Changes for the Better

MITSUBISHI ELECTRIC

CNC
MELDAS AC SERVO
MDS-B-SVJ2 Series

SPECIFICATIONS AND INSTRUCTION MANUAL

BNP-B3937H(ENG)

Introduction

Thank you for purchasing the Mitsubishi CNC.
This instruction manual describes the handling and caution points for using this CNC.
Incorrect handling may lead to unforeseen accidents, so always read this instruction manual thoroughly to ensure correct usage.
Make sure that this instruction manual is delivered to the end user.

Precautions for safety

Please read this instruction manual and auxiliary documents before starting installation, operation, maintenance or inspection to ensure correct usage. Thoroughly understand the device, safety information and precautions before starting operation.

The safety precautions in this instruction manual are ranked as "DANGER" and "CAUTION".

DANGER	When a dangerous situation may occur if handling is mistaken leading to fatal or major injuries.
CAUTION	When a dangerous situation may occur if handling is mistaken leading to medium or minor injuries, or physical damage.

Note that some items described as **CAUTION** may lead to major results depending on the situation. In any case, important information that must be observed is described.

The signs indicating prohibited and mandatory items are described below.

	This sign indicates that the item is prohibited (must not be carried out). For example, is used to indicate "Fire Prohibited".
	This sign indicates that the item is mandatory (must be carried out). For example, is used to indicate grounding.

After reading this instruction manual, keep it in a safe place for future reference.

POINT	In this manual, this mark indicates important matters the operator should be aware of when using the CNC.

CAUTION	This manual describes the specifications for the C4 and subsequent versions of software. Note that some functions cannot be used with software version C3 and below.

For Safe Use

1. Electric shock prevention

DANGER

- Wait at least 10 minutes after turning the power OFF, confirm that the CHARGE lamp has gone out, and check the voltage between P and N terminals with a tester, etc., before starting wiring or inspections.
  Failure to observe this could lead to electric shocks.
- Ground the servo amplifier and servomotor with Class C protective grounding (former Class 3 grounding).
- Wiring and inspection work must be done by a qualified technician.
- Wire the servo amplifier and servomotor after installation. Failure to observe this could lead to electric shocks.
- Do not touch the switches with wet hands. Failure to observe this could lead to electric shocks.
- Do not damage, apply forcible stress, place heavy items or engage the cable. Failure to observe this could lead to electric shocks.

2. Fire prevention

CAUTION

- Install the servo amplifier, servomotor and regenerative resistor on noncombustible material. Direct installation on combustible material or near combustible materials could lead to fires.
- Following the instructions in this manual, always install no-fuse breakers and contactors on the servo amplifier power input. Select the correct no-fuse breakers and contactors using this manual as a reference. Incorrect selection could lead to fires.
- Turn the servo amplifier power OFF if the servo amplifier fails. Fires could start if a large current continues to flow.
- Shut off the main circuit power at the contactors to emergency stop when an alarm occurs.

3. Injury prevention

⚠ CAUTION	
	Do not apply a voltage other than that specified in Instruction Manual on each terminal. Failure to observe this item could lead to ruptures or damage, etc.
	Do not mistake the terminal connections. Failure to observe this item could lead to ruptures or damage, etc.
	Do not mistake the polarity (⊕ ,⊖) . Failure to observe this item could lead to ruptures or damage, etc.
	Do not touch the servo amplifier fins, regenerative resistor or servomotor, etc., while the power is turned ON or immediately after turning the power OFF. Some parts are heated to high temperatures. Failure to observe this could lead to burns or part damage.

4. Various precautions

Observe the following precautions. Incorrect handling of the unit could lead to faults, injuries and electric shocks, etc.

(1) Transportation and installation

⚠ CAUTION	
	Correctly transport the product according to its weight.
	Do not stack the products above the tolerable number.
	Do not hold the cables, axis or detector when transporting the servomotor.
	Do not hold the front cover when transporting the servo amplifier. The unit could drop.
	Follow this Instruction Manual and install the unit in a place where the weight can be borne.
	Do not get on top of or place heavy objects on the unit.
	Always observe the installation directions.
	Secure the specified distance between the servo amplifier and control panel, or between the servo amplifier and other devices.
	Do not install or run a servo amplifier or servomotor that is damaged or missing parts.
	Do not let conductive objects such as screws or metal chips, etc., or combustible materials such as oil enter the servo amplifier or servomotor.
	The servo amplifier and servomotor are precision devices, so do not drop them or apply strong impacts to them.

⚠ CAUTION

⚠ Store and use the units under the following environment conditions.

Environment	Conditions		
	Servo amplifier	Servomotor	
Ambient temperature	0°C to +55°C (with no freezing)	0°C to +40°C (with no freezing)	
Ambient humidity	90% RH or less (with no dew condensation)	80%RH or less (with no dew condensation)	
Storage temperature	–20°C to +65°C (with no freezing)	–15°C to +70°C (with no freezing)	
Storage humidity	90% RH or less (with no dew condensation)		
Atmosphere	Indoors (Where unit is not subject to direct sunlight) Must be no conductive fine particles, corrosive gas, flammable gas, oil mist or dust.		
Altitude	1000m or less above sea level		
Vibration	5.9m/sec^2 (0.6G) or less	HC□ (1.5kW or less) HA□N (1.0kW or less) HC□R, HC-RF HC-SF (1.5kW or less)	X: 9.8m/sec^2 (1G) Y: 24.5m/sec^2 (2.5G) or less
		HC□ (2.0kW or more) HA□N (2.0kW or more) HC-SF (2.0kW or more)	X: 19.6m/sec^2 (2G) Y: 49m/sec^2 (5G) or less
		HA-FF, HC-MF	X: 19.6m/sec^2 (2G) Y: 19.6m/sec^2 (2G) or less

⚠ Securely fix the servomotor to the machine. Insufficient fixing could lead to the servomotor deviating during operation.

⚠ Never touch the rotary sections of the servomotor during operations. Install a cover, etc., on the shaft.

⚠ When coupling to a servomotor shaft end, do not apply an impact by hammering, etc. The detector could be damaged.

⚠ Do not apply a load exceeding the tolerable load onto the servomotor shaft. The shaft could break.

❗ When storing for a long time, please contact your dealer.

(2) Wiring

⚠ CAUTION

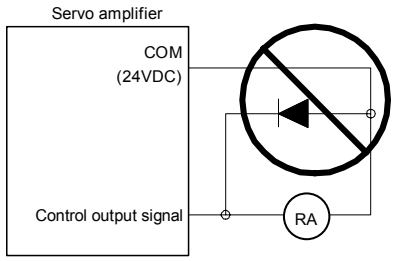
⚠ Correctly and securely perform the wiring. Failure to do so could lead to runaway of the servomotor.

⚠ Do not install a phase advancing capacity, surge absorber or radio noise filter on the output side of the servo amplifier.

⚠ Correctly connect the output side (terminals U, V, W). Failure to do so could lead to abnormal operation of the servomotor.

⚠ Do not directly connect a commercial power supply to the servomotor. Doing so could lead to faults.

⚠ When connecting a DC relay for the control output signals such as the brake signal or contactor, do not mistake the polarity of the diode. Failure to observe this could cause the signals not to be output due to a fault or the protective circuit to fail.



(3) Trial operation and adjustment

⚠ CAUTION

⚠ Do not carry out operation with the face cover removed. Failure to observe this could lead to electric shocks because the high voltage terminal and charged section are exposed.

⚠ Do not open the face cover while the power is turned ON or during operation. Failure to observe this could lead to electric shocks.

⚠ Check and adjust each parameter before starting operation. Failure to do so could lead to unforeseen operation of the machine.

⚠ Do not make remarkable adjustments and changes as the operation could become unstable.

(4) Usage methods

⚠ CAUTION

⚠ Install an external emergency stop circuit so that the operation can be stopped and power shut off immediately.

⚠ Unqualified persons must not disassemble or repair the unit.

⚠ Never make modifications.

⚠ Reduce magnetic interference by installing a noise filter. The electronic devices used near the servo amplifier could be affected by magnetic noise. Install a line noise filter, etc., when there is an influence from magnetic interference.

⚠ Always use the servomotor and servo amplifier with the designated combination.

⚠ The servomotor's magnetic brakes are for holding purposes. Do not use them for normal braking.

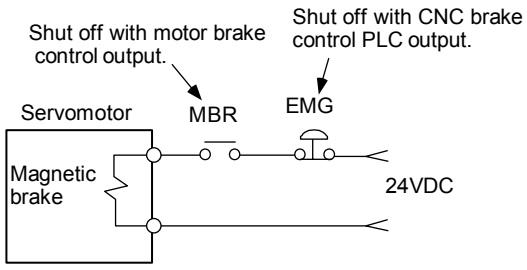
⚠ There may be cases when holding is not possible due to the magnetic brake's life or the machine construction (when ball screw and servomotor are coupled via a timing belt, etc.). Install a stop device to ensure safety on the machine side.

(5) Troubleshooting

⚠ CAUTION

⚠ If a hazardous situation is predicted during stop or product trouble, use a servomotor with magnetic brakes or install an external brake mechanism.

⚠ Use a double circuit configuration that allows the operation circuit for the magnetic brakes to be operated even by the external emergency stop signal.



⚠ If an alarm occurs, remove the cause and secure the safety before resetting the alarm.

⚠ Never go near the machine after restoring the power after a failure, as the machine could start suddenly.
(Design the machine so that personal safety can be ensured even if the machine starts suddenly.)

(6) Maintenance, inspection and part replacement

⚠ CAUTION
⚠ The capacity of the electrolytic capacitor will drop due to deterioration. To prevent secondary damage due to failures, replacing this part every ten years when used under a normal environment is recommended. Contact the nearest dealer for repair and replacement of parts.

(7) General precautions

⚠ CAUTION
⚠ The drawings given in this Specifications and Maintenance Instruction Manual show the covers and safety partitions, etc., removed to provide a clearer explanation. Always return the covers or partitions to their respective places before starting operation, and always follow the instructions given in this manual.

○ Treatment of waste ○

The following two laws will apply when disposing of this product. Considerations must be made to each law. The following laws are in effect in Japan. Thus, when using this product overseas, the local laws will have a priority. If necessary, indicate or notify these laws to the final user of the product.

1. **Requirements for laws related to promotion of effective use of resources (Laws for Promotion of Effective Resource Use)**
   (1) Recycle as much of this product as possible when finished with use.
   (2) When recycling, often parts are sorted into steel scraps and electric parts, etc., and sold to scrap contractors. Mitsubishi recommends sorting the product and selling the members to appropriate contractors.

2. **Requirements for laws related to the treatment and cleaning of waste (Laws for Treating and Cleaning Waste)**
   (1) Mitsubishi recommends recycling and selling the product when no longer needed according to item 1. above. The user should make an effort to reduce waste in this manner.
   (2) When disposing a product that cannot be resold, it shall be treated as a waste product.
   (3) The treatment of industrial waste must be commissioned to a licensed industrial waste treatment contractor, and appropriate measures, including a manifest control, must be taken.
   (4) Batteries correspond to "primary batteries", and must be disposed of according to local disposal laws.

Compliance to European EC Directives

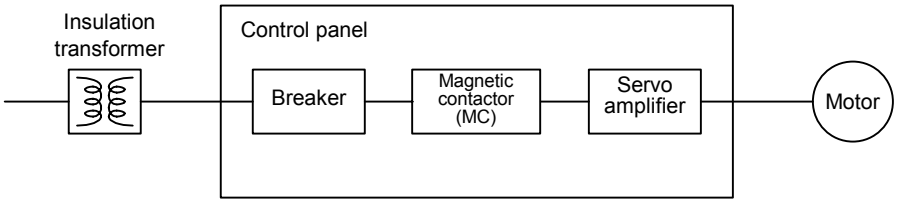
1. European EC Directives

The European EC Directives were issued to unify Standards within the EU Community and to smooth the distribution of products of which the safety is guaranteed. In the EU Community, the attachment of a CE mark (CE marking) to the product being sold is mandatory to indicate that the basic safety conditions of the Machine Directives (issued Jan. 1995), EMC Directives (issued Jan. 1996) and the Low-voltage Directives (issued Jan. 1997) are satisfied. The machines and devices in which the servo is assembled are a target for CE marking.
The servo is a component designed not to function as a single unit but to be used with a combination of machines and devices. Thus, it is not subject to the EMC Directives, and instead the machines and devices in which the servo is assembled are targeted.
This servo complies with the Standards related to the Low-voltage Directives in order to make CE marking of the assembled machines and devices easier. The EMC INSTALLATION GUIDELINES (IB (NA) 67303) which explain the servo amplifier installation method and control panel manufacturing method, etc., has been prepared to make compliance to the EMC Directives easier. Contact Mitsubishi or your dealer for more information.

2. Cautions of compliance

Use the standard servo amplifier and EN Standards compliance part (some standard models are compliant) for the servomotor. In addition to the items described in this instruction manual, observe the items described below.

(1) Configuration



Use a type B (AC/DC detectable type) breaker

(2) Environment

The servo amplifier must be used within an environment having a Pollution Class 2 or less (Pollution Class 1 or 2) as stipulated in the IEC60664. For this, install the servo amplifier in a control panel having a structure (IP54) into which water, oil, carbon and dust cannot enter.

(3) Power supply

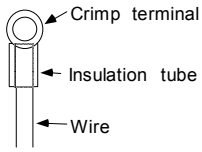
① The servo amplifier must be used with the overvoltage category II conditions stipulated in IEC60664. For this, prepare a reinforced insulated transformer that is IEC or EN Standards complying at the power input section.
② When supplying the control signal input/output power supply from an external source, use a 24 VDC power supply of which the input and output have been reinforced insulated.

(4) Installation

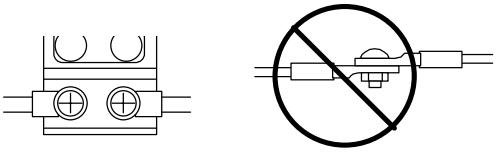
① To prevent electric shocks, always connect the servo amplifier protective earth (PE) terminal (terminal with ⏚ mark) to the protective earth (PE) on the control panel.
② When connecting the earthing wire to the protective earth (PE) terminal, do not tighten the wire terminals together. Always connect one wire to one terminal.

(5) Wiring

① Always use crimp terminals with insulation tubes so that the wires connected to the servo amplifier terminal block do not contact the neighboring terminals.



② Connect the HC-MF Series servomotor power lead to the servo amplifier using a fixed terminal block. Do not connect the wires directly. (EN standards compliance parts of the HA-FF motor have cannon plug specifications.)



(6) Peripheral devices

① Use a no-fuse breaker and magnetic contactor that comply with the EN/IEC Standards described in Chapter 7 Peripheral Devices.

② The wires sizes must follow the conditions below. When using other conditions, follow Table 5 of EN60204-1 Appendix C.

- Ambient temperature: 40°C
- Sheath: PVC (polyvinyl chloride)
- Install on wall without duct or conduit

(7) Servomotor

A servomotor that complies with the EN Standards as a standard, and an EN Standards compatible part are available.

Motor series name	EN Standards compatible part
HC□Series	Complies as a standard
HC□R Series	
HA Series	
HC-SF Series	
HC-RF Series	
HA-FF Series	HA-FF□C-UE
HC-MF Series	HC-MF□-UE HC-MF□-S15

Refer to "Chapter 6 Dedicated Options" for the connectors and detector cables, and use the EN Standards compatible parts.

(8) Enforcement of EMC test

The EMC test for a machine or device incorporating a servo amplifier must match the magnetism compatibility (immunity and emission) standards in the state that the working environment and electric device specifications are satisfied.
Refer to the EMC INSTALLATION GUIDELINES (IB (NA) 67303) for the EMC Directive measures for the servo amplifier.

Compliance to UL/c-UL Standards

The handling, performance and specifications, etc., of the UL/c-UL Standards compliant parts are the same as the standard parts unless noted in particular. When using options or peripheral devices, use UL/c-UL Standards compliant parts.

Cautions for compliance to UL/c-UL Standards

The following matters must be observed for UL/c-UL Standards compliance.

(1) General precautions

The capacitor discharge time is as shown below. For safety purposes, wait at least 15 minutes before touching the charged sections after turning the power OFF.

Amplifier type	Discharge time (min.)
MDS-B-SVJ2-01,-03,-04	1
MDS-B-SVJ2-06	2
MDS-B-SVJ2-07,-10,-20	3

(2) Installation

The MDS-B-SVJ2 Series servo amplifier is designated for installation in a panel. The capacity of the panel must be 150% or more of the total unit volume in the panel. Design the panel so that the unit's ambient temperature does not exceed 55°C (131°F).
(Refer to "Chapter 3 Installation".)
If necessary, install a fan in the power distribution panel to agitate the heat over the amplifier. When carrying out the temperature test with the following installation conditions, the standards are satisfied by ventilating the inside of the panel with a fan.

Amplifier type	Power distribution panel size	Ventilation conditions
MDS-B-SVJ2-20	150% of amplifier volume	Install a fan with 100CFM air flow 10cm (4 inches) above the amplifier.

(3) Short-circuit ratings

A UL short-circuit test has been carried out with the servo amplifier using an AC circuited having a peak current limited at 5000 [A] or less. The servo amplifier complies with this circuit.

(4) Installing the servomotor

Install the servomotor on the following flange sizes, or on material having the equivalent or higher heat dissipation effect.

Flange size (mm)	Motor type and capacity					
	HC□	HC□R	HC-SF	HC-RF	HA-FF	HC-MF
150×150×6					50 to 100W	50 to 100W
250×250×6					200 to 300W	200W
250×250×12	0.5 to 1.5kW	1 to 2kW	0.5 to 1.5kW	1 to 2kW	400 to 600W	400W
300×300×12						750W
300×300×20	2 to 3.5kW		2 to 3.5kW			

(5) External wiring

The UL-recommended round crimp terminals are used for wiring the input/output terminals. Use the crimp tool designated by the terminal maker.

Amplifier type	Wire size (Note 1)				Crimp terminal (Note 2)		
	L1,L2,L3 ⏚ (Note 3)	L11, L21	U, V, W (Note 4)	P, C (Note 5)	Magnetic brakes	Type	Tool
MDS-B-SVJ2-01	IV1.25SQ (AWG16)	IV1.25SQ (AWG16)	IV1.25SQ (AWG16)	IV2SQ (AWG14)	IV1.25SQ (AWG16)	32959	47387
MDS-B-SVJ2-03							
MDS-B-SVJ2-04							
MDS-B-SVJ2-06	IV2SQ (AWG14)		IV2SQ (AWG14)				
MDS-B-SVJ2-07							
MDS-B-SVJ2-10							
MDS-B-SVJ2-20	IV3.5SQ (AWG12)		IV3.5SQ (AWG12)			32968	59239

(Note 1) As a standard, the wire is a 600V vinyl wire (the conductor must be copper).
(Note 2) This indicates the UL/c-UL Standard compliant wire. (AMP). Refer to section 2-2-3 for the L11, L21, P and C below SVJ2-07.
(Note 3) This value is for the single part. Refer to Chapter 7 when bridging several amplifiers.
(Note 4) The wires (U, V, W) in the table indicate the case when the distance between the servomotor and servo amplifier is 30m or less.
(Note 5) Twist the wire for the regenerative option (P, C).

(6) Terminal block tightening torque

Wire to the terminal block with the appropriate tightening torque.

Amplifier type	L1, L2, L3, U, V, W		L11, L21, P, C		PE	
	Terminal screw	Tightening torque	Terminal screw	Tightening torque	Terminal screw	Tightening torque
MDS-B-SVJ2-01	M4×0.7	1.24N·m	Built-in insertion plug type	0.5 to 0.6 N·m	M4×0.7	1.24N·m
MDS-B-SVJ2-03						
MDS-B-SVJ2-04						
MDS-B-SVJ2-06						
MDS-B-SVJ2-07						
MDS-B-SVJ2-10			M4×0.7	1.24N·m		
MDS-B-SVJ2-20						

(7) Peripheral devices

Select peripheral devices that match the UL/c-UL Standards. The following table shows the devices for one axis capacities. When using multiple axes, or when sharing the power supply with other units, refer to "Chapter 7 Peripheral devices".

Amplifier type	No-fuse breaker	Fuse (Class K5)	Contactor
MDS-B-SVJ2-01	NF30 type 5A	250VAC 10A	S-N10 200VAC
MDS-B-SVJ2-03			
MDS-B-SVJ2-04	NF30 type 10A	250VAC 15A	
MDS-B-SVJ2-06	NF30 type 15A	250VAC 20A	
MDS-B-SVJ2-07			
MDS-B-SVJ2-10	NF30 type 20A	250VAC 40A	S-N18 200VAC
MDS-B-SVJ2-20	NF30 type 30A	250VAC 70A	S-N20 200VAC

⚠ CAUTION

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

Contents

Chapter 1 Preface

1-1 Inspection at purchase

Open the package, and read the rating nameplate to confirm that the servo amplifier and servomotor are as ordered.

1-1-1 Package contents

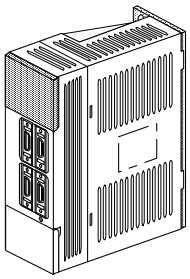
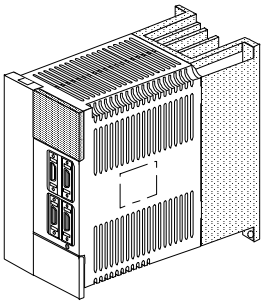
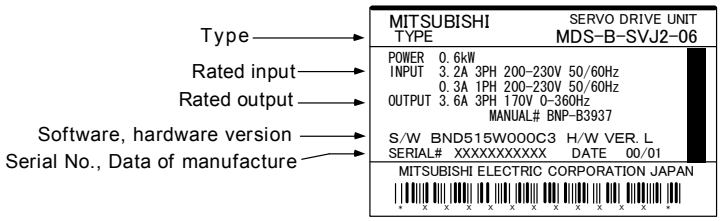
①Servo amplifier

Packaged parts	Qty.
Servo amplifier	1
Control power connector (Excluding MDS-B-SVJ2-10 and MDS-B-SVJ2-20)	1

②Servomotor

Packaged parts	Qty.
Servomotor	1

1-1-2 Explanation of types

	Appearance	Rating nameplate and type configuration
Servo amplifier	 	

MDS-B-SVJ2-□

MELDAS
AC servo drive unit

Capacity class symbol

Symbol	Corresponding motor				
	HC□		HC□R	HA□N	
	(2000r/min)	(3000r/min)	(3000r/min)	(2000r/min)	(3000r/min)
01	–	–	–	–	053N, 13N
03	–	–	–	–	23N, 33N
04	–	–	–	–	–
06	52	53	–	40N	43N
07	102*	–	–	–	–
10	102, 152*, 202*	103	103, 153	80N	83N
20	152, 202, 352*	153, 203*	203	100N, 200N*	103N*

The asterisk "*" in the motor type refers to the combination with an amplifier having a one-rank lower capacity. The motor is the same as the standard motor, but the output characteristics are limited.
Only the detector code A47 can be used for HC102*, HC152* and HC202*.

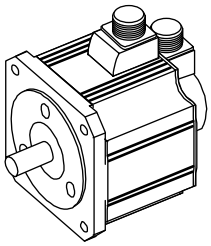
Symbol	Corresponding motor				
	HC-SF (2000r/min)	HC-SF (3000r/min)	HC-RF (3000r/min)	HA-FF (3000r/min)	HC-MF (3000r/min)
01	–	–	–	053, 13	053, 13
03	–	–	–	23, 33	23
04	–	–	–	43	43
06	52	53	–	63	–
07	102	103	–	–	73
10	152, 202	153, 203	103, 153	–	–
20	352	353	203	–	–

(Note) As a standard, the MDS-B-SVJ2 servo amplifier complies with the EN Standards and UL Standards.

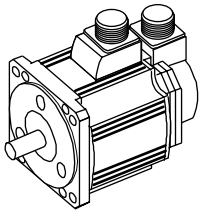
Servomotor

Appearance

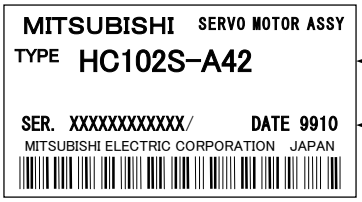
HC□ Series
- Medium inertia
- For CNC feed shaft



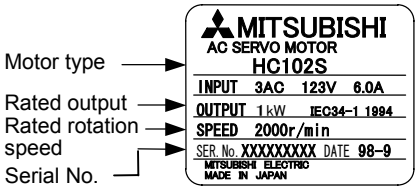
HC□R Series
- Low inertia
- For CNC peripheral axis



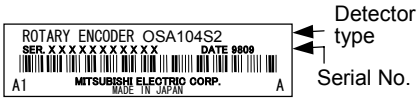
Rating nameplate and type configuration



Rating nameplate



Motor rating nameplate



Detector rating nameplate

(Caution) With the HC□ Series and HC□R Series, the motor and detector nameplates are attached in addition to the general rating nameplate.

HC ① ② ③ ④ – ⑤

⑤ Detector

Symbol	Detection method	Detector resolution	Detector type
A47	absolute position	100,000p/rev	OSA17
A42		100,000p/rev	OSA104S2
A33		25,000p/rev	OSA253S2
E42	Incremental	100,000p/rev	OSE104S2
E33		25,000p/rev	OSE253S2

④ Protective structure

Symbol	Shaft end shape
None	IP65
W	IP67

Detector A47 only have a IP65.

③ Shaft end shape

Symbol	Shaft end shape
S	Straight
T	Tapered

The HC202, 203 and 352 only have a straight shaft.

② Magnetic brake

Symbol	Magnetic brake
None	None
B	With magnetic brake

① Rated output, rated speed and motor series

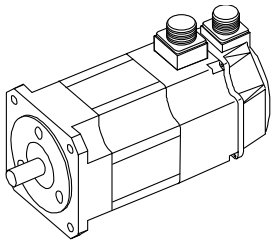
HC□ Series				HC□R Series	
Rating 2000r/min		Rating 3000r/min		Rating 3000r/min	
Symbol	Rating output	Symbol	Rating output	Symbol	Rating output
52	0.5kW	53	0.5kW	103R	1.0kW
102	1.0kW	103	1.0kW	153R	1.5kW
152	1.5kW	153	1.5kW	203R	2.0kW
202	2.0kW	203	2.0kW		
352	3.5kW				

(Note) As a standard, the HC motor complies with the EN Standards and UL Standards.

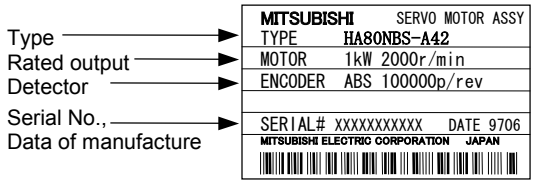
Servomotor

Appearance

HA□N Series
- Medium inertia
- For CNC feed shaft



Rating nameplate and type configuration



HA ① N ② ③ ④ − ⑤

⑤ Detector

Symbol	Detection method	Detector resolution	Detector type
E33	Incremental	25000p/rev	OSE253
E42		100000p/rev	OSE104
A33	ABS (absolute position)	25000p/rev	OSA253
A42		100000p/rev	OSA104

The detector types for HA053N to 33N are OSE□□□S and OSA□□□S.

④ Protective structure

Symbol	Protective structure
None	IP54
D5	IP65

③Shaft end shape

Symbol	Shaft end shape
S	Straight
T	Tapered

The HA053N, 13N, 100N, 103N and 200N only have a straight shaft.

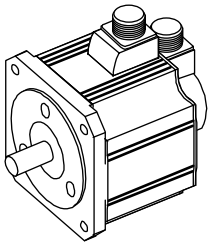
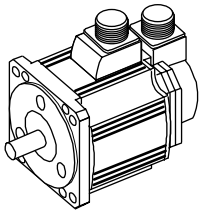
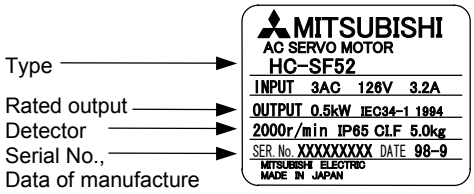
② Magnetic brake

Symbol	Magnetic brake
None	None
B	With magnetic brake

① Rated output and rated speed

Rating 2000r/min		Rating 3000r/min	
Symbol	Rating output	Symbol	Rating output
40	0.5kW	053	0.05kW
80	1.0kW	13	0.1kW
100	2.0kW	23	0.3kW
200	3.5kW	33	0.45kW
		43	0.5kW
		83	1.0kW
		103	2.0kW

(Note) As a standard, the HC motor complies with the EN Standards.

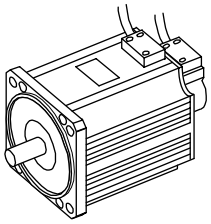
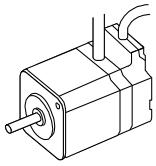
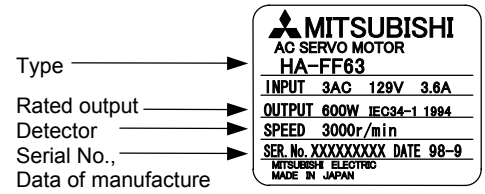
	Appearance	Rating nameplate and type configuration
Servomotor	HC-SF Series • Medium inertia • Peripheral axis, for general industrial machines  HC-RF Series • Low inertia • Peripheral axis, for general industrial machines 	 **HC–SF** ② ③ ④ ④Shaft end shape The taper shaft specifications comply only to the SF52 to 152, 53 to 153, and RF103 to 203. The key is not attached in the keyway. ③ Magnetic brake ②Rated output and rated speed ① Motor series **(Note)** As a standard, the HC-SF and HC-RF motor complies with the EN Standards and UL Standards.

Symbol	Shaft end shape
None	Straight
T	Taper
K	Keyway

Symbol	Magnetic brake
None	None
B	With magnetic brake

HC-SF Series				HC-RF Series	
Rating 2000r/min		Rating 3000r/min		Rating 3000r/min	
Symbol	Rating output	Symbol	Rating output	Symbol	Rating output
52	0.5kW	53	0.5kW	103	1.0kW
102	1.0kW	103	1.0kW	153	0.5kW
152	1.5kW	153	1.5kW	203	2.0kW
202	2.0kW	203	2.0kW		
352	3.5kW	353	3.5kW		

Symbol	Motor series
HC-SF	Medium inertia, medium capacity
HC-RF	Low inertia, medium capacity

	Appearance	Rating nameplate and type configuration
Servomotor	HA-FF Series • Compact, low inertia • Peripheral axis, for general industrial machines  HC-MF Series • Compact, ultra-low inertia • Peripheral axis, for general industrial machines 	 HA-FF ② ③ ④ ⑤ ⑥ ⑥ Standards and environment compliance ⑤Shaft end shape ④ Magnetic brake ③ Power input ② Rated output and rated speed ① Motor series

⑥ Standards and environment compliance

Symbol	Standards and environment compliance
None	None (IP44 Specifications)
−UE	EN Standards + UL Standards (Only the HA-FF follows IP54 Standards)
−S15	EN Standards + UL Standards + IP65 Standards (Set for HC-MF13, 23, 43 and 73)

⑤Shaft end shape

Symbol	HA-FF		HC-MF	
	053•13	23~63	053•13	23~73
None	Straight	Keyway (with key)	Straight	Straight
K	×	×	×	Keyway (with key)
D	D cut	×	D cut	×

④ Magnetic brake

Symbol	Magnetic brake
None	None
B	With magnetic brake

③ Power input

Symbol	Power input
None	Lead
C	Cannon connector

Always attach "C" to the HA-FF-UE. There is no "C" for other series servomotors.

② Rated output and rated speed

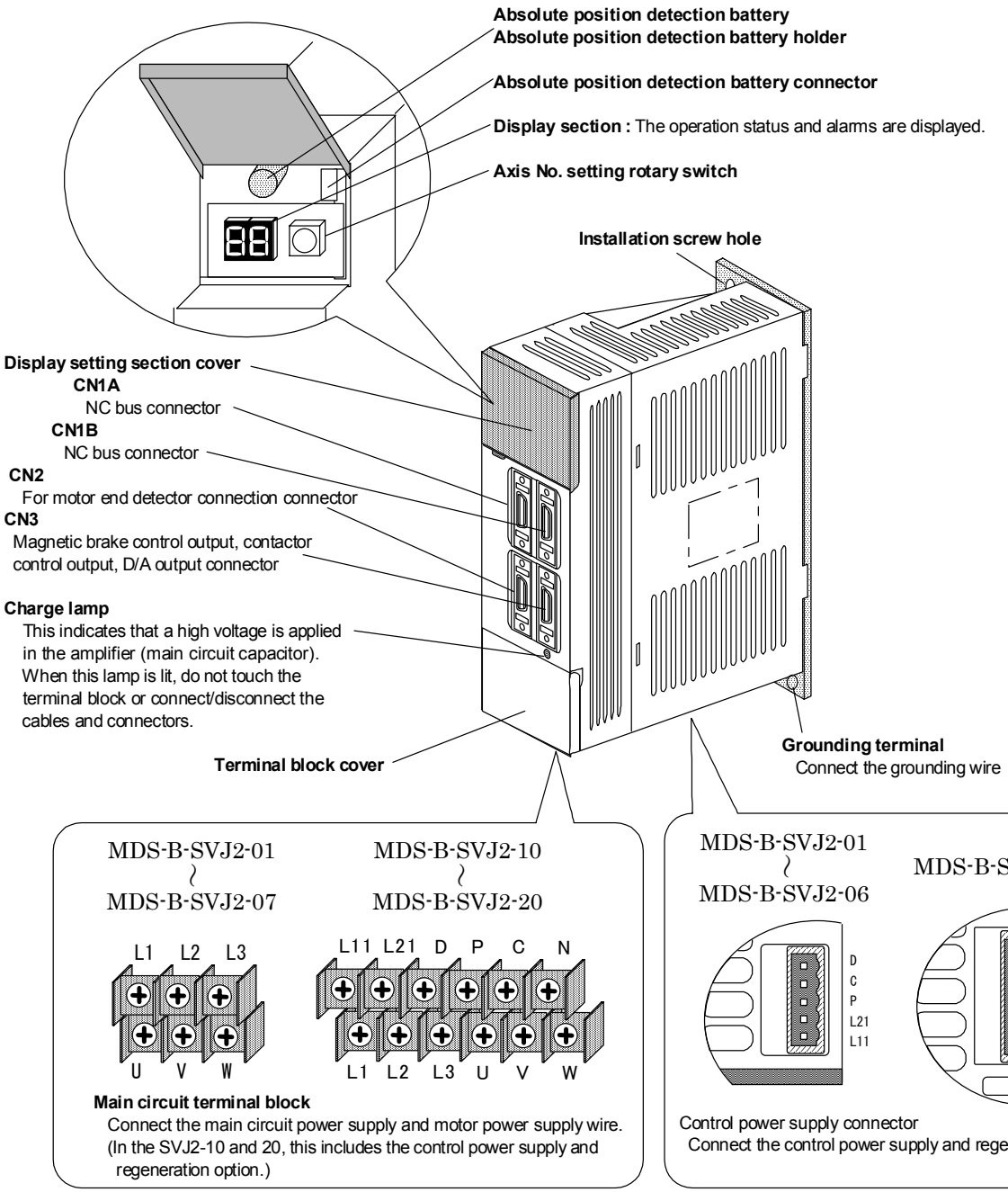
HA-FF Series		HC-MF Series	
Rating 3000r/min		Rating 3000r/min	
Symbol	Rating output	Symbol	Rating output
053	0.05kW	053	0.05kW
13	0.1kW	13	0.1kW
23	0.2kW	23	0.2kW
33	0.3kW	43	0.4kW
43	0.4kW	73	0.75kW
63	0.6kW		

① Motor series

Symbol	Motor series
HA-FF	Low inertia, small capacity
HC-MF	Ultra-low inertia, small capacity

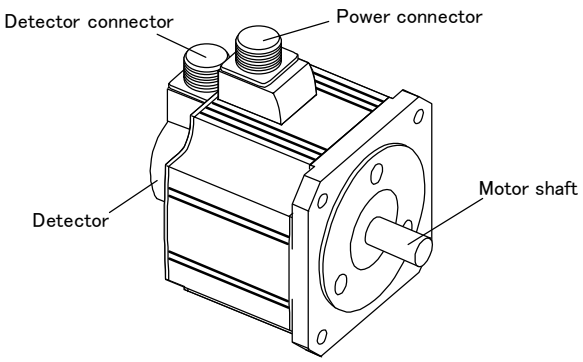
1-2 Explanation of each part

1-2-1 Explanation of each servo amplifier part

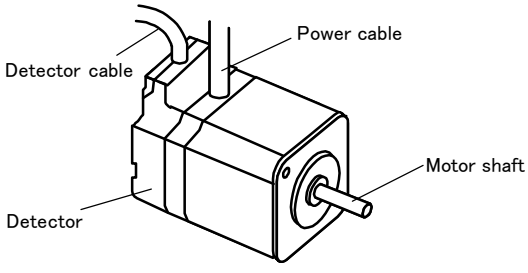


1-2-2 Explanation of each servomotor part

HC□, HC□R, HA□N
HC-SF, HC-RF Series



HA-FF, HC-MF Series



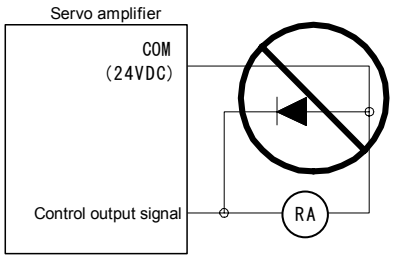
Chapter 2 Wiring and Connection

DANGER

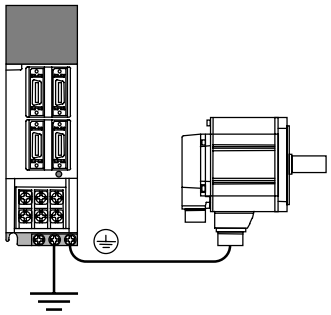
1. Wiring work must be done by a qualified technician.
2. Wait at least 10 minutes after turning the power OFF and check the voltage with a tester, etc., before starting wiring. Failure to observe this could lead to electric shocks.
3. Securely ground the servo amplifier and servomotor with Class 3 grounding or higher.
4. Wire the servo amplifier and servomotor after installation. Failure to observe this could lead to electric shocks.
5. Do not damage, apply forcible stress, place heavy items or engage the cable. Failure to observe this could lead to electric shocks.
6. Carry out insulation treatment to the connection part of the power supply terminal. Failure to observe this could lead to electric shocks.

CAUTION

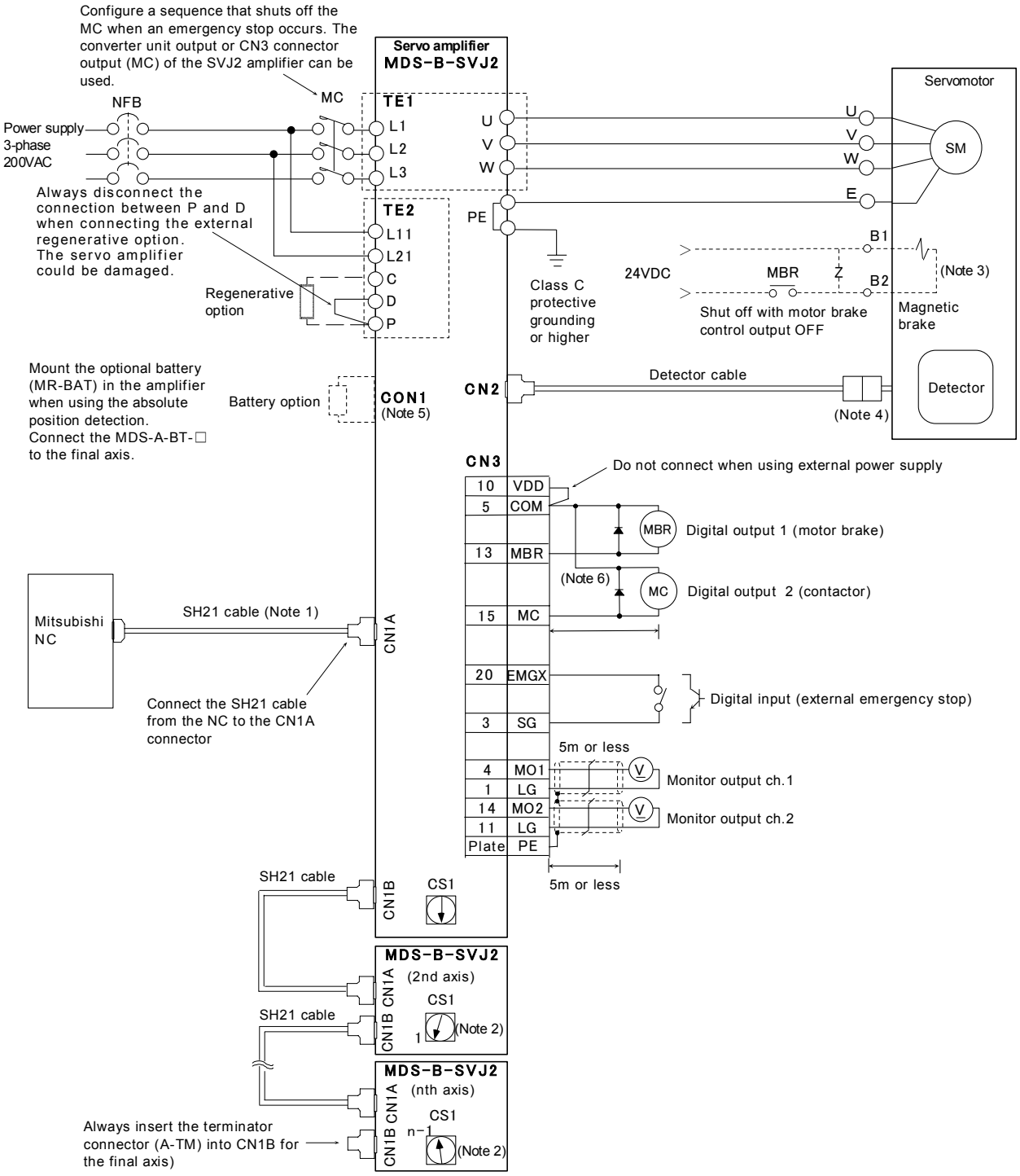
1. Correctly and securely perform the wiring. Failure to do so could lead to runaway of the servomotor.
2. Do not mistake the terminal connections.
   Failure to observe this item could lead to ruptures or damage, etc.
3. Do not mistake the polarity (+ , –). Failure to observe this item could lead to ruptures or damage, etc.
4. Do not mistake the direction of the diodes for the surge absorption installed on the DC relay for the motor brake and contactor (magnetic contact) control. The signal might not be output when a failure occurs.



5. Electronic devices used near the servo amplifier may receive magnetic obstruction. Reduce the effect of magnetic obstacles by installing a noise filter, etc.
6. Do not install a phase advancing capacitor, surge absorber or radio noise filter on the power supply wire (U, V, W) of the servomotor.
7. Do not modify this unit.
8. The CN1A, CN1B, CN2 and CN3 connectors on the front of the amplifier have the same shape. If the connectors are connected incorrectly, faults could occur. Make sure that the connection is correct.
9. When grounding the motor, connect to the protective grounding terminal on the servo amplifier, and ground from the other protective grounding terminal. (Use one-point grounding)
   Do not separately ground the connected motor and servo amplifier as noise could be generated.



2-1 System connection diagram



Notes)

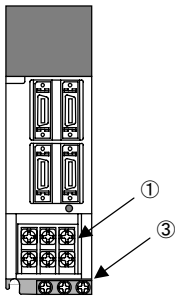
1. The total length of the SH21 cable must be within 30 m.
2. The motor side connections following the 2nd axis have been omitted.
3. This is a motor with magnetic brakes. The power connected to the magnetic brake does not have a polarity.
4. The connection method will differ according to the motor.
5. When using as an absolute position detector, connect MR-BAT or MDS-A-BT-□ instead of the terminator connector.
6. Do not mistake the diode direction. If connected in reverse, the amplifier will fail and the signal will not be output.

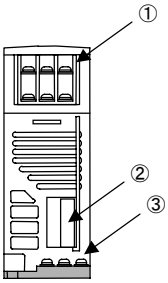
2-2 Servo amplifier main circuit terminal block, control circuit terminal block

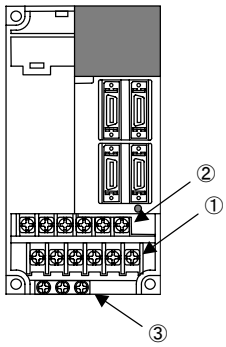
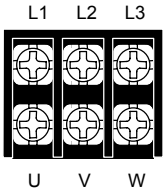
> **⚠ CAUTION** Do not apply a voltage other than that specified in Instruction Manual on each terminal. Failure to observe this item could lead to ruptures or damage, etc.

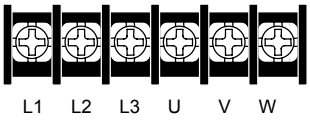
2-2-1 Main circuit terminal block, control circuit terminal block signal layout

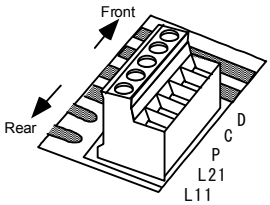
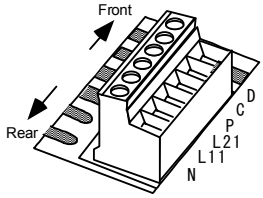
The signal layout of each terminal block is as shown below.

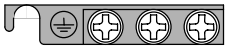
<table>
<tr><th colspan="3">Servo amplifier / Terminal</th><th>MDS-B-SVJ2-01
MDS-B-SVJ2-03
MDS-B-SVJ2-04
MDS-B-SVJ2-06</th><th>MDS-B-SVJ2-07</th><th>MDS-B-SVJ2-10
MDS-B-SVJ2-20</th></tr>
<tr><td colspan="3">Terminal position</td><td> 

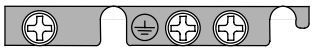
Front


Bottom</td><td colspan="2"> 
</td></tr>
<tr><td rowspan="3">Terminal signal</td><td>①</td><td>Main circuit terminal block (TE1)</td><td> 

Terminal screw : M4×0.7 Tightening torque : 1.24N·m</td><td colspan="2"> 

Terminal screw : M4×0.7
Tightening torque : 1.24N·m</td></tr>
<tr><td>②</td><td>Control circuit terminal block (TE2)</td><td> 
</td><td> 
</td><td> 

Terminal screw : M4×0.7
Tightening torque : 1.24N·m</td></tr>
<tr><td>③</td><td>Protective grounding terminal block (PE)</td><td> 
MDS-B-SVJ2-01～04

MDS-B-SVJ2-06
Terminal screw : M4×0.7
Tightening torque : 1.24N·m</td><td> 
Terminal screw : M4×0.7
Tightening torque : 1.24N·m</td><td> 
Terminal screw : M4×0.7
Tightening torque : 1.24N·m</td></tr>
</table>

2-2-2 Names and application of main circuit terminal block and control circuit terminal block signals

The following table shows the details for each terminal block signal.

Name	Signal name	Description
L1·L2·L3	Main circuit power supply	Main circuit power supply input terminal Connect a 3-phase 200 to 230VAC, 50/60Hz power supply.
L11·L12	Control circuit power supply	Control circuit power supply input terminal Connect a single-phase 200 to 230VAC, 50/60Hz power supply. Connect the same power supply phase for L11 and L1, and L21 and L2.
P·C·D	Regenerative option	Regenerative option connection terminal. P to D is wired at shipment. When using the regenerative option, disconnect the wire between P and D and wire the regenerative option between P and C.
(N)	Main circuit reference potential	This is not used normally. (This is the reference potential for the main circuit DC voltage.)
U·V·W	Servomotor output	Servomotor power supply output terminal The servomotor power supply terminal (U, V, W) is connected.
⏚	Protective grounding (PE)	Grounding terminal The servomotor grounding terminal is connected and grounded.

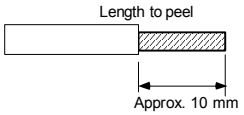
DANGER Never connect anything to the main circuit reference voltage (N).
Failure to observe this could lead to electric shock or servo amplifier damage.

CAUTION When using a standard built-in regenerative resistor, connect it between the P and D terminals. (Shipment state.)
When using an external option regenerative resistor, disconnect the wiring between the P and D terminals, and connect between P and C. Standard built-in regenerative resistors cannot be used in combination with an external option regenerative resistor.

2-2-3 How to use the control circuit terminal block (MDS-B-SVJ2-01~07)

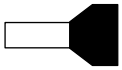
① Treatment of wire end

Single strand: Peel the wire sheath, and use the wire.
(Wire size: 0.25 to 2.5 mm^2)



Stranded wire: Peel the wire sheath, and then twist the core wires. Take care to prevent short circuits with the neighboring poles due to the fine strands of the core wires. Solder plating onto the core wire section could cause a contact defect and must be avoided. (Wire size: 0.25 to 2.5 mm^2)
Use a bar terminal and bundle the strands. (Phoenix contact)

Bar terminal for one wire
(Bar terminal phenol with insulation sleeve)

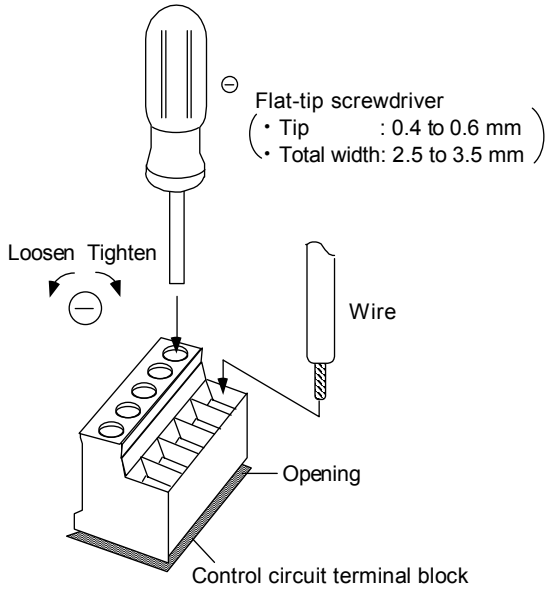


Bar terminal for two wires
(TWIN phenol with insulation sleeve)

Wire size		Bar terminal type		Crimping tool
[mm^2]	AWG	For one wire	For two wires	
0.25	24	AI0.25-6YE AI0.25-8YE	–	CRIMPFOX-UD6
0.5	20	AI0.5-6WH AI0.5-8WH	–	
0.75	18	AI0.75-6GY AI0.75-8GY	AI-TWIN2×0.75-8GY AI-TWIN2×0.75-10GY	
1	18	AI1-6RD AI1-8RD	AI-TWIN2×1-8RD AI-TWIN2×1-10RD	
1.5	16	AI1.5-6BK AI1.5-8BK	AI-TWIN2×1.5-8BK AI-TWIN2×1.5-12BK	
2.5	14	AI2.5-8BU AI2.5-8BU-1000	AI-TWIN2×2.5-10BU AI-TWIN2×2.5-13BU	

② Connection method

Insert the core wire section of the wire into the opening, and tighten with a screwdriver so that the wire does not come out. (Tightening torque: 0.5 to 0.6 N•m) When inserting the wire into the opening, make sure that the terminal screw is sufficiently loose. When using a wire that is 1.5 mm^2 or less, two wires can be inserted into one opening.

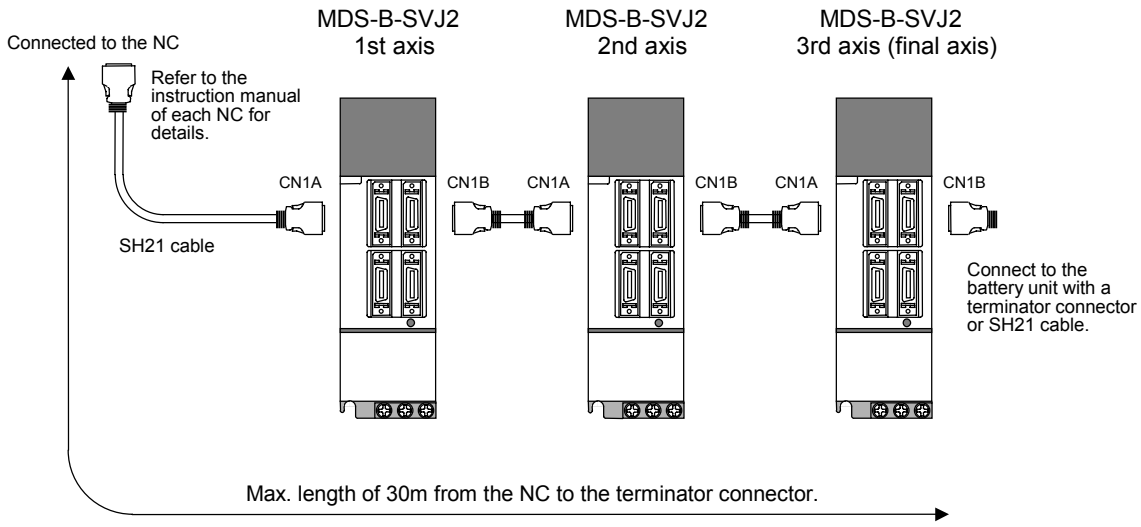


2-3 NC and servo amplifier connection

The NC bus cables are connected from the NC to each servo amplifier so that they run in a straight line from the NC to the terminator connector (battery unit). MDS-C1-V1/V2 Series servo amplifiers and spindle amplifiers can be connected in combination, and up to 7 axes can be connected per system. (Note that the number of connected axes is limited by the NC. The following drawing shows an example with three axes connected.)

< Connection >

CN1A : CN1B connector of NC side amplifier or NC output
CN1B : CN1A connector of terminator connector side amplifier or terminator connector (battery unit)



CAUTION	Arrange the NC and servo amplifiers so that the NC bus cable length from the NC to the terminator connector (battery unit) is 30m or less.

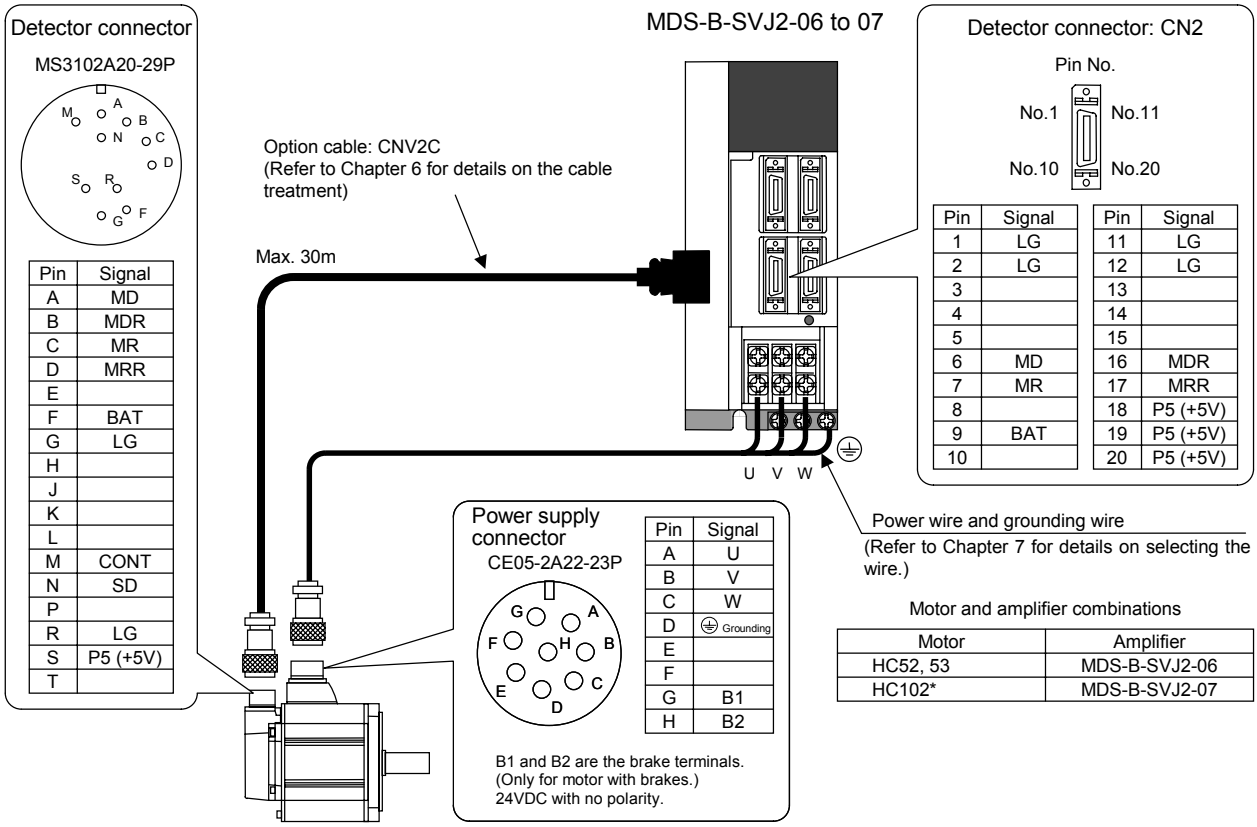
POINT	Axis Nos. are determined by the rotary switch for setting the axis No. (Refer to section "4-1-1 Setting the rotary switches".) The axis No. has no relation to the order for connecting to the NC.

2-4 Motor and detector connection

2-4-1 Connection of HC52, HC53, HC102*

(1) HC52/HC53/HC102□-A47

The OSA17 detector is used, and the wiring differs from the other HC motor detectors. HC102* is connected with an amplifier having a one-rank lower capacity.



Pin	Signal
A	MD
B	MDR
C	MR
D	MRR
E	
F	BAT
G	LG
H	
J	
K	
L	
M	CONT
N	SD
P	
R	LG
S	P5 (+5V)
T	

Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

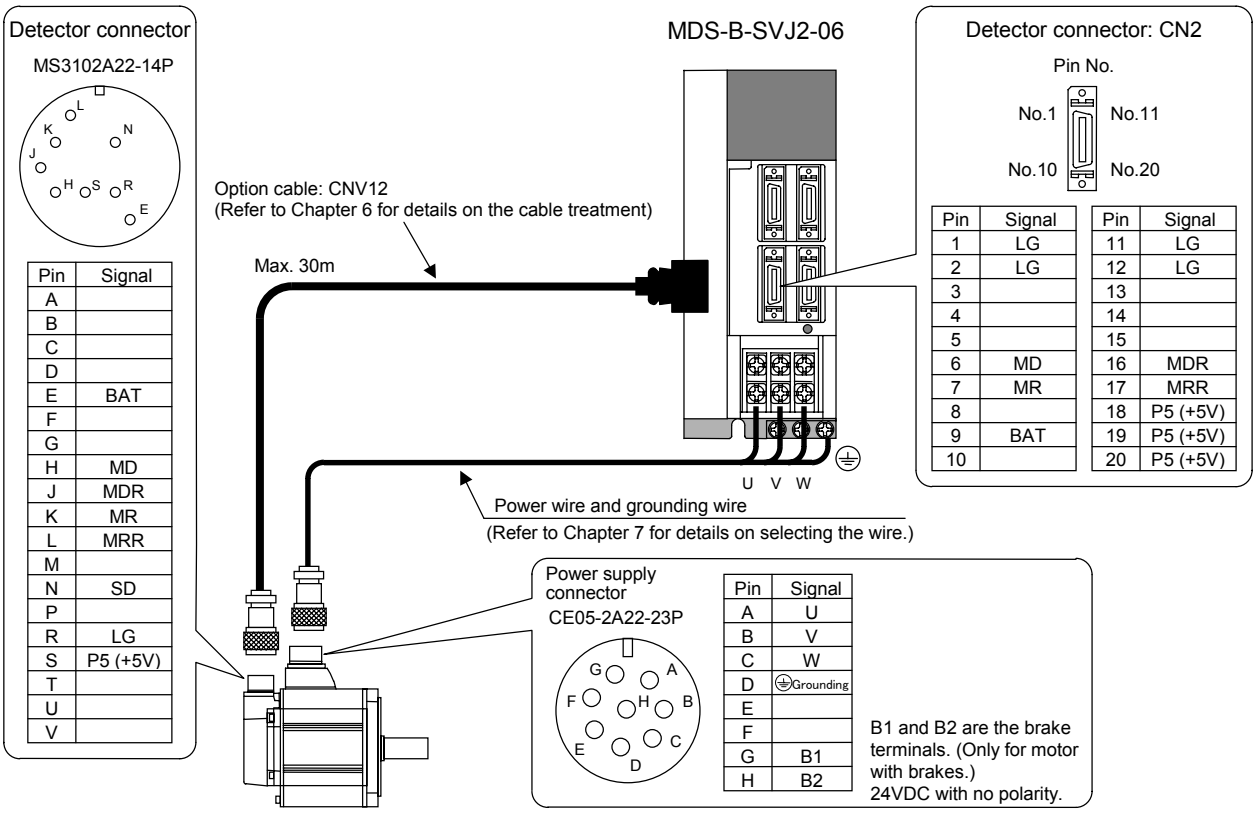
Pin	Signal
A	U
B	V
C	W
D	⏚ Grounding
E	
F	
G	B1
H	B2

Motor and amplifier combinations

Motor	Amplifier
HC52, 53	MDS-B-SVJ2-06
HC102*	MDS-B-SVJ2-07

(2) HC52/HC53□-E42/A42/E33/A33

Either the OSE104, OSA104, OSE253 or OSA253 detector can be used. The connection methods are the same for all types.



Pin	Signal
A	
B	
C	
D	
E	BAT
F	
G	
H	MD
J	MDR
K	MR
L	MRR
M	
N	SD
P	
R	LG
S	P5 (+5V)
T	
U	
V	

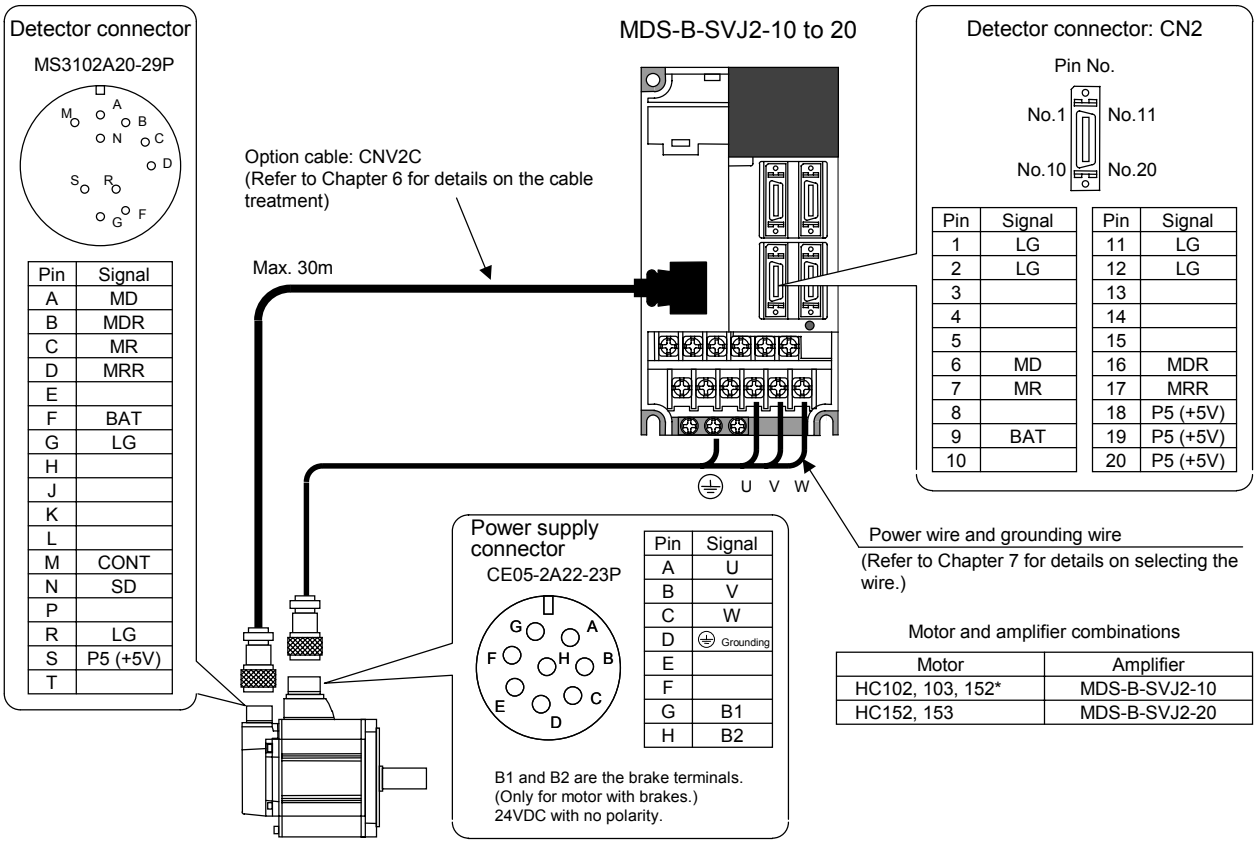
Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

Pin	Signal
A	U
B	V
C	W
D	⏚ Grounding
E	
F	
G	B1
H	B2

2-4-2 Connection of HC102, HC103, HC152*, HC152, HC153

(1) HC102/HC103/HC152/HC153□-A47

The OSA17 detector is used, and the wiring differs from the other HC motor detectors.
HC152* is connected with an amplifier having a one-rank lower capacity.



Pin	Signal
A	MD
B	MDR
C	MR
D	MRR
E	
F	BAT
G	LG
H	
J	
K	
L	
M	CONT
N	SD
P	
R	LG
S	P5 (+5V)
T	

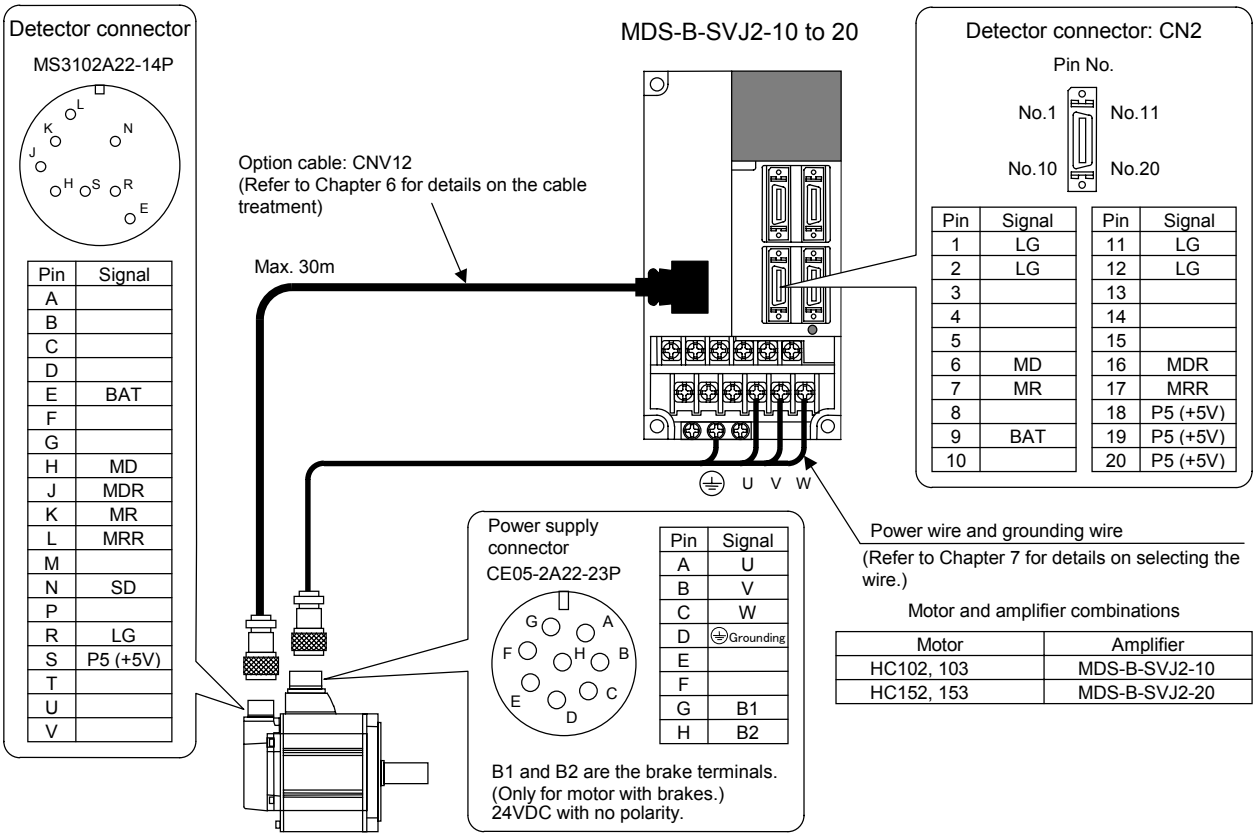
Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

Pin	Signal
A	U
B	V
C	W
D	Grounding
E	
F	
G	B1
H	B2

Motor	Amplifier
HC102, 103, 152*	MDS-B-SVJ2-10
HC152, 153	MDS-B-SVJ2-20

(2) HC102/HC103/HC152/HC153□-E42/A42/E33/A33

Either the OSE104, OSA104, OSE253 or OSA253 detector can be used. The connection methods are the same for all types.



Pin	Signal
A	
B	
C	
D	
E	BAT
F	
G	
H	MD
J	MDR
K	MR
L	MRR
M	
N	SD
P	
R	LG
S	P5 (+5V)
T	
U	
V	

Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

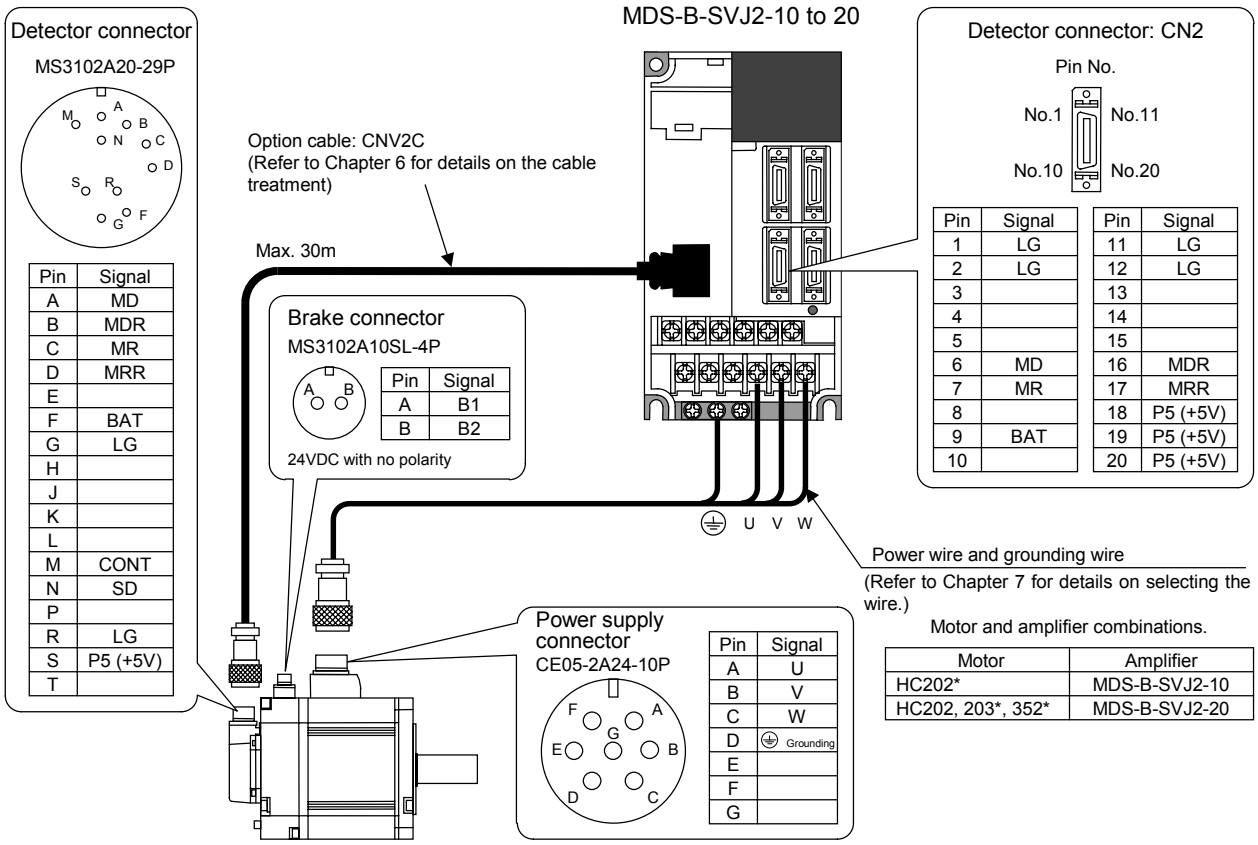
Pin	Signal
A	U
B	V
C	W
D	Grounding
E	
F	
G	B1
H	B2

Motor	Amplifier
HC102, 103	MDS-B-SVJ2-10
HC152, 153	MDS-B-SVJ2-20

2-4-3 Connection of HC202*, HC202, HC203*, HC352*

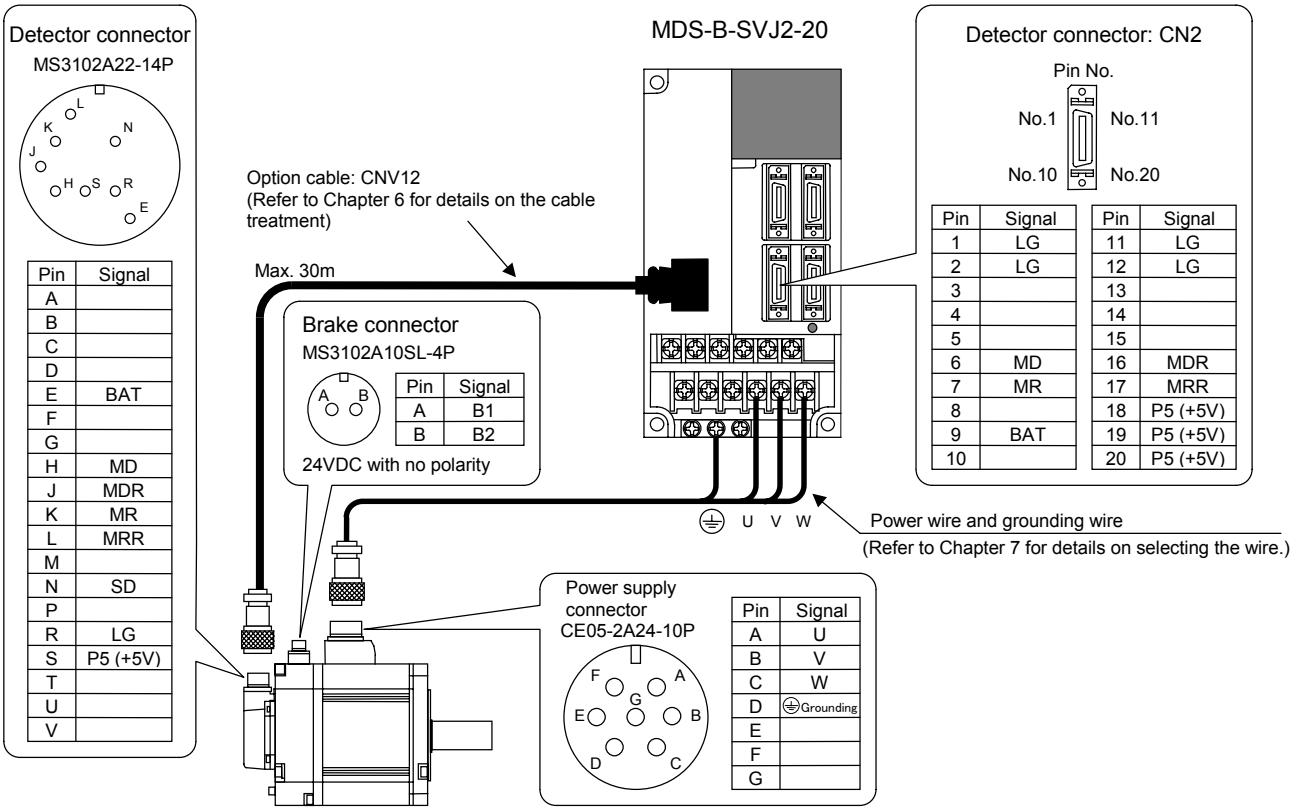
(1) HC202/HC203/HC352□-A47

The OSA17 detector is used, and the wiring differs from the other HC motor detectors.
HC202* is connected with an amplifier having a one-rank lower capacity.



(2) HC202/HC203/HC352□-E42/A42/E33/A33

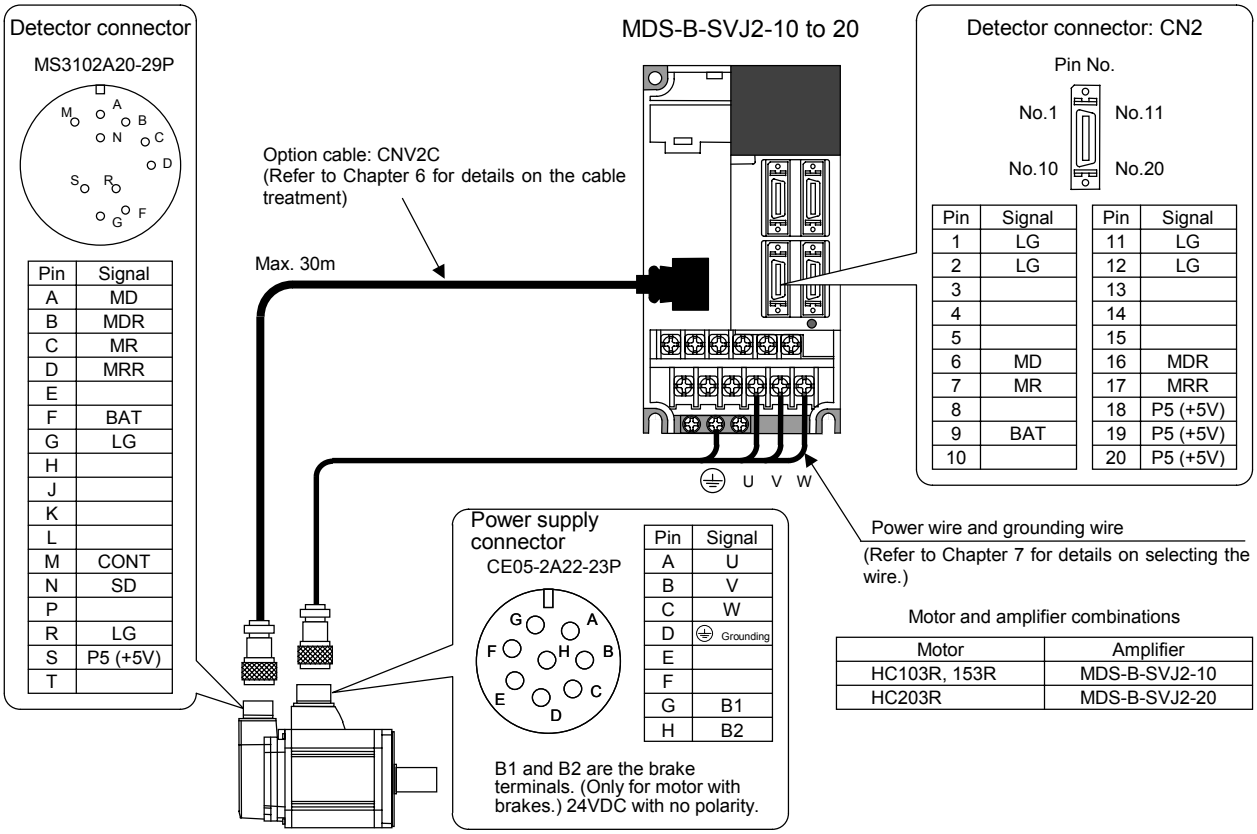
Either the OSE104, OSA104, OSE253 or OSA253 detector can be used. The connection methods are the same for all types.



2-4-4 Connection of HC103R, HC153R, HC203R

(1) HC103R/HC153R/HC203R□-A47

The OSA17 detector is used, and the wiring differs from the other HC motor detectors.



Pin	Signal
A	MD
B	MDR
C	MR
D	MRR
E	
F	BAT
G	LG
H	
J	
K	
L	
M	CONT
N	SD
P	
R	LG
S	P5 (+5V)
T	

Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

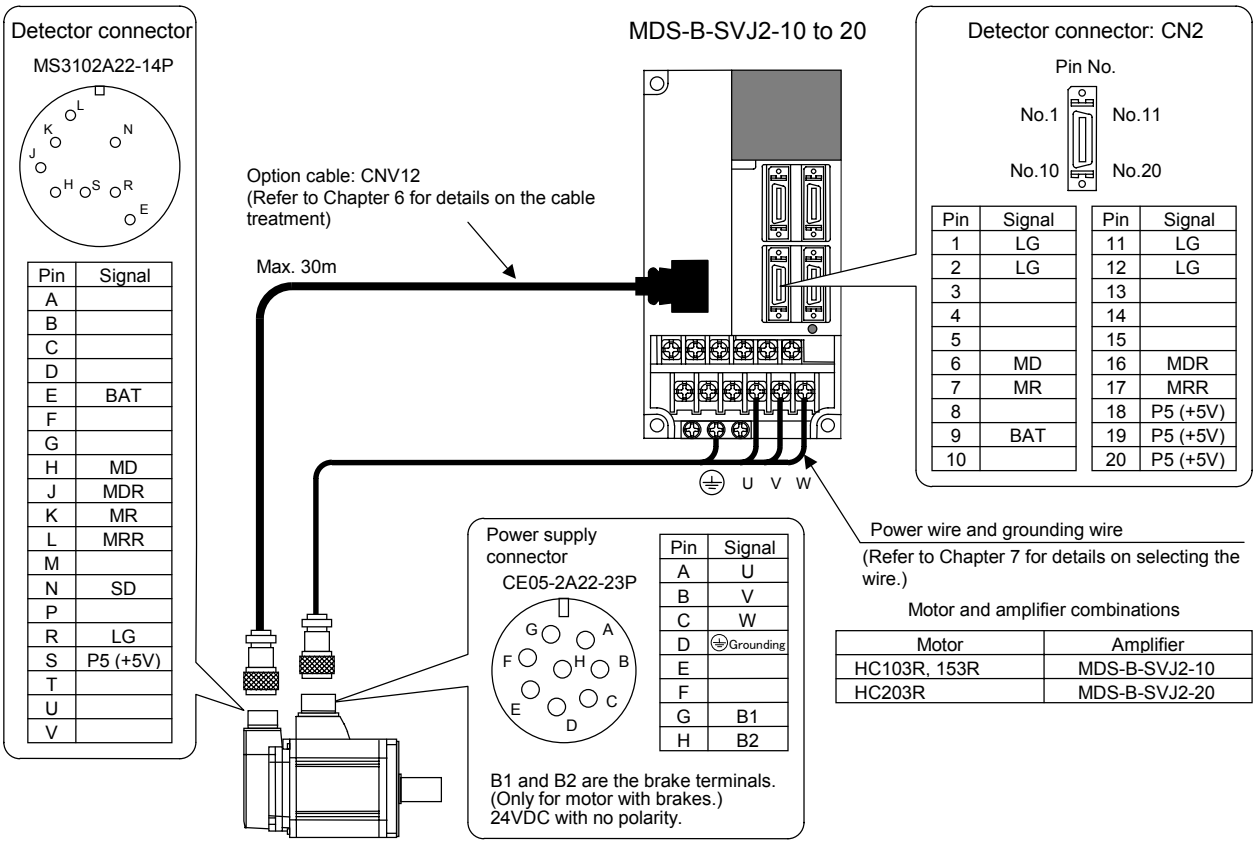
Pin	Signal
A	U
B	V
C	W
D	Grounding
E	
F	
G	B1
H	B2

Motor and amplifier combinations

Motor	Amplifier
HC103R, 153R	MDS-B-SVJ2-10
HC203R	MDS-B-SVJ2-20

(2) HC103R/HC153R/HC203R□-E42/A42/E33/A33

Either the OSE104, OSA104, OSE253 or OSA253 detector can be used. The connection methods are the same for all types.



Pin	Signal
A	
B	
C	
D	
E	BAT
F	
G	
H	MD
J	MDR
K	MR
L	MRR
M	
N	SD
P	
R	LG
S	P5 (+5V)
T	
U	
V	

Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

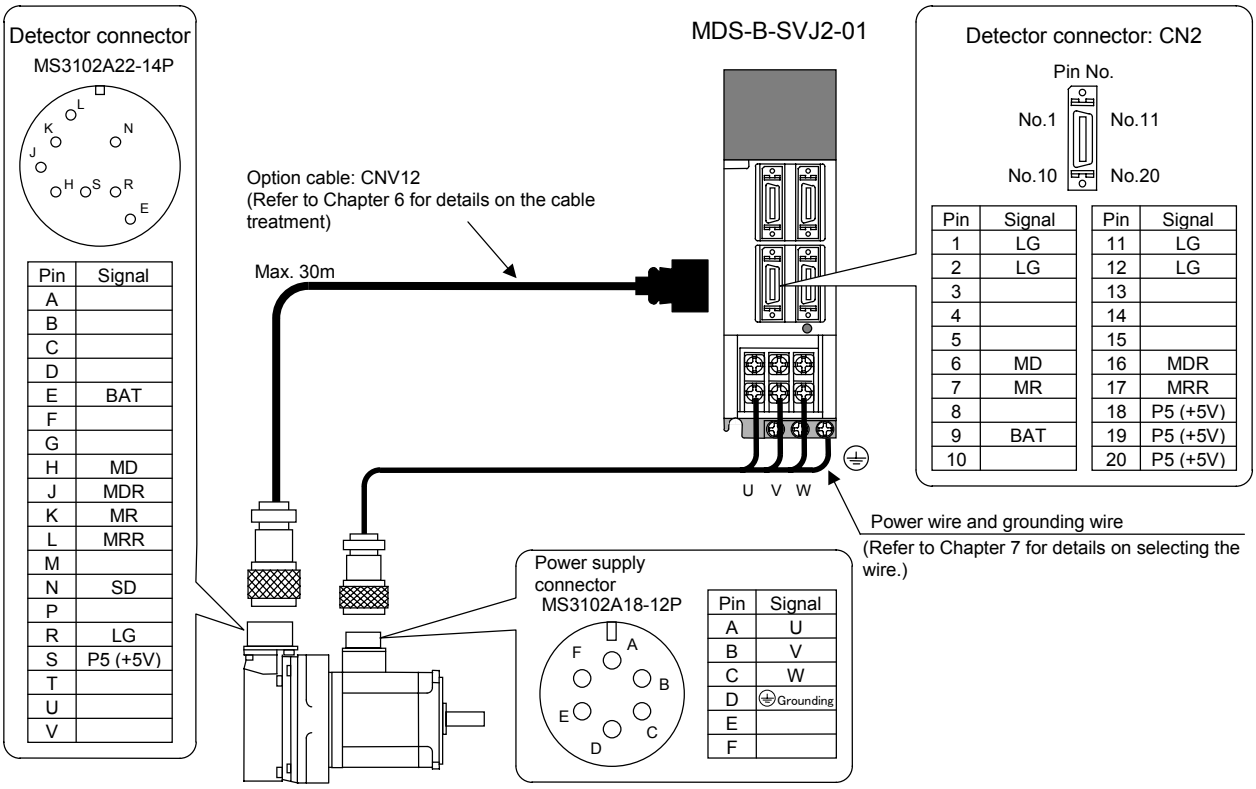
Pin	Signal
A	U
B	V
C	W
D	Grounding
E	
F	
G	B1
H	B2

Motor and amplifier combinations

Motor	Amplifier
HC103R, 153R	MDS-B-SVJ2-10
HC203R	MDS-B-SVJ2-20

2-4-5 Connection of HA053N, HA13N

Either the OSE253, OSA253, OSE104 or OSA104 detector can be used. The connection methods are the same for all types.



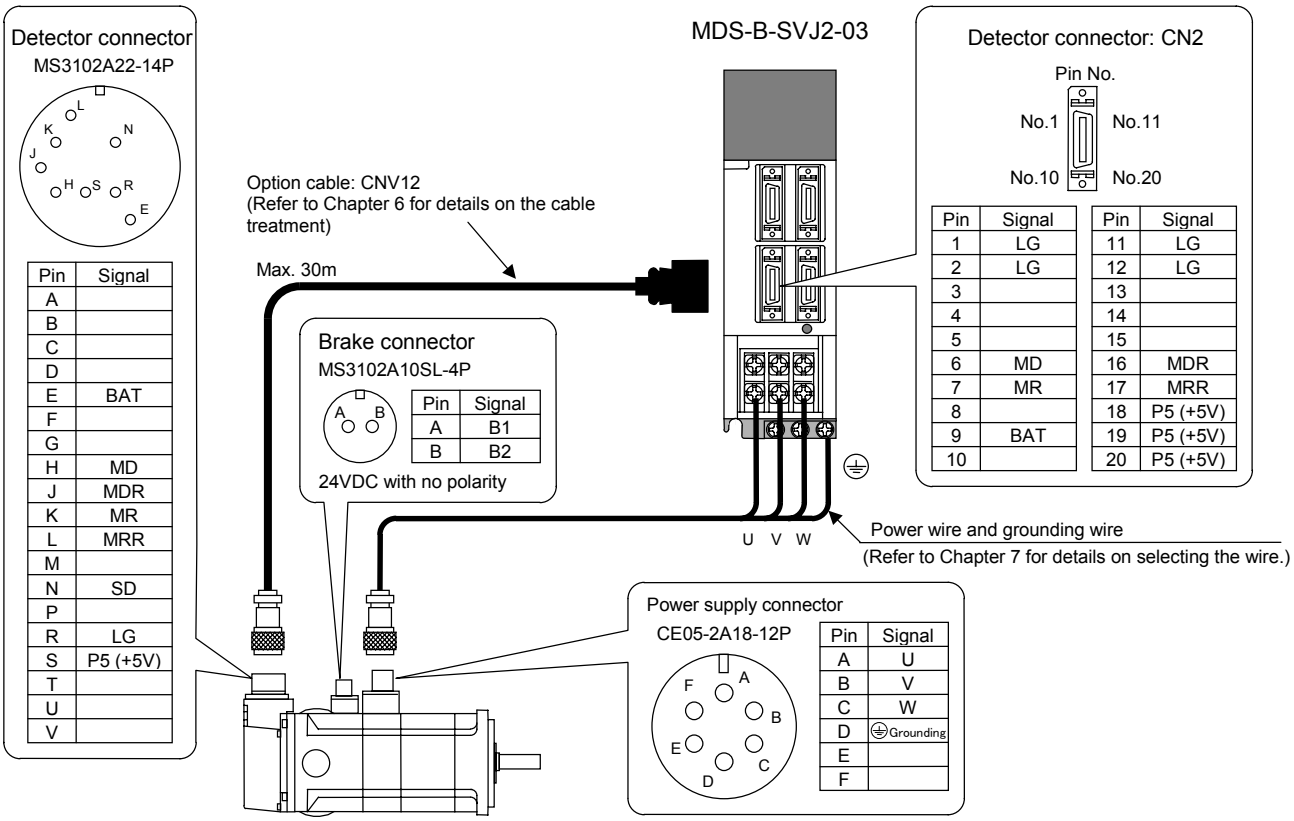
Pin	Signal
A	
B	
C	
D	
E	BAT
F	
G	
H	MD
J	MDR
K	MR
L	MRR
M	
N	SD
P	
R	LG
S	P5 (+5V)
T	
U	
V	

Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

Pin	Signal
A	U
B	V
C	W
D	Grounding
E	
F	

2-4-6 Connection of HA23N, HA33N

Either the OSE253, OSA253, OSE104 or OSA104 detector can be used. The connection methods are the same for all types.



Pin	Signal
A	
B	
C	
D	
E	BAT
F	
G	
H	MD
J	MDR
K	MR
L	MRR
M	
N	SD
P	
R	LG
S	P5 (+5V)
T	
U	
V	

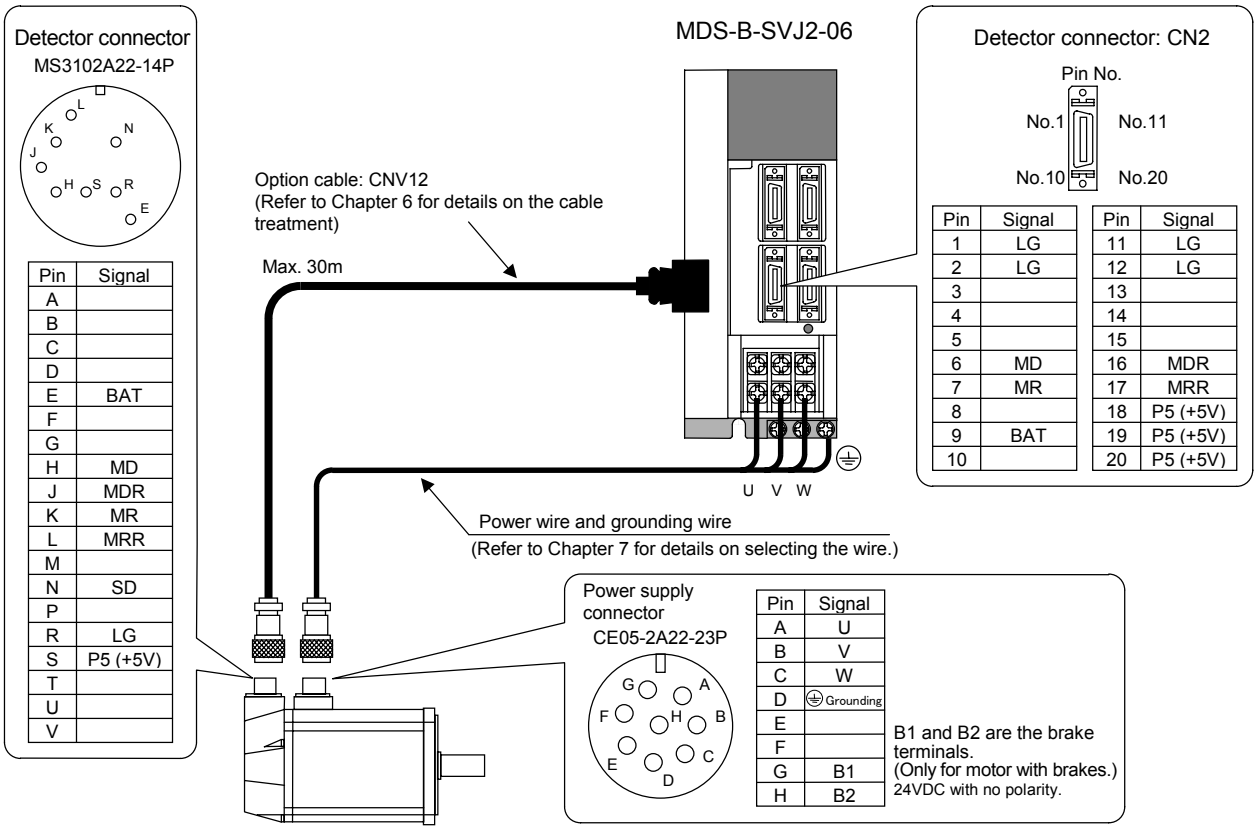
Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

Pin	Signal
A	B1
B	B2

Pin	Signal
A	U
B	V
C	W
D	Grounding
E	
F	

2-4-7 Connection of HA40N,HA43N

Either the OSE253, OSA253, OSE104 or OSA104 detector can be used. The connection methods are the same for all types.



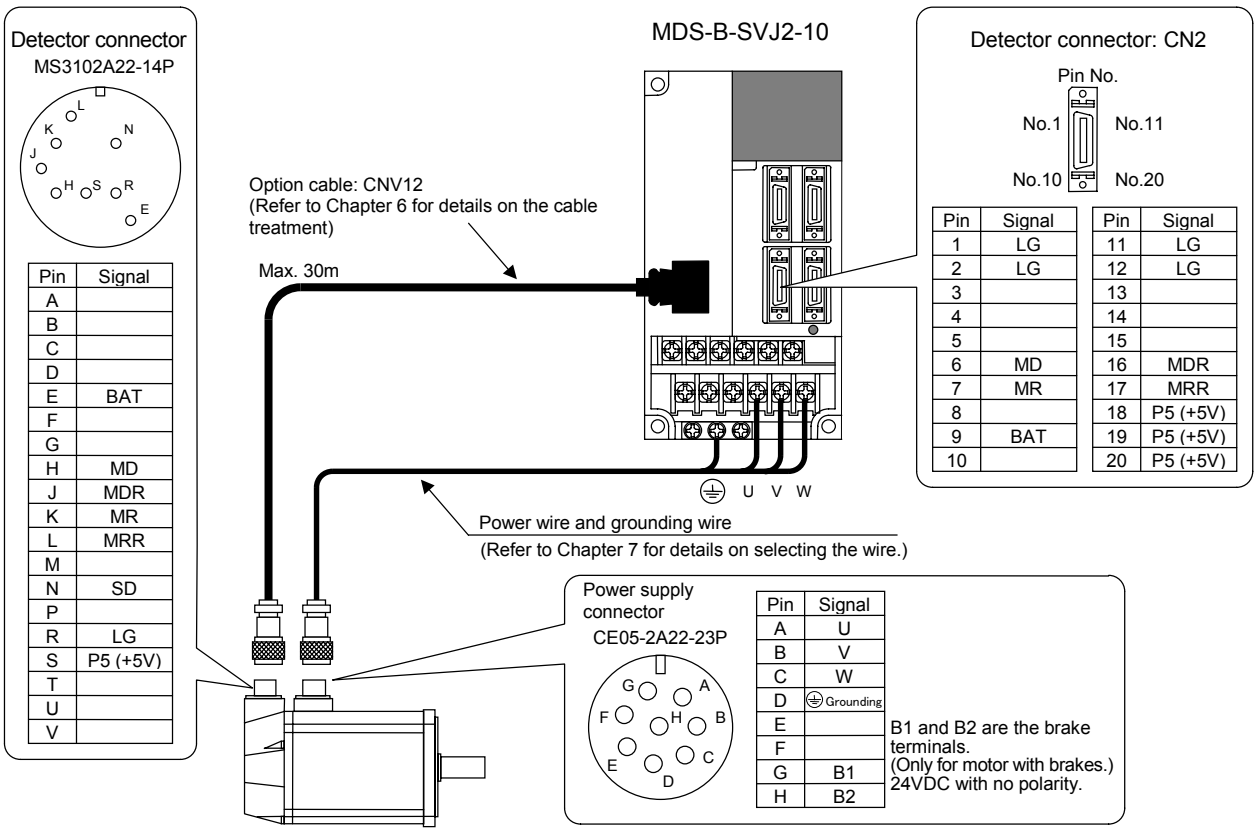
Pin	Signal
A	
B	
C	
D	
E	BAT
F	
G	
H	MD
J	MDR
K	MR
L	MRR
M	
N	SD
P	
R	LG
S	P5 (+5V)
T	
U	
V	

Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

Pin	Signal
A	U
B	V
C	W
D	Grounding
E	
F	
G	B1
H	B2

2-4-8 Connection of HA80N, HA83N

Either the OSE253, OSA253, OSE104 or OSA104 detector can be used. The connection methods are the same for all types.



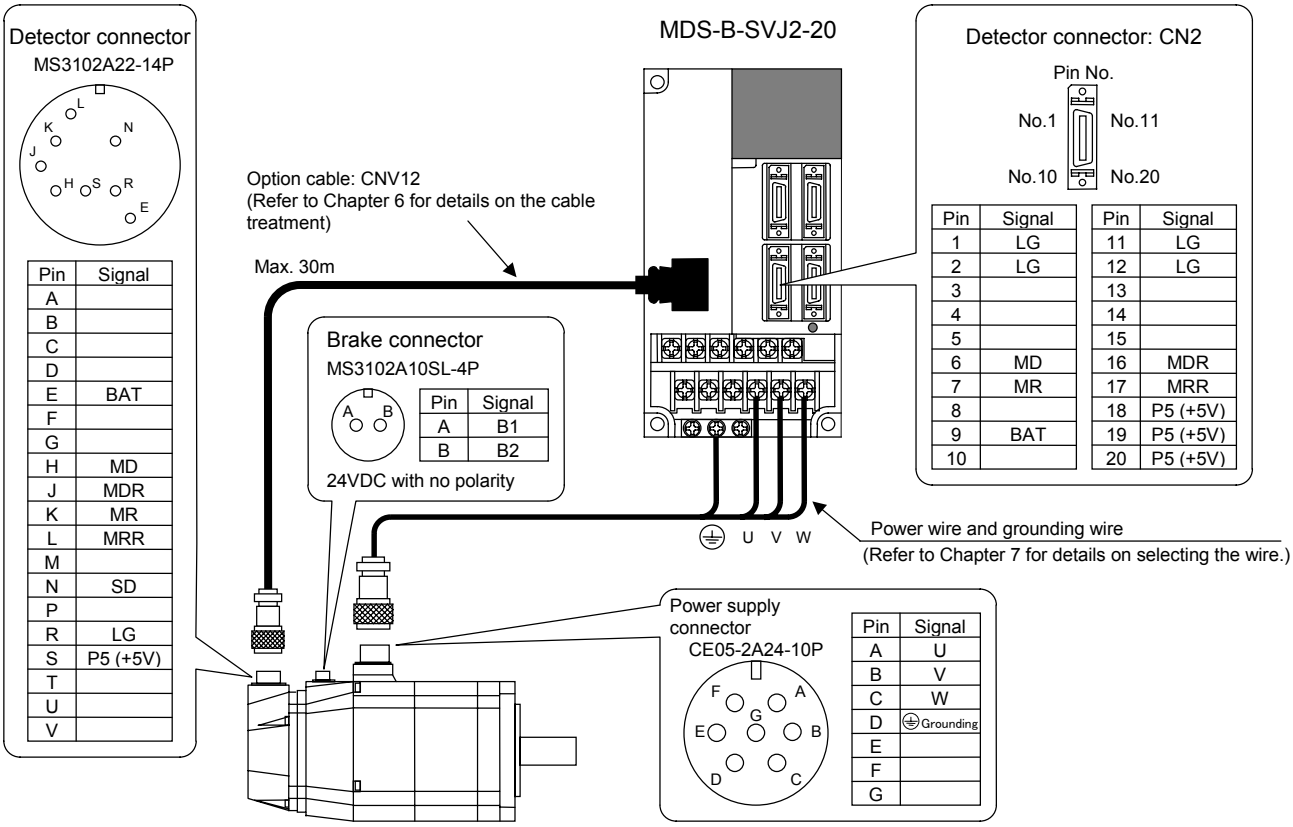
Pin	Signal
A	
B	
C	
D	
E	BAT
F	
G	
H	MD
J	MDR
K	MR
L	MRR
M	
N	SD
P	
R	LG
S	P5 (+5V)
T	
U	
V	

Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

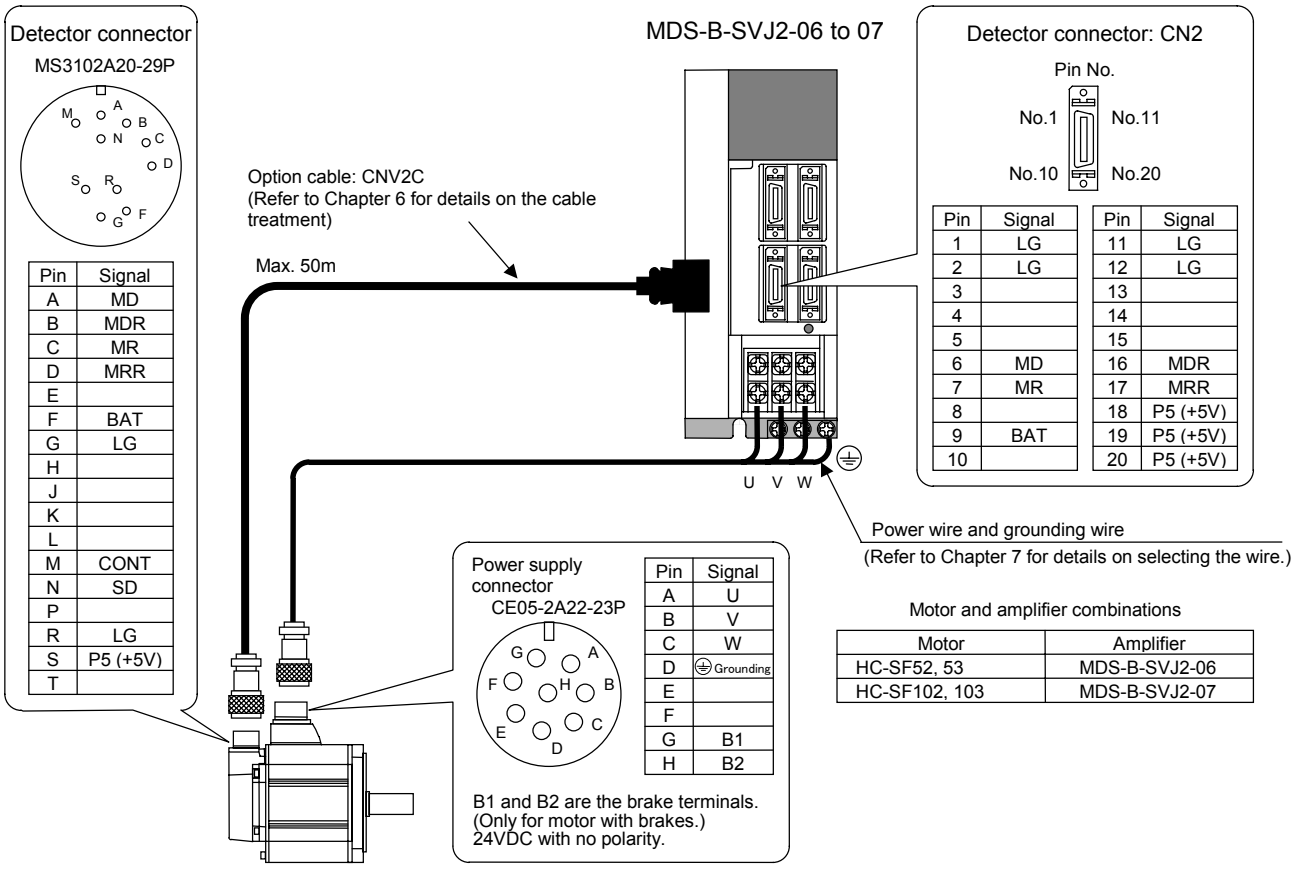
Pin	Signal
A	U
B	V
C	W
D	Grounding
E	
F	
G	B1
H	B2

2-4-9 Connection of HA100N, HA103N*, HA200N*

Either the OSE253, OSA253 OSE104 or OSA104 detector can be used. The connection methods are the same for all types. HA103N* and HA200N* are connected with an amplifier having a one-rank lower capacity than the standard detector.



2-4-10 Connection of HC-SF52, HC-SF53, HC-SF102, HC-SF103



Pin	Signal
A	MD
B	MDR
C	MR
D	MRR
E	
F	BAT
G	LG
H	
J	
K	
L	
M	CONT
N	SD
P	
R	LG
S	P5 (+5V)
T	

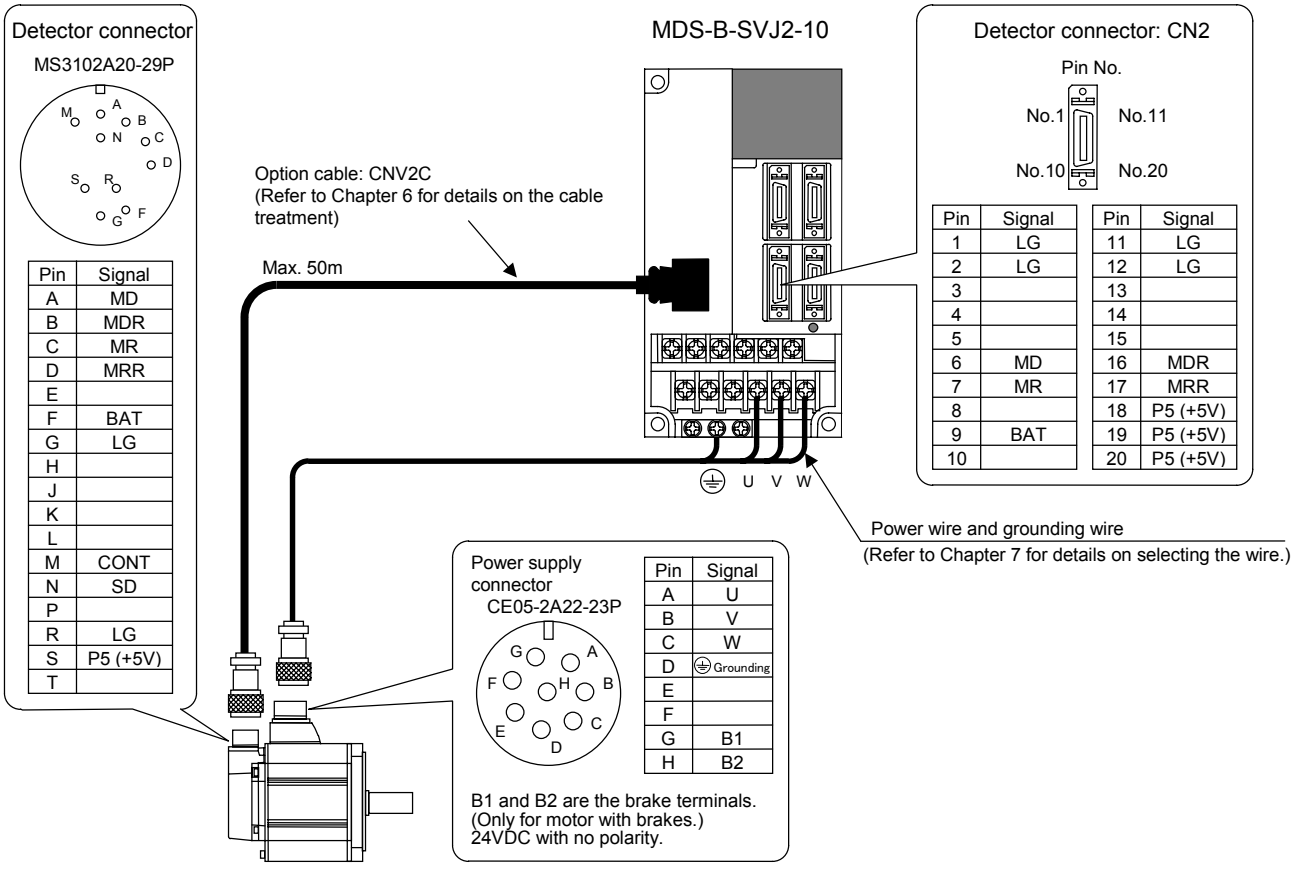
Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

Pin	Signal
A	U
B	V
C	W
D	⏚ Grounding
E	
F	
G	B1
H	B2

Motor and amplifier combinations

Motor	Amplifier
HC-SF52, 53	MDS-B-SVJ2-06
HC-SF102, 103	MDS-B-SVJ2-07

2-4-11 Connection of HC-SF152, HC-SF153

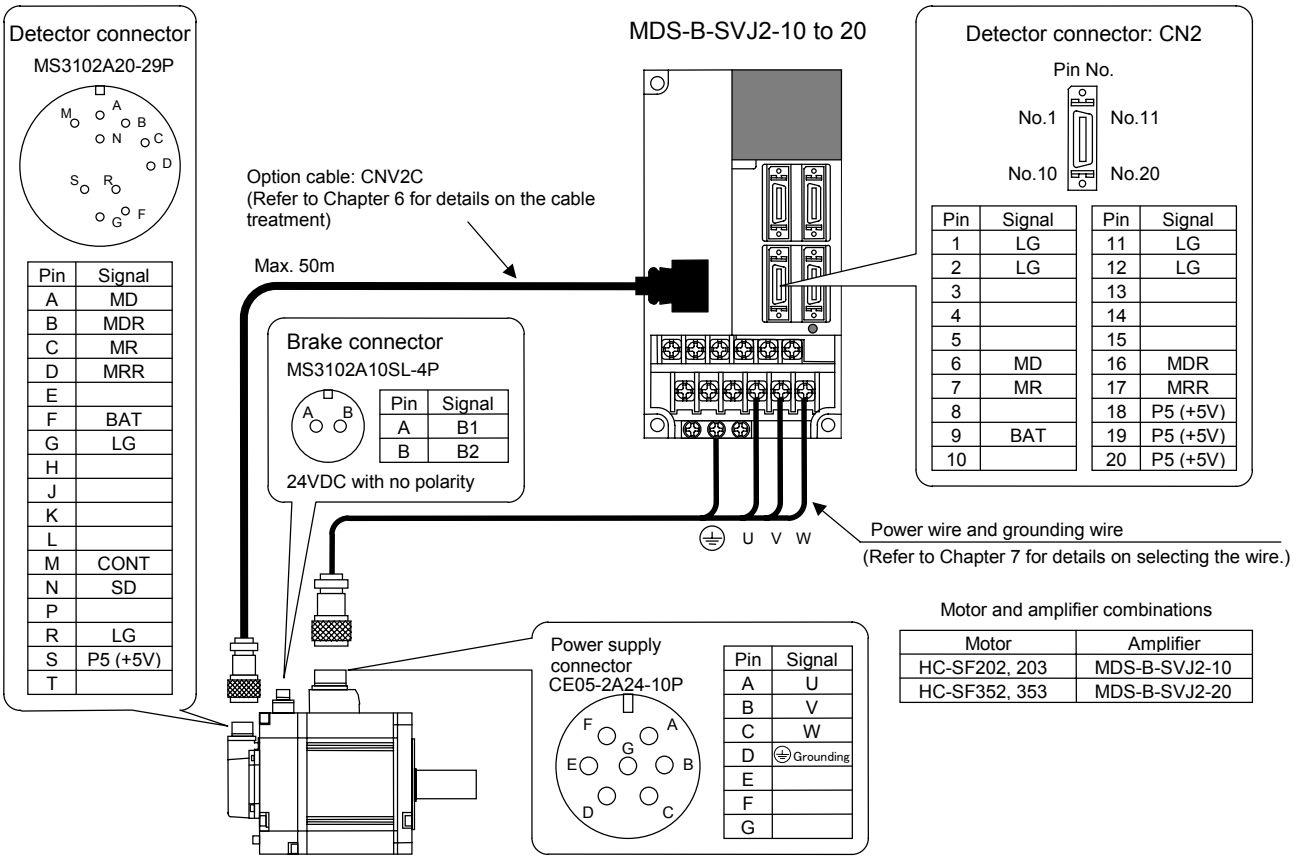


Pin	Signal
A	MD
B	MDR
C	MR
D	MRR
E	
F	BAT
G	LG
H	
J	
K	
L	
M	CONT
N	SD
P	
R	LG
S	P5 (+5V)
T	

Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

Pin	Signal
A	U
B	V
C	W
D	⏚ Grounding
E	
F	
G	B1
H	B2

2-4-12 Connection of HC-SF202, HC-SF203, HC-SF352, HC-SF353



Pin	Signal
A	MD
B	MDR
C	MR
D	MRR
E	
F	BAT
G	LG
H	
J	
K	
L	
M	CONT
N	SD
P	
R	LG
S	P5 (+5V)
T	

Pin	Signal
A	B1
B	B2

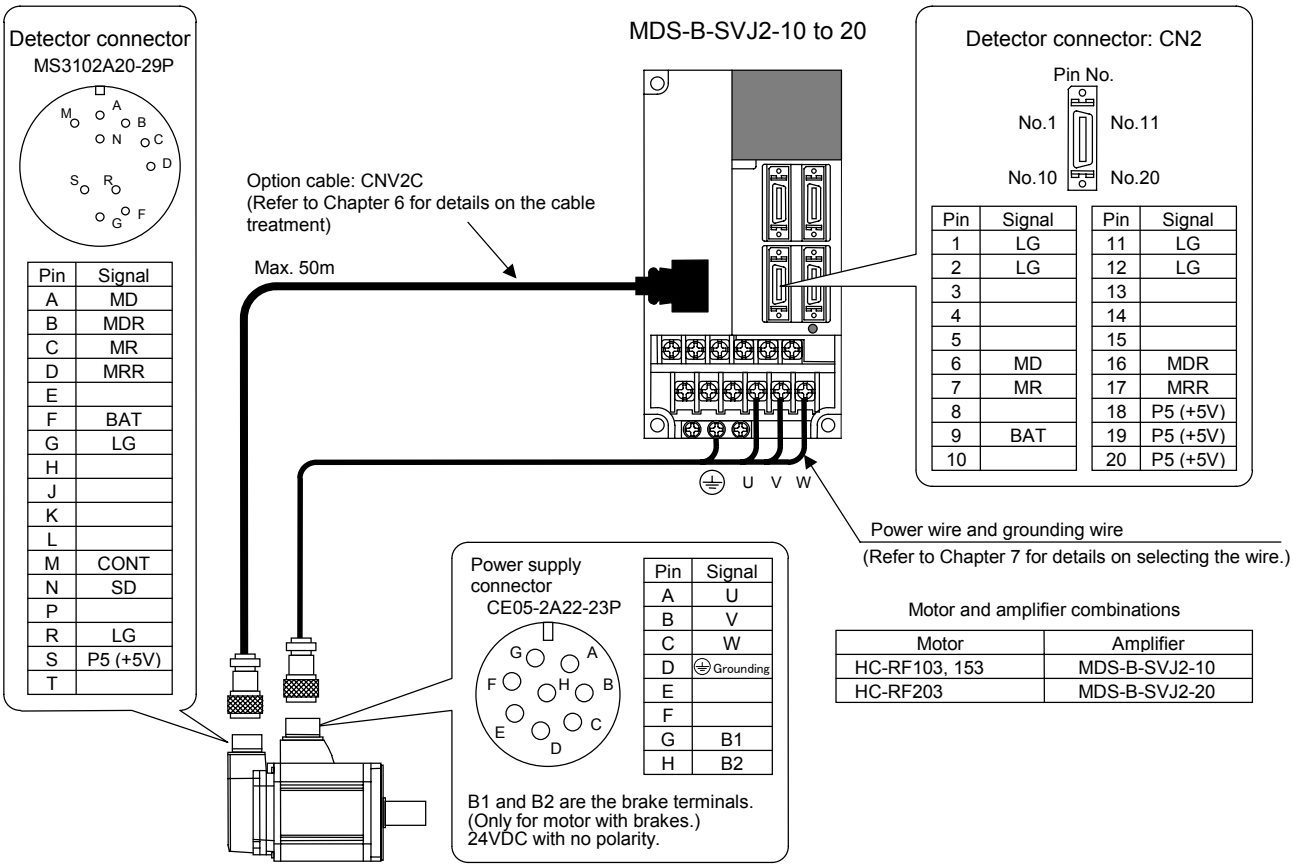
Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

Pin	Signal
A	U
B	V
C	W
D	⏚ Grounding
E	
F	
G	

Motor and amplifier combinations

Motor	Amplifier
HC-SF202, 203	MDS-B-SVJ2-10
HC-SF352, 353	MDS-B-SVJ2-20

2-4-13 Connection of HC-RF103, HC-RF153, HC-RF203



Pin	Signal
A	MD
B	MDR
C	MR
D	MRR
E	
F	BAT
G	LG
H	
J	
K	
L	
M	CONT
N	SD
P	
R	LG
S	P5 (+5V)
T	

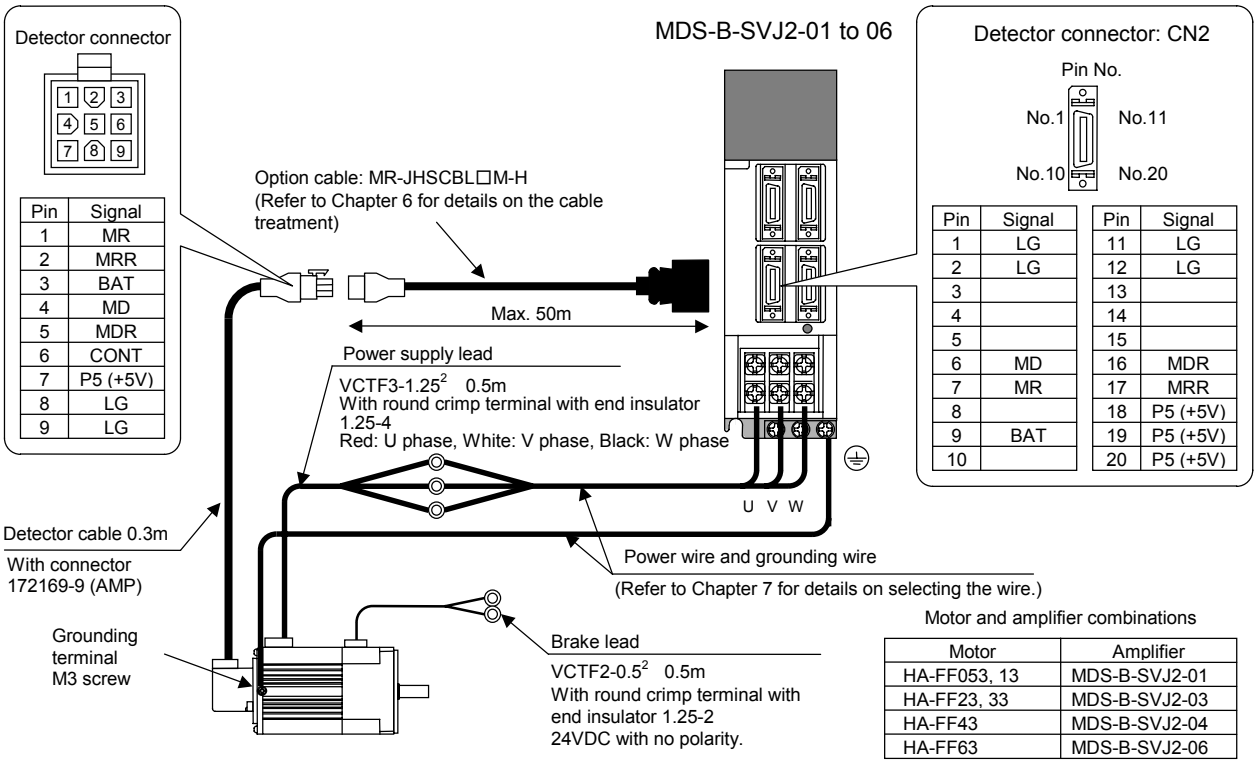
Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

Pin	Signal
A	U
B	V
C	W
D	⏚ Grounding
E	
F	
G	B1
H	B2

Motor and amplifier combinations

Motor	Amplifier
HC-RF103, 153	MDS-B-SVJ2-10
HC-RF203	MDS-B-SVJ2-20

2-4-14 Connection of HA-FF Series



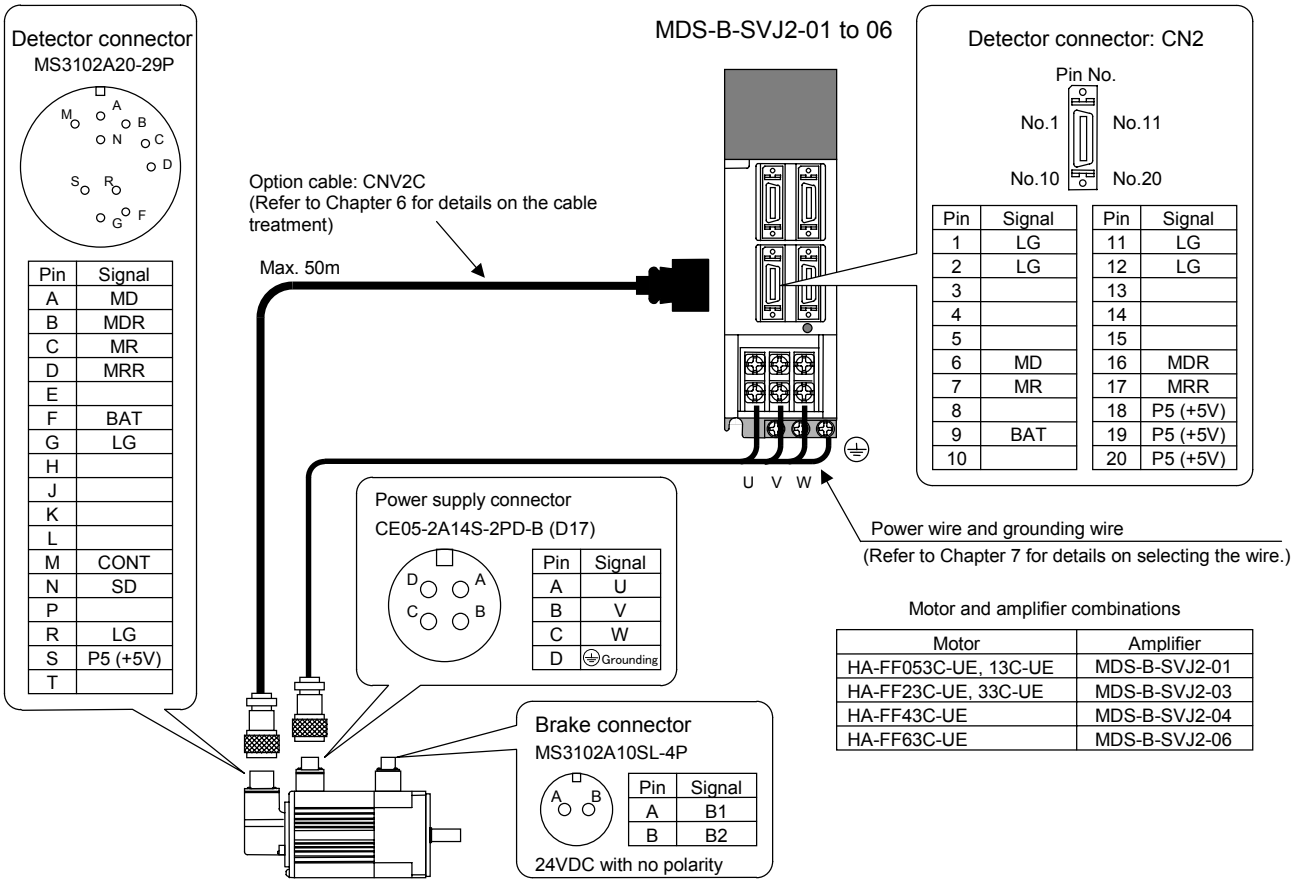
Pin	Signal
1	MR
2	MRR
3	BAT
4	MD
5	MDR
6	CONT
7	P5 (+5V)
8	LG
9	LG

Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

Motor and amplifier combinations

Motor	Amplifier
HA-FF053, 13	MDS-B-SVJ2-01
HA-FF23, 33	MDS-B-SVJ2-03
HA-FF43	MDS-B-SVJ2-04
HA-FF63	MDS-B-SVJ2-06

2-4-15 Connection of HA-FF□C-UE Series



Pin	Signal
A	MD
B	MDR
C	MR
D	MRR
E	
F	BAT
G	LG
H	
J	
K	
L	
M	CONT
N	SD
P	
R	LG
S	P5 (+5V)
T	

Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

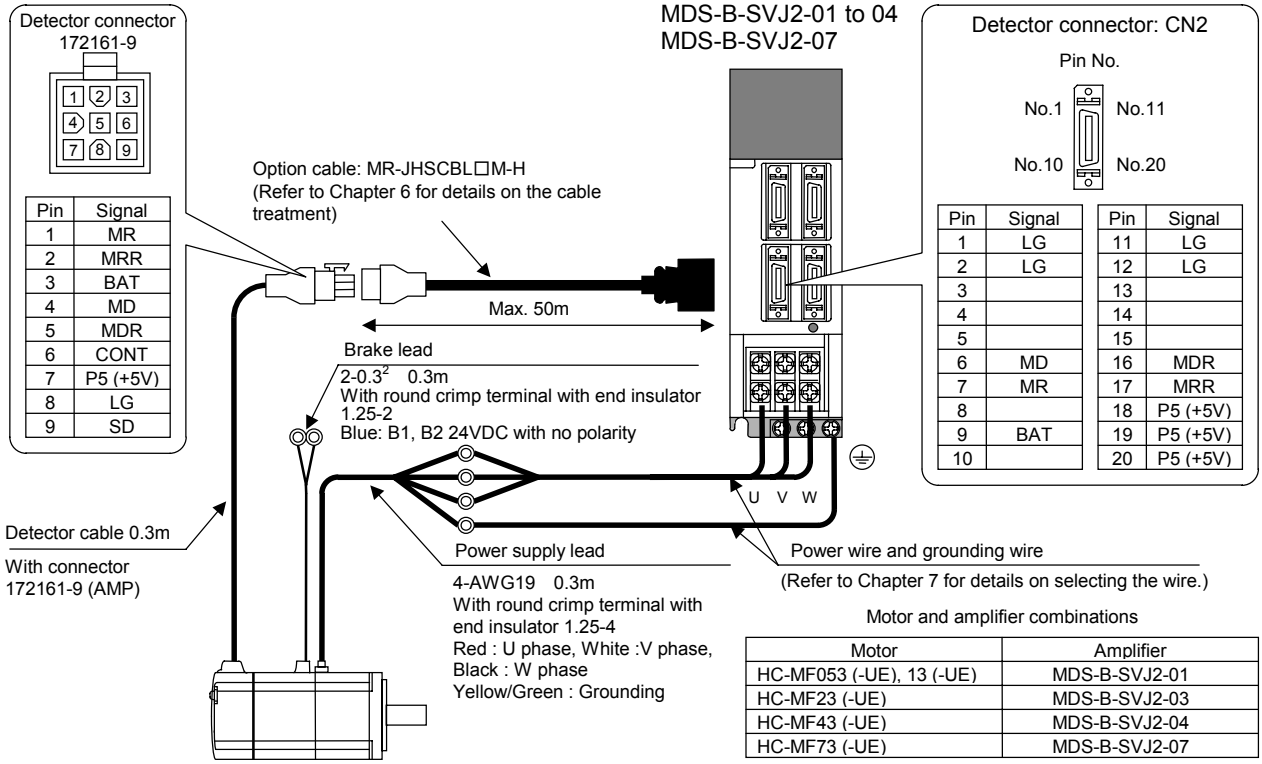
Pin	Signal
A	U
B	V
C	W
D	⏚ Grounding

Pin	Signal
A	B1
B	B2

Motor and amplifier combinations

Motor	Amplifier
HA-FF053C-UE, 13C-UE	MDS-B-SVJ2-01
HA-FF23C-UE, 33C-UE	MDS-B-SVJ2-03
HA-FF43C-UE	MDS-B-SVJ2-04
HA-FF63C-UE	MDS-B-SVJ2-06

2-4-16 Connection of HC-MF(-UE) Series



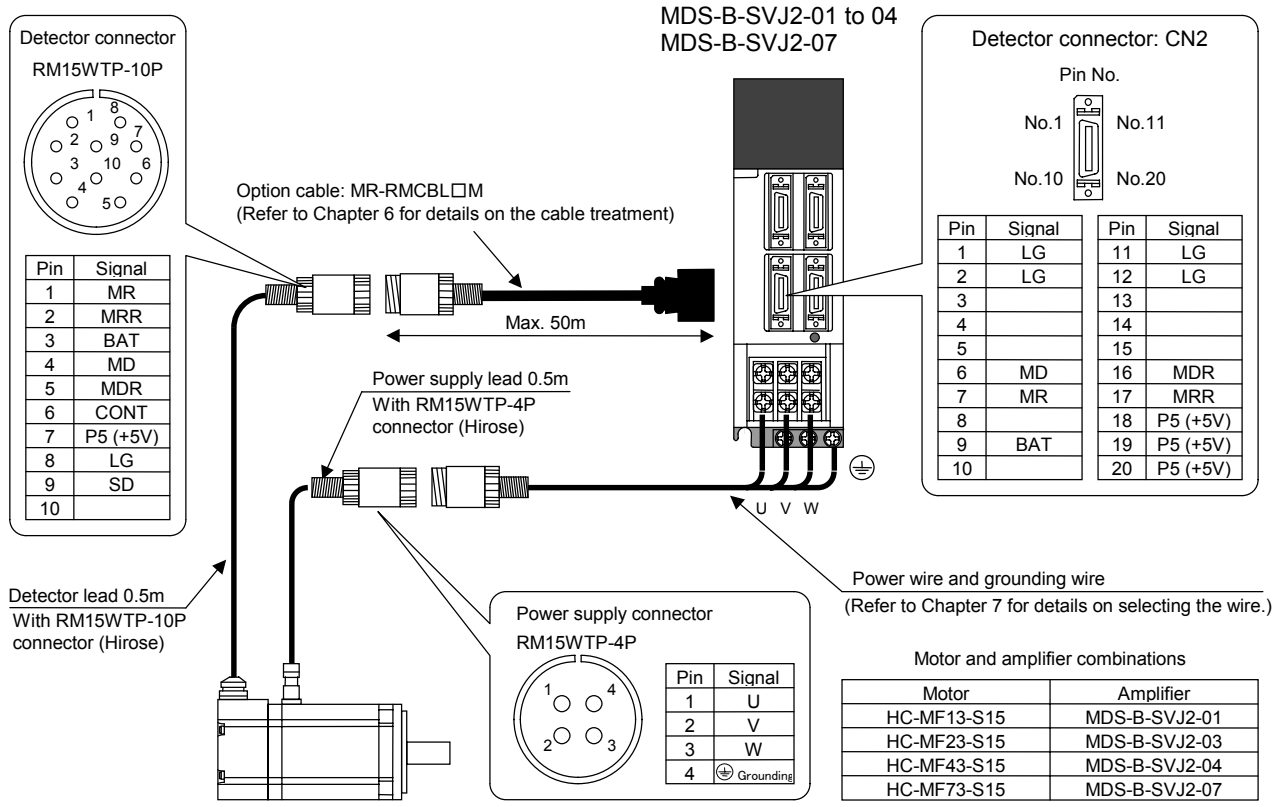
Pin	Signal
1	MR
2	MRR
3	BAT
4	MD
5	MDR
6	CONT
7	P5 (+5V)
8	LG
9	SD

Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

Motor and amplifier combinations

Motor	Amplifier
HC-MF053 (-UE), 13 (-UE)	MDS-B-SVJ2-01
HC-MF23 (-UE)	MDS-B-SVJ2-03
HC-MF43 (-UE)	MDS-B-SVJ2-04
HC-MF73 (-UE)	MDS-B-SVJ2-07

2-4-17 Connection of HC-MF□-S15 Series



Pin	Signal
1	MR
2	MRR
3	BAT
4	MD
5	MDR
6	CONT
7	P5 (+5V)
8	LG
9	SD
10	

Pin	Signal	Pin	Signal
1	LG	11	LG
2	LG	12	LG
3		13	
4		14	
5		15	
6	MD	16	MDR
7	MR	17	MRR
8		18	P5 (+5V)
9	BAT	19	P5 (+5V)
10		20	P5 (+5V)

Motor and amplifier combinations

Motor	Amplifier
HC-MF13-S15	MDS-B-SVJ2-01
HC-MF23-S15	MDS-B-SVJ2-03
HC-MF43-S15	MDS-B-SVJ2-04
HC-MF73-S15	MDS-B-SVJ2-07

Pin	Signal
1	U
2	V
3	W
4	⏚ Grounding

2-5 Connection of power supply

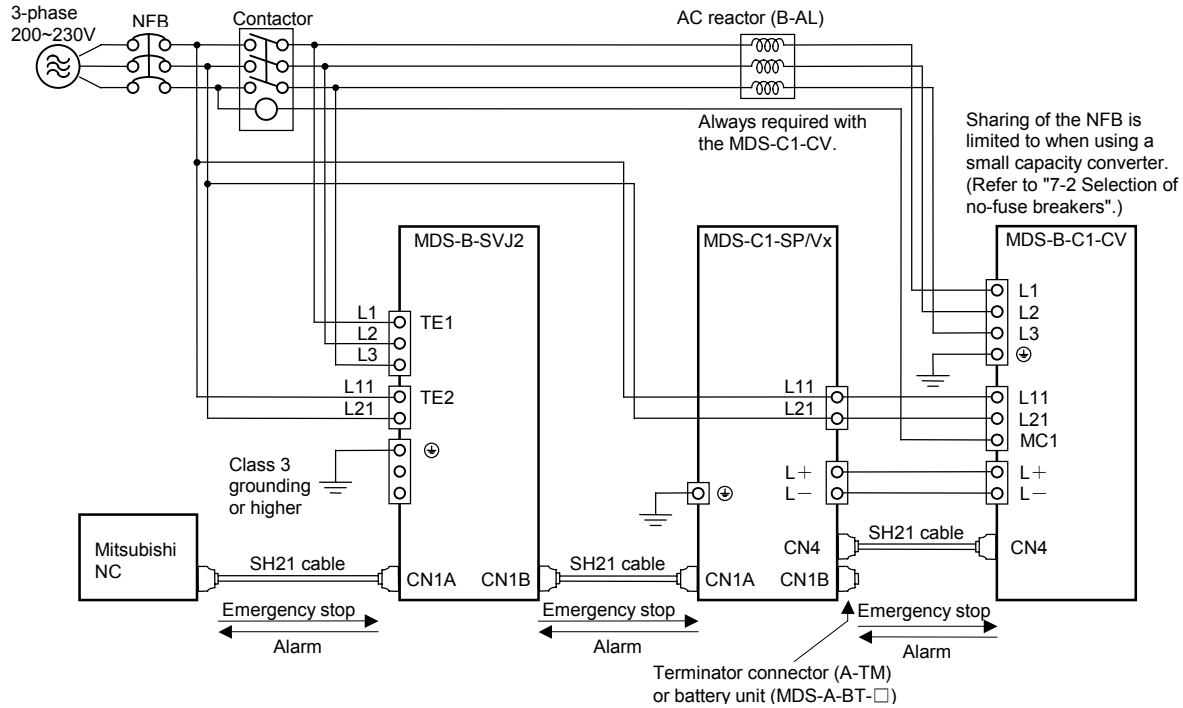
⚠ CAUTION

1. Make sure that the power supply voltage is within the specified range of the servo amplifier. Failure to observe this could lead to damage or faults.
2. For safety purposes, always install a no-fuse breaker (NFB), and make sure that the circuit is cut off when an error occurs or during inspections. Refer to Chapter 7 and select the no-fuse breaker.
3. The wire size will differ according to the amplifier capacity. Refer to Chapter 7 and select the size.
4. For safety purposes, always install a contactor (magnetic contactor) on the main circuit power supply input. Large rush currents will flow when the power is turned ON. Refer to Chapter 7 and select the correct contactor.

2-5-1 Example of connection when using converter unit

When there is a converter unit in the system, use the contactor control output (MC1) of the converter. The MDS-C1-CV can directly drive the contactor.

(1) When sharing a converter and power supply

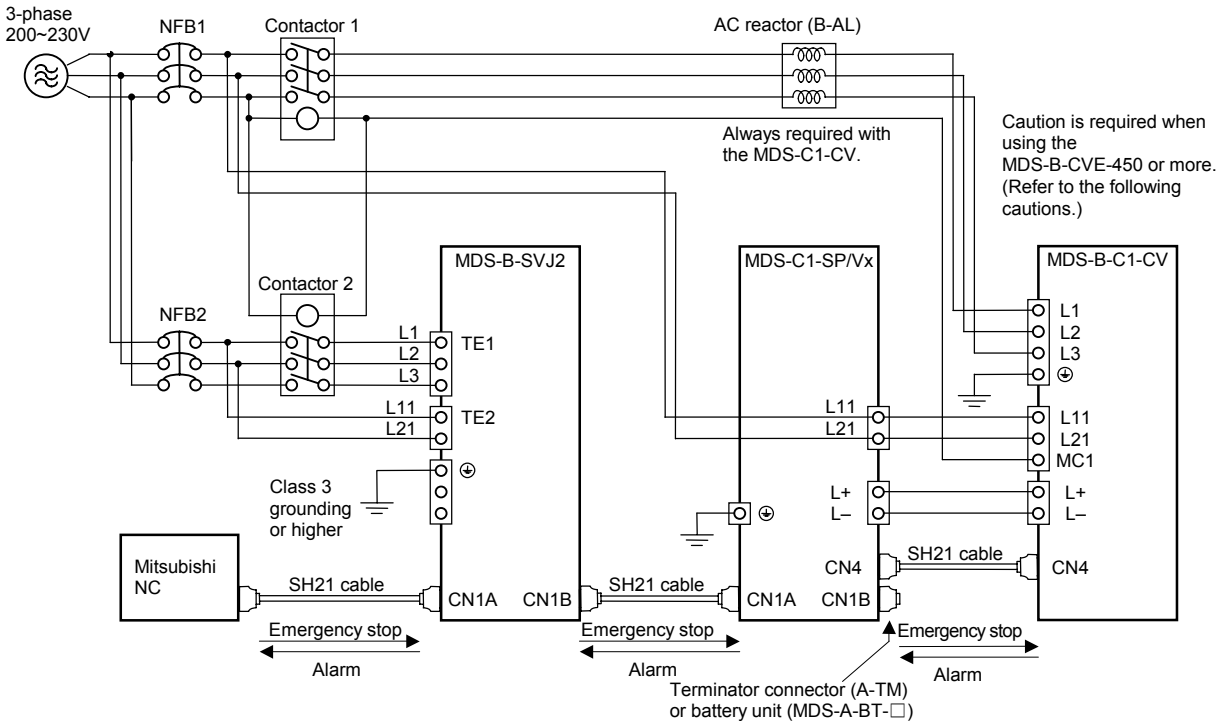


⚠ CAUTION

1. The MDS-C1-CV is a power supply regenerative type converter; an AC reactor is required in the power supply line.
   Connect the MDS-B-SVJ2 main circuit power supply on the power supply side of the AC reactor.
2. A no-fuse breaker and contactor cannot be shared when the rated current of the no-fuse breaker exceeds 60A.

(2) When not sharing a converter and power supply

If the rated current exceeds 60A by the selection of the no-fuse breaker when the converter and power supply are shared, install the no-fuse breakers and contactors separate from the converter unit.



⚠ DANGER

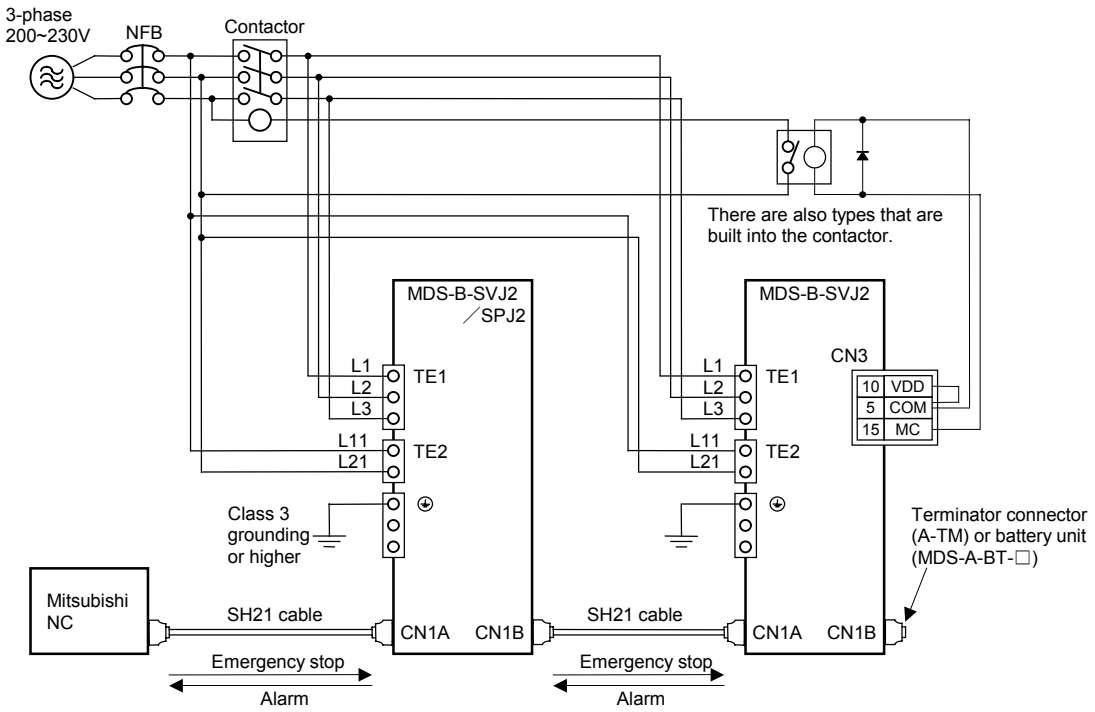
Install independent no-fuse breakers and contactors as the SVJ2 main circuit power supply if the total current capacity exceeds 60A when the converter and power supply are shared.
No-fuse breakers may not operate for short-circuits in small capacity amplifiers if they are shared with a large capacity unit, and this could cause fires. For the SVJ2, use an NF60 type or lower capacity breaker.
(Refer to section "7-2 Selection of no-fuse breakers".)

⚠ CAUTION

If the converter capacity is more than 45kW or more (MDS-B-CVE-450 or more), the MDS-B-SVJ2 contactor drive cannot be shared with the converter. Refer to "2-5-2 Example of connection when controlling the contactor with the MDS-B-SVJ2" and control contactor 2 from the MDS-B-SVJ2.

2-5-2 Example of connection when controlling the contactor with the MDS-B-SVJ2

Drive the contactor via the relay from the contactor control output (MC) of the CN3 connector. There are also some types of contactors that can be directly driven with 24VDC.



POINT The parameters must be set when controlling the contactor (CN3: drive with MC) with the MDS-B-SVJ2. (Refer to section "2-7 Wiring of contactors".)

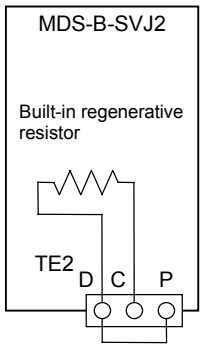
2-6 Connection of regenerative resistor

The servo amplifier has an internal regenerative resistor electronic thermal (software process), and when overheating of the regenerative resistor is detected, an over-regeneration (alarm 30) is detected. The parameters must be set correctly for the electronic thermal to operate correctly.
Refer to section "6-1-1 Combinations with servo amplifiers" for details on the combination of parameter settings, external option regenerative resistor and servo amplifier capacity.

> ⚠ **CAUTION** The parameters must be set to the regenerative resistor in use for the electronic thermal to operate correctly.

2-6-1 Connection of standard built-in regenerative resistor

The built-in regenerative resistor is connected by short-circuiting between the P and D terminals of the control circuit terminal block (TE2). (Shipment state). Confirm that a short bar has been connected between the P and D terminals.



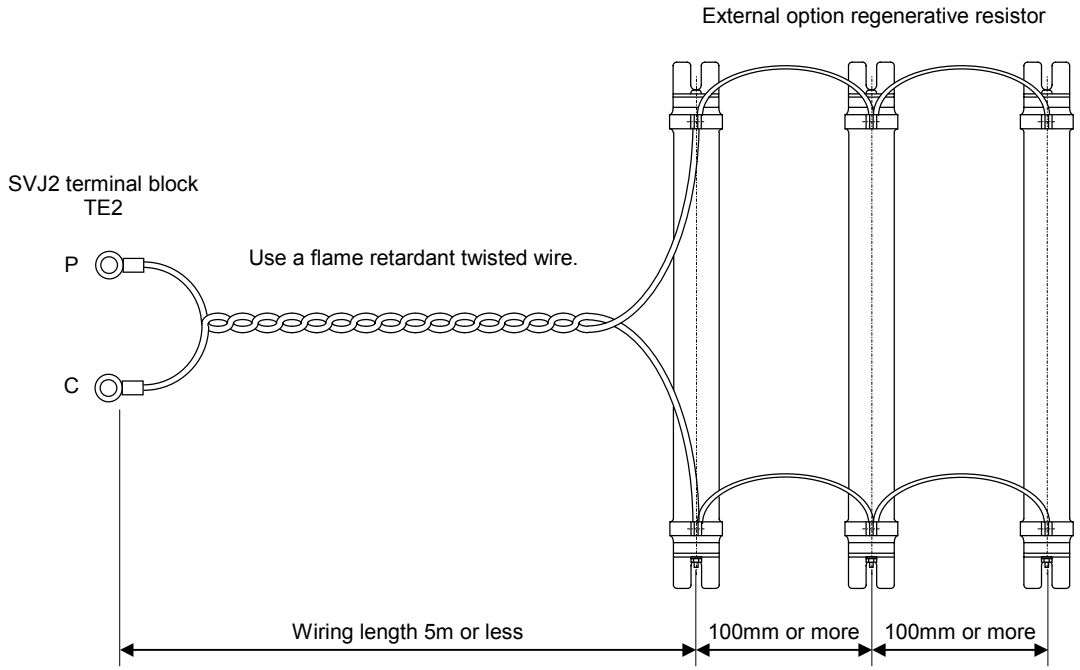
(Note) The terminal block TE2 is on the top front of the amplifier in the MDS-B-SVJ2-10 and -20.

Confirm that a short bar has been connected between the P and D terminals

> ⚠ **CAUTION** The MDS-B-SVJ2-01 does not have a built-in regenerative resistor. If the load inertia is small, there will be no problem with the capacitor regeneration (regenerative resistance is not required as the circuit is charged with the capacitor in the amplifier). However, the overvoltage alarm (ALM33) will occur if the load inertia is large. In this case, connect the external option regenerative resistor. Refer to section "11-4 Selection of regenerative resistor" for details on making a selection.

2-6-2 Connection of external option regenerative resistor

Remove the short bar connected between terminals P and D, and connect the regenerative resistor between terminals P and C.



DANGER

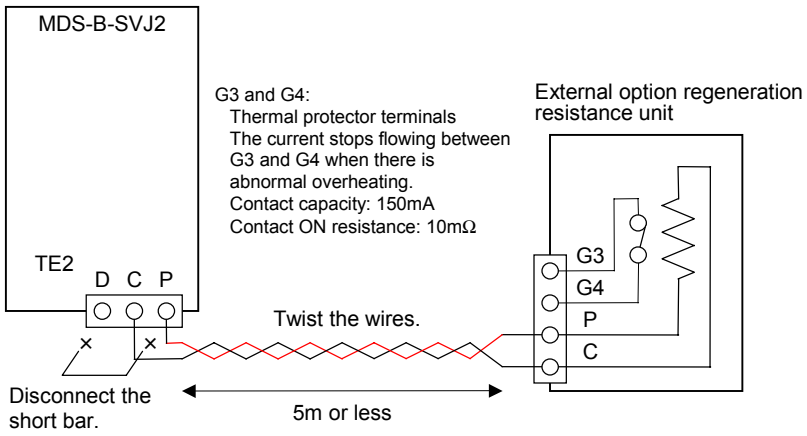
1. Always install a protective cover so that the cables, etc., do not directly contact the regenerative resistor. Select the installation place so that foreign matter (cutting chips, cutting oil, etc.) do not enter the regenerative resistor's terminal block. A short-circuit between the P and C terminals could lead to servo amplifier damage.
2. The regenerative resistor generates heat of approximately 100°C (or higher, depending on the installation conditions). Give sufficient consideration to heat dissipation and installation position.
3. Use flame retardant wire or provide flame retardant treatment for the wire connected to the regenerative resistor.

CAUTION

1. When installing on a wall, install the regenerative resistors vertically.
2. The regenerative resistor generates heat and will reach high temperatures if the regeneration frequency is high. Do not install on wall surfaces susceptible to heat.
3. When installing three resistors in a row, leave a space of 100mm or more between each unit.
4. Always use twisted pair cable to connect to the servo amplifier, and keep the length of the wiring to 5m or less. Refer to section "7-1 Selection of wire" for details on selecting the wire.

2-6-3 Connection of external option regeneration resistance unit

Disconnect the short bar connected between the P and D terminals, and connect the option regeneration resistor between the P and C terminals. The thermal protector terminals (G3, G4) are used together with the electronic thermal to provide double-protection against overheating of the regenerative resistor. Construct a sequence in which an emergency stop results when the current stops flowing between G3 and G4.



DANGER

1. Select the installation place so that foreign matter (cutting chips, cutting oil, etc.) do not enter the regenerative resistance unit's terminal block. A short-circuit between the P and C terminals could lead to servo amplifier damage.
2. The regenerative resistor generates heat of approximately 100°C (or higher, depending on the installation conditions). Give sufficient consideration to heat dissipation and installation position.
3. Use flame retardant wire or provide flame retardant treatment for the wire connected to the regenerative resistance unit.

CAUTION

Always use twisted pair cable to connect to the servo amplifier, and keep the length of the wiring to 5m or less.
Refer to section "7-1 Selection of wire" for details on selecting the wire.

2-7 Wiring of contactors

A contactor (magnetic contactor) is inserted in the main circuit power supply input (L1, L2, L3) of servo amplifier, and the power supply input is shut off when an emergency stop or servo alarm occurs.
When an emergency stop or servo alarm occurs, the servo amplifier stops the motor using deceleration control or a dynamic brake. The contactors cannot be shut off during deceleration control, because the regeneration energy (MDS-C1-CV Series) is returned to the power supply, and the power supply for deceleration must be held. Therefore, the CNC controls the contactors. The CNC confirms that all axes are stopped, or confirms the dynamic brake operation. Then it outputs a shutoff command for amplifiers that drive contactors.
If a converter unit (MDS-C1-CV/A-CR) is present when actually wiring the contactor, the drive is from the converter unit. When a converter unit is not present, the drive is from the vertical axis or the servo axis having the longest deceleration time constant. Note that the SVJ2-01 cannot control the contactors unless an option resistor is externally connected.
Give consideration to the above, and examine the contactor drive method in the following order of priority.

(Order of priority of the contactor drive method)

1. Using the contactor control output (MC1) of the converter unit.
2. Driving from the servo amplifier (MDS-B-SVJ2) of the vertical axis (unbalanced axis).
3. Driving from the servo amplifier (MDS-B-SVJ2) having the longest deceleration time constant.

⚠ CAUTION

1. The contactors cannot be driven other than from an amplifier or converter. Undervoltage (alarm) may occur if the contactors are shut off at the same time as an emergency stop occurs.
2. Do not directly shut off the contactors with an external sequence. They may shut off faster than the emergency stop input, and the input power supply may be shut off during the deceleration control or vertical axis drop prevention control. If this happens, an undervoltage alarm will occur, and deceleration control or drop hold may not be possible. When double-protecting, use an amplifier external emergency stop input. (Refer to section "2-9 Wiring of an external emergency stop")
3. When driving contactors with the MDS-B-SVJ2-01, always externally install a regenerative resistor. If there is no regenerative resistor installed, the contactor fusion alarm will be incorrectly detected.

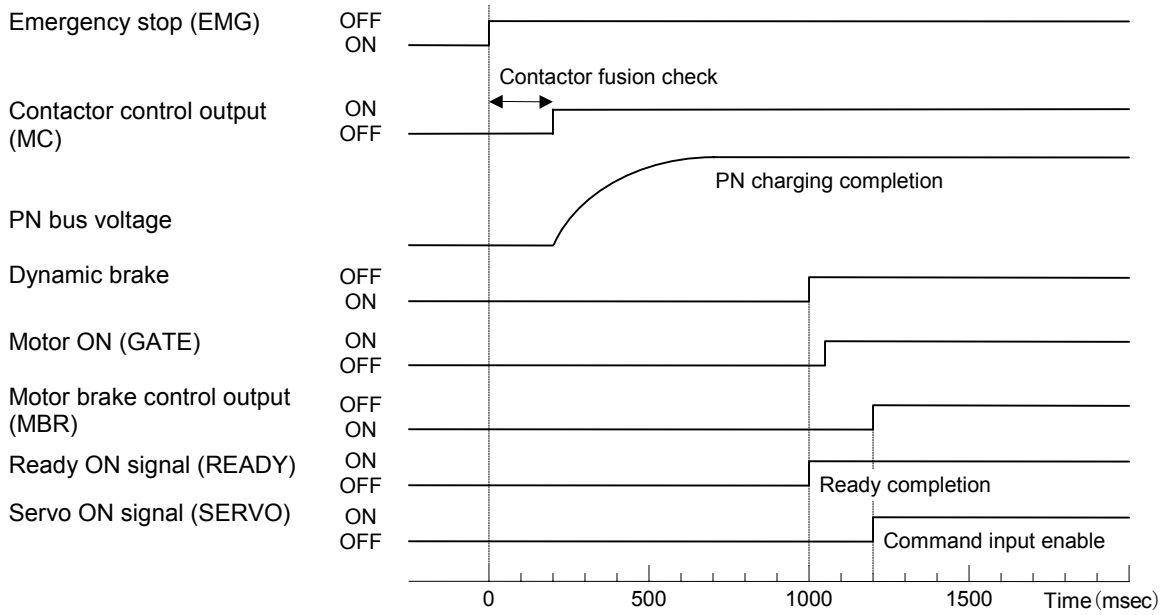
No.	Abbrevia-tion	Parameter name	Descriptions
SV017	SPEC	Servo specification selection	The following parameters must be set when controlling contactors with the MDS-B-SVJ2.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
								abs		vdir		mc			dmk

bit		Meaning when "0" is set.	Meaning when "1" is set.
3	mc	Contactor control output invalid.	Contactor control output valid.

2-7-1 Contactor power ON sequences

The main circuit power supply is turned ON in the sequences in the following drawing when the contactor control output (CN3 connector: MC) of the MDS-B-SVJ2 servo amplifier is used. In the 200msec interval after the amplifier emergency stop input is canceled, the contactor contact fusion is checked by discharging the PN bus voltage with the regenerative resistor. A contactor fusion (alarm 5F) is detected when the contactor has fusion.



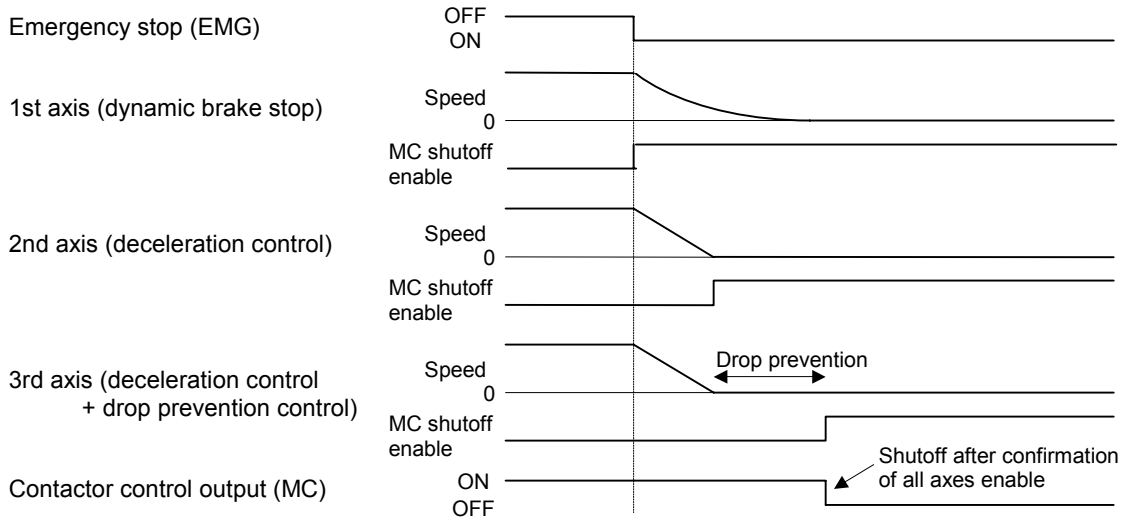
Contactor power ON sequences

POINT

1. The parameters must be set when controlling the contactor (CN3: drive with MC) with the MDS-B-SVJ2.
2. A regenerative resistor is always required to detect contactor fusion. Externally connect an option resistor when controlling contactors with the SVJ2-01.

2-7-2 Contactor shutoff sequences

When an emergency stop or servo alarm occurs, the NC confirms the MC shutoff enabled (motor stop or dynamic brake operation) for all axes, and then shuts off the contactors. When an MC shutoff enabled signal is not output, the contactors will be forcibly shut off by the controlling unit after 30 seconds.

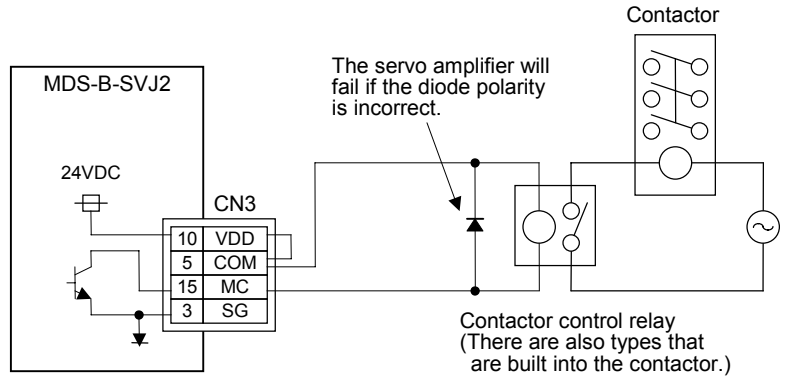


Contactor shutoff sequences

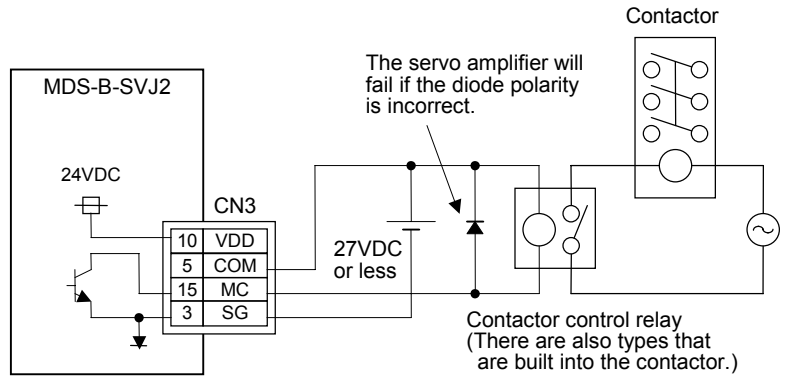
2-7-3 Contactor control signal (MC) output circuit

A relay or photo coupler can be driven. When using an inductive load, install a diode.
(Tolerable current: 40mA or less, rush current: 100mA or less)

When using an internal power supply



When using an external power supply



POINT

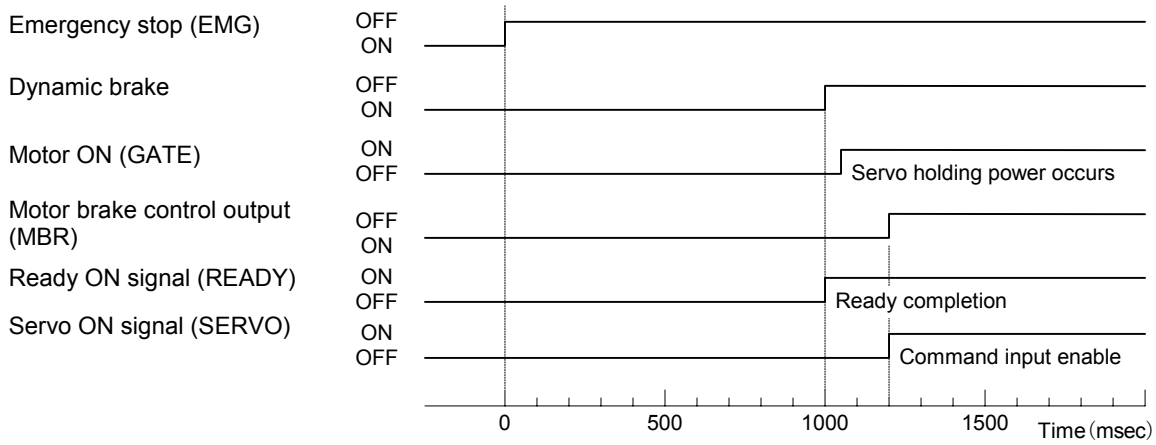
When using an internal power supply, the power supply can be directly connected to VDD if only the digital output (MC, MBR) is being used. When using the digital input (EMGX), always connect between VDD and COM.

2-8 Wiring of motor brake

The magnetic brake of servomotors with magnetic brake is driven by the control signal (MBR) output by the servo amplifier MDS-B-SVJ2. The servo amplifier releases the brake when the motor is ON. (Servo ON means when torque is generated in the motor.)
Parameter setting is not required when using motor brake control output (MBR).

2-8-1 Motor brake release sequence

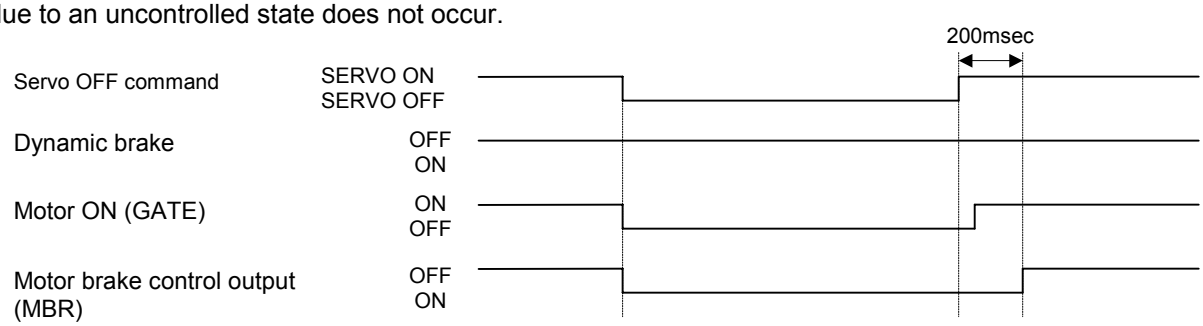
The motor brake control output (CN3 connector: MBR) releases the motor brake in the sequences in the following drawing when canceling the emergency stop. Because the brake is released after the start of the power ON to the servomotor, dropping due to an uncontrolled state does not occur.



Motor brake control output operation sequences when an emergency stop is canceled

2-8-2 Control during servo OFF commands

When a servo OFF command is input by an NC sequence input, the motor brake turns ON simultaneously when the motor ON is shut off. Note that the vertical axis drop prevention control is not validated, so a drop due to the brake operation lag occurs. When the servo OFF is canceled, a drop due to an uncontrolled state does not occur.



Motor brake control output operation sequences when a servo OFF command is canceled

> **⚠ CAUTION** The vertical axis drop prevention control only operates during an emergency stop (including alarms and power failures). It does not operate when a servo OFF command is input.

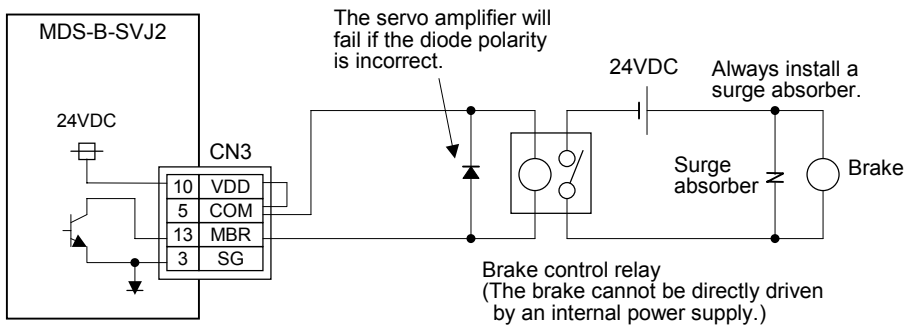
2-8-3 Operation sequences when an emergency stop occurs

The motor brake control output operation when an emergency stop occurs differs according to the motor deceleration stop method. Refer to section "5-4 Setting for emergency stop" for details on the operation sequences for each stop method.

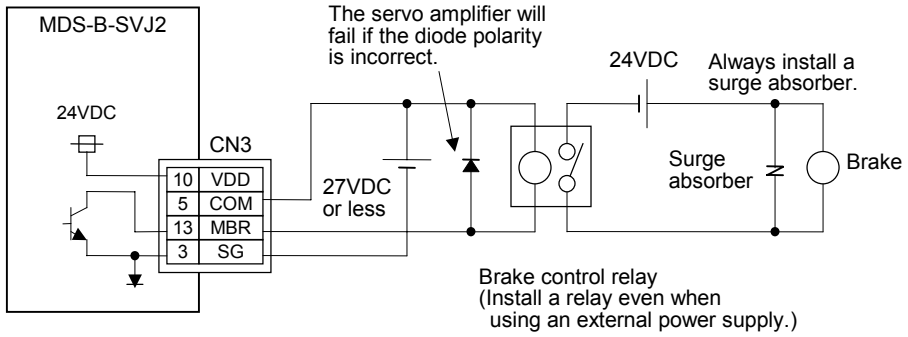
2-8-4 Motor brake control signal (MBR) output circuit

The motor brake power supply is controlled via a relay. When using an inductive load, install a diode. (Tolerable current: 40mA or less, rush current: 100mA or less)

When using an internal power supply



When using an external power supply



POINT

When using an internal power supply, the power supply can be directly connected to VDD if only the digital output (MC, MBR) is being used. When using the digital input (EMGX), always connect between VDD and COM.

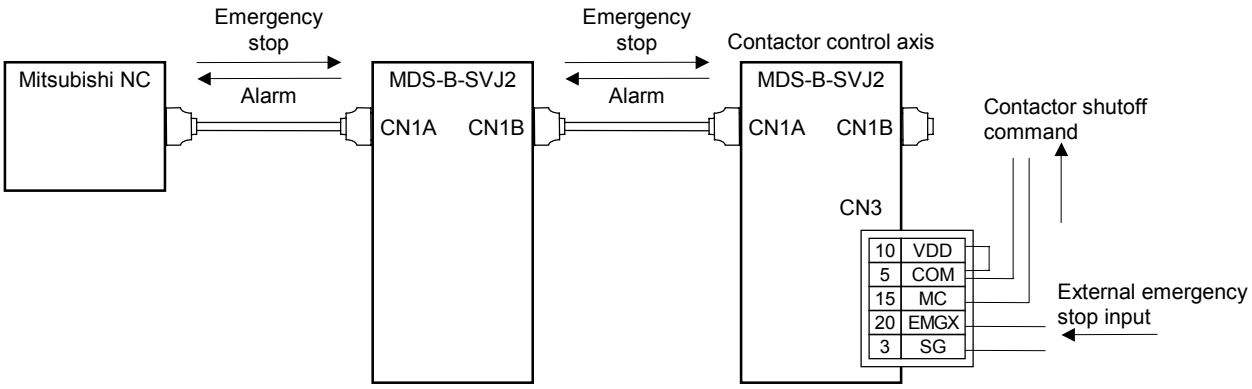
⚠ CAUTION

1. Always install a surge absorber near the motor's brake terminal to eliminate noise and protect the contacts. Refer to section "7-4-2 Surge absorber".
2. The magnetic brakes cannot be directly driven with the output signal from the servo amplifier. Always install a relay.
3. The magnetic brakes cannot be driven by the servo amplifier's VDD (24VDC). Always install a separate power supply.

2-9 Wiring of external emergency stop

2-9-1 External emergency stop setting

Besides the main emergency stop input from the CNC bus line (CN1A, CN1B), double-protection when an emergency stop occurs is possible by directly inputting an independent external emergency stop to the servo amplifier. Even if the main emergency stop is not input for some reason, the contactors will be shut off within 30 seconds after the external emergency stop is input.



No.	Abbreviation	Parameter name	Descriptions
SV036	PTYP	Regenerative resistor type	Set the external emergency stop in the following parameters.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
amp				rtyp				emgx							

bit		Descriptions
4	emgx	Set the external emergency stop function. (Setting is prohibited for values with no description.)
5		0 External emergency stop invalid
6		4 External emergency stop valid
7		

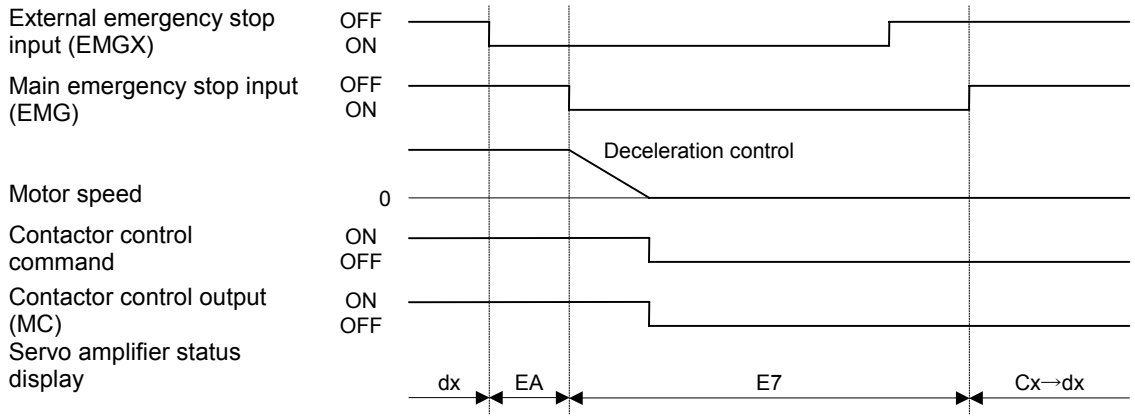
⚠ CAUTION Always input the external emergency stop to the servo amplifier controlling the contactors.

POINT

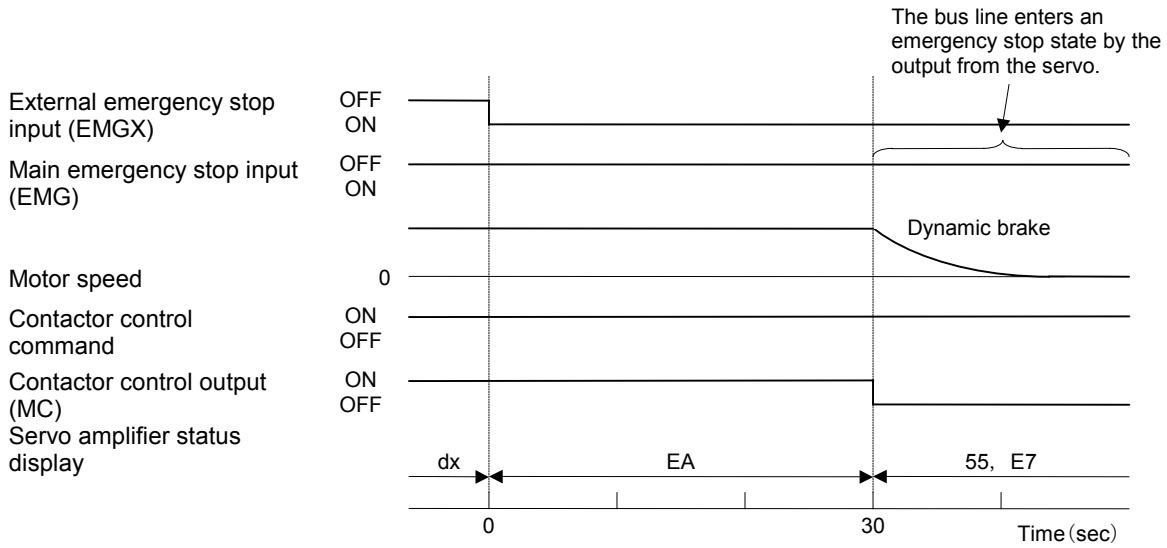
1. When the SVJ2 controls the contactor, the external emergency stop input is validated for the axis receiving the main circuit power supply from that contactor. When the converter controls the contactor, use the external emergency stop input of the converter.
2. So that the external emergency stop input will be an auxiliary input as much as possible, always input the main emergency stop (NC bus line). An external emergency stop error (alarm 55) will occur if only an external emergency stop is input.

2-9-2 External emergency stop operation sequences

If only an external emergency stop is input when external emergency stop valid is set in the parameters (the main emergency stop is not input), an "In external emergency stop" (warning EA) will be detected. At this time, the system itself does not enter an emergency stop status. (There will be no deceleration control or dynamic brake stop).
If a contactor shutoff command is not issued from the CNC within 30 seconds after the external emergency stop is input, the SVJ2 itself shuts off the contactors, and an external emergency stop error (alarm 55) is detected. If the main emergency stop is input within 30 seconds, the warning EA replaces the "In CNC emergency stop" (warning E7). A normal emergency stop status (warning E7) will result if contactor shutoff commands from the CNC are further input.
Ready ON is possible even if an external emergency stop has been input when the emergency stop is canceled, but an external emergency stop error (alarm 55) will occur after 30 seconds.



External emergency stop input sequences

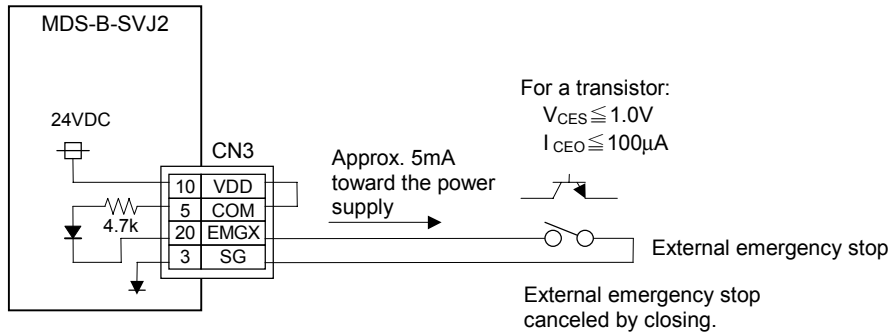


When neither a main emergency stop nor contactor shutoff command is input

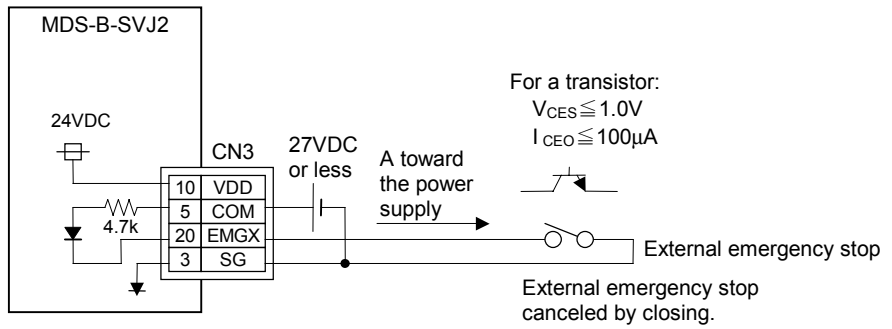
2-9-3 External emergency stop signal (EMGX) input circuit

Issue a signal with a relay or open collector transistor. When using an external power supply, the power supply for the contactor control output and motor brake control output is the same external power supply.

When using an internal power supply



When using an external power supply



Chapter 3 Installation

⚠ CAUTION

1. Install the unit on noncombustible material. Direct installation on combustible material or near combustible materials could lead to fires.
2. Follow this Instruction Manual and install the unit in a place where the weight can be borne.
3. Do not get on top of or place heavy objects on the unit.
   Failure to observe this could lead to injuries.
4. Always use the unit within the designated environment conditions.
5. Do not let conductive objects such as screws or metal chips, etc., or combustible materials such as oil enter the servo amplifier or servomotor.
6. Do not block the servo amplifier intake and outtake ports. Doing so could lead to failure.
7. The servo amplifier and servomotor are precision devices, so do not drop them or apply strong impacts to them.
8. Do not install or run a servo amplifier or servomotor that is damaged or missing parts.
9. When storing for a long time, please contact your dealer.

3-1 Installation of servo amplifier

⚠ CAUTION

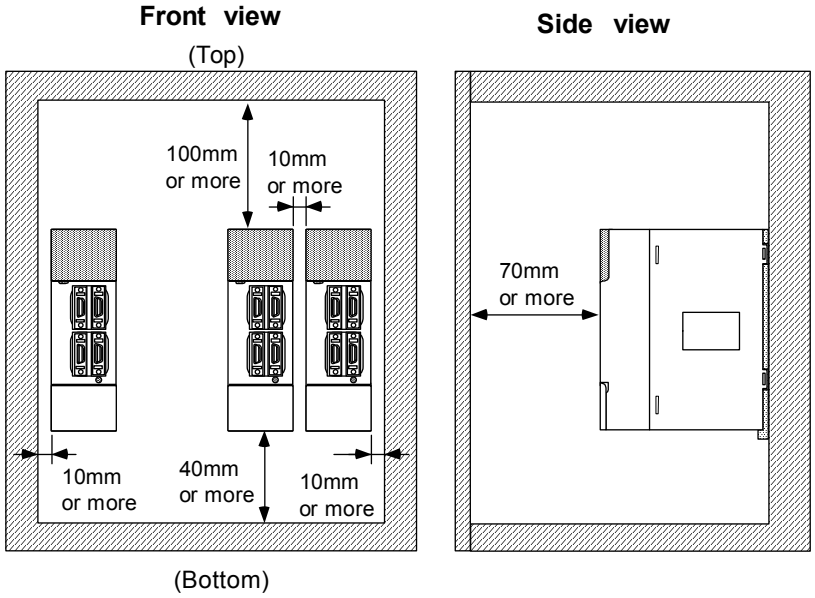
1. Always observe the installation directions. Failure to observe this could lead to faults.
2. Secure the specified distance between the servo amplifier and control panel, or between the servo amplifier and other devices. Failure to observe this could lead to faults.

3-1-1 Environmental conditions

Environment	Conditions
Ambient temperature	0°C to +55°C (with no freezing)
Ambient humidity	90% RH or less (with no dew condensation)
Storage temperature	–20°C to +65°C (with no freezing)
Storage humidity	90% RH or less (with no dew condensation)
Atmosphere	Indoors (Where unit is not subject to direct sunlight) Must be no conductive fine particles, corrosive gas, flammable gas, oil mist or dust.
Altitude	1000m or less above sea level
Vibration	5.9m/sec^2 (0.6G) or less

3-1-2 Installation direction and clearance

Install the servo amplifier so that the front side is visible. Refer to the following drawings for the heat dissipation and wiring of each unit, and secure sufficient space for ventilation.

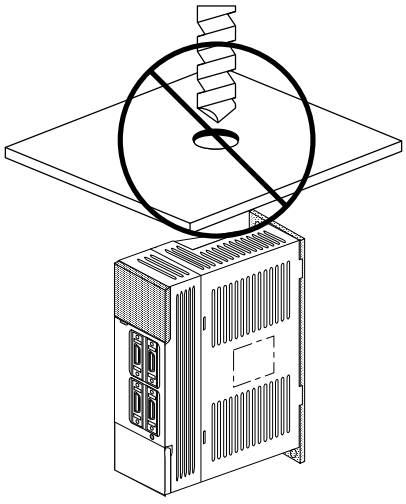


> **⚠ CAUTION**
>
> The ambient temperature condition for the servo amplifier is 55°C or less. Because heat can easily accumulate in the upper portion of the amplifier, give sufficient consideration to heat dissipation when designing the power distribution panel. If required, install a fan in the power distribution panel to agitate the heat in the upper portion of the amplifier.

3-1-3 Prevention of entering of foreign matter

Treat the cabinet with the following items.

- Make sure that the cable inlet is dust and oil proof by using packing, etc.
- Make sure that the external air does not enter inside by using head radiating holes, etc.
- Close all clearances.
- Securely install door packing.
- If there is a rear cover, always apply packing.
- Oil will tend to accumulate on the top. Take special measures such as oil-proofing the top so that oil does not enter the cabinet from the screw holds.
- After installing each unit, avoid machining in the periphery. If cutting chips, etc., stick onto the electronic parts, trouble may occur.



3-2 Installation of servomotor

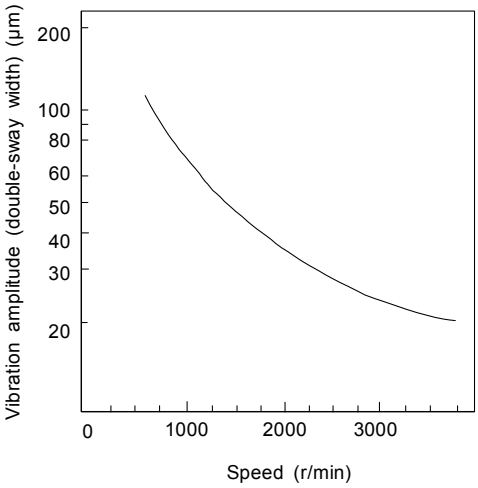
⚠ CAUTION

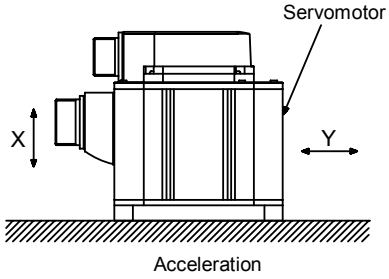
1. Do not hold the cables, axis or detector when transporting the servomotor. Failure to observe this could lead to faults or injuries.
2. Securely fix the servomotor to the machine. Insufficient fixing could lead to the servomotor deviating during operation. Failure to observe this could lead to injuries.
3. When coupling to a servomotor shaft end, do not apply an impact by hammering, etc. The detector could be damaged.
4. Never touch the rotary sections of the servomotor during operations. Install a cover, etc., on the shaft.
5. Do not apply a load exceeding the tolerable load onto the servomotor shaft. The shaft could break.
6. Do not connect or disconnect any of the connectors while the power is ON.
7. Use the suspender bolts of the servomotor only when transporting the servomotor. Do not use those bolts for transportation with the servomotor installed on a machine.

3-2-1 Environmental conditions

Environment	Conditions	
Ambient temperature	0°C to +40°C (with no freezing)	
Ambient humidity	80% RH or less (with no dew condensation)	
Storage temperature	–15°C to +70°C (with no freezing)	
Storage humidity	90% RH or less (with no dew condensation)	
Atmosphere	• Indoors (Where unit is not subject to direct sunlight) • Must be no conductive fine particles, corrosive gas, flammable gas, oil mist or dust.	
Altitude	1000m or less above sea level	
Vibration	HC□ (1.5kW) or less HA□N (1.0kW) or less HC□R, HC-RF HC-SF (1.5kW) or less	X: 9.8 m/sec^2 (1G) Y: 24.5m/sec^2 (2.5G) or less
	HC□ (2.0kW) or over HA□N (2.0kW) or over HC-SF (2.0kW) or over	X: 19.6 m/sec^2 (2G) Y: 49 m/sec^2 (5G) or less
	HA-FF, HC-MF	X: 19.6 m/sec^2 (2G) Y: 19.6 m/sec^2 (2G) or less

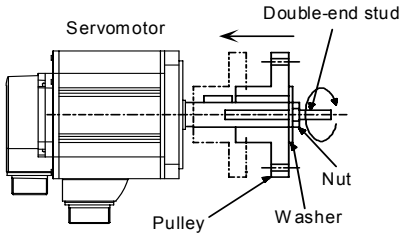
The vibration conditions are as shown below.



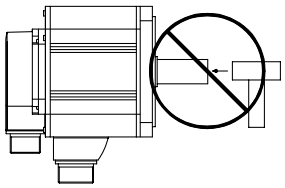


3-2-2 Cautions for mounting load (prevention of impact on shaft)

① When using the servomotor with key way, use the screw hole at the end of the shaft to mount the pulley onto the shaft. To install, first place the double-end stud into the shaft screw holes, contact the coupling end surface against the washer, and press in as if tightening with a nut. When the shaft does not have a key way, use a frictional coupling, etc.
② When removing the pulley, use a pulley remover, and make sure not to apply an impact on the shaft.
③ Install a protective cover on the rotary sections such as the pulley installed on the shaft to ensure safety.
④ The direction of the detector installation on the servomotor cannot be changed.

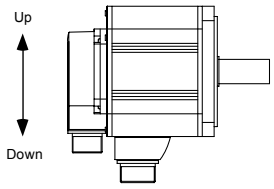


⚠ CAUTION Never hammer the end of the shaft during assembly.



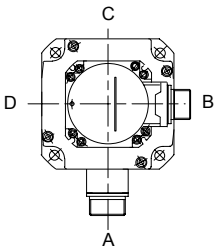
3-2-3 Installation direction

① There are no restrictions on the installation direction. Installation in any direction is possible, but as a standard the servomotor is installed so that the motor power supply wire and detector cable cannon plugs (lead-in wires) face downward. Installation in the standard direction is effective against dripping. Measure against oil and water must be taken when not installing in the standard direction. When the servomotor is not installed in the standard direction, refer to section "3-2-5 Oil and waterproofing measures" and take the appropriate measures.
The brake plates may make a sliding sound when a servomotor with magnetic brake is installed with the shaft facing upward, but this is not a fault.



Standard installation direction

② In a situation where the detector cannon plug cannot be wired in the same direction as the power supply wire, the motor is prepared so that the detector installation direction can be changed in 90° increments, as shown in the drawing at the right. (Special correspondence) Designate the motor direction when ordering. (Note that HC-SF, HC-RF, HA-FF, HC-MF Series motors are not compatible.)
For HA053N to 33N motors, the parameters must be set when the detector is installed in the direction B or D. (Refer to the following table.)



No.	Abbreviation	Parameter name	Descriptions
SV017	SPEC	Servo specification selection	Set the following parameters when the HA053 to 33N motor detector is installed in the direction B or D.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
								abs		vdir		mc			dmk

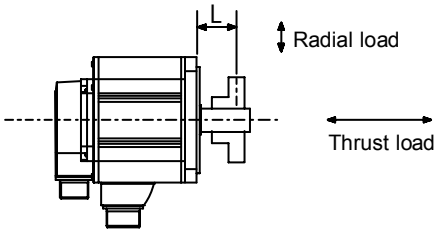
bit		Meaning when "0" is set.	Meaning when "1" is set.
5	vdir	HA053N to HA33N motor detector standard installation position (A, C)	HA053N to HA33N motor detector 90° installation position (B, D)

3-2-4 Tolerable load of axis

There is a limit to the load that can be applied on the motor shaft. Make sure that the load applied on the radial direction and thrust direction, when mounted on the machine, is below the tolerable values given below. These loads also affect the motor output torque, so consider them when designing the machine.

Servomotor	Tolerable radial load	Tolerable thrust load
HC52T, 53T, 102T, 103T, 152T, 153T (Taper shaft)	392N (L=58)	490N
HC52S, 53S, 102S, 103S, 152S, 153S (Straight shaft)	980N (L=55)	490N
HC202S, 203S, 352S	2058N (L=79)	980N
HC103RT, 153RT, 203RT (Taper shaft)	392N (L=58)	196N
HC103RS, 153RS, 203RS (Straight shaft)	686N (L=45)	196N
HA053N, 13N	72N (L=26)	49N
HA23N, 33N	196N (L=30)	147N
HA40NT, 43NT, 80NT, 83NT (Taper shaft)	392N (L=58)	490N
HA40NS, 43NS, 80NS, 83NS (Straight shaft)	980N (L=55)	490N
HA100NS, 103NS, 200NS	2058N (L=79)	980N
HC-SF52T, 53T, 102T, 103T, 152T, 153T (Taper shaft)	392N (L=58)	490N
HC-SF52, 53, 102, 103, 152, 153 (Straight shaft)	980N (L=55)	490N
HC-SF202, 203, 352, 353	2058N (L=79)	980N
HC-RF103T, 153T, 203T (Taper shaft)	392N (L=58)	196N
HC-RF103, 153, 203 (Straight shaft)	686N (L=45)	196N
HA-FF053	108N (L=30)	98N
HA-FF13	118N (L=30)	98N
HA-FF23, 33	176N (L=30)	147N
HA-FF43, 63	323N (L=40)	284N
HC-MF053, 13	88N (L=25)	59N
HC-MF23, 43	245N (L=30)	98N
HC-MF73	392N (L=40)	147N

Caution: The symbols in the table follow the drawing below.



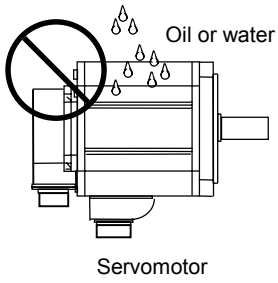
L : Length from flange installation surface to center of load weight [mm]

⚠ CAUTION

1. Use a flexible coupling when connecting with a ball screw, etc., and keep the shaft core deviation to below the tolerable radial load of the shaft.
2. When directly installing the gears on the motor shaft, the radial load increases as the diameter of the gear decreases. This should be carefully considered when designing the machine.
3. When directly installing the pulley on the motor shaft, carefully consider so that the radial load (double the tension) generated from the timing belt tension is less than the values shown in the table above.
4. In machines where thrust loads such as a worm gear are applied, carefully consider providing separate bearings, etc., on the machine side so that loads exceeding the tolerable thrust loads are not applied to the motor.
5. Do not use a rigid coupling as an excessive bending load will be applied on the shaft and could cause the shaft to break.

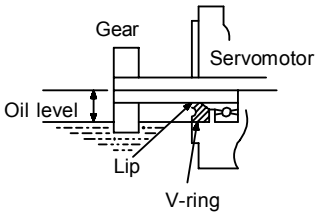
3-2-5 Oil and waterproofing measures

① A format based on IEC Standards (IP types) is displayed as the servomotor protective format (refer to "10-2-1 List of Specifications."). However, these Standards are short-term performance specifications. They do not guarantee continuous environmental protection characteristics. Measures such as covers, etc., must be provided if there is any possibility that oil or water will fall on the motor, or the motor will be constantly wet and permeated by water. Note that IP-type motors are not indicated as corrosion-resistant.

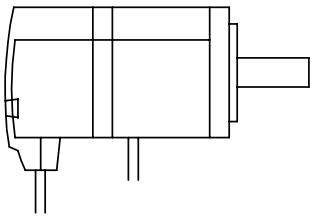


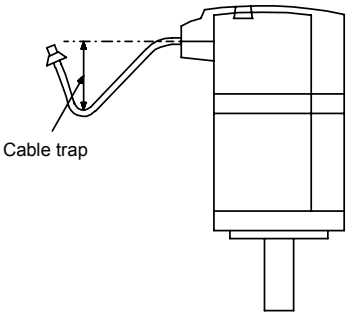
② When a gear box is installed on the servomotor, make sure that the oil level height from the center of the shaft is higher than the values given below. Open a breathing hole on the gear box so that the inner pressure does not rise. An oil seal is provided only on the HA-FF□C-UE and HC-MF□-S15 of the HA-FF and HC-MF Series.

Servomotor	Oil level (mm)
HC52, 102, 152, 53, 103, 153	20
HC202, 203, 352	25
HC103R, 153R, 203R	20
HA053N, 13N	8
HA23N, 33N	10
HA40N, 43N, 80N, 83N	20
HA100N, 103N, 200N	25
HC-SF52, 102, 152, 53, 103, 153	20
HC-SF202, 203, 352, 353	25
HC-RF103, 153, 203	20
HA-FF053C-UE, 13C-UE	8
HA-FF23C-UE, 33C-UE	12
HA-FF43C-UE, 63C-UE	14
HC-MF13-S15	10
HC-MF23-S15, 43-S15	15
HC-MF73-S15	20



③ When installing the servomotor horizontally, set the power cable and detector cable to face downward. When installing vertically or on an inclination, provide a cable trap.

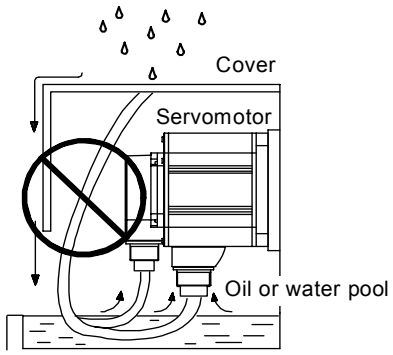




⚠ CAUTION

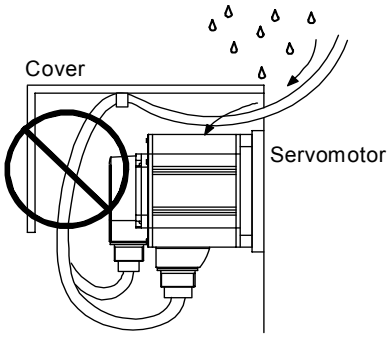
1. The servomotors, including those having IP65, IP67 specifications, do not have a completely waterproof (oil-proof) structure. Do not allow oil or water to constantly contact the motor, enter the motor, or accumulate on the motor. Oil can also enter the motor through cutting chip accumulation, so be careful of this also.
2. When the motor is installed facing upwards, take measures on the machine side so that gear oil, etc., does not flow onto the motor shaft.
3. The standard HC-MF Series and HA-FF Series servomotors do not have an oil seal. Provide a seal on the gear box side so that lubricating oil, etc., does not enter the servomotor.
4. Do not remove the detector from the motor. (The detector installation screw is treated for sealing.)

④ Do not use the unit with the cable submerged in oil or water. (Refer to right drawing.)



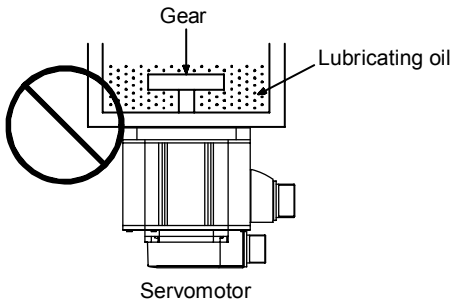
<Fault> Capillary tube phenomenon

⑤ Make sure that oil and water do not flow along the cable into the motor or detector. (Refer to right drawing.)



<Fault> Respiration

⑥ When installing on the top of the shaft end, make sure that oil from the gear box, etc., does not enter the servomotor. The servomotor does not have a waterproof structure.

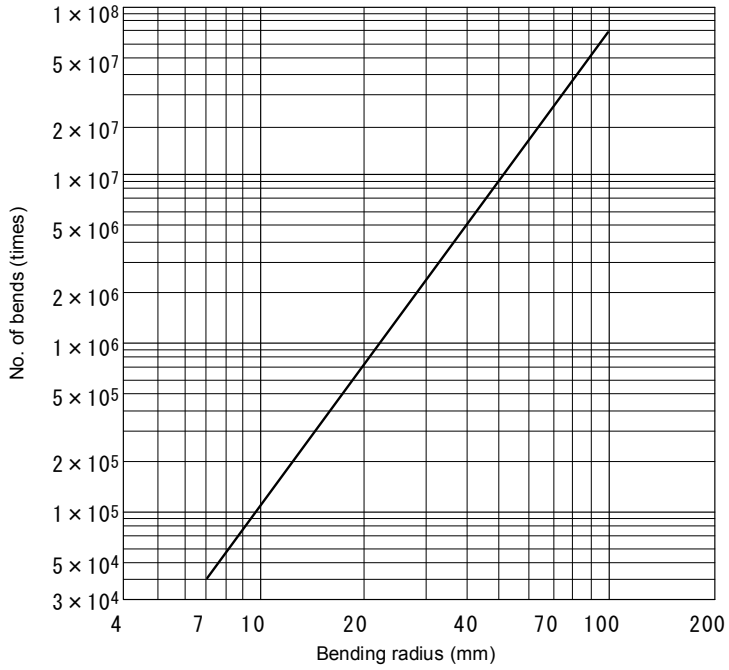


3-2-6 Cable stress

⚠ CAUTION

1. Sufficiently consider the cable clamping method so that bending stress and the stress from the cable's own weight is not applied on the cable connection. Failure to observe this could lead to damage of the cable sheath and electric shocks.
2. Make sure that the cable sheathes will not be cut by sharp cutting chips, worn by contacting the machine corners, or stepped on by workers or vehicles. Failure to observe this could lead to damage of the cable sheath and electric shocks.
3. In applications where the servomotor moves, make sure that excessive stress is not applied on the cable.
   If the detector cable and servomotor wiring are stored in a cable bear and the servomotor moves, make sure that the cable bending section is within the range of the optional detector cable.
   Fix the detector cable and power cable enclosed with the servomotor.

The bending life of the detector cable is as shown below. Regard this with a slight allowance. If the servomotor is installed on a machine that moves, make the bending radius as large as possible.



Detector cable bending life
(The optional detector cable and wire of our company: A14B2343)

Note: The values in this graph are calculated values and are not guaranteed.

3-3 Noise measures

Noise includes that which enters the servo amplifier from an external source and causes the servo amplifier to malfunction, and that which is radiated from the servo amplifier or motor and causes the peripheral devices or amplifier itself to malfunction. The servo amplifier output is a source of noise as the DC voltage is switched at a high frequency. If the peripheral devices or amplifier malfunction because of the noise, measures must be taken to suppressed this noise. These measures differ according to the propagation path of the noise.

(1) General measures for noise

- Avoid wiring the servo amplifier's power supply wire and signal wires in parallel or in a bundled state. Always use separate wiring. Use a twisted pair shield wire for the detector cable, the control signal wires for the bus cable, etc., and for the control power supply wire. Securely ground the shield.
- Use one-point grounding for the servo amplifier and motor.

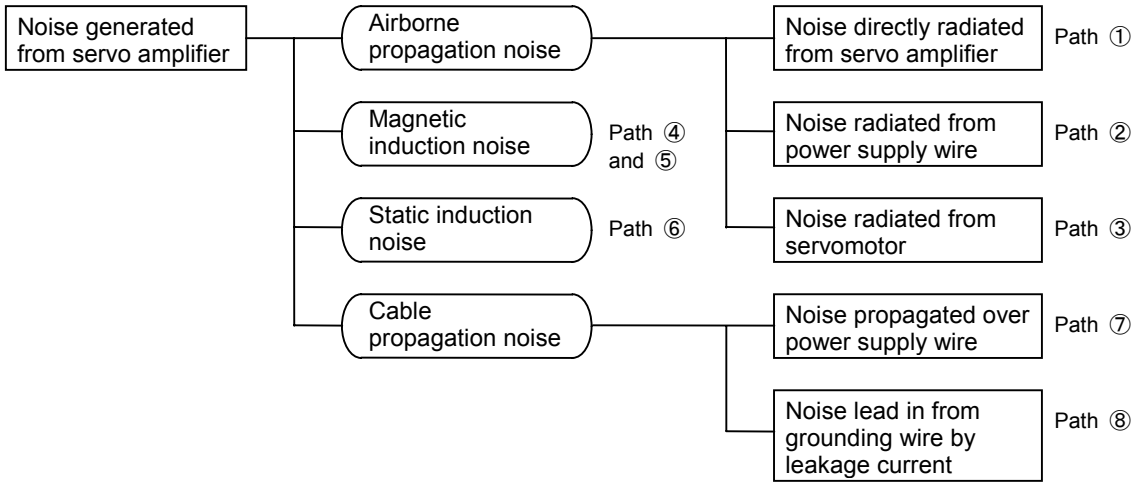
(2) Measures against noise entering from external source and causing servo amplifier to malfunction

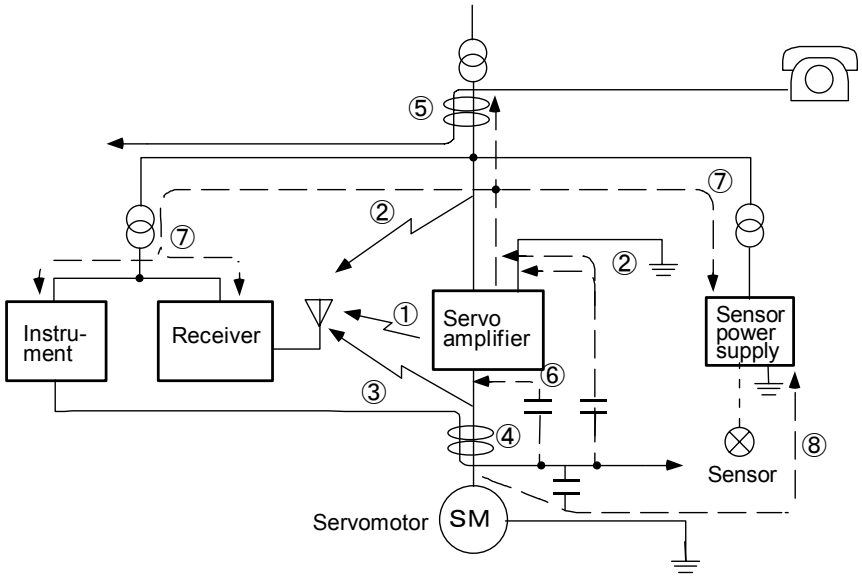
If a device generating noise is installed near the servo amplifier, and the servo amplifier could malfunction, take the following measures.

- Install a surge killer on devices (magnetic contactor, relay, etc.) that generate high levels of noise.
- Install a data line filter on the control signal wire.
- Ground the detector cable shield with a cable clamp.

(3) Measures against noise radiated from the servo amplifier and causing peripheral devices to malfunction

The types of propagation paths of the noise generated from the servo amplifier and the noise measures for each propagation path are shown below.





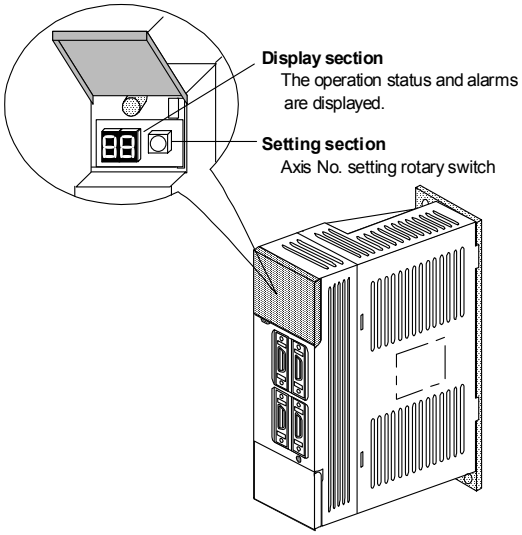
Noise propaga-tion path	Measures
① ② ③	When devices such as instruments, receivers or sensors, which handle minute signals and are easily affected by noise, or the signal wire of these devices, are stored in the same panel as the servo amplifier and the wiring is close, the device could malfunction due to airborne propagation of the noise. In this case, take the following measures. (1) Install devices easily affected as far away from the servo amplifier as possible. (2) Lay the signals wires easily affected as far away from the input wire with the servo amplifier. (3) Avoid parallel wiring or bundled wiring of the signal wire and power wire. (4) Insert a line noise filter on the input/output wire or a radio noise filter on the input to suppress noise radiated from the wires. (5) Use a shield wire for the signal wire and power wire, or place in separate metal ducts.
④ ⑤ ⑥	If the signal wire is laid in parallel to the power wire, or if it is bundled with the power wire, the noise could be propagated to the signal wire and cause malfunction because of the magnetic induction noise or static induction noise. In this case, take the following measures. (1) Install devices easily affected as far away from the servo amplifier as possible. (2) Lay the signals wires easily affected as far away from the input wire with the servo amplifier. (3) Avoid parallel wiring or bundled wiring of the signal wire and power wire. (4) Use a shield wire for the signal wire and power wire, or place in separate metal ducts.
⑦	If the power supply for the peripheral devices is connected to the power supply in the same system as the servo amplifier, the noise generated from the servo amplifier could back flow over the power supply wire and cause the devices to malfunction. In this case, take the following measures. (1) Install a radio noise filter on the servo amplifier's power wire. (2) Install a line noise filter on the servo amplifier's power wire.
⑧	If a closed loop is structured by the peripheral device and servo amplifier's grounding wires, the leakage current could penetrate and cause the devices to malfunction. In this case, change the device grounding methods and the grounding place.

Chapter 4 Setup

4-1 Initial setup of servo amplifier

4-1-1 Setting the rotary switches

Before turning on the power, the axis No. must be set with the rotary switches. The rotary switch settings will be validated when the amplifier power is turned ON.



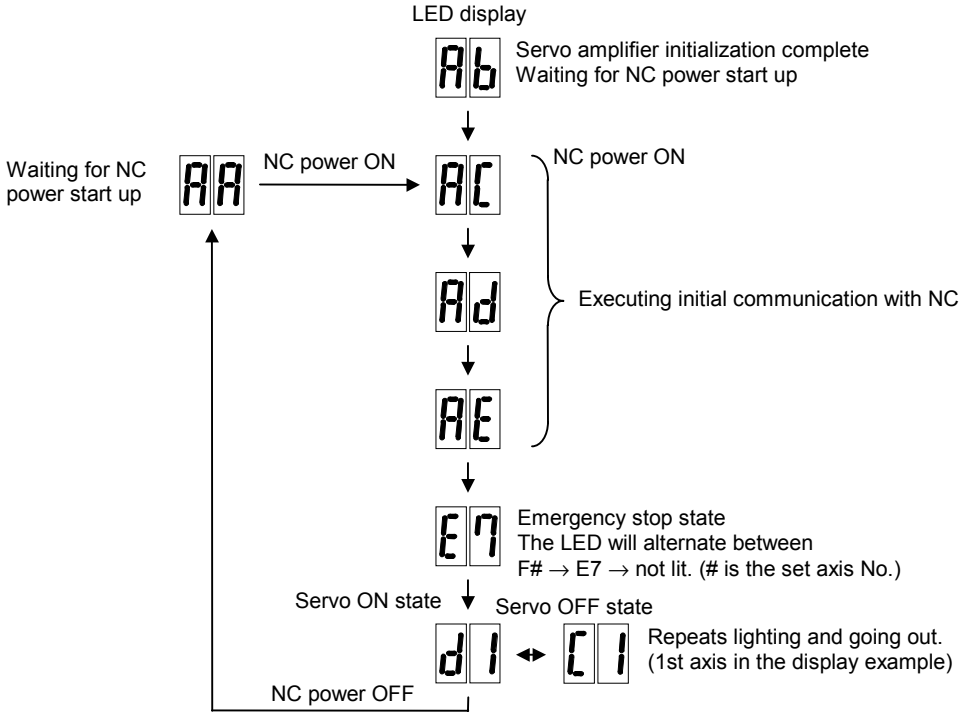
Rotary switch setting	Set axis No.
0	1st axis
1	2nd axis
2	3rd axis
3	4th axis
4	5th axis
5	6th axis
6	7th axis
7	Not usable
8	
9	
A	
B	
C	
D	
E	
F	Axis not used

POINT

When an axis that is not used is selected, that axis will not be controlled when the power is turned ON, and "Ab" will remain displayed on the LED.
If the power of the axis not in use is disconnected, the system's emergency stop cannot be released.

4-1-2 Transition of LED display after power is turned ON

When the axis No. has been set and the servo amplifier power and NC power have been turned ON, the servo amplifier will automatically execute self-diagnosis and initial settings for operation, etc. The LEDs on the front of the servo amplifier will change as shown below according to the progression of these processes.
If an alarm occurs, the alarm No. will appear on the LEDs. Refer to "Chapter 8 Troubleshooting" for details on the alarm displays.



4-2 Setting the initial parameters

The servo parameters must be set to start up the servo drive system.
The servo parameters are input from the CNC. The input method will differ according to the CNC, so refer to the Instruction Manual provided with each CNC.

4-2-1 Servo specification parameters

The servo specification parameters are determined according to the machine specifications and servo system specifications.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV017</td><td>SPEC</td><td>Servo specification selection</td><td>This is a HEX setting parameter. Set this as follows according to the servo specifications.
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>abs</td><td></td><td>vdir</td><td></td><td>mc</td><td></td><td></td><td>dmk</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when "0" is set.</th><th>Meaning when "1" is set.</th></tr>
<tr><td>0</td><td>dmk</td><td>Deceleration control stop (SVJ2 standard)</td><td>Dynamic brake stop</td></tr>
<tr><td>3</td><td>mc</td><td>Contactor control output invalid</td><td>Contactor control output valid</td></tr>
<tr><td>5</td><td>vdir</td><td>HA053N to HA33N motor detector standard installation position (A, C)</td><td>HA053N to HA33N motor detector 90° installation position (B, D)</td></tr>
<tr><td>7</td><td>abs</td><td>Incremental control</td><td>Absolute position control</td></tr>
</table>
Set all bits other than those above to 0.</td></tr>
<tr><td>SV025</td><td>MTYP</td><td>Motor/Detector type</td><td>Set the motor type.
Refer to the standard parameter list for each motor for the settings.</td></tr>
<tr><td>SV036</td><td>PTYP</td><td>Regenerative resistor type</td><td>This is a HEX setting parameter.
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="4">amp</td><td colspan="4">rtyp</td><td colspan="4">emgx</td><td colspan="4"></td></tr>
</table>
<table>
<tr><th>bit</th><th>Descriptions</th></tr>
<tr><td>0~3</td><td>Always set to "0" (0000).</td></tr>
<tr><td>4~7</td><td>Set the external emergency stop function. (Setting is prohibited for values with no description.)
<table>
<tr><th>Setting value</th><th>Details</th></tr>
<tr><td>0</td><td>External emergency stop invalid</td></tr>
<tr><td>4</td><td>External emergency stop valid</td></tr>
</table></td></tr>
<tr><td>8~B</td><td>Set the regenerative resistor type.
<table>
<tr><th>Setting value</th><th>Details</th></tr>
<tr><td>0</td><td>Amplifier standard built-in resistor (SVJ2-01 has no built-in resistor.)</td></tr>
<tr><td>1</td><td>Setting prohibited</td></tr>
<tr><td>2</td><td>MR-RB032</td></tr>
<tr><td>3</td><td>MR-RB12 or GZG200W39OHMK</td></tr>
<tr><td>4</td><td>MR-RB32 or GZG200W120OHMK:
3 units connected in parallel</td></tr>
<tr><td>5</td><td>MR-RB30 or GZG200W39OHMK:
3 units connected in parallel</td></tr>
<tr><td>6</td><td>MR-RB50 or GZG300W39OHMK:
3 units connected in parallel</td></tr>
<tr><td>7 ~ F</td><td>Setting prohibited</td></tr>
</table></td></tr>
<tr><td>C~ F</td><td>Always set to "1" (0001).</td></tr>
</table></td></tr>
<tr><td>SV027</td><td>SSF1</td><td>Servo function selection 1</td><td>Set 4000 as a standard.</td></tr>
<tr><td>SV033</td><td>SSF2</td><td>Servo function selection 2</td><td>Set 0000 as a standard.</td></tr>
<tr><td>SV001</td><td>PC1</td><td>Motor side gear ratio</td><td rowspan="2">Set the motor side gear ratio in PC1 and the machine side gear ratio in PC2.
When using a rotary axis, set the total deceleration (acceleration) ratio.</td></tr>
<tr><td>SV002</td><td>PC2</td><td>Machine side gear ratio</td></tr>
<tr><td>SV018</td><td>PIT</td><td>Ball screw pitch</td><td>Set the ball screw pitch with an mm unit. Set 360 for a rotary axis.</td></tr>
<tr><td>SV019</td><td>RNG1</td><td>Position detector resolution</td><td rowspan="2">Set the motor detector resolution with a kp/rev unit for both settings.
Refer to the standard parameters for each motor for the settings.</td></tr>
<tr><td>SV020</td><td>RNG2</td><td>Speed detector resolution</td></tr>
<tr><td>SV003</td><td>PGN1</td><td>Position loop gain</td><td>Set 33 as a standard.</td></tr>
</table>

4-2-2 Limitations to electronic gear setting value

The servo amplifier has internal electronic gears. The command value from the NC is converted into a detector resolution unit to carry out position control. The electronic gears are single gear ratios calculated from multiple parameters as shown below. However, each value (ELG1, ELG2) must be less than 32767.
If the value overflows, the initial parameter error (alarm 37) or error parameter No. 101 (2301 with M50/M64 Series NC) will be output.
If an alarm occurs, the mechanical specifications and electrical specifications must be revised so that the electronic gears are within the specifications range.

Reduced fraction of

$$\frac{ELG1}{ELG2} = \frac{PC2 \times RANG}{PC1 \times PIT \times IUNIT} \text{ (reduced fraction)}$$

RANG = RNG1 = RNG2
IUNIT = 2/NC command unit (μm)
1μm : IUNIT = 2, 0.1μm: IUNIT = 20

When the above is calculated, the following conditions must be satisfied.

$ELG1 \leq 32767$

$ELG2 \leq 32767$

POINT If the electronic gears in the amplifier overflow, the alarm 37 or error parameter No. 101 (2301 with M50/M64 series NC) will be output.

4-2-3 Parameters set according to feedrate

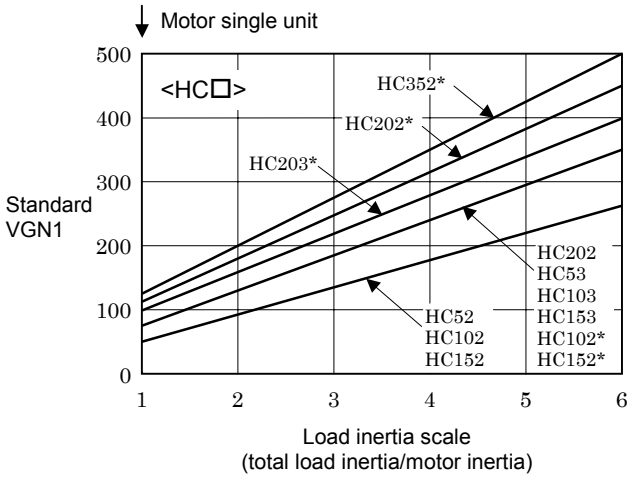
The following parameters are determined according to each axis' feedrate.

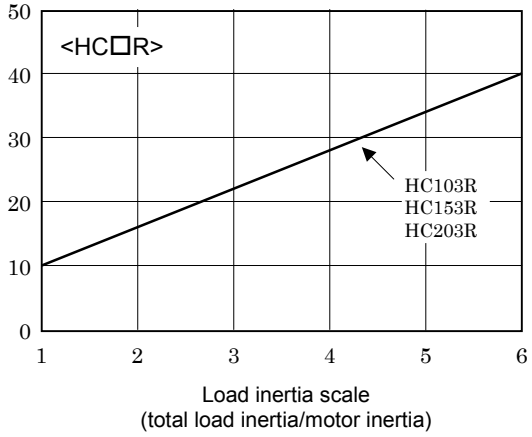
No.	Abbrev.	Parameter name	Explanation
SV023	OD1	Excessive error detection width at servo ON	A protective function will activate if the error between the position command and position feedback is excessive. If the machine load is heavy and problems occur with the standard settings, gradually increase the setting value. **<Calculation of standard setting value>** $OD1 = OD2 = \frac{\text{Rapid traverse rate (mm/min)}}{60 \times PGN1} \div 2 \text{ (mm)}$
SV026	OD2	Excessive error detection width during servo OFF	

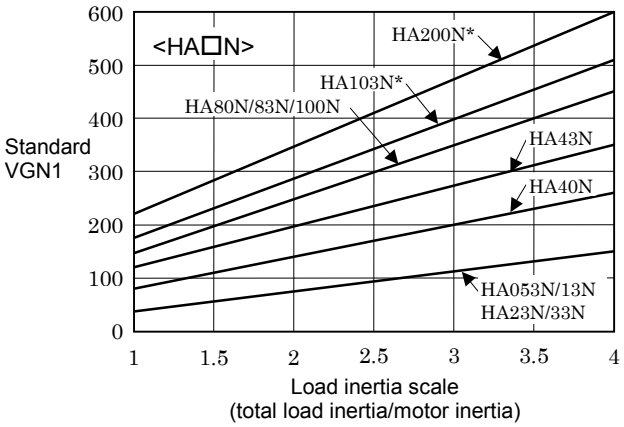
4-2-4 Parameters set according to machine load inertia

The following parameters are set according to the machine's inertia.

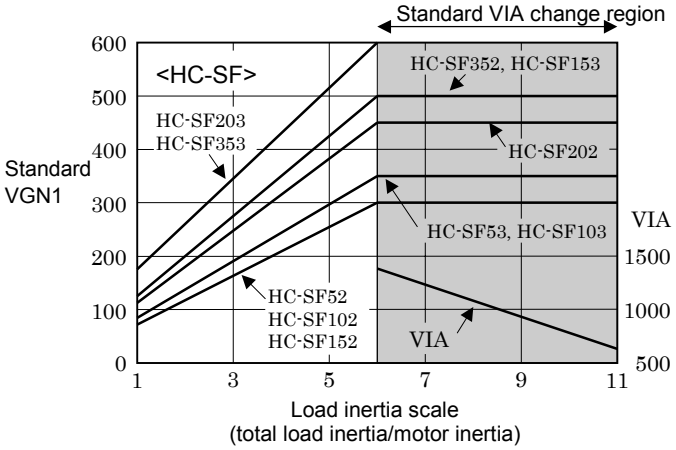
No.	Abbrev.	Parameter name	Explanation
SV005	VGN1	Speed loop gain.	Refer to the comparison graph with the load inertia scale for the standard setting value.
SV008	VIA	Speed loop lead compensation	Set 1364 as a standard. Set 1900 as a standard for the SHG control. If the load inertia is large and is in the standard VIA change region, set the value in the comparison graph regardless of whether normal control or SHG control is used.

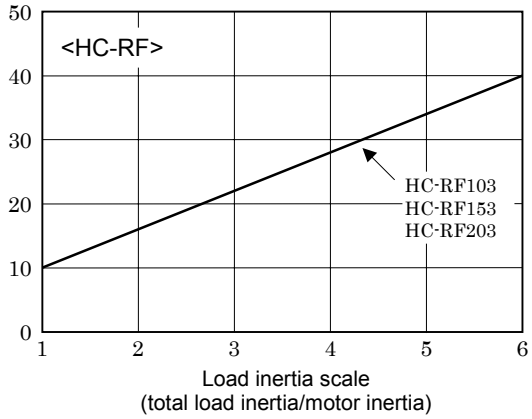


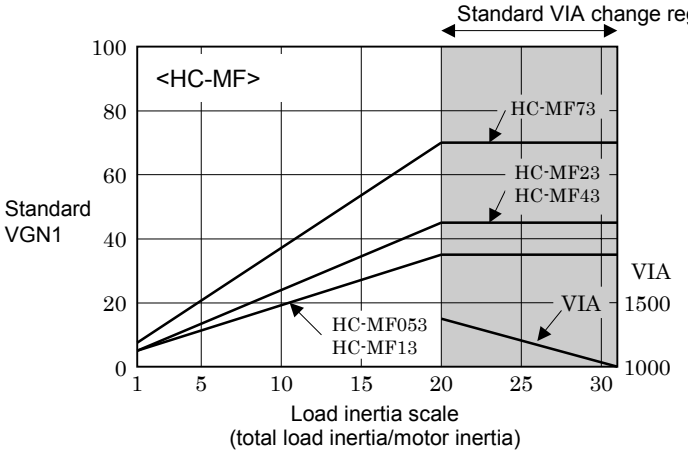


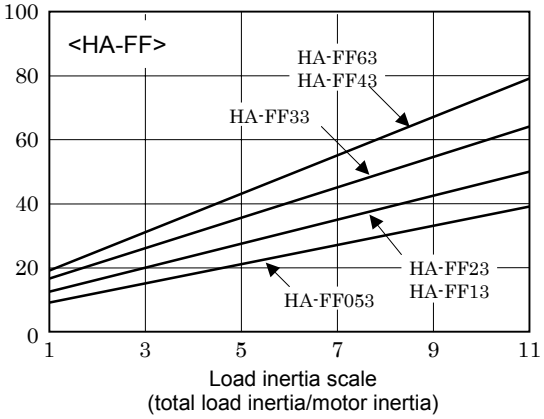


(Note) The asterisk "*" in the motor type indicates the value for a combination with an amplifier having a one-rank lower capacity.









4-3 Standard parameter list according to motor

Set the standard parameters for parameters not explained in section "4-2 Setting the initial parameters".

(1) HC Series (2000r/min. rating)

Motor series name			HC□-E42, -E33, HC□-A47, -A42, -A33							
ABS/INC			HC□-E42, -E33 : INC, HC□-A47, -A42, -A33 : ABS (HC□-A47 can also be used with the INC system)							
Motor capacity symbol			52	102		152		202		352
Connected amplifier type (MDS-B-)			SVJ2-06	SVJ2-07	SVJ2-10	SVJ2-10	SVJ2-20	SVJ2-10	SVJ2-20	SVJ2-20
No.	**Abbrev.**	**Parameter name**								
SV001	PC1	Motor side gear ratio	Set the motor side gear ratio in PC1 and the machine side gear ratio in PC2. When using a rotary axis, set the total deceleration (acceleration) ratio.							
SV002	PC2	Machine side gear ratio								
SV003	PGN1	Position loop gain 1	33							
SV004	PGN2	Position loop gain 2	0							
SV005	VGN1	Speed loop gain	Refer to 4-2-4 Parameters set according to machine load inertia							
SV006	–	–	0							
SV007	–	–	0							
SV008	VIA	Speed loop lead compensation	Refer to 4-2-4 Parameters set according to machine load inertia							
SV009	IQA	Current loop q axis lead compensation	8192	4096	8192	4096	8192	2048	4096	2048
SV010	IDA	Current loop d axis lead compensation	8192	4096	8192	4096	8192	2048	4096	2048
SV011	IQG	Current loop q axis gain	512	256	384	256	384	256	384	256
SV012	IDG	Current loop d axis gain	512	256	384	256	384	256	384	256
SV013	ILMT	Current limit value	500							
SV014	ILMTsp	Current limit value in special control	500							
SV015	FFC	Acceleration rate feed forward gain	0							
SV016	LMC1	Lost motion compensation 1	0							
SV017	SPEC	Servo specification selection	Refer to 4-2-1 Servo specification parameters							
SV018	PIT	Ball screw pitch	Set the ball screw pitch with an mm unit. Set 360 for a rotary axis.							
SV019	RNG1	Position detector resolution	Set to 100 for the HC□-A47, -E42, -A42 Series Set to 25 for the HC□-E33, -A33 Series							
SV020	RNG2	Speed detector resolution								
SV021	OLT	Overload time constant	60							
SV022	OLL	Overload detection level	150							
SV023	OD1	Excessive error detection width during servo ON	Refer to 4-2-3 Parameters set according to feedrate							
SV024	INP	In-position width	50							
SV025	MTYP	Motor/Detector type	22B0	22B1		22B2		22B3		22B4
SV026	OD2	Excessive error detection width during servo OFF	Refer to 4-2-3 Parameters set according to feedrate							
SV027	SSF1	Servo function selection 1	4000							
SV028 ~ 035	–	Compensation function for special functions	0							
SV036	PTYP	Regenerative resistor type	Refer to 4-2-1 Servo specification parameters							
SV037 ~ 046	–	Compensation function for special functions	0							
SV047	EC	Inductive voltage compensation gain	100							
SV048	EMGrt	Vertical axis drop prevention time	0							
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	15							
SV050 ~ 064	–	Compensation function for special functions	0							

(2) HC Series (3000r/min. rating)

Motor series name			HC□-E42, -E33, HC□-A47, -A42, -A33			
ABS/INC			HC□-E42, -E33 : INC, HC□-A47, -A42, -A33 : ABS (HC□-A47 can also be used with the INC system)			
Motor capacity symbol			53	103	153	203
Connected amplifier type (MDS-B-)			SVJ2-06	SVJ2-10	SVJ2-20	SVJ2-20
No.	**Abbrev.**	**Parameter name**				
SV001	PC1	Motor side gear ratio	Set the motor side gear ratio in PC1 and the machine side gear ratio in PC2. When using a rotary axis, set the total deceleration (acceleration) ratio.			
SV002	PC2	Machine side gear ratio				
SV003	PGN1	Position loop gain 1	33			
SV004	PGN2	Position loop gain 2	0			
SV005	VGN1	Speed loop gain	Refer to 4-2-4 Parameters set according to machine load inertia			
SV006	–	–	0			
SV007	–	–	0			
SV008	VIA	Speed loop lead compensation	Refer to 4-2-4 Parameters set according to machine load inertia			
SV009	IQA	Current loop q axis lead compensation	4096	4096	4096	2048
SV010	IDA	Current loop d axis lead compensation	4096	4096	4096	2048
SV011	IQG	Current loop q axis gain	256	256	256	200
SV012	IDG	Current loop d axis gain	256	256	256	200
SV013	ILMT	Current limit value	500			
SV014	ILMTsp	Current limit value in special control	500			
SV015	FFC	Acceleration rate feed forward gain	0			
SV016	LMC1	Lost motion compensation 1	0			
SV017	SPEC	Servo specification selection	Refer to 4-2-1 Servo specification parameters			
SV018	PIT	Ball screw pitch	Set the ball screw pitch with an mm unit. Set 360 for a rotary axis.			
SV019	RNG1	Position detector resolution	Set to 100 for the HC□-A47, -E42, -A42 Series Set to 25 for the HC□-E33, -A33 Series			
SV020	RNG2	Speed detector resolution				
SV021	OLT	Overload time constant	60			
SV022	OLL	Overload detection level	150			
SV023	OD1	Excessive error detection width during servo ON	Refer to 4-2-3 Parameters set according to feedrate			
SV024	INP	In-position width	50			
SV025	MTYP	Motor/Detector type	22C0	22C1	22C2	22C3
SV026	OD2	Excessive error detection width during servo OFF	Refer to 4-2-3 Parameters set according to feedrate			
SV027	SSF1	Servo function selection 1	4000			
SV028 ~ 035	–	Compensation function for special functions	0			
SV036	PTYP	Regenerative resistor type	Refer to 4-2-1 Servo specification parameters			
SV037 ~ 046	–	Compensation function for special functions	0			
SV047	EC	Inductive voltage compensation gain	100			
SV048	EMGrt	Vertical axis drop prevention time	0			
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	15			
SV050 ~ 064	–	Compensation function for special functions	0			

(3) HC□R Series

Motor series name			HC□R-E42, -E33, HC□R-A47, -A42, -A33		
ABS/INC			HC□R-E42, -E33 : INC, HC□R-A47, -A42, -A33 : ABS (HC□R-A47 can also be used with the INC system)		
Motor capacity symbol			103	153	203
Connected amplifier type (MDS-B-)			SVJ2-10	SVJ2-10 (Caution)	SVJ2-20
No.	**Abbrev.**	**Parameter name**			
SV001	PC1	Motor side gear ratio	Set the motor side gear ratio in PC1 and the machine side gear ratio in PC2. When using a rotary axis, set the total deceleration (acceleration) ratio.		
SV002	PC2	Machine side gear ratio			
SV003	PGN1	Position loop gain 1	33		
SV004	PGN2	Position loop gain 2	0		
SV005	VGN1	Speed loop gain	Refer to 4-2-4 Parameters set according to machine load inertia		
SV006	–	–	0		
SV007	–	–	0		
SV008	VIA	Speed loop lead compensation	Refer to 4-2-4 Parameters set according to machine load inertia		
SV009	IQA	Current loop q axis lead compensation	8192	8192	8192
SV010	IDA	Current loop d axis lead compensation	8192	8192	8192
SV011	IQG	Current loop q axis gain	384	384	256
SV012	IDG	Current loop d axis gain	384	384	256
SV013	ILMT	Current limit value	500		
SV014	ILMTsp	Current limit value in special control	500		
SV015	FFC	Acceleration rate feed forward gain	0		
SV016	LMC1	Lost motion compensation 1	0		
SV017	SPEC	Servo specification selection	Refer to 4-2-1 Servo specification parameters		
SV018	PIT	Ball screw pitch	Set the ball screw pitch with an mm unit. Set 360 for a rotary axis.		
SV019	RNG1	Position detector resolution	Set to 100 for the HC□R-A47, -E42, -A42 Series Set to 25 for the HC□R-E33, -A33 Series		
SV020	RNG2	Speed detector resolution			
SV021	OLT	Overload time constant	60		
SV022	OLL	Overload detection level	150		
SV023	OD1	Excessive error detection width during servo ON	Refer to 4-2-3 Parameters set according to feedrate		
SV024	INP	In-position width	50		
SV025	MTYP	Motor/Detector type	22E1	22E2	22E3
SV026	OD2	Excessive error detection width during servo OFF	Refer to 4-2-3 Parameters set according to feedrate		
SV027	SSF1	Servo function selection 1	4000		
SV028 ~ 035	–	Compensation function for special functions	0		
SV036	PTYP	Regenerative resistor type	Refer to 4-2-1 Servo specification parameters		
SV037 ~ 046	–	Compensation function for special functions	0		
SV047	EC	Inductive voltage compensation gain	100		
SV048	EMGrt	Vertical axis drop prevention time	0		
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	15		
SV050 ~ 064	–	Compensation function for special functions	0		

⚠ CAUTION Pay close attention to the connection amplifier capacity of the HC153R.

(4) HA□N Series (2000r/min rating)

Motor series name			HA□-E42, -E33, HA□-A42, -A33			
ABS/INC			HA□-E42, -E33 : INC, HA□-A42, -A33 : ABS			
Motor capacity symbol			40N	80N	100N	200N
Connected amplifier type (MDS-B-)			SVJ2-06	SVJ2-10	SVJ2-20	SVJ2-20
No.	**Abbrev.**	**Parameter name**				
SV001	PC1	Motor side gear ratio	Set the motor side gear ratio in PC1 and the machine side gear ratio in PC2. When using a rotary axis, set the total deceleration (acceleration) ratio.			
SV002	PC2	Machine side gear ratio				
SV003	PGN1	Position loop gain 1	33			
SV004	PGN2	Position loop gain 2	0			
SV005	VGN1	Speed loop gain	Refer to 4-2-4 Parameters set according to machine load inertia			
SV006	–	–	0			
SV007	–	–	0			
SV008	VIA	Speed loop lead compensation	Refer to 4-2-4 Parameters set according to machine load inertia			
SV009	IQA	Current loop q axis lead compensation	2048	2048	2048	2048
SV010	IDA	Current loop d axis lead compensation	2048	2048	2048	2048
SV011	IQG	Current loop q axis gain	512	512	256	200
SV012	IDG	Current loop d axis gain	512	512	512	200
SV013	ILMT	Current limit value	500			
SV014	ILMTsp	Current limit value in special control	500			
SV015	FFC	Acceleration rate feed forward gain	0			
SV016	LMC1	Lost motion compensation 1	0			
SV017	SPEC	Servo specification selection	Refer to 4-2-1 Servo specification parameters			
SV018	PIT	Ball screw pitch	Set the ball screw pitch with an mm unit. Set 360 for a rotary axis.			
SV019	RNG1	Position detector resolution	Set to 100 for the HA□-E42, -A42 Series Set to 25 for the HA□-E33, -A33 Series			
SV020	RNG2	Speed detector resolution				
SV021	OLT	Overload time constant	60			
SV022	OLL	Overload detection level	150			
SV023	OD1	Excessive error detection width during servo ON	Refer to 4-2-3 Parameters set according to feedrate			
SV024	INP	In-position width	50			
SV025	MTYP	Motor/Detector type	2200	2201	2202	2203
SV026	OD2	Excessive error detection width during servo OFF	Refer to 4-2-3 Parameters set according to feedrate			
SV027	SSF1	Servo function selection 1	4000			
SV028 ~ 035	–	Compensation function for special functions	0			
SV036	PTYP	Regenerative resistor type	Refer to 4-2-1 Servo specification parameters			
SV037 ~ 046	–	Compensation function for special functions	0			
SV047	EC	Inductive voltage compensation gain	100			
SV048	EMGrt	Vertical axis drop prevention time	0			
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	15			
SV050 ~ 064	–	Compensation function for special functions	0			

(5) HA□N Series (3000r/min rating)

Motor series name			HA□-E42, -E33, HA□-A42, -A33						
ABS/INC			HA□-E42, -E33 : INC, HA□-A42, -A33 : ABS						
Motor capacity symbol			053N	13N	23N	33N	43N	83N	103N
Connected amplifier type (MDS-B-)			SVJ2-01		SVJ2-03		SVJ2-06	SVJ2-10	SVJ2-20
No.	**Abbrev.**	**Parameter name**							
SV001	PC1	Motor side gear ratio	Set the motor side gear ratio in PC1 and the machine side gear ratio in PC2. When using a rotary axis, set the total deceleration (acceleration) ratio.						
SV002	PC2	Machine side gear ratio							
SV003	PGN1	Position loop gain 1	33						
SV004	PGN2	Position loop gain 2	0						
SV005	VGN1	Speed loop gain	Refer to 4-2-4 Parameters set according to machine load inertia						
SV006	–	–	0						
SV007	–	–	0						
SV008	VIA	Speed loop lead compensation	Refer to 4-2-4 Parameters set according to machine load inertia						
SV009	IQA	Current loop q axis lead compensation	2048	2048	2048	2048	2048	2048	2048
SV010	IDA	Current loop d axis lead compensation	2048	2048	2048	2048	2048	2048	2048
SV011	IQG	Current loop q axis gain	256	256	256	256	256	256	256
SV012	IDG	Current loop d axis gain	256	256	256	256	512	512	256
SV013	ILMT	Current limit value	500						
SV014	ILMTsp	Current limit value in special control	500						
SV015	FFC	Acceleration rate feed forward gain	0						
SV016	LMC1	Lost motion compensation 1	0						
SV017	SPEC	Servo specification selection	Refer to 4-2-1 Servo specification parameters						
SV018	PIT	Ball screw pitch	Set the ball screw pitch with an mm unit. Set 360 for a rotary axis.						
SV019	RNG1	Position detector resolution	Set to 100 for the HA□-E42, -A42 Series Set to 25 for the HA□-E33, -A33 Series						
SV020	RNG2	Speed detector resolution							
SV021	OLT	Overload time constant	60						
SV022	OLL	Overload detection level	150						
SV023	OD1	Excessive error detection width during servo ON	Refer to 4-2-3 Parameters set according to feedrate						
SV024	INP	In-position width	50						
SV025	MTYP	Motor/Detector type	228C	228D	228E	228F	2280	2281	2282
SV026	OD2	Excessive error detection width during servo OFF	Refer to 4-2-3 Parameters set according to feedrate						
SV027	SSF1	Servo function selection 1	4000						
SV028 ~ 035	–	Compensation function for special functions	0						
SV036	PTYP	Regenerative resistor type	Refer to 4-2-1 Servo specification parameters						
SV037 ~ 046	–	Compensation function for special functions	0						
SV047	EC	Inductive voltage compensation gain	100						
SV048	EMGrt	Vertical axis drop prevention time	0						
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	15						
SV050 ~ 064	–	Compensation function for special functions	0						

(6) HC-SF Series (2000r/min rating)

Motor series name			HC-SF□				
ABS/INC			This is only for ABS specifications. This can be used with the INC system.				
Motor capacity symbol			52	102	152	202	352
Connected amplifier type (MDS-B-)			SVJ2-06	SVJ2-07 (Caution)	SVJ2-10 (Caution)	SVJ2-10 (Caution)	SVJ2-20 (Caution)
No.	**Abbrev.**	**Parameter name**					
SV001	PC1	Motor side gear ratio	Set the motor side gear ratio in PC1 and the machine side gear ratio in PC2. When using a rotary axis, set the total deceleration (acceleration) ratio.				
SV002	PC2	Machine side gear ratio					
SV003	PGN1	Position loop gain 1	33				
SV004	PGN2	Position loop gain 2	0				
SV005	VGN1	Speed loop gain	Refer to 4-2-4 Parameters set according to machine load inertia				
SV006	–	–	0				
SV007	–	–	0				
SV008	VIA	Speed loop lead compensation	Refer to 4-2-4 Parameters set according to machine load inertia				
SV009	IQA	Current loop q axis lead compensation	8192	4096	4096	2048	2048
SV010	IDA	Current loop d axis lead compensation	8192	4096	4096	2048	2048
SV011	IQG	Current loop q axis gain	500	300	300	300	250
SV012	IDG	Current loop d axis gain	500	300	300	300	250
SV013	ILMT	Current limit value	500				
SV014	ILMTsp	Current limit value in special control	500				
SV015	FFC	Acceleration rate feed forward gain	0				
SV016	LMC1	Lost motion compensation 1	0				
SV017	SPEC	Servo specification selection	Refer to 4-2-1 Servo specification parameters				
SV018	PIT	Ball screw pitch	Set the ball screw pitch with an mm unit. Set 360 for a rotary axis.				
SV019	RNG1	Position detector resolution	16				
SV020	RNG2	Speed detector resolution	16				
SV021	OLT	Overload time constant	60				
SV022	OLL	Overload detection level	150				
SV023	OD1	Excessive error detection width during servo ON	Refer to 4-2-3 Parameters set according to feedrate				
SV024	INP	In-position width	50				
SV025	MTYP	Motor/Detector type	22B0	22B1	22B2	22B3	22B4
SV026	OD2	Excessive error detection width during servo OFF	Refer to 4-2-3 Parameters set according to feedrate				
SV027	SSF1	Servo function selection 1	4000				
SV028 ~ 035	–	Compensation function for special functions	0				
SV036	PTYP	Regenerative resistor type	Refer to 4-2-1 Servo specification parameters				
SV037 ~ 046	–	Compensation function for special functions	0				
SV047	EC	Inductive voltage compensation gain	100				
SV048	EMGrt	Vertical axis drop prevention time	0				
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	15				
SV050 ~ 064	–	Compensation function for special functions	0				

⚠ CAUTION Pay close attention to the combination of motor capacity and connection amplifier capacity.

(7) HC-SF Series (3000r/min rating)

Motor series name			HC-SF□				
ABS/INC			This is only for ABS specifications. This can be used with the INC system.				
Motor capacity symbol			53	103	153	203	353
Connected amplifier type (MDS-B-)			SVJ2-06	SVJ2-07 (Caution)	SVJ2-10 (Caution)	SVJ2-10 (Caution)	SVJ2-20 (Caution)
No.	**Abbrev.**	**Parameter name**					
SV001	PC1	Motor side gear ratio	Set the motor side gear ratio in PC1 and the machine side gear ratio in PC2. When using a rotary axis, set the total deceleration (acceleration) ratio.				
SV002	PC2	Machine side gear ratio					
SV003	PGN1	Position loop gain 1	33				
SV004	PGN2	Position loop gain 2	0				
SV005	VGN1	Speed loop gain	Refer to 4-2-4 Parameters set according to machine load inertia				
SV006	–	–	0				
SV007	–	–	0				
SV008	VIA	Speed loop lead compensation	Refer to 4-2-4 Parameters set according to machine load inertia				
SV009	IQA	Current loop q axis lead compensation	4096	4096	2048	2048	2048
SV010	IDA	Current loop d axis lead compensation	4096	4096	2048	2048	2048
SV011	IQG	Current loop q axis gain	250	250	200	200	200
SV012	IDG	Current loop d axis gain	250	250	200	200	200
SV013	ILMT	Current limit value	500				
SV014	ILMTsp	Current limit value in special control	500				
SV015	FFC	Acceleration rate feed forward gain	0				
SV016	LMC1	Lost motion compensation 1	0				
SV017	SPEC	Servo specification selection	Refer to 4-2-1 Servo specification parameters				
SV018	PIT	Ball screw pitch	Set the ball screw pitch with an mm unit. Set 360 for a rotary axis.				
SV019	RNG1	Position detector resolution	16				
SV020	RNG2	Speed detector resolution	16				
SV021	OLT	Overload time constant	60				
SV022	OLL	Overload detection level	150				
SV023	OD1	Excessive error detection width during servo ON	Refer to 4-2-3 Parameters set according to feedrate				
SV024	INP	In-position width	50				
SV025	MTYP	Motor/Detector type	22C0	22C1	22C2	22C3	22C4
SV026	OD2	Excessive error detection width during servo OFF	Refer to 4-2-3 Parameters set according to feedrate				
SV027	SSF1	Servo function selection 1	4000				
SV028 ~ 035	–	Compensation function for special functions	0				
SV036	PTYP	Regenerative resistor type	Refer to 4-2-1 Servo specification parameters				
SV037 ~ 046	–	Compensation function for special functions	0				
SV047	EC	Inductive voltage compensation gain	100				
SV048	EMGrt	Vertical axis drop prevention time	0				
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	15				
SV050 ~ 064	–	Compensation function for special functions	0				

⚠ CAUTION Pay close attention to the combination of motor capacity and connection amplifier capacity.

(8) HC-RF Series

Motor series name			HC-RF□		
ABS/INC			This is only for ABS specifications. This can be used with the INC system.		
Motor capacity symbol			103	153	203
Connected amplifier type (MDS-B-)			SVJ2-10	SVJ2-10 (Caution)	SVJ2-20
No.	**Abbrev.**	**Parameter name**			
SV001	PC1	Motor side gear ratio	Set the motor side gear ratio in PC1 and the machine side gear ratio in PC2. When using a rotary axis, set the total deceleration (acceleration) ratio.		
SV002	PC2	Machine side gear ratio			
SV003	PGN1	Position loop gain 1	33		
SV004	PGN2	Position loop gain 2	0		
SV005	VGN1	Speed loop gain	Refer to 4-2-4 Parameters set according to machine load inertia		
SV006	–	–	0		
SV007	–	–	0		
SV008	VIA	Speed loop lead compensation	Refer to 4-2-4 Parameters set according to machine load inertia		
SV009	IQA	Current loop q axis lead compensation	8192	8192	8192
SV010	IDA	Current loop d axis lead compensation	8192	8192	8192
SV011	IQG	Current loop q axis gain	384	384	256
SV012	IDG	Current loop d axis gain	384	384	256
SV013	ILMT	Current limit value	500		
SV014	ILMTsp	Current limit value in special control	500		
SV015	FFC	Acceleration rate feed forward gain	0		
SV016	LMC1	Lost motion compensation 1	0		
SV017	SPEC	Servo specification select	Refer to 4-2-1 Servo specification parameters		
SV018	PIT	Ball screw pitch	Set the ball screw pitch with an mm unit. Set 360 for a rotary axis.		
SV019	RNG1	Position detector resolution	16		
SV020	RNG2	Speed detector resolution	16		
SV021	OLT	Overload time constant	60		
SV022	OLL	Overload detection level	150		
SV023	OD1	Excessive error detection width during servo ON	Refer to 4-2-3 Parameters set according to feedrate		
SV024	INP	In-position width	50		
SV025	MTYP	Motor/Detector type	22E1	22E2	22E3
SV026	OD2	Excessive error detection width during servo OFF	Refer to 4-2-3 Parameters set according to feedrate		
SV027	SSF1	Servo function selection 1	4000		
SV028 ~ 035	–	Compensation function for special functions	0		
SV036	PTYP	Regenerative resistor type	Refer to 4-2-1 Servo specification parameters		
SV037 ~ 046	–	Compensation function for special functions	0		
SV047	EC	Inductive voltage compensation gain	100		
SV048	EMGrt	Vertical axis drop prevention time	0		
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	15		
SV050 ~ 064	–	Compensation function for special functions	0		

⚠ CAUTION Pay close attention to the connection amplifier capacity of the HC-RF153.

(9) HA-FF Series

Motor series name			HC-FF□					
ABS/INC			This is only for ABS specifications. This can be used with the INC system.					
Motor capacity symbol			053	13	23	33	43	63
Connected amplifier type (MDS-B-)			SVJ2-01	SVJ2-01	SVJ2-03	SVJ2-03	SVJ2-04	SVJ2-06
No.	**Abbrev.**	**Parameter name**						
SV001	PC1	Motor side gear ratio	Set the motor side gear ratio in PC1 and the machine side gear ratio in PC2. When using a rotary axis, set the total deceleration (acceleration) ratio.					
SV002	PC2	Machine side gear ratio						
SV003	PGN1	Position loop gain 1	33					
SV004	PGN2	Position loop gain 2	0					
SV005	VGN1	Speed loop gain	Refer to 4-2-4 Parameters set according to machine load inertia					
SV006	–	–	0					
SV007	–	–	0					
SV008	VIA	Speed loop lead compensation	Refer to 4-2-4 Parameters set according to machine load inertia					
SV009	IQA	Current loop q axis lead compensation	8192	4096	4096	4096	4096	4096
SV010	IDA	Current loop d axis lead compensation	8192	4096	4096	4096	4096	4096
SV011	IQG	Current loop q axis gain	500	300	700	500	700	700
SV012	IDG	Current loop d axis gain	500	300	700	500	700	700
SV013	ILMT	Current limit value	500					
SV014	ILMTsp	Current limit value in special control	500					
SV015	FFC	Acceleration rate feed forward gain	0					
SV016	LMC1	Lost motion compensation 1	0					
SV017	SPEC	Servo specification selection	Refer to 4-2-1 Servo specification parameters					
SV018	PIT	Ball screw pitch	Set the ball screw pitch with an mm unit. Set 360 for a rotary axis.					
SV019	RNG1	Position detector resolution	8					
SV020	RNG2	Speed detector resolution	8					
SV021	OLT	Overload time constant	60					
SV022	OLL	Overload detection level	150					
SV023	OD1	Excessive error detection width during servo ON	Refer to 4-2-3 Parameters set according to feedrate					
SV024	INP	In-position width	50					
SV025	MTYP	Motor/Detector type	227C	227D	227E	227F	2270	2271
SV026	OD2	Excessive error detection width during servo OFF	Refer to 4-2-3 Parameters set according to feedrate					
SV027	SSF1	Servo function selection 1	4000					
SV028 ~ 035	–	Compensation function for special functions	0					
SV036	PTYP	Regenerative resistor type	Refer to 4-2-1 Servo specification parameters					
SV037 ~ 046	–	Compensation function for special functions	0					
SV047	EC	Inductive voltage compensation gain	100					
SV048	EMGrt	Vertical axis drop prevention time	0					
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	15					
SV050 ~ 064	–	Compensation function for special functions	0					

(10) HC-MF Series

Motor series name			HC-MF□				
ABS/INC			This is only for ABS specifications. This can be used with the INC system.				
Motor capacity symbol			053	13	23	43	73
Connected amplifier type (MDS-B-)			SVJ2-01	SVJ2-01	SVJ2-03	SVJ2-04	SVJ2-07
No.	**Abbrev.**	**Parameter name**					
SV001	PC1	Motor side gear ratio	Set the motor side gear ratio in PC1 and the machine side gear ratio in PC2. When using a rotary axis, set the total deceleration (acceleration) ratio.				
SV002	PC2	Machine side gear ratio					
SV003	PGN1	Position loop gain 1	33				
SV004	PGN2	Position loop gain 2	0				
SV005	VGN1	Speed loop gain	Refer to 4-2-4 Parameters set according to machine load inertia				
SV006	–	–	0				
SV007	–	–	0				
SV008	VIA	Speed loop lead compensation	Refer to 4-2-4 Parameters set according to machine load inertia				
SV009	IQA	Current loop q axis lead compensation	4096	4096	4096	4096	4096
SV010	IDA	Current loop d axis lead compensation	4096	4096	4096	4096	4096
SV011	IQG	Current loop q axis gain	200	300	400	300	300
SV012	IDG	Current loop d axis gain	200	300	400	300	300
SV013	ILMT	Current limit value	500				
SV014	ILMTsp	Current limit value in special control	500				
SV015	FFC	Acceleration rate feed forward gain	0				
SV016	LMC1	Lost motion compensation 1	0				
SV017	SPEC	Servo specification selection	Refer to 4-2-1 Servo specification parameters				
SV018	PIT	Ball screw pitch	Set the ball screw pitch with an mm unit. Set 360 for a rotary axis.				
SV019	RNG1	Position detector resolution	8				
SV020	RNG2	Speed detector resolution	8				
SV021	OLT	Overload time constant	60				
SV022	OLL	Overload detection level	150				
SV023	OD1	Excessive error detection width during servo ON	Refer to 4-2-3 Parameters set according to feedrate				
SV024	INP	In-position width	50				
SV025	MTYP	Motor/Detector type	229C	229D	229E	2290	2291
SV026	OD2	Excessive error detection width during servo OFF	Refer to 4-2-3 Parameters set according to feedrate				
SV027	SSF1	Servo function selection 1	4000				
SV028 ~ 035	–	Compensation function for special functions	0				
SV036	PTYP	Regenerative resistor type	Refer to 4-2-1 Servo specification parameters				
SV037 ~ 046	–	Compensation function for special functions	0				
SV047	EC	Inductive voltage compensation gain	100				
SV048	EMGrt	Vertical axis drop prevention time	0				
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	15				
SV050 ~ 064	–	Compensation function for special functions	0				

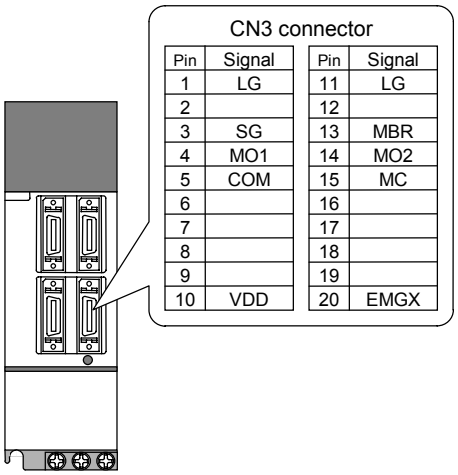
Chapter 5 Adjustment

5-1 Measurement of adjustment data

The MDS-B-SVJ2 servo amplifier has a function to D/A output the various control data. To adjust the servo and set the servo parameters that match the machine, it is necessary to use the D/A output and measure the internal status of the servo. Measure using a hi-coder, synchroscope, etc.

5-1-1 D/A output specifications

Item	Explanation
No. of channels	2 ch.
Output cycle	888μsec (min. value)
Output precision	8-bit
Output voltage range	−10V~0~+10V
Output scale setting	±1/256 to ±128 times
Output pins	CN3 connector MO1 = pin 4 MO2 = pin 14 GND = pin 1, 11
Function	Offset amount adjustment function Output clamp function Low path filter function
Option	Relay terminal: MR-J2CN3TM Connect from the CN3 connector using the SH21 cable as a lead-in wire.



5-1-2 Setting the output data

No.	Abbrev.	Parameter name	Explanation
SV061	DA1NO	D/A output channel 1 data No.	Input the No. of the data to be output to each D/A output channel. (Channel Nos. 9, 10, 29 and 30 correspond to C1 and subsequent versions of software.) (Channel Nos. 8 and 28 correspond from software version C3.)
SV062	DA2NO	D/A output channel 2 data No.	

No.	Output data	Standard output unit	Output cycle
0	0 V test output	For offset amount adjustment	
1	Speed feedback	1000rpm/2V	888 μsec
2	Current feedback	Rated (stall) current/2V	888 μsec
3	Speed command	1000rpm/2V	888 μsec
4	Current command	Rated (stall) current/2V	888 μsec
5	V-phase current value	10A/V	888 μsec
6	W-phase current value	10A/V	888 μsec
7	Estimated disturbance torque	Rated (stall) current/2V	888 μsec
8	Collision detection disturbance torque	Rated (stall) current/2V	888 μsec
9	Position feedback (stroke)	100mm/V	3.55 msec
10	Position feedback (pulse)	10μm/V	3.55 msec
11	Position droop	mm/V	3.55 msec
12	Position droop(×10)	100 μm/V	3.55 msec
13	Position droop(×100)	10 μm/V	3.55 msec
14	Feedrate (FΔT)	10000 (mm/min)/V	888 μsec
15	Feedrate (FΔT×10)	1000 (mm/min)/V	888 μsec
16	Model position droop	mm/V	3.55 msec
17	Model position droop (×10)	100μm/V	3.55 msec
18	Model position droop (×100)	10μm/V	3.55 msec
19	q axis current cumulative value	–	888 μsec
20	d axis current cumulative value	–	888 μsec

No.	Output data	Standard output unit	Output cycle
21	Motor load level	100%/5V	113.7 msec
22	Amplifier load level	100%/5V	113.7 msec
23	Regenerative load level	100%/5V	910.2 msec
24	PN bus wire voltage	50V/V (1/50)	888 μsec
25	Speed cumulative item	–	888 μsec
26	Cycle counter	0–5V (Regardless of resolution)	888 μsec
27	Excessive error detection amount	mm/V	3.55 msec
28	Collision detection estimated torque	Rated (stall) current/2V	888 μsec
29	Position command (stroke)	100mm/V	3.55 msec
30	Position command (pulse)	10μm/V	3.55 msec
31 ~ 99	No setting		
100	5 V test output	–	–
101	Saw-tooth wave test output	–5 ~ 5V Cycle 113.7 msec	888 μsec
102	Rectangular wave test output	0 ~ 5V Cycle 227.5 msec	888 μsec
103 ~	Setting prohibited		

5-1-3 Setting the output scale

This is set when an output is to made with a unit other than the standard output unit.

(Example 1) When SV061= 5, SV063 = 2560
The V-phase current value will be output with 1A/V unit to D/A output ch. 1.

(Example 2) When SV063 = 11, SV064 = 128
The position droop will be output with a 2mm/V unit to the D/A output ch. 2.

No.	Abbrev.	Parameter name	Explanation	Setting range
SV063	DA1MPY	D/A output channel 1 output scale	When "0" is set, the output will be made with the standard output unit. To change the output unit, set a value other than 0.	–32768 ~ 32767
SV064	DA2MPY	D/A output channel 2 output scale	The scale is set with a 1/256 unit. When 256 is set, the unit will be the same as the standard output unit.	

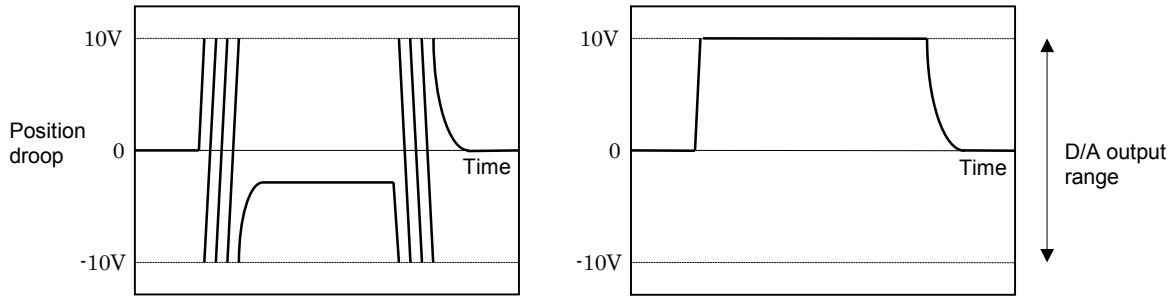
5-1-4 Setting the offset amount

This is used when the zero level of the output voltage is to be finely adjusted. The output scale when the data No. is 0 will be the offset amount. After setting the offset, set the data No. to a value other than 0, and do not set it to 0 again. Because the offset amount is saved in the amplifier memory, it does not need to be set again when the amplifier power is turned ON next.

No.	Abbrev.	Parameter name	Explanation	Setting range
SV061	DA1NO	D/A output channel 1 data No.	Set "0".	0 ~ 102
SV062	DA2NO	D/A output channel 2 data No.		
SV063	DA1MPY	D/A output channel 1 offset amount	The amount can be set with the output precision unit. Observe the output value and set so that the output value is 0 V.	–10 ~ 10
SV064	DA2MPY	D/A output channel 2 offset amount	Because the offset amount is saved in the amplifier memory, it does not need to be set again when the amplifier power is turned ON next.	

5-1-5 Clamp function

This is used when the output value such as the position droop exceeds the output range and over flows.



When overflow is set **When clamp is set**

5-1-6 Filter function

A low path filter with a cutoff frequency of 20 Hz can be set.

No.	Abbrev.	Parameter name	Explanation
SV034	SSF3	Servo function selection 3	Set the clamp function and filter function with the following parameter.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
								daf2	daf1	dac2	dac1	mon			

bit		Meaning when "0" is set.	Meaning when "1" is set.
4	dac1	ch. 1 Overflow setting	ch. 1 Clamp setting
5	dac2	ch. 2 Overflow setting	ch. 2 Clamp setting
6	daf1	ch. 1 No filter	ch. 1 Filter operation
7	daf2	ch. 2 No filter	ch. 2 Filter operation

5-2 Gain adjustment

5-2-1 Current loop gain

No.	Abbrev.	Parameter name	Explanation	Setting range
SV009	IQA	Current loop q axis lead compensation	This setting is determined by the motor's electrical characteristics. Set the standard parameters for all parameters. (These are used for maker adjustments.)	1 ~ 20480
SV010	IDA	Current loop d axis lead compensation		1 ~ 20480
SV011	IQG	Current loop q axis gain		1 ~ 2560
SV012	IDG	Current loop d axis gain		1 ~ 2560

5-2-2 Speed loop gain

(1) Setting the speed loop gain

The speed loop gain (SV005: VGN1) is an important parameter for determining the responsiveness of the servo control. During servo adjustment, the highest extent that this value can be set to becomes important. The setting value has a large influence on the machine cutting precision and cycle time.

To adjust the VGN1 value, first obtain the standard VGN1 to judge how much VGN1 is required for the machine load inertia.

The standard VGN1 is the value that corresponds to the size of the machine load inertia shown in the graph in section 4-2-3. If the load inertia is not clear, estimate it using the following procedure.

① Set the VGN1 of a level where acceleration/deceleration operation is possible. (Set a slightly lower value so resonance does not occur.)

② Set SV037 = 100, SV043 = 600, and SV044 = 0 in the servo parameters. Carry out a return operation within the range where the axis can operate smoothly. At this time, set the acceleration/deceleration time constant so the acceleration/deceleration torque equals or exceeds (is 100% or higher than) the stall (rated) torque.

③ Observe the estimated disturbance using the D/A output, and increase the SV037 value until the disturbance torque during acceleration/deceleration becomes smaller (cannot be observed).
(The unbalance torque is observed as an estimated disturbance torque in the vertical and slanted axes, so ignore this amount or set the torque offset (SV032) and adjust. The friction torque is also observed in the same way for axes having a large amount of friction, but this should be ignored. Refer to section "5-3-3 (3) Disturbance observer" for details.)

④ The SV037 setting where the disturbance torque becomes the smallest during the estimated acceleration/deceleration is the machine's total load inertia magnification including the motor inertia. Obtain the standard VGN1 from the graph in section 4-2-3 based on this value.

<When machine resonance does not occur at the standard VGN1>

Set the standard VGN1. Use the standard value if no problem (such as machine resonance) occurs. If sufficient cutting precision cannot be obtained at the standard VGN1, do not raise the VGN1 further above the standard value. Instead, use the disturbance observer and adjust. Basically, there is no need to set a value higher than the standard value in VGN1.

<When machine resonance occurs at the standard VGN1>

Machine resonance is occurring if the shaft makes abnormal sounds when operating or stopping, and a fine vibration can be felt when the machine is touched while stopped. Machine resonance occurs because the servo control responsiveness includes the machine resonance points. (Speed control resonance points occur, for example, at parts close to the motor such as ball screws.)
Machine resonance can be suppressed by lowering VGN1 and the servo control responsiveness, but the cutting precision and cycle time are sacrificed. Thus, set a vibration suppression filter and suppress the machine resonance (Refer to section "5-3-2 Vibration suppression measures"), and set a value as close as possible to the standard VGN1. If the machine resonance cannot be sufficiently eliminated even by using a vibration suppression filter, then lower the VGN1.

No.	Abbrev.	Parameter name	Explanation	Setting range
SV005	VGN1	Speed loop gain	Set this according to the motor inertia size. If vibration occurs, adjust by lower the setting by 20% to 30% at a time.	1 ~ 999

POINT

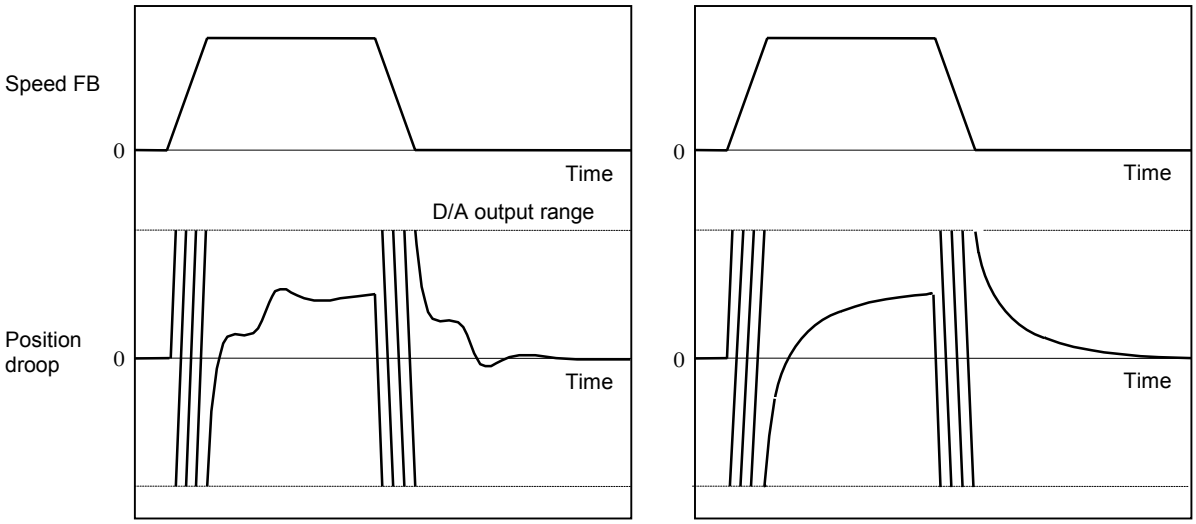
The final VGN1 setting value should be 70 to 80% of the largest value at which machine resonance does not occur.
If the vibration suppression functions are used to suppress the resonance and the VGN1 setting value is raised, the subsequent servo adjustment becomes more favorable.

(2) Setting the speed loop lead compensation

The speed loop lead compensation (SV008: VIA) determines the characteristics of the speed loop mainly at low frequency regions. 1364 is set as a standard, and 1900 is set as a standard during SHG control. The standard value may drop as shown in the graph in section 4-2-3 in respect to loads with a large inertia.

When the VGN1 is set lower than the standard value because the load inertia is large or because machine resonance occurred, the speed loop control band is lowered. If the standard value is set in the leading compensation in this status, the leading compensation control itself will induce vibration. In concrete terms, a vibration of 10 to 20Hz could be caused during acceleration/deceleration and stopping, and the position droop waveform could be disturbed when accelerating to a constant speed and when stopped. (Refer to the following graphs.)

This vibration cannot be suppressed by the vibration suppression functions. Lower the VIA in increments of 100 from the standard setting value. Set a value where vibration does not occur and the position droop waveform converges smoothly. Because lowering the VIA causes a drop in the position control's trackability, the vibration suppression is improved even when a disturbance observer is used without lowering the VIA. (Be careful of machine resonance occurrence at this time.)



Vibration waveform with leading compensation control **Adjusted position droop waveform**

If VIA is lowered, the position droop waveform becomes smooth and overshooting does not occur. However, because the trackability regarding the position commands becomes worse, that amount of positioning time and precision are sacrificed. VIA must be kept high (set the standard value) to guarantee precision, especially in high-speed contour cutting (generally F = 1000 or higher). In other words, a large enough value must be set in VGN1 so that the VIA does not need to be lowered in machines aimed at high-speed precision. When adjusting, the cutting precision will be better if adjustment is carried out to a degree where overshooting does not occur and a high VIA is maintained, without pursuing position droop smoothness.

If there are no vibration or overshooting problems, the high-speed contour cutting precision can be further improved by setting the VIA higher than the standard value. In this case, adjust by raising the VIA in increments of 100 from the standard value.

Setting a higher VIA improves the trackability regarding position commands in machines for which cycle time is important, and the time to when the position droop converges on the in-position width is shortened.

It is easier to adjust the VIA to improve precision and cycle time if a large value (a value near the standard value) can be set in VGN1, or if VGN1 can be raised equivalently using the disturbance observer.

No.	Abbrev.	Parameter name	Explanation	Setting range
SV008	VIA	Speed loop lead compensation	1364 is set as a standard. 1900 is set as a standard during SHG control. Adjust in increments of approx. 100. Raise the VIA and adjust to improve the contour tracking precision in high-speed cutting. If the position droop vibrates (10 to 20Hz), lower the VIA and adjust.	1 ~ 9999

POINT Position droop vibration of 10Hz or less is not leading compensation control vibration. The position loop gain must be adjusted.

5-2-3 Position loop gain

(1) Setting the position loop gain

The position loop gain (SV003:PGN1) is a parameter that determines the trackability to the command position. 33 is set as a standard. Set the same position loop gain value between interpolation axes.

When PGN1 is raised, the settling time will be shortened, but a speed loop that has a responsiveness that can track the position loop gain with increased response will be required. If the speed loop responsiveness is insufficient, several Hz of vibration or overshooting will occur during acceleration/deceleration. Vibration or overshooting will also occur when VGN1 is smaller than the standard value during VIA adjustment, but the vibration that occurs in the position loop is generally 10Hz or less. (The VIA vibration that occurs is 10 to 20Hz.) When the position control includes machine resonance points (Position control machine resonance points occur at the machine end parts, etc.) because of insufficient machine rigidity, the machine will vibrate during positioning, etc. In either case, lower PGN1 and adjust so vibration does not occur.

If the machine also vibrates due to machine backlash when the motor stops, the vibration can be suppressed by lowering the PGN1 and smoothly stopping.

If SHG control is used, an equivalently high position loop gain can be maintained while suppressing these vibrations. To adjust the SHG control, gradually raise the gain from a setting where 1/2 of a normal control PGN1 where vibration did not occur was set in PGN1. If the PGN1 setting value is more than 1/2 of the normal control PGN1 when SHG control is used, there is an improvement effect in position control. (Note that for the settling time the improvement effect is at $1/\sqrt{2}$ or more.)

No.	Abbrev.	Parameter name	Explanation	Setting range
SV003	PGN1	Position loop gain 1	Set 33 as a standard. If PGN1 is increased, the settling time will be shortened, but a sufficient speed loop response will be required.	1 ~ 200
SV004	PGN2	Position loop gain 2	Set 0. (For SHG control)	0 ~ 999
SV057	SHGC	SHG control gain	Set 0. (For SHG control)	0 ~ 999

⚠ CAUTION Always set the same value3 for position loop gain between interpolation axes.

(2) Setting the position loop gain for spindle synchronous control

During spindle synchronous control (synchronous tapping control, etc.), there are three sets of position loop gain parameters besides the normal control.

No.	Abbrev.	Parameter name	Explanation		Setting range
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	Set 15 as a standard.	Set the same parameter as the position loop gain for the spindle synchronous control.	1 ~ 200
SV050	PGN2sp	Position loop gain 2 in spindle synchronous control	Set 0 as a standard. (For SHG control)		0 ~ 999
SV058	SHGCsp	SHG control gain in spindle synchronous control	Set 0 as a standard. (For SHG control)		0 ~ 999

⚠ CAUTION Always set the same value for the position loop gain between the spindle and servo synchronous axes.

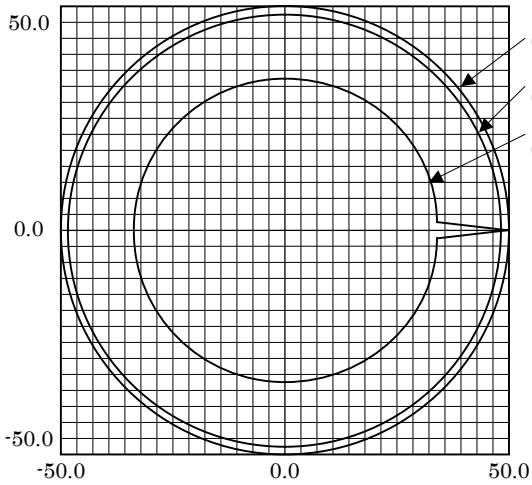
(3) SHG control (option function)

If the position loop gain is increased or feed forward control (CNC function) is used to shorten the settling time or increase the precision, the machine system may vibrate easily.
SHG control changes the position loop to a high-gain by stably compensating the servo system position loop through a delay. This allows the settling time to be reduced and a high precision to be achieved.

(Feature 1) When the SHG control is set, even if PGN1 is set to the same value as the conventional gain, the position loop gain will be doubled.

(Feature 2) The SHG control response is smoother than conventional position control during acceleration/deceleration, so the gain can be increased further with SHG control compared to the conventional position control.

(Feature 3) With SHG control, a high gain is achieved so a high precision can be obtained during contour control.
The following drawing shows an example of the improvement in roundness characteristics with SHG control.



(F=3000mm/min, ERROR=5.0μm/div)

<Effect>

Control method	Roundness error (μm)
SHG control	2.5
Conventional control	22.5

Shape error characteristics

During SHG control, PGN1, PGN2 and SHGC are set with the following ratio.

$$\text{PGN1 : PGN2 : SHGC} = 1 : \frac{8}{3} : 6$$

During SHG control even if the PGN1 setting value is the same, the actual position loop gain will be higher, so the speed loop must have a sufficient response. If the speed loop response is low, vibration or overshooting could occur during acceleration/deceleration in the same manner as conventional control. If the speed loop gain has been lowered because machine resonance occurs, lower the position loop gain and adjust.

No.	Abbrev.	Parameter name	Setting ratio	Setting example					Explanation	Setting range
SV003 (SV049)	PGN1 (PGN1sp)	Position loop gain 1	1	23	26	33	38	47	Always set a combination of the three parameters.	1 ~ 200
SV004 (SV050)	PGN2 (PGN2sp)	Position loop gain 2	8/3	62	70	86	102	125		0 ~ 999
SV057 (SV058)	SHGC (SHGCsp)	SHG control gain	6	140	160	187	225	281		0 ~ 999
SV008	VIA	Speed loop lead compensation	Set 1900 as a standard for SHG control.							1 ~ 9999
SV015	FFC	Acceleration rate feed forward gain	Set 100 as a standard for SHG control.							0 ~ 999

POINT

The SHG control is an optional function. If the option is not set in the CNC, the alarm 37 (at power ON) or warning E4, Error Parameter No. 104 (2304 for M50/M64 Series CNC) will be output.

5-3 Characteristics improvement

5-3-1 Optimal adjustment of cycle time

The following items must be adjusted to adjust the cycle time. Refer to the Instruction Manuals provided with each CNC for the acceleration/deceleration pattern.

①Rapid traverse rate (rapid) : This will affect the maximum speed during positioning.
②Clamp speed (clamp) : This will affect the maximum speed during cutting.
③Acceleration/deceleration time constant (G0t□, G1t□) : Set the time to reach the feedrate.
④In-position width (SV024) : This will affect each block's movement command end time.
⑤Position loop gain (SV003) : This will affect each block's movement command settling time.

(1) Adjusting the rapid traverse rate

To adjust the rapid traverse, the CNC axis specification parameter rapid traverse rate (rapid) and acceleration/deceleration time constant (G0t□) are adjusted. The rapid traverse rate is set so that the motor speed matches the machine specifications in the range below the maximum speed in the motor specifications. For the acceleration/deceleration time constants, carry out rapid traverse reciprocation operation, and set so that the maximum current command value at acceleration /deceleration is within the range shown below. (Only when the rapid traverse rate is below the rated speed.) Set the same value as the adjusted acceleration/deceleration time constant in the servo parameter's deceleration control time constant (SV056:EMGt). (When deceleration control is set.) For motors in which the maximum speed is greater than the rated speed (HC-SF, HC-RF, HC-MF, HA-FF), the output torque is particularly restricted in the region at or above the rated speed. When adjusting, watch the current FB waveform during acceleration/deceleration, and adjust so that the torque is within the specified range. Be careful, as insufficient torque can easily occur when the amplifier input voltage is low (170 to 190V), and an excessive error can easily occur during acceleration/deceleration.

HC□ Series		HA□N Series		HC-SF Series	
Motor type	**Max. current command value**	**Motor type**	**Max. current command value**	**Motor type**	**Max. current command value**
HC52	390% or less	HA40N	420% or less	HC-SF52	270% or less
HC102*	270% or less	HA80N	370% or less	HC-SF102	270% or less
HC102	340% or less	HA100N	270% or less	HC-SF152	270% or less
HC152*	270% or less	HA200N*	270% or less	HC-SF202	270% or less
HC152	380% or less			HC-SF352	270% or less
HC202*	270% or less	HA053N	240% or less		
HC202	275% or less	HA13N	240% or less	HC-SF53	270% or less
HC352*	270% or less	HA23N	235% or less	HC-SF103	270% or less
HC53	265% or less	HA33N	235% or less	HC-SF153	270% or less
HC103	260% or less	HA43N	300% or less	HC-SF203	270% or less
HC153	265% or less	HA83N	280% or less	HC-SF353	270% or less
HC203*	270% or less	HA103N*	270% or less		

HC□R, HC-RF Series		HA-FF Series		HC-MF Series	
Motor type	**Max. current command value**	**Motor type**	**Max. current command value**	**Motor type**	**Max. current command value**
HC103R	225% or less	HA-FF053	270% or less	HC-MF053	290% or less
HC153R	225% or less	HA-FF13	270% or less	HC-MF13	290% or less
HC203R	225% or less	HA-FF23	270% or less	HC-MF23	320% or less
HC-RF103	225% or less	HA-FF33	270% or less	HC-MF43	305% or less
HC-RF153	225% or less	HA-FF43	270% or less	HC-MF73	320% or less
HC-RF203	225% or less	HA-FF63	270% or less		

⚠ CAUTION

When using a range higher than the rated speed for the HC-SF, HC-RF, HA-FF and HC-MF motor, take special care to the acceleration/deceleration torque. If the amplifier input voltage is low (170 to 190V), an excessive error could occur easily during acceleration/deceleration.
When adjusting, decide the acceleration/deceleration time constant from the motor speed - torque characteristics so that the acceleration/deceleration torque is within the specifications range. The output torque at high speed regions can be reduced by using the S-pattern (soft) acceleration/deceleration function (NC function).

(2) Adjusting the cutting rate

To adjust the cutting rate, the CNC axis specification parameter clamp speed (clamp) and acceleration/deceleration time constant (G1t□) are adjusted. The in-position width at this time must be set to the same value as actual cutting.

• Determining the clamp rate and adjusting the acceleration/deceleration time constant

(Features) The maximum cutting rate (clamp speed) can be determined freely.

(Adjustment) Carry out cutting feed reciprocation operation with no dwell at the maximum cutting rate and adjust the acceleration/deceleration time constant so that the maximum current command value during acceleration/deceleration is within the range shown below.

• Setting the step acceleration/deceleration and adjusting the clamp speed

(Features) The acceleration/deceleration time constant is determined with the position loop in the servo, so the acceleration/deceleration F⊿T can be reduced.

(Adjustment) Set 1 (step) for the acceleration/deceleration time constant and carry out cutting feed reciprocation operation with no dwell. Adjust the cutting feed rate so that the maximum current command value during acceleration/deceleration is within the range shown below, and then set the value in the clamp speed.

<Maximum current command value>

For the maximum current command value during acceleration/deceleration, the maximum current command value for one second is output to MAX current 1 and MAX current 2 on the CNC servo monitor screen and observed.

Change "mon" in the servo function selection 3 (SV034: SSF3) and display.

No.	Abbrev.	Parameter name	Explanation
SV034	SSF3	Servo function selection 3	The display data for the maximum current value on the servo monitor is determined with the following parameter.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
								daf2	daf1	dac2	dac1	mon			

bit	mon	MAX current 1	MAX current 2
0~3	0	Max. current command value (%) when power is turned ON	Max. current command value (%) for 1 second
	1	Max. current command value (%) for 1 second	Max. current FB value (%) for 1 second
	2	Max. current FB value (%) when power is turned ON	Max. current FB value (%) for 1 second
	3	Load inertia rate (SV059 setting value)	–
	4	Adaptive filter operation frequency (Hz)	Adaptive filter operation gain (%)
	5	PN bus voltage (V)	Regenerative operation frequency monitor (times/sec)
	6	Maximum estimated torque for one second (%)	Maximum current FB value for one second (%)
	7	Maximum estimated torque for one second (%)	Maximum disturbance torque for two seconds (%)
	8~F	Setting prohibited	

(3) Adjusting the in-position width

Because there is a response delay in the servomotor drive due to position loop control, a "settling time" is also required for the motor to actually stop after the command speed from the CNC reaches 0.

The movement command in the next block is generally started after it is confirmed that the machine has entered the "in-position width" range set for the machine.

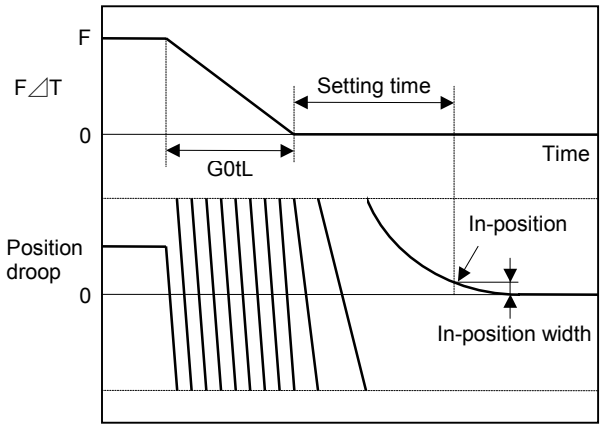
The in-position width is effective even when the standard servo parameters are set. However, it may follow the CNC parameters, so refer to the CNC Instruction Manual for the setting.

No.	Abbrev.	Parameter name	Unit	Explanation	Setting range
SV024	INP	In-position detection width	μm	Set 50 as a standard. Set the precision required for the machine.	0 ~ 32767

POINT The in-position width setting and confirmation availability depend on the CNC parameters

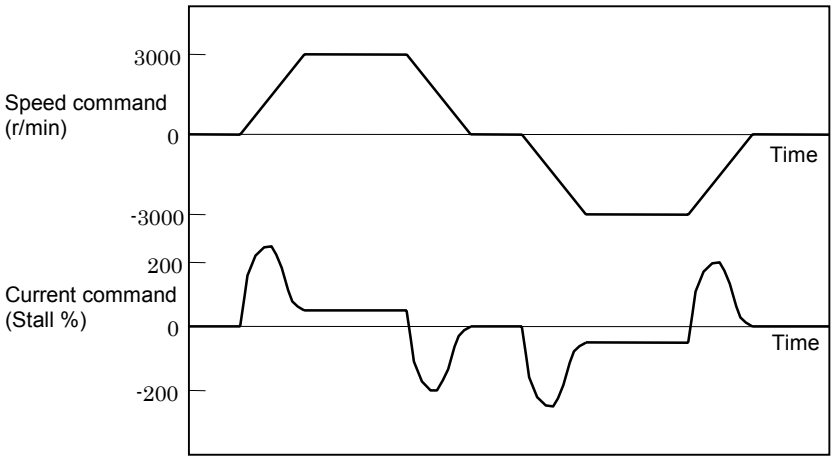
(4) Adjusting the settling time

The settling time is the time required for the position droop to enter the in-position width after the feed command (F⊿T) from the CNC reaches 0.
The settling time can be shortened by raising the position loop gain or using SHG control. However, a sufficient response (sufficiently large VNG1 setting) for the speed loop is required to carry out stable control.
The settling time during normal control when the CNC is set to linear acceleration/deceleration can be calculated using the following equation. During SHG control, estimate the settling time by multiplying PGN1 by $\sqrt{2}$.



$$\text{Settling time (msec)} = -\frac{10^3}{PGN1} \times \ln\left[\frac{INP}{\frac{F \times 10^6}{60 \times G0tL \times PGN1^2} \times \left[1 - \exp\left[-\frac{PGN1 \times G0tL}{10^3}\right]\right]}\right]$$

PGN1	: Position loop gain1 (SV003)	(rad/sec)
F	: Rapid traverse rate	(mm/min)
G0tL	: Rapid traverse linear acceleration/ deceleration time constant	(msec)
INP	: In-position width (SV024)	(μm)



Example of speed/current command waveform during acceleration/deceleration

(Reference) The rapid traverse acceleration/deceleration time setting value G0tL for when linear acceleration/deceleration is set is calculated with the following expression.

$$G0tL = \frac{(J_L + J_M) \times No}{95.5 \times (0.8 \times T_{MAX} - T_L)} - \frac{6000}{(PGN1 \times K)^2} \quad \text{(msec)}$$

N_O	: Motor reach speed	(r/min)
J_L	: Motor shaft conversion load inertia	(kg·cm^2)
J_M	: Motor inertia	(kg·cm^2)
T_{MAX}	: Motor max. torque	(N·m)
T_L	: Motor shaft conversion load (friction, unbalance) torque	(N·m)
PGN1	: Position loop gain 1	(rad/sec)
K	: "1" during normal control, "2" during SHG control	

5-3-2 Vibration suppression measures

If vibration (machine resonance) occurs, it can be suppressed by lowering the speed loop gain (VGN1). However, cutting precision and cycle time will be sacrificed. (Refer to "5-2-2 Speed loop gain".) Thus, try to maintain the VGN1 as high as possible, and suppress the vibration using the vibration suppression functions.

If the VGN1 is lowered and adjusted because vibration cannot be sufficiently suppressed with the vibration suppression functions, adjust the entire gain (including the position loop gain) again.

<Examples of vibration occurrence>

- A fine vibration is felt when the machine is touched, or a groaning sound is heard.
- Vibration or noise occurs during rapid traverse.

No.	Abbrev.	Parameter name	Explanation	Setting range
SV005	VGN1	Speed loop gain	Set according to the load inertia size. If machine resonance occurs, adjust by lowering the value by 20 to 30% at a time. The final setting value should be 70 to 80% of the maximum value where resonance does not occur.	1 ~ 999

POINT Suppress the vibration using the vibration suppression functions, and maintain the speed loop gain (SV005: VGN1) as high as possible.

(1) Notch filter 1

The resonance elimination filter will function at the set frequency. Use the D/A output function to output the current feedback and measure the resonance frequency. Note that the resonance frequency that can be measured is 0 to 500 Hz. For resonance exceeding 500 Hz, directly measure the phase current with a current probe, etc.
When the notch filter is set, vibration may occur at a separate resonance frequency that existed latently at first. In this case, the servo control is stabilized when the notch filter depth is adjusted and the filter is adjusted so as not to operate more than required.

<Setting method>

1. Set the resonance frequency in the notch filter frequency 1 (SV038: FHz1).
2. If the machine starts to vibrate at another frequency, raise (make shallower) the notch filter depth compensation value (SV033: SSF2.nfd), and adjust to the optimum value at which the resonance can be eliminated.
3. When the vibration cannot be completely eliminated, use another vibration suppression control (jitter compensation, adaptive filter) in combination with the notch filter.

No.	Abbrev.	Parameter name	Explanation	Setting range
SV038	FHz1	Notch filter frequency 1	Set the resonance frequency to be suppressed. (Valid at 72 or more). Set 0 when the filter is not to be used.	0 ~ 3000
SV033	SSF2	Servo function selection 2	The notch filter 1 depth compensation is set with the following parameters.	

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
				afs						fhz2		nfd			

bit		Descriptions
0~3	nfd	Set the filter depth for the notch filter.

	Deeper ←						→ Shallower
Setting value	0	2	4	6	8	A	C	E
Depth (dB)	∞	−18.1	−12.0	−8.5	−6.0	−4.1	−2.5	−1.2

(2) Notch filter 2

The frequency can be set separately from the notch filter 1. Note that low frequencies cannot be set and the depth cannot be compensated.

No.	Abbrev.	Parameter name	Explanation
SV033	SSF2	Servo function selection 2	The notch filter 2 sets the operation frequency with the following parameters.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
				afs						fhz2		nfd			

bit		No notch filter	2250Hz	1125Hz	750Hz
4	fhz2	0	1	0	1
5		0	0	1	1

(3) Jitter compensation

The load inertia becomes extremely small if the motor position enters the machine backlash when the motor is stopped. Because this means that an extremely large VGN1 is set for the load inertia, vibration may occur.
Jitter compensation is the suppression of vibration occurring when the motor stops by ignoring the backlash amount of speed feedback pulses when the speed feedback polarity changes.
Increase the number of ignored pulses by one pulse at a time, and set a value at which the vibration can be suppressed. (Because the position feedback is controlled normally, there is no worry of positional deviation.)
When an axis that does not vibrate is set, vibration could be induced, so take care.

No.	Abbrev.	Parameter name	Explanation
SV027	SSF1	Servo function selection 1	Set the jitter compensation with the following parameter.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
aflt	zrn2			ovs		lmc				vfct					

bit		No jitter compensation	One pulse compensation	Two pulse compensation	Three pulse compensation
4	vfct	0	1	0	1
5		0	0	1	1

POINT Jitter compensation vibration suppression is only effective when the motor is stopped.

(4) Adaptive filter (option function)

The servo amplifier detects the machine resonance point and automatically sets the filter constant. Even if the ball screw and table position relation changes causing the resonance point to change, the filter will track these changes.

Set the servo function selection 1 (SV027: SSF1) bit F to activate the adaptive filter.

If the vibration suppression effects do not appear even when the adaptive filter is activated, change the "MAX current" display on the servo monitor, and confirm the operation status of the adaptive filter. When the adaptive filter operation gain is 70% or more, adjust by gradually raising the filter operation sensitivity (SV033: SSF2.afs) from the point where the sufficient filter results do not appear.

Once converged, the adaptive filter constant is stored in the servo amplifier memory when the CNC power is turned OFF. Even if the amplifier is turned OFF, it will start with the previously saved constant when the power is turned ON next. To reset a filter constant that has been converged once, set 0 in SSF1.aflt and stop the adaptive filter.

No.	Abbrev.	Parameter name	Explanation
SV027	SSF1	Servo function selection 1	Activate the adaptive filter by setting the following parameters.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
aflt	zm2			ovs	lmc					vfct					

bit		Meaning when "0" is set.	Meaning when "1" is set.
F	aflt	Adaptive filter stopped	Adaptive filter activated

No.	Abbrev.	Parameter name	Explanation
SV033	SSF2	Servo function selection 2	Set the adaptive filter sensitivity compensation with the following parameters.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
				afs						fhz2		nfd			

bit		Descriptions
8~B	afs	Standard sensitivity when 0 is set. If the filter depth is not deep enough (generally 70% or more) and the vibration cannot be sufficiently eliminated, adjust by raising the setting value in increments of 1.

No.	Abbrev.	Parameter name	Explanation
SV034	SSF3	Servo function selection 3	The display data for the maximum current value on the servo monitor is determined with the following parameter.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
								daf2	daf1	dac2	dac1	mon			

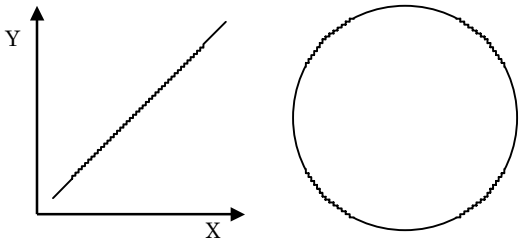
bit	mon	MAX current 1	MAX current 2
0~3	0	Max. current command value (%) when power is turned ON	Max. current command value (%) for 1 second
	1	Max. current command value (%) for 1 second	Max. current FB value (%) for 1 second
	2	Max. current FB value (%) when power is turned ON	Max. current FB value (%) for 1 second
	3	Load inertia rate (SV059 setting value)	–
	4	Adaptive filter operation frequency (Hz)	Adaptive filter operation gain (%)
	5	PN bus voltage (V)	Regenerative operation frequency monitor (times/sec)
	6	Maximum estimated torque for one second (%)	Maximum current FB value for one second (%)
	7	Maximum estimated torque for one second (%)	Maximum disturbance torque for two seconds (%)
	8~F	Setting prohibited	

POINT

The adaptive filter is an optional function. If the option is not set in the CNC, alarm 37 (at power ON) or warning E4 "Error Parameter No. 105 (2305 for M50/M64 Series CNC) will be output.

5-3-3 Improving the cutting surface precision

If the cutting surface precision is poor, it can be improved by adjusting the speed loop gain or by using the voltage dead zone compensation or disturbance observer function.



<Examples of faults>

- The surface precision in the 45° direction of a taper or arc is poor.
- The load fluctuation during cutting is large, causing vibration or surface precision defects to occur.

POINT

Adjust by raising the speed loop gain equivalently to improve cutting surface precision, even if the measures differ. In this case, it is important how much the machine resonance can be controlled, so adjust making sufficient use of vibration suppression functions.

(1) Adjusting the speed loop gain (VGN1)

If the speed loop gain is increased, the cutting surface precision will be improved but the machine will resonate easily.
The final VGN1 setting should be approx. 70 to 80% of the maximum value where resonance does not occur. (Refer to "5-2-2 (1) Setting the speed loop gain")

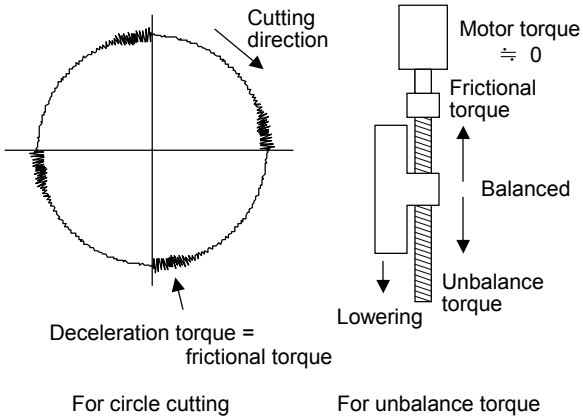
(2) Adjusting the speed loop leading compensation (VIA)

The VIA has a large influence on the position trackability, particularly during high-speed cutting (generally F1000 or more). Raising the setting value improves the position trackability, and the contour precision during cutting can be improved. For high-speed high-precision cutting machines, adjust so that a value equal to or higher than the standard value can be set.
When VIA is set lower than the standard value and set to a value differing between interpolation axes, the roundness may worsen (the circle may distort). This is due to differences occurring in the position trackability between interpolation axes. The distortion can be improved by matching the VIA with the smaller of the values. Note that because the position trackability is not improved, the surface precision will not be improved.
(Refer to "5-2-2 (2) Setting the speed loop leading compensation")

No.	Abbrev.	Parameter name	Explanation	Setting range
SV005	VGN1	Speed loop gain	Increase the value by 20 to 30% at a time. If the machine starts resonating, lower the value by 20 to 30% at a time. The setting value should be 70 to 80% of the value where resonance does not occur.	1 ~ 999
SV008	VIA	Speed loop lead compensation	1364 is set as a standard. 1900 is set as a standard during SHG control. Adjust in increments of approx. 100. Raise the VIA and adjust to improve the contour tracking precision in high-speed cutting. If the position droop vibrates (10 to 20Hz), lower the VIA and adjust.	1 ~ 9999

(3) Voltage non-sensitive zone (Td) compensation (Compatible from software version C3)

With the PWM control of the inverter, a dead time (non-energized time) is set to prevent short-circuits caused by simultaneous energizing of the P side and N side transistors having the same phase. The dead time has a non-sensitive zone for particularly low voltage commands. Thus, when feeding with a low speed and a low torque, the control may be unstable. When an unbalanced axis is lowering, the frictional torque and unbalance torque, and the frictional torque and deceleration torque before the quadrant changes during circle cutting, are balanced. The motor output torque will be approximately zero, and the control accuracy may drop. In this case, the control accuracy can be improved by using the voltage non-sensitive band compensation. Note that this may cause vibration to increased while the motor is running.



No.	Abbrev.	Parameter name	Explanation	Setting range
SV030	IVC	Voltage dead-time compensation	When 100% is set, the voltage equivalent to the logical non-energized time will be compensated. Adjust in increments of 10% from the default value 100%. If increased too much, vibration or vibration noise may be generated.	0 ~ 200

(4) Disturbance observer

The disturbance observer can reduce the effect caused by disturbance, frictional resistance or torsion vibration during cutting by estimating the disturbance torque and compensating it. It also is effective in suppressing the vibration caused by speed leading compensation control.

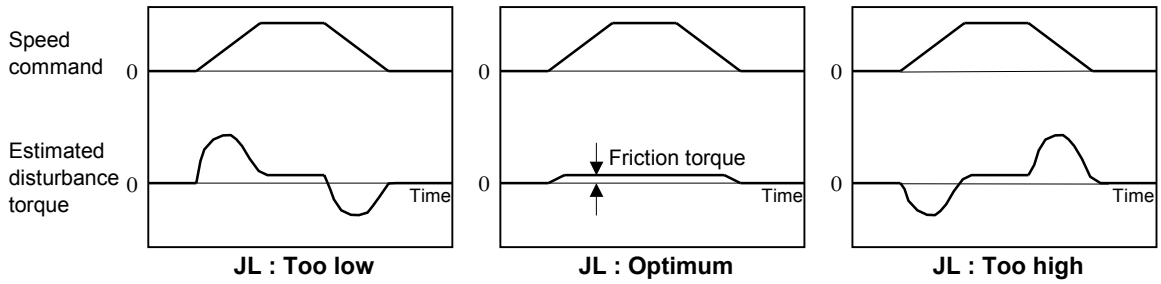
<Setting method>

1. Adjust VGN1 to the value where vibration does not occur, and then lower it 10 to 20%.
2. Set the load inertia scale (SV037:JL) with a percentage in respect to the motor inertia of the total load inertia.
3. Set the observer filter band (observer pole) in the disturbance observer filter frequency (SV043:OBS1), and estimate the high frequency disturbance to suppress the vibration. Set 300 as a standard.
4. Set the observer gain in disturbance observer gain (SV044:OBS2). The disturbance observer will function here for the first time. Set 100 first, and if vibration does not occur, increase the setting by 50 at a time to increase the observer effect.
5. If vibration occurs, lower OBS1 by 50 at a time. The vibration can be eliminated by lowering OBS2, but the effect of the disturbance observer can be maintained by keeping OBS2 set to a high value.

<Load inertia measurement method>

If the load inertia is not clearly known, estimate it with the following method.

1. With the unbalance axis, set the torque offset (SV032:TOF). (Refer to "5-3-4 (2) Unbalance torque compensation")
2. Set JL = 100, OBS1 = 600, and OBS2 = 0, and carry out a return operation within the range where the axis can operate smoothly. At this time, set the acceleration/deceleration time constant so the acceleration/deceleration torque equals or exceeds (is 100% or higher than) the stall (rated) torque.
3. Observe the estimated disturbance torque using the D/A output, and increase JL until the disturbance torque during acceleration/deceleration becomes small (cannot be observed). Even when the torque offset is set and JL is an appropriate value, the friction torque amount remains in the estimated disturbance torque of axes having a large amount of friction. As shown in the graphs below, judge the setting value for JL having only the friction torque remaining as the machine load inertia magnification.



JL : Too low **JL : Optimum** **JL : Too high**

From software Version C3, the load inertia can be measured using the collision detection function. Refer to the section "5-5 Collision detection".

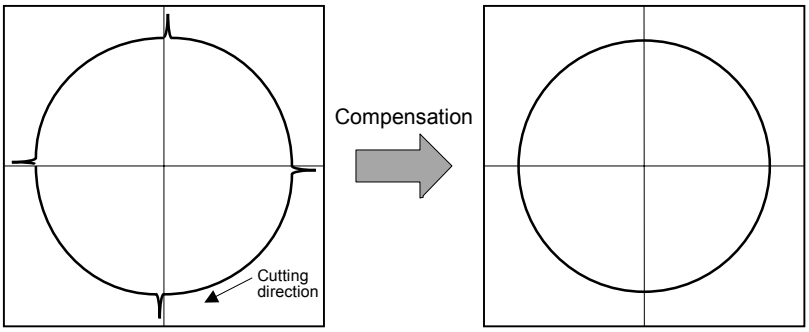
No.	Abbrev.	Parameter name	Unit	Explanation	Setting range
SV037	JL	Load inertia scale	%	Set the load inertia that includes the motor in respect to the motor inertia. (When the motor is a single unit, set 100%) $JL = \frac{Jl + Jm}{Jm}$ Jm : Motor inertia Jl : Machine inertia	0 ~ 5000
SV043	OBS1	Disturbance observer filter frequency	rad/sec	Set the observer filter band (observer pole). Set 300 as a standard, and lower the setting by 50 at a time if vibration occurs.	0 ~ 1000
SV044	OBS2	Disturbance observer gain	%	Set the observer gain. Set 100 to 300 as a standard, and lower the setting if vibration occurs.	0~ 1000

POINT

1. When the observer gain is set to zero (OBS2 = 0), the estimated disturbance torque can be output to the D/A output even if the disturbance observer is not functioning.
2. Parts of the machine that do not move smoothly can be presumed to be the disturbance.
3. When the disturbance observer has been started, the lost motion compensation must be readjusted.

5-3-4 Improvement of protrusion at quadrant changeover

The response delay (caused by non-sensitive band from friction, torsion, expansion/contraction, backlash, etc.) caused when the machine advance direction reverses is compensated with the lost motion compensation (LMC compensation) function.
With this, the protrusions that occur with the quadrant changeover in the DDB measurement method, or the streaks that occur when the quadrant changes during circular cutting can be improved.



Circle cutting path before compensation **Circle cutting path after compensation**

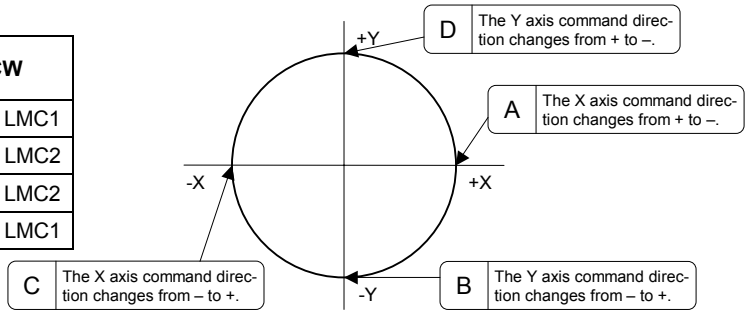
(1) Lost motion compensation (LMC compensation)

The lost motion compensation compensates the response delay during the reversal by adding the torque command set with the parameters when the speed direction changes. There are two methods for lost motion compensation. With the MDS-B-SVJ2, type 2 is used as a standard. (The explanation for type 1 method is omitted because it is interchangeable with the old method.)

<Setting method>

1. Set the servo function selection 1 (SV027:SSF1) bit 9. (The LMC compensation type 2 will start).
2. Set the compensation amount with a stall % (rated current % for the general-purpose motor) unit in the lost motion compensation 1 (SV016:LMC1). The LMC1 setting value will be used for compensation in the positive and negative directions when SV041:LMC2 is 0.
3. If the compensation amount is to be changed in the direction to be compensated, set LMC2. The compensation direction setting will be as shown below with the CW/CCW setting in the CNC parameter. If only one direction is to be compensated, set the side not to be compensated as -1.

Compensation point	CW	CCW
A	X axis: LMC2	X axis: LMC1
B	Y axis: LMC1	Y axis: LMC2
C	X axis: LMC1	X axis: LMC2
D	Y axis: LMC2	Y axis: LMC1



No.	Abbrev.	Parameter name	Explanation
SV027	SSF1	Servo function selection 1	The lost motion compensation starts with the following parameter.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
aflt	zrn2			ovs		lmc				vfct					

bit		Explanation	
8	lmc	00: Lost motion comp. stop	10: Lost motion comp. type 2
9		01: Lost motion comp. type 1	11: Setting prohibited

No.	Abbrev.	Parameter name	Unit	Explanation	Setting range
SV016	LMC1	Lost motion compensation 1	Stall % (rated current %)	While measuring the quadrant protrusion amount, adjust with a 5% unit. The ± direction setting value will be applied when LMC2 is set to 0.	–1 ~ 200
SV041	LMC2	Lost motion compensation 2	Stall % (rated current %)	Set 0 as a standard. Set this when the compensation amount is to be changed according to the direction.	–1 ~ 200

<Adjustment method>

First confirm whether the axis to be compensated is an unbalance axis (vertical axis, slant axis). If it is an unbalance axis, carry out the adjustment after performing step "(2) Unbalance torque compensation".

Next, measure the frictional torque. Carry out reciprocation operation (approx. F1000) with the axis to be compensated and measure the load current % when fed at a constant speed on the CNC servo monitor screen. The frictional torque of the machine at this time is expressed with the following expression.

$$\text{Frictional torque} = \left| \frac{(+\text{ feed load current \%}) - (-\text{ feed load current \%})}{2} \right|$$

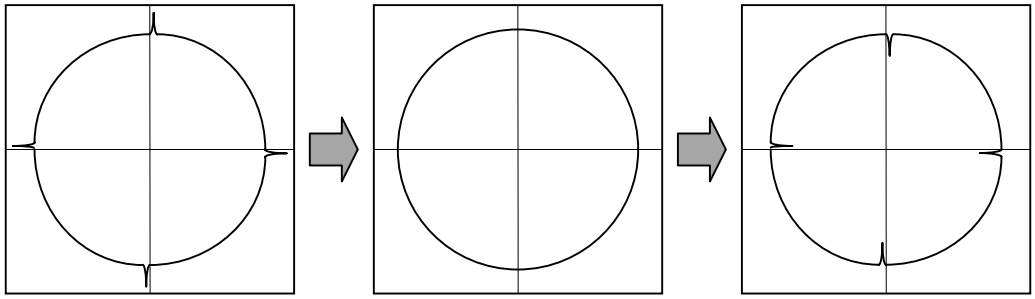
The standard setting value for the lost motion compensation 1 (LMC1) is double the frictional torque above.

(Example)

Assume that the load current % was 25% in the + direction and –15% in the – direction when JOG feed was carried out at approx. F1000. The frictional torque is as shown below, so 20% × 2 = 40% (LMC2 remains at zero, and compensation is carried out in both directions.) is set for LMC1. (LMC2 is left set at 0.) With this setting, 40% compensation will be carried out when the command reverses from the + direction to the - direction, and when the command reverses from the – direction to the + direction.

$$\left| \frac{25 - (-15)}{2} \right| = 20\%$$

For the final adjustment, measure the CNC sampling measurement (DBB measurement) or while carrying out actual cutting. If the compensation amount is insufficient, increase LMC1 or LMC2 by 5% at a time. Note that if the setting is too high, biting may occur.



Compensation 0 **Optimum** **Too high**

POINT

1. When either parameter SV016: LMC1 or SV041: LMC2 is set to 0, the same amount of compensation is carried out in both the positive and negative direction with the setting value of the other parameter (the parameter not set to 0).
2. To compensate in only one direction, set -1 in the parameter (LMC1 or LMC2) for the direction in which compensation is prohibited.
3. The value set based on the friction torque is the standard value for LMC compensation. The optimum compensation value changes with the cutting conditions (cutting speed, cutting radius, blade type, workpiece material, etc.). Be sure to ultimately make test cuts matching the target cutting and determine the compensation amount.
4. When the disturbance observer has been started, the observer compensation will also be effective on quadrant protrusions, so the optimum compensation amount of the lost motion compensation will drop. Note that the quadrant protrusions cannot be completely compensated with only the disturbance observer.

(2) Unbalance torque compensation

If the load torque differs in the positive and negative directions such as with a vertical axis or slant axis, the torque offset (SV032:TOF) is set to carry out accurate lost motion compensation.

<Setting method>

Measure the unbalance torque. Carry out reciprocation operation (approx. F1000) with the axis to be compensated and measure the load current % when fed at a constant speed on the CNC servo monitor screen. The unbalance torque at this time is expressed with the following expression.

$$\text{Unbalance torque} = \left| \frac{(+\text{ feed load current \%}) - (-\text{ feed load current \%})}{2} \right|$$

The unbalance torque value above is set for the torque offset (TOF).
If there is a difference in the protrusion amount according to the direction, make an adjustment with LMC2. Do not adjust with TOF.

(Example)

Assume that the load current % was –40% in the + direction and –20% in the – direction when JOG feed was carried out at approx. F1000. The unbalance torque is as shown below, so –30% is set for TOF.

$$\left| \frac{-40 + (-20)}{2} \right| = -30\%$$

No.	Abbrev.	Parameter name	Unit	Explanation	Setting range
SV032	TOF	Torque offset	Stall % (rated current %)	Set the unbalance torque amount.	–100 ~ 100

POINT

Even when TOF is set, the torque output characteristics of the motor and load current display of the CNC servo monitor will not change. Both the LMC compensation and collision detection function are affected.

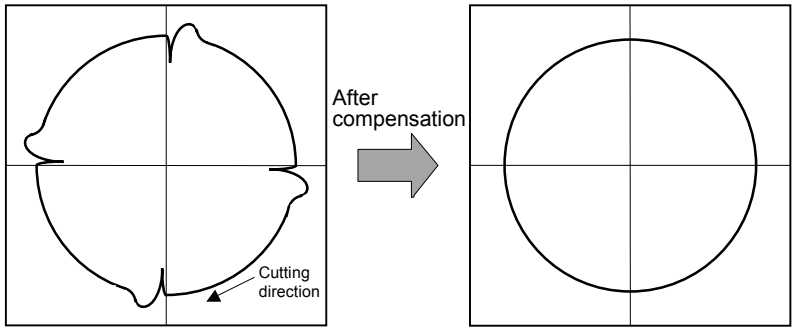
(3) Adjusting the lost motion compensation timing

If the speed loop gain has been lowered from the standard setting value because the machine rigidity is low or because machine resonance occurs easily, or when cutting at high speeds, the quadrant protrusion may appear later than the quadrant changeover point on the servo control. In this case, suppress the quadrant protrusion by setting the lost motion compensation timing (SV039: LMCD) to delay the LMC compensation.

<Adjustment method>

If a delay occurs in the quadrant protrusion in the circle or arc cutting as shown below in respect to the cutting direction when CNC sampling measurement (DDB measurement) or actual cutting is carried out, and the compensation appears before the protrusion position, set the lost motion compensation timing (SV039:LMCD).

While measuring the arc path, increase LMCD by 10 msec at a time, to find the timing that the protrusion and compensation position match.

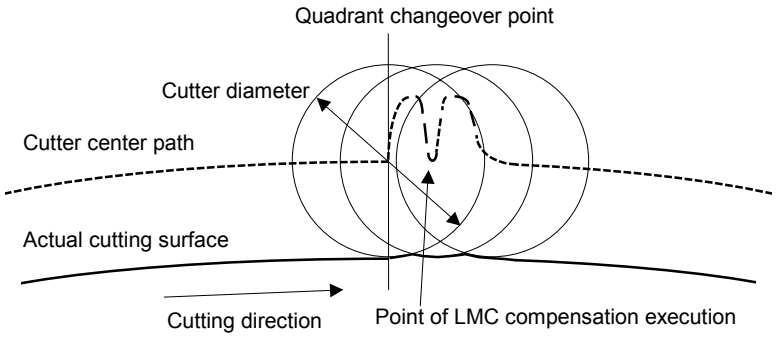


Before timing delay compensation **After timing delay compensation**

No.	Abbrev.	Parameter name	Unit	Explanation	Setting range
SV039	LMCD	Lost motion compensation timing	msec	Set this when the lost motion compensation timing does not match. Adjust while increasing the value by 10 at a time.	0 ~ 2000

When the LMCD is gradually raised, a two-peaked contour may occur at the motor FB position DBB measurement. However, due to the influence of the cutter diameter in cutting such as end milling, the actual cutting surface becomes smooth.

Because satisfactory cutting can be achieved even if this two-peaked contour occurs, consider the point where the protrusion becomes the smallest and finest possible without over compensating (bite-in) as the optimum setting.



(4) Adjusting for feed forward control

In LMC compensation, a model position considering the position loop gain is calculated based on the position command sent from the CNC, and compensation is carried out when the feed changes to that direction. When the CNC carries out feed forward (fwd) control, overshooting equivalent to the operation fraction unit occurs in the position commands, and the timing of the model position direction change may be mistaken. As a result, the LMC compensation timing may deviate, or compensation may be carried out twice.

If feed forward control is carried out and the compensation does not operate correctly, adjust with the non-sensitive band (SV040: LMCT) during feed forward control. In this non-sensitive band control, overshooting of a set width or less is ignored. The model position direction change point is correctly recognized, and the LMC compensation is correctly executed.

This parameter is meaningless when feed forward control is not being carried out.

<Adjustment method>

If the compensation timing deviates during feed forward control, increase the LMCT setting by 1μm at a time.

Note that 2μm are set even when the LMCT is set to 0.

No.	Abbrev.	Parameter name	Unit	Explanation	Setting range
SV040	LMCT	Non-sensitive band during feed forward control	μm	This setting is valid only during feed forward control. 2 μm is set when this is set to 0. Adjust by increasing the value by 1 μm at a time.	0 ~ 100

POINT

Setting of the non-sensitive band (SV040: LMCT) during feed forward control is effective for improving overshooting compensation mis-operation during feed forward control.

5-3-5 Improvement of overshooting

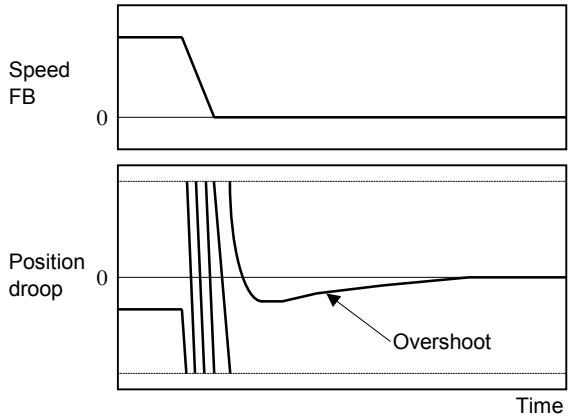
The phenomenon when the machine position goes past or exceeds the command during feed stopping is called overshooting. Overshooting is compensated by overshooting compensation (OVS compensation).

The phenomenon when the machine position exceeds the command during feed stopping is called overshooting. Overshooting occurs due to the following two causes.

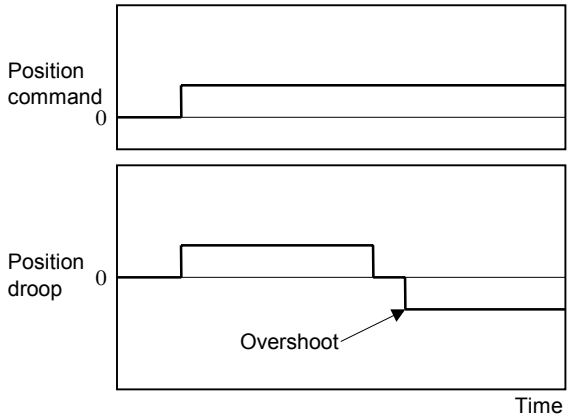
①Machine system torsion: Overshooting will occur mainly during rapid traverse settling

②Machine system friction: Overshooting will occur mainly during one pulse feed

Either phenomenon can be confirmed by measuring the position droop.



①Overshooting during rapid traverse settling



②Overshooting during pulse feed

(1) Overshooting compensation (OVS compensation)

In OVS compensation, the overshooting is suppressed by subtracting the torque command set in the parameters when the motor stops. There are two types of OVS compensation. The standard method for the MDS-B-SVJ2 is type 1.

OVS compensation type1 has a compensation effect for the overshooting during either rapid traverse settling or pulse feed. Note that there is no compensation if the next feed command has been issued before the motor positioning (stop). (Therefore, there is no compensation during circle cutting.) There is also no compensation when the CNC is carrying out feed forward control. To compensate overshooting during feed forward control, refer to the following section "(2) Adjusting for feed forward control".

<Setting and adjustment methods>

① Set the servo function selection 1 (SV027:SSF1) bit A. (OVS compensation type 1 will start.)

② Observe the position droop waveform using the D/A output, and increase the overshoot compensation 1 (SV031: OVS1) value 1% at a time. Set the smallest value where the overshooting does not occur. If SV042:OVS2 is 0, the overshooting will be compensated in both the forward/reverse directions with the OVS1 setting value.

③ If the compensation amount is to be changed in the direction to be compensated, set the + direction compensation value in OVS1 and the – direction compensation value in OVS2. If only one direction is to be compensated, set the side not to be compensated as -1. The compensation direction setting will be as reversed with the CNC parameter CW/CCW setting.

POINT

In OVS compensation type 1, there is no compensation in the following cases.

1. There is no compensation if the next feed command has been issued before the motor positioning (stop). (There is no compensation in circle cutting.)
2. There is no compensation when the CNC is carrying out feed forward (fwd) control.

(2) Adjusting for feed forward control

Use OVS compensation type 2 if overshooting is a problem in contour cutting during feed forward control.

If OVS compensation type 2 is used to attempt to compensate overshooting, the overshooting may conversely become larger, or projections may appear during arc cutting. This is because overshooting equivalent to the operation fraction unit occurs in the position commands when the CNC is carrying out feed forward control. Because of this, the OVS compensation recognizes a change in the command direction, and executes the compensation in the opposite direction.

If the compensation is in the opposite direction when carrying out feed forward control, adjust with the non-sensitive band (SV040: LMCT) during feed forward control in the same way as during LMC compensation. By ignoring overshooting of a set width in the LMCT or less, the command direction change point is correctly recognized, and the OVS compensation is correctly executed. Because this phenomenon is due to the same causes as the phenomenon during LMC compensation, it is adjusted with the same parameters. The adjustment is completed if the correct setting is possible during whichever compensation.

This parameter is insignificant when feed forward control is not used.

<Adjustment method>

If the OVS compensation is carried out in reverse during feed forward control, increase the LMCT setting by 1μm at a time.

Note that 2μm are set even when the LMCT is set to 0.

POINT

OVS compensation type 2 is used if overshooting is a problem during feed forward control.

No.	Abbrev.	Parameter name	Explanation
SV027	SSF1	Servo function selection 1	The overshooting compensation starts with the following parameter.

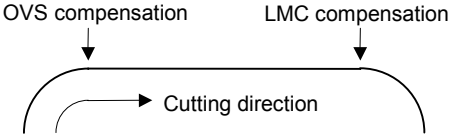
F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
aft	zrn2			ovs		lmc				vfct					

bit		Explanation
A B	ovs	01: Overshooting comp. stop 10: Overshooting comp. type2 11: Overshooting comp. type 1 11: Setting prohibited

No.	Abbrev.	Parameter name	Unit	Explanation	Setting range
SV031	OVS1	Overshooting compensation 1	Stall % (rated current %)	Increase the value by 1% at a time, and find the value where overshooting does not occur. When OVS2 is set to 0, the setting value will be applied in both the ± directions.	–1 ~ 100
SV042	OVS2	Overshooting compensation 2	Stall % (rated current %)	Set 0 as a standard. Set this when the compensation amount is to be changed according to the direction.	–1 ~ 100
SV040	LMCT	Non-sensitive band during feed forward control	μm	This setting is valid only during feed forward control. 2μm are set when the LMCT is set to 0. Adjust by raising 1μm at a time.	0 ~ 100

POINT

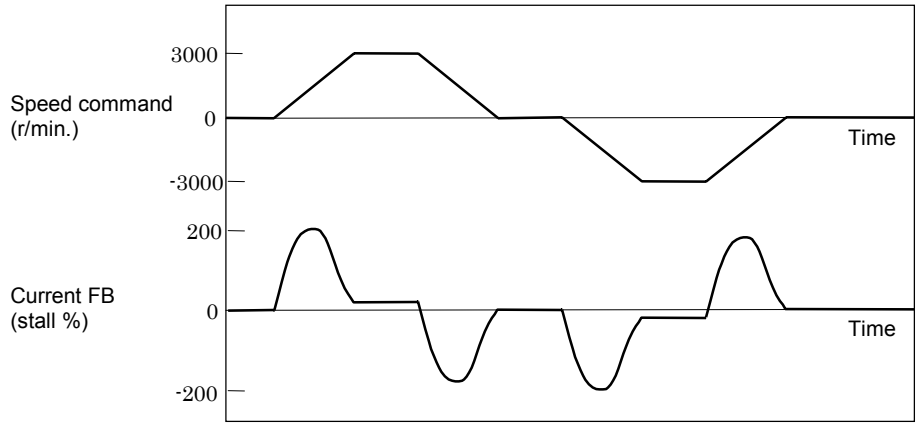
1. When either parameter SV031: OVS1 or SV042: OVS2 is set to 0, the same amount of compensation is carried out in both the positive and negative direction, using the setting value of the other parameter (the parameter not set to 0).
2. To compensate in only one direction, set -1 in the parameter (OVS1 or OVS2) for the direction in which compensation is prohibited.
3. For contour cutting, the projection at the arc end point is compensated with OVS compensation. LMC compensation is carried out at the arc starting point.



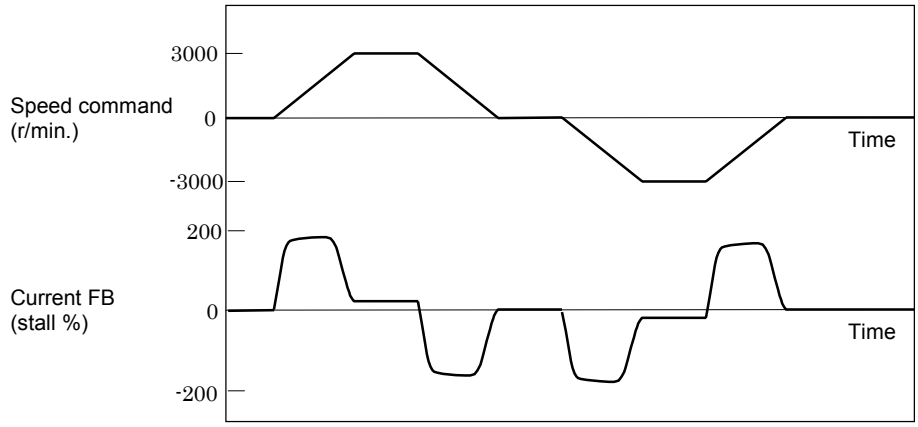
5-3-6 Improvement of characteristics during acceleration/deceleration

(1) SHG control (option function)

Because SHG control has a smoother response than conventional position controls, the acceleration/deceleration torque (current FB) has more ideal output characteristics (A constant torque is output during acceleration/deceleration.) The peak torque is kept low by the same acceleration/deceleration time constant, enabling the time constant to be shortened.
Refer to item "(3) SHG control" in section "5-2-3 Position loop gain" for details on setting SHG control.



Acceleration/deceleration characteristics during conventional control

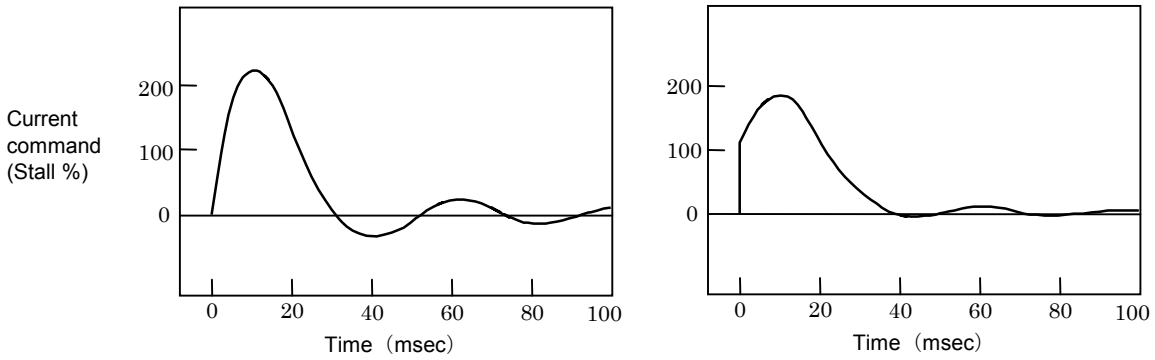


Acceleration/deceleration characteristics during SHG control

No.	Abbrev.	Parameter name	Setting ratio	Setting example					Explanation	Setting range
SV003 (SV049)	PGN1 (PGN1sp)	Position loop gain 1	1	23	26	33	38	47	Always set a combination of 3 parameters.	1 ~ 200
SV004 (SV050)	PGN2 (PGN2sp)	Position loop gain 2	8/3	62	70	86	102	125		0 ~ 999
SV057 (SV058)	SHGC (SHGCsp)	SHG control gain	6	140	160	187	225	281		0 ~ 999
SV008	VIA	Speed loop lead compensation	Set 1900 as a standard value during SHG control.							1 ~ 9999
SV015	FFC	Acceleration rate feed forward gain	Set 100 as a standard value during SHG control.							0 ~ 999

(2) Acceleration feed forward

Vibration may occur at 10 to 20 Hz during acceleration/deceleration when a short time constant of 30 msec or less is applied, and a position loop gain (PGN1) higher than the general standard value or SHG control is used. This is because the torque is insufficient when starting or when starting deceleration, and can be resolved by setting the acceleration rate feed forward gain (SV015:FFC). This is also effective in reducing the peak current (torque).
While measuring the current command waveform, increase FFC by 50 to 100 at a time and set the value where vibration does not occur.



No FFC setting **With FFC setting**

Acceleration feed forward gain means that the speed loop gain during acceleration/deceleration is raised equivalently. Thus, the torque (current command) required during acceleration/deceleration starts sooner. The synchronization precision will improve if the FFC of the delayed side axis is raised between axes for which high-precision synchronous control (such as synchronous tap control and superimposition control).

No.	Abbrev.	Parameter name	Unit	Explanation	Setting range
SV015	FFC	Acceleration rate feed forward gain	%	The standard setting value is 0. To improve the acceleration/deceleration characteristics, increase the value by 50 to 100 at a time. During SHG control, the standard setting value is 100.	1 ~ 999

POINT Overshooting occurs easily when a value above the standard value is set during SHG control.

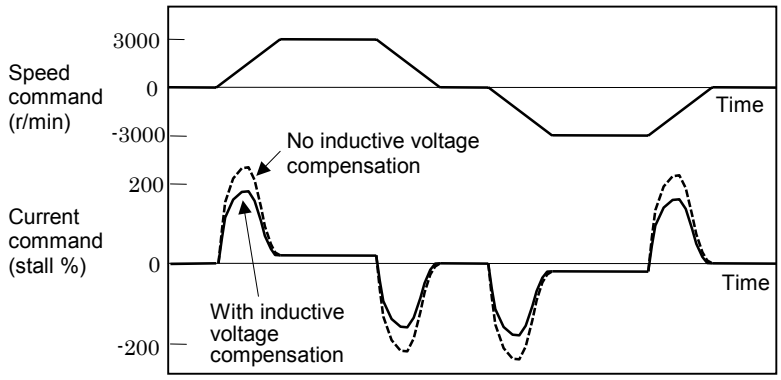
(3) Inductive voltage compensation

The current loop response is improved by compensating the back electromotive force element induced by the motor rotation. This improved the current command efficiency, and allows the acceleration/deceleration time constant to the shortened.

<Adjustment method>

① Set 1 in "mon" of the servo function selection 3 (SV034:SSF3) bit 0, and output the current command and current FB to the servo monitor.

② While accelerating/decelerating at rapid traverse, adjust the inductive voltage compensation gain (SV047:EC) so that the current FB peak is a few % smaller than the current command peak.



Inductive voltage compensation

To adjust the inductive voltage compensation, output 1 second of the maximum current command value and 1 second of the maximum current FB value to MAX current 1 and MAX current 2 on the CNC servo monitor screen and observe.

Change over and display "mon" of the servo function selection 3 (SV034: SSF3).

No.	Abbrev.	Parameter name	Explanation
SV034	SSF3	Servo function selection 3	The display data for the maximum current value on the servo monitor is determined with the following parameter.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
								daf2	daf1	dac2	dac1	mon			

bit	mon	MAX current 1	MAX current 2
0~3	0	Max. current command value (%) when power is turned ON	Max. current command value (%) for 1 second
	1	Max. current command value (%) for 1 second	Max. current FB value (%) for 1 second
	2	Max. current FB value (%) when power is turned ON	Max. current FB value (%) for 1 second
	3	Load inertia rate (SV059 setting value)	–
	4	Adaptive filter operation frequency (Hz)	Adaptive filter operation gain (%)
	5	PN bus voltage (V)	Regenerative operation frequency monitor (times/sec)
	6	Maximum estimated torque for one second (%)	Maximum current FB value for one second (%)
	7	Maximum estimated torque for one second (%)	Maximum disturbance torque for two seconds (%)
	8~F	Setting prohibited	

No.	Abbrev.	Parameter name	Unit	Explanation	Setting range
SV047	EC	Inductive voltage compensation gain	%	Set 100% as a standard. Lower the gain if the current FB peak exceeds the current command peak.	0 ~ 200

POINT

If the current FB peak becomes larger than the current command peak (over compensation), an overcurrent (alarm 3A) will occur easily. Note that over compensation will occur easily if the load inertia is large.

5-4 Setting for emergency stop

The emergency stop referred to here indicates the following states.

① When the external emergency stop was input (including other axis alarms)
② When the CNC power down was detected
③ When a servo alarm was detected

5-4-1 Deceleration control

This MDS-B-SVJ2 servo amplifier decelerates the motor according to the set time constant in the ready ON state even when an emergency stop occurs, and activates the dynamic brakes after stopping and turning ready OFF. This series of controls is called deceleration control. In the MDS-B-SVJ2, deceleration control is the standard method of stopping during an emergency stop.

<Features>

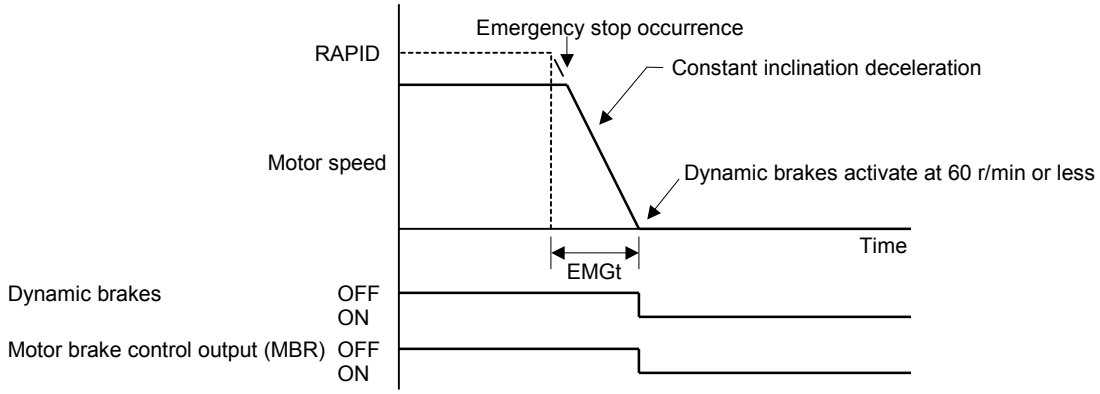
① When the load inertia is large, deceleration and stop are possible with a short time constant using the dynamic brakes. (Stopping is possible with a basically normal acceleration/ deceleration time constant.)
② When used in a transfer line, etc., stopping with little shock is possible by setting a long time constant.

(1) Setting the deceleration control time constant

The time to stopping from the rapid traverse rate (rapid: axis specification parameter) is set in the deceleration time constant at emergency stop (SV056: EMGt). A position loop step stop is carried out when 0 is set.
When linear (straight line) acceleration/deceleration is selected for the rapid traverse, the same value as the acceleration/deceleration time constant (G0tL) becomes the standard value. When another acceleration/deceleration pattern is selected, set the rapid traverse to linear acceleration/deceleration. Adjust to the optimum acceleration/deceleration time constant, and set that value as the standard value.

<Operation>

When an emergency stop occurs, the motor will decelerate at the same inclination from each speed, and will change to the dynamic brakes at 60 r/min or less. If the power fails, etc., the dynamic brakes will be applied during the deceleration control. When the motor brakes are controlled with amplifier output while using an unbalanced axis, the motor brake control output operates simultaneously with the changeover to the dynamic brakes.



No.	Abbrev.	Parameter name	Unit	Explanation	Setting range
SV056	EMGt	Deceleration time constant at emergency stop	msec	Set the time to stop from rapid traverse rate (rapid). Set the same value as the rapid traverse acceleration/deceleration time constant (G0tL) as a standard.	0 ~ 5000

POINT

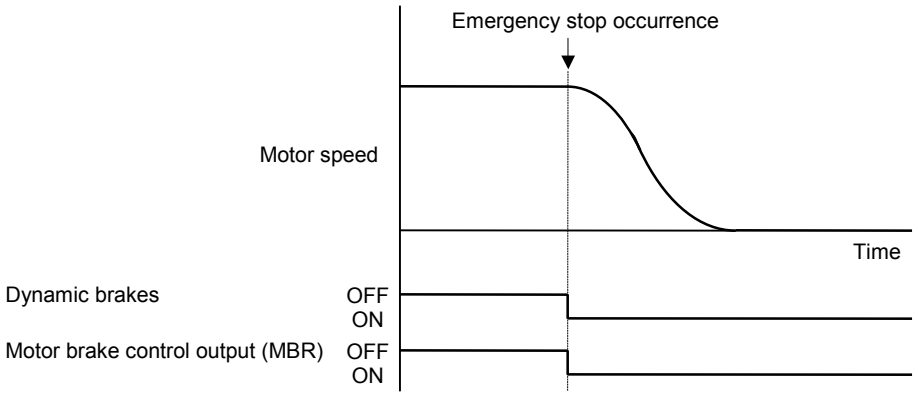
1. The deceleration will not be controlled when a servo alarm that uses the dynamic brake stopping method occurs. Stopping is by the dynamic brake method regardless of the parameter setting.
2. When a power failure occurs, the stopping method may change over to a dynamic brake stop during deceleration control if the deceleration time constant is set comparatively long. This is because of low bus voltage in the amplifier.

⚠ CAUTION

If the deceleration time constant at emergency stop (EMGt) is set longer than the acceleration/deceleration time constant, the overtravel point (stroke end point) may be exceeded.
A collision may be caused on the machine end, so be careful.

(2) Dynamic brake stop

When an emergency stop occurs, it is possible to have the machine stop from the beginning using a dynamic brake without controlling the deceleration. Set bit 0 in the servo specification selection (SV017: SPEC) to select a dynamic brake stop.
In a dynamic brake stop, the dynamic brakes operate at the same time the emergency stop occurs, and the motor brake output also operates at the same time.



No.	Abbrev.	Parameter name	Explanation
SV017	SPEC	Servo specification selection	Set the dynamic brake stop with the following parameter.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
								abs		vdir		mc			dmk

bit		Meaning when "0" is set.	Meaning when "1" is set.
0	dmk	Deceleration control stop	Dynamic brake stop

POINT

If a dynamic brake stop is selected, the software does not participate at all in the motor stop control after an emergency stop occurs.

⚠ CAUTION

When a dynamic brake stop is selected, in general the coasting distance during an emergency stop will be comparatively longer, so be careful.

(3) Deceleration control stop distance

If stopping with deceleration control during an emergency stop, the stop distance L_{DEC} can be approximately calculated with the following expression. However, the value will be higher than the following expression if the current is limited during deceleration. Refer to section "9-4-2 Coasting amount" for the stop distance using dynamic brakes.

$$L_{DEC} = \frac{F}{PGN1 \times 60} + \frac{1}{2} \times \frac{F}{60} \times \frac{F \times EMGt}{rapid \times 1000} \ (mm)$$

F	:	Feedrate during emergency stopped		(mm/min)
rapid	:	Rapid traverse rate		(mm/min)
PGN1	:	Position loop gain 1	(SV003)	(rad/sec)
EMGt	:	Deceleration time constant at emergency stop	(SV056)	(msec)

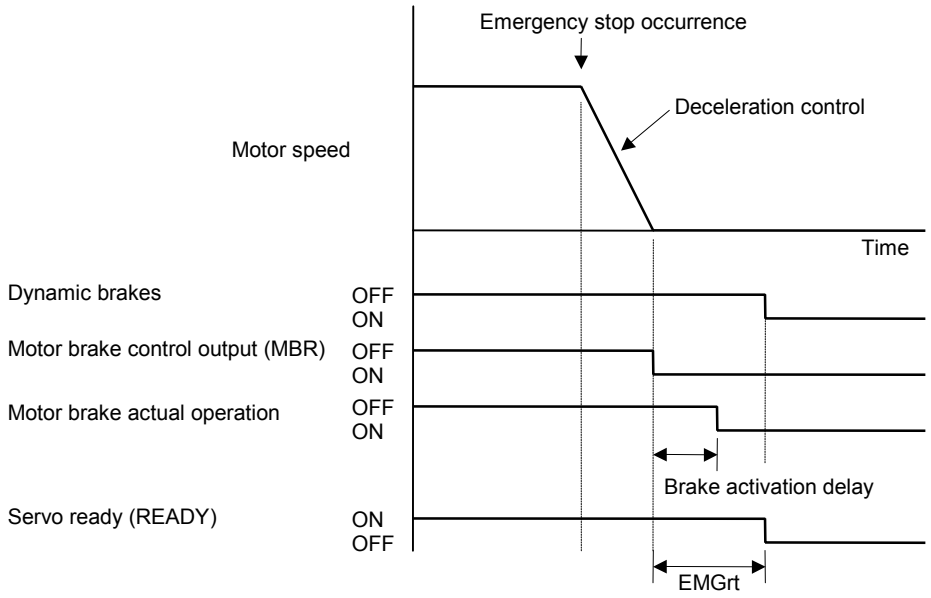
5-4-2 Vertical axis drop prevention control

(1) Vertical axis drop prevention control

The vertical axis drop prevention control is a function that prevents the vertical axis from dropping due to a delay in the brake operation when an emergency stop occurs. The servo ready OFF will be delayed by the time set in the parameter from when the emergency stop occurs. Thus, the no-control time until the brakes activate can be eliminated.

<Setting and adjustment methods>

Set the time to delay the ready OFF in the vertical axis drop prevention time (SV048:EMGrt). Read the current position on the CNC screen, and apply the emergency stop. Set the minimum delay time where the axis does not drop.



No.	Abbrev.	Parameter name	Unit	Explanation	Setting range
SV048	EMGrt	Vertical axis drop prevention time	msec	Input the time to delay the ready OFF when an emergency stop occurs. Increase the setting by 100 msec at a time and set the minimum value where the axis does not drop.	0 ~ 2000

POINT

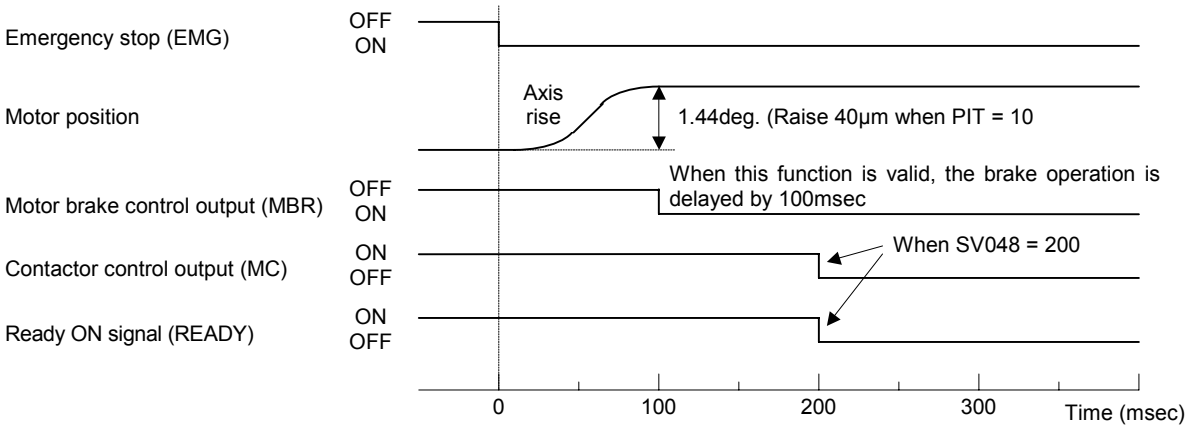
1. This control will not function if the dynamic brake stop is selected with the servo specification selection (SV017: SPEC).
2. This control will not function if an alarm for which the dynamic brakes are set as the stopping method occurs in an axis where vertical axis drop prevention control is being carried out.
3. A drop amount of several μm to 10μm will remain due to the brake play.

⚠ CAUTION

1. Do not set a vertical axis drop prevention time longer than required. The servo control and brakes could collide causing an overload alarm or amplifier damage. There is no problem if the duplicate time is within 100msec.
2. During a power failure, vertical axis drop prevention control (including deceleration control) exceeding 100msec cannot be guaranteed. The control will change to the dynamic brakes.

(2) Vertical axis lift up control

Even when the vertical axis drop prevention control is applied, the axis will drop several μm due to the mechanical play of the motor brakes. This function raises the axis, before the brakes are applied, by a motor angle of 1.44deg. to retract the vertical axis upward during an emergency stop or instantaneous power failure.



Vertical axis lift up control sequence

<Setting and adjustment methods>

① Adjust "5.4.2 (1) Vertical axis drop prevention control".
② Increase the vertical axis drop prevention time (SV048) by 100msec more than the value adjusted in step ①.
③ Turn SV027 bit 0 ON.
④ Set the unbalanced torque. (This is the same setting value as for adjustment of the lost motion compensation.)

No.	Abbrev.	Parameter name	Unit	Explanation	Setting range
SV027	SSF1	Servo function selection 1	The vertical axis lift up control starts with the following parameter.		
SV032	TOF	Torque offset	Stall % (Rated current %)	Set the unbalanced torque. The compensation direction is determined by this parameter's sign. When set to 0, the vertical axis lift up control will not be executed.	–100 ~ 100
SV048	EMGrt	Vertical axis drop prevention time	msec	The brake operation will be delayed 100msec from the normal operation, so set a value of 200msec or more.	0 ~ 2000

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
aflt	zm2			ovs		lmc				vfct					zup

bit		Meaning when "0" is set.	Meaning when "1" is set.
0	zup	Vertical axis lift up control stop	Vertical axis lift up control start

⚠ CAUTION

1. This function is valid for the vertical type machining center's Z axis. This function basically cannot be used with the horizontal type machining center's Y axis or lathe's X axis as collisions could occur. Always confirm the machine's working conditions before using this function.
2. When operating the motor brakes with an external sequence, use this function 100msec after the emergency stop input in the same manner as the servo amplifier output signal (MBR).

5-5 Collision detection

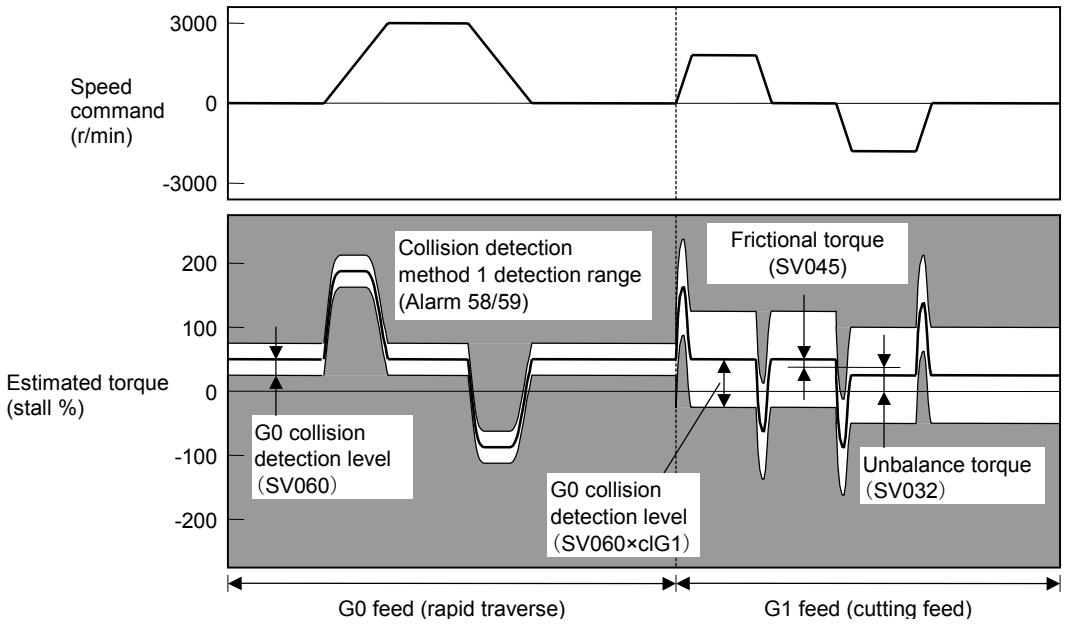
The purpose of the collision detection function is to quickly detect a collision and decelerate to a stop. This suppresses the excessive torque generated to the machine tool, and suppresses the occurrence of an abnormality. Impact during a collision cannot be prevented even when the collision detection function is used, so this function does not guarantee that the machine will not break and does not guarantee the machine accuracy after a collision. Thus, the conventional caution is required to prevent machine collisions from occurring.

(1) Collision detection method 1

The required torque is calculated from the position command issued from the NC. The disturbance torque is calculated from the difference with the actual torque. When this disturbance torque exceeds the collision detection level set with the parameters, the axis will decelerate to a stop with at 80% of the motor's maximum torque or the parameter current limit value (torque limit value), whichever is smaller. After decelerating to a stop, the alarm 58 or 59 will occur, and the system will stop.

	Collision detection level setting parameter	Detection alarm
For rapid traverse (for G0 feed)	SV060	Alarm 58
For cutting feed (for G1 feed)	SV060×clG1 (SV035)	Alarm 59

The collision detection level for rapid traverse (G0) is set with TLMT: SVC060. The collision detection level for cutting feed (G1) is set to 0 to 7-fold (SV053.clG1) based on the collision detection level for rapid traverse. If 0 is set for clG1, the collision detection method 1 will not function during cutting feed. If 0 is set for TLMT: SV060, all collision detections (method 1 and method 2) will not function.



Alarm detection range for collision detection method 1

(2) Collision detection method 2

When the current command reaches the motor's maximum current, the axis will decelerate to a stop with at 80% of the motor's maximum torque or the parameter current limit value (torque limit value), whichever is smaller. After decelerating to a stop, the alarm 5A will occur, and the system will stop. If the acceleration/deceleration time constant is short and incorrect detections are made easily during normal operation, increase the acceleration/deceleration time constant and adjust so that the current during acceleration is not saturated (so that the maximum current is not reached). If the acceleration/deceleration time constant cannot be increased, set parameter SV035.bit F: (SSF4.cl2n) to 1 to ignore the collision detection method 2.

⚠ CAUTION The collision detection function does not guarantee safety or machine accuracy during a collision. Thus, the conventional caution is required to prevent machine collisions from occurring.

<Setting and adjustment methods>

1. Confirm that SHG control is being used. The collision detection function is valid only during SHG control.
2. Measure the unbalance torque, and set in the torque offset (SV32: TOF). Refer to the section "5-3-4 (2) Unbalance torque compensation" for details on measuring the unbalance torque.
3. Measure the frictional torque, and set in the frictional torque (SV045: TRUB). Refer to the section "5-3-4-91) Lost motion compensation" for details on measuring the frictional torque.
4. Measure the load inertia rate, and set in the collision detection torque estimating gain (SV059: TCNV). Measure the load inertia rate with the following method.

Measuring the load inertia rate

Item	Condition	Explanation
Setting the load torque	1. The unbalance torque (SV032) must be set. 2. The frictional torque (SV045) must be set.	To make an accurate measurement, the load torque must be set correctly. After setting, carry out acceleration/deceleration operation again.
Setting the parameters	1. SHG control must be set. 2. SV034.mon = 3 3. SV060 = 0	The load inertia rate cannot be calculated when the collision detection is valid (SV060≠0).
Load inertia display area	NC servo monitor MAX current 1	The calculation results will be reset when READY is turned OFF.
Starting measurement	The calculation results will stabilize when the reciprocating operation is carried out about ten times.	Carry out acceleration/deceleration at the rapid traverse speed when possible to measure accurately.

The load inertia rate can also be measured using the disturbance observer function. Refer to section "5-3-3 (4) Disturbance observer".

5. If the acceleration/deceleration time is short and the current is easily saturated, set SV035.bitF (cl2n) to 1, and ignore the collision detection method 2.
6. Set the collision detection level.

Feed	Detection level setting	Explanation
G0	SV060	First set SV060: TLEV = 100, and carry out no-load operation at the maximum rapid traverse feed rate. If an alarm does not occur, lower the setting by 10, and if an alarm occurs, raise the setting by 20. Set a value that is 1.5 times the limit value where the alarm does not occur. If SV034.mon is set to 7, the maximum disturbance torque will appear on the NC servo monitor, so adjust using this value as a reference.
G1	SV060×clG1 (SV035)	The detection level for G1 is set as an integer-fold of the G0 detection level. Calculate the maximum cutting load, and adjust the SV035.clG1 setting value so that the detection level is larger than the maximum cutting load.

POINT

1. The SHG control must be validated to use the collision detection function or to carry out load inertia measurement operation.
2. If the unbalance torque (SV032) or frictional torque (SV045) setting values change during the load inertia measurement, the measurement results will change. The unbalance torque and frictional torque must be set as accurately as possible to carry out accurate measurements.
3. Set the detection level with an allowance to avoid incorrect detections.
4. When SV060 is set to 0, all collision detection functions will be invalidated.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV034</td><td>SSF3</td><td>Servo function selection 3</td><td>The display for the load inertia rate and collision detection related data is set with the following parameters.
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>daf2</td><td>daf1</td><td>dac2</td><td>dac1</td><td colspan="4">mon</td></tr>
</table>
<table>
<tr><th>bit</th><th>mon</th><th>MAX current 1</th><th>MAX current 2</th></tr>
<tr><td rowspan="9">0~3</td><td>0</td><td>Max. current command value (%) when power is turned ON</td><td>Max. current command value (%) for 1 second</td></tr>
<tr><td>1</td><td>Max. current command value (%) for 1 second</td><td>Max. current FB value (%) for 1 second</td></tr>
<tr><td>2</td><td>Max. current FB value (%) when power is turned ON</td><td>Max. current FB value (%) for 1 second</td></tr>
<tr><td>3</td><td>Load inertia rate (SV059 setting value)</td><td>–</td></tr>
<tr><td>4</td><td>Adaptive filter operation frequency (Hz)</td><td>Adaptive filter operation gain (%)</td></tr>
<tr><td>5</td><td>PN bus voltage (V)</td><td>Regenerative operation frequency monitor (times/sec)</td></tr>
<tr><td>6</td><td>Maximum estimated torque for one second (%)</td><td>Maximum current FB value for one second (%)</td></tr>
<tr><td>7</td><td>Maximum estimated torque for one second (%)</td><td>Maximum disturbance torque for two seconds (%)</td></tr>
<tr><td>8~F</td><td colspan="2">Setting prohibited</td></tr>
</table></td></tr>
<tr><td>SV035</td><td>SSF4</td><td>Servo function selection 4</td><td>The following parameters are used for the collision detection.
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>cl2n</td><td colspan="3">clG1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when "0" is set.</th><th>Meaning when "1" is set.</th></tr>
<tr><td>C
D
E</td><td>clG1</td><td colspan="2">Set the collision detection level for the collision detection method 1 cutting (G1) feed.
G1 collision detection level will be SV060×clG1.
When clG1 is set to 0, the collision detection method 1 will not function during cutting feed.</td></tr>
<tr><td>F</td><td>cl2n</td><td>Collision detection method 2 valid</td><td>Collision detection method 2 invalid</td></tr>
</table></td></tr>
</table>

No.	Abbrev.	Parameter name	Unit	Explanation	Setting range
SV032	TOF	Torque offset	Stall % (rated current %)	Set the unbalance torque amount.	–100 ~ 100
SV045	TRUB	Frictional torque	Stall % (rated current %)	Set the frictional torque for using the collision detection function.	0 ~ 100
SV059	TCNV	Collision detection torque estimating gain (load inertia rate)	%	Set the torque estimated gain for using the collision detection function. With the MDS-B-SVJ2, the value is the same as the load inertia rate including the motor inertia. (= SV037) When SV034.mon is set to 3, SV060 is set to 0, and acceleration/deceleration is carried out, the load inertia rate will appear on the NC Monitor screen.	0 ~ 5000
SV060	TLMT	Collision detection level	Stall % (rated current %)	Set the collision detection level of method 1 G0 feed when using the collision detection function. When 0 is set, all collision detection functions will not function.	0 ~ 200

5-6 Parameter list

No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)
SV001	PC1*	Motor side gear ratio	Set the motor side and machine side gear ratio. For the rotary axis, set the total deceleration (acceleration) ratio. Even if the gear ratio is within the setting range, the electronic gears may overflow and cause an alarm.	1 to 32767
SV002	PC2*	Machine side gear ratio		1 to 32767
SV003	PGN1	Position loop gain 1	Set the position loop gain. The standard setting is “33”. The higher the setting value is, the more precisely the command can be followed and the shorter the positioning time gets, however, note that a bigger shock is applied to the machine during acceleration/deceleration. When using the SHG control, also set SV004 (PGN2) and SV057 (SHGC).	1 to 200 (rad/s)
SV004	PGN2	Position loop gain 2	When using the SHG control, also set SV003 (PGN1) and SV057 (SHGC). When not using the SHG control, set to “0”.	0 to 999 (rad/s)
SV005	VGN1	Speed loop gain	Set the speed loop gain. Set this according to the load inertia size. The higher the setting value is, the more accurate the control will be, however, vibration tends to occur. If vibration occurs, adjust by lowering by 20 to 30%. The value should be determined to be 70 to 80% of the value at the time when the vibration stops.	1 to 999
SV006			Not used. Set to “0”.	0
SV007			Not used. Set to “0”.	0
SV008	VIA	Speed loop lead compensation	Set the gain of the speed loop integration control. The standard setting is “1364”. During the SHG control, the standard setting is “1900”. Adjust the value by increasing/decreasing it by about 100 at a time. Raise this value to improve contour tracking precision in high-speed cutting. Lower this value when the position droop vibrates (10 to 20Hz).	1 to 9999
SV009	IQA	Current loop q axis lead compensation	Set the gain of current loop. As this setting is determined by the motor’s electrical characteristics, the setting is fixed for each type of motor. Set the standard values for all the parameters depending on each motor type.	1 to 20480
SV010	IDA	Current loop d axis lead compensation		1 to 20480
SV011	IQG	Current loop q axis gain		1 to 2560
SV012	IDG	Current loop d axis gain		1 to 2560
SV013	ILMT	Current limit value	Set the normal current (torque) limit value. (Limit values for both + and - direction.) When the value is “500” (a standard setting), the maximum torque is determined by the specification of the motor.	0 to 500 (Stall [rated] current %)
SV014	ILMTsp	Current limit value in special control	Set the current (torque) limit value in a special control (initial absolute position setting, stopper control, etc). (Limit values for both of the + and - directions.) Set to “500” when not using.	0 to 500 (Stall [rated] current %)
SV015	FFC	Acceleration rate feed forward gain	When a relative error in the synchronous control is large, apply this parameter to the axis that is delaying. The standard setting value is “0”. For the SHG control, set to “100”. To adjust a relative error in acceleration/deceleration, increase the value by 50 to 100 at a time.	0 to 999 (%)

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated when the NC power is turned ON again.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range (Unit)</th></tr>
<tr><td rowspan="4">SV016</td><td rowspan="4">LMC1</td><td rowspan="4">Lost motion compensation 1</td><td>Set this when the protrusion (that occurs due to the non-sensitive band by friction, torsion, backlash, etc) at quadrant change is too large.
This compensates the torque at quadrant change.
This is valid only when the lost motion compensation (SV027 (SSF1/lmc)) is selected.</td><td></td></tr>
<tr><td>Type 1: When SV027 (SSF1)/ bit9, 8 (lmc)=01
Set the compensation amount based on the motor torque before the quadrant change.
The standard setting is “100”. Setting to “0” means the compensation amount is zero.
Normally, use Type 2.</td><td>-1 to 200 (%)</td></tr>
<tr><td>Type 2: When SV027 (SSF1)/ bit9, 8 (lmc)=10
Set the compensation amount based on the stall (rated) current of the motor.
The standard setting is double of the friction torque. Setting to “0” means the compensation amount is zero.</td><td>-1 to 100 (Stall [rated] current %)</td></tr>
<tr><td>When you wish different compensation amount depending on the direction
When SV041 (LMC2) is “0”, compensate with the value of SV016 (LMC1) in both of the + and -directions.
If you wish to change the compensation amount depending on the command direction, set this and SV041 (LMC2). (SV016: + direction, SV041: - direction. However, the directions may be opposite depending on other settings.)
When “-1” is set, the compensation won’t be performed in the direction of the command.</td><td></td></tr>
<tr><td>SV017</td><td>SPEC*</td><td>Servo specification selection</td><td colspan="2">
<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>abs</td><td></td><td>vdir</td><td></td><td>mc</td><td></td><td></td><td>dmk</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th></tr>
<tr><td>0</td><td>dmk</td><td>Deceleration control stop (SVJ2 standard)</td><td>Dynamic brake stop</td></tr>
<tr><td>1</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>mc</td><td>Contactor control output invalid</td><td>Contactor control output valid</td></tr>
<tr><td>4</td><td></td><td></td><td></td></tr>
<tr><td>5</td><td>vdir</td><td>HA053N to HA33N motor Detector installation position standard (A, C)</td><td>HA053N to HA33N motor Detector installation position 90 degrees (B, D)</td></tr>
<tr><td>6</td><td></td><td></td><td></td></tr>
<tr><td>7</td><td>abs</td><td>Incremental control</td><td>Absolute position control</td></tr>
<tr><td>8</td><td></td><td></td><td></td></tr>
<tr><td>9</td><td></td><td></td><td></td></tr>
<tr><td>10</td><td></td><td></td><td></td></tr>
<tr><td>11</td><td></td><td></td><td></td></tr>
<tr><td>12</td><td></td><td></td><td></td></tr>
<tr><td>13</td><td></td><td></td><td></td></tr>
<tr><td>14</td><td></td><td></td><td></td></tr>
<tr><td>15</td><td></td><td></td><td></td></tr>
</table>
(Note) Set to “0” for bits with no particular description.
</td></tr>
<tr><td>SV018</td><td>PIT*</td><td>Ball screw pitch</td><td>Set the ball screw pitch. Set to “360” for the rotary axis.</td><td>1 to 32767 (mm/rev)</td></tr>
</table>

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated when the NC power is turned ON again.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range (Unit)</th></tr>
<tr><td>SV019
SV020</td><td>RNG1*
RNG2*</td><td>Position detector resolution
Speed detector resolution</td><td>For both parameters, set the number of pulses per one revolution of the motor detector.
<table>
<tr><th rowspan="2">Motor model name</th><th colspan="2">Setting value</th></tr>
<tr><th>SV019</th><th>SV020</th></tr>
<tr><td>HC*-E42/A42/A47, HC*R-E42/A42/A47
HA*N-E42/A42</td><td>100</td><td>100</td></tr>
<tr><td>HC*-E33/A33, HC*R-E33/A33
HA*N-E33/A33</td><td>25</td><td>25</td></tr>
<tr><td>HC-SF, HC-RF</td><td>16</td><td>16</td></tr>
<tr><td>HA-FF, HC-MF</td><td>8</td><td>8</td></tr>
</table></td><td>8 to 100 (kp/rev)</td></tr>
<tr><td>SV021</td><td>OLT</td><td>Overload detection time constant</td><td>Set the detection time constant of Overload 1 (Alarm 50).
Set to “60” as a standard. (For machine tool builder adjustment.)</td><td>1 to 300 (s)</td></tr>
<tr><td>SV022</td><td>OLL</td><td>Overload detection level</td><td>Set the current detection level of Overload 1 (Alarm 50) in respect to the stall (rated) current. Set to “150” as a standard. (For machine tool builder adjustment.)</td><td>50 to 180 (Stall [rated] current %)</td></tr>
<tr><td>SV023</td><td>OD1</td><td>Excessive error detection width during servo ON</td><td>Set the excessive error detection width when servo ON.
<Standard setting value> $OD1=OD2=\frac{\text{Rapid traverse rate (mm/min)}}{60*PGN1}/2$ (mm)
When “0” is set, the excessive error detection will not be performed.</td><td>0 to 32767 (mm)</td></tr>
<tr><td>SV024</td><td>INP</td><td>In-position detection width</td><td>Set the in-position detection width.
Set the accuracy required for the machine.
The lower the setting is, the higher the positioning accuracy gets, however, the cycle time (setting time) becomes longer. The standard setting is “50”.</td><td>0 to 32767 (μm)</td></tr>
</table>

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated when the NC power is turned ON again.

No.	Abbrev.	Parameter name	Explanation
SV025	MTYP*	Motor/Detector type	

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
pen				ent				mtyp							

bit		Explanation
0 1 2 3 4 5 6 7	mtyp	Set the motor type.

Setting	0x	1x	2x	3x	4x	5x	6x	7x	8x
x0	HA40N							HA-FF43	HA43N
x1	HA80N							HA-FF63	HA83N
x2	HA100N								HA103N
x3	HA200N								
x4									
x5									
x6									
x7									
x8									
x9									
xA									HA93N
xB									
xC								HA-FF053	HA053N
xD								HA-FF13	HA13N
xE								HA-FF23	HA23N
xF								HA-FF33	HA33N

Setting	9x	Ax	Bx	Cx	Dx	Ex	Fx
x0	HC-MF43		HC52 or HC-SF52	HC53 or HC-SF53			
x1	HC-MF73		HC102 or HC-SF102	HC103 or HC-SF103		HC103R or HC-RF103	
x2			HC152 or HC-SF152	HC153 or HC-SF153		HC153R or HC-RF153	
x3			HC202 or HC-SF202	HC203 or HC-SF203		HC203R or HC-RF203	
x4			HC352 or HC-SF352	HC-SF353			
x5							
x6							
x7							
x8							
x9							
xA							
xB							
xC	HC-MF053						
xD	HC-MF13						
xE	HC-MF23						
xF							

8 9 10 11	ent	Set the speed detector type. Set to “2”.
12 13 14 15	pen	Set the position detector type. Set to “2”.

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated when the NC power is turned ON again.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range (Unit)</th></tr>
<tr><td>SV026</td><td>OD2</td><td>Excessive error detection width during servo OFF</td><td>Set the excessive error detection width when servo ON.
For the standard setting, refer to the explanation of SV023 (OD1).
When “0” is set, the excessive error detection will not be performed.</td><td>0 to 32767 (mm)</td></tr>
<tr><td>SV027</td><td>SSF1</td><td>Servo function selection 1</td><td>
<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>aflt</td><td>zrn2</td><td></td><td></td><td colspan="2">ovs</td><td colspan="2">lmc</td><td></td><td></td><td colspan="2">vfct</td><td></td><td></td><td></td><td>zup</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th></tr>
<tr><td>0</td><td>zup</td><td>Vertical axis lift-up control stop</td><td>Vertical axis lift-up control start</td></tr>
<tr><td>1</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td><td></td></tr>
<tr><td>4
5</td><td>vfct</td><td colspan="2">Set the jitter compensation No. of compensation pulses.
00: Jitter compensation invalid 10: Jitter compensation 2 pulses
01: Jitter compensation 1 pulse 11: Jitter compensation 3 pulses</td></tr>
<tr><td>6</td><td></td><td></td><td></td></tr>
<tr><td>7</td><td></td><td></td><td></td></tr>
<tr><td>8
9</td><td>lmc</td><td colspan="2">Set the compensation amount with SV016 (LMC1) and SV041 (LMC2).
00: Lost motion comp.stop 10: Lost motion comp. type 2
01: Lost motion comp. type 1 11: Setting prohibited</td></tr>
<tr><td>10
11</td><td>ovs</td><td colspan="2">Set the compensation amount with SV031 (OVS1) and SV042 (OVS2).
00: Overshooting comp.stop 10: Overshooting comp. type 2
01: Overshooting comp. type 1 11: Setting prohibited</td></tr>
<tr><td>12</td><td></td><td></td><td></td></tr>
<tr><td>13</td><td></td><td></td><td></td></tr>
<tr><td>14</td><td>zrn2</td><td colspan="2">Set to “1”.</td></tr>
<tr><td>15</td><td>aflt</td><td>Adoptive filter stops</td><td>Adoptive filter starts</td></tr>
</table>
(Note) Set to “0” for bits with no particular description.
</td><td></td></tr>
<tr><td>SV028</td><td></td><td></td><td>Not used. Set to “0”.</td><td>0</td></tr>
<tr><td>SV029</td><td></td><td></td><td>Not used. Set to “0”.</td><td>0</td></tr>
<tr><td>SV030</td><td>IVC</td><td>Voltage dead time compensation</td><td>When 100% is set, the voltage equivalent to the logical non-energized time will be compensated.
Adjust in increments of 10% from the default value 100%.
If increased too much, vibration or vibration noise may be generated.
When not using, set to “0”.</td><td>0 to 200 (%)</td></tr>
</table>

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range (Unit)</th></tr>
<tr><td rowspan="4">SV031</td><td rowspan="4">OVS1</td><td rowspan="4">Overshooting compensation 1</td><td>Set this if overshooting occurs during positioning. This compensates the motor torque during positioning.
This is valid only when the overshooting compensation SV027 (SSF1/ovs) is selected.</td><td rowspan="4">-1 to 100 (Stall [rated] current %)</td></tr>
<tr><td>Type 1: When SV027 (SSF1)/ bit11, 10 (ovs)=01
Set the compensation amount based on the motor's stall (rated) current. Increase by 1% and determine the amount that overshooting doesn't occur.
In Type 1, compensation during the feed forward control during circular cutting won't be performed.</td></tr>
<tr><td>Type 2: When SV027 (SSF1)/ bit11, 10 (ovs)=10
Use this if you perform the overshooting compensation during the feed forward control during circular cutting. The setting method is the same in Type 1.</td></tr>
<tr><td>When you wish different compensation amount depending on the direction
When SV042 (OVS2) is "0", compensate with the value of SV031 (OVS1) in both of the + and -directions.
If you wish to change the compensation amount depending on the command direction, set this and SV042 (OVS2). (SV031: + direction, SV042: - direction. However, the directions may be opposite depending on other settings.)
When "-1" is set, the compensation won't be performed in the direction of the command.</td></tr>
<tr><td>SV032</td><td>TOF</td><td>Torque offset</td><td>Set the unbalance torque of vertical axis and inclined axis.</td><td>-100 to 100 (Stall [rated] current %)</td></tr>
<tr><td>SV033</td><td>SSF2</td><td>Servo function selection 2</td><td>
<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="4">afs</td><td></td><td></td><td colspan="2">fhz2</td><td colspan="4">nfd</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when "0" is set</th><th>Meaning when "1" is set</th></tr>
<tr><td>0</td><td rowspan="4">nfd</td><td rowspan="4">Set the filter depth for Notch filter (SV038: FHz1).
The control is stabilized by making the filter shallower.
Value 0 2 4 6 8 A C E
Depth (dB) Infntly deep -18.1 -12.0 -8.5 -6.0 -4.1 -2.5 -1.2
Deep ← → Shallow</td><td rowspan="4"></td></tr>
<tr><td>1</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td rowspan="2">fhz2</td><td rowspan="2">Set the operation frequency of Notch filter 2.
00: No operation 01: 2250Hz 10: 1125Hz 11: 750Hz</td><td rowspan="2"></td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td></td><td></td><td></td></tr>
<tr><td>7</td><td></td><td></td><td></td></tr>
<tr><td>8</td><td rowspan="4">afs</td><td rowspan="4">Set the vibration sensitivity of the adaptive filter.
If the filter depth is not deep enough (generally 70% or more) and the vibration cannot be sufficiently eliminated, raise the value.</td><td rowspan="4"></td></tr>
<tr><td>9</td></tr>
<tr><td>10</td></tr>
<tr><td>11</td></tr>
<tr><td>12</td><td></td><td></td><td></td></tr>
<tr><td>13</td><td></td><td></td><td></td></tr>
<tr><td>14</td><td></td><td></td><td></td></tr>
<tr><td>15</td><td></td><td></td><td></td></tr>
</table>
(Note) Set to "0" for bits with no particular description.
</td><td></td></tr>
</table>

No.	Abbrev.	Parameter name	Explanation
SV034	SSF3	Servo function selection 3	

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
								daf2	daf1	dac2	dac1	mon			

bit		Meaning when “0” is set	Meaning when “1” is set
0	mon	NC servo monitor MAX current display data changeover	
1			
2			
3			
4	dac1	D/A output ch.1 overflow setting	D/A output ch.1 clamp setting
5	dac2	D/A output ch.2 overflow setting	D/A output ch.2 clamp setting
6	daf1	D/A output ch.1 no filter	D/A output ch.1 filter setting
7	daf2	D/A output ch.2 no filter	D/A output ch.2 filter setting
8			
9			
10			
11			
12			
13			
14			
15			

Setting	MAX current 1	MAX current 2
0	Max. current command value after turning the power ON (%)	Max. current command value for one second (%)
1	Max. current command value for one second (%)	Max. current FB value for one second (%)
2	Max. current FB value after turning the power ON (%)	Max. current FB value for one second (%)
3	Load inertia rate (%)	-
4	Adaptive filter operation frequency (Hz)	Adaptive filter operation gain (%)
5	PN bus voltage (V)	Regenerative operation frequency monitor (The number of times/sec)
6	Estimated max. torque for one second (%)	Max. current FB value for one second (%)
7	Estimated max. torque for one second (%)	Max. disturbance torque for two seconds (%)
8 to F	Setting prohibited	

(Note) Set to “0” for bits with no particular description.

No.	Abbrev.	Parameter name	Explanation
SV035	SSF4	Servo function selection 4	

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
cl2n	clG1														

bit		Meaning when “0” is set	Meaning when “1” is set
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12	clG1	Collision detection method 1 Set the collision detection level during cutting feed (G1). The G1 collision detection level=SV060*clG1. When clG1=0, the collision detection method 1 during cutting feed won’t function.	
13			
14			
15	cl2n	Collision detection method 2 valid	Collision detection method 2 invalid

(Note) Set to “0” for bits with no particular description.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV036</td><td>PTYP*</td><td>Regenerative resistor type</td><td>
<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="4">amp</td><td colspan="4">rtyp</td><td colspan="4">emgx</td><td colspan="4"></td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Explanation</th></tr>
<tr><td>0</td><td></td><td rowspan="4">Always set to “0(0000)”.</td></tr>
<tr><td>1</td><td></td></tr>
<tr><td>2</td><td></td></tr>
<tr><td>3</td><td></td></tr>
<tr><td>4</td><td rowspan="4">emgx</td><td rowspan="4">Set the external emergency stop function. (Setting is prohibited for values with no description.)
<table>
<tr><th>Setting</th><th>Explanation</th></tr>
<tr><td>0</td><td>External emergency stop invalid</td></tr>
<tr><td>4</td><td>External emergency stop valid</td></tr>
</table></td></tr>
<tr><td>5</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td rowspan="4">rtyp</td><td rowspan="4">Set the regenerative resistor type.
<table>
<tr><th>Setting</th><th>Explanation</th></tr>
<tr><td>0</td><td>Drive unit standard built-in resistor (SVJ2-01 doesn’t have a built-in resistor)</td></tr>
<tr><td>1</td><td>Setting prohibited</td></tr>
<tr><td>2</td><td>MR-RB032</td></tr>
<tr><td>3</td><td>MR-RB12 or GZG200W390HMK</td></tr>
<tr><td>4</td><td>MR-RB32 or GZG200W1200HMK: 3 units connected in parallel</td></tr>
<tr><td>5</td><td>MR-RB30 or GZG200W390HMK: 3 units connected in parallel</td></tr>
<tr><td>6</td><td>MR-RB50 or GZG300W390HMK: 3 units connected in parallel</td></tr>
<tr><td>7 to F</td><td>Setting prohibited</td></tr>
</table></td></tr>
<tr><td>9</td></tr>
<tr><td>10</td></tr>
<tr><td>11</td></tr>
<tr><td>12</td><td rowspan="4">amp</td><td rowspan="4">Always set to “0(0000)”.</td></tr>
<tr><td>13</td></tr>
<tr><td>14</td></tr>
<tr><td>15</td></tr>
</table>
</td></tr>
</table>

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated when the NC power is turned ON again.

No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)
SV037	JL	Load inertia scale	Set "the motor inertia + motor axis conversion load inertia" in respect to the motor inertia. SV037 (JL) = (Jl+Jm)/Jm *100 Jm: Motor inertia Jl: Motor axis conversion load inertia	0 to 5000 (%)
SV038	FHz1	Notch filter frequency 1	Set the vibration frequency to suppress if machine vibration occurs. (Valid at 72 or more) When not using, set to "0".	0 to 3000 (Hz)
SV039	LMCD	Lost motion compensation timing	Set this when the lost motion compensation timing doest not match. Adjust by increasing the value by 10 at a time.	0 to 2000 (ms)
SV040	LMCT	Non-sensitive band in feed forward control	Set the non-sensitive bad of the lost motion compensation and overshooting compensation during the feed forward control. When "0" is set, the actual value that will be set is 2μm. Adjust by increasing by 1μm.	0 to 100 (μm)
SV041	LMC2	Lost motion compensation 2	Set this with SV016 (LMC1) only when you wish to set the lost motion compensation amount to be different depending on the command directions. Set to "0" as a standard.	-1 to 200 (Stall [rated] current %)
SV042	OVS2	Overshooting compensation 2	Set this with SV031 (OVS1) only when you wish to set the overshooting compensation amount to be different depending on the command directions. Set to "0" as a standard.	-1 to 100 (Stall [rated] current %)
SV043	OBS1	Disturbance observer filter frequency	Set the disturbance observer filter band. The standard setting is "300". Lower the setting by 50 at a time if vibration occurs. To use the disturbance observer, also set SV037 (JL) and SV044 (OBS2). When not using, set to "0".	0 to 1000 (rad/s)
SV044	OBS2	Disturbance observer gain	Set the disturbance observer gain. The standard setting is "100" to "300". To use the disturbance observer, also set SV037 (JL) and SV043 (OBS1). When not using, set to "0".	0 to 1000 (%)
SV045	TRUB	Frictional torque	Set the frictional torque when using the collision detection function.	0 to 100 (Stall [rated] current %)
SV046			Not used. Set to "0".	0
SV047	EC	Inductive voltage compensation gain	Set the inductive voltage compensation gain. Set to "100" as a standard. If the current FB peak exceeds the current command peak, lower the gain.	0 to 200 (%)
SV048	EMGrt	Vertical axis drop prevention time	Input a length of time to prevent the vertical axis from dropping by delaying Ready OFF until the brake works when the emergency stop occurs. Increase the setting by 100msec at a time and set the value where the axis does not drop.	0 to 2000 (ms)
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	Set the position loop gain during the spindle synchronous control (synchronous tapping, synchronous control with spindle/C axis). Set the same value as the value of the spindle parameter, position loop gain in synchronous control. When performing the SHG control, set this with SV050 (PGN2sp) and SV058 (SHGCsp).	1 to 200 (rad/s)
SV050	PGN2sp	Position loop gain 2 in spindle synchronous control	Set this with SV049 (PGN1sp) and SV058 (SHGCsp) if you wish to perform the SHG control in the spindle synchronous control (synchronous tapping, synchronous control with spindle/C axis). When not performing the SHG control, set to "0".	0 to 999 (rad/s)
SV051			Not used. Set to "0".	0
SV052			Not used. Set to "0".	0
SV053	OD3	Excessive error detection width in special control	Set the excessive error detection width when servo ON in a special control (initial absolute position setting, stopper control, etc.). If "0" is set, excessive error detection won't be performed when servo ON during a special control.	0 to 32767 (mm)
SV054			Not used. Set to "0".	0
SV055			Not used. Set to "0".	0

No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)
SV056	EMGt	Deceleration time constant at emergency stop	Set the time constant used for the deceleration control at emergency stop. Set a length of time that takes from rapid traverse rate (rapid) to stopping. Normally, set the same value as the rapid traverse acceleration/deceleration time constant.	0 to 5000 (ms)
SV057	SHGC	SHG control gain	When performing the SHG control, set this with S003 (PGN1) and SV004 (PGN2). When not performing the SHG control, set to “0”.	0 to 999 (rad/s)
SV058	SHGCsp	SHG control gain in spindle synchronous control	Set this with SV049 (PGN1sp) and SV050 (PGN2sp) if you wish to perform the SHG control in the spindle synchronous control (synchronous tapping, synchronous control with spindle/C axis). When not performing the SHG control, set to “0”.	0 to 999 (rad/s)
SV059	TCNV	Collision detection torque estimating gain	To use the collision detection function, set the torque estimating gain. In the case of MDS-B-SVJ2, the value is the same as the load inertia ratio that includes the motor inertia. (=SV037:JL) If acceleration/deceleration is performed after setting SV034.mon=3 and SV060=0, the load inertia ratio will be displayed on the NC monitor screen.	0 to 5000 (%)
SV060	TLMT	Collision detection level	When using the collision detection function, set the collision detection level during the G0 feeding. If “0” is set, none of the collision detection function will work.	0 to 200 (Stall [rated] current %)
SV061	DA1NO	D/A output channel 1 data No.	Input the data number you wish to output to D/A output channel.	0 to 102
SV062	DA2NO	D/A output channel 2 data No.		
SV063	DA1MPY	D/A output channel 1 output scale	When “0” is set, output is done with the standard output unit. Set other than “0” when you wish to change the unit. Set the scale with a 1/256 unit. When “256” is set, the output unit will be the same as the standard output unit.	-32768 to 32767 (Unit: 1/256)
SV064	DA2MPY	D/A output channel 2 output scale		
SV065			Not used. Set to “0”.	0

Chapter 6 Dedicated Options

DANGER	Wait at least 10 minutes after turning the power OFF, confirm that the CHARGE lamp has gone out, and check the voltage with a tester, etc., before connecting the options or peripheral devices. Failure to observe this could lead to electric shocks.

CAUTION	1. Always use the designated options. Failure to observe this could lead to faults or fires. 2. Take care to the installation environment so that cutting chips and oil, etc., do not get on the optional regenerative resistor. A short-circuit fault could occur at the resistor's terminal block, and the oil that adheres could burn leading to fires.

This chapter describes the dedicated option parts that can be ordered from Mitsubishi Electric Corp. (Excluding parts described as parts that cannot be ordered.)

6-1 Regenerative option

6-1-1 Combinations with servo amplifiers

Confirm the regenerative resistor capacity and possibility of connecting with the servo amplifier. Refer to section "11-4 Selection of regenerative resistor" for details on selecting an option regenerative resistor. The regenerative resistor generates heat, so refer to section "2-6 Connection of regenerative resistor", and wire and install the unit while taking safety into consideration.
When using the external option regenerative resistor, install a cover on the machine, etc., so that easily flammable items such as the cable doe not contact the detector and so that dust and oil do not adhere onto the resistor and ignite.

	Standard built-in regenerative resistor		External option regenerative resistor type				
External option regenerative resistor type (Japan Resistor Mfg.)				GZG200W39OHMK	GZG200W120OHMK 3 units connected in parallel	GZG200W39OHMK 3 units connected in parallel	GZG300W39OHMK 3 units connected in parallel
External option regenerative resistance unit type			**MR-RB032**	**MR-RB12**	**MR-RB32**	**MR-RB30**	**MR-RB50**
Corresponding servo amplifier	**Regenerative capacity**		**30W**	**100W**	**300W**	**300W**	**500W**
		Resistance value	**40Ω**	**39Ω (MR-RB12: 40Ω)**	**40Ω**	**13Ω**	**13Ω**
MDS-B-SVJ2-01	No built-in resistor		○	○			
MDS-B-SVJ2-03	10W	100Ω	○	○			
MDS-B-SVJ2-04	10W	100Ω	○	○			
MDS-B-SVJ2-06	10W	40Ω	○	○	○		
MDS-B-SVJ2-07	20W	40Ω		○	○		
MDS-B-SVJ2-10	100W	13Ω				○	○
MDS-B-SVJ2-20	100W	13Ω				○	○

No.	Abbrev.	Parameter name	Explanation
SV036	PTYP	Regenerative resistor type	This is a HEX setting parameter.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
amp				rtyp				emgx							

bit	Explanation
8~B	Set the regenerative resistor type.

Setting value	Regenerative resistor or regenerative resistance unit
0	Amplifier standard built-in resistor (SVJ2-01 has no built-in resistor.)
1	Setting prohibited
2	MR-RB032
3	MR-RB12 or GZG200W39OHMK
4	MR-RB32 or GZG200W120OHMK: 3 units connected in parallel
5	MR-RB30 or GZG200W39OHMK: 3 units connected in parallel
6	MR-RB50 or GZG300W39OHMK: 3 units connected in parallel
7 ~ F	Setting prohibited

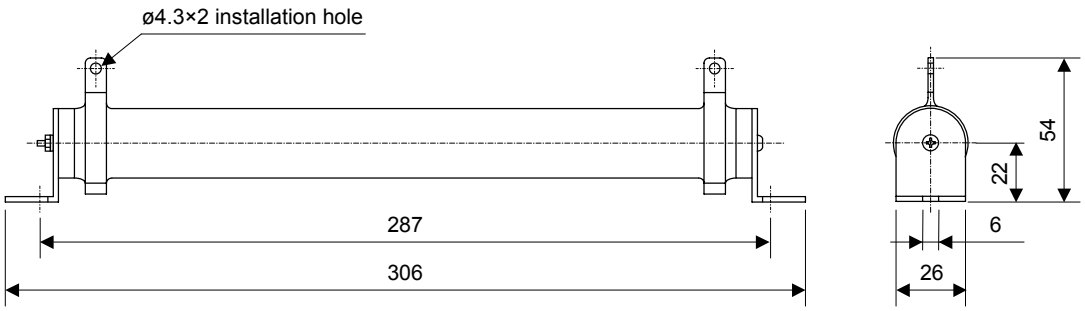
⚠ CAUTION

1. The regenerative option and servo amplifier cannot be set to a combination other than that designated. Failure to use the correct combination could lead to fires.
2. Protection will not be performed correctly if the parameter setting is incorrect. Carefully confirm the regenerative resistor type before setting the parameter.
3. When using the external option regenerative resistor, a cover must be installed on the machine, so that easily flammable items do not contact or adhere onto the resistor.

6-1-2 Outline dimension drawing of external option regenerative resistor

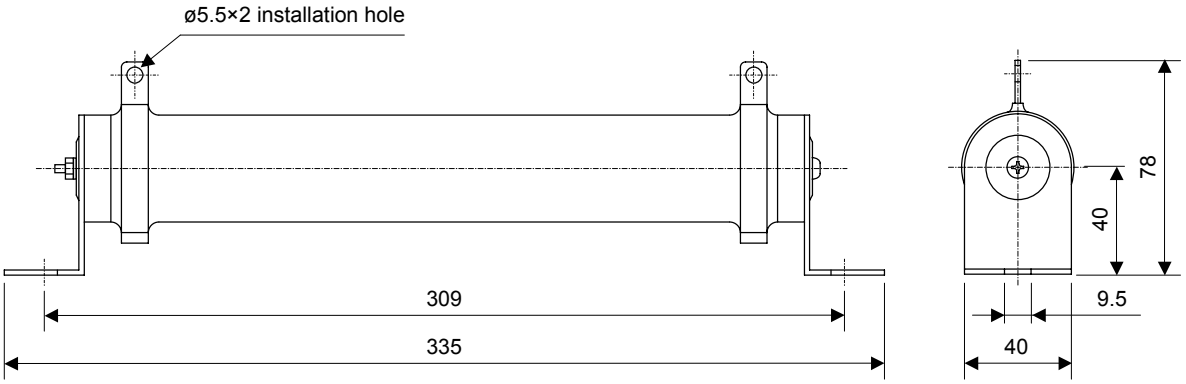
<GZG200W39OHMK, GZG200W120OHMK>

[Unit: mm]



<GZG300W39OHMK>

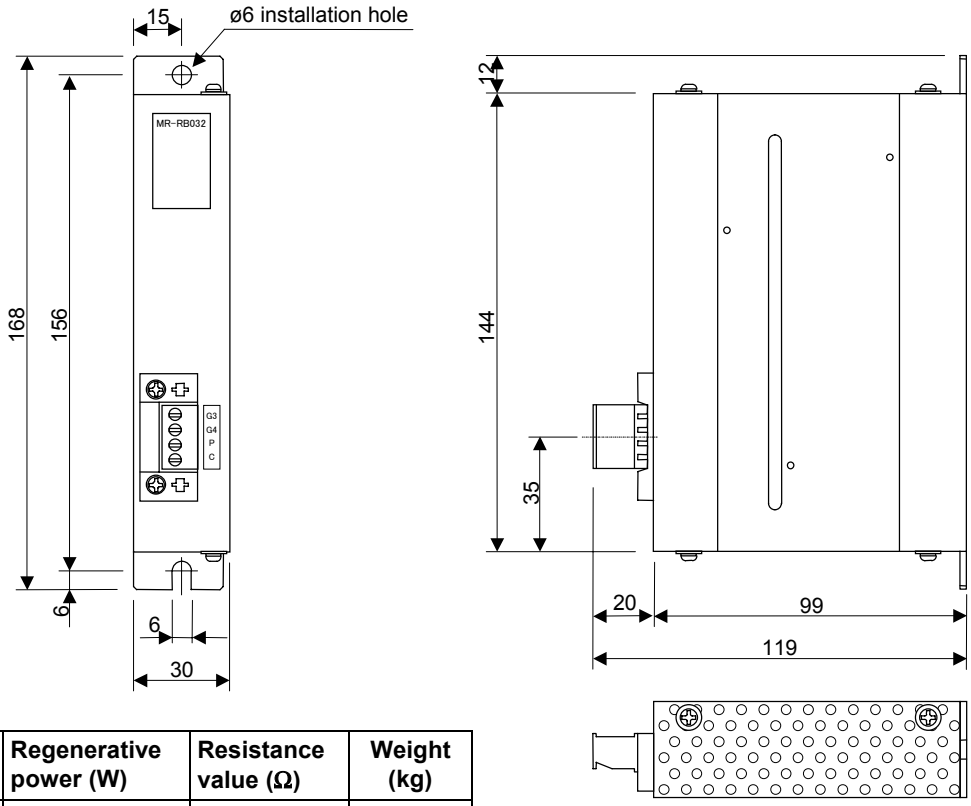
[Unit: mm]



6-1-3 Outline dimension drawing of external option regenerative resistance unit

<MR-RB032>

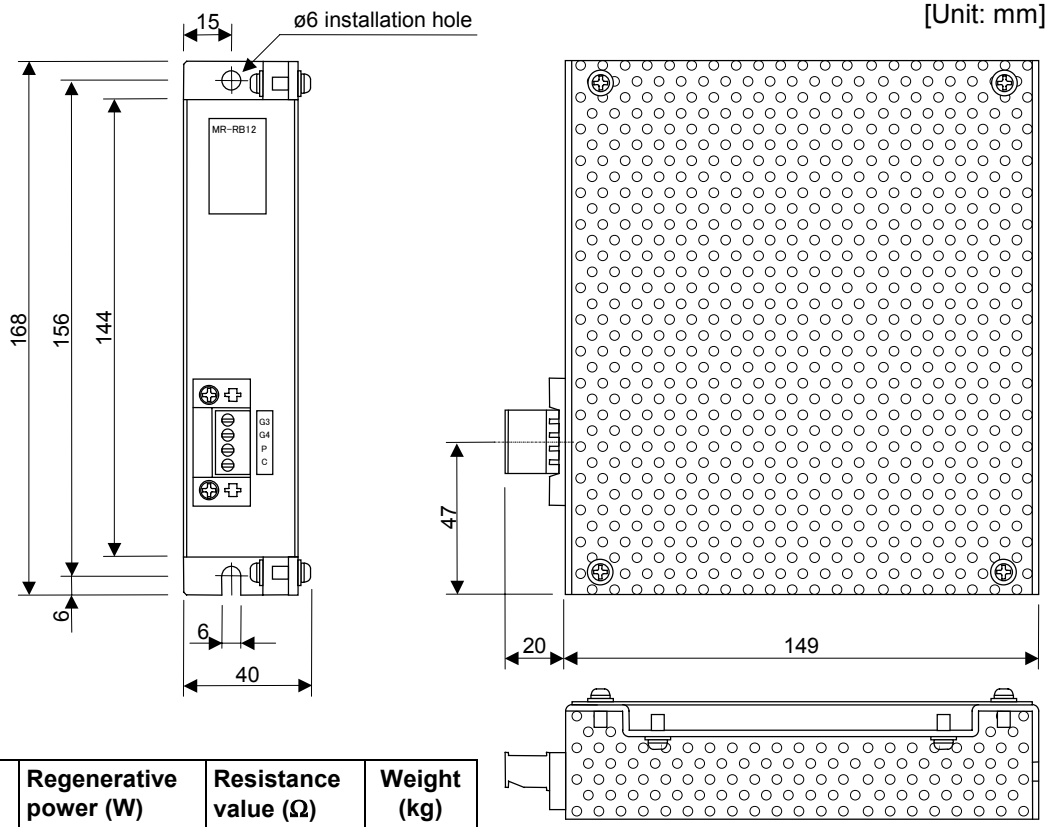
[Unit: mm]



Regenerative option type	Regenerative power (W)	Resistance value (Ω)	Weight (kg)
MR-RB032	30	40	0.5

<MR-RB12>

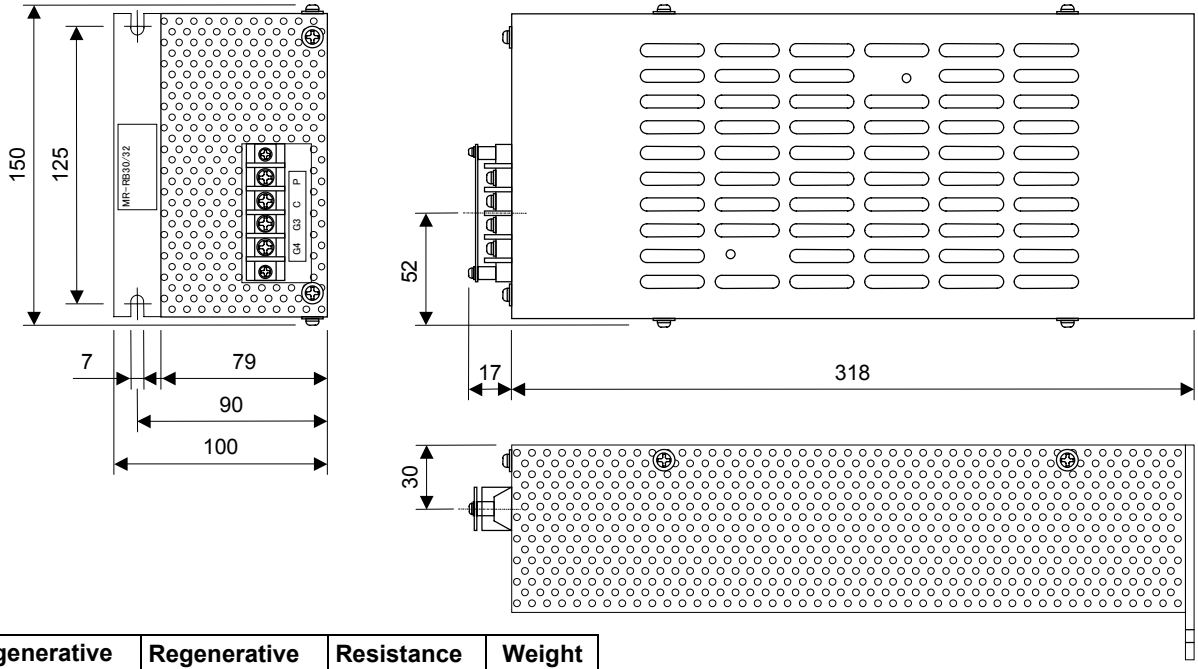
[Unit: mm]



Regenerative option type	Regenerative power (W)	Resistance value (Ω)	Weight (kg)
MR-RB12	100	40	0.8

<MR-RB32, MR-RB30>

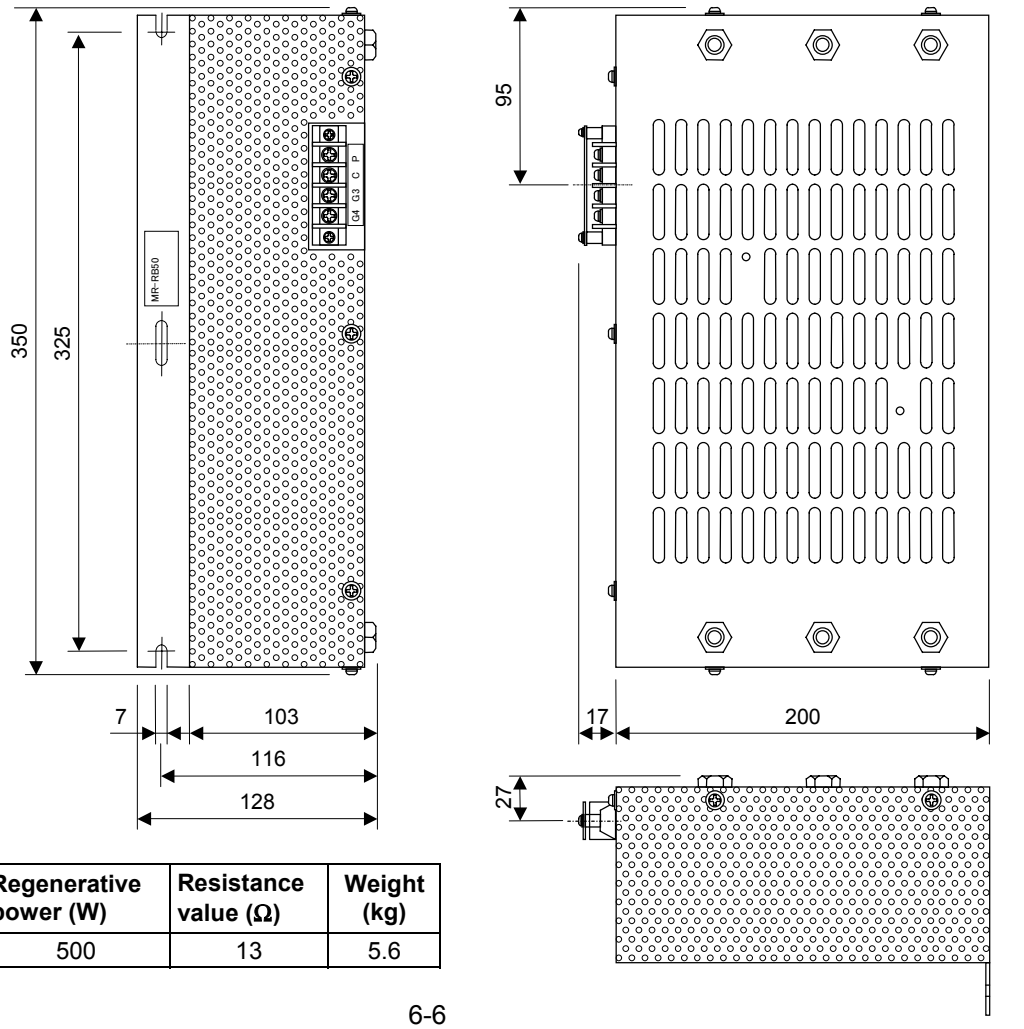
[Unit: mm]



Regenerative option type	Regenerative power (W)	Resistance value (Ω)	Weight (kg)
MR-RB32	300	40	2.9
MR-RB30	300	13	2.9

<MR-RB50>

[Unit: mm]



Regenerative option type	Regenerative power (W)	Resistance value (Ω)	Weight (kg)
MR-RB50	500	13	5.6

6-2 Battery option

A battery or battery unit is required for the absolute position system. Use a battery unit when this servo amplifier is connected to the same bus line as the MDS-B-V1/V2 servo amplifier of the absolute position axis.

Battery option specifications

Item	Battery	Battery unit			
Type	MR-BAT	MDS-A-BT-2, -BT-4, -BT-6, -BT-8			
Nominal voltage	3.6V	3.6V			
Nominal capacity	1700mAh	BT-2	BT-4	BT-6	BT-8
		4000mAh	8000mAh	12000mAh	16000mAh
No. of backup axes	Only one axis by mounted amplifier	Max. 7 axes in one system (in same CNC bus)			
Battery continuous back up time	Approx. 10,000 hours	Approx. 12,000 hours			
Battery useful life	5 years from date of battery manufacture	7 years from date of unit manufacture			
Data save time during battery replacement	HC□, HC□R, HA□N : 20 hours at time of delivery, 10 hours after 5 years HC-SF, HC-RF				
	HA-FF, HC-MF : 2 hours at time of delivery, 1 hour after 5 years				
Back up time from battery warning to alarm occurrence	Approx. 100 hours				

⚠ CAUTION

1. To protect the absolute position, do not shut off the servo amplifier control power supply if the battery voltage becomes low (warning 9F).
2. The battery life will be greatly affected by the ambient temperature. The above data shows the theoretic values for when the ambient temperature of the battery is 25°C. If the ambient temperature rises, generally the back up time and useful life will be shorter.

6-2-1 Battery (MR-BAT)

This is a battery that is built in the servo amplifier. It must be stored in the servo amplifier of the absolute position control axis.

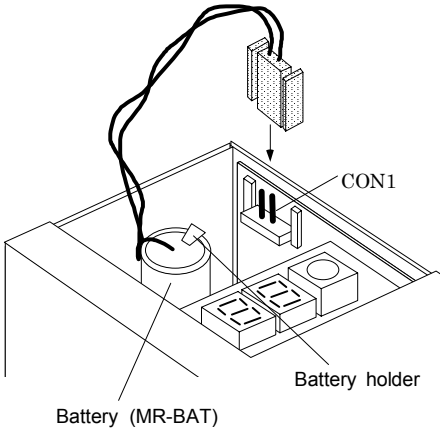
⚠ CAUTION

The internal circuit of the servo amplifier can be damaged by static electricity. Always observe the following points.

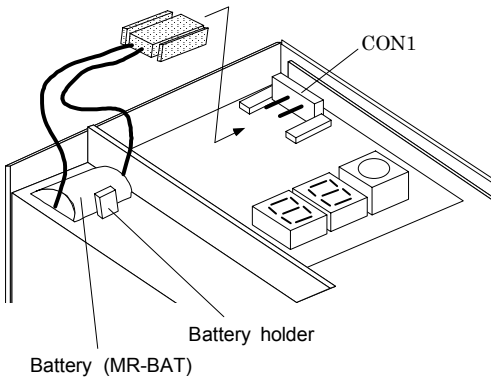
1. Always ground the body and work table.
2. Never touch the conductive parts such as the connector pins or electrical parts by hand.

Mount the battery into the servo amplifier with the following procedure.

① Open the operation section window. (For the MDS-B-SVJ2-10/-20, also remove the front cover.)
② Mount the battery into the battery holder.
③ Insert the battery connector into CON1 until a click is heard.



For MDS-B-SVJ2-01 to MDS-B-SVJ2-07



For MDS-B-SVJ2-10, MDS-B-SVJ2-20

6-2-2 Battery unit (MDS-A-BT-2/-4/-6/-8)

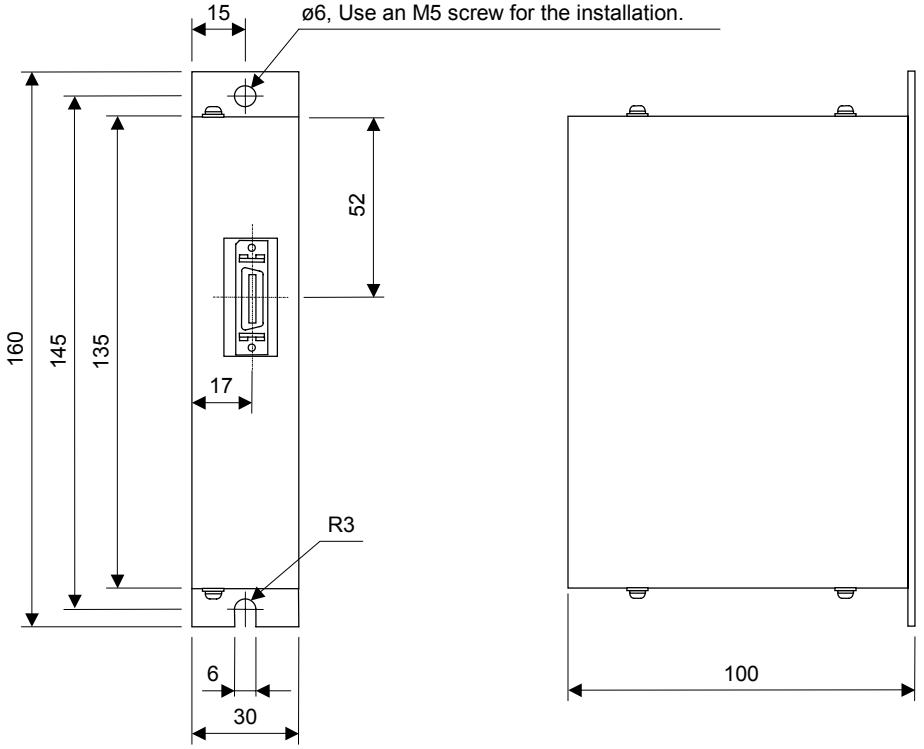
This is a battery that is installed outside of the servo amplifier. This is used when using the servo amplifier MDS-B-V1/V2. One battery unit can back up the absolute position data for the servo amplifiers of several axes. The number of servo amplifiers that can be backed up with one battery unit is as follows.

Battery unit type	No. of units that can be backed up
MDS-A-BT-2	2 units
MDS-A-BT-4	4 units
MDS-A-BT-6	6 units
MDS-A-BT-8	7 units

<Outline dimension drawing>

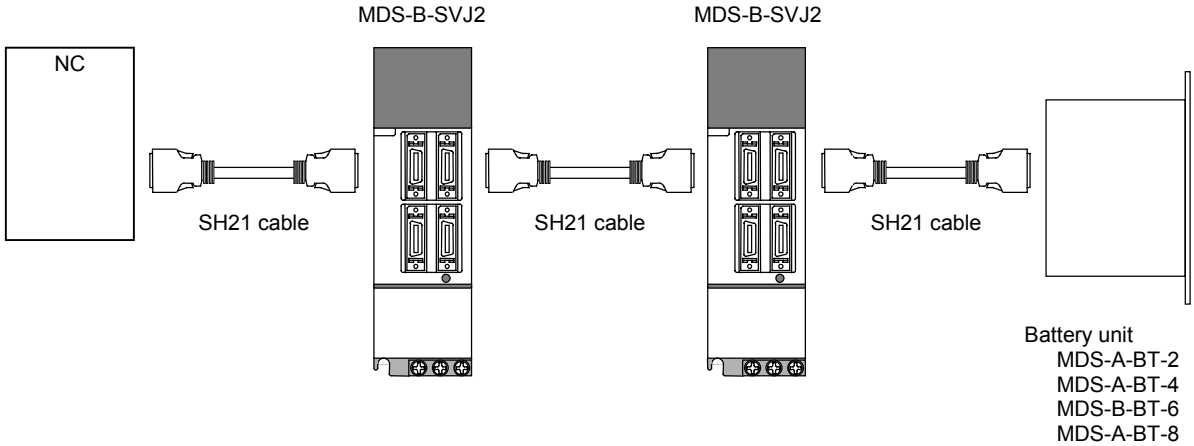
MDS-A-BT-2/-4/-6/-8

[Unit: mm]



<Connection>

The battery unit is connected with a bus cable (SH21) between the amplifiers instead of the terminator.



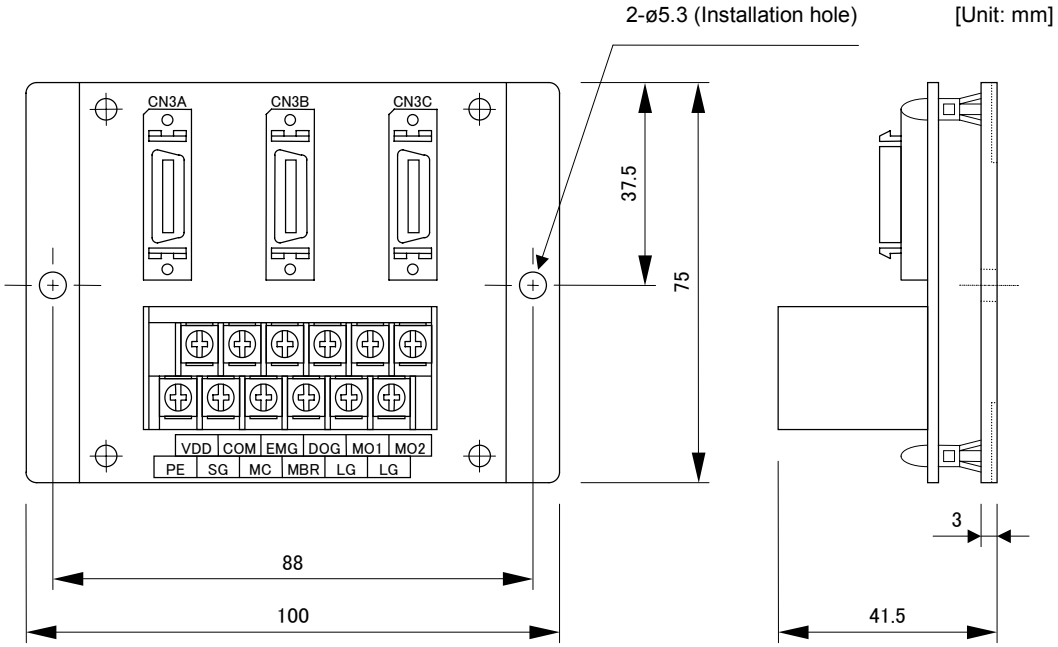
6-3 Relay terminal block

Signals input/output from the CN3 connector on the front of the servo amplifier can be sent to the terminal block. Connect the terminal block to the CN3 connector with an SH21 cable. This can also be used with the servo amplifier MR-J2-CT Series for auxiliary axes.

Abbrev.	Name	Descriptions
CN3A	Connector 3 input/output A	Connect from the CN3 connector with an SH21 cable. Common for any connector, so each signal will pass through. Generally when the CN3 control signal is being used, each signal can be output from the relay terminal block by relaying through these connectors.
CN3B	Connector 3 input/output B	
CN3C	Connector 3 input/output C	
VDD	Internal power supply output	This is the 24V power supply output in the amplifier. When using an internal power supply, use relayed once through the COM terminal.
COM	Common power supply	Connect VDD when using the amplifier internal power supply. Connect the + side of the external power supply when using an external power supply.
EMG	External emergency stop input	This is the input terminal for external emergency stops.
DOG	(Near-point dog input)	This is not used with the MDS-B-SVJ2.
MO1	Monitor output 1	This is the D/A output ch.1. Measure the voltage across MO1-LG.
MO2	Monitor output 2	This is the D/A output ch.2. Measure the voltage across MO2-LG.
PE	Plate ground	This has the same potential as the amplifier FG or cable shield.
SG	24V power supply ground	This is the ground when using digital input/output.
MC	Contactor control output	This is the output terminal for contactor control.
MBR	Motor brake control output	This is the output terminal for motor brake control.
LG	5V power supply ground	This is the ground when using D/A output.

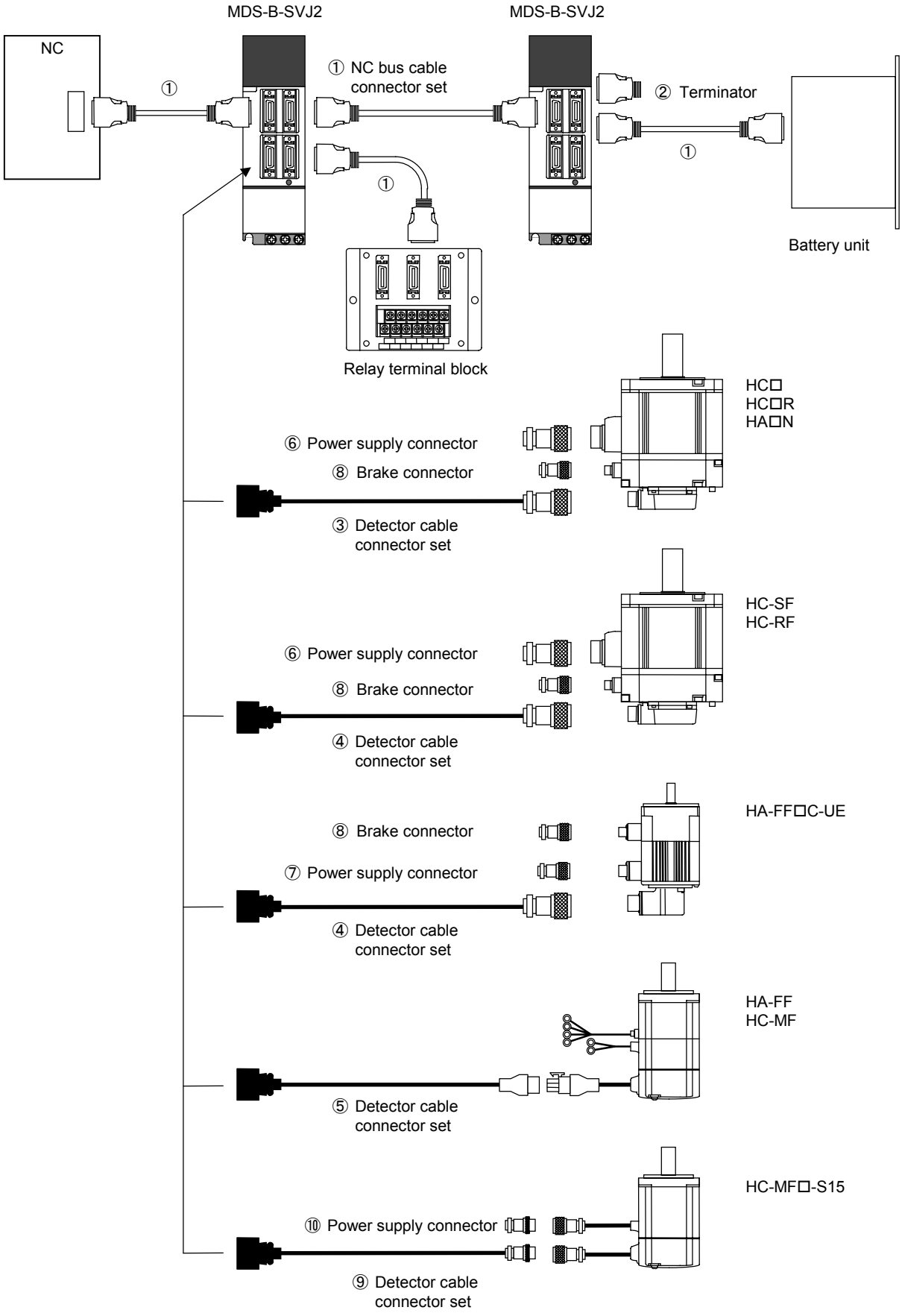
< Outline dimension drawing >

MR-J2CN3TM



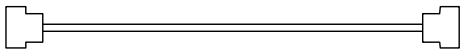
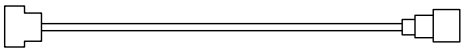
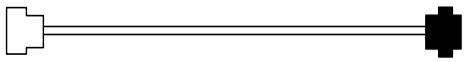
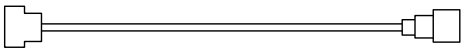
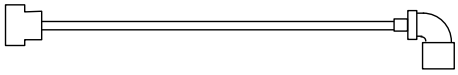
6-4 Cables and connectors

The cables and connectors that can be ordered from Mitsubishi Electric Corp. as option parts are shown below. Cables can only be ordered in the designated lengths shown on the following pages. Purchase a connector set, etc., to create special length cables when required.



6-4-1 Cable option list

(1) Cables

Part name				Type	Descriptions
For CN1A, CN1B	① Communication cable for CNC unit - Amplifier Amplifier - Amplifier			SH21 Length: 0.35, 0.5, 0.7, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 9, 10, 15, 20, 30m FCUA-R000 and [MR-J2HBUS□M can also be used.]	Servo amplifier side connector (Sumitomo 3M) Connector : 10120-6000EL Shell kit : 10320-3210-000 Servo amplifier side connector (Sumitomo 3M) Connector : 10120-6000EL Shell kit : 10320-3210-000 
	② Terminator connector			A-TM [FCUA-A-TM can also be used.]	Terminator connector 
For CN2	③ HC□-A47 HC□R-A47 ④ Detector cable for HC-SF, HC-RF, HA-FF□C-UE	IP65 compatible	Straight	Length is shown in the CNV2C-2P-S-□M. Length : 2, 5, 10, 20, 30m	Servo amplifier side connector (Sumitomo 3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 (Only screw type lock) Servomotor detector side connector (DDK) Connector : MS3106A20-29S(D190) Straight back shell: CE02-20BS-S Clamp: CE3057-12A-3 
		IP65 compatible	Angle	Length is shown in the CNV2C-3P-S-□M Length : 2, 5, 10, 20, 30m	Servo amplifier side connector (Sumitomo 3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 (Only screw type lock) Servomotor detector side connector (DDK) Connector: MS3106A20-29S (D190) Angle back shell: CE-20BA-S Clamp: CE3057-12A-3 
	⑤ Detector cable for HA-FF, HC-MF	For general environment	Straight	Length is shown in the MR-JCCBL□M-H□. Length : 2, 5, 10, 20, 30m	Servo amplifier side connector (Sumitomo 3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 Servomotor detector side connector (Japan AMP) Connector: 172161-9 Connector pin: 170359-1 Clamp: MTI-0002 
	⑨ Detector cable for HC-MF□-S15	IP65 compatible	Straight	Length is shown in the MR-RMCBL□M. Length : 2, 5, 10, 20, 30m	Servo amplifier side connector (Sumitomo 3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 Servomotor detector side connector (Hirose) Plug: RM15WTJA-10S Clamp: RM15WTP-CP (7) 
	③ Detector cable for HC□-A42/E42 HC□-A33/E33 HC□R-A42/E42 HC□R-A33/E33 HA□N-A42/E42 HA□N-A33/E33 (HC□-A47 and HC□R-A47 cannot be used)			CNV12-□-□□-□ Amplifier side connector Blank: One-touch lock S: Screw lock Environment Blank: For general environment P: IP67 compatible Detector side connector 2: Straight cannon 3: Angle cannon Axis No. 0: No display 1: 1st axis ≀ 4: 4th axis Length: 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 20m [CNV2 type FCUA-R080 (straight cannon) and FCUA-R084 (angle cannon) can also be used.]	Servo amplifier side connector (Sumitomo 3M) • Detector connector straight specification Connector : 10120-3000VE (One-touch type lock) Shell kit : 10320-52F0-008 (Screw type lock) Shell kit: 10320-52A0-008 Servomotor detector side connector (DDK) For general environment Straight connector : MS3106B22-14S Clamp: MS3057-12A IP67 compatible Connector : MS3106A22-14S(D190) Straight back shell: CE02-22BS-S Clamp: CE3057-12A-2  • Detector connector straight specification Connector : 10120-3000VE (One-touch type lock) Shell kit : 10320-52F0-008 (Screw type lock) Shell kit: 10320-52A0-008 For general environment Straight connector : MS3108B22-14S Clamp: MS3057-12A IP67 compatible Connector : MS3106A22-14S(D190) Angle back shell: CE-22BA-S Clamp: CE3057-12A-2 

(2) Connector sets

Part name				Type	Descriptions	
For CN1A, CN1B	① Communication connector set for CNC - Amplifier Amplifier - Amplifier			FCUA-CS000	Servo amplifier side connector (Sumitomo 3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 	Servo amplifier side connector (Sumitomo 3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 
For CN2	③ HC□-A47 HC□R-A47 ④ Detector connector set for HC-SF, HC-RF, HA-FF□C-UE	IP65 compati-ble	Straight	MR-ENCNS Compliant cable range ø6.8 ~ ø10	Servo amplifier side connector (Sumitomo 3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 	Servomotor detector side connector (DDK) Connector : MS3106A20-29S(D190) Back shell: CE02-20BS-S Clamp: CE3057-12A-3 
		For general environ-ment	Straight	MR-J2CNS	Servo amplifier side connector (Sumitomo 3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 	Servomotor detector side connector (DDK) Connector : MS3106B20-29S Cable clamp: CE3057-12A 
	⑤ Detector connector set for HA-FF, HC-MF	For general environ-ment	Straight	MR-J2CNM	Servo amplifier side connector (Sumitomo 3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 	Servomotor detector side connector (DDK) Connector : 172161-9 Connector pin : 170359-1 Clamp: MTI-0002 
	⑨ Detector cable for HC-MF□-S15	IP65 compati-ble	Straight	MR-RMCS Adaptive cable range ø6.5 ~ ø7.5	Servo amplifier side connector (Sumitomo 3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 	Servomotor detector side connector (Hirose) Plug: RM15WTJA-10S Clamp: RM15WTP-CP (7) 
	③ Detector connector set for HC□-A42/E42 HC□-A33/E33 HC□R-A42/E42 HC□R-A33/E33 HA□N-A42/E42 HA□N-A33/E33 (HC□-A47 and HC□R-A47 cannot be used)	IP67 compati-ble	Straight	ENCP22-14S3 Compliant cable range ø6.8 ~ ø10	Servo amplifier side connector (Sumitomo 3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 	Servomotor detector side connector (DDK) Connector : MS3106A22-14S(D190) Straight back shell: CE02-22BS-S Clamp: CE3057-12A-3 
			Angle	ENCP22-14L3 Compliant cable range ø6.8 ~ ø10	Servo amplifier side connector (Sumitomo 3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 	Servomotor detector side connector (DDK) Connector : MS3106A22-14S(D190) Angle back shell: CE-22BA-S Clamp: CE3057-12A-3 
		For general environ-ment	Straight	FCUA-CS080	Servo amplifier side connector (Sumitomo 3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 	Servomotor detector side connector (DDK) Connector : MS3106B22-14S Clamp: MS3057-12A 
			Angle	FCUA-CS084	Servo amplifier side connector (Sumitomo 3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 	Servomotor detector side connector (DDK) Connector : MS3108B22-14S Clamp: MS3057-12A 

(Note) The connector maker may change without notice.

Part name				Type	Descriptions
For motor power supply	⑥ Power supply connector for HA053N, HA13N, HA23N, HA33N	IP65 and EN standard compati-ble	Straight	PWCE18-12S Compliant cable range ø8.5 ~ ø11	Servomotor detector side connector (DDK) Connector : CE05-6A18-12SD-B-BSS Clamp: CE3057-10A-2 (D265) 
			Angle	PWCE18-12L Compliant cable range ø8.5 ~ ø11	Servomotor detector side connector (DDK) Connector : CE05-8A18-12SD-B-BAS Clamp: CE3057-10A-2 (D265) 
		For general environ-ment	Straight	FCUA-CN801	Servomotor detector side connector (DDK) Connector : MS3106B18-12S Clamp: MS3057-10A 
			Angle	FCUA-CN805	Servomotor detector side connector (DDK) Connector : MS3108B18-12S Clamp: MS3057-10A 
	⑥ Power supply connector for HC52 ~ 152, HC53 ~ 153, HC103R ~ 203R, HA40N, HA43N, HA80N, HA83N, HC-SF52 ~ 152, HC-SF53 ~ 153, HC-RF103 ~ 203	IP67 and EN standard compati-ble	Straight	PWCE22-23S Compliant cable range ø9.5 ~ ø13 (MR-PWCNS1 can also be used.)	Servomotor detector side connector (DDK) Connector : CE05-6A22-23SD-B-BSS Clamp: CE3057-12A-2 (D265) 
			Angle	PWCE22-23L Compliant cable range ø9.5 ~ ø13	Servomotor detector side connector (DDK) Connector : CE05-8A22-23SD-B-BAS Clamp: CE3057-12A-2 (D265) 
		For general environ-ment	Straight	FCUA-CN802	Servomotor detector side connector (DDK) Connector : MS3106B22-23S Clamp: MS3057-12A 
			Angle	FCUA-CN806	Servomotor detector side connector (DDK) Connector : MS3108B22-23S Clamp: MS3057-12A 

(Note) The connector maker may change without notice.

Part name				Type	Descriptions
For motor power supply	⑥ Power supply connector for HC202, HA100N, HC-SF202~352, HC-SF203~353	IP65 and EN standard compati-ble	Straight	PWCE24-10S Compliant cable range ø13 ~ ø15.5 (MR-WCNS2 can also be used.)	Servomotor detector side connector (DDK) Connector : CE05-6A24-10SD-B-BSS Clamp: CE3057-16A-2 (D265) 
			Angle	PWCE24-10L Compliant cable range ø13 ~ ø15.5	Servomotor detector side connector (DDK) Connector : CE05-8A24-10SD-B-BAS Clamp: CE3057-16A-2 (D265) 
		For general environ-ment	Straight	FCUA-CN803	Servomotor detector side connector (DDK) Connector : MS3106B24-10S Clamp: MS3057-16A 
			Angle	FCUA-CN807	Servomotor detector side connector (DDK) Connector : MS3108B24-10S Clamp: MS3057-16A 
	⑦ Power supply connector for HA-FF□C-UE	For general environ-ment	Straight	MR-PWCNF	Servomotor detector side connector Connector : CE05-6A14S-2SD-B (DDK) Clamp: YSO14-9-11 (Daiwa) 
	⑩ Power supply connector for HC-MF□S15	IP65 compati-ble	Straight	MR-RM4S (□) The value in □ indicates the cable clamp diameter 8, 9, 10mm Compliant cable range Clamp diameter ±0.5mm	Servomotor detector side connector (Hirose) Connector: RM15WTJA-4S Clamp: RM15WTP-CP (8/9/10) 
For motor brakes	⑧ Brake connector for HC202B, HA053NB, HA13NB, HA23NB, HA33NB, HA100NB, HC-SF202B~352B, HC-SF203B~353B, HA-FF□CB-UE	IP67 compati-ble	Straight	BRKP10SL-4S Compliant cable range ø5 ~ ø8.3 (MR-BKCN can also be used.)	Servomotor detector side connector Connector : MS3106A10SL-4S (D190) (DDK) Clamp: YSO10-5-8 (Daiwa) 
			Angle	BRKP10SL-4L Compliant cable range ø5 ~ ø8.3	Servomotor detector side connector Connector : MS3106A10SL-4S (D190) (DDK) Clamp: YLO10-5-8 (Daiwa) 
		For general environ-ment	Straight	FCUA-CN804	Servomotor detector side connector (Japan Aviation Electronics) Connector : MS3106B10SL-4S Clamp: MS3057-4A 
			Angle	FCUA-CN808	Servomotor detector side connector (Japan Aviation Electronics) Connector : MS3108B10SL-4S Clamp: MS3057-4A 

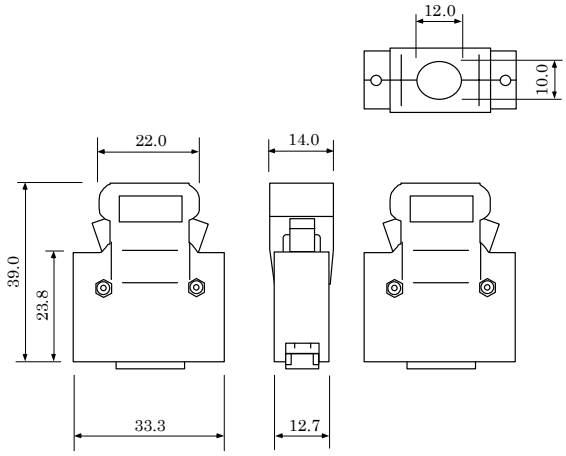
(Note) The connector maker may change without notice.

6-4-2 Connector outline dimension drawings

Servo amplifier CN2 connector

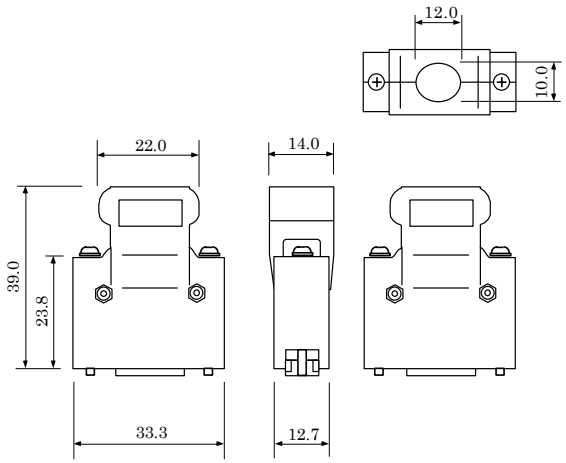
Maker: Sumitomo 3M (Ltd.)
<Type>
Connector: 10120-3000VE
Shell kit: 10320-52F0-008

[Unit: mm]



Maker: Sumitomo 3M (Ltd.)
<Type>
Connector: 10120-3000VE
Shell kit: 10320-52A0-008

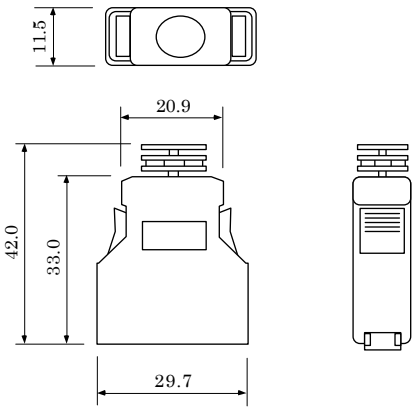
[Unit: mm]



Maker: Sumitomo 3M (Ltd.)
<Type>
Connector: 10120-6000EL
Shell kit: 10320-3210-000

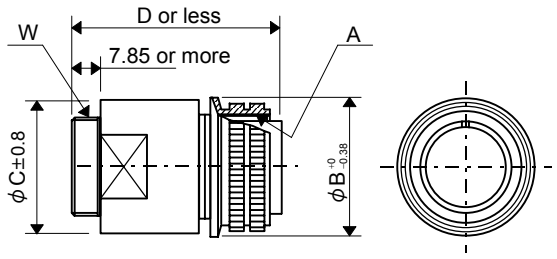
Because this connector is an integrated molding part of the cable, it is not an option setting in the connector set. The terminator connector (A-TM) also has the same outline.

[Unit: mm]



Connectors for detector and motor power supply (IP67 and EN standard compatible)

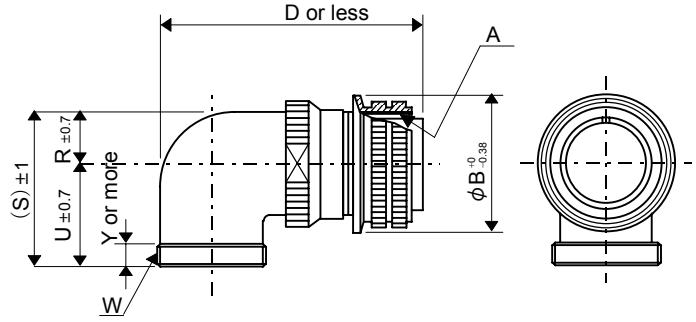
Straight plug
Maker : DDK (Ltd.)



[Unit: mm]

Type	A	B +0 −0.38	C±0.8	D or less	W
CE05-6A18-12SD-B-BSS	$1^{1}/_{8}$-18UNEF-2B	34.13	32.1	57	1-20UNEF-2A
CE05-6A22-23SD-B-BSS	$1^{3}/_{8}$-18UNEF-2B	40.48	38.3	61	$1^{3}/_{16}$-18UNEF-2A
CE05-6A24-10SD-B-BSS	$1^{1}/_{2}$-18UNEF-2B	43.63	42.0	68	$1^{7}/_{16}$-18UNEF-2A

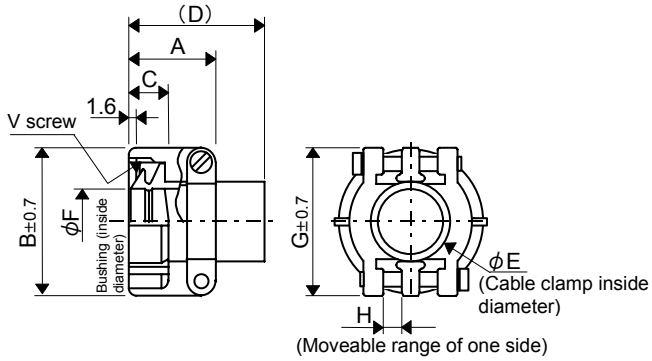
Angle plug
Maker : DDK (Ltd.)



[Unit: mm]

Type	A	B +0 −0.38	D or less	W	R±0.7	U±0.7	(S)±1	Y or more
CE05-8A18-12SD-B-BAS	$1^{1}/_{8}$-18UNEF-2B	34.13	69.5	1-20UNEF-2A	13.2	30.2	43.4	7.5
CE05-8A22-23SD-B-BAS	$1^{3}/_{8}$-18UNEF-2B	40.48	75.5	$1^{3}/_{16}$-18UNEF-2A	16.3	33.3	49.6	7.5
CE05-8A24-10SD-B-BAS	$1^{1}/_{2}$-18UNEF-2B	43.63	86.3	$1^{7}/_{16}$-18UNEF-2A	18.2	36.5	54.7	7.5

Cable clamp
Maker : DDK (Ltd.)

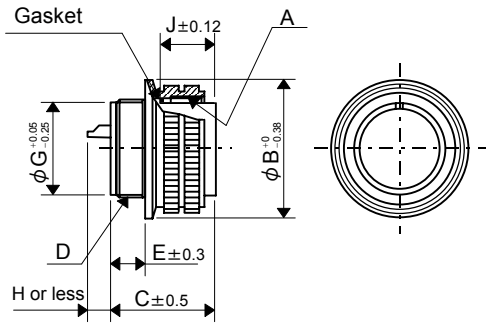


[Unit: mm]

Type	Shell size	Total length A	Outside dia. B	Effective screw length C	D	E	F	G	H	Installation screws (V)	Bushing	Compliant cable
CE3057-10A-2 (D265)	18	23.8	30.1	10.3	41.3	15.9	11	31.7	3.2	1-20UNEF-2B	CE3420-10-2	ø8.5~ø11
CE3057-12A-2 (D265)	20, 22	23.8	35	10.3	41.3	19	13	37.3	4	$1^{3}/_{16}$-18UNEF-2B	CE3420-12-2	ø9.5~ø13
CE3057-12A-3 (D265)							10				CE3420-12-3	ø6.8~ø10
CE3057-16A-2 (D265)	24	26.2	42.1	10.3	41.3	23.8	15.5	42.9	4.8	$1^{7}/_{16}$-18UNEF-2B	CE3420-16-2	ø13~ø15.5

Connectors for detectors, motor power supply and brakes (IP67 and EN standard compatible)

Straight plug
Maker : DDK (Ltd.)

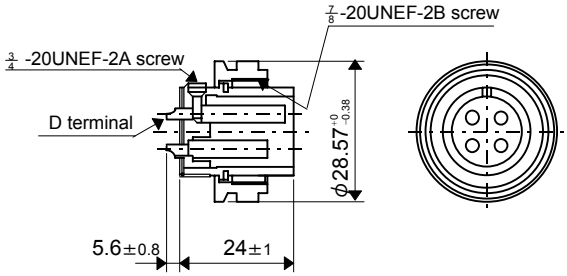


[Unit: mm]

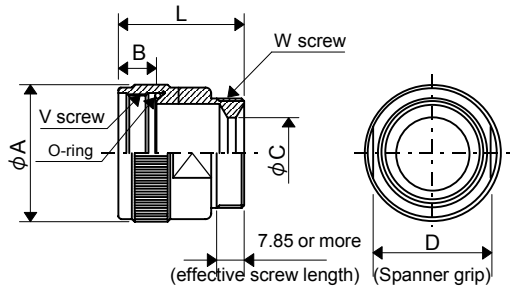
Type	A	B +0 −0.38	C±0.5	D	E±0.3	G +0.05 −0.25	J±0.12
MS3106A10SL-4S (D190)	5/8-24UNEF-2B	22.22	23.3	9/16-24UNEF-2A	7.5	12.5	13.49
MS3106A20-29S (D190)	1 1/4-18UNEF-2B	37.28	34.11	1 1/8-18UNEF-2A	12.16	26.8	18.26
MS3106A22-14S (D190)	1 3/8-18UNEF-2B	40.48	34.11	1 1/4-18UNEF-2A	12.15	29.9	18.26

Straight plug
Maker : DDK (Ltd.)
Type : CE05-6A14S-2SD-B

[Unit: mm]



Straight back shell
Maker : DDK (Ltd.)

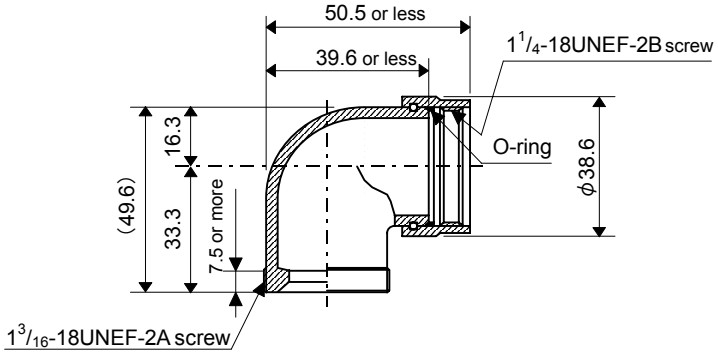


[Unit: mm]

Type	L	A	B	C	D	V	W
CE02-20BS-S	35	35	10.9	17.8	31.6	1 1/8-18UNEF-2B	1 3/16-18UNEF-2A
CE02-22BS-S	35	36.5	10.9	17.8	32.4	1 1/4-18UNEF-2B	1 3/16-18UNEF-2A

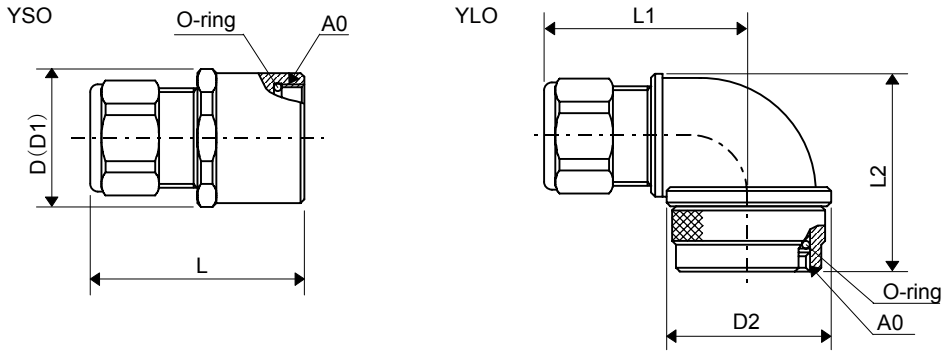
Angle back shell
Maker : DDK (Ltd.)
Type : CE-22BA-S

[Unit: mm]



Connectors for motor power supply and brakes (IP67 and EN standard compatible)

Cable clamp
Maker : Daiwa (Ltd.)



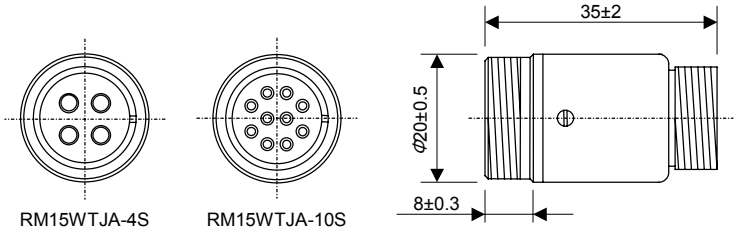
[Unit: mm]

Type	Accommodating outside diameter	American standard screw thread Aø	Length before tightening		L2	Side to side	Corner to corner	
			L	L1		D	D1	D2
YSO10-5 ~ 8, YLO10-5 ~ 8	ø5 ~ 8.3	$^{9}/_{16}$-24UNEF-2B	43	39	42.5	24	26	26
YSO14-9 ~ 11	ø8.3 ~ 11.3	$^{3}/_{4}$-20UNEF-2B	44	43.5	44.5	26	28	35

Connectors for HC-MF□S15 motor detector and power supply (IP65 compatible)

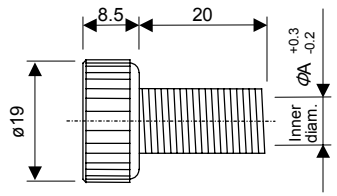
Straight plug
Maker : Hirose
Type : RM15WTJA-4S
RM15WTJA-10S

[Unit: mm]



Cable clamp
Maker : Hirose
Type: RM15WTP-CP(□)

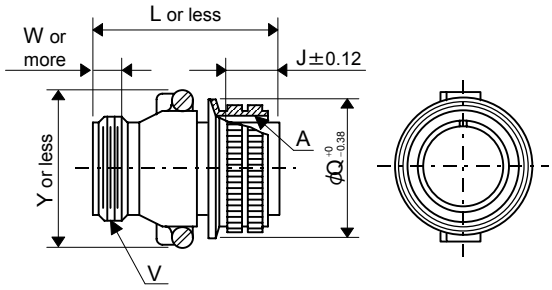
[Unit: mm]



Cable clamp type	Cable clamp diameter	Spring inner diameter øA
RM15WTP-CP(7)	ø7	8.0
RM15WTP-CP(8)	ø8	10.5
RM15WTP-CP(9)	ø9	10.5
RM15WTP-CP(10)	ø10	10.5

Connectors for detectors, motor power supply and brakes (for general environment)

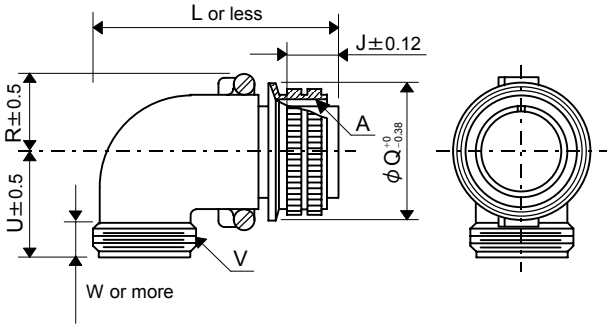
Straight plug
Maker : DDK (Ltd.)



[Unit: mm]

Type	Coupling screw A	Length of coupling section J ± 0.12	Total length L or less	Connection nut outside diameter øQ $^{+0}_{-0.38}$	Cable clamp installation screw V	Effective screw length W or more	Max. width Y or less
MS3106B18-12S	$1^{1}/_{8}$-18UNEF	18.26	52.37	34.13	1-20UNEF	9.53	42
MS3106B20-29S	$1^{1}/_{4}$-18UNEF	18.26	55.57	37.28	$1^{3}/_{16}$-18UNEF	9.53	47
MS3106B22-14S	$1^{3}/_{8}$-18UNEF	18.26	55.57	40.48	$1^{3}/_{16}$-18UNEF	9.53	50
MS3106B22-23S							
MS3106B24-10S	$1^{1}/_{2}$-18UNEF	18.26	58.72	43.63	$1^{7}/_{16}$-18UNEF	9.53	53

Angle plug
Maker : DDK (Ltd.)

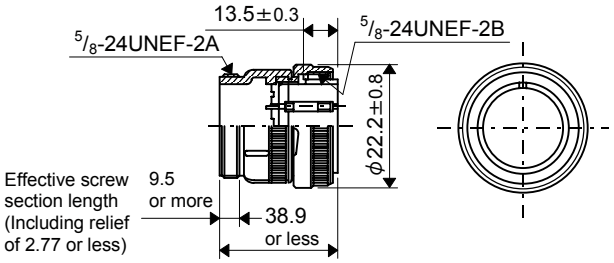


[Unit: mm]

Type	Coupling screw A	Length of coupling section J ± 0.12	Total length L or less	Connection nut outside diameter øQ $^{+0}_{-0.38}$	R±0.5	U±0.5	Cable clamp installation screw V	Effective screw length W or more
MS3108B18-12S	$1^{1}/_{8}$-18UNEF	18.26	68.27	34.13	20.5	30.2	1-20UNEF	9.53
MS3108B22-14S	$1^{3}/_{8}$-18UNEF	18.26	76.98	40.48	24.1	33.3	$1^{3}/_{16}$-18UNEF	9.53
MS3108B22-23S								
MS3108B24-10S	$1^{1}/_{2}$-18UNEF	18.26	86.51	43.63	25.6	36.5	$1^{7}/_{16}$-18UNEF	9.53

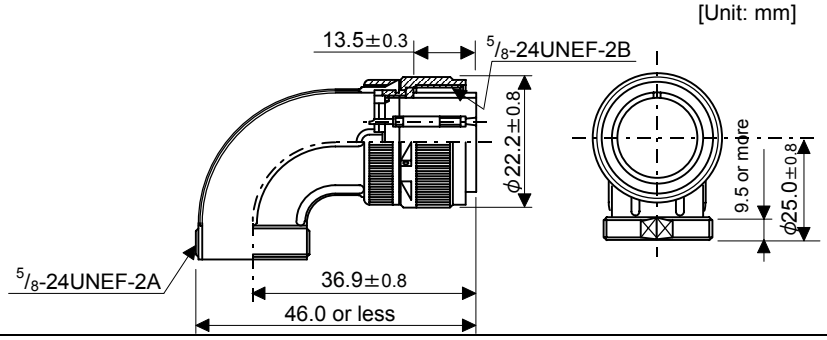
Straight plug
Maker : Japan Aviation Electronics (Ltd.)
Type: MS3106B10SL-4S

[Unit: mm]



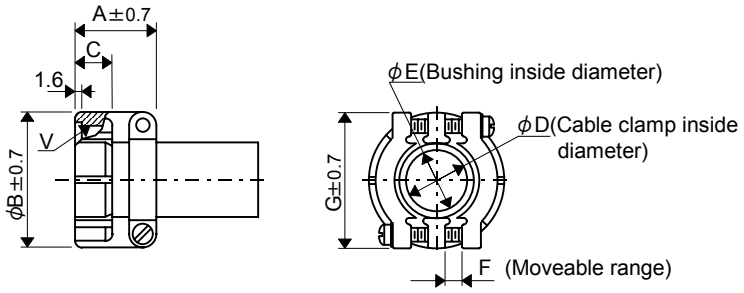
Angle plug
Maker : Japan Aviation Electronics (Ltd.)
Type: MS3106B10SL-4S

[Unit: mm]



Connectors for detectors, motor power supply and brakes (for general environment)

Cable clamp
Maker : DDK (Ltd.)



[Unit: mm]

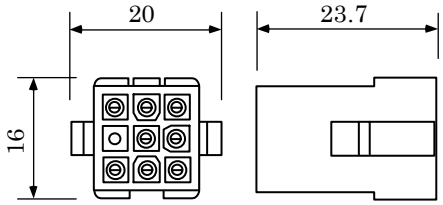
Type	Shell size	Total length A±0.7	Outside diameter øB±0.7	Effective screw length C	øD	øE	F	G±0.7	Installation screw V	Bushing
MS3057-4A	10SL, 12S	20.6	20.6	10.3	7.9	5.6	1.6	22.2	$^{5}/_{8}$-24UNEF	AN3420-4
MS3057-10A	18	23.8	30.1	10.3	15.9	14.3	3.2	31.7	1-20-UNEF	AN3420-10
MS3057-12A	20, 22	23.8	35.0	10.3	19.0	15.9	4.0	37.3	$1^{3}/_{16}$-18UNEF	AN3420-12
MS3057-16A	24, 28	26.2	42.1	10.3	23.8	19.1	4.8	42.9	$1^{7}/_{16}$-18UNEF	AN3420-16

HA-FF, HC-MF motor detector connector (for general environment)

Maker: Japan AMP (Ltd.)
<Type>
Connector: 1-172161-9
Connector pin: 170359-1
Crimp tool: 755330-1

A crimp tool is required for wiring to the connector. Contact Japan AMP (Ltd.) for the crimping tool.

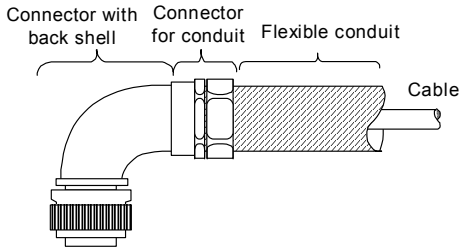
[Unit: mm]



6-4-3 Flexible conduits

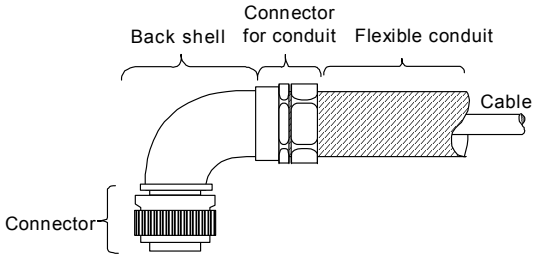
Basically, splash proofing can be ensured if cab-tire cable and connectors with IP65 or higher specifications are used. However, to further improve the oil resistance (chemical resistance to oil), weather resistance (resistance to the environment when used outdoors, etc.), durability, tensile strength, flattening strength, etc., run the cable through a flexible conduit when wiring.
The following shows an example of a flexible conduit. Contact the connector maker for more information.

(1) Method for connecting to a connector with back shell



Application	Applicable motors	Type			
		DDK		Japan Flex	
		Connector (straight)	Connector (angle)	Connector for conduit	Flexible conduit
For power supply	HA053N, HA13N, HA23N, HA33N	CE05-6A18-12S D-B-BSS	CE05-8A18-12S D-B-BAS	RCC-103CA18	VF-03 (Min. inside dia.: 10.6)
				RCC-104CA18	VF-04 (Min. inside dia.: 14)
	HC52~152, HC53~153, HC103R~203R, HA40N, HA43N, HA80N, HA83N, HC-SF52~152, 53~153, HC-RF103~203	CE05-6A22-23S D-B-BSS	CE05-8A22-23S D-B-BAS	RCC-104CA2022	VF-04 (Min. inside dia.: 14)
				RCC-106CA2022	VF-06 (Min. inside dia.: 19)
	HC202, HC203, HC352 HA100N, HA103N, HA200N HC-SF202~352, 203~353	CE05-6A24-10S D-B-BSS	CE05-8A24-10S D-B-BAS	RCC-106CA2428	VF-06 (Min. inside dia.: 19)
				RCC-108CA2428	VF-08 (Min. inside dia.: 24.4)
	HA-FF053C-UE~63C-UE	Select according to section "(2) Method for connecting to the connector main body".			

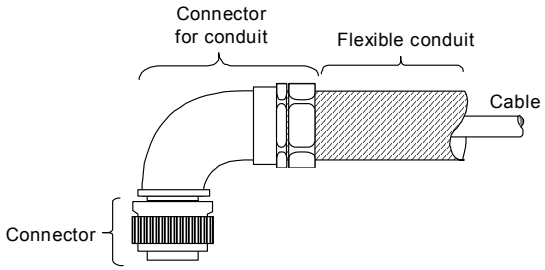
(Note) None of the parts in this table can be ordered from Mitsubishi Electric Corp.



Application	Applicable motors	Type			
		DDK		Japan Flex	
		Connector/ back shell (straight)	Connector/ back shell (angle)	Connector for conduit	Flexible conduit
For brakes	HA053NB~HA33NB HA100NB, HA103NB, HA200NB HC202B, HC203B, HC352B HA-FF□CB-UE HC-SF202B~352B, 203B~353B	Select according to section "(2) Method for connecting to the connector main body".			
For detectors	HC□-A47, HC□R-A47 HC-SF HC-RF HA-FF□C-UE	Connector MS3106A20-29S (D190) Back shell CE02-20BS-S	Connector MS3106A20-29S (D190) Back shell CE-20BA-S	RCC-104CA2022	VF-04 (Min. inside dia.: 14)
				RCC-106CA2022	VF-06 (Min. inside dia.: 19)
	HA□N HC□-E42/A42/E33/A33 HC□R-E42/A42/E33/A33	Connector MS3106A22-14S (D190) Back shell CE02-22BS-S	Connector MS3106A22-14S (D190) Back shell CE-22BA-S	RCC-104CA2022	VF-04 (Min. inside dia.: 14)
				RCC-106CA2022	VF-06 (Min. inside dia.: 19)

(Note) None of the parts in this table can be ordered from Mitsubishi Electric Corp.

(2) Method for connecting to the connector main body



Application	Applicable motors	Type		
		DDK	DAIWA DENGYO Co., Ltd.	
		Connector (straight)	Connector for conduit	Flexible conduit
For power supply	HA053N, HA13N, HA23N, HA33N	CE05-6A18-12SD-B	MSA-12-18 (Straight) MAA-12-18 (Angle)	FCV12 (Min. inside dia.: 12.3)
			MSA-16-18 (Straight) MAA-16-18 (Angle)	FCV16 (Min. inside dia.: 15.8)
	HC52~152, 53~153, 103R~203R, HA40N, HA43N, HA80N, HA83N, HC-SF52~152, 53~153, HC-RF103~203	CE05-6A22-23SD-B	MSA-16-22 (Straight) MAA-16-22 (Angle)	FCV16 (Min. inside dia.: 15.8)
			MSA-22-22 (Straight) MAA-22-22 (Angle)	FCV22 (Min. inside dia.: 20.8)
	HC202, HC203, HC352 HA100N, HA103N, HA200N HC-SF202~352, 203~353	CE05-6A24-10SD-B	MSA-22-24 (Straight) MAA-22-24 (Angle)	FCV22 (Min. inside dia.: 20.8)
			MSA-28-24 (Straight) MAA-28-24 (Angle)	FCV28 (Min. inside dia.: 26.4)
	HA-FF053C-UE~63C-UE	CE05-6A14S-2SD-B	MSA-12-14 (Straight) MAA-12-14 (Angle)	FCV12 (Min. inside dia.: 12.3)
For brakes	HA053NB~HA33NB HA100NB, HA103NB, HA200NB HC202B, HC203B, HC352B HA-FF□CB-UE HC-SF202B~352B, 203B~353B	MS3106A10SL-4S (D190)	MSA-10-10 (Straight) MAA-10-10 (Angle)	FCV10 (Min. inside dia.: 10.0)
For detectors	HC□-A47, HC□R-A47 HC-SF HC-RF HA-FF□C-UE	MS3106A20-29S (D190)	MSA-16-20 (Straight) MAA-16-20 (Angle)	FCV16 (Min. inside dia.: 15.8)
			MSA-22-20 (Straight) MAA-22-20 (Angle)	FCV22 (Min. inside dia.: 20.8)
	HA□N HC□-E42/A42/E33/A33 HC□R-E42/A42/E33/A33	MS3106A22-14S (D190)	MSA-16-22 (Straight) MAA-16-22 (Angle)	FCV16 (Min. inside dia.: 15.8)
			MSA-22-22 (Straight) MAA-22-22 (Angle)	FCV22 (Min. inside dia.: 20.8)

(Note) None of the parts in this table can be ordered from Mitsubishi Electric Corp.

6-4-4 Cable wire and assembly

(1) Cable wire

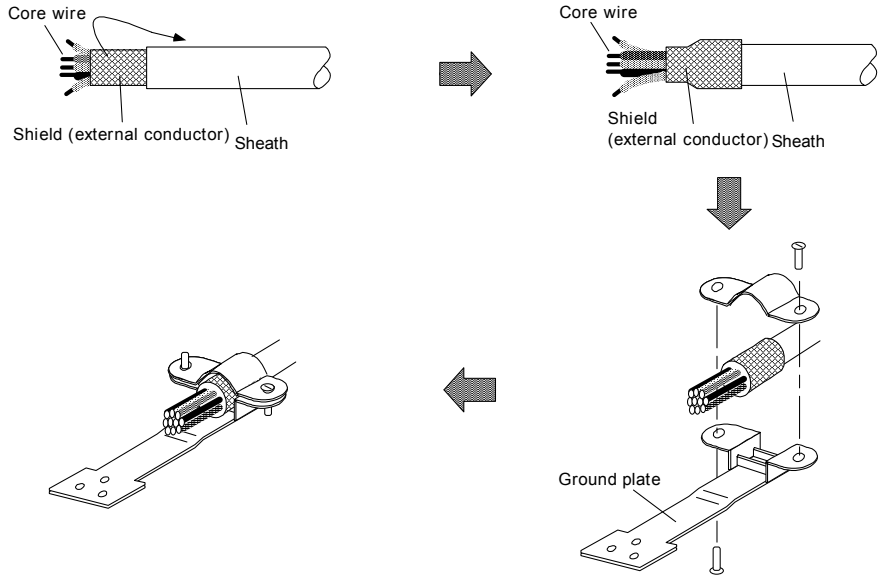
The following shows the specifications and processing of the wire used in each cable. Manufacture the cable using the recommended wire or equivalent parts.

Recommended wire type (Cannot be directly ordered from Mitsubishi Electric Corp.)	Finished outside diameter	Sheath material	No. of pairs	Wire characteristics				Application
				Configuration	Conductor resistance	Withstand voltage	Insulation resistance	
UL20276 AWG28 10pair	6.1mm	PVC	10	7 strands/ 0.13mm	222Ω/km or less	AC350/ 1min	1MΩ/km or more	NC unit bus cable
A14B2343 (Note)	7.2mm	PVC	6	14 strands/ 0.08mm	105Ω/km or less	AC500/ 1min	1500MΩ/km or more	Detector cable

(Note) Junko Co. (Dealer: Toa Denki)

(2) Cable assembly

Assemble the cable as shown in the following drawing, with the cable shield wire securely connected to the ground plate of the connector.



(3) Cable protection tube (noise countermeasure)

If influence from noise is unavoidable, or further noise resistance is required, selecting a flexible tube and running the signal cable through this tube is effective. This is also an effective countermeasure for preventing the cable sheath from being cut or becoming worn.
A cable clamp (MS3057) is not installed on the detector side, so be particularly careful of broken wires in applications involving bending and vibration.

Supplier	Tube	Connector		
		Amplifier side	Installation screws	Motor detector side
Japan Flex (Ltd.)	FBA-4 (FePb wire braid sheath)	RBC-104 (straight) RBC-204 (45°) RBC-304 (90°)	G16 G16 G16	RCC-104-CA2022
Daiwa (Ltd.)	Hi-flex PT #17 (FePb sheath)	PSG-104 (straight) PLG-17 (90°) PS-17 (straight)	Screw diameter ø26.4 Screw diameter ø26.4 PF1/2	PDC20-17
Sankei Works	Purika Tube PA-2 (FePb sheath)	BC-17 (straight)	Wire conduit tube screws : 15	PDC20-17

(Note) None of the parts in this table can be ordered from Mitsubishi Electric Corp.

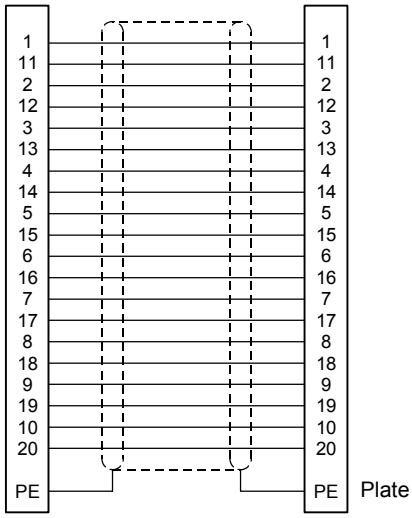
6-4-5 Option cable connection diagram

⚠ CAUTION Do not mistake the connection when manufacturing the detector cable. Failure to observe this could lead to faults, runaway or fires.

(1) NC unit bus cable

< SH21 cable connection diagram >

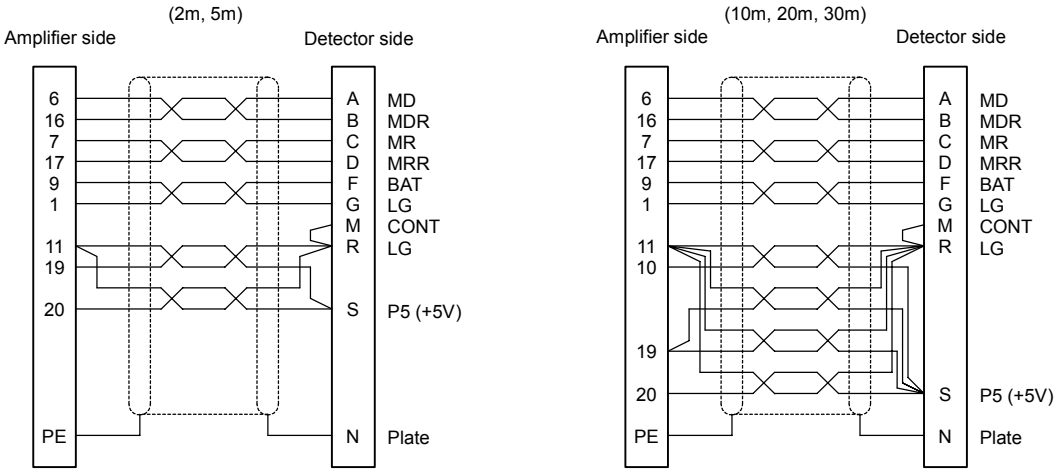
This is an actual connection diagram for the SH21 cable supplied by Mitsubishi. Manufacture the cable as shown below. The cable can be up to 30m long. Refer to section "6-4-4 Cable wire and assembly" for details on wire.



(2) Detector cable for HC□-A47, HC□R-A47, HC-SF, HC-RF, HA-FF□C-UE motors

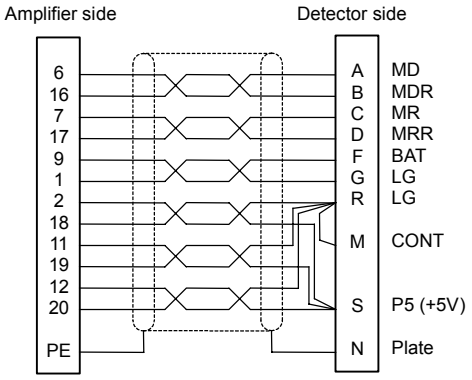
< CNV2 cable connection diagram >

This is an actual connection diagram for the CNV2 cable supplied by Mitsubishi. The connection differs according to the cable length.



< Connection diagram for cable manufacturing >

Manufacture the cable as shown below. The cable can be up to 30m long. Refer to section "6-4-4 Cable wire and assembly" for details on wire.



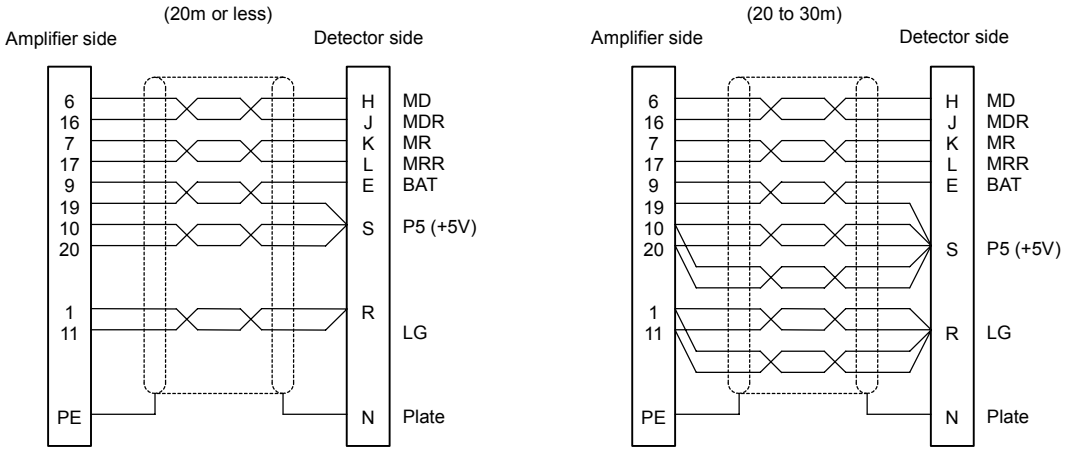
⚠ CAUTION

1. Do not connect anything to pins unless particularly described when manufacturing cable. (Leave OPEN.)
2. Contact Mitsubishi before manufacturing cable over 30m long.

(3) Detector cable for HA□N, HC□-E42/A42/E33/A33, HC□R-E42/A42/E33/A33 motors

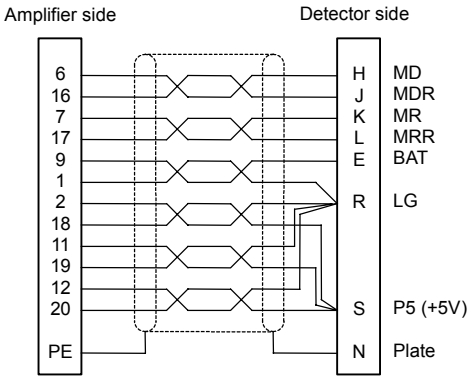
< CNV12 cable connection diagram >

This is an actual connection diagram for the CNV2 cable supplied by Mitsubishi. The connection differs according to the cable length.



< Connection diagram for cable manufacturing >

Manufacture the cable as shown below. The cable can be up to 30m long. Refer to section "6-4-4 Cable wire and assembly" for details on wire.



⚠ CAUTION

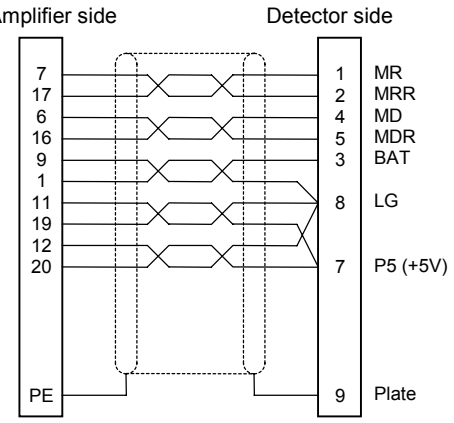
1. Do not connect anything to pins unless particularly described when manufacturing cable. (Leave OPEN.)
2. Contact Mitsubishi before manufacturing cable over 30m long.

(4) Detector cable for HC-MF, HA-FF motors

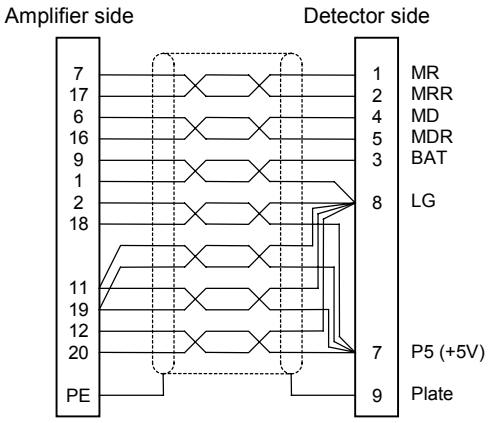
< MR-JCCBL□M-H cable connection diagram >

This is an actual connection diagram for the MR-JCCBL□M-H cable supplied by Mitsubishi. The connection differs according to the cable length.

MR-JCCBL2M-H
MR-JCCBL5M-H

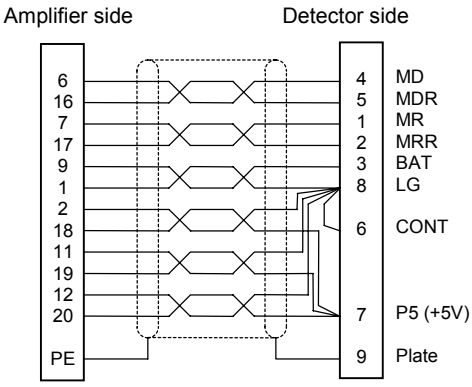


MR-JCCBL10M-H
MR-JCCBL20M-H
MR-JCCBL30M-H



< Connection diagram for cable manufacturing >

Manufacture the detector cable as shown below. The cable can be up to 50m long. Refer to section "6-4-4 Cable wire and assembly" for details on wire.



By connecting across CONT and LG on the detector side, the detector communication will be set to 4-wire (separated transmission/reception lines type) communication.

POINT

The MR-JCCBL□M-H cable is a general-purpose cable that can be used with other detectors. When the MR-JCCBL□M-H cable is used, the 2-wire type detector communication (common transmission/reception lines type) detector will be used so the MD and MDR signals will not be used.

⚠ CAUTION

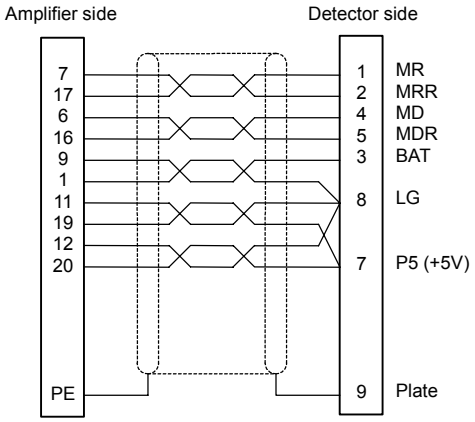
1. The cable manufacturing connection diagram shows the connection for a 4-wire detector communication (separated transmission/reception lines type). 2-wire type detector communication (common transmission/reception lines type) can be used with this motor. However it is recommended to manufacture the 4-wire communication type cable which is more effective against noise.
2. The detector communication method is automatically determined by the servo amplifier.
3. Do not connect the pins that have no particular description. (Leave these OPEN.)
4. Contact Mitsubishi before manufacturing cable over 50m long.

(5) Detector cable for HC-MF□-S15 motors

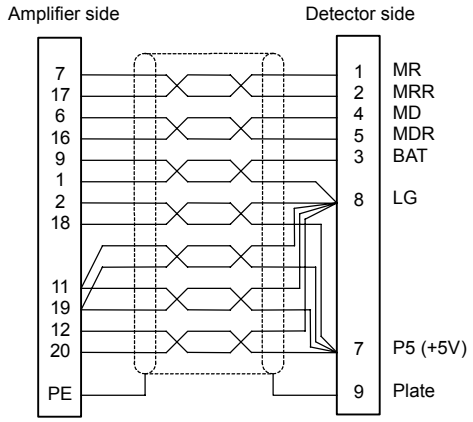
< MR-RMCBL□M cable connection diagram >

This is an actual connection diagram for the MR-RMCBL□M cable supplied by Mitsubishi. The connection differs according to the cable length.

MR-RMCBL2M
MR-RMCBL5M

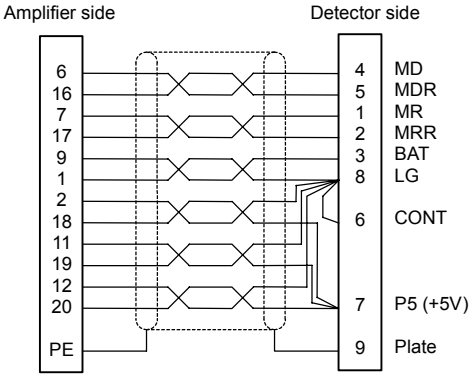


MR-RMCBL10M
MR-RMCBL20M
MR-RMCBL30M



< Connection diagram for cable manufacturing >

Manufacture the detector cable as shown below. The cable can be up to 50m long. Refer to section "6-4-4 Cable wire and assembly" for details on wire.



By connecting across CONT and LG on the detector side, the detector communication will be set to 4-wire (separated transmission/reception lines type) communication.

POINT

The MR-RMCBL□M cable is a general-purpose cable that can be used with other detectors. When the MR-RMCBL□M cable is used, the 2-wire type detector communication (common transmission/reception lines type) detector will be used so the MD and MDR signals will not be used.

⚠ CAUTION

1. The cable manufacturing connection diagram shows the connection for a 4-wire detector communication (separated transmission/reception lines type). 2-wire type detector communication (common transmission/reception lines type) can be used with this motor. However it is recommended to manufacture the 4-wire communication type cable which is more effective against noise.
2. The detector communication method is automatically determined by the servo amplifier.
3. Do not connect the pins that have no particular description. (Leave these OPEN.)
4. Contact Mitsubishi before manufacturing cable over 50m long.

Chapter 7 Peripheral Devices

7-1 Selection of wire

Select the wire size for each servo amplifier capacity as shown below.

Amplifier type	Wire size					Crimp terminal (Note 2)	
	L1, L2, L3 ⏚ (Note 3)	L11, L21	U, V, W (Note 4)	P, C (Note 5)	Magnetic brakes	Type	Tool
MDS-B-SVJ2-01	IV1.25SQ (AWG16)	IV1.25SQ (AWG16)	IV1.25SQ (AWG16)	IV2SQ (AWG14)	IV1.25SQ (AWG16)	32959	47387
MDS-B-SVJ2-03							
MDS-B-SVJ2-04							
MDS-B-SVJ2-06	IV2SQ (AWG14)		IV2SQ (AWG14)				
MDS-B-SVJ2-07							
MDS-B-SVJ2-10							
MDS-B-SVJ2-20	IV3.5SQ (AWG12)		IV3.5SQ (AWG12)			32968	59239

(Note 1) As a standard, the wire is a 600V vinyl wire (the conductor must be copper).
(Note 2) This indicates the UL/c-UL Standard compliant wire. (AMP). Refer to section 2-2-3 for the L11, L21, P and C below SVJ2-07.
(Note 3) This value is for a single amplifier. Refer to the next table when wiring across several amplifiers.
(Note 4) The wires in the table (U, V, W) are for when the distance between the servomotor and servo amplifier is 30m or less.
(Note 5) Twist and wire the connecting wire for the regenerative option (P, C).

When wiring L1, L2, L3 and the ground wire across several servo amplifiers, use the following table and select the wire size from the total capacity of the motors connected downward.

Total motor capacity	1kW or less	2.5kW or less	6kW or less	9kW or less	12kW or less
Wire size (mm^2)	IV1.25SQ (AWG16)	IV2SQ (AWG14)	IV3.5SQ (AWG12)	IV5.5SQ (AWG10)	IV8SQ (AWG8)

(Note) Select IV3.5SQ if the SVJ2-20 is included, even when the total amplifier capacity is 2.5kW or less.

7-2 Selection of no-fuse breakers

Use the following table to obtain the NFB (no-fuse breaker) rated current from the total rated capacity (SVJ2 total output capacity) of the motor driving the SVJ2 servo amplifier to be connected to the NFB to be selected, and select the no-fuse breaker.
When the MDS-B-SPJ2 spindle amplifier or converter unit will share no-fuse breakers, select from the total NFB rated current of each SVJ2 total output capacity and SPJ2 spindle amplifier or converter unit. However, separate the SVJ2 servo amplifier no-fuse breaker from the others, and select the NF60 type (60A) or smaller capacity dedicated for SVJ2 servo amplifiers if the total NFB rated current exceeds 60A.

NFB rated current table

SVJ2 total rated capacity	1.5kW or less	3.5kW or less	7kW or less	10kW or less	13kW or less	16kW or less
NFB rated current	10A	20A	30A	40A	50A	60A

MDS-B-SPJ2	MDS-B-SPJ2-02 MDS-B-SPJ2-04 MDS-B-SPJ2-075 MDS-B-SPJ2-15	MDS-B-SPJ2-22 MDS-B-SPJ2-37	MDS-B-SPJ2-55	MDS-B-SPJ2-75	MDS-B-SPJ2-110
Converter unit	MDS-A-CR-10 MDS-A-CR-15	MDS-C1-CV-37 MDS-A-CR-22 MDS-A-CR-37	MDS-C1-CV-55 MDS-A-CR-55	MDS-C1-CV-75 MDS-A-CR-75	MDS-A-CR-90 MDS-C1-CV-110
NFB rated current	10A	20A	30A	40A	50A

No-fuse breaker selection table

NFB rated current	10A	20A	30A	40A	50A	60A
Recommended NFB (Mitsubishi Electric Corp.: Option part)	NF30-CS3P 10A	NF30-CS3P 20A	NF30-CS3P 30A	NF50-CP3P 40A	NF50-CP3P 50A	NF60-CP3P 60A

(Example 1)

The NFB is selected for the MDS-B-SVJ2-10 with 3 HC102 axes and an MDS-B-SPJ2-75 axis connected.

Because there are 1kW × 3 = 3kW on the SVJ2 side, 20A is selected from the table for the NFB rated current.
40A is selected from the table for the SPJ2-75 rated current.
Therefore, the total rated current is 60A, and the NF60-CP3P60A is selected.

(Example 2)

The NFB is selected for the MDS-B-SVJ2-20 with 2 HC202 axes and an MDS-B-CR-90 connected.

Because there are 2kW × 2 = 4kW on the SVJ2 side, 30A is selected from the table for the NFB rated current.
50A is selected from the table for the MDS-B-CV-90 rated current.
Therefore, the total rated current is 80A. The NFB is separated from converter unit, and the NF30-CS3P30A is selected for the SVJ2. (Refer to the "MDS-A/B Series Specifications Manual" for details on selecting the converter NFB.)

⚠ DANGER

Install independent no-fuse breakers and contactors as the SVJ2 main circuit power supply if the total current capacity exceeds 60A when the power supply is shared between the converter and a large capacity SPJ2 spindle amplifier. No-fuse breakers may not operate for short-circuits in small capacity amplifiers if they are shared with a large capacity unit, and this could cause fires. For the SVJ2, use an NF60 type or lower capacity breaker.

7-3 Selection of contactor

Select the contactor based on section "7-3-1 Selection from rush current" when the system connected to the contactor to be selected is an MDS-B-SVJ2 and 3.7kW or less MDS-B-SPJ2 spindle amplifier. When a converter unit or 5.5kW or more MDS-B-SPJ2 spindle amplifier is included, calculate both the capacities in sections "7-3-1 Selection from rush current" and "7-3-2 Selection from input current", and select the larger of the two capacities.

POINT The contactors can be directly driven from the SVJ2 contactor control output (24VDC) is a DC/AC interface unit is added.

7-3-1 Selection from rush current

Use the following table to select the contactors so the total rush current for each unit does not exceed the closed circuit current amount.

Rush current table

MDS-B-SVJ2	MDS-B-SVJ2-01 MDS-B-SVJ2-03 MDS-B-SVJ2-04	MDS-B-SVJ2-06	MDS-B-SVJ2-07	MDS-B-SVJ2-10 MDS-B-SVJ2-20
Rush current	45A	50A	70A	100A

MDS-B-SPJ2	MDS-B-SPJ2-02 MDS-B-SPJ2-04	MDS-B-SPJ2-075	MDS-B-SPJ2-15 MDS-B-SPJ2-22 MDS-B-SPJ2-37	MDS-B-SPJ2-55 MDS-B-SPJ2-75 MDS-B-SPJ2-110
Rush current	45A	50A	100A	15A

Converter unit	MDS-A-CR-10 ~ MDS-A-CR-90 MDS-C1-CV-37 ~ MDS-C1-CV-75	MDS-C1-CV-110
Rush current	15A	40A

Contactor selection table 1

Contactor closed current capacity (Total rush current)	110A	200A	220A	300A	400A	550A	650A	850A
Recommended contactor (Mitsubishi Electric Corp.: Option part)	S-N10 AC200V	S-N18 AC200V	S-N20 AC200V	S-N25 AC200V	S-N35 AC200V	S-K50 AC200V	S-K65 AC200V	S-K80 AC200V

POINT The rush current of the MDS-B-SPJ2 spindle amplifier decreases at capacities of 5.5kW or more.

(Example 1)

The contactor is selected for the MDS-B-SVJ2-10 with 3 HC102 axes and one MDS-B-SPJ2-37 axis connected.

< Selection only from rush current >

(SVJ2-10 × 3 axes rush current) + (SPJ2-37 × 1 axis rush current)

= 3 × 100A + 1 × 100A = 400A

Therefore, S-N35 200VAC is selected.

7-3-2 Selection from input current

Use the following table to select the contactors so the total input current for each unit does not exceed the rated continuity current.

Input current table

SVJ2 total output capacity	1.5kW or less	3.5kW or less	7kW or less	10kW or less	13kW or less	16kW or less
Input current	10A	20A	30A	40A	50A	60A

MDS-B-SPJ2	MDS-B-SPJ2-02 MDS-B-SPJ2-04 MDS-B-SPJ2-075 MDS-B-SPJ2-15	MDS-B-SPJ2-22 MDS-B-SPJ2-37	MDS-B-SPJ2-55	MDS-B-SPJ2-75	MDS-B-SPJ2-110
Input current	10A	20A	30A	40A	50A

Converter unit	MDS-A-CR-10 MDS-A-CR-15	MDS-C1-CV-37 MDS-A-CR-22 MDS-A-CR-37	MDS-C1-CV-55 MDS-A-CR-55	MDS-C1-CV-75 MDS-A-CR-75	MDS-A-CR-90 MDS-C1-CV-110
Input current	10A	20A	30A	40A	50A

Contactor selection table 2

Contactor rated continuity current (Total input current)	20A	32A	50A	60A
Recommended contactor (Mitsubishi Electric Corp.: Option part)	S-N10 AC200V	S-N20 AC200V	S-N25 AC200V	S-N35 AC200V

(Example 2)

The contactor is selected for the MDS-B-SVJ2-10 with 4 HC102 axes and an MDS-C1-CV-55 connected.

< Selection from rush current >

(SVJ2-10 × 4 axes rush current) + (MDS-C1-CV-55 rush current) = 4 × 100A + 15A
= 415A

Therefore, S-K50 200VAC.

< Selection from input current >

(HC102 × 4 axes input current) + (MDS-C1-CV-55 input current) = 30A + 30A = 60A

Therefore, S-N35 200VAC.

From these, the S-K50 200VAC is selected as having the larger of the two capacities.

7-4 Control circuit related

7-4-1 Circuit protector

When installing a circuit protector dedicated for the control power input, use a circuit protector with inertial delay to prevent malfunctioning in respect to the rush current generated when the power is turned ON. The size and conductivity time of the rush current fluctuate according to the power supply impedance and potential.

Servo amplifier	Rush current	Conductivity time
MDS-B-SVJ2-01~07	70 ~ 100A	0.5 ~ 1msec
MDS-B-SVJ2-10~20	100 ~ 130A	0.5 ~ 1msec

Recommended circuit protector (Mitsubishi Electric Corp.: Option part)	CP30-BA type with medium-speed inertial delay
Circuit protector rated current	1.0A per axis

7-4-2 Relays

Use the following relays for the input/output interface (motor brake output: MBR, contactor output: MC, external emergency stop : EMGX.)

Interface name	Selection example
For digital input signal (EMGX)	Use a minute signal relay (twin contact) to prevent a contact defect. **<Example>** OMRON: G2A type, MY type
For digital output signal (MBR, MC)	Use a compact relay with 24VDC, 40mA or less. **<Example>** OMROM: MY type

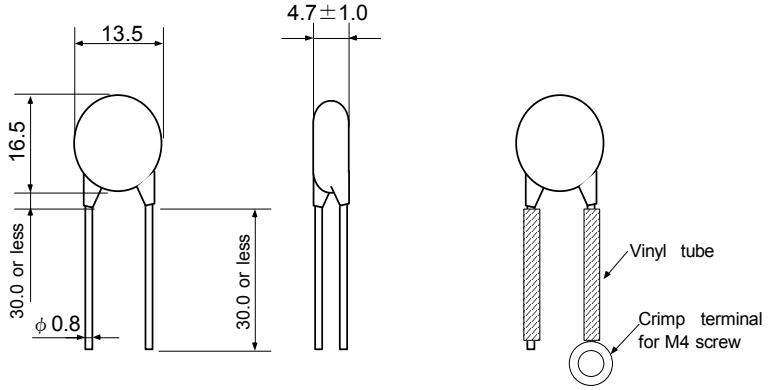
7-4-3 Surge absorber

A surge absorber is required when using magnetic brakes. Use a surge absorber with the following specifications or an equivalent part.
When using the surge absorber, carry out insulation treatment with a vinyl tube, etc., as shown in the outline dimension drawing.

Max. rating					Max. limit voltage		Static electricity capacity (reference value)	Varistor voltage rating (range)
Tolerable circuit voltage		Surge with-stand level	Energy with-stand level	Rated power				
AC(V)	DC(V)	(A)	(J)	(W)	(A)	(V)	(pF)	(V)
140	180	500/time	5	0.4	25	360	300	220 (198 ~ 242)

<Example> (These parts cannot be directly ordered from Mitsubishi Electric Corp.)
- ERZ-C10DK221 (Matsushita Denki)
- TNR-12G221K (Malcon Denshi)

<Outline dimension drawing>
ERZ-C10DK221 [Unit: mm]



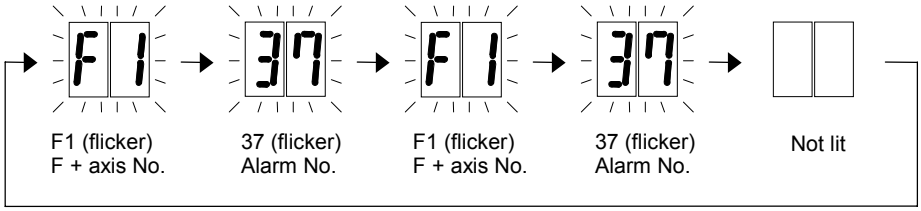
Chapter 8 Troubleshooting

8-1 Points of caution and confirmation

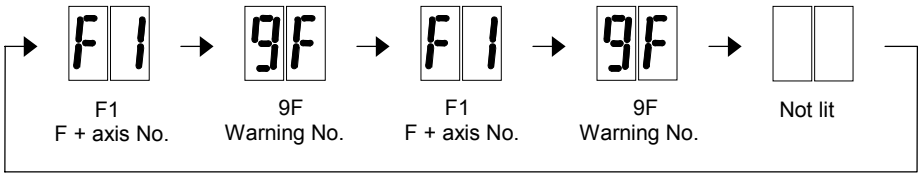
If an error occurs in the servo system, the servo warning or servo alarm will occur. When a servo warning or alarm occurs, check the state while observing the following points, and inspect or remedy the unit according to the details given in this section.

<Points of confirmation>

1. What is the alarm code display?
2. Can the error or trouble be repeated? (Check alarm history)
3. Is the motor and servo amplifier temperature and ambient temperature normal?
4. Are the servo driver, control unit and motor grounded?
5. Was the unit accelerating, decelerating or running at a set speed? What was the speed?
6. Is there any difference during forward and backward run?
7. Was there a momentary power failure?
8. Did the trouble occur during a specific operation or command?
9. At what frequency does the trouble occur?
10. Is a load applied or removed?
11. Has the amplifier unit been replaced, parts replaced or emergency measures taken?
12. How many years has the unit been operating?
13. Is the power voltage normal? Does the state change greatly according to the time band?



LED display during servo alarm



LED display during servo warning

⚠ CAUTION

1. This servo amplifier uses a large capacity electrolytic capacitor. When the CHARGE lamp on the front of the driver is lit, there is still a voltage in the unit. Take care to prevent electric shocks and short circuits. (The voltage will remain for several minutes after the power is turned OFF.)
2. The conductivity in the amplifier cannot be checked due to the structure.
3. Do not carry out a megger test as the amplifier could be damaged.

8-2 Troubleshooting at start up

If the CNC system does not start up correctly and a system error occurs when the CNC power is turned ON, the servo amplifier may not have been started up correctly.
Confirm the LED display on the amplifier, and take measures according to this section.

LED display	Symptom	Cause of occurrence	Investigation method	Remedy
AA	Initial communication with the CNC was not completed correctly.	The amplifier axis No. setting is incorrect.	Is there any other amplifier that has the same axis No. set?	Set correctly.
		The CNC setting is incorrect.	Is the No. of CNC controlled axes correct?	Set correctly.
		Communication with CNC is incorrect.	Is the connector (CN1A, CN1B) disconnected?	Connect correctly.
			Is the cable broken? Check the conductivity with a tester.	Replace the cable.
Ab	Initial communication with the CNC was not carried out.	The axis is not used, the setting is for use inhibiting.	Is the axis setting rotary switch set to "7" to "F"?	Set correctly.
		Communication with CNC is incorrect.	Is the connector (CN1A, CN1B) disconnected?	Connect correctly.
			Is the cable broken? Check the conductivity with a tester	Replace the cable.
–0 ~ –F	Amplifier self diagnosis error (Alarm 15 may appear on the CNC unit screen.)	Amplifier fault	Check the repeatability.	Replace the amplifier.
			Check the grounding state and ambient temperature.	Improve the ambient environment.
00	Amplifier has not started.	Amplifier fault	Check the repeatability.	Replace the amplifier.

8-3 Protective functions list

8-3-1 Alarm

When an alarm occurs, the motor will stop by the deceleration control or dynamic brakes. At the same time, the alarm No. will appear on the CNC monitor screen and with the LEDs on the front of the amplifier. Check the alarm No., and remove the cause of the alarm by following this list.

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
10	Insufficient voltage	The PN bus wire voltage is 200 V or less. (Detected only when the servo is in a ready ON status.)	Contactor operation, conductivity defect	Parameter confirmation (SV017. bit 0)	Set correctly.
				Check the output from the amplifier. • Is connector (CN3) disconnected? • Is the cable broken?	Connect correctly. Replace the cable.
				Check the contactor operation, check the conductivity.	Replace the contactor.
				Check the contactor drive relay operation, and for conductivity defects.	Replace the relay.
			Power supply wire breakage of undervoltage	Check the input voltage. • Is a single-phase 200 V or 100 V input? • Is there an open phase?	Input 3-phase 200 V.
				Check the power capacity.	Review the power supply.
13	Software processing error 1	Software operation sequence error or operation timing error [Also detected when the control axis is removed.]	CPU peripheral circuit error	Check the repeatability.	Replace the amplifier.
				Check the grounding state and ambient temperature.	Improve the ambient environment.
15	Memory error 2	Amplifier self-diagnosis error. (The amplifier LED display reads "-□".)	CPU peripheral circuit error	Check the repeatability.	Replace the amplifier.
17	A/D converter error	The A/D converter conversion value is incorrect.	CPU peripheral circuit error	Check the repeatability.	Replace the amplifier.
				Check the grounding state and ambient temperature.	Improve the ambient environment.
18	Motor side detector: Initial communication error	Initial communication with the detector was not possible. [Also detected when the control axis is installed.]	The detector input connector is disconnected.	Check the connector (CN2) connection. Check the cable connection.	Connect correctly.
			The detector cable is broken.	Replace with the cable for another axis and check the repeatability.	Replace the detector cable.
			Detector fault	Exchange the detector and amplifier connection with that for another axis and check the repeatability. (Pinpoint the cause)	Replace the parts on the side that caused the alarm.
			Amplifier input circuit fault		
22	LSI error	LSI operation error [Also detected when the control axis is removed.]	LSI operation error	Check the repeatability.	Replace the amplifier.
				Check the grounding state and ambient temperature.	Improve the ambient environment.
24	Grounding	A motor cable ground fault was detected. (Detected only at the ready ON instant.)	Motor power line (U, V, W phase) ground fault	Check the motor cable and connection. Check the conductivity between cables.	Replace the cable. Correct the connection.
			Motor fault		Replace the motor.
25	Absolute position data lost	The absolute position in the detector was lost.	Battery voltage drop	Check the battery voltage with a test. (Occurs at 3 V or less)	Replace the battery
			The battery connector (in the amplifier) is disconnected.	Open the panel at the top of the amplifier and check.	Connect correctly.
			The battery line in the detector cable is broken.	Check the conductivity with a tester.	Replace the cable.
			The detector cable was disconnected when the power was turned OFF.	After alarm 18 has occurred, correctly connect the detector cable and turn the power ON again.	Connect correctly.
2B	Motor side detector: CPU error 1	Detector internal circuit error	Detector fault	Check the repeatability. Check the ambient environment.	Replace the detector. Review the ambient environment.

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
2C	Motor side detector: EEPROM/LED error	The LED in the detector has deteriorated.	Detector fault (life)	Check the repeatability. Check the ambient environment.	Replace the detector. Review the ambient environment.
2D	Motor side detector: Data error	Detector position data error	Detector fault	Check the repeatability. Check the ambient environment.	Replace the detector. Review the ambient environment.
2F	Motor side detector: Communication error	Communication with the detector was cut off or there was an error in the received data.	The detector input connector is disconnected.	The alarm 18 occurs when the power is turned ON. Check the connector (CN2) connection.	Connect correctly.
			The detector cable is broken.		Replace the detector cable.
			Detector fault	Alarm 18 occurs when the power is turned ON. Exchange the detector and amplifier connection with that for another axis and check the repeatability. (Pinpoint the cause)	Replace the parts on the side that caused the alarm.
			Amplifier input circuit fault		
			Cable noise	Is the cable shielded? Is the cable wired in the same conduit as the motor power line?	Review the cable wiring and shield.
			Incorrect grounding	Are the motor grounding and amplifier grounding grounded separately?	Ground the motor and amplifier at one point.
30	Over regeneration	Overheating of the regenerative resistor was detected.	The regenerative resistor selection is incorrect.	Check the regeneration capacity.	Change the regenerative resistor.
			The parameter setting is incorrect.	Check the parameter (SV036).	Set correctly.
			The power voltage is high. (260V or more)	Occurs at ready OFF. Check the power voltage with a tester.	Review the power supply.
31	Overspeed	The motor speed exceeded the tolerable value.	The axis specification parameter (rapid) setting is incorrect.	Check the machine specifications.	Set correctly.
			The servo parameter setting is incorrect.	Check SV001 (PC1), SV002 (PC2), SV018 (PIT), SV025 (MTYP).	Set correctly.
			The speed is overshooting.	Is the speed loop gain too low?	Adjust the gain.
				Is the acceleration/deceleration time constant too short causing the current to be limited?	Increase the acceleration/decele-ration time constant.
				Is the current limit value too low?	Adjust the limit value.
			Detector fault	Does the alarm occur when the power is turned ON? Change with another axis and check the repeatability.	Replace the detector.
32	Power module overcurrent	The power module overcurrent protection function activated.	The motor power line (U, V, W phase) has a short circuit or ground fault.	This should happen simultaneously with ready ON. Check the motor cable and connection. Check the conductivity between the cables.	• Replace the cable • Correct the connection
			Amplifier fault		Replace the amplifier.
33	Overvoltage	The PN bus wire voltage exceeded 400 V. [Also detected when the control axis is removed.]	The power voltage is high. (280V or more)	Occurs at ready ON. Check the power voltage with a tester.	Review the power supply.
			Broken wire in the regenerative resistor. The resistor wire is broken.	Check the resistance value of the regenerative resistor.	Replace the regenerative resistor.
			P-D are not short-circuited when using the standard (built-in) regenerative resistor.	Check the connectors at the bottom of the amplifier. (SVJ2-01 to 07) Are the P and D terminal screws securely fastened?	Correctly connect.
			Power supply connector is faulty when using the SVJ2-01 to 07.	The connection in the connector at the bottom of the amplifier is faulty or broken.	Replace the connector.
			SV036 is the standard setting when using the MDS-B-SVJ2-01.	Check the parameter (SV036). 1000 is set when using the option regenerative resistor.	Set correctly.
			The regenerative capacity is large when using the MDS-B-SVJ2-01.	An external option regenerative resistor is not being used.	Use an option regenerative resistor.

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
34	NC-DRV communication: CRC error	There was an error in the communication data from the CNC. [Also detected when the control axis is removed.]	The communication cable is broken.	Check the conductivity with a tester.	Replace the cable.
			The communication cable connection is incorrect.	Are the communication pair cables connected in reverse?	
			The terminator is faulty.	Is the terminator dislocated?	Check the connection.
				Replace the terminator.	Replace the connector.
			Battery unit fault	Is the battery unit dislocated?	Check the connection.
				Replace the battery.	Replace the battery.
			The grounding is incomplete.	Check the grounding state.	Correctly ground.
			Incorrect grounding	Are the motor grounding and amplifier grounding grounded separately?	Ground the motor and amplifier at one point.
			Amplifier fault	Change the connection with that for another amplifier and find the cause.	Replace the amplifier.
			CNC unit fault		Replace the CNC unit.
35	NC command error	The movement command data sent from the CNC was excessive.	Not within amplifier specifications.	Is this a sub-micron system? Is the axis a rotary axis?	Consult with Mitsubishi.
36	NC-DRV communication: Communication error	The communication from the CNC was cut off. [Also detected when the control axis is removed.]	The communication cable is disconnected.	Check the connector (CN1A, CN1B). (Including the other axes)	Set correctly.
			The communication cable is broken.	Check the conductivity with a tester.	Replace the cable.
37	Initial parameter error	The servo parameter setting is incorrect. Check the error parameter No. If there are several error parameters, the most recent No. is output. [Also detected when the control axis is installed.]	The parameter is not within the setting range.	Check the setting range of the parameter having the error NO.	Set correctly.
			The HEX setting parameter setting is incorrect.	SV025: A non-entered motor type was selected. SV027: Both ovs 1 and 2 were set. ovs and aflt were set with lmcl. SV036: A non-entered resistor type was selected.	Set correctly.
			The electronic gears' constant is overflowing.	The error No. is 101 (2301). Check parameters SV001, SV002 and SV018.	If the settings are OK, consult with Mitsubishi.
			ABS was set for an INC detector connected axis.	The error No. is 102 (2302). Check parameters SV017.	Set correctly or replace the detector.
			The amplifier and motor capacities do not match.	Check the corresponding amplifier type for each servomotor in "Ch. 10 Specifications".	Replace with the correct combination.
			The SHG control option setting is not provided.	The error No. is 104 (2304). Check parameters SV057 and SV058.	Set correctly.
			The adaptive filter option setting is not provided.	The error No. is 105 (2305). Check parameters SV027 bit 15.	Set correctly.
38	NC-DRV communication: Protocol Error 1	There was an error in the communication data from the CNC. [Also detected when the control axis is removed.]	The communication cable is broken.	Check the conductivity with a tester.	Replace the cable.
			The communication cable connection is incorrect.	Are the communication pair cables connected in reverse?	
			The grounding is incomplete.	Check the grounding state.	Correctly ground.
			Amplifier fault	Change the connection with that for another amplifier and find the cause.	Replace the amplifier.
			CNC unit fault		Replace the CNC unit.
			CNC unit fault.		Replace the CNC unit.

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
39	NC-DRV communication: Protocol Error 2	There was an error in the communication data from the CNC. [Also detected when the control axis is removed.]	The communication cable is broken.	Check the conductivity with a tester.	Replace the cable
			The communication cable connection is incorrect.	Are the communication pair cables connected in reverse?	
			The grounding is incomplete.	Check the grounding state.	Correctly ground.
			Amplifier fault.	Change the connection with that for another amplifier and find the cause.	Replace the amplifier.
3A	Overcurrent	The motor drive current is excessive.	The speed loop gain (VGN1) is excessive.	Is VGN1 higher than the standard value in respect to the load inertia? (The standard VGN1 differs according to the motor. Check "Chapter 4" again.)	Lower VGN1.
				Is vibration occurring?	
			The current loop gain setting is incorrect.	Check the current loop gain.	Set the standard value.
			The inductive voltage compensation gain is high.	Is the current FB exceeding the current command during acceleration/deceleration?	Lower EC.
			The motor power line connection is incorrect.	The U, V, W phase connection is incorrect.	Connect correctly.
				The line is connected to the motor of another axis.	
			The detector cable connection is incorrect.	The detector cable is connected to another axis.	Connect correctly.
			The grounding is incomplete.	Measure the resistance value between amplifier FG and the ground, or the potential difference during operation.	Securely ground.
			Amplifier fault	Check the repeatability.	Replace the amplifier.
			Detector fault		Replace the detector.
3C	Regeneration circuit error	An error was detected in the regenerative transistor or resistor.	Regenerative resistor error	Check the resistance value of the regenerative resistor. (Refer to "Chapter 6" for the resistance values.)	Replace the regenerative resistor.
			The regenerative transistor is damaged by a short circuit.	Is the regenerative resistor burned?	Replace the amplifier.
			The power supply voltage is high. (260V or more)	Check the power supply voltage that occurs at ready OFF with a tester.	Review the power supply.
		In the SVJ2-10 and -20, the cooling fan stopped and power module overheating was detected.	The cooling fan in the bottom of the amplifier cooling fin stopped.	Check that the fan turns when the control power supply (L11, L21) is turned ON.	Repair the amplifier.
46	Motor overheat	Overheating of the motor was detected.	The ambient temperature is high.	Check the ambient temperature.	Improve the ambient environment.
			The motor load is large.	Has the overload alarm (50) cut off the amplifier power and caused a forced reset?	Review the operation pattern.
				Is the load too large?	
4F	Instantaneous power interruption	The power was cut off for 50msec or more.	The power supply connection is poor.	Is the connector or connection disconnected?	Connect correctly.
			The power supply state is poor.	Is the weather OK? (Has lightning occurred?)	Review the power supply.
				When using overseas, there are cases when the power supply is poor.	

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
50	Overload 1	An excessive load was applied for longer than the set time.	The motor capacity is insufficient.	Review the motor capacity selection.	Change the motor or amplifier capacity.
			The brakes cannot be released.	Check the brake operation. • Check the brake relay. • Check the connector (CN3) connection.	Repair the faulty section.
			An excessive force is being applied from the machine.	Check the load current on the CNC servo monitor and find the machine load. Is the ball screw bent?	Replace the faulty section in the machine.
				Is there interference with the positioning pin?	Do not use positioning pins.
			The parameter setting is incorrect.	Are SV021 and SV022 set to the standard values?	Set the standard values.
51	Overload 2	An excessive load was applied for longer than the set time.	The machine was collided with.	Visually check whether there was a collision with the machine.	Check the cause of the collision.
				Is there interference with the positioning pin?	Do not use positioning pins.
			The motor cable connection is incorrect.	Check the motor power line (U, V, W). • Is the U, V, W phase order correct? • The power line is not connected. • Is the cable connected to the motor for another axis?	Connect correctly.
			Detector fault	Change with another axis and check the repeatability.	Replace the detector.
			The detector connection is incorrect.	Check the connection.	Connect correctly.
52	Excessive error 1	The actual motor position and model position difference was excessive at servo ON.	The speed loop gain (VGN1) is small.	Is the motor speed fluctuating?	Adjust the gain.
			The motor load is too large.	Is the acceleration/deceleration time constant too short?	Adjust the parameters.
				The current limit value is too low and a sufficient torque is not output.	
				The motor brakes cannot be released?	Repair the brake circuit.
			The motor is demagnetized.	The HA motor is easily demagnetized. Remove the motor, and check that it turns smoothly. (CNC motor)	Replace the motor.
			The excessive error detection width is too small.	Check the SV023 (SV053) setting value.	Adjust the parameters.
			The input voltage is low.	Is the input voltage 170V or less, or near 170V? Is the input voltage unstable?	Check the power supply. Increase the acceleration/deceleration time constant.
			The motor cable connection is incorrect.	Check the motor drive line (U, V, W). • Is the U, V, W phase order correct? • Is the cable connected to the motor for another axis?	Connect correctly.
			Detector fault	Change with another axis and check the repeatability.	Replace the detector.
			The detector connection is incorrect.	Check the connection.	Connect correctly.
53	Excessive error 2	The actual motor position and model position difference was excessive at servo OFF.	The excessive error detection width is too small.	Check the VS026 setting value.	Adjust the parameter.
			The CNC has stopped the follow up function.	Check the CNC parameters.	
55	External emergency stop error	There is no contactor shutoff command even after 30sec. have elapsed from the input of the external emergency stop. [Detected even when the control axis is removed.]	Main emergency stop (sequence input) error	Check the emergency stop input and sequence program.	Improve the emergency stop sequence.
			The parameter setting is incorrect.	Check the setting of the SV036 external emergency stop selection.	Set correctly.

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
58	Collision detection 1: G0	During rapid traverse (G0), the disturbance torque exceeded the collision detection level.	The machine collided.	Check the machine and workpiece state.	Check the program.
					Check the overtravel setting.
			The machine friction increased.	The machine was stopped for a long time.	Check the repeatability.
				This can occur easily in the morning during the winter.	Readjust the detection level.
			The detection level is too low.	Set the detection level to approx. 1.5 times the maximum disturbance torque, and provide an allowance.	
59	Collision detection 1: G1	During cutting traverse (G1), the disturbance torque exceeded the collision detection level.	The machine collided.	Check the machine and workpiece state.	Same as ALM58.
			The detection level is too low.	Check the maximum cutting load.	Set to above the maximum cutting load.
5A	Collision detection 2	The command torque reached the motor's maximum torque.	The machine collided.	Check the machine and workpiece state.	Same as ALM58.
			The machine friction increased.	The machine was stopped for a long time.	Check the repeatability.
				This can occur easily in the morning during the winter.	Increase the acceleration/deceleration time constant.
			The acceleration/ deceleration time constant is too small.	Check the current during acceleration.	
				The time constant cannot be increased.	Set to ignore collision detection method 2.
5F	External contactor welding	The contact of the external contactor fused. (Detected only when ready is turned ON.) [Detected even when the control axis is removed.]	Contactor fusing	Check the contactor conductivity.	Replace the contactor.
			Contactor control was set for a system that has no contactor.	SV017 (SPEC) bit 3 should be set to 1. (The setting is made only for the axis that is actually controlling the contactor.)	Set the parameter.
			The contactor drive relay operation is defective.	Check the relay and control cable (CN3).	Repair the defective section.
			Broken wire in the regenerative resistor.	• Is the short bar between the P and D terminals loose? • Is the cable loose when using the option resistor?	Repair the regenerative resistor circuit.
88	Watchdog	The amplifier system did not operate correctly. [Detected even when the control axis is removed.]	Amplifier fault	Check the repeatability.	Replace the amplifier.
			The grounding is incomplete.	Check the grounding state.	Ground correctly.

⚠ CAUTION Alarms without particular descriptions are not detected during control axis removal command input.

8-3-2 Warnings

When a warning occurs, a warning No. will appear on the CNC monitor screen and with the LEDs on the front of the amplifier. Check the warning No., and remove the cause of the warning by following this list.

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
93	Initial absolute position fluctuation	The position data fluctuated when creating the initial absolute position.	The vertical axis or slant axis dropped when the CNC power was turned ON.	Check the state of the axis when the CNC power was turned ON.	Repair the fault section.
			The axis moved due to an external force when the CNC power was turned ON.		
9E	Absolute position detector: Revolution counter error	There was an error in the data of the multi-rotation counter in the detector.	Detector fault	Check the repeatability.	Replace the detector.
9F	Battery voltage drop	The battery voltage dropped. Do not shut off the servo amplifier control power supply when this warning is detected. (This is to protect the absolute position.)	Battery life	The battery life is approx. 5 years. (This will change according to the usage state.)	Replace the battery.
			The battery connector (in the amplifier) is disconnected.	Open the panel at the top of the amplifier and check.	Connect correctly.
			The battery line in the detector cable is broken.	Check the conductivity with a tester.	Replace the cable.
E0	Over regeneration warning	The regeneration level reached 80% or more.	Refer to the over-regeneration (30) column.		
E1	Overload warning	The load level reached 80% or more.	Refer to the overload (50) column.		
E2	Continuous high-speed revolution warning	The motor continuously rotated at a speed exceeding the rated rotation speed.	Rotary axis program command	Check whether the motor is continuously rotating at a speed exceeding the rated rotation speed.	Apply a duty when rotating at a speed exceeding the rated rotation speed.
E3	Absolute position counter warning	A deviation was detected in the absolute position data and relative position data	There is an error in the detector's multi-rotation data	Check the movement of the multi-rotation data (Rn) from the CNC monitor screen.	Replace the detector.
E4	Set parameter warning	A parameter exceeding the setting range was set.	The parameter setting range is not within the range.	Check the parameter setting conditions.	Set correctly.
E6	Control axis detachment warning	Control axis removal was commanded. (Status display)	Control axis removal was input from the CNC unit sequence.	The control axis removal has been input correctly.	
E7	In NC emergency stop state	Emergency stop was input from the NC (Status display)	The CNC emergency stop has been input.	The CNC emergency stop has been input correctly.	
			An alarm is occurring with another axis.	Has an alarm occurred with another axis?	Reset the alarm in the other axis to cancel this warning.
			The terminator or battery unit connector is disconnected.	Check the connection of the CNC communication line cable (CN1A, CN1B).	Set correctly.
E9	Instantaneous power interruption warning	The power was cut off for 25msec or more but 50msec or less.	Refer to the instantaneous stop (4F) column.		
EA	In external emergency stop state	External emergency stop (CN3 connector input) was input.	Only the external emergency stop was input without inputting the CNC unit emergency stop.		

8-3-3 Alarm and warning deceleration method and reset method

No.	Name	Deceleration method	Reset method	Explanation
10	Insufficient voltage	Deceleration control	PR	When the power is cut off, the dynamic brakes may be switched to.
13	Software processing error 1	Dynamic	PR	
15	Memory error 2	Initial error	AR	
17	A/D converter error	Dynamic	PR	
18	Motor side detector: Initial communication error	Initial error	PR	
22	LSI error	Dynamic	AR	
24	Grounding	Dynamic	PR	
25	Absolute position data lost	Initial error	AR	
2B	Motor side detector: CPU error 1	Initial error	AR	
2C	Motor side detector: EEPROM/LED error	Deceleration control	PR	
2D	Motor side detector: Data error	Dynamic	PR	
2F	Motor side detector: Communication error	Dynamic	PR	
30	Over regeneration	Deceleration control	PR	PR reset is not possible when the regeneration level is 50% or more. Do not reset (AR) forcibly by turning off the amplifier. If AR is carried out at 50% or more, 80% will be set the next time the power is turned ON.
31	Overspeed	Deceleration control	PR	
32	Power module overcurrent	Dynamic	PR	
33	Overvoltage	Dynamic	PR	
34	NC-DRV communication: CRC error	Deceleration control	PR	
35	NC command error	Deceleration control	PR	
36	NC-DRV communication: Communication error	Deceleration control	PR	
37	Initial parameter error	Initial error	PR	
38	NC-DRV communication: Protocol Error 1	Deceleration control	PR	
39	NC-DRV communication: Protocol Error 2	Deceleration control	PR	
3A	Overcurrent	Dynamic	PR	
3C	Regeneration circuit error	Dynamic	AR	
46	Motor overheat	Deceleration control	NR	NR and PR reset cannot be carried out when the motor is overheated.
4F	Instantaneous power interruption	Deceleration control	NR	
50	Overload 1	Deceleration control	NR	NR and PR reset is not possible when the load level is 50% or more. Do not reset (AR) forcibly by turning off the amplifier. If AR is carried out at 50% or more, 80% will be set the next time the power is turned ON.
51	Overload 2	Dynamic	NR	
52	Excessive error 1	Deceleration control	NR	A step stop is carried out in deceleration control. The deceleration control time constant is meaningless. (C1 and subsequent versions. The dynamic method is fixed in the C0 version.)
53	Excessive error 2	Dynamic	NR	
55	External emergency stop error	Dynamic	NR	Forcibly turn the contactor OFF.
58	Collision detection 1: G0	Deceleration control	NR	After detecting a collision, the axis will decelerate and stop at 80% of the motor's maximum torque or the servo parameter current limit value (torque limit value), whichever is smaller.
59	Collision detection 1: G1	Deceleration control	NR	
5A	Collision detection 2	Deceleration control	NR	
5F	External contactor welding	During ready ON	NR	This is detected when ready ON, starts.
88	Watchdog	Dynamic	AR	
93	Initial absolute position fluctuation	The motor will not stop.	PR	
9E	Absolute position detector: Revolution counter error		*	
9F	Battery voltage drop		*	
E0	Over regeneration warning		*	
E1	Overload warning		*	
E2	Continuous high-speed revolution warning		*	The warning can only be reset automatically
E3	Absolute position counter warning		*	
E4	Set parameter warning		*	
E7	In NC emergency stop state	Deceleration control	*	
E9	Instantaneous power interruption warning	The motor will not stop.	NR	When the instantaneous warning occur, use NR reset. The state will also be reset automatically after 5 minutes.
EA	In external emergency stop state		*	

• Deceleration method

Deceleration control : The motor will be decelerated and controlled with the time constant set in the parameter (EMGt).
If dynamic brake stop is selected with the parameter (SPEC), the motor will stop with the dynamic brakes.

Dynamic : The motor will stop with the dynamic brakes, even if a deceleration stop is set.

• Reset method

＊ : The unit will be automatically reset when the state in which the warning occurred is canceled.

NR : Reset with the CNC reset button. Resetting is also possible with the PR, AR resetting conditions.

PR : Reset by turning the CNC power ON again. Resetting is also possible with the AR resetting conditions.
Resetting while the control axis is removed is possible with the CNC unit reset button. (Note that alarm 32, 37 and warning 93 are excluded.)

AR : Reset by turning the servo amplifier power ON again.

Chapter 9 Characteristics

9-1 Overload protection characteristics

The servo amplifier has an electronic thermal relay to protect the servomotor and servo amplifier from overloads. The operation characteristics of the electronic thermal relay when standard parameters (SV021=60, SV022=150) are set shown below.

If overload operation over the electronic thermal relay protection curve shown below is carried out, overload 1 (alarm 50) will occur. If the maximum current is commanded at 95% or higher continuously for one second or more due to a machine collision, etc., overload 2 (alarm 51) will occur.

The HA-FF053/13 and HC-MF053/13 have characteristics different from the other motors.

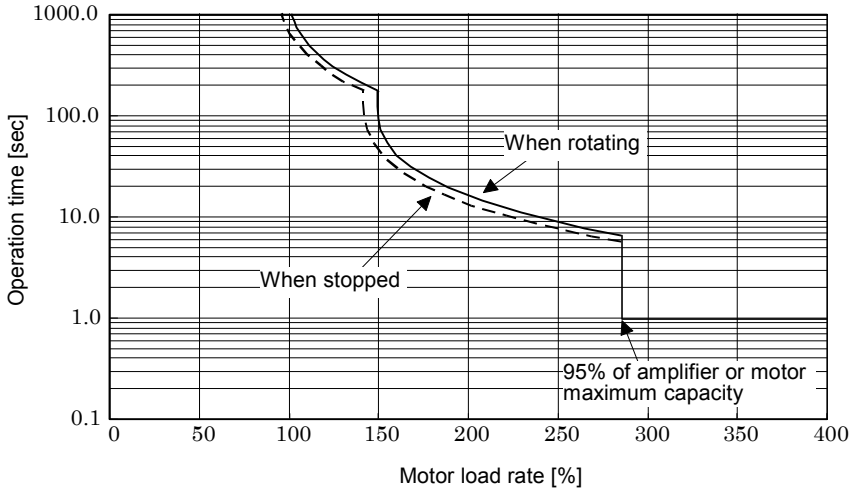


Fig. 9-1 (1) Overload protection characteristics of MDS-B-SVJ2-01, -03, -04, -06, -07

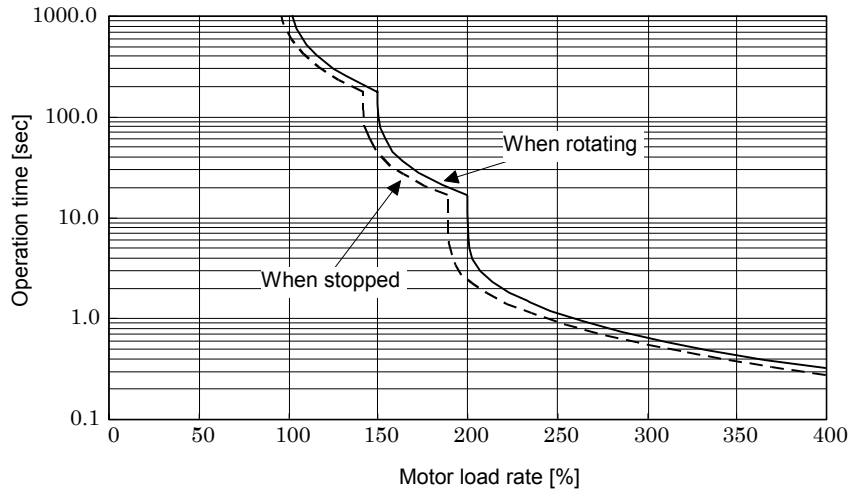


Fig. 9-1 (2) Overload protection characteristics of MDS-B-SVJ2-10, -20

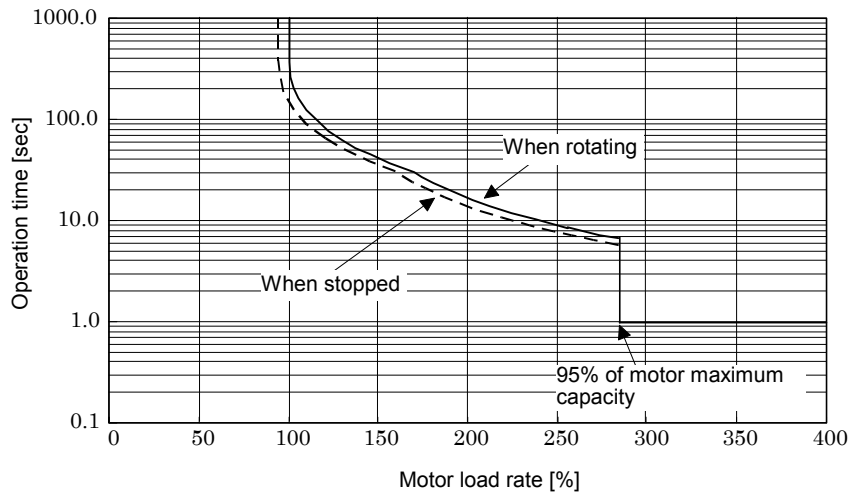


Fig. 9-1 (3) Overload protection characteristics of HA-FF053/13, HC-MF053/13

9-2 Servo amplifier generation loss

9-2-1 Servo amplifier calorific value

The servo amplifier calorific value is determined from the following table by the motor with which the servo amplifier is combined. The calorific value for the actual machine will be a value between the calorific values at the stall torque (at the rated torque) and the zero torque according to the frequency during operation. Consider the worst usage conditions for the thermal design of the fully closed type control panel, and use the values given below. Even when the servomotor is run below the maximum speed, the servo amplifier calorific value will not change if the generated torque is the same.

Table 9-1 Servo amplifier calorific values

Motor type	Calorific value (W)		Area required for heat radiation (m^2)	Motor type	Calorific value (W)		Area required for heat radiation (m^2)
	At stall torque	At zero torque			At rated torque	At zero torque	
HC52	45	15	0.9	HC-SF52	40	15	0.8
HC102*	50	15	1.0	HC-SF102	50	15	1.0
HC102	55	20	1.1	HC-SF152	60	20	1.2
HC152*	60	20	1.2	HC-SF202	85	20	1.7
HC152	90	20	1.8	HC-SF352	140	20	2.8
HC202*	85	20	1.7	HC-SF53	40	15	0.8
HC202	130	20	2.6	HC-SF103	50	15	1.0
HC352*	140	20	2.8	HC-SF153	60	20	1.2
HC53	70	15	1.5	HC-SF203	85	20	1.7
HC103	70	20	1.5	HC-SF353	140	20	2.8
HC153	135	20	2.7				
HC203*	140	20	2.8	HC-RF103	45	15	0.9
				HC-RF153	60	20	1.2
HC103R	45	15	0.9	HC-RF203	120	20	2.4
HC153R	60	20	1.2				
HC203R	120	20	2.4	HA-FF053	25	15	0.5
				HA-FF13	25	15	0.5
HA40N	45	15	0.9	HA-FF23	25	15	0.5
HA80N	50	20	1.0	HA-FF33	30	15	0.6
HA100N	120	20	2.4	HA-FF43	35	15	0.7
HA200N*	140	20	2.8	HA-FF63	40	15	0.8
HA053N	25	15	0.5				
HA13N	25	15	0.5	HC-MF053	25	15	0.5
HA23N	40	15	0.8	HC-MF13	25	15	0.5
HA33N	40	15	0.8	HC-MF23	25	15	0.5
HA43N	65	15	1.3	HC-MF43	35	15	0.7
HA83N	65	20	1.3	HC-MF73	50	15	1.0
HA103N*	130	20	2.6				

(Note) The asterisk "*" in the motor type indicates the value for a combination with an amplifier having a one-rank lower capacity than the standard.

POINT

1. The heat generated by the regeneration resistor is not included in the servo amplifier calorific value. Refer to section "11-4 Selection of regenerative resistor" and calculate the calorific value of the regenerative resistor using the regeneration load and positioning frequency.
2. The area required for heat radiation is the heat radiation area (guideline) of the fully closed type control panel storing the servo amplifier when using the unit at an ambient temperature of 40°C and stall (rated) load.

9-2-2 Heat radiation area of fully closed type control panel

Set the temperature in the fully closed type control panel (hereafter control panel) in which the servo amplifier is stored so that the ambient temperature is 40°C +10°C or less. (Provide a 5°C allowance in respect to the maximum working environment conditions temperature of 55°C.) The control panel heat radiation area is usually calculated with the following expression.

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

A : Heat radiation area (m^2)
P : Loss generated in control panel
△T : Temperature difference between control panel and outside air (°C)
K : Heat radiation coefficient (5 ~ 6)

When calculating the heat radiation area with expression (9-1), use P as the total loss generated in the control panel. Refer to the table in section "9-2-1 Servo amplifier calorific value" for the servo amplifier calorific values. A indicates the area effective for heat radiation, so if the control panel is directly installed on a heat insulating wall, etc., provide the control panel's surface area as an allowance.

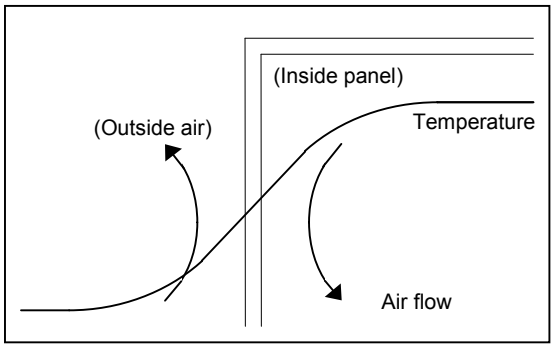


Fig. 9-2 Fully closed type control panel temperature gradient

When air flows along the outside of the panel, the temperature slope will become sudden, and an effective heat exchange will be possible both inside and outside of the fully closed control type panel.

The required heat radiation area will also differ according to the conditions in the control panel. If the convection in the control panel is poor, effective heat radiation will not be possible. In this case, when designing the control panel, consider the placement of devices in the control panel, and mixing the air with a fan, etc.

9-3 Magnetic brake characteristics

⚠ CAUTION

1. The axis will not be mechanically held even when the dynamic brakes are used. If the machine could drop when the power fails, use a servomotor with magnetic brakes or provide an external brake mechanism as holding means to prevent dropping.
2. The magnetic brakes are used for holding, and must not be used for normal braking. There may be cases when holding is not possible due to the life or machine structure (when ball screw and servomotor are coupled with a timing belt, etc.). Provide a stop device on the machine side to ensure safety. When releasing the brakes, always confirm that the servo is ON first. Sequence control considering this condition is possible if the amplifier motor brake control signal (MBR) is used.
3. When operating the brakes, always turn the servo OFF (or ready OFF). When releasing the brakes, always confirm that the servo is ON first. Sequence control considering this condition is possible if the amplifier motor brake control signal (MBR) is used.
4. When the vertical axis drop prevention function is used, the drop of the vertical axis during an emergency stop can be suppressed to the minimum.

9-3-1 Motor with magnetic brakes

(1) Types

The motor with magnetic brakes is set for each motor. The "B" following the standard motor type indicates the motor with brakes.

(2) Applications

When this type of motor is used for the vertical feed axis in a machining center, etc., slipping and dropping of the spindle head can be prevented even when the hydraulic balancer's hydraulic pressure reaches zero when the power turns OFF. When used with a robot, deviation of the posture when the power is turned OFF can be prevented.
When used for the feed axis of a grinding machine, a double safety measures is formed with the deceleration stop (dynamic brake stop), and the risks of colliding with the grinding stone and scattering can be prevented.
This motor cannot be used for purposes other than holding and braking during a power failure (emergency stop). (This cannot be used for normal deceleration, etc.)

(3) Features

① The magnetic brakes use a DC excitation method, thus:
- The brake mechanism is simple and the reliability is high.
- There is no need to change the brake tap between 50 Hz and 60 Hz.
- There is no rush current when the excitation occurs, and shock does not occur.
- The brake section is not larger than the motor section.

② The magnetic brakes are built into the motor, and the installation dimensions are the same as the motor without brakes.

9-3-2 Magnetic brake characteristics

Table 9-2 (1) Magnetic brake characteristics 1

Item \ Motor type			HC□ Series		HC□R Series
			52B, 53B, 102B, 103B, 152B, 153B	202B, 203B, 352B	103RB, 153RB, 203RB
Type (Note 1)			Spring braking type safety brakes		
Rated voltage			24 VDC		
Rated current at 20°C		(A)	0.80	1.43	0.80
Excitation coil resistance at 20°C		(Ω)	29	16.8	30
Capacity		(W)	19	34	19
Attraction current		(A)	0.2	0.4	0.25
Dropping current		(A)	0.08	0.2	0.085
Static friction torque		(N·m)	8.3	43.1	6.8
Inertia (Note 2)		($kg \cdot cm^2$)	2.0	10	0.35
Release delay time (Note 3)		(sec)	0.04	0.1	0.03
Braking delay time (Note 3)	AC OFF	(sec)	0.12	0.12	0.12
	DC OFF	(sec)	0.03	0.03	0.03
Tolerable braking work amount	Per braking	(J)	400	4,500	400
	Per hour	(J)	4,000	45,000	4,000
Brake play at motor axis		(degree)	0.2 ~ 0.6	0.2 ~ 0.6	0.2 ~ 0.6
Brake life (Note 4)	No. of braking operations	(times)	20,000	20,000	20,000
	Braking amount per braking	(J)	200	1,000	200

Table 9-2 (2) Magnetic brake characteristics 2

Item \ Motor type			HA□N Series			
			053N, 13N	23NB, 33NB	40NB, 80NB, 43NB, 83NB	100NB, 200NB, 103NB
Type (Note 1)			Spring braking type safety brakes			
Rated voltage			24 VDC			
Rated current at 20°C		(A)	0.22	0.49	0.63	1.04
Excitation coil resistance at 20°C		(Ω)	111	49	38	23
Capacity		(W)	5.2	12	15	25
Attraction current		(A)	0.15	0.2	0.25	0.5
Dropping current		(A)	0.06	0.06	0.12	0.18
Static friction torque		(N·m)	0.4	2.0	5.9	29
Inertia (Note 2)		($kg \cdot cm^2$)	0.016	0.2	0.7	4.3
Release delay time (Note 3)		(sec)	0.03	0.05	0.07	0.10
Braking delay time (Note 3)	AC OFF	(sec)	0.10	0.20	0.24	0.27
	DC OFF	(sec)	0.02	0.03	0.04	0.04
Tolerable braking work amount	Per braking	(J)	5.6	49	294	980
	Per hour	(J)	56	490	2,940	9,800
Brake play at motor axis		(degree)	0.25 ~ 2.5	0.2 ~ 1.5	0.16 ~ 0.57	0.10 ~ 0.36
Brake life (Note 4)	No. of braking operations	(times)	30,000	30,000	30,000	30,000
	Braking amount per braking	(J)	5.6	49	294	980

Notes:

1. There is no manual release mechanism. If handling is required such as during the machine core alignment work, prepare a separate 24 VDC power supply, and electrically release the brakes.
2. These are the values added to the servomotor without brakes.
3. This is the value for 20°C at the initial attraction gap.
4. The brake gap will widen through brake lining wear caused by braking. However, the gap cannot be adjusted. Thus, the brake life is reached when adjustments are required.
5. The internal power output (VDD) 24 VDC for digital output cannot be used. Always prepare a separate power supply.
6. A leakage flux will be generated at the shaft end of the servomotor with magnetic brakes.
7. When operating in low speed regions, the sound of loose brake lining may be heard. However, this is not a problem in terms of function.

Table 9-2 (3) Magnetic brake characteristics 3

Item \ Motor type			HC-SF Series		HC-RF Series
			52B, 102B, 152B 53B, 103B, 153B	202B, 352B 203B, 353B	103B, 153B, 203B
Type (Note 1)			Spring braking type safety brakes		
Rated voltage			24 VDC		
Rated current at 20°C		(A)	0.80	1.43	0.80
Excitation coil resistance at 20°C		(Ω)	29	16.8	30
Capacity		(W)	19	34	19
Attraction current		(A)	0.2	0.4	0.25
Dropping current		(A)	0.08	0.2	0.085
Static friction torque		(N·m)	8.3	43.1	6.8
Inertia (Note 2)		($kg·cm^2$)	2.0	10	0.35
Release delay time (Note 3)		(sec)	0.04	0.1	0.03
Braking delay time (Note 3)	AC OFF	(sec)	0.12	0.12	0.12
	DC OFF	(sec)	0.03	0.03	0.03
Tolerable braking work amount	Per braking	(J)	400	4,500	400
	Per hour	(J)	4,000	45,000	4,000
Brake play at motor axis		(degree)	0.2 ~ 0.6	0.2 ~ 0.6	0.2 ~ 0.6
Brake life (Note 4)	No. of braking operations	(times)	20,000	20,000	20,000
	Braking amount per braking	(J)	200	1,000	200

Table 9-2 (4) Magnetic brake characteristics 4

Item \ Motor type			HA-FF Series			HC-MF Series		
			053B, 13B	23B, 33B	43B, 63B	053B, 13B	23B, 43B	73B
Type (Note 1)			Spring braking type safety brakes					
Rated voltage			24 VDC					
Rated current at 20°C		(A)	0.22	0.31	0.46	0.26	0.33	0.42
Excitation coil resistance at 20°C		(Ω)	111	78	52	91	73	57
Capacity		(W)	7	7.4	11	6.3	7.9	10
Attraction current		(A)	0.15	0.2	0.3	0.18	0.18	0.2
Dropping current		(A)	0.06	0.06	0.1	0.06	0.11	0.12
Static friction torque		(N·m)	0.39	1.18	2.3	0.32	1.3	2.4
Inertia (Note 2)		($kg·cm^2$)	0.02	0.13	0.34	0.0031	0.04	0.13
Release delay time (Note 3)		(sec)	0.03	0.03	0.03	0.03	0.03	0.03
Braking delay time (Note 3)	AC OFF	(sec)	0.08	0.1	0.12	0.08	0.1	0.12
	DC OFF	(sec)	0.01	0.03	0.03	0.01	0.02	0.03
Tolerable braking work amount	Per braking	(J)	3.9	18.0	46.0	5.6	22.0	64.0
	Per hour	(J)	39	180	460	56	220	640
Brake play at motor axis		(degree)	0.3 ~ 3.5	0.2 ~ 2.0	0.2 ~ 1.3	0.19 ~ 2.5	0.12 ~ 1.2	0.1 ~ 0.9
Brake life (Note 4)	No. of braking operations	(times)	30,000	30,000	30,000	20,000	20,000	20,000
	Braking amount per braking	(J)	4	18	47	4	15	32

9-3-3 Magnetic brake power supply

⚠ CAUTION

1. The internal power supply output (VDD) 24 VDC as digital output cannot be used for the magnetic brake release power supply. Always prepare an external release power supply dedicated for the magnetic brakes.
2. Always install a surge absorber on the brake terminal when using DC OFF.
3. Do not connector or disconnect the cannon plug while the brake power is ON. The cannon plug pins could be damaged by sparks.

(1) Brake excitation power supply

① Prepare a brake excitation power supply that can accurately ensure the attraction current in consideration of the voltage fluctuation and excitation coil temperature.

② The brake terminal polarity is random. Make sure not to mistake the terminals with other circuits.

(2) Brake excitation circuit

(a) AC OFF and (b) DC OFF can be used to turn OFF the brake excitation power supply (to apply the brakes).

(a) AC OFF

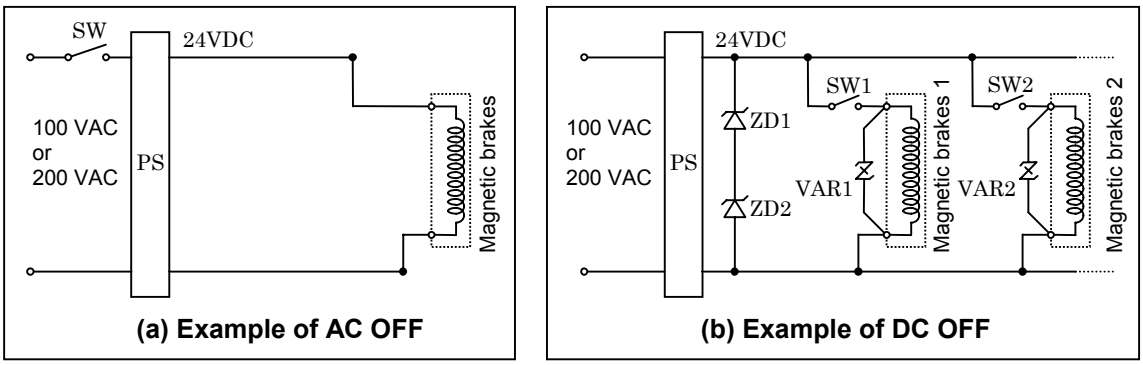
The braking delay time will be longer, but the excitation circuit will be simple, and the relay cut off capacity will be smaller.

(b) DC OFF

The braking delay time can be shortened, but a surge absorber will be required and the relay cut off capacity will increase.

<Cautions>

- Provide sufficient DC cut off capacity at the contact.
- Always use a serge absorber.
- When using the cannon plug type, the surge absorber will be further away, so use shielded wires between the motor and surge absorber.



PS : 25 VDC stabilized power supply
ZD1, ZD2 : Zener diode for power supply protection (1W, 24V)
VAR1, VAR2: Surge absorber (220V)

Fig. 9-3 Magnetic brake circuits

9-4 Dynamic brake characteristics

When an emergency stop occurs such as that due to a servo alarm detection, the motor will stop with the deceleration control at the standard setting. However, by setting the servo parameter (SV017: SPEC), the dynamic brake stop can be selected. If a servo alarm that cannot control the motor occurs, the dynamic brakes stop the servomotor regardless of the parameter setting.

9-4-1 Deceleration torque

The dynamic brakes use the motor as a generator, and obtains the deceleration torque by consuming that energy with the dynamic brake resistance. The characteristics of this deceleration torque have a maximum deceleration torque (Tdp) regarding the motor speed as shown in the following drawing. The torque for each motor is shown in the following table.

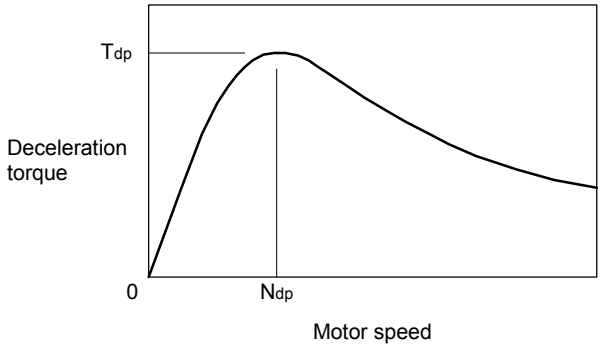


Fig. 9-4 Deceleration torque characteristics of a dynamic brake stop

Table 9-3 Max. deceleration torque of a dynamic brake stop

Motor type	Stall torque (N·m)	Tdp (N·m)	Ndp (r/min)	Motor type	Rated torque (N·m)	Tdp (N·m)	Ndp (r/min)
HC52	2.94	2.40	496	HC-SF52	2.39	2.40	496
HC102*	4.78	5.59	473	HC-SF102	4.78	5.59	473
HC102	5.88	11.19	884	HC-SF152	7.16	18.49	1062
HC152*	7.16	18.49	1062	HC-SF202	9.55	10.56	457
HC152	8.82	18.49	1062	HC-SF352	16.70	32.57	945
HC202*	9.55	10.56	457	HC-SF53	1.59	2.54	472
HC202	13.72	10.56	457	HC-SF103	3.18	5.36	417
HC352*	16.70	32.57	945	HC-SF153	4.78	18.88	1676
HC53	2.94	2.54	472	HC-SF203	6.37	10.63	771
HC103	5.88	10.72	1045	HC-SF353	11.1	22.94	1338
HC153	8.82	18.88	1676				
HC203*	10.50	10.63	771	HC-RF103	3.18	3.67	582
				HC-RF153	4.78	5.44	668
HC103R	3.18	3.67	582	HC-RF203	6.37	7.16	973
HC153R	4.78	5.44	668				
HC203R	6.37	7.16	973	HA-FF053	0.16	0.12	3509
				HA-FF13	0.32	0.17	2646
HA40N	2.94	1.52	555	HA-FF23	0.64	0.38	1163
HA80N	5.88	7.15	677	HA-FF33	0.95	0.56	1064
HA100N	13.72	11.57	537	HA-FF43	1.30	0.75	668
HA200N*	16.70	25.59	844	HA-FF63	1.90	0.96	624
HA053N	0.25	0.10	2686				
HA13N	0.49	0.24	2056	HC-MF053	0.16	0.11	1445
HA23N	0.98	0.57	1205	HC-MF13	0.32	0.34	1642
HA33N	1.96	1.15	823	HC-MF23	0.64	0.40	465
HA43N	2.94	1.51	554	HC-MF43	1.30	0.76	426
HA83N	5.88	6.98	853	HC-MF73	2.40	1.59	260
HA103N*	10.50	10.02	773				

(Note) The asterisk "*" in the motor type indicates the value for a combination with an amplifier having a one-rank lower capacity than the standard.

9-4-2 Coasting amount

The motor coasting amount when stopped by a dynamic brake can be approximated using the following expression.

$$C_{MAX} = \frac{No}{60} \cdot te + \left(1 + \frac{J_L}{J_M}\right) \cdot (A \cdot No^3 + B \cdot No)$$

C_{MAX}	:	Maximum motor coasting amount	(turn)
No	:	Initial motor speed	(r/min)
J_M	:	Motor inertia	($kg \cdot cm^2$)
J_L	:	Motor shaft conversion load inertia	($kg \cdot cm^2$)
te	:	Brake drive relay delay time	(sec) (Normally, 0.03sec)
A	:	Coefficient A (Refer to the table below)	
B	:	Coefficient B (Refer to the table below)	

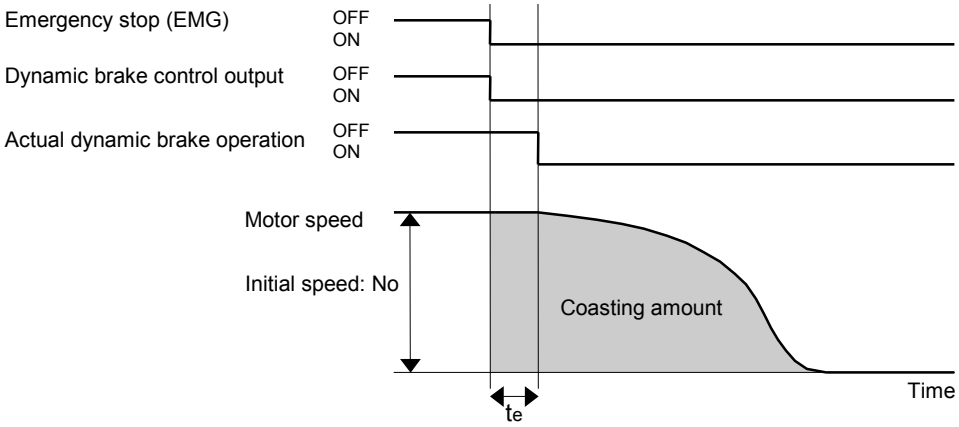


Fig. 9-5 Dynamic brake braking diagram

Table 9-4 Coasting amount calculation coefficients

Motor type	J_M ($kg \cdot cm^2$)	A	B	Motor type	J_M ($kg \cdot cm^2$)	A	B
HC52	6.6	16.13×10^{-11}	11.93×10^{-5}	HC-SF52	6.6	16.13×10^{-11}	11.93×10^{-5}
HC102*	13.6	14.97×10^{-11}	10.03×10^{-5}	HC-SF102	13.6	14.97×10^{-11}	10.03×10^{-5}
HC102	13.6	4.00×10^{-11}	9.38×10^{-5}	HC-SF152	20.0	2.96×10^{-11}	10.03×10^{-5}
HC152*	20.0	2.96×10^{-11}	10.03×10^{-5}	HC-SF202	42.5	25.60×10^{-11}	16.07×10^{-5}
HC152	20.0	2.96×10^{-11}	10.03×10^{-5}	HC-SF352	82.0	7.75×10^{-11}	20.76×10^{-5}
HC202*	42.5	25.60×10^{-11}	16.07×10^{-5}	HC-SF53	6.6	15.99×10^{-11}	10.71×10^{-5}
HC202	42.5	25.60×10^{-11}	16.07×10^{-5}	HC-SF103	13.6	17.70×10^{-11}	9.24×10^{-5}
HC352*	82.0	14.00×10^{-11}	21.54×10^{-5}	HC-SF153	20.0	1.84×10^{-11}	15.49×10^{-5}
HC53	6.6	15.99×10^{-11}	10.71×10^{-5}	HC-SF203	42.5	15.08×10^{-11}	26.92×10^{-5}
HC103	13.6	3.53×10^{-11}	11.58×10^{-5}	HC-SF353	82.0	7.77×10^{-11}	41.74×10^{-5}
HC153	20.0	1.84×10^{-11}	15.49×10^{-5}				
HC203*	42.5	17.24×10^{-11}	27.42×10^{-5}	HC-RF103	1.5	2.04×10^{-11}	2.07×10^{-5}
				HC-RF153	1.9	1.52×10^{-11}	2.04×10^{-5}
HC103R	1.5	2.04×10^{-11}	2.07×10^{-5}	HC-RF203	2.3	0.96×10^{-11}	2.73×10^{-5}
HC153R	1.9	1.52×10^{-11}	2.04×10^{-5}				
HC203R	2.3	0.96×10^{-11}	2.73×10^{-5}	HA-FF053	0.063	0.11×10^{-11}	16.21×10^{-5}
				HA-FF13	0.095	0.15×10^{-11}	12.72×10^{-5}
HA40N	9.8	8.46×10^{-11}	31.23×10^{-5}	HA-FF23	0.35	0.58×10^{-11}	9.35×10^{-5}
HA80N	19.6	2.95×10^{-11}	16.21×10^{-5}	HA-FF33	0.5	0.61×10^{-11}	8.23×10^{-5}
HA100N	68.5	8.02×10^{-11}	27.75×10^{-5}	HA-FF43	0.98	1.42×10^{-11}	7.60×10^{-5}
HA200N*	131.0	4.41×10^{-11}	37.69×10^{-5}	HA-FF63	1.2	1.46×10^{-11}	6.83×10^{-5}
HA053N	0.19	0.50×10^{-11}	43.36×10^{-5}				
HA13N	0.37	0.54×10^{-11}	27.27×10^{-5}	HC-MF053	0.019	0.35×10^{-11}	2.17×10^{-5}
HA23N	0.98	1.04×10^{-11}	18.11×10^{-5}	HC-MF13	0.03	0.16×10^{-11}	1.27×10^{-5}
HA33N	1.96	1.50×10^{-11}	12.23×10^{-5}	HC-MF23	0.088	1.38×10^{-11}	0.90×10^{-5}
HA43N	9.8	8.53×10^{-11}	31.41×10^{-5}	HC-MF43	0.143	1.29×10^{-11}	0.70×10^{-5}
HA83N	19.6	2.40×10^{-11}	20.90×10^{-5}	HC-MF73	0.6	4.29×10^{-11}	0.87×10^{-5}
HA103N*	68.5	6.43×10^{-11}	46.14×10^{-5}				

(Note) The asterisk "*" in the motor type indicates the value for a combination with an amplifier having a one-rank lower capacity than the standard.

9-5 Vibration class

The vibration class of the servomotor is V-10 at the rated speed. The servomotor installation posture and measurement position to be used when measuring the vibration are shown below.

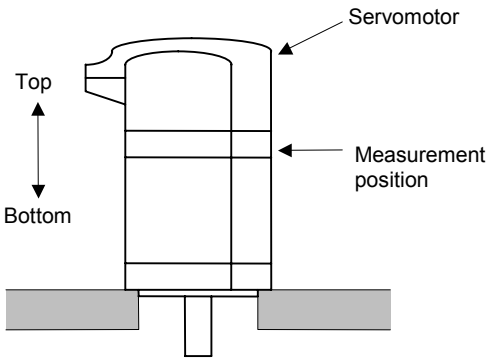


Fig. 9-6 Servomotor vibration measurement conditions

Chapter 10 Specifications

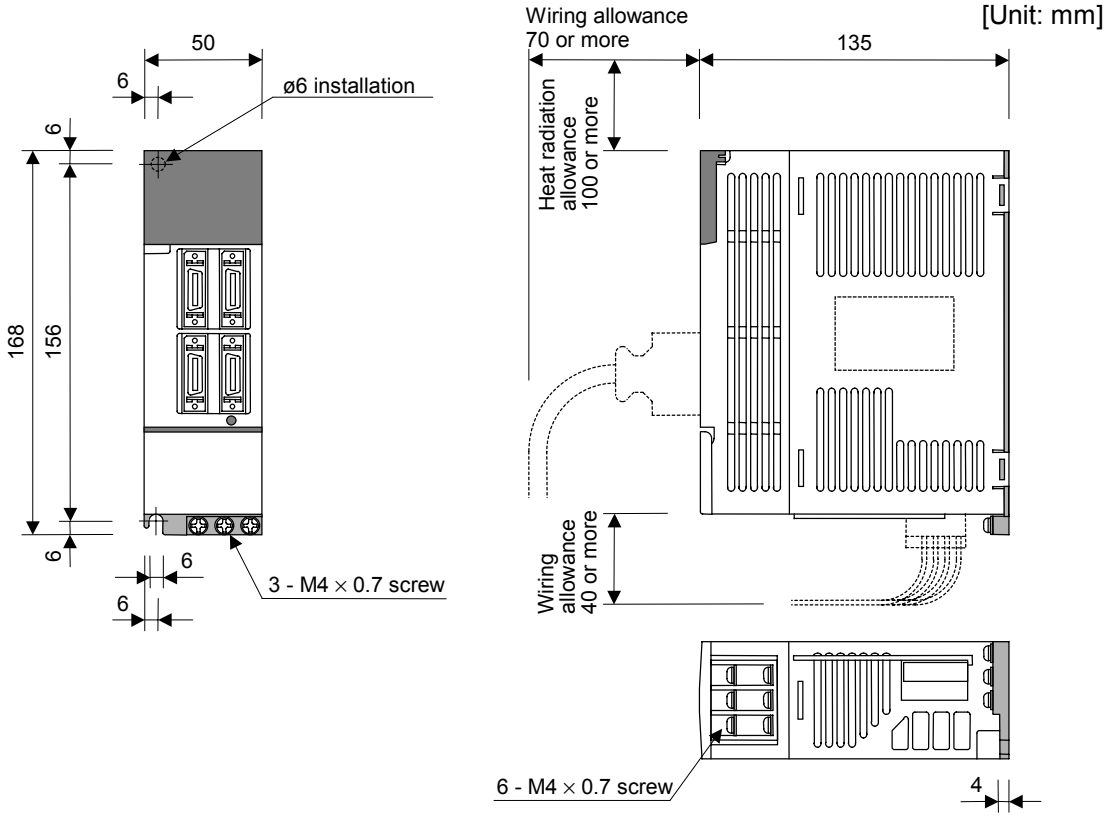
10-1 Servo amplifiers

10-1-1 List of specifications

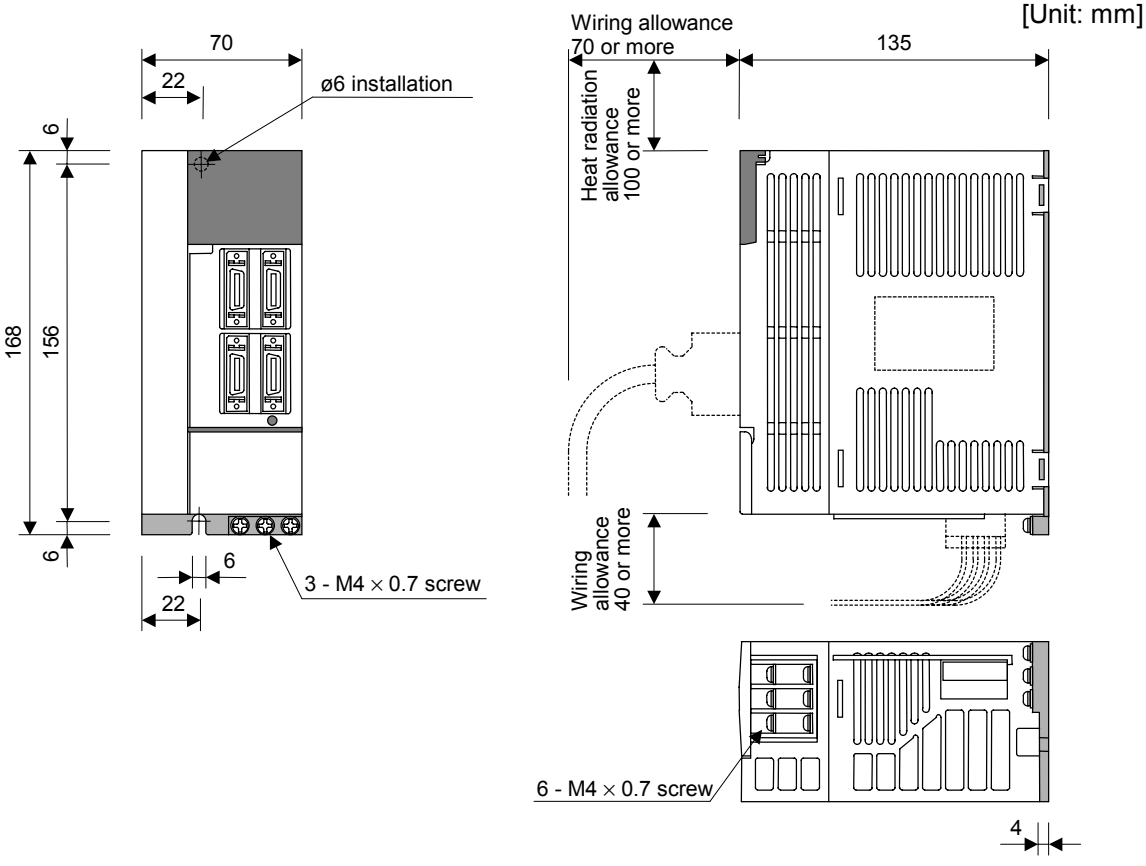
Servo amplifier type (MDS-B-)		SVJ2-01	SVJ2-03	SVJ2-04	SVJ2-06	SVJ2-07	SVJ2-10	SVJ2-20
Power supply	Voltage, frequency	3-phase 200 to 230 VAC/ 50, 60 Hz						
	Tolerable voltage fluctuation	3-phase 170 to 253 VAC/ 50, 60 Hz						
	Tolerable frequency fluctuation	Within ±5%						
Method		Sine wave PWM control, current control method						
Dynamic brakes		Built-in						
Regenerative resistor		External only	Built-in or external option					
External digital input		External emergency stop input						
External digital output		Contactor control output, motor brake control output						
External analog output		±10V, 2ch						
Protective functions		Overcurrent cut off, over voltage cut off, overload cut off (electronic thermal relay), servomotor overheating protection, detector error protection, regeneration error protection, undervoltage, instantaneous power failure protection, overspeed protection, excessive error protection						
Structure		Protective type (Protective model: IP20)						
Environment conditions		To follow section 3-1-1 Environmental conditions						
Weight [kg]		0.7	0.7	0.7	1.1	1.5	2.0	2.0

10-1-2 Outline dimension drawings

- **MDS-B-SVJ2-01, 03 04**

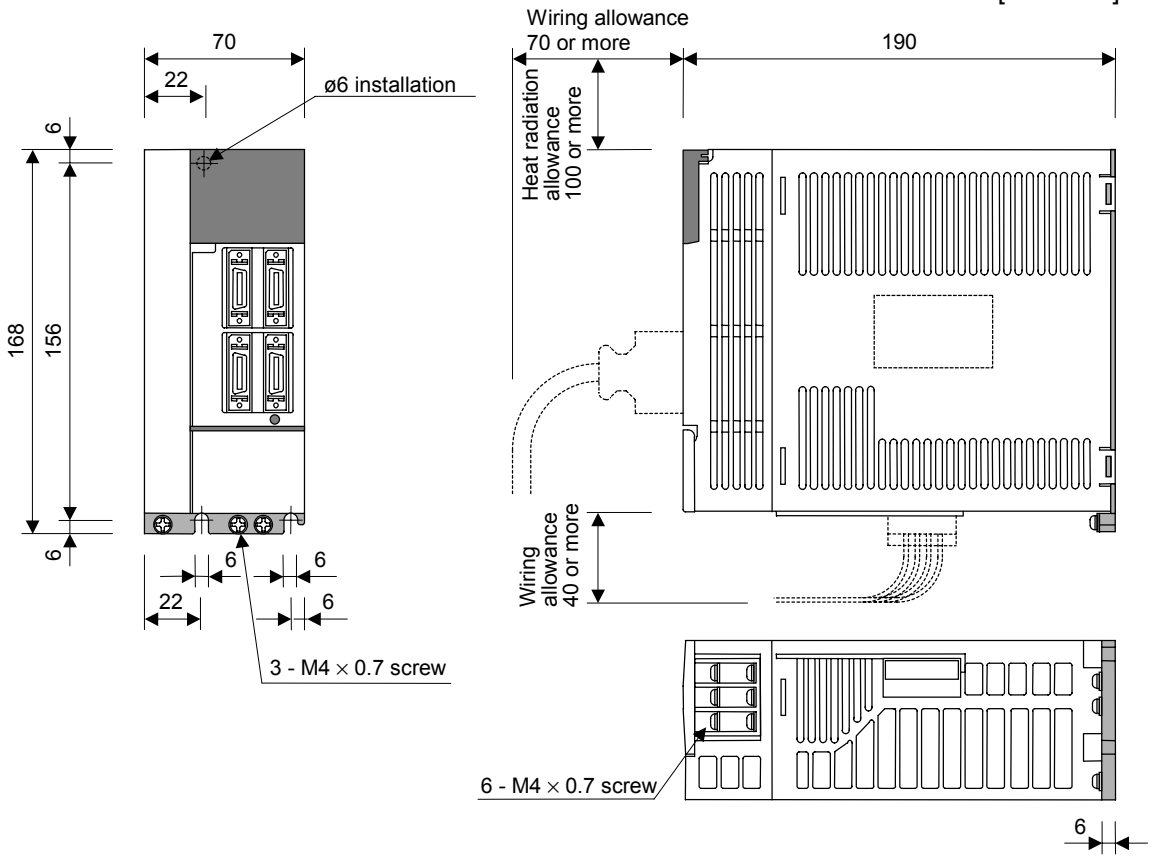


- **MDS-B-SVJ2-06**



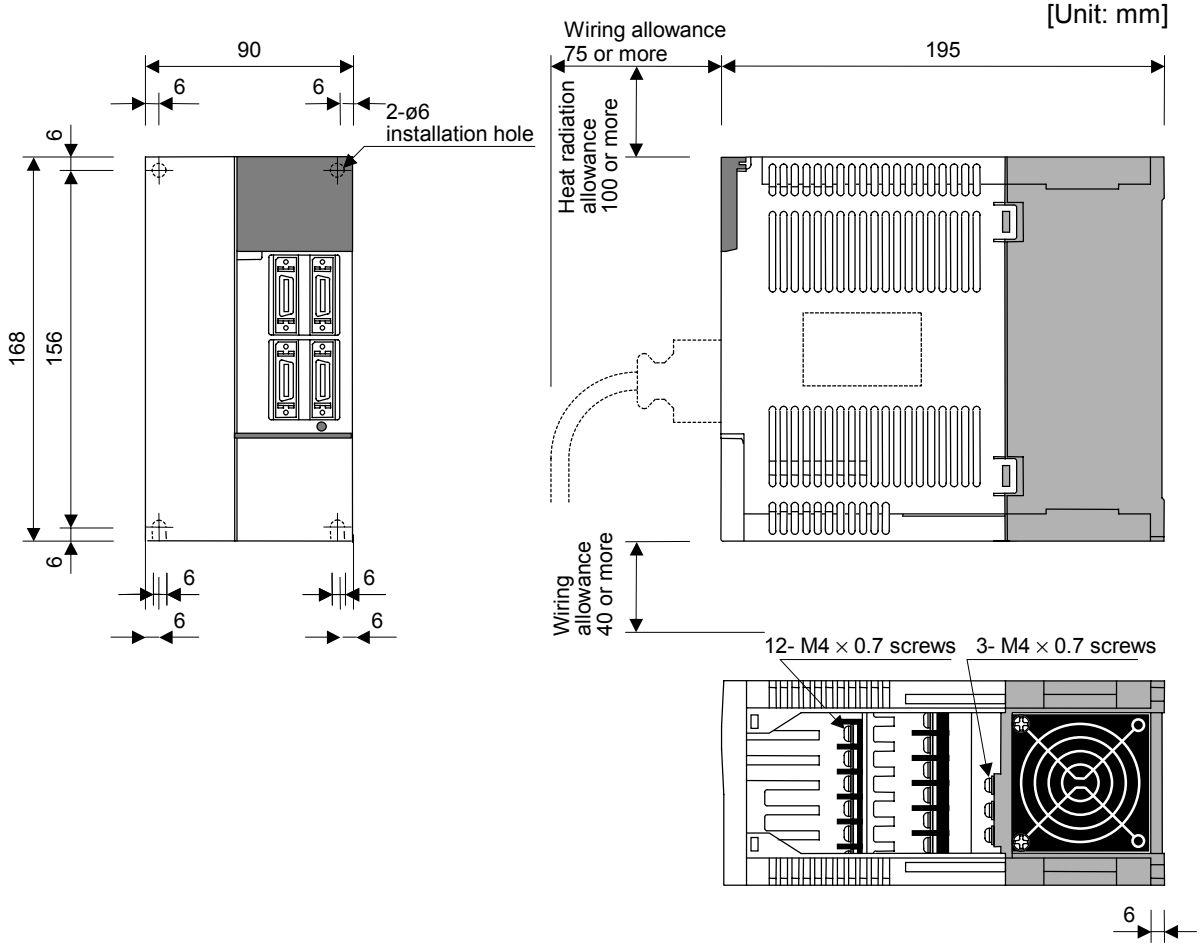
• **MDS-B-SVJ2-07**

[Unit: mm]



• **MDS-B-SVJ2-10, -20**

[Unit: mm]



10-2 Servomotor

10-2-1 List of specifications

Servomotor type		HC Series (2000r/min. rating)							
		INC specifications: HC□-E42/-E33, ABS specifications: HC□-A47/-A42/-A33							
		HC52	HC102		HC152		HC202		HC352
Corresponding servo amplifier type		SVJ2-06	SVJ2-07	SVJ2-10	SVJ2-10	SVJ2-20	SVJ2-10	SVJ2-20	SVJ2-20
Continuous characteristics	Rated output [kW]	0.5	1.0		1.5		2.0		3.5
	Rated current [A]	3.2	6.0		9.0		10.7		16.6
	Rated torque [N·m]	2.39	4.78		7.16		9.55		16.7
	Stall current [A]	3.9	6.0	7.4	9.0	11.1	10.7	15.4	16.6
	Stall torque [N·m]	2.94	4.78	5.88	7.16	8.82	9.55	13.7	16.7
Rated speed [r/min]		2000							
Max. speed [r/min]		2000							
Max. current [A]		17	18	28	27	47	33	47	51
Max. torque [N·m]		11.8	14.4	21.6	21.6	35.3	28.5	41.7	50.1
Motor inertia [kg·cm^2]		6.6	13.7		20.0		42.5		82.0
Motor inertia with brakes [kg·cm^2]		8.6	15.7		22.0		52.5		92.0
Recommended motor shaft conversion load inertia rate		High-speed, high-accuracy machine : 2 times or less of motor inertia General machine tool : 3 times or less of motor inertia General machine : 5 times or less of motor inertia							
Power facility capacity [kVA]		1.0	1.7		2.6		3.5		5.5
Speed/position detector		Resolution per motor rotation E42/A42/A47 : 100000 (pulse/rev), E33/A33: 25000 (pulse/rev)							
Structure		Fully closed, self-cooling (protection method: IP65, IP67)							
Environment conditions		To follow section 3-2-1 Environment conditions							
Weight With/without brakes [kg]		5.0 / 7.5	7.0 / 9.0		9.0 / 11		12 / 18		19 / 25
Armature insulation class		Class F							

(Note 1) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the amplifier.

(Note 2) Only the A47 detector is compatible for use with the HC102, HC152 or HC202 amplifier having one-rank lower capacity.

Servomotor type		HC Series (3000r/min. rating)			
		INC specifications: HC□-E42/-E33, ABS specifications: HC□-A47/-A42/-A33			
		HC53	HC103	HC153	HC203
Corresponding servo amplifier type		SVJ2-06	SVJ2-10	SVJ2-20	SVJ2-20
Continuous characteristics	Rated output [kW]	0.5	1.0	1.5	2.0
	Rated current [A]	3.2	5.3	8.6	10.2
	Rated torque [N·m]	1.59	3.18	4.77	6.37
	Stall current [A]	5.8	9.8	15.9	16.8
	Stall torque [N·m]	2.94	5.88	8.82	10.5
Rated speed [r/min]		3000			
Max. speed [r/min]		3000			
Max. current [A]		17	28	47	51
Max. torque [N·m]		8.82	16.7	28.4	31.4
Motor inertia [kg·cm^2]		6.6	13.7	20.0	42.5
Motor inertia with brakes [kg·cm^2]		8.6	15.7	22.0	52.5
Recommended motor shaft conversion load inertia rate		High-speed, high-accuracy machine : 2 times or less of motor inertia General machine tool : 3 times or less of motor inertia General machine : 5 times or less of motor inertia			
Power facility capacity [kVA]		1.0	1.7	2.6	3.5
Speed/position detector		Resolution per motor rotation E42/A42/A47 : 100000 (pulse/rev), E33/A33: 25000 (pulse/rev)			
Structure		Fully closed, self-cooling (protection method: IP65, IP67)			
Environment conditions		To follow section 3-2-1 Environment conditions			
Weight With/without brakes [kg]		5.0 / 7.5	7.0 / 9.0	9.0 / 11	12 / 18
Armature insulation class		Class F			

(Note) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the amplifier.

Servomotor type		HC□R Series (3000r/min. rating)		
		INC specifications: HC□R -E42/-E33, ABS specifications: HC□R-A47/-A42/-A33		
		HC103R	HC153R	HC203R
Corresponding servo amplifier type		SVJ2-10		SVJ2-20
Continuous characteristics	Rated output [kW]	1.0	1.5	2.0
	Rated current [A]	6.1	8.8	14
	Rated torque [N·m]	3.18	4.77	6.37
	Stall current [A]	6.1	8.8	14
	Stall torque [N·m]	3.18	4.77	6.37
Rated speed [r/min]		3000		
Max. speed [r/min]		3000		
Max. current [A]		18.4	23.4	37
Max. torque [N·m]		7.95	11.9	15.9
Motor inertia [kg·cm^2]		1.5	1.9	2.3
Motor inertia with brakes [kg·cm^2]		1.9	2.3	2.7
Recommended motor shaft conversion load inertia rate		5-times or less of motor inertia		
Power facility capacity [kVA]		1.7	2.6	3.5
Speed/position detector		Resolution per motor rotation E42/A42/A47 : 100000 (pulse/rev), E33/A33: 25000 (pulse/rev)		
Structure		Fully closed, self-cooling (protection method: IP65)		
Environment conditions		To follow section 3-2-1 Environment conditions		
Weight With/without brakes [kg]		3.9 / 6.0	5.0 / 7.0	6.2 / 8.3
Armature insulation class		Class F		

(Note) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the amplifier.

Servomotor type		HA□N Series (2000r/min. rating)			
		INC specifications: HC□N -E42/-E33, ABS specifications: HC□N-A42/-A33			
		HA40N	HA80N	HA100N	HA200N
Corresponding servo amplifier type		SVJ2-06	SVJ2-10	SVJ2-20	SVJ2-20
Continuous characteristics	Rated output [kW]	0.5	1.0	2.0	3.5
	Rated current [A]	3.0	5.5	10	16
	Rated torque [N·m]	2.39	4.77	9.55	16.7
	Stall current [A]	3.6	6.6	14	16
	Stall torque [N·m]	2.94	5.88	13.7	16.7
Rated speed [r/min]		2000			
Max. speed [r/min]		2000			
Max. current [A]		17	28	42	49
Max. torque [N·m]		14.2	25.5	42.0	50.1
Motor inertia [kg·cm^2]		9.8	19.6	68.5	131
Motor inertia with brakes [kg·cm^2]		10.5	20.3	72.8	135
Recommended motor shaft conversion load inertia rate		3-times or less of motor inertia			
Power facility capacity [kVA]		1.0	1.7	3.5	5.5
Speed/position detector		Resolution per motor rotation E42/A42 : 100000 (pulse/rev), E33/A33: 25000 (pulse/rev)			
Structure		Fully closed, self-cooling (protection method: IP54, IP65)			
Environment conditions		To follow section 3-2-1 Environment conditions			
Weight With/without brakes [kg]		8 / 10	12 / 14	21 / 27	31 / 37
Armature insulation class		Class F			

(Note) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the amplifier.

Servomotor type		HA□N Series (3000r/min. rating)						
		INC specifications: HC□N-E42/-E33, ABS specifications: HC□N-A42/-A33						
		HA053N	HA13N	HA23N	HA33N	HA43N	HA83N	HA103N
Corresponding servo amplifier type		SVJ2-01		SVJ2-03		SVJ2-06	SVJ2-10	SVJ2-20
Continuous characteristics	Rated output [kW]	0.05	0.1	0.3	0.45	0.5	1.0	2.0
	Rated current [A]	0.95	0.95	2.9	2.2	2.8	4.9	9.2
	Rated torque [N·m]	0.16	0.32	0.95	1.43	1.59	3.18	6.37
	Stall current [A]	1.4	1.4	3.0	3.0	5.0	8.8	15.0
	Stall torque [N·m]	0.25	0.49	0.98	1.96	2.94	5.88	10.5
Rated speed [r/min]		3000						
Max. speed [r/min]		3000						
Max. current [A]		3.8	3.8	8.1	8.1	17	28	45
Max. torque [N·m]		0.69	1.37	2.7	5.6	10.2	19.2	31.4
Motor inertia [kg·cm^2]		0.188	0.365	0.98	1.96	9.8	19.6	68.5
Motor inertia with brakes [kg·cm^2]		0.204	0.381	1.18	2.16	10.5	20.3	72.8
Recommended motor shaft conversion load inertia rate		3-times or less of motor inertia						
Power facility capacity [kVA]		0.3	0.3	0.6	0.9	1.0	1.7	3.5
Speed/position detector		Resolution per motor rotation E42/A42 : 100000 (pulse/rev), E33/A33: 25000 (pulse/rev)						
Structure		Fully closed, self-cooling (protection method: IP54, IP65, IP67)						
Environment conditions		To follow section 3-2-1 Environment conditions						
Weight With/without brakes [kg]		2.1 / 2.5	2.5 / 2.9	3.5 / 4. 5	4.5 / 5.5	8 / 10	12 / 14	21 / 27
Armature insulation class		Class F						

(Note) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the amplifier.

Servomotor type		HC-SF Series (2000r/min rating)				
		Absolute position standard				
		HC-SF52	HC-SF102	HC-SF152	HC-SF202	HC-SF352
Corresponding servo amplifier type		SVJ2-06	SVJ2-07	SVJ2-10		SVJ2-20
Continuous characteristics	Rated output [kW]	0.5	1.0	1.5	2.0	3.5
	Rated current [A]	3.2	6.0	9.0	10.7	16.6
	Rated torque [N·m]	2.39	4.78	7.16	9.55	16.7
Rated speed [r/min]		2000				
Max. speed [r/min]		3000			2500	
Max. current [A]		9.6	18	27	33	51
Max. torque [N·m]		7.16	14.4	21.6	28.5	50.1
Motor inertia [kg·cm^2]		6.6	13.7	20.0	42.5	82.0
Motor inertia with brakes [kg·cm^2]		8.6	15.7	22.0	52.5	92.0
Recommended motor shaft conversion load inertia rate		10-times or less of motor inertia				
Power facility capacity [kVA]		1.0	1.7	2.5	3.5	5.5
Speed/position detector		Resolution per motor rotation 16384 (pulse/rev)				
Structure		Fully closed, self-cooling (protection method: IP65)				
Environment conditions		To follow section 3-2-1 Environment conditions				
Weight With/without brakes [kg]		5.0 / 7.5	7.0 / 9.0	9.0 / 11	12 / 18	19 / 25
Armature insulation class		Class F				

(Note) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the amplifier.

Servomotor type		HC-SF Series (3000r/min rating)				
		Absolute position standard				
		HC-SF53	HC-SF103	HC-SF153	HC-SF203	HC-SF353
Corresponding servo amplifier type		SVJ2-06	SVJ2-07	SVJ2-10		SVJ2-20
Continuous characteristics	Rated output [kW]	0.5	1.0	1.5	2.0	3.5
	Rated current [A]	3.2	5.4	8.6	10.2	16.8
	Rated torque [N·m]	1.59	3.18	4.78	6.37	11.0
Rated speed [r/min]		3000				
Max. speed [r/min]		3000				
Max. current [A]		9.6	16	26	31	49
Max. torque [N·m]		4.77	9.55	14.3	19.1	33.4
Motor inertia [kg·cm^2]		6.6	13.7	20.0	42.5	82.0
Motor inertia with brakes [kg·cm^2]		8.6	15.7	22.0	52.5	92.0
Recommended motor shaft conversion load inertia rate		10-times or less of motor inertia				
Power facility capacity [kVA]		1.0	1.7	2.5	3.5	5.5
Speed/position detector		Resolution per motor rotation 16384 (pulse/rev)				
Structure		Fully closed, self-cooling (protection method: IP65)				
Environment conditions		To follow section 3-2-1 Environment conditions				
Weight With/without brakes [kg]		5.0 / 7.5	7.0 / 9.0	9.0 / 11	12 / 18	19 / 25
Armature insulation class		Class F				

(Note) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the amplifier.

Servomotor type		HC-RF Series		
		Absolute position standard		
		HC-RF103	HC-RF153	HC-RF203
Corresponding servo amplifier type		SVJ2-10		SVJ2-20
Continuous characteristics	Rated output [kW]	1.0	1.5	2.0
	Rated current [A]	6.1	8.8	14
	Rated torque [N·m]	3.18	4.77	6.37
Rated speed [r/min]		3000		
Max. speed [r/min]		4500		
Max. current [A]		18.4	23.4	37
Max. torque [N·m]		7.95	11.9	15.9
Motor inertia [kg·cm^2]		1.5	1.9	2.3
Motor inertia with brakes [kg·cm^2]		1.9	2.3	2.7
Recommended motor shaft conversion load inertia rate		5-times or less of motor inertia		
Power facility capacity [kVA]		1.7	2.5	3.5
Speed/position detector		Resolution per motor rotation 16384 (pulse/rev)		
Structure		Fully closed, self-cooling (protection method: IP65)		
Environment conditions		To follow section 3-2-1 Environment conditions		
Weight With/without brakes [kg]		3.9 / 6.0	5.0 / 7.0	6.2 / 8.3
Armature insulation class		Class F		

(Note) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the amplifier.

Servomotor type		HA-FF Series					
		Absolute position standard					
		HA-FF053	HA-FF13	HA-FF23	HA-FF33	HA-FF43	HA-FF63
Corresponding servo amplifier type		SVJ2-01		SVJ2-03		SVJ2-04	SVJ2-06
Continuous characteristics	Rated output [kW]	0.05	0.1	0.2	0.3	0.4	0.6
	Rated current [A]	0.6	1.1	1.3	1.9	2.5	3.6
	Rated torque [N·m]	0.16	0.32	0.64	0.95	1.3	1.9
Rated speed [r/min]		3000					
Max. speed [r/min]		4000					
Max. current [A]		1.8	3.3	3.9	5.7	7.5	10.8
Max. torque [N·m]		0.48	0.95	1.9	2.9	3.8	5.7
Motor inertia [kg·cm^2]		0.063	0.095	0.35	0.5	0.98	1.2
Motor inertia with brakes [kg·cm^2]		0.08	0.113	0.483	0.633	1.325	1.55
Recommended motor shaft conversion load inertia rate		10-times or less of motor inertia					
Power facility capacity [kVA]		0.3	0.3	0.5	0.7	0.9	1.1
Speed/position detector		Resolution per motor rotation 8192 (pulse/rev)					
Structure		Fully closed, self-cooling (protection method: IP44, excluding connector section. IP54 for HA-FF□C-UE Series.)					
Environment conditions		To follow section 3-2-1 Environment conditions					
Weight With/without brakes [kg]		1.3 / 1.6	1.5 / 1.8	2.3 / 2.9	2.6 / 3.2	4.2 / 5.0	4.8 / 5.6
Armature insulation class		Class B					

(Note) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the amplifier.

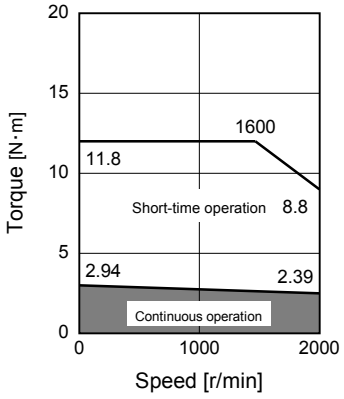
Servomotor type		HC-MF Series				
		Absolute position standard				
		HC-MF053	HC-MF13	HC-MF23	HC-MF43	HC-MF73
Corresponding servo amplifier type		SVJ2-01		SVJ2-03	SVJ2-04	SVJ2-07
Continuous characteristics	Rated output [kW]	0.05	0.1	0.2	0.4	0.75
	Rated current [A]	0.85	0.85	1.5	2.8	5.2
	Rated torque [N·m]	0.16	0.32	0.64	1.3	2.4
Rated speed [r/min]		3000				
Max. speed [r/min]		4500				
Max. current [A]		2.6	2.6	5.0	9.0	18
Max. torque [N·m]		0.48	0.95	1.9	3.8	7.2
Motor inertia [kg·cm^2]		0.019	0.03	0.088	0.143	0.6
Motor inertia with brakes [kg·cm^2]		0.022	0.033	0.13	0.19	0.8
Recommended motor shaft conversion load inertia rate		30-times or less of motor inertia				
Power facility capacity [kVA]		0.3	0.3	0.5	0.9	1.3
Speed/position detector		Resolution per motor rotation 8192 (pulse/rev)				
Structure		Fully closed, self-cooling (protection method: IP44 excluding the shaft penetration section and connectors)				
Environment conditions		To follow section 3-2-1 Environment conditions				
Weight With/without brakes [kg]		0.40 / 0.75	0.53 / 0.89	0.99 / 1.6	1.45 / 2.1	3.0 / 4.0
Armature insulation class		Class B				

(Note) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the amplifier.

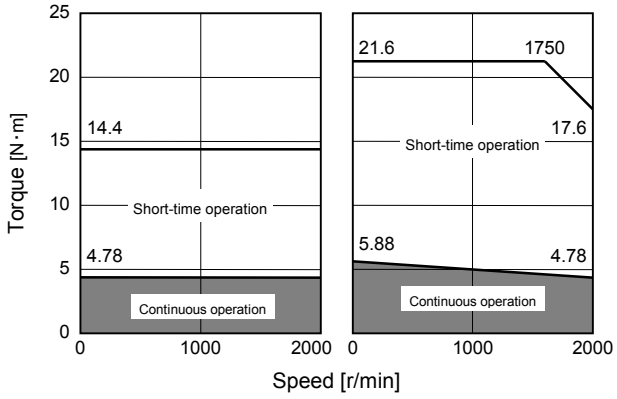
10-2-2 Torque characteristic drawings

(1) HC Series

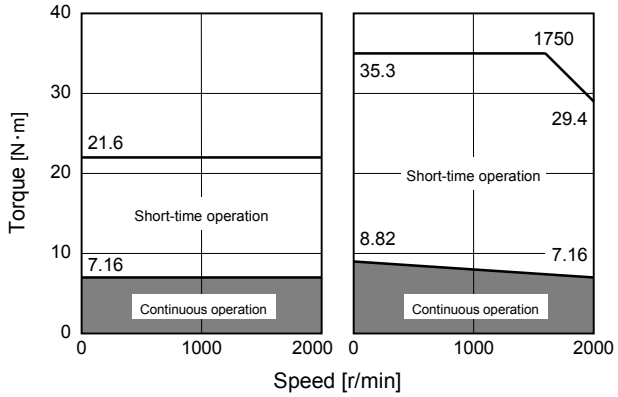
[HC52]



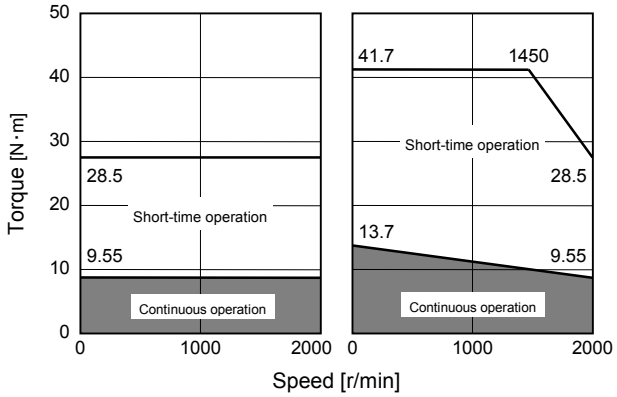
[HC102+SVJ2-07] [HC102+SVJ2-10]



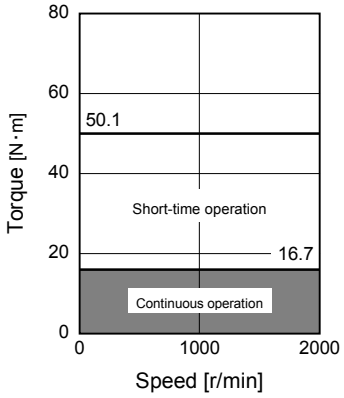
[HC152+SVJ2-10] [HC152+SVJ2-20]



[HC202+SVJ2-10] [HC202+SVJ2-20]

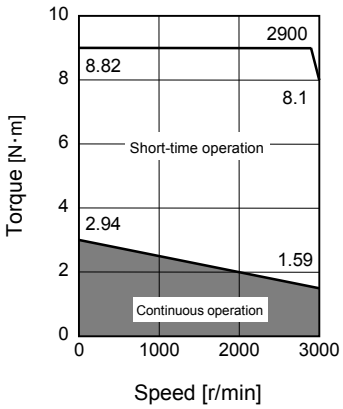


[HC352]

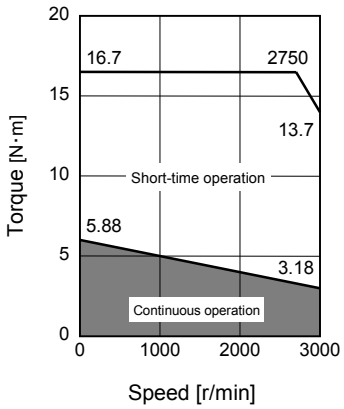


(Caution) The data in these characteristics is for an input voltage of 200VAC.

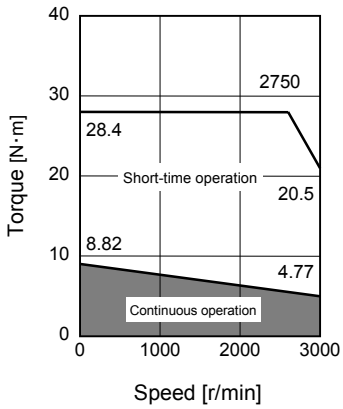
[HC53]



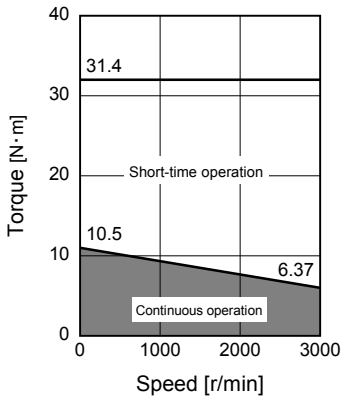
[HC103]



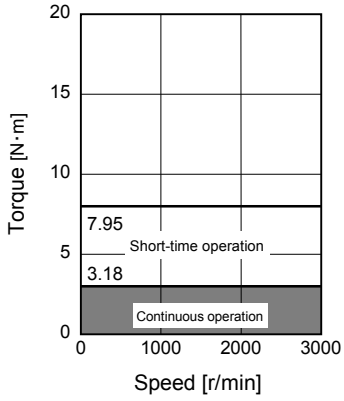
[HC153]



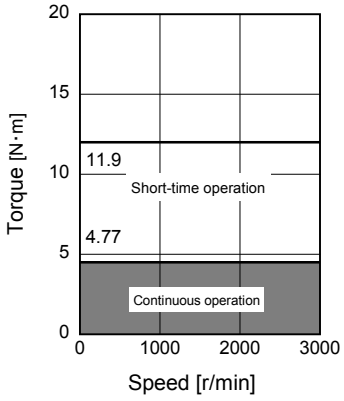
[HC203]



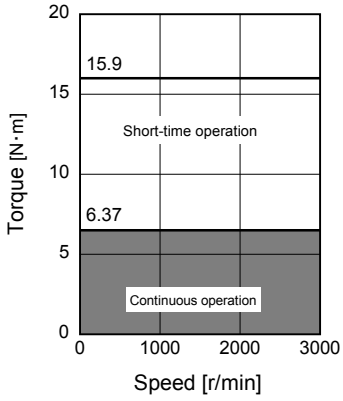
[HC103R]



[HC153R]



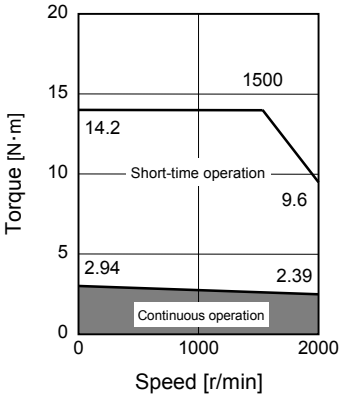
[HC203R]



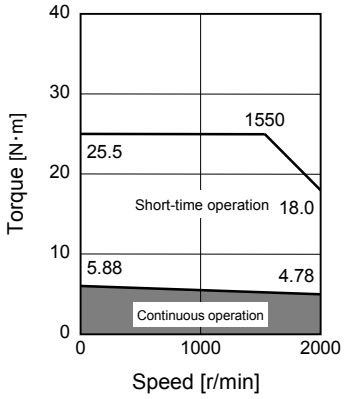
(Caution) The data in these characteristics is for an input voltage of 200VAC.

(2) HA Series

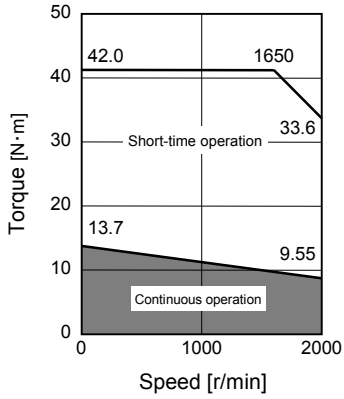
[HA40N]



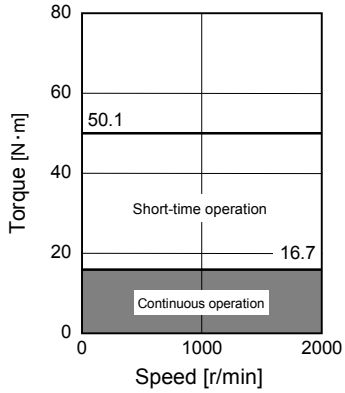
[HA80N]



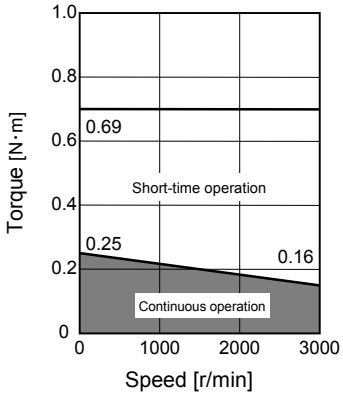
[HA100N]



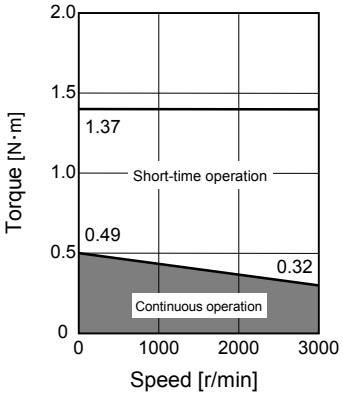
[HA200N]



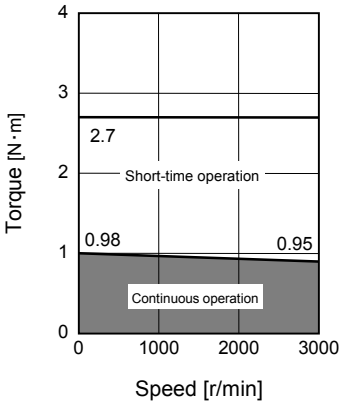
[HA053N]



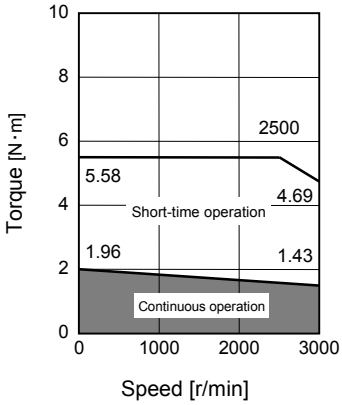
[HA13N]



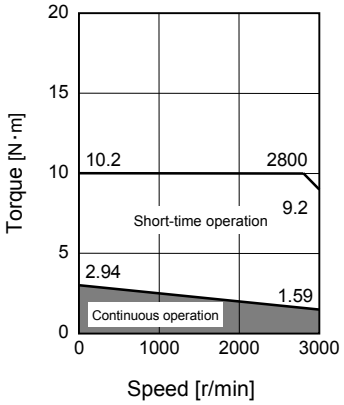
[HA23N]



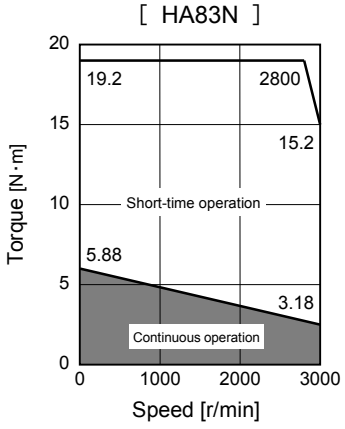
[HA33N]



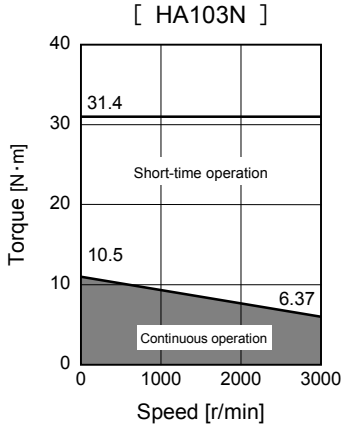
[HA43N]



[HA83N]



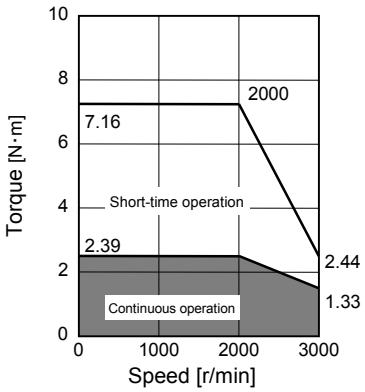
[HA103N]



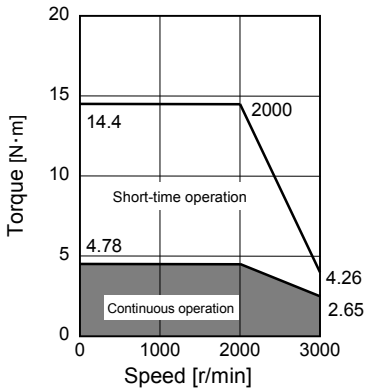
(Caution) The data in these characteristics is for an input voltage of 200VAC.

(3) HC-SF Series

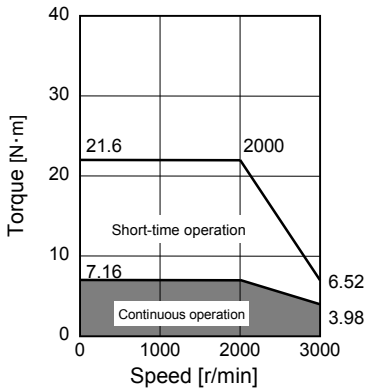
[HC-SF52]



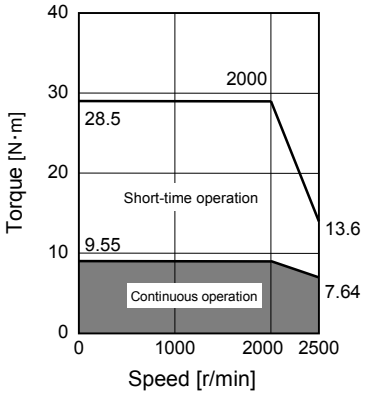
[HC-SF102]



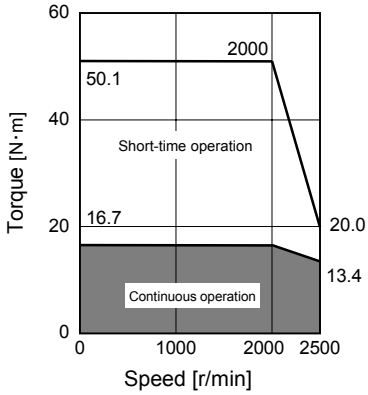
[HC-SF152]



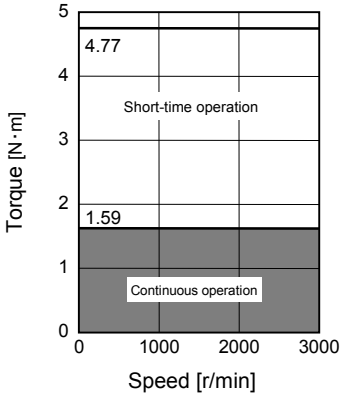
[HC-SF202]



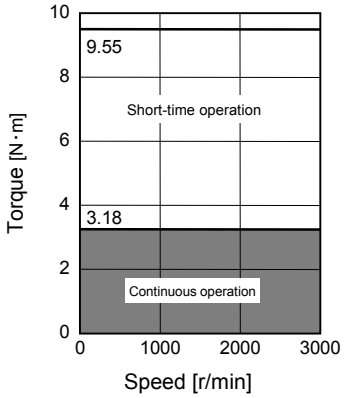
[HC-SF352]



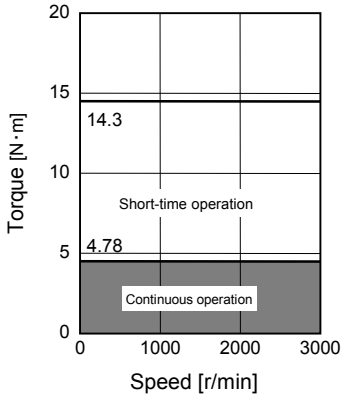
[HC-SF53]



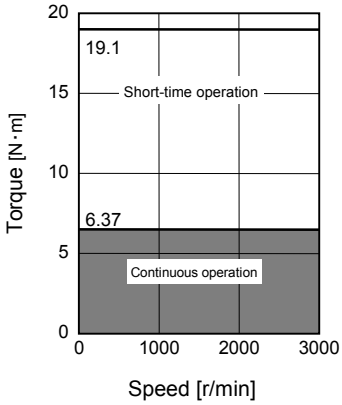
[HC-SF103]



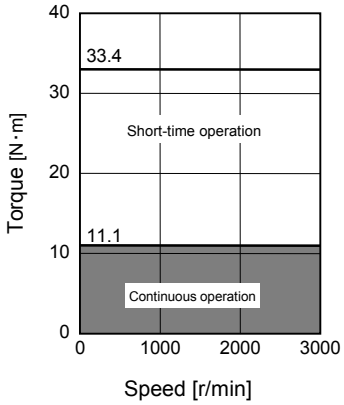
[HC-SF153]



[HC-SF203]

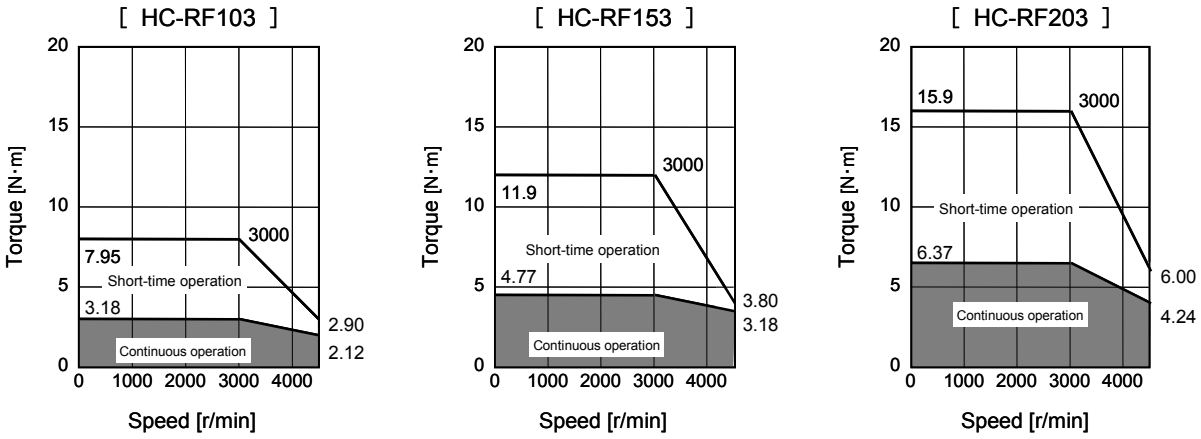


[HC-SF353]



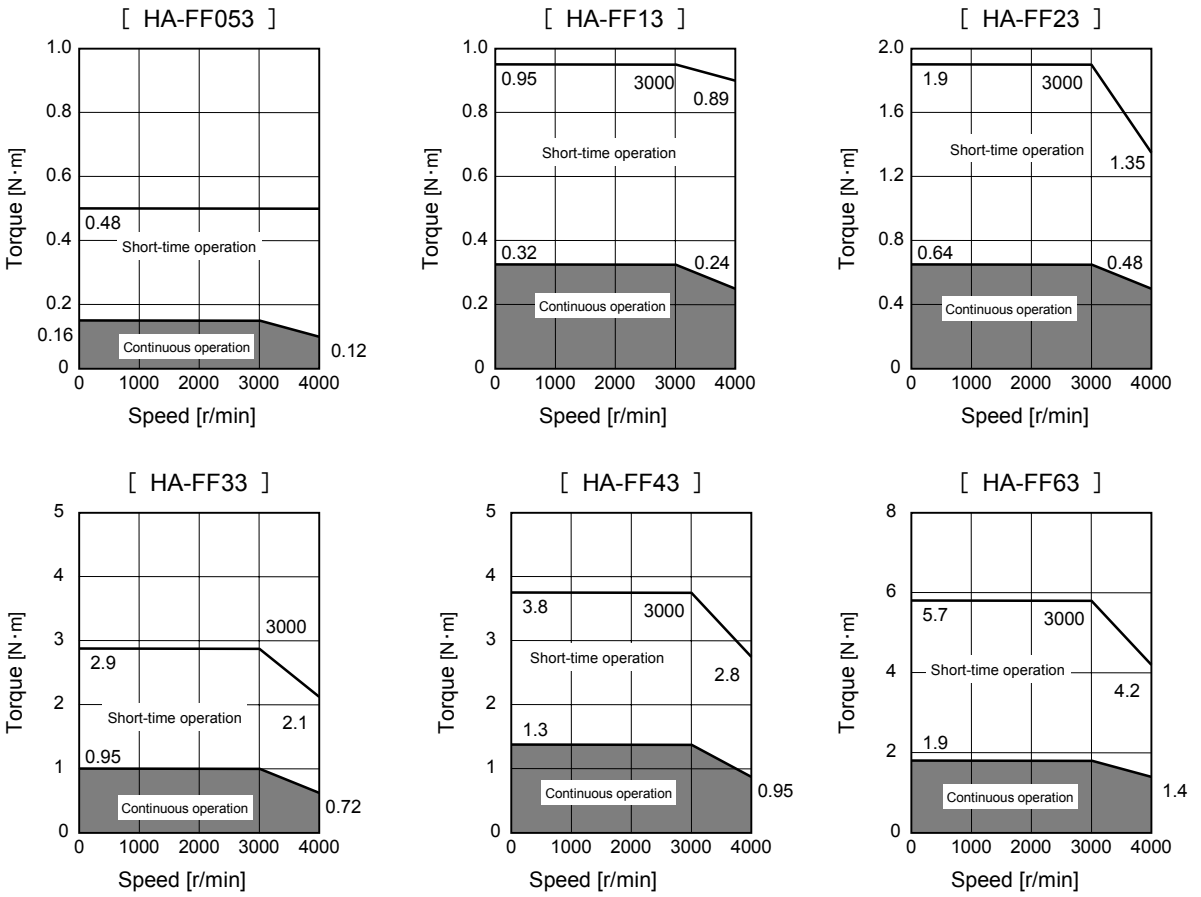
(Caution) The data in these characteristics is for an input voltage of 200VAC.

(4) HC-RF Series



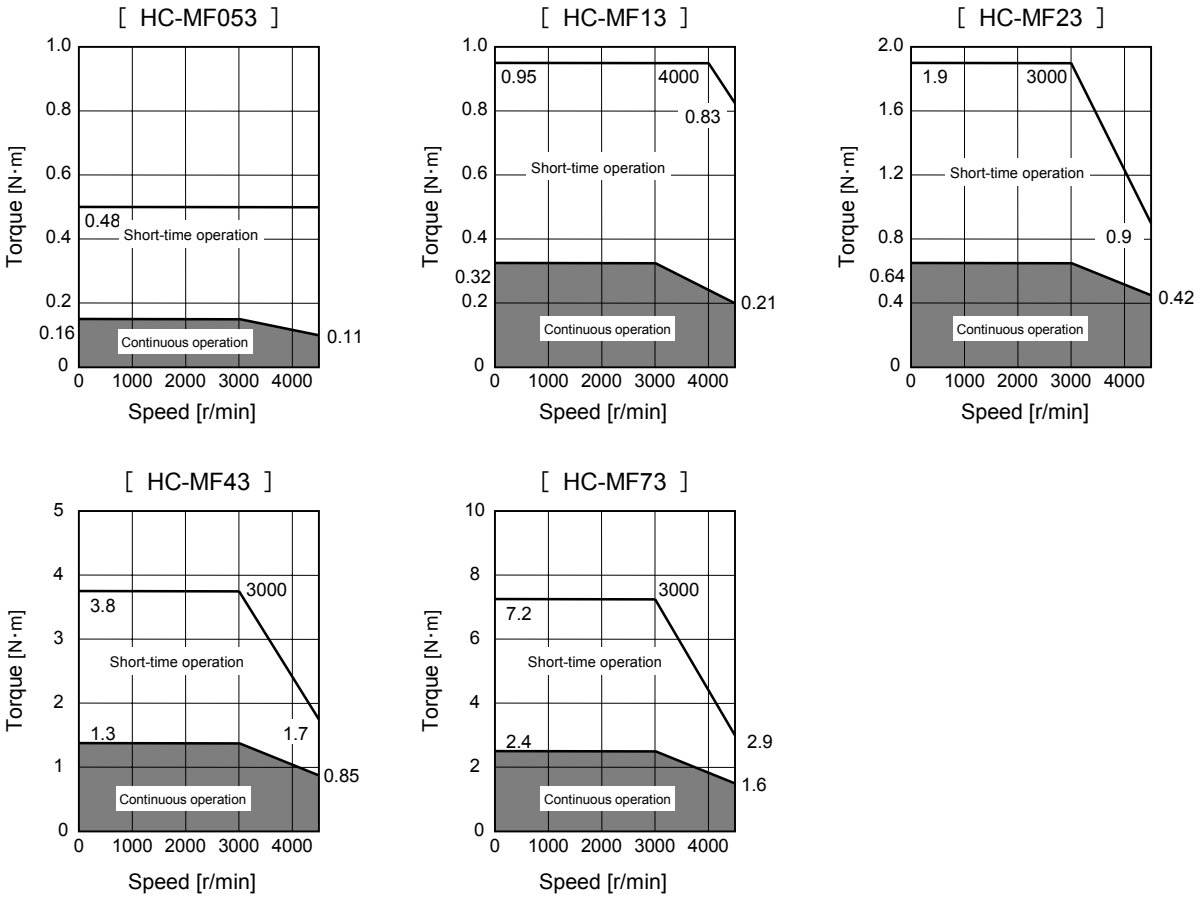
(Caution 1) The data in these characteristics is for an input voltage of 200VAC.
(Caution 2) Continuous operation for 10 minutes or more at a speed exceeding the rated rotation speed may be separately limited on the servo amplifier side.

(5) HA-FF Series



(Caution 1) The data in these characteristics is for an input voltage of 200VAC.
(Caution 2) Continuous operation for 10 minutes or more at a speed exceeding the rated rotation speed may be separately limited on the servo amplifier side.

(6) HC-MF Series

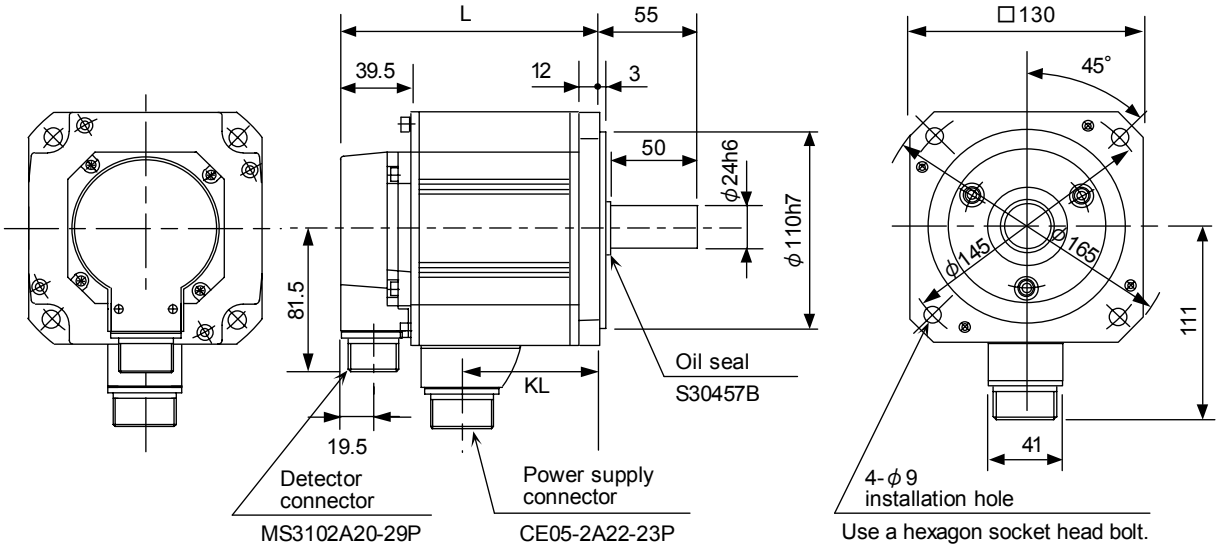


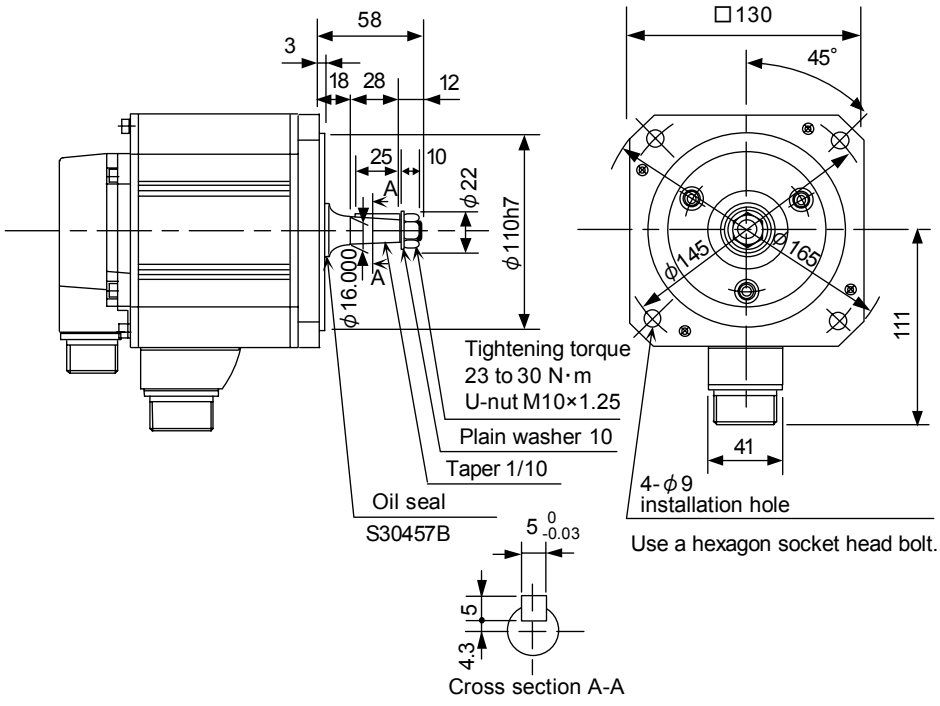
(Caution 1) The data in these characteristics is for an input voltage of 200VAC.
(Caution 2) Continuous operation for 10 minutes or more at a speed exceeding the rated rotation speed may be separately limited on the servo amplifier side.

10-2-3 Outline dimension drawings

- HC52(B)S-A47
- HC102(B)S-A47
- HC152(B)S-A47
- HC53(B)S-A47
- HC103(B)S-A47
- HC153(B)S-A47
- HC52(B)T-A47
- HC102(B)T-A47
- HC152(B)T-A47
- HC53(B)T-A47
- HC103(B)T-A47
- HC153(B)T-A47

[Unit: mm]



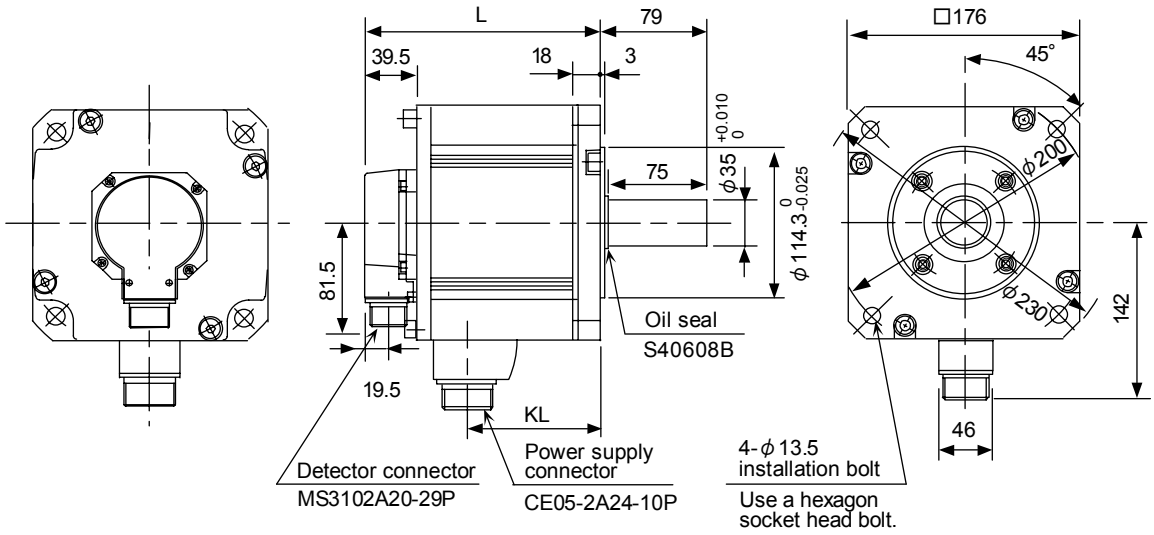


Servomotor type		L (Note 1)	KL
2000r/min	3000r/min		
HC52(B)□-A47	HC53(B)□ -A47	120 (153)	51.5
HC102(B)□ -A47	HC103(B)□ -A47	145 (178)	76.5
HC152(B)□ -A47	HC153(B)□ -A47	170 (203)	101.5

Note 1. The dimensions given in parentheses are for when magnetic brakes are provided.
Note 2. Use a friction coupling (Spun ring, etc.) to connect with the load.

- HC202S-A47
- HC203S-A47
- HC352S-A47

[Unit: mm]

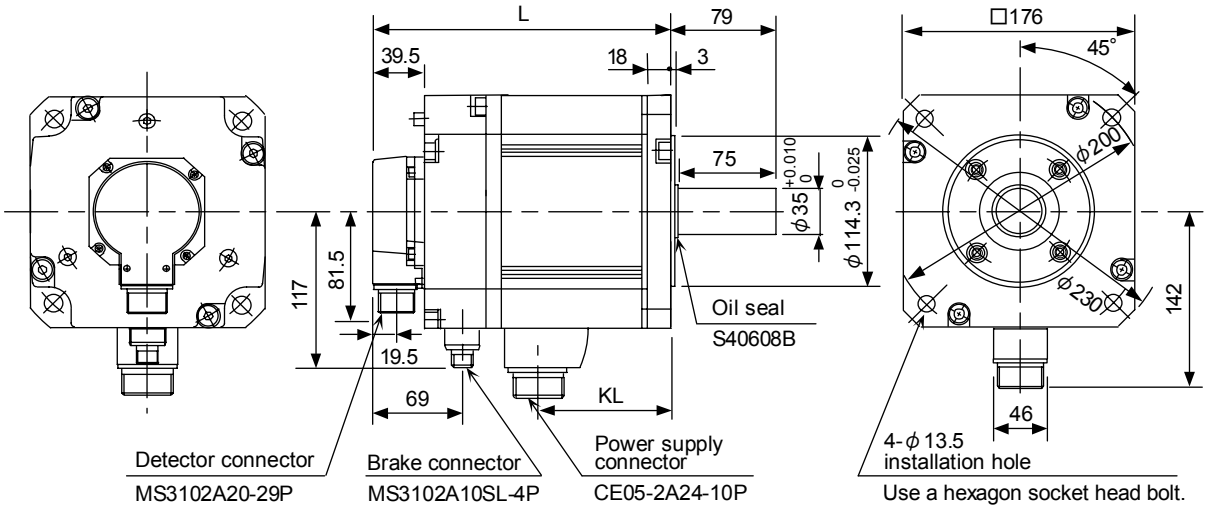


Servomotor type		L	KL
2000r/min	3000r/min		
HC202S-A47	HC203S-A47	145	68.5
HC352S-A47		187	110.5

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.

- HC202BS-A47
- HC203BS-A47
- HC352BS-A47

[Unit: mm]

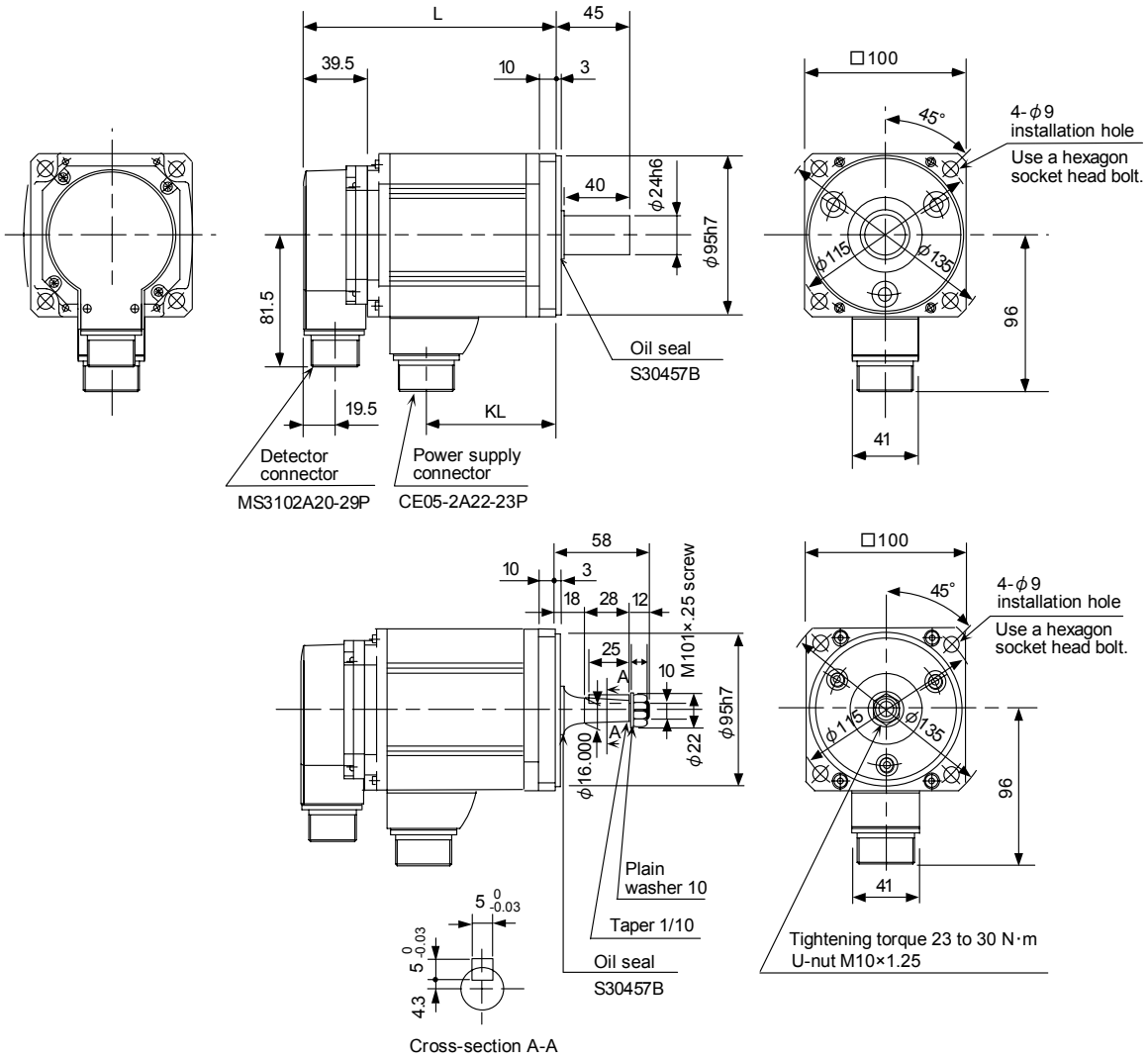


Servomotor type		L	KL
2000r/min	3000r/min		
HC202BS-A47	HC203BS-A47	193	68.5
HC352BS-A47		235	110.5

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.

- HC103R(B)S-A47
- HC153R(B)S-A47
- HC203R(B)S-A47
- HC103R(B)T-A47
- HC153R(B)T-A47
- HC203R(B)T-A47

[Unit: mm]

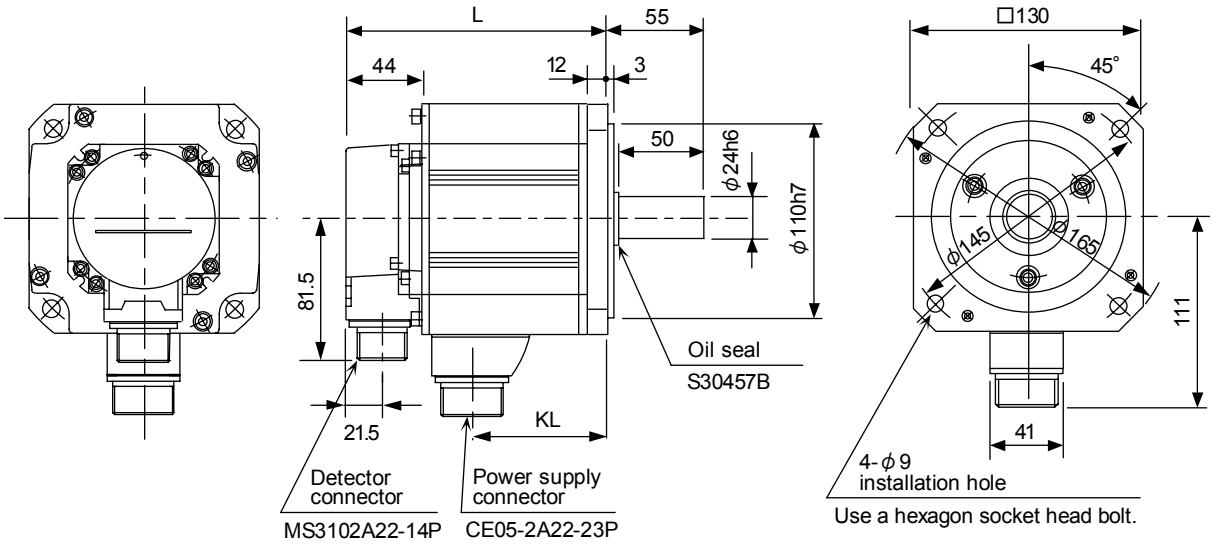


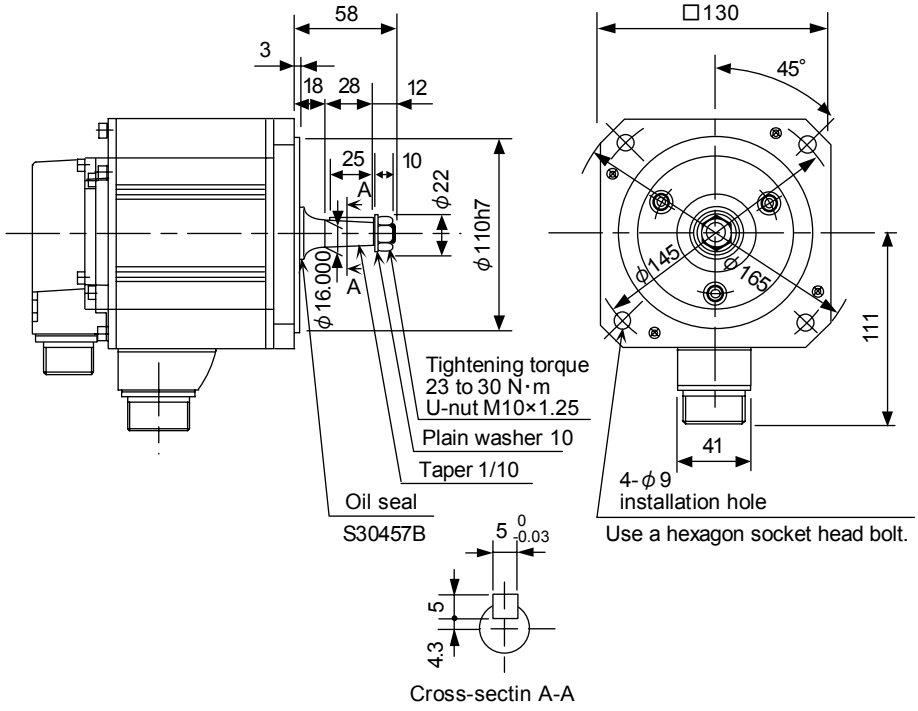
Servomotor type	L (Note 1)	KL
HC103R(B)□-A47	147 (185)	71
HC153R(B)□-A47	172 (210)	96
HC203R(B)□-A47	197 (235)	121

Note 1. The dimensions given in parentheses are for when magnetic brakes are provided.
Note 2. Use a friction coupling (Spun ring, etc.) to connect with the load.

- HC52(B)S(W)-A42/E42/A33/E33
- HC102(B)(W)S-A42/E42/A33/E33
- HC152(B)(W)S-A42/E42/A33/E33
- HC53(B)S(W)-A42/E42/A33/E33
- HC103(B)S(W)-A42/E42/A33/E33
- HC153(B)S(W)-A42/E42/A33/E33
- HC52(B)(W)T-A42/E42/A33/E33
- HC102(B)(W)T-A42/E42/A33/E33
- HC152(B)(W)T-A42/E42/A33/E33
- HC53(B)T(W)-A42/E42/A33/E33
- HC103(B)T(W)-A42/E42/A33/E33
- HC153(B)T(W)-A42/E42/A33/E33

[Unit: mm]



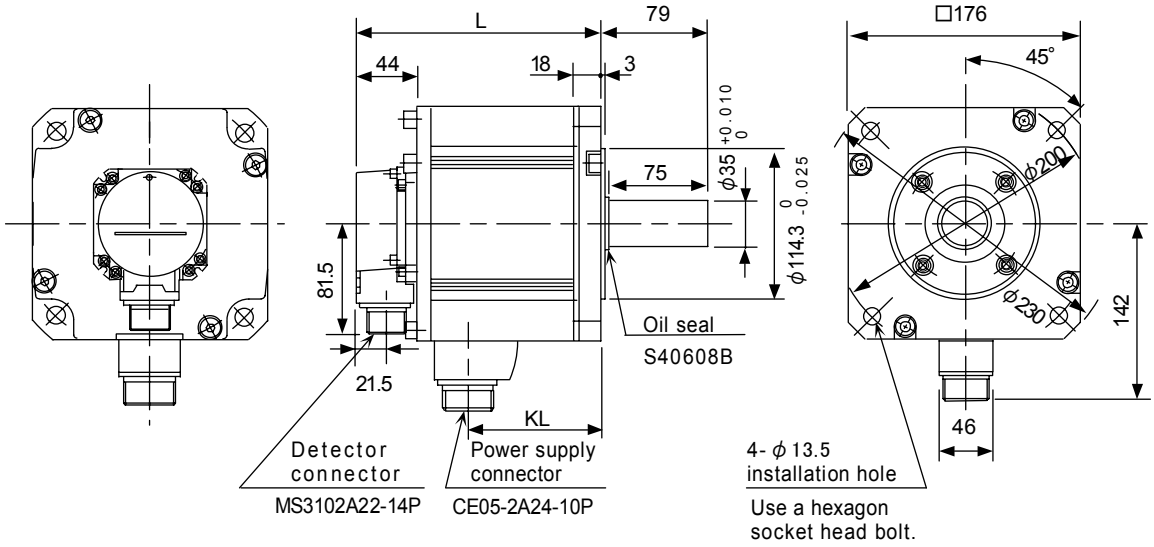


Servomotor type		IP67 specifications		IP67 specifications (with W)	
2000r/min	3000r/min	L (Note 1)	KL	L (Note 1)	KL
HC52(B)	HC53(B)	125 (158)	51.5	135 (168)	51.5
HC102(B)	HC103(B)	150 (183)	76.5	160 (193)	76.5
HC152(B)	HC153(B)	175 (208)	101.5	185 (218)	101.5

Note 1. The dimensions given in parentheses are for when magnetic brakes are provided.
Note 2. Use a friction coupling (Spun ring, etc.) to connect with the load.

- HC202S(W)-A42/E42/A33/E33
- HC203S(W)-A42/E42/A33/E33
- HC352S(W)-A42/E42/A33/E33

[Unit: mm]

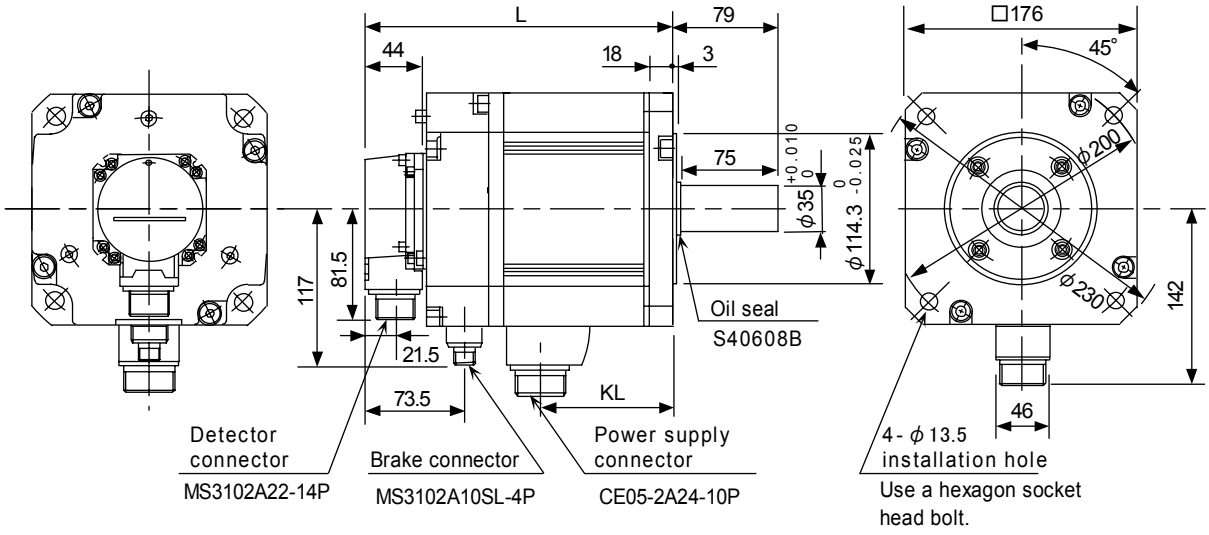


Servomotor type		L	KL
2000r/min	3000r/min		
HC202S	HC203S	150	68.5
HC352S		192	110.5

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. IP67 specifications (with W) is also the same size.

- HC202BS(W)-A42/E42/A33/E33
- HC203BS(W)-A42/E42/A33/E33
- HC352BS(W)-A42/E42/A33/E33

[Unit: mm]

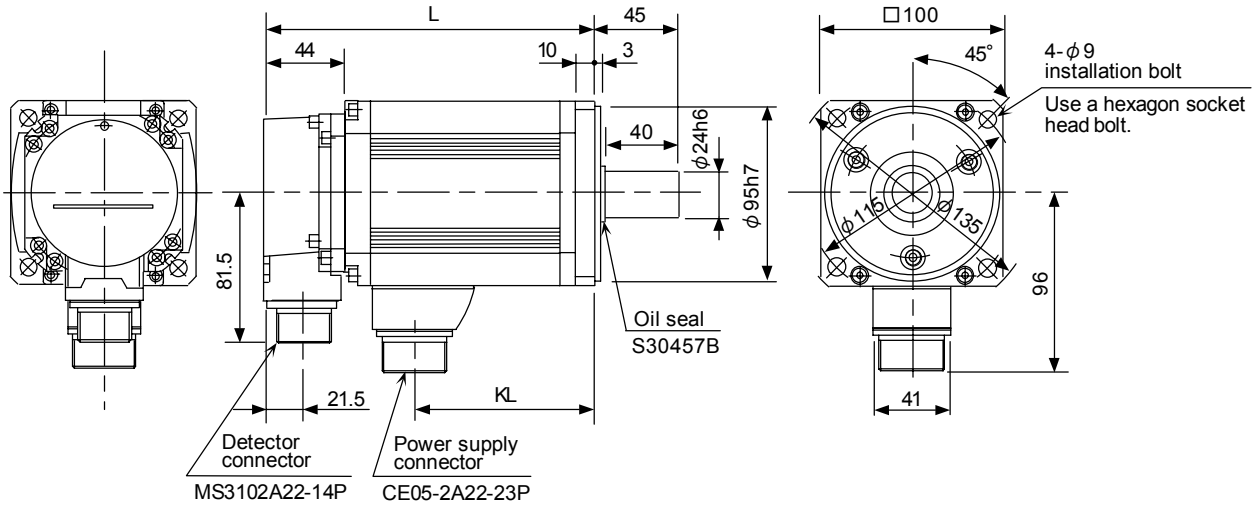


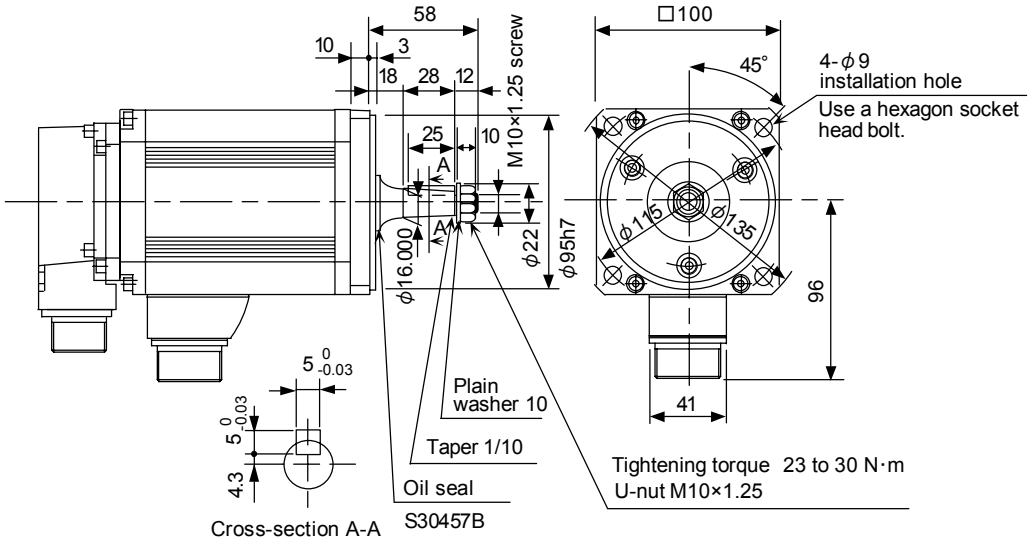
Servomotor type		L	KL
2000r/min	3000r/min		
HC202BS	HC203BS	198	68.5
HC352BS		240	110.5

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. IP67 specifications (with W) is also the same size.

- HC103R(B)S-A42/E42/A33/E33
- HC153R(B)S-A42/E42/A33/E33
- HC203R(B)S-A42/E42/A33/E33
- HC103R(B)T-A42/E42/A33/E33
- HC153R(B)T-A42/E42/A33/E33
- HC203R(B)T-A42/E42/A33/E33

[Unit: mm]



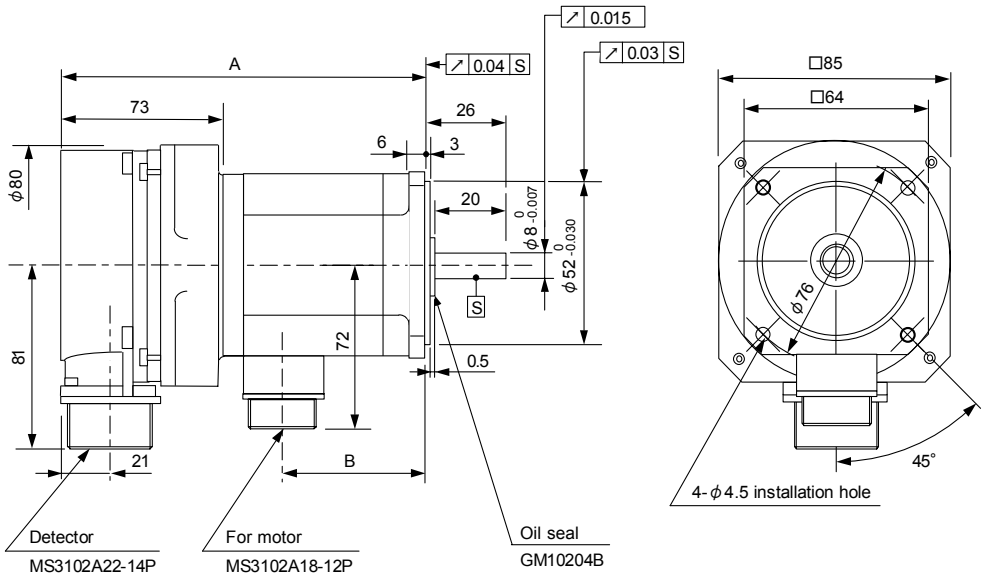


Servomotor type	L (Note 1)	KL
HC103R(B)	152 (189)	71
HC153R(B)	177 (214)	96
HC203R(B)	202 (239)	121

Note 1. The dimensions given in parentheses are for when magnetic brakes are provided.
Note 2. Use a friction coupling (Spun ring, etc.) to connect with the load.

- HA053NS(D5)-A42/E42/A33/E33
- HA13NS(D5)-A42/E42/A33/E33

[Unit: mm]

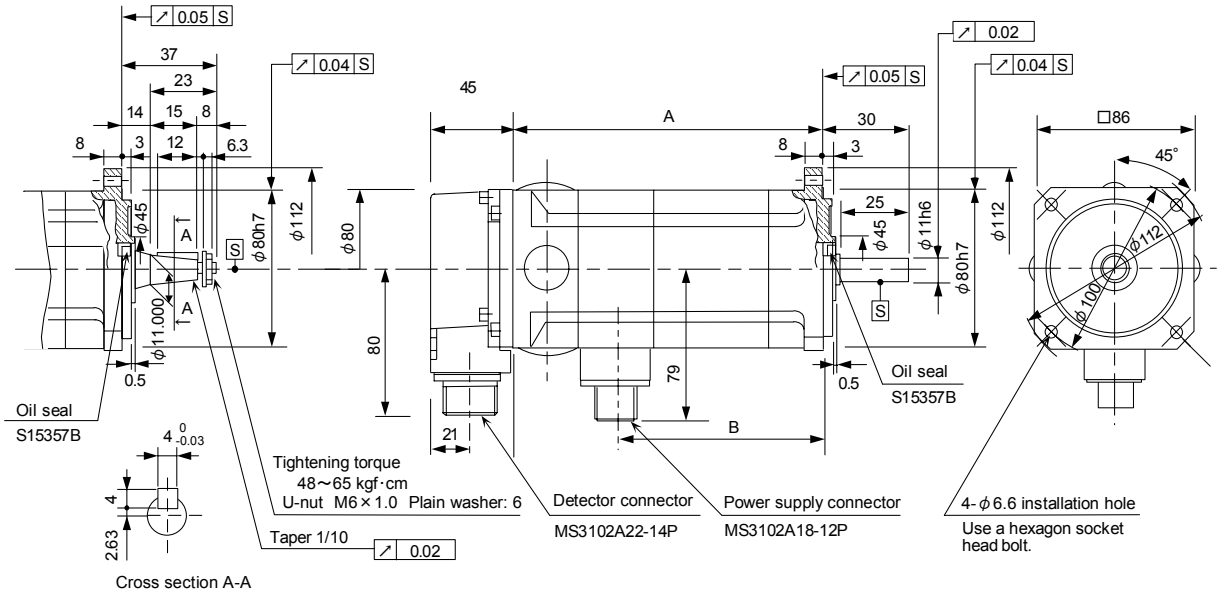


Servomotor type	A	B
HA053NS	139	43
HA13NS	156	60

Note 1. The dimensions do not differ between the incremental specifications and absolute value specifications.
Note 2. Install a cannon connector facing downward. This is effective for splash proofing.
Note 3. The wiring plug is an option.
Note 4. Taper axis specifications have not been prepared. Contact the nearest branch office/dealer for magnetic brake specifications.

- HA23NT(D5)-A42/E42/A33/E33
- HA33NT(D5)-A42/E42/A33/E33
- HA23NS(D5)-A42/E42/A33/E33
- HA33NS(D5)-A42/E42/A33/E33

[Unit: mm]

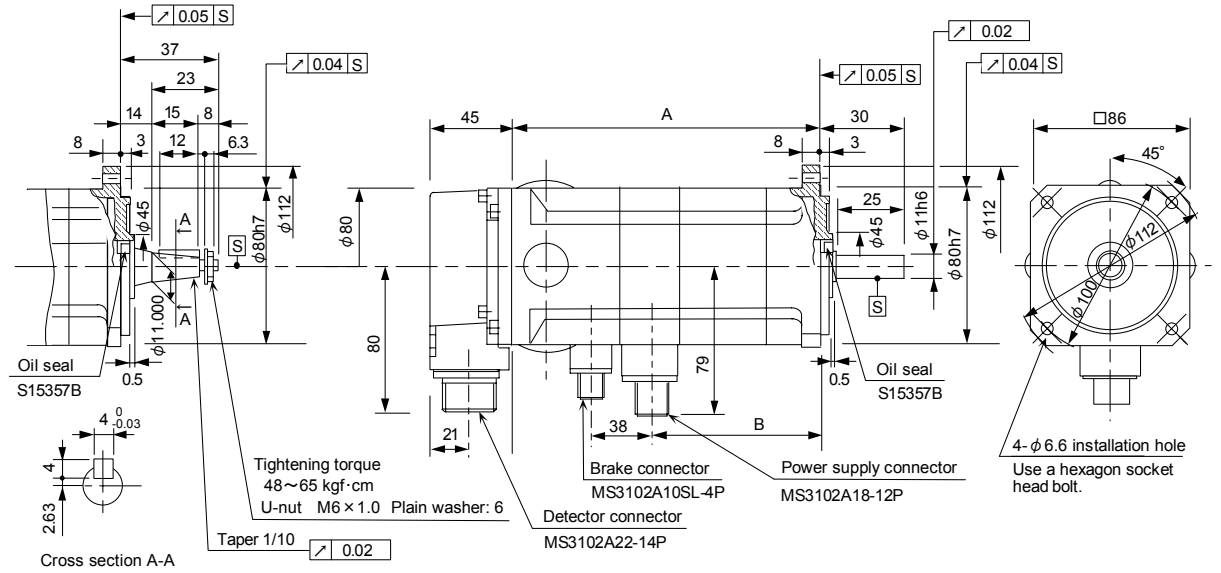


Servomotor type	A	B
HA23N	125	81
HA33N	155	111

Note 1. The dimensions do not differ between the incremental specifications and absolute value specifications.
Note 2. Install a cannon connector facing downward. This is effective for splash proofing.
Note 3. The wiring plug is an option.

- HA23NBT(D5)-A42/E42/A33/E33
- HA33NBT(D5)-A42/E42/A33/E33
- HA23NBS(D5)-A42/E42/A33/E33
- HA33NBS(D5)-A42/E42/A33/E33

[Unit: mm]

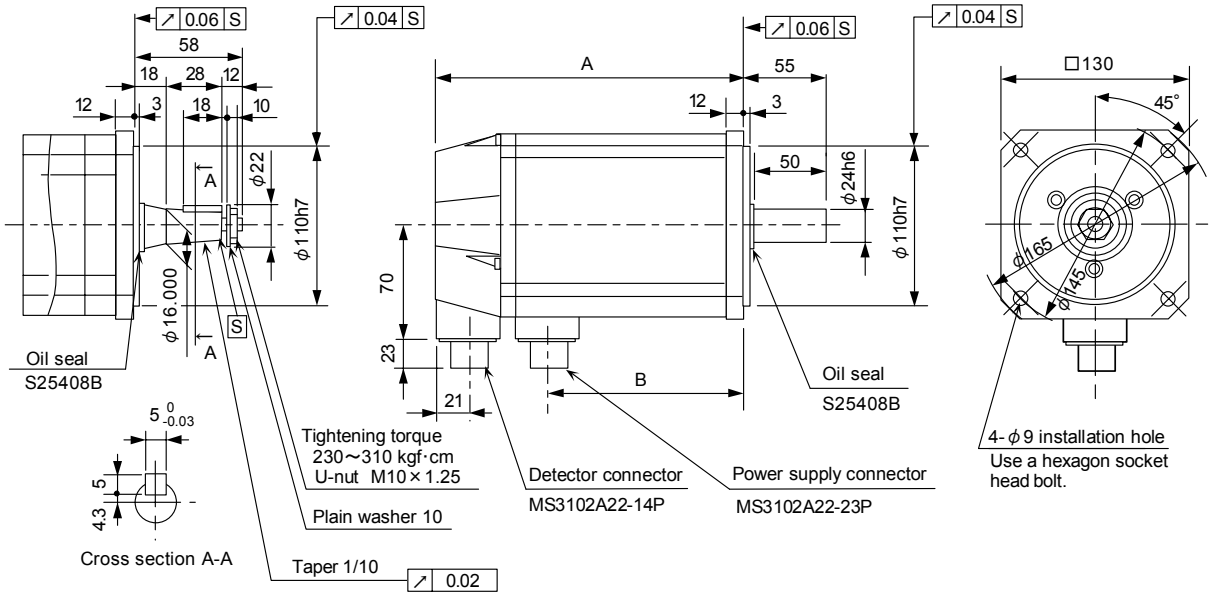


Servomotor type	A	B
HA23NB	162	81
HA33NB	192	111

Note 1. The dimensions do not differ between the incremental specifications and absolute value specifications.
Note 2. Install a cannon connector facing downward. This is effective for splash proofing.
Note 3. The wiring plug is an option.

- HA40N(B)T(D5)-A42/E42/A33/E33
- HA43N(B)T(D5)-A42/E42/A33/E33
- HA80N(B)T(D5)-A42/E42/A33/E33
- HA83N(B)T(D5)-A42/E42/A33/E33
- HA40N(B)S(D5)-A42/E42/A33/E33
- HA43N(B)S(D5)-A42/E42/A33/E33
- HA80N(B)S(D5)-A42/E42/A33/E33
- HA83N(B)S(D5)-A42/E42/A33/E33

[Unit: mm]

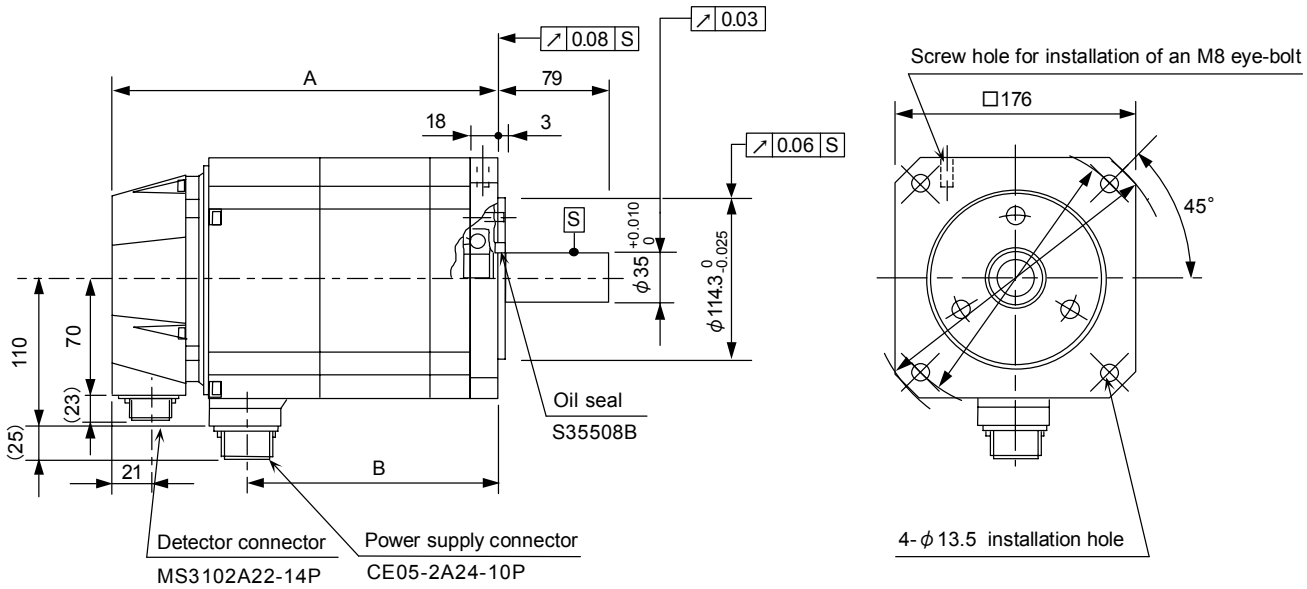


Servomotor type		A (Note 1)	B
2000r/min	3000r/min		
HA40N(B)	HA43N(B)	214 (270)	131
HA80N(B)	HA83N(B)	254 (310)	171

Note 1. The dimensions given in parentheses are for when magnetic brakes are provided.
Note 2. The dimensions do not differ between the incremental specifications and absolute value specifications.
Note 3. Install a cannon connector facing downward. This is effective for splash proofing.
Note 4. The wiring plug is an option.

- HA100NS(D5)-A42/E42/A33/E33
- HA200NS(D5)-A42/E42/A33/E33
- HA103NS(D5)-A42/E42/A33/E33

[Unit: mm]

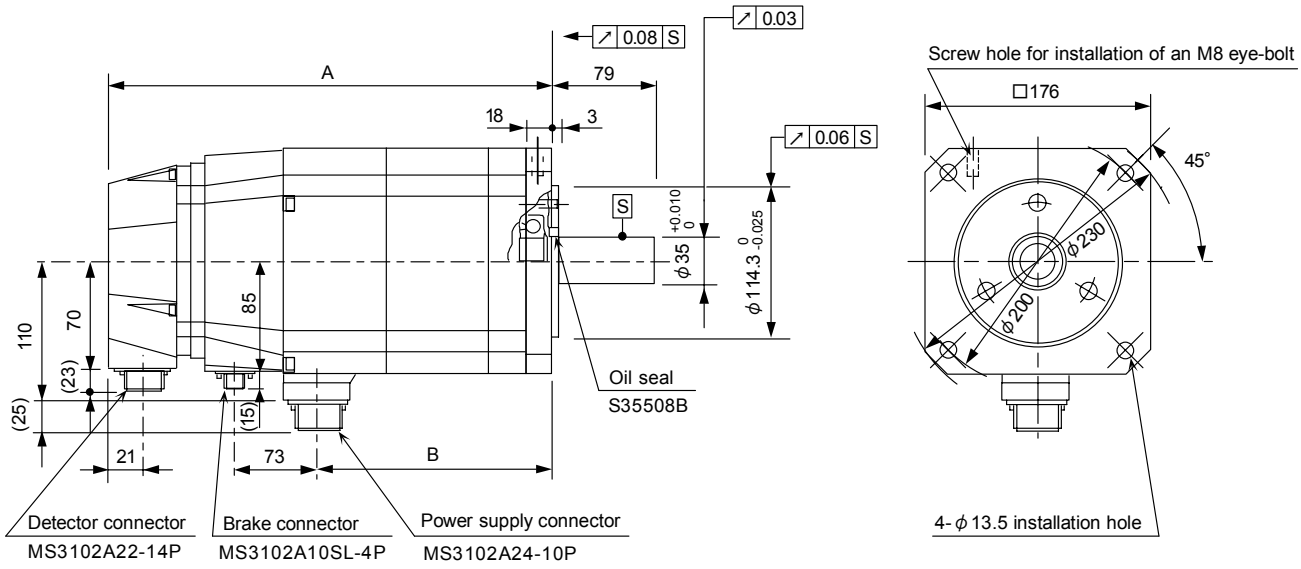


Servomotor type		A	B
2000r/min	3000r/min		
HA100NS	HA103NS	260	179
HA200NS		328	247

Note 1. The dimensions do not differ between the incremental specifications and absolute value specifications.
Note 2. Install a cannon connector facing downward. This is effective for splash proofing.
Note 3. The wiring plug is an option.

- HA100NBS(D5)-A42/E42/A33/E33
- HA200NBS(D5)-A42/E42/A33/E33
- HA103NBS(D5)-A42/E42/A33/E33

[Unit: mm]



Servomotor type		A	B
2000r/min	3000r/min		
HA100NBS	HA103NBS	336	179
HA200NBS		404	247

Note 1. The dimensions do not differ between the incremental specifications and absolute value specifications.
Note 2. Install a cannon connector facing downward. This is effective for splash proofing.
Note 3. The wiring plug is an option.

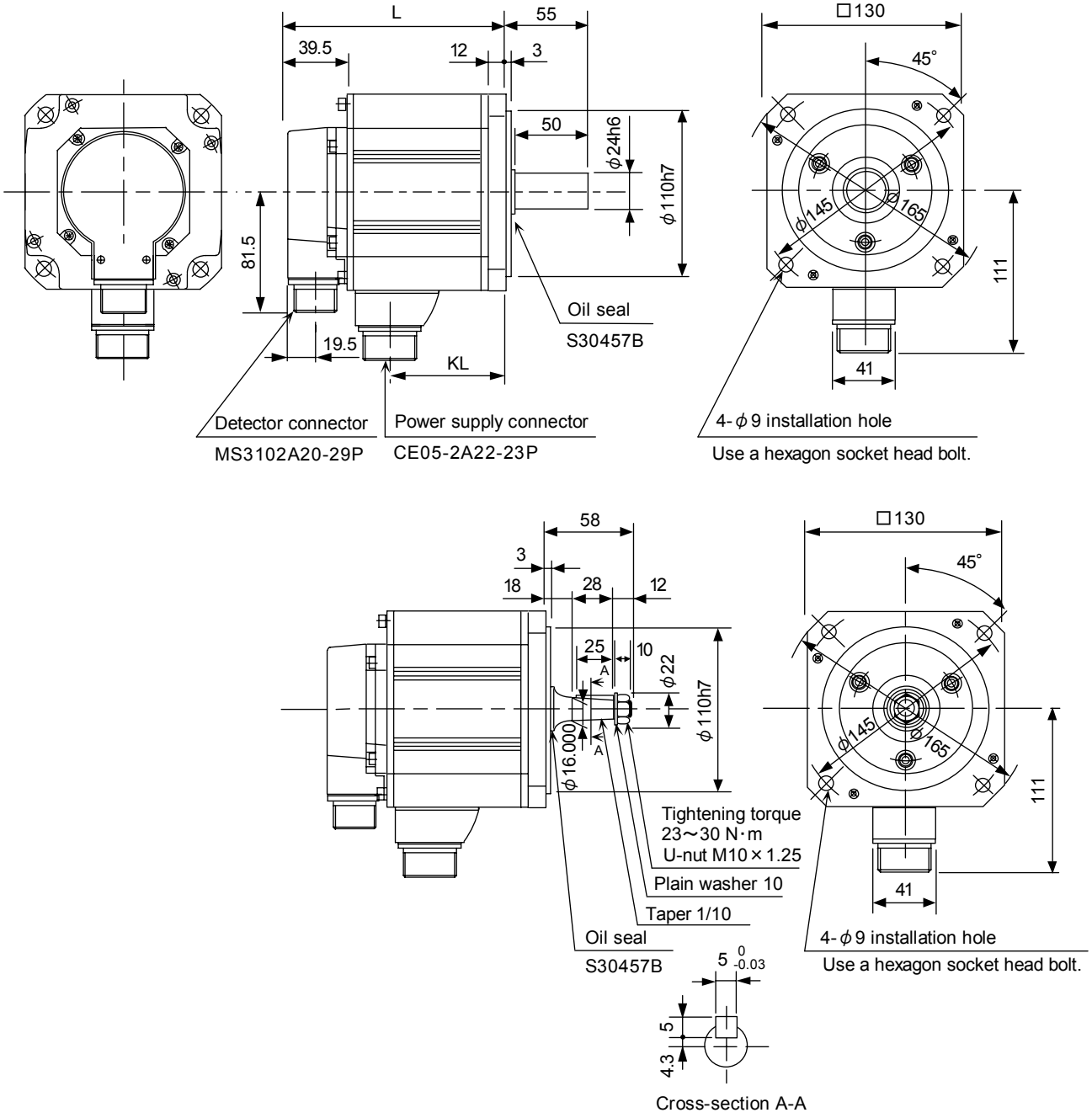
- HC-SF52(B)(K)
- HC-SF102(B)(K)
- HC-SF152(B)(K)

- HC-SF53(B)(K)
- HC-SF103(B)(K)
- HC-SF153(B)(K)

- HC-SF53(B)T
- HC-SF103(B)T
- HC-SF153(B)T

- HC-SF53(B)T
- HC-SF103(B)T
- HC-SF153(B)T

[Unit: mm]

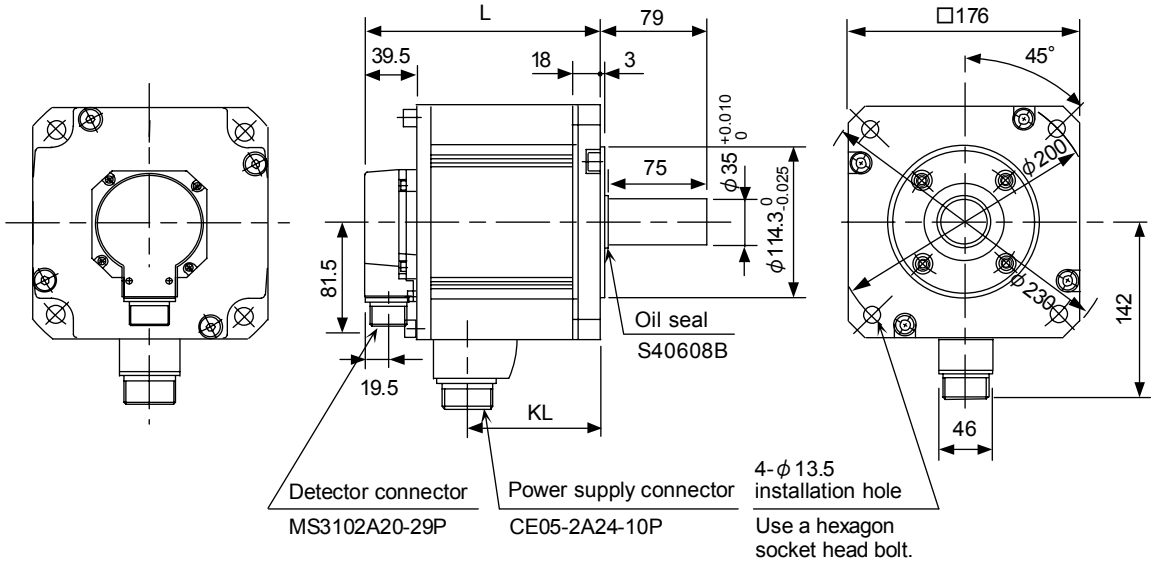


Servomotor type		L (Note 1)	KL
2000r/min	3000r/min		
HC-SF52(B)	HC-SF53(B)	120 (153)	51.5
HC-SF102(B)	HC-SF103(B)	145 (178)	76.5
HC-SF152(B)	HC-SF153(B)	170 (203)	101.5

Note 1. The dimensions given in parentheses are for when magnetic brakes are provided.
Note 2. Refer to section 10-2-4 for the dimension of K (keyway).

- HC-SF202(K)
- HC-SF203(K)
- HC-SF352(K)
- HC-SF353(K)

[Unit: mm]

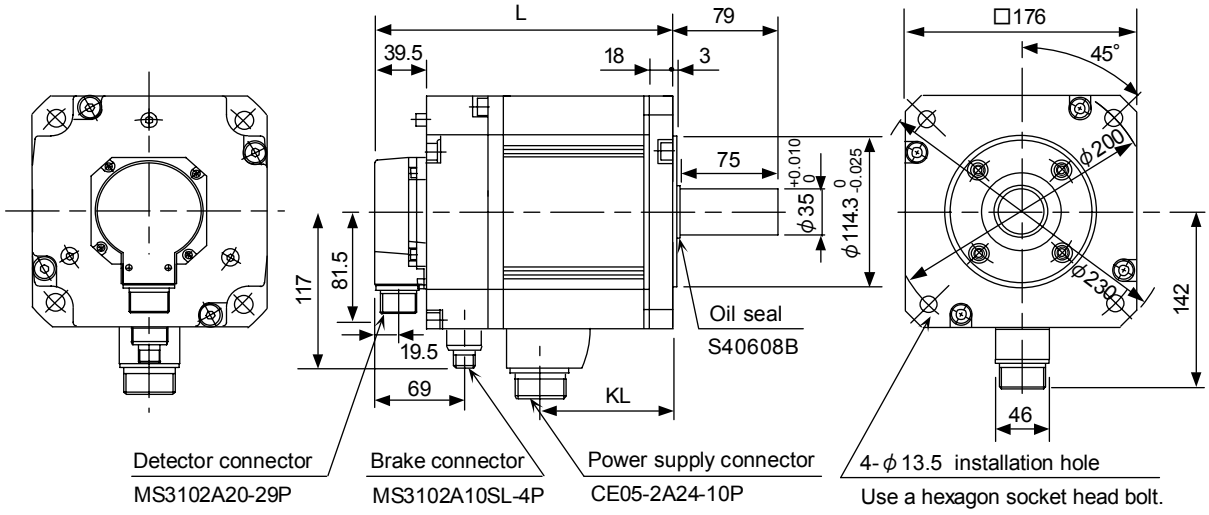


Servomotor type		L	KL
2000r/min	3000r/min		
HC-SF202	HC-SF203	145	68.5
HC-SF352	HC-SF353	187	110.5

Note 1. Refer to section 10-2-4 for the dimension of K (keyway).

- HC-SF202B(K)
- HC-SF203B(K)
- HC-SF352B(K)
- HC-SF353B(K)

[Unit: mm]



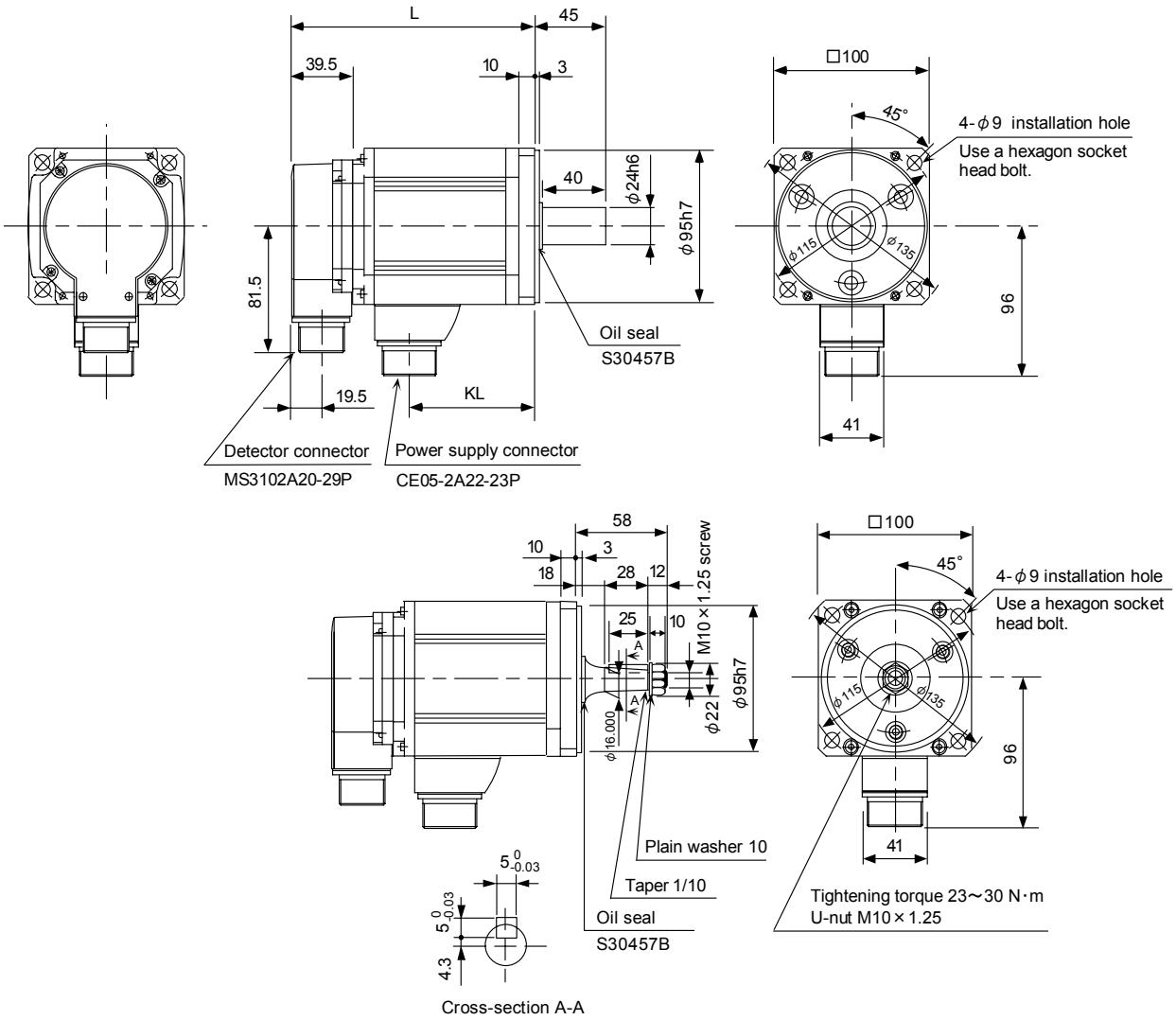
Servomotor type		L	KL
2000r/min	3000r/min		
HC-SF202B	HC-SF203B	193	68.5
HC-SF352B	HC-SF353B	235	110.5

Note 1. Refer to section 10-2-4 for the dimension of K (keyway).

- HC-RF103(B)(K)
- HC-RF153(B)(K)
- HC-RF203(B)(K)

- HC-RF103(B)T
- HC-RF153(B)T
- HC-RF203(B)T

[Unit: mm]

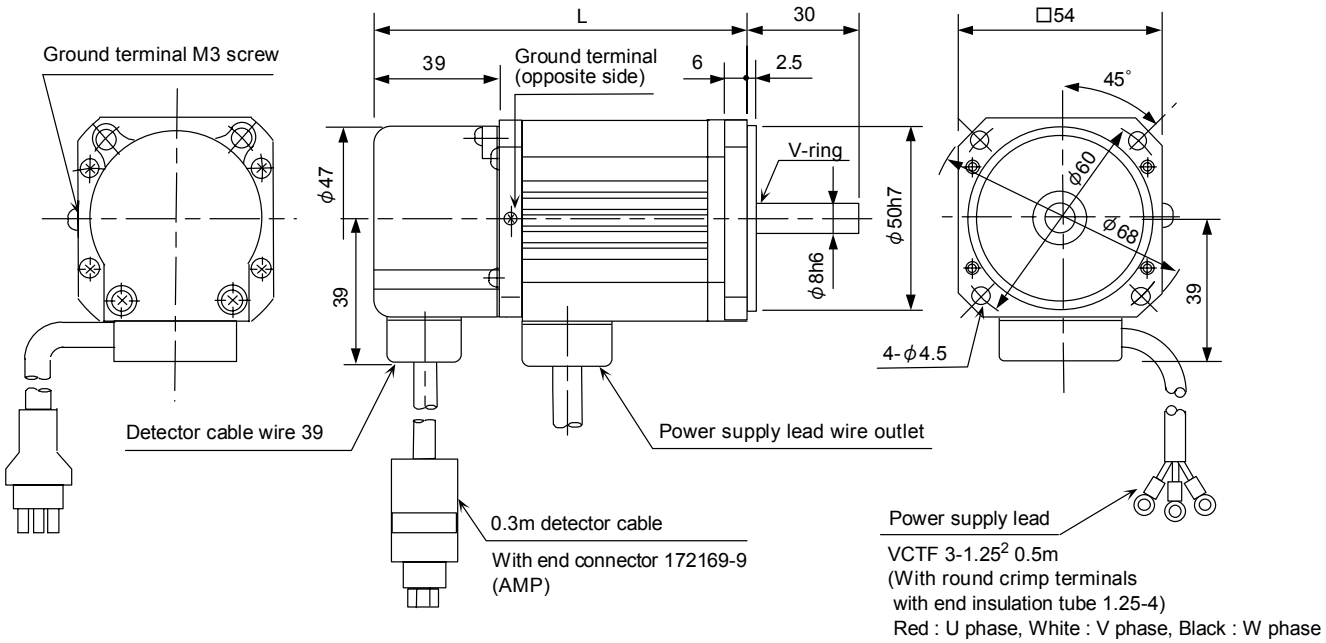


Servomotor type	L (Note 1)	KL
HC-RF103(B)	147(185)	71
HC-RF153(B)	172(210)	96
HC-RF203(B)	197(235)	121

Note 1. The dimensions given in parentheses are for when magnetic brakes are provided.
Note 2. Refer to section 10-2-4 for the dimension of K (keyway).

- HA-FF053(D)
- HA-FF13(D)

[Unit: mm]

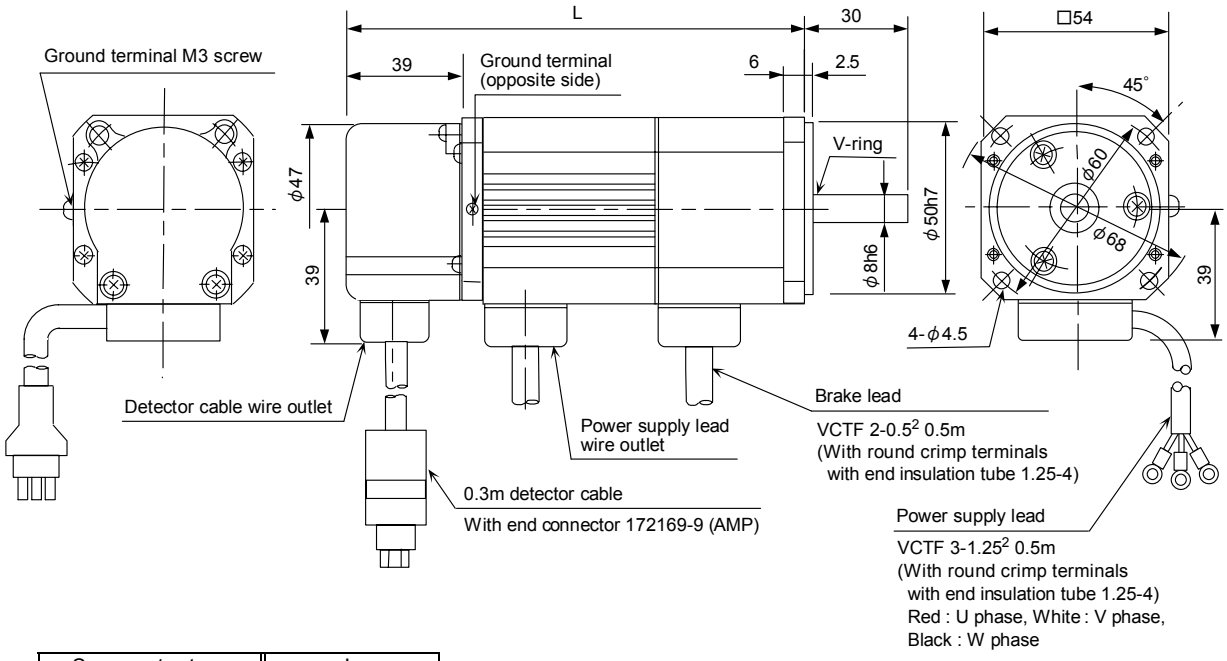


Servomotor type	L
HA-FF053	106
HA-FF13	123

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. Refer to section 10-2-4 for the dimension of D (D cut).

- HA-FF053B(D)
- HA-FF13B(D)

[Unit: mm]

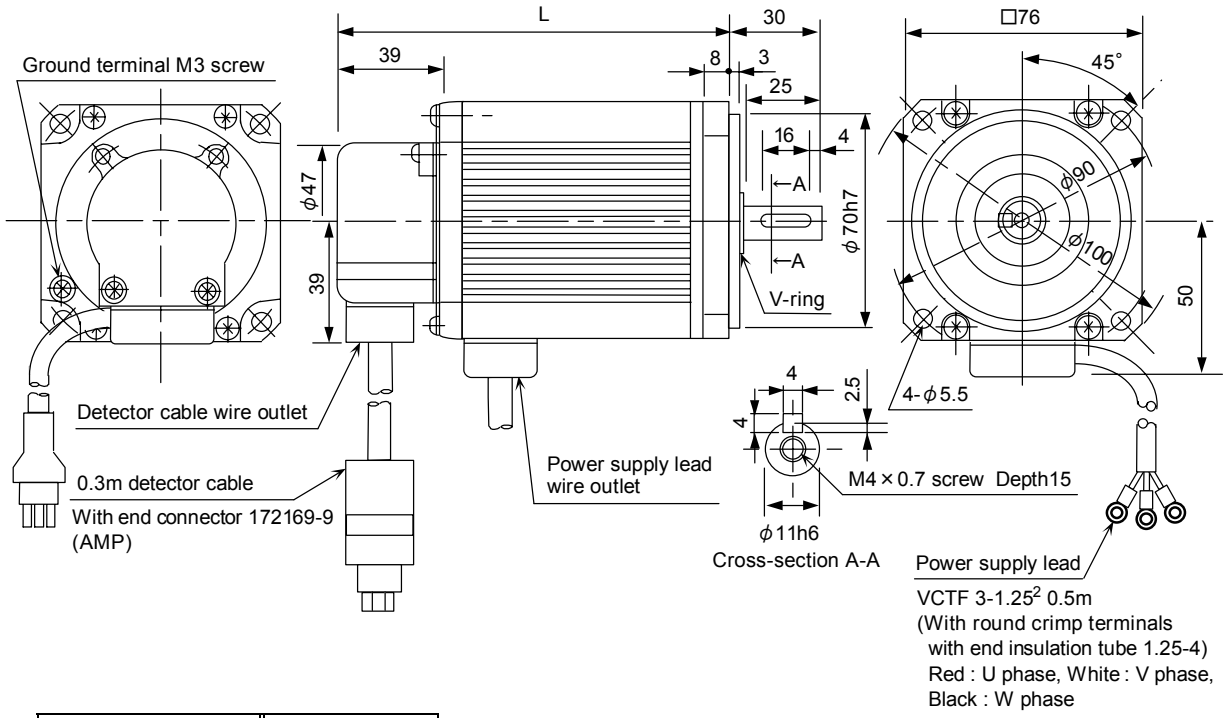


Servomotor type	L
HA-FF053B	141
HA-FF13B	158

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. Refer to section 10-2-4 for the dimension of D (D cut).

- HA-FF23
- HA-FF33

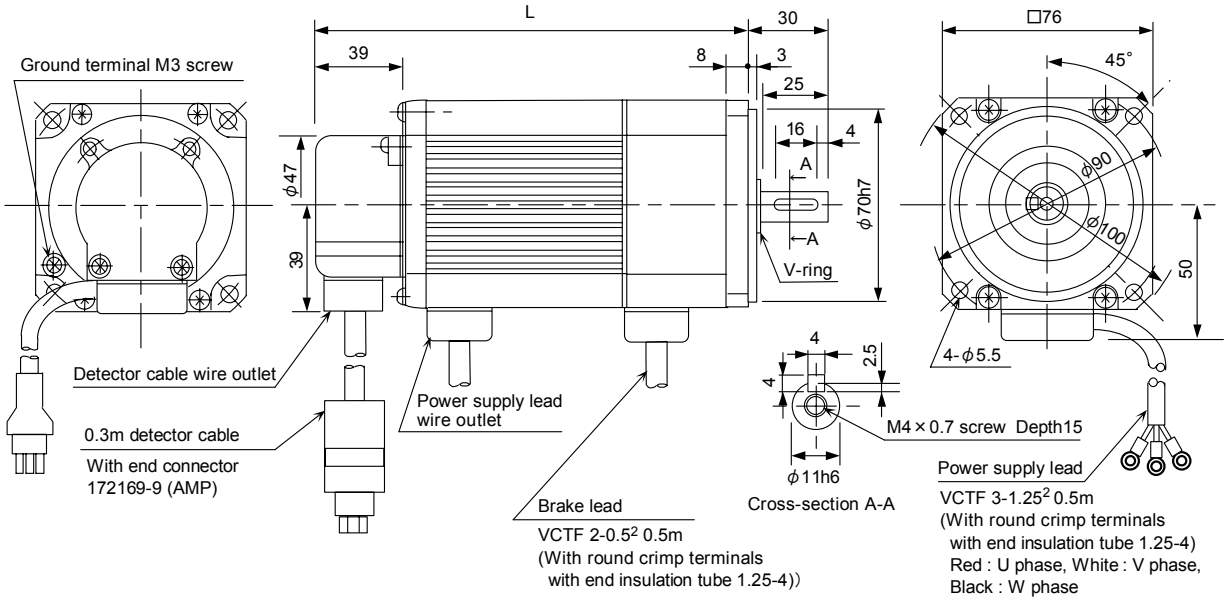
[Unit: mm]



Servomotor type	L
HA-FF23	130.5
HA-FF33	148

- HA-FF23B
- HA-FF33B

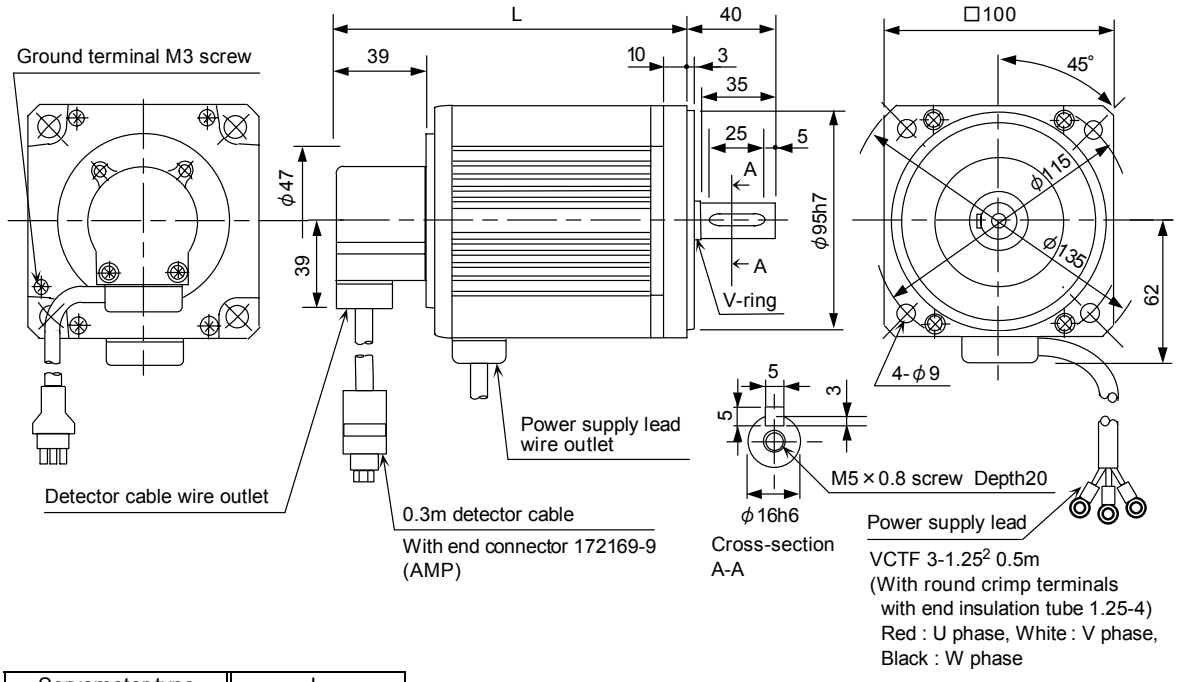
[Unit: mm]



Servomotor type	L
HA-FF23B	168
HA-FF33B	185.5

- HA-FF43
- HA-FF63

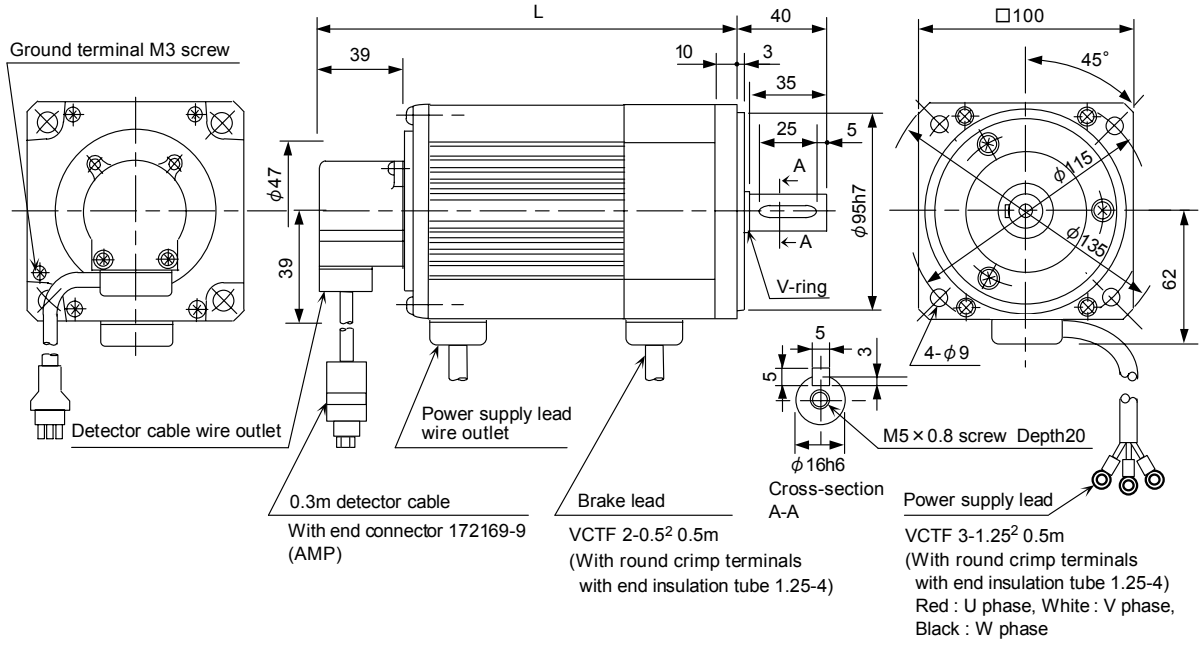
[Unit: mm]



Servomotor type	L
HA-FF43	154.5
HA-FF63	169.5

- HA-FF43B
- HA-FF63B

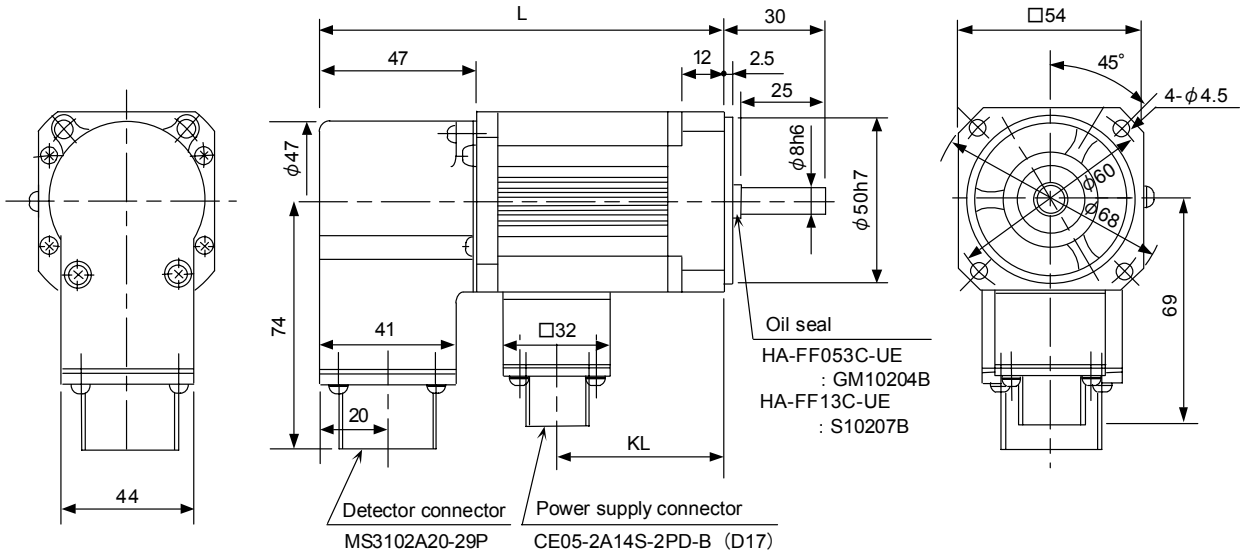
[Unit: mm]



Servomotor type	L
HA-FF43B	191.5
HA-FF63B	206.5

- HA-FF053C(D)-UE
- HA-FF13C(D)-UE

[Unit: mm]

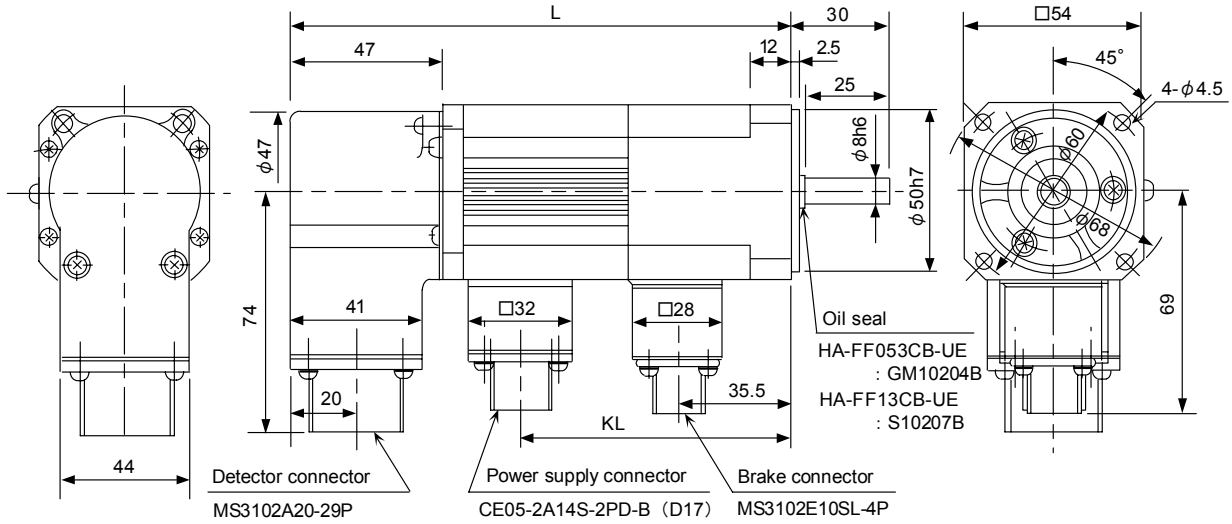


Servomotor type	L	KL
HA-FF053C-UE	120	49.5
HA-FF13C-UE	137	66.5

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. Refer to section 10-2-4 for the dimension of D (D cut).

- HA-FF053CB(D)-UE
- HA-FF13CB(D)-UE

[Unit: mm]

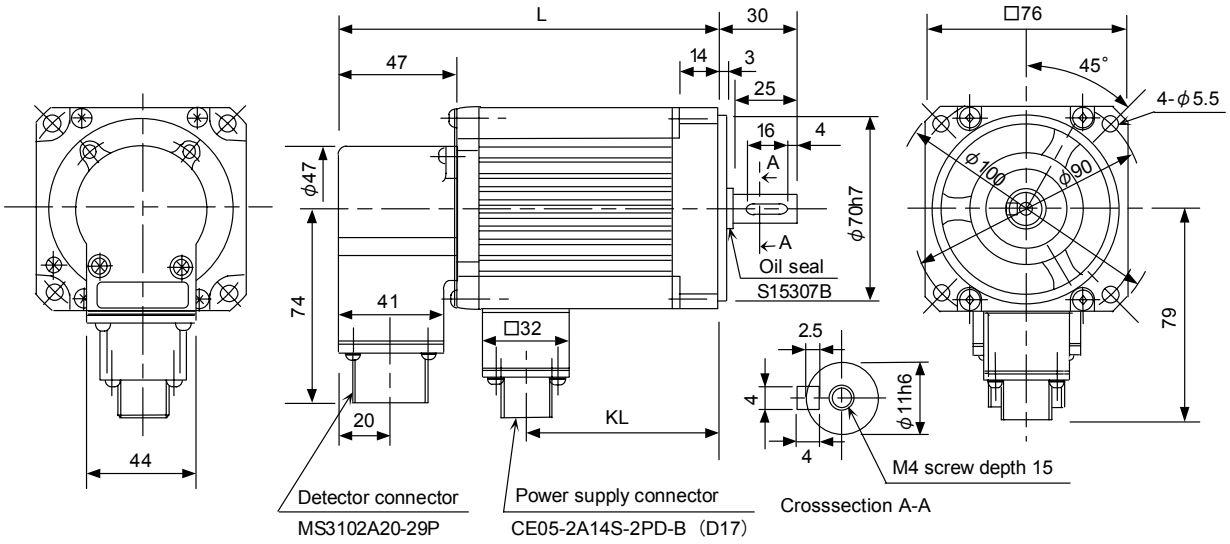


Servomotor type	L	KL
HA-FF053CB-UE	155	84
HA-FF13CB-UE	172	101

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. Refer to section 10-2-4 for the dimension of D (D cut).

- HA-FF23C-UE
- HA-FF33C-UE

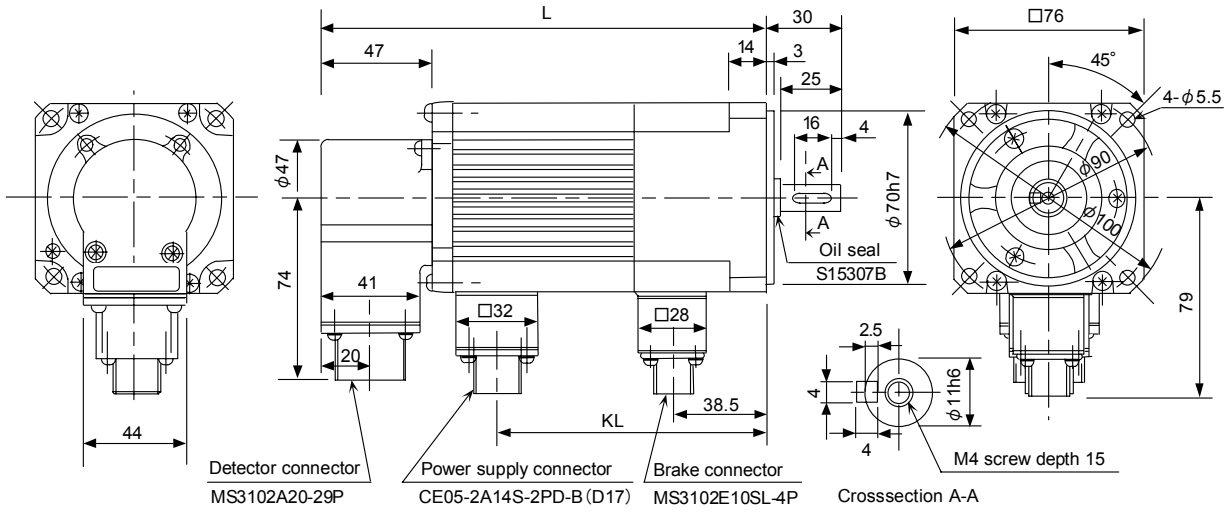
[Unit: mm]



Servomotor type	L	KL
HA-FF23C -UE	145	71.5
HA-FF33C -UE	162	89

- HA-FF23CB-UE
- HA-FF33CB-UE

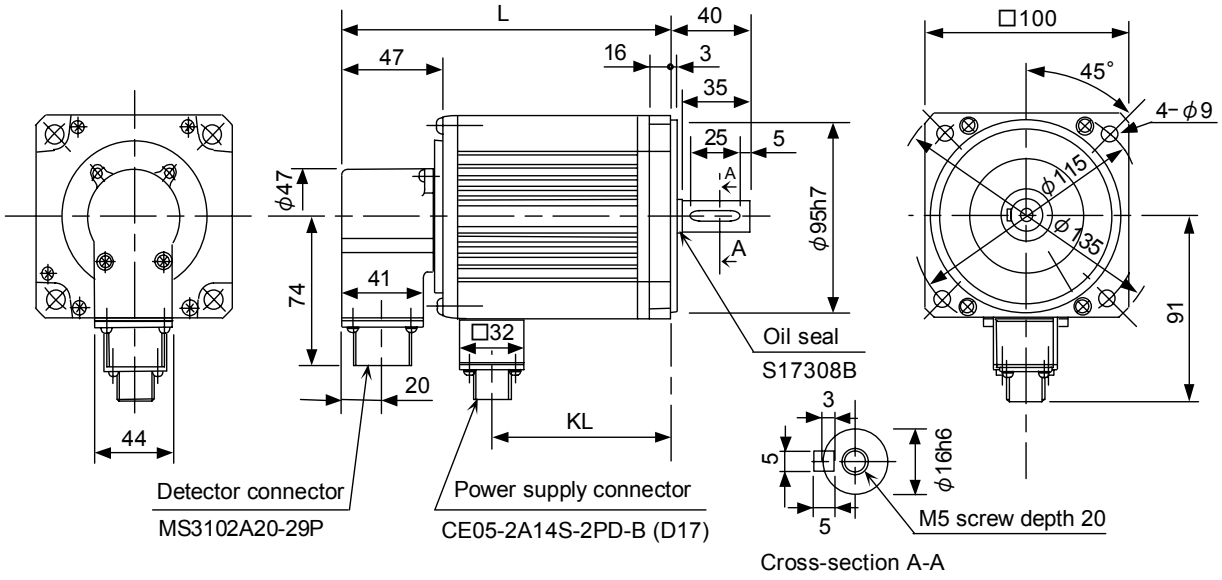
[Unit: mm]



Servomotor type	L	KL
HA-FF23CB-UE	182	109
HA-FF33CB-UE	200	127

- HA-FF43C-UE
- HA-FF63C-UE

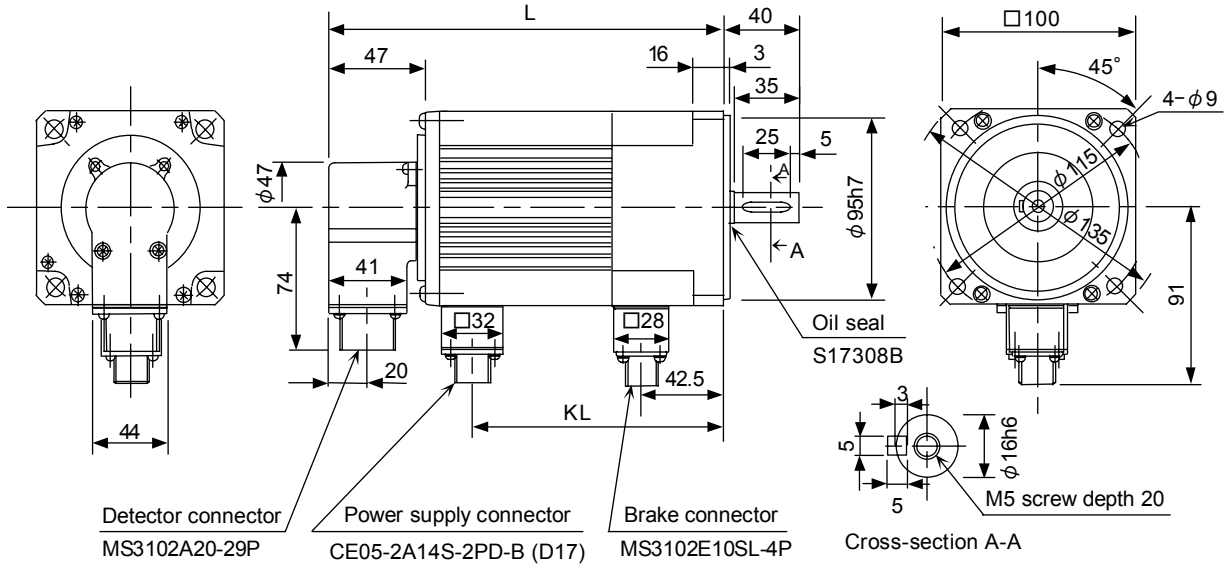
[Unit: mm]



Servomotor type	L	KL
HA-FF43C-UE	169	93
HA-FF63C-UE	184	108

- HA-FF43CB-UE
- HA-FF63CB-UE

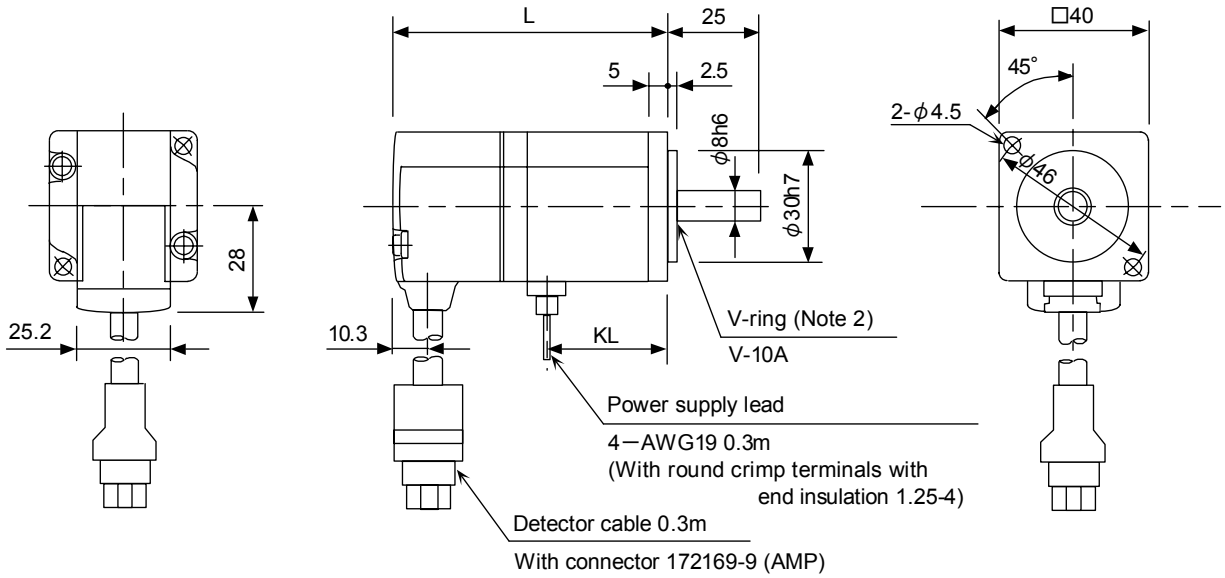
[Unit: mm]



Servomotor type	L	KL
HA-FF43CB-UE	206	130
HA-FF63CB-UE	221	145

- HC-MF053(D) (-UE)
- HC-MF13(D) (-UE)

[Unit: mm]

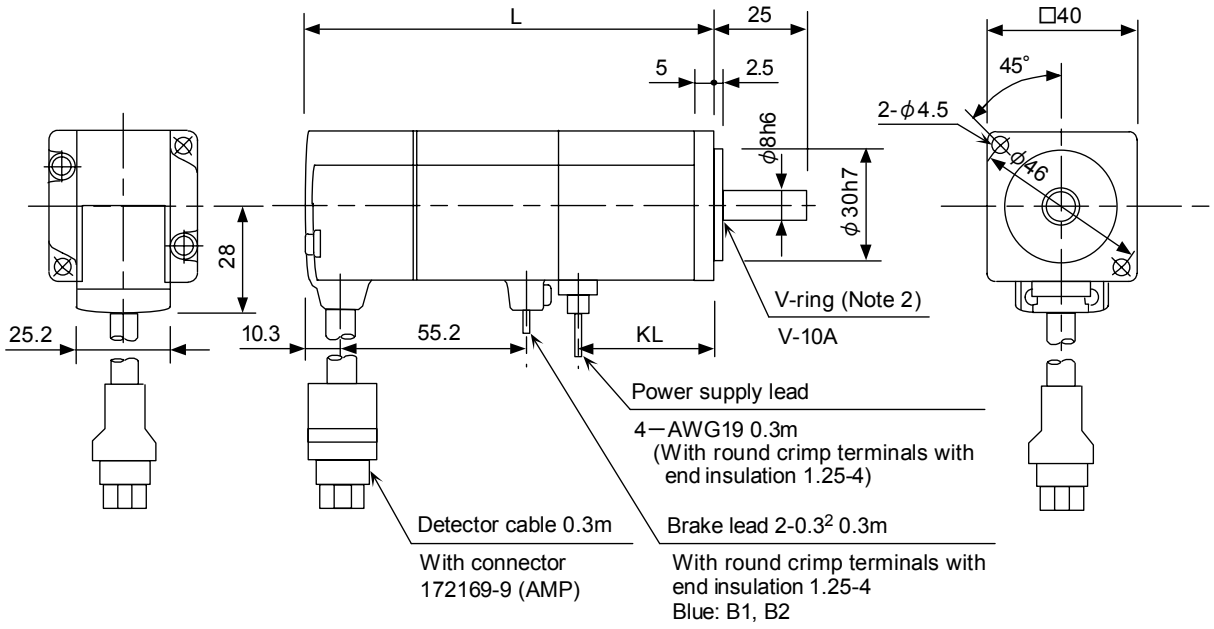


Servomotor type	L	KL
HC-MF053(-UE)	81.5 (89.5)	30.5 (38.5)
HC-MF13(-UE)	96.5 (104.5)	45.5 (53.5)

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. EN standard compatible motors (HC-MF053-UE, HC-MF13-UE) have a V-ring.
Note 3. Refer to section 10-2-4 for the dimension of D (D cut).

- HC-MF053B(D) (-UE)
- HC-MF13B(D) (-UE)

[Unit: mm]

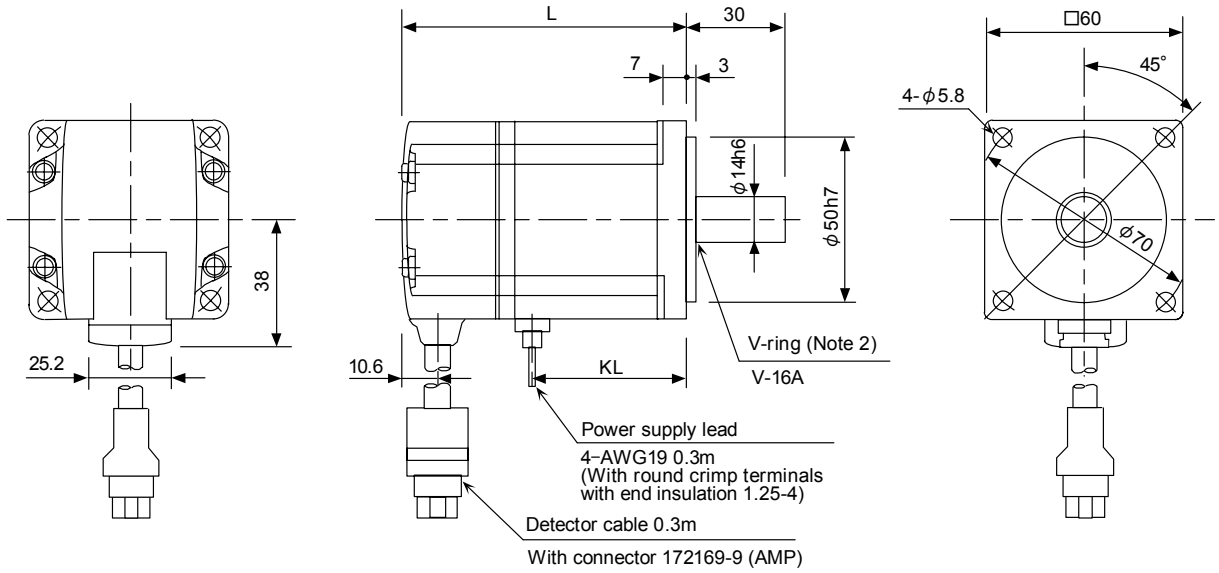


Servomotor type	L	KL
HC-MF053B(-UE)	109.5 (117.5)	30.5 (38.5)
HC-MF13B(-UE)	124.5 (132.5)	45.5 (53.5)

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. EN standard compatible motors (HC-MF053B-UE, HC-MF13B-UE) have a V-ring.
Note 3. Refer to section 10-2-4 for the dimension of D (D cut).

- HC-MF23(K) (-UE)
- HC-MF43(K) (-UE)

[Unit: mm]

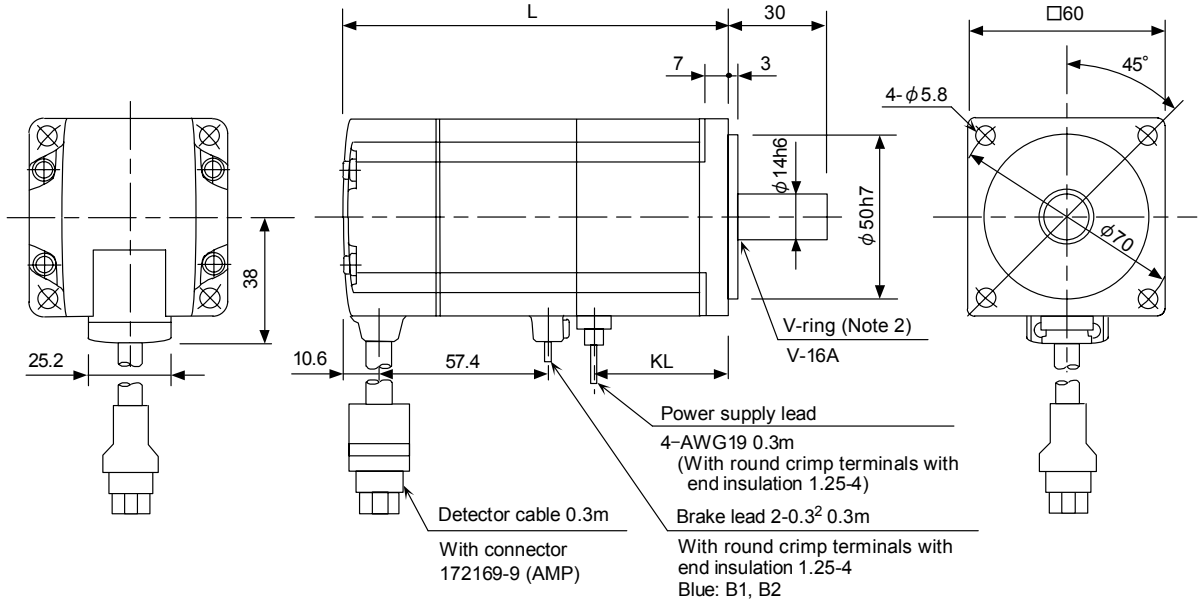


Servomotor type	L	KL
HC-MF23(-UE)	99.5 (108.5)	50 (59)
HC-MF43(-UE)	124.5 (133.5)	75 (84)

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. EN standard compatible motors (HC-MF23-UE, HC-MF43-UE) have a V-ring.
Note 3. Refer to section 10-2-4 for the dimension of D (D cut).

- HC-MF2B(K) (-UE)
- HC-MF43B(K) (-UE)

[Unit: mm]

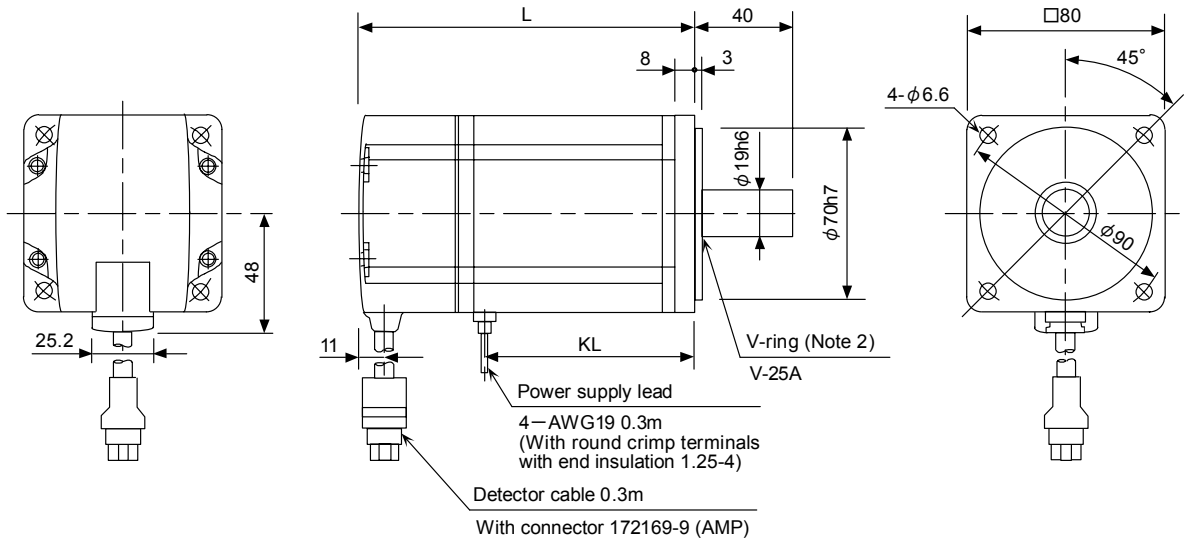


Servomotor type	L	KL
HC-MF23B(-UE)	131.5 (140.5)	50 (59)
HC-MF43B(-UE)	156.5 (165.5)	75 (84)

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. EN standard compatible motors (HC-MF23B-UE, HC-MF43B-UE) have a V-ring.
Note 3. Refer to section 10-2-4 for the dimension of D (D cut).

• HC-MF73(K)(-UE)

[Unit: mm]

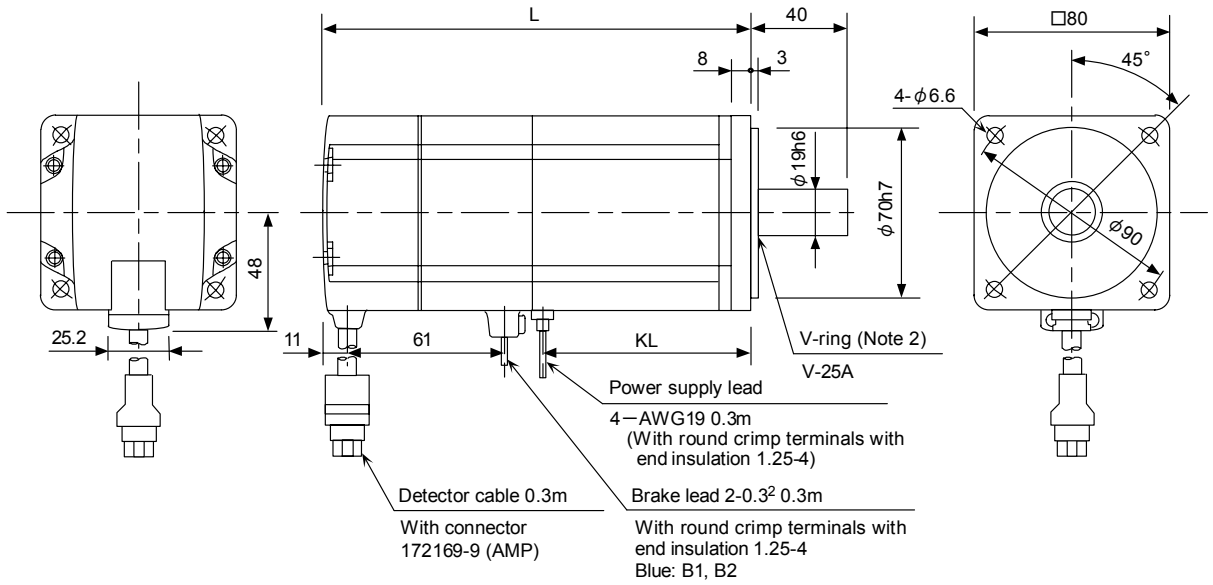


Servomotor type	L	KL
HC-MF73(-UE)	142 (150)	90 (98)

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. EN standard compatible motors (HC-MF73-UE) have a V-ring.
Note 3. Refer to section 10-2-4 for the dimension of D (D cut).

• HC-MF73B(K)(-UE)

[Unit: mm]

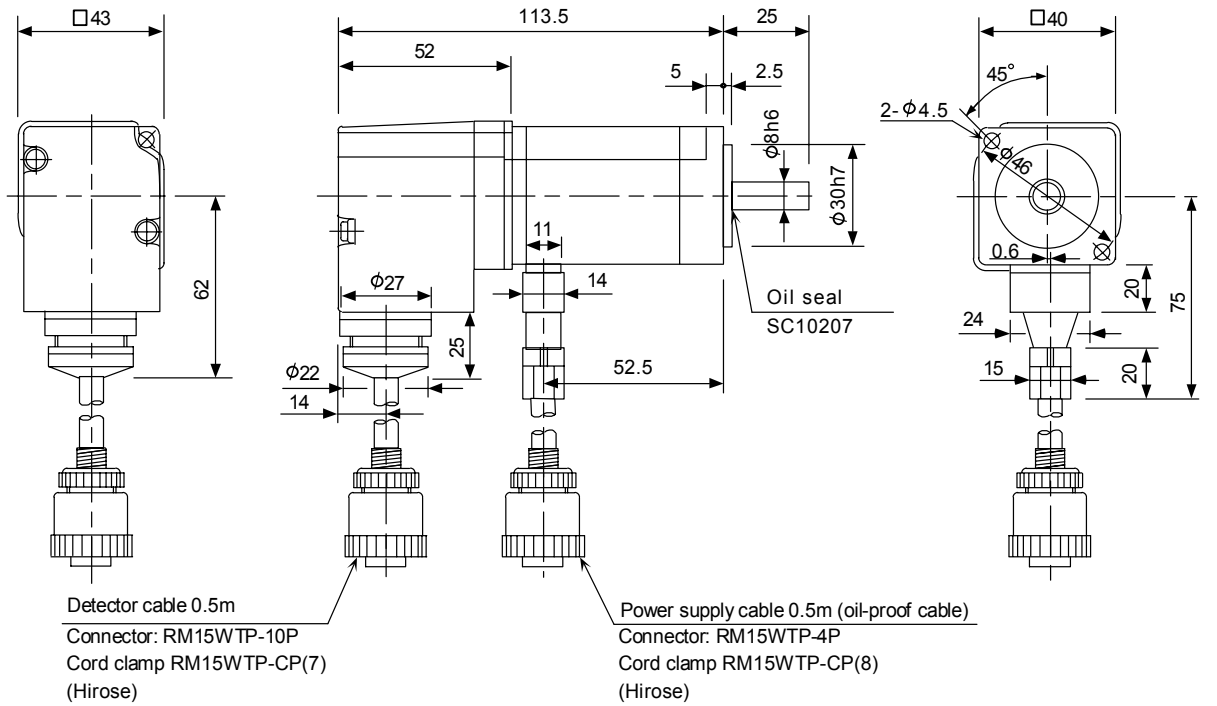


Servomotor type	L	KL
HC-MF73B(-UE)	177.5 (185.5)	90 (98)

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. EN standard compatible motors (HC-MF73B-UE) have a V-ring.
Note 3. Refer to section 10-2-4 for the dimension of D (D cut).

• HC-MF13(D)-S15

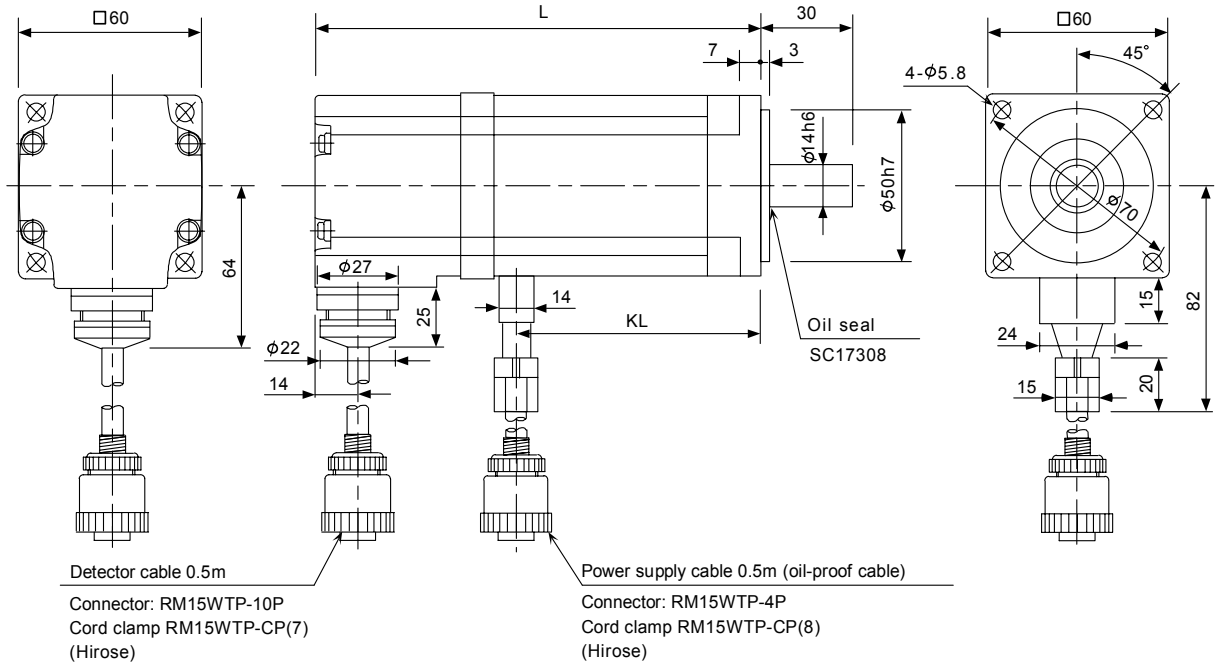
[Unit: mm]



Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. Refer to section 10-2-4 for the dimension of D (D cut).
Note 3. The magnetic brakes are special specifications. Contact Mitsubishi or your dealer for the specifications.

• HC-MF23(K)-S15
• HC-MF43(K)-S15

[Unit: mm]

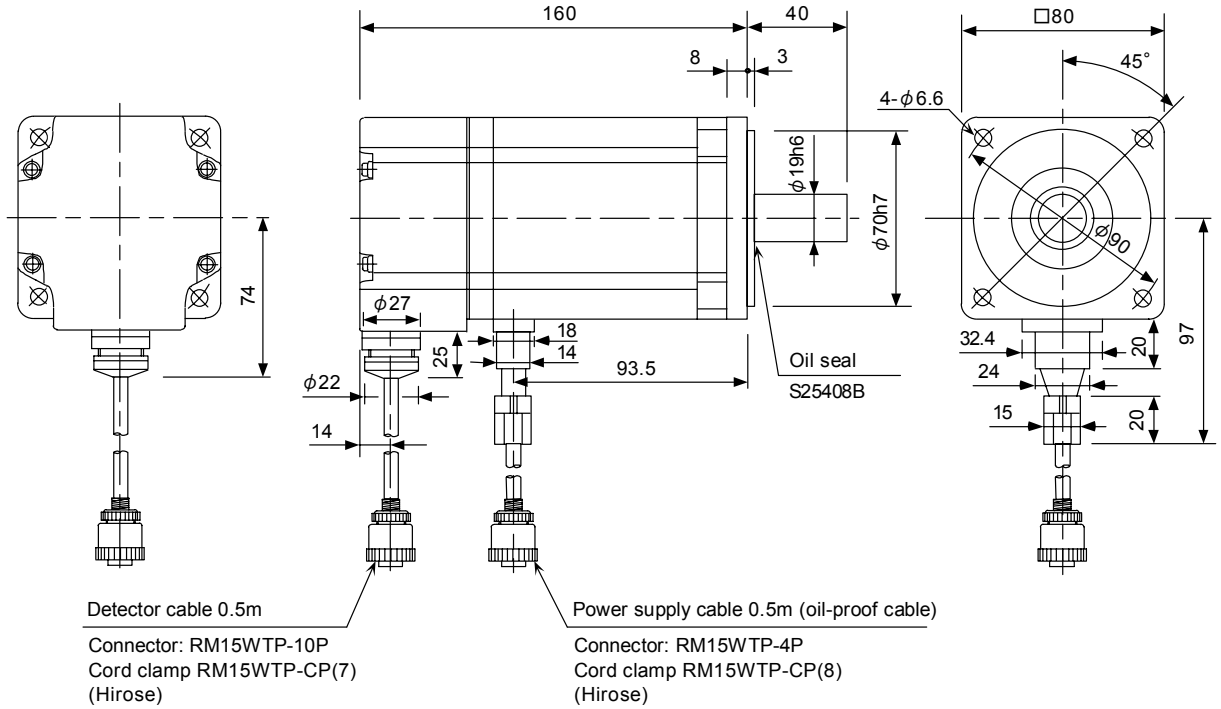


Servomotor type	L	KL
HC-MF23-S15	126.5	58
HC-MF43-S15	151.5	81

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. Refer to section 10-2-4 for the dimension of D (D cut).
Note 3. The magnetic brakes are special specifications. Contact Mitsubishi or your dealer for the specifications.

• HC-MF73(K)-S15

[Unit: mm]



Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. Refer to section 10-2-4 for the dimension of D (D cut).
Note 3. The magnetic brakes are special specifications. Contact Mitsubishi or your dealer for the specifications.

10-2-4 Special axis servomotor

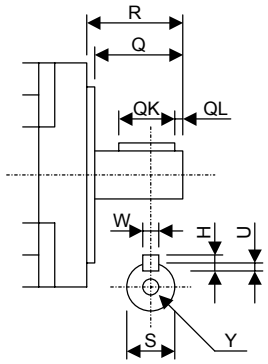
For the HC-SF, HC-RF, HA-FF and HC-MF Series motors, a key way shaft and a D cut shaft are available as special shaft shapes. However, the HA-FF23 to 63 uses the key way shaft as a standard. Note that these shapes may not apply to some motors. (Refer to the following tables.)

Servomotor type	Shaft shape	
	Key way	D cut
HC-MF053, 13	×	○
HC-MF23 ~ 73	**(Note 1)** ○	×
HA-FF053, 13	×	○
HA-FF23 ~ 63	**(Note 2)** ○	×

Servomotor type	Shaft shape	
	Key way	D cut
HC-SF52 ~ 352	○	×
HC-SF53 ~ 353	○	×
HC-RF103 ~ 203	○	×

(Note 1) With key.
(Note 2) With key as a standard. Refer to section "10-2-3 Outline dimensions drawings" for the shapes.

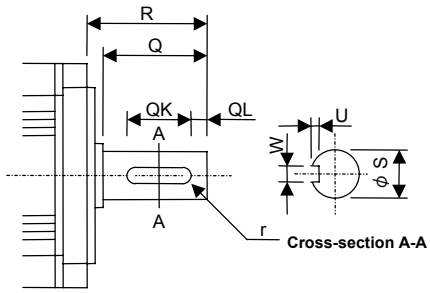
With key



Changed dimensions table (Unit: mm)

Servomotor type	Changed dimensions								
	S	R	Q	W	QK	QL	U	H	Y
HC-MF23K HC-MF43K	14h6	30	27	5	20	3	3	5	M4 × 0.7 Depth 15
HC-MF73K	19h6	40	37	6	25	5	3.5	6	M5 × 0.8 Depth 20

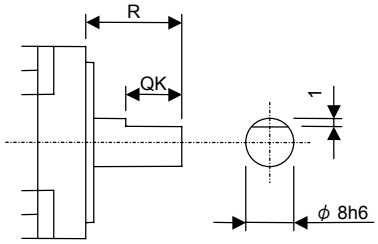
With key



Changed dimensions table (Unit: mm)

Servomotor type	Changed dimensions							
	S	R	Q	W	QK	QL	U	r
HC-SF52K ~ 152K HC-SF53K ~ 153K	24h6	55	50	$8^{0}_{-0.036}$	36	5	$4^{+0.2}_{0}$	4
HC-SF202K ~ 352K HC-SF203K ~ 353K	$35^{+0.01}_{0}$	79	–	$10^{0}_{-0.036}$	55	5	$5^{+0.2}_{0}$	5
HC-RF103K ~ 203K	24h6	45	40	$8^{0}_{-0.036}$	25	5	$4^{+0.2}_{0}$	4

D cut



Changed dimensions table (Unit: mm)

Servomotor type	Changed dimensions	
	R	QK
HC-MF053D, 13D	25	20.5
HA-FF053D, 13D	30	25.5

Chapter 11 Selection

11-1 Outline

11-1-1 Servomotor

It important to select a servomotor matched to the purpose of the machine that will be installed. If the servomotor and machine to be installed do not match, the motor performance cannot be fully realized, and it will also be difficult to adjust the parameters. Be sure to understand the servomotor characteristics in this chapter to select the correct motor.

(1) Motor inertia

The servomotor series is mainly categorized according to the motor inertia size. The features in Table 11-1 are provided according to the motor inertia size.

Table 11-1 Motor inertia

Motor model	Medium inertia motor	Low inertia motor
Motor type	HC□, HA□N, HC-SF	HC□R, HC-RF, HA-FF, HC-MF
Inertia	The flange size is large. The inertia is comparatively large.	The flange size is small. The inertia is small.
Acceleration/deceleration	The acceleration/deceleration time constant does not change much even for a low inertia load. The effect of the motor inertia is large.	Acceleration/deceleration is possible with a short time constant in respect to low inertia loads. The effect of the motor inertia is small.
Installation	The motor size in respect to the output capacity is large, and the installation space is large.	The motor size in respect to the output capacity is small, and the installation space is smaller.
Disturbance characteristics	The effect of disturbance is small.	The effect of disturbance is large.
Speed fluctuation	The effect of the torque ripple and cogging torque is small, and speed fluctuation does not occur easily.	The effect of the torque ripple and cogging torque is large, and speed fluctuation occurs easily.
Suitability	Suitable for high precision interpolation control	Suitable for high speed high frequency positioning

Select a medium inertia motor when interpolation precision is required, or for machines having a large load inertia. Select a low inertia motor when a shorter positioning time is required by machines having a small amount of inertia. In general, use HC□ and HA□N motors for axis control of machine tools, and use HC□R, HC-SF, HC-RF, HA-FF and HC-MF motors for machine tool auxiliary axes, peripheral axes, and general industrial machine positioning.
The servomotor has an optimum load inertia scale. If the load inertia exceeds the optimum range, the control becomes unstable and the servo parameters become difficult to adjust. When the load inertia is too large, decelerate with the gears (The motor axis conversion load inertia is proportional to the square of the deceleration ratio.), or change to a motor with a large inertia.

POINT

The HC-MF motor has the lowest inertia. This series pursues low inertia motor performance. To realize the proper acceleration/deceleration performance of the low inertia motor, set the load inertia to within five times of the motor inertia. If the load inertia ratio increases, the control stability will deteriorate, and in the end the positioning will take longer.

(2) Rated speed

Even with motors having the same capacity, the rated speed will differ according to the motor. The motor's rated output is designed to be generated at the rated speed, and the output P (W) is expressed with expression (11-1). Thus, even when the motors have the same capacity, the rated torque will differ according to the rated speed.

$$P = 2\pi NT \ (W) \quad \text{.....} \quad (11\text{-}1)$$

N : Motor speed (1/sec)
T : Output torque (N·m)

In other words, even with motors having the same capacities, the one with the lower rated speed will generate a larger torque. When actually mounted on the machine, if the positioning distance is short and the motor cannot reach the maximum speed, the motor with the lower rated speed will have a shorter positioning time. When selecting the motor, consider the axis stroke and usage methods, and select the motor with the optimum rated speed.
If the maximum speed is larger than the rated speed, such as with the HC-SF, HC-RF, HA-FF or HC-MF, the continuous characteristic torque over the rated speed will be lower than the rated torque due to the relation of the expression above.

11-1-2 Regeneration methods

When the servomotor decelerates, rotating load inertia or the operation energy of the moving object is returned to the servo amplifier through the servomotor as electrical power. This is called "regeneration". The three general methods of processing regeneration energy are shown below.

Table 11-2 Servo amplifier regeneration methods

Regeneration method	Explanation
1. Condenser regeneration method	This is a regeneration method for small-capacity amplifiers. The regeneration energy is charged to the condenser in the amplifier, and this energy is used during the next acceleration. The regeneration capacity decreases as the power supply voltage becomes higher.
2. Resistance regeneration method	If the condenser voltage rises too high when regenerating with the condenser only, the regenerative electrical power is consumed using the resistance. If the regeneration energy is small, it will only be charged to the condenser. Because regeneration energy becomes heat due to resistance, heat radiation must be considered. In large capacity servo amplifiers the regenerative resistance becomes large and this is not practical.
3. Power supply regeneration method	This is a method to return the regeneration energy to the power supply. The regeneration energy does not become heat as in regenerative resistance. (Heat is generated due to regeneration efficiency problems.) The circuit becomes complicated, but in large capacity servo amplifiers having large regeneration capacity this method is more advantageous than resistance regeneration.

The condenser regeneration method and resistance regeneration method are used in the MDS-B-SVJ2. For amplifiers (SVJ2-03 and higher) driving motors of 200W or more, the regenerative resistor is mounted in the amplifier as a standard. If the regenerative capacity becomes large, an option regenerative resistor is connected externally to the amplifier. (Combined use with the built-in resistor is not possible.)
When the power supply regeneration method is used, consider using the MDS-C1-V1/V2 + MDS-C1-CV Series.

POINT The MDS-B-SVJ2-01 (100W) uses condenser regeneration as a standard. A built-in regenerative resistor is not mounted.

11-2 Selection of servomotor series

11-2-1 Motor series characteristics

The servomotor series is categorized according to purpose, motor inertia size, and detector resolution. Select the motor series that matches the purpose of the machine to be installed.

Table 11-3 Motor series characteristics

Motor series	Capacity (rated speed)	Detector resolution	Characteristics
HC□	0.5 to 3.5kW (2000r/min) 0.5 to 2.0kW (3000r/min)	100000p/rev/ 25000p/rev	This is a motor for NC unit machine tool feed axes. It has smooth torque characteristics and is compatible to high resolution detectors. It has the same shaft shape and flange size as conventional HA motors (HA□N), but with shorter L dimensions and an easier to use design. It is drip-proofed against cutting oil entering the unit, and it clears IP65 specifications for environmental resistance performance as a standard. (There is also IP67 specifications.)
HC□R	1.0 to 2.0kW (3000r/min)	100000p/rev/ 25000p/rev	This is the standard HC motor made into a low inertia motor. It has a high output, compact design, and is suitable for high speed driving of light loads such as loaders. The motor itself is common with the HC-RF Series, but the detector has been made common for feed axes. It is drip-proofed against cutting oil entering the unit, and it clears IP65 specifications for environmental resistance performance as a standard.
HA□N	0.5 to 3.5kW (2000r/min) 50W to 2.0kW (3000r/min)	100000p/rev/ 25000p/rev	This is a motor for conventional NC unit machine tool feed axes. Amplifiers can be replaced without replacing the motor by substituting with older model MDS-A-SVJ Series. Give priority to and select the HC motor to newly use motors for NC unit machine tool feed axes. However, for 50W to 450W motors, select the HA motor as conventionally.
HC-SF	0.5 to 3.5kW (2000r/min) 0.5 to 3.5kW (3000r/min)	16384p/rev	This is a motor for medium inertia machine tool peripheral axes. It is suitable for comparatively heavy load positioning such as for pallet changers, etc. It is drip-proofed against cutting oil entering the unit, and it clears IP65 specifications for environmental resistance performance. This motor can also be used with the servo amplifier MR-J2-CT for miscellaneous axes.
HC-RF	1.0 to 2.0kW (3000r/min)	16384p/rev	This is a motor for low inertia machine tool peripheral axes. It has a high output, compact design, and is suitable for high speed driving of light loads such as loaders. It is drip-proofed against cutting oil entering the unit, and it clears IP65 specifications for environmental resistance performance. This motor can also be used with the servo amplifier MR-J2-CT for miscellaneous axes.
HA-FF	50 to 600W (3000r/min)	8192p/rev	This is a motor for low inertia machine tool peripheral axes. It is suitable for high speed positioning of light loads such as for tool changers and turrets. The HA-FF□C-UE Series with canon plug specifications wiring is also available. This motor can also be used with the servo amplifier MR-J2-CT for miscellaneous axes.
HC-MF	50 to 750W (3000r/min)	8192p/rev	This is a motor for ultra-low inertia machine tool peripheral axes. It is suitable for ultra-high speed positioning of light loads such as high speed arms and machine end sections. A molded structure using high heat conducting resin is utilized to realize a high output motor with a compact design. The motor characteristics can be realized even further and the positioning time shortened by making the load inertia ratio smaller. This motor can also be used with the servo amplifier MR-J2-CT for miscellaneous axes.

11-2-2 Servomotor precision

The control precision of the servomotor is determined by the detector resolution, motor characteristics and parameter adjustment. This section examines the following four types of servomotor control precision when the servo parameters are adjusted. When selecting a servo, confirm that these types of precision satisfy the machine specifications before determining the servomotor series.

(1) Theoretic precision: $\Delta\varepsilon$

This value is determined by the motor detector precision, and is the value obtained by dividing the movement amount (ΔS) per motor rotation by the detector resolution (RNG).

(2) Positioning precision : $\Delta\varepsilon p$

This is the precision outline that affects the machine targeted for positioning, and expresses the machine's positioning precision.

When the motor is a single unit, this is determined by the detector resolution and matches with the theoretic precision $\Delta\varepsilon$p. When the motor is actually installed on a machine, the positioning precision $\Delta\varepsilon$p becomes 1 to 2 times the theoretic precision $\Delta\varepsilon$. This is due to the effect on the motor control by the machine rigidity, etc. Furthermore, the value to which the error from the motor shaft to the machine end is added becomes the actual machine end positioning precision. For machines requiring accurate positioning precision at the machine end, use the MDS-C1-V1/V2 Series servo amplifier capable of scale feedback input.

(3) Surface precision during machining : $\Delta\varepsilon v$

This is the precision outline that affects the machine tools, etc., which are important factors in the machine operation path and interpolation functions. It also affects the surface roughness of the machining surface. The machining surface roughness is affected by elements caused by the motor's electrical characteristics (torque ripple, etc.) and mechanical characteristics (cogging torque, etc.). In the NC unit feed axis motor (HC□, HA□N) those torque characteristics are excellent, and higher precision machining is possible than that of other motors. Because the effects of torque ripple and cogging torque are relatively smaller in motors with large amounts of inertia, the motor with the larger inertia of two identical capacity motors will be more advantageous for surface precision. Due to the effects of differences in characteristics of the motor itself, the surface precision during machining will differ greatly according to the motor series.

(4) Absolute position repeatability : $\Delta\varepsilon a$

This is the precision outline that affects the absolute position system machine, and expresses the repeatability of the position before the power was shut off and the position when the power is turned on again.

With the single motor unit, the precision is 1 to 2 times the theoretic precision $\Delta\varepsilon$. Note that the absolute position repeatability $\Delta\varepsilon$a is the difference from when the power was turned off last and returned on. This error is not cumulated.

Table 11-4 shows the approximate precision at the motor end of each motor series. Obtain the precision at the motor end during actual machining by adding the machine precision to the value in the table.

Table 11-4 Precision by motor series

Motor series	Control resolution RNG (pulse/rev)	Theoretic precision Δε	Positioning precision Δεp	Surface precision Δεv	Absolute position repeatability Δεa
HC□-A42/E42 (OSA104, OSE104)	100000	$\frac{\Delta S}{RNG}$	Δε ~ 2Δε	10Δε ~ 20Δε	Δε ~ 2Δε
HC□-A47 (OSA17)	100000			30Δε ~ 40Δε	
HC□-A33/E33 (OSA253, OSE253)	25000			10Δε ~ 20Δε	
HC□R-A42/E42 (OSA104, OSE104)	100000			60Δε ~ 80Δε	
HC□R-A47 (OSA17)	100000			80Δε ~ 100Δε	
HC□R-A33/E33 (OSA253, OSE253)	25000			20Δε ~ 30Δε	
HA□N-A42/E42 (OSA104, OSE104)	100000			10Δε ~ 20Δε	
HA□N-A33/E33 (OSA253, OSE253)	25000				
HC-SF	16384	$\frac{\Delta S}{RNG}$	Δε ~ 2Δε	15Δε ~ 25Δε	Δε ~ 2Δε
HC-RF	16384			20Δε ~ 30Δε	
HA-FF	8192				
HC-MF	8192			30Δε ~ 40Δε	

Table 11-5 Example of precision when movement amount is Δs = 10mm per motor rotation

Motor series	Theoretic precision Δε	Positioning precision Δεp	Surface precision Δεv	Absolute position repeatability Δεa
HC□-A42/E42, HA□N-A42/E42	0.1	0.1 ~ 0.2	1 ~ 2	0.1 ~ 0.2
HC□-A47	0.1	0.1 ~ 0.2	3 ~ 4	0.1 ~ 0.2
HC□-A33/E33, HA□N-A33/E33	0.4	0.4 ~ 0.8	4 ~ 8	0.4 ~ 0.8
HC□R-A42/E42	0.1	0.1 ~ 0.2	6 ~ 8	0.1 ~ 0.2
HC□R -A47	0.1	0.1 ~ 0.2	8 ~ 10	0.1 ~ 0.2
HC□R-A33/E33	0.4	0.4 ~ 0.8	8 ~ 12	0.4 ~ 0.8
HC-SF	0.61	0.6 ~ 1.2	9 ~ 15	0.6 ~ 1.2
HC-RF	0.61	1.2 ~ 2.5	12 ~ 18	1.2 ~ 2.5
HA-FF	1.22	1.2 ~ 2.5	24 ~ 37	1.2 ~ 2.5
HC-MF	1.22	1.2 ~ 2.5	37 ~ 50	1.2 ~ 2.5

11-3 Selection of servomotor capacity

The following three elements are used to determine the servomotor capacity.

1. Load inertia ratio
2. Short time characteristics (acceleration/deceleration torque)
3. Continuous characteristics (continuous effective load torque)

Carry out appropriate measures, such as increasing the motor capacity, if any of the above conditions is not fulfilled.

11-3-1 Load inertia ratio

Each servomotor has an appropriate load inertia ratio (load inertia/motor inertia). The control becomes unstable when the load inertia ratio is too large, and parameter adjustment becomes difficult. It becomes difficult to improve the surface precision in the feed axis, and the positioning time cannot be shortened in the position axis because the settling time is longer.
If the load inertia ratio exceeds the recommended value in the servomotor list of specifications, increase the motor capacity or change to a motor series with a large inertia. Note that the recommended value for the load inertia ratio is strictly one guideline. This does not mean that controlling a load with inertia exceeding the recommended value is impossible.

POINT

When selecting feed axis servomotors for NC unit machine tools, place importance on the surface precision during machining. To do this, always select a servomotor with a load inertia ratio within the recommended value. Select the lowest value possible within that range.

11-3-2 Short time characteristics

In addition to the rated output, the servomotor has an output range that can only be used for short times such as acceleration/deceleration. This range is expressed at the maximum torque. The maximum torque differs for each motor even at the same capacity, so confirm the torque in section "10-2 Servomotor".
The maximum torque affects the acceleration/deceleration time constant that can be driven. The linear acceleration/deceleration time constant ta can be approximated from the machine specifications using expression (11-2). Determine the maximum motor torque required from this expression, and select the motor capacity. The same selection can also be made by using the simple motor capacity selection diagrams on the last pages of this section (11-3).

$$ta = \frac{(J_L + J_M) \times N}{95.5 \times (0.8 \times T_{MAX} - T_L)} \quad (msec) \qquad \text{..... (11-2)}$$

N	: Motor reach speed	(r/min)
J_L	: Motor shaft conversion load inertia	($kg \cdot cm^2$)
J_M	: Motor inertia	($kg \cdot cm^2$)
TMAX	: Maximum motor torque	(N·m)
T_L	: Motor shaft conversion load (friction, unbalance) torque	(N·m)

11-3-3 Continuous characteristics

A typical operation pattern is assumed, and the motor's continuous effective load torque (Trms) is calculated from the motor shaft conversion and load torque. If numbers ① to ⑧ in the following drawing were considered a one cycle operation pattern, the continuous effective load torque is obtained from the root mean square of the torque during each operation, as shown in the expression (11-3).

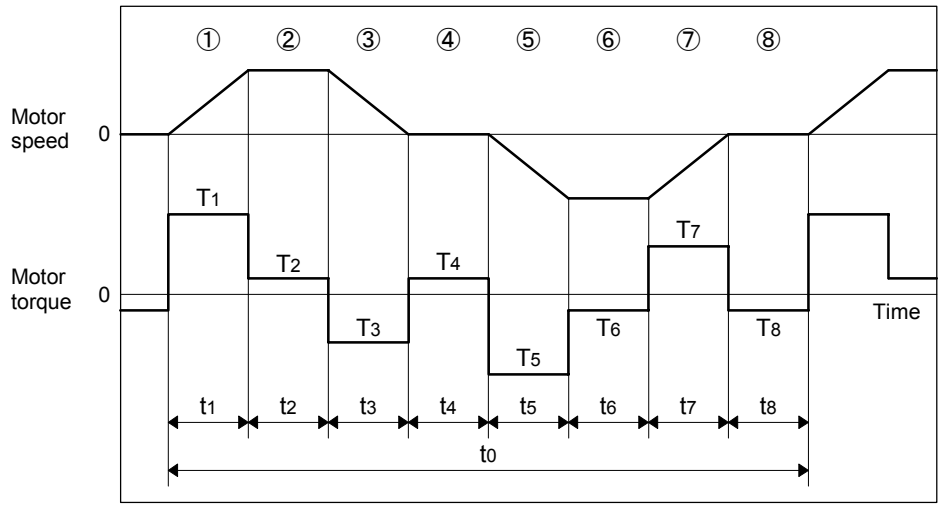


Fig. 11-1 Continuous operation pattern

$$Trms = \sqrt{\frac{T1^2 \cdot t1 + T2^2 \cdot t2 + T3^2 \cdot t3 + T4^2 \cdot t4 + T5^2 \cdot t5 + T6^2 \cdot t6 + T7^2 \cdot t7 + T8^2 \cdot t8}{t0}} \quad \text{..... (11-3)}$$

Select a motor so that the continuous effective load torque (Trms) is 80% or less of the motor rated torque (Tra) (stall torque (Tst) in the HC□, HA□N Series).

$$Trms \leq 0.8 \cdot Tra \text{ (or } 0.8 \cdot Tst) \quad \text{..... (11-4)}$$

The amount of acceleration torque (Ta) shown in tables 11-6 and 11-7 is the torque to accelerate the load inertia in a frictionless state. It can be calculated by the expression (11-5). (For linear acceleration/deceleration)

$$Ta = \frac{(J_L + J_M) \times N}{95.5 \times ta} \quad (N \cdot m) \quad \text{..... (11-5)}$$

N	:	Motor reach speed	(r/min)
J_L	:	Motor shaft conversion load inertia	($kg \cdot cm^2$)
J_M	:	Motor inertia	($kg \cdot cm^2$)
ta	:	Linear acceleration/deceleration time constant	(msec)

In case of axis with imbalance torque. Select a motor so that a motor shaft conversion load torque (T_L) (friction torque + unbalance torque) is 60% or less of the motor rated torque (Tra) (stall torque (Tst) in the HC□, HA□N Series).

$$T_L \leq 0.6 \cdot Tra \text{ (or } 0.6 \cdot Tst) \quad \text{..... (11-6)}$$

(1) Horizontal axis load torque

When operations ① to ⑧ are for a horizontal axis, calculate so that the following torques are required in each period.

Table 11-6 Load torques of horizontal axes

Period	Load torque calculation method	Explanation
①	(Amount of acceleration torque) + (Kinetic friction torque)	Normally the acceleration/deceleration time constant is calculated so this torque is 80% of the maximum torque of the motor.
②	(Kinetic friction torque)	
③	(Amount of deceleration torque) + (Kinetic friction torque)	The signs for the amount of acceleration torque and amount of deceleration torque are reversed when the absolute value is the same value.
④	(Static friction torque)	Calculate so that the static friction torque is always required during a stop.
⑤	– (Amount of acceleration torque) – (Kinetic friction torque)	The signs are reversed with period ① when the kinetic friction does not change according to movement direction.
⑥	– (Kinetic friction torque)	The signs are reversed with period ② when the kinetic friction does not change according to movement direction.
⑦	– (Amount of deceleration torque) – (Kinetic friction torque)	The signs are reversed with period ③ when the kinetic friction does not change according to movement direction.
⑧	– (Static friction torque)	Calculate so that the static friction torque is always required during a stop.

(2) Unbalance axis load torque

When operations ① to ⑧ are for an unbalance axis, calculate so that the following torques are required in each period. Note that the forward speed shall be an upward movement.

Table 11-7 Load torques of unbalance axes

Period	Load torque calculation method	Explanation
①	(Amount of acceleration torque) + (Kinetic friction torque) + (Unbalance torque)	Normally the acceleration/deceleration time constant is calculated so this torque is 80% of the maximum torque of the motor.
②	(Kinetic friction torque) + (Unbalance torque)	
③	(Amount of deceleration torque) + (Kinetic friction torque) + (Unbalance torque)	The signs for the amount of acceleration torque and amount of deceleration torque are reversed when the absolute value is the same value.
④	(Static friction torque) + (Unbalance torque)	The holding torque during a stop becomes fairly large. (Upward stop)
⑤	– (Amount of acceleration torque) – (Kinetic friction torque) + (Unbalance torque)	
⑥	– (Kinetic friction torque) + (Unbalance torque)	The generated torque may be in the reverse of the movement direction, depending on the size of the unbalance torque.
⑦	– (Amount of deceleration torque) – (Kinetic friction torque) + (Unbalance torque)	
⑧	– (Static friction torque) + (Unbalance torque)	The holding torque becomes smaller than the upward stop. (Downward stop)

POINT

During a stop, the static friction torque may constantly be applied. The static friction torque and unbalance torque may particularly become larger during an unbalance upward stop, and the torque during a stop may become extremely large. Therefore, caution is advised.

< Acceleration/deceleration time constant 1 for servomotors >

When No = Rated speed and PGN1 = 33.

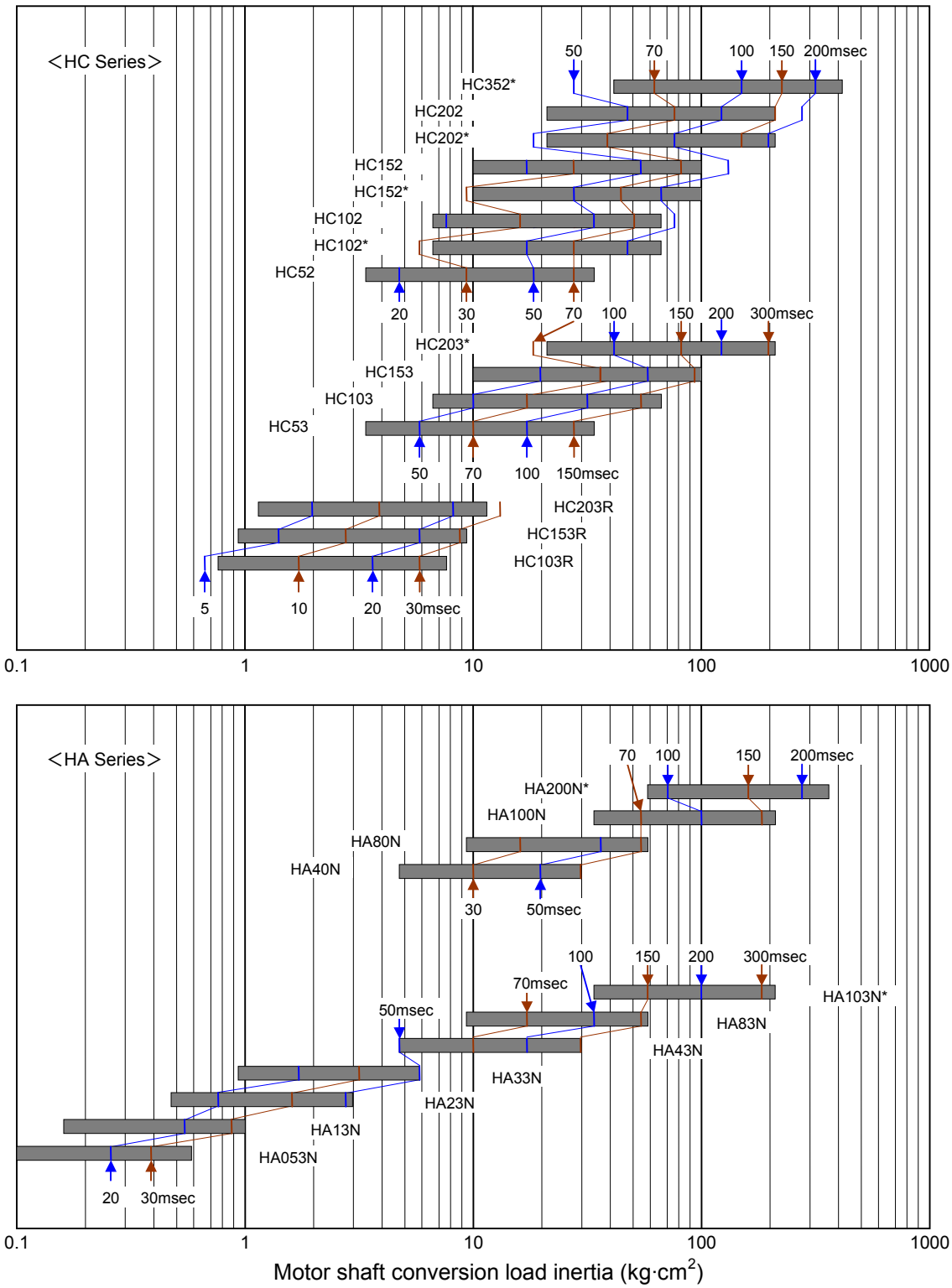
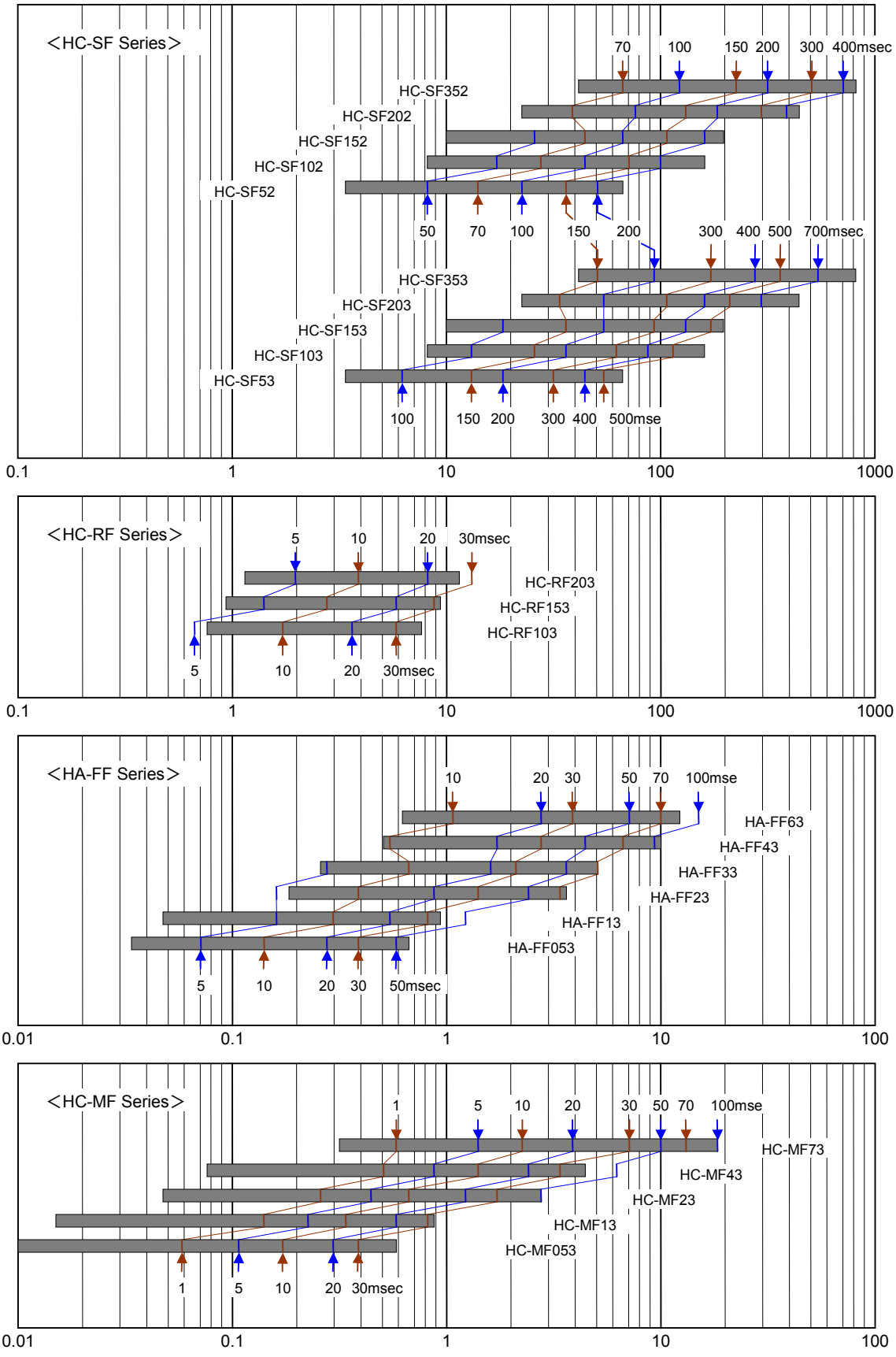


Fig. 11-2 (1) Simple motor capacity selection diagram 1

> **⚠ CAUTION** The friction torque and unbalanced torque are not considered in the acceleration/deceleration time constants given in Fig. 11-2.

< Acceleration/deceleration time constant 2 for servomotors >

When No = Rated speed and PGN1 = 33.



Motor shaft conversion load inertia (kg·cm^2)

Fig. 11-2 (2) Simple motor capacity selection diagram 2

11-4 Selection of regenerative resistor

To select the regenerative resistor, first the regenerative energy from when each axis stops (is positioned) is calculated. A regenerative resistor having a capacity to satisfy the positioning frequency, determined from the machine specifications, is selected.

11-4-1 Calculation of regenerative energy

(1) For horizontal axis

For the horizontal axis, the regenerative energy E_R consumed by the regenerative resistor can be calculated with the expression (11-7). If the E_R value is negative, all of the regenerative energy is absorbed (CONDENSER REGENERATION) by the capacitor on the amplifier, and the energy consumption by the regenerative resistor is zero ($E_R = 0$).

$$E_R = 5.48 \times 10^{-7} \cdot \eta \cdot (J_L + J_M) \cdot N^2 - Ec \ (J) \quad \text{..... (11-7)}$$

η : Motor reverse effect
J_L : Motor inertia (kg·cm^2)
J_M : Load inertia (kg·cm^2)
N : Motor speed (r/min)
Ec : Amplifier charging energy (J)

Example

The regeneration energy is obtained for when the axis stops from the rated speed while a load with the same inertia as the motor is connected to the HC52 motor.
Regeneration energy ER is calculated using expression (11-7) below.

$$ER = 5.48 \times 10^{-7} \times 0.85 \times (6.6 + 6.6) \times 2000^2 - 11 = 13.6 \ (J)$$

Table 11-8 (1) Amplifier charging energy

Amplifier capacity	Charging energy Ec (J)	Amplifier capacity	Charging energy Ec (J)
MDS-B-SVJ2-01	9	MDS-B-SVJ2-07	20
MDS-B-SVJ2-03	9	MDS-B-SVJ2-10	40
MDS-B-SVJ2-04	9	MDS-B-SVJ2-20	40
MDS-B-SVJ2-06	11		

Table 11-8 (2) Servomotor reverse effect

Servomotor	Motor reverse effect η	Servomotor	Motor reverse effect η	Servomotor	Motor reverse effect η	Servomotor	Motor reverse effect η
HC52	0.85	HA40N	0.85	HC-SF52	0.85	HA-FF053	0.35
HC102	0.85	HA80N	0.85	HC-SF102	0.85	HA-FF13	0.55
HC152	0.85	HA100N	0.85	HC-SF152	0.85	HA-FF23	0.70
HC202	0.85	HA200N	0.85	HC-SF202	0.85	HA-FF33	0.75
HC352	0.85			HC-SF352	0.85	HA-FF43	0.85
HC53	0.85	HA053N	0.55	HC-SF53	0.85	HA-FF63	0.85
HC103	0.85	HA13N	0.70	HC-SF103	0.85		
HC153	0.85	HA23N	0.75	HC-SF153	0.85	HC-MF053	0.35
HC203	0.85	HA33N	0.75	HC-SF203	0.85	HC-MF13	0.55
		HA43N	0.85	HC-SF353	0.85	HC-MF23	0.70
HC103R	0.85	HA83N	0.85			HC-MF43	0.85
HC153R	0.85	HA103N	0.85	HC-RF103	0.85	HC-MF73	0.85
HC203R	0.85			HC-RF153	0.85		
				HC-RF203	0.85		

POINT

The regenerative energy is the value for when the amplifier input power voltage is 220 V.
If the input voltage is higher than this, the charging energy will decrease and the regeneration energy will increase.

(2) For an unbalance axis

The regenerative energy differs in the upward stop and downward stop for an unbalance axis. A constant regeneration state results during downward movement if the unbalance torque is the same as or larger than the friction torque.

	Regeneration energy
Upward stop	A regeneration state only occurs when deceleration torque (downward torque) is generated. $ERU = 5.24 \times 10^{-5} \cdot \eta \cdot Tdu \cdot N \cdot td - Ec$ (J) ..... (11-8) η : Motor reverse efficiency Tdu : Upward stop deceleration torque (N·m) N : Motor speed (r/min) td : Deceleration time (time constant) (msec) Ec : Amplifier charging energy (J)
Downward stop	A regeneration state occurs even during constant rate feed when the upward torque Ts during dropping is generated. Calculated so that Ts = 0 when Ts is downward. $ERD = \frac{2\pi \cdot \eta \cdot Ts \cdot L}{\Delta S} + 5.24 \times 10^{-5} \cdot \eta \cdot Tdd \cdot N \cdot td - Ec$ (J) ..... (11-9) η : Motor reverse efficiency Ts : Upward torque during dropping (N·m) L : Constant rate travel (mm) ΔS : Travel per motor rotation (mm) Tdd : Downward stop deceleration torque (N·m) N : Motor speed (r/min) td : Deceleration time (time constant) (msec) Ec : Amplifier charging energy (J)
One return is assumed to be one cycle, and the regeneration energy per cycle (ER) is obtained using expression (11-10). ER = ERU + ERD (J) ..... (11-10)	

(Example)

A return operation is executed for a time constant of 50msec for 200mm. The operation is executed at F20000 in a machine tool vertical axis driven by an HC52 motor. The regenerative energy per return operation is obtained at this time.

Note the following :

Travel per upward motor rotation	: 10mm
Upward stop deceleration torque	: 5N·m
Downward stop deceleration torque	: 8N·m
Upward torque during downward movement	: 0.5N·m

Using expression (11-8), the upward stop regeneration energy ERU is as follows :

$ERU = 5.24 \times 10^{-5} \times 0.85 \times 5 \times 2000 \times 50 - 11 = 11.3$ (J)

The acceleration/deceleration distance required to accelerate at the 50msec acceleration/ deceleration time constant to 20000mm/min. is as follows:

$$\frac{20000 \times 50}{2 \times 60 \times 1000} = 8.3 \text{ (mm)}$$

Therefore, the constant speed travel is 183.4mm.
The downward stop regeneration energy ERD is obtained using the following expression (11-9).

$$ERD = \frac{2\pi \times 0.85 \times 0.5 \times 183.4}{10} + 5.24 \times 10^{-5} \times 0.85 \times 8 \times 2000 \times 50 - 11 = 73.6 \text{ (J)}$$

Thus, the regeneration energy per return operation ER is as follows :

ER = 11.3 + 73.6 = 84.9 (J)

11-4-2 Calculation of positioning frequency

Select the regenerative resistor so that the positioning frequency DP (times/minute) calculated by the regenerative resistor capacity P_R (W) and the regenerative energy ER (J) consumed by the regenerative resistor is within the range shown in expression (11-11). With the unbalance axis, the number of times for one cycle to raise and lower the axis is judged as DP.

$$DP < 48 \cdot \frac{P_R}{E_R} \quad \text{(times/minute)} \qquad \text{..... (11-11)}$$

Table 11-9 Regenerative resistor correspondence table

	Standard built-in regenerative resistor		External option regenerative resistor type				
External option regenerative resistor type (Japan Resistor Mfg.)				GZG200W39OHMK	GZG200W120OHMK 3 units connected in parallel	GZG200W39OHMK 3 units connected in parallel	GZG300W39OHMK 3 units connected in parallel
External option regenerative resistance unit type			**MR-RB032**	**MR-RB12**	**MR-RB32**	**MR-RB30**	**MR-RB50**
Corresponding servo amplifier	**Regenerative capacity**		**30W**	**100W**	**300W**	**300W**	**500W**
		Resistance value	**40Ω**	**39Ω (MR-RB12: 40Ω)**	**40Ω**	**13Ω**	**13Ω**
MDS-B-SVJ2-01	No built-in resistor		○	○			
MDS-B-SVJ2-03	10W	100Ω	○	○			
MDS-B-SVJ2-04	10W	100Ω	○	○			
MDS-B-SVJ2-06	10W	40Ω	○	○	○		
MDS-B-SVJ2-07	20W	40Ω		○	○		
MDS-B-SVJ2-10	100W	13Ω				○	○
MDS-B-SVJ2-20	100W	13Ω				○	○

11-5 Example of servo selection

A servomotor is selected using a machining center with the following specifications as an example.

Specification item	Unit	X axis	Y axis	Z axis
Axis type		Linear	Linear	Linear
Movement direction		Horizontal	Horizontal	Vertical
Table support method		Rolling	Rolling	Rolling
Table movement friction coefficient	%	5	5	2
Ball screw diameter	mm	40	40	40
Ball screw length	mm	900	800	1000
Ball screw lead	mm	10	10	10
Deceleration ratio		1	1	2/3
Primary side gear inertia	$kg \cdot cm^2$	–	–	1.6
Secondary side gear inertia	$kg \cdot cm^2$	–	–	8.1
Motor/ball screw connection section inertia	$kg \cdot cm^2$	2.0	2.0	–
Weight of moving object installed on the machine (table, etc.)	kg	500	400	400
Weight of standard added object (workpiece, etc.)	kg	100	100	10
Rapid traverse rate	mm/min	30000	30000	20000
Target acceleration/deceleration time constant	msec	120	120	120
Rapid traverse positioning frequency	times/min.	20	20	20
Motor brakes		Not available	Not available	Available

11-5-1 Motor selection calculation

The selection calculation is carried out in order using the Z axis as an example.

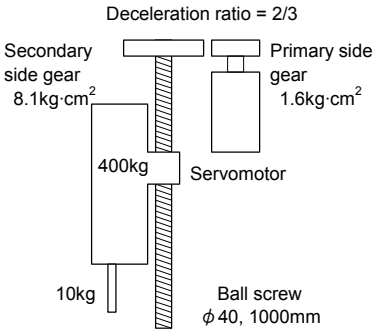


Fig. 11-3 Z axis configuration

(1) Obtaining the load inertia

Calculate the motor shaft conversion load inertia separately for the rotation load and linear movement load. Furthermore, calculate the rotation load inertia separately for the primary and secondary side.

- **Primary side rotation load inertia: J_{R1}**

  This is the primary side gear inertia.

  $J_{R1} = 1.6\ (kg \cdot cm^2)$

- **Secondary rotation load inertia: J_{R2}**

  This is the sum of the ball screw inertia J_B and secondary side gear inertia.

  The ball screw is generally calculated as a cylinder made of steel.

  Refer to section "11-7 Load inertia calculation"

  $$J_{R2} = J_B + 8.1 = \frac{\pi \cdot \rho \cdot L}{32} D^4 + 8.1 = \frac{\pi \times 7.80 \times 10^{-3} \times 100}{32} \times 4^4 + 8.1$$
  $$= 19.6 + 8.1 = 27.7\ (kg \cdot cm^2)$$

- **Total rotation load inertia: J_R**

  This is the sum of the primary side load inertia and secondary side load inertia. To convert the secondary side load inertia to the motor shaft (primary side), multiply by the square of the deceleration ratio.

  $$J_R = J_{R1} + \left(\frac{2}{3}\right)^2 \times J_{R2} = 1.6 + \frac{4}{9} \times 27.7 = 1.6 + 12.3 = 13.9\ (kg \cdot cm^2)$$

- **Linear movement load inertia: J_T**

  The inertia is calculated when a standard workpiece, tool, etc., is attached. The conversion to the motor shaft by the deceleration ratio is included in the travel increment per motor rotation. Refer to section "11-7 Load inertia calculation".

  $$J_T = W \cdot \left(\frac{\Delta S}{20\pi}\right)^2 = (400 + 10) \cdot \left(\frac{10 \times 2}{20\pi \times 3}\right)^2 = 4.6\ (kg \cdot cm^2)$$

- **Load inertia: J_L**
  This is the sum of the total rotation load inertia and the linear movement inertia.

  $J_L = 13.9 + 4.6 = 18.5\ (kg \cdot cm^2)$

  When looking at the load inertia components, the linear movement weight tends to increase. However, the rotation load generally accounts for most of the inertia. The load inertia does not change much even if the workpiece weight changes greatly in the table axis.

(2) Obtaining unbalance torque

The unbalance torque is obtained from the moving object weight. Here, the drive system efficiency is calculated as 1.
Refer to section "11-6 Motor shaft conversion load torque".

$$T_U = \frac{(W_1 - W_2) \cdot g \cdot \Delta S}{2 \times 10^3 \pi \cdot \eta} = \frac{(410 - 0) \times 9.8 \times 10 \times 2}{2 \times 10^3 \pi \times 1 \times 3} = 4.3\ (N \cdot m)$$

(3) Obtaining friction torque

The friction torque is obtained from the moving object weight and friction coefficient. Here, the drive system efficiency is calculated as 1. Refer to section "11-6 Motor shaft conversion load torque".

$$T_F = \frac{F \cdot \Delta S}{2 \times 10^3 \pi \cdot \eta} = \frac{\mu \cdot W \cdot g \cdot \Delta S}{2 \times 10^3 \pi \cdot \eta} = \frac{0.02 \times 410 \times 9.8 \times 10 \times 2}{2 \times 10^3 \pi \times 1 \times 3} = 0.09\ (N \cdot m)$$

(4) Selecting the appropriate motor from the load inertia ratio

Because it is a machine tool, the HC□ Motor Series is required for precise control, and a motor maximum speed of 3000r/min. or more is required because of the rapid traverse speed and gear ratio. Furthermore, the motor to be selected is limited to the HC□3B Series because a motor with brakes is required. The load inertia for all the HC53B to HC153B motors in the table below is judged to be appropriate if the load inertia is within 5-fold of the recommended load inertia ratio.

Motor type	Motor inertia ($kg \cdot cm^2$)	Load inertia ($kg \cdot cm^2$)	Load inertia magnification	Judgment
HC53B	8.6	18.5	2.15	○
HC103B	15.7	18.5	1.18	○
HC153B	22.0	18.5	0.84	○

(5) Selecting the appropriate motor from the short time characteristics (acceleration/deceleration time constant)

The acceleration/deceleration time constant is calculated using expression (11-2), and it is judged whether it satisfies the target acceleration/deceleration time constant of 120msec.

$$\text{HC53B} : t_a = \frac{(J_L + J_M) \times N}{95.5 \times (0.8 \times T_{MAX} - T_U - T_F)} = \frac{(18.5 + 8.6) \times 3000}{95.5 \times (0.8 \times 8.82 - 4.3 - 0.09)} = 320.5\ (msec)$$

$$\text{HC103B} : t_a = \frac{(J_L + J_M) \times N}{95.5 \times (0.8 \times T_{MAX} - T_U - T_F)} = \frac{(18.5 + 15.7) \times 3000}{95.5 \times (0.8 \times 16.7 - 4.3 - 0.09)} = 119.9\ (msec)$$

$$\text{HC153B} : t_a = \frac{(J_L + J_M) \times N}{95.5 \times (0.8 \times T_{MAX} - T_U - T_F)} = \frac{(18.5 + 22.0) \times 3000}{95.5 \times (0.8 \times 28.4 - 4.3 - 0.09)} = 69.4\ (msec)$$

The motors that satisfy the conditions from the calculation results above are the HC103B and HC153B.

Motor type	Maximum torque (N·m)	Total inertia ($kg \cdot cm^2$)	Acceleration/ deceleration time constant (msec)	Judgment
HC53B	8.82	27.1	320.5	×
HC103B	16.7	34.2	119.9	○
HC153B	28.4	40.5	69.4	○

(6) Selecting the appropriate motor from the continuous characteristics

Generally, the expressions (11-3) and (11-4) are calculated following the typical operation pattern, and the motor is judged from the continuous characteristics. Because the Z axis is the vertical axis here, the motor will be judged by the torque during an upward stop.
The unbalance axis torque during a stop is 60% or less of the stall torque (rated torque in general-purpose motors). As shown in the following table, the only motor that satisfies this reference is the HC153B. From the judgment in steps (4) to (6) it is the motor with the appropriate Z axis.

Motor type	Stall torque (N·m)	Torque during stop TU+TF (kg·cm^2)	Load rate (%)	Judgment	Explanation
HC53B	2.94	4.39	149.1	×	An overload alarm occurs from just holding.
HC103B	5.88	4.39	74.6	×	There is no allowance for an acceleration/ deceleration operation.
HC153B	8.82	4.39	49.8	○	The torque during a stop is 60% or less.

11-5-2 Regenerative resistor selection calculation

Calculation is carried out in order with the Z axis as an example.

(1) Obtaining the generated torque

The deceleration torque required to calculate the regeneration energy is obtained.

- **Upward stop deceleration torque: T_{du}**

The amount of deceleration torque (=amount of acceleration torque) is first calculated using expression (11-5).

$$T_a = \frac{(J_L + J_M) \times N}{95.5 \times ta} = \frac{(18.5 + 22.0) \times 3000}{95.5 \times 120} = 10.6\ (N \cdot m)$$

The upward stop deceleration torque is obtained from the amount of deceleration torque, unbalance torque and friction torque.

$T_{du} = T_a - T_U - T_F = 10.6 - 4.3 - 0.09 = 6.2\ (N \cdot m)$

- **Downward stop deceleration torque: T_{dd}**

The downward stop deceleration torque is obtained from the amount of deceleration torque, unbalance torque and friction torque.

$T_{dd} = T_a - T_U - T_F = 10.6 - 4.3 - 0.09 = 14.8\ (N \cdot m)$

- **Upward torque during dropping: T_s**

The upward torque during dropping is obtained from the unbalance torque and friction torque.

$T_s = T_U - T_F = 4.3 - 0.09 = 4.2\ (N \cdot m)$

- **Constant rate travel: L**

Because the constant rate travel is not clearly described in the specifications, the axis stroke, etc., is considered, and the value used here is L=200mm.

(2) Obtaining the regeneration energy

Because the Z axis is the vertical axis, the regenerative energy is calculated separately for an upward stop and downward stop.

- **Upward stop regeneration energy: E_{RU}**

This is obtained from expression (11-8).

$$E_{RU} = 5.24 \times 10^{-5} \cdot \eta \cdot T_{du} \cdot N \cdot td - Ec = 5.24 \times 10^{-5} \times 0.85 \times 6.2 \times 3000 \times 120 - 40 = 59.4\ (J)$$

- **Downward stop regeneration energy: E_{RU}**

This is obtained from expression (11-9).

$$E_{RD} = \frac{2\pi \cdot \eta \cdot Ts \cdot L}{\Delta S} + 5.24 \times 10^{-5} \cdot \eta \cdot T_{dd} \cdot N \cdot td - Ec$$

$$= \frac{2\pi \times 0.85 \times 4.2 \times 200 \times 3}{10 \times 2} + 5.24 \times 10^{-5} \times 0.85 \times 14.8 \times 3000 \times 120 - 40$$

$$= 672.9 + 237.3 - 40 = 870.2\ (J)$$

- **Stop regeneration energy per cycle: E_R**

This is obtained from expression (11-10).

$E_R = 59.4 + 870.2 = 929.6\ (J)$

(3) Obtaining the tolerable No. of positionings

The tolerable cycle operation frequency per minute DP is calculated respectively for the standard built-in regeneration resistor and option regeneration resistor.
Refer to expression (11-11).

- **Standard built-in regenerative resistor**

$$DP_0 = 48 \cdot \frac{P_R}{E_R} = 48 \times \frac{100}{929.6} = 5.2 \text{ (times)}$$ No. of positionings = 10.4 (times)

- **MR-RB30 (300W)**

$$DP_1 = 48 \cdot \frac{P_R}{E_R} = 48 \times \frac{300}{929.6} = 15.5 \text{ (times)}$$ No. of positionings = 31.0 (times)

- **MR-RB50 (500W)**

$$DP_2 = 48 \cdot \frac{P_R}{E_R} = 48 \times \frac{500}{929.6} = 25.8 \text{ (times)}$$ No. of positionings = 51.6 (times)

Because the No. of times described above is the No. of cycle operations for 1 return for a vertical axis, the No. of positionings is 2-fold. Thus, it is shown that the MR-RB30 (300W) option resistor is required to satisfy the specified positioning frequency of 20 times/min.

POINT

Try to choose a resistor with some allowance in the vertical axis, because the regeneration load can easily become large compared to a horizontal axis.

11-5-3 Servo selection results

As a result of calculating the servo selection, the servo specifications for the Z axis of this machining center have been determined.

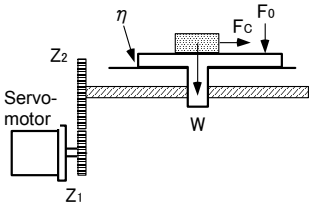
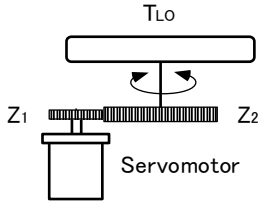
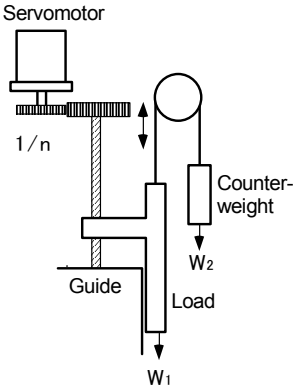
Item	Type
Servo amplifier	MDS-B-SVJ2-20
Servomotor	HC153B□
Option regenerative resistor	MR-RB30

The □ in the motor type will be decided based on separate machine specifications such as motor shaft shape and absolute position system.
The following table shows the servo selections for all axes.

Item	Unit	X axis	Y axis	Z axis
Axis type		Linear	Linear	Linear
Movement direction		Horizontal	Horizontal	Vertical
Table support method		Rolling	Rolling	Rolling
Table movement friction coefficient	%	5	5	2
Ball screw diameter	mm	40	40	40
Ball screw length	mm	900	800	1000
Ball screw lead	mm	10	10	10
Deceleration ratio		1	1	2/3
Primary side gear inertia	$kg \cdot cm^2$	–	–	1.6
Secondary side gear inertia	$kg \cdot cm^2$	–	–	8.1
Motor/ball screw connection section inertia	$kg \cdot cm^2$	2.0	2.0	–
Weight of moving object installed on the machine (table, etc.)	kg	500	400	400
Weight of standard added object (workpiece, etc.)	kg	100	100	10
Rapid traverse rate	mm/min	30000	30000	20000
Target acceleration/deceleration time constant	msec	120	120	120
Rapid traverse positioning frequency	times/min.	20	20	20
Motor brakes		Not available	Not available	Available
Motor shaft conversion rotation load inertia	$kg \cdot cm^2$	19.6	17.7	13.9
Motor shaft conversion linear movement load inertia	$kg \cdot cm^2$	15.2	12.7	4.6
Motor shaft conversion total load inertia	$kg \cdot cm^2$	34.8	30.4	18.5
Motor inertia	$kg \cdot cm^2$	13.7	13.7	22.0
Motor shaft conversion load inertia magnification	-fold	2.54	2.22	0.84
Motor shaft conversion unbalance torque	N·m	0.0	0.0	4.3
Motor shaft conversion friction torque	N·m	0.47	0.39	0.09
Motor shaft conversion total load torque	N·m	0.47	0.39	4.39
Motor speed during rapid traverse	r/min	3000	3000	3000
Rapid traverse acceleration/deceleration time constant	msec	118.3	106.7	69.4
Maximum torque during motor stop	N·m	0.47	0.39	4.39
Maximum load rate during motor stop	%	8.0	6.6	49.8
Regeneration energy per braking (cycle)	J	163.5	144.7	929.6
Standard built-in resistor Tolerable positioning frequency	times/min.	29.4	33.2	10.4
MR-RB30 Tolerable positioning frequency	times/min.	88.1	99.5	31.0
Servo amplifier type		MDS-B-SVJ2-10	MDS-B-SVJ2-10	MDS-B-SVJ2-20
Servomotor type		HC103□	HC103□	HC153B□
Regenerative resistor type		Built-in standard	Built-in standard	MR-RB30

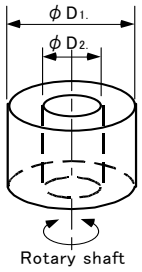
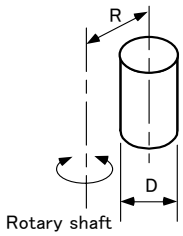
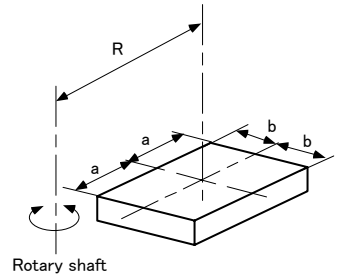
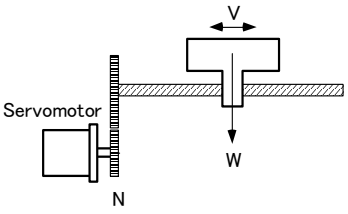
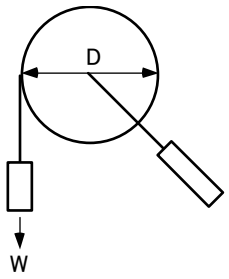
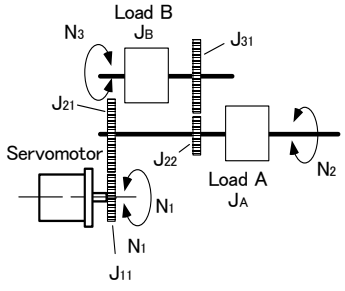
11-6 Motor shaft conversion load torque

The main load torque calculation expressions are shown below.

Type	Mechanism	Calculation expression
Linear movement		$T_L = \frac{F}{2\times10^3\pi\eta} \cdot \left(\frac{V}{N}\right) = \frac{F\cdot\Delta S}{2\times10^3\pi\eta}$ T_L : Load torque (N·m) F : Force in axial direction of linear motion machine (N) η : Drive system efficiency (%) V : Speed of linear operation object (mm/min) N : Motor speed (r/min) ΔS: Object movement amount per motor rotation (mm) Z_1, Z_2: Deceleration ratio F in the above expression is obtained from the lower expression when the table is moved as shown on the left. $F = Fc + \mu (W \cdot g \cdot F_0)$ Fc : Force applied on axial direction of moving section (N) F_0 : Tightening force on inner surface of table guide (N) W : Total weight of moving section (kg) g : Gravitational acceleration (m/sec^2) μ : Friction coefficient
Rotary movement		$T_L = \frac{Z_1}{Z_2} \cdot \frac{1}{\eta} \cdot T_{LO} + T_F = \frac{1}{n} \cdot \frac{1}{\eta} \cdot T_{LO} + T_F$ T_L : Load torque (N·m) T_{LO} : Load torque on load shaft (N) T_F : Motor shaft conversion load friction torque (N·m) η : Drive system efficiency Z_1, Z_2 : Deceleration ratio n : Deceleration rate
Vertical movement		When rising $T_L = T_U + T_F$ When lowering $T_L = -T_U \cdot \eta^2 + T_F$ T_L : Load torque (N·m) T_U : Unbalanced torque (N·m) T_F : Friction torque on moving section (N·m) $T_U = \frac{(W_1 - W_2)\cdot g}{2\times10^3\pi\eta} \cdot \left(\frac{V}{N}\right) = \frac{(W_1 - W_2)\cdot g\cdot \Delta S}{2\times10^3\pi\eta}$ $T_F = \frac{\mu\cdot(W_1 + W_2)\cdot g\cdot \Delta S}{2\times10^3\pi\eta}$ W_1 : Load weight (kg) W_2 : Counterweight weight (kg) η : Drive system efficiency g : Gravitational acceleration = 9.8 (m/sec^2) V : Speed of linear operation object (mm/min) N : Motor speed (r/min) ΔS: Object movement speed per motor rotation (mm) μ : Friction coefficient

11-7 Expressions for load inertia calculation

The calculation method for a representative load inertia is shown.

<table>
<tr><th>Type</th><th>Mechanism</th><th>Calculation expression</th></tr>
<tr><td rowspan="2">Cylinder</td><td>Rotary shaft is cylinder center
 
</td><td>$J_L = \frac{\pi \cdot \rho \cdot L}{32} (D_1^4 - D_2^4) = \frac{W}{8} (D_1^2 - D_2^2)$
J_L : Load inertia [kg·cm^2]
ρ : Density of cylinder material [kg·cm^2]
L : Length of cylinder [cm]
D_1 : Outer diameter of cylinder [cm]
D_2 : Inner diameter of cylinder [cm]
W : Weight of cylinder [kg]
Reference data
Material densities Iron
..... 7.80×10^{-3} [kg/cm^3]
Aluminum
..... 2.70×10^{-3} [kg/cm^3]
Copper
..... 8.96×10^{-3} [kg/cm^3]</td></tr>
<tr><td>When rotary shaft and cylinder shaft are deviated
 
</td><td>$J_L = \frac{W}{8} (D^2 + 8R^2)$
J_L : Load inertia [kg·cm^2]
W : Weight of cylinder [kg]
D : Outer diameter of cylinder [cm]
R : Distance between rotary axis and cylinder axis [cm]</td></tr>
<tr><td>Column</td><td> 
</td><td>$J_L = W \left(\frac{a^2 + b^2}{8} + R^2 \right)$
J_L : Load inertia [kg·cm^2]
W : Weight of cylinder [kg]
a.b.R : Left diagram [cm]</td></tr>
<tr><td>Object that moves linearly</td><td> 
</td><td>$J_L = W \left(\frac{1}{2\pi N} \cdot \frac{V}{10} \right)^2 = W \left(\frac{\Delta S}{20\pi} \right)^2$
J_L : Load inertia [kg·cm^2]
W : Weight of object that moves linearly [kg]
N : Motor speed [r/min]
V : Speed of object that moves linearly [mm/min]
ΔS : Stroke of object that moves linearly per motor rotation [mm]</td></tr>
<tr><td>Suspended object</td><td> 
</td><td>$J_L = W \left(\frac{D}{2} \right)^2 + J_P$
J_L : Load inertia [kg·cm^2]
W : Weighty of object [kg]
D : Diameter of pulley [cm]
J_P : Inertia of pulley [kg·cm^2]</td></tr>
<tr><td>Converted load</td><td> 
</td><td>$J_L = J_{11} + (J_{21} + J_{22} + J_A) \cdot \left(\frac{N_2}{N_1} \right)^2 + (J_{31} + J_B) \cdot \left(\frac{N_3}{N_1} \right)^2$
J_L : Load inertia [kg·cm^2]
J_A,J_B : Inertia of load A, B [kg·cm^2]
J_{11}~J_{31} : Inertia [kg·cm^2]
N_1~N_3 : Each shaft's speed [r/min]</td></tr>
</table>

Chapter 12 Inspections

DANGER

1. Wait at least 10 minutes after turning the power OFF and check that the input/output and voltage are zero with a tester, etc., before starting wiring or inspections. Failure to observe this could lead to electric shocks.
2. Only qualified persons must carry out the inspections. Failure to observe this could lead to electric shocks. Contact your dealer for repairs or part replacements.

CAUTION

1. Do not perform a megger test (insulation resistance measurement) on the servo amplifier. Failure to observe this could lead to faults.
2. Never disassemble or modify the unit.

12-1 Inspections

Periodically inspecting the following points is recommended.

① Are any screws on the terminal block loose? Tighten if loose.
② Is there any abnormal noise from the servomotor bearings or the brakes?
③ Are any of the cables damaged or cracked? If the cable moves with the machine, carry out a periodic inspection according to the usage conditions.
④ Is the axis at the load coupling section misaligned?

12-2 Life parts

The guidelines for the part replacement interval are as shown below. These will differ according to the usage methods and environmental conditions, of if an abnormality is found, the part must be replaced. Contact your dealer for repairs and part replacements.

Part name		Standard replacement time	Remarks
Servo amplifier	Smoothing capacity	10 years	The standard replacement time is a reference time. If an abnormality is found before the standard replacement time is reached, the part must be replaced.
	Relay	–	
	Cooling fan	10,000 to 30,000 hours (2 to 3 years)	
	Battery	10,000 hours	
Servomotor	Bearings	20,000 to 30,000 hours	
	Detector	20,000 to 30,000 hours	
	Oil seal, V-ring	5,000 hours	

①Smoothing capacitor : The smoothing capacitor characteristics will deteriorate due to the effect of the ripple current, etc. The capacitor life will be greatly affected by the ambient temperature and usage conditions, but when run continuously in a normal air-conditioned environment, the life will be reached in 10 years.

②Relays : Contact defects will occur due to contact wear caused by the switching current. This will differ according to the power capacity, but the life will be reached at a No. of cumulative switches (switching life) of 100,000 times.

③ Servomotor bearings : When used at the rated speed and rated load, replace the bearings after about 20,000 to 30,000 hours. This will differ according to the operation state, but if abnormal noise or vibration is found during the inspection, the bearings must be replaced.

④ Servomotor oil seal, V-ring: These parts must be replaced after about 5,000 hours of operation at the rated speed. This will differ according to the operation state, but these parts must be replaced if oil leaks, etc., are found during the inspection.

Revision History

Printing date	Specification manual No.	Revision details
Jan., 1997	BNP-B3937∗B	Printing of tentative version (informal version)
Feb., 1997	BNP-B3937A	Printing of first proper version (informal version)
Mar., 1997	BNP-B3937B	Mass printing Software version B (B0, B1, B2, B3, B4) compatible Section 5-3-6 (2) Added items on inductive voltage compensation. Section 6-1-2 Added items on battery option for absolute position system
Aug., 1998	BNP-B3937C	Software version C (C0 onward) compatible Added HC52, HC102, HC152, HC202, HC53, HC103, HC153, HC103R, HC153R, HC203R, HC-RF103, HC-RF153 and HC-RF203. Preface Added explanations. Revised errors. Section 1-1-1 Revised servomotor packing details. Section 1-1-2 Revised type display errors. Added new motor type descriptions. Section 1-2-1 Revised control power supply terminal name errors. Section 1-2-2 Added new motor Old Section 1-3 Eliminated. Ch. 2 Preface Changed caution additions. Section 2-1 Revised system connection diagram errors. Added external emergency stop input. Section 2-2-3 Added crimp tool maker name. Section 2-3 Newly added "Connection of NC unit and servo amplifier". Section 2-4 Added new motor. Changed P5E → P5. Revised errors. Section 2-5 Reviewed power supply connection method. Section 2-6 Newly added. Section 2-7 Newly added. Section 2-8 Newly added. Section 2-9 Newly added. Section 3-1-2 Revised wiring allowance dimensions. Section 3-2-1 Revised errors. Added new motor. Section 3-2-3 Added new motor. Section 3-2-4 Added new motor. Section 4-2-1 Added description of SV017.bit5, SV036.emgx. Section 4-2-3 Added new motor. Section 4-2-4 Added new motor. Changed standard current loop gain of HC-SF, HA-FF and HC-MF motors. Section 5-1-2 Added output data channel. Section 5-1-4 Stored offset amount in memory. Section 5-2 Reviewed gain adjustment. Section 5-3-1 Added maximum current of new motor. Added MAX current display setting. Added settling time theory. Section 5-3-2 Added notch filter depth compensation. Added adaptive filter sensitivity compensation and operation monitor. Section 5-3-3 (2) Newly added. Section 5-3-3 (3) Reviewed. Section 5-3-4 Added friction torque and unbalance torque calculation example. Reviewed timing adjustment explanation drawing. Added other general explanations. Section 5-3-5 Added overshooting compensation type 2. Added explanation for feed forward control. Added other general explanations. Section 5-3-6 Added (1) SHG control. Section 5-4 Added dynamic brake setting explanation. Added sequence explanation drawing. Added other general explanations. Section 5-5 Added SV017, SV027, SV033, SV034 and SV036. Changed SV040 parameter name. Revised SV015, SV019, SV020 and SV022 setting ranges.

Printing date	Specification manual No.	Revision details	
Aug., 1998	BNP-B3937C (continued)	Section 6-3	Newly added relay terminal explanation.
		Section 6-4-1, 2	Added EN standards compliance to cables and connector options, added IP67 specification compliant parts.
		Section 6-4-3	Newly added flexible conduit explanation.
		Section 6-4-4	Reviewed cable wire explanation. Revised cable connection diagrams and manufacturing diagrams error and reviewed.
		Chapter 7	Moved peripheral devices from Chapter 6, and reviewed peripheral device setting methods.
		Section 8-3-1	Added alarm 55. Deleted alarm 54. Added explanation of detection when the axis is removed.
		Section 8-3-2	Added warning EA.
		Section 8-3-3	Changed alarm 2C and 52 to deceleration control stop. Change alarm 5F detection timing.
		Section 9-2-1	Added new motor.
		Section 9-3-2	Added new motor.
		Section 9-4	Overall change of explanation for dynamic brake characteristics.
		Section 10-1-1	Added servo amplifier specification items.
		Section 10-2-1	Added new motor. Revised HA83N, HA40N, HC-SF52, 102, HA-FF23, 33 and 63 specification data.
		Section 10-2-2	Added new motor.
		Section 10-2-3	Added new motor.
		Section 11-1-1	Added new motor.
		Section 11-1-2	Newly added.
		Section 11-2-1	Newly added.
		Section 11-2-2	Added new motor.
		Section 11-3	Added new motor.
		Section 11-3-1	Newly added.
		Section 11-4-1	Added new motor. Changed regenerative energy calculation expression description.
		Section 11-4-2	Changed unbalance axis regeneration capacity calculation expression.
		Section 11-5	Newly added servo system selection example.
		Section 11-6	Revised linear operation calculation expression errors.
		Section 11-7	Revised prism calculation expression errors.
		Chapter 12	Moved from old Chapter 7.
Jan., 1999	BNP-B3937D	Added HC-SF53, HC-SF103, HC-SF153, HC-SF203 and HC-SF353 motors.	
		Section 1-1-2	Added new motors.
		Ch. 2 Preface	Added cautions.
		Section 2-1	Revised and added explanations.
		Section 2-2-1	Revised amplifier and terminal block drawings.
		Section 2-2-2	Changed protective grounding name.
		Section 2-3	Revised drawing.
		Section 2-4	Revised drawings. Added new motors. Changed HA23N to 83N, 40N to 100N power connector type.
		Section 2-7	Partially changed explanation.
		Section 2-7-3	Changed SG symbol in drawing. Added points.
		Section 2-8-4	Changed SG symbol in drawing. Added points.
		Section 2-9-3	Changed SG symbol in drawing.
		Section 3-2-1	Deleted IP65 and above conditions.
		Section 3-2-3	Revised errors.
		Section 3-2-4	Revised explanations, corrected mistakes and added new motor. Added cautions.
		Section 3-2-5	Revised explanations

Printing date	Specification manual No.	Revision details
Jan., 1999	BNP-B3937D (continued)	Section 3-2-6 Revised drawings. Added wires, etc. Section 3-3 Newly added. Section 4-2-2 Newly added. Section 4-2-4 Added new motors. Section 4-3 Added new motors. Section 5-1-1 Revised drawings. Section 5-3-1 Revised contents. Added cautions, corrected table errors. Section 5-4-1 Added section (3) Deceleration control stop distance. Section 5-4-2 Added cautions. Section 6-1-2 Revised option regenerative resistor outline dimension drawing. Section 6-2 Added battery option specification item. Section 6-2-2 Revised outline dimension drawing. Revised connection drawing. Section 6-4 Reviewed drawing Section 6-4-1 Changed No. and added motors. Section 6-4-3 Added detector connector for HC-SF. Added new motors. Change DAIWA DENGYO Co., Ltd. conduit type. Section 7-1 Reviewed contents. Section 7-2 Changed selection table configuration. Section 7-3 Changed selection table configuration. Section 7-4-1 Newly added. Section 8-3-1 Added explanation for alarm 33 and 34. Section 9-2-1 Added new motors. Section 9-3-2 Added new motors. Section 9-4 Added new motors. Changed drawings. Section 10-2-1 Added new motors. Changed details described in HA-FF configuration. Section 10-2-2 Added new motors. Revised HC102, HC-SF202, HC-SF352. Section 10-2-3 Added new motors. Revised motor dimensions for HC∗∗, HC∗∗R, HA100N, HC-SF, HC-MF(B)-UE. Changed HA23N to 83N, 40N to 100N power supply connector type. Section 10-2-4 Newly added. Section 11-2-1 Added new motors. Added HA-FF details. Section 11-3 Added new motors in Fig. 11-2 (2). Added cautions. Section 11-4-1 Added new motor. Added points. Section 11-5 Changed pulley to gear.
Feb., 2000	BNP-B3937E	Unified units unified to IS units due to the new measuring laws. Changed font size and pitch. Acquired UL/c-UL Standards compliance. Corrected area code 06 telephone numbers. Introduction Revised explanation regarding EN Standards. Added explanation regarding UL Standards. Section 1-1-2 Changed servo amplifier rating nameplate to comply with UL Standards. Changed HC motor rating nameplate drawing. Added HC-SF and HC-RF motor taper shaft specifications. Added HC-MF∗∗-S15 (IP65 Specifications). Added description regarding UL standards compliance. Section 2-2-1 Added terminal screw size and tightening torque for each terminal block. Section 2-4-10 to 17 Added MD, MDR and CONT to the amplifier connector pin displays and detector connector pin displays.

Printing date	Specification manual No.	Revision details	
Feb., 2000	BNP-B3937E (continued)	Section 2-4-14	Corrected detector cable connector type. Added detector connector type. Corrected detector connector pin 9 name (LG → SD).
		Section 2-4-16	Corrected detector cable connector type. Added detector connector type. Corrected detector connector pin 9 name (LG → SD).
		Section 2-4-17	Added HC-MF∗∗S15 (IP65 specifications) connection drawing.
		Section 2-5-1	Changed converter type description to MDS-B-CVE. Added cautions for (2) MDS-B-CVE-450 and above.
		Section 3-2-2	Changed explanatory drawing.
		Section 3-2-4	Added HC-SF and HC-RF motor taper shaft specifications. Corrected HC-MF23 tolerable shaft load.
		Section 3-2-5	Added items, and changed explanatory drawing. Added cautions. Added HC-MF motor IP65 specifications.
		Section 5-1-2	Added D/A output function channels 8 and 28.
		Section 5-3-1	(1) Corrected HC motor maximum current command values (table values). Revised (4) Settling time explanatory drawing.
		Section 5-3-2	Added notch filter 2.
		Section 5-3-3	Added explanation on (4) Voltage non-sensitive compensation. Added point for (4) Disturbance torque. Revised parameter explanation (SV037).
		Section 5-3-4	Added point for (1) Lost motion compensation. Revised (2) parameter explanation (SV032). Revised the points.
		Section 5-4-2	Added cautions.
		Section 5-5	Added collision detection.
		Section 5-6	Added parameters (SV034, 35, 45, 59, 60). Revised parameter explanations (SV032, 37). Revised parameter setting range (SV041).
		Section 6-4	Added HC-MF∗∗S15 (IP65 specifications) detector cable, connector set and power supply connector.
		Section 6-4-5	Changed (3) and (4) general-purpose motor detector cable manufacturing connection drawing to 4-wire type communication.
		Section 7-1	Added UL Standards compliance notations to the wire sizes. Added crimp terminal and tool type.
		Section 7-2	Changed converter series to MDS-B-CVE.
		Section 7-3	Changed converter series to MDS-B-CVE.
		Section 7-4-1	Corrected circuit protector rated current.
		Section 7-4-3	Revised surge absorber (Matsushita Electric Industrial Co., Ltd.) to the new series type.
		Section 8-3-1	Added explanation for alarm 31. Added explanations for alarms 58, 59 and 5A.
		Section 8-3-3	Added explanations for alarms 58, 59 and 5A.
		Section 9-4-2	Revised Fig. 9-5.
		Section 10-1-2	Added terminal block screw size description.
		Section 10-2-1	Changed HC motor shaft conversion recommended load inertia rate specifications.
		Section 10-2-3	Added outline dimension drawing for the HC-SF and HC-RF motor taper shaft specifications. Divided HC-MF motor outline drawing into three capacities. Added HC-MF∗∗S15 (IP65 specifications). Changed tightening torque unit (kgf·cm → N·m). Added precautions.
July, 2002	BNP-B3937F	Software version C4 compatible Added HC□-A47, HC□R-A47 motors.	

Printing date	Specification manual No.	Revision details
July, 2002	BNP-B3937F (continued)	Enabled drive of HC102, HC152, HC202, HC203, HC352, HA103N and HA200N motor with amplifier having one-rank lower capacity than standard, and added specifications with output limit. Changed motor type change section from ** to □. Preface — Added 3.5kW HC motor to section (4) in Compliance to UL/c-UL Standards Added caution indicating software version was C4 and subsequent versions Preface 1 — Changed from Class 3 to Class C protective grounding (former Class 3 grounding). Preface 2 — Added caution to turn power OFF if servo amplifier fails Preface 3 — Changed from burns to burns or part damage Preface 4 — Added conductive fine particles to Atmosphere section in table of environment conditions. Preface 4 (7) — Eliminated section titled "Disposal" and added explanations regarding treatment of waste Preface EC Directives (1) Configuration Added configuration drawing (2) Environment Changed IEC664 to IEC60664 Changed Pollution Class 2 or more to Pollution Class 2 or less (6) Peripheral devices Changed EN60204 ... to Table 5 of EN60204-1 Appendix C (6) Peripheral devices Changed Install on wall or open table tray ... to Install on wall without duct or conduit Section 1-1-2 — Added combinations with HC102, HC152, HC202 one-rank lower capacity amplifier. Added HC352, HC203, HA200N and HA103N. Added detector A47 (OSA17) to HC motor series. Deleted explanation on HC and HA motor series IP67 specifications Section 2-4 — Changed CNV2 cable to CNV12 cable Changed MR-JHSCBL cable to CNV2C cable Section 2-4-1 — Added connection of HC52-A47, HC-53-A47 and HC102-A47. Section 2-4-2 — Added connection of HC102-A47, HC-103-A47, HC152-A47 and HC-153-A47. Section 2-4-3 — Added connection of HC202-A47, HC-203-A47 and HC352-A47. Section 2-4-4 — Added connection of HC103R-A47, HC-153R-A47 and HC203R-A47. Section 2-4-9 — Added connection of HA103N and HA200N. Section 2-7 — Changed MDS-B-CVE in explanation to MDS-C1-CV. Section 3-1-1 — Added conductive fine particles to Atmosphere section in table of environment conditions. Section 3-2-1 — Added conductive fine particles to Atmosphere section in table of environment conditions. Section 3-2-4 — Added HC203, HC352, HA103N and HA200N to table of characteristics. Section 3-2-5 — Added HC203, HC352, HA103N and HA200N to table of characteristics. Section 4-2-1 — Added external option regenerative resistor to setting of regenerative resistor type parameters. Section 4-2-4 — Added characteristics for combination with HC102, HC152 or HC202 one-rank lower capacity amplifier. Added HC352, HC203, HA200N and HA103N characteristics.

Printing date	Specification manual No.	Revision details	
July, 2002	BNP-B3937F (continued)	Section 4-3	Added parameters for combination with HC102, HC152 or HC202 one-rank lower capacity amplifier. Added HC352, HC203, HA200N and HA103N parameters. Added HC□-A47 and HC□R-47 parameters.
		Section 5-3-1 (1)	Added characteristics of new motor to the table of maximum current command value
		Section 5-4-2 (2)	Added explanation of vertical axis lift up control function.
		Section 5-6	Changed method of expressing parameters validated after power ON. Added vertical axis lift up control (SV027 bit0). Revised explanation on SV005. (Motor inertia → load inertia) Added external option regenerative resistor type to SV036 regenerative resistor types.
		Section 6-1-1	Added external option regenerative resistor specifications.
		Section 6-1-2	Added outline drawing of external option regenerative resistor.
		Section 6-4-1 (1)	Added CNV2C-2P-S and CNV2C-3P-S cable specifications. Deleted CNV2 cable specifications. Added CNV12 cable specifications. Deleted MR-ENCBL and MR-JHSCBL cable specifications.
		Section 6-4-1 (2)	Added HC□-A47 to MR-ENCNS connector set.
		Section 6-4-2	Added outline drawing for servo amplifier CN2 connector shell kit 10320-52A0-008.
		Section 6-4-5 (2)	Added CNV2C cable connection diagram.
		Section 6-4-5 (3)	Deleted CNV2 cable connection diagram. Added CNV12 cable connection diagram.
		Section 6-4-5 (5)	Added MR-RMCBL cable connection diagram.
		Section 7-2	Changed MDS-B-CVE to MDS-C1-CV due to changes in model.
		Section 7-3	Changed MDS-B-CVE to MDS-C1-CV due to changes in model
		Section 8-3-1	Revised alarm 25 Investigation method column, added note to Remedy column.
		Section 8-3-2	Added explanation of warning E2.
		Section 8-3-3	Added warning E2.
		Section 9-2-1	Added calorific value characteristics for combination with HC102, HC152 or HC202 one-rank lower capacity amplifier. Added HC352, HC203, HA200N and HA103N calorific value characteristics.
		Section 9-3-2	Added HC352, HC203, HA200N and HA103N magnetic brake characteristics.
		Section 9-4	Added brake characteristics for combination with HC102, HC152 or HC202 one-rank lower capacity amplifier. Added HC352, HC203, HA200N and HA103N brake characteristics.
		Section 10-2-1	Changed motor type change section notation to □. Added HC□-A47 and HC□R-A47 specifications. Added specifications for combination with HC102, HC152 or HC202 one-rank lower capacity amplifier. Added HC352, HC203, HA200N and HA103N specifications.
		Section 10-2-2	Added torque characteristics drawing for combination with HC102, HC152 or HC202 one-rank lower capacity amplifier. Added HC352, HC203, HA200N and HA103N torque characteristics drawing. Added cautions to torque characteristics diagram for HC-RF, HA-FF and HC-MF motor.

Printing date	Specification manual No.	Revision details
July, 2002	BNP-B3937F (continued)	Section 10-2-3 Added outline drawing of HC□-A47 and HC□R-A47. Deleted IP67 specifications motor type. Revised L dimension in HC-MF73(K)-S15 motor outline drawing. (161 → 160) Section 11-1-2 Changed MDS-B-V1/V2 + MDS-B-CV to MDS-C1-V1/V2 + MDS-C1-CV. Section 11-2-1 Deleted explanation of IP67 specifications in explanation of HC□ and HC□R Series features. Section 11-2-2 Changed MDS-B-V1/V2 to MDS-C1-V1/V2. Added HC□-A47 and HC□R-A47 to Tables 11-4 and 11-5. Section 11-3 Added characteristics of new motor to Fig. 11-2 (1) and (2). Section 11-4-1 Divided Table 11-8 into Table 11-8 (1) and Table 11-8 (2), and added new motors. Section 11-4-2 Added external option regenerative resistor to Table 11-9. Section 11-5-3 Revised Y axis motor shaft conversion total load inertia in measurement results table from 30.3 to 30.4.
Nov., 2002	BNP-B3937G	Changed parameter names, alarm names and warning names to integrated names. Changed bit description in HEX setting parameter from 10 ~ 15 to A ~ F. Preface 4 Added tow cautions. Ch. 2 Preface Added caution. Section 2-1 Changed Class 3 grounding or higher in system connection diagram to Class C protective grounding or higher. Section 2-3 Changed MDS-B-V1/V2 to MDS-C1-V1/V2. Section 2-7 Changed bit description. Changed Servo specifications to Servo specification selection. Section 2-9 Changed bit description. Section 3-2 Added caution. Section 3-2-3 Changed bit description. Changed Servo specifications to Servo specification selection. Section 3-2-6 Created CAUTION and added explanation. Section 4-2-1 Changed bit description. Changed parameter names to integrated names. Section 4-2-3 Changed parameter names to integrated names. Section 4-2-4 Changed Speed loop leading compensation to Speed loop lead compensation. Section 4-3 Changed parameter names to integrated names. Section 5-1-6 Changed bit description. Changed Special servo function selection 3 to Servo function selection 3. Section 5-2-1 Changed parameter names to integrated names. Section 5-2-2 (2) Changed parameter names to integrated names. Section 5-2-3 Changed "during spindle synchronization" to "in spindle synchronous control" in parameter table. (x 3) Section 5-2-3 (3) Changed parameter names to integrated names. Section 5-3-1 (1) Recreated max. current command value table. Section 5-3-1 (2) Changed Special servo function selection 3 to Servo function selection 3. (in body, parameter table) Changed HEX parameter bit description. Section 5-3-2 (1) Corrected title. Corrected explanation. Changed parameter names to integrated names. Changed bit description. Section 5-3-2 (2) Corrected explanation. Changed parameter names to integrated names. Changed bit description. Section 5-3-2 (3) Changed parameter name to integrated name. Changed bit description.

Printing date	Specification manual No.	Revision details
Nov., 2002	BNP-B3937G (continued)	Section 5-3-2 (4) Corrected explanation. Changed parameter names to integrated names. Changed bit description. Section 5-3-3 (2) Changed Speed loop leading compensation to Speed loop lead compensation. Section 5-3-3 (3) Changed Voltage non-sensitive band compensation to Voltage dead-time compensation. Section 5-3-3 (4) Corrected explanation. Changed parameter names to integrated names. Section 5-3-4 (1) Corrected explanation. Changed parameter names to integrated names. Changed bit description. Changed parameter explanation. Deleted 5. in POINT. Section 5-3-5 (1) Changed bit description. Changed parameter name to integrated name. Section 5-3-5 (2) Changed parameter name to integrated name. Changed bit description. Changed parameter explanation. Section 5-3-6 (1) Changed parameter names to integrated names. Section 5-3-6 (2) Changed parameter names to integrated names Section 5-3-6 (3) Corrected explanation. Changed parameter names to integrated names. Changed bit description. Section 5-4-1 (1) Corrected explanation. Changed parameter names to integrated names. Corrected description in CAUSION. Section 5-4-1 (2) Corrected explanation. Changed parameter names to integrated names. Changed bit description. Section 5-4-1 (3) Changed parameter name to integrated name. Section 5-4-2 (1) Corrected description in POINT. Section 5-4-2 (2) Changed parameter name to integrated name. Changed bit description. Section 5-5 Corrected explanation. Changed parameter names to integrated names. Changed bit description. Section 5-6 Changed parameter names to integrated names, reviewed and corrected all explanations. Section 6-1-1 Changed bit description. Added caution. Section 8-3 Changed alarm names and warning names to integrated names. Section 10-2-3 Corrected and added outline dimension drawings of HC203S/HC352S-A42/E42/A33/E33 and HC203BS/HC352BS-A42/E42/A33/E33. Corrected HA100NSB to HA100NBS, HA103NSB to HA103NBS and HA200NSB to HA200NBS
June., 2003	BNP-B3937H	Section 1-1-2 Added HC□ and HC□R motor series IP67 specifications. Section 5-6 Changed explanation when parameter SV027 servo function selection 1 bit 4 and 5 are set. Section 9-4-2 Corrected coasting amount calculation coefficients. Section 10-2-1 Deleted a power rate at continuous rated torque from list of the servo motor specifications. Section 10-2-3 Change the size of HC-MF23/43-S15. Section 11-3-3 Added selection expression in case of unbalanced axis. Section 11-5-1 Changed a selection percentage in case of unbalanced axis. (Changed into 60% from 50%.)

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MODEL	MDS-B-SVJ2 Series
MODEL CODE	007-061
Manual No.	BNP-B3937H(ENG)

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