MITSUBISHI

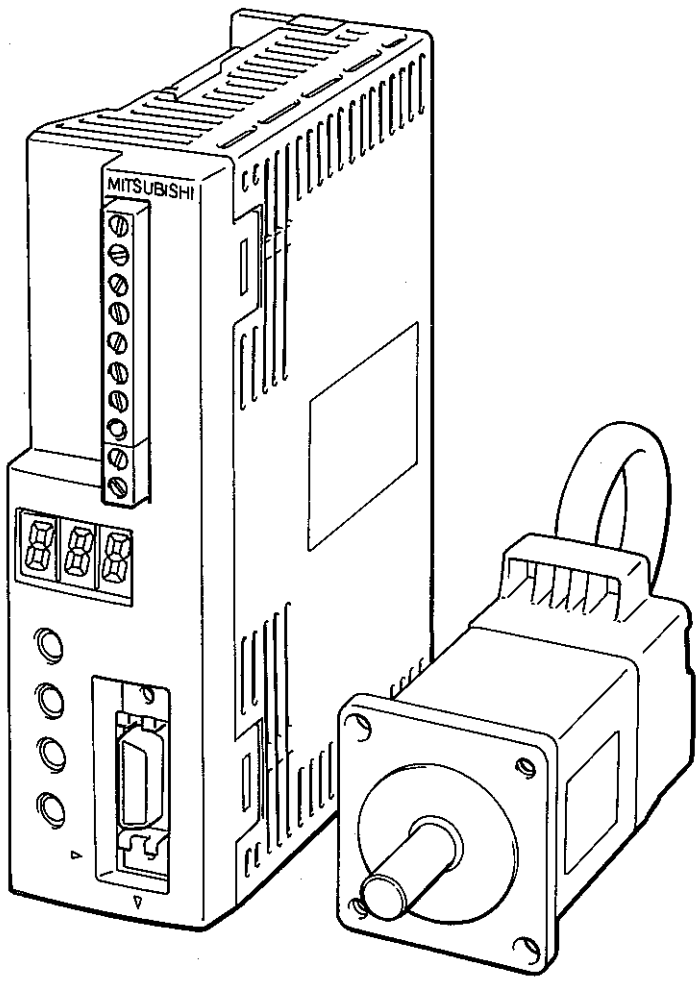
General Purpose AC Servo

MELSERVO-C Series

General Purpose Interface

MR-C□A

Instruction Manual



MITSUBISHI ELECTRIC

D

● Safety Instructions ●

(Always read these instructions before using the equipment.)

Do not attempt to install, operate, maintain or inspect the servo amplifier and servo motor until you have read through this Instruction Manual, Installation guide and appended documents carefully and can use the equipment correctly. Do not use the servo amplifier and servo motor until you have a full knowledge of the equipment, safety information and instructions.
In this instruction manual, the safety instruction levels are classified into "WARNING" and "CAUTION".

⚠WARNING	Indicates that incorrect handling may cause hazardous conditions, resulting in death or severe injury.
⚠CAUTION	Indicates that incorrect handling may cause hazardous conditions, resulting in medium or slight injury to personnel or may cause physical damage.

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:

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

● : 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 "NOTICE", "INFORMATION" and "MEMORANDUM".

NOTICE Indicates that incorrect handling may cause the servo amplifier to be faulty and may not lead to physical damage.

INFORMATION Indicates that parameter setting change, etc. will provide another function or there are other usages.

MEMORANDUM Indicates information needed for use of this equipment.

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

1. To prevent electric shock, note the following:

⚠ WARNING

- Before wiring or inspection, switch power off and wait for more than 10 minutes. Then, confirm the voltage is safe with voltage tester. Otherwise, you may get an electric shock.
- Connect the servo amplifier 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 servo amplifier 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.

2. To prevent fire, note the following:

⚠ CAUTION

- Do not install the servo amplifier, servo motor and regenerative break resistor on or near combustibles. Otherwise, a fire may cause.
- When the servo amplifier has become faulty, switch off the main servo amplifier power side. Continuous flow of a large current may cause a fire.
- When a regenerative break resistor is used, use an alarm signal to switch main power off. Otherwise, a regenerative break transistor fault or the like may overheat the regenerative break resistor, causing a fire.

3. To prevent injury, note the follow

⚠ CAUTION

- Only the voltage specified in the Installation 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.
- During power-on or for some time after power-off, do not touch or close a parts (cable etc.) to the servo amplifier heat sink, regenerative break resistor, servo motor, etc. Their temperatures may be high and you may get burnt or a parts may dameged.

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 motor by the cables, shaft or encoder.
- Do not hold the front cover to transport the controller. The controller may drop.
- Install the servo amplifier 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 controller and servo motor must be installed in the specified direction.
- Leave specified clearances between the servo amplifier and control enclosure walls or other equipment.
- Do not install or operate the servo amplifier 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 servo amplifier.
- Do not drop or strike servo amplifier or servo motor. Isolate from all impact loads.
- Use the servo amplifier and servo motor under the following environmental conditions:

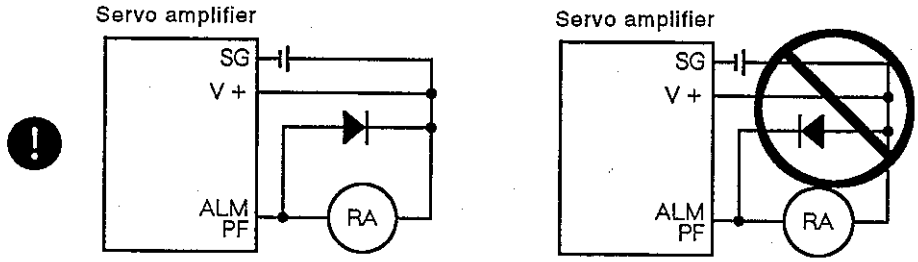
Environment		Conditions	
		Servo Amplifier	Servo Motor
Ambient temperature	[°C]	0 to +50 (non-freezing)	0 to +40 (non-freezing)
	[°F]	32 to 122 (non-freezing)	32 to 104 (non-freezing)
Ambient humidity		90%RH or less (non-condensing)	80%RH or less (non-condensing)
Storage temperature	[°C]	-20 to +65 (non-freezing)	-15 to +70 (non-freezing)
	[°F]	-4 to 149 (non-freezing)	5 to 158 (non-freezing)
Storage humidity		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 (3280ft) above sea level	
Vibration	[m/s^2]	5.9 or less	X, Y: 19.6
	[ft/s^2]	19.4 or less	X, Y: 64

- Securely attach the servo motor to the machine. If attach insecurely, the servo motor may come off during operation.
- The servo motor with reduction gear must be installed in the specified direction to prevent oil leakage.
- For safety of personnel, always cover rotating and moving parts.
- 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, consult the service center or service station.

(2) Wiring

⚠ CAUTION

- Wire the equipment correctly and securely. Otherwise, the servo motor may misoperate.
- Do not install a power capacitor, surge absorber or radio noise filter (FR-BIF option) between the servo motor and servo amplifier.
- Connect the output terminals (U, V, W) correctly. Otherwise, the servo motor will operate improperly.
- 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 must be wired in the specified direction. Otherwise, the emergency stop and other protective circuits may not operate.



(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

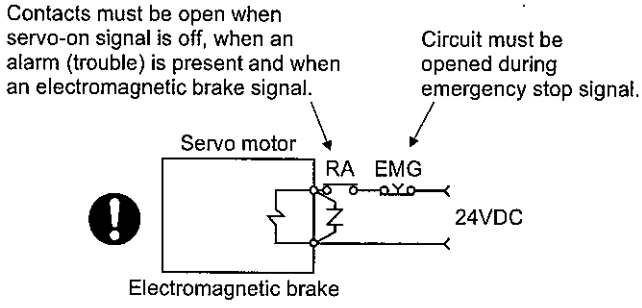
⚠ CAUTION

- 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 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 servo amplifier.
- Use the servo amplifier 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 ballscrew 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 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 servo amplifier signals but also by an external emergency stop signal.



- 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 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) Disposal

⚠ CAUTION

- Dispose of the product as general industrial waste.

(8) General instruction

- To illustrate details, the equipment in the diagrams of this 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 Instruction Manual.

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 servo amplifiers 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).
This servo is certified by TUV, third-party assessment organization, to comply with the EMC directive in the conforming methods of the EMC Installation Guidelines.

(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.

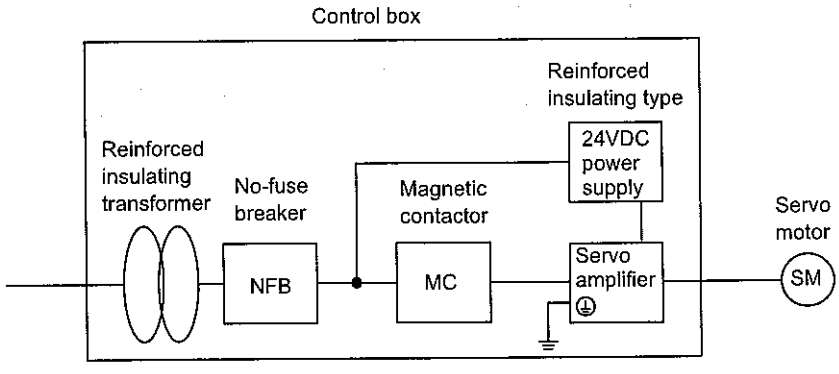
(3) Machine directive
Not being machines, the servo amplifiers need not comply with this directive.

2. PRECAUTIONS FOR COMPLIANCE

(1) Servo amplifiers and servo motors used
Use the servo amplifier and servo motors which comply with the EN Standard-compliant model.

Servo amplifier :MR-C10A-UE to MR-C40A-UE
Servo motor :HC-PQ☐ (produced in and after February, 2001)
HC-PQ☐-UE

(2) Configuration



(3) Environment
Operate the servo amplifier at or above the contamination level 2 set forth in IEC664. For this purpose, install the servo amplifier in a control box which is protected against water, oil, carbon, dust, dirt, etc. (IP54).

(4) Power supply

(a) Operate the servo amplifier to meet the requirements of the overvoltage category II set forth in IEC664. For this purpose, a reinforced insulating transformer conforming to the IEC or EN Standard should be used 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

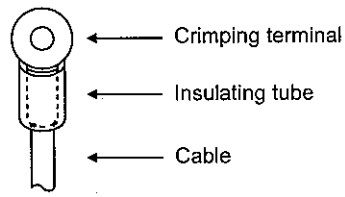
(a) To prevent an electric shock, always connect the protective earth (PE) terminals (marked ⏚) of the servo amplifier to the protective earth (PE) of the control box.

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

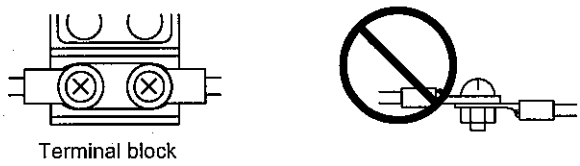
(c) If a leakage current breaker is used to prevent an electric shock, the protective earth (PE) terminals of the servo amplifier must be connected to the corresponding earth terminals.

(6) Wiring

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



(b) When the servo motor has a power supply lead, use a fixed terminal block to connect it with the servo amplifier. Do not connect cables directly.



(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 13.2.2.

(b) The sizes of the cables described in Section 13.2.1 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. The radio noise filter (FR-BIF) is not required.

(8) Servo motor

For the outline dimension drawing, connector signal arrangement and encode cable, contact Mitsubishi.

(9) Performing EMC tests

When EMC tests are run on a machine/device into which the servo amplifer 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 servo amplifier, refer to the EMC Installation Guidelines(IB(NA)67310).

CONFORMANCE WITH UL/C-UL STANDARD

(1) Servo amplifiers and servo motors used
Use the servo amplifiers and servo motors which comply with the UL/C-UL Standard-compliant model.

Servo amplifier :MR-C10A-UL to MR-C40A-UL
Servo motor :HC-PQ☐ (produced in and after February, 2001)
HC-PQ☐-UE

(2) Installation
Install a fan of 100CFM air flow 10.16 cm (4 in) above the servo amplifier or provide cooling of at least equivalent capability.

(3) Short circuit rating
The servo amplifier conforms to the circuit whose peak current is limited to 5000A or less. Having been subjected to the short-circuit tests of the UL in the alternating-current circuit, the servo amplifier conforms to the above circuit.

(4) Motor flange
Mount the servo motor on the flange which has the following size or provides an equivalent or higher heat dissipation effect.

Flange Size [mm]	Motor (HC-PQ series)
150 × 150 × 6	033·053·13
250 × 250 × 6	23
250 × 250 × 12	43

(5) Capacitor discharge time
The capacitor discharge time is as listed below. To ensure safety, do not touch the charging section for 10 minutes after power-off.

Servo amplifier	Discharge time [min]
MR-C10A(1) • 20A(1)	1
MR-C40A	2

<<About the manuals>>

Relevant manuals

Manual name	Manual No.
MELSERVO-C Series MR-C☐A Installation Guide (Packed with the servo amplifier)	IB(NA)67279
EMC Installation Guidelines	IB(NA)67310

CONTENTS

CHAPTER 1
INTRODUCTION

This chapter provides basic information needed to use this servo.

1. INTRODUCTION

1 – 1 Model Definition

(1) Servo amplifier

MR-C □ A □ □

Series

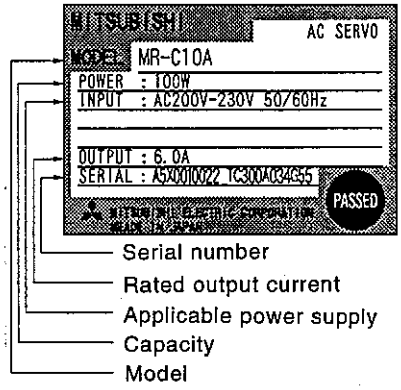
Symbol	Compliance with Standard
None	Standard model (In Japan)
-UE	EN Standard, UL/C-UL Standard

Symbol	Power supply
None	Single-phase 200V
(Note) 1	Single-phase 100V

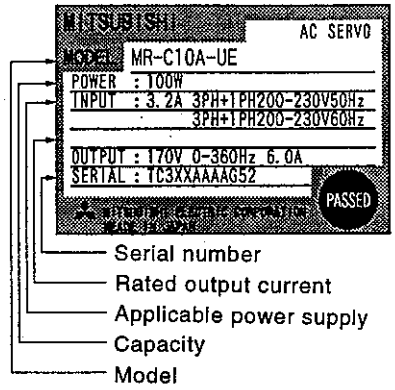
Note: Unavailable for MR-C40A.

Symbol	Applicable servo motor
10	HC-PQ033/053/13
20	HC-PQ23
40	HC-PQ43

Name plate



Name plate



(2) Servo motor

HC-PQ □ 3 □ □ □ □

Series

Symbol	Compliance with Standard
None	(Note) Standard model (EN·UL/C-UL Standard)
-UE	EN·UL/C-UL Standard

Note: The standard model produced in and after February, 2001 complies with the EN·UL/C-UL Standard.

Symbol	Shaft
None	Straight shaft
K	With key (200W or more)
D	D cut
L	L cut (200W or more)

Symbol	(Note) Reduction gear
None	Without
G1	For general industrial machines
G2	For high precision

Note: HC-PQ033 with reduction gear is not available.

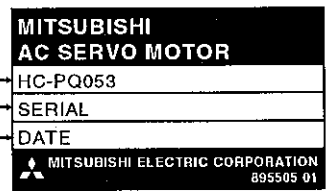
Symbol	Electromagnetic brake
None	Without
B	With

Reted speed (3000r/min)

Symbol	Rated output [W]
03	30
05	50
1	100
2	200
4	400

Date of manufacture
Serial number
Model

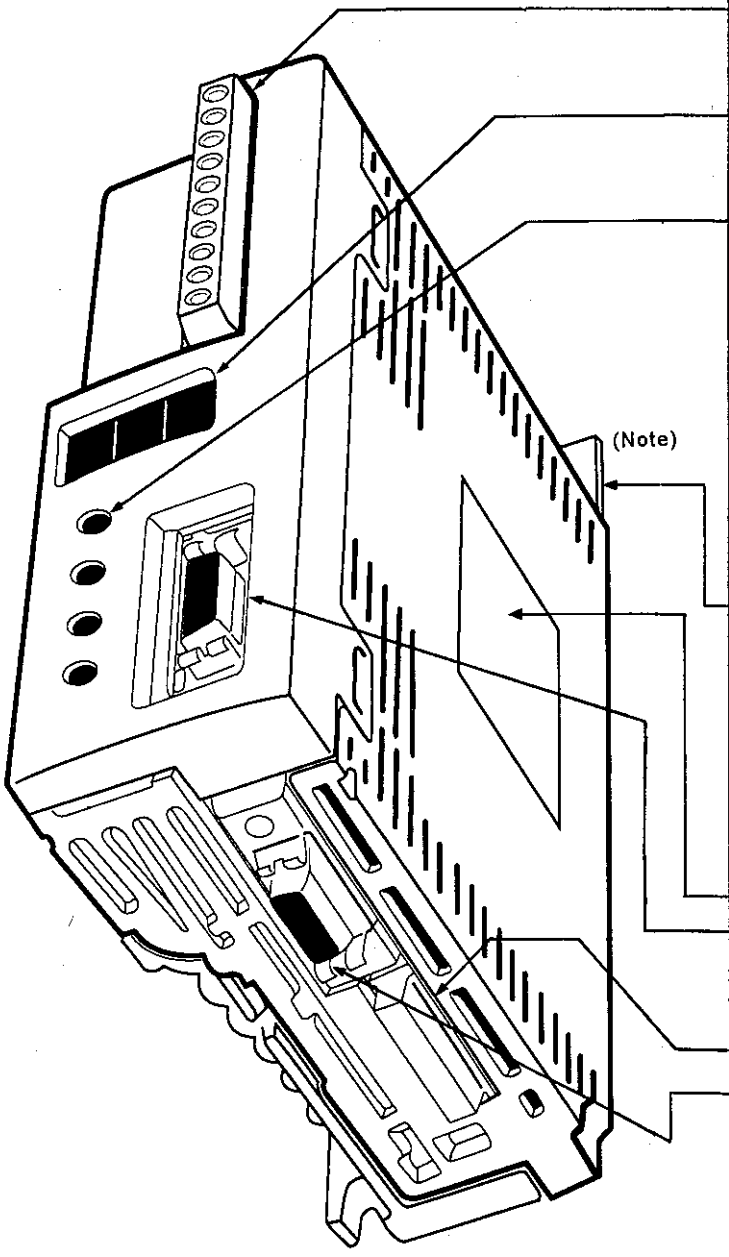
Name plate

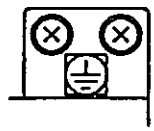


1. INTRODUCTION

1 – 2 Parts Identification and Application

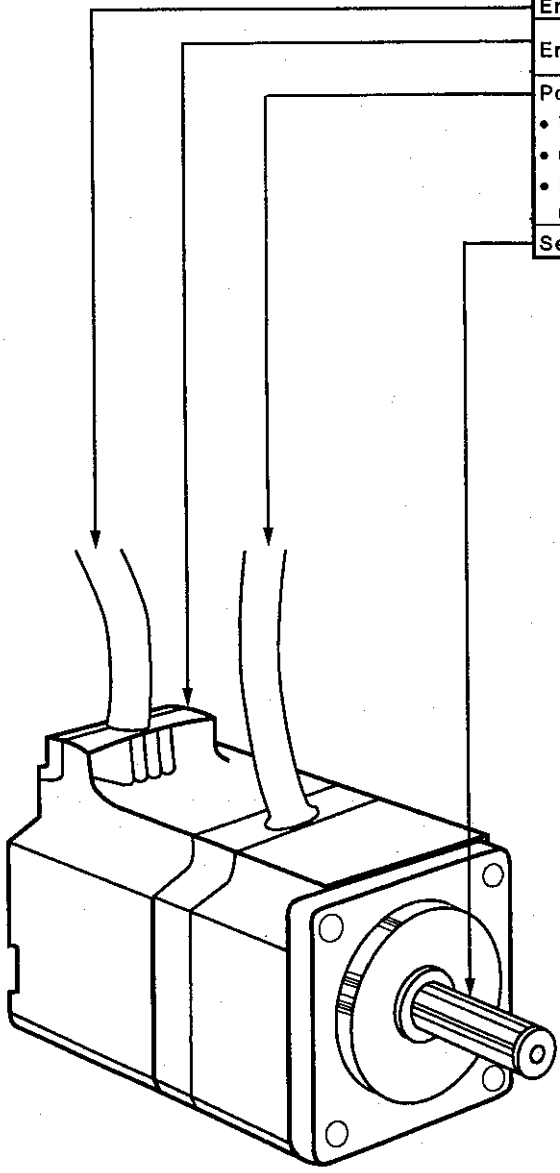
1 – 2 – 1 Servo amplifier



Name/Application	Refer To
Main circuit terminal block (TE) Used to connect the power supply, servo motor, regenerative brake option and ground.	Section 3 – 1 – 1
Display The three-digit, seven-segment LED shows the servo status and alarm number.	Section 2 – 3
Operation section Used to perform status display, diagnostic, alarm and parameter setting operations. MODE ◉ Used to change the mode. UP ◉ / DOWN ◉ Used to change the display or data in each mode. SET ◉ Used to set parameter data.	Section 2 – 3
Protective earth (PE) terminals (EN Standard-, UL/C-UL Standard-compliant models)  When using the EN Standard-, UL/C-UL Standard-compliant models, use these terminals for grounding.	Section 1 – 3 – 2 EMC INSTALLATION GUIDELINES IB (NA) 67310
Name plate	Section 1 – 1
I/O signal connector (CN1) Used to connect digital I/O signals such as servo-on and trouble. Plug after peeling off the CAUTION seal.	Section 3 – 1 – 2
RS232C option unit connector (CN3)	Section 3 – 1 – 2 Section 6 – 1 – 4
Encoder connector (CN2) Connector for connection of the servo motor encoder	Section 3 – 1 – 2

Note: Provided for EN Standard-, UL/C-UL Standard-compliant models and unavailable for standard models.

1 – 2 – 2 Servo motor

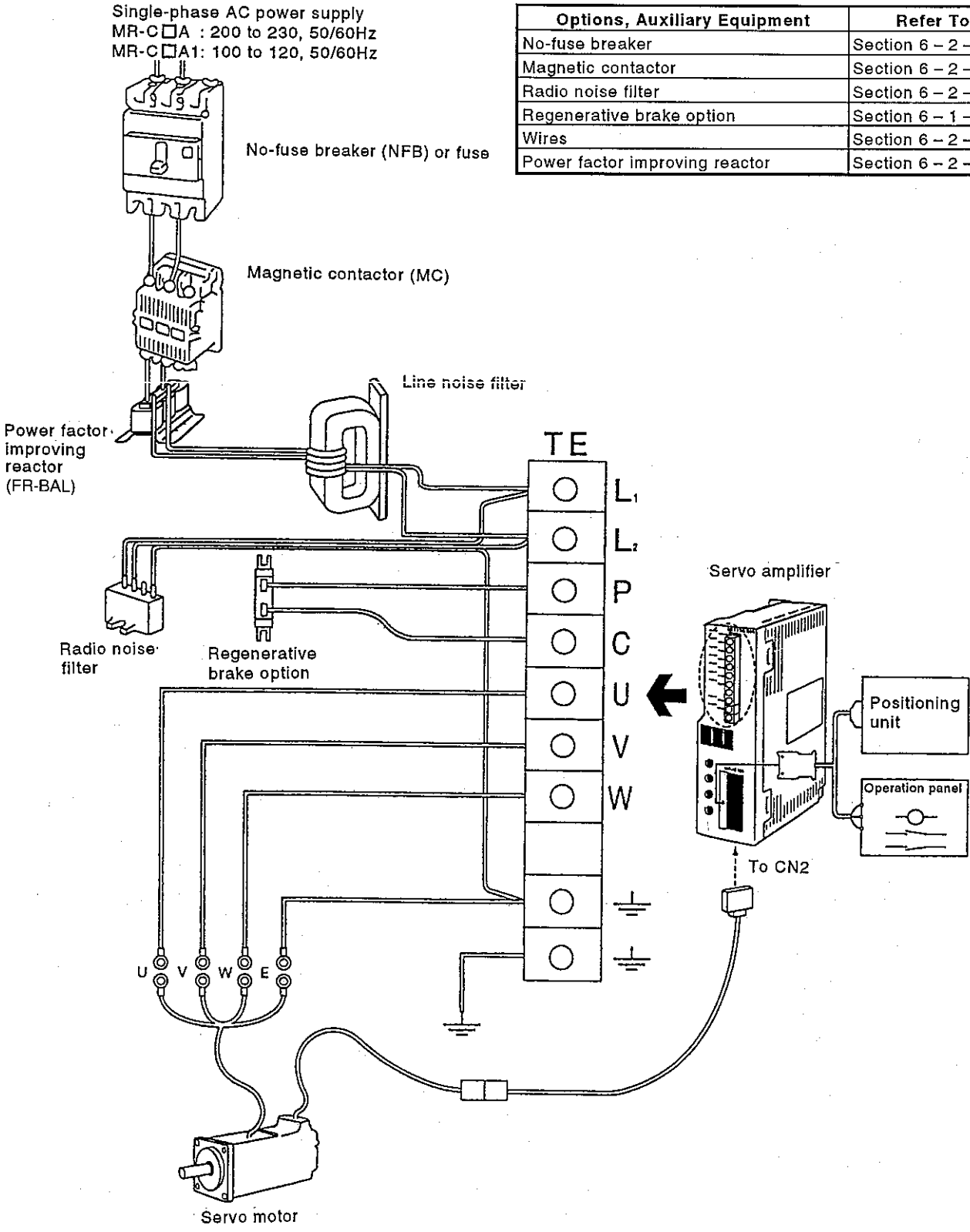


Name/Application	Refer To
Encoder cable	Section 3 – 2
Encoder	Section 3 – 2 Section 10 – 1
Power cable • Power lead (U, V, W) • Ground lead • Electromagnetic brake lead (For the motor with electromagnetic brake)	Section 3 – 2
Servo motor shaft	Section 4 – 2 (4)

1. INTRODUCTION

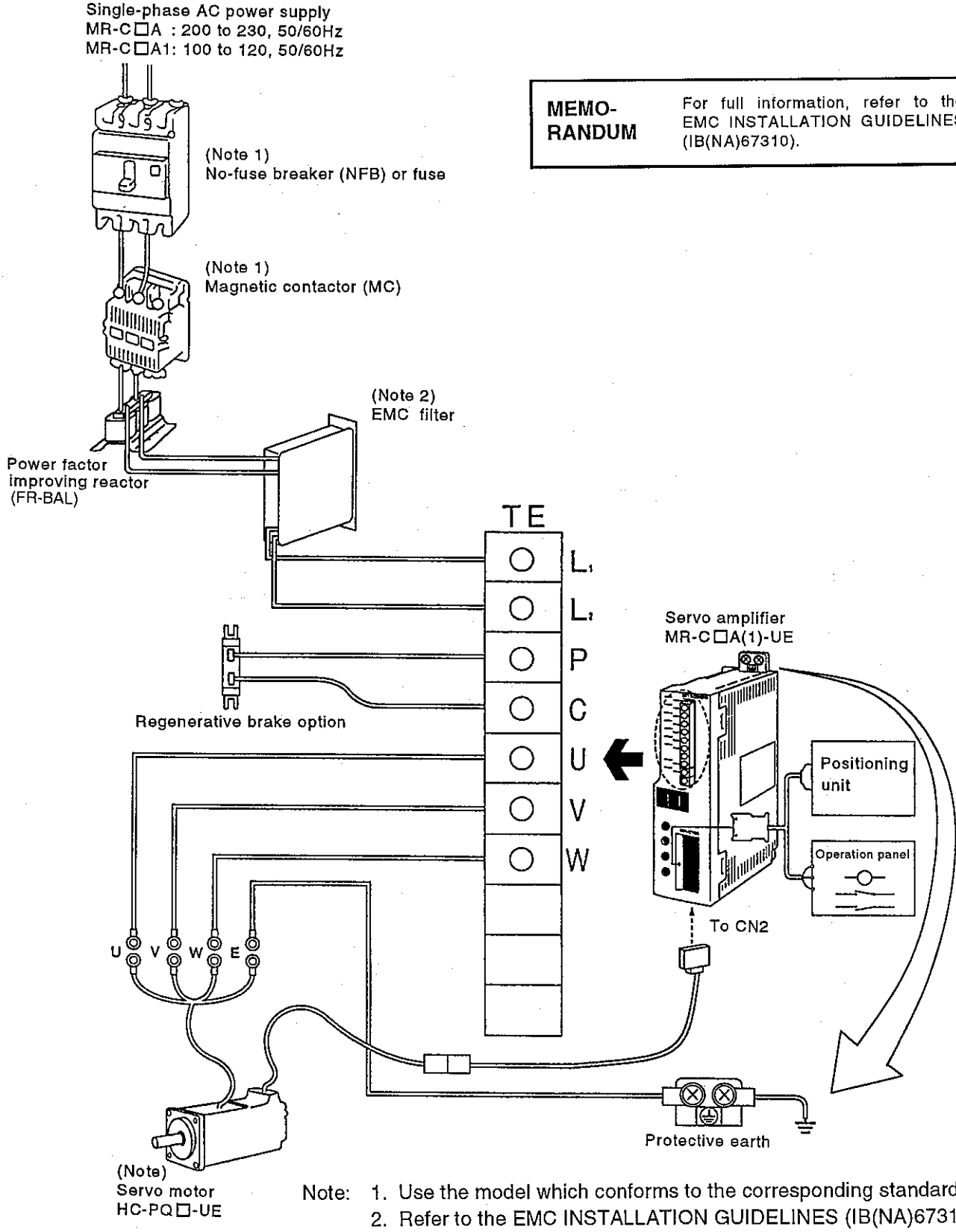
1 – 3 Basic Configuration

1 – 3 – 1 Standard models



Options, Auxiliary Equipment	Refer To
No-fuse breaker	Section 6 – 2 – 1
Magnetic contactor	Section 6 – 2 – 1
Radio noise filter	Section 6 – 2 – 6(5)
Regenerative brake option	Section 6 – 1 – 1
Wires	Section 6 – 2 – 1
Power factor improving reactor	Section 6 – 2 – 3

1 – 3 – 2 EN Standard-, UL/C-UL Standard-compliant models



MEMO-RANDUM For full information, refer to the EMC INSTALLATION GUIDELINES (IB(NA)67310).

Note: 1. Use the model which conforms to the corresponding standard.
2. Refer to the EMC INSTALLATION GUIDELINES (IB(NA)67310). When the model complies with the UL/C-UL Standard, the standard line noise filter may be used.

CHAPTER 2
OPERATION

This chapter gives basic connection examples and operation procedure.

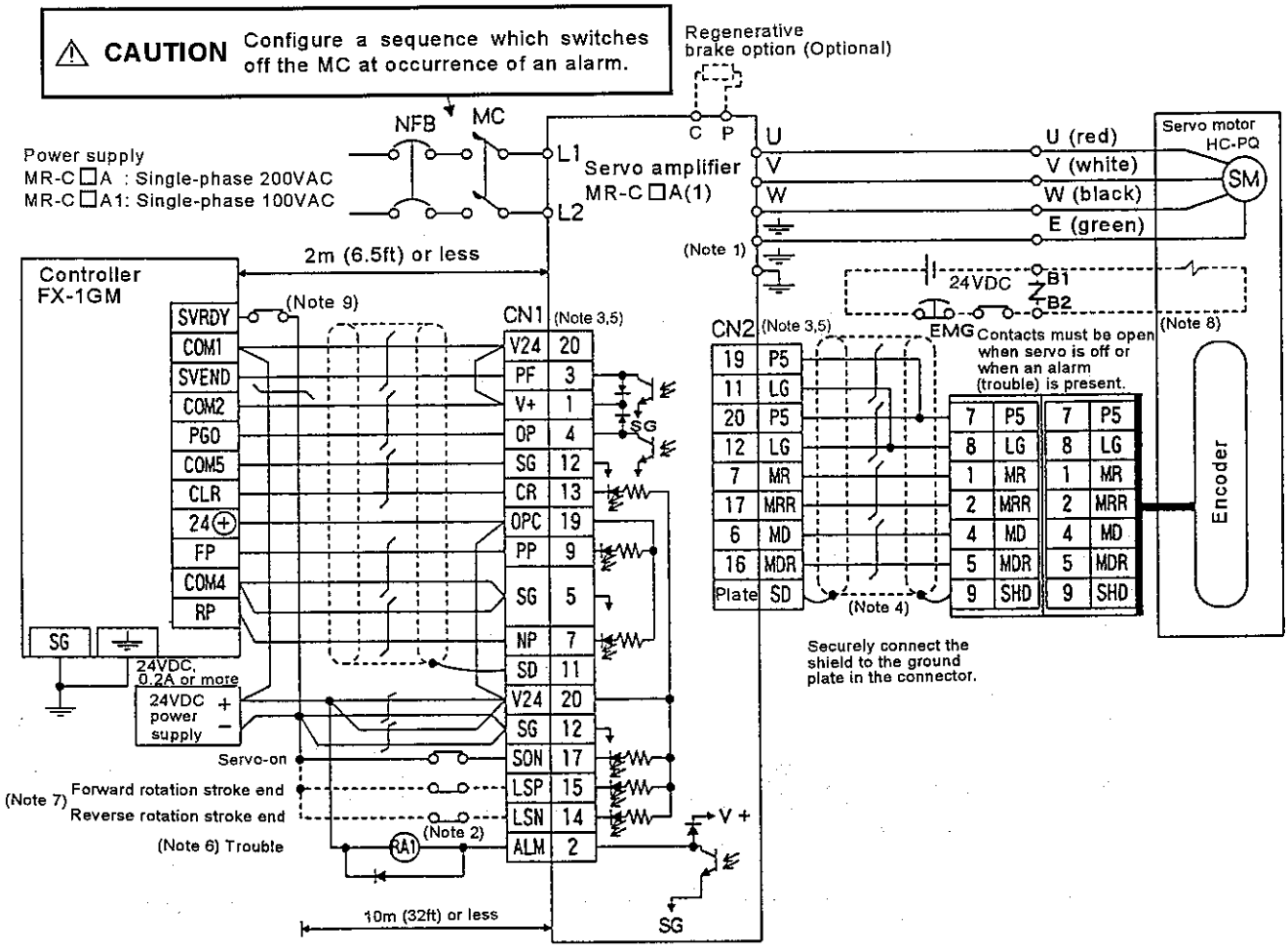
INTRODUCTION	CHAPTER 1
OPERATION	CHAPTER 2
WIRING	CHAPTER 3
INSTALLATION	CHAPTER 4
ADJUSTMENTS AND APPLICATION OPERATIONS	CHAPTER 5
OPTIONS AND AUXILIARY EQUIPMENT	CHAPTER 6
MAINTENANCE AND INSPECTION	CHAPTER 7
TROUBLESHOOTING	CHAPTER 8
CHARACTERISTICS	CHAPTER 9
SPECIFICATIONS	CHAPTER 10
SELECTION	CHAPTER 11
OPTIONAL PRODUCTS	CHAPTER 12

2. OPERATION

2 – 1 Standard Connection Examples

⚠ CAUTION Always follow the wiring instructions in Chapter 3.

2 – 1 – 1 Connection with the FX-1GM



⚠ WARNING

Note 1. For the EN Standard model, always connect the protective earth (PE) terminal (marked ⏚) of the servo amplifier to the protective earth (PE) of the control box to prevent an electric shock.

⚠ CAUTION

Note 2. Connect the diode in the correct direction. Otherwise, the servo amplifier will fail and will not output the connect signals, disabling the emergency stop and other protective circuits.

NOTICE

Note 3. CN1 and CN2 have the same shape. Wrong connection of the connectors will cause a failure.

MEMO-RANDUM

Note 4. This wiring applies to the standard cable of less than 10m (32 ft).

5. The pins with the same signal name are connected together in the servo amplifier.

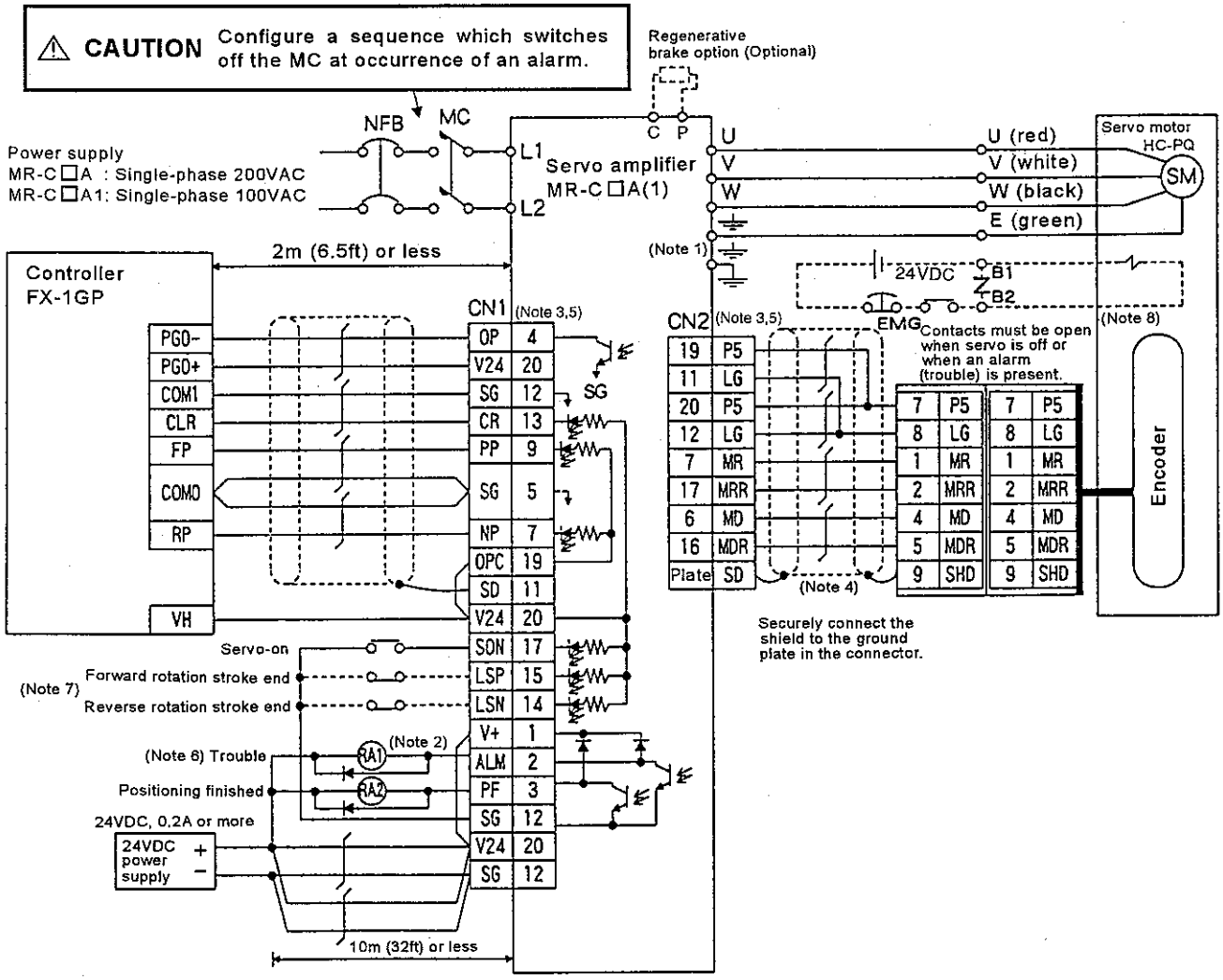
6. The trouble (ALM) signal conducts current when there is no alarm, i.e. in the normal state.
   When this signal is switched off (at occurrence of an alarm), the output of the controller must be stopped by the sequence program.

7. Since the LSP and LSN signals have been automatically switched on internally before shipment, set □0□ in parameter No. 6 to make the function valid.

8. For the servo motor with electromagnetic brake.

9. After making sure that the servo is without fault (ALM signal is on), configure a sequence which switches on the relay SVRDY.

2 – 1 – 2 Connection with the FX-1GP



⚠ WARNING

Note 1. For the EN Standard model, always connect the protective earth (PE) terminal (marked ⏚) of the servo amplifier to the protective earth (PE) of the control box to prevent an electric shock.

⚠ CAUTION

Note 2. Connect the diode in the correct direction. Otherwise, the servo amplifier will fail and will not output the connect signals, disabling the emergency stop and other protective circuits.

NOTICE

Note 3. CN1 and CN2 have the same shape. Wrong connection of the connectors will cause a failure.

MEMO-RANDUM

Note 4. This wiring applies to the standard cable of less than 10m (32 ft).

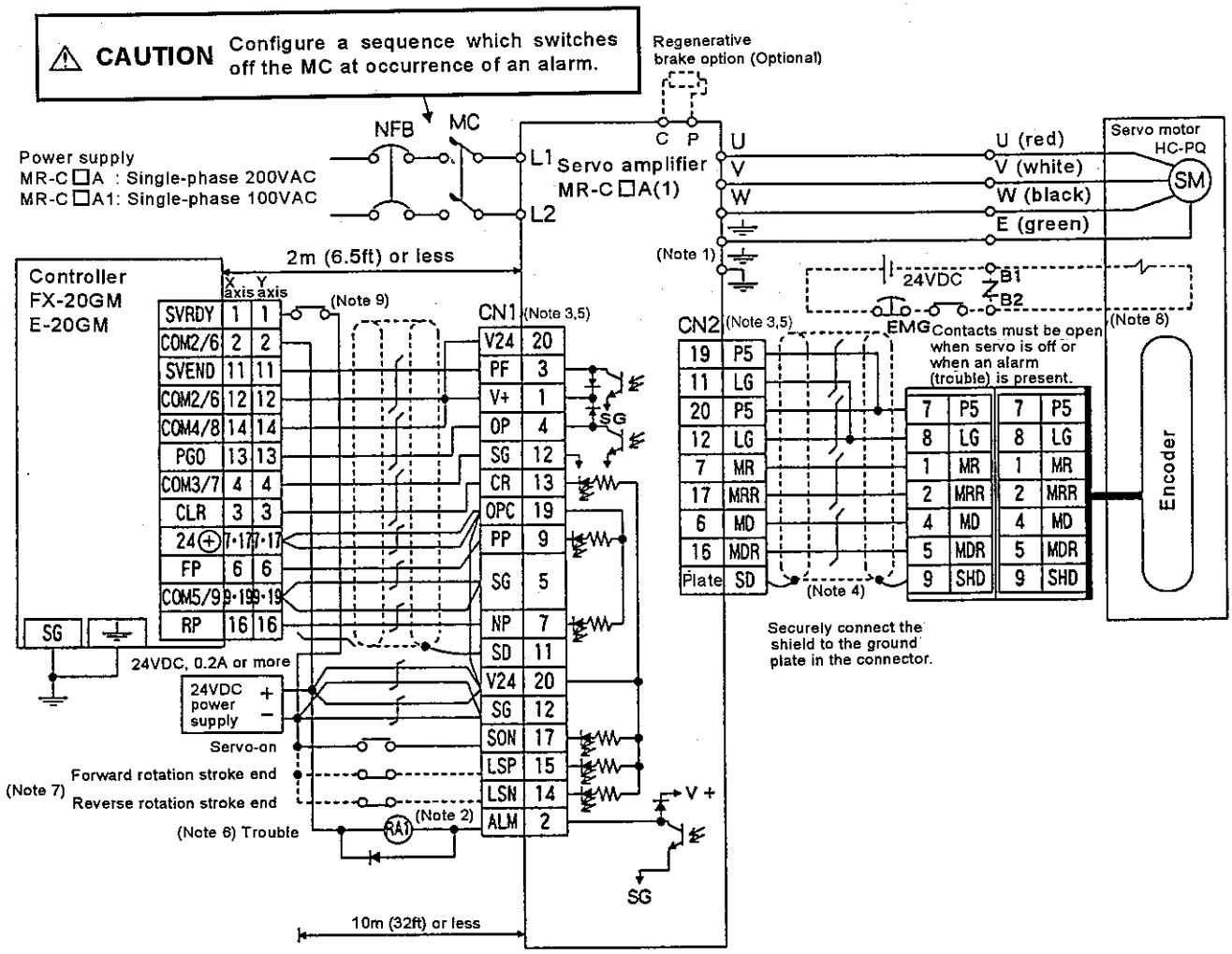
5. The pins with the same signal name are connected together in the servo amplifier.

6. The trouble (ALM) signal conducts current when there is no alarm, i.e. in the normal state.
   When this signal is switched off (at occurrence of an alarm), the output of the controller must be stopped by the sequence program.

7. Since the LSP and LSN signals have been automatically switched on internally before shipment, set □0□ in parameter No. 6 to make the function valid.

8. For the servo motor with electromagnetic brake.

2 – 1 – 3 Connection with the FX-20GM or E-20GM



⚠ WARNING

Note 1. For the EN Standard model, always connect the protective earth (PE) terminal (marked ⏚) of the servo amplifier to the protective earth (PE) of the control box to prevent an electric shock.

⚠ CAUTION

Note 2. Connect the diode in the correct direction. Otherwise, the servo amplifier will fail and will not output the connect signals, disabling the emergency stop and other protective circuits.

NOTICE

Note 3. CN1 and CN2 have the same shape. Wrong connection of the connectors will cause a failure.

MEMO-RANDUM

Note 4. This wiring applies to the standard cable of less than 10m (32 ft).

5. The pins with the same signal name are connected together in the servo amplifier.

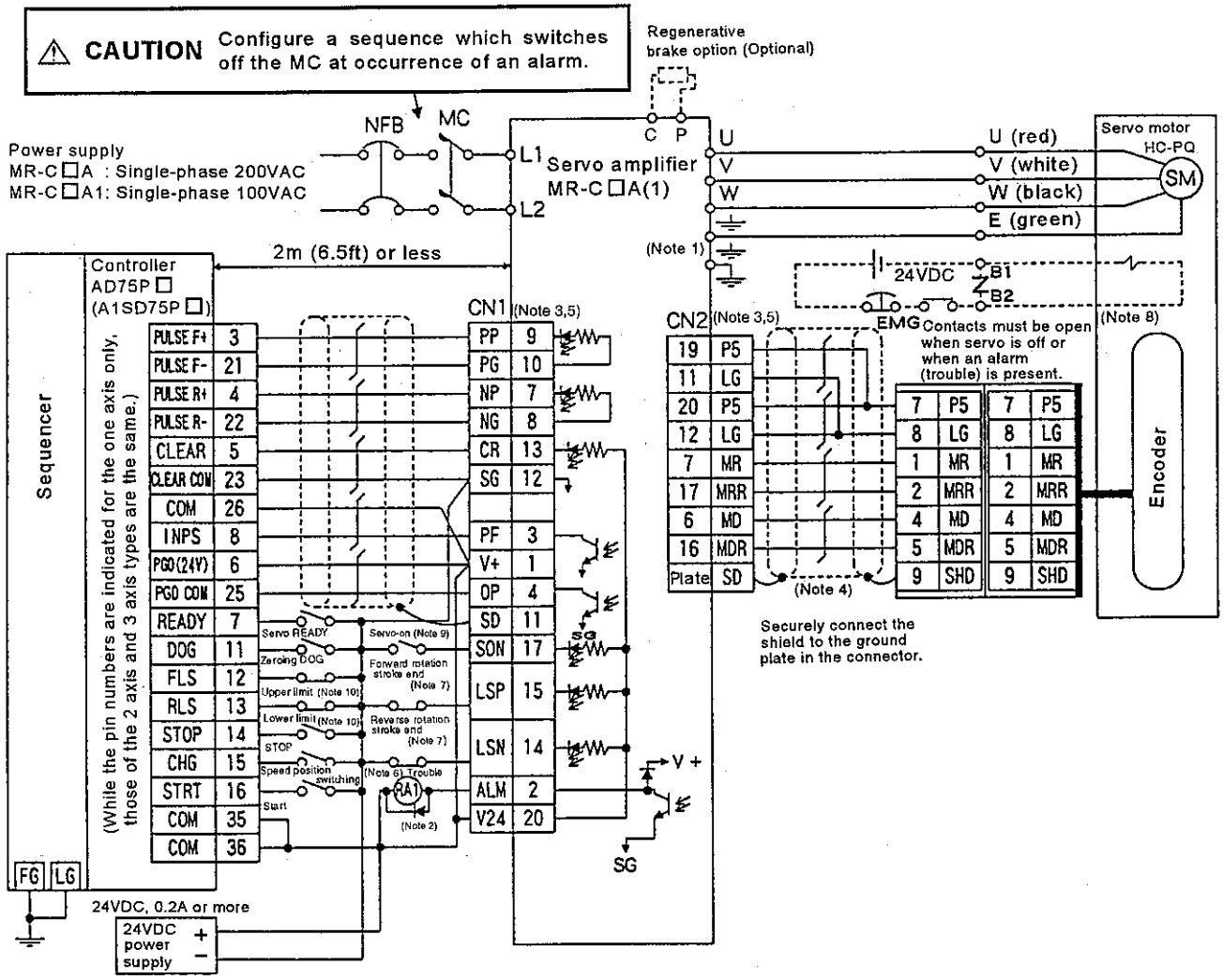
6. The trouble (ALM) signal conducts current when there is no alarm, i.e. in the normal state.
   When this signal is switched off (at occurrence of an alarm), the output of the controller must be stopped by the sequence program.

7. Since the LSP and LSN signals have been automatically switched on internally before shipment, set □0□ in parameter No. 6 to make the function valid.

8. For the servo motor with electromagnetic brake.

9. After making sure that the servo is without fault (ALM signal is on), configure a sequence which switches on the relay SVRDY.

2 – 1 – 4 Connection with the AD75P□ or A1SD75P□



⚠ WARNING

Note 1. For the EN Standard model, always connect the protective earth (PE) terminal (marked ⏚) of the servo amplifier to the protective earth (PE) of the control box to prevent an electric shock.

⚠ CAUTION

Note 2. Connect the diode in the correct direction. Otherwise, the servo amplifier will fail and will not output the connect signals, disabling the emergency stop and other protective circuits.

NOTICE

Note 3. CN1 and CN2 have the same shape. Wrong connection of the connectors will cause a failure.

MEMO-RANDUM

Note 4. This wiring applies to the standard cable of less than 10m (32 ft).

5. The pins with the same signal name are connected together in the servo amplifier.

6. The trouble (ALM) signal conducts current when there is no alarm, i.e. in the normal state.
   When this signal is switched off (at occurrence of an alarm), the output of the controller must be stopped by the sequence program.

7. Since the LSP and LSN signals have been automatically switched on internally before shipment, set □0□ in parameter No. 6 to make the function valid.

8. For the servo motor with electromagnetic brake.

9. After making sure that the servo is without fault (ALM signal is on), configure a sequence which switches on the relay RDY.

10. The upper limit signal (FLS) and lower limit signal (RLS) of the AD75P/A1SD75P are used for the zeroing retry function. Set them on the inside of the forward/reverse rotation stroke end of the servo amplifire.

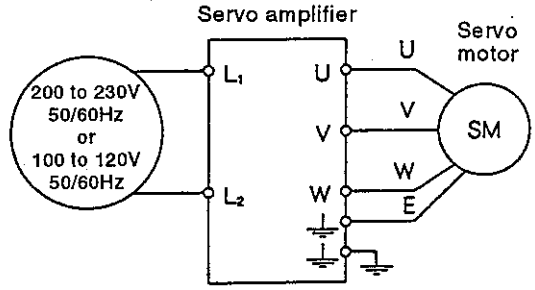
2 – 2 Operation

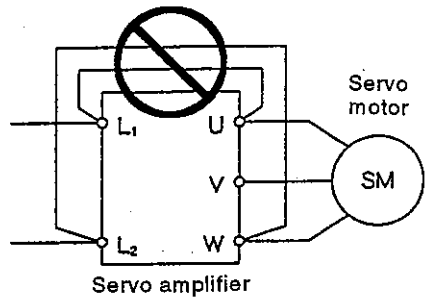
2 – 2 – 1 Pre-operation checks

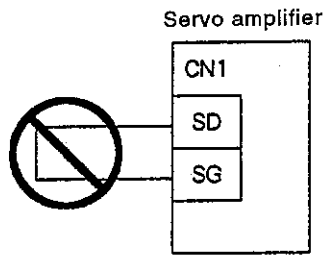
Before starting operation, check the following:

(1) Wiring

1) A correct power supply is connected to the power input terminals (L_1, L_2) of the servo amplifier.
2) The servo motor power supply terminals (U, V, W) of the servo amplifier match in phase with the power input terminals (U, V, W) of the servo motor.
3) The servo amplifier and servo motor are grounded securely.
4) The servo motor power supply terminals (U, V, W) of the servo amplifier are not connected to the power input terminals (L_1, L_2).
5) When using the regenerative brake option, disconnect the lead across D-P of the main circuit terminal block. Also, twisted cables should be used for the wiring of the regenerative brake option.
6) When stroke end limit switches are used, the signals across LSP-SG and LSN-SG of CN1 are on during operation.
7) 24VDC or higher voltages are not applied to the pins of connector CN1.
8) SD and SG of connector CN1 are not connected.
9) The wiring cables are free from excessive force.







(2) Environment

Ensure that signal and power cables are not shorted by wire offcuts, metallic clust, etc.

(3) Machine

1) Ensure that all motor mounting screws and shaft-to-machine connections are tightened securely.
2) Ensure that servo motor and machine are clear to operate.

2 – 2 – 2 Operation procedure

⚠ **WARNING** Do not operate the switches with wet hands. You may get electric shock.

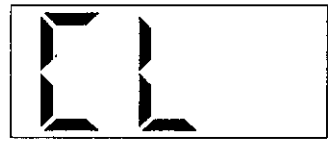
⚠ **CAUTION**

1. Before starting operation, check the parameters. Some machines may perform unexpected operation.
2. During power-on or soon after power-off, do not touch the servo amplifier heat sink, regenerative brake resistor, servo motor, etc. as they may be extremely hot! You may get burnt.
3. The specified combination of servo amplifier and servo motor must only be set. Otherwise, a fire may occur.
4. Do not plug or unplug the connectors (CN1, CN2) with power on. The amplifier or the equipment connected with the amplifier may fail.

Disconnect the servo motor from the machine, make sure that they operate properly. Then, connect the servo motor to the machine.

Power on

1) Switch on the servo-on signal (SON).
2) When power (NFB) is switched on, the display shows CL (lower 3 digits of the cumulative feedback pulses)



Input signal check

Using the external I/O display, check the digital I/O signal on/off states to see if operation can be performed. Make sure that the stroke end (LSP, LSN) signals are on.
(Refer to Section 2 – 3 – 3 (1).)

Test operation

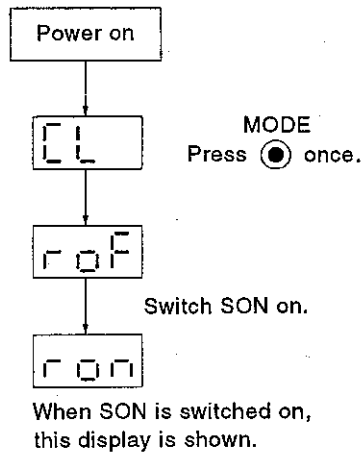
In the test operation mode, make sure that the servo motor operates.
(Refer to Section 2 – 3 – 3 (3).)

Servo on

When the servo-on signal (SON) is switched on, the servo motor is ready to operate and the servo motor shaft is locked. (Servo lock state)

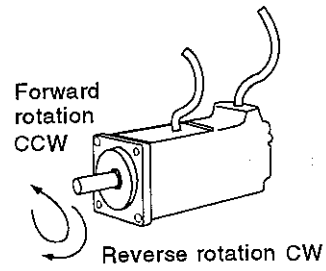
If the shaft is not servo-locked, the servo-on signal is not on. Check the external sequence up to the diagnostic display.

Confirmation method



Command pulse train input

- When a pulse train is input from the positioning unit, the servo motor starts rotating. First, run the motor at low speed and check the rotation direction, etc. If the motor does not run as expected, recheck the input signals.



- On the status display, check the servo motor speed, command pulse frequency, load factors, etc.
- When machine operation check is over, confirm automatic operation with the positioning unit program.
- This servo amplifier contains the real-time auto tuning function under model adaptive control. Generally, therefore, gain adjustment is not needed, and starting servo operation automatically makes gain adjustment. Depending on the rigidity of the machine, however, response setting can be adjusted to provide the optimum tuning for the machine by changing the parameter No. 1 setting.

Stop

Operation is interrupted and stopped by:

1) Servo off ..... The base circuit is shut off and the servo motor coasts to a stop.
2) Stroke end off ....The servo motor comes to a sudden stop and is servo-locked. The servo motor is allowed to run in the opposite direction. (Set in parameter No. 6.)
3) Alarm ..... When an alarm occurs, the base circuit is shut off.

MEMO-RANDUM	A sudden stop indicates that a stop is made with the droop pulses erased.

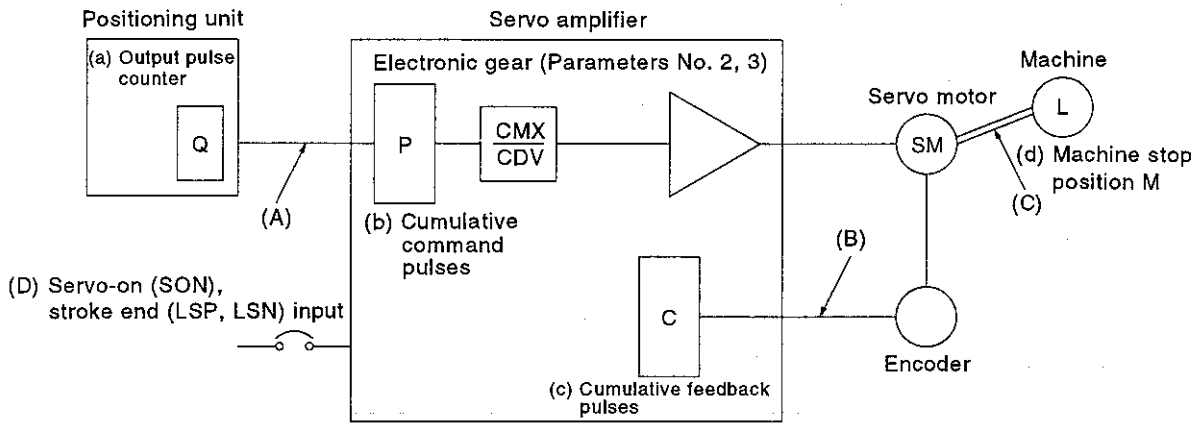
2 – 2 – 3 Troubleshooting at start-up

> **⚠CAUTION** Never adjust and change the parameter settings extremely. Otherwise, operation will be instable.

The following table lists faults that may occur in each step in the servo start-up sequence, and their check points and assumed causes. If an alarm occurs, refer to Chapter 8 and take the appropriate action.

No.	Start-Up Sequence	Fault	Check Point	Assumed Cause	Refer To
1	Power on	• The LED is not lit. • The LED flickers.	Not improved when the connectors CN1 and CN2 are disconnected.	• Power supply voltage faulty. • Servo amplifier failure	
			Improved when the connector CN1 is disconnected.	Short circuit in the power supply of the CN1 cable wiring	
			Improved when the connector CN2 is disconnected.	1) Short circuit in the power supply of the encoder cable wiring 2) Encoder failure	
		An alarm occurs.	Refer to Chapter 8 "TROUBLESHOOTING" and remove the cause.		Chapter 8
2	Servo-on signal is switched on.	An alarm occurs.	Refer to Chapter 8 "TROUBLESHOOTING" and remove the cause.		Chapter 8
		Servo is not locked. (The servo motor shaft is free.)	Confirm the external I/O signal display.	1) The servo ON signal is not input. (Wiring error) 2) V24 or V5 is not supplied with DC power.	Section 2 – 3 – 3 (1)
3	Position command is input (test run)	The servo motor does not rotate.	Confirm the cumulative command pulses.	1) Wiring error (a) For the open collector pulse train input, OPC is not supplied with 24VDC. (b) LSP or LSN and SG are not connected. 2) Pulse is not input.	Section 2 – 3 – 3 (3)
4	Gain adjustment	Rotation ripples are (speed fluctuation is) large at low speed.	Make gain adjustment in the following procedure: 1) Increase the response setting of auto tuning. 2) Repeat acceleration/deceleration three or four times to complete auto tuning.	Gain adjustment fault	Section 5 – 1
		Due to large load inertia, the servo motor vibrates side to side.	Make gain adjustment in the following procedure: If operation can be performed safely, repeat acceleration/deceleration three or four times to complete auto tuning.	Gain adjustment fault	Section 5 – 1
5	Cyclic operation	A position offset occurs. (Position servo)	Confirm the controller's output counter, cumulative command pulses, cumulative feedback pulses and actual servo motor position.	Pulse mis-count due to noise, etc.	Section 2 – 2 – 4

2 – 2 – 4 Determining the cause of a position offset



In the above diagram, the (a) output pulse counter, (b) cumulative command pulses (PL, PH) display, (c) cumulative feedback pulses (CL, CH) display, and (d) machine stop position represent points to be checked when a position offset occurs.

Also, (A), (B), (C) and (D) indicate places where position offset may occur. For example, (A) indicates the wiring between the positioning unit and servo amplifier where noise may be picked up. The noise may cause the mis-count of pulses.

In a normal operation without a position offset, the following relationships are established and maintained:

1) Q = P (output pulse counter value of the positioning unit
= servo amplifier's cumulative command pulses)

2) $P \cdot \frac{CMX\,(Parameter\,No.\,2)}{CDV\,(Parameter\,No.\,3)} = C$ (cumulative command pulses × electronic gear ratio
= cumulative feedback pulses)

3) $C \cdot \Delta = M$ (cumulative feedback pulses × travel per pulse = machine position)

When a position offset occurs, check the following situations:

1) When $Q \neq P$

Noise picked up by the pulse train signal wiring between the positioning unit and servo amplifier may have caused a pulse count error. (Factor (A))

2) When $P \cdot \frac{CMX}{CDV} \neq C$

The servo-on (SON) signal or forward/reverse run stroke end (LSP, LSN) signal may have switched off during operation, or the clear (CR) signal switched on. (Factor (D))

3) When $C \cdot \Delta \neq M$

Noise picked up by the encoder cable may have caused a count error, or mechanical slip may have occurred between the servo motor and machine.

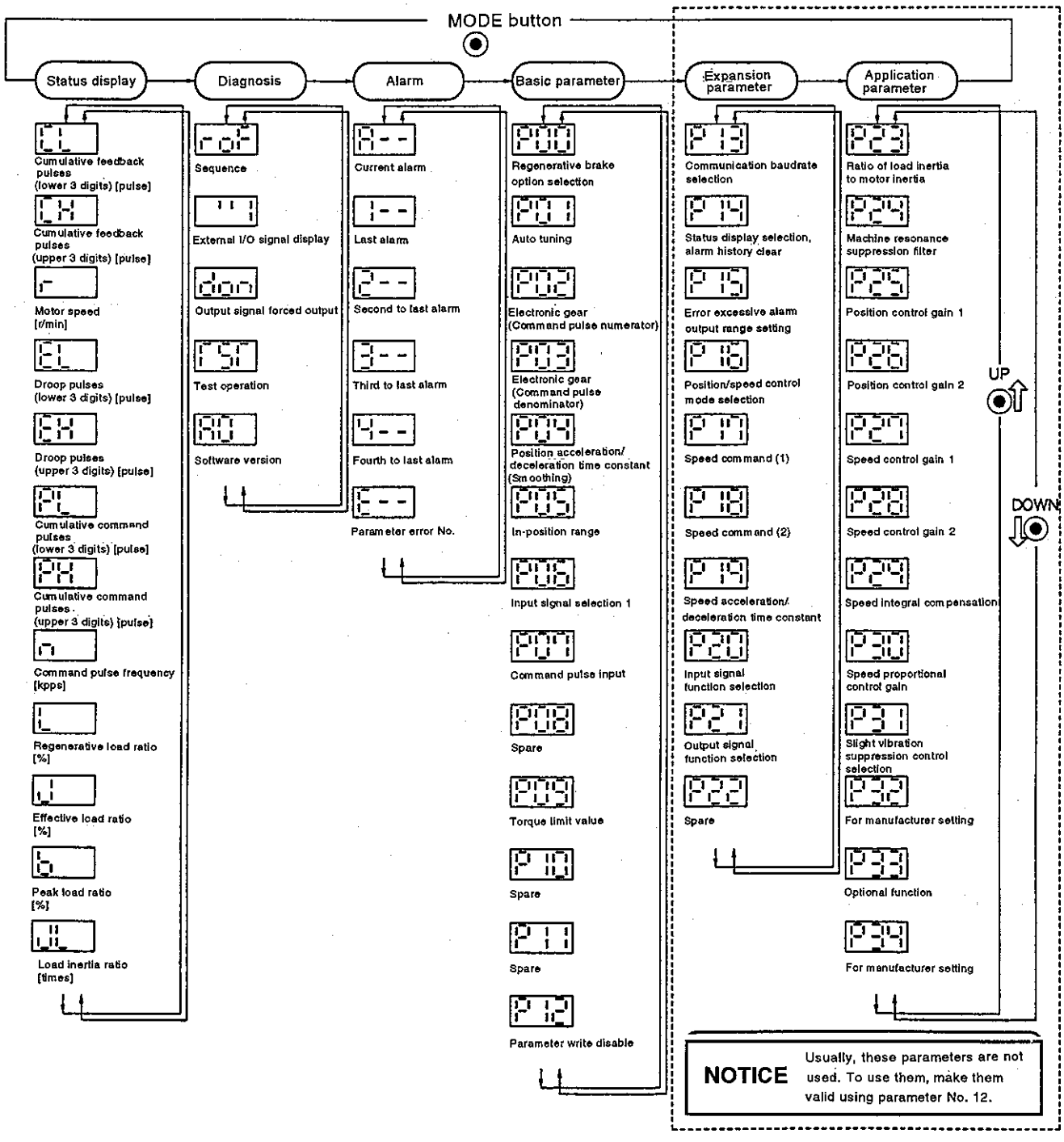
2 – 3 Display and Operation

2 – 3 – 1 Display flowchart

Use the display (3-digit, 7-segment LED) on the front panel of the servo amplifier for status display, parameter setting, etc. Use the display to set the parameters before operation, diagnose an alarm, confirm external sequences, or confirm the operation status.

Press the MODE ◉ , UP ◉ or DOWN ◉ button once to move to the next screen. When power is switched on, the symbol for the cumulative feedback pulses (lower 3 digits) CL is displayed.

To refer to or set the expansion parameters and application parameters, make them valid using parameter No. 12 (parameter write disable).

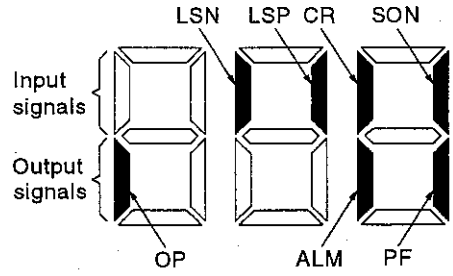
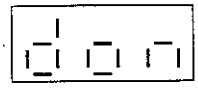
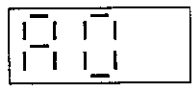


2 – 3 – 2 Status display

The servo status during operation is shown on the 3-digit, 7-segment LED display.
Press the UP ◉ or DOWN ◉ button to change display data as desired. When the required data is selected, the corresponding symbol is displayed. Press the SET ◉ button to display that data.

Name	Symbol	Display Range	Unit	Description
Cumulative feedback pulses (Lower 3 digits)	CL	-999999 to 999999	Pulse	After operation has been made ready, the travel distance of the servo motor is counted and displayed. When ±999999 is exceeded, the value begins with zero. Press the SET ◉ button to reset the display value to zero. When the servo motor is rotating in the reverse direction, the decimal points in all digits are lit.
Cumulative feedback pulses (Upper 3 digits)	CH			
Servo motor speed	r	-540 to 540	×10r/min	The servo motor speed is displayed. When the servo motor is rotating in the reverse direction, the decimal points in all digits are lit. The r/min value rounded off is displayed. (The display data is updated every 0.3s.) Hold down the SET ◉ button to display the value in r/min.
Droop pulses (Lower 3 digits)	EL	-999999 to 999999	Pulse	The number of droop pulses in the deviation counter is displayed. When ±999999 is exceeded, the value begins with zero. When the servo motor is rotating in the reverse direction, the decimal points in all digits are lit. The displayed number of pulses is not yet multiplied by the electronic gear value.
Droop pulses (Upper 3 digits)	EH			
Cumulative command pulses (Lower 3 digits)	PL	-999999 to 999999	Pulse	The position command input pulses are counted and displayed. As this value is displayed before it is multiplied by the electronic gear (CMX/CDV), it may not match the cumulative feedback pulses. Press the SET ◉ button to reset the display value to zero. When the servo motor is rotating in the reverse direction, the decimal points in all digits are lit.
Cumulative command pulses (Upper 3 digits)	PH			
Command pulse frequency	n	-200 to 200	kpps	The frequency of the position command input pulses is displayed in kpps which is represented by the decimal point. This value is displayed before it is multiplied by the electronic gear (CMX/CDV). When the servo motor is rotating in the reverse direction, the decimal points in all digits are lit. Hold down the SET ◉ button to display the value in 0.1kpps.
Regenerative load ratio	L	0 to 100	%	The ratio of regenerative power to permissible regenerative power is displayed in %. As the permissible regenerative power depends on whether there is the regenerative brake option or not, set parameter No. 0 correctly.
Effective load ratio	J	0 to 300	%	The continuous effective load torque is displayed. When rated torque is generated, this value is 100%. The display data is updated every 910.1 ms.
Peak load ratio	b	0 to 400	%	The maximum torque generated during acceleration/deceleration, etc. is displayed. When rated torque is generated, this value is 100%. The peak torque for the past 4 seconds is displayed. The display data is updated every 910.1ms.
Load inertia ratio	JL	0 to 100	Times	The estimated ratio of the load inertia to the inertia of the servo motor shaft is displayed. The display data is updated every 60ms.

2 – 3 – 3 Diagnostic mode

Name	Display	Description
Sequence		Not ready. Indicates that the unit is being initialized or an alarm has occurred.
		Ready. Indicates that the servo was switched on after completion of initialization and the unit is ready to operate.
External I/O signal display		Indicates the on/off states of the external I/O signals. The upper segments correspond to the input signals and the lower segments to the output signals. Lit: ON Extinguished: OFF Refer to (1) in this section. The I/O signals can be changed using parameters No. 20 and 21. The ALM signal is ON when there is no alarm. Refer to Section 5 – 2 – 2.
Output signal forced output		The digital output signal can be forcibly switched on/off. For more information, refer to (2) in this section.
Test operation mode		The servo motor can be operated without pulse train input. During test operation, speed control servo is provided. The status display values of the droop pulses, cumulative command pulses and command pulse frequency do not change. For details, refer to (3) in this section.
Software version		Indicates the version of the software.

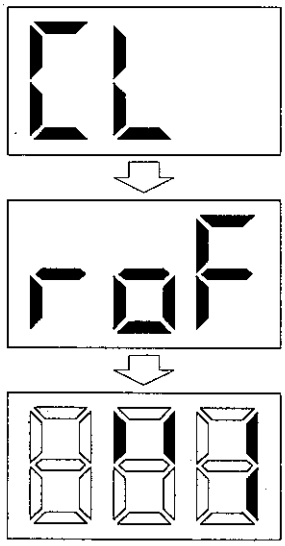
(1) External I/O signal display

MEMO-RANDUM	This function is available for the servo amplifier with software version A2 or later.

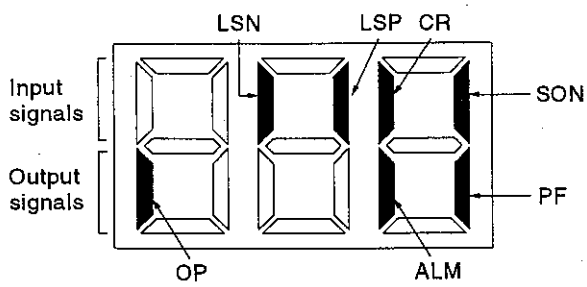
The on/off states of the digital I/O signals connected to the servo amplifier can be confirmed. In addition, the I/O signals displayed for parameters No. 20 and 21 can be changed. Refer to Section 5 – 2 – 2.

1) Operation

Display screen after power-on is shown.



2) Display definition



The 7-segment LED shown above indicates on/off.

Each segment at top indicates the input signal and each segment at bottom indicates the output signal.

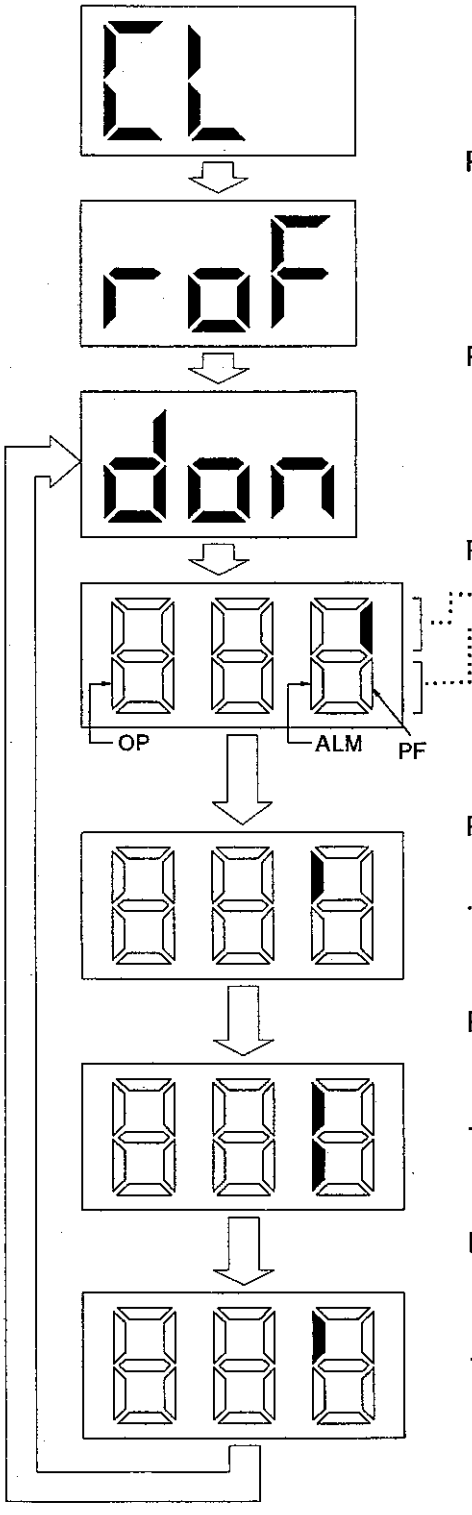
Symbol	Signal
SON	Servo-on
LSP	Forward rotation stroke end
LSN	Reverse rotation stroke end
CR	Clear
ALM	Trouble (ON in normal state)
PF	Positioning finished
OP	Encoder Z-phase pulse

(2) Output signal forced output

MEMO-RANDUM	This function is available for the servo amplifier with software version A2 or later.

The output signal can be forcibly switched on/off independently of the servo status. This operation is used to check output signal wiring.

Display screen after power-on is shown.



Press MODE ◉ once.

Press UP ◉ twice.

Press SET ◉ for more than 2s.

..... Switch on/off the signal below the lit segment.

..... Indicates the on/off of the output signal. The correspondences between segments and signals are as in the output signals of the external I/O signal display.

(Lit: ON, Not lit: OFF)

Press MODE ◉ once.

..... The segment above ALM is lit.

Press UP ◉ once.

..... ALM is switched on.

(ALM-SG conducts.)

Press DOWN ◉ once..

..... ALM is switched off.

Press SET ◉ for more than 2s.

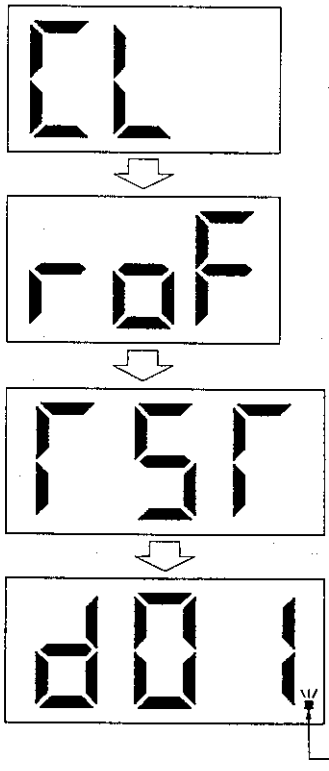
(3) Test operation mode

⚠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 it with the servo motor alone.

Jog operation can be performed without a pulse train input command unit.

1) Mode switching

Display screen after power-on is shown.



Press MODE ◉ once.

Press UP ◉ three times.

Press SET ◉ for more than 2s.

..... When this screen is displayed, jog operation can be performed.

Flickers in the test operation mode.

2) Starting method

Perform the following operation to rotate the servo motor at 200r/min.
At this time, the acceleration/deceleration time is 1s.

Rotation Direction	Operation
CCW	Press UP ◉ .
CW	Press DOWN ◉ .

To stop, release the corresponding button.

3) Status display

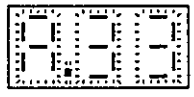
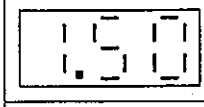
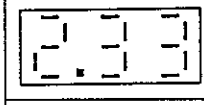
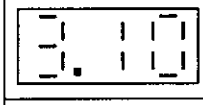
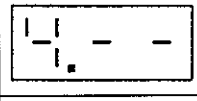
The servo status during test operation can be displayed. Press MODE ◉ to shift to the status display screen. The display data is the same as in the status display in Section 2 – 3 – 2.

4) Termination of test operation

To terminate the test operation, switch power off once, or press MODE ◉ to call the d01 screen, then press SET ◉ for more than 2s.

2 – 3 – 4 Alarm mode

The current alarm, past alarm history and parameter error are displayed. The corresponding alarm number or the parameter number in error is shown in the two least significant digits of the display. Display examples are listed in the following table:

Name	Display	Description
Current alarm		No occurrence of an alarm.
		Alarm 33 (overvoltage) occurred. Flickers at occurrence of the alarm.
Alarm history		The last alarm is alarm 50 (overload).
		The second alarm in the past is alarm 33 (overvoltage).
		The third alarm in the past is alarm 10 (undervoltage).
		There is no fourth alarm in the past.
Parameter error		No occurrence of alarm 37 (parameter error).
		The data of parameter No. 1 is faulty.

Functions at occurrence of an alarm

(1) The unit can enter the alarm mode from any screen.

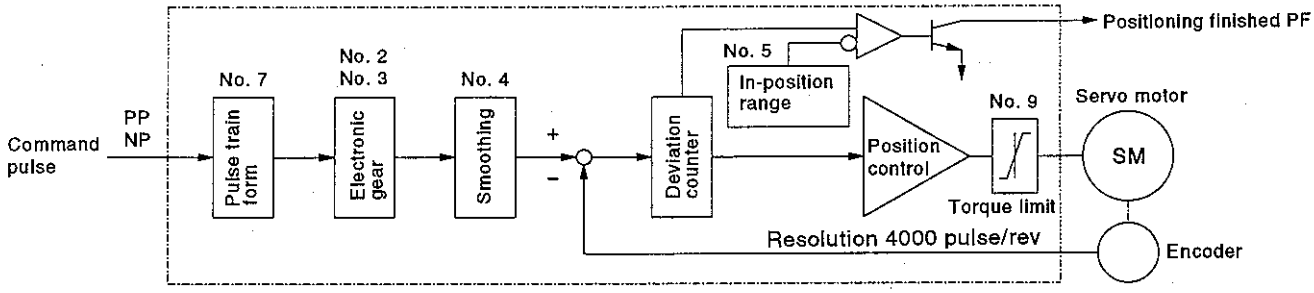
(2) The other screen is visible during occurrence of an alarm. At this time, the decimal point in the third digit flickers.

(3) To clear any alarm, switch power on, then off or press the SET button on the current alarm screen. Note that this should be done after removing the cause of the alarm.

(4) Use parameter No. 14 to clear the alarm history.

2 – 3 – 5 Parameter mode

The basic parameter control block diagram is shown below. Set the parameters as required.

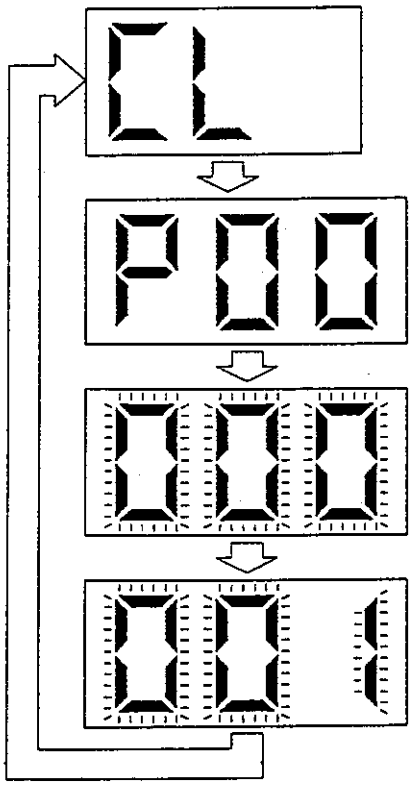


The parameter settings need not be changed to operate this servo. Note that the parameter settings should be changed when:

1) The regenerative brake option is used;
2) The stroke end function is used;
3) The number of input pulses per servo motor revolution is changed
4) The machine mounted servo motor hunts oscillates or performance need to be further improved.

(1) Operation example

When using the regenerative brake option (MR-RB013), call the display screen shown, after power-on.



Press MODE three times.

..... The parameter number is displayed.
Press UP or DOWN to change the number.

Press SET twice.

..... The set value of the specified parameter number flickers.

Press SET once.

..... The set value flickering can be changed.
Use UP or DOWN .

Press UP to enter.

For the setting of parameter No. 0, change its set value, then switch power off once.

(2) Expansion and application parameters

These parameters are not used usually. The gains can be adjusted in the speed control mode or manually. To use the expansion and application parameters, change the setting of parameter No. 12 (parameter write disable). After setting parameter No. 12, switch power off once, then on to make the parameters valid.

The table below shows the parameters referenced and write enabled by the setting of parameter No. 12. Those parameters marked O can be operated.

Set Value	Operation	Basic Parameters No. 0 to 12	Expansion Parameters No. 13 to 22	Application Parameters No 23 to 34
000 (initial value)	Reference	O		
	Write	O		
00A	Reference	O		
	Write	Allowed for No. 12 only.		
00B	Reference	O	O	
	Write	O		
00C	Reference	O	O	
	Write	O	O	
00D	Reference	O	O	O
	Write	O	O	O

(3) Parameter list

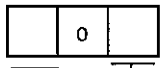
Note: To make the parameter marked * valid, set the parameter, switch power off once, then switch power on again.

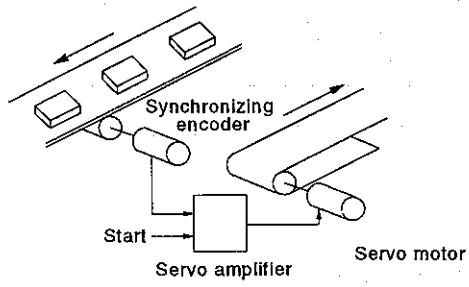
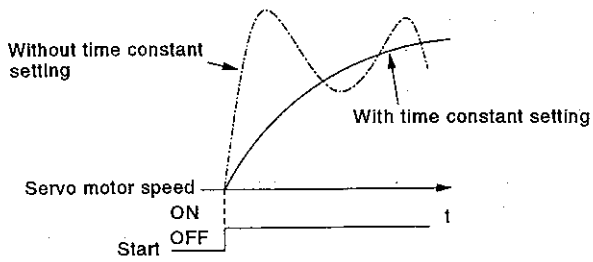
Class	No.	Symbol	Name	Initial Value	Unit	Customer Setting
Basic parameters	0	*REG	Regenerative brake option/Low acoustic mode selection	000		
	1	ATU	Auto tuning	002		
	2	CMX	Electronic gear (Command pulse multiplying factor numerator)	1		
	3	CDV	Electronic gear (Command pulse multiplying factor denominator)	1		
	4	PST	Position acceleration/deceleration time constant (Smoothing)	5	ms	
	5	INP	In-position range	100	pulse	
	6	*IP1	Input signal selection 1	010		
	7	*PLS	Command pulse input	010		
	8		For manufacturer setting	0		
	9	TLL	Torque limit value	100	%	
	10		For manufacturer setting	0		
	11		For manufacturer setting	0		
	12	*BLK	Parameter write disable	000		
Expansion parameters	13	*SIO	Communication baudrate selection	000		
	14	*DMD	Status display selection, alarm history clear	000		
	15	ERZ	Error excessive alarm output range setting	50	kpulse	
	16	*OP1	Position/speed control mode selection	001		
	17	SC1	Speed command (1)	10	10r/min	
	18	SC2	Speed command (2)	100	10r/min	
	19	STC	Speed acceleration/deceleration time constant	0	10ms	
	20	*DIF	Input signal function selection	210		
	21	*DOF	Output signal function selection	010		
	22		For manufacturer setting			
Application parameters	23	GD2	Ratio of load inertia to motor inertia	8		
	24	NCH	Machine resonance suppression filter	0		
	25	PG1	Position control gain 1 (model position gain)	70	rad/s	
	26	PG2	Position control gain 2 (actual position gain)	25	rad/s	
	27	VG1	Speed control gain 1 (model position gain)	120	x 10rad/s	
	28	VG2	Speed control gain 2 (actual position gain)	60	x 10rad/s	
	29	VIC	Speed integral compensation	20	ms	
	30	VDC	Speed proportional control gain	980		
	31	MVC	Slight vibration suppression control selection	000		
	32		For manufacturer setting	412		
	33	*OP2	Optional function	A00		
	34		For manufacturer setting	0		

NOTICE Usually, the expansion and application parameters are not used. To use them, make them valid using parameter No. 12.

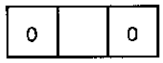
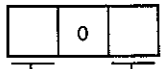
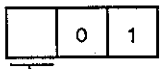
(4) Detailed explanation of the parameters

Note: To make the parameter marked * valid, set the parameter, switch power off once, then switch power on again.

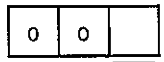
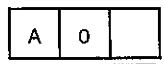
<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name</th><th>Initial Value</th><th>Unit</th><th>Setting Range</th></tr>
<tr><td rowspan="2">Basic parameters</td><td>0</td><td>*REG</td><td>Regenerative brake option/low acoustic noise mode selection:
Used to select the regenerative brake option and low acoustic noise mode.
 
Select the regenerative brake option.
0: Not used
1: MR-RB013
2: MR-RB033
NOTICE If wrong setting is made, the regenerative brake option may overheat!
Low acoustic noise mode selection (software version A3 or later)
By choosing the low acoustic noise mode, electromagnetic sound generated by the servo motor can be reduced by about 20dB.
At this time, the torque characteristic of the servo motor changes. (Refer to Section 10 – 2)
0: non-low acoustic noise
1: low acoustic noise</td><td>000</td><td></td><td>000 to 102h</td></tr>
<tr><td>1</td><td>ATU</td><td>Auto tuning:
Used to set response for execution of auto tuning.
 
Auto tuning response setting
<table><tr><th>Set Value</th><th>Response</th></tr><tr><td>1</td><td>Slow response</td></tr><tr><td>2</td><td>to</td></tr><tr><td>3</td><td>Medium response</td></tr><tr><td>4</td><td>to</td></tr><tr><td>5</td><td>Fast response</td></tr></table>• 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.
Machine selection
Used to adjust the position setting characteristic according to the machine status.
<table><tr><th colspan="2" rowspan="2"></th><th colspan="2">Position Setting Characteristic</th></tr><tr><th>Ordinary</th><th>Better (Note)</th></tr><tr><td rowspan="2">Machine friction</td><td>Small</td><td>0</td><td>2</td></tr><tr><td>Large</td><td>1</td><td>3</td></tr></table>Note: This setting is available for software version A3 or later.
Choosing "Better" automatically tunes the speed integral compensation (parameter No. 29) rather small.
Auto tuning selection
0: Executed for both position and speed loops
1: Interpolation axis control (normally not set)
2: Not executed.</td><td>002</td><td></td><td>001 to 235h</td></tr>
</table>

Class	No.	Symbol	Name	Initial Value	Unit	Setting Range
Basic parameters	2	CMX	Electronic gear (Command pulse multiplying factor, numerator): Used to set the multiplier of the command pulse input. Command pulse input f_1 → $\frac{CMX}{CDV}$ → Position command $f_2 = f_1 \cdot \frac{CMX}{CDV}$ Note: Set in the range of $\frac{1}{50} < \frac{CMX}{CDV} < 20$. The setting of the number of input pulses per servo motor revolution can be changed by the following formula: $4000 \cdot \frac{CDV}{CMX}$ (pulse/rev) ⚠ **CAUTION** If a wrong setting is made, the servo motor way rotate at unexpectedly high speed, causing injury.	1		1 to 999
	3	CDV	Electronic gear (Command pulse multiplying factor, denominator): Used to set the divisor of the command pulse input.	1		1 to 999
	4	PST	Position command acceleration/deceleration time (smoothing): Used to set the time of a low pass filter to the position command. Example: When a command is received from a synchronizing encoder, synchronous operation can be started smoothly.  	5	ms	0 to 999
	5	INP	In-position range: Used to set the range of droop pulses in which the positioning finished (PF) signal is output.	100	pulse	0 to 999

<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name</th><th>Initial Value</th><th>Unit</th><th>Setting Range</th></tr>
<tr><td rowspan="6">Basic parameters</td><td>6</td><td>*IP1</td><td>Input signal selection 1:
Used to change the functions of the digital input signals.
 
SON signal function selection
0: Servo is switched on when the signal across SON-SG is switched on.
1: Servo is switched on when the signal across SON-SG is switched off.
MEMO-RANDUM When "1" is selected, note that the servo amplifier enters the servo-on status if the external 24V power is lost.
LSP, LSN signal selection
0: Function valid
(Invalid if the signal is not switched on in the external wiring.)
1: Normally on
(When the limit switch is not used)
Clear signal selection
0: Droop pulses are cleared on the leading edge.
1: Always cleared while on.</td><td>010</td><td></td><td>000 to 111h</td></tr>
<tr><td>7</td><td>*OP1</td><td>Command pulse selection:
Used to select the input form of the pulse train input signal.
Refer to Section 5 – 2 – 1.
 
Command pulse input form
0: Forward/reverse rotation pulse train
1: Signed pulse train
2: A/B phase pulse train
Pulse train logic selection
0: Positive logic
1: Negative logic</td><td>010</td><td></td><td>000 to 012h</td></tr>
<tr><td>8</td><td></td><td>For manufacturer setting:
Must not be change.</td><td>0</td><td></td><td></td></tr>
<tr><td>9</td><td>TLL</td><td>Torque limit value:
Set with the maximum torque being 100%.
This parameter is set to limit the torque generated by the servo motor.</td><td>100</td><td>%</td><td>0 to 100</td></tr>
<tr><td>10
11</td><td></td><td>For manufacturer setting:
Must not be change.</td><td></td><td></td><td></td></tr>
<tr><td>12</td><td>*BLK</td><td>Parameter write disable:
Used to select the reference and write ranges of the parameters.
<table><tr><th>Set Value</th><th>Reference Range</th><th>Write Range</th></tr><tr><td>000</td><td>No. 0 to 12</td><td>No. 0 to 12</td></tr><tr><td>00A</td><td>No. 0 to 12</td><td>No. 12</td></tr><tr><td>00B</td><td>No. 0 to 22</td><td>No. 0 to 12</td></tr><tr><td>00C</td><td>No. 0 to 22</td><td>No. 0 to 22</td></tr><tr><td>00D</td><td>No. 0 to 22</td><td>No. 0 to 34</td></tr></table></td><td>000</td><td></td><td>000 to 00Dh</td></tr>
</table>

Class	No.	Symbol	Name	Initial Value	Unit	Setting Range
Expansion parameters	13	*SIO	Communication baudrate selection: Used to select the serial interface when the RS-232C option unit is fitted to use the communication function.  Selection of baud rate when RS-232C is selected 0: 9600 (bps) 1: 19200 (bps) 2: 4800 (bps)	000		000 to 020h
	14	*DMD	Status display selection, alarm history clear: Used to select the status display shown at power-on.  Status display at power-on 0: Cumulative feedback pulses (lower 3 digits) 1: Cumulative feedback pulses (upper 3 digits) 2: Servo motor speed 3: Droop pulses (lower 3 digits) 4: Droop pulses (upper 3 digits) 5: Cumulative command pulses (lower 3 digits) 6: Cumulative command pulses (upper 3 digits) 7: Command pulse frequency 8: Regenerative load factor 9: Effective torque A: Peak torque B: Load inertia Alarm history clear 0: Invalid 1: Valid When alarm history clear is selected, this function is made valid at next power-on. After the alarm history is cleared, the setting is automatically reset to zero.	000		000 to 10Ah
	15	ERZ	Excessive error output range setting: Used to set the range in which the excessive error alarm (A52) is output.	50	kpulse	1 to 999
	16	*OP1	Position/speed control mode selection: Used to select the optional function.  Control mode selection 0: Position control 1: Speed control	001		001 to 101h
	17	SC1	Speed command (1): Used to set speed 1 of the internal speed command.	10	10r/min	0 to 450
	18	SC2	Speed command (2): Used to set speed 2 of the internal speed command.	100	10r/min	0 to 450

Class	No.	Symbol	Name	Initial Value	Unit	Setting Range
Expansion parameters	19	STC	Speed acceleration/deceleration time constant: Used to set the acceleration/deceleration time required to reach the rated speed in response to the speed command. Example Set 300 (3s) to accelerate the HC-PQ series servo motor (rated speed: 3000r/min) from 0r/min to 1000r/min in 1s.	0	10ms	0 to 500
	20	*DIF	Input signal function selection: Used to select the input signal functions of pins No. 13, 14 and 15 on connector CN1. [ ][ ][ ] Pin 15 Set values and functions 0: LSP 3: ST1 6: PC 1: LSN 4: ST2 7: TL 2: CR 5: DI1 8: RES Pin 14 Set values and functions 0: LSP 3: ST1 6: PC 1: LSN 4: ST2 7: TL 2: CR 5: DI1 8: RES Pin 13 Set values and functions 0: LSP 3: ST1 6: PC 1: LSN 4: ST2 7: TL 2: CR 5: DI1 8: RES **MEMO-RANDUM** 1. Selection of the same function will result in a parameter error. 2. When automatic on of LSP/LSN is selected in parameter No. 6, LSP/LSN is always on independently of the function selected in parameter No. 20.	210		000 to 888h
	21	*DOF	Output signal function selection: Used to select the output signal functions of pins No. 3 and 4 on connector CN1. [0][ ][ ] Pin 4 Set values and functions 0: OP 2: RD 4: TLC 1: PF 3: ZSP 5: BRK Pin 3 Set values and functions 0: OP 2: RD 4: TLC 1: PF 3: ZSP 5: BRK **MEMO-RANDUM** Selection of the same function will result in a parameter error.	010		000 to 055h
	22		For manufacturer setting: Must not be change.			

<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name</th><th>Initial Value</th><th>Unit</th><th>Setting Range</th></tr>
<tr><td rowspan="14">Application parameters</td><td>23</td><td>GD2</td><td>Ratio of load inertia to motor inertia:
Used to set the ratio of the load inertia to the servo motor inertia. Note that when auto tuning is selected, the result of auto tuning is automatically set.</td><td>8</td><td></td><td>0 to 100</td></tr>
<tr><td>24</td><td>NCH</td><td>Machine resonance suppression filter:
Used to set the frequency that matches the resonance frequency of the mechanical system.
<table><tr><th>Set Value</th><th>Machine Resonance Frequency [Hz]</th></tr><tr><td>0</td><td>Not used</td></tr><tr><td>1</td><td>1125</td></tr><tr><td>2</td><td>563</td></tr><tr><td>3</td><td>375</td></tr><tr><td>4</td><td>282</td></tr><tr><td>5</td><td>225</td></tr><tr><td>6</td><td>188</td></tr><tr><td>7</td><td>161</td></tr></table></td><td>0</td><td></td><td>0 to 7</td></tr>
<tr><td>25</td><td>PG1</td><td>Position control gain 1:
Used to set the gain of the model position loop.</td><td>70</td><td>rad/s</td><td>4 to 999</td></tr>
<tr><td>26</td><td>PG2</td><td>Position control gain 2:
Used to set the gain of the actual position loop.</td><td>25</td><td>rad/s</td><td>1 to 500</td></tr>
<tr><td>27</td><td>VG1</td><td>Speed control gain 1:
Used to set the gain of the model speed loop. Higher setting increases response but is liable to generate vibration and noise.</td><td>120</td><td>10rad/s</td><td>10 to 500</td></tr>
<tr><td>28</td><td>VG2</td><td>Speed control gain 2:
Used to set the gain of the actual speed loop. Higher setting increases response but is liable to generate vibration and noise.</td><td>60</td><td>10rad/s</td><td>2 to 800</td></tr>
<tr><td>29</td><td>VIC</td><td>Speed integral compensation:
Used to set the time constant of integral compensation of the actual speed loop.</td><td>20</td><td></td><td>1 to 999</td></tr>
<tr><td>30</td><td>VDC</td><td>Speed proportional control gain:
Switch the proportional control input signal (PC) on to make this function valid.</td><td>980</td><td></td><td>0 to 999</td></tr>
<tr><td>31</td><td>MVC</td><td>Slight vibration suppression control selection:
Used to select ON-OFF of slight vibration suppression control.
 
Slight vibration suppression control
0: Not done.
1: Done.</td><td>000</td><td></td><td>000 to 001h</td></tr>
<tr><td>32</td><td></td><td>For manufacturer setting:
Must not be change.</td><td>412</td><td></td><td></td></tr>
<tr><td>33</td><td>*OP2</td><td>Optional function:
Used to select the optional function.
 
Selection of stop mode at LSP/LSN off under position control
0: Sudden stop
1: Slow stop
(The servo motor is decelerated to a stop at the time constant set in parameter No. 4.)</td><td>A00</td><td></td><td>A00 to A01h</td></tr>
<tr><td>34</td><td></td><td>For manufacturer setting:
Must not be change.</td><td>0</td><td></td><td></td></tr>
</table>

CHAPTER 3
WIRING

This chapter provides information required for wiring. Before wiring, always read this chapter.

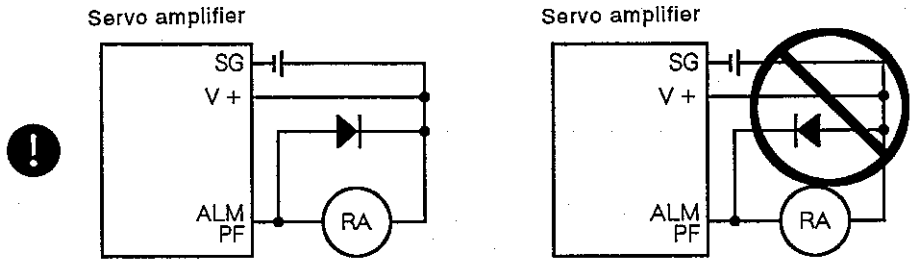
3. WIRING

⚠ **WARNING**

1. All wiring must be done by competent personnel.
2. Before starting wiring, switch power off and wait for more than 10 minutes. Then, confirm that the voltage is zero with a voltage tester. Otherwise, you may get an electric shock.
3. Ground the servo amplifier and the servo motor.
4. Do not attempt to wire the servo amplifier and servo motor until they have been properly installed. Otherwise, you may get an electric shock.
5. The wires should not be damaged, stressed, loaded or pinched. Otherwise, you may get an electric shock.

⚠ **CAUTION**

1. Wire the equipment correctly and securely. Otherwise, the servo motor may misoperate, resulting in injury.
2. Connect wires to correct terminals to prevent a burst, fault, etc.
3. Ensure that polarity (+, –) is correct. Otherwise, a burst, damage, etc. may occur.
4. The surge absorbing diode installed on the DC output signal relay must be wired in the specified direction.
   Otherwise, the emergency stop and other protective circuits may not operate.



5. Use a noise filter, etc. to minimize electromagnetic interference, caused by electronic equipment used near the servo amplifier.
6. Do not install a power capacitor, surge absorber or radio noise filter (FR-BIF option) between the servo amplifier and servo motor.
7. Use the fault signal to switch power off. Otherwise, the fault of the regenerative brake transistor or the like may overheat the regenerative brake resistor, causing a fire.
8. Do not modify the equipment.

NOTICE CN1 and CN2 have the same shape. Wrong connection made to the connectors may cause a failure. Connect them correctly.

3. WIRING

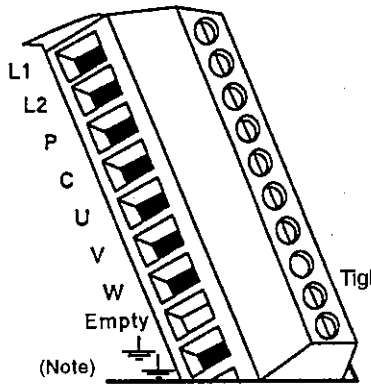
3 – 1 Servo Amplifier

> **⚠ CAUTION** Only the voltage specified in the instruction manual should be applied to each terminal. Otherwise, a burst, damage, etc. may occur.

3 – 1 – 1 Terminal block

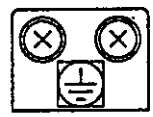
(1) Signal arrangement

1) Main circuit terminal block (TE)



Tightening torque :
0.49 to 0.785 [N·m]
(4.337 to 6.948 [lb-in])

2) Protective earth (PE) terminals



Terminal screw : M4
Tightening torque : 1.275 [N·m]
(11.285 [lb-in])

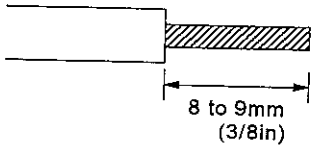
Note: Unavailable for the EN Standard- and UL/C-UL Standard-compliant models.

(2) Signals

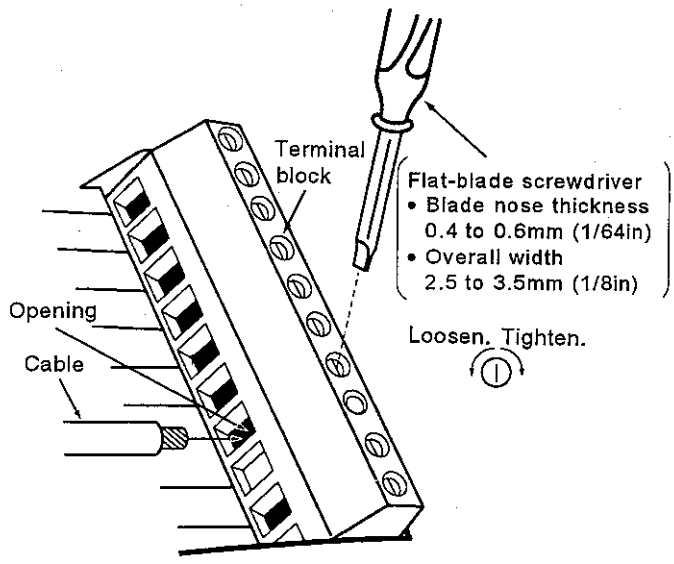
Signal	Symbol	Description
Main circuit power supply	L_1, L_2	Power input terminals. MR-C ☐A: Single-phase 200 to 230VAC, 50/60Hz MR-C ☐A1: Single-phase 100 to 120VAC, 50/60Hz When the servo amplifier is connected near a large-capacity power transformer (500kVA or more in the transfomer wiring distance of not more than 10m), an excessive peak current may flow in the power input circuit, failing the amplifier. In such a case, install the power factor improving reactor.
Regenerative brake option	P, C	Regenerative brake option connection terminals. Connect the regenerative brake option.
Servo motor power	U, V, W	Servo motor power terminals. Connect to the servo motor power supply terminals (U, V, W).
Ground	⏚	Ground terminals. Connect one to the servo motor and the other one to the ground. For the EN Standard- and UL/C-UL Standard-compliant models, do not use this terminal.
Protective earth (PE) terminals	⊕	Ground terminals For the EN Standard-, UL/C-UL Standard-compliant models, use the protective earth (PE) terminals for grounding. Connect one of the two terminals to the servo motor and the other to the protective earth of the control box.

(3) Connection method

1) Strip the insulation from the wire.



2) Insert the wire into the opening and tighten the corresponding screw with a flat-blade screwdriver so that the cable is not disconnected.
(Tightening torque: 0.49 to 0.785 N•m (4.337 to 6.948 lb-in))
Before inserting the cable into the opening, make sure that the screw of the corresponding terminal is fully loose.
When using a cable of 1.25mm^2 (16 AWG) or less, two cables can be inserted into one opening.



(4) Termination of the cables

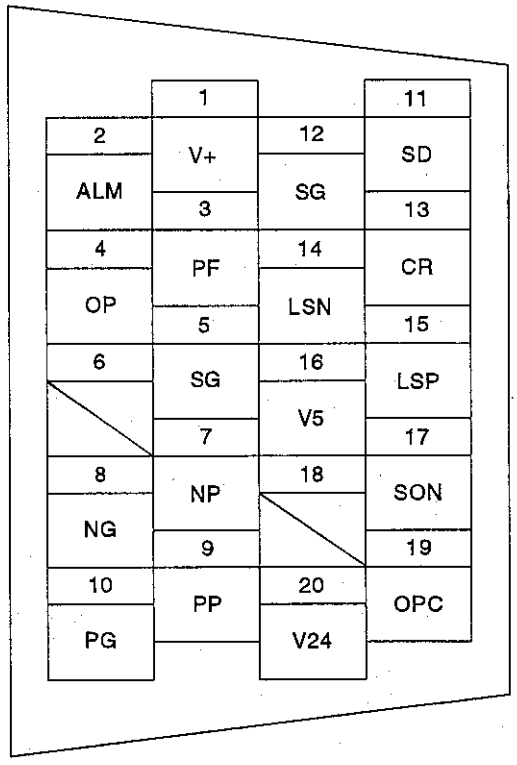
1) Solid wire ..... After the insulation has been stripped, the cable can be used as it is. (Wire size: 0.2 to 4.0mm^2 (24-11 AWG))

2) Twisted wire ... Use the cable after stripping the insulation and twisting the wire. At this time, note the short-circuit with the adjoining terminal by loose wires. Do not solder the core as it may cause a contact fault. (Wire size: 0.25 to 2.5mm^2 (23 to 13 AWG))

3 – 1 – 2 Signal connectors

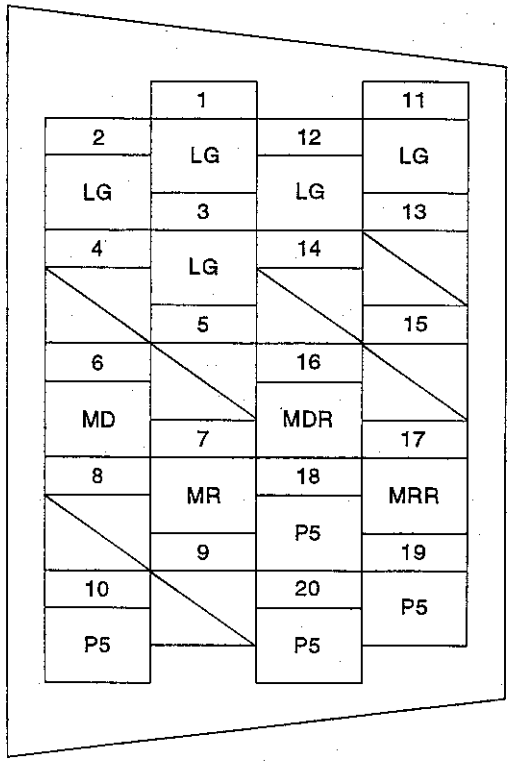
(1) Connector pin layout (View from the cable side)

1) CN1 (I/O signal connector)



Molex make
52986-2011 or equivalent

2) CN2 (Encoder connector)



Molex make
52986-2011 or equivalent

MEMO-RANDUM	The connector pin layouts are views looked from the cable connector wiring section.

(2) Explanation of the connector pins

The pin number in the Connector Pin No. field indicates the initial status.

1) CN1

Signal	Symbol	Connector Pin No.	Functions/Applications	I/O Division (Note)
Servo on	SON	17	Servo start signal terminal. Connect SON-SG to switch on the base circuit (servo on). Disconnect SON-SG to shut off the base circuit (servo off) and coast the servo motor. Set □□1 in parameter No. 6 to change the setting as follows: Disconnect SON-SG to switch servo on and connect SON-SG to switch servo off.	DI-1
Forward rotation stroke end	LSP	15	Forward rotation stroke end signal input terminal. This terminal cannot be used in the factory setting. To use this terminal, set □0□ in parameter No. 6. In this case, when LSP-SG are disconnected, the servo motor cannot be run in the CCW direction. The servo motor can be run in the CW direction. When LSP-SG are disconnected, an alarm does not occur but the home position is lost and zeroing is required again.	DI-1
Reverse rotation stroke end	LSN	14	Reverse rotation stroke end signal input terminal. This terminal cannot be used in the factory setting. To use this terminal, set □0□ in parameter No. 6. In this case, when LSN-SG are disconnected, the servo motor cannot be run in the CW direction. The servo motor can be run in the CCW direction. When LSN-SG are disconnected, an alarm does not occur but the home position is lost and zeroing is required again.	DI-1
Clear	CR	13	Clear signal input terminal. Connect CR-SG to clear the position control counter on the leading edge of the signal. Using parameter No. 6, the setting can be changed to always clear the position counter during connection of CR-SG. The pulse width should be 10ms or more.	DI-1
Trouble	ALM	2	Trouble signal output terminal. ALM-SG are disconnected when power is switched off or the protective circuit is activated to shut off the base circuit. Normally, ALM-SG are connected within 1.5s after power on. Connect the regenerative brake option or the like with a temperature detector to make up a protective circuit.	DO-1
Positioning finished	PF	3	Positioning finished signal output terminal. PF-SG are connected when the number of droop pulses is in the preset in-position range. The in-position range can be changed with parameter No. 5.	DO-1
Encoder Z-phase pulse	OP	4	Outputs the zero-point signal of a encoder. One pulse is output per servo motor revolution. The minimum pulse width is about 800μs. For zeroing using this pulse, set the creep speed to 100r/min or less.	DO-1
Forward rotation pulse train Reverse rotation pulse train	PP PG NP NG	9 10 7 8	Command pulse train input terminals. Input command pulse trains. In the open collector system: Forward pulse train across PP-SG Reverse pulse train across NP-SG In the differential receiver system: Forward pulse train across PG-NG Reverse pulse train across NP-NG	DI-2

Signal	Symbol	Connector Pin No.	Functions/Applications	I/O Division (Note)
Open collector power input	OPC	19	When inputting a pulse train in the open collector system, supply this terminal with (+) 24VDC.	
Interface power input	V24 V5	20 16	Interface power input terminals. 24VDC or 5VDC can be used as an external power supply for interface in the digital input section. Connect the positive (+) terminal of the external supply to V24 when using 24VDC or to V5 when using 5VDC. Supply either of 24VDC and 5VDC to the power supply. Do not supply both at the same time. 24VDC, 24VDC ±10%, 200mA or more 5VDC, 5VDC ±5%, 100mA or more **NOTICE** If power is supplied to both terminals V5 and V24, the servo amplifier will be faulty.	
Digital output power input	V+	1	Digital output power input terminal. Supply power for driving the digital output section.	
Power supply common	SG	5 12	Common terminals. Common terminals for OPC, V24, V5 and V+. Connect the negative (-) terminal of the external power supply.	
Shield	SD	11	Shield terminal. Connect one end of the shield cable.	

Note: Refer to Section 3 – 1 – 4.

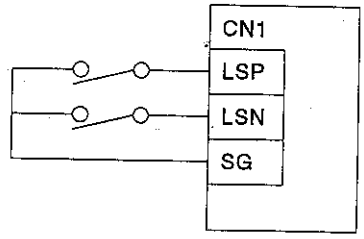
2) CN2, CN3

Connector	Function/Application
CN2	Connect with the servo motor encoder. CN1 and CN2 have the same shape. Wrong connection to the connectors may cause a failure.
CN3	Connect the RS-232C option unit (MR-C-T01).

3 – 1 – 3 Control I/O signals

(1) Forward, reverse rotation stroke ends (LSP, LSN)

To use these signals, set □0□ in parameter No. 6. To perform operation, connect LSP-SG or LSN-SG using a limit switch or the like. When the stroke end terminal (LSP during CCW rotation or LSN during CW rotation) is disconnected during operation, the servo motor is brought to a sudden stop and then servo-locked. At this time, the deviation counter is cleared.

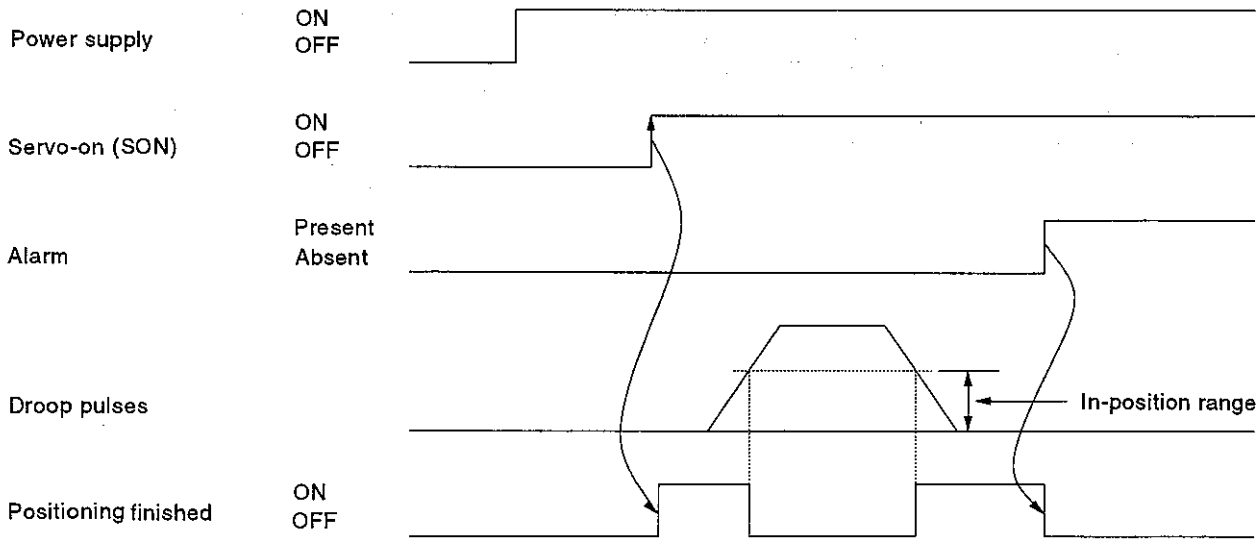


(2) Clear (CR)

When CR-SG are connected, the deviation counter is cleared on the leading edge of its signal. By setting 1□□ in parameter No. 6, the deviation counter is kept cleared during connection of this terminal. Disconnect this terminal when operation is to be performed.

(3) Positioning finished (PF)

This signal is switched on when the droop pulse value of the deviation counter is within the preset in-position range (parameter No. 5). If a large value has been set in the in-position range (parameter No. 5), the PF signal may remain on during low-speed operation where the droop pulse value is small.



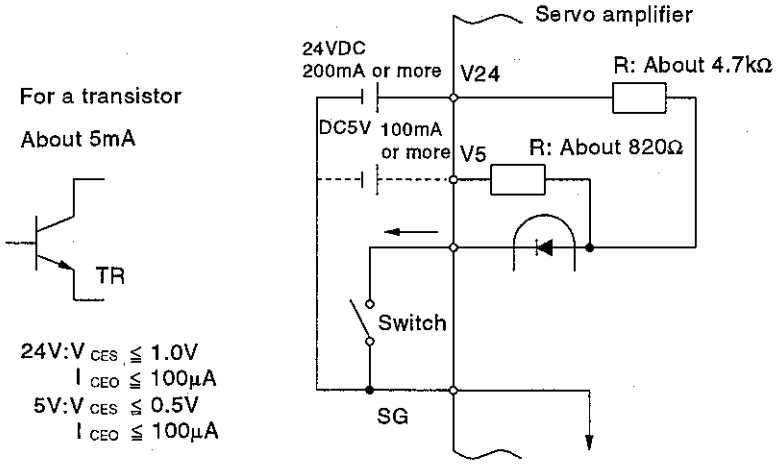
3 – 1 – 4 Interfaces

The details of the interfaces (refer to I/O Section in the table) to the signals indicated in Section 3 – 1 – 2 (2) are given below. Refer to the following to connect to external equipment.

(1) Digital input interface DI-1

Supply a signal with a relay or open collector transistor.

Supply either of 24VDC and 5VDC to the power supply. Do not supply both at the same time.

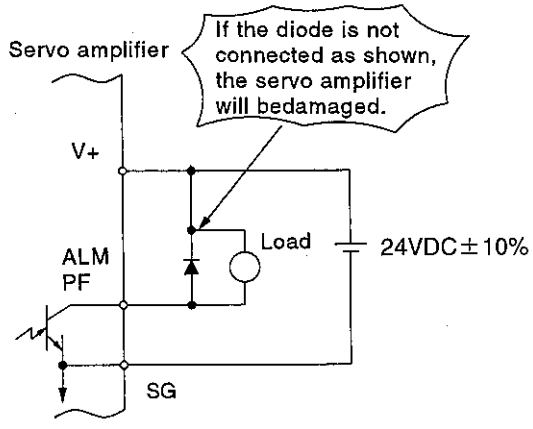


NOTICE	If power is supplied to both terminals V5 or V24, the servo amplifier will be faulty.

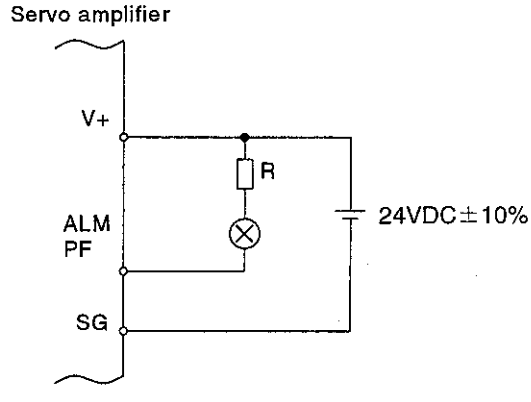
(2) Digital output interface DO-1

A lamp, relay or photocoupler can be driven. Provide a diode (D) for an inductive load, or an in-rush current suppressing resistor (R) for a lamp load. (Permissible current: 40mA or less, inrush current: 100mA or less)

(a) Inductive load



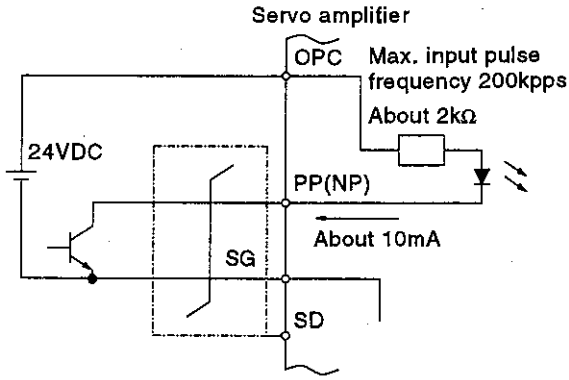
(b) Lamp load



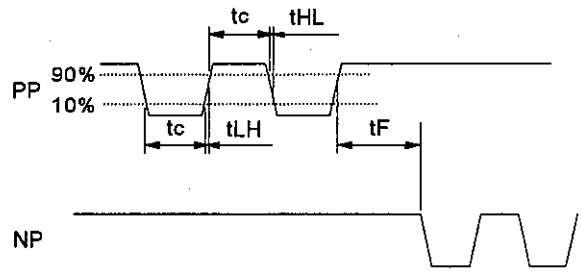
(3) Pulse train input interface DI-2

1) Open collector system

- Interface example



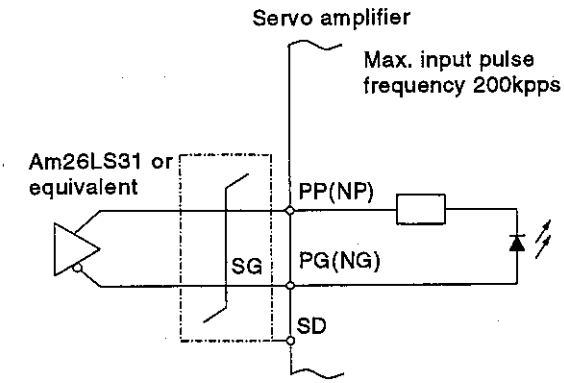
- Input pulse specification



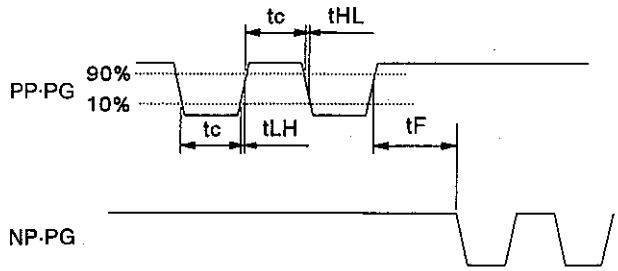
tLH=tHL < 0.2μs
tc > 2μs
tF > 3μs

2) Differential line driver system

- Interface example



- Input pulse specification



tLH=tHL < 0.2μs
tc > 2μs
tF > 3μs

3 – 2 Servo Motor

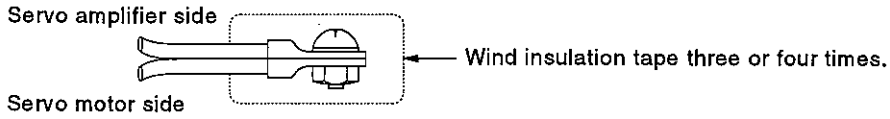
3 – 2 – 1 Connection instructions

⚠ **WARNING**	Insulate the power connection terminals to prevent an electric shock.

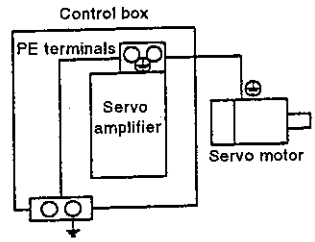
⚠ **CAUTION**	1. Connect the output terminals (U, V, W) correctly. Otherwise, the servo motor will not operate correctly. 2. Do not connect AC power supply directly to the servo motor. Otherwise, a fault may occur.

NOTICE	Do not run the power cable and encoder cable in parallel. Such wiring may cause a fault.

1) Wind insulation tape around the connection three or four times to ensure insulation. For the EN Standard-compliant models, make connection via a fixed terminal block.



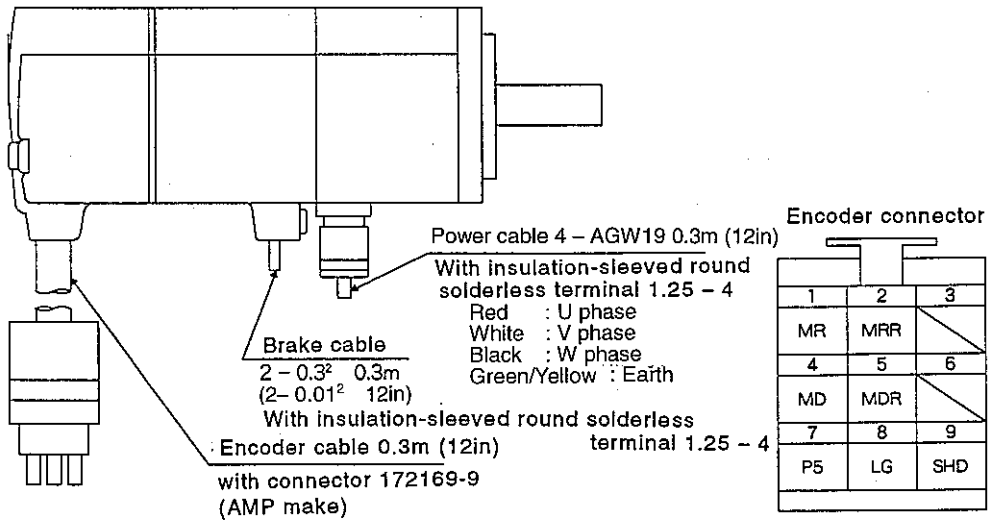
2) For grounding, make connection via the protective earth (PE) terminals of the servo amplifier, and connect the protective earth of the control box to the ground. Do not connect it directly to the protective earth of the control box.



3) Supply exclusive 24VDC power to the brake leads of the servo motor equipped with electromagnetic brake.

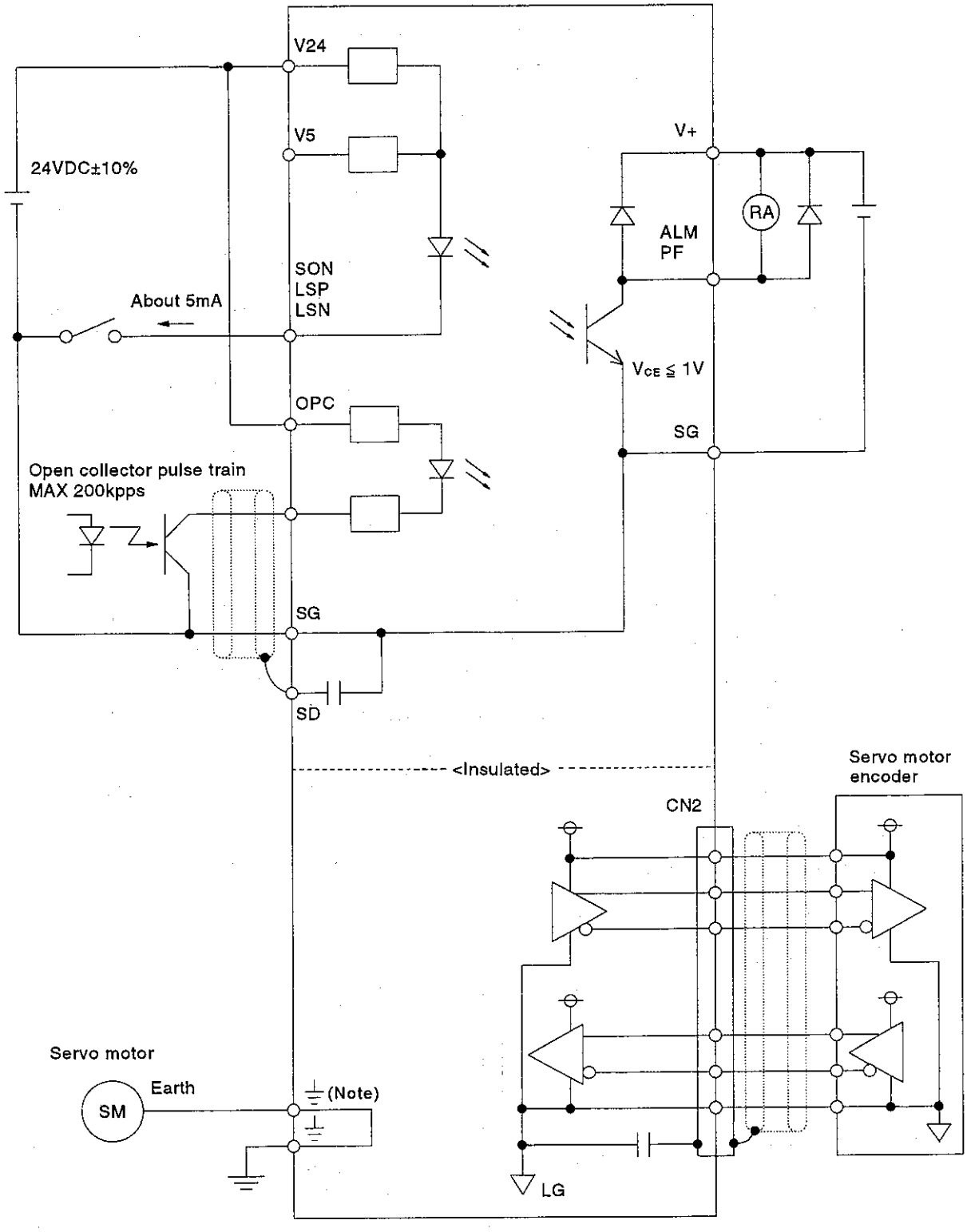
4) Do not share the 24VDC interface power supply between the interface and electromagnetic brake. Always use the power supply designed exclusively for the electromagnetic brake.

3 – 2 – 2 I/O terminals



3 – 3 Common Line

The power supply and its common line are shown below.



Note: When using the EN Standard-, UL/C-UL Standard-compliant model, use the protective earth (PE) terminals.

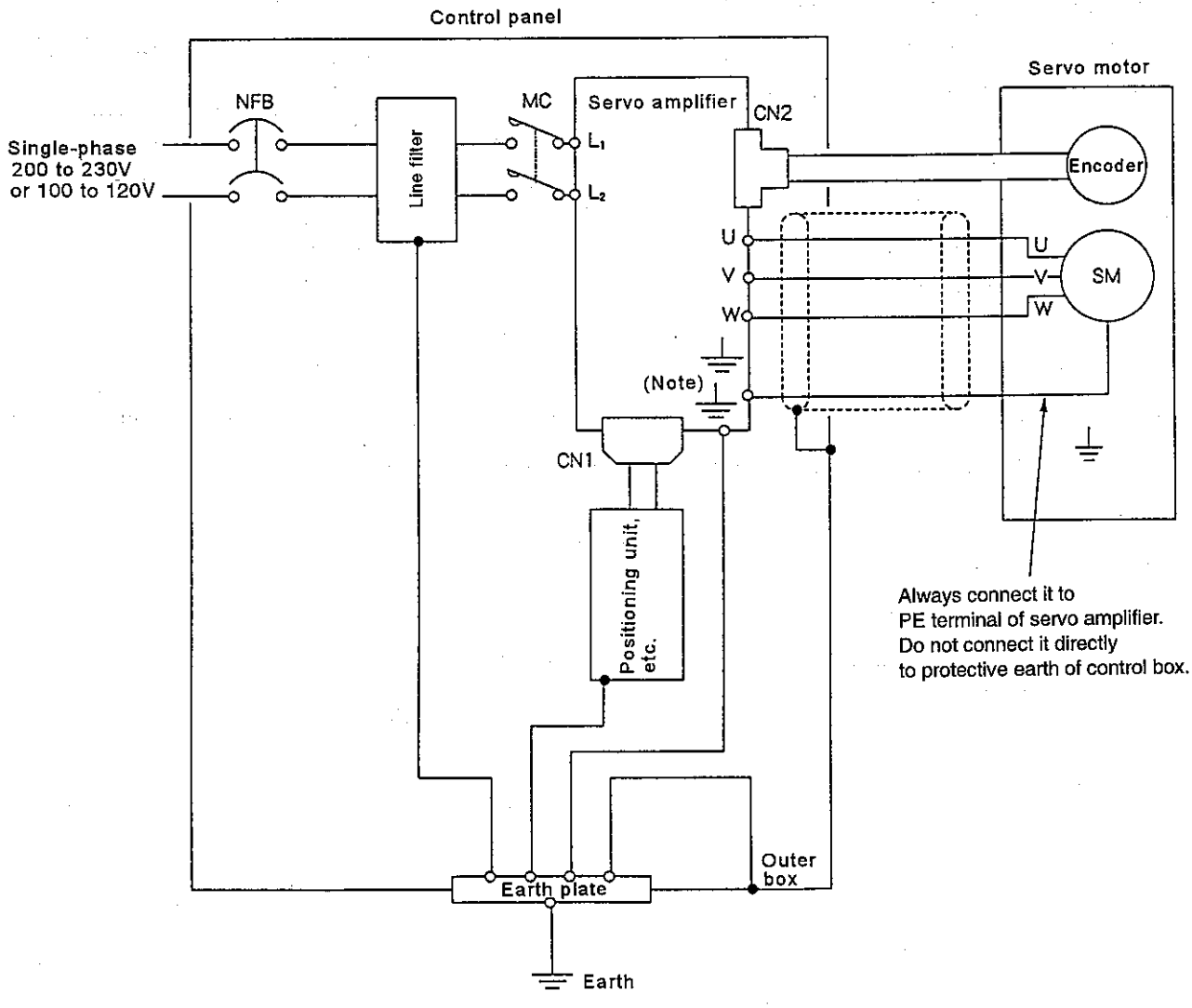
3 – 4 Grounding

⚠ WARNING	1. Connect the servo amplifier and servo motor to ground. 2. For the EN Standard-compliant model, always connect the protective earth (PE) terminal (marked ⏚) of the servo amplifier to the protective earth (PE) of the control box to prevent an electric shock.

The servo amplifier switches the power transistor on-off to supply power to the servo motor. Depending on the wiring and ground cable routing, the servo amplifier may be affected by the switching noise (due to di/dt and dv/dt) of the transistor. To prevent a fault, always follow the grounding and wiring instructions.

Refer to the following diagram and always ground.

To conform to the EMC Directive, refer to the EMC INSTALLATION GUIDELINES (IB(NA)67310).



Note: When using the EN Standard-, UL/C-UL Standard-compliant model, use the protective earth (PE) terminals.

3 – 5 Power Supply Circuit

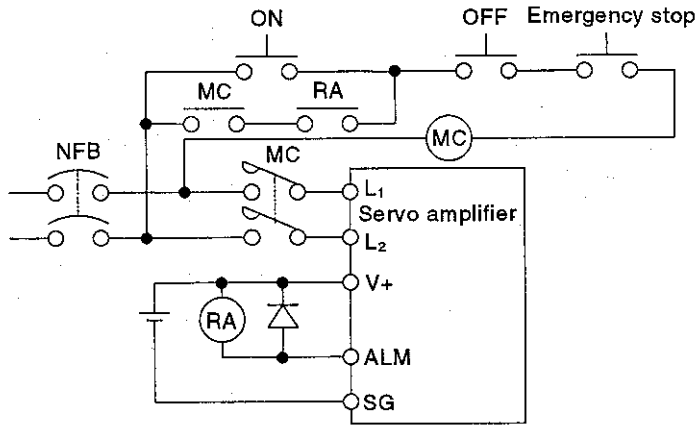
⚠ CAUTION

1. If you suspect faulty operation, immediately switch the power off. Continuous flow of a large current may cause a fire.
2. When a regenerative brake resistor is used, use an alarm signal to switch power off. Otherwise, a regenerative brake transistor fault may overheat the regenerative brake resistor and cause a fire.
3. If a 200V power supply is used with the servo amplifier designed for 100V power supply (MR-C☐A1), the internal capacitor will explode, causing injury.

(1) Connection example

Wire the power and main circuits as shown below. A no-fuse breaker (NFB) must be used with the input cables of the power supply.

Wire the circuits so that detection of alarm occurrence switches on power and simultaneously turns off the servo on signal.

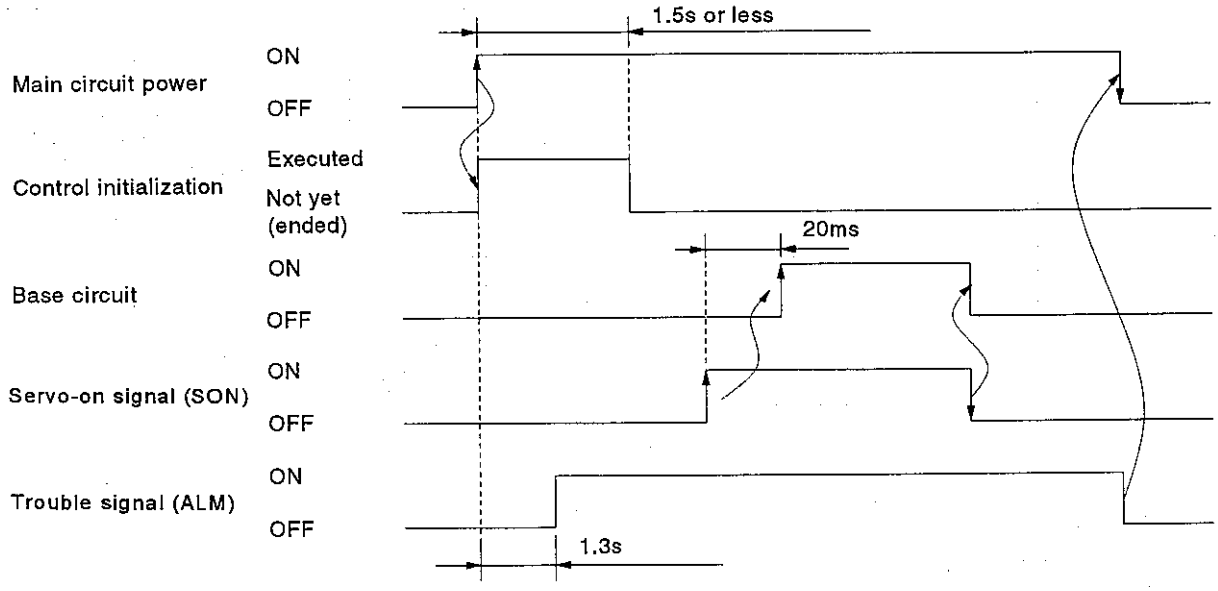


Single-phase AC power supply

MR-C☐A	200 to 230V, 50/60Hz
MR-C☐A1	100 to 120V, 50/60Hz

(2) Timing chart

When power is applied to L_1 and L_2, the control circuit is switched on. The servo-on signal (SON) is switched on after about 1.5s, then operation can be performed.

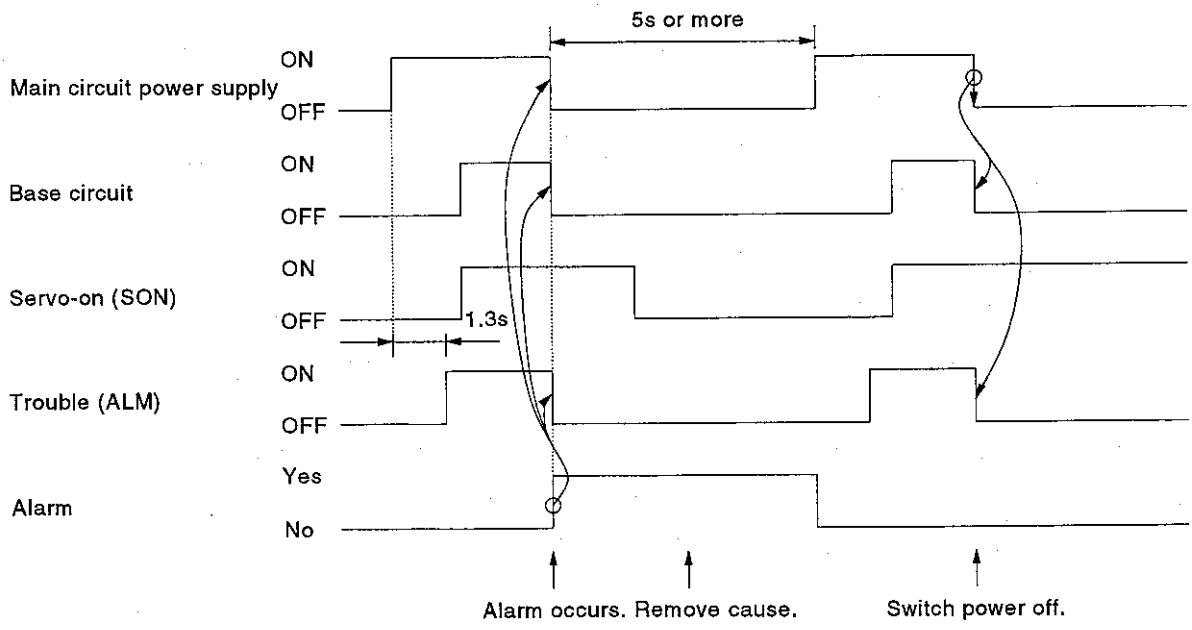


MEMO-RANDUM Switching power on within 5s after power-off will cause the undervoltage alarm (A10).

3 – 6 Timing Chart at Alarm Occurrence

⚠ 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.

When an alarm occurs in the servo amplifier, the base circuit is shut off and the servo motor is coated to a stop. Switch power off in the external sequence. To reset the alarm, remove the cause of the alarm and switch power on.

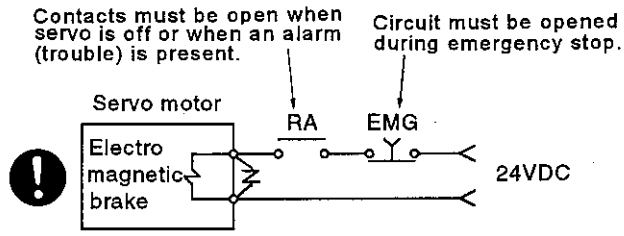


1) If operation is repeated by switching power off, then on after the occurrence of the overcurrent (A32) or overload (A50) alarm, without the cause of the alarm removed, the servo amplifier and servo motor may become faulty due to temperature rise.
2) If operation is repeated by switching power off, then on after the occurrence of the regenerative (A30) alarm, the external regenerative brake resistor will generate heat, resulting in a hazardous accident.

3 – 7 Servo Motor with Electromagnetic Brake

⚠CAUTION

1. Configure the electromagnetic brake circuit so that it is activated not only by the servo amplifier signals but also by an external emergency stop signal.



2. The electromagnetic brake is designed for holding and should not be used for ordinary braking.

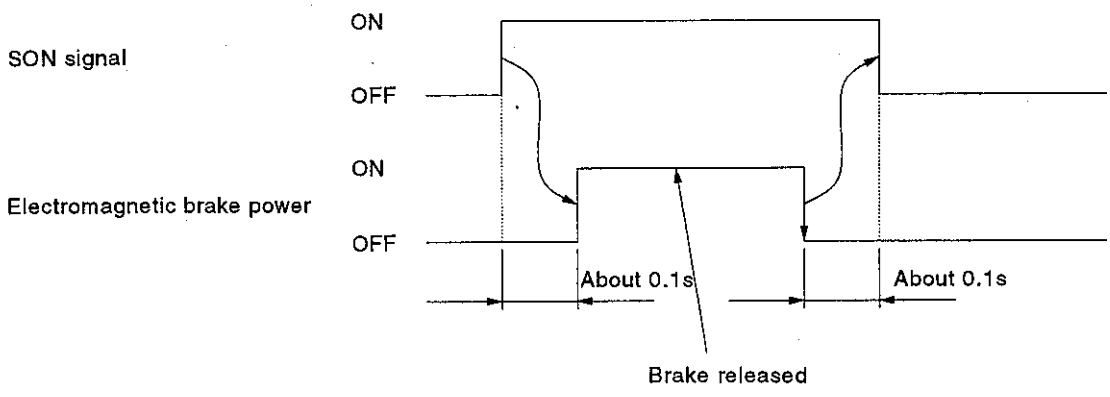
MEMO-RANDUM Refer to Section 9 – 3 for the specifications such as the power supply capacity of the electromagnetic brake.

For applications requiring a brake to hold the motor shaft (vertical lift applications), a servo motor with electromagnetic brake should be used. Please note the following:

1) Do not share the 24VDC power supply for interface between the interface and the electromagnetic brake. An exclusive power supply must be provided for the electromagnetic brake.
2) The brake will stop the motor when the power (24VDC) is off.
3) When operating the brake, always switch off the SON signal.
4) Turn off the servo on signal after the servo motor has stopped.
5) In all applications, take the braking delay time into consideration.

   Braking delay time AC shut-off: About 0.1s
   DC shut-off: About 0.03s

6) Configure a sequence which will satisfy the following timing chart:



Also, the electromagnetic brake interlock signal may be used by changing the setting of parameter No. 21. Refer to Section 5 – 2 – 2.

CHAPTER 4
INSTALLATION

This chapter deals with the installation and environmental conditions. Follow the instructions in this chapter when installing the equipment.

4. INSTALATION

⚠ CAUTION

1. Stacking in excess of the limited number of products is not allowed.
2. Do not install the equipment on or near combustibles. Installing them directly or close to combustibles will cause a fire.
3. Install the equipment in a load-bearing place in accordance with the instruction manuals.
4. Do not climb or stand on servo equipment. Do not put heavy objects on servo equipment.
5. Use the equipment within the specified environmental range.
6. Provide adequate protection to prevent screws and other conductive matter, oil and other combustible matter from entering the servo amplifier.
7. Do not block the air intake/exhaust areas of the servo amplifier. Otherwise, a fault may occur.
8. Do not drop or strike servo amplifier or servo motor. Isolate from all impact loads.
9. Do not install or operate a faulty servo amplifier or servo motor.
10. When the product has been stored for an extended period of time, consult Mitsubishi.

4 – 1 Servo Amplifier

⚠ CAUTION

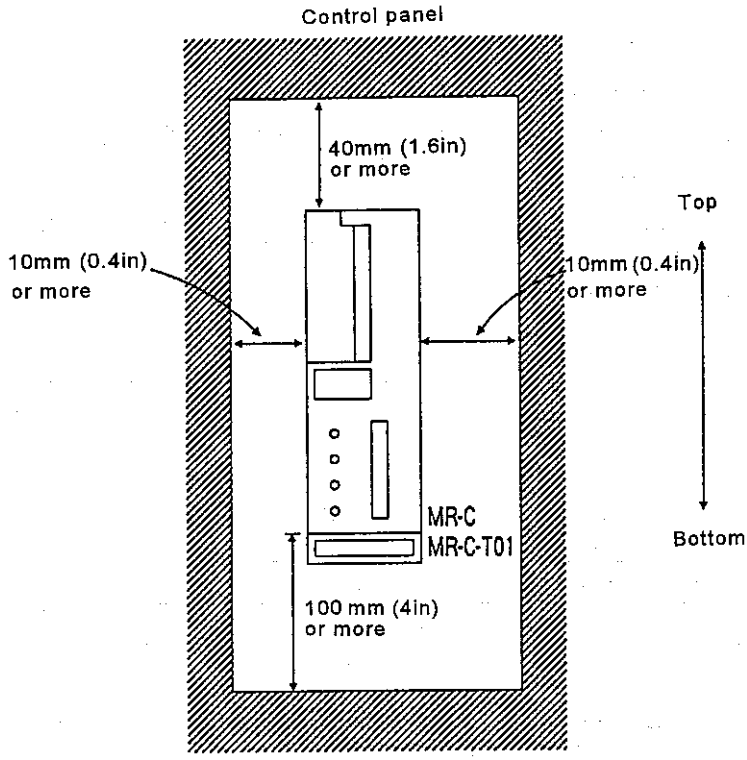
1. The equipment must be installed in the specified direction. Otherwise, a fault may occur.
2. Leave specified clearances between the servo amplifier and all other surface or equipment. Otherwise, a fault may occur.

(1) Environmental conditions

Environment	Conditions
Ambient temperature	0 to +50 [°C] (non-freezing)
	32 to 122 [°F] (non-freezing)
Ambient humidity	90%RH or less (non-condensing)
Storage temperature	–20 to +65 [°C] (non-freezing)
	–4 to 149 [°F] (non-freezing)
Storage humidity	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 above sea level
Vibration	5.9 [m/s^2] or less
	194 [ft/s^2] or less

(2) Installation direction and clearances

1) Installation of one servo amplifier



2) Installation of two or more servo amplifiers

Allow clearance between the top of the servo amplifier and the internal surface of the control panel, and install a fan to prevent the internal temperature of the control enclosure from exceeding the environmental conditions.

3) Others

When using heat generating equipment such as regenerative brake option, install them with full consideration of heat generation so that the servo amplifier is not affected.

Install the servo amplifier on a vertical surface so that it is located correctly.

(3) Keep out foreign materials

1) When installing the unit on a panel or inside an enclosure, prevent drill chips and wire fragments from entering the servo amplifier.

2) Prevent oil, water and metallic dust from entering the amplifier through openings in the enclosure.

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.

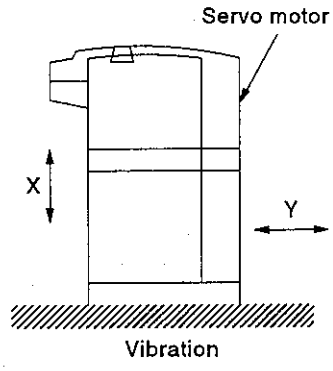
4 – 2 Servo Motor

⚠ CAUTION

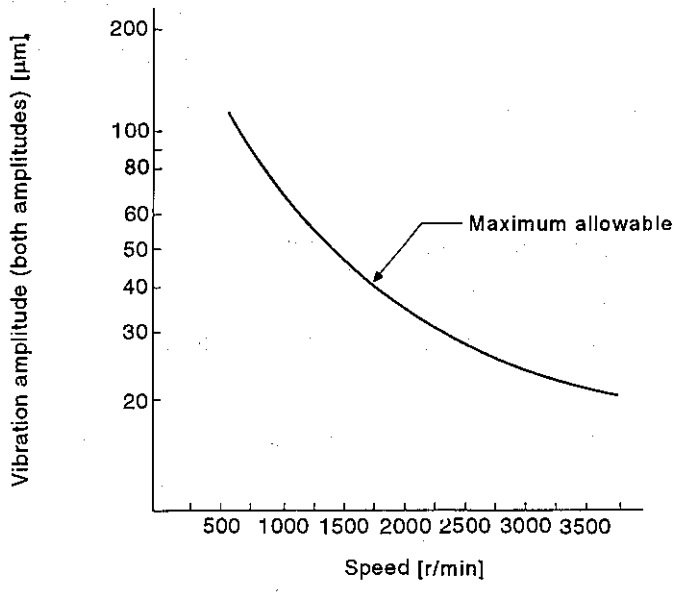
1. Do not handle the motor by the cables, shaft or encoder.
2. Securely mount the servo motor to the machine. If mount insecurely, the servo motor may come off during operation.
3. Never hit the servo motor or shaft, especially when coupling the servo motor to the machine. The encoder may become faulty.
4. For safety of personnel, always cover rotating and moving parts.
5. Do not load the servo motor shaft to more than the permissible load. Otherwise, the shaft may break.

(1) Environmental conditions

Environment	Conditions
Ambient temperature	0 to +40 [°C] (non-freezing)
	32 to 104 [°F] (non-freezing)
Ambient humidity	80%RH or less (non-condensing)
Storage temperature	−15 to +70 [°C] (non-freezing)
	5 to 158 [°F] (non-freezing)
Storage humidity	90%RH or less (non-condensing)
Ambience	Indoors (no direct sunlight) Free from corrosive gas, flammable gas, oil mist, dust and dirt.
Altitud	Max. 1000m (3280 ft) above sea level
Vibration	X, Y: 19.6 [m/s^2]
	X, Y: 64.3 [ft/s^2]



Graph of servo motor vibration amplitude vs speed

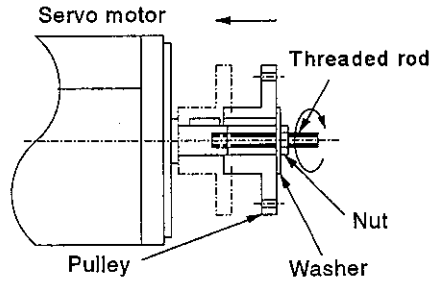


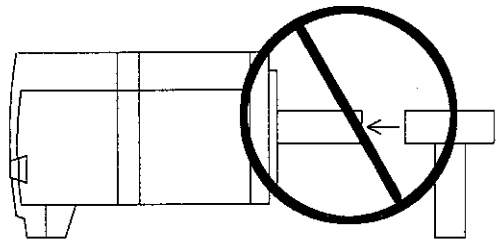
(2) Transportation

Do not carry the motor by the shaft or encoder or cables.

(3) Servo motor load-mounting precautions

1) When mounting a pulley to the shaft of the servo motor with a keyway, use the screw hole on the end of the shaft. To install the pulley, first insert a threaded rod into the screw hole of the shaft, put a washer against the end face of the coupling, and insert and tighten a nut to force on the pulley.
2) When mounting a pulley to the shaft of the servo motor with a keyway, use the screw hole on the end of the shaft. For a shaft without a keyway, use a friction coupling or the like.
3) When removing the pulley, use a pulley remover to protect the shaft from impact.
4) For safety of personnel, a profective cover must be installed overall rotating and moving components.
5) When a shaft end threaded part is needed to mount a pulley on the shaft, please contact us.
6) During assembling, do not strike the shaft.
7) The orientation of the encoder on the servo motor cannot be changed.
8) For installation of the servo motor, use spring washers and fully tighten the bolts so that they do not become loose.



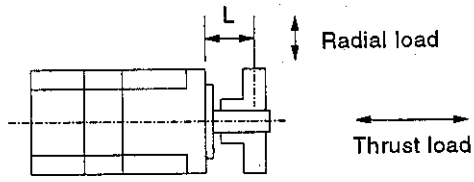


(4) Permissible load for the shaft

1) Use a flexible coupling and make sure that the misalignment of the shaft is less than the permissible radial load.
2) When using a pulley, sprocket or timing belt, select a diameter that will fit into the permissible radial load.
3) Do not use a rigid coupling as it will apply excessive bending load to the shaft, leading to shaft breakage.

Servo Motor	L		Permissible Radial Load		Permissible Thrust Load	
	[m]	[In]	[N]	[lb]	[N]	[lb]
HC-PQ033, 053, 13	25	1	88	19.8	59	13.2
HC-PQ23, 43	30	1.2	245	55	98	22

Note: For the symbols in the table, refer to the following diagram:

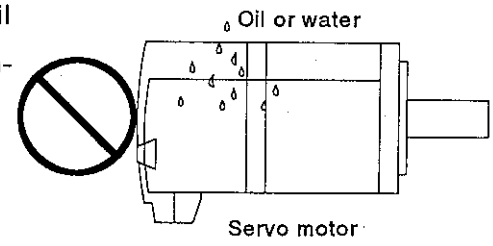


L: Distance from flange mounting surface to load center

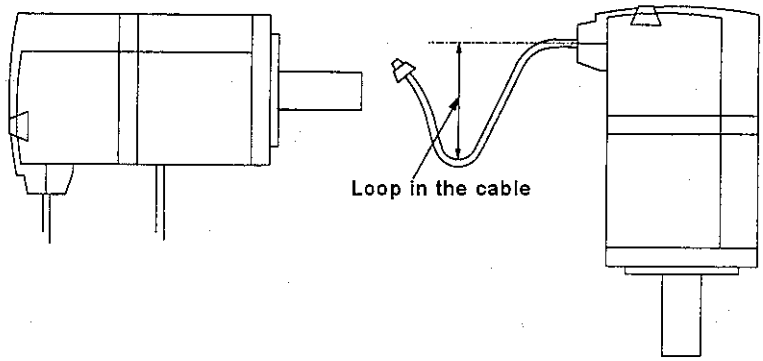
(5) Oil and water protection

1) The servo motor is not waterproof (IP44). Prevent oil and water from entering the servo motor.

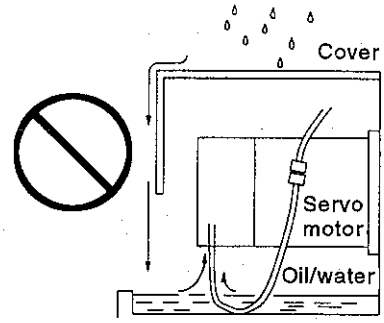
2) The HC-PQ series servo motor is not provided with an oil seal. Seal the gear box to prevent lubricating oil from entering the servo motor.



3) When installing the servo motor horizontally, direct the power cable and encoder cable downward. When installing the servo motor vertically or obliquely, provide a loop in the cable.

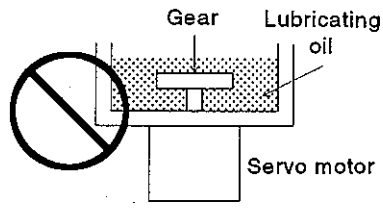


4) Do not allow cables to touch oil or water. (Figure on the right)



5) When the servo motor is to be installed with the shaft up prevent oil from entering the servo motor from the gear box, etc.

<Incorrect> Capillary action



(6) Installation orientation

The servo motor may be installed in any orientation. When the servo motor with electromagnetic brake is installed with the shaft up, the brake plate may generate sliding sound. The servo motor with reduction gear may also be installed in any orientation.

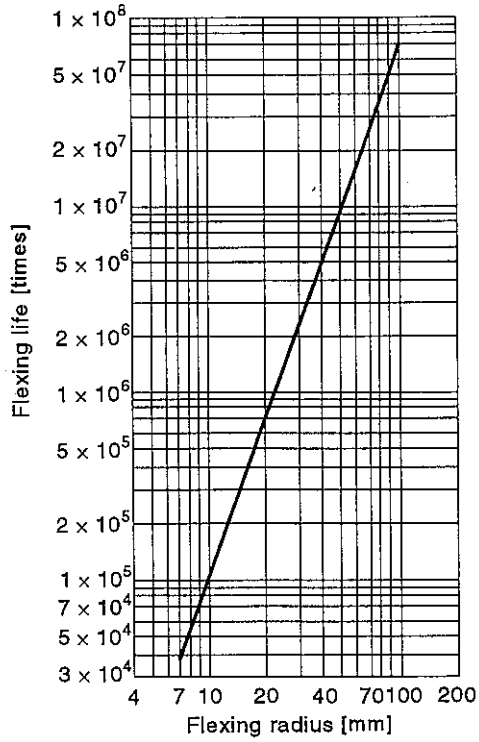
(7) Cable stress

1) The methed 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) In any application where the servo motor moves, the cables should be free from excessive stress. When the servo motor moves, e.g. the encoder cable and motor cables are contained in cable bearers, run the cables so that their flexing portions fall within the optional encoder cable range and fix the encoder cable and power cable of the servo motor.

3) Avoid any probability that the cable sheath might be cut by sharp objects, rubbed by a machine corner or walked on by workers or vehicles.

4) The flexing life of the MR-CCBL□M-H encoder cable is shown below. It is 5000 times at the flexing radius of 10mm. In actuality, provide a little allowance for these values. For installation on a machine where the servo motor will move, the flexing radius should be as large as possible.



Note: This graph gives calculated values.

Flexing Life of MR-CCBL□M-H Encoder Cable

CHAPTER 5
ADJUSTMENTS AND APPLICATION OPERATIONS

This chapter presents a servo gain adjustment procedure and expansion functions available by parameter setting.

INTRODUCTION	CHAPTER 1
OPERATION	CHAPTER 2
WIRING	CHAPTER 3
INSTALLATION	CHAPTER 4
ADJUSTMENTS AND APPLICATION OPERATIONS	CHAPTER 5
OPTIONS AND AUXILIARY EQUIPMENT	CHAPTER 6
MAINTENANCE AND INSPECTION	CHAPTER 7
TROUBLESHOOTING	CHAPTER 8
CHARACTERISTICS	CHAPTER 9
SPECIFICATIONS	CHAPTER 10
SELECTION	CHAPTER 11
OPTIONAL PRODUCTS	CHAPTER 12

5. ADJUSTMENTS AND APPLICATION OPERATIONS

5 – 1 Adjustments

5 – 1 – 1 Auto tuning

In general machines, gains are automatically adjusted by auto tuning. As auto tuning has been made valid by parameter setting before shipment, the optimum gains for the machine are automatically achieved by merely operating the servo motor. Therefore, special operation or setting is not needed. If you are not satisfied with machine motions at the time of operation, however, change and adjust the response setting (parameter No. 1) of auto tuning in the following procedure.

Actual Machine Motion	Ideal Machine Motion	Setting Method for Parameter No. 1
Stop setting time is long (Note 1)	Reduce stop setting time.	Increase the set value of response setting.
Overshoot is large at a stop.	Reduce overshoot.	Set the machine selection value to "1".
Overshoot is small at a stop but setting time is long. (Note 2)	Shorten the setting time.	Set the machine selection value to "2".
Overshoot is large at a stop and setting time is long, too. (Note 2)	Reduce overshoot and shorten the setting time.	Set the machine selection value to "3".
Gear noise is generated from the machine.	Reduce gear noise.	Decrease the set value of response setting.

Note 1: Stop setting time indicates a period of time from when the command pulse value is zeroed to when the servo motor comes to a stop.

2: Can be adjusted in software version A3 or later.

5 – 1 – 2 Manual gain setting

In most machines, gains can be adjusted automatically by performing auto tuning. In the following cases, however, the gains should be adjusted manually.

Manual Gain Adjustment Is Required When		Phenomenon	Adjustment Procedure
1)	The machine vibrates at a low-range resonance frequency.	The servo motor shaft vibrates at a high frequency (10Hz or more) a. When the machine generates noise and vibrates, you can not ignore the motion of the servo motor shaft. b. When the response setting is increased by auto tuning, vibration increases.	Adjustment 1 Adjustment 2
2)	On a machine whose ratio of load inertia to motor inertia is 20 or more times, the servo motor vibrates.	The servo motor shaft vibrates at a low frequency (5Hz or less). a. When vibration occurs, you can ignore the lateral vibration of the servo motor shaft. b. The ratio of load inertia to motor inertia is extremely large.	Adjustment 3
3)	The stop setting time made available by auto tuning should be further decreased.		Adjustment 4
4)	The position control gain of each axis should be set to the same for interpolation operation with two or more axes.		Adjustment 5

5. ADJUSTMENTS AND APPLICATION OPERATIONS

The following parameters are used for manual gain adjustment. Note that 00D should be set in parameter No. 12 (parameter write disable) to make application parameter write-enabled.

Parameter No.	Name
No. 1	Auto tuning
No. 23	Ratio of load inertia to motor inertia
No. 24	Machine resonance suppression filter
No. 25	Position control gain 1
No. 26	Position control gain 2
No. 27	Speed control gain 1
No. 28	Speed control gain 2
No. 29	Speed integral compensation

Adjustment 1

Step	Operation	Description
1	Set 001 in parameter No. 1.	Auto tuning is selected. Response setting is set to slow response.
2	Set 001 in parameter No. 24.	Machine resonance frequency: 1125Hz
3	Switch servo on and perform operation several times.	Auto tuning is performed. Check to see if vibration reduced.
4	Increase the setting of parameter No. 24 sequentially and execute step 3.	The optimum value is achieved just before vibration begins to increase.
5	To reduce the stop setting time, increase the response setting of parameter No. 1 sequentially and execute steps 2 to 4.	

Adjustment 2

Step	Operation	Description
1	Set 001 in parameter No. 1.	Auto tuning is selected. Response setting is set to slow response.
2	Set the machine's load inertia to motor inertia in parameter No. 23. (When it is unclear, set an approximate value.)	When this parameter value is set, the following parameter values are set automatically. Each value provides an ideal, hunting-less gain for parameter No. 23 if machine resonance does not occur. • Parameter No. 25 • Parameter No. 26 • Parameter No. 27 • Parameter No. 28 • Parameter No. 29
3	Set 2 □□ in parameter No. 1.	Auto tuning is made invalid to enable manual setting of parameters No. 25 to 28.
4	In parameter No. 28, set a value about 100 smaller than the value set automatically in step 3.	The optimum value is achieved just before vibration begins to increase.
5	Execute steps 2 to 4 of Adjustment 1.	
6	When machine response does not occur any more, confirm the operating status, and at the same time, gradually return the setting of parameter No. 28 reduced in step 4.	Set a value which is about 50 to 100 smaller than the set value at which gear noise and vibration begins to be generated by machine resonance.
7	To reduce the stop setting time, increase the response setting of parameter No. 1 sequentially and execute steps 1 to 6.	

Adjustment 3

Step	Operation	Description
1	Set 001 in parameter No. 1.	Auto tuning is selected. Response setting is set to slow response.
2	Set the machine's load inertia to motor inertia in parameter No. 23. (When it is unclear, set an approximate value.)	When this parameter value is set, the following parameter values are set automatically. Each value provides an ideal, hunting-less gain for parameter No. 23 if machine resonance does not occur. • Parameter No. 25 • Parameter No. 26 • Parameter No. 27 • Parameter No. 28 • Parameter No. 29
3	Switch servo on and perform operation several times.	Auto tuning is performed.
4	If vibration still persists, re-set the parameter No. 23 value and execute steps 2 and 3.	
5	If vibration occurs due to machine resonance, make adjustment in the procedure of Adjustment 1 or 2.	

Adjustment 4

Step	Operation	Description
1	Set 001 in parameter No. 1.	Auto tuning is selected. Response setting is set to slow response.
2	Switch servo on and perform operation several times.	Auto tuning is performed. Check to see if vibration reduced.
3	Make gain adjustment in either of the following methods 1) and 2).	Temporary adjustment
	1) Set the machine's load inertia to motor inertia in parameter No. 23. (When it is unclear, set an approximate value.)	When this parameter value is set, the following parameter values are set automatically. Each value provides an ideal, hunting-less gain for parameter No. 23 if machine resonance does not occur. • Parameter No. 25 • Parameter No. 26 • Parameter No. 27 • Parameter No. 28 • Parameter No. 29
	2) Switch servo on and perform operation several times.	Auto tuning is performed.
4	Set 2 □□ in parameter No. 1.	Auto tuning is made invalid to enable manual setting of parameters No. 25 to 28.
5	While confirming the operating status, adjust the following parameters:	The optimum value is achieved just before vibration begins to increase.
	• Parameter No. 25 • Parameter No. 26	Increase the setting to reduce the stop setting time. Note that overshoot is more likely to occur.
	• Parameter No. 27 • Parameter No. 28	Increase the setting to improve servo response. Note that vibration is more likely to occur.
	• Parameter No. 29	Decrease the setting to keep the speed constant to load disturbance and increase holding force at a stop (servo rigidity). Note that overshoot is more likely to occur.

5. ADJUSTMENTS AND APPLICATION OPERATIONS

Adjustment 5

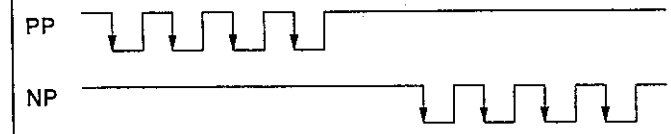
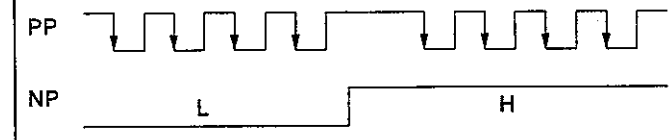
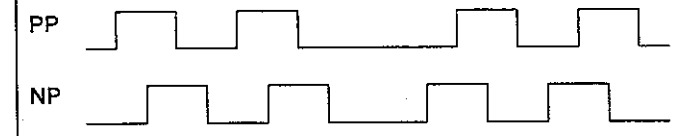
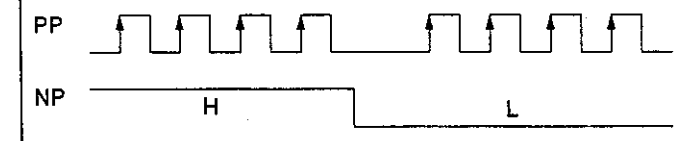
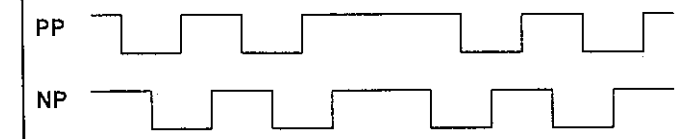
Step	Operation	Description
1	Make gain adjustment of all axes in procedures 1 to 4.	Adjust the gain of each axis.
2	Set 1□□ or 2 □□ in parameter No. 1.	1 □□ "interpolation control" : The values of parameters No. 25 and 27 change in subsequent operation. 2 □□ "no" : Auto tuning is made invalid to enable manual setting of parameters No. 25 to 29.
3	Set the following parameters for each axis to the minimum value of all interpolation-controlled axes: • Parameter No. 25 • Parameter No. 26	The gains for operation of all axes are set to the same value.

5 – 2 Application Operations

5 – 2 – 1 Changing the command pulse train input form

(1) Input pulse waveform selection

A position command pulse train can be input in any of three formats (forward/reverse pulse train, sign plus pulse train, A/B phase pulse train) and further positive or negative logic can be selected. On the basis of the following table, set parameter No. 7 according to the pulse train form of the command section.

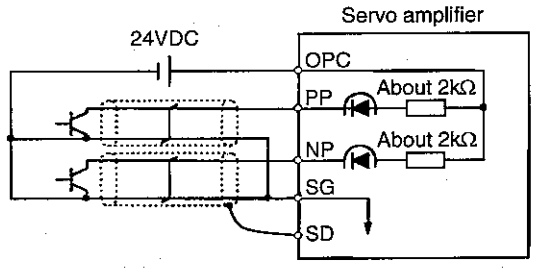
	Command Pulse Train Form	Forward Rotation	Reverse Rotation	Parameter No. 7 Setting
Negative logic	Forward rotation pulse train Reverse rotation pulse train			Factory setting 010
	Pulse train + sign			011
	A phase pulse train B phase pulse train			012
Positive logic	Forward rotation pulse train Reverse rotation pulse train			000
	Pulse train + sign			001
	A phase pulse train B phase pulse train			002

Note: ↑ ↓ indicate the timings at which the command pulses are imported.

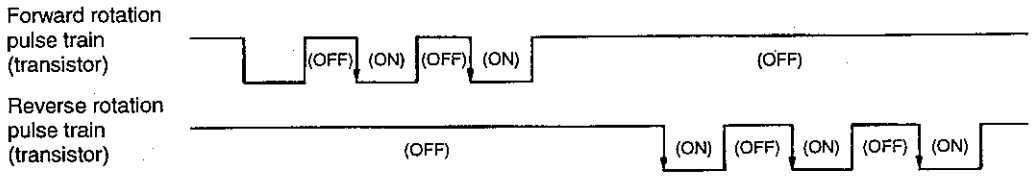
(2) Connections and waveforms

1) Open collector system

Connect as shown below:

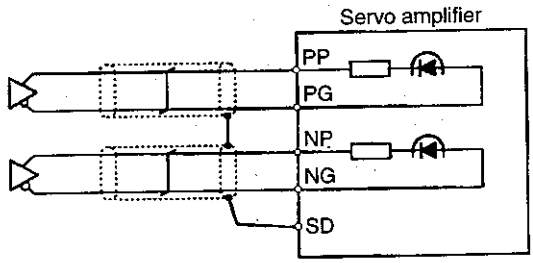


The explanation assumes that the input waveform has been set to the negative logic and forward and reverse rotation pulse trains (parameter No. 7 has been set to 010). The waveforms in the table in (1) of this section are voltage waveforms of PP and NP based on SG. Their relationships with transistor ON/OFF are as follows:



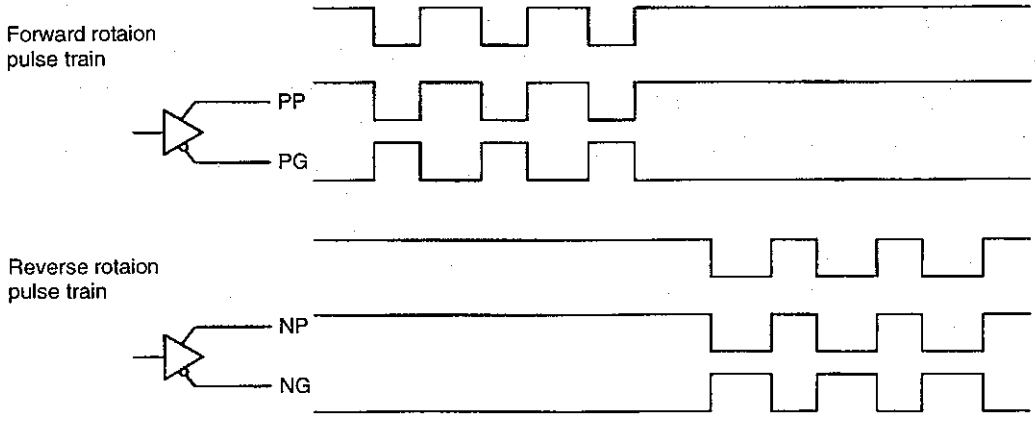
2) Differential line driver system

Connect as shown below:



The explanation assumes that the input waveform has been set to the negative logic and forward and reverse rotation pulse trains (parameter No. 7 has been set to 010). For the differential line driver, the waveforms in the table in (1) of this section are as follows.

The waveforms of PP, PG, NP and NG are waveforms based on the ground of the differential line driver.



5 – 2 – 2 Changing the I/O signals

The input signal functions of the CN1 connector's pins 13, 14 and 15 and the output signal functions of pins 3 and 4 can be changed as indicated below. Use parameters No. 20 and 21 to change the functions of the I/O pins.

(1) Functions selectabl

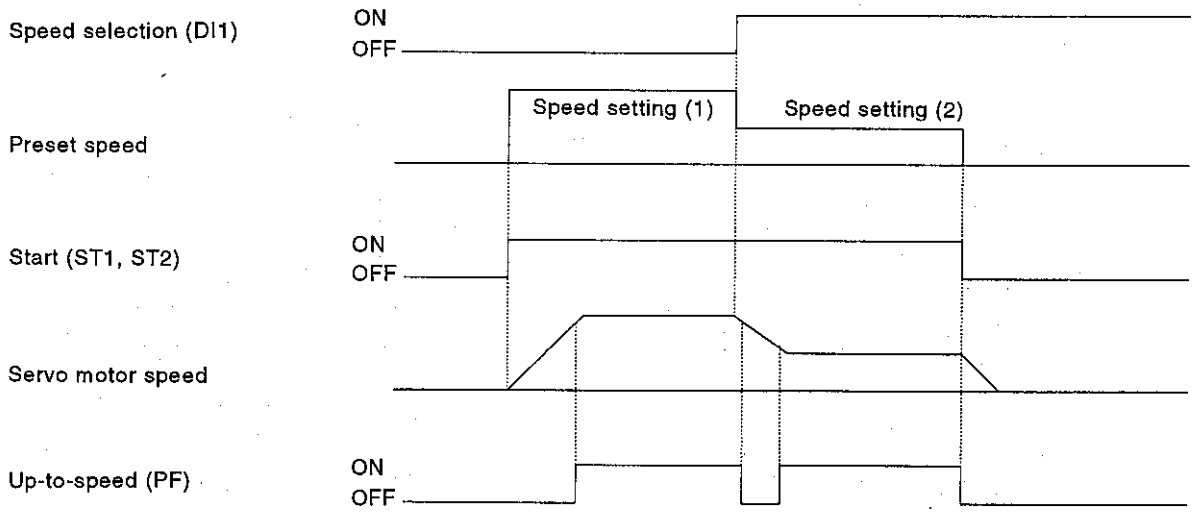
1) I/O signals

	Signal Name	Symbol	Connector Pin No.	Functions/Applications	I/O Division (Note 1)	Control Mode (Note 2)
Input signals	Forward rotation start Reverse rotation start	ST1 ST1	(13, 14, 15) (13, 14, 15)	Start signal input terminals. In the speed control mode, connect ST1-SG to rotate the servo motor in the CCW direction, or connect ST2-SG to rotate it in the CW direction. Disconnect both ST1 and ST2 from SG to bring the servo motor to a stop. The servo motor will not rotate if the servo is not on.	DI-1	S
	Speed selection	DI1	(13, 14, 15)	Speed selection signal input terminal. In the speed control mode, select the servo motor speed. DI1-SG: Disconnected → Servo Motor Speed: Speed command (1) (parameter No. 17) DI1-SG: Connected → Servo Motor Speed: Speed command (2) (parameter No. 17)	DI-11	S
	Torque limit	TL	(13, 14, 15)	Torque limit selection signal input terminal. Connect TL-SG to limit the torque according to the to rque limit value (parameter No. 9). TL-SG: Disconnected → Servo Motor Speed: Maximum torque TL-SG: Connected → Servo Motor Speed: Torque limited by parameter No. 9 setting When the function of TL is not selected, the output torque is limited to the value set in parameter No. 9.	DI-1	P, S
	Proportional control	PC	(13, 14, 15)	Proportional control selection signal input terminal. Connect PC-SG to switch from the proportional integral type to the proportional type. Connect PC-SG when it is desired to suppress slight vibration during servo lock, for	DI-1	P, S
	Reset	RES	(13, 14, 15)	Reset signal input terminal. Connect RES-SG for more than 50ms to reset the alarm. The following alarms cannot be reset: • Memory alarm 1 (A12) • Memory alarm 2 (A15) • Board alarm 1 (A17) • Encoder alarm 1 (A20) • Parameter alarm (A37) Also, the regenerative alarm (A30) and overload (A50) cannot be reset until the regenerative brake resistor and power transistor are cooled, respectively.	DI-1	P, S
Output signals (Note 3)	Up-to-speed	PF	(3, 4)	Up-to-speed signal output terminal. When the servo motor speed has nearly reached the preset speed, PF-SG are connected. They are kept connected when the preset speed is 50r/min or less. (Refer to 2) a. in this section.)	DO-1	S
	Encoder Z-phase pulse	OP	3 (4)	Described in (2), Section 3 – 1 – 2. The output pin can be changed to pin 4.	DO-1	P, S
	Ready	RD	(3, 4)	Ready signal output terminal. When the servo is switched on and the servo motor is ready to operate, RD-SG are connected. (Refer to 2) b. in this section.)	DO-1	P, S
	Zero speed detection	ZSP	(3, 4)	Zero speed detection signal output terminal. When the servo motor speed is about 50r/min. or less, ZSP-SG are connected.	DO-1	P, S
	Torque limit in progress	TLC	(3, 4)	Torque limit-in-progress signal output terminal. When the torque limit range is reached, TLC-SG are connected.	DO-1	P, S
	Electromagnetic brake interlock	BRK	(3, 4)	Electromagnetic brake interlock signal output terminal. When the servo is switched off or an alarm occurs, BRK-SG are disconnected. When an alarm occurs, BRK-SG are disconnected independently of the base circuit state. (Refer to 2) c. in this section.)	DO-1	P, S

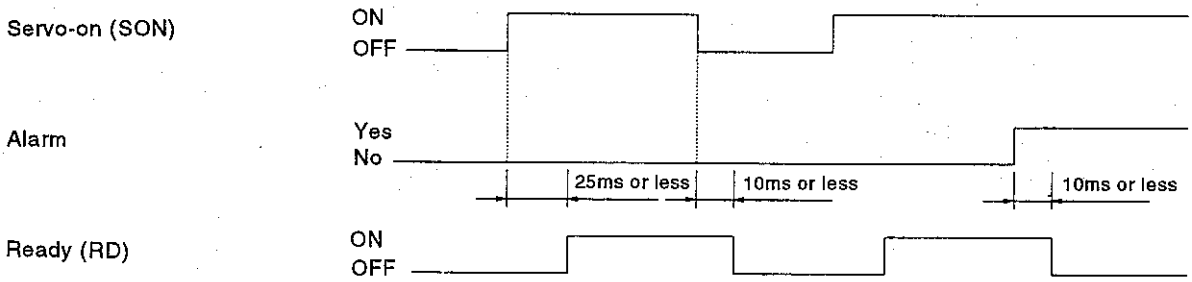
Note: 1. For the I/O interfaces, refer to Section 3 – 1 – 4.
2. P: Position control mode, S: Speed control mode
3. Available for the servo amplifier of software version A2 or later

2) Detailed description

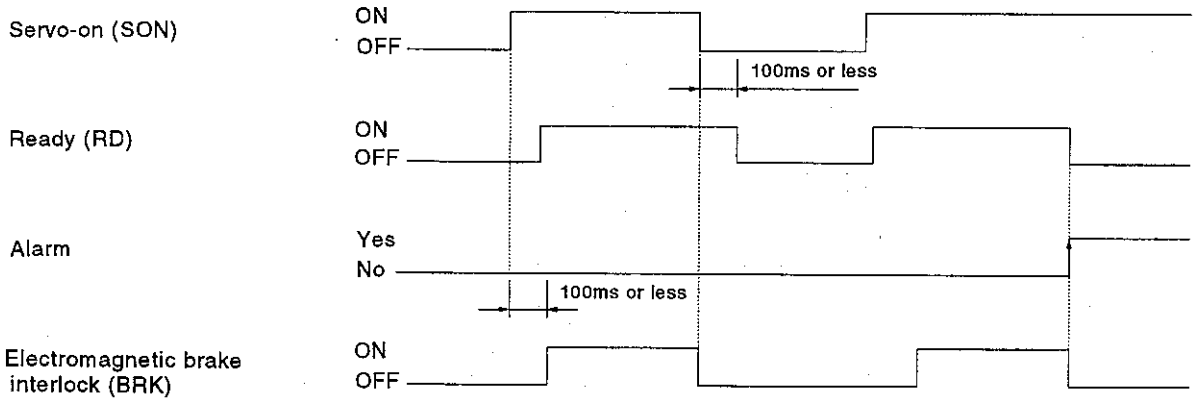
a. Up-to-speed

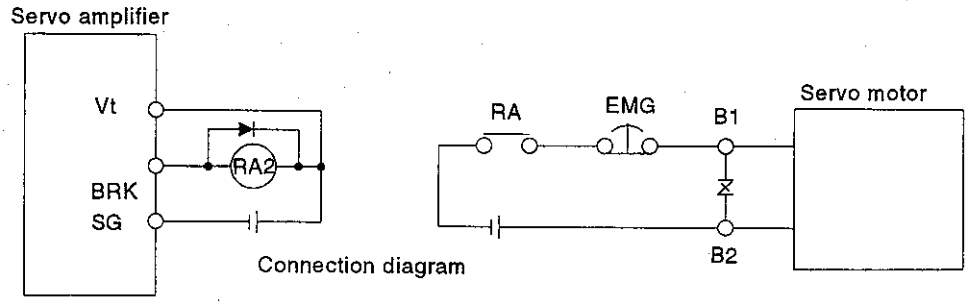


b. Ready



c. Electromagnetic brake interlock





Connection diagram

(2) To make the functions valid

Set the corresponding parameters. Three input signals (pins 13, 14, 15 of CN1) and two output signals (pins 3, 4 of CN1) can be selected as listed below. Use the parameters to select the required functions.

Parameter	Set Value	Abbreviation	Signal Name	CN1 Pin No.
No. 20	0	LSP	Forward rotation stroke end	13, 14, 15
	1	LSN	Reverse rotation stroke end	
	2	CR	Clear	
	3	ST1	Forward rotation start	
	4	ST2	Reverse rotation start	
	5	DI1	Speed selection	
	6	PC	Proportional control	
	7	TL	Torque limit	
	8	RES	Reset	

Parameter	Set Value	Abbreviation	Signal Name	CN1 Pin No.
(Note) No. 21	0	OP	Encoder Z-phase pulse	3, 4
	1	PF	Up-to-speed	
	2	RD	Ready	
	3	ZSP	Zero speed detection	
	4	TLC	Torque limit in progress	
	5	BRK	Electromagnetic brake interlock	

Note: Available for the servo amplifier of software version A2 or later.

The digits of parameters No. 20 and 21 correspond to the pins of CN1 as shown on the right. Allocate the functions in the above table for the respective pins.

Parameter No. 20
(Input signal function selection)

Pin 13	Pin 14	Pin 15

Parameter No. 21
(Output signal function selection)

—	Pin 3	Pin 4

MEMO-RANDUM When LSP and LSN are not selected, set ☐1☐ in parameter No. 6 to automatically switch these signals on internally. Operation cannot be performed.

Setting example

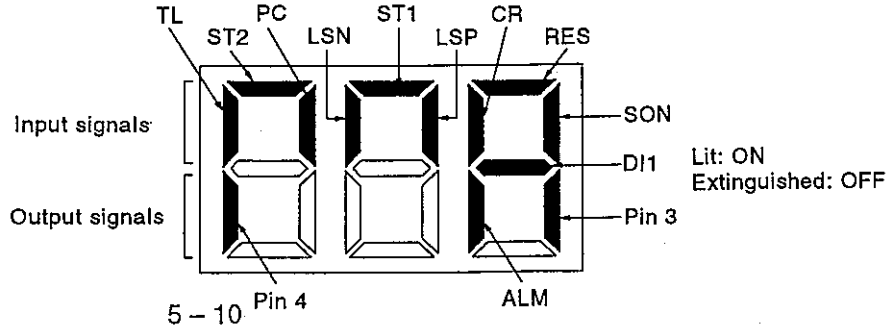
To select the I/O signals in the following table:

Pin No.	Abbreviation	Parameter Setting
13 14 15	TL RES CR	Parameter No. 20 7 8 2
3 4	TLC BRK	Parameter No. 21 0 4 5

After setting the parameters, switch power off once, then on again.

(3) External I/O signal display and output signal forced-output

When the functions of the I/O signals are changed, they correspond to the segments on the display screen as shown below:



5 – 2 – 3 Speed control mode

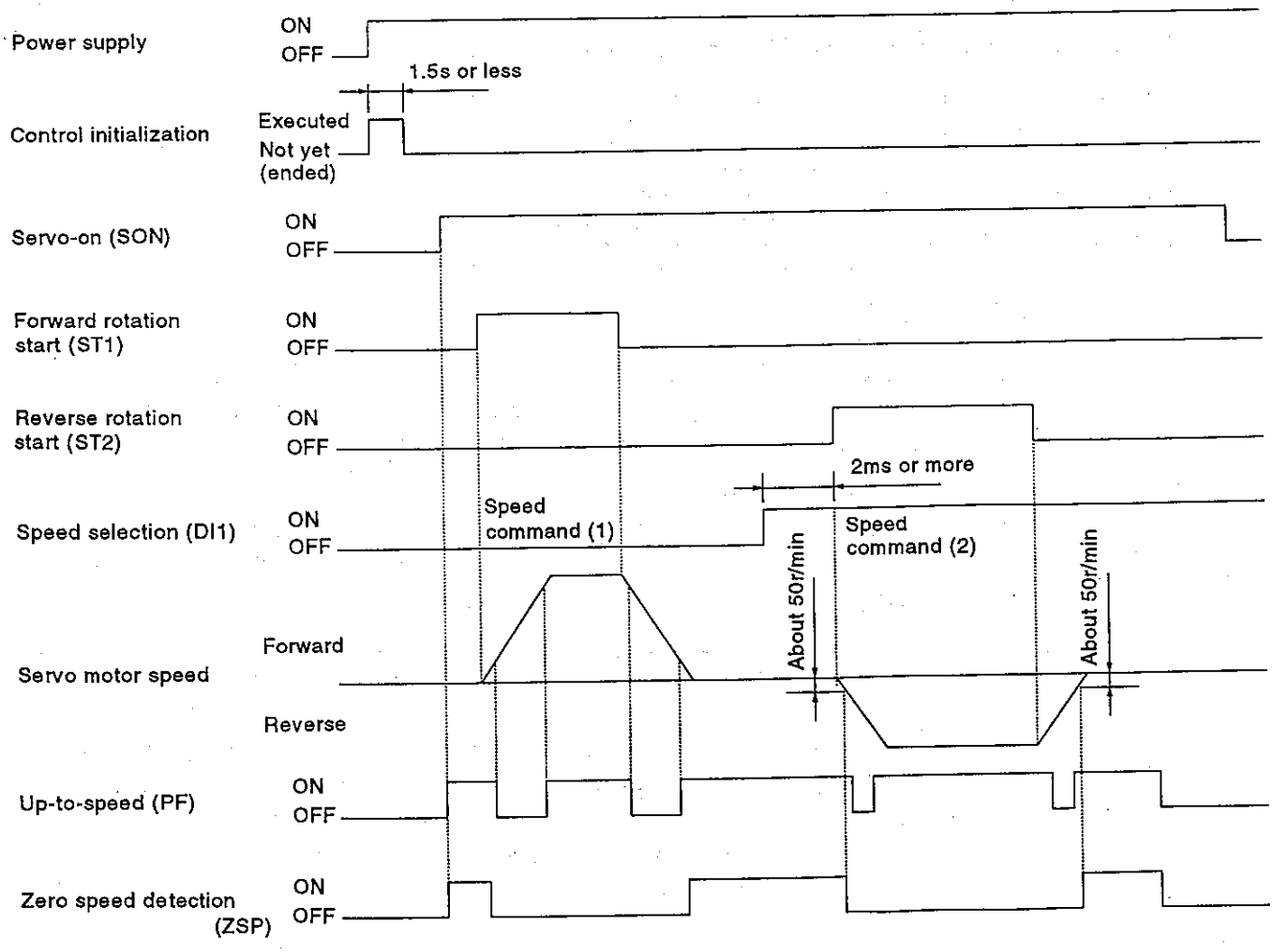
The servo motor can be rotated at constant speed without the pulse train signal being input. To enter the speed control mode, change the settings of the following parameters. Note that 00C should be set in parameter No. 12 (parameter write disable) to make application parameter write-enabled.

Parameter	Name	Set Value	Description
No. 6	Input signal selection 1	□1□	LSP and LSN are automatically switched on internally.
No. 16	Position/speed control mode selection	101	Select the speed control mode.
No. 17	Speed command (1)		Set the servo motor speed.
No. 18	Speed command (2)		
No. 19	Speed acceleration/deceleration time constant		Set the acceleration/deceleration time constant
No. 20	Input signal function selection	345	Make ST1, ST2 and DI1 valid.
(Note) No. 21	Output signal function selection	013	Make PF and ZSP valid.

Note: Available for the servo amplifier of software version A2 or later.

MEMO-RANDUM To use the equipment in the speed control mode, set the torque limit value (parameter No. 9) to 75 or less or the acceleration/deceleration time constant (parameter No. 19) to 50ms or more so that the output torque of the servo motor is not clamped at the maximum torque.

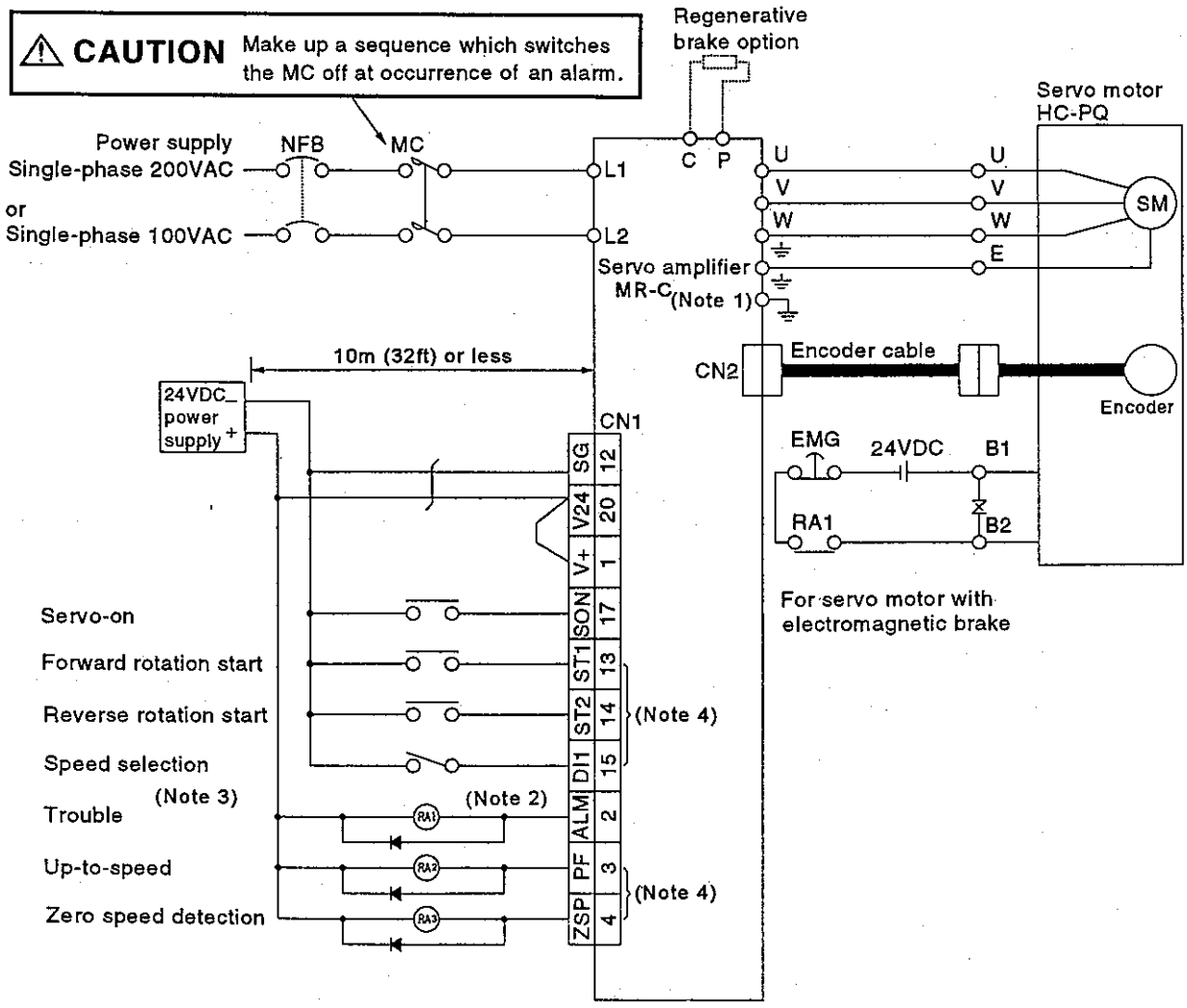
Timing chart



Connection example

⚠ CAUTION Always follow the instructions in Chapter 3.

⚠ CAUTION Make up a sequence which switches the MC off at occurrence of an alarm.



⚠ WARNING

Note 1. For the EN Standard model, always connect the protective earth (PE) terminal (marked ⏚) of the servo amplifier to the protective earth (PE) of the control box to prevent an electric shock.

⚠ CAUTION

Note 2. Connect the diode in the correct direction. If it is connected reversely, the servo amplifier will be faulty and will not output signals, disabling the emergency stop and other protective circuits.

MEMORANDUM

Note 3. The trouble (ALM) signal is in conduction when there is no alarm, i.e. in the normal state.
When this signal is switched off (at occurrence of an alarm), the output of the controller should be stopped by the sequence program.

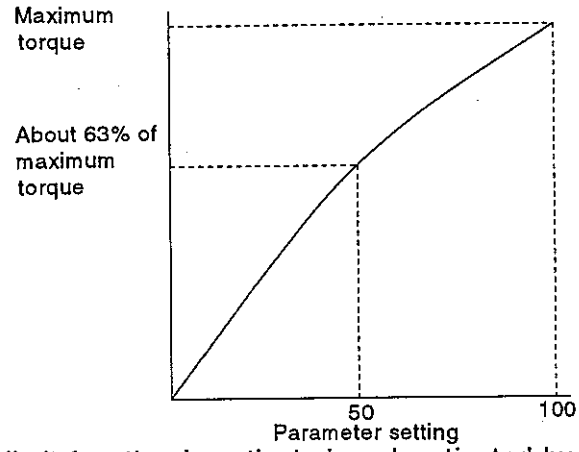
4. Use parameters No. 20 and 21 to set these signals. Note that the functions of parameter No. 21 are available for the servo amplifiers of software version A2 or later.

5 – 2 – 4 Torque limit

The maximum torque of the servo motor can be limited by setting parameter No. 9.

(1) To keep the maximum torque limited

Set the limit value in parameter No. 9 (torque limit value). The relationship between the parameter setting and approximate torque is shown on the right.



(2) Use the torque limit (TL) signal

When the torque limit (TL) signal is used, the torque limit function is activated or deactivated by switching TL on or off. Use parameter No. 20 to make TL valid.

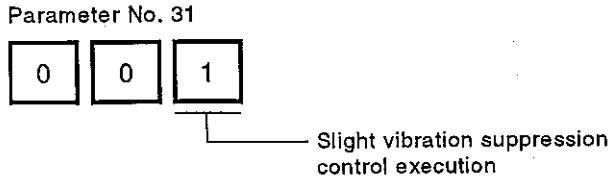
TL-SG	Maximum Torque of Servo Motor
Disconnected	Maximum torque
Connected	Torque limited by the setting of parameter No. 9

5 – 2 – 5 Slight vibration suppression control

The slight vibration suppression control mode is used to reduce servo-specific ±1 pulse vibration at the time of a stop. This mode produces an effect especially when the ratio of load inertia to motor inertia is small (2 to 5 times). Note that when vibration is attributable to looseness (such as gear backlash) or machine resonance, use the machine resonance suppression filter (parameter No. 24). The slight vibration suppression control mode should be used after real-time auto tuning or manual gain adjustment.

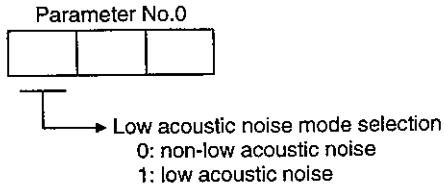
Usage

First, perform real-time auto tuning or manual gain adjustment so that vibration falls within ±2 to 3 pulses. Set 001 in parameter No. 31 to enter the slight vibration suppression control mode at the time of a stop.



5 – 2 – 6 Low acoustic noise mode

By choosing the low acoustic noise mode in parameter No. 0, the electromagnetic noise of audible frequency generated by the servo motor can be suppressed by about 20dB.



CHAPTER 6
OPTIONS AND AUXILIARY EQUIPMENT

This chapter describes how to use various options and auxiliary equipment.

INTRODUCTION	CHAPTER 1
OPERATION	CHAPTER 2
WIRING	CHAPTER 3
INSTALLATION	CHAPTER 4
ADJUSTMENTS AND APPLICATION OPERATIONS	CHAPTER 5
OPTIONS AND AUXILIARY EQUIPMENT	CHAPTER 6
MAINTENANCE AND INSPECTION	CHAPTER 7
TROUBLESHOOTING	CHAPTER 8
CHARACTERISTICS	CHAPTER 9
SPECIFICATIONS	CHAPTER 10
SELECTION	CHAPTER 11
OPTIONAL PRODUCTS	CHAPTER 12

6. OPTIONS AND AUXILIARY EQUIPMENT

⚠WARNING	Before connecting any option or auxiliary equipment, confirm the voltage, etc. with a tester more than 10 minutes after power-off. Otherwise, you may get an electric shock.

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

6 – 1 Dedicated Options

6 – 1 – 1 Regenerative brake option

(1) Judgment of whether this option is required or not

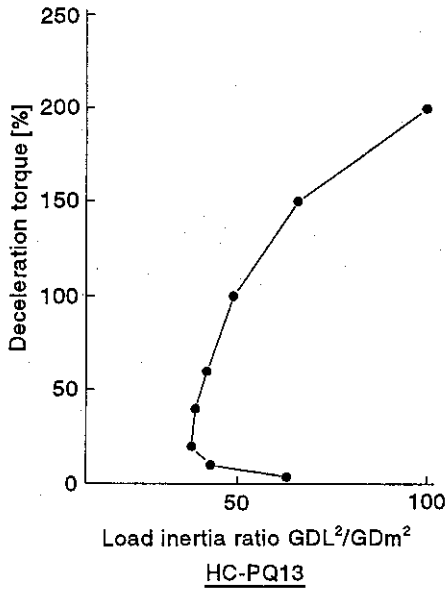
The regenerative brake option is not required for the servo motors in the following cases:

1) HC-PQ033, 053

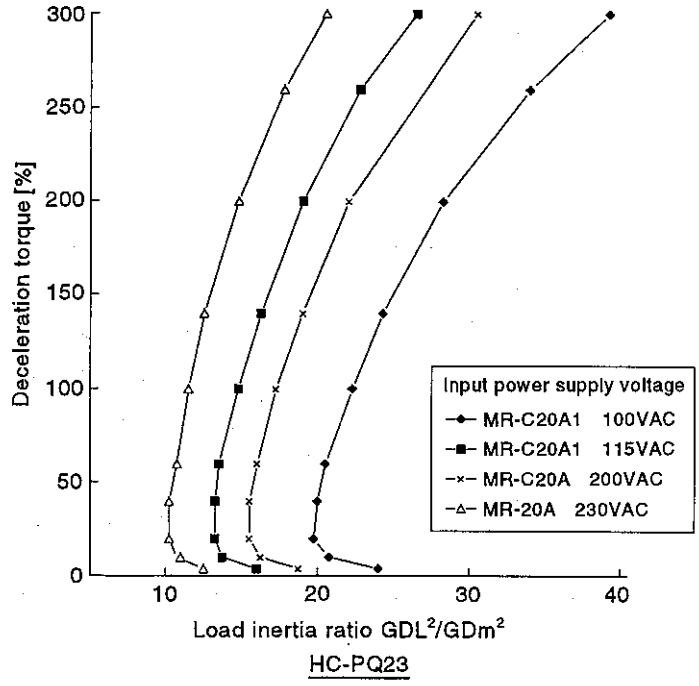
Except for continuous occurrence of regeneration in a vertical motion application or the like, the regenerative brake option is not required. At this time, there is no limit to the frequency of regeneration.

2) HC-PQ13, 23, 43

Except for continuous occurrence of regeneration in a vertical motion application or the like, the regenerative brake option is not required when the servo motor is run in the left-hand side area of the curves in the following chart. At this time, there is no limit to the frequency of regeneration. (For the HC-PQ23, the characteristic varies according to the input power supply voltage.)

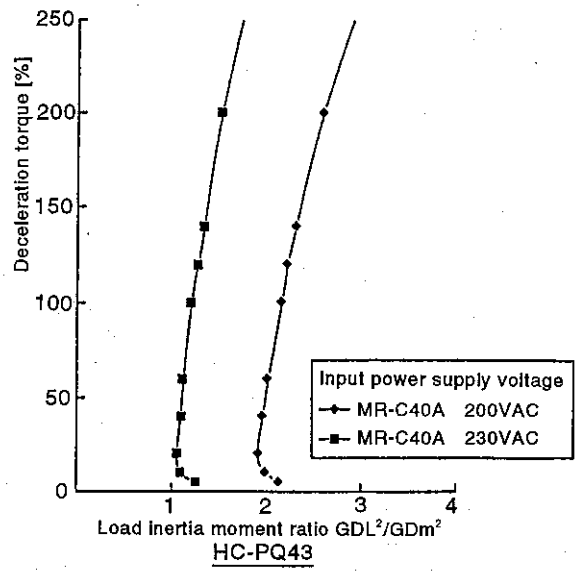


HC-PQ13



HC-PQ23

Note: If the input power supply voltage may become higher than the power supply voltage indicated in this graph, reduce the load inertia ratio or use the regenerative brake option.



HC-PQ43

Note: If the input power supply voltage may become higher than the power supply voltage indicated in this graph, reduce the load inertia ratio or use the regenerative brake option.

(2) Selection of the regenerative brake option

When it has been determined that the regenerative brake option is required in (1), select the regenerative brake option as described below.

1) Simple selection method

In horizontal motion applications, select the regenerative brake option as described below:

When the servo motor is run alone in the regenerative mode from the running speed to a stop, the permissible duty is as indicated in Section 10-1 "Standard Specifications". When a load is connected, the permissible duty changes according to the inertia of the load and can be calculated by the following formula:

$$\text{Permissible duty} = \frac{\text{permissible duty for operation of the servo motor alone (value indicated in Section 10-1)}}{(m+1)} \times \left(\frac{\text{rated speed}}{\text{running speed}}\right)^2 \text{[times/minute]}$$

where m = load inertia/servo motor inertia

From the permissible duty, find whether the regenerative brake option is required or not.

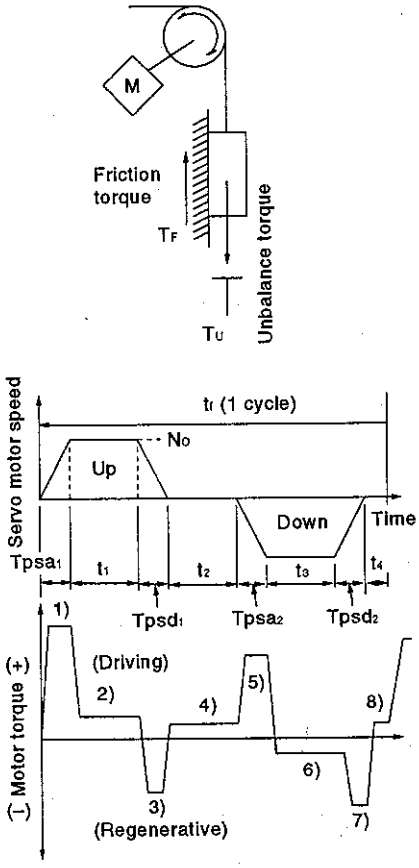
Permissible duty < number of positioning times n1 [times/minute]

Between the MR-RB013 and MR-RB033, select the one which satisfies the above formula.

2) To make selection according to regenerative energy

Use the following method when regeneration occurs continuously in vertical motion applications or when it is desired to make an in-depth selection of the regenerative brake option:

a) Use the following table to calculate the regenerative energy.



Formulas for Calculating Torque and Energy for Operation

Operation Region	Torque Applied to Servo Motor T [N·m]	Energy E [J]
1)	$T_1 = \frac{(J_L+J_M)\cdot No}{9.55\times10^4}\cdot\frac{1}{Tpsa_1}+T_U+T_F$	$E_1 = \frac{0.1047}{2}\cdot No\cdot T_1\cdot Tpsa_1$
2)	$T_2 = T_U+T_F$	$E_2 = 0.1047\cdot No\cdot T_2\cdot t_1$
3)	$T_3 = \frac{(J_L+J_M)\cdot No}{9.55\times10^4}\cdot\frac{1}{Tpsd_1}+T_U+T_F$	$E_3 = \frac{0.1047}{2}\cdot No\cdot T_3\cdot Tpsd_1$
4), 8)	$T_4 = T_U$	$E_4 \geq 0$ (Not in regenerative mode.)
5)	$T_5 = \frac{(J_L+J_M)\cdot No}{9.55\times10^4}\cdot\frac{1}{Tpsa_2}-T_U+T_F$	$E_5 = \frac{0.1047}{2}\cdot No\cdot T_5\cdot Tpsa_2$
6)	$T_6 = T_U+T_F$	$E_6 = 0.1047\cdot No\cdot T_6\cdot t_3$
7)	$T_7 = \frac{(J_L+J_M)\cdot No}{9.55\times10^4}\cdot\frac{1}{Tpsd_2}-T_U+T_F$	$E_7 = \frac{0.1047}{2}\cdot No\cdot T_7\cdot Tpsd_2$
Sum total of regenerative energies E_S		Sum total of negative energies in 1) to 8) E_S

b) Losses of servo motor and servo amplifier in regenerative mode

The following table lists the efficiencies and other data of the servo motor and servo amplifier in the regenerative mode.

Servo Motor	Inverse Efficiency [%]	Amplifier Loss [W]	Capacitor Charging [J]
HC-PQ033	35	1	4
HC-PQ053	55		
HC-PQ13	55		
HC-PQ23	70		
HC-PQ43	85		8

Inverse efficiency (η) : Efficiency including some efficiencies of the servo motor and servo amplifier when rated (regenerative) torque is generated at rated speed. Since the efficiency changes according to the speed and generated torque, allow for about 10%.

Servo amplifier loss (E_A): Loss consumed in the servo amplifier. Convert this loss into regenerative energy in accordance with the following expression:

E_A [Joule] = P [W] · t [s]

where t : regenerative operation time, not including driving time

Capacitor charging (Ec) : Energy charged into the electrolytic capacitor in the servo amplifier.

Subtract the servo amplifier loss from the inverse efficiency to calculate the energy consumed by the regenerative brake option.

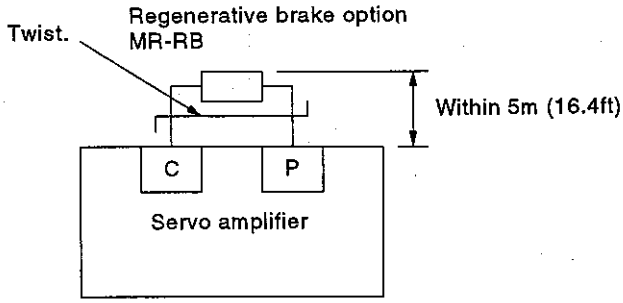
E_R [Joule] = $\eta \cdot E_S - E_A - E_C$

Calculate the consumption power of the regenerative brake option on the basis of single-cycle operation period t_f [s] to select the regenerative brake option.

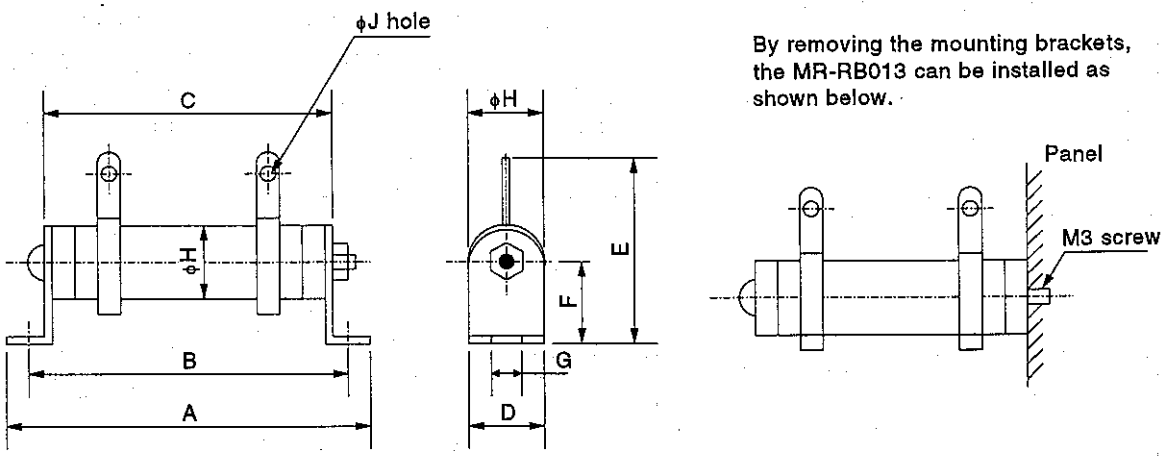
P_R [W] = E_R/t_f .....(6-1)

(3) Connection of the regenerative brake option

The regenerative brake option used should be connected as shown below:



(4) Outline drawing

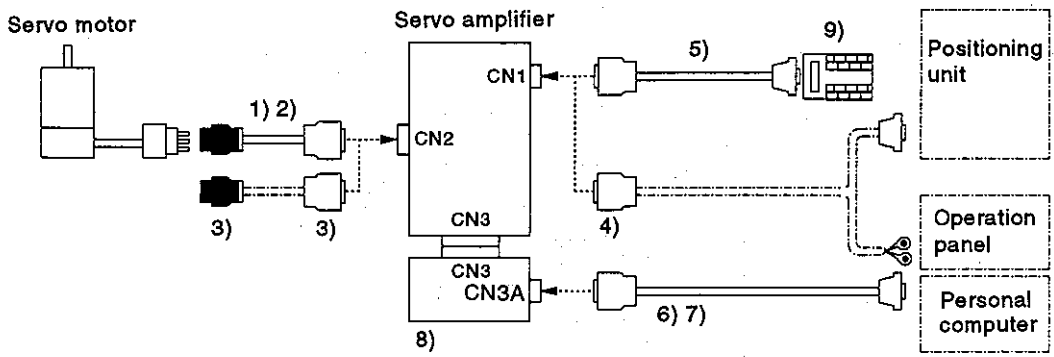


Regenerative Brake Option Model	Regenerative Power [W]	Variable Dimensions [mm] ([in])									Weight [kg] ([lb])	Resistance [Ω]
		A	B	C	D	E	F	G	H	J		
MR-RB013	10	110 (4.33)	101 (3.98)	85 (3.35)	18 (0.71)	35 (1.38)	16 (0.63)	4.5 (0.18)	18 (0.71)	3.2 (0.13)	0.1 (0.2)	52
MR-RB033	30	192 (7.56)	173 (6.81)	152 (5.98)	26 (1.02)	54 (2.13)	22 (0.87)	6 (0.24)	26 (1.02)	3.2 (0.13)	0.2 (0.4)	52

6. OPTIONS AND AUXILIARY EQUIPMENT

6 – 1 – 2 Cable connectors

- Use the encoder cable 1) or 2) after confirming the required wiring length. When the encoder cable is to be fabricated by yourself, use the encoder connector set 3) and refer to (2) in this section.
- To connect the control signals, they may either be exported directly using the CN1 connector 4) or via the CN1-junction terminal block cable 5) to the junction terminal block 9). Use the options according to the connection method.
- To use the RS-232C communication function, use the RS-232C option unit 8) and the communication cable 6) or 7) which matches the personal computer used.



		Model	Product	Description
Use one of these for CN2	1)	Standard encoder cable for HC-PQ series	MR-JCCBL□M-L Cable length in □: 2, 5, 10, 20, 30 [m]	Servo motor encoder — Servo motor encoder side connector (AMP make) 1-172161-9 (housing) — Servo amplifier side connector (3M make or equivalent) 10120-3000VE (connector) 10320-52F0-008 (Shell kit)
	2)	Highly-flexible, long-life encoder cable for HC-PQ series	MR-JCCBL□M-H Cable length in □: 2, 5, 10, 20, 30, 40, 50 [m]	
	3)	Encoder connector for HC-PQ series	MR-CCNS	Junction connector (AMP make) 1-172161-9 (housing) 170359-1 (connector) MTI-0002 (clamp) — Servo amplifier side connector (3M make or equivalent) 10120-3000VE (connector) 10320-52F0-008 (Shell kit)
Use one of these for CN1	4)	Select one of these for CN1	MR-CCN1	Servo amplifier side connector (3M make or equivalent) 10120-3000VE (connector) 10320-52F0-008 (Shell kit)
	5)	Cable for junction terminal block	MR-CTBL05M Cable length: 0.5[m]	Junction terminal block side connector HIF3BA-20D-2.54R (Horose Electric make) — Servo amplifier side connector (3M make or equivalent) 10120-6000EL (connector) 10320-3210-000 (shell kit)
For CN3	6)	Communication cable for PC98	MR-CPC98CBL3M Cable length: 3[m]	RS-232C option side connector (3M make or equivalent) 10120-6000VE(Connector) 10320-3210-000 (Shell kit) — PC98 series personal computer side connector (Japan Aviation Electonics) DE-25PF-N (Connector) DE-C2-J9 (Shell kit)
	7)	Communication cable for DOS/V	MR-CPCATCBL3M Cable length: 3[m]	RS-232C option side connector (3M make or equivalent) 10120-6000VE(Connector) 10320-3210-000 (Shell kit) — DOS/V personal computer side connector (Japan Aviation Electonics) DE-9SF-N (Connector) DE-C1-J6-S6 (Shell kit)
	8)	RS-232C option unit	MR-C-T01	Refer to Section 6 – 1 – 5.
	9)	Junction terminal block	MR-TB20	Refer to Section 6 – 1 – 3.

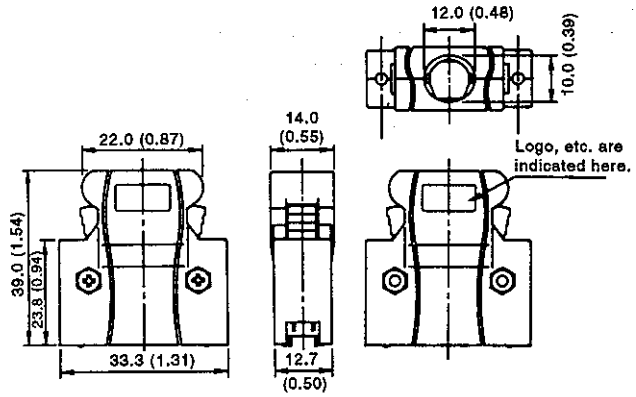
6. OPTIONS AND AUXILIARY EQUIPMENT

(1) Connector outline drawings

[Unit: mm]

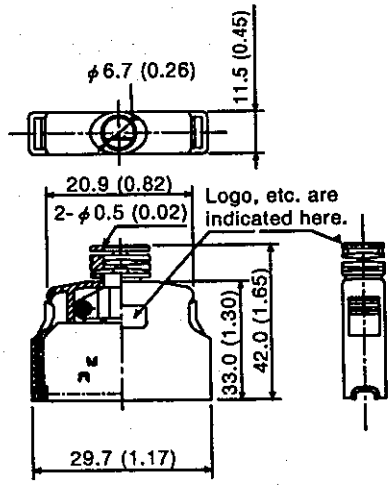
Servo amplifier Connector for CN1, CN2
RS-232C option unit Connector for CN3A
(Sumitomo 3M make)

Model
Connector : 10120-3000VE
Shell kit : 10320-52F0-008



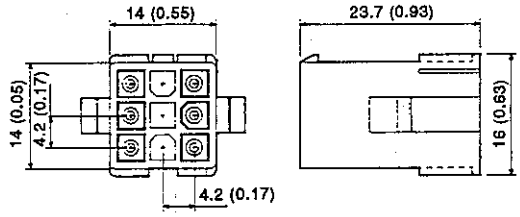
Model
Connector : 10120-6000EL
Shell kit : 10320-3210-000

[Unit: mm (in)]



Junction connector for encoder (Nippon AMP make)

Model
Housing : 1-172161-9
Connector pin : 170359-1
Crimp termination tool : 755330-1



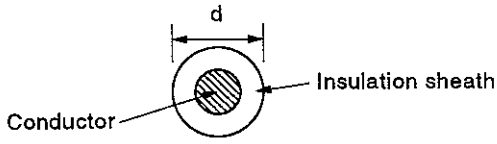
MEMO RANDUM The crimp termination tool is required for wiring to the connector. For the crimp termination tool, contact Nippon AMP.

(2) Assembling of cable

The specifications and connection of each cable are indicated below. A fabricated cable should be as specified in this section or equivalent and connected correctly. Use the cable conforming to the following list.

Size [mm^2]	Lead Insulation Sheath OD (Note) d[mm(in)]	Recommended Wire Model	Cable Type
0.2	0.9 to 1.27 (0.04 to 0.05)	UL20276 AWG28 7pair (BLACK)	Encoder cable Communication cable
0.3		UL20276 AWG24 7pair (BLACK)	Encoder cable

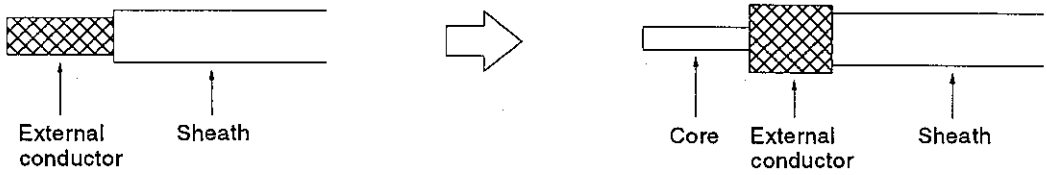
Note: d is as shown below.



Sectional view of lead

For the connector CN1, CN2 or CN3A, connect the external conductor of the shielded cable to the ground plate securely as shown below.

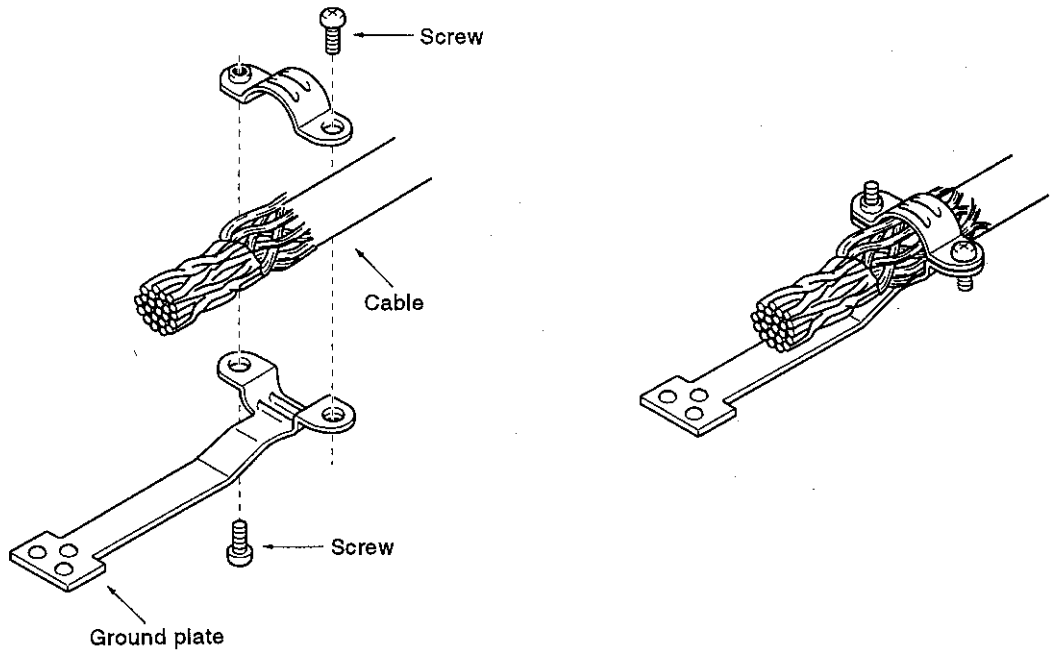
a. Termination of external conductor



Strip the sheath.

Pull back the external conductor to cover the sheath.

b. Fitting of the ground plate



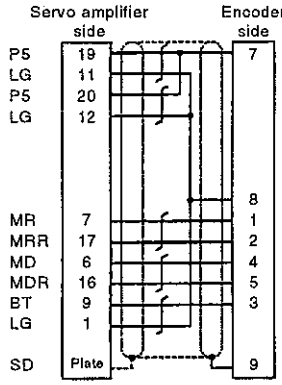
6. OPTIONS AND AUXILIARY EQUIPMENT

1) Encoder cable

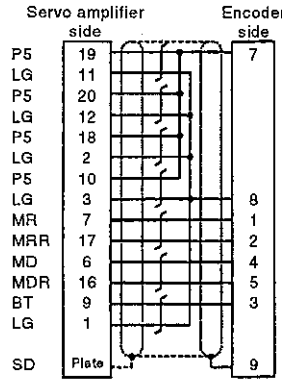
> **⚠CAUTION** When fabricating the encoder cable, connect it correctly. Otherwise, misoperation may lead to injury.

Optional cables

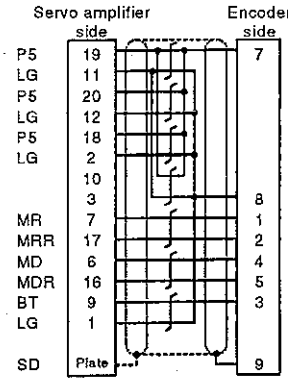
MR-JCCBL2M-L
MR-JCCBL5M-L
MR-JCCBL2M-H
MR-JCCBL5M-H



MR-JCCBL10M-L
to
MR-JCCBL30M-L

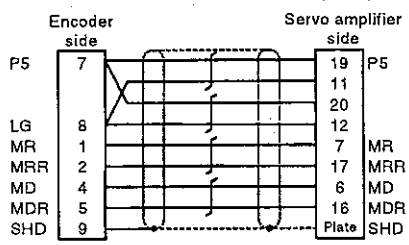


MR-JCCBL10M-H
to
MR-JCCBL50M-H

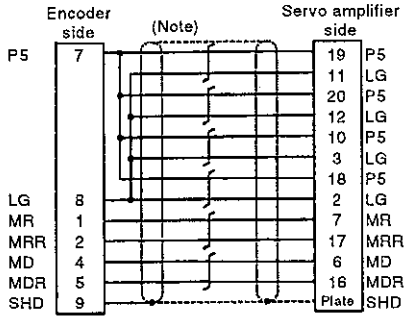


For fabrication

• Connection distance of less than 10m (32ft)

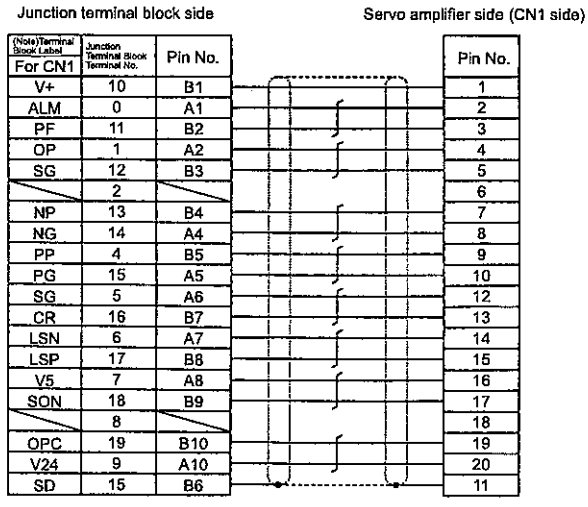


• Connection distance of 10m (32ft) to 50m (164ft)



Note: When 0.3mm^2 (AWG22) wires are used, three wires are connected to each of P5 and LG.

2) Junction terminal block cable



(Note)Terminal Block Label For CN1	Junction Terminal Block Terminal No.	Pin No.	Pin No.
V+	10	B1	1
ALM	0	A1	2
PF	11	B2	3
OP	1	A2	4
SG	12	B3	5
	2		6
NP	13	B4	7
NG	14	A4	8
PP	4	B5	9
PG	15	A5	10
SG	5	A6	12
CR	16	B7	13
LSN	6	A7	14
LSP	17	B8	15
V5	7	A8	16
SON	18	B9	17
	8		18
OPC	19	B10	19
V24	9	A10	20
SD	15	B6	11

Note: Label for position control mode.
Signals change with the parameter setting and control mode.
Use the accessory signal seals to change the signal abbreviations.

3) Communication cable

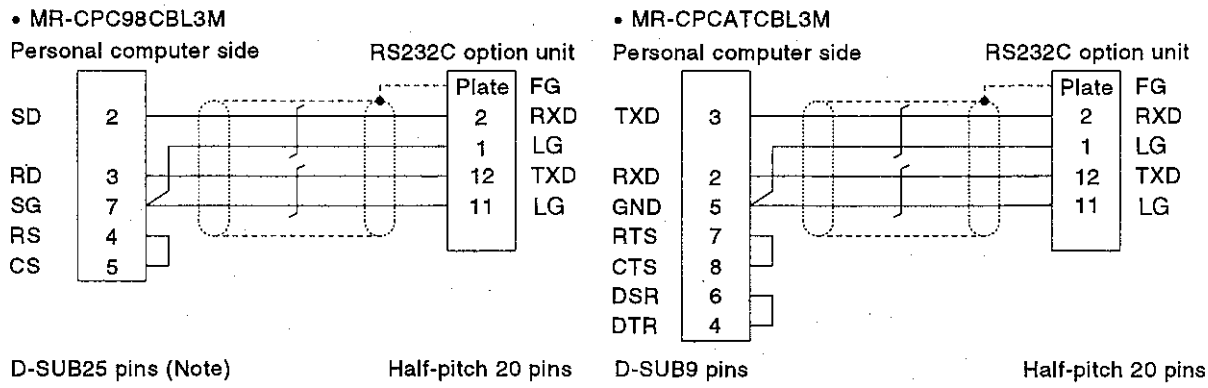
NOTICE	This cable may not be used with some personal computers. After fully examining the signals of the RS-232C connector, refer to this section and fabricate the cable.

Select the communication cable according to the RS-232C connector shape of the personal computer used.

When fabricating the cable, refer to the connection diagram in this section. The following must be observed in fabrication:

- Always use a shielded, multi-core cable and connect the shield with FG securely.
- The maximum wiring distance, which depends on the surrounding environment, is 15m in a well-environmental office with minimal noise. Use the cable over the shortest possible distance.

Connection diagram

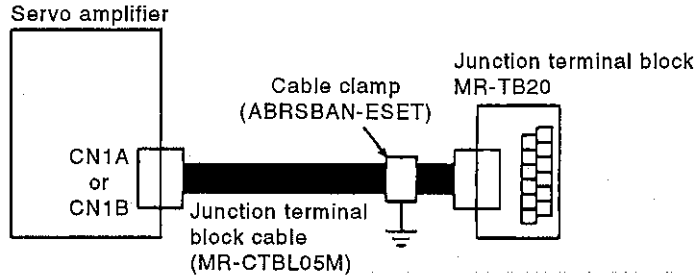


Note: The PC98 Note also has the connector of half-pitch 14 pins.
Confirm the shape of the RS-232C connector of the personal computer used.

6 – 1 – 3 Junction terminal block

(1) How to use the junction terminal block

Always use the junction terminal block (MR-TB20) with the junction terminal block cable(MR-CTBL05M) as a set. A connection example is shown below:

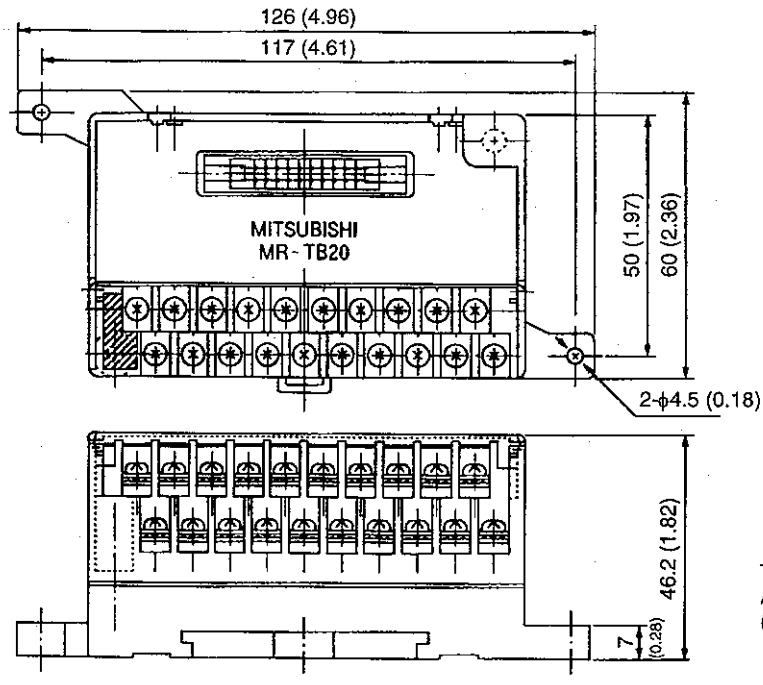


Ground the junction terminal block cable on the junction terminal block side with the standard accessory cable clamp fitting (AERSBAN-ESET). For the use of the cable clamp fitting, refer to (3), Section 6 – 2 – 6.

(2) Terminal labels

The junction terminal block has three terminal block labels which indicate signal arrangement. Out of these labels, use the one for MR-C. This label is for use in the position control mode. When the parameter settings of I/O signals have been changed or the position control mode is switched to the speed or torque control mode, refer to (2) in Section 6 – 1 – 2 or (2) in Section 3 – 1 – 2 and apply the accessory signal seales to the labels.

(3) Outline drawing



Terminal screw : M3.5
Applicable cable: Max. 2mm
(Crimping terminal width:
7.2mm (0.283in) max.)

6 – 1 – 4 Setup software

The setup software (MR-ZJW3-SETUP31E or later) uses the communication function of the servo amplifier to perform parameter setting changes, graph display, test operation, etc. on a personal computer.

(1) Specifications

Item	Description
Communication signal	RS-232C standard
Baudrate	DOS/V system: 19200bps
Monitor	Batch display, high-speed display Graph display (minimum resolution changes according to the processing speed of the personal computer)
Alarm	Alarm display, alarm history
Diagnosis	DI/DO display, software number display, tuning data display
Parameters	Data setting, list display, change list display, detailed information display
Test operation	Jog operation, DO forced output (output signal forced output)
File operation	Data read, storage, printing
Others	Help display

(2) System configuration

1) Components

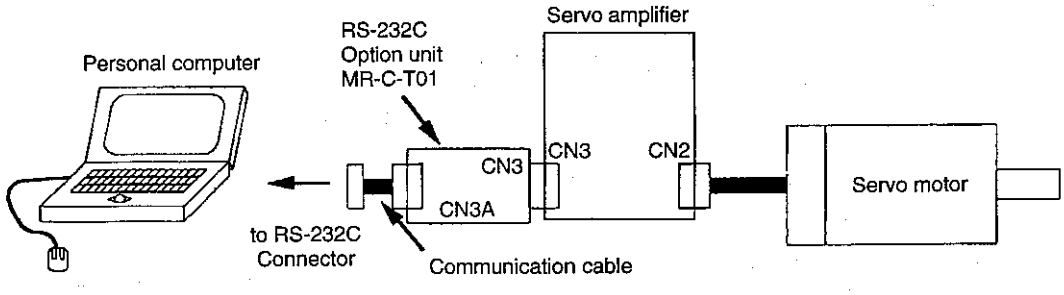
To use setup software, the following components are required in addition to the servo amplifier and servo motor. Make up a system in accordance with the installation guide of each equipment.

Model	(Note 1) Description
(Note 2) Personal computer	Which contains a 80386 or more CPU and on which Windows 3.1·95 (English) runs (80486 or more recommended). Memory : 8MB or more, hard disk : 1MB or more, serial port used.
OS	Windows 3.1·95 (English)
Display	640 × 400 or more color or 16-tone monochrome display which can be used with Windows 3.1·95 (English).
Keyboard	Which can be connected to the personal computer.
Mouse	Which can be used with Windows 3.1·95 (English). Note that a serial mouse is not used.
Printer	Which can be used with Windows 3.1·95 (English).
Communication cable	MR-CPCATCBL3M When these cannot be used, refer to Section 6 – 1 – 2 and fabricate.
RS-232C option unit	MR-C-T01

Note 1: Windows is the trade mark of Microsoft Corporation, U.S.A.

2: On some personal computers, setup software may not run properly.

2) Configuration diagram



6 – 1 – 5 RS-232C option unit (MR-C-T01)

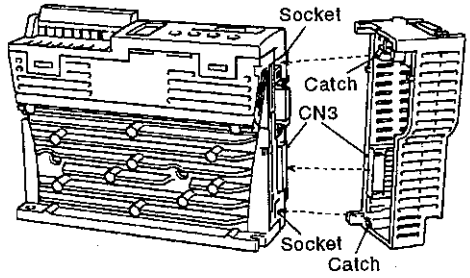
This unit is required to use the setup software.

(1) Installation and removal of the unit

NOTICE	Install or remove option unit as vertically as possible to or from the servo amplifier. If it is installed or removed diagonally, the connector CN3 may be damaged.

1) Installation

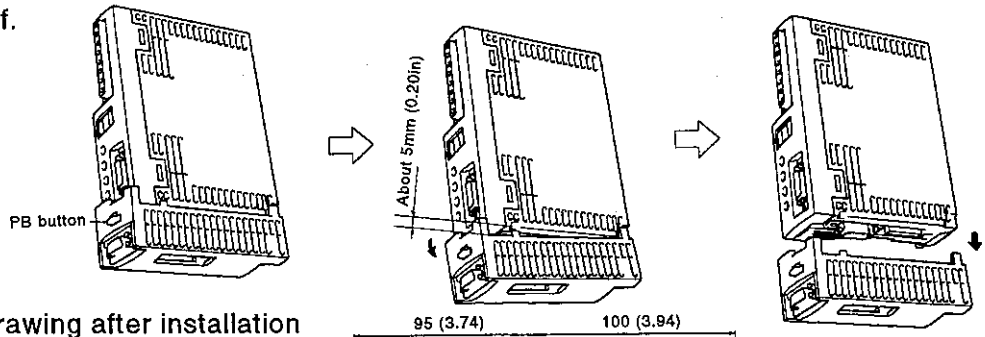
Install the unit after disconnecting the encoder cable from CN2. Securely insert the two catches of the MR-C-T01 into the sockets of the servo amplifier.



MEMO-RANDUM	Install option unit after fixing the servo amplifier on the control box. After installation, the servo amplifier fixing holes are covered by the option unit and the servo amplifier cannot be fixed to the control box.

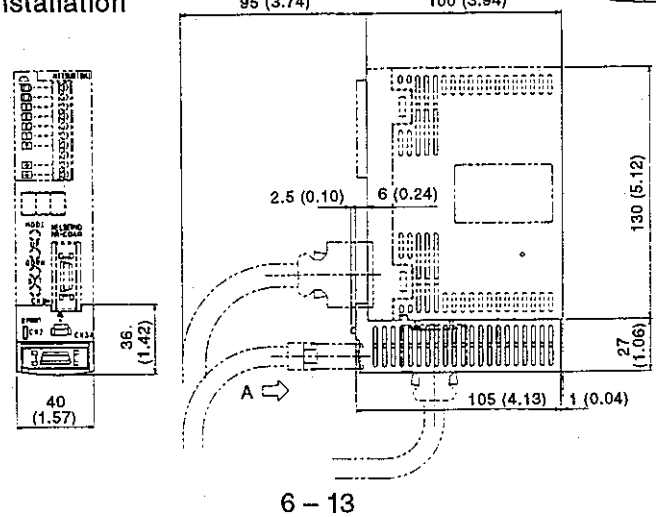
2) Removal

Hold down the PB button and pull the front side down about 5mm (0.20). Then, pull the back side off.



(2) Outline drawing after installation

[Unit: mm (in)]



6 – 2 Auxiliary Equipment

The auxiliary equipment used must be those specified in this section or equivalent. To comply with the EN or UL/C-UL Standard, use the equipment which conform to the corresponding standard.

6 – 2 – 1 Electric wires

Servo Amplifier	(Note 1) Wire [mm²]				Torque (pound inch)
	L1,L2 ⏚	U,V,W ⏚	P,C	Electromagnetic brake	
MR-C10A MR-C20A MR-C10A1 MR-C20A1	0.75 (AWG18)	0.75 (AWG18)	(Note 2) 0.75 (AWG18)	0.75 (AWG18)	5.6
MR-C40A		1.25 (AWG16)			

Note: 1. The wires are based on the 600V vinyl wires. The wires (U, V, W) in the table assume that the distance between the servo motor and servo amplifier is 30m or less.

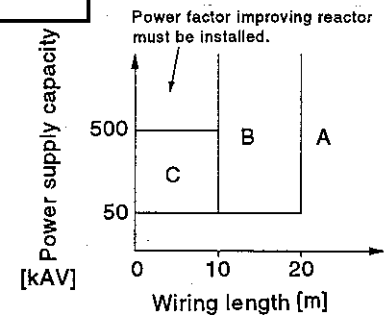
2. Twist the wires for connection of the regenerative brake option (P, C).

6 – 2 – 2 No-fuse breakers · fuses · magnetic contactors

Servo Amplifier	No-Fuse Breaker	Fuse			Magnetic Contactor		
		Class	Current [A]	Voltage [V]	A	B	C
MR-C10A MR-C20A MR-C10A1	NF30 type 5A	K5	10	AC250	S-N18	S-N21	S-N21
MR-C20A1 MR-C40A	NF30 type 10A						

6 – 2 – 3 Power factor improving reactors

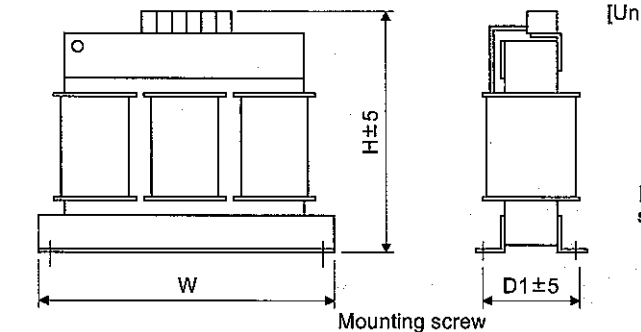
When connecting directly to a large capacity power transformer (500kVA or more, with wiring 10m or less), an excessive current will flow when the power is switched on, and may damage the converter section. In such a case, install a power factor improving reactor (FR-BAL) to suppress the current.

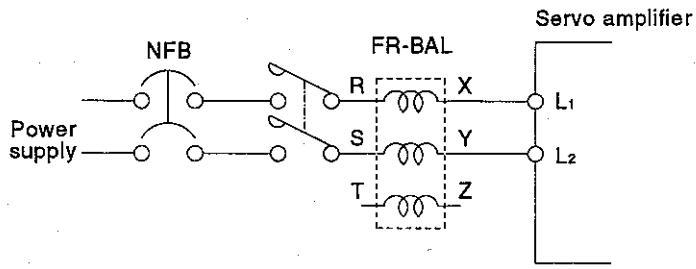


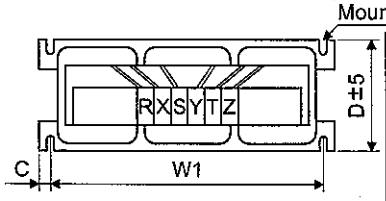
The input power factor is improved to be about 90%. For use with a single-phase power supply, it may be slightly lower than 90%.

Outline drawing and connection diagram of the power factor improving reactor

[Unit: mm]







Servo Amplifier	Model	Dimensions [mm (in)]						Mounting screw size	Terminal screw size	Weight [kg (lb)]
		W	W1	H	D	D1	C			
MR-C10A MR-C20A MR-C10A1	FR-BAL-0.4K	135 (5.31)	120 (4.72)	115 (4.53)	59 (2.32)	45 (1.77)	7.5 (0.29)	M4	M3.5	2.0 (4.4)
MR-C20A1 MR-C40A	FR -BAL-0.75K	135 (5.31)	120 (4.72)	115 (4.53)	69 (2.72)	57 (2.24)	7.5 (0.29)	M4	M3.5	2.8 (6.17)

6 – 2 – 4 Relays

The following relays should be used with the interfaces:

Interface	Selection Example
Relay used especially for switching analog input command and digital input command (interface DI-1)	Relay used for switching signals on/off To prevent defective contacts, use a relay for small signal (twin contacts). (Ex.) OMRON : type G2A,MY
Relay used for digital output signals (interface DO-1)	Small relay with 12VDC or 24VDC of 40mA or less (Ex.) OMRON : type MY

6 – 2 – 5 Surge absorbers

When wiring the electromagnetic brake, always use a surge absorber. Use the following surge absorber or equivalent.

Insulate the wiring as shown in the diagram.

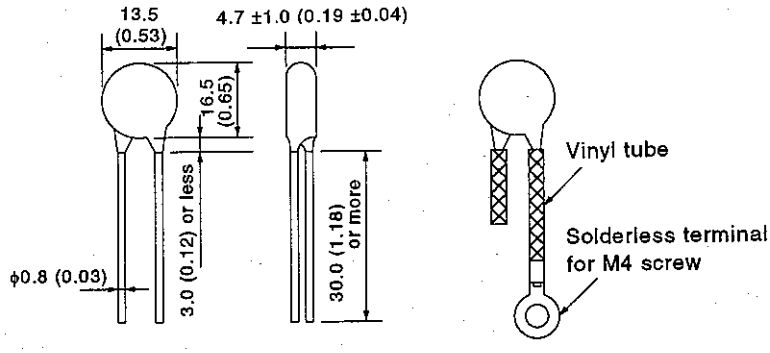
Maximum Rating					Maximum Limit Voltage		Static Capacity (Reference value)	Varistor Voltage Rating (Range) V_{1mA}
Permissible Circuit Voltage		Surge Immunity	Energy Immunity	Rated Power				
AC[V_{rms}]	DC[V]	[A] (Note)	[J]	[W]	[A]	[V]	[pF]	[V]
140	180	500/time	5	0.4	25	360	300	220 (198 to 242)

Note: 1 time = 8 · 20μs

(Example) ERZ-C10DK221 (Matsushita Electric)

TNR-10V221K (Japan Kemikon)

Outline drawing [mm (in)] (ERZ-C10DK221)



6 – 2 – 6 Noise reduction techniques

Noises are classified into external noises which enter the servo amplifier to cause it to malfunction and those radiated by the servo amplifier to cause peripheral devices to malfunction. Since the servo amplifier is an electronic device which uses small signals, it requires general noise reduction as mentioned below.

And, since the output of the servo amplifier is chopped by high carrier frequencies, the servo amplifier can be a source of noise. If peripheral devices malfunction due to noises produced by the servo amplifier, noise preventive measures must be provided. The measures will vary slightly according to the route of noise transmission.

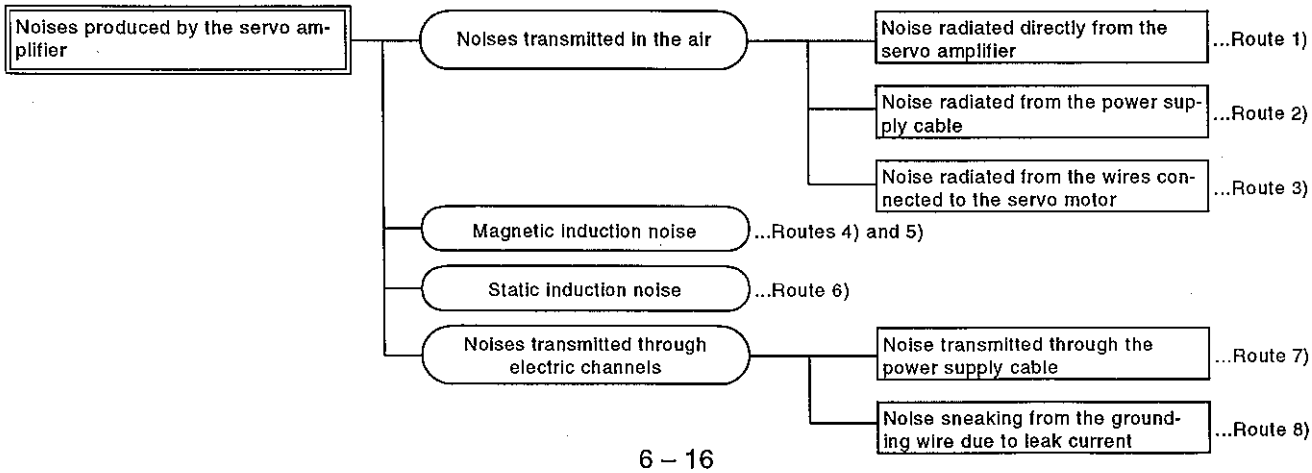
1) General reduction techniques
   - Avoid laying power lines (input and output cables) and signal cables side by side or do not bundle them together. Separate power lines from signal cables.
   - Use shielded twisted-wire pair cables for connecting to an encoder and for control signal transmission, and connect the shield to the SD terminal.
   - Ground the servo amplifier, servo motor, etc. together at one point (refer to Section 3 – 4).

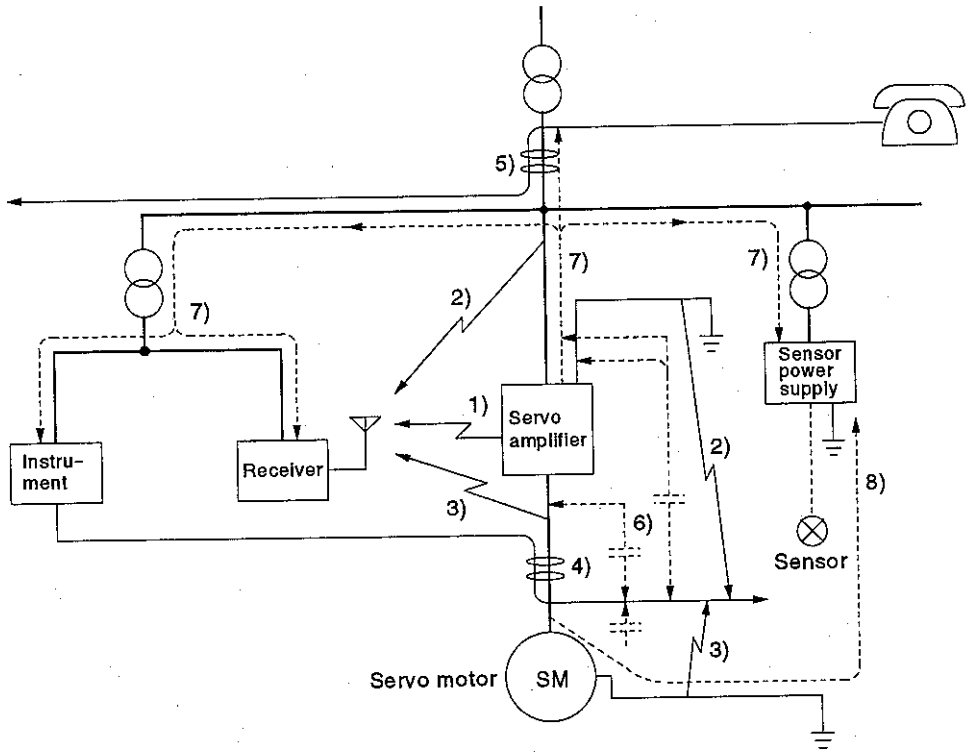
2) Reduction techniques for external noises that cause the servo amplifier to malfunction

   If there are noise sources (such as magnetic contactor, magnetic brake, and a large number of relays) which make a large amount of noise near the servo amplifier and the servo amplifier 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 wire and the control signal cables with cable clamp fittings.

3) Techniques for noises radiated by the servo amplifier that cause peripheral devices to malfunction

   Noises which the servo amplifier produces are classified into those which are radiated from the cables connected to the servo amplifier body and the servo amplifier main circuits (input and output circuits), those which are induced electromagnetically or statically by the signal cables of the peripheral devices which are located close to the main circuit wires, and those which are transmitted through the power supply cables.





Noise Transmission Route	Countermeasures
1) 2) 3)	When measuring instruments, receivers, sensors, etc. which handle weak signals and may malfunction due to noise and their signal cables are installed on a panel together with a servo amplifier or close to a servo amplifier, such devices may malfunction due to noise transmitted through the air. The following techniques are required. (1) Provide maximum clearance between the devices which are liable to be influenced by noise and a servo amplifier. (2) Provide maximum clearance between the signal cables which are liable to be influenced by noise and the I/O cables of the servo amplifier. (3) Avoid laying the power lines (I/O cables of the servo amplifier) and signal cables side by side or bundling them together. (4) Insert a line noise filter FR-BSF01 to the I/O cables or a radio frequency noise filter (FR-BIF) 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 are required. (1) Provide maximum clearance between the devices which are liable to be influenced by noise and a servo amplifier. (2) Provide maximum clearance between the signal cables which are liable to be influenced by noise and the I/O cables of the servo amplifier. (3) Avoid laying the power lines (I/O cables of the servo amplifier) 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 servo amplifier system, noises produced by the servo amplifier may be transmitted backward through the power supply cable and the devices may malfunction. The following techniques are required. (1) Insert a radio frequency noise filter (FR-BIF) on the power cables (I/O cables) of the servo amplifier. (2) Insert a line noise filter (FR-BSF01) on the power cables of the servo amplifier.
8)	When the cables of peripheral devices are connected to the servo amplifier to make a closed loop circuit, leakage current may flow to malfunction the peripheral devices. In that case, malfunction may be prevented by disconnecting the grounding wire of the peripheral device.

6. OPTIONS AND AUXILIARY EQUIPMENT

(1) Data line filter

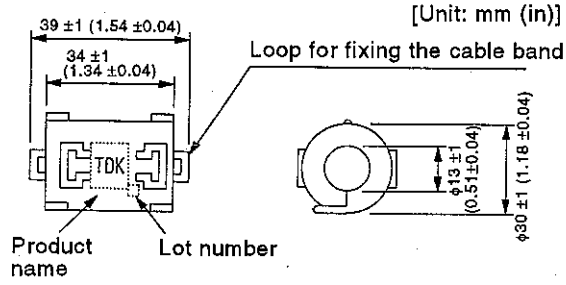
Noise can be prevented by installing a data line filter onto encoder cable, etc.

For example, the ZCAT3035-1330 of TDK make and the ESD-SR-25 of 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.

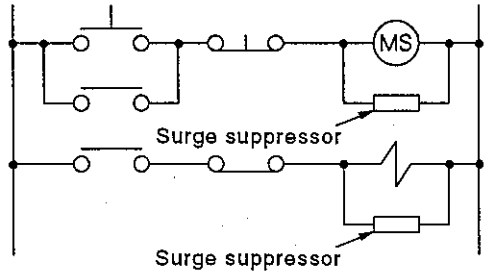
Impedance [Ω]	
10 to 100MHZ	100 to 500MHZ
80	150

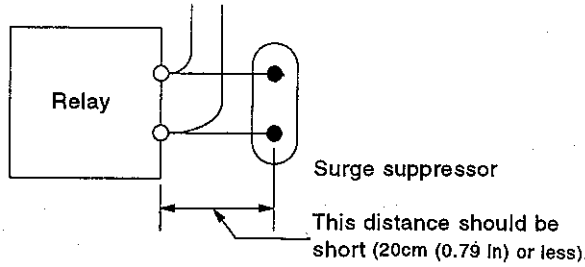


Outline drawing (ZCAT3035-1330)

(2) Surge suppressor

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

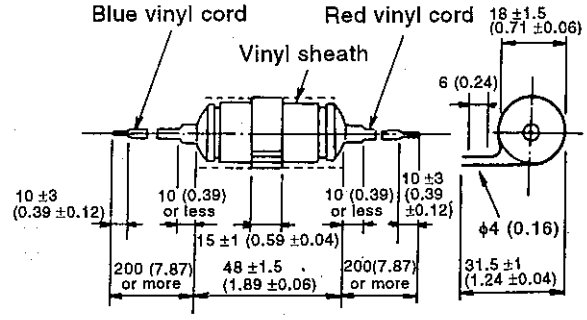




(Ex.) 972A-2003 504 11
(Matsuo Electric ... 200VAC rating)

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

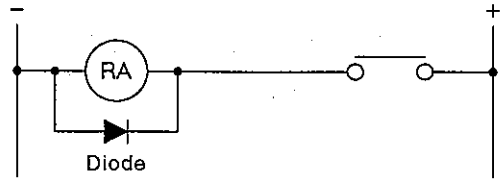
Outline Drawing [Unit: mm (in)]



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

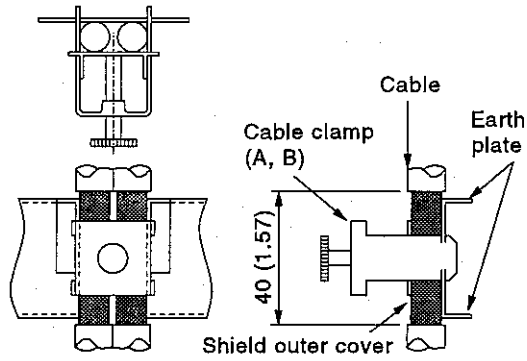


(3) Cable clamp fitting (AERSBAN-□SET)

The shield wire earth plate normally only needs to be connected to the connector's SD terminal. However, the effect can be increased by directly connecting the wire to an earth plate as shown below.

Install the earth plate near the servo amplifier for the encoder cable. Peel part of the cable sheath to expose the shield, and insert that part into 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.

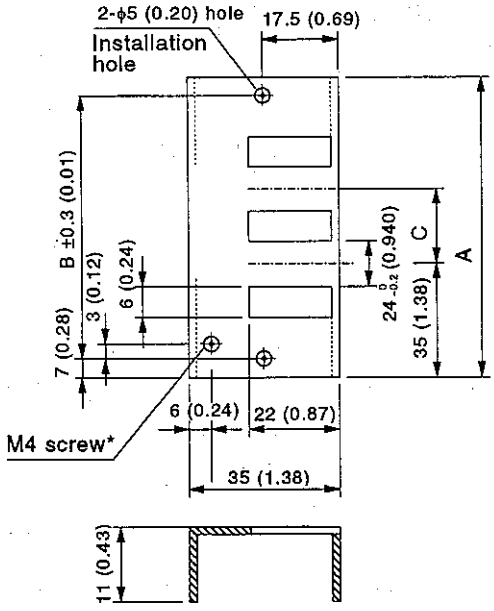


Clamp section diagram

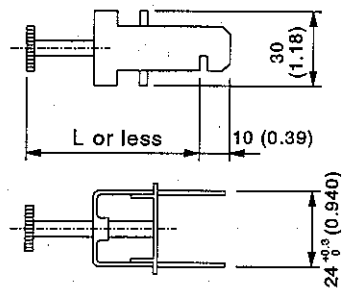
• Outline drawing

[Unit: mm (in)]

Earth plate



Cable clamp



1) Always wire from the earth plate to the cabinet ground.

2) *Screw hole for wiring to cabinet ground.

	A	B	C	Enclosed Fittings
AERSBAN-DSET	100 (3.94)	86 (3.39)	30 (1.18)	Clamp A : 2pcs.
AERSBAN-ESET	70 (2.76)	56 (2.20)		Clamp B : 1pc.

Clamp	L
A	70 (2.76)
B	45 (1.77)

(4) Line noise filter (FR-BSF01)

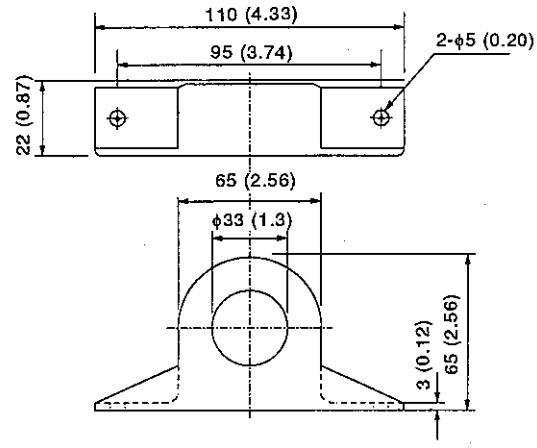
This filter is effective in suppressing noises radiated from the power supply side and output side of the servo amplifier and also in suppressing high-frequency leakage current (zero-phase current) especially within 0.5MHz to 5MHz band.

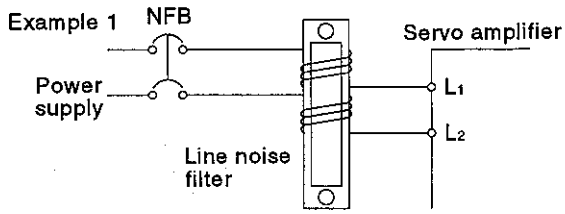
Connection Chart

Wind the 3-phase wires by the equal number of times in the same direction, and connect the filter to the power supply side and output side of the servo amplifier.
The effect of the filter on the power supply side is higher as the number of winds is larger. The number of turns is generally four. If the wires are too thick to be wound, use two or more filters and make the total number of turns as mentioned above.
On the output side, the number of turns must be four or less.
Do not wind the grounding wire together with the 3-phase wires. The filter effect will decrease. Use a separate wire for grounding.

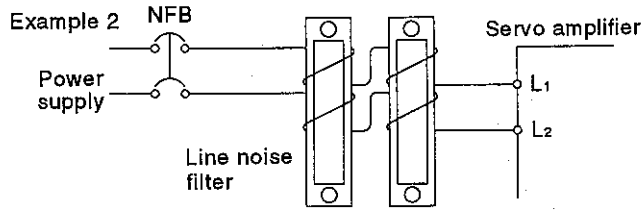
Outline Drawing [Unit: mm (in)]

FR-BSF01





(Number of turns: 4)



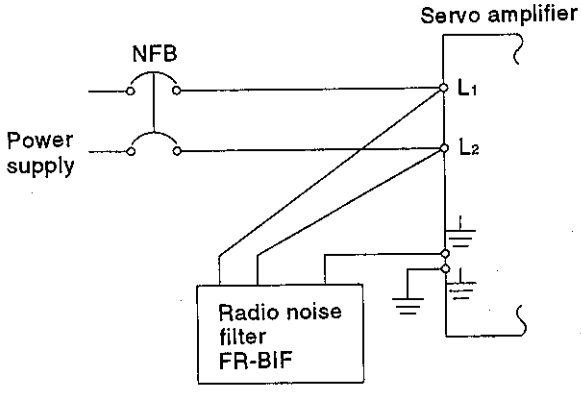
Two filters are used
(Total number of turns: 4)

(5) Radio noise filter (FR-BIF)...exclusively for the input side

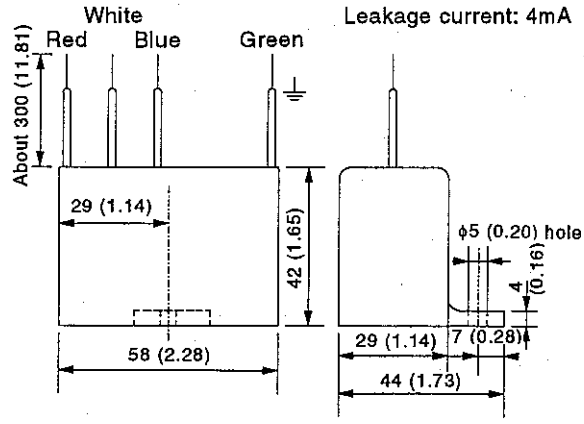
This filter is effective in suppressing noises radiated from the power supply side of the servo amplifier especially in 10MHz and lower radio frequency band. The FR-BIF is designed for three-pole input. When the FR-BIF is used with this servo amplifier, insulate the unused terminals.

Connection Chart

Make the connecting cables as short as possible. Grounding is always required.



Outline Drawing [Unit: mm (in)]



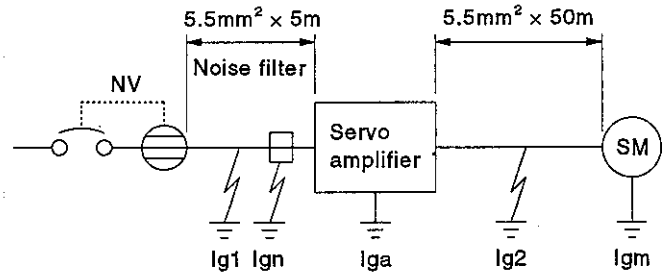
6 – 2 – 7 Leakage current breaker

High-frequency chopper current controlled by pulse width modulation flows in the AC servo circuit. Leakage current containing the harmonic contents is larger than that of a motor which is run with a commercial power supply.

Select a leakage current breaker as mentioned below, and ground the servo amplifier, servo motor, etc. securely. Make the input and output cables as short as possible, and also make the grounding wire as long as possible (about 30cm(11.8in)) to minimize leakage currents.

Selection

- Leakage current on the electric channel from the leakage current breaker to the input terminal of the servo amplifier: Ig1 [mA] (Obtain from Fig. 6-1.)
- Leakage current on the electric channel from the output terminal of the servo amplifier to the servo motor: Ig2 [mA] (Obtain from Fig. 6-1.)



- Leakage current when a filter is connected to the input side: Ign [mA] (4.4[mA] per one FR-BIF)
- Leakage current of the servo amplifier: Iga [mA] (2[mA])
- Leakage current of the servo motor: Igm [mA] (Obtain from Table 6-1.)

Rated sensitivity current $\geq 10 \cdot \{ Ig1 + Ign + Iga + K \cdot (Ig2 + Igm) \}$ [mA]

K: Constant considering the harmonic contents

(varies according to the frequency characteristics of the leakage circuit breaker)

Models provided with countermeasures against harmonics and surge: K=1

(equivalent to MITSUBISHI NV-SF or CF)

General models (equivalent to MITSUBISHI NV-CA, CS or SS) : K=3

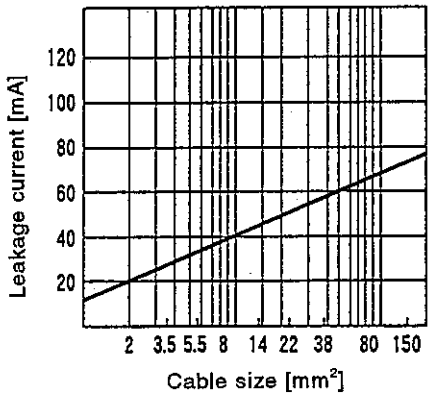


Fig. 6-1 Leakage Current per 1km (Ig1, Ig2) when CV Cable Is Laid in a Metal Conduit

Table 6-1 Leakage Current of Servo Motor (Igm)

Servo Motor [kW]	Leakage Current [mA]
0.03 to 0.4	0.1

Table 6-2 Leakage Circuit Breaker Selection Example

Servo Amplifier	Rated Sensitivity Current of Leakage Circuit Breake [mA]
MR-C10A(1) to MR-C20A(1)	15
MR-C40A	

CHAPTER 7
MAINTENANCE AND INSPECTION

This chapter describes maintenance items.

7. MAINTENANCE AND INSPECTION

⚠ WARNING

1. Before starting maintenance or inspection, switch power off and wait for more than 10 minutes. Then, confirm the voltage is zero with multi meter. Otherwise, you may get an electric shock.
2. Any person who is involved in maintenance and inspection should be fully competent to do the work. Otherwise, you may get an electric shock. For repair and parts replacement, contact our safes representative.

NOTICE

1. Do not test the control circuit of the servo amplifier with a megger (measure insulation resistance)!
2. Do not disassemble or repair on the customer side.

(1) Check areas

It is recommended to make the following checks periodically;

1) Check for loose terminal block screws. Retighten any loose screws.
2) Check the servo motor bearings, brake section, etc. for unusual noise.
3) Check that there are no scratches or cracks in the cables (especially the encoder cable). Carry out the periodic inspection according to the usage conditions for the moving parts.
4) Check the servo motor shaft and coupling for misalignment.

(2) Life

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. Also, when using the servo motor in the atmosphere where there are many oil mists, dust particles and others, perform cleaning/inspection every three months. For parts replacement, please contact your sales representative.

Part Name		Standard Life
Servo amplifier	Smoothing capacitor	10 years
Servo motor	Bearings	20,000 to 30,000 hours
	Encoder	20,000 to 30,000 hours
	V ring	5,000 hours

1) Smoothing capacitor : The characteristics of the smoothing capacitor will deteriorate because of effects from the ripple current. The life of the capacitor will differ greatly according to the ambient temperature and usage conditions. When operated under normal environmental conditions, the life will be approximately 10 years.

2) Servo motor bearings: When the servo motor is run at rated speed under rated load, change the bearings in 20,000 to 30,000 hours as a guideline. This differs on the operating conditions. The bearings must also be changed if unusual noise or vibration is found during inspection.

3) Servo motor V ring : Must be changed in 5,000 hours of operation at rated speed as a guideline. This differs on the operating conditions. These parts must also be changed if oil leakage, etc. is found during inspection.

CHAPTER 8
TROUBLESHOOTING

This chapter gives the alarm codes, their definitions and corrective actions. When any alarm has occurred, refer to this chapter and take the corresponding action.

Alarm List

8. TROUBLESHOOTING

⚠ CAUTION	When any alarm has occurred, eliminate its cause, ensure safety, then reset the alarm, and restart operation.

NOTICE	When the regeneration fault (A30) or overload (A50) alarm has occurred, always remove the cause of occurrence before restarting operation. If operation is repeated by switching power off to reset the alarm, the servo motor, servo amplifier and regenerative brake option will fail!

When an alarm occurs, the trouble signal (ALM) switches off. Therefore, the magnetic contactor installed before the power input terminals (L_1, L_2) switches off and power is switched off. For several seconds after that, the corresponding alarm code is displayed and then disappears.
Switch power on again, refer to the alarm history, and confirm the alarms that have occurred. The alarm definitions and their corrective actions are as follows.

Display	Alarm Name	Definition	Cause	Action
A10	Undervoltage	Power supply voltage dropped. MR-C□A : 165V or less MR-C□A1: 83V or less	1. Power supply voltage is low.	Review the power supply.
			2. Power switched on within 5s after it had switched off.	
			3. Instantaneous power failure of 15ms or longer occurred.	
			4. Shortage of power supply capacity caused the power supply voltage to drop at start, etc.	
			5. Faulty parts in the servo amplifier Checking method Alarm (A10) occurs if power is switched on after CN1 and CN2 connectors are disconnected.	Change the servo amplifier.
A12	Memory error 1	RAM/ROM memory error	Faulty parts in the servo amplifier Checking method Alarm (any of A12, A14 and A15) occurs if power is switched on after CN1A and CN2 connectors are disconnected.	Change the servo amplifier.
A14	Watchdog	CPU/parts error		
A15	Memory error 2	EEPROM error		
A16	Motor combination error	The combination of servo amplifier and servo motor is not correct.	1. The 200W servo motor is connected with the servo amplifier MR-C10A(1). The 100W or less servo motor is connected with the servo amplifier MR-C20A(1).	Use correct combination as in Section 10 – 1.
			2. Encoder fault	Change the servo motor.

8. TROUBLESHOOTING

Display	Alarm Name	Definition	Cause	Action
A17	Board error	CPU/parts error	Faulty parts in the servo amplifier Checking method Alarm (A17) occurs if power is switched on after CN1 and CN2 connectors have been disconnected.	Change the servo amplifier.
A20	Encoder error	A communication error occurred between the encoder and servo amplifier.	1. Encoder connector disconnected.	Connect correctly.
			2. Encoder cable fault (wire breakage or short)	Repair or change the cable.
A30	Regeneration error	Excessive regeneration	1. Wrong setting of parameter No. 0	Set correctly.
			2. High-duty operation or continuous regenerative operation. Checking method Use the status display to check the regenerative load factor.	1. Reduce the frequency of positioning. 2. Use larger regenerative brake option. 3. Reduce the load.
		Regenerative transistor error	Regenerative transistor faulty. Checking method 1) The regenerative brake option has overheated abnormally. 2) The alarm occurs after removal of the regenerative brake option.	Change the servo amplifier.
A31	Overspeed	Speed has exceeded the instantaneous permissible speed.	1. Electronic gear ratio is large (parameters No. 2, 3).	Set correctly.
			2. Small acceleration/deceleration time caused overshoot to be large.	Increase the acceleration/deceleration time.
			3. Encoder faulty.	Change the servo motor.
A32	Overcurrent	Excessive amplifier currents	1. Short occurred in phases U, V and W of the servo amplifier output.	Correct the wiring.
			2. Ground fault occurred in phases U, V and W of the servo amplifier output.	
			3. Transistor (IPM) of the servo amplifier faulty. Checking method Alarm (A10) occurs if power is switched on after U, V and W are disconnected.	Change the servo amplifier.
			4. External noise caused the overcurrent detection circuit to misoperate.	Eliminate noise

8. TROUBLESHOOTING

Display	Alarm Name	Definition	Cause	Action
A33	Overvoltage	Converter bus voltage exceeded 400V.	1. Power supply voltage exceeded the following value: MR-C□A : 260V MR-C□A1: 130V	Verify the power supply.
			2. Large spikes on power supply caused the capacitor to over charge. (When the regenerative brake option is not used)	1. Use the FR-BAL. 2. Provide a power supply different from the one used with equipment that generates distortion.
			3. Broken regenerative brake wires.	Change the regenerative brake option.
			4. The lead of the regenerative brake option is broken or disconnected.	1. Change the lead. 2. Connect correctly.
A35	Command pulse alarm	Input command pulse exceeded 250kpps.	1. Command pulse frequency exceeded 250kpps.	Reduce the command pulse frequency to 200kpps or less.
			2. Noise affecting the command pulse.	Eliminate noise.
			3. Command unit faulty.	Change the command unit.
A37	Parameter error	Parameter setting is wrong.	1. Servo amplifier fault caused the parameter setting to be rewritten.	Change the servo amplifier.
			2. The same signals have been made valid for different pins in parameters No. 20 or 21.	Set correctly.
A50	Overload	Overload protection is exceeded. Load factor 300%: 4s or more Load factor 200%: 4s or more Servo motor locked: 0.3s or more	1. Wrong connection of the servo motor. The output terminals U, V, W of the servo amplifier do not match the input terminals U, V, W of the servo motor.	Connect correctly.
			2. Continuous output current of the servo amplifier is exceeded.	1. Review operation pattern. 2. Increase the servo motor capacity.
			3. Servo system is unstable and hunting.	1. Repeat acceleration/deceleration and execute auto tuning. 2. Using parameter No. 1, change response setting. 3. Using parameter No. 1, set auto tuning to off and make gain adjustment manually. (Refer to Section 5 – 1.) Parameter / Adjustment No. 26 / Decrease No. 27 / Increase No. 29 / Increase
			4. Machine struck something.	1. Review operation pattern. 2. Provide limit switches.

Display	Alarm Name	Definition	Cause	Action
A50			5. Encoder faulty. Checking method When the servo motor shaft is rotated slowly in the servo off state, the cumulative feedback pulse value should vary in proportion to the angular value. If its reading skips or returns at any point, the encoder is faulty.	Change the servo motor.
A52	Excessive error	Value of the deviation counter exceeded 50k pulse.	1. Acceleration/deceleration time is too small.	Increase the acceleration/deceleration time.
			2. Torque limit value (parameter No. 9) is too small.	Increase the torque limit value.
			3. Start not allowed by torque shortage due to power supply voltage drop.	1. Review the power supply equipment capacity. 2. Increase the servo motor capacity.
			4. Machine struck something.	1. Review operation pattern. 2. Provide limit switches.
			5. Wrong connection of the servo motor. The output terminals U, V, W of the servo amplifier do not match the input terminals U, V, W of the servo motor.	Connect correctly.
			6. Encoder faulty.	Change the servo motor.

CHAPTER 9
CHARACTERISTICS

This chapter provides the characteristics and data of the servo.

9. CHARACTERISTICS

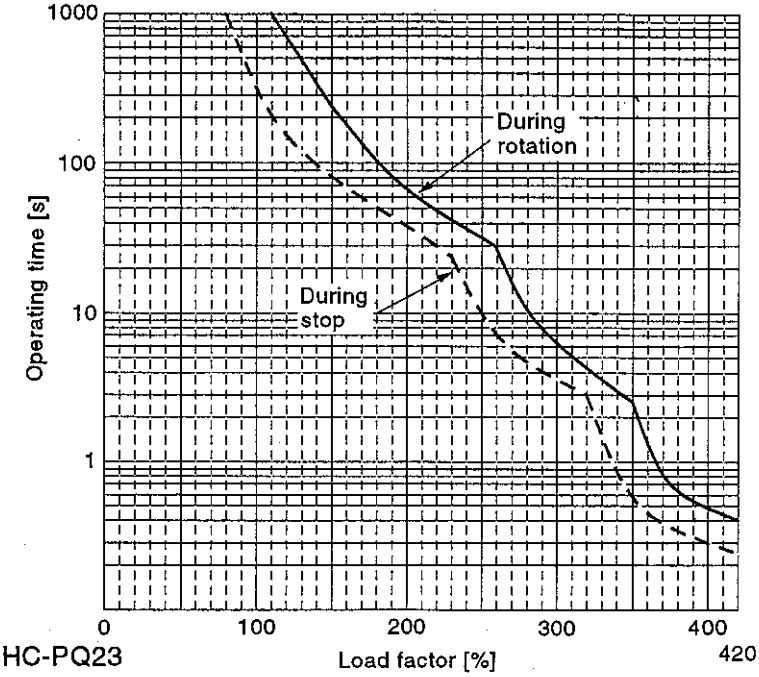
9 – 1 Overload Protection Characteristics

An electronic thermal relay is built in the servo amplifier to protect the servo motor and servo amplifier from overloads. The operation characteristics of the electronic thermal relay are shown below.

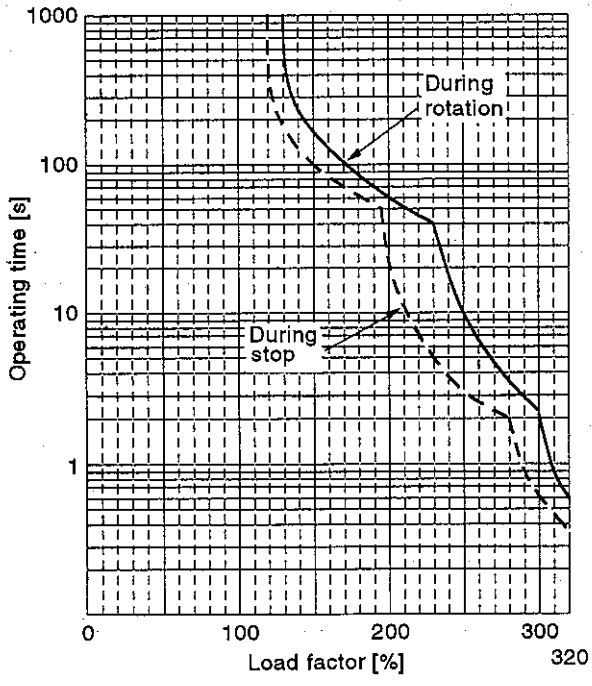
Overload 1 alarm (A50) is displayed to indicate that overload operation has been performed above the electronic thermal relay protection curve shown below or that the maximum current flew continuously for several seconds because the machine struck something, for example. Use the equipment on the left-hand side area of the continuous or broken line in the graph.

In 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.

a. HC-PQ033 to 13



b. HC-PQ23



c. HC-PQ43

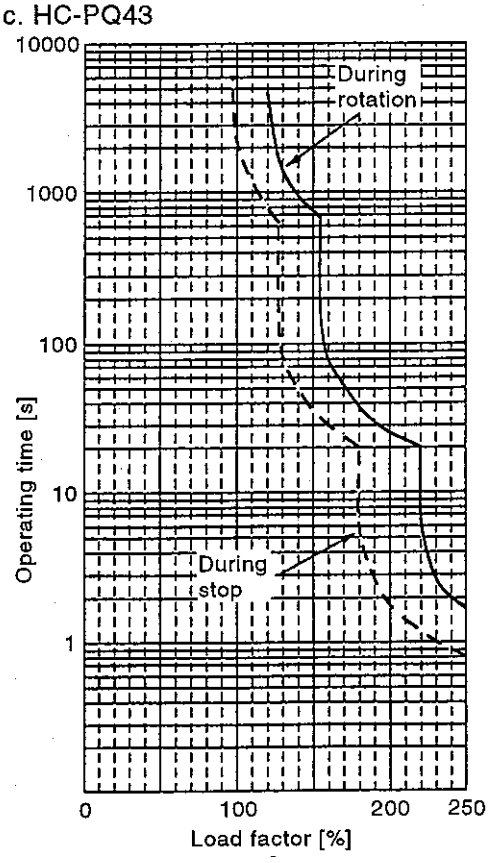


Fig. 9-1 Electronic Thermal Relay Protection Characteristics

9 – 2 Losses Generated in the Servo Amplifier

(1) Amount of heat generated by the servo amplifier

The losses generated during the servo amplifier's rated load operation and the power capacities are shown below. Use the size of closed-type control box under the worst usage conditions. The actual amount of generated heat will be a value between the rated output and zero torque according to the duty used. The servo motor's nominal output will decrease when the servo motor is not used at maximum speed. The power capacity is lower than the values given below. However, the servo amplifier's generated heat will not change.

Table 9-1 Power Capacity and Generated Heat Amount Per Servo Amplifier

Servo Amplifier	Servo Motor	(Note 1) Power Supply Capacity [kVA]	(Note 2) Servo Amplifier-Generated Heat		Area Required for Heat Dissipation	
			At Rated Output [W]	At Zero Torque [W]	[m^2]	[ft^2]
MR-C10A	HC-PQ033	0.1	20	4	0.4	4.3
MR-C10A1	HC-PQ053	0.2	20	4	0.4	4.3
MR-C20A	HC-PQ13	0.3	20	4	0.4	4.3
MR-C20A1	HC-PQ23	0.5	25	4	0.5	5.3
MR-C40A	HC-PQ43	0.9	30	4	0.6	6.4

Note: 1. Note that the power supply capacity will vary according to the power supply impedance.

2. Heat generated during regeneration is not included in the servo amplifier-generated heat. To calculate heat generated by the regenerative brake option, use Equation 6-1 in Section 6 – 1 – 1.

(2) Heat dissipation area for enclosed servo amplifier

An enclosure or control box for the servo amplifier should be designed to operate at the ambient temperature of 40°C (104°F) within a temperature rise of 10°C (50°F). (With a 5°C (41°F) safety margin, the system should operate within a maximum 50°C (122°F) limit.) The necessary enclosure heat dissipation area can be calculated by Equation 9-1:

$$A = \frac{P}{K \cdot \Delta T} \quad \text{.....(9-1)}$$

where, A: Heat dissipation area [m^2]

P: Loss generated in the control box [W]

ΔT: Difference between internal and ambient temperatures [°C]

K: Heat dissipation coefficient [5 to 6]

The heat dissipation area calculated in equation (9-1) should be calculated so that P is the sum of all losses generated in the enclosure. For the heat generated amount of the servo amplifier, refer to Table 9-1.

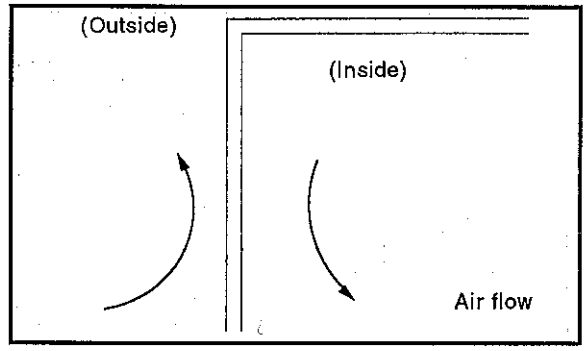


Fig. 9-2 Distribution of Temperature in Enclosure

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

"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 differ according to the conditions in the enclosure. If the convection in the enclosure is poor and the heat builds up, effective heat dissipation will not be possible. Therefore, arrangement of the equipment in the enclosure and the use of a fan should be considered.

Table 9-1 lists the enclosure surface area for each servo amplifier when the servo amplifier is operated at an ambient temperature of 40°C (104°F).

9. CHARACTERISTICS

9 – 3 Electromagnetic Brake Characteristics

> ⚠ **CAUTION** The electromagnetic brake is designed to hold a load. Do not use it for braking.

An electromagnetic brake is used in vertical motion applications to hold the load when power is removed from the drive. It is also used in conjunction with dynamic braking during an emergency stop. The characteristics of the electromagnetic brake are shown in the table below.

(1) Characteristics

Table 9-2 Electromagnetic Brake Characteristics

Item \ Servo motor			HC-PQ033B	HC-PQ053B	HC-PQ13B	HC-PQ23B	HC-PQ43B
Type			Spring-loaded safety brake				
Rated voltage (Note 1)			24VDC				
Rated current at 20°C [A]			0.26			0.33	
Excitation coil resistance at 20°C [Ω]			91			73	
Capacity [W]			6.3			7.9	
ON current [A]			0.18			0.18	
OFF current [A]			0.06			0.11	
Static friction torque [N·m]			0.32			1.3	
Inertia (Note 2) [10^{-4}kg·m^2]			0.0031			0.04	
Release delay time [S] (Note 3)			0.03			0.03	
Braking delay time [S] (Note 3)	AC off		0.08			0.10	
	DC off		0.01			0.02	
Permissible braking work	Per braking	[J]	5.6			22	
		[oz·in]	793.6			3117.6	
	Per hour	[J]	56			220	
		[oz·in]	7936			31176	
Brake looseness at motor shaft [degrees]			0.19 to 2.5			0.12 to 1.2	
Brake life (Note 4)	Frequency [times]		20000			20000	
	Work per braking	[J]	4			15	
		[oz·in]	567			2126	

Note: 1. A manual releasing mechanism is not installed. When the servo motor shaft is required to turn for core alignment of the machine, etc., use a separate 24VDC power and open the brake electrically.
2. This value is added to the inertia of the servo motor without a brake.
3. The value for initial suction gap at 20°C.
4. The brake gap will increase due to wear of the brake lining. The brake gap cannot be adjusted. Therefore, it is assumed that the brake life will expire when adjustment is required.
5. The interface power in the servo amplifier's (VDD: +24V) cannot be used. Always use a separate power source.
6. A leakage magnetic flux will occur at the shaft end of the servo motor with electromagnetic brake.
7. Though the brake lining may rattile during low-speed operation, it poses no functional problem.

(2) Electromagnetic brake power supply

Prepare the following power supply for use with the electromagnetic brake only.

Examples of connection of the brake power supply are shown in Fig. 9-3 (a) to (c). (a) is for AC off, and (b) and (c) for DC off. When the DC is off, the braking delay time will be shortened, but a surge absorber must be installed on the brake terminal. For the selection of the surge absorber, refer to Section 6 – 2 – 3.

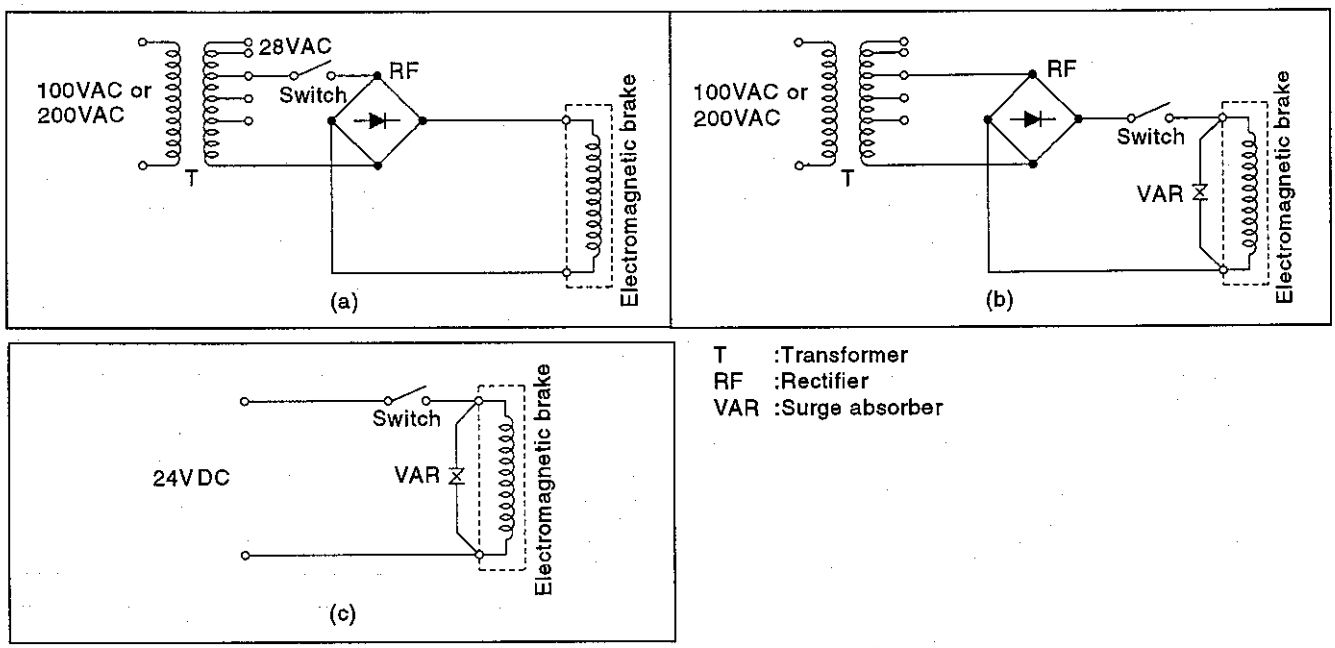


Fig. 9-3 Connection Examples

(3) Coasting distance

During an emergency stop, the servo motor will decelerate to a stop in the following pattern. Here, the maximum coasting distance (during fast feed), Lmax, will be the area shown with the diagonal line in the figure, and can be calculated with the following equation. The effect of the load torque is greater near the stopping area. When the load torque is large, the servo motor will stop faster than the value obtained in the equation.

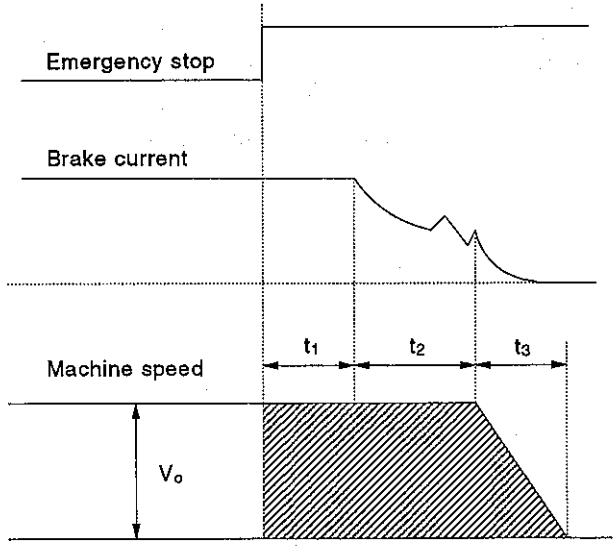


Fig. 9-4 Coasting Distance during Emergency Stop

$$L_{max} = \frac{V_o}{60} \cdot (t_1 + t_2 + \frac{t_3}{2}) \quad \text{(9-2)}$$

Here,

L_{max}	:	Maximum coasting distance	[mm]
V_o	:	Machine's fast feed speed	[mm/min]
t_1	:	Delay time of control section	[s]
t_2	:	Braking delay time of brake (*)	[s]
t_3	:	Braking time	[s]

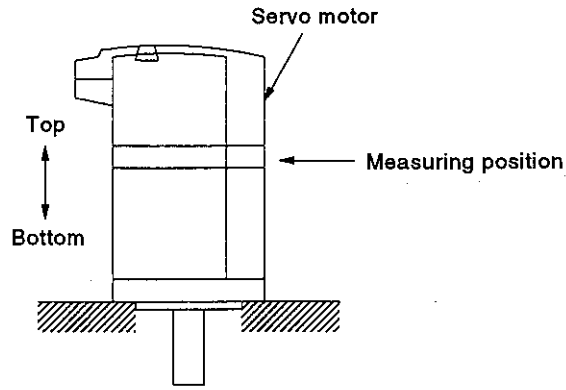
$$t_3 = \frac{(J_L + J_M) \cdot N_o}{9.55 \times 10^4 \cdot (T_L + 0.8T_B)}$$

J_L	:	load inertia converted into equivalent value on servo motor shaft	[x10^{-4}kg·m^2]
J_M	:	Servo motor inertia	[x10^{-4}kg·m^2]
N_o	:	Servo motor speed during fast feed	[r/min]
T_L	:	Load torque converted into equivalent value on servo motor shaft	[N·m]
T_B	:	Brake static friction torque (*)	[N·m]

*:t_2 and T_B are the values noted in Table 9-2 Characteristics. J_L is the sum of the electromagnetic brake's inertia (Table 9-2) and the motor's inertia.

9 – 4 Vibration Rank

The servo motor vibration rank is V-10 at the rated speed. The servo motor installation position and measuring position at the time of measurement are shown below.



Servo Motor Vibration Measuring Condition

CHAPTER 10
SPECIFICATIONS

This chapter gives the specifications of the servo.

10. SPECIFICATIONS

10 – 1 Standard Specifications

These specifications also apply to the EN and UL/C-UL Standard-compliant models.

(1) Servo amplifier

Item \ Servo amplifier		MR-C10A	MR-C20A	MR-C40A	MR-C10A1	MR-C20A1
Power supply (Note 3)	Voltage/frequency	Single-phase 200 to 230VAC 50/60Hz			Single-phase 100 to 120VAC 50/60Hz	
	Permissible voltage fluctuation	Single-phase 170 to 253VAC			Single-phase 85 to 126VAC	
	Permissible frequency fluctuation	Within ±5%				
Control method		Sine-wave PWM control, current controlled system				
Control mode		Pulse train input position control				
Control theory		Model adaptive control				
Auto tuning		Real-time auto tuning				
Protective functions		Overcurrent protection, motor combination fault, overload shut off (electronic thermal relay), overvoltage protection, encoder alarm protection, regenerative alarm protection, undervoltage/ instantaneous power failure protection, overspeed protection, excessive error protection				
Position control specifications	Max. input pulse frequency	200kpps				
	Positioning feedback pulses	4000 pulse/rev servo motor revolution				
	Command pulse multiplication	Electronic gear A, B: 1 to 999 pulses 1/50 < A/B < 20				
	Positioning completion width setting	0 to 999 pulses				
	Excessive error	±50K pulses				
Interface power supply		24VDC or 5VDC power supplied from outside				
Communication with personal computer	Required option	RS-232C option unit (MR-C-T01), communication cable, setup software				
	Functions	Status display, diagnostic display, alarm display, parameter setting, operation waveform monitor				
Structure		Open				
Environment conditions		Refer to Section 4 – 1 (1).				
Weight	[kg]	0.6		1.0	0.6	
	[lb]	1.32		2.20	1.32	

(2) Servo motor

Item \ Servo motor			HC-PQ series				
			033	053	13	23	43
Corresponding servo amplifier model			MR-C10A (1)			MR-C20A (1)	MR-C40A
Continuous running duty (Note 2)	Rated output[W]		30	50	100	200	400
	Rated torque	[N·m]	0.095	0.16	0.32	0.64	1.27
		[oz·in]	13.45	22.66	45.32	90.63	184.1
Max. torque (Note 2,10)		[N·m]	0.38	0.64	1.28	1.92	2.92
		[oz·in]	53.81	90.63	181.26	271.89	414
Rated speed[r/min]			3000				
Max. speed[r/min]			4500				
Instantaneous permissible speed[r/min]			5400				5175
Power rate at continuous rated torque[kw/s]			6.45	13.47	34.13	46.02	116.55
Moment of inertia (Note 7)	J	[kg·cm^2]	0.014	0.019	0.03	0.089	0.145
	WK^2	[oz·in^2]	0.077	0.104	0.164	0.487	0.793
Recommended load inertia to servo motor shaft inertia			30 or less times (Note 9)				
Rated output current [A]			0.85	0.85	0.85	1.5	2.8
Max. output current [A]			5.0	5.0	5.0	6.0	6.44
Regenerative brake duty [times/min] (Note 4)	Without option		(Note 5)	(Note 5)	(Note 6)	(Note 7)	(Note 8)
	MR-RB013 (10W)		(Note 5)	(Note 5)	4660	1400	800
	MR-RB033 (30w)		(Note 5)	(Note 5)	(Note 5)	4300	2400
Power facility capacity [kVA] (Note 3)			0.1	0.2	0.3	0.5	0.9
Speed/position detector			Encoder (resolution 4000 [Pulse/rev])				
Accessories			Encoder, (serial communication system)				
Structure			Totally enclosed, natural air cooling (protection degree: IP44 (Note 12))				
Environmental condition (Note 1)			Refer to Section 4 – 2 (1)				
Weight (Note 11)		[kg]	0.32	0.37	0.50	0.96	1.42
		[lb]	0.71	0.82	1.1	2.12	3.13

Note: 1. Special specifications will be required for the servo motor used in a site where it is exposed to oil or rain.

2. The output torque and rated speed are not guaranteed during a power voltage drop.

3. The power facility capacity will differ according to the impedance.

4. The regenerative brake duty is the permissible duty applied when the servo motor under no load is decelerated to a stop from the rated speed.
   When a load is applied, the value is 1/(m+1) of the value in the table. (m = load inertia/motor inertia) If the speed exceeds the rated speed, the permissible number of times is in inverse proportion to the square of (running speed/rated speed). When the running speed frequently varies or when the regeneration state is constantly established as in vertical motion applications, calculate the amount of regenerative heat generated during the operation so that the amount of heat generated will not be larger than the permissible value.

5. There are no limits to the regenerative duty if the effective torque is not more than the rated torque.

6. When the load inertia is 30 times or less, there is no limit to the regenerative brake duty if the effective torque is not more than the rated torque.

7. When the load inertia is 10 times or less, there is no limit to the regenerative brake duty if the effective torque is not more than the rated torque.

8. When the load inertia is 1 times or less, there is no limit to the regenerative brake duty if the effective torque is not more than the rated torque.

9. Please consult Mitsubishi when the load inertia ratio exceeds the value noted above.

10. For the servo motor with reduction gear, the ratio is 300% of the rated torque on the servo motor shaft.

11. For the servo motors with reduction gear and with electromagnetic brake, refer to the outline drawings.

12. Except the shaft through area and connector.

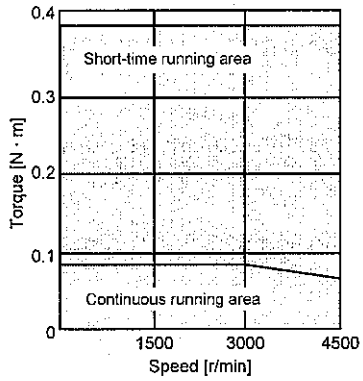
10 – 2 Torque Characteristics

NOTICE	In 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.

MEMO-RANDUM	The short-time operation area of the servo motor with reduction gear is as indicated by the broken line.

10 – 2 – 1 Standard

[HC-PQ033]



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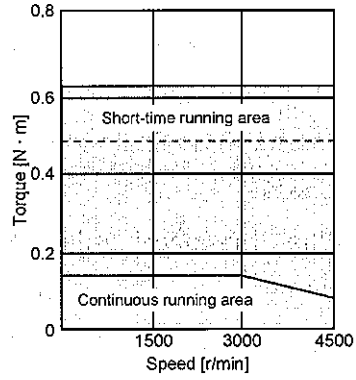

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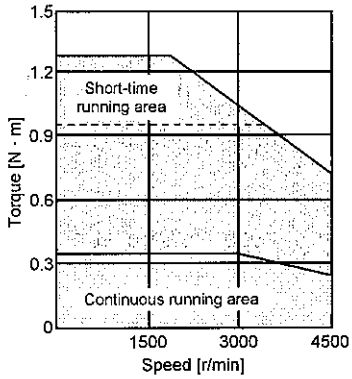

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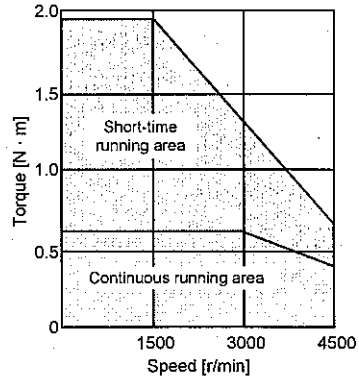

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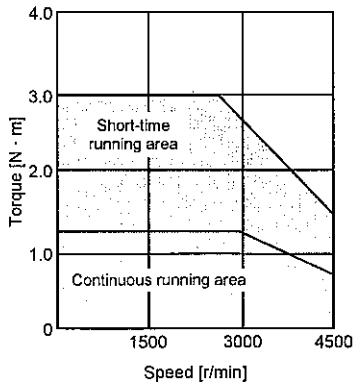
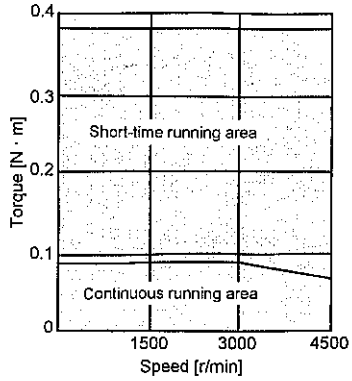


10 – 2 – 2 Low acoustic noise mode (carrier frequency 9.0kHz)

[HC-PQ033]



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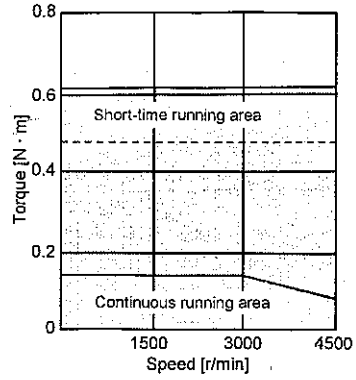

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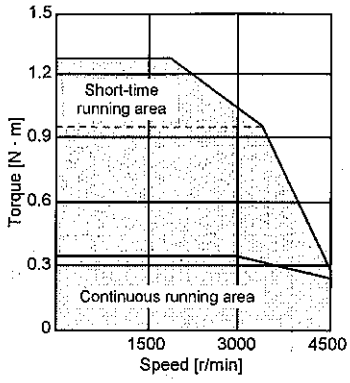

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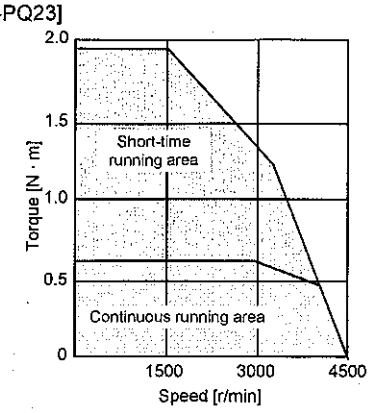

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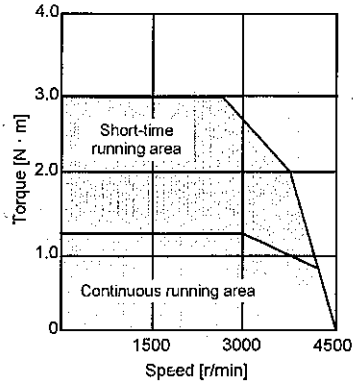


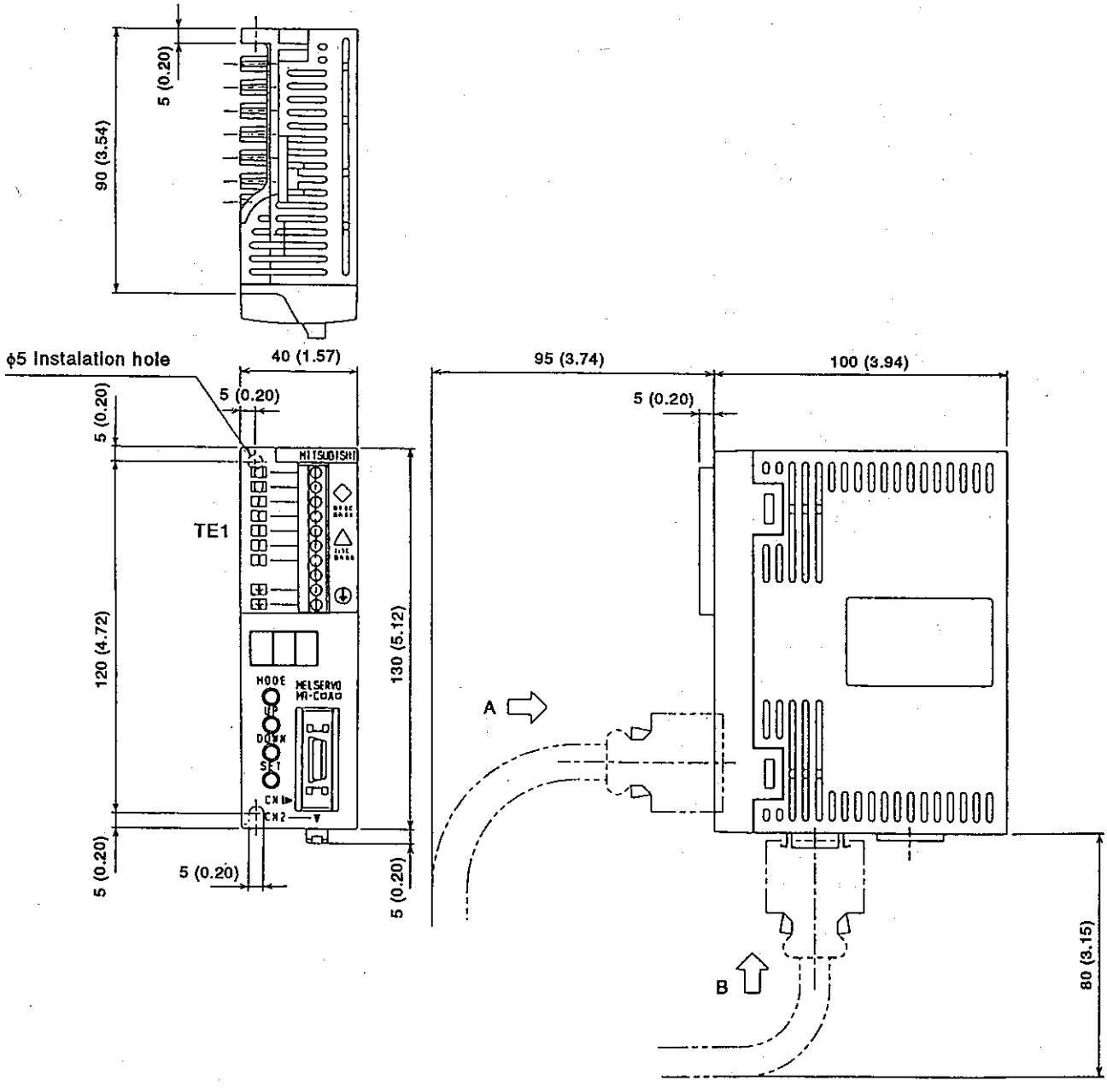
10. SPECIFICATIONS

10 – 3 Outline Drawings

10 – 3 – 1 Servo amplifiers

MR-C10A(1), MR-C20A(1)

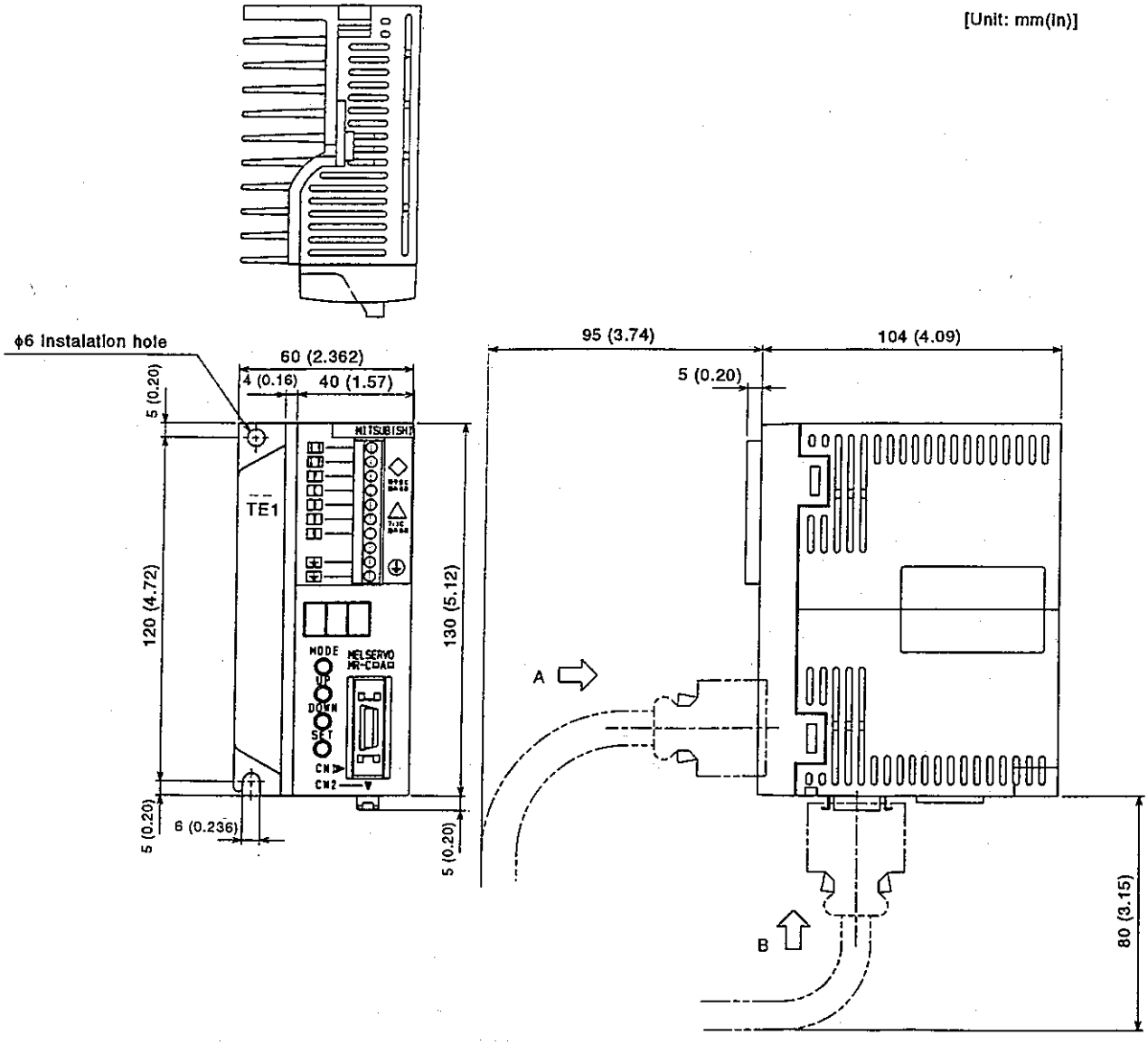
[Unit: mm(in)]



10. SPECIFICATIONS

MR-C40A

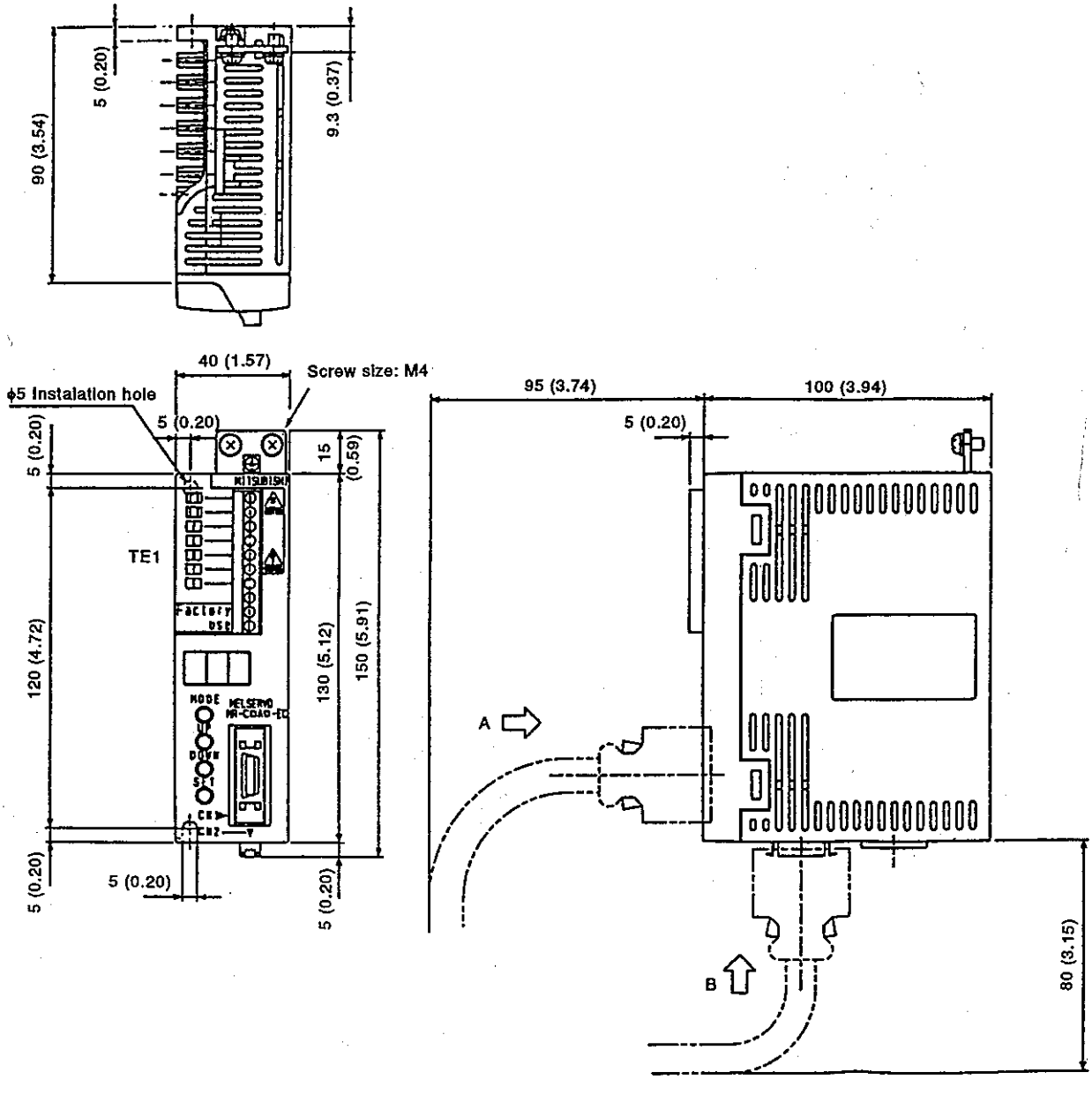
[Unit: mm(in)]



10. SPECIFICATIONS

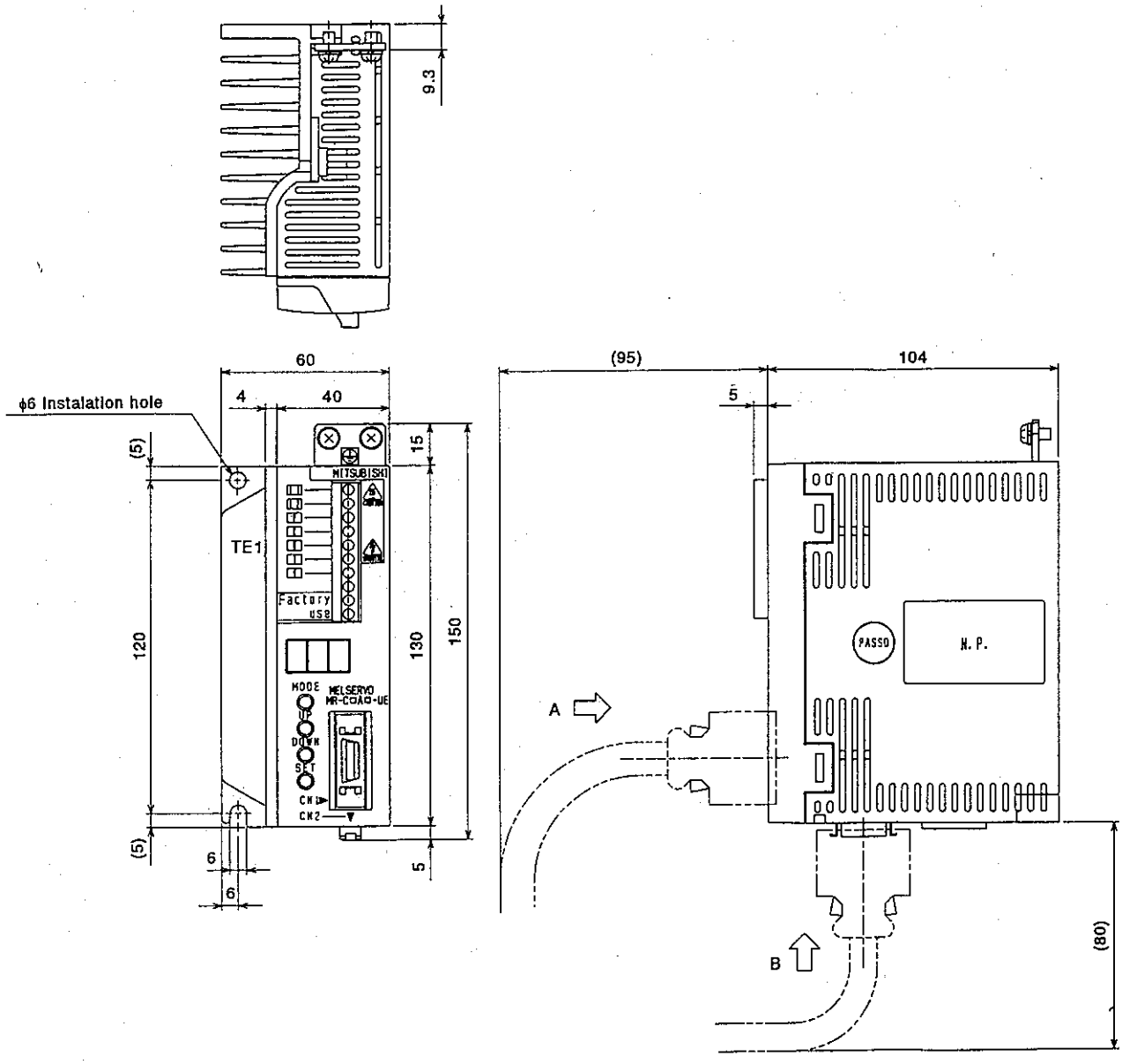
MR-C10A(1)-UE, MR-C20A(1)-UE

[Unit: mm(in)]



MR-C40A-UE

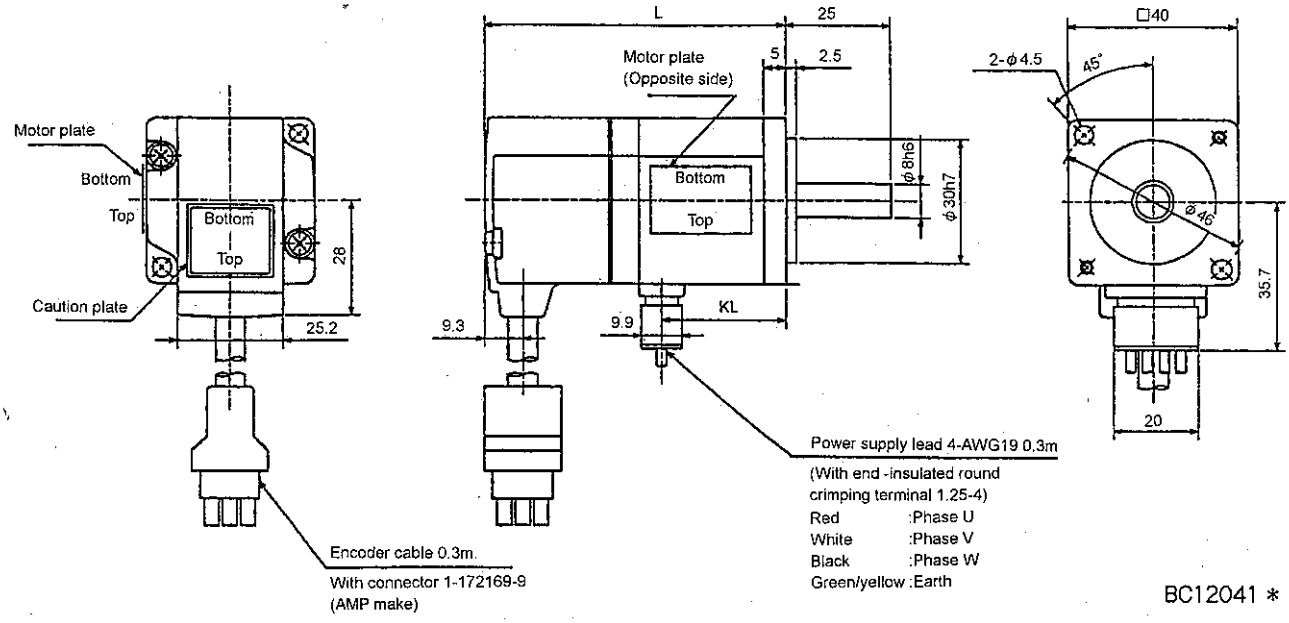
[Unit: mm]



10. SPECIFICATIONS

10 – 3 – 2 Servo motors

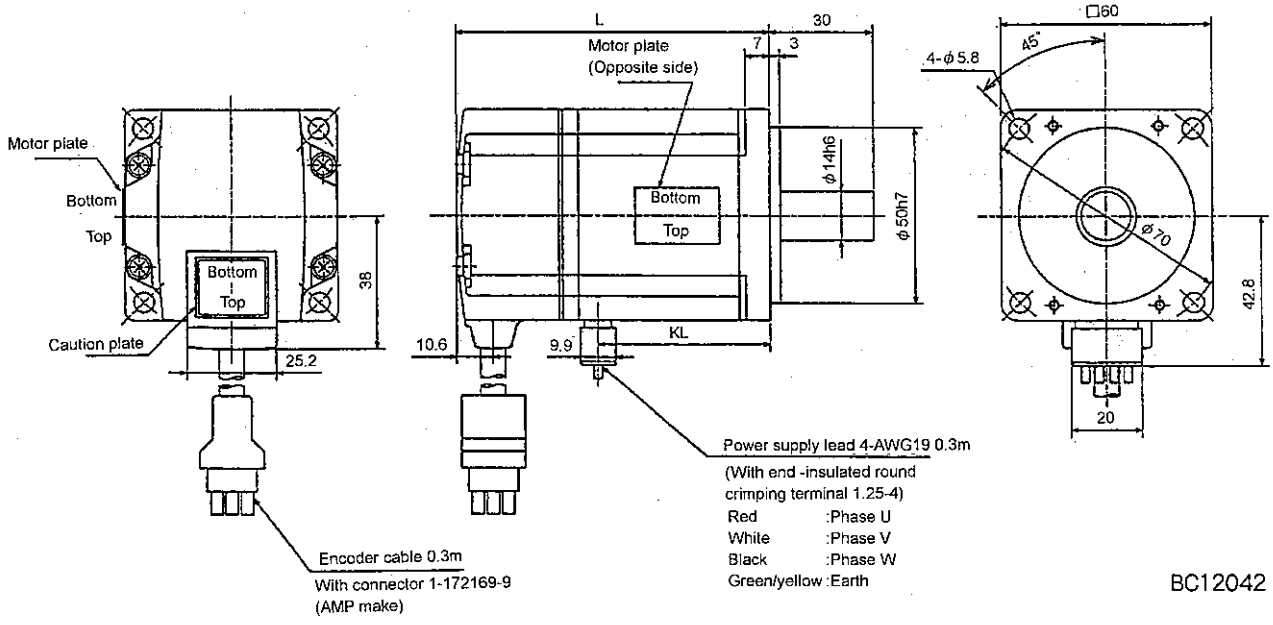
(1) Standard (without electromagnetic brake, without reduction gear)



BC12041 *

[Unit: mm]

Model	Output [W]	Variable Dimensions		Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
		L	KL		
HC-PQ033	30	65.5	23.5	0.014	0.32
HC-PQ053	50	71.5	29.5	0.019	0.37
HC-PQ13	100	86.5	44.5	0.03	0.50



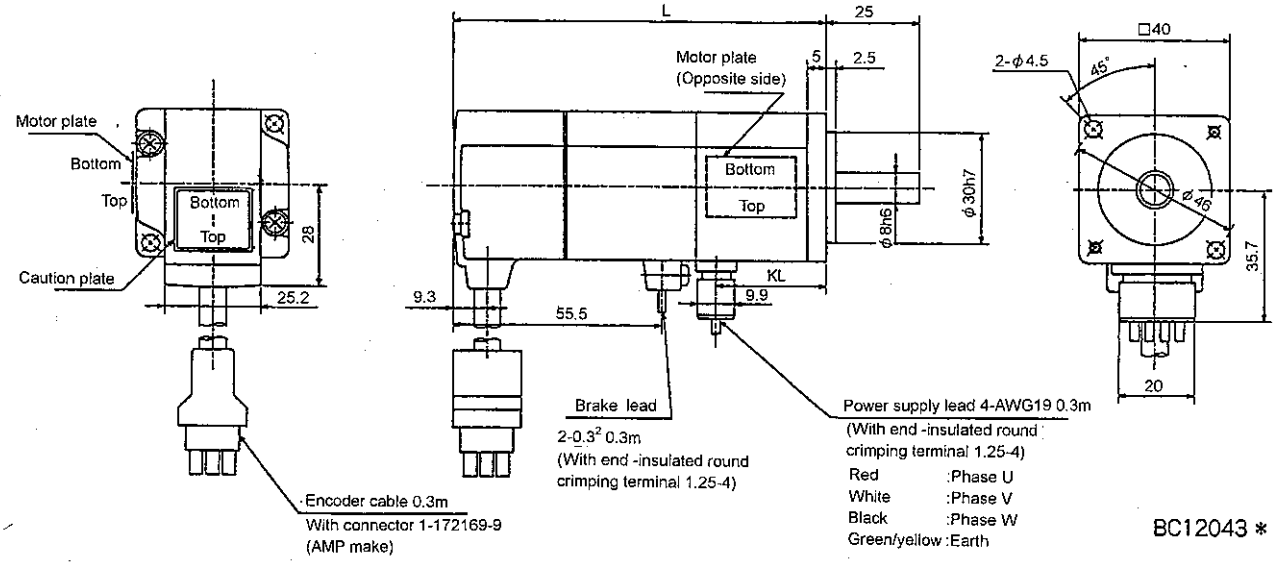
BC12042 *

[Unit: mm]

Model	Output [W]	Variable Dimensions		Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
		L	KL		
HC-PQ23	200	89	49.1	0.088	0.96
HC-PQ43	400	114	72.1	0.143	1.45

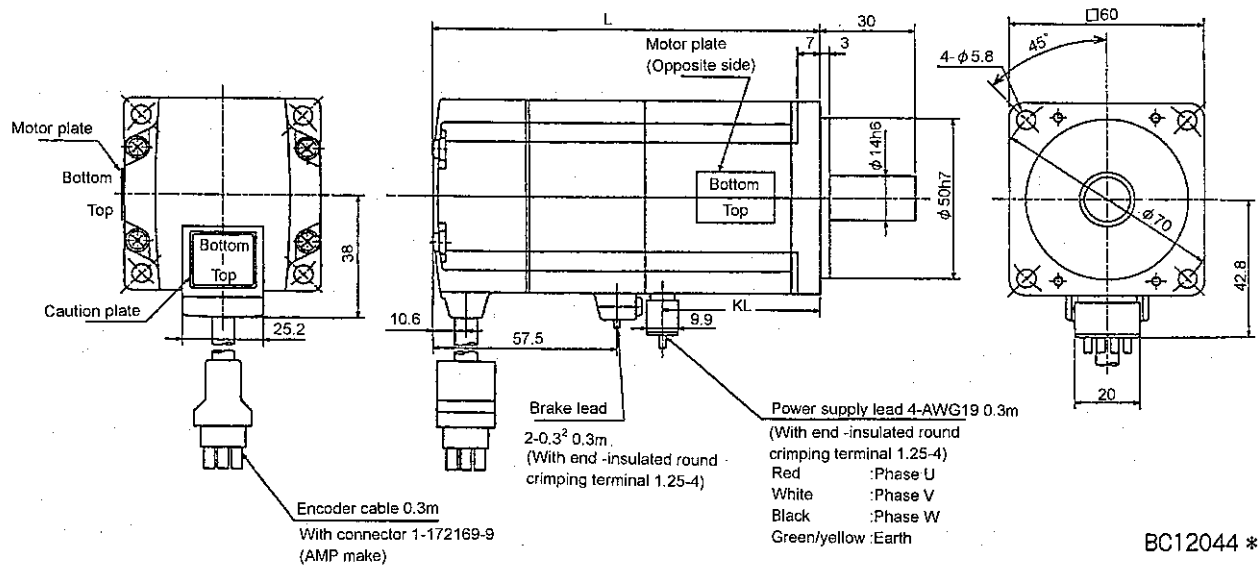
10. SPECIFICATIONS

(2) With electromagnetic brake



[Unit: mm]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment J [x10⁻⁴kg•m²]	Weight [kg]
		L	KL			
HC-PQ033B	30	93.5	23.5	0.32	0.017	0.63
HC-PQ053B	50	99.5	29.5	0.32	0.022	0.69
HC-PQ13B	100	114.5	44.5	0.32	0.032	0.83



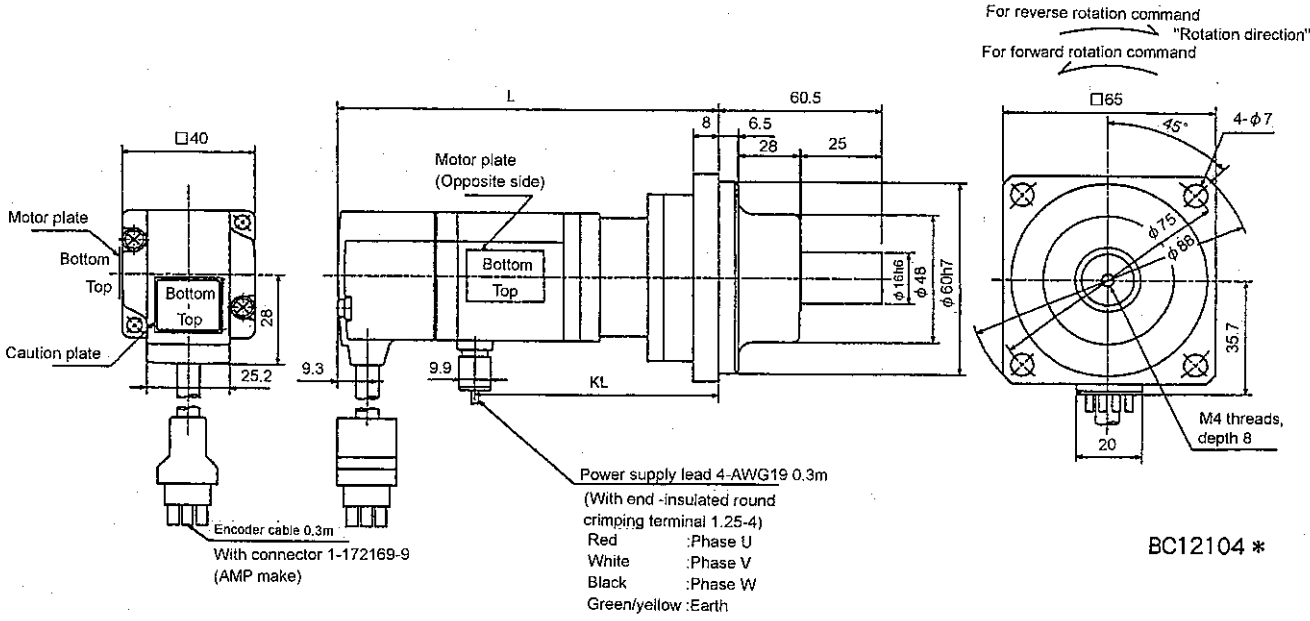
[Unit: mm]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment J [x10⁻⁴kg•m²]	Weight [kg]
		L	KL			
HC-PQ23B	200	121	49.1	1.3	0.136	1.6
HC-PQ43B	400	146	72.1	1.3	0.191	2.1

10. SPECIFICATIONS

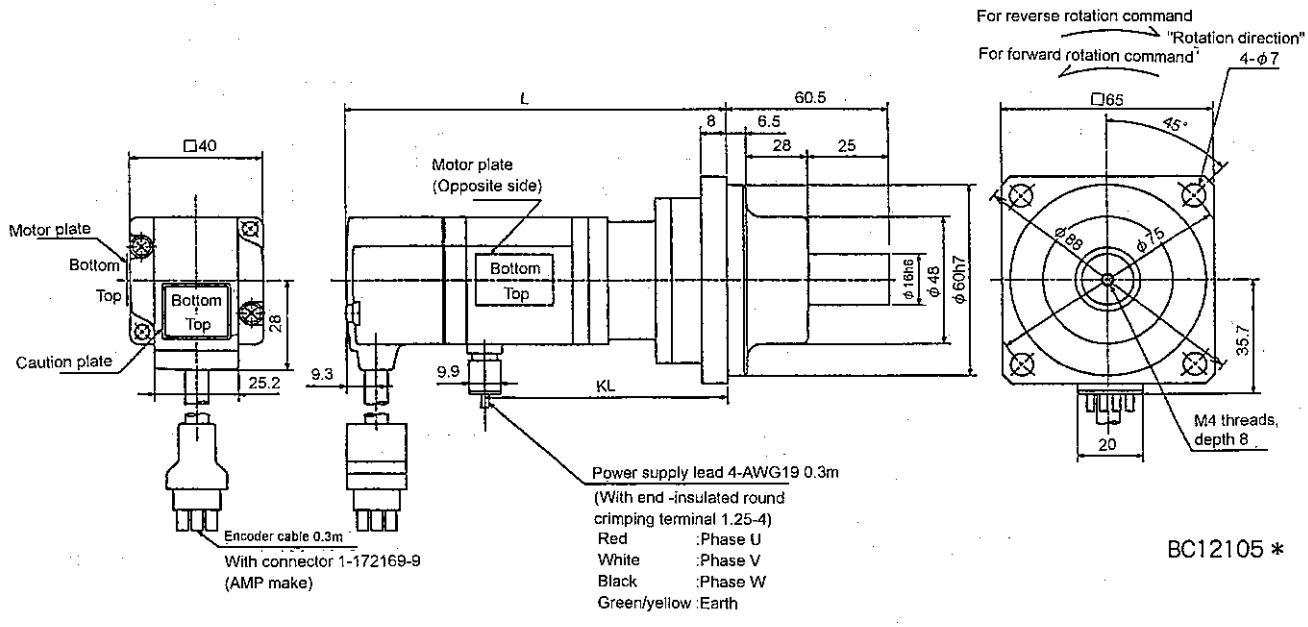
(3) With reduction gear for general industrial machine

(a) Without electromagnetic brake



[Unit: mm]

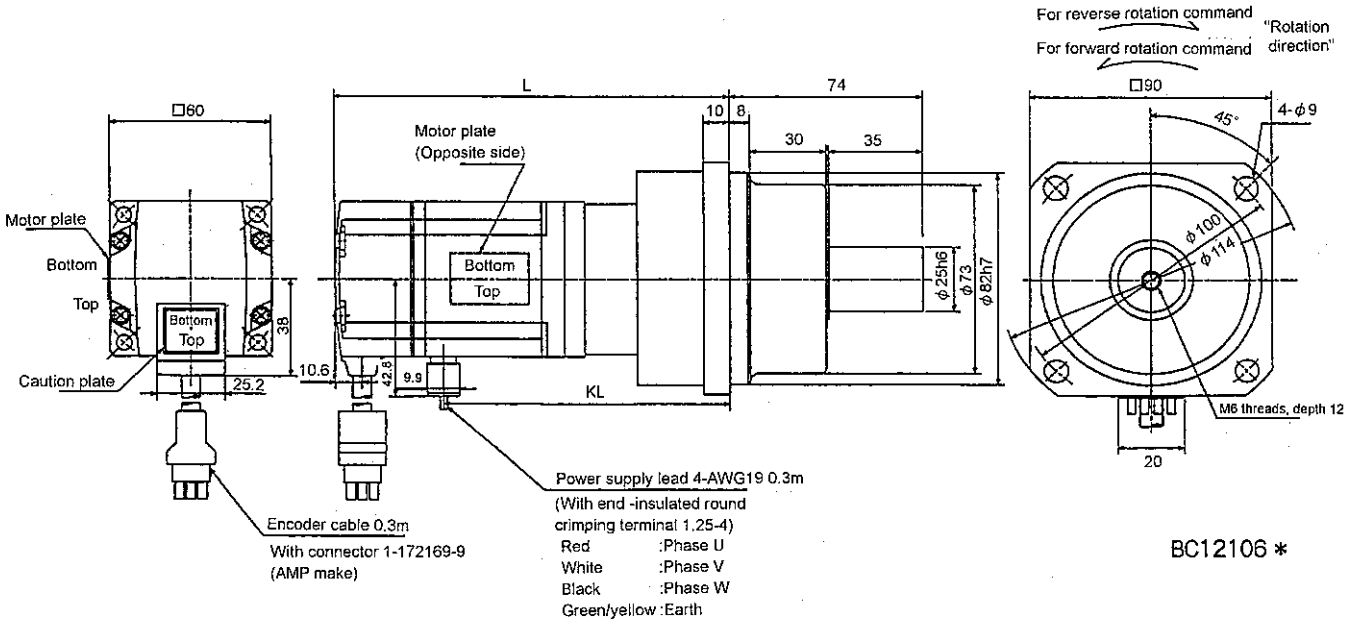
Model	Output [W]	Variable Dimensions		Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Backlash	Weight [kg]
		L	KL					
HC-PQ053BG1	50	115.5	74	K6505	1/5 (9/44)	0.055	60min.max.	1.4
HC-PQ053BG1	50	134	92	K6512	1/12 (49/576)	0.077	60min.max.	1.8
HC-PQ053BG1	50	134	92	K6520	1/20 (25/484)	0.059	60min.max.	1.8



[Unit: mm]

Model	Output [W]	Variable Dimensions		Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Backlash	Weight [kg]
		L	KL					
HC-PQ13G1	100	130.5	89	K6505	1/5 (9/44)	0.067	60min.max.	1.5
HC-PQ13G1	100	149	107	K6512	1/12 (49/576)	0.089	60min.max.	1.9
HC-PQ13G1	100	149	107	K6520	1/20 (25/484)	0.071	60min.max.	1.9

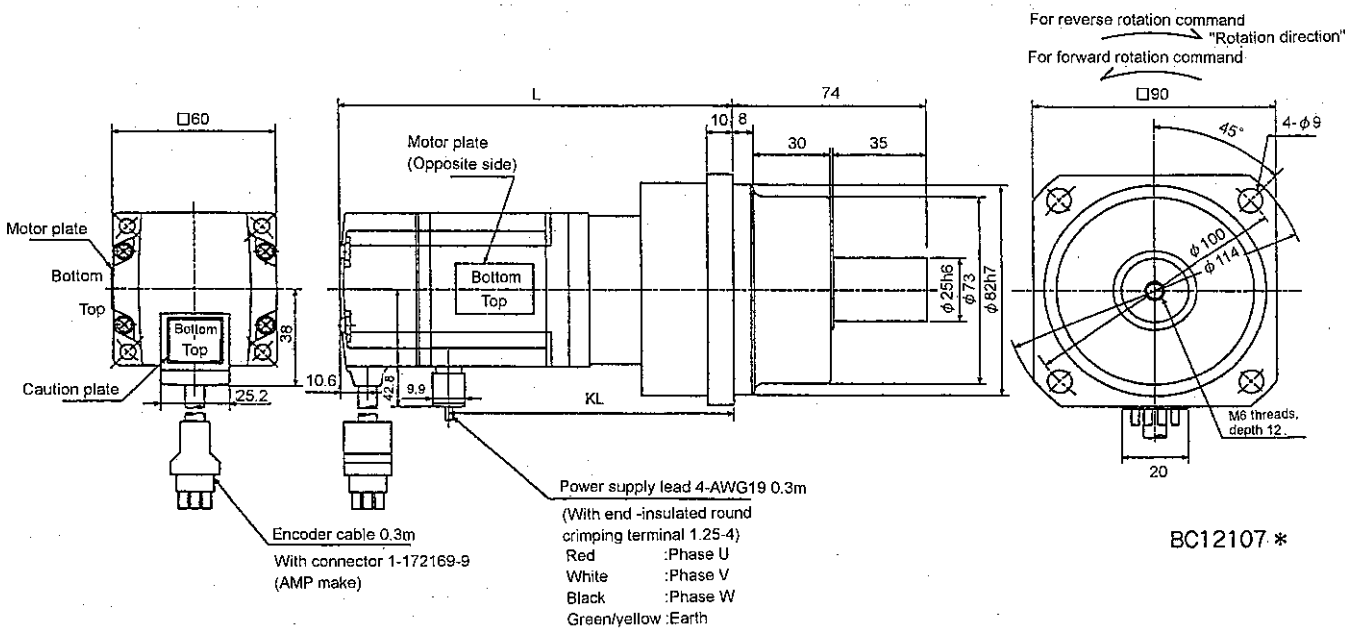
10. SPECIFICATIONS



BC12106 *

[Unit: mm]

Model	Output [W]	Variable Dimensions		Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Backlash	Weight [kg]
		L	KL					
HC-PQ23G1	200	142.5	102.6	K9005	1/5 (19/96)	0.249	60min.max.	3.3
HC-PQ23G1	200	162	122.6	K9012	1/12 (25/288)	0.293	60min.max.	3.9
HC-PQ23G1	200	162	122.6	K9020	1/20 (253/5000)	0.266	60min.max.	3.9

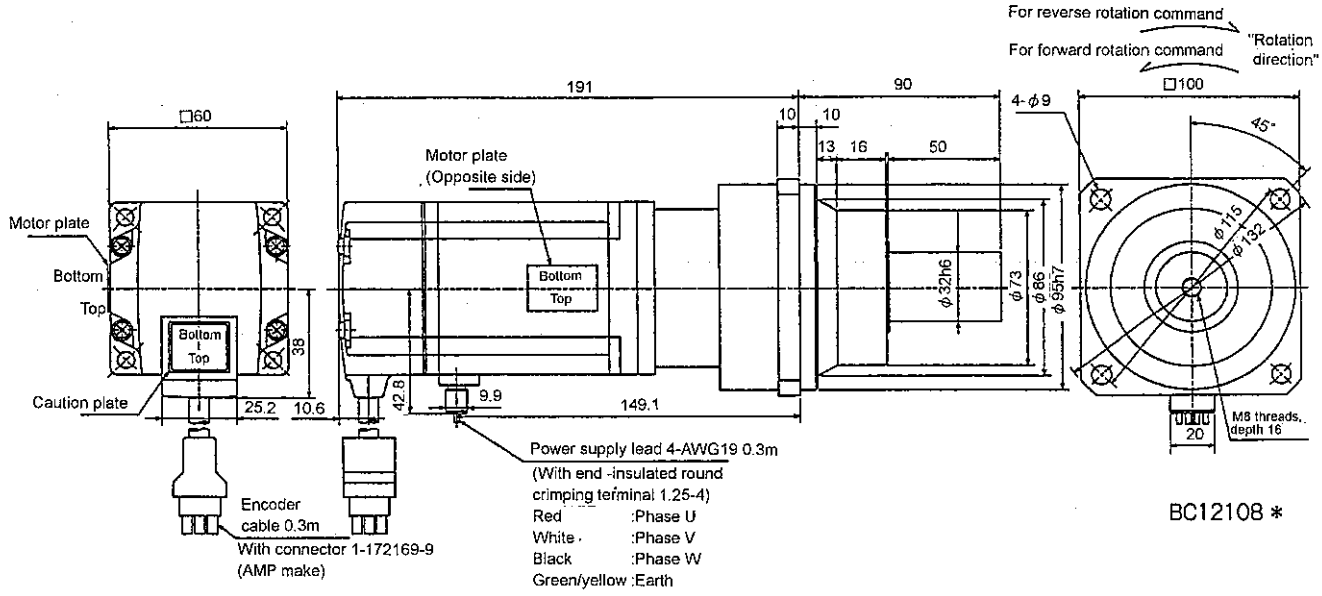


BC12107 *

[Unit: mm]

Model	Output [W]	Variable Dimensions		Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Backlash	Weight [kg]
		L	KL					
HC-PQ43G1	400	168	125.6	K9005	1/5 (19/96)	0.296	60min.max.	3.8
HC-PQ43G1	400	187	145.6	K9012	1/12 (25/288)	0.339	60min.max.	4.4

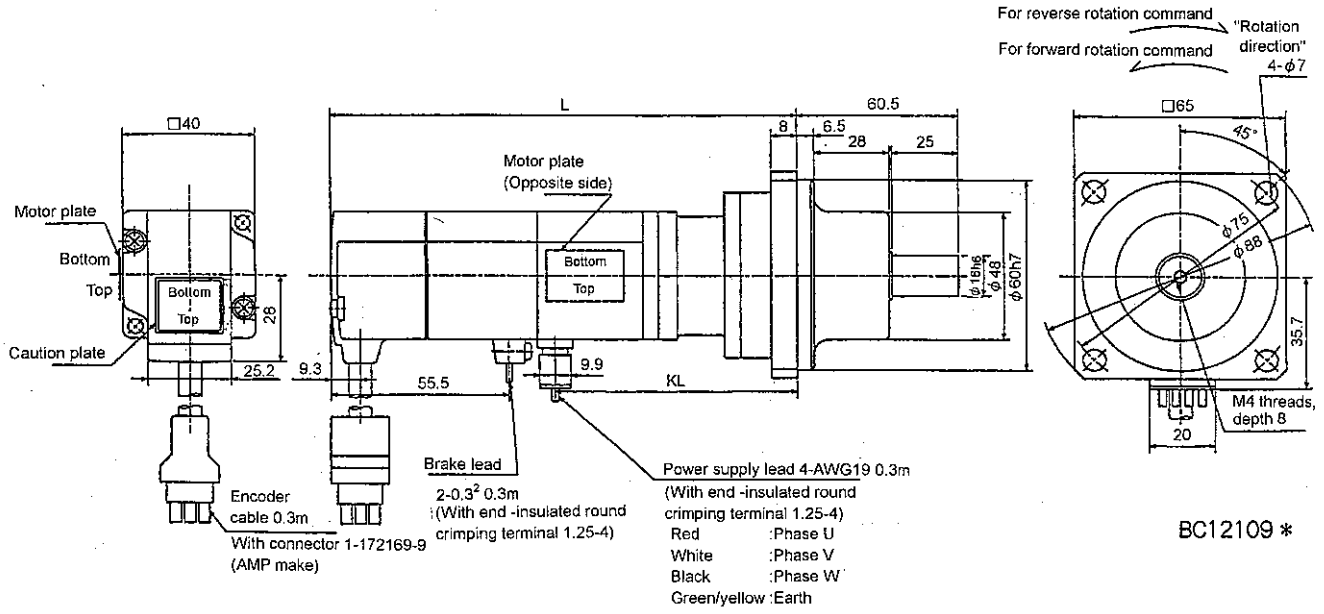
10. SPECIFICATIONS



[Unit: mm]

Model	Output [W]	Reduction Gear Model	Reduction Ratio		Inertia Moment J [$\times 10^{-4}$kg•m^2]	Backlash	Weight [kg]
			Normal Reduction Ratio	Actual Reduction Ratio			
HC-PQ43G1	400	K10020	1/20	253/5000	0.653	60min.max.	5.5

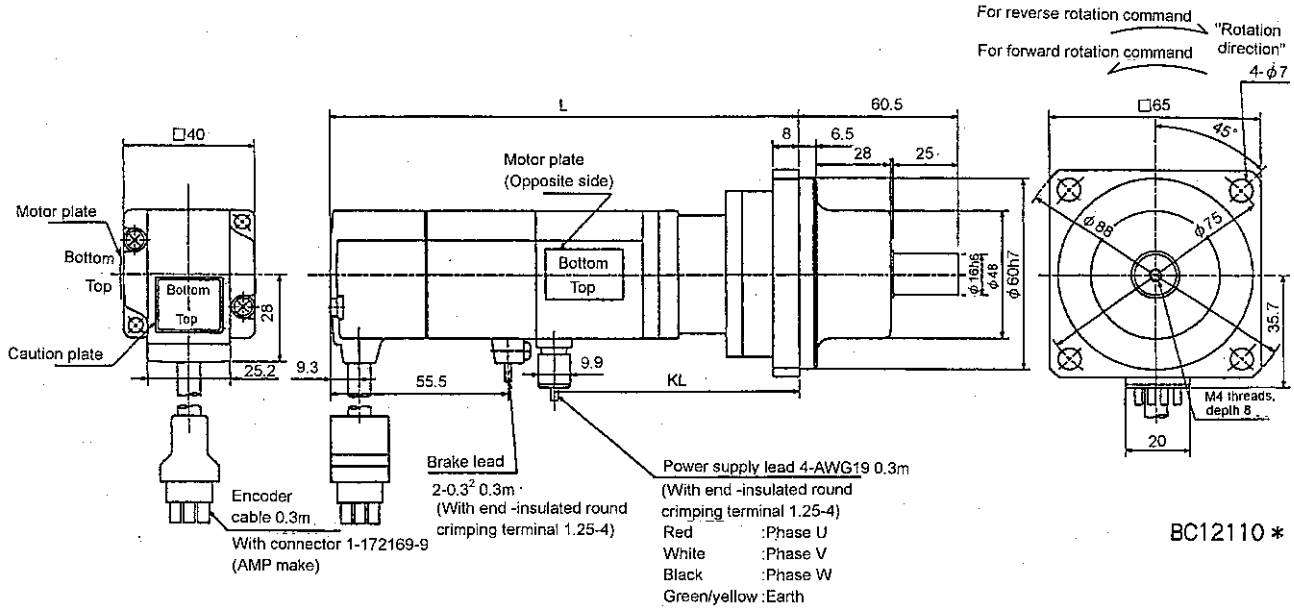
(b) With electromagnetic brake



[Unit: mm]

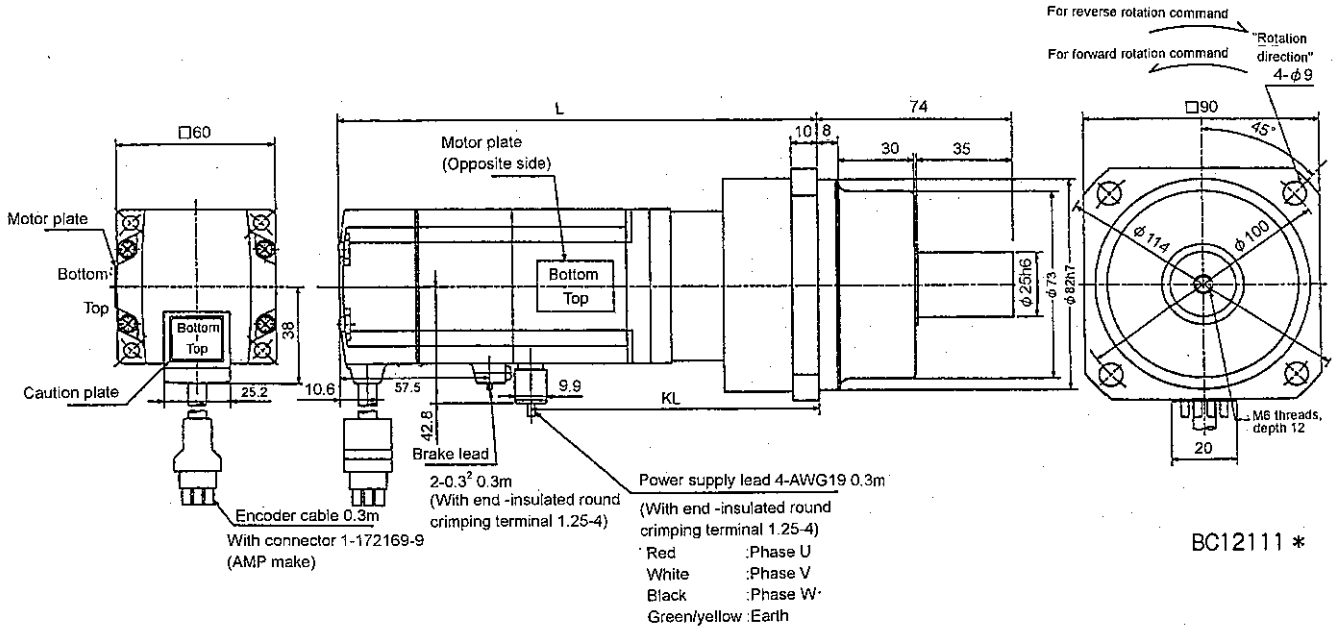
Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Backlash	Weight [kg]
		L	KL						
HC-PQ053BG1	50	143.5	74	0.32	K6505	1/5 (9/44)	0.058	60min.max.	1.8
HC-PQ053BG1	50	162	92	0.32	K6512	1/12 (49/576)	0.080	60min.max.	2.2
HC-PQ053BG1	50	162	92	0.32	K6520	1/20 (25/484)	0.062	60min.max.	2.2

10. SPECIFICATIONS



[Unit: mm]

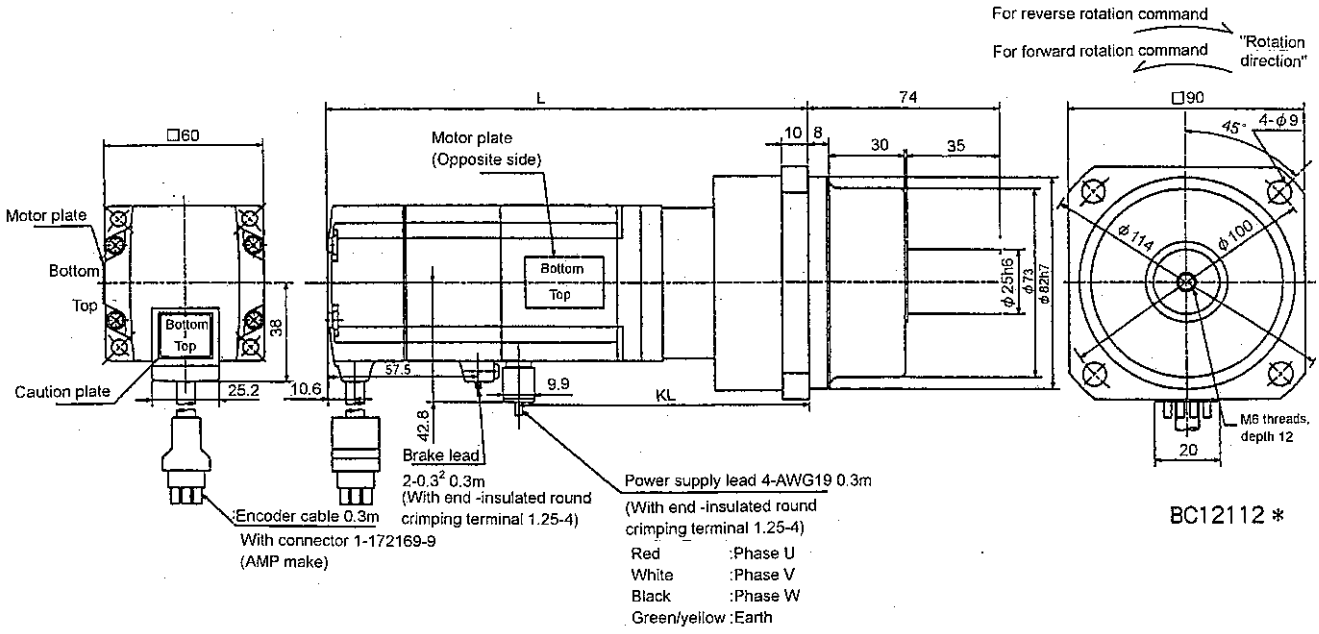
Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Backlash	Weight [kg]
		L	KL						
HC-PQ13BG1	100	158.5	89	0.32	K6505	1/5 (9/44)	0.069	60min.max.	1.9
HC-PQ13BG1	100	177	107	0.32	K6512	1/12 (49/576)	0.091	60min.max.	2.3
HC-PQ13BG1	100	177	107	0.32	K6520	1/20 (25/484)	0.073	60min.max.	2.3



[Unit: mm]

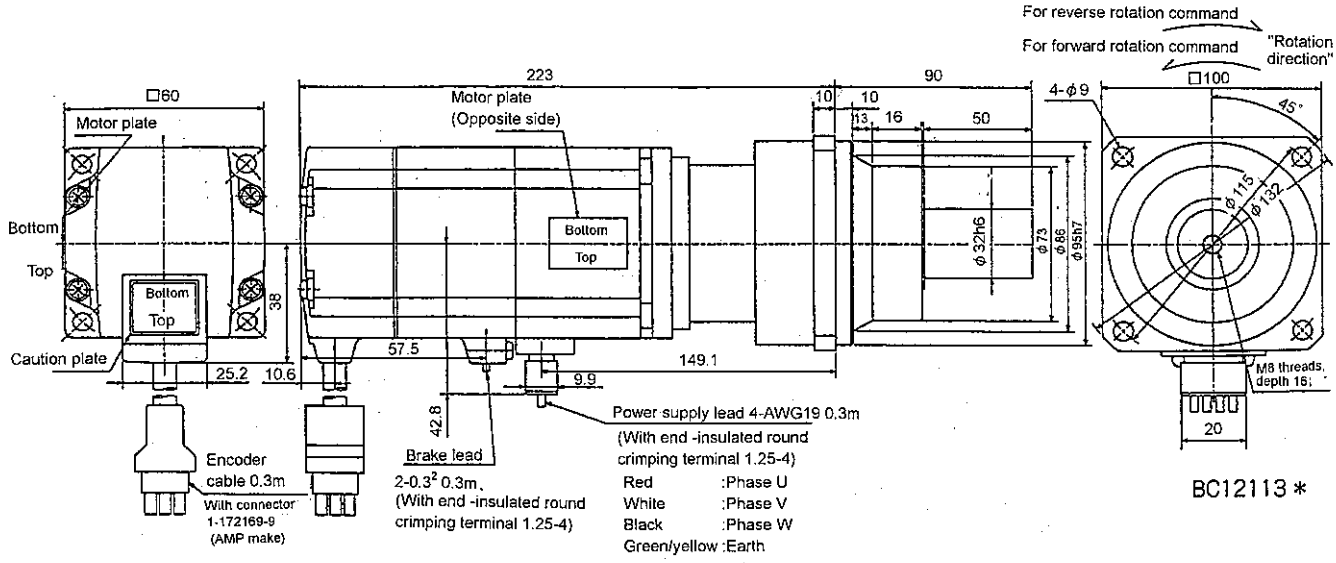
Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Backlash	Weight [kg]
		L	KL						
HC-PQ23BG1	200	174.5	102.6	1.3	K9005	1/5 (19/96)	0.289	60min.max.	3.9
HC-PQ23BG1	200	194	122.6	1.3	K9012	1/12 (25/288)	0.333	60min.max.	4.5
HC-PQ23BG1	200	194	122.6	1.3	K9020	1/20 (253/5000)	0.306	60min.max.	4.5

10. SPECIFICATIONS



[Unit: mm]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment J [x10^{-4}kg•m^2]	Backlash	Weight [kg]
		L	KL						
HC-PQ43BG1	400	200	125.6	1.3	K9005	1/5 (19/96)	0.344	60min.max.	4.4
HC-PQ43BG1	400	219	145.6	1.3	K9012	1/12 (25/288)	0.388	60min.max.	5.0



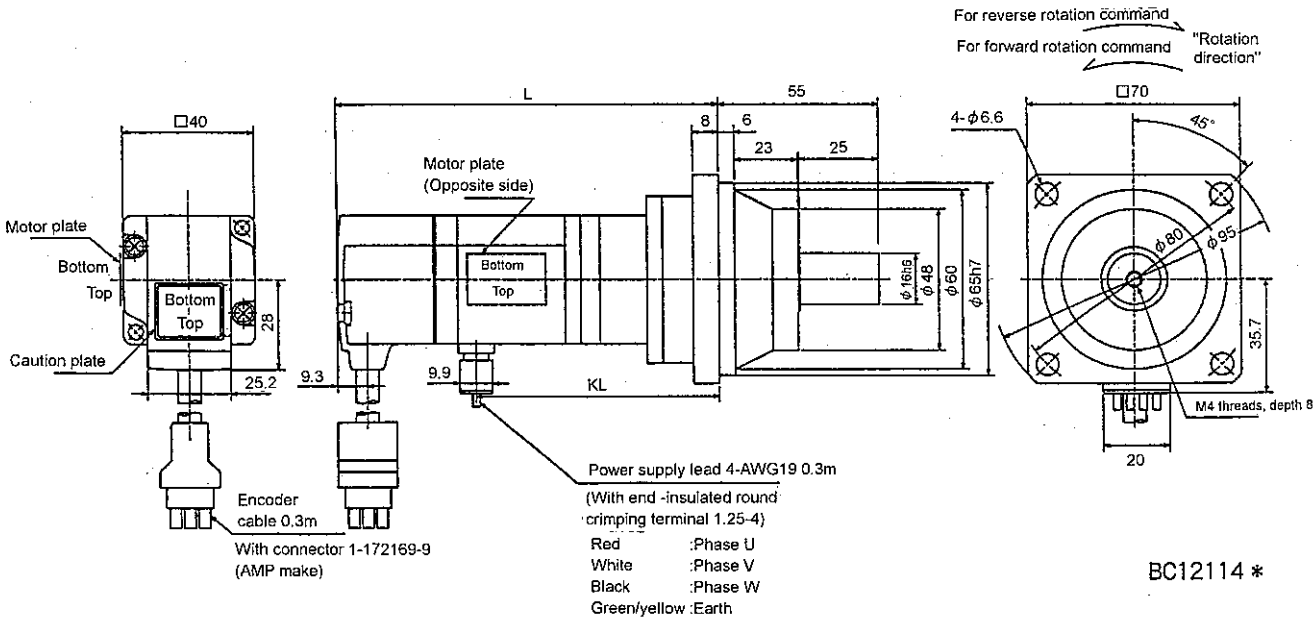
[Unit: mm]

Model	Output [W]	Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio		Inertia Moment J [x10^{-4}kg•m^2]	Backlash	Weight [kg]
				Normal Reduction Ratio	Actual Reduction Ratio			
HC-PQ43BG1	400	1.3	K10020	1/20	253/5000	0.700	60min.max.	6.1

10. SPECIFICATIONS

(4) With reduction gear for precision application

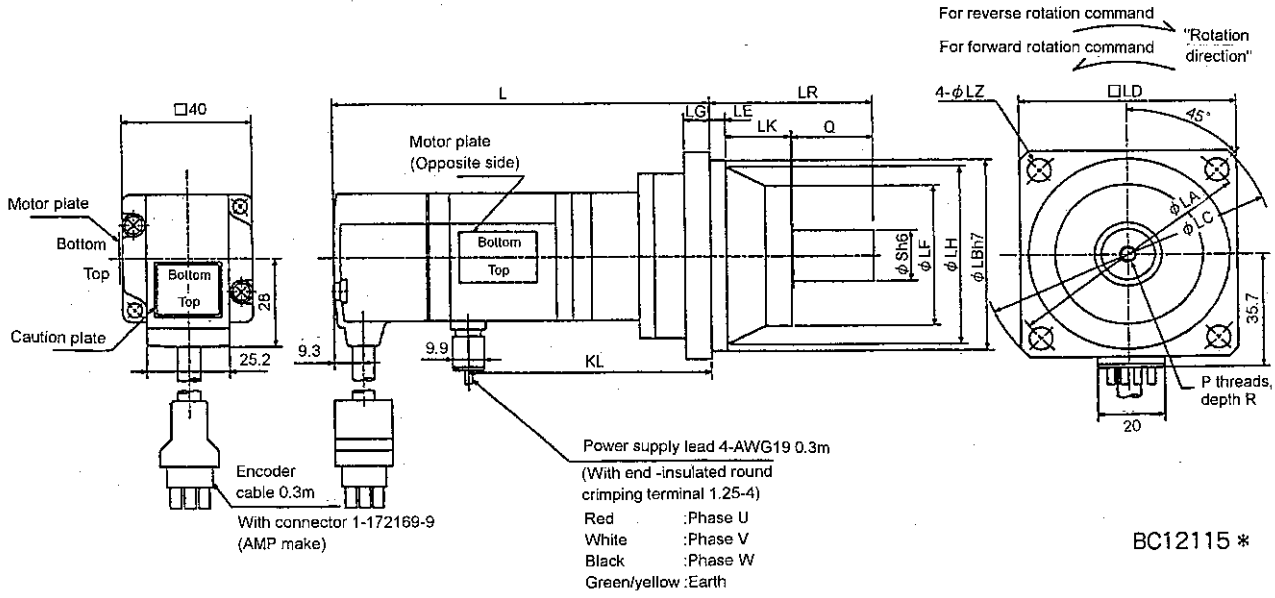
(a) Without electromagnetic brake



[Unit: mm]

Model	Output [W]	Variable Dimensions		Reduction Gear Model	Reduction Ratio	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Backlash	Weight [kg]
		L	KL					
HC-PQ053G2	50	119.5	78	BK1-05B-A5MEKA	1/5	0.067	3min.max.	1.4
HC-PQ053G2	50	135.5	94	BK1-09B-A5MEKA	1/9	0.060	3min.max.	1.7
HC-PQ053G2	50	135.5	94	BK1-20B-A5MEKA	1/20	0.069	3min.max.	1.8
HC-PQ053G2	50	135.5	94	BK1-29B-A5MEKA	1/29	0.057	3min.max.	1.8

10. SPECIFICATIONS

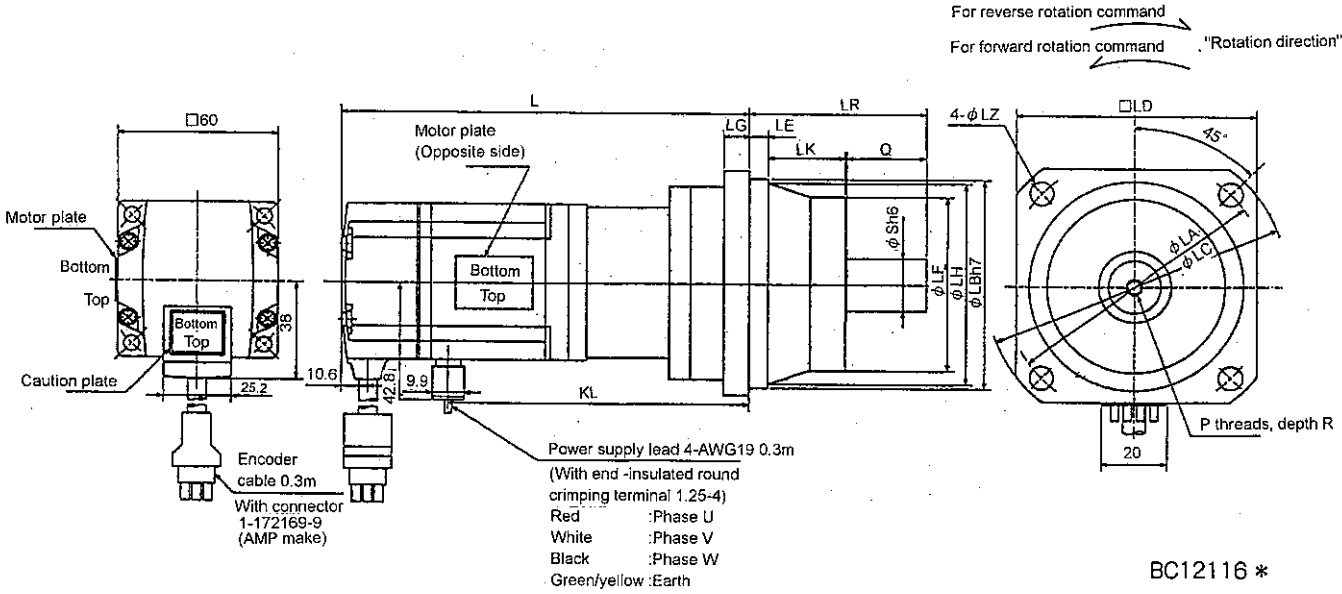


Model	Output [W]	Reduction Gear Model	Reduction Ratio	Inertia Moment J [$\times 10^{-4}$kg·m^2]	Backlash	Weight [kg]
HC-PQ13G2	100	BK1-05B-01MEKA	1/5	0.078	3min.max.	1.5
HC-PQ13G2	100	BK1-09B-01MEKA	1/9	0.072	3min.max.	1.8
HC-PQ13G2	100	BK2-20B-01MEKA	1/20	0.122	3min.max.	3.0
HC-PQ13G2	100	BK2-29B-01MEKA	1/29	0.096	3min.max.	3.0

[Unit: mm]

Model	Output [W]	Variable Dimensions																	Reduction Ratio
		LA	LB	LC	LD	LE	LF	LG	LH	LK	L	LR	KL	LZ	Q	S	P	R	
HC-PQ13G2	100	80	65	95	70	6	48	8	60	23	134.5	55	93	6.6	25	16	M4	8	1/5
HC-PQ13G2	100	80	65	95	70	6	48	8	60	23	150.5	55	109	6.6	25	16	M4	8	1/9
HC-PQ13G2	100	100	80	115	85	6	65	10	74	33	156.5	75	115	6.6	35	20	M5	10	1/20
HC-PQ13G2	100	100	80	115	85	6	65	10	74	33	156.6	75	115	6.6	35	20	M5	10	1/29

10. SPECIFICATIONS

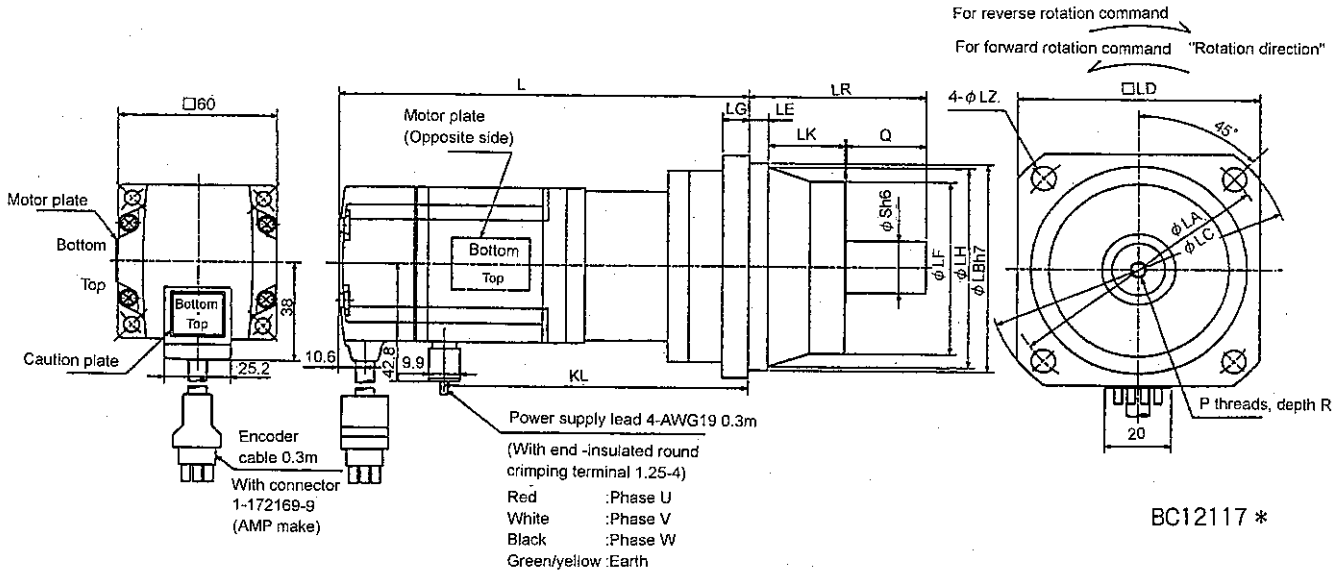


Model	Output [W]	Reduction Gear Model	Reduction Ratio	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Backlash	Weight [kg]
HC-PQ23G2	200	BK1-05B-02MEKA	1/5	0.191	3min.max.	2.1
HC-PQ23G2	200	BK1-09B-02MEKA	1/9	0.208	3min.max.	3.5
HC-PQ23G2	200	BK2-20B-02MEKA	1/20	0.357	3min.max.	5.0
HC-PQ23G2	200	BK2-29B-02MEKA	1/29	0.276	3min.max.	5.0

[Unit: mm]

Model	Output [W]	Variable Dimensions																	Reduction Ratio
		LA	LB	LC	LD	LE	LF	LG	LH	LK	L	LR	KL	LZ	Q	S	P	R	
HC-PQ23G2	200	80	65	95	70	6	48	8	60	23	146	55	106.6	6.6	25	16	M4	8	1/5
HC-PQ23G2	200	100	80	115	85	6	65	10	74	33	164	75	124.6	6.6	35	20	M5	10	1/9
HC-PQ23G2	200	115	95	135	100	8	75	10	85	35	169	85	129.6	9	40	25	M6	12	1/20
HC-PQ23G2	200	115	95	135	100	8	75	10	85	35	169	85	129.6	9	40	25	M6	12	1/29

10. SPECIFICATIONS

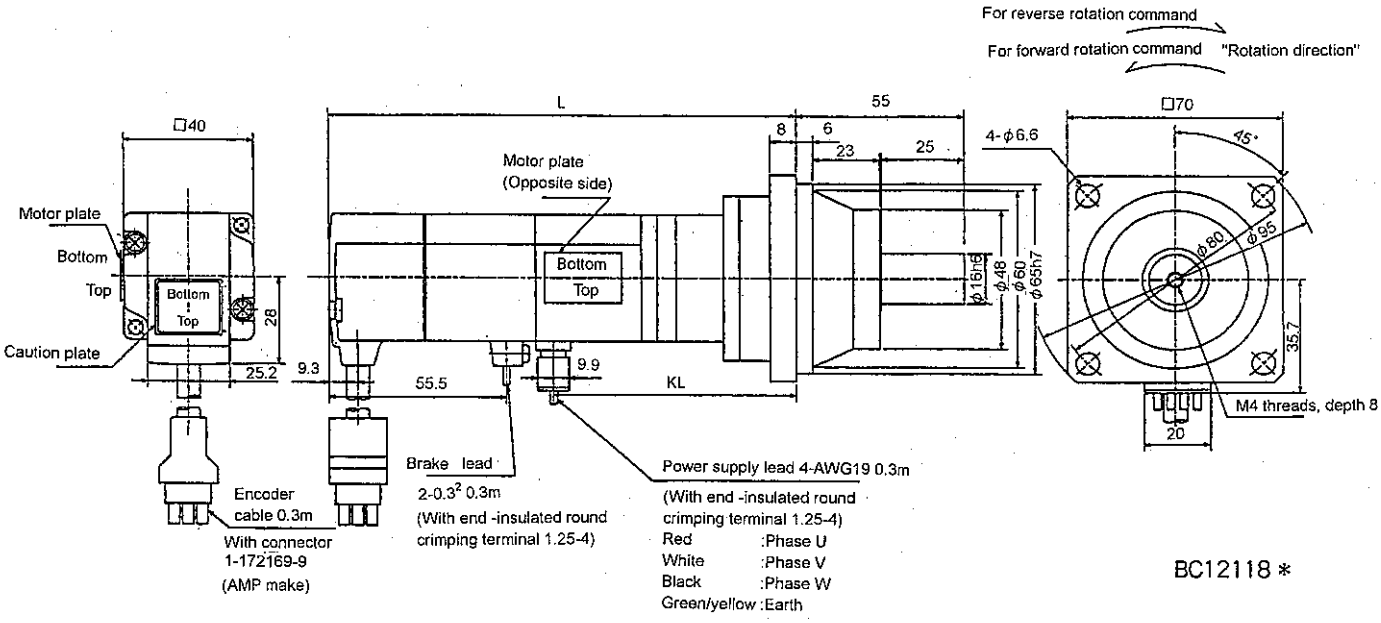


Model	Output [W]	Reduction Gear Model	Reduction Ratio	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Backlash	Weight [kg]
HC-PQ43G2	400	BK2-05B-04MEKA	1/5	0.295	3min.max.	3.7
HC-PQ43G2	400	BK2-09B-04MEKA	1/9	0.323	3min.max.	5.3
HC-PQ43G2	400	BK4-20B-04MEKA	1/20	0.426	3min.max.	7.5
HC-PQ43G2	400	BK4-29B-04MEKA	1/29	0.338	3min.max.	7.5

[Unit: mm]

Model	Output [W]	Variable Dimensions																Reduction Ratio
		LA	LB	LC	LD	LE	LF	LG	LH	LK	L	LR	KL	LZ	Q	S	P	R	
HC-PQ43G2	400	100	80	115	85	6	65	10	74	33	174	75	131.6	6.6	35	20	M5	10	1/5
HC-PQ43G2	400	115	95	135	100	8	75	10	85	35	195	85	152.6	9	40	25	M6	12	1/9
HC-PQ43G2	400	135	110	155	115	8	90	12	100	40	201	100	158.6	11	50	32	M8	16	1/20
HC-PQ43G2	400	135	110	155	115	8	90	12	100	40	201	100	158.6	11	50	32	N8	16	1/29

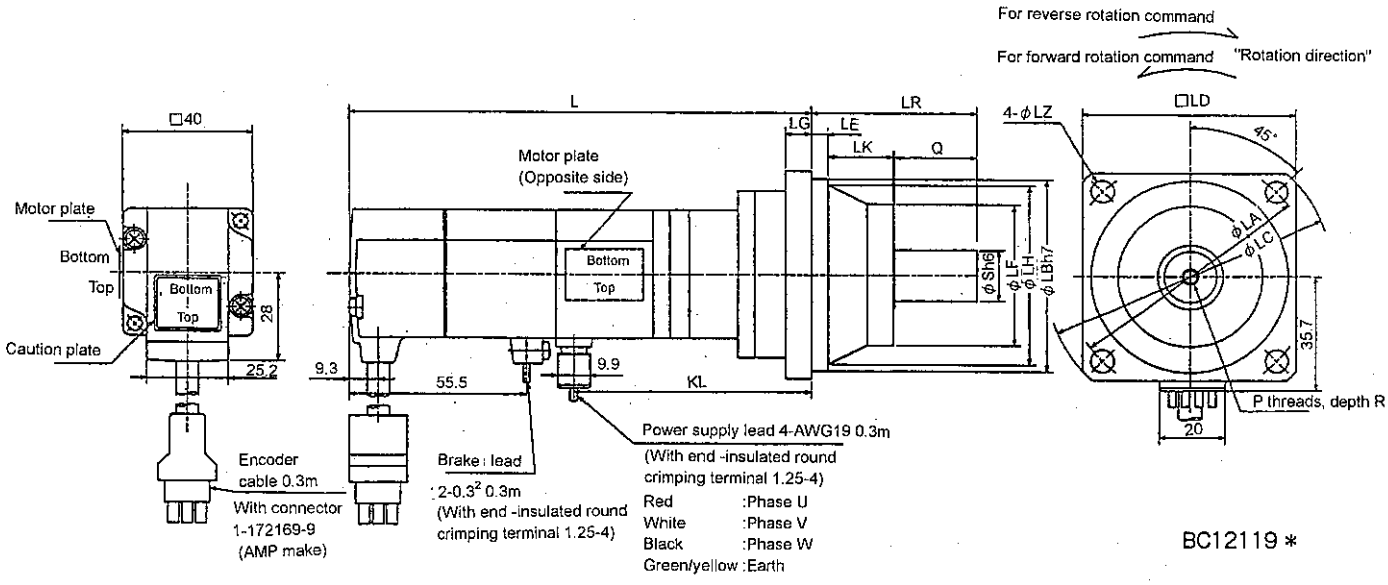
(b) With electromagnetic brake



[Unit: mm]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Backlash	Weight [kg]
		L	KL						
HC-PQ053BG2	50	147.5	78	0.32	BK1-05B-A5MEKA	1/5	0.070	3min.max.	1.8
HC-PQ053BG2	50	163.5	94	0.32	BK1-09B-A5MEKA	1/9	0.063	3min.max.	2.1
HC-PQ053BG2	50	163.5	94	0.32	BK1-20B-A5MEKA	1/20	0.072	3min.max.	2.2
HC-PQ053BG2	50	163.5	94	0.32	BK1-29B-A5MEKA	1/29	0.060	3min.max.	2.2

10. SPECIFICATIONS

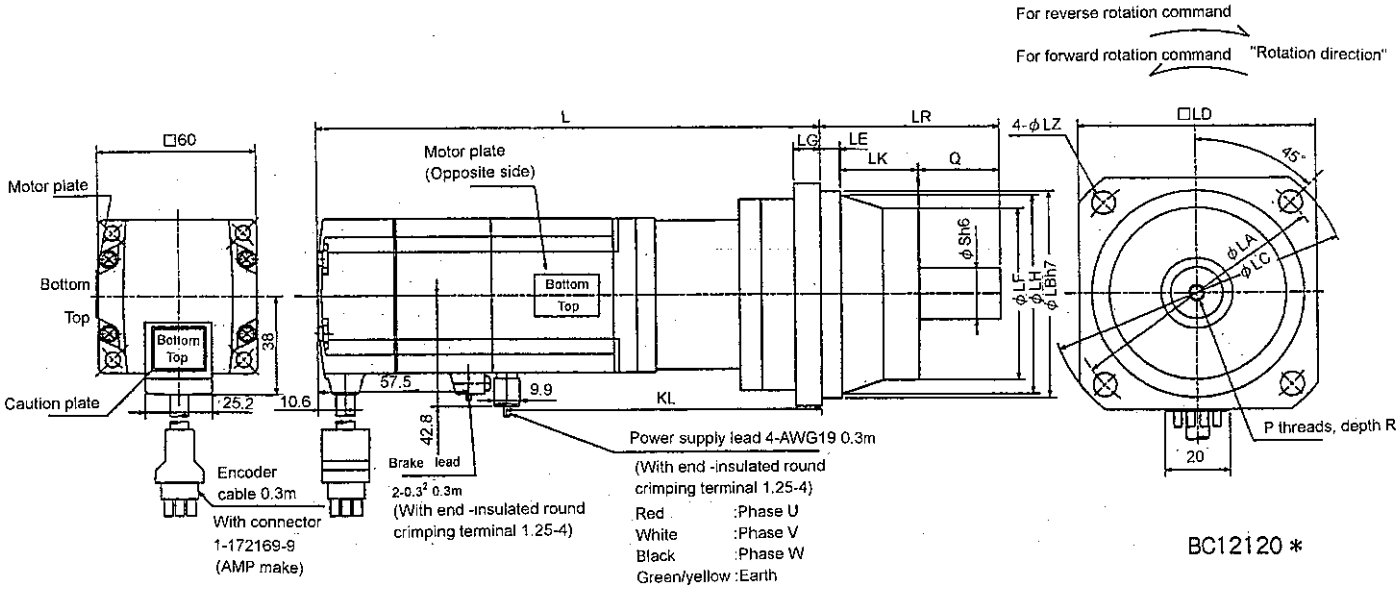


Model	Output [W]	Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Backlash	Weight [kg]
HC-PQ13BG2	100	0.32	BK1-05B-01MEKA	1/5	0.080	3min.max.	1.9
HC-PQ13BG2	100	0.32	BK1-09B-01MEKA	1/9	0.074	3min.max.	2.2
HC-PQ13BG2	100	0.32	BK2-20B-01MEKA	1/20	0.124	3min.max.	3.4
HC-PQ13BG2	100	0.32	BK2-29B-01MEKA	1/29	0.098	3min.max.	3.4

[Unit: mm]

Model	Output [W]	Variable Dimensions																Reduction Ratio
		LA	LB	LC	LD	LE	LF	LG	LH	LK	L	LR	KL	LZ	Q	S	P	R	
HC-PQ13BG2	100	80	65	95	70	6	48	8	60	23	162.5	55	93	6.6	25	16	M4	8	1/5
HC-PQ13BG2	100	80	65	95	70	6	48	8	60	23	178.5	55	109	6.6	25	16	M4	8	1/9
HC-PQ13BG2	100	100	80	115	85	6	65	10	74	33	184.5	75	115	6.6	35	20	M5	10	1/20
HC-PQ13BG2	100	100	80	115	85	6	65	10	74	33	184.5	75	115	6.6	35	20	M5	10	1/29

10. SPECIFICATIONS

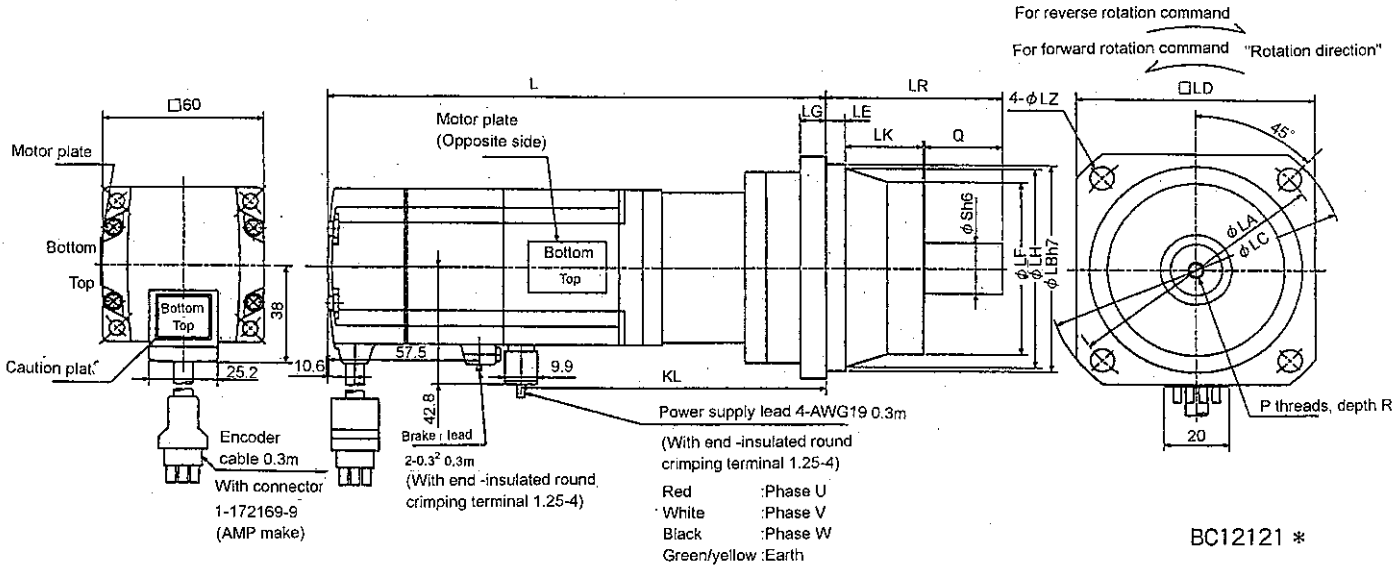


Model	Output [W]	Brake Static Friction Torque [N·m]	Reduction Gear Model	Reduction Ratio	Inertia Moment J [$\times 10^{-4}$kg·m^2]	Backlash	Weight [kg]
HC-PQ23BG2	200	1.3	BK1-05B-02MEKA	1/5	0.239	3min.max.	2.7
HC-PQ23BG2	200	1.3	BK2-09B-02MEKA	1/9	0.256	3min.max.	4.1
HC-PQ23BG2	200	1.3	BK3-20B-02MEKA	1/20	0.405	3min.max.	5.6
HC-PQ23BG2	200	1.3	BK3-29B-02MEKA	1/29	0.324	3min.max.	5.6

[Unit: mm]

Model	Output [W]	Variable Dimensions																Reduction Ratio
		LA	LB	LC	LD	LE	LF	LG	LH	LK	L	LR	KL	LZ	Q	S	P	R	
HC-PQ23BG2	200	80	65	95	70	6	48	8	60	23	178	55	106.6	6.6	25	16	M4	8	1/5
HC-PQ23BG2	200	100	80	115	85	6	65	10	74	33	196	75	124.6	6.6	35	20	M5	10	1/9
HC-PQ23BG2	200	115	95	135	100	8	75	10	85	35	201	85	129.6	9	40	25	M6	12	1/20
HC-PQ23BG2	200	115	95	135	100	8	75	10	85	35	201	85	129.6	9	40	25	M6	12	1/29

10. SPECIFICATIONS



Model	Output [W]	Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Backlash	Weight [kg]
HC-PQ43BG2	400	1.3	BK2-05B-04MEKA	1/5	0.344	3min.max.	4.3
HC-PQ43BG2	400	1.3	BK3-09B-04MEKA	1/9	0.372	3min.max.	5.9
HC-PQ43BG2	400	1.3	BK4-20B-04MEKA	1/20	0.475	3min.max.	8.1
HC-PQ43BG2	400	1.3	BK4-29B-04MEKA	1/29	0.386	3min.max.	8.1

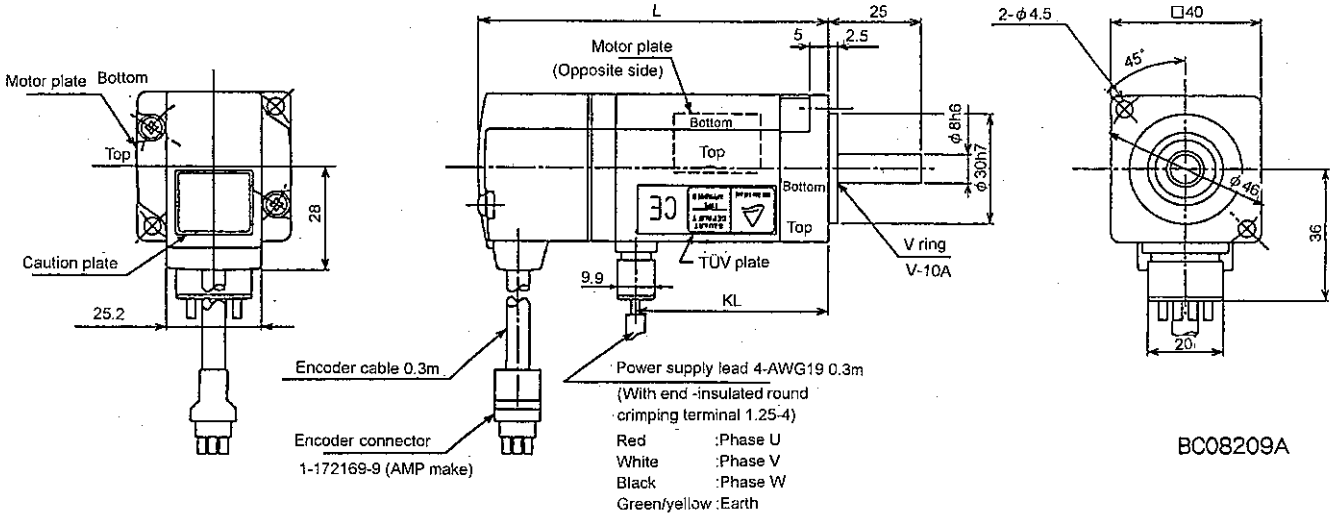
[Unit: mm]

Model	Output [W]	Variable Dimensions																	Reduction Ratio
		LA	LB	LC	LD	LE	LF	LG	LH	LK	L	LR	KL	LZ	Q	S	P	R	
HC-PQ43BG2	400	100	80	115	85	6	65	10	74	33	206	75	131.6	6.6	35	20	M5	10	1/5
HC-PQ43BG2	400	115	95	135	100	8	75	10	85	35	227	85	152.6	9	40	25	M6	12	1/9
HC-PQ43BG2	400	135	110	155	115	8	90	12	100	40	233	100	158.6	11	50	32	M8	16	1/20
HC-PQ43BG2	400	135	110	155	115	8	90	12	100	40	233	100	158.6	11	50	32	M8	16	1/29

10. SPECIFICATIONS

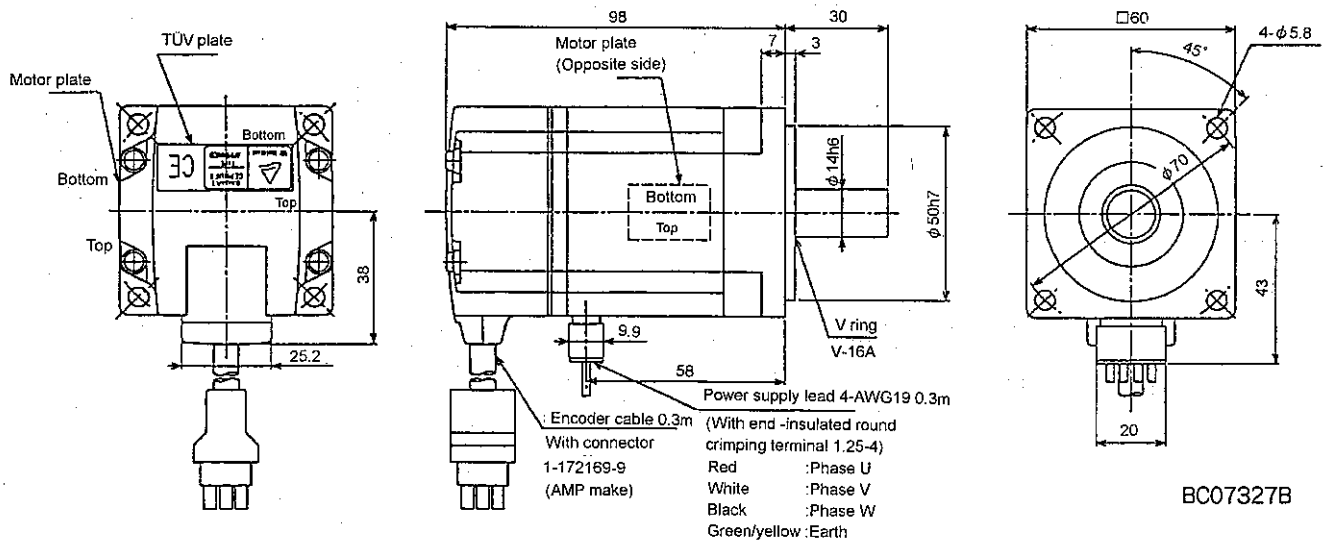
(5) EN•UL/C-ULStandard-Compliant Model

(a) Standard (without electromagnetic brake, without reduction gear)



[Unit: mm]

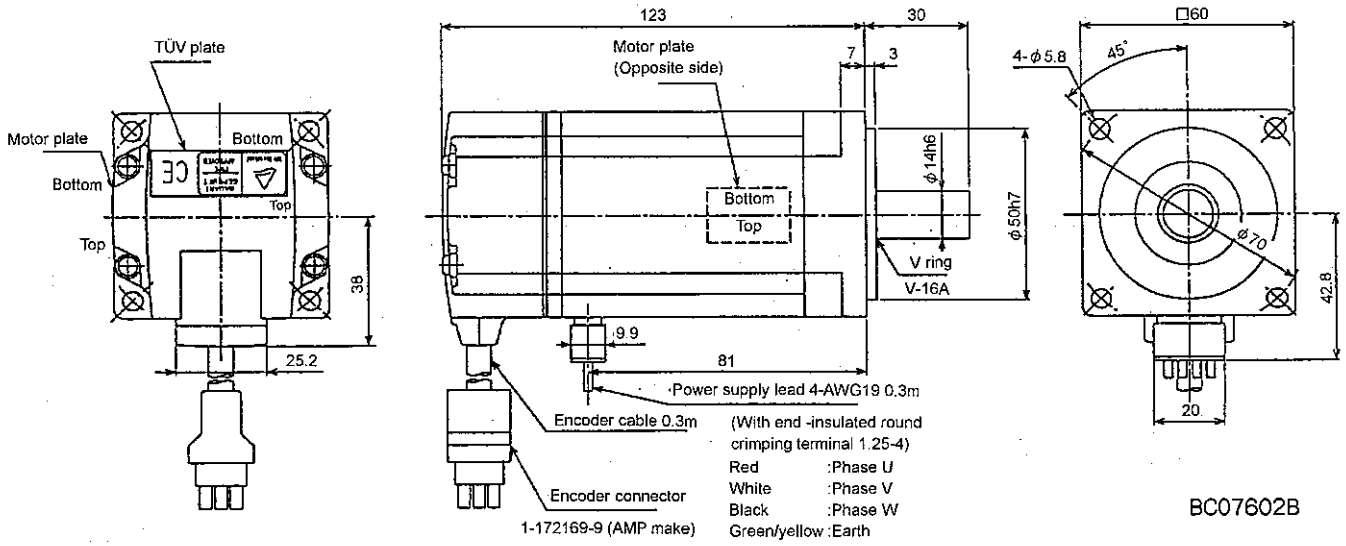
Model	Output [W]	Variable Dimensions		Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
		L	KL		
HC-PQ033-UE	30	73.5	31.5	0.014	0.4
HC-PQ053-UE	50	79.5	37.5	0.019	0.5
HC-PQ13-UE	100	94.5	52.5	0.03	0.6



[Unit: mm]

Model	Output [W]	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
HC-PQ23-UE	200	0.093	1.1

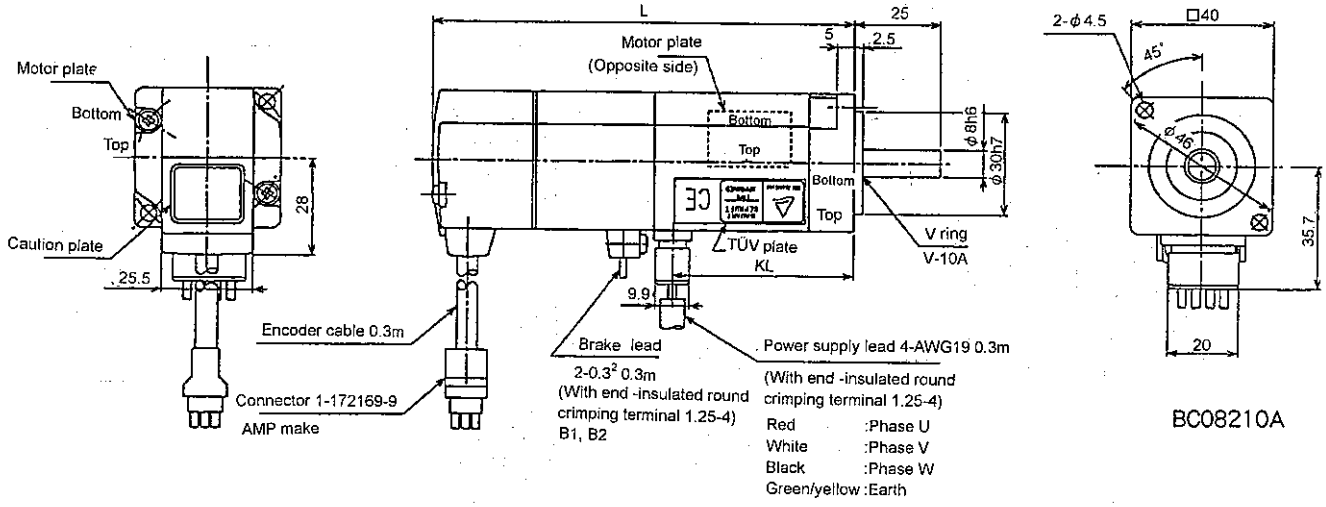
10. SPECIFICATIONS



[Unit: mm]

Model	Output [W]	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
HC-PQ43-UE	400	0.148	1.55

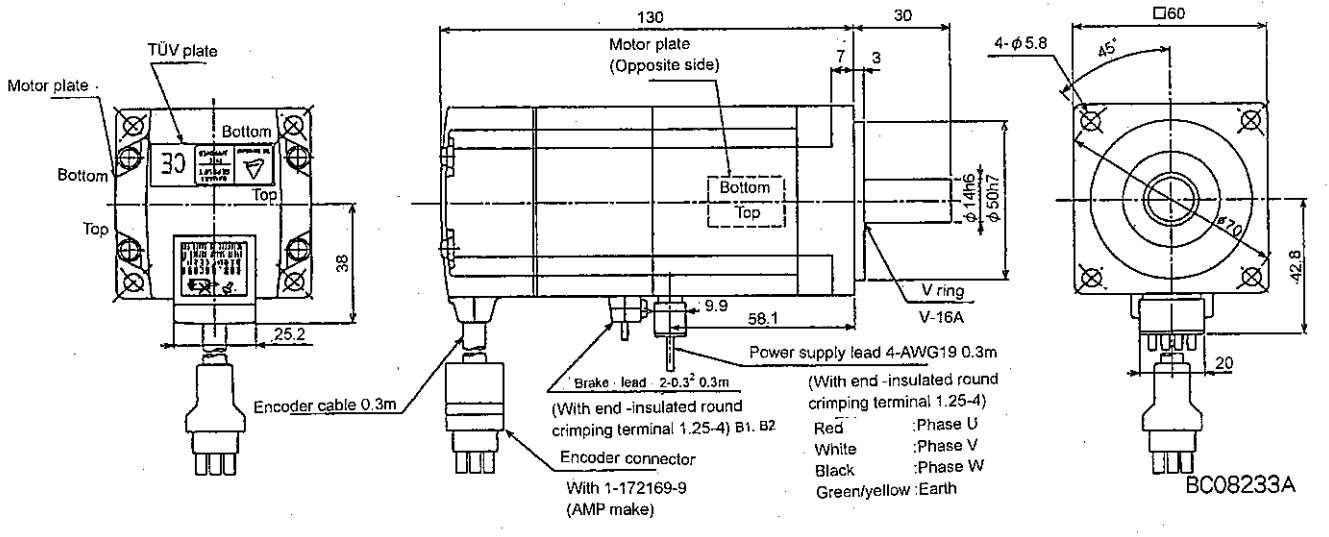
(b) With electromagnetic brake



[Unit: mm]

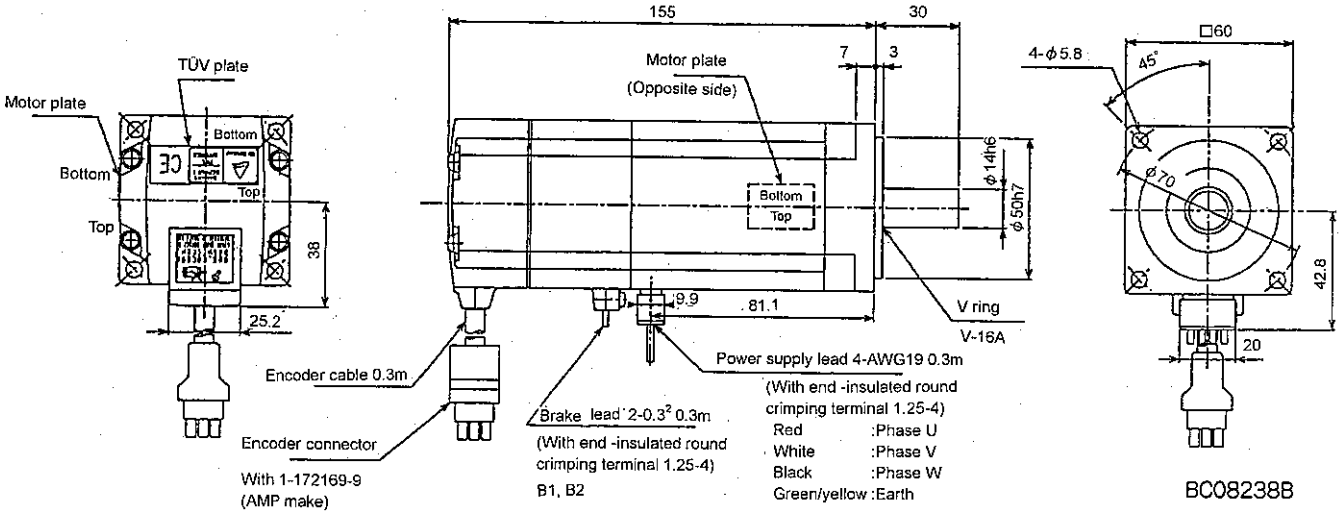
Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
		L	KL			
HC-PQ033B-UE	30	101.5	31.5	0.32	0.017	0.7
HC-PQ053B-UE	50	107.5	37.5	0.32	0.022	0.7
HC-PQ13B-UE	100	122.5	52.5	0.32	0.032	0.9

10. SPECIFICATIONS



[Unit: mm]

Model	Output [W]	Brake Static Friction Torque [N•m]	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
HC-PQ23B-UE	200	1.3	0.142	1.7

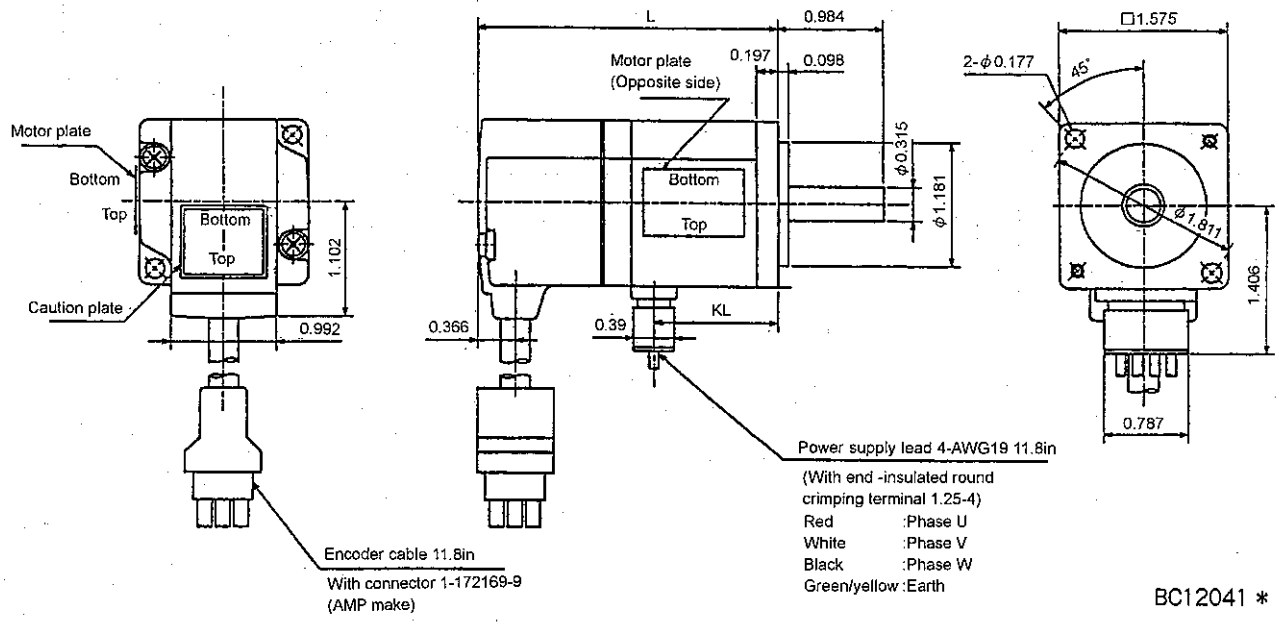


[Unit: mm]

Model	Output [W]	Brake Static Friction Torque [N•m]	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
HC-PQ43B-UE	400	1.3	0.197	2.2

10 – 3 – 3 Servo motors (in inches)

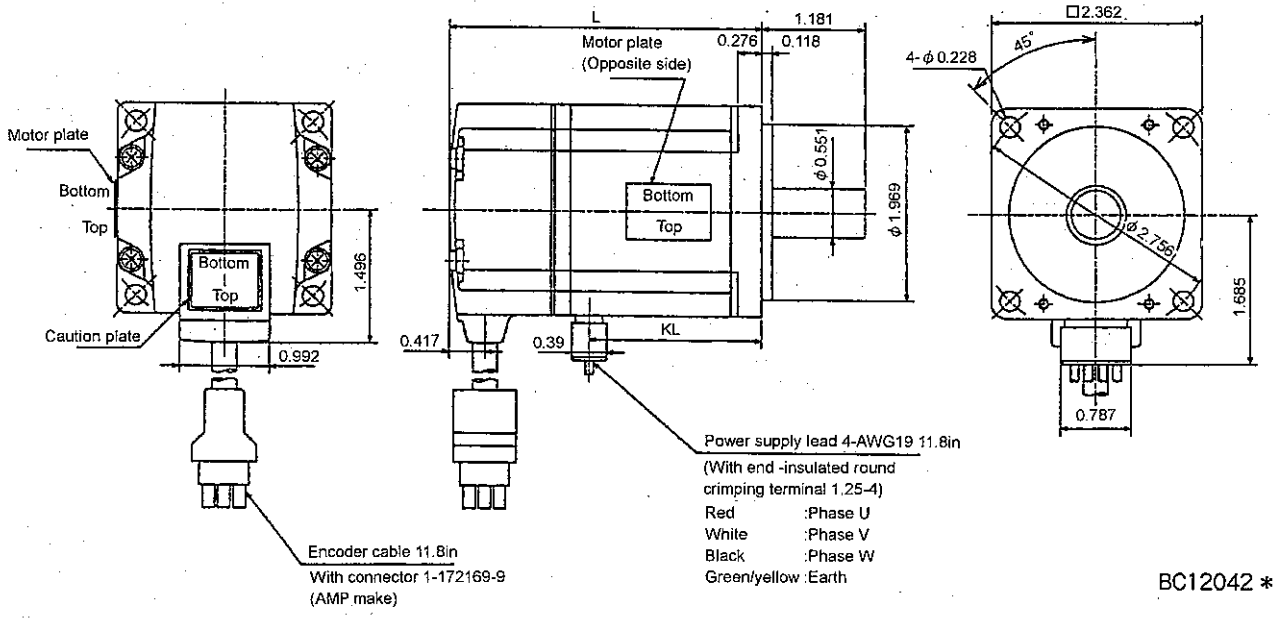
(1) Standard (without electromagnetic brake, without reduction gear)



BC12041 *

[Unit: in]

Model	Output [W]	Variable Dimensions		Inertia Moment wk^2 [oz·in^2]	Weight [lb]
		L	KL		
HC-PQ033	30	2.6	0.9	0.08	0.71
HC-PQ053	50	2.8	1.2	0.10	0.82
HC-PQ13	100	3.4	1.8	0.16	1.10



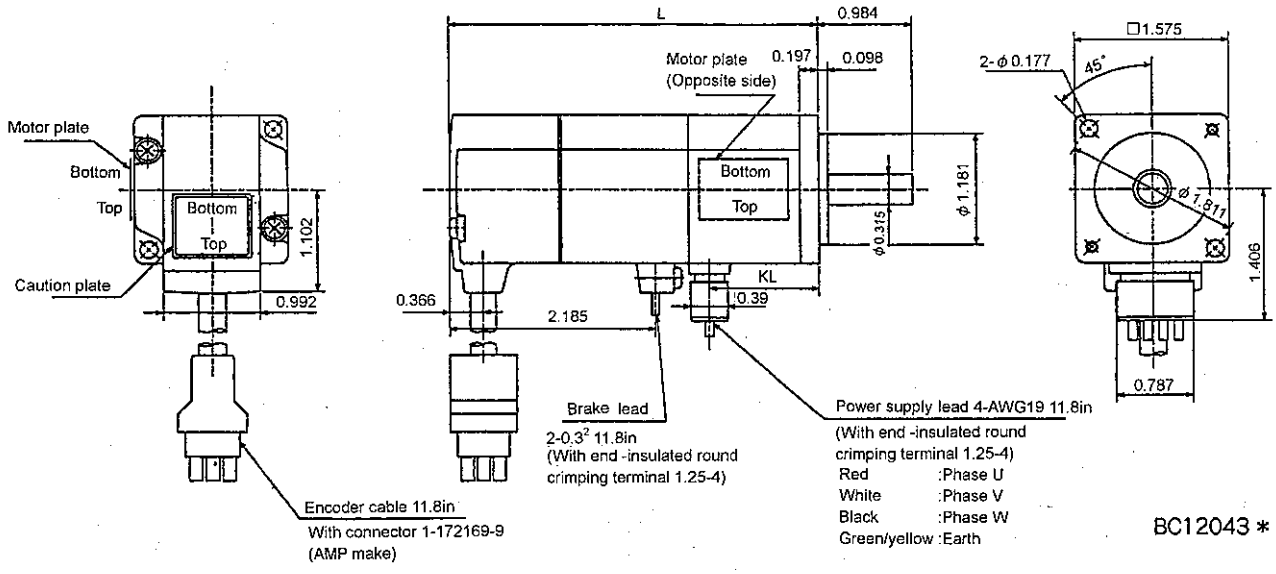
BC12042 *

[Unit: in]

Model	Output [W]	Variable Dimensions		Inertia Moment wk^2 [oz·in^2]	Weight [lb]
		L	KL		
HC-PQ23	200	3.50	1.93	0.48	2.12
HC-PQ43	400	4.49	2.83	0.78	3.2

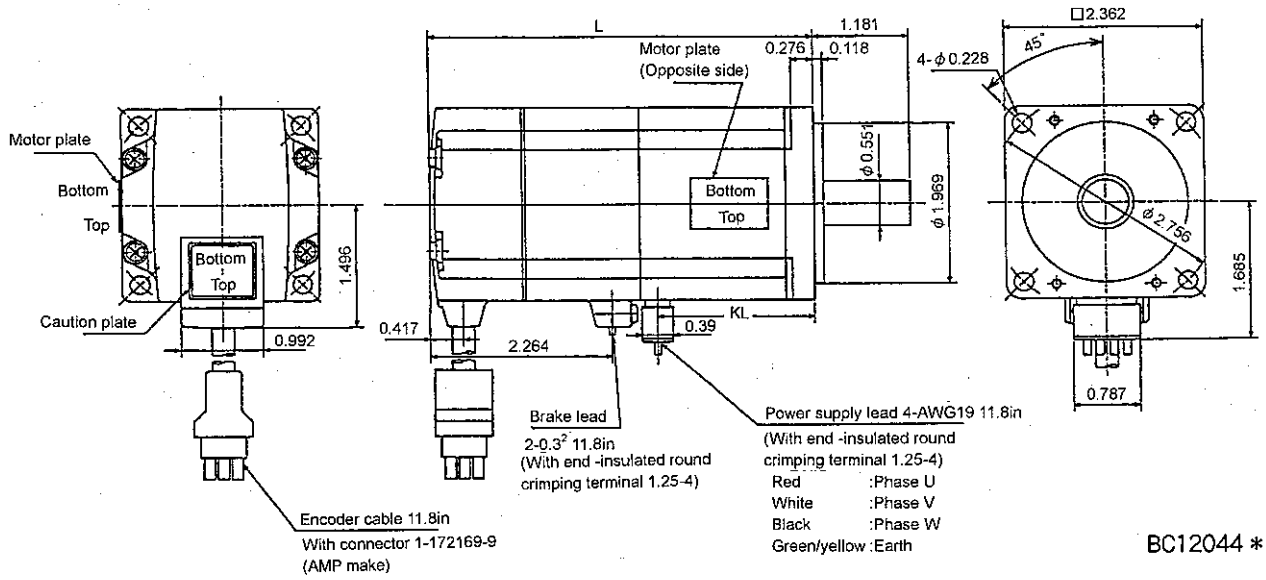
10. SPECIFICATIONS

(2) With electromagnetic brake



[Unit: in]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment wk² [oz•in²]	Weight [lb]
		L	KL			
HC-PQ033B	30	3.68	0.93	0.32	0.09	1.39
HC-PQ053B	50	3.92	1.16	0.32	0.12	1.52
HC-PQ13B	100	4.51	1.75	0.32	0.18	1.83



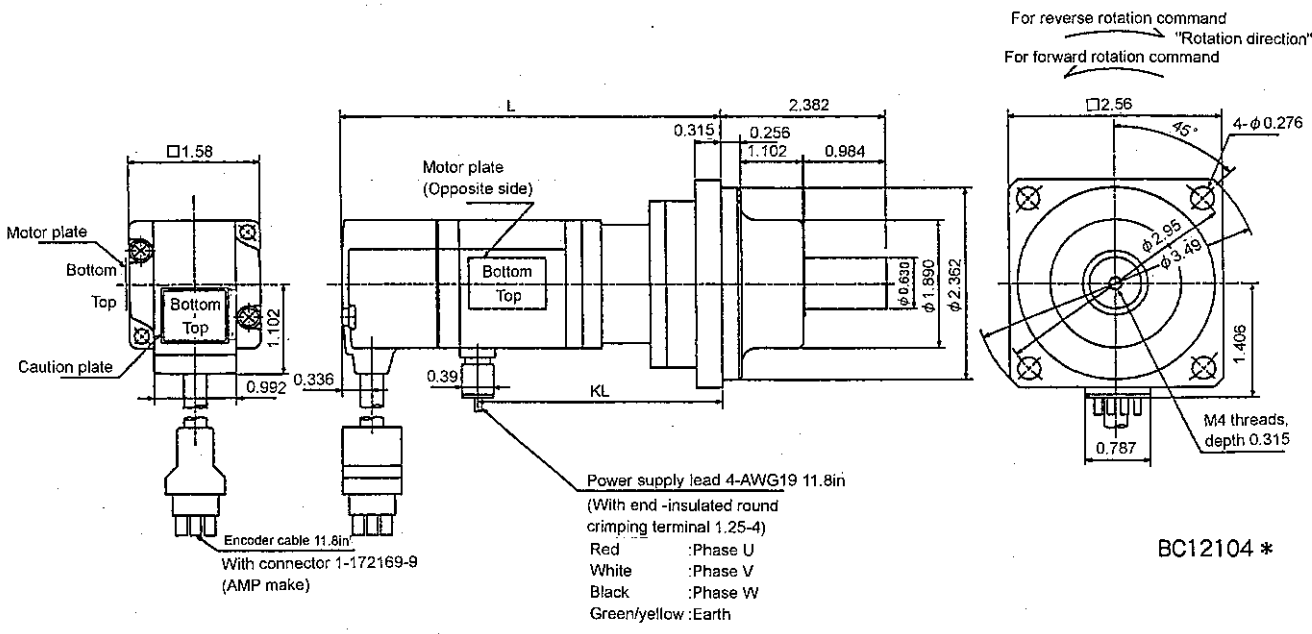
[Unit: in]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment wk² [oz•in²]	Weight [lb]
		L	KL			
HC-PQ23B	200	4.76	1.93	1.3	0.74	3.53
HC-PQ43B	400	5.75	2.84	1.3	1.04	4.63

10. SPECIFICATIONS

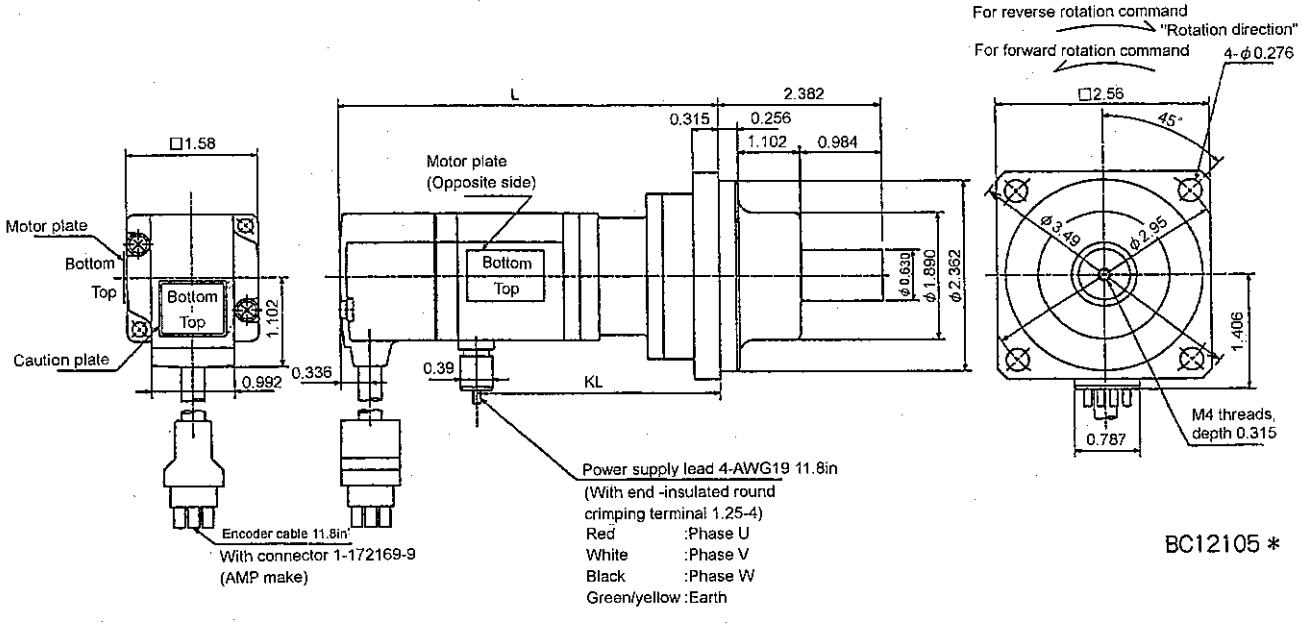
(3) With reduction gear for general industrial machine

(a) Without electromagnetic brake



[Unit: in]

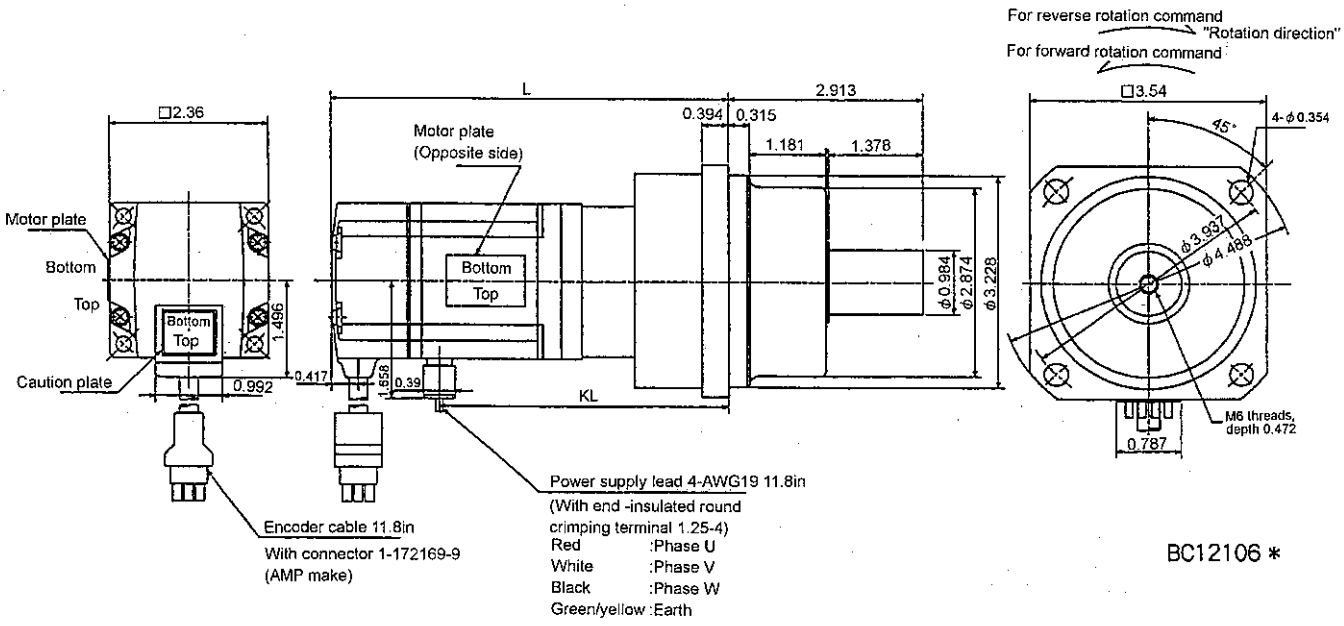
Model	Output [W]	Variable Dimensions		Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment wk² [oz·in²]	Backlash	Weight [lb]
		L	KL					
HC-PQ053BG1	50	4.55	2.91	K6505	1/5 (9/44)	0.30	60min.max.	3.09
HC-PQ053BG1	50	5.28	3.62	K6512	1/12 (49/576)	0.42	60min.max.	3.97
HC-PQ053BG1	50	5.28	3.62	K6520	1/20 (25/484)	0.32	60min.max.	3.97



[Unit: in]

Model	Output [W]	Variable Dimensions		Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment wk² [oz·in²]	Backlash	Weight [lb]
		L	KL					
HC-PQ13G1	100	5.14	3.50	K6505	1/5 (9/44)	0.36	60min.max.	3.31
HC-PQ13G1	100	5.87	4.21	K6512	1/12 (49/576)	0.48	60min.max.	4.19
HC-PQ13G1	100	5.87	4.21	K6520	1/20 (25/484)	0.38	60min.max.	4.19

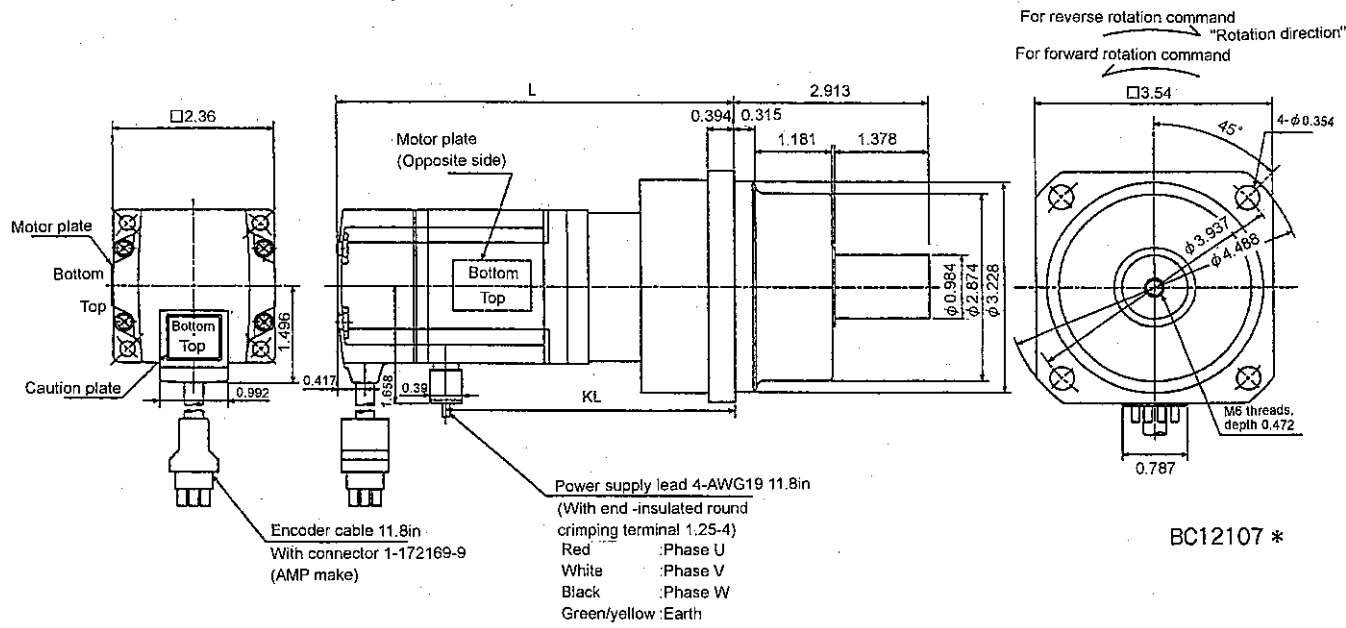
10. SPECIFICATIONS



BC12106 *

[Unit: in]

Model	Output [W]	Variable Dimensions		Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment wk² [oz·in²]	Backlash	Weight [lb]
		L	KL					
HC-PQ23G1	200	5.61	4.04	K9005	1/5 (19/96)	1.36	60min.max.	7.28
HC-PQ23G1	200	38	4.83	K9012	1/12 (25/288)	1.60	60min.max.	8.6
HC-PQ23G1	200	6.38	4.83	K9020	1/20 (253/5000)	1.45	60min.max.	8.6

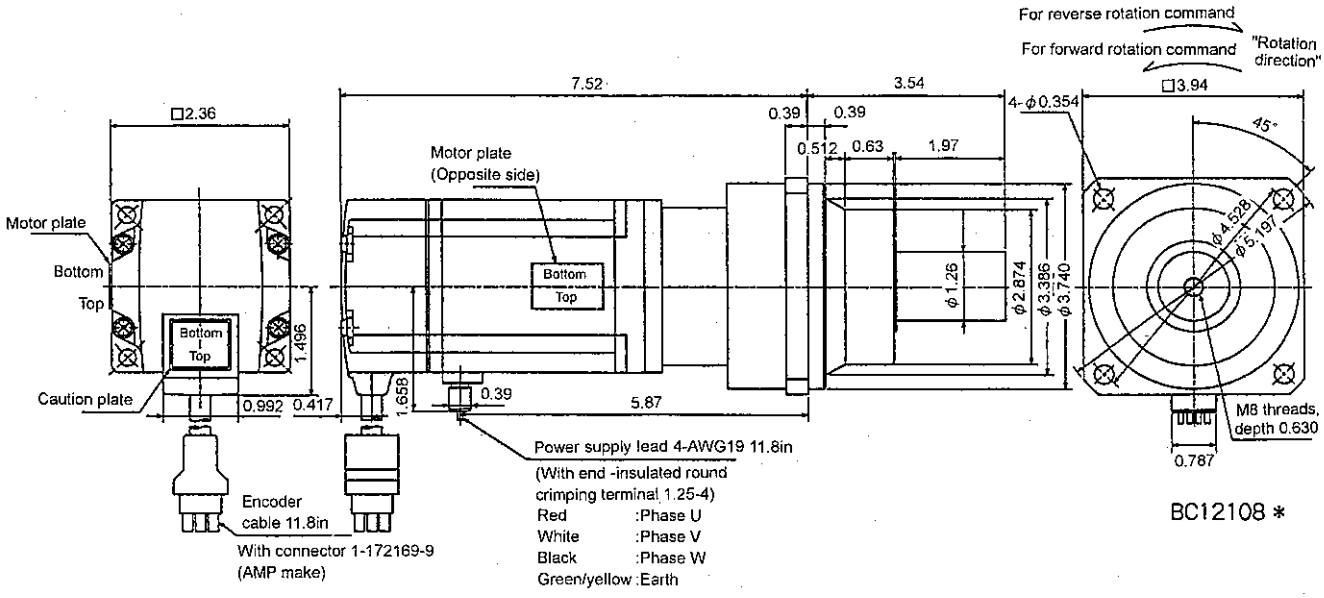


BC12107 *

[Unit: in]

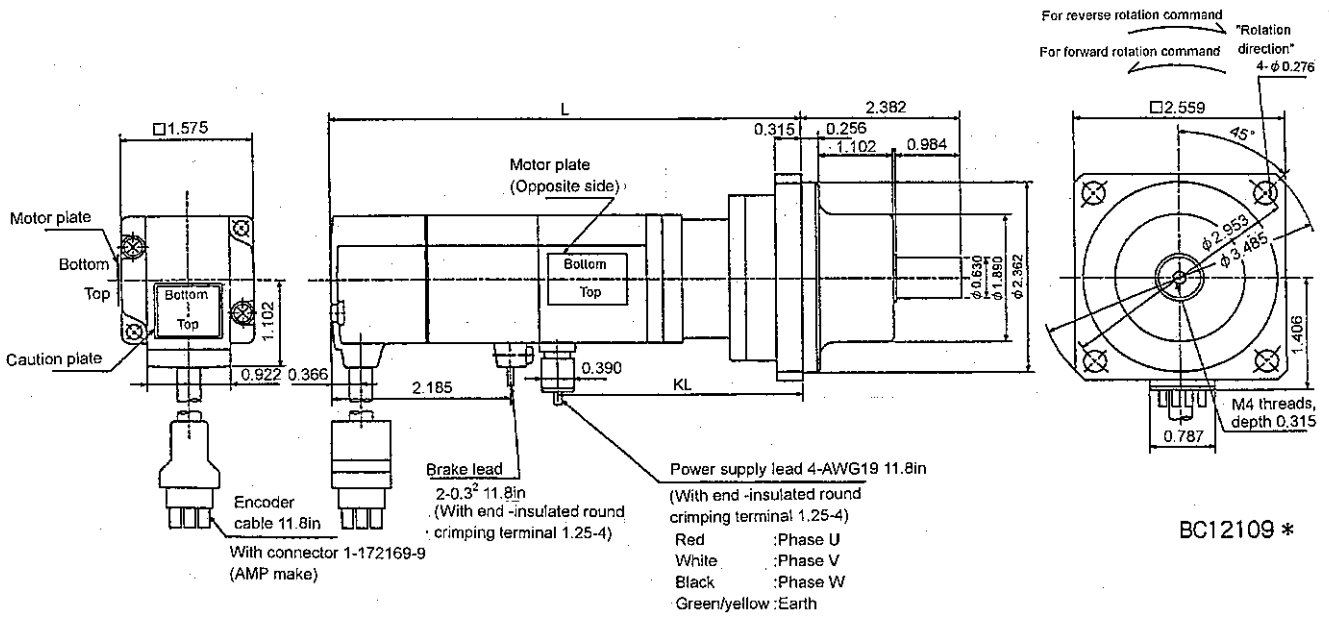
Model	Output [W]	Variable Dimensions		Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment wk² [oz·in²]	Backlash	Weight [lb]
		L	KL					
HC-PQ43G1	400	6.61	4.95	K9005	1/5 (19/96)	1.62	60min.max.	8.38
HC-PQ43G1	400	7.36	5.73	K9012	1/12 (25/288)	1.85	60min.max.	9.7

10. SPECIFICATIONS



[Unit: in]

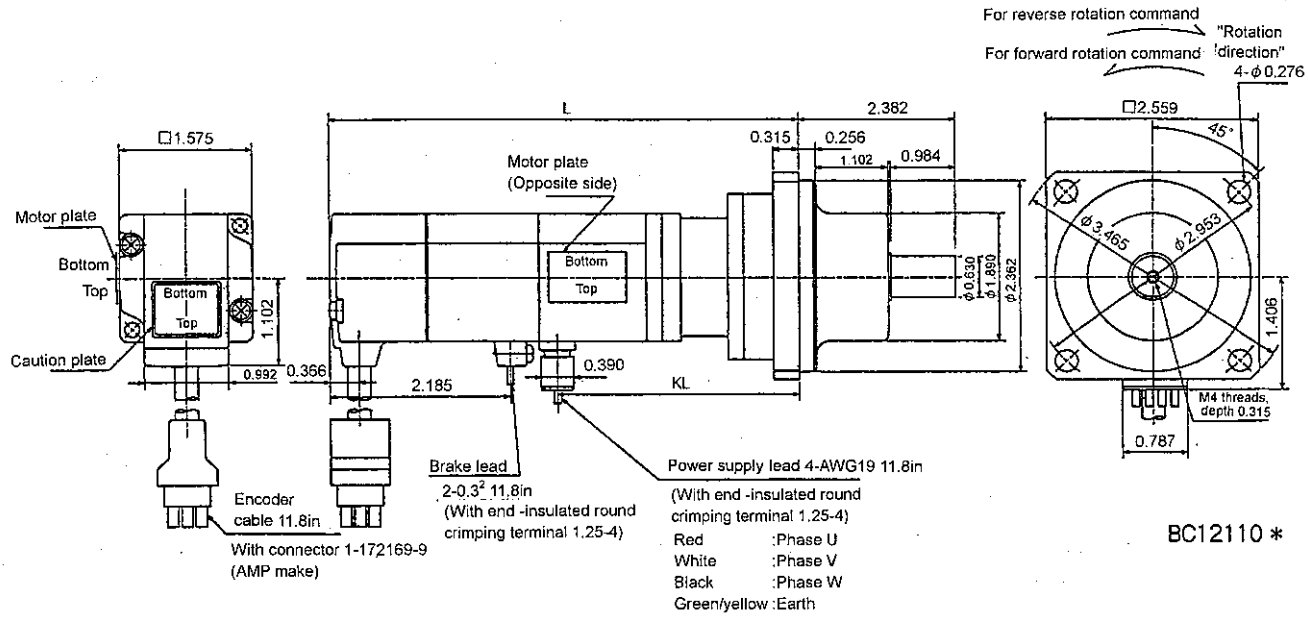
Model	Output [W]	Reduction Gear Model	Reduction Ratio		Inertia Moment wk² [oz·in²]	Backlash	Weight [lb]
			Normal Reduction Ratio	Actual Reduction Ratio			
HC-PQ43G1	400	K10020	1/20	253/5000	3.57	60min.max.	12.13



[Unit: in]

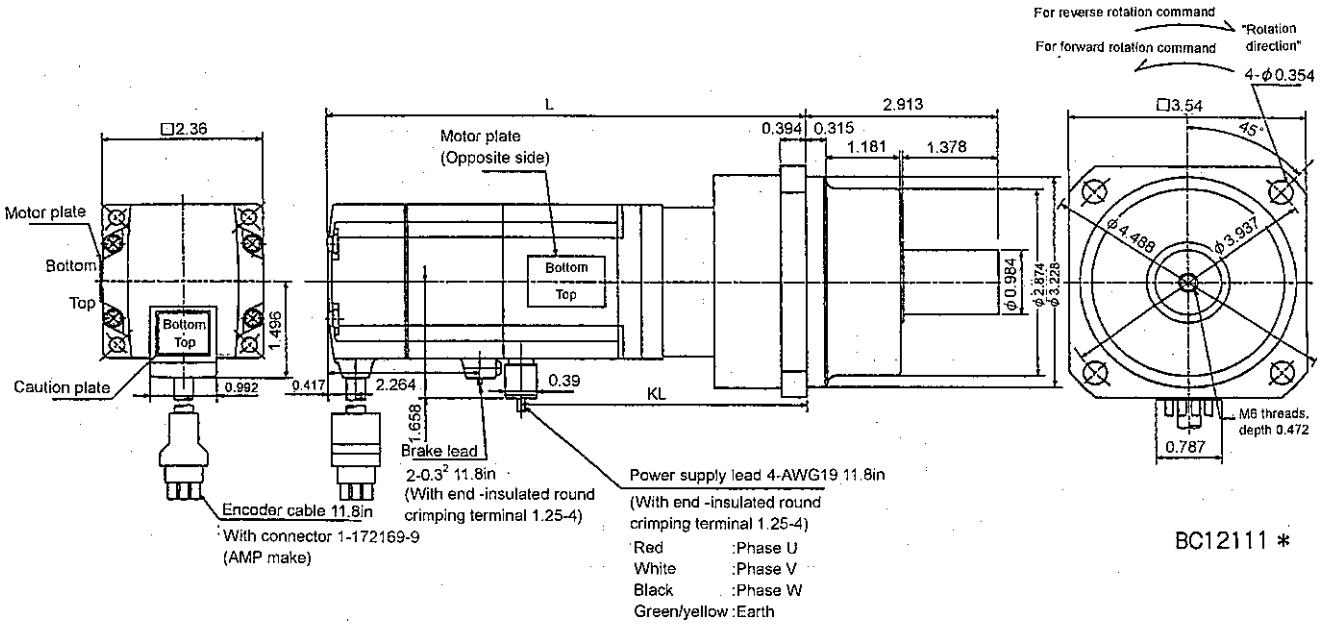
Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment wk² [oz·in²]	Backlash	Weight [lb]
		L	KL						
HC-PQ053BG1	50	5.65	2.91	0.32	K6505	1/5 (9/44)	0.32	60min.max.	3.97
HC-PQ053BG1	50	6.38	3.62	0.32	K6512	1/12 (49/576)	0.44	60min.max.	4.85
HC-PQ053BG1	50	6.38	3.62	0.32	K6520	1/20 (25/484)	0.34	60min.max.	4.85

10. SPECIFICATIONS



[Unit: in]

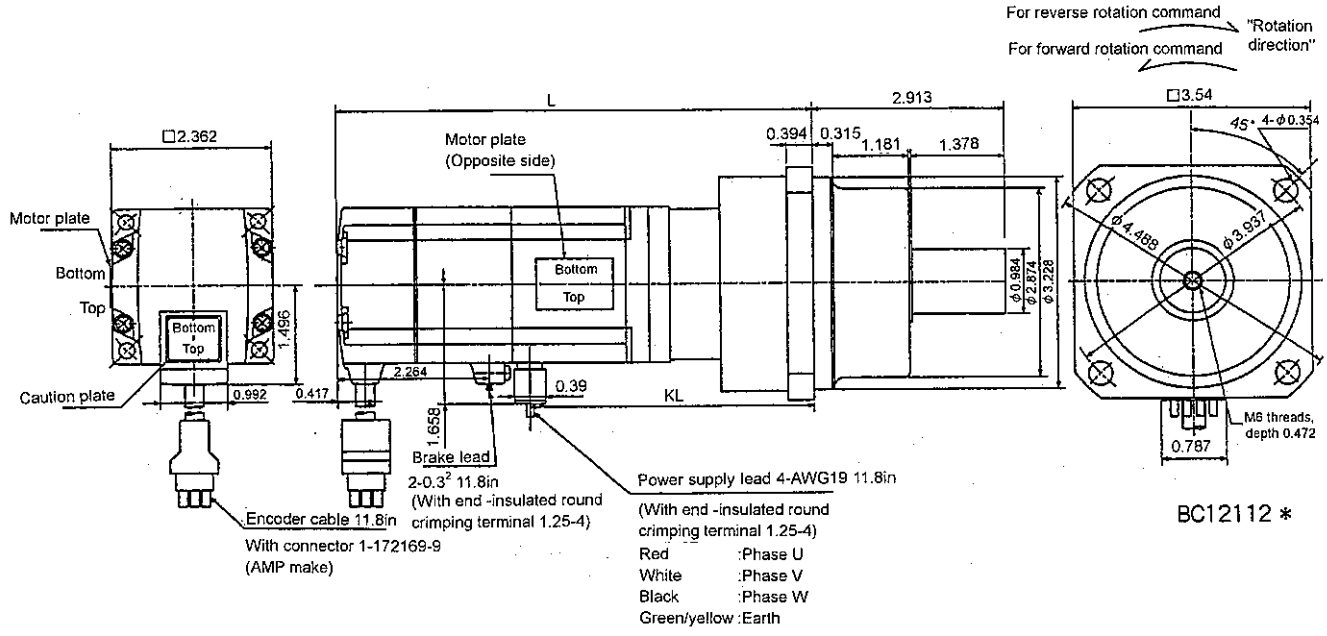
Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment wk² [oz•in²]	Backlash	Weight [lb]
		L	KL						
HC-PQ13BG1	100	6.24	3.50	0.32	K6505	1/5 (9/44)	0.38	60min.max.	4.19
HC-PQ13BG1	100	6.97	4.21	0.32	K6512	1/12 (49/576)	0.50	60min.max.	5.07
HC-PQ13BG1	100	6.97	4.21	0.32	K6520	1/20 (25/484)	0.40	60min.max.	5.07



[Unit: in]

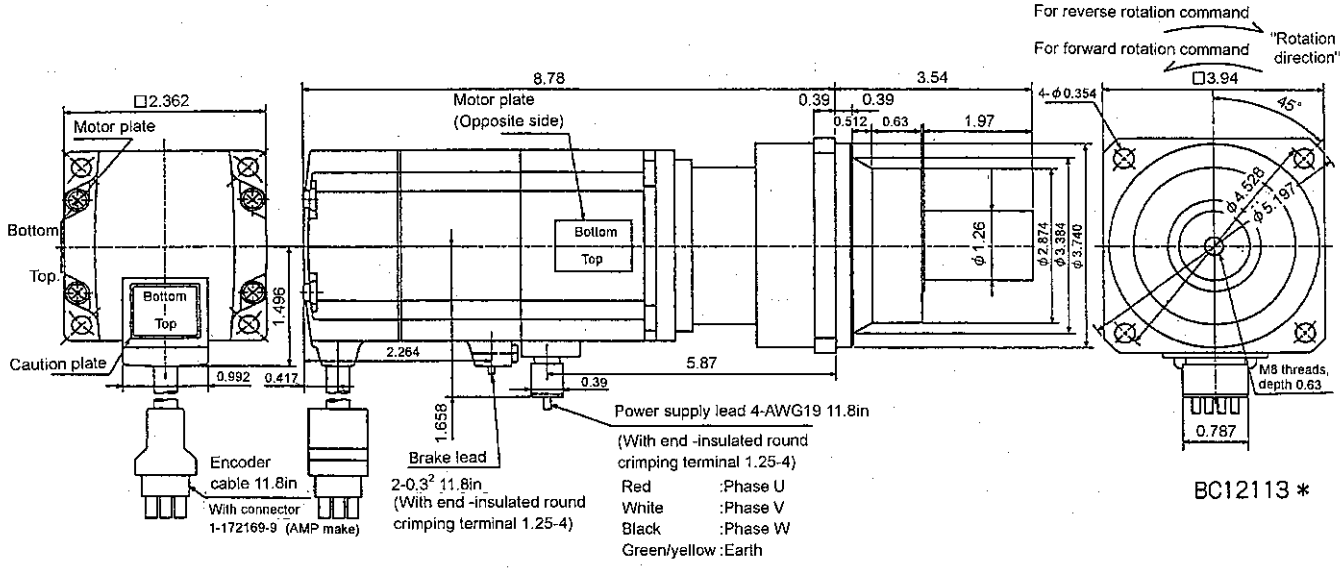
Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment wk² [oz•in²]	Backlash	Weight [lb]
		L	KL						
HC-PQ23BG1	200	6.87	4.04	1.3	K9005	1/5 (19/96)	1.58	60min.max.	8.6
HC-PQ23BG1	200	7.64	4.83	1.3	K9012	1/12 (25/288)	1.82	60min.max.	9.92
HC-PQ23BG1	200	7.64	4.83	1.3	K9020	1/20 (253/5000)	1.62	60min.max.	9.92

10. SPECIFICATIONS



[Unit: in]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio (Actual Reduction Ratio)	Inertia Moment wk² [oz•in²]	Backlash	Weight [lb]
		L	KL						
HC-PQ43BG1	400	7.87	4.95	1.3	K9005	1/5 (19/96)	1.88	60min.max.	9.7
HC-PQ43BG1	400	8.62	5.73	1.3	K9012	1/12 (25/288)	2.12	60min.max.	11.02

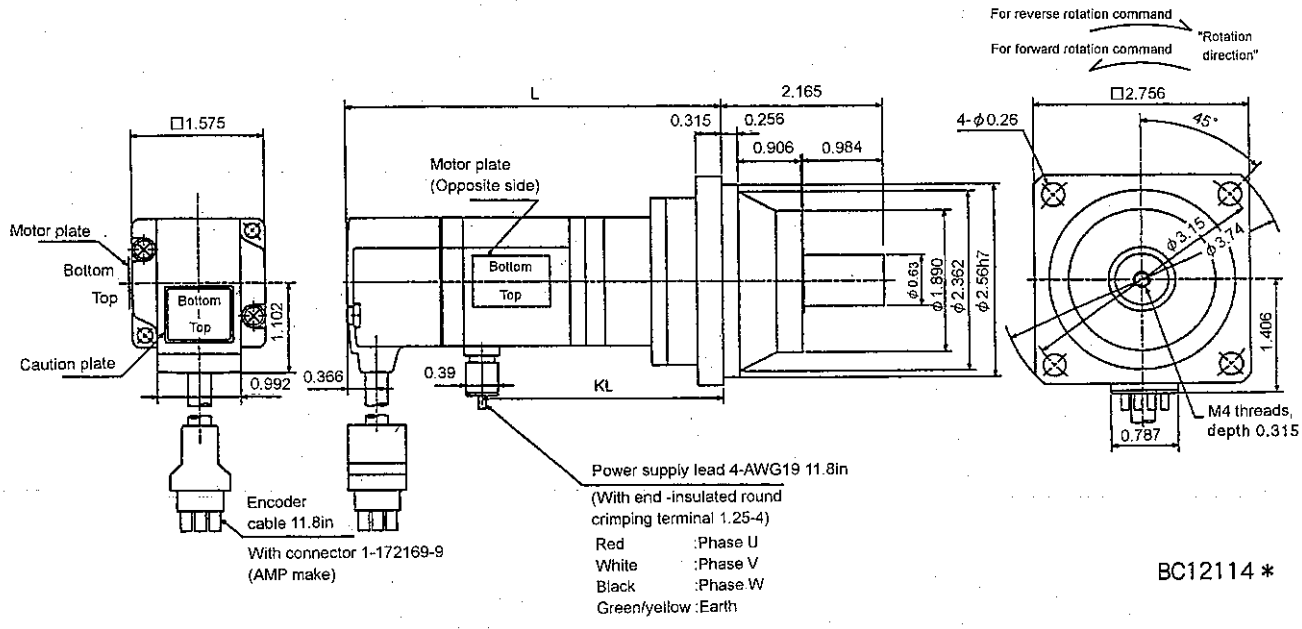


[Unit: in]

Model	Output [W]	Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio		Inertia Moment wk² [oz•in²]	Backlash	Weight [lb]
				Normal Reduction Ratio	Actual Reduction Ratio			
HC-PQ43BG1	400	1.3	K10020	1/20	253/5000	3.83	60min.max.	13.45

(4) With reduction gear for precision application

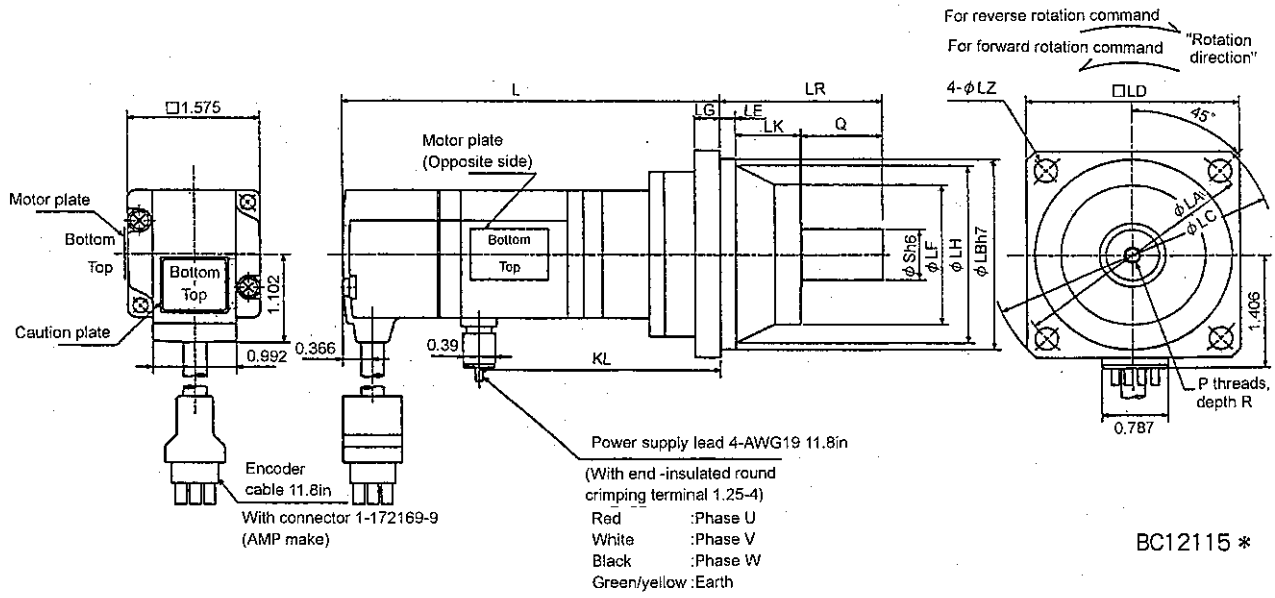
(a) Without electromagnetic brake



[Unit: in]

Model	Output [W]	Variable Dimensions		Reduction Gear Model	Reduction Ratio	Inertia Moment wk^2 [oz·in^2]	Backlash	Weight [lb]
		L	KL					
HC-PQ053G2	50	4.71	3.07	BK1-05B-A5MEKA	1/5	0.36	3min.max.	3.09
HC-PQ053G2	50	5.34	3.70	BK1-09B-A5MEKA	1/9	0.33	3min.max.	3.75
HC-PQ053G2	50	5.34	3.70	BK1-20B-A5MEKA	1/20	0.38	3min.max.	3.97
HC-PQ053G2	50	5.34	3.70	BK1-29B-A5MEKA	1/29	0.31	3min.max.	3.97

10. SPECIFICATIONS

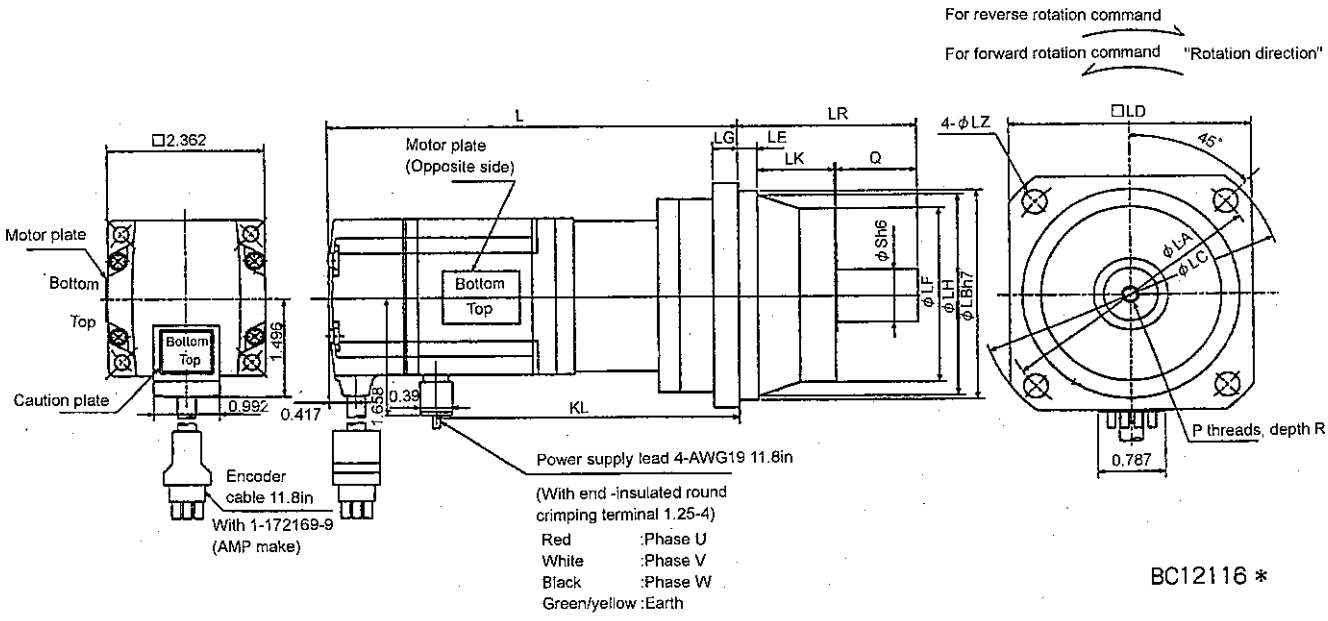


Model	Output [W]	Reduction Gear Model	Reduction Ratio	Inertia Moment wk^2 [oz·in^2]	Backlash	Weight [lb]
HC-PQ13G2	100	BK1-05B-01MEKA	1/5	0.43	3min.max.	3.31
HC-PQ13G2	100	BK1-09B-01MEKA	1/9	0.39	3min.max.	3.97
HC-PQ13G2	100	BK2-20B-01MEKA	1/20	0.66	3min.max.	6.61
HC-PQ13G2	100	BK2-29B-01MEKA	1/29	0.52	3min.max.	6.61

[Unit: in]

Model	Output [W]	Variable Dimensions																	Reduction Ratio
		LA	LB	LC	LD	LE	LF	LG	LH	LK	L	LR	KL	LZ	Q	S	P	R	
HC-PQ13G2	100	3.15	2.56	3.74	2.76	0.24	1.89	0.32	2.36	0.91	5.3	2.17	3.66	0.26	0.98	0.63	M4	0.32	1/5
HC-PQ13G2	100	3.15	2.56	3.74	2.76	0.24	1.89	0.32	2.36	0.91	5.93	2.17	4.29	0.26	0.98	0.63	M4	0.32	1/9
HC-PQ13G2	100	3.94	3.15	4.53	3.35	0.24	2.56	0.39	2.91	1.3	6.16	2.95	4.23	0.26	1.38	0.79	M5	0.39	1/20
HC-PQ13G2	100	3.94	3.15	4.53	3.35	0.24	2.56	0.39	2.91	1.3	6.16	2.95	4.23	0.26	1.38	0.79	M5	0.39	1/29

10. SPECIFICATIONS

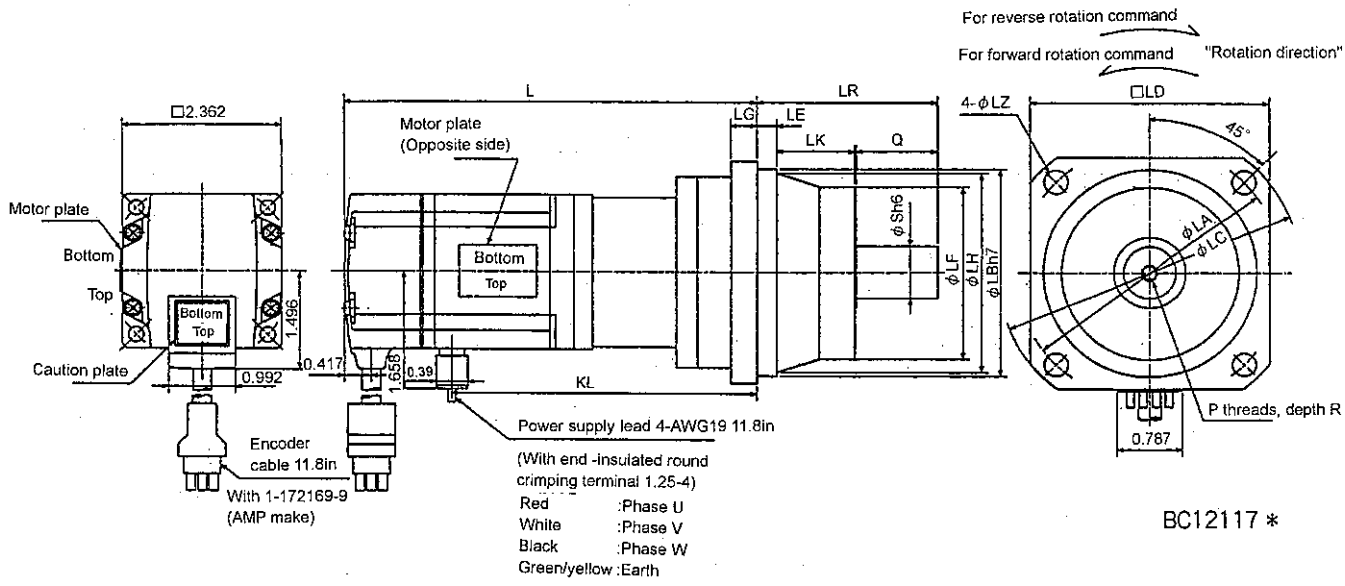


Model	Output [W]	Reduction Gear Model	Reduction Ratio	Inertia Moment wk^2 [oz·in^2]	Backlash	Weight [lb]
HC-PQ23G2	200	BK1-05B-02MEKA	1/5	1.04	3min.max.	4.63
HC-PQ23G2	200	BK1-09B-02MEKA	1/9	1.14	3min.max.	7.72
HC-PQ23G2	200	BK2-20B-02MEKA	1/20	1.95	3min.max.	11.02
HC-PQ23G2	200	BK2-29B-02MEKA	1/29	1.51	3min.max.	11.02

[Unit: in]

Model	Output [W]	Variable Dimensions																	Reduction Ratio
		LA	LB	LC	LD	LE	LF	LG	LH	LK	L	LR	KL	LZ	Q	S	P	R	
HC-PQ23G2	200	3.15	2.56	3.74	2.76	0.24	1.89	0.32	2.36	2.36	5.75	2.17	4.2	0.26	0.98	0.63	M4	0.32	1/5
HC-PQ23G2	200	3.94	3.15	4.23	3.35	0.24	2.56	0.39	2.91	2.91	6.46	2.95	4.91	0.26	1.38	0.76	M5	0.39	1/9
HC-PQ23G2	200	4.53	3.74	5.32	3.94	0.32	2.95	0.39	3.35	1.38	6.65	3.35	5.10	0.35	1.58	0.98	M6	0.47	1/20
HC-PQ23G2	200	4.53	3.74	5.32	3.94	0.32	2.95	0.39	3.35	1.38	6.65	3.35	5.10	0.35	1.58	0.98	M6	0.47	1/29

10. SPECIFICATIONS



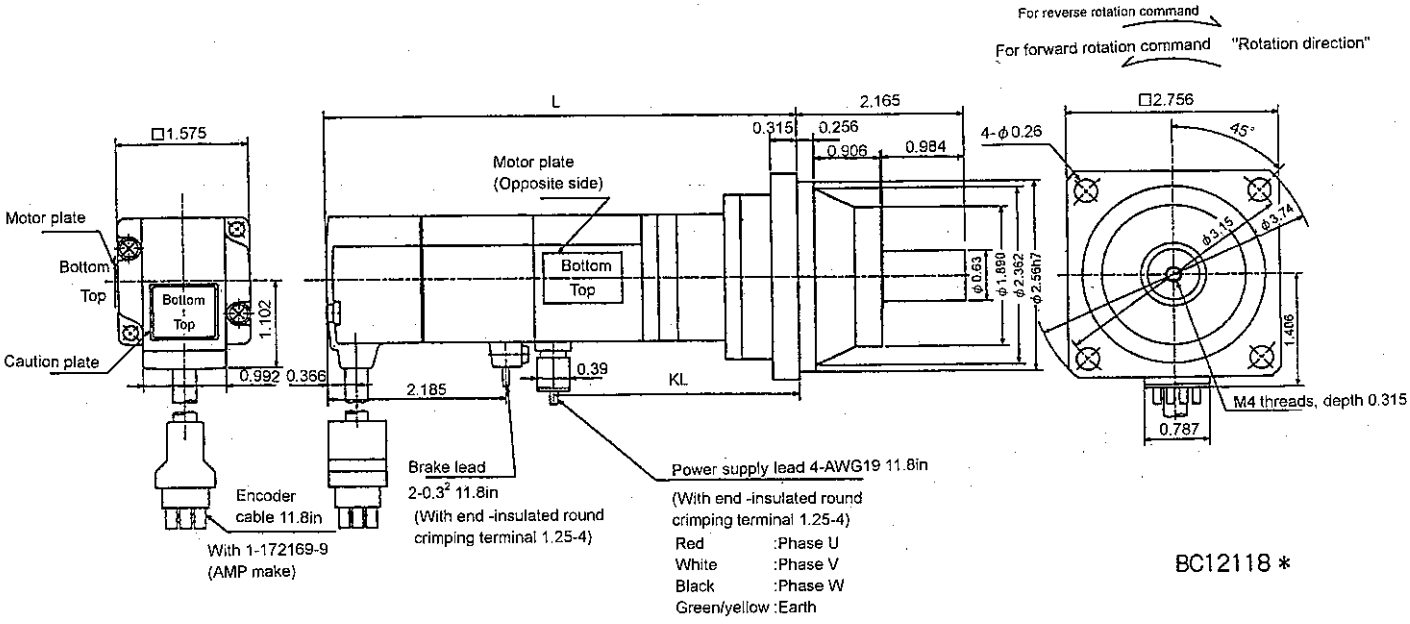
Model	Output [W]	Reduction Gear Model	Reduction Ratio	Inertia Moment wk^2 [oz·in^2]	Backlash	Weight [lb]
HC-PQ43G2	400	BK2-05B-04MEKA	1/5	1.61	3min.max.	8.16
HC-PQ43G2	400	BK2-09B-04MEKA	1/9	1.77	3min.max.	11.68
HC-PQ43G2	400	BK4-20B-04MEKA	1/20	2.33	3min.max.	16.54
HC-PQ43G2	400	BK4-29B-04MEKA	1/29	1.85	3min.max.	16.54

[Unit: in]

Model	Output [W]	Variable Dimensions																Reduction Ratio
		LA	LB	LC	LD	LE	LF	LG	LH	LK	L	LR	KL	LZ	Q	S	P	R	
HC-PQ43G2	400	3.94	3.15	4.23	3.35	0.24	2.56	0.39	2.91	1.3	6.85	2.95	5.18	0.26	1.38	0.79	M5	0.39	1/5
HC-PQ43G2	400	4.53	3.74	5.32	3.94	0.32	2.95	0.39	3.35	1.38	7.68	3.35	6.01	0.35	1.58	0.98	M6	0.47	1/9
HC-PQ43G2	400	5.32	4.33	6.10	4.23	0.32	3.54	0.47	3.94	1.58	7.91	3.94	6.24	0.43	1.97	1.26	M8	0.63	1/20
HC-PQ43G2	400	5.32	4.33	6.10	4.23	0.32	3.54	0.47	3.94	1.58	7.91	3.94	6.24	0.43	1.97	1.26	M8	0.63	1/29

10. SPECIFICATIONS

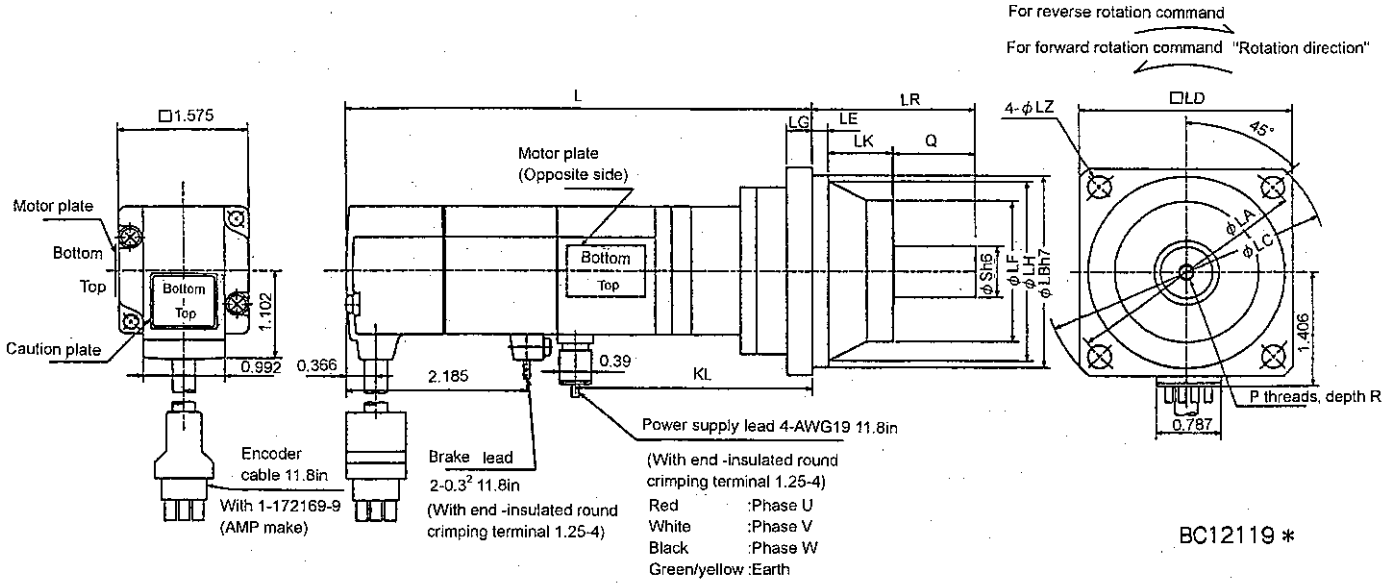
(b) With electromagnetic brake



[Unit: in]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio	Inertia Moment wk^2 [oz•in^2]	Backlash	Weight [lb]
		L	KL						
HC-PQ053BG2	50	5.81	3.07	0.32	BK1-05B-A5MEKA	1/5	0.38	3min.max.	3.97
HC-PQ053BG2	50	6.44	3.70	0.32	BK1-09B-A5MEKA	1/9	0.34	3min.max.	4.63
HC-PQ053BG2	50	6.44	3.70	0.32	BK1-20B-A5MEKA	1/20	0.39	3min.max.	4.85
HC-PQ053BG2	50	6.44	3.70	0.32	BK1-29B-A5MEKA	1/29	0.33	3min.max.	4.85

10. SPECIFICATIONS

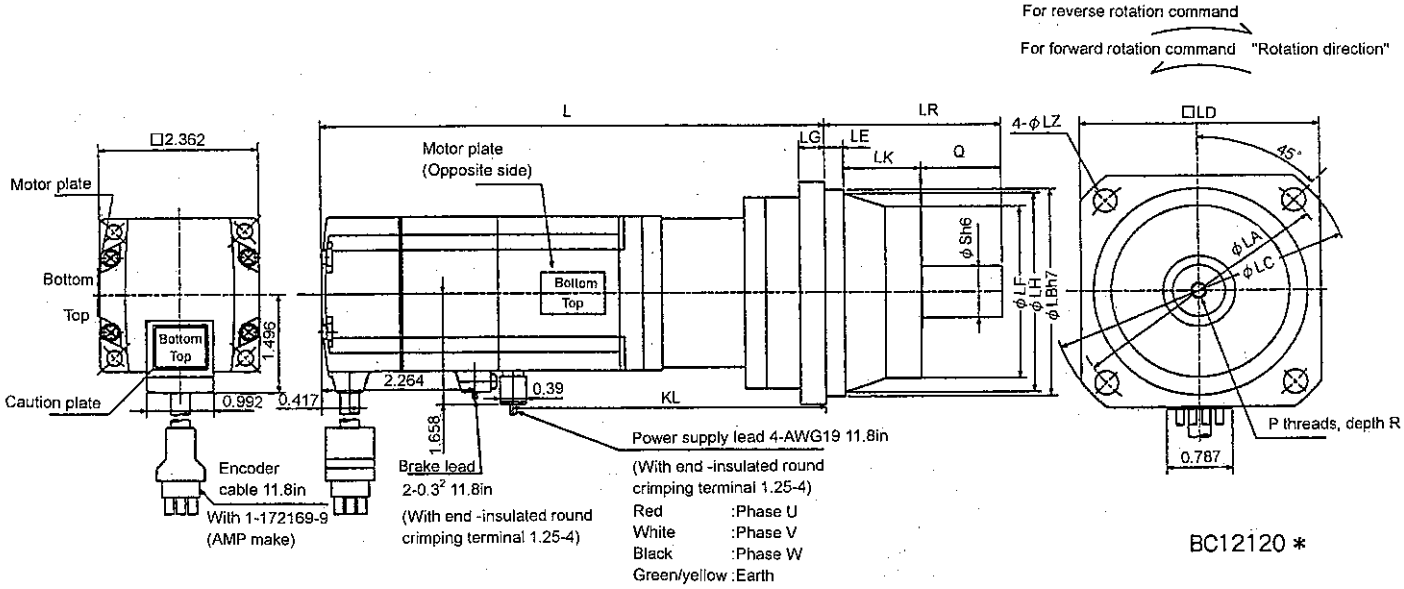


Model	Output [W]	Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio	Inertia Moment wk² [oz•in²]	Backlash	Weight [lb]
HC-PQ13BG2	100	0.32	BK1-05B-01MEKA	1/5	0.44	3min.max.	4.19
HC-PQ13BG2	100	0.32	BK1-09B-01MEKA	1/9	0.40	3min.max.	4.85
HC-PQ13BG2	100	0.32	BK2-20B-01MEKA	1/20	0.68	3min.max.	7.5
HC-PQ13BG2	100	0.32	BK2-29B-01MEKA	1/29	0.53	3min.max.	7.5

[Unit: in]

Model	Output [W]	Variable Dimensions																Reduction Ratio
		LA	LB	LC	LD	LE	LF	LG	LH	LK	L	LR	KL	LZ	Q	S	P	R	
HC-PQ13BG2	100	3.15	2.56	3.74	2.76	0.24	1.89	0.32	2.36	0.91	6.4	2.17	3.66	0.26	0.98	0.63	M4	0.32	1/5
HC-PQ13BG2	100	3.15	2.56	3.74	2.76	0.24	1.89	0.32	2.36	0.91	7.03	2.17	4.29	0.26	0.98	0.63	M4	0.32	1/9
HC-PQ13BG2	100	3.94	3.15	4.53	3.35	0.24	2.56	0.39	2.91	1.3	7.27	2.95	4.23	0.26	1.38	0.79	M5	0.39	1/20
HC-PQ13BG2	100	3.94	3.15	4.53	3.35	0.24	2.56	0.39	2.91	1.3	7.27	2.95	4.23	0.26	1.38	0.79	M5	0.39	1/29

10. SPECIFICATIONS

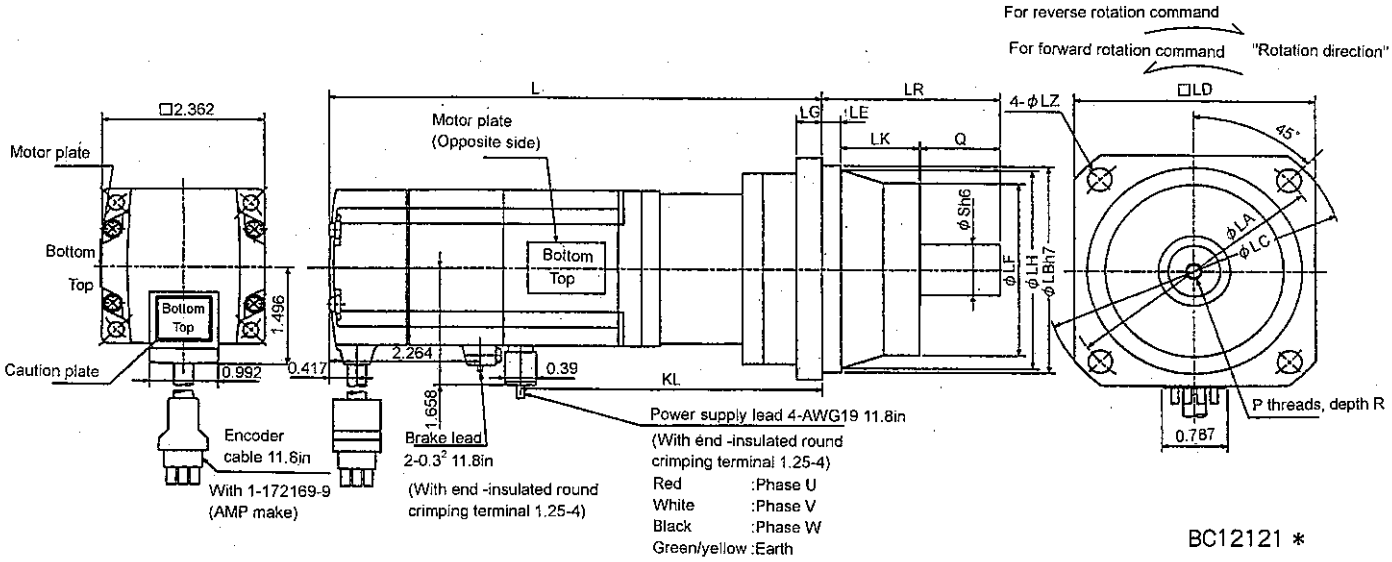


Model	Output [W]	Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio	Inertia Moment wk² [oz·in²]	Backlash	Weight [lb]
HC-PQ23BG2	200	1.3	BK1-05B-02MEKA	1/5	1.31	3min.max.	5.95
HC-PQ23BG2	200	1.3	BK2-09B-02MEKA	1/9	1.40	3min.max.	9.04
HC-PQ23BG2	200	1.3	BK3-20B-02MEKA	1/20	2.21	3min.max.	12.35
HC-PQ23BG2	200	1.3	BK3-29B-02MEKA	1/29	1.77	3min.max.	12.35

[Unit: in]

Model	Output [W]	Variable Dimensions																Reduction Ratio
		LA	LB	LC	LD	LE	LF	LG	LH	LK	L	LR	KL	LZ	Q	S	P	R
HC-PQ23BG2	200	3.15	2.56	3.74	2.76	0.24	1.89	0.32	2.36	2.36	7.01	2.17	4.2	0.26	0.98	0.63	M4	0.32	1/5
HC-PQ23BG2	200	3.94	3.15	4.23	3.35	0.24	2.56	0.39	2.91	2.91	7.72	2.95	4.91	0.26	1.38	0.79	M5	0.39	1/9
HC-PQ23BG2	200	4.53	3.74	5.32	3.94	0.32	2.95	0.39	3.35	1.38	7.91	3.35	5.10	0.35	1.58	0.98	M6	0.47	1/20
HC-PQ23BG2	200	4.53	3.74	5.32	3.94	0.32	2.95	0.39	3.35	1.38	7.91	3.35	5.10	0.35	1.58	0.98	M6	0.47	1/29

10. SPECIFICATIONS



Model	Output [W]	Brake Static Friction Torque [N•m]	Reduction Gear Model	Reduction Ratio	Inertia Moment wk^2 [oz·in^2]	Backlash	Weight [lb]
HC-PQ43BG2	400	1.3	BK2-05B-04MEKA	1/5	1.88	3min.max.	9.48
HC-PQ43BG2	400	1.3	BK3-09B-04MEKA	1/9	2.03	3min.max.	13.01
HC-PQ43BG2	400	1.3	BK4-20B-04MEKA	1/20	2.59	3min.max.	17.86
HC-PQ43BG2	400	1.3	BK4-29B-04MEKA	1/29	2.11	3min.max.	17.86

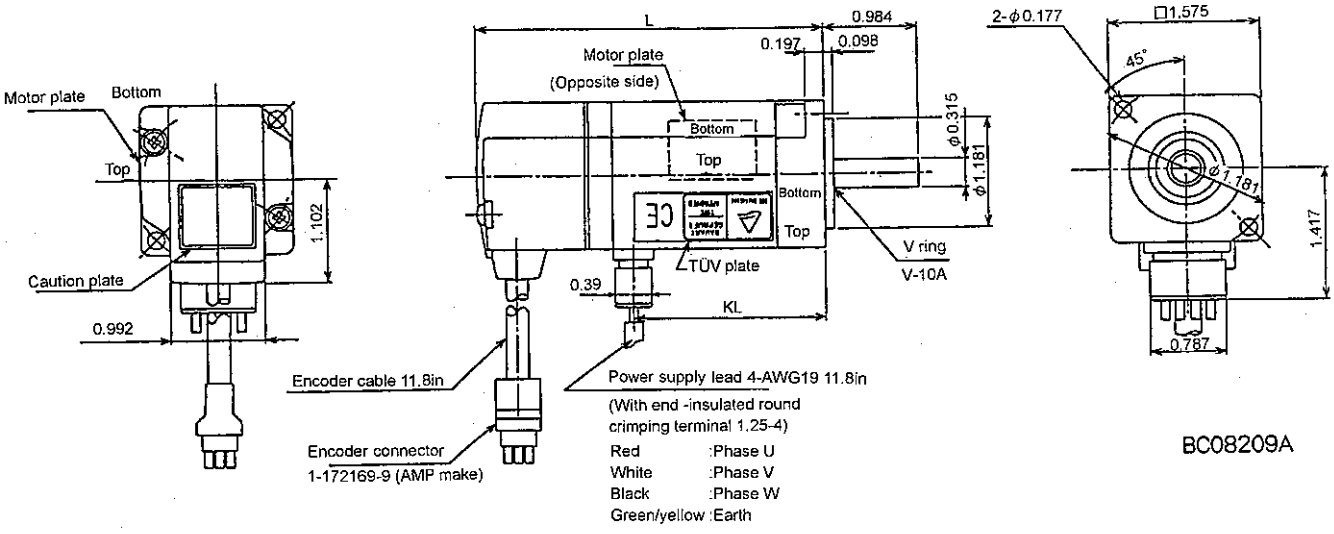
[Unit: in]

Model	Output [W]	Variable Dimensions																	Reduction Ratio
		LA	LB	LC	LD	LE	LF	LG	LH	LK	L	LR	KL	LZ	Q	S	P	R	
HC-PQ43BG2	400	3.94	3.15	4.23	3.35	0.24	2.56	0.39	2.91	1.3	8.11	2.95	5.18	0.26	1.38	0.79	M5	0.39	1/5
HC-PQ43BG2	400	4.53	3.74	5.32	3.94	0.32	2.95	0.39	3.35	1.38	8.94	3.35	6.01	0.35	1.58	0.98	M6	0.47	1/9
HC-PQ43BG2	400	5.32	4.33	6.10	4.23	0.32	3.54	0.47	3.94	1.58	9.17	3.94	6.24	0.43	1.97	1.26	M8	0.63	1/20
HC-PQ43BG2	400	5.32	4.33	6.10	4.23	0.32	3.54	0.47	3.94	1.58	9.17	3.94	6.24	0.43	1.97	1.26	M8	0.63	1/29

10. SPECIFICATIONS

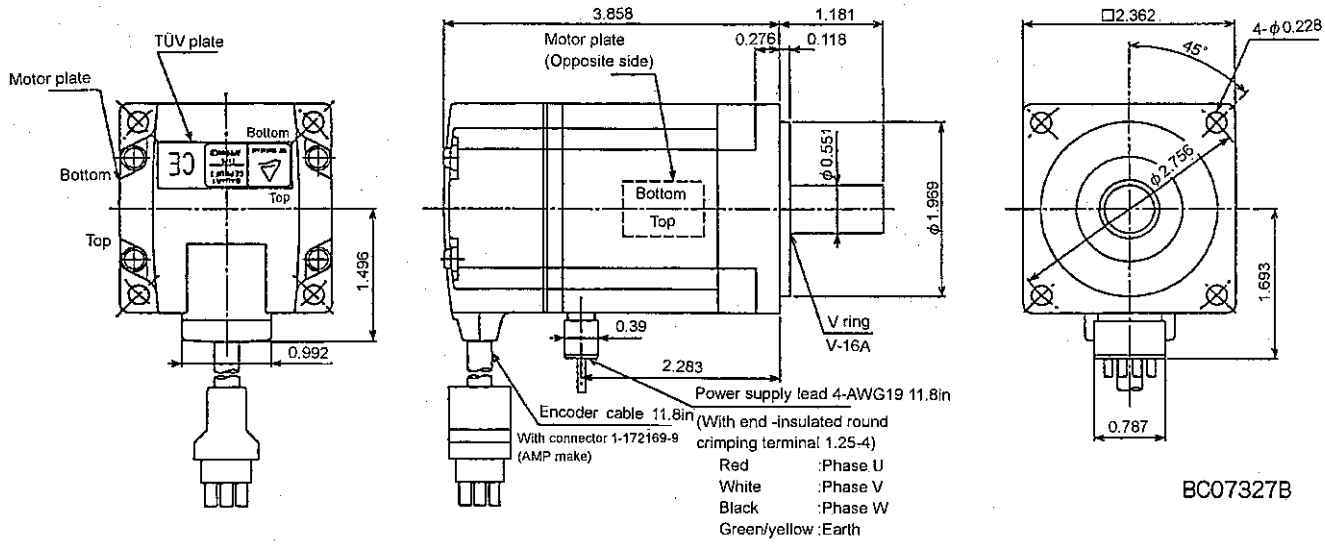
(5) EN•UL/C-UL Standard-Compliant Model

(a) Standard (without electromagnetic brake, without reduction gear)



[Unit: in]

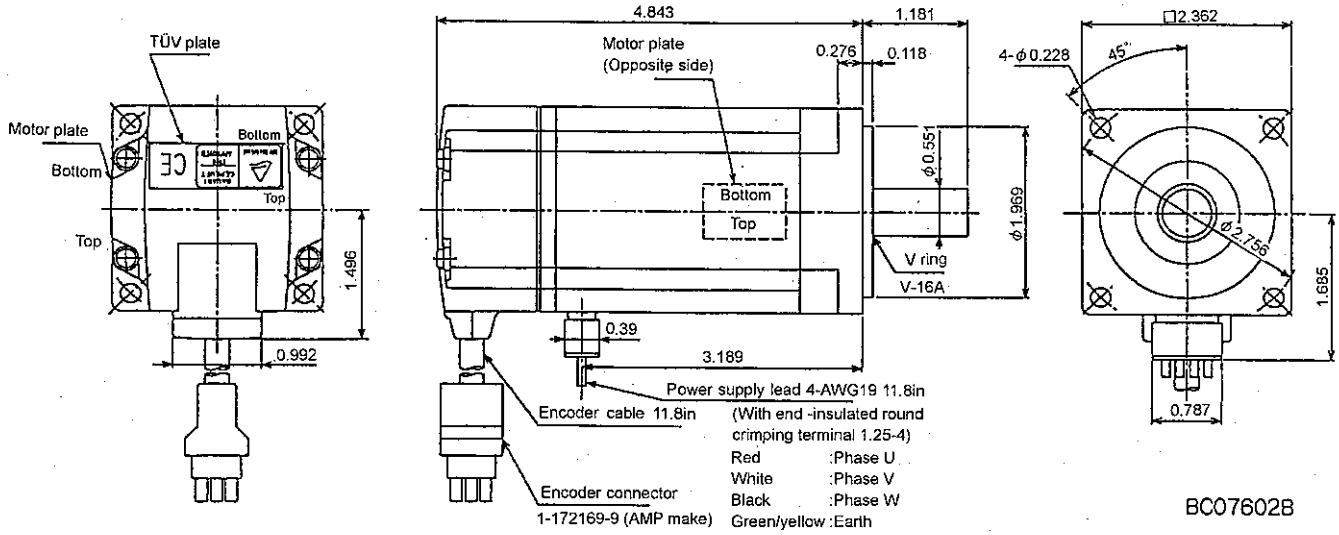
Model	Output [W]	Variable Dimensions		Inertia Moment wk^2 [oz•in^2]	Weight [lb]
		L	KL		
HC-PQ033-UE	30	2.89	1.24	0.08	0.88
HC-PQ053-UE	50	3.13	1.48	0.10	1.10
HC-PQ13-UE	100	3.72	2.07	0.16	1.323



[Unit: in]

Model	Output [W]	Inertia Moment wk^2 [oz•in^2]	Weight [lb]
HC-PQ23-UE	200	0.51	2.43

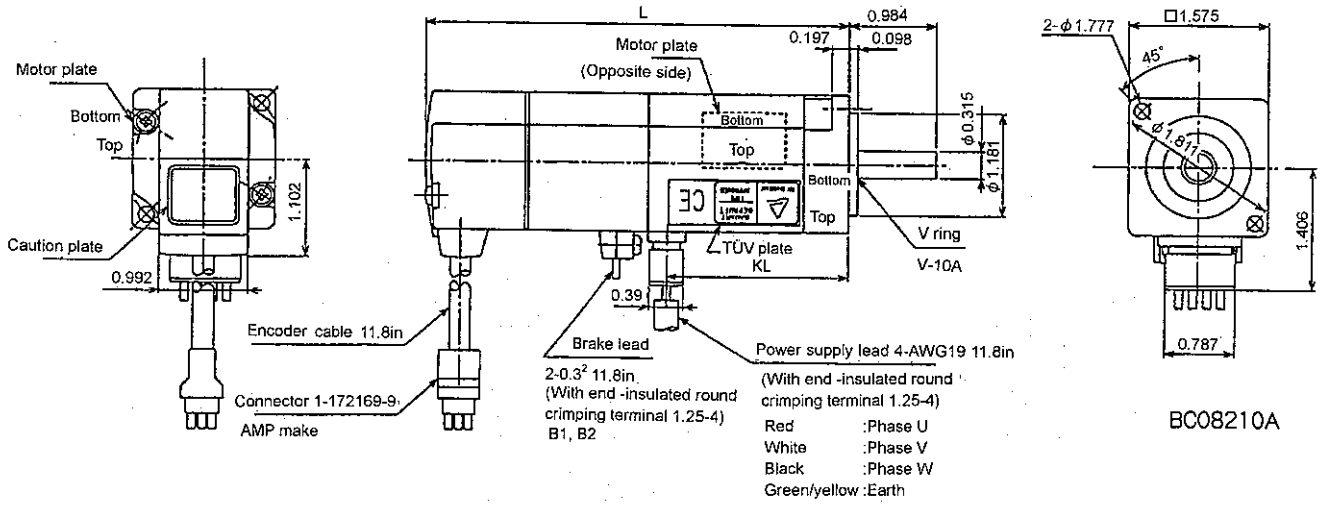
10. SPECIFICATIONS



[Unit: in]

Model	Output [W]	Inertia Moment wk^2 [oz·in^2]	Weight [lb]
HC-PQ43-UE	400	0.81	3.42

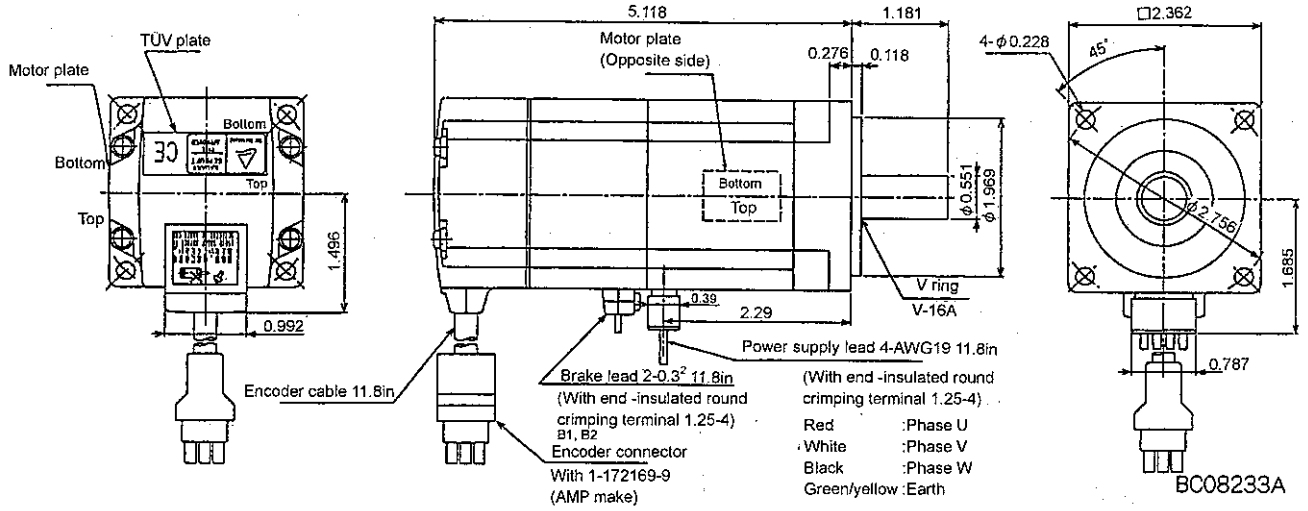
(b) With electromagnetic brake



[Unit: in]

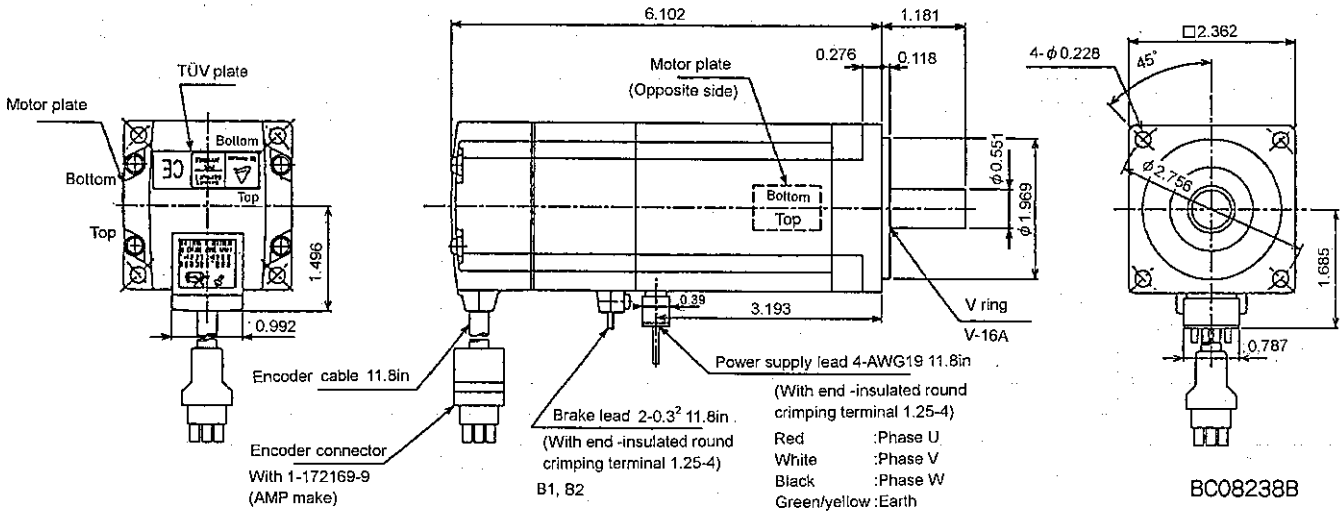
Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N·m]	Inertia Moment wk^2 [oz·in^2]	Weight [lb]
		L	KL			
HC-PQ033B-UE	30	3.99	1.24	0.32	0.09	1.54
HC-PQ053B-UE	50	4.23	1.48	0.32	0.12	1.54
HC-PQ13B-UE	100	4.82	2.07	0.32	0.18	1.98

10. SPECIFICATIONS



[Unit: in]

Model	Output [W]	Brake Static Friction Torque [N•m]	Inertia Moment wk^2 [oz•in²]	Weight [lb]
HC-PQ23B-UE	200	1.3	0.78	3.75



[Unit: in]

Model	Output [W]	Brake Static Friction Torque [N•m]	Inertia Moment wk^2 [oz•in²]	Weight [lb]
HC-PQ43B-UE	400	1.3	1.08	4.85

10. SPECIFICATIONS

10 – 4 Servo Motor with Reduction Gear

The servo motors with reduction gears are available in two lines: 1) for general industrial machines; and 2) for high precision.

The servo motors with reduction gears marked (G1, G2) in the table will be manufactured. G1 and G2 are symbols appended to the servo motor model names. (Refer to section 1-1(2))

Reduction gear series	For General Industrial Machines			For High Precision			
Note: Reduction ratio	1/5	1/12	1/20	1/5	1/9	1/20	1/29
HC-PQ033□							
HC-PQ053□	G1	G1	G1	G2	G2	G2	G2
HC-PQ13□	G1	G1	G1	G2	G2	G2	G2
HC-PQ23□	G1	G1	G1	G2	G2	G2	G2
HC-PQ43□	G1	G1	G1	G2	G2	G2	G2

Note: Reduction ratios for general industrial machines are nominal values.
For actual reduction ratios, refer to the following table.

Reduction Gear Line		1) For General Industrial Machines		2) For High Precision
Method of mounting		Flange mounting		Flange mounting
Mounting direction		In any directions		In any directions
Lubrication		Grease lubrication (already pack)		Grease lubrication (already pack)
	Recommended grease	50 to 100W	200·400W	LDR101BV/America Oil Center Reseach
		Mobilplex46/Mobil	Mobiltac81/Mobil	
Output shaft rotation direction		In the same direction as that of the servo motor output shaft.		In the same direction as that of the servo motor output shaft.
With electromagnetic brake		Available		Available
Backlash		60 minutes or less on reduction gear output shaft		3 minutes or less on reduction gear output shaft
Permissible load inertia ratio (on servo motor shaft)		25 times or less		25 times or less
Permissible speed (on servo motor shaft)		4500 r/min		4500 r/min

The actual reduction ratios of the servo motors for general industrial machines are as listed below:

Servo motor / Nominal reduction ratio	HC-PQ053(B)G1	HC-PQ13(B)G1	HC-PQ23(B)G1	HC-PQ43(B)G1
1/5	9/44		19/96	
1/12	49/576		25/288	
1/20	25/484		253/5000	

10 – 5 Servo Motor with Special Shaft

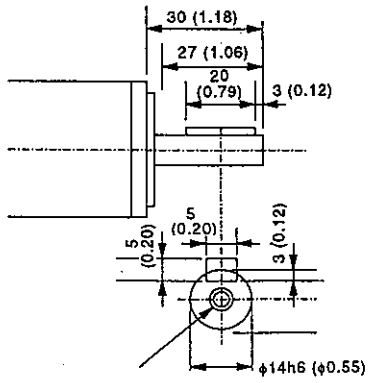
In addition to the standard straight shaft without a key groove, shafts with key, D cut and L cut are also available. These shafts are not appropriate for applications where the servo motor with Special Shaft is started and stopped frequently. Since trouble such as broken shafts due to key looseness are not guaranteed, use a friction coupling or the like.

Servo Motor Model	Shaft Shape		
	With Key	D Cut	L Cut
HC-PQ033		O	
HC-PQ053		O	
HC-PQ13		O	
HC-PQ23	O	O	O
HC-PQ43	O	O	O

Machining Dimension Diagram

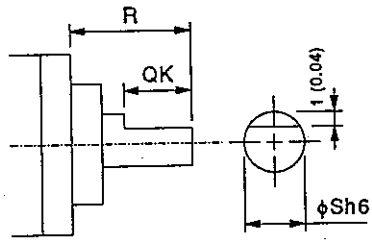
[Unit: mm (in)]

With Key



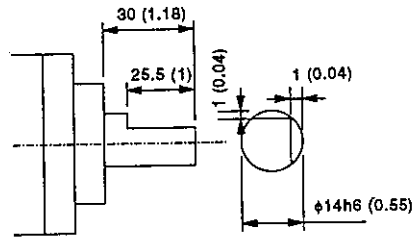
M4×0.7 screw depth 15

D Cut



Capacity [W]	Variable Dimensions		
	R	QK	S
30, 50, 100	25 (0.98)	20.5 (0.81)	8 (0.31)
200,400	30 (1.18)	25.5 (1)	14 (0.55)

L Cut



CHAPTER 11
SELECTION

This chapter describes how to calculate the capacity of the servo motor needed for the machine used.

11. SELECTION

11 – 1 List of Specification Symbols

The following symbols are required for selecting the proper servo.

T_a	: Acceleration torque	[N·m]	P_t	: Number of feedback pulses in position control mode	[pulse/rev]
T_b	: Deceleration torque	[N·m]			
T_{Ma}	: Motor torque necessary for acceleration	[N·m]	f	: Input pulse frequency in position control mode	[pps]
T_{Mb}	: Motor torque necessary for deceleration	[N·m]			
T_{LH}	: Torque applied when the servo motor is stopping	[N·m]	f_o	: Input pulse frequency during fast feed in position control mode	[pps]
T_L	: Load torque converted into equivalent value on servo motor shaft	[N·m]	T_{psa}	: Acceleration time constant of frequency command in position control mode	[s]
T_{LM}	: Load torque converted into equivalent value on servo motor shaft during stopping	[N·m]	T_{psb}	: Deceleration time constant of pulse frequency command in position control mode	[s]
T_U	: Unbalance torque	[N·m]	K_p	: Position control gain 1 (Parameter No.6)	[rad/s]
T_F	: Load friction torque	[N·m]	T_p	: Position control time constant ($T_p = 1/K_p$)	[s]
T_{LO}	Load torque on load shaft	[N·m]			
T_{rms}	: Continuous effective load torque converted into equivalent value on servo motor shaft	[N·m]	K_v	: Speed control gain	[rad/s]
			T_v	: Speed control time constant ($T_v = 1/K_v$)	[s]
			Δ	: Movement amount per feedback pulse in position control mode	[mm/pulse]
J_L	: Load inertia converted into equivalent value on servo motor shaft	[kg·cm^2]			
J_{LO}	: Load inertia on load shaft	[kg·cm^2]	Δ_o	: Movement amount per command pulse in position control mode	[mm/pulse]
J_M	: Servo motor's rotor inertia	[kg·cm^2]			
N	: Servo motor speed	[r/min]		: Movement amount	[mm]
No	: Servo motor speed during fast feed	[r/min]	P	: Number of input command pulses in position control mode	[pulse]
N_{LO}	: Load shaft speed during fast feed	[r/min]			
V	: Motion part speed	[mm/min]	ts	: Stop setting time in position control mode	[s]
Vo	: Motion part speed during fast feed	[mm/min]			
P_b	: Ball screw lead	[mm]	to	: Positioning time	[s]
Z_1	: Number of gear teeth on servo motor shaft		tc	: Time of constant speed of servo motor in 1 cycle	[s]
Z_2	: Number of gear teeth on load gear				
n	: Gear ratio $n = \frac{Z_2}{Z_1}$		t	: Stopping time in 1 cycle	[s]
			$\Delta\varepsilon$	: Positioning accuracy	[mm]
	Speed reduced when n>1, Speed increased when n<1		ε	: Number of droop pulses	[pulse]
			$\Delta\theta$	: Load shaft rotation angle per pulse in position control mode	[degree/pulse]
η	: Drive part efficiency		e	: Euler constant = 2.71878	
g	: Acceleration of gravity (9.8 [m/s^2])		ΔS	: Movement amount per servo motor revolution	[mm/rev]
μ	: Friction coefficient				

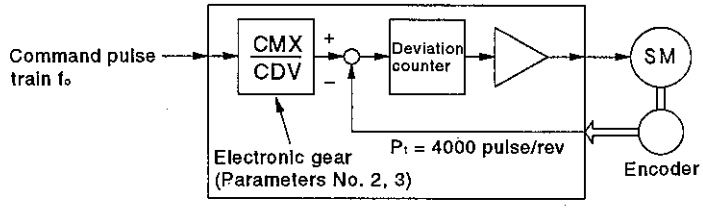
11 – 2 Position Resolution and Electronic Gear Setting

The position resolution (movement amount per pulse $\Delta\ell$) is determined from the movement amount per servo motor revolution ΔS and the number of encoder feedback pulses P_t. The following equation shows this.

$$\Delta\ell = \frac{\Delta S}{P_t} \quad \text{.....(11-1)}$$

$\Delta\ell$: movement amount per pulse [mm]
ΔS: movement amount per servo motor revolution [mm/rev]
P_t : number of feedback pulses [pulse/rev]

The value for $\Delta\ell$ is related to the equation (11-1) and the value in the control system is fixed when the drive system and encoder are determined. However, the movement amount per command pulse can be set with the parameters.



As shown above, the command pulse is multiplied by CMX/CDV to become the position control pulse. Therefore, the movement amount per command pulse $\Delta\ell_o$ is expressed with the following equation.

$$\Delta\ell_o = \frac{\Delta S}{P_t} \cdot \frac{CMX}{CDV} = \Delta\ell \cdot \frac{CMX}{CDV} \quad \text{.....(11-2)}$$

CMX: parameter No. 2
CDV: parameter No. 3

Using the above relation, the movement amount per command pulse can be set to a number without fraction.

[Setting example]
Obtain the parameter value for $\Delta\ell_o$= 0.01 [mm] in the drive system with a ball screw lead P_b = 10 [mm], reduction ratio 1/n = 1.
The encoder feedback pulse of the HC-PQ is P_t = 4000 [pulse/rev].
ΔS = 10 [mm/rev]. So, with equation (11-2), the following is obtained.

$$\frac{CMX}{CDV} = \Delta\ell_o \cdot \frac{P_t}{\Delta S}$$
$$= 0.01 \cdot \frac{4000}{10} = 4$$

Therefore, the parameters are set as CMX=4 and CDV=1.

11. SELECTION

<Relation of position resolution Δ and total accuracy>

Total accuracy (machine's positioning accuracy) is the sum of the electrical error and mechanical error. Therefore, the electrical system error is normally set so that it does not influence overall error. Refer to the equation below as a guideline.

$$\Delta\ell < \left(\frac{1}{5} \text{ to } \frac{1}{10}\right) \cdot \Delta\varepsilon \quad \text{.....(11-3)}$$

Here: $\Delta\ell$: Feed value per feedback pulse [mm/pulse]

$\Delta\varepsilon$: Positioning accuracy [mm]

11 – 3 Servo Motor Speed and Command Pulse Frequency

The servo motor is commanded to run at a speed where the command pulse and feedback pulse are equivalent. Therefore, the command pulse frequency and feedback pulse frequency are equivalent. The relation including the parameter command pulse multiplication set value (CMX, CDV) is shown below. (Refer to the figure below.)

$$f_o \cdot \frac{CMX}{CDV} = P_t \cdot \frac{N_o}{60} \quad \text{.....(11-4)}$$

Here: f_o : Command pulse frequency [pps]
CMX: Electronic gear (Command pulse multiplication numerator) Parameter No. 2
CDV : Electronic gear (Command pulse multiplication denominator) Parameter No. 3
N_o : Servo motor speed [r/min]
P_t : Number of feedback pulses [pulse/rev]
(P_t = 4000 for HC-PQ)

According to Equation (11-4), the following equations may be used to find the electronic gear ratio and command pulse frequency required to rotate the servo motor at N_o:

• electronic gear

$$\frac{CMX}{CDV} = P_t \cdot \frac{N_o}{60} \cdot \frac{1}{f_o} \quad \text{.....(11-5)}$$

• input pulse train frequency

$$f_o = P_t \cdot \frac{N_o}{60} \cdot \frac{CDV}{CMX} \quad \text{.....(11-6)}$$

[Setting example]

Find the command pulse frequency required to run the HC-PQ at 4000[r/min].

Supposing that the electronic gear ratio is 1 (default parameter value), the above frequency is found as follows according to Equation (11-6):

$$f_o = 4000 \cdot \frac{N_o}{60} \cdot \frac{CDV}{CMX}$$

(input command pulse frequency)

$$= 4000 \cdot \frac{4000}{60} \cdot 1$$

$$= 266667\text{[pps]}$$

However, 266667pps cannot be input because the maximum input command pulse frequency is 200kpps in the open collector system.

Hence, the electronic gear ratio must be changed to run the servo motor with not more than 200kpps at the speed of 4000[r/min]. Use Equation (11-5) to find this electronic gear ratio.

$$\frac{CMX}{CDV} = 4000 \cdot \frac{4000}{60} = 4000 \cdot \frac{1}{200 \cdot 10^3}$$

(electronic gear)

$$= \frac{4}{3}$$

Therefore, the parameter is set to CMX=4 and CDV=3.

11 – 4 Stopping Characteristics

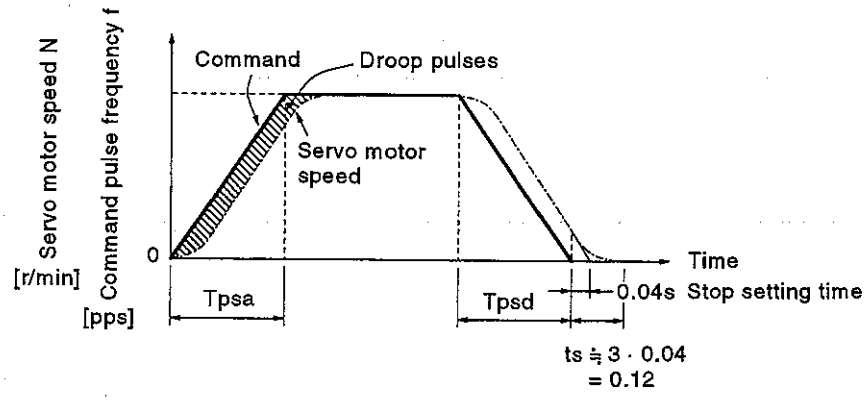
(1) Droop pulses (ε)

When running the servo motor with a pulse train command, the encoder feedback pulses are delayed during acceleration. The difference between the command pulses and feedback pulses are called droop pulses. The droop pulses are accumulated in the servo amplifier's deviation counter. The following equation defines the relationship between the command pulse frequency (f), position loop gain (K_p), and the number of droop pulses (ε).

$$\varepsilon = \frac{f_o}{K_P} \text{ [pulse]} \quad \text{.....(11-7)}$$

In the MELSERVO-C, the initial value of the position control gain is 25[rad/s]. In this case, if the command pulse frequency is 200 [kpps], the droop pulses during operation will be as follows according to the above equation (11-7).

$$\varepsilon = \frac{200 \times 10^3}{25} = 8000 \text{ [pulse]}$$



(2) Stop setting time (ts) during linear acceleration/deceleration

The servo amplifier during operation has droop pulses, so a stop setting time (ts) is required from the time the command reaches 0 to when the motor stops. Set the operation pattern while taking the stop setting time into consideration.

The ts value will be obtained in the following equation:

$$ts \fallingdotseq 3 \cdot T_P$$
$$= 3 \cdot \frac{1}{K_P} \text{ [s]} \quad \text{.....(11-8)}$$

*When K_P = 25 [rad/s] is used, ts ≒ 0.12 [s]. (Refer to above diagram.)

Note: The stop setting time (ts) indicates the time required for the servo motor to stop in the necessary position accuracy range. This does not always mean that the servo motor has stopped completely. Thus, at high cycle rates, a larger value than the value obtained in the equation (11-8) must be considered when there is no allowance in the positioning accuracy for the movement amount per pulse (Δ). The ts will differ depending on the moving part conditions. If the load friction torque is especially large, the movement may be unstable near the stopping position.

11. SELECTION

11 – 5 Capacity selection method

To select a servo motor, the load conditions must first be calculated. Next, a servo motor is selected according to these initial calculations. Then, the load of the servo motor is included in further calculations to determine if the servo motor initially selected will provide the necessary performance.

(1) Initial selection of servo motor capacity

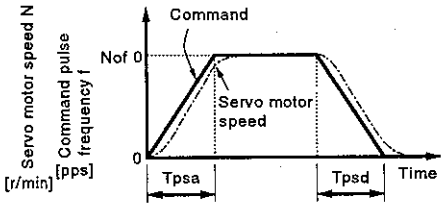
When the load torque (T_L) and load inertia (J_L) have been calculated, select a servo motor using servo motor rated torque > T_L, servo motorJ_M > $J_L/3$ as a guideline.

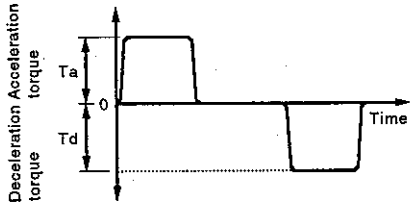
Find the torque for acceleration/deceleration, and the continuous effective load torque following the steps in (2) and then, verify the selection.

For frequent positioning, the J_L value should be as small as possible. If positioning is infrequent such as in line control, the J_L value can be slightly larger than the above conditions.

(2) Acceleration/deceleration torque

The equation for obtaining the acceleration/deceleration torque with the following pattern is shown.





• Acceleration torque

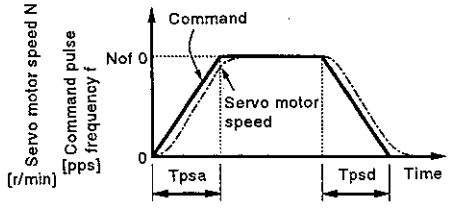
$$T_a = \frac{(J_L + J_M) \cdot N_o}{9.55 \times 10^4} \cdot \frac{1}{Tpsa} \quad \text{.....(11-9)}$$

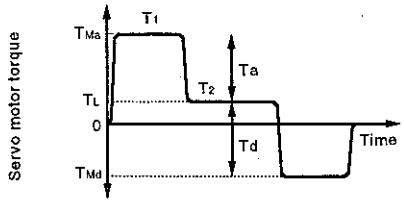
• Deceleration torque

$$T_b = \frac{(J_L + J_M) \cdot N_o}{9.55 \times 10^4} \cdot \frac{1}{Tpsd} \quad \text{.....(11-10)}$$

(3) Torque required for operation

The highest torque is applied to the servo motor during acceleration. If the torque required for the servo motor during acceleration obtained in the following equation exceeds the maximum servo motor torque, acceleration will not be possible in the commanded time. Confirm that the calculated value is lower than the servo motor's maximum torque. Normally, a friction load is applied during deceleration, so only the acceleration torque needs to be considered.





$T_1 = T_{Ma} = T_a + T_L$ ..... (11-11)

$T_2 = T_L$ ..... (11-12)

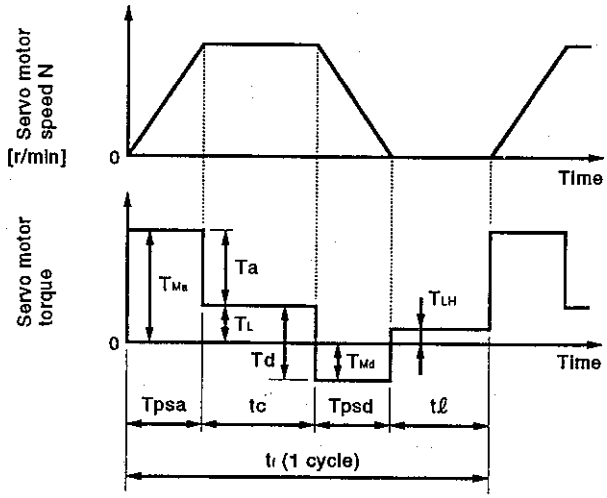
$T_3 = T_{Md} = -T_d + T_L$ ..... (11-13)

Note: The regenerative status will be indicated if the value obtained in the equation (11-13) is a negative value.

(4) Continuous effective load torque

If the torque required for the servo motor changes with time, the continuous effective load torque obtained in the following equation must be lower than the servo motor's rated torque.

There may be a servo motor torque delay at acceleration or deceleration due to a delay in the control system. But, to simplify the calculation, the calculation assumes that a constant acceleration/deceleration torque is applied during Tpsa and Tpsd. The equation for the continuous effective load torque for the following operation pattern is given below.



$$T_{rms} = \sqrt{\frac{T_{Ma}^2 \cdot T_{psa} + T_L^2 \cdot tc + T_{Md}^2 \cdot T_{psd} + T_{LH}^2 \cdot t}{t_f}} \quad \text{..... (11-14)}$$

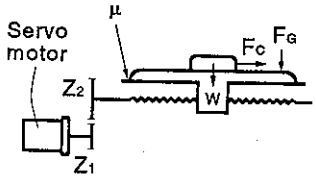
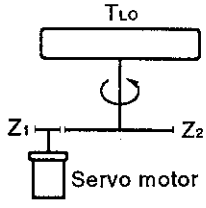
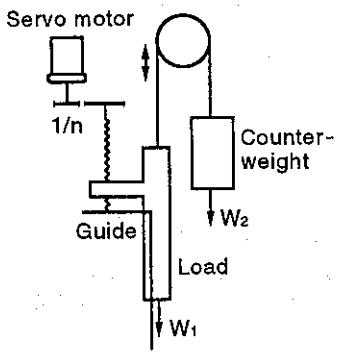
Note: T_{LH} in the diagram shows the torque applied during stopping. A torque is applied to the servo motor especially when stopping during vertical operations. During vertical drive, the unbalanced torque T_U will be T_{LH}.

11. SELECTION

11 – 6 Load Torque Equations

The main load torque equations are shown below.

Load Torque Equations

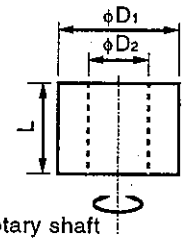
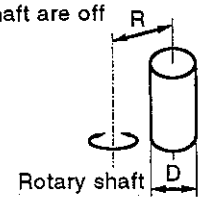
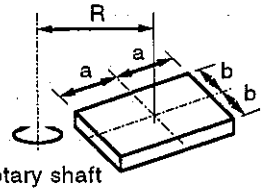
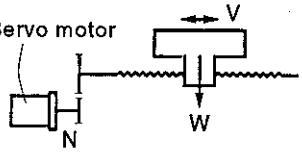
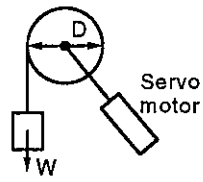
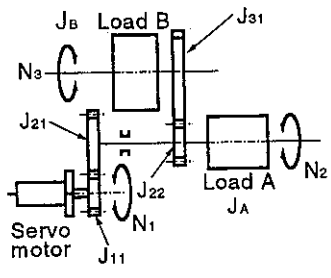
Type	Mechanism	Equation
Linear movement		$T_L = \frac{F}{2\times10^3\cdot\pi\cdot\eta}\cdot\frac{V}{N} = \frac{F\cdot\Delta S}{2\times10^3\cdot\pi\cdot\eta}$ ..... (11-15) F : Shaft direction force of the machine in linear motion [N] F in Equation (11-15) is obtained with Equation (11-16) when moving a table, for example, as shown in the diagram. $F = F_C + \mu\cdot(W\cdot g + F_G)$ ..... (11-16) F_C : Shaft direction force applied on moving part [N] F_G : Tightening force of the table guide surface [N] W : Total weight of the moving part [kg]
Rotary movement		$T_L = \frac{1}{n}\cdot\frac{1}{\eta}\cdot T_{LO} + T_F$ ..... (11-17) T_F : Load friction torque converted into equivalent value on servo motor shaft [N·m]
Vertical movement		During rising $T_L = T_U + T_F$ ..... (11-18) During lowering $T_L = -T_U\cdot\eta^2 + T_F$ ..... (11-19) T_F : Friction torque of the moving part [N·m] $T_U = \frac{(W_1 - W_2)\cdot g}{2\times10^3\cdot\pi\cdot\eta}\cdot\frac{V}{N} = \frac{(W_1 - W_2)\cdot g\cdot\Delta S}{2\times10^3\cdot\pi\cdot\eta}$ ..... (11-20) $T_F = \frac{\mu(W_1 + W_2)\cdot g\cdot\Delta S}{2\times10^3\cdot\pi\cdot\eta}$ ..... (11-21) W_1 : Load weight [kg] W_2 : Counterweight [kg]

11. SELECTION

11 – 7 Load Inertia Equations

The main load inertia equations are shown below.

Load Inertia Equations

Type	Mechanism	Equation
Cylinder	Rotary shaft is at cylinder center 	$J_{LO} = \frac{\pi \cdot \rho \cdot L}{32} \cdot (D_1^4 - D_2^4) = \frac{W}{8} \cdot (D_1^2 + D_2^2)$ ..... (11-22) ρ : Cylinder material density [kg·cm²] L : Cylinder length [cm] D1 : Cylinder outer diameter [cm] D2 : Cylinder inner diameter [cm] W : Cylinder weight [kg] Reference data material density : Steel : 7.8 × 10⁻³ [kg/cm³] Aluminum : 2.7 × 10⁻³ [kg/cm³] Copper : 8.96 × 10⁻³ [kg/cm³]
	When rotary shaft and cylinder shaft are off 	$J_{LO} = \frac{W}{8}(D^2 + 8R^2)$ ..... (11-23)
Square block		$J_{LO} = W \cdot \left(\frac{a^2 + b^2}{3} + R^2\right)$ ..... (11-24) W : Square block weight [kg] a, b, R : Left diagram [cm]
Object which moves linearly		$J_L = W \cdot \frac{V}{600\omega} = W \cdot \left(\frac{1}{2 \cdot \pi \cdot N} \cdot \frac{V}{10}\right)^2 = W \cdot \left(\frac{\Delta S}{20 \cdot \pi}\right)^2$ ..... (11-25) V : Speed of object moving linearly [mm/min] ΔS : Movement amount of object moving linearly per servo motor revolution [mm/rev] W : Object weight [kg]
Object that is hung with pulley		$J_L = W \cdot \left(\frac{D}{2}\right)^2 + J_P$ ..... (11-26) JP : Pulley inertia [kg·cm²] D : Pulley diameter [cm] W : Object weight [kg]
Converted load		$J_L = J_{11} + (J_{21}+J_{22}+J_A) \cdot \left(\frac{N_2}{N_1}\right)^2 + (J_{31}+J_B) \cdot \left(\frac{N_3}{N_1}\right)^2$ ..... (11-27) JA, JB : Load A, B inertia [kg·cm²] J11 to J31 : Inertia [kg·cm²] N1 to N3 : Speed of each shaft [r/min]

11 – 8 Zeroing Instructions

To return the system to the home position with the MELSERVO-C, use a zeroing dog or actuator. The method and precautions for setting the mechanical origin are given below. In the following zeroing, an actuator and the zero pulse signal (encoder Z-phase pulse OP) of a servo motor encoder are used to set the mechanical origin. Whether the encoder Z-phase pulse signal (OP) is on or off can be confirmed on the external I/O signal display.

When a general positioning module (AD75 etc.) is used, the sequence of events is as shown in Fig. 11-1.

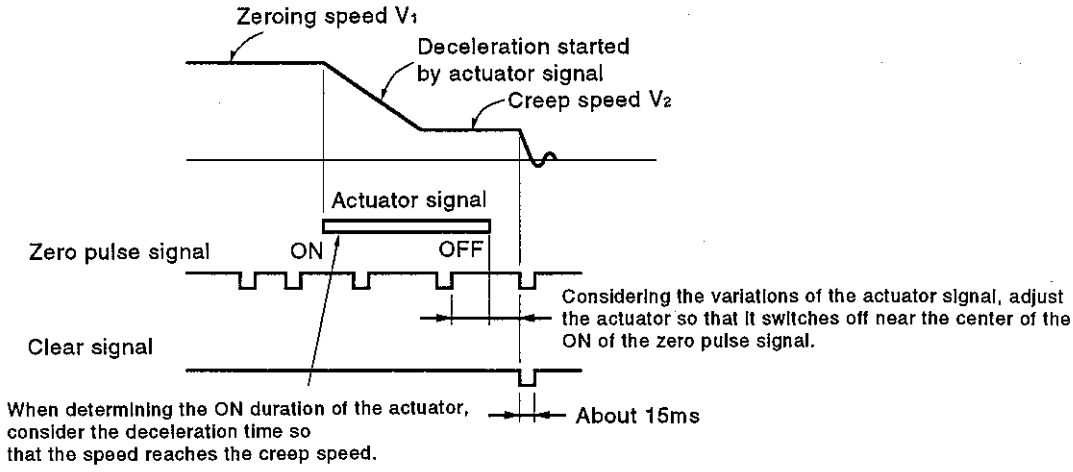
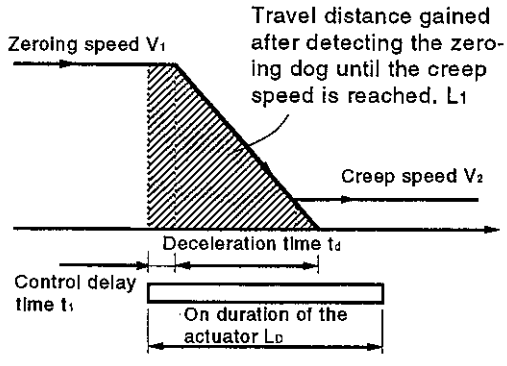


Fig. 11-1 Zeroing Using the Actuator

(1) When determining the on duration of the actuator, consider the delay time of the control section and the deceleration time so that the creep speed is attained. If the actuator signal switches off during deceleration, precise home position return cannot be performed.



- Travel distance L_1 in the chart can be obtained by Formula (11-28)
- On duration of the actuator L_D [mm] must be longer than L_1 obtainedby formula (11-28) as in Formula (11-29).

$$L_1 = \frac{1}{60} \cdot V_1 \cdot t_1 + \frac{1}{120} \cdot V_1 \cdot t_d \cdot \left\{1 - \left(\frac{V_2}{V_1}\right)^2\right\} + \frac{1}{60} \cdot V_1 \cdot T_p \quad \text{..... (11-28)}$$

$$L_D > L_1 \quad \text{..... (11-29)}$$

where,

V_1, V_2: as shown in the chart [mm/min]

t_1, t_d : same as above [s]

L_1 : same as above [mm]

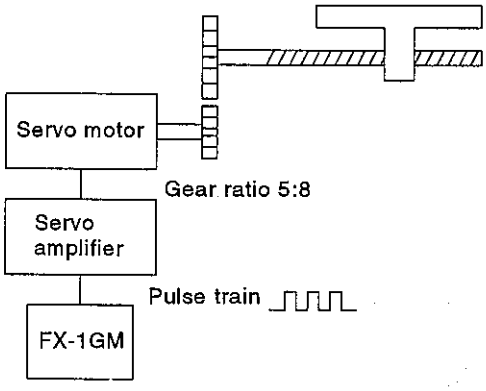
L_D : same as above [mm]

(2) Set the end (off position) of the actuator signal at the middle of two on positions (Lows) of the zero pulse signal. If it is set near either on position of the zero pulse signal, the positioning module is liable to misdetect the zero pulse signal.
In this case, a fault will occur, e.g. the home position will shift by one revolution of the servo motor.
The zero pulse output position can be confirmed by OP (Encoder Z-phase pulse) on the external I/O signal display.

(3) Set the creep speed so that the machine is not shocked when the operation comes to a stop.
The operation instantly stops since the clear (CR) signal is given to the servo amplifier immediately when a zero pulse signal is detected.

11 – 9 Selection Example

Machine specifications



Speed of moving part during fast feed	V_o	= 30000[mm/min]
Movement amount per pulse	$\Delta\ell$	= 0.005[mm]
Movement amount	ℓ	= 400[mm]
Positioning time	t_o	= 1[s] or less
Number of feeds		40[times/min.]
(Operation cycle	t_f	= 1.5[s]
Gear ratio	n	= 8/5
Moving part weight	W	= 60[kg]
Drive system efficiency	η	= 0.8
Friction coefficient	μ	= 0.2
Ball screw lead	P_b	= 16[mm]
Ball screw diameter		20[mm]
Ball screw length		500[mm]
Gear diameter (servo motor)		25[mm]
Gear diameter (load shaft)		40[mm]
Gear tooth width		10[mm]

(1) Selection of control parameter

1) Setting of electronic gear (pulse multiplication numerator, denominator)

The following relation is established between the multiplication setting and movement amount per pulse $\Delta\ell$.

$$\Delta\ell = \frac{(\text{ball screw read})}{4000\times(\text{gear ratio})}\times\frac{CMX}{CDV}$$

When the machining specification is substituted for the above equation:

$$\frac{CMX}{CDV} = 0.005\cdot\frac{4000\cdot 8/5}{16} = 2$$

OK if the $\frac{CMX}{CDV}$ ratio is within $\frac{1}{50}$ to 20.

2) Input pulse train frequency for fast feed f_o

$$f_o = \frac{V_o}{60\cdot\Delta\ell} = \frac{30000}{60\cdot 0.005} = 10000\ [\text{pps}]$$

OK if f_o is 200kpps or less.

(2) Servo motor speed

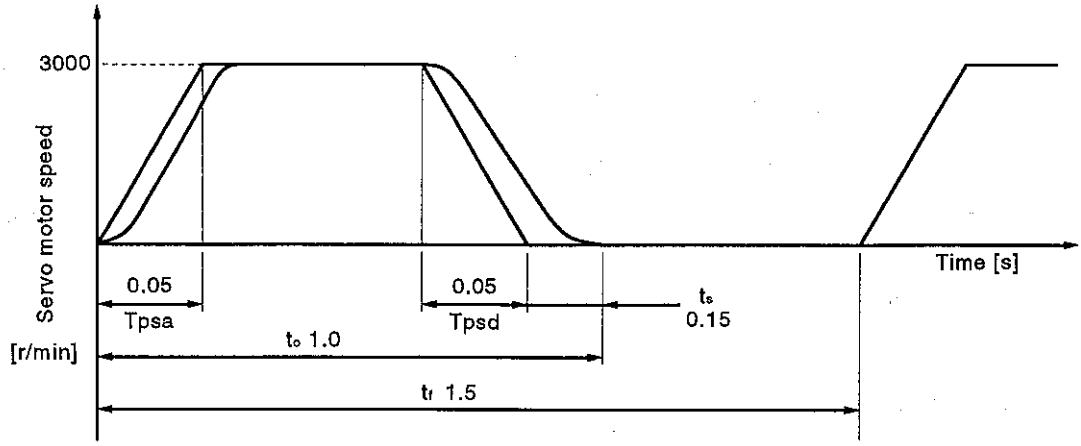
$$N_o = \frac{V_o}{P_b}\cdot n = 3000\ [\text{r/min}]$$

(3) Acceleration/deceleration time constant

$$T_{psa} = T_{psd} = t_o - \frac{\ell}{V_o/60} - ts = 0.05\ [\text{s}]$$

*ts: stop setting time. Here, this is assumed to be 0.15s.

(4) Operation pattern



(5) Load torque (converted into equivalent value on servo motor shaft)

Movement amount per servo motor revolution

$$\Delta S = P_b \cdot \frac{1}{n} = 10 \text{ [mm]}$$

$$T_L = \frac{\mu \cdot W \cdot g \cdot \Delta S}{2 \times 10^3 \cdot \pi \cdot \eta} = 0.23 \text{ [N·m]}$$

(6) Load inertia (converted into equivalent value on servo motor shaft)

Moving part

$$J_{L1} = W \cdot \left(\frac{\Delta S}{20 \cdot \pi}\right)^2 = 1.52 \text{ [kg·cm}^2\text{]}$$

Ball screw

$$J_{L2} = \frac{\pi \cdot \rho \cdot L}{32} \cdot D^4 \cdot \left(\frac{1}{n}\right)^2 = 0.24 \text{ [kg·cm}^2\text{]}$$

* $\rho = 7.8 \times 10^{-3}$ [kg/cm^3] (iron)

Gear (servo motor shaft)

$$J_{L3} = \frac{\pi \cdot \rho \cdot L}{32} \cdot D^4 = 0.03 \text{ [kg·cm}^2\text{]}$$

Gear (load shaft)

$$J_{L4} = \frac{\pi \cdot \rho \cdot L}{32} \cdot D^4 \cdot \left(\frac{1}{n}\right)^2 = 0.8 \text{ [kg·cm}^2\text{]}$$

Full load inertia (converted into equivalent value on servo motor shaft)

$$J_L = J_{L1} + J_{L2} + J_{L3} + J_{L4} = 1.9 \text{ [kg·cm}^2\text{]}$$

(7) Temporary selection of servo motor

Selection conditions

1) Load torque < servo motor rated torque
2) Full load inertia < 10 × servo motor inertia

From the above, the HC-PQ23 (200W) is temporarily selected.

(8) Acceleration/deceleration torque

Torque required for servo motor during acceleration

$$T_{Ma} = \frac{(J_L + J_M) \cdot N_o}{9.55 \times 10^4 \cdot T_{psa}} + T_L = 1.7 \text{ [N·m]}$$

Torque required for servo motor during deceleration

$$T_{Md} = -\frac{(J_L + J_M) \cdot N_o}{9.55 \times 10^4 \cdot T_{psd}} + T_L = -1.2 \text{ [N·m]}$$

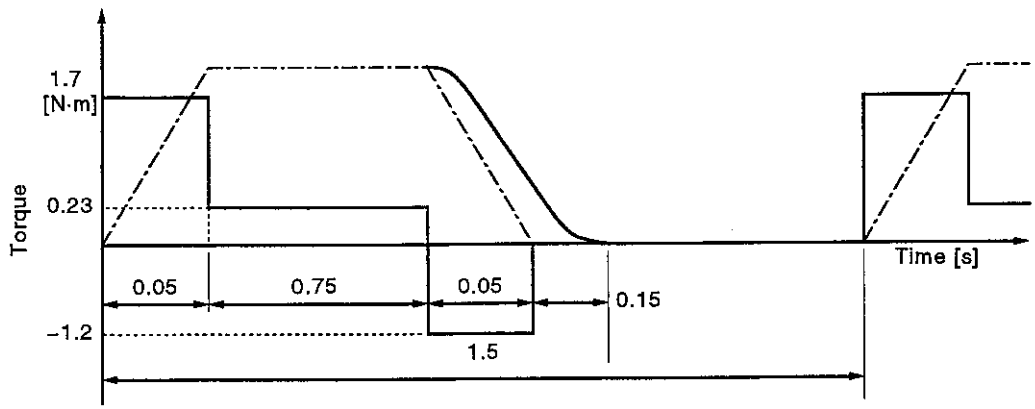
The torque required for the servo motor during acceleration/deceleration must be lower than the servo motor's maximum torque.

(9) Continuous effective load torque

$$Trms = \sqrt{\frac{T_{Ma}^2 \cdot T_{psa} + T_L^2 \cdot tc + T_{Md}^2 \cdot T_{psd}}{t_f}} = 0.41 \text{ [N·m]}$$

The continuous effective load torque must be lower than the servo motor's rated torque.

(10) Torque pattern



(11) Selection results

The servo motor HC-PQ23 and servo amplifier MR-C20A(1) are selected with the above conditions.

1) Electronic gear setting

Parameter No. 2	Command pulse multiplication numerator (CMX)	2
Parameter No. 3	Command pulse multiplication denominator (CDV)	1

2) During fast feed

- Servo motor speed.....N_o = 3000 r/min
- Input pulse train frequency.....f_o = 100 kpps

3) Acceleration/deceleration time constant

$T_{psa} = T_{psd} = 0.05s$

CHAPTER 12
OPTIONAL PRODUCTS

Products given in this chapter are available as options.
Please contact us for delivery time, prices, etc.
Items that are not described in this chapter are the same as in the standard models.

12. OPTIONAL PRODUCTS

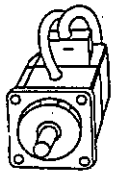
12 – 1 Servo Motors with Special Flanges

The NEMA and stepping motor intercompatibility type are available as servo motors equipped with special flanges.

12 – 1 – 1 Model definition

HC-PQ □ 3 □ □ □ □ □

Series



Symbol	Compliance with standard
None	Standard model (In Japan)
-UE	EN Standard, UL/C-UL Standard-compliant

Symbol	Shaft
None	Straight shaft
K	With key (200W or more)
D	D cut
L	L cut (200W or more)

Symbol	Electromagnetic brake
None	Without
B	With

Symbol	Motor type
N	NEMA flange type
P	Stepping motor intercompatibility type

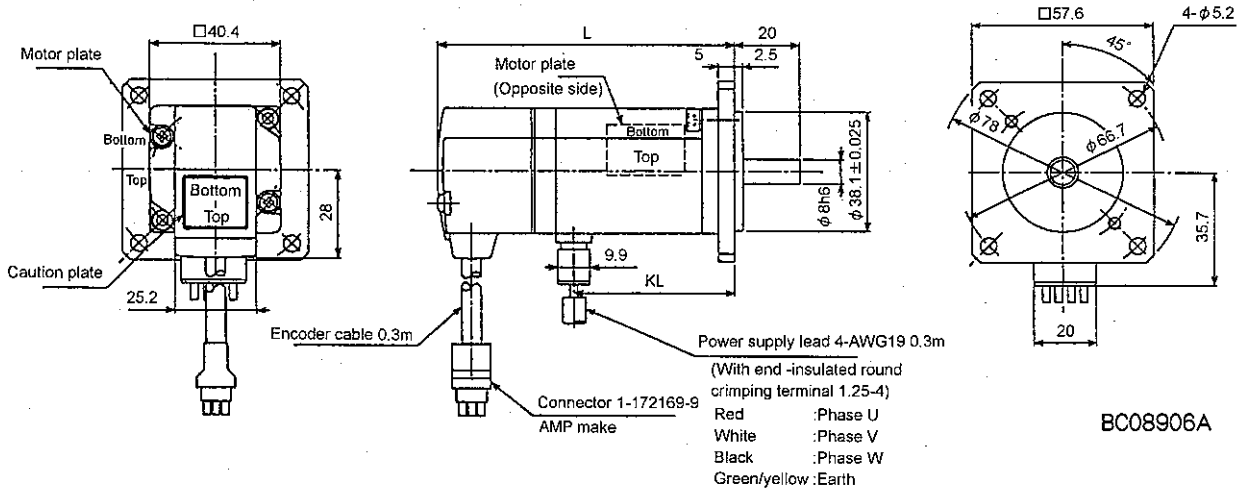
Rated speed (3000r/min)

Symbol	Rated output [W]
03	30
05	50
1	100
2	200
4	400

12. OPTIONAL PRODUCTS

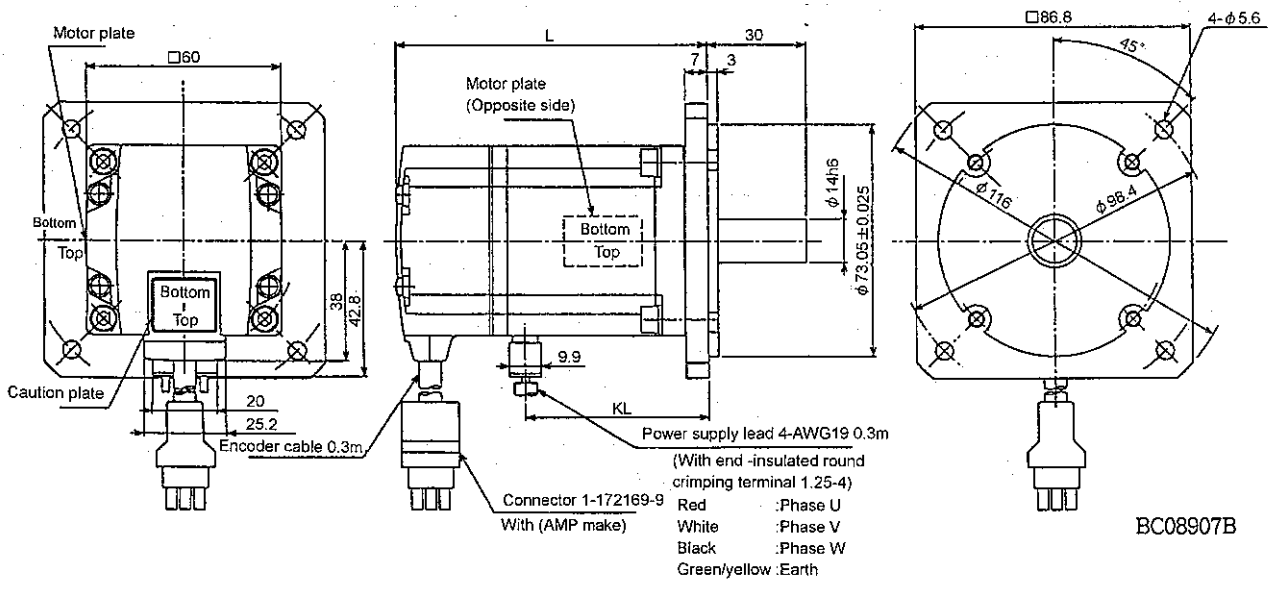
12 – 1 – 2 NEMA flange type

(1) Standard



[Unit: mm]

Model	Output [W]	Variable Dimensions		Inertia Moment J [x10^{-4}kg•m^2]	Weight [kg]
		L	KL		
HC-PQ033N	30	70.5	28.5	0.014	0.4
HC-PQ053N	50	76.5	34.5	0.019	0.5
HC-PQ13N	100	91.5	49.5	0.030	0.6

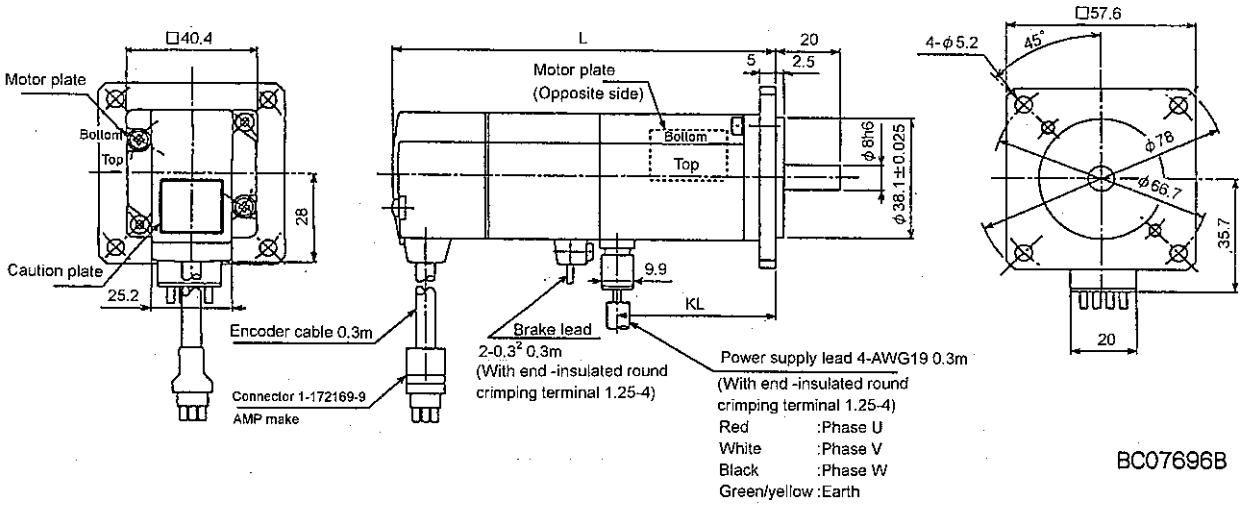


[Unit: mm]

Model	Output [W]	Variable Dimensions		Inertia Moment J [x10^{-4}kg•m^2]	Weight [kg]
		L	KL		
HC-PQ23N	200	96.5	56.6	0.090	1.1
HC-PQ43N	400	121.5	79.6	0.145	1.6

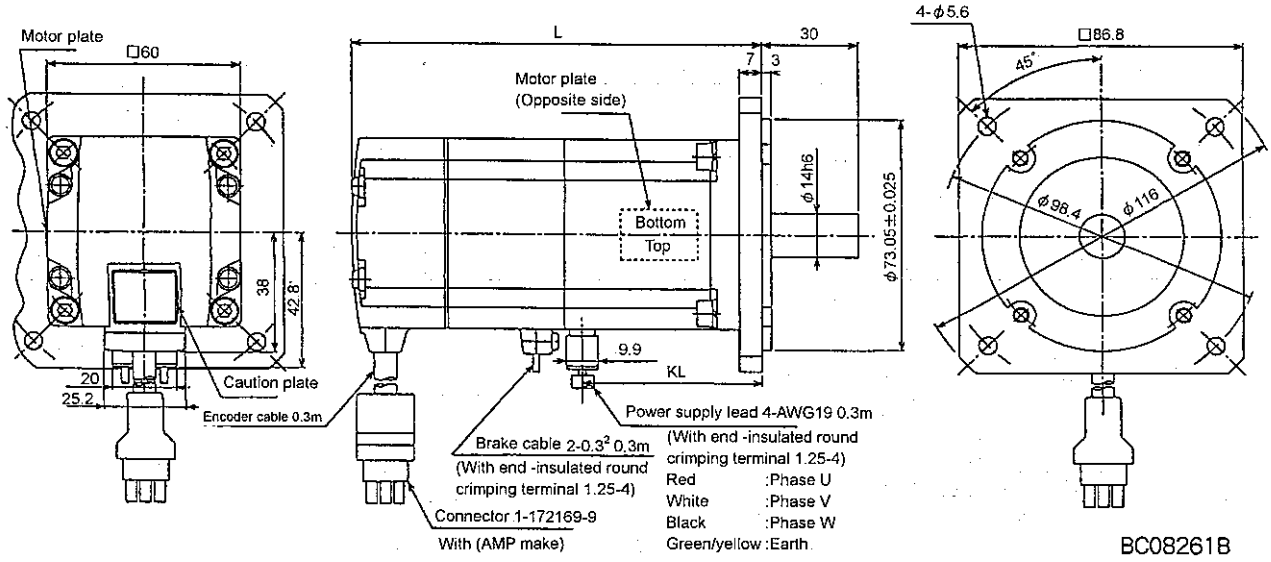
12. OPTIONAL PRODUCTS

(2) With electromagnetic brake



[Unit: mm]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment J [×10⁻⁴kg•m²]	Weight [kg]
		L	KL			
HC-PQ033NB	30	98.5	28.5	0.32	0.017	0.7
HC-PQ053NB	50	104.5	34.5	0.32	0.022	0.7
HC-PQ13NB	100	119.5	49.5	0.32	0.032	0.9



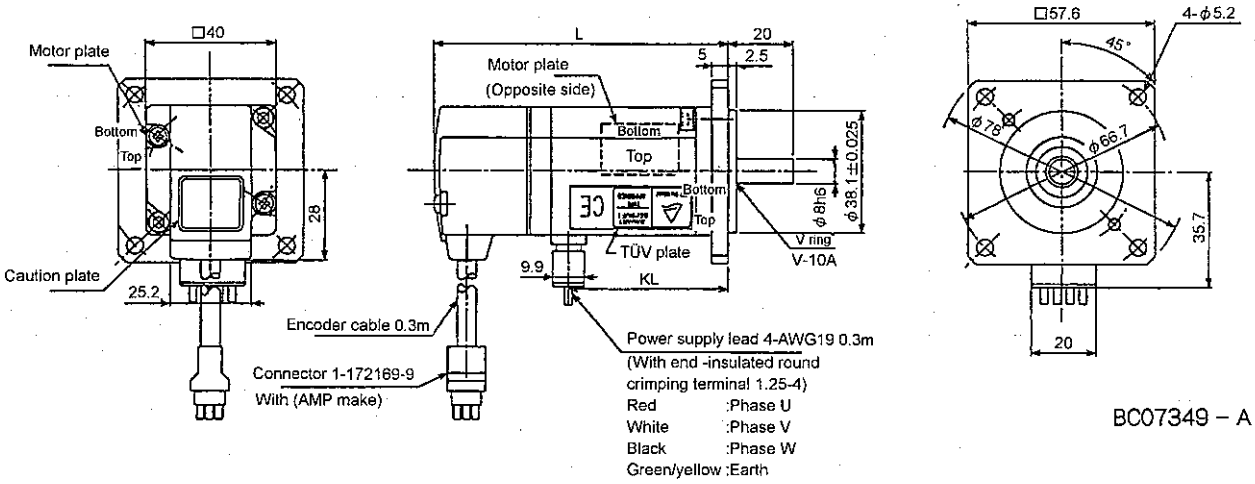
[Unit: mm]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment J [×10⁻⁴kg•m²]	Weight [kg]
		L	KL			
HC-PQ23NB	200	128.5	56.1	1.3	0.138	1.8
HC-PQ43NB	400	153.5	79.1	1.3	0.193	2.3

12. OPTIONAL PRODUCTS

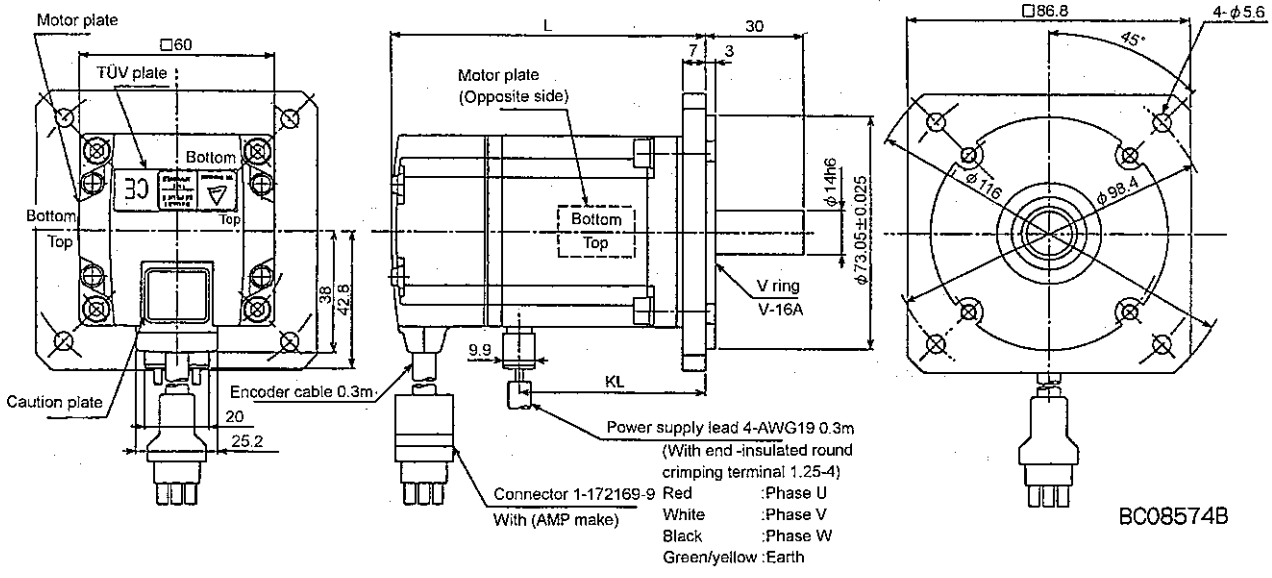
(3) EN•UL/C-UL Standard-Compliant Model

(a) Standard



[Unit: mm]

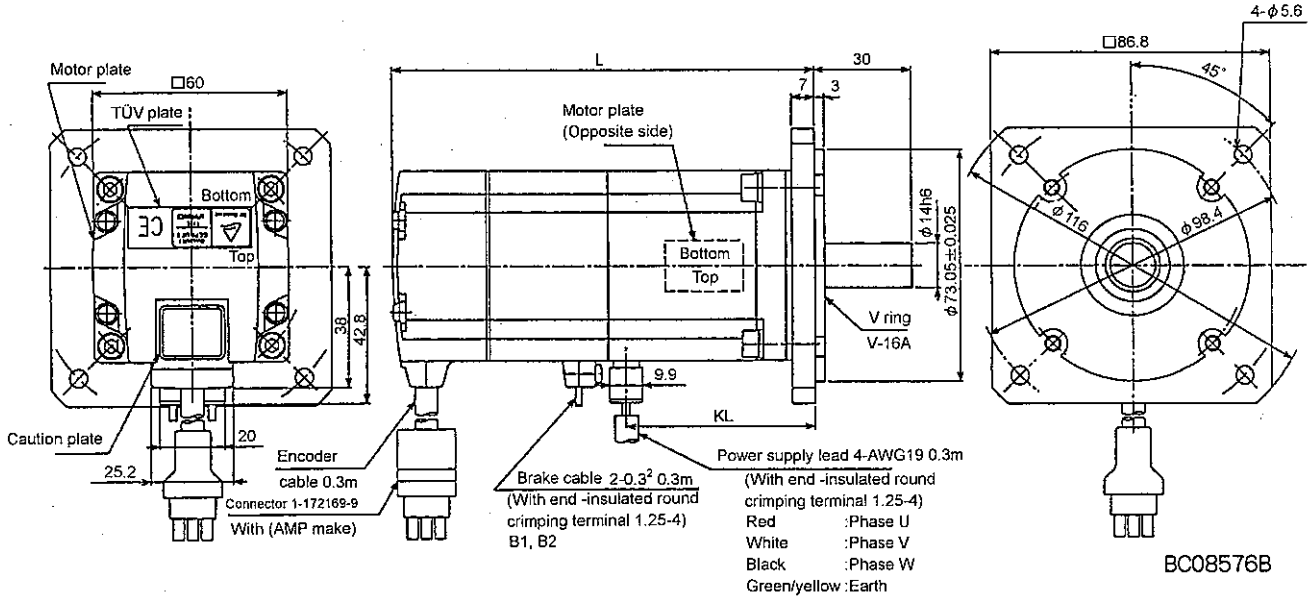
Model	Output [W]	Variable Dimensions		Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
		L	KL		
HC-PQ033N-UE	30	70.5	28.5	0.014	0.4
HC-PQ053N-UE	50	76.5	34.5	0.019	0.5
HC-PQ13N-UE	100	91.5	49.5	0.030	0.6



[Unit: mm]

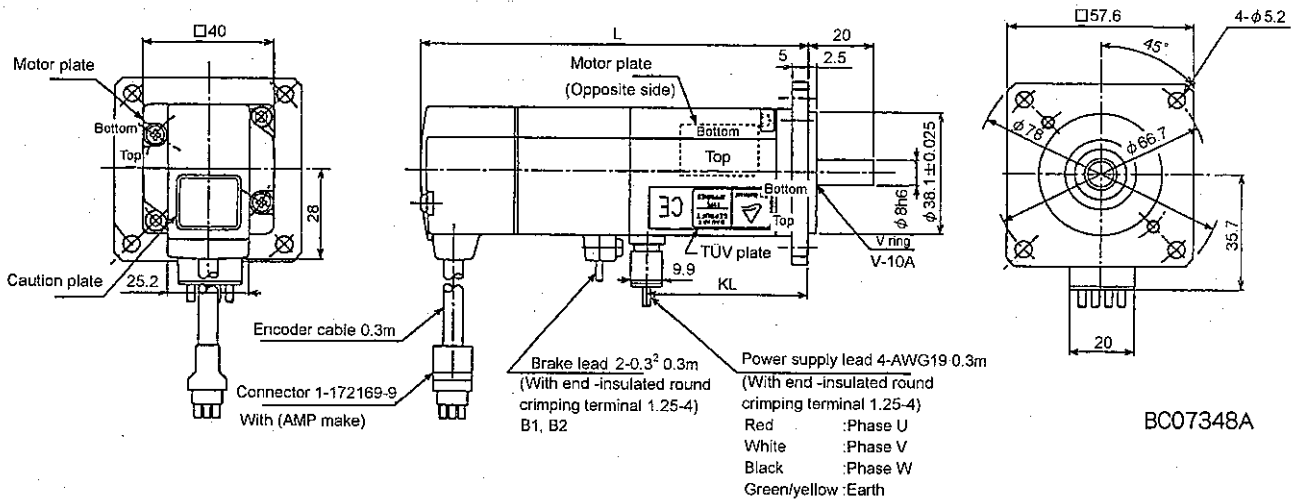
Model	Output [W]	Variable Dimensions		Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
		L	KL		
HC-PQ23N-UE	200	98	58.1	0.093	1.1
HC-PQ43N-UE	400	123	81.1	0.148	1.6

(b) With electromagnetic brake



[Unit: mm]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
		L	KL			
HC-PQ23NB-UE	200	130	58.1	1.3	0.142	1.8
HC-PQ43NB-UE	400	155	81.1	1.3	0.197	2.3



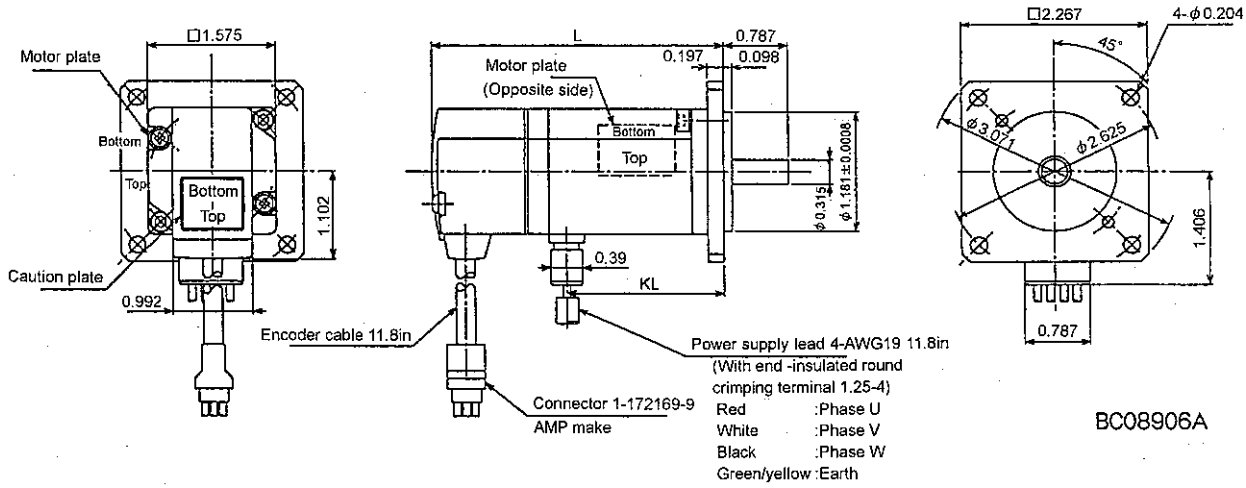
[Unit: mm]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
		L	KL			
HC-PQ033NB-UE	30	98.5	28.5	0.32	0.017	0.7
HC-PQ053NB-UE	50	104.5	34.5	0.32	0.022	0.7
HC-PQ13NB-UE	100	119.5	49.5	0.32	0.032	0.9

12. OPTIONAL PRODUCTS

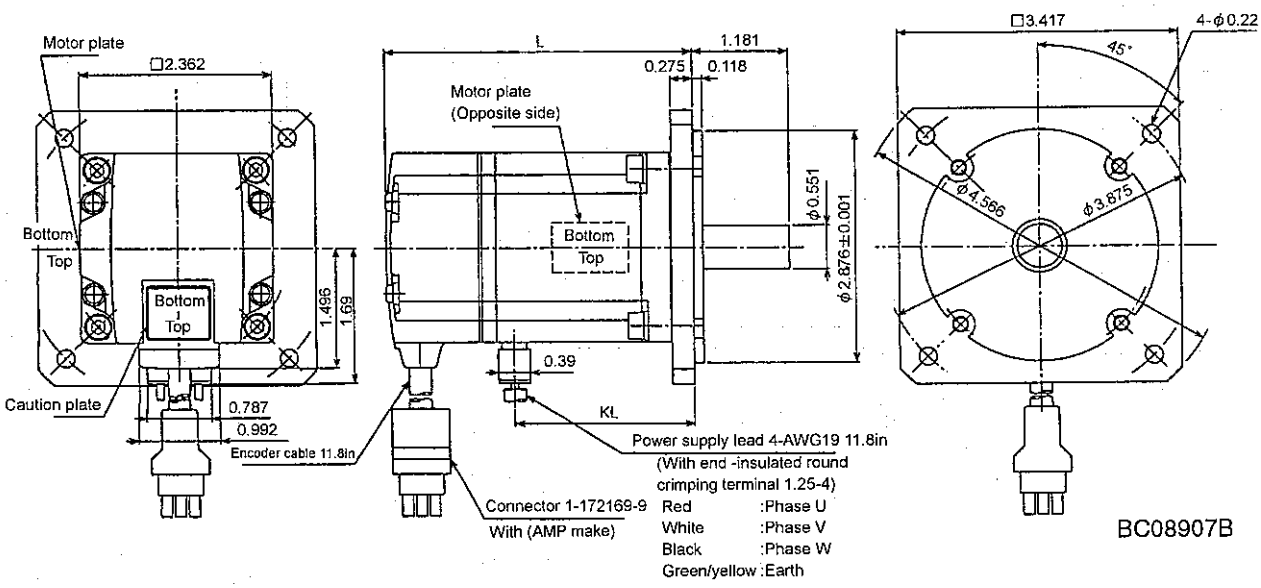
12 – 1 – 3 NEMA flange type (in inches)

(1) Standard



[Unit: in]

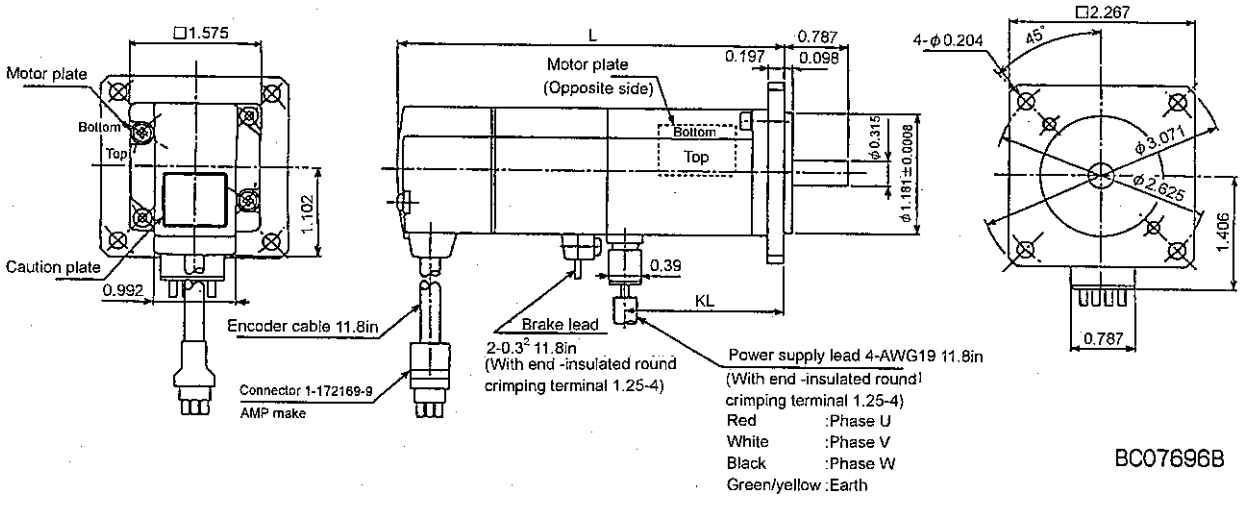
Model	Output [W]	Variable Dimensions		Inertia Moment wk^2 [oz·in^2]	Weight [lb]
		L	KL		
HC-PQ033N	30	2.78	1.12	0.08	0.88
HC-PQ053N	50	3.01	1.36	0.10	1.10
HC-PQ13N	100	3.60	1.95	0.16	1.32



[Unit: in]

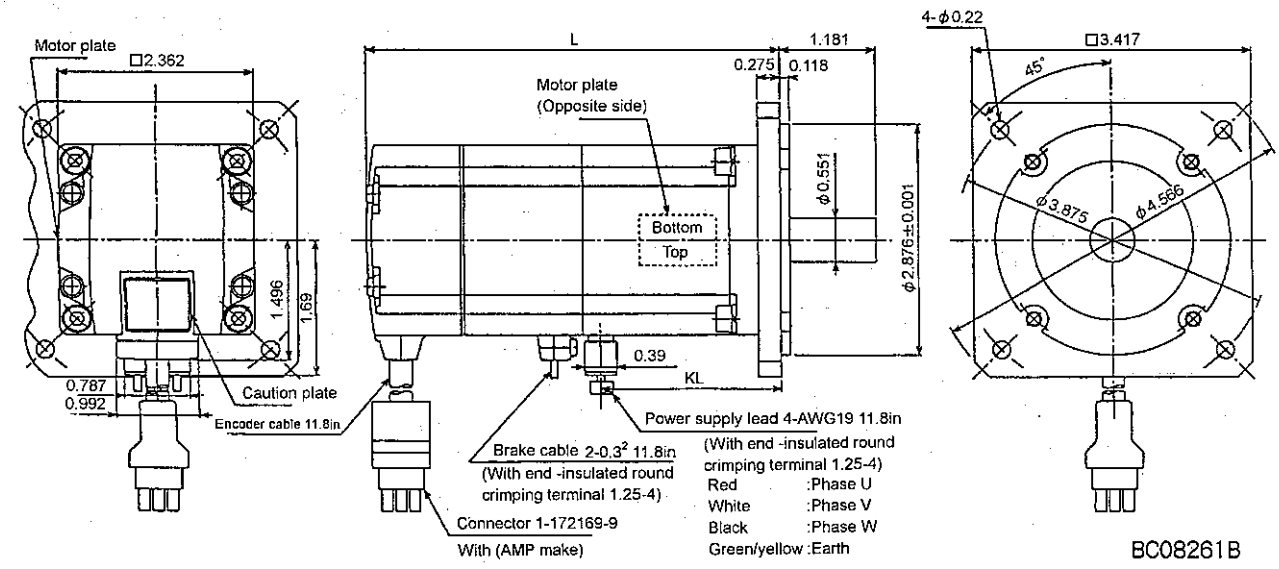
Model	Output [W]	Variable Dimensions		Inertia Moment wk^2 [oz·in^2]	Weight [lb]
		L	KL		
HC-PQ23N	200	3.79	2.23	0.492	2.43
HC-PQ43N	400	4.78	3.13	0.792	3.53

(2) With electromagnetic brake



[Unit: in]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment wk² [oz•in²]	Weight [lb]
		L	KL			
HC-PQ033NB	30	3.88	1.12	0.32	0.09	1.54
HC-PQ053NB	50	4.11	1.36	0.32	0.12	1.54
HC-PQ13NB	100	4.71	1.95	0.32	0.18	1.98



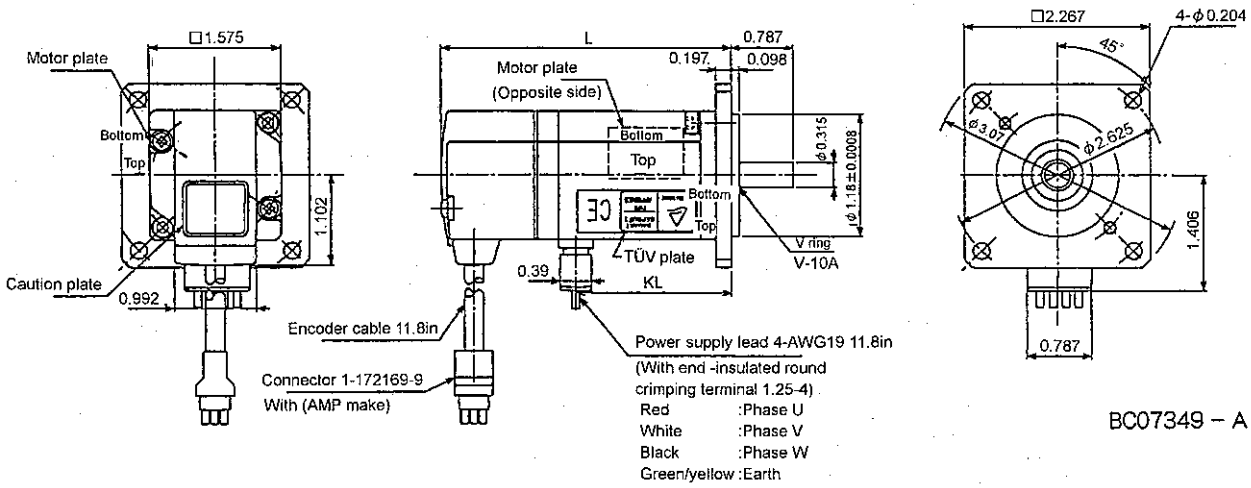
[Unit: in]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment wk² [oz•in²]	Weight [lb]
		L	KL			
HC-PQ23NB	200	5.06	2.21	1.3	0.755	3.97
HC-PQ43NB	400	6.04	3.11	1.3	1.055	5.07

12. OPTIONAL PRODUCTS

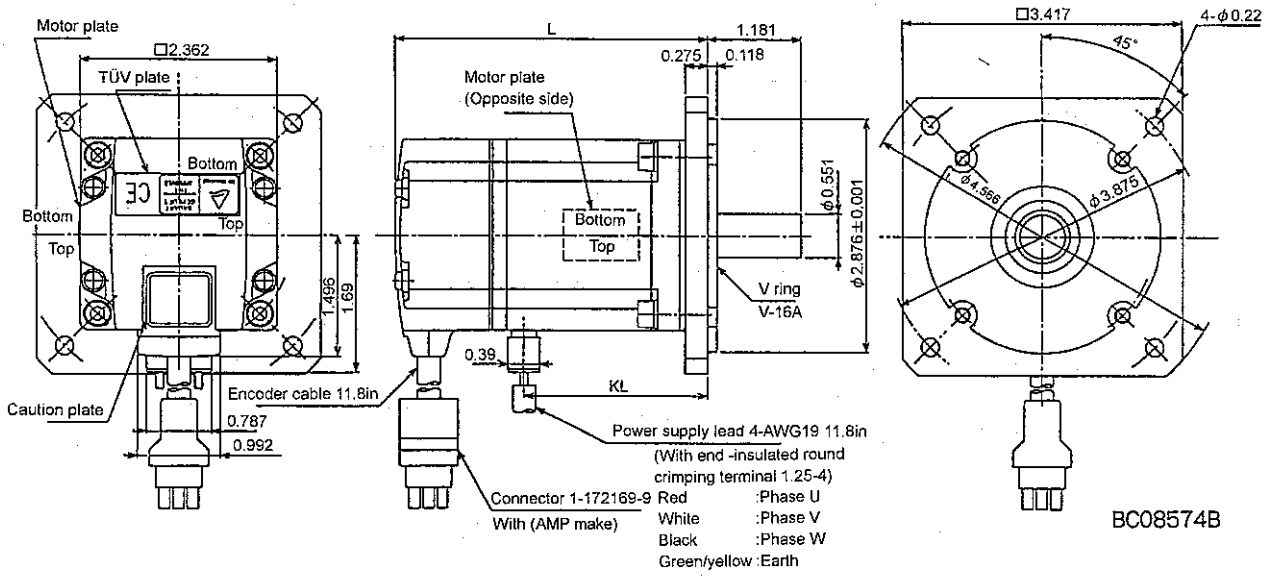
(3) EN•UL/C-UL Standard-Compliant Model

(a) Standard



[Unit: in]

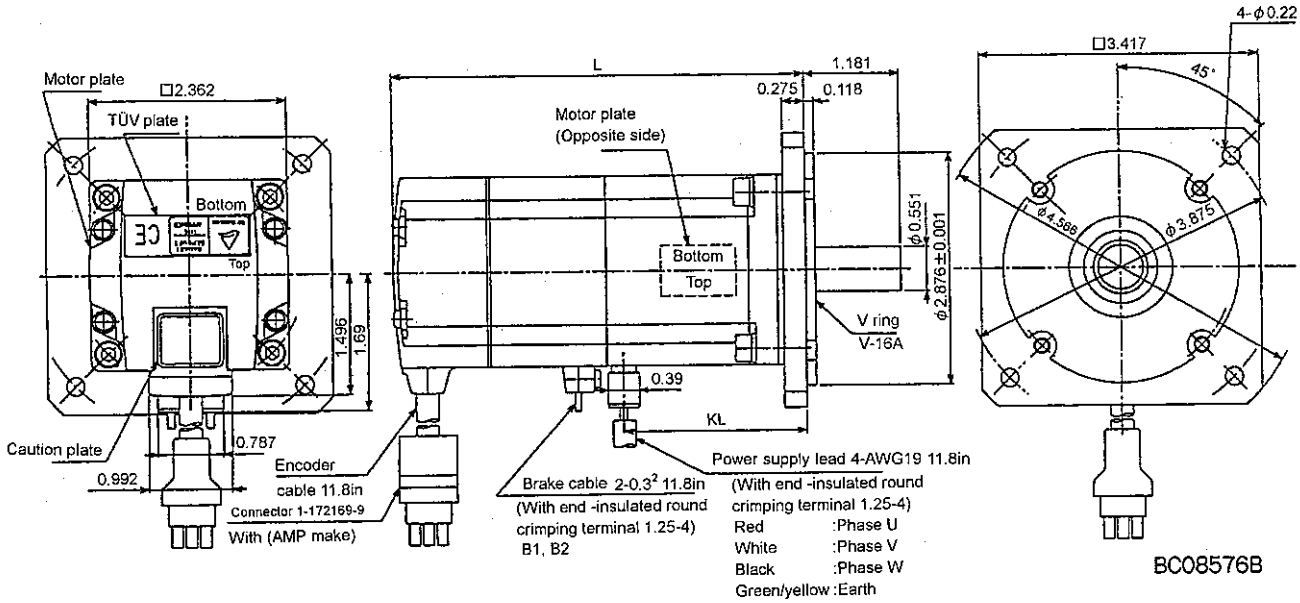
Model	Output [W]	Variable Dimensions		Inertia Moment wk^2 [oz•in^2]	Weight [lb]
		L	KL		
HC-PQ033N-UE	30	2.78	1.12	0.08	0.88
HC-PQ053N-UE	50	3.01	1.36	0.10	1.10
HC-PQ13N-UE	100	3.60	1.95	0.16	1.323



[Unit: in]

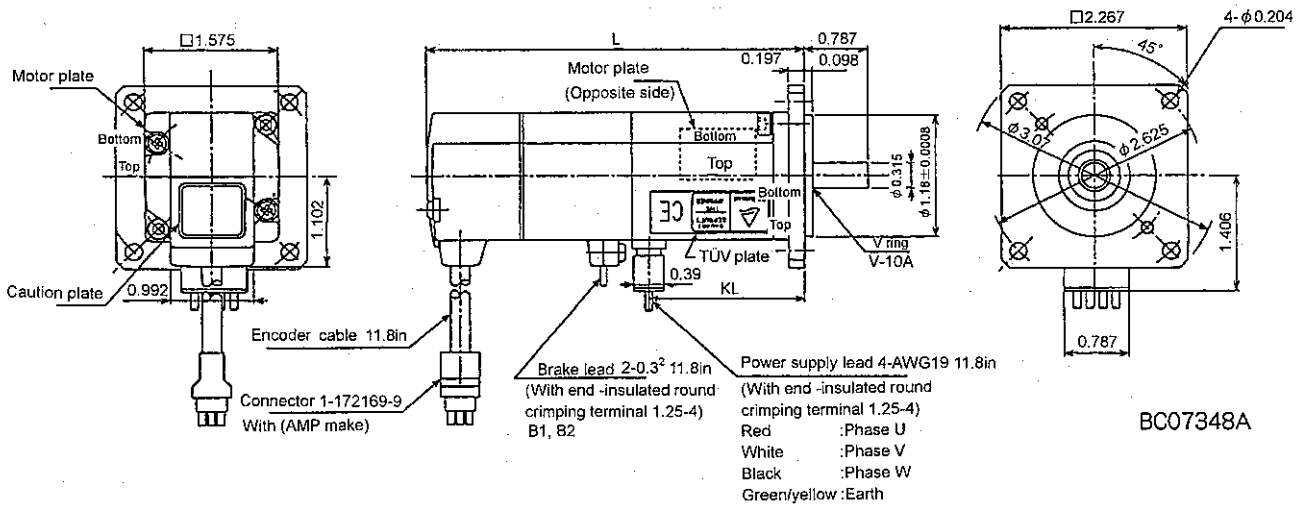
Model	Output [W]	Variable Dimensions		Inertia Moment wk^2 [oz•in^2]	Weight [lb]
		L	KL		
HC-PQ23N-UE	200	3.86	2.29	0.51	2.43
HC-PQ43N-UE	400	4.84	3.19	0.809	3.53

(b) With electromagnetic brake



[Unit: in]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N·m]	Inertia Moment wk^2 [oz·in²]	Weight [lb]
		L	KL			
HC-PQ23NB-UE	200	5.12	2.29	1.3	0.78	3.97
HC-PQ43NB-UE	400	6.10	3.19	1.3	1.08	5.07



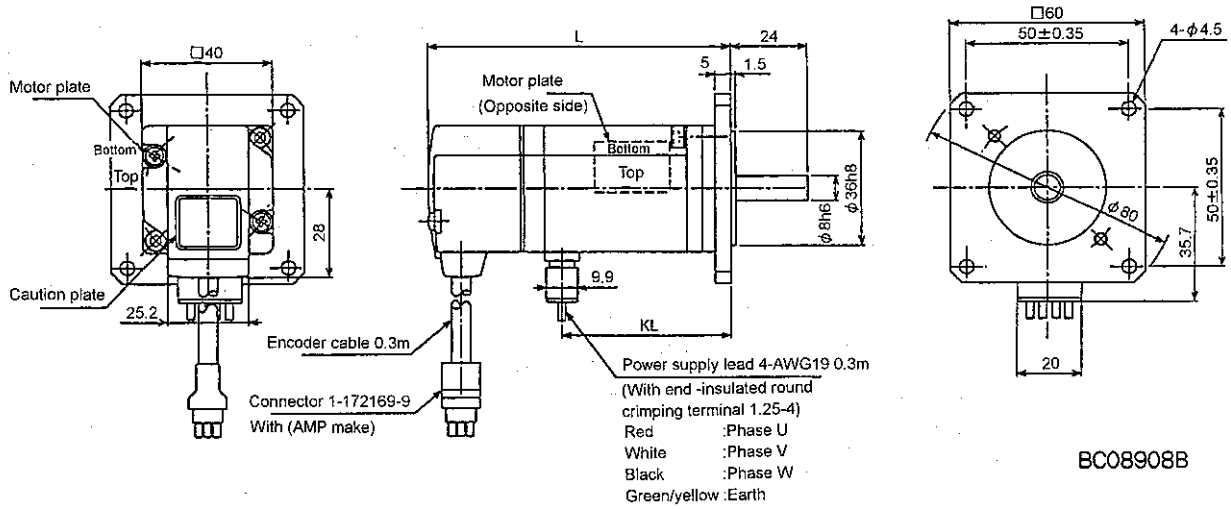
[Unit: in]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N·m]	Inertia Moment wk^2 [oz·in²]	Weight [lb]
		L	KL			
HC-PQ033NB-UE	30	3.88	1.12	0.32	0.09	1.54
HC-PQ053NB-UE	50	4.11	1.36	0.32	0.12	1.54
HC-PQ13NB-UE	100	4.71	1.95	0.32	0.18	1.98

12. OPTIONAL PRODUCTS

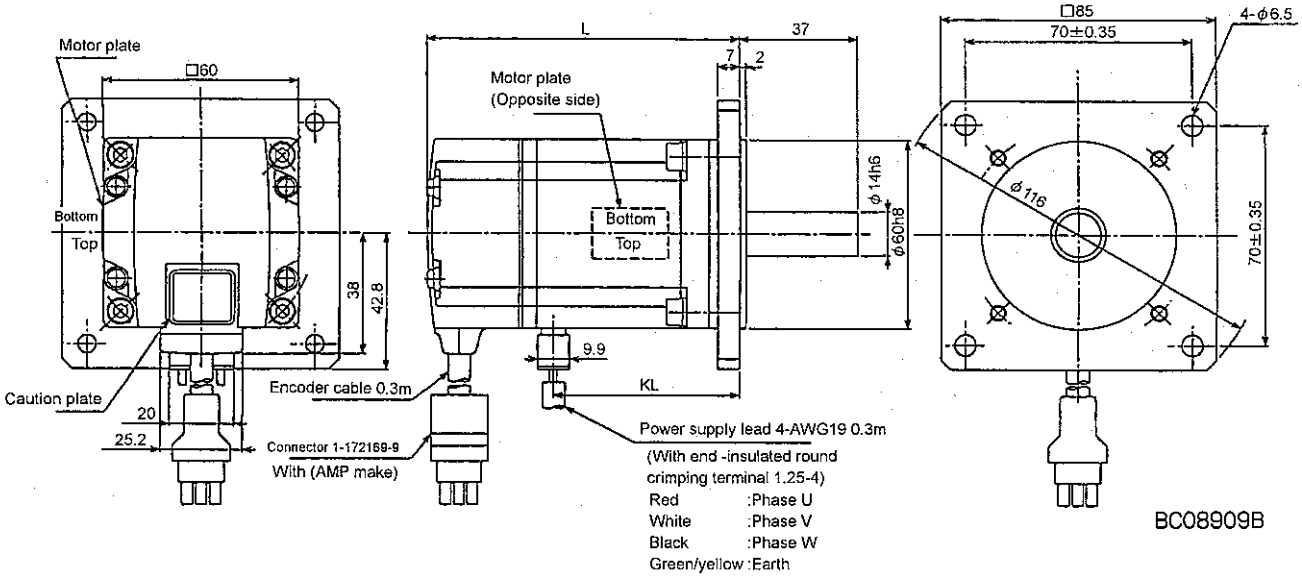
12 – 1 – 4 Stepping motor intercompatibility type

(1) Standard



[Unit: mm]

Model	Output [W]	Variable Dimensions		Inertia Moment J [$\times 10^{-4}$kg·m^2]	Weight [kg]
		L	KL		
HC-PQ033P	30	74.5	32.5	0.014	0.4
HC-PQ053P	50	80.5	38.5	0.019	0.5
HC-PQ13P	100	95.5	53.5	0.030	0.6

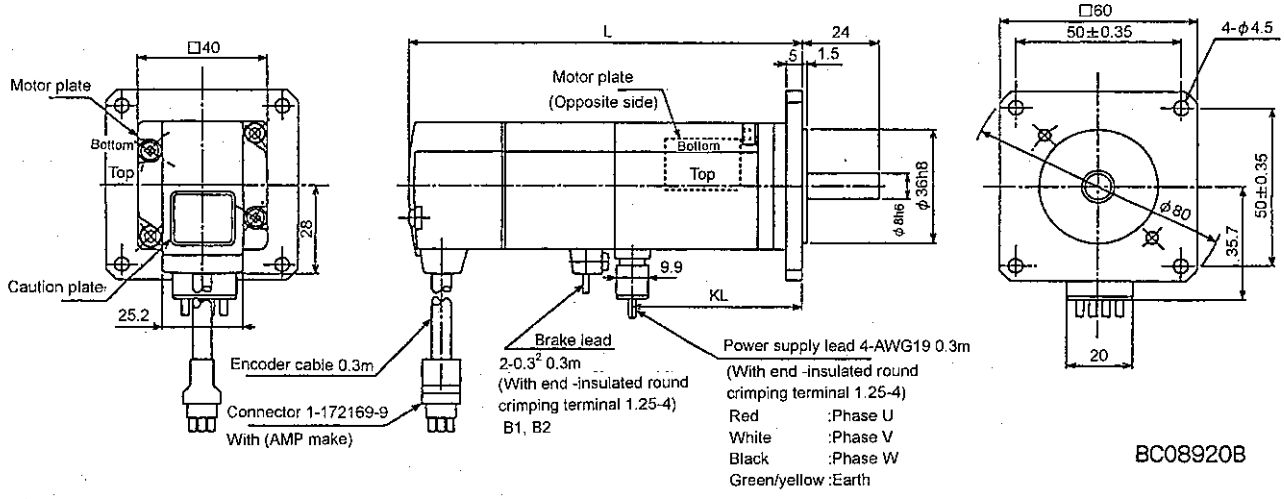


[Unit: mm]

Model	Output [W]	Variable Dimensions		Inertia Moment J [$\times 10^{-4}$kg·m^2]	Weight [kg]
		L	KL		
HC-PQ23P	200	99	59.1	0.095	1.1
HC-PQ43P	400	124	82.1	0.150	1.6

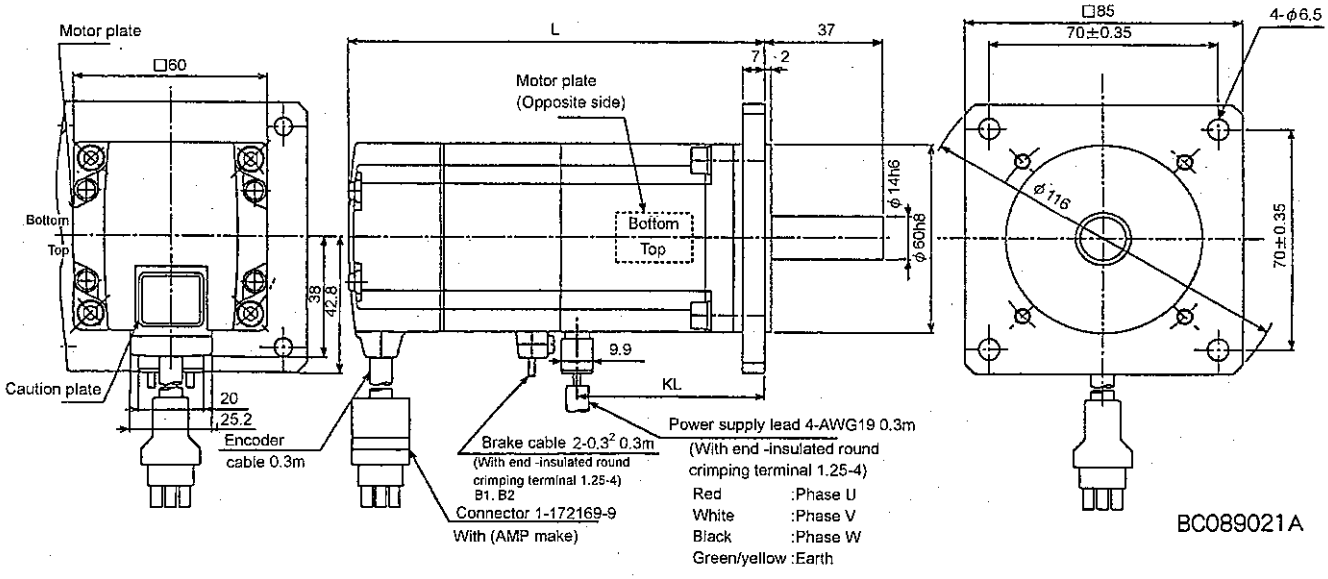
12. OPTIONAL PRODUCTS

(2) With electromagnetic brake



[Unit: mm]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
		L	KL			
HC-PQ033PB	30	102.5	32.5	0.32	0.018	0.7
HC-PQ053PB	50	108.5	38.5	0.32	0.022	0.8
HC-PQ13PB	100	123.5	53.5	0.32	0.033	0.9



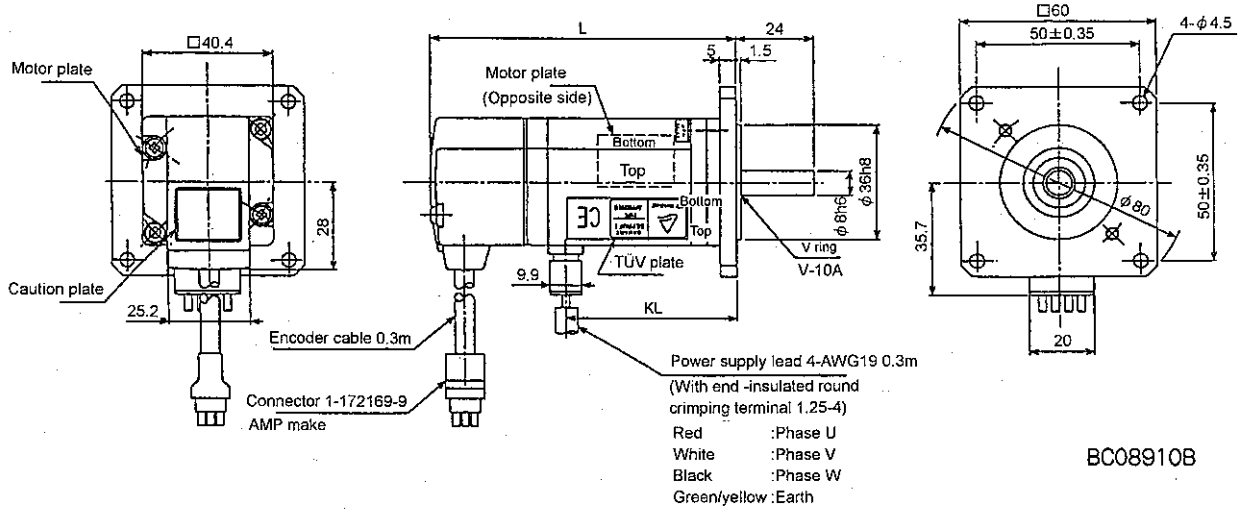
[Unit: mm]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
		L	KL			
HC-PQ23PB	200	131	59.1	1.3	0.143	1.8
HC-PQ43PB	400	156	82.1	1.3	0.193	2.3

12. OPTIONAL PRODUCTS

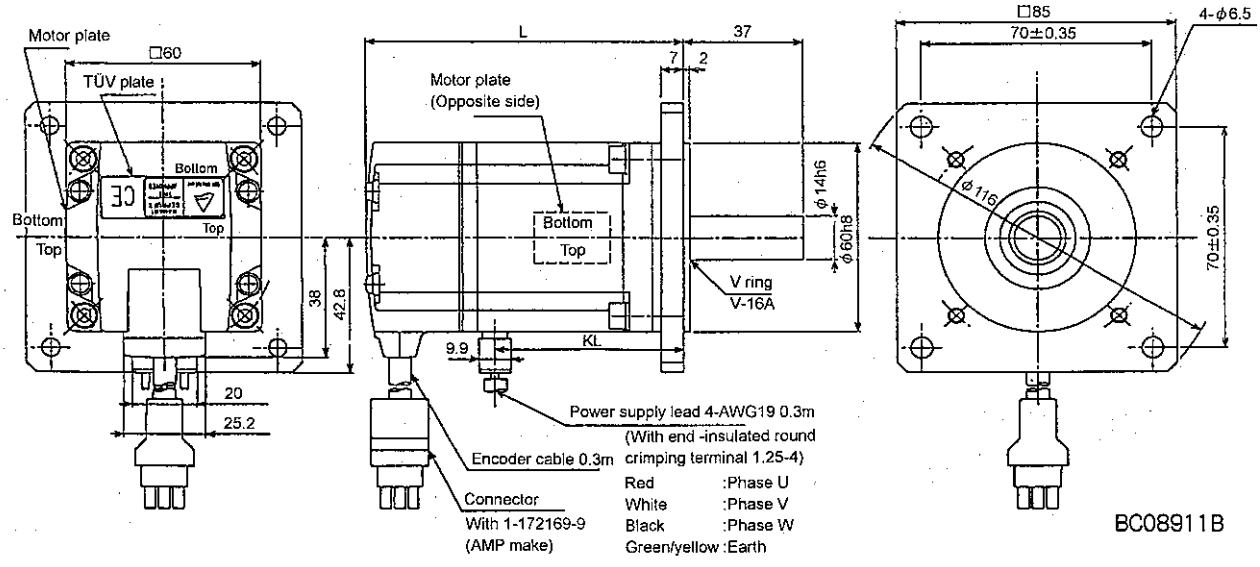
(3) EN•UL/C-UL Standard-Compliant Model

(a) Standard



[Unit: mm]

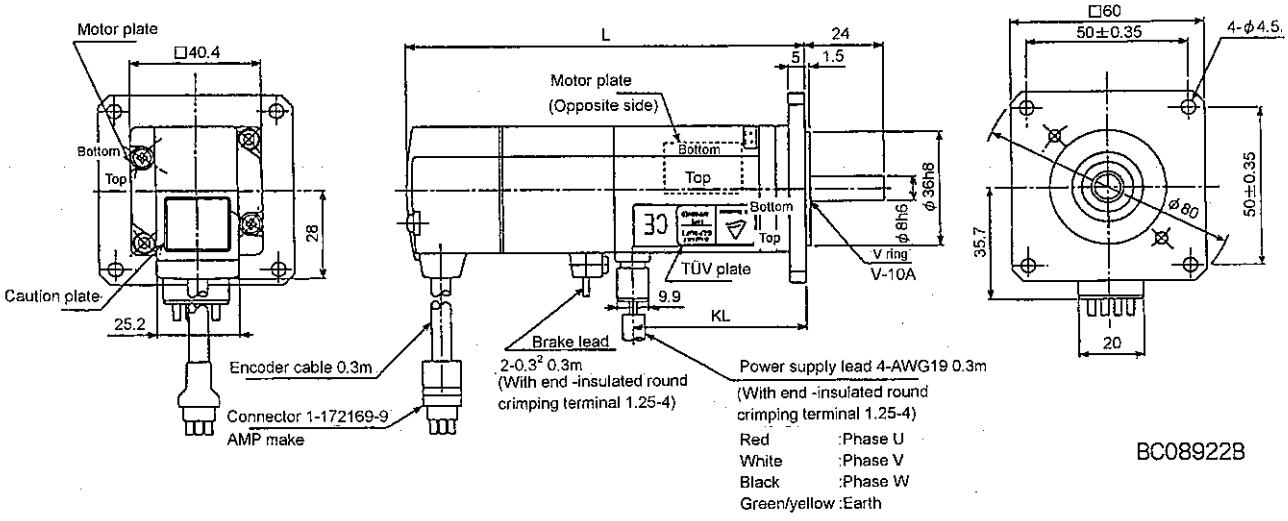
Model	Output [W]	Variable Dimensions		Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
		L	KL		
HC-PQ033P-UE	30	74.5	32.5	0.014	0.4
HC-PQ053P-UE	50	80.5	38.5	0.019	0.5
HC-PQ13P-UE	100	95.5	53.5	0.030	0.6



[Unit: mm]

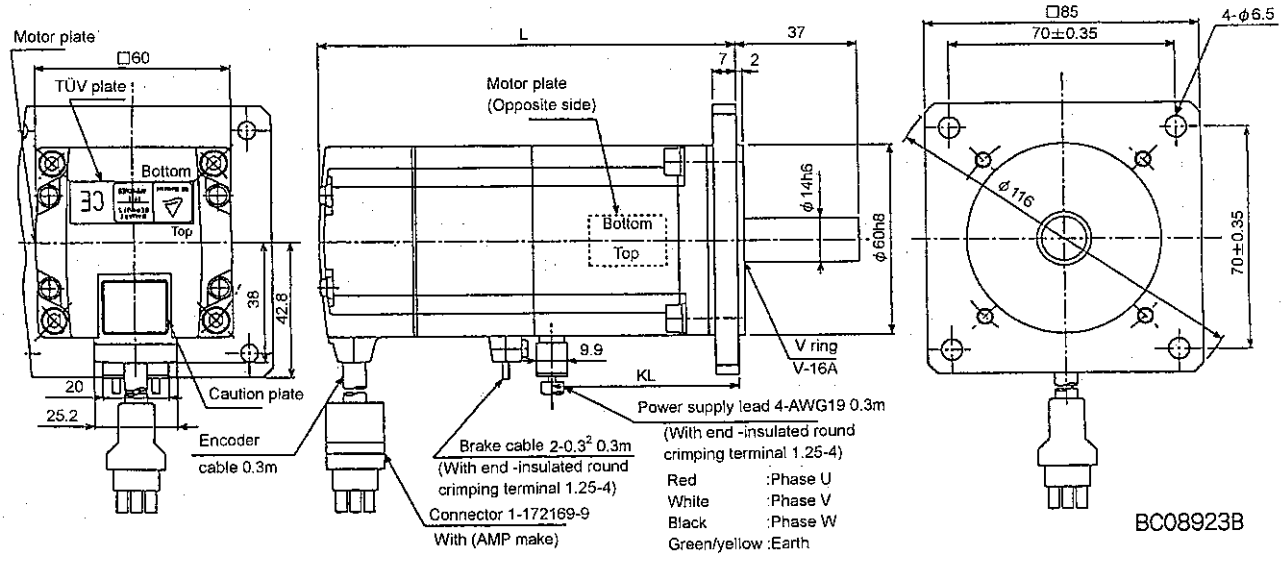
Model	Output [W]	Variable Dimensions		Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
		L	KL		
HC-PQ23P-UE	200	99	59.1	0.096	1.2
HC-PQ43P-UE	400	124	82.1	0.151	1.7

(b) With electromagnetic brake



[Unit: mm]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
		L	KL			
HC-PQ033PB-UE	30	102.5	32.5	0.32	0.018	0.7
HC-PQ053PB-UE	50	108.5	38.5	0.32	0.022	0.8
HC-PQ13PB-UE	100	123.5	53.5	0.32	0.033	0.9

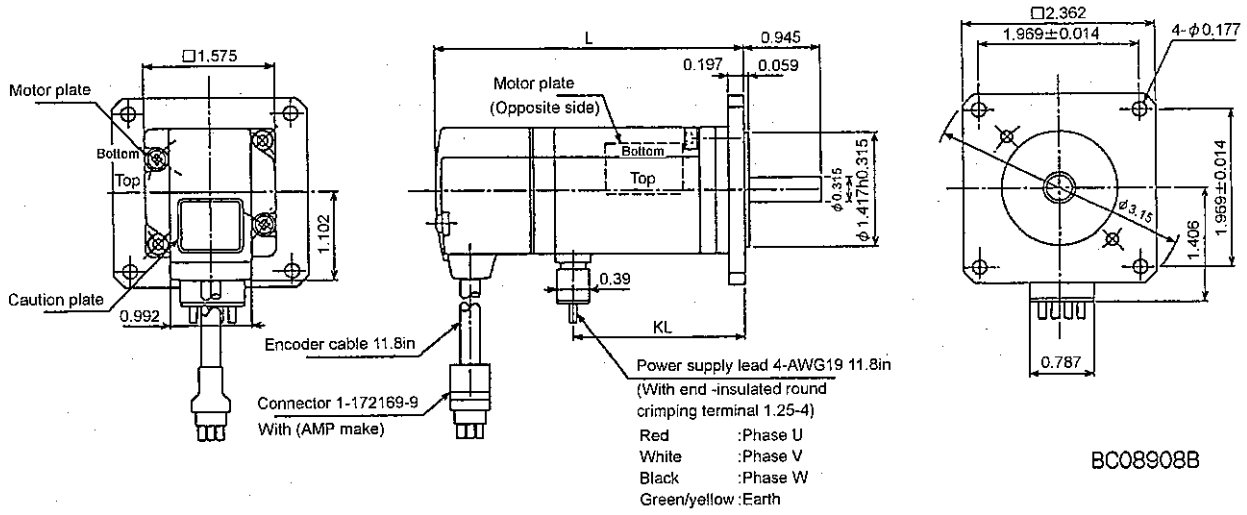


[Unit: mm]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment J [$\times 10^{-4}$kg•m^2]	Weight [kg]
		L	KL			
HC-PQ23PB-UE	200	131	59.1	1.3	0.144	1.8
HC-PQ43PB-UE	400	156	82.1	1.3	0.199	2.3

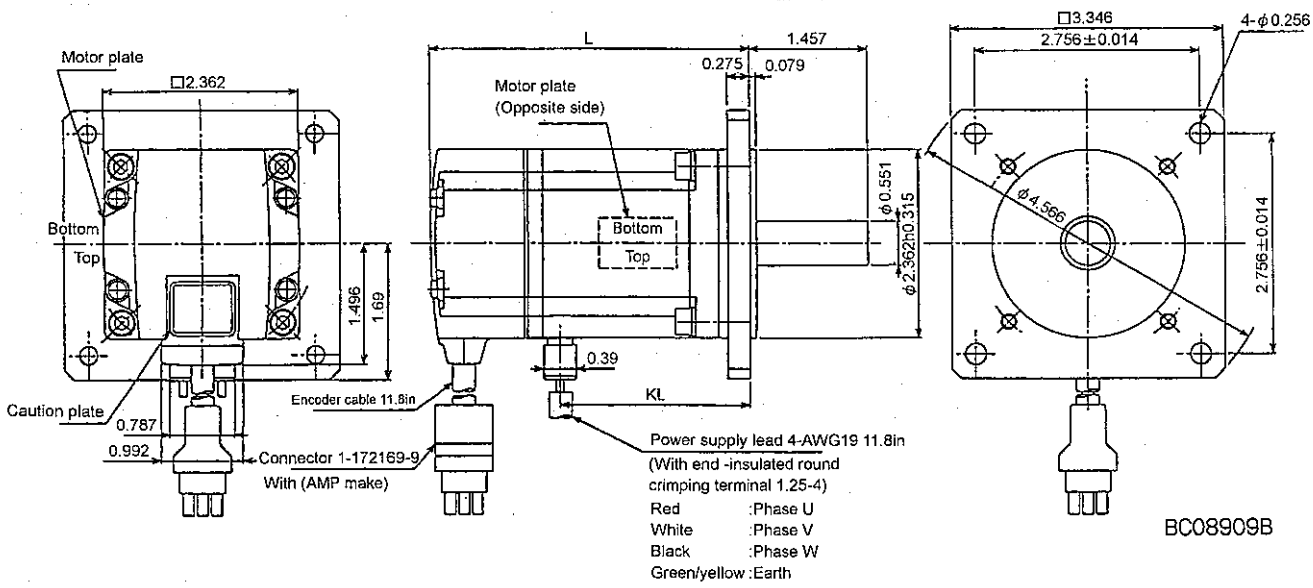
12 – 1 – 5 Stepping motor intercompatibility type (in inches)

(1) Standard



[Unit: in]

Model	Output [W]	Variable Dimensions		Inertia Moment wk^2 [oz•in^2]	Weight [lb]
		L	KL		
HC-PQ033P	30	2.93	1.28	0.08	0.88
HC-PQ053P	50	3.17	1.52	0.10	1.10
HC-PQ13P	100	3.76	2.11	0.16	1.32

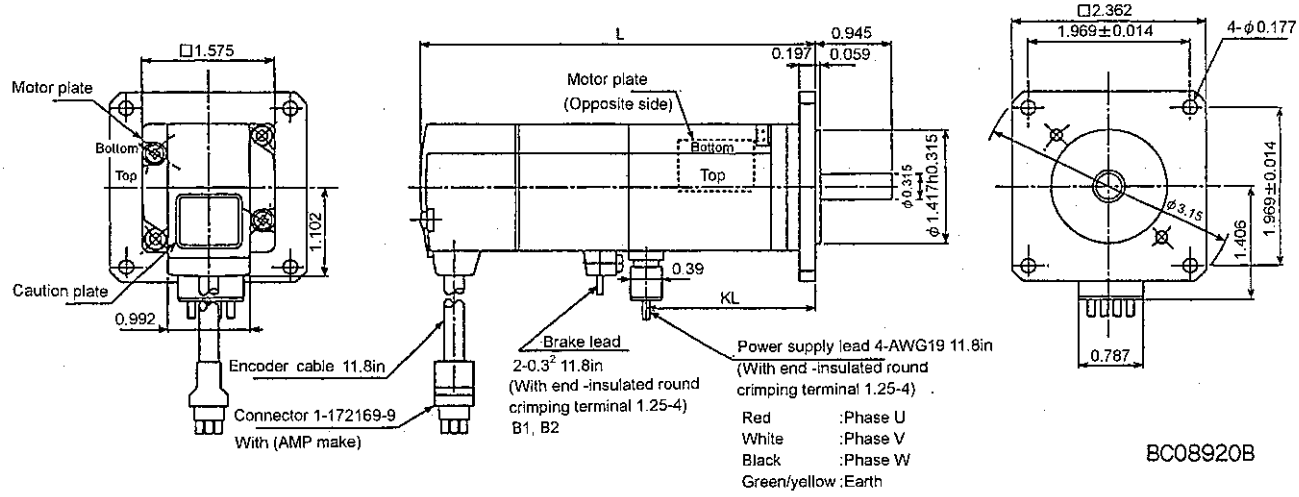


[Unit: in]

Model	Output [W]	Variable Dimensions		Inertia Moment wk^2 [oz•in^2]	Weight [lb]
		L	KL		
HC-PQ23P	200	3.89	2.33	0.52	2.43
HC-PQ43P	400	4.88	3.23	0.82	3.53

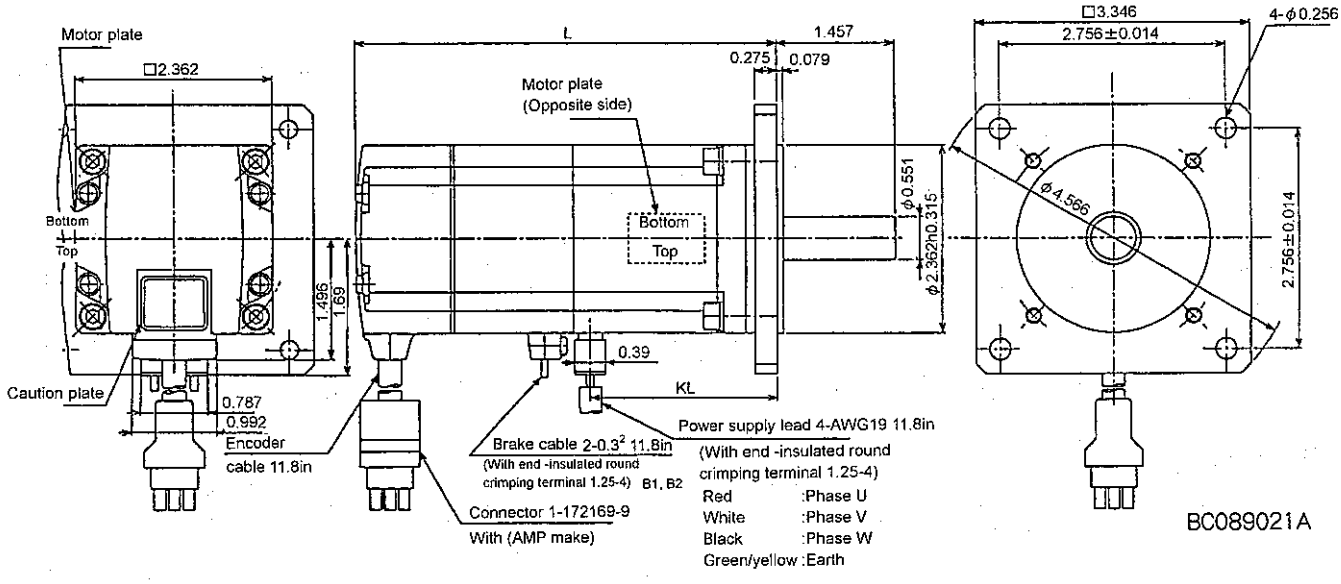
12. OPTIONAL PRODUCTS

(2) With electromagnetic brake



[Unit: in]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment wk² [oz•in²]	Weight [lb]
		L	KL			
HC-PQ033PB	30	4.04	1.28	0.32	0.098	1.54
HC-PQ053PB	50	4.27	1.52	0.32	0.12	1.76
HC-PQ13PB	100	4.86	5.35	0.32	0.18	1.98



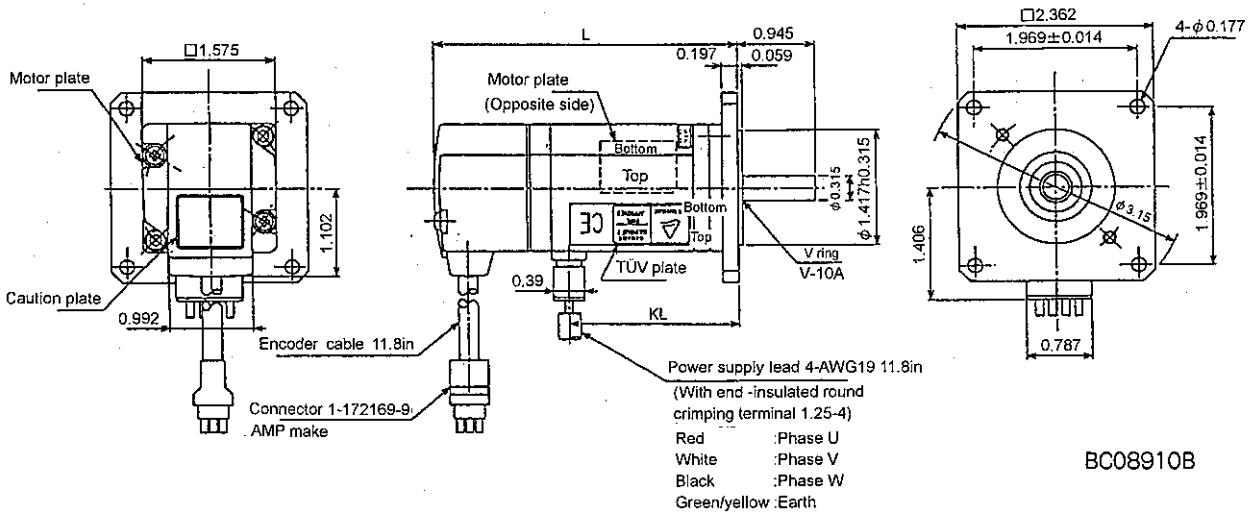
[Unit: in]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment wk² [oz•in²]	Weight [lb]
		L	KL			
HC-PQ23PB	200	5.16	2.33	1.3	0.78	3.97
HC-PQ43PB	400	6.14	3.23	1.3	1.08	5.07

12. OPTIONAL PRODUCTS

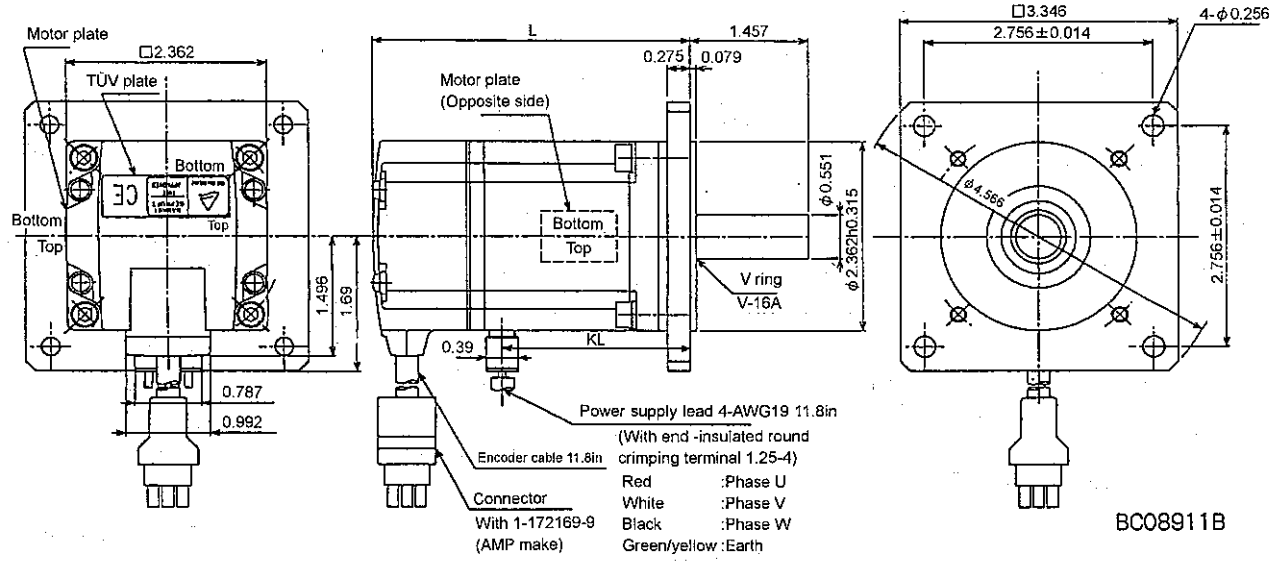
(3) EN•UL/C-UL Standard-Compliant Model

(a) Standard



[Unit: in]

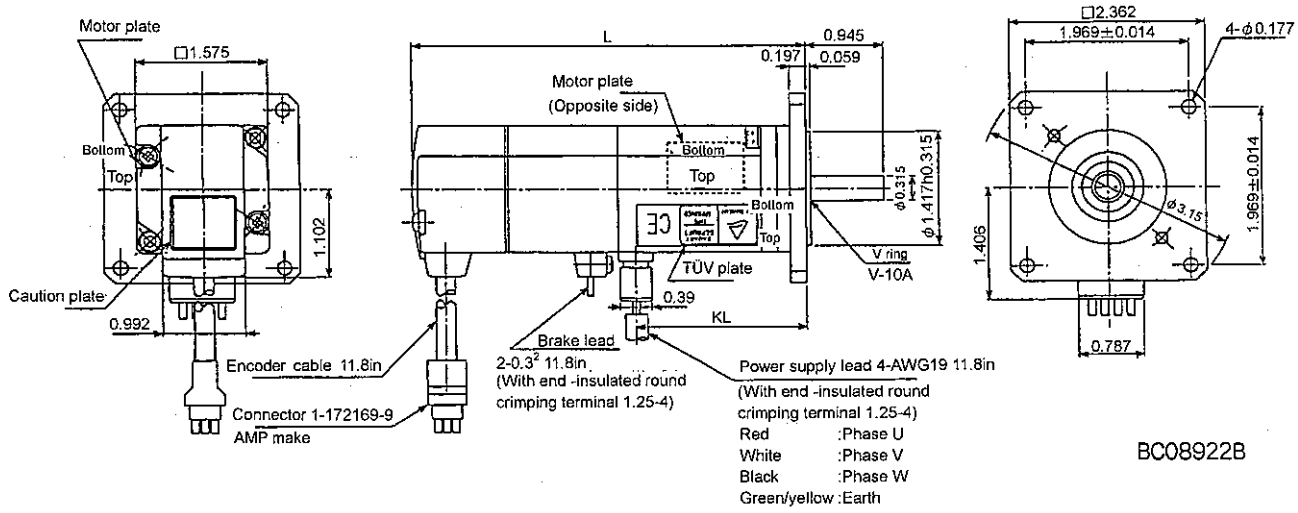
Model	Output [W]	Variable Dimensions		Inertia Moment wk^2 [oz•in^2]	Weight [lb]
		L	KL		
HC-PQ033P-UE	30	2.93	1.28	0.08	0.88
HC-PQ053P-UE	50	3.17	1.52	0.10	1.10
HC-PQ13P-UE	100	3.76	2.11	0.16	1.32



[Unit: in]

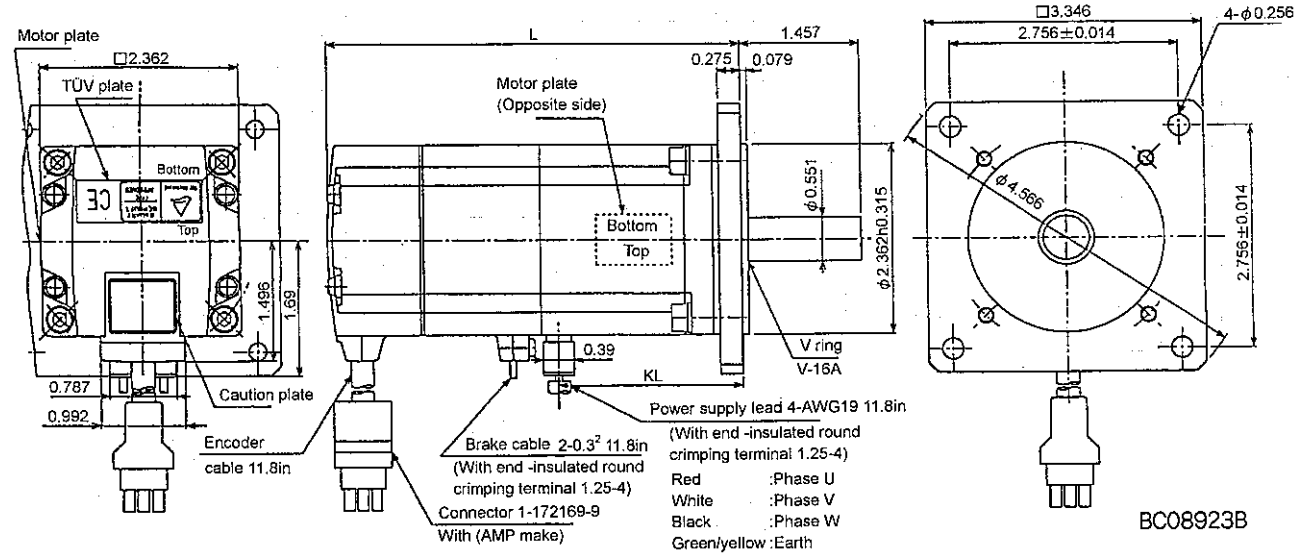
Model	Output [W]	Variable Dimensions		Inertia Moment wk^2 [oz•in^2]	Weight [lb]
		L	KL		
HC-PQ23P-UE	200	3.89	2.33	0.53	2.65
HC-PQ43P-UE	400	4.88	3.23	0.83	3.75

(b) With electromagnetic brake



[Unit: in]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment wk² [oz•in²]	Weight [lb]
		L	KL			
HC-PQ033PB-UE	30	4.04	1.28	0.32	0.098	1.54
HC-PQ053PB-UE	50	4.27	1.52	0.32	0.12	1.76
HC-PQ13PB-UE	100	4.86	2.11	0.32	0.18	1.98



[Unit: in]

Model	Output [W]	Variable Dimensions		Brake Static Friction Torque [N•m]	Inertia Moment wk² [oz•in²]	Weight [lb]
		L	KL			
HC-PQ23PB-UE	200	5.16	2.33	1.3	0.79	3.97
HC-PQ43PB-UE	400	6.14	3.23	1.3	1.09	5.07

12. OPTIONAL PRODUCTS

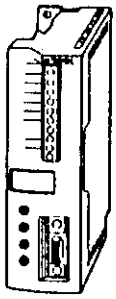
12 – 2 5V Pulse Train Input Servo Amplifiers

Servo amplifiers with 5V pulse train input are available.

12 – 2 – 1 Model definition

MR-C □A □ □ □

Series



Symbol	Compliance with Standard
None	Standard (in Japan)
-UE	EN Standard-, UL/C-UL Standard-compliant models

Symbol	Input Pulse Train Voltage
None	Standard (24V)
-L	5V

Symbol	Power supply
None	Single-phase 200V
(Note) 1	Single-phase 100V

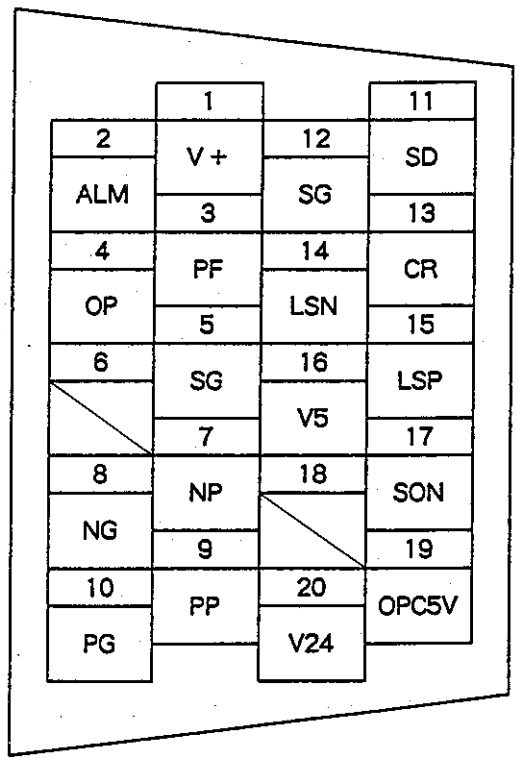
Note: Unavailable for MR-C40A.

Symbol	Applicable servo motor
10	HC-PQ033/53/13
20	HC-PQ23
40	HC-PQ43

12 – 2 – 2 Signal connectors

(1) Connector pin layout

CN1 (I/O signal connector)



Molex make
52986-2011 or equivalent

MEMO-RANDUM	The connector pin layouts are views looked from the cable connector wiring section.

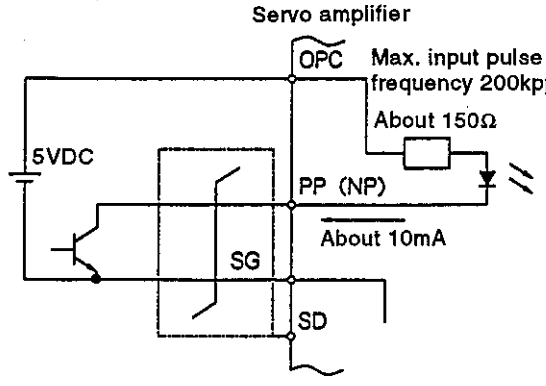
(2) Explanation of the connector pins (CN1A)

Signal	Symbol	Connector Pin No.	Functions/Applications
Open collector power input	OPC5V	19	When inputting a pulse train in the open collector system, supply this terminal with (+) 5VDC.

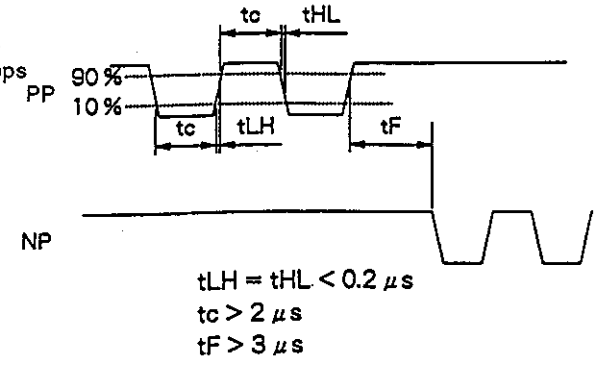
12 – 2 – 3 Inter faces

Pulse train input interface DI-2 [Open collector system]

- Interface example

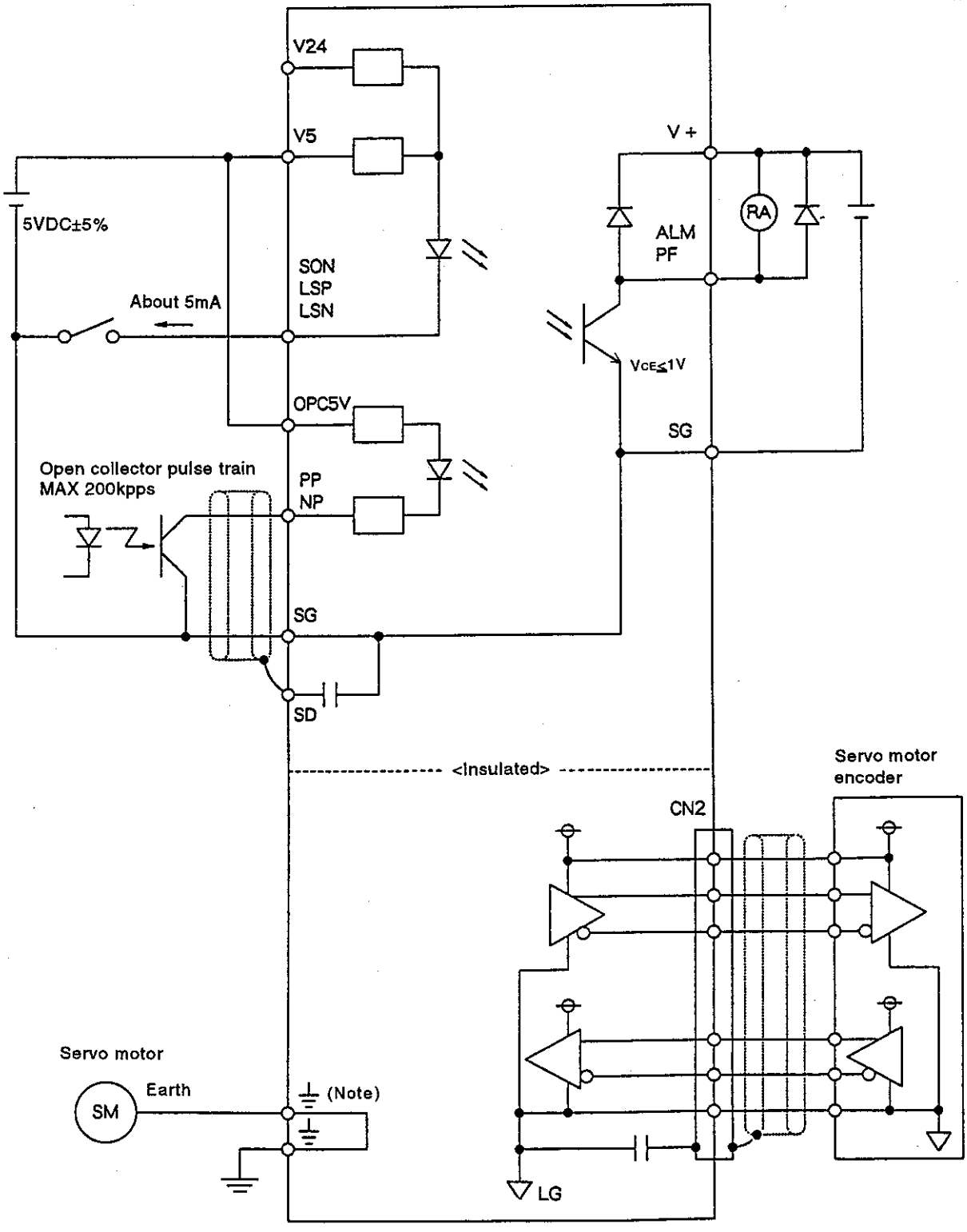


- Input pulse specification



12 – 2 – 4 Common Line

The power supply and its common line are shown below.



Note: When using EN Standard-, UL/C-UL Standard-compliant models, use the protective earth (PE) terminals.

REVISIONS

* The manual number is given on the bottom left of the back cover.

Print Date	*Manual Number	Revision
Dec., 1996	SH (NA) 3167-A	First edition
Aug., 1997	SH (NA) 3167-B	Addition of instructions for conformance with the UL/C-UL Standard Specification value of single-phase 100V changed to 100-120VAC Section 2-1-4 : Change made to connection diagram Section 2-3-5 (4) : Correction made to SON signal function selection in parameter No. 6 Section 3-1-2 (2), 1): Correction made to LSP, LSN parameter settings Section 3-1-3 (1) : Correction made to parameter No. 6 setting Section 6-1-2 : Change made to encoder cables in 1), 2) Section 6-1-2 (2), 1): Addition of MR-JCCBL2M-L/H Section 6-2-1 : Addition of torque Section 10-1 (2) : Change made to max. torque of HC-PQ43 Section 10-3-1 : Addition of MR-C40A-UE Section 10-3-2 (2) : Change made to inertia moment of HC-PQ13B/HC-PQ43B Section 10-3-2 (3) : Change made to LL dimension of HC-PQ43(B)G1(-EC/UL) Section 10-5 : Correction made to machining dimension diagram for shaft with key
Feb., 1999	SH(NA)3167-C	Conformity with the EC Directives: Chapter 1, (8) changed Conformity with the UL/C-UL Standard: (2) changed. Section 1-1 (2) : Change made to the models for the EN·UL/C-UL Standard. Section 2-3-5 (4) : Addition of low acoustic noise mode selection to parameter No. 0 Change made to machine selection in parameter No. 1 Change made to machine resonance frequency in parameter No. 24 Reconsideration of the contents of parameter No. 30 Section 3-1-1 (2) : Addition to the description of the main circuit power supply Section 5-1-1 : Addition of response setting changes Section 5-2-2 (1) 1) : Change made to Control Mode for proportional control Section 5-2-6 : Addition of low acoustic noise mode Section 10-2 : Correction made to the torque characteristic graph Section 10-2-2 : Addition of data in the low acoustic noise mode

Nov., 2000	SH(NA)3167-D	Section 1-1 (1) : Changing of name plate Section 1-3-1 : Addition of power factor improving reactor Section 1-3-2 : Addition of power factor improving reactor Section 2-2-2 : Addition of Memorandum Section 2-3-3 (3) : Addition of Caution Section 3-2-1 : Addition of 4) Section 3-2-2 : Changing of outline drawing Section 3-7 : Addition of 4) Section 6-1-6 : Deletion Section 6-2-3 : Changing of power factor improving reactor outline drawing Section 6-2-6 (2) : Changing of diode connection diagram Section 7 (2) : Changing Section 10-3-2 : Overall changing of outline drawing Section 10-3-3 : Overall changing of outline drawing Section 11-9 : Deletion of gravitational systems of units Section 12-1-1 : Reexamination Section 12-1-2 : Overall changing of outline drawing Section 12-1-3 : Overall changing of outline drawing Section 12-1-4 : Overall changing of outline drawing Section 12-1-5 : Overall changing of outline drawing

MITSUBISHI ELECTRIC CORPORATION
HEAD OFFICE:MITSUBISHI DENKI BLDG MARUNOUCHI TOKYO 100-8310

SH (NA) 3167-D (0101) MEE Printed in Japan

This instruction manual uses recyded paper.
Specifications subject to change without notice.