Changes for the Better

MITSUBISHI
ELECTRIC

CNC
MELDAS AC SERVO/SPINDLE
MDS-CH Series

SPECIFICATIONS MANUAL

BNP-C3016F(ENG)

Introduction

Thank you for selecting the Mitsubishi numerical control unit.
This instruction manual describes the handling and caution points for using this AC servo/spindle.
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.
Always store this manual in a safe place.
All specifications for the MDS-CH Series are described in this manual. However, each CNC may not be provided with all specifications, so refer to the specifications for the CNC on hand before starting use.

Notes on Reading This Manual

(1) Since the description of this specification manual deals with NC in general, for the specifications of individual machine tools, refer to the manuals issued by the respective machine manufacturers. The "restrictions" and "available functions" described in the manuals issued by the machine manufacturers have precedence to those in this manual.

(2) This manual describes as many special operations as possible, but it should be kept in mind that items not mentioned in this manual cannot be performed.

Precautions for safety

Please read this 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 "WARNING" and "CAUTION".

⚠ **DANGER**	When there is a potential risk of fatal or serious injuries if handling is mistaken.
⚠ **WARNING**	When a dangerous situation, or fatal or serious injuries may occur if handling is mistaken.
⚠ **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 numeric control unit is configured of the control unit, operation board, servo drive unit, spindle drive unit, power supply, servomotor and spindle motor, etc.

In this manual, the following items are generically called the "motor".
- Servomotor
- Linear servomotor
- Spindle motor

In this manual, the following items are generically called the "unit".
- Servo drive unit
- Spindle drive unit
- Power supply unit
- Scale I/F unit
- Magnetic pole detection unit

⚠ DANGER

There are no "DANGER" items in this manual.

⚠ WARNING

1. Electric shock prevention

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

⚠ Do not operate the unit with the front cover removed. The high voltage terminals and charged sections will be exposed, and can cause electric shocks.

⚠ Do not remove the front cover even when the power is OFF unless carrying out wiring work or periodic inspections. The inside of the units is charged, and can cause electric shocks.

⚠ Wait at least 15 minutes after turning the power OFF before starting wiring or inspections. Failure to observe this could lead to electric shocks.

⚠ Ground the unit and motor with Class C (former class 3) grounding or higher.

⚠ Wiring and inspection work must be done by a qualified technician.

⚠ Wire the servo drive unit 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 on the cables or get them caught. Failure to observe this could lead to electric shocks.

2. Injury prevention

⚠ The linear servomotor uses a powerful magnet on the secondary side, and could adversely affect pacemakers, etc.

⚠ During installation and operation of the machine, do not place portable items that could malfunction or fail due to the influence of the linear servomotor's magnetic force.

⚠ Take special care not to pinch fingers, etc., when installing (and unpacking) the linear servomotor.

⚠ CAUTION

1. Fire prevention

⚠ Install the units, motors and regenerative resistor on noncombustible material. Direct installation on combustible material or near combustible materials could lead to fires.

⚠ Shut off the power on the power supply unit side if a fault occurs in the units. Fires could be caused if a large current continues to flow.

⚠ Provide a sequence that shut off the power at the regenerative resistor error signal-ON when using the regenerative resistor. The regenerative resistor could abnormally overheat and cause a fire due to a fault in the regenerative transistor, etc.

⚠ The battery unit could heat up, ignite or rupture if submerged in water, or if the poles are incorrectly wired.

⚠ CAUTION

2. Injury prevention

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 radiation fin on unit back face, regenerative resistor or motor, etc., or place parts (cables, etc.) while the power is turned ON or immediately after turning the power OFF. These parts may reach high temperatures, and can cause burns.

Structure the cooling fan on the unit back face so that it cannot be touched after installation. Touching the cooling fan during operation could lead to injuries.

3. Various precautions

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

(1) Transportation and installation

⚠ Correctly transport the product according to its weight.

Use the motor's hanging bolts only when transporting the motor. Do not transport the motor when it is installed on the machine.

⚠ Do not stack the products above the tolerable number.

⚠ Do not hold the cables, axis or detector when transporting the motor.

⚠ Do not hold the connected wires or cables when transporting the units.

⚠ Do not hold the front cover when transporting the unit. The unit could drop.

⚠ Follow this Instruction Manual and install the unit or motor 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 of the units or motors.

⚠ Secure the specified distance between the units and control panel, or between the servo drive unit and other devices.

⚠ Do not install or run a unit or motor that is damaged or missing parts.

⚠ Do not block the intake or exhaust ports of the motor provided with a cooling fan.

⚠ Do not let foreign objects enter the units or motors. In particular, if conductive objects such as screws or metal chips, etc., or combustible materials such as oil enter, rupture or breakage could occur.

⚠ The units and motors 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	
		Unit	**Motor**
Ambient temperature	During operation	0°C to 55°C (with no freezing)	0°C to 40°C (with no freezing)
	During storage/ transportation	–15°C to 70°C (with no freezing)	–20°C to 65°C **Note 1)** (with no freezing)
Ambient humidity	During operation	90%RH or less (with no dew condensation)	20% to 90%RH (with no dew condensation)
	During storage/ transportation	90%RH or less (with no dew condensation)	90% RH or less (with no dew condensation)
Atmosphere		Indoors (where unit is not subject to direct sunlight), with no corrosive gas, combustible gas, oil mist, dust or conductive particles	
Altitude		Operation/storage: 1,000m or less above sea level Transportation: 10,000m or less above sea level (This specified value may be exceeded only during air-transport)	
Vibration		To follow each unit and motor specifications	

Note 1) -15°C to 55°C for linear servomotor.

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

⚠ Always install the servomotor with reduction gear in the designated direction. Failure to do so could lead to oil leaks.

⚠ Structure the rotary sections of the motor so that it can never be touched during operation. Install a cover, etc., on the shaft.

⚠ When installing a 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.

⚠ Store the motor in the package box.

⚠ When inserting the shaft into the built-in IPM motor, do not heat the rotor higher than 130°C. The magnet could be demagnetized, and the specifications characteristics will not be ensured.

⚠ Always use a nonmagnetic tool (explosion-proof beryllium copper alloy safety tool: NGK Insulators) when installing the linear servomotor.

⚠ Always provide a mechanical stopper on the end of the linear servomotor's travel path.

❗ If the unit has been stored for a long time, always check the operation before starting actual operation. Please contact the Service Center or Service Station.

⚠ CAUTION

(2) Wiring

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

⚠ Do not install a condensing capacitor, surge absorber or radio noise filter on the output side of the drive unit.

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

⚠ Always install an AC reactor for each power supply unit.

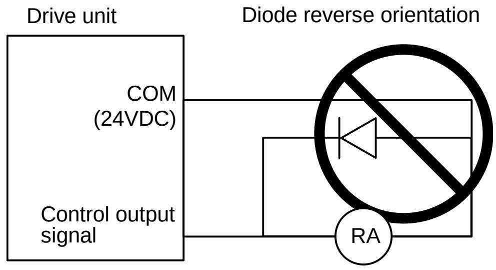
⚠ Always install an appropriate breaker for each power supply unit. Breakers cannot be shared by several units.

⚠ Direct application of a commercial power supply to the motor could cause burning. Always connect the motor to the drive unit's output terminals (U, V, W).

⚠ When using an inductive load such as a relay, always connect a diode as a noise measure parallel to the load.

⚠ When using a capacitance load such as a lamp, always connect a protective resistor as a noise measure serial to the load.

⚠ Do not reverse the direction of a diode which connect to a DC relay for the control output signals to suppress a surge. Connecting it backwards could cause the drive unit to malfunction so that signals are not output, and emergency stop and other safety circuits are inoperable.



⚠ Do not connect/disconnect the cables connected between the units while the power is ON.

⚠ Securely tighten the cable connector fixing screw or fixing mechanism. An insecure fixing could cause the cable to fall off while the power is ON.

⚠ When using a shielded cable instructed in the connection manual, always ground the cable with a cable clamp, etc.

⚠ Always separate the signals wires from the drive wire and power line.

⚠ Use wires and cables that have a wire diameter, heat resistance and flexibility that conforms to the system.

CAUTION

(3) Trial operation and adjustment

Check and adjust each program and 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.

The usable motor and unit combination is predetermined. Always check the models before starting trial operation.

If the axis is unbalanced due to gravity, etc., balance the axis using a counterbalance, etc.

The linear servomotor does not have a stopping device such as magnetic brakes. Install a stopping device on the machine side.

(4) Usage methods

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

Turn the power OFF immediately if smoke, abnormal noise or odors are generated from the unit or motor.

Unqualified persons must not disassemble or repair the unit.

Never make modifications.

Reduce magnetic damage by installing a noise filter. The electronic devices used near the unit could be affected by magnetic noise.

Use the unit, motor and regenerative resistor with the designated combination. Failure to do so could lead to fires or trouble.

The brake (magnetic brake) assembled into the servomotor are for holding, and must not be used for normal braking. Do not apply the brakes in the servo ON state. Doing so will lead to a drop in the brake life. Always turn the servo OFF before applying the brakes.

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.

After changing the programs/parameters or after maintenance and inspection, always test the operation before starting actual operation.

Do not enter the movable range of the machine during automatic operation. Never place body parts near or touch the spindle during rotation.

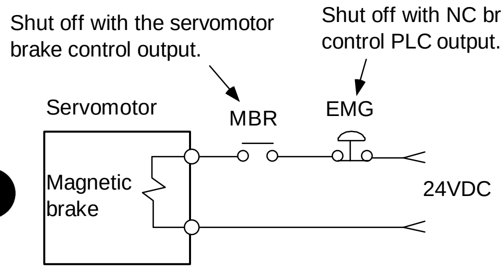
Follow the power supply specification conditions given in the separate specifications manual for the power (input voltage, input frequency, tolerable sudden power failure time, etc.).

CAUTION

(5) Troubleshooting

If a hazardous situation is predicted during power failure 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.



Always turn the input power OFF when an alarm occurs.

Never go near the machine after restoring the power after a power 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

Always backup the programs and parameters in the CNC device before starting maintenance or inspections.

The capacity of the electrolytic capacitor will drop over time due to self-discharging, etc. To prevent secondary disasters due to failures, replacing this part every five years when used under a normal environment is recommended. Contact the Service Center or Service Station for replacement.

Do not perform a megger test (insulation resistance measurement) during inspections.

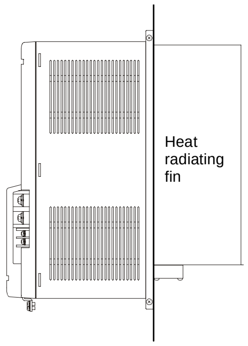
If the battery low warning is issued, back up the machining programs, tool data and parameters with an input/output unit, and then replace the battery.

Do not short circuit, charge, overheat, incinerate or disassemble the battery.

The heat radiating fin used in the 37kW and smaller unit contains substitute Freon as the refrigerant.
Take care not to damage the heat radiating fin during maintenance and replacement work.

(7) Disposal

Do not dispose of this unit as general industrial waste. The 37kW and smaller unit with heat radiating fin protruding from the back of the unit contains substitute Freon. Do not dispose of this type of unit as general industrial waste. Always return to the Service Center or Service Station.



Do not disassemble the unit or motor.

Dispose of the battery according to local laws.

Always return the secondary side (magnet side) of the linear servomotor to the Service Center or Service Station.

⚠ CAUTION

(8) Transportation

⚠ The unit and motor are precision parts and must be handled carefully.

⚠ According to a United Nations Advisory, the battery unit and battery must be transported according to the rules set forth by the International Civil Aviation Organization (ICAO), International Air Transportation Association (IATA), International Maritime Organization (IMO), and United States Department of Transportation (DOT), etc.

(9) General precautions

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.

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1-1 Inspection at purchase

Open the package, and read the rating nameplates to confirm that the drive units, power supply unit and servomotor are as ordered.

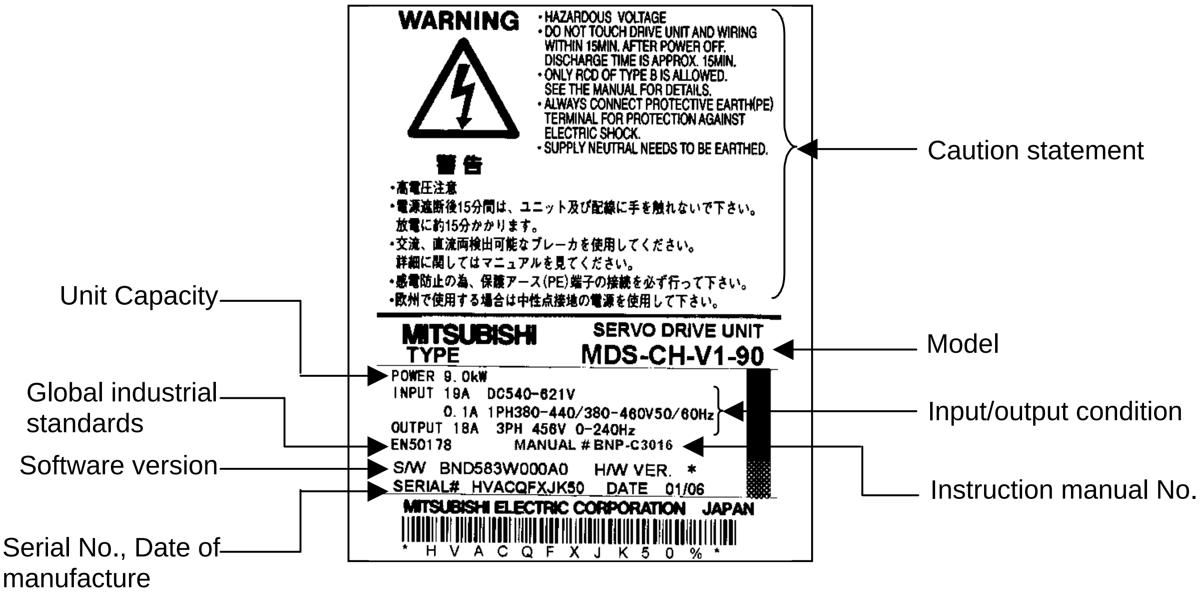
1-1-1 Package contents

Packaged parts	Qty.
Power supply unit	1
Servo/spindle motor	1

Packaged parts	Qty.
Servo drive unit	1
Spindle drive unit	1

1-1-2 Rating nameplate

The rating nameplate is attached to the front of the unit.
The following rating nameplate is for the servo drive unit. The same matters are indicated on the power supply unit and spindle drive unit.



WARNING

- HAZARDOUS VOLTAGE
- DO NOT TOUCH DRIVE UNIT AND WIRING WITHIN 15MIN. AFTER POWER OFF. DISCHARGE TIME IS APPROX. 15MIN.
- ONLY RCD OF TYPE B IS ALLOWED. SEE THE MANUAL FOR DETAILS.
- ALWAYS CONNECT PROTECTIVE EARTH(PE) TERMINAL FOR PROTECTION AGAINST ELECTRIC SHOCK.
- SUPPLY NEUTRAL NEEDS TO BE EARTHED.

警告

・高電圧注意
・電源遮断後15分間は、ユニット及び配線に手を触れないで下さい。
放電に約15分かかります。
・交流、直流両検出可能なブレーカを使用してください。
詳細に関してはマニュアルを見てください。
・感電防止の為、保護アース(PE)端子の接続を必ず行って下さい。
・欧州で使用する場合は中性点接地の電源を使用して下さい。

MITSUBISHI SERVO DRIVE UNIT
TYPE MDS-CH-V1-90
POWER 9.0kW
INPUT 19A DC540-621V
0.1A 1PH380-440/380-460V50/60Hz
OUTPUT 18A 3PH 456V 0-240Hz
EN50178 MANUAL # BNP-C3016
S/W BND583W000A0 H/W VER. *
SERIAL# HVACQFXJK50 DATE 01/06
MITSUBISHI ELECTRIC CORPORATION JAPAN
* H V A C Q F X J K 5 0 % *

1-1-3 Power supply unit model

MDS - CH - CV - [   ]

Series: MDS
Power supply unit: CV

Symbol	Rated Output [kW]
37	2.2
55	3.7
75	5.5
110	7.5
150	11.0
185	15.0
220	18.5

Symbol	Rated Output [kW]
260	22.0
300	26.0
370	30.0
450(Note)	37.0
550(Note)	45.0
750(Note)	55.0

(Note) DC connection bar is required. Always install a large capacity drive unit in the left side of power supply unit, and connect with DC connection bar.

1-1-4 Servo drive unit model

MDS - CH - V1 - [ ]

Series

1-axis servo drive unit

Symbol	Rated Output [kW]
05	0.5
10	1.0
20	2.0
35	3.5
45	4.5

Symbol	Rated Output [kW]
70	7.0
90	9.0
110	11.0
150	15.0
185(Note)	18.5

(Note) DC connection bar is required. Always install a large capacity drive unit in the left side of power supply unit, and connect with DC connection bar.

MDS - CH - V2 - [ ]

Series

2-axis servo drive unit

Symbol	Rated Output [kW]
0505	0.5 / 0.5
1005	1.0 / 0.5
1010	1.0 / 1.0
2010	2.0 / 1.0
2020	2.0 / 2.0

Symbol	Rated Output [kW]
3510	3.5 / 1.0
3520	3.5 / 2.0
3535	3.5 / 3.5
4520	4.5 / 2.0
4535	4.5 / 3.5

1-1-5 Spindle drive unit model

MDS - CH - SP[ ] - [ ]

Series

Spindle drive unit

Symbol	Cont. Rating [kW]
15	0.75
22	1.5
37	2.2
55	3.7
75	5.5
110	7.5
150	11.0

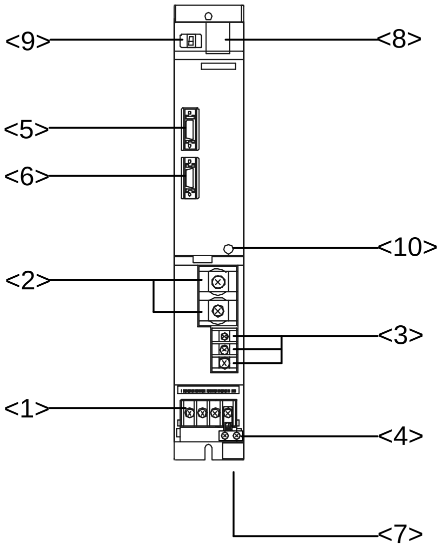
Symbol	Cont. Rating [kW]
185	15.0
220	18.5
260	22.0
300	26.0
370(Note)	30.0
450(Note)	37.0
550(Note)	45.0
750(Note)	55.0

Symbol	Corresponding spindle motor
None	Standard specifications part
H	• High-speed part: 10000r/min or more • C axis detector (1/10000°) correspondence: ERM280 (HEIDENHAIN) • IPM spindle motor compatible (Conventional SPM class has been eliminated.)

(Note) DC connection bar is required. Always install a large capacity drive unit in the left side of power supply unit, and connect with DC connection bar.

1-2 Explanation of each part

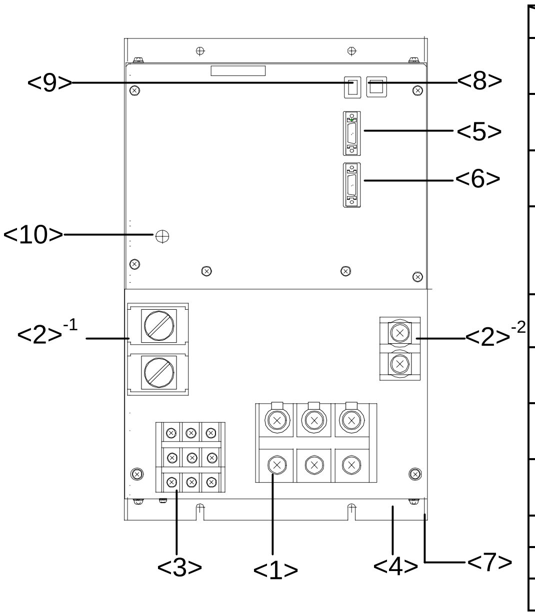
1-2-1 Explanation of each power supply unit part



Each part name

		Name		Description
<1>	Main circuit	TE1	L1, L2, L3	Power supply input terminal (3-phase AC input)
<2>		TE2	L+, L–	Converter voltage output terminal (DC output)
<3>		TE3	L11, L21	Control power input terminal (single-phase AC input)
			MC1	External contactor control terminal
<4>		PE	⏚	Grounding terminal
<10>		---	CHARGE LAMP	TE2 output charging/discharging circuit indication LED
<5>	Control circuit	CN4	---	Servo/spindle communication connector (master)
<6>		CN9	---	Servo/spindle communication connector (slave)
<7>		CN23	---	External emergency stop input connector
<8>		SW1	---	Power supply setting switch
<9>		LED	---	Power supply status indication LED

Precautions
CN23 is located at the bottom of the power supply unit.



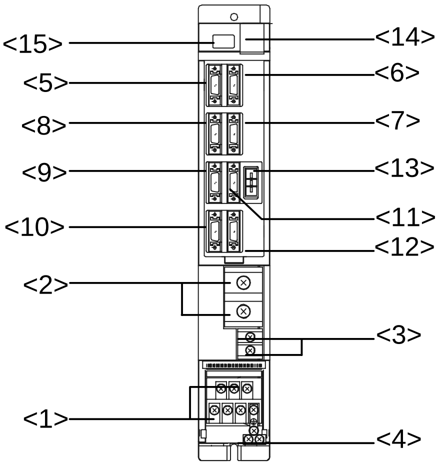
Each part name

		Name		Description
<1>	Main circuit	TE1	L1, L2, L3	Power supply input terminal (3-phase AC input)
<2>$^{-1}$		TE2-1	L+, L–	Voltage output terminal (DC output) CV-450/550/750
<2>$^{-2}$		TE2-2	L+, L–	Voltage output terminal (DC output) CV-450/550
<3>		TE3	L11, L21	Control power input terminal (single-phase AC input)
			MC1, MC2	External contactor control terminal
<4>		PE	⏚	Grounding terminal
<10>		---	CHARGE LAMP	TE2 output charging circuit indication LED
<5>	Control circuit	CN4	---	Servo/spindle communication connector (master)
<6>		CN9	---	Servo/spindle communication connector (slave)
<7>		CN23	---	External emergency stop input connector
<8>		SW1	---	Power supply setting switch
<9>		LED	---	Power supply status indication LED

Precautions
CN23 is located at the bottom of the power supply unit.
TE2-2 is used to connect a 30kW or smaller drive unit.

The connector layout will differ according to the units being used. Check each unit outline drawing for details.

1-2-2 Explanation of each servo drive unit part



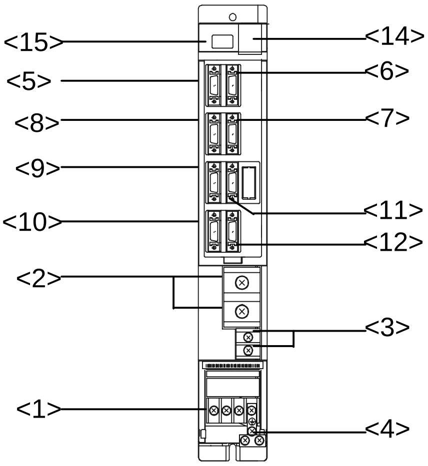
Each part name

		Name		Description
<1>	Main circuit	TE1	MU, MV, MW LU, LV, LW	Motor drive output terminal (3-phase AC output)
<2>		TE2	L+, L–	Converter voltage input terminal (DC input)
<3>		TE3	L11, L21	Control power input terminal (single-phase AC input)
<4>		PE	⏚	Grounding terminal
<5>	Control circuit	CN1A	---	NC or upward axis communication connector
<6>		CN1B	---	Battery unit/terminator Lower axis communication connector
<7>		CN4	---	Power supply communication connector
<8>		CN9	---	Maintenance connector (normally not used)
<9>		CN2L	---	Motor side detector connection connector (L axis)
<10>		CN2M	---	Motor side detector connection connector (M axis)
<11>		CN3L	---	Machine side detector connection connector (L axis)
<12>		CN3M	---	Machine side detector connection connector (M axis)
<13>		CN20	---	Electromagnetic/dynamic brake connector
<14>		SW1	---	Axis No. setting switch
<15>		LED	---	Unit status indication LED

Precautions

1. The connector names differ for the V1 drive unit.
   (CN2L/CN3L → CN2/CN3, CN2M/CN3M → Not mounted)
   The MU, MV and MW terminals are not provided. The LU, LV and LW terminals are named U, V and W.

1-2-3 Explanation of each spindle drive unit part



Each part name

		Name		Description
<1>	Main circuit	TE1	U, V, W	Motor drive output terminal (3-phase AC output)
<2>		TE2	L+, L–	Converter voltage input terminal (DC input)
<3>		TE3	L11, L21	Control power input terminal (single-phase AC input)
<4>		PE	⏚	Grounding terminal
<5>	Control circuit	CN1A	---	NC or upward axis communication connector
<6>		CN1B	---	Battery unit/terminator lower axis communication connector
<7>		CN4	---	Power supply communication connector
<8>		CN9	---	Maintenance connector (normally not used)
<9>		CN5	---	Internal PLG encoder connection connector
<10>		CN7	---	C axis control encoder connection connector
<11>		CN6	---	Magnetic sensor connection connector
<12>		CN8	---	CNC connection connector
<14>		SW1	---	Axis No. setting switch
<15>		LED	---	Unit status indication LED

Precautions

The connector and terminal block layout will differ according to the units being used.
Check each unit outline drawing for details.

2. Wiring and Connection

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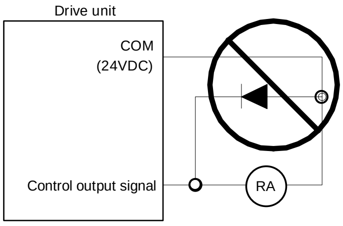
⚠ DANGER

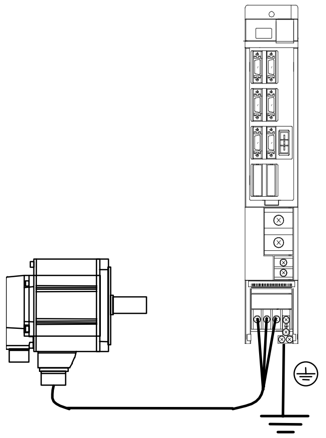
1. Wiring work must be done by a qualified technician.
2. Wait at least 15 minutes after turning the power OFF and check the voltage with a tester, etc., before starting wiring. Failure to observe this could lead to electric shocks.
3. Securely ground the drive units and servo/spindle motor with Class 3 grounding or higher.
4. Wire the drive units and servo/spindle motor after installation. Failure to observe this could lead to electric shocks.
5. Do not damage, apply forcible stress, place heavy items on the cables or get them caught. Failure to observe this could lead to electric shocks.
6. Always insulate the power terminal connection section. Failure to observe this could lead to electric shocks.

⚠ CAUTION

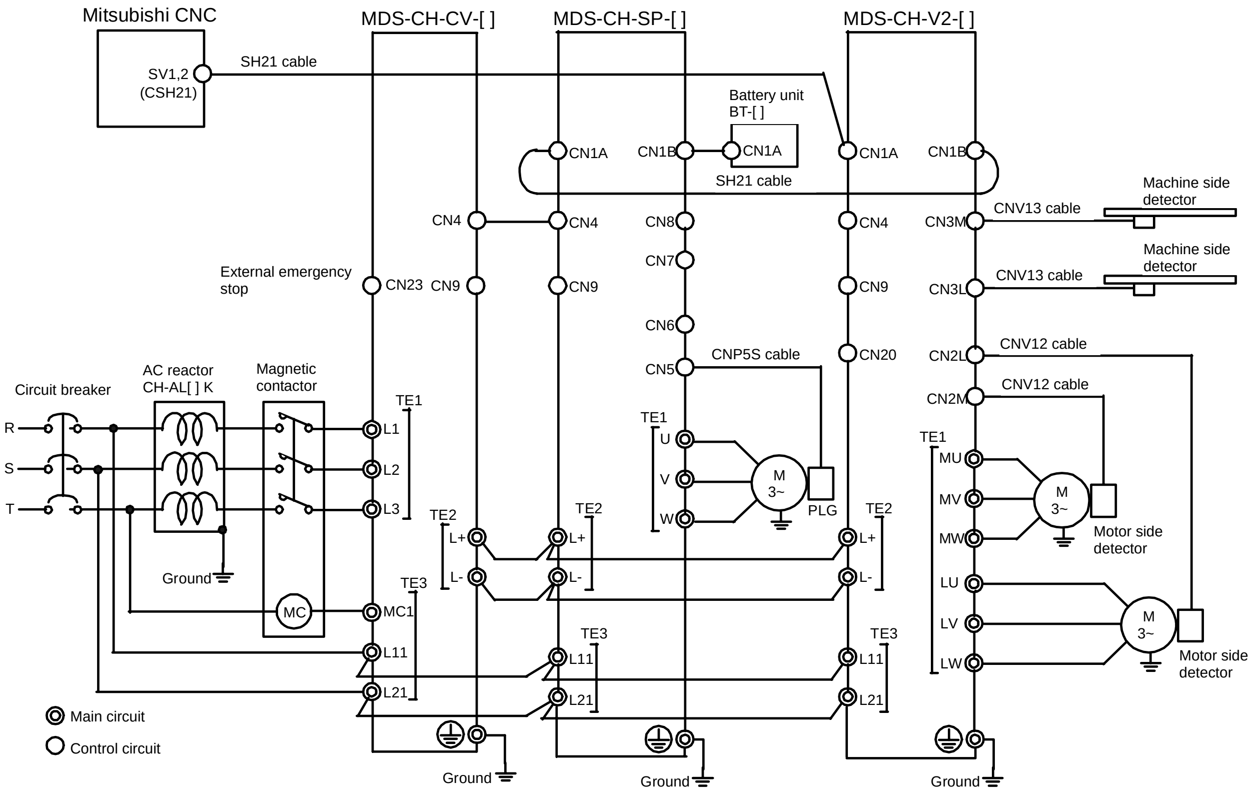
1. Correctly and securely perform the wiring. Failure to do so could lead to runaway of the servo/spindle motor.
2. Do not mistake the terminal connections.
   Failure to observe this item could lead to ruptures or damage, etc.
3. Do not mistake the polarity (+ , –). Failure to observe this item could 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 contactor) control. The signal might not be output when a failure occurs.



5. Electronic devices used near the drive units 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 line (U, V, W) of the servo/spindle motor.
7. Do not modify this unit.
8. The half-pitch connector (CN1A, etc.) on the front of the drive units 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 drive units, and ground from the other protective grounding terminal.
   (Use one-point grounding)
   Do not separately ground the connected motor and drive unit as noise could be generated.

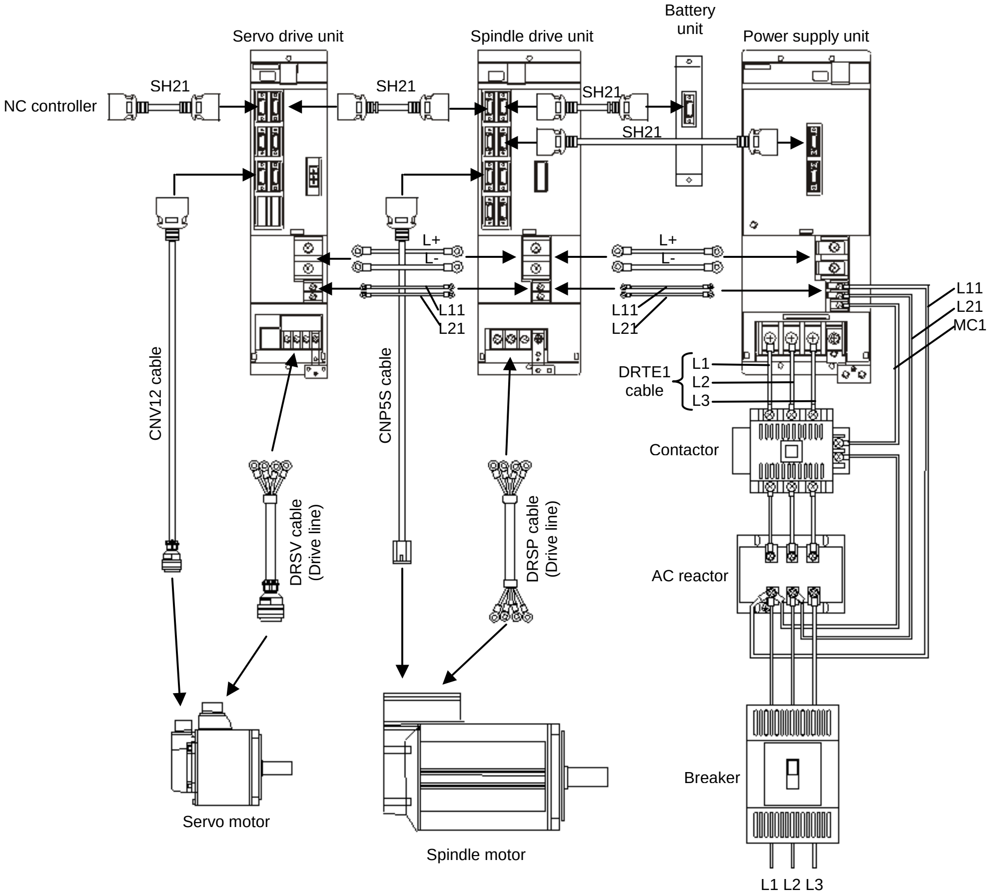


2-1 Part system connection diagram



(Note 1) The total length of the SH21 cable must be within 30m.
(Note 2) The connection method will differ according to the used motor.
(Note 3) When not using an absolute position detector, connect the terminal connector (R-TM).
(Note 4) The main circuit (◎) and control circuit (○) are safely separated.

Example of actual wiring



Note)

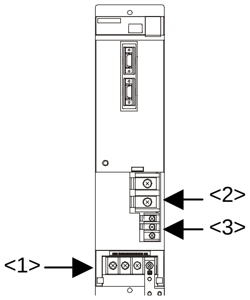
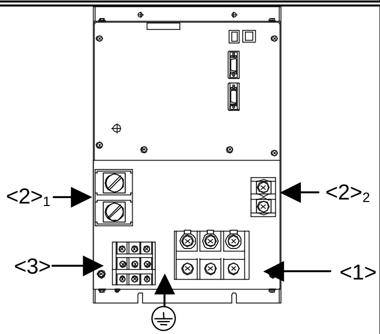
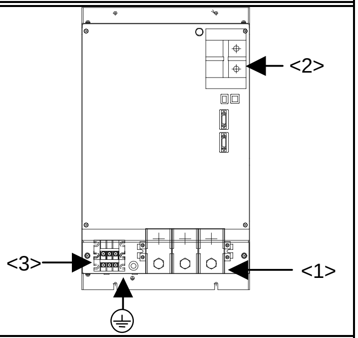
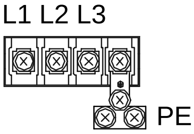
The main circuit cable wiring must be prepared by the user.
The wiring to the grounding cable is not shown. Refer to section "2-10 Wiring the Grounding Cable".

2-2 Main circuit terminal block/control circuit connector

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

2-2-1 Connector pin assignment

Power supply unit

<table>
<tr><th colspan="3">Unit
Terminal</th><th>MDS-CH-CV-37 to
MDS-CH-CV-370</th><th>MDS-CH-CV-450
MDS-CH-CV-550</th><th>MDS-CH-CV-750</th></tr>
<tr><td colspan="3">Terminal position</td>
<td> </td>
<td> </td>
<td> </td></tr>
<tr><td rowspan="4">Terminal specification/Pin assignment</td><td><1></td><td>TE1</td>
<td><1>

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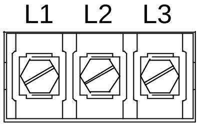
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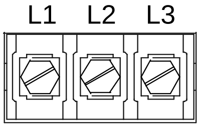
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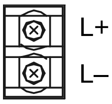
<tr><td><2></td><td>TE2</td>
<td><2>

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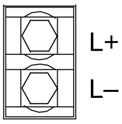
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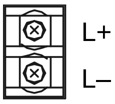
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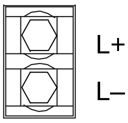
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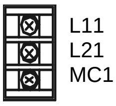
<tr><td><3></td><td>TE3</td>
<td><3>

<table><tr><th></th><th>37-185</th><th>220-370</th></tr><tr><td>Screw size</td><td>M4 × 10</td><td>M4 × 10</td></tr><tr><td>Tightening torque</td><td>1.2Nm</td><td>1.2Nm</td></tr></table></td>
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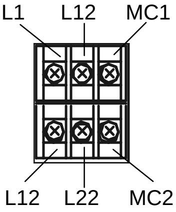
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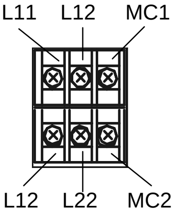
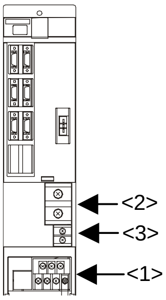
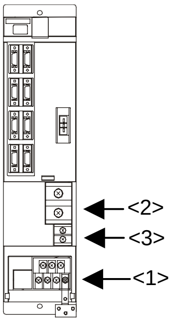
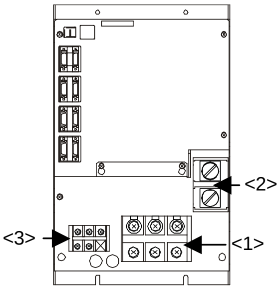
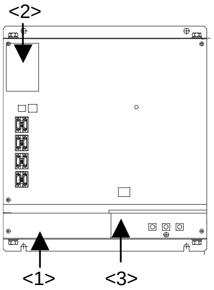
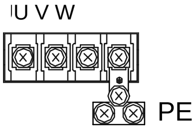
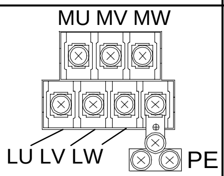
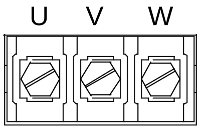
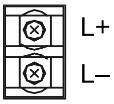
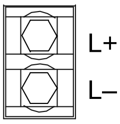
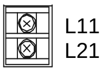
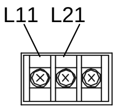

<table><tr><th></th><th>750</th></tr><tr><td>Screw size</td><td>M4 × 8</td></tr><tr><td>Tightening torque</td><td>1.2Nm</td></tr></table></td></tr>
<tr><td></td><td>⏚</td>
<td>Refer to PE terminal of TE1.</td>
<td><table><tr><th></th><th>450</th><th>550</th></tr><tr><td>Screw size</td><td>M8 × 16</td><td>M10 × 20</td></tr><tr><td>Tightening torque</td><td>6.0Nm</td><td>11.0Nm</td></tr></table></td>
<td><table><tr><th></th><th>750</th></tr><tr><td>Screw size</td><td>M10 × 20</td></tr><tr><td>Tightening torque</td><td>11.0Nm</td></tr></table></td></tr>
</table>

Servo/spindle drive unit

<table>
<tr><th colspan="3">Unit
Terminal</th><th>MDS-CH-V-150 or less
MDS-CH-SP-300 or less</th><th>MDS-CH-V2 Series</th><th>MDS-CH-V1-185
MDS-CH-SP-370
MDS-CH-SP-450/550</th><th>MDS-CH-SP-750</th></tr>
<tr><td colspan="3">Terminal position</td>
<td> </td>
<td> </td>
<td> </td>
<td> </td></tr>
<tr><td rowspan="4">Terminal specification/Pin assignment</td><td><1></td><td>TE1</td>
<td colspan="2"><1>  <1> 
<table>
<tr><td rowspan="3">Corresponding unit</td><td>V1-</td><td>10-35</td><td>45-90</td><td>110-150</td></tr>
<tr><td>V2-</td><td>1010-4535</td><td>----</td><td>----</td></tr>
<tr><td>SP-</td><td>15-37</td><td>55-185</td><td>220-300</td></tr>
<tr><td colspan="2">Screw size</td><td>M4 × 10</td><td>M5 × 12</td><td>M8 × 14</td></tr>
<tr><td colspan="2">Tightening torque</td><td>1.2Nm</td><td>2.0Nm</td><td>6.0Nm</td></tr>
</table></td>
<td colspan="2"><1> 
<table>
<tr><td></td><td>370</td><td>450/550/750</td></tr>
<tr><td>Screw size</td><td>M8 × 16</td><td>M10 × 20</td></tr>
<tr><td>Tightening torque</td><td>6.0Nm</td><td>11.0Nm</td></tr>
</table></td></tr>
<tr><td><2></td><td>TE2</td>
<td colspan="2"><2> 
<table>
<tr><td></td><td>V1/V2/SP</td></tr>
<tr><td>Screw size</td><td>M6 × 16</td></tr>
<tr><td>Tightening torque</td><td>3.0Nm</td></tr>
</table></td>
<td colspan="2"><2> 
<table>
<tr><td></td><td>370</td><td>450/550/750</td></tr>
<tr><td>Screw size</td><td>M10 × 20</td><td>M10 × 20</td></tr>
<tr><td>Tightening torque</td><td>11.0Nm</td><td>11.0Nm</td></tr>
</table></td></tr>
<tr><td><3></td><td>TE3</td>
<td colspan="2"><3> 
<table>
<tr><td></td><td>V1/V2/SP</td></tr>
<tr><td>Screw size</td><td>M4 × 10</td></tr>
<tr><td>Tightening torque</td><td>1.2Nm</td></tr>
</table></td>
<td colspan="2"><3> 
<table>
<tr><td></td><td>370/450/550</td><td>750</td></tr>
<tr><td>Screw size</td><td>M4 × 8</td><td>Refer to "2-2-3".</td></tr>
<tr><td>Tightening torque</td><td>1.2Nm</td><td>Refer to "2-2-3".</td></tr>
</table></td></tr>
<tr><td></td><td>⏚</td>
<td colspan="2">Refer to PE terminal of TE1.</td>
<td colspan="2"><table>
<tr><td></td><td>370</td><td>450/550/750</td></tr>
<tr><td>Screw size</td><td>M8 × 16</td><td>M10 × 20</td></tr>
<tr><td>Tightening torque</td><td>6.0Nm</td><td>11.0Nm</td></tr>
</table></td></tr>
</table>

2-2-2 Names and applications of main circuit terminal block signals and control circuit connectors

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

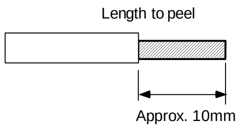
Name	Signal name	Description
L1 · L2 · L3	Main circuit power supply	Main circuit power supply input terminal Connect a 3-phase 380 to 480VAC, 50/60Hz power supply.
L11 · L21 (L12 · L22)	Control circuit power supply	Control circuit power supply input terminal Connect a single-phase 380 to 480VAC, 50/60Hz power supply. Connect the same power supply phase for L11 and L12, and L21 and L22.
MC1 (MC2)	Contactor control	Contactor control terminal The MC1 terminal has the same phase as L21. Connect to a different phase than the phase connected to L21. (Connect MC2 with L21.)
U · V · W	Motor output	Servo/spindle motor power output terminal The servo/spindle motor power terminal (U, V, W) is connected.
LU · LV · LW MU · MV · MW	Motor output	Servo motor power output terminal (L-axis/M-axis) The servo/spindle motor power terminal (U, V, W) is connected.
⏚	Protective grounding (PE)	Grounding terminal The servomotor/spindle motor grounding terminal is connected and grounded.

⚠ **CAUTION**

1. Always use one AC reactor per power supply unit.
   Failure to observe this could lead to unit damage.
2. When sharing a breaker for several power supply units, of a short-circuit fault occurs in a small capacity unit, the breaker could trip. This can be hazardous, so do not share the breaker.
3. Be sure to use the breaker of proper capacity for each Power Supply Unit.

2-2-3 How to use the control circuit terminal block (MDS-CH-SP-750)

The control power for the 75kW spindle unit is not connected to the terminal block, so wire according to the following instructions.

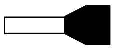


<1> Treatment of wire end

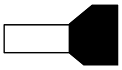
Single wire: Peel the wire sheath, and use the wire.
(Wire size: 0.25 to 2.5 mm^2)

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. (Made by Phoenix contact)



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

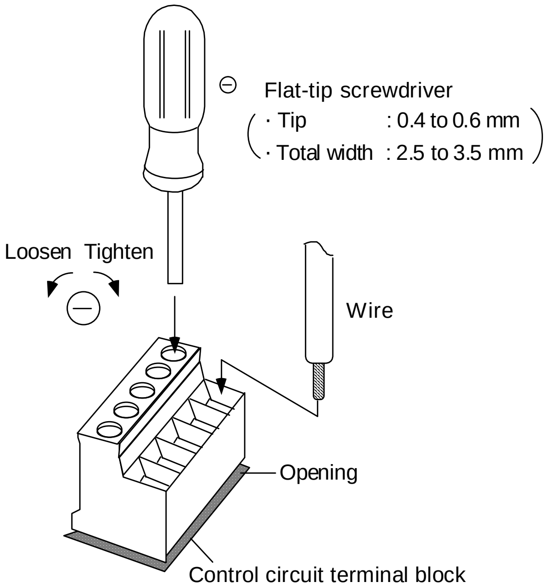


Bar terminal for two wires
(TWIN phenol with insulation sleeve)

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.

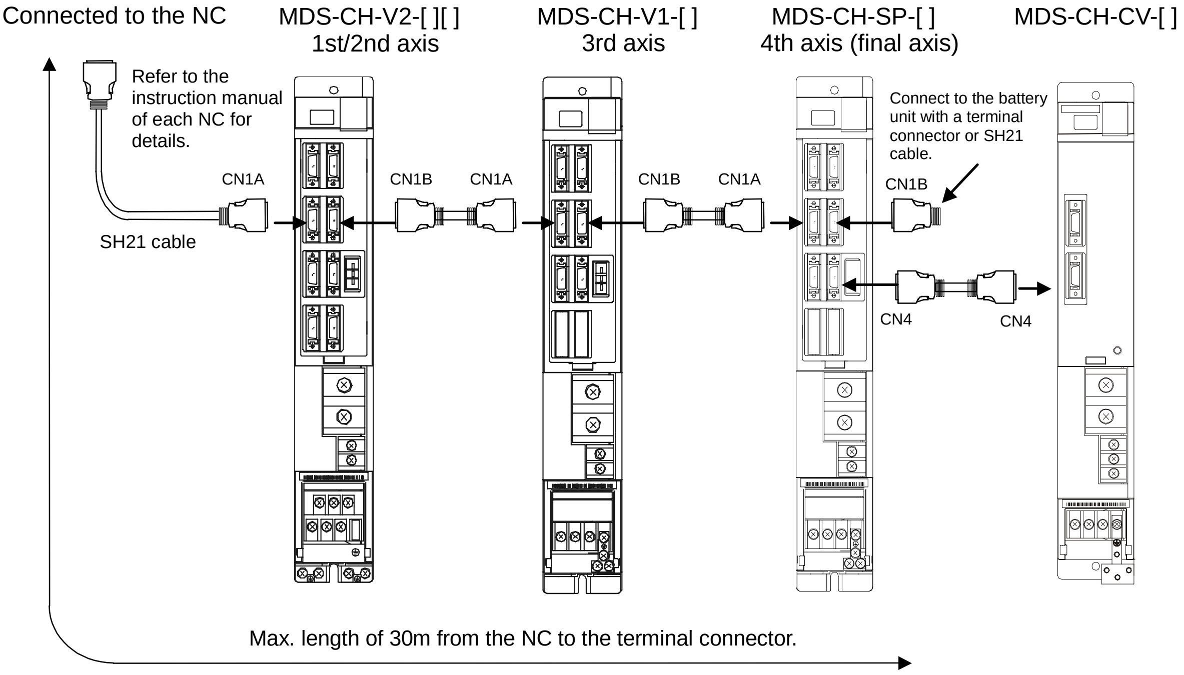

Flat-tip screwdriver
· Tip : 0.4 to 0.6 mm
· Total width : 2.5 to 3.5 mm
Loosen
Tighten
Wire
Opening
Control circuit terminal block

2-3 NC and drive unit connection

The NC bus cables are connected from the NC to each drive unit so that they run in a straight line from the NC to the terminal connector (battery unit). And up to 7 axes can be connected per system. (Note that the number of connected axes is limited by the CNC. The following drawing shows an example with 4 axes connected.)

< Connection >

CN1A : CN1B connector on NC or previous stage's drive unit
CN1B : CN1A connector on next stage's drive unit or terminal connector (battery unit)
CN4 : Connector for communication between power supply unit (master side) and drive unit



⚠ **CAUTION**	Wire the SH21 cable between the NC and drive unit so that the distance between the NC and terminal connector (battery unit) is within 30m.

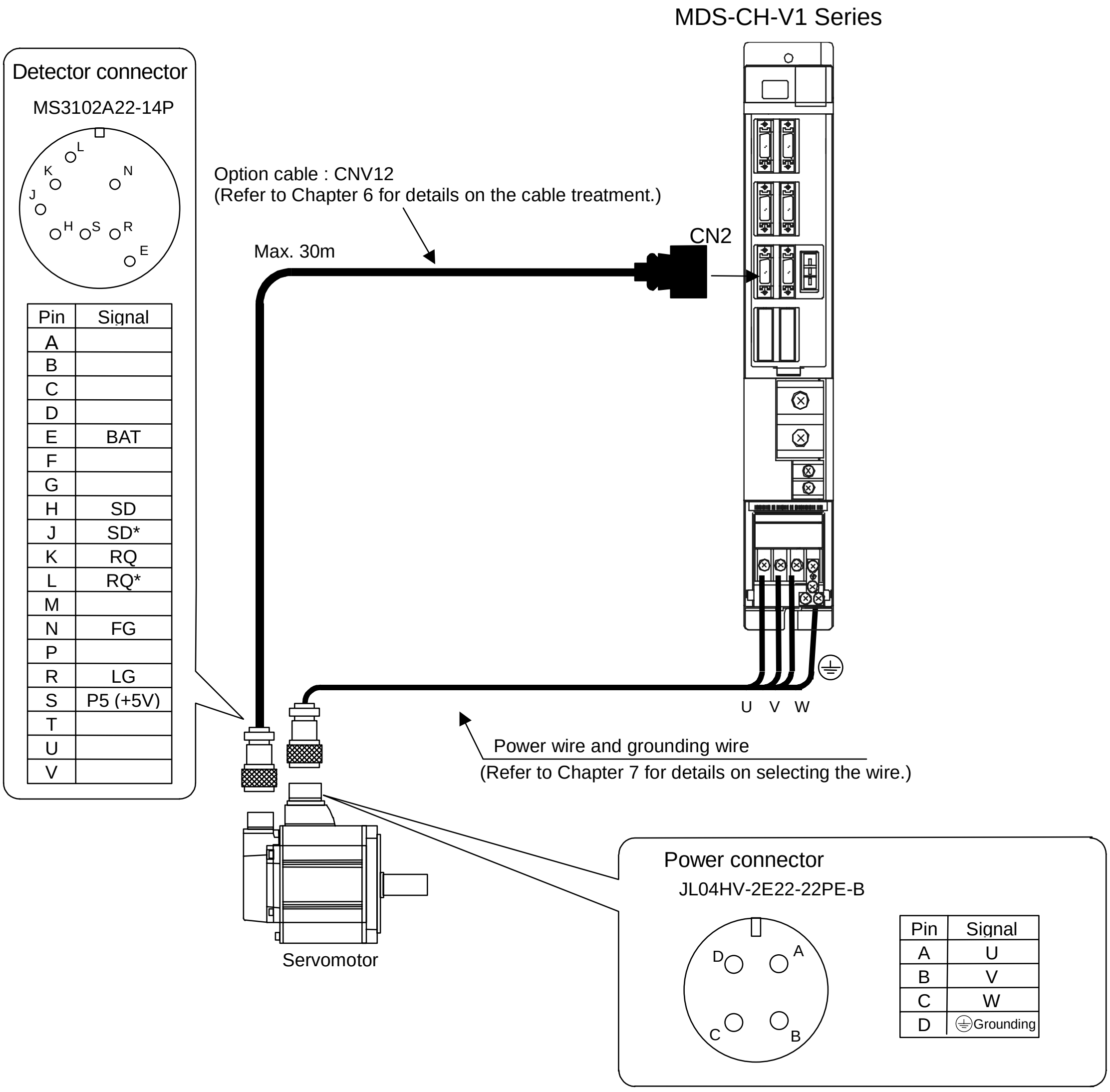
POINT	Axis Nos. are determined by the rotary switch for setting the axis No. (Refer to section "4-1-1 Setting the rotary switch".) The axis No. has no relation to the order for connecting to the NC.

2-4 Motor and detector connection

2-4-1 Connection of HC-H Series

The OSE105, OSA105, OSE104 or OSA104 detector can be used. The detector connection method is the same for all models.

(1) Connecting the servomotor without brakes



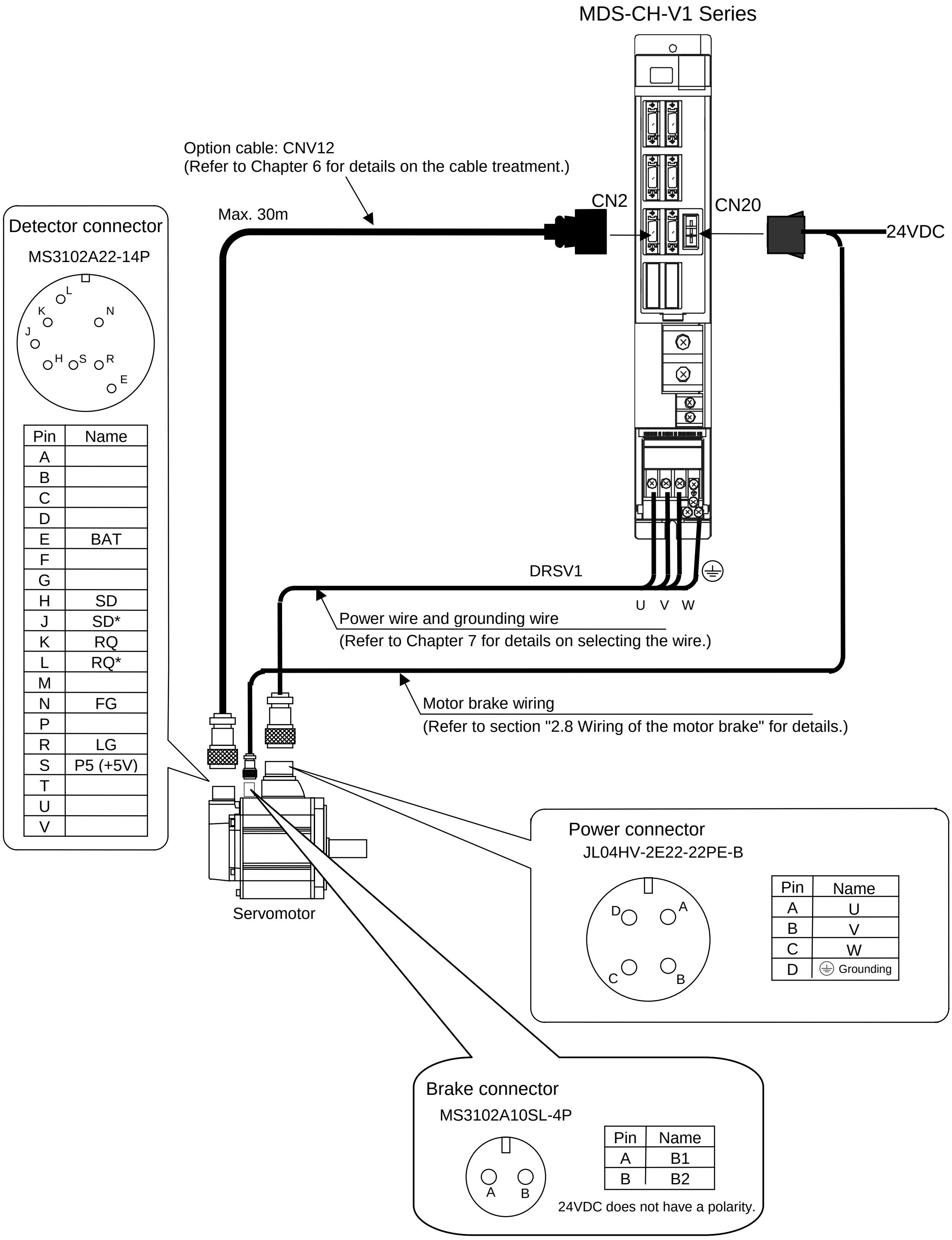
Pin	Signal
A	
B	
C	
D	
E	BAT
F	
G	
H	SD
J	SD*
K	RQ
L	RQ*
M	
N	FG
P	
R	LG
S	P5 (+5V)
T	
U	
V	

Pin	Signal
A	U
B	V
C	W
D	⏚Grounding

Note) The above connection is used for the single-axis servo drive unit.

(2) Connecting the servomotor with brakes

Use the same wiring as the servomotor without brakes, and add the wiring for the brakes. The brakes can be released when 24VDC is supplied. To ensure safety, use a twisted wire or shielded wire for the motor brake wiring, and sequence it with the emergency stop switch.



Option cable: CNV12
(Refer to Chapter 6 for details on the cable treatment.)

Power wire and grounding wire
(Refer to Chapter 7 for details on selecting the wire.)

Motor brake wiring
(Refer to section "2.8 Wiring of the motor brake" for details.)

Detector connector MS3102A22-14P

Pin	Name
A	
B	
C	
D	
E	BAT
F	
G	
H	SD
J	SD*
K	RQ
L	RQ*
M	
N	FG
P	
R	LG
S	P5 (+5V)
T	
U	
V	

Power connector JL04HV-2E22-22PE-B

Pin	Name
A	U
B	V
C	W
D	⏚ Grounding

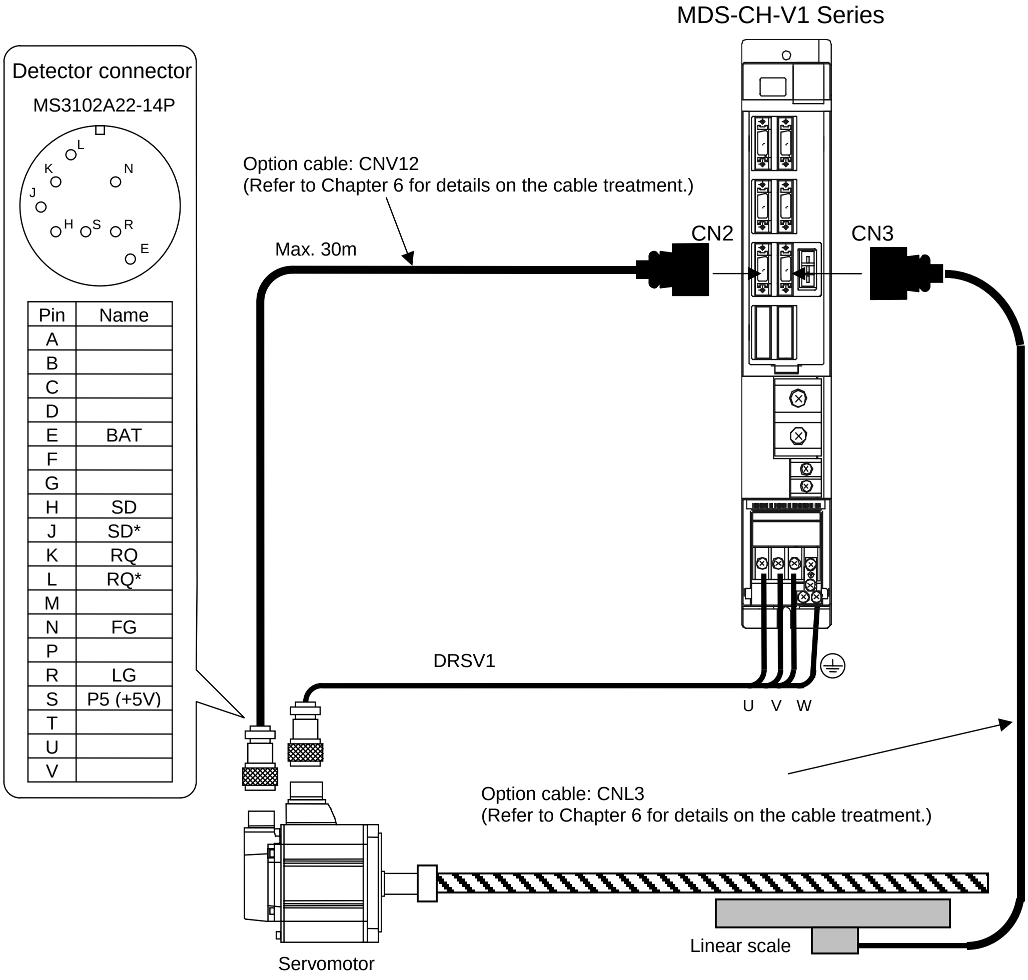
Brake connector MS3102A10SL-4P

Pin	Name
A	B1
B	B2

24VDC does not have a polarity.

Note) The above connection is used for the single-axis servo drive unit.
Refer to section "2.8 Wiring of the motor brake" for details on the motor brake wiring.

(3) When linear scale is connected as a closed system

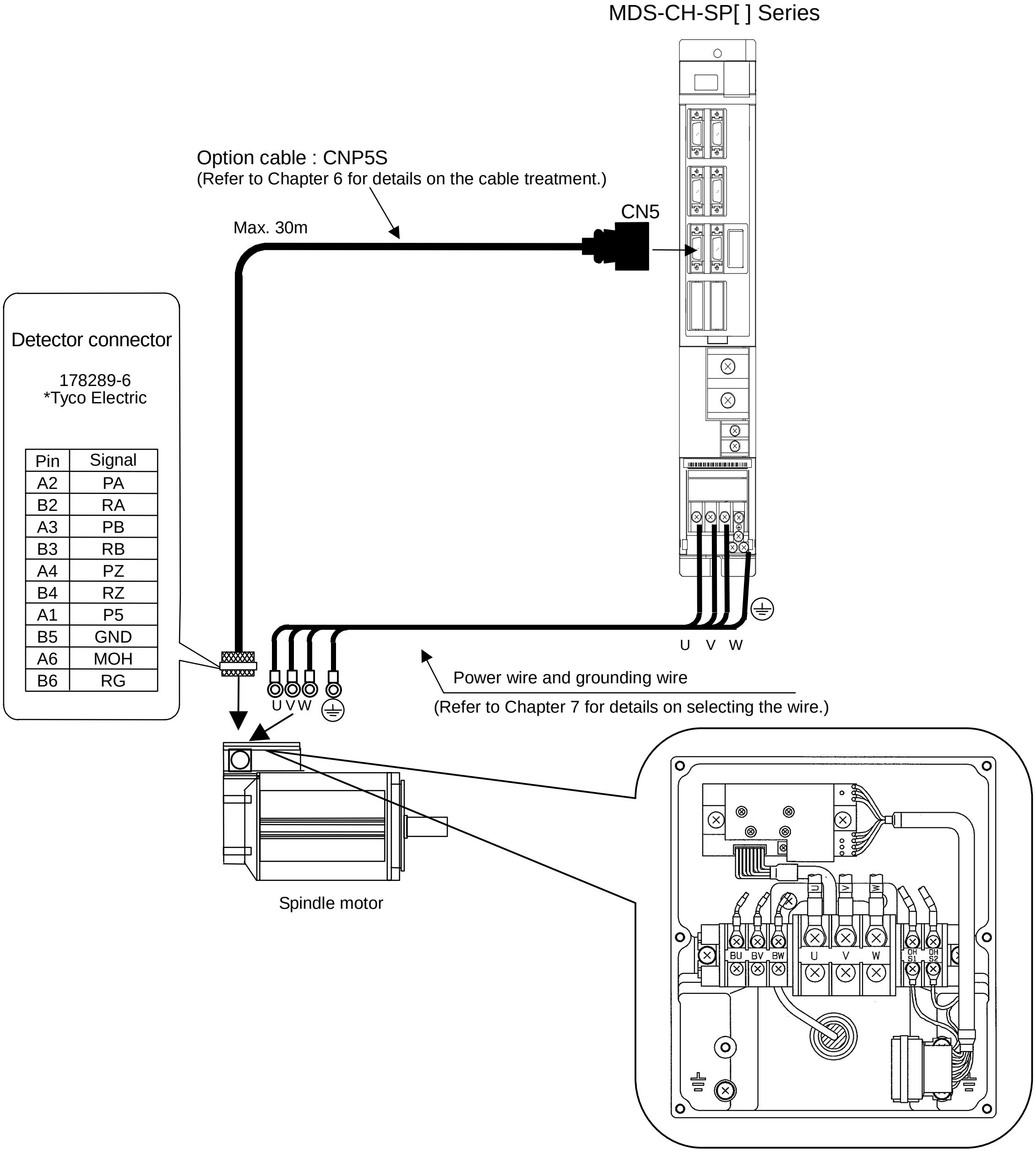


Pin	Name
A	
B	
C	
D	
E	BAT
F	
G	
H	SD
J	SD*
K	RQ
L	RQ*
M	
N	FG
P	
R	LG
S	P5 (+5V)
T	
U	
V	

Note) The above connection is used for the single-axis servo drive unit.
Refer to section "6-4-6 Example of scale I/F unit connection" for details on connecting the linear scale.

2-4-2 Connection of the spindle motor

Refer to each motor specifications for details on the motor side connection destination, specifications and outline, and for the spindle PLG detector specifications.

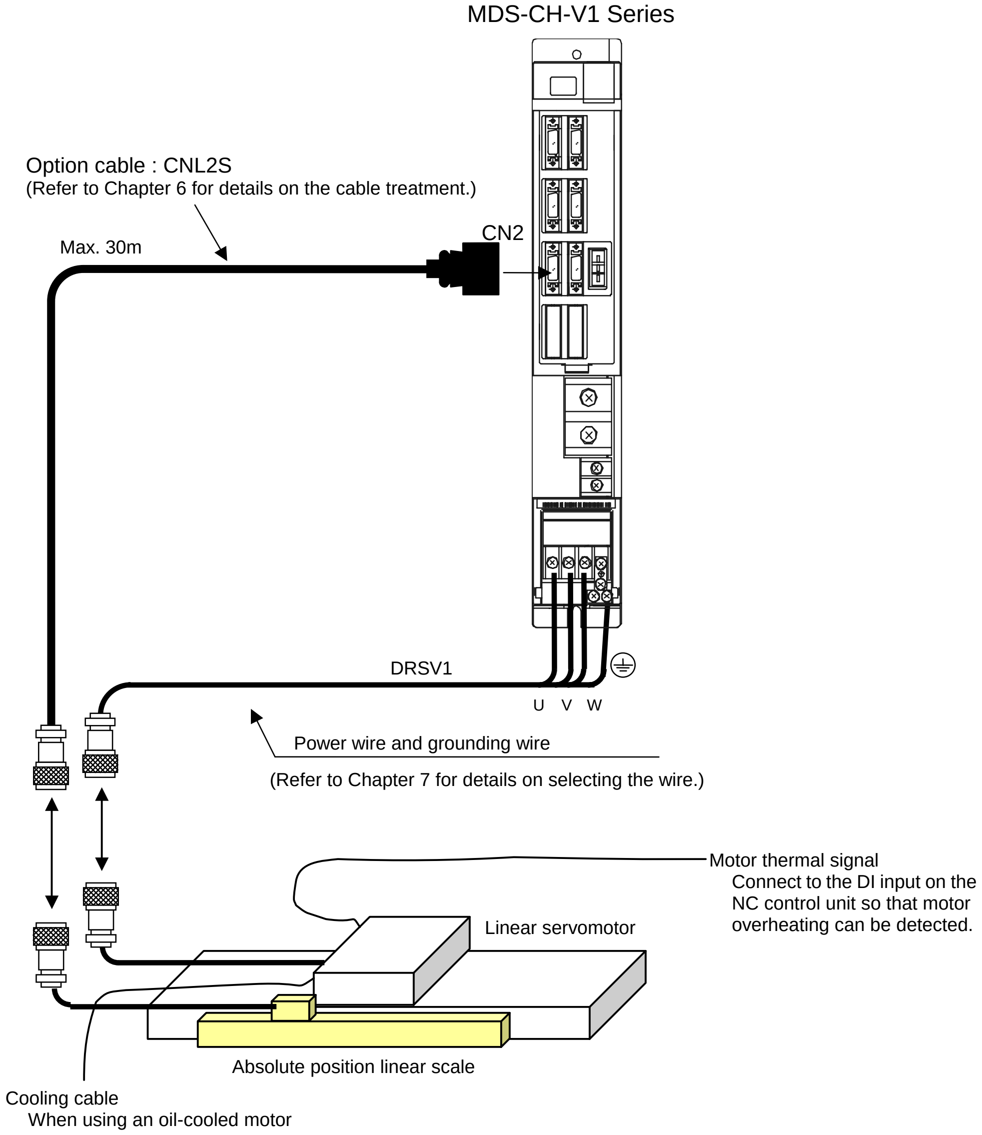


Pin	Signal
A2	PA
B2	RA
A3	PB
B3	RB
A4	PZ
B4	RZ
A1	P5
B5	GND
A6	MOH
B6	RG

2-4-3 Connection of the linear servomotor LM-NP Series

Refer to section "6-4 Scale I/F unit" when connecting the linear scale via the scale I/F unit

(1) Connecting the linear scale directly to the drive unit



⚠ **CAUTION**	1. Only the absolute position linear scale can be directly connected to the drive unit. Connect the relative linear scale via the scale I/F unit. (Refer to section "6-4 Scale I/F unit for details.) 2. Only the MDS-CH-V1 Series can drive the linear servomotor.

2-5 Connection of power supply

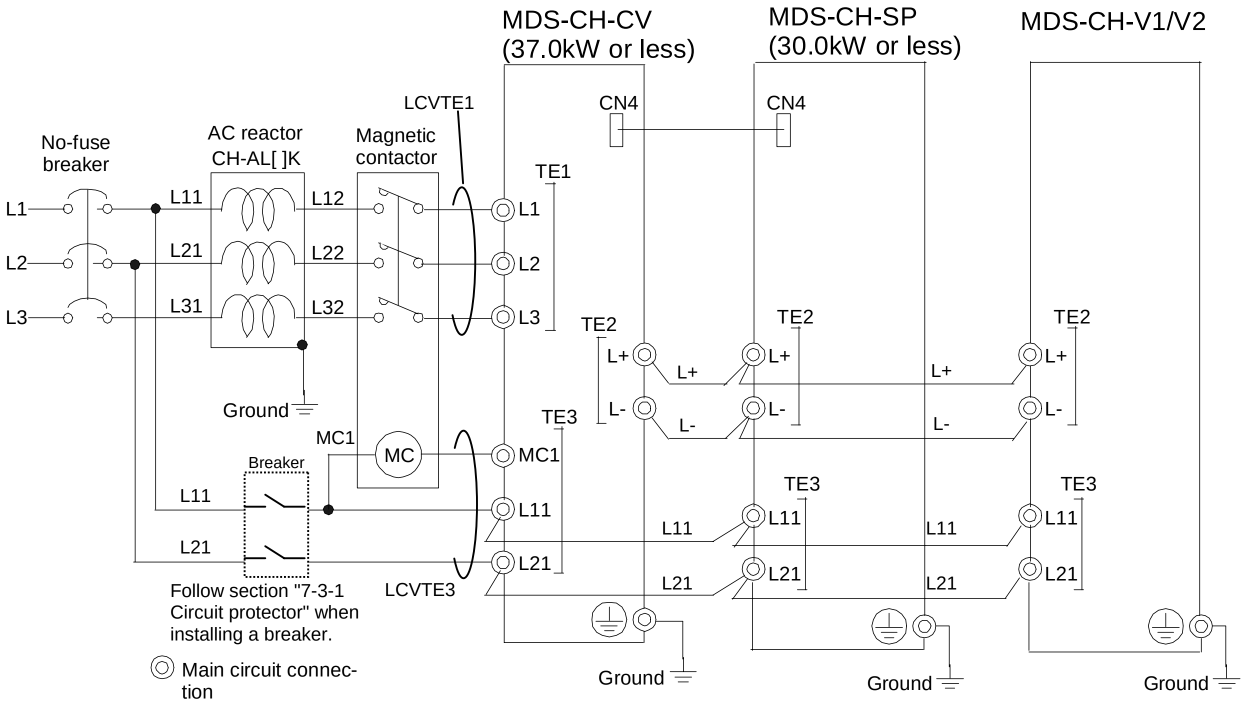
⚠ CAUTION

1. Make sure that the power supply voltage is within the specified range of the power supply unit. Failure to observe this could lead to damage or faults.
2. For safety purposes, always install a circuit breaker (CB), and make sure that the circuit is cut off when an error occurs or during inspections. Refer to Chapter 7 and select a circuit breaker.
3. The wire size will differ according to each unit capacity. Refer to Chapter 7 and select the size.
4. For safety purposes, always install a magnetic contactor (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.
5. A semiconductor element (bidirectional thyristor) is used in the power supply unit's magnetic contact drive circuit. A surge absorber is incorporated to protect this element, and a leakage current of up to 15mA is passed. Check with the maker beforehand to confirm that the exciting coil (contactor) will not malfunction with this leakage current.
6. Do not connect anything to the MC1 terminal when not using the contactor. The semiconductor element in the power supply unit will be damaged if the power supply (R, S, T) is directly connected.

2-5-1 Standard connection

Directly drive the magnetic contactor (contactor) using the power supply unit's TE3 terminal (MC1)

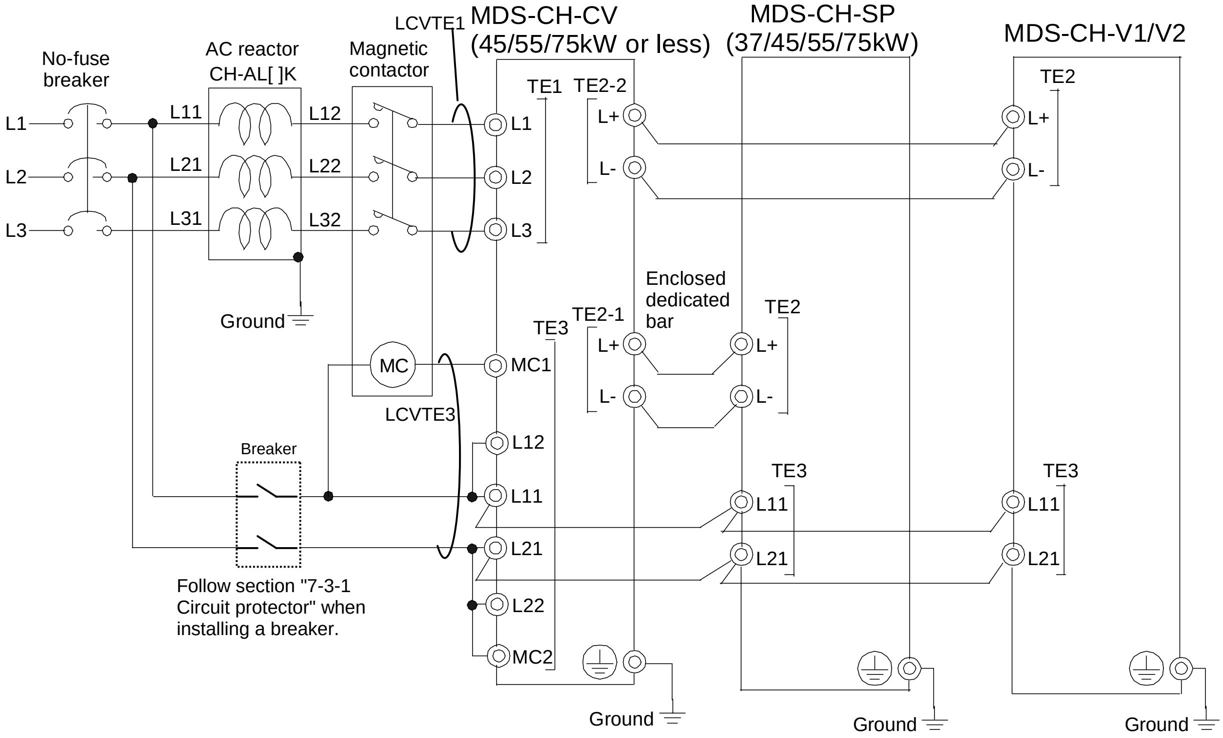
(1) For MDS-CH-CV-370 and smaller



⚠ CAUTION

1. The power supply unit is a power supply regenerative type converter; an AC reactor is installed in the power supply line. When connecting to the TE3 terminal, connect to the power supply side (primary side) of the AC reactor.
2. Connect the power supply unit's CN4 connector with the spindle drive unit in the same system. (Connect with the servo drive unit if there is no spindle drive unit.)

(2) For MDS-CH-CV-450 and larger



POINT

The TE3 MC2 is used to control the magnetic contactor (contactor) with an independent power supply.
Normally, use the wiring shown above. (MC1 and L21 are the same phase.)

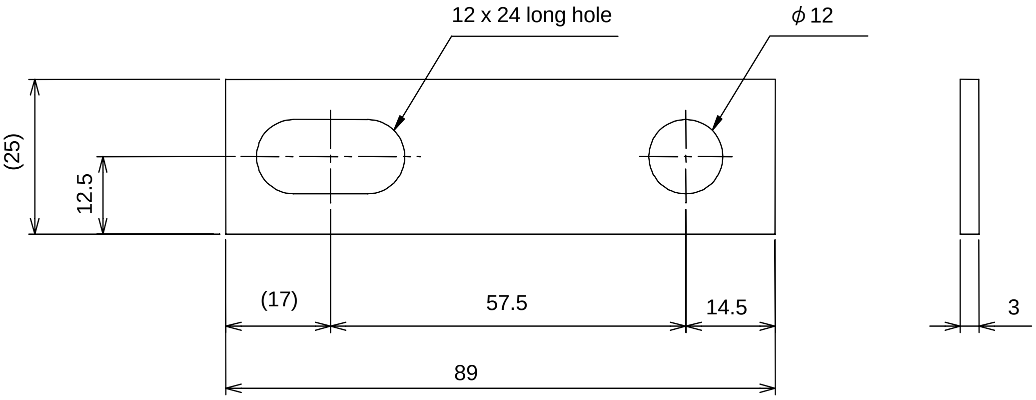
2-5-2 DC connection bar

When connecting a large capacity drive unit with the L+L- terminal of power supply unit, DC connection bar is required. In use of the following large capacity drive units, use a dedicated DC connection bar. The DC connection bar to be used depends on the connected power supply, so make a selection according to the following table. Also refer to the section "3-1-4 Panel installation hole work drawings".

Large capacity drive unit	Power supply unit	Required connection bar
MDS-CH-V1-185 MDS-DH-SP-370 MDS-CH-SP-450 MDS-CH-SP-550	MDS-CH-CV-450 MDS-CH-CV-550	Following (1)
MDS-CH-SP-750	MDS-CH-CV-750	Following (2)

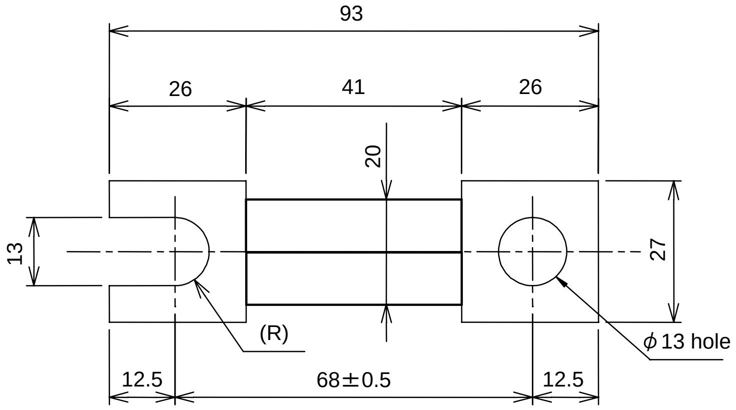
< Outline dimension drawings >

(1) For connecting MDS-CH-CV-450/550



(Note) This DC connection bar is a set of two DC connection bars.

(2) For connecting MDS-CH-CV-750

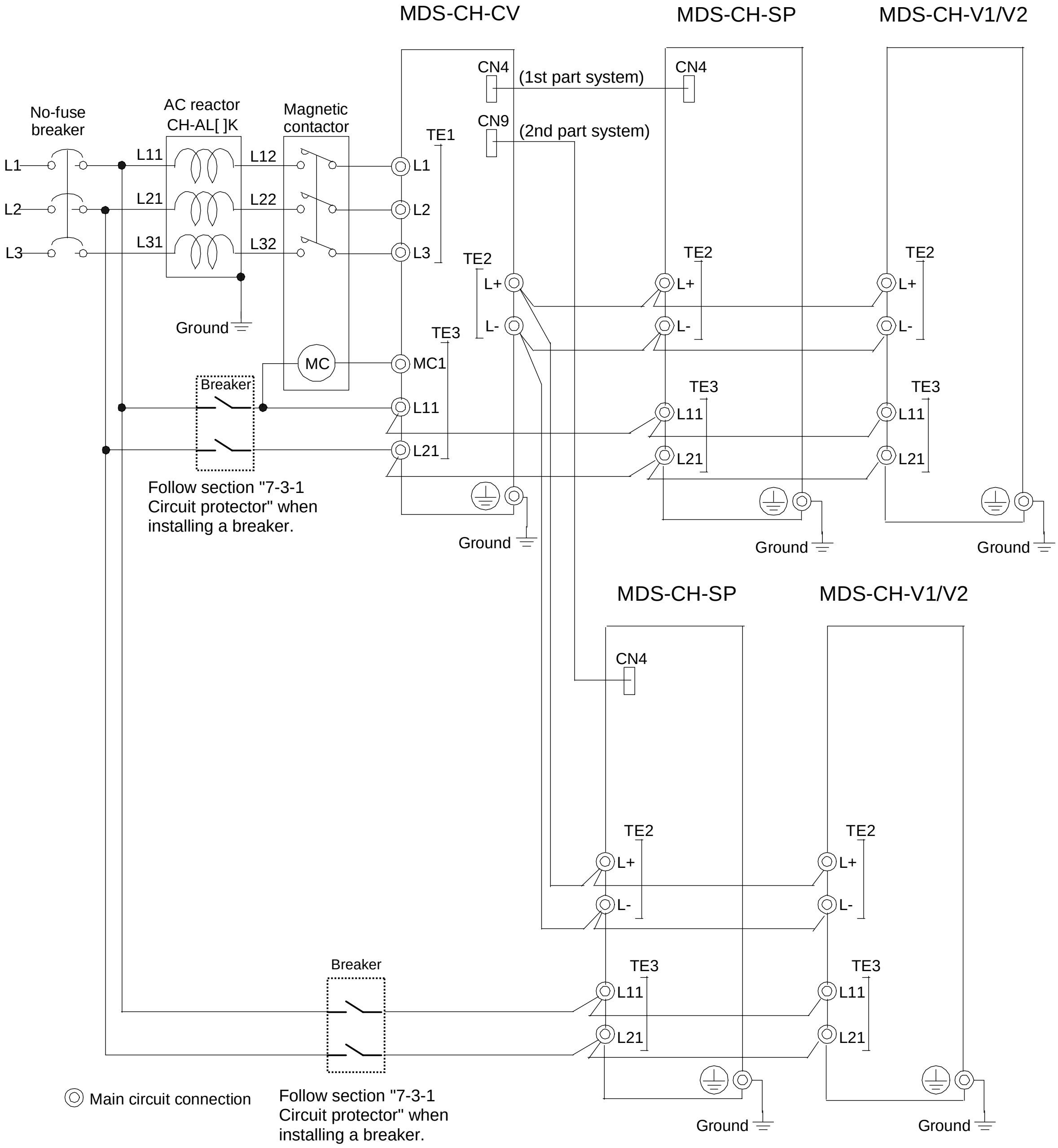


⚠CAUTION

1. These DC connection bars are accessories.
2. Always install a large capacity drive unit in the left side of power supply unit, and connect with DC connection bar.

2-5-3 Two-part system control of power supply unit

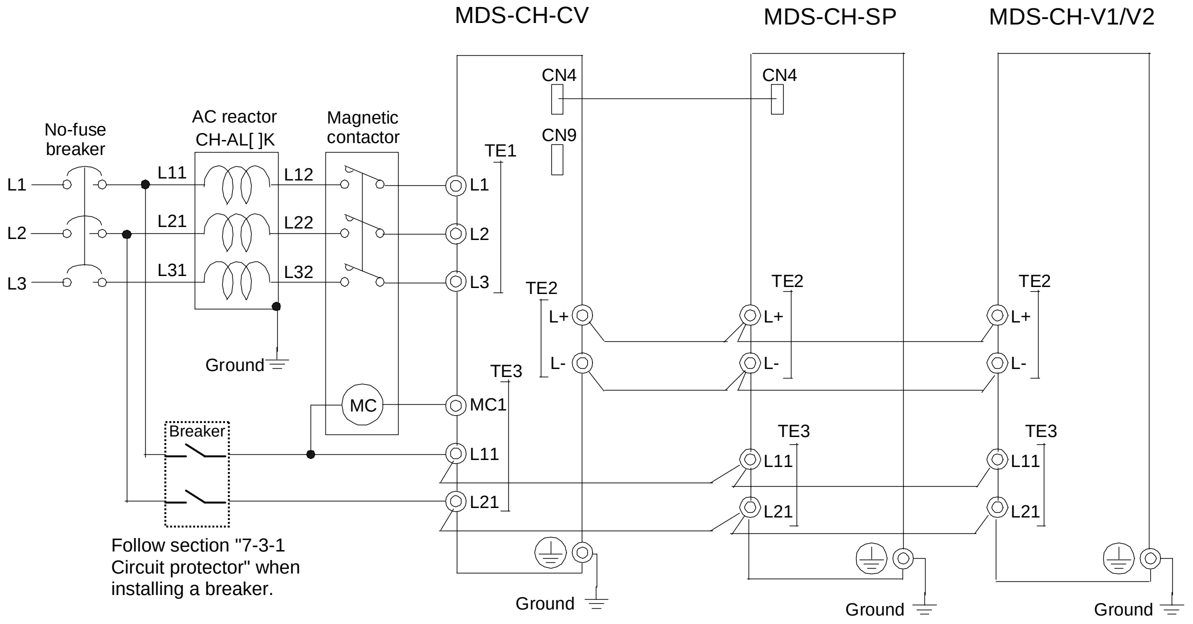
Confirm that the total capacity of the drive units does not exceed the power supply unit's capacity. The axis controlled to the power supply unit's CN4 connector is the axis controlled by the power supply unit. The final axis connected to the CN4 connector must be the spindle drive unit.

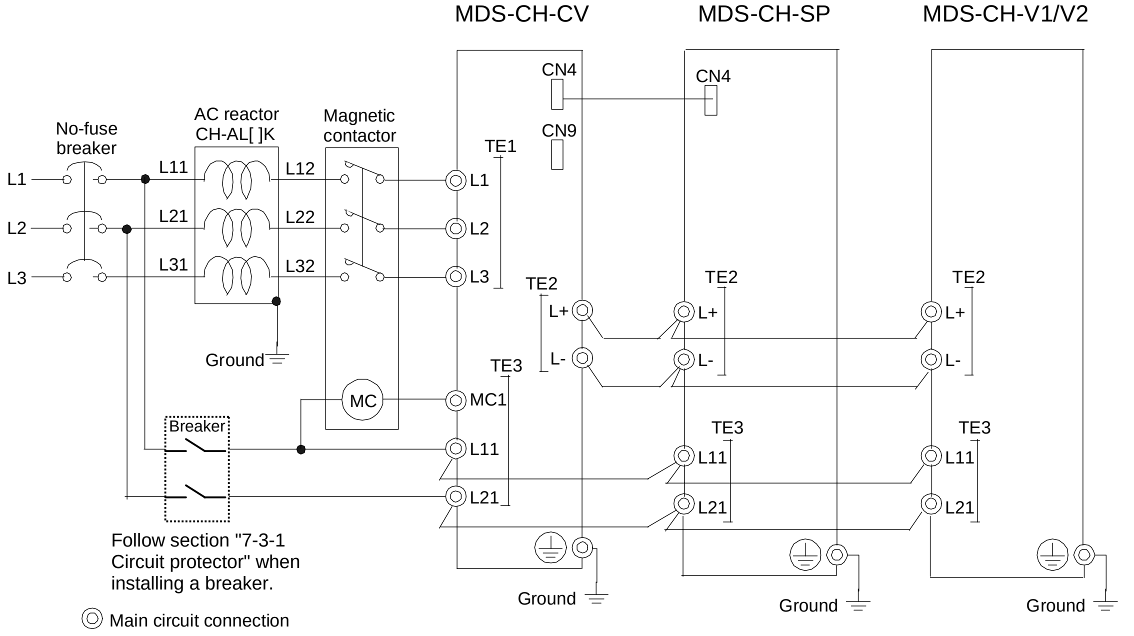


⚠ **CAUTION**	Arrange the units next to each other so that the TE2 (L+, L-) wiring is as short as possible. The above drawing shows the units in two stages for explanatory purposes.

2-5-4 Using multiple power supply units

In a system configured of multiple spindle drive units, etc., there may be cases when the units cannot be driven with one power supply unit. Use several power supply units in this case. Refer to section "11-7 Selecting the power supply unit" for details on making a selection.





⚠ **CAUTION**

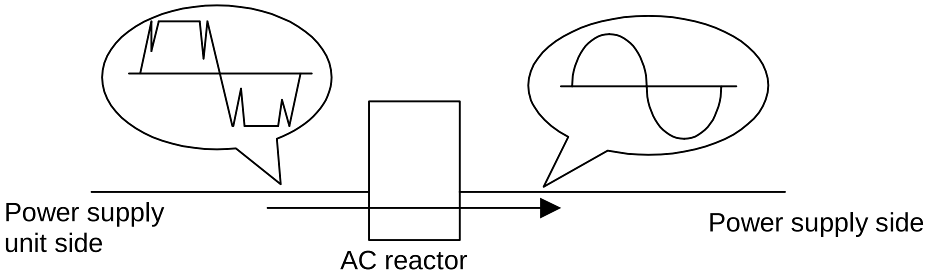
1. An AC reactor and breaker must be installed for each power supply unit.
2. The communication cable connected with the NC can be split for each power supply unit.
   (Refer to section 2-3. NC and drive unit connection.)

2-6 Connection of AC reactor

2-6-1 Features of the AC reactor

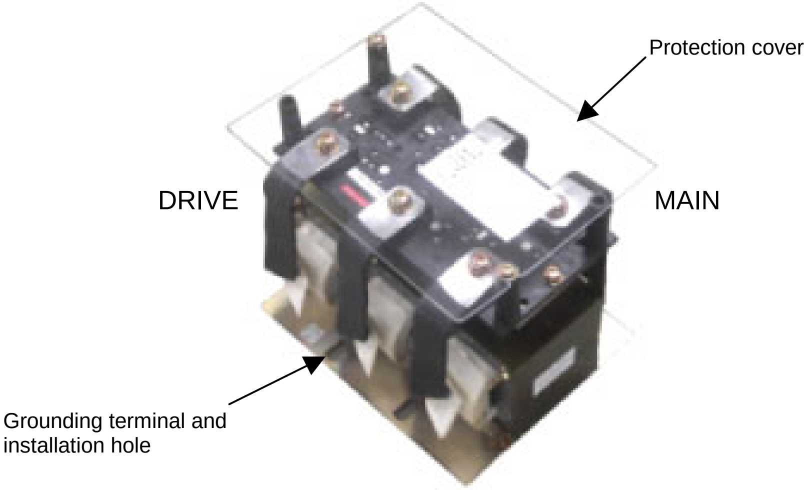
This AC reactor smoothes out distorted waveforms when regenerating unnecessary energy into the power, and is effective in suppressing unnecessary higher harmonics.
These features prevent other devices from malfunctioning. A radio noise filter is assembled in the AC reactor.

During power regeneration



2-6-2 Wiring of AC reactor

The installation direction of the AC reactor is set. If installed in reverse, the effective of the AC reactor will not be sufficiently achieved, and the noise suppressing effect may also drop.



Refer to section "6-7 AC reactor" for the outline dimensions of the AC reactor.

⚠ **CAUTION**	1. The AC reactor's terminal protection cover is provided only on the upper installation surface. Install so that the terminals cannot be touched from the side. Add a protection cover as required. 2. The AC reactor will become hot. • Use flame-resistant wires. • Lead the wires so that they do not contact the AC reactor. 3. A ⏚ terminal is provided on the AC reactor, so always ground the unit.

2-7 Wiring of contactors

A contactor (magnetic contactor) is inserted in the main circuit power supply input (L1, L2, L3) of a power supply unit, 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 drive unit stops the motor using deceleration control or a dynamic brake. The spindle drive unit performs the deceleration stop control. The power supply unit must maintain the power supply (power regeneration) while returning the energy from each axis being decelerated to the power line. Thus, the contactor cannot be shut off. Therefore, the NC controls the contactors. The NC confirms that all axes are stopped, or confirms the dynamic brake operation, and then it outputs a contactor shutoff command of the power supply unit via the drive unit.

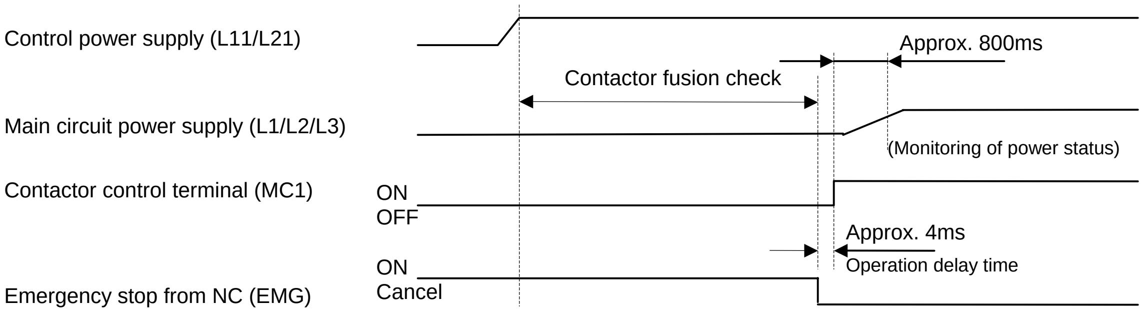
Give consideration to the above, and examine the contactor drive method in the following order of priority.

⚠ **CAUTION**	1. The contactors cannot be driven other than from a power supply unit. Undervoltage (alarm) may occur if the contactors are shut off at the same time as an emergency stop occurrence. 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 a power supply unit external emergency stop input. (Refer to section "2-9 Wiring of an external emergency stop.)

<table>
<tr><th>No.</th><th>Abbrevia-tion</th><th>Parameter name</th><th>Descriptions</th></tr>
<tr><td>SV036</td><td>PTYP</td><td>Power supply type</td><td>The following parameter must be set.
<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="8">PTYP</td></tr>
</table>
</td></tr>
</table>

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 (TE3: MC1) of the power supply unit is used. Each interface voltage of the main circuit power supply (L1/L2/L3) is checked. If voltage is applied on any voltage (if the contactor is melted), contactor melting (alarm 6A) is detected.



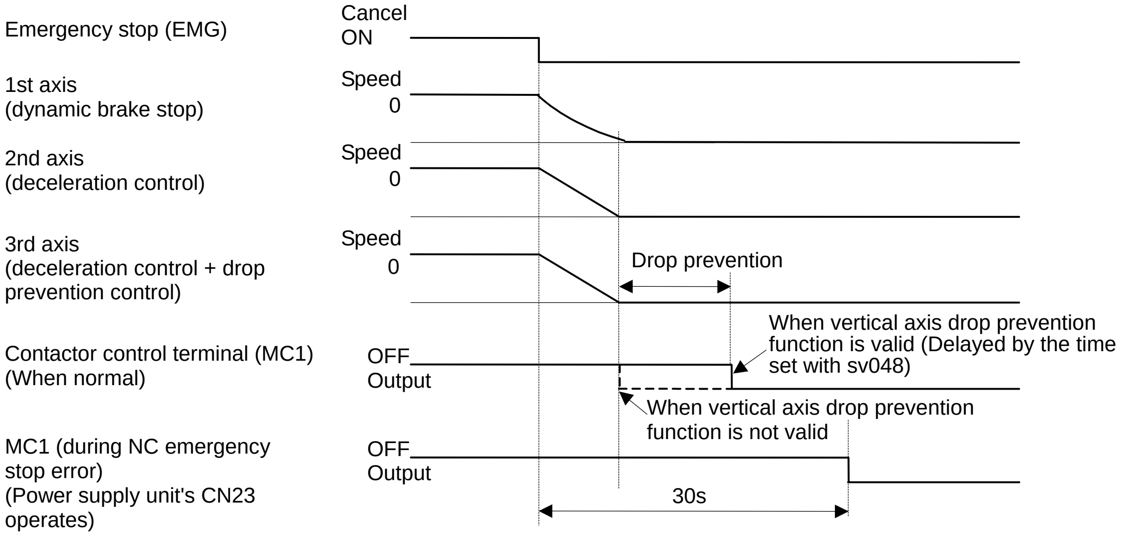
Contactor power ON sequences

POINT

1. The parameters must be set when controlling the contactor (MC1)
2. The power supply unit's power state is monitored approx. 800ms after the contactor control terminal (MC1) turns ON. If the voltage is insufficient, the main circuit error (alarm 6C) or open phase (alarm 67) will occur. In all other cases, a ground fault (alarm 69) will occur.

2-7-2 Contactor shutoff sequences

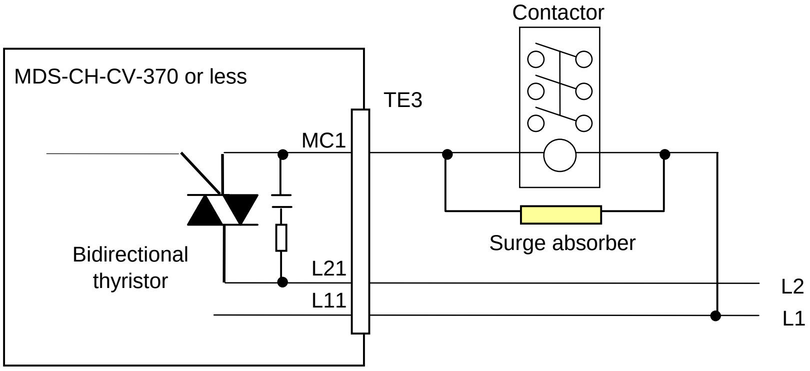
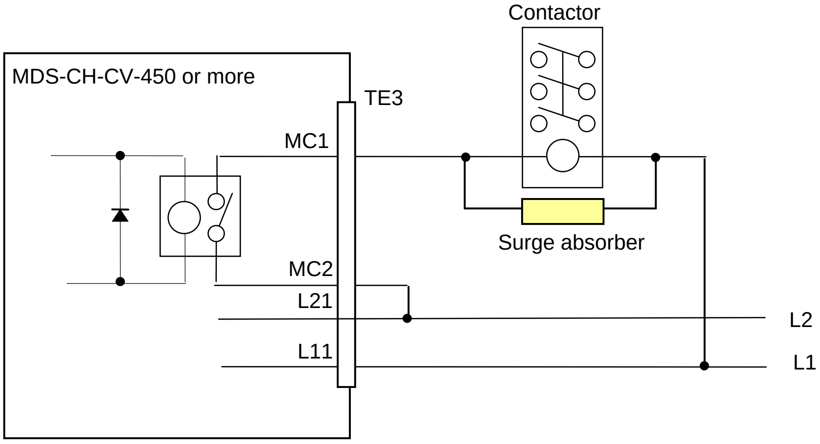
When an emergency stop or servo alarm occurs, the NC confirms the zero speed (motor stop or dynamic brake operation) for all axes, and then shuts off the contactors.
If MC shut off enabled is not output, an external emergency stop signal (EMGX) will be output in 30 seconds from the power supply unit's CN23 connector to forcibly shut off the MC1 terminal. The spindle will coast after that.



Contactor shutoff sequences

2-7-3 Contactor control signal (MC1) output circuit

A contactor or AC relay, etc., can be driven. Install a surge absorber when using a conductive load.

37kW or less	
45kW or more	

POINT

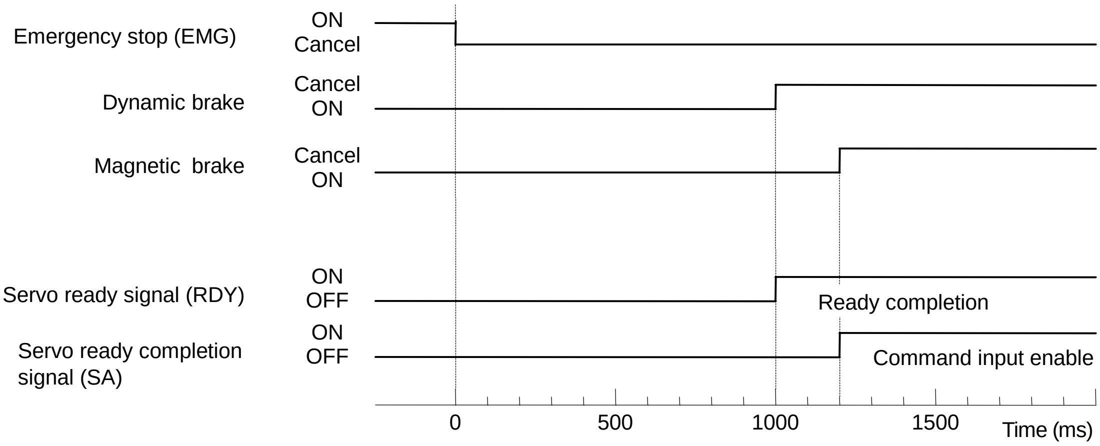
The 45kW and larger units have MC1 and MC2. For normal use, connect MC2 and L21. MC2 is used when controlling the contactor with an independent power supply.

2-8 Wiring of the motor brake

The magnetic brake of servomotors with a magnetic brake is driven by the motor brake control connector (CN20) on the servo drive unit. The servo drive unit releases the brake when the motor is ON. (Servo ON means when torque is generated in the motor.)

2-8-1 Motor brake release sequence

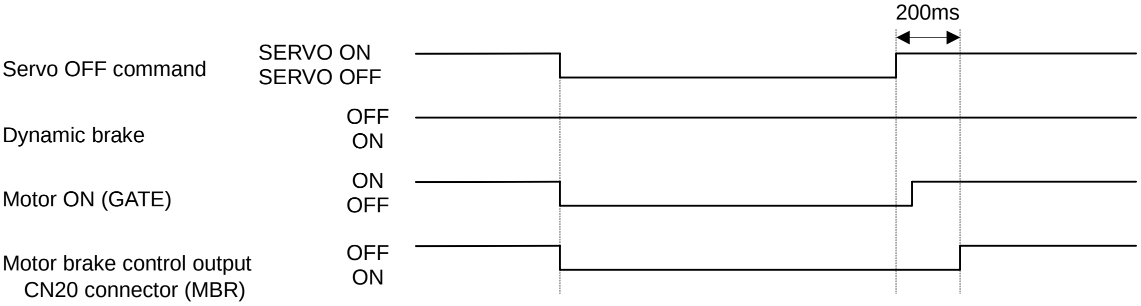
The motor brake control connector (CN20: MBR) releases the magnetic brake in the sequences in the following drawing when canceling the emergency stop. The brake is released after the start of the power ON to the servomotor.



Motor brake control sequences when an emergency stop is canceled

2-8-2 Control during the servo OFF command

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 sequences when a servo OFF command is output

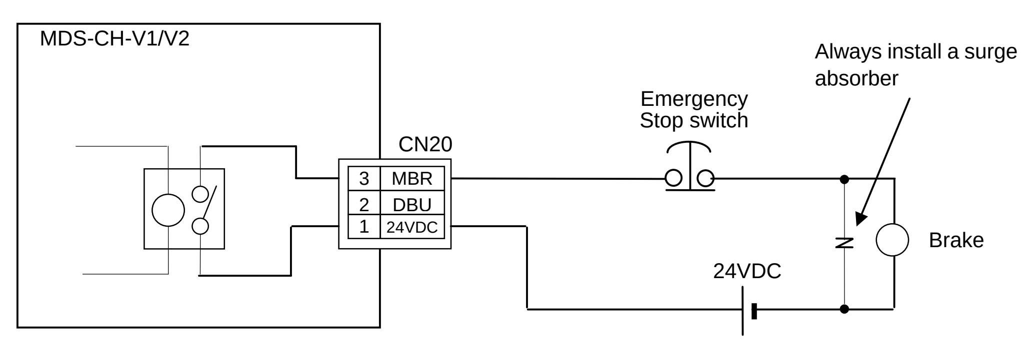
⚠ **CAUTION**	The vertical axis drop prevention control only is performed during an emergency stop (including alarms and power failures). It is not performed when a servo OFF command is input.

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 connector (CN20) output circuit

The motor brakes can be controlled with the CN20 connector.
The brakes controlled with the CN20 connector include the magnetic brakes and dynamic brakes (external dedicated option for MDS-CH-V1-110 or more). (Unit internal relay specifications: 30VDC-5A/ 250VAC-8A)

When using CN20	

POINT

To ensure safety in an emergency, make sure that the magnetic brakes are applied in sequence with the emergency stop switch.

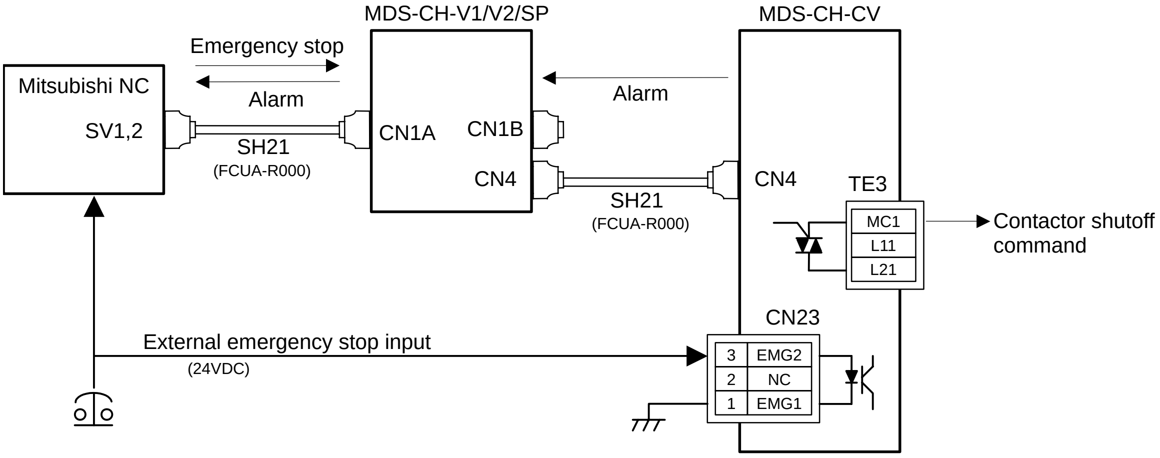
⚠ CAUTION

1. Always install a surge absorber near the motor's brake terminal to eliminate noise and protect the contacts. Refer to section "7-4-3 Surge absorber".
2. The brakes cannot be released just by connecting the CN20 and motor brake terminal. 24VDC must be supplied.

2-9 Wiring of an external emergency stop

2-9-1 External emergency stop setting

Besides the emergency stop input from the NC communication cable (CN1A, CN1B), double-protection when an emergency stop occurs can be provided by directly inputting an external emergency stop to the CN23 connector on the power supply unit. Even if the emergency stop is not input from CNC for some reason, the contactors will be shut off by the external emergency stop input from CN23 connector on the power supply unit.



No.	Abbrevia-tion	Parameter name	Descriptions
SV036	PTYP	Power supply unit type	Set the external emergency stop with the PTYP parameter of the drive unit connected to the power supply unit. Setting value: External emergency stop invalid Setting value +40 [hex]: External emergency stop valid **Example)** For CV-300, change PTYP [30] to PTYP [70]. When connecting with a unit SP370 or above, set bit8 to 1.
SP041			

CAUTION The emergency stop signal input to the CNC side cannot be used as a substitute for the external emergency stop function (CN23).

POINT

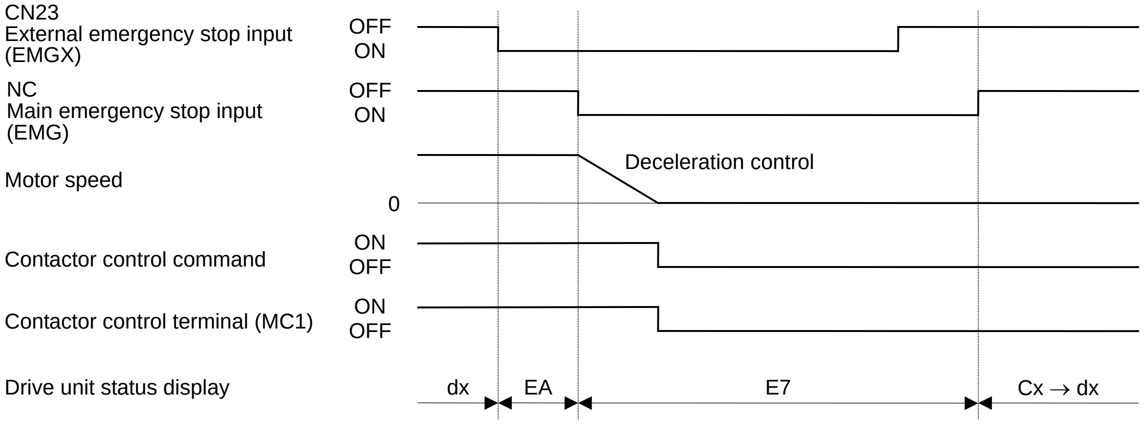
1. The parameter must be set for the CN23 external emergency stop function.
2. The emergency stop signal input to the CNC side cannot be used as a substitute for the external emergency stop function.

2-9-2 Operation sequences of CN23 external emergency stop function

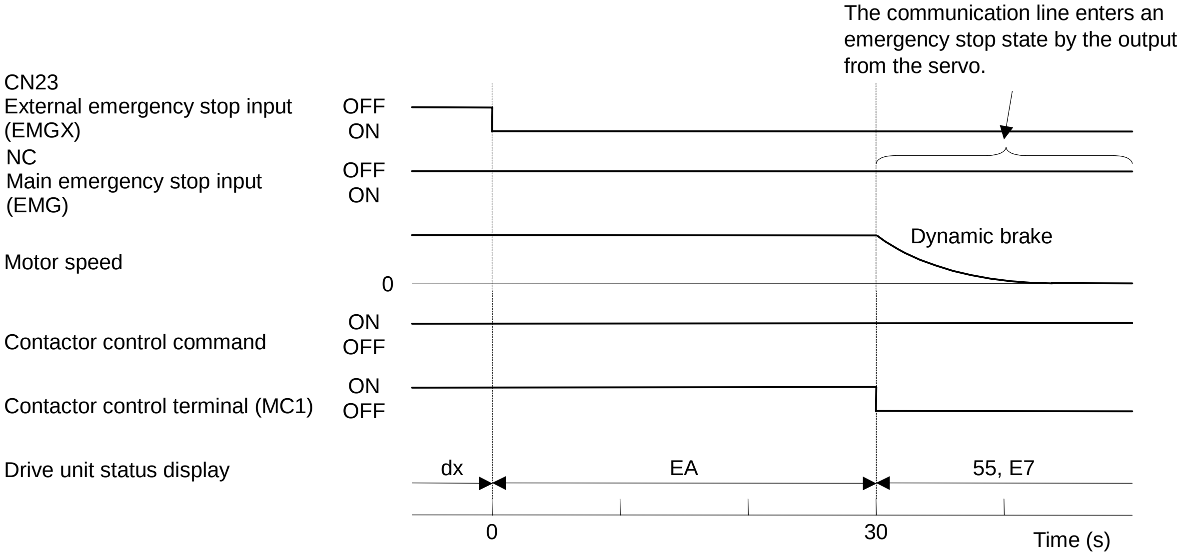
If only CN23, an external emergency stop, is input when external emergency stop valid is set in the parameters (the emergency stop is not input in CNC), an "In external emergency stop" (warning EA) will be detected. At this time, the system itself does not enter an emergency stop status. (There will 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 power supply unit itself outputs contactor shutoff signal (MC1), and then it shuts off the contactors, and an external emergency stop error (alarm 55) is detected. If the emergency stop is input from CNC within 30 seconds, the warning EA replaces the "In CNC emergency stop" (warning E7). A normal emergency stop status (warning E7) will result if the contactor shutoff command from the CNC are further input.

Ready ON is possible even if CN23, 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 Example of emergency stop circuit

(1) Outline of function

The power supply unit's external emergency stop can be validated by wiring to the CN23 connector, and setting the parameters and rotary switch. If the emergency stop cannot be processed and the external contractor cannot be shut off (due to a fault) by the CNC unit, the external contactor can be shut off by the power supply unit instead of the CNC. At this time, the spindle motor will coast and the servomotor will stop with the dynamic brakes.
EN60204-1 Category 1 can be basically complied with by installing the external emergency stop switch and contactor.

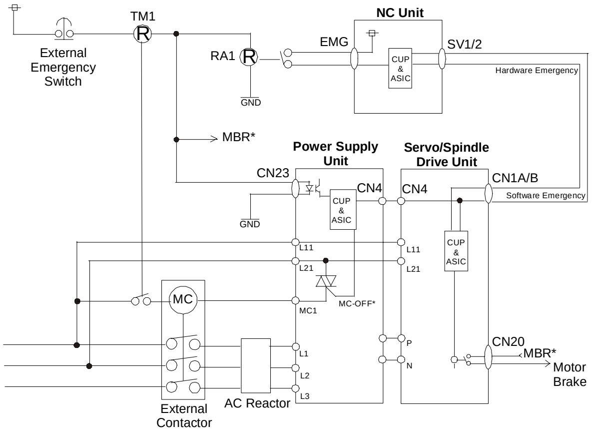
⚠ CAUTION

1. The power supply unit external emergency stop function is a function that assists the NC emergency stop.
2. The emergency stop signal input to the CNC side cannot be used as a substitute for the external emergency stop function (CN23).
3. It will take 30 seconds for the external contactor to function after the emergency stop is input to CN23. (This time is fixed.)

The emergency stop is a signal used to stop the machine in an emergency. This is connected to the CNC unit. Wire to the power supply unit when necessary.
The servo/spindle unit will be decelerated and controlled by the software according to the deceleration stop command issued from the CNC unit.

(2) Example of emergency stop circuit

The diagram on the right shows an example of the emergency stop circuit (EN60204-1 Category 0 stop) in which an off delay timer (TM1) is installed as a power shutoff method independent from the NC emergency stop input. The required safety category may be high depending on the machine and the Safety Standards may not be met. Thus, always pay special attention when selecting the parts and designing the circuit.



Setting the off delay timer (TM1) time

Set the TM1 operation time so that it functions after it has been confirmed that all axes have stopped.
If the set time is too short, the spindle motor will coast to a stop.

tm ≥ All axes stop time

Provide a mechanism that shuts off the power even if the CNC system fails.

POINT

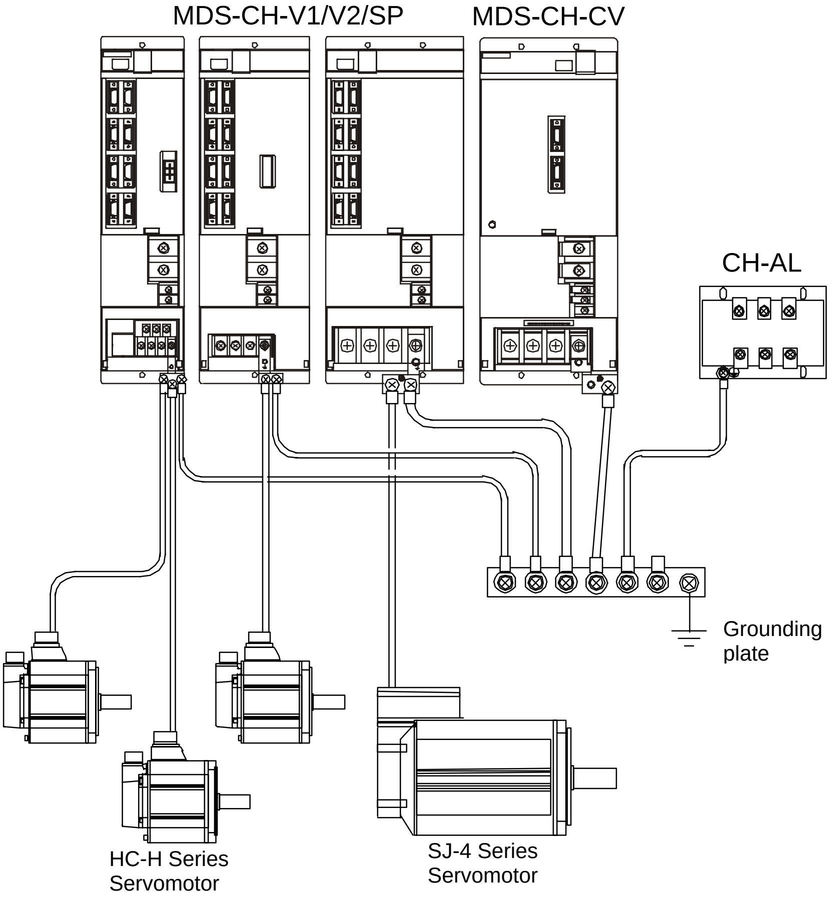
Stop Categories in EN60204-1
- Category 0: The power is instantly shut off using machine parts.
- Category 1: The drive section is stopped with the control (hardware/software or communication network), and then the power is instantly shut off using machine parts.

(Caution) Refer to the Standards for details.
Refer to Section 9.2.5.4.2 in EN60204-1: Safety of Machinery Electrical Equipment of Machines – Part 1.

2-10 Connecting the Grounding Cable

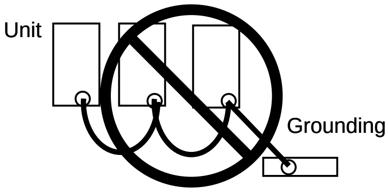
2-10-1 Connecting the Frame Ground (FG)

Each unit has an FG connection terminal. Please connect an earth wire to the main ground of a cabinet or a machine frame.



POINT

Connect the grounding cable from each unit directly to the grounding plate. Noise from other units could result in malfunctions.



2-10-2 Grounding cable size

Earth wire size should follow the following table.

Type	Grounding cable size
MDS-CH-CV Unit	Same as TE1 (L1/L2/L3)
MDS-CH-V1/V2/SP[] Unit	Same as TE1 (U/V/W)
CH-AL (AC Reactor)	5.5 mm^2 (AWG10) or more

3. Installation

3-1 Installation of the units 3-2
  3-1-1 Environmental conditions 3-2
  3-1-2 Installation direction and clearance.. 3-3
  3-1-3 Prevention of entering of foreign matter.. 3-3
  3-1-4 Panel installation hole work drawings (Panel cut drawings) 3-4
  3-1-5 Heating value 3-5
  3-1-6 Heat radiation countermeasures.. 3-6
3-2 Installation of servomotor/spindle motor 3-7
  3-2-1 Environmental conditions 3-7
  3-2-2 Cautions for mounting load (prevention of impact on shaft) 3-8
  3-2-3 Installation direction... 3-8
  3-2-4 Tolerable load of axis 3-9
  3-2-5 Oil and waterproofing measures 3-10
  3-2-6 Cable stress 3-12
3-3 Installing the linear servomotor 3-13
  3-3-1 Installation environment 3-13
  3-3-2 Installing the linear servomotor 3-13
  3-3-3 Cooling the linear servomotor 3-15
3-4 Noise measures 3-16

⚠ CAUTION

1. Install the unit on noncombustible material. Direct installation on combustible material or near combustible materials may lead to fires.
2. Follow the instructions in this manual and install the unit while allowing for the unit weight.
3. Do not get on top of the units or motor, 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 units.
6. Do not block the units intake and outtake ports. Doing so could lead to failure.
7. The units and servomotor are precision devices, so do not drop them or apply strong impacts to them.
8. Do not install or run units or servomotor that is damaged or missing parts.
9. When storing for a long time, please contact your dealer.

3-1 Installation of the units

⚠ CAUTION

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

3-1-1 Environmental conditions

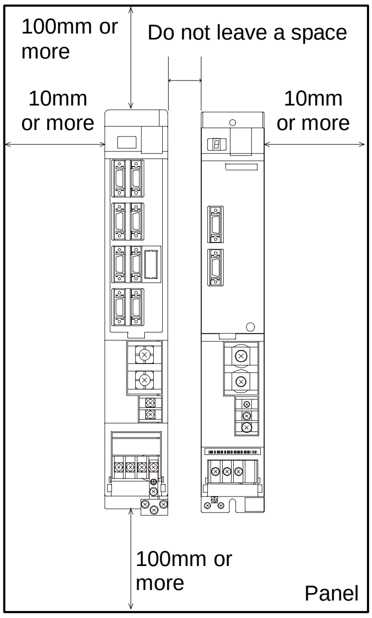
Environment	Conditions
Ambient temperature	0°C to +55°C (with no freezing)
Ambient humidity	90% RH or less (with no dew condensation)
Storage temperature	–15°C to +70°C (with no freezing)
Storage humidity	90% RH or less (with no dew condensation)
Atmosphere	Indoors (Where unit is not subject to direct sunlight) With no corrosive gas, combustible gas, oil mist or dust
Altitude	Operation/storage: 1000m or less above sea level Transportation: 10000m or less above sea level
Vibration	Operation/storage: 4.9m/s^2 (0.5G) or less Transportation: 49m/s^2 (5G) or less

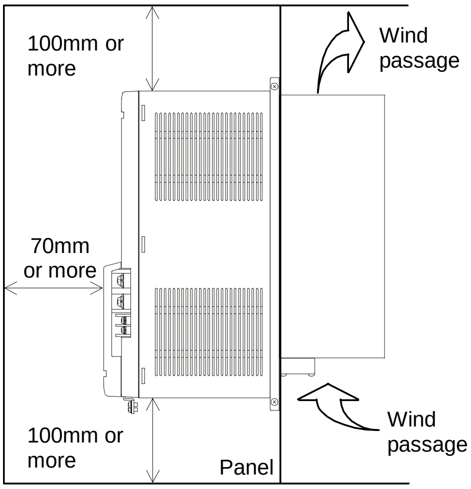
Caution) When installing at 1,000m or higher above sea level, the unit's heat dissipation characteristics will drop as the altitude gets higher.
The upper limit of the ambient temperature drops by 1°C per each 100m increase in altitude. (The ambient temperature at an altitude of 2000m is 0 to 45°C.).

3-1-2 Installation direction and clearance

Wire each unit in consideration of the maintainability and the heat dissipation, also secure sufficient space for ventilation.

Do not leave a space between the power supply unit and drive unit when installing.



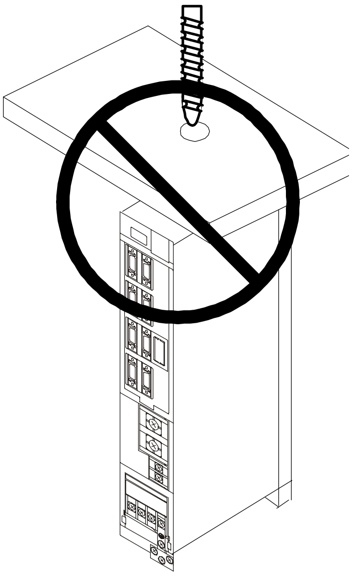


⚠ **CAUTION**	The ambient temperature condition for the power supply unit or the drive units is 55°C or less. Because heat can easily accumulate in the upper portion of the units, give sufficient consideration to heat dissipation when designing the panel. If required, install a fan in the panel to agitate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

3-1-3 Prevention of entering of foreign matter

Treat the cabinet with the following items.

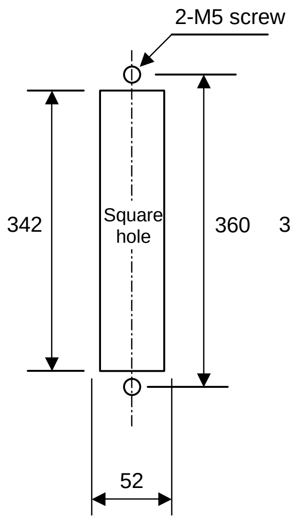
- Make sure that the cable inlet is dust and oil proof by using packing, etc.
- Make sure that the external air does not enter inside by using head radiating holes, etc.
- Close all clearances.
- Securely install door packing.
- If there is a rear cover, always apply packing.
- Oil will tend to accumulate on the top. Take special measures such as oil-proofing to 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.



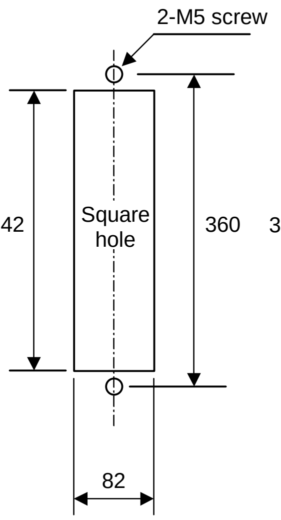
3-1-4 Panel installation hole work drawings (Panel cut drawings)

Prepare a square hole to match the unit width.

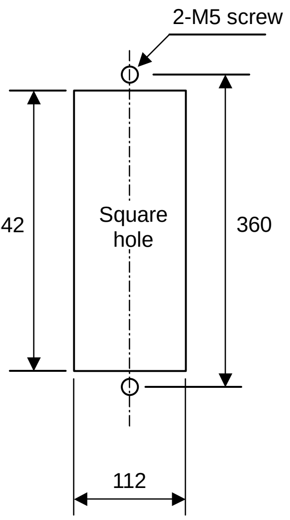
Unit [mm]



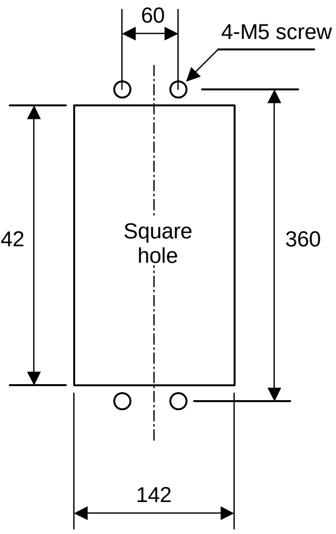
Unit width: 60mm



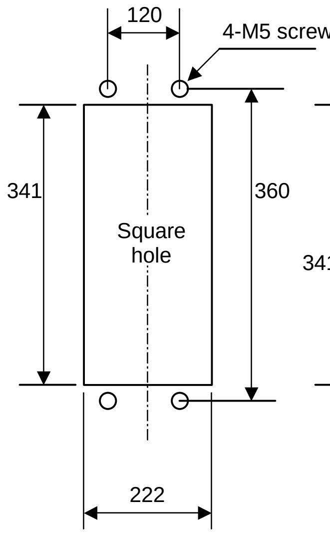
Unit width: 90mm



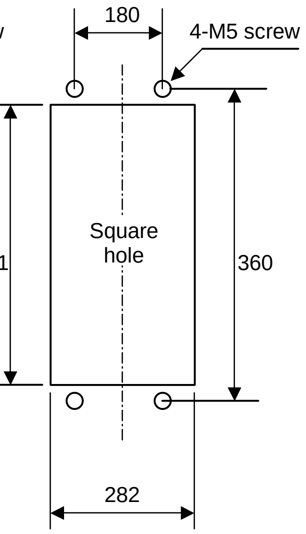
Unit width: 120mm



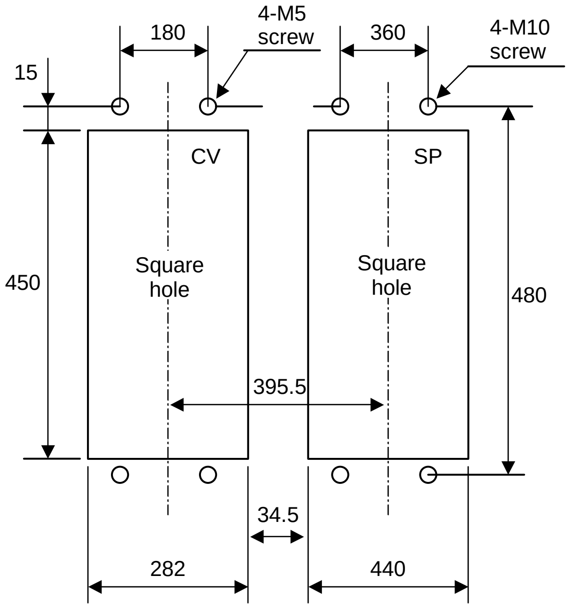
Unit width: 150mm



Unit width: 240mm



Unit width: 300mm



CV-750 and SP-750

POINT

1. The 75kW spindle drive unit is always installed to the right of the 75kW power supply unit with no space between. When using the enclosed bar (for L+/L– connection fitting), leave 34.5mm open between the CV and SP square holes. Other units cannot be connected together. (Enclosed bar: C352D058 ... Refer to section 2-5.)
2. Always install the 37kW to 55kW spindle drive units to the left of the power supply unit with no space between.
3. A TE2-1 terminal (L+/L–) connection fitting is enclosed with the 45kW and higher power supply units.
4. Install the power supply unit and drive unit with no space between.

3-1-5 Heating value

Each heating value is calculated with the following values.
The value for the spindle drive unit includes the continuous rated output, the value for the servo drive unit includes the rated output, and the value for the power supply unit includes the AC reactor's heating value.

Type MDS-CH-	Heating amount [W]		Type MDS-CH-	Heating amount [W]		Type MDS-CH-	Heating amount [W]		Type MDS-CH-	Heating amount [W]	
	Inside panel	Outside panel		Inside panel	Outside panel		Inside panel	Outside panel		Inside panel	Outside panel
CV-37	34	21	SP[]-15	20	50	V1-05	11	25	V2-0505	22	50
CV-55	35	30	SP[]-37	50	54	V1-10	18	41	V2-1005	29	66
CV-75	38	43	SP[]-55	55	88	V1-20	28	76	V2-1010	35	82
CV-110	44	81	SP[]-75	61	121	V1-35	35	115	V2-2010	44	134
CV-150	49	106	SP[]-110	70	170	V1-45	44	164	V2-2020	47	155
CV-185	55	140	SP[]-150	81	231	V1-70	60	258	V2-3510	49	166
CV-220	57	153	SP[]-185	102	353	V1-90	68	302	V2-3520	53	189
CV-260	65	196	SP[]-220	107	380	V1-110	76	327	V2-3535	61	232
CV-300	74	247	SP[]-260	131	513	V1-150	95	455	V2-4520	62	238
CV-370	86	315	SP[]-300	158	668	VI-185	225	575	V2-4535	69	276
CV-450	148	353	SP[]-370	306	797						
CV-550	173	428	SP[]-450	355	945						
CV-750	235	615	SP[]-550	420	1140						
			SP[]-750	566	1579						

POINT

Design the panel's heating value taking the actual axis operation (load rate) into consideration. With a general machine tool, the servo drive unit's load rate is approx. 50%, so the heating values inside the panel are half the values shown above. (Excluding the power supply and spindle drive unit.)

(Example 1)

When using MDS-CH-CV-260, MDS-CH-SP[]-185 and MDS-CH-V2-3535

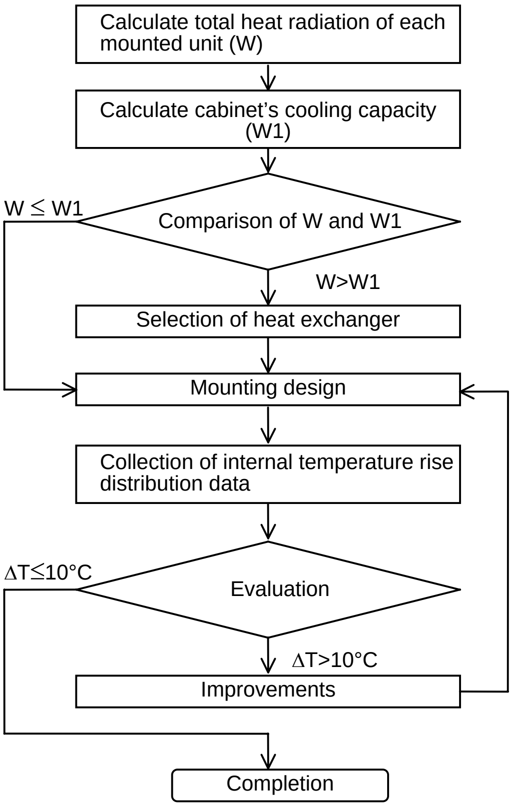
Total heating value = (65 + 196) + (102 + 353) + (61 + 232) = 1009 [W]

Heating value in panel = (65) + (102) + (61 × 0.5) = 197.5 [W]

3-1-6 Heat radiation countermeasures

In order to secure reliability and life, design the temperature in the panel so that the ambient temperature of each unit is 55°C or less.
If heat accumulates at the top of the unit, etc., install a fan so that the temperature in the panel remains constant.

Please refer to following method for heat radiation countermeasures.



<Hypothetical conditions>

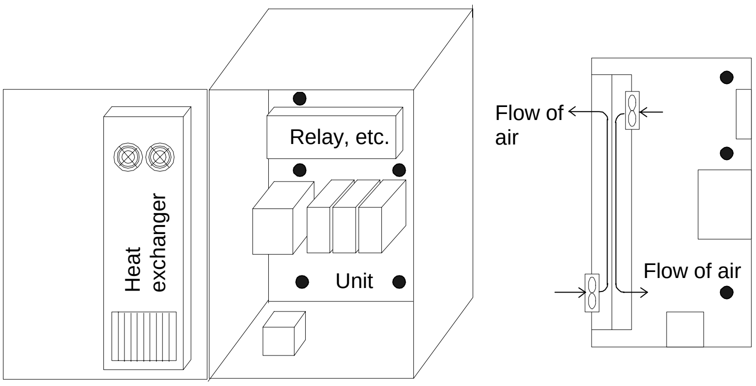
(1) Average temperature in cabinet : $T \leq 55°C$
(2) Cabinet peripheral temperature : $Ta \leq 0°C$ to $45°C$
(3) Internal temperature rise value : $\Delta T = T–Ta_{max}$
$= 10°C$

<Supplement>

1) Refer to Specifications Manual, etc. for the heat generated by each unit.
2) Enclosed cabinet (thin steel plate) cooling capacity calculation equation
   $W1 = U \times A \times \Delta T$
   U: $6W/m^2 \times °C$ (with internal agitating fan)
   $4W/m^2 \times °C$ (without internal agitating fan)
   A: Effective heat radiation area (m^2)
   (Heat dissipation area in panel)
   Sections contacting other objects are excluded.
   ΔT: Internal temperature rise value (10°C)
3) Points of caution for heat radiation countermeasures when designing mounting state
   - Layout of convection in panel
   - Collect hot air at suction port in heat exchanger cabinet.
4) Understanding the temperature rise distribution in the panel
   ΔT (average value) $\leq 10°C$
   ΔT_{max} (maximum value) $\leq 15°C$
   R (inconsistency $\Delta T_{max} – \Delta T_{min}$) $\leq 6°C$
   (Evaluate existence of heat spots)

Examples of mounting and temperature measurement positions (reference)

● **Measurement position (example)**



3-2 Installation of servomotor/spindle motor

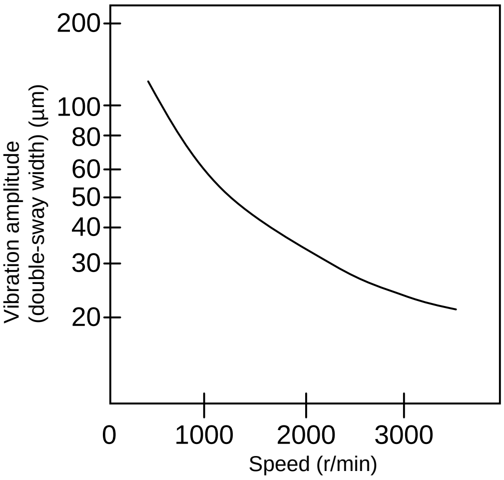
⚠ CAUTION	1. Do not hold the cables, axis or detector when transporting the motor. Failure to observe this could lead to faults or injuries. 2. Securely fix the motor to the machine. Insufficient fixing could lead to the motor deviating during operation. Failure to observe this could lead to injuries. 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 motor 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.

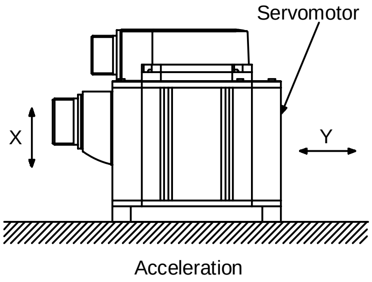
3-2-1 Environmental conditions

Environment	Conditions	
Ambient temperature	0°C to +40°C	(with no freezing)
Ambient humidity	20% to 90%RH or less	(with no dew condensation)
Storage temperature	–20°C to +65°C	(with no freezing)
Storage humidity	20% to 90%RH or less	(with no dew condensation)
Atmosphere	• Indoors (Where unit is not subject to direct sunlight) • No corrosive gases, flammable gases, oil mist or dust	
Altitude	Operation/storage: 1000m or less above sea level Transportation: 10000m or less above sea level	
Vibration	HC-H Series (Servomotor)	X: 19.6m/s^2 (2G) Y: 19.6m/s^2 (2G)
	SJ Series (Spindle motor)	Refer to each specifications.

Refer to section "3-3 Installing the linear servomotor" for the linear servomotor's environmental conditions.

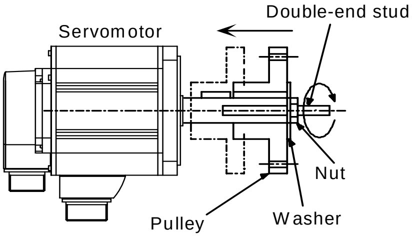
The vibration conditions are as shown below.





Refer to each spindle motor specifications for details on the spindle motor vibration conditions.

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.

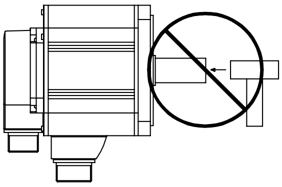
<2> When removing the pulley, use a pulley remover, and make sure not to apply an impact on the shaft.

<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 installed on the servomotor cannot be changed.

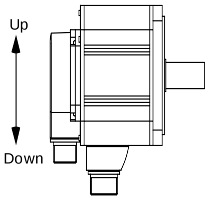
⚠ **CAUTION**

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 motor is installed so that the motor power line and detector cable cannon plugs (lead-in wires) face downward. Installation in the standard direction is effective against dripping. Measure to prevent oil and water must be taken when not installing in the standard direction. When the motor 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.



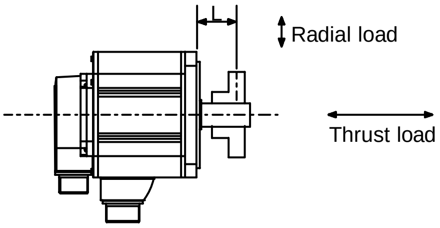
Standard installation direction

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	During operation	
	Tolerable radial load	Tolerable thrust load
HC-H52T, 53T, 102T, 103T, 152T, 153T (Taper shaft)	392N (L=52.7)	490N
HC-H52S, 53S, 102S, 103S, 152S, 153S (Straight shaft)	980N (L=52.7)	490N
HC-H202S, 203S, 352S, 353S, 452S, 453S (Straight shaft)	1500N (L=52.7)	490N
HC-H702S, 703S (Straight shaft)	1300N (L=52.7)	590N
HC-H902S, 903S (Straight shaft)	2500N (L=52.7)	1100N
HC-H1102S, 1103S (Straight shaft)	2700N (L=52.7)	1500N

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



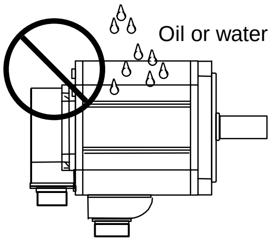
L : Length from flange installation surface to center of load weight [mm]

⚠ 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 gear 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.

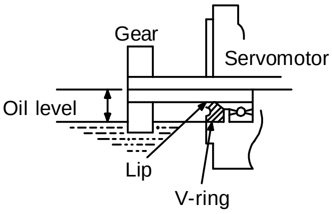
3-2-5 Oil and waterproofing measures

<1> A format based on IEC Standards (IP types) is displayed as the motor protective format (refer to "10-2-1 Specifications list."). 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 the motor's IP-type is not indicated as corrosion-resistant.

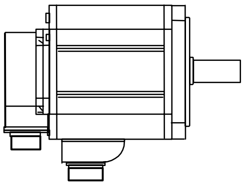


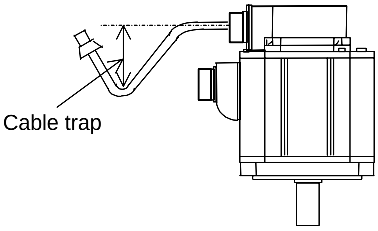
<2> When a gear box is installed on the servomotor, make sure that the oil level height from the center of the shaft is higher than the values given below. Open a breathing hole on the gear box so that the inner pressure does not rise.

Servomotor	Oil level (mm)
HC-H52, 53, 102, 103, 152, 153	20
HC-H202, 203, 352, 353	25
HC-H452, 453, 702, 703	25
HC-H902, 903, 1102, 1103	30



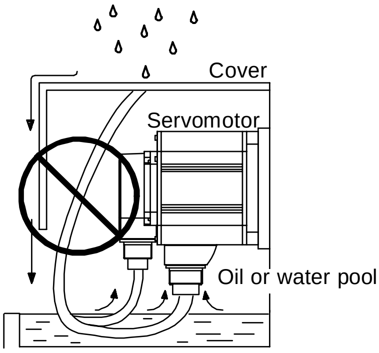
<3> When installing the servomotor horizontally, set the power cable and detector cable to face downward.
When installing vertically or on an inclination, provide a cable trap.





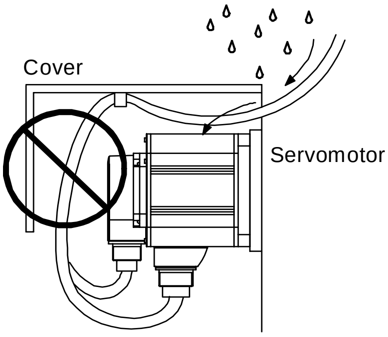
⚠ CAUTION	1. The servomotors, including those having IP65 and IP67 specifications, do not have a completely waterproof (oil-proof) structure. Do not allow oil or water to constantly contact the motor, enter the motor, or accumulate on the motor. Oil can also enter the motor through cutting chip accumulation, 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. 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.)



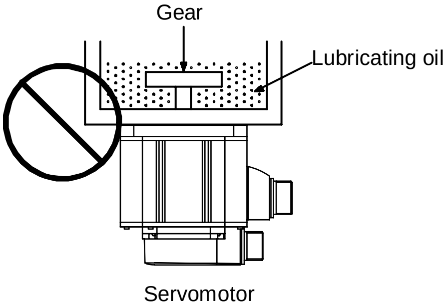
<Fault> Capillary tube Phenomenon

<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.



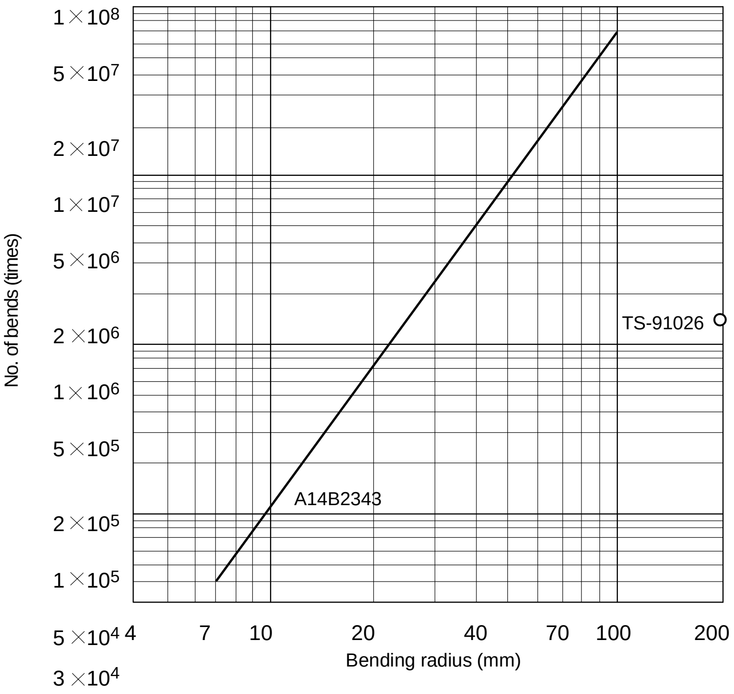
3-2-6 Cable stress

<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 part.

<2> 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 part is within the range of the optional detector cable.
Fix the detector cable and power cable enclosed with the servomotor.

<3> Make sure that the cable sheathes will not be cut by sharp cutting chips, worn, or stepped on by workers or vehicles.

<4> The bending life of the detector cable is as shown below. Regard this with a slight allowance. If the servomotor/spindle motor is installed on a machine that moves, make the bending radius as large as possible.



Detector cable bending life

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

<5> The oil resistance characteristics are given below. Note that these values are not guaranteed for all types of oils.

Item			Characteristics
Oil resistance	Sheath	Tensile strength	65% or more of value before immersion in oil
		Elongation	65% or more of value before immersion in oil
	Oil resistance conditions		70°C for four hours (JIS C 2320 Class 1 No. 2 insulation oil)

<6> The detector cable sheath is made of flame retardant PVC.

3-3 Installing the linear servomotor

⚠ **CAUTION**

1. Securely fix the linear servomotor onto the machine. Incomplete fixing could cause the servomotor to come off during operation, and lead to injuries.
2. The connectors, cooling ports, etc., cannot be repaired or replaced. The entire servomotor must be replaced, so take special care when handling.
3. Use nonmagnetic tools during installation.
4. An attraction force is generated in the magnetic body by the secondary side permanent magnet. Take care not to catch fingers or hands. Take special care when installing the primary side after the secondary side.
5. Install the counterbalance for the vertical axis and the holding brakes on the machine side. The balance weight cannot track at 9.8m/s^2 or more, so use a pneumatic counterbalance, etc., having high trackability.
6. Always install an electrical and mechanical stopper at the stroke end.
7. Take measure to prevent metal cutting chips from being attracted to the secondary side permanent magnet.
8. Oil-proofing and dust-proofing measures must be provided for the linear scale.

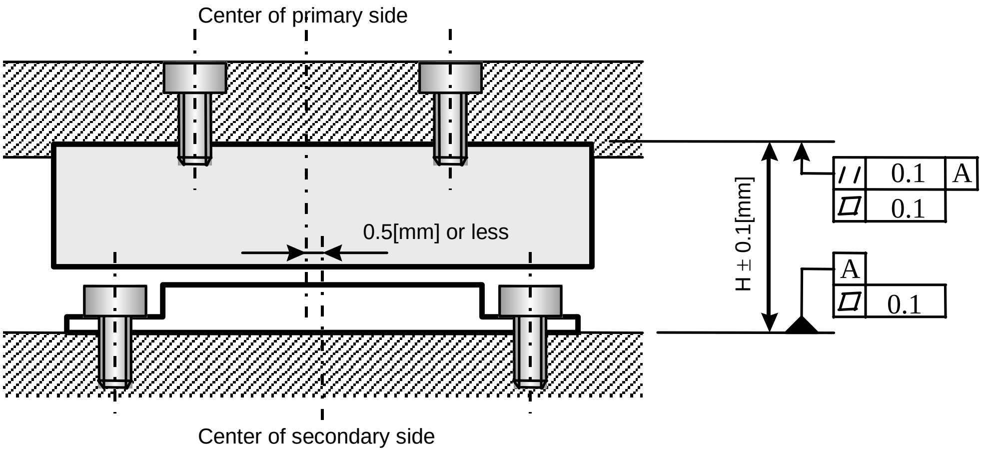
3-3-1 Installation environment

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 50°C (with no freezing)
Storage humidity	90% RH or less (with no dew condensation)
Atmosphere	Indoors (Where unit is not subject to direct sunlight) With no corrosive gas, flammable gas or dust
Vibration	4.9m/s^2 or less

3-3-2 Installing the linear servomotor

(1) Installing the primary side

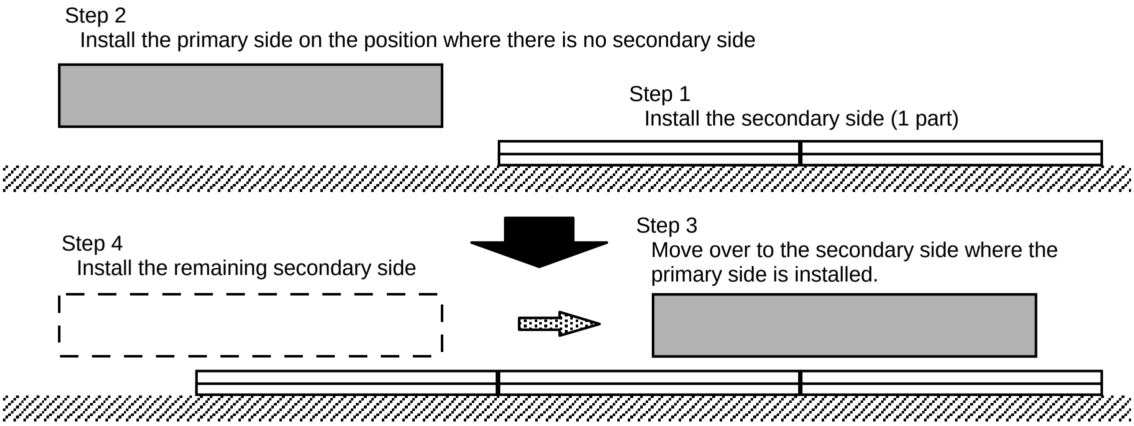
Dimensions for tie-in with secondary side



Caution: H dimensions = (primary side height dimensions) + (secondary side height dimensions) + (clearance length: 0.5[mm]).

Example of installation procedures

An example of the installation procedures is shown below.



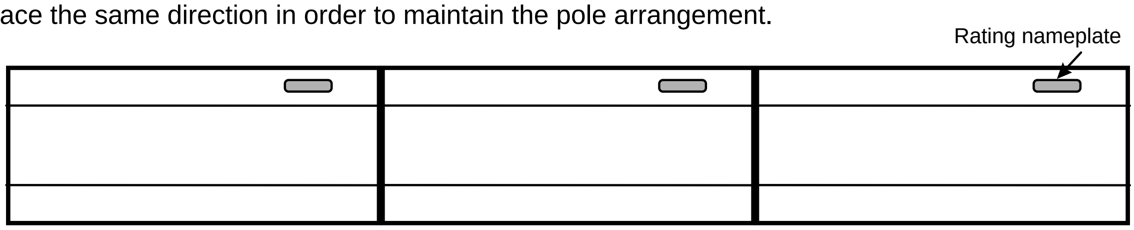
⚠ **CAUTION**	1. Installing the primary side on the position where there is no secondary side, as shown above, is recommended to avoid risks posed by the attraction force of the permanent magnet between the primary side and secondary side. 2. If the primary side must be installed over the secondary side, use a material handling device, such as a crane, which can sufficiently withstand the load such as the attraction force. 3. Note that an attraction force will be generated even after the primary side has been installed and is moved over to the secondary side.

POINT	1. Keep the moving sections (primary side) as light as possible, and the base section (secondary side) as heavy and rigid as possible. 2. Make the machine's rigidity as high as possible. 3. Securely fix the base section (secondary side) onto the foundation with anchor bolts. 4. Keep the primary resonance frequency of the entire machine as high as possible. (Should be 200Hz or more.) Install the servomotor so that the thrust is applied on the center of the moving sections. If the force is not applied on the center of the moving parts, a moment will be generated. 5. Use an effective cooling method such as circulated cooling oil. 6. Select a motor capacity that matches the working conditions. 7. Create a mechanism that can withstand high speeds and high acceleration/ deceleration.

(2) Installing the secondary side

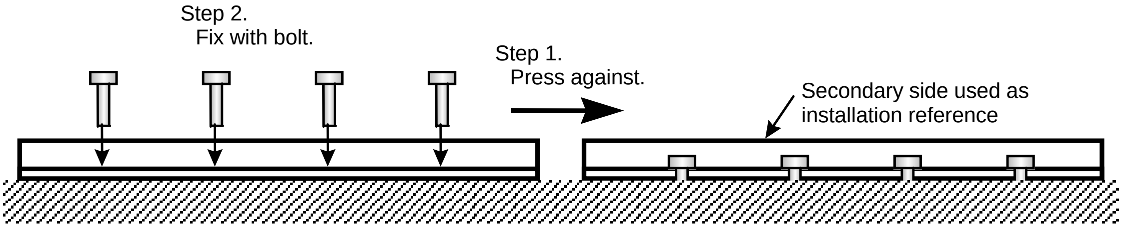
Direction

When using multiple secondary sides, lay the units out so that the nameplates on the products all face the same direction in order to maintain the pole arrangement.



Procedures

Install with the following procedure to eliminate clearances between the secondary sides.



⚠ **CAUTION**	1. Use nonmagnetic tools when installing the secondary side. 2. When placing the secondary side onto the installation surface, use the screws on the product, and suspend with eye bolts, etc. 3. If the secondary side is already installed and another secondary side is being added, place the secondary side away from the side already installed, and then slide the additional secondary side to the specific position.

3-3-3 Cooling the linear servomotor

(1) A cooling pipe is embedded on the primary side of the linear servomotor. Flow at least 5 liters of cooling oil per minute.

(2) When using with natural cooling, the continuous rating will be dropped to 50% compared to when using cooling oil.

3-4 Noise measures

Noise includes "propagation noise" generated from the power supply or relay, etc., and propagated along a cable causing the power supply unit or drive unit to malfunction, and "radiated noise" propagated through air from a peripheral device, etc., and causing the power supply unit or drive unit to malfunction.
Always implement these noise measures to prevent the peripheral devices and unit from malfunctioning.
The measures differ according to the noise propagation path, so refer to the following explanation and take appropriate measures.

(1) Mandatory noise measures

- Accurately ground all of the cables connected to this unit and requiring shielding treatment with clamp fittings. (The communication cable connected to the NC can be grounded with one clamp fitting on the NC side. However, the communication cables connected between each drive unit are not required to ground with the clamp fitting.)
  Make sure that the detector cable or the signal wire (FG wire) for the communication cable to the NC is accurately grounded to the connector shell section.
- Do not lay the "drive unit input/output power wire" and "signal wires" bundled in a parallel state. Always separate these wires.
- Use one-point grounding for the drive unit and motor.
  (Refer to section "2-10 Wiring the grounding cable.)
- Accurately ground the AC reactor using the FG terminal on the terminal block in addition to the PE terminal on the body.
- Install a surge killer on devices (magnetic contactor, relay, etc.) that generate high levels of noise.
- Accurately ground all of the detector cables with clamp fittings.
  (The FG wire to the connector shell must also be grounded.)
- Always take the measures given in "Appendix 2 EMC Installation Guidelines" for the European EMC Directives.

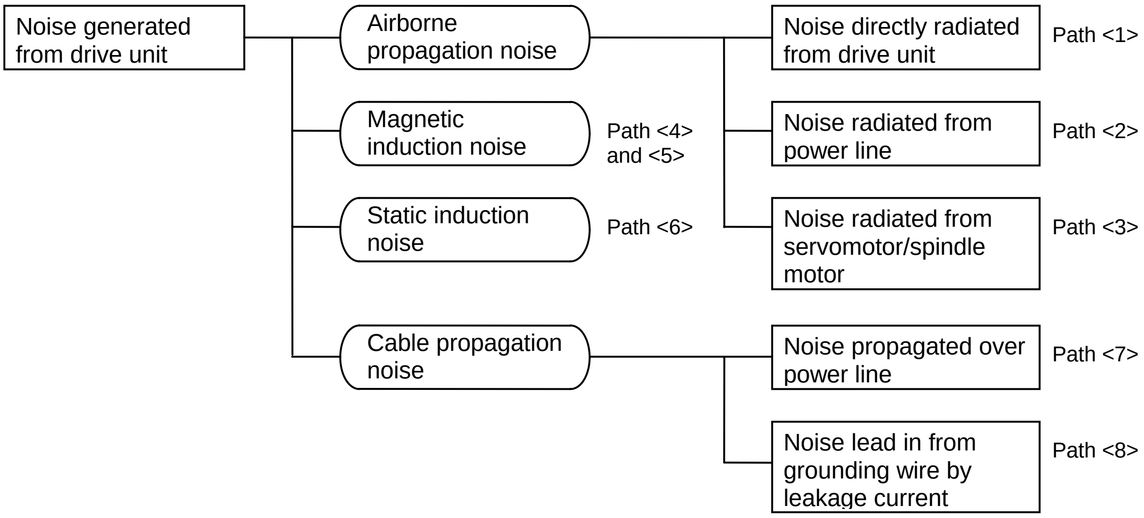
(2) Propagation noise measures

Always take the following measures when noise generating devices are installed near this unit.

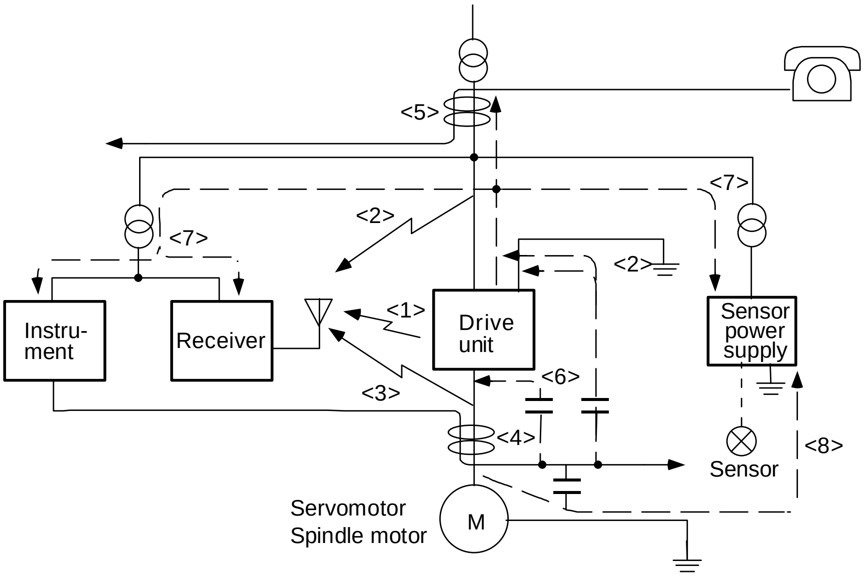
- Install a power line filter in the stage before the power supply unit.
- Install a ferrite core on the signal wire.
- Wire the spindle PLG detector cable away from other wires.

(3) Measures against radiated noise

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



Example) Drive system



Noise propagation path	Measures
<1> <2> <3>	When devices such as instrument, receiver or sensor, 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 drive units 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 drive units as possible. (2) Lay devices easily affected as far away from the signal wire of the drive unit as possible. (3) Do not lay the signal wire and power line in parallel or in a bundled state. (4) Insert a line noise filter on the input/output wire to suppress noise radiated from the wires. (5) Use a shield wire for the signal wire and power line, or place in separate metal ducts.
<4> <5> <6>	If the signal wire is laid in parallel to the power line, or if it is bundled with the power line, 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 drive unit as possible. (2) Lay devices easily affected as far away from the signal wire of the drive unit as possible. (3) Do not lay the signal wire and power line in parallel or in a bundled state. (4) Use a shield wire for the signal wire and power line, 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 drive units, the noise generated from the power supply unit could back flow over the power line and cause the devices to malfunction. In this case, take the following measures. • Install a power line filter on the power supply unit's power line.
<8>	If a closed loop is created by the peripheral device and drive unit grounding wire, the noise current could be fed back causing the device to malfunction. In this case, change the device grounding methods and the grounding place.

4. Setup

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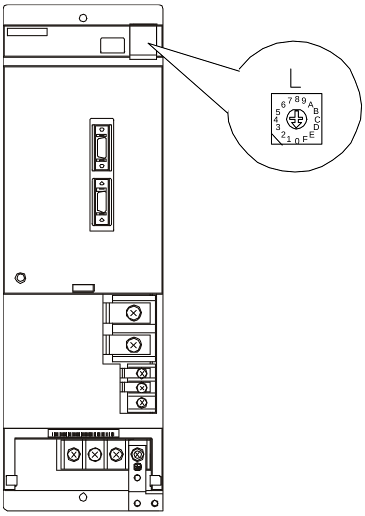
4-1 Initial setup

Check the combination of the drive unit and motor connected.
The linear servomotor can be driven with the MDS-CH-V1 Series software version "BND-583W000-B0" and higher.

4-1-1 Setting the rotary switch

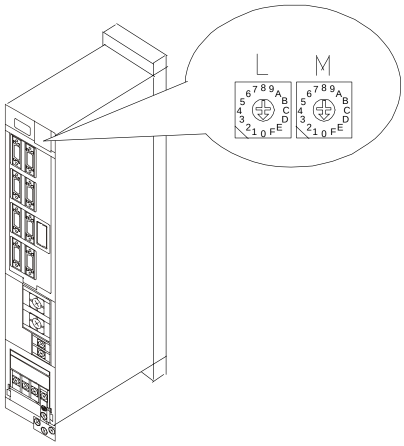
Before turning on the power, the axis No. must be set with the rotary switch. The rotary switch settings will be validated when the units are turned ON.

(1) Setting the power supply unit



SW1	MDS-CH-CV setting	
0	With contactor (melting detection)	External emergency stop (Not used CN23)
1	With no contactor	
2	Setting prohibited	
3		
4	With contactor (melting detection)	External emergency stop (Used CN23)
5	With no contactor	
6	Setting prohibited	
7		
8		
9		
A		
B		
C		
D		
E		
F		

(2) Setting the servo/spindle drive unit



When MDS-CH-V2 Series are used

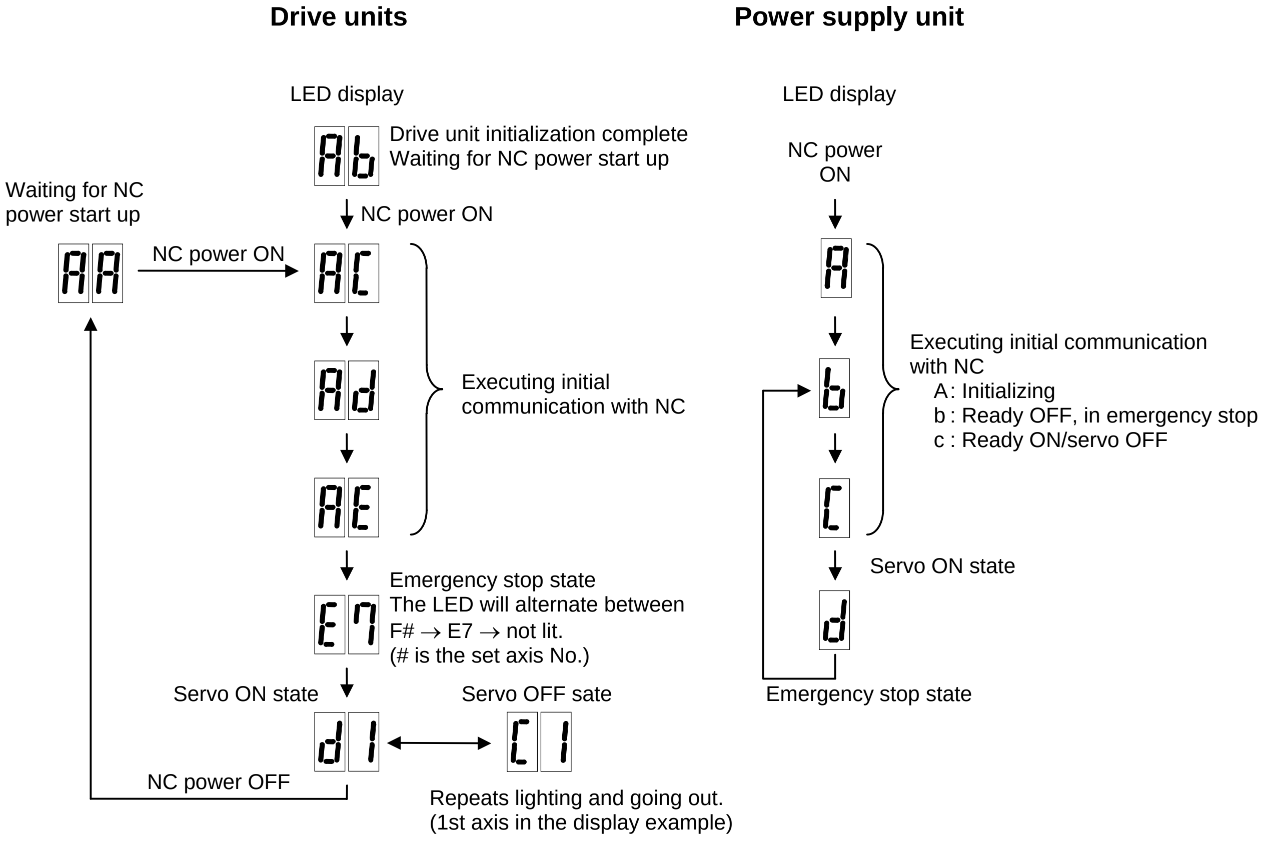
Rotary switch setting	Set axis No.
0	1st axis
1	2nd axis
2	3rd axis
3	4th axis
4	5th axis
5	6th axis
6	7th axis
7	Not usable
8	
9	
A	
B	
C	
D	
E	
F	Axis not used

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 NC system's emergency stop cannot be released.

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

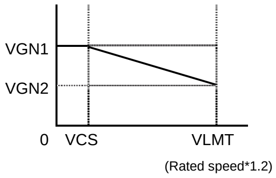
When CNC, each drive unit and the power supply unit power have been turned ON, each unit will automatically execute self-diagnosis and initial settings for operation, etc. The LEDs on the front of the units will change as shown below according to the progression of these processes.
If an alarm occurs,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



4-2 Servo drive unit initial parameter settings

Refer to each CNC instruction manual for details on the operation methods and system specification parameter settings.

4-2-1 List of servo parameters

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). (If “201” or bigger is set, the SHG control cannot be used.)	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 1	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 10000
SV006	VGN2	Speed loop gain 2	If the noise is bothersome at high speed during rapid traverse, etc, lower the speed loop gain. As in the right figure, set the speed loop gain of the speed 1.2 times as fast as the motor’s rated speed, and use this with SV029 (VCS). When not using, set to “0”. 	-1000 to 1000
SV007	VIL	Speed loop delay compensation	Set this when the limit cycle occurs in the full-closed loop, or overshooting occurs in positioning. Select the control method with SV027 (SSF1)/bit1, 0 (vcnt). Normally, use “Changeover type 2”. When you set this parameter, make sure to set the torque offset (SV032 (TOF)). When not using, set to “0”.	0 to 32767
			No changeover When SV027 (SSF1)/ bit1, 0 (vcnt)=00 The delay compensation control is always valid.	
			Changeover type 1 When SV027 (SSF1)/ bit1, 0 (vcnt)=01 The delay compensation control works when the command from the NC is “0”. Overshooting that occurs during pulse feeding can be suppressed.	
			Changeover type 2 When SV027 (SSF1)/ bit1, 0 (vcnt)=10 The delay compensation control works when the command from the NC is “0” and the position droop is “0”. Overshooting or the limit cycle that occurs during pulse feeding or positioning can be suppressed.	
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

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

No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)
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		
SV011	IQG	Current loop q axis gain		1 to 4096 In case of MDS-B-Vx4, 1 to 8192
SV012	IDG	Current loop d axis gain		
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 999 (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 999 (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 (%)
SV016	LMC1	Lost motion compensation 1	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.	
			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.	-1 to 200 (%)
			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.	-1 to 100 (Stall [rated] current %)
			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.	

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated with 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>SV017</td><td>SPEC*</td><td>Servo specification selection</td><td colspan="2">HEX setting
<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">spm</td><td>drvall</td><td>drvup</td><td>mpt3</td><td>mp</td><td>abs</td><td></td><td>vdir</td><td>fdir</td><td>vfb</td><td>seqh</td><td>dfbx</td><td>fdir2</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>fdir2</td><td>Speed feedback forward polarity</td><td>Speed feedback reverse polarity</td></tr>
<tr><td>1</td><td>dfbx</td><td>Dual feedback control stop</td><td>Dual feedback control start</td></tr>
<tr><td>2</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>vfb</td><td>Speed feedback filter stop</td><td>Speed feedback filter stop (2250Hz)</td></tr>
<tr><td>4</td><td>fdir</td><td>Position feedback forward polarity</td><td>Position feedback reverse polarity</td></tr>
<tr><td>5</td><td></td><td></td><td></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>mp</td><td>MP scale 360P (2mm pitch)</td><td>MP scale 720P (1mm pitch)</td></tr>
<tr><td>9</td><td>mpt3</td><td>MP scale ABS detection NC control</td><td>MP scale ABS detection automatic (Standard swetting)</td></tr>
<tr><td>A</td><td></td><td></td><td></td></tr>
<tr><td>B</td><td></td><td></td><td></td></tr>
<tr><td>C</td><td rowspan="4">spm</td><td colspan="2" rowspan="4">2 : Rotary servomotor
8 : Linear servomotor
All other setting values are prohibited</td></tr>
<tr><td>D</td></tr>
<tr><td>E</td></tr>
<tr><td>F</td></tr>
</table>
(Note 1) Set to “0” for bits with no particular description.</td></tr>
<tr><td rowspan="2">SV018</td><td rowspan="2">PIT*</td><td>Ball screw pitch</td><td>Set the ball screw pitch. Set to “360” for the rotary axis.</td><td rowspan="2">1 to 32767 (mm/rev)</td></tr>
<tr><td>Pole pitch</td><td>Set the pole pitch when using the linear servomotor.</td></tr>
</table>

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated with 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="3">SV019</td><td rowspan="3">RNG1*</td><td rowspan="3">Position detector resolution</td><td>In the case of the semi-closed loop control
Set the same value as SV020 (RNG2). (Refer to the explanation of SV020.)</td><td>1 to 9999
(kp/rev)</td></tr>
<tr><td>In the case of the full-closed loop control
Set the number of pulses per ball screw pitch.
<table>
<tr><th>Detector model name</th><th>Resolution</th><th>SV019 setting</th></tr>
<tr><td>OHE25K-ET, OHA25K-ET</td><td>100,000 (p/rev)</td><td>100</td></tr>
<tr><td>OSE104-ET,OSA104-ET</td><td>100,000 (p/rev)</td><td>100</td></tr>
<tr><td>OSE105-ET,OSA105-ET</td><td>1,000,000 (p/rev)</td><td>1000</td></tr>
<tr><td>RCN723 (Heidenhain)</td><td>8,000,000 (p/rev)</td><td>8000</td></tr>
<tr><td>Relative position detection scale</td><td>Refer to specification manual for each detector</td><td>PIT/Resolution (m)</td></tr>
<tr><td>AT41 (Mitsutoyo)</td><td>1 (m/p)</td><td>The same as SV018 (PIT)</td></tr>
<tr><td>FME type, FLE type (Futaba)</td><td>Refer to specification manual for each detector</td><td>PIT/Resolution (m)</td></tr>
<tr><td>MP type (Mitsubishi Heavy Industries)</td><td>Refer to specification manual for each detector</td><td>PIT/Resolution (m)</td></tr>
<tr><td>AT342 (Mitsutoyo)</td><td>0.5 (m/p)</td><td>Twice as big as SV018 (PIT)</td></tr>
<tr><td>AT343 (Mitsutoyo)</td><td>0.05 (m/p)</td><td>20 times as big as SV018 (PIT)</td></tr>
<tr><td>AT543 (Mitsutoyo)</td><td>0.05 (m/p)</td><td>PIT/Resolution (m)</td></tr>
<tr><td>LC191M (Heidenhain)</td><td>Refer to specification manual for each detector.</td><td>PIT/Resolution (m)</td></tr>
<tr><td>LC491M (Heidenhain)</td><td>Refer to specification manual for each detector.</td><td>PIT/Resolution (m)</td></tr>
<tr><td>MDS-B-HR</td><td>Analog cycle/500</td><td>PIT/Resolution (m)</td></tr>
</table></td><td>1 to 9999
(kp/pit)</td></tr>
<tr><td>For linear servomotor control
Set the number of pulses (K pulses) per pole pitch.
(Set the same value for SV020: RNG2.)
<table>
<tr><td>AT342</td><td>LC191M</td><td>HR + relative position detector</td><td>HR + AT342</td></tr>
<tr><td>120</td><td>600 or 1200</td><td>PIT/Resolution (m)</td><td>1500</td></tr>
</table>
Note) The above value applies for the linear servomotor with 60mm pole pitch.</td><td>1 to 9999
(kp/pit)</td></tr>
<tr><td rowspan="2">SV020</td><td rowspan="2">RNG2*</td><td rowspan="2">Speed detector resolution</td><td>Set the number of pulses per one revolution of the motor side detector.
<table>
<tr><th>Detector model name</th><th>SV020 setting</th></tr>
<tr><td>OSE104, OSA104</td><td>100</td></tr>
<tr><td>OSE105, OSA105</td><td>1000</td></tr>
</table></td><td rowspan="2">1 to 9999
(kp/rev)</td></tr>
<tr><td>Set the same value as SV019: RNG1 when using linear servomotor control.</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 999
(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>110 to 500
(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> $\text{OD1=OD2=} \frac{\text{Rapid traverse rate (mm/min)}}{\text{60*PGN1}} \text{/2 (mm)}$
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
(m)</td></tr>
</table>

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

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV025</td><td>MTYP*</td><td>Motor/Detector type</td><td>
HEX setting
<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">pen</td><td colspan="4">ent</td><td colspan="8">mtyp</td></tr>
</table>
<table>
<tr><th>bit</th><th></th><th>Explanation</th></tr>
<tr><td>0
1
2
3
4
5
6
7</td><td>mtyp</td><td>
Set the motor type. Set this along with SV017 (SPEC)/spm.
1) When SV017/spm=2 (Rotary servomotor)
<table>
<tr><th>Setting</th><th>0x</th><th>1x</th><th>2x</th><th>3x</th><th>4x</th><th>5x</th><th>6x</th><th>7x</th></tr>
<tr><td>x0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x6</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x7</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x9</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xA</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xB</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xC</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xD</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xE</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xF</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
<table>
<tr><th>Setting</th><th>8x</th><th>9x</th><th>Ax</th><th>Bx</th><th>Cx</th><th>Dx</th><th>Ex</th><th>Fx</th></tr>
<tr><td>x0</td><td></td><td></td><td></td><td>HC-H52</td><td>HC-H53</td><td></td><td></td><td></td></tr>
<tr><td>x1</td><td></td><td></td><td></td><td>HC-H102</td><td>HC-H103</td><td></td><td></td><td></td></tr>
<tr><td>x2</td><td></td><td></td><td></td><td>HC-H152</td><td>HC-H153</td><td></td><td></td><td></td></tr>
<tr><td>x3</td><td></td><td></td><td></td><td>HC-H202</td><td>HC-H203</td><td></td><td></td><td></td></tr>
<tr><td>x4</td><td></td><td></td><td></td><td>HC-H352</td><td>HC-H353</td><td></td><td></td><td></td></tr>
<tr><td>x5</td><td></td><td></td><td></td><td>HC-H452</td><td>HC-H453</td><td></td><td></td><td></td></tr>
<tr><td>x6</td><td></td><td></td><td></td><td>HC-H702</td><td>HC-H703</td><td></td><td></td><td></td></tr>
<tr><td>x7</td><td></td><td></td><td></td><td>HC-H902</td><td>HC-H903</td><td></td><td></td><td></td></tr>
<tr><td>x8</td><td></td><td></td><td></td><td>HC-H1102</td><td>HC-H1103</td><td></td><td></td><td></td></tr>
<tr><td>x9</td><td></td><td></td><td></td><td>HC-H1502</td><td></td><td></td><td></td><td></td></tr>
<tr><td>xA</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xB</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xC</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xD</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xE</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xF</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
2) When SV017/spm=8 (Linear servomotor)
<table>
<tr><th>Setting</th><th>0x</th><th>1x</th><th>2x</th><th>3x</th><th>4x</th><th>5x</th><th>6x</th><th>7x</th></tr>
<tr><td>x0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x6</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x7</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x8</td><td>LM-NP5G-60P
(Natural cooling)</td><td>LM-NP5G-60P
(Oil cooled)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x9</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xA</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xB</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xC</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xD</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xE</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>xF</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
</table>
</td></tr>
</table>

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

No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)
SV025	MTYP*	Motor/Detector type	HEX setting 8, 9, A, B: ent C, D, E, F: pen Set the detector type. Set the position detector type for “pen”, and the speed detector type for “ent”. In the case of the semi-closed loop control, set the same value for “pen” and “ent”.	
SV026	OD2	Excessive error detection width during servo OFF	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.	0 to 32767 (mm)

pen setting	ent setting	Detector model name
0	0	OSE104
1	1	OSA104
2	2	OSE105, OSA105
3	3	
4	Setting impossible	OHE25K-ET, OSE104-ET
5	Setting impossible	OHA25K-ET, OSA104-ET
6	Setting impossible	OSE105-ET, OSA105-ET, RCN723 (Heidenhain)
7	Setting impossible	
8	Setting impossible	Relative position detection scale, MP type (Mitsubishi Heavy Industries)
9	Setting impossible	AT41 (Mitsutoyo), FME type, FLE type (Futaba)
A	A	AT342, AT343, AT543 (Mitsutoyo), LC191M/491M (Heidenhain), MDS-B-HR
B	Setting impossible	
C	-	For semi-closed speed synchronization setting
C	C (Current synchronization)	The setting of the slave axis in the speed/current synchronization control. When the master axis is the semi-closed control.
D	-	For closed-loop speed control
D	A	Settings for slave axis in 2-scale 2-linear servomotor system (Using CN3 connector)
D	D	The setting of the slave axis in the speed/ current synchronization control. When the master axis is the full-closed control. For linear servomotor current synchronization
D	E	For V2 closed-loop current synchronization control
E	Setting impossible	
F	Setting impossible	

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated with 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>SV027</td><td>SSF1</td><td>Servo function selection 1</td><td colspan="2">
HEX setting
<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>aflt</td><td>zrn2</td><td colspan="2">afse</td><td colspan="2">ovs</td><td colspan="2">lmc</td><td>omr</td><td>zrn3</td><td colspan="2">vfct</td><td></td><td></td><td colspan="2">vcnt</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
1</td><td>vcnt</td><td colspan="2">Set the execution changeover type of the speed loop delay compensation.
00: Delay compensation changeover invalid 10: Delay compensation type 2
01: Delay compensation changeover type 1 11: Setting prohibited</td></tr>
<tr><td>2</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td colspan="2"></td></tr>
<tr><td>4
5</td><td>vfct</td><td colspan="2">Set the number of compensation pulses of the jitter compensation.
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>zrn3</td><td colspan="2">ABS scale: Set to “1” in using AT342, AT343, AT543, LC191M/491M.</td></tr>
<tr><td>7</td><td>omr</td><td>Machine side compensation invalid</td><td>Machine side compensation valid</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 compensation stop 10: Lost motion compensation type 2
01: Lost motion compensation type 1 11: Setting prohibited</td></tr>
<tr><td>A
B</td><td>ovs</td><td colspan="2">Set the compensation amount with SV031 (OVS1) and SV042 (OVS2).
00: Overshooting compensation stop 10: Overshooting compensation type 2
01: Overshooting compensation type 1 11: Setting prohibited</td></tr>
<tr><td>C
D</td><td>afse</td><td colspan="2">00: Adoptive filter sensitivity standard
11: Adoptive filter sensitivity increase (Set 2bits at a time)</td></tr>
<tr><td>E</td><td>zrn2</td><td colspan="2">Set to “1”.</td></tr>
<tr><td>F</td><td>aflt</td><td>Adoptive filter stop</td><td>Adoptive filter start</td></tr>
</table>
(Note) Set to "0" for bits with no particular description.
</td></tr>
<tr><td>SV028</td><td>MSFT</td><td>Pole shift amount</td><td>Set the pole shift amount for the linear servomotor.
This is not used for the rotary servomotor.
Set to “0”.</td><td>-32768 to 32767 (µm)</td></tr>
<tr><td rowspan="2">SV029</td><td rowspan="2">VCS</td><td rowspan="2">Speed at the change of speed loop gain</td><td>If the noise is bothersome at high speed during rapid traverse, etc, lower the speed loop gain.
Set the speed at which the speed loop gain changes, and use this with SV006 (VGN2).
When not using, set to “0”.</td><td>0 to 9999
(r/min)</td></tr>
<tr><td>The setting unit differs for the linear servo, but the function is the same as that explained here.</td><td>0 to 9999
(mm/s)</td></tr>
<tr><td>SV030</td><td colspan="3">
<table>
<tr><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range
(Unit)</th></tr>
<tr><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.
When “0” is set, a 100% compensation will be performed.
Adjust in increments of 10% from the default value 100%.
If increased too much, vibration or vibration noise may be generated.</td><td>0 to 255
(%)</td></tr>
</table>
</td><td>0 to 255</td></tr>
</table>

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

No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)
SV031	OVS1	Overshooting compensation 1	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. Type 1: When SV027 (SSF1)/ bitB, A (ovs)=01 Set the compensation amount based on the motor's stall current. This compensates overshooting that occurs during pulse feeding. Normally, use Type 2. Type 2: When SV027 (SSF1)/ bitB, A (ovs)=10 Set the compensation amount based on the motor's stall current. Increase by 1% and determine the amount that overshooting doesn't occur. In Type 2, compensation during the feed forward control during circular cutting won't be performed. Type 3: When SV027 (SSF1)/ bitB, A (ovs)=11 Use this to perform the overshooting compensation during circular cutting or the feed forward control. The setting method is the same in Type 2. 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.	-1 to 100 (Stall [rated] current %)
SV032	TOF	Torque offset	Set the unbalance torque of vertical axis and inclined axis.	-100 to 100 (Stall [rated] current %)
SV033	SSF2	Servo function selection 2	HEX setting	

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
dos								nfd2			nf3	nfd1			zck

bit		Meaning when "0" is set	Meaning when "1" is set
0	zck	Z phase check valid (Alarm 42)	Z phase check invalid
1	nfd1	Set the filter depth for Notch filter 1 (SV038). Value 000 001 010 011 100 101 110 111 Depth (dB) Infntly deep -18.1 -12.0 -8.5 -6.0 -4.1 -2.5 -1.2 Deep← Shallow→	
2			
3			
4	nf3	Notch filter 3 stop	Notch filter 3 start (1125Hz)
5	nfd2	Set the operation frequency of Notch filter 2 (SV046). Value 000 001 010 011 100 101 110 111 Depth (dB) Infntly deep -18.1 -12.0 -8.5 -6.0 -4.1 -2.5 -1.2 Deep← Shallow→	
6			
7			
8			
9			
A			
B			
C	dos	0: MP scale absolute position detection, offset demand signal output	
D			
E			
F			

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

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated with 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>SV034</td><td>SSF3</td><td>Servo function selection 3</td><td>
HEX setting
<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">ovsn</td><td></td><td></td><td></td><td></td><td></td><td></td><td>zeg</td><td></td><td></td><td>mohn</td><td>has2</td><td>has1</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>has1</td><td>Setting for normal use.</td><td>HAS control 1 valid
(High acceleration rate support)</td></tr>
<tr><td>1</td><td>has2</td><td>Setting for normal use.</td><td>HAS control 2 valid
(Overshooting support)</td></tr>
<tr><td>2</td><td>mohn</td><td>MDS-B-HR motor thermal valid</td><td>MDS-B-HR motor thermal ignored</td></tr>
<tr><td>3</td><td></td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td><td></td></tr>
<tr><td>5</td><td>zeg</td><td>Z phase normal edge detection (normal)</td><td>Z phase reverse edge detection (Valid only when SV027/bit6=1)</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">linN</td><td colspan="2" rowspan="4">Set the number of linear servos connected in parallel.</td></tr>
<tr><td>9</td></tr>
<tr><td>A</td></tr>
<tr><td>B</td></tr>
<tr><td>C</td><td rowspan="4">ovsn</td><td colspan="2" rowspan="4">Set the non-sensitive band of the overshooting compensation type 3 in increments of 2 m at a time.
In the feed forward control, the non-sensitive band of the model position droop is set, and overshooting of the model is ignored.
Set the same value as the standard SV040.</td></tr>
<tr><td>D</td></tr>
<tr><td>E</td></tr>
<tr><td>F</td></tr>
</table>
(Note) Set to “0” for bits with no particular description.
</td><td></td></tr>
<tr><td>SV035</td><td>SSF4</td><td>Servo function selection 4</td><td>
HEX setting
<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>clt</td><td colspan="3">clG1</td><td>cl2n</td><td>clet</td><td colspan="2">cltq</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>0</td><td></td><td></td><td></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</td><td></td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td><td></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="2">Cltq</td><td colspan="2" rowspan="2">Set the retracting torque for collision detection in respect to the maximum torque of the motor.
00: 100% 01: 90% 10: 80% (Standard) 11: 70%</td></tr>
<tr><td>9</td></tr>
<tr><td>A</td><td>clet</td><td>Setting for normal use</td><td>The disturbance torque peak of the latest two seconds is displayed in MPOS of the servo monitor screen.</td></tr>
<tr><td>B</td><td>cl2n</td><td>Collision detection method 2 valid</td><td>Collision detection method 2 invalid</td></tr>
<tr><td>C</td><td rowspan="3">clG1</td><td colspan="2" rowspan="3">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.</td></tr>
<tr><td>D</td></tr>
<tr><td>E</td></tr>
<tr><td>F</td><td>clt</td><td>Setting for normal use</td><td>The guide value of the SV059 setting value is displayed in MPOS of the servo monitor screen.</td></tr>
</table>
</td><td></td></tr>
</table>

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<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range
(Unit)</th></tr>
<tr><td>SV036</td><td>PTYP*</td><td>Power supply type</td><td colspan="2">
HEX setting
<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="8">ptyp</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Explanation</th></tr>
<tr><td>0
1
2
3
4
5
6
7</td><td>ptyp</td><td>When the CN4 connector of the drive unit and the power supply are connected, setting below is necessary.
To validate the external emergency stop function, add 40h.
<table>
<tr><th>Setting</th><th>0x</th><th>1x</th><th>2x</th><th>3x</th><th>4x</th><th>5x</th><th>6x</th><th>7x</th><th>8x</th></tr>
<tr><td>x0</td><td>Not used</td><td></td><td></td><td>CV-300</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x1</td><td></td><td>CV-110</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x2</td><td></td><td></td><td>CV-220</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x4</td><td>CV-37</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x5</td><td></td><td>CV-150</td><td></td><td></td><td>CV-450</td><td>CV-550</td><td></td><td>CV-750</td><td></td></tr>
<tr><td>x6</td><td>CV-55</td><td></td><td>CV-260</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x7</td><td></td><td></td><td></td><td>CV-370</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x8</td><td>CV-75</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>x9</td><td></td><td>CV-185</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>8
9
A
B</td><td>rtyp</td><td>"0": Standard setting
"1": When MDS-CH-V1-185 is connected</td></tr>
<tr><td>C
D
E
F</td><td>amp</td><td>Set "0".</td></tr>
</table>
</td></tr>
<tr><td rowspan="2">SV037</td><td rowspan="2">JL</td><td rowspan="2">Load inertia scale</td><td>Set “the motor inertia + motor axis conversion load inertia” in respect to the motor inertia.
$\text{SV037(JL)} = \frac{Jl+Jm}{Jm} *100$
Jm Motor inertia
Jl Motor axis conversion load inertia</td><td>0 to 5000
(%)</td></tr>
<tr><td>Set total weight of the moving section for the linear servomotor as a kg unit.</td><td>0 to 5000
(kg)</td></tr>
<tr><td>SV038</td><td>FHz1</td><td>Notch filter frequency 1</td><td>Set the vibration frequency to suppress if machine vibration occurs.
(Valid at 36 or more) When not using, set to “0”.</td><td>0 to 9000
(Hz)</td></tr>
<tr><td>SV039</td><td>LMCD</td><td>Lost motion compensation timing</td><td>Set this when the lost motion compensation timing doest not match.
Adjust by increasing the value by 10 at a time.</td><td>0 to 2000
(ms)</td></tr>
<tr><td>SV040</td><td colspan="3">
<table>
<tr><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range
(Unit)</th></tr>
<tr><td>LMCT</td><td>Lost motion compensation non-sensitive band</td><td>Set the non-sensitive band of the lost motion compensation in the feed forward control.
When “0” is set, the actual value that is set is 2 m.
Adjust by increasing by 1 m at a time.</td><td>0 to 100
(µm)</td></tr>
</table>
</td><td>0 to 100</td></tr>
</table>

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<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range (Unit)</th></tr>
<tr><td>SV041</td><td>LMC2</td><td>Lost motion compensation 2</td><td>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.</td><td>-1 to 200 (Stall [rated] current %)</td></tr>
<tr><td>SV042</td><td>OVS2</td><td>Overshooting compensation 2</td><td>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.</td><td>-1 to 100 (Stall [rated] current %)</td></tr>
<tr><td>SV043</td><td>OBS1</td><td>Disturbance observer filter frequency</td><td>Set the disturbance observer filter band.
Set to “100” as a standard.
To use the disturbance observer, also set SV037 (JL) and SV044 (OBS2).
When not using, set to “0”.</td><td>0 to 1000 (rad/s)</td></tr>
<tr><td>SV044</td><td>OBS2</td><td>Disturbance observer gain</td><td>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”.</td><td>0 to 500 (%)</td></tr>
<tr><td>SV045</td><td colspan="3"><table>
<tr><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range (Unit)</th></tr>
<tr><td>TRUB</td><td>Frictional torque</td><td>When you use the collision detection function, set the frictional torque.</td><td>0 to 100 (Stall [rated] current %)</td></tr>
</table></td><td>0 to 100</td></tr>
<tr><td>SV046</td><td>FHz2</td><td>Notch filter frequency 2</td><td>Set the vibration frequency to suppress if machine vibration occurs.
(Valid at 36 or more) When not using, set to “0”.</td><td>0 to 9000 (Hz)</td></tr>
<tr><td>SV047</td><td>EC</td><td>Inductive voltage compensation gain</td><td>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.</td><td>0 to 200 (%)</td></tr>
<tr><td>SV048</td><td>EMGrt</td><td>Vertical axis drop prevention time</td><td>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.</td><td>0 to 20000 (ms)</td></tr>
<tr><td>SV049</td><td>PGN1sp</td><td>Position loop gain 1 in spindle synchronous control</td><td>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).</td><td>1 to 200 (rad/s)</td></tr>
<tr><td>SV050</td><td>PGN2sp</td><td>Position loop gain 2 in spindle synchronous control</td><td>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”.</td><td>0 to 999 (rad/s)</td></tr>
<tr><td>SV051</td><td>DFBT</td><td>Dual feed back control time constant</td><td>Set the control time constant in dual feed back.
When “0” is set, the actual value that is set is 1msec.
The higher the time constant is, the closer it gets to the semi-closed control, so the limit of the position loop gain is raised.</td><td>0 to 9999 (ms)</td></tr>
<tr><td>SV052</td><td>DFBN</td><td>Dual feedback control dead zone</td><td>Set to “0” as a standard.
Set the dead zone in the dual feedback control.</td><td>0 to 9999 (μm)</td></tr>
<tr><td>SV053</td><td>OD3</td><td>Excessive error detection width in special control</td><td>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.</td><td>0 to 32767 (mm)</td></tr>
</table>

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No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)
SV054	ORE	Overrun detection width in closed loop control	Set the overrun detection width in the full-closed loop control. If the gap between the motor side detector and the linear scale (machine side detector) exceeds the value set by this parameter, it is judged to be overrun and Alarm 43 will be detected. When "-1" is set, the alarm detection won't be performed. When "0" is set, overrun is detected with a 2mm width.	-1 to 32767 (mm)
SV055	EMGx	Max. gate off delay time after emergency stop	Set a length of time from the point when the emergency stop is input to the point when READY OFF is compulsorily executed. Normally, set the same value as the absolute value of SV056. In preventing the vertical axis from dropping, the gate off is delayed for the length of time set by SV048 if SV055's value is smaller than that of SV048.	0 to 20000 (ms)
SV056	EMGt	Deceleration time constant at emergency stop	In the vertical axis drop prevention time control, 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. When executing the synchronous operation, put the minus sign to the settings of both of the master axis and slave axis.	-20000 to 20000 (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 1200 (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 1200 (rad/s)
SV059	TCNV	Collision detection torque estimating gain	Set the torque estimating gain when using the collision detection function. After setting as SV035/bitF(clt)=1 and performing acceleration/deceleration, set the value displayed in MPOS of the NC servo monitor screen. Set to "0" when not using the collision detection function.	-32768 to 32767
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 999 (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. In the case of MDS-C1-V2, set the axis on the side to which the data will not be output to "-1".	-1 to 127
SV062	DA2NO	D/A output channel 2 data No.		
SV063	DA1MPY	D/A output channel 1 output scale	Set the scale with a 1/256 unit. When "0" is set, output is done with the standard output unit.	-32768 to 32767 (Unit: 1/256)
SV064	DA2MPY	D/A output channel 2 output scale		
SV065	TLC	Machine side compensation spring constant	Set the spring constant of the machine side compensation. In the semi-closed loop control, the machine side compensation amount is calculated with the following equation. $\text{Compensation amount}=\dfrac{F\ (\text{mm/min})^2 * \text{SV065}}{R\ (\text{mm}) * 10^9}\quad (\ \text{m})$ When not using, set to "0".	-32768 to 32767

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<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV081</td><td>SPEC2*</td><td>Servo specification selection 2</td><td>
<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></td><td></td><td></td><td>pabs</td><td></td><td></td><td>rabs</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>0</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td>rabs</td><td>Normal setting</td><td>Rotary axis machine end absolute position control</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</td><td>pabs</td><td>Normal setting</td><td>Speed/current synchronous control absolute position control</td></tr>
<tr><td>5</td><td></td><td></td><td></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></td><td></td><td></td></tr>
<tr><td>9</td><td></td><td></td><td></td></tr>
<tr><td>A</td><td></td><td></td><td></td></tr>
<tr><td>B</td><td></td><td></td><td></td></tr>
<tr><td>C</td><td></td><td></td><td></td></tr>
<tr><td>D</td><td></td><td></td><td></td></tr>
<tr><td>E</td><td></td><td></td><td></td></tr>
<tr><td>F</td><td></td><td></td><td></td></tr>
</table>
(Note) Set to "0" for bits with no particular description.
</td></tr>
<tr><td>SV082</td><td>SSF5</td><td>Servo function selection5</td><td>
<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>obshj</td><td></td><td></td><td></td><td></td><td></td><td>lmc3</td><td>lmct</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>lmct</td><td>Setting for normal use</td><td>Lost motion compensation 3 adjustment time measurement valid</td></tr>
<tr><td>1</td><td>lmc3</td><td>Lost motion compensation 3 stop</td><td>Lost motion compensation 3 start</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</td><td></td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td><td></td></tr>
<tr><td>6</td><td></td><td></td><td></td></tr>
<tr><td>7</td><td>obshj</td><td>Normal use</td><td>Disturbance observer
High-load inertia compatible 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>A</td><td></td><td></td><td></td></tr>
<tr><td>B</td><td></td><td></td><td></td></tr>
<tr><td>C</td><td></td><td></td><td></td></tr>
<tr><td>D</td><td></td><td></td><td></td></tr>
<tr><td>E</td><td></td><td></td><td></td></tr>
<tr><td>F</td><td></td><td></td><td></td></tr>
</table>
(Note) Set to "0" for bits with no particular description.
</td></tr>
</table>

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated with the NC power 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>SV083</td><td>SSF6</td><td>Servo function selection 6</td><td>
<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 colspan="3">nfd5</td><td></td><td colspan="3">nfd4</td><td></td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when set to 0</th><th>Meaning when set to 1</th></tr>
<tr><td>0</td><td></td><td></td><td></td></tr>
<tr><td>1
2
3</td><td>nfd4</td><td colspan="2">Set the filter depth for Notch filter 4 (SV038).
Setting value Deep ← → Shallow
<table>
<tr><td></td><td>000</td><td>001</td><td>010</td><td>011</td><td>100</td><td>101</td><td>110</td><td>111</td></tr>
<tr><td>Depth (dB)</td><td>-∞</td><td>-18.1</td><td>-12.0</td><td>-8.5</td><td>-6.0</td><td>-4.1</td><td>-2.5</td><td>-1.2</td></tr>
</table></td></tr>
<tr><td>4</td><td></td><td></td><td></td></tr>
<tr><td>5
6
7</td><td>nfd5</td><td colspan="2">Set the filter depth for Notch filter 5 (SV046).
Setting value Deep ← → Shallow
<table>
<tr><td></td><td>000</td><td>001</td><td>010</td><td>011</td><td>100</td><td>101</td><td>110</td><td>111</td></tr>
<tr><td>Depth (dB)</td><td>-∞</td><td>-18.1</td><td>-12.0</td><td>-8.5</td><td>-6.0</td><td>-4.1</td><td>-2.5</td><td>-1.2</td></tr>
</table></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>A</td><td></td><td></td><td></td></tr>
<tr><td>B</td><td></td><td></td><td></td></tr>
<tr><td>C</td><td></td><td></td><td></td></tr>
<tr><td>D</td><td></td><td></td><td></td></tr>
<tr><td>E</td><td></td><td></td><td></td></tr>
<tr><td>F</td><td></td><td></td><td></td></tr>
</table>
(Note) Set to "0" for bits with no particular description.</td><td></td></tr>
<tr><td>SV084</td><td>SSF7</td><td>Servo function selection 7</td><td>
<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></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 set to 0</th><th>Meaning when set to 1</th></tr>
<tr><td>0</td><td></td><td></td><td></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</td><td></td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td><td></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></td><td></td><td></td></tr>
<tr><td>9</td><td></td><td></td><td></td></tr>
<tr><td>A</td><td></td><td></td><td></td></tr>
<tr><td>B</td><td></td><td></td><td></td></tr>
<tr><td>C</td><td></td><td></td><td></td></tr>
<tr><td>D</td><td></td><td></td><td></td></tr>
<tr><td>E</td><td></td><td></td><td></td></tr>
<tr><td>F</td><td></td><td></td><td></td></tr>
</table>
(Note) Set to "0" for bits with no particular description.</td><td></td></tr>
</table>

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

No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)
SV085	LMCk	Lost motion compensation spring constant	Set the machine system's spring constant when using lost motion compensation type 3.	0 to 32767
SV086	LMCc	Lost motion compensation viscous coefficient	Set the machine system's viscous coefficient when using lost motion compensation type 3.	0 to 32767
SV087	FHz4	Notch filter frequency 4	Set the vibration frequency to suppress if machine vibration occurs. (Valid at 141 or more) When not using, set to "0". To use this function, set to not "0" (normally "1") when turning the power ON. This function cannot be used with adaptive filter.	0 to 2250 (Hz)
SV088	FHz5	Notch filter frequency 5		0 to 2250 (Hz)
SV089 : SV100			Not used. Set to "0".	0

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

4-2-2 Limitations to electronic gear setting value

The servo drive unit has internal electronic gear. 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. However, each value (ELG1, ELG2) must be 32767 or less.
If the value overflows, the initial parameter error (alarm 37) 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.

Parameters related to electronic gears
SV001 (PC1), SV002 (PC2), SV003 (PGN1) (SV049 (PGN1sp)), SV018 (PIT), SV019 (RNG1), SV020 (RNG2)

Reduced fraction of

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

<Semi-closed loop> RANG = RNG1	<Closed loop> RANG = (RNG2 × PGN1sp)
IUNIT = 2/NC command unit (μm)	1μm: IUNIT = 2, 0.1μm: IUNIT = 20

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

$\text{ELG1} \leq 32767$

$\text{ELG2} \leq 32767$

Method of confirming maximum setting range for PC1 and PC2 (Example)

For semi-closed loop, 10mm ball screw lead, 1μm command unit and OSA104 motor side detector.

The following parameters can be determined with the above conditions.

SV018 (PIT) = 10, SV019 (RNG1) = 100, SV020 (RNG2) = 100, IUNIT = 2
According to the specifications, the maximum setting value for ELG1 and ELG2 is 32767.

$$\frac{\text{ELG1}}{\text{ELG2}} = \frac{\text{PC2} \times 100}{\text{PC1} \times 10 \times 2} = \frac{5 \times \text{PC2}}{1 \times \text{PC1}}$$

Thus, the maximum value is: PC2 < 6553, PC1 < 32767

Set the PC1 and PC2 gear ratio to within the above calculation results.

4-2-3 Setting excessive detection error width

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

No.	Abbrev.	Parameter name	Explanation
SV023	OD1	Excessive error detection width at servo ON	Set "6" as a standard. 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>** $\text{OD1} = \text{OD2} = \frac{\text{Rapid traverse rate (mm/min)}}{60 \times \text{PGN1}} \div 2 \text{ (mm)}$
SV026	OD2	Excessive error detection width at servo OFF	

4-2-4 Setting motor and detector model

The settings are made as shown below according to the motor and detector model being used. Check the model in the specifications, and set accordingly.

No.	Abbr.	Parameter name	Explanation
SV025	MTYP	Motor/detector model	Set the servomotor and detector model. (HEX setting)

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
pen				ent				mon							

pen (Position detector)

bit	Semi-closed loop	bit	Closed loop
0	OSE104	4	OSE104-ET
1	OSA104	5	OSA104-ET
2	OSA105 / OSE105 OBA13/OBA14/OBA17	6	OSA105-ET/OSE105-ET
		8	ABZ SCALE
		9	ABS SCALE (AT41, FME, FLE type)
		A	ABS SCALE (AT342, 343, 543, LC191M type) Scale I/F unit
		C	Synchronous control (only slave axis) (MDS-B-HR type)
		D	2-scale 2-linear servo system closed-loop synchronous control

ent (Speed detector)

bit	Explanation
0	OHE25K/OSE104
1	OHA25K/OSA104
2	OSA105/OSE105/OBA13/OCA14/OSA17
A	For normal control, speed synchronous control/linear servo (ABS SCALE, scale I/F)
C	Dedicated for synchronous control semi-closed loop (current instructed synchronization)
D	For speed synchronous control, current command synchronization/ linear current synchronization
E	Closed current synchronization

The scale detectors used in combination with the linear servomotor are shown below.

Model	Resolution (um)	Detector ID	Display type	Type	Pen	ent
LC191M	0.1	B0h	H-ABS-LS	ABS	A or D	A or D
	0.05	B1h				
LC491M	0.1	B0h				
	0.05	B1h				
AT342	0.5	24h	AT342			
AT343	0.05	25h				
AT543	0.05	25h	M-ABS-LS			
MDS-B-HR	Analog cycle/500	51h	HR + AT32			
		52h, 56h	BHR-Version	INC		

When connecting the detector ID:52H, set SV034(SSF) to 1.

mon (Motor model)

bit 0 to 7	Setting	Motor model	Setting	Motor model
Hex setting	B0	HC-H52	C0	HC-H53
	B1	HC-H102	C1	HC-H103
	B2	HC-H152	C2	HC-H153
	B3	HC-H202	C3	HC-H203
	B4	HC-H352	C4	HC-H353
	B5	HC-H452	C5	HC-H453
	B6	HC-H702	C6	HC-H702
	B7	HC-H902	C7	HC-H903
	B8	HC-H1102	C8	HC-H1103
	B9	HC-H1502		
	08	LM-NP5G-60P (Natural cooling)	18	LM-NP5G-60P (Oil-cooled)

SV017 spm must also be set.

Note 1) For synchronous control, the master axis is set as the standard, and synchronous control is set for the slave axis.

Note 2) When carrying out synchronous control with the MDS-CH-V2 Series, set the L axis as the master and the M axis as the slave.

Note 3) Synchronous control with the MDS-CH-V1 Series is compatible only with the absolute position system.

4-2-5 Setting servo specifications

<table>
<tr><th>No.</th><th>Abbr.</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV017</td><td>SPEC</td><td>Servo specifications</td><td>These parameters are set with HEX values. Set as shown below to match 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 colspan="4">spm</td><td></td><td></td><td>mpt3</td><td>mp</td><td>abs</td><td></td><td>vdir</td><td>fdir</td><td>spwv</td><td>seqh</td><td>dfbx</td><td>vdir2</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when set to 0</th><th>Meaning when set to 1</th></tr>
<tr><td>0</td><td>vdir2</td><td>Speed feedback forward polarity</td><td>Speed feedback reverse polarity</td></tr>
<tr><td>1</td><td>dfbx</td><td>Dual feedback control invalid</td><td>Dual feedback control valid</td></tr>
<tr><td>2</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>spwv</td><td>Speed feedback filter invalid</td><td>Speed feedback filter valid</td></tr>
<tr><td>4</td><td>fdir</td><td>Position feedback forward polarity</td><td>Position feedback reverse polarity</td></tr>
<tr><td>5</td><td></td><td></td><td></td></tr>
<tr><td>7</td><td>abs</td><td>Relative position detection</td><td>Absolute position detection</td></tr>
<tr><td>8</td><td>mp</td><td>MP scale 360P (2mm pitch)</td><td>MP scale 720P (1mm pitch)</td></tr>
<tr><td>9</td><td>mpt3</td><td>MP scale absolute position detection type 1, 2</td><td>MP scale absolute position detection type 3</td></tr>
<tr><td>A</td><td></td><td></td><td></td></tr>
<tr><td>B</td><td></td><td></td><td></td></tr>
<tr><td>C to F</td><td>spm</td><td colspan="2">"0010": HC-H motor (hexadecimal setting "2")
"1001": LN-NP5G linear servomotor (hexadecimal setting "8")</td></tr>
</table>
Set "0" for all bits other than those above.</td></tr>
<tr><td>SV036</td><td>PTYP</td><td>Power supply type</td><td>These parameters are set with HEX values.
<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="8">ptyp</td></tr>
</table>
<table>
<tr><th>bit</th><th>Explanation</th></tr>
<tr><td>ptyp</td><td>Set a power supply unit model. (Only units with wiring to CN4 connector)
<table>
<tr><th>Setting value</th><th>Content</th><th>Setting value</th><th>Content</th></tr>
<tr><td>00</td><td>With no power supply unit</td><td>22</td><td>CH-CV-220 22kW</td></tr>
<tr><td>04</td><td>CH-CV-37 3.7kW</td><td>26</td><td>CH-CV-260 26kW</td></tr>
<tr><td>06</td><td>CH-CV-55 5.5kW</td><td>30</td><td>CH-CV-300 30kW</td></tr>
<tr><td>08</td><td>CH-CV-75 7.5kW</td><td>37</td><td>CH-CV-370 37kW</td></tr>
<tr><td>11</td><td>CH-CV-110 11kW</td><td>45</td><td>CH-CV-450 45kW</td></tr>
<tr><td>15</td><td>CH-CV-150 15kW</td><td>55</td><td>CH-CV-550 55kW</td></tr>
<tr><td>19</td><td>CH-CV-185 18.5kW</td><td>75</td><td>CH-CV-750 75kW</td></tr>
</table>
Normally, set "00".</td></tr>
<tr><td>rtyp</td><td>Always set "0". (Power regeneration type)
Set "1" when connecting V1-185.</td></tr>
<tr><td>Amp</td><td>Always set "0". (For MDS-CH)</td></tr>
</table></td></tr>
<tr><td>SV027</td><td>SSF1</td><td>Special servo function selection 1</td><td>Normally, set "4000".</td></tr>
<tr><td>SV033</td><td>SSF2</td><td>Special servo function selection 2</td><td>Normally, set "0000".</td></tr>
<tr><td>SV001</td><td>PC1</td><td>Motor gear ratio</td><td rowspan="2">Set the motor gear ratio in PC1 and the machine gear ratio in PC2.
For the rotary axis, set the total deceleration (acceleration) ratio.</td></tr>
<tr><td>SV002</td><td>PC2</td><td>Machine gear ratio</td></tr>
<tr><td>SV018</td><td>PIT</td><td>Ball screw pitch</td><td>Set the ball screw pitch as an mm unit. Set 360 for the rotary axis.</td></tr>
<tr><td>SV019</td><td>RNG1</td><td>Position detector resolution</td><td rowspan="2">Set the motor detector resolution as a kp/rev unit for both parameters.
Refer to section "4-2-4 Setting motor and detector model" for details on 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 1</td><td>Normally, set "33".</td></tr>
</table>

4-2-6 Initial setup of the linear servo system

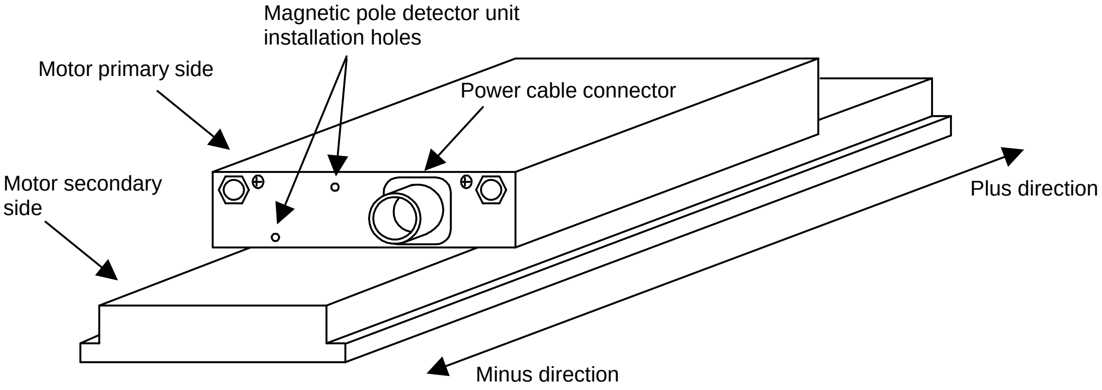
The methods of setting up the poles for the linear servomotor are explained in this section.
The motor is driven by the magnetic force created by the coil and the magnetic force of the permanent magnet. Thus, it is necessary to comprehend at which pole of the permanent magnet the coil is located.
With the conventional rotary motor, the coil and permanent magnet are located in the motor, and the relation of the two parts is fixed. The relation of the detector installed on the motor and the motor itself is also fixed.
With the linear servo system the coil (motor primary side), permanent magnet (motor secondary side) and linear are installed independently, so the pole must be adjusted according to the linear servomotor and linear scale relation.
If this pole is not adjusted, the motor may not operate or may not operate correctly, so always set as explained below.

(1) Installing the linear servomotor and linear scale

The installation direction of the linear servomotor and linear scale is explained in this section.

1) Linear servomotor's pole direction

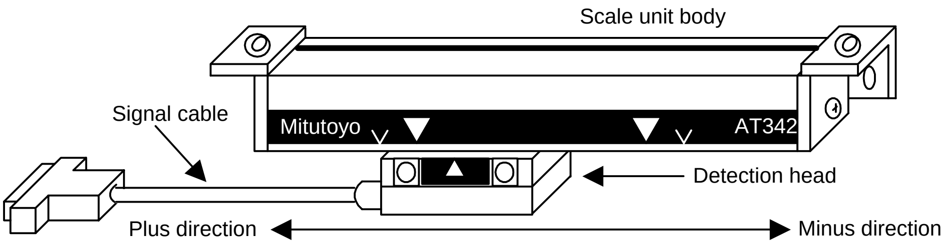
The pole direction of the linear servomotor is shown below. As shown in the drawing, if moved in the direction having the power cable connector or MDS-B-MD installation hole, the pole will move in the minus direction. If moved in the opposite direction, the pole will move in the plus direction.

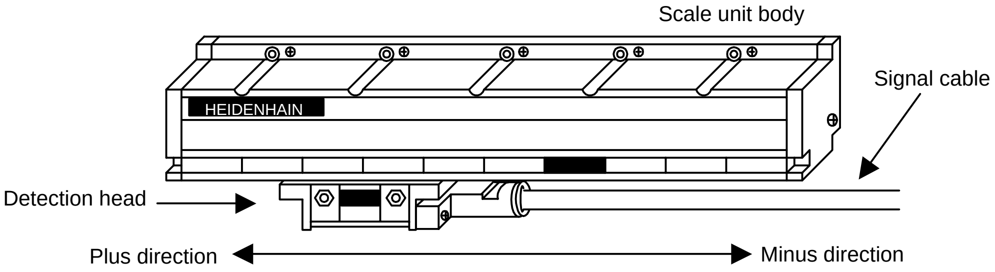


2) Linear scale feedback direction

The linear scales include the Mitutoyo scale and Heidenhain scale, etc. The feedback direction of the Mitutoyo AT342 scale is shown below. When moved to the left, looking from the direction with the detector head facing downward and the AT342 display facing forward, the feedback moves in the plus direction. When moved in the opposite direction, the position moves in the minus direction.

The polarity (plus/minus) of the Heidenhain scale is the opposite of the Mitutoyo scale.





If the linear servomotor's pole direction and linear scale's feedback direction are same, the state is called forward polarity. If these directions differ, the state is called reverse polarity. Normally, these are installed to achieve forward polarity, but can be installed to achieve reverse polarity. Set the parameters as shown below. When this parameter is set, the servo drive unit's position direction can be reversed. Thus, the position data displayed on the Servo Monitor screen will have a plus/minus direction opposite from the linear scale feedback direction.

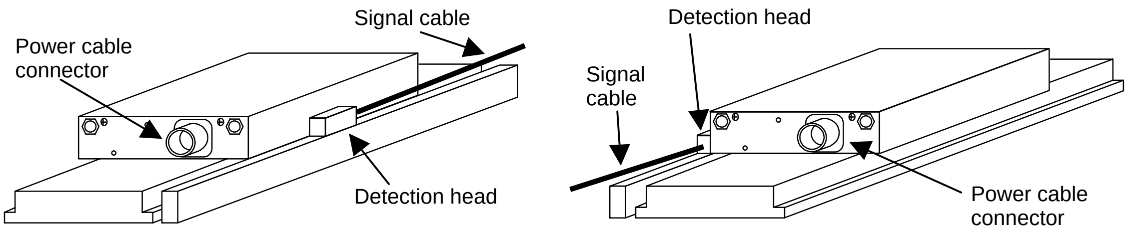
(The Heidenhain scale indicates the case of the A, B phase analog output of the measurement length system LS, LIDA and LIF. Thus, when using another scale, confirm that the A and B phase analog outputs have the same relation.)

<table>
<tr><th>No.</th><th>Abbr.</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV017</td><td>SPEC</td><td>Servo specifications</td><td>HEX setting parameter. Set as shown below 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 colspan="4">spm</td><td>drvall</td><td>drvup</td><td>mpt3</td><td>mp</td><td>abs</td><td>vmh</td><td>vdir</td><td>fdir</td><td></td><td>seqh</td><td>dfbx</td><td>vdir2</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when set to 0</th><th>Meaning when set to 1</th></tr>
<tr><td>4</td><td>fdir</td><td>Main side (CN2) feedback forward polarity</td><td>Main side (CN2) feedback reverse polarity</td></tr>
</table>
</td></tr>
</table>

Table of feedback polarity according to linear servomotor and linear scale installation direction

Connected scale		AT342 scale		Heidenhain scale	
Item		Polarity	SPEC (fdir)	Polarity	SPEC (fdir)
Installation No.	1	Forward polarity	0	Reverse polarity	1
	2	Reverse polarity	1	Forward polarity	0
	3	Reverse polarity	1	Forward polarity	0
	4	Forward polarity	0	Reverse polarity	1
	5	Reverse polarity	0	Forward polarity	1
	6	Forward polarity	0	Reverse polarity	1
	7	Forward polarity	1	Reverse polarity	0
	8	Reverse polarity	1	Forward polarity	0

Installation 1 **Installation 2**



Installation 3 **Installation 4**

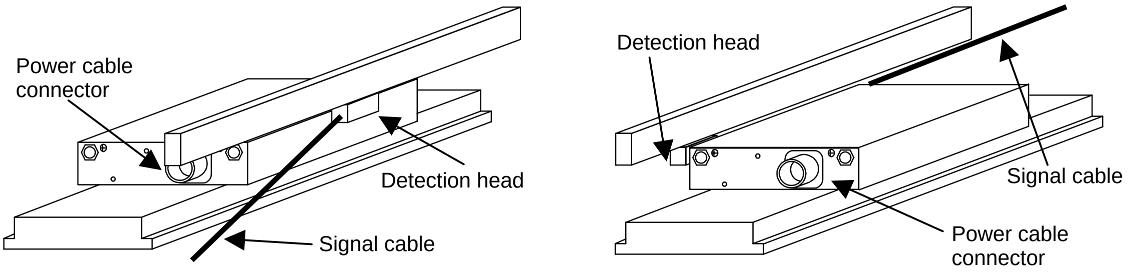
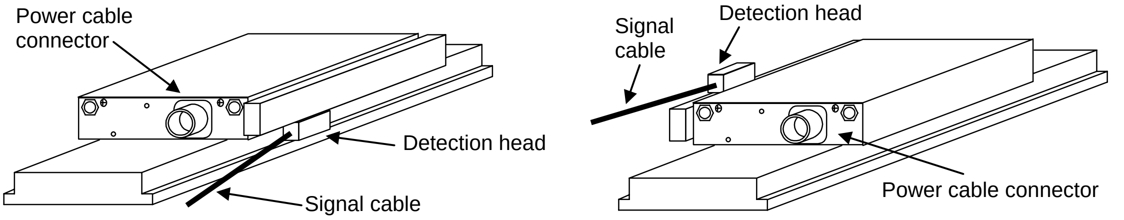


Fig. (1)-1 When linear scale detection head is installed on motor's primary side
(This is for the AT342. The signal cable direction is reversed for the Heidenhain scale.)

Installation 5 **Installation 6**



Installation 7 **Installation 8**

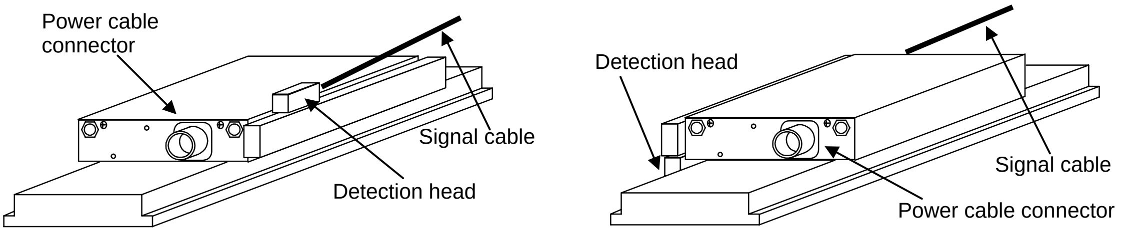


Fig. (1)-2 When linear scale body is installed on motor's primary side
(This is for the AT342. The signal cable direction is reversed for the Heidenhain scale.)

(2) DC excitation function

By using the DC excitation function, the linear servomotor can be moved to 0º on the pole regardless of the feedback from the linear scale.
This DC excitation function is required to determine the pole shift amount. When determining the pole shift amount, carry out DC excitation after confirming that the cycle counter displayed on the Servo Monitor screen is not "0" (Z phase passed).
The following parameters are used for DC excitation.

No.	Abbr.	Parameter name	Explanation
SV034	SSF3	Servo function selection 3	HEX setting parameter. Set as shown below according to the servo specifications.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
ovsm				linN				toff	os2		dcd	test	mohn	has2	has1

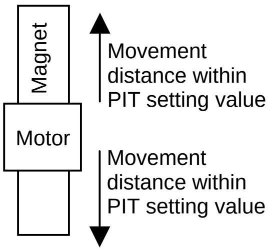
bit		Meaning when set to 0	Meaning when set to 1
4	dcd	Setting for normal use.	DC excitation mode

No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)
SV061	DA1NO	D/A output channel 1 data No.	Set the initial excitation level for DC excitation. Set 20 when starting DC excitation.	0 to 100 [Stall rated current %]
SV062	DA2NO	D/A output channel 2 data No.	Set the final excitation level for DC excitation. Normally, 40 is set.	0 to 100 [Stall rated current %]
SV063	DA1MPY	D/A output channel 1 output scale	Set the initial excitation time for DC excitation. (ms) Normally, 500 is set.	-32768 to 32767 [Stall rated current %]

* Set to |SV061| ≤ |SV062|.

<Adjustment methods>

1. Secure the distance (PIT) that the linear servomotor moves during DC excitation.
2. Set SV034:dcd to "1", and the setting values for starting DC excitation in SV061 to SV063.
3. Release emergency stop. (Start DC excitation.)
4. Apply emergency stop. (Stop DC excitation)



<Operation>

1. When the emergency stop is released, the value set in SV061 will flow to the V phase (V phase excitation) for (SV063 setting value × 1/2) msec, and the motor will move toward the pole 120°. The movement direction and distance depend on the position of the linear servomotor when emergency stop is released as shown below. (It may not be possible to confirm movement when already near pole 120°.)
2. Next, the current set in SV061 will flow the U phase (U phase excitation) for (SV063 setting value × 1/2) msec, and the servomotor will move toward the pole 0°. In this case, the movement will be in the same direction for all examples shown below.
3. Finally, the current set in SV062 will flow to the U phase, and the magnetic pole 0° position will be established.

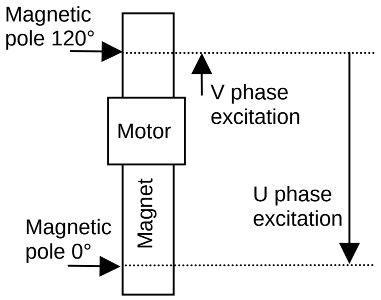


Fig. (2)-1 When linear servo-motor is between pole 0° and 120°.

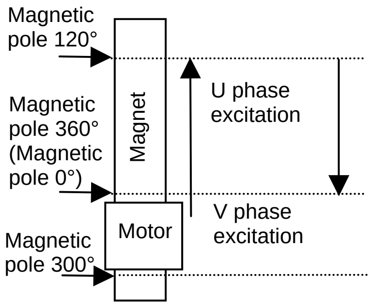


Fig. (2)-2 When linear servo-motor is between pole 300° and 360°.

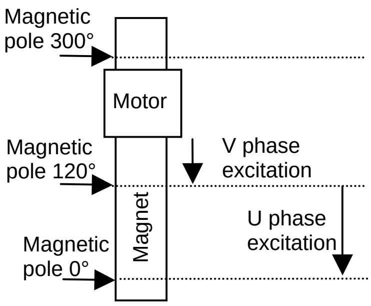


Fig. (2)-3 When linear servo-motor is between pole 120° and 300°.

<Confirmation>

1. During DC excitation, confirm the value displayed at MAX CURRENT 2 on the NC Servo Monitor screen.
   If the linear servomotor does not move even when the MAX CURRENT 2 value is 100 or more, the cable connection may be incorrect, so confirm the connection.
2. Confirm the MAIN side feedback polarity (SPEC/fdir) achieved with DC excitation.
   The MAIN side feedback polarity can be confirmed with the direction that the linear servomotor moves during U phase excitation, and the increment/decrement of the cycle counter displayed on the NC Servo Monitor screen. Judge whether the polarity confirmed with DC excitation matches the polarity set with the servo parameters. Correct the servo parameter polarity if incorrect.

fdir correction table according to linear servomotor movement with DC excitation.

Motor movement	Linear servomotor polarity Minus direction		Linear servomotor polarity Plus direction	
Cycle counter increment/decrement	Increment	Decrement	Increment	Decrement
ABS SCALL	Correctly set	Incorrectly set	Incorrectly set	Correctly set
MDS-B-HR	Incorrectly set	Correctly set	Correctly set	Incorrectly set

(3) Setting the pole shift

When the linear servomotor and linear scale are installed, the linear servomotor does not know which pole the permanent magnet is at. Thus, if the linear servomotor is driven in that state, it may not move or could runaway. By setting the pole shift amount, the linear servomotor can be driven correctly no matter which pole it is at.
For the pole shift amount, set the data displayed at Rn on the NC Absolute Position Monitor screen during DC excitation (while the emergency stop is released).

No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)
SV028	MSFT	Pole shift amount	Set the pole shift amount	-30000 to 30000 (µm)

* The SV028 setting value is validated after the NC power is rebooted.

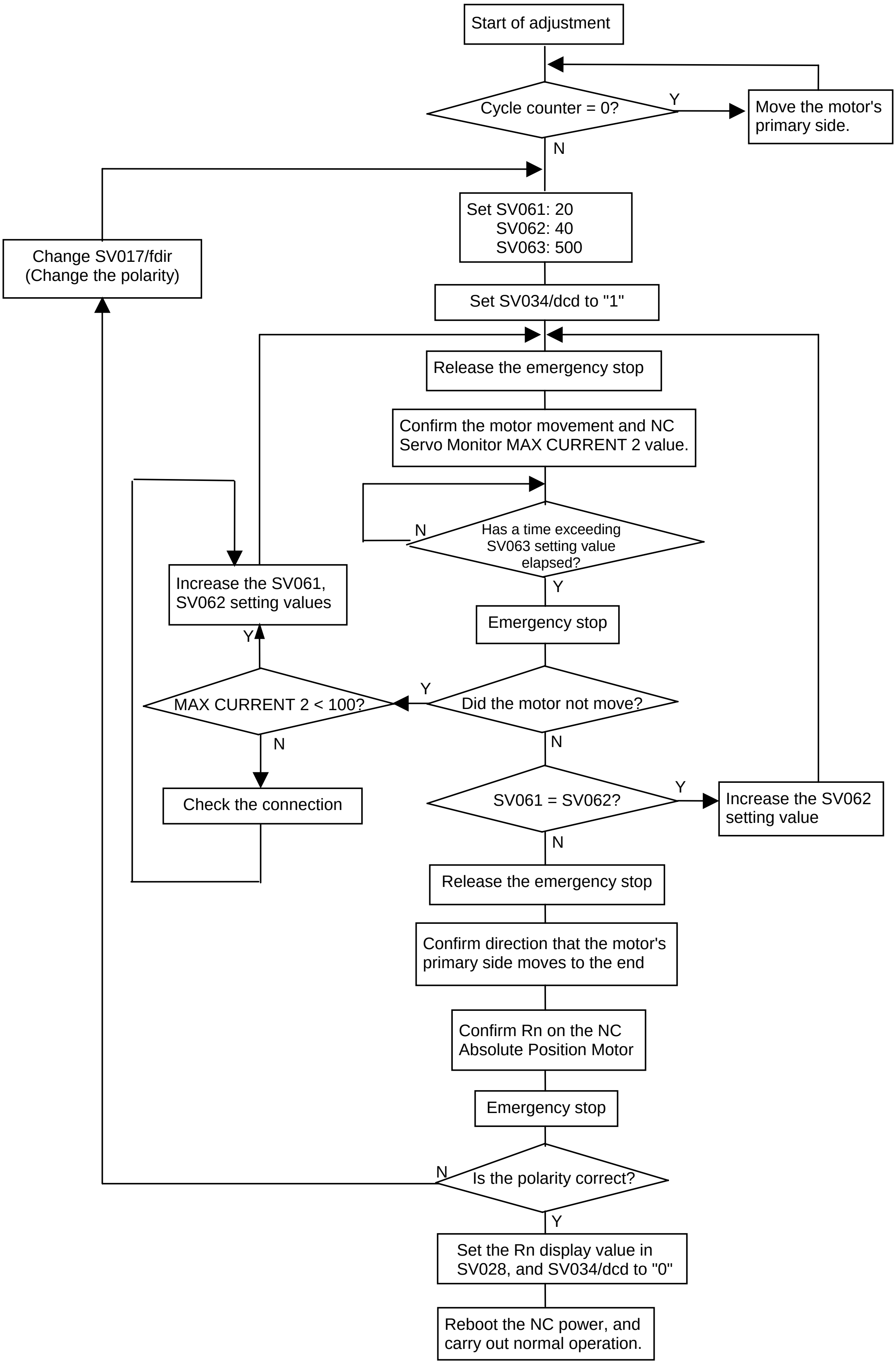
1) For system to which MDS-B-MD is not connected

If the pole shift amount is set, it will be validated after the NC power is rebooted.

2) For system to which MDS-B-MD is connected

Normally, the motor is driven with the pole created by MDS-B-MD. However, if this pole shift amount is set, it will be validated when the Z phase has been passed once after the NC power has been rebooted. However, if there is a deviation of 30º or more between the pole before and after pole shifting, the pole shift amount will not be validated, and instead the 9B warning (Pole shift warning) will be detected. The motor will be driven with the pole achieved before pole shifting.
If the "9B alarm" occurs, carry out DC excitation again to determine the pole shift amount. The correct pole shift amount can be achieved even if a value is set in SV028 at this time.

Flow chart for DC excitation and pole shift amount setting



(4) Setting the parallel drive system

When driving the linear servomotor with a parallel drive system, confirm that the following parameters are correctly set for each control method. If incorrectly set, correct the setting and reboot the NC power supply.
When using a parallel drive system, do not simultaneously DC excite the master side and slave side. When carrying out DC excitation of either axis, make sure that current is not flowing to the other axis.

<table>
<tr><th>No.</th><th>Abbr.</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV017</td><td>SPEC</td><td>Servo specifications</td><td>HEX setting parameter. Set as shown below 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 colspan="4">spm</td><td>drvall</td><td>drvup</td><td>mpt3</td><td>mp</td><td>abs</td><td>vmh</td><td>vdir</td><td>fdir</td><td></td><td>seqh</td><td>dfbx</td><td>vdir2</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when set to 0</th><th>Meaning when set to 1</th></tr>
<tr><td>4</td><td>fdir</td><td>Main side (CN2) feedback forward polarity</td><td>Main side (CN2) feedback reverse polarity</td></tr>
<tr><td>0</td><td>vdir2</td><td>Sub-side (CN3) feedback forward polarity</td><td>Sub-side (CN3) feedback reverse polarity</td></tr>
</table></td></tr>
<tr><td>SV025</td><td>MTYP</td><td>Motor/detector type</td><td>HEX setting parameter. Set as follows according to detector type.
<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">pen</td><td colspan="4">ent</td><td colspan="8">mtyp</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Details</th></tr>
<tr><td>8</td><td rowspan="4">ent</td><td rowspan="4">Set the position detector type. (Refer to section 4-2-4.)</td></tr>
<tr><td>9</td></tr>
<tr><td>A</td></tr>
<tr><td>B</td></tr>
<tr><td>C</td><td rowspan="4">pen</td><td rowspan="4">Set the speed detector type. (Refer to section 4-2-4.)</td></tr>
<tr><td>D</td></tr>
<tr><td>E</td></tr>
<tr><td>F</td></tr>
</table></td></tr>
</table>

No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)
SV028	MSFT	Pole shift amount	Set the pole shift amount	-30000 to 30000 (µm)

2-scale 2-drive control (System using only main side (CN2 connector side) feedback)

Setting parameter	Master axis	Slave axis
SV017/fdir	Normally, set the setting value for control.	Normally, set the setting value for control.
SV017/vdir2	Set "0".	Set "0".
SV025/pen, ent	Set AAxx.	Set AAxx.
SV028	Normally, set the setting value for control.	Normally, set the setting value for control.

2-scale 2-drive control (System also using sub- side (CN3 connector side) feedback)

Setting parameter	Master axis	Slave axis
SV017/fdir	Normally, set the setting value for control.	Normally, set the setting value for control.
SV017/vdir2	Set "0".	If the master axis and linear servomotor pole directions are the same, set to the same setting as SV017/fdir for the master axis. If the pole directions are reversed, set the opposite setting as SV017/fdir for the master axis.
SV025/pen, ent	Set AAxx.	Set DAxx.
SV028	Normally, set the setting value for control.	Normally, set the setting value for control.

1-scale 2-drive control

Setting parameter	Master axis	Slave axis
SV017/fdir	Normally, set the setting value for control.	If the master axis and linear motor pole directions are the same, set to the same setting as SV017/fdir for the master axis. If the pole directions are reversed, set the opposite setting as SV017/fdir for the master axis.
SV017/vdir2	Set "0".	Set "0".
SV025/pen, ent	Set AAxx.	Set DDxx.
SV028	Normally, set the setting value for control.	Set the pole shift amount when DC excitation is carried out with the connected detector.

⚠ **CAUTION**

1. When carrying out DC excitation with the parallel drive system, if the current flows to the parallel axis the machine could break down or the accuracy may not be satisfied.
2. When carrying out DC excitation with the parallel drive system, make sure that current does not flow to the parallel axis.

(5) Settings when motor thermal is not connected

POINT

When driving the motor with a system connected to the MDS-B-HR, the servo drive unit's protection function will activate if the motor reaches an abnormal temperature.
If the system does not require the motor abnormal temperature detection, set the following parameter to ignore the signal from the MDS-B-HR.

<table>
<tr><th>No.</th><th>Abbr.</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV034</td><td>SSF3</td><td>Servo function selection 3</td><td>Set the motor thermal with the following 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">ovsm</td><td></td><td></td><td></td><td></td><td>toff</td><td>os2</td><td></td><td>dcd</td><td></td><td>mohn</td><td>has2</td><td>has1</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when set to 0</th><th>Meaning when set to 1</th></tr>
<tr><td>2</td><td>mohm</td><td>HR motor thermal valid</td><td>HR motor thermal invalid</td></tr>
</table>
</td></tr>
</table>

4-2-7 Standard parameter list according to motor

(1) HC-H Series (2000, 3000r/min rating)

Motor	HC-H Standard motor																		
	52	**53**	**102**	**103**	**152**	**153**	**202**	**203**	**352**	**353**	**452**	**453**	**702**	**703**	**902**	**903**	**1102**	**1103**	**1502**
Unit name	05	05	10	10	20	20	20	35	35	45	45	70	70	90	90	110	150	150	185
SV001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SV002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SV003	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
SV004	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
SV005	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
SV006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV008	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
SV009	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096
SV010	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096
SV011	1024	1024	1024	1280	1024	1280	1024	1024	1024	768	1024	768	768	768	768	768	768	768	768
SV012	1024	1024	1024	1280	1024	1280	1024	1024	1024	768	1024	768	768	768	768	768	768	768	768
SV013	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
SV014	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
SV015	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
SV016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV017	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
SV018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SV019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SV020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SV021	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
SV022	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
SV023	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
SV024	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
SV025	xxB0	xxC0	xxB1	xxC1	xxB2	xxC2	xxB3	xxC3	xxB4	xxC4	xxB5	xxC5	xxB6	xxC6	xxB7	xxC7	xxB8	xxC8	xxB9
SV026	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
SV027	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
SV028	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV029	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV031	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV032	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV033	0010	0010	0010	0010	0010	0010	0010	0010	0010	0010	0010	0010	0010	0010	0010	0010	0010	0010	0010
SV034	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
SV035	0000	0000	0000	0000	0040	0040	0040	0040	0040	0040	0040	0040	0040	0000	0000	0000	0000	0000	0000
SV036	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
SV037	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV038	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV039	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV040	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV041	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV042	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV043	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV044	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV046	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV047	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
SV048	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV049	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
SV050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV051	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV052	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV053	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV054	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV055	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV056	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV057	281	281	281	281	281	281	281	281	281	281	281	281	281	281	281	281	281	281	281
SV058	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV059	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV060	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV061	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV062	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV063	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV064	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV065	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(System parameter area)																			
SV081	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
SV082	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
SV083	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
SV084	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
SV085	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV086	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV087	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV088	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV089 : SV100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note) Set the detector model in the xx of SV025. Normally, "00", "11" or "22" is set.

(2) Linear servomotor LM-N Series

Motor	LM-N Series (Natural cooling)	LM-N Series (Oil-cooled)
	LM-NP5G-60P-X0	LM-NP5G-60P-X0
Unit name	150	150
SV001	1	1
SV002	1	1
SV003	47	47
SV004	125	125
SV005	-	-
SV006	0	0
SV007	0	0
SV008	1364	1364
SV009	10240	10240
SV010	10240	10240
SV011	1024	1024
SV012	1024	1024
SV013	500	500
SV014	500	500
SV015	0	0
SV016	0	0
SV017	8xxx	8xxx
SV018	60	60
SV019	-	-
SV020	-	-
SV021	60	60
SV022	150	150
SV023	20	20
SV024	50	50
SV025	Xx08	Xx18
SV026	20	20
SV027	4000	4000
SV028	-	-
SV029	0	0
SV030	0	0
SV031	0	0
SV032	0	0
SV033	0000	0000
SV034	0003	0003
SV035	0000	0000
SV036	0000	0000
SV037	0	0
SV038	0	0
SV039	0	0
SV040	0	0
SV041	0	0
SV042	0	0
SV043	0	0
SV044	0	0
SV045	0	0
SV046	0	0
SV047	100	100
SV048	0	0
SV049	15	15
SV050	0	0
SV051	0	0
SV052	0	0
SV053	0	0
SV054	0	0
SV055	0	0
SV056	0	0
SV057	281	281
SV058	0	0
SV059	0	0
SV060	0	0
SV061	0	0
SV062	0	0
SV063	0	0
SV064	0	0
OS1		
OS2		

4-3 Spindle drive unit initial parameter settings

Refer to each CNC instruction manual for details on the operation methods and system specification parameter settings.

4-3-1 List of spindle parameters

(Note 1) The settings of parameters with an asterisk in the CNG column can be changed without turning the CNC power OFF.

(Note 2) "DEC" in the TYP column means that the parameter is set with a decimal, and "HEX" means that the parameter is set with a hexadecimal.

(Note 3) If "0002" is set for SP257 (RPM)", the speed (r/min) set with each parameter will be doubled.
(Example: If SP017 is set to 20000r/min, the motor's actual maximum speed will be 40000r/min.)

<Class: Spindle specifications>

Name	Abbr.	Parameter name	Details	TYP	CNG	Standard setting	Unit	Permissible setting range
SP001	PGM	Magnetic sensor, motor built-in encoder orientation position loop gain	As the set value is larger, the orientation time becomes shorter and servo rigidity is increased. However, vibration is increased and the machine becomes likely to overshoot.	DEC	*	100	1/10 s^{-1}	0 to 2000
SP002	PGE	Encoder orientation position loop gain	As the set value is larger, the orientation time becomes shorter and servo rigidity is increased. However, vibration is increased and the machine becomes likely to overshoot.	DEC	*	100	1/10 s^{-1}	0 to 2000
SP003	PGC	Position gain during C-axis non-cutting	Set the position loop gain for the C-axis non-cutting mode. (Valid when the control input 1 bit F is set to "0" in the C-axis control mode.)	DEC	*	15	s^{-1}	0 to 200
SP004	OINP	Orientation in-position width	Set the position error range in which an orientation completion signal is output.	DEC	*	16	1/16°	0 to 2880
SP005	OSP	Orientation mode changing speed limit value	Set the motor speed limit value to be used when the speed loop is changed to the position loop in orientation mode. When this parameter is set to "0", SP017 (TSP) becomes the limit value. If the orientation is not stable when using a machine with two or more gear stages with a large deceleration rate, the operation may be stabilized by setting the SP037 bit D to "1".	DEC		0	r/min	0 to 32767
SP006	CSP	Orientation mode deceleration rate	As the set value is larger, the orientation time becomes shorter. However, the machine becomes likely to overshoot.	DEC	*	20		0 to 1000
SP007	OPST	Position shift amount for orientation	Set the stop position for orientation. (1) Motor built-in encoder and encoder orientation Set a value obtained by dividing 360° by 4096. (2) Magnetic sensor orientation Divide -5°C to +5° by 1024, and set 0° as "0".	DEC	*	0		(1) -4095 to 4095 (2) -512 to 512
SP008			Not used. Set "0".	–		0	–	–
SP009	PGT	Synchronous tap position loop gain	Set the spindle position loop gain for synchronous tapping.	DEC	*	15	s^{-1}	0 to 200
SP010	PGS	Spindle synchronization position loop gain	Set the spindle position loop gain for spindle synchronization.	DEC	*	15	s^{-1}	0 to 200
SP011 to SP016			Not used. Set "0".	–		0	–	–
SP017	TSP	Maximum motor speed	Set the maximum motor speed.	DEC		6000	r/min	1 to 32767
SP018	ZSP	Motor zero speed	Set the motor speed for which zero-speed output is performed. The spindle will coast at speeds less than the set speed.	DEC		50	r/min	1 to 1000

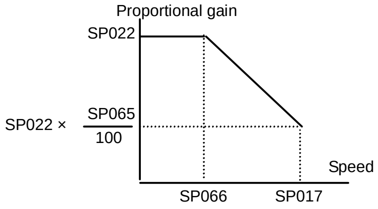
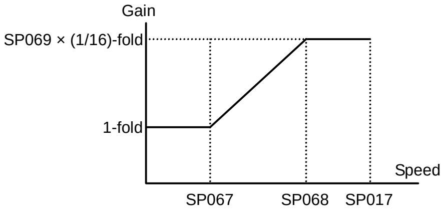
Name	Abbr.	Parameter name	Details	TYP	CNG	Stand-ard setting	Unit	Permissible setting range
SP019	CSN1	Speed command acceleration/ deceleration time constant	Set the time constant for a speed command from "0" to the maximum speed. (This parameter is invalid in position loop mode.)	DEC		30	10ms	1 to 32767
SP020	SDTS	Speed detection set value	Set the motor speed for which speed detection output is performed. Usually, the setting value is 10% of SP017 (TSP).	DEC		600	r/min	0 to 32767
SP021	TLM1	Torque limit 1	Set the torque limit rate for torque limit signal 001.	DEC	*	10	%	1 to 120
SP022	VGNP1	Speed loop gain proportional term under speed control	Set the speed loop proportional gain in speed control mode. When the gain is increased, response is improved but vibration and sound become larger.	DEC		63	rad/s	1 to 1000
SP023	VGNI1	Speed loop gain integral term under speed control	Set the speed loop integral gain in speed control mode. Normally, this is set so that the ratio in respect to SP022 (VGNP1) is approximately constant.	DEC		60	1/10 rad/s	1 to 1000
SP024			Not used. Set "0".	DEC		0		–
SP025	GRA1	Spindle gear teeth count 1	Set the number of gear teeth of the spindle corresponding to gear 00. • When spindle speed is slower than motor speed GRA[ ] > GRB [ ] will be established. • When GRA or GRB is larger than 32767 Adjust to less than 32767	DEC		1		1 to 32767
SP026	GRA2	Spindle gear teeth count 2	Set the number of gear teeth of the spindle corresponding to gear 01.	DEC		1		1 to 32767
SP027	GRA3	Spindle gear teeth count 3	Set the number of gear teeth of the spindle corresponding to gear 10.	DEC		1		1 to 32767
SP028	GRA4	Spindle gear teeth count 4	Set the number of gear teeth of the spindle corresponding to gear 11.	DEC		1		1 to 32767
SP029	GRB1	Motor shaft gear teeth count 1	Set the number of gear teeth of the motor shaft corresponding to gear 00.	DEC		1		1 to 32767
SP030	GRB2	Motor shaft gear teeth count 2	Set the number of gear teeth of the motor shaft corresponding to gear 01.	DEC		1		1 to 32767
SP031	GRB3	Motor shaft gear teeth count 3	Set the number of gear teeth of the motor shaft corresponding to gear 10.	DEC		1		1 to 32767
SP032	GRB4	Motor shaft gear teeth count 4	Set the number of gear teeth of the motor shaft corresponding to gear 11.	DEC		1		1 to 32767

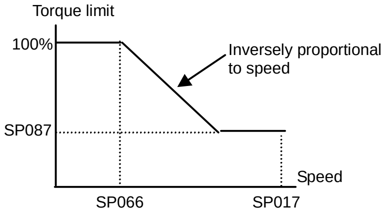
<Class: Spindle/machine specifications>

Name	Abbr.	Parameter name	Details	TYP	CNG	Standard setting	Unit	Permissible setting range
SP033	SFNC1	Spindle function 1	Set the spindle function 1 in bit units. Refer to the section "4-3-2" for details.	HEX		0000		0000 to FFFF
SP034	SFNC2	Spindle function 2	Set the spindle function 2 in bit units. Refer to the section "4-3-2" for details.	HEX		0000		0000 to FFFF
SP035	SFNC3	Spindle function 3	Set the spindle function 3 in bit units. Refer to the section "4-3-2" for details.	HEX		0000		0000 to FFFF
SP036	SFNC4	Spindle function 4	Set the spindle function 4 in bit units. Refer to the section "4-3-2" for details.	HEX		0000		0000 to FFFF
SP037	SFNC5	Spindle function 5	Set the spindle function 5 in bit units. Refer to the section "4-3-2" for details.	HEX		0000		0000 to FFFF
SP038	SFNC6	Spindle function 6	Set the spindle function 6 in bit units. Refer to the section "4-3-2" for details.	HEX		0000		0000 to FFFF
SP039	ATYP	Drive unit type	Set the drive unit type. Set the compatible unit No. from the standard motors indicated in section "4-3-3".	HEX		0000		0000 to 0011
SP040	MTYP	Motor type	This parameter is valid when SP034 (SFNC2) bit0 is set to "0". Set the compatible motor No. from the standard motors indicated in section "4-3-3". (Set 0 for the CH Series.)	HEX		0000		0000 to 001F
SP041	PTYP	Power supply unit type	Set the power supply unit type. Set according to the table in section "4-3-3". Set 0 when not connecting the unit.	HEX		0000		0000 to FFFF
SP042	CRNG	C-axis detector range	Set to 0 unless especially designated.	DEC		0		0 to 11
SP043	TRNG	Synchronous tap, spindle synchronization detection range	Set to 0 unless especially designated.	DEC		0		0 to 7
SP044	TRANS	NC communication frequency	Set a frequency of data communication with NC.	DEC		Standard=0 Special=1028		-32768 to 32767
SP045	CSNT	Fixed control constant	Set to 0 unless especially designated.	DEC	*	0		0 to 1000
SP046	CSN2	Speed command dual cushion	For an acceleration/deceleration time constant defined in SP019 (CSN1), this parameter is used to provide smooth movement only at the start of acceleration/deceleration. As the value of this parameter is smaller, it moves smoother but the acceleration/deceleration time becomes longer. To make this parameter invalid, set "0".	DEC		0		0 to 1000
SP047	SDTR	Speed detection reset value	Set the reset hysteresis width for a speed detection set value defined in SP020 (SDTS).	DEC		30	r/min	0 to 1000
SP048	SUT	Speed reach range	Set the speed deviation rate with respect to the commanded speed for output of the speed reach signal.	DEC		15	%	0 to 100
SP049	TLM2	Torque limit 2	Set the torque limit rate for the torque limit signal 010.	DEC	*	20	%	0 to 120
SP050	TLM3	Torque limit 3	Set the torque limit rate for the torque limit signal 011.	DEC	*	30	%	0 to 120
SP051	TLM4	Torque limit 4	Set the torque limit rate for the torque limit signal 100.	DEC	*	40	%	0 to 120
SP052	TLM5	Torque limit 5	Set the torque limit rate for the torque limit signal 101.	DEC	*	50	%	0 to 120
SP053	TLM6	Torque limit 6	Set the torque limit rate for the torque limit signal 110.	DEC	*	60	%	0 to 120
SP054	TLM7	Torque limit 7	Set the torque limit rate for the torque limit signal 111.	DEC	*	70	%	0 to 120
SP055	SETM	Excessive speed deviation timer	Set the timer value until the excessive speed deviation alarm is output. The value of this parameter should be longer than the acceleration/deceleration time. Set a value approx. 1.5-fold of the acceleration/deceleration time.	DEC		12	s	0 to 60

Name	Abbr.	Parameter name	Details	TYP	CNG	Standard setting	Unit	Permissible setting range
SP056	PYVR	Variable excitation	Set the minimum value of the variable excitation rate. Select a smaller value when gear noise is too high. However, a larger value is effective for impact response. • If "50" or higher is set to improve the impact load response, check that there are no problems with the gear noise, motor excitation noise, vibration during position control excluding C-axis control, and vibration during orientation stop. • If "50" or less is set to improve the gear noise, motor excitation noise or vibration during orientation, check that there are no problems with the impact load response, cutting accuracy during position control excluding C-axis control, and the holding force during orientation stop. If there is any problem with the vibration or cutting accuracy during position control excluding C-axis control, or if an insufficient rigidity or vibration occurs during orientation stop, set the variable excitation minimum value for only position control and orientation separately in SP116. (Practical setting range: 20 to 75)	DEC	*	50	%	0 to 100
SP057	STOD	Fixed control constant	Set the value shown in the parameter list. The standard setting is 7.	DEC		7	r/min	0 to 50
SP058	SDT2	Fixed control constant	Set the value shown in the parameter list. The standard setting is 0.	DEC		0	r/min	0 to 32767
SP059	MKT	Coil changeover base cutoff timer	Set the base cutoff time when changing the contactor during coil changeover. If the value is too small, the contactor could melt. The value must be set higher than the standard setting value (150ms) when controlling a large contactor. Set the maximum delay time for ON/OFF of the contactor + 50ms.	DEC		150	ms	0 to 10000
SP060	MKT2	Current limit timer after coil changeover	Set the time to limit the current after changing the contactor when the coil is changed.	DEC		500	ms	0 to 10000
SP061	MKIL	Current limit value after coil changeover	Set the current limit value after changing the contactor when the coil is changed. The limit time is SP060.	DEC		75	%	0 to 120
SP062	–	–	Not used. Set "0".	DEC		0	–	–
SP063	OLT	Overload alarm detection time	Set the detection time constant for the motor overload alarm detection process.	DEC		60	s	0 to 1000
SP064	OLL	Overload alarm detection level	Set the detection level for the motor overload alarm detection process.	DEC		120	%	0 to 180

<Class: Speed control>

<table>
<tr><th>Name</th><th>Abbr.</th><th>Parameter name</th><th>Details</th><th>TYP</th><th>CNG</th><th>Standard setting</th><th>Unit</th><th>Permissible setting range</th></tr>
<tr><td>SP065</td><td>VCGN1</td><td>Target value of variable speed loop proportional gain</td><td>Set the magnification of speed loop proportional gain with respect to SP022 (VGNP1) at the maximum motor speed defined in SP017 (TSP).</td><td>DEC</td><td></td><td>100</td><td>%</td><td>0 to 100</td></tr>
<tr><td>SP066</td><td>VCSN1</td><td>Change starting speed of variable speed loop proportional gain</td><td>Set the speed when the speed loop proportional gain change starts.
 </td><td>DEC</td><td></td><td>0</td><td>r/min</td><td>0 to 32767</td></tr>
<tr><td>SP067</td><td>VIGWA</td><td>Change starting speed of variable current loop gain</td><td>Set the speed where the current loop gain change starts.</td><td>DEC</td><td></td><td>0</td><td>r/min</td><td>0 to 32767</td></tr>
<tr><td>SP068</td><td>VIGWB</td><td>Change ending speed of variable current loop gain</td><td>Set the speed where the current loop gain change ends.</td><td>DEC</td><td></td><td>0</td><td>r/min</td><td>0 to 32767</td></tr>
<tr><td>SP069</td><td>VIGN</td><td>Target value of variable current loop gain</td><td>Set the magnification of current loop gain (torque component and excitation component) for a change ending speed defined in SP068 (VIGWB).
When this parameter is set to "0", the magnification is 1.

Use the following table for reference when setting SP067 to SP069.
<table>
<tr><th>Motor maximum speed SP017 (TSP)</th><th>SP067 (VIGWA)</th><th>SP068 (VIGWB)</th><th>SP069 (VIGN)</th></tr>
<tr><td>6000 or less</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>6001 to 8000</td><td>5000</td><td>8000</td><td>32</td></tr>
<tr><td>8001 or more</td><td>5000</td><td>10000</td><td>32</td></tr>
</table>
Observe the following when setting this parameter:
1) If the motor seems to hunt (high frequency vibration) when rotating at high speeds, decrement SP069 (VIGN) by "-8" at a time, and set a value at which hunting does not occur.
2) If the motor seems to groan (low frequency vibration) when rotating at high speeds, increment SP069 (VIGN) by "+8" at a time, and set a value at which groaning does not occur.
3) If "AL32" (overcurrent) or "AL75" (overvoltage) occurs when decelerating from the maximum speed, decrement or increment SP069 (VIGN) by "+8" or "-8" to a value where the alarm does not occur.
4) If there is no problem when rotating at the maximum speed, but phenomenon 1) or 2) occurs during rotation in the medium-speed range, change the SP067 (VIGWA) and SP068 (VIGWB) setting.
Also refer to section 5-7. Spindle adjustment.</td><td>DEC</td><td></td><td>0</td><td>1/16-fold</td><td>0 to 32767</td></tr>
<tr><td>SP070</td><td>FHz</td><td>Machine resonance suppression filter frequency 1</td><td>If mechanical vibration occurs during speed or position control, set the frequency for suppressing the vibration. Set a value higher than 100Hz. Set "0" when not using this function.</td><td>DEC</td><td>*</td><td>0</td><td>Hz</td><td>0 to 2250</td></tr>
</table>

Name	Abbr.	Parameter name	Details	TYP	CNG	Stand-ard setting	Unit	Permissible setting range
SP071	VR2WA	Fixed control constant	These parameters are determined by Mitsubishi. Do not change them unless specially designated.	DEC		0	r/min	0 to 32767
SP072	VR2WB	Fixed control constant		DEC		0	r/min	0 to 32767
SP073	VR2GN	Fixed control constant		DEC		0	r/min	0 to 32767
SP074	IGDEC	Fixed control constant		DEC		0	%	0 to 1000
SP075	R2KWS	Fixed control constant		DEC	*	0		-32768 to 32767
SP076	FONS	Machine resonance suppression filter operation speed	If the vibration increases while the motor is stopped (ex., during orientation stop) when the machine vibration suppression filter is activated with SP070 and SP084, set this parameter to activate the machine vibration suppression filter at a speed higher than that set with this parameter. The filter is valid in all speed ranges when "0" is set.	DEC	*	0	r/min	0 to 32767
SP077	TDSL	Fixed control constant	These parameters are determined by Mitsubishi. Do not change them unless specially designated.	DEC		14		0 to 63
SP078	FPWM	Fixed control constant		DEC		0		0 to 3
SP079	ILMT	Fixed control constant		DEC		0		0 to 32767
SP080	SWTD	Fixed control constant		DEC		0		0 to 32767
SP081	–	–	Not used. Set "0".	–		0		
SP082	–	–	Not used. Set "0".	–		0		
SP083	VGPYR	Fixed control constant	These parameters are determined by Mitsubishi. Do not change them unless specially designated.	DEC	*	0	%	0 to 100
SP084	FHz2	Machine resonance suppression filter frequency 2	If the machine vibrates during speed or position control, and the vibration cannot be eliminated only with the previous machine resonance filter 1, set the frequency for controlling the vibration here. Set a value higher than 71Hz. Set "0" when not using this function.	DEC	*	0	Hz	0 to 2250
SP085	AIQM	Fixed control constant	These parameters are determined by Mitsubishi. Do not change them unless specially designated.	DEC		0	%	0 to 150
SP086	AIQN	Fixed control constant		DEC		0	r/min	0 to 32767
SP087	DIQM	Target value of variable torque limit magnification at deceleration	Set the minimum value of variable torque limit at deceleration.	DEC		75	%	0 to 150
SP088	DIQN	Speed for starting change of variable torque limit magnification at deceleration	Set the speed where the torque limit value at deceleration starts to change.  1) When using the high-speed rotation (10000r/min or higher) specifications motor, and occurrence of the "AL32" (overcurrent) or "AL75" (overvoltage) alarm during deceleration is not improved by changing the SP067 (VIGWA) to SP069 (VIGN) setting values, decrement the SP087 (DIQM) value by "-15" at a time until the alarms no longer occur. 2) If the above problems are not occurring, and the deceleration time is longer than the acceleration time, change the SP087 (DIQM) value following the acceleration/deceleration adjustment procedures explained in section "5-7 Spindle adjustment". Adjust the deceleration time so that it is the same as the acceleration time.	DEC		3000	r/min	0 to 32767

Name	Abbr.	Parameter name	Details	TYP	CNG	Stand-ard setting	Unit	Permissible setting range
SP089 to SP092			Not used. Set "0".	DEC		0		–
SP093	ORE	Fixed control constant	These parameters are determined by Mitsubishi. Do not change them unless specially designated.	DEC		0		0 to 32767
SP094	LMAV	Load meter output filter	Set the filter time constant of load meter output. When "0" is set, a filter time constant is set to 200ms.	DEC		0	4ms	0 to 32767
SP095	VFAV	Fixed control constant	These parameters are determined by Mitsubishi. Do not change them unless specially designated	DEC		0		–
SP096	EGAR	Encoder gear ratio	Set the gear ratio between the spindle side and the encoder side (except for the motor-built-in encoder) as indicated below. <1> 1 : 1 Setting value = 0 <2> 1 : 2 Setting value = 1 <3> 1 : 4 Setting value = 2 <4> 1 : 8 Setting value = 3 <5> 1 : 16 Setting value = 4 <6> 2 : 1 Setting value = -1 <7> 4 : 1 Setting value = -2 <8> 3 : 1 Setting value = -3	DEC		0		-3 to 4

<Class: Orientation control>

Name	Abbr.	Parameter name	Details	TYP	CNG	Stand-ard setting	Unit	Permissible setting range
SP097	SPECO	Orientation specification	Set the orientation specifications in bit units. Refer to the section "4-3-2".	HEX		0000		0000 to FFFF
SP098	VGOP	Speed loop gain proportional term in orientation mode	Set the speed loop proportional gain in orientation mode. When this parameter value is increased, response is improved but vibration and sound become larger.	DEC		63	rad/s	0 to 2000
SP099	VGOI	Speed loop gain integral term in orientation mode	Set the speed loop integral gain in orientation mode. Set so that the percentage in respect to SP098 (VGOP) is approximately constant. (Setting value approx. 1:1)	DEC		60	1/10 rad/s	0 to 2000
SP100	VGOD	Speed loop gain delay advance term in orientation mode	Set the speed loop gain delay advance gain in orientation mode. The impact responsiveness will increase when the value is increased, but the deviation of the orientation stop position from forward run, and the orientation stop position from reverse run could increase. PI control is applied when "0" is set. This is effective for a machine with large frictional torque, and for reducing the inconsistency in orientation stop position. Note that when "0" is set, a torque limit signal must always be input for clamping if the spindle is mechanically clamped during orientation stop. Set "15" if there are no particular problems.	DEC		15	1/10 rad/s	0 to 1000
SP101	DINP	Orientation dummy in-position width	This is valid when SP097 (SPEC0) -bit2 is set to "1". If this value is set larger than the normal in-position width (SP004:OINP) to shorten the ATC time, it will appear that orientation is completed earlier. However, if the value is too large, the ATC operation may start before the spindle position reaches the ATC position. Carefully check the operation when using this parameter.	DEC		16	1/16°	0 to 2880
SP102	OODR	Excessive error value in orientation mode	Set the excessive error width for detecting the excessive error alarm during orientation. Normally set "32767". The excessive error alarm will not be output when "0" is set.	DEC		32767	1/4 pulse	0 to 32767 (1 pulse = 0.088°)
SP103	FTM	Positioning completion OFF time timer	Set the time for forcedly turning OFF the index positioning completion signal (different from the orientation completion signal) after the leading edge of the indexing start signal.	DEC		200	ms	0 to 10000

Name	Abbr.	Parameter name	Details	TYP	CNG	Standard setting	Unit	Permissible setting range
SP104	TLOR	Torque limit value for orientation servo locking	Set the torque limit value for orientation in-position output. The external torque limit value will have the priority when the external torque limit signal is input.	DEC		100	%	0 to 120
SP105	IQGO	Current loop gain magnification 1 in orientation mode	Set the magnification for current loop gain (torque component) at orientation completion. The magnification will be 100% (1-fold) when "100" is set. If vibration occurs during orientation stop, and the vibration cannot be eliminated by changing the SP001 (PGM), SP002 (PGE), SP098 (VGOP) and SP099 (VGOI) settings, the state may be improved by changing this parameter. 1) Reduce the setting value when minute vibration occurs in the frequency. 2) Increase the setting value if minute vibration occurs at low frequencies. Always change the SP106 (IDGO) value to the same value when changing this parameter. (Practical setting range: 50 to 300)	DEC		100	%	0 to 1000
SP106	IDGO	Current loop gain magnification 2 in orientation mode	Set the magnification for current loop gain (excitation component) at orientation completion. Refer to SP105 (IQGO) for details on setting this parameter.	DEC		100	%	0 to 1000
SP107	CSP2	Deceleration rate 2 in orientation mode	Set the deceleration rate in orientation mode corresponding to the gear 01. When this parameter is set to "0", the rate will be the same as SP006 (CSP).	DEC	*	0		0 to 1000
SP108	CSP3	Deceleration rate 3 in orientation mode	Set the deceleration rate in orientation mode corresponding to the gear 10. When this parameter is set to "0", the rate will be the same as SP006 (CSP).	DEC	*	0		0 to 1000
SP109	CSP4	Deceleration rate 4 in orientation mode	Set the deceleration rate in orientation mode corresponding to the gear 11. When this parameter is set to "0", the rate will be the same as SP006 (CSP).	DEC	*	0		0 to 1000
SP110	WCML	Fixed control constant	These parameters are determined by Mitsubishi. Do not change them unless specially designated.	DEC	*	0	Fold	0 to 32767
SP111	WDEL	Fixed control constant		DEC	*	0	1/256 fold	0 to 32767
SP112	WCLP	Fixed control constant		DEC	*	0	r/min	0 to 32767
SP113	WINP	Fixed control constant		DEC	*	0	360/ 4096 fold	0 to 32767
SP114	OPER	Orientation pulse miss check value	If the pulse miss value during orientation stop exceeds this setting, the alarm "5C" will occur. (Set 0 to invalidate.) The orientation start memo setting must always be invalidated when this parameter is set to a value other than "0". (Set SP038 (SFNC6) bit6 to "0".) Establish the following expression when using this setting. SP114 setting value ≥ SP004 setting value/16/(360/4096) + 20, or set a multiple of 4 larger or equal to the value calculated with the right side when using PLG orientation.	DEC	*	0	360/ 4096°	0 to 32767
SP115	OPS2	Index clamp speed	When the control input 4 bitC is set to "1", the value set in this parameter is used for the orientation changeover speed instead of SP005 (OSP). In all other cases, if SP097 (SPECO) -bit4 is set to "1", the maximum spindle speed for indexing is set here.	DEC		0	r/min	0 to 32767

Name	Abbr.	Parameter name	Details	TYP	CNG	Stand-ard setting	Unit	Permissible setting range
SP116	OPYVR	Variable constant rate during position loop	When the control input 4-bitB is set to "1", the value set in this parameter is used for the minimum excitation rate instead of SP056 (PYVR). In all other cases, if this parameter is set to a value other than "0", the value set in this parameter will be used instead of SP056 (PYVR) for the minimum excitation rate during position control including orientation control (excluding C-axis control).	DEC	*	0	%	0 to 100
SP117	ORUT	Orientation changeover speed reach range	Set this value when using a machine with large inertia, and the motor continues to run when orientation is executed from the stopped state, or if it takes a long time for orientation to stop. Normally set this to "0".	DEC	*	0	r/min	0 to 32767
SP118	ORCT	Number of orientation retries	Set the number of times to retry orientation when an orientation pulse miss occurs. This parameter is invalid when SP114 (OPER) is set to "0". Alarm "A9" will appear while retrying orientation, and alarm "5C" will appear if there is a pulse miss even after the designated number of retires.	DEC	*	0	times	0 to 100
SP119	MPGH	Orientation position loop gain H coil magnification	Set the orientation position loop gain for the H coil when using the coil changeover motor. Set the magnification in respect to SP001 (PGM) and SP002 (PGE), using "256" as 1-fold. The magnification will also be 1-fold when "0" is set. This is used to shorten the orientation time for each coil. However, normally the time is adjusted with SP121 (MPCSH). Use this parameter when the time cannot be adjusted sufficiently with SP121.	DEC	*	0	1/256 fold	0 to 2560
SP120	MPGL	Orientation position loop gain L coil magnification	Set the orientation position loop gain for the L coil when using the coil changeover motor. The setting method is the same as SP119 (MPGH).	DEC	*	0	1/256 fold	0 to 2560
SP121	MPCSH	Orientation deceleration rate H coil magnification	When using the coil changeover motor, set the deceleration rate for orientation with the H coil. Set the magnification in respect to SP006 (CSP), using "256" as 1-fold. The magnification will also be 1-fold when "0" is set. This is used to shorten the orientation time for each coil.	DEC	*	0	1/256 fold	0 to 2560
SP122	MPCAL	Orientation deceleration rate L coil magnification	When using the coil changeover motor, set the deceleration rate for orientation with the L coil. The setting method is the same as SP121 (MPCSH).	DEC	*	0	1/256 fold	0 to 2560
SP123	MGD0	Magnetic sensor output peak value	This parameter is used for adjusting the operation during magnetic sensor orientation. Set the peak value of the magnetic sensor output. If the gap between the sensor and magnet is small, set a large value. If the gap is large, set a small value. If the operation stops just before the stop point during orientation, change this parameter so that the target point is reached. Use the standard setting if there are no problems.	DEC	*	Standard magnet = 542 Compact magnet = 500	–	0 to 10000
SP124	MGD1	Magnetic sensor linear zone width	This parameter is used for adjusting the operation during magnetic sensor orientation. Set the width of the magnetic sensor linear zone. If the installation radius of the magnet is large, set a small value. If the radius is small, set a large value. Use the standard setting if there are no problems during orientation.	DEC	*	Standard magnet = 768 Compact magnet = 440	–	0 to 10000
SP125	MGD2	Magnetic sensor changeover point	This parameter is used for adjusting the operation during magnetic sensor orientation. Set the distance from the target stop point for changing the position feedback to magnetic sensor output. Normally, a value that is approx. half of SP124 (MGDI) is set.	DEC	*	Standard magnet = 384 Compact magnet = 220	–	0 to 10000
SP126 to SP128			Not used. Set "0".	DEC		0	–	–

<Class: C-axis control>

<table>
<tr><th>Name</th><th>Abbr.</th><th>Parameter name</th><th>Details</th><th>TYP</th><th>CNG</th><th>Standard setting</th><th>Unit</th><th>Permissible setting range</th></tr>
<tr><td>SP129</td><td>SPECC</td><td>C-axis specification</td><td>Select the specifications for C-axis control with bit correspondence. Refer to section 4-3-2 for details.</td><td>HEX</td><td></td><td>0000</td><td></td><td>0000 to FFFF</td></tr>
<tr><td>SP130</td><td>PGC1</td><td>1st position loop gain for C-axis cutting</td><td rowspan="3">Set the position loop gain for C-axis cutting (when control input 1 bitF is "1").
Select SP130 to 132 according to the control input 3 bit combination.
[Control input 3]
<table>
<tr><th>bit4</th><th>bit3</th><th>bit2</th><th>bit1</th><th>bit0</th><th>Position loop gain selection</th></tr>
<tr><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>SP130</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>SP131</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>SP132</td></tr>
</table></td><td>DEC</td><td>*</td><td>15</td><td>s^{-1}</td><td>0 to 200</td></tr>
<tr><td>SP131</td><td>PGC2</td><td>2nd position loop gain for C-axis cutting</td><td>DEC</td><td>*</td><td>15</td><td>s^{-1}</td><td>0 to 200</td></tr>
<tr><td>SP132</td><td>PGC3</td><td>3rd position loop gain for C-axis cutting</td><td>DEC</td><td>*</td><td>15</td><td>s^{-1}</td><td>0 to 200</td></tr>
<tr><td>SP133</td><td>PGC3</td><td>Position loop gain when stopped during C-axis cutting</td><td>Set the position loop gain when stopped during C-axis cutting (when control input 1bitF is "1").
Regardless of the control input 3 bit0 and 1 states, the value set in this parameter will be valid when stopping during C-axis cutting.</td><td>DEC</td><td>*</td><td>15</td><td>s^{-1}</td><td>0 to 200</td></tr>
<tr><td>SP134</td><td>VGCP0</td><td>Speed loop proportional item for C-axis non-cutting</td><td rowspan="13">Proportional item:
Set the speed loop proportional gain for the C-axis. The responsiveness will increase when the value is increased, but vibration and noise will increase.
Integral item:
Set the speed loop integral gain for the C-axis.
Delay/advance item:
Set the speed loop delay/advance gain for the C-axis. The impact responsiveness will increase when the value is increased, but the stop position may become more inconsistent.
"PI" control is applied when "0" is set. Set this when the machine's frictional torque is large, or to improve the accuracy during C-axis cutting.
Note that when "0" is set, if the spindle is mechanically stopped during spindle stopping, always input a torque limit signal when fixing the spindle.

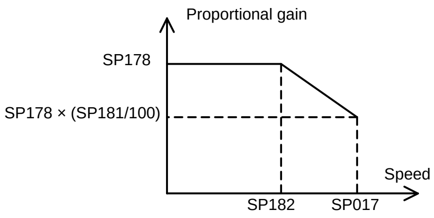
The selected parameter No. for each of the above gains depends on the status of the control input 1 and 3 bit for C-axis control.

[Control input 1, 3]
<table>
<tr><th>Control input 1</th><th colspan="5">Control input 3</th><th colspan="2">Gain selection</th></tr>
<tr><th>bitF</th><th>bit4</th><th>bit3</th><th>bit2</th><th>bit1</th><th>bit0</th><th>Movement command present</th><th>Movement command 0</th></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1</td><td>0 or 1</td><td>0 or 1</td><td>SP134
SP135
SP136</td><td>Same as left</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>SP137
SP138
SP139</td><td rowspan="4">SP146
SP147
SP148</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>SP140
SP141
SP142</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>SP143
SP144
SP145</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>SP137
SP138
SP139</td></tr>
</table></td><td>DEC</td><td></td><td>63</td><td>rad/s</td><td>0 to 5000</td></tr>
<tr><td>SP135</td><td>VGCI0</td><td>Speed loop gain integral item for C-axis non-cutting</td><td>DEC</td><td></td><td>60</td><td>1/10 rad/s</td><td>0 to 5000</td></tr>
<tr><td>SP136</td><td>VGCD0</td><td>Speed loop gain delay/advance item for C-axis non-cutting</td><td>DEC</td><td></td><td>15</td><td>1/10 rad/s</td><td>0 to 5000</td></tr>
<tr><td>SP137</td><td>VGCP1</td><td>1st speed loop gain proportional time for C-axis cutting</td><td>DEC</td><td></td><td>63</td><td>rad/s</td><td>0 to 5000</td></tr>
<tr><td>SP138</td><td>VGCI1</td><td>1st speed loop gain integral item for C-axis cutting</td><td>DEC</td><td></td><td>60</td><td>1/10 rad/s</td><td>0 to 5000</td></tr>
<tr><td>SP139</td><td>VGCD1</td><td>1st speed loop gain delay/advance item for C-axis cutting</td><td>DEC</td><td></td><td>15</td><td>1/10 rad/s</td><td>0 to 5000</td></tr>
<tr><td>SP140</td><td>VGCP2</td><td>2nd speed loop gain proportional time for C-axis cutting</td><td>DEC</td><td></td><td>63</td><td>rad/s</td><td>0 to 5000</td></tr>
<tr><td>SP141</td><td>VGCI2</td><td>2nd speed loop gain integral item for C-axis cutting</td><td>DEC</td><td></td><td>60</td><td>1/10 rad/s</td><td>0 to 5000</td></tr>
<tr><td>SP142</td><td>VGCD2</td><td>2nd speed loop gain delay/advance item for C-axis cutting</td><td>DEC</td><td></td><td>15</td><td>1/10 rad/s</td><td>0 to 5000</td></tr>
<tr><td>SP143</td><td>VGCP3</td><td>3rd speed loop gain proportional time for C-axis cutting</td><td>DEC</td><td></td><td>63</td><td>rad/s</td><td>0 to 5000</td></tr>
<tr><td>SP144</td><td>VGCI3</td><td>3rd speed loop gain integral item for C-axis cutting</td><td>DEC</td><td></td><td>60</td><td>1/10 rad/s</td><td>0 to 5000</td></tr>
<tr><td>SP145</td><td>VGCD3</td><td>3rd speed loop gain delay/advance item for C-axis cutting</td><td>DEC</td><td></td><td>15</td><td>1/10 rad/s</td><td>0 to 5000</td></tr>
<tr><td>SP146</td><td>VGCP4</td><td>Speed loop gain proportional item when stopped during C-axis cutting</td><td>DEC</td><td></td><td>63</td><td>rad/s</td><td>0 to 5000</td></tr>
</table>

Name	Abbr.	Parameter name	Details	TYP	CNG	Stand-ard setting	Unit	Permissible setting range
SP147	VGCI4	Speed loop gain integral item when stopped during C-axis cutting		DEC		60	1/10 rad/s	0 to 5000
SP148	VGCD4	Speed loop gain delay/advance item when stopped during C-axis cutting		DEC		15	1/10 rad/s	0 to 5000
SP149	CZRN	C-axis zero point return speed	This is valid when the SP129 (SPECC) bitE is set to "0". Set the speed for changing from the speed loop to the position loop during C-axis automatic zero point return.	DEC	*	50	r/min	0 to 500
SP150	CPDT	C-axis zero point return deceleration rate	This is valid when the SP129 (SPECC) bitE is set to "0". Set the deceleration rate for decelerating from the C-axis zero point return speed to the target stop point. Decrease the setting if machine sways when stopping.	DEC	*	1		0 to 10000
SP151	CPSTL	C-axis zero point return position shift amount (Low byte)	This is valid when the SP129 (SPECC) bitE is set to "0". Set the C-axis zero point position.	HEX	*	0	1/ 1000°	0 to FFFFFFFF
SP152	CPSTH	C-axis zero point return position shift amount (High byte)		HEX	*	0		
SP153	CINP	C-axis in-position width	Set the position error range for outputting the in-position signal during C-axis control.	HEX	*	03E8	1/ 1000°	0 to FFF
SP154	CODRL	Excessive error width for C-axis (Low byte)	Set the excessive error width for the C-axis.	HEX		D4C0	1/ 1000°	0 to FFFFFFFF
SP155	CODRH	Excessive error width for C-axis (High byte)		HEX		0001		
SP156	OVSH	Fixed control constant	These parameters are determined by Mitsubishi. Set to "0" unless especially designated.	DEC	*	0	0.1%	0 to 1000
SP157 to SP158			Not used. Set "0".	DEC		0		
SP159	CPY0	Variable excitation rate during C-axis non-cutting	Set the minimum value of the variable excitation rate during C-axis non-cutting (when control input 1 bitF is "0").	DEC	*	50	%	0 to 100
SP160	CPY1	Variable excitation rate during C-axis cutting	Set the minimum value of the variable excitation rate during C-axis cutting (when control input 1 bitF is "1").	DEC	*	100	%	0 to 100
SP161	IQGC0	Current loop gain magnification 1 for C-axis non-cutting	Set the magnification of the current loop gain (torque amount) during C-axis non-cutting (when control input 1 bitF is "0").	DEC		100	%	0 to 1000
SP162	IDGC0	Current loop gain magnification 2 for C-axis non-cutting	Set the magnification of the current loop gain (excitation amount) during C-axis non-cutting (when control input 1 bitF is "0").	DEC		100	%	0 to 1000
SP163	IQGC1	Current loop gain magnification 1 for C-axis cutting	Set the magnification of the current loop gain (torque amount) during C-axis cutting (when control input 1 bitF is "1").	DEC		100	%	0 to 1000
SP164	IDGC1	Current loop gain magnification 2 for C-axis cutting	Set the magnification of the current loop gain (excitation amount) during C-axis cutting (when control input 1 bitF is "1").	DEC		100	%	0 to 1000
SP165	PGC2	C-axis position loop gain 2	Set the 2nd position loop gain for carrying out SHG control during C-axis control. This setting value is valid for both non-cutting and cutting.	DEC	*	0	s^{-1}	0 to 999
SP166	PGC3	C-axis position loop gain 3	Set the 3rd position loop gain for carrying out SHG control during C-axis control. This setting value is valid for both non-cutting and cutting.	DEC	*	0	s^{-1}	0 to 999

Name	Abbr.	Parameter name	Details	TYP	CNG	Stand-ard setting	Unit	Permissible setting range
SP167	PGU	Position loop gain during increased spindle holding force	Set the position loop gain when the disturbance observer is validated during C-axis control (when control input 4 bitF is "1"). This setting value is valid for both non-cutting and cutting.	DEC		15	s^{-1}	0 to 200
SP168	VGUP	Speed loop gain proportional item during increased spindle holding force	Set the speed loop proportional gain when the disturbance observer is validated during C-axis control (when control input 4 bitF is "1"). This setting value is valid for both non-cutting and cutting.	DEC		0	rad/s	0 to 5000
SP169	VGU1	Speed loop gain integral item during increased spindle holding force	Set the speed loop integral gain when the disturbance observer is validated during C-axis control (when control input 4 bitF is "1"). This setting value is valid for both non-cutting and cutting.	DEC		0	1/10 rad/s	0 to 5000
SP170	VGUD	Speed loop gain delay/advance item during increased spindle holding force	Set the speed loop delay/advance gain when the disturbance observer is validated during C-axis control (when control input 4 bitF is "1"). This setting value is valid for both non-cutting and cutting.	DEC		0	1/10 rad/s	0 to 5000
SP171 to SP176			Not used. Set "0".			0		

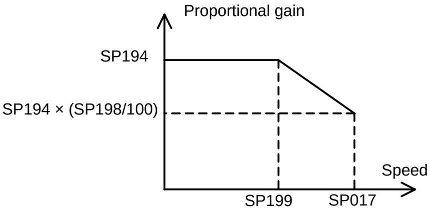
<Class: Spindle synchronization control>

Name	Abbr.	Parameter name	Details	TYP	CNG	Stand-ard setting	Unit	Permissible setting range
SP177	SPECS	Spindle specifications for spindle synchronization	Select the spindle specifications for spindle synchronous control with bit correspondence. Refer to the section "4-3-2" for details.	HEX		0000		0000 to FFFF
SP178	VGSP	Spindle synchronous speed loop gain proportional term	Set the speed loop proportional gain in spindle synchronous mode. The responsiveness will increase when the value is increased, but the vibration and noise will also increase.	DEC		63	rad/s	0 to 2000
SP179	VGSI	Spindle synchronous speed loop gain integral term	Set the speed loop integral gain in spindle synchronous mode.	DEC		60	1/10 rad/s	0 to 2000
SP180	VGSD	Spindle synchronous speed loop gain delay advance term	Set the speed loop delay advance gain in spindle synchronous mode. The impact responsiveness will increase when the value is increased, but the stop position may become more inconsistent. "PI" control is applied when "0" is set. Set "15" if there are no problems.	DEC		15	1/10 rad/s	0 to 1000
SP181	VCGS	Spindle synchronous target value of variable speed loop proportional gain	Set the percentage of the speed loop proportional gain in respect to the maximum speed set in SP178 (VGSP) for spindle synchronization SP017 (TSP).	DEC		100	%	0 to 100
SP182	VCSS	Spindle synchronous change starting speed of variable speed loop proportional gain	Set the speed to start changing the speed loop proportional gain during spindle synchronization. 	DEC		0	r/min	0 to 32767

Name	Abbr.	Parameter name	Details	TYP	CNG	Standard setting	Unit	Permissible setting range
SP183	SYNV	Spindle synchronous sync matching speed	Set the error range of the speed command for outputting the synchronous speed matching signal when changing from the speed loop to the position loop spindle synchronization.	DEC	*	20	r/min	0 to 1000
SP184			Not used. Set "0".			0		
SP185	SINP	Spindle synchronous in-position width	Set the error range of the position for outputting the in-position signal during spindle synchronization.	DEC	*	16	1/16°	0 to 2880
SP186	SODR	Spindle synchronous excessive error width	Set the excessive error width in the spindle synchronous mode.	DEC		32767	Pulse (1 pulse = 0.088°)	0 to 32767
SP187	IQGS	Spindle synchronous current loop gain magnification1	Set the magnification of current loop gain (torque component) in the spindle synchronous mode.	DEC		100	%	0 to 1000
SP188	IDGS	Spindle synchronous current loop gain magnification 2	Set the magnification of current loop gain (excitation component) in the spindle synchronous mode.	DEC		100	%	0 to 1000
SP189	PG2S	Position loop gain 2 for spindle synchronous	Set the second position loop gain for SGH control during spindle synchronous.	DEC	*	0	s^{-1}	0 to 999
SP190	PG3S	Position loop gain 3 for spindle synchronous	Set the third position loop gain for SGH control during spindle synchronous.	DEC	*	0	s^{-1}	0 to 999
SP191 to SP192			Not used. Set "0".			0		

<Class: Synchronous tap control>

Name	Abbr.	Parameter name	Details	TYP	CNG	Standard setting	Unit	Permissible setting range
SP193	SPECT	Synchronized tapping specifications	Set the synchronized tapping specifications in bit units. Refer to the section "4-3-2" for details.	HEX		0000		0000 to FFFF
SP194	VGTP	Synchronized tapping speed loop gain proportional term	Set the speed loop proportional gain in synchronized tapping mode. The responsiveness will increase when the value is increased, but the vibration and noise will also increase.	DEC		63	rad/s	0 to 2000
SP195	VGTI	Synchronized tapping speed loop gain integral term	Set the speed loop integral gain in synchronized tapping mode.	DEC		60	1/10 rad/s	0 to 2000
SP196	VGTD	Synchronized tapping speed loop gain delay advance term	Set the speed loop delay advance gain in synchronized tapping mode. The impact responsiveness will increase when the value is increased, but the stop position may become more inconsistent. "PI" control is applied when "0" is set. Set "15" if there are no problems.	DEC		15	1/10 rad/s	0 to 1000
SP197			Not used. Set "0".			0		
SP198	VCGT	Synchronized tapping target value of variable speed loop proportional gain	Set the percentage of the speed loop proportional gain in respect to SP194 (VGTP) for the maximum speed set in SP017 (TSP) during synchronous tap control.	DEC		100	%	0 to 100

Name	Abbr.	Parameter name	Details	TYP	CNG	Standard setting	Unit	Permissible setting range
SP199	VCST	Synchronized tapping change starting speed of variable speed loop proportional gain	Set the speed where the speed loop proportional gain change starts during synchronized tapping. 	DEC		0	r/min	0 to 32767
SP200	FFC1	Synchronized tapping acceleration feed forward gain	Set the acceleration feed forward gain for selection of gear 00 at synchronized tapping. Set this value if the positional error with the Z axis increases when the motor's acceleration rate changes.	DEC	*	0	%	0 to 1000
SP201	FFC2	Synchronized tapping acceleration feed forward gain	Set the acceleration feed forward gain for selection of gear 01 at synchronized tapping. The setting method is the same as SP200 (FFC1).	DEC	*	0	%	0 to 1000
SP202	FFC3	Synchronized tapping acceleration feed forward gain	Set the acceleration feed forward gain for selection of gear 10 at synchronized tapping. The setting method is the same as SP200 (FFC1).	DEC	*	0	%	0 to 1000
SP203	FFC4	Synchronized tapping acceleration feed forward gain	Set the acceleration feed forward gain for selection of gear 11 at synchronized tapping. The setting method is the same as SP200 (FFC1).	DEC	*	0	%	0 to 1000
SP204 to SP213			Not used. Set "0".			0		
SP214	TZRN	Synchronized tapping zero point return speed	This parameter is valid when SP193 (SPECT) bitE is set to "0". Set the speed for changing from the speed loop to position loop during zero point return.	DEC	*	50	r/min	0 to 500
SP215	TPDT	Synchronized tapping zero point return deceleration rate	This parameter is valid when SP193 (SPECT) bitE is set to "0". Set the deceleration rate for decelerating from the synchronous tapping zero point return speed to the target stop point. Decrease the setting if machine sways during zero point return.	DEC	*	1	Pulse	0 to 10000
SP216	TPST	Synchronous tapping zero point return position shift amount	This parameter is valid when SP193 (SPECT) bitE is set to "0". Set the synchronized tapping zero point position.	HEX	*	0	360°/ 4096	0 to 4095
SP217	TINP	Synchronized tapping in-position width	Set the position error range for outputting the in-position signal during synchronous tapping.	DEC	*	16	1/16°	0 to 2880
SP218	TODR	Synchronized tapping excessive error width	Set the excessive error width during synchronized tapping.	DEC		32767	Pulse (1 pulse = 0.088°)	0 to 32767
SP219	IQGT	Synchronized tapping current loop gain magnification 1	Set the magnification of current loop gain (torque component) during synchronized tapping.	DEC		100	%	0 to 1000
SP220	IDGT	Synchronized tapping current loop gain magnification 2	Set the magnification of current loop gain (excitation component) during synchronized tapping.	DEC		100	%	0 to 1000

Name	Abbr.	Parameter name	Details	TYP	CNG	Stand-ard setting	Unit	Permissible setting range
SP221	PG2T	Position loop gain 2 for synchronous tapping	Set the second position loop gain for SGH control during synchronous tapping.	DEC	*	0	s^{-1}	0 to 999
SP222	PG3T	Position loop gain 3 for synchronous tapping	Set the third position loop gain for SGH control during synchronous tapping.	DEC	*	0	s^{-1}	0 to 999

<Class: Miscellaneous>

Name	Abbr.	Parameter name	Details	TYP	CNG	Stand-ard setting	Unit	Permissible setting range
SP223	SPDV	Fixed control constant	These parameters are determined by Mitsubishi. Set to "0" unless especially designated.	DEC	*	0	r/min	0 to 800
SP224	SPDF	Fixed control constant		DEC	*	0		0 to 2813
SP225	OXKPH	Fixed control constant		DEC	*	0	1/256 fold	0 to 2560
SP226	OXKPL	Fixed control constant		DEC	*	0	1/256 fold	0 to 2560
SP227	OXVKP	Fixed control constant		DEC	*	0	1/256 fold	0 to 2560
SP228	OXVKI	Fixed control constant		DEC	*	0	1/256 fold	0 to 2560
SP229	OXSFT	Fixed control constant		DEC	*	0	1/256 fold	0 to 2048
SP230	WIH	Fixed control constant		DEC	*	0	%	0 to 100
SP231	OL2T	Fixed control constant		DEC	*	0	min	0 to 60
SP232			Not used. Set "0".			0		
SP233	JL	Disturbance observer total inertia ratio	Set the ratio of the motor inertia + load inertia and motor inertia when using the disturbance observer (when control input 4 bitF is set to "1"). Setting value = $\frac{\text{Motor inertia + Load inertia}}{\text{Motor inertia}} \times 100$ Normally set a value higher than "100". This parameter is invalid when a value less than "50" is set.	DEC		0	%	0 to 5000
SP234	OBS1	Disturbance observer low pass filter frequency	Set the low pass filter frequency when using the disturbance observer (when control input 4 bitF is set to "1"). Setting value (1/s) = $2\pi f$ Input a value approx. 1.5-fold of the disturbance frequency in f.	DEC		0	1/s	0 to 1000
SP235	OBS2	Disturbance observer gain	Set the gain when using the disturbance observer (when control input 4 bitF is set to "1").	DEC		0	%	0 to 500
SP236	OBS3	Fixed control constant	These parameters are determined by Mitsubishi. Set to "0" unless especially designated.	DEC	*	0		-32768 to 32767
SP237 to SP241			Not used. Set "0".			0		
SP242	Vavx	Fixed control constant	These parameters are determined by Mitsubishi. Set to "0" unless especially designated.	DEC	*	0	r/min	0 to 32767
SP243	UTTM	Transient/steady judgment timer	When the difference between the speed command during motor acceleration/deceleration and the speed feedback is within the judgment value and the time set in this parameter has elapsed, the motor control is changed from the transient state to the steady state. Setting "0" is the same as 1000ms.	DEC	*	0	ms	0 to 1000

Name	Abbr.	Parameter name	Details	TYP	CNG	Stand-ard setting	Unit	Permissible setting range
SP244	OPLP	Torque command for open loop	Set the torque command value for an open loop. The value will be the same as 2048 (=50%) when "0" is set. If the load is heavy, and the motor does not rotate past a set speed, set a value higher than 2048. Wait at least five minutes before running the motor in this case as the drive unit or motor could be damaged.	DEC	*	0	100/ 4096 %	0 to 4096
SP245	PGHS	PLG compensation setting	Set "1" to validate the PLG waveform compensation function. Carry out compensation again when the value is set to "0".	DEC	*	0		0 to 1
SP246	TEST	Fixed control constant	These parameters are determined by Mitsubishi. Set to "0" unless especially designated.	DEC	*	0		-32768 to 32767
SP247 to SP248			Not used. Set "0".			0		
SP249	SMO	Speedometer speed	Set the motor speed for outputting 10V.	DEC	*	0	r/min	0 to 32767
SP250	LMO	Load meter voltage	Set the output voltage for a 120% load.	DEC	*	0	V	0 to 10
SP251 to SP252			Not used. Set "0".			0		
SP253	DA1NO	D/A output channel 1 data number	Set the output data NO. in channel 1 (CN9-9 pin) of the D/A output function. Normally set "0". Refer to section 5-6 for details on setting.	DEC	*	0		-32768 to 32767
SP254	DA2NO	D/A output channel 2 data number	Set the output data NO. in channel 2 (CN9-19 pin) of the D/A output function. Normally set "0". Refer to section 5-6 for details on setting.	DEC	*	0		-32768 to 32767
SP255	DA1MP	D/A output channel 1 magnification	Set the output magnification for the first channel (CN9-9) of the D/A output function. Refer to section 5-6 for details on setting.	DEC	*	0	1/256 fold	-32768 to 32767
SP256	DA2MP	D/A output channel 2 magnification	Set the output magnification for the second channel (CN9-19) of the D/A output function. Refer to section 5-6 for details on setting.	DEC	*	0	1/256 fold	-32768 to 32767

<Class: Motor constants>

Name	Abbr.	Parameter name	Details	TYP	CNG	Stand-ard setting	Unit	Permissible setting range
SP257 to SP320	RPM to BSD	Motor constant (H)	Set these parameters in the following cases. 1) When using the standard motor with the wide range output specifications and base slide function (when SP034 (SFNC2)-bit0 is set to "0", and SP035(SFNC3)-bit0 or bit2 is set to 1), set the values from SP314 (SPO) to SP320 (BSD). 2) When using a special motor without coil changeover (electronic output changeover) specifications (when SP034 (SFNC2)-bit0 is set to "1" or bit2 is set to "0"), set the values from SP257 (RPM) to SP320 (BSD). 3) When using the coil changeover (electronic output changeover) specifications motor (when SP034 (SFNC2)-bit0 is set to "1", and bit2 is set to "1"), set the H coil (high-speed output) motor constants in SP257 (RPM) to SP320 (BSD). This parameter is determined by Mitsubishi, and must not be changed by the user.	HEX		0000		0000 to FFFF
SP321 to SP384	RPML to BSDL	Motor constant (L)	Set this parameter when using the coil changeover motor (electronic output changeover motor). (When SP034 (SFNC2)-bit0 is set to "1" and bit2 is set to "1".) Set the L coil (low-speed output) motor constants for the coil changeover motor (electronic output changeover motor). This parameter is determined by Mitsubishi, and must not be changed by the user.	HEX		0000		0000 to FFFF

4-3-2 Details of bit-corresponding parameters

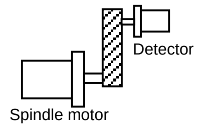
The bits not explained in the section "4-3-1 List of spindle parameters" are shown below. These parameters are designated in the "List of spindle parameter settings" enclosed when the spindle motor is delivered. Basically none of the settings need to be changed by the machine maker.

Bits with no explanation must be set to "0".

<table>
<tr><th>Name</th><th>Abbr.</th><th>Details</th><th>TYP</th></tr>
<tr><td>SP033</td><td>SFNC1</td><td>Spindle function 1
<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>poff</td><td>hzs</td><td></td><td>ront</td><td></td><td></td><td>pycal</td><td>pychg</td><td></td><td>pyoff</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbr.</th><th>Content</th><th>0 setting</th><th>1 setting</th><th>Supplement</th></tr>
<tr><td>6</td><td>pyoff</td><td>Special function</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>8</td><td>pychg</td><td>Special function</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>9</td><td>pycal</td><td>Motor temperature rise reduce function</td><td>Invalid</td><td>Valid</td><td>Only during high-speed operation</td></tr>
<tr><td>C</td><td>ront</td><td>READY ON control</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>E</td><td>hzs</td><td>High-speed gate OFF during zero speed</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>F</td><td>poff</td><td>Contactor hold during NC OFF</td><td>Invalid</td><td>Valid</td><td></td></tr>
</table></td><td>HEX setting</td></tr>
<tr><td>SP034</td><td>SFNC2</td><td>Spindle function 2
<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="3">nfd2</td><td colspan="3">nfd1</td><td></td><td></td><td>sdir</td><td></td><td></td><td>nf3</td><td></td><td>mkc2</td><td></td><td>mts1</td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbr.</th><th>Content</th><th>0 setting</th><th>1 setting</th><th>Supplement</th></tr>
<tr><td>0</td><td>mtsl</td><td>Special motor constant setting</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>2</td><td>mkc2</td><td>Coil changeover function</td><td>Not available</td><td>Available</td><td></td></tr>
<tr><td>4</td><td>nf3</td><td>3rd resonance filter</td><td>Valid</td><td>Invalid</td><td></td></tr>
<tr><td>7</td><td>sdir</td><td>Speed detector installation direction</td><td>Normal</td><td>Reverse</td><td></td></tr>
<tr><td>A-C</td><td>nfd1</td><td colspan="4">1st filter SP070 (FHz) depth setting for machine resonance suppression filter
Deep ← → Shallow
<table>
<tr><td>Setting value (CBA)</td><td>000</td><td>001</td><td>010</td><td>011</td><td>100</td><td>101</td><td>110</td><td>111</td></tr>
<tr><td>Depth (Dd)</td><td>-∞</td><td>-18</td><td>-12</td><td>-9</td><td>-6</td><td>-4</td><td>-3</td><td>-1</td></tr>
</table></td></tr>
<tr><td>D-F</td><td>nfd2</td><td colspan="4">1st filter SP084 (FHz) depth setting for machine resonance suppression filter
Deep ← → Shallow
<table>
<tr><td>Setting value (CBA)</td><td>000</td><td>001</td><td>010</td><td>011</td><td>100</td><td>101</td><td>110</td><td>111</td></tr>
<tr><td>Depth (Dd)</td><td>-∞</td><td>-18</td><td>-12</td><td>-9</td><td>-6</td><td>-4</td><td>-3</td><td>-1</td></tr>
</table></td></tr>
</table></td><td>HEX setting</td></tr>
<tr><td>SP035</td><td>SFNC3</td><td>Spindle function 3
<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></td><td></td><td></td><td></td><td>lbsd</td><td>hbsd</td><td>lwid</td><td>hwid</td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbr.</th><th>Content</th><th>0 setting</th><th>1 setting</th><th>Supplement</th></tr>
<tr><td>0</td><td>hwid</td><td>H-coil wide-range constant output</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>1</td><td>lwid</td><td>L-coil wide-range constant output</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>2</td><td>hbsd</td><td>H-coil base slide</td><td>Invalid</td><td>Valid</td><td>Set in SP320</td></tr>
<tr><td>3</td><td>lbsd</td><td>L-coil base slide</td><td>Invalid</td><td>Valid</td><td>Set in SP384</td></tr>
</table></td><td>HEX setting</td></tr>
<tr><td>SP036</td><td>SFNC4</td><td>Spindle function 4
<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></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbr.</th><th>Content</th><th>0 setting</th><th>1 setting</th><th>Supplement</th></tr>
<tr><td></td><td>–</td><td>–</td><td>Valid</td><td>Invalid</td><td></td></tr>
<tr><td></td><td>–</td><td>–</td><td>Valid</td><td>Invalid</td><td></td></tr>
<tr><td></td><td>–</td><td>–</td><td>Valid</td><td>Invalid</td><td></td></tr>
<tr><td></td><td>–</td><td>–</td><td>Valid</td><td>Invalid</td><td></td></tr>
</table>
There are no settings.</td><td>HEX setting</td></tr>
</table>

<table>
<tr><th>Name</th><th>Abbr.</th><th>Details</th><th>TYP</th></tr>
<tr><td>SP037</td><td>SFNC5</td><td>Spindle function 5
<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>splg</td><td></td><td>osocl</td><td></td><td>nplgc</td><td>noplg</td><td>nsno</td><td>nosg</td><td></td><td></td><td></td><td></td><td></td><td>plgo</td><td>nsno</td><td>enco</td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbr.</th><th>Content</th><th>0 setting</th><th>1 setting</th><th>Supplement</th></tr>
<tr><td>0</td><td>enco</td><td>Encoder orientation</td><td>Invalid</td><td>Valid</td><td>Also output to CN8 when valid.</td></tr>
<tr><td>1</td><td>nsno</td><td>Magnetic sensor orientation</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>2</td><td>plgo</td><td>PLG orientation</td><td>Invalid</td><td>Valid</td><td>Also output to CN8 when valid.</td></tr>
<tr><td>8</td><td>nosg</td><td>No-signal detection</td><td>Always</td><td>Only during position loop orientation</td><td>From immediately after position detector power is turned ON</td></tr>
<tr><td>9</td><td>pl80</td><td>Special function</td><td>Invalid</td><td>Valid</td><td>Set to "0"</td></tr>
<tr><td>A</td><td>noplg</td><td>Constant monitor of Z-phase no-signal detection</td><td>Invalid</td><td>Valid</td><td>Motor built-in encoder</td></tr>
<tr><td>B</td><td>nplgc</td><td>AB-phase error detection</td><td>Valid</td><td>Invalid</td><td>Motor built-in encoder</td></tr>
<tr><td>D</td><td>ospcl</td><td>Orientation changeover speed limit value</td><td>Motor side</td><td>Spindle side</td><td></td></tr>
<tr><td>F</td><td>splg</td><td>Special function</td><td>Invalid</td><td>Valid</td><td>Set to "0"</td></tr>
</table>
</td><td>HEX setting</td></tr>
<tr><td>SP038</td><td>SFNC6</td><td>Spindle function 6
<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>open</td><td></td><td></td><td>XFzs</td><td>dcsn</td><td></td><td>P180</td><td>sdt2</td><td></td><td>orm</td><td>adin</td><td></td><td>plg2</td><td>pftm</td><td></td><td>alty</td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbr.</th><th>Content</th><th>0 setting</th><th>1 setting</th><th>Supplement</th></tr>
<tr><td>0</td><td>alty</td><td>Decelerate to stop at specific alarm occurrence</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>2</td><td>pftm</td><td>Encoder feedback serial communication</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>3</td><td>Plg2</td><td>Semi-closed pulse signal output 2-fold</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>5</td><td>adin</td><td>Special function</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>6</td><td>orm</td><td>Orientation start memo</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>8</td><td>sdt2</td><td>Special function</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>9</td><td>pl80</td><td>Special function</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>B</td><td>dcsn</td><td>Dual cushion valid range</td><td>Acceleration/deceleration</td><td>Deceleration</td><td></td></tr>
<tr><td>C</td><td>XFzs</td><td>Special function</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>F</td><td>open</td><td>Open loop operation</td><td>Invalid</td><td>Valid</td><td></td></tr>
</table>
</td><td>HEX setting</td></tr>
</table>

<table>
<tr><th>Name</th><th>Abbr.</th><th>Details</th><th>TYP</th></tr>
<tr><td>SP097</td><td>SPECO</td><td>Orientation specifications
<table>
<tr><th>F</th><th>E</th><th>D</th><th>C</th><th>B</th><th>A</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td></td><td></td><td>ksft</td><td>gcgh</td><td>tlmp</td><td>isp2</td><td>zdir</td><td>tlet</td><td>vg8x</td><td>mdir</td><td>fdir</td><td>ocsl</td><td>pyfx</td><td>dmin</td><td>odi2</td><td>odi1</td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbr.</th><th>Content</th><th>0 setting</th><th>1 setting</th><th>Supplement</th></tr>
<tr><td>0</td><td>odi1</td><td rowspan="2" colspan="3">Orientation rotation direction
00: Pre 01: Motor forward run direction
10: Motor reverse run 11: Setting not possible</td><td rowspan="2">Set with two bits 0 and 1 bit</td></tr>
<tr><td>1</td><td>odi2</td></tr>
<tr><td>2</td><td>dmin</td><td>Orientation position front loading</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>3</td><td>pyfx</td><td>Excitation during servo lock
min. (50%)
SP056/SP116 setting value</td><td>Invalid</td><td>Valid</td><td>Movable excitation rate during orientation stop</td></tr>
<tr><td>4</td><td>ocsl</td><td>Maximum speed clamp value</td><td>SP005</td><td>SP115</td><td>During indexing</td></tr>
<tr><td>5</td><td>fdir</td><td>Encoder detector polarity</td><td>+</td><td>–</td><td></td></tr>
<tr><td>6</td><td>mdir</td><td>Magnetic sensor installation polarity</td><td>+</td><td>–</td><td></td></tr>
<tr><td>7</td><td>vg8x</td><td>Special function</td><td>Invalid</td><td>Valid</td><td>Set "0".</td></tr>
<tr><td>8</td><td>tlet</td><td>Special function</td><td>Invalid</td><td>Valid</td><td>Set "0".</td></tr>
<tr><td>9</td><td>zdir</td><td>Special function</td><td>Invalid</td><td>Valid</td><td>Set "0".</td></tr>
<tr><td>A</td><td>isp2</td><td>Special function</td><td>Invalid</td><td>Valid</td><td>Set "0".</td></tr>
<tr><td>B</td><td>tlmp</td><td>Special function</td><td>Invalid</td><td>Valid</td><td>Set "0".</td></tr>
<tr><td>C</td><td>gcgh</td><td>Special function</td><td>Invalid</td><td>Valid</td><td>Set "0".</td></tr>
<tr><td>D</td><td>ksft</td><td>Special function</td><td>Invalid</td><td>Valid</td><td>Set "0".</td></tr>
</table>
Set all other bits to "0".</td><td>HEX setting</td></tr>
<tr><td>SP129</td><td>SPECC</td><td>C-axis control
<table>
<tr><th>F</th><th>E</th><th>D</th><th>C</th><th>B</th><th>A</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>zrtn</td><td>ptyp</td><td>fb9x</td><td>zrtd</td><td>zrn2</td><td></td><td></td><td></td><td>vg8x</td><td></td><td>fdir</td><td></td><td></td><td>rtrn</td><td>adin</td><td>fclx</td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbr.</th><th>Content</th><th>0 setting</th><th>1 setting</th><th>Supplement</th></tr>
<tr><td>0</td><td>fclx</td><td>Droop</td><td>Closed</td><td>Semi-closed</td><td></td></tr>
<tr><td>1</td><td>adin</td><td>Interpolation A/D compensation</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>2</td><td>rtrn</td><td>Special function</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>5</td><td>fdir</td><td>Position detection direction</td><td>Positive side</td><td>Negative side</td><td></td></tr>
<tr><td>7</td><td>vg8x</td><td>Speed gain during torque limit x 1/8</td><td>Valid</td><td>Invalid</td><td></td></tr>
<tr><td>B</td><td>zrn2</td><td>Special function</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>C</td><td>zrtd</td><td>Special function</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>D</td><td>fb9x</td><td>Pulse selection for speed control</td><td>Normal pulse</td><td>C-axis control pulse</td><td>During C-axis control</td></tr>
<tr><td>E</td><td>ptyp</td><td>Automatic zero point return operation</td><td>Available</td><td>Not available</td><td>During C-axis control</td></tr>
<tr><td>F</td><td>zrtn</td><td>Spindle rotation direction</td><td>Forward run</td><td>Reverse run</td><td>During automatic zero point return</td></tr>
</table></td><td>HEX setting</td></tr>
<tr><td>SP177</td><td>SPECS</td><td>Spindle synchronous control
<table>
<tr><th>F</th><th>E</th><th>D</th><th>C</th><th>B</th><th>A</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td></td><td></td><td>odx8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>fdir</td><td></td><td></td><td>rtrn</td><td>adin</td><td>fclx</td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbr.</th><th>Content</th><th>0 setting</th><th>1 setting</th><th>Supplement</th></tr>
<tr><td>0</td><td>fclx</td><td>Spindle synchronous control loop</td><td>Closed</td><td>Semi-closed</td><td></td></tr>
<tr><td>1</td><td>adin</td><td>Interpolation A/D compensation</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>2</td><td>rtrn</td><td>Special function</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>5</td><td>fdir</td><td>Spindle synchronous position detector polarity</td><td>(+)</td><td>(-)</td><td>Direction commanded from NC</td></tr>
<tr><td>D</td><td>odx8</td><td>Excessive error width (SP186)</td><td>1-fold</td><td>8-fold</td><td>Detection width enlarged</td></tr>
</table></td><td>HEX setting</td></tr>
</table>

<table>
<tr><th>Name</th><th>Abbr.</th><th>Details</th><th>TYP</th></tr>
<tr><td>SP193</td><td>SPECT</td><td>Synchronous tap control
<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>zrtn</td><td>ptyp</td><td>odx8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>fdir</td><td>cdir</td><td></td><td>rtrn</td><td>adin</td><td>fclx</td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbr.</th><th>Content</th><th>0 setting</th><th>1 setting</th><th>Supplement</th></tr>
<tr><td>0</td><td>fclx</td><td>Droop</td><td>Closed</td><td>Semi-closed</td><td rowspan="5">For [fdir] opposing

</td></tr>
<tr><td>1</td><td>adin</td><td>Interpolation A/D compensation</td><td>Invalid</td><td>Valid</td></tr>
<tr><td>2</td><td>rtrn</td><td>Special function</td><td>Invalid</td><td>Valid</td></tr>
<tr><td>4</td><td>cdir</td><td>Position command polarity</td><td>Forward run</td><td>Reverse run</td></tr>
<tr><td>5</td><td>fdir</td><td>Position detector polarity</td><td>(+) opposing</td><td>(-) correct position</td></tr>
<tr><td>D</td><td>odx8</td><td>Excessive error width (SP218)</td><td>1-fold</td><td>8-fold</td><td>During synchronous tap control</td></tr>
<tr><td>E</td><td>ptyp</td><td>Automatic zero point return operation</td><td>Available</td><td>Not available</td><td>During synchronous tap control</td></tr>
<tr><td>F</td><td>zrtn</td><td>Spindle rotation direction</td><td>Forward run</td><td>Reverse run</td><td>During zero point return</td></tr>
</table></td><td>HEX setting</td></tr>
</table>

4-3-3 Setting spindle drive unit and motor model

<table>
<tr><th>Name</th><th>Abbr.</th><th>Details</th><th>TYP</th></tr>
<tr><td>SP039</td><td>ATYP</td><td>Set the drive unit model.
<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"></td><td colspan="4"></td><td colspan="8">ATYP</td></tr>
</table>
<table>
<tr><th>Setting value</th><th colspan="2">Content</th><th>Setting value</th><th colspan="2">Content</th></tr>
<tr><td>00</td><td colspan="2">---</td><td>0A</td><td>CH-SP-220</td><td>22kW</td></tr>
<tr><td>01</td><td>CH-SP-075</td><td>0.75kW</td><td>0B</td><td>CH-SP-260</td><td>26kW</td></tr>
<tr><td>02</td><td>CH-SP-15</td><td>1.5kW</td><td>0C</td><td>CH-SP-300</td><td>30kW</td></tr>
<tr><td>03</td><td>CH-SP-22</td><td>2.2kW</td><td>0D</td><td>CH-SP-370</td><td>37kW</td></tr>
<tr><td>04</td><td>CH-SP-37</td><td>3.7kW</td><td>0E</td><td>CH-SP-450</td><td>45kW</td></tr>
<tr><td>05</td><td>CH-SP-55</td><td>5.5kW</td><td>0F</td><td>CH-SP-04</td><td>0.4kW</td></tr>
<tr><td>06</td><td>CH-SP-75</td><td>7.5kW</td><td>10</td><td>CH-SP-550</td><td>55kW</td></tr>
<tr><td>07</td><td>CH-SP-110</td><td>11kW</td><td>11</td><td>CH-SP-750</td><td>75kW</td></tr>
<tr><td>08</td><td>CH-SP-150</td><td>15kW</td><td></td><td colspan="2"></td></tr>
<tr><td>09</td><td>CH-SP-185</td><td>18.5kW</td><td></td><td colspan="2"></td></tr>
</table>
</td><td>HEX setting</td></tr>
<tr><td>SP040</td><td>MTYP</td><td>Set the motor being used. (Refer to the "List of spindle parameter settings", separately enclosed with the product.)
Note that this parameter is valid only when SP034 (SFNC2)-bit0 is set to "0".
<table>
<tr><th>Setting value</th><th>Motor model</th><th>Maximum speed (r/min)</th><th>Compatible drive unit model</th></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>
Set 0 for the CH Series.</td><td>HEX setting</td></tr>
<tr><td>SP041</td><td>PTYP</td><td>
<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 colspan="8">ptyp</td></tr>
</table>
ptyp Set the power supply type. (Only units with wiring to CN4 connector)
<table>
<tr><th>Setting value</th><th colspan="2">Content</th><th>Setting value</th><th colspan="2">Content</th></tr>
<tr><td>00</td><td colspan="2">With no power supply unit</td><td>22</td><td>CH-CV-220</td><td>22kW</td></tr>
<tr><td>04</td><td>CH-CV-37</td><td>3.7kW</td><td>26</td><td>CH-CV-260</td><td>26kW</td></tr>
<tr><td>06</td><td>CH-CV-55</td><td>5.5kW</td><td>30</td><td>CH-CV-300</td><td>30kW</td></tr>
<tr><td>08</td><td>CH-CV-75</td><td>7.5kW</td><td>37</td><td>CH-CV-370</td><td>37kW</td></tr>
<tr><td>11</td><td>CH-CV-110</td><td>11kW</td><td>45</td><td>CH-CV-450</td><td>45kW</td></tr>
<tr><td>15</td><td>CH-CV-150</td><td>15kW</td><td>55</td><td>CH-CV-550</td><td>55kW</td></tr>
<tr><td>19</td><td>CH-CV-185</td><td>18.5kW</td><td>75</td><td>CH-CV-750</td><td>75kW</td></tr>
</table>
When using an external emergency stop function (CN23 connector) of the power supply unit, set a value of the above setting values with "40" added.
Example) When using an external emergency stop in CH-CV-260,
setting value = 26 + 40 = 66

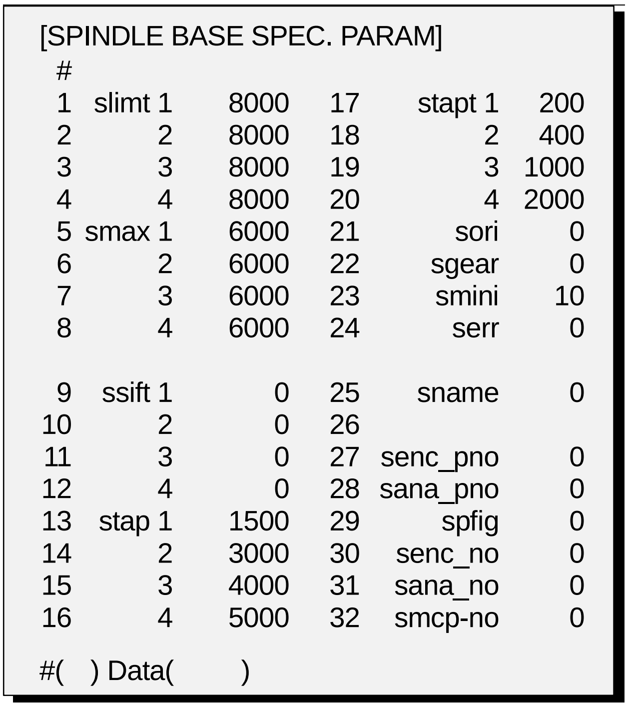
Set bit8 to "1" when connecting a unit higher than MDS-CH-SP[ ]-370.</td><td>HEX setting</td></tr>
</table>

4-3-4 Spindle specification parameters screen

The spindle parameters include parameters used with the spindle drive unit and on the NC side.

(1) The 384 parameters transferred from the NC to the spindle drive unit are the parameters transferred when the power is turned ON.

(2) Parameters used on NC side
The spindle specification parameters indicated in this section are the parameters used on the NC side.



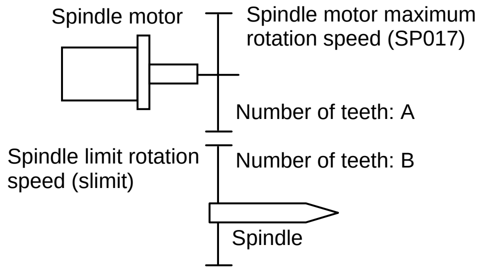
```
[SPINDLE BASE SPEC. PARAM]
  #
  1  slimt 1    8000   17      stapt 1   200
  2        2    8000   18            2   400
  3        3    8000   19            3  1000
  4        4    8000   20            4  2000
  5   smax 1    6000   21         sori     0
  6        2    6000   22        sgear     0
  7        3    6000   23        smini    10
  8        4    6000   24         serr     0

  9   ssift 1      0   25        sname     0
 10        2       0   26
 11        3       0   27     senc_pno     0
 12        4       0   28     sana_pno     0
 13   stap 1    1500   29        spfig     0
 14        2    3000   30      senc_no     0
 15        3    4000   31      sana_no     0
 16        4    5000   32      smcp-no     0

 #(   ) Data(        )
```

No.	Items		Details	Setting range (Unit)
1	slimt 1	Limit rotation speed Gear 00	Set spindle rotation speed for maximum motor rotation speed with gears 00, 01, 10, 11.	0 to 99999 (r/min)
2	slimt 2	Limit rotation speed Gear 01		
3	slimt 3	Limit rotation speed Gear 10		
4	slimt 4	Limit rotation speed Gear 11		
5	smax 1	Maximum rotation speed Gear 00	Set maximum spindle rotation speed with gears 00, 01, 10, 11. Set the value that equal to or larger than "slimit" value.	0 to 99999 (r/min)
6	smax 2	Maximum rotation speed Gear 01		
7	smax 3	Maximum rotation speed Gear 10		
8	smax 4	Maximum rotation speed Gear 11		
9	ssift 1	Shift rotation speed Gear 00	Set spindle rotation speed for gear shifting with gears 00, 01, 10, 11.	0 to 32767 (r/min)
10	ssift 2	Shift rotation speed Gear 01		
11	ssift 3	Shift rotation speed Gear 10		
12	ssift 4	Shift rotation speed Gear 11		
13	stap 1	Maximum tap rotation speed Gear 00	Set maximum spindle rotation speed during tap cycle with gears 00, 01, 10, 11.	0 to 99999 (r/min)
14	stap 2	Maximum tap rotation speed Gear 01		
15	stap 3	Maximum tap rotation speed Gear 10		
16	stap 4	Maximum tap rotation speed Gear 11		
17	stapt1	Tap time constant Gear 00	Set the time constant to the maximum tap speed during constant inclination tap cycle at gear 00, 01, 10, 11.	0 to 5000 (ms)
18	stapt2	Tap time constant Gear 01		
19	stapt3	Tap time constant Gear 10		
20	stapt4	Tap time constant Gear 11		
22	sgear	Encoder gear ratio	Set the gear ratio between the spindle and encoder.	0 : 1/1 1 : 1/2 2 : 1/4 3 : 1/8
23	smini	Minimum rotation speed	Set the spindle's minimum rotation speed. Even if an S command lower than this value is input, the spindle will continue rotating at this rotation speed.	0 to 32767 (r/min)

Limit rotation speed (slimit)

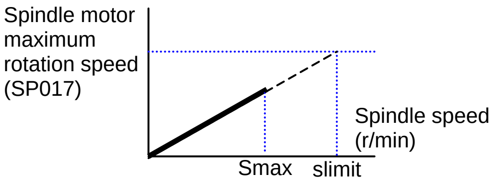
slimit sets the spindle's maximum rotation speed. Set a value obtained by multiplying the spindle motor's maximum rotation speed (SP017) with the gear ratio.
There are four slimit settings used for gear changeover.

Limit rotation speed = (SP017) × $\frac{A}{B}$



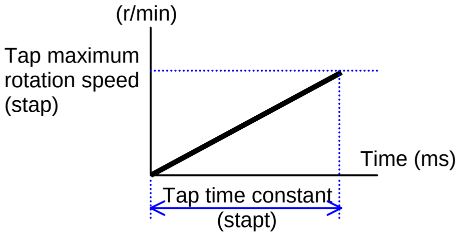
Maximum rotation speed (Smax)

Set this when the spindle's maximum rotation speed is to be limited to below the limit rotation speed (slimit) depending on the gear specifications or machine specifications, etc.
There are four Smax settings used for gear changeover.



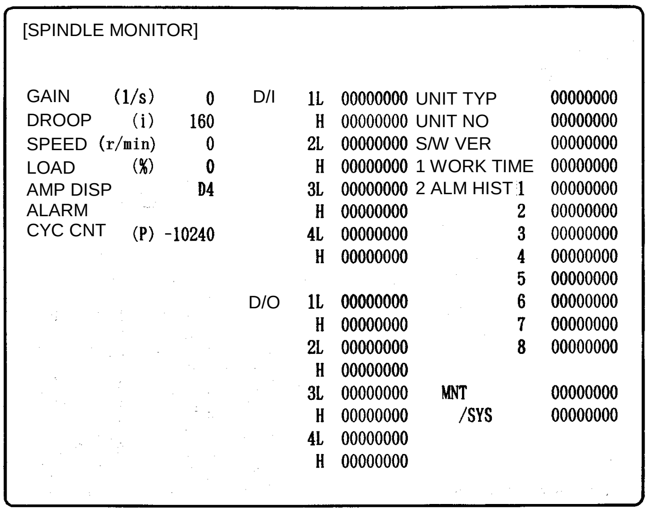
Tap maximum rotation speed (Stap)

Set the spindle's maximum rotation speed (stap) for the tap cycle. The relation of the tap maximum rotation speed and spindle tap time constant is shown on the right.



(2) Spindle monitor screen

The spindle drive unit status can be confirmed on the NC screen. An example is shown below. The screen configuration may differ depending on the NC, but the items are the same.



```
[SPINDLE MONITOR]

GAIN      (1/s)     0   D/I  1L 00000000 UNIT TYP     00000000
DROOP       (i)   160         H 00000000 UNIT NO      00000000
SPEED  (r/min)      0        2L 00000000 S/W VER      00000000
LOAD        (%)     0         H 00000000 1 WORK TIME  00000000
AMP DISP           D4        3L 00000000 2 ALM HIST 1 00000000
ALARM                         H 00000000            2 00000000
CYC CNT     (P) -10240       4L 00000000            3 00000000
                              H 00000000            4 00000000
                                                    5 00000000
                        D/O  1L 00000000            6 00000000
                              H 00000000            7 00000000
                             2L 00000000            8 00000000
                              H 00000000
                             3L 00000000   MNT        00000000
                              H 00000000     /SYS     00000000
                             4L 00000000
                              H 00000000
```

Item	Unit	Display details
GAIN	1/s	Displays the position loop gain when operating with the position command.
DROOP	pulse	Displays the position deviation amount when operating with the position command.
SPEED	r/min	The motor rotation speed is displayed.
LOAD	%	The motor load ratio (load) is displayed. The short-term rating is 100%. (30-minute rating for standard spindle motor.)
AMP DISP		The data of the 7-segment LED display for the spindle drive unit is displayed.
ALARM		The alarm No. is displayed when an alarm other than that displayed on the AMP DISP 7-segment LED.
CYC CNT		Displays the current position from the position detector's reference Z-phase when operating with the position command.
D/I 1L H		Control signal input 1 Displays the control input signal sent from the NC to the spindle drive unit.
D/I 2L H		Control signal input 2 Displays the control input signal sent from the NC to the spindle drive unit.
D/I 3L H		Control signal input 3 Displays the control input signal sent from the NC to the spindle drive unit.
D/I 4L H		Control signal input 4 Displays the control input signal sent from the NC to the spindle drive unit.
D/O 1L H		Control signal output 1 Displays the control input signal sent from the spindle drive unit to the NC.
D/O 2L H		Control signal output 2 Displays the control input signal sent from the spindle drive unit to the NC.
D/O 3L H		Control signal output 3 Displays the control input signal sent from the spindle drive unit to the NC.
D/O 4L H		Control signal output 4 Displays the control input signal sent from the spindle drive unit to the NC.
UNIT TYP		The spindle drive unit type is displayed.
UNIT NO		The spindle drive unit serial No. is displayed.
S/W VER		The software version in the spindle drive unit is displayed.
1 WORK TIME		The cumulative working time of the spindle drive unit is displayed.
2 ALM HIST 1~8		Displays the history of alarms occurring in the spindle drive. "1" indicates the alarm that occurred last.

Refer to section "4-3-5 Spindle control signals" for details on the control input and control output.

4-3-5 Spindle control signals

(1) Spindle control input

The control input signals are shown below. The corresponding control input bit changes from 0 to 1 while the command is received from the NC.

Note that some signals cannot be input depending on the NC specifications.

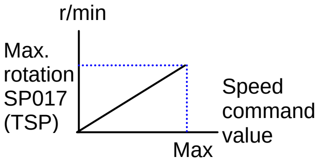
<table>
<tr><th>Name</th><th>Details</th></tr>
<tr><td>Control input 1</td><td>
<table>
<tr><td></td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>1L</td><td>ALMR</td><td>PRM</td><td></td><td></td><td></td><td></td><td>SRV</td><td>RDY</td></tr>
<tr><td></td><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td></tr>
<tr><td>1H</td><td>G1</td><td></td><td></td><td></td><td></td><td>TL3</td><td>TL2</td><td>TL1</td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbrev.</th><th>Details</th></tr>
<tr><td>0</td><td>RDY</td><td>Ready ON command</td></tr>
<tr><td>1</td><td>SRV</td><td>Servo ON command</td></tr>
<tr><td>6</td><td>PRM</td><td>Parameter conversion command</td></tr>
<tr><td>7</td><td>ALMR</td><td>Drive unit alarm reset command</td></tr>
<tr><td>8</td><td>TL1</td><td>Torque limit 1</td></tr>
<tr><td>9</td><td>TL2</td><td>Torque limit 2</td></tr>
<tr><td>A</td><td>TL3</td><td>Torque limit 3</td></tr>
<tr><td>F</td><td>G1</td><td>Cutting</td></tr>
</table>
</td></tr>
<tr><td>Control input 2</td><td>
<table>
<tr><td></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>1L</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td></tr>
<tr><td>1H</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
This signal is not used.
</td></tr>
<tr><td>Control input 3</td><td>
<table>
<tr><td></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>1L</td><td></td><td>GR2</td><td>GR1</td><td>SC5</td><td>SC4</td><td>SC3</td><td>SC2</td><td>SC1</td></tr>
<tr><td></td><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td></tr>
<tr><td>1H</td><td>PCGH</td><td></td><td>LCS</td><td>ORC</td><td>WRI</td><td>WRN</td><td>SRI</td><td>SRN</td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbrev.</th><th>Details</th></tr>
<tr><td>0</td><td>SC1</td><td>Spindle control mode selection command 1</td></tr>
<tr><td>1</td><td>SC2</td><td>Spindle control mode selection command 2</td></tr>
<tr><td>2</td><td>SC3</td><td>Spindle control mode selection command 3</td></tr>
<tr><td>3</td><td>SC4</td><td>Spindle control mode selection command 4</td></tr>
<tr><td>4</td><td>SC5</td><td>Spindle control mode selection command 5</td></tr>
<tr><td>5</td><td>GR1</td><td>Gear selection command 1</td></tr>
<tr><td>6</td><td>GR2</td><td>Gear selection command 2</td></tr>
<tr><td>8</td><td>SRN</td><td>Forward run start command</td></tr>
<tr><td>9</td><td>SRI</td><td>Reverse run start command</td></tr>
<tr><td>A</td><td>WRN</td><td>Index forward run command</td></tr>
<tr><td>B</td><td>WRI</td><td>Index reverse run command</td></tr>
<tr><td>C</td><td>ORC</td><td>Orientation start command</td></tr>
<tr><td>D</td><td>LCS</td><td>L coil selection command (When using coil changeover motor)</td></tr>
</table>
</td></tr>
<tr><td>Control input 4</td><td>
<table>
<tr><td></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>1L</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td></tr>
<tr><td>1H</td><td>TLUP</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbrev.</th><th>Details</th></tr>
<tr><td>F</td><td>TLUP</td><td>Spindle holding force up</td></tr>
</table>
</td></tr>
</table>

(2) Spindle control input signals

Each signal function and signal name for control input is shown below.

1) Speed command

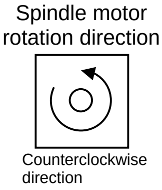
When the speed command value is "0", the motor speed will be "0". The motor's maximum speed is designated with SP017 (TSP) when the speed command value is the maximum.
The run command must also be input to rotate the motor.



2) Forward run start command (SRN)

This is the run command. The speed command must also be input to rotate the motor.

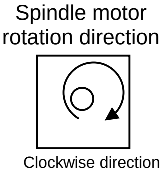
SRN	Explanation
1 (ON)	The motor rotates in the counterclockwise direction (CCW), looking from the shaft, according to the speed command.
0 (OFF)	The motor decelerates to a stop. The drive unit's power module is then turned OFF.
Orientation has a priority when the orientation command is input.	



3) Reverse run start command (SRI)

This is the run command. The speed command must also be input to rotate the motor.

SRI	Explanation
1 (ON)	The motor rotates in the clockwise direction (CW) according to the speed command.
0 (OFF)	The motor decelerates to a stop. The drive unit's power module is then turned OFF.
Orientation has a priority when the orientation command is input.	



4) Torque limit 1, 2, 3 (TL1, TL2, TL3)

Use this to temporarily decrease the spindle motor's output torque, such as when clamping the spindle motor on the machine side. Designate a percentage, using the motor's short-term rating as 100%, for the torque limit.
Set the SP021 and SP049 to 054 torque limit values with a combination of TL1 to 3.

TL3	TL2	TL1	Torque limit value	TL3	TL2	TL1	Torque limit value
0	0	1	SP021	1	0	1	SP052
0	1	0	SP049	1	1	0	SP053
0	1	1	SP050	1	1	1	SP054
1	0	0	SP051				

5) Orientation start command (ORC)

This signal starts orientation.

ORC	Explanation
1 (ON)	Orientation starts regardless of the run command (SRN, SRI).
0 (OFF)	When one of the run commands (SRN or SRI) is selected, the motor starts rotating at the commanded speed again.
Orientation has a priority when the orientation command is input.	

6) Gear selection command 1, 2 (GR1, GR2)

Select the number of spindle gear stages required to carry out orientation or various position control operations.

GR2	GR1	Gear ratio
0	0	SP025, 029
0	1	SP026, 030
1	0	SP027, 031
1	1	SP028, 032

⚠ **CAUTION** Do not change the gear selection command signal while the orientation command or servo command is input.

7) Index forward run command (WRN), reverse run command (WRI)

This command is valid while the orientation start signal is ON.

WRN	Explanation	WRI	Explanation
1 (ON)	Indexing starts in the counterclockwise direction (CCW) looking from the motor shaft side.	1 (ON)	Indexing starts in the clockwise direction (CW) looking from the motor shaft side.
0 (OFF)	Indexing is not carried out.	0 (OFF)	Indexing is not carried out.

8) L coil selection command (LCS)

This command is input to select the coil method when changing the coils.

LSC	Explanation
1 (ON)	Select low-speed coil.
0 (OFF)	Select high-speed coil.

9) READY ON command (MS)

This signal is input when the motor is ready to rotate. The forward run and reverse run start commands will not be accepted if input before this signal turns ON.

MS	Explanation
1 (ON)	Ready-ON
0 (OFF)	Ready-OFF

10) Cutting (G1)

This signal judges the cutting and non-cutting state during C-axis control.

G1	Explanation
1 (ON)	Judged as cutting.
0 (OFF)	Judged as not cutting.

11) Spindle control mode selection command 1, 2, 3, 4, 5 input (SC1, SC2, SC3, SC4, SC5)

The speed control mode is entered when the following bits are not selected.

SC5	SC4	SC3	SC2	SC1	Gear ratio	SC5	SC4	SC3	SC2	SC1	Gear ratio
0	1	0	0	0	Synchronous tap control mode	1	0	0	0	0	Spindle synchronous control mode
0	1	0	0	1		1	0	0	0	1	
0	1	0	1	0		1	0	0	1	0	
0	1	0	1	1		1	0	0	1	1	
0	1	1	0	0	C-axis control mode						
0	1	1	0	1							
0	1	1	1	0							
0	1	1	1	1							

12) Servo ON command (SRV)

This command is input for position control, excluding orientation. If this signal is not ON, position control will not start even if the position control mode is selected with the spindle control mode selection command combination.

G1	Explanation
1 (ON)	Servo ON
0 (OFF)	Servo OFF

(3) Spindle control output bit

The control signal outputs are shown below. The corresponding control output bit will change from 0 to 1 while the command is output from the spindle drive unit to the NC.

<table>
<tr><th>Name</th><th>Details</th></tr>
<tr><td>Control output 1</td><td>
<table>
<tr><th></th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>1L</td><td>ALM</td><td>PRMA</td><td></td><td>WRN</td><td></td><td></td><td>SON</td><td>RON</td></tr>
</table>
<table>
<tr><th></th><th>F</th><th>E</th><th>D</th><th>C</th><th>B</th><th>A</th><th>9</th><th>8</th></tr>
<tr><td>1H</td><td>CD</td><td>INP</td><td>ZFIN</td><td></td><td></td><td>TL3A</td><td>TL2A</td><td>TL1A</td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbrev.</th><th>Details</th></tr>
<tr><td>0</td><td>RON</td><td>In ready ON</td></tr>
<tr><td>1</td><td>SON</td><td>In servo ON</td></tr>
<tr><td>4</td><td>WRN</td><td>In drive unit warning</td></tr>
<tr><td>6</td><td>PRMA</td><td>In parameter conversion</td></tr>
<tr><td>7</td><td>ALM</td><td>In drive unit alarm</td></tr>
<tr><td>8</td><td>TL1A</td><td>Inputting torque limit 1 signal</td></tr>
<tr><td>9</td><td>TL2A</td><td>Inputting torque limit 2 signal</td></tr>
<tr><td>A</td><td>TL3A</td><td>Inputting torque limit 3 signal</td></tr>
<tr><td>D</td><td>ZFIN</td><td>Z-phase passed</td></tr>
<tr><td>E</td><td>INP</td><td>In position loop in-position</td></tr>
<tr><td>F</td><td>CL</td><td>Limiting current</td></tr>
</table>
</td></tr>
<tr><td>Control output 2</td><td>
<table>
<tr><th></th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>1L</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
<table>
<tr><th></th><th>F</th><th>E</th><th>D</th><th>C</th><th>B</th><th>A</th><th>9</th><th>8</th></tr>
<tr><td>1H</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
This signal is not used.
</td></tr>
<tr><td>Control output 3</td><td>
<table>
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<tr><td>1L</td><td></td><td>GR2A</td><td>GR1A</td><td>SC5A</td><td>SC4A</td><td>SC3A</td><td>SC2A</td><td>SC1A</td></tr>
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<table>
<tr><th></th><th>F</th><th>E</th><th>D</th><th>C</th><th>B</th><th>A</th><th>9</th><th>8</th></tr>
<tr><td>1H</td><td></td><td></td><td>LCSA</td><td>ORCA</td><td>WRIA</td><td>WRNA</td><td>SRIA</td><td>SRNA</td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbrev.</th><th>Details</th></tr>
<tr><td>0</td><td>SC1A</td><td>Inputting spindle control mode selection command 1 signal</td></tr>
<tr><td>1</td><td>SC2A</td><td>Inputting spindle control mode selection command 2 signal</td></tr>
<tr><td>2</td><td>SC3A</td><td>Inputting spindle control mode selection command 3 signal</td></tr>
<tr><td>3</td><td>SC4A</td><td>Inputting spindle control mode selection command 4 signal</td></tr>
<tr><td>4</td><td>SC5A</td><td>Inputting spindle control mode selection command 5 signal</td></tr>
<tr><td>5</td><td>GR1A</td><td>Inputting gear selection command 1 signal</td></tr>
<tr><td>6</td><td>GR2A</td><td>Inputting gear selection command 2 signal</td></tr>
<tr><td>8</td><td>SRNA</td><td>Motor in forward run</td></tr>
<tr><td>9</td><td>SRIA</td><td>Motor in reverse run</td></tr>
<tr><td>A</td><td>WRNA</td><td>In index forward run command</td></tr>
<tr><td>B</td><td>WRIA</td><td>In index reverse run command</td></tr>
<tr><td>C</td><td>ORCA</td><td>Inputting orientation start command signal</td></tr>
<tr><td>D</td><td>LCSA</td><td>Selecting L coil (when using coil changeover motor)</td></tr>
</table>
</td></tr>
<tr><td>Control output 4</td><td>
<table>
<tr><th></th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>1L</td><td>WRCF</td><td>MKC</td><td>SYSA</td><td>ORCF</td><td>ZS</td><td>US</td><td>SD</td><td>CD</td></tr>
</table>
<table>
<tr><th></th><th>F</th><th>E</th><th>D</th><th>C</th><th>B</th><th>A</th><th>9</th><th>8</th></tr>
<tr><td>1H</td><td></td><td>TLUA</td><td>ATA</td><td></td><td></td><td></td><td>SD2</td><td></td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbrev.</th><th>Details</th></tr>
<tr><td>0</td><td>CD</td><td>Current detection</td></tr>
<tr><td>1</td><td>SD</td><td>Speed detection 1</td></tr>
<tr><td>2</td><td>US</td><td>Speed reached</td></tr>
<tr><td>3</td><td>ZS</td><td>Zero speed</td></tr>
<tr><td>4</td><td>ORCF</td><td>Orientation completed</td></tr>
<tr><td>5</td><td>SYSA</td><td>Synchronous speed match</td></tr>
<tr><td>6</td><td>MKC</td><td>In coil changeover</td></tr>
<tr><td>7</td><td>WRCF</td><td>Index positioning completed</td></tr>
<tr><td>9</td><td>SD2</td><td>Speed detection 2</td></tr>
<tr><td>D</td><td>ATA</td><td>In automatic adjustment</td></tr>
<tr><td>E</td><td>TLUA</td><td>Spindle holding force increased</td></tr>
</table>
</td></tr>
</table>

(4) Spindle control output signals

Each signal function and signal name for control output is shown below.

<1> Orientation completed (ORCF)
  1) This signal turns ON when the orientation command is input and the spindle position has reached a set range (in-position range) in respect to the target stop position.
  2) This signal turns OFF when orientation is completed and the spindle position leaves the in-position range, and turns ON again when the spindle enters the in-position range again. When the orientation command turns OFF, this signal will turn OFF even if the spindle is in the in-position range.
  3) The in-position range can be set with parameter SP004 (OINP).

<2> Index positioning completed (WRCF)
  1) This signal turns ON during indexing when the spindle position has reached a set range (in-position range) in respect to the target stop position.
     Once this signal turns ON, it remains ON regardless of the spindle position until the orientation signal turns OFF or the next indexing signal is input.
     This signal will always turn OFF when the indexing signal is input even if the currently stopped position and next indexing position are within the in-position range. Minimum off period = 200ms (standard value)
  2) The minimum off period can be set with parameter SP103 (FTM).

<3> Inputting torque limit 1, 2, 3 signal (TL1A, TL2A, TL3A)
  1) This signal turns ON while the torque limit signal (1 to 3) is input.

<4> Motor in forward run (SRNA)
  1) This signal turns ON while the start signal is input and the motor is rotating in the CCW direction looking from the motor shaft.
  2) This signal may turn ON and OFF if the motor speed is several r/min or less.

<5> Motor in reverse run (SRIA)
  1) This signal turns ON while the start signal is input and the motor is rotating in the CW direction looking from the motor shaft.
  2) This signal may turn ON and OFF if the motor speed is several r/min or less.

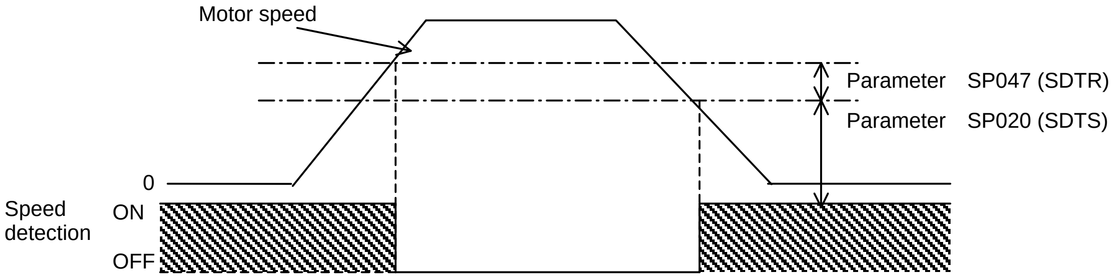
<6> In drive unit alarm (ALM)
  1) This signal turns ON while an alarm is occurring in the unit.

<7> In READY ON (RON)
  1) If there is no abnormality, this signal turns ON one second after the READY ON signal is input from the NC.
  2) The motor will start rotating if the start signal (forward run, reverse run, orientation) is turned ON while this signal is ON.
  3) This signal turns OFF if the READY ON signal is input from the NC, or if an alarm occurs.
  4) If the READY ON signal from the NC turns OFF while the spindle motor is rotating, the motor will decelerate to a stop. This signal will remain ON until the motor stops.

<8> Current detection (CD)
  1) This signal turns ON if the current flowing to the motor is approx. 110% or more of the rating while the start signal (forward run, reverse run, orientation) is ON.
     (The motor output (current) guarantee value is 120% of the rating.)

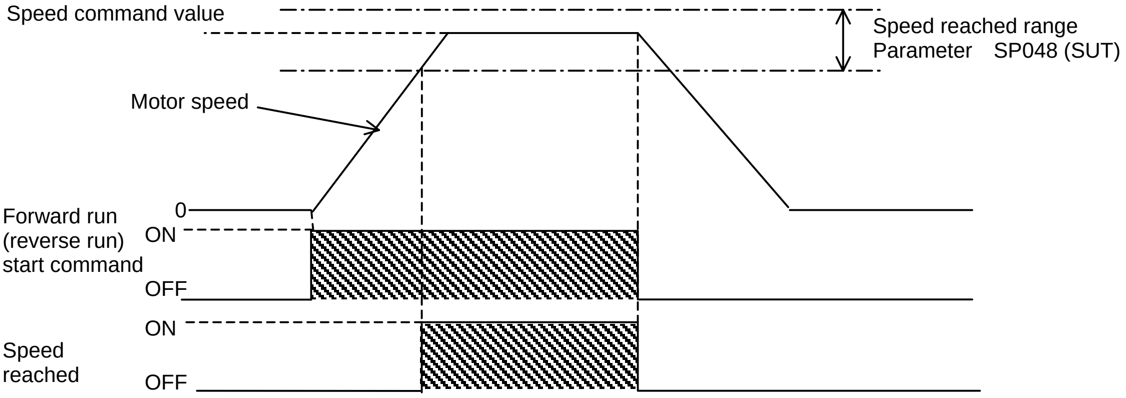
<9> Speed detection (SD)

1) This signal turns ON if the motor speed drops to below the value set in parameter SP020 (SDTS).
2) The ON to OFF hysteresis width is set with parameter SP047 (SDTR).
3) This signal turns ON when the motor speed drops below the set speed regardless of the input signal status.

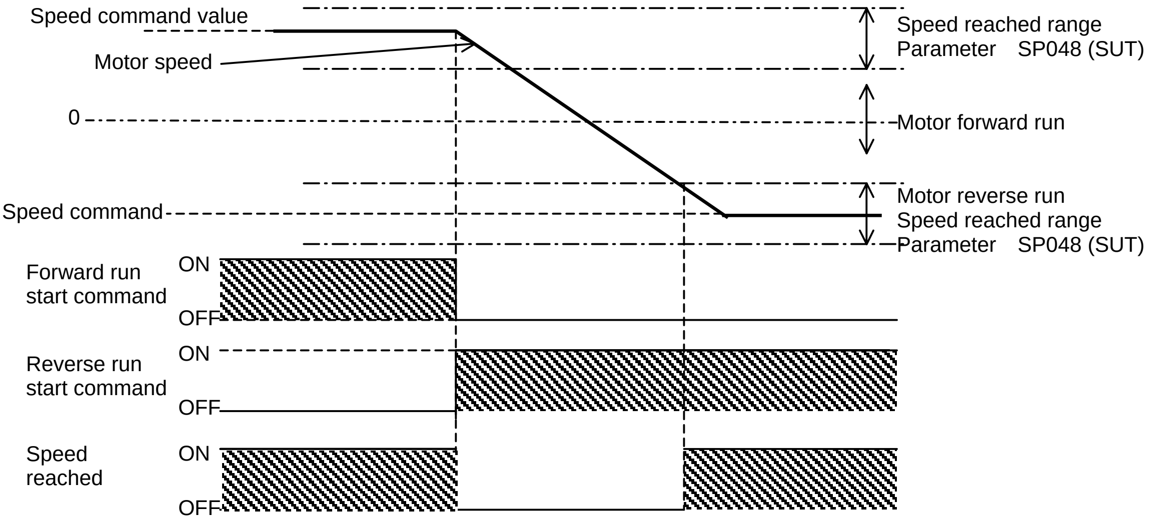


<10> Speed reached (US)

1) This signal turns ON when the start command signal (forward run, reverse run) turns ON and the motor speed reaches the ±15% (standard value) range of the speed command value.

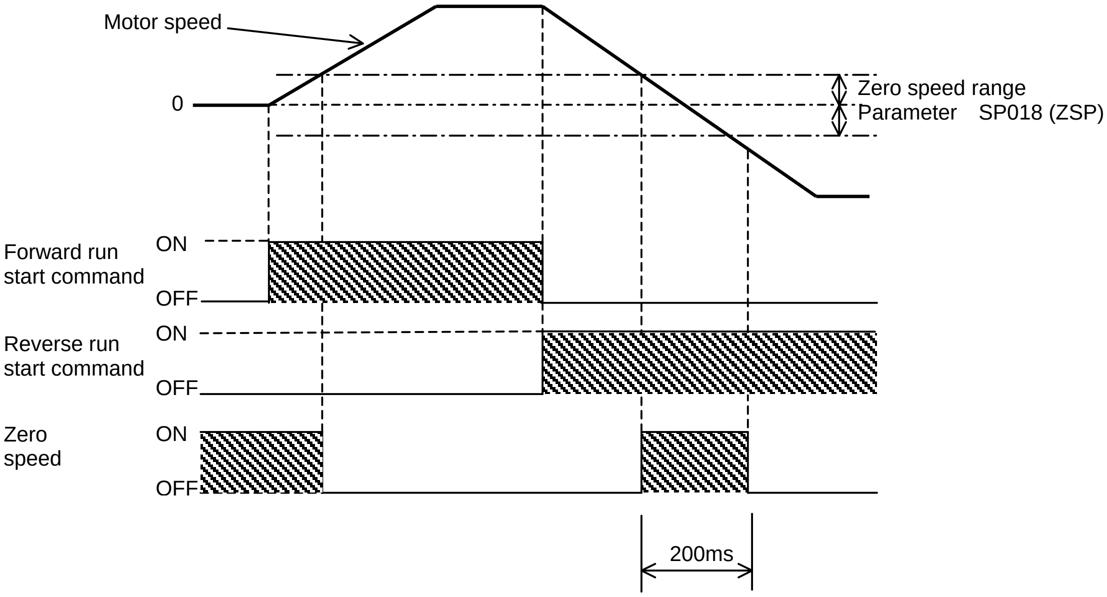


2) This signal turns OFF when the start command signal turns OFF.
3) If the forward run signal turns OFF and the reverse run signal turns ON during forward run, the signal will be output as shown below.
4) The speed reached range can be set with parameter SP048 (SUT).



<11> Zero speed (ZS)

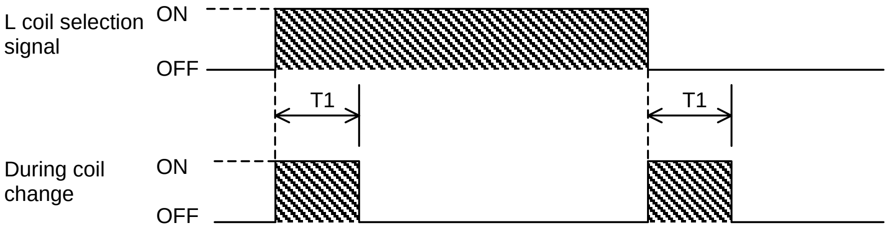
1) This signal turns ON when the motor speed drops below the speed set in parameter SP018 (ZSP) regardless of the input signal state.
2) Once this signal turns ON, it will not turn OFF for at least 200ms.
3) If the parameter SP018 (ZSP) setting value is too small (approx. 10r/min or less), the output may not turn ON even if the motor is stopped.



<12> Changing coil (MKC)

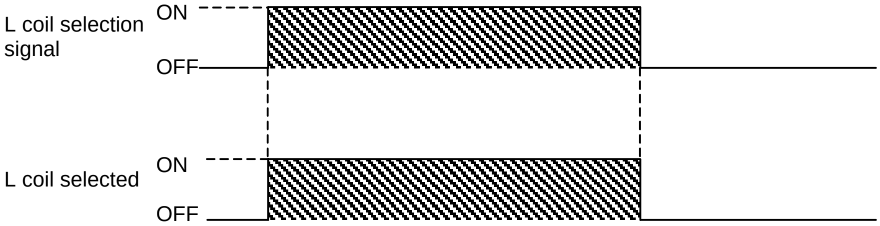
1) This signal turns ON for the time set in parameter SP059: MKT while the L coil selection signal is ON or OFF when using the coil changeover motor.
2) The coil is not changed while the orientation command is input, so this signal will not turn ON even if the L coil selection signal turns ON or OFF. In this case, the coil will be changed after the orientation command turns OFF. This signal will turn ON at that time.

<u>Do not turn the start command ON or OFF while this signal is ON.</u>



<13> Changing L coil selection (LCSA)

1) This signal turns ON while the L coil is selected for the coil changing motor.
2) This signal turns ON when the L coil selection signal is ON, and stays ON until the L coil selection signal turns OFF.
3) The coil will not change when the orientation command is input, so this signal will not turn ON even if the L coil selection signal turns ON. In this case, the coil will be changed after the orientation command turns OFF. This signal will turn ON at that time.



<14> In orientation start command signal (ORCA)

1) This signal turns ON while the orientation start command (ORC) is input to the spindle drive unit.

<15> Inputting gear selection 1, 2, signal (GR1A, GR2A)

1) The corresponding output signal turns ON while the gear selection 1, 2 (GR1, GR2) is input to the spindle drive unit.

<16> In forward run indexing (WRNA), in reverse run indexing (WRIA)

1) The corresponding output signal turns ON while forward run indexing (WRN) or reverse run indexing (WRI) is input to the spindle drive unit.

<17> Synchronization speed match (SYSA)

1) During spindle synchronous control, this signal turns ON when the control changes from speed control to spindle synchronous control.

<18> In drive unit warning (WRN)

1) This signal turns ON when a warning is occurring in the spindle drive unit.

<19> Z-phase passed (ZFIN)

1) This signal turns ON when the Z-phase is passed for the first time after servo ON in position control.

<20> In servo ON (SON)

1) This signal turns ON after the servo ON signal (SRV) is input from the NC and the loop changes from the speed loop to the position loop.

<21> In position loop in-position (INP)

1) This signal turns ON when the spindle position is in the rang set with SP153 (CINP) during C-axis control, SP185 (SINP) during spindle synchronous control, or SP217 (TINP) during synchronous tap control.

<22> In spindle control mode selection command 1, 2, 3, 4, 5 signal input (SC1A, SC2A, SC3A, SC4A, SC5A)

1) The corresponding output signal turns ON when the spindle control mode selection command 1, 2, 3, 4, 5 (SC1, SC2, SC3, SC4, SC5) is input.

<23> Spindle holding force increased (TLUA)

1) This signal turns ON while the spindle holding force up (TLUP) signal is input.

<24> Limiting current (CL)

1) This signal turns ON when a load exceeding the spindle's overload withstand level is applied during spindle motor rotation. This may also turn ON during motor acceleration/deceleration.

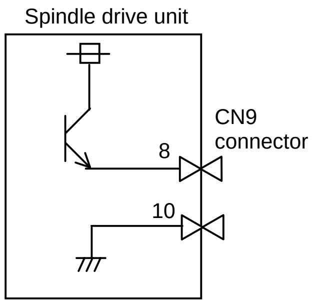
(5) Input/output interface

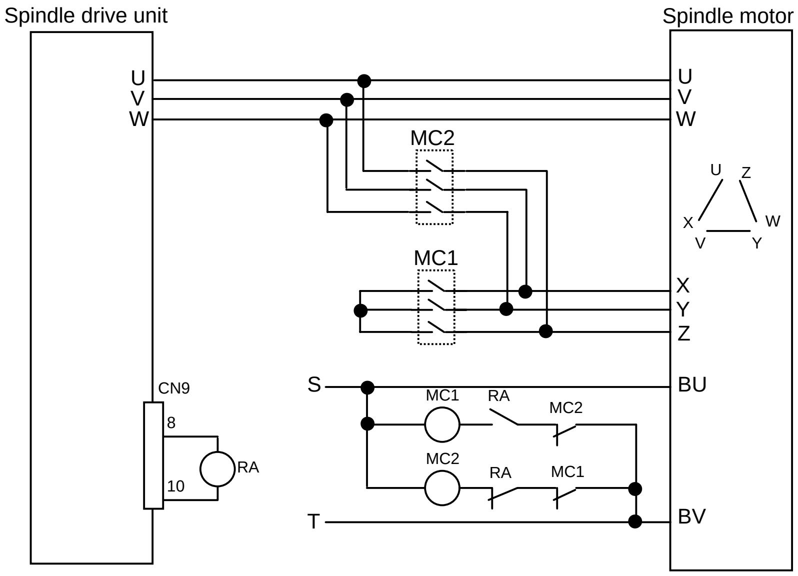
The spindle drive unit has a general-purpose input/output interface.

Output interface

The signals required for coil changeover can be output.
To output the coil changeover signal to the CN9 connector's pin 8, set SP034 (SFC2) bit2 (mkch) to "1".
The signal will be output if the L coil is designated for the control signal input.

Tolerable voltage	24VDC or less
Tolerable current	50mA or less





Coil changeover wiring diagram

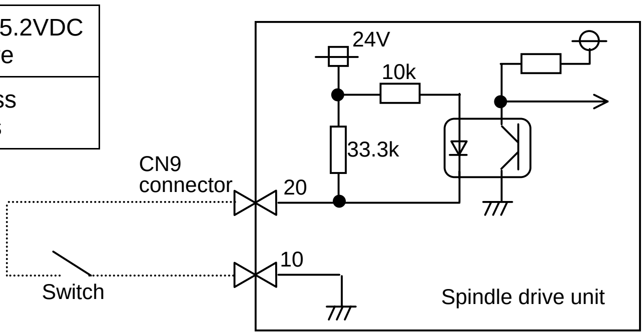
Low-speed coil selection : Y connection (MC1 ON, MC2 OFF)
High-speed coil selection : △ connection (MC1 OFF, MC2 ON)

Use the contactors recommended in section "7-2-3 Selecting the contactor" for the MC1 and MC2 contactors.
Refer to section "5-8-1(4) Coil changeover contactor (magnetic contact)".

Input interface

A trigger is input to shift to the speed monitor mode. (Protective door open/close information, etc.) The spindle drive unit monitors the spindle motor's speed at this time. (Function to monitor whether spindle motor is below limit speed together with corresponding NC.) This function monitors the spindle monitor speed limit value designated with SP223 (SPDV) and the error speed detection time designated with SP224 (SPDF). The 5E alarm occurs when an error is detected.
(This is not supported with the MDS-CH Series drive unit.)

External contact ON conditions	18VDC to 25.2VDC 9mA or more
External contact OFF conditions	4VDC or less 2mA or less



5. Adjustment

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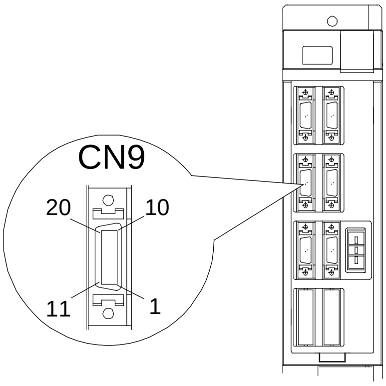
5-1 Servo adjustment data output function (D/A output)

The MDS-CH-V1/V2 servo drive unit has a function to D/A output the various control data.
The servo adjustment data required for setting the servo parameters to match the machine can be D/A output. Measure using a hi-coder, synchroscope, etc.

5-1-1 D/A output specifications

Item	Explanation
No. of channels	2ch
Output cycle	888µs
Output precision	8bit
Output voltage range	0 to +5V
Output magnification setting	±1/256 to ±128-fold
Output pins	CN9 connector Channel 1 = Pin 9 Channel 2 = Pin 19 GND = Pins 1, 11



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. (When "-1" is set, the D/A output for that channel will be invalid.) (When using the 2-axis integrated unit, set the D/A output for the axis not to be measured to invalid (-1).)
SV062	DA2NO	D/A output channel 2 data No.	

No.	CH1 output data	Standard output unit	Output magnification standard setting value (SV063, SV064)	Output unit for standard setting	Output cycle
-1	D/A output not selected				
0	CH1: Speed feedback	r/min	13 (2000 r/min)	1000 r/min / V	3.5ms
			9 (3000 r/min)	1500 r/min / V	3.5ms
	CH2: Current command	Rated (stall) current %	131	Stall 100% / V	3.5ms
1	Current command	Rated (stall) current %	131	Stall 100% / V	3.5ms
2	Current command	Rated (stall) current %			
3	Current feedback	Rated (stall) current %	131	Stall 100% / V	3.5ms
6	Position droop low-order	Interpolation unit	328 (Display unit: 1µm)	10µm / 0.5V	3.5ms
7	–	–	–		
8	Position FΔT low-order	Interpolation unit/ NC communication cycle	55 (1µm, 3.5ms)	1000mm/min / 0.5V	3.5ms
9	–	–	–		
10	Position command low-order	Interpolation unit	328 (Display unit: 1µm)	10µm / 0.5V	3.5ms
11	–	–	–		
12	Feedback position low-order	Interpolation unit	328 (Display unit: 1µm)	10µm / 0.5V	3.5ms
13	–	–	–		
125	Test output saw tooth wave	0 to +5V	0 or 256	Cycle: 227.5ms	0.8ms
126	Test output oblong wave	0 to +5V	0 or 256	Cycle: 1.7ms	0.8ms
127	Test output 2.5V (data 0)		0 or 256	–	0.8ms

* Interpolation unit
This is the NC internal unit. The command unit (input unit) will be as shown on the right.

Command unit	Interpolation unit
10µm	5µm
1µm	0.5µm
0.1µm	0.05µm

5-1-3 Setting the output magnification

No.	Abbrev.	Parameter name	Explanation	Setting range
SV063	DA1MPY	D/A output channel 1 output magnification	The magnification is set with a 1/256 unit. When 256 is set, the magnification will be 1.	–32768 to 32767
SV064	DA2MPY	D/A output channel 2 output magnification		

Analog output voltage = {(Output data value) × (Setting value of SV063 or SV064) × 76.3/1,000,000} + 2.5V

5-2 Gain adjustment

5-2-1 Current loop gain

No.	Abbrev.	Parameter name	Explanation	Setting range
SV009	IQA	Current loop q axis leading 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 to 20480
SV010	IDA	Current loop d axis leading compensation		1 to 20480
SV011	IQG	Current loop q axis gain		1 to 8192
SV012	IDG	Current loop d axis gain		1 to 8192

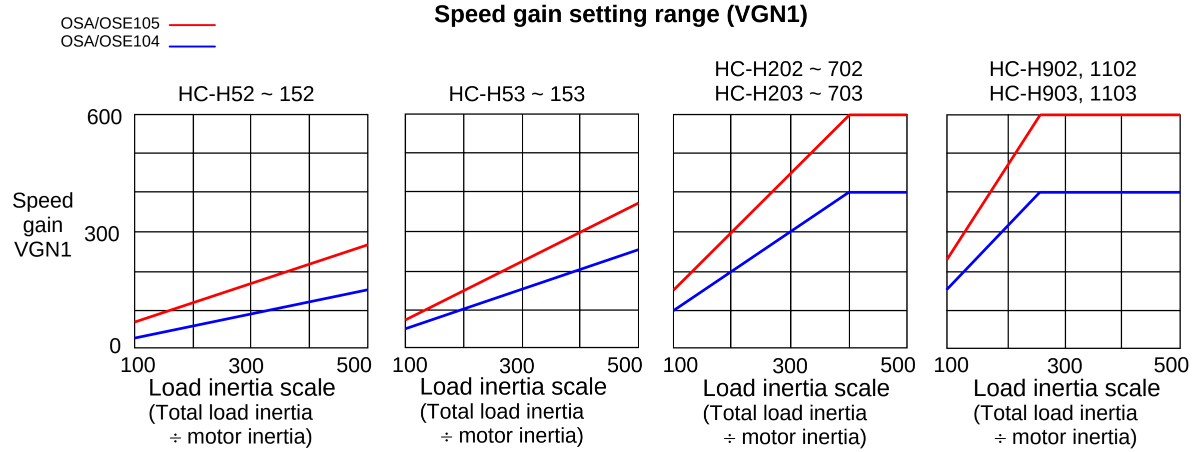
5-2-2 Speed loop gain

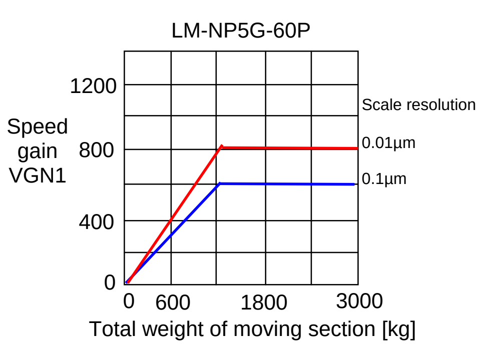
(1) Setting the speed loop gain

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.

1) Refer to the following table and set the standard VGN1 according to the size of the entire load inertia (motor and machine load inertia).
2) If the standard speed gain setting value is exceeded, the current command fluctuation will increase even if the speed feedback fluctuates by one pulse. This can cause the machine to vibrate easily, so set a lower value to increase the machine stability.

Speed gain setting range (VGN1)





POINT

The final VGN1 setting value is 70 to 80% of the maximum value at which the machine does not resonate.
Suppressing the resonance with the vibration suppression function and increasing the VGN1 setting is effective for adjusting the servo later.

<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, VGN1 can be raised above the standard value as long as a 70 percent margin in respect to the machine resonance occurrence limit is maintained. The cutting accuracy can also be improved by adjusting with the disturbance observer.

<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.

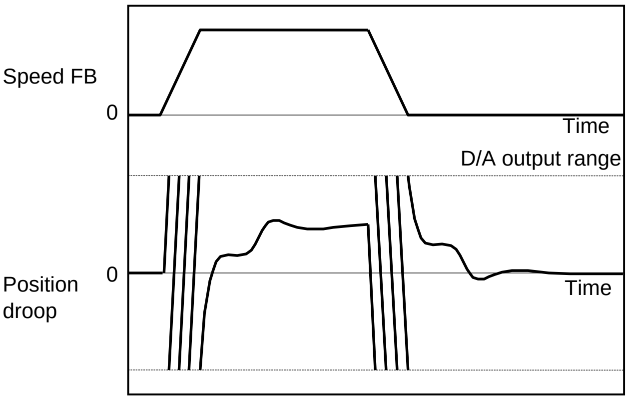
No.	Abbrev.	Parameter name	Explanation	Setting range
SV005	VGN1	Speed loop gain	Set this according to the load inertia size. If vibration occurs, adjust by lowering the setting by 20% to 30% at a time.	1 to 10000

(2) Setting the speed loop leading compensation

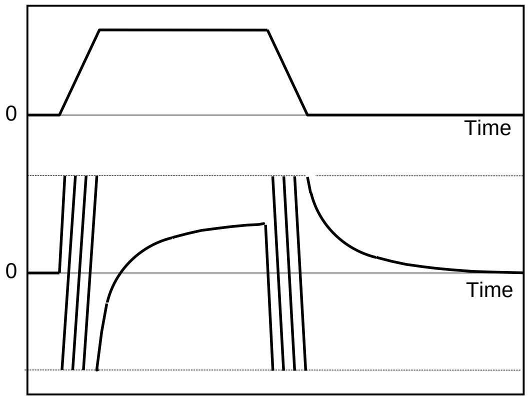
The speed loop leading compensation (SV008 (VIA)) determines the characteristics of the speed loop mainly at low frequency regions. 1364 is set as a standard, and 1900 is set as a standard during SHG control. The standard value may drop in respect to loads with a large inertia.

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 or 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 in respect to the position commands becomes worse, the positioning time and accuracy 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). 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 leading 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 to 9999 (0.0687rad/s)

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 trackability will be raised and 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 in the position loop occurs generally 10Hz or less. (The VIA vibration occurs from 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 that 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 to 400 (rad/s)
SV004	PGN2	Position loop gain 2	Set 0. (For SHG control)	0 to 999
SV057	SHGC	SHG control gain	Set 0. (For SHG control)	0 to 1200

⚠ CAUTION Always set the same value for the position loop gain between the 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 during spindle synchronization	Set 15 as a standard.	Set the same parameter as the position loop gain for the spindle synchronous control.	1 to 200 (rad/s)
SV050	PGN2sp	Position loop gain 2 during spindle synchronization	Set 0 as a standard. (For SHG control)		0 to 999
SV058	SHGCsp	SHG control gain during spindle synchronization	Set 0 as a standard. (For SHG control)		0 to 1200

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

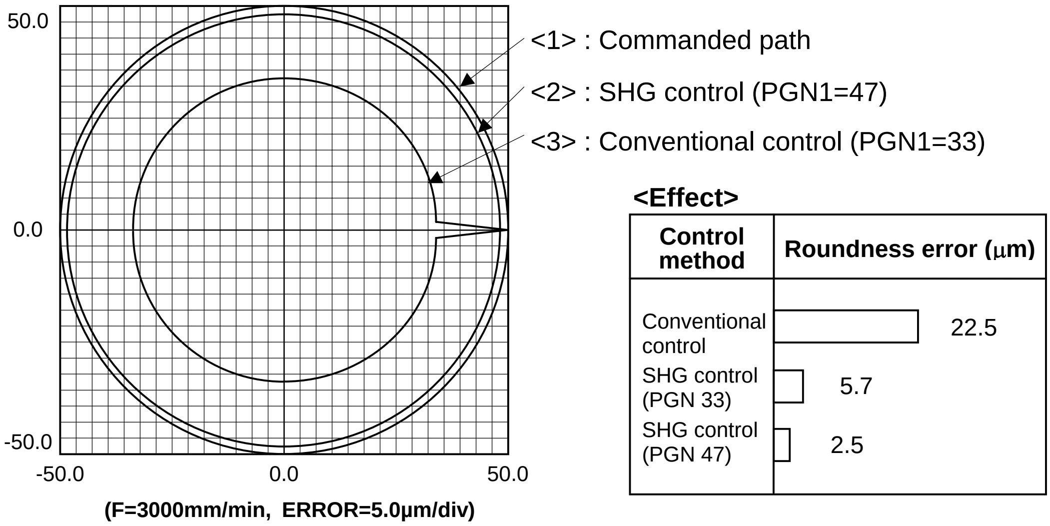
(3) SHG control (option function)

If the position loop gain is increased or feed forward control (NC 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. (SHG: Smooth High-Gain)

(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.



Shape error characteristics

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

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

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	60	70	80	90	100	1 to 400
SV004 (SV050)	PGN2 (PGN2sp)	Position loop gain 2	$\frac{8}{3}$	62	70	86	102	125	160	186	213	240	266	0 to 999
SV057 (SV058)	SHGC (SHGCsp)	SHG control gain	6	140	160	187	225	281	360	420	480	540	600	0 to 1200
SV008	VIA	Speed loop leading compensation	Set 1900 as a standard for SHG control.											1 to 9999
SV015	FFC	Acceleration feed forward gain	Set 100 as a standard for SHG control.											0 to 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/M60 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.

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

(1) Adjusting the rapid traverse acceleration/deceleration time constants

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.

If the drive unit's input voltage is less than the rated voltage, the torque will easily become insufficient, and excessive errors will occur easily during acceleration/deceleration.

(2) Adjusting the cutting feed acceleration/deceleration time constants

To adjust the cutting rate, the NC 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 to 90% or less (refer to following table).
- 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 FΔT 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.

2000r/min HC-H Series		3000r/min HC-H Series	
Motor model	**Max. current command value**	**Motor model**	**Max. current command value**
(HC-H52)	(385% or less)	(HC-H53)	(289% or less)
(HC-H102)	(353% or less)	HC-H103	276% or less
HC-H152	498% or less	HC-H153	351% or less
HC-H202	340% or less	HC-H203	318% or less
HC-H352	263% or less	HC-H353	243% or less
HC-H452	272% or less	HC-H453	243% or less
HC-H702	283% or less	HC-H703	194% or less
HC-H902	217% or less	HC-H903	219% or less
HC-H1102	200% or less	HC-H1103	187% or less

Natural cooling		Oil cooled	
Motor model	**Max. current command value**	**Motor model**	**Max. current command value**
LM-NP5G-60P	658% or less	LM-NP5G-60P	273% or less

(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.
Set the precision required for the machine as the in-position width. If a high precision is set needlessly, the cycle time will increase due to a delay in the settling time.
The in-position width is validated with the servo parameter settings, but there may be cases when the NC parameters must also be set. Refer to each NC Instruction Manual.

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 to 32767

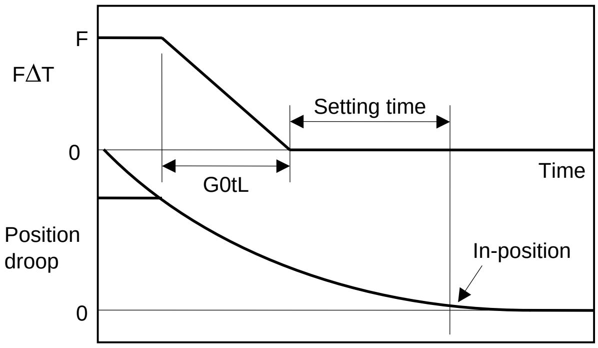
POINT The in-position width setting and confirmation availability depend on the CNC parameters.

(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 (FΔT) from the CNC reaches 0.

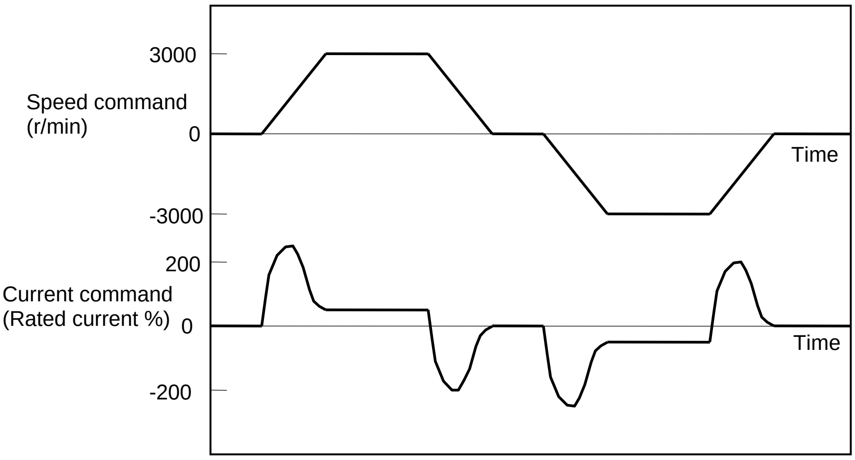
The settling time can be shortened by raising the position loop gain or using SHG control. However, a sufficient response (sufficiently large VGN1 setting) for the speed loop is required to carry out stable control.

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 $\sqrt{2}$.



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

PGN1 : Position loop gain1 (SV003) (rad/s)
F : Rapid traverse rate (mm/min)
G0tL : Rapid traverse linear acceleration/ deceleration time constant (ms)
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.

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

N_O : Motor reach speed (r/min)
J_L : Motor shaft conversion load inertia ($\times 10^{-4}$ kg·m^2)
J_M : Motor inertia ($\times 10^{-4}$ kg·m^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/s)
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.

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

(1) Machine resonance suppression filter

The machine resonance suppression 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 500Hz. For resonance exceeding 500Hz, directly measure the phase current with a current probe, etc. (Refer to next page.)

When the machine resonance suppression 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 machine resonance suppression 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 machine resonance suppression filter frequency (SV038 (FHz1), SV046 (FHz2)).
2. If the machine starts to vibrate at another frequency, raise (make shallower) the machine resonance suppression 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 machine resonance suppression filter.

No.	Abbrev.	Parameter name	Unit	Explanation	Setting range
SV038	FHz1	Machine resonance suppression filter frequency 1	Hz	Set the resonance frequency to be suppressed. (Valid at 36 or more). Set 0 when the filter is not to be used.	0 to 9000 (Hz)
SV046	FHz2	Machine resonance suppression filter frequency 2	Hz	Set the resonance frequency to be suppressed. (Valid at 36 or more). Set 0 when the filter is not to be used.	0 to 9000 (Hz)

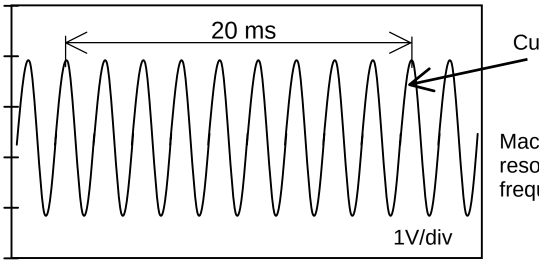
<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range (Unit)</th></tr>
<tr><td>SV033</td><td>SSF2</td><td>Servo function selection 2</td><td>
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="4">dos</td><td></td><td></td><td>hvx</td><td>svx</td><td colspan="3">nfd2</td><td>nf3</td><td colspan="3">nfd1</td><td>zck</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>zck</td><td>Z phase check valid (Alarm 42)</td><td>Z phase check invalid</td></tr>
<tr><td>1
2
3</td><td>nfd1</td><td colspan="2">Set the filter depth for Notch filter 1 (SV038).
<table>
<tr><td>Value</td><td>000</td><td>001</td><td>010</td><td>011</td><td>100</td><td>101</td><td>110</td><td>111</td></tr>
<tr><td>Depth (dB)</td><td>Infntly deep</td><td>-18.1</td><td>-12.0</td><td>-8.5</td><td>-6.0</td><td>-4.1</td><td>-2.5</td><td>-1.2</td></tr>
</table>
Deep← Shallow→</td></tr>
<tr><td>4</td><td>nf3</td><td>Notch filter 3 stop</td><td>Notch filter 3 start (1125Hz)</td></tr>
<tr><td>5
6
7</td><td>nfd2</td><td colspan="2">Set the filter depth of Notch filter 2 (SV046).
<table>
<tr><td>Value</td><td>000</td><td>001</td><td>010</td><td>011</td><td>100</td><td>101</td><td>110</td><td>111</td></tr>
<tr><td>Depth (dB)</td><td>Infntly deep</td><td>-18.1</td><td>-12.0</td><td>-8.5</td><td>-6.0</td><td>-4.1</td><td>-2.5</td><td>-1.2</td></tr>
</table>
Deep← Shallow→</td></tr>
<tr><td>8</td><td></td><td colspan="2">Set "0".</td></tr>
<tr><td>9</td><td></td><td colspan="2">Set "0".</td></tr>
<tr><td>A</td><td></td><td colspan="2">Set "0".</td></tr>
<tr><td>B</td><td></td><td colspan="2">Set "0".</td></tr>
<tr><td>C
D
E
F</td><td>dos</td><td colspan="2">Digital signal output selection
0000: MP scale absolute position detection, offset demand signal output
0001: Specified speed signal output
0010 to 1111: Setting prohibited</td></tr>
</table>
</td><td>HEX setting</td></tr>
</table>

Measuring the phase current

Direct observation

The phase current is output to the CN9 pin. Connect a hi-corder between the GND (pin 1, 11) and the phase current to be measured, and observe the state.

7: L axis U-phase current FB
17: L axis V-phase current FB
6: M axis U-phase current FB
16: M axis V-phase current FB



Current feedback: 9 crests

⇩

$$\text{Machine resonance frequency} = \frac{9 \text{ cycles}}{20 \times 10^{-3} \text{ s}} = 450 \text{ Hz}$$

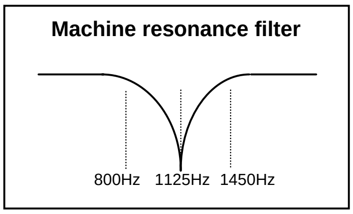
Set the speed loop gain (SV005: VGN1) to approx. 50 to 100, disconnect the resonance filter, and measure the waveform while the axis is stopped.

<Setting the machine resonance filter frequency when resonance cannot be eliminated>

This function is compatible with the MDS-CH-V1/V2 Series' machine resonance suppression filter (SV038: FHz1, SV046: FHz2). Some machines have three or more machine resonance points and the resonance cannot be eliminated. Try the following methods in this case.

1) When there are three machine resonance points including one exceeding 800Hz

When the 3rd machine resonance filter is set (SV033: nfd3), the resonance filter is applied at 1125Hz, and the machine may not resonate at 800Hz or more. Then, remove the remaining two machine resonances with the 1st and 2nd machine resonance suppression filters.
If the machine resonance cannot be eliminated even by setting the 1st and 2nd machine resonance suppression filter frequencies, it may be possible to suppress the machine resonance by additionally setting the 3rd machine resonance suppression filter.


Machine resonance filter

[Example] If the machine resonance is approx. 1100Hz and high, validate the 3rd machine resonance suppression filter. Then, adjust the machine resonance suppression filters (SV038: FHz1, SV046: FHz2).

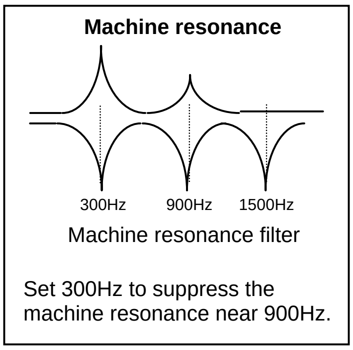
2) When there are three or more machine resonance points 1

Eliminate as much of the machine resonance as possible with the 1st and 2nd machine resonance filters. It may then be possible to eliminate the machine resonance by increasing the adaptive filter sensitivity (SV027: afse).

3) When there are three or more machine resonance points 2

With the MDS-CH-V1/V2 Series machine resonance suppression filter, the filter is also applied at the odd-fold of the set frequency. If one machine resonance is near the odd-fold of another machine resonance, set the machine resonance suppression filter frequency to the lower resonance, and try changing it by approx. 10 to 20Hz. It may be possible to eliminate two machine resonances by setting the most effective value.

[Example] If the machine resonates at 300Hz and 900Hz, both machine resonances can be eliminated by setting 300Hz.


Machine resonance

Set 300Hz to suppress the machine resonance near 900Hz.

4) When machine resonance does not change even when machine resonance filter is set

Only the frequency calculated with the following expression can be set with the MDS-CH-V1/V2 Series machine resonance suppression filter. If the set frequency is not available, set a frequency that is 1 part of the odd amount (1/3, etc.). It may be possible to eliminate the machine resonance.

Machine resonance frequency setting range (Hz) = 9000/N (N = 4 to 128)

[Example] To set 1400Hz, setting 470Hz may be just as effective.

(2) Jitter compensation

The load inertia becomes much smaller than usual 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 can suppress the vibration that occurs at the motor stop 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 jitter compensation is set to an axis that is not vibrating is set, vibration could be induced, so take care.

No.	Abbrev.	Parameter name	Explanation
SV027	SSF1	Special 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	afrg	afse	ovs2	ovs1	lmc2	lmc1	omr		**vfct2**	**vfct1**		upc	vcnt2	vcnt1

bit		No jitter compensation	One pulse compensation	Two pulse compensation	Three pulse compensation
4	vfct1	0	1	0	1
5	vfct2	0	0	1	1

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

(3) Adaptive filter (option function)

The servo drive unit 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 special servo function selection 1 (SV027 (SSF1)) bit F to activate the adaptive filter.

If the adaptive filter's sensitivity is low, and the machine resonance cannot be suppressed, set (SV027 (SSF1)) bits 12 and 13.

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

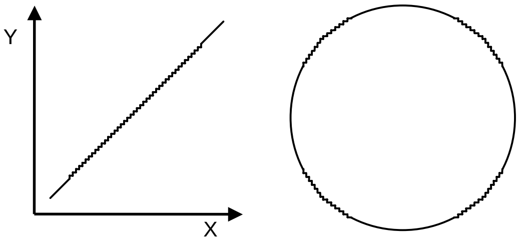
F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
aflt	zrn2	**afrg**	**afse**	ovs2	ovs1	lmc2	lmc1	omr		vfct2	vfct1		upc	vcnt2	vcnt1

bit		Meaning when "0" is set	Meaning when "1" is set
F	aflt	Adaptive filter stopped	Adaptive filter activated
D	afrg	00: Normal adaptive filter sensitivity	11: Increased adaptive filter sensitivity
C	afse		

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/M60 Series CNC) will be output.

5-3-3 Improving the cutting surface precision

If the cutting surface precision or roundness is poor, these can be improved by increasing the speed loop gain (VGN1, VIA) or by using the 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 high-speed 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 10 to 20% 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 to 999
SV008	VIA	Speed loop leading 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 to 9999 (0.0687rad/s)

(3) 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 1 (SV043 (OBS1)), and estimate the high frequency disturbance to suppress the vibration. Set "600" as a standard.

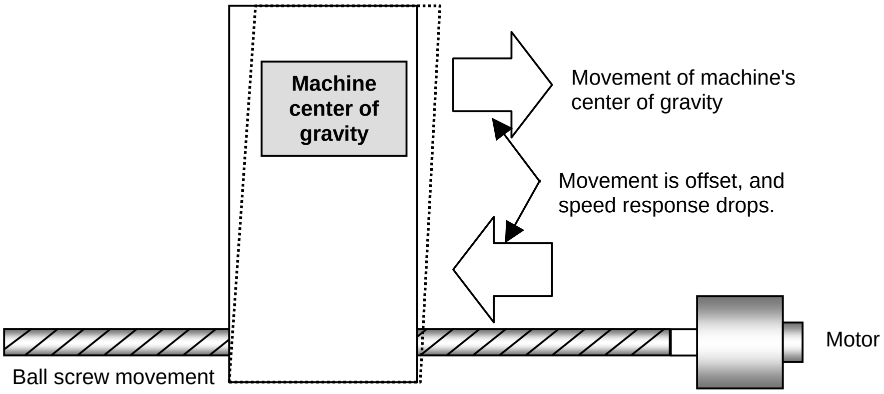
<4> Set the observer gain in disturbance observer 2 (SV044 (OBS2)). The disturbance observer will function here for the first time. Set 100 first, and if vibration does not occur, increase the setting by 50 at a time to increase the observer effect.

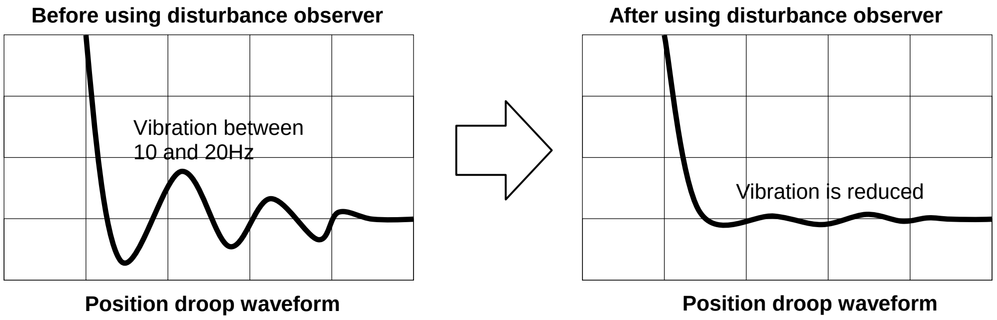
<5> If vibration occurs, lower OBS1 by 50 at a time. The vibration can be eliminated by lowering OBS2, but the effect of the disturbance observer can be maintained by keeping OBS2 set to a high value.

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 to 5000 (%)
			kg	Set the total weight of the moving section for the linear servo.	0 to 5000
SV043	OBS1	Disturbance observer 1	rad/s	Set the observer filter band (observer pole). Set "600" as a standard, and raise the setting by 50 at a time if vibration occurs.	0 to 1000 (rad)
SV044	OBS2	Disturbance observer 2	%	Set the observer gain. Set 100 to 300 as a standard, and lower the setting if vibration occurs.	0 to 500 (%)

<u>Machine behavior when machine's center of gravity is high (Example)</u>

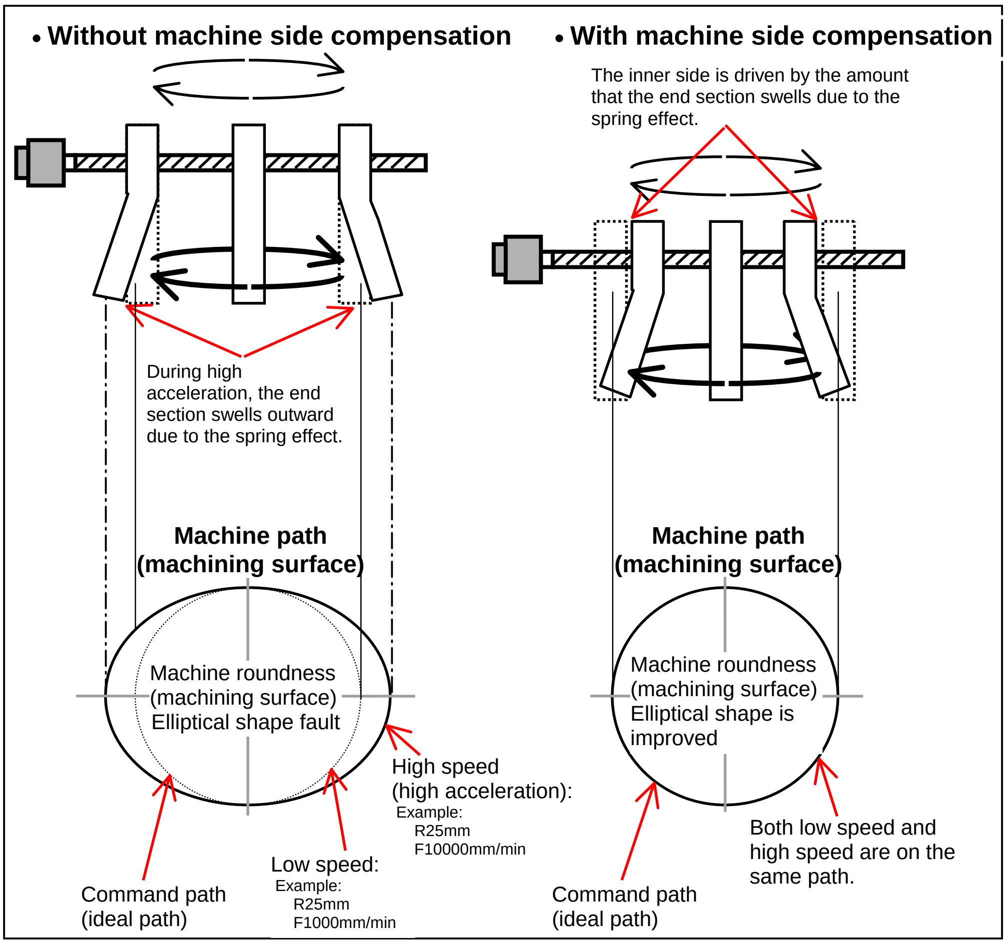
If the machine's center of gravity is high, the speed response may drop in respect to the ball screw section's movement, making it difficult to attain a stable speed range. The disturbance observer is effective in this case.





(4) Machine side compensation (Machining center)

This function compensates the shape of the machine end during high-speed and high acceleration/ deceleration. The spring effect from the tool (spindle) end to the motor (scale) end is compensated. If the machine has a large spring effect, the shape may be fine during low-speed operation. However, at high speeds (specially when using a small diameter), the section from the tool (shaft) end to the outer sides of the motor (scale) end could swell, and deteriorate the shape (cause the shape to round).
This function controls the movement of the motor (scale) end caused by the speed, and improves the tool (spindle) end accuracy at all speeds. This is particularly effective for the roundness accuracy during servo adjustment. Note that the roundness must be adjusted at the machine end with a DDB or grid encoder.



No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)
SV027	SSF1	Servo function selection 1	The machine side compensation starts with the following parameter. F: aflt, E: zrn2, D–C: afse, B–A: ovs, 9–8: lmc, 7: **omr**, 6: zrn3, 5–4: vfct, 3: –, 2: upc, 1–0: vcnt bit 7 omr — Meaning when "0" is set: Machine side compensation invalid; Meaning when "1" is set: Machine side compensation valid	
SV065	TLC	Machine side compensation spring constant	The value calculated with the following expression is used as the compensation amount. Compensation amount (μm) = $\frac{\text{Command speed F (mm/min)}^2 \times \text{SV065 (TOF)}}{\text{Radius R (mm)} \times 10^9}$ This is the value for an open loop and will actually vary according to the tool's spring constant. Determine the actual value when adjusting. Set to "0" when not using this function.	-32768 to 32767

SV027 bit layout:

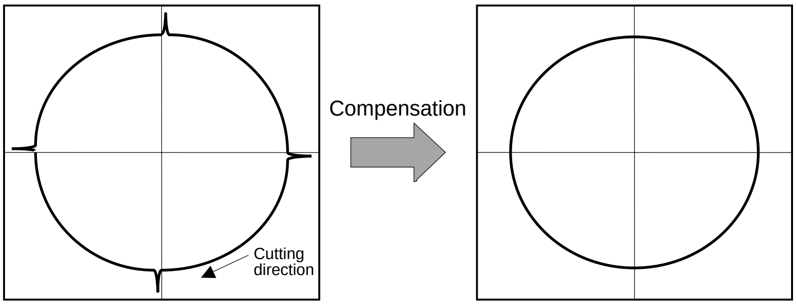
F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
aflt	zrn2	afse		ovs		lmc		**omr**	zrn3	vfct			upc	vcnt	

bit		Meaning when "0" is set	Meaning when "1" is set
7	omr	Machine side compensation invalid	Machine side compensation valid

⚠ **CAUTION** If an excessive value is set in the machine side compensation spring constant (SV065: TLC), the machine could vibrate when stopping.

5-3-4 Improvement of protrusion at quadrant changeover

The response delay (caused by dead 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 at the quadrant changeover in the DBB 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**

DBB: Double Ball Bar

(1) Lost motion compensation (LMC compensation)

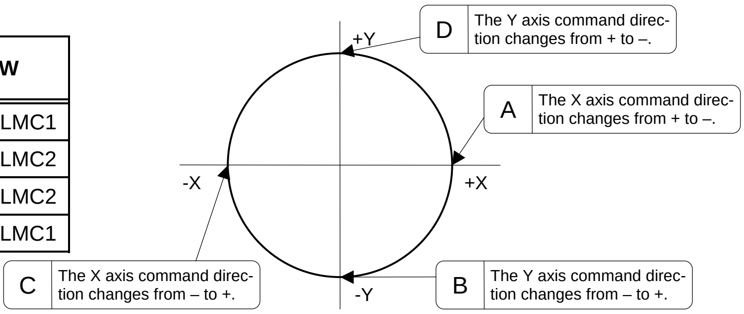
The lost motion compensation compensates the response delay during the reversal by adding the torque command set with the parameters when the speed direction changes. There are three methods of LMC compensation. Type 2 is explained below.

Type 1: Compensation effective in areas where axis movement speed is slow.
(Usually, Type 2 is used.)
Type 2: Compensation effective for lathe systems
Type 3: Compensation effective for machining centers

<Setting method>

<1> Set the special 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 NC 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



<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV027</td><td>SSF1</td><td>Special servo function selection 1</td><td>The lost motion compensation starts with the following 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>aflt</td><td>zrn2</td><td>afrg</td><td>afse</td><td>ovs2</td><td>ovs1</td><td>lmc2</td><td>lmc1</td><td>omr</td><td></td><td>vfct2</td><td>vfct1</td><td></td><td>upc</td><td>vcnt2</td><td>vcnt1</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>No LMC</th><th>LMC type 1</th><th>LMC type 2</th><th>Setting prohibited.</th></tr>
<tr><td>8</td><td>lmc1</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>9</td><td>lmc2</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
</table>
</td></tr>
</table>

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 to 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 to 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 NC servo monitor screen. The frictional torque of the machine at this time is expressed with the following expression.

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

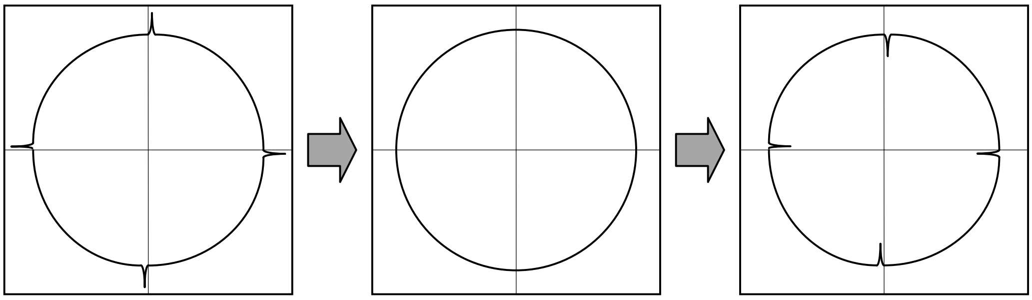
The standard setting value for the lost motion compensation 1 (LMC1) is double the frictional torque above.

(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.

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

Perform the final adjustment, carrying out the CNC sampling measurement (DBB measurement) or 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. Once LMC compensation type 1 is started, the overshooting compensation and the adaptive filter cannot be simultaneously started.

(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 NC servo monitor screen. The unbalance torque at this time is expressed with the following expression.

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

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 this parameter when carrying out the lost motion compensation. Set the unbalance torque amount.	–100 to 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. Only the characteristics of the LMC compensation function are affected.

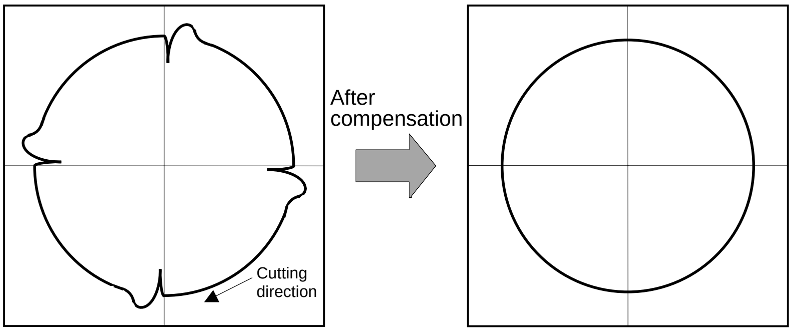
(3) Adjusting the lost motion compensation timing

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 (DBB 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 ms at a time, to find the timing that the protrusion and compensation position match.

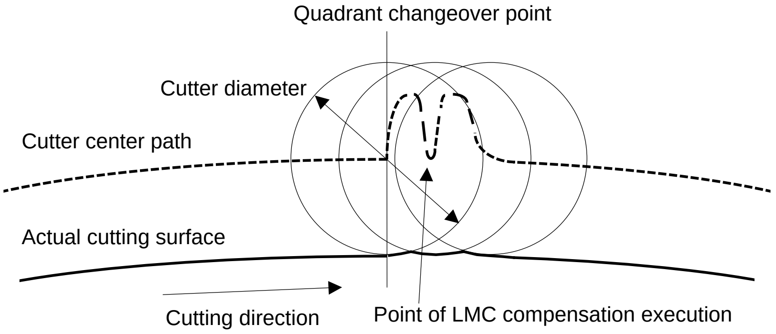


Before timing delay compensation **After timing delay compensation**

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

When the LMCD is gradually raised, a two-peaked contour may occur at the motor side 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 or more.

If feed forward control is carried out and the compensation does not operate correctly, adjust with the dead band (SV040 (LMCT)) during feed forward control. In this dead band control, overshooting of the 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	Dead band during feed forward control	µm	This setting is valid only during feed forward control. 2µm is set when this is set to 0. Adjust by increasing the value by 1µm at a time.	0 to 100 (µm)

POINT

Setting of the dead 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

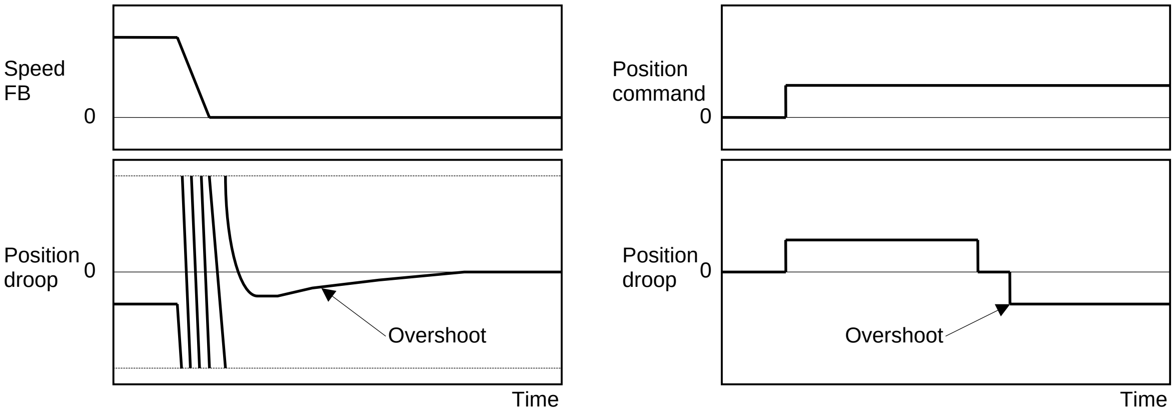
The phenomenon when the machine position goes past or exceeds the command during feed stopping is called overshooting. Overshooting is compensated by overshooting compensation (OVS compensation).

Overshooting occurs due to the following two causes.

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

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

Either phenomenon can be confirmed by measuring the position droop.



<1> Overshooting during rapid traverse settling **<2> Overshooting 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 (type 1 and type 2) of OVS compensation. The standard method is type 2.

OVS compensation type 2 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 for the dead band 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 special servo function selection 1 (SV027 (SSF1)) bit B. (OVS compensation type 2 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 NC parameter CW/CCW setting.

POINT

In OVS compensation type 2, 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 3 if overshooting is a problem in contour cutting during feed forward control.
If OVS compensation type 3 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 (fwd) 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 dead band (SV034 (SSF3) bit C to F: ovsn) during feed forward control. By ignoring overshooting of a set width in the ovsn or less, the command direction change point is correctly recognized, and the OVS compensation is correctly executed.
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 3 is used if overshooting is a problem during feed forward control.

No.	Abbrev.	Parameter name	Explanation
SV027	SSF1	Special 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
aflt	zrn2	afrg	afse	**ovs2**	**ovs1**	lmc2	lmc1	omr		vfct2	vfct1		upc	vcnt2	vcnt1

bit		Meaning when "0" is set.	Meaning when "1" is set.
A	ovs1	Overshooting compensation type 2 stop	Overshooting compensation type 2 start
B	ovs2	Overshooting compensation type 3 stop	Overshooting compensation type 3 start

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 to 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 to 100 (%)

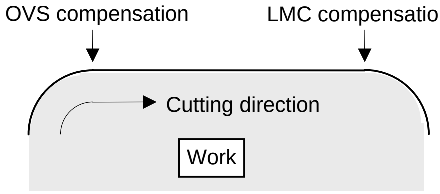
No.	Abbrev.	Parameter name	Explanation
SV034	SSF3	Special servo function selection 3	The overshooting compensation starts with the following parameter.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
ovsn				linN				toff	os2		dcd	test	mohn	has2	has1

bit	Name	Explanation
C	**ovsn**	Set the dead band for the overshoot compensation type 3.
D		
E		
F		

POINT

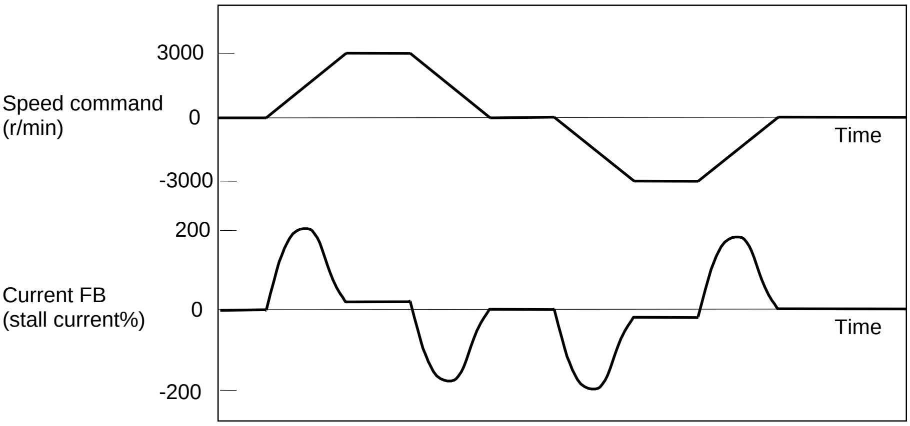
1. When either parameter SV031 (OVS1) or SV042 (OVS2) is set to 0, the same amount of compensation is carried out in both the positive and negative direction, using the setting value of the other parameter (the parameter not set to 0).
2. To compensate in only one direction, set -1 in the parameter (OVS1 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.



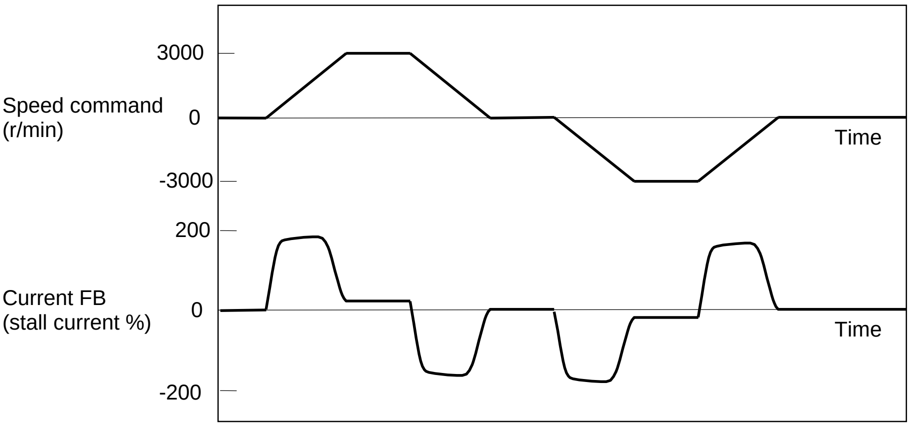
5-3-6 Improvement of characteristics during acceleration/deceleration

(1) SHG control (option function)

Because SHG control has a smoother response during acceleration/deceleration 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

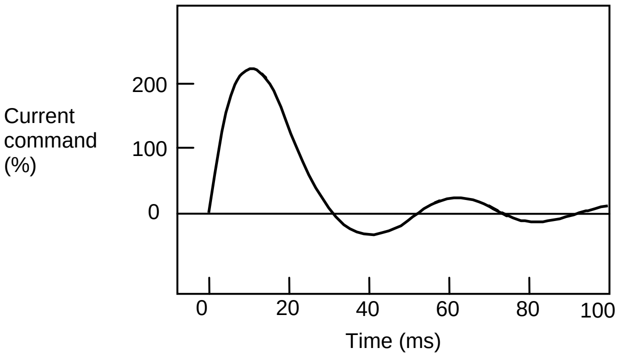


Acceleration/deceleration characteristics during SHG control

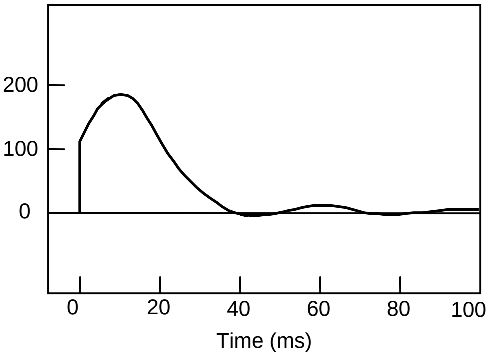
No.	Abbrev.	Parameter name	Setting ratio	Setting example										Explanation	Setting range
SV003 (SV049)	PGN1 (PGN1sp)	Position loop gain 1	1	23	26	33	38	47	60	70	80	90	100	Always set a combination of 3 parameters.	1 to 400 (rad/s)
SV004 (SV050)	PGN2 (PGN2sp)	Position loop gain 2	$\frac{8}{3}$	62	70	86	102	125	160	186	213	240	266		0 to 999
SV057 (SV058)	SHGC (SHGCsp)	SHG control gain	6	140	160	187	225	281	360	420	480	540	600		0 to 1200
SV008	VIA	Speed loop leading compensation	Set 1900 as a standard value during SHG control.												1 to 9999
SV015	FFC	Acceleration feed forward gain	Set 100 as a standard value during SHG control.												0 to 999

(2) Acceleration feed forward

Vibration may occur at 10 to 20 Hz during acceleration/deceleration when a short time constant of 30 ms 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 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 tapping control and superimposition control).

No.	Abbrev.	Parameter name	Unit	Explanation	Setting range
SV015	FFC	Acceleration 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 to 999

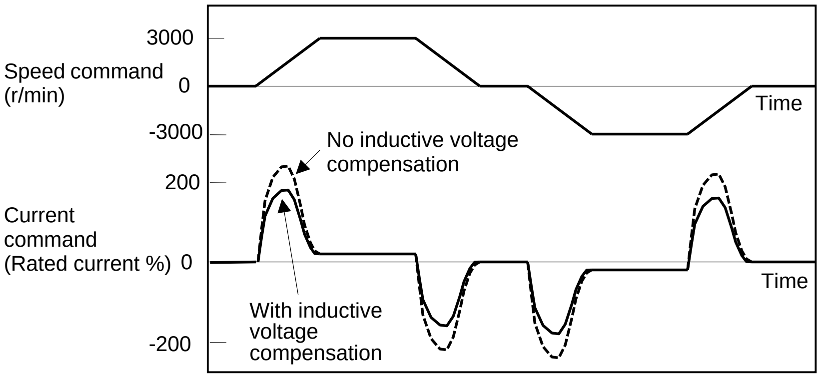
POINT Overshooting occurs easily when a value above the standard value is set during SHG control.

(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. 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

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 to 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 Settings for emergency stop

5-4-1 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 no-control time until the brakes activate can be eliminated by delaying ready OFF from the servo drive unit by the time set in the parameters when an emergency stop occurs.

(1) Operating conditions

<1> The emergency stop signal has been input.
<2> The NC power has been turned OFF.
<3> An alarm has occurred. (This differs according to the occurring alarm. Refer to "Chapter 8 Troubleshooting" for details.)

⚠ CAUTION

1. This function does not prevent dropping of the axis under all conditions.
2. The drop prevention function may not activate if the power fails or if a spindle alarm (overheating, etc.) occurs. To always prevent the vertical axis from dropping, install a balance unit, etc., on the machine.

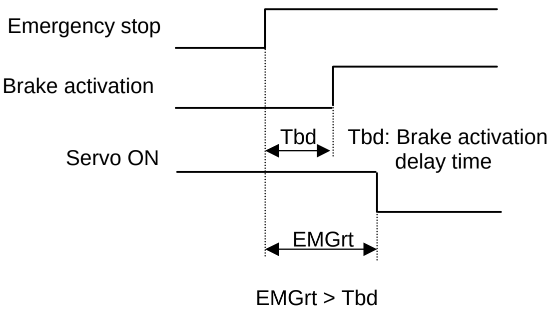
(2) Function outline and parameter settings

While stopped .... The drive unit enters the ready OFF state after the vertical axis drop prevention time (SV048) has elapsed.
While moving......... Deceleration stop is carried out, and the drive unit enters the ready OFF state after the larger value of the vertical axis drop prevention time (SV048) and emergency stop maximum delay time (SV055) has elapsed.

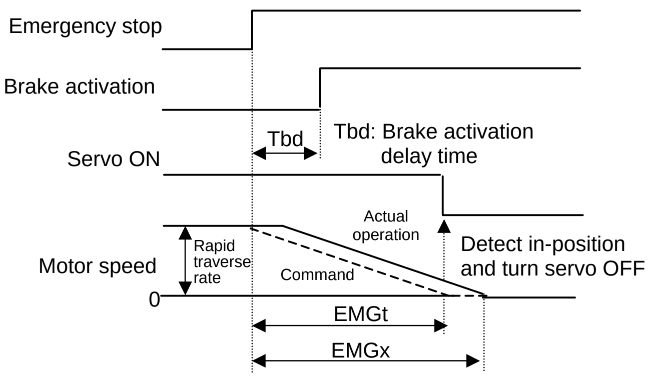
No.	Abbrev.	Parameter name	Explanation	Setting range
SV048	EMGrt	Vertical axis drop prevention time	Set the time to delay the ready OFF when an emergency stop occurs. Set a value larger than the brake activation time. The set time will not be assured if the power supply to the power supply unit is cut off.	0 to 2000 (ms)
SV055	EMGx	Gate cutoff maximum delay time during emergency stop	Set the maximum ready OFF delay time. This is normally set to the same value as SV048. To turn ready OFF after a deceleration stop, set the same value as SV056. Note that this value is valid if SV056 is larger than SV048. When a value smaller than SV048 is input, the same value as SV048 will be automatically set. The set time will not always be assured if the power supply to the power supply unit is cut off.	0 to 2000 (ms)
SV056	EMGt	Deceleration control time constant at emergency stop	Deceleration stop will be carried out if moving when SV048 is set, so set that deceleration stop time constant. Normally set the same value as the rapid traverse time constant. When this parameter is set, a constant inclination direct deceleration stop control will be carried out at emergency stop. A step stop (dynamic brake operation) will be carried out when this parameter is set to "0".	0 to 2000 (ms)

⚠ CAUTION

1. The drop prevention function will be invalidated if SV048 and SV055 are both set to "0".
2. SV048 and SV055 are set for each axis. However, when using a 2-axis drive unit, the value for the axis with the larger setting will be valid.
3. When only SV048 is set, step stop will be used for deceleration stop and the machine could vibrate. Thus, set the rapid traverse time constant in SV055.



Drop prevention function sequence at emergency stop

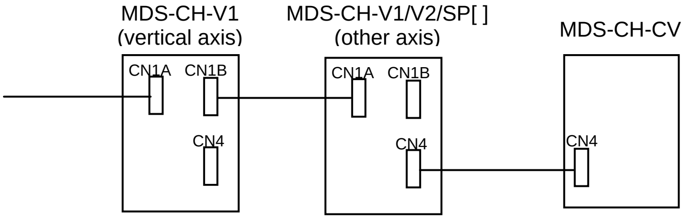


Deceleration stop function sequence at emergency stop

(3) Adjustment procedures

- Set the drop prevention function parameters in the vertical axis servo parameters SV048, 055, and 056.
  - (a) Carry out emergency stops with SV048 (EMGrt) for the vertical axis set to 50, 100, etc., and use the smallest drop amount value on the NC screen for the setting value. (Several um will remain due to the brake play.)
  - (b) Set SV056 (EMGt). This is normally set to the same value as the rapid traverse time constant.
  - (c) Set SV055 (EMGx). This is normally set to the same value as SV048. To turn ready OFF after a deceleration stop, set the same value as SV056 (EMGt). Note that this value is valid if SV056 (EMGt) is larger than SV048 (EMGrt).

- If there is another axis (servo/spindle unit) between the vertical axis and power supply unit, set that axis to the same setting values (SV048, 055, 056) as the vertical axis. (Set the largest value if there are several vertical axes.)
  If the other axis is a spindle, set the spindle parameter SP033 bit F to "1".



- If the 2-axis drive unit is an axis controlling a vertical axis or the power supply unit, set the servo parameters SV048, 055, and 056 for both the L and M axes.

The parameter setting section differs for each system, so change the standard parameter value.

5-4-2 Deceleration control

If the deceleration stop function is validated, the MDS-CH-V1/V2 servo drive unit will decelerate to stop the motor according to the set time constants. After stopping, zero-speed state is immediately notified and the dynamic brakes will be applied.
If an emergency stop factor (external emergency stop, malfunction in unit, etc.) occurs, operation will be stopped with the dynamic brakes.

<Features>

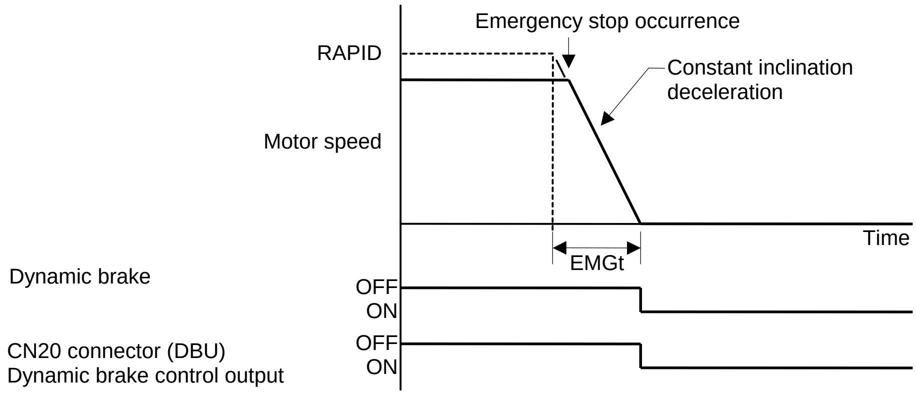
1. When the load inertia is large, deceleration stop can be executed at a shorter time than the dynamic brakes.
   (The stop time for the normal acceleration/deceleration time constants will be achieved.)

(1) Setting the deceleration control time constant

Set the time for stopping from the rapid traverse rate (rapid: axis specification parameter) in the deceleration time constant for emergency stop (SV056: EMGt).
If linear acceleration/deceleration is selected for rapid traverse, the same value as the acceleration/deceleration time constant (G0tL) will be the standard value. If another acceleration/deceleration pattern is selected, set rapid traverse to linear acceleration/deceleration and adjust to a suitable acceleration/deceleration time constant. Use that value as the standard value.

<Operation>

When an emergency stop occurs, the motor will decelerate at the same inclination from each speed.



No.	Abbr.	Parameter name	Unit	Explanation	Setting range
SV055	EMGx	Gate cutoff maximum delay time during emergency stop	ms	This is normally set to the same value as SV056 ENGt. Set "0" when not using the deceleration stop function or drop prevention function.	0 to 20000 (ms)
SV056	EMGt	Deceleration control time constant	ms	Set the time to stop from the rapid traverse rate (rapid). As the standard, set the same value as the rapid traverse acceleration/deceleration time constant (G0tL). Set "0" when not using the deceleration stop function.	0 to 20000 (ms)

POINT

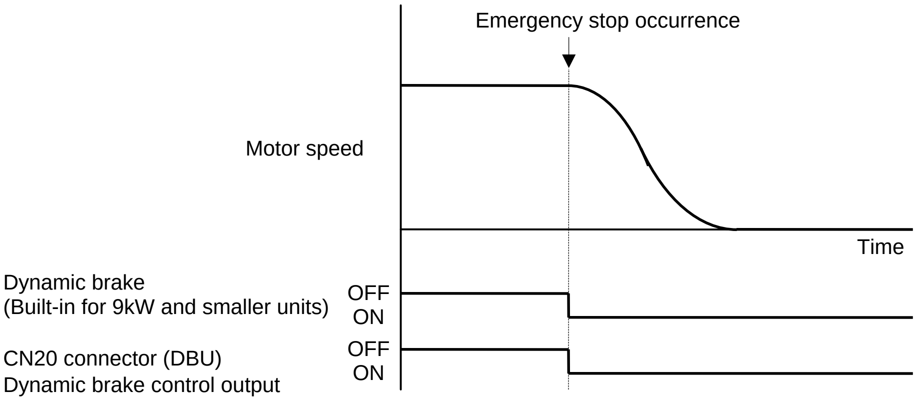
1. Deceleration control will not take place when a servo alarm, for which the stopping method is dynamic, occurs. The motor will stop with dynamic braking regardless of the parameter setting.
2. If the power fails and the deceleration time constant is set to a relatively long time, the braking method may change from deceleration control to dynamic braking due to a drop in the bus voltage in the drive unit.

⚠ CAUTION

If the deceleration control time constant (EMGt) is set to a value longer than the acceleration/deceleration time constant, the overtravel point (stroke end point) may be exceeded.
Take care as the axis could collide with the machine end.

5-4-3 Dynamic braking stop

Dynamic braking stop takes place when the deceleration stop function is not used.
With dynamic braking stop, the dynamic brakes activate simultaneously with the occurrence of an emergency stop. The motor brake control output also activates simultaneously.
Zero-speed state is immediately notified to the NC when dynamic braking stop takes place.



⚠ **CAUTION**	The dynamic brakes cannot be used for normal braking. If the dynamic brakes activate continuously, the internal regenerative resistor could burn, so always eliminate the cause of the emergency stop before resuming operation.

5-5 Collision detection function

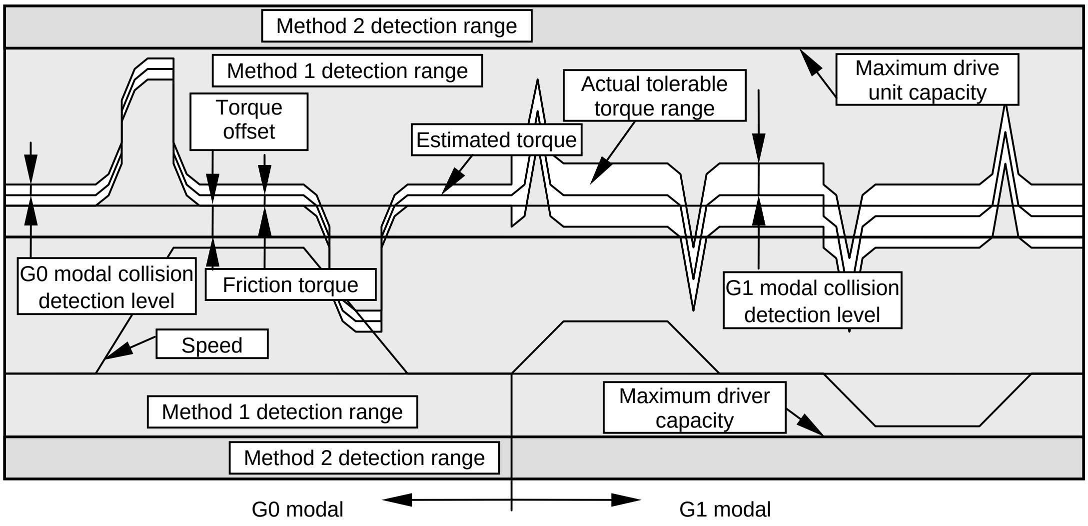
The purpose of the collision detection function is to quickly detect a collision and decelerate to a stop. This allows damage to the head to the machine to be reduced.
Impact during a collision cannot be prevented even when the collision detection function is used, so this function does not guarantee that the machine will not break and does not guarantee the machine fault or machine accuracy after a collision. Add a mechanism to prevent machine collision, etc., on the machine side if necessary.
Collisions are detected using the following two methods. In either method, a servo alarm will occur after deceleration stop.

(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 at the driver unit’s maximum torque. After decelerating to a stop, the alarm will occur, and the system will stop.
Method 1 only operates when SHG control is being used. (If acceleration/deceleration operation is carried out when not using SHG control, a load error alarm (58/59) will immediately occur.)
Method 1 enables independent setting of the collision detection levels for rapid traverse and cutting feed. The collision detection level during cutting feed is set at 0 to 7-fold (integer magnification) of the collision detection level during rapid traverse. When 0-fold is set, collision detection method 1 will not function during cutting feed.

(2) Collision detection method 2

When the current command reaches the drive unit's maximum current, the axis will decelerate to a stop at the drive unit's maximum torque. After decelerating to a stop, the alarm will occur, and the system will stop.
Note that this method can be ignored by setting the servo parameter SV035 (SSF4/cl2n) to "1".



<Setting and adjustment methods>

1. Confirm that SHG control is being used.
2. SV032 (TOF) Torque offset
   Using jog, etc., move the axis to be adjusted at approx. F1000mm/min, and check the load current on the [I/F Diagnosis Screen/Servo Monitor]. If the current load is positive during movement, check the maximum value. If the current load is negative during movement, check the minimum value. Set the average value of the + and - directions.
3. SV045 (TRUB) Friction torque
   Using jog, etc., move the axis to be adjusted at approx. F1000mm/min in both directions, and check the load current on the [I/F Diagnosis Screen/Servo Monitor]. Subtract the current load value during movement in the - direction from the current load value during movement in the + direction, and set the absolute position of that value divided by 2.
4. SV059 (TCNV) Torque estimated gain
   Set SV035 (SSF4/clt) (bit F) of the axis to be adjusted to "1".
   Using jog, etc., move the axis to be adjusted at the maximum rapid traverse rate in both directions until the MPOF display on the [I/F Diagnosis Screen/Servo Monitor] stabilizes.
   Set the MPOF value displayed on the [I/F Diagnosis Screen/ Servo Monitor].
   Return the SV035 (SSF4/clt) (bit F) setting to "0".
5. SV035 (SSF4/cl2n) (bit B)
   Set this bit to "1" when the acceleration/deceleration time constant is short and the current is limited.
6. SV060 (TLMT) Collision detection level (for method 1, G0 modal)
   Initially set to "100". (When SV035 (SSF4/clet) is set to "1", the MPOF value shows the estimated disturbance torque peak value for the last two seconds, so this can be used as a reference when setting. However, this value is averaged, so initially set a value approx. double the display value.)
   Carry out no-load operation at the maximum rapid traverse rate. If it appears an alarm will occur, raise the setting value in increments of 20.
   If it appears an alarm will not occur, lower the setting value in increments of 10.
   Set a value 1.5-fold of the limit where an alarm does not occur.
7. SV035 (SSF4/clG1) (bit C to E)
   Divide the maximum cutting load by the SV060 (TLMT) setting value. (Round up values below the decimal.) Set that value.

(Example) When the maximum cutting load is 200%, and the SV060 (TLMT) setting value is 80%.
200/80 = 2.5 → The setting value is rounded up to "3", so 3xxx is set in SV035 (SSF4).

No.	Abbr.	Parameter name	Explanation
SV035	SSF4	Special servo function selection 4	Set the collision detection with the following parameter.

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
clt	**clG1**			**cl2n**	**clet**	**cltq**			iup	tdt					

bit		Meaning when set to 0	Meaning when set to 1
8,9	cltq	Set the deceleration torque for when a collision is detected.	
A	clet	Setting for normal use	The past two-second estimated disturbance torque peak value is displayed at MPOF on the Servo Monitor screen.
B	cl2n	Setting for normal use	Collision detection method 2 is invalidated.
C D E	clG1	Set the collision detection level for the collision detection method 1, G1 modal. When 0 is set : The method 1, G1 modal collision detection will not be carried out. When 1 to 7 is set : The method 1, G0 modal collision detection level (SV060 (TLMT)) will be multiplied by the set value, and the value is set as the level for the method 1, G1 modal.	
F	clt	Setting for normal use	The guide value for the SV059 (TCNV) setting value is displayed at MPOF on the Servo Monitor screen.

No.	Abbr.	Parameter name	Unit	Explanation	Setting range
SV032	TOF	Torque offset	Stall % (rated current %)	Set the unbalance torque amount of axes having an unbalance torque such as vertical axes as a percentage (%) of the stall rated current.	–100 to 100
SV045	TRUB	Current compensation/ Frictional torque	Stall % (rated current %)	When using the collision detection function, set the friction torque as a percentage of the stall rated current. Use the eight low-order bits. Set "0" when not using the collision detection function.	0 to 100
SV059	TCNV	Torque estimated gain		When using the collision detection function, set the estimated torque gain. A guideline setting value can be displayed in MPOF on the Servo Monitor screen by setting SV035 (SSF4/clt) to "1". Set "0" when not using the collision detection function.	0 to 32767
SV060	TLMT	G0 collision detection level	Stall % (rated current %)	When using the collision detection function, set the collision detection level during method G0 modal as a percentage of the stall rated current. Set "0" when not using the collision detection function.	0 to 100

⚠ CAUTION

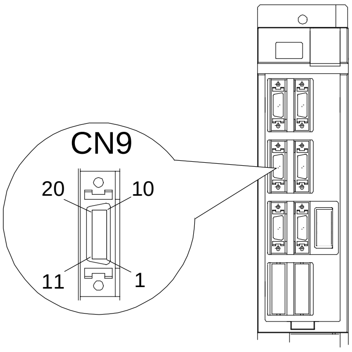
1. Even when this function is valid, complete prevention of collisions may not be possible due to NC faults or the machine structure.
2. If the collision detection level is set very close to its limit, a collision may be mistakenly detected in a normal status, so set a slightly larger collision detection level.
3. After adjusting the machine for maintenance, etc., or replacing the motor or detector, adjust the parameters related to collision detection again.
4. In particular, the SV059 (TCNV) torque estimated gain must be changed when the detector resolution changes due to detector replacement, or when the position control system is changed (when the closed loop and semi-closed loop are changed, etc.).

5-6 Spindle adjustment data output function (D/A output)

The spindle drive unit has a function to D/A output various control data.
The drive unit's status and each data can be confirmed using this D/A output function.

5-6-1 D/A output specifications

Item	Explanation
No. of channels	2ch
Output cycle	444µs
Output precision	8bit
Output voltage range	0 to +10V
Output magnification setting	±1/256 to ±128-fold
Output pin	CN9 connector Channel 1 = Pin 9 Channel 2 = Pin 19 GND = Pins 1, 11
Function	Phase current feedback output function U phase current FB: pin 7 V phase current FB: pin 17



Speedometer

5-6-2 Parameter settings

Each channel's data number and output magnification are set with the following parameters.

No.	Abbr.	Parameter name	Details
SP253	DA1N0	D/A output channel 1 data number	Set the output data number for channel 1 of the D/A output function. *When this parameter is set to "0", the speed meter will be output. Refer to section "5-6-3" for settings other than "0".
SP254	DA2N0	D/A output channel 2 data number	Set the output data number for channel 2 of the D/A output function. * When this parameter is set to "0", the load meter will be output. Refer to section "5-6-3" for settings other than "0".
SP255	DA1MPY	D/A output channel 1 magnification	Set the data magnification for channel 1 of the D/A output function. * The magnification is the setting value divided by 256-fold. Note that if "0" is set, the magnification will be 1-fold.
SP256	DA2MPY	D/A output channel 2 magnification	Set the data magnification for channel 2 of the D/A output function. * The magnification is the setting value divided by 256-fold. Note that if "0" is set, the magnification will be 1-fold.

5-6-3 Output data settings

Set the No. of the data to be output in SP253 and SP254.
A correlation of the output data and the data No. is shown below.
* The values in brackets indicate the conversion value for the output voltage 1V change. (Note that this is when the magnification is set to 1-fold.)

Data No. (setting value)	CH1		CH2	
	Output data	Units	Output data	Units
0 (Normal)	Speedometer output	Maximum speed at 10V **(Note 2)**	Load meter output	120% load at 10V
2	Current command	When the actual data is 4096, the current command data is regarded as 100%. [0.625%/V] **(Note 1)**		
3	Current feedback	When the actual data is 4096, the current feedback data is regarded as 100%. [0.625%/V] **(Note 1)**		
4	Speed feedback	Actual data r/min [25.6r/min/V]		
6	Position droop low-order	Interpolation units (When the actual data is 23040000, the position droop data is regarded as 360°.) [low-order: 0.0004°/V, high-order: 26.2°/V]		
7	Position droop high-order			
8	Position FΔt low-order	Interpolation units/NC communication cycle [low-order: 0.0004°/V, high-order: 26.2°/V]		
9	Position FΔt high-order			
10	Position command low-order	Interpolation units (When the actual data is 23040000, the position command data is regarded as 360°.) [low-order: 0.0004°/V, high-order: 26.2°/V]		
11	Position command high-order			
12	Feedback position low-order	Interpolation units (When the actual data is 23040000, the feedback position data is regarded as 360°.) [low-order: 0.0004°/V, high-order: 26.2°/V]		
13	Feedback position high-order			
80	Control input 1	Bit correspondence		
81	Control input 2			
82	Control input 3			
83	Control input 4			
84	Control output 1	Bit correspondence		
85	Control output 2			
86	Control output 3			
87	Control output 4			

Note 1) The spindle motor's 30-minute rated output is 100%.
Note 2) The maximum speed (motor rotation speed) at the speedometer 10V output can be changed with parameter "SP249".

5-6-4 Setting the output magnification

Set the output magnification of the data to be output in SP255 and SP256.

$$\boxed{\text{DATA} = \text{actual data} \times \frac{\text{SP255 or SP256}}{256}} \quad \text{Expression <1>}$$

The output data has the D/A output specifications shown in "Fig. 1" below.
 * When the data is "0", the output will be 5V. (0 offset: 5V)
When the maximum data "127" is set, the output will be 10V. When the minimum data "–128" is set, the output will be 0V.

(Note) The speedometer output and load meter output data will have the D/A output specifications shown in "Fig. 2" below.

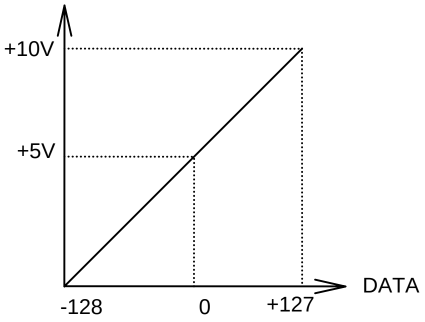


Fig. 1

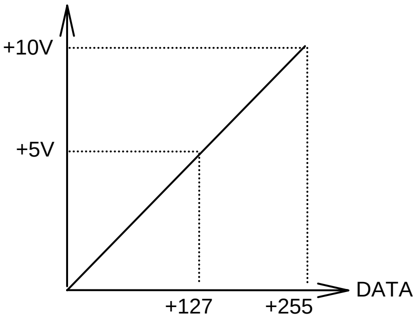


Fig. 2

(Example 1) Current command, current feedback
The data is regarded as 100% when the actual data is 4096.
Therefore, for example, the actual data is output as shown below during +120% current feedback.

Actual data = 4096 × 1.2 = 4915

If parameter SP255 (SP256) is set to "256", or if the magnification is set to 1-fold, the D/A output voltage will be as follows according to Expression <1>.

DATA = 4915 > +128

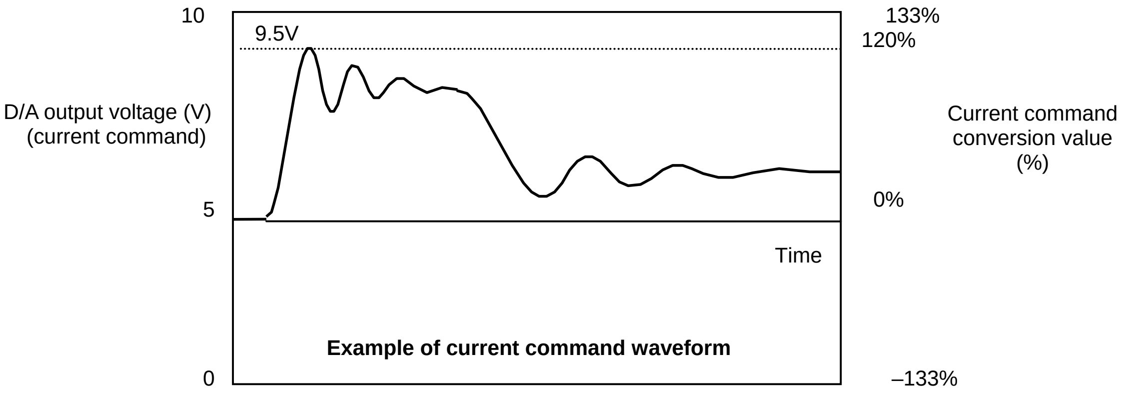
The D/A output maximum voltage value will be exceeded. Thus, in this case, parameter SP255 (SP256) will be set in the following manner.

DATA = 4915 ∗ {setting value} / 256 < 128

Thus, {setting value} < 6.666.... (= 128 ∗ 256/4915), and the data can be confirmed with the SP255 (SP254) setting value "6".
At this time, the D/A output voltage value will be:

D/A output voltage = 5V + {4915 × 6/256 × (5V/128)} = 9.5V.

An example of the waveform is shown below.



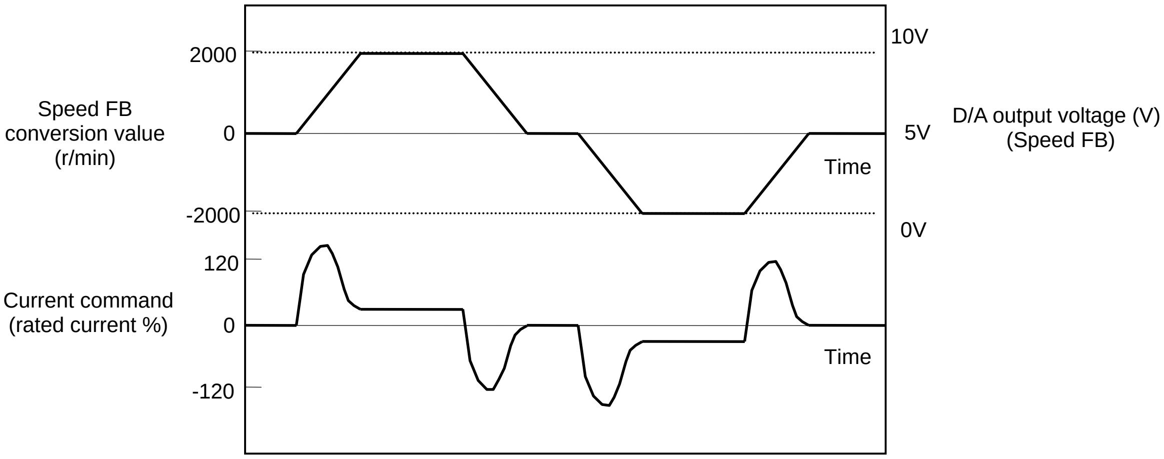
Example of current command waveform

(Example 2) Speed Feedback
The data unit is r/min.
Thus, if the motor is rotating at +2000r/min, the actual data "2000" will be output.
If parameter SP255 (SP256) is set to "256", or if the magnification is set to 1-fold, the D/A output voltage will exceed the maximum value (DATA = 2000 > +128).

Thus, in this case, parameter SP255 (SP256) should be set as follows.

DATA = 2000 ∗ {setting value} / 256 < 128
Thus, {setting value} < 16.384 (= 128 ∗ 256/2000)

The data can be confirmed by setting SP255 (SP254) to "16".
At this time, the D/A output voltage value (= 5V + {2000 × 16/256 × (5V/128)}) will be 9.88V.



Example of speed/current command waveform during acceleration/deceleration

(Example 3) Position droop
The data unit is a value equivalent to 360° when the actual data is 23040000.
Thus, when the position droop is +0.1 degrees, the actual data 0.1 × 23040000/360 = 6400 will be output.
If parameter SP255 (SP256) is set to "256", or if the magnification is set to 1-fold, the D/A output voltage will exceed the maximum value (DATA = 6400 > +128).

Thus, in this case, parameter SP255 (SP256) should be set as follows.

DATA = 6400 ∗ {setting value} / 256 < 128
Thus, {setting value} < 5.12 (= 128 ∗ 256/6400)

The data can be confirmed by setting SP255 (SP256) to "5".
At this time, the D/A output voltage value (= 5V + {6400 × 5/256 × (5V/128)}) will be 9.88V.

(Example 4) Confirm the orientation complete signal with the control output 4L.
The data unit is bit corresponding data.
Refer to the section "1.1" for the meanings of the control output 4L bit corresponding signals.
The orientation complete signal corresponds to the control output 4L/bit 4.
Thus, if the orientation complete signal is ON for example, bit 4 will be set to "1", and the actual data 16 (=2^4) will be output.
If parameter SP255 (SP256) is set to "256", or if the magnification is set to 1-fold, the D/A output voltage will be less than the maximum value (DATA = 16 < +128), so the data can be confirmed.
The D/A output voltage value (= 5V + {16 × 256/256 × (5V/128)}) will be 5.625V.
Note that if bits other than bit 4 are ON, the voltage of that bits will be added to the value 6.25V above, when measuring the actual orientation complete signal, check with the (5.625V-5V) = 0.625V changed voltage.

(Note) When orientation is completed, indexing position complete (bit 7) will turn ON simultaneously, so the actual data = 128 (=2^7) will be added.

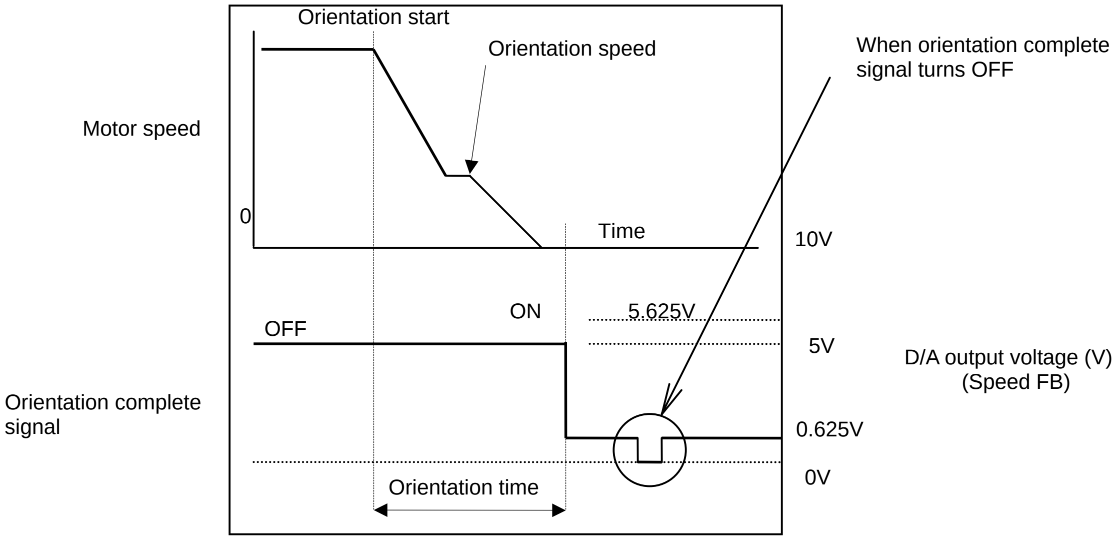
* D/A output voltage = 5V + {(16 + 128) × 256/256 × (5V/128)} = 10.625V

[Reference]

If 10V is exceeded, as explained above, the data will overflow, so the actual voltage will be (= calculated D/A voltage – 10∗n: n is the maximum integer that establishes a positive value in the right side of the expression).

Example: When above indexing position complete signal is added

V = 10.625 – 10∗1 = 0.625 (V)



5-7 Spindle adjustment

The MDS-CH-SP[ ] spindle drive unit has a function to D/A output various control data.
The drive unit's status and each data can be confirmed using this D/A output function.

5-7-1 Items to check during trial operation

Directly couple the motor and machine, and check the control status during machine run-in.

(1) Check that the command speed and actual speed match.
  (a) If the speeds do not match, check spindle parameters SP000 to SP384 again.
  (Especially check SP017, SP034, SP040 and SP257 to SP384.)
  (b) Check the NC parameters Slimit1 to 4, Smax 1 to 4, and Smini.
(2) Is the rotation smooth?
(3) Is there any abnormal noise?
(4) Are there any abnormal odors?
(5) Has the bearing temperature risen abnormally?

5-7-2 Adjusting the spindle rotation speed

The rotation speed is received as digital signals from the NC, and thus does not need to be adjusted. If the spindle rotation speed does not match the commanded value due to a dimensional error, such as the pulley diameter, adjust the parameters with the following method.

1. Setting Slimit
   Slimit = (SP017 value) × (deceleration rate between motor and spindle)
2. Set the S command to half of the maximum spindle rotation speed, and then measure the spindle rotation speed.
   If the speeds do not match, change the Slimit value in small increments until the speed matches.
3. Set the S command to the maximum spindle rotation speed, and check whether the spindle rotation speed matches.
4. In machines involving gear changeover, etc., change the gears, and then adjust with steps 1. to 3. above.

5-7-3 Adjusting the acceleration/deceleration

Measure the acceleration/deceleration waveform using the "5-6. Spindle adjustment data output function (D/A output function)", and confirm that it is within ±15% of the theoretical acceleration/deceleration time. (**Note:** Refer to "5-7-8" for details on calculating the theoretical acceleration/deceleration time.) Adjust SP087 and SP088.

(1) When acceleration/deceleration time do not match theoretical values

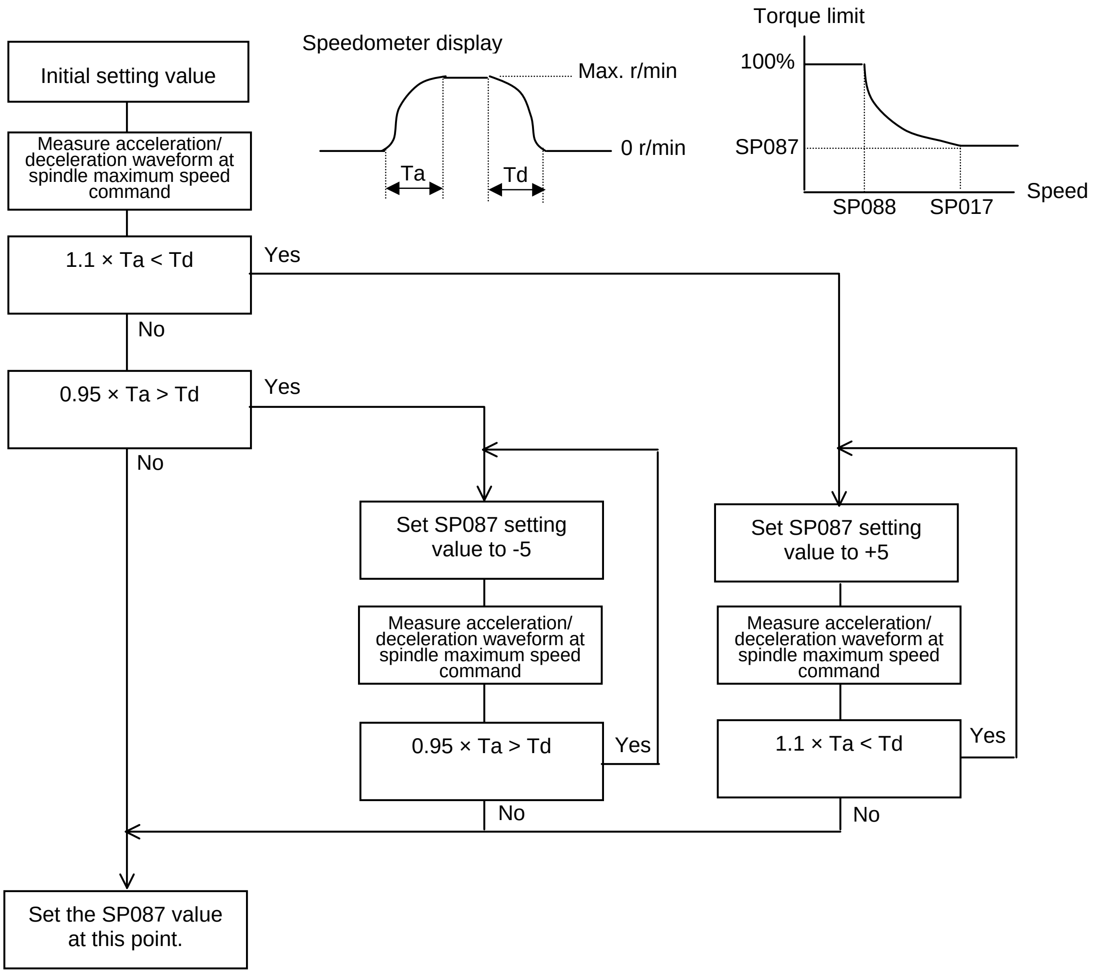
- If there is an error in the motor shaft conversion load inertia calculation, these may not necessary match.
  Check load inertia again.
- If the acceleration time is long and the deceleration time is short, the friction torque may be large. Check the load meter value (Spindle Monitor screen) at the maximum speed. If 10% or more, the friction torque may be relatively high. There may be mechanical friction such as bearing friction or timing belt friction. After running in the machine, measure the acceleration/deceleration time again.

* If the acceleration/deceleration times do not match even when the above problems are not present, the spindle motor and spindle drive unit may not be the designated products, or one of the parameter settings may be incorrect. Check the spindle motor and drive unit models, and check the parameters again.

(2) When the acceleration time is no problem but the deceleration time differs greatly from the acceleration time.
Adjust the deceleration time as indicated on the next page.

Deceleration adjustment procedures

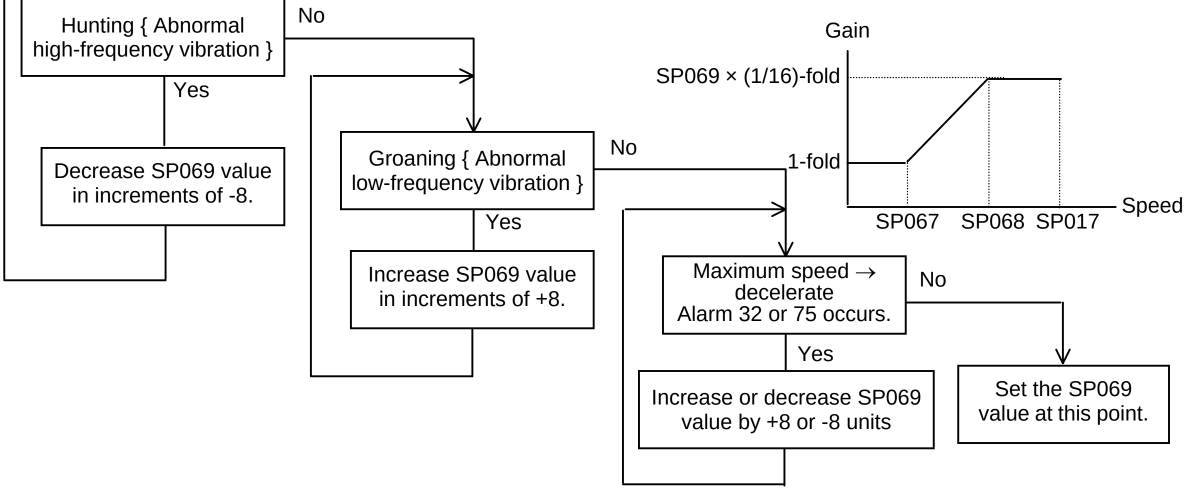
Adjust SP087 as shown below so that the deceleration time is the same as the acceleration time.



Variable current loop gain adjustment

Adjust so that the current output to the spindle motor is stable. In most cases, the default value can be used. However, if fine vibration (hunting), etc., occurs at high speed regions, this must be adjusted.

SP017 Motor maximum speed	**SP067 VIGWA**	**SP068 VIGWB**	**SP069 VIGN**
0 to 6000	0	0	0
6001 to 8000	5000	8000	32
8001 or more	5000	10000	32



5-7-4 Adjusting the orientation

Orientation is not possible if the gear ratio between the spindle motor and spindle exceeds 1:31.

(1) Preparing to adjust the orientation

1) Motor built-in encoder parameters

No.	Abbr.	Parameter name	Initial value
SP001	PGM	Motor built-in encoder orientation position loop gain	100
SP004	OINP	Orientation in-position width	16
SP005	OSP	Orientation mode changing speed limit value	0
SP006	CSP	Orientation mode deceleration rate	20
SP007	OPST	Position shift amount for orientation	0
SP025	GRA1	Spindle gear teeth count 1	1
SP026	GRA2	Spindle gear teeth count 2	1
SP027	GRA3	Spindle gear teeth count 3	1
SP028	GRA4	Spindle gear teeth count 4	1
SP029	GRB1	Motor shaft gear teeth count 1	1
SP030	GRB2	Motor shaft gear teeth count 2	1
SP031	GRB3	Motor shaft gear teeth count 3	1
SP032	GRB4	Motor shaft gear teeth count 4	1
SP097	SPECO	Orientation specification	0000
SP098	VGOP	Speed loop gain proportional term in orientation mode	63
SP099	VGOI	Speed loop gain integral term in orientation mode	60
SP100	VGOD	Speed loop gain delay advance term in orientation mode	15
SP105	IQGO	Current loop gain magnification 1 in orientation mode	100
SP106	IDGO	Current loop gain magnification 2 in orientation mode	100
SP107	CSP2	Deceleration rate 2 in orientation mode	0
SP108	CSP3	Deceleration rate 3 in orientation mode	0
SP109	CSP4	Deceleration rate 4 in orientation mode	0
SP119	MPGH	Orientation position loop gain H coil magnification	0
SP120	MPGL	Orientation position loop gain L coil magnification	0
SP121	MPCSH	Orientation deceleration rate H coil magnification	0
SP122	MPCSL	Orientation deceleration rate L coil magnification	0

[Preparation] 1) Confirm that the parameters are set as shown above.

Note: 1) Motor built-in encoder orientation is only possible when the spindle and motor are directly connected or are connected with gears (timing belt) at 1:1.
The built-in encoder with Z-phase must be mounted in the motor being used.

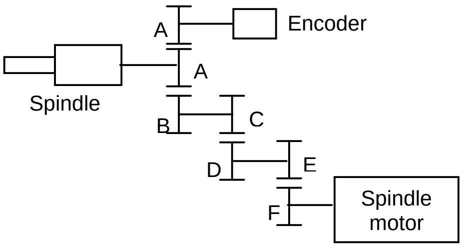
2) Encoder orientation parameters

No.	Abbr.	Parameter name	Initial value
SP002	PGE	Encoder orientation position loop gain	100
SP004	OINP	Orientation in-position width	16
SP005	OSP	Orientation mode changing speed limit value	0
SP006	CSP	Orientation mode deceleration rate	20
SP007	OPST	Position shift amount for orientation	0
SP025	GRA1	Spindle gear teeth count 1	1 to 32767
SP026	GRA2	Spindle gear teeth count 2	1 to 32767
SP027	GRA3	Spindle gear teeth count 3	1 to 32767
SP028	GRA4	Spindle gear teeth count 4	1 to 32767
SP029	GRB1	Motor shaft gear teeth count 1	1 to 32767
SP030	GRB2	Motor shaft gear teeth count 2	1 to 32767
SP031	GRB3	Motor shaft gear teeth count 3	1 to 32767
SP032	GRB4	Motor shaft gear teeth count 4	1 to 32767
SP096	EGRA	Encoder gear ratio	0
SP097	SPECO	Orientation specification	0000
SP098	VGOP	Speed loop gain proportional term in orientation mode	63
SP099	VGOI	Speed loop gain integral term in orientation mode	60
SP100	VGOD	Speed loop gain delay advance term in orientation mode	15
SP105	IQGO	Current loop gain magnification 1 in orientation mode	100
SP106	IDGO	Current loop gain magnification 2 in orientation mode	100
SP107	CSP2	Deceleration rate 2 in orientation mode	0
SP108	CSP3	Deceleration rate 3 in orientation mode	0
SP109	CSP4	Deceleration rate 4 in orientation mode	0
SP119	MPGH	Orientation position loop gain H coil magnification	0
SP120	MPGL	Orientation position loop gain L coil magnification	0
SP121	MPCSH	Orientation deceleration rate H coil magnification	0
SP122	MPCSL	Orientation deceleration rate L coil magnification	0

[Preparation]

1) The correct gear ratio (or pulley ratio) must be set from the motor shaft to the encoder rotation shaft. Confirm that the correct number of gear teeth is set in SP025 (GRA1) to SP032 (GRB4).
   SP025 (GRA1) to SP028 (GRA4) = A × C × E
   SP029 (GRB1) to SP032 (GRB4) = B × D × F

   Note: SP025 (GRA1) to SP032 (GRB4) may be set to the user settings, so correctly set according to the machine.



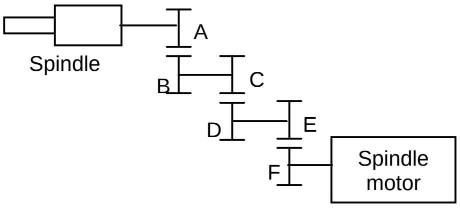
2) Confirm that the parameters are set as shown above.

3) Magnesensor orientation parameters

No.	Abbr.	Parameter name	Initial value
SP001	PGM	Magnetic sensor orientation position loop gain	100
SP004	OINP	Orientation in-position width	16
SP005	OSP	Orientation mode changing speed limit value	0
SP006	CSP	Orientation mode deceleration rate	20
SP007	OPST	Position shift amount for orientation	0
SP025	GRA1	Spindle gear teeth count 1	1 to 32767
SP026	GRA2	Spindle gear teeth count 2	1 to 32767
SP027	GRA3	Spindle gear teeth count 3	1 to 32767
SP028	GRA4	Spindle gear teeth count 4	1 to 32767
SP029	GRB1	Motor shaft gear teeth count 1	1 to 32767
SP030	GRB2	Motor shaft gear teeth count 2	1 to 32767
SP031	GRB3	Motor shaft gear teeth count 3	1 to 32767
SP032	GRB4	Motor shaft gear teeth count 4	1 to 32767
SP097	SPECO	Orientation specification	0000
SP098	VGOP	Speed loop gain proportional term in orientation mode	63
SP099	VGOI	Speed loop gain integral term in orientation mode	60
SP100	VGOD	Speed loop gain delay advance term in orientation mode	15
SP105	IQGO	Current loop gain magnification 1 in orientation mode	100
SP106	IDGO	Current loop gain magnification 2 in orientation mode	100
SP107	CSP2	Deceleration rate 2 in orientation mode	0
SP108	CSP3	Deceleration rate 3 in orientation mode	0
SP109	CSP4	Deceleration rate 4 in orientation mode	0
SP119	MPGH	Orientation position loop gain H coil magnification	0
SP120	MPGL	Orientation position loop gain L coil magnification	0
SP121	MPCSH	Orientation deceleration rate H coil magnification	0
SP122	MPCSL	Orientation deceleration rate L coil magnification	0
SP123	MGD0	Magnetic sensor output peak value	Standard magnet = 542 Compact magnet = 500
SP124	MGD1	Magnetic sensor linear zone width	Standard magnet = 768 Compact magnet = 440
SP125	MGD2	Magnetic sensor changeover point	Standard magnet = 384 Compact magnet = 220

[Preparation]

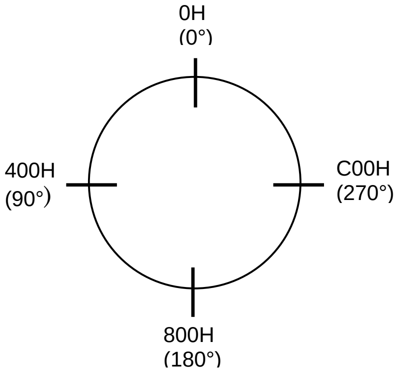
1) The correct gear ratio (or pulley ratio) must be set from the motor shaft to the magnetic sensor rotation shaft. Confirm that the correct number of gear teeth is set in SP025 (GRA1) to SP032 (GRB4).
   SP025 (GRA1) to SP028 (GRA4) = A × C × E
   SP029 (GRB1) to SP032 (GRB4) = B × D × F



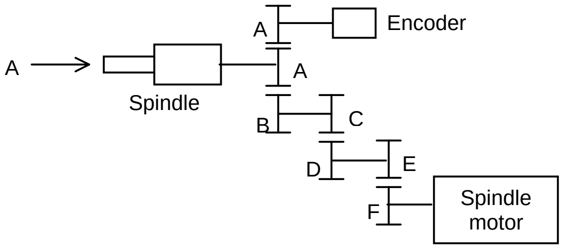
Note: 1) SP025 (GRA1) to SP032 (GRB4) may be set to the user settings, so correctly set according to the machine.
2) Confirm that the parameters are set as shown above.

(2) General adjustment of orientation

1) First confirm that the orientation command (ORC) is input while the machine is in the correct state, and that the orientation complete signal (ORCF) turns ON when there is even one unstable operation point. If the excessive error alarm (AL52) occurs, or if the operation does not stop and forward/reverse run is repeated at a low speed during magnetic sensor orientation, change the value set in SP097 (SPECO) bit-5 or -6. Refer to section 3) if the excessive error alarm is not eliminated even after changing this value.
2) Adjust the position shift SP007 (OPST) value so that the machine stops at the target stop position. If the stop position command data is input from an external source during encoder or motor PLG orientation, the machine will stop as shown below according to the issued data regardless of the detector's installation direction. The 0° position shown below will be shifted by SP007 (OPST).

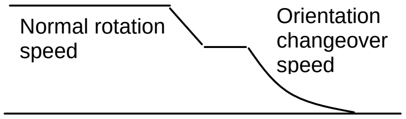


View A



Note 1) The external stop position command data is read in at the rising edge of orientation start, so always change it before inputting the orientation start command. It will not be valid if changed after orientation starts.

3) Adjusting the orientation time and vibration



Phenomenon	Adjustment knack	
	SP001/SP002	**SP006**
Overtravels when stopping	Decrease the setting value	Decrease the setting value
Orientation time is long	Increase the setting value	Increase the setting value
Hunting occurs when stopping	Decrease the setting value	Do not change
Excessive error alarm occurs	Decrease the setting value	Decrease the setting value

Whether to adjust SP001 (PGM) or SP002 (PGE) depends on the orientation method.
SP006 (CSP) is adjusted after adjusting SP001 (PGM)/SP002 (PGE).
To adjust the orientation time quickly for each gear, adjust SP107(CSP2) to SP109(CSP4) in the same manner.
Similarly, when using the coil changeover motor, adjust SP119 (MPGH) to SP122 (MPCSL) to adjust the orientation time quickly for each coil.
If the excessive error alarm (52) occurs at a gear ratio of 1:10 or more, and the state cannot be improved with the adjustments above, adjust SP005 (OSP).
If the motor hunts during orientation stop, review the values set in SP001 (PGM) or SP002 (PGE).

(3) Adjusting the servo rigidity

The cutting precision can be increased by raising the servo rigidity during orientation stop.

1. Increase the SP001 (PGM) or SP002 (PGE) value to the degree that overtravel does not occur during orientation stop.
2. Increase SP0098 (VGOP) and SP099 (VGOI) by the same amount to the degree that vibration does not occur.
3. The servo rigidity can be increased momentarily by increasing the SP100 (VGOD) value.
   Increasing the SP100 (VGOD) value: Adverse effects may occur such as a drop in the torque in respect to the position deflection, or an inconsistency in the stopping position.
   Setting the SP100 (VGOD) value to 0: PI control will be applied. The servo rigidity will drop momentarily, but the stopping position precision will increase.

Note 1) Delay/advance control and PI control
When stopping orientation for a normal tool change, etc., select delay/advance control. (SP100=0)
However, if the spindle's frictional torque is large, and a precise stopping position is required, select PI control. (SP100=0).

Examples of using PI control
1. Positioning a workpiece with a lathe.
2. Orientation of a machine which indexes a 5-plane machining attachment.

Note 2) If the gear ratio between the spindle and motor is large, it may not be possible to set the SP001 (PGM), SP002 (PGE) and SP006 (CSP) values as required, and the values may be limited.
In this case, the setting value will change, but the value will be clamped internally, so the changes will not be visible.

Note 3) If the forward run and reverse run stop positions differ even when using PI control, the machine's backlash may be large. In this case, the stopping precision may be improved by fixing the orientation rotation direction to one direction. (Set with SP097 (SPECO) bit-0, 1.)

Note 4) If the spindle is mechanically locked during orientation stop, always input a torque limit so that the motor's output torque is restricted. (Recommended torque limit: 10% or less)

(4) Troubleshooting

1) Orientation does not take place (motor keeps rotating)

Cause	Investigation item	Remedy	Remarks
Parameter setting values are incorrect	The orientation detector and parameter do not match. SP037 (SFNC5) Motor built-in encoder orientation .... 4 Encoder orientation .... 1 Magnetic sensor orientation . 2	Correctly set SP037 (SFNC5).	
The specification are not correct	Motor built-in encoder orientation is attempted with standard motor instead of motor with Z phase.	Change to a motor having a motor-built-in encoder with Z phase.	For motor built-in encoder orientation
Incorrect wiring	The connector pin numbers are incorrect, The inserted connector number is incorrect, or The cable is disconnected.	Correct the wiring. Replace the cable.	

2) The motor overtravels and stops. (The motor sways when stopping.)

Cause	Investigation item	Remedy	Remarks
Parameter setting values are incorrect	The gear ratio parameters SP025 (GRA1) to SP032 (GRB4) are incorrect.	Correctly set SP025 (GRA1) to SP032 (GRB4).	
	The phenomenon is improved when the deceleration rate for orientation parameter SP006 (CSP) is halved.	Readjust SP006 (CSP)	This also applies to: SP107 (CSP2) SP108 (CSP3) SP109 (CSP4) SP121 (MPCSH) SP122 (MPCSL)
	The phenomenon is improved when the position loop gain parameters SP001 (PGM) and SP002 (PGE) are halved.	Readjust SP001 (PGM), SP002 (PGE).	This also applies to: SP119 (MPGH) SP120 (MPGL)
	The orientation stop direction is set to one direction (CCW or CW).	Set the SP097 (SPECO) bit 0, 1 to "0" (pre).	

3) The stopping position deviates.

Cause	Investigation item	Remedy	Remarks
Mechanical cause	The stopping position is not deviated with the encoder axis.	There is backlash or slipping, etc., between the spindle and encoder. The gear ratio between the spindle and encoder is not 1:1 or 1:2.	For encoder orientation
		There is backlash or slipping between the spindle and motor. The gear ratio between the spindle and motor is not 1:1.	For motor built-in encoder orientation
Noise	The position detector's cable is relayed with a terminal block (connector), etc.	Do not relay the cable.	
	The position detector cable's shield is not treated properly.	Properly treat the shield.	
	The peeled section of signal wire at the position detector cable's connector section is large. (A large section is not covered by the shield.)	Keep the peeled section to 3cm or less when possible. Keep the peeled section as far away from the power cable as possible.	
The magnetic sensor installation direction is incorrect	Check the relation of the magnet and sensor installation following section 6-37.	Correct the relation of the magnet and sensor installation.	For magnetic sensor orientation.

4) The stopping position does not change even when the position shift parameter is changed.

Cause	Investigation item	Remedy	Remarks
Parameter setting values are incorrect	The position shift was changed to 2048 when the gear ratio between the spindle and encoder was 1:2 (one encoder rotation at two spindle rotations).	If the gear ratio on the left is established between the spindle and encoder, the position shift amount for one spindle rotation is 2048 instead of 4096.	

5) The machine vibrates when stopping.

Cause	Investigation item	Remedy	Remarks
Parameter setting values are incorrect	The gear ratio parameters SP025 (GRA1) to SP032 (GRB4) are incorrect.	Correctly set SP025 (GRA1) to SP032 (GRB4).	
The orientation adjustment is faulty	The vibration frequency is several Hz.	Decrease the position loop gain parameters SP001 (PGM) and SP002 (PGE). Increase the current loop gain for orientation parameters SP105 (IQGO) and SP106 (IDGO).	
	The vibration frequency is 10Hz or more.	Decrease the speed loop gain for orientation parameters SP098 (VGOP) and SP099 (VGOI). Decrease the current loop gain for orientation parameters SP105 (IQGO) and SP106 (IDGO).	

6) The orientation complete signal is not output

Cause	Investigation item	Remedy	Remarks
Refer to section (1) Orientation does not take place.			
The machine's load is heavy	The in-position parameter SP004 (OINP) is too small.	Review the in-position range, and increase SP004 (OINP).	
	Phenomenon is improved if the control for orientation stopping is changed from delay/advance to PI control.	Review the values set for the speed loop gain for orientation parameters SP098 (VGOP), SP099 (VGOI) and SP100 (VGOD).	

5-7-5 Synchronous tap adjustment

Always adjust the synchronous tap after adjusting the operation following the speed command and the acceleration/deceleration time, and after adjusting the servo axis synchronized with the spindle during synchronous tap.

(1) Preparation for adjustment

Check the input spindle parameters again.

1) Base specification parameters (NC parameter)

The numbers may differ or the meaning may differ according to the NC, so refer to the NC Maintenance Manual for details.

No.	Abbr.	bit	Details
1229	set01	4	Always set this bit to "1" when carrying out synchronous tap in the G74, G84 tap cycle.
	mpar1	3	Determine the inclination of the command time constant for synchronous tap. When "0" is set, constant time constants will be applied and when "1" is set, inclined constants will be applied. When "1" is set, set the time constants in the spindle specification parameters stapt1 to 4.
	tap-t1	–	Set the time constants for when "0" is set in mpar1 bit-3.

2) Spindle specification parameters (NC parameters)

Refer to section 4-3-4(1) for details.

No.	Abbr.	Details
13	stap1	Set the maximum spindle speed for synchronous tap at gear 00.
14	stap2	Set the maximum spindle speed for synchronous tap at gear 01.
15	stap3	Set the maximum spindle speed for synchronous tap at gear 10.
16	stap4	Set the maximum spindle speed for synchronous tap at gear 11.
17	stapt1	Set the time constant up to the maximum speed for synchronous tap at gear 00.
18	stapt2	Set the time constant up to the maximum speed for synchronous tap at gear 01.
19	stapt3	Set the time constant up to the maximum speed for synchronous tap at gear 10.
20	stapt4	Set the time constant up to the maximum speed for synchronous tap at gear 11.

3) Servo and spindle parameters.

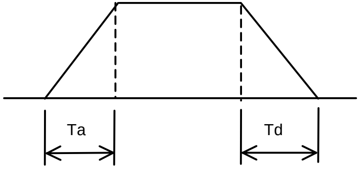
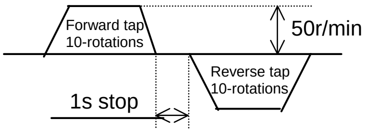
Refer to section 4-2 and 4-3 for details.

No.	Abbr.	Details
SV049	PGN1sp	Set the position loop gain of the axis that moves in synchronization with the spindle during synchronous tap. Always set the same value as the spindle parameter SP009 (PGT).
SP009	PGT	Set the position loop gain for the spindle during synchronous tap. Always set the same value as the servo parameter SP049 (PGN1sp) of the axis that moves in synchronization with the spindle.
SP060	MKT2	Set the time to limit the current after coil changeover when using the coil changeover motor.
SP193	SPECT	Set the synchronous tap specifications. Refer to the explanation of parameters in the previous section for details.
SP194	VGTP	Set the speed loop gain proportional item for synchronous tap.
SP195	VGTI	Set the speed loop gain integral item for synchronous tap.
SP196	VGTD	Set the speed loop gain delay/advance item for synchronous tap.

Caution 1) When using a belt drive, highly accurate synchronous tap may not be possible due to slipping or elongation. In this case, use a spindle encoder and carry out encoder method orientation with the closed method. If the belt rigidity is weak, the gain may not rise and the synchronous tap accuracy may not be attained.

Caution 2) Set the spindle parameter SP096 (EGEAR) and spindle specification parameter #22 (sgear) to "1" when using the spindle encoder and closed method with a deceleration ratio of 1:2.

(2) Confirmation and adjustment of operation

	Normal operation	Confirmation items
1	Accelerate and decelerate to each gear's maximum tap speed. 	1) When base specification parameter mpar1-bit3=1: Set a value obtained by multiplying Ta or Td, whichever is longer, by 1.2-fold for each gear into the corresponding #17 (stapt1) to #20 (stapt4). 2) When base specification parameter mpar1-bit3=0: Set a value obtained by multiplying Ta or Td, whichever is longer, by 1.2-fold for each gear into the corresponding tap-t1.
2	Without workpiece installed G84 Z-10 F1.0 P1000 S50 	1) If the rotation direction is the reverse tap direction, reverse the SP193 (SPECT) bit 4 settings. 2) If the motor does not rotate ten rotations past the spindle speed, review the gear ratio setting SP025 (GRA1) to SP032 (GRB4). 3) In all other cases, refer to the Troubleshooting section.
3	Carry out test cutting with a floating tap chuck installed.	1) The tapper must not elongate or contract. 2) Highly accurate tapping must be possible. 3) In all other cases, refer to the Troubleshooting section.
4	Carry out test cutting without a floating tap chuck.	1) Highly accurate tapping must be possible. 2) In all other cases, refer to the Troubleshooting section.

(3) Troubleshooting

Phenomenon	Cause of occurrence	Investigation method	Remedy
Excessive error alarm (52)	Incorrect parameter setting	Check the SP193 (SPECT) detector polarity	Set correctly
	Incorrect parameter setting	The tap time constant is too short. Set the S command startup time × 1.2 or more.	Set correctly
Overcurrent alarm (32)	Incorrect parameter setting	The tap time constant is too short. Set the S command startup time × 1.2 or more.	Set correctly
The spindle rotation movement amount does not match the command value	Incorrect parameter setting	Check the SP193 (STPECT) bit0 setting value.	Set correctly
		The SP025 (GRA1) to SP032 (GRB4) settings do not match the machine's gear ratio.	Set correctly
The tap breaks The tap cutting accuracy is poor	Incorrect parameter setting	PGNISP and SP001 are not the same	Set correctly
		The tap time constant is short	Increase the time constant
	Correct the program	The tap hole is shallow and the cutting chips cannot be discharged.	Deepen the tap hole
	Check the machine	The tap slips at the chuck	Adjust to the correct state
		Check the tap depth and tap diameter	
		Check the tap cutting edge	Replace with a new part
The spindle stops during tap cutting.	Machine load is heavy	Set SP193 (SPECT) bit 3 to "1".	Set
		Increase the speed loop gain SP194 (VGTP) and SP195 (VGTI) setting values.	Readjust
		The tap time constant value is short, and there is no allowance to the output.	Increase the time constant
The tap accuracy drops when the speed increases	The position loop gain is incorrect	Try adjusting again	Readjust
The accuracy drops if synchronous tapping is carried out immediately after changing the coil.	The current is limited for a set time immediately after the coil is changed, so the acceleration/deceleration time increases and tracking as set in the constants is not possible.	Change the SP060 (MKT2) value.	Decrease the setting value, but note that caution is required. Refer to the Coil Changeover Specifications for details.

5-7-6 Z-phase (magnetic) automatic adjustment (Only when using IPM spindle motor)

Z-phase automatic adjustment is a function that automatically adjusts the relative position of the motor magnetic pole and the PLG Z-phase pulse signal input into the spindle drive unit, and then saves and validates the adjustment data.

This function is used to increase the output torque accuracy, and must always be carried out when the machine is started. Execute this function with the following procedures.

⚠ CAUTION

1. The mechanical adjustments (gear - sensor gap, etc.) must already be completed.
2. When using this function, set the spindle load inertia (max.: approx. 5-fold of the motor inertia) and the frictional load as low as possible.
3. The motor will automatically rotate at the adjustment speed during the Z-phase automatic adjustment. Do not touch the rotating sections, as these are hazardous.
4. If START (ON) is executed before the adjustment is completed, alarm 16 will occur, and the protection function will activate.

(1) Change SP205 from 0 to 1, and start forward run operation. (The power does not need to be turned OFF and ON.)
The control output 4H bit "D" will be set to 1 until the unit power is turned ON again.

  1) The spindle motor will automatically rotate at the adjustment speed (two steps for Z-phase pulse detection and magnetic pole position detection).
  2) The adjustment results will be calculated approximately 90 seconds after forward run is started (this time will differ slightly according to the magnetic pole position). Then operation will stop automatically.

(2) Confirm that the motor has automatically stopped. Leave parameter SP205 set to 1, turn START OFF, and turn the power OFF and ON. (When SP205 is set to 1, the adjustment data saved in SPm will be used.)

  1) If START is turned OFF during automatic rotation, reset SP205 to 0, and turn the power OFF and ON. Then, repeat the procedure from step (1).
  2) If the drive unit or motor is replaced, if the PLG is reinstalled, or if the signals are readjusted, etc., always reset SP205 to 0, and turn the power OFF and ON. Then, repeat the procedure from step (1). Failure to observe this will prevent correct operation due to invalid adjustment data.

5-7-7 PLG automatic adjustment

PLG automatic adjustment is a function that automatically adjusts the PLG A and B-phase sine wave signals input into the SPM unit. (Adjusts the offset and gain, etc.) The adjustment data is then saved and validated.

This function is used to improve the position data accuracy, and must always be carried out when the machine is started up.

⚠ CAUTION

1. As a condition, the Z-phase automatic adjustment described in (1) above must be completed.
2. The motor will automatically rotate at the adjustment speed during the PLG automatic adjustment. Do not touch the rotating sections of the spindle motor or spindle shaft, as these are hazardous.

(1) Change parameter (SP245) from 0 to 1, and start forward run operation.
The control output 4H bit "D" will be set to 1 from when the power is changed to when the power is turned ON again.

  1) The spindle motor will automatically rotate at the adjustment speed (two steps for offset adjustment and gain adjustment).
  2) The adjustment results will be calculated within several seconds after forward run is started. Then operation will stop automatically.

(2) Leave parameter (SP245) set to 1, turn START OFF, and turn the drive unit OFF and ON.

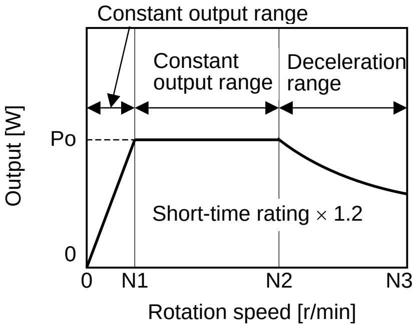
  1) When SP245 is set to 1, the adjustment data saved in SP will be used.
  2) If SP245 is set to 0, the adjustment data will be invalidated.

When the unit h or the PLG has replaced, reset parameter (SP245) to 0, and then repeat the procedure from (1) above to readjust the signals.

5-7-8 Calculating the theoretical acceleration/deceleration

(1) Calculating the theoretical acceleration/deceleration time

Each theoretical acceleration/deceleration time is calculated for each output range based on the spindle motor output characteristics as shown on the right. Note that the load torque (friction torque, etc.) is 0 in this calculation expression, so the acceleration/deceleration time can be known as a rough guide, but this calculation result differs from the acceleration/deceleration time of the actual machine.



Output characteristics for acceleration/deceleration

(a) Maximum motor output during acceleration/deceleration: Po

During acceleration/deceleration operation, the motor can output at 120% of the short-time rating. Thus, the motor output Po in the constant output range during acceleration/deceleration follows the expression below.

Po = (Short-time rated output) × 1.2 [W]

(b) Total load inertia: J_{all}

The inertia of the total load which is accelerated and decelerated follows the expression below.

J_{all} = (Motor inertia) + (motor shaft conversion load inertia) [kg•m^2] (Caution 1)

The acceleration/deceleration time until the rotation speed "N" to be required is calculated for each motor output range as shown below, using the values obtained in (a) and (b).

(c) Acceleration/deceleration time for constant torque range: t1···0 to N [r/min] (0≤N≤N1) (For N>N1, apply N=N1 and also calculate t2 or t3.)

$$t1 = \frac{1.097 \times 10^{-2} \times J_{all} \times N1 \times N}{Po} \quad [s] \quad \text{(Caution 1)}$$

(d) Acceleration/deceleration time for constant output range: t2···N1 to N [r/min] (N1<N≤N2) (For N>N2, apply N=N2 and also calculate t3.)

$$t2 = \frac{1.097 \times 10^{-2} \times J_{all} \times (N^2 - N1^2)}{2 \times Po} \quad [s] \quad \text{(Caution 1)}$$

(e) Acceleration/deceleration time in deceleration output range: t3···N2 to N [r/min] (N2<N≤N3)

$$t3 = \frac{1.097 \times 10^{-2} \times J_{all} \times (N^3 - N2^3)}{3 \times Po \times N2} \quad [s] \quad \text{(Caution 1)}$$

Based on the above expressions, the acceleration/deceleration time: t from 0 to N3 [r/min] is:

t = t1 + t2 + t3 [s] (Caution 2)

⚠ **CAUTION**

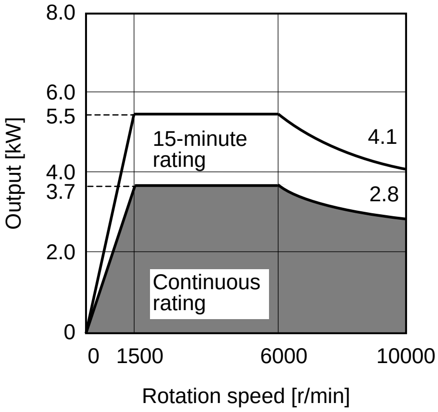
1. Note that the inertia (J) is a quarter of "GD^2".
   Ex.) When "GD^2" is 0.2 [kg·m^2], the inertia is "0.2 ÷ 4 = 0.05 [kg·m^2]".
2. If the AC input power voltage to the power supply is low, or if the input power impedance is high, the acceleration/deceleration time may be long. (Especially, the acceleration/deceleration time of the deceleration output range may be long.)

[Calculation example]

Calculate the acceleration/deceleration time from 0 to 10000[r/min] for an spindle motor having the output characteristics shown on the right when the motor inertia is 0.059 [kg･m^2], and when the motor shaft conversion load inertia is 0.2 [kg•m^2].

Po = (Short-time rated output) x 1.2
= 5500 x 1.2 = 6600 [W]

J_{all} = (Motor inertia) + (load inertia)
= 0.0148 + 0.05 =0.0648 [kg･m^2]



Spindle motor characteristics

$$t1 = \frac{1.097 \times 10^{-2} \times J_{all} \times N1^2}{Po} = \frac{1.097 \times 10^{-2} \times 0.0648 \times 1500^2}{6600} = 0.242\ [s]$$

$$t2 = \frac{1.097 \times 10^{-2} \times J_{all} \times (N2^2 - N1^2)}{2 \times Po} = \frac{1.097 \times 10^{-2} \times 0.0648 \times (6000^2 - 1500^2)}{2 \times 6600} = 1.818\ [s]$$

$$t3 = \frac{1.097 \times 10^{-2} \times J_{all} \times (N3^3 - N2^3)}{3 \times Po \times N2} = \frac{1.097 \times 10^{-2} \times 0.0648 \times (10000^3 - 6000^3)}{3 \times 6600 \times 6000} = 4.691\ [s]$$

Thus,

t = t1 + t2 + t3 = 0.242 + 1.818 + 4.691 = 6.751 [s]

5-8 Spindle specifications

5-8-1 Spindle coil changeover

The coil changeover control enables constant output characteristics over a wide range from low speed to high speed regions by changing the spindle motor coil in the following manner:

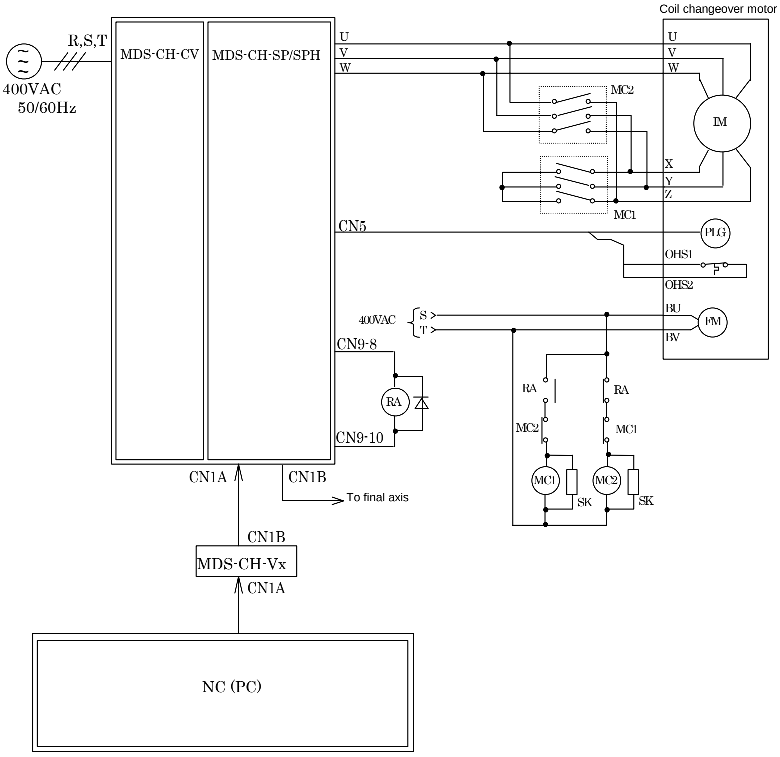
1) ⅄ connection (low-speed coil) ⟷ △ connection (high-speed coil)
2) 1st ⅄ connection (low-speed coil) ⟷ 2nd ⅄ connection (high-speed coil). By electrically carrying out the changeover of the speed ranges, conventionally charred out with mechanical means such as gear, pulleys or belts, etc., the machine structure can be simplified, and the spindle rigidity can be improved. When varying the speed between the low-speed regions and high-speed regions using the conventional mechanical methods, the spindle motor had to be stopped, the gears changed and then the motor accelerated again. By using this coil changeover, the motor does not need to be stopped, and the speed can be varied directly. This is effective in shortening the work time.

The following types of spindle motors can be used.

1) ⅄ connection (low-speed coil) ⟷ △ connection (high-speed coil) changeover method
   The coil changeover specification motor (type: SJ-K○○○, SJ-○B○○○○K○) is used with the built-in type as the target.
2) 1st ⅄ connection (low-speed coil) ⟷ 2nd ⅄ connection (high-speed coil)
   The coil changeover specifications motor (type: SJ-○B○○○○W○) is used with the built-in type as the target.

(1) Coil changeover wiring diagram

1) ⅄ connection ⟷ △ connection method



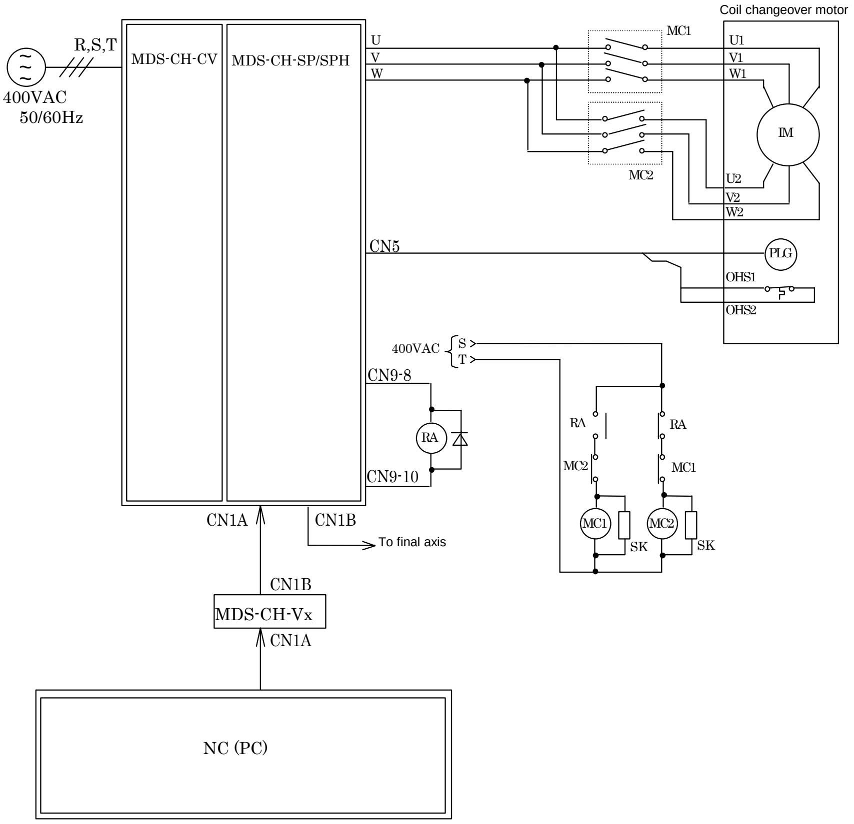
MC1: 3-phase contactor for establishing low-speed coil (⅄ connection).
MC2: 3-phase contactor for establishing high-speed coil (△ connection).

(Note 1) The contactors and relays, etc., shown above must be prepared by the machine maker.

(Note 2) A flywheel diode is connected to relay (RA), and a CR surge absorber (SK) is connected in parallel with the contactors (MC1, CM2).

(Note 3) When using the built-in motor, the fan's BU and BV wirings are not required.
When using the complete type motor, BU, BV and BW must be connected when using the 3-phase wire. Connect BU, BV and BW to the R, S and T phases.

2) 1st ⅄ connection ⟷ 2nd ⅄ connection method



MC1: 3-phase contactor for establishing low-speed coil (1st ⅄ connection).
MC2: 3-phase contactor for establishing high-speed coil (2nd ⅄ connection).

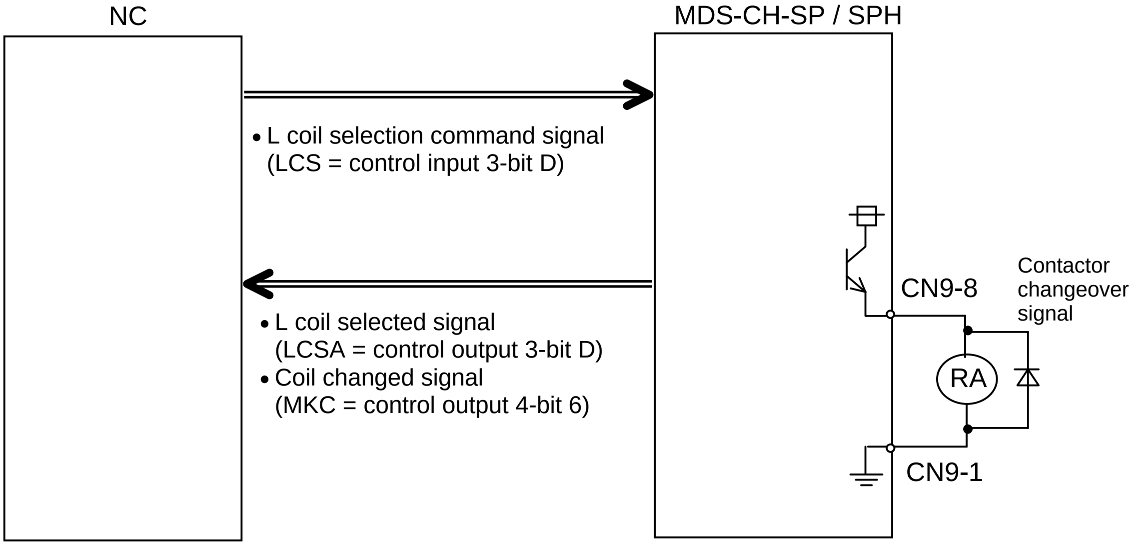
(Note 1) The contactors and relays, etc., shown above must be prepared by the machine maker.

(Note 2) A flywheel diode is connected to relay (RA), and a CR surge absorber (SK) is connected in parallel with the contactors (MC1, CM2).

(Note 3) When using the built-in motor, the fan's BU and BV wirings are not required.
When using the complete type motor, BU, BV and BW must be connected when using the 3-phase wire. Connect BU, BV and BW to the R, S and T phases.

(2) Control signals

1) Input/output signals



- L coil selection command signal (LCS = control input 3-bit D)
- L coil selected signal (LCSA = control output 3-bit D)
- Coil changed signal (MKC = control output 4-bit 6)

<Signal correspondence table>

Input signal	Output signal	Selected coil
L coil selected signal	Contactor changeover signal	
0 (OFF)	0 (OFF = relay open)	High-speed coil
1 (ON)	1 (ON = relay closed)	Low-speed coil

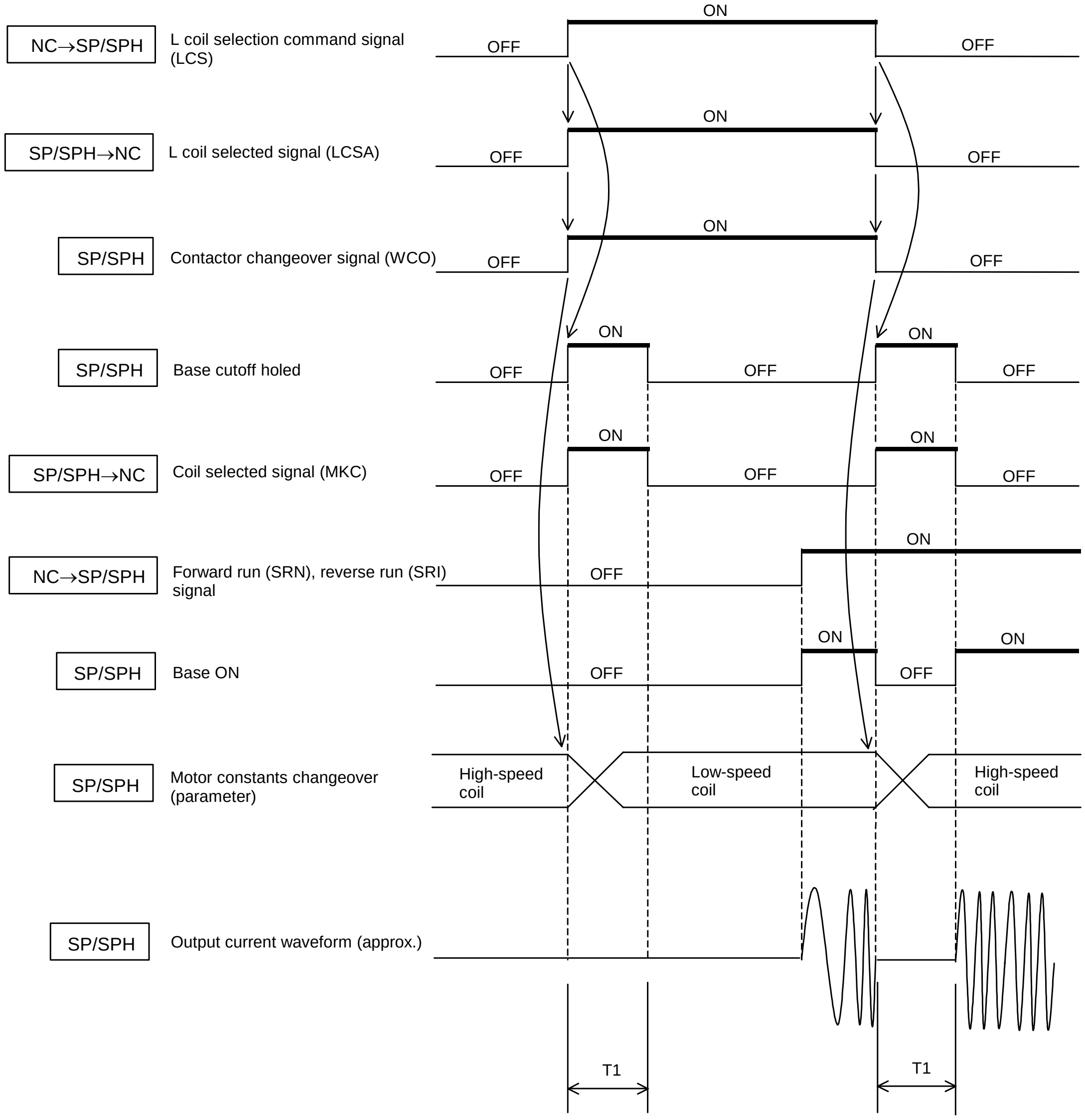
Note 1) The default coil when the spindle amplifier power is turned ON is the high-speed coil.

<Signal functions>

	Signal name	Signal address	Explanation of function
Control input signal	L coil selection command signal (LCS)	Control input 3 -bitD (LCS) (PLC device Y○○○)	• This changeover command signal selects the high-speed coil or low-speed coil. {1 ON : Select low-speed coil 0 OFF : Select high-speed coil • The coil can be changed while the motor is rotating, but if position control such as orientation, spindle/C-axis control, synchronous tap or spindle synchronization is being carried out, the coil will not change even if this L coil selection signal is input. Position control will be executed with the coil selected when position control was started. (Refer to section 6-1-4.) • Once the L coil selection signal is input, the base will remain cut off until the coil changeover operation is completed.
Control output signal	L coil selected signal (LCSA)	Control output 3 -bitD (LCSA) (PLC device X○○○)	• This is the answer signal in respect to the input signal LCS above. It can be confirmed whether the spindle amplifier has received the LCS signal.
	Coil selected signal (MKC)	Control output 4 -bit6 (MKC) (PLC device X○○○)	• This signal turns ON while the base is cut off for changeover when changing from the high-speed coil to the low-speed coil and vice versa. This signal is OFF in all other cases. • No other input commands are accepted while this signal is ON. Change the input signal while this signal is OFF.
Open emitter output	Contactor changeover signal (WCO)	–	• This is the relay drive's open emitter output for changing the high-speed coil and low-speed coil. {ON 24V output : Low-speed coil is selected OFF 0V output : High-speed coil is selected • Refer to section 3-1, and wire the relay and contactor so that the low-speed coil is selected at the 24V output and the high-speed coil is selected at the 0V output. • The contactor's ON/OFF state is changed when the L coil selection command is input and the base is cut off.

Note) Refer to the PLC Interface Manual for the NC in use for details on the numbers of the above PLC devices. Note that the coil changed signal cannot be viewed with some NC units.

2) Coil changeover operation

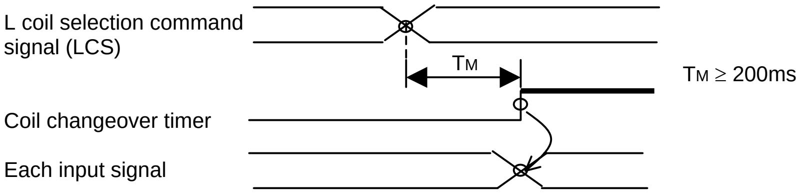


T1: Base cutoff hold time (SP059: MKT setting value Unit: ms)

Precautions

1) The spindle will accept none of the input signals (forward run command, reverse run command, orientation command, servo ON signal with position loop) during T1 (base cutoff interval) shown above. Input the signals to the spindle controller after changing the L coil selected signal (LCS) and establishing a timer of T_M (= T1 + 50ms) or more as shown below. Instead of using a timer, the signal can be input after the coil changed signal (MKC) changes from the ON to OFF state. Note that the coil changed signal cannot be viewed with some NC units.
2) The base cutoff time T1 is determined with the parameter SP059 (MKT) setting value. However, due to the relation with the contactor operation, the standard value is 150ms. Normally set T_M to 200ms or more.

Using a timer

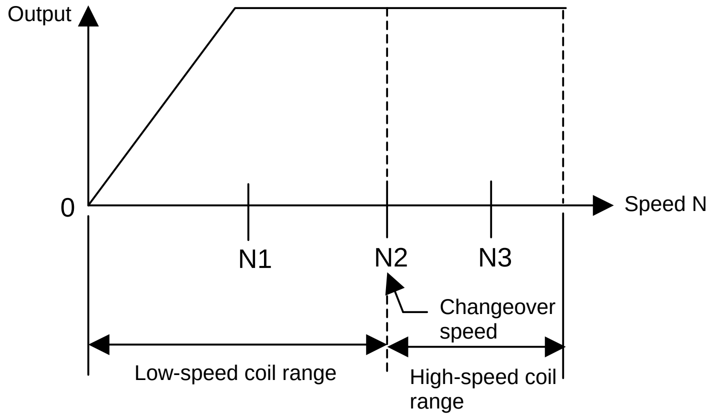


3) Changing the coil in the spindle mode

When the motor's output characteristics listed on the Mitsubishi motor rating table are as follows, N2 is the coil changeover speed, and the following expression is established.

$$\begin{cases} 0 \leq N \leq N2 \text{ is the low-speed coil usage range} \\ N2 < N \text{ is the high-speed coil usage range} \end{cases}$$

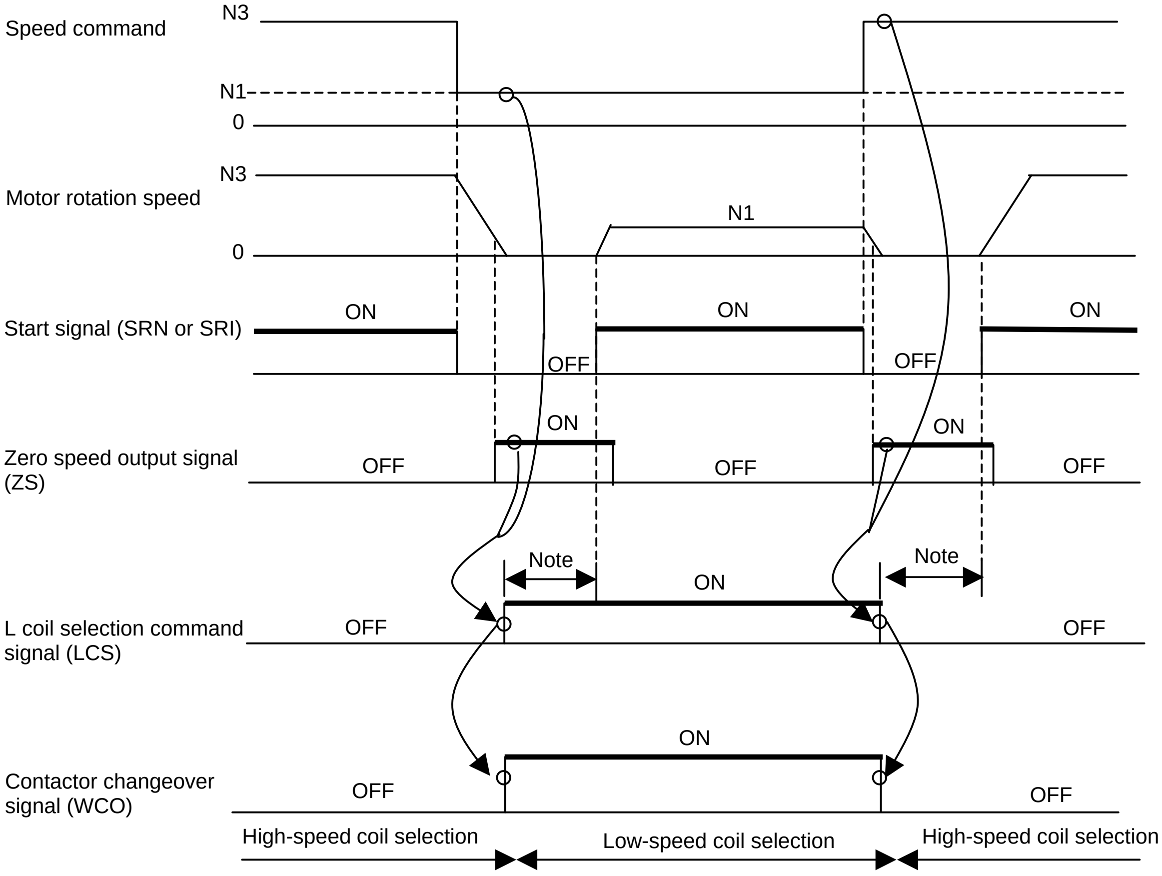
The method for inputting the L coil selection signal (LCS) to change from the low-speed coil range N1 to the high-speed coil range speed N3 is explained in this section.



Stopping the spindle motor and changing the coil

With this method, the high-speed coil and low-speed coils are viewed as electronic gears that are handled in the same manner as the mechanical gears.

<Example of N3 → N1 → N3 changeover sequence>



If the speed command changes to N1 while the motor is rotating at N3 (high-speed coil range), the motor is stopped once by the user's sequence. After confirming that the zero speed output signal (ZS) has turned ON, the L coil selection command signal (LCS) is turned ON. After changing from the low-speed coil to the high-speed coil, the start signal (SRN or SRI) is turned ON again, and the motor is accelerated to N1.

In the same manner, when changing the speed command from N1 to N3, the motor is stopped once. After confirming that the zero speed output signal (ZS) has turned ON, the L coil selection command signal is turned OFF. After changing from the high-speed coil to the low-speed coil, the start signal is turned ON, and the motor is rotated at the N3 speed.

Note 1) Provide a time longer than T_M after the L coil selection command signal (LCS) is input to when the start signal turns ON. Instead of using a timer, set the sequence so that the start signal turns ON after the coil changed signal (MKC) changes from ON to OF. Note that the coil changed signal cannot be viewed with some NC units.

Changing the coil during spindle motor rotation

This method uses the characteristics of coil changeover to change the coil during motor rotation, and changing directly from the low-speed coil to the high-speed coil. The transition time is shorter compared to the method explained in 6-1-3(1). The speed detection signal (SD) is used with this method, and the L coil selection command signal (LCS) is input in the following manner.

To accelerate from a stopped state (To accelerate after zero speed output signal turns ON)

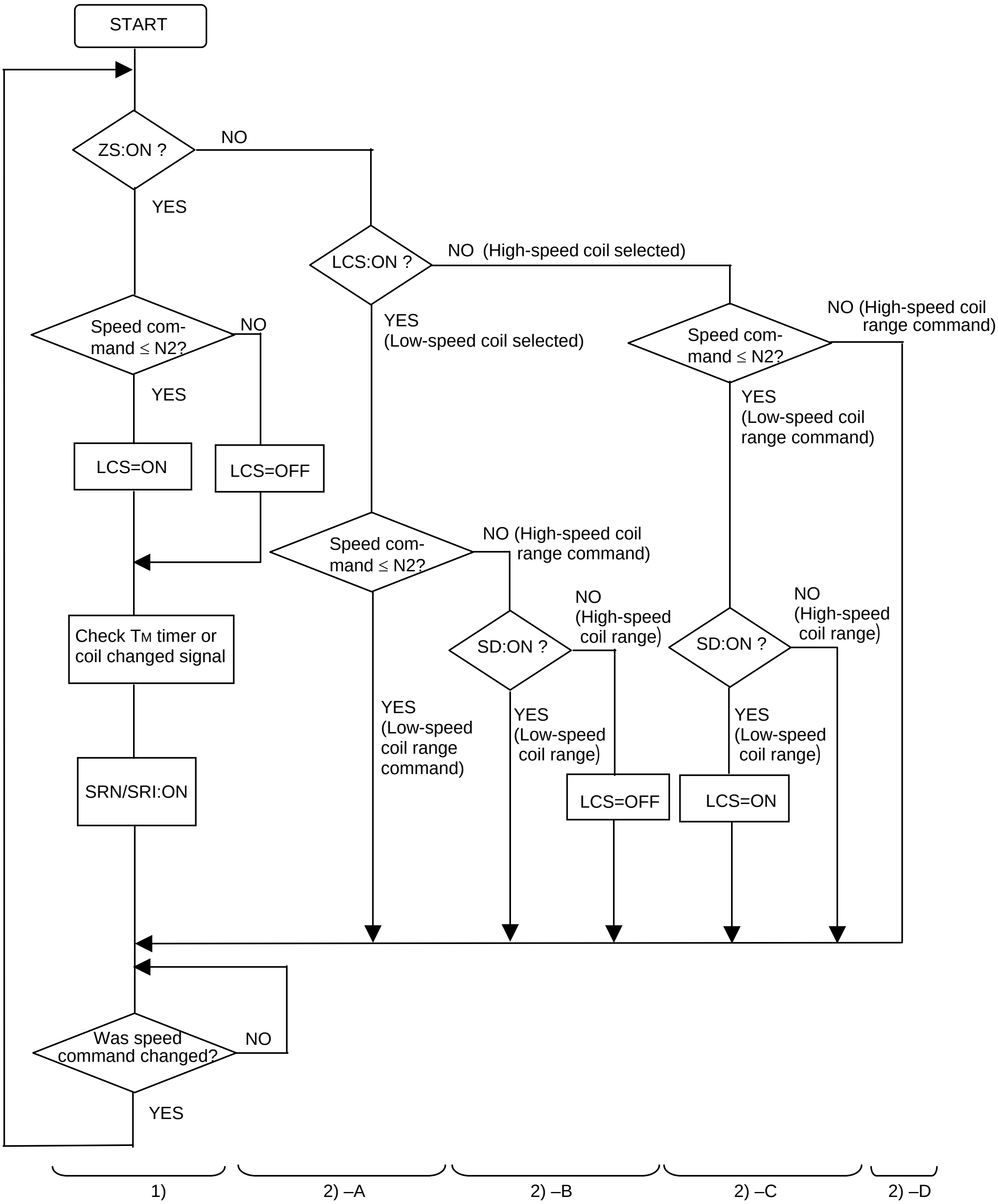
(i) First, judge the high-speed/low-speed coil range with the speed command, and select the coil. (Input the L coil selection command signal (LCS.)
(ii) Next, turn the start signal ON and accelerate the motor.
(iii) Hold the L coil selection command signal (LCS) in the state of (i).

When varying the speed, turn the L coil selection command signal (LCS) ON and OFF as shown in the following table.

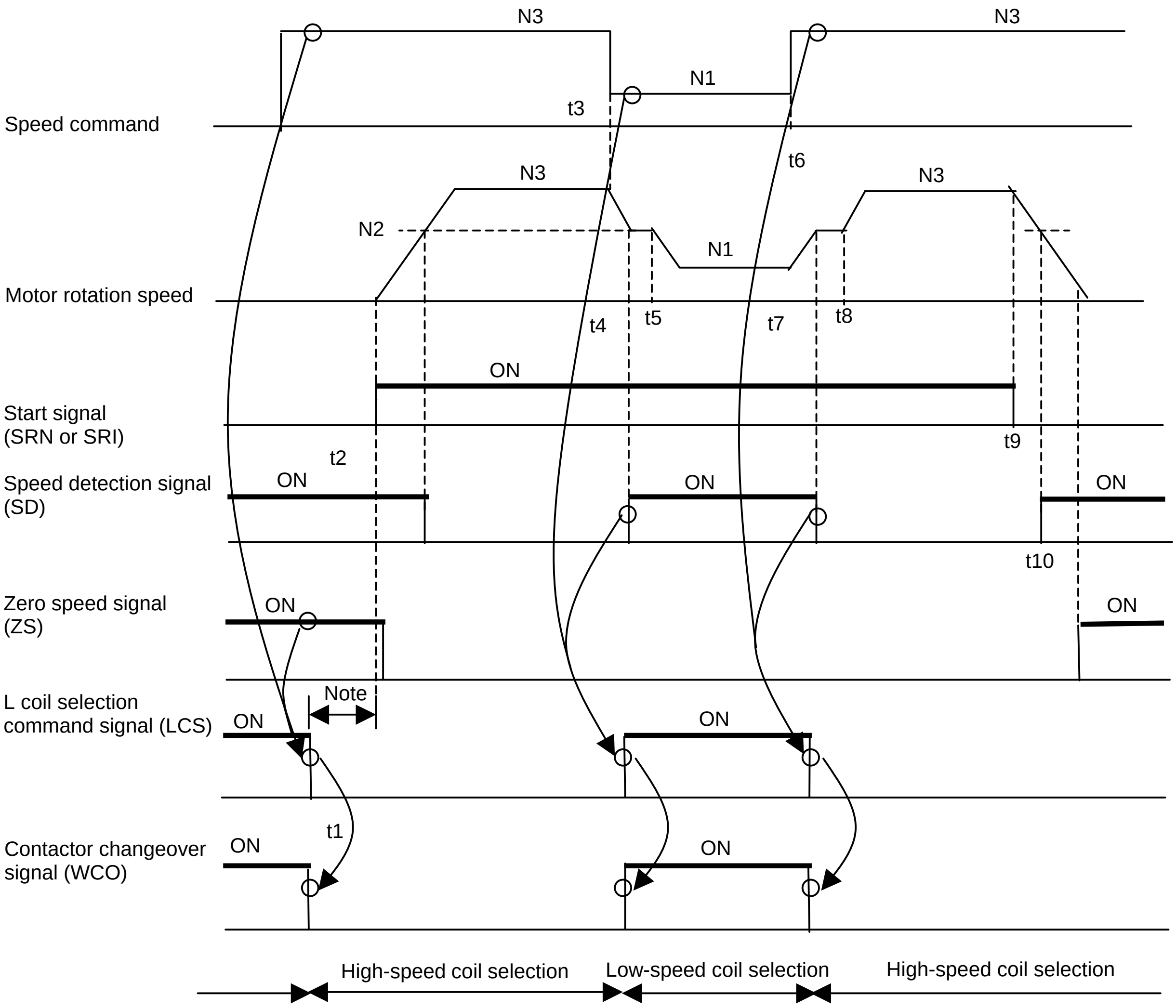
Current coil state	**When low-speed coil is selected**		**When high-speed coil is selected**	
Next speed command	Low-speed coil range Does not change (LCS: ON)	High-speed coil range Judge state of SD signal 1) SD: ON →LCS: ON 2) SD: OFF →LCS: OFF	Low-speed coil range Judge state of SD signal 1) SD: ON →LCS: ON 2) SD: OFF →LCS: OFF	High-speed coil range Does not change (LCS: OFF)
Operation mode	2) - A	2) - B	2) - C	2) - D

Note 1) The conditions in item 1) are applied to prevent the contactor from turning ON/OFF needlessly during acceleration/deceleration.
Since the speed detection signal (SD) has a hysteresis, the conditions in item 2) apply to prevent the contactor from turning ON/OFF needlessly (inconsistently) when operating near the coil change speed and continuously varying the speed.

(Reference) The generation of the signals in item 1) and 2) are shown in the following flow chart.



<0 → N3 → N1→ N3→ 0 changeover sequence>



1. When the speed command reaches N3 (high-speed coil range) at t1, the system confirms that the zero speed signal (ZS) is ON, and then turns the L coil selection command signal (LCS) OFF (high-speed coil selection). The start signal (SRN or SRI) is turned ON at t2, and the motor accelerates.
2. Next when the speed command is changed to N1 (low-speed coil range) at t3, the motor starts decelerating toward N1. However, when it reaches the coil changeover speed N2 at t4, the speed detection signal (SD) changes from OFF to ON. The system confirms that this speed detection signal (SD) has turned ON, and then changes the L coil selection command signal (LCS) from OFF (High-speed coil selection) to ON (low-speed coil selection). This changes the coil, and when completed (t5), the motor continues to decelerate to N1.
3. When the speed command is changed to N3 (high-speed coil range) at t6, the motor starts to decelerate toward N3. However, when changeover speed N2 is reached at t4, the speed detection signal (SD) changes from ON to OFF.
   The system confirms that this speed detection signal (SD) is OFF, and then changes the L coil selection command signal (LCS) from ON (low-speed coil selection) to OFF (high-speed coil selection). The coil changeover is executed with this, and when completed (t6), the motor continues to accelerate to N3.
4. When the start signal (SRN or SRI) turns OFF at t9, the motor decelerates to a stop. The speed detection signal will change from OFF to ON at t10, but this applies when stopping. Since the speed command does not change, there is no need to change the L coil selection command signal (LCS), and the motor will continue to decelerate to a stop with the high-speed coil.

Note 1) The speed detection signal (SD) detection level is set with the parameters.

Note 2) Turn the start signal ON after T_M or longer has elapsed from the input of the L coil selection command signal (LCS) or after the coil changed signal has changed from ON to OFF. Note that viewing of the coil changed signal depends on the NC Series specifications.

Changing the coil in the spindle mode ⇔ position control mode

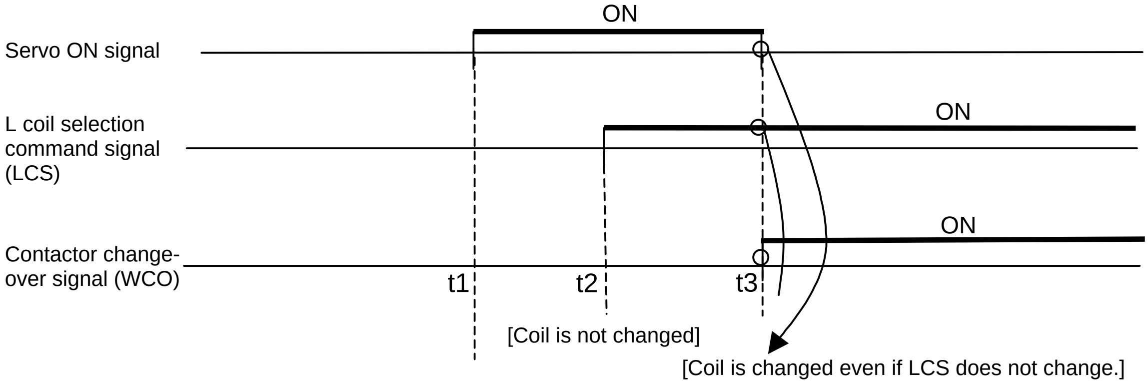
The position control mode refers to controlling the position loop for orientation control, spindle/C-axis control, synchronous tap control or spindle synchronous control. (Note that when using SPA, only orientation control is the position control mode.)
The following caution is required when inputting the L coil selection command signal (LCS) in the position control mode.

Precaution

The L coil selection command signal (LCS) will not be accepted if input after the position loop control has started.

- State with orientation command (ORC) ON.... For orientation control
- State with servo ON signal ON .... Spindle/C-axis control, synchronous tap control, spindle synchronous control, etc.

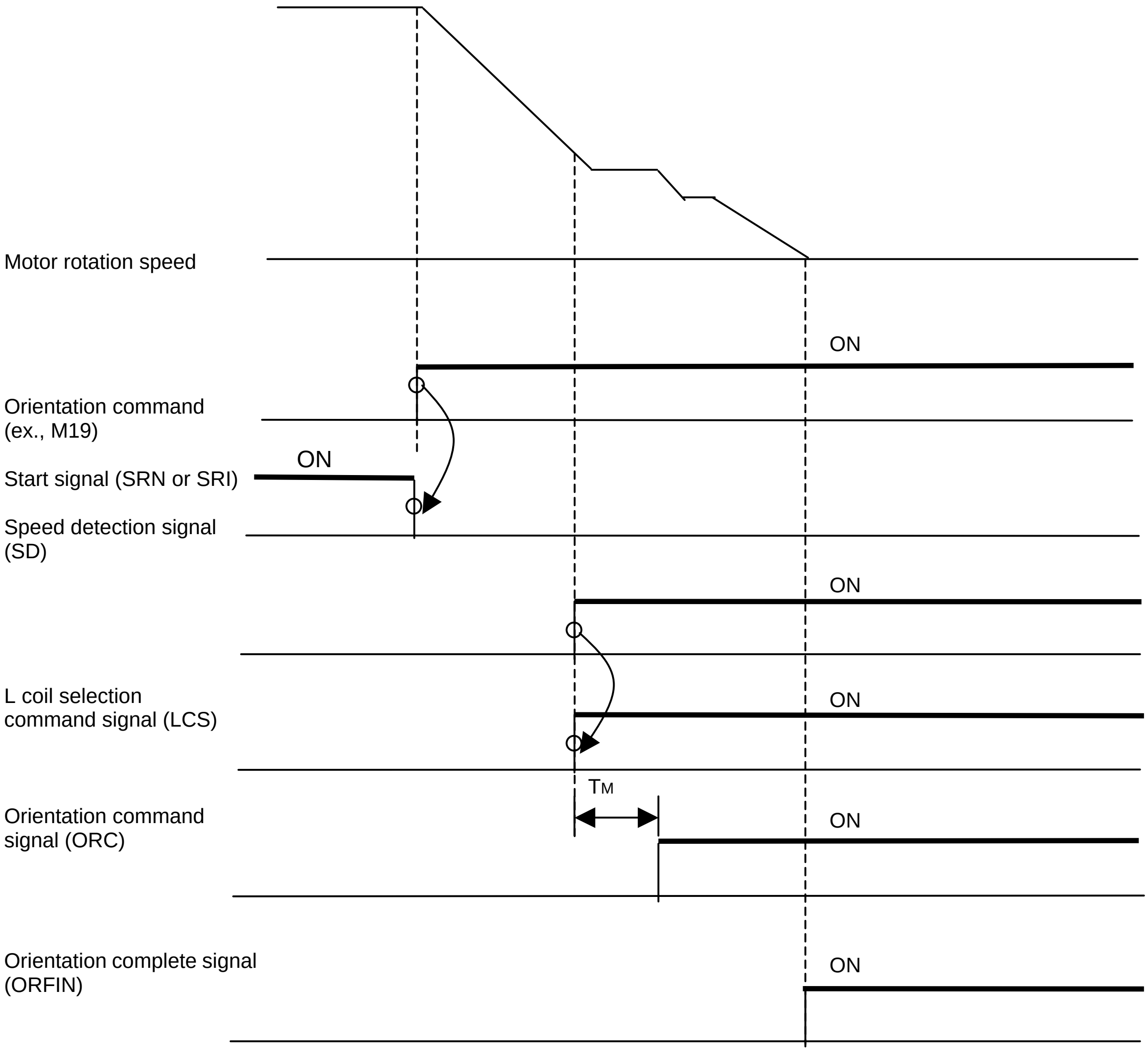
In other words, position control will be executed with the coil state active when the position loop control was started. Conversely, when the position loop control is canceled, the L coil selection signal (LCS) input will be valid. If the coil state during position loop control execution and the L coil selection signal (LCS) input after the position loop is canceled differ, the coil may be changed unintentionally when the position loop control is canceled. Thus, before starting position loop control, select the required coil beforehand (input the LCS signal). Then, start position loop control, and hold the L coil selection signal (LCS).



Each input signal must be input after the T_M or longer time has elapsed from the input of the L coil selection signal (LCS) and the coil selected signal (MKC) has changed from ON to OFF. Note that the coil changed signal cannot be viewed with some NC units.

(1) Orientation control
  1) If the orientation command (ORC) is turned ON during spindle operation, orientation will be completed with the currently selected coil. (Same as conventional mechanical gears.)
  2) If orientation is to be carried out with the low-speed coil even when operating with the high-speed coil as a means to increase the servo rigidity during orientation, use the following procedure to orient with the low-speed coil without stopping the motor once from the high-speed coil state.
    (i) First turn the start signal (SRN or SRI) OFF and decelerate the motor.
    (ii) Using the speed detection signal (SD), change the L coil selection command signal (LCS) from the high-speed coil to the low-speed coil.
    (iii) After the T_M or longer timing, or after the coil selected signal turns ON and OFF using SPA, the orientation command (ORC) turns ON.

Changing to the low-speed coil and orienting during operation with high-speed coil



2) Spindle/C-axis control
When changing from the spindle mode to the C-axis mode, following the procedures in section 3-2, and change to the low-speed coil. Then, input the servo ON signal. If the servo ON signal is input in the high-speed coil state, C-axis control will be executed with the high-speed coil. The C-axis servo torque will be small, and the required C-axis servo torque will not be attained. If the L coil selection command signal (LCS) is not held when the C-axis mode is canceled, the coil may be changed needlessly.

3) Synchronous tap control
The coil used must be fixed according to the target speed for synchronous tapping. If the state of the coil before synchronous tapping is started and the coil to be used for synchronous tapping differ, stop the spindle once, and change to the coil to be used for synchronous tapping before turning the synchronous tap servo ON signal.

4) Spindle synchronous control
Use the same procedures as for synchronous tap control.

Note) After coil changeover is completed, the current will be limited for the amount of time (Standard setting value 500ms) set in SP060. Thus, the output normally required will not be attained. This may result in faults such as a faulty accuracy or spindle overshooting in the position loop. Therefore, to carry out position loop operation after changing the coil, input the position command after the time set in SP060 has passed.

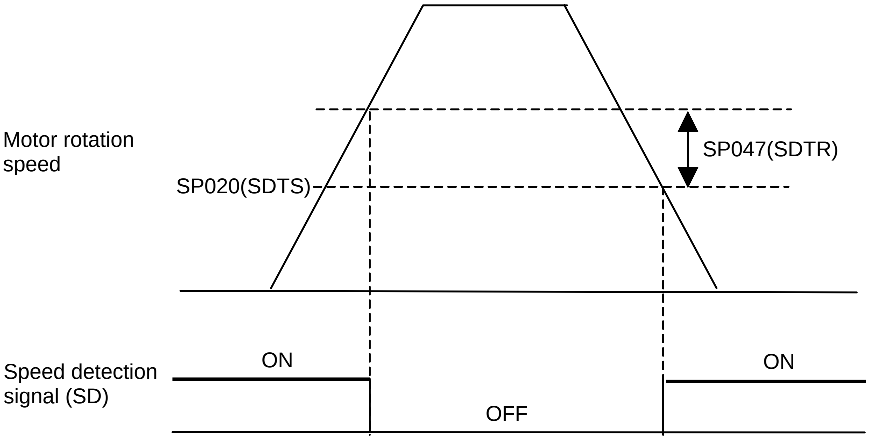
(3) Explanation of parameters for coil changeover function

Only the parameters related to the coil changeover specifications are explained in this section.

<table>
<tr><th>Name</th><th>Abbr.</th><th>Details</th><th>TYP</th></tr>
<tr><td>SP034</td><td>SFNC2</td><td>Spindle function 2
<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></td><td></td><td></td><td></td><td></td><td>mkch</td><td></td><td>mtsl</td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbr.</th><th>Details</th><th>Set 0</th><th>Set 1</th><th>Supplement</th></tr>
<tr><td>0</td><td>mtsl</td><td>Motor constant</td><td>Standard</td><td>Special</td><td></td></tr>
<tr><td>1</td><td>mkch</td><td>Coil changeover motor</td><td>Not used</td><td>Used</td><td></td></tr>
</table>
Set both Bit0 and 1 to "1".</td><td>HEX</td></tr>
<tr><td>SP035</td><td>SFNC3</td><td>Spindle function 3
<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></td><td></td><td></td><td></td><td>lbsd</td><td>hbsd</td><td>lwid</td><td>hwid</td></tr>
</table>
<table>
<tr><th>bit</th><th>Abbr.</th><th>Details</th><th>Set 0</th><th>Set 1</th><th>Supplement</th></tr>
<tr><td>0</td><td>hwid</td><td>High-speed coil wide range constant output</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>1</td><td>lwid</td><td>Low-coil wide range constant output</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>2</td><td>hbsd</td><td>High-speed coil base sliding</td><td>Invalid</td><td>Valid</td><td></td></tr>
<tr><td>3</td><td>lbsd</td><td>Low-speed coil base sliding</td><td>Invalid</td><td>Valid</td><td></td></tr>
</table></td><td>HEX</td></tr>
<tr><td>SP020</td><td>SDTS</td><td>Speed detection set value
This parameter determines the changeover speed for inputting the L coil selection command input (LCS) using the speed detection signal (SD).
The relation of the setting value and speed detection output is as shown in SP047 on the next page.

Standard setting value : Follows motor rating table
Setting range : 0 to 32767 (r/min)</td><td>DEC</td></tr>
</table>

Note) If the coil is changed without turning the NC power OFF after the parameters are changed, the changed parameters will not be validated. Validate the parameters by turning the NC power OFF once after changing the settings, and then change the coil.

Name	Abbr.	Details	TYP
SP047	SDTR	Speed detection reset value Determine the hysteresis value for the speed detection signal (SD). The relation of the setting value and speed detection output is as shown below.  Standard setting value : 300 (Lathe application) 150 (Machining application) Setting range : 0 to 1000 (r/min)	DEC
SP059	MKT	Coil changeover base cutoff time timer Set the base cutoff time for changing the contactor during coil changeover. If the setting value is small, the power will be turned ON before the contactor is changed, and may result in contactor burning. Do not change this setting unless there is a particular problem. Standard setting value : 150 Setting range : 0 to 1000 (ms)	DEC
SP060	MKT2	Coil changeover current limit timer Set the time to limit the current value after the base is cut off and then turned ON during coil changeover. When the position command is input immediately after the coil is changed during synchronous tapping, the cutting accuracy may deteriorate if this value is not small enough. When decreasing the value, make sure that the coil is changed after the motor stops even in the modes other than synchronous tap. Standard setting value : 500 Setting range : 0 to 1000 (ms)	DEC
SP061	MKIL	Coil changeover current limit value Set the current limit value for limiting the current value for the time set in SP060 when the base is cut off and then turned ON during coil changeover. Standard setting value : 75 Setting range : 0 to 120 (%)	DEC
SP0257 to SP320	RPM to BDS	H coil motor constants Set the motor constants for the high-speed coil selection.	HEX
SP0321 to SP384	RPML to BDSL	L coil motor constants Set the motor constants for the low-speed coil selection.	HEX

(4) Coil changeover contactor (magnetic contact)

1) Selection
The coil changeover contactor is selected according to the applicable spindle drive unit's capacity as shown below.
Use a contactor with an operation coil voltage that matches the power specifications in use.
Refer to section "7-2-3 Selecting the contactor" for details on the contactor specifications.

Spindle drive unit type	**Applicable contactor type**
MDS-CH-SP/SPH-55	S-N10
MDS-CH-SP/SPH-75	S-N10
MDS-CH-SP/SPH-110	S-N20
MDS-CH-SP/SPH-150	S-N25
MDS-CH-SP/SPH-185	S-N25
MDS-CH-SP/SPH-220	S-N25
MDS-CH-SP/SPH-260	S-N35
MDS-CH-SP/SPH-300	S-N50
MDS-CH-SP/SPH-370	S-N65
MDS-CH-SP/SPH-450	S-N80
MDS-CH-SP/SPH-550	S-N80
MDS-CH-SP/SPH-750	S-N150

6. Dedicated Options

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⚠ **WARNING**	Always wait at least 15 minutes after turning the power OFF, confirm that the CHARGE lamp has turned OFF, and check the voltage with a tester, etc., before connecting the option or peripheral device. Failure to observe this could lead to electric shocks.

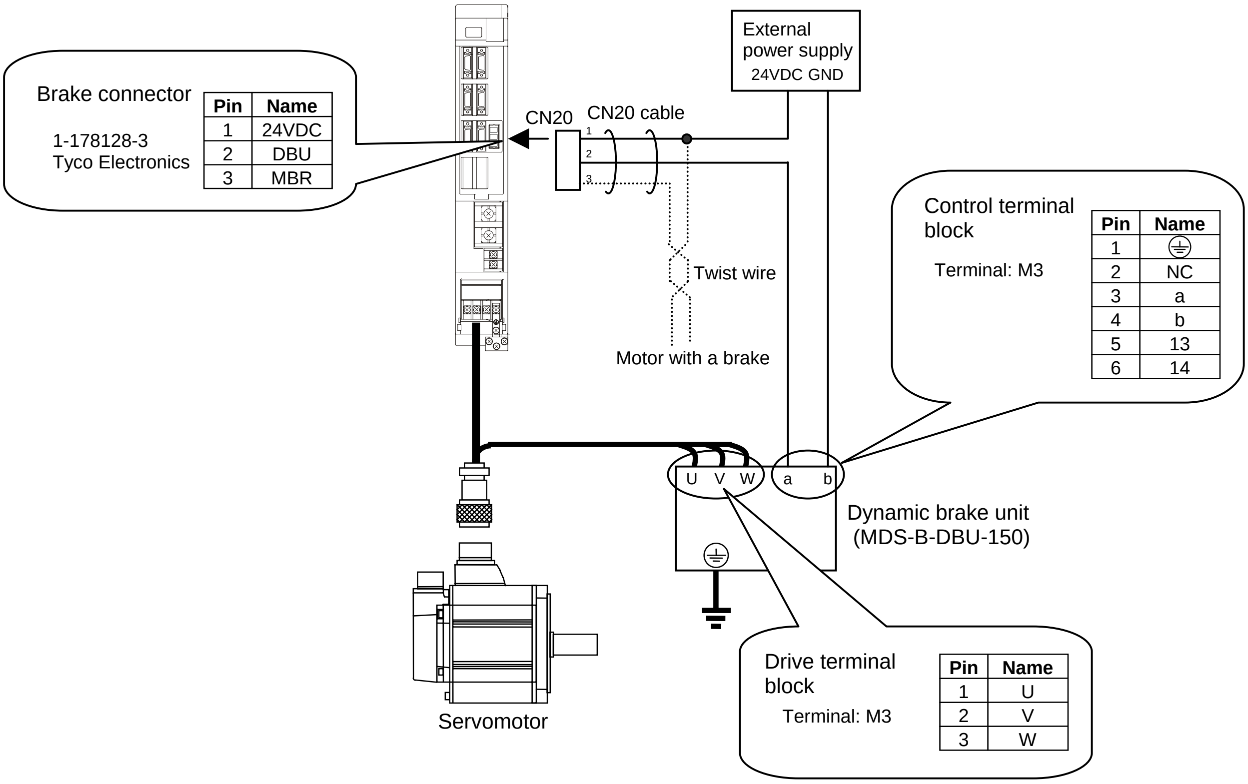
⚠ **CAUTION**	1. Use the designated peripheral device and options. Failure to observe this could lead to faults or fires. 2. Pay attention to the installation environment so that cutting chips or oil, etc., do not come in contact with the dynamic brake unit. There is a risk of short-circuit accidents at the resistor terminal block, or the burning of oil adhered on the resistor. These can lead to fires.

The ordered dedicated options are explained in this section.
(Note that parts indicated as non-ordered parts are excluded.)

6-1 Dynamic brake unit

6-1-1 Combination with servo drive unit

The 11kW and larger servo drive unit does not have built-in dynamic brakes. Always install a dynamic brake unit.
The 9kW and smaller servo drive unit has built-in dynamic brakes.



Brake connector

Pin	Name
1	24VDC
2	DBU
3	MBR

Control terminal block

Pin	Name
1	⏚
2	NC
3	a
4	b
5	13
6	14

Drive terminal block

Pin	Name
1	U
2	V
3	W

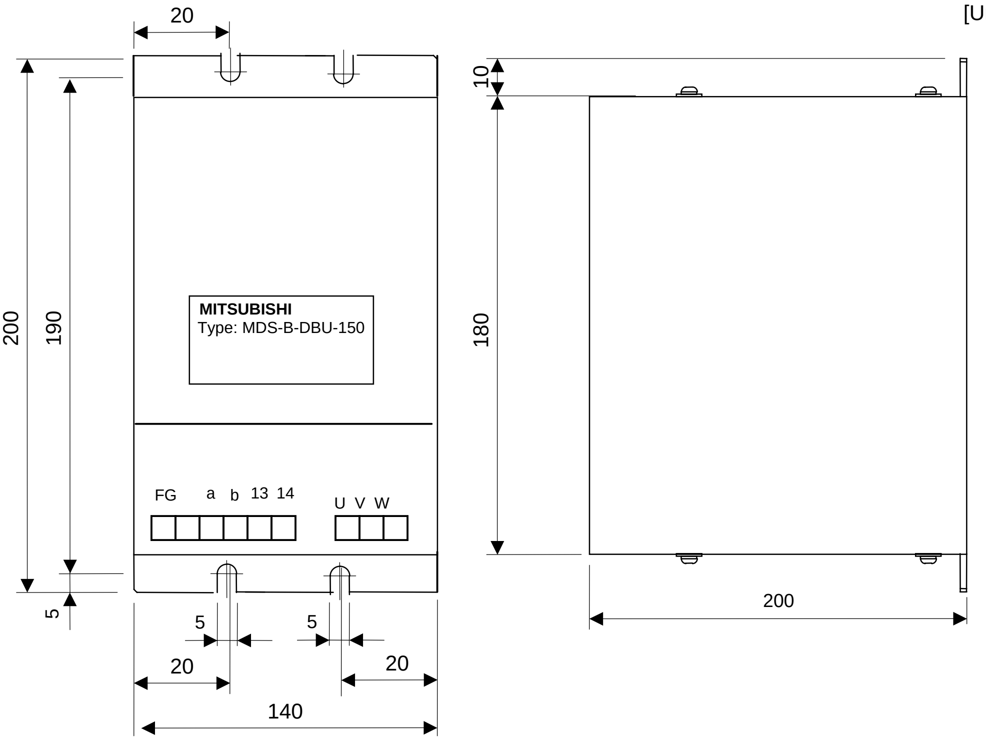
⚠ **CAUTION**	Correct wire the dynamic brake unit to the servo drive unit. Do not use for applications other than emergencies (normal braking, etc.). The internal resistor could heat up, and lead to fires or faults.

POINT	When you use a servomotor with a brake, please wire (between 1 and 3) of CN20 connector.

6-1-2 Outline dimension drawings of dynamic brake unit

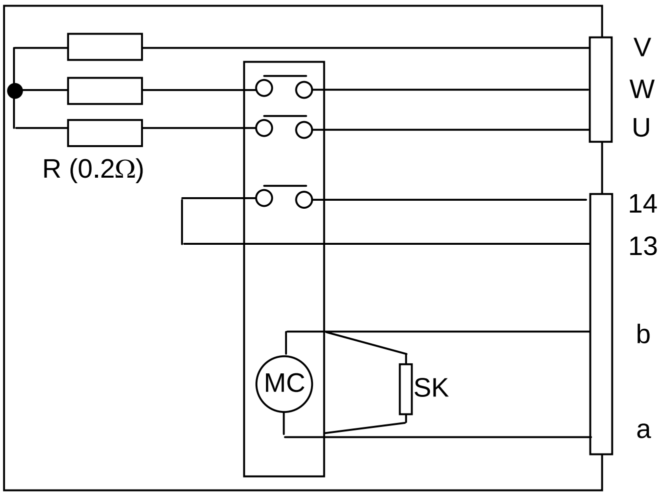
<MDS-B-DBU-150>

[Unit: mm]



Model	Corresponding unit	Weight (kg)
MDS-B-DBU-150	MDS-CH-V1-110 MDS-CH-V1-150 MDS-CH-V1-185	2

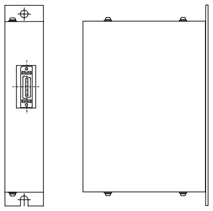
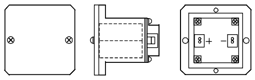
Inside wiring



6-2 Battery option

6-2-1 Battery unit

This battery option may be required to establish absolute position system. Select a battery option from the table below depending on the servo system.

Type	**MDS-A-BT-☐☐**	**FCU6-BTBOX-36**
Installation type	Unit and battery integration type	Unit and battery integration type
Hazard class	Class9 (excluding MDS-A-BT-2)	Not applicable
Number of connectable axes	2 to 8 axes	Up to 6 axes
Battery change	Not possible	Possible
Appearance	(1) 	(2) 

(1) Battery unit (MDS-A-BT-☐)

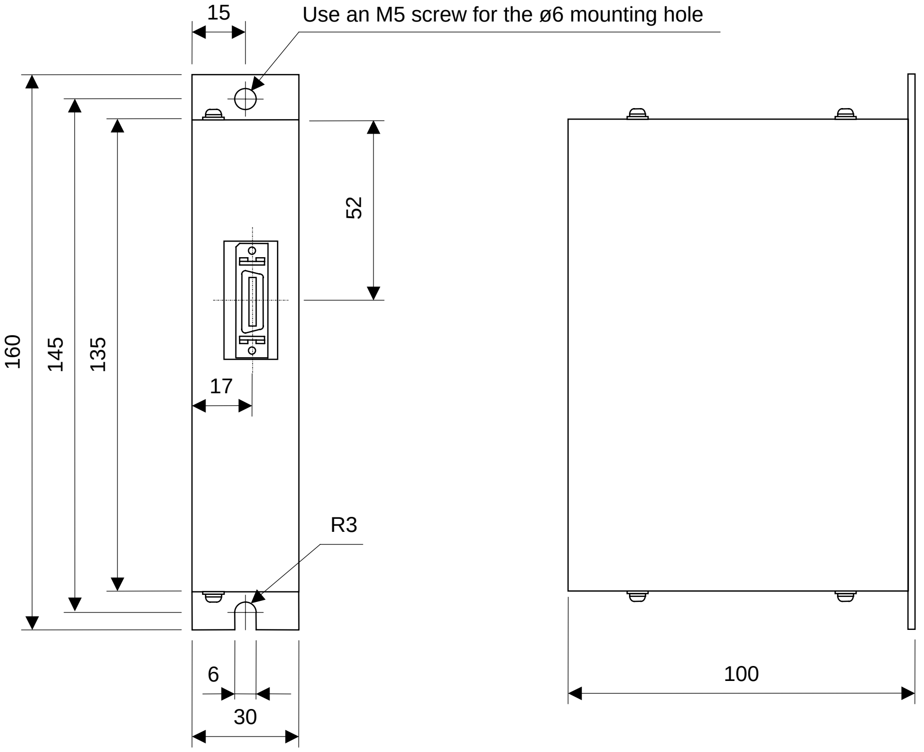
< Specifications >

Battery option type		Battery unit			
		MDS-A-BT-2	**MDS-A-BT-4**	**MDS-A-BT-6**	**MDS-A-BT-8**
Lithium battery series		ER6V			
Nominal voltage		3.6V			
Nominal capacity		4000mAh	8000mAh	12000mAh	16000mAh
Battery safety	Hazard class	Class 9			
	Battery shape	Set battery			
	Number of batteries used	ER6V x 2	ER6V x 4	ER6V x 6	ER6V x 8
	Lithium alloy content	1.3g	2.6g	3.9g	5.2g
	Mercury content	1g or less			
Number of connectable axes		Up to 2 axes	Up to 4 axes	Up to 6 axes	Up to 8 axes
Battery continuous backup time		Approx. 30000 hours			
Battery useful life (From date of unit manufacture)		7 years			
Data save time in battery replacement		HC-H series: approx. 20 hours at time of delivery, approx. 10 hours after 5 years			
Back up time from battery warning to alarm occurrence (Note)		Approx. 100 hours			
Weight		600g			

(Note) This time is a guideline, so does not guarantee the back up time. Replace the battery with a new battery as soon as a battery warning occurs.

< Outline dimension drawings >

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



[Unit: mm]

(2) Battery unit (FCU6-BTBOX-36)

< Specifications >

Battery option type		**Battery unit**
		FCU6-BTBOX-36 (**Note1**)
Lithium battery series		2CR5
Nominal voltage		6.0V (Lithium battery), 3.6V (Output)
Nominal capacity		2600mAh
Battery safety	Hazard class	-
	Battery shape	Single battery
	Number of batteries used	2CR5×2
	Lithium alloy content	1.96g
	Mercury content	1g or less
Number of connectable axes		Up to 6 axes
Battery continuous backup time		Approx. 5000 hours (when 6 axes are connected)
Battery useful life (From date of unit manufacture)		5 years [Note2]
Data save time in battery replacement		HC-H series: approx. 20 hours at time of delivery, approx. 10 hours after 5 years
Back up time from battery warning to alarm occurrence (Note3)		Approx. 30 hours (when 6 axes are connected)
Weight		200g

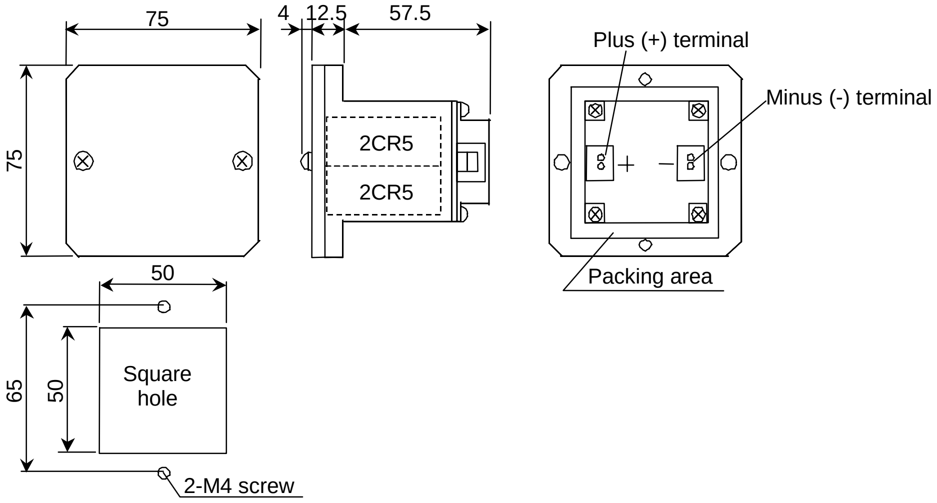
(Note1) A lithium battery in FCU6-BTBOX-36 is commercially available. The battery for replacement has to be prepared by the user.

(Note2) Use new batteries (nominal capacity 1300mAh or more) within five years from the date of manufacture. The batteries should be replaced once a year.

(Note3) This time is a guideline, so does not guarantee the back up time. Replace the battery with a new battery as soon as a battery warning occurs.

< Outline dimension drawings >

- **FCU6-BTBOX-36**



Panel cut drawing

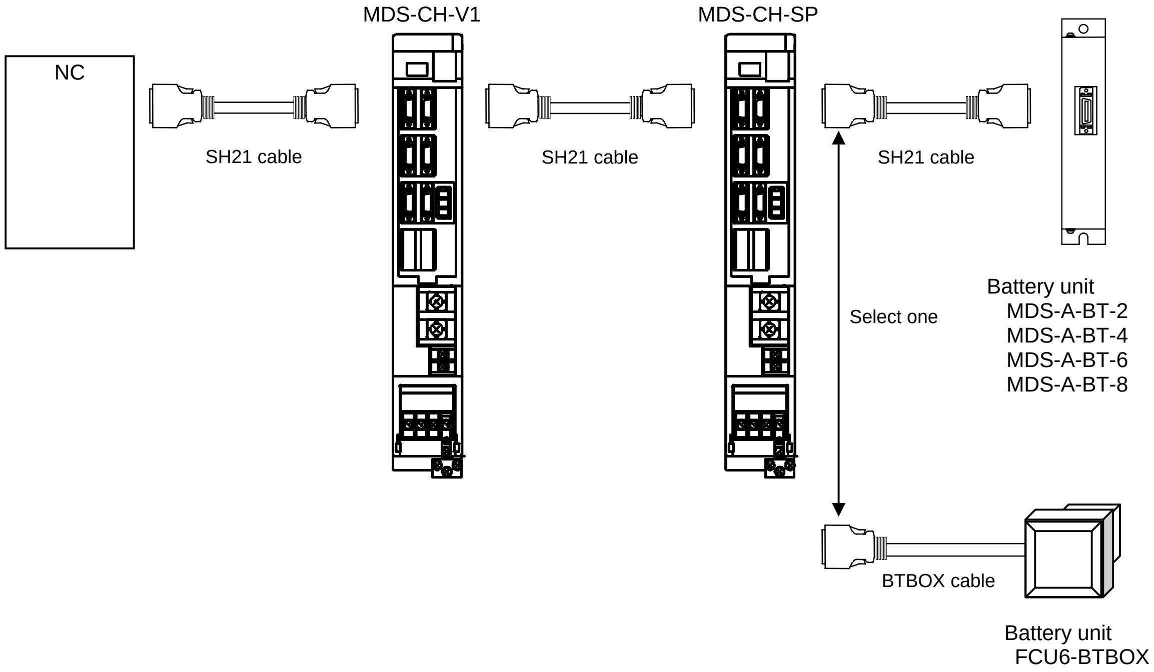
[Unit: mm]

⚠ CAUTION

1. On January 1, 2003, new United Nations requirements, "United Nations Dangerous Goods Regulations Article 12", became effective regarding the transportation of lithium batteries. The lithium batteries are classified as hazardous materials (Class 9) depending on the unit. (Refer to Appendix 4.)
2. The lithium battery must be transported according to the rules set forth by the International Civil Aviation Organization (ICAO), International Air Transportation Association (IATA), International Maritime Organization (IMO), and United States Department of Transportation (DOT), etc. The packaging methods, correct transportation methods, and special regulations are specified according to the quantity of lithium alloys. The battery unit exported from Mitsubishi is packaged in a container (UN approved part) satisfying the standards set forth in this UN Advisory.
3. To protect the absolute value, do not shut off the servo drive unit control power supply if the battery voltage becomes low (warning 9F).
4. Contact the Service Center when replacing the MDS-A-BT Series and cell battery.
5. Replace the FCU6-BTBOX-36 battery with a new battery (2CR5) within the recommended service period. This battery is commercially available for use in cameras, etc.
6. The battery life (backup time) is greatly affected by the working ambient temperature. The above data is the theoretical value for when the battery is used 8 hours a day/240 days a year at an ambient temperature of 25°C. Generally, if the ambient temperature increases, the backup time and useful life will both decrease.

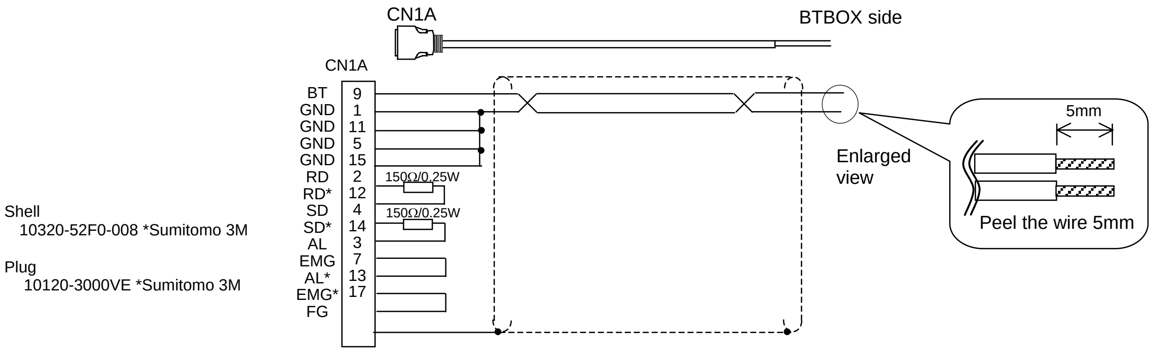
6-2-2 Connection

A terminal connector is built-in, so set as the final connection of the NC and communication cable.



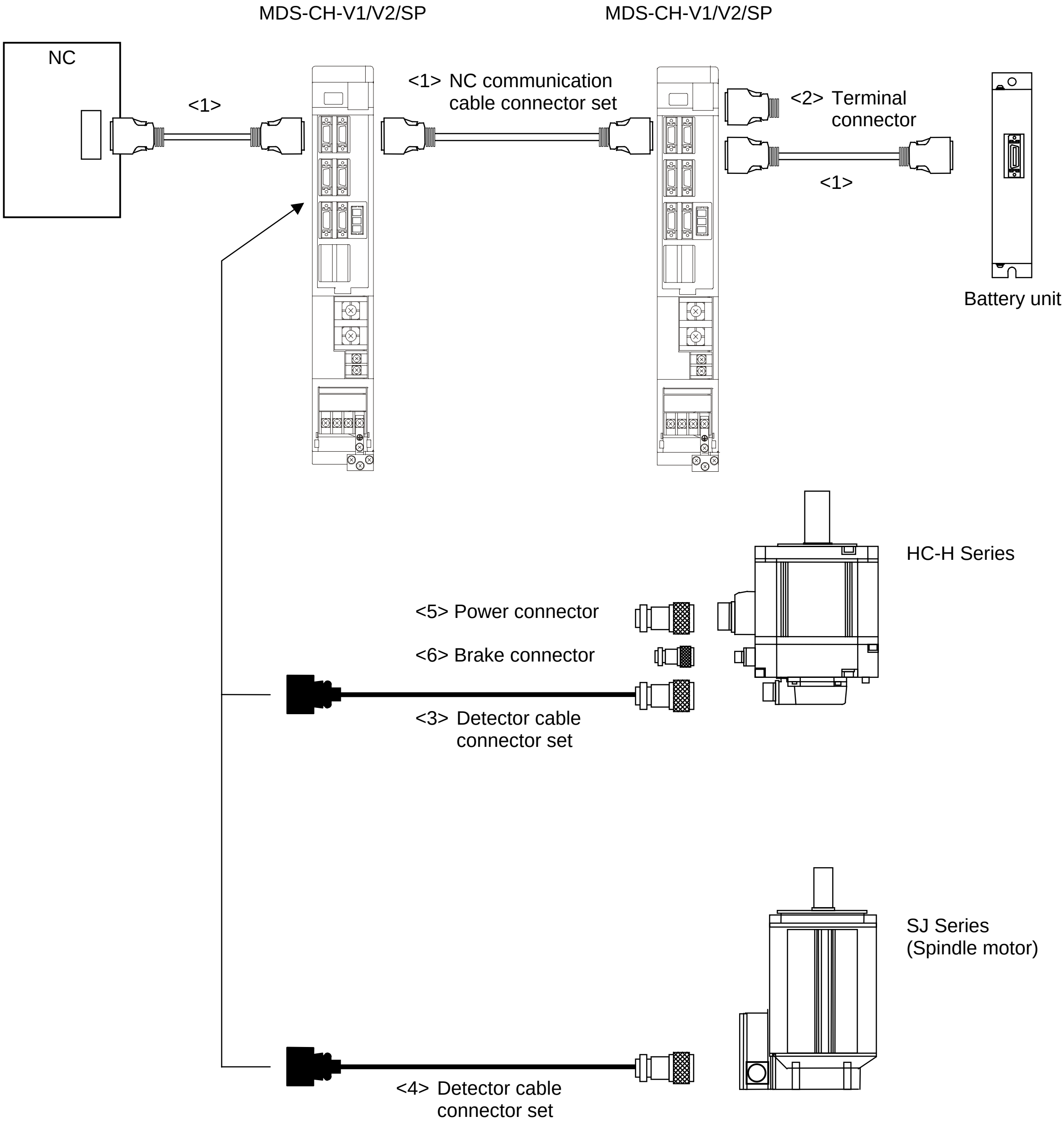
6-2-3 Dedicated battery cable drawing

Refer to the following cable drawing, and manufacture the cable connected to the FCU6-BTBAT.

Cable type: BTBOX cable	**Application: Battery cable for detector backup**	
		

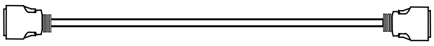
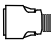
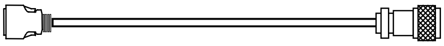
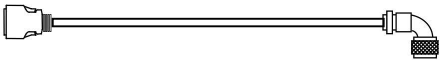
6-3 Cables and connectors

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.

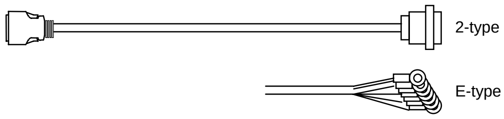
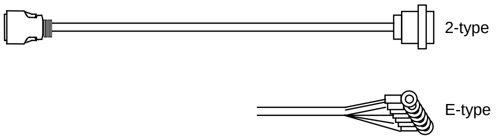
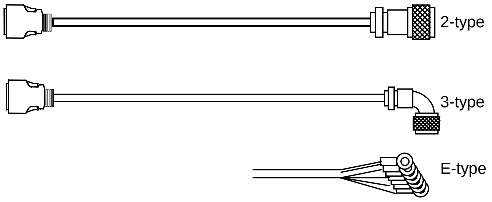


6-3-1 Cable option list

(1) Cables

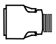
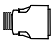
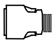
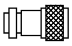
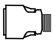
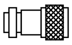
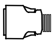
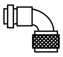
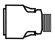
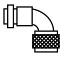
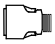
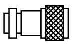
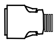
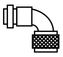
Item		Model	Contents	
For CN1A, CN1B	<1> Communication cable for CNC - Drive unit Drive unit - Drive unit	SH21 Length: 0.35, 0.5, 0.7, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 9, 10, 15, 20, 30m (FCUA-R000 and MR-J2HBUS[ ]M can also be used.)	Servo drive unit side connector (3M) Connector : 10120-6000EL Shell kit : 10320-3210-000 	Servo drive unit side connector (3M) Connector : 10120-6000EL Shell kit : 10320-3210-000
	<2> Terminal connector	A-TM (FCUA-A-TM can also be used.)	Terminal connector 	
For CN2	<3> Detector cable for HC-H [ ]-A51/E51, HC-H [ ]-A42/E42	CNV12-0-□□-□ Drive unit side connector Blank: One-touch lock S: Screw lock Environment Blank: For general environment P: IP65 compatible Detector side connector 2: Straight cannon 3: Angle cannon	Servo drive unit side connector (3M) • Detector connector straight specification Connector : 10120-3000VE Shell kit : 10320-52F0-008 (One-touch type lock) Shell kit: 10320-52A0-008 (Screw-type lock) 	Servomotor detector side connector (DDK) For general environment Straight connector : MS3106B22-14S Clamp: MS3057-12A IP65 compatible Connector : MS3106A22-14S (D190) Straight back shell: CE02-22BS-S Clamp: CE3057-12A-3
		Length: 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 20, 30m (FCUA-R080 (straight cannon) and FCUA-R084 (angle cannon) can also be used.)	• Detector connector angle specification Connector : 10120-3000VE Shell kit : 10320-52F0-008 (One-touch type lock) Shell kit; 10320-52A0-008 (Screw-type lock) 	For general environment Angle connector : MS3108B22-14S Clamp: MS3057-12A IP65 compatible Connector : MS3106A22-14S (D190) Angle back shell: CE-22BA-S Clamp: CE3057-12A-3

(Note) The connector maker may change without notice.

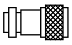
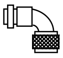
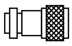
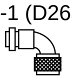
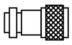
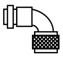
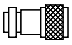
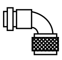
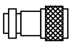
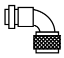
Item		Model	Contents
For CN5	<4> PLG detector cable for SJ spindle	CNP5S - □ Connector type 2: Connector E: Crimped terminal Length: 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 20, 30m	Spindle drive unit side connector (3M) Connector: 10120-3000VE Shell kit: 10320-52F0-008 Spindle motor side connector For 2-type (Tyco Electronics) Housing: 178289-6 Pin: 1-175217-2 For E-type (J.S.T.) Crimped terminal: V1.25-4 
For CN6	<4> For SJ spindle Magnetic sensor orientation cable Encoder orientation cable	CNP6 □ - □ Connector type 2: Connector E: Crimped terminal Type A: Encoder M: Magnetic sensor Length: 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 20, 30m	Spindle drive unit side connector (3M) Connector: 10120-3000VE Shell kit: 10320-52F0-008 Spindle motor side connector For M-2- type (Tajimi Musen) Connector: TRC116-12A10-7F10.5 For A-2-type (DDK) Connector: MS3106B20-29S For E-type (J.S.T.) Crimped terminal: V1.25-4 
For CN7	<4> C-axis control cable for SJ spindle	CNP7 □ A - □ Connector type 2: Connector (Straight) 3: Connector (Right angle) E: Crimped terminal Type A: OSE90K + 1024 Other connections Black: None 1: Connect with NC 6: Connect with CN6 Length: 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 20, 30m	Spindle drive unit side connector (3M) Connector: 10120-3000VE Shell kit: 10320-52F0-008 Spindle motor side connector For A-2-type (DDK) Connector: MS3106B20-29S For A-3-type (DDK) Connector: MS3108B20-29S Clamp: MS3057-12A For E-type (J.S.T) Crimped terminal: V1.25-4 

(Note) The connector maker may change without notice.

(2) Connector sets

Item				Model	Contents	
For CN1A, CN1B	<1> Communication connector set for CNC - Drive unit Drive unit - Drive unit			FCUA-CS000	Servo drive unit side connector (3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 	Servo drive unit side connector (3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 
For CN2	<3> Detector cable connector set for HC-H[_]-A51/A42 HC-H[_]-E51/E42	IP65 and EN standard compati-ble	Straight	ENCP22-14S3 Compliant cable range ø6.8 to ø10 (when using A14B2343) Refer to section "6-4-4".	Servo drive unit side connector (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 
				ENCP22-14S2 Compliant cable range ø9.5 to ø13	Servo drive unit side connector (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-2 
			Angle	ENCP22-14L3 Compliant cable range ø6.8 to ø10 (when using A14B2343) Refer to section "6-4-4".	Servo drive unit side connector (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 
				ENCP22-14L2 Compliant cable range ø9.5 to ø13	Servo drive unit side connector (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-2 
		For general environ-ment	Straight	FCUA-CS080	Servo drive unit side connector (3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 	Servomotor detector side connector (DDK) Connector : MS3106B22-14S Clamp: MS3057-12A 
			Angle	FCUA-CS084	Servo drive unit side connector (3M) Connector : 10120-3000VE Shell kit : 10320-52F0-008 	Servomotor detector side connector (DDK) Connector : MS3108B22-14S Clamp: MS3057-12A 
For CN5, CN6, CN7	<4> SJ spindle detector cable connector set				A dedicated connector set is not prepared. The FCUA-CS000 set can be used on the drive unit side.	

(Note) The connector maker may change without notice.

Item				Model	Contents
For motor power	<5> Power connector for HC-H52 to 352, HC-H53 to 353	IP67 and EN standard compatible	Straight	Special order part	Servomotor side power connector (JAE) Plug: JL04V-6A22-22SE-EB Clamp: JL04-2022CK (14) 
			Angle	Special order part	Servomotor side power connector (JAE) Plug: JL04V-8A22-22SE-EB Clamp: JL04-2022CK (14) 
	Power connector for HC-H452 to 1102, HC-H453 to 1103	IP67 and EN standard compatible	Straight	PWCE32-17S Compliant cable range ø22 to ø23.8	Servomotor side power connector (DDK) Connector: CE05-6A32-17SD-B-BSS Clamp: CE3057-20A-1 (D265) 
			Angle	PWCE24-10L Compliant cable range Ø13 to ø15.5	Servomotor side power connector (DDK) Connector: CE05-8A32-17SD-B-BAS Clamp: CE3057-20A-1 (D265) 
		For general environment	Straight	FCUA-CN811	Servomotor side power connector (DDK) Connector: MS3106B32-17S Clamp: MS3057-20A 
			Angle	FCUA-CN815	Servomotor side power connector (DDK) Connector: MS3108B32-17S Clamp: MS3057-20A 
For motor brake	<6> Brake connector for HC-H52B to 1102B, HC-H53B to 1103B	IP67 and EN standard compatible	Straight	BPKP10SL-4S Compliant cable range ø5 to ø8.3 (MR-BKCN can also be used.)	Servomotor side brake connector Connector: MS3106A10SL-4S (D190) (DDK) Clamp: YSO10-5-8 (DAIWA DENGYO) 
			Angle	BRKP10SL-4L Compliant cable range ø5 to ø8.3	Servomotor side brake connector Connector: MS3106A10SL-4S (D190) (DDK) Clamp: YLO10-5-8 (DAIWA DENGYO) 
		For general environment	Straight	FCUA-CN804	Servomotor side brake connector (Japan Aviation Electronics) Connector: MS3106B10SL-4S Clamp: MS3057-4A 
			Angle	FCUA-CN808	Servomotor side brake connector (Japan Aviation Electronics) Connector: MS3108B10SL-4S Clamp: MS3057-4A 

(Note) The connector maker may change without notice.

6-3-2 Connector outline dimension drawings

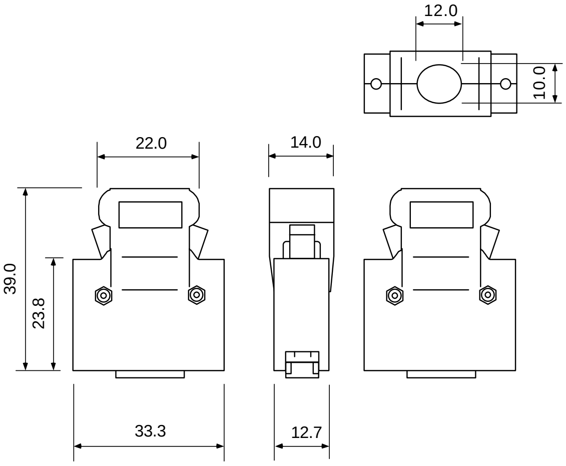
Connector for CN1A, CN1B, CN2, CN3, CN4, CN5, CN6, CN9

Maker: 3M (Ltd.)

<Model>

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

[Unit: mm]



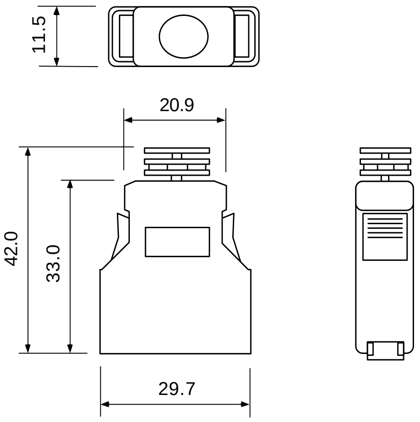
Maker: 3M (Ltd.)

<Model>

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 terminal connector (A-TM) also has the same outline.

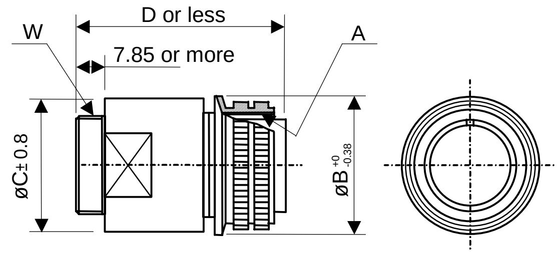
[Unit: mm]



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

Straight plug

Maker : DDK (Ltd.)

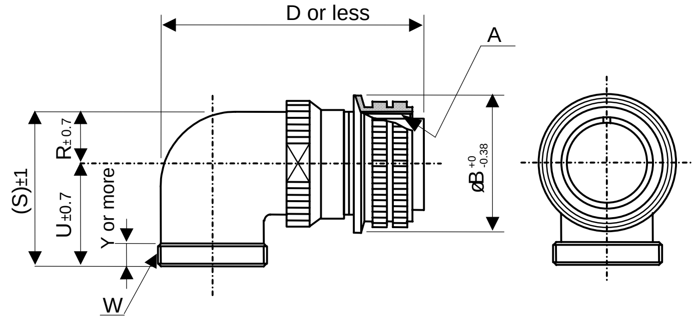


[Unit: mm]

Model	A	B	C	D	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
CE05-6A32-17SD-B-BSS	2-18UNS-2B	56.33	54.2	79	$1^{3}/_{4}$-18UNS-2A

Angle plug

Maker : DDK (Ltd.)

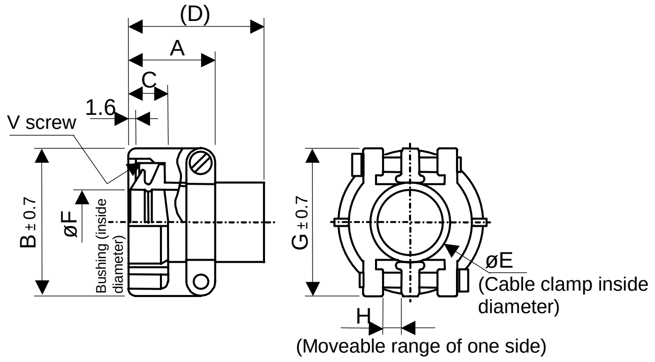


[Unit: mm]

Model	A	B	D	W	R	U	S	Y
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
CE05-8A32-17SD-B-BAS	2-18UNS-2B	56.33	93.5	$1^{3}/_{4}$-18UNS-2A	24.6	44.5	61.9	8.5

Cable clamp

Maker : DDK (Ltd.)



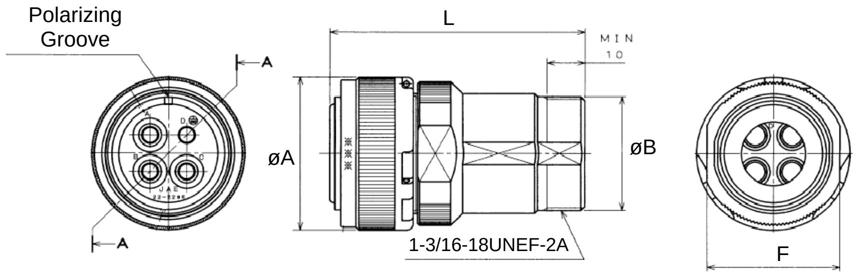
[Unit: mm]

Model	Shell size	Total length A	Outside dia. B	Effective screw length C	D	E	F	G	H	Installation screw (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 to 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 to ø13
CE3057-12A-3 (D265)							10				CE3420-12-3	ø6.8 to ø10
CE3057-20A-1 (D265)	32	27.8	51.6	11.9	43.0	31.7	23.8	51.6	6.3	$1^{3}/_{4}$-18UNS-2B	CE3420-20-1	ø22 to ø23.8

Connectors for motor power (IP67 and EN standard compatible)

Straight plug

Maker : Japan Aviation Electronics (Ltd.)

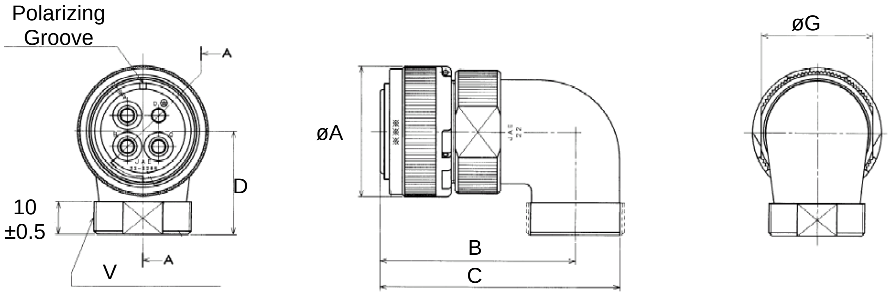


[Unit: mm]

Model	Contact configuration		øA ±0.8	øB ±0.2	L ±0.8	F ±0.5	øG ±0.5	V screw
	Layout symbol	Size × No. of cores						
JL04V-6A22-22SE-EB	22-22	#8 × 4	40.5	30.05	67.63	35	17	1-3/16-18UNEF-2A

Right angle plug

Maker : Japan Aviation Electronics (Ltd.)

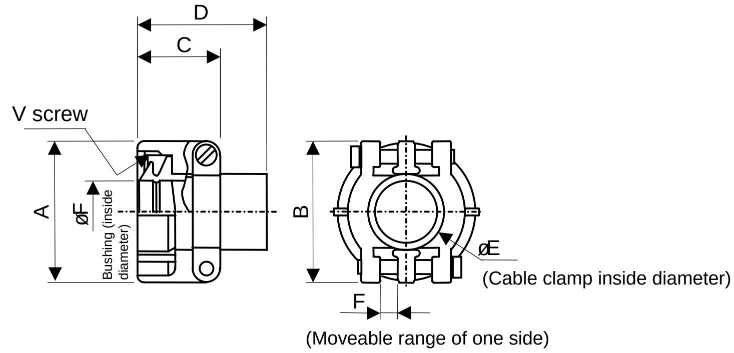


[Unit: mm]

Model	Contact configuration		øA ±0.8	øB ±0.8	C ±0.8	D ±0.8	øG ±0.5	V screw
	Layout symbol	Size × No. of cores						
JL04V-8A22-22SE-EB	22-22	#8 × 4	40.5	60.23	73.93	32	17	1-3/16-18UNEF-2A

Cable clamp

Maker : Japan Aviation Electronics (Ltd.)

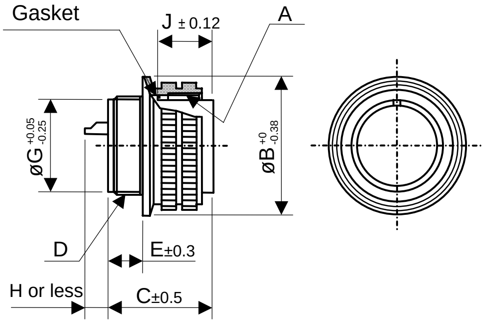


[Unit: mm]

Model	A ±0.8	B ±0.8	C ±0.8	D ±0.8	øE ±0.8	F ±0.8	W screw	Applicable cable diameter
JL04V-2022CK (14)	37.3	34.9	24.3	53.8	15.9	4	1-3/16-18UNEF-2A	ø 12.9 to ø15.9

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

Straight plug
Maker : DDK (Ltd.)

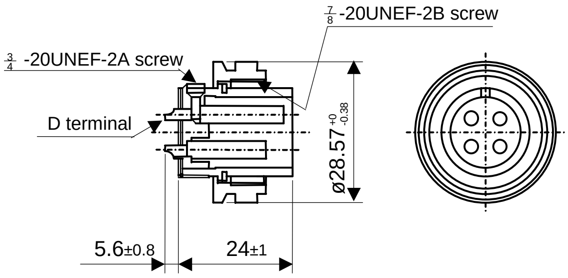


[Unit: mm]

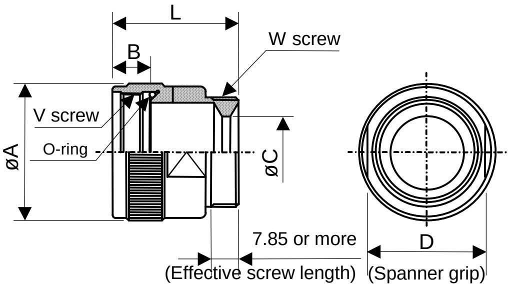
Model	A	B	C	D	E	G	J
MS3106A10SL-4S (D190)	$^{5}/_{8}$-24UNEF-2B	22.22	23.3	$^{9}/_{16}$-24UNEF-2A	7.5	12.5	13.49
MS3106A22-14S (D190)	$1^{3}/_{8}$-18UNEF-2B	40.48	34.11	$1^{1}/_{4}$-18UNEF-2A	12.15	29.9	18.26

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

[Unit: mm]



Straight back shell
Maker : DDK (Ltd.)

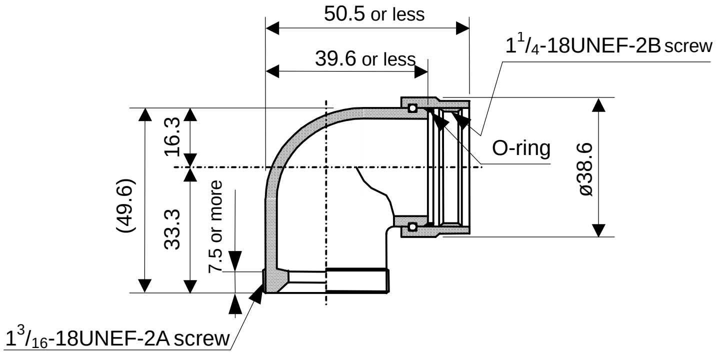


[Unit: mm]

Model	L	A	B	C	D	V	W
CE02-22BS-S	35	36.5	10.9	17.8	32.4	$1^{1}/_{4}$-18UNEF-2B	$1^{3}/_{16}$-18UNEF-2A

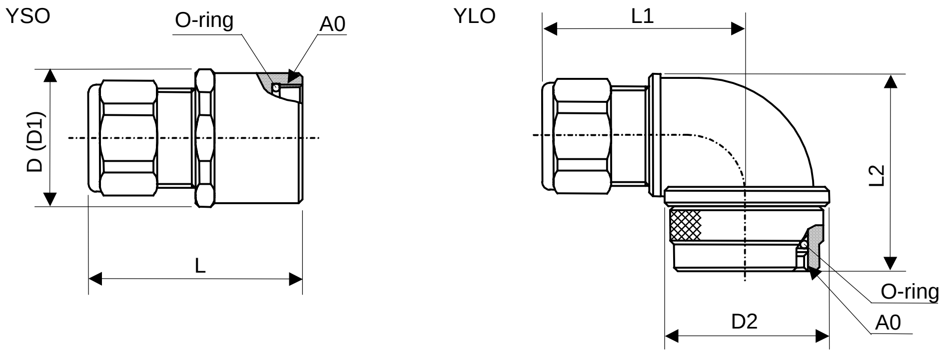
Angle back shell
Maker : DDK (Ltd.)
Model : CE-22BA-S

[Unit: mm]



Connectors for motor power and brake (IP67 and EN standard compatible)

Cable clamp
Maker : DAIWA DENGYO (CO., LTD.)



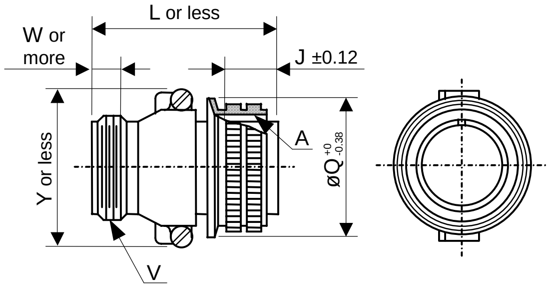
[Unit: mm]

Model	Accommodating outside diameter	American standard screw A0	Length before tightening			Side to side	Corner to corner	
			L	L1	L2	D	D1	D2
YSO10-5 to 8, YLO10-5 to 8	ø5 to 8.3	$^{9}/_{16}$-24UNEF-2B	43	39	42.5	24	26	26
YSO14-9 to 11	ø8.3 to 11.3	$^{3}/_{4}$-20UNEF-2B	44	43.5	44.5	26	28	35

Connectors for detector, motor power and brake (for general environment)

Straight plug

Maker : DDK (Ltd.)

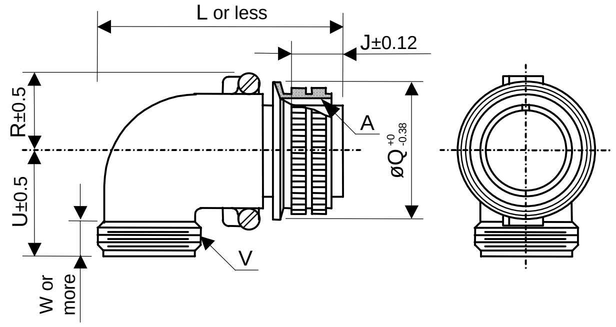


[Unit: mm]

Model	Coupling screw A	Length of coupling section J	Total length L	Connection nut outside diameter Q	Cable clamp installation screw V	Effective screw length W	Max. width Y
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 MS3106B22-23S	1$^{3}/_{8}$-18UNEF	18.26	55.57	40.48	1$^{3}/_{16}$-18UNEF	9.53	50
MS3106B32-17S	2-18UNEF	18.26	61.92	56.33	1$^{3}/_{4}$-18UNS	11.13	66

Angle plug

Maker : DDK (Ltd.)



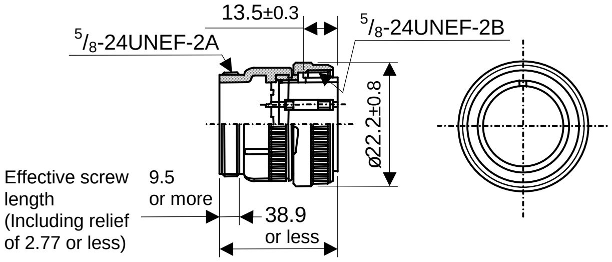
[Unit: mm]

Model	Coupling screw A	Length of coupling section J	Total length L	Connection nut outside diameter Q	R	U	Cable clamp installation screw V	Effective screw length W
MS3108B18-12S	1$^{1}/_{8}$-18UNEF	18.26	68.27	34.13	20.5	30.2	1-20UNEF	9.53
MS3108B22-14S MS3108B22-23S	1$^{3}/_{8}$-18UNEF	18.26	76.98	40.48	24.1	33.3	1$^{3}/_{16}$-18UNEF	9.53
MS3108B32-17S	2-18UNEF	18.26	95.25	56.33	32.8	44.4	1$^{3}/_{4}$-18UNS	11.13

Straight plug

[Unit: mm]

Maker : Japan Aviation
Electronics (Ltd.)
Model: MS3106B10SL-4S



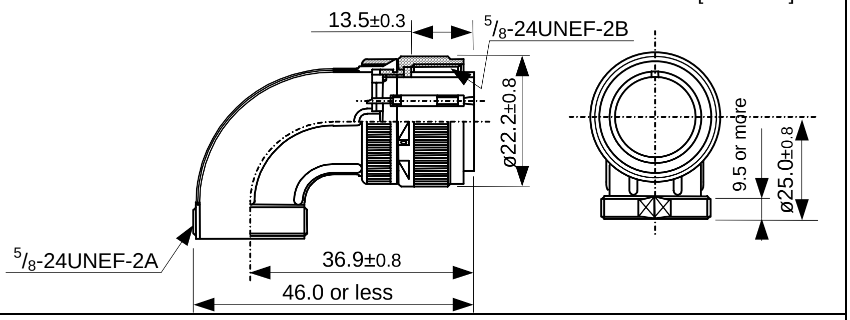
Connectors for detector, motor power and brake (for general environment)

Angle plug

Maker : Japan Aviation Electronics (Ltd.)

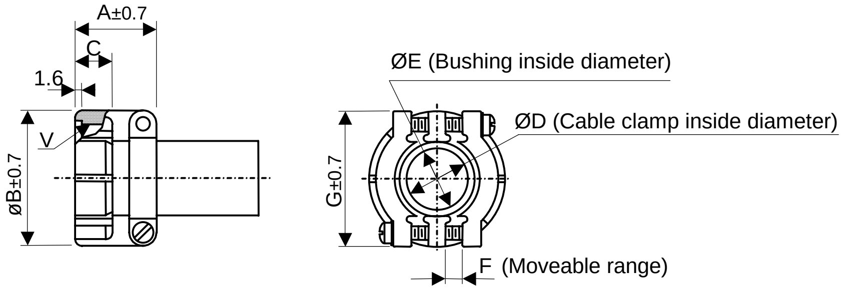
Model: MS3108B10SL-4S

[Unit: mm]



Cable clamp

Maker : DDK (Ltd.)



[Unit: mm]

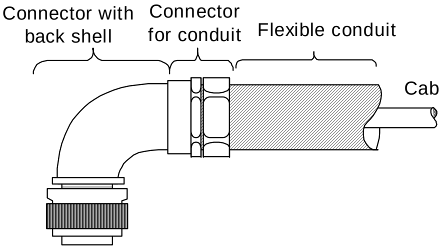
Model	Shell size	Total length A	Outside diameter B	Effective screw length C	D	E	F	G	Installation screw V	Bushing
MS3057-4A	10SL, 12S	20.6	20.6	10.3	7.9	5.6	1.6	22.2	$^5/_8$-24UNEF	AN3420-4
MS3057-10A	18	23.8	30.1	10.3	15.9	14.3	3.2	31.7	1-20UNEF	AN3420-10
MS3057-12A	20, 22	23.8	35.0	10.3	19.0	15.9	4.0	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

6-3-3 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.

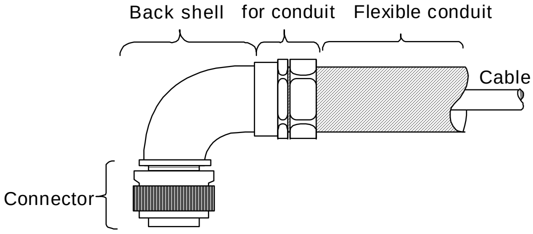
The following shows an example of a flexible conduit. Contact the connector maker for more information.

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



Appli-cation	Applicable motors	Model			
		DDK		Nippon Flex	
		Connector (straight)	Connector (angle)	Connector for conduit	Flexible conduit
For power	HC-H52 to 102 HC-H53 to 103	CE05-6A22-23SD-B-BSS	CE05-8A22-23SD-B-BAS	RCC-104CA2022	VF-04 (Min. inside diameter: 14)
				RCC-106CA2022	VF-06 (Min. inside diameter: 19)
	HC-H152 to 452 HC-H203 to 353	CE05-6A24-10SD-B-BSS	CE05-8A24-10SD-B-BAS	RCC-106CA2428	VF-06 (Min. inside diameter: 19)
				RCC-108CA2428	VF-08 (Min. inside diameter: 24.4)
	HC-H702 to 1102 HC-H453 to 1103	CE05-6A32-17SD-B-BSS	CE05-8A32-17SD-B-BAS	RCC108CA32	VF-08 (Min. inside diameter: 24.4)
				RCC110CA32	VF-10 (Min. inside diameter: 33.0)

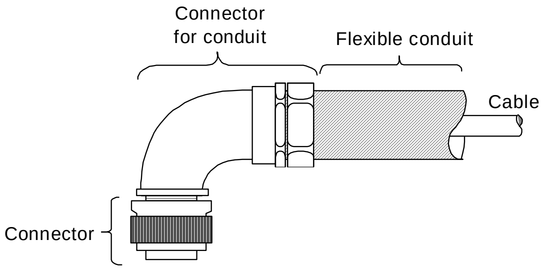
(Note) None of the parts in this table can be ordered from Mitsubishi Electric Corp.



Appli-cation	Applicable motors	Model			
		DDK		Nippon Flex	
		Connector/back shell (straight)	Connector/back shell (angle)	Connector for conduit	Flexible conduit
For brake	HC-H202B to H1102B HC-H203B to H1103B	Select according to section "(2) Method for connecting to the connector main body".			
For detector	HC-H52 to H1102 HC-H53 to H1103	Connector MS3106A22-14S (D190) Back shell CE02-22BS-S	Connector MS3106A22-14S (D190) Back shell CE-22BA-S	RCC-104CA2022	VF-04 (Min. Inside diameter: 14)
				RCC-106CA2022	VF-06 (Min. Inside diameter: 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



Applica-tion	Applicable motors	Model		
		DDK	DAIWA DENGYO	
		Connector (straight)	Connector for conduit	Flexible conduit
For power	HC-H52 to 352 HC-H53 to 353	CE05-6A22-23SD-B	MSA-16-22 (Straight) MAA-16-22 (Angle)	FCV16 (Min. inside diameter: 15.8)
			MSA-22-22 (Straight) MAA-22-22 (Angle)	FCV22 (Min. inside diameter: 20.8)
	HC-H452 to H1102 HC-H453 to H1103	CE05-6A32-17SD-B	Please contact to a maker.	FCV36 (Min. inside diameter: 35.0)
For brake	HC-H202B to H1102B HC-H203B to H1103B	MS3106A10SL-4S (D190)	MSA-10-10 (Straight) MAA-10-10 (Angle)	FCV10 (Min. inside diameter: 10.0)
For detector	OSA104, 105 OSE104, 105	MS3106A22-14S (D190)	MSA-16-22 (Straight) MAA-16-22 (Angle)	FCV16 (Min. inside diameter: 15.8)
			MSA-22-22 (Straight) MAA-22-22 (Angle)	FCV22 (Min. inside diameter: 20.8)

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

6-3-4 Cable wire and assembly

(1) Cable wire

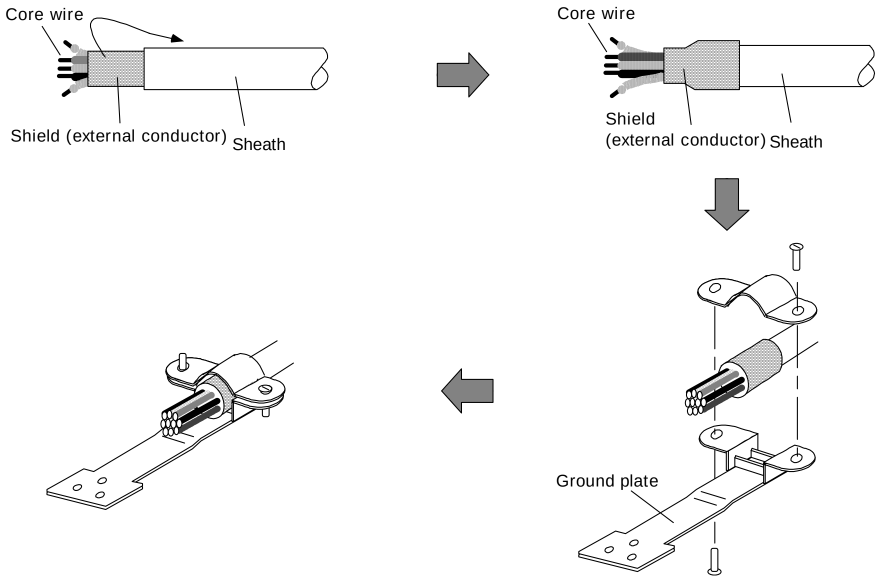
The following shows the specifications and processing of the wire used in each cable. Manufacture the cable using the following recommended wire or equivalent parts.

Recommended wire model (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	Heat resistant temperature	
UL20276 AWG28 10pair	6.1mm	PVC	10	7 strands/ 0.13mm	222Ω/km or less	AC350/ 1min	1MΩ/km or more	80°C	NC unit communication cable
A14B2343 (Note 1)	7.2mm	PVC	6	40 strands/ 0.08mm	105Ω/km or less	AC500/ 1min	1500MΩ/km or more	105°C	Detector cable
TS-91026 (Note 2)	11.6mm	PVC	2 (0.3 mm^2)	60 strands/ 0.08mm	63Ω/km or less	AC750V/ 1min	60MΩ/km or more	60°C	Detector cable (Cable length: 20m or more)
			10 (0.2 mm^2)	40 strands/ 0.08mm	95Ω/km or less				

(Note 1) Junko Co. (Dealer: Toa Denki)
(Note 2) BANDO ELECTRIC WIRE (http: //www.bew.co.jp)

(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		
		Drive unit side	Installation screws	Motor detector side
Nippon Flex Control Corp.	FBA-4 (FePb wire braid sheath)	RBC-104 (straight) RBC-204 (45°) RBC-304 (90°)	G16 G16 G16	RCC-104-CA2022
DAIWA DENGYO CO., 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 #17 (FePb sheath)	BC-17 (straight)	Wire tube screws : 15	PDC20-17

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

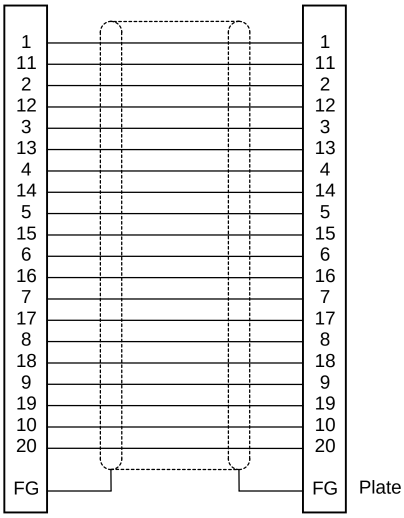
6-3-5 Option cable connection diagram

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 communication cable

< SH21 cable connection diagram >

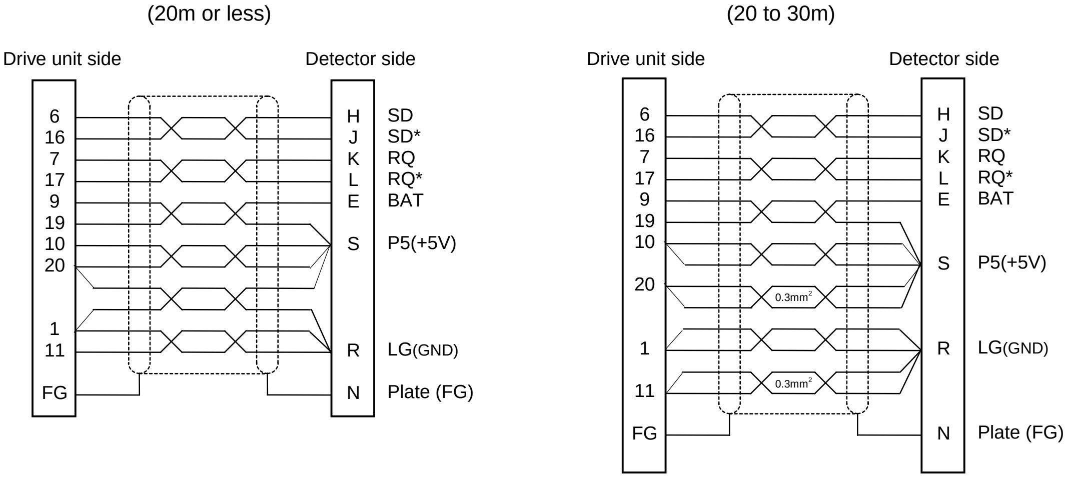
This is an actual connection diagram for the SH21 cable supplied by Mitsubishi.
Manufacture the cable as shown below. The cable can be up to 30m long. Refer to section "6-4-4 Cable wire and assembly" for details on wire.



(2) Detector cable for HC-H [_]-A51/42, -E51/42

<CNV12 cable connection diagram>

This is an actual connection diagram for the CNV12 cable supplied by Mitsubishi. The connection differs according to the cable length.



CAUTION Do not connect anything to pins unless particularly specified when manufacturing a cable.

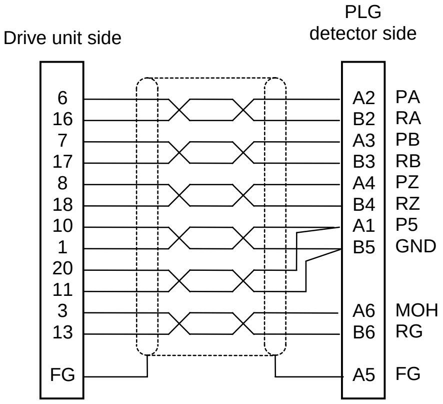
(3) PLG detector cable for SJ spindle

<CNP5S cable connection diagram>

This is an actual connection diagram for the CNP5S cable supplied by Mitsubishi.

<Connection diagram for cable manufacturing>

Manufacture the cable as shown below. The cable can be manufactured to 30m. Refer to section "6-3-4 Cable wire and assembly" for details on wire.



CAUTION The CNP5S cable is dedicated for the 400V compatible spindle PLG detector.

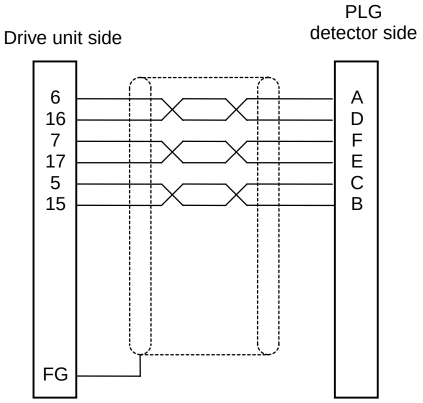
<CNP6M/CNP6A cable connection diagram>

This is an actual connection diagram for the CNP6M or CNP6A cable supplied by Mitsubishi.

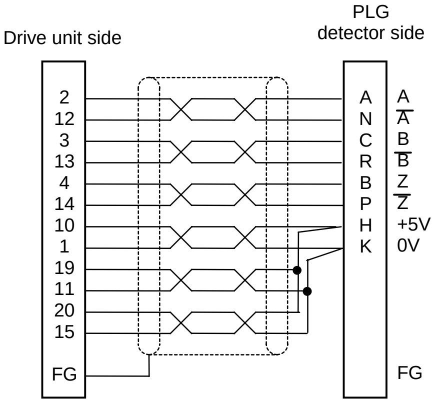
<Connection diagram for cable manufacturing>

Manufacture the cable as shown below. The cable can be manufactured to 30m. Refer to section "6-3-4 Cable wire and assembly" for details on wire.

CNP6M cable



CNP6A cable



CAUTION When manufacturing the cable, do not connect anything to the pins having no description.

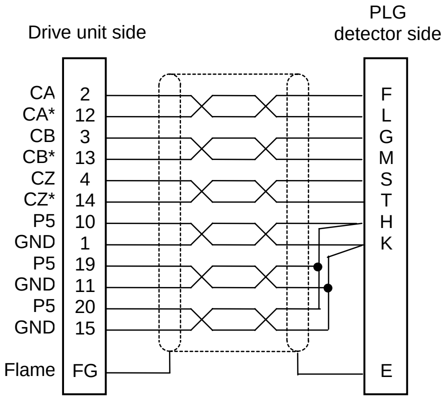
<CNP7A/CNP76A cable connection diagram>

This is an actual connection diagram for the cable supplied by Mitsubishi.

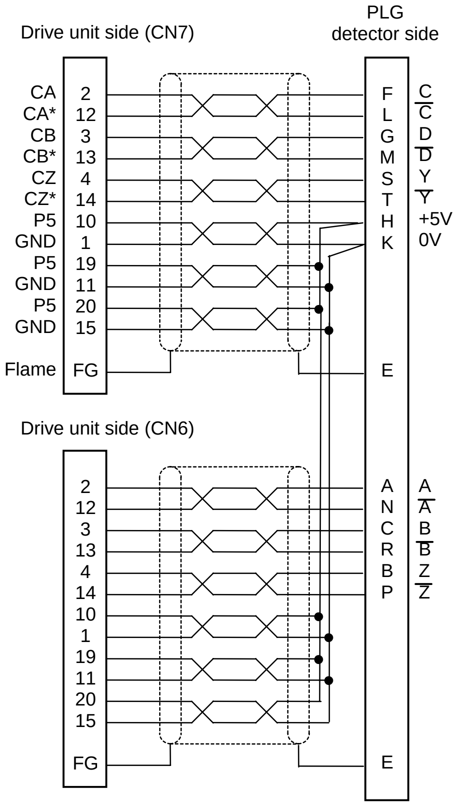
<Connection diagram for cable manufacturing>

Manufacture the cable as shown below. The cable can be manufactured to 30m. Refer to section "6-3-4 Cable wire and assembly" for details on wire.

CNP7A cable



CNP76A cable



6-3-6 Main circuit cable connection drawing

The methods for wiring to the main spindle are explained in this section.

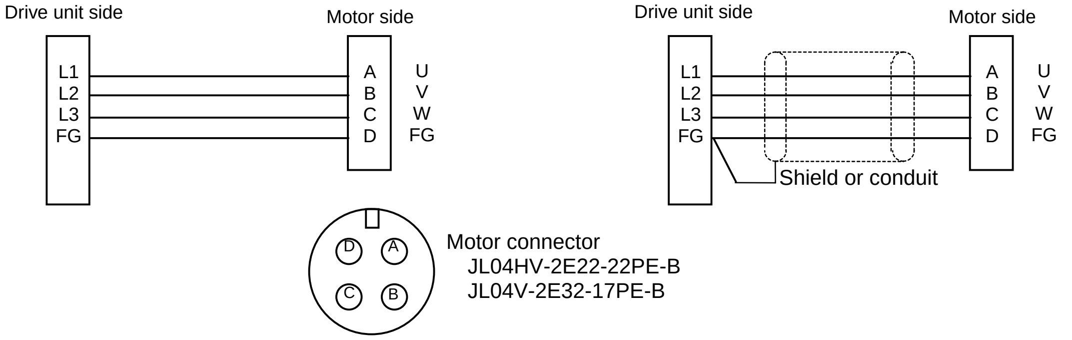
⚠ CAUTION	1. The main circuit cable must be manufactured by the user. 2. Refer to Chapter 7 "Selection of peripheral devices" or Appendix 4 "UL/c-UL Standard Compatible Unit Instruction Manual" for details on selecting the wire material. 3. Lay out the terminal block on the drive unit as explained in section "2-2 Main circuit terminal block and control circuit connector". 4. Refer to section "10-2-4 Outline dimension drawings" for details on the servomotor connectors and terminal block. Refer to the Spindle Motor Specifications for details on the spindle motor terminal block.

(1) DRSV1 cable and DRSV2 cable

These cables connect the TE1 terminal on the servo drive unit with the HC-H motor.

- DRSV1 cable : Power cable for L axis in 1-axis unit (MDS-CH-V1-) and 2-axis integrated unit (MDS-CH-V2).
- DRSV2 cable : Power cable for M axis in 2-axis integrated unit (MDS-CH-V2-).

<DRSV1/DRSV2 cable connection diagram>


Example of general wiring

Example of EMC Directive compliant wiring

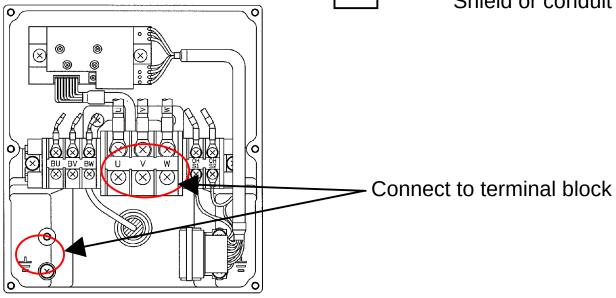
(2) DRSP cable

This cable connects the TE1 terminal on the spindle drive unit with the SJ-4 spindle motor.

<DRSP cable connection diagram>


Example of general wiring

Example of EMC Directive compliant wiring



Example of connection terminal box layout on spindle motor side

6-4 Scale I/F unit

6-4-1 Outline

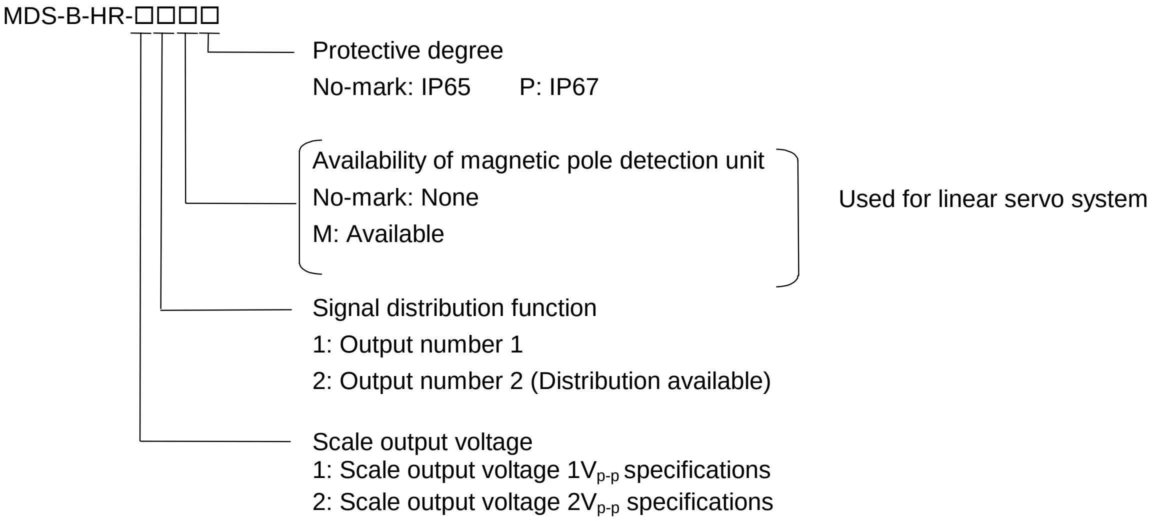
MDS-B-HR outline

(1) The unit interpolates the original wave of scale analog output to create high-resolution position data. Increasing the detector resolution is effective for obtaining high gain of the servo.

(2) 1-scale, 2-drive operation will be possible with the signal distribution function (model division available).

6-4-2 Model configuration

Scale I/F unit model configuration



MDS-B-HR-□□□□

Protective degree
No-mark: IP65 P: IP67

Availability of magnetic pole detection unit
No-mark: None
M: Available

Used for linear servo system

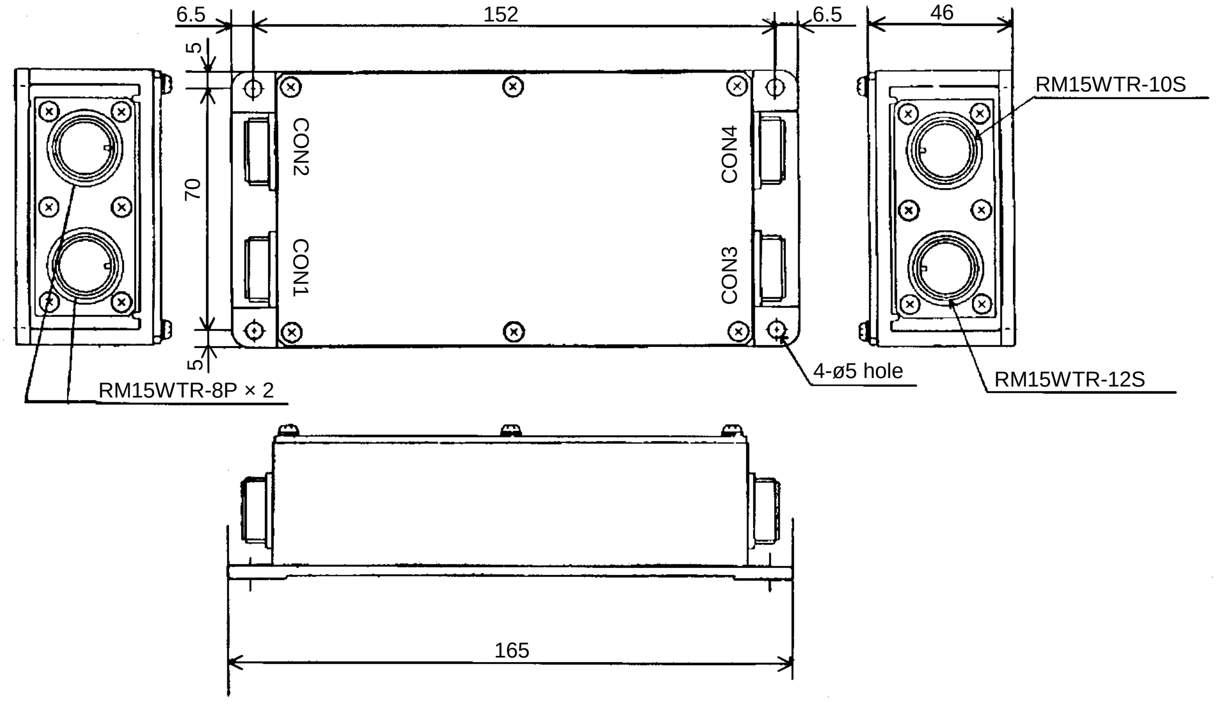
Signal distribution function
1: Output number 1
2: Output number 2 (Distribution available)

Scale output voltage
1: Scale output voltage $1V_{p\text{-}p}$ specifications
2: Scale output voltage $2V_{p\text{-}p}$ specifications

6-4-3 List of specifications

	Unit	Scale I/F unit model							
		MDS-B-HR-		MDS-B-HR-		MDS-B-HR-		MDS-B-HR-	
		11	12	11P	12P	21	22	21P	22P
Corresponding scale (Example)		LS186/LIDA181/LIF181 (HEIDENHAIN product)				AT342 special (Mitsutoyo product)			
Signal 2-distribution function		×	○	×	○	×	○	×	○
Analog signal input specification		A-phase, B-phase and Z-phase 2.5V reference Amplitude 1Vp-p				A-phase, B-phase and Z-phase 2.5V reference Amplitude 2Vp-p			
Applicable frequency		Analog original waveform 200 kHz max.							
Scale resolution		Analog original waveform/512 div.							
Input/output communication form		High-speed serial communication I/F, equivalent to RS485							
Availability of magnetic pole detector		Compatible parts are indicated with an M after the type							
Tolerable ambient temperature	°C	0 to 55°C							
Tolerable ambient relative humidity	%	90% or less (no condensing)							
Atmosphere		With no poisonous gas							
Tolerable vibration	m/s2 (G)	98.0m/s2 (10G)							
Tolerable impact (shock)	m/s2 (G)	294.0m/s2 (30G)							
Tolerable power voltage	V	5VDC±5%							
Maximum heat generation	W	2W							
Weight	kg	0.5kg or less							
Protective degree		IP65		IP67		IP65		IP67	

6-4-4 Unit outline dimension drawing



6-4-5 Description of connector

Connector name	Application	Remarks
CON1	For connection with servo drive unit (2nd part system)	None for 1st part system specifications
CON2	For connection with servo drive unit	
CON3	For connection with scale	
CON4	For connection with magnetic pole detection unit (MDS-B-MD)	Only for linear servo motor specifications

Assignment of connector pins

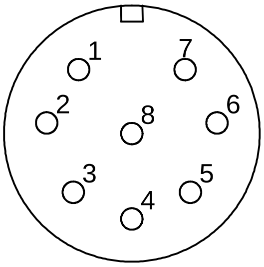
CON1	
Pin No.	Function
1	RQ+ signal
2	RQ– signal
3	SD+ signal
4	SD– signal
5	P5
6	P5
7	GND
8	GND

CON2	
Pin No.	Function
1	RQ+ signal
2	RQ– signal
3	SD+ signal
4	SD– signal
5	P5
6	P5
7	GND
8	GND

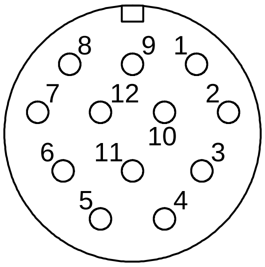
CON3	
Pin No.	Function
1	A+ phase signal
2	A– phase signal
3	B+ phase signal
4	B– phase signal
5	Z+ phase signal
6	Z– phase signal
7	RQ+ signal
8	RQ– signal
9	SD+ signal
10	SD– signal
11	P5
12	GND

CON4	
Pin No.	Function
1	A-phase signal
2	REF signal
3	B-phase signal
4	REF signal
5	P24
6	MOH signal
7	P5
8	P5
9	TH signal
10	GND

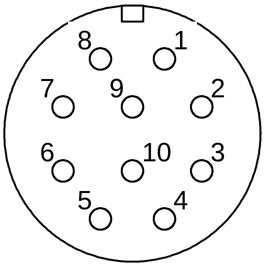
Connector: RM15WTR – 8P (Hirose Electric) ….. CON1, CON2
RM15WTR – 12S (Hirose Electric) … CON3
RM15WTR – 10S (Hirose Electric) ….. CON4



CON1
CON2

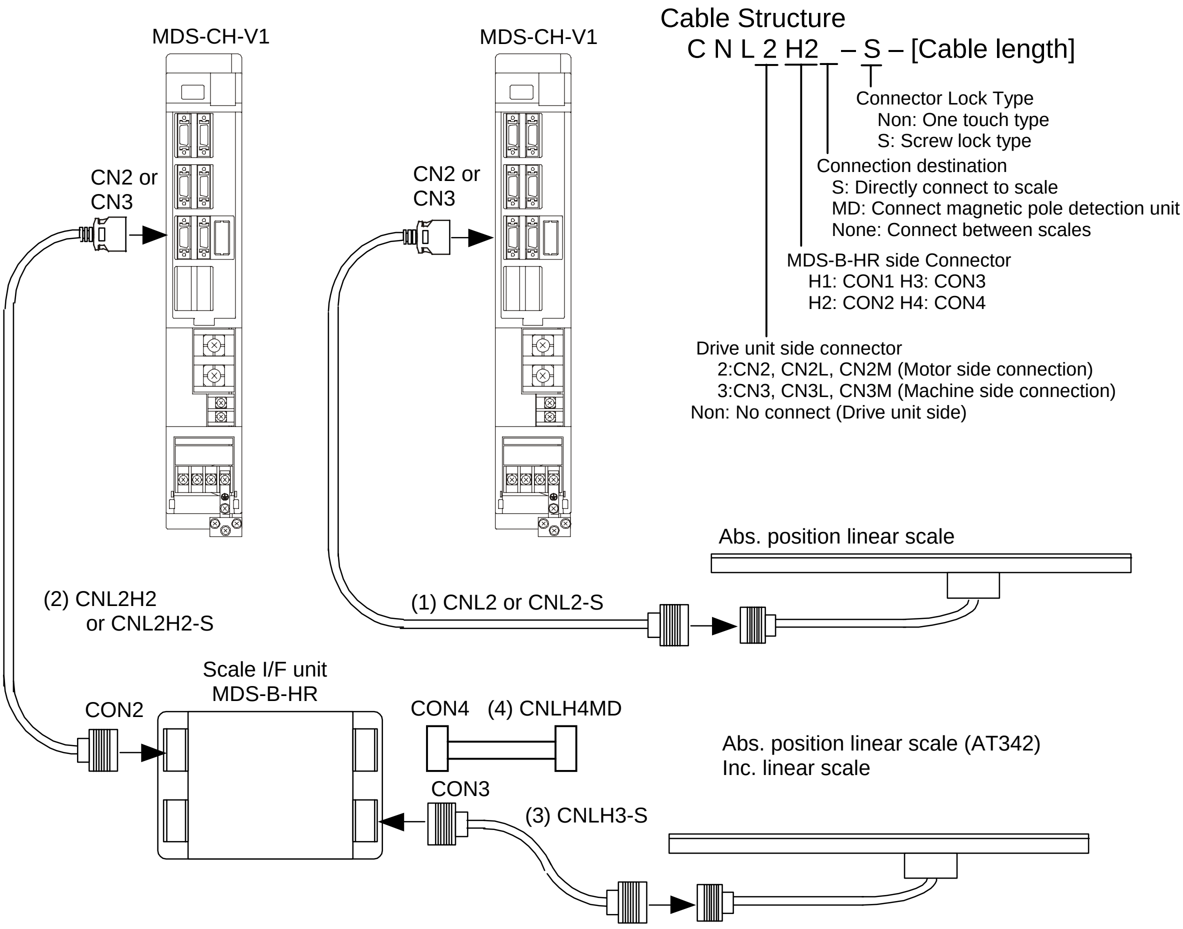


CON3



CON4

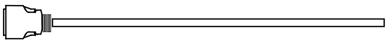
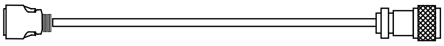
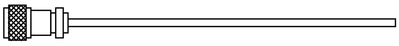
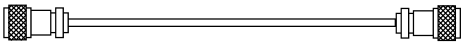
6-4-6 Example of detector conversion unit connection



The Mitsubishi NC compatible linear scale (serial part) can be directly connected to the drive unit. Refer to section "6-6-1 List of detector specifications".

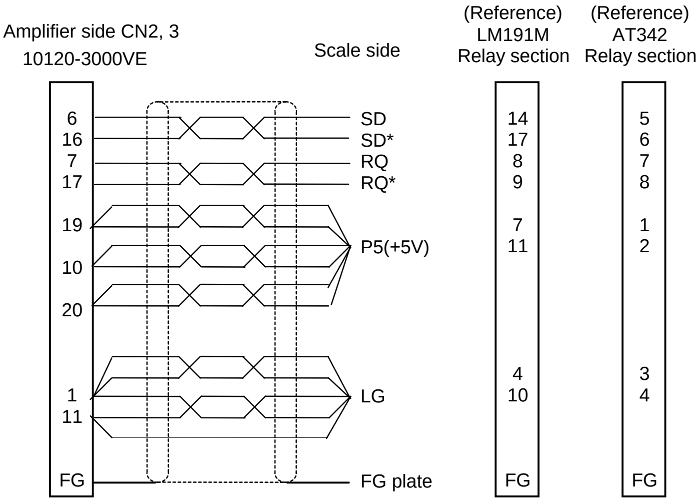
6-4-7 Cables

(1) Cable list

Item			Model name	Content
For CN2 CN3	<1>	Cable for direct connection of scale	CNL □ - □ Unit side connector shape Blank: One-touch type S: Screw type lock Connection destination 2: CN2 3: CN3 Length: 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 20, 30m	Servo drive unit side connector (3M or the equivalent) Connector : 10120-3000VE Shell kit : 10320-52F0-008 (One-touch type) : 10320-52A0-008 (Screw type)  This cable must be manufactured by the user according to the scale being used.
	<2>	Cable between drive unit and HR unit	CNL □ - □ Unit side connector shape Blank: One-touch type S: Screw type lock Connection destination 2: CN2 3: CN3 Length: 2, 5, 10, 20, 30m	Servo drive unit side connector (3M or the equivalent) Connector :10120-3000VE Shell kit:10320-52F0-008 (One-touch type) :10320-52A0-008 (Screw type) MDS-B-HR unit side connector (Hirose Electric) Connector : RM15WTP-8S Clamp : RM15WTP-CP (10) 
For MDS-B-HR unit	<3>	Cable between HR unit and scale	CNLH3S Length Max. 30m	MDS-B-HR unit side connector (Hirose Electric) Connector : RM15WTP-12P Clamp : RM15WTP-CP (10)  This cable must be manufactured by the user according to the scale being used.
For CN4	<4>	Magnetic pole detection unit connection cable	CNLH4MD Length 2, 5, 10, 20, 30m	MDS-B-HR unit side connector (Hirose Electric) Connector: RM15WTP-10P Clamp: RM15WTP-CP (10) MDS-B-MD unit side connector (Hirose Electric) Connector: RM15WTP-8S Clamp: RM15WTP-CP (10) 

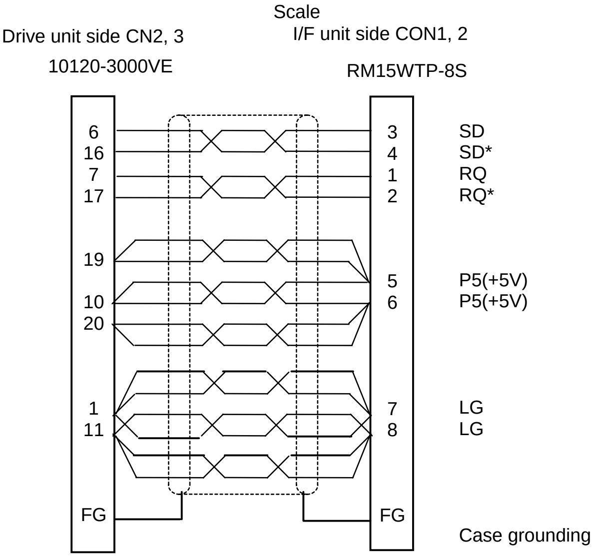
(2) Manufacturing drawings for each cable

1) Cable for direct connection of scale (CNL2S cable, etc.)



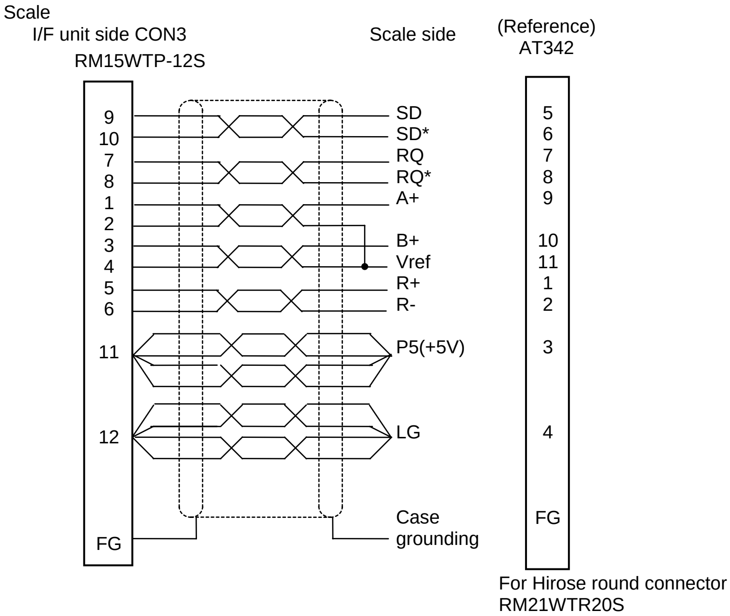
Note) Only the absolute position scale can be connected directly to the drive unit.

2) Cable between drive unit and scale I/F unit (CNL2H2 cable, etc.)

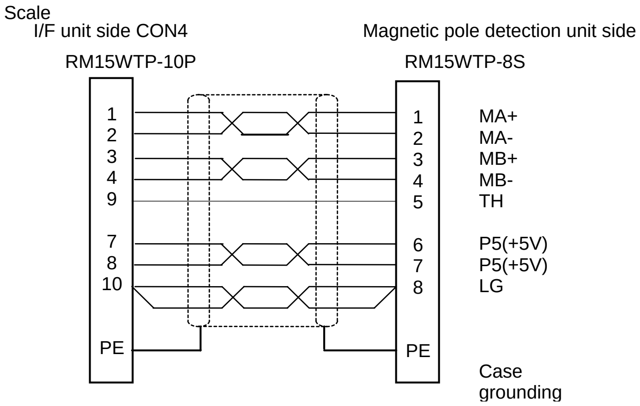


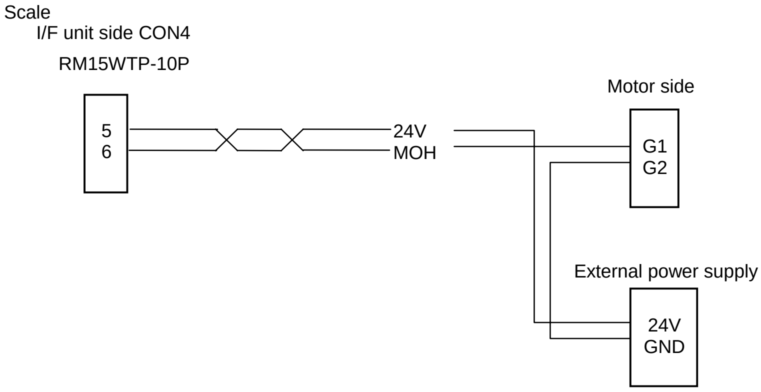
⚠ **CAUTION**	When manufacturing the cable, do not connect anything to the pins having no description.

3) Cable between scale I/F unit and scale (CNLH3 cable, etc.)



4) Cable between scale I/F unit and magnetic pole detection unit (CNLH4MD cable)





Refer to section "6-3-4 Cable wire and assembly" for details on the wire materials. Recommended wire type: A14B2343 (Junkosha, Inc.)

⚠ **CAUTION**	When manufacturing the cable, do not connect anything to the pins having no description.

(3) Cable connectors

Maker: Hirose Electric

Scale I/F unit side connectors

CON1 CON2	RM15WTP - 8S
	RM15WTP - CP (□□)
CON3	RM15WTP - 12P
	RM15WTP - CP (□□)
CON4	RM15WTP - 10P
	RM15WTP - CP (□□)

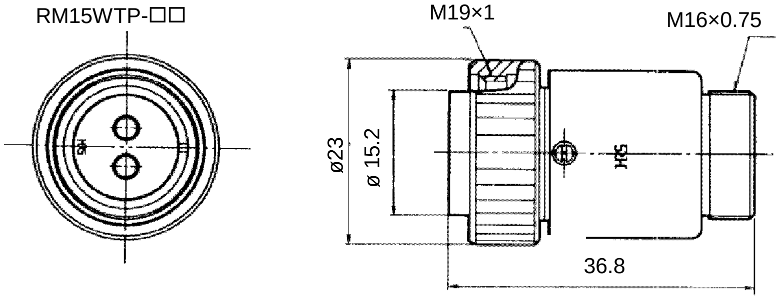
Magnetic pole detection unit connectors

CNM1	RM15WTP - 8S
	RM15WTP - CP (□□)

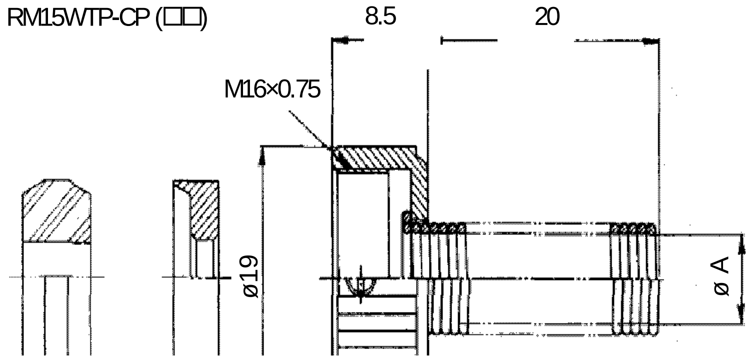
Caution:
□□ indicates the cable diameter.

[Unit: mm]

Plug



Cord clamp



Product name	ø A	Applicable cable diameter
RM15WTP - CP (5)	6.5	5
RM15WTP - CP (6)	6.5	6
RM15WTP - CP (7)	8	7
RM15WTP - CP (8)	10.5	8
RM15WTP - CP (9)	10.5	9
RM15WTP - CP (10)	10.5	10

6-5 Magnetic pole detection unit

6-5-1 Outline

This unit detects the magnetic pole of the linear servomotor's secondary magnet, and outputs the results as an analog voltage. (Only linear servomotor)
When using the relative value specifications, always install this unit as the magnetic poles do not need to be positioned when the power is turned ON.

6-5-2 Model configuration

MDS–B-MD– [ ][ ][ ]

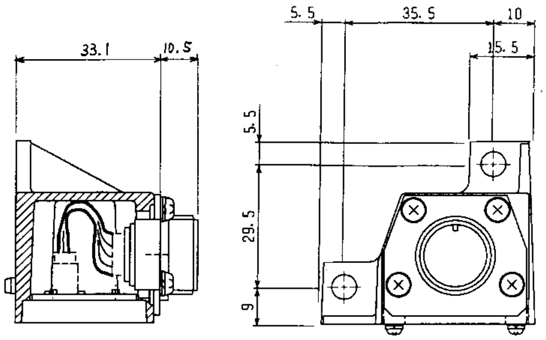
Protective degree No-mark: IP65, P: IP67
Applicable motor 0: 200V Class linear servomotor
1: 400V Class linear servomotor
Compatible pole pitch class 60: Pole 60mm pitch

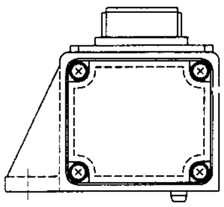
6-5-3 List of specifications

Specification	Unit	Magnetic pole detection unit model	
		MDS-B-MD60[_]	MDS-B-MD60[_]P
Tolerable ambient temperature	°C	0 to 55°C	
Tolerable ambient relative humidity	%	90% (RH) or less (no condensing)	
Atmosphere		With no poisonous gas	
Tolerable vibration	m/s^2	98 m/s^2	
Tolerable impact (shock)	m/s^2	294 m/s^2	
Tolerable power voltage	V	5VDC ± 5%	
Maximum heat generation	W	1W or less	
Weight	Kg	0.1kg or less	
Protective degree		IP65	IP67

Either "1" or "0" is indicated in [_].

6-5-4 Outline dimensions

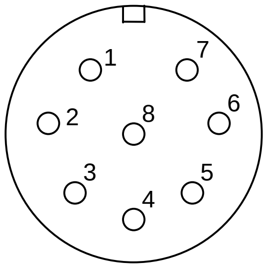




6-5-5 Assignment of connector pins

Connector name	Application	Remarks
CON1	Detects magnetic pole of linear servomotor's secondary magnet, and outputs an analog voltage	Connect with scale I/F unit (MDS-B-HR)

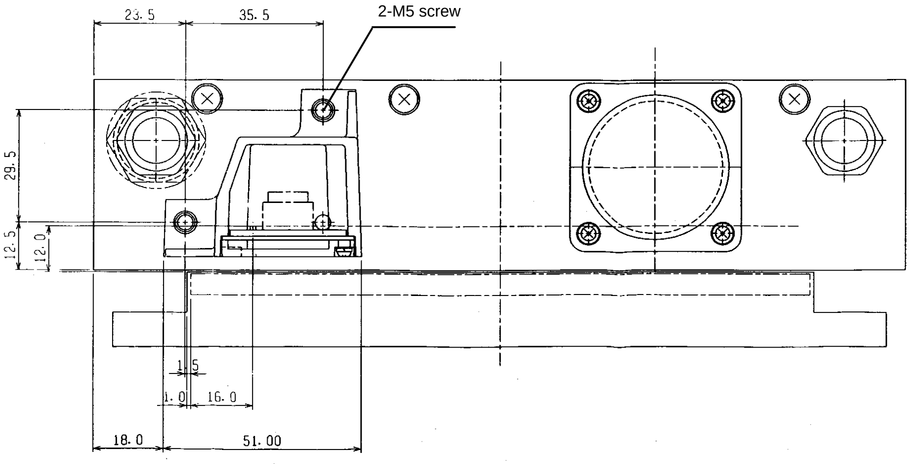
CON1	
Pin No.	**Function**
1	A-phase signal
2	REF signal
3	B-phase signal
4	REF signal
5	TH signal
6	P5 (5VDC)
7	P5 (5VDC)
8	GND

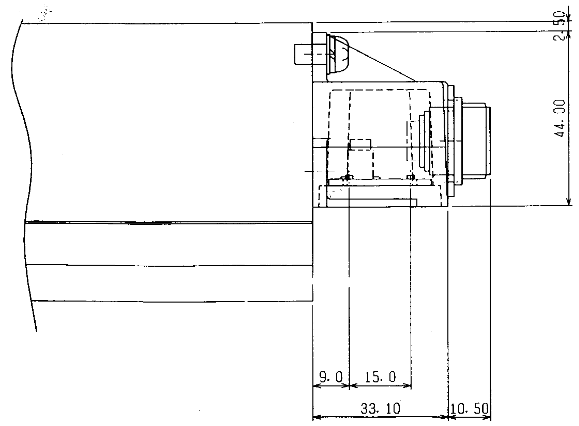


Applicable connector
RM15WTR-8P (Hirose Electric)

6-5-6 Installing onto the linear servomotor

(1) For LM-NP4





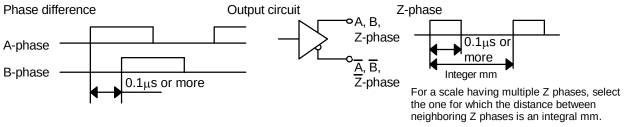
(2) For other motors

Refer to each Linear Servomotor Specifications for details on installing onto other linear servomotors.

6-6 Detectors

⚠ CAUTION The MDS-CH Series servo drive units use the serial encoders only as the motor side detectors.

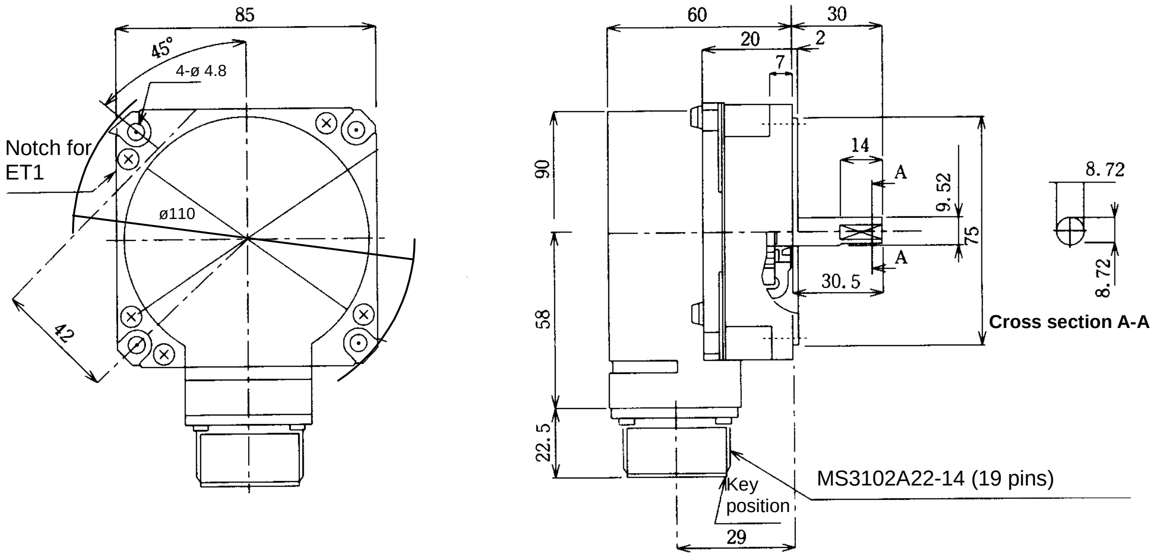
6-6-1 List of detector specifications

Class	Type	Model	Max. rotation speed	Detector output	Output signal usage class
Motor side detector	Relative position detector	OSE104, OSE104S, OSE104S1, OSE104S2	3000r/min	Serial data	Motor position detection 100000p/rev
	Absolute position detector	OSE105, OSE105S, OSE105S1, OSE105S2	3000r/min	Serial data	Motor position detection 1000000p/rev
Ball screw side detector	Relative position detector	OHE25K-ET	3000r/min	A, B-phase 25000p/rev	Ball screw side position detection 100000p/rev after multiplying by four
				Z-phase 1p/rev	Zero point indexing
		OSE104-ET	3000r/min	Serial data	Ball screw side position detection 100000p/rev
		OSE105-ET	3000r/min	Serial data	Ball screw side position detection 1000000p/rev
	Absolute position detector	OHA25K-ET	3000r/min	A, B-phase 25000p/rev	Ball screw side position detection 100000p/rev after multiplying by four
				Z-phase 1p/rev	Zero point indexing
		OSA104-ET	3000r/min	Serial data	Ball screw side position detection 100000p/rev
		OSA105-ET	3000r/min	Serial data	Ball screw side position detection 1000000p/rev
Machine side detector **(Note)** Purchase from a manufacturer.	Relative position detector	Use an incremental scale for the machine side that satisfies the conditions on the right.	(1) When linear scale I/F unit (MDS-B-HR) is not used · Use a scale with an A/B phase difference and Z-phase width of 0.1μs or more at the maximum feedrate. · Use an A, B, Z-phase signal with differential output (RS-422 standard product) for the output signal. 		
			(2) ∗ When linear scale I/F unit (MDS-B-HR) is used (Output signal) (a) 2.5V reference $1V_{p-p}$ analog A-phase, B-phase, Z-phase differential output (b) 2.5V reference $2V_{p-p}$ analog A-phase, B-phase, Z-phase differential output (Output signal frequency) Max. 200kHz		
	Absolute position detector	AT41 (Mitsutoyo product)	50m/min	A, B-phase	Machine side position detection 1μm/p after multiplying by four
				Z-phase	Zero point indexing 10mm spacing
				Serial data	Absolute position 1μm/p
		FME, FML (FUTABA product)	5.1 to 120m/min Differs according to the resolution.	A, B-phase	Machine side position detection 0.1 to 10μm/p after multiplying by four
				Serial data	
		MP scale (Mitsubishi Heavy Industries product) ∗ Motor side detector also needs an absolute position encoder.	30m/min	A, B-phase	Machine side position detection 1μm/p after multiplying by four
				Z-phase	Zero point indexing 2mm spacing
		AT342 (Mitsutoyo product)	110m/min	Serial data	Machine side position detection 0.5μm/p
		AT343 (Mitsutoyo product)	120m/min	Serial data	Machine side position detection 0.05μm/p
		LC191M (HEIDENHAIN product)	120m/min	Serial data	Machine side position detection 0.1μm/p, 0.05μm/p
		LC491M (HEIDENHAIN product)	120m/min	Serial data	Machine side position detection 0.05μm/p

⚠ CAUTION Confirm each maker specifications before using the machine side detector.

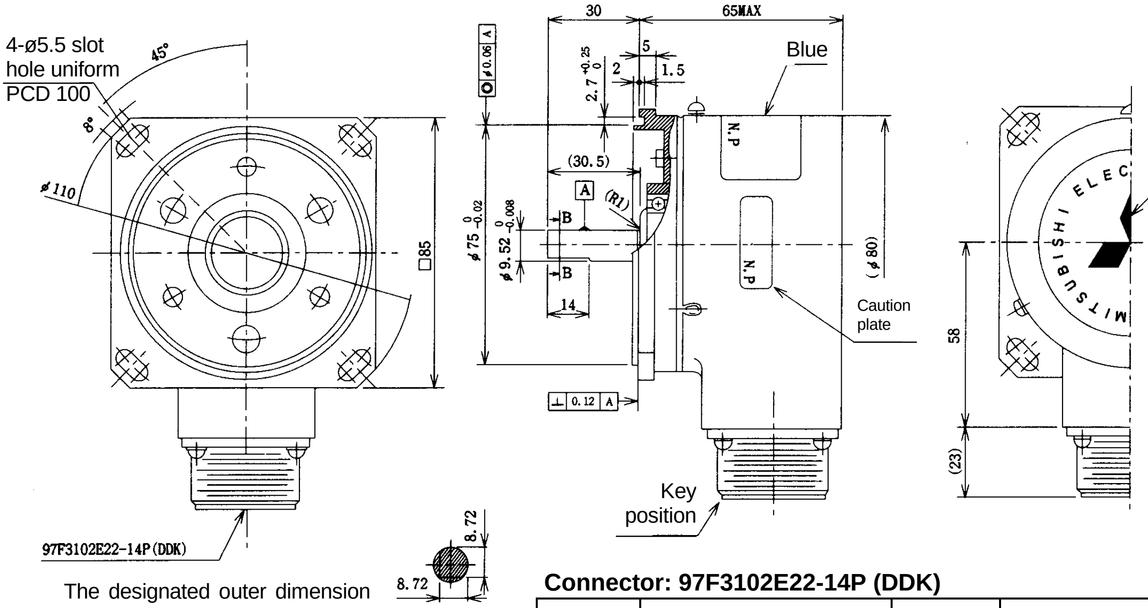
6-6-2 Outline dimension drawings

(1) Standalone encoder (OSA☐ET/OSE☐ET Series) outline drawing



(2) Outline drawings of OHE/OHA type ball screw side detector

- **OHE 25K-ET**



The designated outer dimension tolerance is ± 0.5mm.

Weight	1.0 [kg] or less
Moment of inertia	0.2 × 10^{-4} [kg·m^2] or less
Friction torque	0.0196 [N·m] or less
Thermal relay	Functions at 85 ± 5 [°C]

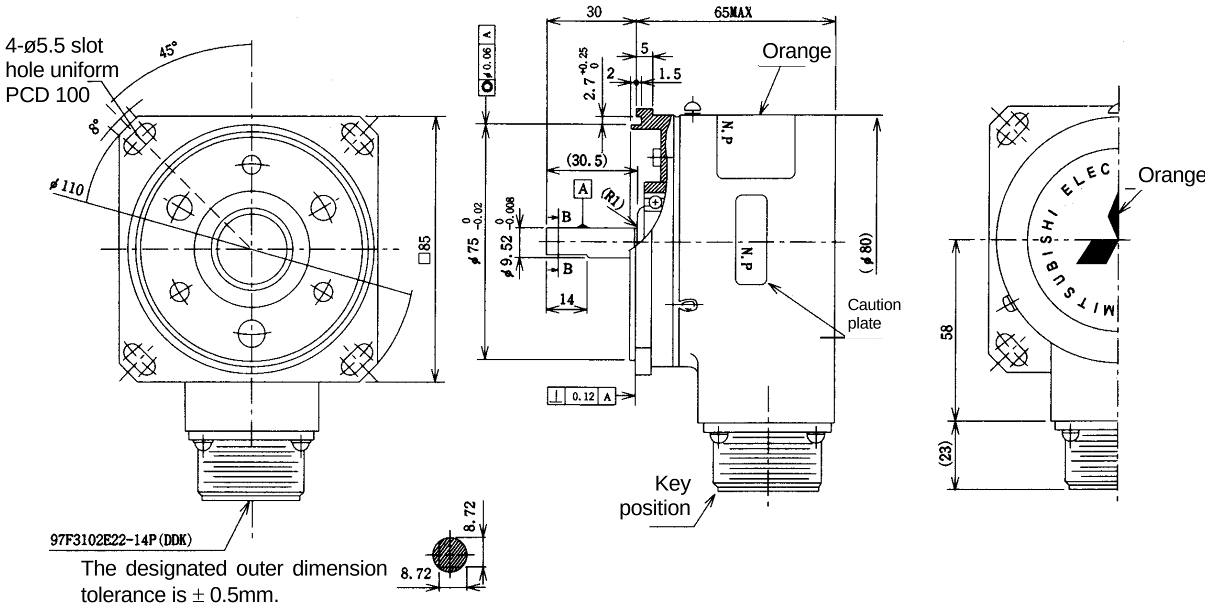
Connector: 97F3102E22-14P (DDK)

Pin No.	Function	Pin No.	Function
A	A-phase signal	K	V-phase signal
B	$\overline{A}$-phase signal	L	$\overline{V}$-phase signal
C	B-phase signal	M	W-phase signal
D	$\overline{B}$-phase signal	N	Case grounding
E	NC	P	NC
F	Z-phase signal	R	GND
G	$\overline{Z}$-phase signal	S	+5VDC
H	U-phase signal	U	$\overline{W}$-phase signal
J	$\overline{U}$-phase signal	T	Thermal relay
		V	Thermal relay

(Note 1) This is an incremental encoder for the ball screw side.

(Note 2) The outline dimensions are the same as for the absolute encoder, and only the nameplate color differs.

- **OHA 25K-ET**



The designated outer dimension tolerance is ± 0.5mm.

Cross section B-B

Weight	1.0 [kg] or less
Moment of inertia	0.2 × 10^{-4} [kg · m^2] or less
Friction torque	0.0196 [N · m] or less
Thermal relay	Functions at 85 ± 5 [°C]

Connector: 97F3102E22-14P (DDK)

Pin No.	Function	Pin No.	Function
A	A-phase signal	K	RQ signal
B	$\overline{A}$-phase signal		
C	B-phase signal	L	$\overline{RQ}$ signal
D	$\overline{B}$-phase signal		
E	VB (Battery)	M	NC
F	Z-phase signal	N	Case grounding
G	$\overline{Z}$-phase signal	P	NC
H	RX signal	R	GND
		S	+5VDC
J	$\overline{RX}$ signal	T	Thermal relay
		U	NC
		V	Thermal relay

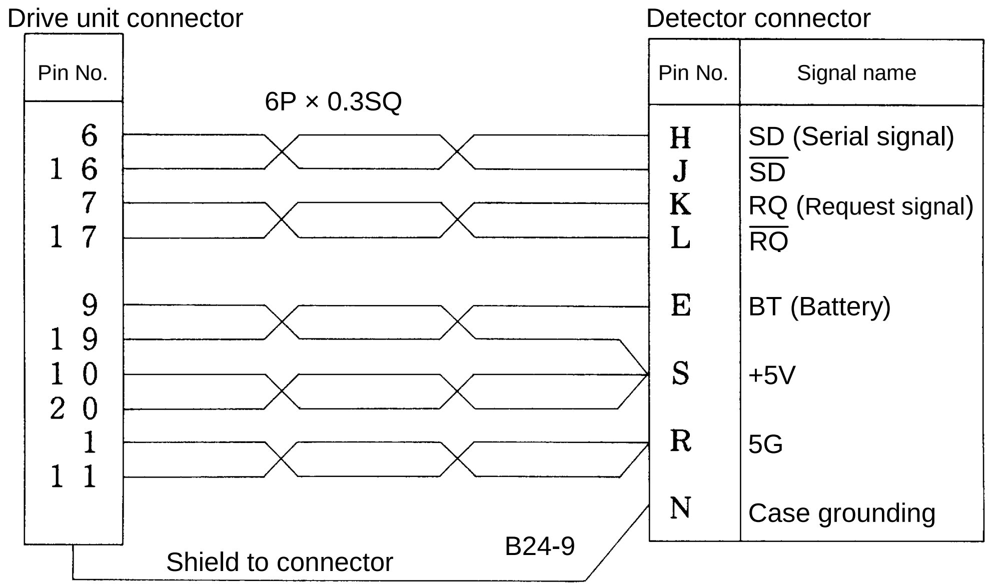
(Note 1) This is an incremental encoder for the ball screw side.
(Note 2) The outline dimensions are the same as for the absolute encoder, and only the nameplate color differs.

6-6-3 Cable connection diagram

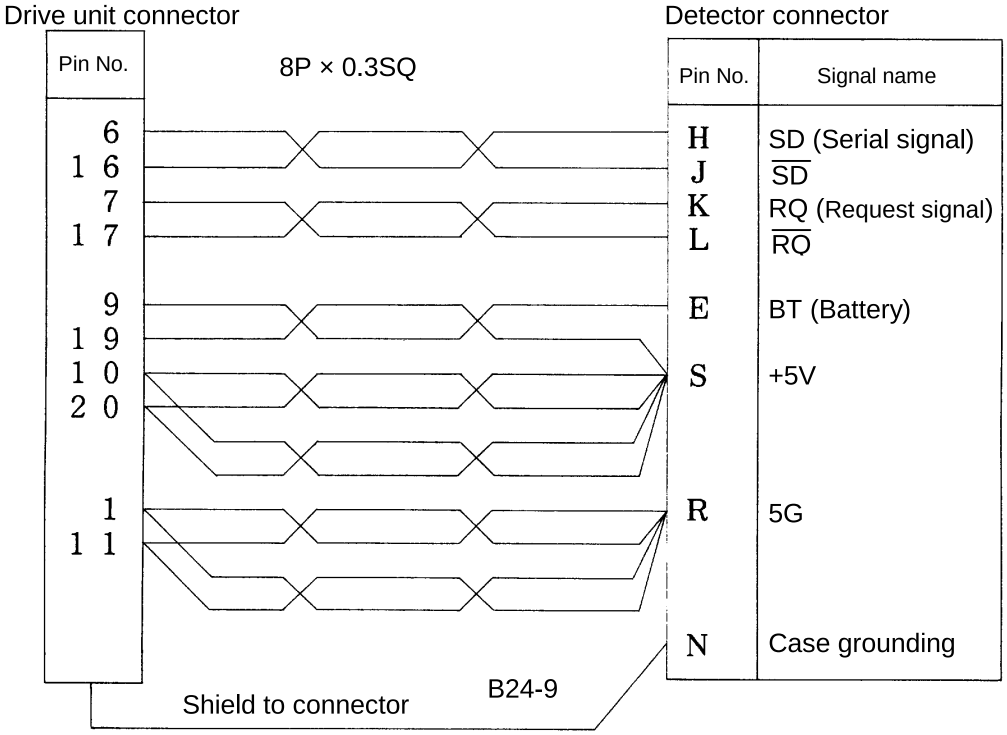
⚠ **CAUTION** Do not mistake the connection when manufacturing the detector cable. Failure to observe this could lead to runaway.

CNV2 and CNV3 cables for MDS-B/C1 Series can be used.

(1) CNV12, CNV13 cable (L ≤ 20m)



(2) CNV12, CNV13 cable (20 < L ≤ 30m)



The drive unit side connector or the detector connector is same connector as the conventional CNV2 or CNV3.

6-6-4 Maintenance

⚠ **WARNING**

1. Wait at least 15 minutes after turning the power OFF before starting maintenance or inspections. Failure to observe this could lead to electric shocks.
2. Only qualified persons must carry out the maintenance or inspections. Failure to observe this could lead to electric shocks. Contact Service Center or Service Station for repairs or part replacements.

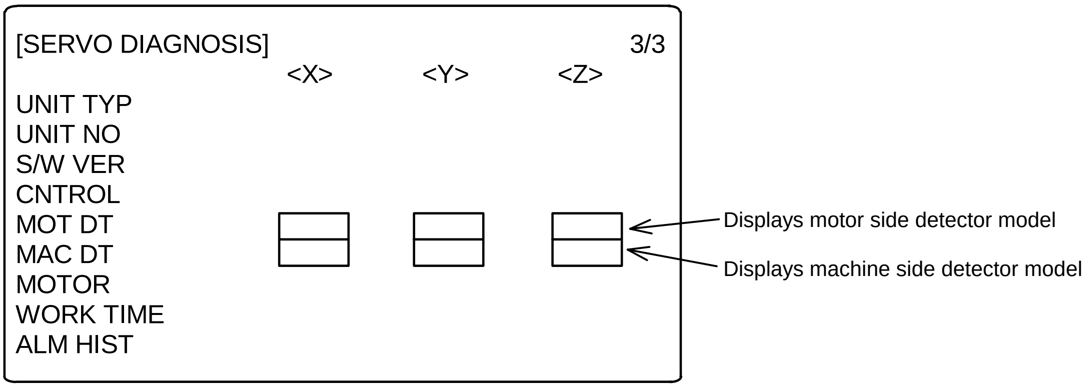
If any fault occurs in the configuration components, carry out service with the following procedures.

(1) Encoder

As a rule, replace the detector with the same type as the detector before exchanging it.
If changes are to be made, always confirm the compatibility and usable combination.

- Confirmation of encoder model
  Confirm the encoder model on the nameplate attached to the motor cover, or displayed on the Servo Monitor screen.

Servo Monitor (SERVO DIAGNOSIS) Screen



```
[SERVO DIAGNOSIS]                                3/3
                        <X>        <Y>        <Z>
UNIT TYP
UNIT NO
S/W VER
CNTROL
MOT DT
MAC DT
MOTOR
WORK TIME
ALM HIST
```

If a fault occurs in the motor unit, replace the motor and encoder as a set.

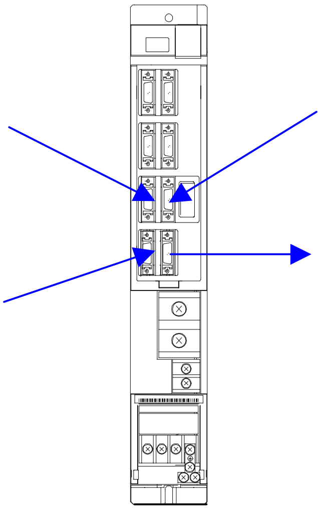
6-7 Spindle option specification parts

When the orientation specifications or C-axis specifications, etc., are selected as spindle options, the magnetic sensor (one-point orientation), external encoder (multi-point orientation, C-axis control), and motor built-in PLG detector can be designated with the spindle delivery specifications.
The Heidenhain detector (special order part) can be used for C-axis control in the same manner as the motor built-in PLG detector.
The C-axis detector (MBE90K, MHE90K) used with the 200V Class drive unit (MDS-B/C1 Series) cannot be used.

Correspondence of spindle functions and applicable detectors

Spindle specifications / Detector	Orientation		C-axis control (contour control)	Synchronous tap control	Thread cutting control	Spindle synchronous control
	One-point	4096 points				
Magnetic sensor	X	–	–	–	–	–
External detector (OSE/RFH-1024)	–	X	–	X	X	X
External detector (OSE90K+1024)	–	X	X	X	X	X
Heidenhain detector	–	X	X Note 2	X Note 2	X	X
Motor built-in PLG detector	–	X	X Note 1, 2	X Note 2	X	X

Note 1) Simple C-axis.
Note 2) Zero point return valid only for 1:1 gear ratio.



CN5
Connect the motor built-in PLG detector. (Motor side detector)

CN7
Connect the C-axis (contour) OSE90K+1024 control detector.
(Machine side detector)

CN6
Connect the magnetic sensor or external OSE/RFH-1024 detector when using the orientation function.
(Machine side detector)

CN8
Outputs the differential output's short waveform (ABZ phase) to the NC. The thread cutting applications or spindle speed can be viewed with the NC.

Outputs the PLG detector or external detector signals depending on the orientation type. Designate with SP037 (spindle function 5).

6-7-1 Magnetic sensor orientation (one-point orientation)

Prepare the magnetic sensor orientation parts with the following types. When purchasing independently, always prepare with the required configuration part types.

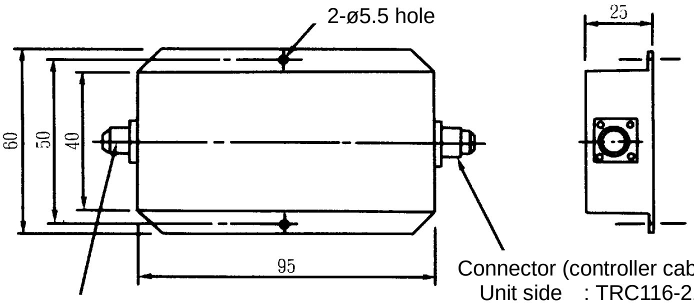
(1) Preparation type

Type	Model	Tolerable speed [r/min]	Combination		
			Amplifier	Sensor	Magnet
Standard	MAGSENSOR BKO-C1810H01-3	0 to 6000	H01	H02	H03
High-speed standard	MAGSENSOR BKO-C1730H01.2.6	0 to 12000	H01	H02	H06
High-speed small	MAGSENSOR BKO-C1730H01.2.9	0 to 12000	H01	H02	H09
High-speed ring	MAGSENSOR BKO-C1730H01.2.41	0 to 25000	H01	H02	H41
	MAGSENSOR BKO-C1730H01.2.42	0 to 25000	H01	H02	H42
	MAGSENSOR BKO-C1730H01.2.43	0 to 30000	H01	H02	H43
	MAGSENSOR BKO-C1730H01.2.44	0 to 30000	H01	H02	H44

Caution) When preparing with independent types, replace the section following the H in the prepared type with the independent type.
Example: When preparing only the standard magnetic sensor's sensor section, the type will be MAGSENSOR BKO-C1810H02.

Outline dimensions:

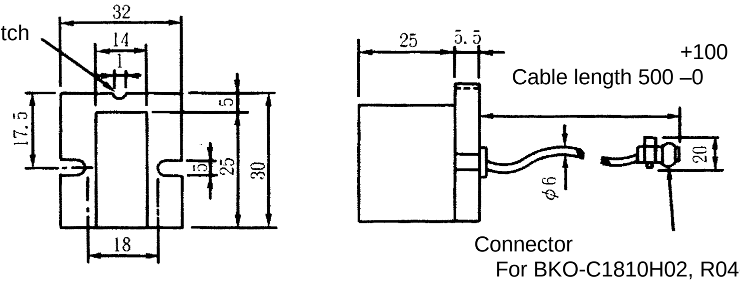
- **Amplifier H01**



Connector (sensor side)
For BKO-C1810H01, R04-R-8F is used.
For BKO-C1730H01, TRC116-21A10-7F is used.

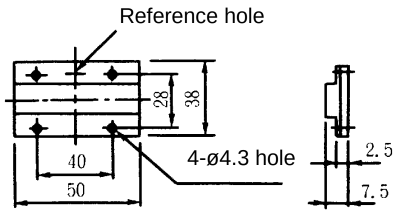
Connector (controller cable side)
Unit side : TRC116-21A10-7M
Cable side : TRC116-12A10-7F10.5

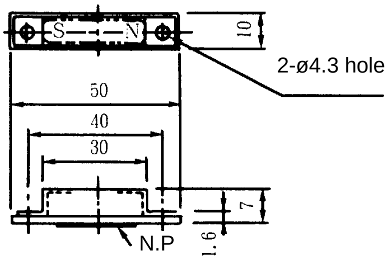
- **Sensor H02**

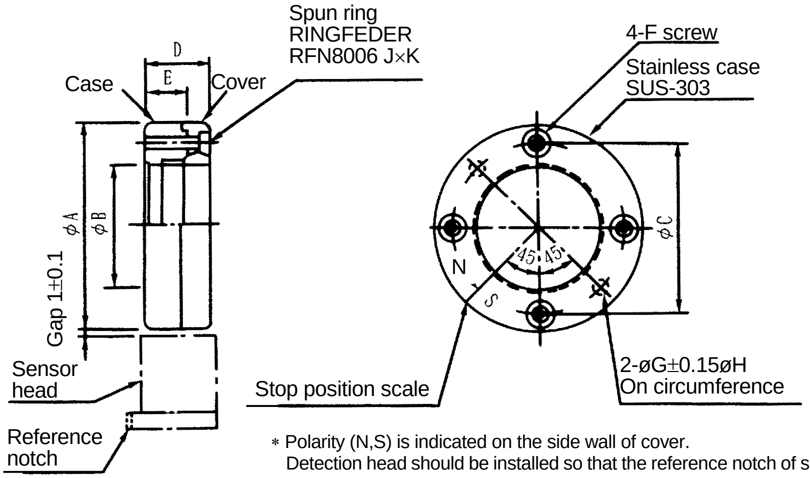


Connector
For BKO-C1810H02, R04-R-8M is used.
For BKO-C1730H02, TRC116-12A10-7M is used.

● Magnet

<table>
<tr><th>Part No.</th><th>Tolerable speed [r/min]</th><th>Outline drawings</th></tr>
<tr><td>H03</td><td>0 to 6000</td><td rowspan="2">Weight: 40 ± 1.5g


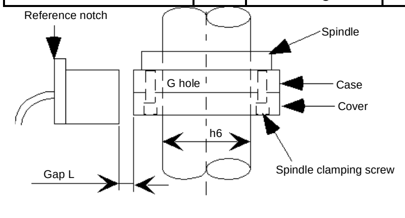
Installation screw: M4</td></tr>
<tr><td>H06</td><td>0 to 12000</td></tr>
<tr><td>H09</td><td>0 to 12000</td><td>Weight: 14.8 ± 0.7g


Installation screw: M4</td></tr>
<tr><td>H41</td><td>0 to 25000</td><td rowspan="4">

* Polarity (N,S) is indicated on the side wall of cover.
Detection head should be installed so that the reference notch of sensor head comes on the case side.

Magnet DIM IN mm

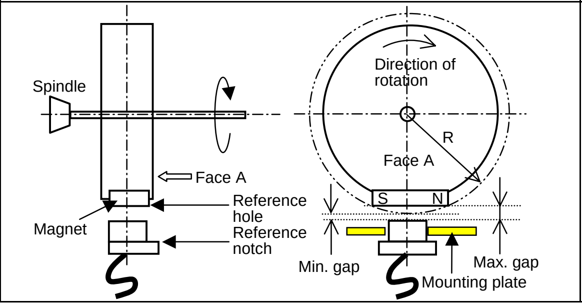
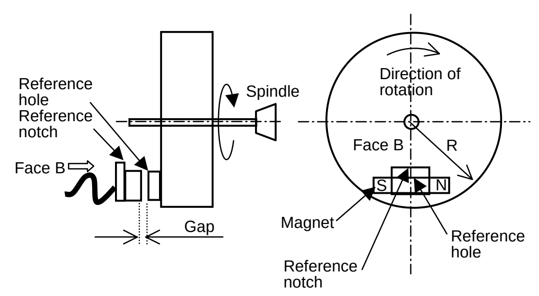
<table>
<tr><th></th><th colspan="11">Dimensions</th></tr>
<tr><th>Model</th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>G</th><th>H</th><th>J × X</th><th>L</th><th>Weight (g)</th></tr>
<tr><td>BKO-C1730H41</td><td>105</td><td>70H7$^{+0.030}_{-0}$</td><td>90</td><td>28</td><td>19</td><td>M6×1.0</td><td>5</td><td>90</td><td>70×79</td><td>1</td><td>1024±4</td></tr>
<tr><td>BKO-C1730H42</td><td>94</td><td>60H7$^{+0.030}_{-0}$</td><td>79</td><td>25</td><td>17</td><td>M5×0.8</td><td>5</td><td>79</td><td>60×68</td><td>1</td><td>768±4</td></tr>
<tr><td>BKO-C1730H43</td><td>78</td><td>50H7$^{+0.025}_{-0}$</td><td>66</td><td>23</td><td>15</td><td>M5×0.8</td><td>5</td><td>66</td><td>50×57</td><td>1</td><td>478±4</td></tr>
<tr><td>BKO-C1730H44</td><td>66</td><td>40H7$^{+0.025}_{-0}$</td><td>54</td><td>20</td><td>13</td><td>M4×0.7</td><td>5</td><td>54</td><td>40×45</td><td>1</td><td>322±4</td></tr>
</table>



Installation of magnet

Caution on installation of H41 to H44
1. Tolerance to shaft dimension should be "h6" on the part for installing a magnet.
2. 2-øG hole can be used for positioning of spindle and magnet.
3. Magnet shall be installed as shown to the left.
4. Misalignment between sensor head and magnetic center line shall be within ±2mm.
5. There is an NS indication on the side of the cover. Install so that the reference notch on the sensor head comes to the case side.</td></tr>
<tr><td>H42</td><td>0 to 25000</td></tr>
<tr><td>H43</td><td>0 to 30000</td></tr>
<tr><td>H44</td><td>0 to 30000</td></tr>
</table>

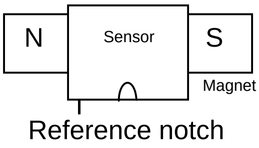
(2) Gap between magnet and sensor

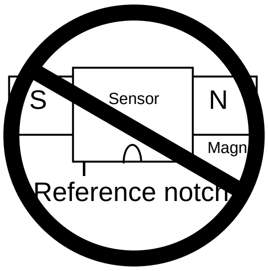
Circumference installation	Horizontal installation
	

Magnet model	BKO-C1810H03			BKO-C1730H06			BKO-C1730H09	
Installation direction	Circumference installation		Horizontal installation	Circumference installation		Horizontal installation	Circumference installation	
R (Radius) mm	Gap mm			Gap mm			Gap mm	
	Max. value	Min. value		Max. value	Min. value		Max. value	Min. value
40	11.5±0.5	2.7±0.5	6.0±0.5	10.0±0.5	1.22±0.5	5.0±0.5	6.25±0.5	3.30±0.5
50	9.5±0.5	2.8±0.5	6.0±0.5	8.0±0.5	1.31±0.5	5.0±0.5	6.00±0.5	3.70±0.5
60	8.5±0.5	3.0±0.5	6.0±0.5	7.0±0.5	1.50±0.5	5.0±0.5	5.75±0.5	3.85±0.5
70	8.0±0.5	3.4±0.5		7.0±0.5	2.38±0.5		5.50±0.5	3.87±0.5

(3) Magnet and sensor installation directions

- Install so that the magnet's reference hole and sensor's reference notch are aligned. (Standard/high-speed standards)
- Install so that the magnet's N pole comes to the left side when the sensor's reference notch is faced downward. (High-speed compact/high-speed ring)

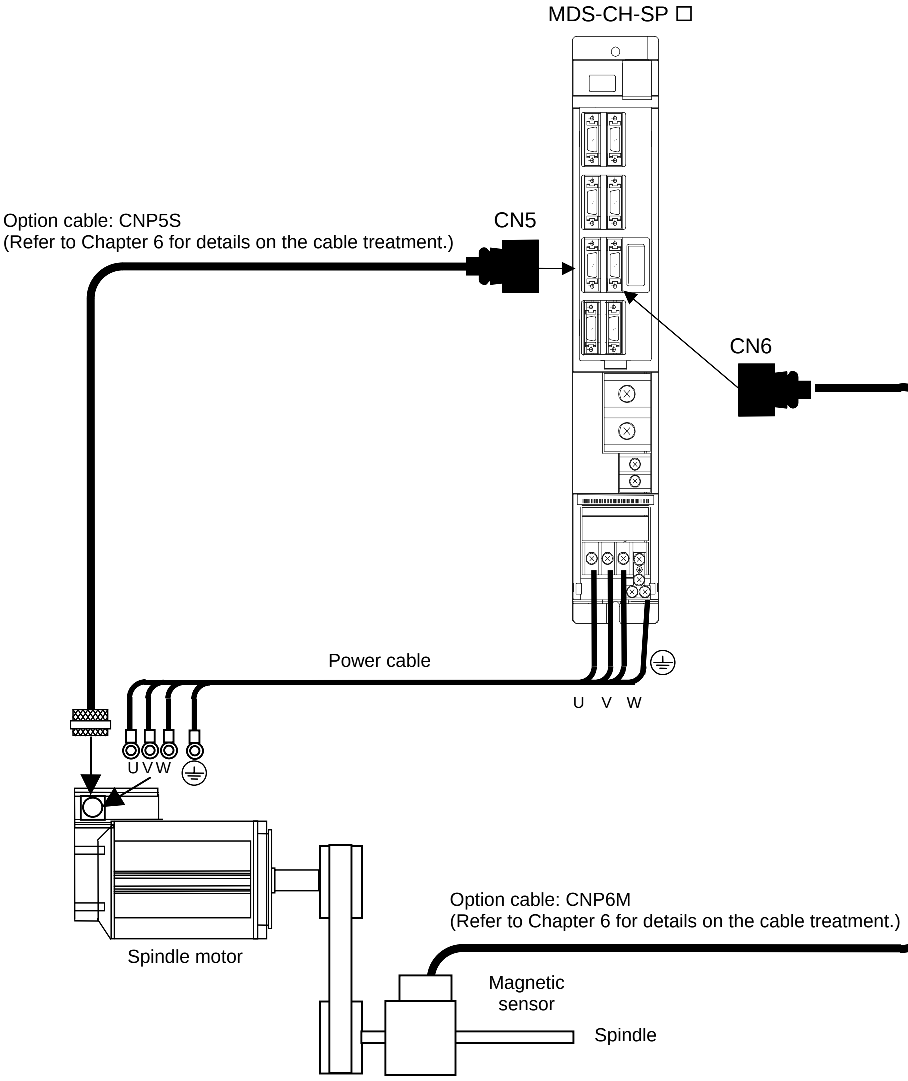




(4) Cautions

(a) Do not apply impacts on the magnet. Do not install strong magnets near the magnet.
(b) Sufficiently clean the surrounding area so that iron chips and cutting chips do not adhere to the magnet. Demagnetize the round disk before installing.
(c) Securely install the magnet onto the spindle with an M4 screw. Take measures to prevent screw loosening as required.
(d) Balance the entire spindle rotation with the magnet installed.
(e) Install a magnet that matches the spindle's rotation speed.
(f) When installing the magnet onto a rotating body's plane, set the speed to 6,000r/min or less.
(g) Install so that the center line at the end of the head matches the center of the magnet.
(h) The BKO-C1730 is not an oil-proof product. Make sure that oil does not come in contact with BNO-C1730 or BKO-C1810.
(i) When connecting to the spindle drive unit, wire so that the effect of noise is suppressed.

(5) Connecting a magnetic sensor and a drive unit



6-7-2 Multi-point orientation using encoder (4096-point orientation)

Prepare the encoder orientation parts with the following types. When purchasing independently, always prepare with the required configuration part types. The encoder is capable of 4096-point multi-point orientation by multiplying 1024p/rev by four.

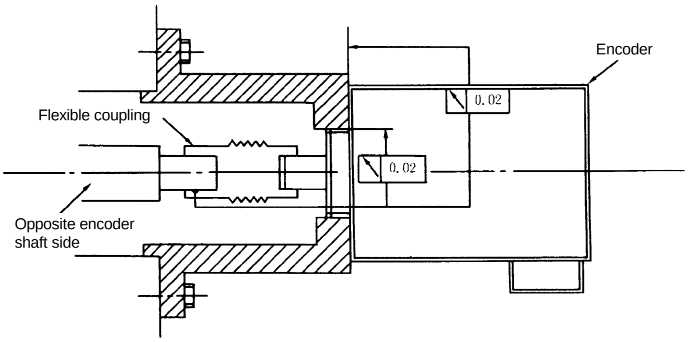
(1) Preparation type

Preparation type	Tolerable rotation	Preparation type	Tolerable rotation
OSE1024-3-15-68	6000r/min	OSE1024-3-15-68-8	8000 r/min
RFH-1024-22-1M-68	6000r/min	RFH-1024-22-1M-68-8	8000 r/min

(2) Encoder specifications

Item	Feature	OSE1024-3-15-68	RFH-1024-22-1M-68	OSE1024-3-15-68-8	RFH-1024-22-1M-68-8
Mechanical characteristics for rotation	Inertia	0.1×10^{-4}kgm^2 or less		0.1×10^{-4}kgm^2 or less	
	Shaft friction torque	0.98Nm or less		0.98Nm or less	
	Shaft angle acceleration	10^4rad/s^2 or less		10^4rad/s^2 or less	
	Tolerable continuous rotation speed	6000r/min		8000r/min	
Mechanical configuration	Bearing maximum non-lubrication time	20000Hr / 6000r/min		20000Hr / 8000r/min	
	Shaft amplitude (position 15mm from end)	0.02mm or less		0.02mm or less	
	Tolerable load (thrust direction/radial direction)	10kg/20kg; Half of value during operation		10kg/20kg; Half of value during operation	
	Weight	1.5kg		1.5kg	
	Squareness of flange to shaft	0.05mm or less			
	Flange matching eccentricity	0.05mm or less			
Working conditions	Working temperature range	–5°C to +55°C			
	Storage temperature range	–20°C to +85°C			
	Humidity range	95%PH			
	Vibration resistance	5 to 50Hz, total vibration width 1.5mm, each shaft for 30 min.			
	Impact resistance	294.20m/s^2 (30G)			

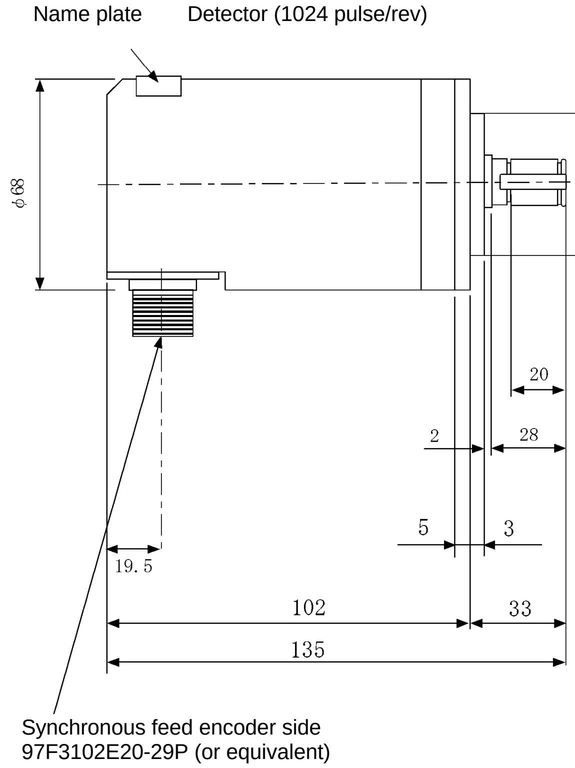
Use of a flexible coupling is recommended for the coupling of the encoder and spindle shaft. The following maker's flexible coupling is recommended.

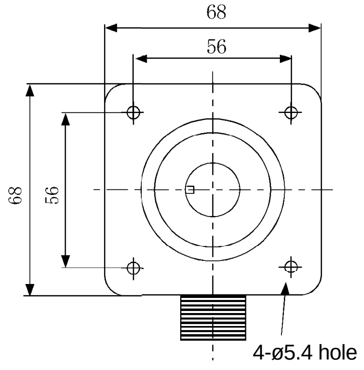


Manufacturer		Tokushu Seiko	Eagle
Model		Model M1	FCS38A
Resonance frequency		1374Hz	3515Hz
Position detection error		0.8×10-3°	1.2×10-3°
Tolerable speed		20000r/min	10000r/min
Mis-alignment	Core deviation	0.7mm	0.16mm
	Angle displacement	1.5°	1.5°
Outline dimensions	Max. length	74.5mm	33mm
	Max. diameter	ø57mm	ø38mm

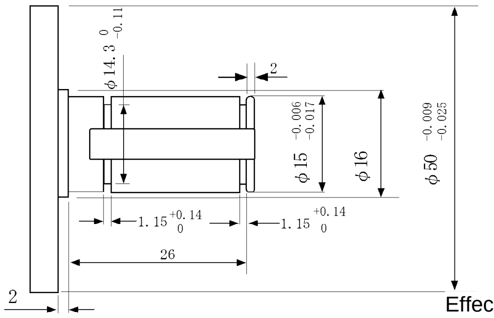
(3) Outline dimensions

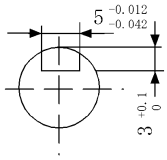
OSE-1024-3-15-68





A	1chA	K	0V
B	1chZ	L	
C	1chB	M	
D		N	1chA*
E	Case grounding	P	1chZ*
F		R	1chB*
G		S	
H	+5V	T	
J			



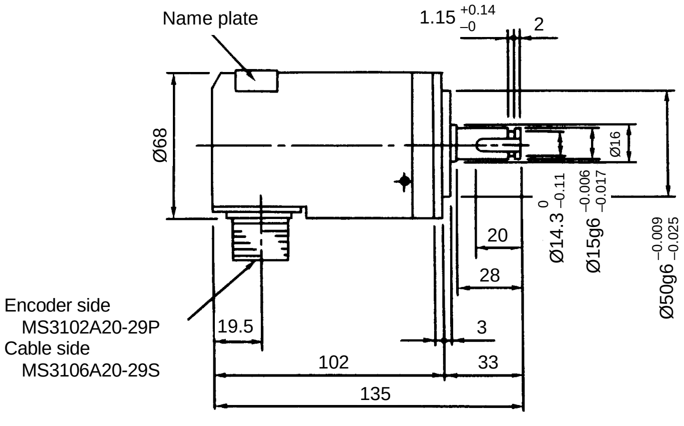


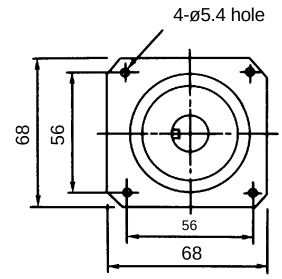
Cross-section BB

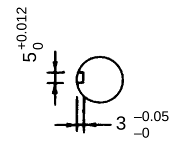
Effective depth of key way is 21mm

Enlarged view of key

RFH-1024-22-1M-68





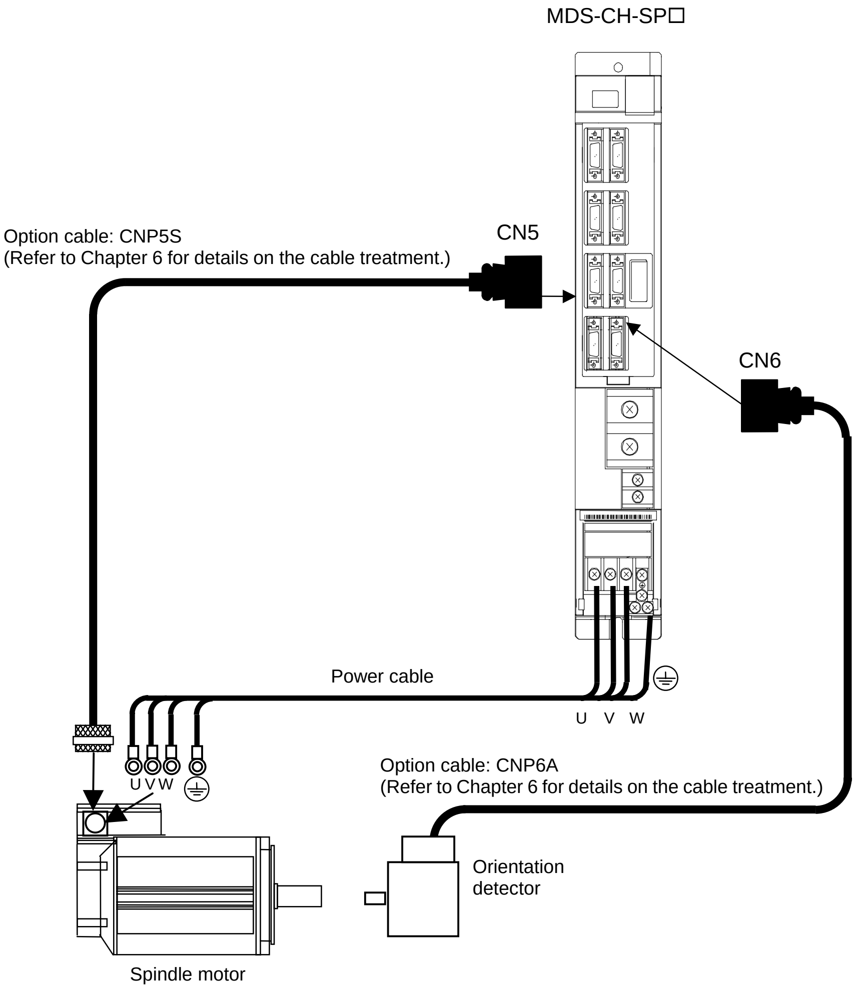


Key way dimensions

Encoder side pin assignment

Pin	Name	Pin	Name
A	A	N	$\overline{A}$
C	B	R	$\overline{B}$
B	Z	P	$\overline{Z}$
H	+5V	K	0V

(4) Connecting an encoder and a spindle drive unit



6-7-3 Multi-point orientation using motor built-in encoder (4096-point orientation)

A spindle motor with motor built-in encoder with Z phase and PLG detector is required for these specifications. Zero point return is possible only when the motor and spindle are connected with a reduction gear ratio of 1:1.

(1) Preparation type

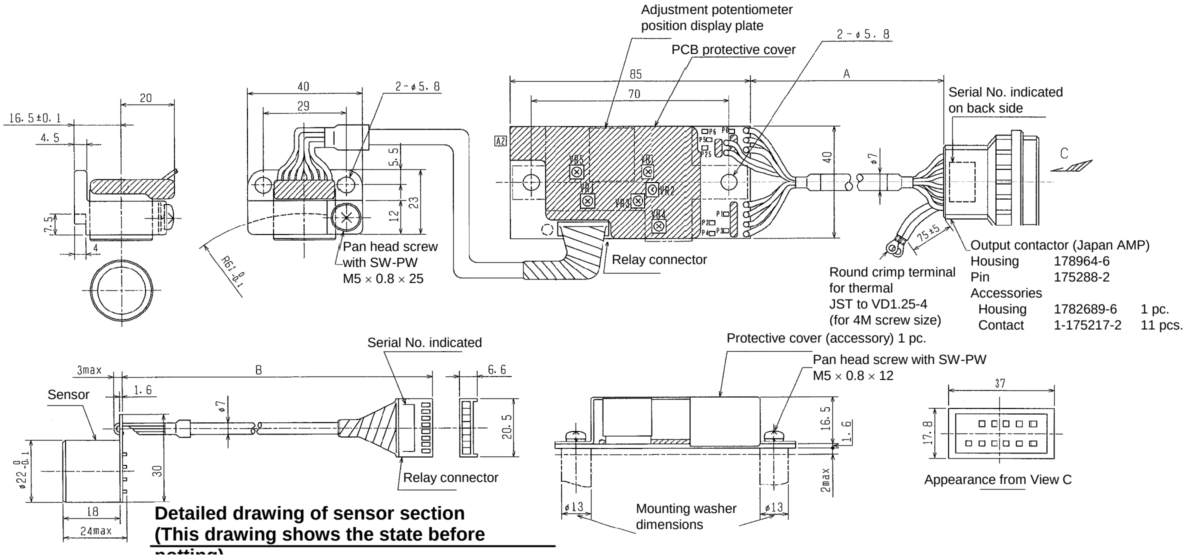
Preparation type	Cable length (Refer to outline drawing)	
	A	B
TS5276N1170H01	200 ± 10mm	270 ± 10mm
TS5276N1171H02	200 ± 10mm	400 ± 10mm
TS5276N1173H03	200 ± 10mm	600 ± 10mm
TS5276N1174H06	200 ± 10mm	800 ± 20mm
TS5276N1175H05	200 ± 10mm	1500 ± 30mm
TS5276N1179H04	200 ± 10mm	1100 ± 20mm

(2) Encoder specifications

Item	Specification	Supplement
Power voltage	5VDC ± 5%	
Power current	Max. 100mA	At 25°C
Operation temperature	-10 to 80°C	
Storage temperature	-20 to 110°C	Both sensor section and PCB
Humidity (operation/storage)	5 to 95% RH	With no dew condensation
Vibration resistance	9.8m/s^2 or less	

Item	A, B phase specifications	Z phase specifications	Supplement
Output wave number	Output wave number	0 to 200 Hz (0 to 12000 r/min)	
Output voltage pulse height value Vp-p	0.54V ± 0.1V Note 1	0.5V ± 0.1V Note 2	Note 1 25°C, 7.68kHz with 120Ω load resistor Note 2 25°C, 30kHz with 120Ω load resistor

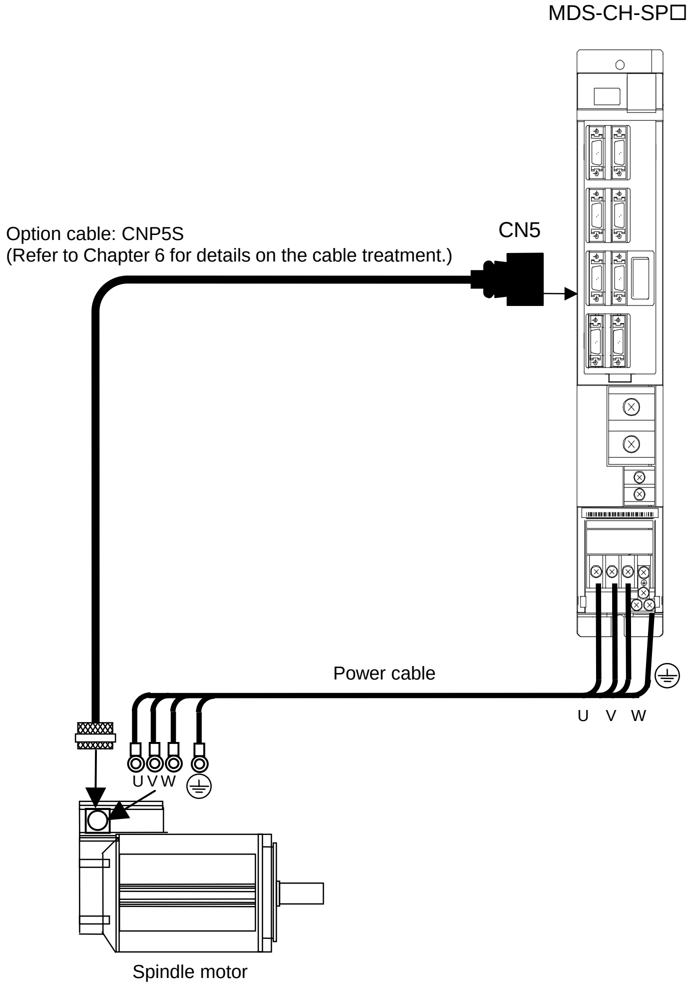
(3) Outline dimensions



Detailed drawing of sensor section (This drawing shows the state before

The combined gears differ according to the spindle motor specifications.
The details must be discussed separately and determined to attain the optimum product specifications.

(4) Connection of motor built-in PLG detector and spindle drive unit



6-7-4 Contour control (C axis control) encoder

Prepare the following type of shaft type encoder part for contour control (C axis control).
A 1/1000 degree resolution (multiplied by four inside the unit) can be attained by connecting the 90,000p/rev signal for the C-axis control to the CN7 connector. A 1024p/rev function is also available for encoder multi-point orientation.

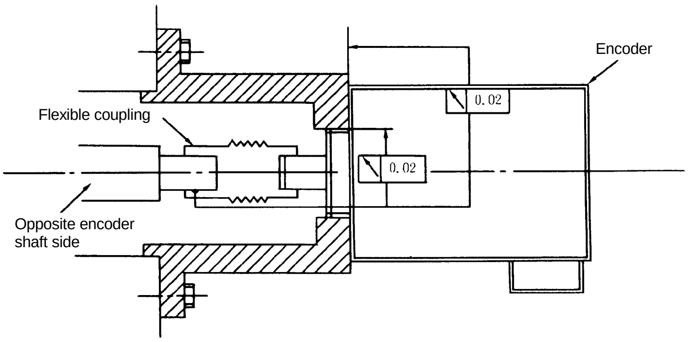
(1) Preparation type

Preparation type	Tolerable rotation
OSE90K+1024 BKO-NC6336H01	6000r/min

(2) Encoder specifications

Item	Features	OSE90K+1024 BKO-NC6336H01
Mechanical characteristics for rotation	Inertia	0.1 × 10^{-4}kgm^2 or less
	Shaft friction torque	0.98Nm or less
	Shaft angle acceleration	10^5rad/s^2 or less
	Tolerable speed	7.030r/min
Mechanical configuration	Bearing maximum non-lubrication time	20000Hr / 6000r/min
	Shaft amplitude (position 15mm from end)	0.02mm or less
	Tolerable load (thrust direction/radial direction)	10kg/20kg Half of value during operation
	Weight	2.0kg
	Squareness of flange to shaft	0.05mm or less
	Flange matching eccentricity	0.05mm or less
Working conditions	Working temperature range	–5°C to +55°C
	Storage temperature range	–20°C to +85°C
	Humidity range	95%PH
	Vibration resistance	5 to 50Hz, total vibration width 1.5mm, each shaft for 30 min.
	Impact resistance	294.20m/s^2 (30G)

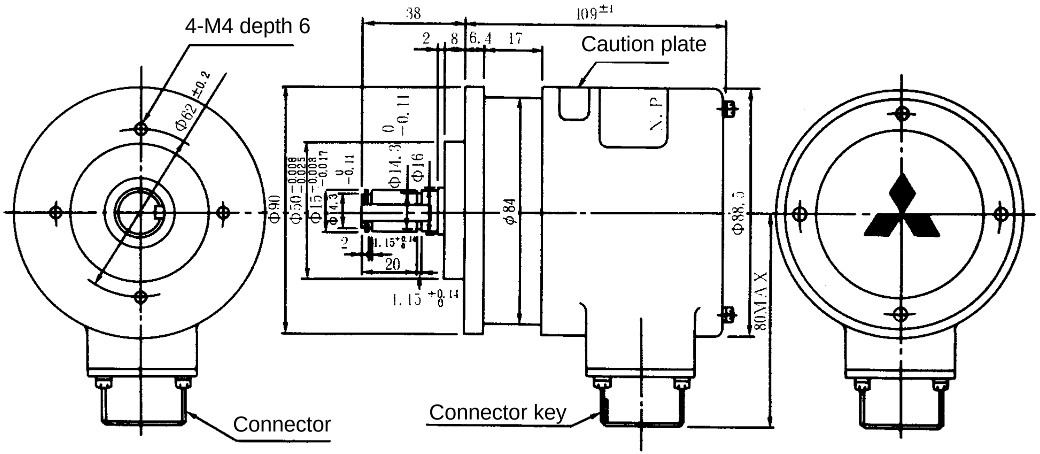
Use of a flexible coupling is recommended for the coupling of the encoder and spindle shaft.
The following maker's flexible coupling is recommended.



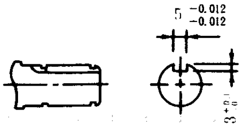
Manufacturer		Tokushu Seiko	Eagle
Model		Model M1	FCS38A
Resonance frequency		1374Hz	3515Hz
Position detection error		0.8×10-3°	1.2×10-3°
Tolerable speed		20000r/min	10000r/min
Mis-alignment	Core deviation	0.7mm	0.16mm
	Angle displacement	1.5°	1.5°
Outline dimensions	Max. length	74.5mm	33mm
	Max. diameter	ø57mm	ø38mm

(3) Outline drawings

- **Encoder OSE90K+1024 BKO-NC6336H01**



Main unit side : MS3102A20-29P
Controller cable side : MS3102A20-29S (The connector on the controller cable side must be prepared by the user.)



Note 1. The max. encoder speed must be 6000r/min or less.
Note 2. The dimensional tolerance that is not specified is ±0.5mm.

Signal

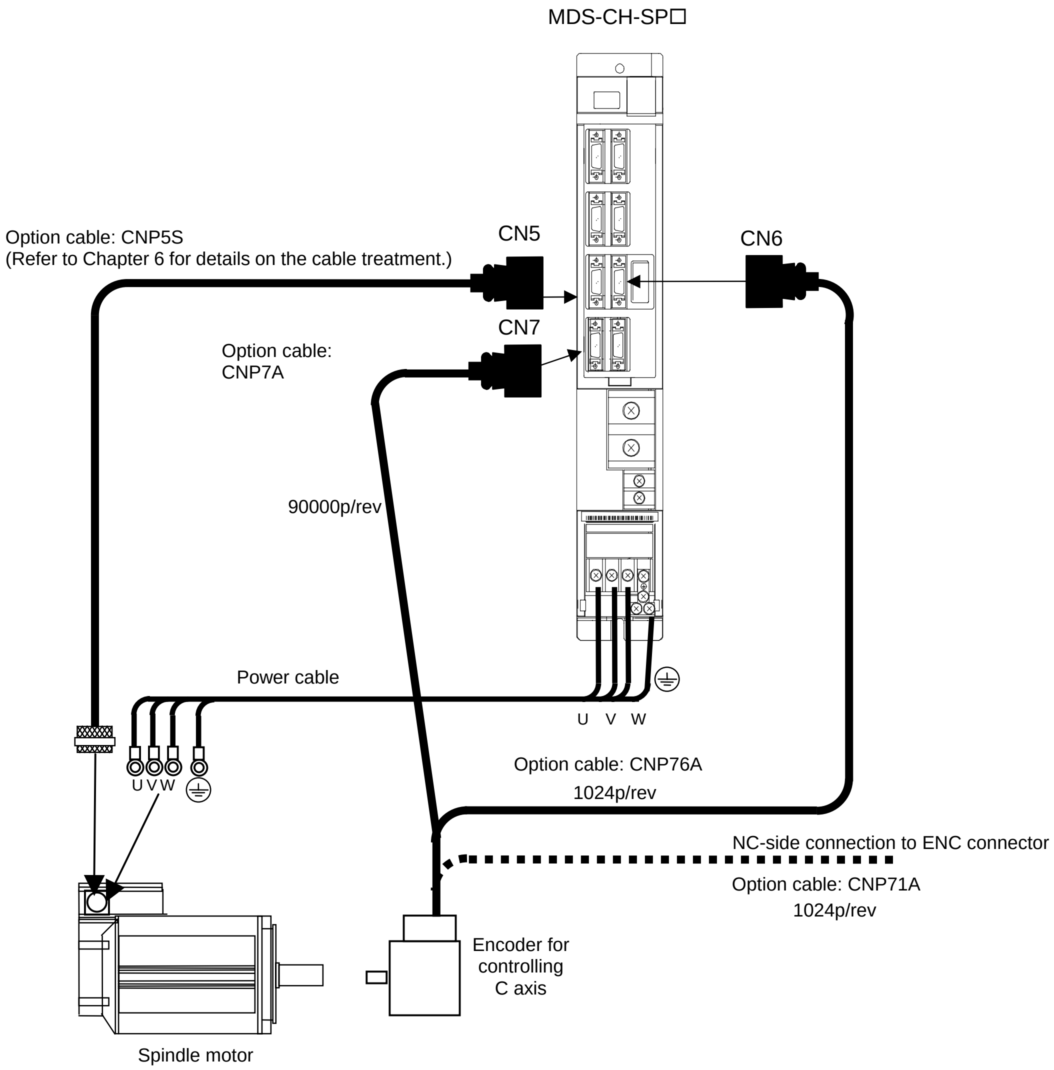
	Generated signals	Remarks	
1ch	1024 C/T	A • B-phase, $\overline{A}$ •$\overline{B}$ -phase	Connect to NC or CN6.
2ch	1 C/T	Z-phase • $\overline{Z}$ -phase	
3ch	90000 C/T	C • D-phase, $\overline{C}$ •$\overline{D}$ -phase	Connect to CN7.
4ch	1 C/T	Y-phase • $\overline{Y}$ •B-phase	

Connector pin assignment

Pin	Function
A	1ch A-phase
B	2ch Z-phase
C	1ch B-phase
D	——
E	Case grounding
F	3ch C-phase
G	3ch D-phase
H	+5V DC $^{+5\%}_{-10\%}$
J	0V

Pin	Function
K	0V
L	3ch $\overline{C}$ -phase
M	3ch $\overline{D}$ -phase
N	1ch $\overline{A}$ -phase
P	2ch $\overline{Z}$ -phase
R	1ch $\overline{B}$ -phase
S	4ch Y-phase
T	4ch $\overline{Y}$ -phase

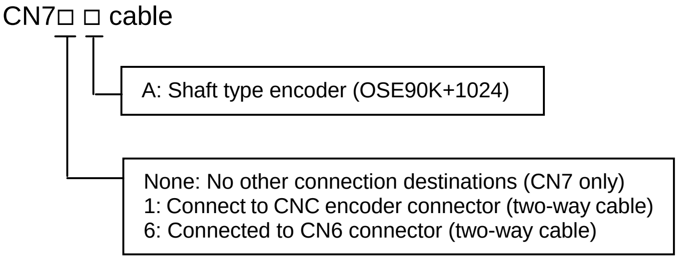
(4) Connecting an encoder and a spindle drive unit



Supplement

1. The C-axis control function is connected to the CN7 connector.
2. When using both the C-axis control function and orientation function, connect two cables (two-way cable) from the detector.
3. The orientation signal connected to CN5 or CN6 can be connected to the NC as a differential output from CN8.

(5) Cable name

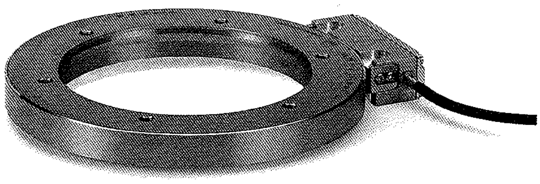

CN7□ □ cable

A: Shaft type encoder (OSE90K+1024)

None: No other connection destinations (CN7 only)
1: Connect to CNC encoder connector (two-way cable)
6: Connected to CN6 connector (two-way cable)

6-7-5 Integrated rotary encoder (Special order part)

Contour (C-axis) control can be carried out using the Heidenhain integrated rotary encoder ERM280 Series. The magnetic memory drum and nonmagnetic sensor are combined in this encoder. This type can be installed only on the built-in type spindle motor, so the motor specifications must also be considered. Prepare this rotary encoder after setting the spindle motor specifications.



(1) Preparation type

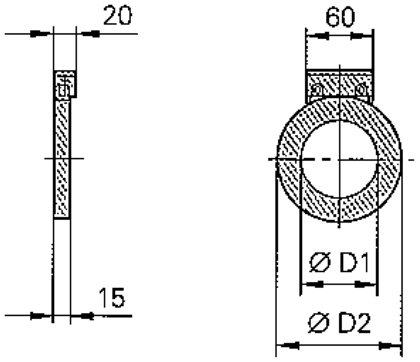
This rotary encoder is not available from Mitsubishi, and must be directly purchased from Heidenhain.

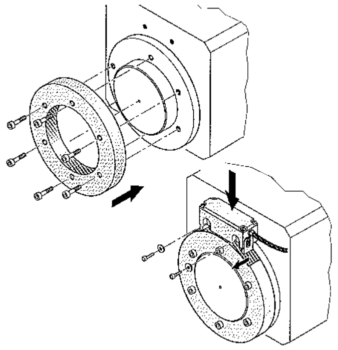
(2) Encoder specifications

Type	ERM280		
Output signal	1Vp-p		
Number of scale lines	1024	1200	2048
Mechanical tolerable speed	18000 r/min	12000 r/min	8000 r/min
Drum Inner diameter D1	ø80mm	ø120mm	ø180mm
Outer diameter D2	ø128.75mm	ø150.88mm	ø257.5mm

Contact the encoder maker for details as the specifications are subject to change.

(3) Outline dimensions





Contact: Heidenhain Corporation

Japan : http://www.heidenhain.co.,jp
Germany : http://www.heidenhain.de

6-8 AC reactor

An AC reactor must be installed for each power supply unit. Refer to section "2-6 Connection of AC reactor" for details on the wiring methods.

6-8-1 Combination with power supply unit

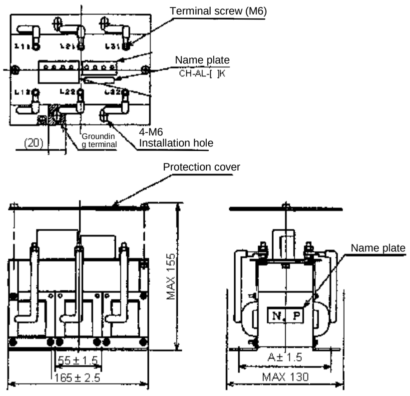
Use the AC reactor and power supply unit with the following combination.

Power supply unit model	AC reactor model CH- AL-☐K							
MDS-CH-☐	7.5k	11k	18.5k	30k	37k	45k	55k	75k
~ CV-75	X							
CV-110		X						
CV-150			X					
CV-185			X					
CV-220				X				
CV-260				X				
CV-300				X				
CV-370					X			
CV-450						X		
CV-550							X	
CV-750								X

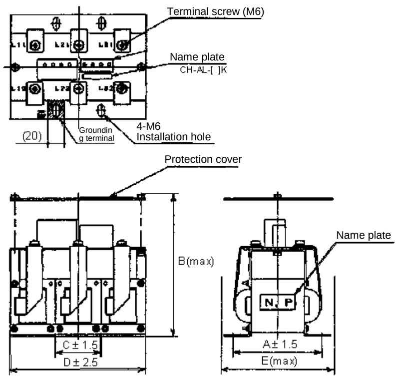
Caution) The X mark indicates the compatible combinations.

6-8-2 Outline dimension drawings

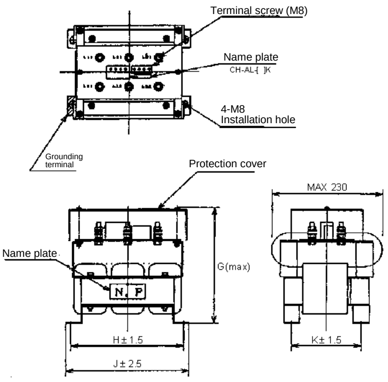
AC reactor model	A	B	C	D	E	G	H	J	K	Weight [kg]
CH-AL-7.5K	82	---	---	---	---	---	---	---	---	3.8
CH-AL-11K	75	---	---	---	---	---	---	---	---	3.3
CH-AL-18.5K	105	155	55	165	130	---	---	---	---	5.2
CH-AL-30K	110	155	55	165	140	---	---	---	---	6.0
CH-AL-37K	110	175	70	215	150	---	---	---	---	9.5
CH-AL-45K	120	175	70	215	160	---	---	---	---	10.5
CH-AL-55K	---	---	---	---	---	210	200	220	120	11.5
CH-AL-75K	---	---	---	---	---	215	230	250	143	14.0



CH-AL-7.5K / CH-AL-11K



CH-AL-18.5K / CH-AL-30K
CH-AL-37K / CH-AL-45K



CH-AL-55K / CH-AL-75K

7. Peripheral Devices

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7-1 Selection of wire

7-1-1 Example of wires by unit

Selected wires must be able to tolerate rated current of the unit's terminal to which the wire is connected. How to calculate tolerable current of an insulated wire or cable is shown in "Tolerable current of electric cable" (1) of Japanese Cable Makers' Association Standard (JCS)-168-E (1995), its electric equipment technical standards or JEAC regulates tolerable current, etc. wire.
When exporting wires, select them according to the related standards of the country or area to export. In the UL standards, certification conditions are to use wires of 60^{o}C and 75^{o}C product. (UL508C)
Wire's tolerable current is different depending on conditions such as its material, structure, ambient temperature, etc. Check the tolerable current described in the specification of the wire to use.
Example of wire selections according to each standard is as follows.

(1) 600V vinyl insulated wire (IV wire) 60^{o}C product (Example according to IEC/EN60204-1, UL508C)

Terminal name / Unit type		TE1 (L1, L2, L3, ⏚)		TE2 (L+, L-)		TE3 (L11, L21, L12, L22, MC1)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG
Power supply unit	MDS-CH-CV-37	2	14	Same as TE1		2	14
	MDS-CH-CV-55	2	14				
	MDS-CH-CV-75	2	14				
	MDS-CH-CV-110	3.5	12				
	MDS-CH-CV-150	5.5	10				
	MDS-CH-CV-185	8	8				
	MDS-CH-CV-220	14	6				
	MDS-CH-CV-260	14	6				
	MDS-CH-CV-300	22	4				
	MDS-CH-CV-370	38	2				
	MDS-CH-CV-450	38	2	TE2-1: Bar enclosed TE2-2: Same as TE1			
	MDS-CH-CV-550	60	—				
	MDS-CH-CV-750	---	---	Bar enclosed			
Spindle drive unit	MDS-CH-SP-15	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-CH-SP-37	2	14				
	MDS-CH-SP-55	2	14				
	MDS-CH-SP-75	2	14				
	MDS-CH-SP-110	5.5	10				
	MDS-CH-SP-150	5.5	10				
	MDS-CH-SP-185	8	8				
	MDS-CH-SP-220	8	8				
	MDS-CH-SP-260	14	6				
	MDS-CH-SP-300	22	4				
	MDS-CH-SP-370	38	2				
	MDS-CH-SP-450	38	2	TE2-1: Bar enclosed			
	MDS-CH-SP-550	38	---	TE2-2: Same as TE1			
	MDS-CH-SP-750	---	---	Bar enclosed			
Servo drive unit	MDS-CH-V1-05	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-CH-V1-10	2	14				
	MDS-CH-V1-20	2	14				
	MDS-CH-V1-35	2	14				
	MDS-CH-V1-45	2	14				
	MDS-CH-V1-70	5.5	10				
	MDS-CH-V1-90	5.5	10				
	MDS-CH-V1-110	5.5	10				
	MDS-CH-V1-150	5.5	10				
	MDS-CH-V1-185	8	8				
Servo drive unit (2-axis)	MDS-CH-V2-0505	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-CH-V2-1005	2	14				
	MDS-CH-V2-1010	2	14				
	MDS-CH-V2-2010	2	14				
	MDS-CH-V2-2020	2	14				
	MDS-CH-V2-3510	2	14				
	MDS-CH-V2-3520	2	14				
	MDS-CH-V2-3535	2	14				
	MDS-CH-V2-4520	2	14				
	MDS-CH-V2-4535	2	14				

(2) 600V double (heat proof) vinyl insulated wire (HIV wire) 75 °C product (Example according to IEC/EN60204-1, UL508C)

Unit type	Terminal name	TE1 (L1, L2, L3, ⏚)		TE2 (L+, L-)		TE3 (L11, L21, L12, L22, MC1)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG
Power supply unit	MDS-CH-CV-37	2	14	Same as TE1		2	14
	MDS-CH-CV-55	2	14				
	MDS-CH-CV-75	2	14				
	MDS-CH-CV-110	3.5	12				
	MDS-CH-CV-150	5.5	10				
	MDS-CH-CV-185	8	8				
	MDS-CH-CV-220	8	8				
	MDS-CH-CV-260	14	6				
	MDS-CH-CV-300	14	6				
	MDS-CH-CV-370	22	4				
	MDS-CH-CV-450	22	4	TE2-1: Bar enclosed TE2-2: Same as TE1			
	MDS-CH-CV-550	38	2				
	MDS-CH-CV-750	60	–	Bar enclosed			
Spindle drive unit	MDS-CH-SP-15	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-CH-SP-37	2	14				
	MDS-CH-SP-55	2	14				
	MDS-CH-SP-75	2	14				
	MDS-CH-SP-110	5.5	10				
	MDS-CH-SP-150	5.5	10				
	MDS-CH-SP-185	8	8				
	MDS-CH-SP-220	8	8				
	MDS-CH-SP-260	14	6				
	MDS-CH-SP-300	22	4				
	MDS-CH-SP-370	22	4				
	MDS-CH-SP-450	38	2	TE2-1: Bar enclosed TE2-2: Same as TE1			
	MDS-CH-SP-550	38	2				
	MDS-CH-SP-750	60	–	Bar enclosed			
Servo drive unit	MDS-CH-V1-05	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-CH-V1-10	2	14				
	MDS-CH-V1-20	2	14				
	MDS-CH-V1-35	2	14				
	MDS-CH-V1-45	2	14				
	MDS-CH-V1-70	5.5	10				
	MDS-CH-V1-90	5.5	10				
	MDS-CH-V1-110	5.5	10				
	MDS-CH-V1-150	5.5	10				
	MDS-CH-V1-185	8	8				
Servo drive unit (2-axis)	MDS-CH-V2-0505	2	14	Match with TE2 of selected power supply unit		2	14
	MDS-CH-V2-1005	2	14				
	MDS-CH-V2-1010	2	14				
	MDS-CH-V2-2010	2	14				
	MDS-CH-V2-2020	2	14				
	MDS-CH-V2-3510	2	14				
	MDS-CH-V2-3520	2	14				
	MDS-CH-V2-3535	2	14				
	MDS-CH-V2-4520	2	14				
	MDS-CH-V2-4535	2	14				

(3) 600V bridge polyethylene insulated wire (IC) 105 °C product (Example according to JEAC8001)

Unit type	Terminal name	TE1 (L1, L2, L3, ⏚)		TE2 (L+, L-)		TE3 (L11, L21, L12, L22, MC1)	
		mm^2	AWG	mm^2	AWG	mm^2	AWG
Power supply unit	MDS-CH-CV-37	2	14	Same as TE1		1.25~2	16 ~14
	MDS-CH-CV-55	2	14				
	MDS-CH-CV-75	2	14				
	MDS-CH-CV-110	2	14				
	MDS-CH-CV-150	3.5	12				
	MDS-CH-CV-185	5.5	10				
	MDS-CH-CV-220	8	8				
	MDS-CH-CV-260	14	6				
	MDS-CH-CV-300	14	6				
	MDS-CH-CV-370	22	4				
	MDS-CH-CV-450	22	4	TE2-1: Bar enclosed TE2-2: Same as TE1			
	MDS-CH-CV-550	38	2				
	MDS-CH-CV-750	38	2	Bar enclosed			
Spindle drive unit	MDS-CH-SP-15	2	14	Match with TE2 of selected power supply unit		1.25~2	16 ~14
	MDS-CH-SP-37	2	14				
	MDS-CH-SP-55	2	14				
	MDS-CH-SP-75	2	14				
	MDS-CH-SP-110	2	14				
	MDS-CH-SP-150	3.5	12				
	MDS-CH-SP-185	5.5	10				
	MDS-CH-SP-220	8	8				
	MDS-CH-SP-260	14	6				
	MDS-CH-SP-300	14	6				
	MDS-CH-SP-370	22	4				
	MDS-CH-SP-450	22	4	TE2-1: Bar enclosed TE2-2: Same as TE1			
	MDS-CH-SP-550	38	2				
	MDS-CH-SP-750	50	–	Bar enclosed			
Servo drive unit	MDS-CH-V1-05	2	14	Match with TE2 of selected power supply unit		1.25~2	16 ~14
	MDS-CH-V1-10	2	14				
	MDS-CH-V1-20	2	14				
	MDS-CH-V1-35	2	14				
	MDS-CH-V1-45	2	14				
	MDS-CH-V1-70	2	14				
	MDS-CH-V1-90	3.5	12				
	MDS-CH-V1-110	5.5	10				
	MDS-CH-V1-150	5.5	10				
	MDS-CH-V1-185	8	8				
Servo drive unit (2-axis)	MDS-CH-V2-0505	2	14	Match with TE2 of selected power supply unit		1.25~2	16 ~14
	MDS-CH-V2-1005	2	14				
	MDS-CH-V2-1010	2	14				
	MDS-CH-V2-2010	2	14				
	MDS-CH-V2-2020	2	14				
	MDS-CH-V2-3510	2	14				
	MDS-CH-V2-3520	2	14				
	MDS-CH-V2-3535	2	14				
	MDS-CH-V2-4520	2	14				
	MDS-CH-V2-4535	2	14				

⚠CAUTION

1. Selection conditions follow IEC/EN60204-1, UL508C, JEAC8001.
   - Ambient temperature is maximum 40°C.
   - Cable installed on walls without ducts or conduits.

   To use the wire under conditions other than above, check the standards you are supposed to follow.
2. The maximum wiring length to the motor is 30m.
   If the wiring distance between the drive unit and motor is 20m or longer, use a thick wire so that the cable voltage drop is 2% or less.
3. Always wire the grounding wire.

7-2 Selection of main circuit breaker and contactor

The methods for selecting the breaker and contactor connected to the power supply unit are explained in this section. Note that the breaker (wiring breaker) must be installed for each power supply unit.

Circuit protection breaker	If an error occurs in the circuit, the power circuit is cut (shut off) immediately to prevent abnormal overheating or burning of the wiring. This is also called a no-fuse breaker.
Earth leakage breaker	Shuts off the breaker before an earth leakage accident (protects human life) or fire occurs due to an earth leakage.

7-2-1 Selection of earth leakage breaker

When installing an earth leakage breaker, select the breaker on the following basis to prevent the breaker from malfunctioning by the higher frequency earth leakage current generated in the servo or spindle drive unit.

(1) Selection

Obtaining the earth leakage current for all drive units referring to the following table, select an earth leakage breaker within the “rated non-operation sensitivity current”.
Usually use an earth leakage breaker for inverter products that function at a leakage current within the commercial frequency range (50 to 60Hz).
If a product sensitive to higher frequencies is used, the breaker could malfunction at a level less than the maximum earth leakage current value.

Earth leakage current for each unit

Unit	Earth leakage current	Maximum earth leakage current
MDS- CH -SP-15 to 750	6mA	15mA
MDS- CH -V1-05 to 185	1mA	2mA
MDS- CH -V2-0505 to 4535	1mA	4mA (for two axes)

(Note1) Maximum earth leakage current: Value that considers wiring length and grounding, etc.
(Commercial frequency 50/60Hz)

(Note2) The earth leakage current in the power supply unit side is included in the drive unit side.

(2) Measurement of earth leakage current

When actually measuring the earth leakage current, use a product that is not easily affected by the higher frequency earth leakage current. The measurement range should be 50 to 60Hz.

POINT

1. The earth leakage current tends to increase as the motor capacity increases.
2. A higher frequency earth leakage current will always be generated because the inverter circuit in the drive unit switches the transistor at high speed. Always ground to reduce the higher frequency earth leakage current as much as possible.
3. An earth leakage current containing higher frequency may reach approx. several hundreds of mA. According to IEC479-2, this level is not hazardous to the human body.

7-2-2 Selection of no-fuse breaker

Select the breaker selection current that is calculated from the rated output and the nominal input voltage as in the expression below. And then select the minimum capacity no-fuse breaker whose rated current meets the breaker selection current.

$$\text{Breaker selection current [A]} = \frac{\text{No-fuse breaker selection current for 380V input [A]}}{\text{Nominal input voltage [V]}} \times 380\ \text{[V]}$$

Selection of no-fuse breaker for 380V input [A]

Unit type MDS-DH-CV-	37	55	75	110	150	185	220	260	300	370	450	550	750
Rated output	3.7kW	5.5kW	7.5kW	11kW	15kW	18.5kW	22kW	26kW	30kW	37kW	45kW	55kW	75kW
Breaker selection current	8A	12A	16A	24A	33A	40A	48A	56A	65A	80A	98A	119A	163A
Recommended breaker (Mitsubishi Electric Corp.: option part)	NF50-CW3P-10A	NF50-CW3P-15A	NF50-CW3P-20A	NF50-CW3P-30A	NF50-CW3P-40A	NF50-CW3P-40A	NF50-CW3P-50A	NF100-CW3P-60A	NF100-CW3P-75A	NF100-CW3P-100A	NF100-CW3P-100A	NF225-CW3P-125A	NF225-CW3P-200A
Rated current of the recommended breaker	10A	15A	20A	30A	40A	40A	50A	60A	75A	100A	100A	125A	200A

Option part: A breaker is not prepared as an NC unit accessory, so purchase the part from your dealer, etc.

(Example)

Select a no-fuse breaker for using the MDS-DH-CV-450 with a 480V nominal input voltage.
Breaker selection current =98/480 x 380 = 77.6 [A]
According to the table above, select "NF100-CW3P-100".

⚠ **CAUTION**

1. It is dangerous to share a no-fuse breaker for multiple power supply units, so do not share it. Always install the breakers for each power supply unit.
2. If the control power (L11, L21) must be protected, select according to the section "7-3-1 Circuit protection".

7-2-3 Selection of contactor

Select the contactor selection current that is calculated from the rated output and the nominal input voltage as in the expression below. And then select the contactor whose conventional free-air thermal current meets the contactor selection current.

$$\text{Contactor selection current [A]} = \frac{\text{Contactor selection current for 380V input [A]}}{\text{Nominal input voltage [V]}} \times 380\ \text{[V]}$$

Selection of contactor for 380V input [A]

Unit type MDS-CH-CV-	37	55	75	110	150	185	220	260	300	370	450	550	750
Rated output	3.7kW	5.5kW	7.5kW	11kW	15kW	18.5kW	22kW	26kW	30kW	37kW	45kW	55kW	75kW
Contactor selection current	8A	12A	16A	24A	33A	40A	48A	56A	65A	80A	98A	119A	163A
Recommended contactor (Mitsubishi Electric Corp.: option part)	S-N12-AC400V	S-N12-AC400V	S-N12-AC400V	S-N21-AC400V	S-N25-AC400V	S-N25-AC400V	S-N25-AC400V	S-N35-AC400V	S-N50-AC400V	S-N50-AC400V	S-N65-AC400V	S-N80-AC400V	S-N150-AC400V
Conventional free-air thermal current of the recommended contactor	20A	20A	20A	32A	50A	50A	50A	60A	80A	80A	100A	135A	200A

Option part: A breaker is not prepared as an NC unit accessory, so purchase the part from your dealer, etc.

(Example)

Select a contactor for using the MDS-CH-CV-450 with a 480V nominal input voltage.
Contactor selection current = 98/480 × 380 = 77.6 [A]
According to the table above, select "S-N50-AC400V".

POINT

1. If the contactor selection current is 20A or less, select the S-N12 product for the contactor.
2. Select a contactor whose excitation coil does not operate at 15mA or less.

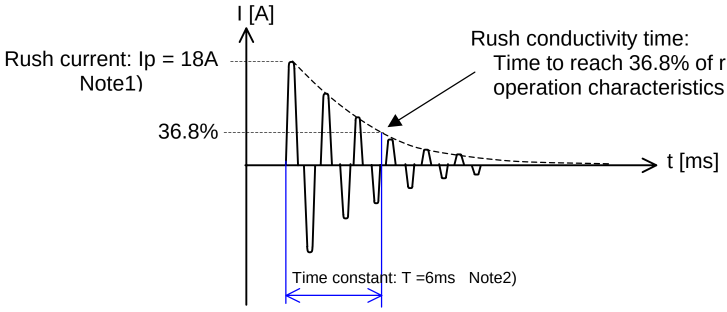
7-3 Control circuit related

7-3-1 Circuit protector

This breaker is used to switch the power and to provide overload and short-circuit protection at the control circuit.

When connecting a circuit protector or breaker to the power input (TE3 terminals L11 and L21) for the control circuit, use a product that does not trip (incorrectly activate) by a rush current when the power is turned ON. A circuit protector with inertial delay and an operation delayed type breaker are available to prevent unnecessary tripping. Select the product to be used according to the machine specifications.

The rush current and rush conductivity time differ according to the power impedance and power ON timing, so select a product that does not trip even under the conditions listed in the following table.



Note1) When using MDS-CH-CV-450 to 750, the rush current is selected with rush current in contactor ON (45A).

Note2) When using MDS-CH-CV-450 to 750, the time constant is selected with rush current conductivity time in contactor ON (450/550: 200ms, 750: 260ms).

POINT

When collectively protecting the control circuit power for multiple units, select a circuit protector or breaker that satisfies the total sum of the rush current IP. The largest value is used for the rush conductivity time T.

(Example 1)

Selecting a breaker to be connected to the power supply for the MDS-CH-CV-550, SP-370, V2-3535 and V1-35 control circuit

Rush current Ip [A] = 45 + 18 + 18 + 18 = 99 [A]
(CV, SP, V2, V1)

Rush conductivity time T [s] = 200 [ms]
← (CV-550 is the maximum)

Refer to the breaker operation characteristics diagram, and select a breaker with a rated current that does not trip even at the minimum operation time.

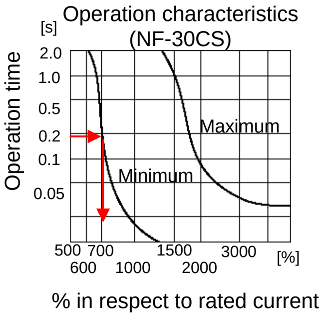
In this case, a current 7-fold the breaker's rated current can be tolerated at the operation time 0.2[s]. According to the table on the right, the following applies.

Rated current= 15 [A] × 7-fold = 105 [A].

The breaker's rated current is larger than the rush current 99 [A], so a breaker with 15[A] rated current can be used.

Select the "NF-30CS-2P-15A" breaker in this case.

Example of breaker (cost efficient model)



Type	NF-30CP-2P [Rated current] A
Rated current	3, 5, 10, 15, 20, 30

7-3-2 Fuse protection

The fuse of branch-circuit protection must use UL class CC, J or T. In the selection, please consider rush current and rush conductive time.

Selection of branch-circuit protection fuse

Connected total of unit	Fuse (Class CC)		Wire Size
	Rated [V]	Current [A]	AWG
1 – 4	600	20	16 to 14
5 – 8		35	

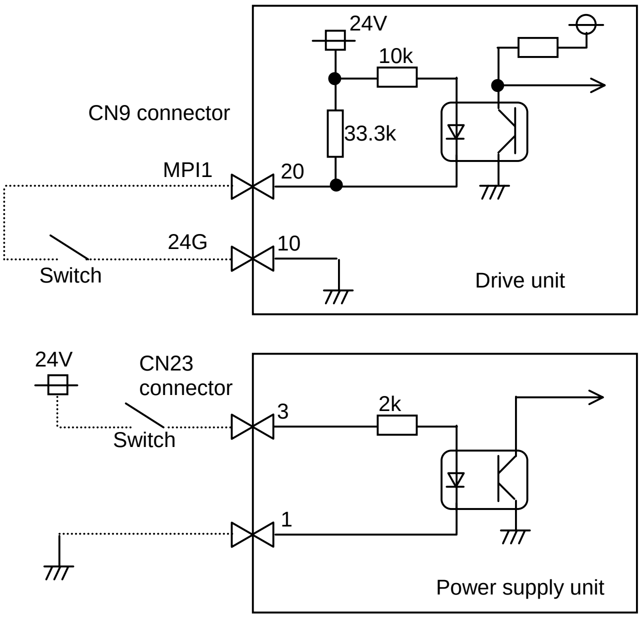
⚠ **CAUTION**	For continued protection against risk of fire, replace only with same type 600 V, 20 or 35 A (UL CLASS CC) fuse.

7-3-3 Relays

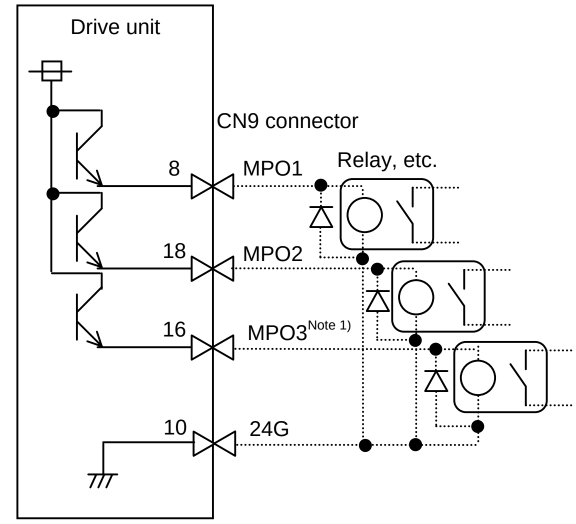
Use the following relays for the input/output interface (power supply, external emergency stop function: CN23 or CN9.)

Interface name	Selection example
For digital input signal (CN23, etc.)	Use a minute signal relay (Example: twin contact) to prevent a contact defect. **<Example>** OMRON: G2A, G6B type, MY type, LY type
For digital output signal (CN9)	Use a compact relay with rating of 24VDC, 50mA or less. **<Example>** OMROM: G6B type, MY type

Input circuit



Output circuit



Note 1) MPO3 is not provided with the MDS-CH-V1/V2.

External contact ON conditions	18VDC to 25.2VDC 9mA or more
External contact OFF conditions	4VDC or less 2mA or less

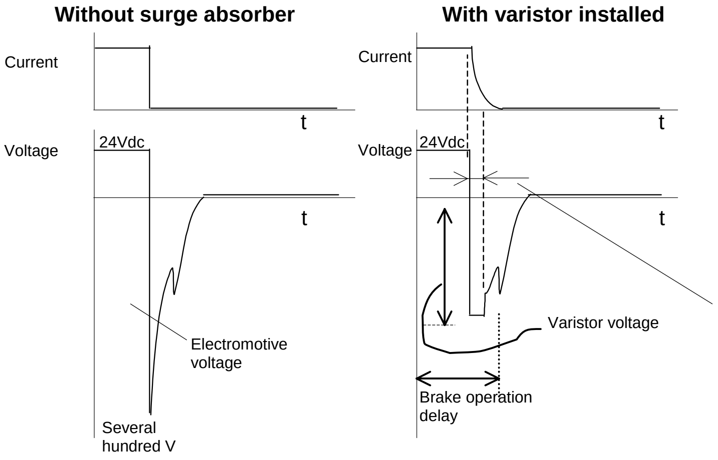
Output voltage	24VDC ±5%
Tolerable output current Io	50mA or less

7-3-4 Surge absorber

When using magnetic brakes, a surge absorber must be installed to protect the relay contact and brakes. Commonly a varistor is used.

(1) Necessity of surge absorber

When the state of the motor's magnetic brakes changes from energized (brakes open) to non-energized (brakes applied), a large voltage (electromotive voltage) is generated in the coil. This can cause the power unit to fail, and can shorten the life of the relay contacts, etc. A surge absorber must be installed to suppress this electromotive voltage.



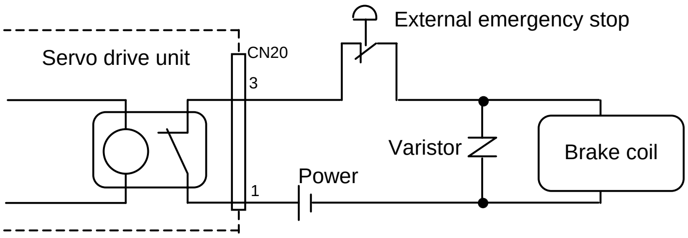
Without surge absorber

With varistor installed

Caution
A voltage is applied on he coils while the surge absorber (varistor) is adsorbing the energy, so the brake operation time will be delayed.

(2) Selection of varistor

When a varistor is installed in parallel with the coil, the surge voltage can be adsorbed as heat and the electromotive voltage can be suppressed to approximately the same level as the varistor voltage. If the varistor voltage is low, the energy consumed as heat increases, so allow for the current passed to the coil during braking and the contact open/close frequency when selecting the varistor. When using a relay for motor breaking, the brake operation time will be delayed if the varistor voltage is extremely low. Always confirm the operation with an actual machine.



Select a varistor with the following or equivalent specifications. To prevent short-circuiting, attach a flame resistant insulation tube, etc., onto the leads as shown in the following outline dimension drawing.

Applying a 24VDC voltage onto the coil with CN20 connector

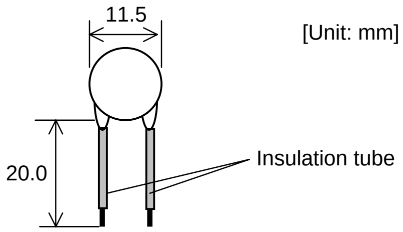
Rating							Max. limit voltage V 20A	Electrostatic capacity (reference value)	Varistor voltage rating (range)
Tolerable circuit voltage V 1mA		Surge current withstand level @8/20us (A)		Energy withstand level (J)		Maximum average pulse power			
AC (V)	DC (V)	1 time	2 times	10/1000us	2ms	(W)	(V)	(pF)	(V)
75	100	3500	2500	20	14.5	0.4	200	1400	120 (108 to 132)
140	180	3500	2500	39	27.5	0.4	360	410	220 (198 to 242)

Selection condition	:	When ON/OFF frequency is 10 times/min or less, and exciting current is 2A or less
Supplement	:	Normally use a product with 120V varistor voltage. If there is no allowance for the brake operation time, use the 220V product. If the varistor voltage exceeds 200V, the specifications of the relay in the unit will be exceeded, and the contact life will be shortened.

<Example> (These parts cannot be directly ordered from Mitsubishi Electric Corp.)

- ERZV10D121, ERZV10D221 (Matsushita Electric Industrial Co., Ltd.)
- TNR10V121K, TNR-12G221K (MARCON Electronics Co., Ltd.)

<Outline dimension drawing> ERZV10D121, ERZV10D221



8. Troubleshooting

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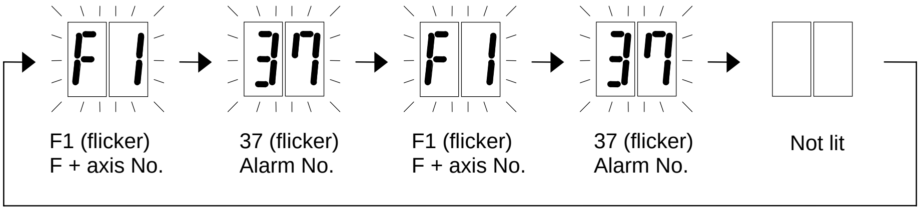
8-1 Points of caution and confirmation

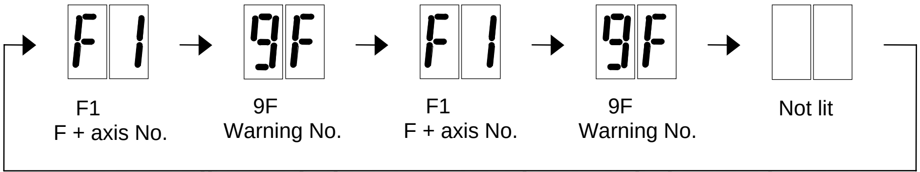
If an error occurs in the servo drive unit or spindle drive unit, the warning or alarm will occur. When a warning or alarm occurs, check the state while observing the following points, and inspect or remedy the unit according to the details given in this section.

<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 drive unit temperature and ambient temperature normal?
4. Are the servo drive unit, 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 drive unit been replaced, parts replaced or emergency measures taken?
12. How many years has the unit been operating?
13. Is the power supply voltage normal? Does the state change greatly according to the time band?



LED display during servo alarm or spindle alarm



LED display during servo warning or spindle warning

⚠ CAUTION

1. This power supply unit uses a large capacity electrolytic capacitor. When the CHARGE lamp on the front of the power supply unit is lit, voltage is still present at the PN terminal (TE2). Do not touch the terminal block in this state.
2. Before replacing the unit, etc., always confirm that there is no voltage at the PN terminal (TE2) with a tester or wait at least 15 minutes after turning the main power OFF.
3. The conductivity in the unit cannot be checked.
4. Do not carry out a megger test as the unit 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 drive unit or spindle drive unit may not have been started up correctly.
Confirm the LED display on each unit, 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 drive unit axis No. setting is incorrect.	Is there any other drive unit 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.
AC	During parameter transmission request	Communication with CNC is incorrect.	Refer to the remedies for "Ab"	
Ad	During parameter conversion request	Communication with CNC is incorrect.		
AE	Unit initialization standby	Communication with CNC is incorrect.		
b[ ]	READY OFF			
C[ ]	SERVO OFF			
d[ ]	SERVO ON	Drive operation preparation completed (The drive unit is normal)		
9[ ]	WARNING	Drive unit is incorrect.	Check with the warning No. for the target unit.	
E[ ]	WARNING	Drive unit is incorrect.		
			E6: Control axis being removed	
			E7: CNC emergency stop	Remove the cause
F[ ]	Control axis No. (n = axis No.)			

8-3 Protective functions list of units

8-3-1 List of alarms

When an alarm occurs, the servo drive unit will make the motor stop by the deceleration control or dynamic brake. The spindle drive unit will coast to a stop or will decelerate to a stop. At the same time, the alarm No. will appear on the NC monitor screen and with the LEDs on the front of the drive unit. Check the alarm No., and remove the cause of the alarm by following this list.

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
11	Axis selection error	The rotary switches are set to the same value. Otherwise, the switches are set to an illegal value.	Axis No. setting is incorrect.	Check the axis-No. setting for each unit.	Set correctly.
12	Memory error 1	An error was detected in a memory IC or feedback IC by self-check to be made during the unit power ON.	CPU peripheral circuit error	Check the repeatability.	Replace the unit.
				Check the grounding state and ambient temperature.	Improve the ambient environment.
13	Software processing error 1	Software operation sequence error or operation timing error [Also detected while the control axis is removed.]	CPU peripheral circuit error	Check the repeatability.	Replace the unit.
				Check the grounding state and ambient temperature.	Improve the ambient environment.
14	Software processing error 2	An error was detected in the current processing circuit.	CPU peripheral circuit error	Check the repeatability.	Replace the unit.
				Check the grounding state and ambient temperature.	Improve the ambient environment.
16	Magnetic pole position detection error	Starting of the IPM spindle was commanded before positioning the magnetic poles.	Automatic adjustment has not been completed.	Check SP205 = 0: Incomplete/ 1: Completed	Carry out automatic adjustment
				Check whether the unit has been replaced.	Carry out automatic adjustment
17	A/D converter error	An error was detected in the A/D converter for current detection. [Detected at power ON and 7s after ready OFF]	CPU peripheral circuit error	Check the repeatability. (Occurs each time the power is turned ON)	Replace the unit.
				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 drive unit for those of another axis and check the repeatability. (Pinpoint the cause)	Replace the parts on the side that caused the alarm.
			Drive unit input circuit fault		
1A	Machine side detector, initial communication error	Initial communication with the detector cannot be performed in the system that uses OHA25K-ET or high-speed serial detector as the machine side detector. (Refer to the detector alarms list.)	The detector input connector is disconnected.	Check the connector (CN3) 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 drive unit for those of another axis and check the repeatability. (Pinpoint the cause)	Replace the parts on the side that caused the alarm.
			The unit input circuit is broken.		
			The parameters are set incorrectly.	The serial detector bit (SP034/bit8 =1) is valid even through the serial detector is not connected.	Set correctly.
1B	Machine side detector, CPU error 1	In the high-speed serial detector connected with the machine side, an error was detected in the data stored in an EEPROM. (Refer to the detector alarms list.)	Refer to No. "1A".		

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
1C	Machine side detector, EEPROM/LED abnormality	In the linear scale connected with the machine side, an error in an EEPROM was detected. Otherwise, in the high-speed serial detector connected with the machine side, a deteriorated LED was detected.	Refer to No. "1A".		
1D	Machine side detector, data error	In the high-speed serial detector connected with the machine side, an error (a position error within one rotation) was detected.			
1E	Machine side detector, memory error	In the linear scale connected with the machine side, an error on ROM or RAM was detected. Otherwise, in the high-speed serial detector connected with the machine side, the built-in thermal protector functioned.			
1F	Machine side detector, communication error	In the high-speed serial detector connected with the machine side, communication with the detector stopped.			
20	Motor side detector, No signal 1	An error was detected in A, B, Z-phase of the motor side detector, or U, V, W-phase.	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 drive unit for those of another axis and check the repeatability. (Pinpoint the cause)	Replace the parts on the side that caused the alarm.
			Drive unit input circuit fault		
			Z phase is not input (Only spindle)	Check whether the Z phase is output within 3 rotations after orientation is started	Replace the PLG.
			The spindle parameter setting is incorrect.	Check that SP037 bit-8 is set to "1".	Set correctly.
21	Machine side detector, No signal 2	An error was detected in the A, B, Z-phase in a servo closed-loop system. Otherwise, an error was detected in the A, B, Z-phase in the spindle encoder.	The detector input connector is disconnected.	Check the connector connected with the detector. 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 drive unit for those of another axis and check the repeatability. (Pinpoint the cause)	Replace the parts on the side that caused the alarm.
			Drive unit input circuit fault		
			The spindle parameter setting is incorrect.	Check that SP037 bit-8 is set to "0".	Set correctly.
22	LSI error	LSI operation error [Also detected while the control axis is removed.]	Unit fault	Check the repeatability.	Replace the unit.
				Check the grounding state and ambient temperature.	Improve the ambient environment.

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
23	Excessive speed deflection 1	Occurs when the difference between the speed command and motor speed is large.	The detector cable is broken.	Replace with the cable for another axis and check the repeatability.	Replace the detector cable.
			The spindle parameter setting is incorrect.	Check SP034, 040, 055, 257 and following.	Set correctly.
		Occurs during acceleration/ deceleration.	Measure the forward run → reverse run time, and reset SP055.	If higher than 12 seconds, increase the value.	Set correctly.
				If less than 12 seconds, check the load rate.	Reduce the load.
		Occurs during cutting.	Check the load rate.	If higher than 120%, reduce the load.	Reduce the load.
24	Ground fault	A motor cable ground fault was detected. (Detected after emergency stop have been released.)	Drive unit fault	Is the cable sheath damaged?	Replace the unit.
			Motor fault		Replace the motor.
25	Absolute position 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 communication cable is incorrectly connected or is disconnected.	Check that the wiring between the unit and battery unit is correct.	Connect correctly.
			The battery line in the detector cable or communication cable is broken.	Check the conductivity with a tester.	Replace or correctly wire 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.	
26	Unusable axis error	A power module error occurred in the axis set as the unusable axis "F".	2-axis unit dedicated alarm	Check the repeatability.	Replace the unit.
				Check the grounding state and ambient temperature.	Improve the ambient environment.
27	Machine side detector, CPU error 2	An error was detected in the CPU for the linear scale or serial detector.	The detector is faulty.	Check the repeatability.	Replace the detector.
				Check the grounding state and ambient temperature.	Improve the ambient environment.
28	Machine side detector, overspeed	The linear scale speed became to 45m/s or more at the power ON. A frequency signal exceeding the tolerable speed was detected.	The detector is faulty.	Check the repeatability.	Replace the detector.
				Check the grounding state and ambient temperature.	Improve the ambient environment.
29	Machine side detector, absolute position data error	In the absolute position linear scale, an error was detected in the circuit.	Linear scale fault	Check the repeatability.	Replace the detector.
				Check the grounding state and ambient temperature.	Improve the ambient environment.
2A	Machine side detector, incremental position data error	In the incremental position linear scale, an error was detected in the circuit.	Linear scale fault	Check the repeatability.	Replace the detector.
				Check the grounding state and ambient temperature.	Improve the ambient environment.
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.
2C	Motor side detector, EEPROM/LED error	EEPROM error was detected in the motor side linear scale. Also, the LED in the detector has deteriorated.	Detector fault (life)	Check the repeatability. Check the ambient environment.	Replace the detector. Review the ambient environment.

⚠ **CAUTION** Contact your nearest Service Center when an alarm not shown above occurs.

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
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.
2E	Motor side detector, memory error	ROM/RAM error was detected in the motor side linear scale.			
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.	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 drive unit for those of another axis and check the repeatability. (Pinpoint the cause)	Replace the parts on the side that caused the alarm.
			Drive unit 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 drive unit grounding grounded separately?	Ground the motor and drive unit at one point.
31	Overspeed	The motor speed exceeded the tolerable value.	The axis specification parameter (rapid) setting is incorrect.	Check the machine specifications.	Set correctly.
			The parameter setting is incorrect.	Check SV001 (PC1), SV002 (PC2), SV018 (PIT), SV025 (MTYP)	Set correctly.
				SP017 (TSP) or SP193 (SPECT) Maximum speed: (SP017) × 1.15 Check Slimit.	
			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/deceleration 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.	Does the alarm occur simultaneously with ready ON? Check the motor cable and connection. Check the conductivity between the cables.	• Replace the cable • Correct the connection
			Drive unit fault		Replace the unit.
			Motor fault		Replace the motor.
			The parameter setting is incorrect.	Check the setting of SP034, SP040, SP055 and SP257 and following.	Set correctly.
			The power voltage is low.	Is the power voltage 323V or less during the acceleration/deceleration?	Review the power supply capacity.
			Occurs during cutting.	If higher than 120%, reduce the load.	Reduce the load.
			Occurs before movement.	Occurs before READY ON.	Replace the unit.

⚠ CAUTION Contact your nearest Service Center when an alarm not shown above occurs.

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
33	Overvoltage	The PN bus voltage exceeded 630V. [Also detected while the control axis is removed.]	The power voltage is high. (550V or more)	Occurs at power ON. Check the power voltage with a tester.	Review the power supply.
			Broken wire to the terminal block.	The TE2 (L+/L–) wiring is faulty or disconnected.	Rewire.
			The power voltage waveform distortion is great.	Using a synchroscope, check for abnormalities in the power voltage.	Review the power, and suppress the waveform distortion.
34	Communication or CRC error between NC and drive unit	There was an error in the communication data from the CNC. [Also detected while the control axis is removed.] This alarm occurs if the CRC error is detected 20 or more times within 910ms while the error detection is valid.	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 terminal connector fault	Is the terminal connector dislocated?	Check the connection.
				Replace the terminal connector.	Replace the connector.
			Battery unit fault	Is the battery unit dislocated?	Check the connection.
				Replace the battery unit.	Replace the battery.
			The grounding is incomplete.	Check the grounding state.	Correctly ground.
			The communication cable is disconnected	Check the connectors (CN1A, CN1B) (Including other axes)	Connect correctly.
			Incorrect grounding	Are the motor grounding and drive unit grounding grounded separately?	Ground the motor and drive unit at one point.
			Drive unit fault	Change the connection with that for another drive unit and find the cause.	Replace the unit.
			CNC unit fault		Replace the CNC unit.
35	NC command error	The movement command data sent from the CNC was excessive.	NC program is incorrect.	Check the program and CNC specifications.	Check CNC unit.
			Also refer to No. "34".		
36	Communication or transmission error between NC and drive unit	The communication from the CNC was cut off. [Also detected while the control axis is removed.]	Also refer to No. "34".		
37	Initial parameter error	The 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 that the error No. have been displayed.	Set correctly.
			The HEX setting parameter setting is incorrect.	Check SV025, SV027 and SV036.	Set correctly.
			The electronic gears' constant is overflowing.	Check parameters SV001, SV002 and SV018.	If the settings are OK, consult with Mitsubishi.
			ABS was set for an INC detector connected axis.	Check parameters SV017.	Set correctly or replace the detector.
			The drive unit and motor capacities do not match.	Check the corresponding drive unit model for each servomotor in "10. Specifications".	Replace with the correct combination.
			The SHG control option setting is not provided.	Check parameters SV057 and SV058.	Set correctly.
			The adaptive filter option setting is not provided.	Check parameter SV027 bit F.	Set correctly.

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
38	Communication or protocol error 1 between NC and drive unit	There was an error in the communication data from the CNC. [Also detected while 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.
			Drive unit fault	Change the connection with that for another drive unit and find the cause.	Replace the unit.
			CNC unit fault		Replace the CNC unit.
39	Communication or protocol error 2 between NC and drive unit	There was an error in the communication data from the CNC. [Also detected while 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.
			Drive unit fault.	Change the connection with that for another drive unit and find the cause.	Replace the unit.
			CNC unit fault		Replace the CNC unit.
3A	Overcurrent	The servomotor 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.	Is the U, V, W phase connection 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 drive unit FG and the ground, or the potential difference during operation.	Securely ground.
			Drive unit fault	Check the repeatability.	Replace the unit.
			Detector fault		Replace the detector.
		The spindle unit's output current was excessive (during motor rotation command).	The spindle unit's capacity is insufficient.	Check parameter SP039 and the unit capacity.	Set correctly.
			An excessive motor load continued	View the load meter to see whether the motor's maximum output is exceeded.	Reduce the motor load.
			The motor power line connection is incorrect.	Is the U, V, W phase connection incorrect?	Connect correctly.
				The low-speed and high-speed coils are interchanged.	
		An excessive current flowed during the initial magnetic pole estimation for the IPM spindle motor. (When emergency stop was released after power ON.)	The spindle unit's capacity is insufficient.	Check parameter SP039 and the unit capacity.	Set correctly.
			The motor power line connection is incorrect.	Is the U, V, W phase connection incorrect?	Connect correctly.
				The low-speed and high-speed coils are interchanged.	
			The parameter setting is incorrect.	Check parameter SP268.	Consult with Mitsubishi if the setting is correct.

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
3B	Power module overheat	The power module's temperature protection function activated.	Check the time when the unit power is turned ON again.	Assuring more than 10 seconds for the time from when the power is turned OFF till when it is turned ON, turn the unit power ON again, and check the rotation speed of the fan.	If the fan is rotating, continue to use.
			Check the inner-panel temperature.	Check whether the inner-panel temperature exceeds 55°C.	Lower the inner-panel temperature.
			The cooling fan is stopped.	Check whether the cooling fan at the back of the unit is stopped.	Replace the unit or fan.
			Check the operation state.	Check whether continuous operation exceeding the rating is being carried out.	Change the program. Review the pattern.
			Also refer to No. "32".		
3C	Regenerative 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.
3D	Spindle speed lock	The motor maximum torque command continued for longer than the time set with sp239 while rotating at 45 or higher.	The parameter setting is incorrect.	Check the parameters.	Set correctly.
3E	Spindle speed overrun	The motor rotated more than 10° when a stop command was issued while continuously rotating, exceeding 112.5% of the designated value.	The parameter setting is incorrect.	Check the parameters.	Set correctly.
3F	Speed excessive deflection 2	A state exceeding the deflection detection range (sp238) continued for longer than the detection time (sp239).	The parameter setting is incorrect.	Check the parameters.	Set correctly.
40	Detector changeover unit, changeover error	The changeover signal order is incorrect.	Check TK unit wiring.	Is the connector or wire loose?	Connect correctly.
41	Detector changeover unit, communication error	Communication with the TK unit is not correct.	The communication cable is broken.	Check the continuity with a tester.	Replace the cable.
42	Feedback error 1	A feedback pulse skip or Z-phase error was detected in the detector.	Detector fault	Check the repeatability. Check the ambient environment.	Replace the detector.
			The cable is broken.	Check for broken wires, and check A, B, Z phase waveform.	Replace the cable.
		The detector's number of pulses and the parameter setting value did not match when positioning the IPM spindle motor's magnetic poles.	The detector is incorrect.	Check the detector's number of pulses.	Replace the detector.
			The parameter setting is incorrect.	Check parameter SP263/327.	Set correctly.
43	Feedback error 2	Excessive difference was detected in the feedback amount between the motor side detector and the machine side detector. Otherwise a feedback IC error was detected.	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
44	C-axis changeover alarm	When using a coil changeover motor, the C-axis was controlled with the H coil.	Check the wiring.	Is the connector or connection disconnected?	Correctly connect.
46	Motor overheat	Overheating of the motor was detected. The detector or motor's built-in thermal protector activated. (Activated at 100°C)	The ambient temperature is high.	Check the ambient temperature.	Improve the ambient environment.
			The motor load is large.	Has the power of the drive unit turned OFF and performed the forced reset to release the overload alarm (50)?	Review the operation pattern.
				Is the load too large?	
48	Scale CPU error	The CPU in the absolute position linear scale is not operating correctly.	Detector fault	Check the repeatability. Check the ambient environment.	Replace the detector.
			The cable is broken.	Check the connection	Replace the cable.
49	Scale overspeed	A speed exceeding 45m/s was detected when the power was turned ON.	Detector fault	Check the repeatability. Check the ambient environment.	Replace the detector.
4A	Absolute position detection circuit error	An error was detected in the scale or scale's circuit.	Detector fault	Check the repeatability. Check the ambient environment.	Replace the detector.
4B	Incremental position detection circuit error	An error was detected in the scale or scale's circuit.	Detector fault	Check the repeatability. Check the ambient environment.	Replace the detector.
4C	Current error during magnetic pole detection	A current was not detected during initial magnetic pole estimation of the IPM spindle motor. (When emergency stop was released after power ON.)	The spindle unit's capacity is insufficient.	Check parameter SP039 and the unit capacity.	Set correctly.
			The motor power line connection is incorrect.	Is the U, V, W phase connection incorrect?	Connect correctly.
				The low-speed and high-speed coils are interchanged.	
				The motor power line is cut off	
			The parameter setting is incorrect.	Check parameter SP268.	Consult with Mitsubishi if the setting is correct.
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 drive unit capacity.
			The brake 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 NC servo monitor and find the machine load. Is the ball screw bent? Has the load exceeded the rating?	Replace the faulty section in the machine.
				Is there interference?	Check the structure.
			The parameter setting is incorrect.	Are SV021 and SV022 set to the standard values? Check the setting of SP034, SP040, SP055, SP063, SP064, SP257 and following.	Set the standard values.
			The spindle is locked.	Check whether the load meter is exceeding the motor's maximum output in the locked state.	Unlock the spindle.

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No.	Name	Details	Cause of occurrence	Investigation method	Remedy
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?	Check the structure.
			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 the detector for that of 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. The position tracking error exceeds the specified value.	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 brake cannot be released?	Repair the brake circuit.
			The motor is demagnetized.	Remove the motor, and check that it rotates smoothly. (CNC motor)	Replace the motor.
			The excessive error detection width is too small.	Check the SV023 (SV053) setting value.	Adjust the parameters.
			Occurs during orientation.	Check SP097 (SPECO), and double the SP001 and SP00 values, or half the SP006 value.	Set correctly.
			Occurs during spindle synchronization.	Check SP177 (SPECS) bit 5. Check SP010 (PGS).	Set correctly.
			Occurs during synchronous tapping.	Check SP193 (SPECT) bit 5. Check SP009 (PGT).	Set correctly.
			The input voltage is low.	Is the input voltage 323V or less, or near 323V? Is the input voltage unstable?	Check the power supply. Increase the acceleration/deceleration time constant.
			The motor cable connection is incorrect.	Check the motor power 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 the detector for that of 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.	The excessive error detection width is too small.	Check the SV026 setting value.	Adjust the parameter.
			The CNC has stopped the follow up function.	Check the NC parameters.	
54	Excessive error 3	When an excessive error 1 is detected, no motor current flows.	Excessive error 1	Reinvestigate the causes of excessive error 1.	Set correctly.
55	External emergency stop error	There is no contactor shutoff command even after 30sec. Have elapsed from the input of the external emergency stop. [Also detected while 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 G00	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 G01	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 detection ignoral.
5C	Orientation feedback error	The pulse miss value during orientation stop exceeded the parameter setting value.	Checking of the parameters failed.	Check the SP114 (OPER) setting.	Set correctly.
			The cable is broken.	Check the encoder cable and shield.	Change the wiring.
5D	Speed monitor/ input mismatch	The DI input for speed monitor differs from the state from the NC.	The cable is broken.	Check the DI input wiring.	Correctly wire.
			The unit is faulty.	Check the repeatability.	Replace the unit.
5E	Speed monitor/ feedback error	The specified speed was exceeded while monitoring the speed.	Check the investigation items for No. "2F".		
61	Power module overcurrent	The power supply unit IPM detected an overcurrent.	The unit is faulty.	Check the repeatability.	Replace the unit.
62	Frequency error	The input power frequency is not within the specifications.	The input power is faulty.	Check the frequency input to the power supply unit.	Improve the power related matters.
67	Phase failure	A fault occurred in the 3-phase input voltage.	The input power is faulty.	Check the voltage input to the power supply unit.	Improve the power related matters.
68	Watch dog	The power supply unit cannot operate correctly.	The unit is faulty.	Check the repeatability.	Replace the unit.
			The grounding is incomplete.	Check the grounding state.	Correctly ground.
69	Ground fault	There is a ground fault in the motor or unit	The motor is faulty.	The insulation across the motor UVW terminals and ground is 100kΩ or less	Replace the motor and cable.
			Oil entered the motor	A large amount of oil has contacted the motor or cannon connector	Clean the connector, and study measures to prevent oil adhesion
			The unit is faulty.	The insulation across the unit UVW terminals and ground is less than 100kΩ	Replace the drive unit.
				The insulation across the motor UVW terminals and ground is 100kΩ or more	Replace the power supply unit.
6A	External contactor melting	The external contactor has melted.	The contactor has melted.	Check the contactor contact melting.	Replace the contactor.
			The parameter setting is incorrect.	Check SV036 (PTYP) (Set only for the axis actually controlling the contactor.)	Correct the parameter setting.
			The unit is faulty.	A short-circuit or infinite value was detected when measured across P(N)-L1, 2, 3 with a tester.	Replace the unit.

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
6C	Main circuit error	Main circuit capacitor charging error	The unit is faulty.	Check the repeatability.	Replace the unit.
6E	Memory error	An error was detected in the power supply unit's internal circuit.	The unit is faulty.	Check the repeatability. Check the working environment.	Replace the unit.
6F	Power supply error	An error was found in the power supply unit's A/D converter, or emergency stop from the NC cannot be detected.	The unit is faulty.	Check the repeatability.	Replace the unit.
71	Instantaneous power failure/ external emergency stop	The power failed instantly for 55ms or more. The external contactor turned OFF.	The power supply connection is poor.	Is the connector or connection disconnected?	Correctly connect.
			The power supply state is poor.	Has lightning struck (the weather changed)?	Improve the power related matters.
				The power related matters are poor in the working area.	
75	Overvoltage	The voltage across L+/L– exceeded 820VDC.	The drive unit is faulty.	Check the repeatability.	Replace the unit.
			The grounding is incomplete.	Check the grounding state.	Correctly ground.
76	External emergency stop setting error	The power supply unit's setting rotary switch and parameters do not match.	The parameter setting is incorrect.	Check SW1 and SV036/SP041 (PTYP).	Set correctly.
77	Power module overheat	The power module's temperature protection function activated.	Check the time when the unit power is turned ON again.	Assuring more than 10 seconds for the time from when the power is turned OFF till when it is turned ON, turn the unit power ON again, and check the rotation speed of the fan.	If the fan is rotating, continue to use.
			Check the inner-panel temperature.	Check whether the inner-panel temperature exceeds 55°C.	Lower the inner-panel temperature.
			The cooling fan is stopped.	Check whether the cooling fan at the back of the unit is stopped.	Replace the unit or fan.
			Check the operation state.	Check whether continuous operation exceeding the rating is being carried out.	Change the program.
7F	Power reboot request	Start software selection error E^2ROM data error	Refer to the investigation methods for alarm No. "75"		
80	HR unit, connection error	The connection to the MDS-B-HR unit is incorrect.	The power supply connection is poor.	Is the connector or connection disconnected?	Correctly connect.
81	HR unit, HSS error	An error occurred in the communication between the MDS-B-HR unit and scale.	The power supply connection is poor.	Is the connector or connection disconnected?	Correctly connect.
			HR unit is faulty.	The error is not eliminated even when the wiring is changed with that for another unit.	Replace the HR unit.
			The grounding is incomplete.	Check the grounding state.	Correctly ground.
83	HR unit, scale judgment error	The MDS-B-HR unit could not judge the connected linear scale.	The power supply connection is poor.	Is the connector or connection disconnected?	Correctly connect.
			Detector fault	Check the repeatability.	Replace the detector.
84	HR unit, CPU error	The MDS-B-HR unit CPU is faulty.	HR unit is faulty.	Check the repeatability.	Replace the HR unit.
				The error is not eliminated even when the wiring is changed with that for another unit.	Replace the HR unit.
			Drive unit fault	The error is eliminated when the wiring is changed with that for another unit.	Replace the drive unit.
			The grounding is incomplete.	Check the grounding state.	Correctly ground.

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
85	HR unit, data error	An error was found in the MDS-B-HR unit's analog interpolation data.	HR unit is faulty.	Check the repeatability.	Replace the HR unit.
				The error is not eliminated even when the wiring is changed with that for another unit.	Replace the HR unit.
			The grounding is incomplete.	Check the grounding state.	Correctly ground.
86	HR unit, magnetic pole error	An error was found in the magnetic pole data for the MDS-B-HR unit.	HR unit is faulty.	Check the repeatability.	Replace the HR unit.
			The grounding is incomplete.	Check the grounding state.	Correctly ground.
88	Watch dog	The drive unit did not operate correctly. [Also detected while the control axis is removed.]	Drive unit fault	Check the repeatability.	Replace the unit.
			The grounding is incomplete.	Check the grounding state.	Ground correctly.
89	HR unit, connection error (SUB)	The connection to the MDS-B-HR unit on the SUB side is incorrect.	The power supply connection is poor.	Is the connector or connection disconnected?	Correctly connect.
8A	HR unit, HSS connection error (SUB)	A communication error was detected between the MDS-B-HR unit on the SUB side and scale.	The power supply connection is poor.	Is the connector or connection disconnected?	Correctly connect.
			HR unit is faulty.	The error is not eliminated even when the wiring is changed with that for another unit.	Replace the HR unit.
			The grounding is incomplete.	Check the grounding state.	Correctly ground.
8C	HR unit, scale recognition error (SUB)	The MDS-B-HR unit on the SUB side did not recognized the connected linear scale.	The power supply connection is poor.	Is the connector or connection disconnected?	Correctly connect.
			Detector fault	Check the repeatability.	Replace the detector.
8D	HR unit, CPU error (SUB)	The CPU of MDS-B-HR unit on the SUB side does not operate properly.	HR unit is faulty.	Check the repeatability.	Replace the HR unit.
				The error is not eliminated even when the wiring is changed with that for another unit.	Replace the HR unit.
			Drive unit is faulty.	The error is eliminated when the wiring is changed with that for another unit.	Replace the drive unit.
			The grounding is incomplete.	Check the grounding state.	Correctly ground.
8E	HR unit, data error (SUB)	In MDS-B-HR unit on the SUB side, an error was detected in the analog data.	HR unit is faulty.	Check the repeatability.	Replace the HR unit.
			The grounding is incomplete.	Check the grounding state.	Correctly ground.
8F	HR unit, magnetic polarity error (SUB)	In MDS-B-HR unit on the SUB side, an error was detected in the magnetic polarity data.	HR unit is faulty.	Check the repeatability.	Replace the HR unit.
			The grounding is incomplete.	Check the grounding state.	Correctly ground.

8-3-2 List of warnings

When a warning occurs, a warning No. will appear on the NC monitor screen and with the LEDs on the front of the drive unit. Check the warning No., and remove the cause of the warning by following this list.

No.	Name	Details	Cause of occurrence	Investigation method	Remedy
90	Detector, initial communication error	Initial communication with the absolute position linear scale cannot be performed.	Detector error	Check the repeatability	Replace the detector.
91	Detector, communication error	The absolute position data could not be transmitted correctly from the OHA type detector or low-speed absolute position linear scale.		Check the installation and wiring lead-in methods.	Change the wiring path.
92	Detector, protocol error	There was an illegal format data in the serial data.			
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.		
96	MP scale feedback error	There is an excessive difference in the feedback amount between the motor side detector and the MP scale.	Refer to the MP scale specifications.		
97	MP scale offset error	An error was detected in the data to be read by CNC power ON.			
9E	Absolute position detector, multi-rotation 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. To protect the absolute position data, do not turn OFF the control power (L11, L21) to the servo drive unit when this warning is detected.	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 drive unit) is disconnected.	Open the panel at the top of the drive unit and check.	Connect correctly.
			The battery line in the detector cable is broken.	Check the conductivity with a tester.	Replace the cable.
E1	Overload warning	The load level reached 80% or more.	Refer to the alarm No. 50 "Overload 1".		
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 NC monitor screen.	Replace the detector.
E4	Parameter error 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 removal 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	CNC emergency stop	Emergency stop was input from the CNC. (Status display)	The CNC emergency stop has been input.	The CNC emergency stop has been input correctly.	
			An alarm has occurred with another axis.	Has an alarm occurred with another axis?	Reset the alarm in the other axis to cancel this warning.
			The terminal resistor or battery unit connector is disconnected.	Check the connection of the CNC communication line cable (CN1A, CN1B).	Connect correctly.
E9	Instantaneous power failure warning	The power was shut off for 25ms or more, 50ms or less	Refer to the alarm No. 71 "Instantaneous power failure".		
EA	External emergency stop	External emergency stop (CN23 connector input) was input.	Only CN23 of the power supply unit was input without inputting the CNC unit emergency stop.		

8-3-3 Protection functions and resetting methods

The following alarm and warning indications are provided as functions to protect the unit.

The methods for resetting the alarms and warnings include turning the power OFF and ON, and using resetting operations.

No.	Name	Deceleration method	Reset method	Explanation
11	Axis selection error	Dynamic	AR	
12	Memory error 1		AR	
13	Software processing error 1	Dynamic	PR	
14	Software processing error 2	Dynamic	PR	
15	Memory error 2	Initial error	AR	
16	Magnetic pole position detection error		PR	
17	A/D converter error	Dynamic	PR	
18	Motor side detector, initial communication error	Initial error	PR	
1A	Machine side detector, initial communication error		PR	
1B	Machine side detector, CPU error 1		PR	
1C	Machine side detector, EEPROM/LED abnormality		PR	
1D	Machine side detector, data error		PR	
1E	Machine side detector, memory error		PR	
1F	Machine side detector, communication error		PR	
20	Motor side detector, No signal 1		PR	
21	Machine side detector, No signal 2		PR	
22	LSI error	Dynamic	AR	
23	Excessive speed deflection 1		PR	
24	Ground fault	Dynamic	PR	
25	Absolute position lost	Initial error	AR	
26	Unusable axis error		PR	
27	Machine side detector, CPU error 2		PR	
28	Machine side detector, overspeed		PR	
29	Machine side detector, absolute position error		PR	
2A	Machine side detector, incremental position error		PR	
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, serial detector communication error	Dynamic	PR	
31	Overspeed	Deceleration control	PR	
32	Power module overcurrent	Dynamic	PR	
33	Overvoltage	Dynamic	PR	
34	Communication or CRC error between NC and drive unit	Deceleration control	PR	
35	NC command error	Deceleration control	PR	
36	Communication or transmission error between NC and drive unit	Deceleration control	PR	
37	Initial parameter error	Initial error	PR	
38	Communication or protocol error 1 between NC and drive unit	Deceleration control	PR	
39	Communication or protocol error 2 between NC and drive unit	Deceleration control	PR	
3A	Overcurrent	Dynamic	PR	
3B	Power module overheat		PR	
3C	Regeneration circuit error	Dynamic	AR	
3D	Spindle speed Lock		PR	
3E	Spindle speed overrun		PR	
3F	Speed excessive deflection 2		PR	
40	Detector changeover unit, changeover error		PR	
41	Detector changeover unit, communication error		PR	
42	Feedback error 1		PR	

No.	Name	Deceleration method	Reset method	Explanation
43	Feedback error 2		PR	
44	C-axis changeover alarm		NR	
46	Motor overheat Thermal error	Deceleration control	NR	NR and PR reset cannot be carried out when the motor is overheated.
4C	Initial magnetic pole detection		NR	
4E	NC command mode error		NR	
50	Overload 1	Deceleration control	NR	NR or PR reset is not possible when the load level is 50% or more. Do not reset (AR) forcibly by turning off the drive unit. If AR is carried out at 50% or more, 80% will be set at the next time the power is turned ON.
51	Overload 2	Dynamic	NR	
52	Excessive error 1		NR	
53	Excessive error 2	Dynamic	NR	
54	Excessive error 3		NR	
55	External emergency stop error	Dynamic	NR	Forcibly turn the contactor OFF.
58	Collision detection 1 G00	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 G01	Deceleration control	NR	
5A	Collision detection 2	Deceleration control	NR	
5C	Orientation feedback error		NR	
5D	Speed monitor/input mismatch		PR	
5E	Speed monitor/feedback error		PR	
5F	External contactor melting	At ready ON	NR	Detected at the rising edge of ready ON
61	Power module overcurrent		PR	
62	Frequency error		PR	
67	Phase failure		PR	
68	Watch dog		AR	
69	Ground fault		PR	
6A	External contactor melting		PR	
6C	Main circuit error		PR	
6E	Memory error		AR	
6F	Power supply error		AR	
71	Instantaneous power failure/external emergency stop		NR	
75	Overvoltage		NR	Reset the alarm after the L+/L– voltage has dropped below the power voltage (after five or more minutes have elapsed).
76	External emergency stop setting error		AR	
77	Power module overheat		AR	
7F	Power reboot request		AR	
88	Watch dog	Dynamic	AR	
90	Detector, initial communication error	The motor will not stop.	PR	
91	Detector, communication error		*	
92	Detector, protocol error		*	
93	Initial absolute position fluctuation		PR	
96	MP scale feedback error		*	
97	MP scale offset error		PR	
9E	Absolute position detector, multi-rotation counter error		*	
9F	Battery voltage drop		*	
E0	Over-regeneration warning		*	
E1	Overload warning		*	
E3	Absolute position counter warning		*	
E4	Parameter error warning		*	
E7	CNC emergency stop	Dynamic	*	
E9	Instantaneous power failure 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	External emergency stop		*	

- **Deceleration method**
  - Deceleration control : The motor will be decelerated and controlled with the time constant set in the servo parameter (SV056).
  - Dynamic : If dynamic brake stop is selected with the servo parameters (SV055, 056), the motor will stop with the dynamic brakes.
- **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 or 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 power supply unit on servo/spindle drive unit power ON again.

8-3-4 Parameter numbers during initial parameter error

If an initial parameter error (alarm 37) occurs, the alarm and the number of the parameter that may be set incorrectly will appear on the CNC Diagnosis screen. The method of displaying this information on the CNC differs according to the CNC Series and screen size, so refer to the Instruction Manual and Operation Manual for each Series.

S02 Initial parameter error [ ] [ ] [ ] [ ] [ ]

Axis name display

Parameter number

If a number larger than the parameter number is displayed for the servo drive unit, the alarm is occurring for several related parameters. Refer to the following table, and correctly set the parameters.

No.	Details	Related parameter
69	The CNC setting maximum rapid traverse rate value is incorrect. The CNC system software may be illegal. Turn the power ON again.	NC setting rapid
71	The CNC setting maximum cutting speed setting value is incorrect. The CNC system software may be illegal. Turn the power ON again.	NC setting clamp
101	The following settings are overflowing. • Electronic gears • Position loop gain • Speed feedback	SV001, SV002 SV003, SV018 SV019, SV020 SV049
102	The absolute position detection parameter is valid when OSE104 and OSE105 are connected.	SV017, SV025
103	The servo option is not available. The closed loop or dual feedback control function is set.	SV025, SV017
104	The servo option is not available. The SHG control function is set.	SV057, SV058
105	The servo option is not available. The adaptive filter function is set.	SV027
106	The servo option is not available. The MP scale absolute position function is set.	SV017
107	The dual-axis control is executed. Or, the rotary motor setting is applied. The high-speed processing mode function is dedicated for the linear motor single-axis control.	SV017
108	The valid/invalid setting of the 4th or 5th notch filter is changed from the initial setting.	SV087, SV088

8-3-5 Troubleshooting

Follow this section to troubleshoot the main alarms that occur during start up or while the machine is operating. Also, refer to the explanations in section "8-3-1 List of alarms".

[Alarm/warning check timing]

f1: When servo drive unit power is turned ON
f2: When CNC power supply is turned ON (emergency stop ON)
f3: During normal operation (servo ON)
f4: During axis removal (ready ON, servo OFF)

(Note) Note that warning "93" could occur even when the axis is reinstalled after removal.

Alarm No.	Memory error: Error in drive unit memory IC (SRAM, FROM)	**Alarm check timing**			
12		f1	f2	f3	f4
		○	–	–	–

	Investigation details	**Investigation results**	**Remedies**
1	Check the repeatability.	The error is always repeated.	Replace the drive unit.
		The state returns to normal once, but occurs sometimes thereafter.	Investigate item 2.
2	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the drive unit.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

Alarm No.	Software process error: The driver's software processing time did not end within the specified time, or an illegal IT process was carried out.	**Alarm check timing**			
13		f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check whether the servo software version was changed recently.	The version was changed.	Try replacing with the drive unit containing the original software version.
		The version was not changed.	Investigate item 2.
2	Check the repeatability.	The error is always repeated.	Replace the drive unit.
		The state returns to normal once, but occurs sometimes thereafter.	Investigate item 3.
3	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the drive unit.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

Alarm No.	Software processing error 2: The current loop process, of the driver software processing times, did not end within the specified time.	**Alarm check timing**			
14		f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check whether the servo software version was changed recently.	The version was changed.	Try replacing with the drive unit containing the original software version.
		The version was not changed.	Investigate item 2.
2	Check the repeatability.	The error is always repeated.	Replace the drive unit.
		The state returns to normal once, but occurs sometimes thereafter.	Investigate item 3.
3	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the drive unit.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

Alarm No. **17**	A/D converter error: There is an error in the drive unit's A/D converter.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	–	–

	Investigation details	**Investigation results**	**Remedies**
1	Check the repeatability.	The error is always repeated.	Replace the drive unit.
		The state returns to normal once, but occurs sometimes thereafter.	Investigate item 2.
2	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the drive unit.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

Alarm No. **18**	Initial communication error: Initial communication was not possible with the detector in the system using a high-speed serial detector for the motor side.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	–	–

	Investigation details	**Investigation results**	**Remedies**
1	Check the servo parameter (SV025) setting value.	The value is not set correctly.	Correctly set VO205.
		The value is set correctly.	Investigate item 2.
2	Wiggle the connectors by hand to check whether the detector connectors (drive unit side and detector side) are disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 3.
3	Turn the power OFF, and check the detector cable connection with a tester.	There is a connection fault.	Replace the detector cable.
		The connection is normal.	Investigate item 4.
4	Connect to another normal axis driver, and check whether the fault is on the driver side or detector side.	The alarm is on the driver side.	Replace the drive unit.
		The alarm is on the detector side.	Investigate item 5.
5	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the detector.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

Alarm No. **1A**	Serial detector initial communication error (SUB): Initial communication was not possible with the detector in the system using a high-speed serial detector for the machine side.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	–	–

	Investigation details	**Investigation results**	**Remedies**
1	Check the alarm No. "18" items.		

Alarm No. **1B**	CPU error (SUB): An error was detected in the data stored in the EEPROM of an absolute position linear scale connected to the machine side.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check whether the connector on the drive unit side or scale side is disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 2.
2	Turn the power OFF, and check the detector cable connection with a tester.	There is a connection fault.	Replace the detector cable.
		The connection is normal.	Investigate item 3.
3	Connect to another normal axis driver, and check whether the fault is on the drive unit side or scale side.	The alarm is on the driver side.	Replace the drive unit.
		The alarm is on the absolute position linear scale side.	Investigate item 4.
4	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the absolute position linear scale.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

Alarm No.		**Alarm check timing**			
1C	EEPROM/LED error (SUB): An error was detected in the EEPROM of an absolute position linear position linear scale connected to the machine side.	f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check the alarm No. "1B" items.		

Alarm No.		**Alarm check timing**			
1D	Data error (SUB): An error was detected within one rotation position of an absolute position linear position linear scale connected to the machine side.	f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check the alarm No. "1B" items.		

Alarm No.		**Alarm check timing**			
1E	ROM, RAM/thermal error (SUB): A ROM/RAM error was detected in the absolute position linear scale connected to the machine side.	f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check the alarm No. "1B" items.		

Alarm No.		**Alarm check timing**			
1F	Serial detector communication error (SUB) Communication was cut off with the detector in the absolute position scale connected to the machine side.	f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check items 2 and following for alarm No. "18".		

Alarm No.		**Alarm check timing**			
27	Scale CPU error (SUB): The CPU of the absolute position linear scale connected to the machine side is not operating correctly.	f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Wiggle the connectors by hand to check whether the absolute position linear scale connectors (unit side and scale side) are disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 2.
2	Turn the power OFF, and check the detector cable connection with a tester.	There is a connection fault.	Replace the detector cable.
		The connection is normal.	Investigate item 3.
3	Connect to another normal axis unit, and check whether the fault is on the unit side or scale side.	The alarm is on the unit side.	Replace the drive unit.
		The alarm is on the absolute position linear scale side.	Investigate item 4.
4	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the absolute position linear scale.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

⚠ **CAUTION** Do not drive the motor with a drive unit having a capacity exceeding the motor capacity. The motor could be demagnetized.

<table>
<tr><td rowspan="3">Alarm No.
28</td><td rowspan="3">Scale overspeed (SUB):
The absolute position liner scale connected to the machine side detected a speed of 45m/sec or more when the CNC power was turned ON.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>–</td><td>–</td></tr>
</table>

	Investigation details	Investigation results	Remedies
1	Check that the system is an absolute position linear scale specification system.	The system is not the absolute position linear scale specifications.	Correctly set the SV025: MTYP parameter.
		The system is the absolute position linear scale specifications.	Investigate item 2.
2	Check whether the machine was operating when the alarm occurred.	The machine was operating.	Check the motor's mechanical brakes and machine system.
		The machine was not operating.	Investigate item 3.
3	Wiggle the connectors by hand to check whether the absolute position linear scale connectors (unit side and scale side) are disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 4.
4	Turn the power OFF, and check the detector cable connection with a tester.	There is a connection fault.	Replace the detector cable.
		The connection is normal.	Investigate item 5.
5	Connect to another normal axis unit, and check whether the fault is on the unit side or detector side.	The alarm is on the unit side.	Replace the drive unit.
		The alarm is on the absolute position linear scale side.	Investigate item 6.
6	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the absolute position linear scale.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

<table>
<tr><td rowspan="3">Alarm No.
29</td><td rowspan="3">Absolute position detection circuit error (SUB):
An error was detected in the scale or scale side circuit of the absolute position linear scale connected to the machine side.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>○</td></tr>
</table>

	Investigation details	Investigation results	Remedies
1	Check the alarm No. "28" items.		

<table>
<tr><td rowspan="3">Alarm No.
2A</td><td rowspan="3">Incremental position detection circuit error (SUB):
A speed exceeding the max. movement speed of the absolute position linear scale connected to the machine side was detected.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>○</td></tr>
</table>

	Investigation details	Investigation results	Remedies
1	Check whether the machine was operating when the alarm occurred.	The machine was operating.	Investigate item 3.
		The machine was not operating.	Investigate item 2.
2	Check whether the operation is normal at low-speeds.	The machine was operating.	Investigate item 3.
		The machine was not operating.	Check the precautions for turning the power ON. • Wiring check • Parameter check
3	Wiggle the connectors by hand to check whether the absolute position linear scale connectors (unit side and scale side) are disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 4.
4	Turn the power OFF, and check the detector cable connection with a tester.	There is a connection fault.	Replace the detector cable.
		The connection is normal.	Investigate item 5.
5	Connect to another normal axis unit, and check whether the fault is on the unit side or detector side.	The alarm is on the unit side.	Replace the drive unit.
		The alarm is on the absolute position linear scale side.	Investigate item 6.
6	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the motor (the absolute position linear scale).
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

Alarm No. **2B**	CPU error: An error was detected in the data stored in the EEPROM of an absolute position linear scale connected to the motor side.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check items 3 and following for alarm No. "2A".		

Alarm No. **2C**	EEPROM/LED error: An error was detected in the EEPROM of an absolute position linear position linear scale connected to the motor side.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check items 3 and following for alarm No. "2A".		

Alarm No. **2D**	Date error: An error was detected within one rotation position of an absolute position linear position linear scale connected to the motor side.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check items 3 and following for alarm No. "2A".		

Alarm No. **2E**	ROM/RAM error: A ROM/RAM error was detected in the absolute position linear scale connected to the motor side.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check items 3 and following for alarm No. "2A".		

Alarm No. **2F**	Serial detector communication error: Communication was cut off with detector of the absolute position linear scale connected to the motor side.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check items 2 and following for alarm No. "18".		

Alarm No. **31**	Overspeed: Movement was carried out at a speed exceeding the linear motor's tolerable speed.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check whether the machine was operating when the alarm occurred.	The machine was operating.	Investigate item 4.
		The machine was not operating.	Investigate item 2.
2	Check whether the operation is normal at low-speeds.	The machine was operating.	Investigate item 3.
		The machine was not operating.	Check the wiring and the parameters at power ON.
3	Check whether the rapid traverse speed is too high.	The speed is too high.	Lower the speed to below the rated speed.
		The speed is set below the rated speed.	Investigate item 4.
4	Check whether the acceleration/ deceleration constant is too small. • Check the current value display on the Servo Monitor screen.	A value that is 80% or more of the max. value is displayed.	Reduce the rapid traverse time constant so that the current value on the Servo Monitor screen is 80% or less of the max. value during rapid traverse acceleration/deceleration.
		The value is 80% or less of the max. value.	Investigate item 5.
5	Check items 2 and following for alarm No. "18".		

⚠ **CAUTION** Do not drive the motor with a drive unit having a capacity exceeding the motor capacity. The motor could be demagnetized.

Alarm No. **32**	Power module error (Overcurrent): The IPM used for the inverter detected an overcurrent.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check for a short-circuit in the UWV phases of the unit output. • Disconnect the U V W connection from the terminal block and the motor's cannon plug, and check with a tester.	The phases are short circuited or there is no continuity.	Replace the UVW wires.
		The phases are normal.	Investigate item 2.
2	Check whether there is a ground fault in the UVW wires. • Check between the UVW wires and ground with a tester in the state given in item 1.	The phases are short circuited or there is no continuity.	Replace the UVW wires.
		The phases are normal.	Investigate item 3.
3	Check whether there is a ground fault in the motor. • Check between the motor's wires and ground with a tester (megger) in the state given in item 1.	The phases are short circuited or there is no continuity.	Replace the motor.
		The phases are normal. (same level as other axes)	Investigate item 4.
4	Check the parameter setting values. • Refer to the adjustment procedures.	The settings are incorrect.	Correctly set.
		The settings are correct.	Investigate item 5.
5	Wiggle the connectors by hand to check whether the detector connectors (unit side and detector side) are disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 6.
6	Turn the power OFF, and check the detector cable connection with a tester.	There is a connection fault.	Replace the detector cable.
		The connection is normal.	Investigate item 7.
7	Check the repeatability.	The alarm is not repeated. The alarm is repeated sometimes.	Investigate item 9.
		The alarm is always repeated.	Investigate item 8.
8	Connect to another normal axis driver, and check whether the fault is on the unit side or scale side.	The alarm is on the unit side.	Replace the drive unit.
		The alarm is on the detector.	Replace the motor (the detector).
9	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Monitor the state for a while.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

<table>
<tr><td rowspan="3">Alarm No.
34</td><td rowspan="3">CNC communication CRC error:
An error was detected in the data sent from the CNC to the driver.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>F2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>○</td></tr>
</table>

	Investigation details	**Investigation results**	**Remedies**
1	Wiggle the connection cables by hand between the CNC and drive unit, between the battery unit and drive unit, and between the drive units to see if any of the connectors are loose. Check whether any force is being applied on the connectors.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 2.
2	Turn the power OFF, and check the connection of the communication cables listed in item 1. Try replacing the cables with normal ones.	There is a connection fault.	Replace the communication cable.
		The connection is normal.	Investigate item 3.
3	Check whether the CNC and drive unit software versions have been changed recently.	The version was changed.	Replace with the original software version.
		The version was not changed.	Investigate item 4.
4	Try replacing with another unit to determine whether the fault is on the CNC side or units side.	The alarm is on the unit side.	Replace the drive unit.
		The driver is not the cause.	Investigate item 5.
5	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the MCP card on the CNC side.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

<table>
<tr><td rowspan="3">Alarm No.
35</td><td rowspan="3">CNC communication data error:
An error was detected in the movement command data from the CNC.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>–</td></tr>
</table>

	Investigation details	**Investigation results**	**Remedies**
1	Check the alarm No. "34" items.		

<table>
<tr><td rowspan="3">Alarm No.
36</td><td rowspan="3">CNC communication, communication error:
The communication from the CNC was cut off.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>–</td></tr>
</table>

	Investigation details	**Investigation results**	**Remedies**
1	Check the alarm No. "34" items.		

<table>
<tr><td rowspan="3">Alarm No.
37</td><td rowspan="3">Initial parameter error:
An illegal parameter was detected in the parameters sent when the CNC power was turned ON.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>–</td><td>○</td></tr>
</table>

	Investigation details	**Investigation results**	**Remedies**
1	The illegal parameter No. will appear on the CNC Diagnosis screen, so check that servo parameter with the parameter adjustment procedures.	The parameter is incorrect.	Set to the correct parameter.
		The parameter is correct.	Investigate item 3.
		The parameter No. is not 1 to 64.	If the No. is 101, check investigation item 2.
2	Check whether the servo parameter (PIT) (RNG1) (RNG2) (PC1) and (PC2) combination is illegal, or whether the setting range is exceeded.	The combination is illegal, or the setting range is exceeded.	Refer to the parameter settings in the specifications and to the supplements, and set to the correct values.
		The parameter is correct.	Investigate item 3.
3	Check the alarm No. "34" items.		

Alarm No. **38**	CNC communication protocol error 1: An error was detected in the communication frame sent from the CNC.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check the alarm No. "34" items.		

Alarm No. **39**	CNC communication protocol error 2 An error was detected in the axis information data sent from the CNC.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check the alarm No. "34" items.		

Alarm No. **3A**	Overcurrent: An excessive current was detected in the motor drive current.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Check the alarm No. "32" items.		

Alarm No. **3B**	Power module overheat: The power module's temperature protection function activated.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	○	○

	Investigation details	**Investigation results**	**Remedies**
1	Turn the unit power ON again, and confirm the rotation of the fan. Note) Assure more than 10 seconds for the time from when the power is turned OFF till when it is turned ON. For the fan used for the drive unit, assuring more than 10 seconds for the time from when the power is turned OFF till when it is turned ON is required.	The fan is rotating, and an alarm did not occur again.	Continue to use. The power may be turned ON without assuring more than 10 seconds for the time from when the power is turned OFF till when it is turned ON. Leave for more than 10 seconds or more, and turn the power ON again.
		The fan did not rotate. Or, an alarm occurred again.	Investigate item 2.
2	Confirm adhesion of cutting oil or cutting chips, etc. at the fan. Or check if there is any abnormality such as low rotation speed.	Large amounts of cutting oil or cutting chips, etc., are adhered, or the rotation is slow.	Clean or replace the fan.
		The fan is rotating properly.	Investigate item 3.
3	Check whether the heat dissipating fins are dirty.	Cutting oil or cutting chips, etc., are adhered, and the fins are clogged.	Clean the fins.
		The fins are normal.	Investigate item 4.
4	Measure the drive unit's ambient temperature.	55°C or more	Improve the ventilation and cooling for the power distribution panel.
		Less than 55°C.	Investigate item 5.
5	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	If the alarm occurs even after the unit temperature has dropped, replace the unit.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature: Check the cooling fan. Incomplete grounding: Additionally ground.

Alarm No. **43**	Feedback error 2: An excessive deviation of the feedback amount for the motor side detector and machine side detector was detected in the 2-scale 2-motor (2-amplifier) control.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	○	–

	Investigation details	**Investigation results**	**Remedies**
1	Check items 3 and following for alarm No. "2A".		

<table>
<tr><td rowspan="3">Alarm No.
46</td><td rowspan="3">Motor overheat:
A temperature error was detected in the motor being driven. (°C)
(Temperature exceeded 100°C)</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>–</td></tr>
</table>

	Investigation details	**Investigation results**	**Remedies**
1	Check whether the specifications provide the motor thermal.	The specifications do not provide the motor thermal.	Investigate item 2.
		The specifications provide the motor thermal.	Investigate item 3.
2	Check the servo parameter (SV034) setting value.	The parameter is not set correctly.	Correctly set SV034/mohm
		The parameter is set correctly.	Investigate item 3.
3	Check the repeatability.	The alarm is repeated within one minute after startup.	Investigate item 5.
		The alarm is repeated sometimes after operating for a while.	Investigate item 4.
4	Check the motor temperature when the alarm occurs.	The motor is hot.	Ease the operation pattern. ↓ If the problem is not solved, check investigation item 5.
		The motor is not high.	Investigate item 5.
5	Wiggle the connectors by hand to check whether the detector connectors (unit side and motor side cannon) are disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 6.
6	Turn the power OFF, and check the detector cable connection with a tester.	There is a connection fault.	Replace the detector cable.
		The connection is normal.	Investigate item 7.
7	Connect to another normal axis unit, and check whether the fault is on the unit side.	The alarm is on the unit side.	Replace the drive unit.
		The alarm occurs even when the unit is replaced.	Investigate item 8.
8	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the motor.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

<table>
<tr><td rowspan="3">Alarm No.
48</td><td rowspan="3">Scale CPU error:
The CPU of the absolute position linear scale connected to the motor side is not operating correctly.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>○</td></tr>
</table>

	Investigation details	**Investigation results**	**Remedies**
1	Wiggle the connectors by hand to check whether the absolute position linear scale connectors (unit side and scale side) are disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 2.
2	Turn the power OFF, and check the detector cable connection with a tester.	There is a connection fault.	Replace the detector cable.
		The connection is normal.	Investigate item 3.
3	Connect to another normal axis unit, and check whether the fault is on the unit side or scale side.	The alarm is on the unit side.	Replace the drive unit.
		The alarm is on the absolute position linear scale side.	Investigate item 4.
4	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the absolute position linear scale.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

<table>
<tr><td rowspan="3">Alarm No.
49</td><td rowspan="3">Scale overspeed:
The absolute position liner scale connected to the motor side detected a speed of 45m/sec or more when the CNC power was turned ON.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>–</td><td>–</td></tr>
</table>

	Investigation details	**Investigation results**	**Remedies**
1	Check that the system is an absolute position linear scale specification system.	The system is not the absolute position linear scale specifications.	Correctly set the SV025: MTYP parameter.
		The system is the absolute position linear scale specifications.	Investigate item 2.
2	Check whether the machine was operating when the alarm occurred.	The machine was operating.	Check the motor's mechanical brakes and machine system.
		The machine was not operating.	Investigate item 3.
3	Wiggle the connectors by hand to check whether the absolute position linear scale connectors (unit side and scale side) are disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 4.
4	Turn the power OFF, and check the detector cable connection with a tester.	There is a connection fault.	Replace the detector cable.
		The connection is normal.	Investigate item 5.
5	Connect to another normal axis unit, and check whether the fault is on the unit side or detector side.	The alarm is on the unit side.	Replace the drive unit.
		The alarm is on the absolute position linear scale side.	Investigate item 6.
6	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the absolute position linear scale.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

<table>
<tr><td rowspan="3">Alarm No.
4A</td><td rowspan="3">Absolute position detection circuit error:
An error was detected in the scale or scale side circuit of the absolute position linear scale connected to the motor side.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>○</td></tr>
</table>

	Investigation details	**Investigation results**	**Remedies**
1	Check the alarm No. "49" items.		

<table>
<tr><td rowspan="3">Alarm No.
4B</td><td rowspan="3">Incremental position detection circuit error:
A speed exceeding the max. movement speed of the absolute position linear scale connected to the motor side was detected.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>○</td></tr>
</table>

	Investigation details	**Investigation results**	**Remedies**
1	Check whether the machine was operating when the alarm occurred.	The machine was operating.	Investigate item 3.
		The machine was not operating.	Investigate item 2.
2	Check whether the operation is normal at low-speeds.	The machine was operating.	Investigate item 3.
		The machine was not operating.	Check the wiring and the parameters at power ON.
3	Check whether the connector is disconnected from the unit side or scale side.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 4.
4	Turn the power OFF, and check the detector cable connection with a tester.	There is a connection fault.	Replace the detector cable.
		The connection is normal.	Investigate item 5.
5	Connect to another normal axis unit, and check whether the fault is on the unit side or detector side.	The alarm is on the unit side.	Replace the drive unit.
		The alarm is on the absolute position linear scale side.	Investigate item 6.
6	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the motor (the linear scale).
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

⚠ **CAUTION**

Do not drive the motor with a drive unit having a capacity exceeding the motor capacity. The motor could be demagnetized.

<table>
<tr><td rowspan="3">Alarm No.
50</td><td rowspan="3">Overload 1:
The servomotor or servo drive unit load level obtained from the motor current reached the overload level set with the overload detection level (SV022:OLL).</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>○</td></tr>
</table>

	Investigation details	Investigation results	Remedies
1	Check the servo parameter (OLL) setting value. Standard setting value OLL: 150.	The value differs from the standard setting value.	When not using special specifications, set the value to the standard setting value.
		The value is the standard setting value.	Investigate item 2.
2	Check the motor temperature when the alarm occurs.	The motor is hot.	Ease the operation pattern. ↓ If the problem is not solved, check investigation item 3.
		The motor is not high.	Investigate item 3.
3	Check whether the motor is hunting.	The motor is hunting.	Refer to the adjustment procedures and readjust. • Check the cable wiring and connector connection. • Check for incorrect parameter settings. • Adjust the gain. ↓ If the problem is not resolved, check investigation item 4.
		The motor is not hunting.	Investigate item 4.
4	Connect to another normal axis unit, and check whether the fault is on the unit side.	The alarm is on the unit side.	Replace the drive unit.
		The alarm occurs even when the unit is replaced.	Investigate item 5.
5	Check whether the current value on the CNC Servo Monitor screen is an abnormally large value when stopped and operating.	An abnormal value is displayed.	Check the machine system.
		A correct value is displayed.	Investigate item 6.
6	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the motor (the detector).
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

<table>
<tr><td rowspan="3">Alarm No.
51</td><td rowspan="3">Overload 2:
A current command exceeding 95% of the drive units max. capacity continued for 1 sec. or more.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>–</td><td>○</td><td>–</td></tr>
</table>

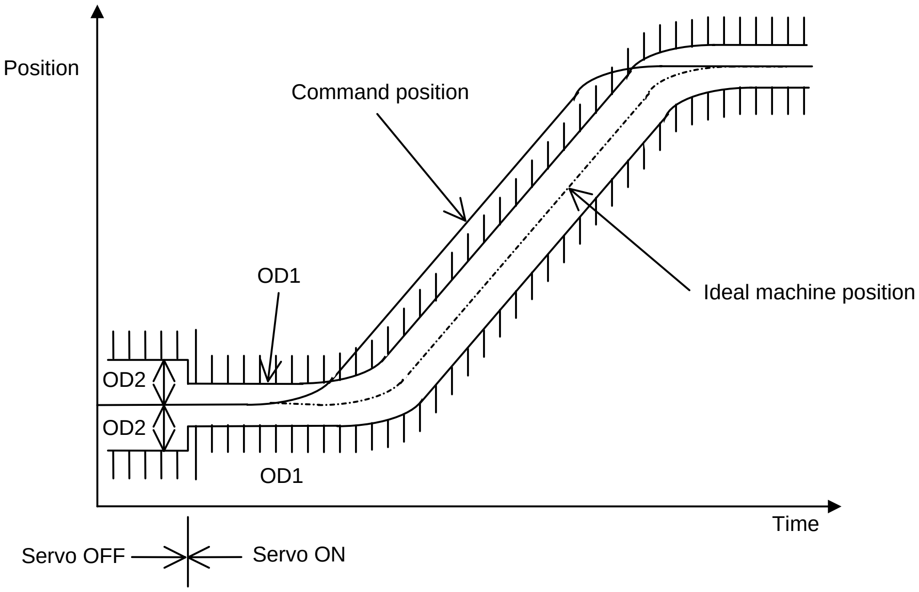
	Investigation details	Investigation results	Remedies
1	Check whether the PN power is supplied to the drive unit. • Check the axis for which the alarm is occurring and the axis farthest from the power supply.	The voltage is being supplied.	Investigate item 3.
		The voltage is not being supplied.	Investigate item 2.
2	Check whether the power supply unit's CHARGE lamp is lit, and the PN terminal voltage.	There is no voltage at the PN terminal. (The lamp is not lit.)	Check the power supply unit.
		There is voltage at the PN terminal.	Check the PN wiring between the units.
3	Check whether the current value on the CNC Servo Monitor screen is an abnormally large value during acceleration/deceleration.	The max. value is exceeding the x level given on the previous page.	Increase the acceleration/deceleration time constant to lower to approx. 80% of the limit value.
		A correct value is displayed.	Investigate item 4.
4	Check items 3 and following for alarm No. "50".		

<table>
<tr><th rowspan="3">Alarm No.
52</th><td rowspan="3">Excessive error 1:
The difference of the ideal position and actual position exceeded the parameter SV023:OD1 (or SV053:OD3) at servo ON.</td><th colspan="4">Alarm check timing</th></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>–</td><td>○</td><td>–</td></tr>
</table>

	Investigation details	Investigation results	Remedies
1	Check whether the PN power is supplied to the drive unit. • Check the axis for which the alarm is occurring and the axis farthest from the power supply.	The voltage is being supplied.	Investigate item 3.
		The voltage is not being supplied.	Investigate item 2.
2	Check whether the power supply unit's CHARGE lamp is lit, and the PN terminal voltage.	There is no voltage at the PN terminal. (The lamp is not lit.)	Check the power supply unit.
		There is voltage at the PN terminal.	Check the PN wiring between the units.
3	Check the servo parameter (OD1) setting value.	The value differs from the standard setting value.	When not using special specifications, set the value to the standard setting value.
		The value is the standard setting value.	Investigate item 4.
4	Check items 3 and following for alarm No. "50".		

Supplement

Depending on the ideal machine position in respect to the command position, the actual machine position could enter the actual shaded section shown below, which is separated more than the distance set in OD1.



⚠ **CAUTION**

Do not drive the motor with a drive unit having a capacity exceeding the motor capacity. The motor could be demagnetized.

<table>
<tr><td rowspan="3">Alarm No.
53</td><td rowspan="3">Excessive error 2:
The difference of the ideal position and actual position exceeded parameter SV026:OD2 at servo OFF.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>–</td><td>–</td></tr>
</table>

	Investigation details	Investigation results	Remedies
1	Check the servo parameter (OD2) setting value.	The value differs from the standard setting value.	When not using special specifications, set the value to the standard setting value.
		The value is the standard setting value.	Investigate item 2.
2	Check whether the machine is moving during servo OFF.	The machine was operating.	Check the machine and mechanical brakes.
		The machine was not operating.	Investigate item 3.
3	Wiggle the communication cable between the CNC and final connector by hand to check whether the detector connectors (unit side and CNC side) are disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 4.
4	Turn the power OFF, and check the communication cable connection with a tester. Try replacing with normal cables.	There is a connection fault.	Replace the communication cable.
		The connection is normal.	Investigate item 5.
5	Replace with another normal axis unit, and check whether the fault is in the unit.	The alarm is on the unit side.	Replace the drive unit.
		The alarm occurs even when the unit is replaced.	Replace the MCP card on the CNC side. ↓ If the problem is not resolved, check investigation item 6.
6	Wiggle the connectors by hand to check whether the detector connectors (unit side and motor side) are disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 7.
7	Turn the power OFF, and check the detector cable connection with a tester.	There is a connection fault.	Replace the detector cable.
		The connection is normal.	Investigate item 8.
8	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the motor.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

<table>
<tr><td rowspan="3">Alarm No.
54</td><td rowspan="3">Excessive error 3:
The motor current is not flowing when the excessive error alarm 1 was detected.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>–</td></tr>
</table>

	Investigation details	Investigation results	Remedies
1	Check whether the PN power is supplied to the driver. • Check the axis for which the alarm is occurring and the axis farthest from the power supply.	The voltage is being supplied.	Investigate item 3.
		The voltage is not being supplied.	Investigate item 2.
2	Check whether the power supply unit's CHARGE lamp is lit, and the PN terminal voltage.	There is no voltage at the PN terminal. (The lamp is not lit.)	Check the power supply unit.
		There is voltage at the PN terminal.	Check the PN wiring between the units.
3	Check whether the motor power line is connected to the motor. • Disconnect the power line from the terminal block, and check between UVW with a tester.	The power line is not connected or is disconnected.	Increase the acceleration/deceleration time constant to lower to approx. 80% of the limit value.
		The power line is correctly connected.	Investigate item 4.
4	Replace with another normal unit, and check whether the fault is in the unit.	The alarm is on the unit side.	Replace the drive unit.
		The alarm is on the motor side.	Replace the motor.

⚠ **CAUTION**	Do not drive the motor with a drive unit having a capacity exceeding the motor capacity. The motor could be demagnetized.

Alarm No.		**Alarm check timing**			
58	Collision detection 0: A collision detection method 1 error was detected during the G0 modal (rapid traverse). (A disturbance torque exceeding the tolerable disturbance torque was detected.)	f1	f2	f3	f4
		–	–	○	–

	Investigation details	**Investigation results**	**Remedies**
1	Check whether the collision detection function is being used. Check whether the machine is colliding.	The collision detection function is not being used.	Investigate item 2.
		The motor is colliding.	Improve so that the machine does not collide.
		The collision detection is being used, but the machine is not colliding.	Investigate item 3.
2	Check the parameter. Is SV060 (TLTM) set to "0"?	The setting is incorrect.	Set SV060 (TLMT) to "0".
3	Check whether the current during normal rapid traverse acceleration/ deceleration has reached the current limit value, or whether it is 90% or more of the limit value.	The current is 90% or more of the current limit value.	Lengthen the time constant, and check investigation item 4.
		The current is less than 90% of the current limit value.	Investigate item 4.
4	Readjust the collision detection function, and then operate. (Refer to the separate collision detection function specifications.)	The alarm does not occur.	――――――――
		The alarm occurs.	Investigate item 5.
5	Is the machine or current vibrating?	They are vibrating.	Eliminate the vibration by adjusting the gain, and check investigation item 4.
		They are not vibrating.	Investigate item 6.
6	Raise the detection level.	The alarm does not occur.	If the problem is not resolved even after replacing the drive unit, raise the level.
		The alarm occurs.	Replace the drive unit.

Alarm No.		**Alarm check timing**			
59	Collision detection 1: A collision detection method 1 error was detected during the G1 modal (cutting feed). (A disturbance torque exceeding the tolerable disturbance torque was detected.)	f1	f2	f3	f4
		–	–	○	–

	Investigation details	**Investigation results**	**Remedies**
1	Check whether the collision detection function is being used. Check whether the machine is colliding.	The collision detection function is not being used.	Investigate item 2.
		The motor is colliding.	Improve so that the machine does not collide.
		The collision detection is being used, but the machine is not colliding.	Investigate item 2.
2	Check the parameter. Is SV060 (TLTM) set to "0"?	The setting is incorrect.	Set SV060 (TLMT) to "0".
3	Check whether the current during normal rapid traverse acceleration/ deceleration has reached the current limit value, or whether it is 90% or more of the limit value.	The current is 90% or more of the current limit value.	Lengthen the time constant, and check investigation item 4.
		The current is less than 90% of the current limit value.	Investigate item 4.
4	Readjust the collision detection function, and then operate. (Refer to the separate collision detection function specifications.)	The alarm does not occur.	――――――――
		The alarm occurs.	Investigate item 5.
5	Is the machine or current vibrating?	They are vibrating.	Eliminate the vibration by adjusting the gain, and check investigation item 4.
		They are not vibrating.	Investigate item 6.
6	Raise the detection level.	The alarm does not occur.	If the problem is not resolved even after replacing the drive unit, raise the level.
		The alarm occurs.	Replace the drive unit.

Alarm No.		**Alarm check timing**			
5A	Collision detection 2: A collision detection method 2 error was detected.	f1	f2	f3	f4
		–	–	○	–

	Investigation details	**Investigation results**	**Remedies**
1	Check the alarm No. "58" items.		

<table>
<tr><td rowspan="3">Alarm No.
80</td><td rowspan="3">HR unit connection error:
An incorrect connection or cable breakage was detected in the MDS-B-HR connected to the motor side.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>○</td></tr>
</table>

	Investigation details	Investigation results	Remedies
1	Wiggle the connectors by hand to check whether the MDS-B-HR connectors (unit side, HR side and linear scale side) are disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 2.
2	Turn the power OFF, and check the connection of the detector cables (between driver I/F units and between I/F unit and scale) with a tester.	There is a connection fault.	Replace the communication cable.
		The connection is normal.	Investigate item 3.
3	Connect with another normal axis unit (or MDS-B-HR) and check whether the fault is on the unit side or MDS-B-HR (linear scale) side.	The alarm is on the unit side.	Replace the drive unit.
		The alarm is on the MDS-B-HR (linear scale) side.	Investigate item 4.
4	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace MDS-B-HR (linear scale).
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

<table>
<tr><td rowspan="3">Alarm No.
81</td><td rowspan="3">HR unit HSS communication error:
The MDS-B-HR connected to the motor side detected an error in the communication with the absolute position linear scale.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>○</td></tr>
</table>

	Investigation details	Investigation results	Remedies
1	Check the alarm No. "80" items.		

<table>
<tr><td rowspan="3">Alarm No.
83</td><td rowspan="3">HR unit scale judgment error:
The MDS-B-HR connected to the motor side could not judge the analog frequency of the connected linear scale.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>○</td></tr>
</table>

	Investigation details	Investigation results	Remedies
1	Wiggle the connectors by hand to check whether the MDS-B-HR connectors (unit side, HR side, linear scale side and MD side) are disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 2.
2	Turn the power OFF, and check the connection of the detector cables (between driver and I/F units, between I/F unit and scale and between I/F unit and pole detector) with a tester.	There is a connection fault.	Replace the communication cable.
		The connection is normal.	Investigate item 3.
3	Connect with another normal axis unit (or MDS-B-HR) and check whether the fault is on the unit side or MDS-B-HR (linear scale or MDS-B-MD) side.	The alarm is on the unit side.	Replace the drive unit.
		The alarm is on the MDS-B-HR (linear scale or MDS-B-MD) side.	Investigate item 4.
4	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace MDS-B-HR (linear scale or MDS-B-MD).
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

⚠ CAUTION Do not drive the motor with a drive unit having a capacity exceeding the motor capacity. The motor could be demagnetized.

Alarm No.		Alarm check timing			
		f1	f2	f3	f4
84	HR unit CPU error: The CPU of the MDS-B-HR connected to the motor side is not operating correctly.	○	–	–	–

	Investigation details	Investigation results	Remedies
1	Wiggle the connectors by hand to check whether the MDS-B-HR connectors (unit side and HR side) are disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 2.
2	Turn the power OFF, and check the connection of the detector cables (between drive unit and I/F units) with a tester.	There is a connection fault.	Replace the communication cable.
		The connection is normal.	Investigate item 3.
3	Connect with another normal axis unit and check whether the fault is on the unit side or MDS-B-HR side.	The alarm is on the unit side.	Replace the drive unit.
		The alarm is on the MDS-B-HR side.	Investigate item 4.
4	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace MDS-B-HR.
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

Alarm No.		Alarm check timing			
		f1	f2	f3	f4
85	HR unit data error: An error was detected in the analog interpolation data of the MDS-B-HR connected to the motor side.	–	○	○	○

	Investigation details	Investigation results	Remedies
1	Check the alarm No. "80" items.		

Alarm No.		Alarm check timing			
		f1	f2	f3	f4
86	HR unit pole error: An error was detected in the pole data of the MDS-B-HR connected to the motor side.	–	○	○	○

	Investigation details	Investigation results	Remedies
1	Wiggle the connectors by hand to check whether the MDS-B-HR connectors (unit side, HR side and MD side) are disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 2.
2	Turn the power OFF, and check the connection of the detector cables (between drive unit and I/F units and between I/F unit and pole detector) with a tester.	There is a connection fault.	Replace the communication cable.
		The connection is normal.	Investigate item 3.
3	Connect with another normal axis unit (or MDS-B-HR) and check whether the fault is on the unit side or MDS-B-HR (MDS-B-MD) side.	The alarm is on the unit side.	Replace the drive unit.
		The alarm is on the MDS-B-HR (MDS-B-MD) side.	Investigate item 4.
4	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace MDS-B-HR (MDS-B-MD).
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

<table>
<tr><td colspan="2" rowspan="3">Alarm No.
88</td><td colspan="2" rowspan="3">Watch dog:
The servo drive software processing time did not end within the specified time.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>○</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td></td><td>Investigation details</td><td>Investigation results</td><td colspan="5">Remedies</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Check whether the servo software version has been changed recently.</td><td>The version was changed.</td><td colspan="5">Replace with the original software version.</td></tr>
<tr><td>The version was not changed.</td><td colspan="5">Investigate item 2.</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Check if there is any abnormality in the unit's ambient environment.
(Ex. Ambient temperature, noise, grounding)</td><td>No abnormality is found in particular.</td><td colspan="5">Replace the drive unit.</td></tr>
<tr><td>An abnormality was found in the ambient environment.</td><td colspan="5">Take remedies according to the causes of the abnormality.
Ex. High temperature : Check the cooling fan.
Incomplete grounding : Additionally ground.</td></tr>
</table>

<table>
<tr><td colspan="2" rowspan="3">Alarm No.
89</td><td colspan="2" rowspan="3">HR unit connection error (SUB):
An incorrect connection or cable breakage was detected in the MDS-B-HR connected to the machine side.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td></td><td>Investigation details</td><td>Investigation results</td><td colspan="5">Remedies</td></tr>
<tr><td>1</td><td>Check the alarm No. "80" items.</td><td></td><td colspan="5"></td></tr>
</table>

<table>
<tr><td colspan="2" rowspan="3">Alarm No.
8A</td><td colspan="2" rowspan="3">HR unit HSS communication error (SUB):
The MDS-B-HR connected to the machine side detected an error in the communication with the absolute position linear scale.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td></td><td>Investigation details</td><td>Investigation results</td><td colspan="5">Remedies</td></tr>
<tr><td>1</td><td>Check the alarm No. "80" items.</td><td></td><td colspan="5"></td></tr>
</table>

<table>
<tr><td colspan="2" rowspan="3">Alarm No.
8C</td><td colspan="2" rowspan="3">HR unit scale judgment error (SUB):
The MDS-B-HR connected to the machine side could not judge the analog frequency of the connected linear scale.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td></td><td>Investigation details</td><td>Investigation results</td><td colspan="5">Remedies</td></tr>
<tr><td>1</td><td>Check the alarm No. "83" items.</td><td></td><td colspan="5"></td></tr>
</table>

<table>
<tr><td colspan="2" rowspan="3">Alarm No.
8D</td><td colspan="2" rowspan="3">HR unit CPU error (SUB):
The CPU of the MDS-B-HR connected to the machine side is not operating correctly.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>○</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td></td><td>Investigation details</td><td>Investigation results</td><td colspan="5">Remedies</td></tr>
<tr><td>1</td><td>Check the alarm No. "84" items.</td><td></td><td colspan="5"></td></tr>
</table>

<table>
<tr><td colspan="2" rowspan="3">Alarm No.
8E</td><td colspan="2" rowspan="3">HR unit data error (SUB):
An error was detected in the analog interpolation data of the MDS-B-HR connected to the machine side.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td></td><td>Investigation details</td><td>Investigation results</td><td colspan="5">Remedies</td></tr>
<tr><td>1</td><td>Check the alarm No. "80" items.</td><td></td><td colspan="5"></td></tr>
</table>

<table>
<tr><td colspan="2" rowspan="3">Alarm No.
8F</td><td colspan="2" rowspan="3">HR unit pole error (SUB):
An error was detected in the pole data of the MDS-B-HR connected to the machine side.</td><td colspan="4">Alarm check timing</td></tr>
<tr><td>f1</td><td>f2</td><td>f3</td><td>f4</td></tr>
<tr><td>–</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td></td><td>Investigation details</td><td>Investigation results</td><td colspan="5">Remedies</td></tr>
<tr><td>1</td><td>Check the alarm No. "86" items.</td><td></td><td colspan="5"></td></tr>
</table>

Alarm No. **93**	Absolute position fluctuation: A fluctuation exceeding the tolerable value was detected in the absolute position detected when the CNC power is turned ON.	**Alarm check timing**			
		f1	f2	f3	f4
		–	○	–	–

	Investigation details	**Investigation results**	**Remedies**
1	Check whether the connector is disconnected from the unit side or detector side.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 2.
2	Turn the power OFF, and check the connection of the detector cables with a tester.	There is a connection fault.	Replace the communication cable.
		The connection is normal.	Investigate item 3.
3	Check the repeatability. Carry out zero point return again.	The alarm is not repeated.	If no abnormality is found with investigation item 5, continue use.
		The alarm is always repeated. Or, the state returns to normal once, but then is repeated sometimes.	Investigate item 4.
4	Connect with another normal axis unit and check whether the fault is on the unit side.	The alarm is on the unit side.	Replace the drive unit.
		The alarm occurs even when the unit is replaced.	Investigate item 5.
5	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace the motor (detector).
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

Alarm No. **9B**	Pole shift warning: An error was detected in the pole shift amount set in servo parameter SV028.	**Alarm check timing**			
		f1	f2	f3	f4
		–	–	○	–

	Investigation details	**Investigation results**	**Remedies**
1	Check whether the MDS-B-MD system is being used.	The system is not MDS-B-MD.	Investigate item 4.
		The system is MDS-B-MD.	Investigate item 2.
2	Check whether the warning occurred at the first movement after setting the servo parameter (SV028).	Movement is possible several times without a warning.	Investigate item 4.
		The warning occurred at the first movement.	Investigate item 3.
3	Carry out DC excitation again, and check the servo parameter (SV028) setting value.	The SV028 setting value is the same with the previous and current DC excitation.	Investigate item 4.
		The SV028 setting value is different with the previous and current DC excitation.	Set SV028 to the current DC excitation value. ↓ If the problem is not resolved, check investigation item 4.
4	Wiggle the connectors by hand to check whether the MDS-B-HR connectors (unit side, HR side and MD side) are disconnected.	The connector is disconnected (or loose).	Correctly install.
		The connector is not disconnected.	Investigate item 5.
5	Turn the power OFF, and check the connection of the detector cables (between drive unit I/F units and between I/F unit and pole detector) with a tester.	There is a connection fault.	Replace the communication cable.
		The connection is normal.	Investigate item 6.
6	Connect with another normal axis unit (or MDS-B-HR) and check whether the fault is on the unit side or MDS-B-HR (MDS-B-MD) side.	The alarm is on the unit side.	Replace the drive unit.
		The alarm is on the MDS-B-HR (MDS-B-MD) side.	Investigate item 7.
7	Check if there is any abnormality in the unit's ambient environment. (Ex. Ambient temperature, noise, grounding)	No abnormality is found in particular.	Replace MDS-B-HR (linear scale or MDS-B-MD).
		An abnormality was found in the ambient environment.	Take remedies according to the causes of the abnormality. Ex. High temperature : Check the cooling fan. Incomplete grounding : Additionally ground.

Alarm No.		Alarm check timing			
		f1	f2	f3	f4
9C	HR unit pole warning: An error was detected in the pole position data of the MDS-B-HR connected to the MAIN side after passing the Z phase.	–	○	○	○

	Investigation details	Investigation results	Remedies
1	Check the alarm No. "86" items.		

Alarm No.		Alarm check timing			
		f1	f2	f3	f4
9D	HR unit pole warning (SUB): An error was detected in the pole position data of the MDS-B-HR connected to the SUB side after passing the Z phase.	–	○	○	○

	Investigation details	Investigation results	Remedies
1	Check the alarm No. "86" items.		

Alarm No.		Alarm check timing			
		f1	f2	f3	f4
E1	Overload warning: An level 80% of the overload alarm 1 was detected.	–	○	○	○

	Investigation details	Investigation results	Remedies
1	Check whether the motor is hot.	The motor is not hot.	Check the alarm No. "50" items.
		The motor is hot.	Investigate item 2.
2	Check whether there is a problem during acceleration/deceleration operation.	Operation is possible without problem.	1. If possible, ease the operation pattern. 2. If an alarm does not occur with continued operation, continue in this state.
		There is a problem in the operation.	Check investigation items 3 and following of alarm No. "50".

Alarm No.		Alarm check timing			
		f1	f2	f3	f4
E4	Parameter error warning: A parameter exceeding the setting range was set.	–	○	○	–

	Investigation details	Investigation results	Remedies
1	Set the correct values following the parameter adjustment procedures.		

Alarm No.		Alarm check timing			
		f1	f2	f3	f4
E7	CNC emergency stop: An emergency stop signal is being sent from the CNC, or an alarm is occurring in another axis.	–	○	○	○

	Investigation details	Investigation results	Remedies
1	Check whether the CNC side emergency stop switch has been applied.	The emergency stop state is entered.	Investigate item 2.
		Emergency stop has been canceled.	Investigate item 3.
2	Cancel the emergency stop.	Operation starts normally.	Normal
		"E7" remains displayed.	Investigate item 3.
3	Check whether the terminator or battery unit is connected, or whether these are loose.	Pinpoint the cause of the fault.	Correct the fault.
		Normal	Check the alarm No. "34" items.

⚠ CAUTION Do not drive the motor with a drive unit having a capacity exceeding the motor capacity. The motor could be demagnetized.

8-4 Spindle system troubleshooting

Use the following explanation to diagnose faults (symptoms) not described in "8-3 Protective functions list of units" when using a spindle drive unit and spindle motor combination.

8-4-1 Introduction

If any trouble occurs in the control unit, first check as many of the following matters as possible. Then, inspect and repair the unit following the explanations in this section.
These following matters are also helpful information when contacting the Mitsubishi Service Center.

NOTICE Do not perform a megger test (insulation resistance measurement) on the drive unit's control circuit.

Matters to confirm when trouble occurs

1. Check the unit's 7-segment display or CNC Diagnosis screen to find the displayed alarm and the alarms that have occurred in the past. (Refer to section "8-3 Protective functions list of units".)
2. Can the fault or error be repeated?
3. Is the ambient temperature and inner-panel temperature normal?
4. Was the unit accelerating, decelerating or in constant speed operation? What was the speed?
5. Does the symptom change during forward run or reverse run?
6. Was there an instantaneous power failure?
7. Does the fault occur during specific operations or at a specific command?
8. How often does the fault occur?
9. Does the fault occur when a load is applied or removed?
10. Were remedial measures, etc., taken?
11. How many years has the system been operating?
12. Is the power voltage correct?
13. Do the symptoms change greatly depending on the time zone?

8-4-2 First step

Check the following matters as the first step of troubleshooting.

(1) Check the power voltage. The voltage drop must be within the specified value.
(Example) • The voltage drops at a set time each day.
• The voltage drops when starting a specific machine.

(2) Are the unit's peripheral control functions normal?
(Example) • Are the NC and sequence circuits, etc., normal?
• Visually check the wiring, etc., for abnormalities.

(3) Is the control unit's peripheral temperature (inner-panel temperature) 55°C or less?

(4) Are there any abnormalities on the outside of the unit?
(Example) • Loose connection connectors, damage, entry of foreign matter, etc.

By sufficiently checking the above state, a general idea on the faulty section can be grasped.

The MDS-CH-SP[ ] Series errors are largely categorized into the following groups.

- Fault class A
  - The control unit power was turned ON for the first time, but normal operation was not possible. (I)
  - The control unit operated normally but suddenly became inoperable. (II)
  - The unit does not operate normally some times. The orientation stop position is deviated. An alarm is displayed. (III)

- Fault class B
  - Unit fault
    - Regenerative resistance unit/regenerative resistance error
    - Spindle drive unit error
  - Detector error
    - Speed detection encoder error
    - 1024p/rev encoder error
  - Error in parameters or transmission data from NC
  - Power supply error
  - Motor error
  - Other errors (incorrect input signal conditions, broken cables)

8-4-3 Second step

Fault class I	Investigation items		Remedies
The control unit power was turned ON for the first time, but normal operation was not possible.	The control unit is tested before shipment. Normal operation when the power is turned ON for the first time may not be possible due to:		
	1	The unit was bumped against something and damaged during operation or installation.	Investigate and remedy according to (2).
	2	Incorrect or broken external wiring or sequence. Is the cable broken? Is the ground wire correctly wired? Note that the power phase order is irrelevant.	Check that the unit's LED is ON. Check the operation sequence.
	3	Are the parameter settings correct?	Check the parameters.
	4	The motor speed does not increase.	Check the UVW wiring. Check the detector output waveform for the built-in type.
	5	Operation is normal when motor is run as a single unit.	Is the load too heavy?
	6	Orientation stop is incorrect (over-travels, etc.)	Adjust the orientation.
	7	The C-axis, synchronous tap and spindle synchronization are incorrect.	Adjust and check the detector waveform.
	8	The unit's LED is displayed.	Check section "8-3".

8-4-4 When there is no alarm or warning

(1) No abnormality is displayed, but the motor does not rotate.

	Investigation item	Investigation results	Remedies
1	Check the wiring around the spindle drive unit. Also check for loosening in the terminal screws and disconnections, etc.	The wiring is incorrect, the screws are loose, or the cables are disconnected.	Correctly wire. Correctly tighten the screws. Replace the cables.
		No particular problems found.	Investigate investigation item 2 and remedy.
2	Check the input voltage.	The voltage is exceeding the specification value.	Restore the power to the correct state.
		The voltage is within the specification value.	Investigate investigation item 3 and remedy.
3	Check all of the spindle parameters.	The correct values are not set.	Set the correct values.
		The correct values are set.	Investigate investigation item 4 and remedy.
4	Check the input signals. • Are the READY, forward run and reverse run signals input? • In particular, the forward run and reverse run signals must be input at least one second after READY is turned ON. • Check whether the forward run and reverse run signals are turned ON simultaneously.	The signals are not input or the sequence is incorrect. The orientation command is input.	Correct the input signals.
		No particular problems found.	Investigate investigation item 5 and remedy.
5	Check the speed command.	The speed command is not input correctly.	Input the correct speed command.
		The speed command is input correctly.	Replace the unit.

(2) No fault is displayed, but the motor only rotates slowly, or a large noise is heard from the motor.

	Investigation item	Investigation results	Remedies
1	Check the U, V and W wiring between the spindle drive unit and motor.	The wires are not connected correctly.	Correctly connect.
		The wires are connected correctly.	Investigate investigation item 2 and remedy.
2	Check the input voltage.	One of the three phases is not within the specification value. No particular problems found.	Restore the power to the correct state. Investigate investigation item 3 and remedy.
3	Check the speed command.	The speed command is not input correctly.	
		The speed command is input correctly.	Investigate investigation item 4 and remedy.
4	Tug on the connector by hand to check whether the speed detector connector (spindle drive unit side and speed detector side) is loose.	The connector is disconnected (or loose).	Correctly connect the connector.
		The connector is not disconnected (or loose).	Investigate investigation item 5 and remedy.
5	Turn the power OFF, and check the connection of the speed detector cable with a tester.	The connection is faulty or disconnected.	Replace the detector cable. Correct the connection.
		The connection is normal.	Replace the unit.

(3) The rotation speed command and actual rotation speed do not match.

	Investigation item	Investigation results	Remedies
1	Check the speed command.	The speed command is not input correctly.	Input the correct speed command.
		The speed command is correct.	Investigate investigation item 2 and remedy.
2	Check whether there is slipping between the motor and spindle. (When connected with a belt or clutch.)	There is slipping.	Repair the machine side.
		No particular problems found.	Investigate investigation item 3 and remedy.
3	Check the spindle parameters (SP034, SP040, SP017, SP257 and following).	The correct values are not set.	Set the correct values.
		The correct values are set.	Replace the spindle drive unit.

(4) The starting time is long or has increased in length.

	Investigation item	Investigation results	Remedies
1	Check whether the friction torque has increased.	The friction torque has increased.	Repair the machine side.
		No particular problems found.	Investigate investigation item 2 and remedy.
2	Manually rotate the motor bearings and check the movement.	The bearings do not rotate smoothly.	Replace the spindle motor.
		The bearings rotate smoothly.	Investigate investigation item 3 and remedy.
3	Check whether the torque limit signal has been input.	The signal has been input.	Do not input this signal.
		The signal is not input.	Replace the unit.

(5) The motor stops during cutting.

	Investigation item	Investigation results	Remedies
1	Check the load rate during cutting.	The load meter sways past 120% during cutting.	Reduce the load.
		No particular problems found.	Investigate investigation item 2 and remedy.
2	Investigate the same matters as item (4), and remedy.		

(6) The vibration and noise (gear noise), etc., are large.

	Investigation item	Investigation results	Remedies
1	Check the machine's dynamic balance. (Coast from the maximum speed.)	The same noise is heard during coasting.	Repair the machine side.
		No particular problems found.	Investigate investigation item 2 and remedy.
2	Check whether there is a resonance point in the machine. (Coast from the maximum speed.)	Vibration and noise increase at a set rotation speed during coasting.	Repair the machine side.
		No particular problems found.	Investigate investigation item 3 and remedy.
3	Check the machine's backlash.	The backlash is great.	Repair the machine side.
		No particular problems found.	Investigate investigation item 4 and remedy.
4	Check the spindle parameter SP022 (VGNP1), SP023 (VGNI1), SP056 (PYVR) settings.	Symptoms decrease when setting value is set to approx. half.	Change the setting value. Note that the impact response will drop.
		The symptoms do not change even when the above value is set.	Return the setting values to the original values. Investigate investigation item 5 and remedy.
5	Tug on the connector by hand to check whether the speed detector connector (spindle drive unit side and speed detector side) is loose.	The connector is disconnected (or loose).	Correctly connect the connector.
		The connector is not disconnected (or loose).	Investigate investigation item 6 and remedy.
6	Turn the power OFF, and check the connection of the speed detector cable with a tester.	The connection is faulty or disconnected.	Replace the detector cable. Correct the connection.
		The connection is normal.	Replace the unit.

(7) The spindle coasts during deceleration.

	Investigation item	Investigation results	Remedies
1	Check whether there is slipping between the motor and spindle. (When connected with a belt or clutch.)	There is slipping.	Repair the machine side.
		No particular problems found.	Replace the unit.

(8) The rotation does not stabilize.

	Investigation item	Investigation results	Remedies
1	Check the spindle parameter SP022 (VGNP1), SP023 (VGNI1) settings.	The rotation stabilizes when the settings values are both set to approx. double.	Change the setting value. Note that the gear noise may increase.
		The symptoms do not change even when the above value is set.	Return the setting values to the original values. Investigate investigation item 2 and remedy.
2	Tug on the connector by hand to check whether the speed detector connector (spindle drive unit side and speed detector side) is loose.	The connector is disconnected (or loose).	Correctly connect the connector.
		The connector is not disconnected (or loose).	Investigate investigation item 3 and remedy.
3	Turn the power OFF, and check the connection of the speed detector cable with a tester. (Especially check the shield wiring.)	The connection is faulty or disconnected.	Replace the detector cable. Correct the connection.
		The connection is normal.	Investigate investigation item 4 and remedy.
4	Investigate the wiring and installation environment. 1) Is the ground correctly connected? 2) Are there any noise-generating devices near the unit?	1) The grounding is incomplete.	Correctly ground.
		2) The alarm occurs easily when a specific device operates.	Use noise measures on the device described on the left.
		No particular problems found.	Replace the spindle drive unit.

(9) The speed does not rise above a set level.

	Investigation item	Investigation results	Remedies
1	Check the speed command. Check whether the override input is input from the machine operation panel.	The speed command is not input correctly.	Input the correct speed command.
		The speed command is input correctly.	Investigate investigation item 2 and remedy.
2	Check whether the load has suddenly become heavier.	The load has become heavier.	Repair the machine side.
		No particular problems found.	Investigate investigation item 3 and remedy.
3	Manually rotate the motor bearings and check the movement.	The bearings do not rotate smoothly.	Replace the spindle motor.
		The bearings rotate smoothly.	Investigate investigation item 4 and remedy.
4	Tug on the connector by hand to check whether the speed detector connector (spindle drive unit side and speed detector side) is loose.	The connector is disconnected (or loose).	Correctly connect the connector.
		The connector is not disconnected (or loose).	Investigate investigation item 5 and remedy.
5	Turn the power OFF, and check the connection of the speed detector cable with a tester. (Especially check the shield wiring.)	The connection is faulty or disconnected.	Replace the detector cable. Correct the connection.
		The waveform is normal.	Replace the spindle drive unit.

9. Characteristics

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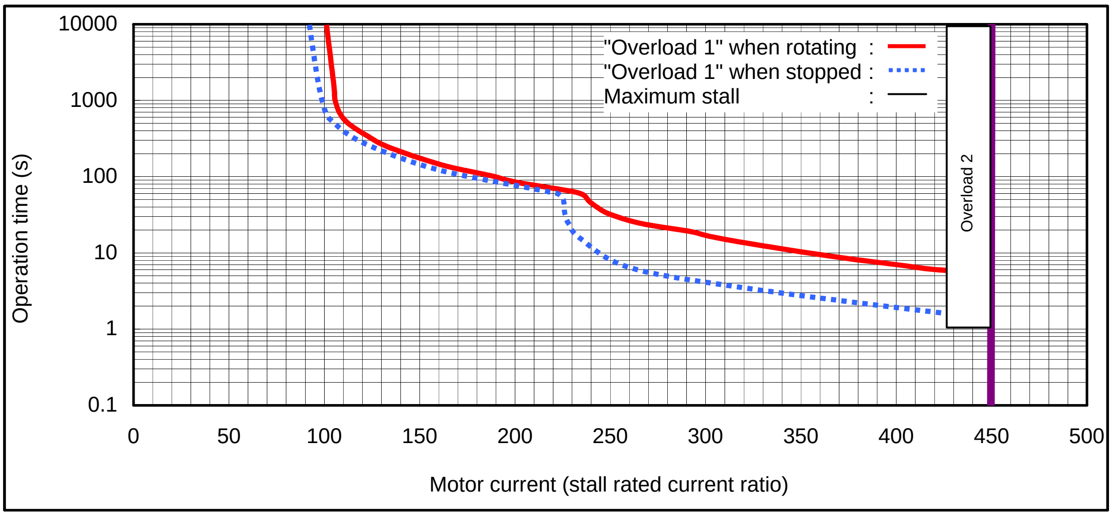
9-1 Overload protection characteristics

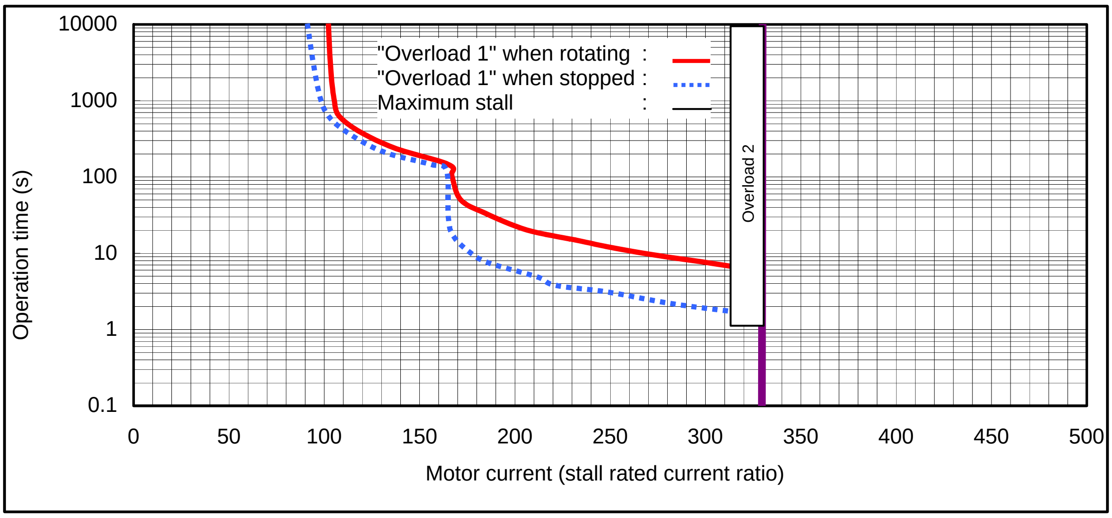
The servo drive unit has an electronic thermal relay to protect the servomotor and servo drive unit from overloads. The operation characteristics of the electronic thermal relay are shown below when standard parameters (SV021=60, SV022=150) are set.
If overload operation over the electronic thermal relay 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.

9-1-1 Servomotor (HC-H series)

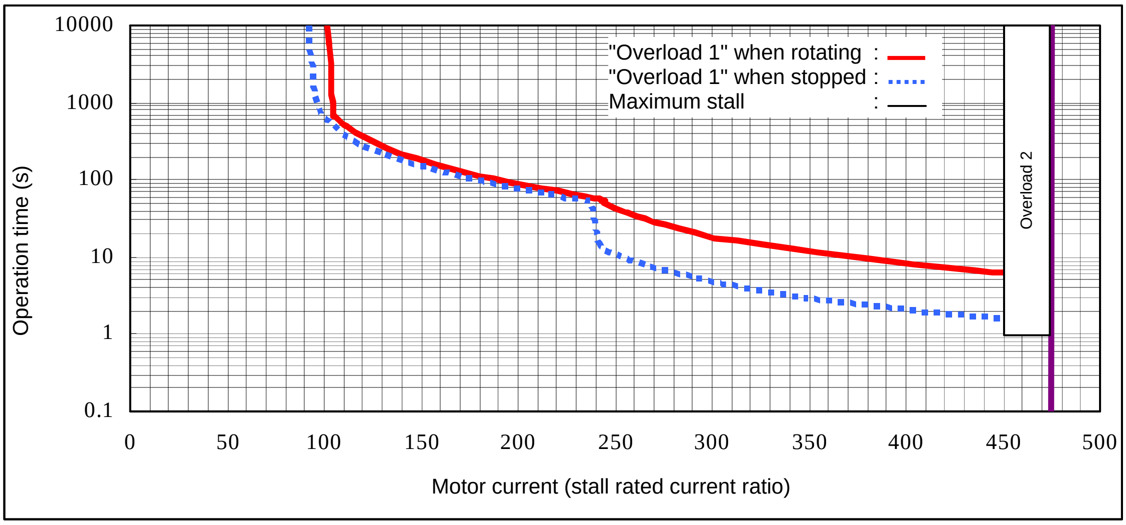
(1) Motor HC-H52



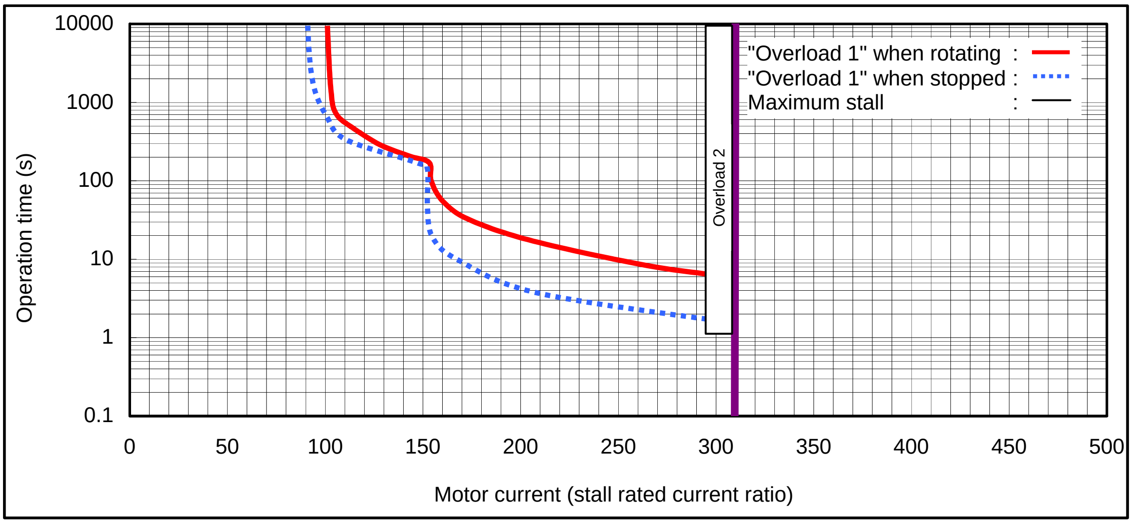
(2) Motor HC-H53



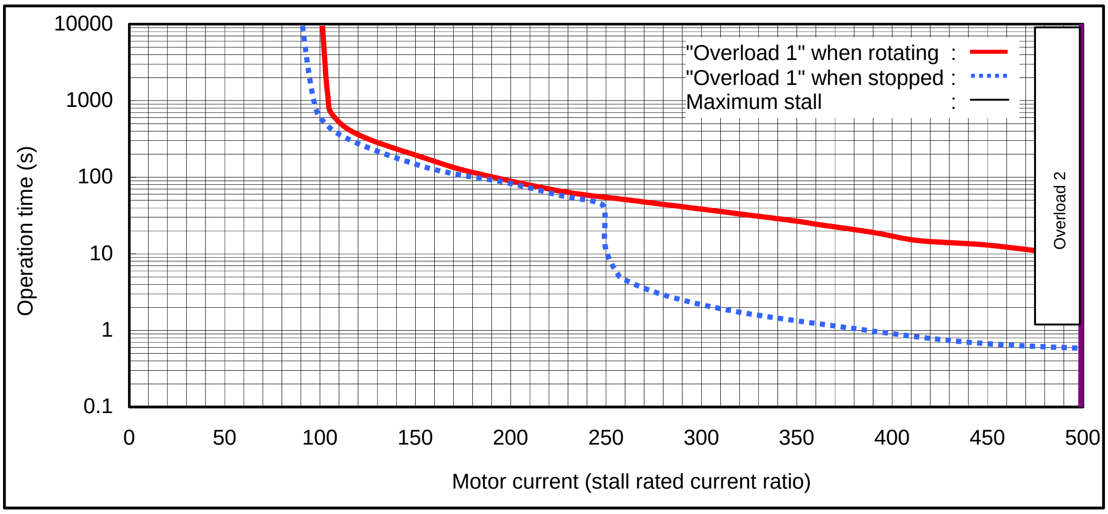
(3) Motor HC-H102



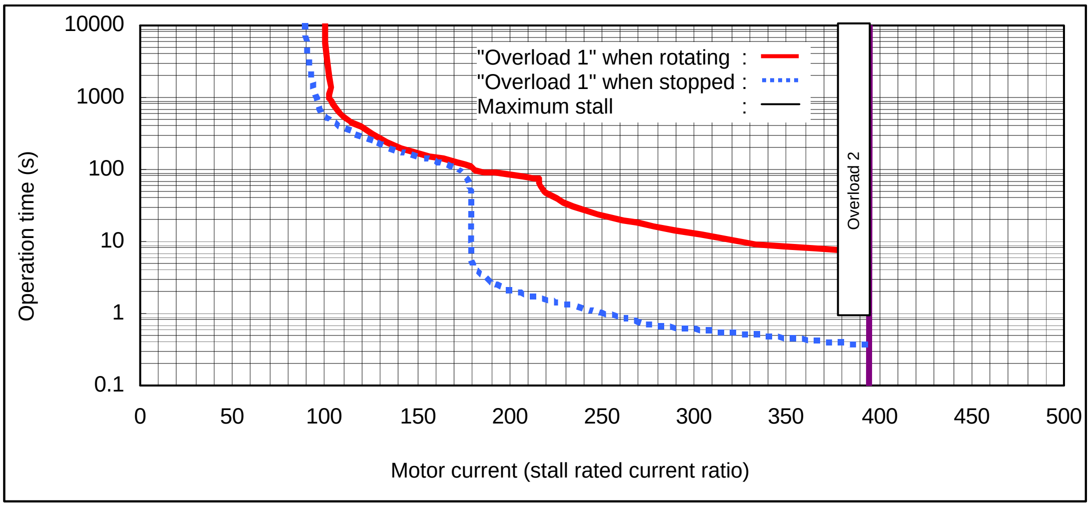
(4) Motor HC-H103



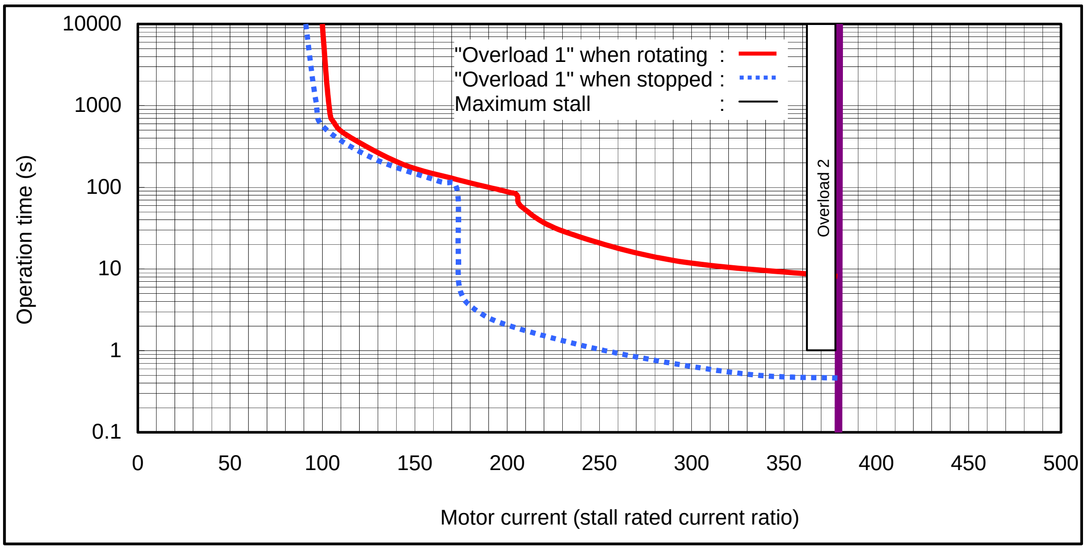
(5) Motor HC-H152



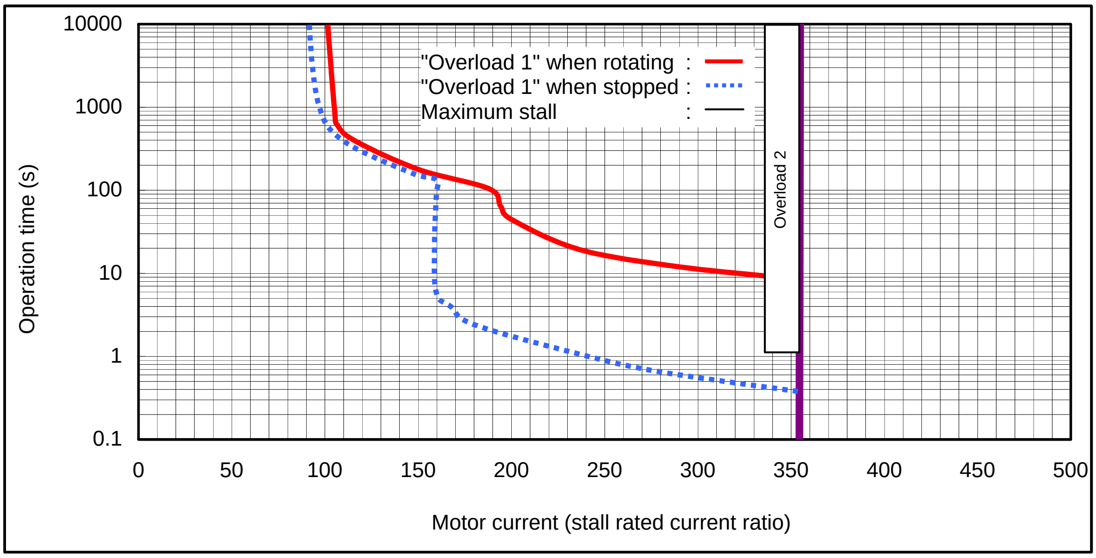
(6) Motor HC-H153



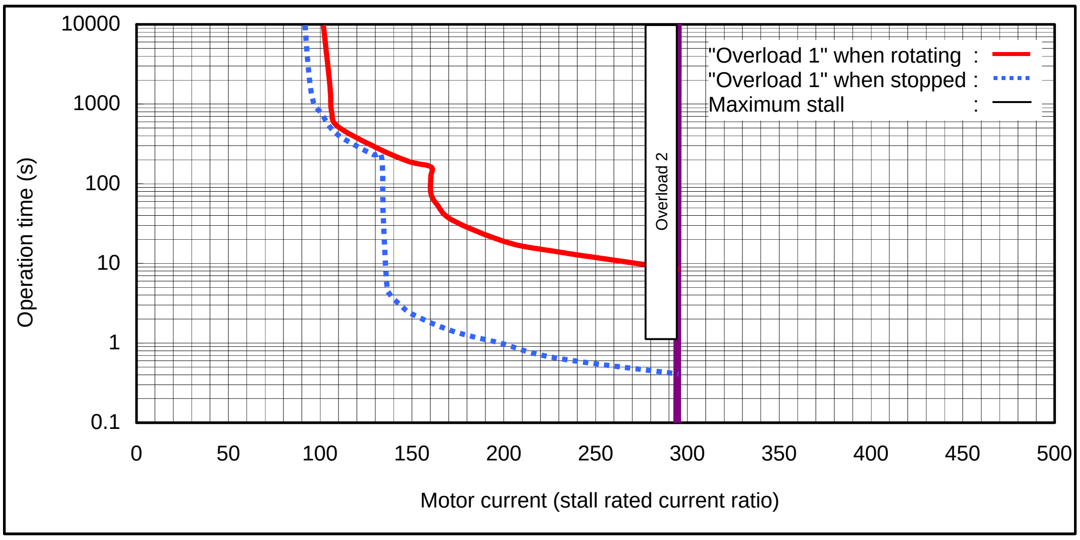
(7) Motor HC-H202



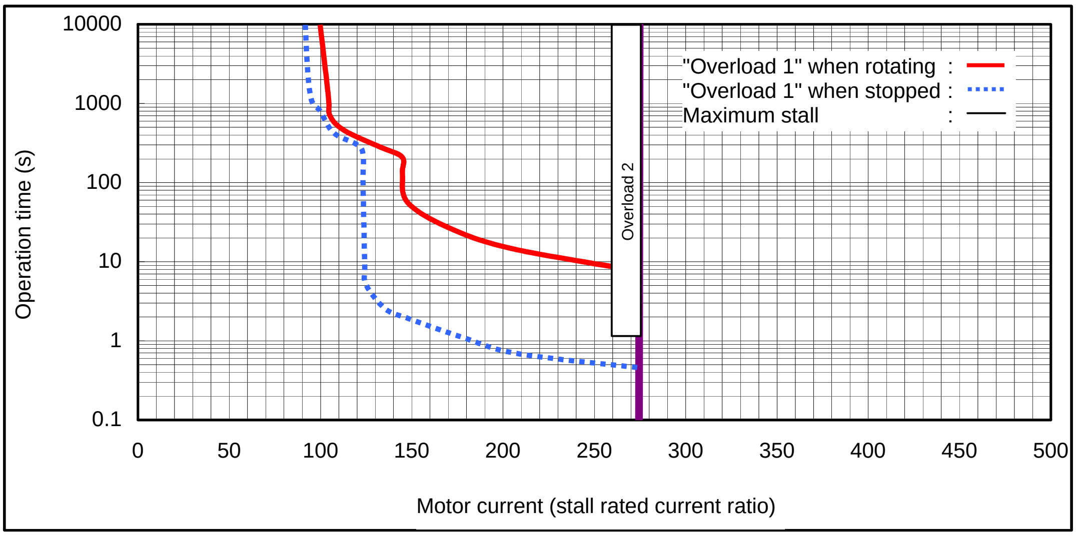
(8) Motor HC-H203



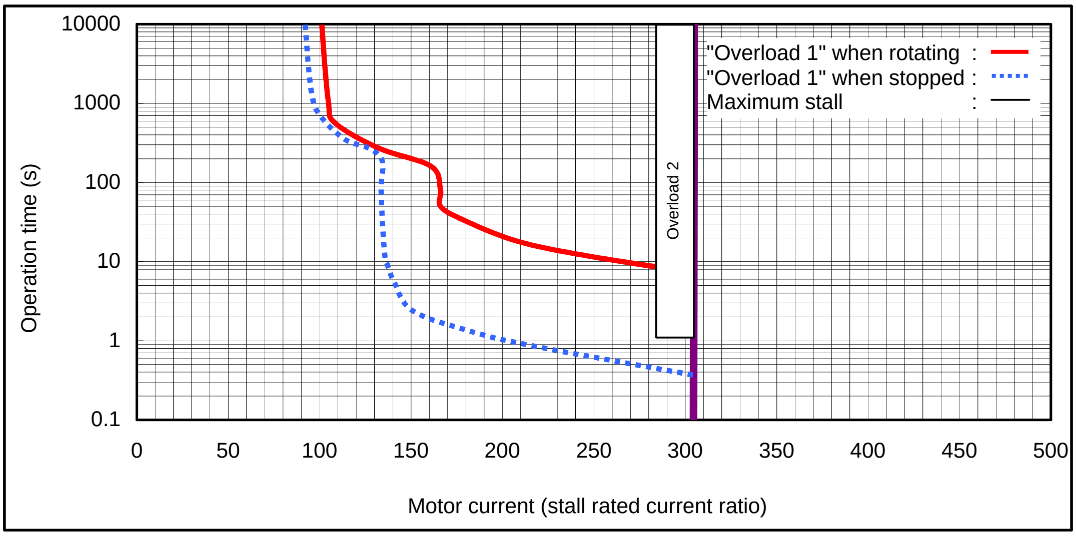
(9) Motor HC-H352



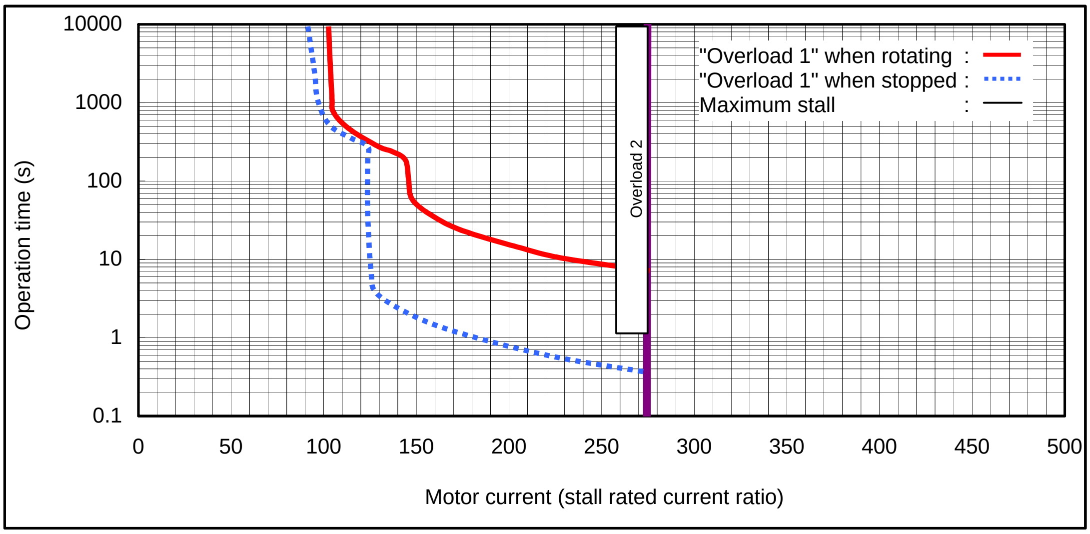
(10) Motor HC-H353



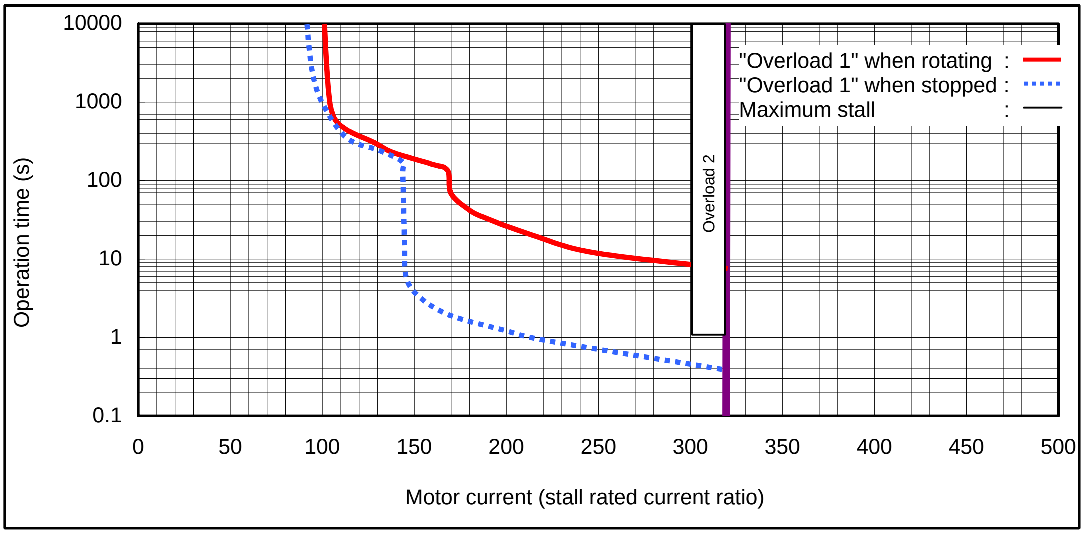
(11) Motor HC-H452



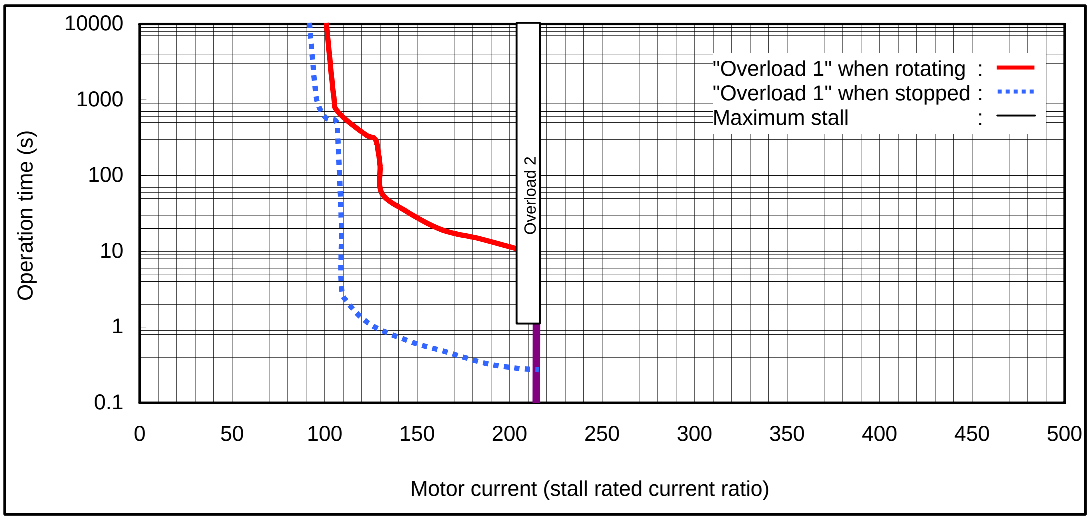
(12) Motor HC-H453



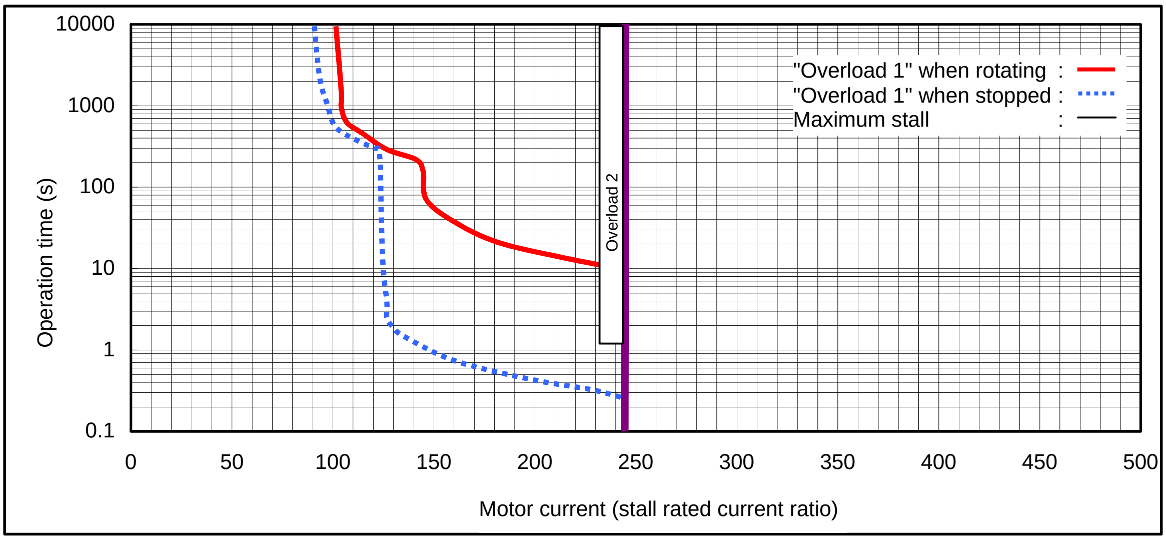
(13) Motor HC-H702



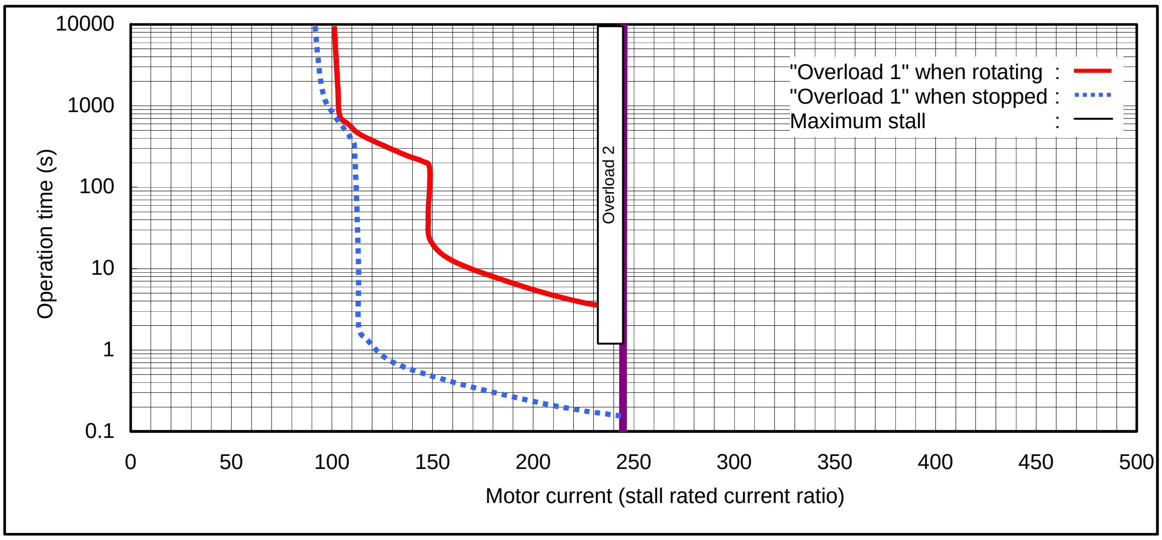
(14) Motor HC-H703



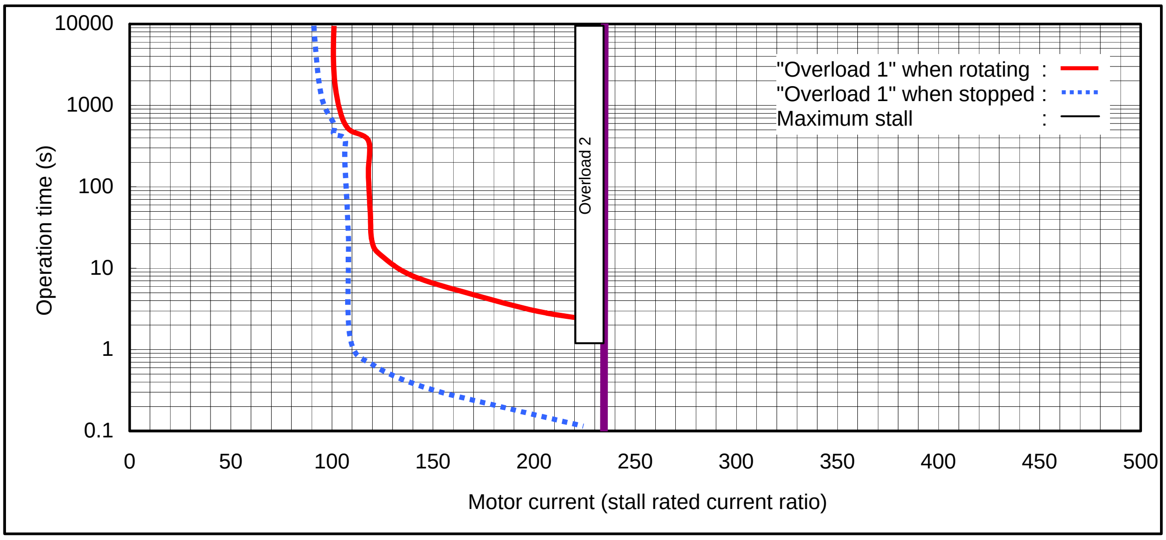
(15) Motor HC-H902



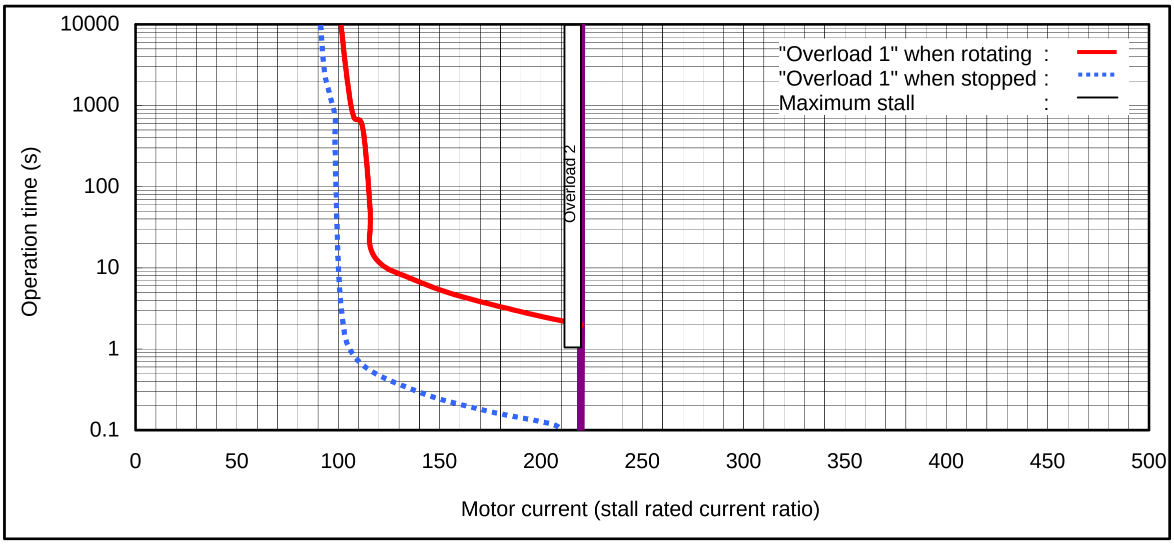
(16) Motor HC-H903



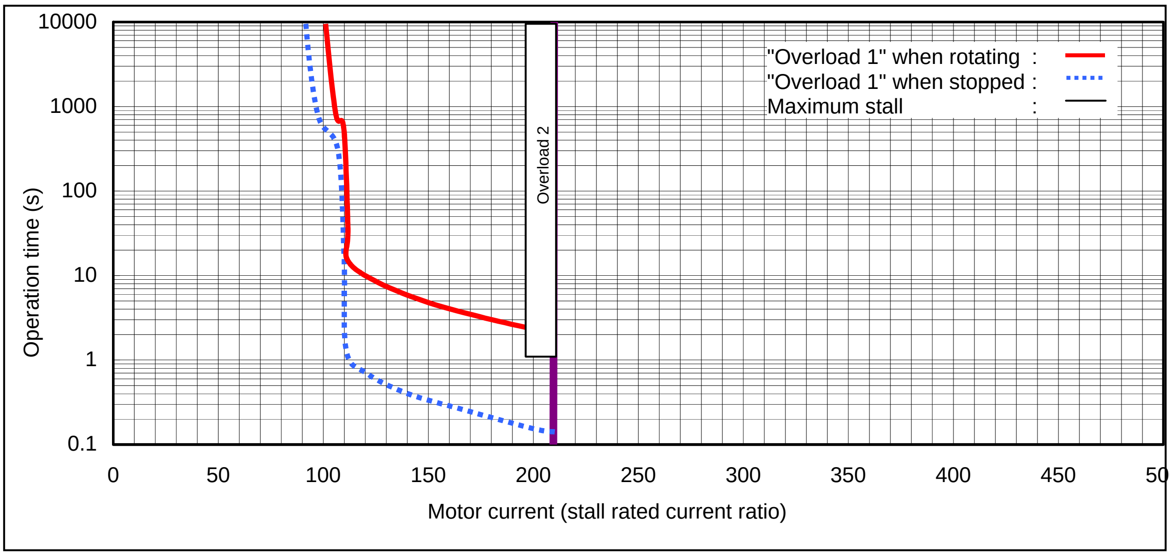
(17) Motor HC-H1102



(18) Motor HC-H1103

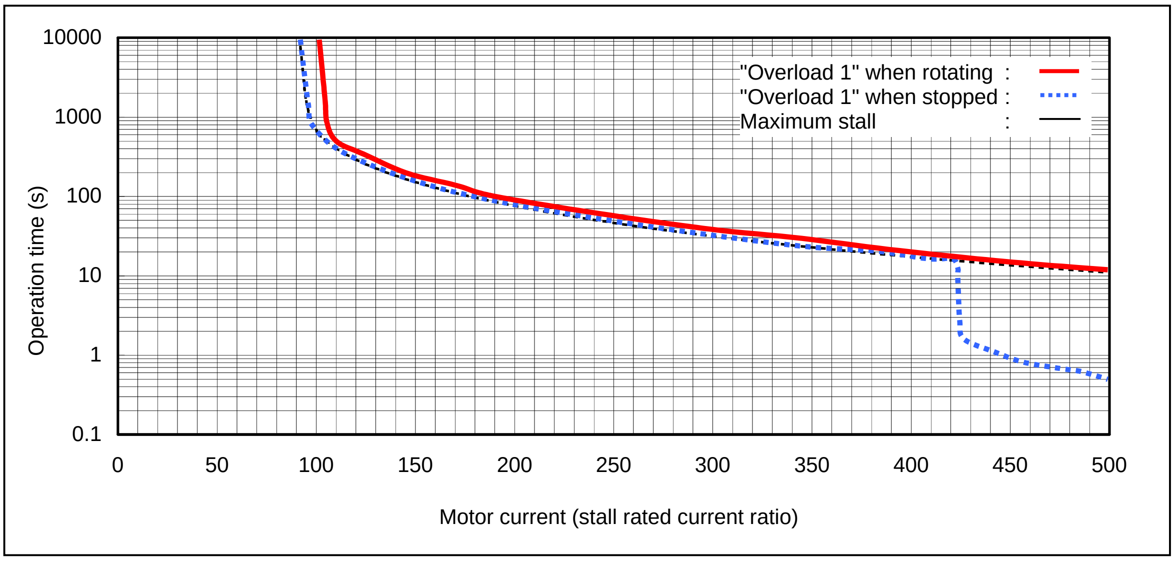


(19) Motor HC-H1502



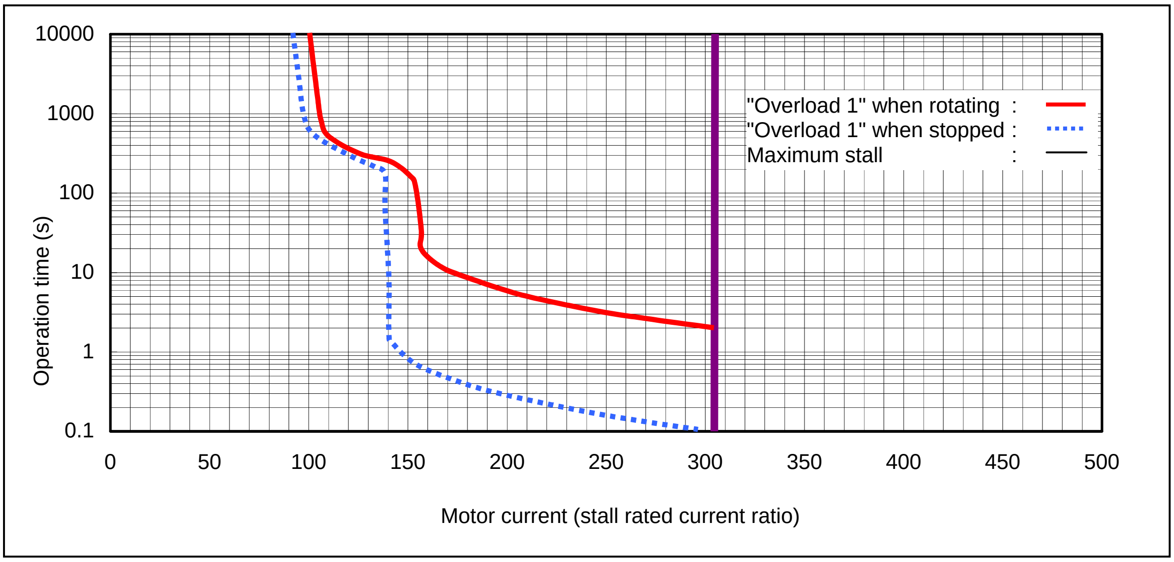
9-1-2 Linear servomotor (LM-NP Series)

(1) LM-NP5G60P (Natural-cooled type)



The maximum stall current is 732.

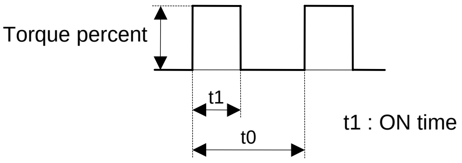
(2) LM-NP5G60P (Oil-cooled type)



9-2 Duty characteristics

The duty drive characteristics are calculated from the motor's armature winding temperature rise element and heat time constant. These characteristics express the output limit characteristics for an independently rotating motor. The motor's thermal protection will activate and a motor overheat (ALM46) will be detected if this limit is exceeded.

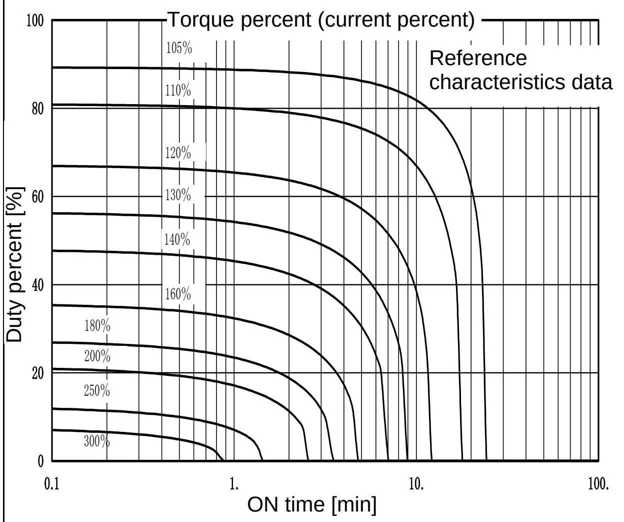
In the actual servo system, the electronic thermal protection is also controlled with software operations in the servo amplifier. Thus, these characteristics may be limited by the servo amplifier.



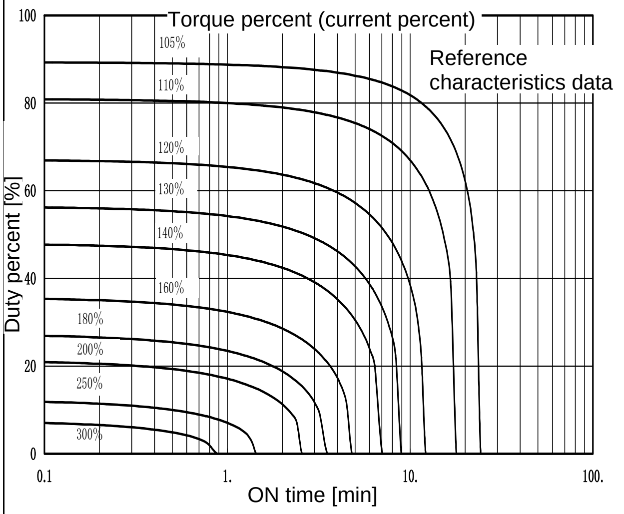
$$\text{Duty percent} = \frac{t1}{t0} \times 100\ (\%)$$

(1) Servomotor (HC-H series)

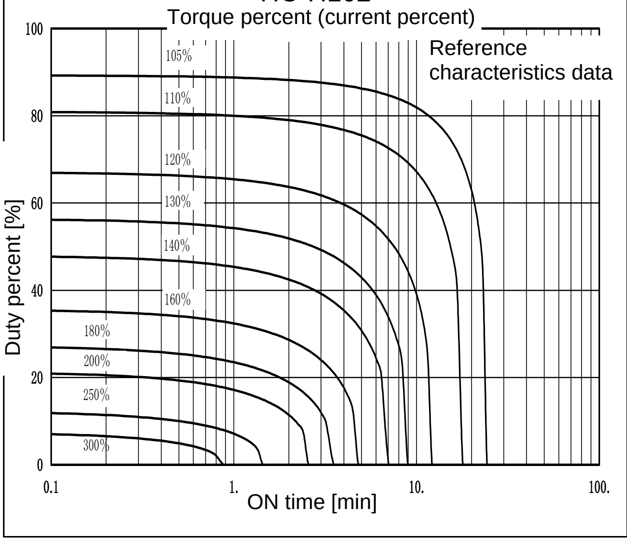
HC-H52



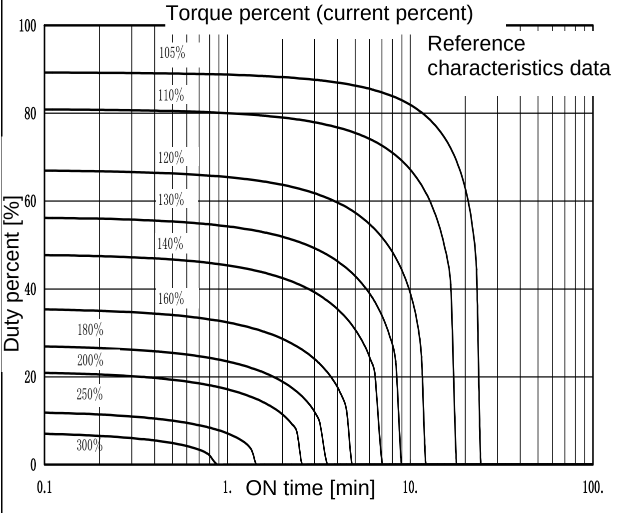
HC-H53



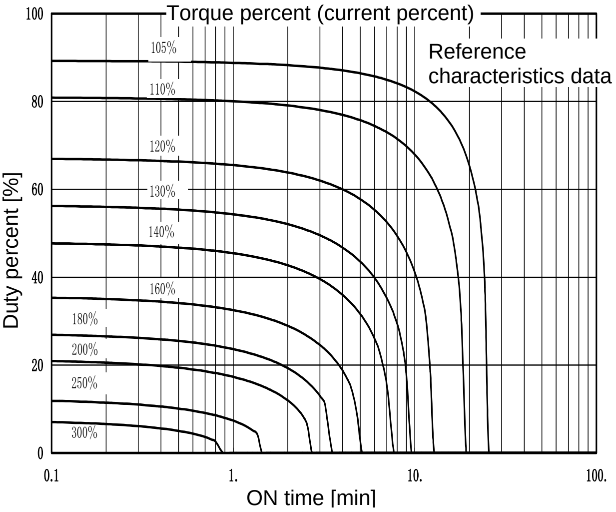
HC-H102



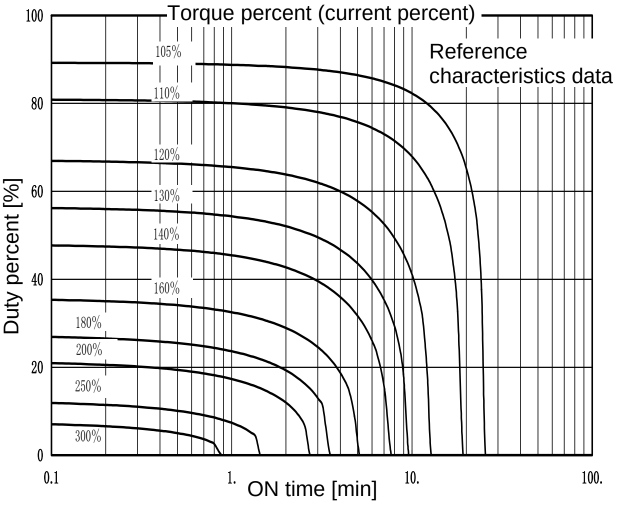
HC-H103



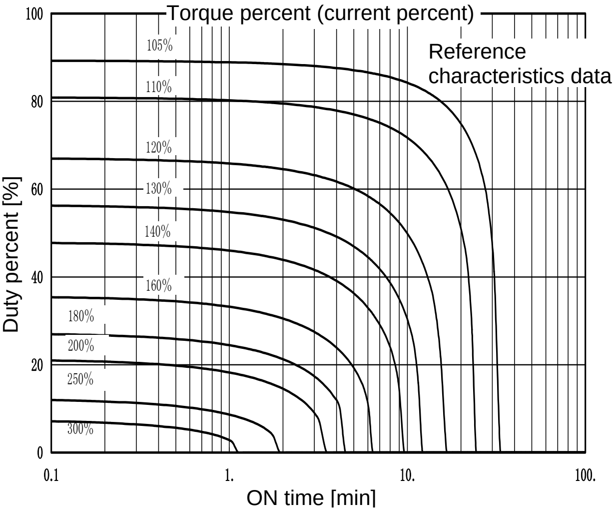
HC-H152



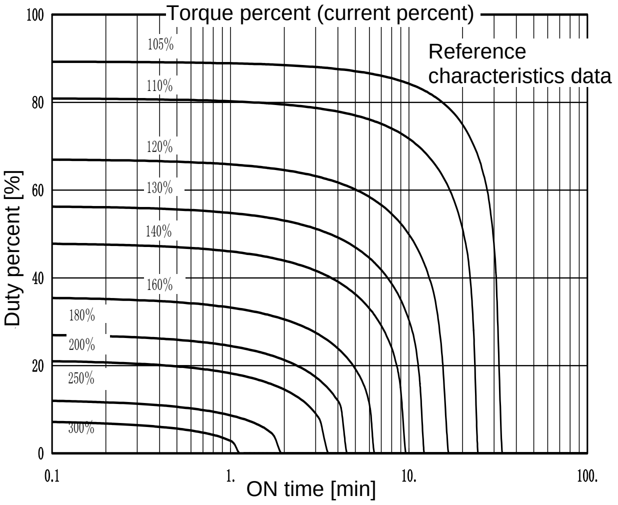
HC-H153



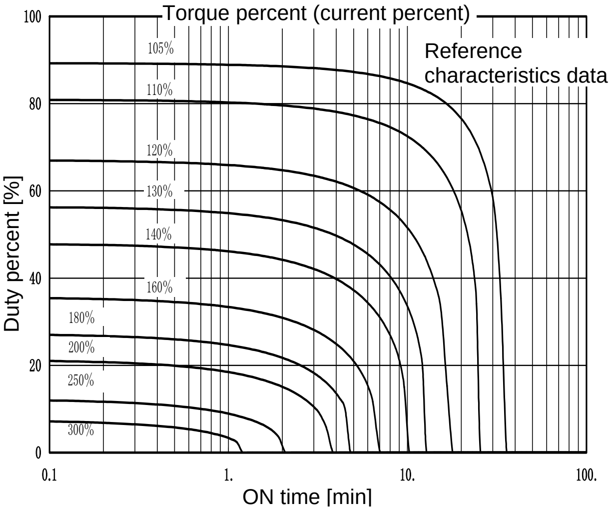
HC-H202



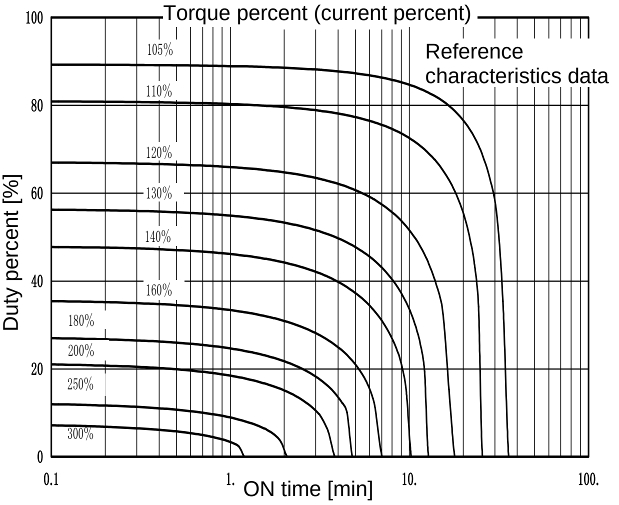
HC-H203



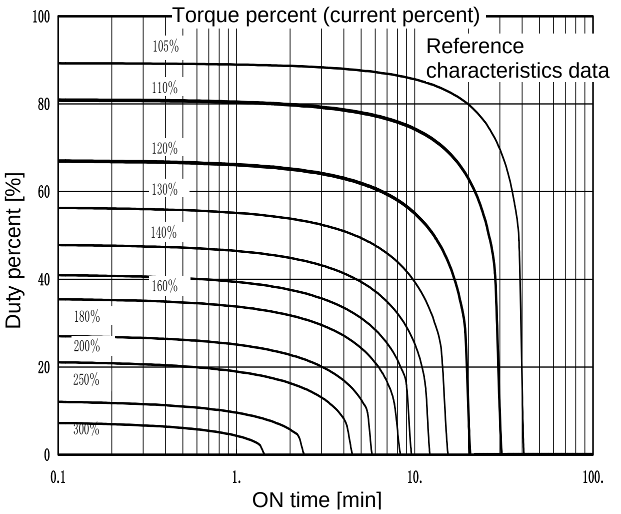
HC-H352



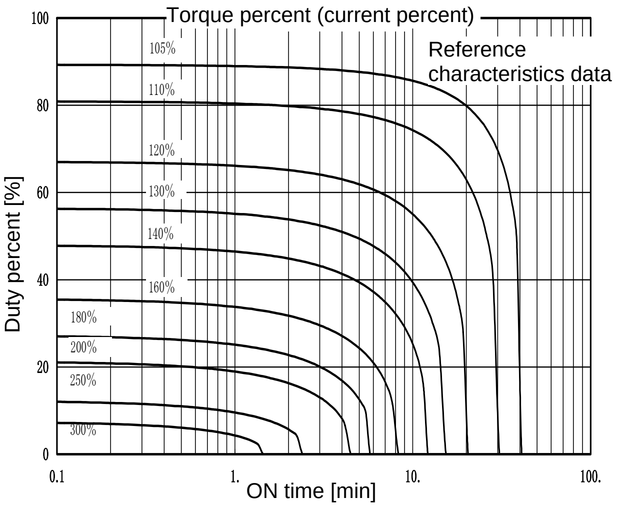
HC-H353



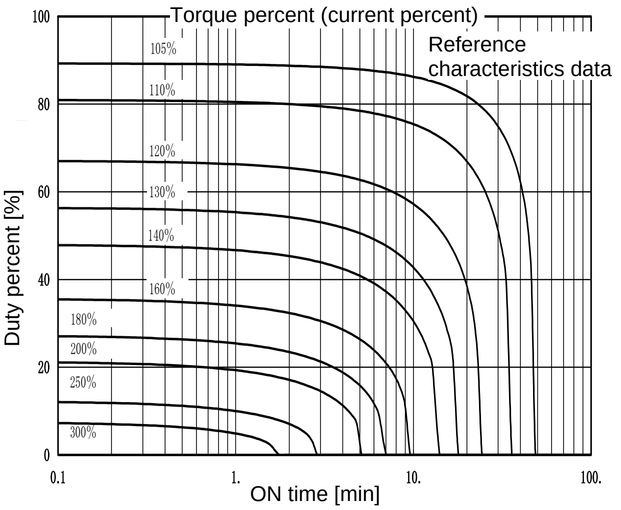
HC-H452



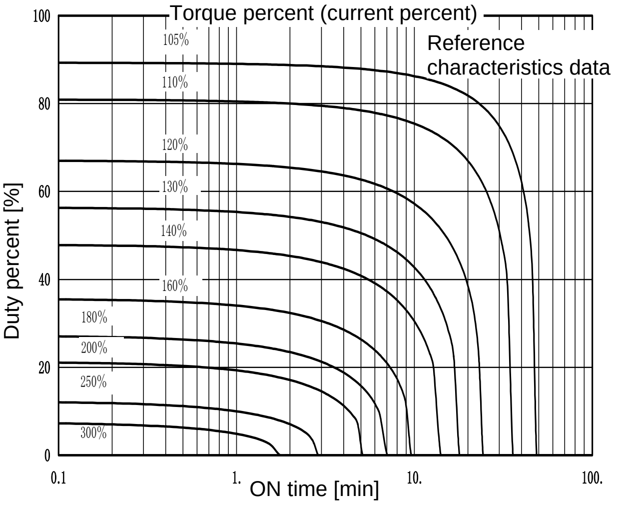
HC-H453



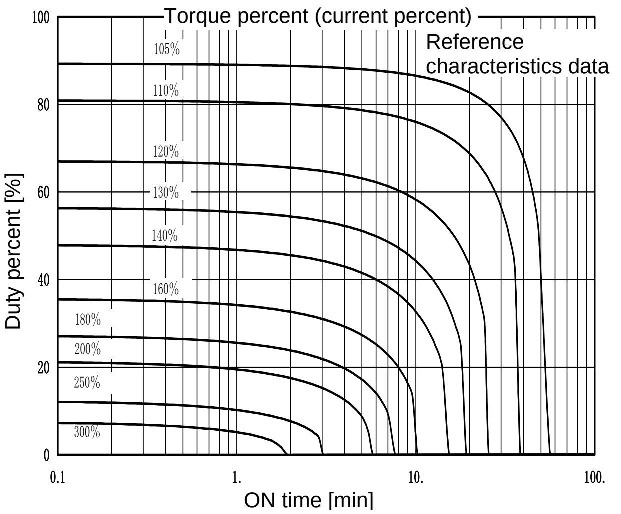
HC-H702



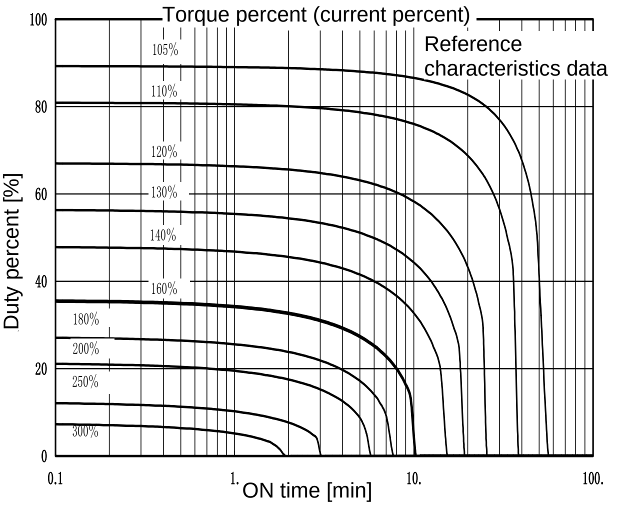
HC-H703

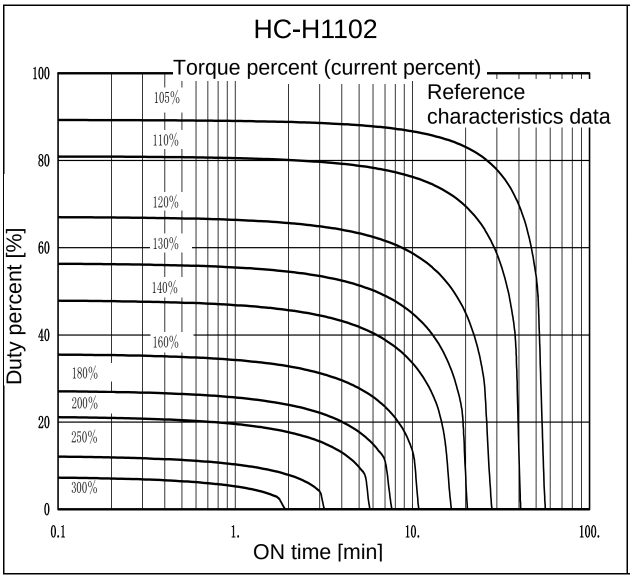


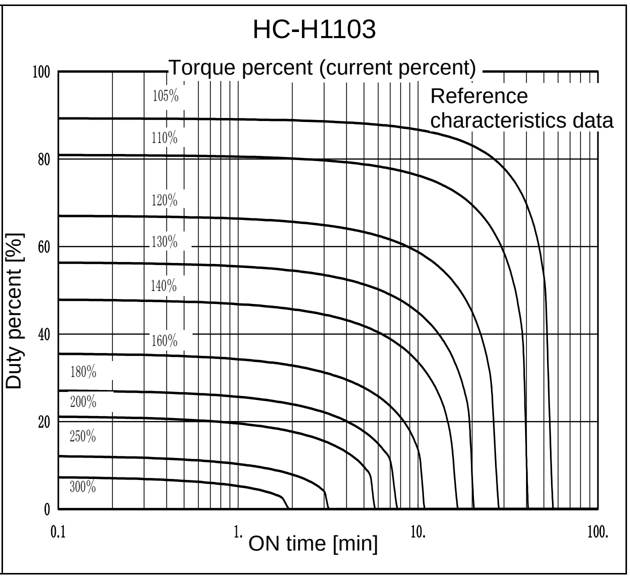
HC-H902



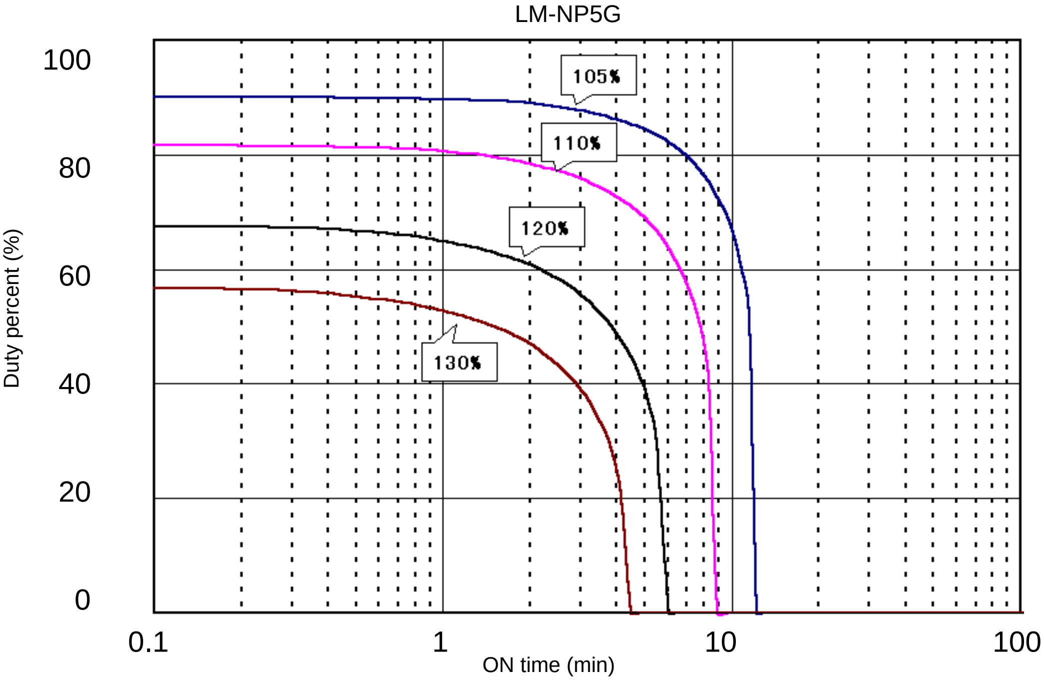
HC-H903







(2) Linear servomotor (LM-NP series)



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.
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 by using the brake contact connection terminal (CN20) on the servo drive unit.
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.

(1) Motor with magnetic brake

(a) Types

The motor with a magnetic brake is set for each motor. The "B" following the standard motor model stands for the motor with a brake.

(b) Applications

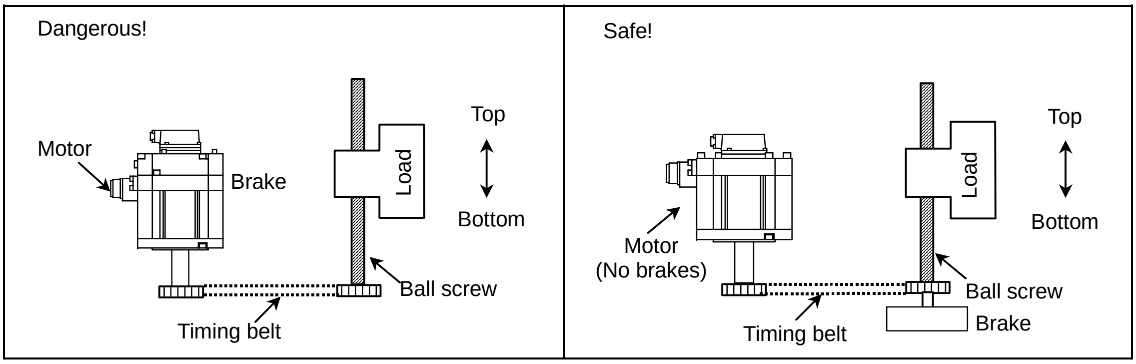
When this type of motor is used for the vertical feed axis in a machining center, etc., slipping and dropping of the spindle head can be prevented even when the hydraulic balancer's hydraulic pressure reaches zero when the power turns OFF. When used with a robot, deviation of the posture when the power 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) during emergency stop, and the risks of colliding with the grinding stone and scattering can be prevented.
This motor cannot be used for the purposes other than holding and braking during a power failure (emergency stop). (This cannot be used for normal deceleration, etc.)

(c) 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 50Hz and 60Hz.
   - 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 brake is built into the motor, and the installation dimensions are the same as the motor without brake. (Note that the L dimension will be longer in comparison with the motor with no break. For details, refer to the outline dimension.)

(d) Considerations to safety

1) Using a timing belt
   Connecting the motor with magnetic brakes and the load (ball screw, etc.) with a timing belt as shown on the left below could pose a hazard if the belt snaps. Even if the belt's safety coefficient is increased, the belt could snap if the tension is too high or if cutting chips get imbedded. Safety can be maintained by using the method shown on the right below.



(2) Magnetic brake characteristics

Motor type HC-H Item			52B 53B	102B 152B 103B 153B	202B 203B	352B 452B 353B 453B	702B 703B	902B 1102B 903B 1103B
Type (Note 1)			Spring closed non-exciting operation magnetic brakes (for maintenance and emergency braking)					
Rated voltage			24VDC					
Rated current at 20°C		(A)	0.91	0.86	1.0	1.4	1.4	1.7
Capacity		(W)	22	21	24	34	34	41
Static friction torque		(N•m)	3.5	9	12	32	54.9	90
Inertia (Note 2)		(kg•cm^2)	0.5	0.5	0.5	3.4	4.5	24
Release delay time (Note 3)		(s)	0.1	0.1	0.1	0.12	0.3	0.3
Braking delay time (DC OFF) (Note 3)		(s)	0.1	0.1	0.1	0.1	0.1	0.1
Tolerable braking work amount	Per braking	(J)	700	700	700	4,500	4,500	4,500
	Per hour	(J)	7,000	7,000	7,000	45,000	45,000	45,000
Brake play at motor axis		(degree)	0.2 to 0.6	0.2 to 0.6	0.2 to 0.6	0.2 to 0.6	0.2 to 0.6	0.2 to 0.6
Brake life (Note 4)	No. of braking operations	(times)	20,000	20,000	20,000	20,000	20,000	20,000
	Work amount per braking	(J)	200	200	200	1,000	1,000	1,000

(Note 1) There is no manual release mechanism. If handling is required such as during the machine core alignment work, prepare a separate 24VDC power supply, and electrically release a brake.

(Note 2) These are the values added to the servomotor without a brake.

(Note 3) This is the representative value for the initial attraction gap at 20°C.

(Note 4) The brake gap will widen through brake lining wear caused by braking. However, the gap cannot be adjusted. Thus, the brake life is considered to be reached when adjustments are required.

(Note 5) A leakage flux will be generated at the shaft end of the servomotor with a magnetic brake.

(Note 6) 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.

(3) Magnetic brake power supply

CAUTION

1. Always install a surge absorber on the brake terminal when using DC OFF.
2. Do not pull out the cannon plug while the brake power is ON. The cannon plug pins could be damaged by sparks.

(a) Brake excitation power supply

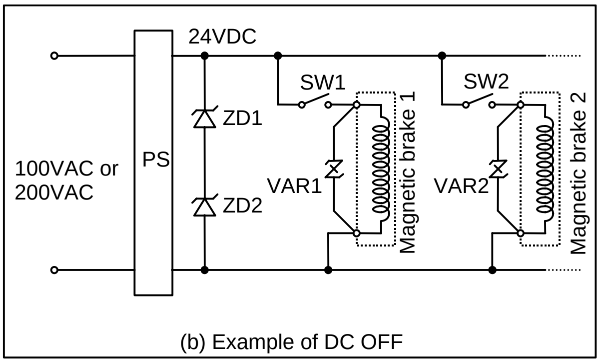
1) Prepare a brake excitation power supply that can accurately ensure the attraction current in consideration of the voltage fluctuation and excitation coil temperature.
2) The brake terminal polarity is random. Make sure not to mistake the terminals with other circuits.

(b) Brake excitation circuit

1) When turning OFF the brake excitation power supply (to apply the brake), DC OFF is used to shorten the braking delay time. A surge absorber will be required. Pay attention to the relay cut off capacity.

<Cautions>

- Provide sufficient DC cut off capacity at the contact.
- Always use a surge absorber.
- When using the cannon plug type, the surge absorber will be further away, so use shielded wires between the motor and surge absorber.



(b) Example of DC OFF

PS : 24VDC stabilized power supply
ZD1, ZD2 : Zener diode for power supply protection (1W, 24V)
VAR1, VAR2 : Surge absorber

Magnetic brake circuits

9-4 Dynamic brake characteristics

If a servo alarm that cannot control the motor occurs or emergency stop is input from NC, the dynamic brake stop the servomotor.

9-4-1 Deceleration torque

The dynamic brake 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.

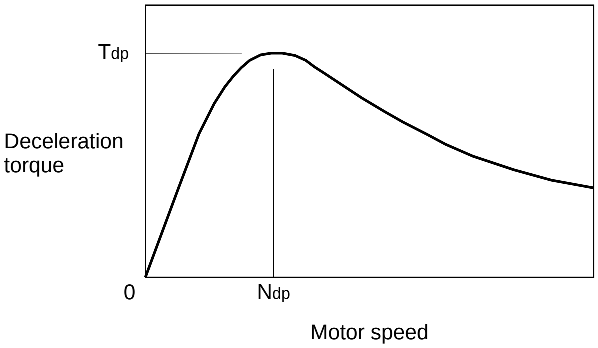


Fig. 9-2 Deceleration torque characteristics of a dynamic brake

Table 9-3 Max. deceleration torque of a dynamic brake

Motor model	Stall torque (N·m)	T_{dp} (N·m)	N_{dp} (r/min)	Motor model	Rated torque (N·m)	T_{dp} (N·m)	N_{dp} (r/min)
HC-H52	3.0	2.96	284	HC-H53	3.0	2.95	326
HC-H102	6.0	7.30	286	HC-H103	5.8	7.36	334
HC-H152	9.0	12.53	281	HC-H153	9.0	12.53	345
HC-H202	12.0	14.16	210	HC-H203	12.0	14.23	313
HC-H352	22.0	25.92	272	HC-H353	22.0	25.78	458
HC-H452	31.9	39.56	333	HC-H453	31.9	38.82	617
HC-H702	49.0	71.42	402	HC-H703	49.0	70.69	765
HC-H902	70.0	172.40	966	HC-H903	70.0	98.94	1178
HC-H1102	110.0	182.16	1165	HC-H1103	110.0	182.16	1165
HC-H1502	146.0	237.80	1828				

9-4-2 Determining the coasting amount with emergency stop

(1) HC-H servomotor

The motor coasting amount when stopped by a dynamic brake can be approximated using the following expression.

$$L_{MAX} = \frac{F_{G0} \times 10^3}{60} \cdot \{te + (1 + \frac{J_L}{J_M}) \cdot (A \cdot N^2 + B) \cdot 1.1\}$$

L_{MAX}	:	Coasting amount of machine	(mm)
F_{G0}	:	Feedrate (rapid traverse)	(r/m)
N	:	Motor speed (Maximum speed)	(r/m)
J_M	:	Motor inertia	(kg·cm^2)
J_L	:	Motor shaft conversion load inertia	(kg·cm^2)
te	:	Brake drive relay delay time	(s) (Normally, 0.03s)
A	:	Coefficient A (Refer to the table below)	
B	:	Coefficient B (Refer to the table below)	
1.1	:	Margin	

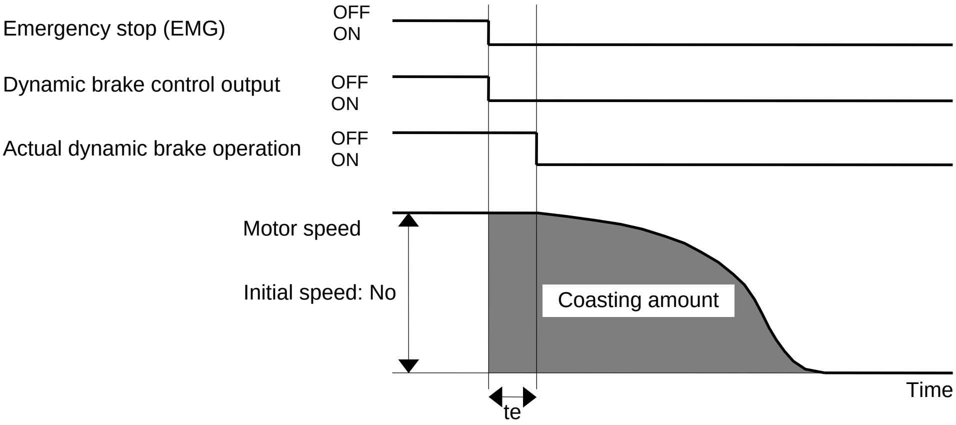


Fig. 9-3 Dynamic brake braking diagram

Table 9-4 Coasting amount calculation coefficients (HC-H Motor)

Motor model	J_M (kg·cm^2)	A	B	Motor model	J_M (kg·cm^2)	A	B
HC-H52	4.6	9.57×10^{-9}	2.31×10^{-3}	HC-H53	4.6	8.35×10^{-9}	2.67×10^{-3}
HC-H102	7.4	6.20×10^{-9}	1.52×10^{-3}	HC-H103	7.4	5.25×10^{-9}	1.76×10^{-3}
HC-H152	10.1	5.00×10^{-9}	1.19×10^{-3}	HC-H153	10.1	4.08×10^{-9}	1.46×10^{-3}
HC-H202	30.2	17.70×10^{-9}	2.35×10^{-3}	HC-H203	30.2	11.82×10^{-9}	3.48×10^{-3}
HC-H352	42.9	10.64×10^{-9}	2.35×10^{-3}	HC-H353	42.9	6.35×10^{-9}	3.99×10^{-3}
HC-H452	57.0	7.55×10^{-9}	2.51×10^{-3}	HC-H453	57.0	4.15×10^{-9}	4.74×10^{-3}
HC-H702	95.0	5.78×10^{-9}	2.80×10^{-3}	HC-H703	87.0	2.81×10^{-9}	4.93×10^{-3}
HC-H902	205.0	2.25×10^{-9}	6.31×10^{-3}	HC-H903	205.0	3.22×10^{-9}	13.41×10^{-3}
HC-H1102	270.0	2.22×10^{-9}	9.04×10^{-3}	HC-H1103	270.0	2.22×10^{-9}	9.04×10^{-3}
HC-H1502	550.0	2.21×10^{-9}	22.14×10^{-3}				
HC-H52B	5.9	0.13×10^{-9}	3.19×10^{-3}	HC-H53B	5.1	9.29×10^{-9}	2.97×10^{-3}
HC-H102B	8.9	7.44×10^{-9}	1.82×10^{-3}	HC-H103B	7.9	6.02×10^{-9}	2.01×10^{-3}
HC-H152B	11.6	6.83×10^{-9}	1.62×10^{-3}	HC-H153B	10.6	4.67×10^{-9}	1.67×10^{-3}
HC-H202B	32.1	19.00×10^{-9}	2.50×10^{-3}	HC-H203B	30.7	12.00×10^{-9}	3.54×10^{-3}
HC-H352B	47.9	12.00×10^{-9}	2.64×10^{-3}	HC-H353B	46.3	6.85×10^{-9}	4.31×10^{-3}
HC-H452B	62.0	7.79×10^{-9}	2.89×10^{-3}	HC-H453B	60.4	4.38×10^{-9}	5.01×10^{-3}
HC-H702B	101.0	6.13×10^{-9}	2.97×10^{-3}	HC-H703B	91.5	2.94×10^{-9}	5.18×10^{-3}
HC-H902B	239.0	2.17×10^{-9}	6.09×10^{-3}	HC-H903B	215.0	2.94×10^{-9}	12.71×10^{-3}
HC-H1102B	294.0	2.27×10^{-9}	10.48×10^{-3}	HC-H1103B	314.0	2.57×10^{-9}	10.56×10^{-3}

(2) Linear servomotor

The motor coasting amount when stopped by a dynamic brake can be approximated using the following expression.

$$L_{MAX} = \frac{F_0}{60} \cdot \{te + M \cdot (A + B \cdot F_0^2) \cdot 1.1\}$$

L_{MAX}	: Coasting amount of machine	(m)	
F_0	: Speed during brake operation	(m/min)	
M	: Total weight of moving section	(kg)	
te	: Brake drive relay delay time	(s)	(Normally, 0.03s)
A	: Coefficient A (Refer to the table below)		
B	: Coefficient B (Refer to the table below)		
1.1	: Margin		

Table 9-5 Coasting amount calculation coefficients (Linear servomotor)

Motor model	A	B
LN-NP5G-60P	1.31×10^{-4}	5.38×10^{-9}

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.

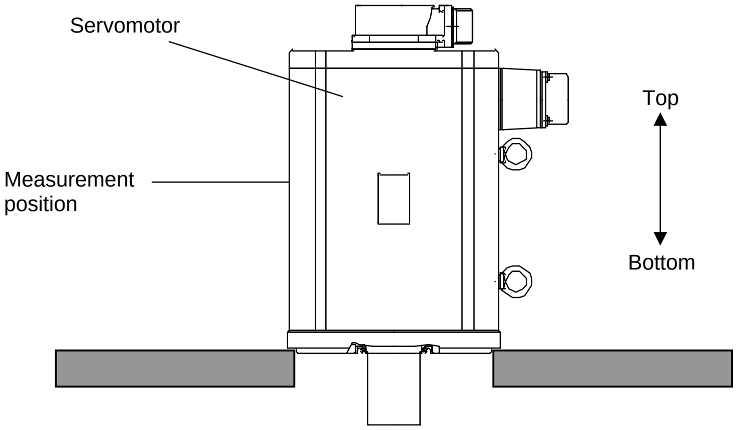


Fig. 9-4 Servomotor vibration measurement conditions

The vibration class of the spindle motor is V-5 or V10. The posture for installing the spindle motor for measurements is shown below. The vibration class will differ according to the motor, so refer to each corresponding motor specifications.

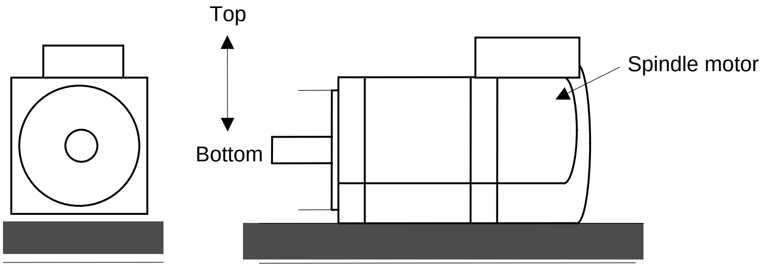


Fig. 9-5 Spindle motor vibration measurement conditions

10. Specifications

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10-1 Power supply unit/drive unit

10-1-1 Installation environment conditions

Common installation environment conditions for servo, spindle and power supply unit are shown below.

Environ-ment	Ambient temperature	0 to 55°C (with no freezing), Storage: -15°C to 70°C (with no freezing)
	Ambient humidity	90%RH or less (with no dew condensation) Storage: 90%RH or less (with no dew condensation)
	Atmosphere	Indoors (no direct sunlight) With no corrosive gas, inflammable gas, oil mist, dust or conductive fine particles
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 13000 meters or less above sea level
	Vibration/impact	4.9m/s^2 (0.5G) / 49m/s^2 (5G)

10-1-2 Servo drive unit

(1) 1-axis servo drive unit

			1-axis servo drive unit MDS-CH-V1 Series									
Servo drive unit type	**MDS-CH-V1-**		**05**	**10**	**20**	**35**	**45**	**70**	**90**	**110**	**150**	**185**
Rated output		[kW]	0.5	1.0	2.0	3.5	4.5	7.0	9.0	11.0	150	18.5
Output Note	Rated voltage	[V]	456VAC									
	Rated current	[A]	1.7	2.6	5.0	8.4	11.0	16	18	17	29	39
Input	Rated voltage	[V]	513 to 648VDC									
	Rated current	[A]	1.4	2.4	4.6	8.0	10	15	19	20	30	39
Control power	Voltage	[V]	380 to 440VAC (50Hz) ／380 to 480VAC (60Hz) Power fluctuation rate within +6%/-10%									
	Frequency	[Hz]	50／60Hz Frequency fluctuation within ±3%									
	Current	[A]	Max. 0.1									
	Rush current	[A]	Max. 18									
	Rush conductivity time	[ms]	Max. 6									
Earth leakage current		[A]	1 (Max.2)									
Control method			Sine wave PWM control method									
Braking			Regenerative braking and dynamic brakes									
	Dynamic brakes		Built-in							External (MDS-B-DBU-150)		
Structure			Open (Protection method: IP00)									
Weight		[kg]	5.5				6.0	7.0		10.0		15.0
Maximum radiated heat		[W]	40	65	105	150	210	320	370	400	550	800
Noise			Less than 55dB									

(2) 2-axis servo drive unit

			2-axis servo drive unit MDS-CH-V2 Series									
Servo drive unit type	**MDS-CH-V2-**		**0505**	**1005**	**1010**	**2010**	**2020**	**3510**	**3520**	**3535**	**4520**	**4535**
Rated output		[kW]	0.5+0.5	1.0+0.5	1.0+1.0	2.0+1.0	2.0+2.0	3.5+1.0	3.5+2.0	3.5+3.5	4.5+2.0	4.5+3.5
Output Note	Rated voltage	[V]	456VAC									
	Rated current	[A]	1.7 / 1.7	2.6 / 1.7	2.6 / 2.6	5.0 / 2.6	5.0/ 5.0	8.4 / 2.6	8.4 / 5.0	8.4/ 8 .4	11.0 / 5.0	11.0 / 8.4
Input	Rated voltage	[V]	513 to 648VDC									
	Rated current	[A]	2.8	3.8	4.8	7	9.2	10.4	12.6	16	14.7	18.1
Control power	Voltage	[V]	380 to 440VAC (50Hz) / 380 to 480VAC (60Hz) Power fluctuation rate within +6%/-10%									
	Frequency	[Hz]	50／60Hz Frequency fluctuation within ±3%									
	Current	[A]	Max. 0.1									
	Rush current	[A]	Max. 18									
	Rush conductivity time	[ms]	Max. 6									
Earth leakage current		[A]	1 (Max.4 For ２axes)									
Control method			Sine wave PWM control method Current control method									
Braking			Regenerative braking and dynamic brakes									
	Dynamic brakes		Built-in									
Structure			Open (Protection method: IP00)									
Cooling method			Forced wind cooling									
Weight		[kg]	5.5					6.0				
Maximum heating value		[W]	80	105	120	180	200	215	240	295	300	345
Noise			Less than 55dB									

Note) The listed voltage in the output characteristics is the maximum value, and the current is the motor's continuous rated current value.

10-1-3 Spindle drive unit

		Spindle drive unit MDS-CH-SP[ ] Series													
Spindle drive unit type	**MDS-CH-SP[ ]-**	**15**	**37**	**55**	**75**	**110**	**150**	**185**	**220**	**260**	**300**	**370**	**450**	**550**	**750**
Continuous rated output [kW]		0.75	2.2	3.7	5.5	7.5	11	15	18.5	22	26	30	37	45	55
Output Note3	Rated voltage [V]	340VAC													
	Rated current [A]	2.3	7.5	9.0	13	19	25	32	40	49	65	73	87	103	132
Input	Rated voltage [V]	513 to 648VDC													
	Rated current [A]	2.3	7.1	10	15	21	29	38	47	57	72	82	99	119	150
Control power	Voltage [V]	380 to 440VAC (50Hz) / 380 to 480VAC (60Hz) Power fluctuation rate within +6%/-10%													
	Frequency [Hz]	50 / 60Hz Frequency fluctuation within ±3%													
	Current [A]	Max.0.1A													
	Rush current [A]	Max. 18													
	Rush conductivity time [ms]	Max. 6													
Earth leakage current		6 (MAX.15)													
Control method		Sine wave PWM control method													
Braking		Power supply regeneration braking													
Structure		Open (Protection method: IP00)													
Cooling method		Forced air cooling													
Weight [kg]		6.5		6.5			8.5		10.0			15.0	20.0		47.0
Maximum heating value [W]		70	105	145	180	240	315	455	490	645	825	1105	1300	1560	2145
Noise		Less than 55dB													

Note1) [ ] is either blank, or a combination of H and M

Note2) C-axis detector [model: MBE90K and MHE90K] cannot be used with MDS-CH-SP[ ] series.

Note3) The listed voltage in the output characteristics is the maximum value, and the current is the motor's continuous rated current value.

10-1-4 Power supply unit

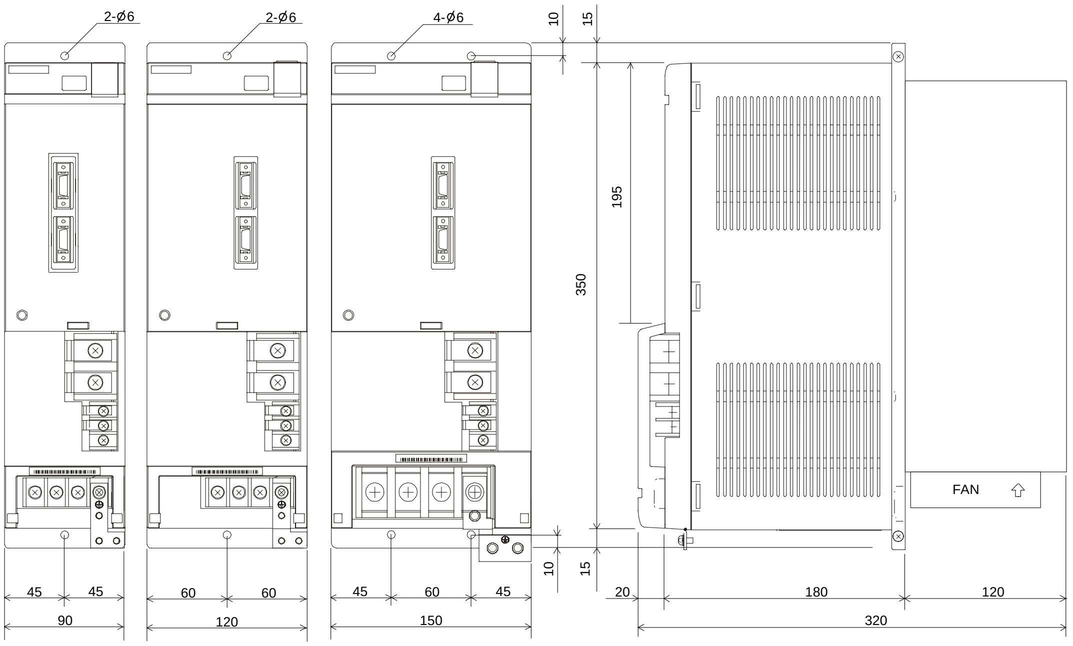
		Power supply unit MDS-CH-CV Series												
Power supply unit type	**MDS-CH-CV-**	**37**	**55**	**75**	**110**	**150**	**185**	**220**	**260**	**300**	**370**	**450**	**550**	**750**
Rated output [kW]		3.7	5.5	7.5	11.0	15.0	18.5	22.0	26.0	30.0	37.0	45.0	55.0	75.0
Power capacity [KVA]		5.3	8.0	11.0	16.0	21.0	28.0	32.0	37.0	43.0	53.0	64.0	78.0	107.0
Input	Rated voltage [V]	380 to 440VAC (50Hz) / 380 to 480VAC (60Hz) Power fluctuation rate within +6%/-10%												
	Frequency [Hz]	50 / 60Hz Frequency fluctuation within ±3%												
	Rated current [A]	5.2	8.7	13	18	26	35	44	52	61	71	87	106	130
Output	Rated voltage [V]	513 to 648VDC												
	Rated current [A]	7.1	10	15	21	29	38	47	57	72	82	99	119	150
Control power	Voltage [V]	380 to 440VAC (50Hz) / 380-480VAC (60Hz) Power fluctuation rate within +6%/-10%												
	Frequency [Hz]	50 / 60Hz Frequency fluctuation within ±3%												
	Current [A]	Max. 0.1												
	Rush current (in contactor ON) [A]	Max. 18										Max. 18 Note (Max. 45)		
	Rush conductivity time (in contactor ON) [ms]	Max. 6										Max. 6 Note (Max. 200)		(Max. 260)
Protective function		Regeneration overvoltage shutdown, overload shutdown, regeneration fault protection, undervoltage/sudden power outage protection, etc												
Structure		Open (Protection method: IP00)												
Cooling method		Forced air cooling												
Weight [kg]		8.5				10.5		12.5				15.0	20.0	24.0
Maximum heating value [W]		55	65	80	125	155	195	210	260	320	400	500	600	850
Noise		Less than 55dB												

Note) The value in the table is rush current and rush current conductivity time when the unit control power is turned ON. When the contactor is turned ON, rush current for charging flows.

10-1-5 Outline dimension drawings

• MDS-CH-CV-37 to 370

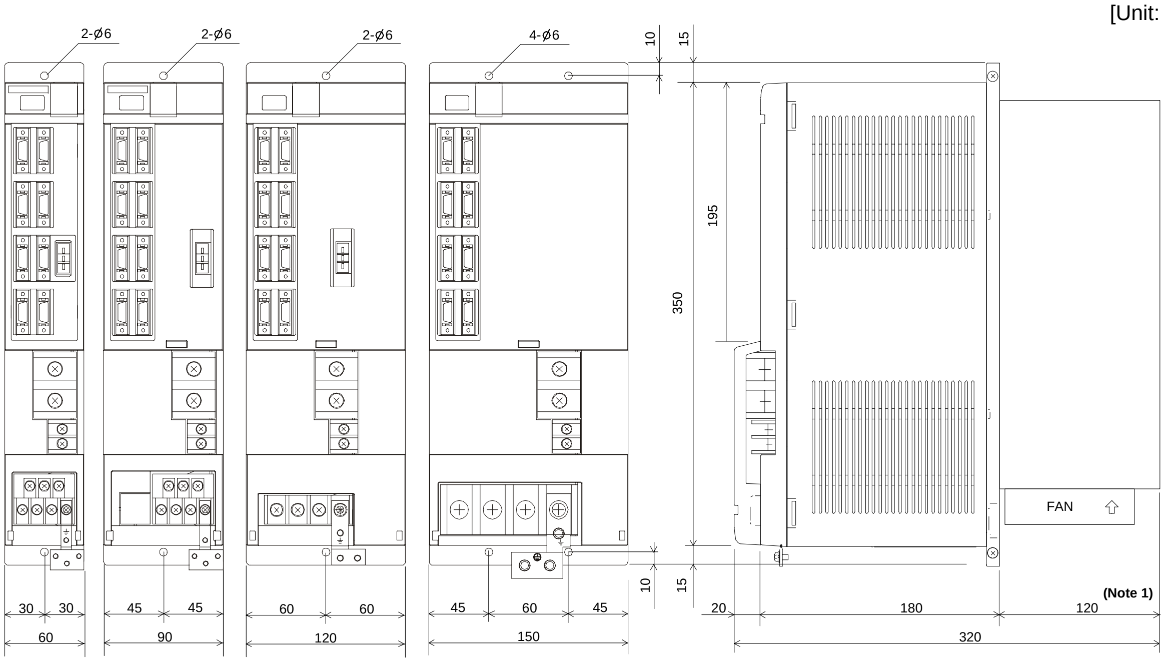
[Unit: mm]



CV-37 to 110 CV-150 to 185 CV-220 to 370

• MDS-CH-SP[ ]-15 to 300/MDS-CH-V1-10 to 150/MDS-CH-V2-0505 to 4535

[Unit: mm]



V1-05 to 35
V2-0505 to 2020

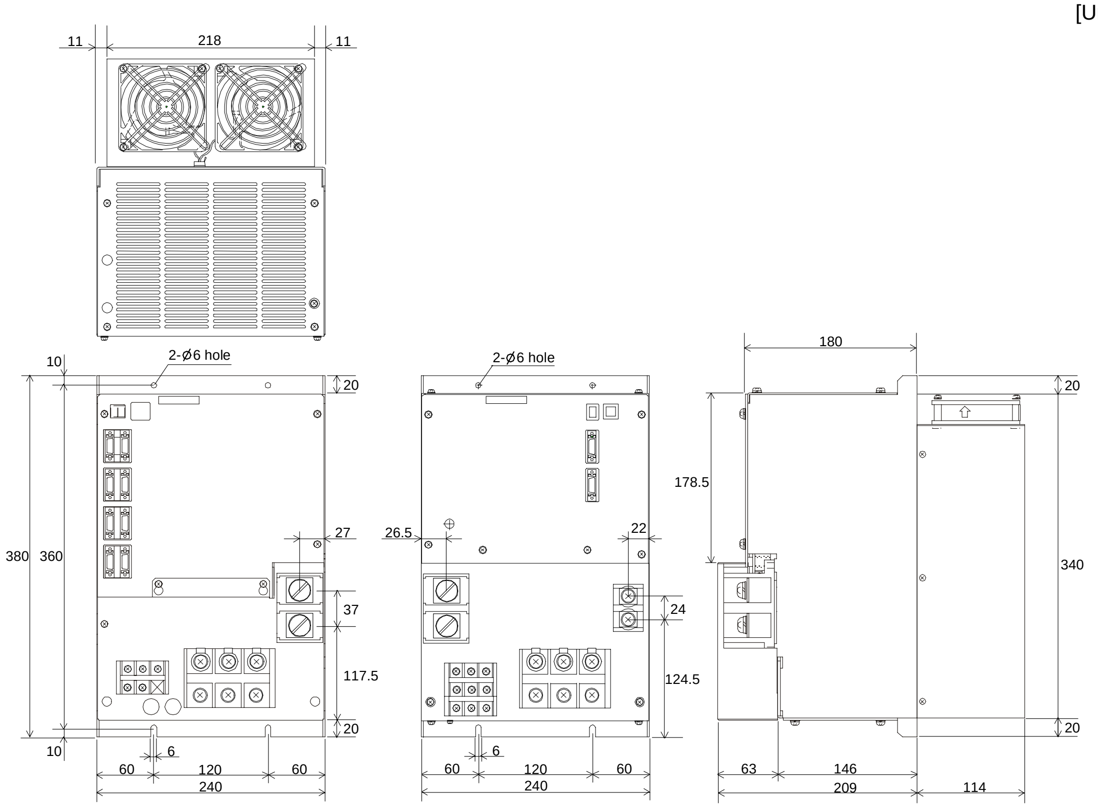
SP[ ]-15 to 110
V1-45
V2-3510 to 4535

SP[ ]-150 to 185
V1-70 to 90

SP[ ]-220 to 300
V1-110 to 150

• MDS-CH-SP[ ]-370/MDS-CH-V1-185/MDS-CH-CV-450

[Unit: mm]

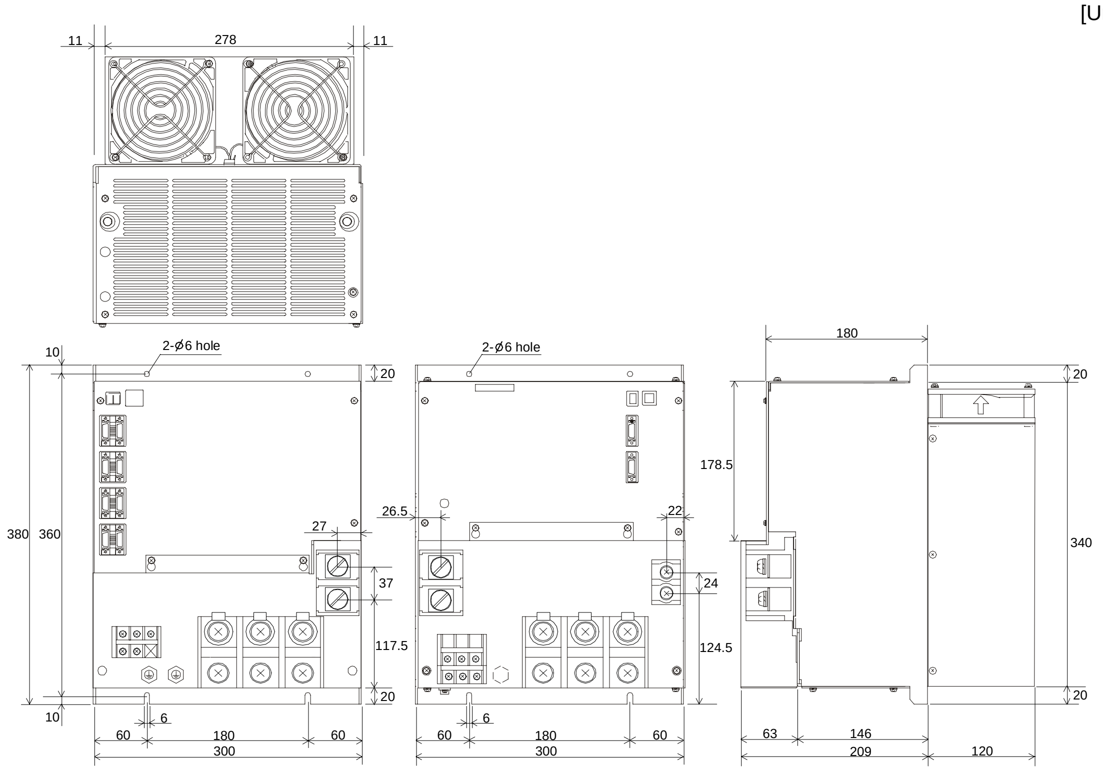


SP[ ]-370　　CV-450

Note) DC connection bar is required. Always install a large capacity drive unit in the left side of power supply unit, and connect with DC connection bar.

• MDS-CH-SP[ ]-450,550/MDS-CH-CV-550

[Unit: mm]

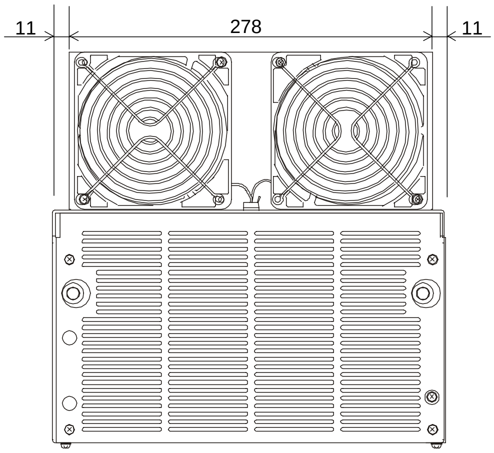


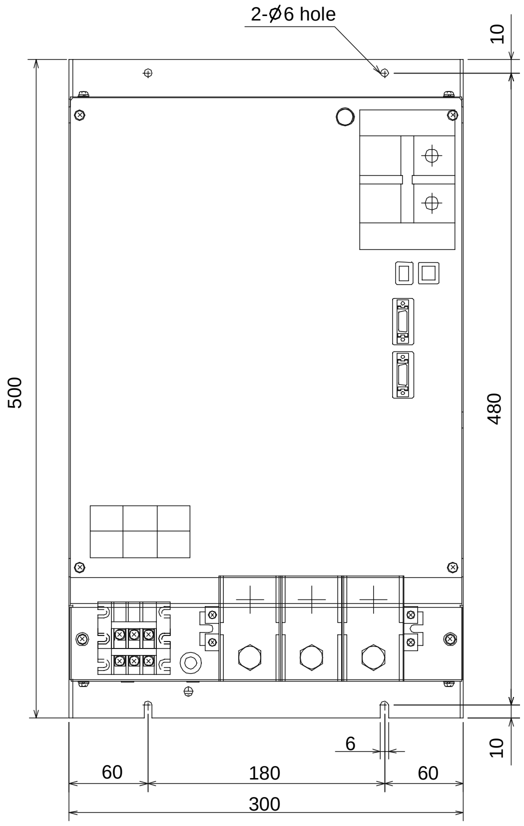
SP[ ]-450,550　　CV-550

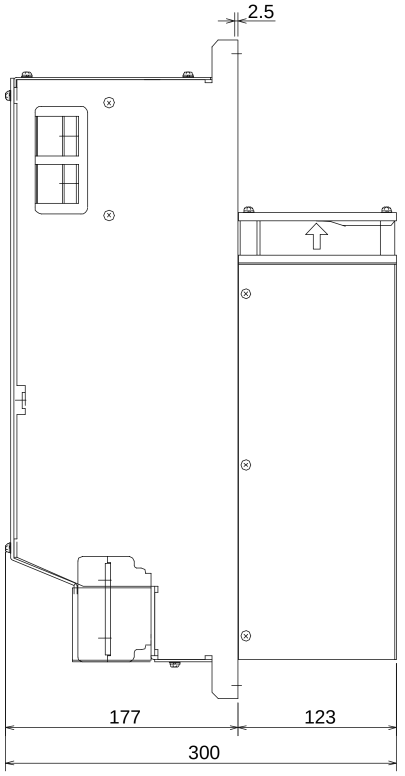
Note) DC connection bar is required. Always install a large capacity drive unit in the left side of power supply unit, and connect with DC connection bar.

• MDS-CH-CV-750

[Unit: mm]



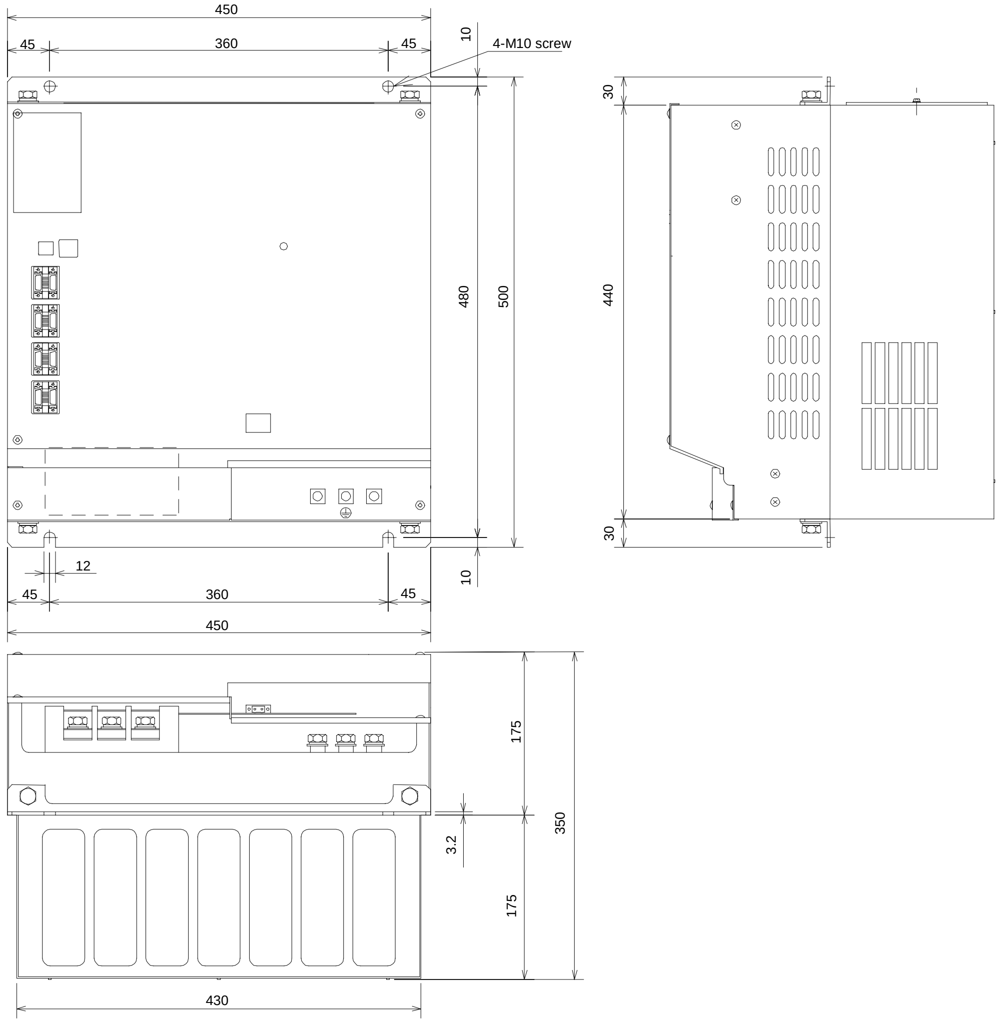




Note) DC connection bar is required. Always install a large capacity drive unit in the left side of power supply unit, and connect with DC connection bar.

• MDS-CH-SP[]-750

[Unit: mm]

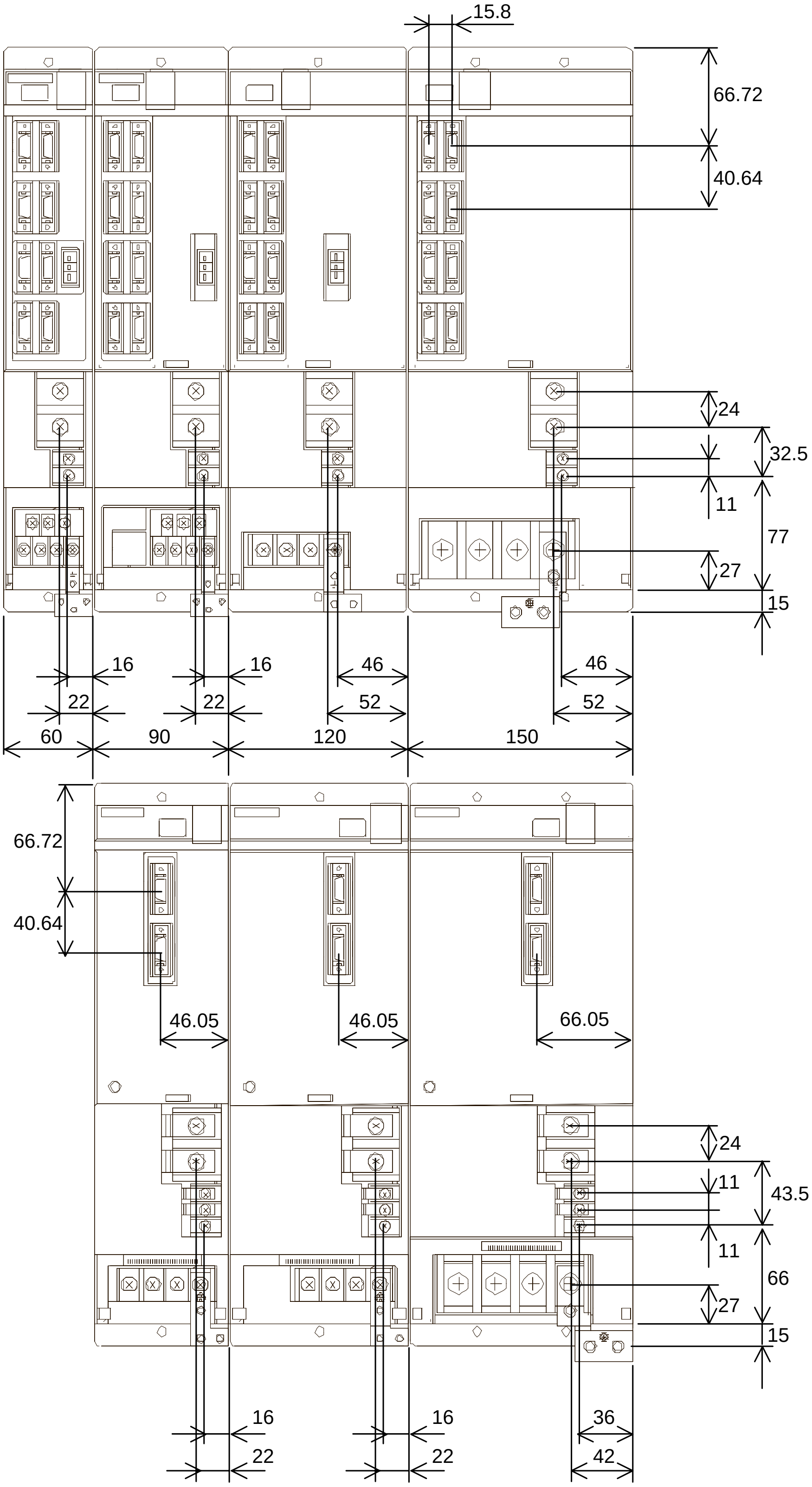


Note) DC connection bar is required. Always install a large capacity drive unit in the left side of power supply unit, and connect with DC connection bar.

10-1-6 Terminal layout

When manufacturing the bar connected between units, refer to the following positional relation of the TE2 and TE3 terminal blocks.

[Unit: mm]



10-1-7 The combination of servo drive unit and a motor

Motor			Drive unit									
	Type		MDS-CH-V1-[_]									
			05	10	20	35	45	70	90	110	150	185
Middle inertia	HC-H[_] 2000 r/min	52	X									
		102		X								
		152			X							
		202			X							
		352				X						
		452					X					
		702						X				
		902							X			
		1102									X	
		1502										X
	HC-H[_] 3000 r/min	53	X									
		103		X								
		153			X							
		203				X						
		353					X					
		453						X				
		703							X			
		903								X		
		1103									X	

Caution 1) "X" indicates the combination of the corresponding motor and unit.
Caution 2) 2-axis integrated servo drive unit (MDS-CH-V2) is the same as the combination of the capacity of MDS-CH-V1.

10-2 Servomotor

10-2-1 Specifications list

Servomotor series			Medium inertia HC Series (Rated speed 2000r/min)									
			INC specification: HC∗∗-E51/-E42, ABS specification: HC∗∗-A51/-A42									
Model Specifica-tions	Servomotor	HC-	H52	H102	H152	H202	H352	H452	H702	H902	J1102	J1502
	Drive unit	MDS-CH-V1/2-	05	10	20	20	35	45	70	90	150	185
Continuous charac-teristics	Rated output	[kW]	0.5	1.0	1.5	2.0	3.5	4.5	7.0	9.0	11.0	15.0
	Rated current	[A]	1.6	2.5	3.8	5.0	8.4	10.6	15.5	18.0	26.6	38.8
	Stall current	[A]	1.9	3.0	4.3	6.3	10.9	15.8	20.2	29.4	55.8	76.8
	Rated torque	[N·m]	2.39	4.78	7.16	9.55	16.7	21.5	33.4	43.0	42.0	71.6
	Stall torque	[N·m]	3.0	6.0	9.0	12.0	22.0	31.9	49.0	70.0	110.0	146.0
Rated rotation speed		[r/min]	2000								2500	2000
Maximum rotation speed		[r/min]	2000								2500	
Maximum current		[A]	8.4	11.4	23.8	23.8	31.8	47.7	63.6	71.0	124.0	160.0
Maximum torque		[N·m]	10.0	19.0	35.3	41.7	58.0	87.5	120	170.0	230.0	280.0
Power rate at continuous rated torque		[kW/s]	13.6	33.8	54.2	30.0	67.0	81.0	117.0	89.8	100.0	104.5
Instantaneous angle acceleration		[rad/s^2]	29500	33600	40200	15900	16000	17700	14500	9500	8700	5860
Motor inertia		[$\times 10^{-4}$ kg·m^2]	4.6	7.4	10.1	30.2	42.9	57.0	95.0	215.0	270.0	550
Motor inertia with brake		[$\times 10^{-4}$ kg·m^2]	5.1	7.9	10.6	30.7	46.3	60.4	99.5	239.0	194.0	–
Maximum motor shaft conversion load inertia rate			High-speed, high-accuracy machine : 3 times or less of motor inertia General machine tool : 5 times or less of motor inertia General machine :10 times or less of motor inertia									
Armature resistance (phase 20°C)		[Ω]	5.8	3.4	2.09	0.68	0.49	0.24	0.173	0.087	0.032	0.0381
Armature inductance (phase 20°C)		[mH]	53.0	32.6	22.0	13.4	8.7	5.3	4.0	1.45	1.09	0.7026
Inductive voltage constant (phase 20°C, ±10%)		[mV/r/min]	67.7	83.4	89.8	74.5	81.2	78.3	91.4	85.5	76.2	69.9
Torque constant (±10%)		[N·m/A]	1.80	2.39	2.16	2.13	2.32	2.24	2.62	2.82	2.18	1.95
Electrical time constant		[ms]	9.1	9.6	10.5	20.0	18.0	22.0	23.0	34.0	34.0	18.4
Mechanical time constant		[ms]	2.1	1.82	1.0	1.4	1.2	0.8	0.72	0.7	0.54	1.65
Thermal time constant		[min]	15	20	25	35	45	50	55	65	70	26.4
Armature coil temperature upper limit degree		[°C]	100									
Motor side detector			Resolution per motor rotation E51/A51: 1,000,000 pulse/rev, E42/A42: 100,000 pulse/rev									
Structure			Fully closed, self-cooling (protective degree: IP65, ~~IP67~~)									
Environ-ment	Ambient temperature		Operation: 0 to 40°C (non freezing), Storage/transportation: –15 to 70°C (non freezing)									
	Ambient humidity		Operation: 20% to 90%RH (non condensing), Storage/transportation: 90%RH max. (non condensing)									
	Atmosphere		Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust									
	Elevation		Operation/storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level									
	Vibration		X: 19.6m/s^2 (2G) Y: 19.6m/s^2 (2G)									
Weight Without/with brake		[kg]	5.1/6.4	7.0/8.5	8.2/9.7	15/16.9	19.1/24.1	23.2/28.2	38.5/44.5	55.4/65.8	78.7/89.1	160/–
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 drive unit.
The HC-H1502 motor does not have brakes.
Use HC-H motor with the 200V input-compliant MDS-CH-V1/V2 Unit. It cannot be used with the conventional MDS-B/C1-V1/V2 Unit.

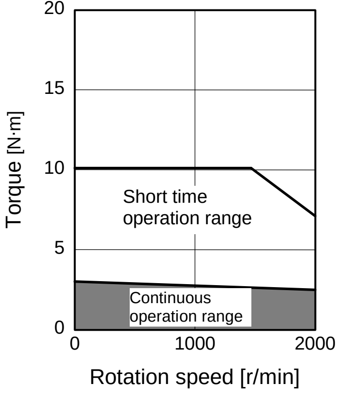
Servomotor series			Medium inertia HC Series (Rated speed 3000r/min)								
			INC specification: HC**-E51/-E42, ABS specification: HC**-A51/-A42								
Model / Specifications	Servomotor	HC-	H53	H103	H153	H203	H353	H453	H703	H903	H1103
	Drive unit	MDS-CH-V1/2-	05	10	20	35	45	70	90	110	150
Continuous characteristics	Rated output	[kW]	0.5	1.0	1.5	2.0	3.5	4.5	7.0	9.0	11.0
	Rated current	[A]	1.7	2.6	3.4	4.8	9.8	10.6	15.0	17.4	28.5
	Stall current	[A]	2.6	4.6	6.1	9.0	17.7	23.6	33.0	41.8	59.6
	Rated torque	[N·m]	1.6	3.3	5.0	6.4	11.2	14.3	22.3	29.1	35.6
	Stall torque	[N·m]	3.0	5.8	9.0	12.0	22.0	31.9	49.0	70.0	110.0
Rated rotation speed		[r/min]	3000								
Maximum rotation speed		[r/min]	3000								
Maximum current		[A]	8.4	14.1	23.8	31.8	47.7	63.6	71.0	106.0	124.0
Maximum torque		[N·m]	8.0	16.7	28.4	36.0	55.9	79.8	105.0	153.0	210.0
Power rate at continuous rated torque		[kW/s]	8.7	14.7	24.8	30.0	67.0	81.0	129.0	86.0	100.0
Instantaneous angle acceleration		[rad/s^2]	22000	26000	32300	15300	15000	16100	13900	8600	7900
Motor inertia		[× 10^{-4} kg·m^2]	4.6	7.4	10.1	30.2	42.9	57.0	87.0	215.0	270.0
Motor inertia with brake		[× 10^{-4} kg·m^2]	5.1	7.9	10.6	30.7	46.3	60.4	91.5	239.0	294.0
Maximum motor shaft conversion load inertia rate			High-speed, high-accuracy machine : 3 times or less of motor inertia General machine tool : 5 times or less of motor inertia General machine :10 times or less of motor inertia								
Armature resistance (phase 20°C)		[Ω]	2.7	1.29	1.06	0.34	0.19	0.12	0.077	0.033	0.032
Armature inductance (phase 20°C)		[mH]	23.4	12.8	10.8	6.4	3.6	2.4	1.8	1.08	1.09
Inductive voltage constant (phase 20°C, ±10%)		[mV/r/min]	44.9	52.5	62.9	51.6	52.1	52.2	61.0	55.9	76.2
Torque constant (±10%)		[N·m/A]	1.28	1.40	1.65	1.48	1.49	1.50	1.75	1.72	2.18
Electrical time constant		[ms]	8.7	5.0	10.2	19.0	19.0	20.0	23.0	33.0	34.0
Mechanical time constant		[ms]	2.3	2.54	1.0	1.4	1.1	0.9	0.7	0.77	0.54
Thermal time constant		[min]	15	20	25	35	45	50	55	65	70
Static friction torque		[N·m]									
Armature coil temperature upper limit degree		[°C]	100								
Motor side detector			Resolution per motor rotation E51/A51: 1,000,000 pulse/rev, E42/A42: 100,000 pulse/rev								
Structure			Fully closed, self-cooling (protective degree: IP65, ~~IP67~~)								
Environment	Ambient temperature		Operation: 0 to 40°C (non freezing), Storage/transportation: –15 to 70°C (non freezing)								
	Ambient humidity		Operation: 20% to 90%RH (non condensing), Storage/transportation: 90%RH max. (non condensing)								
	Atmosphere		Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust								
	Elevation		Operation/storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level								
	Vibration		X: 19.6m/s^2 (2G) Y: 19.6m/s^2 (2G)								
Weight Without/with brake		[kg]	5.1/ 6.4	7.0/ 8.5	8.2/ 9.7	15.0/ 16.9	19.1/ 24.1	23.2/ 28.2	38.5/ 44.5	55.4/ 65.8	78.7/ 89.1
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 drive unit.
A HC-H motor is only for MDS-CH-V1/V2 Unit. It cannot be used for MDS-B/C1-V1/V2 Unit.

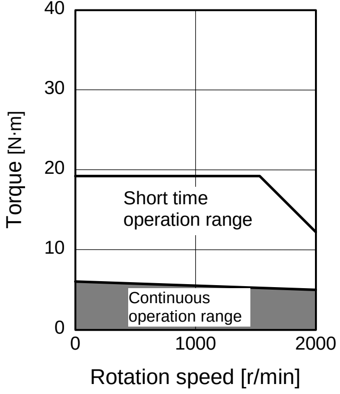
10-2-2 Torque characteristics

(1) HC-H Series

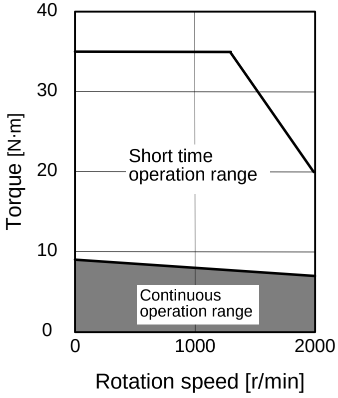
[HC-H52]



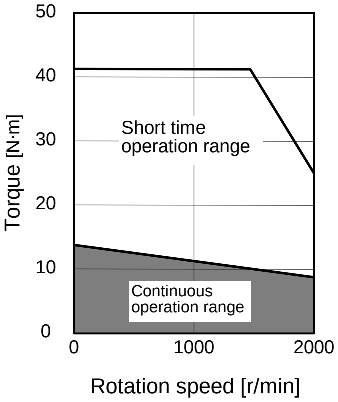
[HC-H102]



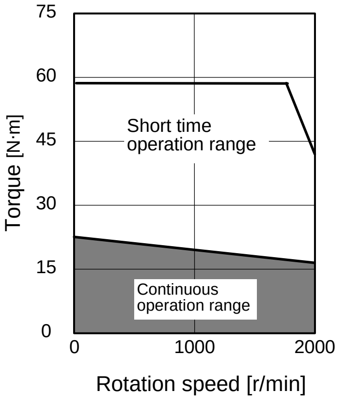
[HC-H152]



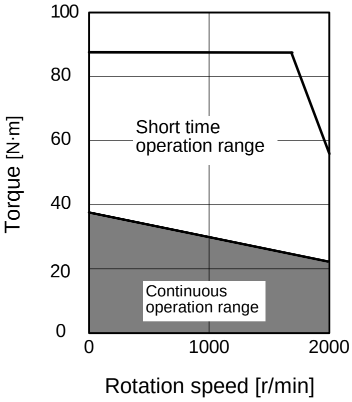
[HC-H202]



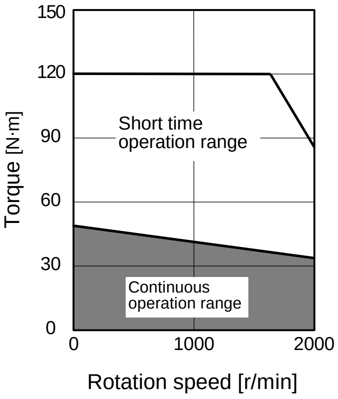
[HC-H352]



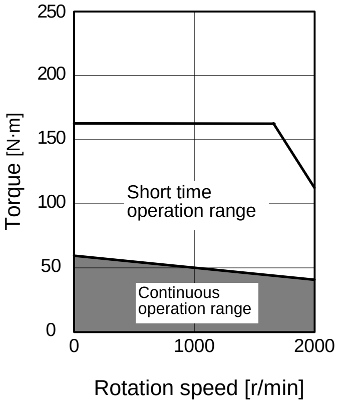
[HC-H452]



[HC-H702]



[HC-H902]



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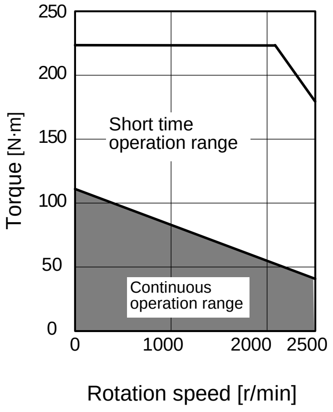
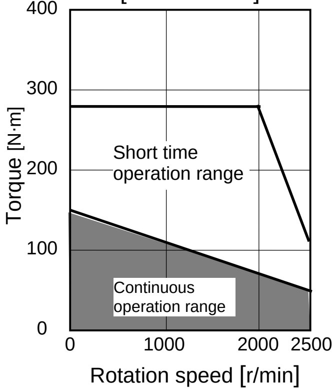
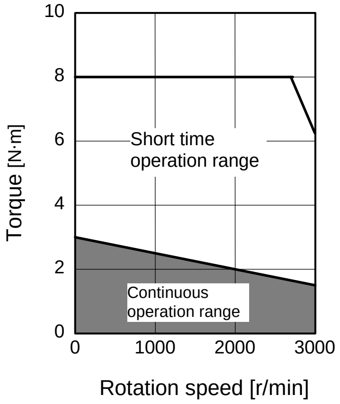


[HC-H1502]

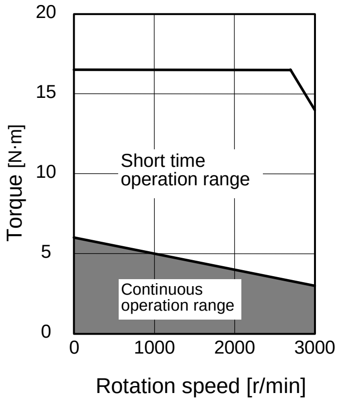


(Note 1) The above graphs show the data for the input voltage of 380VAC. When the input voltage is 380VAC or less, the short time operation range is limited.

[HC-H53]



[HC-H103]



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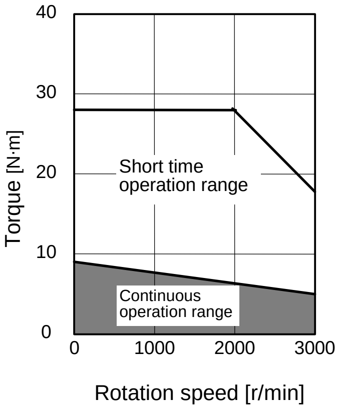
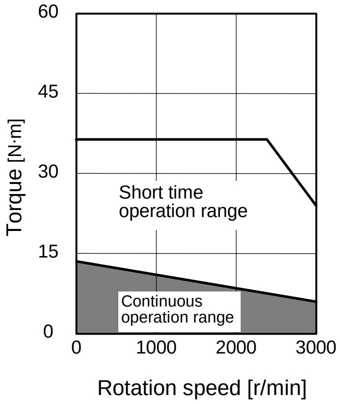
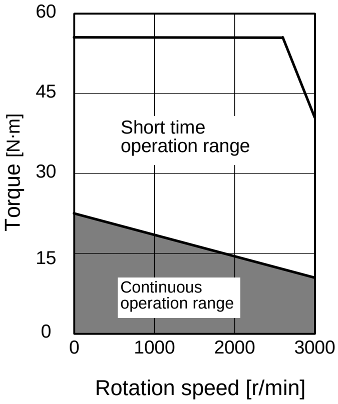


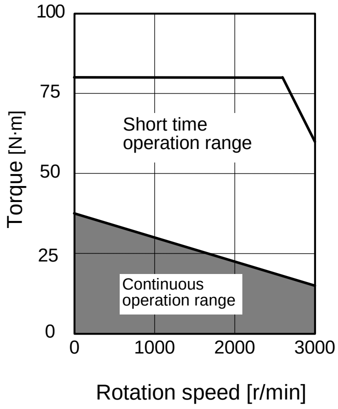
[HC-H203]



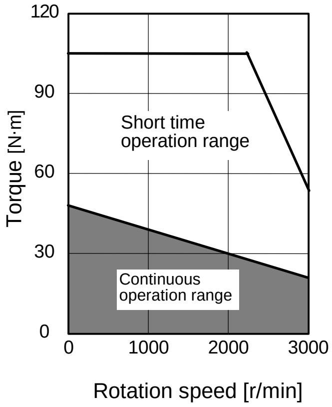
[HC-H353]



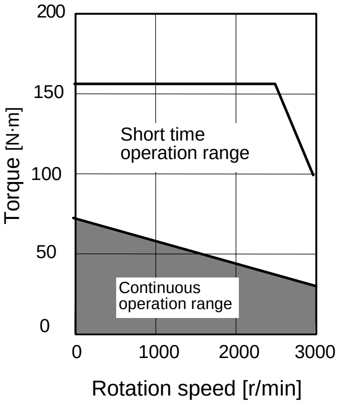
[HC-H453]



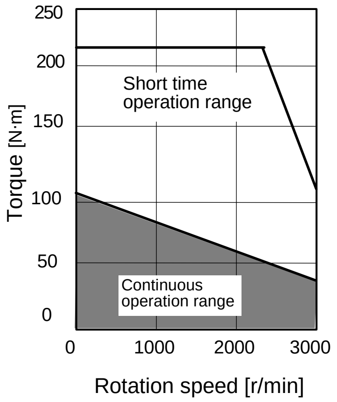
[HC-H703]



[HC-H903]



[HC-H1103]



(Note 1) The above graphs show the data for the input voltage of 380VAC.
When the input voltage is 380VAC or less, the short time operation range is limited.

10-2-3 Model configuration

HC-H 20 3 B S - A51

Series name

Symbol	Rated ouput [kW]
5	0.5
10	1.0
15	1.5
20	2.0
35	3.5
45	4.5
70	7.0
90	9.0
110	11.0
150	15.0

Symbol	Max. speed [r/min.]
2	2000
3	3000

Symbol	Magnetic brakes
	Available
B	Not available

Symbol	Axis end shape
S	Straight axis
T	Tapered shaft

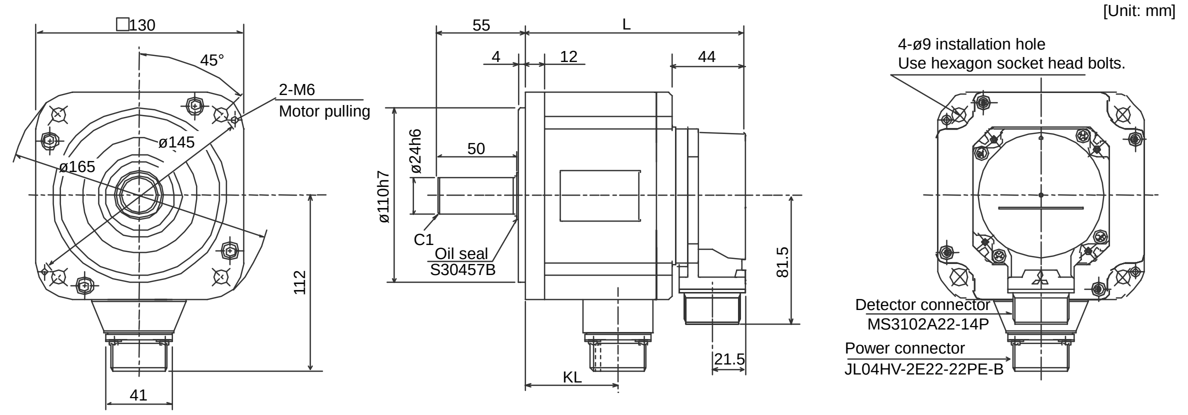
Symbol	Protective structure
	IP65

Symbol	Detector specifications [p/rev]
A42	ABS: 100,000
A51	ABS: 1,000,000
E42	INC: 100,000
E51	INC: 1,000,000

10-2-4 Outline dimension drawings

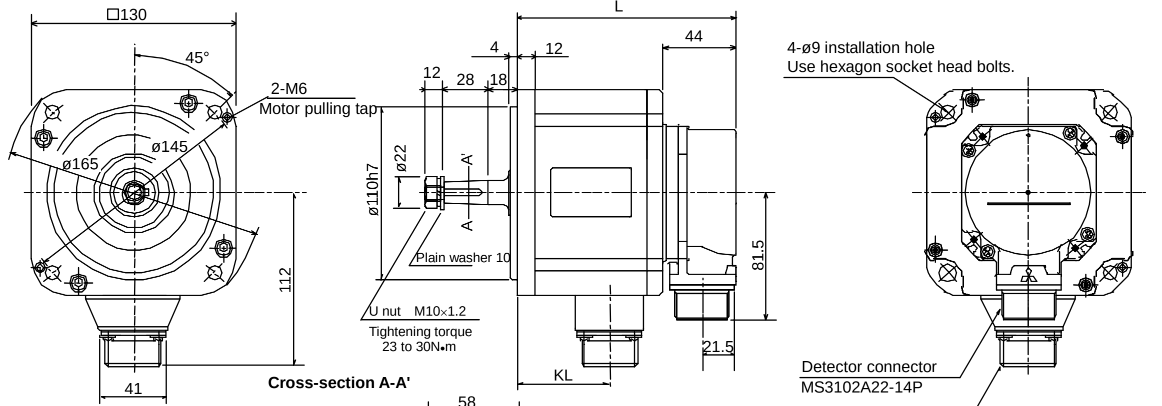
- HC-H52S
- HC-H102S
- HC-H152S
- HC-H53S
- HC-H103S
- HC-H153S

[Unit: mm]

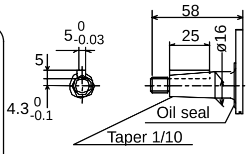


- HC-H52T
- HC-H102T
- HC-H152T
- HC-H53T
- HC-H103T
- HC-H153T

[Unit: mm]

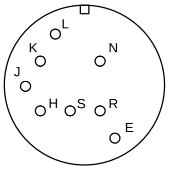


Cross-section A-A'



Detector connector

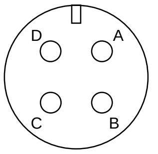
MS3102A22-14P



Pin	CH-V1/V2
A	
B	
C	
D	
E	BT
F	
G	
H	SD
J	$\overline{\text{SD}}$
K	RQ
L	$\overline{\text{RQ}}$
M	
N	SD
P	
R	5G
S	+5V
T	
U	
V	

Power connector (JAE)

JL04HV-2E22-22PE-B

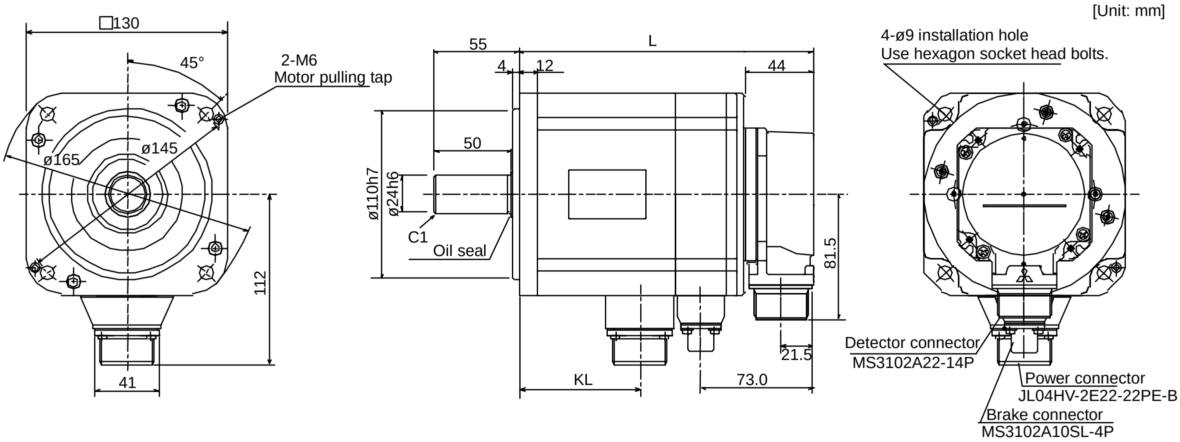


Pin	Name
A	U
B	V
C	W
D	⏚ Ground

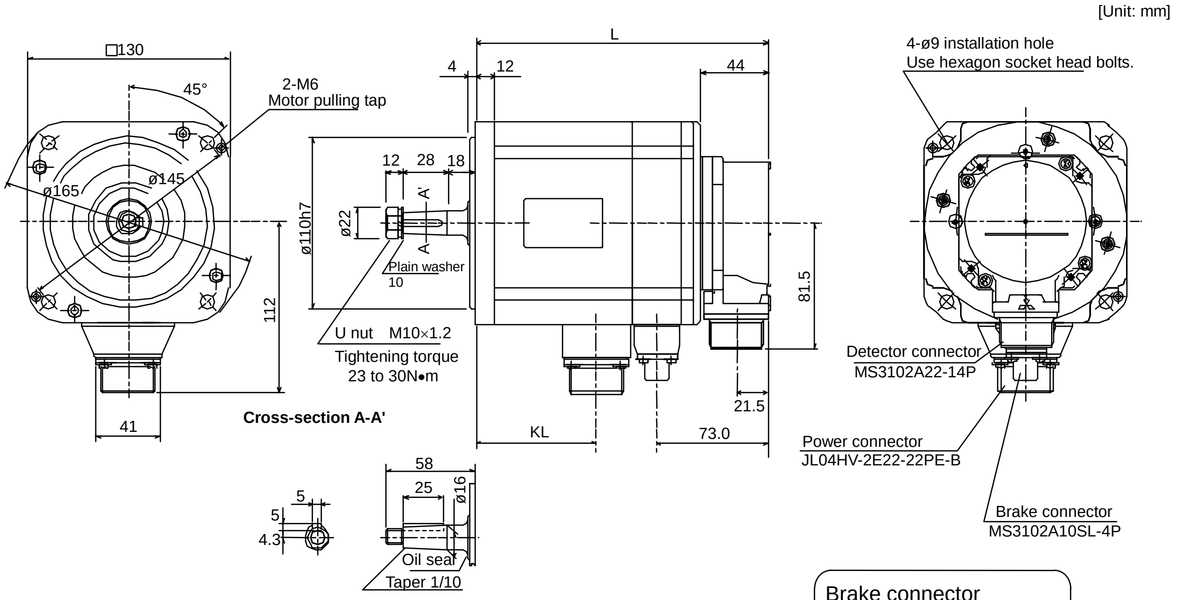
Servomotor model		L	KL
2000 r/min	**3000 r/min**		
HC-H52☐	HC-H53☐	139	59
HC-H102☐	HC-H103☐	158	78
HC-H152☐	HC-H153☐	179	97

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. The detector connector pin assignments are common for all HC-H motors.

- HC-H52BS
- HC-H102BS
- HC-H152BS
- HC-H53BS
- HC-H103BS
- HC-H153BS



- HC-H52BT
- HC-H102BT
- HC-H152BT
- HC-H53BT
- HC-H103BT
- HC-H153BT

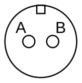


Servomotor model		L	KL
2000 r/min	3000 r/min		
HC-H52B□	HC-H53B□	171	59
HC-H102B□	HC-H103B□	190	78
HC-H152B□	HC-H153B□	209	97

Note: Use a friction coupling (Spun ring, etc.) to connect with the load.

Brake connector

MS3102A10SL-4P

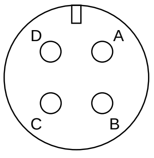


Pin	Name
A	B1
B	B2

There is no need for concern regarding the polarity when supplying 24VDC.

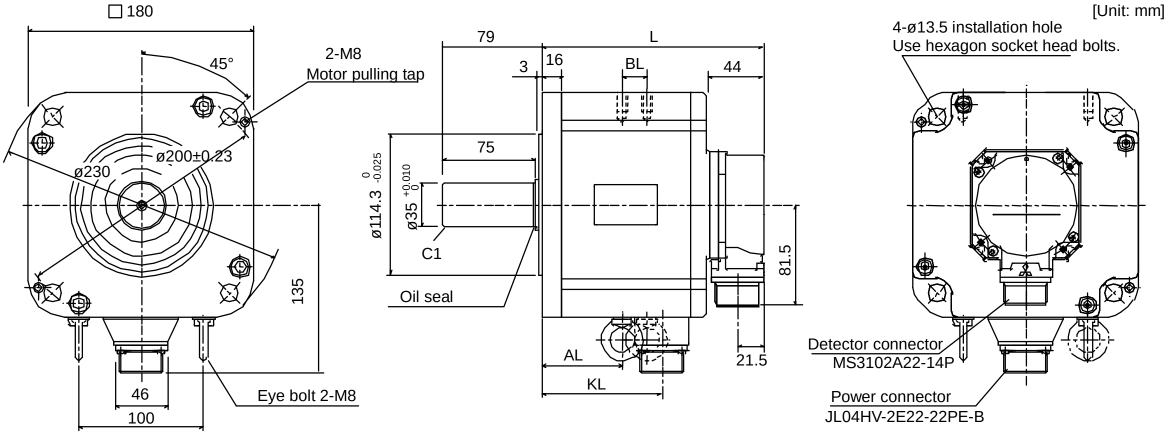
Power connector (JAE)

JL04HV-2E22-22PE-B



Pin	Name
A	U
B	V
C	W
D	⏚Ground

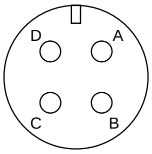
- HC-H202S
- HC-H203S
- HC-H352S
- HC-H353S



Servomotor model		L	KL	AL	BL
2000 r/min	3000 r/min				
HC-H202S	HC-H203S	180	96	64	20
HC-H352S	HC-H353S	203	119	62	45

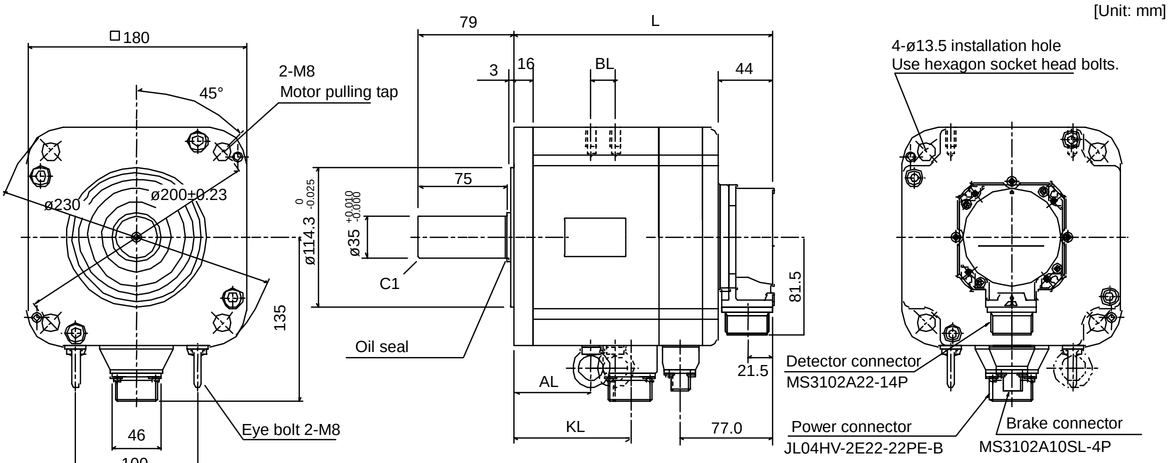
Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. Screw holes for hanging bolt (M8).

Power connector (JAE)
JL04HV-2E22-22PE-B

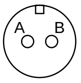


Pin	Name
A	U
B	V
C	W
D	⏚ Ground

- HC-H202BS
- HC-H203BS
- HC-H352BS
- HC-H353BS



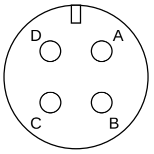
Brake connector
MS3102A10SL-4P



Pin	Name
A	B1
B	B2

There is no need for concern regarding the polarity when supplying 24VDC.

Power connector (JAE)
JL04HV-2E22-22PE-B



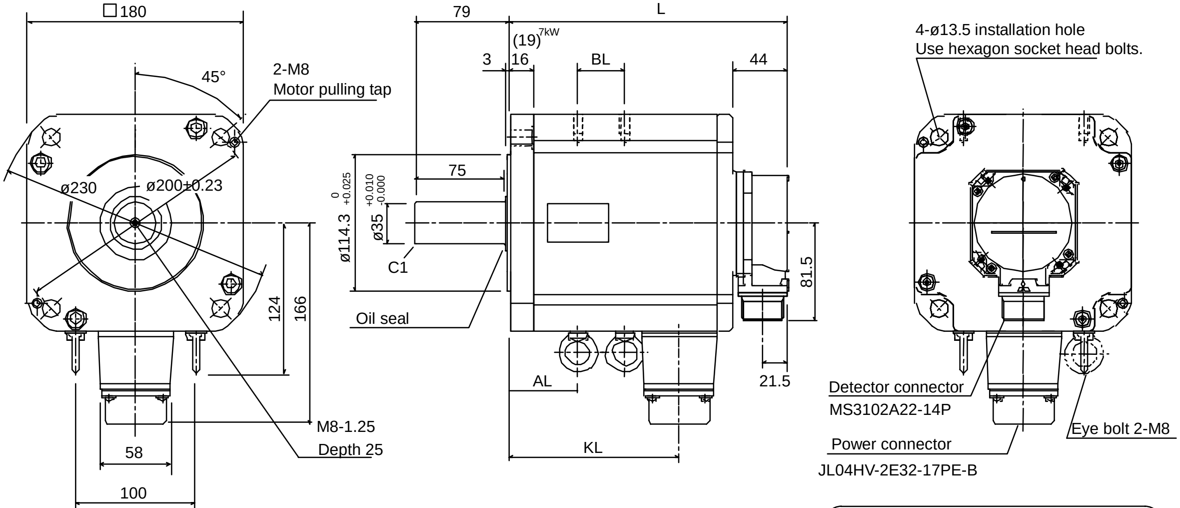
Pin	Name
A	U
B	V
C	W
D	⏚ Ground

Servomotor model		L	KL	AL	BL
2000 r/min	3000 r/min				
HC-H202BS	HC-H203BS	216	96	64	20
HC-H352BS	HC-H353BS	239	119	62	45

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. Screw holes for hanging bolt (M8).

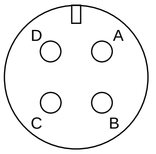
- HC-H452S
- HC-H453S
- HC-H702S
- HC-H703S

[Unit: mm]



Power connector (JAE)

JL04V-2E32-17PE-B



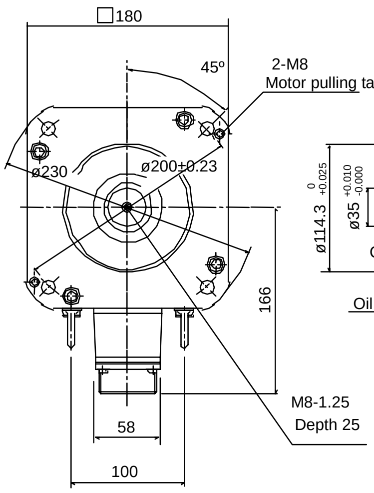
Pin	Name
A	U
B	V
C	W
D	⏚ Ground

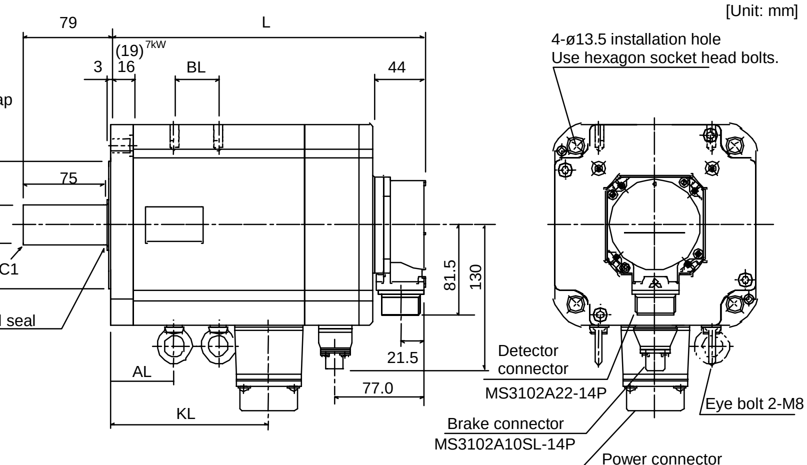
Servomotor model		L	KL	AL	BL
2000 r/min	3000 r/min				
HC-H452S	HC-H453S	234	140	56	39
HC-H702S	HC-H703S	314	220	60	115

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. Screw holes for hanging bolt (M8).

- HC-H452BS
- HC-H453BS
- HC-H702BS
- HC-H703BS

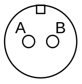
[Unit: mm]





Brake connector

MS3102A10SL-4P

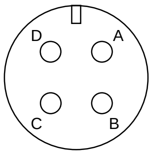


Pin	Name
A	B1
B	B2

There is no need for concern regarding the polarity when supplying 24VDC.

Power connector (JAE)

JL04V-2E32-17PE-B

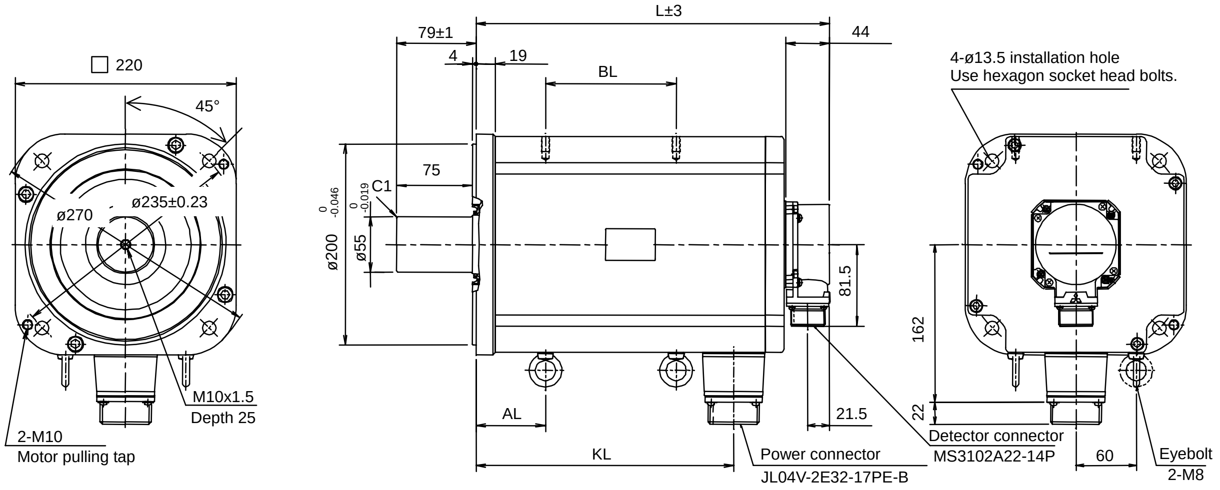


Pin	Name
A	U
B	V
C	W
D	⏚ Ground

Servomotor model		L	KL	AL	BL
2000 r/min	3000 r/min				
HC-H452BS	HC-H453BS	270	140	56	39
HC-H702BS	HC-H703BS	362	220	60	115

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. Screw holes for hanging bolt (M8).

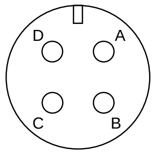
- HC-H902S
- HC-H903S
- HC-H1102S
- HC-H1103S



Servomotor model		L	KL	AL	BL
2000 r/min	3000 r/min				
HC-H902S	HC-H903S	352	256	69	130
HC-H1102S	HC-H1103S	425	329	69	200

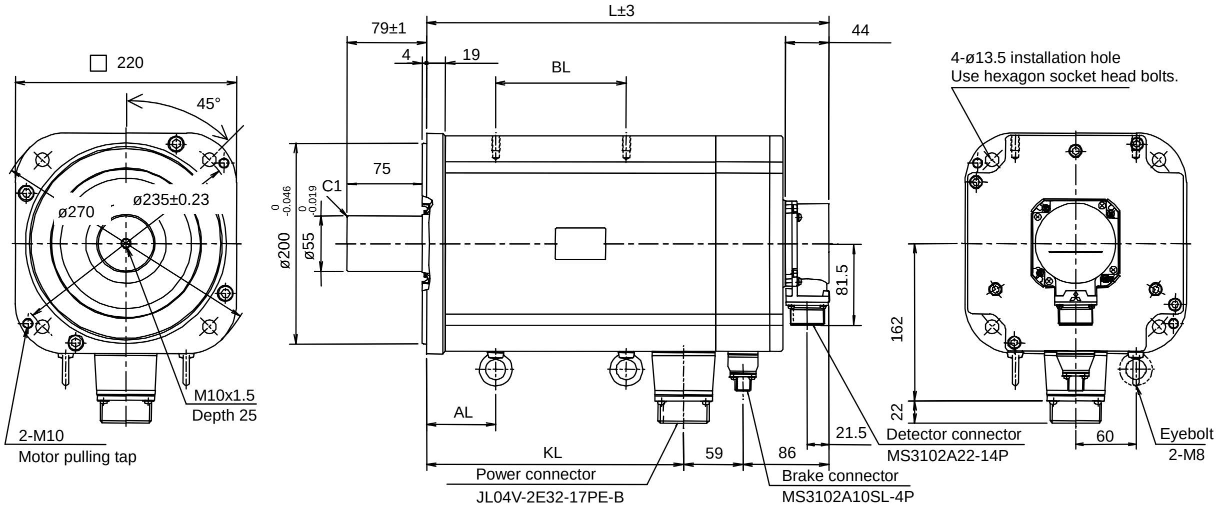
Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. Screw holes for hanging bolt (M8).

Power connector (JAE)
JL04V-2E32-17PE-B

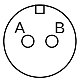


Pin	Name
A	U
B	V
C	W
D	⏚ Ground

- HC-H902BS
- HC-H903BS
- HC-H1102BS
- HC-H1103BS



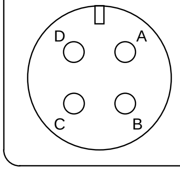
Brake connector
MS3102A10SL-4P



Pin	Name
A	B1
B	B2

There is no need for concern regarding the polarity when supplying 24VDC.

Power connector (JAE)
JL04V-2E32-17PE-B

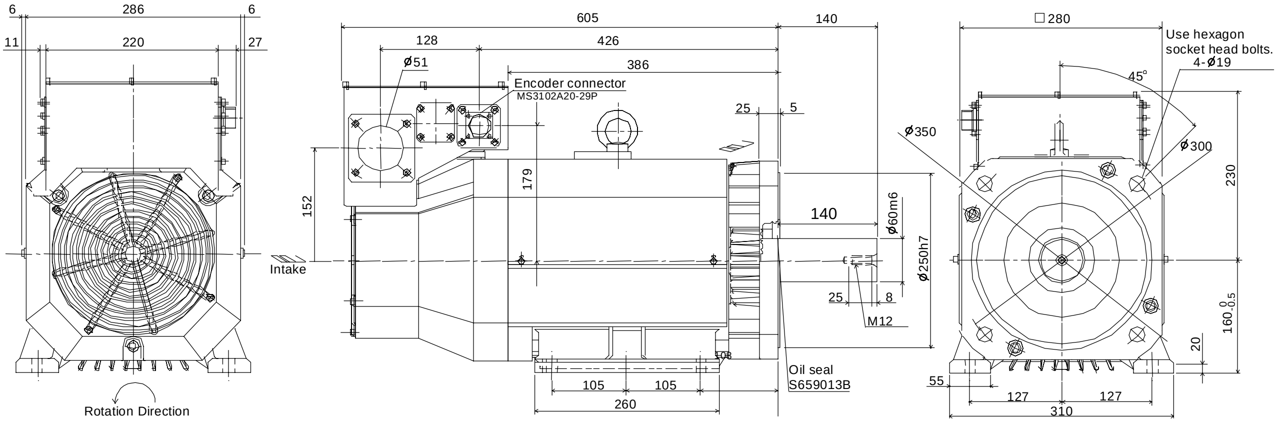


Pin	Name
A	U
B	V
C	W
D	⏚ Ground

Servomotor model		L	KL	AL	BL
2000 r/min	3000 r/min				
HC-H902BS	HC-H903BS	401	256	69	130
HC-H1102BS	HC-H1103BS	474	329	69	200

Note 1. Use a friction coupling (Spun ring, etc.) to connect with the load.
Note 2. Screw holes for hanging bolt (M8).

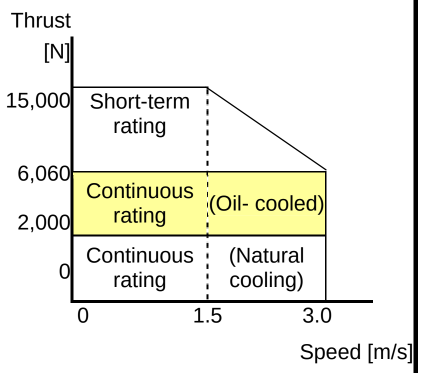
- HC-H1502S


6
286
6
11
220
27
Rotation Direction
Intake
605
140
128
426
ϕ51
386
Encoder connector
MS3102A20-29P
25
5
152
179
140
ϕ60m6
ϕ350
ϕ250h7
25
8
M12
Oil seal
S659013B
105
105
260
□280
Use hexagon
socket head bolts.
4-ϕ19
45°
ϕ300
230
$160^{\ 0}_{-0.5}$
20
55
127
127
310

10-3 Linear servomotor

10-3-1 List of specifications

Type	Primary side	LM-NS5G-60P-X0
	Secondary side	LM-NS50-360-X0
		LM-NS50-540-X0
Electromotive voltage constant (at 20°C)		51.3 [Vrms/(m/s)/phase]
Speed (maximum)		3.0 [m/s]
Thrust/ current (at 20°C)	Continuous rating (natural-cooling type)	2,000 [N] / 14.0 [Arms]
	Continuous rating (oil-cooling type)	6,060[N] / 43.0 [Arms]
	Maximum rating	15,000 [N] / 124 [Arms]
Magnet attraction force		42,000 [N] *1
Drive unit type		MDS-CH-V1-150
Required cooling capacity		5.0 [L/min]
Mass	Primary side	70.0 [kg]
	Secondary side (LM-NS-40-)	15.0 [kg/unit]
		22.0 [kg/unit]

Insulation class		Class F
Coil resistance		1.22 [Ω at 20°C] (U-V, V-W, W-U)
Working ambient temperature		0 to 40 [°C]
Installation place		Indoors
Thrust/speed characteristics *2		
Thermal protector	Type	T145AR3U1 (Matsushita)
	Operation temperature	145 ± 5 [°C]
	Rated voltage/ current	6 [Vdc] / 0.15 [A]
		125 [Vac] / 3 [A]
		250 [Vac] / 2 [A]

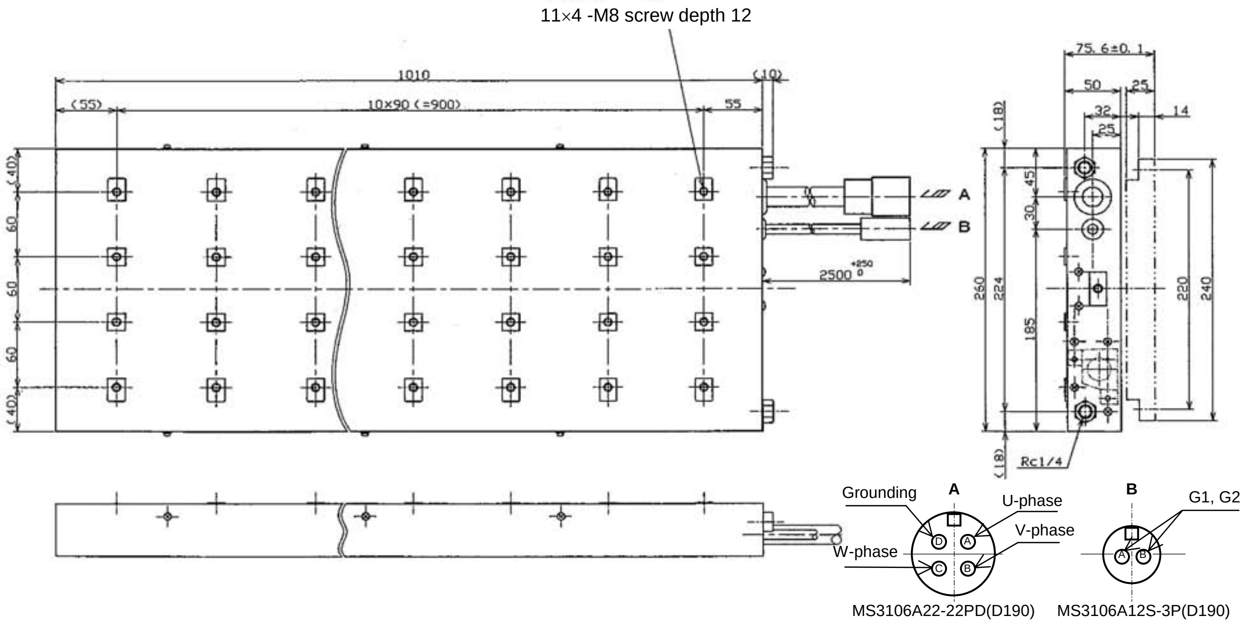
*1) The magnet attraction force is a reference value and is not the specified value.
*2) The continuous thrust when the oil-cooled type is completed stopped is max. 5,000[N].

The linear servomotor protection method is IP00.
Use explosion-proof oil, etc., as necessary.

⚠ CAUTION To ensure correct use, always carefully read the instruction manual and materials enclosed with the motor before starting installation, operation, maintenance or inspections.

10-3-2 Outline dimension drawings

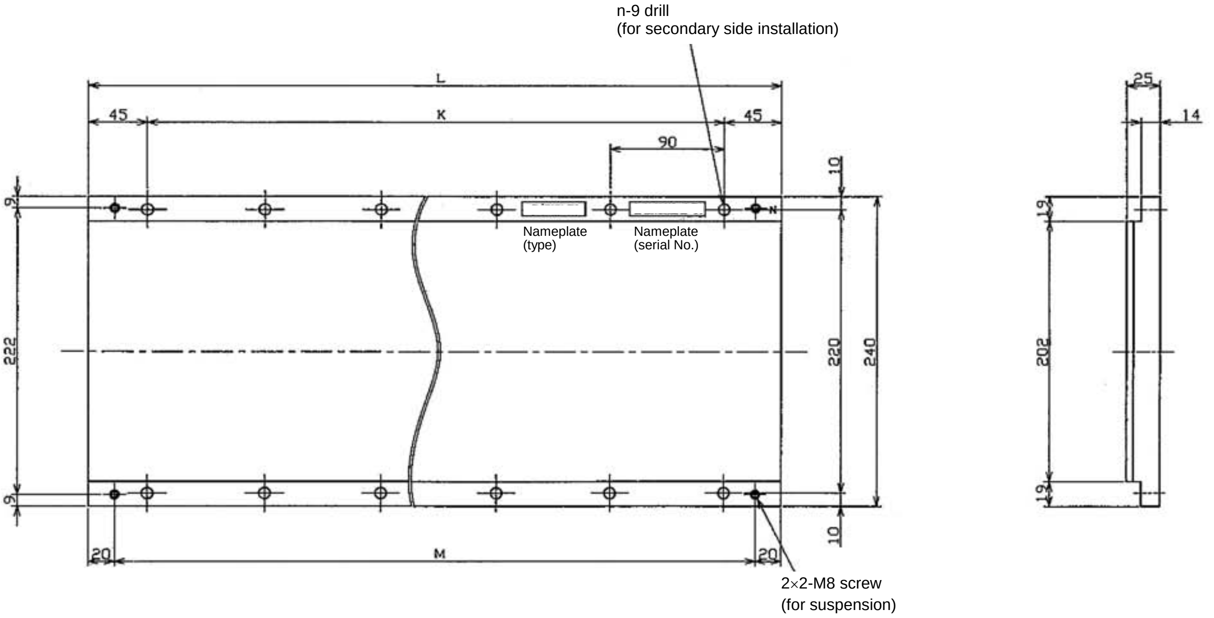
(1) LM-NP5G-60P-X00 (Primary side type)



CAUTION

1. The cable enclosed with the motor is not a movable cable, so fix the cable to the machine side to prevent it from moving. For the moving sections, select a cable that matches the operation speed and bending radius, etc.
2. Use hexagon socket bolts (material SCM435, lower yield point 900[N/mm^2] or more) for installation.

(2) LM-NS50-[_]-X0 (Secondary side type)



Type	Changed dimensions			
	L	K	M	n
LM-NS50-360-X0	360	3 x 90 (=270)	320	4 x 2
LM-NS50-540-X0	540	5 x 90 (=450)	500	6 x 2

CAUTION

Use hexagon socket bolts (material SCM435, lower yield point 900[N/mm^2] or more) for installation.

11. Selection

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11-1 Selection of servomotor

The methods of selecting the HC-H servomotor are explained in this section.
Refer to section 11-2. Selection of linear servomotor for details on selecting the linear servomotor.

11-1-1 Servomotor

It is 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.

Select a medium inertia motor when interpolation precision is required, or for machines having a large load inertia. In general, use HC-H Series motors for the control axis.
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.

Motor shaft conversion recommended load inertia ratio
High-speed, High-accuracy Standards: 3-times or less of motor inertia
General machine tool (interpolation axis): 5-times or less of motor inertia
General machine (non-interpolation): 10-times or less of motor inertia

(2) Rated speed

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.

$$P = 2\pi NT \text{ (W)} \qquad \text{..} \quad (11\text{-}1)$$

N : Motor speed (1/s)
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.

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 drive unit 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 drive unit regeneration methods

Regeneration method	Explanation
1. Capacitor regeneration method	This is a regeneration method for small-capacity drive units. The regeneration energy is charged to the capacitor in the drive unit, 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 capacitor voltage rises too high when regenerating with the capacitor only, the regenerative electrical power is consumed using the resistance. If the regeneration energy is small, it will only be charged to the capacitor. Because regeneration energy becomes heat due to resistance, heat radiation must be considered. In large capacity servo drive units 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 is not converted into heat by the resistor. (Some heat is generated due to the regeneration efficiency to the power supply.) Regeneration control is complicated, but there is no need to install a resistor regeneration unit.

The "3. Power regeneration method" is used for the MDS-CH Series.

POINT

The MDS-CH Series uses a power regeneration method. Connect the regeneration energy to the power line via an AC reactor. If the AC reactor connection is improper, the other peripheral devices may not function correctly.

11-1-3 Motor series characteristics

The HC-H Series servomotor is a medium-inertia compact motor for the MDS-CH Series (400V series input) basic feed axis.

Table 11-3 Motor series characteristics

Motor series	Capacity (rated speed)	Detector resolution	Features
HC-H	0.5 to 11kW (2000r/min) 0.5 to 11kW (3000r/min)	1,000,000p/rev/ 100,000p/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 200V type HC motors 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.

11-1-4 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: Δε

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 : Δεp

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 Δεp. When the motor is actually installed on a machine, the positioning precision Δεp becomes 1 to 2 times the theoretic precision Δε. 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 is added becomes the actual machine positioning precision. For machines requiring accurate positioning precision at the machine, the scale feedback input can be performed.

(3) Surface precision during machining : Δεv

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 detector resolution, the motor's electrical characteristics (torque ripple, etc.) and mechanical characteristics (cogging torque, etc.). In the NC unit feed axis motor (HC-H) 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 : Δεa

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 Δε. Note that the absolute position repeatability Δεa 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 of each motor series. Obtain the precision at the machine during actual operating by adding the machine precision to the value in the table.

Table 11-4 Precision by motor series

Motor series	Control resolution RNG (p/rev)	Theoretic precision $\Delta\varepsilon$	Positioning precision $\Delta\varepsilon p$	Surface precision $\Delta\varepsilon v$	Absolute position repeatability $\Delta\varepsilon a$
HC-H[ ]-A42/E42 (OSA104S2, OSE104S2)	100,000	$\frac{\Delta S}{RNG}$	$\Delta\varepsilon$ to $2\Delta\varepsilon$	$10\Delta\varepsilon$ to $20\Delta\varepsilon$	$\Delta\varepsilon$ to $2\Delta\varepsilon$
HC-H[ ]-A51/E51 (OSA253S2, OSE253S2)	1,000,000				

Table 11-5 Example of precision when movement amount is Δs = 10mm per motor rotation

(Unit: µm)

Motor series	Theoretic precision $\Delta\varepsilon$	Positioning precision $\Delta\varepsilon p$	Surface precision $\Delta\varepsilon v$	Absolute position repeatability $\Delta\varepsilon a$
HC-H[ ]-A42/E42	0.1	0.1 to 0.2	1 to 2	0.1 to 0.2
HC-H[ ]-A51/E51	0.1	0.1 to 0.2	1 to 2	0.1 to 0.2

11-1-5 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 changing the motor series or increasing the motor capacity, if any of the above conditions is not fulfilled.

(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 the servo 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 specifications list, 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.

(2) Short time characteristics

In addition to the continuous operation range, the servomotor has the short time operation 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 specifications 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).

$$ta = \frac{(J_L + J_M) \times N}{95.5 \times (0.8 \times T_{MAX} - T_L)} \ \text{(ms)} \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (11\text{-}2)$$

N : Motor reach speed (r/min)
J_L : Motor shaft conversion load inertia ($kg{\cdot}cm^2$)
J_M : Motor inertia ($kg{\cdot}cm^2$)
T_{MAX} : Maximum motor torque (N·m)
T_L : Motor shaft conversion load (friction, unbalance) torque (N·m)

(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).

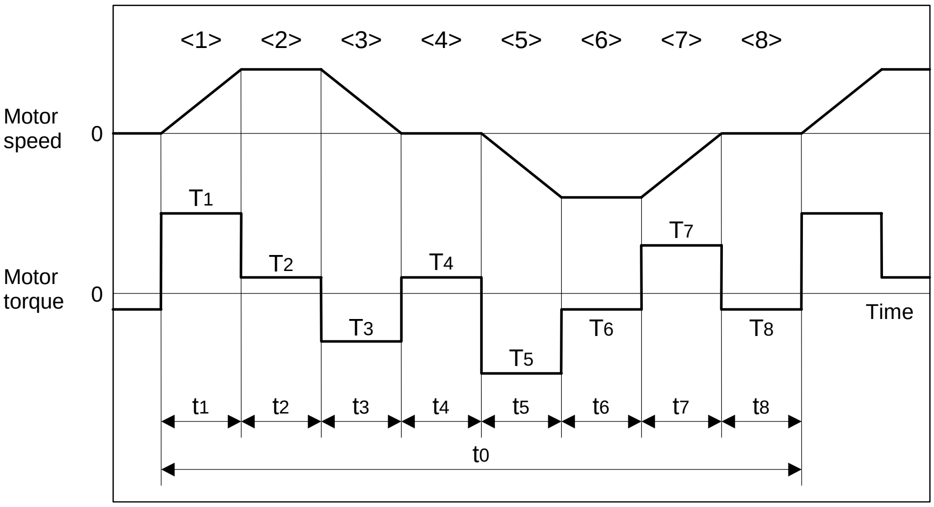


Fig. 11-1 Continuous operation pattern

$$\text{Trms} = \sqrt{\frac{T1^2 \cdot t1 + T2^2 \cdot t2 + T3^2 \cdot t3 + T4^2 \cdot t4 + T5^2 \cdot t5 + T6^2 \cdot t6 + T7^2 \cdot t7 + T8^2 \cdot t8}{t0}} \quad \text{....................} \quad (11\text{-}3)$$

Select a motor so that the continuous effective load torque Trms is 80% or less of the motor stall torque Tst.

$$\text{Trms} \le 0.8 \cdot \text{Tst} \quad \text{...} \quad (11\text{-}4)$$

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)

$$\text{Ta} = \frac{(J_L + J_M) \times N}{95.5 \times ta} \ (\text{N}\cdot\text{m}) \quad \text{...} \quad (11\text{-}5)$$

N	:	Motor reach speed	(r/min)
J_L	:	Motor shaft conversion load inertia	(kg·cm^2)
J_M	:	Motor inertia	(kg·cm^2)
ta	:	Linear acceleration/deceleration time constant	(ms)

(3-1) 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 that this torque is 80% of the maximum torque of the motor.
<2>	(Kinetic friction torque)	–
<3>	(Amount of deceleration torque) + (Kinetic friction torque)	The absolute value of the acceleration torque amount is same as one of the deceleration torque amount. The signs for the amount of acceleration torque and amount of deceleration torque are reversed.
<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.

(3-2) 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.
The torque while the unbalance axis is stopped should be 50% or less than the stall torque (40% or less for V1-185).

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 that 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 absolute value of the acceleration torque amount is same as one of the deceleration torque amount. The signs for the amount of acceleration torque and amount of deceleration torque are reversed.
<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 be applied during an unbalance axis 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.

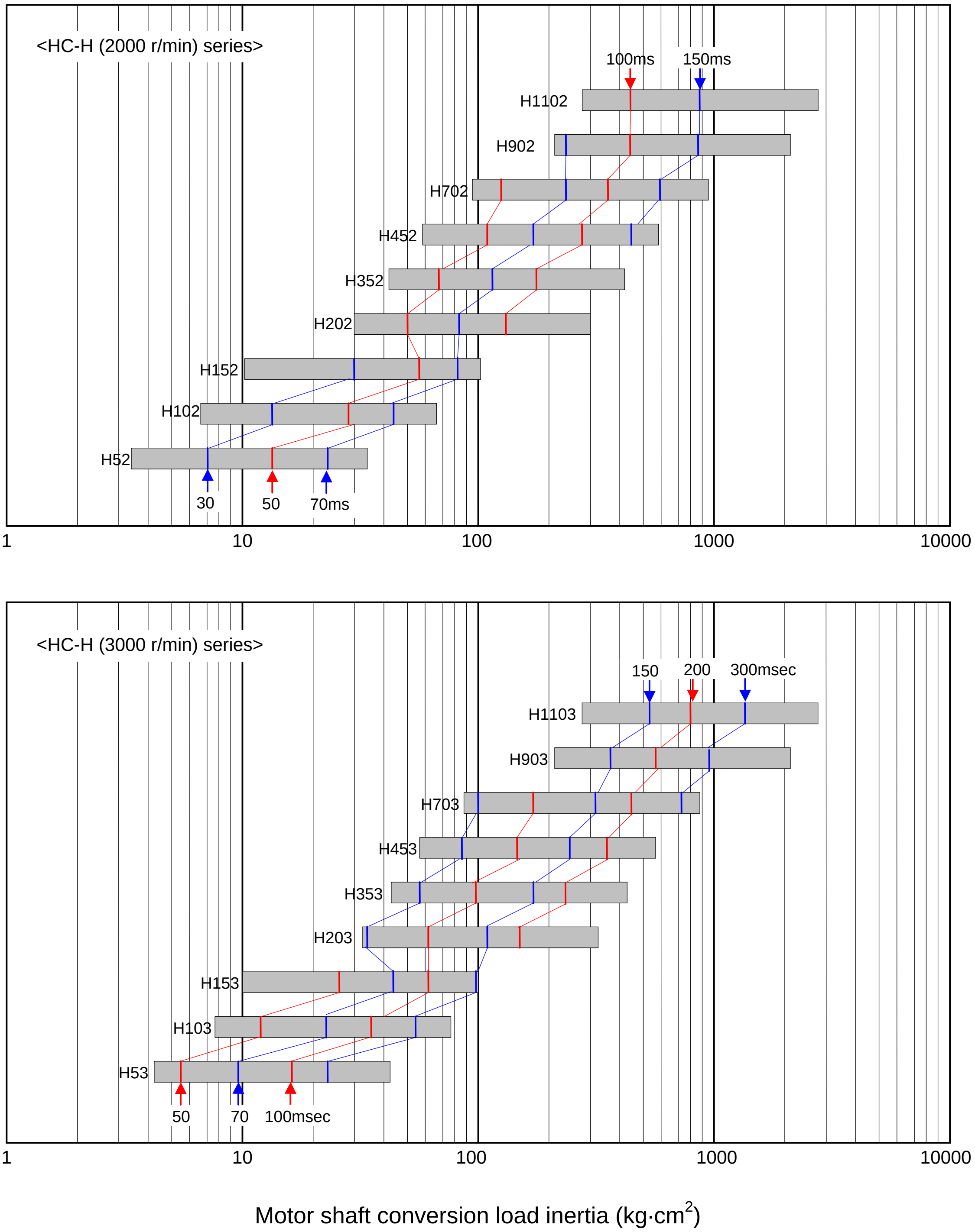


Fig. 11-2 Simple motor capacity selection diagram

⚠ CAUTION The friction torque and unbalanced torque are not considered in the acceleration/ deceleration time constants given in Fig. 11-2.

11-1-6 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·cm^2	–	–	1.6
Secondary side gear inertia	kg·cm^2	–	–	8.1
Motor/ball screw connection section inertia	kg·cm^2	2.0	2.0	–
Weight of moving object installed on the machine (table, etc.)	kg	500	400	400
Weight of standard-added-moving object (workpiece, etc.)	kg	100	100	10
Rapid traverse rate	mm/min	30000	30000	20000
Target acceleration/deceleration time constant	ms	120	120	120
Rapid traverse positioning frequency	times/min	20	20	20
Motor brake		Without	Without	With

(1) Motor selection calculation

The selection calculation is carried out in order using the Z axis as an example.

1) Determine the maximum rotation speed

Select the motor from the 2000r/min system or 3000r/min system

2) 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.

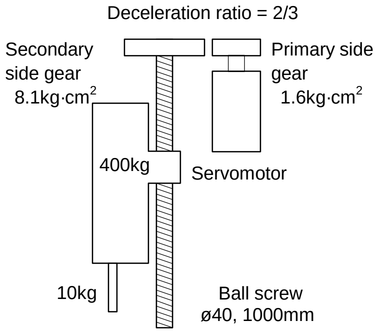


Fig. 11-3 Z axis configuration

- **Primary side rotation load inertia: J_{R1}**
  This is the primary side gear inertia.

$$J_{R1} = 1.6 \text{ (kg·cm}^2\text{)}$$

- **Secondary side 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 "11-1-8 Expressions for load inertia calculation".

$$J_{R2} = J_B + 8.1 = \frac{\pi \cdot \rho \cdot L}{32} D^4 + 8.1 = \frac{\pi \times 7.80 \times 10^{-3} \times 100}{32} \times 4^4 + 8.1$$

$$= 19.6 + 8.1 = 27.7 \text{ (kg·cm}^2\text{)}$$

- **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.

$$J_R = J_{R1} + \left(\frac{2}{3}\right)^2 \times J_{R2} = 1.6 + \frac{4}{9} \times 27.7 = 1.6 + 12.3 = 13.9 \text{ (kg·cm}^2\text{)}$$

- **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 movement increment per motor rotation.
  Refer to section "11-1-8 Expressions for load inertia calculation".

$$J_T = W \cdot \left(\frac{\Delta S}{20\pi}\right)^2 = (400 + 10) \cdot \left(\frac{10 \times 2}{20\pi \times 3}\right)^2 = 4.6 \text{ (kg·cm}^2\text{)}$$

- **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·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.

3) 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 "11-1-7 Motor shaft conversion load torque".

$$T_U = \frac{(W_1 - W_2) \cdot g \cdot \Delta S}{2 \times 10^3 \pi \cdot \eta} = \frac{(410 - 0) \times 9.8 \times 10 \times 2}{2 \times 10^3 \pi \times 1 \times 3} = 4.3 \text{ (N·m)}$$

4) 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 "11-1-7 Motor shaft conversion load torque".

$$T_F = \frac{F \cdot \Delta S}{2 \times 10^3 \pi \cdot \eta} = \frac{\mu \cdot W \cdot g \cdot \Delta S}{2 \times 10^3 \pi \cdot \eta} = \frac{0.02 \times 410 \times 9.8 \times 10 \times 2}{2 \times 10^3 \pi \times 1 \times 3} = 0.09 \text{ (N·m)}$$

5) Selecting the appropriate motor from the load inertia ratio

Because it is a machine tool, the HC-H Motor Series is required for the control precision, 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 HC-H[ ]B Series because a motor with a brake is required. The load inertia for all the HC-H53B to HC-H153B 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·cm^2)	Load inertia (kg·cm^2)	Load inertia magnification	Judgment
HC-H53B	8.6	18.5	2.15	○
HC-H103B	15.7	18.5	1.18	○
HC-H153B	22.0	18.5	0.84	○

6) 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 120ms.

$$\text{HC53B} \quad : ta = \frac{(J_L + J_M) \times N}{95.5 \times (0.8 \times T_{MAX} - T_U - T_F)} = \frac{(18.5 + 8.6) \times 3000}{95.5 \times (0.8 \times 8.82 - 4.3 - 0.09)} = 320.5 \text{ (ms)}$$

$$\text{HC103B} : ta = \frac{(J_L + J_M) \times N}{95.5 \times (0.8 \times T_{MAX} - T_U - T_F)} = \frac{(18.5 + 15.7) \times 3000}{95.5 \times (0.8 \times 16.7 - 4.3 - 0.09)} = 119.9 \text{ (ms)}$$

$$\text{HC153B} : ta = \frac{(J_L + J_M) \times N}{95.5 \times (0.8 \times T_{MAX} - T_U - T_F)} = \frac{(18.5 + 22.0) \times 3000}{95.5 \times (0.8 \times 28.4 - 4.3 - 0.09)} = 69.4 \text{ (ms)}$$

The motors that satisfy the conditions from the calculation results above are the HC-H103B and HC-H153B as shown below.

Motor type	Maximum torque (N·m)	Total inertia (kg·cm^2)	Acceleration/ deceleration time constant [ms]	Judgment
HC-H53B	8.82	27.1	320.5	×
HC-H103B	16.7	34.2	119.9	○
HC-H153B	28.4	40.5	69.4	○

7) 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 stopped torque during an upward stop.

The unbalance axis torque during a stop should be 50% or less of the stall torque. This is one of the references for motor selection. As shown in the following table, the only motor that satisfies this reference is HC-H153B. From the judgment in steps (4) to (6) it is the appropriate motor with Z axis.

Motor type	**Stall torque (N·m)**	**Torque during stop T_U+T_F (kg·cm^2)**	**Load rate (%)**	**Judgment**	**Explanation**
HC-H53B	2.9	4.39	151.4	×	An overload alarm occurs from just holding.
HC-H103B	5.8	4.39	75.7	×	There is no allowance for an acceleration/ deceleration operation.
HC-H153B	9.0	4.39	48.8	○	The torque during stop should be 50% or less.

(2) 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 drive unit	MDS-CH-V1-20
Servomotor	HC-H153B[ ]

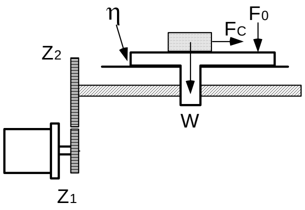
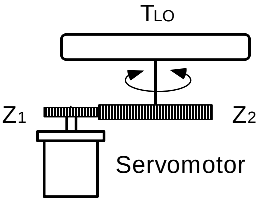
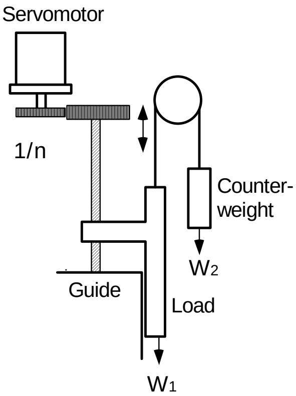
The [ ] in the motor model will be decided based on separate machine specifications such as motor shaft shape and absolute position system.

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·cm^2	–	–	1.6
Secondary side gear inertia	kg·cm^2	–	–	8.1
Motor/ball screw connection section inertia	kg·cm^2	2.0	2.0	–
Weight of moving object installed on the machine (table, etc.)	kg	500	400	400
Weight of standard-added-moving object (workpiece, etc.)	kg	100	100	10
Rapid traverse rate	mm/min	30000	30000	20000
Target acceleration/deceleration time constant	ms	120	120	120
Rapid traverse positioning frequency	times/min	20	20	20
Motor brake		Without	Without	With
Motor shaft conversion rotation load inertia	kg·cm^2	19.6	17.7	13.9
Motor shaft conversion linear movement load inertia	kg·cm^2	15.2	12.7	4.6
Motor shaft conversion total load inertia	kg·cm^2	34.8	30.3	18.5
Motor inertia	kg·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	ms	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
Servo drive unit model		MDS-CH-V1-10	MDS-CH-V1-10	MDS-CH-V1-20
Servomotor model		HC-H103[ ]	HC-H103[ ]	HC-H153B[ ]

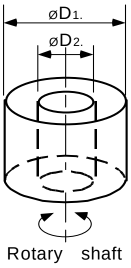
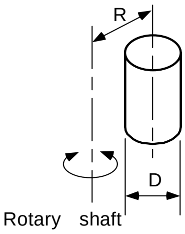
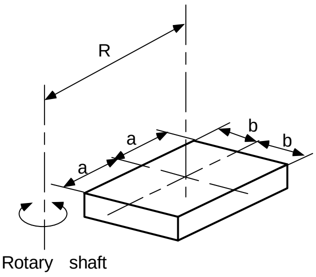
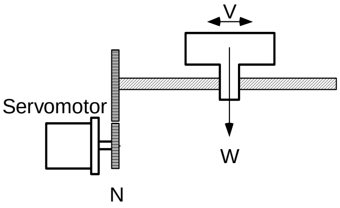
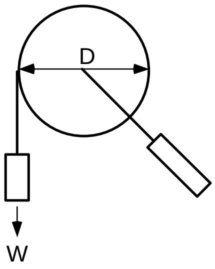
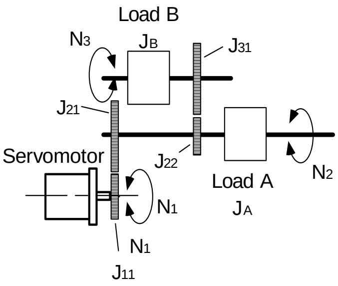
11-1-7 Motor shaft conversion load torque

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 the machine that moves linearly (N) η : Drive system efficiency V : Speed of object that moves linearly (mm/min) N : Motor speed (r/min) ΔS : Object movement amount per motor rotation (mm) Z1, Z2 : Deceleration ratio F in the above expression is obtained from the lower expression when the table is moved as shown on the left. $F = F_C + \mu (W \cdot g + F_0)$ F_C : 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 = 9.8 (m/s^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·m) 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_L : Load torque (N·m) T_U : Unbalanced torque (N·m) T_F : Friction torque on moving section (N·m) $T_U = \frac{(W_1 - W_2) \cdot g}{2 \times 10^3\pi\eta} \cdot \left(\frac{V}{N} \right) = \frac{(W_1 - W_2) \cdot g \cdot \Delta S}{2 \times 10^3\pi\eta}$ $T_F = \frac{\mu \cdot (W_1 + W_2) \cdot g \cdot \Delta S}{2 \times 10^3\pi\eta}$ W_1 : Load weight (kg) W_2 : Counterweight weight (kg) η : Drive system efficiency g : Gravitational acceleration = 9.8 (m/s^2) V : Speed of object that moves linearly (mm/min) N : Motor speed (r/min) ΔS : Object movement amount per motor rotation (mm) μ : Friction coefficient

11-1-8 Expressions for load inertia calculation

The calculation method for a representative load inertia is shown.

Type	Mechanism	Calculation expression
Cylinder	Rotary shaft is cylinder center 	$J_L = \frac{\pi\cdot\rho\cdot L}{32}\cdot(D_1^4 - D_2^4) = \frac{W}{8}\cdot(D_1^2 - D_2^2)$ J_L : Load inertia [kg·cm^2] ρ : Density of cylinder material [kg·cm^3] 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]
	When rotary shaft and cylinder shaft are deviated 	$J_L = \frac{W}{8}\cdot(D^2 + 8R^2)$ 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]
Column		$J_L = W\left(\frac{a^2 + b^2}{3} + R^2\right)$ J_L : Load inertia [kg·cm^2] W : Weight of cylinder [kg] a.b.R : Left diagram [cm]
Object that moves linearly		$J_L = W\left(\frac{1}{2\pi N}\cdot\frac{V}{10}\right)^2 = W\left(\frac{\Delta S}{20\pi}\right)^2$ J_L : Load inertia [kg·cm^2] W : Weight of object that moves linearly [kg] N : Motor speed [r/min]
Suspended object		$J_L = W\left(\frac{D}{2}\right)^2 + J_P$ J_L : Load inertia [kg·cm^2] W : Object weight [kg] D : Diameter of pulley [cm] J_P : Inertia of pulley [kg·cm^2]
Converted load		$J_L = J_{11} + (J_{21} + J_{22} + J_A)\cdot\left(\frac{N_2}{N_1}\right)^2 + (J_{31} + J_B)\cdot\left(\frac{N_3}{N_1}\right)^2$ 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]

11-1-9 Other precautions

The following precautions apply when selecting the servomotor.

⚠ CAUTION

- The maximum torque that can be used with the motor is limited.
  Select a torque at 80% of each motor's specifications.
- For the parallel drive axis calculate the maximum load inertia with the conditions establishing the maximum load for each axis.
  (If the load inertia fluctuates by 30% or more between the parallel driven axes, the position and speed gain may be limited.)
- The unbalanced torque caused by gravity is calculated with the (unbalanced torque element when stopped) + (frictional torque).
  Select a torque within 50% of the motor stall torque in this case.

A different load is applied on the master and slave axes due to the movement of the workpiece mounted on the X axis.

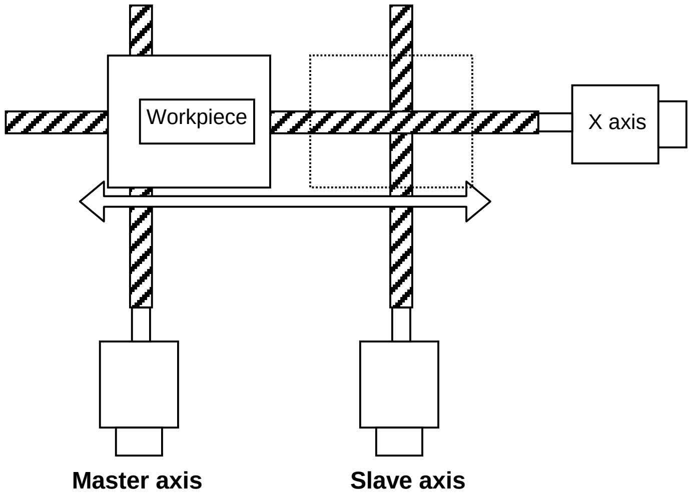


Fig.: For parallel drive system (Example)

11-2 Selection of linear servomotor

The linear servomotor must be selected according to the purpose of the machine in which it is installed. If the installed machine and linear servomotor do not match, the motor's performance will not be utilized to the fullest, and it will be difficult to adjust the servo parameter. Read through this section to fully understand the characteristics of the linear servomotor, and select the correct motor.

11-2-1 Maximum feedrate

The maximum feedrate for the LM-N Series linear servomotor is 120m/min. However, there are systems that cannot reach the maximum speed 120m/min because of the linear scale being used. Refer to the section "10-3 Linear servomotor" for the main systems and possible maximum feedrates.

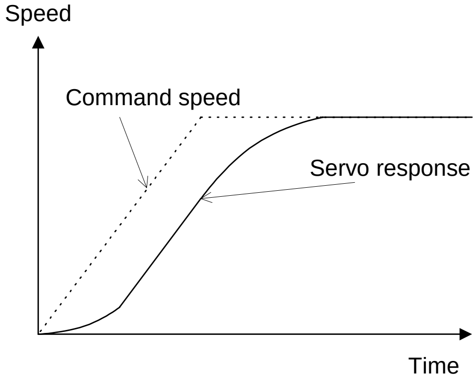
11-2-2 Maximum thrust

The linear servomotor has an output range for the continuous thrust that can be used only for short times such as acceleration/deceleration. If the motor is a natural-cooled type motor, a thrust that is approx. 6-fold can be output. For an oil-cooled type motor, a thrust that is approx. 3-fold can be output. The maximum linear motor thrust required for acceleration/deceleration can be approximated using the machine specifications and expression (3-1). Select the linear servomotor based on these results.

$$\text{Fmax} = (\text{M} \times \text{a} + \text{Ff}\,) \times 1.2 \qquad \text{..} \qquad (3\text{-}1)$$

Fmax : Maximum motor thrust (N)
M : Movable mass (including motor's moving sections) (kg)
a : Acceleration during acceleration/deceleration (m/s^2)
Ff : Load force (including cutting force, friction and unbalance force) (N)

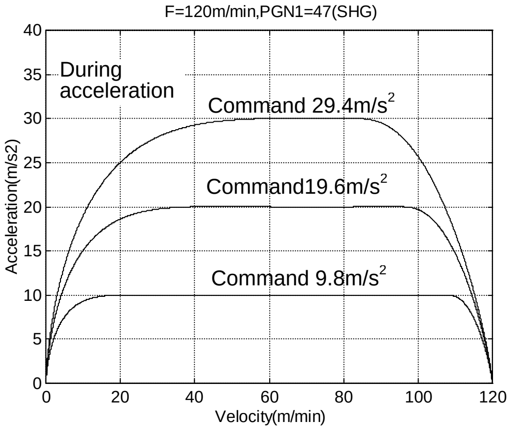
Note that there is a servo response delay as shown on the right in respect to the acceleration in the acceleration/ deceleration command set with the NC. Thus, the acceleration characteristics (thrust characteristics required for acceleration/deceleration when movable mass is applied) in respect to the speed required for the linear servomotor will be as shown on the next page. (Conditions: Indicates the characteristics using the position loop gain during SHG control using a linear acceleration/deceleration command pattern.) Thus, when selecting the linear motor, refer to the speed - acceleration (thrust) characteristics on the next page, and confirm the speed - thrust characteristics (4-4 Torque characteristics drawing) for the linear motor.



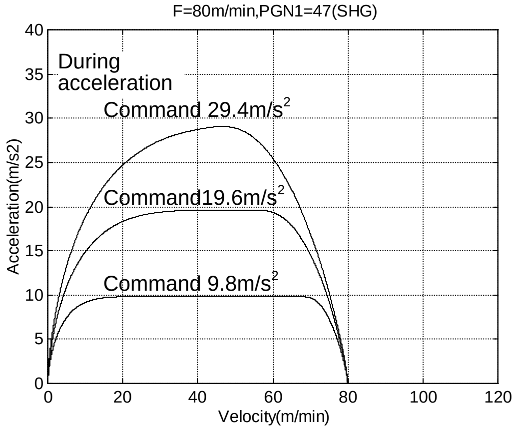
(Note) The speed - acceleration characteristics on the next page are reference values at a specific condition, so if the position loop gain differs when an S-character acceleration/deceleration filter is applied on the command, the characteristics will also differ.

[During acceleration: Speed - acceleration Servo response characteristics]

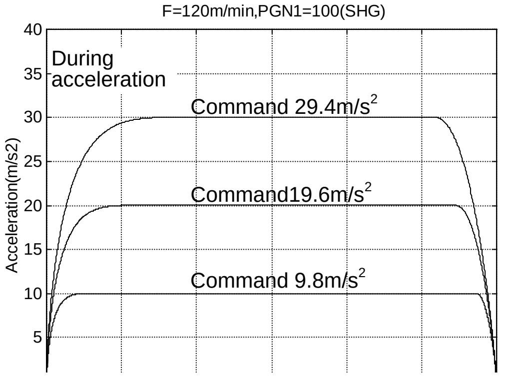
Maximum speed 120m/min, PGN1=47 (SHG)



Maximum speed 80m/min, PGN1=47 (SHG)



Maximum speed 120m/min, PGN1=100 (SHG)



Maximum speed 80m/min, PGN1=100 (SHG)

During
acceleration

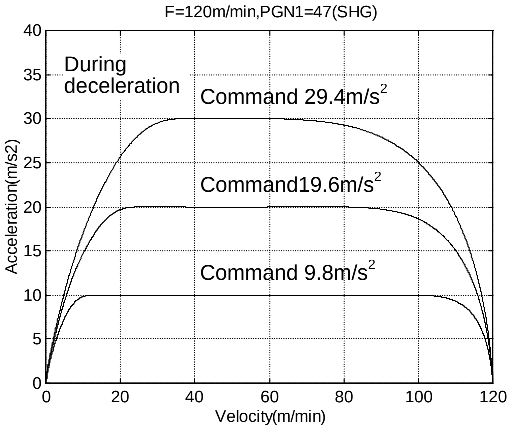
Command 29.4m/s^2

Command19.6m/s^2

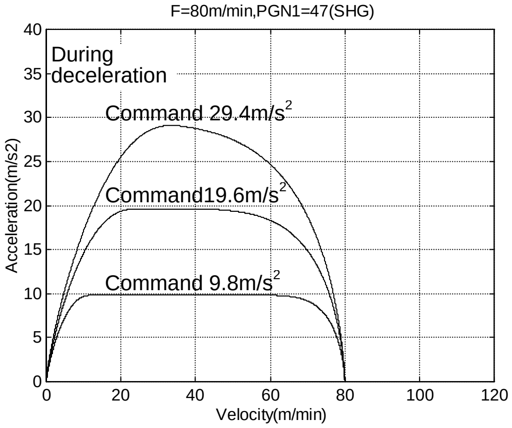
Command 9.8m/s^2

[During deceleration: Speed - acceleration Servo response characteristics]

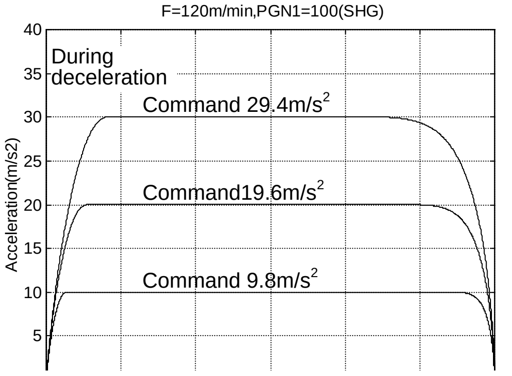
Maximum speed 120m/min, PGN1=47 (SHG)



Maximum speed 80m/min, PGN1=47 (SHG)



Maximum speed 120m/min, PGN1=100 (SHG)



Maximum speed 80m/min, PGN1=100 (SHG)

During
deceleration

Command 29.4m/s^2

Command19.6m/s^2

Command 9.8m/s^2

11-2-3 Continuous thrust

The continuous effective thrust Frms is calculated from the load force using a typical operation pattern. If the operation pattern consists of the one cycle of <1> to <8>, as shown below, the continuous effective load thrust can be obtained from the square mean of the thrust for each operation as shown in expression (3-2).

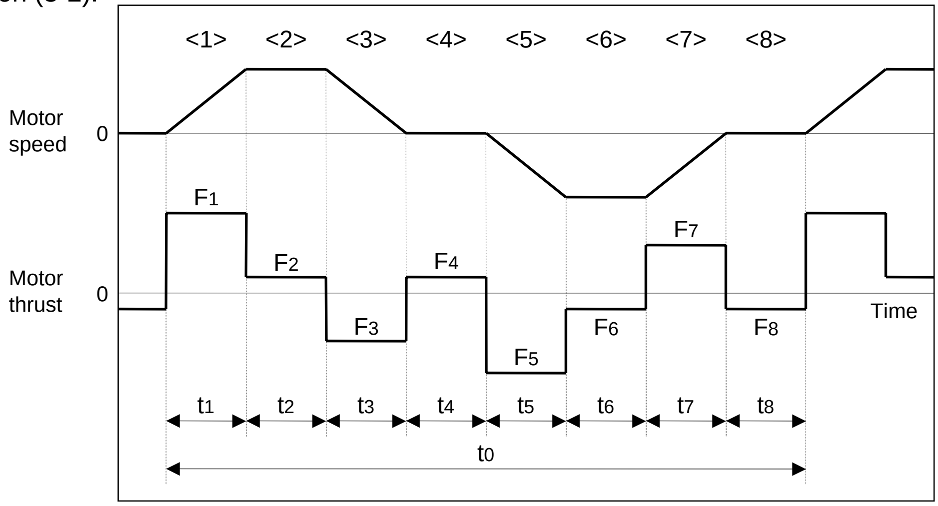


Fig. 3-1 Continuous operation pattern

$$\mathrm{Frms} = \sqrt{\frac{F1^2\cdot t1 + F2^2\cdot t2 + F3^2\cdot t3 + F4^2\cdot t4 + F5^2\cdot t5 + F6^2\cdot t6 + F7^2\cdot t7 + F8^2\cdot t8}{t0}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3\text{-}2)$$

Select the motor so that the continuous effective load thrust Frms is 80% or less of the motor's continuous thrust Fs.

$$\mathrm{Frms} \leq 0.8 \times \mathrm{Fs} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3\text{-}3)$$

(1) Load thrust for horizontal axis

If a horizontal axis is used for steps <1> to <8>, calculate so that the following thrust is attained between each interval.

Table 3-1 Load thrusts for horizontal axis

Interval	Load torque calculation expression	Explanation
<1>	(Acceleration thrust) + (kinetic friction force)	Usually, calculate the acceleration/deceleration time constant so that this thrust is 80% of the motor's maximum thrust.
<2>	(Kinetic friction force) + (cutting force)	–
<3>	(Deceleration thrust) + (kinetic friction force)	The acceleration thrust and the deceleration thrust are the same absolute value with reversed signs.
<4>	(Static friction force)	Calculate as a static friction force is always required when stopped.
<5>	– (Acceleration thrust) – (kinetic friction force)	If the kinetic friction does not change according to the moving direction, the sign is the opposite of <1>.
<6>	– (Kinetic friction force) – (cutting force)	If the kinetic friction does not change according to the moving direction, the sign is the opposite of <2>.
<7>	– (Deceleration thrust) – (kinetic friction force)	If the kinetic friction does not change according to the moving direction, the sign is the opposite of <3>.
<8>	– (Static friction force)	Calculate as a static friction force is always required when stopped.

(2) Load thrust for unbalanced axis

If the operation in steps <1> to <8> is unbalanced, calculate so that the following thrust is attained between each interval. Note that the forward speed is an upward movement.

Table 3-2 Load thrusts for unbalanced axis

Interval	Load torque calculation expression	Explanation
<1>	(Acceleration thrust) + (kinetic friction force) + (unbalance force)	Usually, calculate the acceleration/deceleration time constant so that this thrust is 80% of the motor's maximum thrust.
<2>	(Kinetic friction force) + (unbalance force) + (cutting force)	–
<3>	(Deceleration thrust) + (kinetic friction force) + (unbalance force)	The acceleration thrust and the deceleration thrust are the same absolute value with reversed signs.
<4>	(Static friction force) + (unbalance force)	The holding force when stopped increases greatly. (Upward stop)
<5>	– (Acceleration thrust) – (kinetic friction force) + (unbalance force)	–
<6>	– (Kinetic friction force) + (unbalance force) – (cutting force)	Depending on the size of the unbalanced force, the generated force may be the opposite of the movement direction.
<7>	– (Deceleration thrust) – (kinetic friction force) + (unbalance force)	–
<8>	– (Static friction force) + (unbalance force)	The holding force is smaller than the upward stop. (Downward stop)

POINT

The static friction force may be constantly applied when stopped. During the upward stop of an unbalanced axis, the static friction force and unbalanced force are applied, and the thrust increases greatly when stopped.

(3) Maximum cutting force and maximum cutting duty

If the maximum cutting force and maximum duty (%) are known, the selection conditions can be obtained easily with the following expression.

$$0.8 \times Fs \geq Fc \times \sqrt{\frac{D}{100}} \qquad \text{..} \quad (3\text{-}4)$$

Fs : Motor continuous thrust [N]
Fc : Maximum cutting force during operation [N]
D : Maximum cutting duty [%]

(4) Unbalance force

⚠ CAUTION

For an unbalanced axis, such as a gravity axis, basically balance it with a device such as a counterbalance. With the linear motor, the continuous thrust is lower than the rotary motor, so if the axis is unbalanced the motor's heating amount will increase. If an error should occur, the axis will drop naturally. This is hazardous as the dropping distance and dropping speed are large.

11-3 Selection of the power supply unit

11-3-1 Selection of the power supply unit capacity

In addition to "selection following the rated capacity (continuous rated capacity)", select the power supply unit so that "selection under the maximum momentary rated capacity" are simultaneously satisfied.

11-3-2 Selection with continuous rated capacity

The rated output used in selection is 30-minute rated output.

(1) When using 1-axis servomotor

Power supply unit rated capacity > Σ (Spindle motor output) + (Servomotor output)

(2) When using 2 or more axes servomotor

Power supply unit rated capacity > Σ (Spindle motor output) + 0.7 × Σ (Servomotor output)

(Note 1) Σ (Spindle motor output) is the total of the spindle motor's short time rated output (kW).
If the output characteristics during acceleration/deceleration differ from the output characteristics at the constant state, set the larger output in "spindle motor output".
If the short time output characteristics of the spindle motor are less than 10 minutes, multiply the characteristics with the following coefficient, and set as the "spindle motor output".

Short time output rating time	Coefficient	Short time output rating time	Coefficient
1 minute	0.2	5 minutes	0.7
2 minutes	0.4	6 to 7 minutes	0.8
3 minutes	0.5	8 to 9 minutes	0.9
4 minutes	0.6	10 minutes or more	1.0

To limit the spindle motor's output, set the output multiplied by the limit rate in "spindle motor output".

Σ (Servomotor output) is the total of the servomotor rated output (kW).

(Note 2) Please check having satisfied the following conditions.

Power supply unit capacity	Motor Output Capacity (Total)
MDS-CH-CV-185 or less	Use is possible to 0.5 [kW] over.
MDS-CH-CV-220 or more	Use is possible to 1.0 [kW] over.

(Note 3) If the selected power supply unit exceeds 55[kW], reduce the number of motors connected to one power supply unit, and select again using a combination of two or more power supply units.

(Note 4) For the spindle drive unit, the drive unit capacity may become large depending on the spindle motor such as high-troupe motor. Make sure that the capacity limit of drive unit which can be connected is provided depending on the power supply.

Power supply drive unit		**Spindle drive unit**
MDS-CH-CV-	37	MDS-CH-SP□-15 to 75
	55	MDS-CH-SP□-15 to 110
	75	MDS-CH-SP□-15 to 150
	110	MDS-CH-SP□-15 to 185
	150	MDS-CH-SP□-15 to 220
	185	MDS-CH-SP□-15 to 260
	220	MDS-CH-SP□-15 to 300
	260	MDS-CH-SP□-15 to 370
	300	MDS-CH-SP□-15 to 450
	370	MDS-CH-SP□-15 to 550
	450	MDS-CH-SP□-15 to 550 Note that it must be used in combination including MDS-SP□-370 to 550.
	550	MDS-CH-SP□-370 to 550 Note that it must be used in combination including MDS-SP□-370 to 550.
	750	It can be used in combination with MDS-CH-SP□-750.

11-3-3 Selection with maximum momentary rated capacity

Select the capacity so that the total value of the two outputs "total sum of maximum momentary output during spindle motor acceleration" and "total sum of maximum momentary output during acceleration of servomotor that is accelerating and decelerating simultaneously" is not more than the maximum momentary rated capacity of the power supply unit.

Maximum momentary rated capacity of power supply unit
≥ Σ (Maximum momentary output of spindle motor)
+ Σ (Maximum momentary output of servomotor accelerating/decelerating simultaneously)

If the total value of the right side exceeds 55kW, divide the capacity in two power supply units.

Maximum momentary output of spindle motor

Maximum momentary output of spindle motor
= Spindle motor acceleration/deceleration output × 1.2

Spindle motor acceleration/deceleration output means the maximum output (kW) specified in the acceleration/deceleration output characteristics, or the maximum output (kW) of the short time rated output specified at a time of 30 minutes or less.
If there are no specifications other than the 30-minute rated output, the 30-minute rated output will be the spindle motor acceleration/deceleration output.

Selection data

The maximum momentary output in this table is reference data for selecting the power supply unit and does not guarantee the maximum output.

Motor model HC-H	52	102	152	202	352	452	702	902	1102
Unit model MDS-CH-	V1-05	V1-10	V1-20	V1-20	V1-35	V1-45	V1-70	V1-90	V1-150
Rated output (kW)	0.5	1.0	1.5	2.0	3.5	4.5	7.0	9.0	11.0
Maximum momentary output (kW)	1.5	2.7	4.5	5.3	7.4	10.6	15	19.5	37.0

Motor model HC-H	53	103	153	203	353	453	703	903	1103
Unit model MDS-CH-	V1-05	V1-10	V1-20	V1-35	V1-45	V1-70	V1-90	V1-90	V1-150
Rated output (kW)	0.5	1.0	1.5	2.0	3.5	4.5	7.0	9.0	11.0
Maximum momentary output (kW)	1.6	3.2	5.4	7.6	10.6	13.7	20.1	29.0	40.0

Unit model MDS-CH-CV-	37	55	75	110	150	185	220	260	300	370	450	550	750
Rated output (kW)	3.7	5.5	7.5	11	15	18.5	22	26	30	37	45	55	75
Maximum momentary output (kW)	14	19	21	28	41	42	53	54	55	75	91	125	150

⚠CAUTION

When the large capacity drive unit (MDS-CH-V1-185, MDS-CH-SP-370 to 750) is connected to the power supply unit, always install the drive unit proximally in the left side of the power supply unit and connect PN terminal with the dedicated DC connection bar.

(1) Selection example

(Example 1) Spindle motor : 30-minute rated output 22kW × 1 unit
Servomotor : HC-H352 (V1-35) × 3 units
.... The three units are simultaneously accelerated/decelerated.

(a) Selection with rated capacity

22kW + 0.7 × (3.5kW × 3) = 29.35kW
→ Rated capacity 30kW:

- MDS-CH-CV-300 or more is required.

(b) Selection with maximum momentary rated capacity

22kW × 1.2 + 7.4kW × 3 = 48.6kW
→ Maximum momentary rated capacity 53kW:

- MDS-CH-CV-220 or more is required.

Power supply unit that satisfy conditions (1) and (2):

- Select MDS-CH-CV-300.

(Example 2) Spindle motor : 30-minute rated output 22kW × 1 unit
Servomotor : HC-H353 (V1-45) × 1 units
HC-H453 (V1-70) × 2 units
.... The three units are simultaneously accelerated/decelerated.

(a) Selection with rated capacity

22kW + 0.7 × (3.5kW + 4.5kW × 2) = 30.75kW
→ Rated capacity 30kW:

- MDS-CH-CV-300 or more is required.

(b) Selection with maximum momentary rated capacity

22kW × 1.2 + 10.6kW + 13.7kW × 2 = 64.4kW
→ Maximum momentary rated capacity 75kW:

- MDS-CH-CV-370 or more is required.

Power supply unit that satisfy conditions (1) and (2):

- Select MDS-CH-CV-370.

12. Inspection

12-1 Inspections 12-2
12-2 Service parts 12-2
12-3 Daily inspections 12-3
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⚠ **WARNING**	1. Turn the main circuit power and control power both OFF before starting maintenance and inspection. It will take approx. 15 minutes for the main circuit's capacitor to discharge. After the CHARGE LAMP goes out, use a tester to confirm that the input and output voltages are zero. 2. Inspections must be carried out by a qualified technician. Failure to observe this could lead to electric shocks. Contact the Service Center for repairs and part replacements.

⚠ **CAUTION**	1. Never perform a megger test (measure the insulation resistance) of the servo drive unit. Failure to observe this could lead to faults. 2. The user must never disassemble or modify this product.

12-1 Inspections

Periodic inspection of the following items is recommended.

<1> Are any of the screws on the terminal block loose? If loose, tighten them.
<2> Is any abnormal noise heard from the servomotor bearings or brake section?
<3> Are any of the cables damaged or cracked? If the cables move with the machine, periodically inspect the cables according to the working conditions.
<4> Is the core of the load coupling shaft deviated?

12-2 Service parts

A guide to the part replacement cycle is shown below. Note that these will differ according to the working conditions or environmental conditions, so replace the parts if any abnormality is found. Contact Mitsubishi branch or your dealer for repairs or part replacements.

Part name		**Standard replacement time**	**Remarks**
Servo drive Spindle drive Power supply	Smoothing capacitor	10 years	The standard replacement time is a reference. Even if the standard replacement time is not reached, the part must be replaced if any abnormality is found.
	Unit built-in relay	100,000 times	
	Cooling fan	10,000 to 30,000 hours (2 to 3 years)	
Servomotor Spindle motor Note 1	Bearings	20,000 to 30,000 hours	
	Detector	20,000 to 30,000 hours	
	Oil seal, V-ring	5,000 hours	
	Cooling fan	20,000 to 30,000 hours	
Battery unit	MDS-A-BT-[ ]	45,000 hours (7 years)	
AC reactor	CH-AL-[_]K	At fault	

Note 1: The details will differ according to the motor, so refer to the respective motor specifications.

<1> Power smoothing capacitor : The characteristics of the power smoothing capacitor will deteriorate due to the effect of ripple currents, etc. The capacitor life is greatly affected by the ambient temperature and working conditions. However, when used continuously in a normal air-conditioned environment, the service life will be ten years.
<2> Relays : Contact faults will occur due to contact wear caused by the switching current. The service life will be reached after 100,000 cumulative switches (switching life).
<3> Motor bearings : The motor bearings should be replaced after 20,000 to 30,000 hours of rated load operation at the rated speed. This will be affected by the operation state, but the bearings must be replaced when any abnormal noise or vibration is found in the inspections.
<4> Motor oil seal, V-ring : These parts should be replaced after 5,000 hours of operation at the rated speed. This will be affected by the operation state, but these parts must be replaced if oil leaks, etc., are found in the inspections.

12-3 Daily inspections

12-3-1 Maintenance tools

Prepare the following measuring instruments to check the unit power wiring, etc.

Instrument	Application
Tester	Use this to check that the wiring to the unit is correct before turning the power ON.
Oscilloscope	Use this for general measurement and troubleshooting.
AC voltmeter	Use this to measure the AC power voltage.
DC voltmeter	Use this to measure the DC power voltage. (Relays and I/O, etc.)
AC/DC ammeter	Use this to measure the alternating current supplied to the motor.
Driver tool	Use this to remove the unit and to set the rotary switches.

12-3-2 Inspection positions

(1) Unit inspection

	Inspection item	Inspection cycle	Points	Remedies
1	Cooling fan	Monthly	(1) Rotate by hand to check that the fan rotates smoothly. (AC fan) (2) Turn the power ON to check that the fan rotates with force. (3) Is there any abnormal noise from the bearings?	Replace the unit
2	Contamination/ screw loosening	As required	Periodically clean the areas outside the unit, particularly the cooling fan section. Tighten the input/output terminals and connections.	
3	Wiring	As required	Check that the wires are not connected to other conductive sections, and that they are not caught.	

(2) Motor inspection

	Inspection item	Inspection cycle	Points	Remedies
1	Noise/vibration	Monthly	• Check whether any noise or vibration, previously unnoticed, is occurring. Check the following items when abnormal. (1) Check the foundation and installation. (2) Check the coupling core alignment accuracy. (3) Check whether vibration is being conveyed from the coupler. (4) Check whether the bearings are damaged or are generating abnormal noise. (5) Check for vibration or noise at the reduction gears or belt. (6) Check for abnormalities at the control unit. (7) Check for abnormalities at the cooling fan. (8) Check the belt tension.	Clean
2	Temperature rise	Monthly	• Is the bearing temperature abnormal? (Normally, the temperature should be the ambient temperature +10 to 40°C.) • Is the motor frame temperature abnormal? Check the following items when abnormal. (1) Is the cooling fan rotating correctly? (2) Is the cooling fan wind path (between the frame and cover) obstructed with foreign matter? (3) Is the load abnormally high?	
			(4) Check for abnormalities at the control unit.	Refer to Troubleshooting.
3	Insulation resistance value	Six months	• Is the insulation resistance value abnormally low? Disconnect the wiring with the spindle drive unit, and perform a megger test between the circuit batch and ground. (No problem if the value is 1MΩ or more with a 500V megger.) If the insulation resistance is 1MΩ or less, the inside of the motor must be cleaned and dried. To dry, disassemble the motor, and dry it in a drying furnace set at 90°C or less.	
4	Cooling fan	Weekly, monthly	• Check that the fan is rotating correctly and feeding air, and that there is no abnormal noise or vibration.	

12-4. Replacement methods of units and parts

⚠ **CAUTION** Please do not do replacement work except an expertise person.

12-4-1 Drive unit and power supply unit replacements

Replacement
(1) Power off of a cabinet.
(2) All terminal blocks are disconnected with wire.
(3) A fixed screw is loosened and a unit is removed.

Install
(1) Type of a unit is checked and it installs in a cabinet.
(2) Wire is connected correctly.
(3) Connection and installation are reconfirmed.
(4) Power of a cabinet is turned on. It checks whether a machine runs by MDI etc.

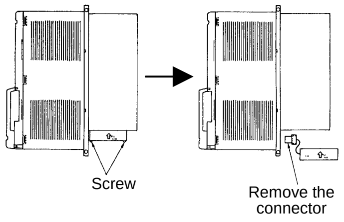
12-4-2 Battery unit replacements

Replacement
(1) Power off of a NC system. All connecter is disconnected with wire.
(2) A fixed screw is loosened and a battery unit is removed.
(3) Complete the battery replacement work within the approx. 10 hours that the detector position information is held.

Install
(1) Type of a battery unit is checked and it installs in a cabinet.
(2) Wire is connected correctly.
(3) Power of a NC system is turned on. It checks whether an alarm etc. Confirm that no alarms, such as the absolute position illegal alarm, are occurring.

12-4-3 Cooling fan replacements

(1) Remove the screws fixing the cooling fan at the bottom of the unit.
(The mounting position and number of fans differ according to the unit.)
(2) Disconnect the fan power cable.
(The position may differ according to the unit, but the procedure is the same.)
(3) Exchange with the new fan.



Appendix 1. Compliance to EC Directives

1. European EC Directives A1-2
2. Cautions for EC Directive compliance A1-2

Appendix 1. Compliance to EC Directives

1. European EC Directives

In the EU Community, the attachment of a CE mark (CE marking) 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 and spindle drive are assembled are the targets for CE marking.

(1) Compliance to EMC Directives

The servo and spindle drive are components designed to be used in combination with a machine or device. These are not directly targeted by the Directives, but a CE mark must be attached to machines and devices in which these components are assembled. The next section "EMC Installation Guidelines", which explains the unit installation and control panel manufacturing method, etc., has been prepared to make compliance to the EMC Directives easier.

(2) Compliance to Low-voltage Directives

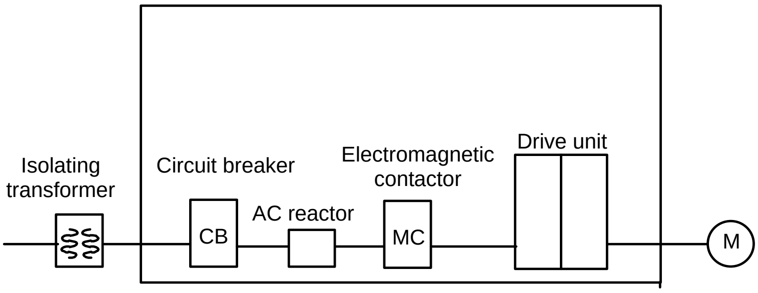
The MDS-CH Series units are targeted for the Low-voltage Directives. An excerpt of the precautions given in this specification is given below. Please read this section thoroughly before starting use.

A Self-Declaration Document has been prepared for the EMC Directives and Low-voltage Directives. Contact Mitsubishi or your dealer when required.

2. Cautions for EC Directive compliance

Use the Low-voltage Directive compatible parts for the servo/spindle drive and servo/spindle motor. 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

Use the units under an Overvoltage Category III and Pollution Class of 2 or less environment as stipulated in IEC60664.

These units do not provide protection against electric shock and fire sufficient for the requirements of the Low-voltage Directive and relevant European standards by themselves, so provide additional protection (refer to 5.2.4 and 7.1.6.1 of EN50178)

Drive unit

	During operation	Storage	During transportation
Ambient temperature	0°C to 55°C	-15°C to 70°C	-15°C to 70°C
Humidity	90%RH or less	90%RH or less	90%RH or less
Altitude	1000m or less	1000m or less	13000m or less

Motor

	During operation	Storage	During transportation
Ambient temperature	0°C to 40°C	-15°C to 70°C	-15°C to 70°C
Humidity	80%RH or less	90%RH or less	90%RH or less
Altitude	1000m or less	1000m or less	13000m or less

(3) Power supply

[1] Use the power supply and servo/spindle drive unit under an Overvoltage Category III as stipulated in IEC60664.

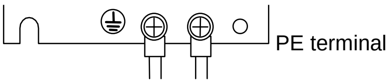
[2] In case of Overvoltage Category III, connect the PE terminal of the units to the earthed-neutral of the star-connection power supply system.

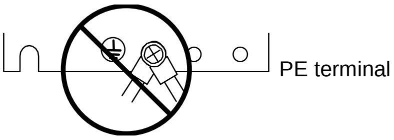
[3] Do not omit the circuit breaker and electromagnetic contactor.

(4) Earthing

[1] To prevent electric shocks, always connect the servo/spindle drive unit 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.

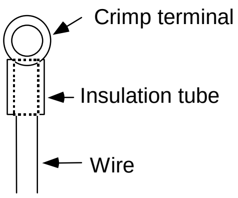




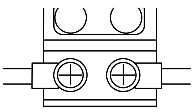
[3] Select the earthing wire size in accordance with Table 1 of EN60204-1.

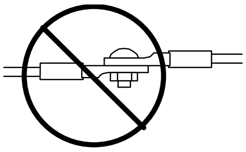
(5) Wiring

[1] Always use crimp terminals with insulation tubes so that the connected wire does not contact the neighboring terminals.



[2] Do not connect the wires directly.





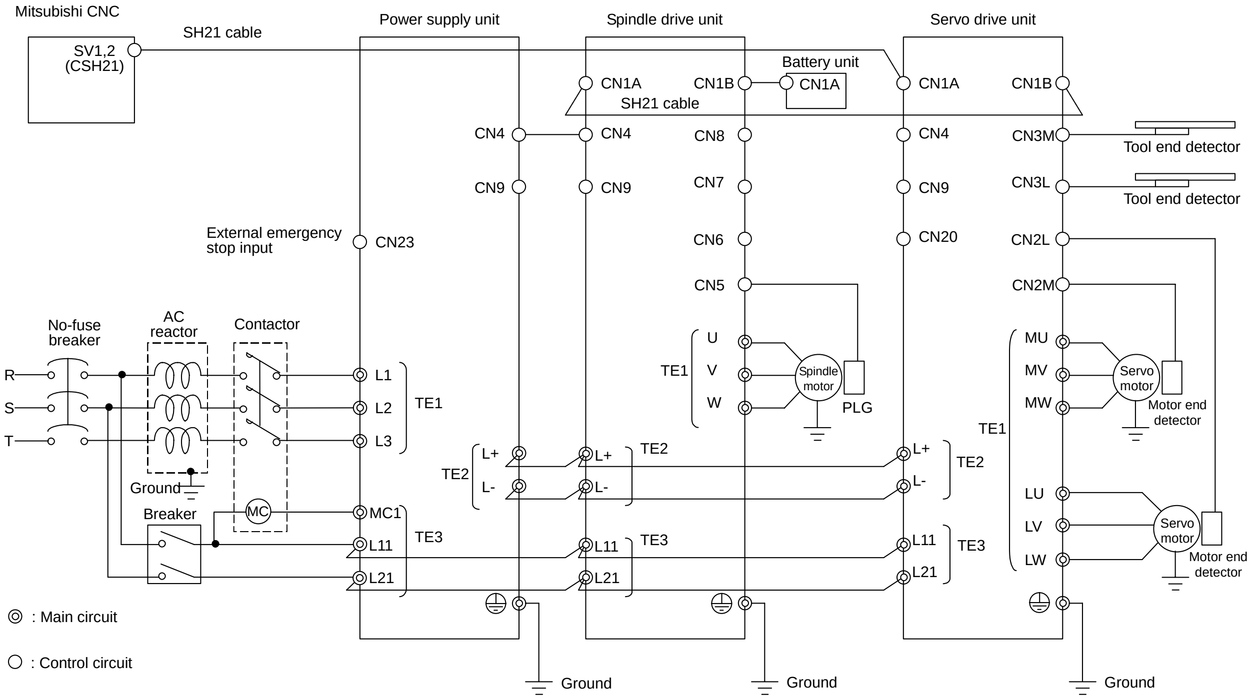
[3] Select the size of the wires for input power supply to Power Supply unit in accordance with Table 4 and 5 of EN60204-1.

(6) Peripheral devices

[1] Use EN/IEC Standards compliant parts for the circuit breaker and contactor.
[2] Select circuit breaker with instantaneous trip function. (Trip within 30 second when over current of 600%). Apply Annex C of EN60204-1 for sizing of the circuit breaker.

(7) Miscellaneous

[1] Refer to the next section "EMC Installation Guidelines" for methods on complying with the EMC Directives.
[2] Ground the facility according to each country's requirements.
[3] The control circuit connector (○) is safely separated from the main circuit (◎).
[4] Inspect the appearance before installing the unit. Carry out a performance inspection of the final unit, and save the inspection records.



Appendix 2. EMC Installation Guidelines

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Appendix 2 EMC Installation Guidelines

1. Introduction

EMC Instructions became mandatory as of January 1, 1996. The subject products must have a CE mark attached indicating that the product complies with the Instructions. As the NC unit is a component designed to control machine tools, it is believed that it is not a direct EMC Instruction subject. However, we would like to introduce the following measure plans to backup EMC Instruction compliance of the machine tool as the NC unit is a major component of the machine tools.

(1) Methods for installation in control/operation panel
(2) Methods of wiring cable outside of panel
(3) Introduction of countermeasure parts

Mitsubishi is carrying out tests to confirm the compliance to the EMC Standards under the environment described in this manual. However, the level of the noise will differ according to the equipment type and layout, control panel structure and wiring lead-in, etc. Thus, we ask that the final noise level be confirmed by the machine manufacturer.
These contents are the same as the EMC INSTALLATION GUIDELINES (BNP-B8582-45).
For measures for CNC, refer to "EMC INSTALLATION GUIDELINES" (BNP-B2230).

2. EMC Instructions

The EMC Instructions largely regulate the following two withstand levels.

(1) Emission....... Capacity to prevent output of obstructive noise that adversely affects external sources.
(2) Immunity....... Capacity not to malfunction due to obstructive noise from external sources.

The details of each level are classified as Table 1. It is assumed that the Standards and test details required for a machine are the same as these.

Table 1

Class	Name	Details	Generic Standard	Standards for determining test and measurement
Emission	Radiated noise	Electromagnetic noise radiated through the air	EN50081-2 EN61800-3 (Industrial environment)	EN55011
	Conductive noise	Electromagnetic noise discharged from power line		
Immunity	Static electricity electrical discharge	**Example)** Withstand level of static electricity discharge from a charged human body	EN61000-6-2 EN61800-3 (Industrial environment)	IEC61000-4-2
	Radiated magnetic field	**Example)** Simulation of immunity from digital wireless transmitters		IEC61000-4-3
	Burst immunity	**Example)** Withstand level of noise from relays or connecting/disconnecting live wires		IEC61000-4-4
	Conductive immunity	**Example)** Withstand level of noise entering through power line, etc.		IEC61000-4-6
	Power supply frequency field	**Example)** 50/60Hz power frequency noise		IEC61000-4-8
	Power dip (fluctuation)	**Example)** Power voltage drop withstand level		IEC61000-4-11
	Surge	**Example)** Withstand level of noise caused by lightning		IEC61000-4-5

3. EMC Measures

The main items relating to EMC measures include the following.

(1) Store the device in an electrically sealed metal panel.
(2) Earth all conductors that are floating electrically. (Lower the impedance.)
(3) Wire the power line away from the signal wire.
(4) Use shielded wires for the cables wired outside of the panel.
(5) Install a noise filter.

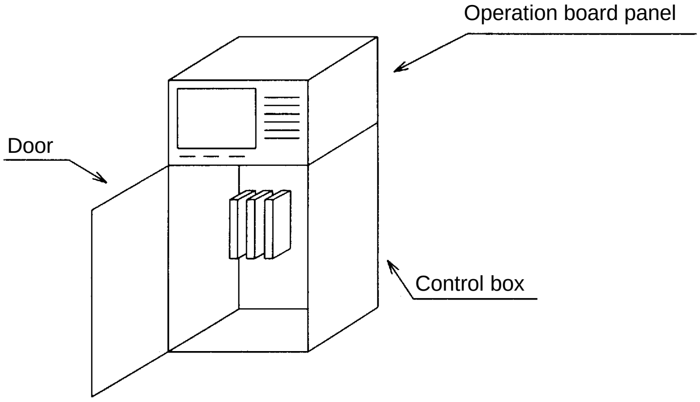
Take caution to the following items to suppress noise radiated outside of the panel.

(1) Securely install the devices.
(2) Use shielded wires.
(3) Increase the panel's electrical seal. Reduce the gap and hole size.

Note that the electromagnetic noise radiated in the air is greatly affected by the clearance of the panel and the quality of the cable shield.

4. Measures for panel structure

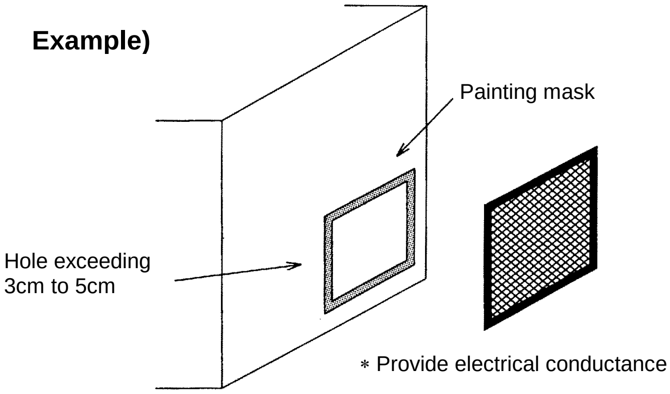
The design of the panel is a very important factor for the EMC measures, so take the following measures into consideration.

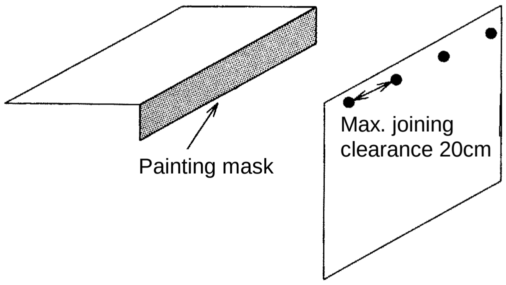


4.1 Measures for control box unit

(1) Use metal for all materials configuring the panel.
(2) For the joining of the top plate and side plates, etc., mask the contact surface with paint, and fix with welding or screws.
In either case, keeping the joining clearance to a max. of 20cm for a better effect.
(3) Note that if the plate warps due to the screw fixing, etc., creating a clearance, noise could leak from that place.
(4) Plate the metal plate surface (with nickel, tin) at the earthing section, such as the earthing plate.
(5) The max. tolerable hole diameter of the openings on the panel surface, such as the ventilation holes, must be 3cm to 5cm. If the opening exceeds this tolerance, use a measure to cover it. Note that even when the clearance is less than 3cm to 5cm, noise may still leak if the clearance is long.

Example)

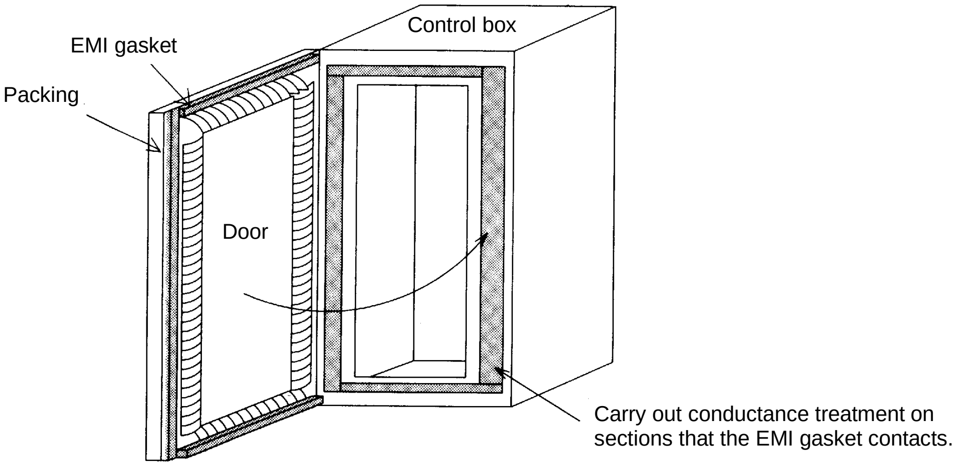




4.2 Measures for door

(1) Use metal for all materials configuring the door.
(2) Use an EMI gasket or conductive packing for the contact between the door and control box unit.
(3) The EMI gasket or conductive packing must contact at a uniform and correct position of the metal surface of the control box unit.
(4) The surface of the control box unit contacted with the EMI gasket or conductive packing must have conductance treatment.

Example) Weld (or screw) a welded plate that is plated (with nickel, tin).



(5) As a method other than the above, the control box unit and door can be connected with a plain braided wire. In this case, the box and door should be contacted at as many points as possible.

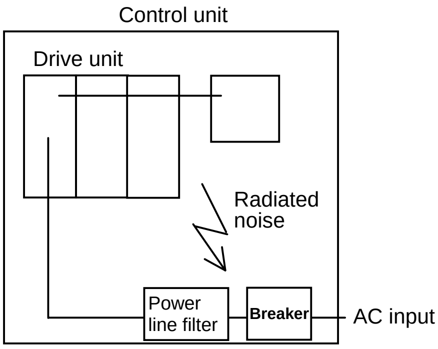
4.3 Measures for operation board panel

(1) Always connect the operation board and indicator with an earthing wire.
(2) If the operation board panel has a door, use an EMI gasket or conductive packing between the door and panel to provide electrical conductance in the same manner as the control box.
(3) Connect the operation board panel and control box with a sufficiently thick and short earthing wire.

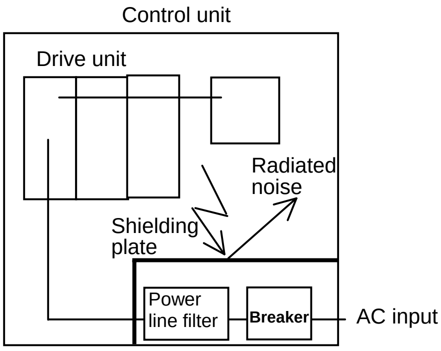
Refer to the "EMC INSTALLATION GUIDELINES" BNP-B2230 for the NC for more details.

4.4 Shielding of the power supply input section

(1) Separate the input power supply section from other parts of the control box so that the input power supply cable will not be contaminated by radiated noise.
(2) Do not lead the power line through the panel without passing it through a filter.



The power supply line noise is eliminated by the filter, but cable contains noise again because of the noise radiated in the control box.



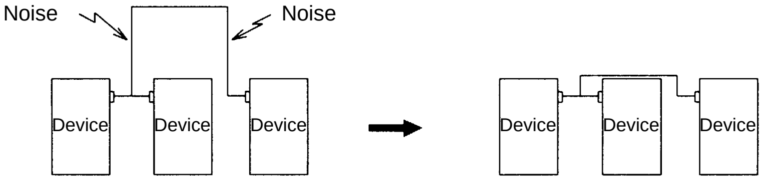
Use a metal plate, etc., for the shielding partition. Make sure not to create a clearance.

5. Measures for various cables

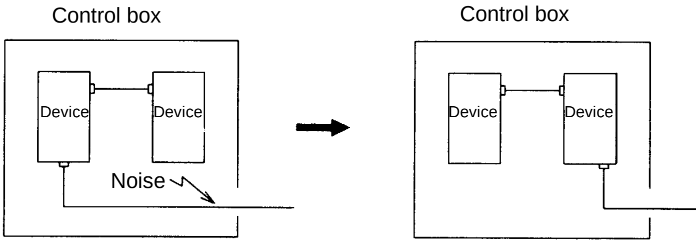
The various cables act as antennas for the noise and discharge the noise externally. Thus appropriate treatment is required to avoid the noise. The wiring between the drive unit and motor act as an extremely powerful noise source, so apply the following measures.

5.1 Measures for wiring in box

(1) If the cables are led unnecessarily in the box, they will easily pick up the radiated noise. Thus, keep the wiring length as short as possible.



(2) The noise from other devices will enter the cable and be discharged externally, so avoid internal wiring near the openings.



(3) Connect the control device earthing terminal and earthing plate with a thick wire. Take care to the leading of the wire.

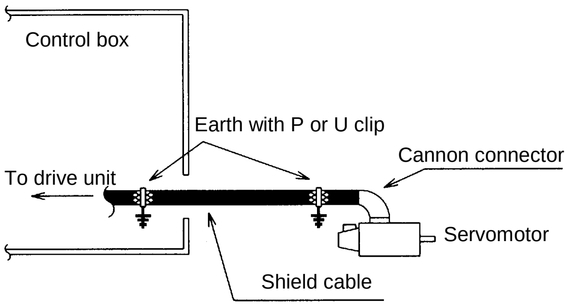
5.2 Measures for shield treatment

Use of shield clamp fittings is recommended for treating the shields. The fittings are available as options, so order as required. (Refer to section "6.1 Shield clamp fitting".)
Clamp the shield at a position within 10cm from the panel lead out port.

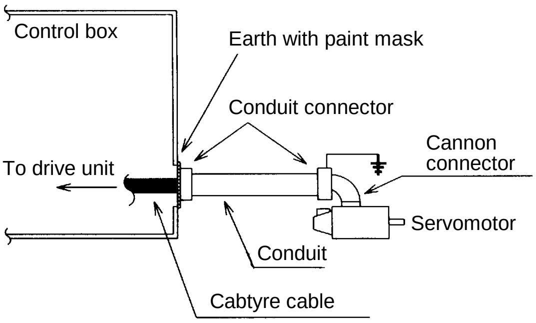
POINT

1. When leading the cables, including the grounding wire (FG), outside of the panel, clamp the cables near the panel outlet (recommendation: within 10cm).
2. When using a metal duct or conduit, the cables do not need to be clamped near the panel outlet.
3. When leading cables not having shields outside the panel, follow the instructions given for each cable. (Installation of a ferrite core, etc., may be required.)

5.3 Servomotor power cable

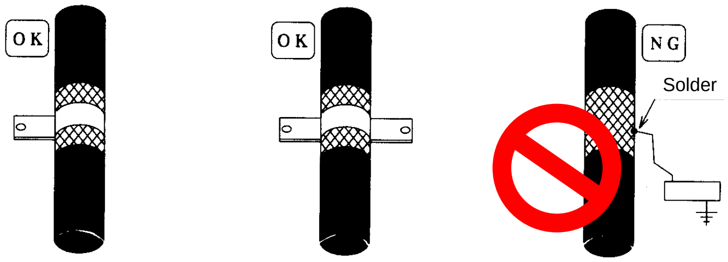


Using shield cable

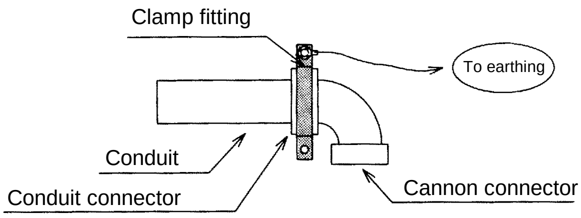


Using conduit

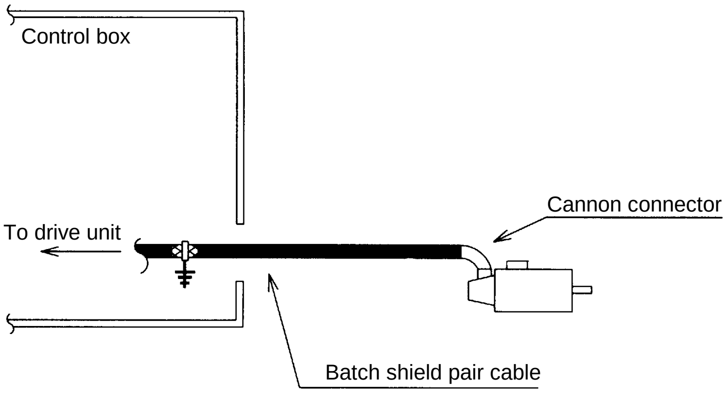
(1) Use four wires (3-phase + earthing) for the power cable that are completely shielded and free from breaks.
(2) Earth the shield on both the control box side and motor chassis side.
(3) Earth the shield with a metal P clip or U clip.
(A cable clamp fitting can be used depending on the wire size.)
(4) Directly earth the shield. Do not solder the braided shield onto a wire and earth the end of the wire.



(5) When not using a shield cable for the power cable, use a conventional cabtyre cable. Use a metal conduit outside the cable.
(6) Earth the power cable on the control box side at the contact surface of the conduit connector and control box. (Mask the side wall of the control box with paint.)
(7) Follow the treatment shown in the example for the conduit connector to earth the power cable on the motor side. (Example: Use a clamp fitting, etc.)



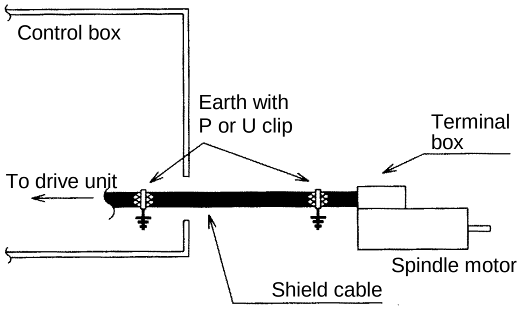
5.4 Servomotor feedback cable



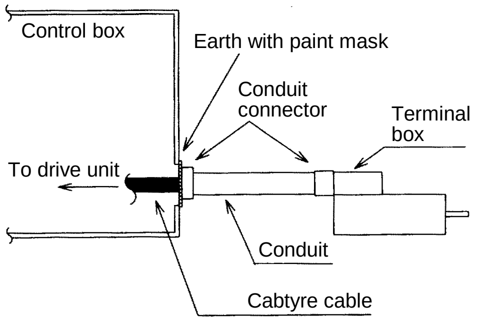
Use a pair shield cable for the servomotor and spindle motor feedback cables, and ground them in the control panel.

Directly mounting a ferrite core onto the unit connector is also effective in suppressing noise.

5.5 Spindle motor power cable



Using shield cable

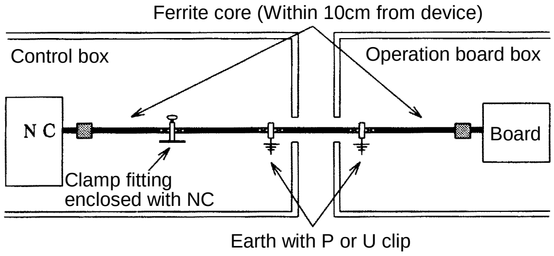


Using conduit

(1) Use four wires (3-phase + earthing) for the power cable, that are completely shielded and free from breaks.
(2) Earth the shield with the same manner as the servomotor power cable.
(3) When not using a shield cable for the power cable, use a conventional cabtyre cable. Use a metal conduit outside the cable.
(4) Earth the power cable on the control box side at the contact surface of the conduit connector and control box side wall in the same manner as the servomotor power cable. (Mask the side wall of the control box with paint.)
(5) Earth at the conduit connector section in the same manner as the servomotor drive cable.

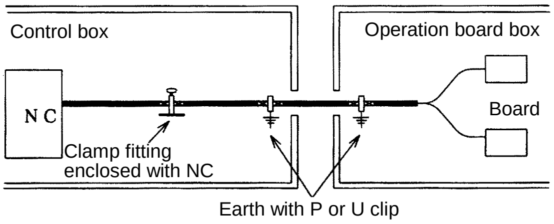
5.6 Cable between control box and operation board panel

SH11 cable (signal cable)



(1) Use a shield cable for the cable between the control box and operation board.
(2) Earth the shield in the same manner as the other cables.
(3) Insert a ferrite core in the SH11 cable at a position within 10cm from the device.
(This provides a better effect.)

PD05 cable (power supply cable)

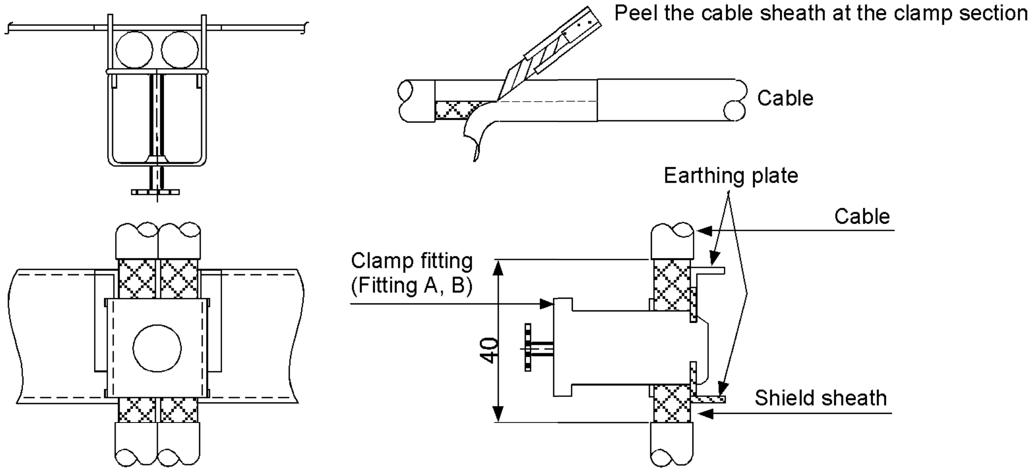


The PD05 cable is used with the MELDAS500 Series.
Refer to the EMC INSTALLATION GUIDELINES for each NC for details.

6. EMC Countermeasure Parts

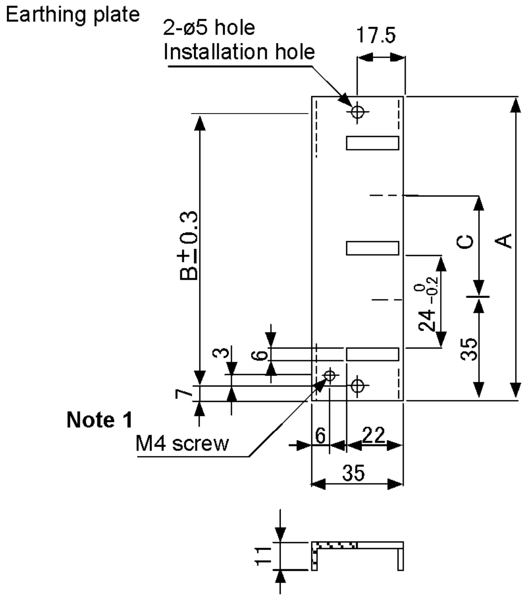
6.1 Shield clamp fitting

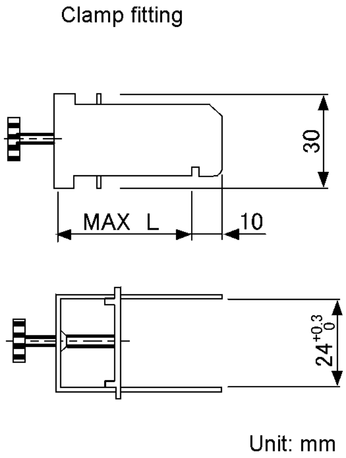
The effect can be enhanced by connecting the cable directly to the earthing plate.
Install an earthing plate near each panel's outlet (within 10cm), and press the cable against the earthing plate with the clamp fitting.
If the cables are thin, several can be bundled and clamped together.
Securely earth the earthing plate with the frame ground. Install directly on the cabinet or connect with an earthing wire.
Contact Mitsubishi if the earthing plate and clamp fitting set (AERSBAN-[ ]SET) is required.



View of clamp section

- **Outline drawing**





Note 1) Screw hole for wiring to earthing plate in cabinet.
Note 2) The earthing plate thickness is 1.6mm.

	A	B	C	Enclosed fittings
AERSBAN-DSET	100	86	30	Two clamp fittings A
AERSBAN-ESET	70	56	–	One clamp fitting B

	L
Clamp fitting A	70
Clamp fitting B	45

6.2 Ferrite core

A ferrite core is integrated and mounted on the plastic case.
Quick installation is possible without cutting the interface cable or power cable.
This ferrite core is effective against common mode noise, allowing measures against noise to be taken without affecting the signal quality.

Recommended ferrite core

TDK ZCAT Series

Shape and dimensions

ZCAT type

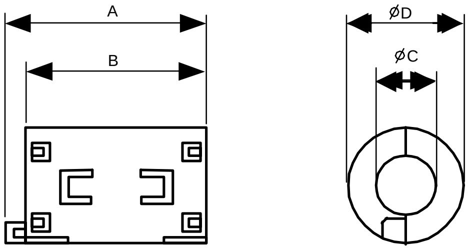


Fig. 1

ZCAT-A type

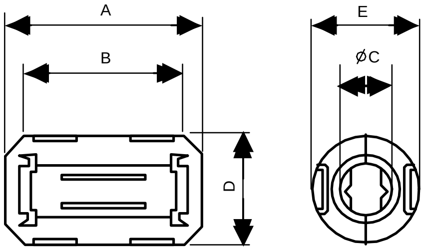


Fig. 2

ZCAT-B type

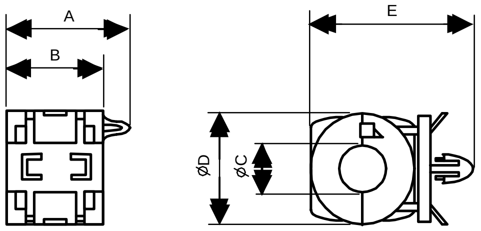


Fig. 3

ZCAT-C type

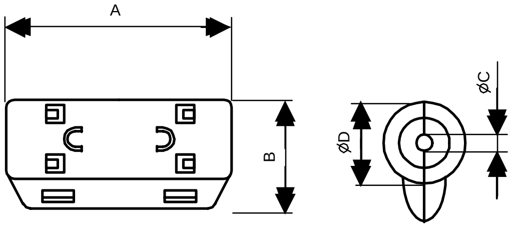


Fig. 4

⊙ Recommended ferrite core

Unit [mm]

Part name	Fig.	A	B	C	D	E	Applicable cable outline	Weight
⊙ ZCAT3035-1330 (-BK)*1	1	39	34	13	30	---	13 max.	63
ZCAT2035-0930-M (-BK)	2	35	29	13	23.5	22	10 to 13	29
ZCAT2017-0930B-M (-BK)	3	21	17	9	20	28.5	9 max.	12
ZCAT2749-0430-M (-BK)	4	49	27	4.5	19.5	---	4.5 max.	26

*1 A fixing band is enclosed when shipped.

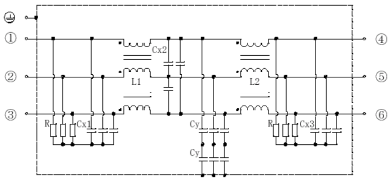
ZCAT-B type: Cabinet fixed type, installation hole ø4.8 to 4.9mm, plate thickness 0.5 to 2mm
ZCAT-C type: Structured so that it cannot be opened easily by hand once closed.

6.3 Power line filter

The low leakage current 3-phase inverter and power drive system filter is recommended for the power line filter. EMC Measures have been confirmed by Mitsubishi using the following filter.
Install on the primary side (factory power side) of the AC reactor.

OKAYA Electric Industries Co., Ltd. 3SUP-HL-ER-6B Series

- 3-phase, 3-wire type high attenuation type
- CE marking compatible
- Rated current value 30A to 200A
- For EN55011 Class A, B measures
- Application: Primary side of inverter power supply, UPS, CNC machine tool, etc.



1. Technical specifications

Type	3SUP-HL30-ER-6B	3SUP-HL50-ER-6B	3SUP-HL75-ER-6B	3SUP-HL100-ER-6B	3SUP-HL150-ER-6B
Rated current	30A (50°C)	50A (50°C)	75A (50°C)	100A (50°C)	150A (50°C)
Maximum working voltage	500Vrms (50°C)				
Working frequency	50 / 60Hz				
Leakage current	8mA (at 500Vrms 60Hz) [A leakage current will not flow if there is no phase failure in a power supply grounded at a neutral point.]				
Connection terminal	M4	M6	M6	M6	M8
Weight	5.2kg	6.5kg	12.0kg	12.5kg	23.5kg
Nominal inductance	6×1.4mH	6×1.4mH	6×1.0mH	6×0.56mH	6×0.6mH
Safety standards	EN133200 (compliant)				

These specifications are for reference. Contact the filter maker for detailed data.

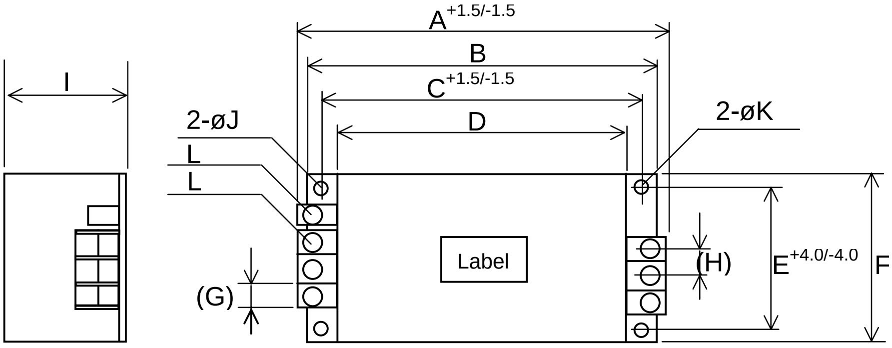
Notes:

- If the leakage current is limited, use 3SUP-HL[_]-ER-6B-4 (leakage current 4mA product).
- Please use 3SUP-HL[_]-ER-6 series, when high specification is required.

2. Mechanical data

[unit: mm]
Tolerance: ±1.5mm

	A	B	C	D	E	F	G	H	I	J	K	L
3SUP-HL30-ER-6B	246	230	215	200	100	85	13	18	140	4.5x7	4.5	M4
3SUP-HL50-ER-6B	286	270	255	240	120	90	13	18	150	5.5x7	5.5	M6
3SUP-HL75-ER-6B	396	370	350	330	170	140	18	23	155	6.5x8	6.5	M6
3SUP-HL100-ER-6B	396	370	350	330	170	140	18	23	155	6.5x8	6.5	M6
3SUP-HL150-ER-6B	484	440	420	400	200	170	30	25	200	6.5x8	6.5	M8
3SUP-HL200-ER-6B	484	440	420	400	200	170	30	25	200	6.5x8	6.5	M8



SOHIN ELECTRIC Co., Ltd. HF3000C-TMA series

- 3-phase, 3-wire type high attenuation type

1. Technical specifications

Type	HF3030C-TMA	HF3050C-TMA	HF3060C-TMA	HF3080C-TMA	HF3100C-TMA	HF3150C-TMA	HF3200C-TMA
Rated current	30A	50A	60A	80A	100A	150A	200A
Maximum working voltage	460VAC (50°C) For Natural grounding						
Working frequency	50 / 60Hz						
Leakage current	5.3mA (at 460Vrms 60Hz) [A leakage current will not flow if there is no phase failure in a power supply grounded at a neutral point.]						
Rated current	Rated current x 150% 1min						
Connection terminal	M5 / M4(E)	M6 / M4(E)	M6 / M4(E)	M8 / M6(E)	M8 / M6(E)	M10 / M8(E)	M10 / M8(E)
Weight	3.2kg	6.7kg	10.0kg	13.0kg	14.5kg	23.0kg	23.5kg
Safety standards	EN133200 (compliant)						

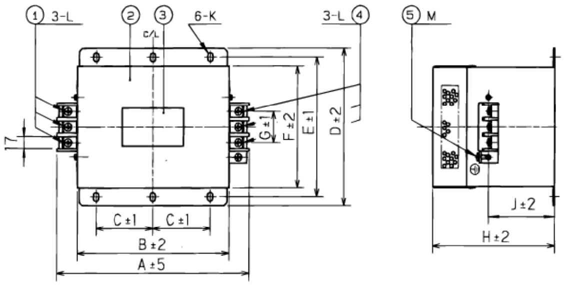
These specifications are for reference. Contact the filter maker for detailed data.

[unit: mm]

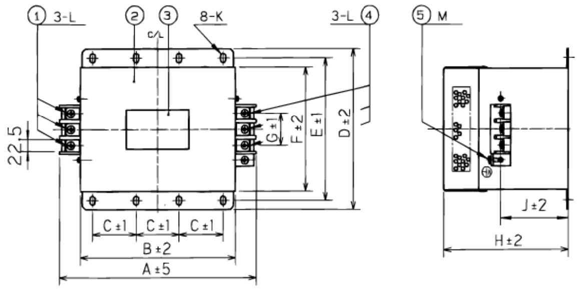
Tolerance: ±1.5mm

	A	B	C	D	E	F	G	H	J	K	L	M	N
HF3030C-TMA	260	210	85	155	140	125	44	140	70	R3.25 / L8	M5	M4	---
HF3050C-TMA	290	240	100	190	175	160	44	170	100	R3.25 / L8	M6	M4	---
HF3060C-TMA	290	240	100	190	175	160	44	230	160	R3.25 / L8	M6	M4	---
HF3080C-TMA	405	350	100	220	200	180	56	210	135	R4.25 / L12	M8	M6	---
HF3100C-TMA	405	350	100	220	200	180	56	210	135	R4.25 / L12	M8	M6	---
HF3150C-TMA	570	550	530	230	190	100	15	210	140	100	M10	M8	33
HF3200C-TMA	570	550	530	230	190	100	15	210	140	100	M10	M8	33

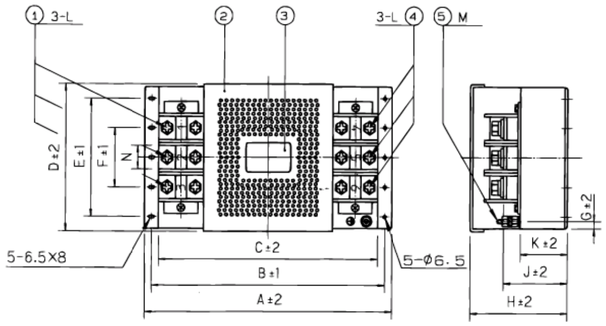
30A to 60A

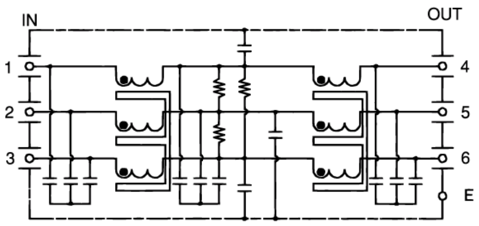


80A, 100A



150A, 200A





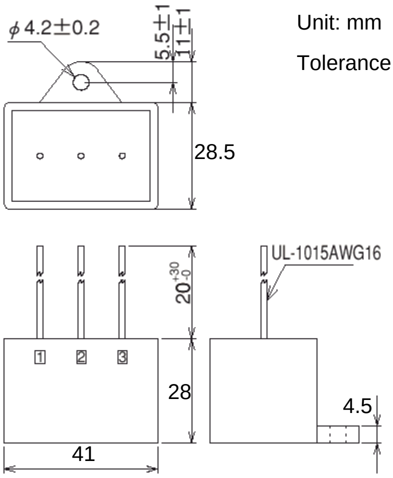
6.4 Surge protector

Insert a surge protector in the power input section to prevent damage to the control unit or power supply unit, etc. caused by the surge (lightning or sparks, etc.) applied on the AC power line.
Use a surge protector that satisfies the following electrical specifications.

(1) Surge protector R, A, V Series Okaya Electric Co., Ltd.

Part name	Circuit voltage 50/60Hz Vrms	Maximum tolerable circuit voltage	Clamp voltage (V) ± 10%	Surge withstand level 8/20 µS (A)	Surge withstand voltage 1.2/50 µS (V)	Electrostatic capacity	Service temperature
RAV-152BYZ-2A	3AC 430V	500V	1476V	2500A	20kV	35pF	-20 to 70°C

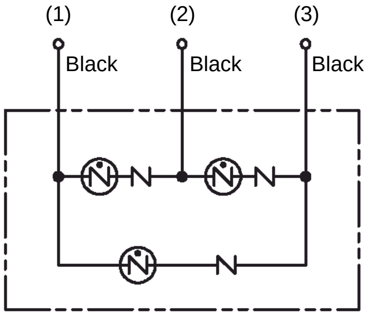
Outline dimension drawings



Unit: mm

Tolerance: ±10

Circuit diagram

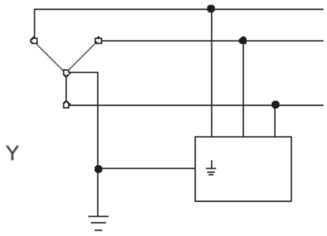


Refer to the maker's catalog for details on the surge protector's characteristics and specifications, etc.

(2) Surge protector RCM Series Okaya Electric Co., Ltd.

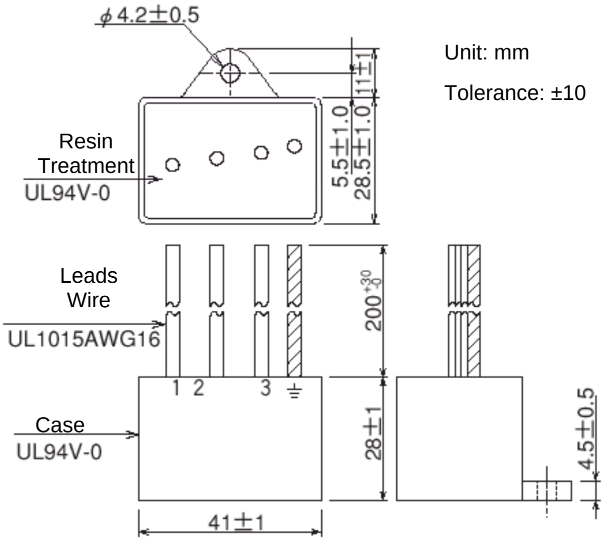
Part name	Rated voltage	AC discharge start voltage (V) ± 20%	Surge withstand level 8/20 µS (A)	Surge withstand voltage 1.25/50 µS (V)
RCM-781BUZ-4	3AC 250/430V	700VAC	2500A	2kV
RCM-801BUZ-4	3AC 290/500V	800VAC	2500A	2.32kV

For neutral point grounding



Voltage across three phases is 500Vrms or less

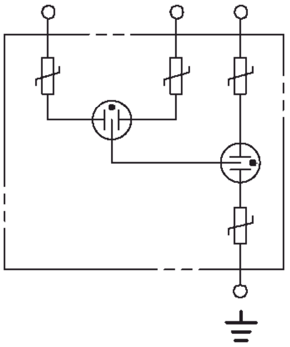
Outline dimension drawings



Unit: mm

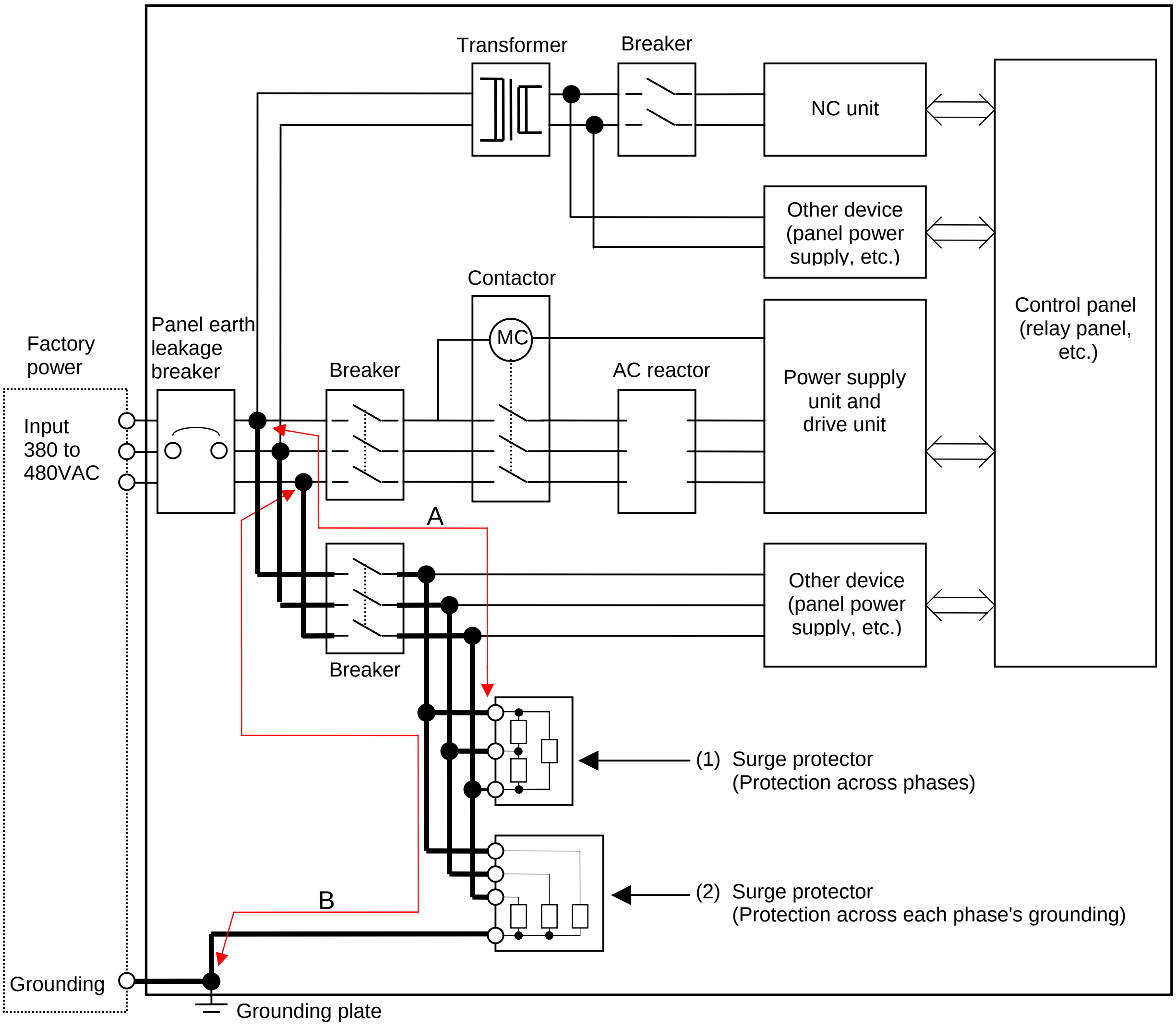
Tolerance: ±10

Circuit diagram



Example of surge protector installation

An example of installing the surge protector in the machine control panel is shown below. A short-circuit fault will occur in the surge protector if a surge exceeding the tolerance is applied. Thus, install a circuit protection breaker in the stage before the surge protector. Note that almost no current flows to the surge protector during normal use, so a breaker installed as the circuit protection for another device can be used for the surge protector.



Installing the surge absorber

⚠ CAUTION

1. The wires from the surge protector should be connected without extensions.
2. If the surge protector cannot be installed just with the enclosed wires, keep the wiring length of A and B to 2m or less. If the wires are long, the surge protector's performance may drop and inhibit protection of the devices in the panel.

Appendix 3. EC Declaration of conformity

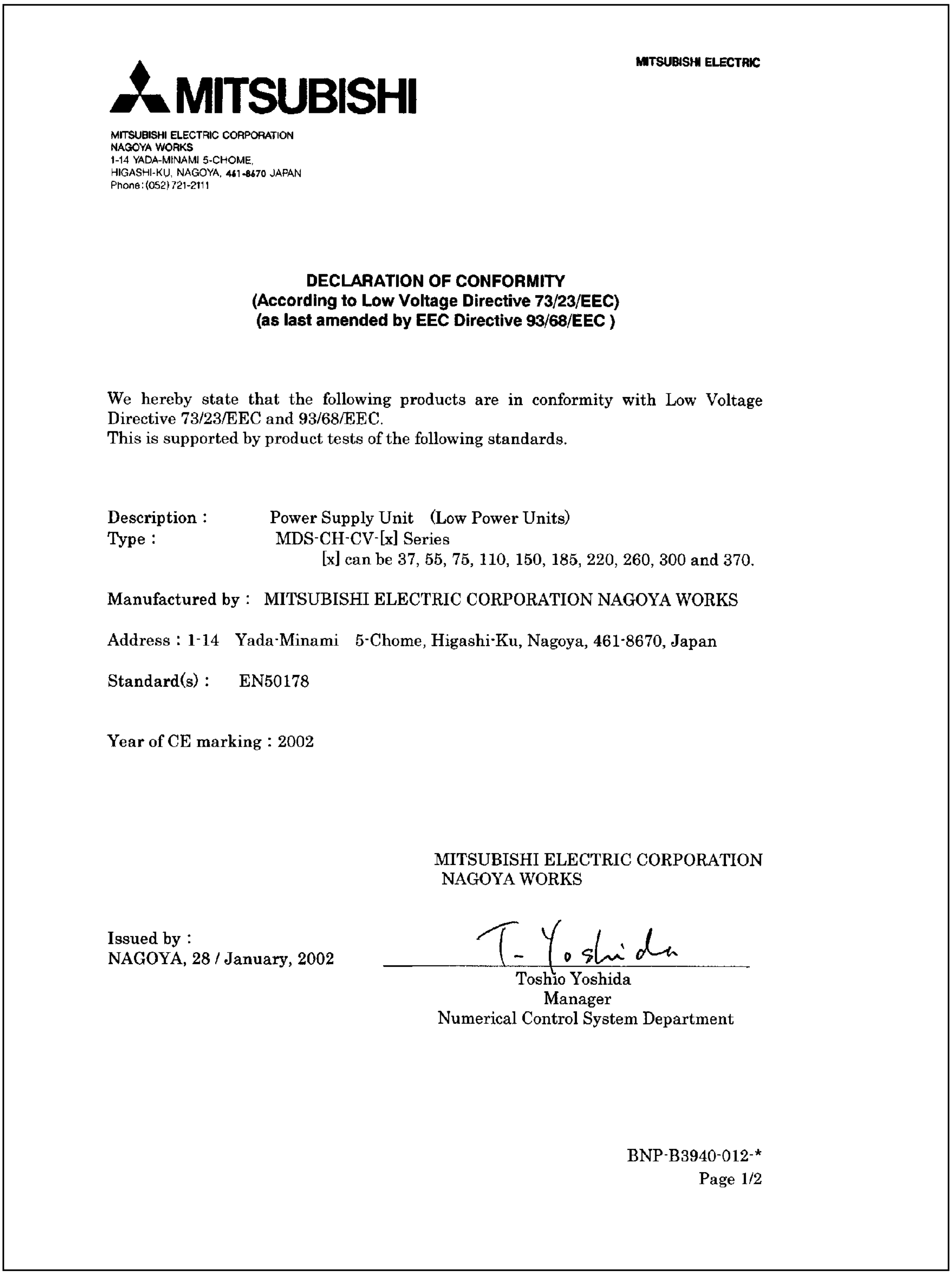
1. Low voltage equipment..A3-2
2. Electromagnetic compatibility..A3-12

Appendix 3 EC Declaration of conformity

MDS-CH Series can respond to LVD and EMC directive.
Approval from a third party certification organization has been acquired for the Low Voltage Directive.
The declaration of conformity of each unit is shown below.

1. Low voltage equipment

MDS-CH-CV-37 to 370



MITSUBISHI ELECTRIC

MITSUBISHI

MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS
1-14 YADA-MINAMI 5-CHOME,
HIGASHI-KU, NAGOYA, 461-8670 JAPAN
Phone: (052) 721-2111

DECLARATION OF CONFORMITY
(According to Low Voltage Directive 73/23/EEC)
(as last amended by EEC Directive 93/68/EEC)

We hereby state that the following products are in conformity with Low Voltage Directive 73/23/EEC and 93/68/EEC.
This is supported by product tests of the following standards.

Description : Power Supply Unit (Low Power Units)
Type : MDS-CH-CV-[x] Series
[x] can be 37, 55, 75, 110, 150, 185, 220, 260, 300 and 370.

Manufactured by : MITSUBISHI ELECTRIC CORPORATION NAGOYA WORKS

Address : 1-14 Yada-Minami 5-Chome, Higashi-Ku, Nagoya, 461-8670, Japan

Standard(s) : EN50178

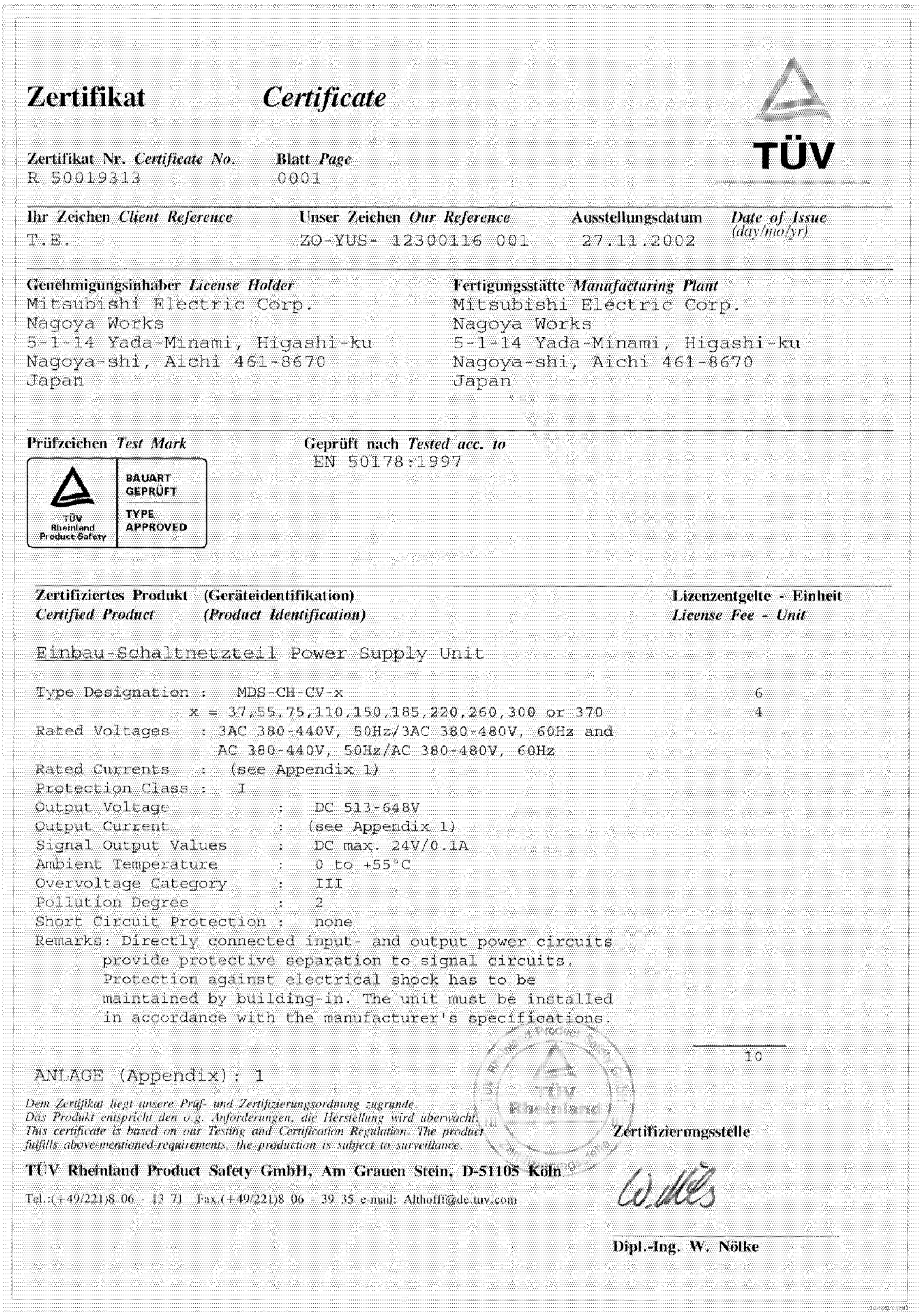
Year of CE marking : 2002

MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS

Issued by :
NAGOYA, 28 / January, 2002

T- Yoshida
Toshio Yoshida
Manager
Numerical Control System Department

BNP-B3940-012-*
Page 1/2



Zertifikat *Certificate*

TÜV

Zertifikat Nr. *Certificate No.* R 50019313

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Ihr Zeichen *Client Reference* T.E.

Unser Zeichen *Our Reference* ZO-YUS- 12300116 001

Ausstellungsdatum *Date of Issue (day/mo/yr)* 27.11.2002

Genehmigungsinhaber *License Holder*

Mitsubishi Electric Corp.
Nagoya Works
5-1-14 Yada-Minami, Higashi-ku
Nagoya-shi, Aichi 461-8670
Japan

Fertigungsstätte *Manufacturing Plant*

Mitsubishi Electric Corp.
Nagoya Works
5-1-14 Yada-Minami, Higashi-ku
Nagoya-shi, Aichi 461-8670
Japan

Prüfzeichen *Test Mark*

TÜV Rheinland Product Safety
BAUART GEPRÜFT
TYPE APPROVED

Geprüft nach *Tested acc. to*
EN 50178:1997

Zertifiziertes Produkt (Geräteidentifikation) *Certified Product (Product Identification)*	**Lizenzentgelte - Einheit** *License Fee - Unit*
Einbau-Schaltnetzteil Power Supply Unit	
Type Designation : MDS-CH-CV-x	6
x = 37,55,75,110,150,185,220,260,300 or 370	4

Rated Voltages : 3AC 380-440V, 50Hz/3AC 380-480V, 60Hz and
AC 380-440V, 50Hz/AC 380-480V, 60Hz
Rated Currents : (see Appendix 1)
Protection Class : I
Output Voltage : DC 513-648V
Output Current : (see Appendix 1)
Signal Output Values : DC max. 24V/0.1A
Ambient Temperature : 0 to +55°C
Overvoltage Category : III
Pollution Degree : 2
Short Circuit Protection : none

Remarks: Directly connected input- and output power circuits provide protective separation to signal circuits. Protection against electrical shock has to be maintained by building-in. The unit must be installed in accordance with the manufacturer's specifications.

10

ANLAGE (Appendix): 1

Dem Zertifikat liegt unsere Prüf- und Zertifizierungsordnung zugrunde. Das Produkt entspricht den o.g. Anforderungen, die Herstellung wird überwacht. This certificate is based on our Testing and Certification Regulation. The product fulfills above-mentioned requirements, the production is subject to surveillance.

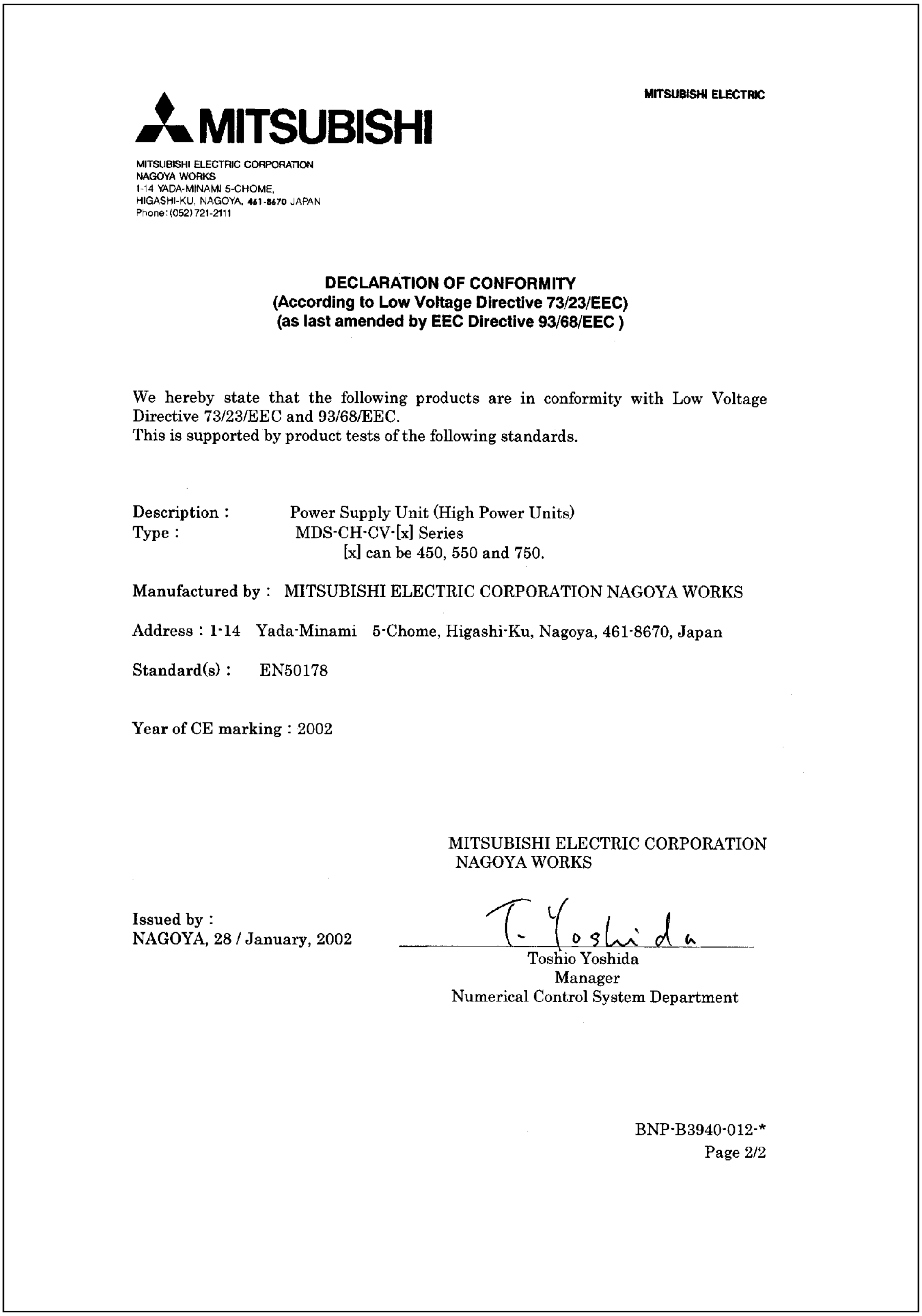
TÜV Rheinland Product Safety GmbH, Am Grauen Stein, D-51105 Köln
Tel.:(+49/221)8 06 - 13 71 Fax.(+49/221)8 06 - 39 35 e-mail: Althofff@de.tuv.com

Zertifizierungsstelle

Dipl.-Ing. W. Nölke

Supplement: Refer to "Chapter 10 Specifications" for the rated values indicated in (See Appendix 1).

MDS-CH-CV-450 to 750



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MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS
1-14 YADA-MINAMI 5-CHOME,
HIGASHI-KU, NAGOYA, 461-8670 JAPAN
Phone: (052) 721-2111

DECLARATION OF CONFORMITY
(According to Low Voltage Directive 73/23/EEC)
(as last amended by EEC Directive 93/68/EEC)

We hereby state that the following products are in conformity with Low Voltage Directive 73/23/EEC and 93/68/EEC.
This is supported by product tests of the following standards.

Description : Power Supply Unit (High Power Units)
Type : MDS-CH-CV-[x] Series
[x] can be 450, 550 and 750.

Manufactured by : MITSUBISHI ELECTRIC CORPORATION NAGOYA WORKS

Address : 1-14 Yada-Minami 5-Chome, Higashi-Ku, Nagoya, 461-8670, Japan

Standard(s) : EN50178

Year of CE marking : 2002

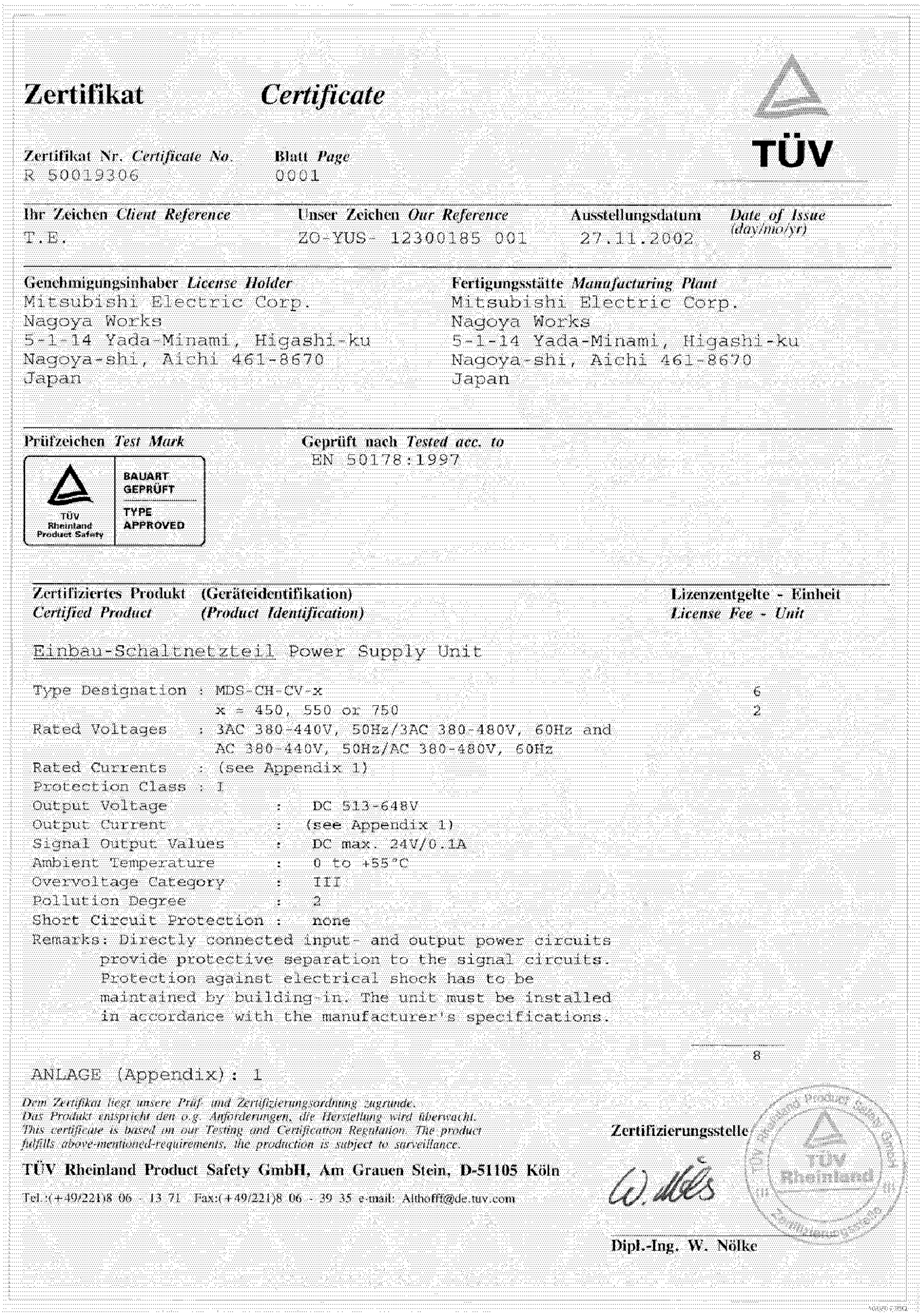
MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS

Issued by :
NAGOYA, 28 / January, 2002

T. Yoshida

Toshio Yoshida
Manager
Numerical Control System Department

BNP-B3940-012-*
Page 2/2



Zertifikat *Certificate*

TÜV

Zertifikat Nr. *Certificate No.* R 50019306
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Ihr Zeichen *Client Reference* T.E.
Unser Zeichen *Our Reference* ZO-YUS- 12300185 001
Ausstellungsdatum *Date of Issue (day/mo/yr)* 27.11.2002

Genehmigungsinhaber *License Holder*
Mitsubishi Electric Corp.
Nagoya Works
5-1-14 Yada-Minami, Higashi-ku
Nagoya-shi, Aichi 461-8670
Japan

Fertigungsstätte *Manufacturing Plant*
Mitsubishi Electric Corp.
Nagoya Works
5-1-14 Yada-Minami, Higashi-ku
Nagoya-shi, Aichi 461-8670
Japan

Prüfzeichen *Test Mark*
TÜV Rheinland Product Safety
BAUART GEPRÜFT
TYPE APPROVED

Geprüft nach *Tested acc. to*
EN 50178:1997

Zertifiziertes Produkt (Geräteidentifikation) *Certified Product (Product Identification)*
Lizenzentgelte - Einheit *License Fee - Unit*

Einbau-Schaltnetzteil Power Supply Unit

Type Designation : MDS-CH-CV-x 6
x = 450, 550 or 750 2
Rated Voltages : 3AC 380-440V, 50Hz/3AC 380-480V, 60Hz and
AC 380-440V, 50Hz/AC 380-480V, 60Hz
Rated Currents : (see Appendix 1)
Protection Class : I
Output Voltage : DC 513-648V
Output Current : (see Appendix 1)
Signal Output Values : DC max. 24V/0.1A
Ambient Temperature : 0 to +55°C
Overvoltage Category : III
Pollution Degree : 2
Short Circuit Protection : none
Remarks: Directly connected input- and output power circuits provide protective separation to the signal circuits. Protection against electrical shock has to be maintained by building-in. The unit must be installed in accordance with the manufacturer's specifications.

8

ANLAGE (Appendix): 1

Dem Zertifikat liegt unsere Prüf- und Zertifizierungsordnung zugrunde.
Das Produkt entspricht den o.g. Anforderungen, die Herstellung wird überwacht.
This certificate is based on our Testing and Certification Regulation. The product fulfills above-mentioned-requirements, the production is subject to surveillance.

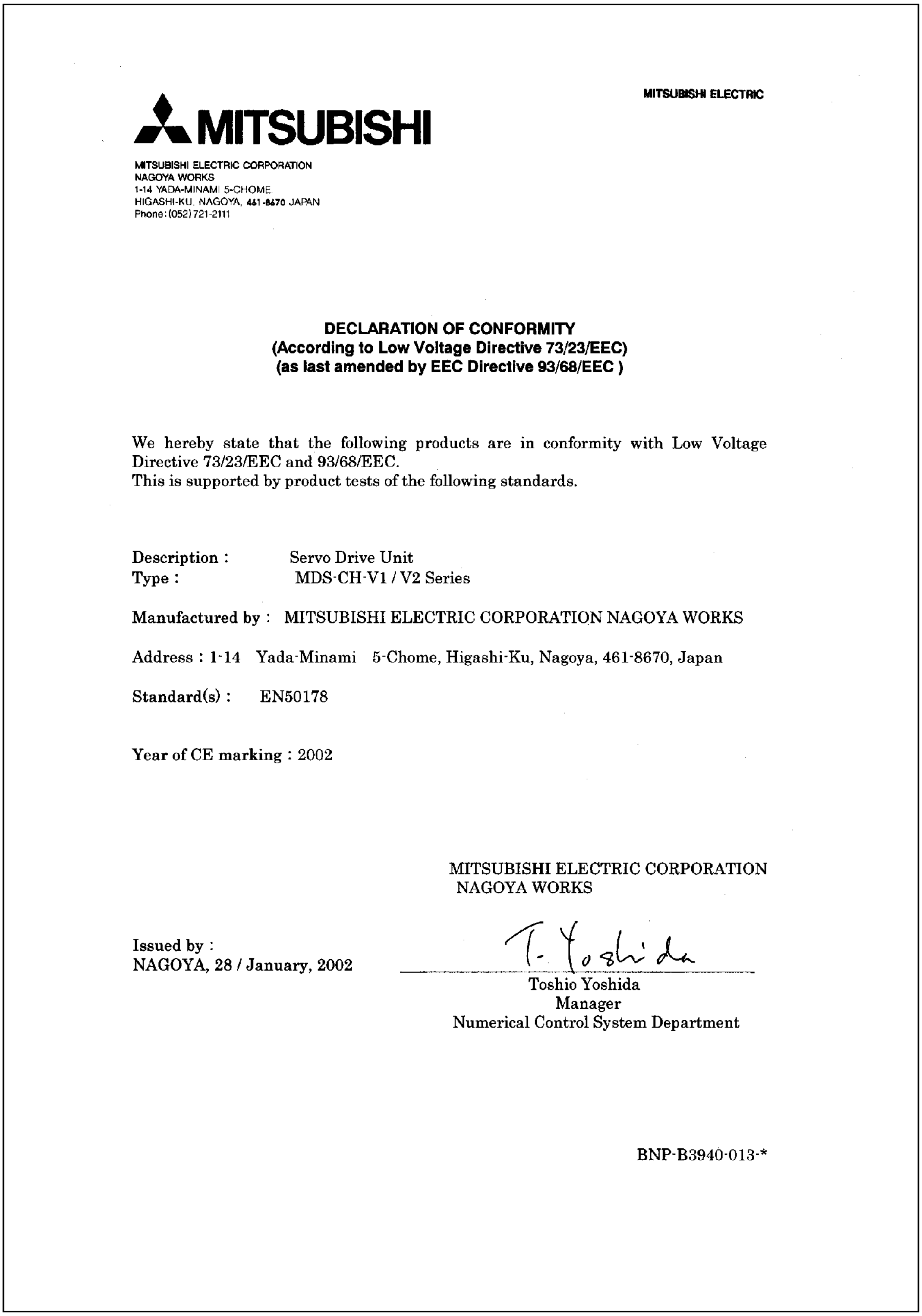
TÜV Rheinland Product Safety GmbH, Am Grauen Stein, D-51105 Köln
Tel.:(+49/221)8 06 - 13 71 Fax:(+49/221)8 06 - 39 35 e-mail: Althofff@de.tuv.com

Zertifizierungsstelle

Dipl.-Ing. W. Nölke

Supplement: Refer to "Chapter 10 Specifications" for the rated values indicated in (See Appendix 1).

MDS-CH-V1-05 to 150
MDS-CH-V2-0505 to 4535



MITSUBISHI ELECTRIC

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MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS
1-14 YADA-MINAMI 5-CHOME
HIGASHI-KU, NAGOYA, 461-8670 JAPAN
Phone:(052) 721-2111

DECLARATION OF CONFORMITY
(According to Low Voltage Directive 73/23/EEC)
(as last amended by EEC Directive 93/68/EEC)

We hereby state that the following products are in conformity with Low Voltage Directive 73/23/EEC and 93/68/EEC.
This is supported by product tests of the following standards.

Description : Servo Drive Unit
Type : MDS-CH-V1 / V2 Series

Manufactured by : MITSUBISHI ELECTRIC CORPORATION NAGOYA WORKS

Address : 1-14 Yada-Minami 5-Chome, Higashi-Ku, Nagoya, 461-8670, Japan

Standard(s) : EN50178

Year of CE marking : 2002

MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS

Issued by :
NAGOYA, 28 / January, 2002

T. Yoshida

Toshio Yoshida
Manager
Numerical Control System Department

BNP-B3940-013-*

Zertifikat *Certificate*

TÜV

Zertifikat Nr. *Certificate No.*
R 50019316

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Ihr Zeichen *Client Reference*
T.E.

Unser Zeichen *Our Reference*
ZO-YUS- 12300116 001

Ausstellungsdatum *Date of Issue (day/mo/yr)*
27.11.2002

Genehmigungsinhaber *License Holder*
Mitsubishi Electric Corp.
Nagoya Works
5-1-14 Yada-Minami, Higashi-ku
Nagoya-shi, Aichi 461-8670
Japan

Fertigungsstätte *Manufacturing Plant*
Mitsubishi Electric Corp.
Nagoya Works
5-1-14 Yada-Minami, Higashi-ku
Nagoya-shi, Aichi 461-8670
Japan

Prüfzeichen *Test Mark*
TÜV Rheinland Product Safety
BAUART GEPRÜFT
TYPE APPROVED

Geprüft nach *Tested acc. to*
EN 50178:1997

Zertifiziertes Produkt (Geräteidentifikation)
Certified Product (Product Identification)

Lizenzentgelte - Einheit
License Fee - Unit

Steuergerät für Stellmotoren AC Servo Drive Unit

Type Designations : MDS-CH-V1-xx 5
MDS-CH-V2-xxxx 1
xx, xxxx = (see table 1 of Appendix 1 & 1.1) 4
Rated Voltages : DC 513-648V and
AC 380-440V, 50Hz/AC 380-480V, 60Hz
Rated Currents : (see Appendix 1 or 1.1)
Protection Class : I
Output Voltage : 3AC 456V, 0 - 240Hz
Output Current : (see Appendix 1 or 1.1)
Ambient Temperature : 0 to +55°C
Overvoltage Category : III
Pollution Degree : 2
Short Circuit Protection : none
Remarks: Directly connected input- and output power circuits provide protective separation to signal circuits. Protection against electrical shock has to be maintained by building-in. The unit must be installed in accordance with the manufacturer's specifications.

10

ANLAGE (Appendix): 1, 1.1

Dem Zertifikat liegt unsere Prüf- und Zertifizierungsordnung zugrunde.
Das Produkt entspricht den o.g. Anforderungen, die Herstellung wird überwacht.
This certificate is based on our Testing and Certification Regulation. The product fulfills above-mentioned-requirements, the production is subject to surveillance.

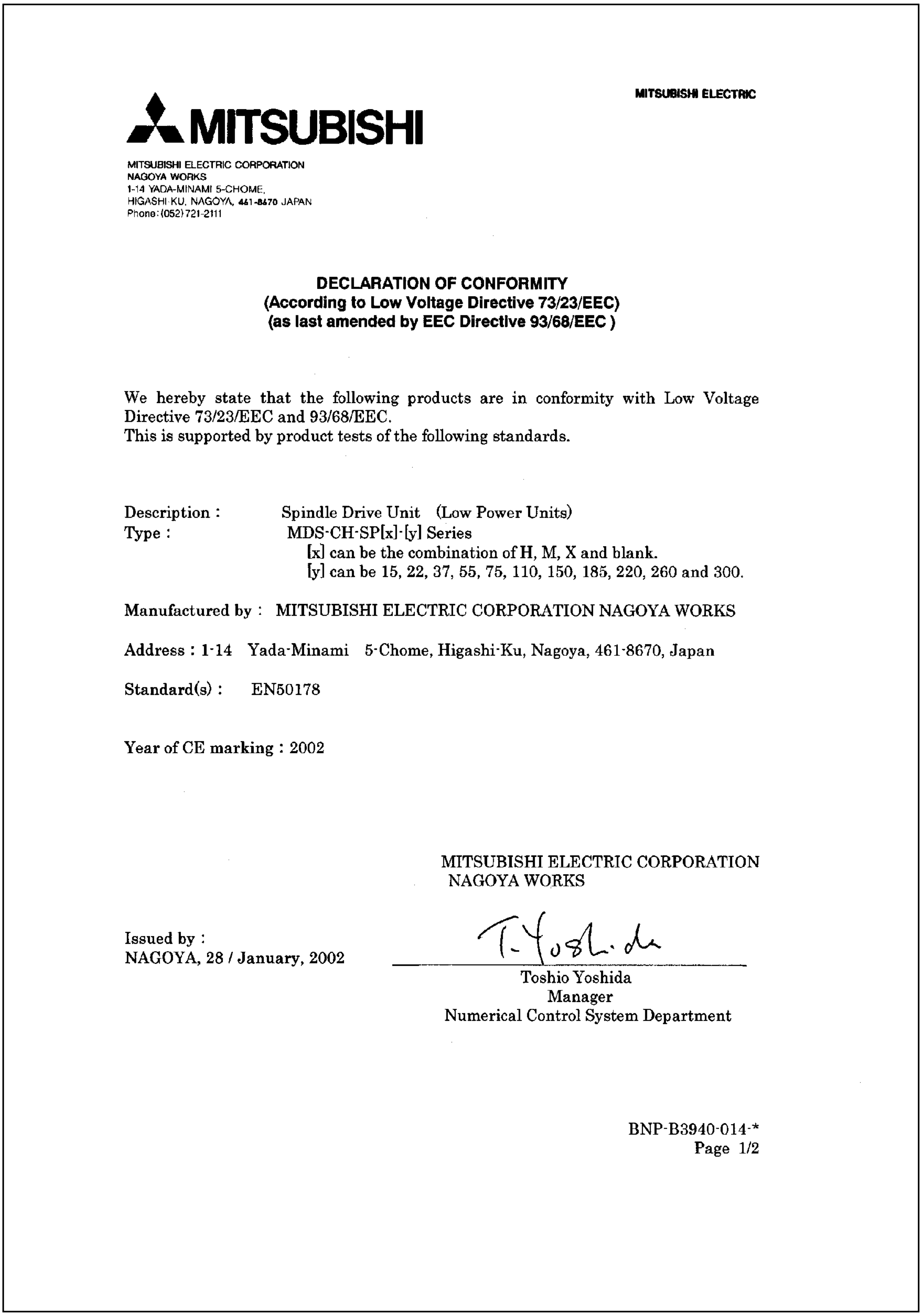
TÜV Rheinland Product Safety GmbH, Am Grauen Stein, D-51105 Köln
Tel.:(+49/221)8 06 - 13 71 Fax:(+49/221)8 06 - 39 35 e-mail: Althofff@de.tuv.com

Zertifizierungsstelle

Dipl.-Ing. W. Nölke

Supplement: Refer to "Chapter 10 Specifications" for the rated values indicated in (See Appendix 1).

MDS-CH-SP□-04 to 300



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MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS
1-14 YADA-MINAMI 5-CHOME,
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Phone: (052) 721-2111

DECLARATION OF CONFORMITY
(According to Low Voltage Directive 73/23/EEC)
(as last amended by EEC Directive 93/68/EEC)

We hereby state that the following products are in conformity with Low Voltage Directive 73/23/EEC and 93/68/EEC.
This is supported by product tests of the following standards.

Description : Spindle Drive Unit (Low Power Units)
Type : MDS-CH-SP[x]-[y] Series
[x] can be the combination of H, M, X and blank.
[y] can be 15, 22, 37, 55, 75, 110, 150, 185, 220, 260 and 300.

Manufactured by : MITSUBISHI ELECTRIC CORPORATION NAGOYA WORKS

Address : 1-14 Yada-Minami 5-Chome, Higashi-Ku, Nagoya, 461-8670, Japan

Standard(s) : EN50178

Year of CE marking : 2002

MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS

Issued by :
NAGOYA, 28 / January, 2002

T. Yoshida

Toshio Yoshida
Manager
Numerical Control System Department

BNP-B3940-014-*
Page 1/2

Zertifikat *Certificate*

TÜV

Zertifikat Nr. *Certificate No.* R 50019315

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Ihr Zeichen *Client Reference* T.E.

Unser Zeichen *Our Reference* ZO-YUS- 12300116 001

Ausstellungsdatum *Date of Issue (day/mo/yr)* 27.11.2002

Genehmigungsinhaber *License Holder*
Mitsubishi Electric Corp.
Nagoya Works
5-1-14 Yada-Minami, Higashi-ku
Nagoya-shi, Aichi 461-8670
Japan

Fertigungsstätte *Manufacturing Plant*
Mitsubishi Electric Corp.
Nagoya Works
5-1-14 Yada-Minami, Higashi-ku
Nagoya-shi, Aichi 461-8670
Japan

Prüfzeichen *Test Mark*

TÜV Rheinland Product Safety
BAUART GEPRÜFT
TYPE APPROVED

Geprüft nach *Tested acc. to*
EN 50178:1997

Zertifiziertes Produkt (Geräteidentifikation) *Certified Product (Product Identification)*	Lizenzentgelte - Einheit *License Fee - Unit*
Steuergerät für Stellmotoren AC Spindle Drive Unit	
Type Designation : MDS-CH-SPy-x	6
x = 22,37,55,75,110,150,185,220,260 or 300	4
y = H, M or blank	1

Rated Voltages : DC 513-648V and
AC 380-440V, 50Hz/AC 380-480V, 60Hz
Rated Currents : (see Appendix 1)
Protection Class : I
Output Voltage : 3AC 340V, 0-500Hz/0-1167Hz(only y=H)
Output Current : (see Appendix 1)
Ambient Temperature : 0 to +55°C
Overvoltage Category : III
Pollution Degree : 2
Short Circuit Protection : none
Remarks: Directly connected input- and output power circuits provide protective separation to signal circuits. Protection against electrical shock has to be maintained by building-in. The unit must be installed in accordance with the manufacturer's specifications.

11

ANLAGE (Appendix): 1

Dem Zertifikat liegt unsere Prüf- und Zertifizierungsordnung zugrunde. Das Produkt entspricht den o.g. Anforderungen, die Herstellung wird überwacht. This certificate is based on our Testing and Certification Regulation. The product fulfills above-mentioned requirements, the production is subject to surveillance.

TÜV Rheinland Product Safety GmbH, Am Grauen Stein, D-51105 Köln

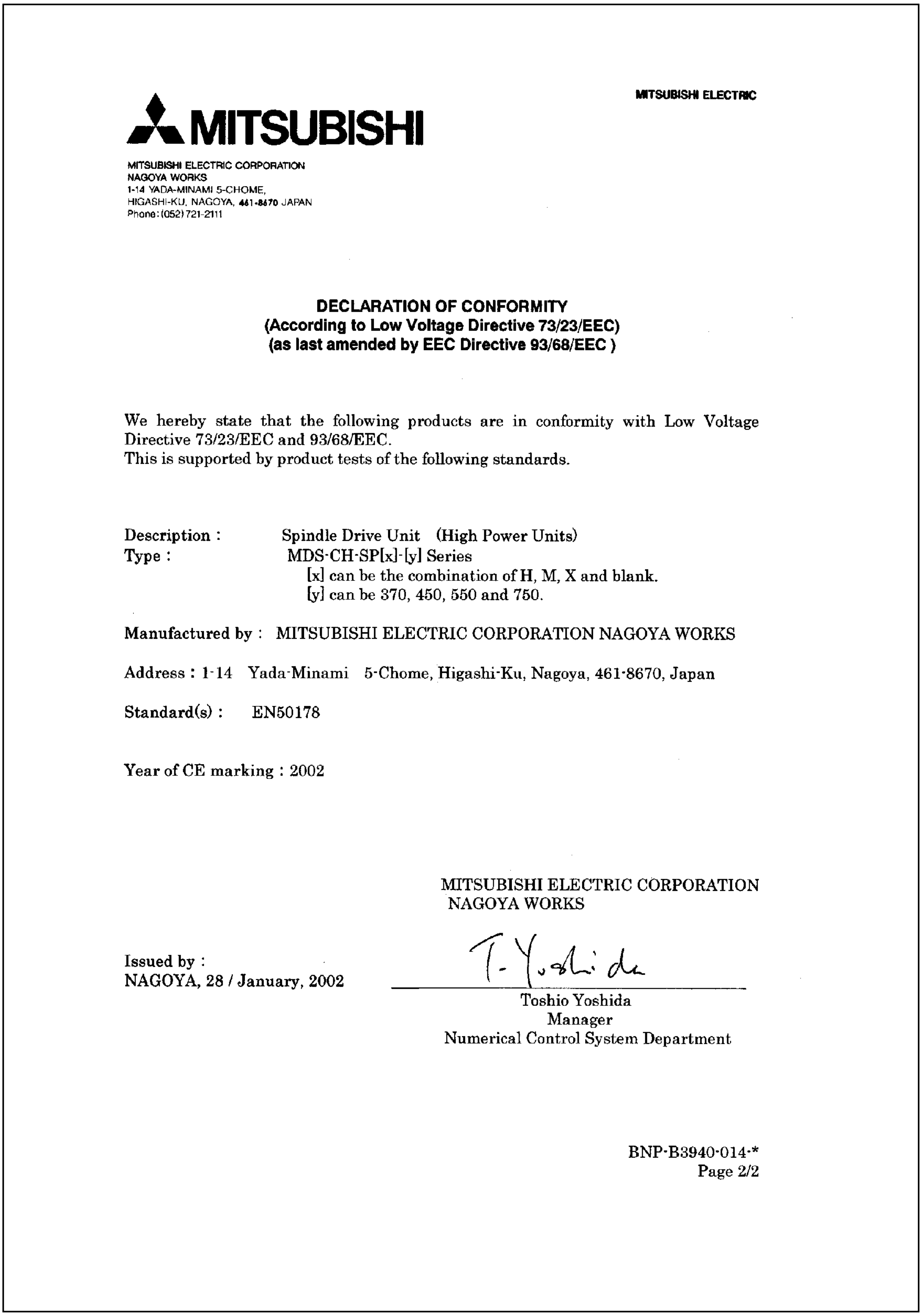
Tel.:(+49/221)8 06 - 13 71 Fax:(+49/221)8 06 - 39 35 e-mail: Althofff@de.tuv.com

Zertifizierungsstelle

Dipl.-Ing. W. Nölke

Supplement: Refer to "Chapter 10 Specifications" for the rated values indicated in (See Appendix 1).

MDS-CH-SP[ ]-370 to 750



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MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS
1-14 YADA-MINAMI 5-CHOME,
HIGASHI-KU, NAGOYA, 461-8670 JAPAN
Phone: (052) 721-2111

DECLARATION OF CONFORMITY
(According to Low Voltage Directive 73/23/EEC)
(as last amended by EEC Directive 93/68/EEC)

We hereby state that the following products are in conformity with Low Voltage Directive 73/23/EEC and 93/68/EEC.
This is supported by product tests of the following standards.

Description : Spindle Drive Unit (High Power Units)
Type : MDS-CH-SP[x]-[y] Series
[x] can be the combination of H, M, X and blank.
[y] can be 370, 450, 550 and 750.

Manufactured by : MITSUBISHI ELECTRIC CORPORATION NAGOYA WORKS

Address : 1-14 Yada-Minami 5-Chome, Higashi-Ku, Nagoya, 461-8670, Japan

Standard(s) : EN50178

Year of CE marking : 2002

MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS

Issued by :
NAGOYA, 28 / January, 2002

T. Yoshida

Toshio Yoshida
Manager
Numerical Control System Department

BNP-B3940-014-*
Page 2/2

Zertifikat *Certificate*

TÜV

Zertifikat Nr. *Certificate No.*
R 50019308

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0001

Ihr Zeichen *Client Reference*
T.E.

Unser Zeichen *Our Reference*
ZO-YUS- 12300185 001

Ausstellungsdatum *Date of Issue* *(day/mo/yr)*
27.11.2002

Genehmigungsinhaber *License Holder*
Mitsubishi Electric Corp.
Nagoya Works
5-1-14 Yada-Minami, Higashi-ku
Nagoya-shi, Aichi 461-8670
Japan

Fertigungsstätte *Manufacturing Plant*
Mitsubishi Electric Corp.
Nagoya Works
5-1-14 Yada-Minami, Higashi-ku
Nagoya-shi, Aichi 461-8670
Japan

Prüfzeichen *Test Mark*

TÜV Rheinland Product Safety
BAUART GEPRÜFT
TYPE APPROVED

Geprüft nach *Tested acc. to*
EN 50178:1997

Zertifiziertes Produkt (Geräteidentifikation) *Certified Product (Product Identification)*		**Lizenzentgelte - Einheit** *License Fee - Unit*
Steuergerät für Stellmotoren AC Spindle Drive Unit		
Type Designation	: MDS-CH-SPy-x	6
	x = 370, 450, 550 or 750	2
	y = H, M or blank	1
Rated Voltages	: DC 513-648V and	
	AC 380-440V, 50Hz/AC 380-480V, 60Hz	
Rated Currents	: (see Appendix 1)	
Protection Class	: I	
Output Voltage	: 3AC 340V, 0-500Hz/0-1167Hz(only y=H)	
Output Current	: (see Appendix 1)	
Ambient Temperature	: 0 to +55°C	
Overvoltage Category	: III	
Pollution Degree	: 2	
Short Circuit Protection	: none	
		9

Remarks: Directly connected input- and output power circuits provide protective separation to signal circuits. Protection against electrical shock has to be maintained by building-in. The unit must be installed in accordance with the manufacturer's specifications.

ANLAGE (Appendix): 1

Dem Zertifikat liegt unsere Prüf- und Zertifizierungsordnung zugrunde.
Das Produkt entspricht den o.g. Anforderungen, die Herstellung wird überwacht.
This certificate is based on our Testing and Certification Regulation. The product fulfills above-mentioned-requirements, the production is subject to surveillance.

TÜV Rheinland Product Safety GmbH, Am Grauen Stein, D-51105 Köln
Tel.:(+49/221)8 06 - 13 71 Fax:(+49/221)8 06 - 39 35 e-mail: Althofff@de.tuv.com

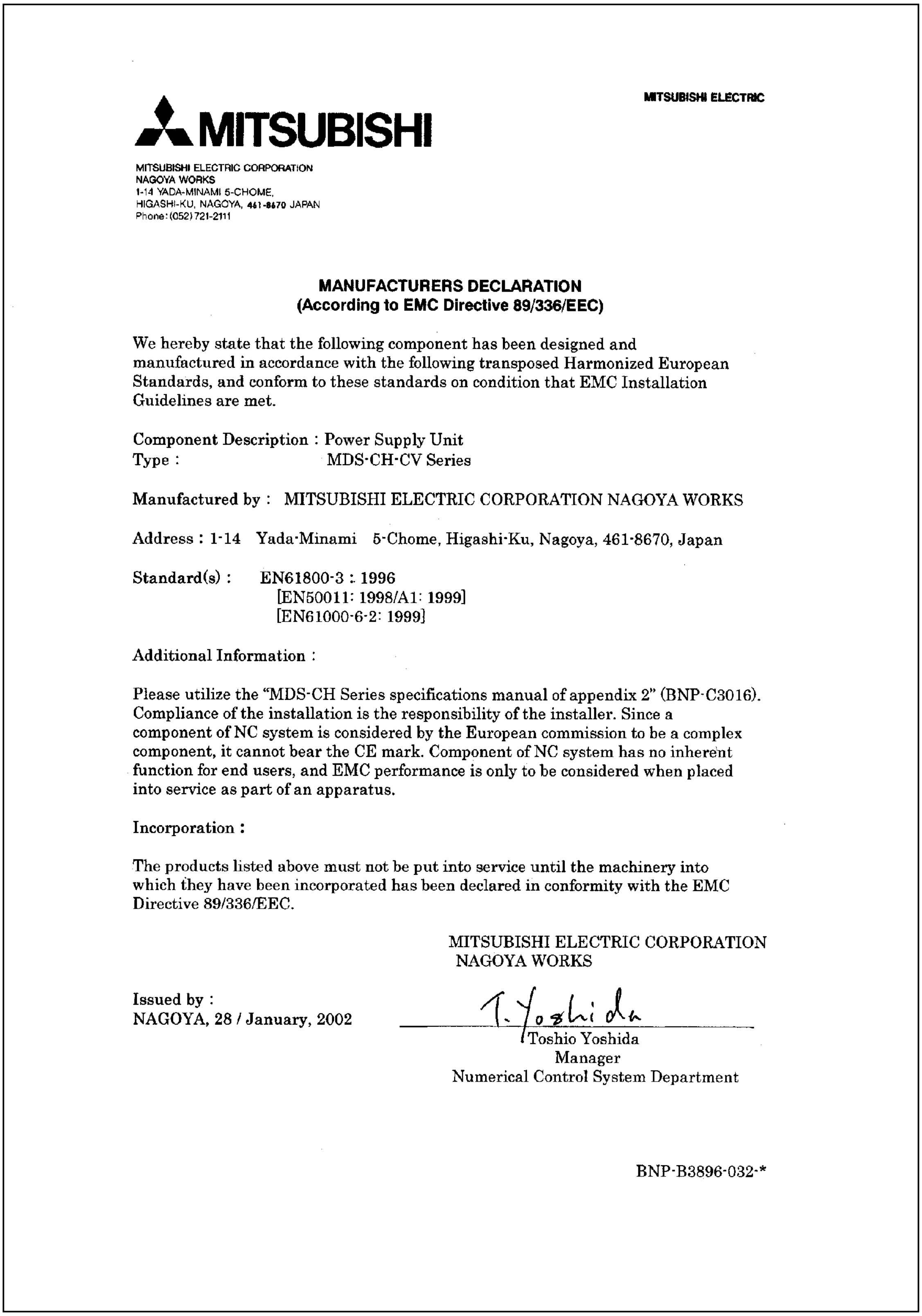
Zertifizierungsstelle

Dipl.-Ing. W. Nölke

Supplement: Refer to "Chapter 10 Specifications" for the rated values indicated in (See Appendix 1).

2. Electromagnetic compatibility

MDS-CH-CV-37 to 370



MITSUBISHI ELECTRIC

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MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS
1-14 YADA-MINAMI 5-CHOME,
HIGASHI-KU, NAGOYA, 461-8670 JAPAN
Phone: (052) 721-2111

MANUFACTURERS DECLARATION
(According to EMC Directive 89/336/EEC)

We hereby state that the following component has been designed and manufactured in accordance with the following transposed Harmonized European Standards, and conform to these standards on condition that EMC Installation Guidelines are met.

Component Description : Power Supply Unit
Type : MDS-CH-CV Series

Manufactured by : MITSUBISHI ELECTRIC CORPORATION NAGOYA WORKS

Address : 1-14 Yada-Minami 5-Chome, Higashi-Ku, Nagoya, 461-8670, Japan

Standard(s) : EN61800-3 : 1996
[EN50011: 1998/A1: 1999]
[EN61000-6-2: 1999]

Additional Information :

Please utilize the "MDS-CH Series specifications manual of appendix 2" (BNP-C3016). Compliance of the installation is the responsibility of the installer. Since a component of NC system is considered by the European commission to be a complex component, it cannot bear the CE mark. Component of NC system has no inherent function for end users, and EMC performance is only to be considered when placed into service as part of an apparatus.

Incorporation :

The products listed above must not be put into service until the machinery into which they have been incorporated has been declared in conformity with the EMC Directive 89/336/EEC.

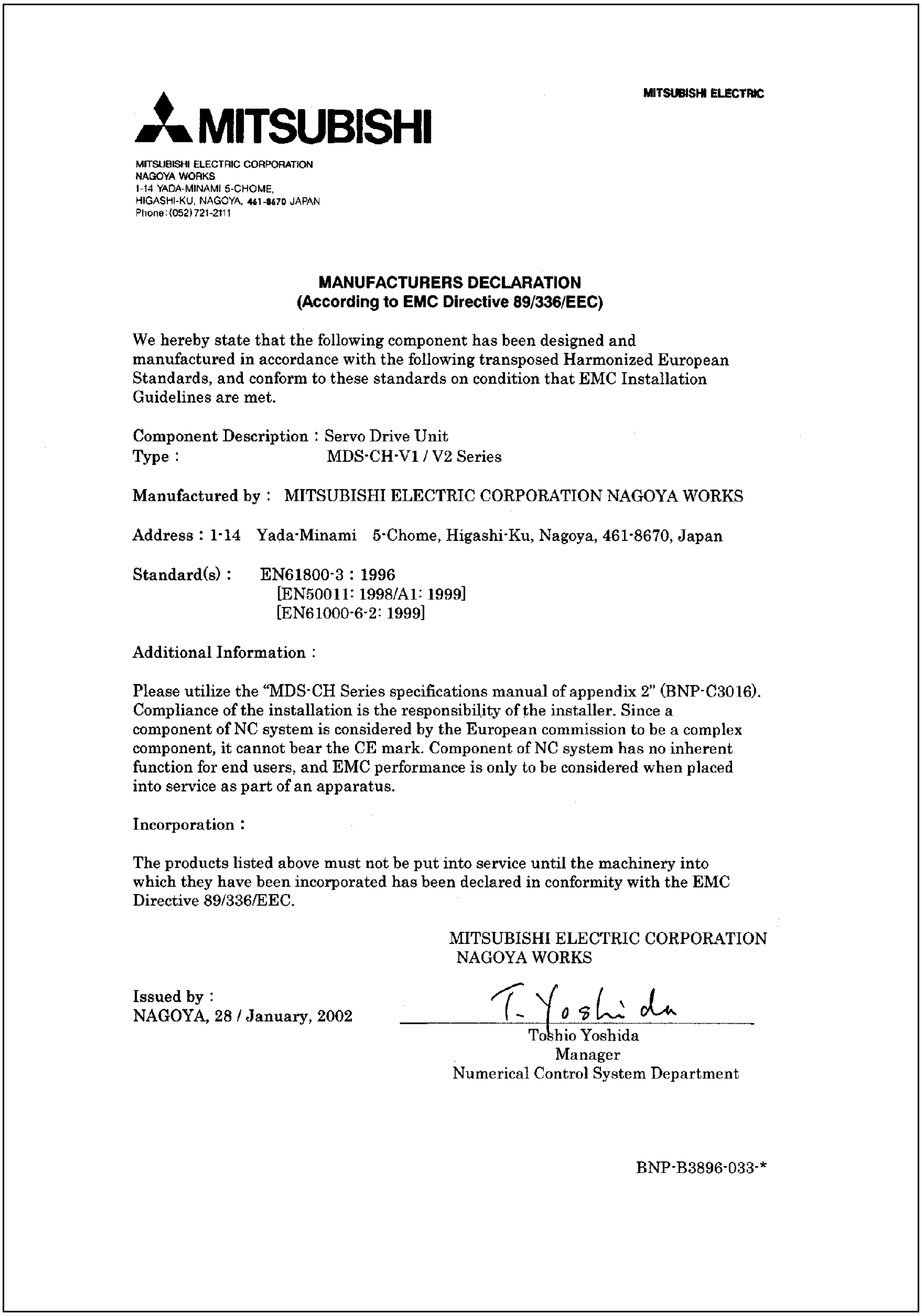
MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS

Issued by :
NAGOYA, 28 / January, 2002

T. Yoshida
Toshio Yoshida
Manager
Numerical Control System Department

BNP-B3896-032-*

MDS-CH-V1-05 to 150
MDS-CH-V2-0505 to 4535



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MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS
1-14 YADA-MINAMI 5-CHOME,
HIGASHI-KU, NAGOYA, 461-8670 JAPAN
Phone: (052) 721-2111

MANUFACTURERS DECLARATION
(According to EMC Directive 89/336/EEC)

We hereby state that the following component has been designed and manufactured in accordance with the following transposed Harmonized European Standards, and conform to these standards on condition that EMC Installation Guidelines are met.

Component Description : Servo Drive Unit
Type : MDS-CH-V1 / V2 Series

Manufactured by : MITSUBISHI ELECTRIC CORPORATION NAGOYA WORKS

Address : 1-14 Yada-Minami 5-Chome, Higashi-Ku, Nagoya, 461-8670, Japan

Standard(s) : EN61800-3 : 1996
[EN50011: 1998/A1: 1999]
[EN61000-6-2: 1999]

Additional Information :

Please utilize the "MDS-CH Series specifications manual of appendix 2" (BNP-C3016). Compliance of the installation is the responsibility of the installer. Since a component of NC system is considered by the European commission to be a complex component, it cannot bear the CE mark. Component of NC system has no inherent function for end users, and EMC performance is only to be considered when placed into service as part of an apparatus.

Incorporation :

The products listed above must not be put into service until the machinery into which they have been incorporated has been declared in conformity with the EMC Directive 89/336/EEC.

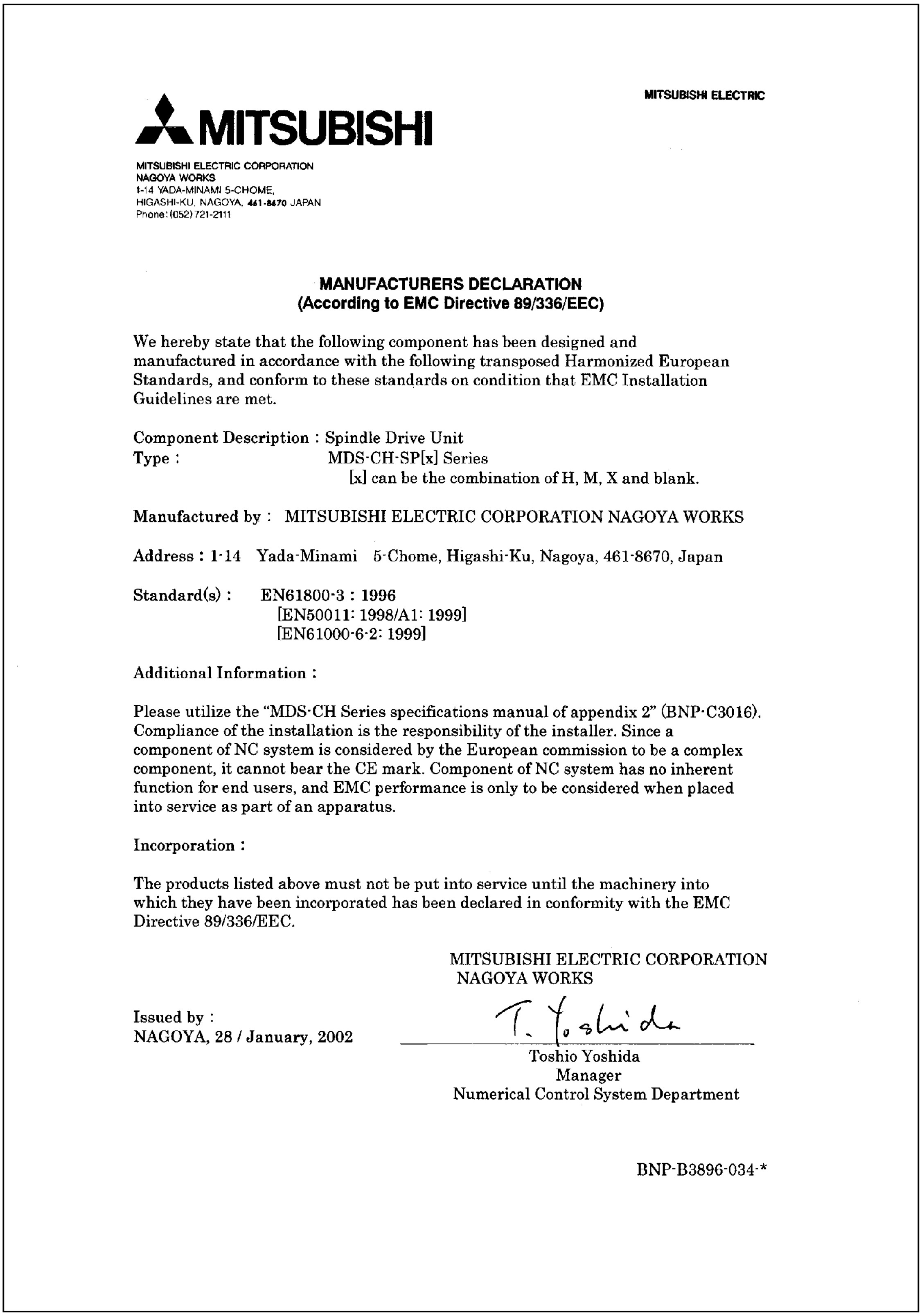
MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS

Issued by :
NAGOYA, 28 / January, 2002

T. Yoshida
Toshio Yoshida
Manager
Numerical Control System Department

BNP-B3896-033-*

MDS-CH-SP[_]-04 to 750



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MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS
1-14 YADA-MINAMI 5-CHOME,
HIGASHI-KU, NAGOYA, 461-8670 JAPAN
Phone: (052) 721-2111

MANUFACTURERS DECLARATION
(According to EMC Directive 89/336/EEC)

We hereby state that the following component has been designed and manufactured in accordance with the following transposed Harmonized European Standards, and conform to these standards on condition that EMC Installation Guidelines are met.

Component Description : Spindle Drive Unit
Type : MDS-CH-SP[x] Series
[x] can be the combination of H, M, X and blank.

Manufactured by : MITSUBISHI ELECTRIC CORPORATION NAGOYA WORKS

Address : 1-14 Yada-Minami 5-Chome, Higashi-Ku, Nagoya, 461-8670, Japan

Standard(s) : EN61800-3 : 1996
[EN50011: 1998/A1: 1999]
[EN61000-6-2: 1999]

Additional Information :

Please utilize the "MDS-CH Series specifications manual of appendix 2" (BNP-C3016). Compliance of the installation is the responsibility of the installer. Since a component of NC system is considered by the European commission to be a complex component, it cannot bear the CE mark. Component of NC system has no inherent function for end users, and EMC performance is only to be considered when placed into service as part of an apparatus.

Incorporation :

The products listed above must not be put into service until the machinery into which they have been incorporated has been declared in conformity with the EMC Directive 89/336/EEC.

MITSUBISHI ELECTRIC CORPORATION
NAGOYA WORKS

Issued by :
NAGOYA, 28 / January, 2002

T. Yoshida

Toshio Yoshida
Manager
Numerical Control System Department

BNP-B3896-034-*

Appendix 4. Instruction Manual for Compliance with UL/c-UL Standard

1. UL/c-UL listed products A4-2
2. Operation surrounding air ambient temperature A4-3
3. Notes for AC servo/spindle system A4-3
   3.1 General Precaution A4-3
   3.2 Installation A4-3
   3.3 Short-circuit ratings A4-3
   3.4 Peripheral devices A4-3
   3.5 Field Wiring Reference Table for Input and Output A4-4
      3.5.1 Power Supply Unit (MDS-CH-CV) A4-4
      3.5.2 Spindle Drive Unit (MDS-CH-SP) A4-5
      3.5.3 Servo Drive Unit (MDS-CH-V1/V2) A4-6
   3.6 Motor Over Load Protection A4-6
      3.6.1 MDS-CH-SP A4-7
      3.6.2 MDS-CH-V1/V2 .... A4-7
   3.7 Flange of servomotor A4-7
   3.8 Spindle Drive / Motor Combinations A4-7
4. AC Servo/Spindle System Connection A4-8

Appendix 4 Instruction Manual for Compliance with UL/c-UL Standard

The instruction of UL/c-UL listed products is described in this manual.
The descriptions of this manual are conditions to meet the UL/c-UL standard for the UL/c-UL listed products. To obtain the best performance, be sure to read this manual carefully before use.
To ensure proper use, be sure to read specification manual, connection manual and maintenance manual carefully for each product before use.

1. UL/c-UL listed products

[AC servo/spindle system]

Unit name	Unit part number
Power supply unit [Note 1]	MDS-CH-CV- [*1]
Servo drive unit	MDS-CH-V1- [*2], MDS-CH-V2- [*3]
Spindle drive unit	MDS-CH-SP [*4]-[*5]
Option unit	MDS-B-PJEX
Battery unit	FCU6-BT[*6], MDS-A-BT-[*7]
Servo motor	HC-H [*10][*11][*12][*13]-[*14][*15]
Spindle Motor	SJ-4- [*20][*21][*22]-[*23][*24][*25][*26]-[*27] SJ-4- [*28][*29][*30][*31][*32][*33][*34]

Suffixes listed below may be attached to the above part numbers at portions marked with [*]. For details regarding specifications, see the specification manuals.

[*1] 37, 55, 75, 110, 150, 185, 220, 260, 300, 370, 450, 550, 750
[*2] 10, 20, 35, 45, 70, 90, 110, 150
[*3] 2010, 2020, 3510, 3520, 3535, 4520, 4535
[*4] None, H, M
[*5] 22, 37, 55, 75, 110, 150, 185, 220, 260, 300, 370, 450, 550, 750
[*6] 4D1, BOX
[*7] 2, 4, 6, 8
[*10] 10, 15, 20, 35, 45, 70, 90, 110
[*11] 2, 3
[*12] None, B
[*13] S, T
[*14] A, E
[*15] 42, 51
[*20] V, VL, PMF
[*18] None, K
[*22] None, S
[*23] Two digits decimal two digits
[*24] 01~99
[*25] None, F, G, Y, Z
[*26] None, M
[*27] None, S01~S99
[*28] None, K
[*29] Two digits decimal two digits
[*30] A, B, L, M, N, X
[*31] None, W, Hex
[*32] None, D, H, P, Z
[*33] None, B, C, F, G, R
[*34] None, M

Note 1) AC reactor (CH-AL-75 ~ 750) is included in the power supply unit.

2. Operation surrounding air ambient temperature

The recognized operation ambient temperature of each units are as shown in the table below. The recognized operation ambient temperatures are the same as an original product specification for all of the units.

Classification	Unit name	Operation ambient temperature
AC Servo/Spindle System	Power supply unit	0 to 55°C
	Servo, Spindle drive unit	0 to 55°C
	Option unit, Battery unit	0 to 55°C
	Servo, Spindle motor	0 to 40°C

3. Notes for AC servo/spindle system

3.1 General Precaution

It takes 15 minutes to discharge the bus capacitor.
When starting wiring or inspection, shut the power off and wait for more than 15 minutes to avoid a hazard of electrical shock.

3.2 Installation

MDS-CH Series have been approved as the products which have been installed in the electrical enclosure. The minimum enclosure size is based on 150 percent of each MDS-CH Series combination.
And also, design the enclosure so that the ambient temperature in the enclosure is 55°C (131°F) or less, refer to the specifications manual.

3.3 Short-circuit ratings

Suitable for use in a circuit capable of delivering, not more than 5kA rms symmetrical amperes.

3.4 Peripheral devices

To comply with UL/c-UL Standard, use the peripheral devices which conform to the corresponding standard.

- Circuit Breaker, Fuses, Magnetic Contactor and AC Reactor

Applicable power supply unit	Circuit Breaker	Fuse Class K5	Magnetic contactor (AC3)	AC Reactor
MDS-CH-CV-37	NF50 10A	20A	S-N21	CH-AL-7.5K
MDS-CH-CV-55	NF50 20A	40A	S-N21	CH-AL-7.5K
MDS-CH-CV-75	NF50 20A	40A	S-N21	CH-AL-7.5K
MDS-CH-CV-110	NF50 30A	60A	S-N21	CH-AL-11K
MDS-CH-CV-150	NF50 40A	80A	S-N25	CH-AL-18.5K
MDS-CH-CV-185	NF50 50A	100A	S-N25	CH-AL-18.5K
MDS-CH-CV-220	NF100 60A	125A	S-N35	CH-AL-30K
MDS-CH-CV-260	NF100 75A	150A	S-N50	CH-AL-30K
MDS-CH-CV-300	NF100 75A	150A	S-N50	CH-AL-30K
MDS-CH-CV-370	NF100 100A	200A	S-N65	CH-AL-37K
MDS-CH-CV-450	NF150 125A	250A	S-N80	CH-AL-45K
MDS-CH-CV-550	NF150 150A	300A	S-N95	CH-AL-55K
MDS-CH-CV-750	NF225 200A	400A	S-N150	CH-AL-75K

- Circuit Breaker for of spindle motor Fan

Select the Circuit Breaker by doubling the spindle motor fan rated.
A rush current that is approximately double the rated current will flow, when the fan is started

<Notice>

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

3.5 Field Wiring Reference Table for Input and Output

Use the UL-approved Round Crimping Terminals to wire the input and output terminals of MDS-CH Series. Crimp the terminals with the crimping tool recommended by the terminal manufacturer. Following described crimping terminals and tools type are examples of Japan Solderless Terminal Mfg. Co., Ltd.

This wire size is each unit maximum rating. The selection method is indicated in each specification manual. (See Manual: No. BNP-C3016 or BNP-A2993-77)

3.5.1 Power Supply Unit (MDS-CH-CV)

Unit Type		37 to 185	220 to 370	450	550	750
Terminal Screw Size	L+, L-	M6		M6, M10		M10
	Screw Torque [lb in/ N m]	26.6/3.0		26.6/3.0, 177/20		177/20
	L11, L21, MC1	M4		M4		
	Screw Torque [lb in/ N m]	10.6/1.2		10.6/1.2		
	L1, L2, L3,⏚	M5	M8	M8	M10	
	Screw Torque [lb in/ N m]	17.7/2.0	53.1/6.0	53.1/6.0	234.3/26.5	

TE2 (L+, L-)

Unit Type	37, 55, 75	110	150	185	220
Wire Size (AWG) /Temp Rating Note 1	#14/60°C	#10/60°C	#10/60°C	#8/60°C	#6/60°C
	#14/75°C	#10/75°C	#10/75°C	#8/75°C	#8/75°C
Crimping Terminals Type	2-6	5.5-6	5.5-6	8-6	14-6
					8-6
Crimping Tools Type	YHT-2210			YPT-60-21	

Unit Type	260	300	370	450,550	750
Wire Size (AWG) /Temp Rating Note 1	#4/60°C	#2/60°C	#2/60°C	The bus-bar is attached to the product.	
	#6/75°C	#4/75°C	#4/75°C		
Crimping Terminals Type	22-6	38-S6	38-S6		
	14-6	22-6	22-6		
Crimping Tools Type	YPT-60-21				

TE3 (L11, L21, MC1)

Unit Type	37 to 750
Wire Size (AWG) /Temp Rating Note 1	#16/ 60°C
	#16/ 75°C
Crimping Terminals Type	1.25-4
Crimping Tools Type	YHT-2210

TE1 (L1, L2, L3)

Unit Type	37,55,75	110	150	185	220
Wire Size (AWG) /Temp Rating Note 1	#14/60°C	#12/60°C	#10/60°C	#8/60°C	#8/60°C
	#14/75°C	#12/75°C	#10/75°C	#8/75°C	#8/75°C
Crimping Terminals Type	2-4	5.5-S4	5.5-5	8-5	8-8
Crimping Tools Type	YHT-2210				YPT-60-21
Earth Wire Size (AWG)	#14/60°C	#12/60°C	#10/60°C	#8/60°C	#8/60°C
	#14/75°C	#12/75°C	#10/75°C	#8/75°C	#8/75°C

Unit Type	260	300	370	450	550	750
Wire Size (AWG) /Temp Rating Note 1	#6/60°C	#4/60°C	#2/60°C	#2/60°C	---	---
	#6/75°C	#6/75°C	#4/75°C	#2/75°C	#2/75°C	#1/0 / 75°C
Crimping Terminals Type	14-8	22-8	38-8	38-10	---	---
	14-8	14-8	22-8	38-10	38-10	60-10
Crimping Tools Type	YPT-60-21					
Earth Wire Size (AWG)	#6/60°C	#4/60°C	#2/60°C	#2/60°C	---	---
	#6/75°C	#6/75°C	#4/75°C	#2/75°C	#2/75°C	#1/0 /75°C

3.5.2 Spindle Drive Unit (MDS-CH-SP)

Unit Type		15 to 37	55 to 185	220 to 300	370	450 to 750
Terminal Screw Size	L+, L-	M6			M10	
	Screw Torque	26.6[lbf.in] / 3.0[Nm]			177[lb in] / 20[Nm]	
	L11, L21	M4			M4	
	Screw Torque	10.6[lbf.in] / 1.2[Nm]			10.6[lbf.in] /1.2[Nm]	
	U, V, W,⏚	M4	M5	M8	M8	M10
	Screw Torque [lb in/ N m]	10.6/1.2	17.7/2.0	53.1/6.0	53.1/6.0	234.3/26.5

TE2 (L+, L-)

Wire size depends on the Power Supply Unit (MDS-CH-CV Series).

TE3 (L11, L21) (The clamping terminal is not used for 750.)

Unit Type	15~550	750
Wire Size (AWG) /Temp Rating Note 1	#16/ 60°C	#16/ 60°C
	#16/ 75°C	#16/ 75°C
Crimping Terminals Type	1.25-4	
Crimping Tools Type	YHT-2210	

TE1 (U, V, W)

Unit Type	15 to 37	55	110	150	185	220
Wire Size (AWG) /Temp Rating Note 1	#14/60°C		#12/60°C	#10/60°C	#8/60°C	
	#14/75°C		#12/75°C	#10/75°C	#8/75°C	
Crimping Terminals Type	R2-4		5.5-S5	5.5-5	8-5	8-8
	R2-4		5.5-S5	5.5-5	8-5	8-8
Crimping Tools Type	YHT-2210					YPT-60-21
Earth Wire Size (AWG)	#14/60°C	#14/60°C	#12/60°C	#10/60°C	#8/60°C	#8/60°C
	#14/75°C	#14/75°C	#12/75°C	#10/75°C	#8/75°C	#8/75°C

Unit Type	260	300	370	450	550	750
Wire Size (AWG) /Temp Rating [Note 1]	#6/60°C	#4/60°C	#2/60°C	#2/60°C	---	
	#8/75°C	#6/75°C	#4/75°C	#2/75°C	#2/75°C	#1/0/75°C
Crimping Terminals Type	R14-8	22-8	38-8	38-10	---	
	R8-8	14-8	22-8	38-10	38-10	60-10
Tools Type	YPT-60-21					
Earth Wire Size (AWG)	#6/60°C	#4/60°C	#2/60°C	#2/60°C	---	
	#8/75°C	#6/75°C	#4/75°C	#2/75°C	#2/75°C	#1/0/75°C

Note 1: 60°C: Polyvinyl chloride insulated wires (IV)
75°C: Grade heat-resistant polyvinyl chloride insulated wires (HIV).
Use copper wire only.
Above listed wire are for use in the electric cabinet on machine or equipment.

3.5.3 Servo Drive Unit (MDS-CH-V1/V2)

Axis		**1-axis (V1)**			**2-axes (V2)**	
Unit Type		10 to 35	45 to 90	110,150	2010,2020	3510 to 4535
Terminal Screw Size	L+, L-	M6			M6	
	Screw Torque	26.6[lbf.in] / 3.0[Nm]			26.6[lb in] / 3.0[Nm]	
	L11, L21	M4			M4	
	Screw Torque	10.6[lb in] / 1.2[Nm]			10.6[lb in] / 1.2[Nm]	
	U, V, W,⏚	M4	M5	M8	M4	M5
	Screw Torque [lb in/ N m]	10.6 /1.2	17.7 /2.0	53.1 /6.0	10.6 /1.2	17.7 /2.0

TE2 (L+, L-)

Wire size depends on the Power Supply Unit (MDS-CH-CV Series).

TE3 (L11, L21)

Unit Type	10 to 15
Wire Size (AWG) /Temp Rating [Note 1]	#16/ 60°C
	#16/ 75°C
Crimping Terminals Type	1.25-4
Crimping Tools Type	YHT-2210

TE1 (U, V, W)

Unit Type	10	20	35	45	70	90	110	150
Wire Size (AWG) /Temp Rating [Note 1]	#14/60°C			#14/60°C	#12/60°C		#12/60°C	#10/60°C
	#14/75°C			#14/75°C	#12/75°C	#12/75°C	#12/75°C	#10/75°C
Crimping Terminals Type	2-4				5-5-5		5-5-8	8-8
Crimping Tools Type	YHT-2210							
Earth wire Size (AWG)	#14/60°C			#14/60°C	#12/60°C		#12/60°C	#10/60°C
	#14/75°C			#14/75°C	#12/75°C	#12/75°C	#12/75°C	#10/75°C

3.6 Motor Over Load Protection

Spindle drive unit MDS-CH-SP and V1/V2 series have each solid-state motor over load protection. When adjusting the level of motor over load, set the parameter as follows.

3.6.1 MDS-CH-SP

Parameter No.	Parameter Abbr.	Parameter Name	Setting Procedure	Standard Setting Value	Setting Range
SP063	OLT	Overload Time constant	Set the time constant for overload detection. (Unit: 1 second.)	60s	0 to 1000s
SP064	OLL	Overload Detection level	Set the overload current detection level with a percentage (%) of the rating.	110%	1 to 200%

3.6.2 MDS-CH-V1/V2

Parameter No.	Parameter Abbr.	Parameter Name	Setting Procedure	Standard Setting Value	Setting Range
SV021	OLT	Overload Time constant	Set the time constant for overload detection. (Unit: 1 second.)	60s	1 to 300s
SV022	OLL	Overload Detection level	Set the overload current detection level with a percentage (%) of the stall rating.	150%	1 to 500%

3.7 Flange of servomotor

Mount the servomotor on a flange which has the following size or produces an equivalent or higher heat dissipation effect:

Flange size (mm)	Servo Motor
	HC-H
250×250×12	1.0 to 1.5kW
300×300×20	2.0 to 7.0kW
800×800×35	9.0 to 11.0kW

3.8 Spindle Drive / Motor Combinations

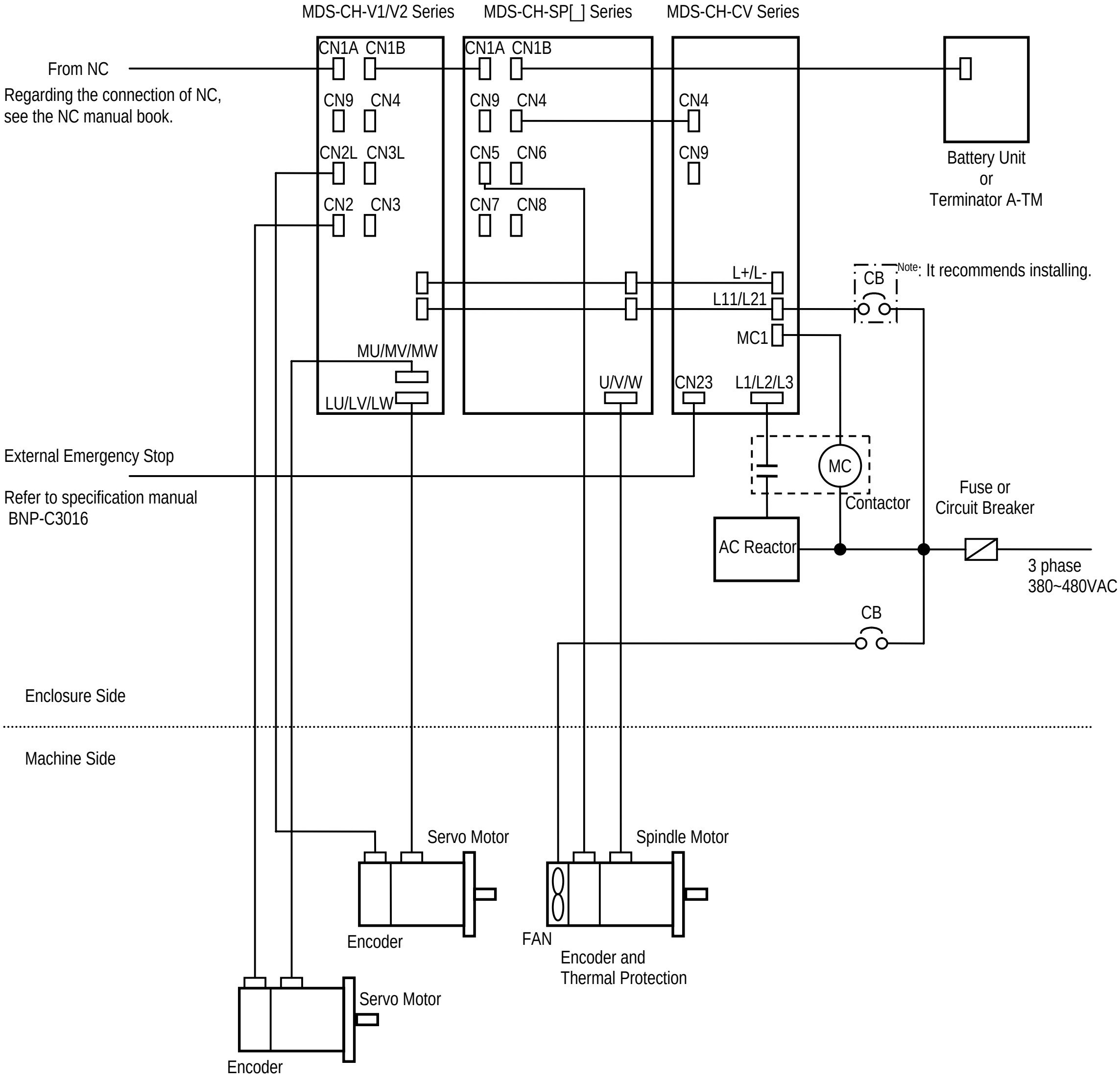
Following combinations are the Standard combinations

Drive Unit Note: 2	Rating Output (kW) of Applicable Spindle Motor
	SJ-4 Series Note: 1
MDS-CH-SP[_]-15	1.5
MDS-CH-SP[_]-22	2.2
MDS-CH-SP[_]-37	3.7
MDS-CH-SP[_]-55	5.5
MSD-CH-SP[_]-75	5.5, 7.5
MDS-CH-SP[_]-110	5.5, 7.5, 11
MDS-CH-SP[_]-150	7.5, 11, 15
MDS-CH-SP[_]-185	11, 15, 18.5
MDS-CH-SP[_]-220	11, 15, 18.5, 22
MDS-CH-SP[_]-260	11, 15, 18.5, 22, 26
MDS-CH-SP[_]-300	15, 18.5, 22, 26, 30
MDS-CH-SP[_]-370	15, 18.5, 22, 26, 30, 37
MDS-CH-SP[_]-450	22, 26, 30, 37, 45
MDS-CH-SP[_]-550	30, 37, 45, 55
MDS-CH-SP[_]-750	45, 55, 75

Note 1: Applicable unit depends on the range of power constant of motor. Inquire of Mitsubishi about the detail of the combinations.

Note 2: [_] can be H, M or blank.

4. AC Servo/Spindle System Connection

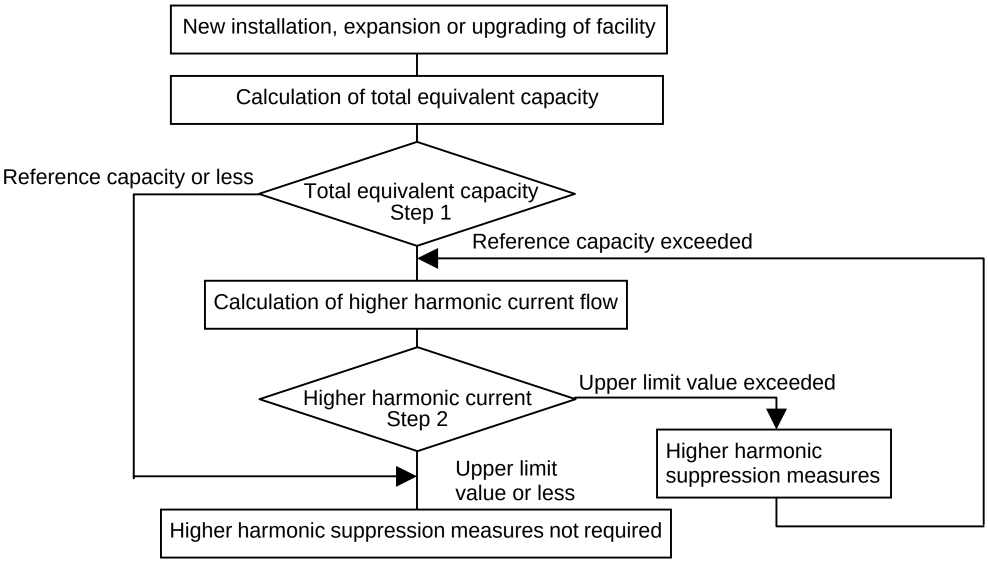


Appendix 5. Higher Harmonic Suppression Measure Guidelines

1. Calculating the equivalent capacity of the higher harmonic generator A5-3
  1.1 Calculating the total equivalent capacity (Step 1).. A5-3
  1.2 Calculating the higher harmonic current flow (Step 2).. A5-4

Appendix 5 Higher Harmonic Suppression Measure Guidelines

These guidelines apply to users for which the 6-pulse equivalent capacity total of the installed higher harmonic generator exceeds the reference in the following table. (Note that household appliances and general-purpose products having a rated current of 20A/phase or less connected to a 300V or less commercial power supply are excluded from the generators.)
Use the following flow chart to confirm whether the total exceeds the reference.



Higher Harmonic Suppression Guidelines were set in September 1994 by the Ministry of International Trade and Industry's Agency of Natural Resources and Energy.

- Higher Harmonic Suppression Measure Guidelines for Household Appliances and General-purpose Products
- Higher Harmonic Suppression Measure Guidelines for Consumers Receiving High Voltage or Special High Voltage Power

1. Calculating the equivalent capacity of the higher harmonic generator

As a principle, the <Specific Consumer Guidelines> must be met by the consumer.

1.1 Calculating the total equivalent capacity (Step 1)

Calculate the total equivalent capacity with the following expression.

Total equivalent circuit: $Po = \Sigma \bullet Ki \bullet Pi$

Ki : Conversion coefficient (Refer to following table)
Pi : Rated input capacity of each device

(Table 1) Rated capacity of each unit

Unit type	Rated input capacity Pi [kVA]	Unit type	Rated input capacity Pi [kVA]	Unit type	Rated input capacity Pi [kVA]
MDS-A/B/C1/CH-SP-37	4.61	MDS-A/B/C1-V1-03	0.6	MDS-A/B/C1-V2-0503	1.6
MDS-A/B/C1/CH-SP-55	6.77	MDS-A/B/C1-V1-05	1.0	MDS-A/B/C1-V2-0505	2.0
MDS-A/B/C1/CH-SP-75	9.07	MDS-A/B/C1/CH-V1-10	1.6	MDS-B/C1-V2-1003	2.2
MDS-A/B/C1/CH-SP-110	13.1	MDS-A/B/C1/CH-V1-20	2.7	MDS-A/B/C1-V2-1005	2.6
MDS-A/B/C1/CH-SP-150	17.6	MDS-A/B/C1/CH-V1-35	4.7	MDS-A/B/C1-V2-1010	3.2
MDS-A/B/C1/CH-SP-185	21.8	MDS-A/B/C1/CH-V1-45	5.9	MDS-A/B/C1-V2-2010	4.3
MDS-A/B/C1/CH-SP-220	25.9	MDS-A/B/C1/CH-V1-70	9.0	MDS-A/B/C1-V2-2020	5.4
MDS-A/B/C1/CH-SP-260	30.0	MDS-A/B/C1/CH-V1-90	11.5	MDS-A/B/C1-V2-3510	6.3
MDS-A/B/C1/CH-SP-300	34.7	MDS-A/B/C1/CH-V1-110	13.1	MDS-A/B/C1-V2-3520	7.4
MDS-B/CH-SP-370	42.8	MDS-A/B/C1/CH-V1-150	17.6	MDS-A/B/C1-V2-3535	9.4
MDS-B/CH-SP-450	52.1	MDS-CH-V1-185	21.8	MDS-A/B/C1-V2-4520	8.6
MDS-B/CH-SP-550	63.7			MDS-A/B/C1-V2-4535	10.6
MDS-CH-SP-750	86.8			MDS-C1-V2-4545	11.8
				MDS-C1-V2-7070	18.0

SP: Includes SPA, SPH, SPM and SPX V1: Includes V14 V2: Includes V24

Caution) The rated capacity Pi above, is the value used to calculate whether the product corresponds to the higher harmonic guidelines. Thus, the value will differ from the actual power facility's capacity. (The power supply unit is not included.)

(Table 2) Circuit class and conversion coefficient for each unit

Name	Model	Circuit class	Circuit type	Conversion coefficient Ki
AC servo drive unit	MDS-A-SVJ MDS-B-SVJ2 MR-J2-CT Series	3	3-phase bridge (with smoothing capacitor) Without reactor	K31=3.4
	MDS-A-V1/V2 MDS-B-V1/V14/V2/V24 MDS-C1-V1/V2 Series	3	3-phase bridge (with smoothing capacitor) With AC reactor Note 1	K32=1.8
	MDS-CH-V1/V2 Series	3	3-phase bridge (with smoothing capacitor) With AC reactor Note 1	K32=1.8
AC spindle drive unit	MDS-A-SPJ MDS-B-SPJ2 Series	3	3-phase bridge (with smoothing capacitor) Without reactor	K31=3.4
	MDS-A-SP/SPA MDS-B-SP/SPA/SPH/SPM/SPX MDS-C1-SP/SPH/SPM/SPX Series	3	3-phase bridge (with smoothing capacitor) With AC reactor Note 1	K32=1.8
	MDS-CH-SP Series	3	3-phase bridge (with smoothing capacitor) With AC reactor Note 1	K32=1.8

Note 1: This applies when an AC reactor is installed on the power supply unit.

(Table 3) Limit values for total equivalent capacity

Incoming voltage	Total of 6-pulse equivalent capacity
6.6kV	50kVA
22/33kV	300kVA
66kV	2,000kVA

If the total equivalent capacity Po exceeds the limit value given in (Table 3), proceed to "1.2 Calculating the higher harmonic current flow" below.
Measures are not required if the value is not exceeded.

(Example 1)

When using MDS-CH-SP-220/MDS-CH-CV-220 for incoming power voltage

Po = 1.8 × 25.9 = 46.6kVA

Following (Table 3), the limit value 50kVA for 6.6kV is not exceeded, so higher harmonic measures are not required.
When two sets are used, the value will be 93.2kVA, and the current must be confirmed with Step 2.

1.2 Calculating the higher harmonic current flow (Step 2)

To calculate the higher harmonic current flow, calculate the rated current for the incoming power voltage conversion.

Rated current for incoming power voltage conversion (mA) = a • Pi

(Table 4)
Incoming power voltage conversion coefficient a

Incoming power voltage	Coefficient a
6.6kV	87.5
22 kV	26.2
33 kV	17.5
66 kV	8.75
77 kV	7.5

(Table 5) Upper limit of higher harmonic current flow (mA/kW)

Conversion coefficient	5th-order	7th-order	11th-order	13th-order	17th-order	19th-order	23rd-order	25th-order
6.6kV	3.5	2.5	1.6	1.3	1.0	0.9	0.76	0.70
22kV	1.8	1.3	0.82	0.69	0.53	0.47	0.39	0.36
33kV	1.2	0.86	0.55	0.46	0.35	0.32	0.26	0.24
66kV	0.59	0.42	0.27	0.23	0.17	0.16	0.13	0.12
77kV	0.50	0.36	0.23	0.19	0.15	0.13	0.11	0.10

Obtain the upper limit of the higher harmonic current flow (judgment value) for each order.
(The contracted electricity must be known for this.)

Upper limit of higher harmonic current flow (mA) = Contracted electricity, flow upper limit value

Flow upper limit value : Insert a value from Table 5 according to the higher harmonic order to be calculated.

Obtain the higher harmonic current flow for each order using the following expression.

Higher harmonic current flow (mA) = (a • Pi), Device's maximum operation rate, target order

Device's maximum operation rate : The user must set the operation rate.
Target order : Insert a value from Table 6 according to the higher harmonic order to be calculated.

(Table 6) Higher harmonic current generation rate %

Conversion coefficient	5th-order	7th-order	11th-order	13th-order	17th-order	19th-order	23rd-order	25th-order
K32 = 1.8	38.0	14.5	7.4	3.4	3.2	1.9	1.7	1.3
K31 = 3.4	65.0	41.0	8.5	7.7	4.3	3.1	2.6	1.8

Values when basic wave current is 100%.

Check whether the calculated results exceed the limit value.
If the limit value for the higher harmonic current flow is exceeded, consider the higher harmonic measures shown below.

Examples of higher harmonic measures

Item	Details
Power-factor improving capacitor	Higher harmonics are suppressed by adding a leading capacitor for improving the power factor.
Installation of AC line filter	A reactor and capacitor are combined to reduce the impedance for specific frequencies.

1.3 Higher harmonic current flow calculation form

A higher harmonic current flow calculation form is shown below for reference.

<Form 1>

Date of application	
Application No.	
Date of acceptance	

Higher harmonic generating device's higher harmonic current flow calculation form (Part 1)

User name		**Industry**		**Incoming power voltage**	kV	**Contracted electricity**	kW

	Step 1: Details of higher harmonic generating device									**Step 2: Calculation of higher harmonic current flow rate**									
No.	**Higher harmonic generating device**			**Rated capacity (kVA)**	**Qty. of devices**	**Total capacity Pi (kVA)**	**Circuit type classification No.**	**6-pulse calculation coefficient Ki**	**6-pulse equivalent capacity [Ki×Pi](kVA)**	**Rated current value for incoming power voltage conversion [a×Pi] (mA)**	**Device's maximum operation rate (%)**	**Higher harmonic current flow per order**							
	Device name	**Maker**	**Type**									**5th-order**	**7th-order**	**11th-order**	**13th-order**	**17th-order**	**19th-order**	**23rd-order**	**25th-order**
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			
					6-pulse equivalent capacity total P.					Total									
									Necessity of measures										

Higher harmonic current flow upper limit value (Higher harmonic current flow upper limit per contracted kW x contracted electricity)

Order	**5th-order**	**7th-order**	**11th-order**	**13th-order**	**17th-order**	**19th-order**	**23rd-order**	**25th-order**
Current upper limit value (mA)								

<Instructions for completing form>

Step 1
- ☐ Indicate the details of the higher harmonic generating device.
  Refer to the reference and indicate the circuit type classification No., etc.
- ☐ If the device's circuit type classification No. is 10, complete the application shown in <Format 3>.
- ☐ If P, > 50kVA (6kV incoming power), 300kVA (22, 33kV incoming power), 2000kVA (66kV or higher incoming power), proceed to Step 2. (Step 2 does not need to be completed in all other cases.)

Step 2
- ☐ If the current flow > current flow upper limit value at each order, then
  - ○ If there is a facility that lowers the higher harmonics in the factory, or when suppression measures are implemented, proceed to Calculation Form (Part 2)
  - ○ In all other cases, separate measures must be taken

Appendix 6. Transportation Restrictions for Lithium Batteries

Appendix 6-1 Transportation restrictions for lithium batteries A6-2
  Appendix 6-1-1 Restriction for packing A6-2
    1. Target products A6-2
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  Appendix 6-1-2 Issuing domestic law of the United State for primary lithium battery transportation A6-5
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    3. Handling by user A6-5
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Appendix 6-1 Transportation restrictions for lithium batteries

Appendix 6-1-1 Restriction for packing

The United Nations Dangerous Goods Regulations "Article 12" became effective from 2003. When transporting lithium batteries with means subject to the UN Regulations, such as by air transport, measures corresponding to the Regulations must be taken. The UN Regulations classify the batteries as dangerous goods (Class 9) or not dangerous goods according to the lithium content.
To ensure safety during transportation, lithium batteries (battery unit) directly exported from Mitsubishi are packaged in a dedicated container (UN package) for which safety has been confirmed. When the customer is transporting these products with means subject to the UN Regulations, such as air transport, the shipper must follow the details explained in section 2. .

1. Target products

The following Mitsubishi NC products use lithium batteries. The UN Regulations classify the batteries as dangerous goods (Class 9) or not dangerous goods according to the lithium content. (Refer to the battery unit's rating nameplate or section "4-1-2 Battery option" for details on the lithium content.) If the batteries subjected to hazardous materials are incorporated in a device and shipped, a dedicated packaging (UN packaging) is not required. However, the item must be packed and shipped following the Packing Instruction 912 specified in the IATA DGR (Dangerous Goods Regulation) book.
Also, all lithium battery products incorporated in a machinery or device must be fixed securely in accordance with the Packing Instruction 900 and shipped with protection in a way as to prevent damage or short-circuits.

(a) Products requiring dedicated packaging (Materials falling under Class 9)

Mitsubishi type	Battery type	Lithium metal content	Battery manufacturer	Battery class
MDS-A-BT-4	ER6-B4-11	2.6g	Toshiba Battery	Battery
MDS-A-BT-6	ER6-B6-11	3.9g		
MDS-A-BT-8	ER6-B8-11	5.2g		
FCU6-BT4-D1	Combination of ER6-B4D-11 and ER6	2.6g+0.65g		
(built-in battery)	CR23500SE-CJ5	1.52g	Sanyo Battery	Battery cell

(b) Products not requiring dedicated packaging (Materials not falling under Class 9)

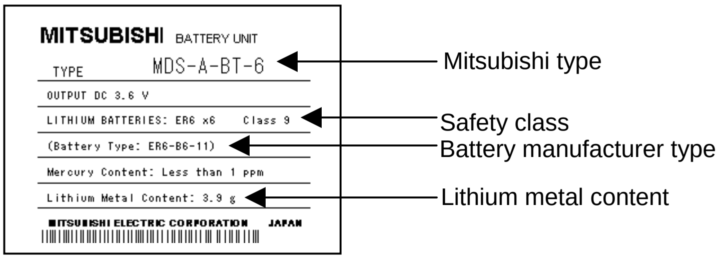
Mitsubishi type	Battery type	Lithium metal content	Battery manufacturer	Battery class
MDS-A-BT-2	ER6-B2-12	1.3g	Toshiba Battery	Battery
FCU6-BTBOX	2CR5	1.96g		
(built-in battery)	CR2032	0.067g		Battery cell
(built-in battery)	CR2450	0.173g		
(built-in battery)	ER6, ER6V	0.7g		
MR-BAT	MR-BAT	0.48g		
Q6BAT	Q6BAT	0.49g	Mitsubishi Electric Battery	

Note 1) Dedicated packaging is required if the shipment exceeds 12 batteries/24 battery cells.
Package the batteries so that this limit is not exceeded.

Note 2) The battery units labeled as "FCUA-" instead of "MDS-A-" also use the same battery.

Note 3) Always use the cell battery (MR-BAT) in combination with the dedicated case (MDS-BTCASE).
Maximum 8 (either 2, 4, 6 or 8) cell batteries can be installed to the dedicated case (MDS-BTCASE).

Example) Rating nameplate for battery units



2. Handling by user

The following technical opinion is solely Mitsubishi's opinion. The shipper must confirm the latest IATA Dangerous Goods Regulations, IMDG Codes and laws and orders of the corresponding export country. These should be checked by the company commissioned for the actual transportation.

IATA : International Air Transport Association
IMDG Code : A uniform international code for the transport of dangerous goods by seas determined by IMO (International Maritime Organization).

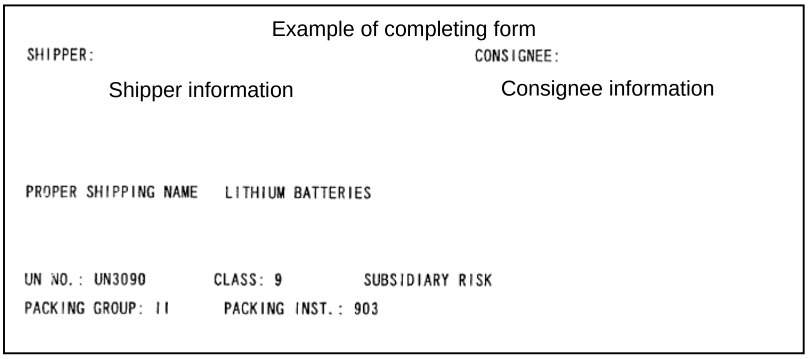
(a) When shipping isolated lithium battery products (Packing Instruction 903)

1) Reshipping in Mitsubishi UN packaging

The isolated battery's safety test and packaging specifications comply with the UN Regulations (Packing Instruction 903). Thus, the user only needs to add the following details before shipping. (Consult with the shipping company for details.)

i) Indication of container usage mark on exterior box (Label with following details recorded.)

- Proper shipping name (Lithium batteries)
- UN NO. (UN3090 for isolated battery, UN3091 for battery incorporated in a device or included)
- Shipper and consignee's address and name



Example of completing form

SHIPPER: Shipper information

CONSIGNEE: Consignee information

PROPER SHIPPING NAME LITHIUM BATTERIES

UN NO.: UN3090 CLASS: 9 SUBSIDIARY RISK
PACKING GROUP: II PACKING INST.: 903

ii) Preparation of shipping documents (Declaration of dangerous goods)

2) When packaged by user

The user must follow UN Regulations when packing, preparing for shipping and preparing the indications, etc.

i) **Packing a lithium battery falling under Class 9**

- Consult with The Ship Equipment Inspection Society of Japan for details on packaging.
- Prepare for shipping as explained in "1) Reshipping in Mitsubishi UN packaging".

The Ship Equipment Inspection Society of Japan
Headquarters Telephone: 03-3261-6611 Fax: 03-3261-6979

ii) **Packing a lithium battery not falling under Class 9**

- Cells and batteries are separated so as to prevent short circuits and are stored in a strong outer packaging. (12 or less batteries, 24 or less cells.)
- Certificates or test results showing compliance to battery safety test.
  The safety test results have been obtained from the battery manufacturer. (Consult with Mitsubishi when the safety test results are required.)
- Prepare for shipping as explained in "1) Reshipping in Mitsubishi UN packaging".

(b) When shipping lithium batteries upon incorporating in a machinery or device (Packing Instruction 900)

Pack and prepare for shipping the item in accordance with the Packing Instruction 900 specified in the IATA DGR (Dangerous Goods Regulation) book. (Securely fix the batteries that comply with the UN Manual of Tests and Criteria to a machinery or device, and protect in a way as to prevent damage or short-circuit.)
Note that all the lithium batteries provided by Mitsubishi have cleared the UN recommended safety test; fixing the battery units or cable wirings securely to the machinery or device will be the user's responsibility.
Check with your shipping company for details on packing and transportation.

(c) When shipping a device with lithium batteries incorporated (Packing Instruction 912)

A device incorporating lithium batteries does not require a dedicated packaging (UN packaging). However, the item must be packed, prepared for shipping and labeled following the Packing Instruction 912 specified in the IATA DGR (Dangerous Goods Regulation) book.
Check with your shipping company for details on packing and transportation.

The outline of the Packing Instruction 912 is as follows:

- All the items in the packing instructions for shipping the isolated lithium battery products (Packing Instruction 903) must be satisfied, except for the items related to container, short-circuit, and fixation.
- A device incorporating lithium batteries has to be stored in a strong water-proofed outer packaging.
- To prevent an accidental movement during shipment, securely store the item in an outer packaging.
- Lithium content per device should be not more than 12g for cell and 500g for battery.
- Lithium battery mass per device should be not more than 5kg.

3. Reference

Refer to the following materials for details on the regulations and responses.

Guidelines regarding transportation of lithium batteries and lithium ion batteries (Edition 2)
.... Battery Association of Japan

Appendix 6-1-2 Issuing domestic law of the United State for primary lithium battery transportation

Federal Aviation Administration (FAA) and Research and Special Programs Administration (RSPA) announced an additional regulation (interim final rule) for the primary lithium batteries transportation restrictions item in "Federal Register" on Dec.15 2004. This regulation became effective from Dec.29, 2004.

This law is a domestic law of the United States, however if also applies to the domestic flight and international flight departing from or arriving in the United States. Therefore, when transporting lithium batteries to the United State, or within the United State, the shipper must take measures required to transport lithium batteries.

Refer to the Federal Register and the code of Federal Regulation ("(a), (b) and (c) in the item 4." described below) for details.

1. Outline of regulation

(a) Transporting primary lithium battery by passenger aircraft is forbidden.

- Excluding primary lithium battery for personal use in a carry-on or checked luggage (Lithium metal content should be not more than 5g for cell and 25g for battery. For details on the lithium metal content, refer to "(a) and (b) in the section 4-1-1 item 1.".)

(b) When transporting primary lithium battery by cargo aircraft, indicate that transportation by passenger aircraft is forbidden on the exterior box.

2. Target products

All NC products for which the lithium batteries are used are subject to the regulation.
(Refer to the table "(a) and (b) in the section 4-1-1 item 1.".)

3. Handling by user

The "1. Outline of regulation" described above is solely Mitsubishi's opinion. The shipper must confirm orders of "(a), (b) and (c) in the item 4." described below for transportation method corresponding the regulation. Actually, these should be checked by the company commissioned for the actual lithium buttery transportation.

(a) Indication of exterior box

When transporting primary lithium battery by cargo aircraft, indicate that transportation by passenger aircraft is forbidden on the exterior box.

Display example

PRIMARY LITHIUM BATTERIES
FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT.

- The character color must be displayed with contrast. (black characters against white background, black characters against yellow background, etc.)
- The height (size) of characters to be displayed is prescribed depending on the packaging weight.

When the total weight is over 30kg:	at least 12mm
When the total weight is less than 30kg:	at least 6mm

4. Reference

(a) Federal Register (Docket No. RSPA-2004-19884 (HM-224E)) PDF format

http://www.regulations.gov/fredpdfs/05-11765.pdf

(b) 49CFR (Code of Federal Regulation, Title49) (173.185 Lithium batteries and cells.)

http://www.access.gpo.gov/nara/cfr/waisidx_00/49cfr173_00.html

(c) DOT regulation body (Department of Transportation)

http://hazmat.dot.gov/regs/rules/final/69fr/docs/69fr-75207.pdf

Appendix 7. Compliance with China Compulsory Product Certification (CCC Certification) System

Appendix 7-1 Outline of China Compulsory Product Certification System A7-2
Appendix 7-2 First Catalogue of Products subject to Compulsory Product Certification.......................A7-2
Appendix 7-3 Precautions for Shipping Products..A7-3
Appendix 7-4 Application for Exemption A7-4
Appendix 7-5 Mitsubishi NC Product Subject to/Not Subject to CCC Certification................................A7-5

Appendix 7-1 Outline of China Compulsory Product Certification System

The Safety Certification enforced in China included the "CCIB Certification (certification system based on the "Law of the People’s Republic of China on Import and Export Commodity Inspection" and "Regulations on Implementation of the Import Commodities Subject to the Safety and Quality Licensing System" enforced by the State Administration of Import and Export Commodity Inspection (SACI) on import/export commodities, and the "CCEE Certification" (certification system based on "Product Quality Certification Management Ordinance" set forth by the China Commission for Conformity Certification of Electrical Equipment (CCEE) on commodities distributed through China.

CCIB Certification and CCEE Certification were merged when China joined WTO (November 2001), and were replaced by the "China Compulsory Product Certification" (hereinafter, CCC Certification) monitored by the State General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) of the People's Republic of China.

The CCC Certification system was partially enforced from May 2002, and was fully enforced from May 2003. Target commodities which do not have CCC Certification cannot be imported to China or sold in China. (Indication of the CCIB or CCEE mark has been eliminated from May 1, 2003.)

CCIB : China Commodity Inspection Bureau
CCEE: China Commission for Conformity Certification of Electrical Equipment
CCC : China Compulsory Certification

Appendix 7-2 First Catalogue of Products subject to Compulsory Product Certification

The First Catalogue of Products subject to Compulsory Product Certification, covering 132 items (19 categories) based on the CCIB products (104 items), CCEE products (107 items) and CEMC products (Compulsory EMC Certification products) was designated on December 3, 2001.

Class	Product catalogue	
1	Electric Wires and Cables (5 items)	
2	Switches, Installation protective and connection devices (6 items)	
3	Low-voltage Electrical Apparatus (9 items)	Compulsory Certification Regulations
	Circuit-breakers (including RCCB, RCBO, MCB)	CNCA -01C -011: 2001 (Switch and Control Equipment) CNCA -01C -012: 2001 (Installation Protective Equipment)
	Low-voltage switchers (disconnectors, switch-disconnectors, and fuse-combination devices.	
	Other protective equipment for circuits (Current limiting devices, circuits protective devices, over current protective devices, thermal protectors, over load relays, low-voltage electromechanical contactors and motor starters)	
	Relays (36V < Voltage ≤ 1000V)	
	Other switches (Switches for appliances, vacuum switches, pressure switches, proximity switches, foot switches, thermal sensitive switches, hydraulic switches, push-button switches, position limit switches, micro-gap switches, temperature sensitive switches, travel switches, change-over switches, auto-change-over switches, knife switches)	
	Other devices (contactors, motor starters, indicator lights, auxiliary contact assemblies, master controllers, A.C. Semiconductor motor controllers and starters)	
	Earth leakage protectors	
	Fuses	
	Low-voltage switchgear	CNCA-01C-010:2001 (Low-voltage switchgear)
4 **(Note)**	Small power motors (1 item)	CNCA-01C-013:2001 (Small power motors)

Class	Product catalogue	
5	Electric tools	(16 items)
6	Welding machines	(15 items)
7	Household and similar electrical appliances	(18 items)
8	Audio and video equipment	(16 items)
9	Information technology equipment	(12 items)
10	Lighting apparatus	(2 items)
11	Telecommunication terminal equipment	(9 items)
12	Motor vehicles and Safety Parts	(4 items)
13	Tyres	(4 items)
14	Safety Glasses	(3 items)
15	Agricultural Machinery	(1 item)
16	Latex Products	(1 item)
17	Medical Devices	(7 items)
18	Fire Fighting Equipment	(3 items)
19	Detectors for Intruder Alarm Systems	(1 item)

(Note) When the servomotor or the spindle motor of which output is 1.1kW or less (at 1500 r/min) is used, NC could have been considered as a small power motor. However, CQC (China Quality Certification Center) judged it is not.

Appendix 7-3 Precautions for Shipping Products

As indicated in Appendix 7-2, NC products are not included in the First Catalogue of Products subject to Compulsory Product Certification. However, the Customs Officer in China may judge that the product is subject to CCC Certification just based on the HS Code.Note 2
NC cannot be imported if its HS code is used for the product subject to CCC Certification. Thus, the importer must apply for a "Certification of Exemption" with CNCA.Note 3 Refer to Appendix 7-4. Application for Exemption for details on applying for an exemption.

(Note 1) The First Catalogue of Products subject to Compulsory Product Certification (Target HS Codes) can be confirmed at http://www.cqc.com.cn/Center/html/60gonggao.htm.

(Note 2) HS Code: Internationally unified code (up to 6 digits) assigned to each product and used for customs.

(Note 3) CNCA: Certification and Accreditation Administration of People's Republic of China (Management and monitoring of certification duties)

Appendix 7-4 Application for Exemption

Following "Announcement 8" issued by the Certification and Accreditation Administration of the People's Republic of China (CNCA) in May 2002, a range of products for which application for CCC Certification is not required or which are exempt from CCC marking has been approved for special circumstances in production, export and management activities.
An application must be submitted together with materials which prove that the corresponding product complies with the exemption conditions. Upon approval, a "Certification of Exemption" shall be issued.

<Range of products for which application is exempt>

Range of products not requiring application	(a) Items brought into China for the personal use by the foreign embassies, consulates, business agencies and visitors (Excluding products purchased from Service Company for Exporters) (b) Products presented on a government-to-government basis, presents (c) Exhibition products (products not for sale) (d) Special purpose products (e.g., for military use) Products not requiring application for CCC Certification are not required to be CCC marked or certified.
Range of products for which application is exempted	(e) Products imported or manufactured for research and development and testing purposes (f) Products shipped into China for integration into other equipment destined for 100% re-export to a destination outside of China (g) Products for 100% export according to a foreign trade contract (Excluding when selling partially in China or re-importing into China for sales) (h) Components used for the evaluation of an imported product line (i) The products imported or manufactured for the service (service and repairs) to the end-user. Or the spare parts for the service (service and repairs) of discontinued products. (j) Products imported or manufactured for research and development, testing or measurements (k) Other special situations

The following documents must be prepared to apply for an exemption of the "Import Commodity Safety and Quality License" and "CCC Certification".

(1) Formal Application
  (a) Relevant introduction and description of the company.
  (b) The characteristics of the products to be exempted.
  (c) The reason for exemption and its evidence (ex. customs handbook).
  (d) The name, trademark, quantity, model and specification of the products to be exempted. (Attach a detail listing of these items for a large quantity of products. When importing materials for processing and repair equipments, submit a list of the importing materials for each month and repair equipments.)
  (e) Guarantee for the safety of the products; self-declaration to be responsible for the safety during the manufacturing and use.
  (f) To be responsible for the authenticity and legitimacy of the submitted documents. Commitment to assist CNCA to investigate on the authenticity of the documents (When CNCA finds it necessary to investigate on the authenticity of the documents.)

(2) Business license of the company (Copy)

(3) Product compliance declaration
Indicate which standard’s requirements the products comply with or submit a test report (Copy is acceptable. The report can be prepared in a manufacturer’s laboratory either at home or overseas.)

(4) Import license (Only if an import license is needed for this product. Copy is acceptable.)

(5) Quota certificate (Only if a quota certificate is needed for this product. Copy is acceptable.)

(6) Commercial contract (Copy is acceptable.)

(7) If one of item (4), (5) or (6) cannot be provided, alternative documents, such as bill of lading, the invoice, and other evidential documents must be submitted.

Appendix 7-5 Mitsubishi NC Product Subject to/Not Subject to CCC Certification

The state whether or not Mitsubishi NC products are subject to the CCC Certification is indicated below, based on the "First Catalogue of Products subject to Compulsory Product Certification" issued by the State General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) of the People's Republic of China and the Certification and Accreditation Administration of the People's Republic of China (CNCA) on July 1, 2002.

Model	China HS Code (Note 1)	Judgment on whether or not subject to CCC Certification
Power supply unit Servo/spindle drive unit	85044090 85371010	Not subject to CCC Certification
Servo/spindle	85015100 85015200	Not subject to CCC Certification
NC	–	Not subject to CCC Certification
Display unit	–	Not subject to CCC Certification

(Note 1) The China HS Code is determined by the customs officer when importing to China. The above HS Codes are set based on the HS Codes used normally when exporting from Japan.

(Note 2) Reference IEC Standards are used as the actual IEC Standards may not match the GB Standards in part depending on the model.

Whether or not the NC products are subject to CCC Certification was judged based on the following five items.

(a) Announcement 33 (Issued by AQSIQ and CNCA in December 2001)
(b) HS Codes for the products subject to CCC Certification (Export Customs Codes)
  * HS Codes are supplementary materials used to determine the applicable range. The applicable range may not be determined only by these HS Codes.
(c) GB Standards (This is based on the IEC Conformity, so check the IEC. Note that some parts are deviated.)
(d) Enforcement regulations, and products specified in applicable range of applicable standards within
(e) "Products Excluded from Compulsory Certification Catalogue" (Issued by CNCA, November 2003)

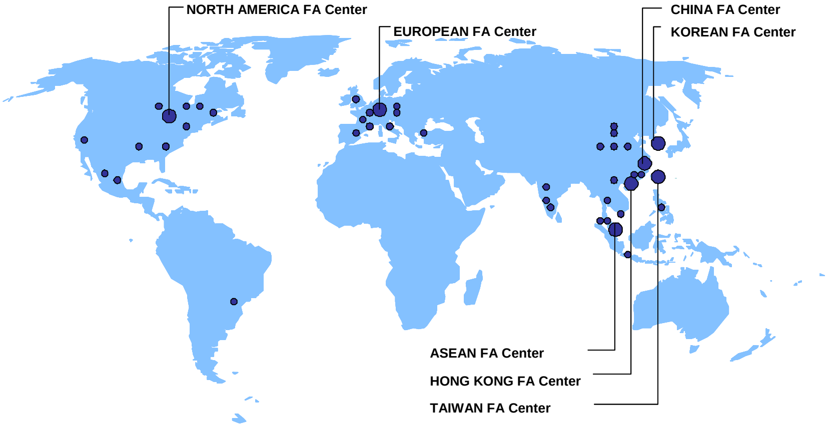
Reference

- Outline of China's New Certification System (CCC Mark for Electric Products), Japan Electrical Manufacturers' Association
- Outline of China's New Certification System (CCC Mark for Electric Products) and Electric Control Equipment, Nippon Electric Control Equipment Industries Association

Revision History

Date of revision	Manual No.	Revision details
Mar. 2002	BNP-C3016A	First edition created.
Jul. 2003	BNP-C3016C	• The MDS-CH-V1-185 specifications were added. • Battery unit "FCU6-BTBOX" was added. • Spindle specifications were added. •"Magnetic pole detection unit" was added. • The HC-H1502 motor specifications were added. • The linear servomotor specifications were added. • "UL/c-UL Standard Compatible Unit Instruction Manual" was added. • Miswrite is corrected.
Apr. 2004	BNP-C3016D	• LM491M (Heidenhain) was added to machine side detector. • Units scheduled for development, SP-15, V1-05, V1-10 and V2-0505 to 1010 were produced, and production of SP-04 to 075 and SP-22 was discontinued. • HC-H52, -H53 and -H102 were produced. • Miswrite is corrected.
Sep. 2005	BNP-C3016E	• DC connection bar specifications were added. • Drive unit specifications list was revised. • Selection of wire was revised. • Protection fuse specifications were added. • Motor outline drawings of HC-H1102 and HC-C1103S were revised. • The section of "Compliance with China Compulsory Product Certification (CCC Certification) System " was added. • Miswrite is corrected.
Feb. 2006	BNP-C3016F	• Servo parameters SV081 to SV100 were added. • Alarm "3B" and "77" were revised. • Troubleshooting "3B" and "77" were revised. • Calculating the theoretical acceleration/deceleration was revised. • Magnetic brake characteristic was revised. • Miswrite is corrected.

Global service network



North America FA Center (MITSUBISHI ELECTRIC AUTOMATION INC.)

Illinois CNC Service Center
500 CORPORATE WOODS PARKWAY, VERNON HILLS, IL. 60061, U.S.A.
TEL: +1-847-478-2500 (Se FAX: +1-847-478-2650 (Se
California CNC Service Center
5665 PLAZA DRIVE, CYPRESS, CA. 90630, U.S.A.
TEL: +1-714-220-4796 FAX: +1-714-229-3818
Georgia CNC Service Center
2810 PREMIERE PARKWAY SUITE 400, DULUTH, GA., 30097, U.S.A.
TEL: +1-678-258-4500 FAX: +1-678-258-4519
New Jersey CNC Service Center
200 COTTONTAIL LANE SOMERSET, NJ. 08873, U.S.A.
TEL: +1-732-560-4500 FAX: +1-732-560-4531
Michigan CNC Service Satellite
2545 38TH STREET, ALLEGAN, MI., 49010, U.S.A.
TEL: +1-847-478-2500 FAX: +1-269-673-4092
Ohio CNC Service Satellite
62 W. 500 S., ANDERSON, IN., 46013, U.S.A.
TEL: +1-847-478-2608 FAX: +1-847-478-2690
Texas CNC Service Satellite
1000, NOLEN DRIVE SUITE 200, GRAPEVINE, TX. 76051, U.S.A.
TEL: +1-817-251-7468 FAX: +1-817-416-1439
Canada CNC Service Center
4299 14TH AVENUE MARKHAM, ON. L3R OJ2, CANADA
TEL: +1-905-475-7728 FAX: +1-905-475-7935
Mexico CNC Service Center
MARIANO ESCOBEDO 69 TLALNEPANTLA, 54030 EDO. DE MEXICO
TEL: +52-55-9171-7662 FAX: +52-55-9171-7698
Monterrey CNC Service Satellite
ARGENTINA 3900, FRACC. LAS TORRES, MONTERREY, N.L., 64720, MEXICO
TEL: +52-81-8365-4171 FAX: +52-81-8365-4171
Brazil MITSUBISHI CNC Agent Service Center
(AUTOMOTION IND. COM. IMP. E EXP. LTDA.)
ACESSO JOSE SARTORELLI, KM 2.1 18550-000 BOITUVA – SP, BRAZIL
TEL: +55-15-3363-9900 FAX: +55-15-3363-9911

European FA Center (MITSUBISHI ELECTRIC EUROPE B.V.)

Germany CNC Service Center
GOTHAER STRASSE 8, 40880 RATINGEN, GERMANY
TEL: +49-2102-486-0 FAX:+49-2102486-591
South Germany CNC Service Center
KURZE STRASSE. 40, 70794 FILDERSTADT-BONLANDEN, GERMANY
TEL: +49-711-3270-010 FAX: +49-711-3270-0141
France CNC Service Center
25, BOULEVARD DES BOUVETS, 92741 NANTERRE CEDEX FRANCE
TEL: +33-1-41-02-83-13 FAX: +33-1-49-01-07-25
Lyon CNC Service Satellite

U.K CNC Service Center
TRAVELLERS LANE, HATFIELD, HERTFORDSHIRE, AL10 8XB, U.K.
TEL: +44-1707-282-846 FAX:-44-1707-278-992
Italy CNC Service Center
ZONA INDUSTRIALE VIA ARCHIMEDE 35 20041 AGRATE BRIANZA, MILANO ITALY
TEL: +39-039-60531-342 FAX: +39-039-6053-206
Spain CNC Service Satellite
CTRA. DE RUBI, 76-80 -APDO.420 08190 SAINT CUGAT DEL VALLES, BARCELONA SPAIN
TEL: +34-935-65-2236 FAX:
Turkey MITSUBISHI CNC Agent Service Center
(GENEL TEKNIK SISTEMLER LTD. STI.)
DARULACEZE CAD. FAMAS IS MERKEZI A BLOCK NO.43 KAT2 80270 OKMEYDANI ISTANBUL, TURKEY
TEL: +90-212-320-1640 FAX: +90-212-320-1649
Poland MITSUBISHI CNC Agent Service Center (MPL Technology Sp. z. o. o)
UL SLICZNA 34, 31-444 KRAKOW, POLAND
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Notice

Every effort has been made to keep up with software and hardware revisions in the contents described in this manual. However, please understand that in some unavoidable cases simultaneous revision is not possible.
Please contact your Mitsubishi Electric dealer with any questions or comments regarding the use of this product.

Duplication Prohibited

MITSUBISHI ELECTRIC CORPORATION

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