Doc. no. LEC-OM03001

Operation Manual

PRODUCT NAME

AC Servo Motor Controller (SSCNETⅢ Type)

MODEL/ Series

LECSS Series

SMC Corporation

LECSS□-□ Series / Driver
1. Safety Instructions

These safety instructions are intended to prevent hazardous situations and/or equipment damage.
These instructions indicate the level of potential hazard with the labels of “Caution,” “Warning” or “Danger.”
They are all important notes for safety and must be followed in addition to International Standards (ISO/IEC), Japan Industrial Standards (JIS)*1) and other safety regulations*2).

*1) ISO 4414: Pneumatic fluid power -- General rules relating to systems
ISO 4413: Hydraulic fluid power -- General rules relating to systems
IEC 60204-1: Safety of machinery -- Electrical equipment of machines (Part 1: General requirements)
ISO 10218-1992: Manipulating industrial robots -- Safety
JIS B 8370: General rules for pneumatic equipment.
JIS B 8361: General rules for hydraulic equipment.
JIS B 9960-1: Safety of machinery – Electrical equipment for machines. (Part 1: General requirements)
JIS B 8433-1993: Manipulating industrial robots - Safety. etc.

*2) Labor Safety and Sanitation Law, etc.

Caution	**Caution** indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
Warning	**Warning** indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
Danger	**Danger** indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.

Warning

1. The compatibility of the product is the responsibility of the person who designs the equipment or decides its specifications.
Since the product specified here is used under various operating conditions, its compatibility with specific equipment must be decided by the person who designs the equipment or decides its specifications based on necessary analysis and test results.
The expected performance and safety assurance of the equipment will be the responsibility of the person who has determined its compatibility with the product.
This person should also continuously review all specifications of the product referring to its latest catalog information, with a view to giving due consideration to any possibility of equipment failure when configuring the equipment.

2. Only personnel with appropriate training should operate machinery and equipment.
The product specified here may become unsafe if handled incorrectly.
The assembly, operation and maintenance of machines or equipment including our products must be performed by an operator who is appropriately trained and experienced.

3. Do not service or attempt to remove product and machinery/equipment until safety is confirmed.
The inspection and maintenance of machinery/equipment should only be performed after measures to prevent falling or runaway of the driven objects have been confirmed.
When the product is to be removed, confirm that the safety measures as mentioned above are implemented and the power from any appropriate source is cut, and read and understand the specific product precautions of all relevant products carefully.
Before machinery/equipment is restarted, take measures to prevent unexpected operation and malfunction.

4. Contact SMC beforehand and take special consideration of safety measures if the product is to be used in any of the following conditions.
1) Conditions and environments outside of the given specifications, or use outdoors or in a place exposed to direct sunlight.
2) Installation on equipment in conjunction with atomic energy, railways, air navigation, space, shipping, vehicles, military, medical treatment, combustion and recreation, or equipment in contact with food and beverages, emergency stop circuits, clutch and brake circuits in press applications, safety equipment or other

applications unsuitable for the standard specifications described in the product catalog.
3) An application which could have negative effects on people, property, or animals requiring special safety analysis.
4) Use in an interlock circuit, which requires the provision of double interlock for possible failure by using a mechanical protective function, and periodical checks to confirm proper operation.

Note that the CAUTION level may lead to a serious consequence according to conditions. Please follow the instructions of both levels because they are important to personnel safety.

What must not be done and what must be done are indicated by the following diagrammatic symbols.

Prohibition	Indicates what must not be done. For example, "No Fire" is indicated by 
Compulsion	Indicates what must be done. For example, grounding is indicated by 

In this Instruction Manual, instructions at a lower level than the above, instructions for other functions, and so on are classified into "POINT".

After reading this installation guide, always keep it accessible to the operator.

LECSS□-□ Series / Driver
1. Safety Instructions

⚠Caution

The product is provided for use in manufacturing industries.
The product herein described is basically provided for peaceful use in manufacturing industries.
If considering using the product in other industries, consult SMC beforehand and exchange specifications or a contract if necessary.
If anything is unclear, contact your nearest sales branch.

Limited warranty and Disclaimer/Compliance Requirements

The product used is subject to the following “Limited warranty and Disclaimer” and “Compliance Requirements”.
Read and accept them before using the product.

Limited warranty and Disclaimer

The warranty period of the product is 1 year in service or 1.5 years after the product is delivered.*3)
Also, the product may have specified durability, running distance or replacement parts. Please consult your nearest sales branch.

For any failure or damage reported within the warranty period which is clearly our responsibility, a replacement product or necessary parts will be provided.
This limited warranty applies only to our product independently, and not to any other damage incurred due to the failure of the product.

Prior to using SMC products, please read and understand the warranty terms and disclaimers noted in the specified catalog for the particular products.

***3) Vacuum pads are excluded from this 1 year warranty.**
A vacuum pad is a consumable part, so it is warranted for a year after it is delivered.
Also, even within the warranty period, the wear of a product due to the use of the vacuum pad or failure due to the deterioration of rubber material are not covered by the limited warranty.

Compliance Requirements

When the product is exported, strictly follow the laws required by the Ministry of Economy, Trade and Industry (Foreign Exchange and Foreign Trade Control Law).

1. To prevent electric shock, note the following

⚠ WARNING

- Before wiring or inspection, turn off the power and wait for 15 minutes or more until the charge lamp turns off. Then, confirm that the voltage between P(＋) and N(－) is safe with a voltage tester and others. Otherwise, an electric shock may occur. In addition, always confirm from the front of the driver, whether the charge lamp is off or not.
- Connect the driver and servo motor to ground.
- Any person who is involved in wiring and inspection should be fully competent to do the work.
- Do not attempt to wire the driver and servo motor until they have been installed. Otherwise, you may get an electric shock.
- Operate the switches with dry hand to prevent an electric shock.
- The cables should not be damaged, stressed, loaded, or pinched. Otherwise, you may get an electric shock.
- During power-on or operation, do not open the front cover of the driver. You may get an electric shock.
- Do not operate the driver with the front cover removed. High-voltage terminals and charging area are exposed and you may get an electric shock.
- Except for wiring or periodic inspection, do not remove the front cover even of the driver if the power is off. The driver is charged and you may get an electric shock.

2. To prevent fire, note the following

⚠ CAUTION

- Install the driver, servo motor and regenerative resistor on incombustible material. Installing them directly or close to combustibles will lead to a fire.
- Always connect a magnetic contactor (MC) between the main circuit power supply and L_1, L_2, and L_3 of the driver, and configure the wiring to be able to shut down the power supply on the side of the driver's power supply. If a magnetic contactor (MC) is not connected, continuous flow of a large current may cause a fire when the driver malfunctions.
- When a regenerative resistor is used, use an alarm signal to switch main power off. Otherwise, a regenerative transistor fault or the like may overheat the regenerative resistor, causing a fire.

3. To prevent injury, note the follow

⚠ CAUTION

- Only the voltage specified in the Instruction Manual should be applied to each terminal, Otherwise, a burst, damage, etc. may occur.
- Connect the terminals correctly to prevent a burst, damage, etc.
- Ensure that polarity (＋, －) is correct. Otherwise, a burst, damage, etc. may occur.
- Take safety measures, e.g. provide covers, to prevent accidental contact of hands and parts (cables, etc.) with the driver heat sink, regenerative resistor, servo motor, etc. since they may be hot while power is on or for some time after power-off. Their temperatures may be high and you may get burnt or a parts may damaged.
- During operation, never touch the rotating parts of the servo motor. Doing so can cause injury.

4. Additional instructions

The following instructions should also be fully noted. Incorrect handling may cause a fault, injury, electric shock, etc.

(1) Transportation and installation

⚠ CAUTION

- Transport the products correctly according to their weights.
- Stacking in excess of the specified number of products is not allowed.
- Do not carry the servo motor by the cables, shaft or encoder.
- Do not hold the front cover to transport the driver. The driver may drop.
- Install the driver in a load-bearing place in accordance with the Instruction Manual.
- Do not climb or stand on servo equipment. Do not put heavy objects on equipment.
- The driver and servo motor must be installed in the specified direction.
- Leave specified clearances between the driver and control enclosure walls or other equipment.
- Do not install or operate the driver and servo motor which has been damaged or has any parts missing.
- Provide adequate protection to prevent screws and other conductive matter, oil and other combustible matter from entering the driver and servo motor.
- Do not drop or strike driver or servo motor. Isolate from all impact loads.
- When you keep or use it, please fulfill the following environmental conditions.

Environment			Conditions	
			Driver	Servo motor
Ambient temperature	In operation	[°C]	0 to +55 (non-freezing)	0 to +40 (non-freezing)
		[°F]	32 to 131 (non-freezing)	32 to 104 (non-freezing)
	In storage	[°C]	−20 to +65 (non-freezing)	−15 to +70 (non-freezing)
		[°F]	−4 to 149 (non-freezing)	5 to 158 (non-freezing)
Ambient humidity	In operation		90%RH or less (non-condensing)	80%RH or less (non-condensing)
	In storage		90%RH or less (non-condensing)	
Ambience			Indoors (no direct sunlight) Free from corrosive gas, flammable gas, oil mist, dust and dirt	
Altitude			Max. 1000m (3280 ft) above sea level	
(Note) Vibration	[m/s^2]		5.9 or less	LECS□□-S5 LECS□□-S7 LECS□□-S8 series: X・Y: 49

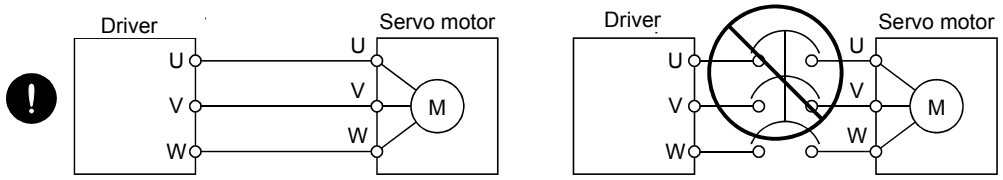
- Securely attach the servo motor to the machine. If attach insecurely, the servo motor may come off during operation.
- The servo motor with a reduction gear must be installed in the specified direction to prevent oil leakage.
- Take safety measures, e.g. provide covers, to prevent accidental access to the rotating parts of the servo motor during operation.
- Never hit the servo motor or shaft, especially when coupling the servo motor to the machine. The encoder may become faulty.
- Do not subject the servo motor shaft to more than the permissible load. Otherwise, the shaft may break.
- When the equipment has been stored for an extended period of time, contact your local sales office.

(2) Wiring

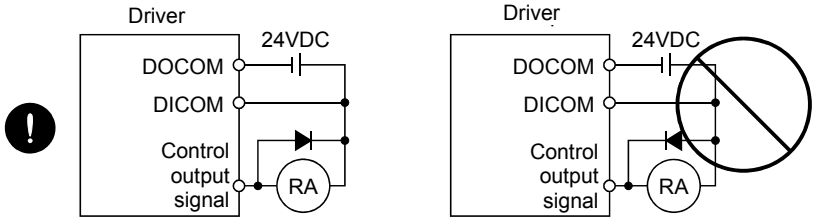
⚠ CAUTION

- Wire the equipment correctly and securely. Otherwise, the servo motor may operate unexpectedly.
- Do not install a power capacitor, surge absorber or radio noise filter (FR-BIF-(H) option) between the servo motor and driver.
- Connect the wires to the correct phase terminals (U, V, W) of the driver and servo motor.

  Not doing so may cause unexpected operation.
- Connect the servo motor power terminal (U, V, W) to the servo motor power input terminal (U, V, W) directly. Do not let a magnetic contactor, etc. intervene.



- Do not connect AC power directly to the servo motor. Otherwise, a fault may occur.
- The surge absorbing diode installed on the DC output signal relay of the driver must be wired in the specified direction. Otherwise, the forced stop (EMG) and other protective circuits may not operate.



- When the cable is not tightened enough to the terminal block (connector), the cable or terminal block (connector) may generate heat because of the poor contact. Be sure to tighten the cable with specified torque.

(3) Test run adjustment

⚠ CAUTION

- Before operation, check the parameter settings. Improper settings may cause some machines to perform unexpected operation.
- The parameter settings must not be changed excessively. Operation will be insatiable.

(4) Usage

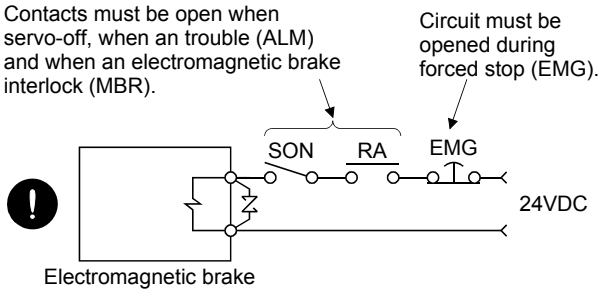
⚠ CAUTION

- Provide an external emergency stop circuit to ensure that operation can be stopped and power switched off immediately.
- Any person who is involved in disassembly and repair should be fully competent to do the work.
- Before resetting an alarm, make sure that the run signal of the driver is off to prevent an accident. A sudden restart is made if an alarm is reset with the run signal on.
- Do not modify the equipment.
- Use a noise filter, etc. to minimize the influence of electromagnetic interference, which may be caused by electronic equipment used near the driver.
- Burning or breaking a driver may cause a toxic gas. Do not burn or break a driver.
- Use the driver with the specified servo motor.
- The electromagnetic brake on the servo motor is designed to hold the motor shaft and should not be used for ordinary braking.
- For such reasons as service life and mechanical structure (e.g. where a ball screw and the servo motor are coupled via a timing belt), the electromagnetic brake may not hold the motor shaft. To ensure safety, install a stopper on the machine side.

(5) Corrective actions

⚠ CAUTION

- When it is assumed that a hazardous condition may take place at the occur due to a power failure or a product fault, use a servo motor with an electromagnetic brake or an external brake mechanism for the purpose of prevention.
- Configure the electromagnetic brake circuit so that it is activated not only by the driver signals but also by an external forced stop (EMG).



- When any alarm has occurred, eliminate its cause, ensure safety, and deactivate the alarm before restarting operation.
- When power is restored after an instantaneous power failure, keep away from the machine because the machine may be restarted suddenly (design the machine so that it is secured against hazard if restarted).

(6) Maintenance, inspection and parts replacement

⚠ CAUTION

- With age, the electrolytic capacitor of the driver will deteriorate. To prevent a secondary accident due to a fault, it is recommended to replace the electrolytic capacitor every 10 years when used in general environment. Please consult our sales representative.

(7) General instruction

- To illustrate details, the equipment in the diagrams of this Specifications and Instruction Manual may have been drawn without covers and safety guards. When the equipment is operated, the covers and safety guards must be installed as specified. Operation must be performed in accordance with this Specifications and Instruction Manual.

● About processing of waste ●

When you discard driver, a battery (primary battery), and other option articles, please follow the law of each country (area).

⚠ FOR MAXIMUM SAFETY

- These products have been manufactured as a general-purpose part for general industries, and have not been designed or manufactured to be incorporated in a device or system used in purposes related to human life.
- Before using the products for special purposes such as nuclear power, electric power, aerospace, medicine, passenger movement vehicles or under water relays, contact your local sales office..
- These products have been manufactured under strict quality control. However, when installing the product where major accidents or losses could occur if the product fails, install appropriate backup or failsafe functions in the system.

⚠ EEP-ROM life

The number of write times to the EEP-ROM, which stores parameter settings, etc., is limited to 100,000. If the total number of the following operations exceeds 100,000, the driver and/or converter unit may fail when the EEP-ROM reaches the end of its useful life.

- Write to the EEP-ROM due to parameter setting changes
- Home position setting in the absolute position detection system
- Write to the EEP-ROM due to device changes
- Write to the EEP-ROM due to point table changes

Precautions for Choosing the Products

SMC will not be held liable for damage caused by factors found not to be the cause of SMC; machine damage or lost profits caused by faults in the SMC products; damage, secondary damage, accident compensation caused by special factors unpredictable by SMC; damages to products other than SMC products; and to other duties.

COMPLIANCE WITH EC DIRECTIVES

1. WHAT ARE EC DIRECTIVES?

The EC directives were issued to standardize the regulations of the EU countries and ensure smooth distribution of safety-guaranteed products. In the EU countries, the machinery directive (effective in January, 1995), EMC directive (effective in January, 1996) and low voltage directive (effective in January, 1997) of the EC directives require that products to be sold should meet their fundamental safety requirements and carry the CE marks (CE marking). CE marking applies to machines and equipment into which drivers have been installed.

(1) EMC directive

The EMC directive applies not to the servo units alone but to servo-incorporated machines and equipment. This requires the EMC filters to be used with the servo-incorporated machines and equipment to comply with the EMC directive. For specific EMC directive conforming methods, refer to the EMC Installation Guidelines (IB(NA)67310).

(2) Low voltage directive

The low voltage directive applies also to servo units alone. Hence, they are designed to comply with the low voltage directive.

This servo is certified by TUV, third-party assessment organization, to comply with the low voltage directive.

(3) Machine directive

Not being machines, the drivers need not comply with this directive.

2. PRECAUTIONS FOR COMPLIANCE

(1) Drivers and servo motors used

Use the drivers and servo motors which comply with the standard model.

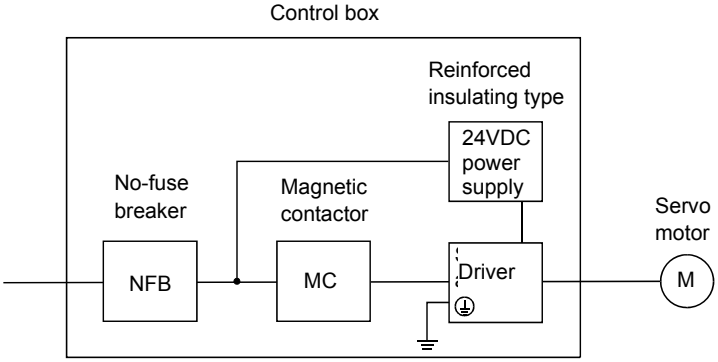
Driver : LECSS□-□

Servo motor : LE-S5-□、LE-S6-□、LE-S7-□、LE-S8-□(Note)

Note. For the latest information of compliance, contact your local sales office..

(2) Configuration

The control circuit provide safe separation to the main circuit in the driver.



(3) Environment

Operate the driver at or above the contamination level 2 set forth in IEC60664-1. For this purpose, install the driver in a control box which is protected against water, oil, carbon, dust, dirt, etc. (IP54).

(4) Power supply

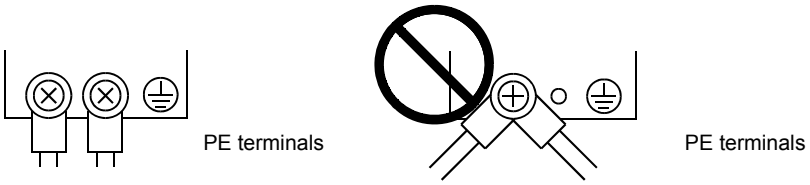
(a) This driver can be supplied from star-connected supply with earthed neutral point of overvoltage category III set forth in IEC60664-1. However, when using the neutral point of 400V class for single-phase supply, a reinforced insulating transformer is required in the power input section.

(b) When supplying interface power from external, use a 24VDC power supply which has been insulation-reinforced in I/O.

(5) Grounding

(a) To prevent an electric shock, always connect the protective earth (PE) terminals (marked ⏚) of the driver to the protective earth (PE) of the control box.

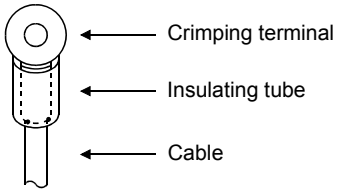
(b) Do not connect two ground cables to the same protective earth (PE) terminal (marked ⏚). Always connect the cables to the terminals one-to-one.



(c) If a leakage current breaker is used to prevent an electric shock, the protective earth (PE) terminals (marked ⏚) of the driver must be connected to the corresponding earth terminals.

(6) Wiring

(a) The cables to be connected to the terminal block of the driver must have crimping terminals provided with insulating tubes to prevent contact with adjacent terminals.



(b) Use the servo motor side power connector which complies with the EN Standard. The EN Standard compliant power connector sets are available from us as options. (Refer to section 14.1)

(7) Auxiliary equipment and options

(a) The no-fuse breaker and magnetic contactor used should be the EN or IEC standard-compliant products of the models described in section 14.10.
Use a type B (Note) breaker. When it is not used, provide insulation between the driver and other device by double insulation or reinforced insulation, or install a transformer between the main power supply and driver.
Note. Type A: AC and pulse detectable
Type B: Both AC and DC detectable

(b) The sizes of the cables described in section 14.9 meet the following requirements. To meet the other requirements, follow Table 5 and Appendix C in EN60204-1.
- Ambient temperature: 40 (104) [°C (°F)]
- Sheath: PVC (polyvinyl chloride)
- Installed on wall surface or open table tray

(c) Use the EMC filter for noise reduction.

(8) Performing EMC tests

When EMC tests are run on a machine/device into which the driver has been installed, it must conform to the electromagnetic compatibility (immunity/emission) standards after it has satisfied the operating environment/electrical equipment specifications.
For the other EMC directive guidelines on the driver, refer to the EMC Installation Guidelines (IB(NA)67310).

CONFORMANCE WITH UL/C-UL STANDARD

(1) Drivers and servo motors used

Use the drivers and servo motors which comply with the standard model.

Driver :LECSS□-□
Servo motor : LE-□-□(Note)

Note. For the latest information of compliance, contact your local sales office..

(2) Installation

Install a fan of 100CFM (2.8m^3/min) air flow 4[in] (10.16[cm]) above the driver or provide cooling of at least equivalent capability to ensure that the ambient temperature conforms to the environment conditions (55℃ or less).

(3) Short circuit rating (SCCR: Short Circuit Current Rating)

Suitable For Use In A Circuit Capable Of Delivering Not More Than 100 kA rms Symmetrical Amperes, 500 Volts Maximum.

(4) Capacitor discharge time

The capacitor discharge time is as listed below. To ensure safety, do not touch the charging section for 15 minutes after power-off.

Driver	Discharge time [min]
LECSS2-S5・LECSS2-S7	1
LECSS2-S8・LECSS1-S5・LECSS1-S7	2

(5) Options and auxiliary equipment

Use UL/C-UL standard-compliant products.

(6) Attachment of a servo motor

For the flange size of the machine side where the servo motor is installed, refer to “CONFORMANCE WITH UL/C-UL STANDARD” in the Servo Motor Instruction Manual (Vol.2).

(7) About wiring protection

For installation in United States, branch circuit protection must be provided, in accordance with the National Electrical Code and any applicable local codes.

For installation in Canada, branch circuit protection must be provided, in accordance with the Canada Electrical Code and any applicable provincial codes.

<<About the manuals>>

This Instruction Manual are required if you use the General-Purpose AC servo LECSS□-□ for the first time. Always purchase them and use the LECSS□-□ safely.

Relevant manuals

<<About the wires used for wiring>>

Wiring wires mentioned in this instruction manual are selected based on the ambient temperature of 40°C (104°F).

MEMO

CONTENTS

MEMO

1. FUNCTIONS AND CONFIGURATION

1. FUNCTIONS AND CONFIGURATION

1.1 Introduction

The LECSS□-□ driver connects to servo system driver and others via high speed synchronous network and operates by directly reading position data. The rotation speed/direction control of servo motor and the high accuracy positioning are executed with the data from command module. SSCNETⅢ equipped by the LECSS □-□ driver greatly improved its communication speed and noise tolerance by adopting optical communication system compared to the current SSCNET. For wiring distance, 50m of the maximum distance between electrodes is also offered.

The torque limit with clamping circuit is put on the driver in order to protect the power transistor of main circuit from the overcurrent caused by rapid acceleration/deceleration or overload. In addition, torque limit value can be changed to desired value in the servo system driver.

As this new series has the USB communication function, a set up software (MR Configurator)-installed personal computer or the like can be used to perform parameter setting, test operation, status display monitoring, gain adjustment, etc.

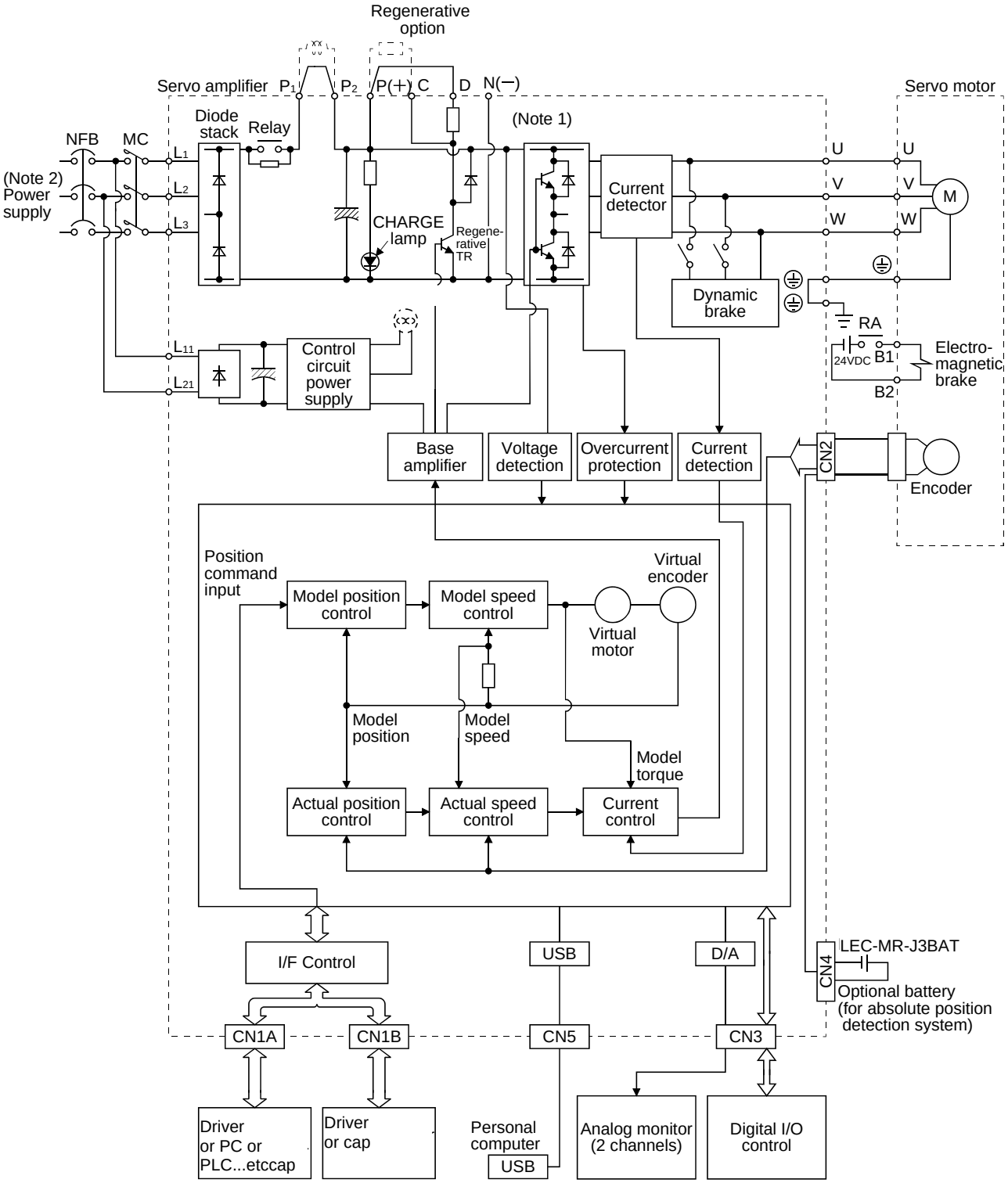
With real-time auto tuning, you can automatically adjust the servo gains according to the machine.

The LECS□□-□ series servo motor is with an absolute position encoder which has the resolution of 262144 pulses/rev to ensure more accurate control. Simply adding a battery to the driver makes up an absolute position detection system. This makes home position return unnecessary at power-on or alarm occurrence by setting a home position once.

1.2 Function block diagram

The function block diagram of this servo is shown below.

(1) LECSS□-□



Note 1. The built-in regenerative resistor is not provided for the LECSS□-S5.

2. For 1-phase 200 to 230VAC, connect the power supply to L_1, L_2 and leave L_3 open.
There is no L_3 for 1-phase 100 to 120VAC power supply. Refer to section 1.3 for the power supply specification.

1.3 Driver standard specifications

(1) 200V class, 100V class

Item \ Driver LECSS□-□				S5	S7	S8
Power supply		Voltage/frequency		3-phase or 1-phase 200 to 230VAC, 50/60Hz		
		Permissible voltage fluctuation		3-phase or 1-phase 200 to 230VAC: 170 to 253VAC		
		Permissible frequency fluctuation		Within ±5%		
		Power supply capacity		Refer to section 10.2		
		Inrush current		Refer to section 10.5		
Control circuit power supply		Voltage, frequency		1-phase 200 to 230VAC, 50/60Hz		
		Permissible voltage fluctuation		1-phase 170 to 253VAC		
		Permissible frequency fluctuation		Within ±5%		
		Input		30W		
		Inrush current		Refer to section 10.5		
Interface power supply		Voltage		24VDC ±10%		
		Power supply capacity		(Note 1) 150mA or more		
Control System				Sine-wave PWM control, current control system		
Dynamic brake				Built-in		
Protective functions				Overcurrent shut-off, regenerative overvoltage shut-off, overload shut-off (electronic thermal relay), servo motor overheat protection, encoder error protection, regenerative error protection, undervoltage, instantaneous power failure protection, overspeed protection, excessive error protection.		
Structure				Self-cooled, open (IP00)		
Environment	Ambient temperature	In operation In storage	[°C]	(Note 2) 0 to +55 (non-freezing)		
			[°F]	32 to +131 (non-freezing)		
			[°C]	−20 to +65 (non-freezing)		
			[°F]	−4 to +149 (non-freezing)		
	Ambient humidity	In operation		90%RH or less (non-condensing)		
		In storage				
	Ambient			Indoors (no direct sunlight) Free from corrosive gas, flammable gas, oil mist, dust and dirt		
	Altitude			Max. 1000m above sea level		
	Vibration			5.9 [m/s^2] or less		
Mass			[kg]	0.8	0.8	1.0
			[lb]	1.76	1.76	2.21

Note 1. 150mA is the value applicable when all I/O signals are used. The current capacity can be decreased by reducing the number of I/O points.

2. When closely mounting the driver of 3.5kW or less, operate them at the ambient temperatures of 0 to 45°C or at 75% or smaller effective load ratio.

1.4 Function list

The following table lists the functions of this servo. For details of the functions, refer to the reference field.

Function	Description	Reference
High-resolution encoder	High-resolution encoder of 262144 pulses/rev is used as a servo motor encoder.	
Absolute position detection system	Merely setting a home position once makes home position return unnecessary at every power-on.	Chapter 12
Gain changing function	You can switch between gains during rotation and gains during stop or use an input device to change gains during operation.	Section 7.6
Advanced vibration suppression control	This function suppresses vibration at the arm end or residual vibration.	Section 7.4
Adaptive filter Ⅱ	Driver detects mechanical resonance and sets filter characteristics automatically to suppress mechanical vibration.	Section 7.2
Low-pass filter	Suppresses high-frequency resonance which occurs as servo system response is increased.	Section 7.5
Machine analyzer function	Analyzes the frequency characteristic of the mechanical system by simply connecting a set up software (MR Configurator) installed personal computer and driver. Set up software (MR Configurator) is necessary for this function.	
Machine simulation	Can simulate machine motions on a personal computer screen on the basis of the machine analyzer results. Set up software (MR Configurator) is necessary for this function.	
Gain search function	Personal computer changes gains automatically and searches for overshoot-free gains in a short time. Set up software (MR Configurator) is necessary for this function.	
Slight vibration suppression control	Suppresses vibration of ±1 pulse produced at a servo motor stop.	Parameters No.PB24
Auto tuning	Automatically adjusts the gain to optimum value if load applied to the servo motor shaft varies.	Chapter 6
Brake unit	Used when the regenerative option cannot provide enough regenerative power. Can be used the 5kW or more driver.	Section 11.3
Return converter	Used when the regenerative option cannot provide enough regenerative power. Can be used the 5kW or more driver.	Section 11.4
Regenerative option	Used when the built-in regenerative resistor of the driver does not have sufficient regenerative capability for the regenerative power generated.	Section 11.2
Alarm history clear	Alarm history is cleared.	Parameter No.PC21
Output signal (DO) forced output	Output signal can be forced on/off independently of the servo status. Use this function for output signal wiring check, etc.	Section 4.5.1 (1) (d)
Test operation mode	JOG operation・positioning operation・DO forced output. However, set up software (MR Configurator) is necessary for positioning operation.	Section 4.5
Analog monitor output	Servo status is output in terms of voltage in real time.	Parameter No.PC09
Set up software (MR Configurator)	Using a personal computer, parameter setting, test operation, status display, etc. can be performed.	Section 11.8

1.5 Model code definition
(1) Model

LECS C 1 — S5

Driver Type

C	SSCNETⅢ type (Absolute encoder)

Motor type

	Type	Capacity	Encoder
S5	AC Servo motor(S5,S6)	50W,100 W	Absolute
S7	AC Servo motor(S7)	200W	
S8	AC Servo motor(S8)	400W	

Power supply

1	AC100V～AC120V 50Hz, 60Hz
2	AC200V～AC230V 50Hz, 60Hz

(1) Option Model
a) Motor cable / Lock cable / Encoder cable

LE — CSM — S 5 A

Motor Type

S	AC Servo motor

Cable Content

M	Motor cable
B	Lock cable
E	Encoder cable

Connector Direction

A	Axis side
B	Opposite axis side

Cable Length (L) [m]

2	2m
5	5m
A	10m

Cable Type

S	Standard cable
R	Robot cable

*LE-CSM-S☐☐ is MR-PWS1CBL☐M-A☐-L of Mitsubishi Electric.
LE-CSB-S☐☐ is MR-BKS1CBL☐M-A☐-L of Mitsubishi Electric.
LE-CSE-S☐☐ is MR-J3ENCBL☐M-A☐-L of Mitsubishi Electric.
LE-CSM-R☐☐ is MR-PWS1CBL☐M-A☐-H of Mitsubishi Electric.
LE-CSB-R☐☐ is MR-BKS1CBL☐M-A☐-H of Mitsubishi Electric.
LE-CSE-R☐☐ is MR-J3ENCBL☐M-A☐-H of Mitsubishi Electric.

b) SSCNETⅢ cable

LE − CS S − 1

モータ種類

S	AC Servo motor

ケーブル内容

S	SSCNETⅢ Cable

Cable Length (L) [m]

L	0.15m
K	0.3m
J	0.5m
1	1m
3	3m

* LE-CSS □ is MR-J3BUS□M of Mitsubishi Electric.

c) I/O Connector

LE-CSNS

Driver Type

S	LECSS

*LE-CSNS is 10126-3000VE (Connector)/ 10320-52F0-008 (Shell kit) of 3M or equivalent goods.

d) Regenerative options

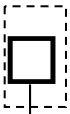
LEC-MR-RB-032

Regenerative option Type

032	Permissible regenerative power 30W
12	Permissible regenerative power 100W

*MR-RB-□ of Mitsubishi Electric.

e) MR Configrator(Setup software Japanese version)

LEC-MR-SETUP221 

Languag

NIL	Japanese version
E	English version

* MRZJW3-SETUP221 of Mitsubishi Electric.
Refer to the website of Mitsubishi Electric for the information of the operating environment and upgrading.
Prepare USB cable should be ordered separately.

f) USB cable(3m)

LEC-MR-J3USB

* MR-J3USB of Mitsubishi Electric.

g) Battery

LEC-MR-J3BAT

* MR-J3BAT of Mitsubishi Electric.
Battery for replacement.
Absolute position data is maintained by installing the battery to the driver.

1.6 Combination with servo motor

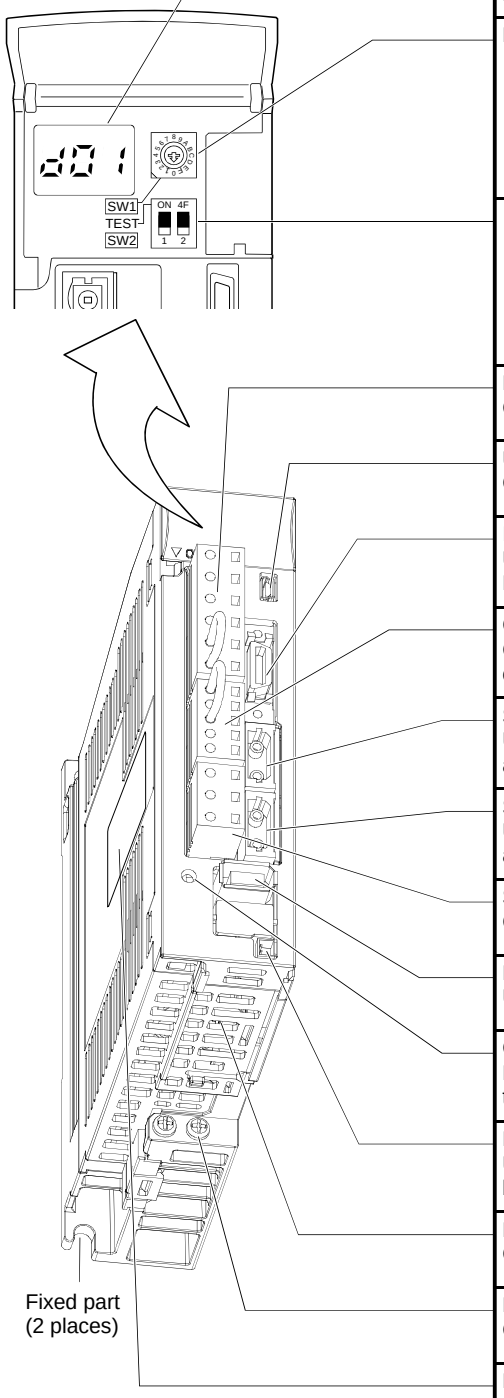
The following table lists combinations of drivers and servo motors. The same combinations apply to the models with an electromagnetic brake and the models with a reduction gear.

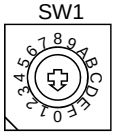
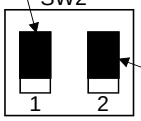
Driver	servo motor
	LE-□-□
LECSS□-S5	S5,S6
LECSS□-S7	S7
LECSS□-S8	S8

1.7 Structure

1.7.1 Parts identification

(1) LECSS□-□



Name/Application	Detailed explanation
Display The 3-digit, seven-segment LED shows the servo status and alarm number.	Chapter 4
Rotary axis setting switch (SW1) SW1  Used to set the axis No. of servo amplifier.	Section 3.13
Test operation select switch (SW2-1) Used to perform the test operation mode by using MR Configurator. SW2  Spare (Be sure to set to the "Down" position).	Section 3.13
Main circuit power supply connector (CNP1) Connect the input power supply.	Section 3.1 Section 3.3
USB communication connector (CN5) Connect the personal computer.	Section 11.8
I/O signal connector (CN3) Used to connect digital I/O signals. More over an analog monitor is output.	Section 3.2 Section 3.4
Control circuit connector (CNP2) Connect the control circuit power supply/regenerative option.	Section 3.1 Section 3.3
SSCNETⅢ cable connector (CN1A) Used to connect the servo system controller or the front axis servo amplifier.	Section 3.2 Section 3.4
SSCNETⅢ cable connector (CN1B) Used to connect the rear axis servo amplifier. For the final axis, puts a cap.	Section 3.2 Section 3.4
Servo motor power connector (CNP3) Connect the servo motor.	Section 3.1 Section 3.3
Encoder connector (CN2) Used to connect the servo motor encoder.	Section 3.4 Section 11.1
Charge lamp Lit to indicate that the main circuit is charged. While this lamp is lit, do not reconnect the cables.	
Battery connector (CN4) Used to connect the battery for absolute position data backup.	Section 11.9 Chapter 12
Battery holder Contains the battery for absolute position data backup.	Section 12.3
Protective earth (PE) terminal (⏚) Ground terminal.	Section 3.1 Section 3.3
Rating plate	Section 1.5

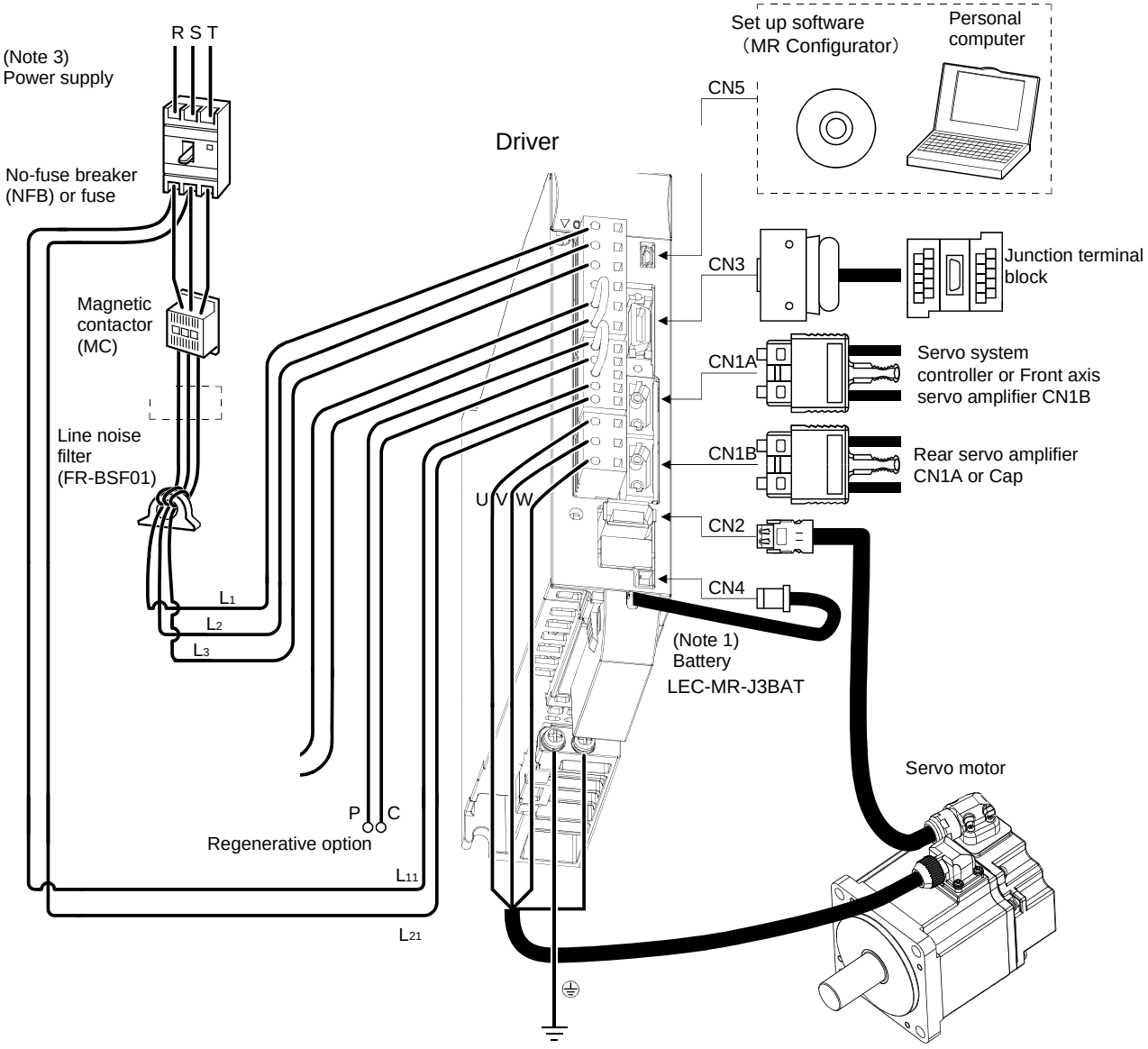
1.8 Configuration including auxiliary equipment

POINT

- Equipment other than the driver and servo motor are optional or recommended products.

(1) LECSS□-□

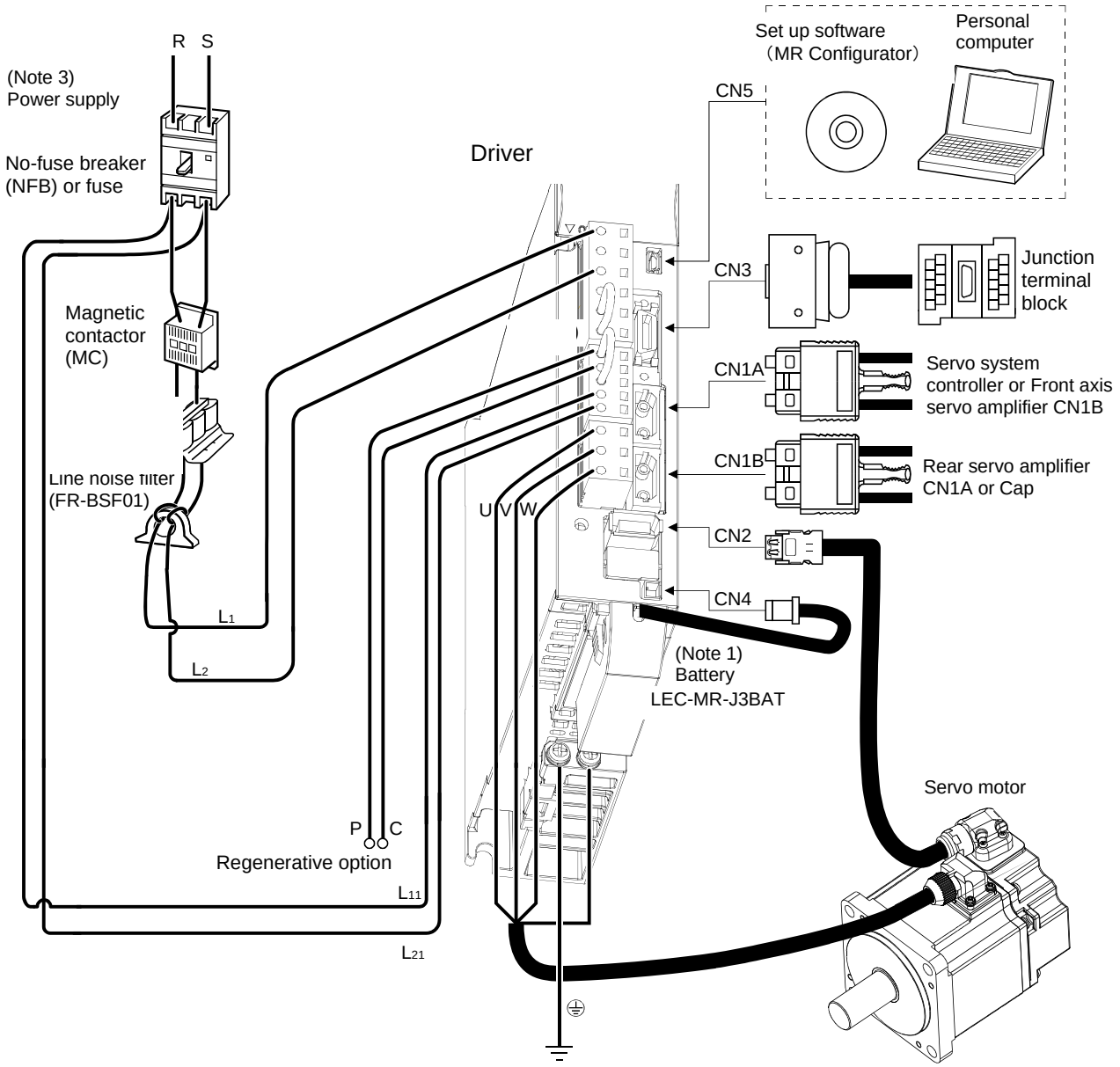
(a) For 3-phase or 1-phase 200V to 230VAC



Note 1. The battery (option) is used for the absolute position detection system in the position control mode.

3. For 1-phase 200V to 230VAC, connect the power supply to L_1 · L_2 and leave L_3 open. Refer to section 1.3 for the power supply specification.

(b) For 1-phase 100V to 120VAC



Note 1. The battery (option) is used for the absolute position detection system in the position control mode.

3. Refer to section 1.3 for the power supply specification.

2. INSTALLATION

2. INSTALLATION

⚠ CAUTION

- Stacking in excess of the limited number of products is not allowed.
- Install the equipment on incombustible material. Installing them directly or close to combustibles will lead to a fire.
- Install the equipment in a load-bearing place in accordance with this Instruction Manual.
- Do not get on or put heavy load on the equipment to prevent injury.
- Use the equipment within the specified environmental condition range. (For the environmental conditions, refer to section 1.3.)
- Provide an adequate protection to prevent screws, metallic detritus and other conductive matter or oil and other combustible matter from entering the driver.
- Do not block the intake/exhaust ports of the driver. Otherwise, a fault may occur.
- Do not subject the driver to drop impact or shock loads as they are precision equipment.
- Do not install or operate a faulty driver.
- When the product has been stored for an extended period of time, contact your local sales office.
- When treating the driver, be careful about the edged parts such as the corners of the driver.

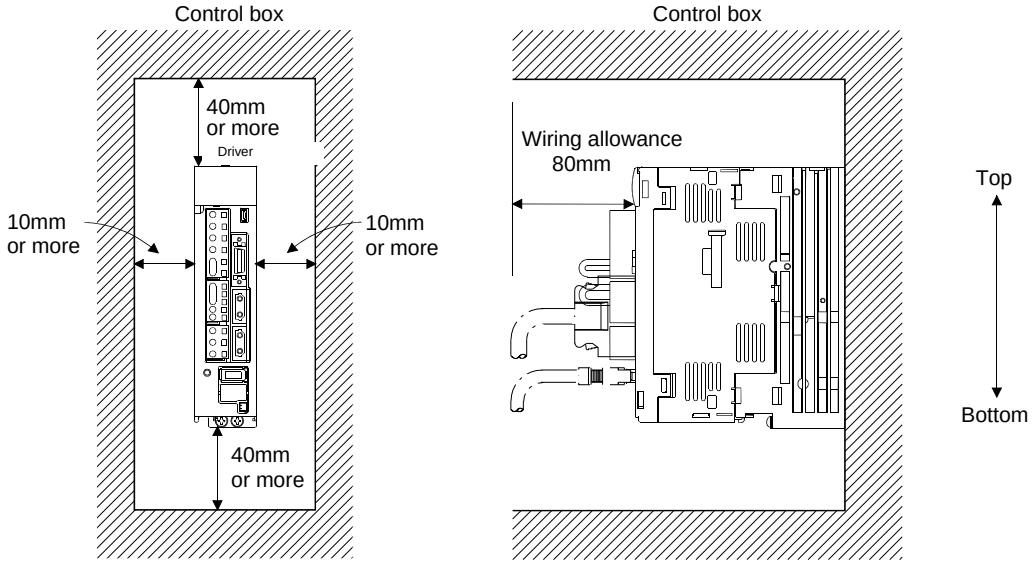
2.1 Installation direction and clearances

⚠ CAUTION

- The equipment must be installed in the specified direction. Otherwise, a fault may occur.
- Leave specified clearances between the driver and control box inside walls or other equipment.

(1) LECSS□-□

(a) Installation of one driver

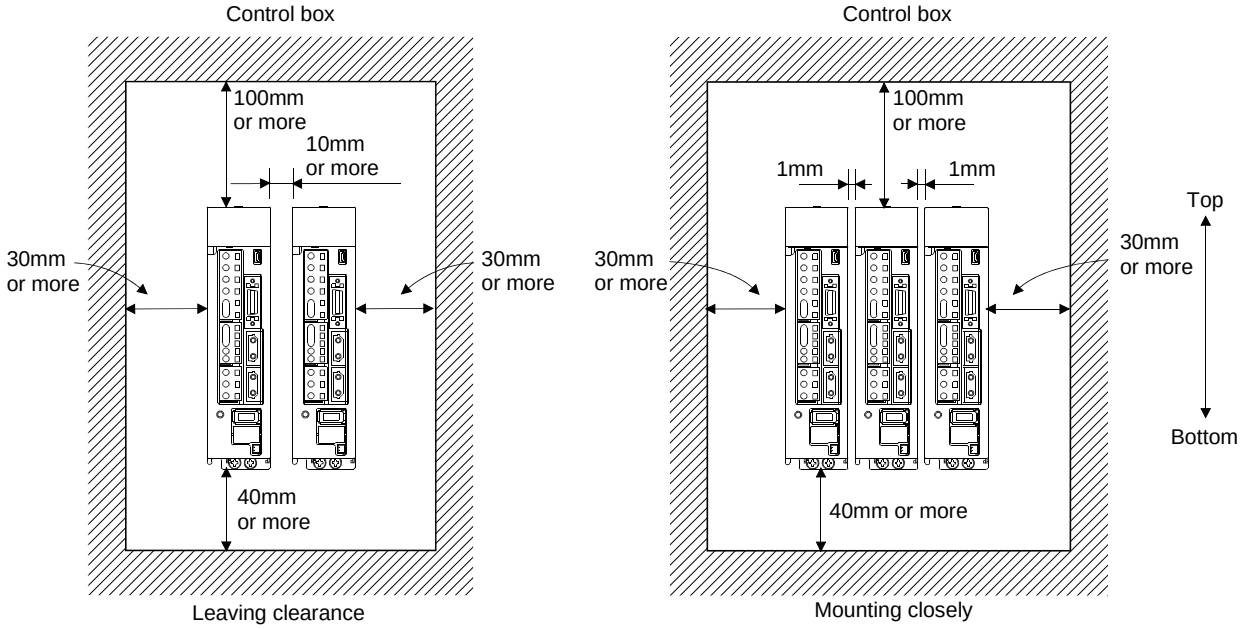


(b) Installation of two or more drivers

POINT

- Close mounting is available for the driver of under 3.5kW for 200V class and 400W for 100V class.

Leave a large clearance between the top of the driver and the internal surface of the control box, and install a cooling fan to prevent the internal temperature of the control box from exceeding the environmental conditions.
When installing the drivers closely, leave a clearance of 1mm between the adjacent drivers in consideration of mounting tolerances.
In this case, bring the ambient temperature within 0 to 45℃ (32 to 113℉), or use it at 75% or smaller effective load ratio.



(3) Others

When using heat generating equipment such as the regenerative option, install them with full consideration of heat generation so that the driver is not affected.
Install the driver on a perpendicular wall in the correct vertical direction.

2.2 Keep out foreign materials

(1) When installing the unit in a control box, prevent drill chips and wire fragments from entering the driver.

(2) Prevent oil, water, metallic dust, etc. from entering the driver through openings in the control box or a cooling fan installed on the ceiling.

(3) When installing the control box in a place where there are much toxic gas, dirt and dust, conduct an air purge (force clean air into the control box from outside to make the internal pressure higher than the external pressure) to prevent such materials from entering the control box.

2.3 Cable stress

(1) The way of clamping the cable must be fully examined so that flexing stress and cable's own weight stress are not applied to the cable connection.

(2) For use in any application where the servo motor moves, fix the cables (encoder, power supply, brake) with having some slack from the connector connection part of the servo motor to avoid putting stress on the connector connection part. Use the optional encoder cable within the flexing life range. Use the power supply and brake wiring cables within the flexing life of the cables.

(3) Avoid any probability that the cable sheath might be cut by sharp chips, rubbed by a machine corner or stamped by workers or vehicles.

(4) For installation on a machine where the servo motor will move, the flexing radius should be made as large as possible. Refer to section 10.4 for the flexing life.

2.4 SSCNETⅢ cable laying

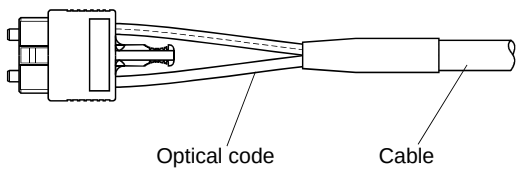
SSCNETⅢ cable is made from optical fiber. If optical fiber is added a power such as a major shock, lateral pressure, haul, sudden bending or twist, its inside distorts or breaks, and optical transmission will not be available. Especially, as optical fiber for LE-CSS-□ is made of synthetic resin, it melts down if being left near the fire or high temperature. Therefore, do not make it touched the part, which becomes high temperature, such as radiator or regenerative option of driver.
Read described item of this section carefully and handle it with caution.

(1) Minimum bend radius

Make sure to lay the cable with greater radius than the minimum bend radius. Do not press the cable to edges of equipment or others. For SSCNETⅢ cable, the appropriate length should be selected with due consideration for the dimensions and arrangement of driver. When closing the door of control box, pay careful attention for avoiding the case that SSCNETⅢ cable is hold down by the door and the cable bend becomes smaller than the minimum bend radius.
For the minimum bend radius, refer to section 11.1.5.

(2) Prohibition of vinyl tape use

Migrating plasticizer is used for vinyl tape. Keep the LE-CSS-□ cables away from vinyl tape because the optical characteristic may be affected.



SSCNETⅢ cable	Code	Cable
LE-CSS-□	△	

△: Phthalate ester plasticizer such as DBP and DOP may affect optical characteristic of cable.
○: Cable is not affected by plasticizer.

(3) Precautions for migrating plasticizer added materials

Generally, soft polyvinyl chloride (PVC), polyethylene resin (PE) and Teflon (fluorine resin) contain non-migrating plasticizer and they do not affect the optical characteristic of SSCNETⅢ cable.
However, some wire sheaths and cable ties, which contain migrating plasticizer (phthalate ester), may affect LE-CSS-□ cables.

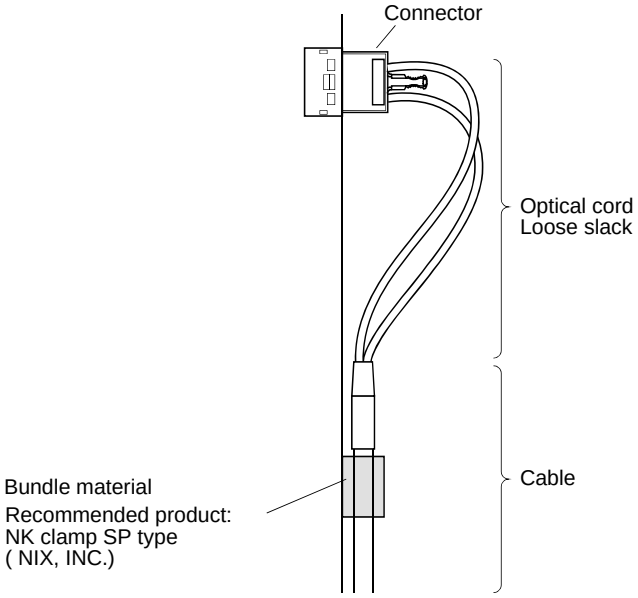
(4) Bundle fixing

Fix the cable at the closest part to the connector with bundle material in order to prevent SSCNETⅢ cable

from putting its own weight on CN1A ・ CN1B connector of driver. Optical cord should be given loose slack to avoid from becoming smaller than the minimum bend radius, and it should not be twisted.

When bundling the cable, fix and hold it in position by using cushioning such as sponge or rubber which does not contain migratable plasticizers.

If using adhesive tape for bundling the cable, fire resistant acetate cloth adhesive tape 570F (Teraoka Seisakusho Co., Ltd) is recommended.



(5) Tension

If tension is added on optical cable, the increase of transmission loss occurs because of external force which concentrates on the fixing part of optical fiber or the connecting part of optical connector. At worst, the breakage of optical fiber or damage of optical connector may occur. For cable laying, handle without putting forced tension. For the tension strength, refer to section 11.1.5.

(6) Lateral pressure

If lateral pressure is added on optical cable, the optical cable itself distorts, internal optical fiber gets stressed, and then transmission loss will increase. At worst, the breakage of optical cable may occur. As the same condition also occurs at cable laying, do not tighten up optical cable with a thing such as nylon band (TY-RAP).

Do not trample it down or tuck it down with the door of control box or others.

(7) Twisting

If optical fiber is twisted, it will become the same stress added condition as when local lateral pressure or bend is added. Consequently, transmission loss increases, and the breakage of optical fiber may occur at worst.

(8) Disposal

When incinerating optical cable (cord) used for SSCNETⅢ, hydrogen fluoride gas or hydrogen chloride gas which is corrosive and harmful may be generated. For disposal of optical fiber, request for specialized industrial waste disposal services who has incineration facility for disposing hydrogen fluoride gas or hydrogen chloride gas.

2.5 Inspection items

⚠WARNING	・Before starting maintenance and/or inspection, turn off the power and wait for 15 minutes or more until the charge lamp turns off. Then, confirm that the voltage between P(+) and N(−) is safe with a voltage tester and others. Otherwise, an electric shock may occur. In addition, always confirm from the front of the driver whether the charge lamp is off or not. ・Any person who is involved in inspection should be fully competent to do the work. Otherwise, you may get an electric shock. For repair and parts replacement, contact your safes representative.

POINT

・Do not test the driver with a megger (measure insulation resistance), or it may become faulty.

・Do not disassemble and/or repair the equipment on customer side.

It is recommended to make the following checks periodically.

(1) Check for loose terminal block screws. Retighten any loose screws.

(2) Check the cables and the like for scratches and cracks. Perform periodic inspection according to operating conditions.

2.6 Parts having service lives

The following parts must be changed periodically as listed below. If any part is found faulty, it must be changed immediately even when it has not yet reached the end of its life, which depends on the operating method and environmental conditions. For parts replacement, please contact your sales representative.

Part name		Life guideline
Driver	Smoothing capacitor	10 years
	Relay	Number of power-on and number of emergency stop times : 100,000 times
	Cooling fan	10,000 to 30,000hours (2 to 3 years)
	Absolute position battery	Refer to section 12.2

(1) Smoothing capacitor

Affected by ripple currents, etc. and deteriorates in characteristic. The life of the capacitor greatly depends on ambient temperature and operating conditions. The capacitor will reach the end of its life in 10 years of continuous operation in normal air-conditioned environment.

(2) Relays

Their contacts will wear due to switching currents and contact faults occur. Relays reach the end of their life when the cumulative number of power-on and emergency stop times is 100,000, which depends on the power supply capacity.

(3) Driver cooling fan

The cooling fan bearings reach the end of their life in 10,000 to 30,000 hours. Normally, therefore, the cooling fan must be changed in a few years of continuous operation as a guideline.

It must also be changed if unusual noise or vibration is found during inspection.

3. SIGNALS AND WIRING

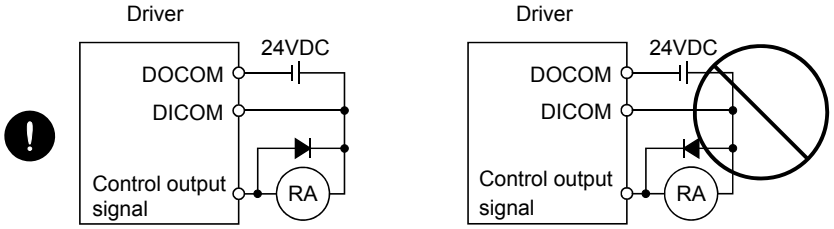
3. SIGNALS AND WIRING

⚠ WARNING

- Any person who is involved in wiring should be fully competent to do the work.
- Before wiring, turn off the power and wait for 15 minutes or more until the charge lamp turns off. Then, confirm that the voltage between P(＋) and N(－) is safe with a voltage tester and others. Otherwise, an electric shock may occur. In addition, always confirm from the front of the driver whether the charge lamp is off or not.
- Ground the driver and the servo motor securely.
- Do not attempt to wire the driver and servo motor until they have been installed. Otherwise, you may get an electric shock.
- The cables should not be damaged, stressed excessively, loaded heavily, or pinched. Otherwise, you may get an electric shock.

⚠ CAUTION

- Wire the equipment correctly and securely. Otherwise, the servo motor may operate unexpectedly, resulting in injury.
- Connect cables to correct terminals to prevent a burst, fault, etc.
- Ensure that polarity (+, －) is correct. Otherwise, a burst, damage, etc. may occur.
- The surge absorbing diode installed to the DC relay designed for control output should be fitted in the specified direction. Otherwise, the signal is not output due to a fault, disabling the forced stop (EM1) and other protective circuits.



- Use a noise filter, etc. to minimize the influence of electromagnetic interference, which may be given to electronic equipment used near the driver.
- Do not install a power capacitor, surge suppressor or radio noise filter (FR-BIF (-H) option) with the power line of the servo motor.
- When using the regenerative resistor, switch power off with the alarm signal. Otherwise, a transistor fault or the like may overheat the regenerative resistor, causing a fire.
- Do not modify the equipment.
- During power-on, do not open or close the motor power line. Otherwise, a malfunction or faulty may occur.

3.1 Input power supply circuit

⚠ CAUTION

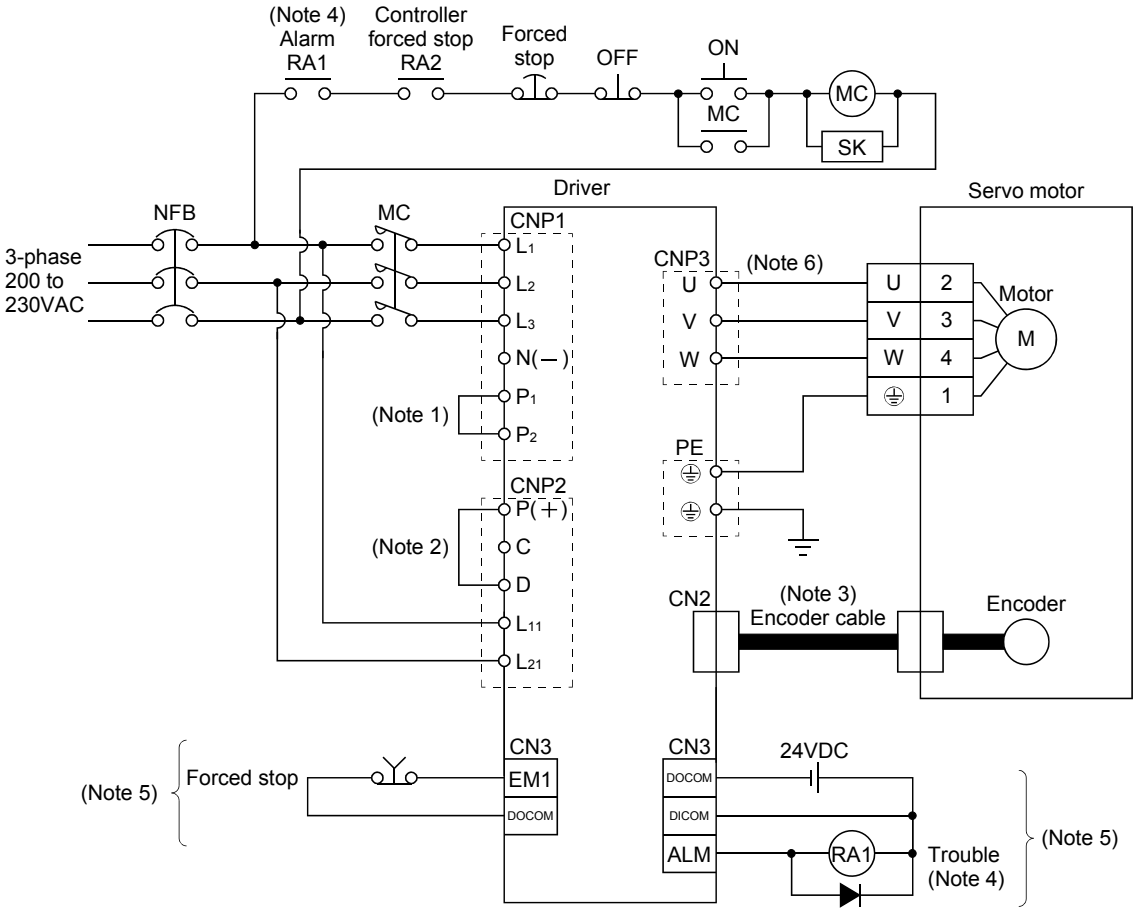
- Always connect a magnetic contactor (MC) between the main circuit power supply and L_1, L_2, and L_3 of the driver, and configure the wiring to be able to shut down the power supply on the side of the driver's power supply. If a magnetic contactor (MC) is not connected, continuous flow of a large current may cause a fire when the driver malfunctions.
- Use the trouble signal to switch main circuit power supply off. Otherwise, a regenerative transistor fault or the like may overheat the regenerative resistor, causing a fire.

POINT

- Even if alarm has occurred, do not switch off the control circuit power supply. When the control circuit power supply has been switched off, optical module does not operate, and optical transmission of SSCNETⅢ communication is interrupted. Therefore, the driver on the rear axis displays "AA" at the indicator and turns into base circuit shut-off. The driver stops with starting dynamic brake.

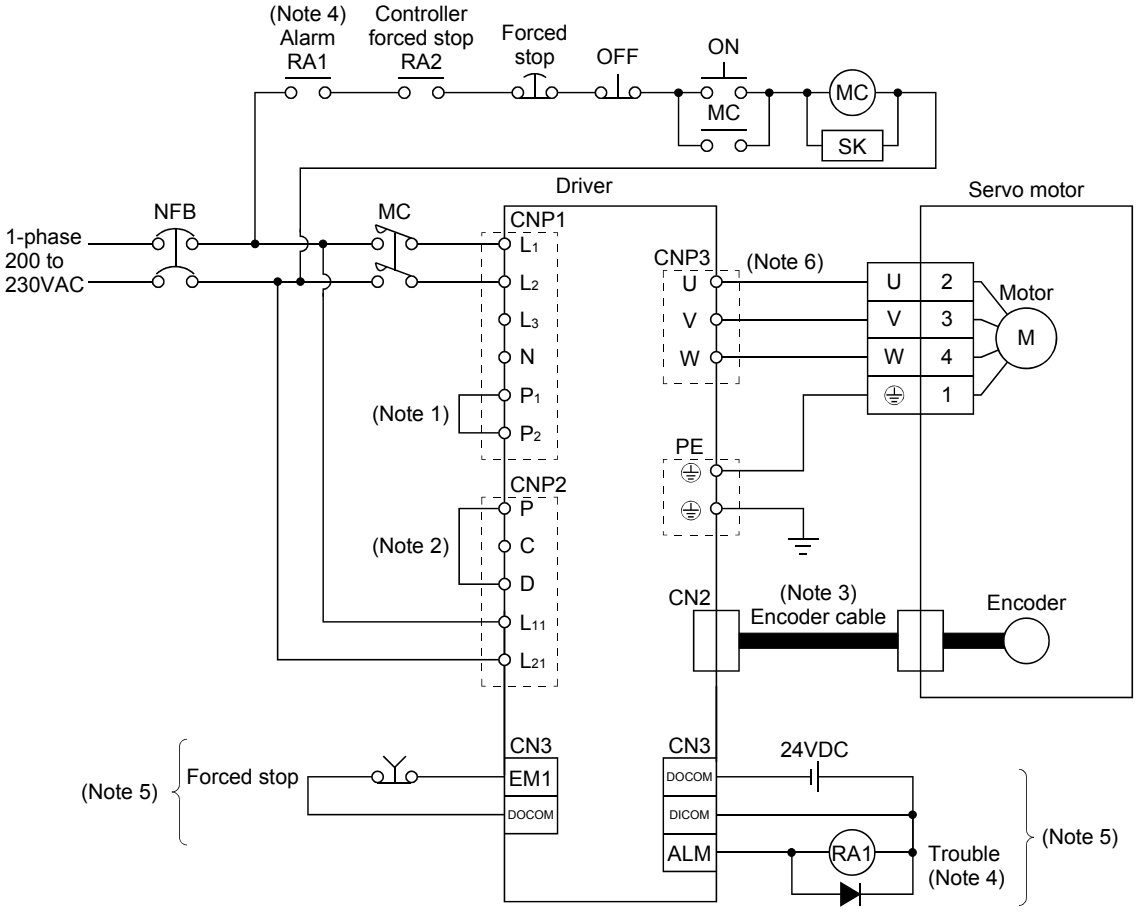
Wire the power supply/main circuit as shown below so that power is shut off and the servo-on command turned off as soon as an alarm occurs, a servo forced stop is made valid, or a PC or PLC...etc forced stop is made valid. A no-fuse breaker (NFB) must be used with the input cables of the main circuit power supply.

(1) For 3-phase 200V to 230VAC power supply to LECSS□-□



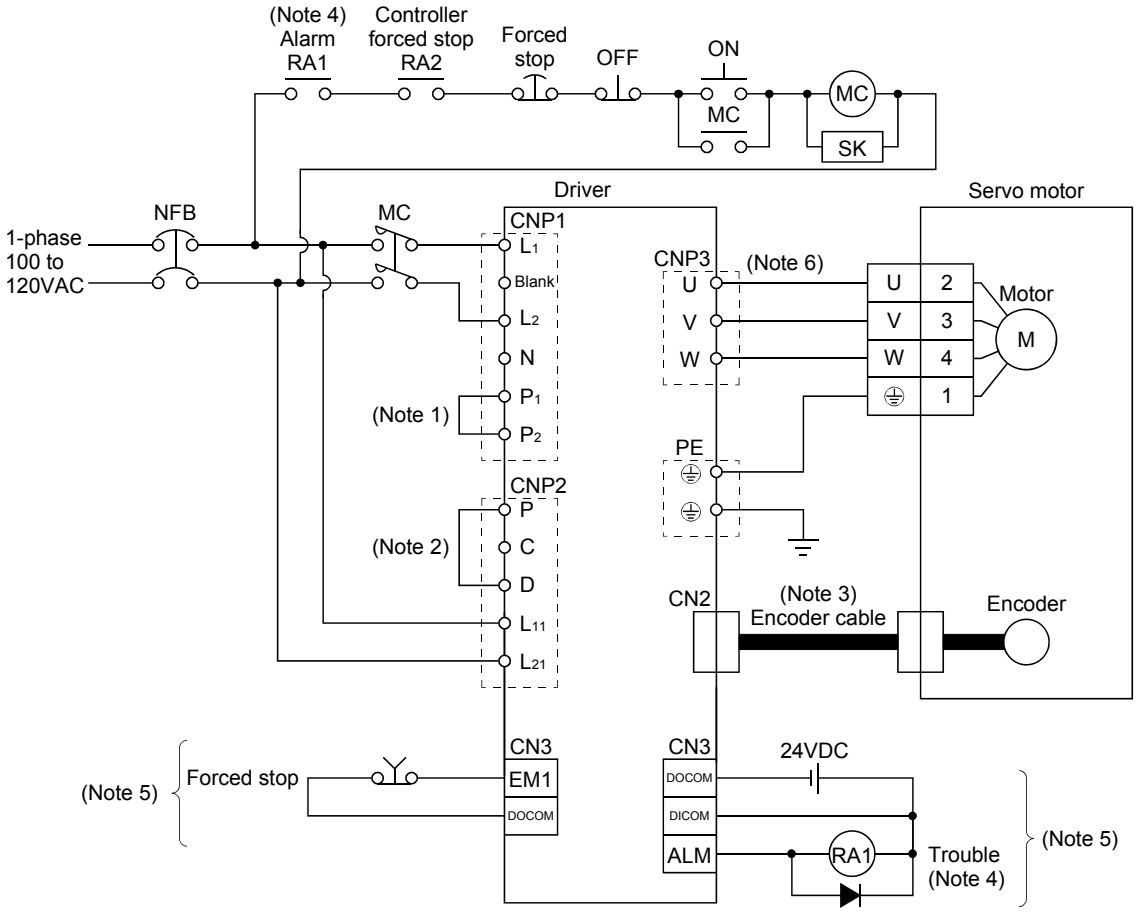
Note 1. Always connect P_1 and P_2. (Factory-wired.)
2. Always connect P(+) and D. (Factory-wired.) When using the regenerative option, refer to section 11.2.
3. For the encoder cable, use of the option cable is recommended. Refer to section 11.1 for selection of the cable.
4. If deactivating output of trouble (ALM) with parameter change, configure up the power supply circuit which switches off the magnetic contactor after detection of alarm occurrence on the PC or PLC...etc side.
5. For the sink I/O interface. For the source I/O interface, refer to section 3.7.3.
6. Refer to section 3.10.

(2) For 1-phase 200V to 230VAC power supply to LECSS□-□



Note 1. Always connect P_1 and P_2. (Factory-wired.)
2. Always connect P and D. (Factory-wired.) When using the regenerative option, refer to section 11.2.
3. For the encoder cable, use of the option cable is recommended. Refer to section 11.1 for selection of the cable.
4. If deactivating output of trouble (ALM) with parameter change, configure up the power supply circuit which switches off the magnetic contactor after detection of alarm occurrence on the PC or PLC...etc side.
5. For the sink I/O interface. For the source I/O interface, refer to section 3.7.3.
6. Refer to section 3.10.

(3) For 1-phase 100 to 120VAC power supply to LECSS□-□

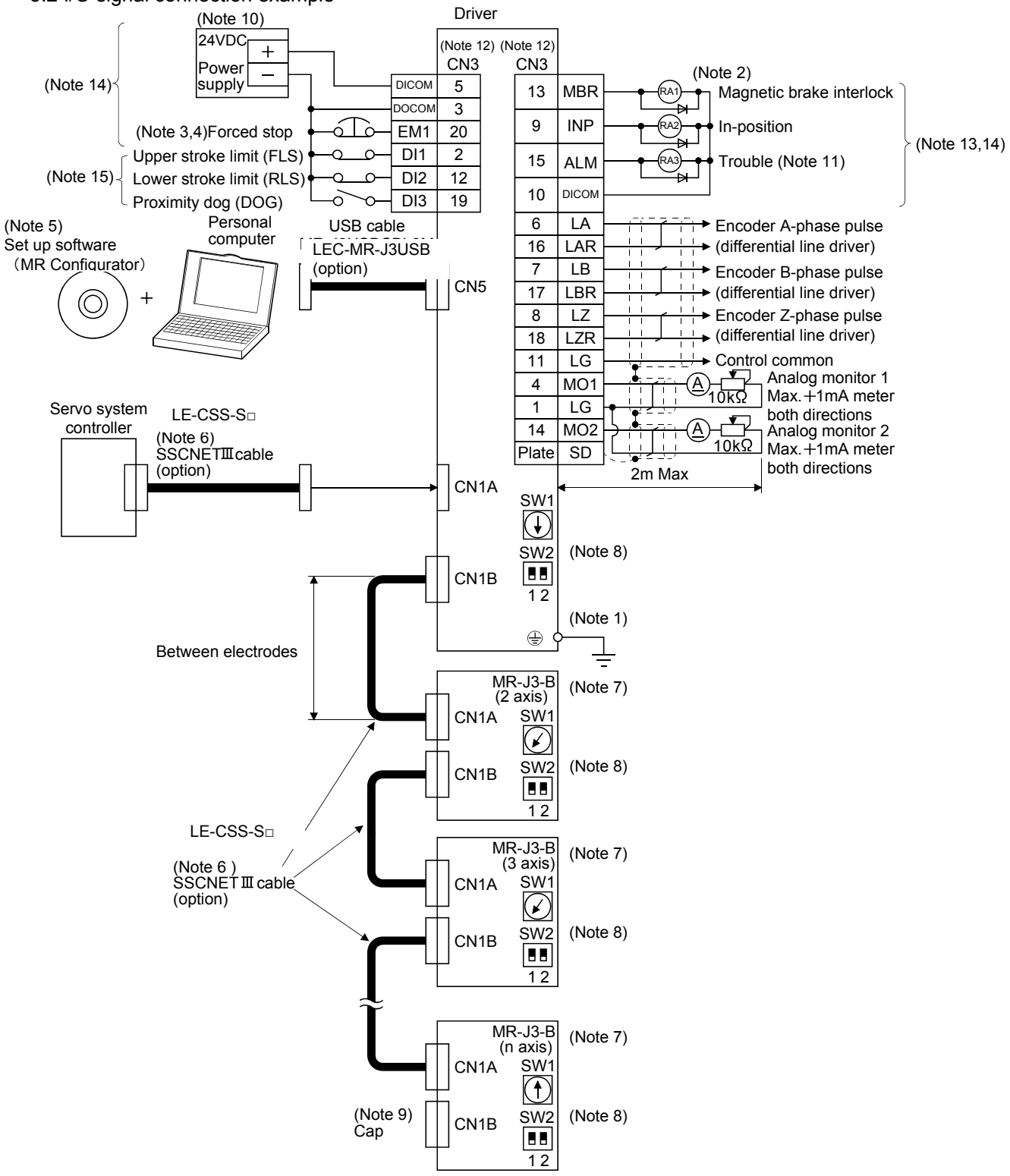


Note 1. Always connect P_1 and P_2. (Factory-wired.)

2. Always connect P and D. (Factory-wired.) When using the regenerative option, refer to section 11.2.
3. For the encoder cable, use of the option cable is recommended. Refer to section 11.1 for selection of the cable.
4. If deactivating output of trouble (ALM) with parameter change, configure up the power supply circuit which switches off the magnetic contactor after detection of alarm occurrence on the PC or PLC...etc side.
5. For the sink I/O interface. For the source I/O interface, refer to section 3.7.3.
6. Refer to section 3.10.

/

3.2 I/O signal connection example



Note 1 To prevent an electric shock, always connect the protective earth (PE) terminal (terminal marked ⏚) of the driver to the protective earth (PE) of the control box.

2. Connect the diode in the correct direction. If it is connected reversely, the driver will be faulty and will not output signals, disabling the forced stop (EM1) and other protective circuits.
3. If the PC or PLC...etc does not have an forced stop (EM1) function, always install a forced stop switch (Normally closed).
4. When starting operation, always turn on the forced stop (EM1). (Normally closed contacts) By setting "□1□□ " in DRU parameter No.PA04 of the drive unit, the forced stop (EM1) can be made invalid.
5. Use LEC-MR-SETUP 221E.
6. For the distance between electrodes of SSCNETⅢ cable, refer to the following table.

Cable	Cable model name	Cable length
Standard code inside panel	LE-CSS-□	0.15m to 3m

7. The wiring of the second and subsequent axes is omitted.
8. Up to eight axes (n = 1 to 8) may be connected. Refer to section 3.13 for setting of axis selection.
9. Make sure to put a cap on the unused CN1A・CN1B.
10. Supply 24VDC±10% 150mA current for interfaces from the outside. 150mA is the value applicable when all I/O signals are used. The current capacity can be decreased by reducing the number of I/O points. Refer to section 3.7.2 (1) that gives the current value necessary for the interface.
11. Trouble (ALM) turns on in normal alarm-free condition. When this signal is switched off (at occurrence of an alarm), the output of the programmable PC or PLC...etc should be stopped by the sequence program.
12. The pins with the same signal name are connected in the driver.
13. The signal can be changed by parameter No.PD07, PD08, PD09.
14. For the sink I/O interface. For the source I/O interface, refer to section 3.7.3.
15. Devices can be assigned for DI1・DI2・DI3 with PC or PLC...etc setting. For devices that can be assigned, refer to the PC or PLC...etc instruction manual. The assigned devices are for the Q173DCPU・Q172DCPU・Q173HCPU・Q172HCPU and QD75MH□.

3.3 Explanation of power supply system

3.3.1 Signal explanations

POINT

・For the layout of connector and terminal block, refer to outline drawings in chapter 9.

<table>
<tr><th>Abbreviation</th><th>Connection target (Application)</th><th>Description</th></tr>
<tr><td>L_1
L_2
L_3</td><td>Main circuit power supply</td><td>Supply the following power to L_1, L_2, L_3. For the 1-phase 200V to 230VAC power supply, connect the power supply to L_1, L_2, and keep L_3 open.
<table>
<tr><th>Power supply \ Driver</th><th>LECSS2-S5
LECSS2-S7
LECSS2-S8</th><th>LECSS1-S5
LECSS1-S7
LECSS1-S8</th></tr>
<tr><td>3-phase 200V to 230VAC, 50/60Hz</td><td>L_1・L_2・L_3</td><td></td></tr>
<tr><td>1-phase 200V to 230VAC, 50/60Hz</td><td>L_1・L_2</td><td></td></tr>
<tr><td>1-phase 100V to 120VAC, 50/60Hz</td><td></td><td>L_1・L_2</td></tr>
</table></td></tr>
<tr><td>P
C
D</td><td>Regenerative option</td><td>When using driver built-in regenerative resistor, connect P(＋) and D. (Factory-wired)
When using regenerative option, disconnect P(＋) and D, and connect regenerative option to P and C.
Refer to section 11.2 to 11.5.</td></tr>
<tr><td>L_{11}
L_{21}</td><td>Control circuit power supply</td><td>Supply the following power to L_{11}・L_{21}.
<table>
<tr><th>Power supply \ Driver</th><th>LECSS2-S5
LECSS2-S7
LECSS2-S8</th><th>LECSS1-S5
LECSS-S7
LECSS1-S8</th></tr>
<tr><td>1-phase 200V to 230VAC, 50/60Hz</td><td>L_{11}・L_{21}</td><td></td></tr>
<tr><td>1-phase 100V to 120VAC, 50/60Hz</td><td></td><td>L_{11}・L_{21}</td></tr>
</table></td></tr>
<tr><td>U
V
W</td><td>Servo motor power</td><td>Connect to the servo motor power supply terminals (U, V, W). During power-on, do not open or close the motor power line. Otherwise, a malfunction or faulty may occur.</td></tr>
<tr><td>N</td><td>Return converter
Brake unit</td><td>Do not connect to driver. .</td></tr>
<tr><td>⏚</td><td>Protective earth (PE)</td><td>Connect to the earth terminal of the servo motor and to the protective earth (PE) of the control box to perform grounding.</td></tr>
</table>

3.3.2 Power-on sequence

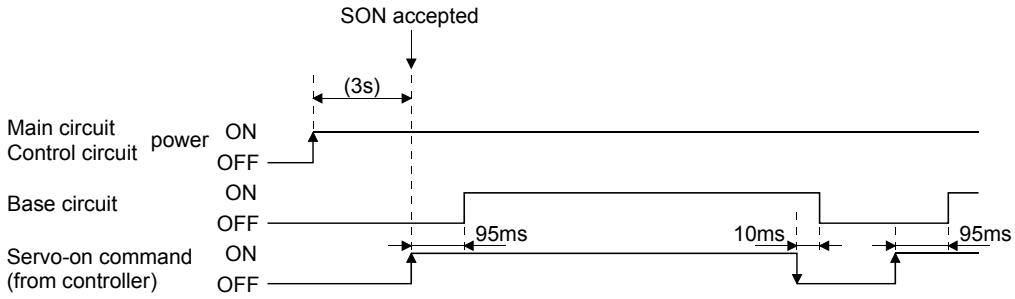
(1) Power-on procedure

1) Always wire the power supply as shown in above section 3.1 using the magnetic contactor with the main circuit power supply (three-phase: L_1, L_2, L_3, single-phase: L_1, L_2). Configure up an external sequence to switch off the magnetic contactor as soon as an alarm occurs.

2) Switch on the control circuit power supply L_{11}, L_{21} simultaneously with the main circuit power supply or before switching on the main circuit power supply. If the main circuit power supply is not on, the display shows the corresponding warning. However, by switching on the main circuit power supply, the warning disappears and the driver will operate properly.

3) The driver can accept the servo-on command within 3s the main circuit power supply is switched on. (Refer to paragraph (2) of this section.)

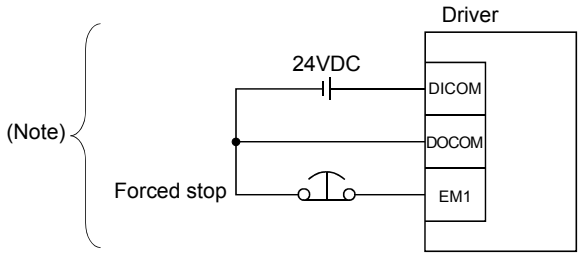
(2) Timing chart



(3) Forced stop

> **CAUTION**
> - Install an forced stop circuit externally to ensure that operation can be stopped and power shut off immediately.

If the PC or PLC...etc does not have an forced stop function, make up a circuit that switches off main circuit power as soon as EM1 is turned off at a forced stop. When EM1 is turned off, the dynamic brake is operated to stop the servo motor. At this time, the display shows the servo forced stop warning (E6).
During ordinary operation, do not use forced stop (EM1) to alternate stop and run. The service life of the driver may be shortened.



Note. For the sink I/O interface. For the source I/O interface, refer to section 3.7.3.

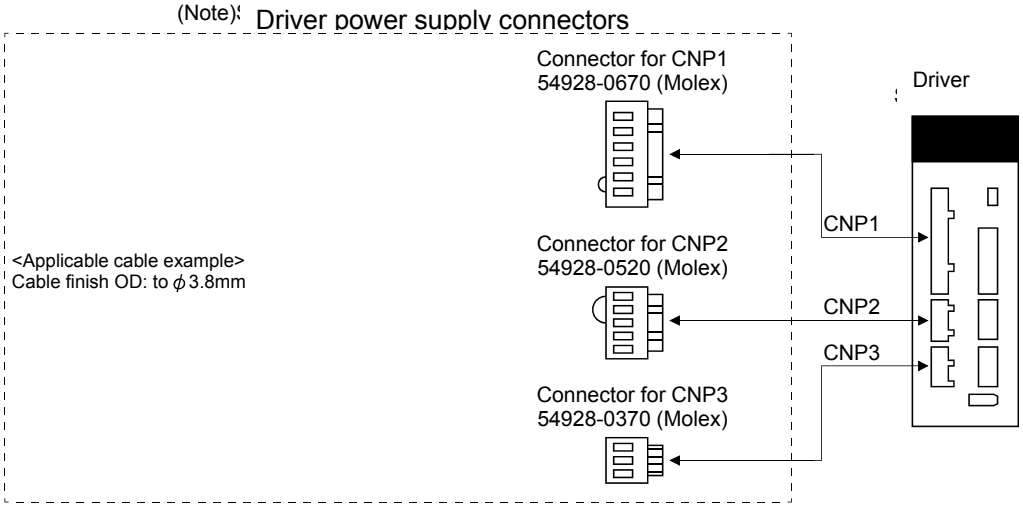
3.3.3 CNP1, CNP2, CNP3 wiring method

POINT

Use the supplied driver power supply connectors for wiring of CNP1, CNP2 and CNP3.

(1) LECSS□-□

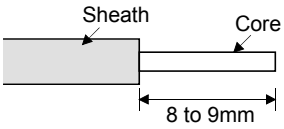
(a) Driver power supply connectors



Note. These connectors are of insert type. As the crimping type, the following connectors (Molex) are recommended.
For CNP1: 51241-0600 (connector), 56125-0128 (terminal)
For CNP2: 51240-0500 (connector), 56125-0128 (terminal)
For CNP3: 51241-0300 (connector), 56125-0128 (terminal)
Crimping tool: CNP57349-5300
<Connector applicable cable example>
Cable finish OD: to ϕ3.8mm

(b) Termination of the cables

Solid wire: After the sheath has been stripped, the cable can be used as it is.



Twisted wire: Use the cable after stripping the sheath and twisting the core. At this time, take care to avoid a short caused by the loose wires of the core and the adjacent pole. Do not solder the core as it may cause a contact fault. Alternatively, a bar terminal may be used to put the wires together.

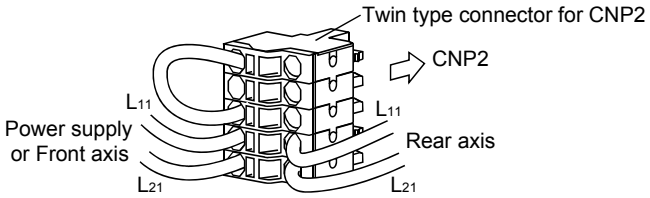
Cable size		Bar terminal type		Crimping tool (Note 2)
[mm^2]	AWG	For 1 cable (Note 1)	For 2 cable	
1.25/1.5	16	AI1.5-10BK	AI-TWIN2 × 1.5-10BK	Variocrimp 4 206-204
2/2.5	14	AI2.5-10BU		

Note 1. Manufacturer: Phoenix Contact
2. Manufacturer: WAGO

(c) The twin type connector for CNP2 (L11・L21): 721-2105/026-000 (WAGO)

Using this connector enables passing a wire of control circuit power supply.

Refer to appendix 3 for details of connector.



(2) Insertion of cable into Molex and WAGO connectors

Insertion of cable into 54928-0610, 54928-0520, 54928 (Molex) connectors and 721-207/026-000, 721-205/026-000 and 721-203/026-000 (WAGO) connectors are as follows.

The following explains for Molex, however use the same procedures for inserting WAGO connectors as well.

POINT
・It may be difficult for a cable to be inserted to the connector depending on wire size or bar terminal configuration. In this case, change the wire type or correct it in order to prevent the end of bar terminal from widening, and then insert it.

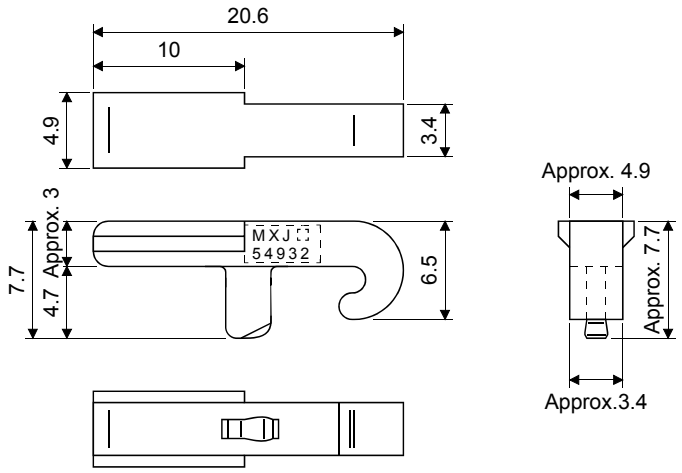
How to connect a cable to the driver power supply connector is shown below.

(a) When using the supplied cable connection lever

1) The driver is packed with the cable connection lever.

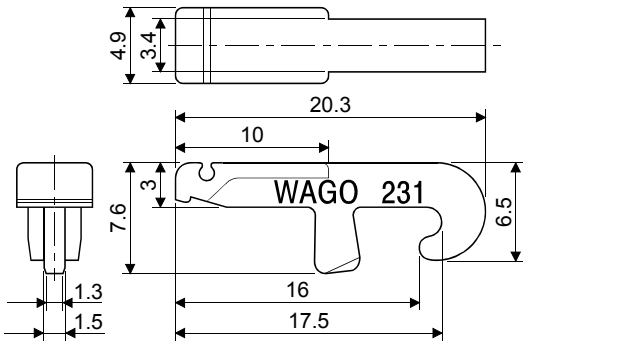
a) 54932-0000 (Molex)

[Unit: mm]

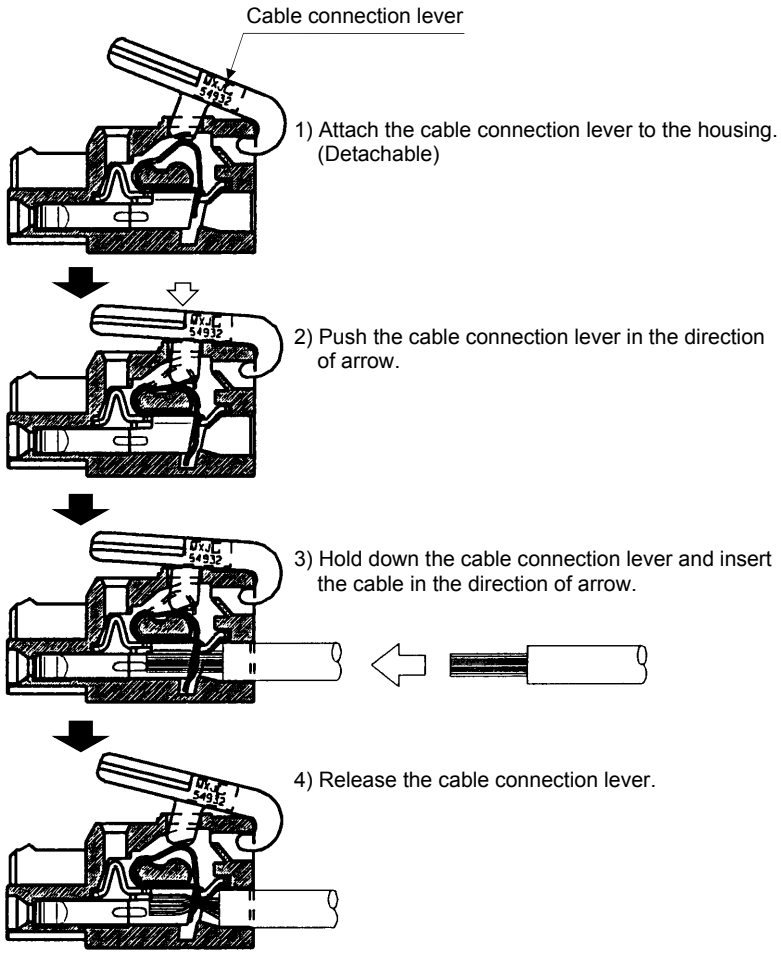


b) 231-131 (WAGO)

[Unit: mm]



2) Cable connection procedure

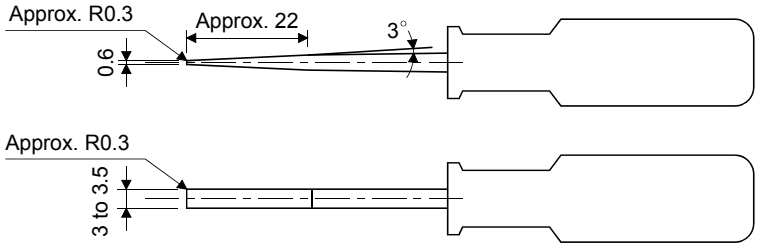


(b) Inserting the cable into the connector

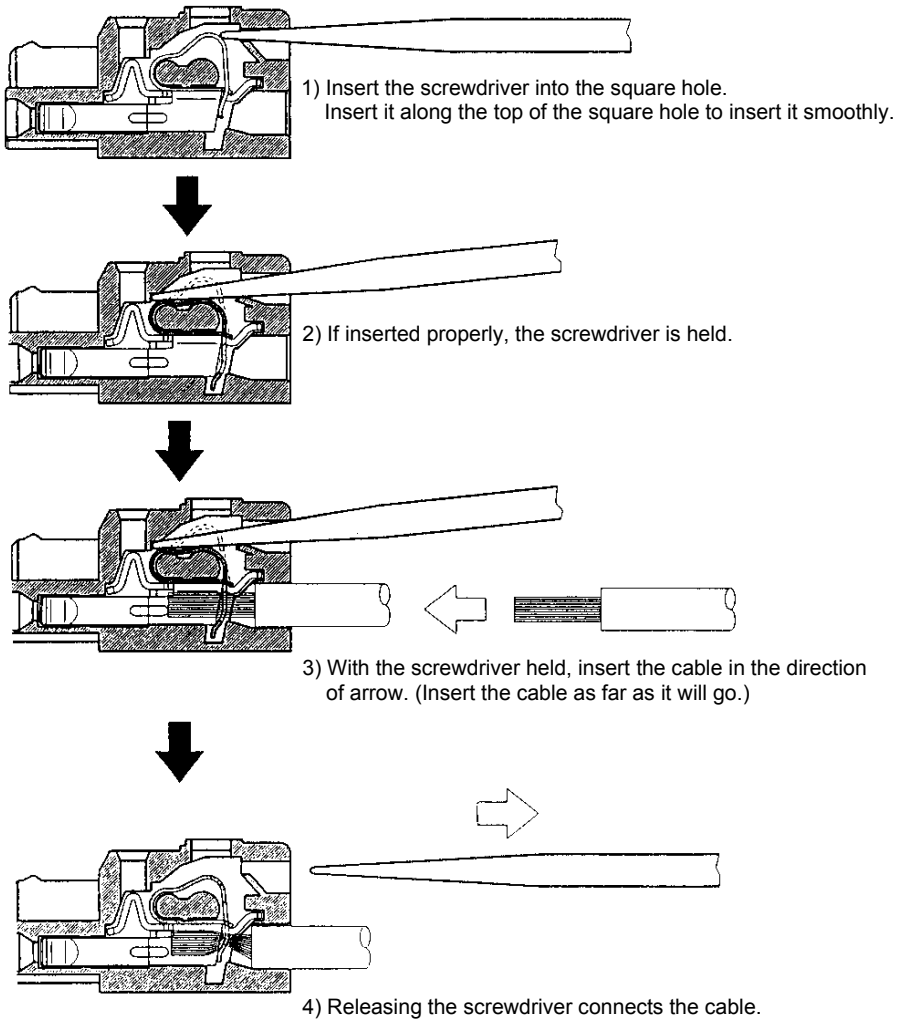
1) Applicable flat-blade screwdriver dimensions

Always use the screwdriver shown here to do the work.

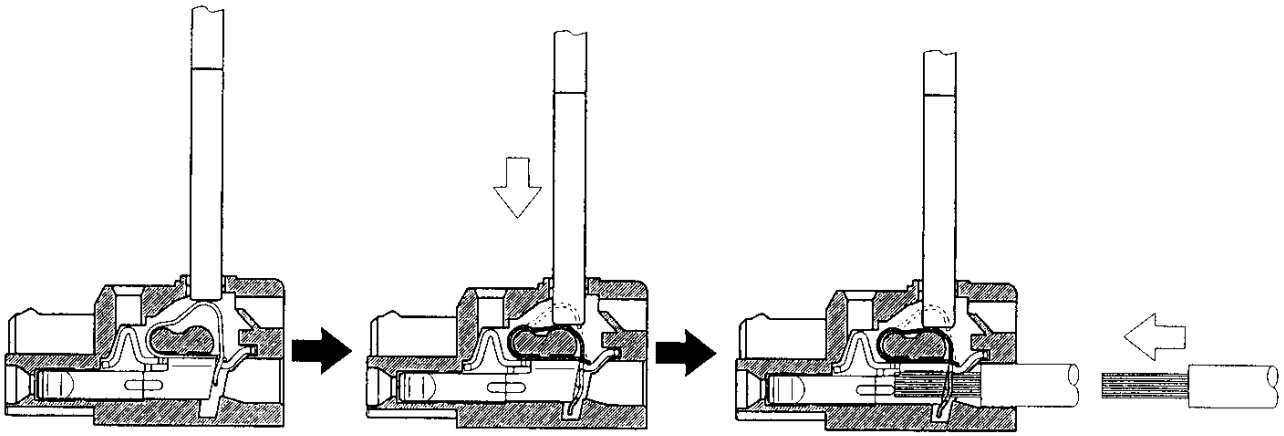
[Unit: mm]



2) When using the flat-blade screwdriver - part 1



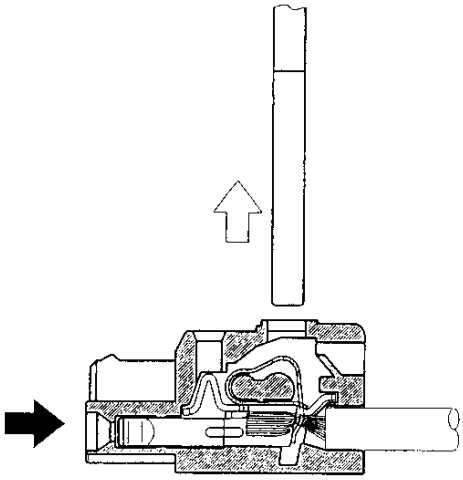
3) When using the flat-blade screwdriver - part 2



1) Insert the screwdriver into the square window at top of the connector.

2) Push the screwdriver in the direction of arrow.

3) With the screwdriver pushed, insert the cable in the direction of arrow. (Insert the cable as far as it will go.)



4) Releasing the screwdriver connects the cable.

(3) How to insert the cable into Phoenix Contact connector

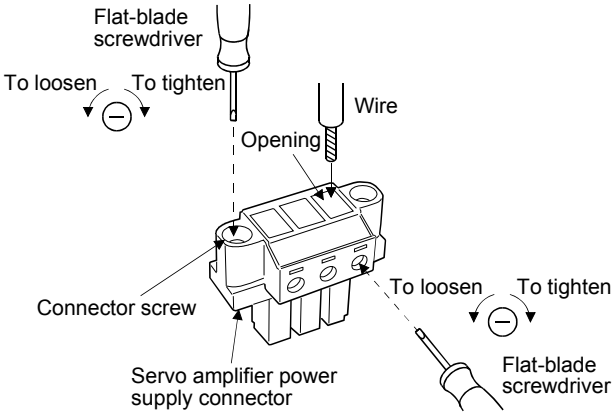
POINT
・Do not use a precision driver because the cable cannot be tightened with enough torque.

Insertion of cables into Phoenix Contact connector PC4/6-STF-7.62-CRWH or PC4/3-STF-7.62-CRWH is shown as follows.

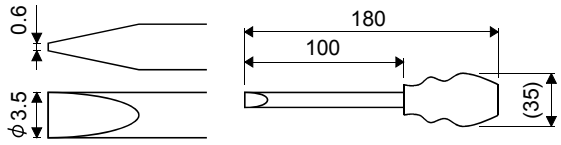
Before inserting the cable into the opening, make sure that the screw of the terminal is fully loose. Insert the core of the cable into the opening and tighten the screw with a flat-blade screwdriver. When the cable is not tightened enough to the connector, the cable or connector may generate heat because of the poor contact. (When using a cable of 1.5mm2 or less, two cables may be inserted into one opening.)

Secure the connector to the driver by tightening the connector screw.

For securing the cable and the connector, use a flat-blade driver with 0.6mm blade edge thickness and 3.5mm diameter (Recommended flat-blade screwdriver: Phoenix Contact SZS 0.6×3.5). Apply 0.5 to 0.6 N・m torque to screw.



[Unit: mm]



Recommended flat-blade screwdriver dimensions

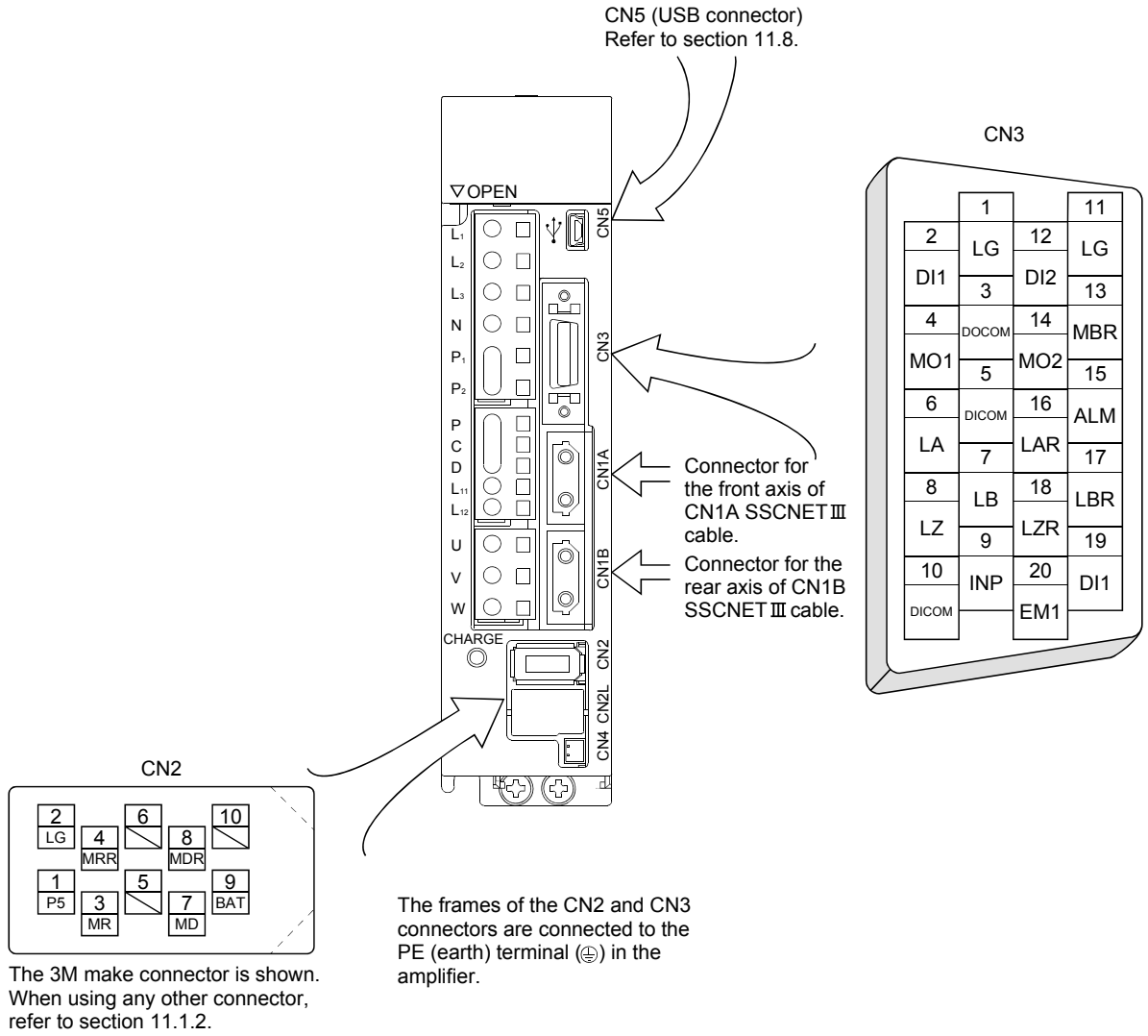
3.4 Connectors and signal arrangements

POINT

- The pin configurations of the connectors are as viewed from the cable connector wiring section.

(1) Signal arrangement

The driver front view shown is that of the LECSS□-S5 and LECSS□-S7. Refer to chapter 9 Outline Drawings for the appearances and connector layouts of the LECSS□-S8.



3.5 Signal (device) explanations

For the I/O interfaces (symbols in I/O division column in the table), refer to section 3.7.2.

In the control mode field of the table

The pin No.s in the connector pin No. column are those in the initial status.

(1) Connector applications

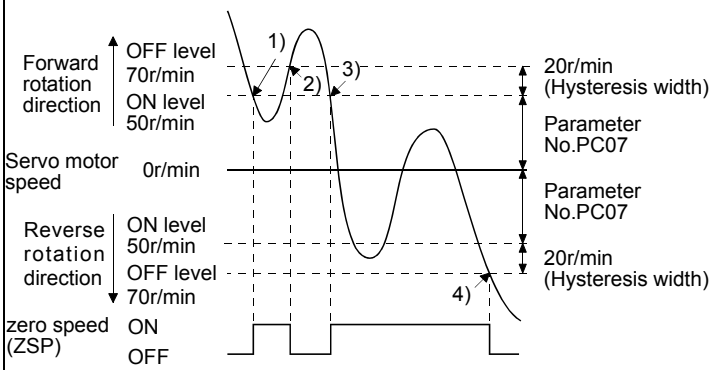
Connector	Name	Function/Application
CN1A	Connector for bus cable from preceding axis.	Used for connection with the PC or PLC...etc or preceding-axis driver.
CN1B	Connector for bus cable to next axis	Used for connection with the next-axis driver or for connection of the cap.
CN2	Encoder connector	Used for connection with the servo motor encoder.
CN4	Battery connection connector	When using as absolute position detection system, connect to battery (LEC-MR-J3BAT). Before installing a battery, turn off the main circuit power while keeping the control circuit power on. Wait for 15 minutes or more (20 minutes or for drive unit 30kW or more) until the charge lamp turns off. Then, confirm that the voltage between P(+) and N(−) (L+ and L− for drive unit 30kW or more) is safe with a voltage tester and others. Otherwise, an electric shock may occur. In addition, always confirm from the front of the driver whether the charge lamp is off or not. Replace the battery with main circuit power OFF and with control circuit power ON. Replacing the battery with the control circuit power OFF results in loosing absolute position data.
CN5	Communication connector	The personal computer is connected.

(2) I/O device

(a) Input device

Device	Symbol	Connector pin No.	Function/Application	I/O division
Forced stop	EM1	CN3-20	Turn EM1 off (open between commons) to bring the motor to an forced stop state, in which the base circuit is shut off and the dynamic brake is operated. Turn EM1 on (short between commons) in the forced stop state to reset that state. When parameter No.PA.04 is set to " □1□□ ", automatically ON (always ON) can be set inside.	DI-1
	DI1	CN3-2	Devices can be assigned for DI1 DI2 DI3 with PC or PLC...etc setting. For devices that can be assigned, refer to the PC or PLC...etc instruction manual. The following devices can be assigned for Q172HCPU Q173HCPU QD75MH. DI1: upper stroke limit (FLS) DI2: lower stroke limit (RLS) DI3: proximity dog (DOG)	DI-1
	DI2	CN3-12		DI-1
	DI3	CN3-19		DI-1

(b) Output device

Device	Symbol	Connector pin No.	Function/Application	I/O division
Trouble	ALM	CN3-15	ALM turns off when power is switched off or the protective circuit is activated to shut off the base circuit. Without alarm occurring, ALM turns on within about 1s after power-on.	DO-1
Electromagnetic brake interlock	MBR	CN3-13	When using this signal, set operation delay time of the electromagnetic brake in parameter No.PC02. In the servo-off or alarm status, MBR turns off.	DO-1
In-position (Positioning completed)	INP	CN3-9	INP turns on when the number of droop pulses is in the preset in-position range. The in-position range can be changed using parameter No.PA10. When the in-position range is increased, INP may be on conductive status during low-speed rotation. INP turns on when servo on turns on. This signal cannot be used in the speed loop mode.	DO-1
Ready	RD		When using the signal, make it usable by the setting of parameter No.PD07 to PD09. RD turns on when the servo is switched on and the driver is ready to operate.	DO-1
Dynamic brake interlock	DB		When using the signal, make it usable by the setting of parameter No.PD07 to PD09. DB turns off simultaneously when the dynamic brake is operated. When using the external dynamic brake on the driver of 11 kW or more, this device is required. (Refer to section 11.6.) For the driver of 7kW or less, it is not necessary to use this device.	DO-1
Speed reached	SA		When using this signal, make it usable by the setting of parameter No.PD07 to PD09. When the servo is off, SA will be turned OFF. When servo motor rotation speed becomes approximately setting speed, SA will be turned ON. When the preset speed is 20r/min or less, SA always turns on. This signal cannot be used in position loop mode.	DO-1
Limiting torque	TLC		When using this signal, make it usable by the setting of parameter No.PD07 to PD09. When torque is produced level of torque set with PC or PLC...etc, TLC will be turned ON. When the servo is off, TLC will be turned OFF.	DO-1
Zero speed	ZSP		When using this signal, make it usable by the setting of parameter No.PD07 to PD09. When the servo is off, SA will be turned OFF. ZSP turns on when the servo motor speed is zero speed (50r/min) or less. Zero speed can be changed using parameter No.PC07. Example Zero speed is 50r/min  ZPS turns on 1) when the servo motor is decelerated to 50r/min, and ZPS turns off 2) when the servo motor is accelerated to 70r/min again. ZPS turns on 3) when the servo motor is decelerated again to 50r/min, and turns off 4) when the servo motor speed has reached -70r/min. The range from the point when the servo motor speed has reached ON level, and ZPS turns on, to the point when it is accelerated again and has reached OFF level is called hysteresis width. Hysteresis width is 20r/min for the LECSS□-□ driver.	DO-1

Device	Symbol	Connector pin No.	Function/Application	I/O division
Warning	WNG		When using this signal, make it usable by the setting of parameter No.PD07 to PD09. When warning has occurred, WNG turns on. When there is no warning, WNG turns off within about 1.5s after power-on.	DO-1
Battery warning	BWNG		When using this signal, make it usable by the setting of parameter No.PD07 to PD09. BWNG turns on when battery cable disconnection warning (92) or battery warning (9F) has occurred. When there is no battery warning, BWNG turns off within about 1.5s after power-on.	DO-1
Variable gain selection	CDPS		When using this signal, make it usable by the setting of parameter No.PD07 to PD09. CDPS is on during variable gain.	DO-1
Absolute position erasing	ABSV		When using this signal, make it usable by the setting of parameter No.PD07 to PD09. ABSV turns on when the absolute position erased. This signal cannot be used in position loop mode.	DO-1

(c) Output signals

Signal name	Symbol	Connector pin No.	Function/Application
Encoder A-phase pulse (Differential line driver)	LA LAR	CN3-6 CN3-16	Outputs pulses per servo motor revolution set in parameter No.PA15 in the differential line driver system. In CCW rotation of the servo motor, the encoder B-phase pulse lags the encoder A-phase pulse by a phase angle of $\pi/2$. The relationships between rotation direction and phase difference of the A- and B-phase pulses can be changed using parameter No.PC03. Output pulse specification and dividing ratio setting can be set. (Refer to section 5.1.9.)
Encoder B-phase pulse (Differential line driver)	LB LBR	CN3-7 CN3-17	
Encoder Z-phase pulse (Differential line driver)	LZ LZR	CN3-8 CN3-18	Outputs the zero-point signal in the differential line driver system of the encoder. One pulse is output per servo motor revolution. turns on when the zero-point position is reached. The minimum pulse width is about 400μs. For home position return using this pulse, set the creep speed to 100r/min. or less.
Analog monitor 1	MO1	CN3-4	Used to output the data set in parameter No.PC09 to across MO1-LG in terms of voltage. Resolution 10 bits
Analog monitor 2	MO2	CN3-14	Used to output the data set in parameter No.PC10 to across MO2-LG in terms of voltage. Resolution 10 bits

(d) Power supply

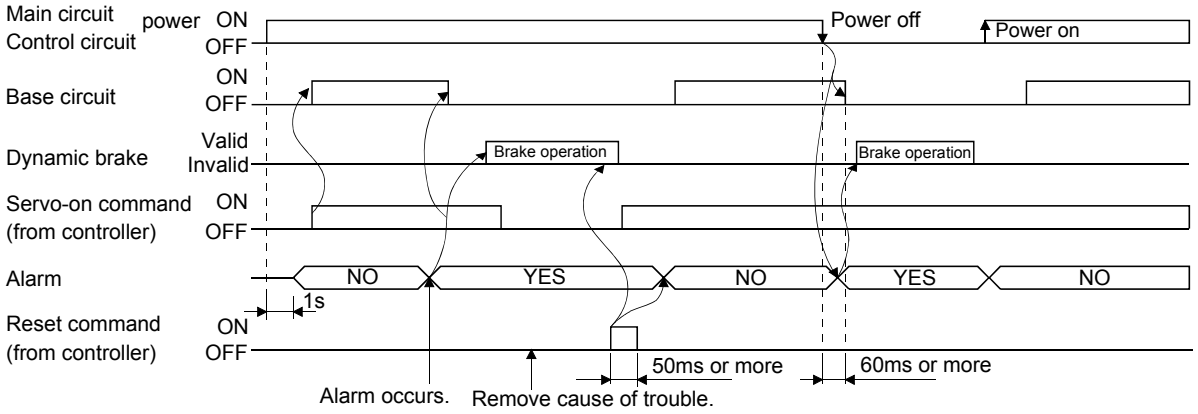
Signal name	Symbol	Connector pin No.	Function/Application
Digital I/F power supply input	DICOM	CN3-5 CN3-10	Used to input 24VDC (24VDC 10% 150mA) for I/O interface of the driver. The power supply capacity changes depending on the number of I/O interface points to be used. Connect the positive terminal of the 24VDC external power supply for the sink interface.
Digital I/F common	DOCOM	CN3-3	Common terminal for input device such as EM1 of the driver. Pins are connected internally. Separated from LG. Connect the positive terminal of the 24VDC external power supply for the source interface.
Monitor common	LG	CN3-1 CN3-11	Common terminal of M01・M02 Pins are connected internally.
Shield	SD	Plate	Connect the external conductor of the shield cable.

3.6 Alarm occurrence timing chart

⚠ CAUTION	・When an alarm has occurred, remove its cause, make sure that the operation signal is not being input, ensure safety, and reset the alarm before restarting operation. ・As soon as an alarm occurs, make the Servo off status and interrupt the main circuit power.

When an alarm occurs in the driver, the base circuit is shut off and the servo motor is coated to a stop. Switch off the main circuit power supply in the external sequence. To deactivate the alarm, power the control circuit off, then on or give the error reset or CPU reset command from the servo system PC or PLC...etc. However, the alarm cannot be deactivated unless its cause is removed.

(Note)



Note. Switch off the main circuit power as soon as an alarm occurs.

(1) Overcurrent, overload 1 or overload 2

If operation is repeated by switching control circuit power off, then on to reset the overcurrent (32), overload 1 (50) or overload 2 (51) alarm after its occurrence, without removing its cause, the driver and servo motor may become faulty due to temperature rise. Securely remove the cause of the alarm and also allow about 30 minutes for cooling before resuming operation.

(2) Regenerative alarm

If operation is repeated by switching control circuit power off, then on to reset the regenerative (30) alarm after its occurrence, the external regenerative resistor will generate heat, resulting in an accident.

(3) Instantaneous power failure

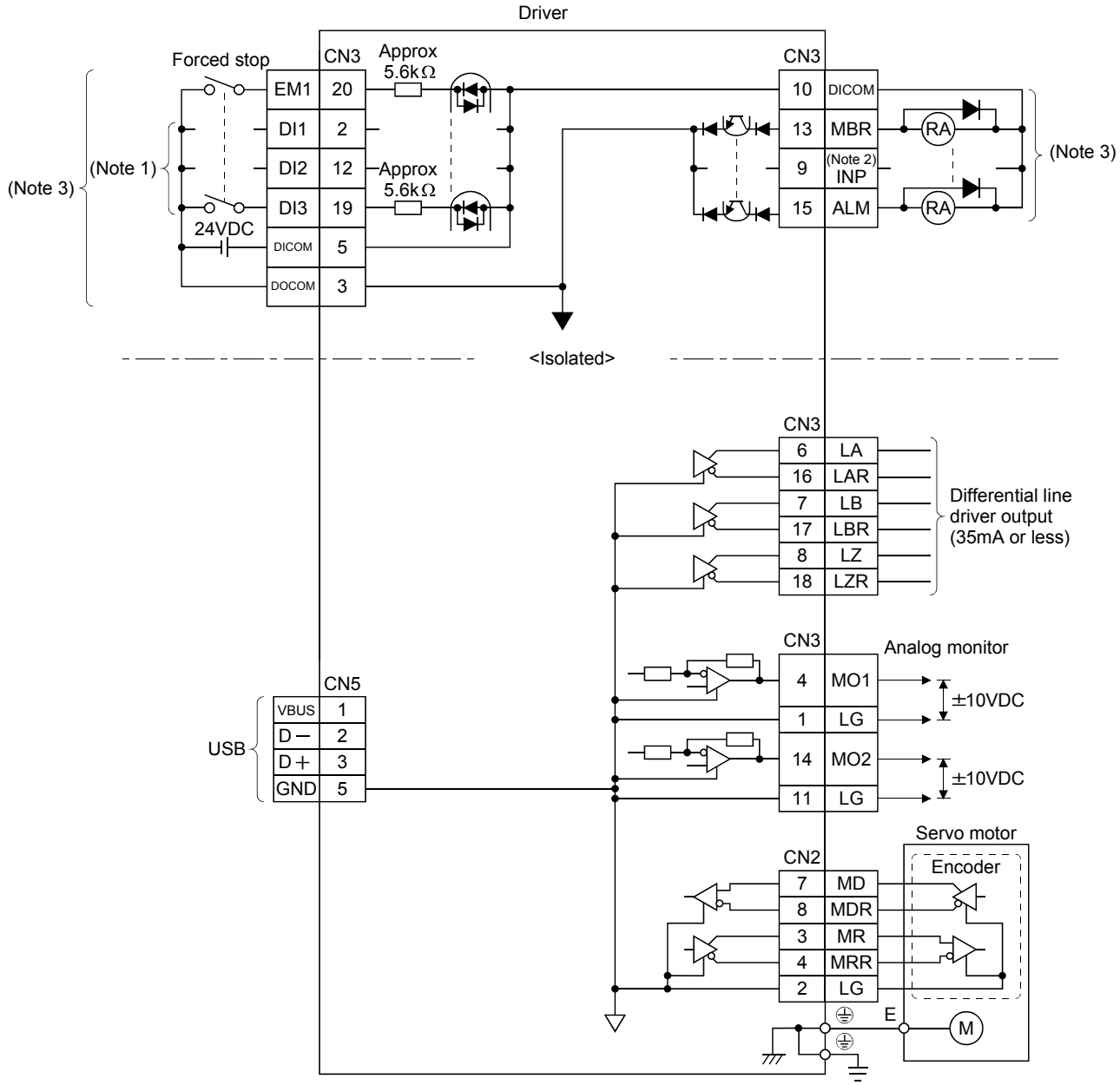
Undervoltage (10) occurs when the input power is in either of the following statuses.

・A power failure of the control circuit power supply continues for 60ms or longer and the control circuit is not completely off.

・The bus voltage dropped to 200VDC or less for the LECSS2-□, to 158VDC or less for the LECSS1-□.

3.7 Interfaces

3.7.1 Internal connection diagram



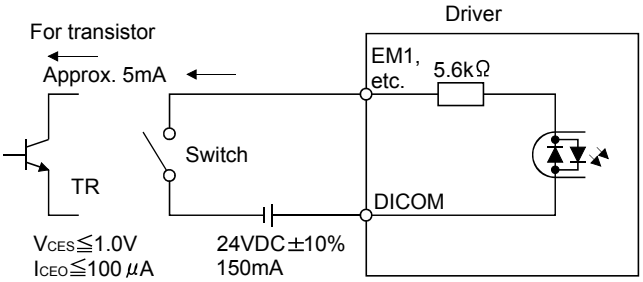
Note 1. Signal can be assigned for these pins with host PC or PLC...etc setting.
For contents of signals, refer to the instruction manual of host PC or PLC...etc.
2. This signal cannot be used with speed loop mode.
3. For the sink I/O interface. For the source I/O interface, refer to section 3.7.3.

3.7.2 Detailed description of interfaces

This section provides the details of the I/O signal interfaces (refer to the I/O division in the table) given in section 3.5. Refer to this section and make connection with the external equipment.

(1) Digital input interface DI-1

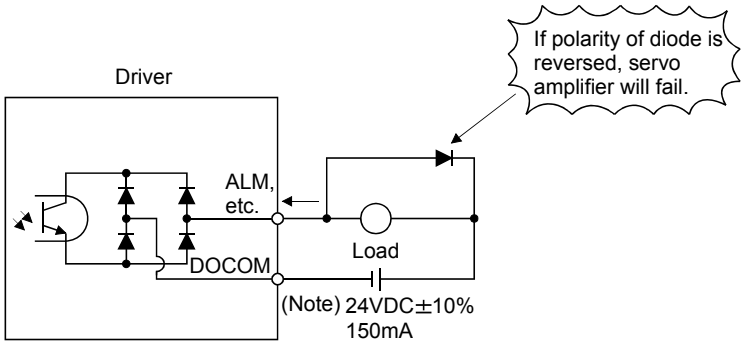
Give a signal with a relay or open collector transistor. Refer to section 3.7.3 for the source input.



(2) Digital output interface DO-1

A lamp, relay or photocoupler can be driven. Install a diode (D) for an inductive load, or install an inrush current suppressing resistor (R) for a lamp load. (Rated current: 40mA or less, maximum current: 50mA or less, inrush current: 100mA or less) A maximum of 2.6V voltage drop occurs in the driver.

Refer to section 3.7.3 for the source output.

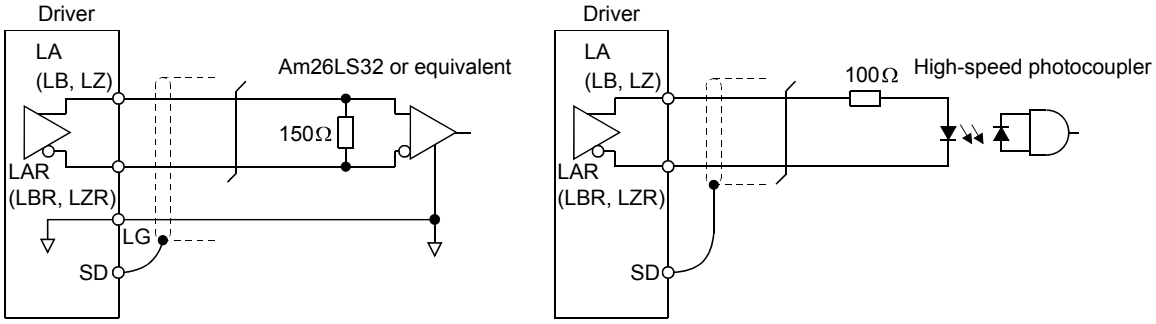


Note. If the voltage drop (maximum of 2.6V) interferes with the relay operation, apply high voltage (up to 26.4V) from external source.

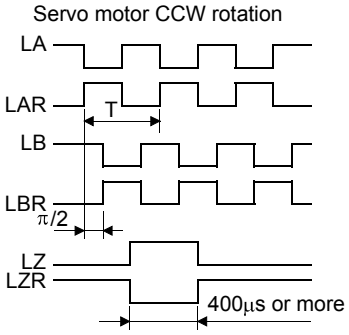
(3) Encoder output pulse DO-2 (Differential line driver system)

(a) Interface

Max. output current: 35mA

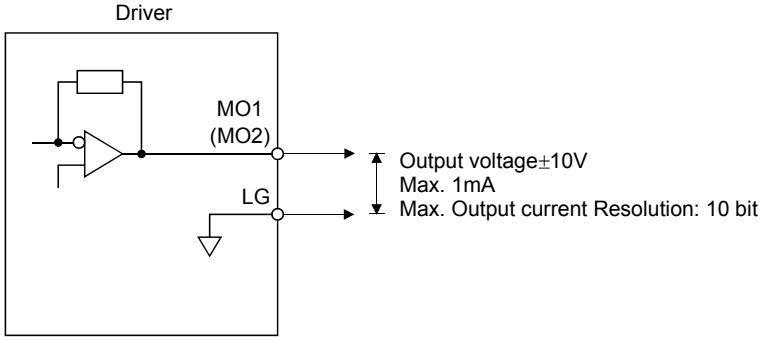


(b) Output pulse



Time cycle (T) is determined by the settings of parameter No.PA15 and PC03.

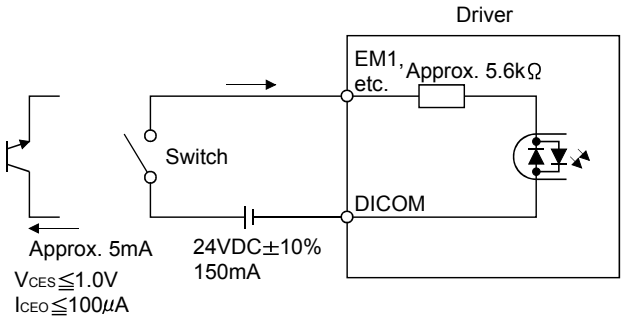
(4) Analog output



3.7.3 Source I/O interfaces

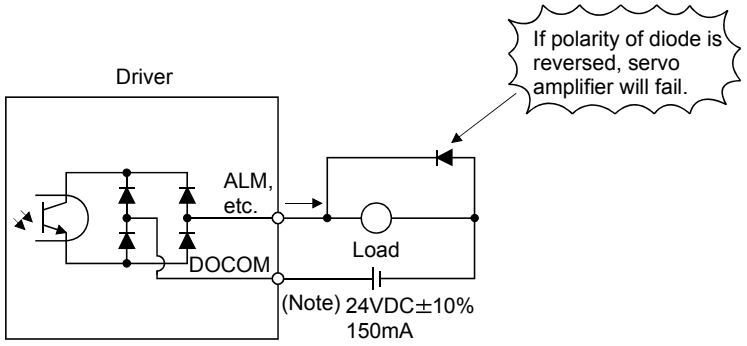
In this driver, source type I/O interfaces can be used. In this case, all DI-1 input signals and DO-1 output signals are of source type. Perform wiring according to the following interfaces.

(1) Digital input interface DI-1



(2) Digital output interface DO-1

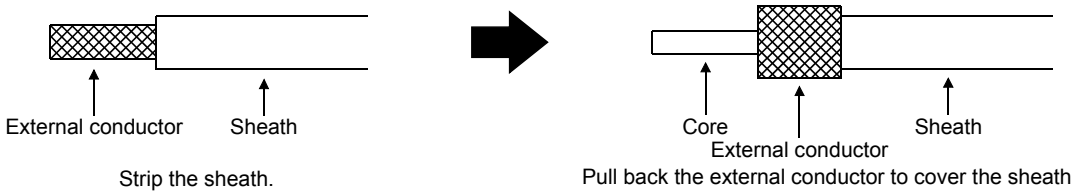
A maximum of 2.6V voltage drop occurs in the driver.



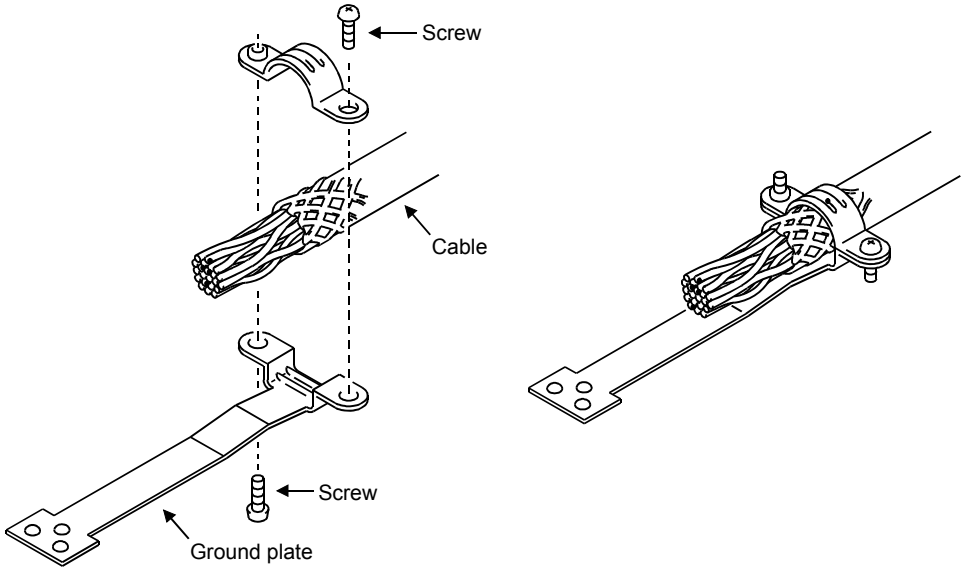
Note. If the voltage drop (maximum of 2.6V) interferes with the relay operation, apply high voltage (up to 26.4V) from external source.

3.8 Treatment of cable shield external conductor

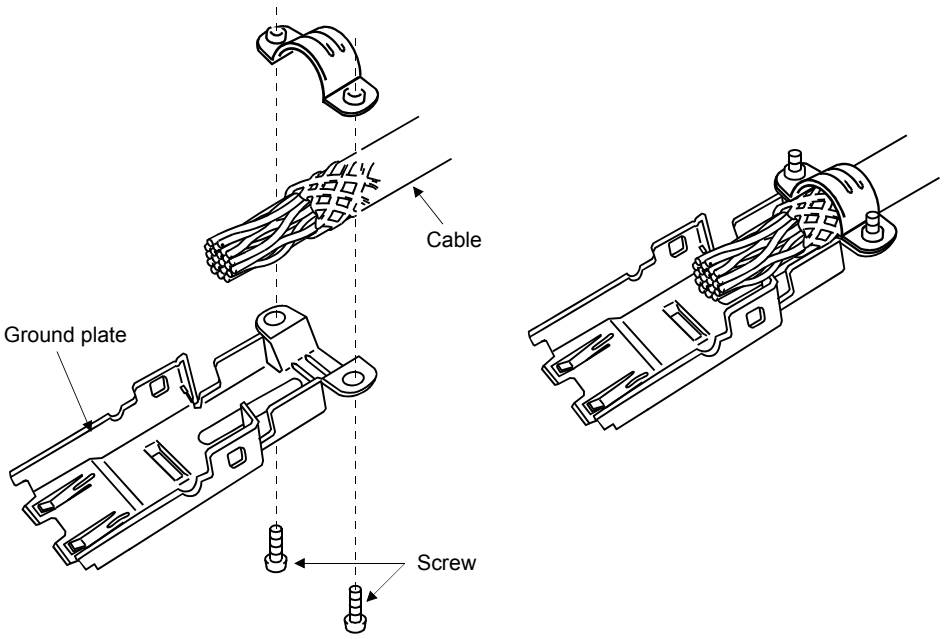
In the case of the CN2 and CN3 connectors, securely connect the shielded external conductor of the cable to the ground plate as shown in this section and fix it to the connector shell.



(1) For CN3 connector (3M connector)



(2) For CN2 connector (3M or Molex connector)



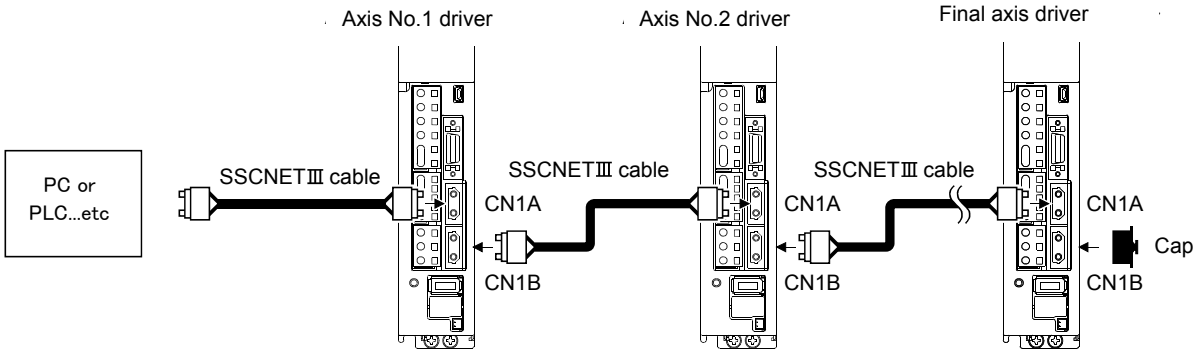
3.9 SSCNETⅢ cable connection

POINT

・Do not see directly the light generated from CN1A・CN1B connector of driver or the end of SSCNETⅢ cable.
When the light gets into eye, may feel something is wrong for eye.
(The light source of SSCNETⅢ complies with class1 defined in JIS C6802 or IEC60825-1.)

(1) SSCNETⅢ cable connection

For CN1A connector, connect SSCNETⅢ cable connected to PC or PLC...etc in host side or driver.
For CN1B connector, connect SSCNETⅢ cable connected to driver in lower side.
For CN1B connector of the final axis, put a cap came with driver.



(2) How to connect/disconnect cable.

POINT

・CN1A・CN1B connector is put a cap to protect light device inside connector from dust.
For this reason, do not remove a cap until just before mounting SSCNETⅢ cable.
Then, when removing SSCNETⅢ cable, make sure to put a cap.

・Keep the cap for CN1A・CN1B connector and the tube for protecting light code end of SSCNETⅢ cable in a plastic bag with a zipper of SSCNETⅢ cable to prevent them from becoming dirty.

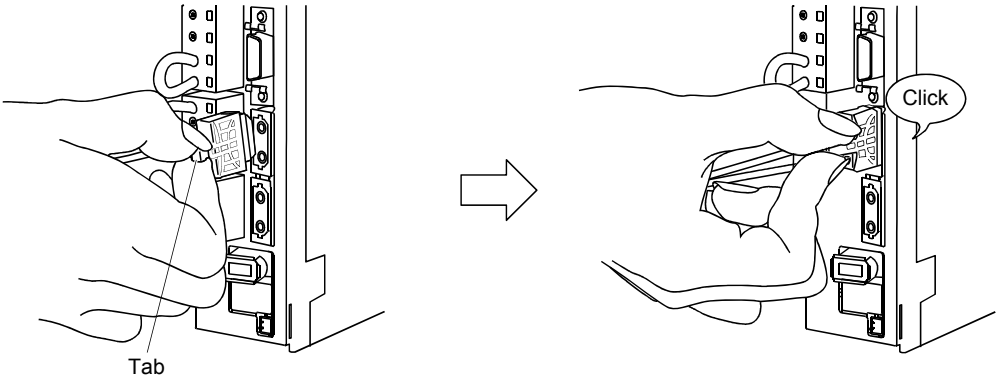
・When asking repair of driver for some troubles, make sure to put a cap on CN1A・CN1B connector.
When the connector is not put a cap, the light device may be damaged at the transit.
In this case, exchange and repair of light device is required.

(a) Mounting

1) For SSCNETⅢ cable in the shipping status, the tube for protect light code end is put on the end of connector. Remove this tube.

2) Remove the CN1A・CN1B connector cap of driver.

3) With holding a tab of SSCNETⅢ cable connector, make sure to insert it into CN1A・CN1B connector of driver until you hear the click.
If the end face of optical code tip is dirty, optical transmission is interrupted and it may cause malfunctions.
If it becomes dirty, wipe with a bonded textile, etc.
Do not use solvent such as alcohol.



(b) Removal

With holding a tab of SSCNETⅢ cable connector, pull out the connector.
When pulling out the SSCNETⅢ cable from driver, be sure to put the cap on the connector parts of driver to prevent it from becoming dirty.
For SSCNETⅢ cable, attach the tube for protection optical code's end face on the end of connector.

3.10 Connection of driver and servo motor

⚠ CAUTION	・During power-on, do not open or close the motor power line. Otherwise, a malfunction or faulty may occur.

3.10.1 Connection instructions

⚠ WARNING	・Insulate the connections of the power supply terminals to prevent an electric shock.

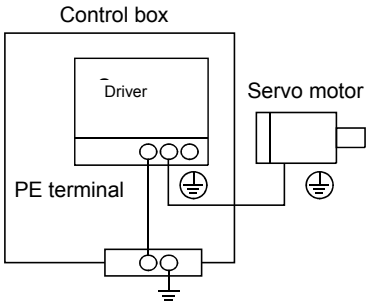
⚠ CAUTION	・Connect the wires to the correct phase terminals (U, V, W) of the driver and servo motor. Not doing so may cause unexpected operation. ・Do not connect AC power supply directly to the servo motor. Otherwise, a fault may occur.

POINT

・Refer to section 11.1 for the selection of the encoder cable.

This section indicates the connection of the servo motor power (U, V, W). Use of the optional cable and connector set is recommended for connection between the driver and servo motor. When the options are not available, use the recommended products. Refer to section 11.1 for details of the options.

(1) For grounding, connect the earth cable of the servo motor to the protective earth (PE) terminal (⏚) of the driver and connect the ground cable of the driver to the earth via the protective earth of the control box. Do not connect them directly to the protective earth of the control panel.

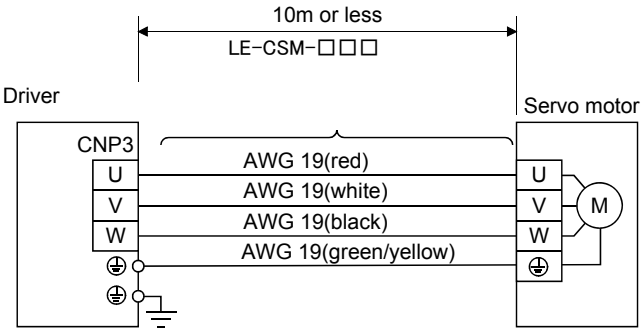


(2) Do not share the 24VDC interface power supply between the interface and electromagnetic brake. Always use the power supply designed exclusively for the electromagnetic brake.

3.10.2 Power supply cable wiring diagrams

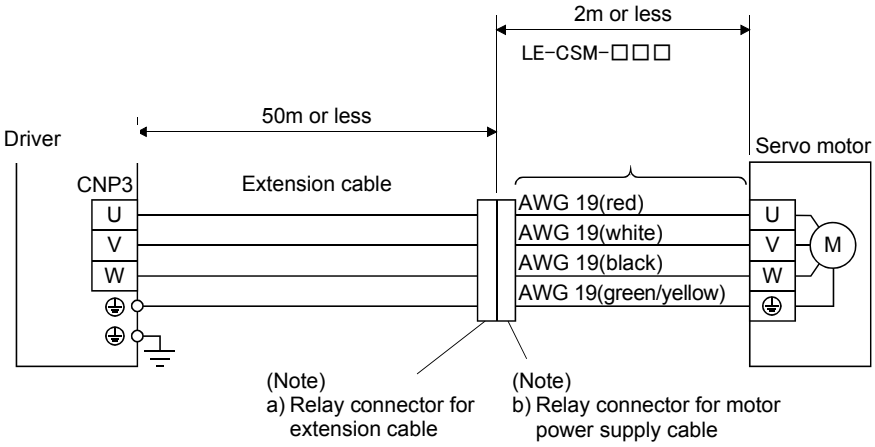
(1) LE-□-□ series servo motor

(a) When cable length is 10m or less



(b) When cable length exceeds 10m

When the cable length exceeds 10m, fabricate an extension cable as shown below. In this case, the motor power supply cable pulled from the servo motor should be within 2m long.
Refer to section 13.9 for the wire used for the extension cable.



Note. Use of the following connectors is recommended when ingress protection (IP65) is necessary.

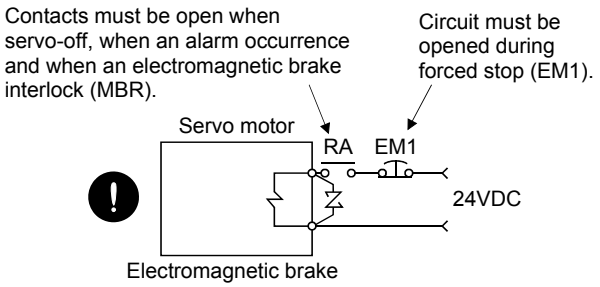
Relay connector	Description	Protective structure
a) Relay connector for extension cable	Connector: RM15WTPZ-4P(71) Cord clamp: RM15WTP-CP(5)(71) (Hirose Electric) └ Numeral changes depending on the cable OD.	IP65
b) Relay connector for motor power supply cable	Connector: RM15WTJA-4S(71) Cord clamp: RM15WTP-CP(8)(71) (Hirose Electric) └ Numeral changes depending on the cable OD.	IP65

3.11 Servo motor with an electromagnetic brake

3.11.1 Safety precautions

⚠ CAUTION

- Configure the electromagnetic brake circuit so that it is activated not only by the interface unit signals but also by a forced stop (EM1).



- The electromagnetic brake is provided for holding purpose and must not be used for ordinary braking.
- Before performing the operation, be sure to confirm that the electromagnetic brake operates properly.

POINT

- Refer to the Servo Motor Instruction Manual (Vol.2) for specifications such as the power supply capacity and operation delay time of the electromagnetic brake.

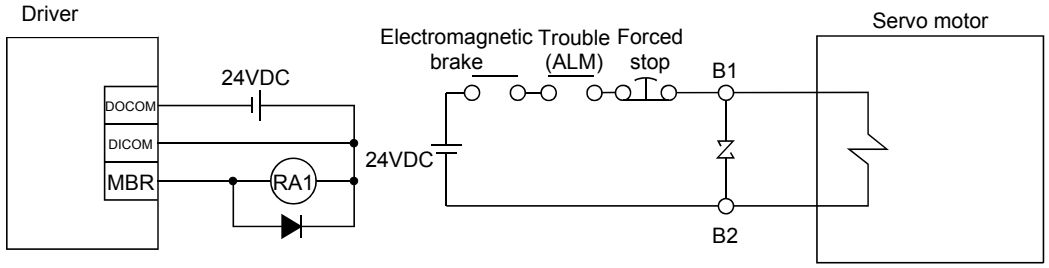
Note the following when the servo motor with an electromagnetic brake is used.

1) Do not share the 24VDC interface power supply between the interface and electromagnetic brake. Always use the power supply designed exclusively for the electromagnetic brake.

2) The brake will operate when the power (24VDC) switches off.

3) Switch off the servo-on command after the servo motor has stopped.

(1) Connection diagram



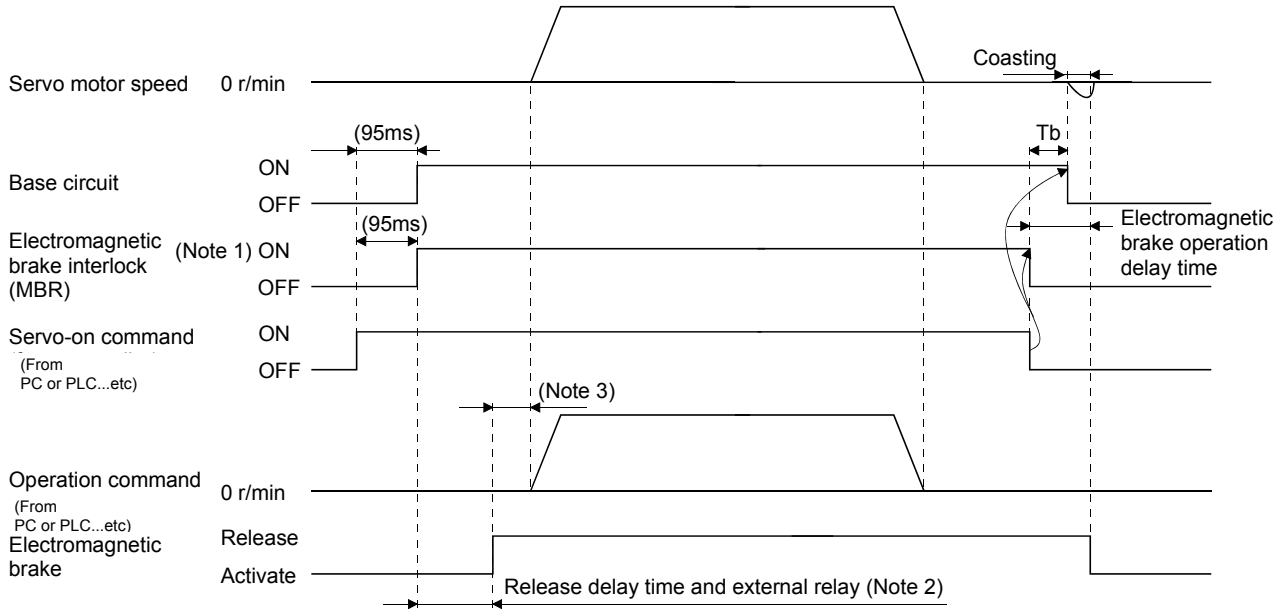
(2) Setting

In parameter No.PC02 (electromagnetic brake sequence output), set the time delay (Tb) from electromagnetic brake operation to base circuit shut-off at a servo off time as in the timing chart in section 3.11.2.

3.11.2 Timing charts

(1) Servo-on command (from PC or PLC...etc) ON/OFF

Tb [ms] after the servo-on is switched off, the servo lock is released and the servo motor coasts. If the electromagnetic brake is made valid in the servo lock status, the brake life may be shorter. Therefore, when using the electromagnetic brake in a vertical lift application or the like, set delay time (Tb) to about the same as the electromagnetic brake operation delay time to prevent a drop.

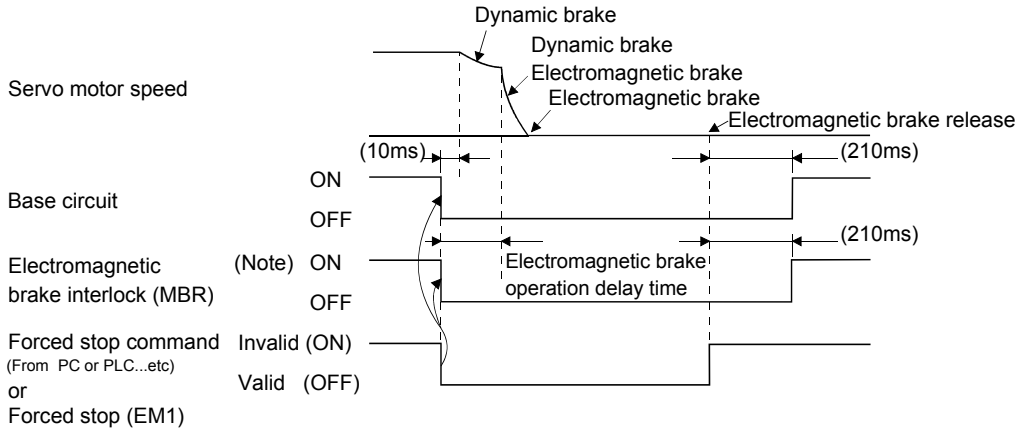


Note 1. ON: Electromagnetic brake is not activated.
OFF: Electromagnetic brake is activated.

2. Electromagnetic brake is released after delaying for the release delay time of electromagnetic brake and operation time of external circuit relay. For the release delay time of electromagnetic brake, refer to the Servo Motor Instruction Manual (Vol.2).

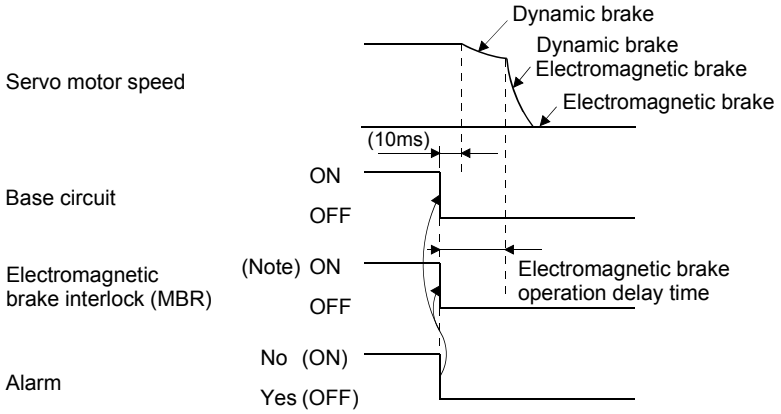
3. Give the operation command from the PC or PLC...etc after the electromagnetic brake is released.

(2) Forced stop command (from PC or PLC...etc) or forced stop (EM1) ON/OFF



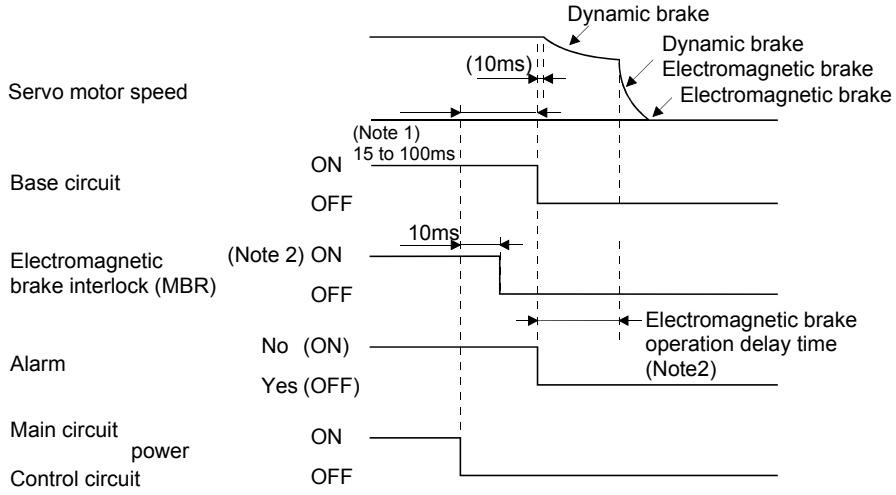
Note. ON: Electromagnetic brake is not activated.
OFF: Electromagnetic brake is activated.

(3) Alarm occurrence



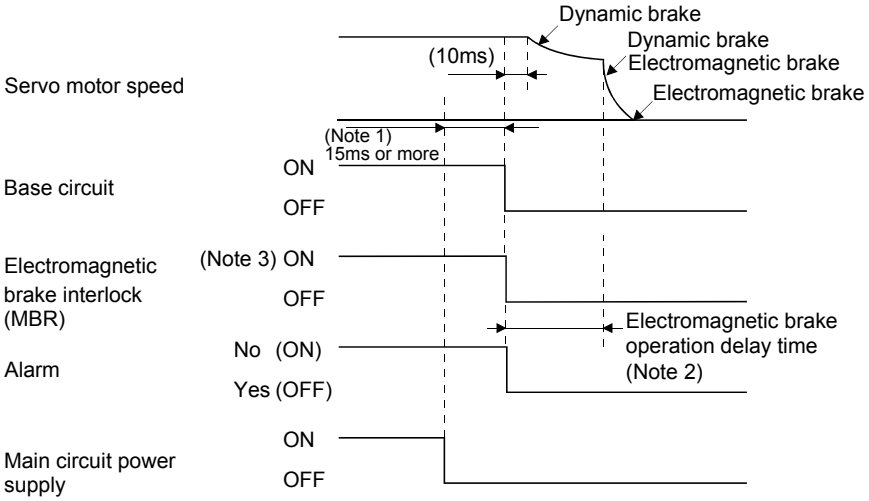
Note. ON: Electromagnetic brake is not activated.
OFF: Electromagnetic brake is activated.

(4) Both main and control circuit power supplies off



Note 1. Changes with the operating status.
2. ON: Electromagnetic brake is not activated.
OFF: Electromagnetic brake is activated.

(5) Only main circuit power supply off (control circuit power supply remains on)



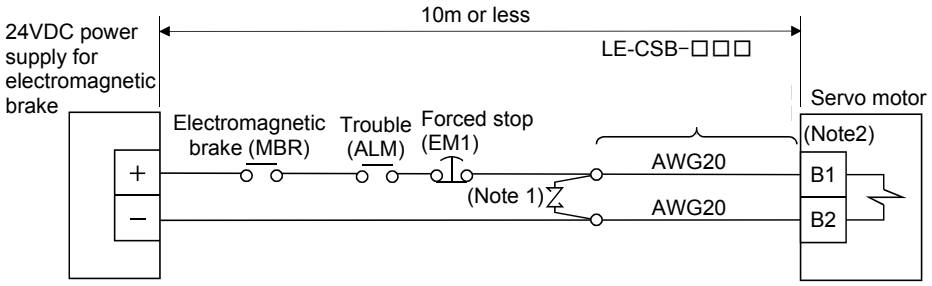
Note 1. Changes with the operating status.

2. When the main circuit power supply is off in a motor stop status, the main circuit off warning (E9) occurs and the alarm (ALM) does not turn off.

3. ON: Electromagnetic brake is not activated.
   OFF: Electromagnetic brake is activated.

3.11.3 Wiring diagrams (LE-□-□ series servo motor)

(1) When cable length is 10m or less



Note 1. Connect a surge absorber as close to the servo motor as possible.
2. There is no polarity in electromagnetic brake terminals (B1 and B2).

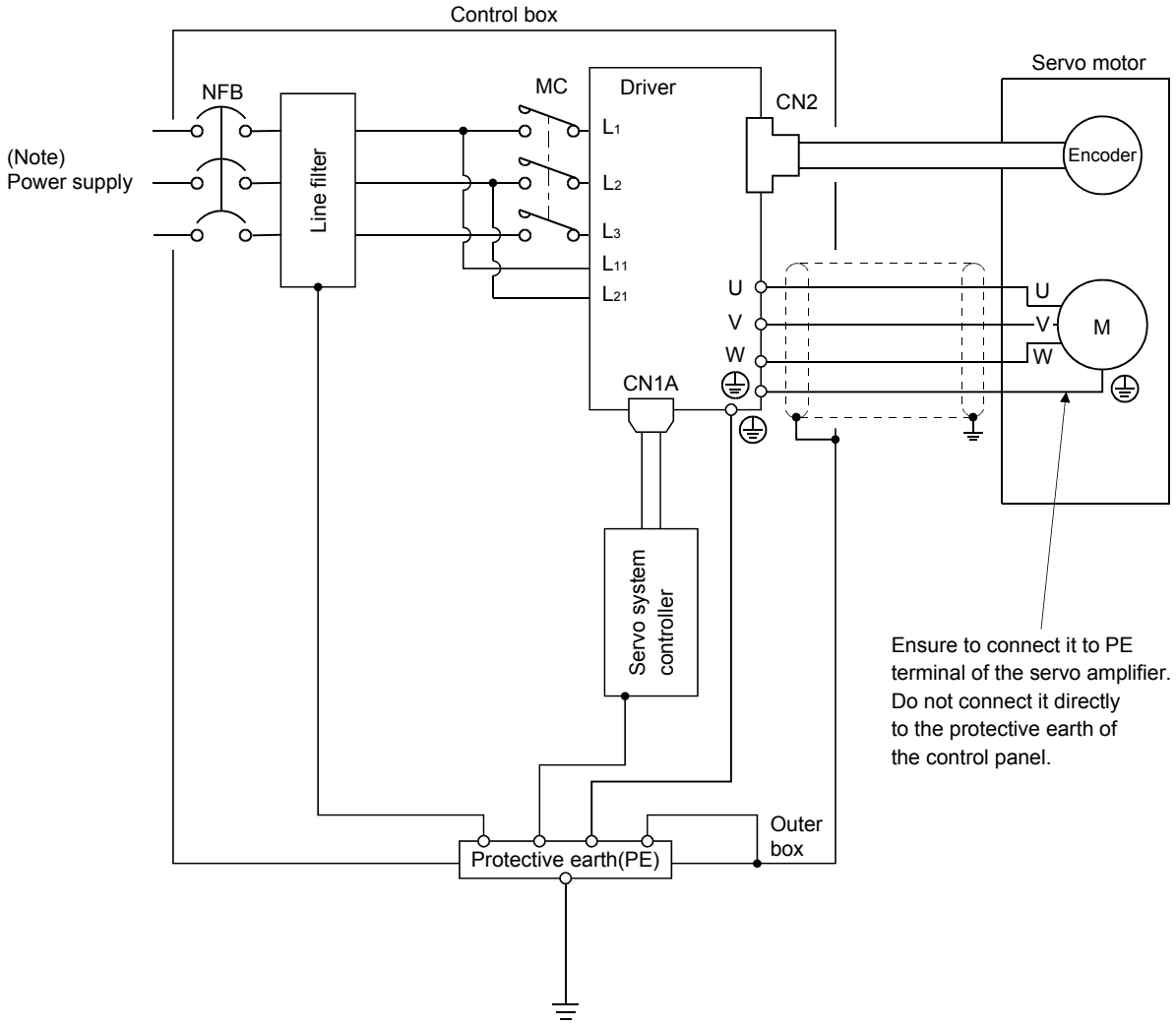
When fabricating the lock cable LE-CSB-R□□, refer to section 11.1.4.

3.12 Grounding

WARNING

- Ground the driver and servo motor securely.
- To prevent an electric shock, always connect the protective earth (PE) terminal (terminal marked ⏚) of the driver with the protective earth (PE) of the control box.

The driver switches the power transistor on-off to supply power to the servo motor. Depending on the wiring and ground cable routing, the driver may be affected by the switching noise (due to di/dt and dv/dt) of the transistor. To prevent such a fault, refer to the following diagram and always ground.
To conform to the EMC Directive, refer to the EMC Installation Guidelines (IB(NA)67310).



Note. For 1-phase 200V to 230VAC, connect the power supply to L_1 and L_2 and leave L_3 open.
There is no L_3 for 1-phase 100 to 120VAC power supply. Refer to section 1.3 for the power supply specification.

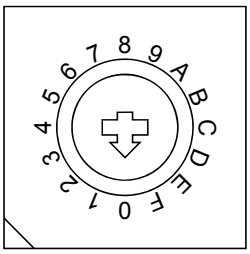
3.13 Control axis selection

POINT

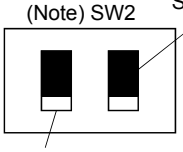
- The control axis number set to rotary axis setting switch (SW1) should be the same as the one set to the servo system PC or PLC...etc.

Use the rotary axis setting switch (SW1) to set the control axis number for the servo. If the same numbers are set to different control axes in a single communication system, the system will not operate properly. The control axes may be set independently of the SSCNET Ⅲ cable connection sequence.

Rotary axis setting switch (SW1)



(Note) SW2



Test operation select switch (SW2-1)
Set the test operation select switch to the “Up” Position, when performing the test operation mode by usinf set up software（MR Configurator）

Note. This table indicates the status when the switch is set to "Down".
(Default)

Spare	Rotary axis setting switch (SW1)	Description	Display
Down (Be sure to set to the "Down" position.)	0	Axis No.1	01
	1	Axis No.2	02
	2	Axis No.3	03
	3	Axis No.4	04
	4	Axis No.5	05
	5	Axis No.6	06
	6	Axis No.7	07
	7	Axis No.8	08
	8	Axis No.9	09
	9	Axis No.10	10
	A	Axis No.11	11
	B	Axis No.12	12
	C	Axis No.13	13
	D	Axis No.14	14
	E	Axis No.15	15
	F	Axis No.16	16

4. STARTUP

WARNING

- Do not operate the switches with wet hands. You may get an electric shock.

CAUTION

- Before starting operation, check the parameters. Some machines may perform unexpected operation.
- Take safety measures, e.g. provide covers, to prevent accidental contact of hands and parts (cables, etc.) with the driver heat sink, regenerative resistor, servo motor, etc. since they may be hot while power is on or for some time after power-off. Their temperatures may be high and you may get burnt or a parts may damaged.
- During operation, never touch the rotating parts of the servo motor. Doing so can cause injury.

4.1 Switching power on for the first time

When switching power on for the first time, follow this section to make a startup.

4.1.1 Startup procedure

Wiring check	Check whether the driver and servo motor are wired correctly using visual inspection, DO forced output function (section 4.5.1), etc. (Refer to section 4.1.2.)
Surrounding environment check	Check the surrounding environment of the driver and servo motor. (Refer to section 4.1.3.)
Axis No. settings	Confirm that the axis No. settings for rotary axis setting switch (SW1) and servo system controller are consistent. (Refer to section 3.12)
Parameter setting	Set the parameters as necessary, such as the used control mode and regenerative option selection. (Refer to chapter 5)
Test operation of servo motor alone in test operation mode	For the test operation, with the servo motor disconnected from the machine and operated at the speed as low as possible, check whether the servo motor rotates correctly. (Refer to sections 4.5)
Test operation of servo motor alone by commands	For the test operation with the servo motor disconnected from the machine and operated at the speed as low as possible, give commands to the driver and check whether the servo motor rotates correctly.
Test operation with servo motor and machine connected	Connect the servo motor with the machine, give operation commands from the host command device, and check machine motions.
Gain adjustment	Make gain adjustment to optimize the machine motions. (Refer to chapter 6.)
Actual operation	
Stop	Stop giving commands and stop operation.

4.1.2 Wiring check

(1) Power supply system wiring

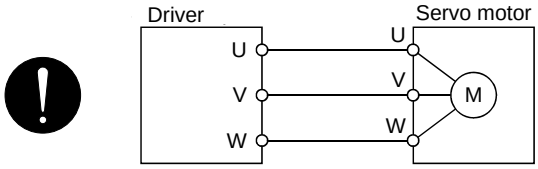
Before switching on the main circuit and control circuit power supplies, check the following items.

(a) Power supply system wiring

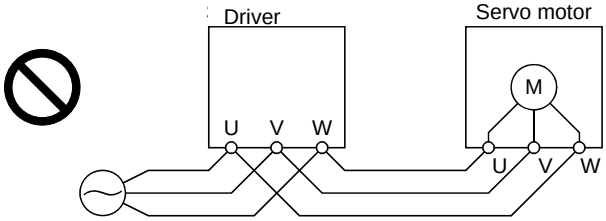
The power supplied to the power input terminals (L_1, L_2, L_3, L_{11}, L_{21}) of the driver should satisfy the defined specifications. (Refer to section 1.3.)

(b) Connection of driver and servo motor

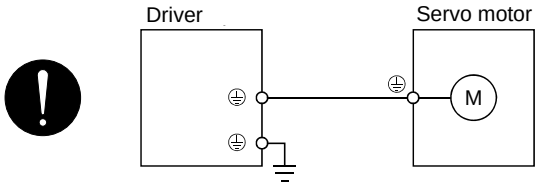
1) The servo motor power supply terminals (U, V, W) of the driver match in phase with the power input terminals (U, V, W) of the servo motor.



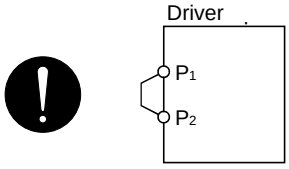
2) The power supplied to the driver should not be connected to the servo motor power supply terminals (U, V, W). To do so will fail the connected driver and servo motor.



3) The earth terminal of the servo motor is connected to the PE terminal of the driver.



4) P_1-P_2 (For 11kW or more, P_1-P) should be connected.



(c) When option and auxiliary equipment are used

1) When regenerative option is used under 3.5kW for 200V class

- The lead between P terminal and D terminal of CNP2 connector should not be connected.
- The generative brake option should be connected to P terminal and C terminal.
- A twisted cable should be used. (Refer to section 11.2)

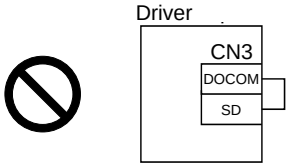
(2) I/O signal wiring

(a) The I/O signals should be connected correctly.

Use DO forced output to forcibly turn on/off the pins of the CN3 connector. This function can be used to perform a wiring check. In this case, switch on the control circuit power supply only.

(b) 24VDC or higher voltage is not applied to the pins of connectors CN3.

(c) SD and DOCOM of connector CN3 is not shorted.



4.1.3 Surrounding environment

(1) Cable routing

(a) The wiring cables are free from excessive force.

(b) The encoder cable should not be used in excess of its flex life. (Refer to section 10.4.)

(c) The connector part of the servo motor should not be strained.

(2) Environment

Signal cables and power cables are not shorted by wire offcuts, metallic dust or the like.

4.2 Start up

Connect the servo motor with a machine after confirming that the servo motor operates properly alone.

(1) Power on

When the main and control circuit power supplies are switched on, "b01" (for the first axis) appears on the driver display.

In the absolute position detection system, first power-on results in the absolute position lost (25) alarm and the servo system cannot be switched on.

The alarm can be deactivated by then switching power off once and on again.

Also in the absolute position detection system, if power is switched on at the servo motor speed of 500r/min or higher, position mismatch may occur due to external force or the like. Power must therefore be switched on when the servo motor is at a stop.

(2) Parameter setting

Set the parameters according to the structure and specifications of the machine. Refer to chapter 5 for the parameter definitions.

Parameter No.	Name	Setting	Description
PA14	Rotation direction setting	0	Increase in positioning address rotates the motor in the CCW direction.
PA08	Auto tuning mode	□□□1	Used.
PA09	Auto tuning response	12	Slow response (initial value) is selected.

After setting the above parameters, switch power off once. Then switch power on again to make the set parameter values valid.

(3) Servo-on

Switch the servo-on in the following procedure.

1) Switch on main circuit/control circuit power supply.

2) The driver transmits the servo-on command.

When placed in the servo-on status, the driver is ready to operate and the servo motor is locked.

(4) Home position return

Always perform home position return before starting positioning operation.

(5) Stop

If any of the following situations occurs, the driver suspends the running of the servo motor and brings it to a stop.

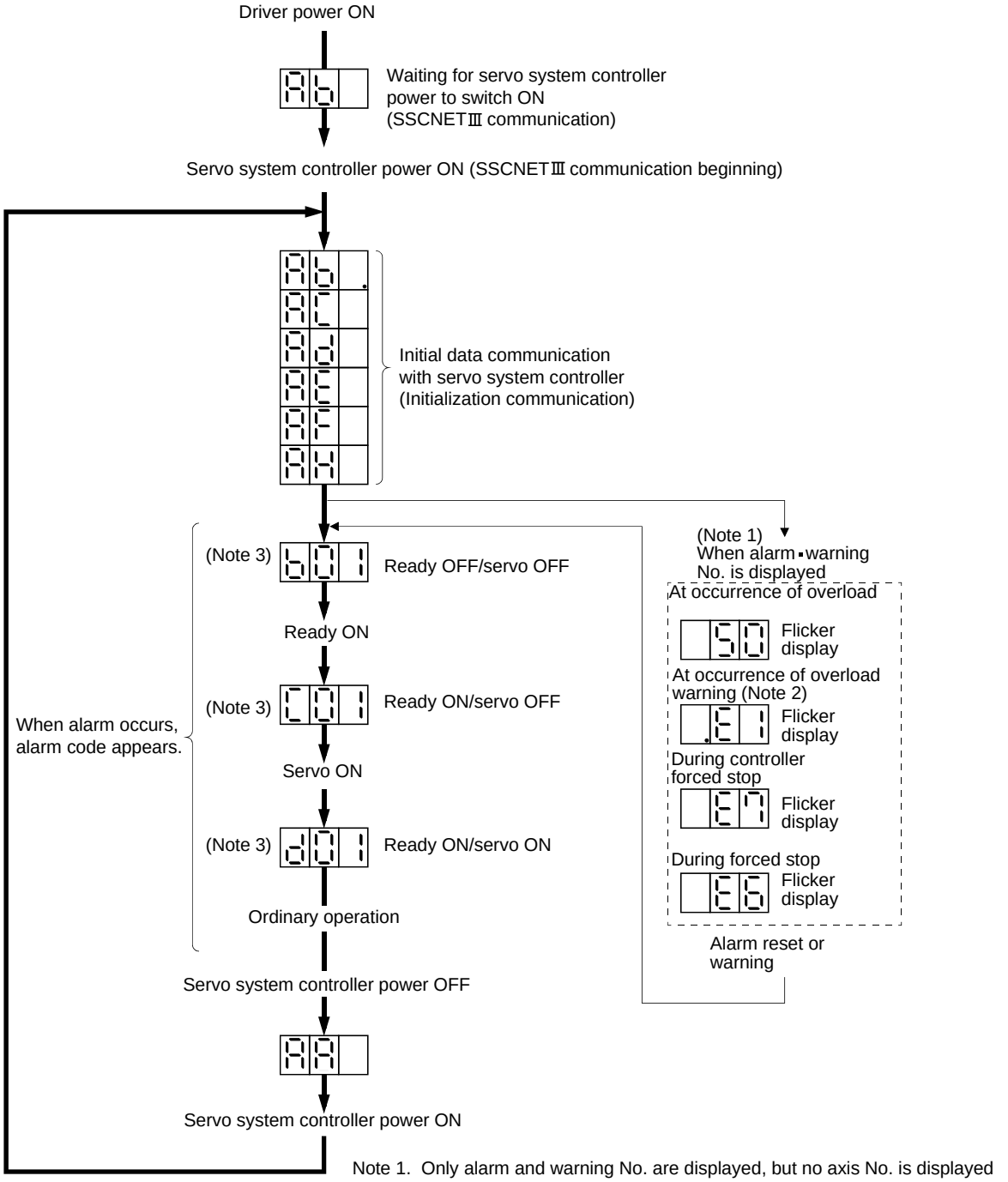
When the servo motor is with an electromagnetic brake, refer to section 3.11.

	Operation/command	Stopping condition
Servo system controller	Servo off command	The base circuit is shut off and the servo motor coasts.
	Forced stop command	The base circuit is shut off and the dynamic brake operates to bring the servo motor to stop. The driver forced stop warning (E7) occurs.
Driver	Alarm occurrence	The base circuit is shut off and the dynamic brake operates to bring the servo motor to stop.
	Forced stop (EM1) OFF	The base circuit is shut off and the dynamic brake operates to bring the servo motor to stop. The servo forced stop warning (E6) occurs.

4.3 Driver display

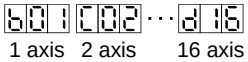
On the driver display (three-digit, seven-segment display), check the status of communication with the servo system controller at power-on, check the axis number, and diagnose a fault at occurrence of an alarm.

(1) Display sequence



Note 1. Only alarm and warning No. are displayed, but no axis No. is displayed

2. If warning other than E6 or E7 occurs during the servo on, flickering the second place of decimal point indicates that it is during the servo on.
3. The right-hand segments of b01, c02 and d16 indicate the axis number. (Below example indicates Axis1)



(2) Indication list

Indication	Status	Description
Ab	Initializing	・Power of the driver was switched on at the condition that the power of servo system controller is OFF. ・The axis No. set to the servo system controller does not match the axis No. set with the rotary axis setting switch (SW1) of the driver. ・A driver fault occurred or an error took place in communication with the servo system controller. In this case, the indication changes. "Ab " → "AC " → "Ad " → "Ab " ・The servo system controller is faulty.
Ab.	Initializing	During initial setting for communication specifications
AC	Initializing	Initial setting for communication specifications completed, and then it synchronized with servo system controller.
Ad	Initializing	During initial parameter setting communication with servo system controller
AE	Initializing	During motor・encoder information and telecommunication with servo system controller
AF	Initializing	During initial signal data communication with servo system controller
AH	Initializing completion	During the completion process for initial data communication with servo system controller
AA	Initializing standby	The power supply of servo system controller is turned off during the power supply of driver is on.
(Note 1) b##	Ready OFF	The ready off signal from the servo system controller was received.
(Note 1) d##	Servo ON	The ready off signal from the servo system controller was received.
(Note 1) C##	Servo OFF	The ready off signal from the servo system controller was received.
(Note 2) **	Alarm・Warning	The alarm No./warning No. that occurred is displayed. (Refer to section 9.1.)
888	CPU Error	CPU watchdog error has occurred.
(Note 3) b00.	(Note 3) Test operation mode	JOG operation, positioning operation, programmed operation, DO forced output.
(Note 1) b##. d##. C##.		Motor-less operation

Note 1. ## denotes any of numerals 00 to 16 and what it means is listed below.

#	Description
0	Set to the test operation mode.
1	First axis
2	Second axis
3	Third axis
4	Fourth axis
5	Fifth axis
6	Sixth axis
7	Seventh axis
8	Eighth axis
9	Ninth axis
10	Tenth axis
11	Eleventh axis
12	Twelfth axis
13	Thirteenth axis
14	Fourteenth axis
15	Fifteenth axis
16	Sixteenth axis

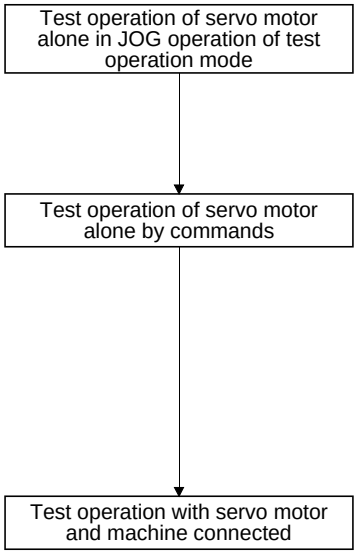
2. ** indicates the warning/alarm No.

3. Requires the set up software (MR Configurator).

4.4 Test operation

Before starting actual operation, perform test operation to make sure that the machine operates normally.
Refer to section 4.2 for the power on and off methods of the driver.

> **POINT**
>
> - If necessary, verify driver program by using motorless operation.
>   Refer to section 4.5.2 for the motorless operation.



In this step, confirm that the driver and servo motor operate normally.
With the servo motor disconnected from the machine, use the test operation mode and check whether the servo motor rotates correctly. Refer to section 4.5 for the test operation mode.

In this step, confirm that the servo motor rotates correctly under the commands from the driver.
Make sure that the servo motor rotates in the following procedure.
Give a low speed command at first and check the rotation direction, etc. of the servo motor.
If the servo motor does not operate in the intended direction, check the input signal.

In this step, connect the servo motor with the machine and confirm that the machine operates normally under the commands from the command device.
Make sure that the servo motor rotates in the following procedure.
Give a low speed command at first and check the operation direction, etc. of the machine. If the machine does not operate in the intended direction, check the input signal. In the status display, check for any problems of the servo motor speed, command pulse frequency, load ratio, etc.
Then, check automatic operation with the program of the command device.

4.5 Test operation mode

CAUTION

- The test operation mode is designed for servo operation confirmation and not for machine operation confirmation. Do not use this mode with the machine. Always use the servo motor alone.
- If an operation fault occurred, use the forced stop (EM1) to make a stop.

POINT

- The content described in this section indicates the environment that driver and personal computer are directly connected.

By using a personal computer and the set up software (MR Configurator), you can execute jog operation, positioning operation, DO forced output program operation without connecting the servo system controller.

4.5.1 Test operation mode in set up software (MR Configurator)

(1) Test operation mode

(a) Jog operation

Jog operation can be performed without using the servo system controller. Use this operation with the forced stop reset. This operation may be used independently of whether the servo is on or off and whether the servo system controller is connected or not.

Exercise control on the jog operation screen of the set up software (MR Configurator).

1) Operation pattern

Item	Initial value	Setting range
Speed [r/min]	200	0 to max. speed
Acceleration/deceleration time constant [ms]	1000	0 to 50000

2) Operation method

Operation	Screen control
Forward rotation start	Click the "Forward" button.
Reverse rotation start	Click the "Reverse" button.
Stop	Click the "Stop" button.

(b) Positioning operation

Positioning operation can be performed without using the servo system controller. Use this operation with the forced stop reset. This operation may be used independently of whether the servo is on or off and whether the servo system controller is connected or not.

Exercise control on the positioning operation screen of the set up software (MR Configurator).

1) Operation pattern

Item	Initial value	Setting range
Travel [pulse]	4000	0 to 99999999
Speed [r/min]	200	0 to max. speed
Acceleration/deceleration time constant [ms]	1000	0 to 50000

2) Operation method

Operation	Screen control
Forward rotation start	Click the "Forward" button.
Reverse rotation start	Click the "Reverse" button.
Pause	Click the "Pause" button.

(c) Program operation

Positioning operation can be performed in two or more operation patterns combined, without using the servo system controller. Use this operation with the forced stop reset. This operation may be used independently of whether the servo is on or off and whether the servo system controller is connected or not.

Exercise control on the programmed operation screen of the set up software (MR Configurator). For full information, refer to the set up software (MR Configurator) Installation Guide.

Operation	Screen control
Start	Click the "Start" button.
Stop	Click the "Reset" button.

(d) Output signal (DO) forced output

Output signals can be switched on/off forcibly independently of the servo status. Use this function for output signal wiring check, etc.

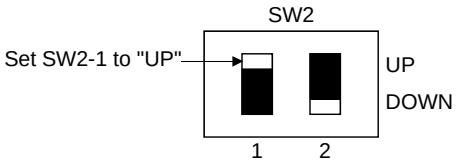
Exercise control on the DO forced output screen of the set up software (MR Configurator).

(2) Operation procedure

(a) Jog operation, positioning operation, program operation, DO forced output.

1) Switch power off.

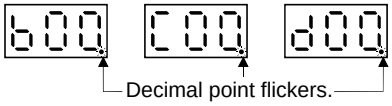
2) Set SW2-1 to "UP".



When SW1 and SW2-1 is set to the axis number and operation is performed by the servo system controller, the test operation mode screen is displayed on the personal computer, but no function is performed.

3) Switch driver power on.

When initialization is over, the display shows the following screen.



4) Perform operation with the personal computer.

4.5.2 Motorless operation in driver

POINT
・Use motor-less operation which is available by making the servo system driver parameter setting.
・Motorless operation is done while connected with the servo system controller.

(1) Motorless operation

Without connecting the servo motor, output signals or status displays can be provided in response to the servo system controller commands as if the servo motor is actually running. This operation may be used to check the servo system controller sequence. Use this operation with the forced stop reset. Use this operation with the driver connected to the servo system controller.

For stopping the motorless operation, set the selection of motorless operation to [Invalid] in servo parameter setting of servo system controller. Motorless operation will be invalid condition after switching on power supply next time.

(a) Load conditions

Load item	Condition
Load torque	0
Load inertia moment ratio	Same as servo motor inertia moment

(b) Alarms

The following alarms and warning do not occur. However, the other alarms and warnings occur as when the servo motor is connected.

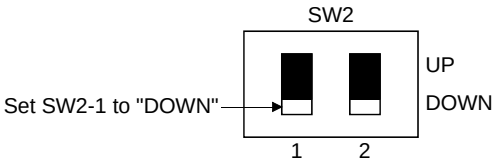
・Encoder error 1 (16)
・Encoder error 2 (20)
・Absolute position erasure (25)
・Battery cable disconnection warning (92)
・Battery warning (9F)
・Main circuit off warning (E9) (Note 1)

Note 1. Main circuit off warning (E9) does not occur only when the forced stop of the converter unit is enabled as the cause of occurrence with the drive unit of 30kW or more. Main circuit of warning, otherwise, occurs when the cause of occurrence with the drive unit of 30kW or more is other than above, or with the driver of 22 kW or less.

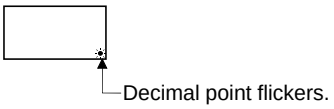
(2) Operating procedure

1) Switch off driver

2) Set parameter No.PC05 to "1", change test operation mode switch (SW2-1) to normal condition side "Down", and then turn on the power supply.



3) Perform motor-less operation with the personal computer.
The display shows the following screen.



5. PARAMETERS

5. PARAMETERS

CAUTION	・Never adjust or change the parameter values extremely as it will make operation instable.

POINT

・When the driver is connected with the servo system controller, the parameters are set to the values of the servo system controller. Switching power off, then on makes the values set on the set up software(MR Configurator) invalid and the servo system controller values valid.
・Setting may not be made to some parameters and ranges depending on the model or version of the servo system controller. For details, refer to the servo system controller user's manual.

In this driver, the parameters are classified into the following groups on a function basis.

Parameter group	Main description
Basic setting parameters (No.PA ☐☐)	Make basic setting with these parameters. Generally, the operation is possible only with these parameter settings.
Gain/filter parameters (No.PB ☐☐)	Use these parameters when making gain adjustment manually.
Extension setting parameters (No.PC ☐☐)	When changing settings such as analog monitor output signal or encoder electromagnetic brake sequence output, use these parameters.
I/O setting parameters (No.PD ☐☐)	Use these parameters when changing the I/O signals of the driver.

Mainly setting the basic setting parameters (No.PA ☐☐) allows the setting of the basic parameters at the time of introduction.

5.1 Basic setting parameters (No.PA☐☐)

POINT

・Parameter whose symbol is preceded by * is made valid with the following conditions.
* : Set the parameter value, switch power off once after setting, and then switch it on again, or perform the driver reset.
**: Set the parameter value, switch power off once, and then switch it on again.
・Never change parameters for manufacturer setting.

5.1.1 Parameter list

No.	Symbol	Name	Initial value	Unit
PA01		For manufacturer setting	0000h	
PA02	**REG	Regenerative option	0000h	
PA03	*ABS	Absolute position detection system	0000h	
PA04	*AOP1	Function selection A-1	0000h	
PA05		For manufacturer setting	0	
PA06			1	
PA07			1	
PA08	ATU	Auto tuning mode	0001h	
PA09	RSP	Auto tuning response	12	
PA10	INP	In-position range	100	pulse
PA11		For manufacturer setting	1000.0	%
PA12			1000.0	%
PA13			0000h	
PA14	*POL	Rotation direction selection	0	
PA15	*ENR	Encoder output pulses	4000	pulse/rev
PA16		For manufacturer setting	0	
PA17			0000h	
PA18			0000h	
PA19	*BLK	Parameter write inhibit	000Bh	

5.1.2 Parameter write inhibit

Parameter			Initial value	Unit	Setting range
No.	Symbol	Name			
PA19	*BLK	Parameter write inhibit	000Bh		Refer to the text.

POINT

- When setting the parameter values from the servo system controller, the parameter No.PA19 setting need not be changed.
- This parameter is made valid when power is switched off, then on after setting, or when the driver reset has been performed.

In the factory setting, this driver allows changes to the basic setting parameter, gain/filter parameter and extension setting parameter settings. With the setting of parameter No.PA19, write can be disabled to prevent accidental changes.

The following table indicates the parameters which are enabled for reference and write by the setting of parameter No.PA19. Operation can be performed for the parameters marked ○ .

Parameter No.PA19 setting	Setting operation	Basic setting parameters No.PA □□	Gain/filter parameters No.PB □□	Extension setting parameters No.PC □□	I/O setting parameters No.PD □□
0000h	Reference	○			
	Write	○			
000Bh (initial value)	Reference	○	○	○	
	Write	○	○	○	
000Ch	Reference	○	○	○	○
	Write	○	○	○	○
100Bh	Reference	○			
	Write	Parameter No.PA19 only			
100Ch	Reference	○	○	○	○
	Write	Parameter No.PA19 only			

5.1.3 Selection of regenerative option

Parameter			Initial value	Unit	Setting range
No.	Symbol	Name			
PA02	**REG	Regenerative option	0000h		Refer to the text.

POINT

- This parameter value and switch power off once, then switch it on again to make that parameter setting valid.
- Wrong setting may cause the regenerative option to burn.
- If the regenerative option selected is not for use with the driver, parameter error (37) occurs.

Set this parameter when using the regenerative option, brake unit, power regeneration converter, or power regeneration common converter.

Parameter No.PA02

0	0		

Selection of regenerative option
00: Regenerative option is not used
- For 100W controller regenerative resistor is not used
- For 200W controller regenerative resistor is used

02: LEC-MR-RB032
03: LEC-MR-RB012

5.1.4 Using absolute position detection system

Parameter			Initial value	Unit	Setting range
No.	Symbol	Name			
PA03	*ABS	Absolute position detection system	0000h		Refer to the text.

POINT

- This parameter is made valid when power is switched off, then on after setting, or when the driver reset has been performed.
- This parameter cannot be used in the speed control mode.

Set this parameter when using the absolute position detection system in the position control mode.

Parameter No.PA03

0	0	0	

Selection of absolute position detection system (refer to chapter 12)
0: Used in incremental system
1: Used in absolute position detection system

5.1.5 Forced stop input selection

Parameter			Initial value	Unit	Setting range
No.	Symbol	Name			
PA04	*AOP1	Function selection A-1	0000h		Refer to the text.

POINT

- This parameter is made valid when power is switched off, then on after setting, or when the driver reset has been performed.

The servo forced stop function is avoidable.

Parameter No.PA04

0		0	0

Selection of servo forced stop
0: Valid (Forced stop (EM1) is used.)
1: Invalid (Forced stop (EM1) is not used.)

When not using the forced stop (EM1) of driver, set the selection of servo forced stop to Invalid (□1□□). At this time, the forced stop (EM1) automatically turns on inside the driver.

5.1.6 Auto tuning

Parameter			Initial value	Unit	Setting range
No.	Symbol	Name			
PA08	ATU	Auto tuning mode	0001h		Refer to the text.
PA09	RSP	Auto tuning response	12		1 to 32

Make gain adjustment using auto tuning. Refer to section 6.2 for details.

(1) Auto tuning mode (parameter No.PA08)

Select the gain adjustment mode.

Parameter No.PA08

0	0	0	

Gain adjustment mode setting

Setting	Gain adjustment mode	Automatically set parameter No. (Note)
0	Interpolation mode	PB06・PB08・PB09・PB10
1	Auto tuning mode 1	PB06・PB07・PB08・PB09・PB10
2	Auto tuning mode 2	PB07・PB08・PB09・PB10
3	Manual mode	

Note. The parameters have the following names.

Parameter No.	Name
PB06	Ratio of load inertia moment to servo motor inertia moment
PB07	Model loop gain
PB08	Position loop gain
PB09	Speed loop gain
PB10	Speed integral compensation

(2) Auto tuning response (parameter No.PA09)

If the machine hunts or generates large gear sound, decrease the set value. To improve performance, e.g. shorten the settling time, increase the set value.

Setting	Response	Guideline for machine resonance frequency [Hz]
1	Low response	10.0
2		11.3
3		12.7
4		14.3
5		16.1
6		18.1
7		20.4
8		23.0
9		25.9
10		29.2
11		32.9
12		37.0
13		41.7
14		47.0
15		52.9
16	Middle response	59.6

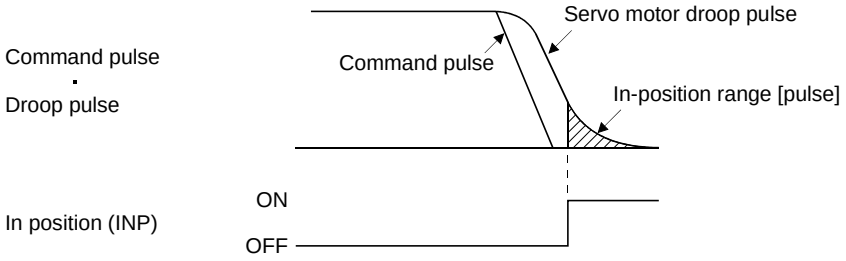
Setting	Response	Guideline for machine resonance frequency [Hz]
17	Low response	67.1
18		75.6
19		85.2
20		95.9
21		108.0
22		121.7
23		137.1
24		154.4
25		173.9
26		195.9
27		220.6
28		248.5
29		279.9
30		315.3
31		355.1
32	Middle response	400.0

5.1.7 In-position range

Parameter			Initial value	Unit	Setting range
No.	Symbol	Name			
PA10	INP	In-position range	100	pulse	0 to 65535

POINT
・This parameter cannot be used in the speed control mode.

Set the range, where in position (INP) is output, in the command pulse unit.



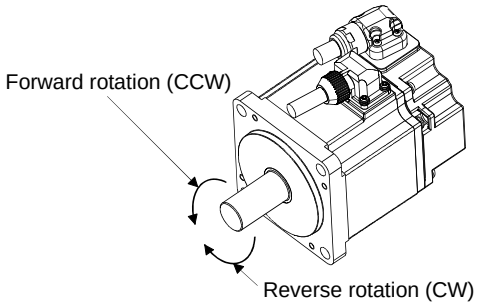
5.1.8 Selection of servo motor rotation direction

Parameter			Initial value	Unit	Setting range
No.	Symbol	Name			
PA14	*POL	Rotation direction selection	0		0 ▪ 1

> POINT
> ▪ This parameter is made valid when power is switched off, then on after setting, or when the driver reset has been performed.

Select servo motor rotation direction relative.

Parameter No.PA14 setting	Servo motor rotation direction	
	When positioning address increases	When positioning address decreases
0	CCW	CW
1	CW	CCW



5.1.9 Encoder output pulse

Parameter			Initial value	Unit	Setting range
No.	Symbol	Name			
PA15	*ENR	Encoder output pulse	4000	pulse/rev	1 to 65535

> POINT
> ▪ This parameter is made valid when power is switched off, then on after setting, or when the driver reset has been performed.

Used to set the encoder pulses (A-phase, B-phase) output by the driver.
Set the value 4 times greater than the A-phase or B-phase pulses.
You can use parameter No.PC03 to choose the output pulse setting or output division ratio setting.
The number of A/B-phase pulses actually output is 1/4 times greater than the preset number of pulses.
The maximum output frequency is 4.6Mpps (after multiplication by 4). Use this parameter within this range.

(1) For output pulse designation

Set "□□0□" (initial value) in parameter No.PC03.

Set the number of pulses per servo motor revolution.

Output pulse = set value [pulses/rev]

For instance, set "5600" to Parameter No.PA15, the actually output A/B-phase pulses are as indicated below.

$$\text{A·B-phase output pulses} = \frac{5600}{4} = 1400\text{[pulse]}$$

(2) For output division ratio setting

Set "□□1□" in parameter No.PC03.

The number of pulses per servo motor revolution is divided by the set value.

$$\text{Output pulse} = \frac{\text{Resolution per servo motor revolution}}{\text{Set value}}\ \text{[pulses/rev]}$$

For instance, set "8" to Parameter No.PA15, the actually output A/B-phase pulses are as indicated below.

$$\text{A·B-phase output pulses} = \frac{262144}{8} \cdot \frac{1}{4} = 8192\text{[pulse]}$$

5.2 Gain/filter parameters (No.PB□□)

POINT

- Parameter whose symbol is preceded by * is made valid with the following conditions.

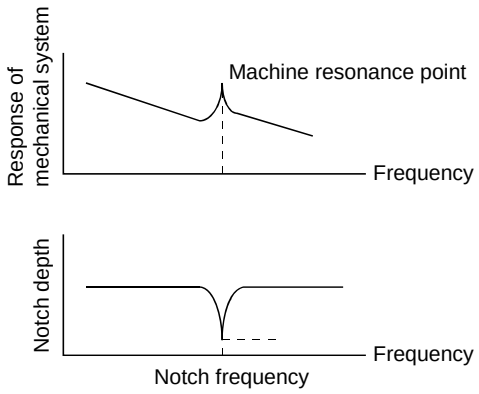
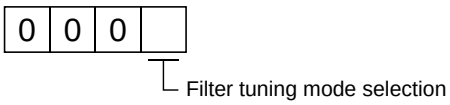
  * : Set the parameter value, switch power off once after setting, and then switch it on again, or perform the driver reset.

5.2.1 Parameter list

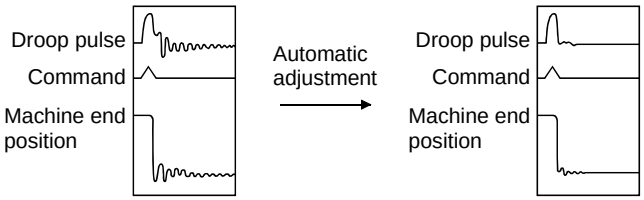
No.	Symbol	Name	Initial value	Unit
PB01	FILT	Adaptive tuning mode (Adaptive filter Ⅱ)	0000h	
PB02	VRFT	Vibration suppression control tuning mode (advanced vibration suppression control)	0000h	
PB03		For manufacturer setting	0	
PB04	FFC	Feed forward gain	0	%
PB05		For manufacturer setting	500	
PB06	GD2	Ratio of load inertia moment to servo motor inertia moment	7.0	Multiplier (×1)
PB07	PG1	Model loop gain	24	rad/s
PB08	PG2	Position loop gain	37	rad/s
PB09	VG2	Speed loop gain	823	rad/s
PB10	VIC	Speed integral compensation	33.7	ms
PB11	VDC	Speed differential compensation	980	
PB12		For manufacturer setting	0	
PB13	NH1	Machine resonance suppression filter 1	4500	Hz
PB14	NHQ1	Notch shape selection 1	0000h	
PB15	NH2	Machine resonance suppression filter 2	4500	Hz
PB16	NHQ2	Notch shape selection 2	0000h	
PB17		Automatic setting parameter		
PB18	LPF	Low-pass filter setting	3141	rad/s
PB19	VRF1	Vibration suppression control vibration frequency setting	100.0	Hz
PB20	VRF2	Vibration suppression control resonance frequency setting	100.0	Hz
PB21		For manufacturer setting	0.00	
PB22			0.00	
PB23	VFBF	Low-pass filter selection	0000h	
PB24	*MVS	Slight vibration suppression control selection	0000h	
PB25		For manufacturer setting	0000h	
PB26	*CDP	Gain changing selection	0000h	
PB27	CDL	Gain changing condition	10	
PB28	CDT	Gain changing time constant	1	ms
PB29	GD2B	Gain changing ratio of load inertia moment to servo motor inertia moment	7.0	Multiplier (×1)
PB30	PG2B	Gain changing position loop gain	37	rad/s
PB31	VG2B	Gain changing speed loop gain	823	rad/s
PB32	VICB	Gain changing speed integral compensation	33.7	ms
PB33	VRF1B	Gain changing vibration suppression control vibration frequency setting	100.0	Hz
PB34	VRF2B	Gain changing vibration suppression control resonance frequency setting	100.0	Hz
PB35		For manufacturer setting	0.00	
PB36			0.00	
PB37			100	
PB38			0.0	
PB39			0.0	

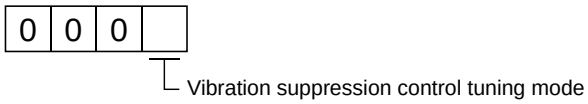
No.	Symbol	Name	Initial value	Unit
PB40		For manufacturer setting	0.0	
PB41			1125	
PB42			1125	
PB43			0004h	
PB44			0.0	
PB45			0000h	

5.2.2 Detail list

No.	Symbol	Name and function	Initial value	Unit	Setting range
PB01	FILT	Adaptive tuning mode (adaptive filter Ⅱ) Select the setting method for filter tuning. Setting this parameter to "□□□1" (filter tuning mode 1) automatically changes the machine resonance suppression filter 1 (parameter No.PB13) and notch shape selection (parameter No.PB14).   (table below) Note. Parameter No.PB13 and PB14 are fixed to the initial values. When this parameter is set to "□□□1", the tuning is completed after positioning is done the predetermined number or times for the predetermined period of time, and the setting changes to "□□□2". When the filter tuning is not necessary, the setting changes to "□□□0". When this parameter is set to "□□□0", the initial values are set to the machine resonance suppression filter 1 and notch shape selection. However, this does not occur when the servo off.	0000h		

Setting	Filter adjustment mode	Automatically set parameter
0	Filter OFF	(Note)
1	Filter tuning mode	Parameter No.PB13 Parameter No.PB14
2	Manual mode	

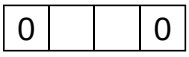
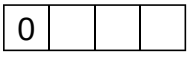
<table>
<tr><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th></tr>
<tr><td>PB02</td><td>VRFT</td><td>Vibration suppression control tuning mode (advanced vibration suppression control)
This parameter cannot be used in the speed control mode.
The vibration suppression is valid when the parameter No.PA08 (auto tuning) setting is "□□□2" or "□□□3". When PA08 is "□□□1", vibration suppression is always invalid.
Select the setting method for vibration suppression control tuning. Setting this parameter to "□□□1" (vibration suppression control tuning mode) automatically changes the vibration suppression control vibration frequency (parameter No.PB19) and vibration suppression control resonance frequency (parameter No.PB20) after positioning is done the predetermined number of times.
 



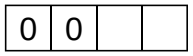
<table>
<tr><th>Setting</th><th>Vibration suppression control tuning mode</th><th>Automatically set parameter</th></tr>
<tr><td>0</td><td>Vibration suppression control OFF</td><td>(Note)</td></tr>
<tr><td>1</td><td>Vibration suppression control tuning mode (Advanced vibration suppression control)</td><td>Parameter No.PB19
Parameter No.PB20</td></tr>
<tr><td>2</td><td>Manual mode</td><td></td></tr>
</table>
Note. Parameter No.PB19 and PB20 are fixed to the initial values.

When this parameter is set to "□□□1", the tuning is completed after positioning is done the predetermined number or times for the predetermined period of time, and the setting changes to "□□□2". When the vibration suppression control tuning is not necessary, the setting changes to "□□□0". When this parameter is set to "□□□0", the initial values are set to the vibration suppression control vibration frequency and vibration suppression control resonance frequency. However, this does not occur when the servo off.</td><td>0000h</td><td></td><td></td></tr>
<tr><td>PB03</td><td></td><td>For manufacturer setting
Do not change this value by any means.</td><td>0</td><td></td><td></td></tr>
<tr><td>PB04</td><td>FFC</td><td>Feed forward gain
This parameter cannot be used in the speed control mode.
Set the feed forward gain. When the setting is 100%, the droop pulses during operation at constant speed are nearly zero. However, sudden acceleration/deceleration will increase the overshoot. As a guideline, when the feed forward gain setting is 100%, set 1s or more as the acceleration/deceleration time constant up to the rated speed.</td><td>0</td><td>%</td><td>0
to
100</td></tr>
<tr><td>PB05</td><td></td><td>For manufacturer setting
Do not change this value by any means.</td><td>500</td><td></td><td></td></tr>
</table>

No.	Symbol	Name and function	Initial value	Unit	Setting range
PB06	GD2	Ratio of load inertia moment to servo motor inertia moment Used to set the ratio of the load inertia moment to the servo motor shaft inertia moment. When auto tuning mode 1 and interpolation mode is selected, the result of auto tuning is automatically used. (Refer to section 6.1.1) In this case, it varies between 0 and 100.0. When parameter No.PA08 is set to "□□□2" or "□□□3", this parameter can be set manually.	7.0	Multiplier (×1)	0 to 300.0
PB07	PG1	Model loop gain Set the response gain up to the target position. Increase the gain to improve track ability in response to the command. When auto turning mode 1,2 is selected, the result of auto turning is automatically used. When parameter No.PA08 is set to "□□□1" or "□□□3", this parameter can be set manually.	24	rad/s	1 to 2000
PB08	PG2	Position loop gain This parameter cannot be used in the speed control mode. Used to set the gain of the position loop. Set this parameter to increase the position response to level load disturbance. Higher setting increases the response level but is liable to generate vibration and/or noise. When auto tuning mode 1,2 and interpolation mode is selected, the result of auto tuning is automatically used. When parameter No.PA08 is set to "□□□3", this parameter can be set manually.	37	rad/s	1 to 1000
PB09	VG2	Speed loop gain Set this parameter when vibration occurs on machines of low rigidity or large backlash. Higher setting increases the response level but is liable to generate vibration and/or noise. When auto tuning mode 1・2, manual mode and interpolation mode is selected, the result of auto tuning is automatically used. When parameter No.PA08 is set to "□□□3", this parameter can be set manually.	823	rad/s	20 to 50000
PB10	VIC	Speed integral compensation Used to set the integral time constant of the speed loop. Lower setting increases the response level but is liable to generate vibration and/or noise. When auto tuning mode 1・2 and interpolation mode is selected, the result of auto tuning is automatically used. When parameter No.PA08 is set to "□□□3", this parameter can be set manually.	33.7	ms	0.1 to 1000.0
PB11	VDC	Speed differential compensation Used to set the differential compensation. When parameter No.PB24 is set to "□□3□", this parameter is made valid. When parameter No.PA08 is set to "□□0□", this parameter is made valid by instructions of driver.	980		0 to 1000
PB12		For manufacturer setting Do not change this value by any means.	0		
PB13	NH1	Machine resonance suppression filter 1 Set the notch frequency of the machine resonance suppression filter 1. Setting parameter No.PB01 (filter tuning mode 1) to "□□□1" automatically changes this parameter. When the parameter No.PB01 setting is "□□□0", the setting of this parameter is ignored.	4500	Hz	100 to 4500

<table>
<tr><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th></tr>
<tr><td>PB14</td><td>NHQ1</td><td>Notch shape selection 1
Used to selection the machine resonance suppression filter 1.
 
Notch depth selection
<table><tr><th>Setting value</th><th>Depth</th><th>Gain</th></tr><tr><td>0</td><td rowspan="4">Deep
to
Shallow</td><td>−40dB</td></tr><tr><td>1</td><td>−14dB</td></tr><tr><td>2</td><td>−8dB</td></tr><tr><td>3</td><td>−4dB</td></tr></table>Notch width
<table><tr><th>Setting value</th><th>Width</th><th>α</th></tr><tr><td>0</td><td rowspan="4">Standard
to
Wide</td><td>2</td></tr><tr><td>1</td><td>3</td></tr><tr><td>2</td><td>4</td></tr><tr><td>3</td><td>5</td></tr></table>Setting parameter No.PB01 (filter tuning mode 1) to "□□□1" automatically changes this parameter.
When the parameter No.PB01 setting is "□□□0", the setting of this parameter is ignored.</td><td>0000h</td><td></td><td>Refer to Name and function column.</td></tr>
<tr><td>PB15</td><td>NH2</td><td>Machine resonance suppression filter 2
Set the notch frequency of the machine resonance suppression filter 2.
Set parameter No.PB16 (notch shape selection 2) to "□□□1" to make this parameter valid.</td><td>4500</td><td>Hz</td><td>100
to
4500</td></tr>
<tr><td>PB16</td><td>NHQ2</td><td>Notch shape selection 2
Select the shape of the machine resonance suppression filter 2.
 
Machine resonance suppression filter 2 selection
0: Invalid
1: Valid
Notch depth selection
<table><tr><th>Setting value</th><th>Depth</th><th>Gain</th></tr><tr><td>0</td><td rowspan="4">Deep
to
Shallow</td><td>−40dB</td></tr><tr><td>1</td><td>−14dB</td></tr><tr><td>2</td><td>−8dB</td></tr><tr><td>3</td><td>−4dB</td></tr></table>Notch width
<table><tr><th>Setting value</th><th>Width</th><th>α</th></tr><tr><td>0</td><td rowspan="4">Standard
to
Wide</td><td>2</td></tr><tr><td>1</td><td>3</td></tr><tr><td>2</td><td>4</td></tr><tr><td>3</td><td>5</td></tr></table></td><td>0000h</td><td></td><td>Refer to Name and function column.</td></tr>
<tr><td>PB17</td><td></td><td>Automatic setting parameter
The value of this parameter is set according to a set value of parameter No.PB06 (Ratio of load inertia moment to servo motor inertia moment).</td><td></td><td></td><td></td></tr>
</table>

No.	Symbol	Name and function	Initial value	Unit	Setting range
PB18	LPF	Low-pass filter setting Set the low-pass filter. Setting parameter No.PB23 (low-pass filter selection) to "☐☐0☐" automatically changes this parameter. When parameter No.PB23 is set to "☐☐1☐", this parameter can be set manually.	3141	rad/s	100 to 18000
PB19	VRF1	Vibration suppression control vibration frequency setting This parameter cannot be used in the speed control mode. Set the vibration frequency for vibration suppression control to suppress low-frequency machine vibration, such as enclosure vibration. (Refer to section 7.4.(4)) Setting parameter No.PB02 (vibration suppression control tuning mode) to "☐☐☐1" automatically changes this parameter. When parameter No.PB02 is set to "☐☐☐2", this parameter can be set manually.	100.0	Hz	0.1 to 100.0
PB20	VRF2	Vibration suppression control resonance frequency setting This parameter cannot be used in the speed control mode. Set the resonance frequency for vibration suppression control to suppress low-frequency machine vibration, such as enclosure vibration. (Refer to section 7.4.(4)) Setting parameter No.PB02 (vibration suppression control tuning mode) to "☐☐☐1" automatically changes this parameter. When parameter No.PB02 is set to "☐☐☐2", this parameter can be set manually.	100.0	Hz	0.1 to 100.0
PB21		For manufacturer setting	0.00		
PB22		Do not change this value by any means.	0.00		
PB23	VFBF	Low-pass filter selection Select the low-pass filter. 0 0 _ 0 Low-pass filter selection 0: Automatic setting 1: Manual setting (parameter No.PB18 setting) When automatic setting has been selected, select the filter that has the band width close to the one calculated with $\frac{VG2 \cdot 10}{1 + GD2}$ [rad/s]	0000h		Refer to Name and function column.
PB24	*MVS	Slight vibration suppression control selection Select the slight vibration suppression control and PI-PID change. When parameter No.PA08 (auto tuning mode) is set to "☐☐☐3", this parameter is made valid. (Slight vibration suppression control cannot be used in the speed control mode.) 0 0 _ _ Slight vibration suppression control selection 0: Invalid 1: Valid PI-PID control switch over selection 0: PI control is valid. (Switching to PID control is possible with instructions of controller.) 3: PID control is always valid.	0000h		Refer to Name and function column.
PB25		For manufacturer setting Do not change this value by any means.	0000h		

No.	Symbol	Name and function	Initial value	Unit	Setting range
PB26	*CDP	Gain changing selection Select the gain changing condition. (Refer to section 7.6.)  Gain changing selection Under any of the following conditions, the gains change on the basis of the parameter No.PB29 to PB32 settings. 0: Invalid 1: Control instructions from a controller. 2: Command frequency (Parameter No.PB27 setting) 3: Droop pulse value (Parameter No.PB27 setting) 4: Servo motor speed (Parameter No.PB27 setting) Gain changing condition 0: Valid at more than condition (For control instructions from a controller, valid with ON) 1: Valid at less than condition (For control instructions from a controller, valid with OFF)	0000h		Refer to Name and function column.
PB27	CDL	Gain changing condition Used to set the value of gain changing condition (command frequency, droop pulses, servo motor speed) selected in parameter No.PB26.The set value unit changes with the changing condition item. (Refer to section 7.6.)	10	kpps pulse r/min	0 to 9999
PB28	CDT	Gain changing time constant Used to set the time constant at which the gains will change in response to the conditions set in parameters No.PB26 and PB27. (Refer to section 7.6.)	1	ms	0 to 100
PB29	GD2B	Gain changing ratio of load inertia moment to servo motor inertia moment Used to set the ratio of load inertia moment to servo motor inertia moment when gain changing is valid. This parameter is made valid when the auto tuning is invalid (parameter No.PA08: ☐☐☐3).	7.0	Multiplier (×1)	0 to 300.0
PB30	PG2B	Gain changing position loop gain This parameter cannot be used in the speed control mode. Set the position loop gain when the gain changing is valid. This parameter is made valid when the auto tuning is invalid (parameter No.PA08: ☐☐☐3).	37	rad/s	1 to 2000
PB31	VG2B	Gain changing speed loop gain Set the speed loop gain when the gain changing is valid. This parameter is made valid when the auto tuning is invalid (parameter No.PA08: ☐☐☐3).	823	rad/s	20 to 20000
PB32	VICB	Gain changing speed integral compensation Set the speed integral compensation when the gain changing is valid. This parameter is made valid when the auto tuning is invalid (parameter No.PA08: ☐☐☐3).	33.7	ms	0.1 to 5000.0
PB33	VRF1B	Gain changing vibration suppression control vibration frequency setting This parameter cannot be used in the speed control mode. Set the vibration frequency for vibration suppression control when the gain changing is valid. This parameter is made valid when the parameter No.PB02 setting is "☐☐☐2" and the parameter No.PB26 setting is "☐☐☐1". When using the vibration suppression control gain changing, always execute the changing after the servo motor has stopped.	100.0	Hz	0.1 to 100.0

No.	Symbol	Name and function	Initial value	Unit	Setting range
PB34	VRF2B	Gain changing vibration suppression control resonance frequency setting This parameter cannot be used in the speed control mode. Set the resonance frequency for vibration suppression control when the gain changing is valid. This parameter is made valid when the parameter No.PB02 setting is "□□□2" and the parameter No.PB26 setting is "□□□1". When using the vibration suppression control gain changing, always execute the changing after the servo motor has stopped.	100.0	Hz	0.1 to 100.0
PB35		For manufacturer setting Do not change this value by any means.	0.00		
PB36			0.00		
PB37			100		
PB38			0.0		
PB39			0.0		
PB40			0.0		
PB41			1125		
PB42			1125		
PB43			0004h		
PB44			0.0		
PB45			0000h		

5.3 Extension setting parameters (No.PC□ □)

POINT

- Parameter whose symbol is preceded by * is made valid with the following conditions.

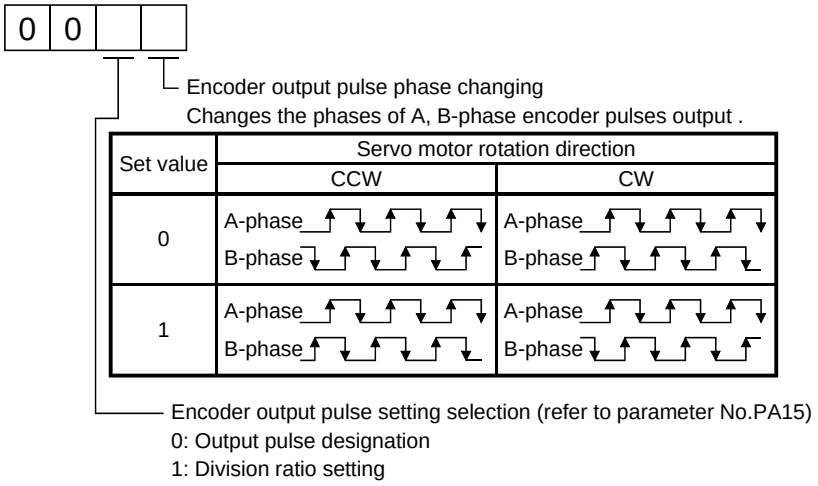
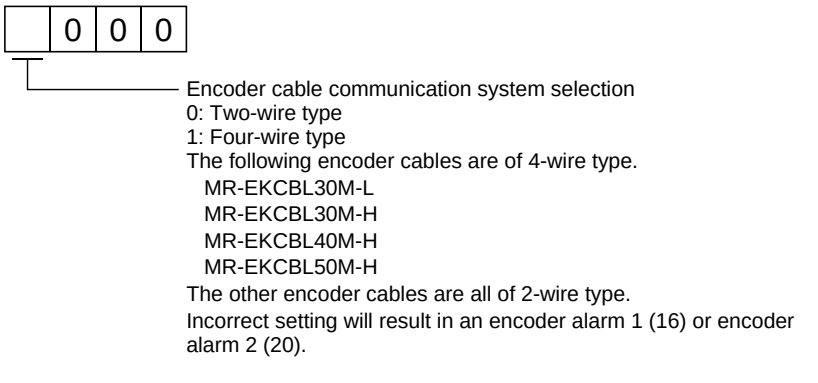
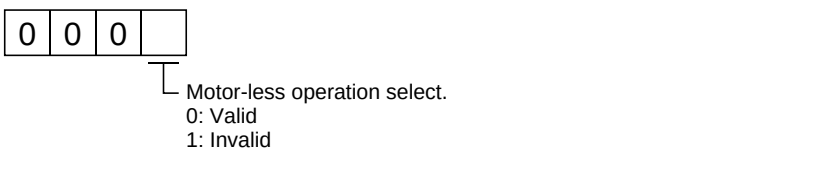
  * : Set the parameter value, switch power off once after setting, and then switch it on again, or perform the driver reset.

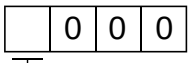
  **: Set the parameter value, switch power off once, and then switch it on again.

5.3.1 Parameter list

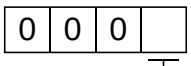
No.	Symbol	Name	Initial value	Unit
PC01	ERZ	Error excessive alarm level	3	rev
PC02	MBR	Electromagnetic brake sequence output	0	ms
PC03	*ENRS	Encoder output pulses selection	0000h	
PC04	**COP1	Function selection C-1	0000h	
PC05	**COP2	Function selection C-2	0000h	
PC06	*COP3	Function selection C-3	0000h	
PC07	ZSP	Zero speed	50	r/min
PC08		For manufacturer setting	0	
PC09	MOD1	Analog monitor 1 output	0000h	
PC10	MOD2	Analog monitor 2 output	0001h	
PC11	MO1	Analog monitor 1 offset	0	mV
PC12	MO2	Analog monitor 2 offset	0	mV
PC13	MOSDL	Analog monitor feedback position output standard data Low	0	pulse
PC14	MOSDH	Analog monitor feedback position output standard data High	0	10000 pulse
PC15		For manufacturer setting	0	
PC16			0000h	
PC17	**COP4	Function selection C-4	0000h	
PC18		For manufacturer setting	0000h	
PC19			0000h	
PC20			0000h	
PC21	*BPS	Alarm history clear	0000h	
PC22		For manufacturer setting	0000h	
PC23			0000h	
PC24			0000h	
PC25			0000h	
PC26			0000h	
PC27			0000h	
PC28			0000h	
PC29			0000h	
PC30			0000h	
PC31			0000h	
PC32			0000h	

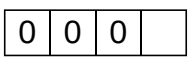
5.3.2 List of details

<table>
<tr><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th></tr>
<tr><td>PC01</td><td>ERZ
(Note 2)</td><td>Error excessive alarm level
This parameter cannot be used in the speed control mode.
Set error excessive alarm level with rotation amount of servo motor.
Note 1. Setting can be changed in parameter No.PC06.
2. For a driver with software version of B2 or later, reactivating the power supply to enable the setting value is not necessary. For a driver with software version of earlier than B2, reactivating the power supply is required to enable the setting value.</td><td>3</td><td>rev
(Note 1)</td><td>1
to
200</td></tr>
<tr><td>PC02</td><td>MBR</td><td>Electromagnetic brake sequence output
Used to set the delay time (Tb) between electronic brake interlock (MBR) and the base drive circuit is shut-off.</td><td>0</td><td>ms</td><td>0
to
1000</td></tr>
<tr><td>PC03</td><td>*ENRS</td><td>Encoder output pulse selection
Use to select the, encoder output pulse direction and encoder output pulse setting.
 
</td><td>0000h</td><td></td><td>Refer to Name and function column.</td></tr>
<tr><td>PC04</td><td>**COP1</td><td>Function selection C-1
Select the encoder cable communication system selection.
 
</td><td>0000h</td><td></td><td>Refer to Name and function column.</td></tr>
<tr><td>PC05</td><td>**COP2</td><td>Function selection C-2
Motor-less operation select.
 
</td><td>0000h</td><td></td><td>Refer to Name and function column.</td></tr>
</table>

<table>
<tr><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th></tr>
<tr><td>PC06</td><td>*COP3</td><td>Function selection C-3
Select the error excessive alarm level setting for parameter No.PC01.
 

Error excessive alarm level setting selection
0: 1 [rev]unit
1: 0.1 [rev]unit
2: 0.01 [rev]unit
3: 0.001[rev]unit

This parameter is available to software version B1 or later.</td><td>0000h</td><td></td><td>Refer to Name and function column.</td></tr>
<tr><td>PC07</td><td>ZSP</td><td>Zero speed
Used to set the output range of the zero speed (ZSP).
Zero speed signal detection has hysteresis width of 20r/min (Refer to section 3.5 (2) (b))</td><td>50</td><td>r/min</td><td>0 to 10000</td></tr>
<tr><td>PC08</td><td></td><td>For manufacturer setting
Do not change this value by any means.</td><td>0</td><td></td><td></td></tr>
<tr><td>PC09</td><td>MOD1</td><td>Analog monitor 1 output
Used to selection the signal provided to the analog monitor 1 (MO1) output. (Refer to section 5.3.3)
 

Analog monitor 1 (MO1) output selection
<table><tr><th>Setting</th><th>Item</th></tr><tr><td>0</td><td>Servo motor speed (±8V/max. speed)</td></tr><tr><td>1</td><td>Torque (±8V/max. torque) (Note 2)</td></tr><tr><td>2</td><td>Servo motor speed (+8V/max. speed)</td></tr><tr><td>3</td><td>Torque (+8V/max. torque) (Note 2)</td></tr><tr><td>4</td><td>Current command (±8V/max. current command)</td></tr><tr><td>5</td><td>Speed command (±8V/max. current command)</td></tr><tr><td>6</td><td>Droop pulses (±10V/100 pulses) (Note 1)</td></tr><tr><td>7</td><td>Droop pulses (±10V/1000 pulses) (Note 1)</td></tr><tr><td>8</td><td>Droop pulses (±10V/10000 pulses) (Note 1)</td></tr><tr><td>9</td><td>Droop pulses (±10V/100000 pulses) (Note 1)</td></tr><tr><td>A</td><td>Feedback position (±10V/1 Mpulses) (Note 1, 3)</td></tr><tr><td>B</td><td>Feedback position (±10V/10 Mpulses) (Note 1, 3)</td></tr><tr><td>C</td><td>Feedback position (±10V/100 Mpulses) (Note 1, 3)</td></tr><tr><td>D</td><td>Bus voltage (±8V/400V)(Note 4)</td></tr></table>
Note 1. Encoder pulse unit.
2. 8V is outputted at the maximum torque.
3. It can be used by the absolute position detection system.
4. For 400V class driver, the bus voltage becomes +8V/800V.</td><td>0000h</td><td></td><td>Refer to Name and function column.</td></tr>
<tr><td>PC10</td><td>MOD2</td><td>Analog monitor 2 output
Used to selection the signal provided to the analog monitor 2 (MO2) output. (Refer to section 5.3.3)
 

Select the analog monitor 2 (MO2) output
The settings are the same as those of parameter No.PC09.</td><td>0001h</td><td></td><td>Refer to Name and function column.</td></tr>
<tr><td>PC11</td><td>MO1</td><td>Analog monitor 1 offset
Used to set the offset voltage of the analog monitor 1 (MO1) output.</td><td>0</td><td>mV</td><td>-999 to 999</td></tr>
</table>

No.	Symbol	Name and function	Initial value	Unit	Setting range
PC12	MO2	Analog monitor 2 offset Used to set the offset voltage of the analog monitor 2 (MO2) output.	0	mV	-999 to 999
PC13	MOSDL	Analog monitor feedback position output standard data Low Used to set the standard position of feedback output with analog monitor 1 (M01) or 2 (M02). For this parameter, the lower-order four digits of standard position in decimal numbers are set.	0	pulse	-9999 to 9999
PC14	MOSDH	Analog monitor feedback position output standard data High Used to set the standard position of feedback output with analog monitor 1 (M01) or 2 (M02). For this parameter, the higher-order four digits of standard position in decimal numbers are set.	0	10000 pulse	-9999 to 9999
PC15		For manufacturer setting	0		
PC16		Do not change this value by any means.	0000h		
PC17	**COP4	Function Selection C-4 Home position setting condition in the absolute position detection system can be selected. 0 0 0 □ └ Selection of home position setting condition 0: Need to pass motor Z-phase after the power supply is switched on. 1: Not need to pass motor Z-phase after the power supply is switched on.	0000h		Refer to Name and function column.
PC18		For manufacturer setting	0000h		
PC19		Do not change this value by any means.	0000h		
PC20			0000h		
PC21	*BPS	Alarm history clear Used to clear the alarm history. 0 0 0 □ └ Alarm history clear 0: Invalid 1: Valid When alarm history clear is made valid, the alarm history is cleared at next power-on. After the alarm history is cleared, the setting is automatically made invalid (reset to 0).	0000h		Refer to Name and function column.
PC22		For manufacturer setting Do not change this value by any means.	0000h		
PC23			0000h		
PC24			0000h		
PC25			0000h		
PC26			0000h		
PC27			0000h		
PC28			0000h		
PC29			0000h		
PC30			0000h		
PC31			0000h		
PC32			0000h		

5.3.3 Analog monitor

The servo status can be output to two channels in terms of voltage. The servo status can be monitored using an ammeter.

(1) Setting

Change the following digits of parameter No.PC09, PC10.

Parameter No.PC09

0	0	0	

Analog monitor (MO1) output selection
(Signal output to across MO1-LG)

Parameter No.PC10

0	0	0	

Analog monitor (MO2) output selection
(Signal output to across MO2-LG)

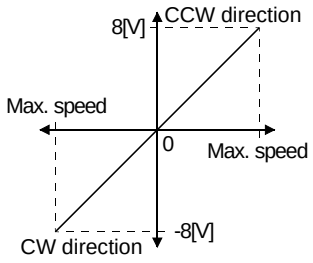
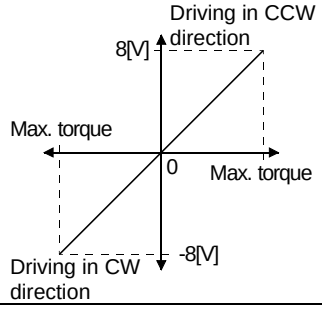
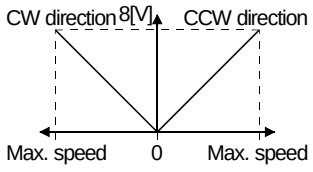
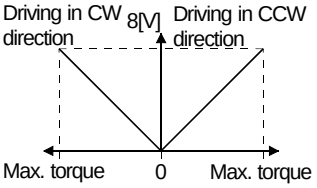
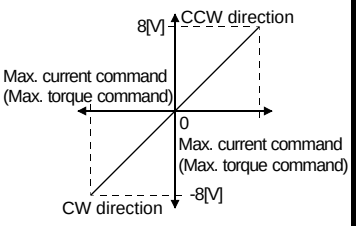
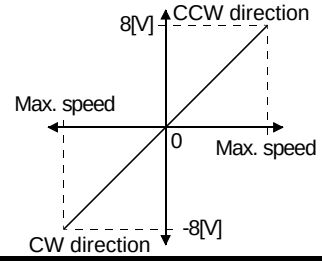
Parameters No.PC11 and PC12 can be used to set the offset voltages to the analog output voltages. The setting range is between −999 and 999mV.

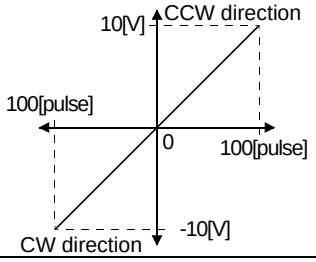
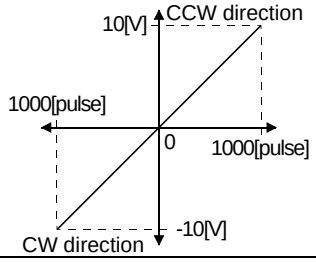
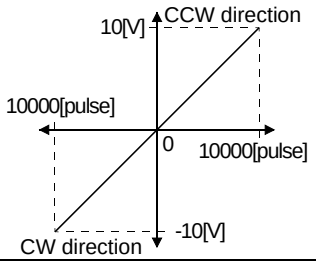
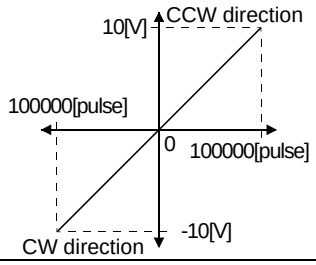
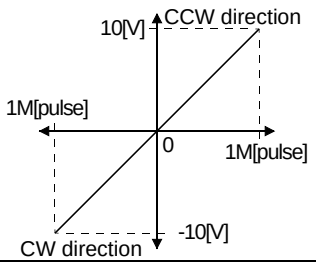
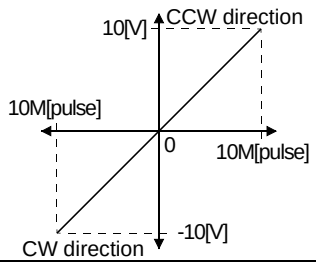
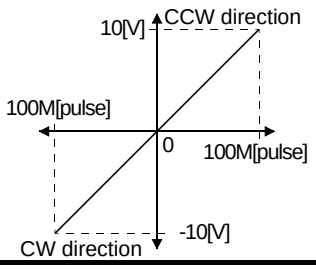
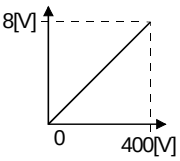
Parameter No.	Description	Setting range [mV]
PC11	Used to set the offset voltage for the analog monitor 1 (MO1).	−999 to 999
PC12	Used to set the offset voltage for the analog monitor 2 (MO2).	

(2) Set content

The driver is factory-set to output the servo motor speed to analog monitor 1 (MO1) and the torque to analog monitor (MO2). The setting can be changed as listed below by changing the parameter No.PC14 and PC12 value.

Refer to (3) for the measurement point.

Setting	Output item	Description	Setting	Output item	Description
0	Servo motor speed		1	Torque (Note 3)	
2	Servo motor speed		3	Torque (Note 3)	
4	Current command		5	Speed command	

Setting	Output item	Description	Setting	Output item	Description
6	Droop pulses (Note 1) (±10V/100 pulses)		7	Droop pulses (Note 1) (±10V/1000 pulses)	
8	Droop pulses (Note 1) (±10V/10000 pulses)		9	Droop pulses (Note 1) (±10V/100000 pulses)	
A	Feedback position (Note 1,2) (±10V/1 Mpulses)		B	Feedback position (Note 1,2) (±10V/10 Mpulses)	
C	Feedback position (Note 1,2) (±10V/100 Mpulses)		D	Bus voltage (Note 4)	

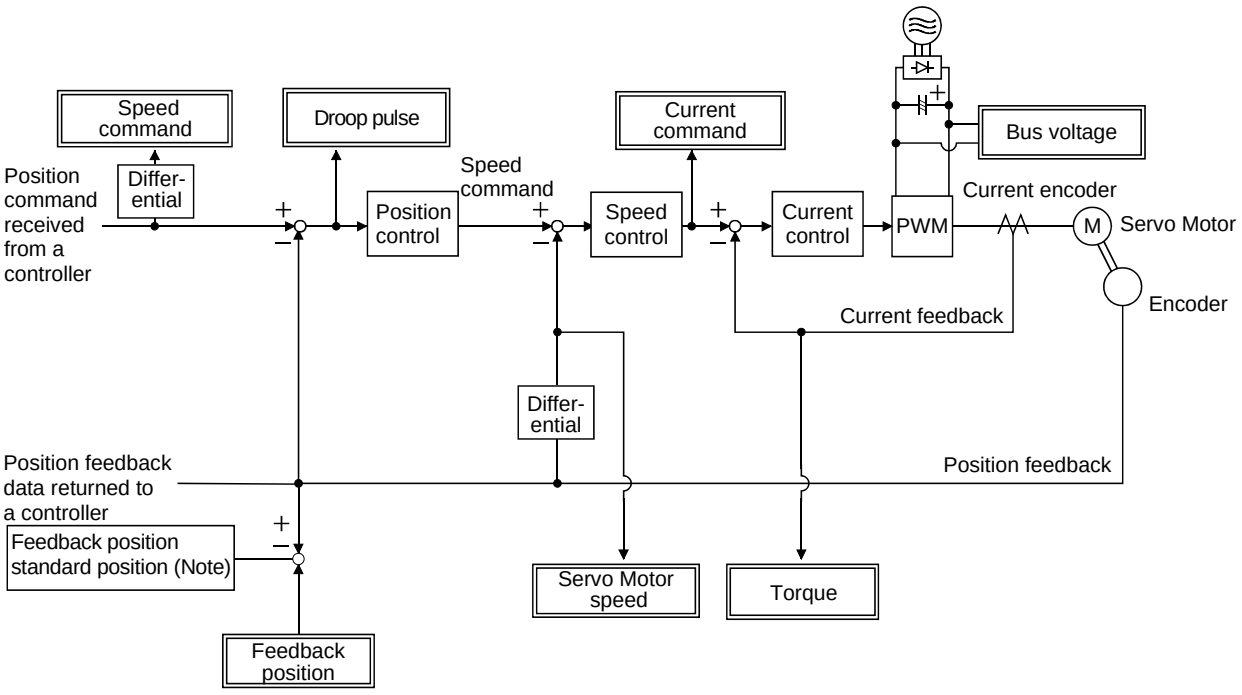
Note 1. Encoder pulse unit.

2. Available in position control mode

3. Outputs 8V at the maximum torque.

4. For 400V class driver, the bus voltage becomes +8V/800V.

(3) Analog monitor block diagram



Note. The feedback position is output based on the position data passed between servo system controller and driver. The parameter number No.PC13/PC14 can set up the standard position of feedback position that is output to analog monitor in order to adjust the output range of feedback position. The setting range is between −99999999 and 99999999 pulses.

Standard position of feedback position = Parameter No.PC14 setting value × 10000 + Parameter No.PC13 setting value

Parameter No.	Description	Setting range
PC13	Sets the lower-order four digits of the standard position of feedback position	−9999 to 9999 [pulse]
PC14	Sets the higher-order four digits of the standard position of feedback position	−9999 to 9999 [10000pulses]

5.3.4 Alarm history clear

The driver stores one current alarm and five past alarms from when its power is switched on first. To control alarms which will occur during operation, clear the alarm history using parameter No.PC21 before starting operation.

Clearing the alarm history automatically returns to "□□□0".

After setting, this parameter is made valid by switch power from OFF to ON.

Parameter No.PC21

0	0	0	

Alarm history clear
0: Invalid (not cleared)
1: Valid (cleared)

5.4 I/O setting parameters (No.PD□□)

POINT

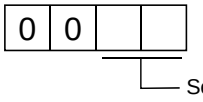
- Parameter whose symbol is preceded by * is made valid with the following conditions.

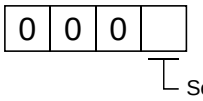
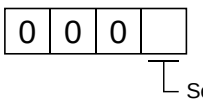
  * : Set the parameter value, switch power off once after setting, and then switch it on again, or perform the driver reset.

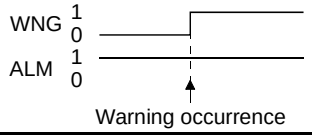
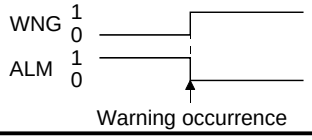
5.4.1 Parameter list

No.	Symbol	Name	Initial value	Unit
PD01		For manufacturer setting	0000h	
PD02			0000h	
PD03			0000h	
PD04			0000h	
PD05			0000h	
PD06			0000h	
PD07	*DO1	Output signal device selection 1 (CN3-13)	0005h	
PD08	*DO2	Output signal device selection 2 (CN3-9)	0004h	
PD09	*DO3	Output signal device selection 3 (CN3-15)	0003h	
PD10		For manufacturer setting	0000h	
PD11			0004h	
PD12			0000h	
PD13			0000h	
PD14	*DOP3	Function selection D-3	0000h	
PD15		For manufacturer setting	0000h	
PD16			0000h	
PD17			0000h	
PD18			0000h	
PD19			0000h	
PD20			0000h	
PD21			0000h	
PD22			0000h	
PD23			0000h	
PD24			0000h	
PD25			0000h	
PD26			0000h	
PD27			0000h	
PD28			0000h	
PD29			0000h	
PD30			0000h	
PD31			0000h	
PD32			0000h	

5.4.2 List of details

<table>
<tr><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th></tr>
<tr><td>PD01</td><td rowspan="6"></td><td rowspan="6">For manufacturer setting
Do not change this value by any means.</td><td>0000h</td><td rowspan="6"></td><td rowspan="6"></td></tr>
<tr><td>PD02</td><td>0000h</td></tr>
<tr><td>PD03</td><td>0000h</td></tr>
<tr><td>PD04</td><td>0000h</td></tr>
<tr><td>PD05</td><td>0000h</td></tr>
<tr><td>PD06</td><td>0000h</td></tr>
<tr><td>PD07</td><td>*DO1</td><td>Output signal device selection 1 (CN3-13)
Any input signal can be assigned to the CN3-13 pin.
 

The devices that can be assigned in each control mode are those that have the symbols indicated in the following table.
<table><tr><th>Setting</th><th>Device</th></tr><tr><td>00</td><td>Always OFF</td></tr><tr><td>01</td><td>For manufacturer setting (Note 3)</td></tr><tr><td>02</td><td>RD</td></tr><tr><td>03</td><td>ALM</td></tr><tr><td>04</td><td>INP (Note 1)</td></tr><tr><td>05</td><td>MBR</td></tr><tr><td>06</td><td>DB</td></tr><tr><td>07</td><td>TLC</td></tr><tr><td>08</td><td>WNG</td></tr><tr><td>09</td><td>BWNG</td></tr></table><table><tr><th>Setting</th><th>Device</th></tr><tr><td>0A</td><td>Always OFF (Note 2)</td></tr><tr><td>0B</td><td>For manufacturer setting (Note 3)</td></tr><tr><td>0C</td><td>ZSP</td></tr><tr><td>0D</td><td>For manufacturer setting (Note 3)</td></tr><tr><td>0E</td><td>For manufacturer setting (Note 3)</td></tr><tr><td>0F</td><td>CDPS</td></tr><tr><td>10</td><td>For manufacturer setting (Note 3)</td></tr><tr><td>11</td><td>ABSV (Note 1)</td></tr><tr><td>12 to 1F</td><td>For manufacturer setting (Note 3)</td></tr><tr><td>20 to 3F</td><td>For manufacturer setting (Note 3)</td></tr></table>Note 1. It becomes always OFF in speed control mode.
2. It becomes SA in speed control mode.
3. For manufacturer setting
Never change this setting.</td><td>0005h</td><td></td><td>Refer to Name and function column.</td></tr>
<tr><td>PD08</td><td>*DO2</td><td>Output signal device selection 2 (CN3-9)
Any input signal can be assigned to the CN3-9 pin.
The devices that can be assigned and the setting method are the same as in parameter No.PD07.
 
</td><td>0004h</td><td></td><td>Refer to Name and function column.</td></tr>
<tr><td>PD09</td><td>*DO3</td><td>Output signal device selection 3 (CN3-15)
Any input signal can be assigned to the CN3-15 pin.
The devices that can be assigned and the setting method are the same as in parameter No.PD07.
 
</td><td>0003h</td><td></td><td>Refer to Name and function column.</td></tr>
</table>

<table>
<tr><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th></tr>
<tr><td>PD10</td><td rowspan="4"></td><td rowspan="4">For manufacturer setting
Do not change this value by any means.</td><td>0000h</td><td rowspan="4"></td><td rowspan="4"></td></tr>
<tr><td>PD11</td><td>0004h</td></tr>
<tr><td>PD12</td><td>0000h</td></tr>
<tr><td>PD13</td><td>0000h</td></tr>
<tr><td>PD14</td><td>*DOP3</td><td>Function selection D-3
Set the ALM output signal at warning occurrence.
0 0 _ 0
└ Selection of output device at warning occurrence
Select the warning (WNG) and trouble (ALM) output status at warning occurrence.
Output of Servo amplifier
<table><tr><th>Setting</th><th>(Note) Device status</th></tr><tr><td>0</td><td>  </td></tr><tr><td>1</td><td>  </td></tr></table>Note. 0: off
1: on</td><td>0000h</td><td></td><td>Refer to Name and function column.</td></tr>
<tr><td>PD15</td><td rowspan="18"></td><td rowspan="18">For manufacturer setting
Do not change this value by any means.</td><td>0000h</td><td rowspan="18"></td><td rowspan="18"></td></tr>
<tr><td>PD16</td><td>0000h</td></tr>
<tr><td>PD17</td><td>0000h</td></tr>
<tr><td>PD18</td><td>0000h</td></tr>
<tr><td>PD19</td><td>0000h</td></tr>
<tr><td>PD20</td><td>0000h</td></tr>
<tr><td>PD21</td><td>0000h</td></tr>
<tr><td>PD22</td><td>0000h</td></tr>
<tr><td>PD23</td><td>0000h</td></tr>
<tr><td>PD24</td><td>0000h</td></tr>
<tr><td>PD25</td><td>0000h</td></tr>
<tr><td>PD26</td><td>0000h</td></tr>
<tr><td>PD27</td><td>0000h</td></tr>
<tr><td>PD28</td><td>0000h</td></tr>
<tr><td>PD29</td><td>0000h</td></tr>
<tr><td>PD30</td><td>0000h</td></tr>
<tr><td>PD31</td><td>0000h</td></tr>
<tr><td>PD32</td><td>0000h</td></tr>
</table>

MEMO

6. GENERAL GAIN ADJUSTMENT

6. GENERAL GAIN ADJUSTMENT

6.1 Different adjustment methods

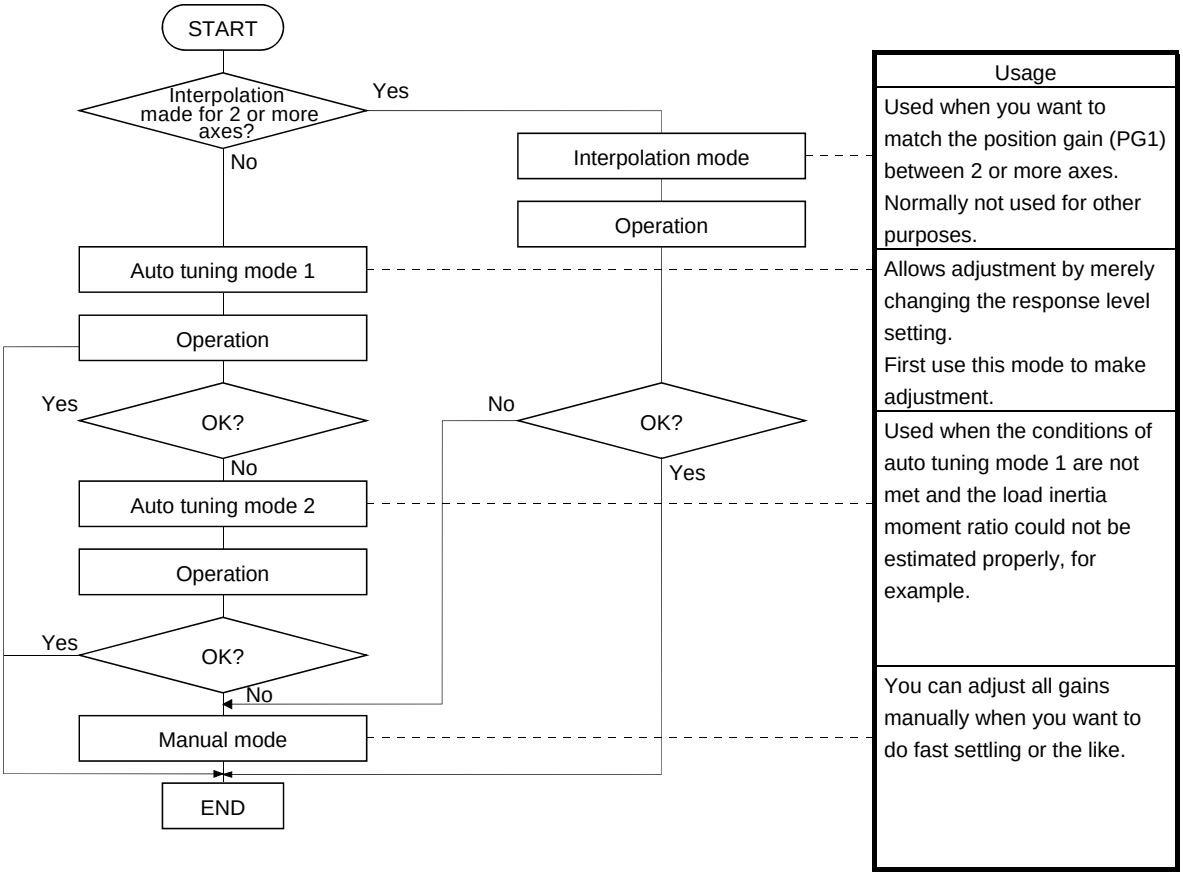
6.1.1 Adjustment on a single driver

The gain adjustment in this section can be made on a single driver. For gain adjustment, first execute auto tuning mode 1. If you are not satisfied with the results, execute auto tuning mode 2 and manual mode in this order.

(1) Gain adjustment mode explanation

Gain adjustment mode	Parameter No.PA08 setting	Estimation of load inertia moment ratio	Automatically set parameters	Manually set parameters
Auto tuning mode 1 (initial value)	0001	Always estimated	GD2 (parameter No.PB06) PG2 (parameter No.PB08) PG1 (parameter No.PB07) VG2 (parameter No.PB09) VIC (parameter No.PB10)	Response level setting of parameter No.2
Auto tuning mode 2	0002	Fixed to parameter No. PB06 value	PG2 (parameter No.PB08) PG1 (parameter No.PB07) VG2 (parameter No.PB09) VIC (parameter No.PB10)	GD2 (parameter No.PB06) Response level setting of parameter No.PA09
Manual mode	0003			PG1 (parameter No.PB07) GD2 (parameter No.PB06) VG2 (parameter No.PB09) VIC (parameter No.PB10)
Interpolation mode	0000	Always estimated	GD2 (parameter No.PB06) PG2 (parameter No.PB08) VG2 (parameter No.PB09) VIC (parameter No.PB10)	PG1 (parameter No.PB07)

(2) Adjustment sequence and mode usage



6.1.2 Adjustment using set up software（MR Configurator）

This section gives the functions and adjustment that may be performed by using the driver with the set up software（MR Configurator） which operates on a personal computer.

Function	Description	Adjustment
Machine analyzer	With the machine and servo motor coupled, the characteristic of the mechanical system can be measured by giving a random vibration command from the personal computer to the servo and measuring the machine response.	・You can grasp the machine resonance frequency and determine the notch frequency of the machine resonance suppression filter. ・You can automatically set the optimum gains in response to the machine characteristic. This simple adjustment is suitable for a machine which has large machine resonance and does not require much settling time.
Gain search	Executing gain search under to-and-fro positioning command measures settling characteristic while simultaneously changing gains, and automatically searches for gains which make settling time shortest.	・You can automatically set gains which make positioning settling time shortest.
Machine simulation	Response at positioning settling of a machine can be simulated from machine analyzer results on personal computer.	・You can optimize gain adjustment and command pattern on personal computer.

6.2 Auto tuning

6.2.1 Auto tuning mode

The driver has a real-time auto tuning function which estimates the machine characteristic (load inertia moment ratio) in real time and automatically sets the optimum gains according to that value. This function permits ease of gain adjustment of the driver.

(1) Auto tuning mode 1

The driver is factory-set to the auto tuning mode 1.

In this mode, the load inertia moment ratio of a machine is always estimated to set the optimum gains automatically.

The following parameters are automatically adjusted in the auto tuning mode 1.

Parameter No.	Abbreviation	Name
PB06	GD2	Ratio of load inertia moment to servo motor inertia moment
PB07	PG1	Model loop gain
PB08	PG2	Position loop gain
PB09	VG2	Speed loop gain
PB10	VIC	Speed integral compensation

POINT

- The auto tuning mode 1 may not be performed properly if the following conditions are not satisfied.
- Time to reach 2000r/min is the acceleration/deceleration time constant of 5s or less.
- Speed is 150r/min or higher.
- The ratio of load inertia moment to servo motor inertia moment is 100 times or less.
- The acceleration/deceleration torque is 10% or more of the rated torque.
- Under operating conditions which will impose sudden disturbance torque during acceleration/deceleration or on a machine which is extremely loose, auto tuning may not function properly, either. In such cases, use the auto tuning mode 2 or manual mode to make gain adjustment.

(2) Auto tuning mode 2

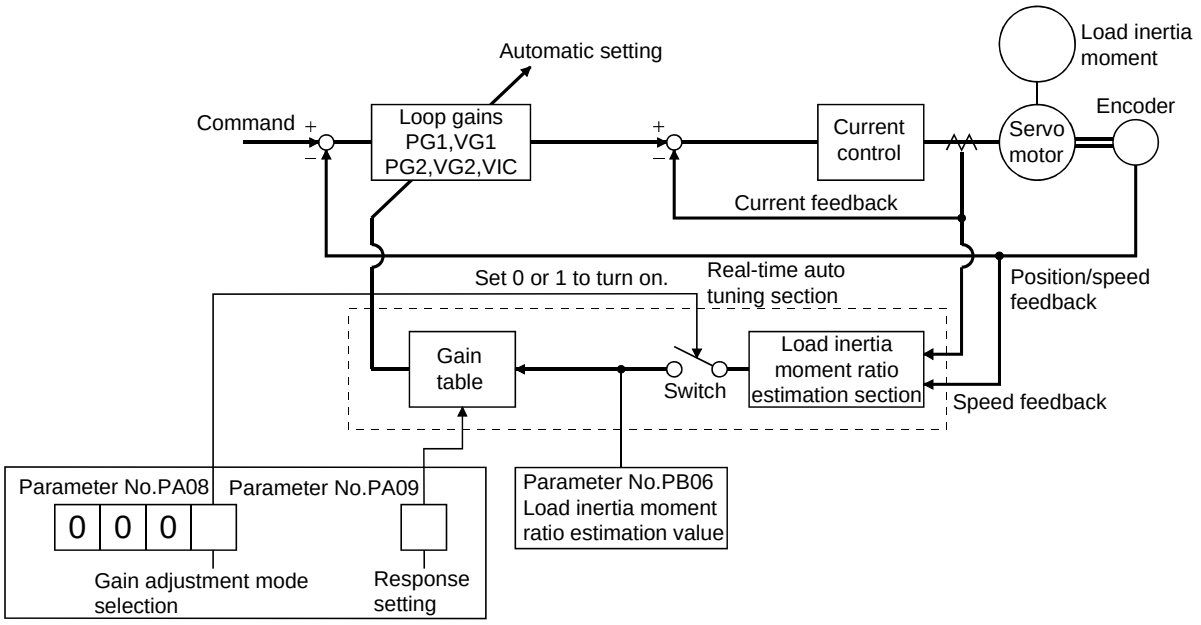
Use the auto tuning mode 2 when proper gain adjustment cannot be made by auto tuning mode 1. Since the load inertia moment ratio is not estimated in this mode, set the value of a correct load inertia moment ratio (parameter No.PB06).

The following parameters are automatically adjusted in the auto tuning mode 2.

Parameter No.	Abbreviation	Name
PB07	PG1	Model loop gain
PB08	PG2	Position loop gain
PB09	VG2	Speed loop gain
PB10	VIC	Speed integral compensation

6.2.2 Auto tuning mode operation

The block diagram of real-time auto tuning is shown below.



When a servo motor is accelerated/decelerated, the load inertia moment ratio estimation section always estimates the load inertia moment ratio from the current and speed of the servo motor. The results of estimation are written to parameter No.PB06 (the ratio of load inertia moment to servo motor). These results can be confirmed on the status display screen of the set up software（MR Configurator）.

If the value of the load inertia moment ratio is already known or if estimation cannot be made properly, chose the "auto tuning mode 2" (parameter No.PA08: 0002) to stop the estimation of the load inertia moment ratio (Switch in above diagram turned off), and set the load inertia moment ratio (parameter No.34) manually.

From the preset load inertia moment ratio (parameter No.PB06) value and response level (parameter No.PA09), the optimum loop gains are automatically set on the basis of the internal gain tale.

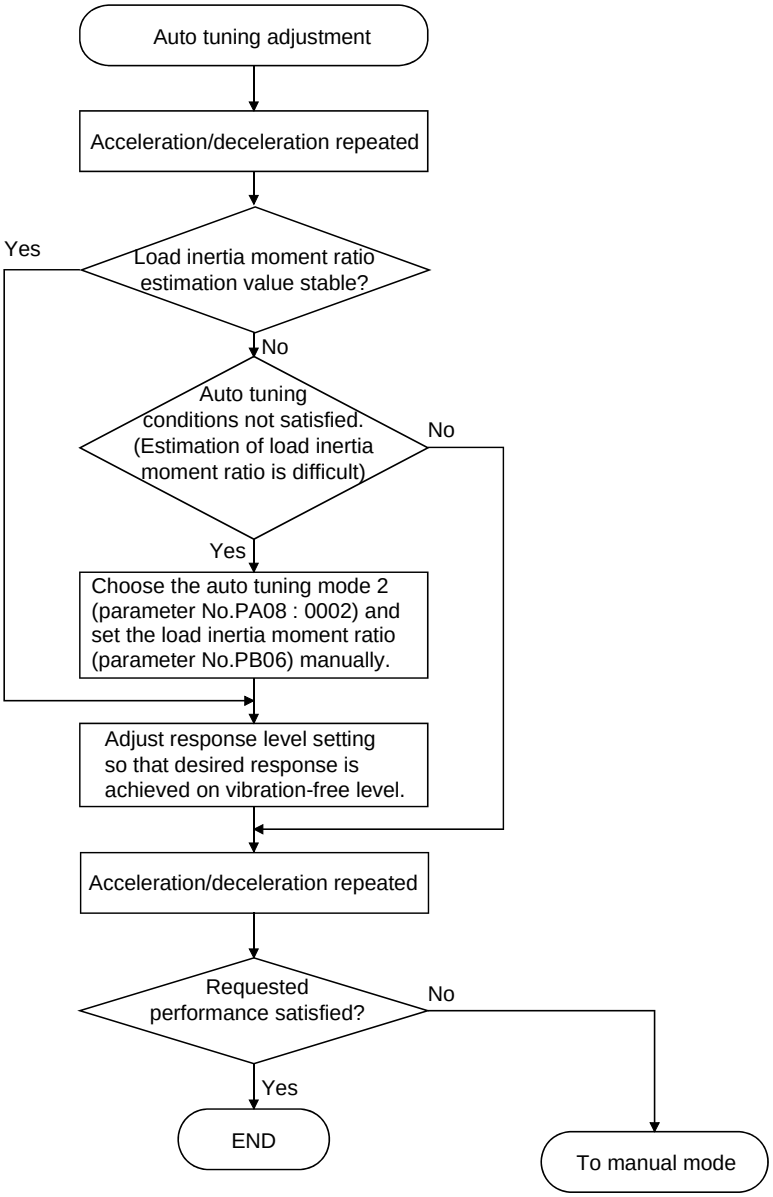
The auto tuning results are saved in the EEP-ROM of the driver every 60 minutes since power-on. At power-on, auto tuning is performed with the value of each loop gain saved in the EEP-ROM being used as an initial value.

POINT

- If sudden disturbance torque is imposed during operation, the estimation of the inertia moment ratio may malfunction temporarily. In such a case, choose the "auto tuning mode 2" (parameter No.PA08: 0002) and set the correct load inertia moment ratio in parameter No.PB06.
- When any of the auto tuning mode 1 and auto tuning mode settings is changed to the manual mode 2 setting, the current loop gains and load inertia moment ratio estimation value are saved in the EEP-ROM.

6.2.3 Adjustment procedure by auto tuning

Since auto tuning is made valid before shipment from the factory, simply running the servo motor automatically sets the optimum gains that match the machine. Merely changing the response level setting value as required completes the adjustment. The adjustment procedure is as follows.

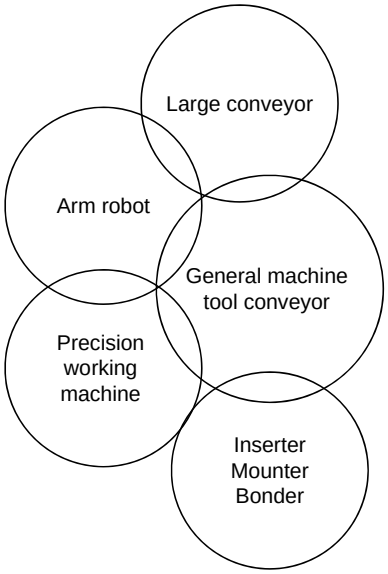


6.2.4 Response level setting in auto tuning mode

Set the response (The first digit of parameter No.PA09) of the whole servo system. As the response level setting is increased, the track ability and settling time for a command decreases, but a too high response level will generate vibration. Hence, make setting until desired response is obtained within the vibration-free range.

If the response level setting cannot be increased up to the desired response because of machine resonance beyond 100Hz, filter tuning mode (parameter No.PB01) or machine resonance suppression filter (parameter No.PB13 to PB16) may be used to suppress machine resonance. Suppressing machine resonance may allow the response level setting to increase. Refer to section 7.3 for filter tuning mode and machine resonance suppression filter.

Setting of parameter No.PA09

Response level setting	Machine characteristic		
	Machine rigidity	Machine resonance frequency guideline	Guideline of corresponding machine
1	Low	10.0	
2		11.3	
3		12.7	
4		14.3	
5		16.1	
6		18.1	
7		20.4	
8		23.0	
9		25.9	
10		29.2	
11		32.9	
12		37.0	
13		41.7	
14		47.0	
15		52.9	
16	Middle	59.6	
17		67.1	
18		75.6	
19		85.2	
20		95.9	
21		108.0	
22		121.7	
23		137.1	
24		154.4	
25		173.9	
26		195.9	
27		220.6	
28		248.5	
29		279.9	
30		315.3	
31		355.1	
32	High	400.0	

6.3 Manual mode 1 (simple manual adjustment)

If you are not satisfied with the adjustment of auto tuning, you can make simple manual adjustment with three parameters.

> POINT
>
> ・If machine resonance occurs, filter tuning mode (parameter No.PB01) or machine resonance suppression filter (parameter No.PB13 to PB16) may be used to suppress machine resonance. (Refer to section 7.3.)

(1) For speed control

(a) Parameters

The following parameters are used for gain adjustment.

Parameter No.	Abbreviation	Name
PB06	GD2	Ratio of load inertia moment to servo motor inertia moment
PB07	PG1	Model loop gain
PB09	VG2	Speed loop gain
PB10	VIC	Speed integral compensation

(b) Adjustment procedure

Step	Operation	Description
1	Brief-adjust with auto tuning. Refer to section 6.2.3.	
2	Change the setting of auto tuning to the manual mode (Parameter No.PA08: 0003).	
3	Set an estimated value to the ratio of load inertia moment to servo motor inertia moment. (If the estimate value with auto tuning is correct, setting change is not required.)	
4	Set a slightly smaller value to the model loop gain Set a slightly larger value to the speed integral compensation.	
5	Increase the speed loop gain within the vibration- and unusual noise-free range, and return slightly if vibration takes place.	Increase the speed loop gain.
6	Decrease the speed integral compensation within the vibration-free range, and return slightly if vibration takes place.	Decrease the time constant of the speed integral compensation.
7	Increase the model loop gain, and return slightly if overshooting takes place.	Increase the model loop gain.
8	If the gains cannot be increased due to mechanical system resonance or the like and the desired response cannot be achieved, response may be increased by suppressing resonance with filter tuning mode or machine resonance suppression filter and then executing steps 2 and 3.	Suppression of machine resonance. Refer to section 7.2, 7.3.
9	While checking the settling characteristic and rotational status, fine-adjust each gain.	Fine adjustment

(c)Adjustment description

1) Speed loop gain (parameter No.PB09)

This parameter determines the response level of the speed control loop. Increasing this value enhances response but a too high value will make the mechanical system liable to vibrate. The actual response frequency of the speed loop is as indicated in the following expression.

$$\text{Speed loop response frequency(Hz)} = \frac{\text{Speed loop gain setting}}{(1+\text{ratio of load inertia moment to servo motor inertia moment}) \times 2\pi}$$

2) Speed integral compensation (VIC: parameter No.PB10)

To eliminate stationary deviation against a command, the speed control loop is under proportional integral control. For the speed integral compensation, set the time constant of this integral control. Increasing the setting lowers the response level. However, if the load inertia moment ratio is large or the mechanical system has any vibratory element, the mechanical system is liable to vibrate unless the setting is increased to some degree. The guideline is as indicated in the following expression.

$$\text{Speed integral compensation setting(ms)} \geq \frac{2000 \text{ to } 3000}{\text{Speed loop gain setting}/ (1+\text{ratio of load inertia moment to servo motor inertia moment setting})}$$

3) Model loop gain (PG1: Parameter No.PB07)

This parameter determines the response level to a position command. Increasing the model loop gain improves track ability to a position command, but a too high value will make overshooting liable to occur at the time of setting.

$$\text{Model loop gain guideline} \leq \frac{\text{Speed loop gain setting}}{(1+\text{ratio of load inertia moment to servo motor inertia moment})} \times \left(\frac{1}{4} \text{ to } \frac{1}{8}\right)$$

(2) For position control

(a) Parameters

The following parameters are used for gain adjustment.

Parameter No.	Abbreviation	Name
PB06	GD2	Ratio of load inertia moment to servo motor inertia moment
PB07	PG1	Model loop gain
PB08	PG2	Position loop gain
PB09	VG2	Speed loop gain
PB10	VIC	Speed integral compensation

(b) Adjustment procedure

Step	Operation	Description
1	Brief-adjust with auto tuning. Refer to section 6.2.3.	
2	Change the setting of auto tuning to the manual mode (Parameter No.PA08: 0003).	
3	Set an estimated value to the ratio of load inertia moment to servo motor inertia moment. (If the estimate value with auto tuning is correct, setting change is not required.)	
4	Set a slightly smaller value to the model loop gain and the position loop gain. Set a slightly larger value to the speed integral compensation.	
5	Increase the speed loop gain within the vibration- and unusual noise-free range, and return slightly if vibration takes place.	Increase the speed loop gain.
6	Decrease the speed integral compensation within the vibration-free range, and return slightly if vibration takes place.	Decrease the time constant of the speed integral compensation.
7	Increase the position loop gain, and return slightly if vibration takes place.	Increase the position loop gain.
8	Increase the model loop gain, and return slightly if overshooting takes place.	Increase the position loop gain.
9	If the gains cannot be increased due to mechanical system resonance or the like and the desired response cannot be achieved, response may be increased by suppressing resonance with filter tuning mode or machine resonance suppression filter and then executing steps 3 to 5.	Suppression of machine resonance. Refer to section 7.2・7.3.
10	While checking the settling characteristic and rotational status, fine-adjust each gain.	Fine adjustment

(c) Adjustment description

1) Speed loop gain (VG2: parameter No.PB09)

This parameter determines the response level of the speed control loop. Increasing this value enhances response but a too high value will make the mechanical system liable to vibrate. The actual response frequency of the speed loop is as indicated in the following expression.

$$\text{Speed loop response frequency(Hz)} = \frac{\text{Speed loop gain 2 setting}}{(1+\text{ ratio of load inertia moment to servo motor inertia moment}) \times 2\pi}$$

2) Speed integral compensation (VIC: parameter No.PB10)

To eliminate stationary deviation against a command, the speed control loop is under proportional integral control. For the speed integral compensation, set the time constant of this integral control. Increasing the setting lowers the response level. However, if the load inertia moment ratio is large or the mechanical system has any vibratory element, the mechanical system is liable to vibrate unless the setting is increased to some degree. The guideline is as indicated in the following expression.

$$\text{Speed integral compensation setting(ms)} \geq \frac{\text{2000 to 3000}}{\text{Speed loop gain 2 setting/ (1+ ratio of load inertia moment to servo motor inertia moment 2 setting)}}$$

3) Model loop gain (PG1: Parameter No.PB07)

This parameter determines the response level to a position command. Increasing the model loop gain improves track ability to a position command, but a too high value will make overshooting liable to occur at the time of setting.

$$\text{Model loop gain guideline} \leq \frac{\text{Speed loop gain setting}}{(1+\text{ ratio of load inertia moment to servo motor inertia moment})} \times \left(\frac{1}{4} \text{ to } \frac{1}{8}\right)$$

4) Model loop gain (PG1: parameter No.PB07)

This parameter determines the response level to a position command. Increasing position loop gain 1 improves track ability to a position command but a too high value will make overshooting liable to occur at the time of settling.

$$\text{Model loop gain guideline} \leq \frac{\text{Speed loop gain 2 setting}}{(1+\text{ ratio of load inertia moment to servo motor inertia moment})} \times \left(\frac{1}{4} \text{ to } \frac{1}{8}\right)$$

6.4 Interpolation mode

The interpolation mode is used to match the position loop gains of the axes when performing the interpolation operation of servo motors of two or more axes for an X-Y table or the like. In this mode, manually set the model loop gain that determines command track ability. Other parameters for gain adjustment are set automatically.

(1) Parameter

(a) Automatically adjusted parameters

The following parameters are automatically adjusted by auto tuning.

Parameter No.	Abbreviation	Name
PB06	GD2	Ratio of load inertia moment to servo motor inertia moment
PB08	PG2	Position loop gain
PB09	VG2	Speed loop gain
PB10	VIC	Speed integral compensation

(b) Manually adjusted parameters

The following parameters are adjustable manually.

Parameter No.	Abbreviation	Name
PB07	PG1	Model loop gain

(2) Adjustment procedure

Step	Operation	Description
1	Set to the auto tuning mode.	Select the auto tuning mode 1.
2	During operation, increase the response level setting (parameter No.PA09), and return the setting if vibration occurs.	Adjustment in auto tuning mode 1.
3	Check the values of model loop gain.	Check the upper setting limits.
4	Set the interpolation mode (parameter No.PA08: 0000).	Select the interpolation mode.
5	Set the model loop gain of all the axes to be interpolated to the same value. At that time, adjust to the setting value of the axis, which has the smallest model loop gain.	Set position loop gain.
6	Looking at the interpolation characteristic and rotation status, fine-adjust the gains and response level setting.	Fine adjustment.

(3) Adjustment description

(a) Model loop gain (parameter No.PB07)

This parameter determines the response level of the position control loop. Increasing model loop gain improves track ability to a position command but a too high value will make overshooting liable to occur at the time of settling. The droop pulse value is determined by the following expression.

$$\text{Droop pulse value (pulse)} = \frac{\dfrac{\text{Rotation speed (r/min)}}{60} \times 262144\text{(pulse)}}{\text{Model loop gain setting}}$$

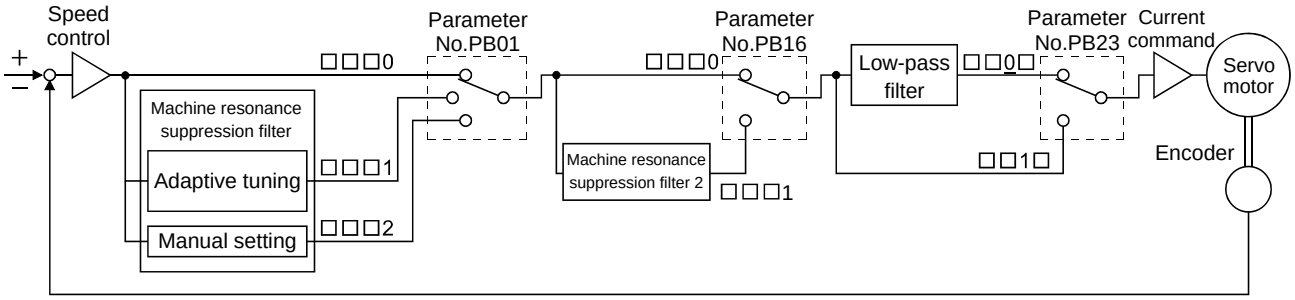
7. SPECIAL ADJUSTMENT FUNCTIONS

7. SPECIAL ADJUSTMENT FUNCTIONS

> POINT
>
> ・The functions given in this chapter need not be used generally. Use them if you are not satisfied with the machine status after making adjustment in the methods in chapter 7.

If a mechanical system has a natural resonance point, increasing the servo system response level may cause the mechanical system to produce resonance (vibration or unusual noise) at that resonance frequency.
Using the machine resonance suppression filter and adaptive tuning can suppress the resonance of the mechanical system.

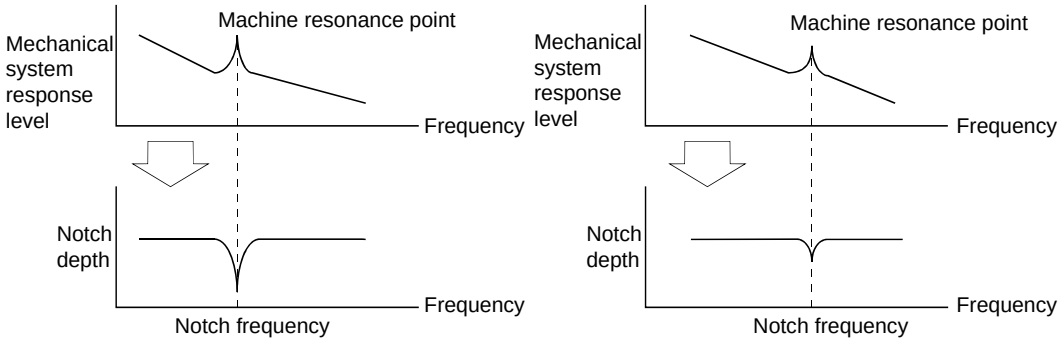
7.1 Function block diagram



7.2 Adaptive filter Ⅱ

(1) Function

Adaptive filter Ⅱ (adaptive tuning) is a function in which the controller detects machine vibration for a predetermined period of time and sets the filter characteristics automatically to suppress mechanical system vibration. Since the filter characteristics (frequency, depth) are set automatically, you need not be conscious of the resonance frequency of a mechanical system.



When machine resonance is large and frequency is low When machine resonance is small and frequency is high

> POINT
>
> ・The machine resonance frequency which adaptive tuning mode can respond to is about 100 to 2.25kHz. Adaptive vibration suppression control has no effect on the resonance frequency outside this range.
>
> ・Adaptive vibration suppression control may provide no effect on a mechanical system which has complex resonance characteristics.

(2) Parameters

The operation of adaptive tuning mode (parameter No.PB01).

Parameter No.PB01

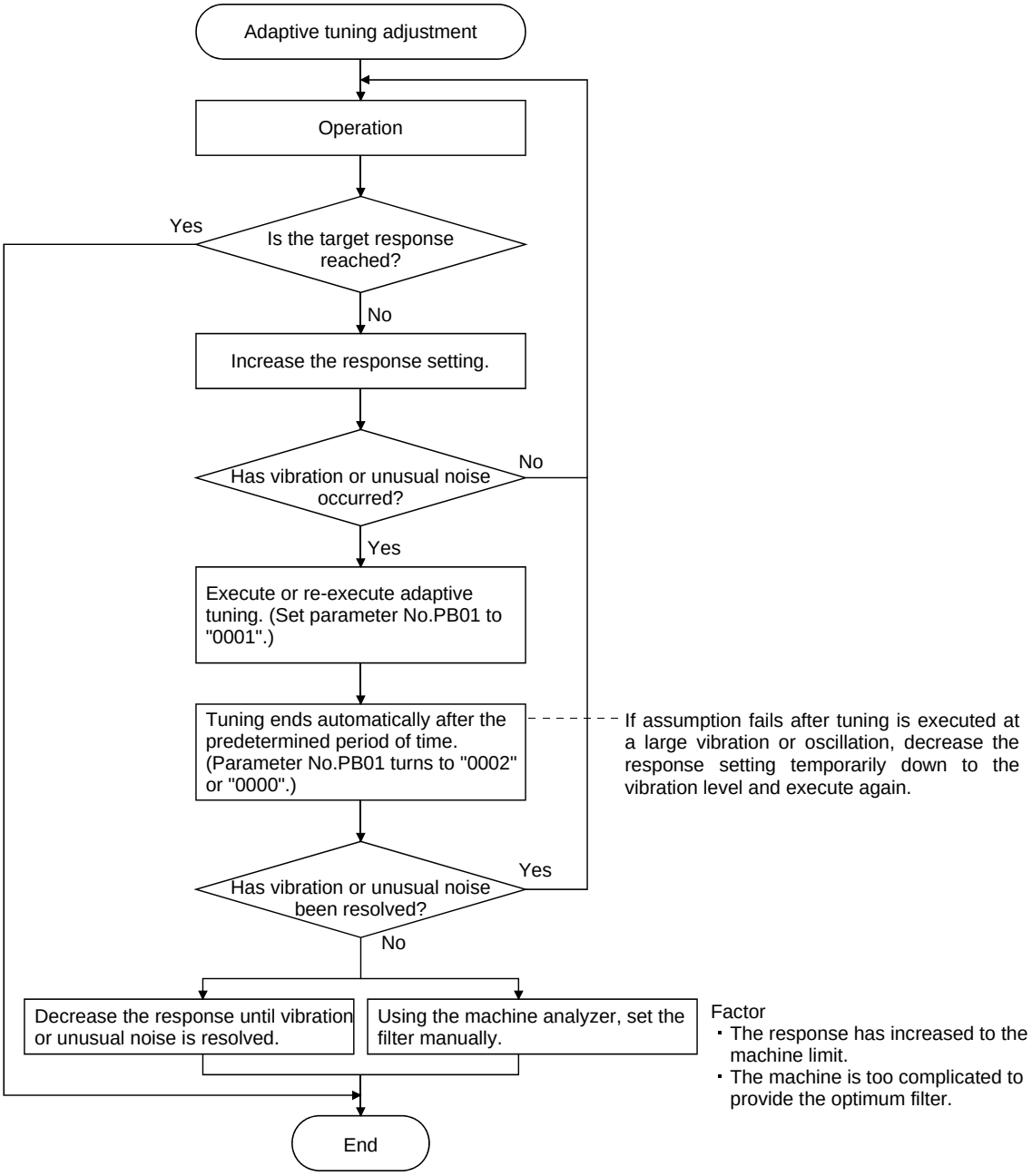
0	0	0	

Filter tuning mode selection

Setting	Filter adjustment mode	Automatically set parameter
0	Filter OFF	(Note)
1	Filter tuning mode	Parameter No.PB13 Parameter No.PB14
2	Manual mode	

Note. Parameter No.PB19 and PB20 are fixed to the initial values.

(3) Adaptive tuning mode procedure



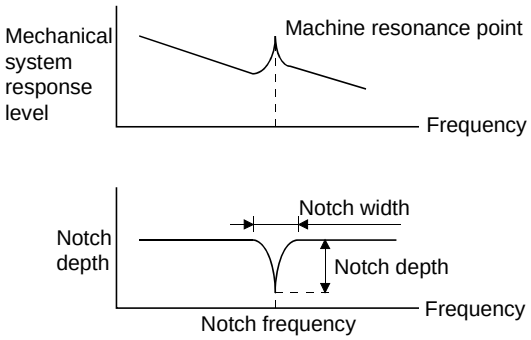
POINT

- "Filter OFF" enables a return to the factory-set initial value.
- When adaptive tuning is executed, vibration sound increases as an excitation signal is forcibly applied for several seconds.
- When adaptive tuning is executed, machine resonance is detected for a maximum of 10 seconds and a filter is generated. After filter generation, the adaptive tuning mode automatically shifts to the manual mode.
- Adaptive tuning generates the optimum filter with the currently set control gains. If vibration occurs when the response setting is increased, execute adaptive tuning again.
- During adaptive tuning, a filter having the best notch depth at the set control gain is generated. To allow a filter margin against machine resonance, increase the notch depth in the manual mode.

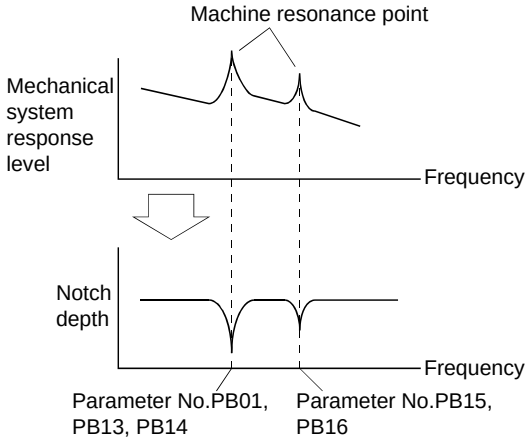
7.3 Machine resonance suppression filter

(1) Function

The machine resonance suppression filter is a filter function (notch filter) which decreases the gain of the specific frequency to suppress the resonance of the mechanical system. You can set the gain decreasing frequency (notch frequency), gain decreasing depth and width.



You can use the machine resonance suppression filter 1 (parameter No.PB13, PB14) and machine resonance suppression filter 2 (parameter No.PB15, PB16) to suppress the vibration of two resonance frequencies. Execution of adaptive tuning in the filter tuning mode automatically adjusts the machine resonance suppression filter. When adaptive tuning is ON, the adaptive tuning mode shifts to the manual mode after the predetermined period of time. The manual mode enables manual setting using the machine resonance suppression filter 1.



(2) Parameters

(a) Machine resonance suppression filter 1 (parameter No.PB13, PB14)

Set the notch frequency, notch depth and notch width of the machine resonance suppression filter 1 (parameter No.PB13, PB14)

When you have made adaptive filter tuning mode (parameter No.PB01) "manual mode", set up the machine resonance suppression filter 1 becomes effective.

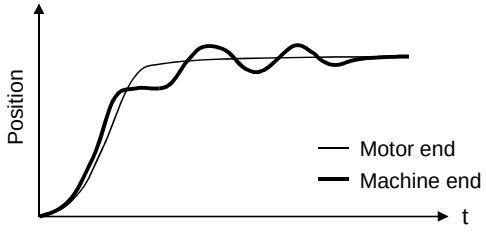
POINT

- The machine resonance suppression filter is a delay factor for the servo system. Hence, vibration may increase if you set a wrong resonance frequency or a too deep notch.
- If the frequency of machine resonance is unknown, decrease the notch frequency from higher to lower ones in order. The optimum notch frequency is set at the point where vibration is minimal.
- A deeper notch has a higher effect on machine resonance suppression but increases a phase delay and may increase vibration.
- A deeper notch has a higher effect on machine resonance suppression but increases a phase delay and may increase vibration.
- The machine characteristic can be grasped beforehand by the machine analyzer on the set up software（MR Configurator）. This allows the required notch frequency and depth to be determined.

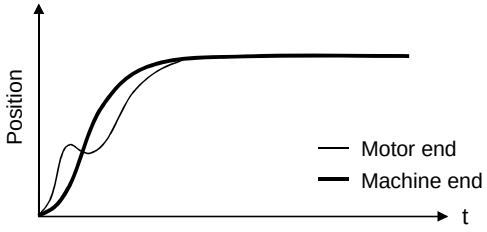
7.4 Advanced vibration suppression control

(1) Operation

Vibration suppression control is used to further suppress machine end vibration, such as workpiece end vibration and base shake. The motor side operation is adjusted for positioning so that the machine does not shake.



Vibration suppression control OFF
(Normal control)



Vibration suppression control ON

When the advanced vibration suppression control (vibration suppression control tuning mode parameter No.PB02) is executed, the vibration frequency at machine end can automatically be estimated to suppress machine end vibration.

In the vibration suppression control tuning mode, this mode shifts to the manual mode after operation is performed the predetermined number of times. The manual mode enables manual setting using the vibration suppression control vibration frequency setting (parameter No.PB19) and vibration suppression control resonance frequency setting (parameter No.PB20).

(2) Parameter

Select the operation of the vibration suppression control tuning mode (parameter No.PB02).

Parameter No.PB02

0	0	0	

Vibration suppression control tuning mode

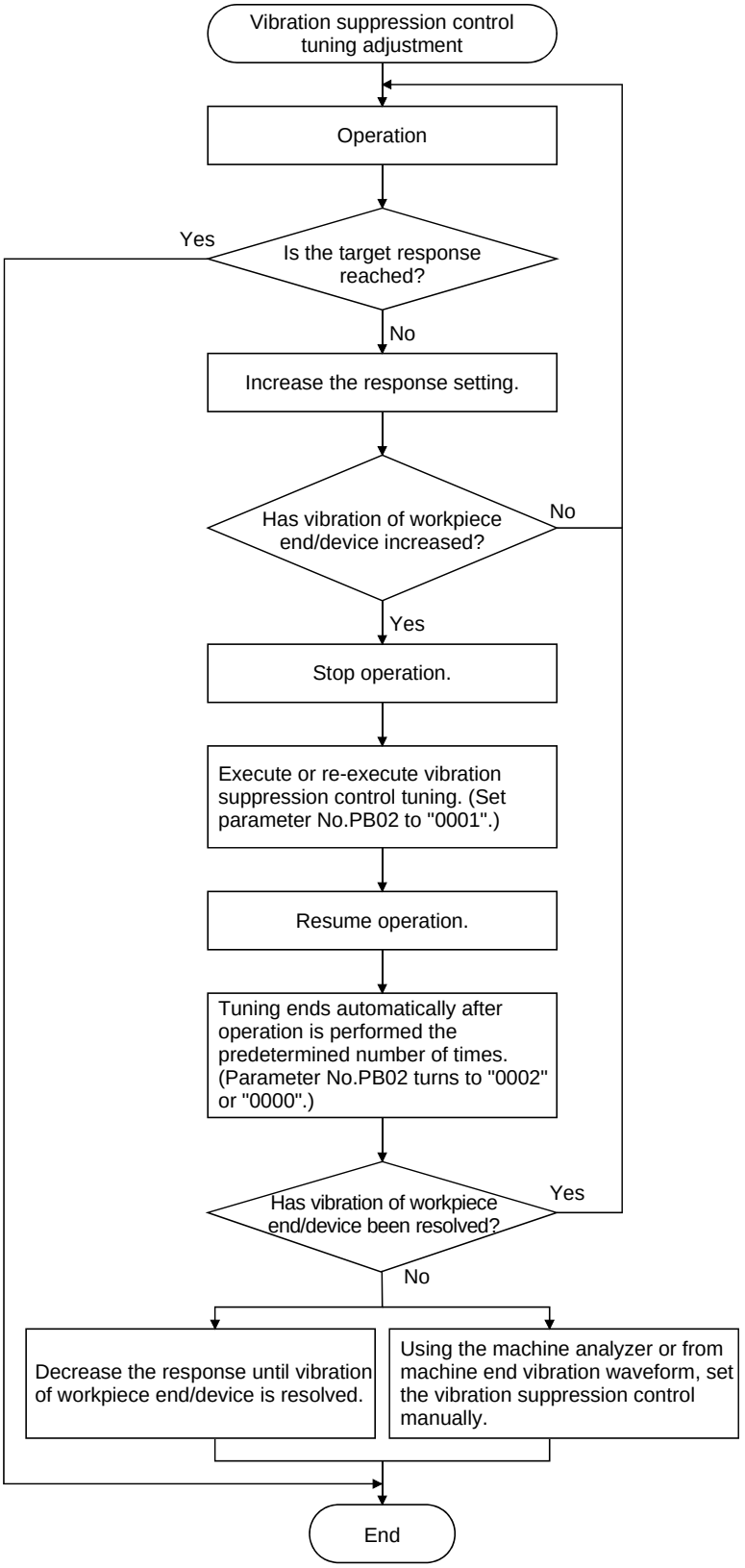
Setting	Vibration suppression control tuning mode	Automatically set parameter
0	Vibration suppression control OFF	(Note)
1	Vibration suppression control tuning mode (Advanced vibration suppression control)	Parameter No.PB19 Parameter No.PB20
2	Manual mode	

Note. Parameter No.PB19 and PB20 are fixed to the initial values.

POINT

- The function is made valid when the auto tuning mode (parameter No.PA08) is the auto tuning mode 2 ("0002") or manual mode ("0003").
- The machine resonance frequency supported in the vibration suppression control tuning mode is 1.0Hz to 100.0Hz. The function is not effective for vibration outside this range.
- Stop the motor before changing the vibration suppression control-related parameters (parameter No.PB02, PB19, PB20, PB33, PB34). A failure to do so will cause a shock.
- For positioning operation during execution of vibration suppression control tuning, provide a stop time to ensure a stop after full vibration damping.
- Vibration suppression control tuning may not make normal estimation if the residual vibration at the motor end is small.
- Vibration suppression control tuning sets the optimum parameter with the currently set control gains. When the response setting is increased, set vibration suppression control tuning again.

(3) Vibration suppression control tuning mode procedure

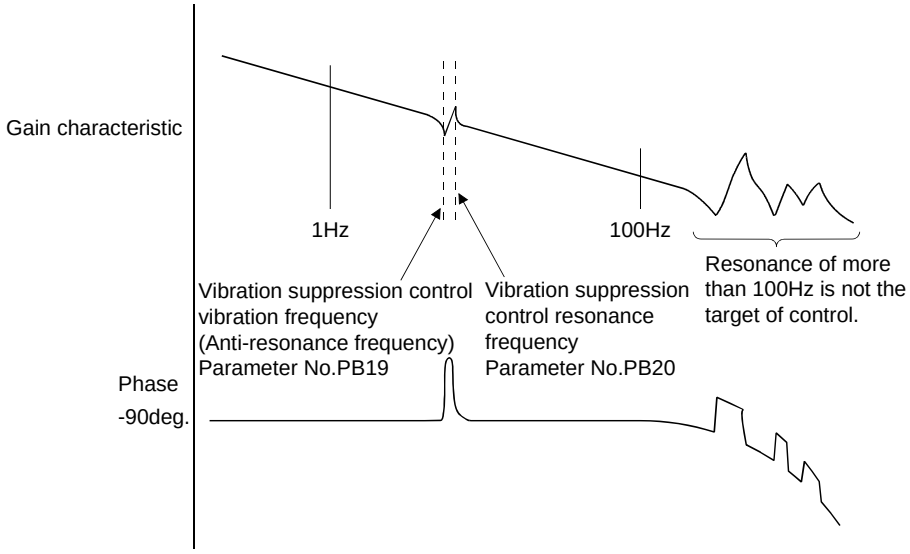


Factor
- Estimation cannot be made as machine end vibration has not been transmitted to the motor end.
- The response of the model loop gain has increased to the machine end vibration frequency (vibration suppression control limit).

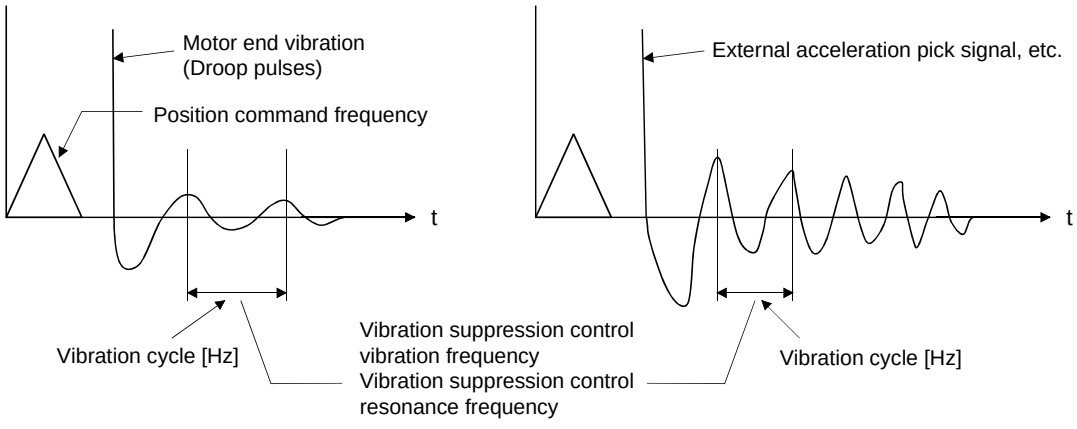
(4) Vibration suppression control manual mode

Measure work end vibration and device shake with the machine analyzer or external measuring instrument, and set the vibration suppression control vibration frequency (parameter No.PB19) and vibration suppression control resonance frequency (parameter No.PB20) to set vibration suppression control manually.

(a) When a vibration peak can be confirmed using set up software（MR Configurator）, machine analyzer or external FFT equipment



(b) When vibration can be confirmed using monitor signal or external sensor



Set the same value.

POINT

- When machine end vibration does not show up in motor end vibration, the setting of the motor end vibration frequency does not produce an effect.
- When the anti-resonance frequency and resonance frequency can be confirmed using the machine analyzer or external FFT device, do not set the same value but set different values to improve the vibration suppression performance.
- A vibration suppression control effect is not produced if the relationship between the model loop gain (parameter No.PB07) value and vibration frequency is as indicated below. Make setting after decreasing PG1, e.g. reduce the response setting.

$$\frac{1}{2\pi}(1.5 \times PG1) > \text{vibration frequency}$$

7.5 Low-pass filter

(1) Function

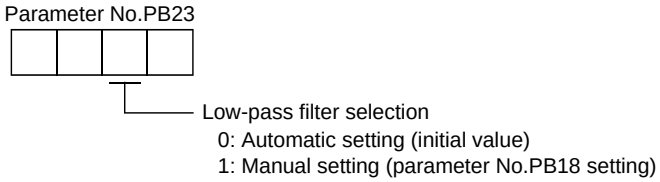
When a ball screw or the like is used, resonance of high frequency may occur as the response level of the servo system is increased. To prevent this, the low-pass filter is factory-set to be valid for a torque command. The filter frequency of this low-pass filter is automatically adjusted to the value in the following expression.

$$\text{Filter frequency(rad/s)} = \frac{\text{VG2}}{1 + \text{GD2}} \times 10$$

When parameter No.PB23 is set to "□□1□", manual setting can be made with parameter No.PB18.

(2) Parameter

Set the operation of the low-pass filter selection (parameter No.PB23.)



7.6 Gain changing function

This function can change the gains. You can change between gains during rotation and gains during stop or can use an input device to change gains during operation.

7.6.1 Applications

This function is used when.

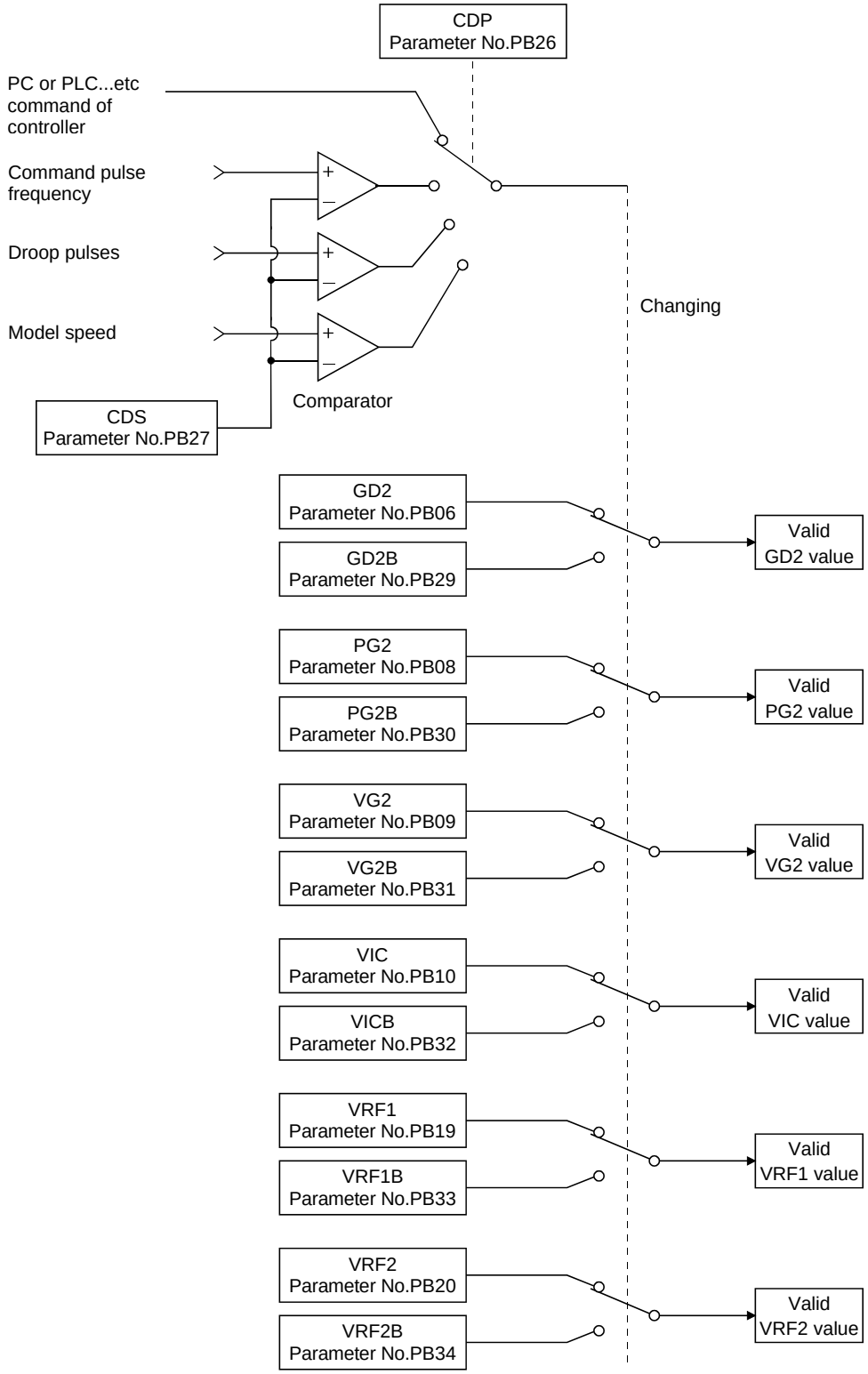
(1) You want to increase the gains during servo lock but decrease the gains to reduce noise during rotation.

(2) You want to increase the gains during settling to shorten the stop settling time.

(3) You want to change the gains using an input device to ensure stability of the servo system since the load inertia moment ratio varies greatly during a stop (e.g. a large load is mounted on a carrier).

7.6.2 Function block diagram

The valid loop gains PG2, VG2, VIC and GD2 of the actual loop are changed according to the conditions selected by gain changing selection CDP (parameter No.PB26) and gain changing condition CDS (parameter No.PB27).



7.6.3 Parameters

When using the gain changing function, always set "□□□3" in parameter No.PA08 (auto tuning) to choose the manual mode of the gain adjustment modes. The gain changing function cannot be used in the auto tuning mode.

Parameter No.	Abbreviation	Name	Unit	Description
PB06	GD2	Ratio of load inertia moment to servo motor inertia moment	Multi-plier (×1)	Control parameters before changing
PB07	PG1	Model loop gain	rad/s	Position and speed gains of a model used to set the response level to a command. Always valid.
PB08	PG2	Position loop gain	rad/s	
PB09	VG2	Speed loop gain	rad/s	
PB10	VIC	Speed integral compensation	ms	
PB29	GD2B	Gain changing ratio of load inertia moment to servo motor inertia moment	Multi-plier (×1)	Used to set the ratio of load inertia moment to servo motor inertia moment after changing.
PB30	PG2B	Gain changing position loop gain 2	rad/s	Used to set the value of the after-changing position loop gain 2.
PB31	VG2B	Gain changing speed loop gain 2	rad/s	Used to set the value of the after-changing speed loop gain.
PB32	VICB	Gain changing speed integral compensation	ms	Used to set the value of the after-changing speed integral compensation.
PB26	CDP	Gain changing selection		Used to select the changing condition.
PB27	CDS	Gain changing condition	kpps pulse r/min	Used to set the changing condition values.
PB28	CDT	Gain changing time constant	ms	You can set the filter time constant for a gain change at changing.
PB33	VRF1B	Gain changing vibration suppression control vibration frequency setting	Hz	Used to set the value of the after-changing vibration suppression control vibration frequency setting.
PB34	VRF2B	Gain changing vibration suppression control resonance frequency setting	Hz	Used to set the value of the after-changing vibration suppression control resonance frequency setting.

(1) Parameters No.PB06 to PB10

These parameters are the same as in ordinary manual adjustment. Gain changing allows the values of ratio of load inertia moment to servo motor inertia moment, position loop gain, speed loop gain and speed integral compensation to be changed.

(2) Gain changing ratio of load inertia moment to servo motor inertia moment (GD2B: parameter No.PB29)

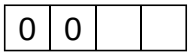
Set the ratio of load inertia moment to servo motor inertia moment after changing. If the load inertia moment ratio does not change, set it to the same value as ratio of load inertia moment to servo motor inertia moment (parameter No.PB06).

(3) Gain changing position loop gain (parameter No.PB30), Gain changing speed loop gain (parameter No.PB31), Gain changing speed integral compensation (parameter No.PB32)

Set the values of after-changing position loop gain, speed loop gain and speed integral compensation.

(4) Gain changing selection (parameter No.PB26)

Used to set the gain changing condition. Choose the changing condition in the first digit and second digit. If you set "1" in the first digit here, you can use the control command from PC or PLC...etc is valid for gain changing.



Gain changing selection
Under any of the following conditions, the gains change on the basis of the parameter No.PB29 to PB32 settings.
0: Invalid
1: Control command from controller is valid
2: Command frequency (Parameter No.PB27 setting)
3: Droop pulse value (Parameter No.PB27 setting)
4: Servo motor speed (Parameter No.PB27 setting)

Gain changing condition
0: Valid at more than condition (Valid with ON for control command from controller.)
1: Valid at less than condition (Valid with OFF for control command from controller.)

(5) Gain changing condition (parameter No.PB27)

When you selected "command frequency", "droop pulses" or "servo motor speed" in gain changing selection (parameter No.PB26), set the gain changing level.

The setting unit is as follows.

Gain changing condition	Unit
Command frequency	kpps
Droop pulses	pulse
Servo motor speed	r/min

(6) Gain changing time constant (parameter No.PB28)

You can set the primary delay filter to each gain at gain changing. This parameter is used to suppress shock given to the machine if the gain difference is large at gain changing, for example.

7.6.4 Gain changing operation

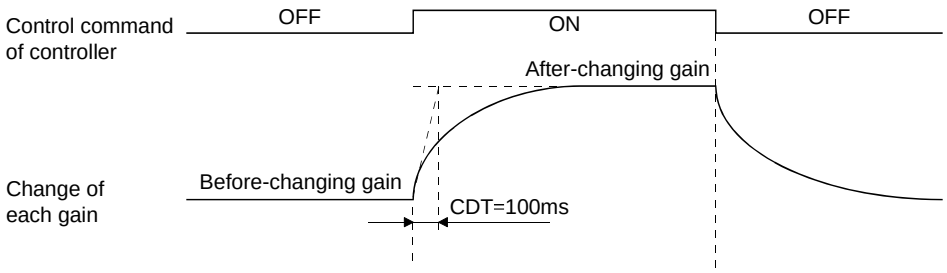
This operation will be described by way of setting examples.

(1) When you choose changing by input device

(a) Setting

Parameter No.	Abbreviation	Name	Setting	Unit
PB07	PG1	Model loop gain	100	rad/s
PB06	GD2	Ratio of load inertia moment to servo motor inertia moment	4.0	Multiplier (×1)
PB08	PG2	Position loop gain	120	rad/s
PB09	VG2	Speed loop gain	3000	rad/s
PB10	VIC	Speed integral compensation	20	Ms
PB29	GD2B	Gain changing ratio of load inertia moment to servo motor inertia moment	10.0	Multiplier (×1)
PB30	PG2B	Gain changing position loop gain	84	rad/s
PB31	VG2B	Gain changing speed loop gain	4000	rad/s
PB32	VICB	Gain changing speed integral compensation	50	ms
PB26	CDP	Gain changing selection	0001 (Changed by ON/OFF of input device)	
PB28	CDT	Gain changing time constant	100	ms
PB33	VRF1B	Gain changing vibration suppression control vibration frequency setting	Used to set the value of the after-changing vibration suppression control vibration frequency setting.	Hz
PB34	VRF2B	Gain changing vibration suppression control resonance frequency setting	Used to set the value of the after-changing vibration suppression control resonance frequency setting.	Hz

(b) Changing operation



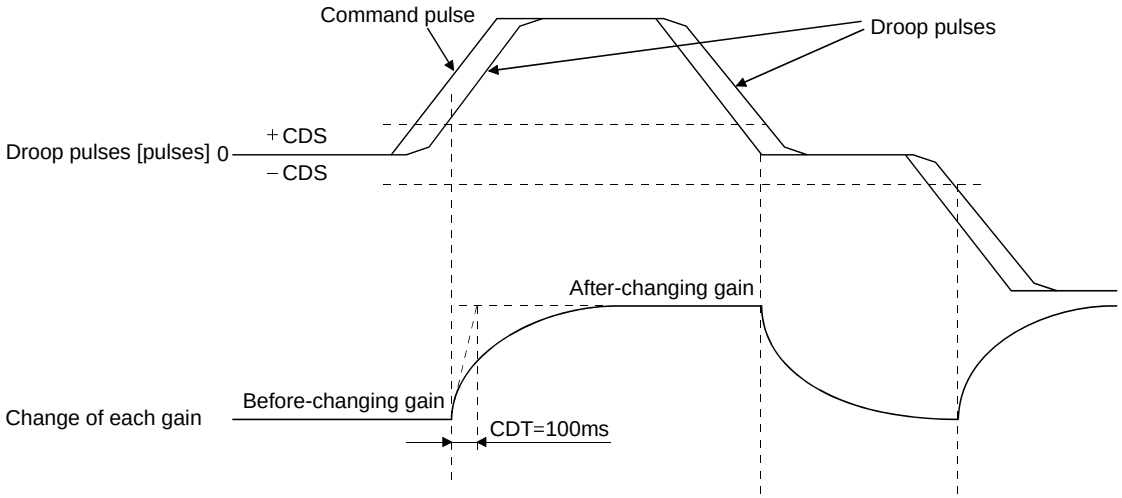
Model loop gain 1	100				
Ratio of load inertia moment to servo motor inertia moment	4.0	→	10.0	→	4.0
Position loop gain	120	→	84	→	120
Speed loop gain	3000	→	4000	→	3000
Speed integral compensation	20	→	50	→	20

(2) When you choose changing by droop pulses

(a) Setting

Parameter No.	Abbreviation	Name	Setting	Unit
PB07	PG1	Model loop gain	100	rad/s
PB06	GD2	Ratio of load inertia moment to servo motor inertia moment	4.0	Multiplier (×1)
PB08	PG2	Position loop gain	120	rad/s
PB09	VG2	Speed loop gain	3000	rad/s
PB10	VIC	Speed integral compensation	20	ms
PB29	GD2B	Gain changing ratio of load inertia moment to servo motor inertia moment	10.0	Multiplier (×1)
PB30	PG2B	Gain changing position loop gain	84	rad/s
PB31	VG2B	Gain changing speed loop gain	4000	rad/s
PB32	VICB	Gain changing speed integral compensation	50	ms
PB26	CDP	Gain changing selection	0003 (Changed by droop pulses)	
PB27	CDS	Gain changing condition	50	pulse
PB28	CDT	Gain changing time constant	100	ms

(b) Changing operation



Model loop gain	100						
Ratio of load inertia moment to servo motor inertia moment	4.0	→	10.0	→	4.0	→	10.0
Position loop gain	120	→	84	→	120	→	84
Speed loop gain	3000	→	4000	→	3000	→	4000
Speed integral compensation	20	→	50	→	20	→	50

MEMO

8. TROUBLESHOOTING

8. TROUBLESHOOTING

POINT

- As soon as an alarm occurs, make the Servo off status and interrupt the main circuit power.

If an alarm/warning has occurred, refer to this chapter and remove its cause.

8.1 Alarms and warning list

When a fault occurs during operation, the corresponding alarm or warning is displayed. If any alarm or warning has occurred, refer to section 8.2 or 8.3 and take the appropriate action. When an alarm occurs, the ALM turns OFF.

After its cause has been removed, the alarm can be deactivated in any of the methods marked ○ in the alarm deactivation column. The alarm is automatically canceled after removing the cause of occurrence.

	Display	Name	Alarm deactivation		
			Power OFF→ON	Error reset	CPU reset
Alarms	10	Undervoltage	○	○	○
	12	Memory error 1 (RAM)	○		
	13	Clock error	○		
	15	Memory error 2 (EEP-ROM)	○		
	16	Encoder error 1 (At power on)	○		
	17	Board error	○		
	19	Memory error 3 (Flash-ROM)	○		
	1A	Motor combination error	○		
	20	Encoder error 2	○		
	24	Main circuit error	○	○	○
	25	Absolute position erase	○		
	30	Regenerative error	(Note 1) ○	(Note 1) ○	(Note 1) ○
	31	Overspeed	○	○	○
	32	Overcurrent	○		
	33	Overvoltage	○	○	○
	34	Receive error 1	○	(Note 2) ○	○
	35	Command frequency error	○	○	○
	36	Receive error 2	○	○	○
	37	Parameter error	○		
	45	Main circuit device overheat	(Note 1) ○	(Note 1) ○	(Note 1) ○
	46	Servo motor overheat	(Note 1) ○	(Note 1) ○	(Note 1) ○
	47	Cooling fan error	○		
	50	Overload 1	(Note 1) ○	(Note 1) ○	(Note 1) ○
	51	Overload 2	(Note 1) ○	(Note 1) ○	(Note 1) ○
	52	Error excessive	○	○	○
	8A	USB communication time-out error	○	○	○
	8E	USB communication error	○	○	○
	888	Watchdog	○		

	Display	Name
Warnings	92	Battery cable disconnection warning
	96	Home position setting warning
	9F	Battery warning
	E0	Excessive regeneration warning
	E1	Overload warning 1
	E3	Absolute position counter warning
	E4	Parameter warning
	E6	Servo forced stop warning
	E7	Servo system controller forced stop warning
	E8	Cooling fan speed reduction warning
	E9	Main circuit off warning
	EC	Overload warning 2
	ED	Output watt excess warning

Note 1. Deactivate the alarm about 30 minutes of cooling time after removing the cause of occurrence.
2. In some servo system controller communication status, the alarm factor may not be removed.

8.2 Remedies for alarms

⚠ CAUTION

- When any alarm has occurred, eliminate its cause, ensure safety, then reset the alarm, and restart operation. Otherwise, injury may occur.
- If an absolute position erase (25) occurred, always make home position setting again. Not doing so may cause unexpected operation.
- As soon as an alarm occurs, mark Servo-off and power off the main circuit and control circuit.

POINT

- When any of the following alarms has occurred, do not deactivate the alarm and resume operation repeatedly. To do so will cause the driver/servo motor to fail. Remove the cause of occurrence, and leave a cooling time of more than 30 minutes before resuming operation. To protect the main circuit elements, any of these servo alarms cannot be deactivated from the servo system controller until the specified time elapses after its occurrence. Judging the load changing condition until the alarm occurs, the driver calculates this specified time automatically.
- Regenerative error (30)
- Overload 1 (50)
- Overload 2 (51)
- The alarm can be deactivated by switching power off, then on or by the error reset command ▪ CPU reset from the servo system controller. For details, refer to section 8.1.

When an alarm occurs, the trouble (ALM) switches off and the dynamic brake is operated to stop the servo motor. At this time, the display indicates the alarm No.
The servo motor comes to a stop. Remove the cause of the alarm in accordance with this section. Use the set up software(MR Configurator) to refer to a factor of alarm occurrence.

Display	Name	Definition	Cause	Action
10	Undervoltage	Power supply voltage dropped. LECSS2-□: 160VAC or less LECSS1-□ 83VAC or less	1. Power supply voltage is low.	Check the power supply.
			2. There was an instantaneous control power failure of 60ms or longer.	
			3. Shortage of power supply capacity caused the power supply voltage to drop at start, etc.	
			4. The bus voltage dropped to the following value or less. LECSS2-□: 200VDC LECSS1-□: 158VDC	
			5. Faulty parts in the driver Checking method Alarm (10) occurs if power is switched on after disconnection of all cables but the control circuit power supply cables.	Change the driver.

Display	Name	Definition	Cause	Action
12	Memory error 1 (RAM)	RAM, memory fault	Faulty parts in the driver Checking method Alarm (any of 12 and 13) occurs if power is switched on after disconnection of all cables but the control circuit power supply cables.	Change the driver.
13	Clock error	Printed board fault		
		Clock error transmitted from the driver	Faulty driver Checking method Alarm (13) occurs, if servo controller is used in multiple CPU system.	Change the servo system controller.
15	Memory error 2 (EEP-ROM)	EEP-ROM fault	1. Faulty parts in the driver Checking method Alarm (15) occurs if power is switched on after disconnection of all cables but the control circuit power supply cables.	Change the driver.
			2. The number of write times to EEP-ROM exceeded 100,000.	
16	Encoder error 1 (At power on)	Communication error occurred between encoder and driver.	1. Encoder connector (CN2) disconnected.	Connect correctly.
			2. Encoder fault	Change the servo motor.
			3. Encoder cable faulty (Wire breakage or shorted)	Repair or change the cable.
			4. Encoder cable type (2-wire, 4-wire) selection was wrong in parameter setting.	Correct the setting in the fourth digit of parameter No.PC04.
17	Board error 2	CPU/parts fault	Faulty parts in the driver Checking method Alarm (17 or 19) occurs if power is switched on after disconnection of all cables but the control circuit power supply cable.	Change the driver.
19	Memory error 3 (Flash ROM)	ROM memory fault		
1A	Motor combination error	Wrong combination of driver and servo motor.	Wrong combination of driver and servo motor connected.	Use correct combination.
20	Encoder error 2	Communication error occurred between encoder and driver.	1. Encoder connector (CN2) disconnected.	Connect correctly.
			2. Encoder cable faulty (Wire breakage or shorted)	Repair or change the cable.
			3. Encoder fault	Change the servo motor.
24	Main circuit error	Ground fault occurred at the servo motor power (U,V and W phases) of the driver.	1. Power input wires and servo motor power wires are in contact.	Connect correctly.
			2. Sheathes of servo motor power cables deteriorated, resulting in ground fault.	Change the cable.
			3. Main circuit of driver failed. Checking method Alarm (24) occurs if the servo is switched on after disconnecting the U, V, W power cables from the servo amplifier.	Change the driver.

Display	Name	Definition	Cause	Action
25	Absolute position erase	Absolute position data in error	1. Voltage drop in encoder (Battery disconnected.)	After leaving the alarm occurring for a few minutes, switch power off, then on again. Always make home position setting again.
			2. Battery voltage low	Change the battery. Always make home position setting again.
			3. Battery cable or battery is faulty.	
		Power was switched on for the first time in the absolute position detection system.	4. Home position not set.	After leaving the alarm occurring for a few minutes, switch power off, then on again. Always make home position setting again.
30	Regenerative error	Permissible regenerative power of the built-in regenerative resistor or regenerative option is exceeded.	1. Wrong setting of parameter No. PA02	Set correctly.
			2. Built-in regenerative resistor or regenerative option is not connected.	Connect correctly.
			3. High-duty operation or continuous regenerative operation caused the permissible regenerative power of the regenerative option to be exceeded. Checking method Call the status display and check the regenerative load ratio.	1. Reduce the frequency of positioning. 2. Use the regenerative option of larger capacity. 3. Reduce the load.
			4. Power supply voltage is abnormal. LECSS2-□:260VAC or more LECSS1-□:More than 135VAC	Check the power supply.
			5. Built-in regenerative resistor or regenerative option faulty.	Change the driver or regenerative option.
		Regenerative transistor fault	6. Regenerative transistor faulty. Checking method 1) The regenerative option has overheated abnormally. 2) The alarm occurs even after removal of the built-in regenerative resistor or regenerative option.	Change the driver.
31	Overspeed	Speed has exceeded the instantaneous permissible speed.	1. Small acceleration/deceleration time constant caused overshoot to be large.	Increase acceleration/deceleration time constant.
			2. Servo system is instable to cause overshoot.	1. Re-set servo gain to proper value. 2. If servo gain cannot be set to proper value. 1) Reduce load inertia moment ratio; or 2) Reexamine acceleration/ deceleration time constant.
			3. Encoder faulty.	Change the servo motor.

Display	Name	Definition	Cause	Action
32	Overcurrent	Current that flew is higher than the permissible current of the driver. (If the alarm (32) occurs again when turning ON the servo after resetting the alarm by turning OFF/ON the power when the alarm (32) first occurred, the transistor (IPM・IGBT) of the driver may be at fault. In the case, do not repeat to turn OFF/ON the power. Check the transistor with the checking method of “Cause 2”.)	1. Short occurred in servo motor power (U, V, W).	Correct the wiring.
			2. Transistor (IPM・IGBT) of the driver faulty. Checking method Alarm (32) occurs if power is switched on after U,V and W are disconnected.	Change the driver.
			3. Ground fault occurred in servo motor power (U, V, W).	Correct the wiring.
			4. External noise caused the overcurrent detection circuit to misoperate.	Take noise suppression measures.
33	Overvoltage	The following shows the input value of converter bus voltage. LECSS□-□: 400VDC or more	1. Regenerative option is not used.	Use the regenerative option.
			2. Though the regenerative option is used, the parameter No.PA02 setting is "□□00 (not used)".	Set correctly.
			3. Lead of built-in regenerative resistor or regenerative option is open or disconnected.	1. Change the lead. 2. Connect correctly.
			4. Regenerative transistor faulty.	Change the driver.
			5. Wire breakage of built-in regenerative resistor or regenerative option	1. For wire breakage of built-in regenerative resistor, change the driver. 2. For wire breakage of regenerative option, change the regenerative option.
			6. Capacity of built-in regenerative resistor or regenerative option is insufficient.	Add regenerative option or increase capacity.
			7. Power supply voltage high.	Check the power supply.
			8. Ground fault occurred in servo motor power (U, V, W).	Correct the wiring.

Display	Name	Definition	Cause	Action
34	Receive error 1	SSCNETⅢ communication error (Continuously communication error with about 3.5ms interval.)	1. The SSCNETⅢ cable is disconnected.	Connect it after turning off the control circuit power supply for driver.
			2. The surface at the end of SSCNETⅢ cable got dirty.	Wipe dirt at the surface away. (Refer to section 3.9)
			3. The SSCNETⅢ cable is broken or severed.	Change the cable.
			4. Noise entered the driver.	Take noise suppression measures.
			5. Optical characteristic of SSCNETⅢ cable deteriorated because vinyl tape and/or wire sheath, which contains migrating plasticizer, adhered to the cable.	Remove the vinyl tape and/or wire sheath, which contains migrating plasticizer, and exchange the cable.
35	Command frequency error	Input pulse frequency of command pulse is too high.	1. Command given is greater than the maximum speed of the servo motor.	Check operation program.
			2. Servo system controller failure.	Change the servo system controller.
			3. Noise entered the driver.	Take noise of I/O signal suppression measures.
			4. Noise entered the driver.	Take noise from the driver suppression measures.
36	Receive error 2	SSCNETⅢ communication error (Intermittently communication error with about 70ms interval.)	1. The SSCNETⅢ cable is disconnected.	Connect it after turning off the control circuit power supply for driver.
			2. The surface at the end of SSCNETⅢ cable got dirty.	Wipe dirt away from the surface. (Refer to section 3.9)
			3. The SSCNETⅢ cable is broken or severed.	Change the cable.
			4. Noise entered the driver.	Take noise suppression measures.
			5. Optical characteristic of SSCNETⅢ cable deteriorated because vinyl tape and/or wire sheath, which contains migrating plasticizer, adhered to the cable.	Remove the vinyl tape and/or wire sheath, which contains migrating plasticizer, and exchange the cable.

Display	Name	Definition	Cause	Action
37	Parameter error	Parameter setting is wrong.	1. Driver fault caused the parameter setting to be rewritten.	Change the driver.
			2. There is a parameter whose value was set to outside the setting range by the driver.	Change the parameter value to within the setting range.
			3. The number of write times to EEP-ROM exceeded 100,000 due to parameter write, etc.	Change the driver.
45	Main circuit device overheat	Main circuit device overheat	1. Driver faulty.	Change the driver.
			2. The power supply was turned on and off continuously by overloaded status.	The drive method is reviewed.
			3. Ambient temperature of servo motor is over 55℃.	Check environment so that ambient temperature is 0 to 55℃.
			4. Used beyond the specifications of close mounting.	Use within the range of specifications.
46	Servo motor overheat	Servo motor temperature rise actuated the thermal sensor.	1. Ambient temperature of servo motor is over 40℃.	Check environment so that ambient temperature is 0 to 40℃.
			2. Servo motor is overloaded.	1. Reduce load. 2. Check operation pattern. 3. Use servo motor that provides larger output.
			3. Thermal sensor in encoder is faulty.	Change the servo motor.
47	Cooling fan error	The cooling fan of the driver stopped, or its speed decreased to or below the alarm level.	1. Cooling fan life expiration (Refer to section 2.5.)	Change the cooling fan of the driver.
			2. Foreign matter caught in the cooling fan stopped rotation.	Remove the foreign matter.
			3. The power supply of the cooling fan failed.	Change the driver.
50	Overload 1	Load exceeded overload protection characteristic of driver.	1. Driver is used in excess of its continuous output current.	1. Reduce load. 2. Check operation pattern. 3. Use servo motor that provides larger output.
			2. Servo system is instable and hunting.	1. Repeat acceleration/ deceleration to execute auto tuning. 2. Change the auto tuning response setting. 3. Set auto tuning to OFF and make gain adjustment manually.
			3. Machine struck something.	1. Check operation pattern. 2. Install limit switches.
			4. Wrong connection of servo motor. Driver's output terminals U, V, W do not match servo motor's input terminals U, V, W.	Connect correctly.
			5. Encoder faulty. Checking method When the servo motor shaft is rotated with the servo off, the cumulative feedback pulses do not vary in proportion to the rotary angle of the shaft but the indication skips or returns midway.	Change the servo motor.
			6. After Overload 2 (51) occurred, turn OFF/ON the power supply to clear the alarm. Then the overload operation is repeated.	1. Reduce load. 2. Check operation pattern. 3. Use servo motor that provides larger output.

Display	Name	Definition	Cause	Action
51	Overload 2	Machine collision or the like caused max. For the time of the alarm occurrence, refer to the section 10.1.	1. Machine struck something.	1. Check operation pattern. 2. Install limit switches.
			2. Wrong connection of servo motor. Driver's output terminals U, V, W do not match servo motor's input terminals U, V, W.	Connect correctly.
			3. Servo system is instable and hunting.	1. Repeat acceleration/deceleration to execute auto tuning. 2. Change the auto tuning response setting. 3. Set auto tuning to OFF and make gain adjustment manually.
			4. Encoder faulty. Checking method When the servo motor shaft is rotated with the servo off, the cumulative feedback pulses do not vary in proportion to the rotary angle of the shaft but the indication skips or returns midway.	Change the servo motor.
52	Error excessive	The deviation between the model position and the actual servo motor position exceeds the parameter No.PC01 setting value (initial value: 3 revolutions).	1. Acceleration/deceleration time constant is too small.	Increase the acceleration/deceleration time constant.
			2. Torque limit value set with driver is too small.	Increase the torque limit value.
			3. Motor cannot be started due to torque shortage caused by power supply voltage drop.	1. Check the power supply capacity. 2. Use servo motor which provides larger output.
			4. Position loop gain 1 (parameter No.PB08) value is small.	Increase set value and adjust to ensure proper operation.
			5. Servo motor shaft was rotated by external force.	1. When torque is limited, increase the limit value. 2. Reduce load. 3. Use servo motor that provides larger output.
			6. Machine struck something.	1. Check operation pattern. 2. Install limit switches.
			7. Encoder faulty	Change the servo motor.
			8. Wrong connection of servo motor. Driver's output terminals U, V, W do not match servo motor's input terminals U, V, W.	Connect correctly.
			9. SSCNETⅢ cable fault	Change the SSCNETⅢ cable.
			10. Optical characteristic of SSCNETⅢ cable deteriorated because vinyl tape and/or wire sheath, which contains migrating plasticizer, adhered to the cable.	Remove the vinyl tape and/or wire sheath, which contains migrating plasticizer, and exchange the cable.
8A	USB communication time-out error	Communication with set up software（MR Configurator） in test operation mode stopped for longer than the specified time.	1. USB cable breakage.	Change the USB cable.

Display	Name	Definition	Cause	Action
(Note) 888	Watchdog	CPU, parts faulty	Fault of parts in driver Checking method Alarm (888) occurs if power is switched on after disconnection of all cables but the control circuit power supply cable.	Change the driver.
8E	USB communication error	Serial communication error occurred between driver and communication device (e.g. personal computer).	1. USB cable fault (Open cable or short circuit)	Change the USB cable.
			2. Communication device (e.g. personal computer) faulty	Change the communication device (e.g. personal computer).
(Note) 888	Watchdog	CPU, parts faulty	Fault of parts in driver Checking method Alarm (888) occurs if power is switched on after disconnection of all cables but the control circuit power supply cable.	Change the driver.

Note. At power-on, "888" appears instantaneously, but it is not an error.

8.3 Remedies for warnings

⚠ CAUTION

- If an absolute position counter warning (E3) occurred, always make home position setting again. Not doing so may cause unexpected operation.

POINT

- When any of the following alarms has occurred, do not resume operation by switching power of the driver OFF/ON repeatedly. The driver and servo motor may become faulty. If the power of the driver is switched OFF/ON during the alarms, allow more than 30 minutes for cooling before resuming operation.
  - Excessive regenerative warning (E0)
  - Overload warning 1 (E1)

If E6, E7 or E9 occurs, the servo off status is established. If any other warning occurs, operation can be continued but an alarm may take place or proper operation may not be performed.
Remove the cause of warning according to this section. Use the set up software（MR Configurator） to refer to a factor of warning occurrence.

Display	Name	Definition	Cause	Action
92	Battery cable disconnection warning	Absolute position detection system battery voltage is low.	1. Battery cable is open.	Repair cable or changed.
			2. Battery voltage supplied from the driver to the encoder fell to about 3V or less. (Detected with the encoder)	Change the battery.
96	Home position setting warning	Home position setting could not be made.	1. Droop pulses remaining are greater than the in-position range setting.	Remove the cause of droop pulse occurrence
			2. Command pulse entered after clearing of droop pulses.	Do not enter command pulse after clearing of droop pulses.
			3. Creep speed high.	Reduce creep speed.
9F	Battery warning	Voltage of battery for absolute position detection system reduced.	Battery voltage fell to 3.2V or less. (Detected with the driver)	Change the battery.
E0	Excessive regeneration warning	There is a possibility that regenerative power may exceed permissible regenerative power of built-in regenerative resistor or regenerative option.	Regenerative power increased to 85% or more of permissible regenerative power of built-in regenerative resistor or regenerative option. Checking method Call the status display and check regenerative load ratio.	1. Reduce frequency of positioning. 2. Change the regenerative option for the one with larger capacity. 3. Reduce load.

Display	Name	Definition	Cause	Action
E1	Overload warning 1	There is a possibility that overload alarm 1 or 2 may occur.	Load increased to 85% or more of overload alarm 1 or 2 occurrence level. Cause, checking method Refer to 50,51.	Refer to 50, 51.
E3	Absolute position counter warning	Absolute position encoder pulses faulty.	1. Noise entered the encoder.	Take noise suppression measures.
			2. Encoder faulty.	Change the servo motor.
		The multi-revolution counter value of the absolute position encoder exceeded the maximum revolution range.	3. The movement amount from the home position exceeded a 32767 rotation or 37268 rotation in succession.	Make home position setting again.
E4	Parameter warning	Parameter outside setting range	Parameter value set from servo system controller is outside setting range	Set it correctly.
E6	Servo forced stop warning	EM1 is off.	External forced stop was made valid. (EM1 was turned off.)	Ensure safety and deactivate forced stop.
E7	Servo system controller forced stop warning		Forced stop signal was entered into the servo system controller.	Ensure safety and deactivate forced stop.
E8	Cooling fan speed reduction warning	The speed of the driver decreased to or below the warning level.	Cooling fan life expiration (Refer to section 2.5.)	Change the cooling fan of the driver.
			The power supply of the cooling fan is broken.	Change the driver.
E9	Main circuit off warning	Servo-on command was issued with main circuit power off.		Switch on main circuit power.
EC	Overload warning 2	Operation, in which a current exceeding the rating flew intensively in any of the U, V and W phases of the servo motor, was repeated.	During a stop, the status in which a current flew intensively in any of the U, V and W phases of the servo motor occurred repeatedly, exceeding the warning level.	1. Reduce the positioning frequency at the specific positioning address. 2. Reduce the load. 3. Replace the driver/ servo motor with the one of larger capacity.
ED	Output watt excess warning	The status, in which the output wattage (speed × torque) of the servo motor exceeded the rated output, continued steadily.	Continuous operation was performed with the output wattage (speed × torque) of the servo motor exceeding 150% of the rated output.	1. Reduce the servo motor speed. 2. Reduce the load.

MEMO

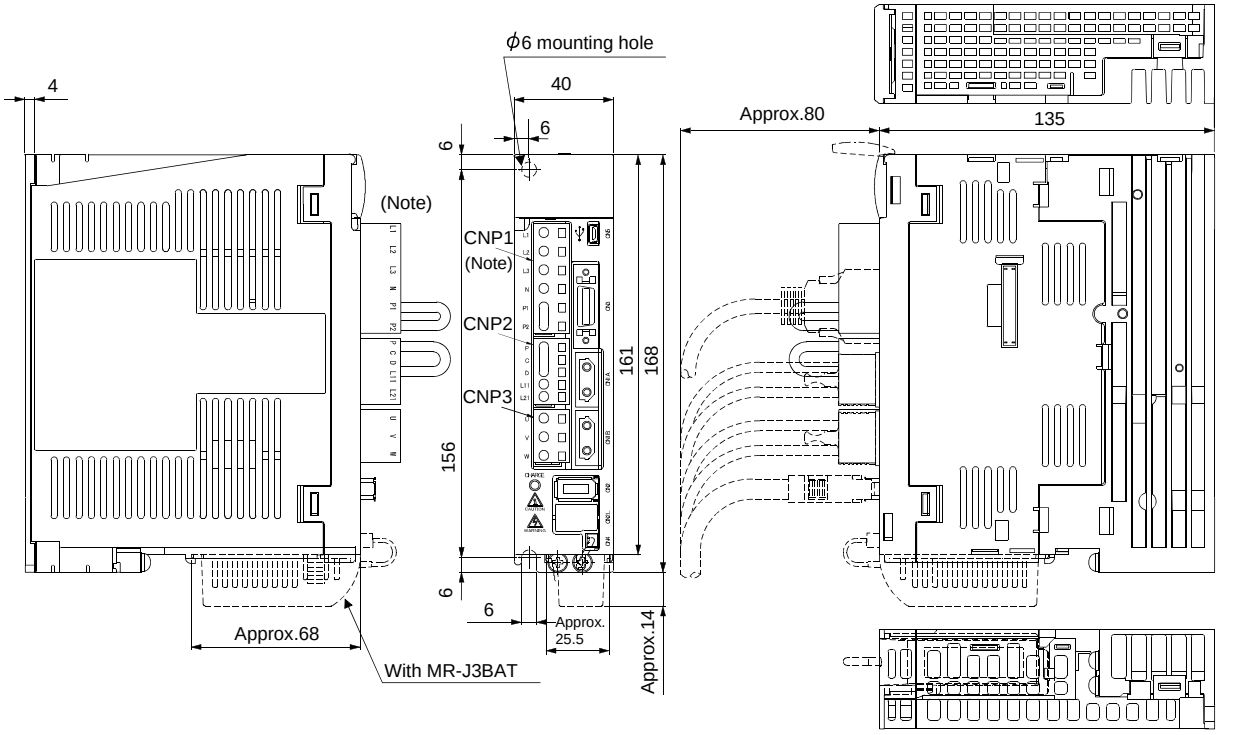
9. OUTLINE DRAWINGS

9. OUTLINE DRAWINGS

9.1 Driver

(1) LECSS□-S5・LECSS□-S7

[Unit: mm]



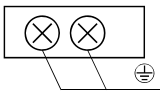
Note. This data applies to the 3-phase or 1-phase 200 to 230VAC power supply models.
For a single-phase, 100 to 120VAC power supply, refer to the terminal signal layout.

Mass: 0.8 [kg] (1.76 [lb])

Terminal signal layout

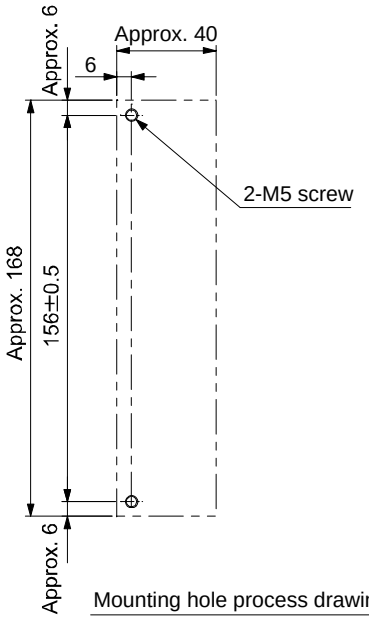
	For 1-phase 100 to 120VAC	For 3-phase or 1-phase 200 to 230VAC
CNP1	L_1	L_1
		L_2
	L_2	L_3
	N	N
	P_1	P_1
	P_2	P_2
CNP2	P	P
	C	C
	D	D
	L_{11}	L_{11}
	L_{21}	L_{21}
CNP3	U	U
	V	V
	W	W

PE terminal



Screw size: M4
Tightening torque:
1.2 [N・m] (10.6 [lb・in])

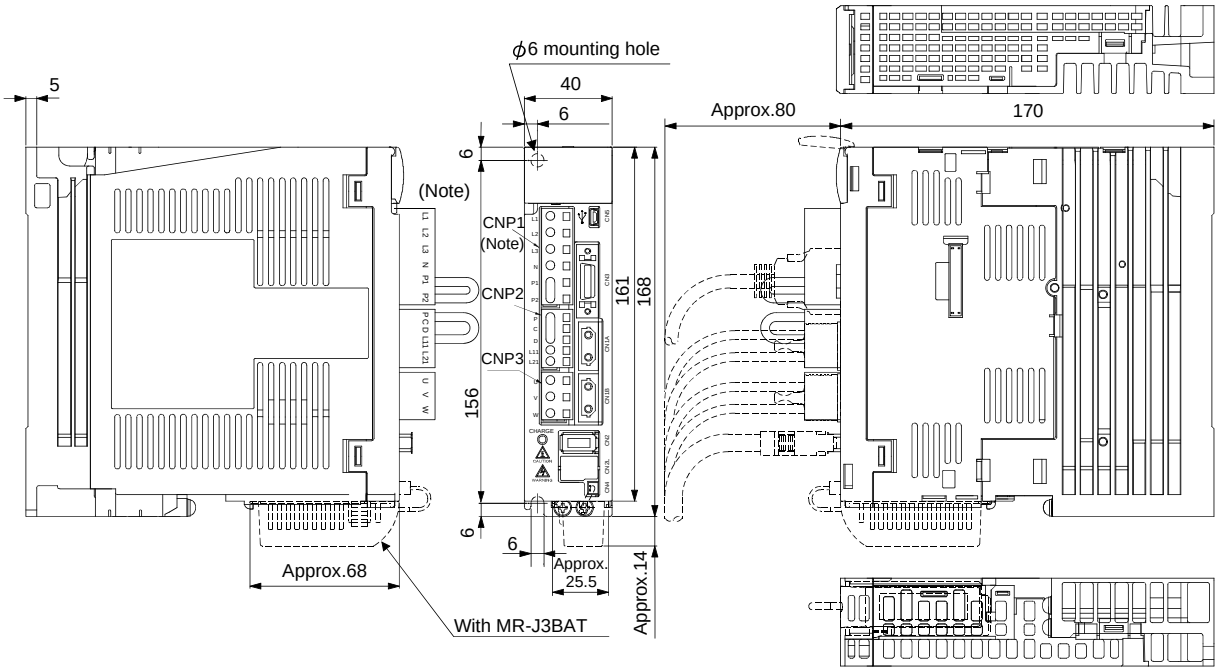
Mounting screw
Screw size: M5
Tightening torque: 3.24 [N・m] (28.7 [lb・in])



Mounting hole process drawing

(2) LECSS□-S8

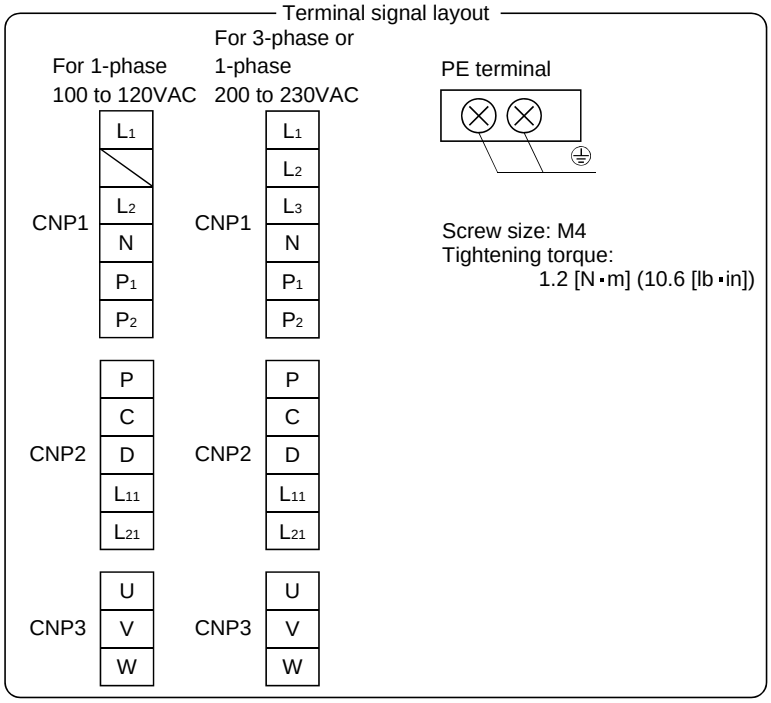
[Unit: mm]



Note. This data applies to the 3-phase or 1-phase 200 to 230VAC power supply models.
For a single-phase, 100 to 120VAC power supply, refer to the terminal signal layout.

Mass: 1.0 [kg] (2.21 [lb])

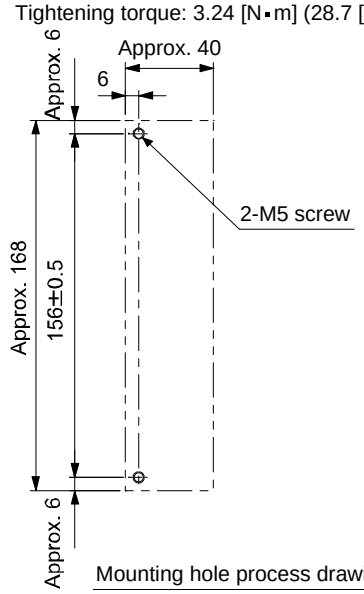
Terminal signal layout



PE terminal

Screw size: M4
Tightening torque:
1.2 [N·m] (10.6 [lb·in])

Mounting screw
Screw size: M5
Tightening torque: 3.24 [N·m] (28.7 [lb·in])



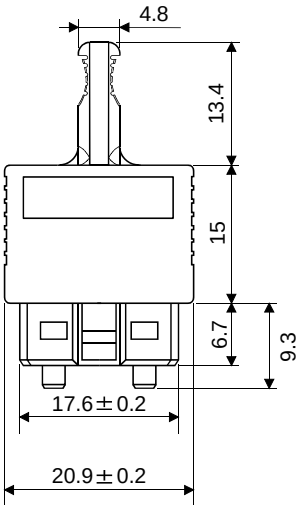
Mounting hole process drawing

9.2 Connector

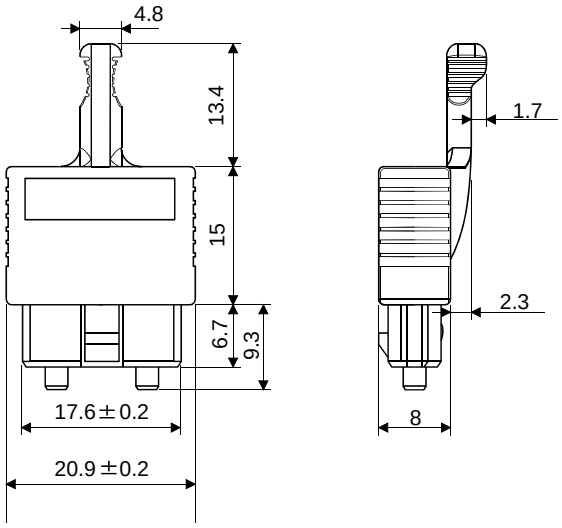
(1) CN1A・CN1B connector

[Unit: mm]

F0-PF2D103



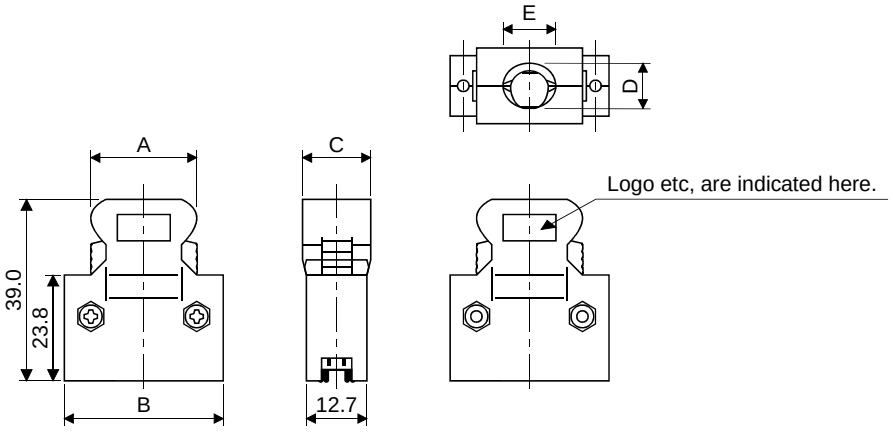
F0-PF2D103-S



(2) Miniature delta ribbon (MDR) system (3M)

(a) One-touch lock type

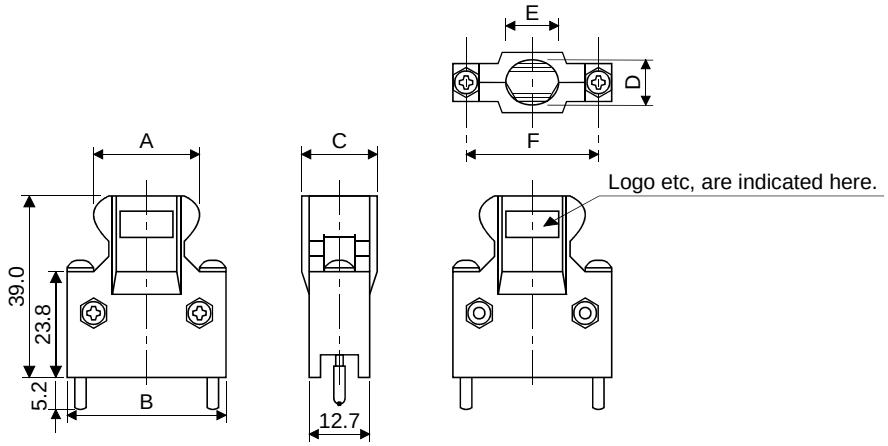
[Unit: mm]



Connector	Shell kit	Each type of dimension				
		A	B	C	D	E
10120-3000PE	10320-52F0-008	22.0	33.3	14.0	10.0	12.0

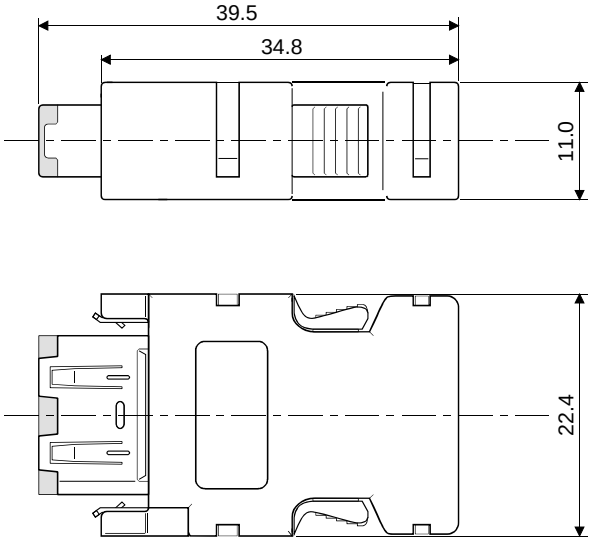
(b) Jack screw M2.6 type
This is not available as option.

[Unit: mm]



Connector	Shell kit	Each type of dimension					
		A	B	C	D	E	F
10120-3000PE	10320-52F0-008	22.0	33.3	14.0	10.0	12.0	27.4

(3) SCR connector system (3M)
Receptacle: 36210-0100PL
Shell kit : 36310-3200-008



MEMO

10. CHARACTERISTICS

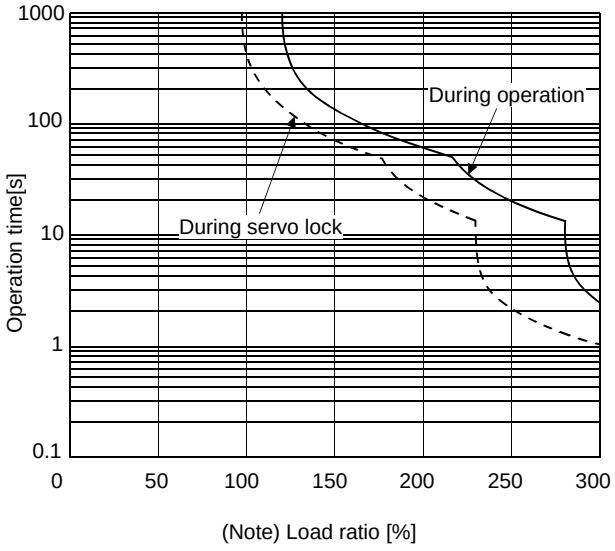
10. CHARACTERISTICS

10.1 Overload protection characteristics

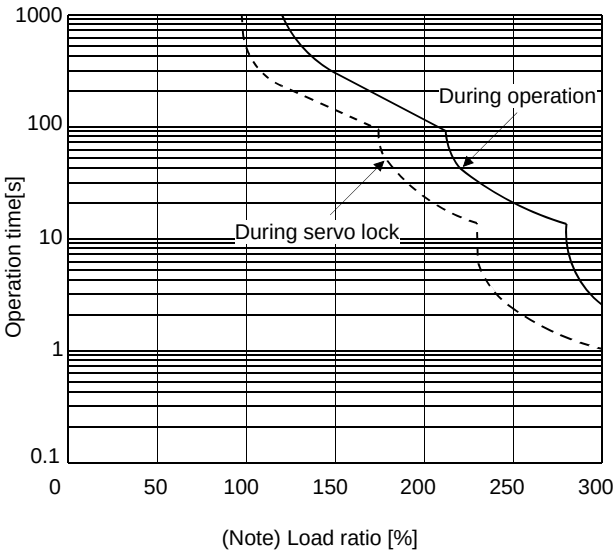
An electronic thermal relay is built in the driver to protect the servo motor and driver from overloads. Overload 1 alarm (50) occurs if overload operation performed is above the electronic thermal relay protection curve shown in any of Figs 10.1. Overload 2 alarm (51) occurs if the maximum current flew continuously for several seconds due to machine collision, etc. Use the equipment on the left-hand side area of the continuous or broken line in the graph.

In a machine like the one for vertical lift application where unbalanced torque will be produced, it is recommended to use the machine so that the unbalanced torque is 70% or less of the rated torque.

When you carry out adhesion mounting of the driver, make circumference temperature into 0 to 45℃, or use it at 75% or smaller effective load ratio.



LECSS□-S5



LECSS□-S7, LECSS□-S8

Note. If operation that generates torque more than 100% of the rating is performed with an abnormally high frequency in a servo motor stop status (servo lock status) or in a 30r/min or less low-speed operation status, the driver may fail even when the electronic thermal relay protection is not activated.

Fig 10.1 Electronic thermal relay protection characteristics

10.2 Power supply equipment capacity and generated loss

(1) Amount of heat generated by the driver

Table 10.1 indicates drivers' power supply capacities and losses generated under rated load. For thermal design of an enclosure, use the values in Table 10.1 in consideration for the worst operating conditions. The actual amount of generated heat will be intermediate between values at rated torque and servo off according to the duty used during operation. When the servo motor is run at less than the maximum speed, the power supply capacity will be smaller than the value in the table, but the driver's generated heat will not change.

Table 10.1 Power supply capacity and generated heat per driver at rated output

Driver	Servo motor	(Note 1) Power supply capacity [kVA]	(Note 2) Driver-generated heat [W]		Area required for heat dissipation [m^2]
			At rated torque	With servo off	
LECSS1-S5	LE-S5-□	0.3	25	15	0.5
	LE-S6-□	0.3	25	15	0.5
LECSS1-S7	LE-S7-□	0.5	25	15	0.5
LECSS1-S8	LE-S8-□	0.9	35	15	0.7

Note 1. Note that the power supply capacity will vary according to the power supply impedance. This value is applicable when the power factor improving reactor is not used.

2. Heat generated during regeneration is not included in the driver-generated heat. To calculate heat generated by the regenerative option, refer to section 11.2.

(2) Heat dissipation area for enclosed driver

The enclosed control box (hereafter called the control box) which will contain the driver should be designed to ensure that its temperature rise is within +10℃ at the ambient temperature of 40℃. (With a 5℃ (41°F) safety margin, the system should operate within a maximum 55℃ (131°F) limit.) The necessary enclosure heat dissipation area can be calculated by Equation 10.1.

$$A = \frac{P}{K \cdot \Delta T} \quad \text{.....(10.1)}$$

where, A : Heat dissipation area [m^2]
P : Loss generated in the control box [W]
ΔT : Difference between internal and ambient temperatures [℃]
K : Heat dissipation coefficient [5 to 6]

When calculating the heat dissipation area with Equation 10.1, assume that P is the sum of all losses generated in the enclosure. Refer to Table 10.1 for heat generated by the driver. "A" indicates the effective area for heat dissipation, but if the enclosure is directly installed on an insulated wall, that extra amount must be added to the enclosure's surface area.

The required heat dissipation area will vary wit the conditions in the enclosure. If convection in the enclosure is poor and heat builds up, effective heat dissipation will not be possible. Therefore, arrangement of the equipment in the enclosure and the use of a cooling fan should be considered.

Table 10.1 lists the enclosure dissipation area for each driver when the driver is operated at the ambient temperature of 40℃ (104°F) under rated load.

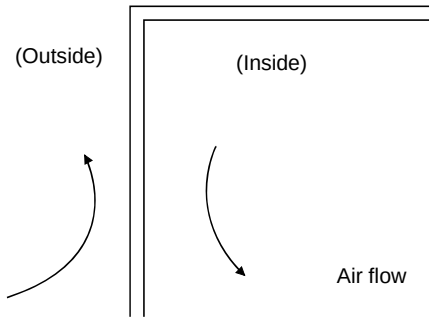


Fig. 10.2 Temperature distribution in enclosure

When air flows along the outer wall of the enclosure, effective heat exchange will be possible, because the temperature slope inside and outside the enclosure will be steeper.

10.3 Dynamic brake characteristics
10.3.1 Dynamic brake operation
(1) Calculation of coasting distance

Fig. 10.3 shows the pattern in which the servo motor comes to a stop when the dynamic brake is operated. Use Equation 10.2 to calculate an approximate coasting distance to a stop. The dynamic brake time constant τ varies with the servo motor and machine operation speeds. (Refer to (2)(a), (b) of this section.)

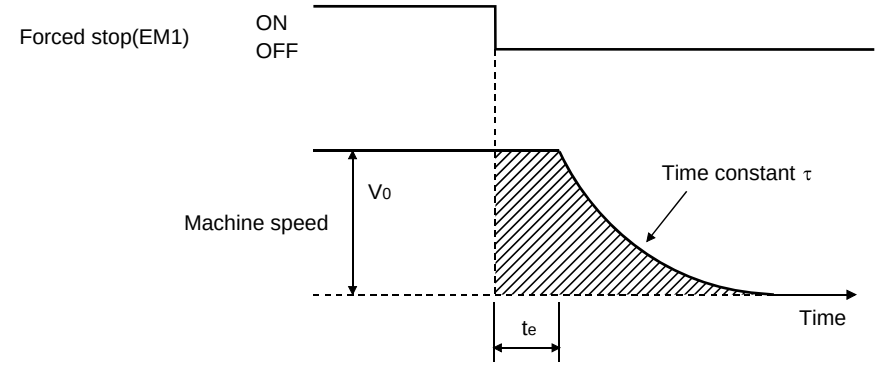


Fig. 10.3 Dynamic brake operation diagram

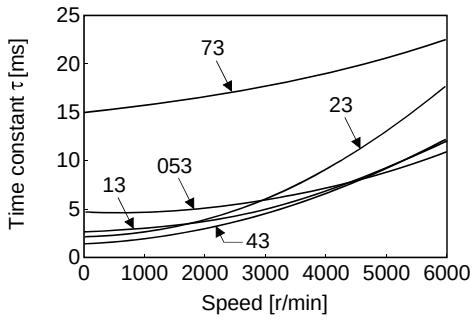
$$L_{max} = \frac{V_0}{60} \cdot \left\{ t_e + \tau \left(1 + \frac{J_L}{J_M} \right) \right\} \quad \text{(10.2)}$$

L_{max} : Maximum coasting distance ..... [mm][in]
Vo : Machine rapid feed rate .....[mm/min][in/min]
J_M : Servo motor inertial moment..... [kg・cm^2][oz・in^2]
J_L : Load inertia moment converted into equivalent value on servo motor shaft ..... [kg・cm^2][oz・in^2]
τ : Brake time constant ..... [s]
t_e : Delay time of control section..... [s]
For 7kW or less servo, there is internal relay delay time of about 30ms. For 11k to 22kW servo, there is delay time of about 100ms caused by a delay of the external relay and a delay of the magnetic contactor built in the external dynamic brake.

(2) Dynamic brake time constant

The following shows necessary dynamic brake time constant τ for the equations (10.2).

(a) 200V class servo motor



LE-□-□series

10.3.2 The dynamic brake at the load inertia moment

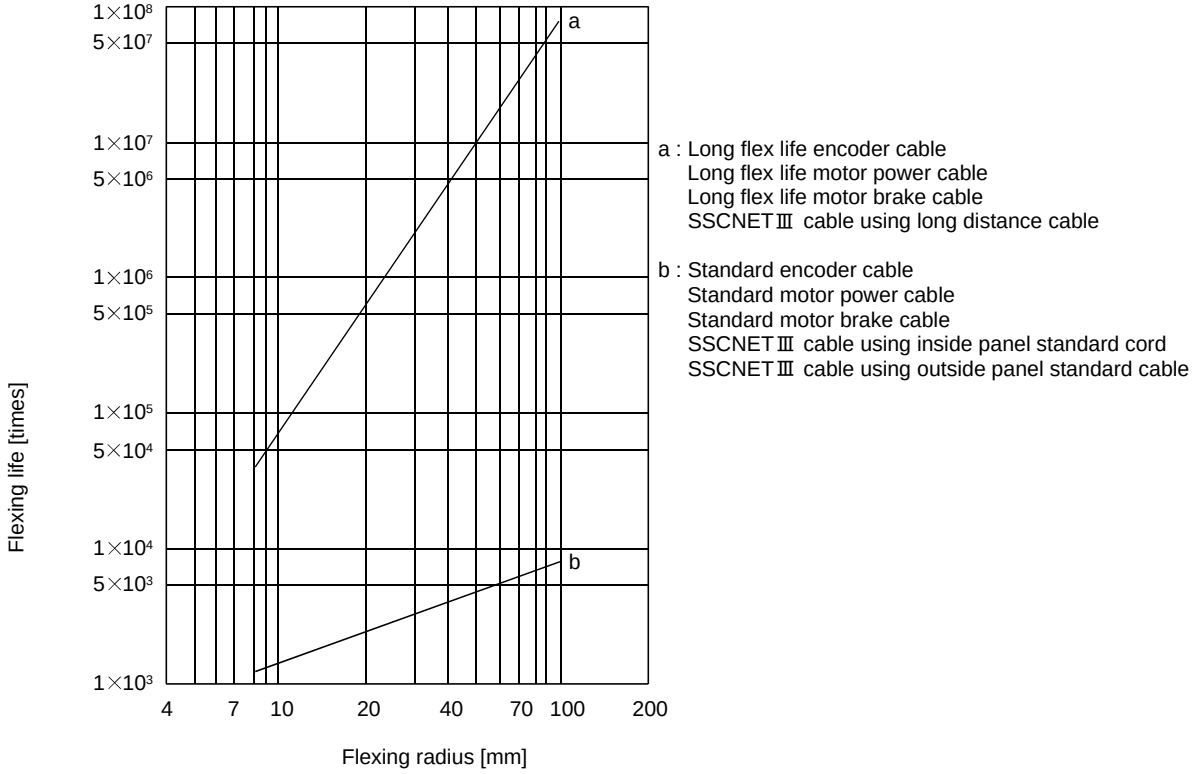
Use the dynamic brake under the load inertia moment ratio indicated in the following table. If the load inertia moment is higher than this value, the built-in dynamic brake may burn. If there is a possibility that the load inertia moment may exceed the value, contact Mitsubishi.

The values of the load inertia moment ratio in the table are the values at the maximum rotation speed of the servo motor.

Driver	Servo motor
	LE−□−□
LECSS□−□	30

10.4 Cable flexing life

The flexing life of the cables is shown below. This graph calculated values. Since they are not guaranteed values, provide a little allowance for these values.



10.5 Inrush currents at power-on of main circuit and control circuit

The following table indicates the inrush currents (reference data) that will flow when the maximum permissible voltage (200V class: 253VAC, 400V class: 528VAC) is applied at the power supply capacity of 2500kVA and the wiring length of 1m (3.28ft).

Driver	Inrush currents (A_{0-p})	
	Main circuit power supply (L_1, L_2, L_3)	Control circuit power supply (L_{11}, L_{21})
LECSS1-□	38A (Attenuated to approx. 14A in 10ms)	20 to 30A (Attenuated to approx. 0A in 1 to 2ms)
LECSS2-□	30A (Attenuated to approx. 5A in 10ms)	

Since large inrush currents flow in the power supplies, always use no-fuse breakers and magnetic contactors. (Refer to section 11.12.)

When circuit protectors are used, it is recommended to use the inertia delay type that will not be tripped by an inrush current.

11. OPTIONS AND AUXILIARY EQUIPMENT

11. OPTIONS AND AUXILIARY EQUIPMENT

⚠WARNING	・Before connecting any option or peripheral equipment, turn off the power and wait for 15 minutes or more until the charge lamp turns off. Then, confirm that the voltage between P(＋) and N(－) is safe with a voltage tester and others. Otherwise, an electric shock may occur. In addition, always confirm from the front of the driver whether the charge lamp is off or not.

⚠CAUTION	・Use the specified auxiliary equipment and options. Unspecified ones may lead to a fault or fire.

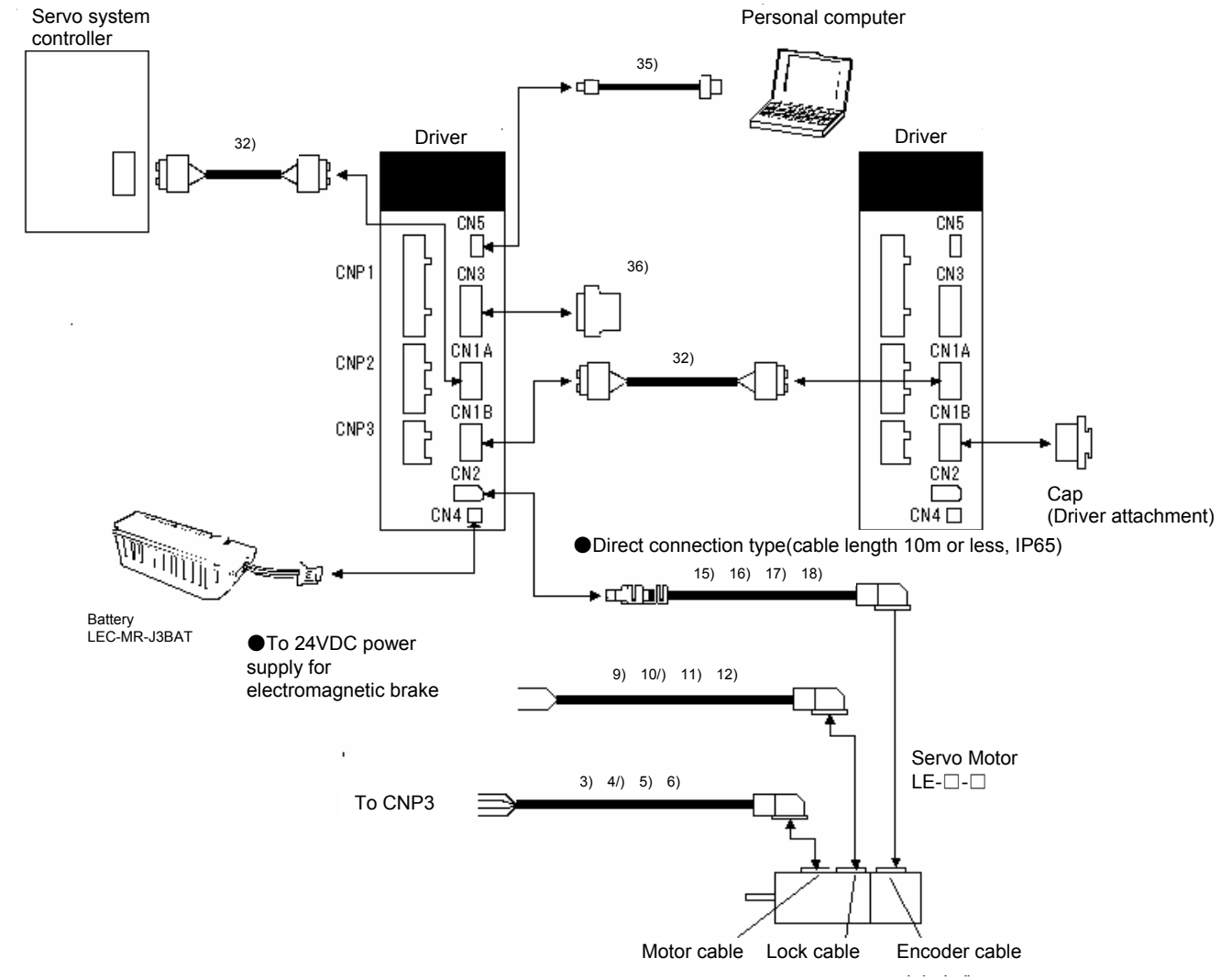
11.1 Cable/connector sets

POINT

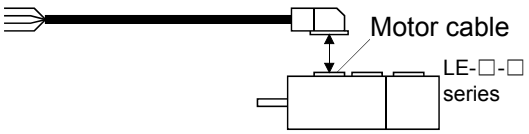
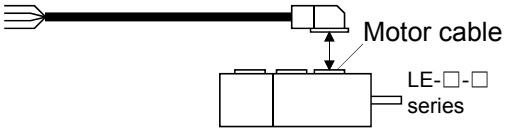
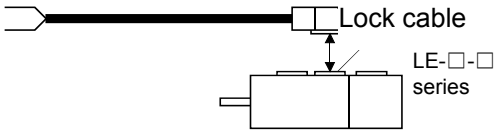
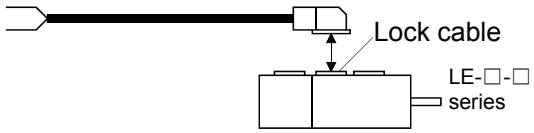
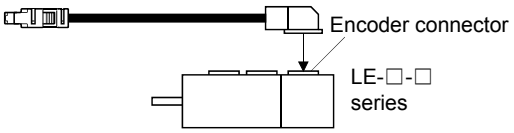
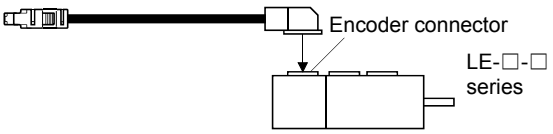
・Protective structure indicated for cables and connecters is for a cable or connector alone. When the cables and connectors are used to connect the driver and servo motor, and if protective structures of the driver and servo motor are lower than that of the cable and connector, specifications of the driver and servo motor apply.

As the cables and connectors used with this servo, purchase the options indicated in this section.

11.1.1 Combinations of cable/connector sets



Note. Connectors for 3.5kW or less. For 5kW or more, terminal blocks.

No.	Product	Model	Description	Application
3)	Motor power supply cable	LE-CSM-S□A Cable length: 2・5・10m	 Refer to section 11.1.3 for details.	IP65 Load side lead
4)	Motor power supply cable	LE-CSM-R□A Cable length: 2・5・10m		IP65 Load side lead Robot cable
5)	Motor power supply cable	LE-CSM-S□B Cable length: 2・5・10m	 Refer to section 11.1.3 for details.	IP65 Opposite-to-load side lead
6)	Motor power supply cable	LE-CSM-R□B Cable length: 2・5・10m		IP65 Opposite-to-load side lead Robot cable
9)	Lock cable	LE-CSB-S□A Cable length: 2・5・10m	 Refer to section 11.1.4 for details.	IP65 Load side lead
10)	Lock cable	LE-CSB-R□A Cable length: 2・5・10m		IP65 Load side lead Robot cable
11)	Lock cable	LE-CSB-S□B Cable length: 2・5・10m	 Refer to section 11.1.4 for details.	IP65 Opposite-to-load side lead
12)	Lock cable	LE-CSB-R□B Cable length: 2・5・10m		IP65 Opposite-to-load side lead Robot cable
15)	Encoder cable	LE-CSE-S□A Cable length: 2・5・10m	 Refer to section 11.1.2 (1) for details.	IP65 Load side lead
16)	Encoder cable	LE-CSE-R□A Cable length: 2・5・10m		IP65 Load side lead Robot cable
17)	Encoder cable	LE-CSE-S□B Cable length: 2・5・10m	 Refer to section 11.1.2 (1) for details.	IP65 Opposite-to-load side lead
18)	Encoder cable	LE-CSE-R□B Cable length: 2・5・10m		IP65 Opposite-to-load side lead Robot cable

No.	Product	Model	Description		Application
32)	SSCNETⅢ cable	LE-CSS-□ Cable length: 0.15 to 3m (Refer to section 11.1.5.)	Connector: PF-2D103 (Japan Aviation Electronics Industry, Ltd.)	Connector: PF-2D103 (Japan Aviation Electronics Industry, Ltd.)	Inside panel standard cord
35)	USB cable	LEC-MR-J3USB Cable length: 3m	For CN5 connector minB connector (5 pins)	For personal computer connector A connector	For connection with PC-AT compatible personal computer
36)	Connector set	LE-CSNS		Connector: 10120-3000PE Shell kit: 10320-52F0-008 (3M or similar product)	

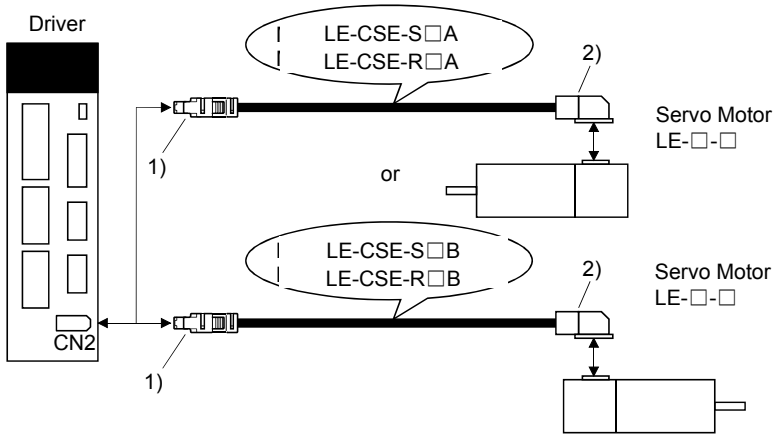
11.1.2 Encoder cable/connector sets

(1) LE-CSE- □□A・LE-CSE-□□B

These cables are encoder cables for the LE-□-□ series servo motors. The numerals in the Cable Length field of the table are the symbols entered in the □ part of the cable model. The cables of the lengths with the symbols are available.

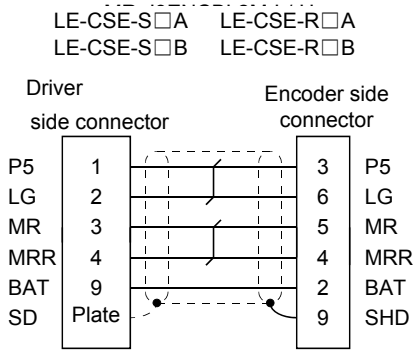
Cable model	Cable length			Protective structure	Flex life	Application
	2m	5m	10m			
LE-CSE-S□A	2	5	A	IP65	Standard	For LE-□-□ servo motor Load side lead
LE-CSE-R□A	2	5	A	IP65	Robot cable	
LE-CSE-S□B	2	5	A	IP65	Standard	For LE-□-□ servo motor Opposite-to-load side lead
LE-CSE-R□B	2	5	A	IP65	Robot cable	

(a) Connection of driver and servo motor



Cable model	1) For CN2 connector	2) For encoder connector
LE-CSE-S□A LE-CSE-R□A LE-CSE-S□B LE-CSE-R□B	Receptacle: 36210-0100PL Shell kit: 36310-3200-008 (3M) Connector set: 54599-1019(Molex) (Note) Signal layout 2 LG, 4 MRR, 6, 8, 10, 1 P5, 3 MR, 5, 7, 9 BAT View seen from wiring side. or (Note) Signal layout 2 LG, 4 MRR, 6, 8, 10, 1 P5, 3 MR, 5, 7, 9 BAT View seen from wiring side. Note. Keep open the pins shown with ⊘. Especially, pin 10 is provided for manufacturer adjustment. If it is connected with any other pin, the driver cannot operate normally.	Connector: 1674320-1 Crimping tool for ground clip: 1596970-1 Crimping tool for receptacle contact: 1596847-1 (Tyco Electronics) (Note) Signal layout 9 SHD, 7, 8, 5 MR, 6 P5G, 3 P5, 4 MRR, 1, 2 BAT View seen from wiring side. Note. Keep open the pin shown with an ⊘.

(b) Cable internal wiring diagram



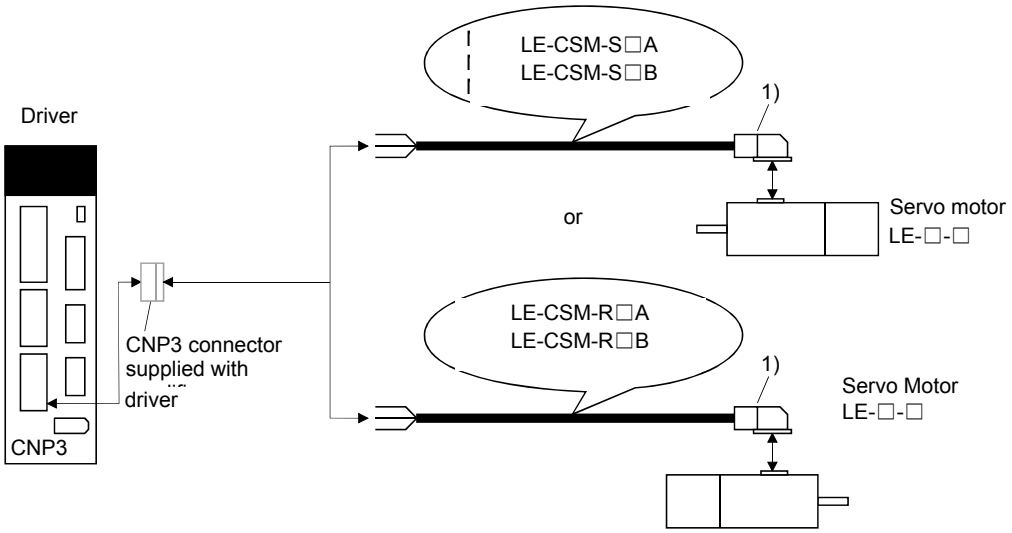
11.1.3 Motor cables

These cables are motor power supply cables for the LE-□-□series servo motors. The numerals in the Cable length field of the table are the symbols entered in the □ part of the cable model. The cables of the lengths with the symbols are available.

Refer to section 3.10 when wiring.

Cable model	Cable length			IP rating	Cable type	Application
	2m	5m	10m			
LE-CSMS□A	2	5	A	IP65	Standard	For LE-□-□ servo motor Load side lead
LE-CSM-S□B	2	5	A	IP65	Standard	For LE-□-□servo motor Opposite-to-load side lead
LE-CSM-R□A	2	5	A	IP65	Robot cable	For LE-□-□ servo motor Load side lead
LE-CSM-R□B	2	5	A	IP65	Robot cable	For LE-□-□ servo motor Opposite-to-load side lead

(1) Connection of driver and servo motor



Cable model	1) For motor power supply connector	
LE-CSM−S□A LE-CSM−S□B LE-CSM-R□A LE-CSM−R□B	Connector: JN4FT04SJ1-R Hood, socket insulator Bushing, ground nut Contact: ST-TMH-S-C1B-100-(A534G) Crimping tool: CT160-3-TMH5B (Japan Aviation Electronics Industry)	Signal layout 1 ⏚ 2 U 3 V 4 W View seen from wiring side.

(2) Internal wiring diagram

LE-CSM-S□A
LE-CSM-S□B

LE-CSM-R□A
LE-CSM-R□B

Note. These are not shielded cables.

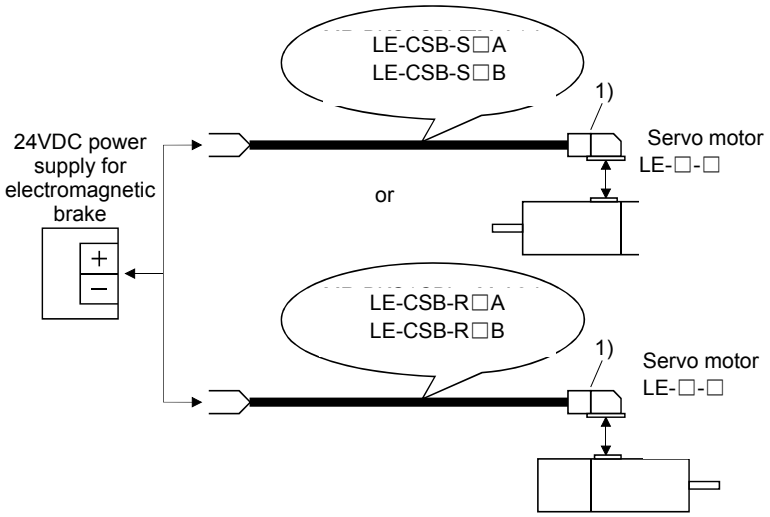
11.1.4 Lock cables

These cables are motor brake cables for the LE-□-□ series servo motors. The numerals in the Cable length field of the table are the symbols entered in the □ part of the cable model. The cables of the lengths with the symbols are available.

Refer to section 3.11 when wiring.

Cable model	Cable length			Protective structure	Flex life	Application
	2m	5m	10m			
LE-CSB-S□A	2	5	A	IP65	Standard	For LE-□-□ servo motor Load side lead
LE-CSB-S□B	2	5	A	IP65	Standard	For LE-□-□servo motor Opposite-to-load side lead
LE-CSB-R□A	2	5	A	IP65	Robot cable	For LE-□-□servo motor Load side lead
LE-CSB-R□B	2	5	A	IP65	Robot cable	For LE-□-□ servo motor Opposite-to-load side lead

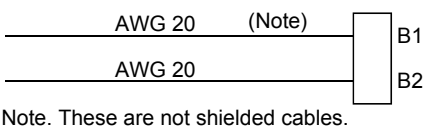
(1) Connection of driver and servo motor



Cable model	1) For motor brake connector	
LE-CSB-S□A LE-CSB-S□B LE-CSB-R□A LE-CSB-R□B	Connector: JN4FT02SJ1-R Hood, socket insulator Bushing, ground nut Contact: ST-TMH-S-C1B-100-(A534G) Crimping tool: CT160-3-TMH5B (Japan Aviation Electronics Industry)	Signal layout 1 B1 2 B2 View seen from wiring side.

(2) Internal wiring diagram

MR-BKS1CBL□M-A1-H MR-BKS1CBL□M-A2-H
MR-BKS2CBL03M-A1-L MR-BKS2CBL03M-A2-L



Note. These are not shielded cables.

11.1.5 SSCNETⅢ cable

POINT

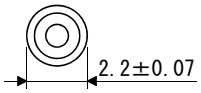
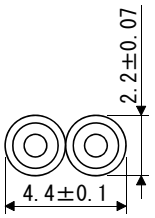
・Do not see directly the light generated from CN1A・CN1B connector of driver or the end of SSCNETⅢ cable. When the light gets into eye, you may feel something is wrong for eye. (The light source of SSCNETⅢ complies with class1 defined in JIS C6802 or IEC60825-1.)

(1) Model explanations

Numeral in the column of cable length on the table is a symbol put in the □ part of cable model. Cables of which symbol exists are available.

Cable model	Cable length					Flex life	Application remark
	0.15 m	0.3 m	0.5 m	1m	3m		
LE-CSS-□	L	K	J	1	3	Standard	Using inside panel standard cord

(2) Specifications

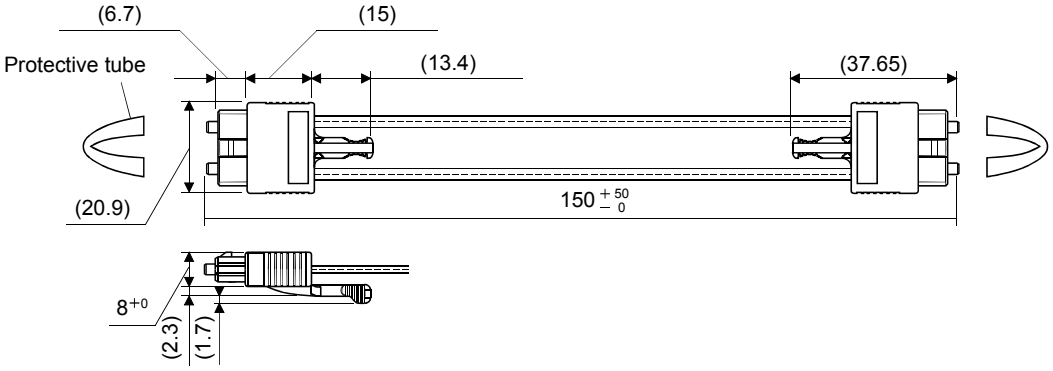
		Description	
SSCNETⅢ cable model		LE-CSS-□	
SSCNETⅢ cable length		0.15m	0.3～3m
Optical cable(cord)	Minimum bend radius	25mm	
	Tension strength	70N	140N
	Temperature range for use (Note)	－40～85℃	
	Ambient	Indoors (no direct sunlight) No solvent or oil	
	External appearance [mm]		

Note. This temperature range for use is the value for optical cable (cord) only. Temperature condition for the connector is the same as that for driver.

(3) Outline drawings

(a) LE-CSS-L

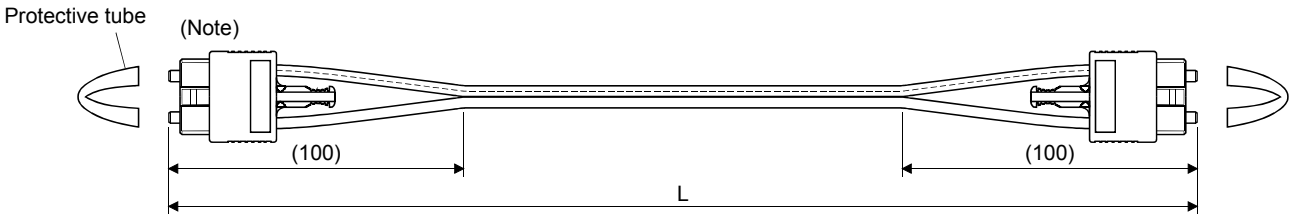
[Unit: mm]



(b) LE-CSS-K / LE-CSS-J / LE-CSS-1 / LE-CSS-3

Refer to the table shown in (1) of this section for cable length (L).

[Unit: mm]



Note. Dimension of connector part is the same as that of LE-CSS-L.

11.2 Regenerative options

⚠ CAUTION	・The specified combinations of regenerative options and drivers may only be used. Otherwise, a fire may occur.

(1) Combination and regenerative power

The power values in the table are resistor-generated powers and not rated powers.

Driver	Regenerative power [W]		
	Built-in regenerative resistor	LEC-MR-RB-032 [40Ω]	LEC-MR-RB-12 [40Ω]
LECSS□-S5		30	
LECSS□-S7	10	30	100
LECSS□-S8	10	30	100

Note 1. Always install a cooling fan.

2. Values in parentheses assume the installation of a cooling fan.

(3) Parameter setting

Set parameter No.PA02 according to the option to be used.

Parameter No.PA02

0	0		

Selection of regenerative option

00 : Regenerative option is not used

・For 100W controller regenerative resistor is not used

・For 200W / 400W controller regenerative resistor is used

02 : LEC-MR-RB032

03 : LEC-MR-RB012

(3) Connection of the regenerative option

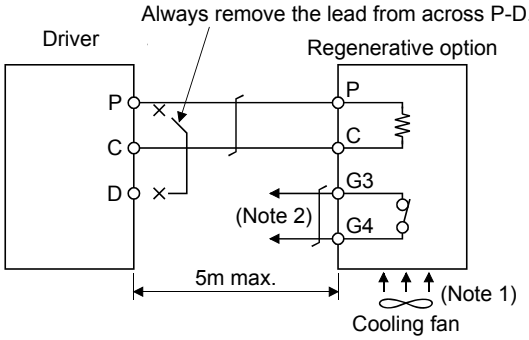
POINT
▪ For the sizes of wires used for wiring, refer to section 11.5.

The regenerative option will cause a temperature rise of +100℃ relative to the ambient temperature. Fully examine heat dissipation, installation position, used cables, etc. before installing the option. For wiring, use flame-resistant wires and keep them clear of the regenerative option body. Always use twisted cables of max. 5m length for connection with the driver.

(a) LECSS□-□

Always remove the wiring from across P-D and fit the regenerative option across P-C.

The G3 and G4 terminals act as a thermal sensor. G3-G4 is disconnected when the regenerative option overheats abnormally.



Note1. Make up a sequence which will switch off the magnetic contactor (MC) when abnormal heating occurs.

G3-G4 contact specifications

Maximum voltage: 120V AC/DC

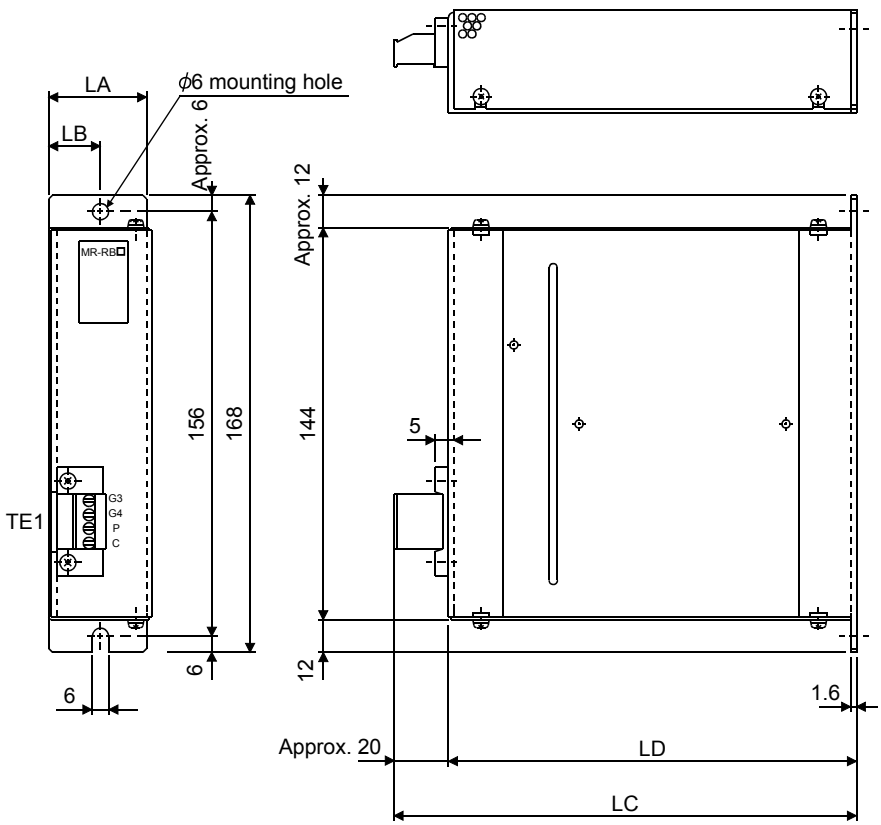
Maximum current: 0.5A/4.8VDC

Maximum capacity: 2.4VA

(4) Outline drawing

(a) LEC-MR-RB032 · LEC-MR-RB12

[Unit: mm (in)]



· TE1
Terminal block

G3
G4
P
C

Terminal screw: M3

Tightening torque: 0.5 to 0.6 [N · m]
(4 to 5 [lb · in])

· Mounting screw

Screw size: M5

Tightening torque: 3.24 [N · m]
(28.7 [lb · in])

Regenerative option	Variable dimensions				Mass	
	LA	LB	LC	LD	[kg]	[lb]
LEC-MR-RB032	30	15	119	99	0.5	1.1
LEC-MR-RB12	40	15	169	149	1.1	2.4

11.3 Set up software (MR Configurator)

The set up software (MR Configurator : MRZJW3-SETUP221E) uses the communication function of the driver to perform parameter setting changes, graph display, test operation, etc. on a personal computer. When setup software (MR Configurator) is used, the selection of the model of LECSS□-□ is needed. Please select 'MR-J3-B' by "Model selection" - "System settings" - "Setup" - "Project name".

(1) Specifications

Item	Description
Compatibility with a driver	The set up software(MR Configurator) software version compatible with the driver is C4 or later.
Monitor	Display, high speed monitor, trend graph Minimum resolution changes with the processing speed of the personal computer.
Alarm	Display, history, amplifier data
Diagnostic	Digital I/O, no motor rotation, total power-on time, amplifier version info, motor information, tuning data, absolute encoder data, Axis name setting.
Parameters	Parameter list, turning, change list, detailed information
Test operation	Jog operation, positioning operation, Do forced output, program operation.
Advanced function	Machine analyzer, gain search, machine simulation.
File operation	Data read, save, delete, print
Others	Automatic demo, help display

(2) System configuration

(a) Components

To use this software, the following components are required in addition to the driver and servo motor.

Equipment		(Note 1) Description
(Note 2, 3) Personal computer	OS	Windows®98, Windows®Me, Windows®2000 Professional, Windows®Xp Professional / Home Edition, Windows Vista® Home Basic / Home Premium, / Business / Ultimate / Enterprise Windows 7® Starter / Home Premium / Professional / Ultimate / Enterprise operates
	Hard Disk	130MB or more of free space
Browser		Internet Explorer 4.0 or more
Display		One whose resolution is 1024 × 768 or more and that can provide a high color (16 bit) display.
Keyboard		Connectable with the above personal computer.
Mouse		Connectable with the above personal computer.
Printer		Connectable with the above personal computer.
USB cable		LEC-MR-J3USBCBL3M（Option）

Note 1. Windows and Windows Vista are the registered trademarks of Microsoft Corporation in the United States and other countries.

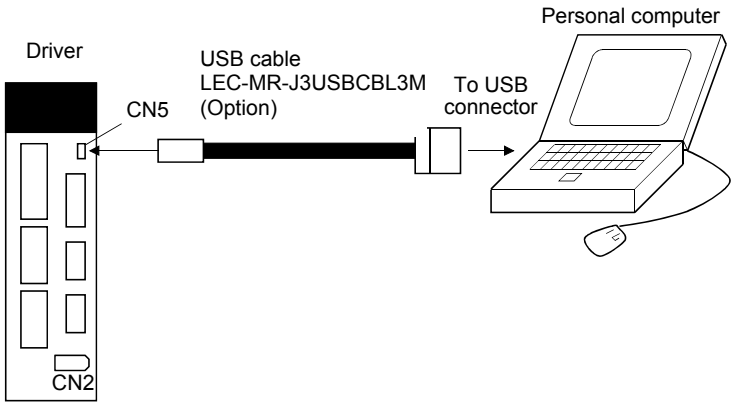
2. On some personal computers, set up software(MR Configurator) may not run properly.

3. 64-bit Windows XP and 64-bit Windows Vista are not supported.

Setup software(MR Configurator) English version, contact your nearest sales branch.

(b) Connection with driver

1) For use of USB



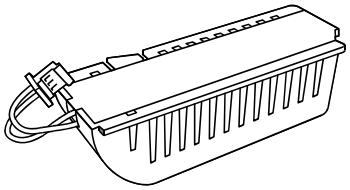
11.4 Battery LEC-MR-J3BAT

POINT

- The revision (Edition 44) of the Dangerous Goods Rule of the International Air Transport Association (IATA) went into effect on January 1, 2003 and was enforced immediately. In this rule, "provisions of the lithium and lithium ion batteries" were revised to tighten the restrictions on the air transportation of batteries. However, since this battery is non-dangerous goods (non-Class 9), air transportation of 24 or less batteries is outside the range of the restrictions. Air transportation of more than 24 batteries requires packing compliant with the Packing Standard 903. When a self-certificate is necessary for battery safety tests, contact our branch or representative. For more information, consult our branch or representative. (As of Jun, 2008).

(1) Purpose of use for LEC-MR-J3BAT

This battery is used to construct an absolute position detection system. Refer to section 12.3 for the fitting method, etc.



(2) Year and month when LEC-MR-J3BAT is manufactured

The year and month when LEC-MR-J3BAT is manufactured are written down in Serial No. on the rating plate of the battery back face.

The year and month of manufacture are indicated by the last one digit of the year and 1 to 9, X(10), Y(11), Z(12).

For October 2004, the Serial No. is like, "SERIAL □4X□□□□□□".

11.5 Selection example of wires

POINT

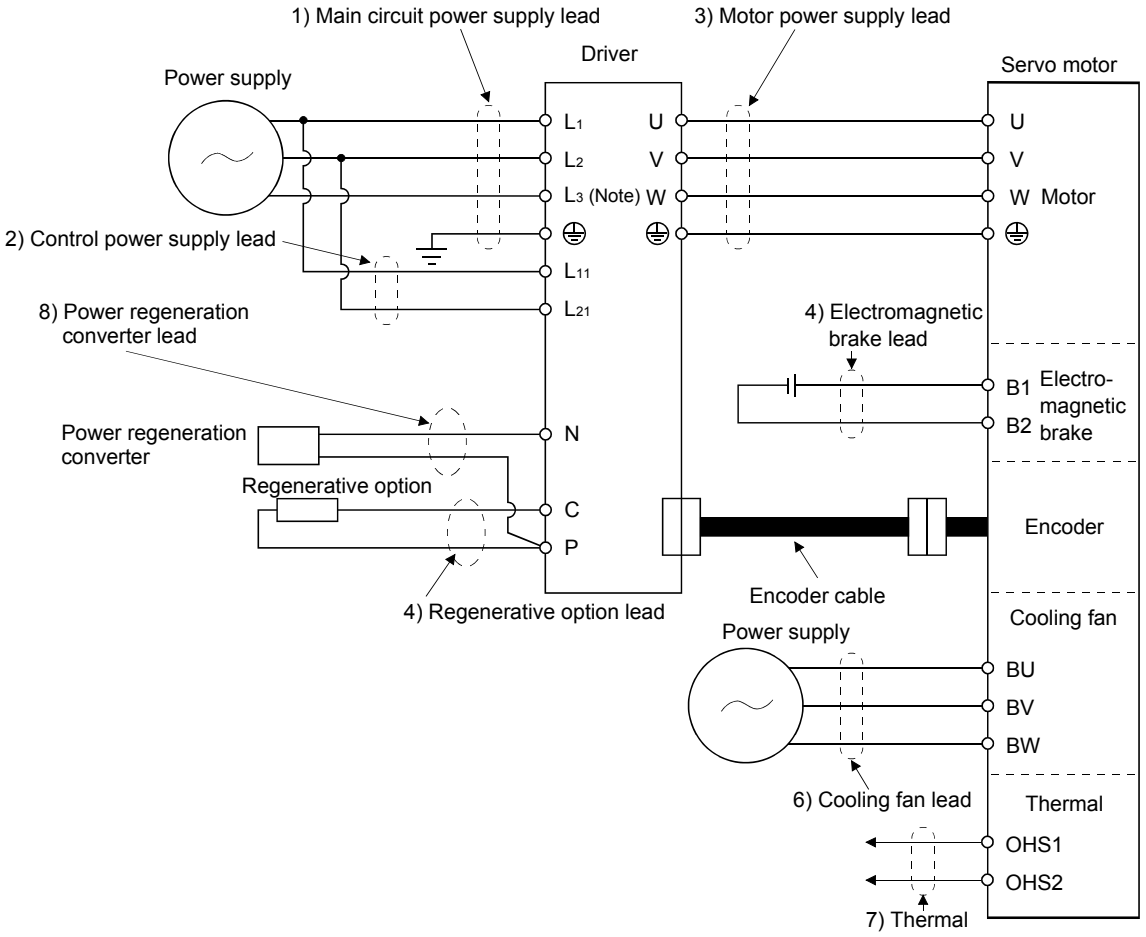
- Refer to section 11.1.5 for SSCNETⅢ cable.
- Wires indicated in this section are separated wires. When using a cable for power line (U, V, and W) between the driver and servo motor, use a 600V grade EP rubber insulated chloroprene sheath cab-tire cable (2PNCT). For selection of cables, refer to appendix 6.
- To comply with the UL/C-UL (CSA) Standard, use UL-recognized copper wires rated at 60℃ (140℉) or more for wiring. To comply with other standards, use a wire that is complied with each standard
- Selection condition of wire size is as follows.

  Construction condition: One wire is constructed in the air

  Wire length: 30m or less

(1) Wires for power supply wiring

The following diagram shows the wires used for wiring. Use the wires given in this section or equivalent.



Note. There is no L3 for 1-phase 100 to 120VAC power supply.

(a) When using the 600V Polyvinyl chloride insulated wire (IV wire)

Selection example of wire size when using IV wires is indicated below.

Table 11.1 Wire size selection example 1 (IV wire)

Driver	Wires [mm^2] (Note 1, 2)						
	1) L_1・L_2・L_3・⏚	2) L_{11}・L_{21}	3) U・V・W・⏚	4) P・C	5) B1・B2	6) BU・BV・BW	7) OHS1・OHS2
LECSS□-S5	2(AWG14)	1.25(AWG16)	1.25(AWG16)	2(AWG14)	1.25(AWG16)		
LECSS□-S7							
LECSS□-S8							

Note 1. Alphabets in the table indicate crimping tools. For crimping terminals and applicable tools, refer to (1) (c) in this section.

2. Wires are selected based on the highest rated current among combining servo motors.

Use wires 8) of the following sizes with the power regeneration converter (FR-RC-(H)).

Model	Wires[mm^2]
FR-RC-15K	14(AWG6)
FR-RC-30K	14(AWG6)
FR-RC-55K	22(AWG4)
FR-RC-H15K	14(AWG6)
FR-RC-H30K	14(AWG6)
FR-RC-H55K	14(AWG6)

(b) When using the 600V Grade heat-resistant polyvinyl chloride insulated wire (HIV wire)

Selection example of wire size when using HIV wires is indicated below. For the wire (8)) for power regeneration converter (FR-RC-(H)), use the IV wire indicated in (1) (a) in this section.

Table 11.2 Wire size selection example 2 (HIV wire)

Driver	Wires [mm^2] (Note 1, 2)						
	1) L_1・L_2・L_3・⏚	2) L_{11}・L_{21}	3) U・V・W・⏚	4) P・C	5) B1・B2	6) BU・BV・BW	7) OHS1・OHS2
LECSS□-S5	2(AWG14)	1.25(AWG16)	1.25(AWG16)	2(AWG14)	1.25(AWG16)		
LECSS□-S7							
LECSS□-S8							

Note 1. Alphabets in the table indicate crimping tools. For crimping terminals and applicable tools, refer to (1) (c) in this section.

2. Wires are selected based on the highest rated current among combining servo motors.

(c) Selection example of crimping terminals

Selection example of crimping terminals for the driver terminal box when using the wires mentioned in (1) (a) and (b) in this section is indicated below.

Symbol	Driver side crimping terminals				
	(Note 2) Crimping terminal	Applicable tool			Manufacturer
		Body	Head	Dice	
a	FVD5.5-4	YNT-1210S			Japan Solderless Terminal
(Note 1)b	8-4NS	YHT-8S			
c	FVD14-6	YF-1・E-4	YNE-38	DH-112・DH122	
d	FVD22-6			DH-113・DH123	
(Note 1)e	38-6	YPT-60-21		TD-112・TD-124	
		YF-1・E-4	YET-60-1		
(Note 1)f	R60-8	YPT-60-21		TD-113・TD-125	
		YF-1・E-4	YET-60-1		
g	FVD2-4	YNT-1614			
h	FVD2-M3				
j	FVD5.5-6	YNT-1210S			
k	FVD5.5-8				
l	FVD8-6	YF-1・E-4	YNE-38	DH-111・DH121	
m	FVD14-8			DH-112・DH122	
n	FVD22-8			DH-113・DH123	
(Note 1)p	R38-8	YPT-60-21		TD-112・TD-124	
		YF-1・E-4	YET-60-1		
q	FVD2-6	YNT-1614			

Note 1. Coat the part of crimping with the insulation tube.

2. Some crimping terminals may not be mounted depending on the size. Make sure to use the recommended ones or equivalent ones.

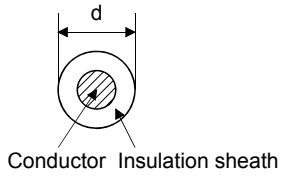
(2) Wires for cables

When fabricating a cable, use the wire models given in the following table or equivalent.

Table 11.3 Wires for option cables

Type	Model	Length [m]	Core size [mm²]	Number of Cores	Characteristics of one core			(Note 3) Finishing OD [mm]	Wire model
					Structure [Wires/mm]	Conductor resistance [Ω/mm]	Insulation coating OD d [mm] (Note 1)		
Encoder Cable	LE-CSE-S□A	2 to 10	AWG22	6 (3 pairs)	7/0.26	53 or less	1.2	7.1±0.3	(Note 3) VSVP 7/0.26 (AWG#22 or equivalent)-3P Ban-gi-shi-16823
	LE-CSE-S□B								
	LE-CSE-R□A	2 to 10	AWG22	6 (3 pairs)	70/0.08	56 or less	1.2	7.1±0.3	(Note 3) ETFE・SVP 70/0.08 (AWG#22 or equivalent)-3P Ban-gi-shi-16824
	LE-CSE-R□B								
Motor cable	LE-CSM-S□A	2 to 10	(Note 5) AWG19	4	50/0.08	25.40 or less	1.8	5.7±0.3	(Note 4) UL Style 2103 AWG19 4 cores
	LE-CSM-S□B	2 to 10							
	LE-CSM-R□A	2 to 10							
	LE-CSM-R□B	2 to 10							
Lock cable	LE-CSB-S□A	2 to 10	(Note 5) AWG20	2	100/0.08	38.14 or less	1.3	4.0±0.3	(Note 4) UL Style 2103 AWG20 2 cores
	LE-CSB-S□B	2 to 10							
	LE-CSB-R□A	2 to 10							
	LE-CSB-R□B	2 to 10							

Note 1. d is as shown below.



2. Purchased from Toa Electric Industry
3. Standard OD. Max. OD is about 10% greater.
4. Kurabe
5. These wire sizes assume that the UL-compliant wires are used at the wiring length of 10m.

11.6 No-fuse breakers, fuses, magnetic contactors

Always use one no-fuse breaker and one magnetic contactor with one driver. When using a fuse instead of the no-fuse breaker, use the one having the specifications given in this section.

Driver	No-fuse breaker		Fuse			Magnetic contactor
	Not using power factor improving reactor	Using power factor improving reactor	(Note) Class	Current [A]	Voltage AC [V]	
LECSS□-S5	30A frame 5A	30A frame 5A	T	10	250	S-N10
LECSS2-S7	30A frame 5A	30A frame 5A		10		
LECSS1-S7	30A frame 10A	30A frame 10A		15		
LECSS2-S8	30A frame 10A	30A frame 5A		15		

Note. When not using the driver as a UL/C-UL Standard compliant product, K5 class fuse can be used.

11.7 Noise reduction techniques

Noises are classified into external noises which enter the driver to cause it to malfunction and those radiated by the driver to cause peripheral devices to malfunction. Since the driver is an electronic device which handles small signals, the following general noise reduction techniques are required.
Also, the driver can be a source of noise as its outputs are chopped by high carrier frequencies. If peripheral devices malfunction due to noises produced by the driver, noise suppression measures must be taken. The measures will vary slightly with the routes of noise transmission.

(1) Noise reduction techniques

(a) General reduction techniques

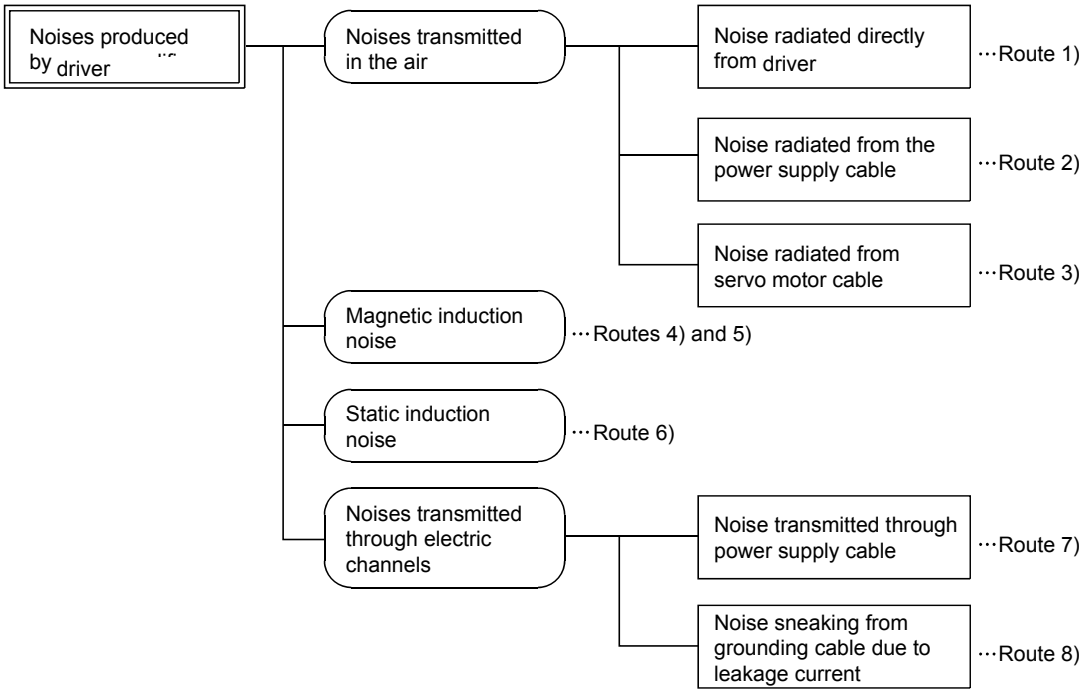
- Avoid laying power lines (input and output cables) and signal cables side by side or do not bundle them together. Separate power lines from signal cables.
- Use shielded, twisted pair cables for connection with the encoder and for control signal transmission, and connect the shield to the SD terminal.
- Ground the driver, servo motor, etc. together at one point (refer to section 3.12).

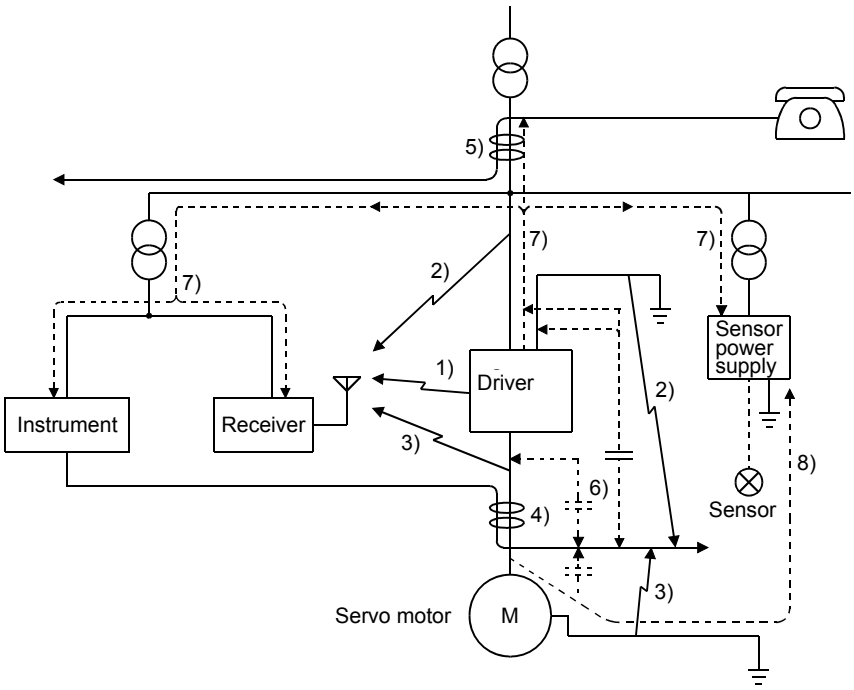
(b) Reduction techniques for external noises that cause the driver to malfunction

If there are noise sources (such as a magnetic contactor, an electromagnetic brake, and many relays which make a large amount of noise) near the driver and the driver may malfunction, the following countermeasures are required.

- Provide surge absorbers on the noise sources to suppress noises.
- Attach data line filters to the signal cables.
- Ground the shields of the encoder connecting cable and the control signal cables with cable clamp fittings.
- Although a surge absorber is built into the driver, to protect the driver and other equipment against large exogenous noise and lightning surge, attaching a varistor to the power input section of the equipment is recommended.

(c) Techniques for noises radiated by the driver that cause peripheral devices to malfunction Noises produced by the driver are classified into those radiated from the cables connected to the driver and its main circuits (input and output circuits), those induced electromagnetically or statically by the signal cables of the peripheral devices located near the main circuit cables, and those transmitted through the power supply cables.


Noises produced by driver
Noises transmitted in the air
Noise radiated directly from driver
…Route 1)
Noise radiated from the power supply cable
…Route 2)
Noise radiated from servo motor cable
…Route 3)
Magnetic induction noise
…Routes 4) and 5)
Static induction noise
…Route 6)
Noises transmitted through electric channels
Noise transmitted through power supply cable
…Route 7)
Noise sneaking from grounding cable due to leakage current
…Route 8)


5)
7)
7)
7)
2)
1)
Driver
2)
Sensor power supply
Instrument
Receiver
3)
8)
6)
4)
Sensor
3)
Servo motor
M

Noise transmission route	Suppression techniques
1) 2) 3)	When measuring instruments, receivers, sensors, etc. which handle weak signals and may malfunction due to noise and/or their signal cables are contained in a control box together with the driver or run near the driver, such devices may malfunction due to noises transmitted through the air. The following techniques are required. 1. Provide maximum clearance between easily affected devices and the driver. 2. Provide maximum clearance between easily affected signal cables and the I/O cables of the driver. 3. Avoid laying the power lines (Input cables of the driver) and signal cables side by side or bundling them together. 4. Insert a line noise filter to the I/O cables or a radio noise filter on the input line. 5. Use shielded wires for signal and power cables or put cables in separate metal conduits.
4) 5) 6)	When the power lines and the signal cables are laid side by side or bundled together, magnetic induction noise and static induction noise will be transmitted through the signal cables and malfunction may occur. The following techniques are required. 1. Provide maximum clearance between easily affected devices and the driver. 2. Provide maximum clearance between easily affected signal cables and the I/O cables of the driver. 3. Avoid laying the power lines (I/O cables of the driver) and signal cables side by side or bundling them together. 4. Use shielded wires for signal and power cables or put the cables in separate metal conduits.
7)	When the power supply of peripheral devices is connected to the power supply of the driver system, noises produced by the driver may be transmitted back through the power supply cable and the devices may malfunction. The following techniques are required. 1. Insert the radio noise filter (FR-BIF-(H)) on the power cables (Input cables) of the driver. 2. Insert the line noise filter (FR-BSF01・FR-BLF) on the power cables of the driver.
8)	When the cables of peripheral devices are connected to the driver to make a closed loop circuit, leakage current may flow to malfunction the peripheral devices. If so, malfunction may be prevented by disconnecting the grounding cable of the peripheral device.

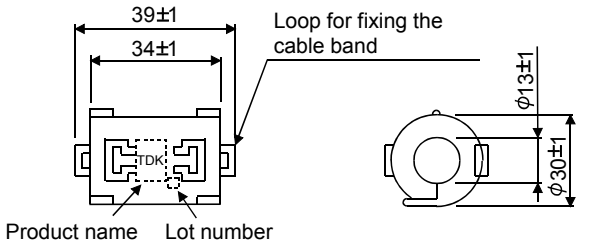
(2) Noise reduction products

(a) Data line filter (Recommended)

Noise can be prevented by installing a data line filter onto the encoder cable, etc. For example, the ZCAT3035-1330 of TDK and the ESD-SR-25 of NEC TOKIN make are available as data line filters. As a reference example, the impedance specifications of the ZCAT3035-1330 (TDK) are indicated below. This impedances are reference values and not guaranteed values.

Impedance[Ω]	
10 to 100MHz	100 to 500MHz
80	150

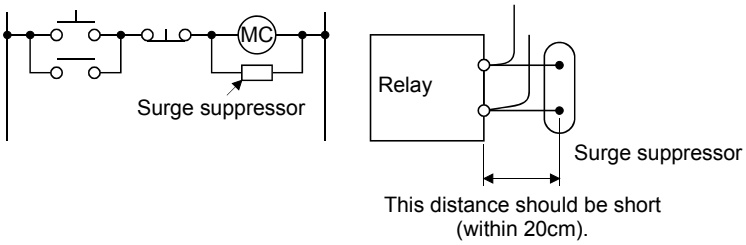
[Unit: mm]



Outline drawing (ZCAT3035-1330)

(b) Surge suppressor

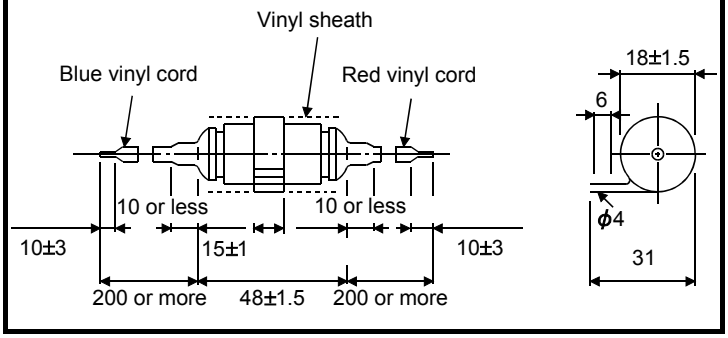
The recommended surge suppressor for installation to an AC relay, AC valve or the like near the driver is shown below. Use this product or equivalent.



(Ex.) 972A.2003 50411
(Matsuo Electric Co.,Ltd.−200VAC rating)

Rated voltage AC[V]	C [μF]	R [Ω]	Test voltage AC[V]
200	0.5	50 (1W)	Across T-C 1000(1 to 5s)

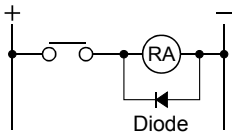
Outline drawing [Unit: mm]



Note that a diode should be installed to a DC relay, DC valve or the like.

Maximum voltage: Not less than 4 times the drive voltage of the relay or the like

Maximum current: Not less than twice the drive current of the relay or the like

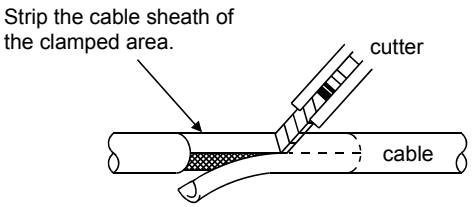


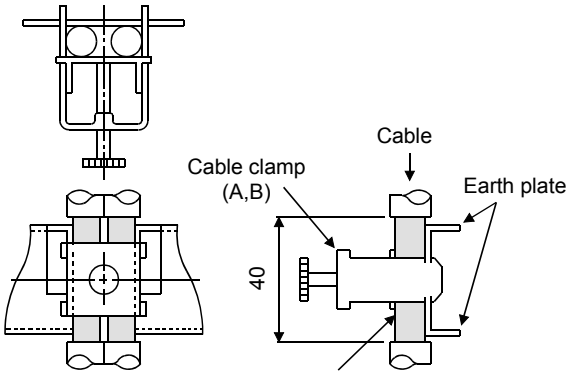
(c) Cable clamp fitting AERSBAN-□SET

Generally, the earth of the shielded cable may only be connected to the connector's SD terminal. However, the effect can be increased by directly connecting the cable to an earth plate as shown below. Install the earth plate near the driver for the encoder cable. Peel part of the cable sheath to expose the external conductor, and press that part against the earth plate with the cable clamp. If the cable is thin, clamp several cables in a bunch.

The clamp comes as a set with the earth plate.

[Unit: mm]



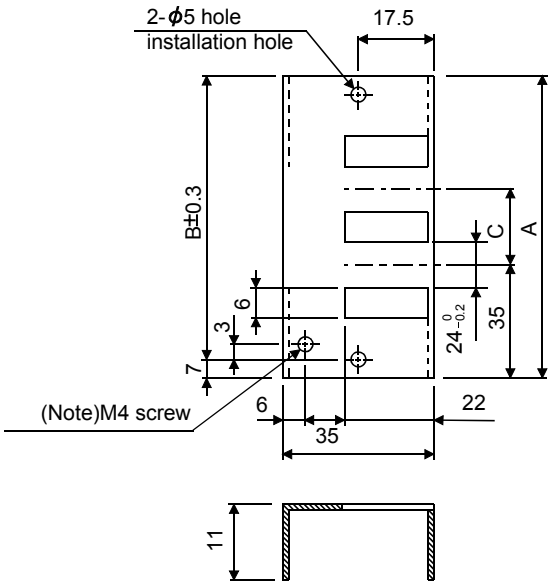


Clamp section diagram

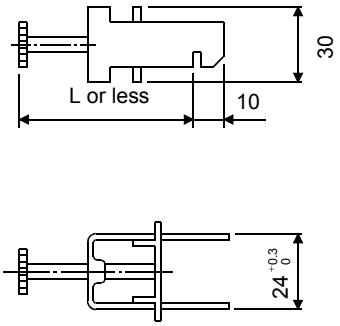
・Outline drawing

[Unit: mm]

Earth plate



Clamp section diagram



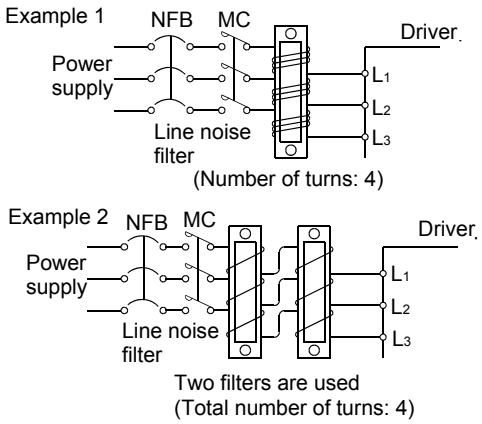
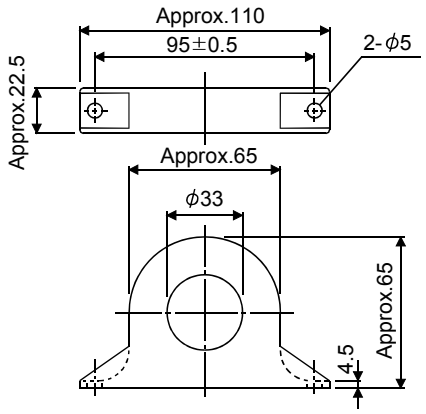
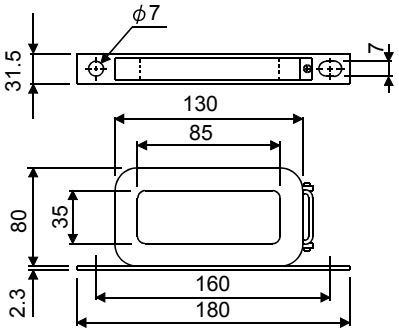
Note. Screw hole for grounding. Connect it to the earth plate of the control box.

Type	A	B	C	Accessory fittings
AERSBAN-DSET	100	86	30	clamp A: 2pcs.
AERSBAN-ESET	70	56		clamp B: 1pc.

Clamp fitting	L
A	70
B	45

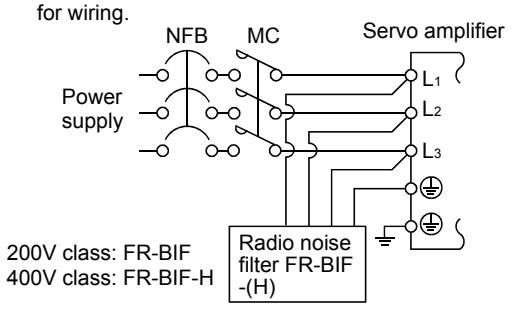
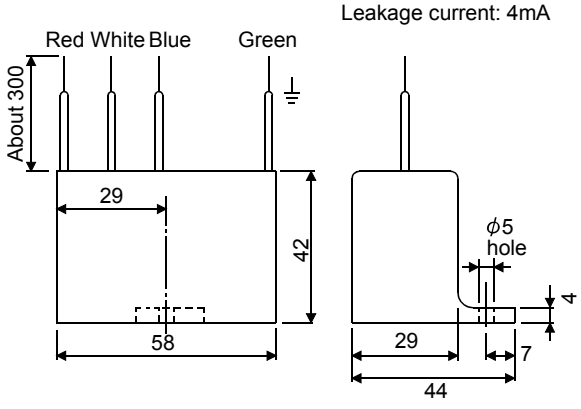
(d) Line noise filter (FR-BSF01, FR-BLF)

This filter is effective in suppressing noises radiated from the power supply side and output side of the driver and also in suppressing high-frequency leakage current (zero-phase current) especially within 0.5MHz to 5MHz band.

Connection diagram	Outline drawing [Unit: mm]
Use the line noise filters for wires of the main power supply (L_1 · L_2 · L_3) and of the motor power supply (U · V · W). Pass each of the 3-phase wires through the line noise filter an equal number of times in the same direction. For the main power supply, the effect of the filter rises as the number of passes increases, but generally four passes would be appropriate. For the motor power supply, passes must be four times or less. Do not pass the grounding (earth) wire through the filter, or the effect of the filter will drop. Wind the wires by passing through the filter to satisfy the required number of passes as shown in Example 1. If the wires are too thick to wind, use two or more filters to have the required number of passes as shown in Example 2. Place the line noise filters as close to the driver as possible for their best performance. 	FR-BSF01 (for wire size 3.5mm^2 (AWG12) or less))  FR-BLF(for wire size 5.5mm^2 (AWG10) or more)) 

(e) Radio noise filter (FR-BIF-(H))

This filter is effective in suppressing noises radiated from the power supply side of the driver especially in 10MHz and lower radio frequency bands. The FR-BIF (-H) is designed for the input only.

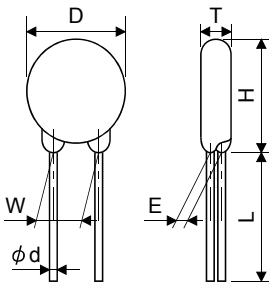
Connection diagram	Outline drawing (Unit: mm)
Make the connection cables as short as possible. Grounding is always required. When using the FR-BIF with a single-phase power supply, always insulate the wires that are not used for wiring. 	Leakage current: 4mA 

(f) Varistors for input power supply (Recommended)

Varistors are effective to prevent exogenous noise and lightning surge from entering the driver. When using a varistor, connect it between each phase of the input power supply of the equipment. For varistors, the TND20V-431K, TND20V-471K and TND20V-102K, manufactured by NIPPON CHEMI-CON, are recommended. For detailed specification and usage of the varistors, refer to the manufacturer catalog.

Power supply voltage	Varistor	Maximum rating					Maximum limit voltage		Static capacity (reference value)	Varistor voltage rating (range) V1mA
		Permissible circuit voltage		Surge current immunity	Energy immunity	Rated pulse power				
		AC[V_{rms}]	DC[V]	8/20μs[A]	2ms[J]	[W]	[A]	[V]	[pF]	[V]
100V class	TND20V-431K	275	350	10000/1 time	195	1.0	100	710	1300	430(387 to 473)
200V class	TND20V-471K	300	385	7000/2 time	215			775	1200	470(423 to 517)
400V class	TND20V-102K	625	825	7500/1 time 6500/2 time	400			1650	500	1000(900 to 1100)

[Unit: mm]



Model	D Max.	H Max.	T Max.	E ±1.0	(Note)L min.	ϕd ±0.05	W ±1.0
TND20V-431K	21.5	24.5	6.4	3.3	20	0.8	10.0
TND20V-471K			6.6	3.5			
TND20V-102K	22.5	25.5	9.5	6.4			

Note. For special purpose items for lead length (L), contact the manufacturer.

11.8 Leakage current breaker

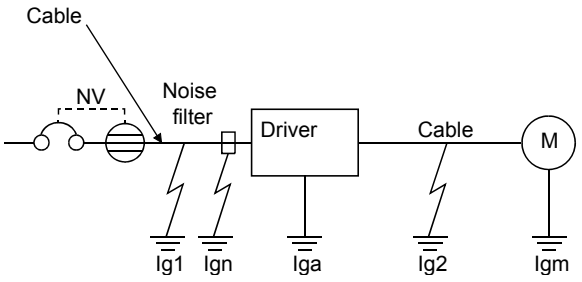
(1) Selection method

High-frequency chopper currents controlled by pulse width modulation flow in the AC servo circuits. Leakage currents containing harmonic contents are larger than those of the motor which is run with a commercial power supply.

Select a leakage current breaker according to the following formula, and ground the driver, servo motor, etc. securely.

Make the input and output cables as short as possible, and also make the grounding cable as long as possible (about 30cm) to minimize leakage currents.

Rated sensitivity current ≥ 10 · {Ig1+Ign+Iga+K · (Ig2+Igm)} [mA] (11.1)



K: Constant considering the harmonic contents

Leakage current breaker		K
Type	Mitsubishi products	
Models provided with harmonic and surge reduction techniques	NV-SP NV-SW NV-CP NV-CW NV-L	1
General models	BV-C1 NFB NV-L	3

Ig1: Leakage current on the electric channel from the leakage current breaker to the input terminals of the driver (Found from Fig. 11.3.)

Ig2: Leakage current on the electric channel from the output terminals of the driver to the servo motor (Found from Fig. 11.3.)

Ign: Leakage current when a filter is connected to the input side (4.4mA per one FR-BIF(-H))

Iga: Leakage current of the driver (Found from Table 11.5.)

Igm: Leakage current of the servo motor (Found from Table 11.4.)

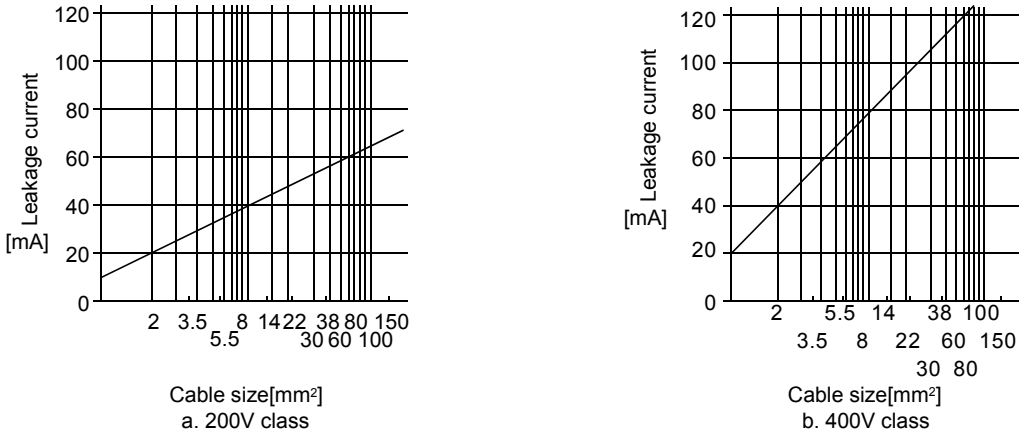


Fig. 11.3 Leakage current example (Ig1, Ig2) for CV cable run in metal conduit

Table 11.4 Servo motor's leakage current example (Igm)

Servo motor output [kW]	Leakage current [mA]
0.05 to 1	0.1

Table 11.5 Driver's leakage current example (Iga)

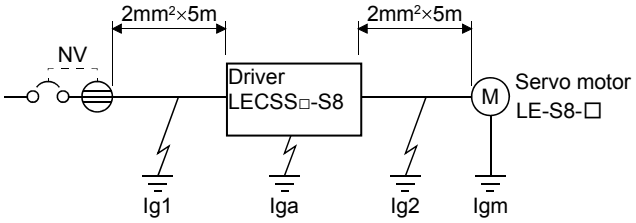
Driver capacity [kW]	Driver capacity [kW]
0.1 to 0.6	0.1 to 0.6

Table 11.6 Leakage circuit breaker selection example

Driver	Driver
LECSS2-□ LECSS1-□	15

(2) Selection example

Indicated below is an example of selecting a leakage current breaker under the following conditions.



Use a leakage current breaker generally available.
Find the terms of Equation (11.1) from the diagram.

$$Ig1 = 20 \cdot \frac{5}{1000} = 0.1 \text{ [mA]}$$

$$Ig2 = 20 \cdot \frac{5}{1000} = 0.1 \text{ [mA]}$$

Ign = 0 (not used)

Iga = 0.1 [mA]

Igm = 0.1 [mA]

Insert these values in Equation (13.1).

$Ig \geq 10 \cdot \{0.1+0+0.1+1 \cdot (0.1+0.1)\}$
≥ 4.0 [mA]

According to the result of calculation, use a leakage current breaker having the rated sensitivity current (Ig) of 4.0[mA] or more. A leakage current breaker having Ig of 15[mA] is used with the NV-SP/SW/CP/CW/HW series.

11.9 EMC filter (recommended)

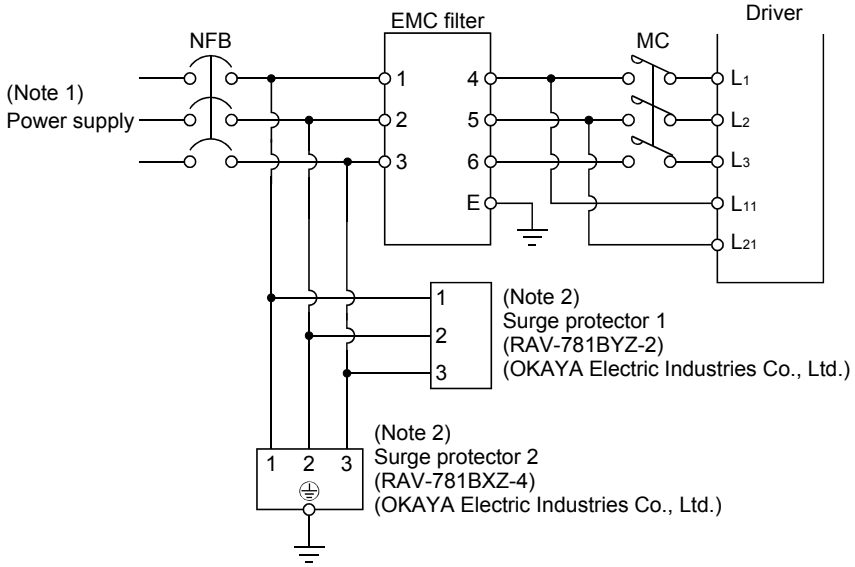
For compliance with the EMC directive of the EN Standard, it is recommended to use the following filter. Some EMC filters are large in leakage current.

(1) Combination with the driver

Driver	Recommended filter (Soshin Electric)		Mass [kg]([lb])
	Model	Leakage current [mA]	
LECSS2-□ LECSS1-□	(Note) HF3010A-UN	5	3 (6.61)

Note. A surge protector is separately required to use any of these EMC filters.

(2) Connection example



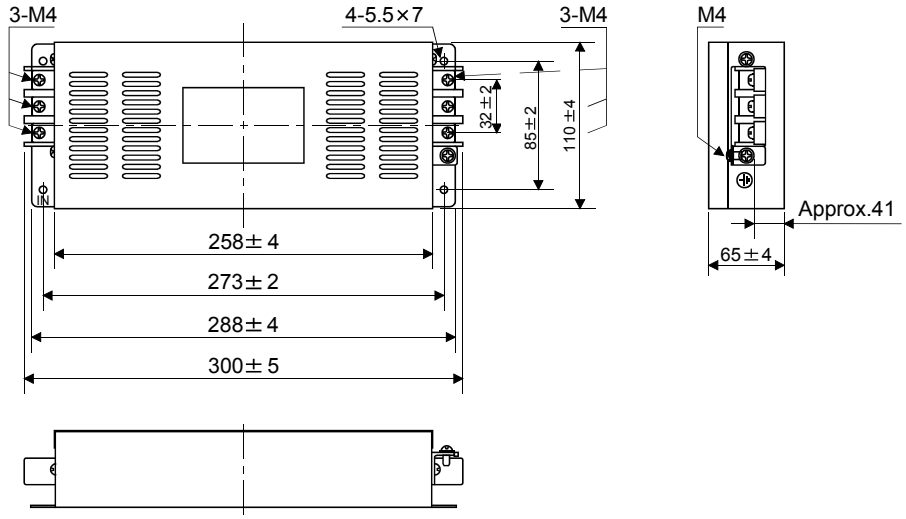
Note 1. For 1-phase 200V to 230VAC power supply, connect the power supply to L_1,L_2 and leave L_3 open.
There is no L_3 for 1-phase 100 to 120VAC power supply. Refer to section 1.3 for the power supply specification.
2. The example is when a surge protector is connected.

(3) Outline drawing

(a) EMC filter

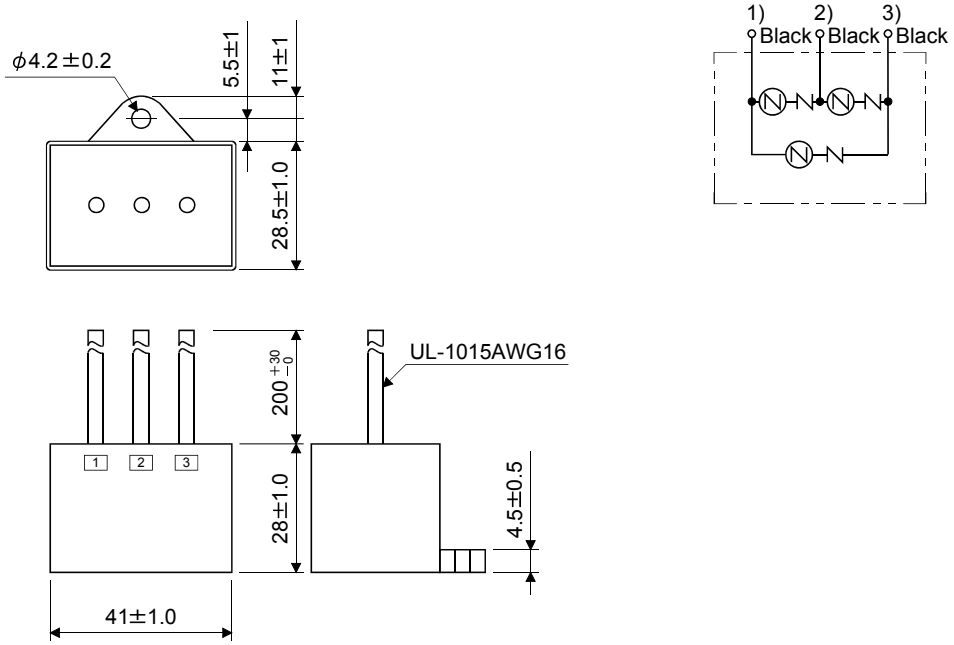
HF3010A-UN

[Unit: mm]

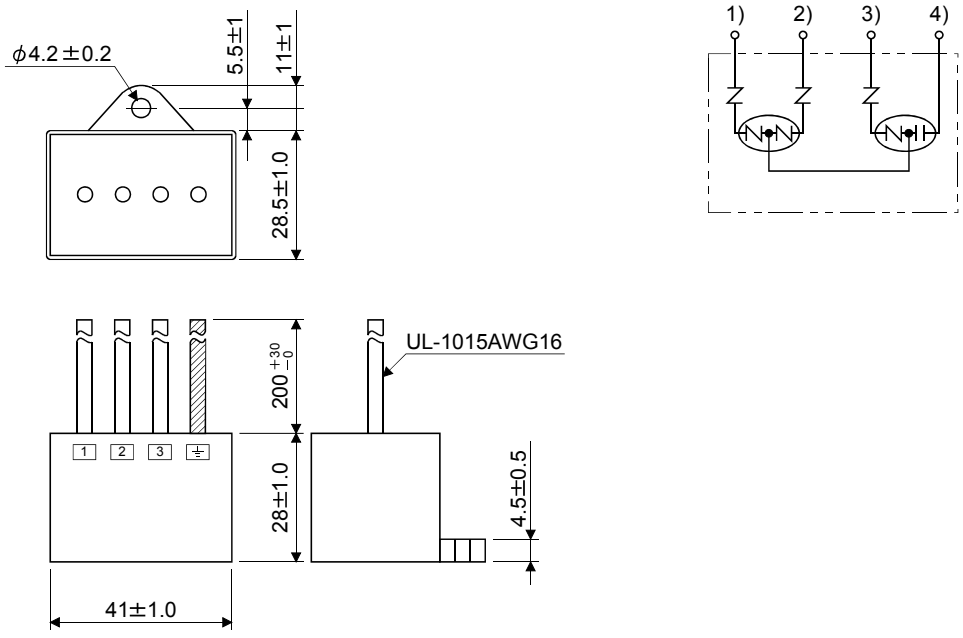


(b) Surge protector

RAV-781BYZ-2 [Unit: mm]



RAV-781BXZ-4 [Unit: mm]



MEMO

12. ABSOLUTE POSITION DETECTION SYSTEM

12. ABSOLUTE POSITION DETECTION SYSTEM

CAUTION

- If an absolute position erase alarm (25) or absolute position counter warning (E3) has occurred, always perform home position setting again. Not doing so can cause runaway. Not doing so may cause unexpected operation.

POINT

- If the encoder cable is disconnected, absolute position data will be lost in the following servo motor series. LE-S6-□・LE-S7-□・LE-S8-□. After disconnecting the encoder cable, always execute home position setting and then positioning operation.

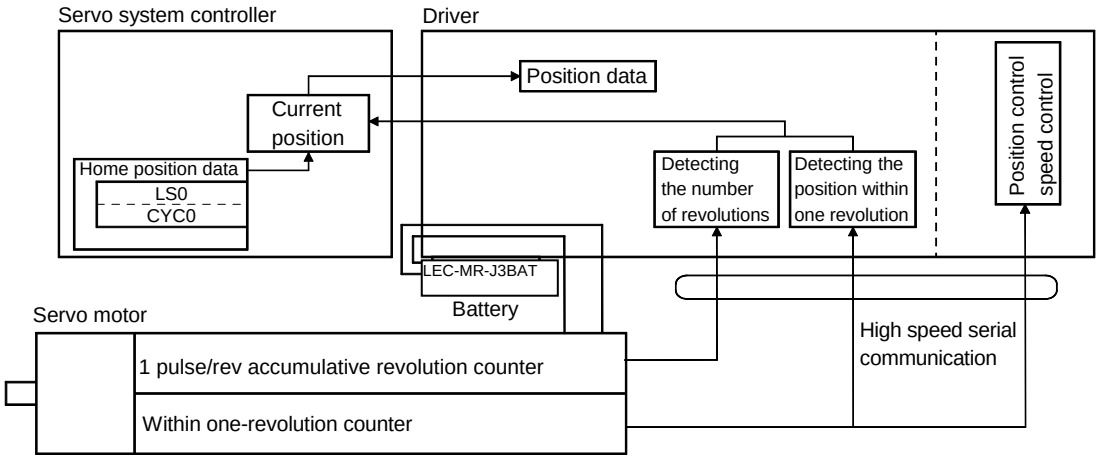
12.1 Features

For normal operation, as shown below, the encoder consists of a detector designed to detect a position within one revolution and a cumulative revolution counter designed to detect the number of revolutions.

The absolute position detection system always detects the absolute position of the machine and keeps it battery-backed, independently of whether the servo system controller power is on or off.

Therefore, once home position return is made at the time of machine installation, home position return is not needed when power is switched on thereafter.

If a power failure or a fault occurs, restoration is easy.



12.2 Specifications

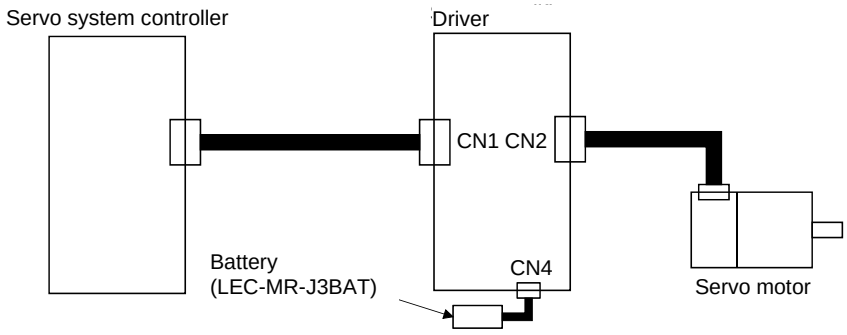
POINT
▪ Replace the battery with only the control circuit power ON. Removal of the battery with the control circuit power OFF will erase the absolute position data.

(1) Specification list

Item	Description
System	Electronic battery backup system
Battery	1 piece of lithium battery (primary battery, nominal + 3.6V) Type: LEC-MR-J3BAT
Maximum revolution range	Home position ± 32767 rev.
(Note 1) Maximum speed at power failure	3000r/min
(Note 2) Battery backup time	Approx. 10,000 hours (battery life with power off)
Battery storage period	5 years from date of manufacture

Note 1. Maximum speed available when the shaft is rotated by external force at the time of power failure or the like.
2. Time to hold data by a battery with power off. It is recommended to replace the battery in three years independently of whether power is kept on or off.

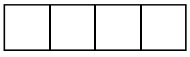
(2) Configuration



(3) Parameter setting

Set "□□□1" in parameter No.PA03 to make the absolute position detection system valid.

Parameter No.PA03



Absolute position detection system selection
0: Used in incremental system
1: Used in absolute position detection system

12.3 Battery installation procedure

⚠ WARNING	・Before installing a battery, turn off the main circuit power while keeping the control circuit power on. Wait for 15 minutes or more (20 minutes or for drive unit 30kW or more) until the charge lamp turns off. Then, confirm that the voltage between P(＋) and N(－) (L＋ and L－ for drive unit 30kW or more) is safe with a voltage tester and others. Otherwise, an electric shock may occur. In addition, always confirm from the front of the driver whether the charge lamp is off or not.

POINT

The internal circuits of the driver may be damaged by static electricity.
Always take the following precautions.

・Ground human body and work bench.

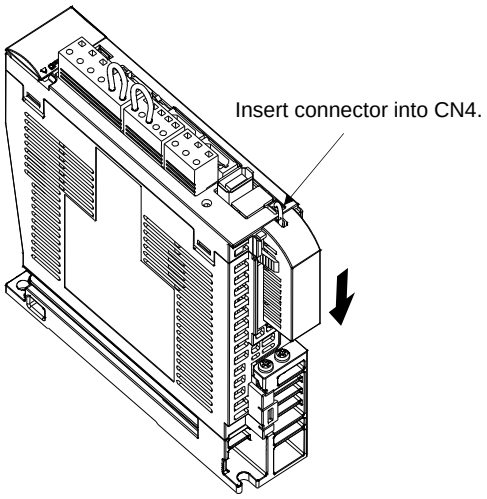
・Do not touch the conductive areas, such as connector pins and electrical parts, directly by hand.

・Before starting battery changing procedure, make sure that the main circuit power is switched OFF with the control circuit power ON. When battery is changed with the control power OFF, the absolute position data is lost.

(1) For LECSS□-S5/LECSS□-S7/LECSS□-S8

POINT

・For the driver with a battery holder on the bottom, it is not possible to wire for the earth with the battery installed. Insert the battery after executing the earth wiring of the driver.

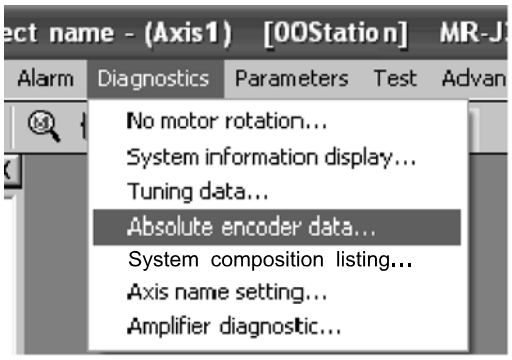


12.4 Confirmation of absolute position detection data

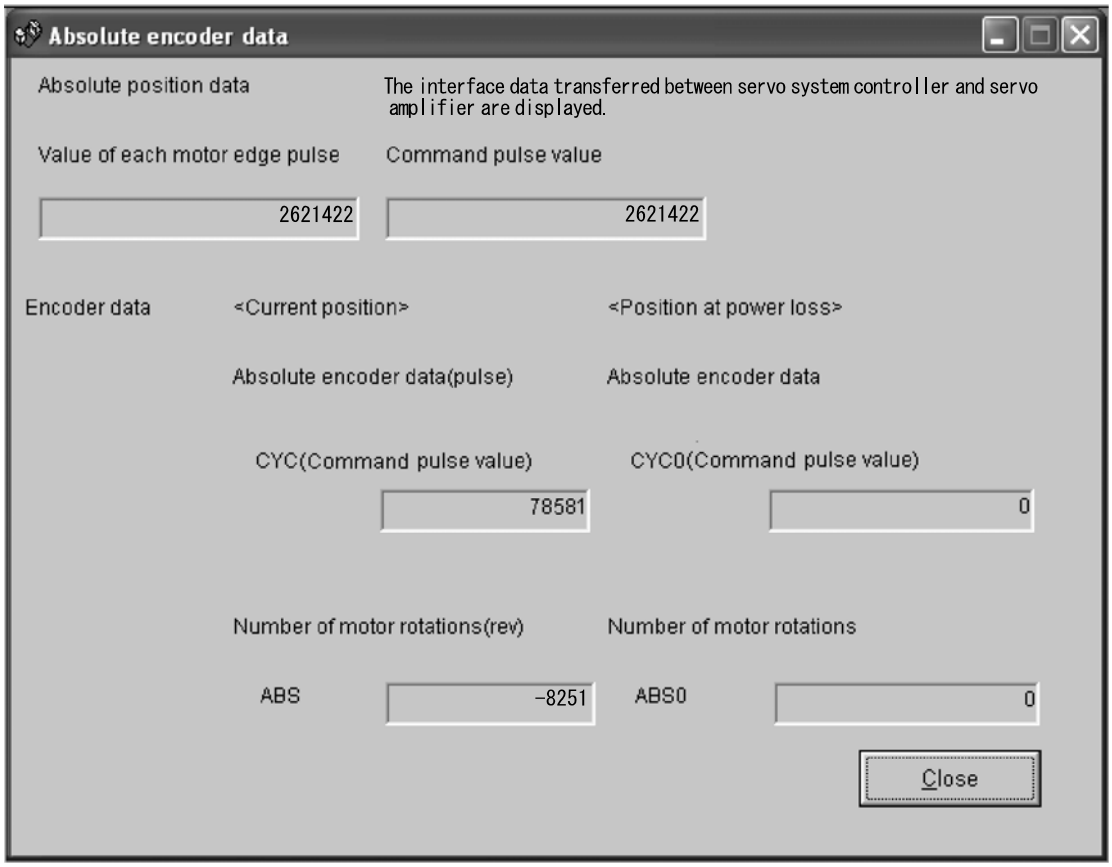
You can confirm the absolute position data with Set up software(MR Configurator).

Choose "Diagnostics" and "Absolute Encoder Data" to open the absolute position data display screen.

(1) Choosing "Diagnostics" in the menu opens the sub-menu as shown below:



(2) By choosing "Absolute Encoder Data" in the sub-menu, the absolute encoder data display window appears.



(3) Press the "Close" button to close the absolute encoder data display window.

MEMO

APPENDIX

App. 1 Parameter list

POINT

- Parameter whose symbol is preceded by * is made valid with the following conditions.

  * : Set the parameter value, switch power off once after setting, and then switch it on again, or perform the driver reset.

  **: Set the parameter value, switch power off once, and then switch it on again.

App. 1.1 Driver (drive unit)

Basic setting parameters (PA ☐☐)		
No.	Symbol	Name
PA01		For manufacturer setting
PA02	**REG	Regenerative option
PA03	*ABS	Absolute position detection system
PA04	*AOP1	Function selection A-1
PA05 to PA07		For manufacturer setting
PA08	ATU	Auto tuning mode
PA09	RSP	Auto tuning response
PA10	INP	In-position range
PA11 to PA13		For manufacturer setting
PA14	*POL	Rotation direction selection
PA15	*ENR	Encoder output pulses
PA16 to PA18		For manufacturer setting
PA19	*BLK	Parameter write inhibit

Gain/filter parameters (PB ☐☐)		
No.	Symbol	Name
PB01	FILT	Adaptive tuning mode (Adaptive filter Ⅱ)
PB02	VRFT	Vibration suppression control filter tuning mode (advanced vibration suppression control)
PB03		For manufacturer setting
PB04	FFC	Feed forward gain
PB05		For manufacturer setting
PB06	GD2	For manufacturer setting Ratio of load inertia moment to servo motor inertia moment
PB07	PG1	Model loop gain
PB08	PG2	Position loop gain
PB09	VG2	Speed loop gain
PB10	VIC	Speed integral compensation
PB11	VDC	Speed differential compensation
PB12		For manufacturer setting
PB13	NH1	Machine resonance suppression filter 1
PB14	NHQ1	Notch form selection 1
PB15	NH2	Machine resonance suppression filter 2
PB16	NHQ2	Notch form selection 2
PB17		Automatic setting parameter
PB18	LPF	Low-pass filter
PB19	VRF1	Vibration suppression control vibration frequency setting
PB20	VRF2	Vibration suppression control resonance frequency setting
PB21		For manufacturer setting
PB22		
PB23	VFBF	Low-pass filter selection
PB24	*MVS	Slight vibration suppression control selection
PB25		For manufacturer setting
PB26	*CDP	Gain changing selection
PB27	CDL	Gain changing condition
PB28	CDT	Gain changing time constant
PB29	GD2B	Gain changing ratio of load inertia moment to servo motor inertia moment
PB30	PG2B	Gain changing position loop gain
PB31	VG2B	Gain changing speed loop gain
PB32	VICB	Gain changing speed integral compensation
PB33	VRF1B	Gain changing vibration suppression control vibration frequency setting
PB34	VRF2B	Gain changing vibration suppression control resonance frequency setting
PB35 to PB45		For manufacturer setting

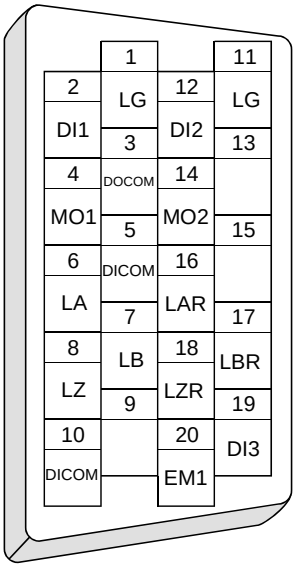
Extension setting parameters (PC ☐☐)		
No.	Symbol	Name
PC01	*ERZ	Error excessive alarm level
PC02	MBR	Electromagnetic brake sequence output
PC03	*ENRS	Encoder output pulses selection
PC04	**COP1	Function selection C-1
PC05	**COP2	Function selection C-2
PC06	*COP3	Function selection C-3
PC07	ZSP	Zero speed
PC08		For manufacturer setting
PC09	MOD1	Analog monitor 1 output
PC10	MOD2	Analog monitor 2 output
PC11	MO1	Analog monitor 1 offset
PC12	MO2	Analog monitor 2 offset
PC13	MOSDL	Analog monitor feedback position output standard data Low
PC14	MOSDH	Analog monitor feedback position output standard data High
PC15 to PC16		For manufacturer setting
PC17	**COP4	Function selection C-4
PC18 to PC20		For manufacturer setting
PC21	*BPS	Alarm history clear
PC22 to PC32		For manufacturer setting

I/O setting parameters (PD ☐☐)		
No.	Symbol	Name
PD01 to PD06		For manufacturer setting
PD07	*DO1	Output signal device selection 1 (CN3-13)
PD08	*DO2	Output signal device selection 2 (CN3-9)
PD09	*DO3	Output signal device selection 3 (CN3-15)
PD10 to PD13		For manufacturer setting
PD14	*DOP3	Function selection D-3
PD15 to PD32		For manufacturer setting

App. 1.2 Converter unit

No.	Symbol	Name
PA01	*REG	Regenerative selection
PA02	*MCC	Magnetic contactor drive output selection
PA03 to PA07		For manufacturer setting
PA08	*DMD	Auto tuning mode
PA09	*BPS	Alarm history clear
PA10 PA11		For manufacturer setting
PA12	*DIF	Input filter setting
PA13 to PA19		For manufacture setting

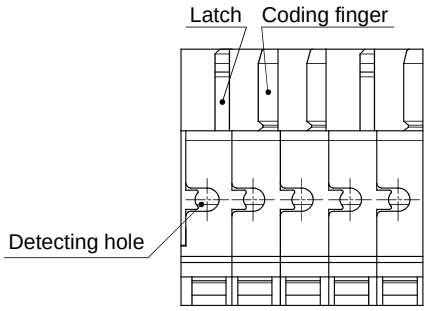
App. 2 Signal layout recording paper

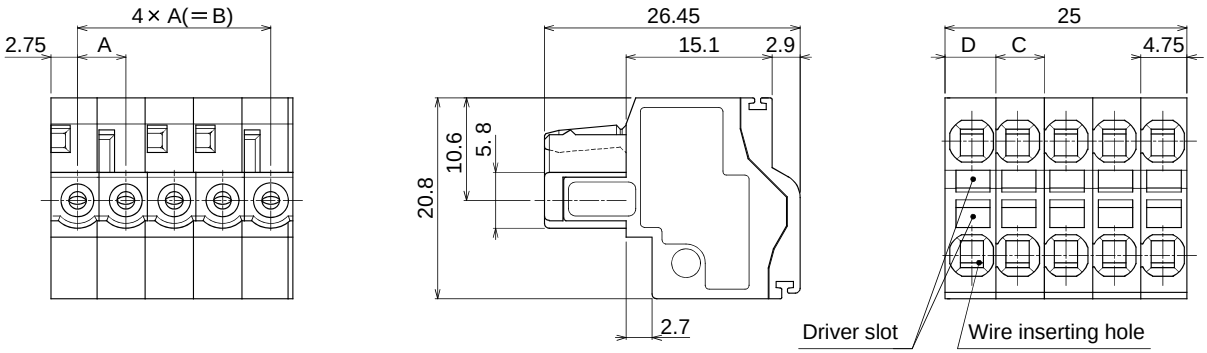


App. 3 Twin type connector : Outline drawing for 721-2105/026-000(WAGO)

[Unit: mm]

Model	Size [mm]			
	A	B	C	D
721-2105/026-000	5	20	5	5.25
721-2205/026-000	7.5	30	7.5	7.75





Revision history

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