia. Tuning can be executed by repeating this while each waveform is checked.

7- After completion of tuning, turn on and off the RS terminal to exit from the auto-tuning mode.

Note 1: This function rewrites the set value of inertia Fd-00 automatically.
Note 2: If tuning is aborted halfway, turn on and off the RS terminal to exit from the auto-tuning mode.

5.12 Online Auto-tuning Function

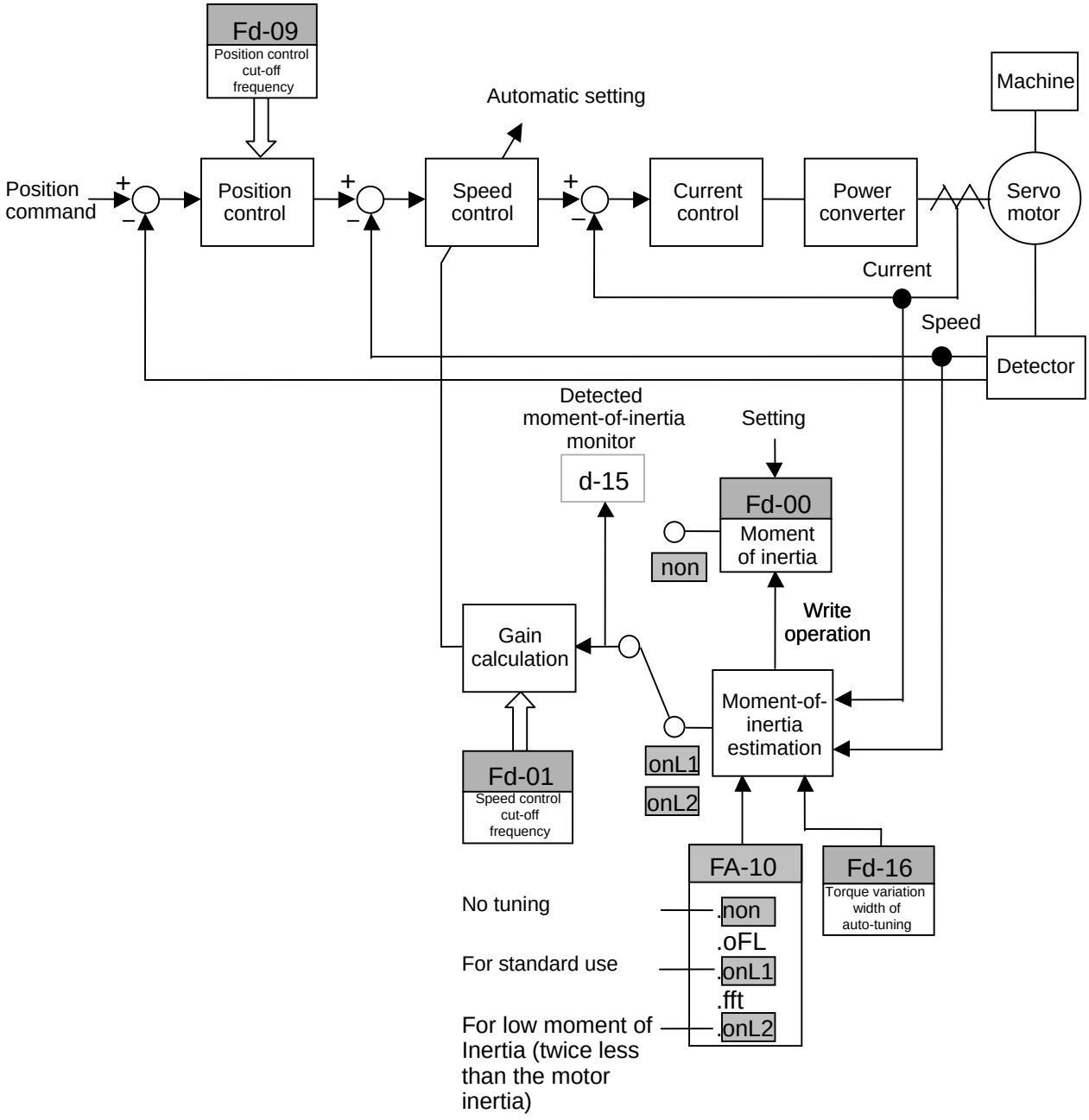
The online auto-tuning function adjusts the gain of the servo system automatically in online mode, without making any adjustment in offline mode beforehand, according to the set the speed control cut-off frequency.

At online auto-tuning, the servo motor is operated with the customer's operation pattern to estimate the value of moment of inertia automatically and to set the parameter Fd-00 correctly.

With this, the control gain is automatically set from the speed control cut-off frequency (Fd-01) that determines the response performance of the speed control loop.

5.12.1 Online Auto-tuning Method

The following figure shows a block diagram of online auto-tuning.



(1) Parameter Constants for Online Auto-tuning
The parameter constants to be used are explained below.

The parameter constants to be used are explained below.

(a) Auto-tuning (FA-10)
This parameter constant gives permission to execute auto-tuning. For executing online auto-tuning, set it to “onL1” or “onL2”. Be sure to set it to “onL1” normally, and if monitor d-15 (Detected moment-of-inertia monitor) is not changed by the shortage of the acceleration / deceleration torque, be sure to set it to “onL2”.

- “onL1” : Set it normally.
- “onL2”: Set it when the moment of inertia of the machine to be connected to the servo motor is little (twice less than the motor inertia).

(b) Speed Control Cut-off Frequency (Fd-01)
This parameter constant determines the response performance of the speed feedback loop. Set it in the range in which the mechanical system does not oscillate. The larger the set value, the higher the response performance.

(c) Position Control Cut-off Frequency (Fd-09)
This parameter constant determines the response performance of the position feedback loop. Set it in the range in which the mechanical system does not oscillate. The larger the set value, the higher the response performance and the shorter the positioning time.
As the setting standard, this parameter constant should be is 1/6 or less of Speed Control Cut-off Frequency (Fd-01).

Table 5.12 shows the rigidity of the machine system and the standard setting gain. Note that these numeric values are only for reference.

Table 5.12

Rigidity of mechanical system	Corresponding machines	Recommended control cut-off frequency [Hz]	
		Position (Fd-09)	Speed (Fd-01)
Low	Machines to be driven by belt or chain - Conveyor	1 to 5	6 to 30
Medium	Machines to be driven by ball screw through a gear - General machine tool - Robot	5 to 10	30 to 60
High	Machines directly connected to a ball screw - Mounter - Bonder	10 or more	60 or more

(2) Online Auto-tuning Operation

1- When the parameter Speed Control Cut-off Frequency (Fd-01) is set, the FOT and ROT terminals are turned on, and the SON terminal is turned on, operation and auto-tuning are started. (The LED indicator of the drive indicates the same value as the normal display.)

2- On the identification moment-of-inertia monitor (d-15), the value of moment of inertia estimated during online tuning can be checked.

3- When the SON terminal is turned off, the estimated value of moment of inertia is written into Fd-00.

Note 1: Perform auto-tuning in the same load condition as the actual operating condition by connecting the servo motor to the machine. Adjust the gain to the optimum status for the load.

Note 2: For auto-tuning, set the control mode of the speed control loop to “Speed PI control” beforehand. (If it is set to “IP control”, tuning cannot be performed correctly.)

Note 3: Note that after tuning is started, it cannot be adjusted correctly, so the operation may be slow.

Note 4: This function is not applicable unless the following conditions are satisfied.
- The acceleration/deceleration torque should be 10% or more of the rated torque.
- The rigidity of the machine including the coupling with the motor should be high.
- Backlash in gears and others should be small.
- The application should be free from problem in safety and give no damage to the machine even in an oscillation status.
- There should be no variation in the pulse train command frequency. (Auto-tuning in the position control mode)
- The moment of inertia of load is less than 20 times of motor one. If it exceeds 20 times, adjust the gain by manual. (Refer to Chapter5 clause 5.10.1 to 5.10.4 for adjustment.)

Note 5: When the machine generates vibration during tuning in the position control mode, set the position control cut-off frequency (Fd-09) to a small value.

(3) Online Procedure in the Auto-tuning Mode

For executing online auto-tuning, select Online Tuning “onL1” or “onL2” in the parameter Auto-tuning (FA-10), and perform “Servo ON” after writing.

(a) If auto-tuning cannot be performed because the load torque varies much during acceleration/deceleration, set the parameter Identification Effective Torque Variation Width (Fd-16) to a larger value according to the torque variation. (Only when the variation width of the load torque is below this set point, identification is performed.)

(b) If accurate tuning cannot be performed by this setting and hunting or overshooting occurs during operation, perform manual setting. Remove the cause of error. Because no trip is caused, take extreme care about the safety upon occurrence of resonance.

5.12.2 Online Auto-tuning Using the Setup Software AHF

When the setup software AHF is used for auto-tuning, the speed and torque data of the servo motor in actual operation can be checked graphically. This procedure is briefly explained below. For details, refer to the instruction manual for the AD series setup software AHF.

(1) Procedure for Auto-tuning

1- Click the Test run and Adjustment buttons on the opening screen.
(Click the online tuning tag.)

2- Set the following parameters required for tuning.

(a) Cut-off Frequency Setting
Set the Speed Control Cut-off Frequency (Fd-01) for auto-tuning.
Set a value that does not cause hunting.

(b) Initial Value of Tuning Moment of Inertia
Set the moment of inertia at a start of auto-tuning. When the approximate value of the moment of inertia is already know, perform setting this value in (Fd-00). If such a value is unclear, the moment of inertia will be estimated by this auto-tuning function without manual setting.

3- When the [Data Trace Valid] button is pressed, the speed and torque waveform of the servo motor are displayed.

Note 1: When the SON terminal is turned off, the estimated value of moment of inertia is written into Fd-00.

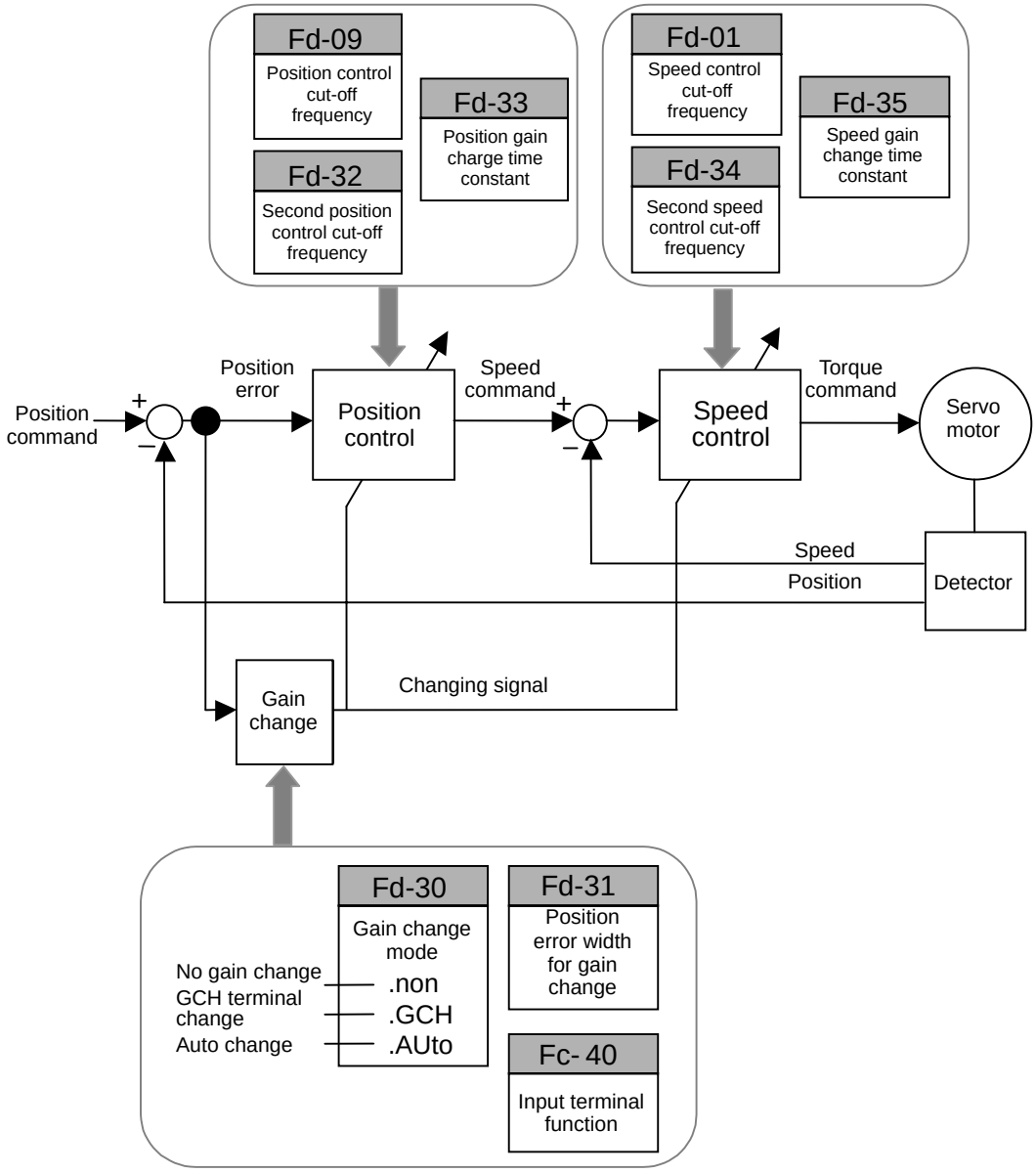
5.13 Gain Change Function

The gain change function switches the position/speed control gain during operation and is used in the following cases.

- To raise the control gain in the servo lock status but to lower the gain to reduce the noise during run.
- To raise the control gain at positioning to reduce the stop positioning time.
- To change the control gain by external signal (input terminal).

5.13.1 Changing the Control Gain

The following figure shows a block diagram of the gain change function.



(1) Parameter Constants for the Gain Change Function
The parameter constants to be used are explained below.

(a) Input Terminal Function (FC-40)
When the “GCH” function of the input terminal is used for gain change, the input terminal must be set to the second function side. (Set the GCH bit to 1. 0: First function, 1: Second function)

(b) Speed Control Cut-off Frequency (Fd-01)
The response performance of the speed control system is set. This is always valid.

(c) Position Control Cut-off Frequency (Fd-09)
The response performance of the position control system is set. This is always valid.

(d) Gain Change Mode (Fd-30)
Whether or not to use the gain change function is set. Input Terminal Switching “GCH” and Auto Switching “AUto” can be set in the position control mode. Input Terminal Switching “GCH” can be set in the speed control mode.

- For GCH
  When GCH is OFF:
  The cut-off frequency of the position control is equal to Position Control Cut-off Frequency (Fd-09). The cut-off frequency of the speed control section is equal to Speed Control Cut-off Frequency (Fd-01).
  When GCH is ON:
  The cut-off frequency of the position control is equal to Second Position Control Cut-off Frequency (Fd-32). The cut-off frequency of the speed control section is equal to Second Speed Control Cut-off Frequency (Fd-34).

- For AUto
  When position error >= position error width for gain change (Fd-31):
  The cut-off frequency of the position control section is equal to Position Control Cut-off Frequency (Fd-09). The cut-off frequency of the speed control section is equal to Speed Control Cut-off Frequency (Fd-01).
  When position error < position error width for gain change (Fd-31):
  The cut-off frequency of the position control is equal to Second Position Control Cut-off Frequency (Fd-32). The response frequency of the speed control is equal to Second Speed Control Cut-off Frequency (Fd-34).

(e) Position Error Width for Gain Change (Fd-31)
Set the “Position error value” to start gain change.

(f) Second Position Control Cut-off Frequency (Fd-32)
Set the position control cut-off frequency after gain change.

(g) Position Gain Change Time Constant (Fd-33)
Set the filter time constant for a gain change at switching (between Fd-09 and Fd-32).

(h) Second Speed Control Cut-off Frequency (Fd-34)
Set the speed control cut-off frequency after gain change.

(i) Speed gain change time constant (Fd-35)
Set the filter time constant for a gain change at switching (between Fd-01 and Fd-34).

(2) Procedure for Setting the Gain Change Function

1- Set the parameter Gain Change Mode to “GCH” or “AUto”.
For “GCH” setting:
- Set the input terminal to the second function side (GCH terminal). (FC-40 setting)
- Turn on and off the GCH terminal to switch the position/speed control gain.

For “AUto” setting:
- Set the Position Error Width for Gain Change (Fd-31).
- The position control gain can be switched according to the relation between Position Error (d-09) and Position Error Width for Gain Change (Fd-31).

2- Set the parameters Second Position Control Cut-off Frequency (Fd-32) and Second Speed Control Cut-off Frequency (Fd-34).
The initial values are as follows:
- The initial value of Second Position Control Cut-off Frequency (Fd-32) is a twofold value (10.00 [Hz]) of Position Control Cut-off Frequency (Fd-09).
- The initial value of Second Speed Control Cut-off Frequency (Fd-34) is a twofold value (60.0 [Hz]) of Speed Control Cut-off Frequency (Fd-01).
- As the setting standard, (Fd-32) should be 1/6 or less of (Fd-34).

3- After setting the above items 1- and 2-, execute “Servo ON”.

Note 1: When the gain difference at gain change is large, a shock may be caused to the machine. In this case, set the parameter Gain Change Time Constant for Position/Speed Control (Fd-35 and Fd-33) to a large value. (The initial value is set to 1 [ms].)

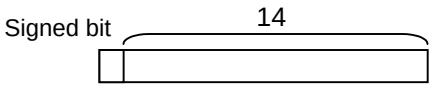
Note 2: When abnormal noise or oscillation occurs in the servo lock status, set the parameter Second Position/Second Speed Control Cut-off Frequency (Fd-32 and Fd-34) to a low value so that the abnormal noise or oscillation may not occur.

5.14 Functions for Absolute Position Encoder

(1) Encoder Data

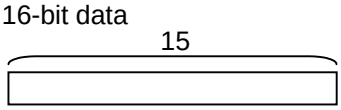
The encoder data is constituted as follows.

Multi-rotation data:



−16384 to 16384

Singed 16-bit data



Data of one rotation or less: 0 to 32767

15-bit data per rotation.

The operation data shown in the following figure is displayed in d-07 to d-09.

(Displayed data) ← (Multi-rotation data) × 2^{15} + (Data of one rotation or less)

(2) Clear Encoder to Zero

When FA-80 = AbS for the absolute position encoder, Absolute Battery Error (E90) may occur. When d-08 goes over 4000.0000 or below C000.0000, Absolute Encoder Counter Overflow (E92) occurs and a trip is caused. In this case, clear the absolute position (Clear Encoder to Zero) according to the following procedure. Only the multi-rotation data of the encoder can be cleared. Cause the upper-level system to manage the data of one rotation or less.

Clear Encoder to Zero can be executed by ECLR input, the digital operator or the setup software AHF.

(2-1) Operating ECLR input

When this signal is ON during 4s or more, the multi-rotation data of absolute encoder is cleared.

In case of clearing E90, E92 or E93, at first ECLR is input during 4s or more. After that RS is input.

(2-2) Operating the Digital Operator

Set FA-98 to AbS and perform a clear operation.

For operational details, refer to 5.15 Clearing the Trip Log and Factory Settings.

(2-3) Operating the Setup Software AHF

Execute Clear Encoder to Zero according to the following procedure.

1- Start the AD series setup software AHF and connect it to the drive.
2- Start the parameter setting screen and click the tool bar “  ”
3- Adjust the initialization mode to Encoder Zero Clear.
4- Click the Initialization Start button.

For the details of the procedure, refer to the item Reverting to Factory Settings in the instruction manual for AD series setup software AHF.

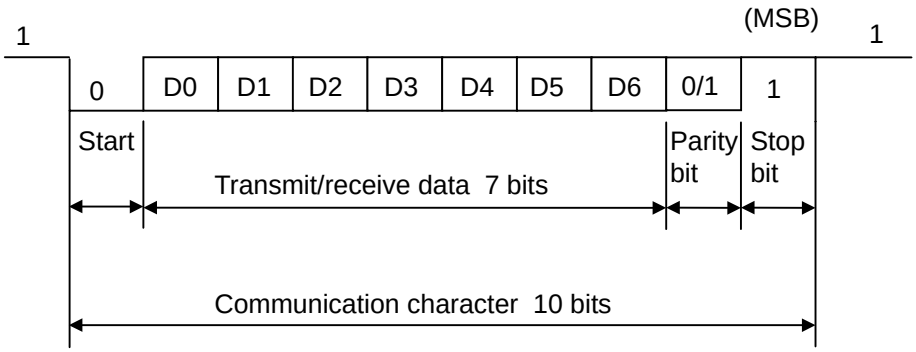
(3) Serial Output of Absolute Position Data

Absolute position data is serial-output by the Phase Z output (OZP, OZN). Its format is shown below.

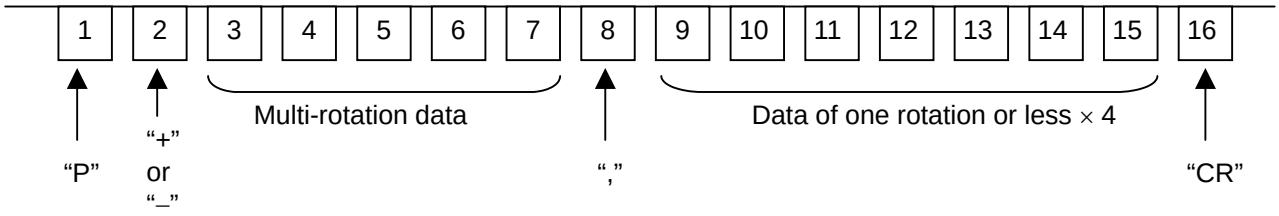
Communication Format

Item	Phase Z output selection FC-12		
	nCunt, ECunt	qFort	
		FA-81=AbSE*	FA-81=AbSA*
Communication system	Start-stop synchronization	Do not use. (This function is not available.) (Do not change the parameter to this setting.)	
Transmission speed (baud rate)	9600 bps		
Start bit	1 bit		
Stop bit	1 bit		
Character length	7 bits		
Parity	Even number		
Transmission code	Decimal ASCII		
Coding	NRZ recording		
Data transfer sequence	LSB (least significant bit) first		
Frame	16 characters		
Data transmission interval	Approx. 40 ms		
Data transmission time	Approx. 17 ms		

The waveform of one character based on this format is shown in the following figure.



The data waveform of one frame is shown in the following figure.



The data structure of one frame is shown in the following table. Number 1 represents the first character.

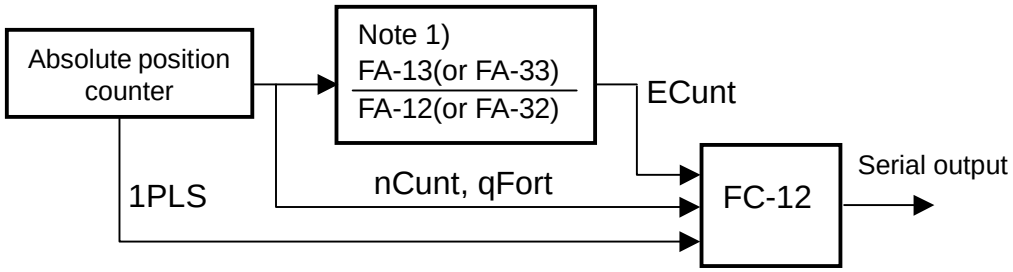
No.	Transmission character	Contents of data
1	"P"	Represents position data.
2	"+" or "–"	Code of rotation speed
3	(Most significant)	Multi-rotation data
4	32768	
5	~ 0000	
6	~ 35767	
7	(Least significant)	
8	","	Delimiter
9	(Most significant)	Absolute position data of one rotation or less (to be converted into 17-bit data of one rotation)
10		
11	0000000 ~	
12	32767 × 4	
13	= 0131068	
14		
15	(Least significant)	
16	CR (0x0D)	Carriage return

Note: The logic of each signal is shown in the following table.

Logic	Direction of current flow
0	OZP←OZN
1	OZP→OZN

When the parameter (FC-12) is set to ECunt, this output data can be serial-output in accordance with the Hitachi EH-POS. In this case, the electronic gear is operated by the reciprocal number of the parameter (FA-12 and FA-13 : EGR2 is OFF / FA-32 and FA-33 : EGR2 is ON). Refer to the following figure.

Phase Z output selection FC-12		Encoder type selection FA-80	
Item	Setting data	Absolute	Incremental
Phase Z output	1PLS	Phase Z output	
Encoder counter Serial output 1	nCunt	Absolute position (without electronic gear)	Incremental position (without electronic gear)
Encoder counter Serial output 2	ECunt	Absolute position (with electronic gear)	Incremental position (with electronic gear)
Encoder counter Serial output 3	qFort	Absolute position (without electronic gear)	Incremental position (without electronic gear)



Note 1: When EGR2 is OFF, (FA-13 / FA-12) is valid. When EGR2 is ON, (FA-33 / FA-32) is valid.
Note 2: In case of ECunt, when the pulse train input is in the decelerating direction, that is to say (FA-12 / FA-13) or (FA-32 / FA-33) < 1, (FA-13 / FA-12) or (FA-33 / FA-32) is larger than 1. So the calculation result overflows.
Accordingly, this data cannot be output correctly.

5.15 Clearing the Trip Log and Factory Settings

The trip log can be cleared, and all the parameters can be reset to the factory settings. The procedure is described below. With this operation, when any parameter data is very different from the estimated value by reason of operation error, the trip log can be cleared or the parameters can be reset to the factory settings according to the following procedure.

(1) Initialization by the Digital Operator

1- Select the initialization mode.

1-1 Open FA-98, select one of the following items according to the contents of initialization.

Clear Trip Log: CH
Factory Setting: dAtA
Clear Encoder to Zero: Abs

1-2 Press the SET key.
(FA-98 is displayed.)
(For setting operations, refer to Chapter 6 Details of Parameters.)

2- Press the ◀ key for 2 seconds or more while pressing the ▼ key.

3- Press and release the SET key while pressing the above key.

With this, initialization is started and the following table is displayed on the display panel.

Contents of initialization	LED indication
Clear trip log	HC
Initialize Japanese data	JP
Clear encoder to zero	AbSC

4- After d-00 reappears on the display panel, turn on the control power supply again.

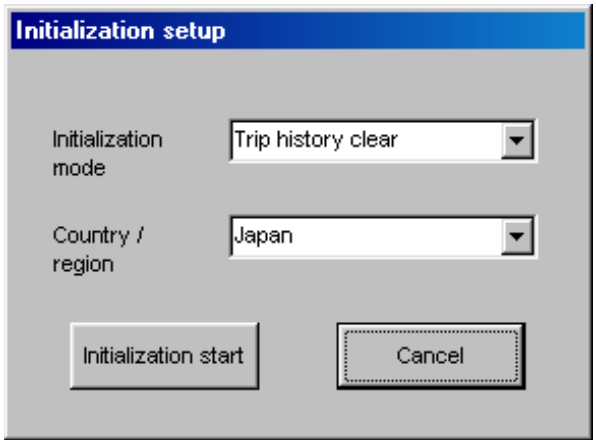
(2) Initialization by the AD series Setup Software AHF

Start the AD series setup software AHF and connect it to the amplifier.

1- On the parameter setting screen, click in tool bar.
(Operation from the pull-down menu is also available.)

2- The following setting screen is started. Set the initialization mode.
The initialization mode can be set in the following items.

Initialization mode
- Trip history clear: Only the trip log is cleared.
- Data initialization: Only the parameter data is cleared.
- Encoder Zero Clear: The multi-rotation data of the absolute encoder is cleared.
(Manage the data of one rotation or less by the master controller.)
- EEPROM program clear: The user program is cleared for the servo drive with programmable function.
(Only the servo drive with programmable function is available.)



3- Click the Initialization Start button. With this, initialization is started.
(Make sure that the aforesaid data is displayed on the display panel of the drive during initialization.)

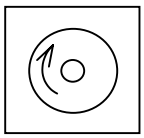
Contents of initialization	LED indication
Clear trip log	HC
Initialize data	JP
Clear encoder to zero	AbSC
EEPROM program clear	PrGC

4- After initialization, the data is read from the drive into the PC and initialization is completed.

Note : Do not turn off the control power supply of the servo drive during initialization to prevent the EEPROM data from damage. Otherwise, the drive may not work normally.

5.16 Directions of Run of the Servo Motor and Servo Drive

In combination of the standard servo drive with the standard servo motor (without gear), the direction of forward run is as shown in the following table. This direction can be changed into the reverse direction by setting the parameter Direction of Motor Forward Run (FA-14).

Rotation	FA-14	
	CC	C
Forward run	 CCW	 CW
Reverse run	 CW	 CCW

Note 1: The above table is a figure viewed from the direction of the motor shaft.

Note 2: For motors whose motor rotating shaft does not output directly, for example, a motor with gear, refer to the installation manual for motor.

5.17 Speed Limit Function

The speed can be limited by Analog Input 1 or the parameters (Fb-20 and Fb-21). In this case, perform settings as shown in the following table.

Contents of setting	AI1 function value FC-03	Speed limitation mode FA-20	Speed limit value	
			Forward run	Reverse run
Limitation from Analog Input AI1	nLit	A1	+ | Analog value |	– | Analog value |
Fixed value by parameter setting	–	non	Fb-20	Fb-21

5.18 Fast positioning Function

This function makes a positioning time the shortest and reduces sharply position error which occurs during the positioning movement. Used parameters in this function are explained in the following.

Fast positioning mode (Fd-40)

There are two functions. One is “Fast positioning mode”, which makes a positioning time the shortest. When you use it, Fd-40 is set to “FAst”. The other is “Minimum position error control”, which reduces position error sharply. When you use it, Fd-40 is set to “FoL”.

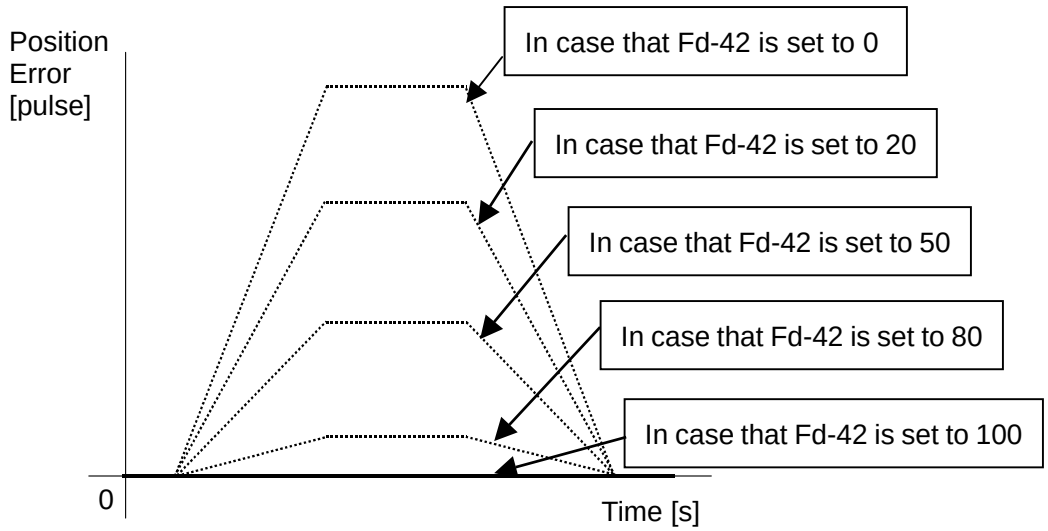
(1) Fast positioning mode “FAst”

When the parameter Fd-40 is set to “FAst” from “non” or “FoL”, the parameter Fd-10 and Fd-41 are automatically set to optimum values. Before changing to “FAst”, be sure to set control constant parameters expressed as Fd-** except Fd-10 and Fd-41.

But position overshoot may occur depending on machine conditions which is connected to servo motor. In that case, be sure to adjust the parameter Fd-10 in order not to make position overshoot occur.

(2) Minimum position error control “FoL”

When the parameter Fd-40 is set to “FoL”, the minimum position error control is performed. At this function, the parameter Fd-42 can adjust the position error which occurs during positioning. Refer to the following figure.



The relationship between position error and parameter Fd-42 setting value in case of position control mode (Fd-40=FoL)

5.19 Notch filter Function

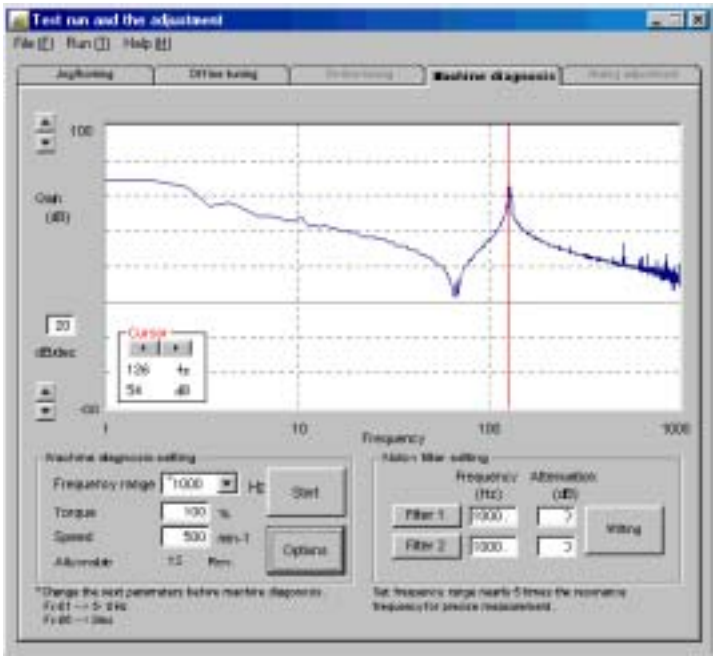
By reducing the gain against the specific frequency, this function reduces the vibration produced by mechanical resonance. Used parameters in this function are explained in the following. These parameters are sure to be set by “mechanical system diagnosis” function in the setup software AHF. For the detail of this function, refer to the instruction manual for AHF.

(1) Notch filter 1 frequency (Fd-12)
This is the first notch filter.
The frequency 1 at which the gain is reduced is set in this parameter.

(2) Notch filter 1 bandwidth (Fd-13)
The extinction ratio 1 used with the frequency 1 is set in this parameter.
When this parameter is set to 0, notch filter 1 is not performed.

(3) Notch filter 2 frequency (Fd-14)
This is the second notch filter.
The frequency 2 at which the gain is reduced is set in this parameter.

(4) Notch filter 2 bandwidth (Fd-15)
The extinction ratio 2 used with the frequency 2 is set in this parameter.
When this parameter is set to 0, notch filter 2 is not performed.



The display of “mechanical system diagnosis” function in the setup software AHF

MEMO

CHAPTER 6 DETAILS OF PARAMETERS

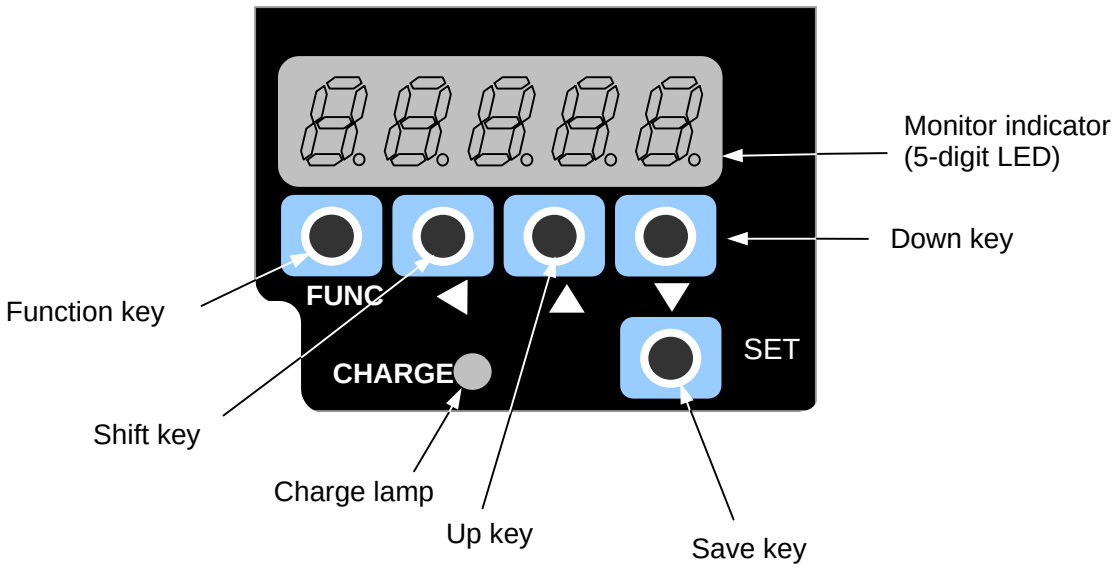
This chapter describes the names of parts of the digital operator built in this product and how to operate it, and explains the details of each monitor indication and each setting parameter.

CHAPTER 6 DETAILS OF PARAMETERS

6.1 Names of Digital Operator Parts and Operating the Digital Operator

6.1.1 Names of Digital Operator Parts

The AD series is operated from the built-in digital operator.

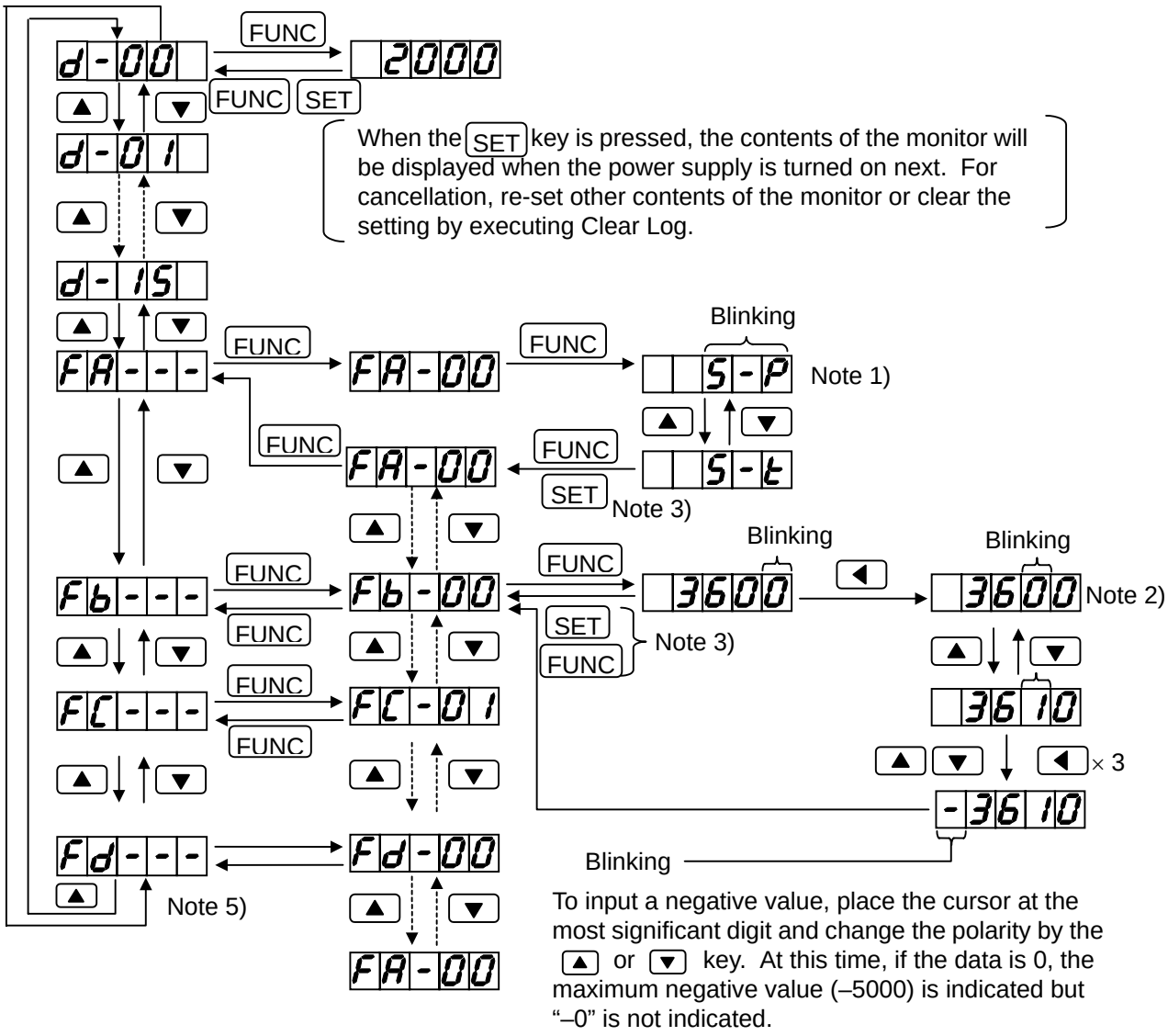


Name	Contents
Monitor indicator	Indicates a monitor value or set value.
Charge lamp	Lights up when the voltage charged on the DC bus capacitor exceeds about 30 V.
FUNC Function key	Used to enter the monitor mode or parameter setting mode.
Shift key	Moves the indication digit or setting digit to the left. When the SHIFT key is pressed at the leftmost end, the position moves to the right end.
Up key Down key	Used to change a monitor number, setting parameter number, or set value.
SET Save key	Saves a set parameter into memory.

6.1.2 Operating the Digital Operator

(1) Changing a monitor indication or parameter setting

The button mark over/under ⇄ or by the side of ↓↑ means that this button has been pressed. To save input data into the memory, be sure to press the SET key. If the FUNC key is pressed, the previous value remains as it is.



Layer 1 Layer 2 Layer 3

Note 1: When the FUNC key is continuously pressed on the display of layer 1, the layer is changed in the order to Later 2 → Layer 3 → Layer 2 → Layer 1. The parameter name to be indicated by the FUNC key at FA---(Layer 1) is indicated as the parameter name if up to Layer 3 has been indicated.

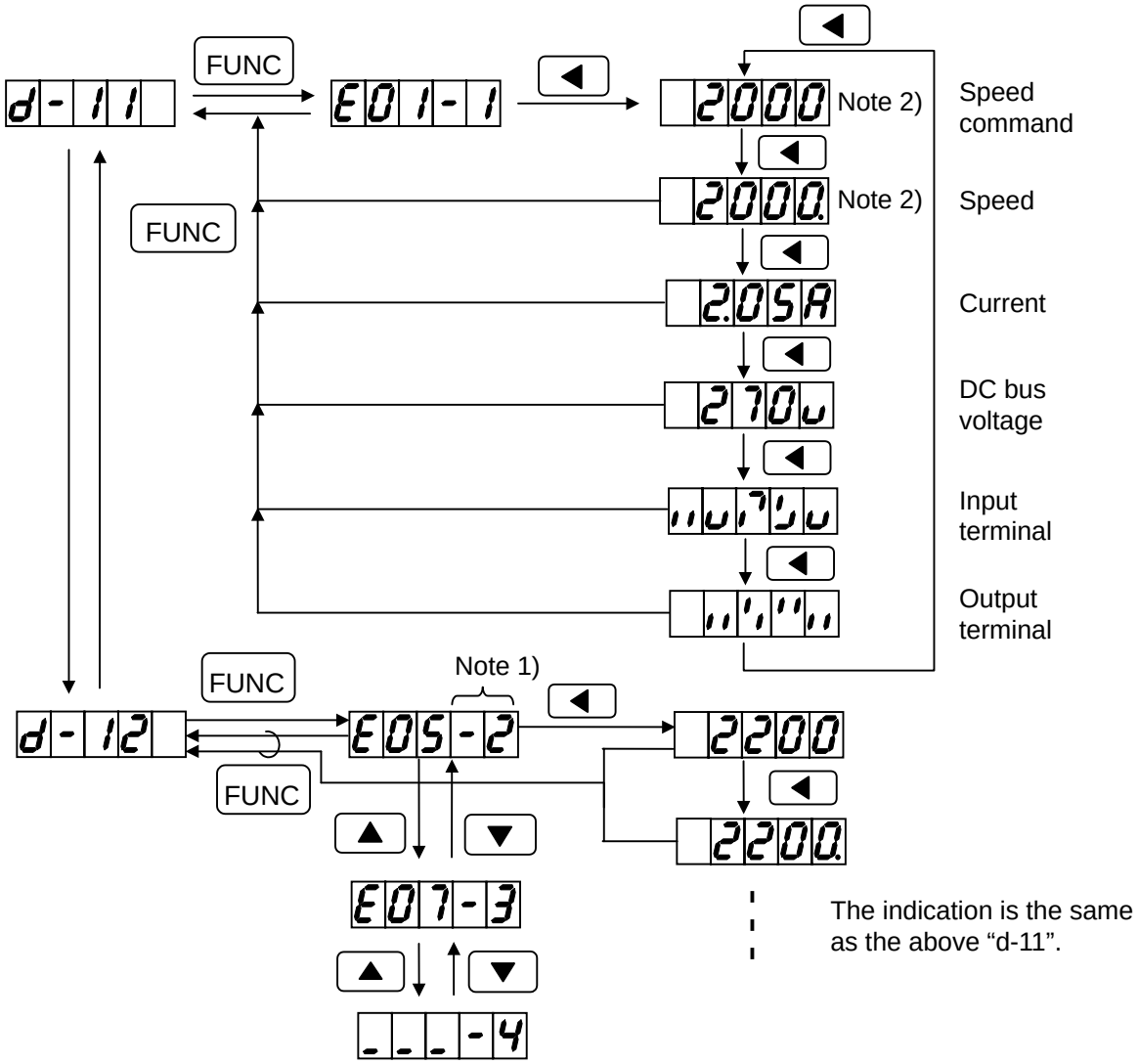
Note 2: The blinking part indicates the current cursor position.

Note 3: When SET key is pressed, the input data is saved into the memory.
When the FUNC key is pressed, the input data is cancelled and the previous value remains as it is.

Note 4: To change the parameter FA-12 or FA-13 from "100" into "001", the input is limited by the minimum value. Accordingly, set "101" and then change this setting into "001".

Note 5: To transfer from the monitor indication (d-xx) to the parameter setting (FA to Fd) indication, use the ▲ or ▼ key to make it quicker.

(2) Operating the trip monitor and the trip log monitor
The button mark over/under ⇄ or by the side of ↓↑ means that this button has been pressed.



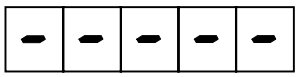
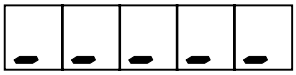
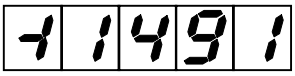
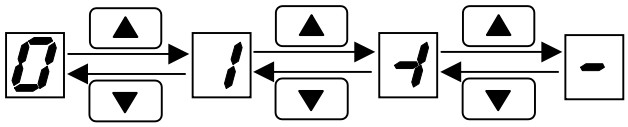
This is indicated when no log is available.

Note 1: The number at the right of the trip factor code denotes the log number.
“1” is the newest. As the number increases, the log number becomes older.
For details, refer to 9.1 Trip Indication.

Note 2: The contents of the following table can be identified by the period of the last digit.

Period	Contents of indication	Remarks
Without period	Speed command	This identification is used for only the trip log monitor.
With period	Speed detection	

(3) Specific indication
A specific indication appears depending on the servo drive status as shown in the following table.

Indication	Contents
	The voltage is insufficient at Servo OFF. (Control power supply)
	No trip log is available.
	User initialization is in progress (rotation of the most significant digit)
	Log initialization is in progress (rotation of the most significant digit)
	The multi-rotation position of the absolute position encoder is cleared.
	A smaller value of –10000 to –19999 is set in Fb-14, Fb-16 or Fb-18. (The value of the most significant digit is only 1. So attach a negative sign.) The example shown at left is an indication of –11491. <Input method for Fb-14, Fb-16, and Fb-18> As a rule, place [◀] at the digit to be changed and select a numeric value to be input by the [▲] or [▼] key. However, the most significant digit is indicated as follows:  Press the [SET] key at the numeric value to be input.

CHAPTER 6 DETAILS OF PARAMETERS

6.2 List of Functions

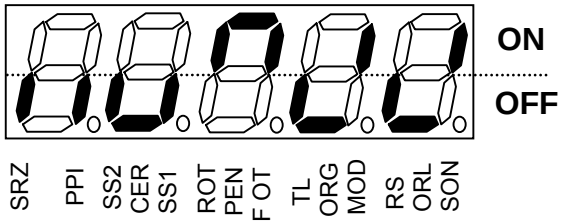
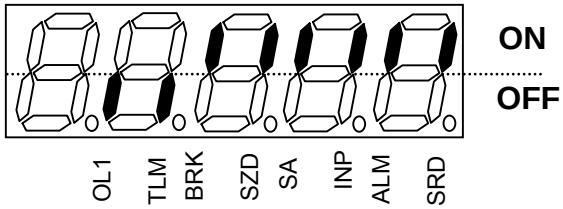
The monitors and parameters that can be set for the servo drive are explained below.

Group	Contents
d-xx	Monitor parameter of speed, position and so on
FA-xx	Operation mode or protection level setting parameter
Fb-xx	Operation constant or limit setting parameter
FC-xx	Input / Output terminal setting parameter
Fd-xx	Control constant setting parameter of moment of inertia, response and so on
FP-xx	Setting parameter regarding DeviceNet Refer to the instruction manual of servo drives with DeviceNet

xx means the parameter number.

The list of parameters are shown from the next page.

6.2.1 List of Monitor Functions

Item	Parameter No.	Parameter name	Indication range	Indication unit
Monitor parameter	d-00	Speed command monitor	-7000~7000	min^{-1}
	d-01	Speed detection value monitor	-7000~7000	min^{-1}
	d-02	Output current monitor	0~400	%
	d-03	Torque command monitor	-400~400	%
	d-04	Output torque monitor	-400~400	%
	d-05	Input terminal monitor		-
	d-06	Output terminal monitor		-
	d-07	Position command monitor	80000000 (negative maximum)~7FFFFFFF (positive maximum)	Pulse
	d-08	Present position monitor	80000000 (negative maximum)~7FFFFFFF (positive maximum)	Pulse
	d-09	Position error monitor	80000000 (negative maximum)~7FFFFFFF (positive maximum)	Pulse
	d-10	Output voltage monitor	0~400	V
	d-11	Trip monitor	Upon occurrence of a trip, the speed command value, speed detection value, current value, DC bus voltage, input terminal information, and output terminal information are indicated.	-
	d-12	Trip log monitor	The past 3 trip logs except the latest, which are in memory, are indicated. Upon occurrence of a trip, the speed command value, speed detection value, current value, DC bus voltage, input terminal information, and output terminal information are indicated.	-
	d-13	Operation control mode	trq / SPd / PoS	-
	d-14	Operation status	non / run / trP / Fot / rot / ot	-
	d-15	Detected moment-of-inertia monitor	Rotor inertia of motor~ Rotor inertia of motor × 128	$\times 10^{-4}$ $Kg \cdot m^2$
	d-16	Encoder phase Z monitor	0 ~ 8192(17bits/rotation incremental encoder) 0 ~ 8191(Wiring saving incremental encoder) (The maximum value is the same as FC-09.)	Pulse
	d-17	Don't use	Don't use this parameter!	-
	d-32	Regenerative braking operating ratio monitor	0 ~ 100	%

6.2.2 List of Setting Parameters

The parameter setting ranges and initial values are shown in the following table.

(1) Operation mode parameters

Item	Parameter No.	Parameter name	Setting range	Initial setting	Setting unit	Change during operation
Operation mode parameter	FA-00	Control mode	S-P, S-t, P-t, P-S, t-S, t-P	S-P	-	×
	FA-01	Encoder wire breaking detection	on, oFF	on	-	×
	FA-02	Allowable time of power failure	0.00, 0.05~1.00	0.00	s	×
	FA-03	Overspeed error detection level	0~150	110	%	×
	FA-04	Speed error detection value	0~maximum speed	maximum speed	min^{-1}	×
	FA-05	Position error detection value	0.0~100.0	20.0	Rotation	×
	FA-07	DC bus power supply	L123, Pn	L123		×
	FA-08	Regenerative braking operating ratio	0.0~100.0	0.5	%	×
	FA-09	Overload notice level	20~100	80	%	×
	FA-10	Auto tuning mode	non, oFL, onL_1 FFt, onL_2	non	-	×
	FA-11	Pulse train input mode	F-r, P-S, A-b r-F, -P-S, b-A	P-S	-	×
	FA-12	Electronic gear numerator	1~65535	1	-	×
	FA-13	Electronic gear denominator	1~65535	1	-	×
	FA-14	Motor revolution direction	CC, C	CC	-	×
	FA-15	High resolution mode	oFF, on	oFF	-	×
	FA-16	DB Operation selection	non, trP, SoF	non	-	×
	FA-17	Torque limit mode	non, A2, oP	non	-	×
	FA-18	Torque bias mode	non, CnS A2, oP	non	-	×
	FA-19	Torque command selection	A2, oP	A2	-	×
	FA-20	Speed limit mode	non, A1, oP	non	-	×
	FA-21	Speed command selection	CnS, A1 oP, A1S	A1	-	×
	FA-22	Position command selection	PLS, Pro, oP	PLS	-	×
	FA-23	Homing mode	L-F, L-r, H1-F, H1-r, H2-F, H2-r, CP	L-F	-	×
	FA-24	Servo OFF wait time	0.00~1.00	0.00	s	×
	FA-25	Operation range at machine diagnosis	1~255	10	Rotation	×

Item	Parameter No.	Parameter name	Setting range	Initial setting	Setting unit	Change during operation
Operation mode parameter	FA-26	Brake operation start speed	0~maximum speed	30	min^{-1}	×
	FA-27	Brake operation start time	0, 0.004~1.000	0.000	s	×
	FA-28	Electronic thermal level	20~125	105	%	×
	FA-32	Electronic gear 2 numerator	1 ~ 65535	1	-	×
	FA-33	Electronic gear 2 denominator	1 ~ 65535	1	-	×
	FA-80	Encoder type selection	inC, AbS	inC	-	×
	FA-81	Encoder selection	Stnd, inCE, AbSE1, AbSE2, AbSA2, AbSA4	inCE	-	×
	FA-82	Encoder resolution	500 ~ 65535 pulse / rotation (FA-81=inCE) $2^{13 \sim 22}$ (FA-81≠inCE)	8192	Pulse	×
	FA-83	Operating mode selection in case of counter overflow	trP, non	trP	-	×
	FA-98	Initialization mode selection	CH, dAtA, AbS	CH	-	×

(2) Operation constant parameters

Item	Parameter No.	Parameter name	Setting range	Initial setting	Setting unit	Change during operation
Operation constant parameter	Fb-00	Multistage speed 1	0~ ± maximum speed	0	min^{-1}	O
	Fb-01	Multistage speed 2	0~ ± maximum speed	0	min^{-1}	O
	Fb-02	Multistage speed 3	0~ ± maximum speed	0	min^{-1}	O
	Fb-03	Jogging speed	0~±300	30	min^{-1}	O
	Fb-04	Acceleration time	0.00~99.99	10.00	s	O
	Fb-05	Deceleration time	0.00~99.99	10.00	s	O
	Fb-07	Torque limit value 1 (first quadrant)	0~maximum torque	300	%	O
	Fb-08	Torque limit value 2 (second quadrant)	0~maximum torque	300	%	O
	Fb-09	Torque limit value 3 (third quadrant)	0~maximum torque	300	%	O
	Fb-10	Torque limit value 4 (fourth quadrant)	0~maximum torque	300	%	O
	Fb-11	Torque bias value	0~± maxinum torque	0	%	O
	Fb-12	Homing speed 1 (high speed)	1~maximum speed	1200	min^{-1}	O
	Fb-13	Homing speed 2 (low speed)	1~999	60	min^{-1}	O
	Fb-14	Homing position offset value (H)	±0~±19999	0	Pulse	O
	Fb-15	Homing position offset value (L)	0~99999	0	Pulse	O
	Fb-16	Forward position (H)	±0~±19999	0	Pulse	O
	Fb-17	Forward position (L)	0~99999	0	Pulse	O
	Fb-18	Reverse position (H)	±0~±19999	0	Pulse	O
	Fb-19	Reverse position (L)	0~99999	0	Pulse	O
	Fb-20	Forward speed limit value	0~maximum speed	maximum speed	min^{-1}	O
	Fb-21	Reverse speed limit value	- maximum speed~0	- maximum speed	min^{-1}	O
	Fb-22	Zero speed detection value	0.0~999.9	5.0	min^{-1}	O
	Fb-23	Positioning defection range	1~65535	100	Pulse	O
	Fb-24	Positioning interval time limit	0.00~10.00 (in 0.02 units)	0.00	s	O
	Fb-25	Up to speed detection range	0~100	10	min^{-1}	O
	Fb-30	S-curve ratio	non, SHArP, rEGLr, LooSE	non	-	O

(3) Input/output terminal parameters

Item	Parameter No.	Parameter name	Setting range	Initial setting	Setting unit	Change during operation
Input/output terminal parameter	FC-01	Input terminal polarity setting	0000~3FFF	0000	-	×
	FC-02	Output terminal polarity setting	0000~00FF	0002	-	×
	FC-03	Analog input 1 function selection	nrEF, nbiAS, nLit	nrEF	-	×
	FC-04	Analog input 2 function selection	tLit, tbiAS, trEF	trEF	-	×
	FC-05	Analog input 1 gain	0.000~±9.999	1.000	-	×
	FC-06	Analog input 2 gain	0.000~±9.999	1.000	-	×
	FC-07	Analog input 1 offset	0.000~±9.999	0.000	V	×
	FC-08	Analog input 2 offset	0.000~±9.999	0.000	V	×
	FC-09	Numerator for encoder monitor resolution	1 ~ 8192	4096	Pulse	×
	FC-10	Denominator for encoder monitor resolution	1 ~ 8192	8192	-	×
	FC-11	Encoder monitor polarity	A, b	b	-	×
	FC-12	Phase Z output selection	1PLS, nCunt Ecunt	1PLS	-	×
	FC-15	Analog input 3 gain	0.000 ~ 9.999	1.000	-	×
	FC-16	Analog input 4 gain	0.000 ~ 9.999	1.000	-	×
	FC-17	Analog input 3 offset	0.000 ~ ±9.999	0.000	V	×
	FC-18	Analog input 4 offset	0.000 ~ ±9.999	0.000	V	×
	FC-19	Command pulse filter time constant	Lo, Hi	Hi	-	×
	FC-21	Communication baud rate	1200, 2400, 4800, 9600, 19200, 38400	19200	bps	×
	FC-22	Communication bit length	7, 8	8	Bit	×
	FC-23	Communication parity	Non, odd, EvEn	non	-	×
	FC-24	Communication stop bit	1, 2	2	-	×
	FC-30	Monitor output 1 function	nrF, nFb, iFb, tqr, nEr, PEr, PFq, brd	nFb	-	×
	FC-31	Monitor output 1 polarity	SiGn, AbS	SiGn	-	×
	FC-32	Monitor output 1 gain	0.0~3000.0	100.0	%	×
	FC-33	Monitor output 2 function	nrF, nFb, iFb, tqr, nEr, PEr, PFq, brd	tqr	-	×
	FC-34	Monitor output 2 code	SiGn, AbS	SiGn	-	×
	FC-35	Monitor output 2 gain	0.0~3000.0	100.0	%	×
	FC-40	Input terminal function	0~3FFF	0	-	×
	FC-45	Alarm code output enable	nor, ALC	nor	-	×
	FC-50	Full closed control enable	SCLS, FCLS	SCLS	-	×
	FC-70	Debug mode selection	0	0	-	-

(4) Control constant parameters

Item	Parameter No.	Parameter name	Setting range	Initial setting	Setting unit	Change during operation
Control constant parameter	Fd-00	Moment of Inertia	Rotor inertia of motor~ Rotor inertia of motor × 128	Rotor inertia of motor	$\times 10^{-4}$ kg•m^2	O
	Fd-01	Speed control cut-off frequency	0.1~500.0	30.0	Hz	O
	Fd-02	Speed control proportional gain	0.01~300.00	100.00	%	O
	Fd-03	Speed control integral gain	0.01~300.00	100.00	%	O
	Fd-04	P-control gain	0.1~99.9	10.0	%	O
	Fd-05	IP-control gain	0.00~1.00	0.00	-	O
	Fd-06	Torque command filter time constant	0.00~500.00	2.00	ms	O
	Fd-07	Position phase compensating ratio	0.01~9.99	1.00	-	O
	Fd-08	Position phase compensating time constant	0.1~999.9	100.0	ms	O
	Fd-09	Position control cut-off frequency	0.01~99.99	5.00	Hz	O
	Fd-10	Position feed forward gain	0.00~1.00	0.00	-	O
	Fd-12	Notch filter 1 frequency	3.0~1000.0	1000.0	Hz	O
	Fd-13	Notch filter 1 bandwidth	0~40	0	dB	O
	Fd-14	Notch filter 2 frequency	3.0~1000.0	1000.0	Hz	O
	Fd-15	Notch filter 2 bandwidth	0~40	0	dB	O
	Fd-16	Torque variation width of auto tuning	5~100	30	%	O
	Fd-20	Speed command filter time constant	0~60000	0	ms	O
	Fd-30	Gain switch mode	non, GCH, AUto	non	-	O
	Fd-31	Position error width for gain change	0~65535	1000	Pulse	O
	Fd-32	Second position control cut-off frequency	0.01~99.99	10.00	Hz	O
	Fd-33	Position gain change time constant	0.0~500.0	1.0	ms	O
	Fd-34	Second speed control cut-off frequency	0.1~500.0	60.0	Hz	O
	Fd-35	Speed gain change time constant	0.0~500.0	1.0	ms	O
	Fd-36	Position command filter time constant	0~60000	0	ms	O
	Fd-40	Fast positioning mode	non, FASt, FoL	non	-	×
	Fd-41	Position feed forward filter time constant	0.0 ~ 500.0	0.00	ms	O
	Fd-42	Position error filter gain	0 ~ 100	100	%	O

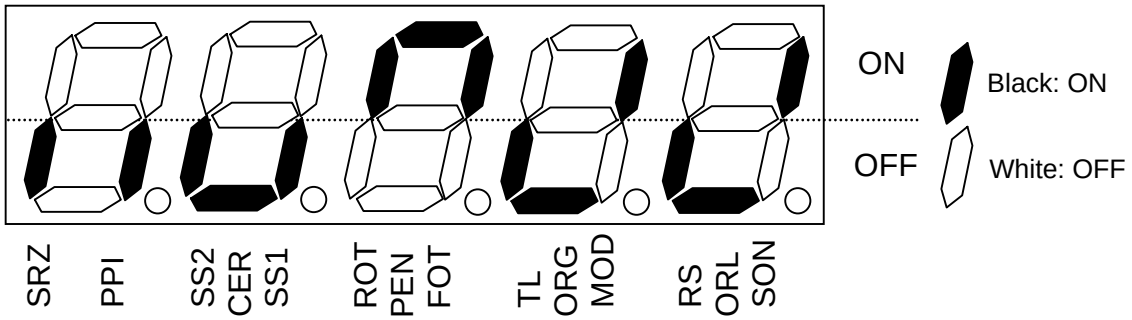
6.3 Details of Functions

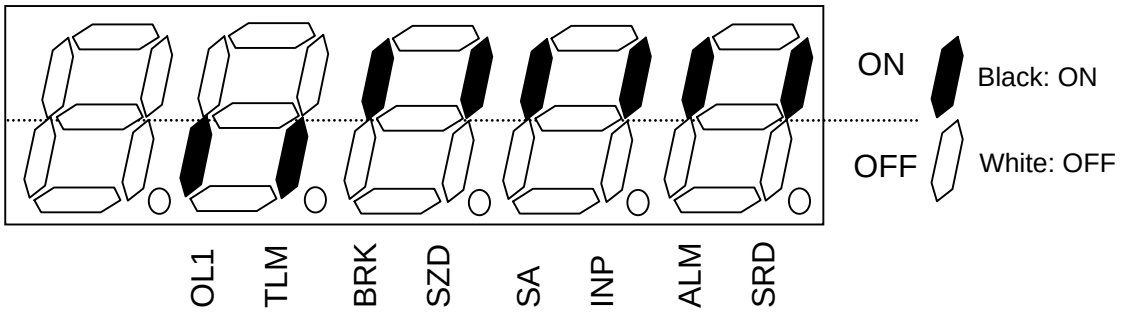
6.3.1 Details of Monitor Indication

To indicate the contents of a parameter when turning on the power supply, press the SET key in the monitor indication status. With this, the contents of monitor will be indicated when the SET key is pressed on the next power ON time. The contents can be cancelled by Clear Trip Log.

Monitor No.	Monitor name	Indication range	Contents
d-00	Speed command monitor	-7000~7000 (min^{-1})	The signed speed command value is indicated in 1 min^{-1} units.
d-01	Speed detection value monitor	-7000~7000 (min^{-1})	The signed speed detection value is indicated in 1 min^{-1} units.
d-02	Output current monitor	0~400 (%)	The output current is indicated in 1% units.
d-03	Torque command monitor	-400~400 (%)	The torque command is indicated in 1% units.
d-04	Output torque monitor	-400~400 (%)	The output torque is indicated in 1% units.
d-05	Input terminal monitor	The input terminal status is indicated. (Refer to the following figure.)	

In the following example, SON, MOD, FOT, ROT and PEN are ON, and the others are OFF.



<table>
<tr><th>Monitor No.</th><th>Monitor name</th><th>Indication range</th><th>Contents</th></tr>
<tr><td>d-06</td><td>Output terminal monitor</td><td colspan="2">The output terminal status is indicated. (Refer to the following figure.)</td></tr>
<tr><td colspan="4">In the following example, OL1 and TLM are OFF, and the others are ON.
 
</td></tr>
<tr><td>d-07</td><td>Position command monitor</td><td>80000000 (negative maximum)
~
7FFFFFFF (positive maximum)
(Pulse)</td><td>The position command is indicated in a hexadecimal 32-bit signed (two’s complement) value. Immediately after d-07 is opened, the 5 low-order digits are indicated. The indication is shifted to the high-order digits by pressing [◁] and the high-order digits can be checked. (A decimal point is indicated between the high-order word and the low-order word.)</td></tr>
<tr><td>d-08</td><td>Present position monitor</td><td>80000000 (negative maximum)
~
7FFFFFFF (positive maximum)
(Pulse)</td><td>The present position is indicated in a hexadecimal 32-bit signed (two’s complement) value. Immediately after d-08 is opened, the 5 low-order digits are indicated. The indication is shifted to the high-order digits by pressing [◁] and the high-order digits can be checked. (A decimal point is indicated between the high-order word and the low-order word.)</td></tr>
<tr><td>d-09</td><td>Position error monitor</td><td>80000000 (negative maximum)
~
7FFFFFFF (positive maximum)
(Pulse)</td><td>The position deviation is indicated in a hexadecimal 32-bit signed (two’s complement) value. Immediately after d-09 is opened, the 5 low-order digits are indicated. The indication is shifted to the high-order digits by pressing [◁] and the high-order digits can be checked. (A decimal point is indicated between the high-order word and the low-order word.)</td></tr>
<tr><td>d-10</td><td>Output voltage monitor</td><td>0~400(V)</td><td>The output voltage is indicated in 1 V units.</td></tr>
<tr><td>d-11</td><td>Trip monitor</td><td colspan="2">The last trip factor, speed command value, speed detection value, current value, and DC bus voltage are indicated. When [◁] is pressed, the data is indicated in the following sequence.
Trip factor: E01, etc. (The last digit of –1 denotes the latest information.)
Speed command value: –5000 (The period is not indicated.)
Speed detection value. –5000. (The period is indicated.)
Current value: 4.60A
DC bus voltage: 270u
Input terminal information: Complies with the indication of d-05.
Output terminal information: Complies with the indication of d-06.</td></tr>
</table>

<table>
<tr><th>Monitor No.</th><th>Monitor name</th><th>Indication range</th><th>Contents</th></tr>
<tr><td>d-12</td><td>Trip log monitor</td><td>Refer to the example shown at right.</td><td>The saved past 3 trip logs except the latest are indicated. When [△] or [▽] is pressed, only the trip factor is indicated. When [◁] is pressed, the details of trip are indicated.
Trip factor: E01, etc. (As the value of the last digit increases, the log is older.)
Speed command value: –5000 (The period is not indicated.)
Speed detection value: –5000. (The period is indicated.)
Current value: 4.60A
DC bus voltage: 270u
Input terminal information: Complies with the indication of d-05.
Output terminal information: Complies with the indication of d-06.</td></tr>
<tr><td>d-13</td><td>Operation control mode monitor</td><td>trq (torque control)
SPd (speed control)
PoS (position control)</td><td>The current operation mode is indicated.</td></tr>
<tr><td>d-14</td><td>Operation status monitor</td><td>non (normal stop)
run (run)
TrP (error)
Fot (forward overtravel)
rot (reverse overtravel)
ot (run inhibit stop)</td><td>The drive operation status is indicated as shown in the following figure.
<table>
<tr><th rowspan="2">Indication of d-14</th><th colspan="3">Terminal status</th><th rowspan="2">Remarks</th></tr>
<tr><th>SON</th><th>Fot</th><th>rot</th></tr>
<tr><td rowspan="3">non</td><td rowspan="3">OFF</td><td>ON</td><td>ON</td><td rowspan="3">Stop status</td></tr>
<tr><td>OFF</td><td>ON</td></tr>
<tr><td>ON</td><td>OFF</td></tr>
<tr><td>run</td><td>ON</td><td>ON</td><td>ON</td><td>Servo ON status</td></tr>
<tr><td>TrP</td><td>–</td><td>–</td><td>–</td><td>Trip status</td></tr>
<tr><td>Fot</td><td>ON</td><td>OFF</td><td>ON</td><td>Forward run inhibit and servo ON status</td></tr>
<tr><td>rot</td><td>ON</td><td>ON</td><td>OFF</td><td>Reverse run inhibit and servo ON status</td></tr>
<tr><td>ot</td><td>–</td><td>OFF</td><td>OFF</td><td>Forward/ reverse run inhibit and servo ON status</td></tr>
</table></td></tr>
<tr><td>d-15</td><td>Detected moment-of-inertia monitor</td><td>Rotor inertia of motor~ Rotor inertia of motor × 128 (× 10^{-4} kgm^2)</td><td>When online auto tuning is selected, the estimated moment of inertia is indicated. However, the moment of inertia set in the parameter Fd-00 is usually indicated.</td></tr>
</table>

Monitor No.	Monitor name	Indication range	Contents
d-16	Encoder phase Z monitor	0 ~ 8192 (17bits/rotation incremental encoder) 0 ~ 8191 (Wiring saving incremental encoder) (The maximum value is the same as FC-09.)	The position monitor which shows the encoder phase Z is displayed. The position of the phase Z is set to the monitor display value = 0. A count value increases by forward rotation. And which direction is forward is selected at FA-14. This monitor's maximum value is the same as FC-09.
d-17	Don't use	—	Don't use this parameter!
d-32	Regenerative braking operating ratio monitor	0 ~ 100 (%)	The operating ratio of the regenerative braking resistor during 5 seconds is indicated. When the operating ratio reaches FA-08, the monitor displays 100. For example, in case that FA-08 is set at 0.5(%), when the regenerative braking resistor works beyond 0.025(s) during 5 seconds ($5 \times 0.005 = 0.025$), a trip is caused. When the trip is caused, the monitor value is 100.

6.3.2 Details of Setting Parameters

(1) Operation mode parameters, etc.

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FA-00</td><td>Control mode</td><td>S-P, P-S, S-t, t-S, t-P, P-t [S-P]</td><td>A selectable combination is set with a control mode switching input.
<table>
<tr><th>Set value</th><th>MOD terminal = OFF</th><th>MOD terminal = ON</th></tr>
<tr><td>S-P</td><td>Speed control</td><td>Position control</td></tr>
<tr><td>P-S</td><td>Position control</td><td>Speed control</td></tr>
<tr><td>S-t</td><td>Speed control</td><td>Torque control</td></tr>
<tr><td>t-S</td><td>Torque control</td><td>Speed control</td></tr>
<tr><td>t-P</td><td>Torque control</td><td>Position control</td></tr>
<tr><td>P-t</td><td>Position control</td><td>Torque control</td></tr>
</table></td></tr>
<tr><td>FA-01</td><td>Encoder wire breaking detection</td><td>ON, OFF [ON]</td><td>Trip or no trip is selected upon occurrence of an encoder error (or detection of disconnection). At on, a trip is caused by Encoder Error (E39) upon occurrence of an encoder communication error. At oFF, no trip is caused by E39 upon occurrence of an encoder communication error. At oFF, however, if the internal counter detects an error in the encoder, a trip (E39) is caused. When the power supply is turned on when the encoder is not connected, a trip (E39) is caused at servo ON regardless of this parameter. Usually, set this parameter to on. In case of emergency and necessary to ignore E39, set this parameter to oFF temporarily to avoid an urgent situation. After avoiding the situation, be sure to set this parameter back to on.</td></tr>
<tr><td>FA-02</td><td>Allowable time of power failure</td><td>0.00, 0.05~1.00 (s) [0.0]</td><td>The allowable time for power failure (main circuit power supply OFF, main circuit power supply missing phase, or insufficient main circuit power supply) is set. At 0.00, the above instantaneous power failure is not detected. (200V class only)</td></tr>
<tr><td>FA-03</td><td>Overspeed error detection level</td><td>0~150 (%) [110]</td><td>When the speed detection value becomes an abnormally high value for the maximum speed, a trip is caused as Overspeed Error. This error detection value is set in this parameter. Set it by the ratio to the maximum motor speed. When 0 is set, overspeed error detection is not performed.</td></tr>
<tr><td>FA-04</td><td>Speed error detection value</td><td>0~ maximum speed *1 (min^{-1}) [maximum speed]</td><td>When the speed error (difference between the speed command value and the speed detection value) becomes an abnormally large value, a trip is caused as Speed Error. This error detection value is set in this parameter. When 0 is set, speed error detection is not performed.</td></tr>
</table>

*1: The maximum rotation speed of the motor. Check the specifications of the motor.

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FA-05</td><td>Position error detection value</td><td>0.0~
100.0
(Rotation)
[20.0]</td><td>When the position deviation (difference between the position command value and the position detection value) becomes an abnormally large value, a trip is caused as Position Deviation Error. This error detection value is set.
This error detection value is set by rotation speed. For example, when the rotation speed is 2 rotations and a half, set 2.5 (rotations). When 00 is set, position deviation error detection is not performed.</td></tr>
<tr><td>FA-07</td><td>DC bus power supply</td><td>L123
Pn
[L123]</td><td>The form of the main power supply is set. When Pn is set, power failure detection or missing phase detection is not performed.
<table>
<tr><th>Set value</th><th>Form of the main power supply</th></tr>
<tr><td>L123</td><td>The main power supply provides a three-phase power from the L1, L2 and L3 terminals.</td></tr>
<tr><td>Pn</td><td>When the main power supply provides a DC power from the (+) and (–) terminals, set Pn. A power failure or missing phase is detected by mistake.</td></tr>
</table></td></tr>
<tr><td>FA-08</td><td>Regenerative braking operating ratio</td><td>0.0~100.0
(%)
[0.5]</td><td>The operating ratio of the regenerative braking resistor during 5 seconds is set. When the regenerative braking time exceeds this set value, a trip is caused. When 0.0 is set, regenerative braking is not performed by this parameter. So in case that 0.0 is set, an external regenerative braking resistor has to be used and overheat protection has to work to a servo amplifier.
<table>
<tr><th colspan="2">Amplifier rated output</th><th>Usable maximum ratio of built-in regenerative braking resistor</th><th>Note</th></tr>
<tr><td rowspan="3">1-phase / 3-phase 200V</td><td>100~ 200W</td><td>Without</td><td rowspan="6">Please use it with the value below the following. If this value is exceeded, built-in regenerative resistor may be damaged.</td></tr>
<tr><td>400W</td><td>0.5%</td></tr>
<tr><td>750W</td><td>0.5%</td></tr>
<tr><td rowspan="3">3-phase 400V</td><td>1.5kW</td><td>0.5%</td></tr>
<tr><td>3.5kW</td><td>0.5%</td></tr>
<tr><td>7kW</td><td>0.5%</td></tr>
</table></td></tr>
<tr><td>FA-09</td><td>Overload notice level</td><td>20~100
(%)
[80]</td><td>When the overload level exceeds the value set in this parameter, the electronic thermal function outputs an overload notice signal.</td></tr>
</table>

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FA-10</td><td>Auto tuning mode</td><td>non
oFL
onL$_1$
FFt
onL$_2$
[non]</td><td>Auto tuning and mechanical system diagnosis are performed by specifying this parameter. Auto tuning is classified into offline auto tuning and online auto tuning, onL$_1$ and onL$_2$.
<table>
<tr><th>Set value</th><th>Contents</th></tr>
<tr><td>non</td><td>Auto tuning is not performed.</td></tr>
<tr><td>oFL</td><td>Offline auto tuning is performed. When servo ON is specified by setting this parameter, offline auto tuning is automatically performed. When auto tuning is completed, Moment of Inertia is automatically set and this parameter is reset to “non”.</td></tr>
<tr><td>onL$_1$</td><td>Online auto tuning is performed. Usually, please choose this mode when you use Online auto tuning. While this is set, online auto tuning is always performed. Moment of Inertia and the speed control gain are calculated and set in real time. (The former set moment of inertia is ignored.)</td></tr>
<tr><td>onL$_2$</td><td>Online auto tuning is performed for the case where the inertia of the machine to be connected is small. Please use this mode, when Identified moment of inertia monitor (d-15) doesn’t change even though onL$_1$ is performed. (Usually, please choose onL$_1$ mode.) This function is the same as onL$_1$.</td></tr>
<tr><td>FFt</td><td>Mechanical system diagnosis is performed. When Servo ON is specified by setting this parameter to FFt, the motor is put into oscillating operation, an FFT analysis is done, and the transmission characteristics of the user’s mechanical system are indicated. After the operation is completed, this parameter is reset to “non”. (Set this parameter through the Setup Software AHF. Otherwise, the operation cannot be performed correctly.)</td></tr>
</table></td></tr>
</table>

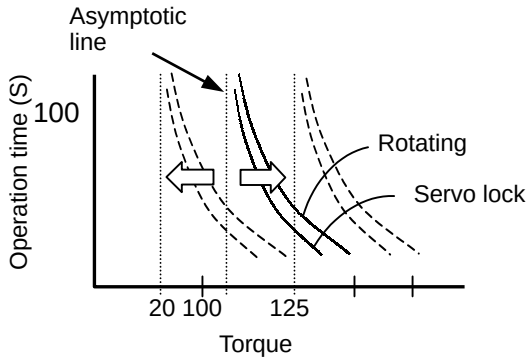
<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FA-11</td><td>Pulse train input mode</td><td>F-r
P-S
A-b
r-F
-P-S
b-A
[P-S]</td><td>A pulse train position command signal form is selected from the type mode and then set.
<table>
<tr><th>Set value</th><th>Pulse train position command signal form</th></tr>
<tr><td>F-r</td><td>PLS: The motion amount in the direction of forward run is given by pulse train.
SIG: The notion amount in the direction of reverse run is given by pulse train.</td></tr>
<tr><td>P-S</td><td>PLS: The motion amount is given as pulse train.
SIG: OFF when the direction of motion is of forward run, or ON when the direction of motion is of reverse run.</td></tr>
<tr><td>A-b</td><td>PLS: The phase A of the phase difference two-phase signal is input.
SIG: The phase B of the phase difference two-phase signal is input.</td></tr>
<tr><td>r-F</td><td>PLS: The motion amount in the direction of reverse run is given by pulse train.
SIG: The motion amount in the direction of forward run is given by pulse train.</td></tr>
<tr><td>-P-S</td><td>PLS: The motion amount is given as pulse train.
SIG: ON when the direction of motion is of forward run, or OFF when the direction of motion is of reverse run.</td></tr>
<tr><td>b-A</td><td>PLS: The phase B of the phase difference two-phase signal is input.
SIG: The phase A of the phase difference two-phase signal is input.</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FA-12</td><td>Electronic gear numerator</td><td rowspan="2">1
~
65535
[1]</td><td rowspan="2">For the pulse train position command, the gear ratio of the electronic gear that is applied to the command value is set. The gear ratio can be given as (FA-12) / (FA-13). The numerator and denominator can be set respectively. The output pulses of the electronic gear are handled as 32768 pulses per rotation with a resolution equivalent to 15 bits per rotation.
Note) The output pulses are handled as 131072 pulses per rotation when High resolution mode (FA-15) is set to ON.</td></tr>
<tr><td>FA-13</td><td>Electronic gear denominator</td></tr>
<tr><td>FA-14</td><td>Motor revolution direction</td><td>CC
C
[CC]</td><td>The direction of forward run of the motor can be changed by parameter.
<table>
<tr><th>Set value</th><th>Direction of the forward run of the motor</th></tr>
<tr><td>CC</td><td>The counterclockwise direction, as viewed from the motor output shaft end, is specified as the direction of forward run.</td></tr>
<tr><td>C</td><td>The clockwise direction, as viewed from the motor output shaft end, is specified as the direction of forward run.</td></tr>
</table></td></tr>
<tr><td>FA-15</td><td>High resolution mode</td><td>oFF
on
[oFF]</td><td>When encoder resolution (FA-82) is set to 2^{17} in case of 17 bits serial encoder, this parameter is valid. This parameter can change the resolution in the position control.
<table>
<tr><th>Set value</th><th>Resolution in the position control</th><th>Position-associated monitor (d-07~d-09)</th></tr>
<tr><td>oFF</td><td>2^{15} pulse</td><td>Those monitors are displayed at 2^{15} pulse.</td></tr>
<tr><td>on</td><td>2^{17} pulse</td><td>Those monitors are displayed at 2^{17} pulse</td></tr>
</table>
Note: The change of this parameter is valid after an amplifier is supplied the power again.</td></tr>
</table>

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FA-16</td><td>DB operation selection</td><td>non
trP
SoF
[non]</td><td>The condition for applying the dynamic brake is set.
<table>
<tr><th>Set value</th><th>Condition for applying the dynamic brake</th></tr>
<tr><td>non</td><td>The dynamic brake is not used. (The dynamic brake is applied only upon occurrence of power OFF. Effective for up to 3kW drive)</td></tr>
<tr><td>trP</td><td>The dynamic brake is applied only upon occurrence of a trip. (Note 2)</td></tr>
<tr><td>SoF</td><td>The dynamic brake is applied when SON terminal signal is turned off. (Note 1 and Note 2)</td></tr>
</table>
Note 1: The dynamic brake is for emergency stop. Do not perform a start or stop with Servo ON or OFF by SON terminal signal. Be sure to make the servo OFF after the motor is stopped.
Note 2: Use the dynamic brake within the allowable moment of load inertia shown in the following table. If the dynamic brake is used over this value, the servo drive may be burnt.
<table>
<tr><th rowspan="2">Amplifier AD*3</th><th rowspan="2">Motor rated output (kW)</th><th colspan="2">Allowable moment of load inertia</th></tr>
<tr><th>Low inertia type</th><th>Middle inertia type</th></tr>
<tr><td>01NSE</td><td>0.1</td><td rowspan="4">30 times or less as large as the moment of motor inertia</td><td rowspan="4"></td></tr>
<tr><td>02NSE</td><td>0.2</td></tr>
<tr><td>04NSE</td><td>0.4</td></tr>
<tr><td>08NSE</td><td>0.75</td></tr>
<tr><td>15HPE</td><td>0.5 ~ 1.5</td><td rowspan="3"></td><td rowspan="3">5 times or less as large as the moment of motor inertia</td></tr>
<tr><td>35HPE</td><td>2.0 ~ 3.5</td></tr>
<tr><td>70HPE</td><td>4.5 ~ 7</td></tr>
</table></td></tr>
<tr><td></td><td colspan="3">Note 3:
Regardless of setting, the dynamic brake is applied upon the under voltage of main power supply with control power supplying for only AD*3-01 and -02NSE.</td></tr>
<tr><td>FA-17</td><td>Torque limit mode</td><td>non
A2
oP
[non]</td><td>The input source of torque limit value and the torque limit mode are set.
<table>
<tr><th>Set value</th><th>Torque limit mode</th></tr>
<tr><td>non</td><td>Torque limit is performed by only the set Torque limit Values of 4 quadrants (Fb-07 to Fb-10).</td></tr>
<tr><td>A2</td><td>Torque limit is performed by the minimum value among the Analog Input 2, 3 and 4.</td></tr>
<tr><td>oP</td><td>Torque limit is performed by the value given in Option.</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FA-18</td><td>Torque bias mode</td><td>non
CnS
A2
oP
[non]</td><td>The input source of torque bias value is set.<table><tr><th>Set value</th><th>Torque bias mode</th></tr><tr><td>non</td><td>Torque bias is not used.</td></tr><tr><td>CnS</td><td>Bias is performed by the set Torque Bias Value (Fb-11).</td></tr><tr><td>A2</td><td>Bias is performed by the value in Analog Input 2.</td></tr><tr><td>oP</td><td>Bias is performed by the value given in Option.</td></tr></table></td></tr>
<tr><td>FA-19</td><td>Torque command selection</td><td>A2
oP
[A2]</td><td>The input source of torque command value in the torque control mode is set.<table><tr><th>Set value</th><th>Input source of torque command</th></tr><tr><td>A2</td><td>The value given in Analog Input 2 is regarded as the torque command value.</td></tr><tr><td>oP</td><td>The value given in Option is regarded as the torque command value.</td></tr></table></td></tr>
<tr><td>FA-20</td><td>Speed limit mode</td><td>non
A1
oP
[non]</td><td>The input source of speed limit value in the position control mode, speed control mode, or torque control mode is set.<table><tr><th>Set value</th><th>Speed limit mode</th></tr><tr><td>non</td><td>Speed limit is performed by only the set Speed Limit Values (Fb-20, Fb-21) of the direction of forward run and the direction of reverse run.</td></tr><tr><td>A1</td><td>The value given in Analog Input 1 is specified as the speed limit value.</td></tr><tr><td>oP</td><td>The value given in Option is specified as the speed limit value.</td></tr></table>Note: In the torque control mode, the torque is automatically limited when it exceeds the speed limit value.</td></tr>
</table>

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FA-21</td><td>Speed command selection</td><td>CnS
A1
oP
A1S
[A1]</td><td>The input source of speed command value in the speed control mode is set.
<table>
<tr><th>Set value</th><th>Input source of speed command</th></tr>
<tr><td>CnS</td><td>The set values (Fb-00 to Fb-01) of multistage speed and the acceleration/deceleration time are set in Fb-04 and Fb-05.</td></tr>
<tr><td>A1</td><td>The value given in Analog Input 1 is specified as the speed command value.</td></tr>
<tr><td>oP</td><td>The value given in Option is specified as the speed command value.</td></tr>
<tr><td>A1S</td><td>For the value A1 given in Analog Input 1, the acceleration/deceleration time can be set in Fb-04 and Fb-05.</td></tr>
</table></td></tr>
<tr><td>FA-22</td><td>Position command selection</td><td>PLS
Pro
oP
[PLS]</td><td>The input source of position command value in the position control mode is set.
<table>
<tr><th>Set value</th><th>Input source of position command</th></tr>
<tr><td>PLS</td><td>Position control is performed with the pulse train command input as the command value.</td></tr>
<tr><td>Pro</td><td>This parameter is set only for the case where the program operating function is used. Set it for only the applicable product.</td></tr>
<tr><td>oP</td><td>Position control is performed by using the value given in Option.</td></tr>
</table></td></tr>
<tr><td>FA-23</td><td>Homing mode</td><td>L-F
L-r
H1-F
H1-r
H2-F
H2-r
CP
[L-F]</td><td>The homing operation mode in the position control mode is set. Low Speed Homing, High Speed Homing 1, High Speed Homing 2, and Optional Homing are available.
For the details of functions, refer to the pages pertaining to ORG and ORL terminals in Chapter 5.
<table>
<tr><th>Set value</th><th>Homing mode</th></tr>
<tr><td>L-F</td><td>Low speed homing (forward run)</td></tr>
<tr><td>L-r</td><td>Low speed homing (reverse run)</td></tr>
<tr><td>H1-F</td><td>High speed homing 1 (forward run)</td></tr>
<tr><td>H1-r</td><td>High speed homing 1 (reverse run)</td></tr>
<tr><td>H2-F</td><td>High speed homing 2 (forward run)</td></tr>
<tr><td>H2-r</td><td>High speed homing (reverse run)</td></tr>
<tr><td>CP</td><td>Optional homing</td></tr>
</table></td></tr>
</table>

Parameter No.	Parameter name	Setting range [Initial value]	Contents
FA-24	Servo OFF wait time	0.00 ~ 1.00(s) [0.00]	The time from turning off the Servo ON command till actually clearing the servo ON status is set.
FA-25	Operation range at machine diagnosis	1~255 (Rotation) [10]	The allowable rotation range of the motor at mechanical system diagnosis is set. Mechanical system diagnosis is performed in the positive/negative range of the set allowable range. Set it in units of one rotation.
FA-26	Brake operation start speed	0~ maximum speed (min^{-1}) [30]	If the speed becomes lower than the set speed when the Servo ON command is turned off or a trip is caused, the brake signal (BRK) goes to the brake status. If the time set in FA-27 elapses before the speed becomes lower than the set speed, the BRK signal goes to the brake ON status.
FA-27	Brake operation start time	0, 0.004 ~1.00(s) [0]	The maximum time from turning off the Servo ON command or causing a trip till turning on the brake signal (BRK) is set. This setting is time of each 4 ms. If the speed becomes lower than the set value of FA-26 after turning off the Servo ON command, the BRK signal goes to the brake ON status regardless of this setting (FA-27).
FA-28	Electronic thermal level	20~125 (%) [105]	The electronic thermal level is set. Change the thermal level in accordance with the ambient temperature, with brake, etc. When this parameter is changed, the asymptotic line level can be moved in parallel with the operation time as shown in the following figure. For details, refer to Chapter 10 Appendixes. 

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FA-32</td><td>Electronic gear 2 numerator</td><td>1 ~ 65535
[1]</td><td>The numerator of the electronic gear 2 used when the electronic gear 2 selection (EGR2) is valid is set up.</td></tr>
<tr><td>FA-33</td><td>Electronic gear 2 denominator</td><td>1 ~ 65535
[1]</td><td>The denominator of the electronic gear 2 used when the electronic gear 2 selection (EGR2) is valid is set up.</td></tr>
<tr><td>FA-80</td><td>Encoder type selection</td><td>inC
AbS
[inC]</td><td>When the absolute position encoder is used, handling of the encoder is set. When this parameter is set to “inC”, an overflow of the encoder is not detected and the position counter is cleared to zero with the power ON. When an overflow occurs, the counter is operated by ring counter.
(80000000 → 7FFFFFFF
7FFFFFFF → 80000000)

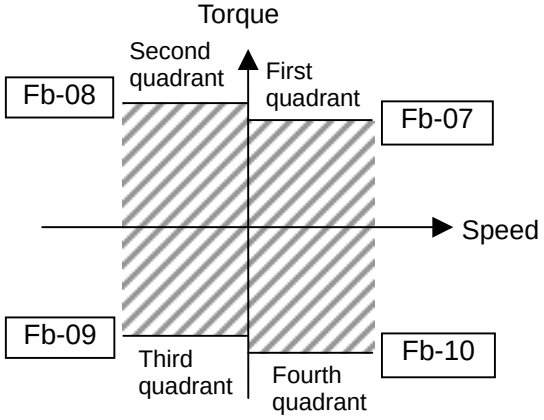
When this parameter is set to “AbS”, a trip is caused if Absolute Encoder Count Overflow (E92) occurs when the parameter Current Position Monitor (d-08) becomes to 4000000 or more, or C0000001 or less.</td></tr>
<tr><td rowspan="2">FA-81</td><td rowspan="2">Encoder selection</td><td>Stnd,
inC = E,
AbS = E1,
AbS = E2,
AbS = A2,
AbS = A4
[inC = E]</td><td>The combination between each setup and the kind of encoders is shown in the following table.
Only Inc=E or Stnd is available.

Note 1: When the combination of a parameter does not suit, “Unmatch error (E40)” occurrs.
Note 2: A setting value becomes effective after a power supply re-injection.
Note 3: This parameter is not initialized by the initialization of the user data.</td></tr>
<tr><td colspan="3">
<table>
<tr><th rowspan="2">FA-81</th><th rowspan="2">FA-82</th><th colspan="2" rowspan="2">Encoder type</th><th rowspan="2">Signal format</th><th colspan="2">Data specification</th><th rowspan="2">Other specifications</th></tr>
<tr><th>one rotation or less</th><th>Multi-rotation data</th></tr>
<tr><td rowspan="2">Stnd</td><td rowspan="2">2^{17}</td><td rowspan="2">17 bits serial</td><td>Increm ental</td><td rowspan="2">Start-stop synchronization half-duplex</td><td>17 bits</td><td>—</td><td>Standard</td></tr>
<tr><td>Absolute</td><td>(17 bits)</td><td>(16 bits)</td><td>(Option)</td></tr>
<tr><td>IncE</td><td>500 ~ 65535</td><td colspan="2">Wire-saving incremental</td><td>Line driver signal output</td><td>500 ~ 65535 (pulse / rotation)</td><td>—</td><td>Standard resolution 8192(pulse / rotation)</td></tr>
<tr><td rowspan="4">AbSE1</td><td>2^{13}</td><td colspan="5" rowspan="4">Don’t use this mode!</td></tr>
<tr><td>2^{15}</td></tr>
<tr><td>2^{17}</td></tr>
<tr><td>2^{21}</td></tr>
<tr><td>AbSE2</td><td>—</td><td colspan="5">This mode doesn’t work. E40 occurs.</td></tr>
<tr><td rowspan="2">AbSA2</td><td>2^{17}</td><td colspan="5" rowspan="2">Don’t use this mode!</td></tr>
<tr><td>2^{21}</td></tr>
<tr><td>AbSA4</td><td>—</td><td colspan="5">This mode doesn’t work. E40 occurs.</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FA-82</td><td>Encoder resolution</td><td>500 ~ 65535 (pulse / rotation) (FA-81 = inCE) [8192]

$2^{13 \sim 22}$ (FA-81 ≠ inCE)</td><td>The number of pulses in 1 rotation of an encoder is set up. A display changes in relation to the setting values of FA-81 like the following.
Note 1: When the combination of a parameter does not suit, “Unmatch error (E40)” occurrs.
Note 2: A setting value becomes effective after a power supply re-injection.
Note 3: This parameter is not initialized by the initialization of the user data.</td></tr>
<tr><td>FA-83</td><td>Operating mode selection in case of counter overflow</td><td>trP, non [trP]</td><td>This parameter defines how the amplifier works when the multi-rotation data overflows.
<table>
<tr><th>Set value</th><th>Contents of operation</th></tr>
<tr><td>trP</td><td>Trip (E92) occurs.</td></tr>
<tr><td>non</td><td>Trip doesn’t occur.</td></tr>
</table>
This parameter is available only when en encoder is the absolute type (FA-80=AbS).</td></tr>
<tr><td>FA-98</td><td>Initialization mode selection</td><td>CH
dAtA
AbS
[CH]</td><td>This parameter is used to select “Clear Trip Log” or “Initialize User Data”.
<table>
<tr><th>Set value</th><th>Initialization mode selection</th></tr>
<tr><td>CH</td><td>Clear Trip Log is selected. The error contents of indication in d-xx are cleared.</td></tr>
<tr><td>dAtA</td><td>Initialize User Data is selected.</td></tr>
<tr><td>AbS</td><td>The multi-rotation data of the absolute position encoder is cleared. (Only the absolute position encoder is indicated.)</td></tr>
</table></td></tr>
</table>

(2) Operation constant parameters

Parameter No.	Parameter name	Setting range [Initial value]	Contents
Fb-00	Multistage speed 1	0~ *1 ±maximum speed (min^{-1}) [0]	When multistage speed is selected as the speed command value in the speed control mode, the multistage operation speed is set in this parameter.
Fb-01	Multistage speed 2		
Fb-02	Multistage speed 3		
Fb-03	Jogging Speed	0~ ±300 (min^{-1}) [30]	For jogging in the speed control mode, the operation speed is set. Jogging operation can be performed by the digital operator when the leftmost digit of the indicated digits is operated. For details, refer to 4.2.3 pertaining to Trial Run.
Fb-04	Acceleration time (of speed command)	0.00~ 99.99 (s) [10.00]	The acceleration/deceleration time for multistage speed operation in the speed control mode and for a back to origin in the position control mode is set. The time for acceleration from speed zero to the maximum speed of the motor (or the time for deceleration from the maximum speed of the motor to speed zero) is set.
Fb-05	Deceleration time (of speed command)		
Fb-07	Torque limit value 1	0~ maximum torque (%) [300]	The torque limit value is set for each quadrant. The torque limit values 1, 2, 3, and 4 correspond to the first quadrant to the fourth quadrant, respectively. For all the quadrants, an absolute value is used for this setting. 
Fb-08	Torque limit value 2		
Fb-09	Torque limit value 3		
Fb-10	Torque limit value 4		
Fb-11	Torque bias value	0~ ± maximum torque (%) [0]	To specify the torque bias by a fixed set value, this bias value is set. In this case, FA-18 = Cns is required. Set the bias value by the ratio when the rated torque is 100%.

Parameter No.	Parameter name	Setting range [Initial value]	Contents
Fb-12	Homing speed 1	1~ maximum speed *1 (min^{-1}) [1200]	For a homing in the position control mode, the high homing speed is set. The high homing speed to be used for high speed homing 1 and 2 is set.
Fb-13	Homing speed 2	1 ~999 (min^{-1}) [60]	For a homing in the position control mode, the low homing speed is set. The low homing speed to be used for low speed homing and high speed homing 1 and 2 is set.
Fb-14	Homing position offset value at homing (H/L)	±0~ *2 ±19999 [0]	For a homing in the position control mode, the homing offset position is set. Ten-digit data consisting of the high-order digits set in Fb-14 and the low-order digits set in Fb-15 is a set value of offset position at homing.
Fb-15		0~99999 [0]	
Fb-16	Forward position limit value (H/L)	±0~ *2 ±19999 [0]	The driving range in the positive direction in the position control mode is set. Ten-digit data (number of encoder pulses) consisting of the high-order digits set in Fb-16 and the low-order digits set in Fb-17 is a set value of position limit value +. When this parameter is set to 0, this means no limit. Note: Refer to the precautions on Fb-18 and Fb-19.
Fb-17		0~99999 [0]	
Fb-18	Reverse position limit value (H/L)	±0~ *2 ±19999 [0]	The driving range in the negative direction in the position control mode is set. When this parameter is set to 0, this means no limit. Note: In the following case, the setting is invalid and the motor is operated without limit. Position limit value + <= Position limit value – (Fb-16: Fb-17) (Fb-18: Fb-19)
Fb-19		0~99999 [0]	

*1: The maximum rotation speed of the motor. Check the specifications of the motor.

*2: The indication and input of –10000 to –19999 become specific. For the operating procedure, refer to the pages pertaining to “Specific indication” in Section 6.1.

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>Fb-20</td><td>Positive side speed limit value</td><td rowspan="2">0~ maximum speed *1 (min^{-1}) [maximum speed]</td><td rowspan="2">The speed limit value in the position control mode and the speed control mode and the speed upper limit value in the torque control mode are set.</td></tr>
<tr><td>Fb-21</td><td>Negative side speed limit value</td></tr>
<tr><td>Fb-22</td><td>Zero speed detection value</td><td>0.0~999.9 (min^{-1}) [5.0]</td><td>When the speed detection value is lower than this set value, the zero speed detection signal is output to provide zero speed.</td></tr>
<tr><td>Fb-23</td><td>Positioning width</td><td>1~65535 (Pulse) [100]</td><td>The threshold value of position deviation (difference between the position command value and the position detection value) upon positioning complete is set. Set the positioning width by the encoder resolution (number of pulse).
<table>
<tr><th>Encoder resolution (FA-82)</th><th>High resolution mode (FA-15)</th><th>Resolution per one pulse [rotation / pulse]</th></tr>
<tr><td rowspan="2">2^{17}</td><td>OFF</td><td>$1 / 2^{15}$</td></tr>
<tr><td>ON</td><td>$1 / 2^{17}$</td></tr>
<tr><td>Other</td><td>—</td><td>1 / (FA-82)</td></tr>
</table></td></tr>
<tr><td>Fb-24</td><td>Positioning monitoring time</td><td>0.00 ~ 10.00(s) [0.00]</td><td>The threshold value of time difference between the position command value and the position detection value (the time required for the position detection value to reach the position command value) upon completion of positioning is set.
When this parameter is set to 0.00, this means that no monitoring is performed. The set value can be specified in 0.02 units.</td></tr>
<tr><td>Fb-25</td><td>Speed arrival width</td><td>0 ~ 100(min^{-1}) [10]</td><td>The threshold value of speed deviation (the difference between the speed command value and the speed detection value) upon completion of the speed arrival is set.</td></tr>
<tr><td>Fb-30</td><td>S-curve ratio</td><td>non
SHArP
rEGLr
LooSE
[non]</td><td>Select the S-curve ratio step by step.
non : Linear
SHArP : Low
rEGLr : Middle
LooSE : High
Note : This function is available for the drive with DeviceNet or programmable function.</td></tr>
</table>

*1: The maximum rotation speed of the motor. Check the specifications of the motor.

(3) Input/output terminal parameters

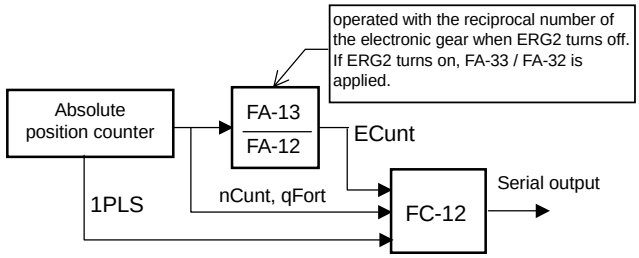
<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FC-01</td><td>Input terminal polarity setting</td><td>0000~3FFF [0000]</td><td>
The logic of ON/OFF of the input terminal is set. (Usually, the logic is positive; namely, the function is turned on when the external contact is closed.)
The logical setting of each terminal is assigned to each bit of the parameter to set the logic as follows.
<table>
<tr><th>Set value of bit</th><th>Logic of input terminal</th></tr>
<tr><td>0</td><td>Positive logic; the function is turned on when the external contact is closed.</td></tr>
<tr><td>1</td><td>Negative logic; the function is turned on when the external contact is opened.</td></tr>
</table>
The bit assignment in the input terminal and this parameter is shown in the following figure. Set by hexadecimal value.
<table>
<tr><td>bit 15</td><td>bit 14</td><td>bit 13</td><td>bit12</td></tr>
<tr><td>O
Not assigned</td><td>O
Not assigned</td><td>CER
/REV</td><td>PEN
/FWD</td></tr>
</table>
<table>
<tr><td>bit 11</td><td>bit 10</td><td>bit 9</td><td>bit 8</td></tr>
<tr><td>ORG
/PRB2</td><td>ORL</td><td>SRZ
/EOH</td><td>PPI
/GCH</td></tr>
</table>
<table>
<tr><td>bit 7</td><td>bit 6</td><td>bit 5</td><td>bit 4</td></tr>
<tr><td>SS2
/ECLR</td><td>SS1
/EGR2</td><td>ROT</td><td>FOT</td></tr>
</table>
<table>
<tr><td>bit 3</td><td>bit 2</td><td>bit 1</td><td>bit 0</td></tr>
<tr><td>TL</td><td>MOD
/PRB1</td><td>RS</td><td>SON</td></tr>
</table>
Note: PRB1 and PRB2 are available for the amplifier with SERCOS.
</td></tr>
</table>

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FC-02</td><td>Output terminal polarity setting</td><td>0000
~00FF
[0002]</td><td>
The logic of ON/OFF of the output terminal is set. (Usually, the logic is positive; namely, the open collector output is turned on when the output signal activates.)

The logical setting of each terminal is assigned to each bit of the parameter to set the logic as follows.
The bit assignment in the output terminal and this parameter is shown in the following figure. Set by hexadecimal value.
<table>
<tr><th>Set value of bit</th><th>Logic of output terminal</th></tr>
<tr><td>0</td><td>Positive logic; the open collector output is turned on when the output activates</td></tr>
<tr><td>1</td><td>Negative logic; the open collector output is turned off when the output activates.</td></tr>
</table>
<table>
<tr><td>bit
15</td><td>bit
14</td><td>bit
13</td><td>bit
12</td></tr>
<tr><td>O
Not
assigned</td><td>O
Not
assigned</td><td>O
Not
assigned</td><td>O
Not
assigned</td></tr>
</table>
<table>
<tr><td>bit
11</td><td>bit
10</td><td>bit
9</td><td>bit
8</td></tr>
<tr><td>O
Not
assigned</td><td>O
Not
assigned</td><td>O
Not
assigned</td><td>O
Not
assigned</td></tr>
</table>
<table>
<tr><td>bit
7</td><td>bit
6</td><td>bit
5</td><td>bit
4</td></tr>
<tr><td>OL1
/AL3</td><td>TL
/AL2</td><td>BRK</td><td>SZD</td></tr>
</table>
<table>
<tr><td>bit
3</td><td>bit
2</td><td>bit
1</td><td>bit
0</td></tr>
<tr><td>SA
/AL1</td><td>INP</td><td>ALM</td><td>SRD</td></tr>
</table>
</td></tr>
</table>

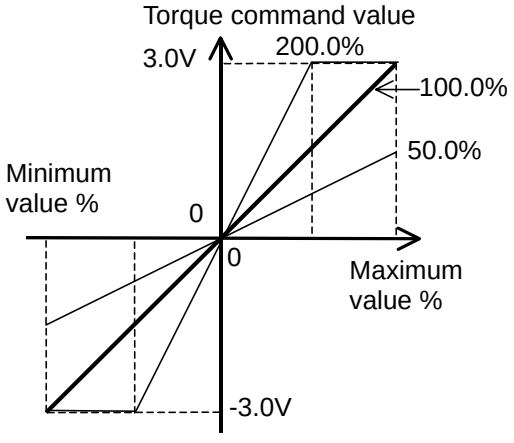
<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FC-03</td><td>Analog input 1 function selection</td><td>nrFF
nbiAS
nLit
[nrEF]</td><td>The functions of analog input 1 [AI1] are assigned. The actual assigning function differs depending on the control status. Refer to the pages pertaining to 5.4 Analog Input Function. The input voltage range is 0 to ±10 (V).
<table>
<tr><th>Set value</th><th>Function name</th><th>Scale</th></tr>
<tr><td>nrEF</td><td>Speed command</td><td>Zero speed to ± maximum speed at 0 (V) to ±10 (V)</td></tr>
<tr><td>nbiAS</td><td>Speed bias</td><td>Zero speed to ± maximum speed at 0 (V) to ±10 (V)</td></tr>
<tr><td>nLit</td><td>Speed limit</td><td>Zero speed to ± maximum speed at 0 (V) to ±10 (V)</td></tr>
</table></td></tr>
<tr><td>FC-04</td><td>Analog input 2 function selection</td><td>tLit
tbiAS
trEF
[trEF]</td><td>The functions of analog input 2 [AI2] are assigned. The actual assigning function differs depending on the control status. Refer to the pages pertaining to 5.4 Analog Input Function. The input voltage range is 0 to ±10 (V).
<table>
<tr><th>Set value</th><th>Function name</th><th>Scale</th></tr>
<tr><td>tLit</td><td>Torque limit</td><td>Zero torque to + maximum torque at 0 (V) to ± 10 (V)</td></tr>
<tr><td>tbiAS</td><td>Torque bias</td><td>Zero torque to + maximum torque at 0 (V) to ± 10 (V)</td></tr>
<tr><td>trEF</td><td>Torque command</td><td>Zero torque to + maximum torque at 0 (V) to ± 10 (V)</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FC-05
FC-06</td><td>Analog input 1,2 gain</td><td>0.000~ ±9.999(V) [1.000]</td><td>The input gain for analog input 1 [AI1] and analog input 2 [AI2] is set. The gain is specified as 1.0 when the analog input value at 10 V input is regarded as the full scale, and the polarity can be reversed.
±10 V input = ± full scale amount is 1.0, the ratio is set.</td></tr>
<tr><td>FC-07
FC-08</td><td>Analog input 1,2 offset</td><td>0.000~ ±9.999(V) [0.000]</td><td>The input offset for analog input 1 [AI1] and analog input 2 [AI2] is set. In this case, the offset voltage of this setting is added to the analog input value.</td></tr>
<tr><td>FC-09</td><td>Encoder monitor resolution M</td><td>1~8192 [4096]</td><td rowspan="2">The pulse resolution ratio M / N of the encoder monitor signal is set. Contents of the setting are changed in relation to the type of an encoder. The "Unmatch error (E40)" occurs without outputting the encoder monitor signals if you set invalid combinations which is mentioned in the following table. After changing this parameter, turn on the power supply again.
<table><tr><th rowspan="2">Encoder selection FA-81</th><th colspan="2">Effective range</th><th rowspan="2">Encoder monitor resolution</th><th rowspan="2">Invalid combinations</th></tr><tr><th>M
FC-09</th><th>N
FC-10</th></tr><tr><td>Stnd
AbSE1
AbSE2
AbSA2
AbSA4</td><td>16~8192</td><td>—
32768 is set up internally.</td><td>M / 32768</td><td>FC-09=1~15</td></tr><tr><td rowspan="3">inCE (Note 1)</td><td>1 (Note 2)</td><td>1~64</td><td>1 / N</td><td>FC-10= 65~8192</td></tr><tr><td>2 (Note 2)</td><td>3~64</td><td>2 / N</td><td>FC-10= 1,2,65~8192</td></tr><tr><td>1~8191</td><td>8192</td><td>M / 8192</td><td>FC-09=8192 FC-10=1~8192</td></tr></table>
Note 1: Parameter FC-10 is valid only when FA-81 is inCE.
Note 2: The encoder monitor resolution is set M / 8192 when 8192 is set in FC-10. In the case of others, the encoder monitor resolution is set 1 / N or 2 / N according to FC-09.</td></tr>
<tr><td>FC-10</td><td>Encoder monitor resolution N</td><td>1~8192 [8192]</td></tr>
</table>

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th colspan="2">Contents</th></tr>
<tr><td>FC-11</td><td>Encoder monitor polarity</td><td>A
b
[b]</td><td colspan="2">This parameter specifies one of phase A or phase B of the encoder signal that is caused to lead when the motor is in forward run.
<table><tr><th>Set value</th><th>Phase relation</th></tr><tr><td>A</td><td>Phase A leads.</td></tr><tr><td>b</td><td>Phase B leads.</td></tr></table>After changing this parameter, turn on the power supply again.</td></tr>
<tr><td>FC-12</td><td>Phase Z output selection</td><td>1PLS
nCunt
ECunt
[1PLS]</td><td colspan="2">The setting of the OZP/OZN terminal output can be changed as shown in the following table. When the parameter is set to ECunt, the electronic gear is operated with the reciprocal number of the parameter (FA-12 / FA-13 when EGR2 turns off, and FA-32 / FA-33 when EGR2 turns on.) selected by the electronic gear change (EGR2).
Refer to the following figure.
<table><tr><th colspan="2">FC-12</th><th colspan="2">FA-80</th></tr><tr><th>Item name</th><th>Setting data</th><th>Absolute</th><th>Incremental</th></tr><tr><td>Phase Z output</td><td>1PLS</td><td colspan="2">Phase Z output</td></tr><tr><td>Encoder counter serial output 1</td><td>nCunt</td><td>Absolute position (without electronic gear)</td><td>Incremental position (without electronic gear)</td></tr><tr><td>Encoder counter serial output 2</td><td>ECurt</td><td>Absolute position (with electronic gear)</td><td>Incremental position (with electronic gear)</td></tr><tr><td>Encoder counter serial output 3</td><td>qFort</td><td>Absolute position (without electronic gear)</td><td>Incremental position (without electronic gear)</td></tr></table> 

Note) In case of qFort, the output format is changed in relation to FA-81. Refer to [5.14 Functions for Absolute Position Encoder].</td></tr>
<tr><td>FC-15</td><td rowspan="2">Analog input 3, 4 gain</td><td rowspan="2">0.000~
9.999
[1.000]</td><td>The gain is specified as 1.000 when the analog input value at 10 V input is regarded as 300% torque.</td><td rowspan="3">Those parameters are valid when TL terminal turns on. In this case, those are compared with the limit value for analog input 2 and the smaller one is set up as the torque limit value.</td></tr>
<tr><td>FC-16</td><td>When the gain is set at 2.000, the analog input value at 5 V input is regarded as 300%</td></tr>
<tr><td>FC-17</td><td rowspan="2">Analog input 3, 4 offset</td><td rowspan="2">0.000~
±9.999(V)
[0.000]</td><td rowspan="2">The offset voltage of this setting added to the analog input value is set as the toque limit value.</td></tr>
<tr><td>FC-18</td></tr>
</table>

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FC-19</td><td>Command pulse filter time constant</td><td>Lo
Hi
[Hi]</td><td>The filter time constant for command pulse is set up as following.<table><tr><th>Set value</th><th>Filter time constant</th></tr><tr><td>Lo</td><td>1 μs</td></tr><tr><td>Hi</td><td>0.2 μs</td></tr></table></td></tr>
<tr><td>FC-21</td><td>Communication baud rate</td><td>1200, 2400,
4800, 9600,
19200, 38400
(Bit /s)
[19200]</td><td>The communication speed of the PC is set.</td></tr>
<tr><td>FC-22</td><td>Communication bit length</td><td>7, 8
(Bit)
[8]</td><td>The communication bit length for PC communication is set.</td></tr>
<tr><td>FC-23</td><td>Communication parity</td><td>non, odd,
EvEn
[non]</td><td>The communication parity for PC communication is set.<table><tr><th>Set value</th><th>Function name</th></tr><tr><td>non</td><td>No communication parity</td></tr><tr><td>odd</td><td>Odd communication parity</td></tr><tr><td>EvEn</td><td>Even communication parity</td></tr></table>After changing the operator, turn on the power supply again. Otherwise, a malfunction will be caused.</td></tr>
<tr><td>FC-24</td><td>Communication stop bit</td><td>1, 2
(Bit)
[2]</td><td>The communication stop bit for PC communication is set.</td></tr>
</table>

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>FC-30</td><td>Monitor output 1 function</td><td rowspan="2">nrF, nFb, iFb, tqr, nEr, PEr, PFq, brd
[nFb]</td><td rowspan="2">The output object of monitor output 1,2 is set as shown in the following table. In the following table, the mark O indicates that the corresponding value is output, and the mark × indicates that 0 V is output. The output value of 3.0 V in the following table is a value when the monitor output gain 1,2 is 100.0.
<table>
<tr><th rowspan="2">Setting</th><th rowspan="2">Data name</th><th rowspan="2">3.0 V output value</th><th colspan="3">Control mode</th></tr>
<tr><th>Position</th><th>Speed</th><th>Torque</th></tr>
<tr><td>nFb</td><td>Speed detection value</td><td>Maximum speed</td><td>O</td><td>O</td><td>O</td></tr>
<tr><td>tqr</td><td>Torque command value</td><td>Maximum torque</td><td>O</td><td>O</td><td>O</td></tr>
<tr><td>nrF</td><td>Speed command value</td><td>Maximum speed</td><td>O</td><td>O</td><td>×</td></tr>
<tr><td>nEr</td><td>Speed deviation</td><td>Maximum speed</td><td>O</td><td>O</td><td>×</td></tr>
<tr><td>Per</td><td>Position deviation</td><td>Five motor rotations</td><td>O</td><td>×</td><td>×</td></tr>
<tr><td>iFb</td><td>Current value</td><td>Maximum current</td><td>O</td><td>O</td><td>O</td></tr>
<tr><td>PFq</td><td>Command pulse frequency</td><td>Maximum speed</td><td>O</td><td>×</td><td>×</td></tr>
<tr><td>brd</td><td>Regenerative braking resistor operating ratio</td><td>Trip level (FA-08)</td><td>O</td><td>O</td><td>O</td></tr>
</table>
Note: Except the speed detection value, 0 V is output in a trip status.
However, the speed detection value also becomes unstable when an encoder error occurs.</td></tr>
<tr><td>FC-33</td><td>Monitor output 2 function</td></tr>
<tr><td>FC-31</td><td>Monitor output 1 porality</td><td rowspan="2">SiGn, AbS
[SiGn]</td><td rowspan="2">This parameter specifies that the data of monitor output monitor 1,2 is to be output as 0 to ±3.0 V or 0 to 3.0 V.
<table>
<tr><th>Set value</th><th>Contents</th></tr>
<tr><td>SiGn</td><td>0 to ±3.0V</td></tr>
<tr><td>Abs</td><td>0 to 3.0V</td></tr>
</table>
Note) In case that FC-30 and FC-33 is set to PFq or brd, output is only positive.</td></tr>
<tr><td>FC-34</td><td>Monitor output 2 porality</td></tr>
<tr><td>FC-32</td><td>Monitor output 1 gain</td><td rowspan="2">0.0
~3000.0
[100.0]</td><td rowspan="2">The gain of monitor output 1,2 is set. At 100.0, the voltage shown in the table of FC-30 and FC-33 is output. The relation between the gain and the output voltage is shown in the following figure. (When tqr is set)
 
</td></tr>
<tr><td>FC-35</td><td>Monitor output 2 gain</td></tr>
</table>

<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td rowspan="2">FC-40</td><td rowspan="2">Input terminal function</td><td>0
~3FFF
[0]</td><td>This parameter specifies one of the 1st function side and 2nd function side of the input terminal that is to be validated. (0 = 1st function, 1 = 2nd function)</td></tr>
<tr><td colspan="2">
<table>
<tr><th>Setting</th><th>b13</th><th>b12</th><th>b11</th><th>b10</th><th>b9</th><th>b8</th></tr>
<tr><td>0</td><td>CER</td><td>PEN</td><td>ORG</td><td>ORL</td><td>SRZ</td><td>PPI</td></tr>
<tr><td>1</td><td>REV</td><td>FWD</td><td>PRB2</td><td>Not function</td><td>EOH</td><td>GCH</td></tr>
</table>
<table>
<tr><th>Setting</th><th>b7</th><th>b6</th><th>b5</th><th>b4</th><th>b3</th><th>b2</th><th>b1</th><th>b0</th></tr>
<tr><td>0</td><td>SS2</td><td>SS1</td><td>ROT</td><td>FOT</td><td>TL</td><td>MOD</td><td>RS</td><td>SON</td></tr>
<tr><td>1</td><td>ECLR</td><td>EGR2</td><td colspan="3">Not function</td><td>PRB1</td><td>Not function</td></tr>
</table>
Note: PRB1 and PRB2 are available for the amplifier with SERCOS.
</td></tr>
<tr><td>FC-45</td><td>Alarm code output enable</td><td>nor, ALC
[nor]</td><td>This parameter specifies whether or not to output the alarm code from AL1 to AL3 when a trip occurs.
<table>
<tr><th>Setting value</th><th>Contents</th></tr>
<tr><td>nor</td><td>Each signal is outputted in case of a trip.</td></tr>
<tr><td>ALC</td><td>Alarm code is outputted from AL1, AL2 and AL3 terminals in case of a trip.</td></tr>
</table>
For the details of the relation between the alarm and alarm code, refer to the pages pertaining to AL1, AL2 and AL3 terminals in Chapter 5.</td></tr>
<tr><td>FC-50</td><td>Full closed control enable</td><td>SCLS, FCLS
[SCLS]</td><td>This parameter specifies whether or not to exert full closed control.
SCLS = Semi-closed control
FCLS = Full closed control
After the setting of this parameter is changed, it is validated by turning on the power supply again. The pulse form is set in FA-11.</td></tr>
<tr><td>FC-70</td><td>Debug mode selection</td><td>0
[0]</td><td>Always set this parameter to 0.</td></tr>
</table>

(4) Control constant parameter

Parameter No.	Parameter name	Setting range [Initial value]	Contents
Fd-00	Moment of inertia	Rotor inertia of motor ~ Rotor inertia of motor × 128 ($\times 10^{-4}$kg•m^2) [Moment of inertia of the motor]	The whole moment of inertia including both motor and load is set. This parameter can also be set automatically by auto tuning.
Fd-01	Speed control cut-off frequency	0.1 ~500.0(Hz) [30.0]	The speed control gain for speed PI control is calculated from the moment of inertia and the set value of this parameter. Set this parameter as a reference. The set value of this parameter is a value close to the 3 dB cut-off frequency obtained by measuring the frequency characteristic with a repetitive waveform when the speed control section performs PI control. When IP control is specified in Fd-05, the response speed becomes lower than the set value.
Fd-02	Speed control proportional gain	0.01 ~300.00(%) [100.00]	The proportional gain to be used for speed PI control is adjusted. AT 100%, the value is the constant specified in Fd-00 and Fd-01. (Proportional gain) ∞ (Fd-00) × (Fd-01) × Fd-02 / 100
Fd-03	Speed control integral gain	0.01 ~300.00(%) [100.00]	The integral gain to be used for speed PI control is adjusted. At 100%, the value is the constant specified by Fd-00 and Fd-01. (Integral gain) ∞ (Fd-00) × (Fd-01)^2 × Fd-03 / 100
Fd-04	P-control gain	0.1 ~99.9(%) [10.0]	The gain to be used for speed P control is set. Set it by the torque to be output when a 1% speed deviation is provided.
Fd-05	IP-control gain	0.00 ~1.00 [0.00]	The speed feedback loop is continuously switched between PI and IP by this parameter. When this parameter is set to 0, ordinary PI control is performed. At 1.00, IP control is performed. However, if the parameter Fd-05 is set to a large value and the Fd-00 and Fd-01 are large, oscillation may occur. In this case, set the parameter Fd-02 to a small value so as to avoid such oscillation.
Fd-06	Torque command filter time constant	0.00 ~500.00(ms) [2.00]	The time constant of the first-order lag filter to be applied to the torque command value is set. When this parameter is set to 0, no filtering is performed.

Parameter No.	Parameter name	Setting range [Initial value]	Contents
Fd-07	Position phase compensating ratio	0.01 ~9.99 [1.00]	The compensation ratio of the first-order lag filter to be applied to the speed command value being a position feedback loop output is set. When this parameter exceeds 1, a phase lag is caused.
Fd-08	Position phase compensating time constant	0.1 ~999.9(ms) [100.0]	The compensation time constant of the phase lag filter to be applied to the speed command value being a position feedback loop output is set.
Fd-09	Position control cut-off frequency	0.01 ~99.99(Hz) [5.00]	The response frequency of the position feedback loop is set. As the standard, the set value is about 1/6 of the speed control cut-off frequency.
Fd-10	Position feed forward gain	0.00~1.00 [0.00]	The ratio to be multiplied by the feed forward compensation of position control is set.
Fd-12	Notch filter 1 frequency	3.0 ~ 1000.0 (Hz) [1000.0]	The resonance frequency of the notch filter 1 is set. (This parameter is set by the set up software “AHF”.)
Fd-13	Notch filter 1 bandwidth	0 ~ 40(dB) [0]	The bandwidth of the notch filter 1 in the resonance frequency is set. (This parameter is set by the set up software “AHF”.)
Fd-14	Notch filter 2 frequency	3.0 ~ 1000.0 (Hz) [1000.0]	The resonance frequency of the notch filter 2 is set. (This parameter is set by the set up software “AHF”.)
Fd-15	Notch filter 2 bandwidth	0 ~ 40(dB) [0]	The bandwidth of the notch filter 2 in the resonance frequency is set. (This parameter is set by the set up software “AHF”.)
Fd-16	Torque variation width of auto tuning	5~100(%) [30]	The effective load torque variation width to measure moment-of-inertia estimated value at online auto tuning is set. Only when the load torque variation width is below this set value, Estimation is performed.
Fd-20	Speed command filter time constant	0 ~ 60000(ms) [0]	The time constant of the first-order lag filter to be applied to the speed command value is set. When this parameter is set to 0, no filtering is performed.

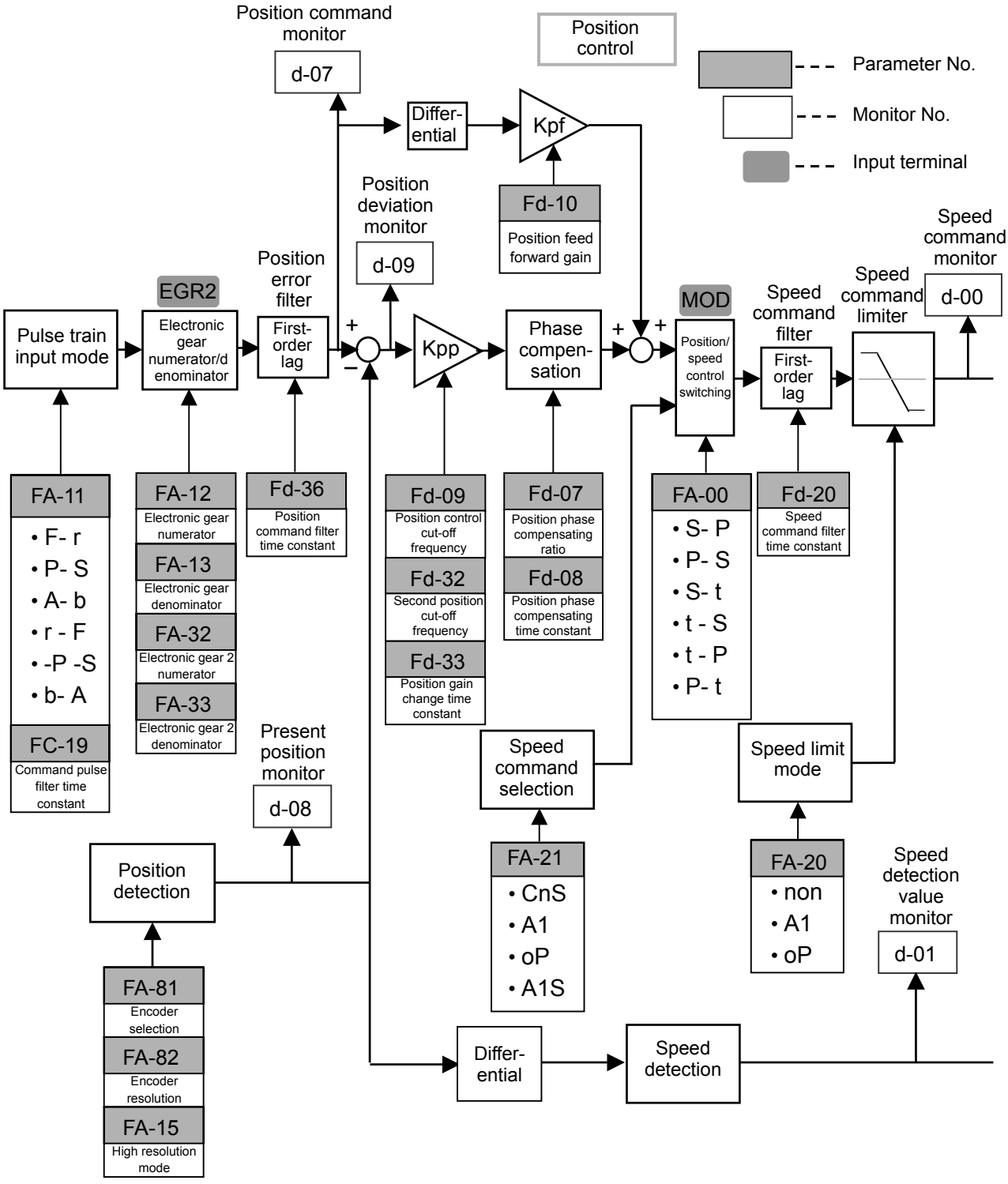
<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>Fd-30</td><td>Gain change mode</td><td>non
GCH
AUto
[non]</td><td>The switching function in the gain switch mode is set.
<table>
<tr><th>Set value</th><th>Contents</th></tr>
<tr><td>non</td><td>No gain change is performed.</td></tr>
<tr><td>GCH</td><td>Gain change is performed by GCH input terminal. (In the position control or speed control mode)</td></tr>
<tr><td>AUto</td><td>Gain change is automatically performed.</td></tr>
</table></td></tr>
<tr><td>Fd-31</td><td>Position error width for gain change</td><td>0~65535
(Pulse)
[1000]</td><td>In the position control mode, the threshold value of position error width (error between the position command value and the position detection value) to start automatic gain change (Fd-30: AUto) is set. This set value is specified by the number of encoder pulses (32768 pulses per rotation).</td></tr>
<tr><td>Fd-32</td><td>Second position control cut-off frequency</td><td>0.01~99.99
(Hz)
[10.00]</td><td>In the position control mode, the second position control cut-off frequency for gain change is set.
<table>
<tr><th>Set value of Fd-30</th><th>GCH terminal</th><th>Position error (d-09)</th><th>Cut-off frequency</th></tr>
<tr><td rowspan="2">GCH</td><td>ON</td><td>–</td><td>(Fd-32)</td></tr>
<tr><td>OFF</td><td>–</td><td>(Fd-09)</td></tr>
<tr><td rowspan="2">AUto</td><td>–</td><td>(d-09) <=Fd-31</td><td>(Fd-32)</td></tr>
<tr><td>–</td><td>(d-09) >Fd-32</td><td>(Fd-09)</td></tr>
</table></td></tr>
<tr><td>Fd-33</td><td>Gain change time constant</td><td>0.0~500.0
(ms)
[1.0]</td><td>In the position control mode, the gain change time constant for gain change is set. When this parameter is set to 0, the gain changes immediately.</td></tr>
<tr><td>Fd-34</td><td>Second speed control cut-off frequency</td><td>0.1~500.0
(Hz)
[60.0]</td><td>In the speed control mode, the second speed control cut-off frequency for gain change is set.
- The gain change mode (Fd-30) is valid for the GCH terminal only.
<table>
<tr><th>Set value of Fd-30</th><th>GCH terminal</th><th>cut-off frequency</th></tr>
<tr><td rowspan="2">GCH</td><td>ON</td><td>(Fd-34)</td></tr>
<tr><td>OFF</td><td>(Fd-01)</td></tr>
</table></td></tr>
<tr><td>Fd-35</td><td>Speed gain change time constant</td><td>0.0~500.0
(ms)
[1.0]</td><td>In the speed control mode, the gain change time constant for gain change is set. When this parameter is set to 0, the gain changes immediately.</td></tr>
</table>

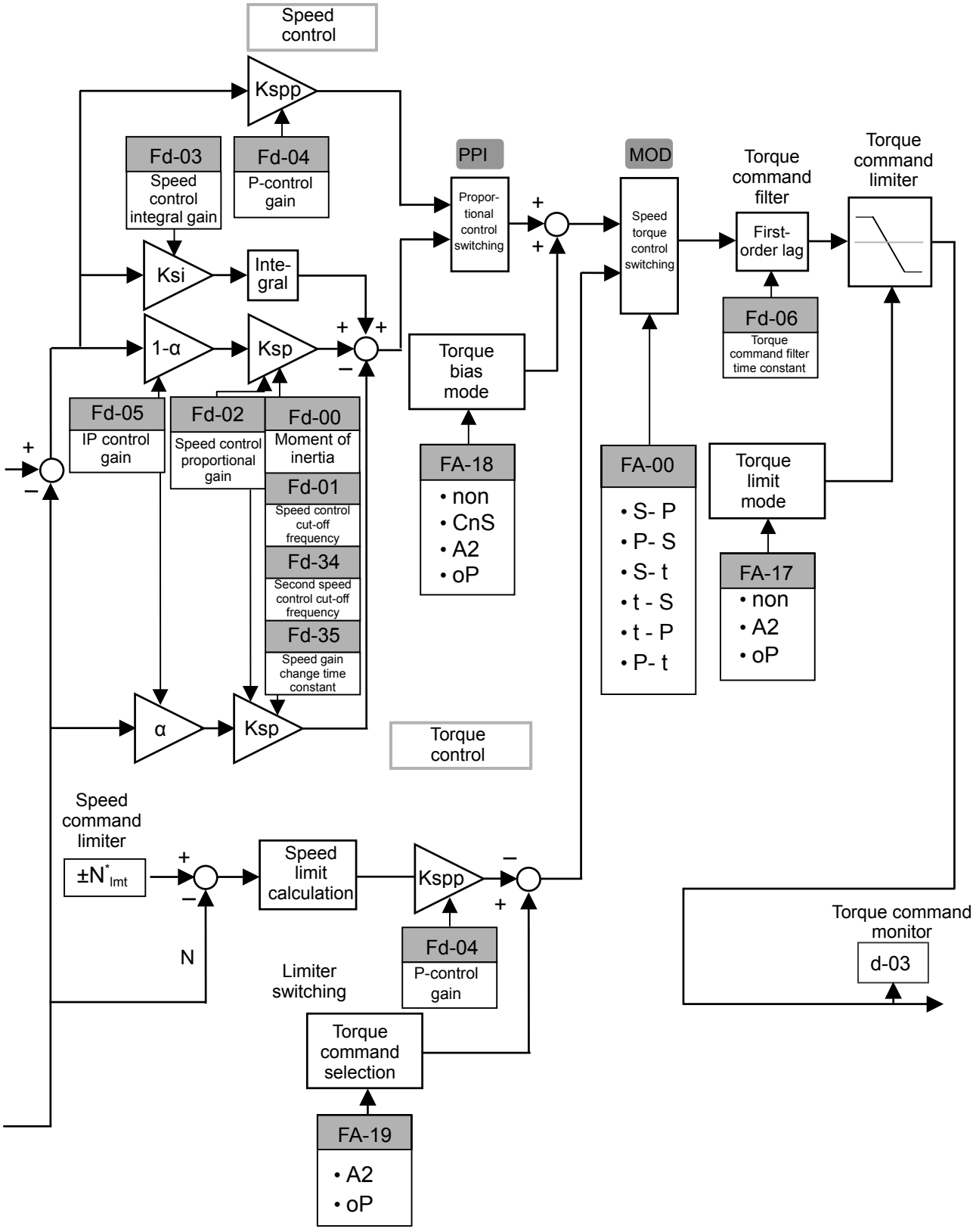
<table>
<tr><th>Parameter No.</th><th>Parameter name</th><th>Setting range [Initial value]</th><th>Contents</th></tr>
<tr><td>Fd-36</td><td>Position command filter time constant</td><td>0~60000 (ms) [0]</td><td>The time constant of the first-order lag filter to be applied to the position command value is set. When this parameter is set to 0, no filtering is performed. Be sure to set to 0 when motor is rotating only one direction continuously in position control mode. Otherwise E83 (Position error fault) occurs.</td></tr>
<tr><td>Fd-40</td><td>Fast positioning mode</td><td>non
FAst
FoL
[non]</td><td>In the position control mode, the fast positioning mode is set.
<table>
<tr><th>Set value</th><th>Contents</th></tr>
<tr><td>non</td><td>Normal position control</td></tr>
<tr><td>FAst</td><td>Fast positioning time control</td></tr>
<tr><td>FoL</td><td>Minimum position error control</td></tr>
</table></td></tr>
<tr><td>Fd-41</td><td>Position feed forward filter time constant</td><td>0.00 ~ 500.00 (ms) [0.00]</td><td>The time constant of the first-order lag filter to be applied to the loop of feed forward in the position control is set. When this parameter is set to 0, no filtering is performed.</td></tr>
<tr><td>Fd-42</td><td>Position error filter gain</td><td>0 ~ 100 (%) [100]</td><td>Position error which occurs in the “Minimum Position Error Control” is adjusted.</td></tr>
</table>

CHAPTER 6 DETAILS OF PARAMETERS

6.4 Control Block Diagram and Monitors

The following figure shows the relation among parameters, input terminals, and monitors in the control block diagram for the servo drive.




Speed control
Kspp
Fd-03
Speed control integral gain
Fd-04
P-control gain
PPI
MOD
Torque command filter
Torque command limiter
Ksi
Inte-gral
Propor-tional control switching
Speed torque control switching
First-order lag
1-α
Ksp
Fd-06
Torque command filter time constant
Torque bias mode
Fd-05
IP control gain
Fd-02
Speed control proportional gain
Fd-00
Moment of inertia
Fd-01
Speed control cut-off frequency
Fd-34
Second speed control cut-off frequency
Fd-35
Speed gain change time constant
FA-18
• non
• CnS
• A2
• oP
FA-00
• S- P
• P- S
• S- t
• t - S
• t - P
• P- t
Torque limit mode
FA-17
• non
• A2
• oP
α
Ksp
Torque control
Speed command limiter
±N*lmt
Speed limit calculation
Kspp
Torque command monitor
d-03
N
Fd-04
P-control gain
Limiter switching
Torque command selection
FA-19
• A2
• oP

MEMO

CHAPTER 7 MAINTENANCE AND INSPECTION

This chapter explains the precautions and inspection method at maintenance and inspection of this product.

CHAPTER 7 MAINTENANCE AND INSPECTION

7.1 Precautions on Maintenance and Inspection

⚠ WARNING
• After a lapse of more than 10 minutes after turning off the input power supply, perform the maintenance and inspection. Otherwise, there is a danger of electric shock. • Make sure that only qualified persons will perform maintenance, inspection and part replacement. (Before starting the work, remove metallic objects from your body.) (wristwatch, bracelet, etc.)

7.1.1 Request at Maintenance and Inspection

(1) Wait at least 10 minutes after turning off the input power supply and make sure that the charge lamp on the panel goes out, before performing maintenance and inspection.
(2) Do not perform disassembly and repair on the customer side.
(3) Do not execute a megger test or withstand voltage test for the servo drive.

7.1.2 Daily Inspection

- Basically, check if an abnormality such as shown below occurs during operation.
  1- Check if the motor is operated in accordance with the settings.
  2- Check if the environment conforms to specifications.
  3- Check if the cooling system is not defective. (Air filter of control box, cooling fan and so on)
  4- Check if abnormal vibration or noise is not caused.
  5- Check if abnormal heating or changes in color is not caused.
  6- Check if any abnormal odor is not generated.

- Check the input voltage of the servo drive with a tester during operation.
  1- Check if power supply voltage fluctuation does not often occur.
  2- Check if the line voltage is balanced.

7.1.3 Cleaning

- Always operate the servo drive in a clean condition.
- At cleaning, wipe dirty portions lightly with a soft cloth soaked in a neutral detergent.

Note: A solvent such as acetone, benzene, toluene and alcohol will result in dissolution of the servo drive surface or peeling of painting. Do not use such a solvent. The display section of the digital operator is apt to be easily damaged by detergent and alcohol. Do not use these for cleaning.

7.1.4 Periodic Inspection

- Check the portions that cannot be inspected unless the operation is stopped, and the portions requiring regular inspection.
  1- Check if the cooling system is not defective. … Cleaning of air filter etc.
  2- Screws' tightening check and further tightening. … The screws and bolts may be loosened by effects of oscillation and temperature changes. Check them carefully and then perform tightening.
  3- Check if conductors and insulators are not corroded or damaged.
  4- Check of cooling fan, smoothing capacitor and replace if necessary.

7.2 Daily Inspection and Periodic Inspection

Check point	Check item	Contents of check	Check interval			Check method	Criteria	Instrument
			Daily	Regular 1 year	Regular 2 years			
General	Ambient environ-ment	Check the ambient temperature, humidity, dust.	O			Refer to "3.1 Installation"	The ambient temperature should be 0°C or more without freezing. The ambient humidity should be 90% or less without condensation.	Thermome-ter, hygrometer, recorder
	Equipment in general	Check if abnormal vibration or noise is not caused.	O			Visual and aural check.	No abnormalities.	
	Power supply voltage	Check the main and control power voltage for normality.	O			Measure the voltage between L1, L2, and L3, between L1C and L2C on the servo drive terminal block.	The voltage should be within the specified input voltage.	Tester and digital multimeter
Main circuit	General	(1) Check connections for tightness. (2) Check for evidence of overheating in the various components. (3) Cleaning		O O	O	(1) Tighten. (2) Visual inspection.	(1)(2) No abnormalities.	
	Connector, cable	(1) Check the looseness of connector. (2) Check the injury of the cable coating.		O O		(1)(2) Visual check.	(1)(2) No abnormalities.	
	Terminal block	Check the damage of the terminal block.		O		Visual check.	No abnormalities.	
	Inverter, converter	Check a resistance check between terminals.			O	Disconnect the servo drive and measure the resistance between terminals L1, L2, or L3 and (+) or (–) and between U, V, or W and (+) or (–) with a tester of x1 Ω range.	Refer to 7.4 Checking the converter and inverter. (Note 2)	Analog tester
	Smoothing capacitor	(1) Check the liquid leakage. (2) Check the deformation.	O O			(1)(2) Visual check.	(1)(2) No abnormalities. Standard replacement interval: 5 years (Note 1)	
	Relay	Check the irregularly chattering noise at ON and OFF.		O		Aural check.	No abnormalities.	
	Braking resistor	Check the break of element.		O		Remove short bar of B1 – B2 (200V class) or B1 – RB (400V class). Check the resistance between B1 and (+).	The error is within ±10% of the indicated resistance value.	Tester
Cooling system	Cooling fan	Check if abnormal vibration or noise is not caused. (200V 750W and 400V class)	O			Rotate the fan by hand in a non-powered status.	The fan should smoothly rotate. Standard replacement interval: 2 to 3 years	
Indicator	Indicator	(1) Check the break of a LED lamp . (2) Cleaning	O			(1) LED display of the digital operator. (2) Clean with a waste cloth.	(1) Check if the lamp comes on.	

Note 1 : The life of the capacitor is affected by ambient temperature. Replace the capacitor referring to 7.5 Capacitor Life Curve as the standard.

Note 2 : The measured value by main circuit terminals U, V, and W for 3.5kW or less is not equal. Because DB circuit is built-in.

Note 3 : Refer to the motor instruction manual regarding the motor check.

7.3 Megger Test and Withstand Voltage Test

Do not conduct a megger test or a withstand voltage test. Since the inverter main circuit uses a semiconductor, the semiconductor may be deteriorated if such a test is conducted.

7.4 Checking the Inverter and Converter

- Using a tester permits checking whether the module is good or not.

(Preparation)

1- Disconnect the externally connected power cables (L1, L2, L3, L1C, L2C), motor connecting cables (U, V, W), and (+), RB and (-).
   Remove short bars of (+1) – (+) and B1 – B2 (200V class) or B1 – RB (400V class).
2- Prepare an analog tester. (The applicable range is a 1Ω resistance measuring range.)

(Checking method)

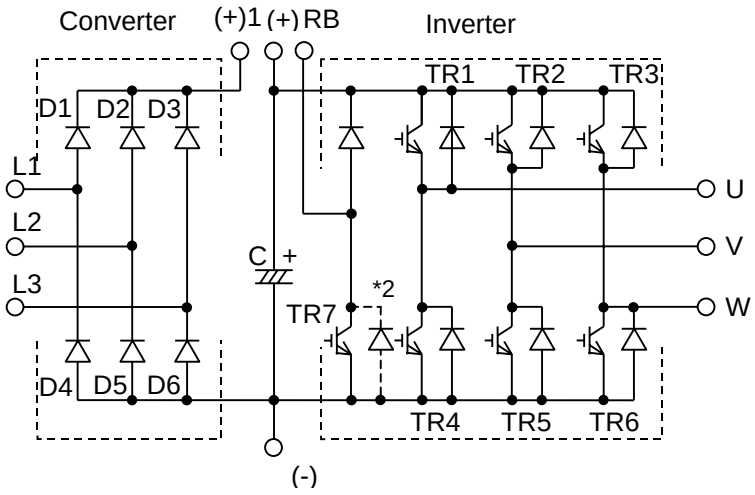
Measure the conduction state of L1, L2, L3, U, V, W, RB, (+), and (–) on the terminal block of the servo drive by changing the polarity of the tester in order to judge if the module is good.

Note 1: Measure the voltage between (+) and (–) with the DC voltage range beforehand to make sure that the smoothing capacitor is discharged enough. After that, conduct a check.

Note 2: In the non-conduction state, the measured value becomes nearly infinity. Conduction may be momentarily provided by an effect of the smoothing capacitor, so that the value may not be infinity. In the conduction state, the value is several ohms to tens of ohms.
The measured value is not the same because of element type or tester type. However, the numeric value of each item is almost equal, the measurement result is OK.

Note 3: The measured value by main circuit terminals U, V, and W for 3.5kW or less is not equal. Because DB circuit between U and W for 200V class and 400V 1.5kW, among U, V and W for 400V 3.5kW is built-in.

		Tester polarity *1		Measured value
		⊕ (red)	⊖ (black)	
Converter	D1	L1	(+)1	Non-conduction
		(+)1	L1	Conduction
	D2	L2	(+)1	Non-conduction
		(+)1	L2	Conduction
	D3	L3	(+)1	Non-conduction
		(+)1	L3	Conduction
	D4	L1	(–)	Conduction
		(–)	L1	Non-conduction
	D5	L2	(–)	Conduction
		(–)	L2	Non-conduction
	D6	L3	(–)	Conduction
		(–)	L3	Non-conduction
Inverter	TR1	U	(+)	Non-conduction
		(+)	U	Conduction
	TR2	V	(+)	Non-conduction
		(+)	V	Conduction
	TR3	W	(+)	Non-conduction
		(+)	W	Conduction
	TR4	U	(–)	Conduction
		(–)	U	Non-conduction
	TR5	V	(–)	Conduction
		(–)	V	Non-conduction
	TR6	W	(–)	Conduction
		(–)	W	Non-conduction
BR section	TR7	RB	(+)	Non-conduction
		(+)	RB	Conduction
		RB	(–)	Non-conduction *2
		(–)	RB	Non-conduction

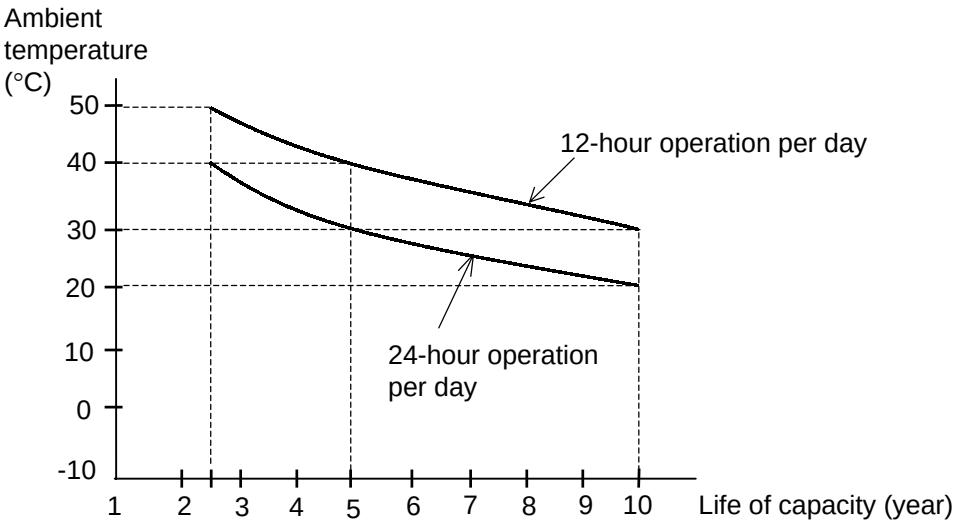


*1: Tester polarity may be in the reverse polarity because of tester type.

*2: In ease of AD*3-70HPE (4.5 to 7kW) the measured value is conduction by the parallel diode of TR7.

CHAPTER 7 MAINTENANCE AND INSPECTION

7.5 Capacitor Life Curve



Note 1: The ambient temperature means the ambient temperature (ambient atmosphere temperature) of the servo drive.
When the servo drive is housed in a box, it means the internal temperature of the box.

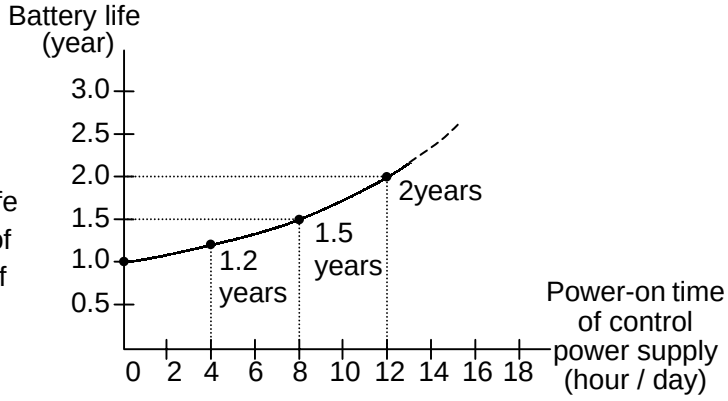
Note 2: The smoothing capacitor is exhausted by chemical reaction. Therefore, it must be usually replaced in 5 years. However, if the ambient temperature of the servo drive is high, the life is remarkably shortened.

7.6 Battery Life for Absolute Encoder

The position data of motor is kept by the backup battery built-in the battery holder when the control power supply is turned off. The incremental encoder does not need the backup battery. Refer to clause 3.2.4 of chapter 3 for the installation of battery. The backup battery is an option.
Its specification is shown in the table.

Item	Contents
Model code	ADABS-BT
Rated voltage	3.6V
Capacity	1600mAh
Mass	20g
Remarks	ER17 / 33 wk Manufactured by Hitachi Maxell, Ltd.

The life of the lithium battery ADABS-BT depends on the power-on time of the control power supply. When the battery is almost dead, this is regarded as the absolute encoder battery alarm, then trip E91 occurs. In this case, replace the battery with a new one. The appoximate life estimation is shown in the figure in case of 17 bits serial encoder. The replacement of battery is recommended before trip E91 referring to the operation record. The battery discharges by itself ever if it is not used for the backup power supply. There fore, the replacement is recommended in 2 years in spite of the life time.



Battery Life of ADABS-BT

CHAPTER 8 SPECIFICATIONS AND DIMENSIONS

This chapter explains the specifications and dimensions of this product.

CHAPTER 8 SPECIFICATIONS AND DIMENSIONS

8.1 Specification Table Standard

Item	Model	ADAX3-01NSE	ADAX3-02NSE	ADAX3-04NSE	ADAX3-08NSE	ADAX3-15HPE			ADAX3-35HPE		ADAX3-70HPE		
Basic specifications	Applicable motor capacity (kW)	0.1	0.2	0.4	0.75	0.5	1.0	1.5	2.0	3.5	4.5	5.5	7.0
	Power supply equipment capacity (KVA)	0.4	0.75	1.2	2.3	1.2	1.8	2.5	3.5	5.6	6.8	8.3	11
	Input power supply (main circuit)	Single-phase AC220 to 230V / Three-phase AC200 to 230V +10%, -15% 50/60Hz ± 5%				Three-phase AC380 to 480V +10%, -15% 50/60Hz ± 5%							
	Input power supply (control circuit)	Single-phase AC200 to 230V +10%,-15% 50/60Hz ± 5%				Single-phase AC200 to 240V +10%,-15% 50/60Hz ± 5%							
	Rated speed (min^{-1})	3000				2000							
	Maximum speed (min^{-1})	4500				3000							
	Maximum torque (Ratio to the rated torque) (%)	300				375	370	266	314	272	326	274	257
	Protective structure (Note 3)	Open type IP00											
	Control system	Sine-wave pulse width modulation PWM system											
	Control mode	Position control / Speed control / Torque control											
	Position/speed feedback	17bits/rotation Incremental encoder				Wiring-saving Incremental encoder							
	Speed control range	1 : 4500				1 : 3000							
	Speed frequency response	500Hz(J_L=J_M)											
Input/output-related functions	Speed command/ limitation input	Analog input: 0 to ±10V / Maximum speed (gain setting enable)											
	Torque command/ limitation input	Analog input: 0 to ±10V / Maximum torque (gain setting enable)											
	Toque limit forward / reverse	Forward : 0 to ±10V / Maximum torque Reverse : 0 to ±10V / Maximum torque (Each setting is independent.)											
	Position command input	Line driver signal (2 M pulses/s or less) (1) Forward/reverse run direction pulse input, (2) Command pulse + code input, (3) Phase difference pulse input(Maximum frequency is 500k pulses/s.) One of them is selectable.											
	Input signal	Contact signal input (Sink or Source signal is available.) (DC24V power supply is available for internal use.) (1)Servo ON, (2)Alarm reset, (3)Control mode switch, (4)Torque limit, (5)Forward overtravel, (6)Reverse overtravel, (7)Multistage speed 1 / Electronic gear change, (8)Multistage speed 2 / Absolute encoder clear (Note 4), (9)Proportional control / Gain change, (10)Zero speed clamp / External error, (11)Homing limit switch, (12)Homing, (13)Pulse train input enable / Forward command, (14) Position error clear / Reverse command,											
	Output signal	(1)Servo ready, (2)Alarm, (3)Positioning complete, (4)Up to speed / Alarm code1, (5)Zero speed detection, (6)Brake release, (7)Torque limiting/Alarm code2, (8)Overload notice / Alarm code3 (All signals are source type output.)											
	Encoder monitor signal output	Phase A, B signal output: Line driver signal output (output resolution settable) Phase Z signal output: Line driver signal output / open collector signal output [Specification of A/B phase separation] 17bits/rotation incremental encoder : N/rotation (N=16 to 8192) Wiring-saving incremental encoder : N/8192 (N=1 to 8191), 1/N (N=1 to 64) or 2/N (N=3 to 64)											
	Absolute position Signal output	9600bps start-stop synchronization (used also as phase Z line driver signal output)											
	Monitor output	2 ch, 0 to ±3 V Voltage output, Speed detection value, Torque command, etc. These are selectively output.											

CHAPTER 8 SPECIFICATIONS AND DIMENSIONS

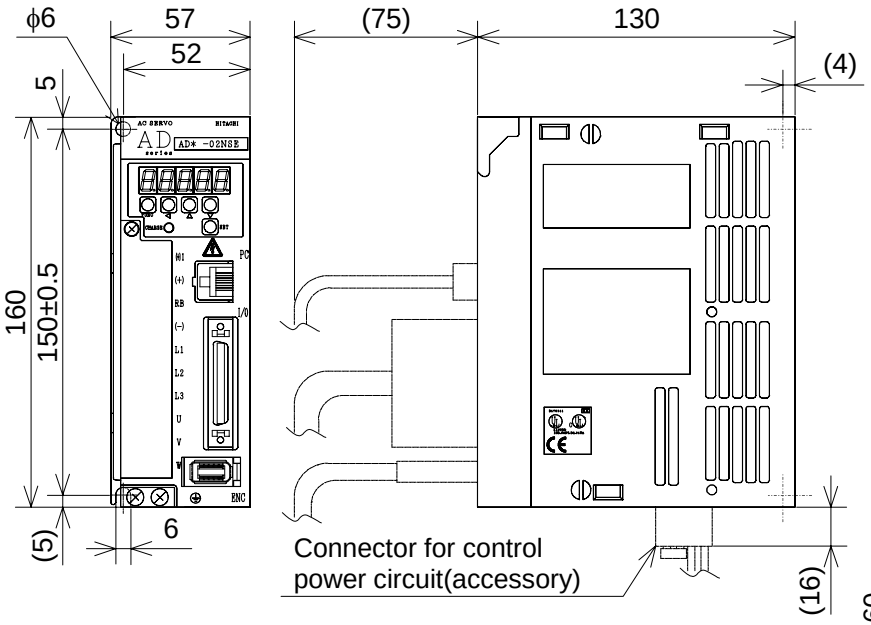
Item \ Model		ADAX3-01NSE	ADAX3-02NSE	ADAX3-04NSE	ADAX3-08NSE	ADAX3-15HPE	ADAX3-35HPE	ADAX3-70HPE
Internal functions	Built-in operator	5-digit number display unit, key input × 5						
	External operator	Windows 95/98/Me, Windows NT/2000/XP PC connectable (using the RS-232C port)						
	Regenerative braking circuit	Built-in type (without a braking resistor)		Built-in type		Built-in type		
	Dynamic brake	Available (operating condition settable)						
	Protective function	overcurrent, overload, braking resistor overload, main circuit overvoltage, memory error, CPU error, main circuit undervoltage, CT error, ground fault detection at servo ON, control circuit undervoltage, external error input, power module error, encoder error, position deviation error, position monitoring timeout error, position deviation error, overspeed error, Driving range error, over travel error, abnormal temperature error, absolute encoder com. error, absolute data error, absolute encoder break down, unmach error, invalid instruction error, nesting error, Execution error						
Operating environment	Ambient temperature/ storage temperature (Note 1)	0 to +55°C / -10 to +70°C						
	Humidity	20 to 90%RH or less (without condensation)						
	Vibration (Note 2)	5.9m/s^2 (0.6G) 10 to 55Hz						
	Installation location	1000m or less above the sea, indoor place (free from corrosive gas and dust)						
Estimated mass (kg)		0.8	0.8	1.4	1.9	1.9	5.0	7.8

Note 1: The storage temperature is the short-term temperature during transport.
Note 2: The testing method of JIS C0040 is applied.
Note 3: The protective system conforms to JEM1030.
Note 4: This case is applied when the absolute encoder is used.

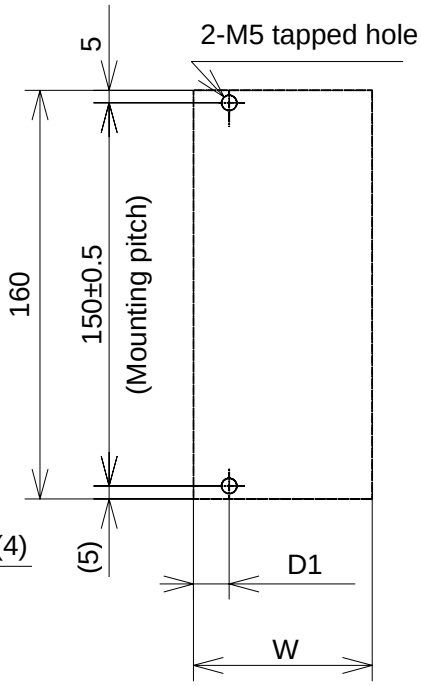
CHAPTER 8 SPECIFICATIONS AND DIMENSIONS

8.2 External Dimensions and Mounting Hole Drawing of Servo Drive

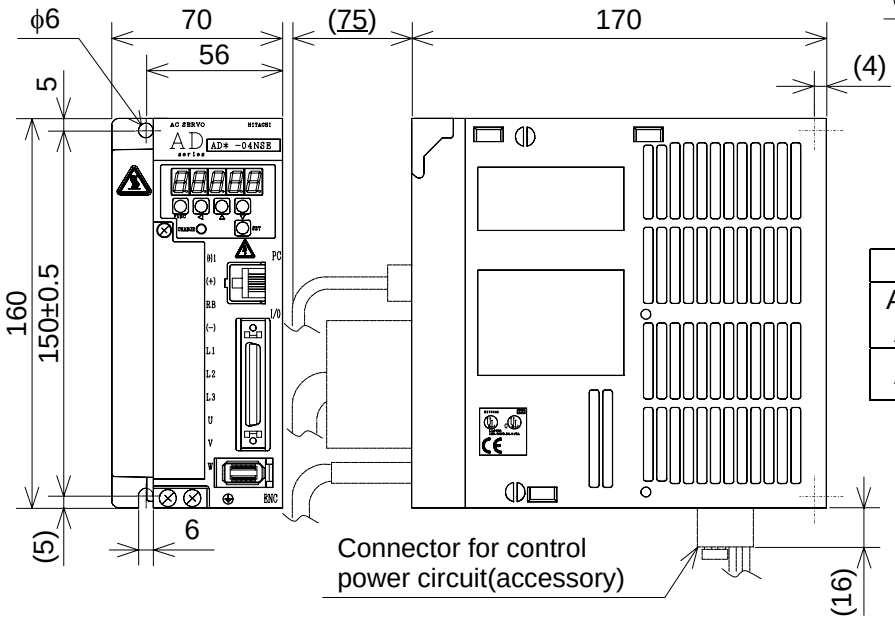
■ ADAX3 – 01NSE
ADAX3 – 02NSE



Mounting hole drawing
■ ADA3 – 01,02,04NSE

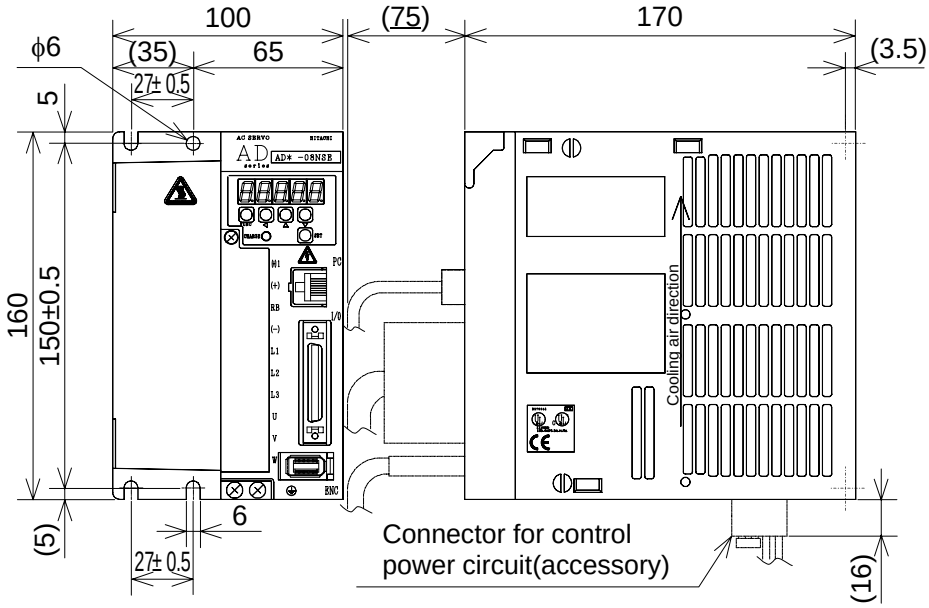


■ ADAX3 – 04NSE



Model	W	D1
ADA X 3-01NSE ADAX3-02NSE	57	5
ADAX3-04NSE	70	14

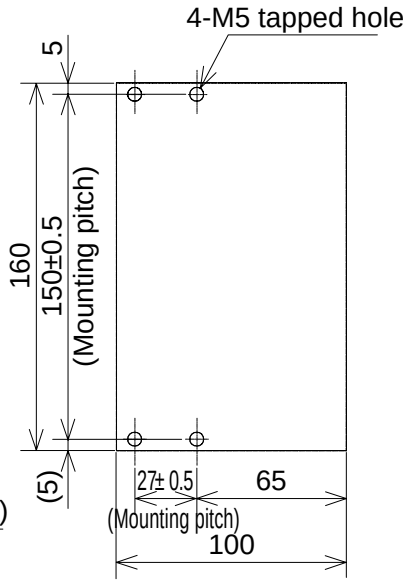
■ ADAX3 – 08NSE



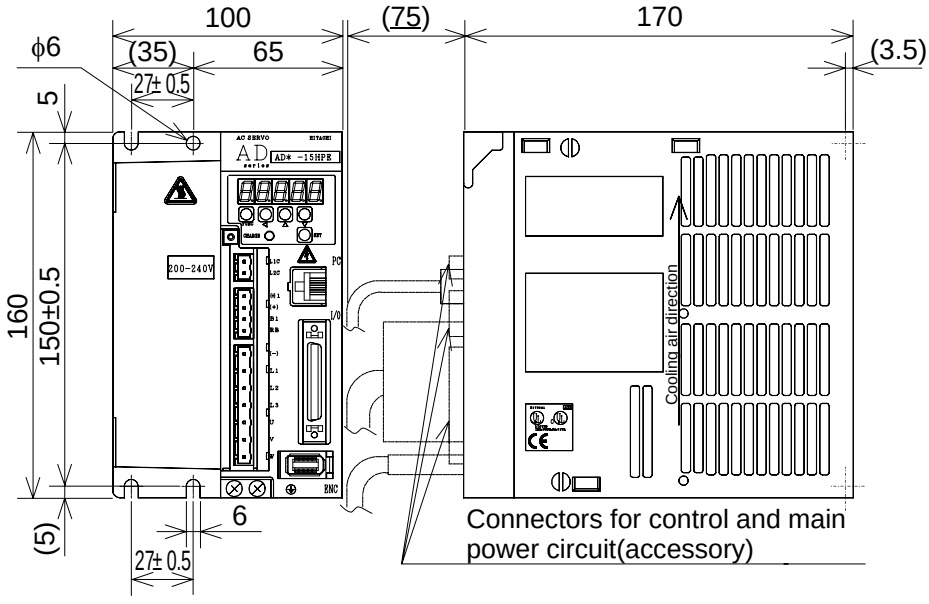
Mounting hole drawing

■ ADAX3 – 08NSE

■ ADAX3 – 15HPE

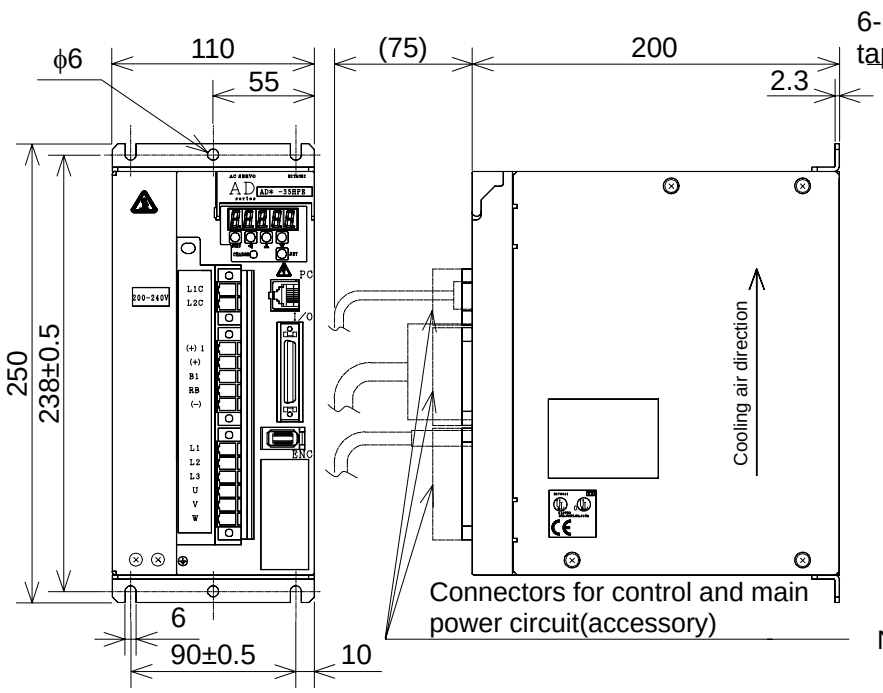


■ ADAX3 – 15HPE (0.5kW / 1kW / 1.5kW)

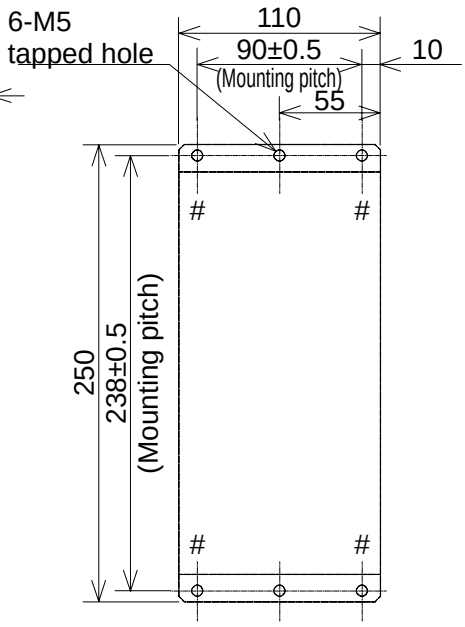


CHAPTER 8 SPECIFICATIONS AND DIMENSIONS

■ ADAX3 – 35HPE (2kW / 3.5kW)

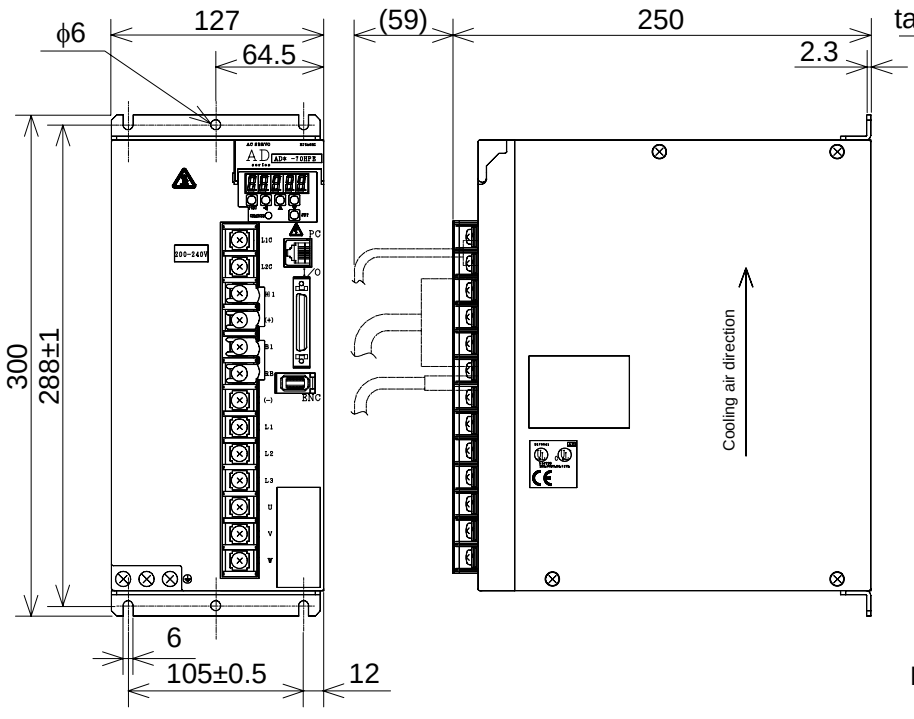


Mounting hole drawing

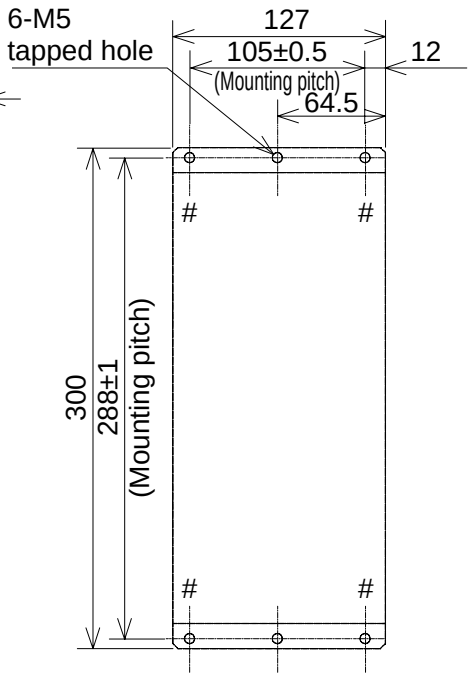


Note) Use 4 holes shown # mark above to fix the drive.
The rest 2 holes are service holes.

■ ADAX3 – 70HPE (4.5kW / 5.5kW / 7kW)



Mounting hole drawing



Note) Use 4 holes shown # mark above to fix the drive.
The rest 2 holes are service holes.

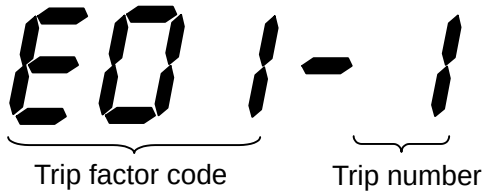
CHAPTER 9 TROUBLESHOOTING

This chapter explained the contents of protection, indications, and troubleshooting of this product.

CHAPTER 9 TROUBLESHOOTING

9.1 Trip Indication (Trip Log)

Upon occurrence of a trip, such contents as shown in the following figure are indicated.
Trip Log d-12 is also indicated in the same way as the following.



Contents of indication	Explanation
Factor code (error indicating number)	Refer to Section 9.2.
Trip number	1 to 4: “1” is the latest and a total of four numbers is saved in memory.

The following contents are indicated by pressing the ◁ key.

Contents of indication	Explanation
Speed command value	Speed command value at a trip
Speed feedback value	Speed feedback value at a trip (decimal indication)
Output current value	Output current value at a trip (For the rated current of the motor, refer to the instruction manual for the motor.)
DC voltage value between (+) and (-)	DC bus (between (+) and (-)) voltage value at a trip
Input terminal information	Refer to the pages pertaining to d-05.
Output terminal information	Refer to the pages pertaining to d-06.

In the above example, a trip may have been caused by overcurrent, or the latest trip log is due to an overcurrent.

9.2 List of Protective Functions

The errors for protecting the servo drive and the servo motor are shown in the following table.

No.	Trip name	Error indication	Outline of error
1	Overcurrent protection	E01	When the motor current flows over the specified value, this is regarded as an error.
2	Overload protection	E05	When the overload current flows for more than the specified time, this is regarded as an error. For details, refer to 10.2 Electronic Thermal Operating Time.
3	Braking resistor overload protection	E06	When the regenerative braking operating ratio (FA-08) is exceeded, this is regarded as an error.
4	Main power overvoltage protection	E07	The main circuit DC bus voltage exceeds the specified value, this is regarded as an error.
5	Memory error	E08	When a sum check error occurs in the EEPROM built in the drive because of noise interference or abnormal temperature rise, this is regarded as an error.
6	Main power undervoltage protection	E09	When a main circuit DC bus voltage below the specified value is detected in the servo ON status, this is regarded as an error.
7	CT error	E10	When an offset value error or out-of-range output value occurs in the CT output current detection in the servo OFF status, this is regarded as an error.
8	CPU error 1	E11	When a watchdog error of the CPU occurs, this is regarded as an error.
9	External error	E12	When EOH terminal is ON, this is regarded as an error.
10	Ground fault protection	E14	When the drive output results in a ground fault when the servo drive changes from OFF to ON, this is regarded as an error.
11	Instantaneous power failure protection	E16	If the servo drive is turned off when the main power supply input is shut off in the servo ON status and the power is not recovered after the allowable time of power failure (FA-02), this is regarded as an error.
12	Control power undervoltage protection	E20	If the servo drive is turned off when a control power supply voltage below the specified value is detected and the power supply is recovered before internal resetting, this is regarded as an error.
13	Abnormal temperature	E21	When the power module temperature or the built-in braking resistor (only for 400V class) temperature.
14	CPU error 2	E22	When a communication error with the CPU occurs, this is regarded as an error.
15	Overtravel error	E25	At servo ON, when both FOT and ROT are simultaneously validated for about 1 second or more, this is regarded as an error.
16	Power module protection	E31	When an overcurrent detected by the power module or a power supply voltage drop of the gate drive circuit occurs, this is regarded as an error.
17	DB overload error	E36	The capacity that can be consumed by the DB resistor built in the servo drive is exceeded. For example, the DB operating frequency is high.
18	Encoder signal error	E39	When encoder wire breaking occurs, an error signal is received from the encoder, or the servo drive is turned on without connecting the encoder in the power ON status, this is regarded as an error.
19	Motor power unmatch	E40	The servo motor output or voltage class mismatches the servo drive and is not applicable, this is regarded as an error. The trip cannot be cleared from the RS terminal.
20	Option error	E42	When a connection error occurs in an option, this is regarded as an error.

CHAPTER 9 TROUBLESHOOTING

No.	Trip name	Error indication	Outline of error
21	Invalid instruction error Note 2)	E43	When the code except for the instruction is fetched at programmed operation, this is regarded as an error. (Refer to the troubleshooting of the instruction manual of programmable function.)
22	Nesting error Note 2)	E44	When the nesting level of the subroutine exceeded the specified level at programmed operation, this is regard as an error. (Refer to the troubleshooting of the instruction manual of programmable function.)
23	Execution error Note 2)	E45	When the program is not excuted at programmed operation, this is regard as an error. (Refer to the troubleshooting of the instruction manual of programmable function.)
24	Position error fault	E83	When the difference between the motor position command and the position detection value exceeds the Position Error Detection Value (FA-05), this is regarded as an error.
25	Speed error fault	E84	When the difference between the speed command and the speed detection value exceeds the Speed Error Detection Value (FA-04), this is regarded as an error.
26	Overspeed error	E85	When the motor detection speed increases over the specified set speed (maximum rotation speed x FA-03), this is regarded as an error.
27	Driving range error	E88	When the position detection value is out of the range of specified set value (Fb-16 to Fb-19), this is regarded as an error.
28	Position monitoring timeout error	E89	When the time required for the position error to enter the positioning range after the position command value reaches a certain position exceeds the Position Monitoring Time (Fb-24), this is regarded as an error.
29	Absolute encoder battery error	E90	When the absolute encoder battery goes down and the absolute encoder position data is lost, this is regarded as an error. The trip can be cleared by changing a battery, inputting ECLR signal during 4s or more and then inputting RS signal.
30	Absolute encoder battery alarm	E91	When the absolute encoder battery is about to go down, this is regarded as an error. The absolute encoder position data is not lost and has a correct value.
31	Absolute encoder counter overflow	E92	When the absolute encoder position counter overflows or underflows, this is regarded as an error. The trip can be cleared by inputting ECLR signal during 4s or more and then inputting RS signal.
32	Absolute encoder error	E93	An error that requires encoder resetting occurs in the absolute encoder. The trip can be cleared by inputting ECLR signal during 4s or more and then inputting RS signal.
33	Insufficient voltage indication Note 1)	- - - - -	This error indicates that the control power supply voltage is insufficient in the servo OFF status.
34	Auto-tuning error Note 1)	– – Err	When the offline auto-tuning can not be successfully executed, the error is indicated.

Note 1) The alarm signal is not output at trip.

Note 2) The alarm signal is only for the amplifier with programming function.
When the alarm signal is assigned to the general output terminal by chg ALM instruction, the alarm signal is output.

Note 3) Clear E31 error by shutting off the power supply. E14 error occurs at servo ON when the error is cleared by the RS terminal. (only for 400V class).

9.3 Troubleshooting

Corrective measures differ depending on whether a trip is caused or not. Each case is explained below.

9.3.1 When a trip is not caused

Symptom	Cause	Contents of check	Corrective measure
The motor does not rotate.	The rated voltage is not applied to the power supply terminals L1, L2, and L3, or L1C and L2C.	- Check the voltage with a tester. - Check the cabling and trip about the earth leakage breaker, electromagnetic contactor, etc.	Correct the failure, trip, or wrong cabling of the earth leakage breaker, electromagnetic contactor, etc.
	The power input section of the drive is defective.	After checking the above, check if the charge lamp lights up.	If the charge lamp does not light up, the drive is defective. Replace or repair the drive.
	Wrong cabling or misconnection of the motor	Check the phase sequence and check if any defective contact exists.	Correct the phase sequence or misconnection.
	The SON terminal is not ON. (Wrong polarity)	- Check if the SON terminal is ON by the parameter Input Terminal Monitor d-05. - Check the polarity setting.	- Turn on the SON terminal. - Correct the polarity setting.
	The torque limit is effective. (Wrong polarity)	- Check if the TL terminal is ON by the parameter Input Terminal Monitor d-05. - Check if the setting is correct.	- Disconnect the TL terminal. - Correct the polarity setting. - Correct the torque limit setting.
	The FOT and ROT terminals are not ON. (Wrong polarity)	- Check if the FOT and ROT terminals are ON by the parameter Input Terminal Monitor d-05. - Check the polarity setting.	- Turn on the FOT and ROT terminals. - Correct the polarity setting.
	The SRZ terminal is ON. (Wrong polarity)	- Check if the SRZ terminal is ON by the parameter Input Terminal Monitor d-05. - Check the polarity setting.	- Disconnect the SRZ terminal. - Correct the polarity setting.
	The multistage speed setting is not performed. (Wrong polarity)	- Check if the SS1 and SS2 terminals are ON by the parameter Input Terminal Monitor d-05. - Check the polarity setting.	- Turn on the SS1 and SS2 terminals. - Correct the polarity setting. - Correct the multistage speed setting.
	The speed analog input is not ON. (Wrong analog input setting)	- Check if the command is ON by the parameter Speed Command Monitor d-00. - Check if the setting is correct.	- Turn on the analog input. - Correct the analog input setting.

CHAPTER 9 TROUBLESHOOTING

Symptom	Cause	Contents of check	Corrective measure
The motor does not rotate. (Cont.)	In the position control mode, the pulse train command is not ON. (Wrong specified mode setting or polarity)	- Check if the command is ON by the parameter Position Command Monitor d-07. - Check if the setting is correct. - The electronic gear ratio is low and does not seem to have moved. - The pulse train input rate is low.	- Turn on the pulse train command. - Adjust the command type to the input pulse train. - Set the electronic gear ratio correctly. - Increase the pulse rate.
	In the position control mode, the PEN terminal is ON. (Wrong polarity)	- Check if the PEN terminal is ON by the parameter Input Terminal Monitor d-05. - Check if the setting is correct.	- Turn on the PEN terminal. - Correct the polarity setting.
	The motor is locked. (Brake ON)	Check the lock.	Release the shaft.
	The servo drive is not turned on in the status where the motor run speed is 0.5% or less of the rated speed immediately after DB. (For the servo drive of 5 kW or more)	- Check if the servo ON status is immediately after DB. - Check if the motor run speed in the servo ON status is 0.5% or less of the rated speed.	Turn on the servo drive after the motor run speed becomes 0.5% or less of the rated speed.
	The servo drive is defective. (Defective encoder)	- The corresponding item is not found in the precedent description. - Make a module check. (Refer to Maintenance and Inspection.)	If the servo drive is defective, replace or repair it.
The motor run is unstable.	Large load variation	- Check the load variation. - Check the capacity calculation.	- Reduce the load variation. - Increase the capacity.
	Large backlash of the mechanical system	Check the backlash.	Reduce the backlash.
	Improper control gain	Check the set parameter.	Readjust the control gain.
	The signal cable or encoder cable intersects the main circuit cable. (They are in the same duct.)	Check the position of the signal cable and encoder cable.	Separate the signal cable and encoder cable from the main circuit cable.
	The shielding wire of the encoder cable is not connected.	Check the connection of the shielding wire of the encoder cable.	Connect the shielding wire of the encoder cable.
	The servo drive is defective. (Defective encoder)	- Make a module check. (Refer to Maintenance and Inspection.) - Check if the position count fluctuates by the parameter Current Position Monitor d-08.	If the servo drive is defective, replace or repair it.
	Offline auto-tuning is set.	Check the set parameter (FA-10) is set to non.	Set it to non.

Symptom	Cause	Contents of check	Corrective measure
The motor run speed does not increase.	Speed limit is applied.	- Check the settings (Fb-20 and Fb-21).	Set the speed limit value correctly.
	Torque limit is effective. (Wrong polarity)	- Check if the TL terminal is ON by the parameter Input Terminal Monitor d-05. - Check if the setting is correct.	- Disconnect the TL terminal. - Correct the polarity setting. - Correct the torque limit setting.
	The speed control is P control. (Wrong polarity)	- Check if the PPI terminal is ON by the parameter Input Terminal Monitor d-05. - Check if the setting is correct.	- Disconnect the PPI terminal. - Correct the polarity setting.
	The command speed setting is wrong.	Check the speed command input by the parameter Monitor d-00.	Correct the command setting.
	The control gain is not proper.	Check if hunting occurs.	Readjust the control gain.
	The load is heavy.	- Check the load. - Check the capacity calculation.	- Reduce the load. - Increase the capacity.
	The brake is applied to the motor.	Check the brake.	Release the brake.

9.3.2 When a Trip is caused

When a trip is caused, clear the trip by the RS terminal and take a corrective measure according to the following table. After that, turn on the servo drive. (For clearing the trip, refer to the pages pertaining on the RS terminal in 5.2 Input Terminal Functions.)

Trip No.	Trip name	Cause	Contents of check	Corrective measure	Reset
E01	Overcurrent protection	- The output terminal is shorted. - Ground fault - Wrong phase sequence	Check the cable connection.	Correct the cable connection.	A
		Sudden motor lock	Check the load.	Adjust the brake timing to avoid a lock.	
		The power supply voltage is low. The power supply fluctuates.	Check the power supply voltage. (Check the power supply capacity.)	Correct the power supply voltage, capacity, and cabling.	
		The encoder is defective.	Check the count by the parameter Present Position Monitor (d-08).	If it is defective, replace or repair it.	C
		The power (inverter) module is damaged.	Make a module check. (Refer to 7. Maintenance and Inspection.)		A
		DB circuit is defective.	Disconnect the motor cables for U, V, W. Turn on power. Check E01 error is caused at Servo ON.		
E05	Overload protection	The load is too heavy.	Check the load.	Reduce the load.	B
		The motor is locked.		Adjust the brake timing to avoid a lock.	C
		The phase sequence of the motor is wrong.	Check the cable connection.	Correct the cable connection.	A
		The encoder of the motor is defective.	Check if the counter is correctly operated by the parameter Current Position Monitor d-08.	If the encoder is defective, replace or repair it.	C
E06	Braking resistor overload protection	The regenerative load is too heavy. The balance weight is so large that the continuous regeneration is applied.	Check the regenerative load.	- Reduce the load. - Increase the deceleration time.	A
		The regenerative capacity is insufficient.		Review the regenerative resistor.	

Symbols in the Reset column:
A: Shut off the power supply of the servo drive, perform troubleshooting, replace or repair parts.
B: Stop the servo motor, and then short between RS and P24 after cooling, and perform troubleshooting.
C: Stop the servo motor, short between RS and P24, perform troubleshooting or shut off the power supply.
D: Stop the servo motor, input ECLR during 4s or more, short between RS and P24 and perform troubleshooting.

Trip No.	Trip name	Cause	Contents of check	Corrective measure	Reset
E06	Braking resistor overload protection	The deceleration time is too short.	Check if a trip is caused during deceleration.	Increase the deceleration time.	B
		The power supply voltage is high.	Check the power supply voltage.	Normalize the power supply voltage.	A
		The regenerative braking operating ratio is set to a small value.	Check the operating ratio in accordance with the regenerative resistor.	Set a correct operating ratio.	B
E07	Main power overvoltage protection	The regenerative resistance value is large.	Check the regenerative resistance.	Reduce the regenerative resistance value to the minimum resistance value R_{BR}min. (Refer to 3.2.2 Main Circuit Wiring, (3).)	A
		The deceleration time is too short.	Check the deceleration time.	Increase the deceleration time.	C
		The motor is put into hunting and momentary regeneration occurs.	Check if the motor is not put in hunting (abnormal noise).	Adjust the position/speed control gain properly.	
		The regenerative resistor is not connected, or open or damaged.	Check the connection and resistance value of the regenerative resistor.	- Correct the connection of the regenerative resistor. - Replace the regenerative resistor.	A
		The received power voltage is high or a ground fault occurs.	- Check the power supply voltage. - Check the connection.	- Reduce the voltage. - Correct the connection.	A
E08	Memory error	Sum error of the built-in EEPROM of the drive	Check if the all the set values of the servo drive are correct.	- After clearing the trip, perform factory-setting, and then restart the drive. - If the servo drive is defective, replace or repair it.	C

Trip No.	Trip name	Cause	Contents of check	Corrective measure	Reset
E08	Memory error	An EEPROM write or read error is caused by noise.	- Check if any noise source exists near the drive. - Check if the set value is correct.	- Remove the noise source. - After clearing the trip, perform factory-setting, and then restart the drive.	A
E09	Main power undervoltage protection	The power supply voltage of the main circuit is low.	Review the power supply system.	Increase the power supply voltage.	C
		A unit using a large current exists in the power supply system, and the voltage is lowered while this unit is in operation.		Divide the power supply system for each of the unit and the drive.	A
		Chattering occurs in the electromagnetic contactor on the power supply side.		Replace the electromagnetic contactor.	
		A connection fault exists in the power supply system.		Correct the connection fault.	
		Insufficient power supply capacity		Ensure the power supply capacity.	
		Only the control power supply is provided.		Perform wiring to the main circuit, too.	
		- The power supply voltage of the main circuit is lowered. - A short power failure occurred.	Check if the symptom shown at left has occurred.	After clearing the trip, restart the operation.	C
E10	CT error	- The current detector is defective. - The current detector malfunctions because of noise.	Turn on the power supply again.	If the CT is defective, replace or repair it.	A
			Check if there is any noise source near the drive.	Keep the noise source away from the drive.	

Trip No.	Trip name	Cause	Contents of check	Corrective measure	Reset
E11	CPU error 1	The microcomputer built in the drive runs away because of noise.	Check if there is any noise source (including the solenoid coil and electromagnetic contactor) near the amplifier.	- Keep the noise source away from the drive. - Install a noise filter or surge absorber.	A
			Turn on the power supply again and check the condition.	If it is defective, replace or repair it.	A
E12	External error	EOH terminal is ON.	Check if EOH terminal is ON.	Remove the cause of the EOH input.	C
E14	Ground fault protection	A ground fault occurs in the motor or between the motor and the drive.	Disconnect the connection and check the ground fault portion by megger test.	Correct the ground fault portion.	A
E16	Instanteous power failure	A unit using a large current exists in the power system, and the voltage is lowered while this unit is in operation.	Review the power supply system.	Divide the power supply system for each of the unit and the drive.	
		Chattering occurs in the electromagnetic contactor on the power supply side.		Replace the electromagnetic contactor.	
		A connection fault exists in the power supply system.		Correct the connection fault.	
		Insufficient power supply capacity		Ensure the power supply capacity.	
		The power supply voltage of the main circuit is lowered. A short power failure occurred.	Check if the symptom shown at left has occurred.	After clearing the trip, restart the operation.	C
		The DC power is supplied.	Check if FA-07 is set to Pn.	Set FA-07 to Pu.	

Trip No.	Trip name	Cause	Contents of check	Corrective measure	Reset
E20	Control power undervoltage protection	The power supply voltage of the main circuit is low.	Review the power supply system.	Increase the power supply voltage.	C
		A unit using a large current exists in the power system, and the voltage is lowered while this unit is in operation.		Divide the power supply system for each of the unit and the drive.	A
		Chattering occurs in the electromagnetic contactor on the power supply side.		Replace the electromagnetic contactor.	
		A connection fault exists in the power supply system.		Correct the connection fault.	
		Insufficient power supply capacity		Ensure the power supply capacity.	
		The power supply voltage of the main circuit is lowered. A short power failure occurred.	Check if the symptom shown at left has occurred.	After clearing the trip, restart the operation.	C
E21	Abnormal temperature	The load is heavy.	Check the load. Check the ambient temperature.	- Clear the trip after the servo drive cools down and lower the ambient temperature. - Replace the servo drive with one fit for the load.	B or C
		The ambient tem - perature of the servo drive is higher than 55 °C.			
		The cooling fan built-in the drive is defective.	Check the fan is running.	Replace the fan.	A
		The motor is locked.	Visual check.	Unlock the motor.	A
		The regenerative braking operating ratio of the built-in resistor is high.	Check the regenerative capacity.	Use the external braking resistor with reviewed capacity.	A
E22	CPU error 2	The microcomputer built in the drive cannot perform communication because of noise.	Check if there is any noise source (including the solenoid coil and electromagnetic contactor) near the amplifier.	- Keep the noise source away from the drive. - Install a noise filter or surge absorber.	A
		The communication circuit is abnormal.	Turn on the power supply again and check the condition.	If the communication is defective, replace or repair it.	A

Trip No.	Trip name	Cause	Contents of check	Corrective measure	Reset
E24	Phase failure protection	Chattering occurs in the electromagnetic contactor on the power supply side.	Review the power supply system.	Replace the electromagnetic contactor.	C
		A connection fault exists in only one phase of the power supply system.		Correct the connection fault.	A
		The DC power is supplied.	Check if FA-07 is et to Pn.	Set FA-07 to Pn.	C
		There is a missing phase of the power supply.		After clearing the trip, restart the operation.	C
E25	Overtravel error	Wrong terminal connection	Check the cable connection.	Correct the cable connection.	A
		The FOT/ROT terminal is not turned on at servo ON.	Check if the FOT/ROT terminal is ON by the parameter input terminal monitor d-05.	Turn on at least one terminal of the FOT and ROT terminals.	C
E31	Power module protection	The output terminal is shorted. A ground fault occurs. The phase sequence of the motor is wrong.	Check the cable connection.	Correct the cable connection.	A
		Sudden motor lock	Check the load.	Adjust the brake timing to avoid a lock.	A
		The power supply voltage is low. The power supply fluctuates.	Check the power supply voltage. (Check the power supply capacity.)	Correct the power supply voltage, capacity, and cabling.	A
		The encoder is defective.	Check if the count is correct by the parameter Current Position Monitor (d-08).	If the communication is defective, replace or repair it.	A
		The power (inverter) module is damaged.	Make a module check. (Refer to Maintenance and Inspection.)		A
E36	DB overload error	The parameter (FA-16) is set so that the DB operating ratio may be increased.	Check the parameter setting.	Correct the parameter setting.	B
		The rotation speed at DB is high.	Check the rotation speed at DB.	Reduce the rotation speed at DB.	
		The moment of load inertia is high.	Check the moment of load inertia.	Reduce the moment of load inertia.	
		The DB operating ratio is high.	Reduce the operating ratio.	Reduce the DB operating ratio.	

Trip No.	Trip name	Cause	Contents of check	Corrective measure	Reset
E39	Encoder signal error	Wire breaking or poor connector fitness exists on the encoder cable.	Check the cable, connector, shielding wire, and grounding conductor.	Correct the wire breaking or fitness.	A
		The cable shield or grounding conductor is imperfect.		Strengthen the shielding wire and grounding conductor.	
		The encoder cable goes along the power cable.		Keep the encoder cable away from the power cable.	
		A malfunction is caused by noise.	Check if there is any noise source nearby.	Keep the noise source away from the drive.	
		When the power supply is turned on with the absolute encoder, the motor rotates.	Check if the motor coasts along.	Stop the motor and turn on the power supply again.	
		The encoder is defective.	In the servo OFF status, move the motor shaft. At that time, check if the parameter present Position Counter (d-08) changes.	If the encoder is defective, replace or repair it.	
		When the power supply is turned on, the encoder is not connected.	Make a check as shown at left.	Turn on the power supply while the encoder is connected.	
E40	Motor power unmatch	The servo drive does not match the motor output.	Check the connection to the drives for the encoder cable of each motors.	Correct the connection of the encoder and combine a servo motor with a servo drive correctly.	A
		The voltage class is not the same between the servo motor and the servo drive.			
		The encoder does not match the parameter setting value.	Check parameters concerning the encoder selection (FA-81 and FA-82).	Correct the parameter setting value.	A
		The setting value of the pulse resolution ration is wrong.	Check the parameters of FC-09 and FC-10.	Correct the parameter setting value.	A
E42	Option error	The connection of the option is wrong.	Check the connection status.	Correct the connection status.	A

Trip No.	Trip name	Cause	Contents of check	Corrective measure	Reset
E83	Position error fault	The pulse position command rate is too fast.	Check the position command input rate.	Make the pulse position command rate slow.	C
		The electronic gear setting is wrong.		Set the electronic gear correctly (reduce the ratio).	
		The control gain does not match.	Check the setting.	Adjust the control gain.	
		The speed or torque limiter is too low.		Set the speed or torque limiter correctly (increase).	
		The position error detection value setting is too small.		Set the position error detection value correctly (increase).	
		A malfunction is caused by noise.	- Check if there is any noise source nearby. - Check the cable, connector, shielding wire, and grounding conductor.	- Keep the noise source away from the drive. - Strengthen the shielding wire and the grounding conductor. - Keep the encoder cable away from the power cable.	A
		The moment of load inertia is too heavy.	Check the relation between the load and the position command rate.	Reduce the load.	
E84	Speed error fault	The speed command input setting is wrong.	Check the setting.	Correct the input setting.	C
		The control gain does not match.		Adjust the control gain.	
		The torque limiter is too low.		Correct (increase) the torque limiter.	
		The speed error detection value setting is too small.		Correct (increase) the speed error detection value.	
		A malfunction is caused by noise.	- Check if there is any noise source nearby. - Check the cable, connector, shielding wire, and grounding conductor.	- Keep the noise source away from the drive. - Strengthen the shielding wire and the grounding conductor. - Keep the encoder cable away from the power cable.	A
		The moment of load inertia is too heavy.	Check the relation between the load and the position command rate.	Reduce the load.	

Trip No.	Trip name	Cause	Contents of check	Corrective measure	Reset
E85	Overspeed error	The speed command input setting is wrong.	Check the setting.	Correct the input setting.	C
		The control gain does not match.		Adjust the control gain.	
		The torque limiter is too low.		Correct (increase) the torque limiter correctly.	
		The overspeed error detection level setting is too low.		Set the overspeed error detection level correctly (increase).	
		A malfunction is caused by noise.	- Check if there is any noise source nearby. - Check the cable, connector, shielding wire, and grounding conductor.	- Keep the noise source away from the drive. - Strengthen the shielding wire and the grounding conductor. - Keep the encoder cable away from the power cable.	A
		The moment of load inertia is too heavy.	Check if overshooting occurs.	Reduce the load.	
		The connection of the motor cable is wrong.	Check the connection.	Correct the connection.	
		The encoder is defective.	Move the motor shaft and check that the indicator can be operated in good order by the parameter d-08.	If the encoder is defective, replace or repair it.	C
E88	Driving range error	- The pulse train position command is wrongly input. - The homing position is wrong. - The operation is performed out of the drive range.	Check the upper-level system.	If any wrong matter is found, remove the cause. Clear the trip and restart the operation.	A
		There is no margin in the setting out of the drive range.	Check if the motor is rotated by the load just at the limit of the drive range.	- Review the setting out of the drive range. - Remove the load with which the motor was rotated.	C
		The electronic gear setting is wrong.	Check the setting.	Correct the setting.	
		The torque limiter is too low.			
		The control gain does not match.		Adjust the control gain.	

Trip No.	Trip name	Cause	Contents of check	Corrective measure	Reset
E89	Position monitoring timeout error	The control gain, positioning detection range (Fb-23), or positioning interval time-limit setting (Fb-24) is not proper.	Check the set value.	Adjust each set value.	C
		The electronic gear setting is wrong.		Correct the set value.	
		The motor is locked.	Check the load.	- Unlock the motor. - Adjust the brake release timing.	
		The load is larger than the estimated level.		- Reduce the load. - Increase the motor/drive capacity.	A
		The torque limiter is effective.	Check the TL terminal and the setting.	- Disconnect the TL terminal. - Change the setting.	C
E90	Absolute encoder battery error	- The absolute encoder battery is not connected. - The battery connection is faulty.	Check the connection with the battery.	Connect the battery and reset the encoder.	D
		The battery voltage is too low.	Check the battery voltage.	Replace the battery and reset the encoder.	
E91	Absolute encoder battery alarm	The battery voltage is low.	Check the battery voltage.	Replace the battery.	C
		- The absolute encoder battery is not connected. - The battery connection is faulty.	Check the connection with the battery.	Connect the battery and reset the encoder.	
E92	Absolute encoder counter overflow	The absolute encoder counter overflows or underflows.	Check the current position and the counter value.	Reset the encoder.	D
E93	Absolute encoder error	Absolute encoder status error	Check the present position and the counter value.	Reset the encoder.	D
--Err	Auto-tuning error	The offline auto-tuning is set.	Check FA-10 is set to non.	After turning off SON terminal, turn on and off RS terminal. Check FA-10 is set to non.	C
		The moment of load inertia exceeds 128 times of motor itself.	Check the moment of load inertia of load.		

MEMO

CHAPTER 10 APPENDIXES

This chapter explains the options of this product.

CHAPTER 10 APPENDIXES

10.1 Options

(1) Communication program (AHF-P01)

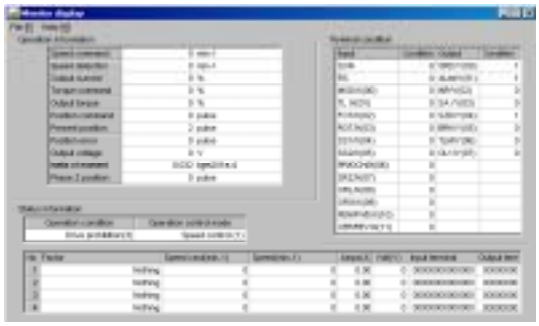
When connected to a PC, parameter setting, position/speed/torque monitoring, and graphic display can be performed. Operations can be performed comfortably in the Windows operating environment.

■ Operating environment

Item	Condition
PC	DOS/V PC Memory : At least 32MB Free hard disc space : At least 30MB Monitor resolution : 800 × 600 or higher recommended.
OS	Windows 95/98/Me, Windows NT, Windows 2000, Windows XP
PC connecting cable	ADCH-AT2

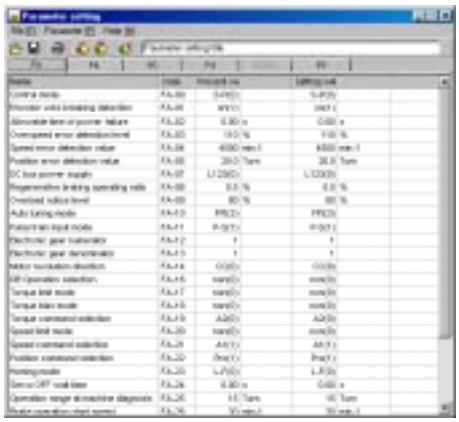
■ Monitoring function

Operation information and terminal status can be monitored in real time.
(Available for AHF-P01, AHF-P02)



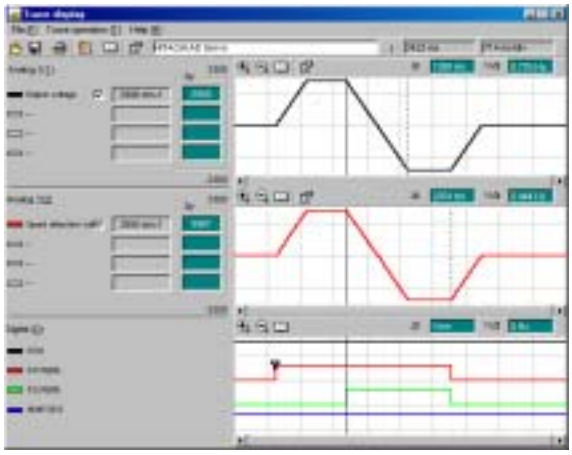
■ Parameter setting

Parameter setting, saving, and reading can be operated from the PC.
(Available for AHF-P01, AHF-P02)



■ Operation trace function

The speed and current of the servo motor and etc. can be graphically displayed.
(Available for AHF-P01, AHF-P02)



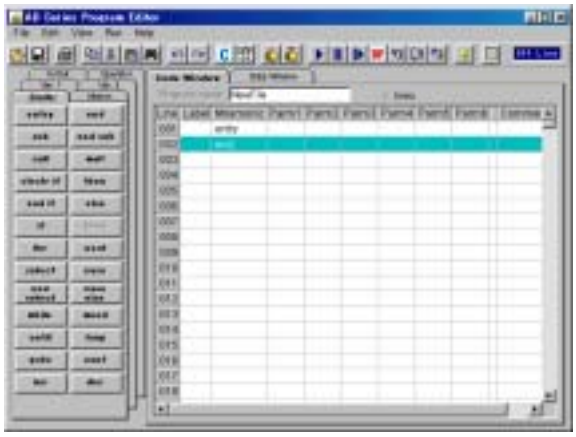
■ Test run and adjustment

Jogging operation, homing,
Offline auto tuning
Online auto tuning

These functions are supported.
(Available for AHF-P01, AHF-P02)

■ Program editor function

For programming function use, editing, compiling, downloading, uploading of program and so on are available.
(Available for AHF-P02)



(2) Cables

■ Explanation of encoder cable model codes

ADCE – C H 003 M1 S

Symbol	Cable name
ADCE-C	Encoder cable

Encoder types

Symbol	Specification
S	17 bits serial encoder
HP	Wiring-saving incremental encoder

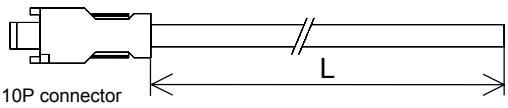
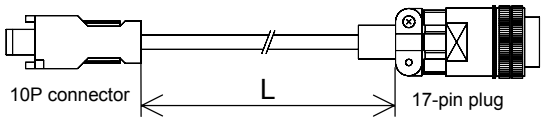
Cable types (classification by output)

M1, M2

Symbol	003	006	010	020	030
Length (m)	3	6	10	20	30

Symbol	Specification
None	Standard
H	High flexure life cable

■ Encoder cables (for incremental and absolute)

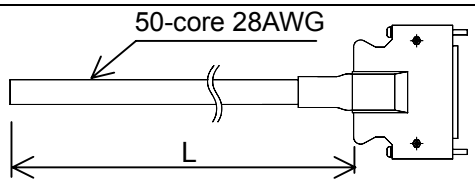
Specification	Model code	Length L	Applicable servo motor	Contents
Standard	ADCE-C003M1S	3m	ADMA-01SA, 02SA, -04SA, 08SA ADMA-01SF, 02SF, -04SF, 08SF	Drive side / Encoder side  10P connector Plug: 54593-1011 Cover: 54599-1005 Manufactured by Molex-Japan Co., Ltd. for all.
	ADCE-C006M1S	6m		
	ADCE-C010M1S	10m		
	ADCE-C020M1S	20m		
	ADCE-C030M1S	30m		
	ADCE-C003M2HP	3m	ADMG-05HP, 10HP, -15HP, 20HP, -35HP, 45HP, -55HP, 70HP	Drive side / Encoder side  10P connector / 17-pin plug Plug: 54593-1011 Cover: 54599-1005 Manufactured by Molex-Japan Co., Ltd. for all. Straight plug: MS3106B20-29S Cable clamp: MS3057-12A Manufactured by DDK Ltd. for all.
	ADCE-C006M2HP	6m		
	ADCE-C010M2HP	10m		
	ADCE-C020M2HP	20m		
	ADCE-C030M2HP	30m		

For the “high flexure life cable, specify “CH” as the model code instead of “C”.

Example) ADCE-C003M1S (standard) → ADCE-CH003M1S (high flexure life cable)

Example) ADCE-C010M2HP (standard) → ADCE-CH010M2HP (high flexure life cable)

■ Command cable

Model code	Length L	Contents
ADCC-03	3 m	 50P connector Connector: 10150-6000EL Manufactured by Sumitomo 3M Ltd. Connector cover: 10350-52A0-008 Manufactured by Sumitomo 3M Ltd.

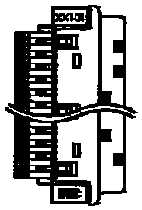
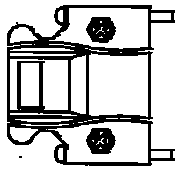
Pin No.	Specification of command cable Cable color / Number of dot (Dot color) Note 1)	Terminal symbol Note 2)	Pin No.	Specification of command cable Cable color / Number of dot (Dot color) Note 1)	Terminal symbol Note 2)
1	Blue ☐ (Red)	P24	26	Green ☐☐☐ (Red)	SON
2	Blue ■ (Black)	PLC	27	Green ■■■ (Black)	RS
3	Pink ☐ (Red)	X(00)/MOD	28	Brown ☐☐☐ (Red)	X(02)/FOT
4	Pink ■ (Black)	X(01)/TL	29	Brown ■■■ (Black)	X(03)/ROT
5	Green ☐ (Red)	X(04)/SS1/EGR2	30	Gray ☐☐☐ (Red)	CM1
6	Green ■ (Black)	X(05)/SS2/ECLR	31	Gray ■■■ (Black)	X(06)/PPI/GCH
7	Brown ☐ (Red)	X(07)/SRZ/EOH	32	Blue ☐☐☐☐ (Red)	X(09)/ORG
8	Brown ■ (Black)	X(08)/ORL	33	Blue ■■■■ (Black)	X(10)/PEN/FWD
9	Gray ☐ (Red)	X(11)/CER/REV	34	Pink ☐☐☐☐ (Red)	CM2
10	Gray ■ (Black)	CM1	35	Pink ■■■■ (Black)	Y(00)/SRD
11	Blue ☐☐ (Red)	Y(01)/ALM	36	Green ☐☐☐☐ (Red)	Y(03)/SA/AL1
12	Blue ■■ (Black)	Y(02)/INP	37	Green ■■■■ (Black)	Y(04)/SZD
13	Pink ☐☐ (Red)	Y(05)/BRK	38	Brown ☐☐☐☐ (Red)	Y(07)/OL1/AL3
14	Pink ■■ (Black)	Y(06)/TLM/AL2	39	Brown ■■■■ (Black)	CM2
15	Green ☐☐ (Red)	PLSP	40	Gray ☐☐☐☐ (Red)	SIGP
16	Green ■■ (Black)	PLSN	41	Gray ■■■■ (Black)	SIGN
17	Brown ☐☐ (Red)	—	42	Blue ☐☐☐☐☐☐☐☐ (Red)	—
18	Brown ■■ (Black)	AI3	43	Blue ■■■■■■■■ (Black)	AI4
19	Gray ☐☐ (Red)	XA(0)/AI1	44	Pink ☐☐☐☐☐☐☐☐ (Red)	XA(1)/AI2
20	Gray ■■ (Black)	L	45	Pink ■■■■■■■■ (Black)	L
21	Blue ☐☐☐ (Red)	OAP	46	Green ☐☐☐☐☐☐☐☐ (Red)	OBP
22	Blue ■■■ (Black)	OAN	47	Green ■■■■■■■■ (Black)	OBN
23	Pink ☐☐☐ (Red)	OZP	48	Brown ☐☐☐☐☐☐☐☐ (Red)	OZ
24	Pink ■■■ (Black)	OZN	49	Brown ■■■■■■■■ (Black)	L
25	Gray ☐☐☐☐☐☐☐☐ (Red)	AO1	50	Gray ■■■■■■■■ (Black)	AO2

Note 1: The number of ☐ or ■ expresses the number of dots in a cable. ☐ expresses that dot is red and ■ expresses that dot is black.

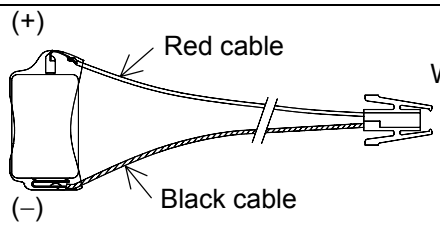
Note 2: Terminal symbol X(**), Y(**) are not available for ADA3 servo drive, but available for ADAX3 servo drive.

CHAPTER 10 APPENDIXES

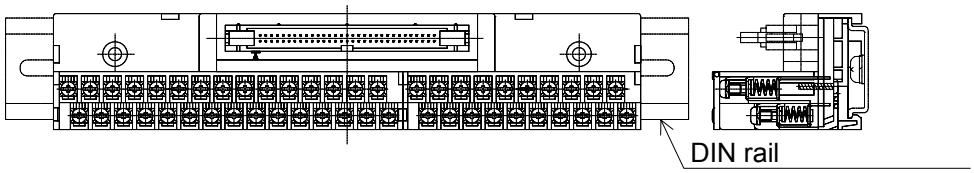
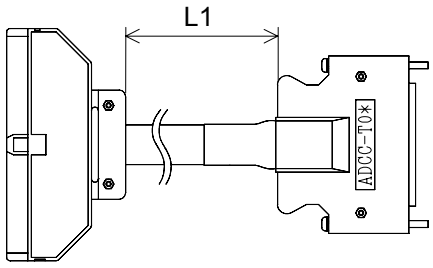
■ Connector set for input/output signals

Model code	Contents
ADCC-CON	 Connector (Soldering type) 10150-3000VE Manufactured by Sumitomo 3M Ltd.  Connector cover (Non shield type) 10350-52A0-008 Manufactured by Sumitomo 3M Ltd.

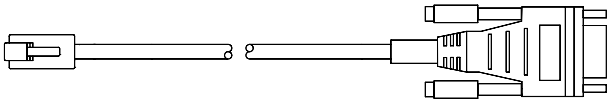
■ Lithium battery (for the absolute encoder)

Model code	Contents
ADABS-BT	 Lithium battery ER17/33WK Manufactured by Hitachi Maxell, Ltd.

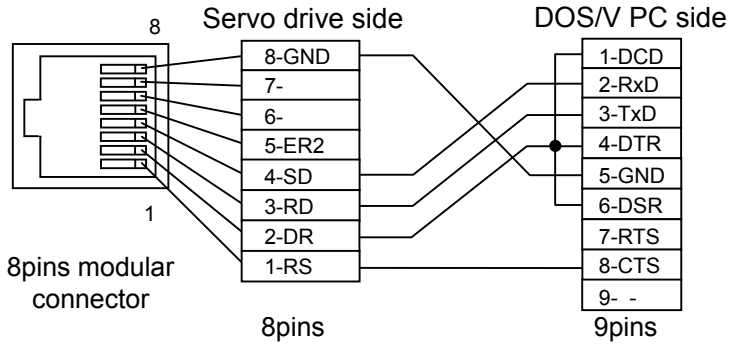
■ Terminal adapter and Terminal adapter connecting cable

Model code	Contents
(Terminal adapter) ADCC-TM	
(Terminal adapter connecting cable) ADCC-T01 (L1=1m) ADCC-T02 (L1=2m)	

■ PC connecting cable

Model code	Length L	Contents
ADCH-AT2	2 m	Servo drive side DOS/V PC side  Pin assignment is shown in the following figure. Modular terminal –8P D-SUB 9P connector

Connection of PC connecting cable ADCH-AT2



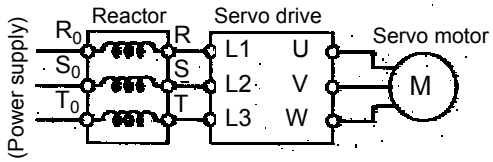
(3) Input side AC reactor (for harmonic suppression, power factor improvement)

■ Model code

ALI–2.5 L

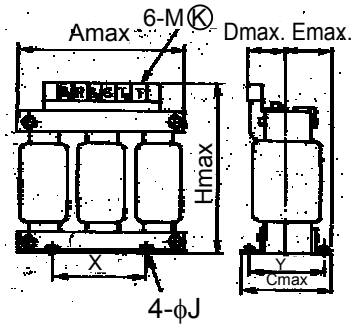
- Input voltage L: 200 V class, H: 400 V class
- Capacity (For the interrelation with the servo drive capacity, refer to the following table.)
- Input side AC reactor

■ Connection diagram

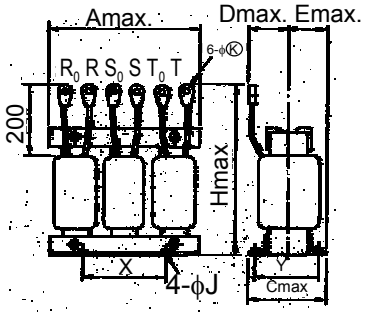


■ Dimension drawing

[Fig. 1]



[Fig. 2]



Servo drive input power supply	Servo drive model	Motor kW	Model code	Fig. No.	Dimensions (mm)							J	K	Mass (kg)
					A	C	D	E	H	X	Y			
3-phase 200 V class	AD*3-01NSE	0.1	ALI-2.5L	Fig. 1	130	82	60	40	150	50	67	6	4	2.4
	AD*3-02NSE	0.2	ALI-2.5L											
	AD*3-04NSE	0.4	ALI-2.5L											
	AD*3-08NSE	0.75	ALI-2.5L											
3-phase 400 V class	AD*3-15HPE	0.5	ALI-2.5H	Fig. 1	130	82	60	40	150	50	67	6	4	2.4
		1.0	ALI-2.5H											
		1.5	ALI-5.5H	Fig. 1	130	98	70	55	150	50	75	6	5	4.0
	AD*3-35HPE	2.0	ALI-5.5H											
		3.5	ALI-11H	Fig. 1	160	116	75	55	170	60	98	6	5	6.0
	AD*3-70HPE	4.5	ALI-11H											
		5.5	ALI-11H											
		7.0	ALI-22H	Fig. 2	180	103	75	55	190	100	80	6	5.3	8.5

(4) DC reactor (for harmonic suppression, power factor improvement)

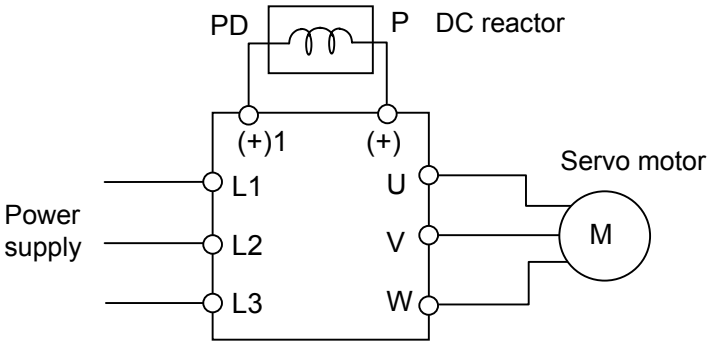
■ Model code

DCL−L−0.2

Capacity (For the interrelation with the servo drive capacity, refer to the following table.)

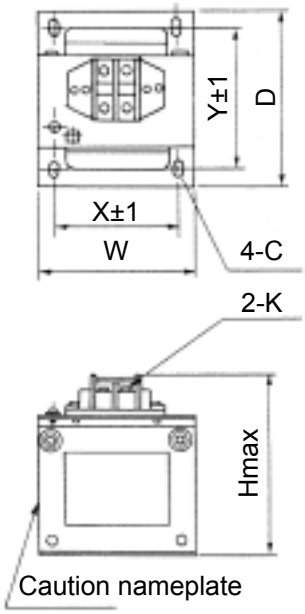
Input voltage
L: 200 V class
H: 400 V class

■ Connection diagram

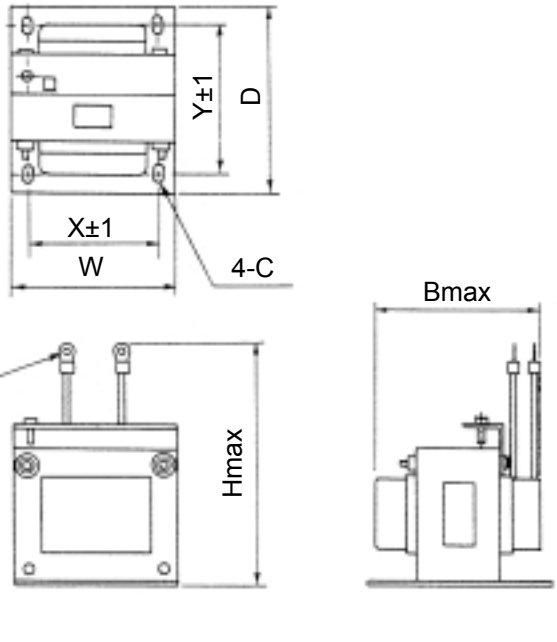


■ Dimension drawing

[Fig. 1]



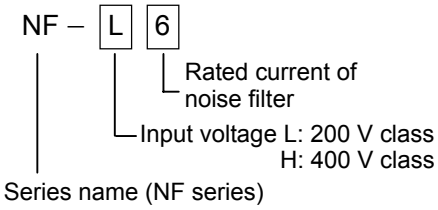
[Fig. 2]



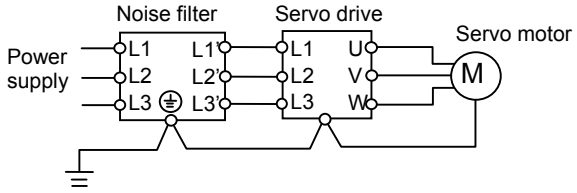
Servo drive input power supply	Servo drive model	Motor kW	Model code	Fig. No.	Dimensions (mm)								Mass (kg)
					W	D	H	B	X	Y	C	K	
3-phase 200 V class	AD*3-01NSE	0.1	DCL-L-0.2	Fig. 1	66	90	98	85	56	72	5.2 × 8	M4	0.8
	AD*3-02NSE	0.2	DCL-L-0.4		66	90	98	95	56	72	5.2 × 8	M4	1.0
	AD*3-04NSE	0.4	DCL-L-0.7		66	90	98	105	56	72	5.2 × 8	M4	1.3
	AD*3-08NSE	0.75	DCL-L-1.5		66	90	98	115	56	72	5.2 × 8	M4	1.6
3-phase 400 V class	AD*3-15HPE	0.5	DCL-H-0.7	Fig. 1	66	90	98	95	56	72	5.2 × 8	M4	1.1
		1.0	DCL-H-1.5		66	90	98	115	56	72	5.2 × 8	M4	1.6
		1.5	DCL-H-2.2		86	100	116	105	71	80	6 × 9	M4	2.1
	AD*3-35HPE	2.0	DCL-H-3.7		86	100	116	120	71	80	6 × 9	M4	2.6
		3.5	DCL-H-5.5		111	100	138	110	95	80	7 × 11	M4	3.6
	AD*3-70HPE	4.5	DCL-H-7.5		111	100	138	115	95	80	7 × 11	M4	3.9
		5.5	DCL-H-7.5										
		7.0	DCL-H-11	Fig. 2	146	120	250	105	124	96	7 × 11	M5	5.2

(5) Input side noise filter

■ Model code

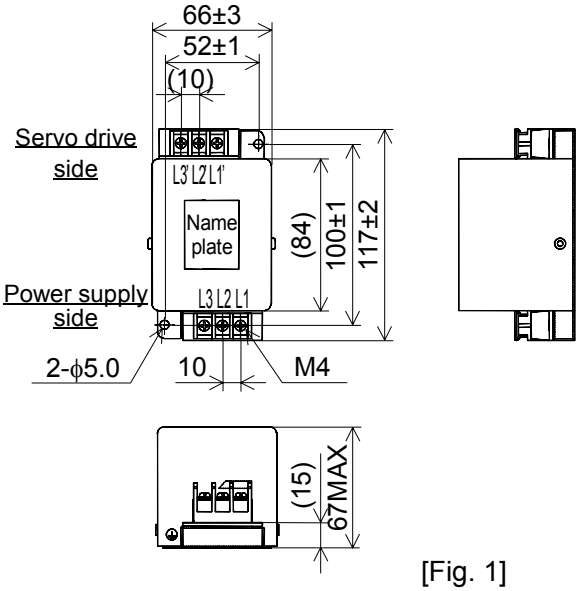


■ Connection diagram (for 3-phase product)



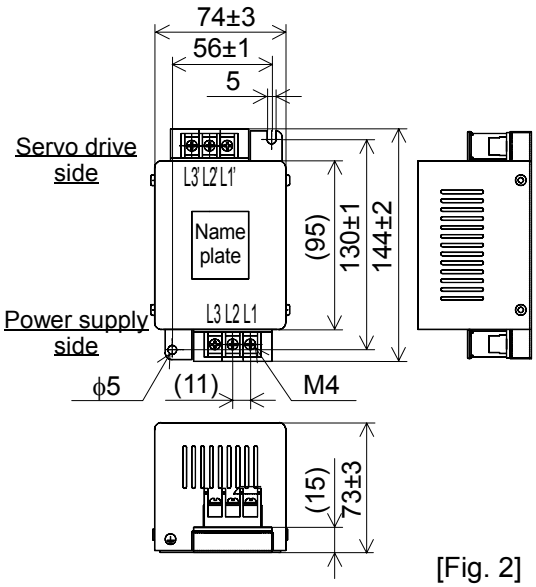
■ Dimensions

NF-L6, L10



[Fig. 1]

NF-H7, H20, H30



[Fig. 2]

■ Specifications and applications

Servo drive input power supply	Servo drive model	Motor kW	Model code	Fig. No.	Rated volt	Rated Amps	Mass (kg)
1-phase 200 V class	AD*3-01NSE	0.1	NF-L6	Fig. 1	AC250V	6A	0.5
	AD*3-02NSE	0.2	NF-L6				
	AD*3-04NSE	0.4	NF-L6				
	AD*3-08NSE	0.75	NF-L10	Fig. 1	AC250V	10A	0.6
3-phase 200 V class	AD*3-01NSE	0.1	NF-L6	Fig. 1	AC250V	6A	0.5
	AD*3-02NSE	0.2	NF-L6				
	AD*3-04NSE	0.4	NF-L6				
	AD*3-08NSE	0.75	NF-L6				
3-phase 400 V class	AD*3-15HPE	0.5	NF-H7	Fig. 2	AC480V	7A	0.7
		1.0	NF-H7				
		1.5	NF-H7				
	AD*3-35HPE	2.0	NF-H7				
		3.5	NF-H20	Fig. 2	AC480V	20A	0.7
	AD*3-70HPE	4.5	NF-H20				
		5.5	NF-H20				
		7.0	NF-H30	Fig. 2	AC480V	30A	0.7

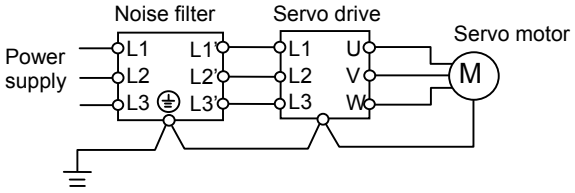
(6) Input side noise filter (EMC compliance)

■ Model code

NF – CE H □

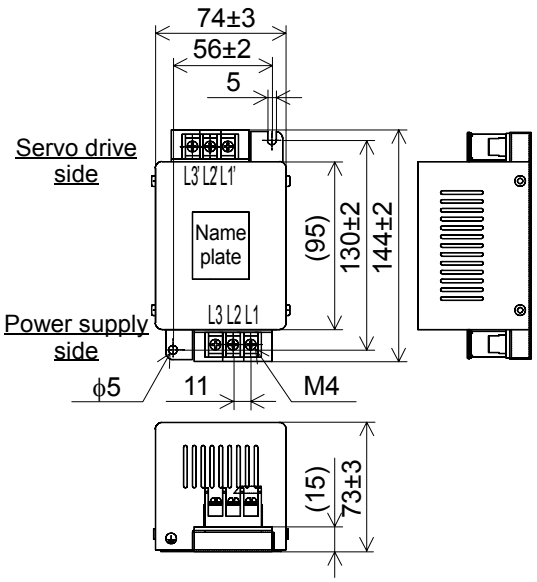
- Rated current of noise filter
- Input voltage H: 400 V class (Including 200 V class)
- EMC compliance
- Series name (NF series)

■ Connection diagram (for 3-phase product)



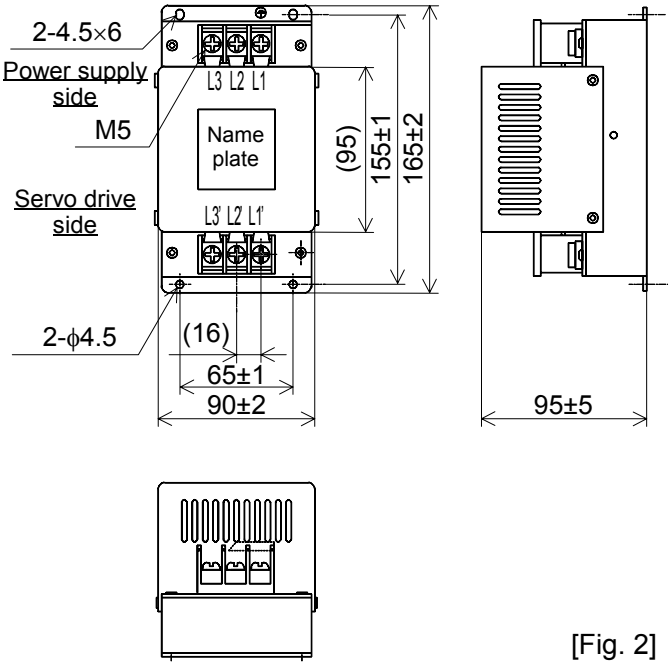
■ Dimensions

NF-CEH7, H10



[Fig. 1]

NF-CEH20, CEH30



[Fig. 2]

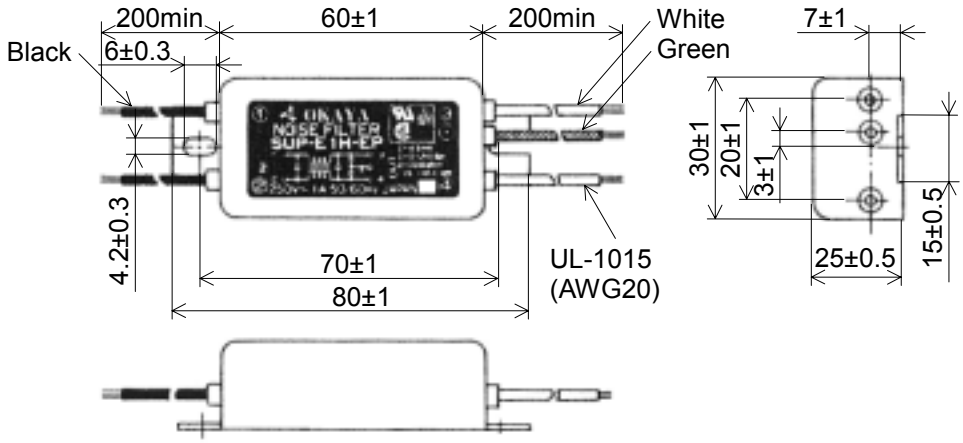
■ Specifications and applications

Servo drive input power supply	Servo drive model	Motor kW	Model code	Fig. No.	Rated volt	Rated Amps	Mass (kg)
1-phase 200 V class	AD*3-01NSE	0.1	NF-CEH7	Fig. 1	AC480V	7A	0.7
	AD*3-02NSE	0.2	NF- CEH7				
	AD*3-04NSE	0.4	NF- CEH7				
	AD*3-08NSE	0.75	NF- CEH10	Fig. 1	AC480V	10A	0.7
3-phase 200 V class	AD*3-01NSE	0.1	NF-CEH7	Fig. 1	AC480V	7A	0.7
	AD*3-02NSE	0.2	NF- CEH7				
	AD*3-04NSE	0.4	NF- CEH7				
	AD*3-08NSE	0.75	NF- CEH7				
3-phase 400 V class	AD*3-15HPE	0.5 to 1.5	NF- CEH7	Fig. 1	AC480V	7A	0.7
	AD*3-35HPE	2 to 3.5	NF- CEH20	Fig. 2	AC480V	20A	1.0
	AD*3-70HPE	4.5 to 7	NF- CEH30	Fig. 2	AC480V	30A	1.3

(7) Noise filter for control power circuit

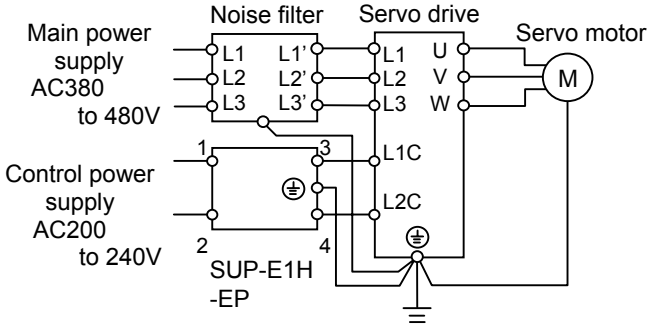
■ Model code

SUP-E1H-EP



■ Connection diagram

Connect it to control power input of 400V class AD*3-☐☐HPE.

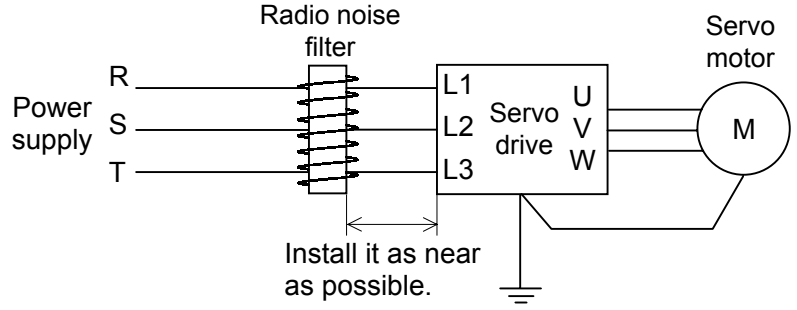


■ Specifications and applications

Servo drive model	Model code	Rated volt	Rated amps	Leakage current (max)	Manufacture
AD*3-15HPE	SUP-E1H-EP	AC250V	1A	0.6mA (at 250Vrms 60Hz)	Okaya Electric Industries Co., Ltd.
AD*3-35HPE					
AD*3-70HPE					

(8) Radio noise filter (zero-phase reactor)

■ Connection diagram

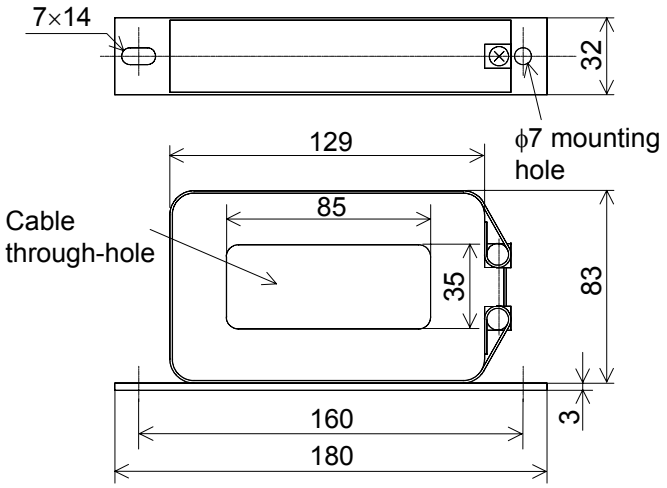


Note 1: Perform winding in the same direction for each of phases L1, L2, and L3.

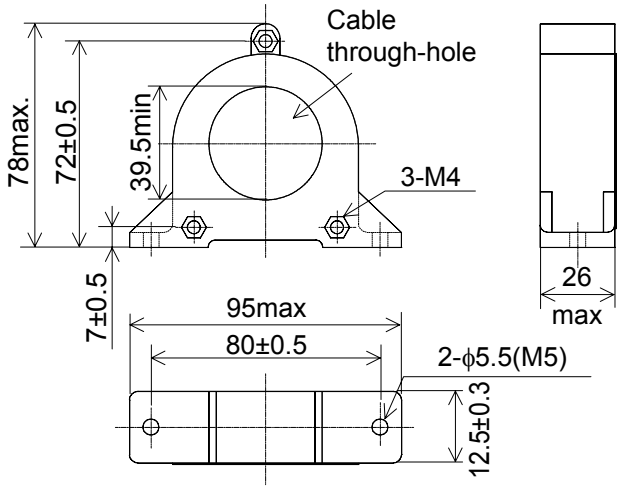
Note 2: Both input side and output side of the servo drive can be used in the same way.

■ Dimensions

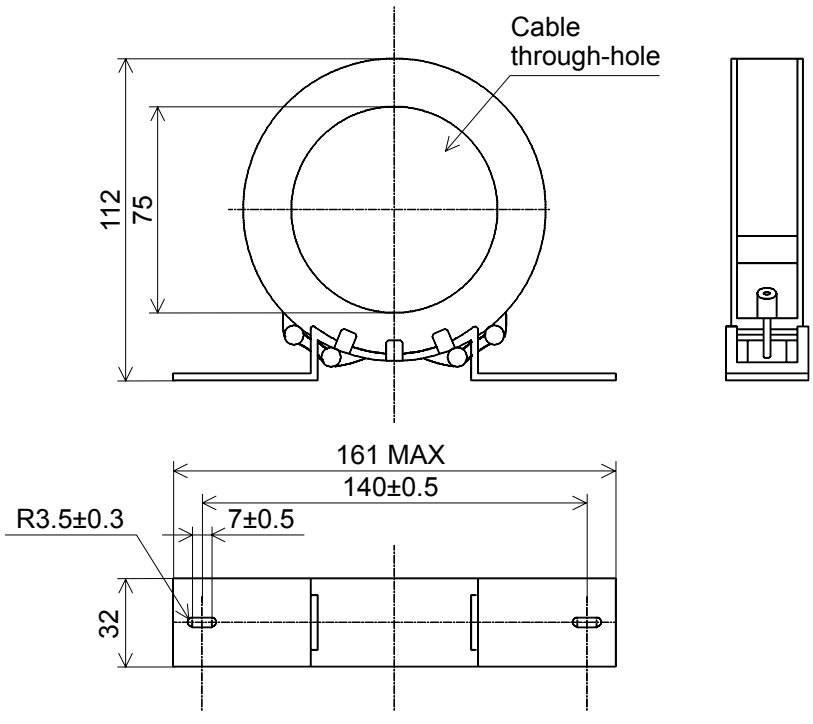
ZCL-A



ZCL-B40

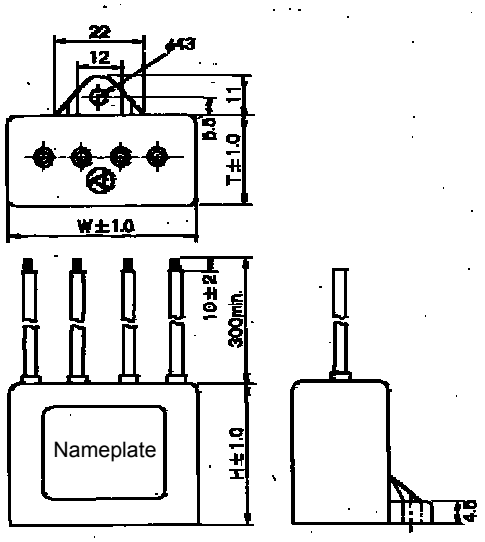


ZCL-B75

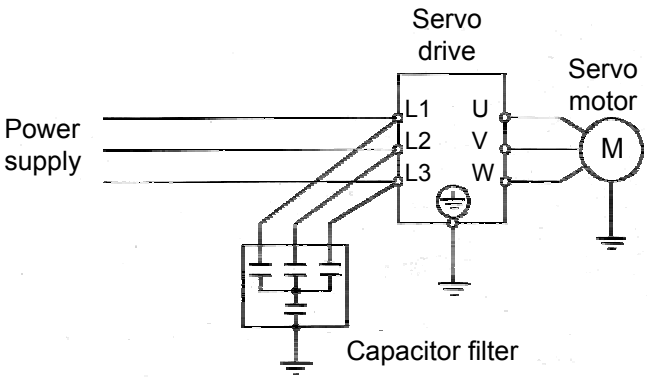


(9) Input side radio noise filter (capacitor filter)
Connect this filter directly to the power terminal of the servo drive to reduce the radiation noise to be emitted from the cable.

■ Dimensions



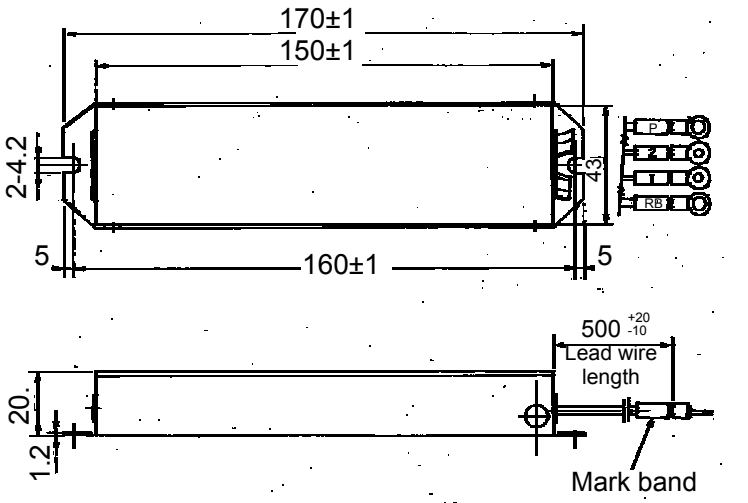
■ Connection diagram



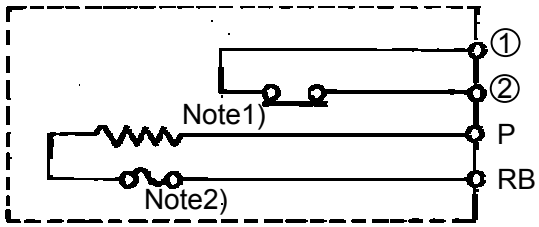
Part name	W	H	T	Applicable servo drive
CFI-L (250 V rating)	48.0	35.0	26.0	200 V class
CFI-H (500 V rating)	55.0	47.0	31.0	400 V class

(10) Braking resistor (small-size type)

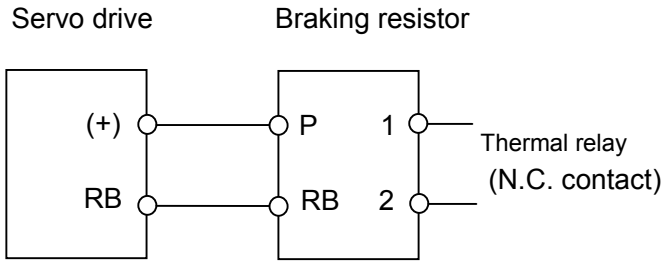
■ Dimensions



■ Circuit diagram



■ Connection diagram



Model code	Rated Capacity	Resistance value	Allowable braking ratio (%ED)	Allowable continuous braking time	Mass (kg)
JRB120-1	120W	180Ω	5% (2%)*	20 sec.	0.27
JRB120-2		100Ω	2.5% (1.5%)*	12 sec.	
JRB120-3		50Ω	1.5%	5 sec.	
JRB120-4		35Ω	1.0%	3 sec.	

Note 1: The internal thermal contact capacity is 250 V AC, 2 A max. It is ON in the normal status (N.C. contact).

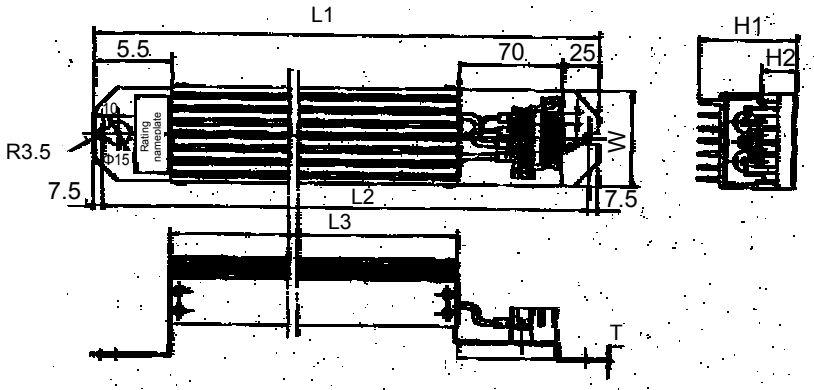
Note 2: The internal thermal fuse prevents abnormal heat generation from operating by mistake. (Unrecoverable)

Note 3: When the thermal relay has been operated, stop the servo drive or increase the deceleration time to reduce the regenerative energy.

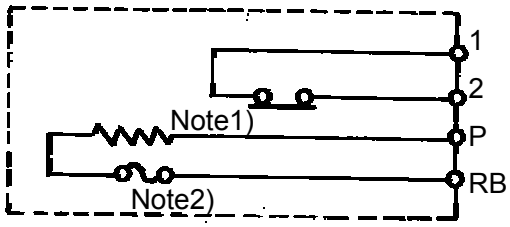
Note 4: The above allowable braking ratio shows %ED for 200 V class drive. For 400 V class drive use, reduce a quarter of the above %ED.

(11) Braking resistor (standard type)

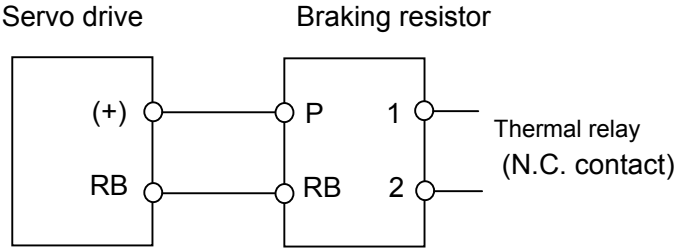
■ Dimensions



■ Circuit diagram



■ Connection diagram



Model code	Dimensions (mm)							Mass (kg)
	L1	L2	L3	H1	H2	W	T	
SRB 200-1	310	295	160	67	12	64	1.6	0.97
SRB 200-2	310	295	160	67	12	64	1.6	0.97
SRB 300-1	470	455	320	67	12	64	1.6	1.68
SRB 400-1	435	422	300	94	15	76	2.0	2.85

Model code	Rated capacity	Resistance value	Allowable braking ratio (%ED)	Allowable continuous braking time
SRB 200-1	200W	180Ω	10% (4%)*	30 sec.
SRB 200-2		100Ω	7.5% (3%)*	30 sec.
SRB 300-1	300W	50Ω	7.5%	30 sec.
SRB 400-1	400W	35Ω	7.5%	20 sec.

Note 1: The internal thermal contact capacity is 250 V AC, 2 A max. It is ON in the normal status (N.C. contact).

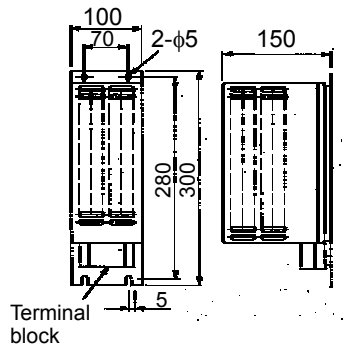
Note 2: The internal thermal fuse prevents abnormal heat generation from operating by mistake. (Unrecoverable)

Note 3: When the thermal relay has been operated, stop the servo drive or increase the deceleration time to reduce the regenerative energy.

Note 4: The above allowable braking ratio shows %ED for 200 V class drive. For 400 V class drive use, reduce a quarter of the above %ED.

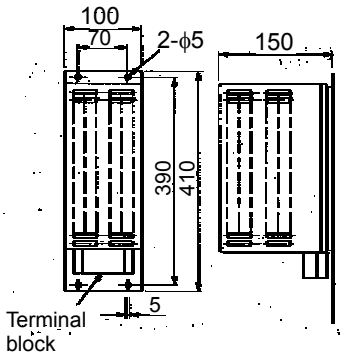
(12) Braking resistor (medium-capacity type)

RB1



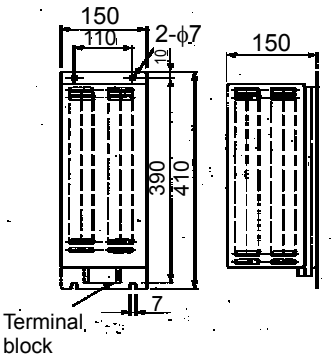
[Fig. 1]

RB2



[Fig. 2]

RB3



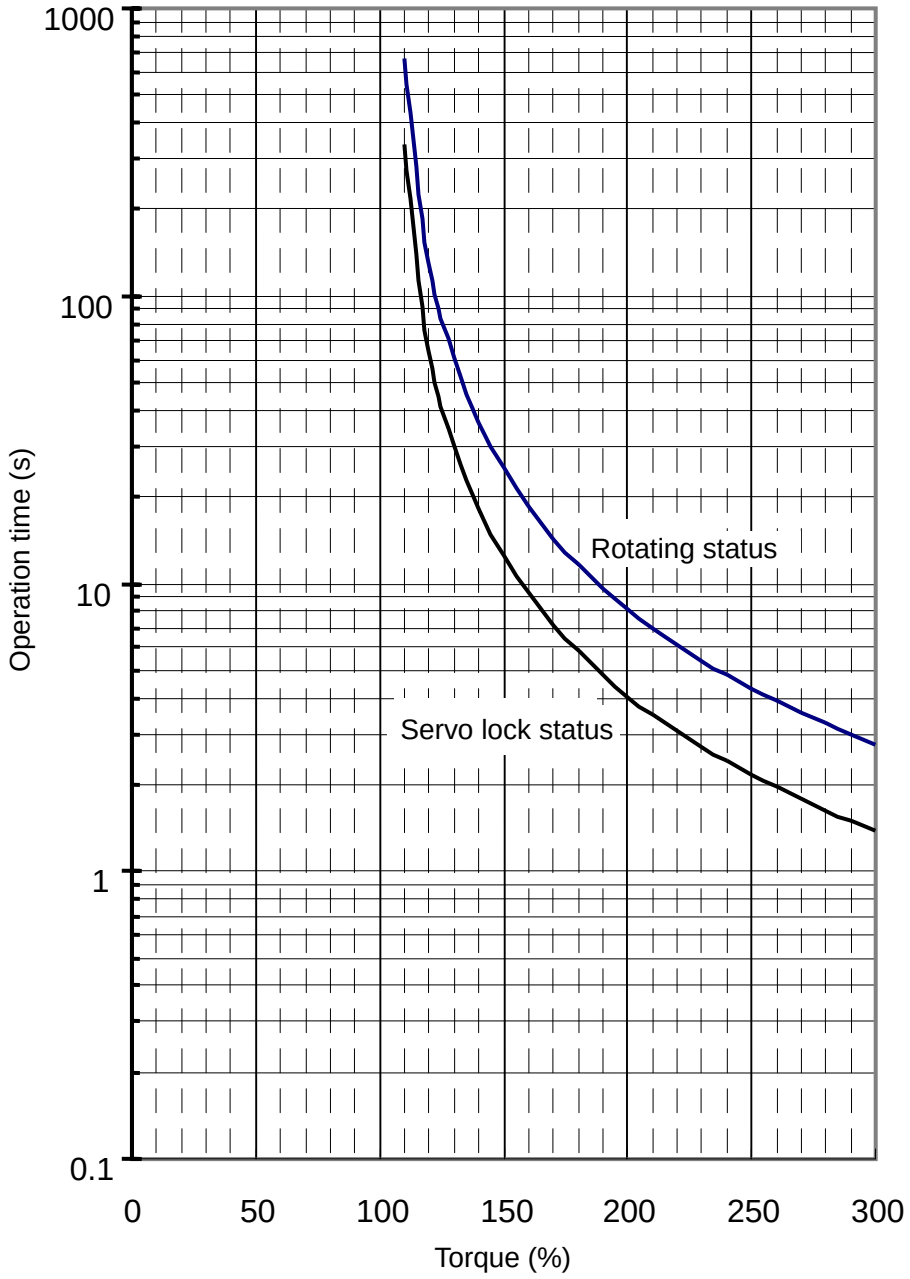
[Fig. 3]

Model code	Resis-tance value (Ω)	Rated capacity (W)	Momen-tary capacity (W)	Allow-able ratio (%ED)	Allowable continuous ON time (sec.)	Heating protection	Fig. No.	Mass (kg)
RB1	50	400	2600	10	10	A thermal relay is built in the resistor. At an abnormal temperature, the “Open” (N.C. contact) signal is output. The contact rating is 240 V AC, 3 A (R load) or 0.2 A (L load), or 36 V DC, 2 A (R load).	Fig. 1	2.5
RB2	35	600	3800	10	10		Fig. 2	3.6
RB3	17	1200	7700	10	10		Fig. 3	6.5

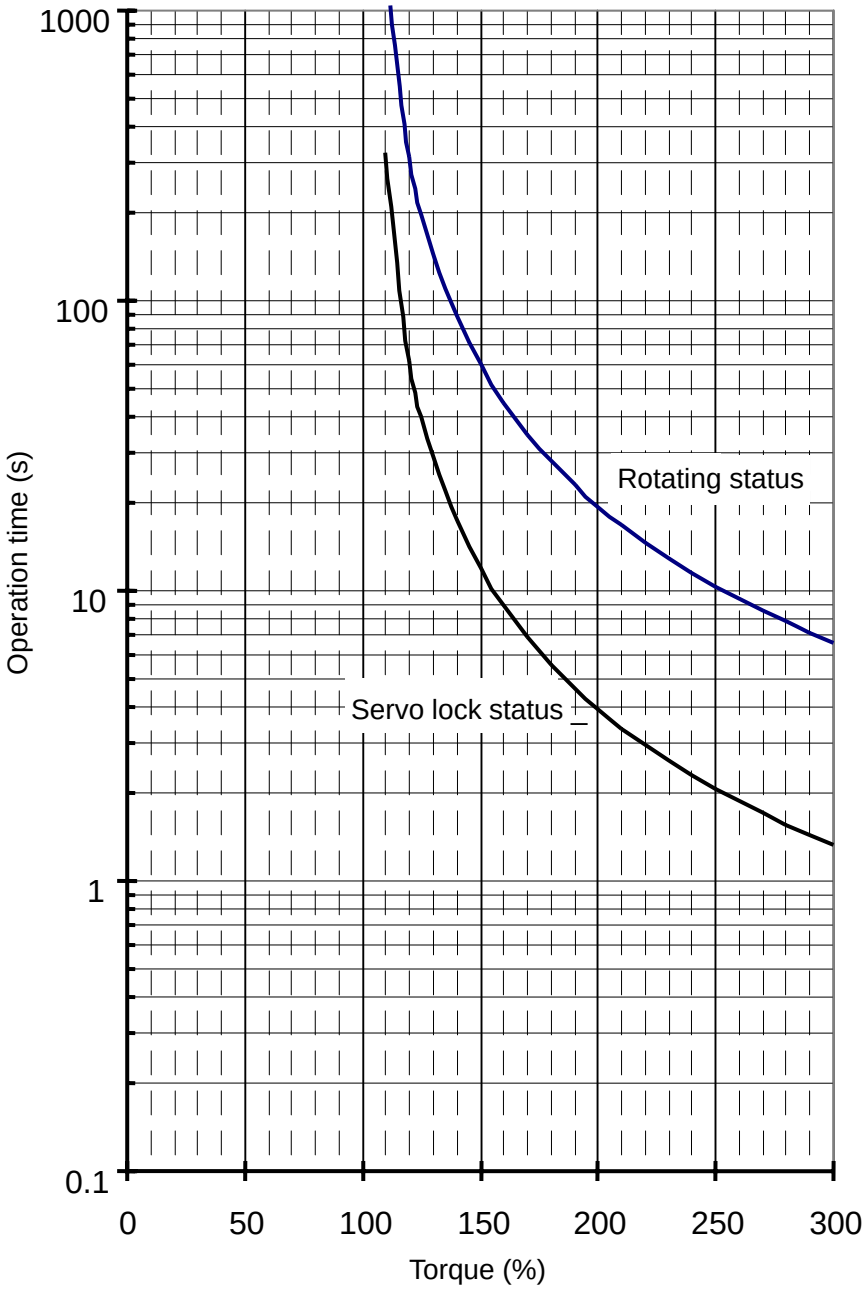
Note : The above allowable braking ratio shows %ED for 200 V class drive. For 400 V class drive use, reduce a quarter of the above %ED.

10.2 Electronic Thermal Operation Time

The electronic thermal operation time is shown below in the status where the parameter Electronic Thermal Level FA-28 is set to 105% (initial value).
Reduce the setting level in the conditions of ambient temperature, with brake, etc.

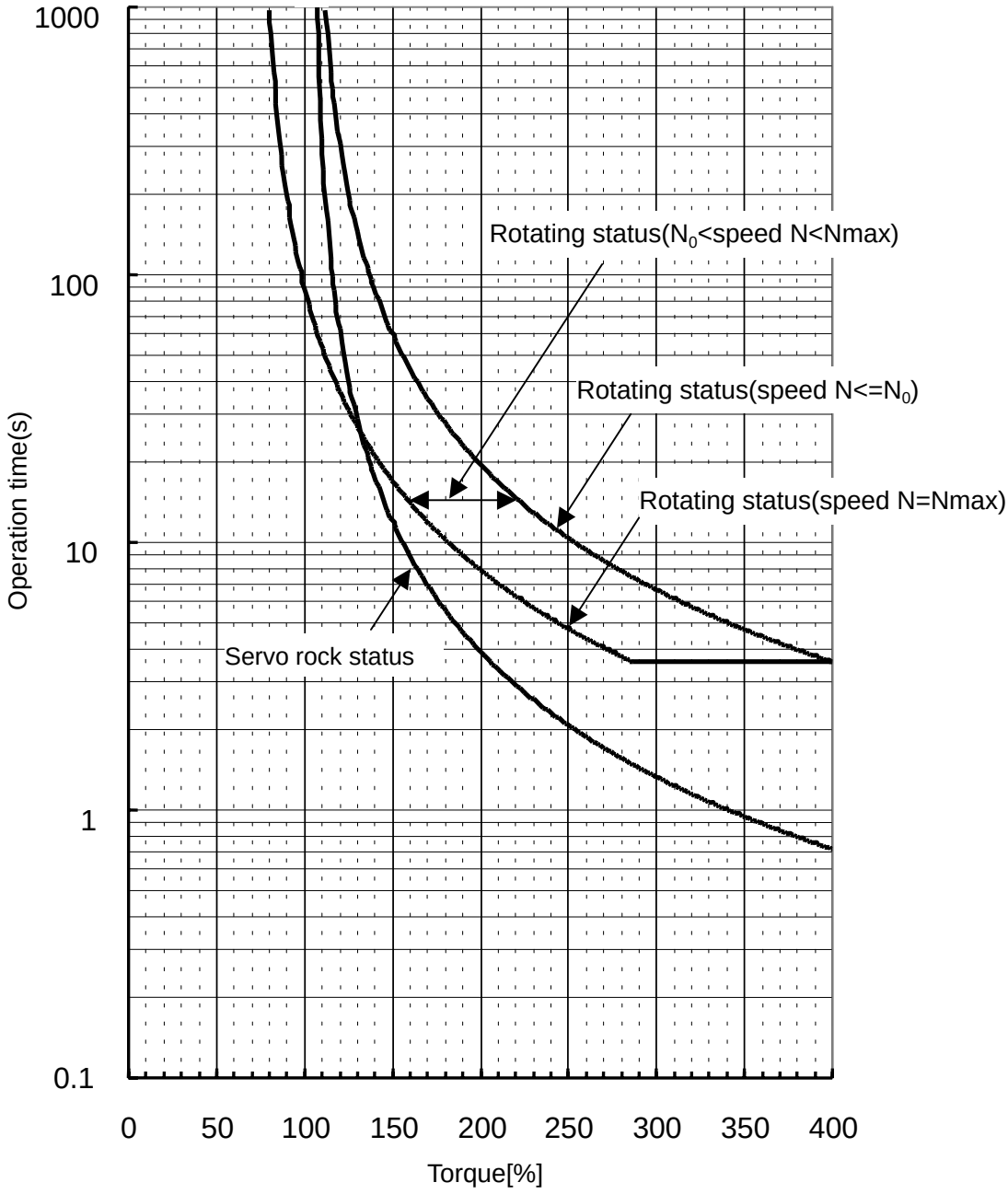


(a) For 200V class 750 W or less (FA–28=105%)



(b) For 200V class 750 W or more (FA–28=105%)

Rated speed N_0=2000 (min^{-1})
Maximum speed Nmax=3000 (min^{-1})



(C) For 400V class (FA-28=105%)

[Setting the parameter Electronic Thermal Level FA-28]

When the standard AC servo motor is delivered, the parameter Electronic Thermal Level FA-28 is set to the initial value. Accordingly, this parameter does not need to be set again. However, in the motor with brake, the torque in the high-temperature area may have to be derated for use, depending on the specification, as shown in the following figure because of the torque characteristic to the ambient temperature of the motor.

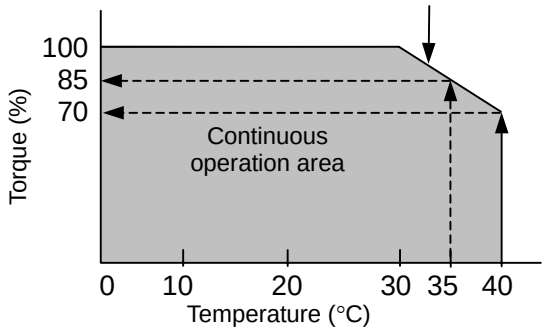
The continuous torque vs. ambient temperature characteristic is described in the specification of the servo motor. Be sure to set this parameter for use.

<Example>

For the servo motor with brake shown in the figure at right, set the parameter according to the ambient temperature as shown below.

Ambient temp.	FA−28
35°C	85%
40°C	70%

An example of servo motor with brake

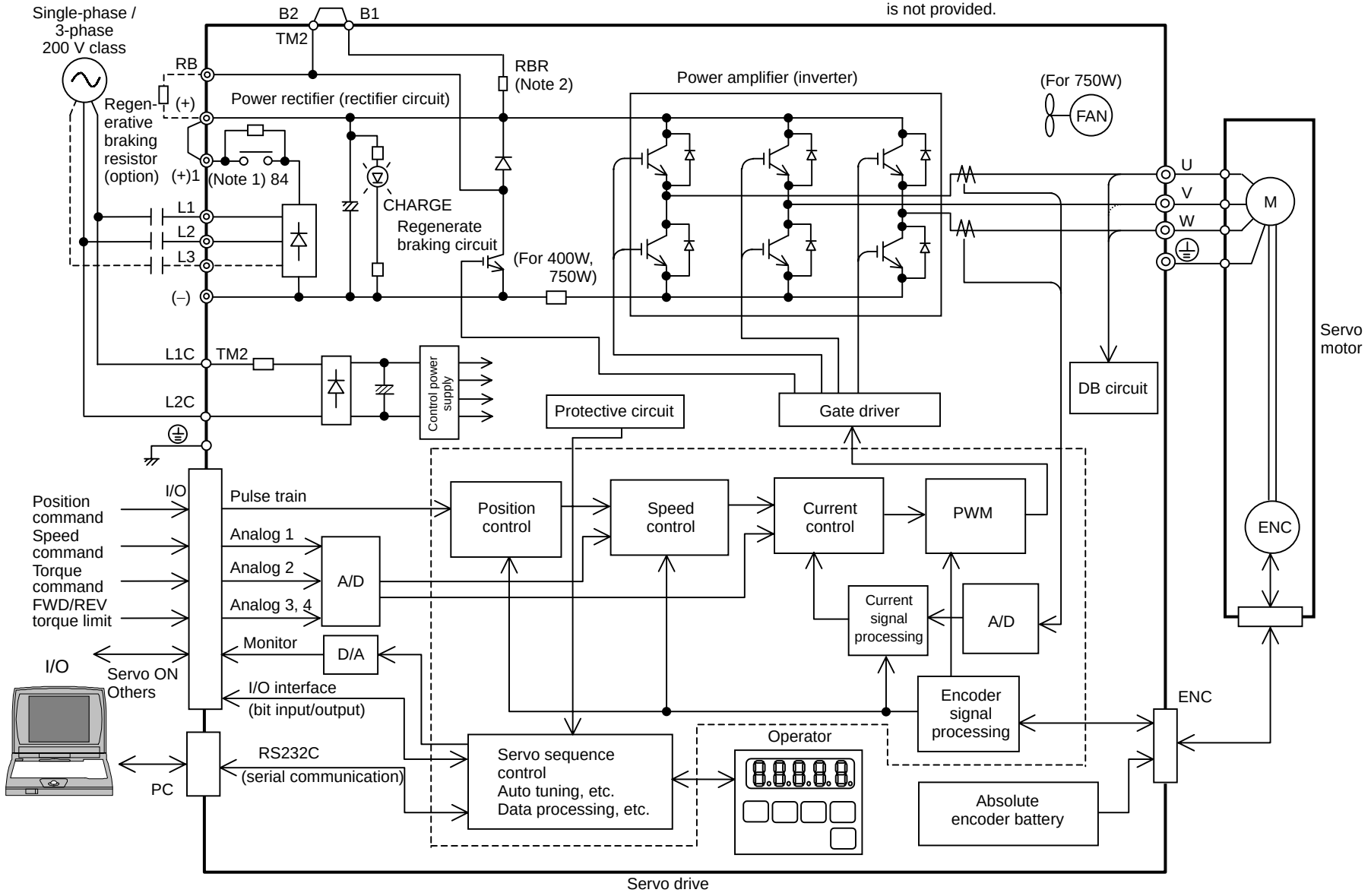


MEMO

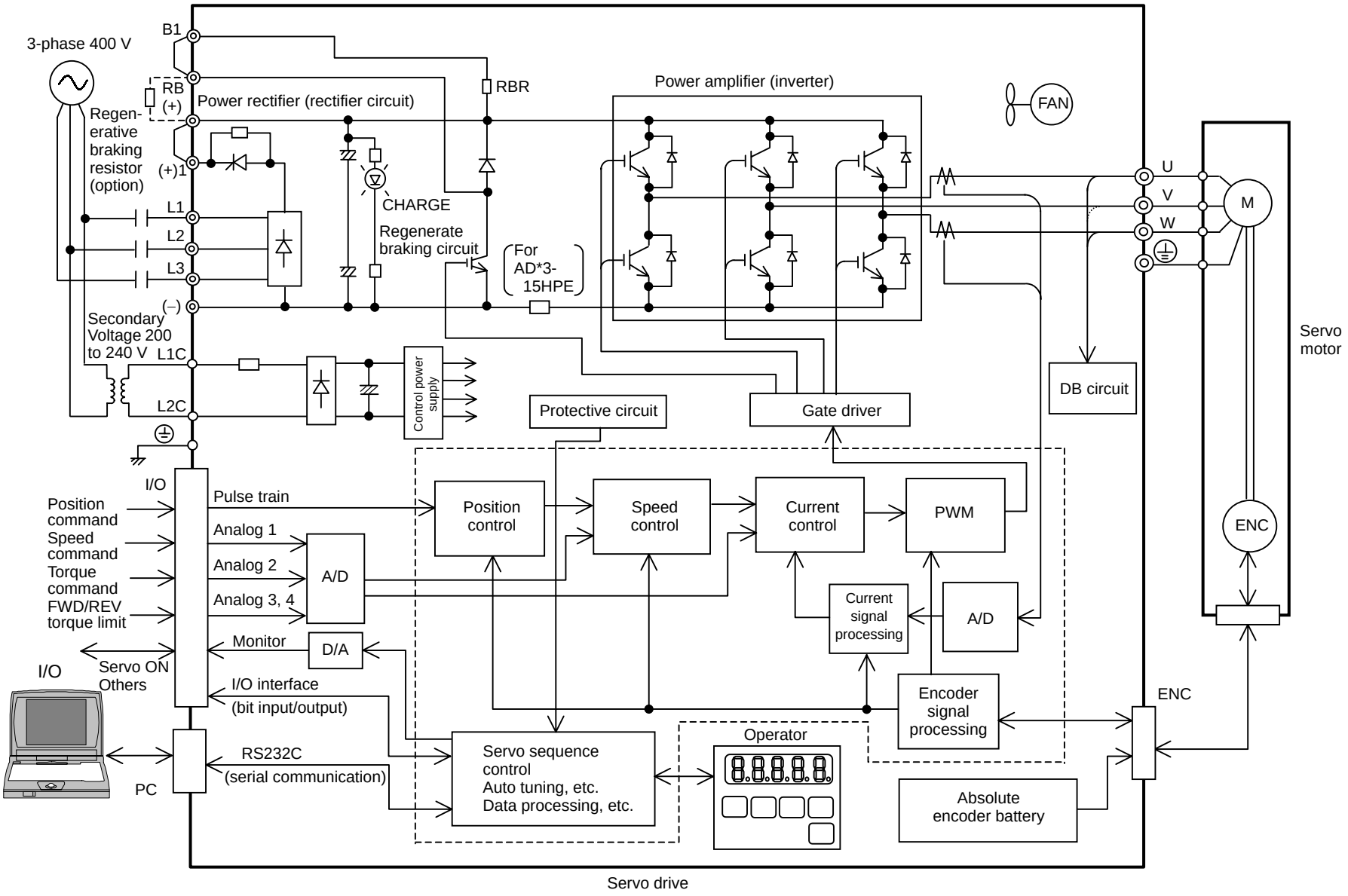
10.3 Internal Block Diagram of Servo Drive

1) Single-phase / 3-phase 200 V class 100 to 750 W (AD*3-01NSE to 08NSE)

Note 1: For 400W and 750W, relay 84 is a thyristor.
Note 2: For 100W and 200W, the built-in regenerative braking resistor RBR is not provided.



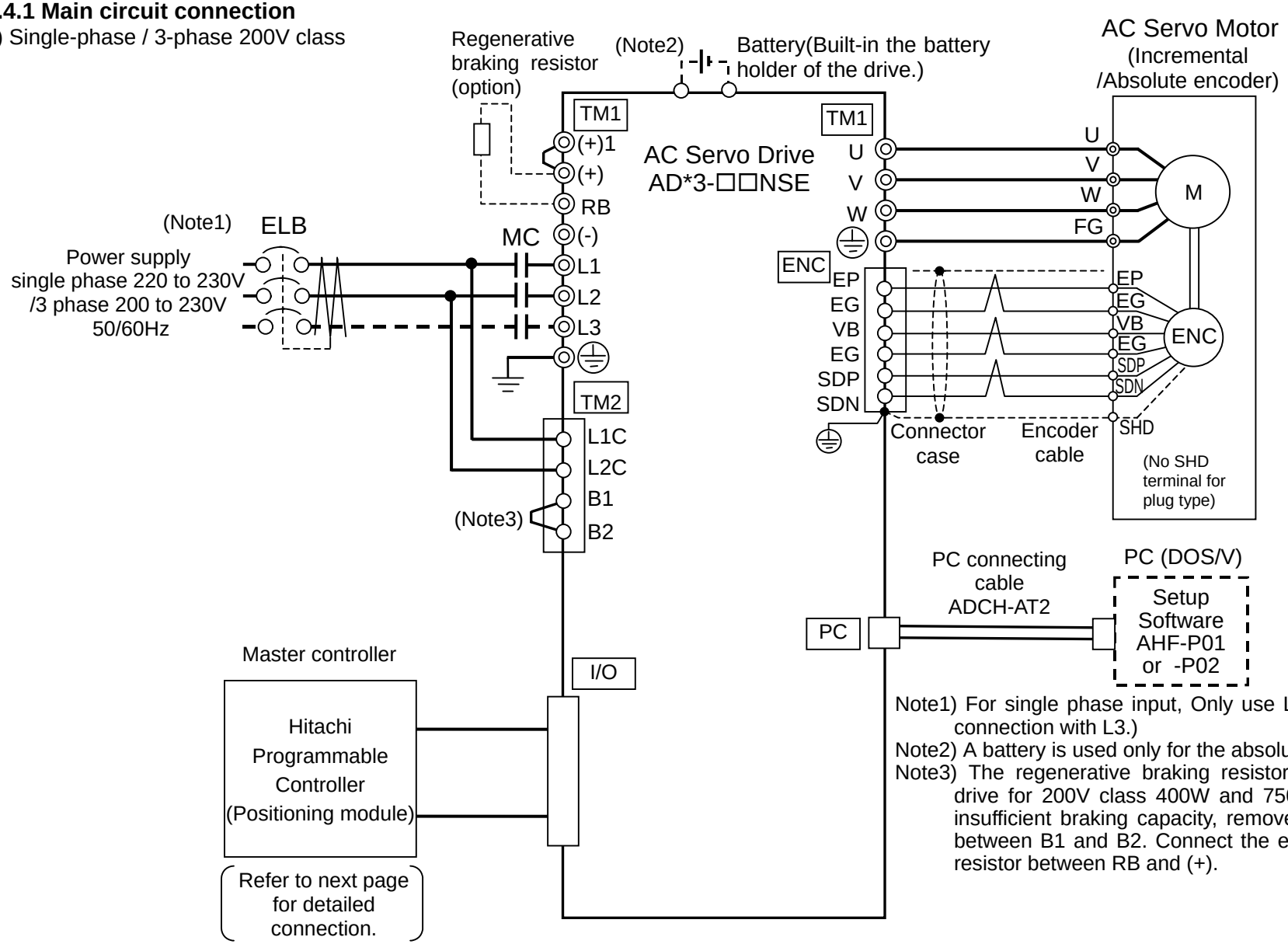
2) 3-phase 400 V class 1.5 to 7 kW (AD*3-15HPE to 70HPE)



10.4 Example Connection with Programmable Controller

10.4.1 Main circuit connection

1) Single-phase / 3-phase 200V class

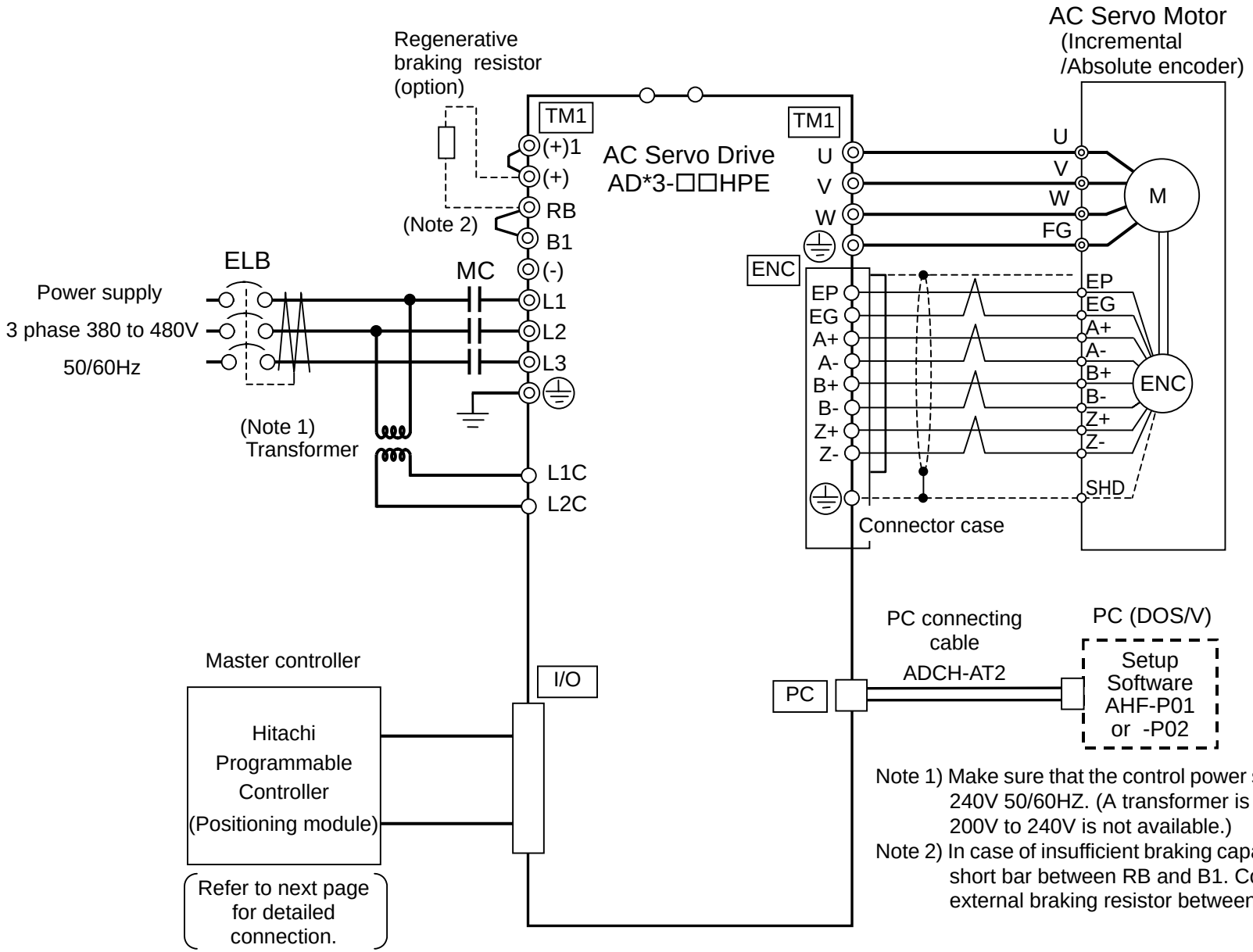


Note1) For single phase input, Only use L1 and L2. (No connection with L3.)

Note2) A battery is used only for the absolute encoder.

Note3) The regenerative braking resistor is built-in the drive for 200V class 400W and 750W. In case of insufficient braking capacity, remove the short bar between B1 and B2. Connect the external braking resistor between RB and (+).

2) 3-phase 400V class

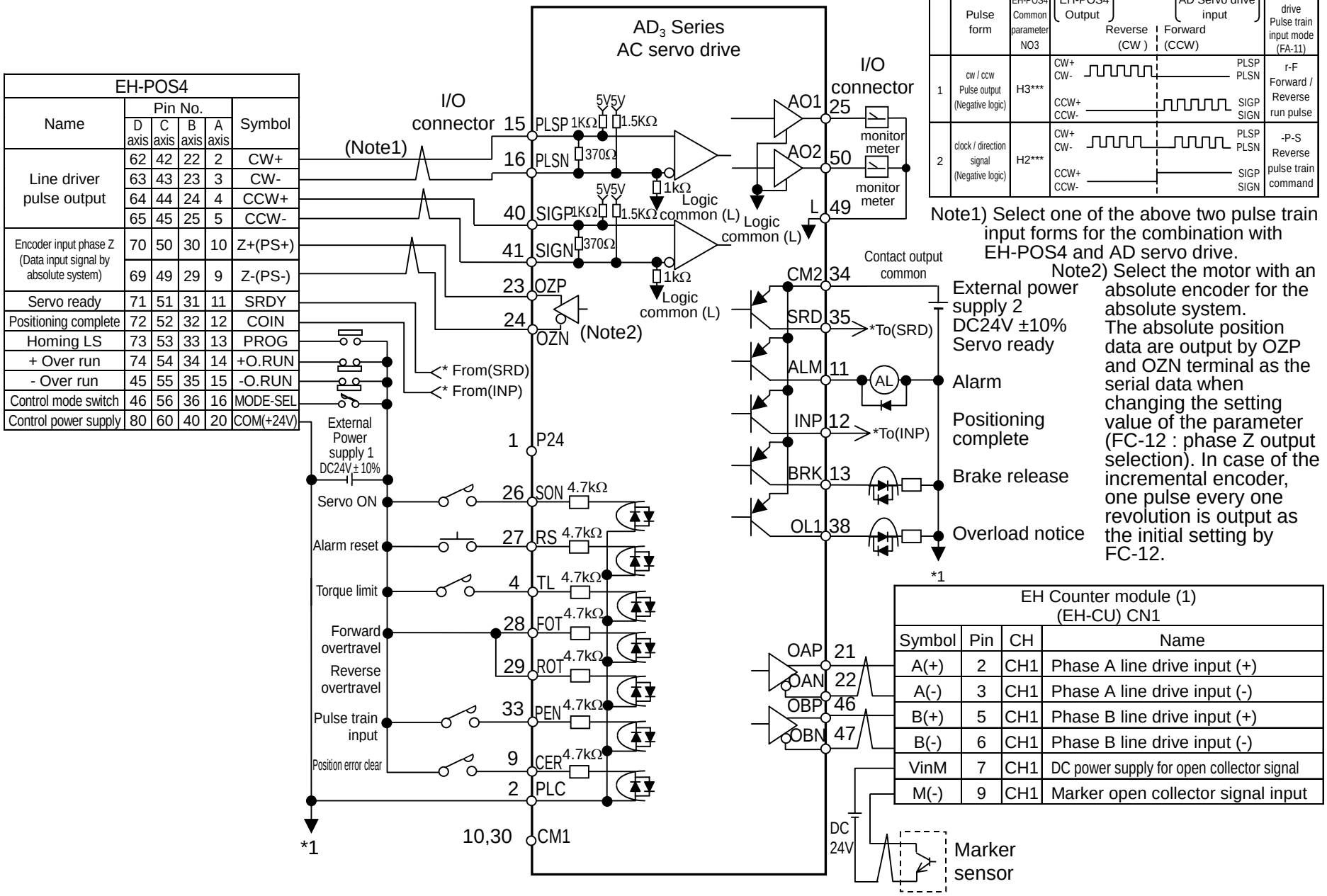


Note 1) Make sure that the control power supply is 200V to 240V 50/60HZ. (A transformer is recommended if 200V to 240V is not available.)

Note 2) In case of insufficient braking capacity, remove the short bar between RB and B1. Connect the external braking resistor between RB and (+).

10.4.2 Connection with Hitachi 4 axes positioning module EH-POS4 (I/O)

EH-POS4					
Name	Pin No. D axis	C axis	B axis	A axis	Symbol
Line driver pulse output	62	42	22	2	CW+
	63	43	23	3	CW-
	64	44	24	4	CCW+
	65	45	25	5	CCW-
Encoder input phase Z (Data input signal by absolute system)	70	50	30	10	Z+(PS+)
	69	49	29	9	Z-(PS-)
Servo ready	71	51	31	11	SRDY
Positioning complete	72	52	32	12	COIN
Homing LS	73	53	33	13	PROG
+ Over run	74	54	34	14	+O.RUN
- Over run	45	55	35	15	-O.RUN
Control mode switch	46	56	36	16	MODE-SEL
Control power supply	80	60	40	20	COM(+24V)



Position pulse train input form

	Pulse form	EH-POS4 Common parameter NO3	EH-POS4 Output / AD Servo drive input (Reverse (CW) / Forward (CCW))	AD Servo drive Pulse train input mode (FA-11)
1	cw / ccw Pulse output (Negative logic)	H3***	CW+ CW- → PLSP PLSN; CCW+ CCW- → SIGP SIGN	r-F Forward / Reverse run pulse
2	clock / direction signal (Negative logic)	H2***	CW+ CW- → PLSP PLSN; CCW+ CCW- → SIGP SIGN	-P-S Reverse pulse train command

Note1) Select one of the above two pulse train input forms for the combination with EH-POS4 and AD servo drive.

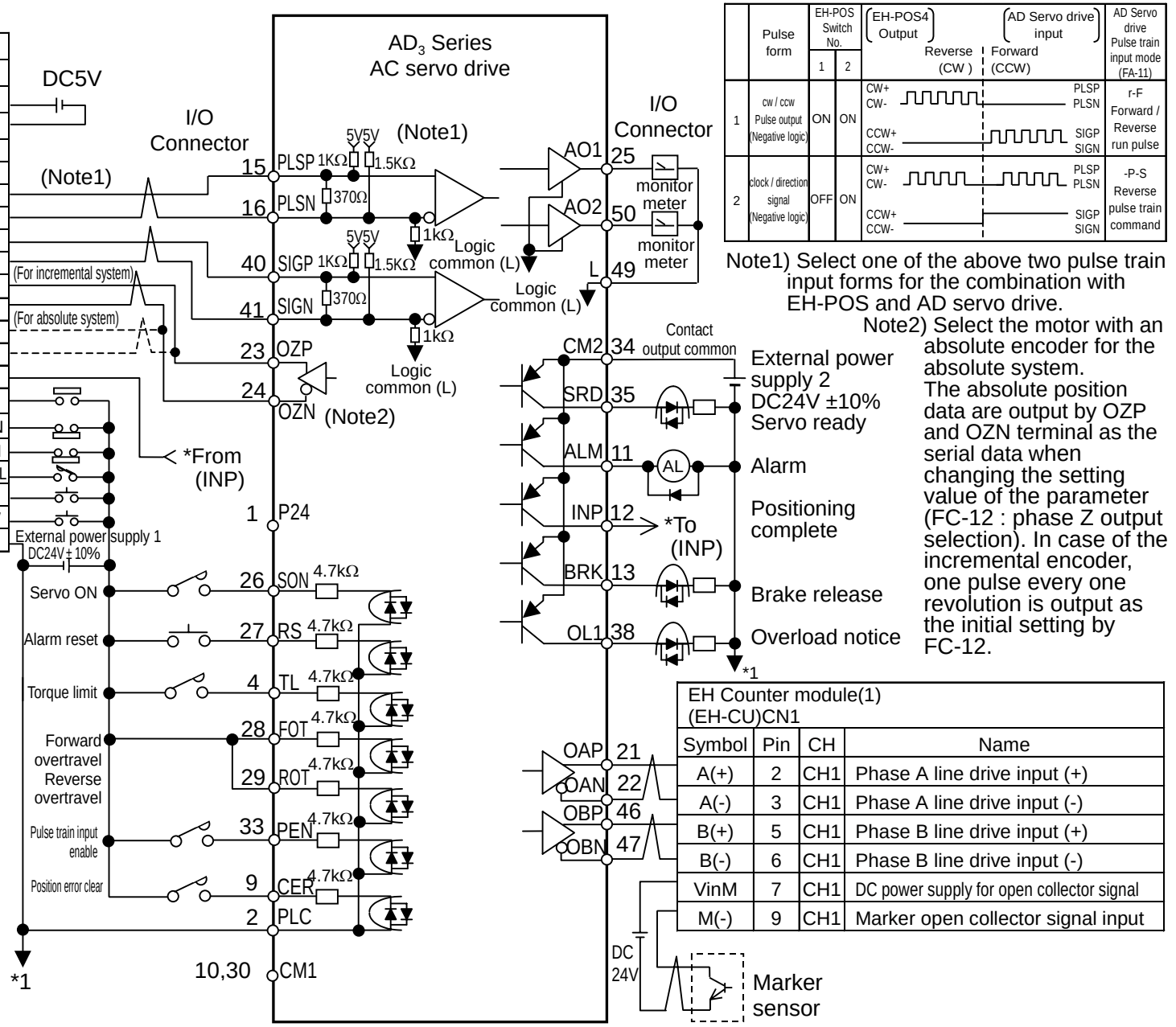
Note2) Select the motor with an absolute encoder for the absolute system. The absolute position data are output by OZP and OZN terminal as the serial data when changing the setting value of the parameter (FC-12 : phase Z output selection). In case of the incremental encoder, one pulse every one revolution is output as the initial setting by FC-12.

EH Counter module (1) (EH-CU) CN1			
Symbol	Pin	CH	Name
A(+)	2	CH1	Phase A line drive input (+)
A(-)	3	CH1	Phase A line drive input (-)
B(+)	5	CH1	Phase B line drive input (+)
B(-)	6	CH1	Phase B line drive input (-)
VinM	7	CH1	DC power supply for open collector signal
M(-)	9	CH1	Marker open collector signal input

10.4.3 Connection with Hitachi one axis positioning module EH-POS (I/O)

EH-150 Series

EH-POS		
Name	Pin No.	Symbol
Power supply for output pulse +	1	5VDC+
Power supply for output pulse -	2	P5G
Open collector pulse output	3	CW
	4	CCW
Line driver pulse output	5	CW+
	6	CW-
	7	CCW+
	8	CCW-
Encoder input phase C	9	C+
	10	C-
Data input signal by absolute system	11	PS-
	12	PS+
Positioning complete	13	COIN
Homing LS	14	PROG
+ Over run	15	+O.RUN
- Over run	16	-O.RUN
Control mode switch	17	MODE-SEL
Manual CW	18	M-CW
Manual CCW	19	M-CCW
Control power supply	20	24VDC+



Position pulse train input form

	Pulse form	EH-POS Switch No. 1	EH-POS Switch No. 2	EH-POS4 Output / AD Servo drive input: Reverse (CW)	Forward (CCW)	AD Servo drive Pulse train input mode (FA-11)
1	cw / ccw Pulse output (Negative logic)	ON	ON	CW+ CW-	CCW+ CCW-	r-F Forward / Reverse run pulse
2	clock / direction signal (Negative logic)	OFF	ON	CW+ CW-	CCW+ CCW-	-P-S Reverse pulse train command

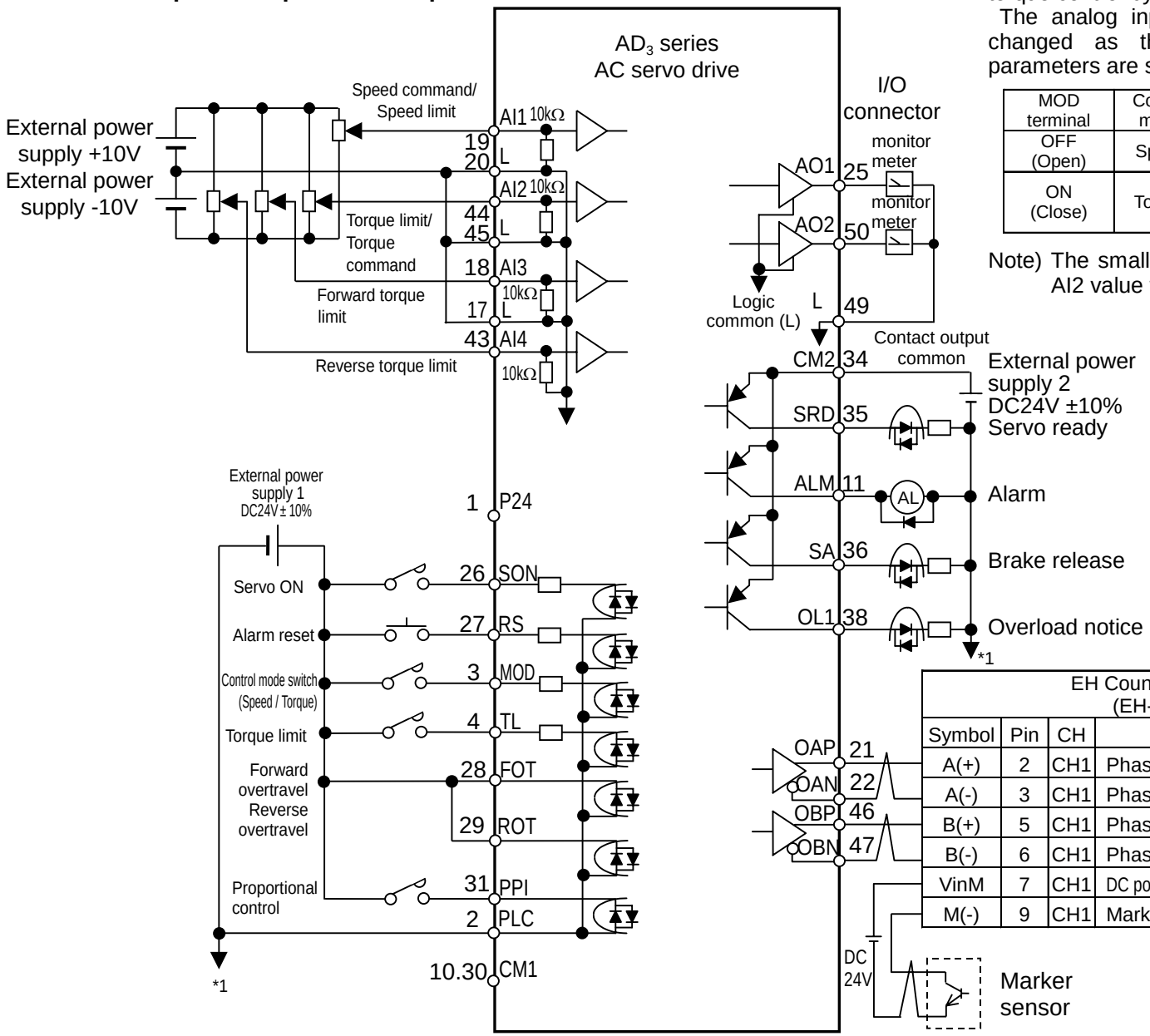
Note1) Select one of the above two pulse train input forms for the combination with EH-POS and AD servo drive.

Note2) Select the motor with an absolute encoder for the absolute system. The absolute position data are output by OZP and OZN terminal as the serial data when changing the setting value of the parameter (FC-12 : phase Z output selection). In case of the incremental encoder, one pulse every one revolution is output as the initial setting by FC-12.

EH Counter module(1) (EH-CU)CN1			
Symbol	Pin	CH	Name
A(+)	2	CH1	Phase A line drive input (+)
A(-)	3	CH1	Phase A line drive input (-)
B(+)	5	CH1	Phase B line drive input (+)
B(-)	6	CH1	Phase B line drive input (-)
VinM	7	CH1	DC power supply for open collector signal
M(-)	9	CH1	Marker open collector signal input

10.5 Example connection with peripheral equipment

10.5.1 Connection of Speed/Torque control operation



The diagram shows the speed control or the torque control by control mode switch (MOD).

The analog input AI1, AI2, AI3 and AI4 are changed as the following table when the parameters are set as follows.

MOD terminal	Control mode	AI1 terminal	AI2, AI3, AI4 terminal
OFF (Open)	Speed	Speed command	Torque limit (Note)
ON (Close)	Torque	Speed limit	Torque command (For AI2 only)

Note) The smaller value is selected by comparing AI2 value with AI3 and AI4 value.

Setting parameter

Parameter No.	Name	Setting value
FA-00	Control mode	S-t
FC-03	Analog input1 function selection	nLit
FC-04	Analog input2 function selection	tLit
FA-17	Torque limit mode	A2
FA-19	Torque command selection	A2
FA-20	Speed limit mode	A1
FA-21	Speed command selection	A1

EH Counter module (1) (EH-CU) CN1			
Symbol	Pin	CH	Name
A(+)	2	CH1	Phase A line drive input (+)
A(-)	3	CH1	Phase A line drive input (-)
B(+)	5	CH1	Phase B line drive input (+)
B(-)	6	CH1	Phase B line drive input (-)
VinM	7	CH1	DC power supply for open collector signal
M(-)	9	CH1	Marker open collector signal input