MITSUBISHI ELECTRIC

Changes for the Better

CNC

MELDAS AC SERVO
MDS-R Series

SPECIFICATIONS AND INSTRUCTION MANUAL

MELDAS

BNP-C3045G(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.
In order to confirm if all function specifications described in this manual are applicable, refer to the specifications for each CNC.

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 signs indicating prohibited and mandatory matters are explained below.

	Indicates a prohibited matter. For example, "Fire Prohibited" is indicated as .

	Indicates a mandatory matter. For example, grounding is indicated as .

After reading this specifications and instructions manual, store it where the user can access it easily for reference.

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 section "Precautions for safety", the following items are generically called the "motor".
- Servomotor
- Linear servomotor
- Spindle motor

In this section "Precautions for safety", the following items are generically called the "unit".
- Servo drive unit
- Spindle drive unit
- Power supply unit
- Scale interface unit
- Magnetic pole detection unit

POINT	Important matters that should be understood for operation of this machine are indicated as a POINT 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 and connector 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.

Since the high voltage is supplied to the main circuit connector while the power is ON or during operation, do not touch the main circuit connector with an adjustment screwdriver or the pen tip. Failure to observe this could lead to electric shocks.

Wait at least 15 minutes after turning the power OFF, confirm that the CHARGE lamp has gone out, and check the voltage between P and N terminals with a tester, etc., before starting wiring, maintenance or inspections. Failure to observe this could lead to electric shocks.

Ground the unit and motor following the standards set forth by each country.

Wiring, maintenance 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.

In the system where the optical communication with CNC is executed, do not see directly the light generated from CN1A/CN1B connector of drive unit or the end of cable. When the light gets into eye, you may feel something is wrong for eye.
(The light source of optical communication corresponds to class1 defined in JISC6802 or IEC60825-1.)

CAUTION

1. Fire prevention

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

Always install a circuit protector and contactor on the servo drive unit power input as explained in this manual. Refer to this manual and select the correct circuit protector and contactor. An incorrect selection could result in fire.

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

When using a regenerative resistor, provide a sequence that shuts off the power with the regenerative resistor's error signal. 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.

Cut off the main circuit power with the contactor when an alarm or emergency stop occurs.

2. Injury prevention

Do not apply a voltage other than that specified in this 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 or part damage.

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

⚠ CAUTION

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

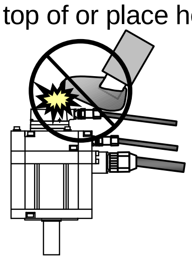
⚠ Correctly transport the product according to its weight.

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

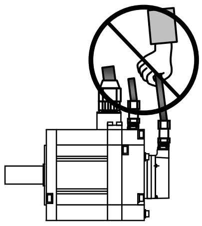
⚠ Do not stack the products above the tolerable number.

⚠ Follow this 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.



⚠ 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.

⚠ 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	Unit	Motor
Ambient temperature	Operation: 0 to 55°C (with no freezing), Storage / Transportation: -15°C to 70°C (with no freezing)	Operation: 0 to 40°C (with no freezing), Storage: -15°C to 70°C (Note 2) (with no freezing)
Ambient humidity	Operation: 90%RH or less (with no dew condensation) Storage / Transportation: 90%RH or less (with no dew condensation)	Operation: 80%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	Operation: 1000 meters or less above sea level, Storage: 10000 meters or less above sea level
Vibration/impact	According to each unit or motor specification	

(Note 1) For details, confirm each unit or motor specifications in addition.
(Note 2) -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, etc.) 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, Service Station, Sales Office or delayer.

⚠ CAUTION

(2) Wiring

⚠ Correctly and securely perform the wiring. Failure to do so could lead to abnormal operation 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.

⚠ When using a power regenerative power supply unit, always install an AC reactor for each power supply unit.

⚠ In the main circuit power supply side of the unit, always install an appropriate circuit protector or contactor for each unit. Circuit protector or contactor cannot be shared by several units.

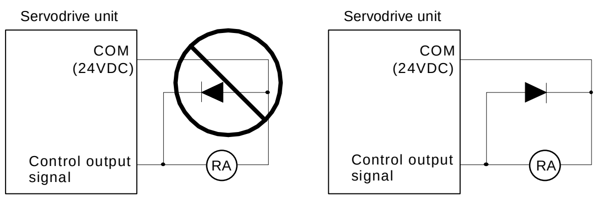
⚠ Always connect the motor to the drive unit's output terminals (U, V, W).

⚠ Do not directly connect a commercial power supply to the servomotor. Failure to observe this could result in a fault.

⚠ 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 such as contractor and motor brake output, etc. 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 instruction 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 of parameter 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

In abnormal state, 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.

Do not disassemble or repair this product.

Never make modifications.

When an alarm occurs, the machine will start suddenly if an alarm reset (RST) is carried out while an operation start signal (ST) is being input. Always confirm that the operation signal is OFF before carrying out an alarm reset. Failure to do so could lead to accidents or injuries.

Reduce magnetic damage by installing a noise filter. The electronic devices used near the unit could be affected by magnetic noise. Install a line noise filter, etc., if there is a risk of 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) of the servomotor are for holding, and must not be used for normal braking.

There may be cases when holding is not possible due to the magnetic brake's life, the machine construction (when ball screw and servomotor are coupled via a timing belt, etc.) or the magnetic brake's failure. 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 each specification for the power (input voltage, input frequency, tolerable sudden power failure time, etc.).

Set all bits to "0" if they are indicated as not used or empty in the explanation on the bits.

Do not use the dynamic brakes except during the emergency stop. Continued use of the dynamic brakes could result in brake damage.

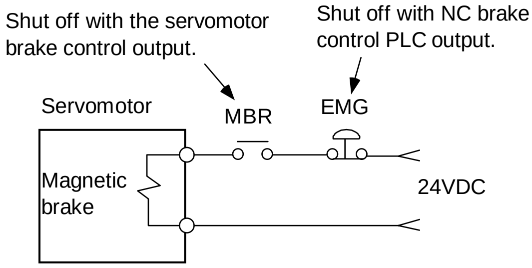
If a circuit protector for the main circuit power supply is shared by several units, the circuit protector may not activate when a short-circuit fault occurs in a small capacity unit. This is dangerous, so never share the circuit protector.

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.

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

Never go near the machine after restoring the power after a 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 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, Service Station, Sales Office or delayer for repairs or part 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 some units 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 type of unit as general industrial waste. Always contact the Service Center, Service Station, Sales Office or delayer for repairs or part replacement.

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.

When incinerating optical communication cable, hydrogen fluoride gas or hydrogen chloride gas which is corrosive and harmful may be generated. For disposal of optical communication cable, request for specialized industrial waste disposal services that has incineration facility for disposing hydrogen fluoride gas or hydrogen chloride gas.

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 manual show the covers and safety partitions, etc., removed to provide a clearer explanation. Always return the covers or partitions to their respective places before starting operation, and always follow the instructions given in this manual.

○ Treatment of waste ○

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

1. Requirements for "Law for Promotion of Effective Utilization of Resources"

(1) Recycle as much of this product as possible when finished with use.
(2) When recycling, often parts are sorted into steel scraps and electric parts, etc., and sold to scrap contractors. Mitsubishi recommends sorting the product and selling the members to appropriate contractors.

2. Requirements for "Law for Treatment of Waste and Cleaning"

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

Disposal

(Note) This symbol mark is for EU countries only.
This symbol mark is according to the directive 2006/66/EC Article 20 Information for end-users and Annex II.

Your MITSUBISHI ELECTRIC product is designed and manufactured with high quality materials and components which can be recycled and/or reused.
This symbol means that batteries and accumulators, at their end-of-life, should be disposed of separately from your household waste.
If a chemical symbol is printed beneath the symbol shown above, this chemical symbol means that the battery or accumulator contains a heavy metal at a certain concentration. This will be indicated as follows:
Hg: mercury (0,0005%), Cd: cadmium (0,002%), Pb: lead (0,004%)
In the European Union there are separate collection systems for used batteries and accumulators.
Please, dispose of batteries and accumulators correctly at your local community waste collection/ recycling centre.

Please, help us to conserve the environment we live in!

本製品の取扱いについて

(日本語 /Japanese)
本製品は工業用 (クラス A) 電磁環境適合機器です。販売者あるいは使用者はこの点に注意し、住商業環境以外での使用をお願いいたします。

Handling of our product

(English)
This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

본 제품의 취급에 대해서

(한국어 /Korean)
이 기기는 업무용 (A 급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며 가정외의 지역에서 사용하는 것을 목적으로 합니다 .

CONTENTS

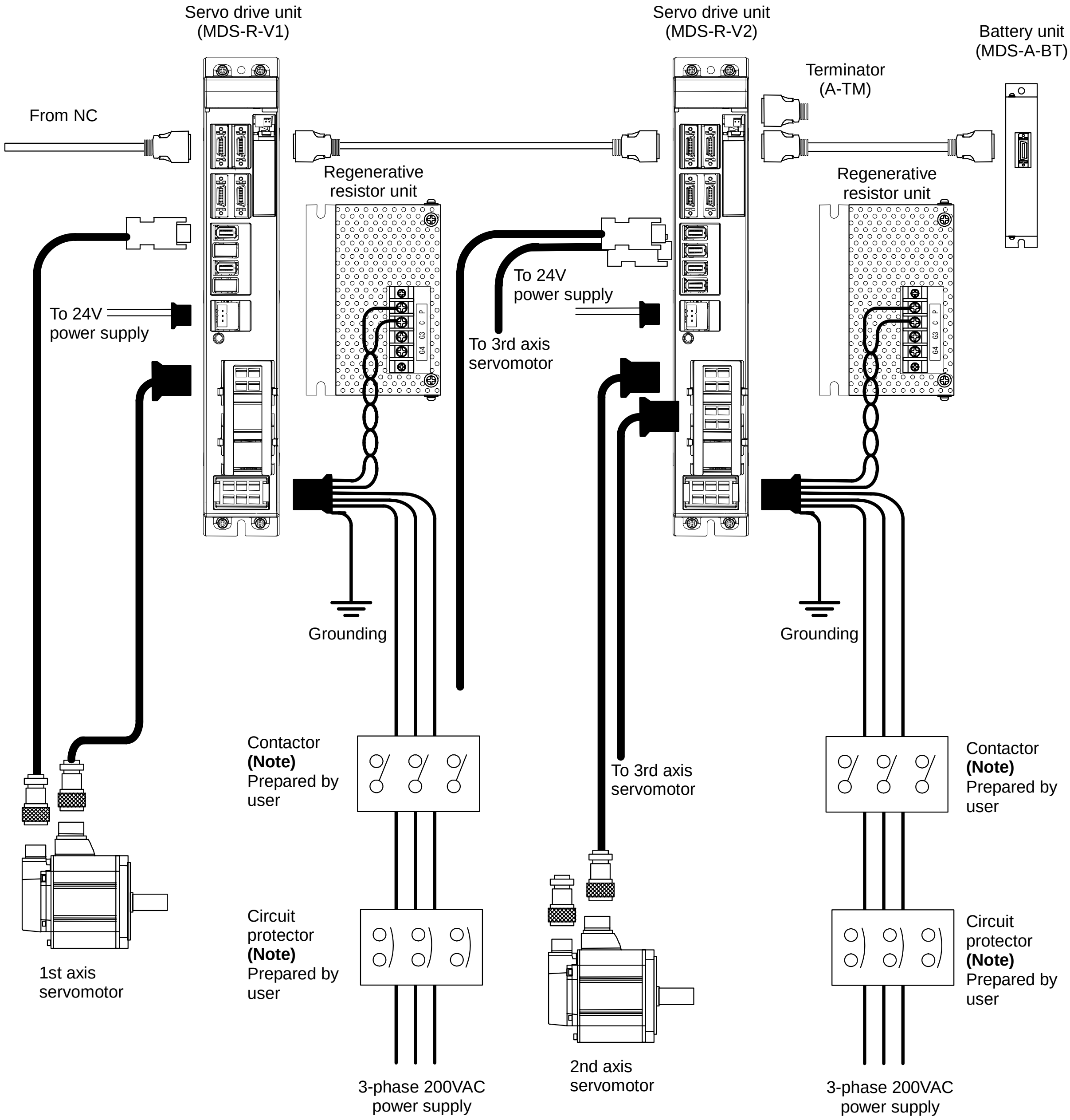
7. Wiring and Connection

8. Setup

9. Adjustment

1. Introduction

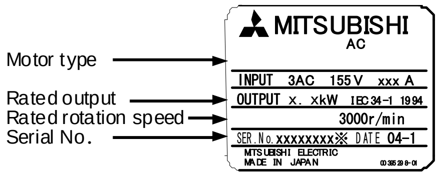
1-1 System configuration



1-2 Explanation of type

1-2-1 Servomotor type

HF Series



Motor rating nameplate

HF (1) (2) (3) - (4)

(4)

Symbol	Detection method	Resolution
A48	Absolute position	260,000p/rev
A51		1,000,000p/rev

(3)

Symbol	Shaft end structure
S	Straight
T	Taper

(Note) HF204, 302, 303, 354 are compatible only with the straight axis specifications.

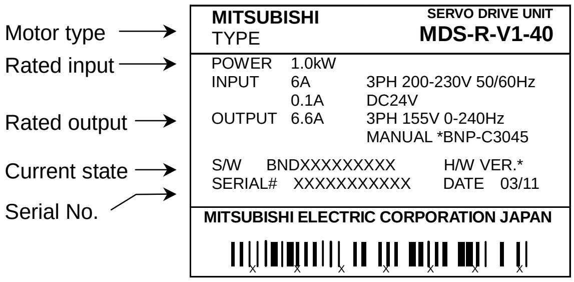
(2)

Symbol	Magnetic brakes
None	None
B	With magnetic brakes

(1)

HF□medium-inertia series		HF□medium-inertia series		HF□medium-inertia series	
Max. 4000r/min		Max. 3000r/min		Max. 2000r/min	
Symbol	Rating	**Symbol**	Rating	**Symbol**	Rating
75	0.4 kW	54	0.5 kW	142	1.4 kW
105	0.75kW	104	1.0 kW	302	3.0 kW
		154	1.5 kW		
		224	2.2 kW		
		204	2.0 kW		
		354	3.5 kW		
		123	1.2 kW		
		223	2.2 kW		
		303	3.3 kW		

1-2-2 Servo drive unit type



Rating nameplate

MDS-R- (1)

1-axis servo drive unit			Compatible motor HF Series												
			Medium-inertia												
(1) Motor type MDS-R-	**Unit width**	**Drive shaft**	75	105	54	104	154	224	204	354	123	223	303	142	302
V1-20	60mm width	L	◎	◎	◎						◎			◎	
V1-40		L				◎						◎			◎
V1-60	90mm width	L					◎	◎	◎				◎		
V1-80		L								◎					

2-axis servo drive unit			Compatible motor HF Series												
			Medium-inertia												
(1) Motor type MDS-R-	**Unit width**	**Drive shaft**	75	105	54	104	154	224	204	354	123	223	303	142	302
V2-2020	60mm width	L/M	◎	◎	◎						◎			◎	
V2-4020		M	◎	◎	◎						◎			◎	
		L				◎						◎			◎
V2-4040		L/M				◎						◎			◎
V2-6040	90mm width	M				◎						◎			◎
		L					◎	◎	◎				◎		
V2-6060		L/M					◎	◎	◎				◎		
V2-8040		M				◎						◎			◎
		L								◎					
V2-8060		M					◎	◎	◎				◎		
		L								◎					
V2-8080		L/M								◎					

(Note) ◎ indicates the motor corresponding to each servo drive unit.

2. Specifications

2-1 Servomotor

2-1-1 Specifications list

HF Series

Servomotor type		HF□□-A48/A51												
		4000r/min Series		3000r/min Series									2000r/min Series	
		HF 75	HF 105	HF 54	HF 104	HF 154	HF 224	HF 204	HF 354	HF 123	HF 223	HF 303	HF 142	HF 302
Compatible servo drive unit type **(Note 4)**	MDS-R-V1/V2-	20	20	20	40	60	60	60	80	20	40	60	20	40
Continuous characteristics	Rated output [kW]	0.4	0.75	0.5	1.0	1.5	2.2	2.0	3.5	1.2	2.2	3.0	1.4	3.0
	Rated current [A]	2.2	3.7	1.9	3.5	5.3	8.5	6.9	10.3	5.2	9.0	10.7	5.2	10.9
	Rated torque [N･m]	1.27	2.39	1.59	3.18	4.77	7.0	6.37	11.1	5.7	10.5	14.3	6.7	14.3
	Stall current [A]	3.2	4.6	3.6	6.5	9.9	14.5	14.8	20.8	6.4	10.2	15.8	6.4	10.9
	Stall torque [N･m]	2.0	3.0	2.94	5.88	8.82	12.0	13.7	22.5	7.0	12.0	22.5	11.0	20.0
Rated rotation speed	[r/min]	3000	3000	3000	3000	3000	3000	3000	3000	2000	2000	2000	2000	2000
Maximum rotation speed	[r/min]	4000		3000									2000	
Maximum current	[A]	13.7	17.0	15.3	25.6	42.0	45.8	45.8	59.2	15.5	29.0	45.8	15.5	29.0
Maximum torque	[N･m]	8.0	11.0	11.8	21.6	35.3	37.0	41.7	59.8	17.0	32.0	60.0	26.5	50.0
Motor inertia	[kg･cm2]	2.6	5.1	6.1	11.9	17.8	23.7	38.3	75.0	11.9	23.7	75.0	17.8	75.0
Motor inertia with brake	[kg･cm2]	2.8	5.3	8.3	14.1	20.0	25.9	48.0	84.7	14.1	25.9	84.7	20.0	84.7
Maximum motor shaft conversion load inertia rate		Machine tool (Compensation axis): 5 times or less of motor inertia General machine (non-compensation axis): 10 times or less of motor inertia												
Motor side detector resolution		A51 : For high-gain 1,000,000 pulse/rev A48 : For general use 260,000 pulse/rev												
Structure		Fully closed, natural-cooling (Protection method: IP67) **(Note 3)**												
Environment	Ambient temperature	Operation: 0 to 40°C (non freezing), Storage: -15 to 70°C (non freezing)												
	Ambient humidity	Operation: 80%RH or less (non condensing), Storage: 90%RH or less (non condensing)												
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust												
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level												
	Vibration	X:49m/s^2 (5G) Y:49m/s^2 (5G)		X:24.5m/s^2 (2.5G) Y:24.5m/s^2 (2.5G)				X:24.5m/s^2 (2.5G) Y:49m/s^2 (5G)		X:24.5m/s^2 (2.5G) Y:24.5m/s^2 (2.5G)		X:24.5 m/s^2 (2.5G) Y:49 m/s^2 (5G)	X:24.5 m/s^2 (2.5G) Y:24.5 m/s^2 (2.5G)	X:24.5 m/s^2 (2.5G) Y:49 m/s^2 (5G)
Mass Without/with brake	[kg]	2.5 /3.9	4.3 /5.7	4.8 /6.8	6.5 /8.5	8.3 /10.3	10/12	12/18	19/25	6.5 /8.5	10/12	19/25	8.3 /10.3	19/25
Armature insulation class		Class F												

(Note 1) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the drive unit.

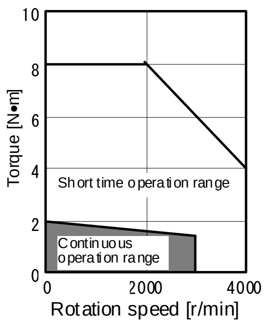
(Note 2) Use the HF motor in combination with the MDS-R Series drive unit compatible with the 200VAC input.
This motor is not compatible with the conventional MDS-B/C1/CH Series.

(Note 3) The shaft-through portion is excluded.

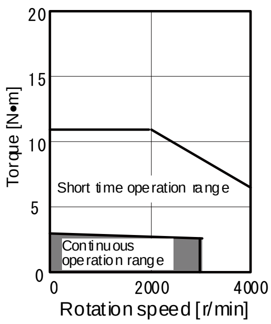
(Note 4) "( )" indicates the combination with the drive unit capacity of one rank up. The motor characteristics are same as the characteristics applied when the drive unit capacity is standard.

2-1-2 Torque characteristics

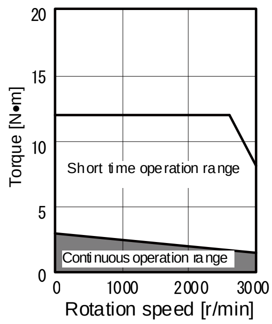
[HF75]



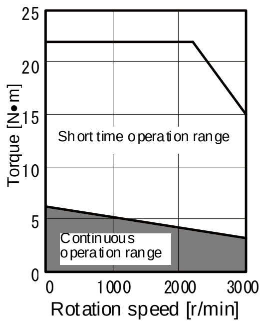
[HF105]



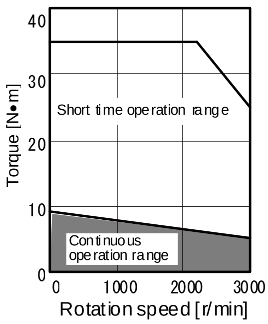
[HF54]



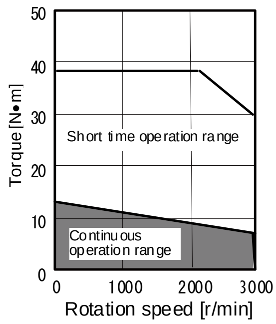
[HF104]



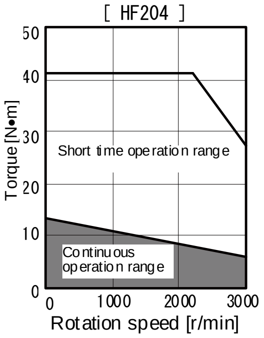
[HF154]



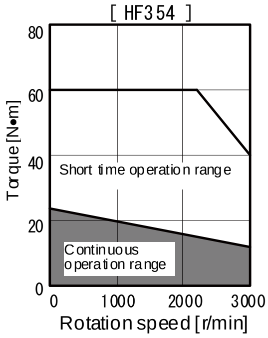
[HF224]



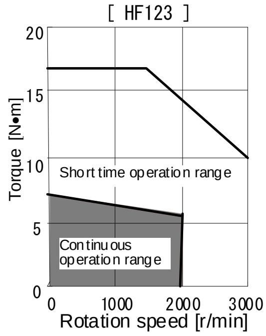
[HF204]



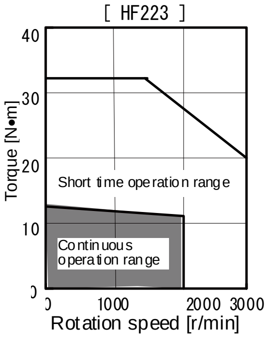
[HF354]



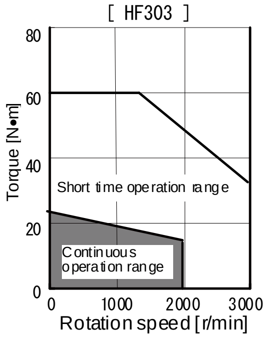
[HF123]



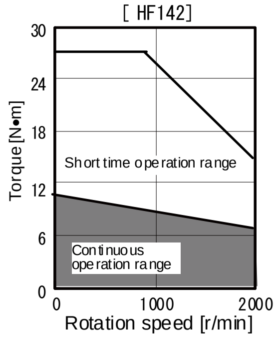
[HF223]



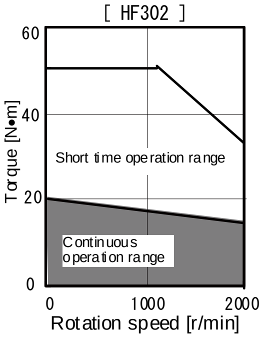
[HF303]



[HF142]



[HF302]



(Note1) The characteristic value in the above graphs is a value applied when the motor is combined with each compatible unit.

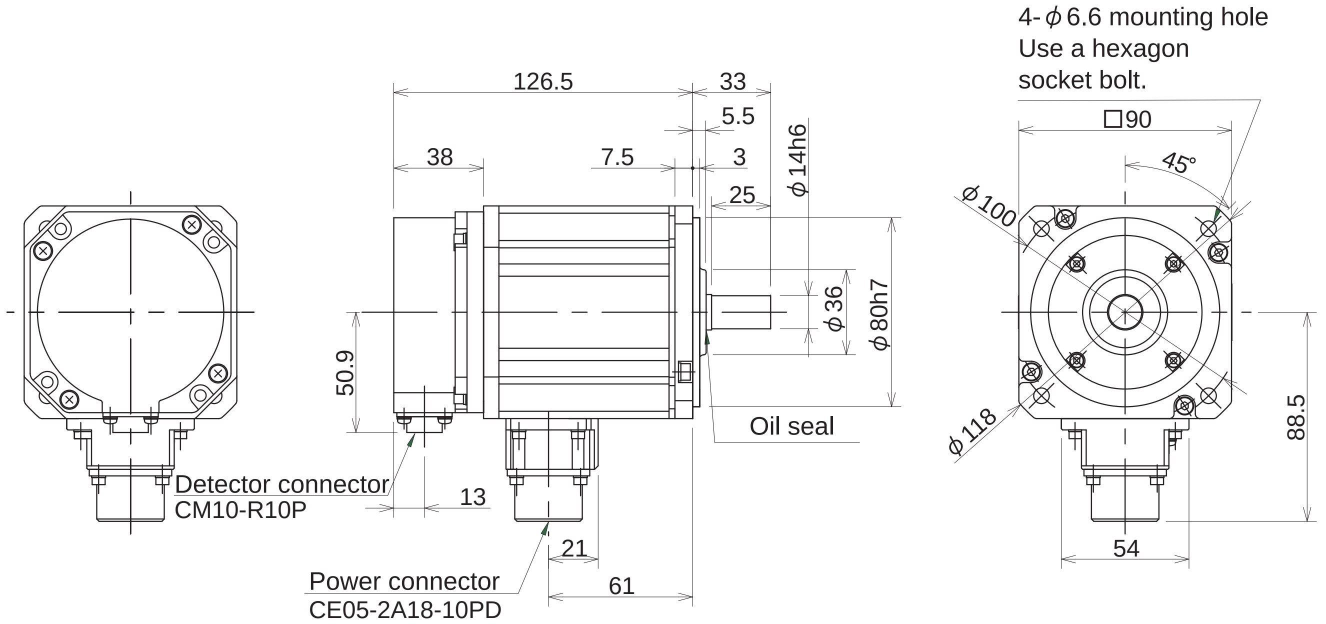
(Note2) The above graphs show the data for the input voltage of 200VAC. When the input voltage is 200VAC or less, the short time operation range is limited.

2-1-3 Outline dimension drawings

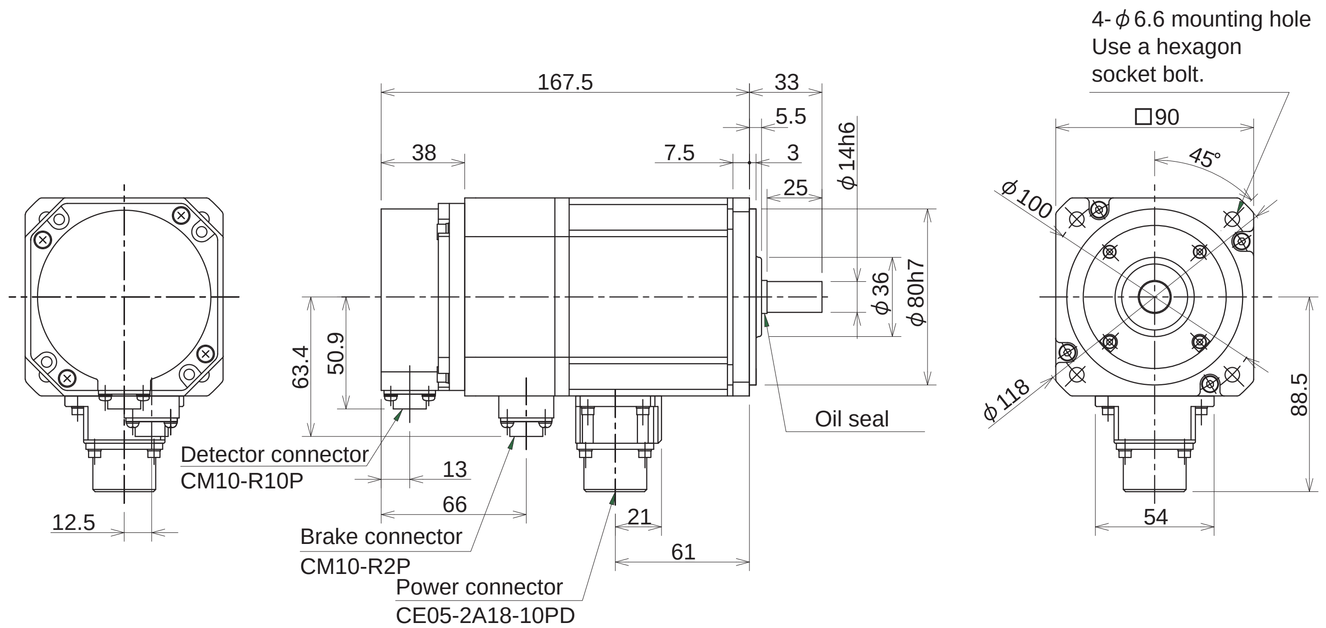
CAUTION !	
	1. Use a friction coupling (Spun ring, etc.) to connect with the load.
	2. Attach the cannon connector facing downward to improve the splash-proof performance.
	3. When hanging up a motor with hanging bolts, stick them to the bearing surface of the hanging bolts.

[Unit:mm]

· **HF75S-A48**

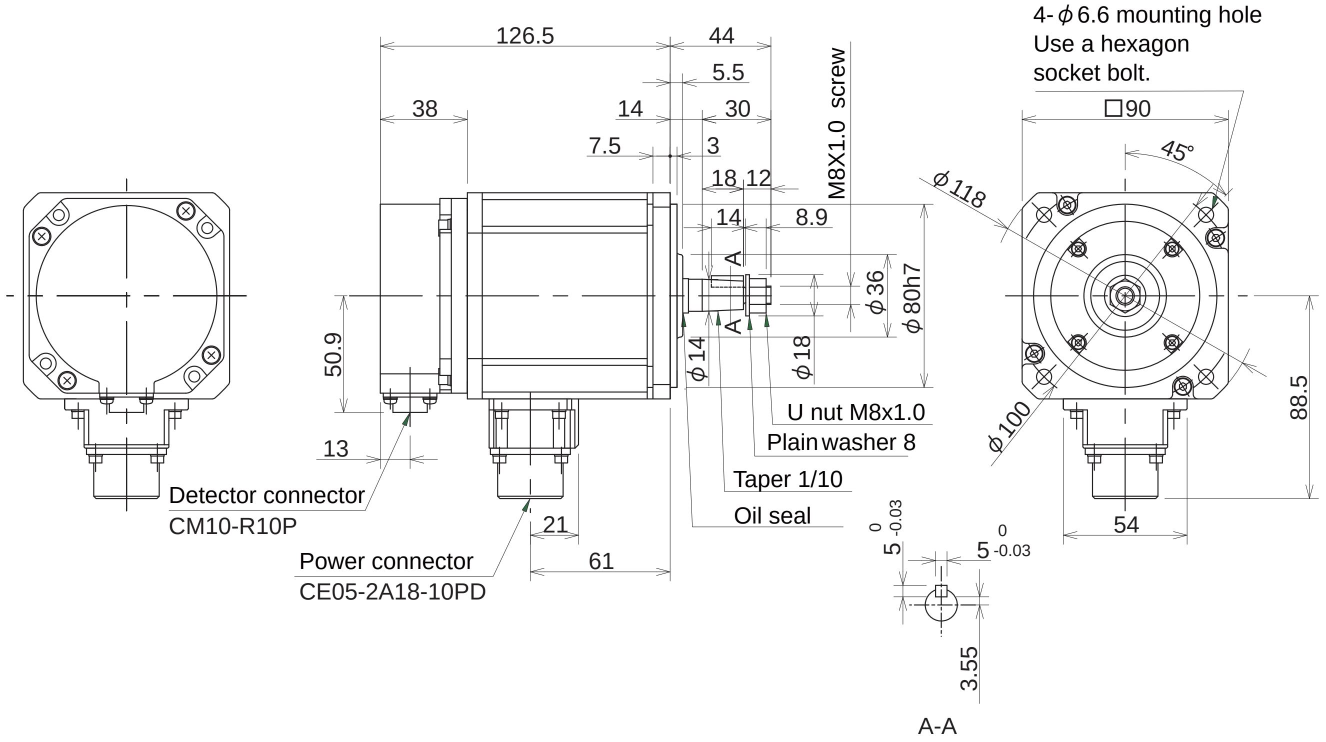


· **HF75BS-A48**

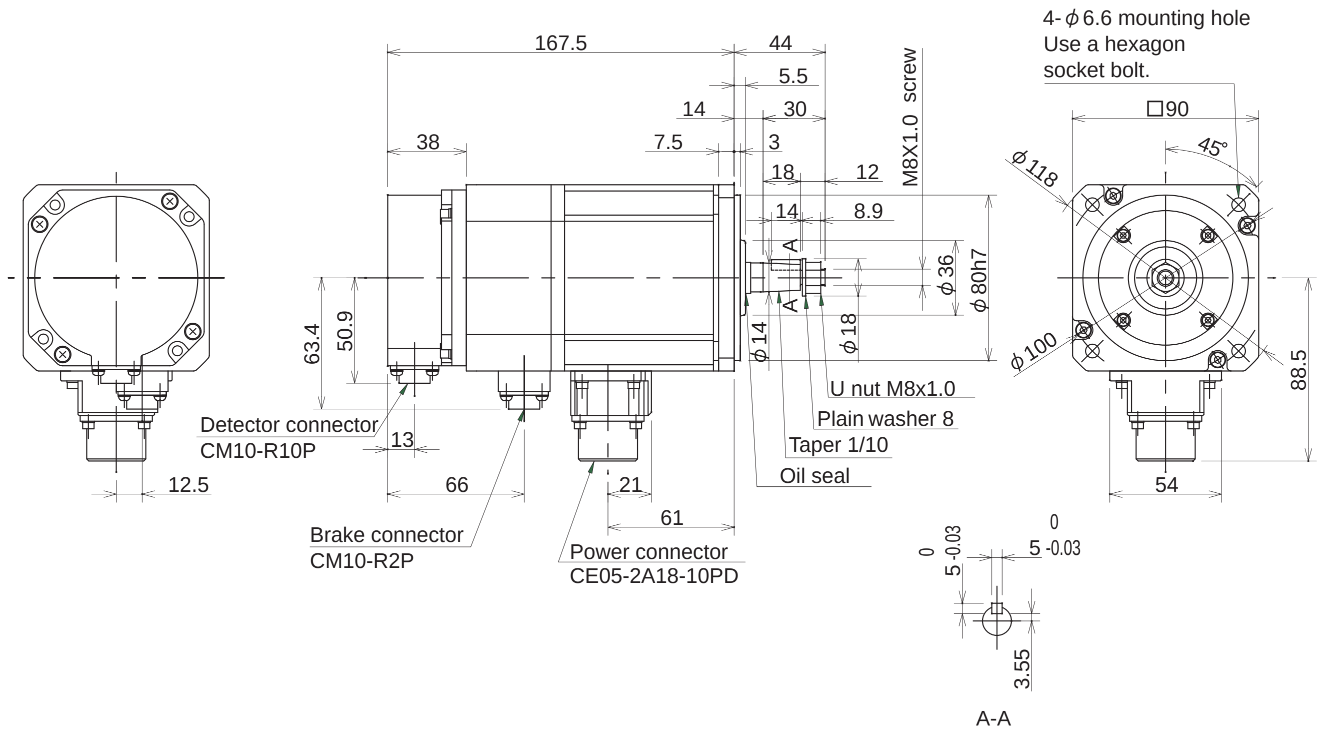


[Unit:mm]

· **HF75T-A48**

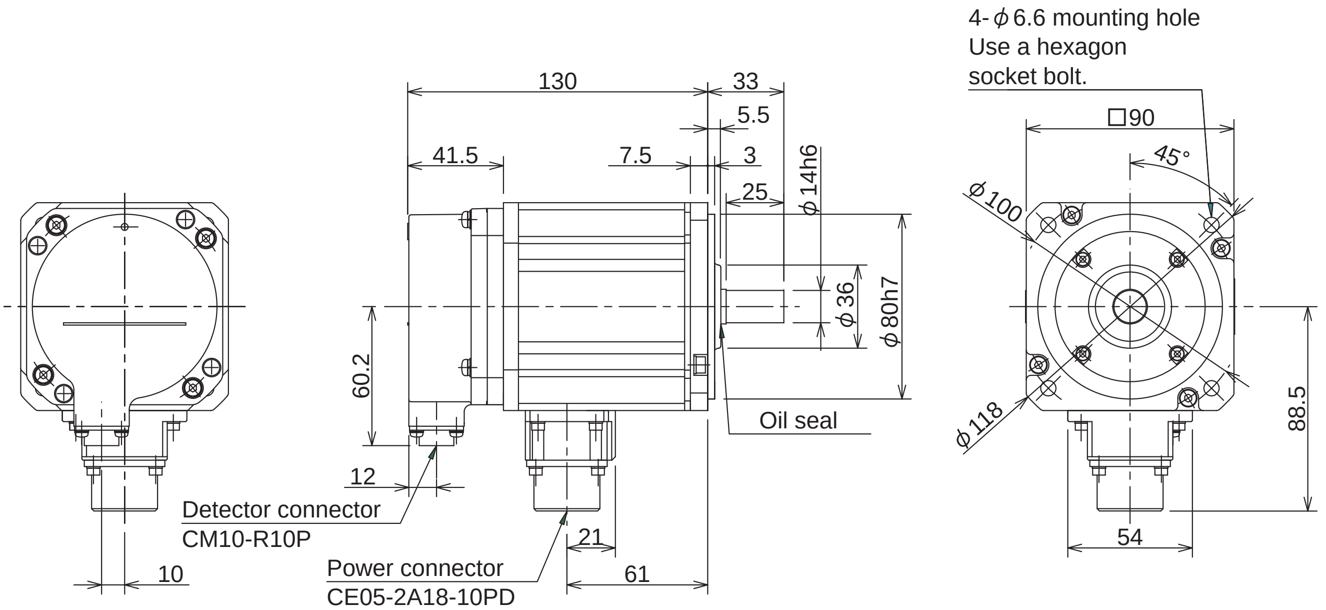


· **HF75BT-A48**



[Unit:mm]

· **HF75S-A51**



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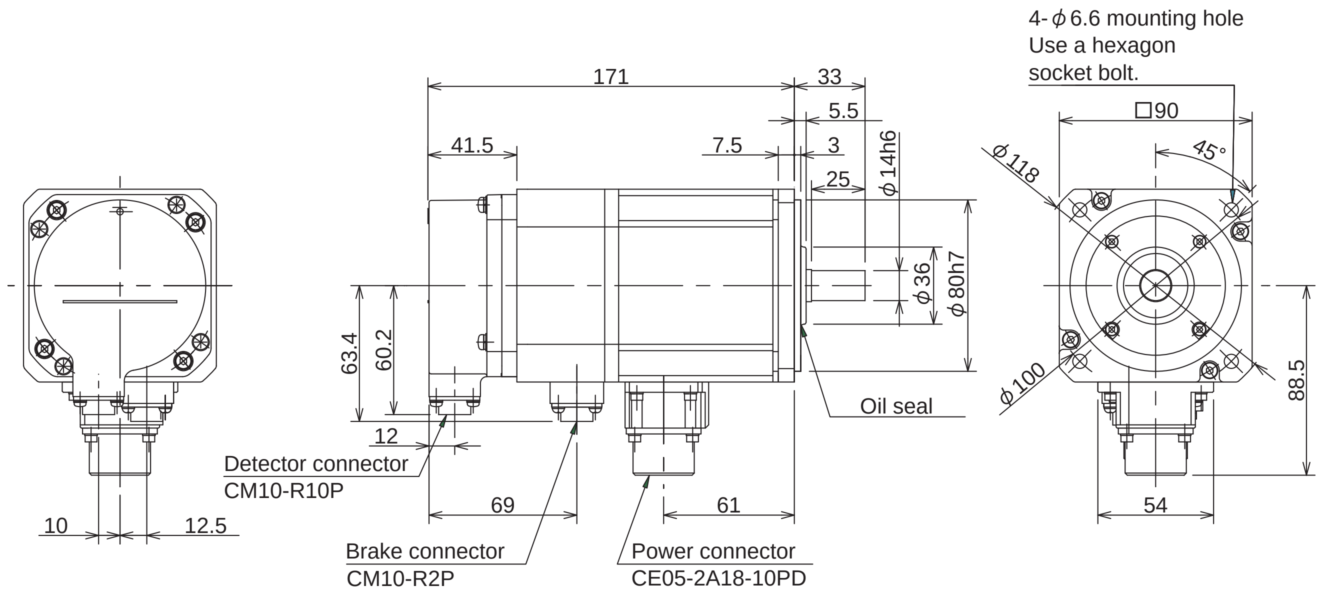
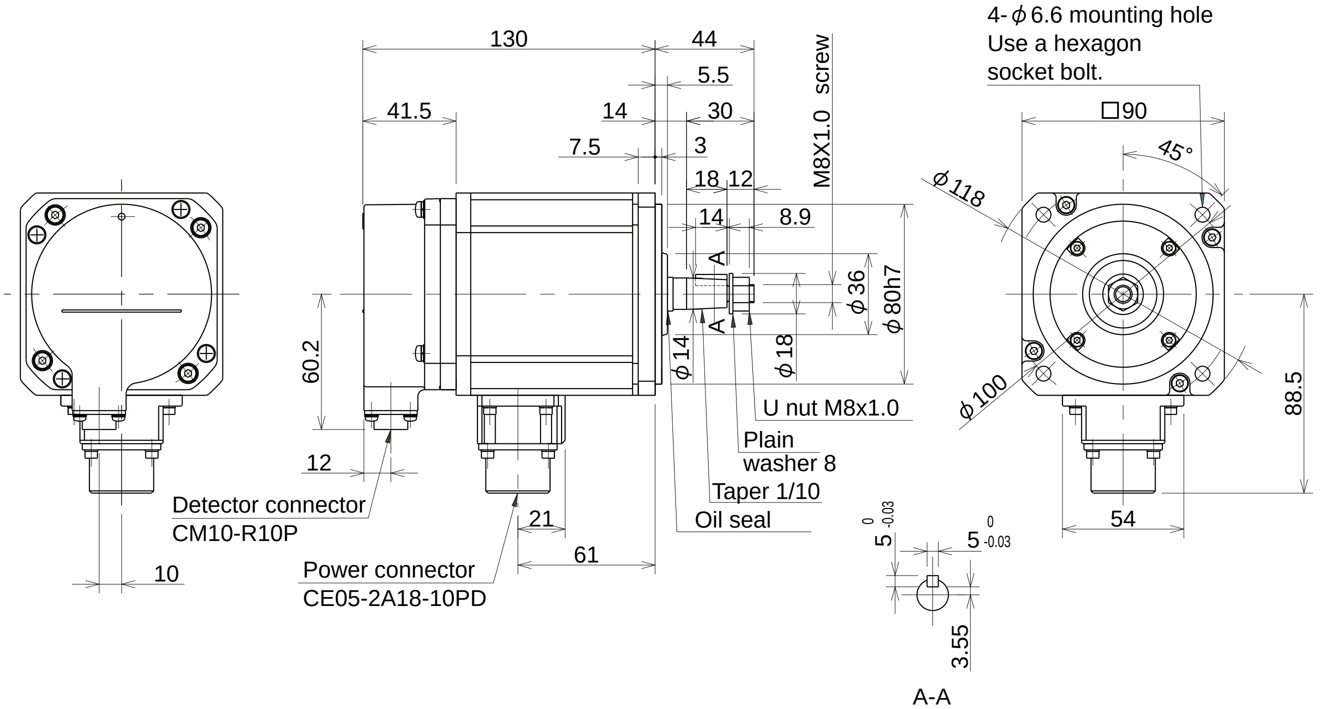
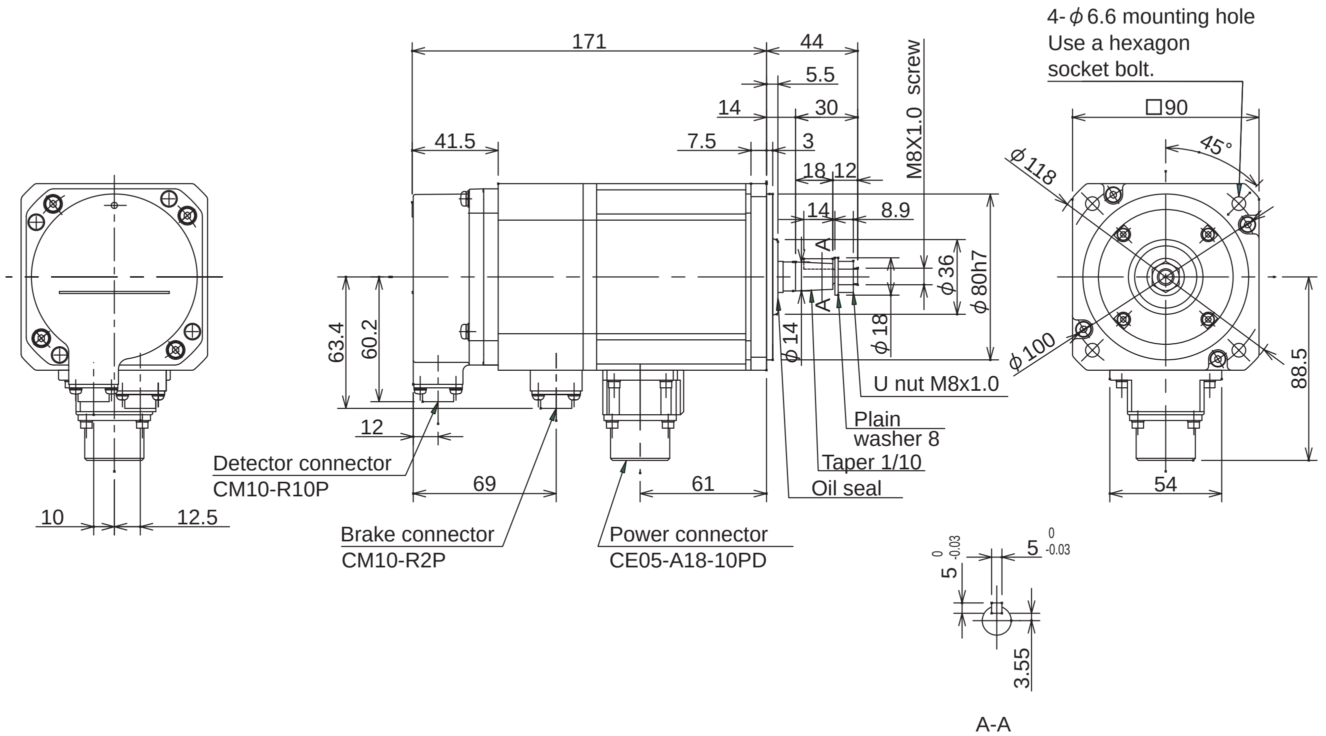


[Unit:mm]

· HF75T-A51

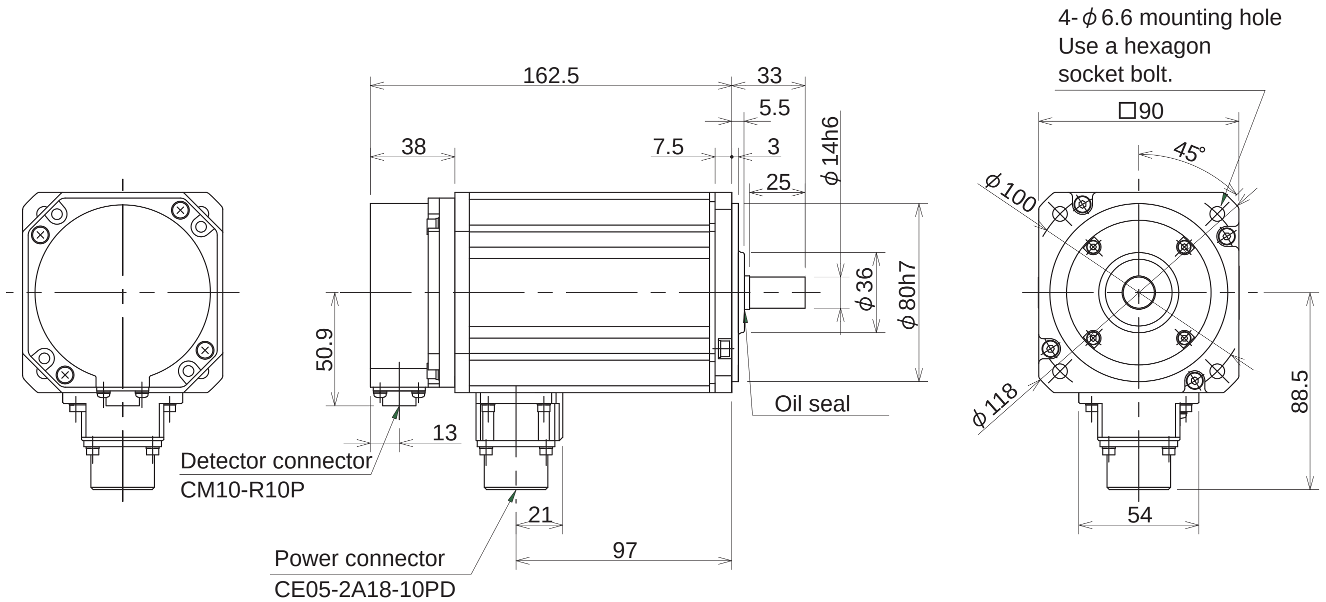


· HF75BT-A51

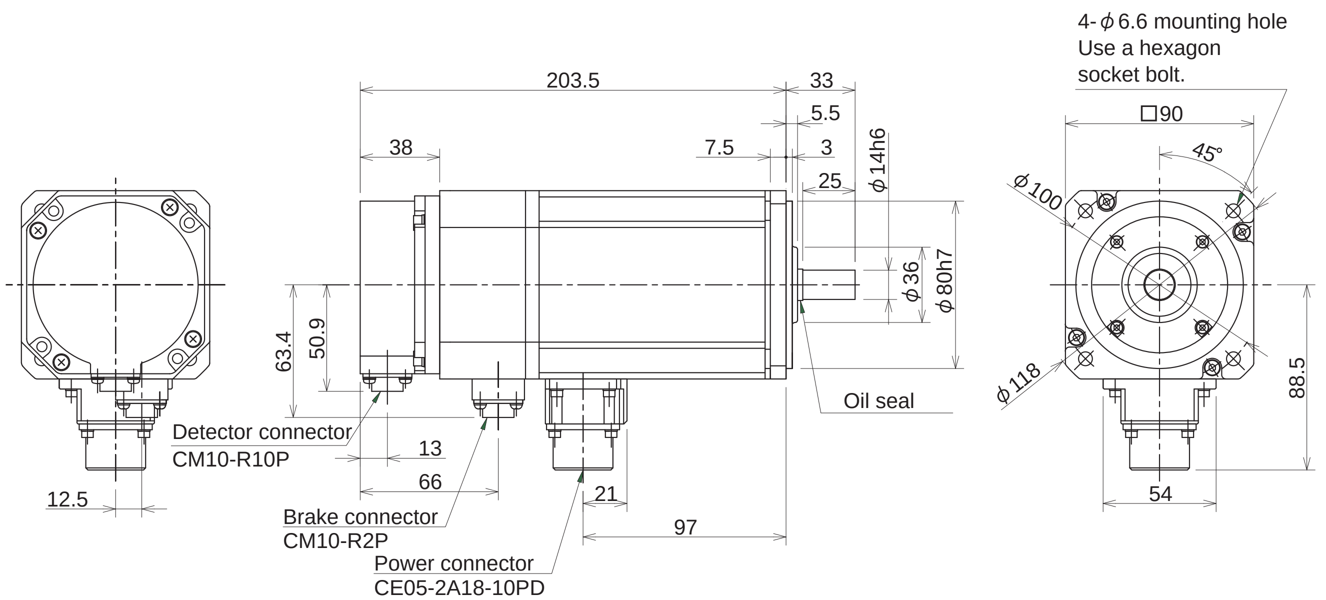


[Unit:mm]

· **HF105S-A48**



· **HF105BS-A48**



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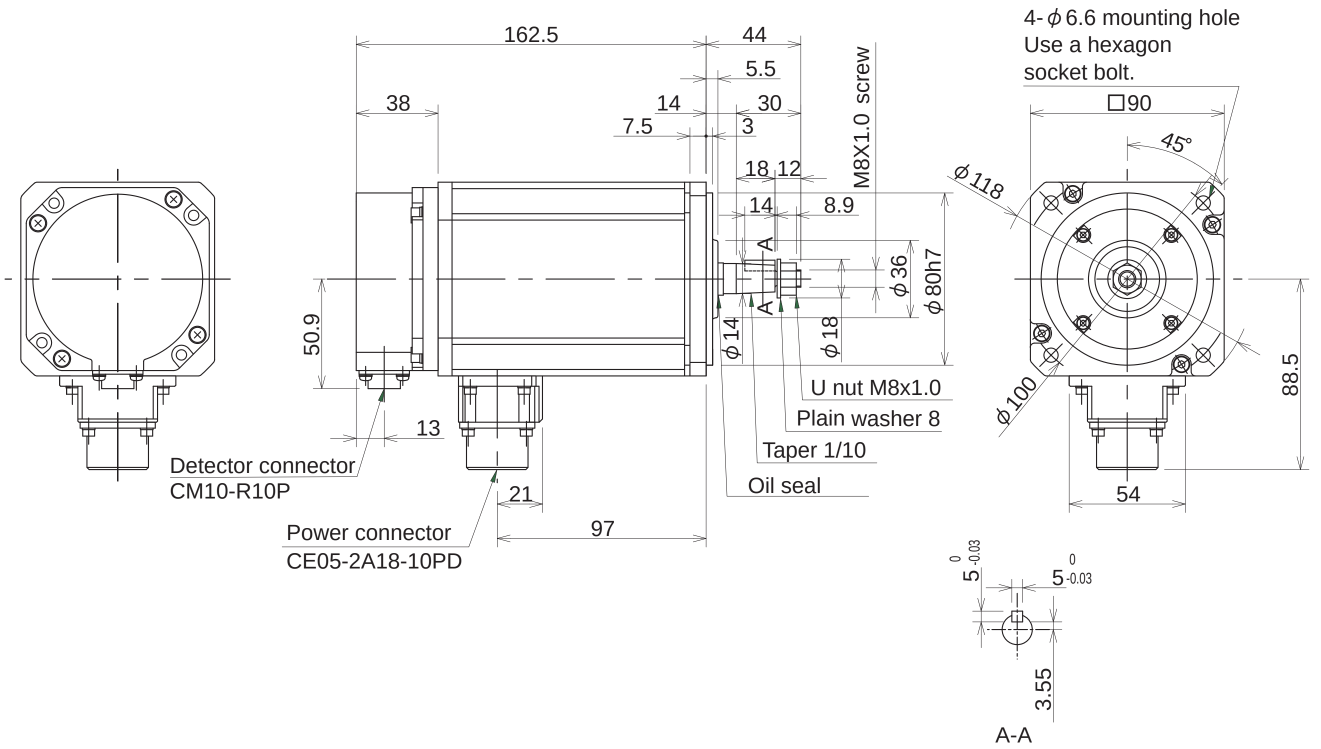

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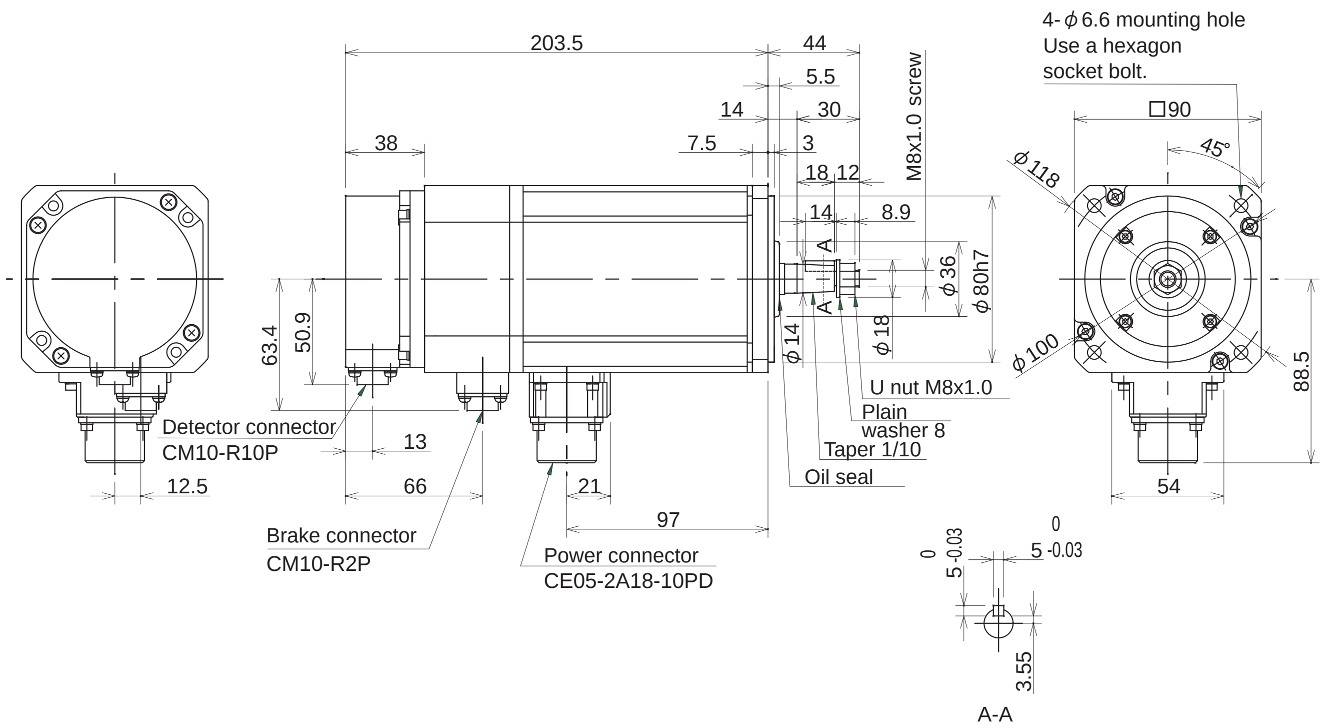

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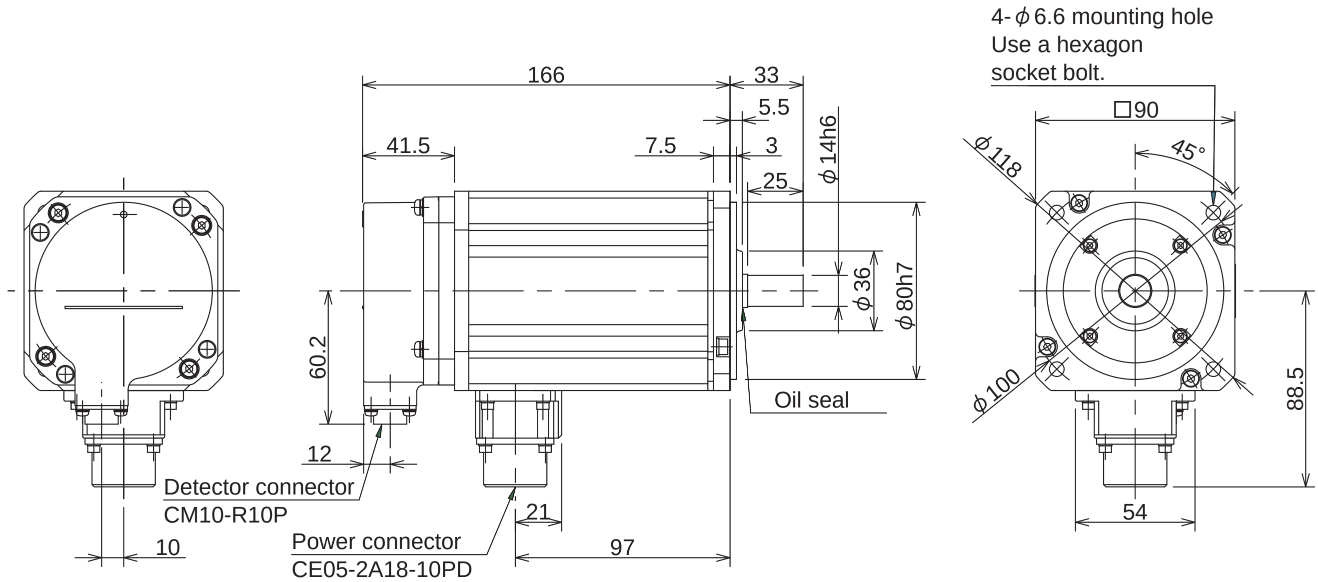

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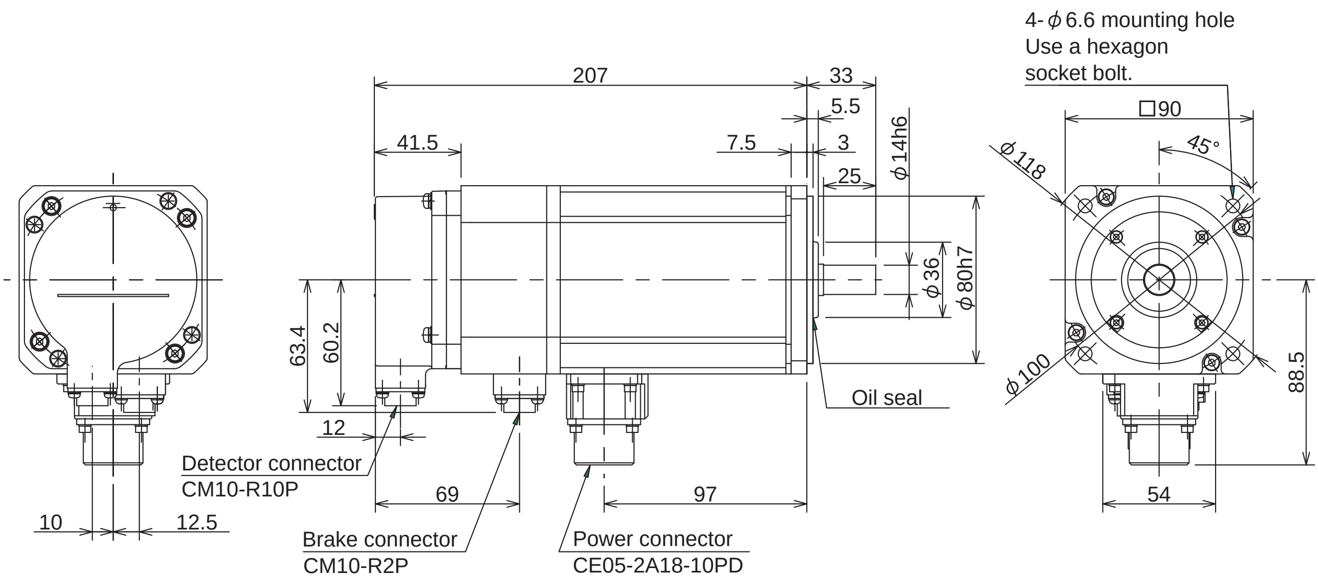
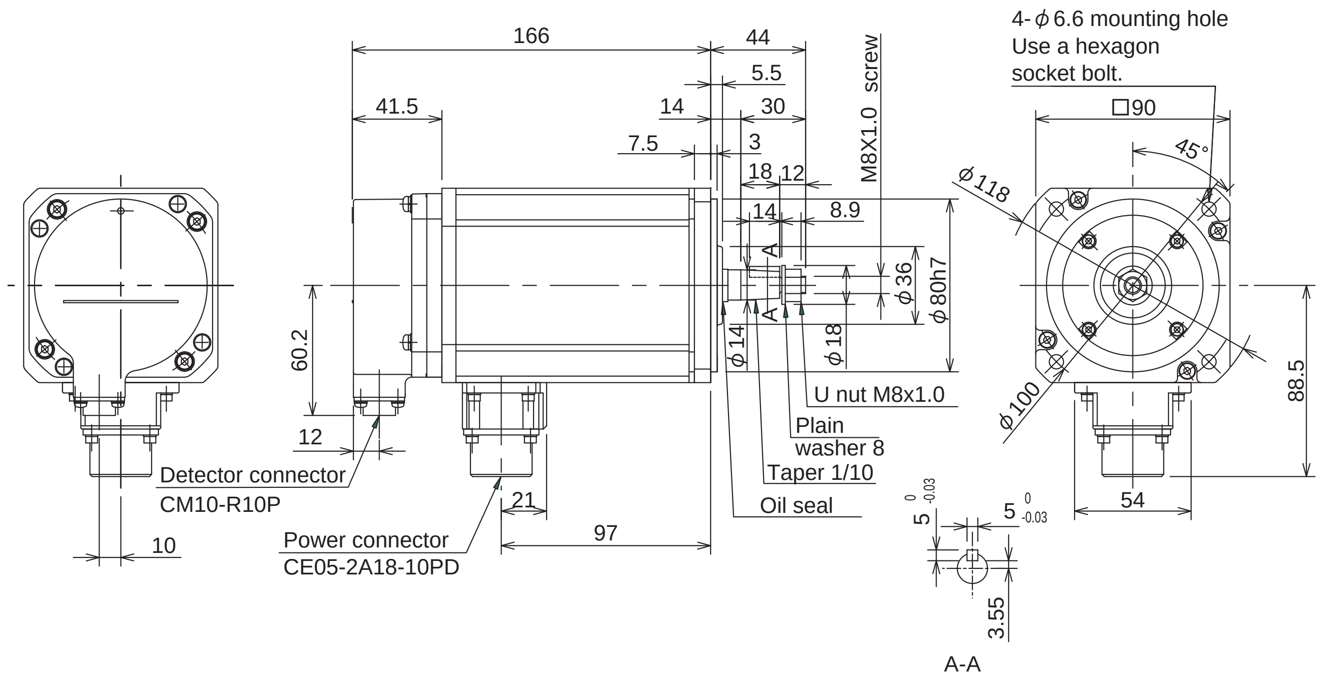


[Unit:mm]

· HF105T-A51



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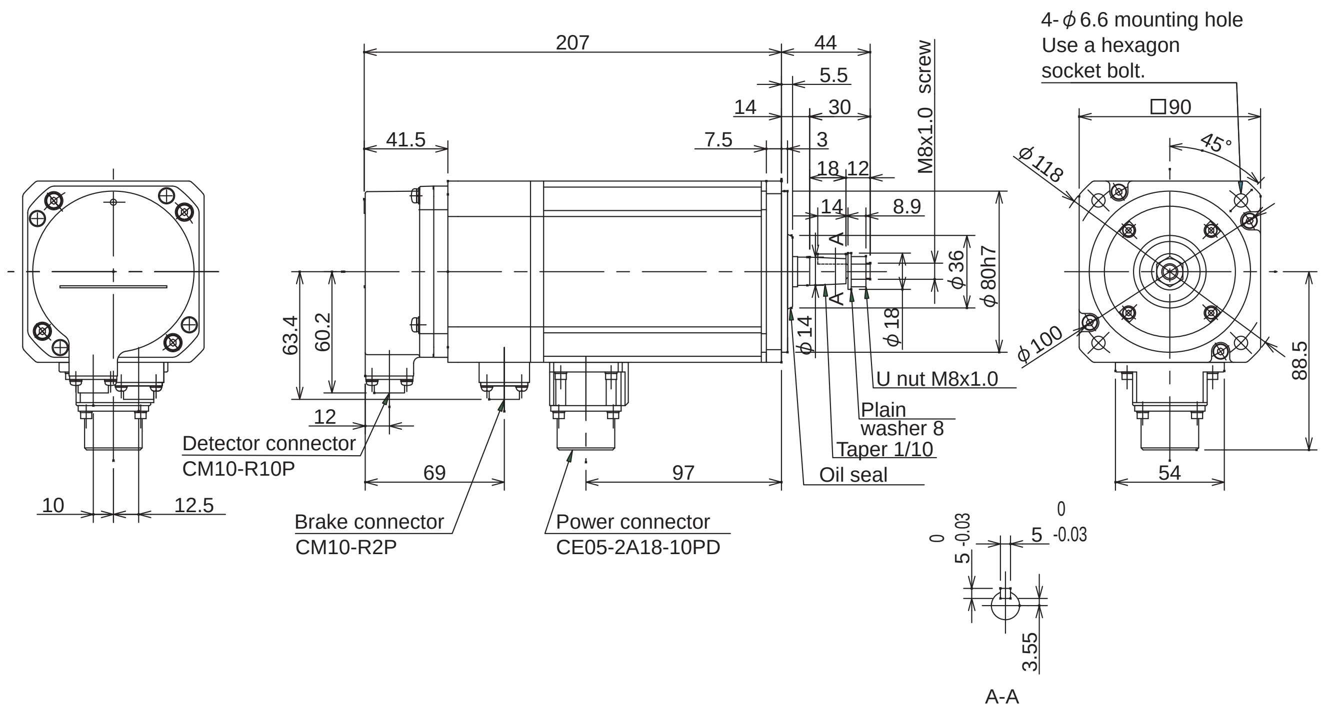

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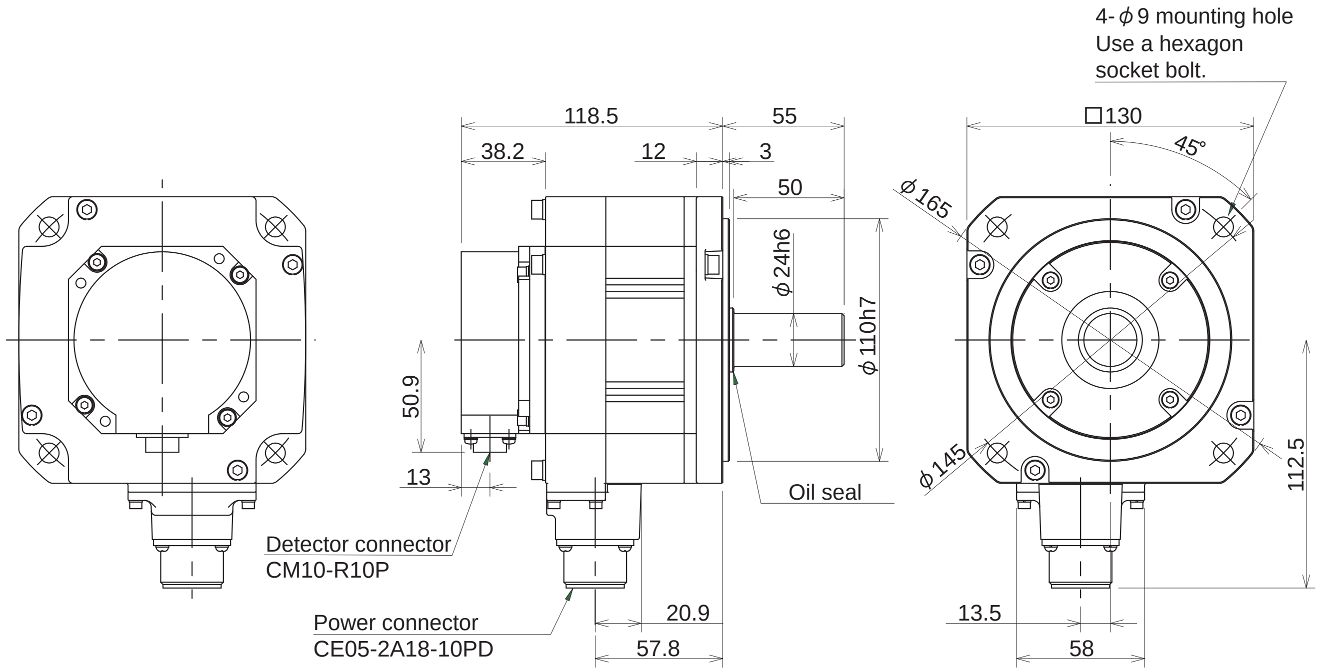

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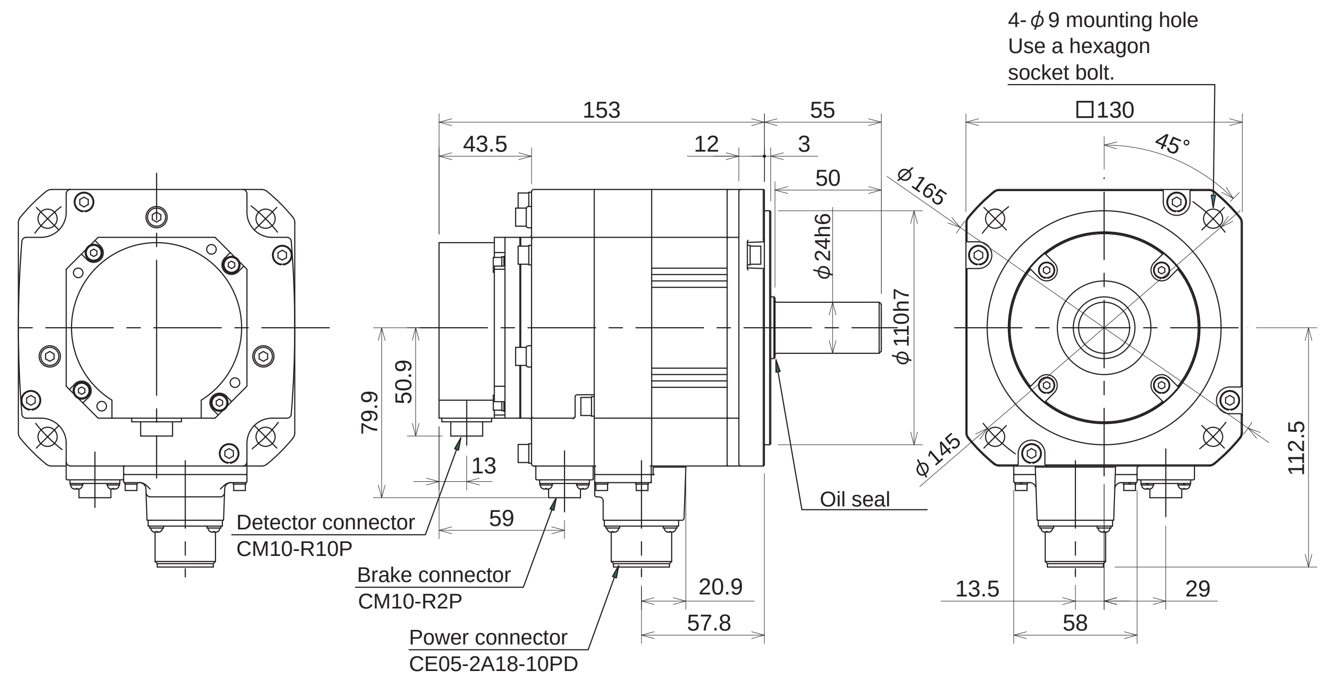

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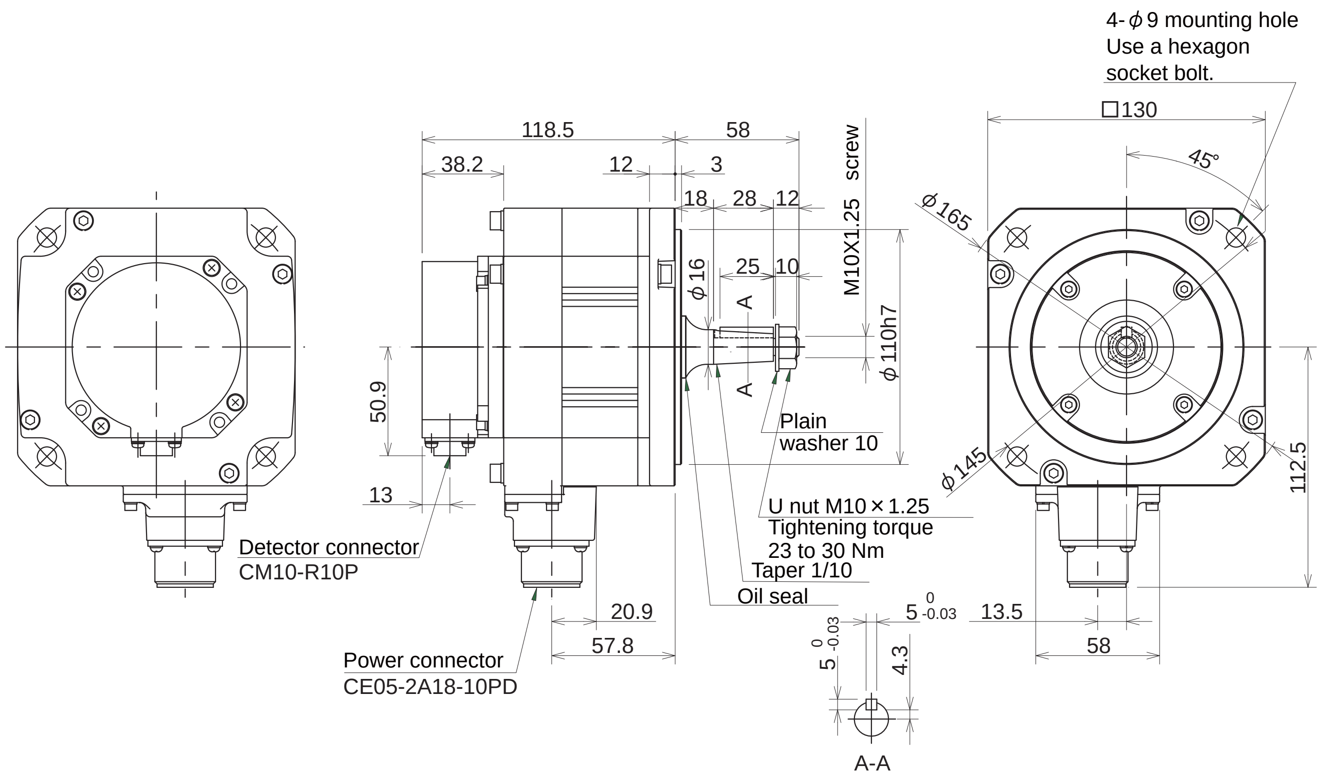

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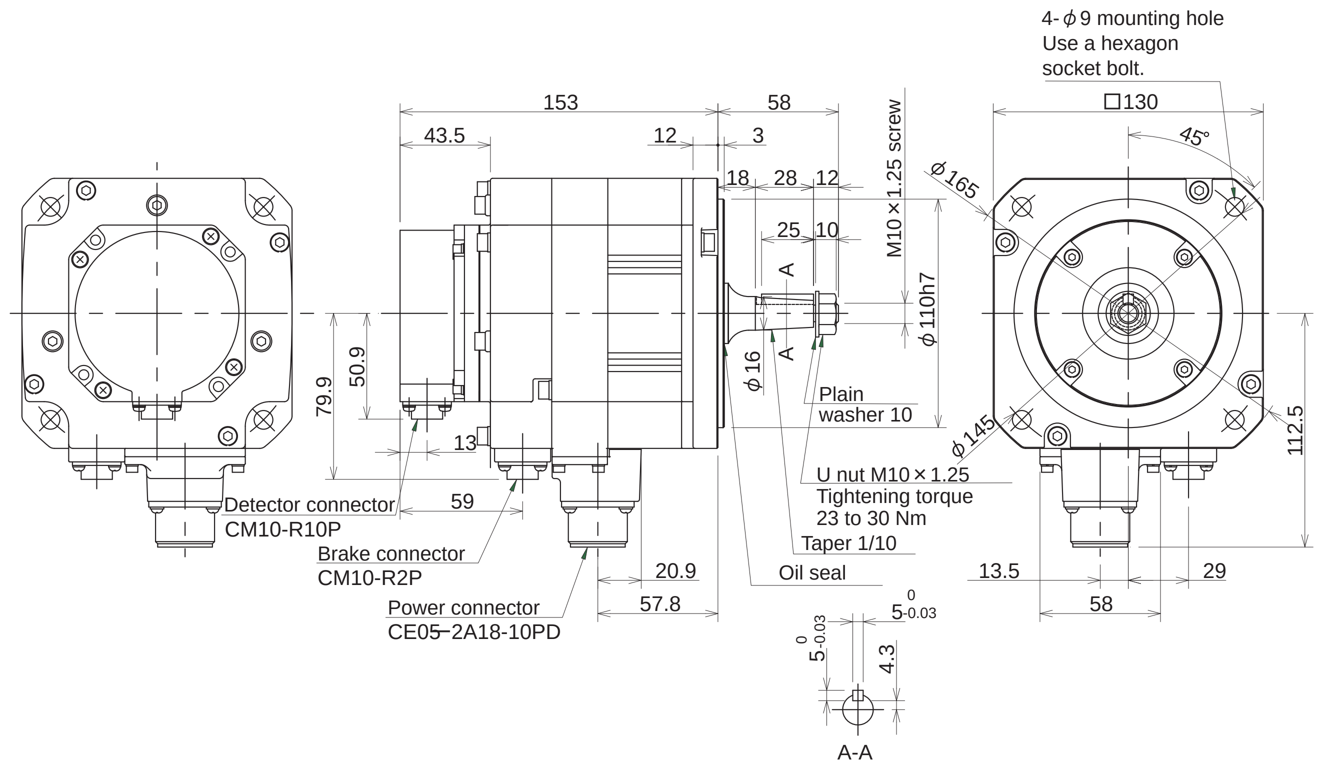

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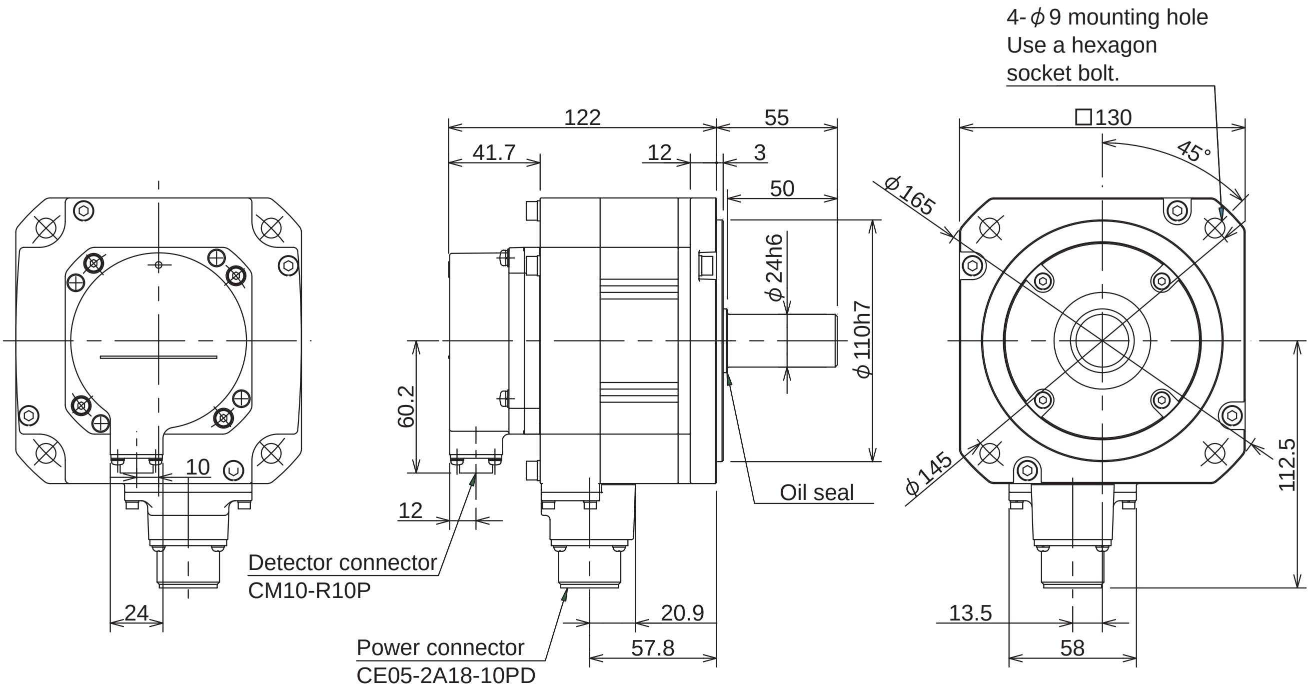

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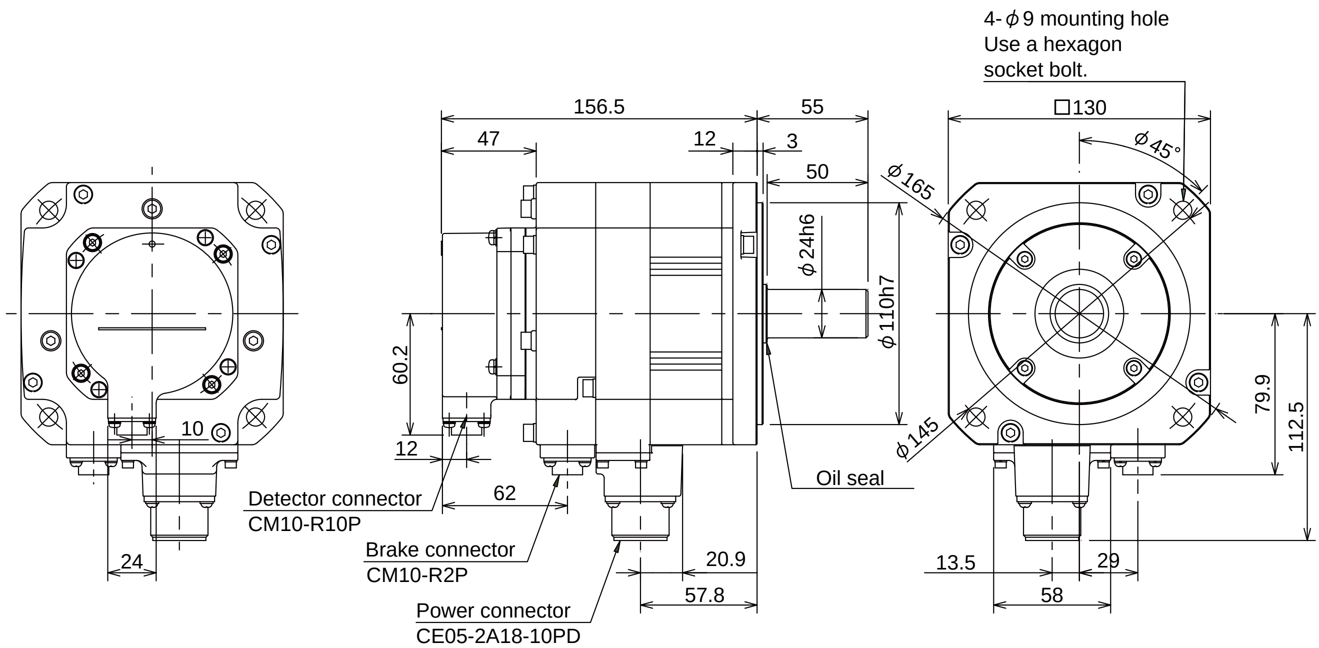

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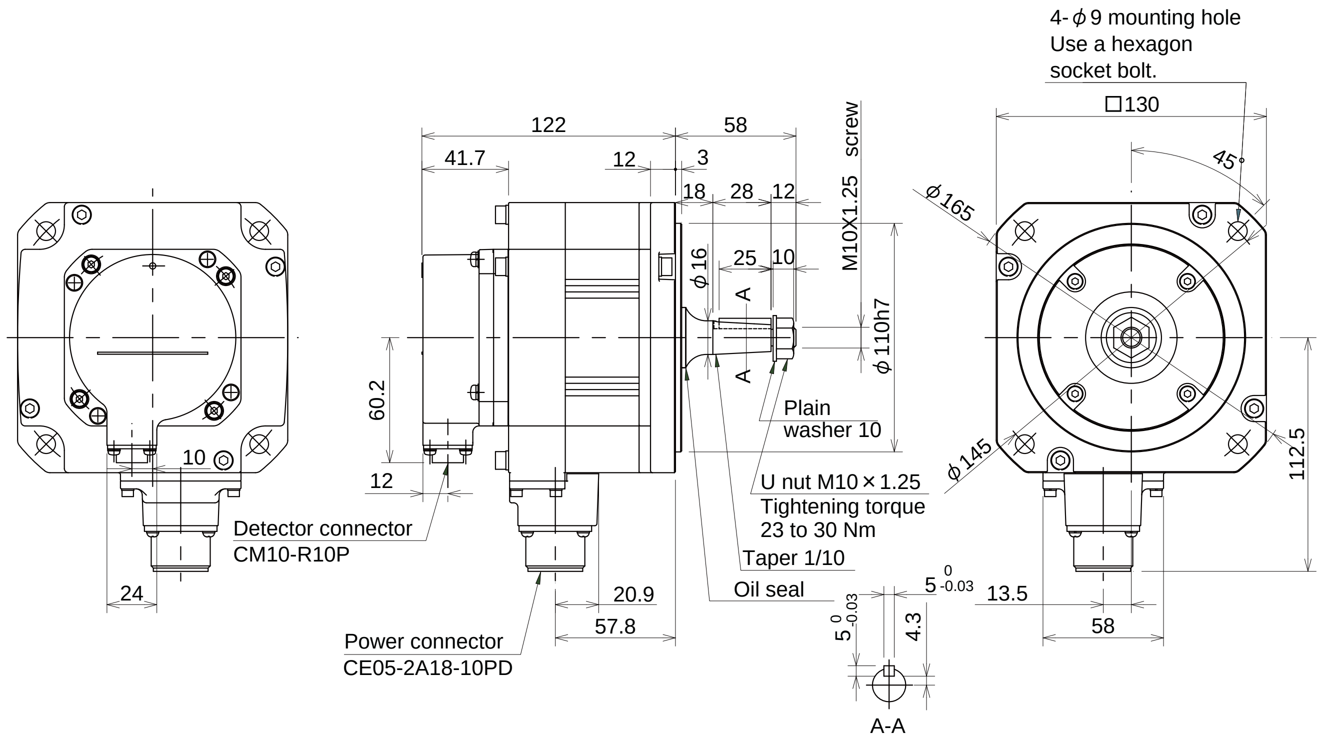

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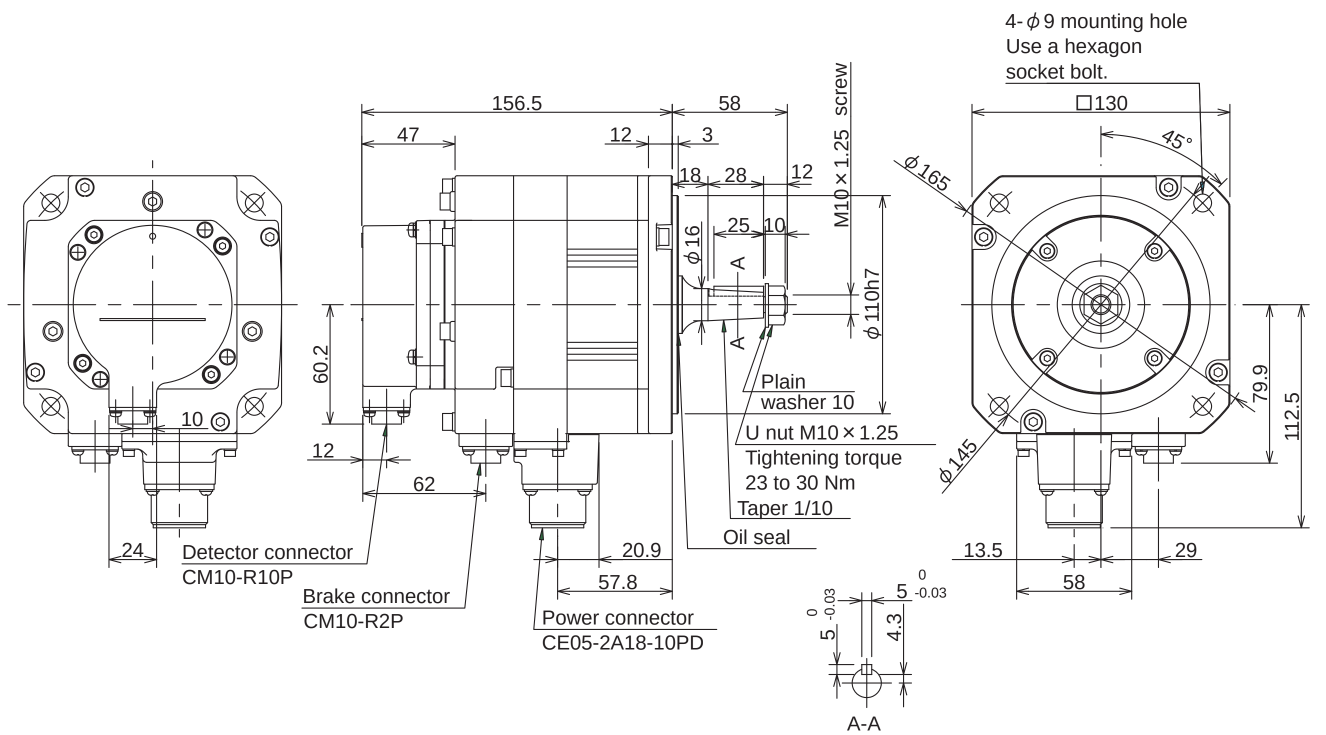

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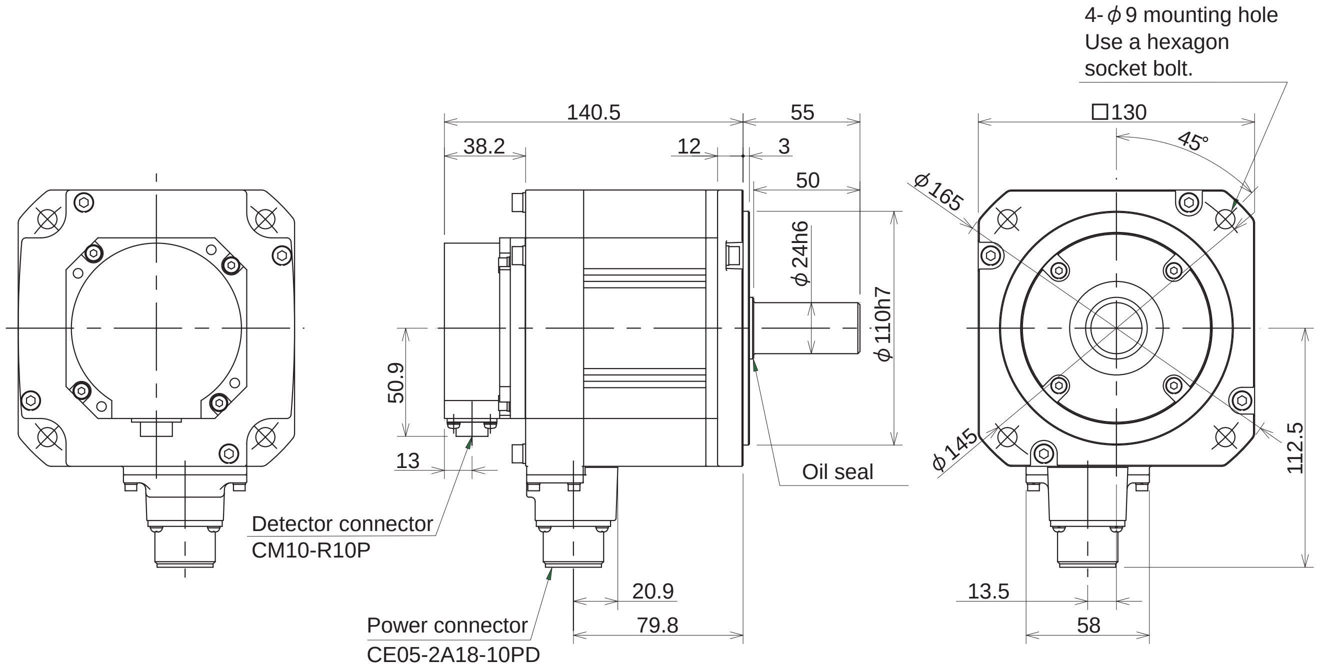

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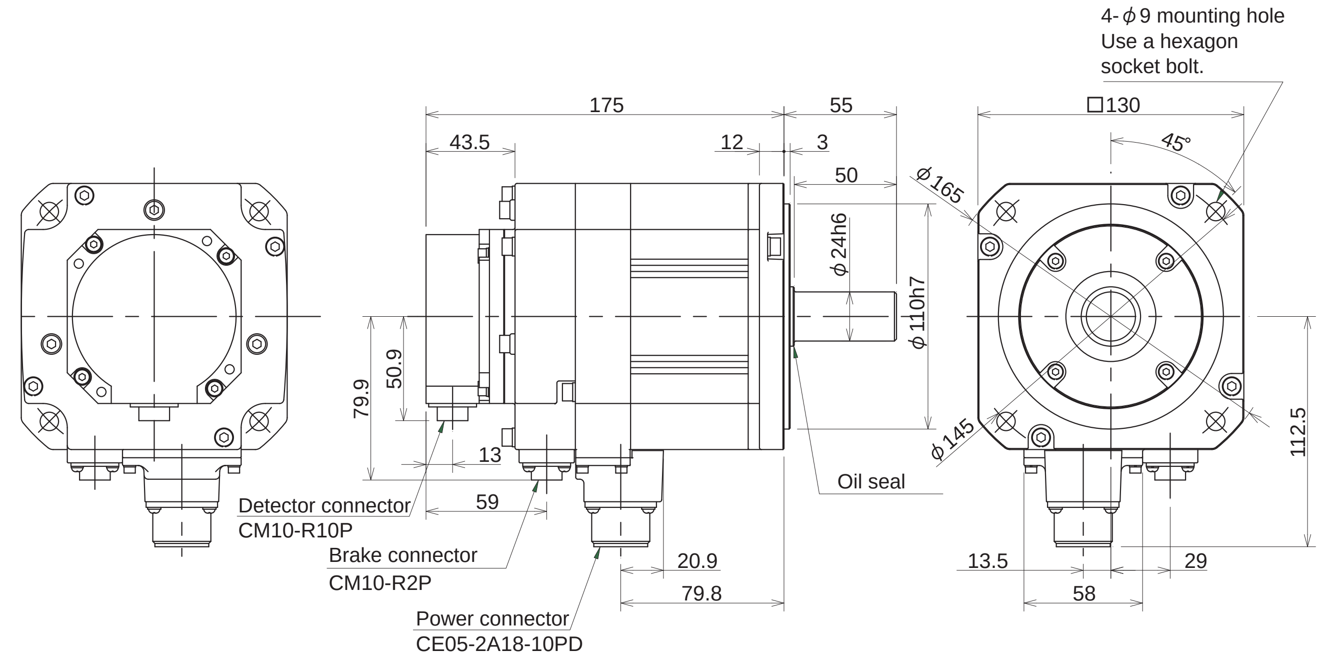

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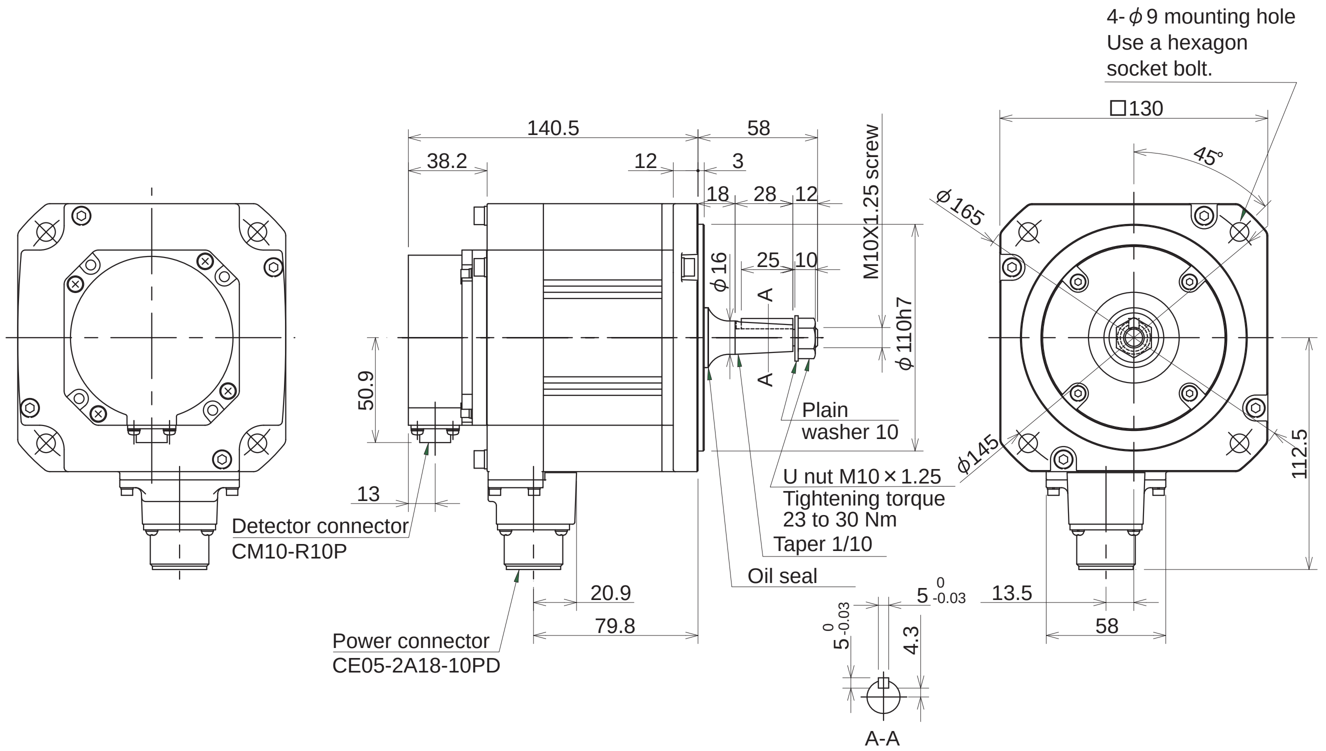

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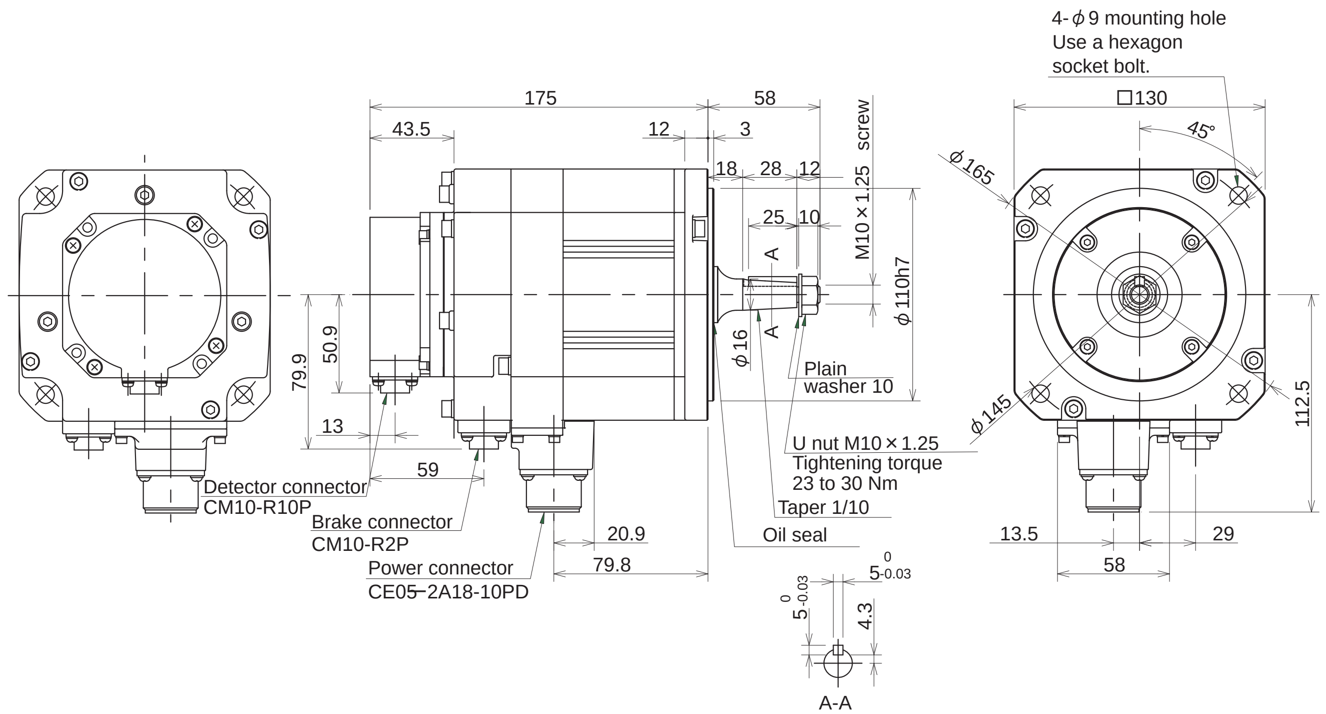

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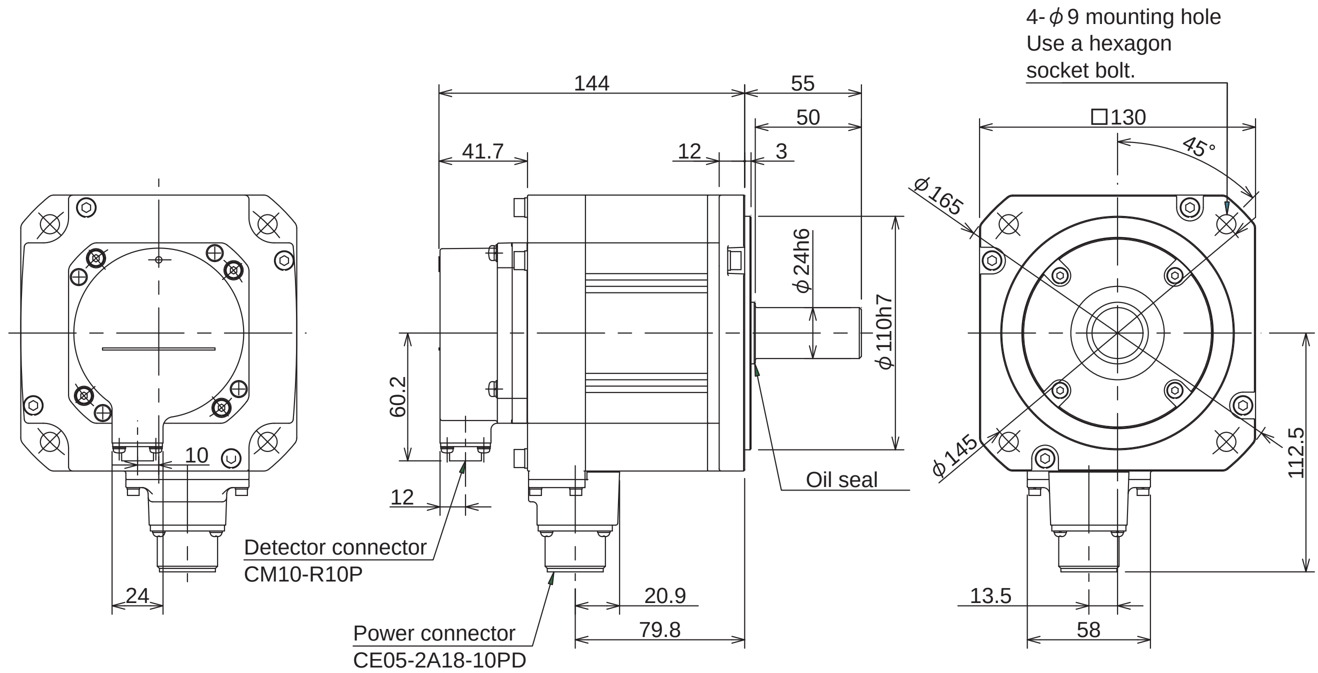

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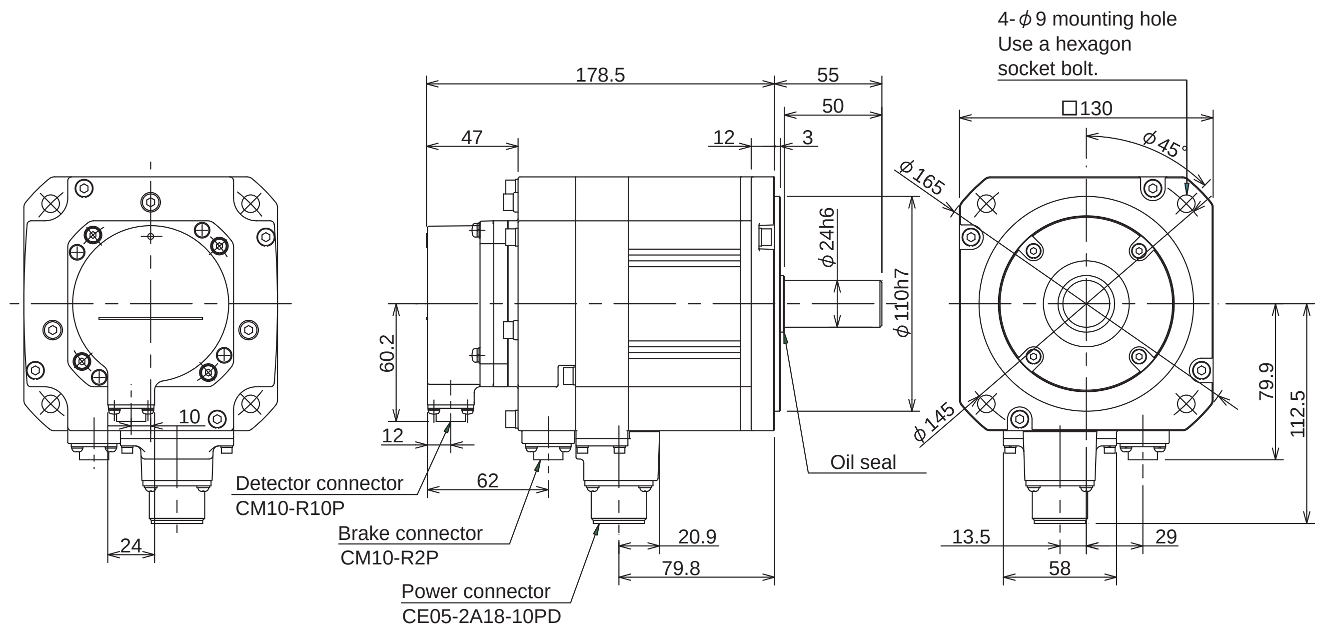

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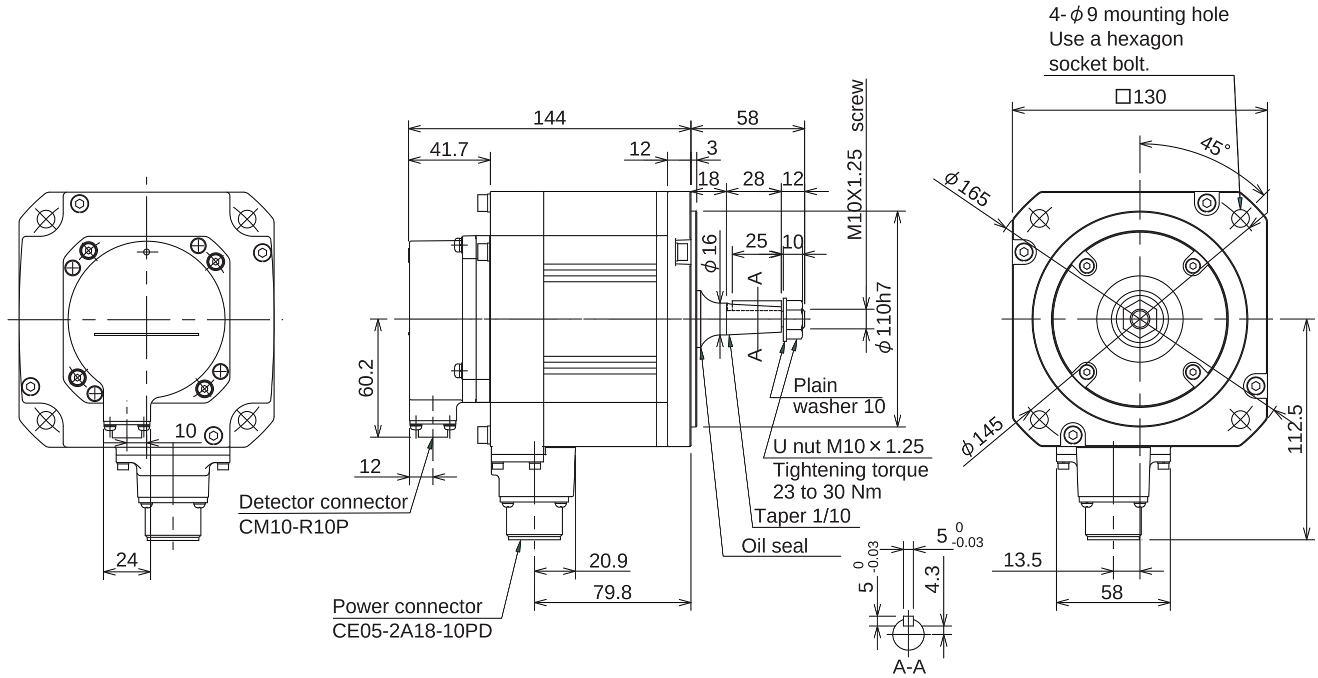

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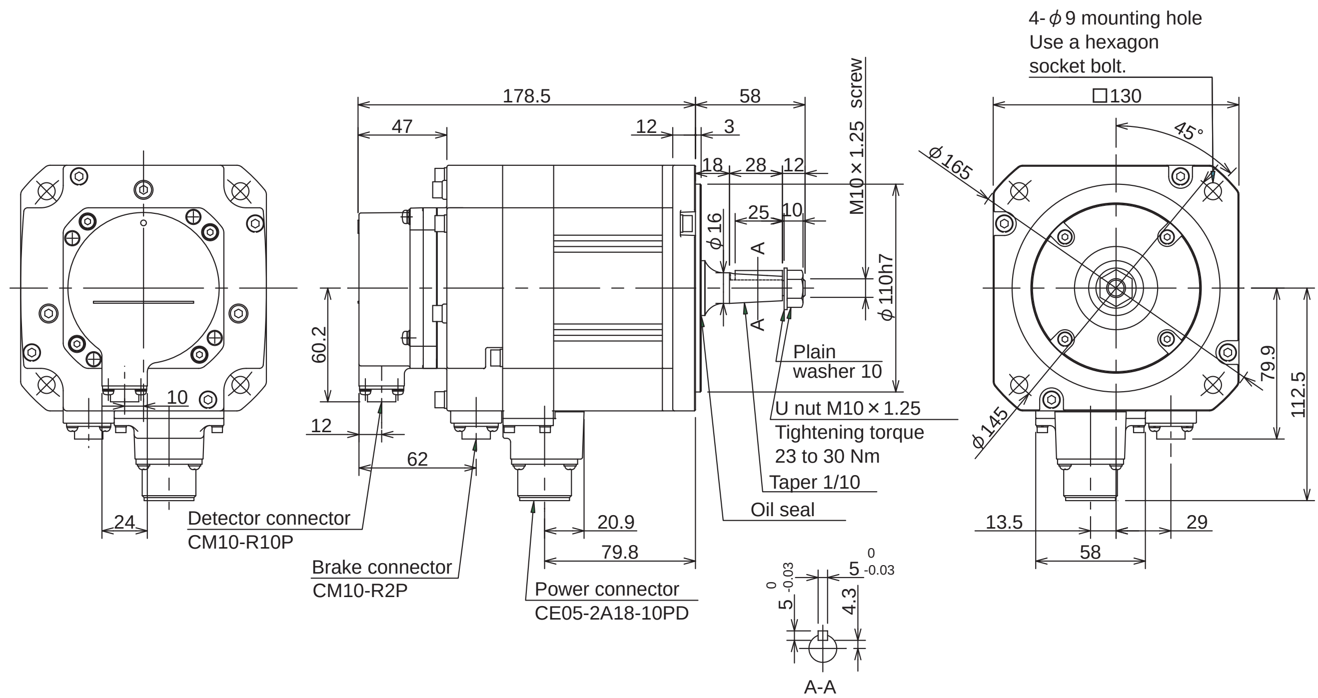

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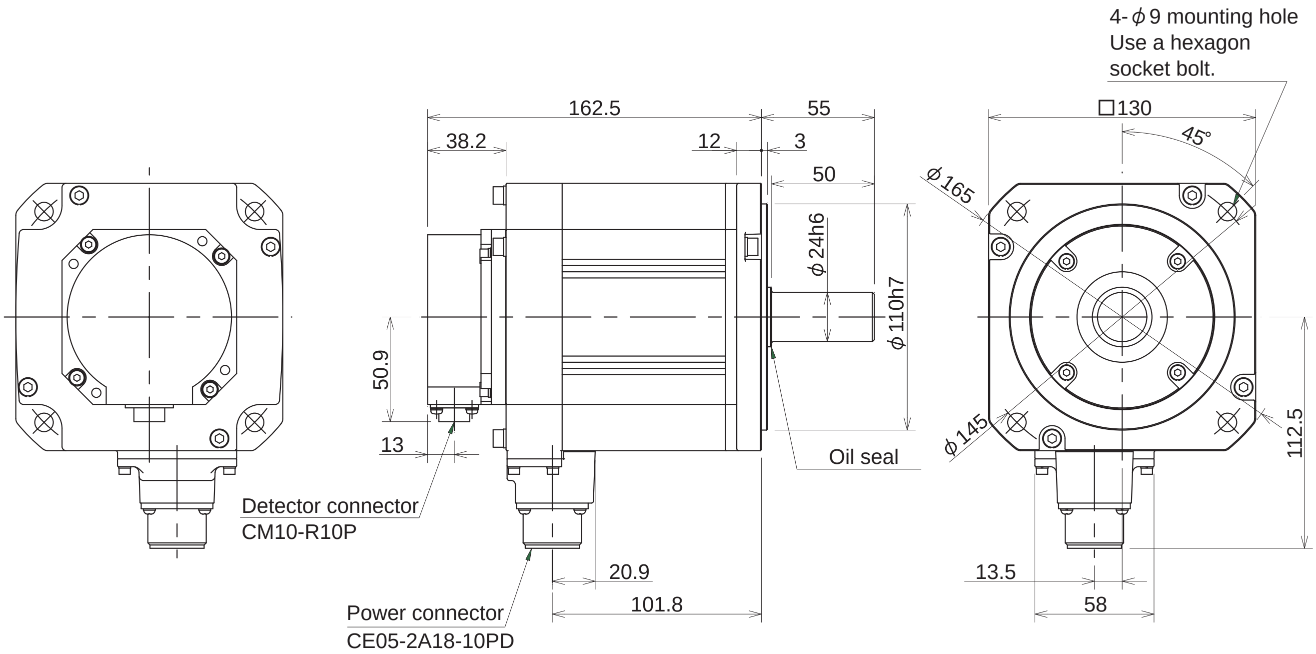

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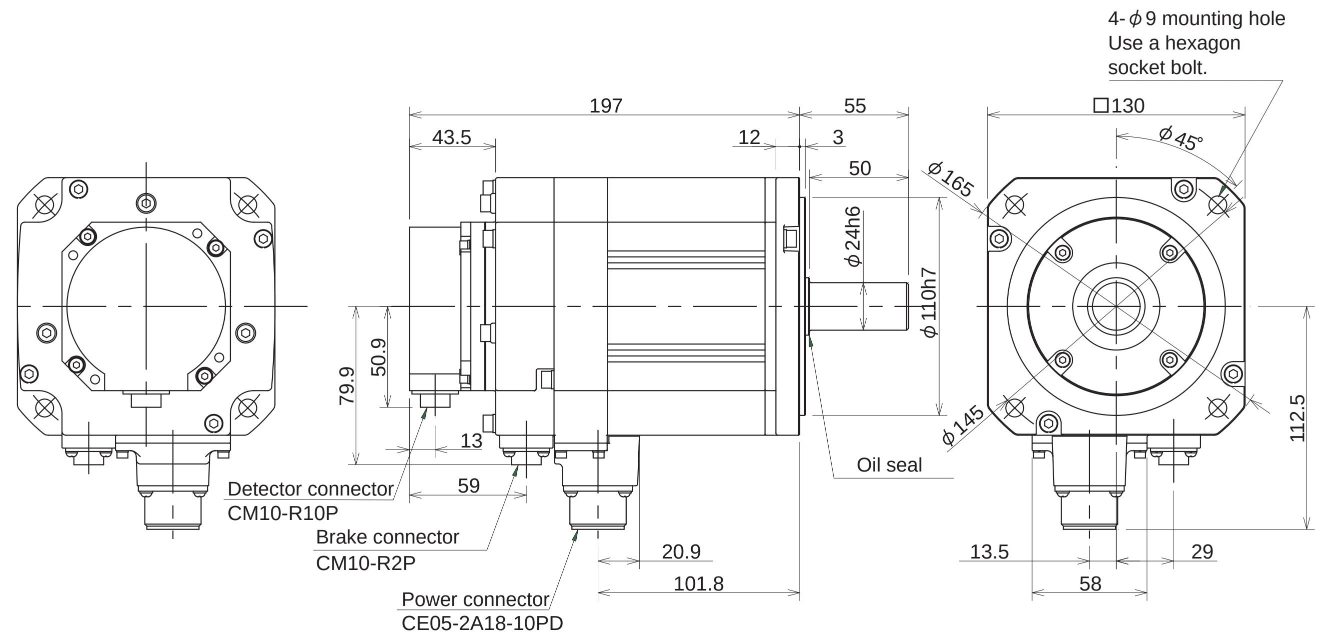

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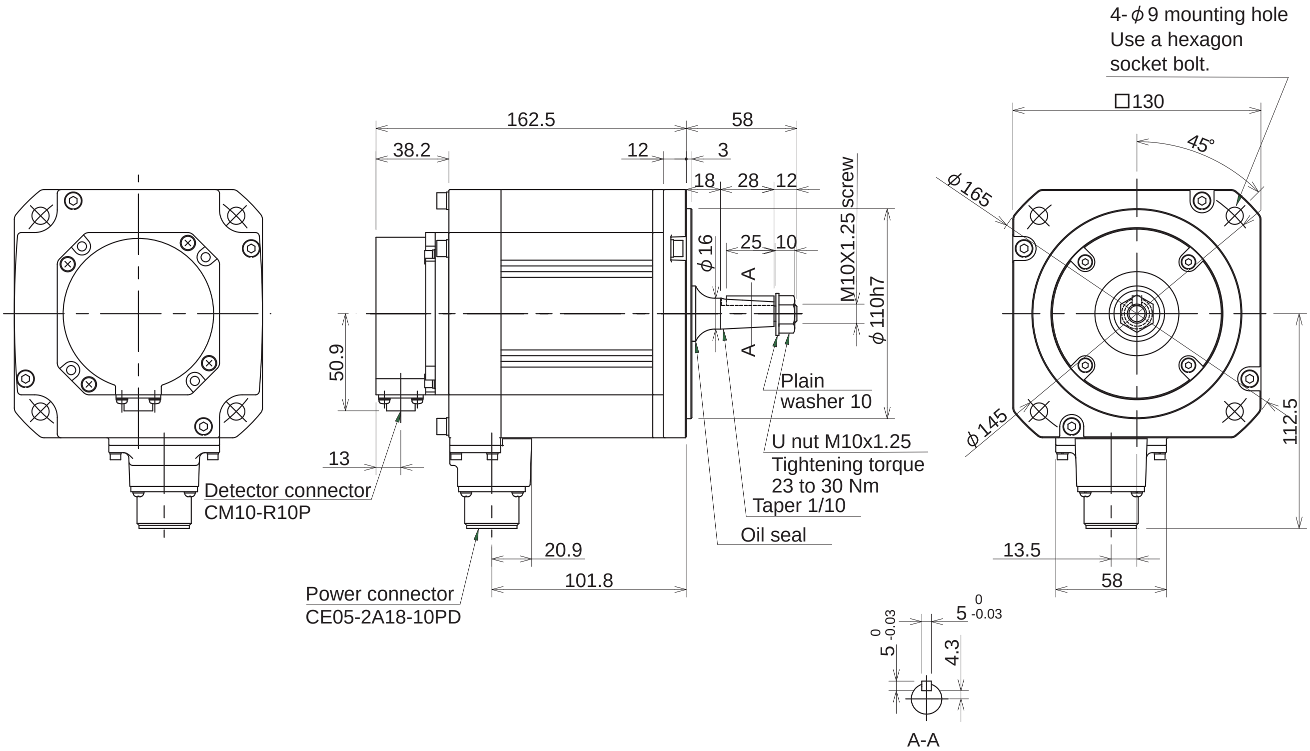

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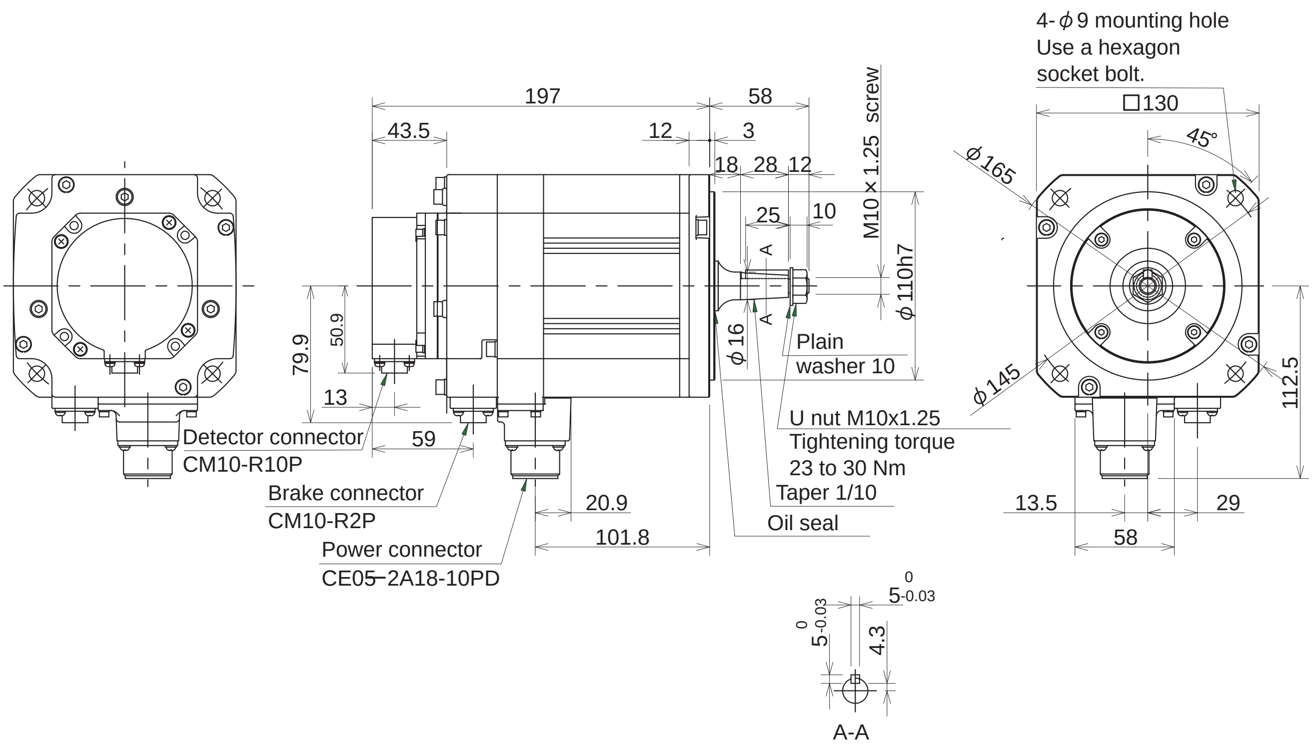

[Unit:mm]

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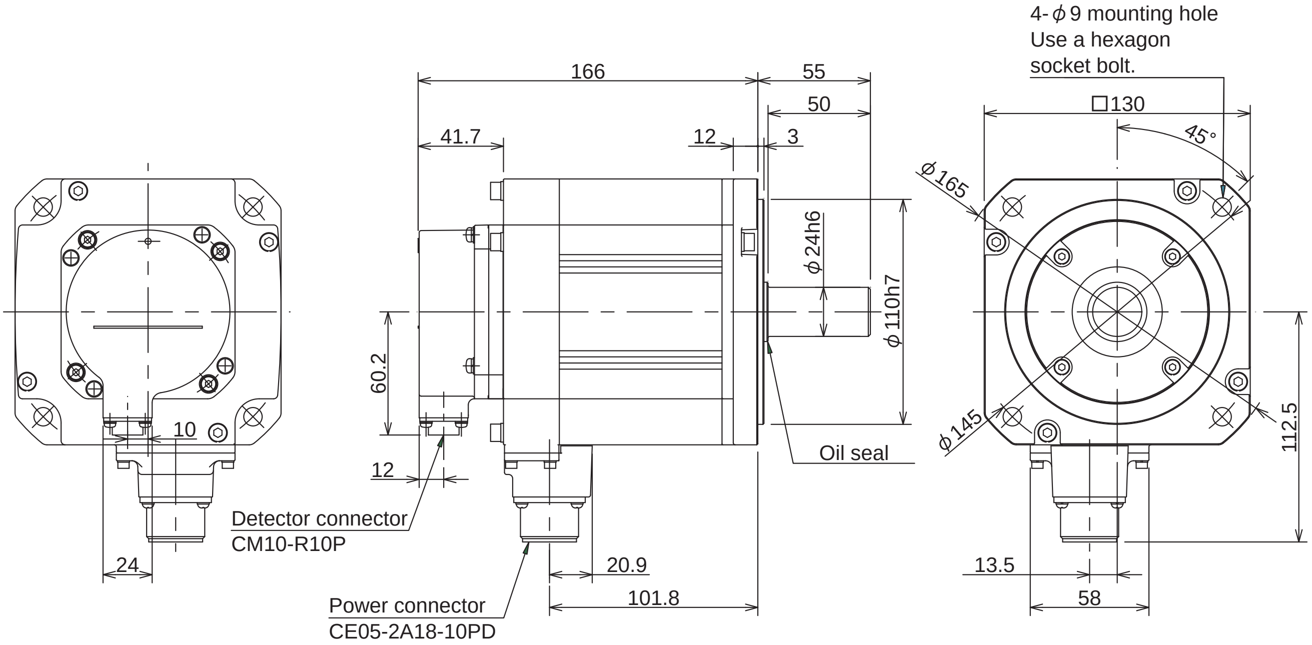

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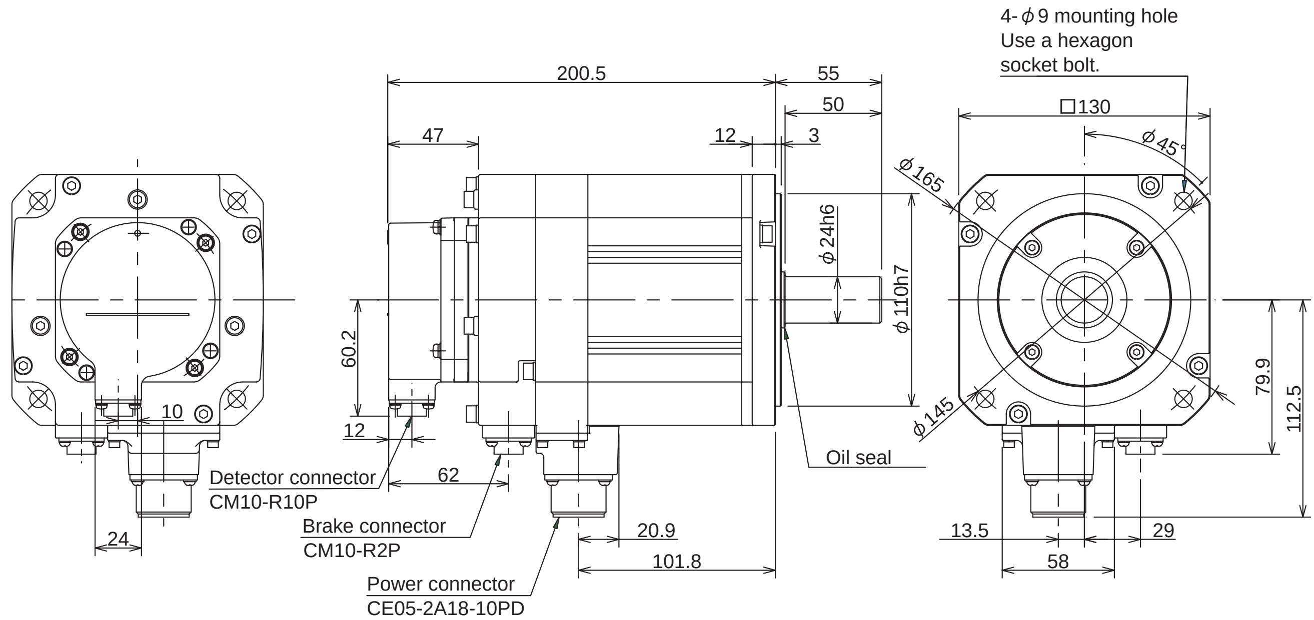

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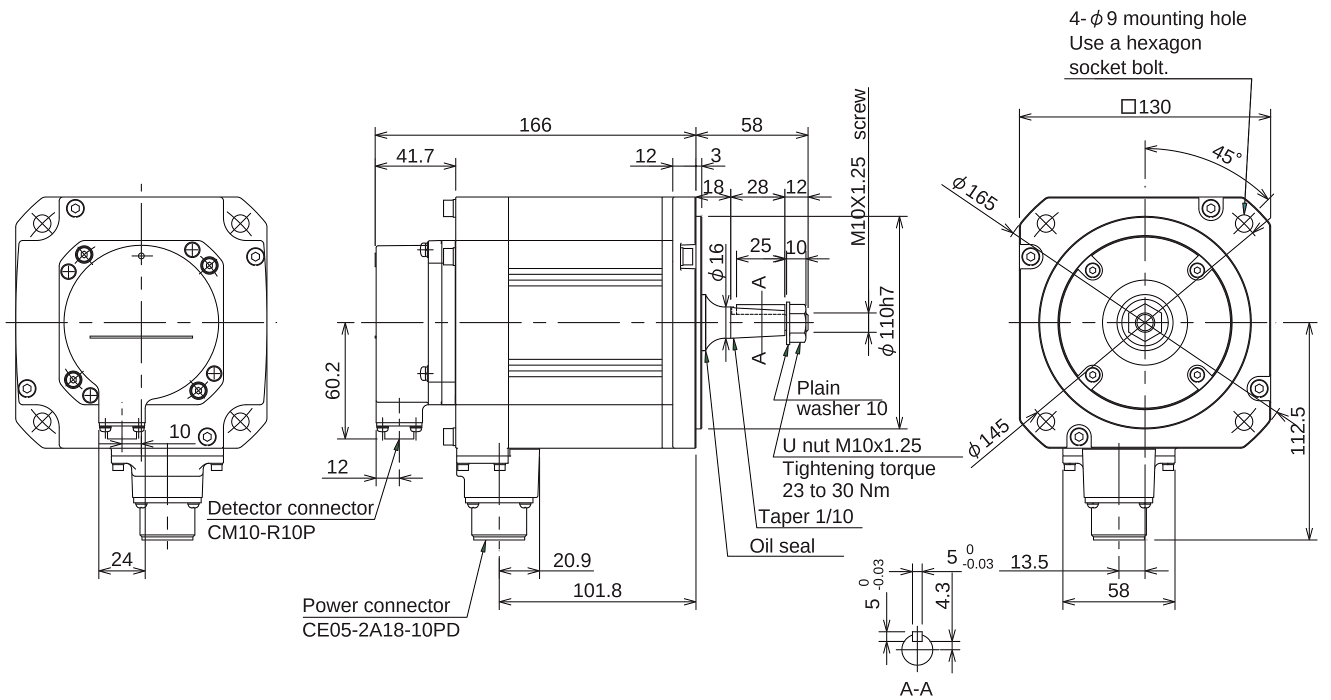

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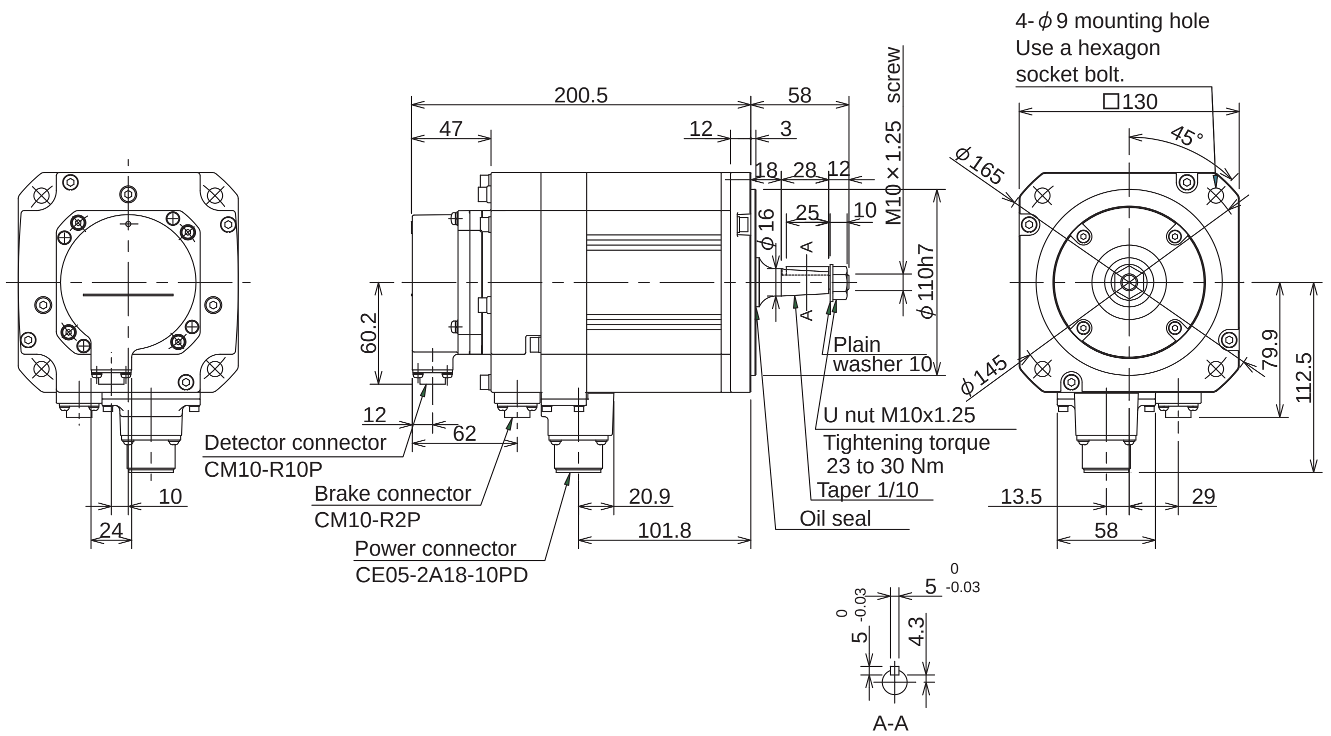

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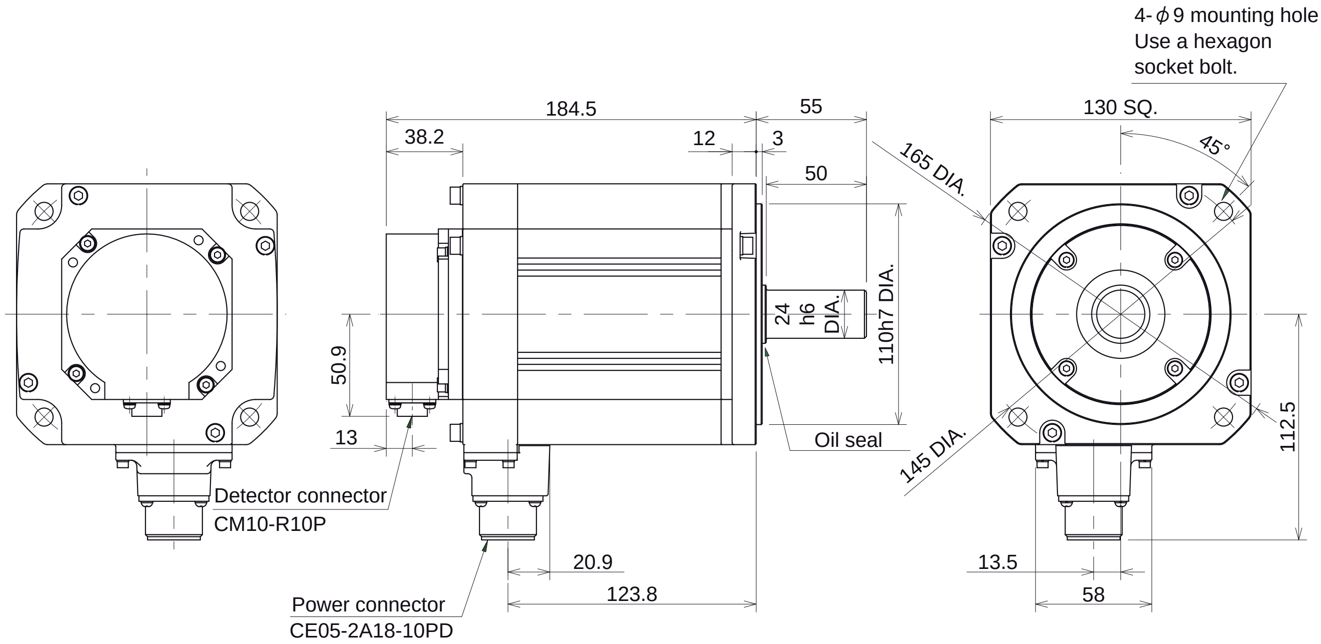
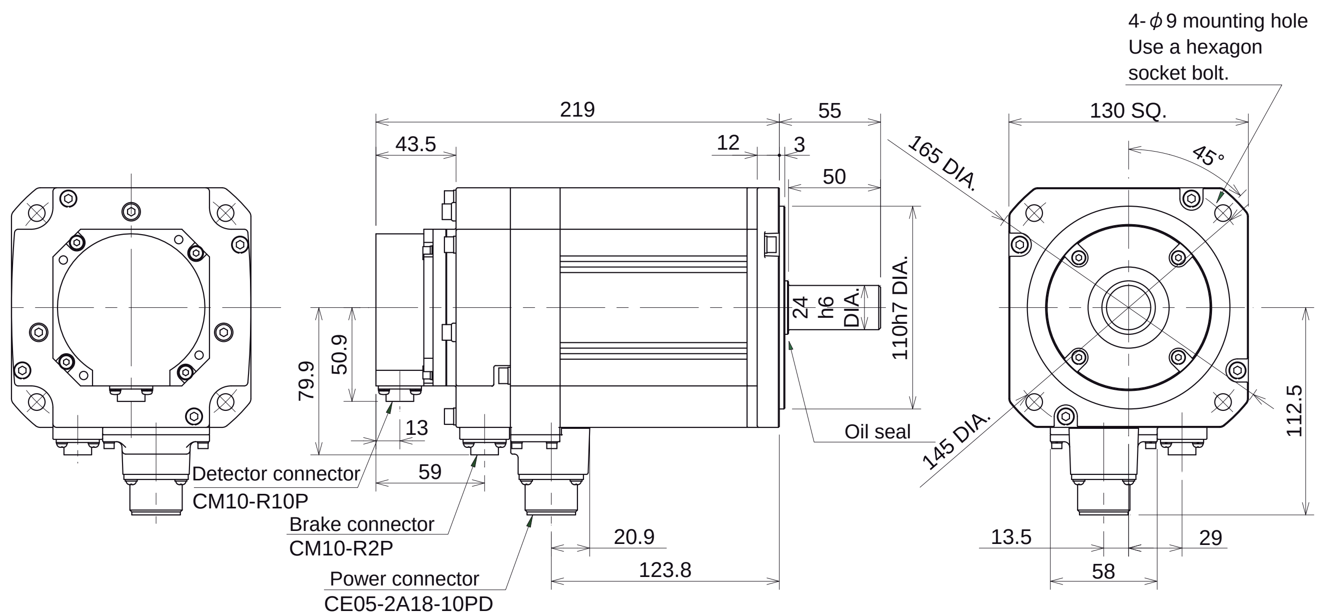
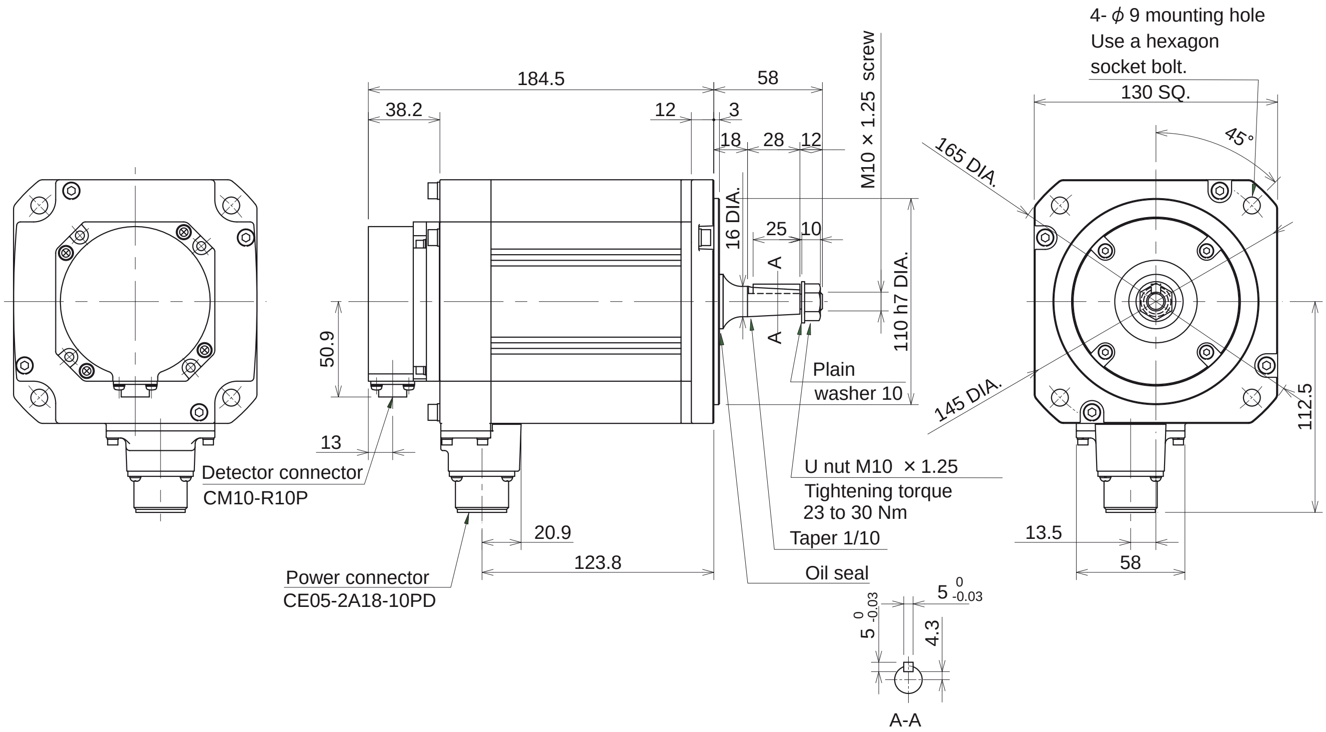


· **HF224BS-A48**



[Unit:mm]

· HF224T-A48



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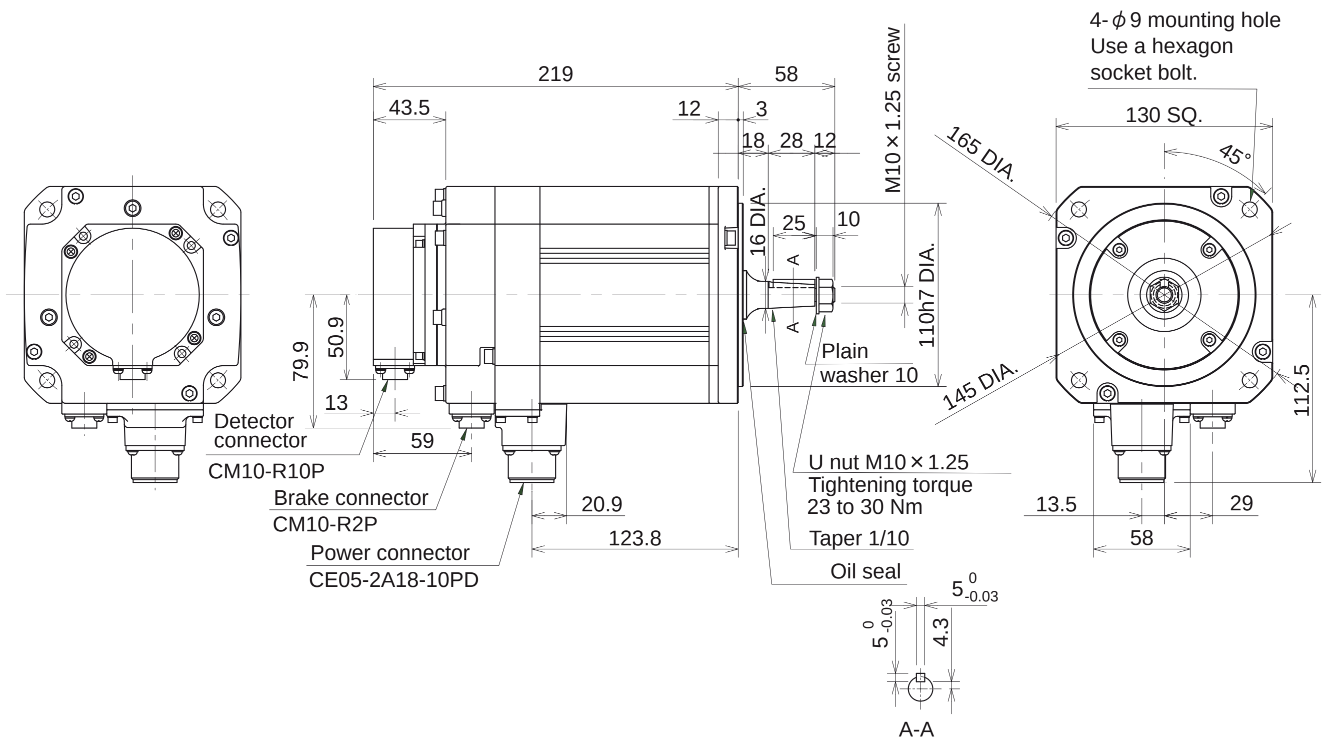

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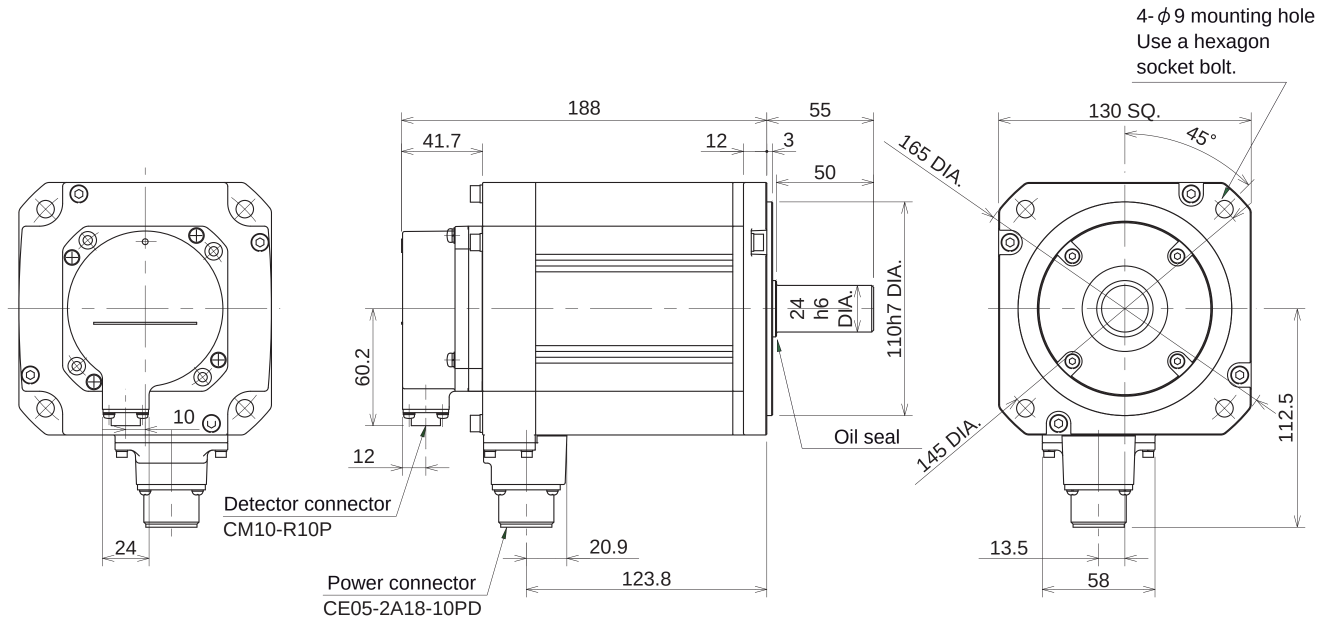

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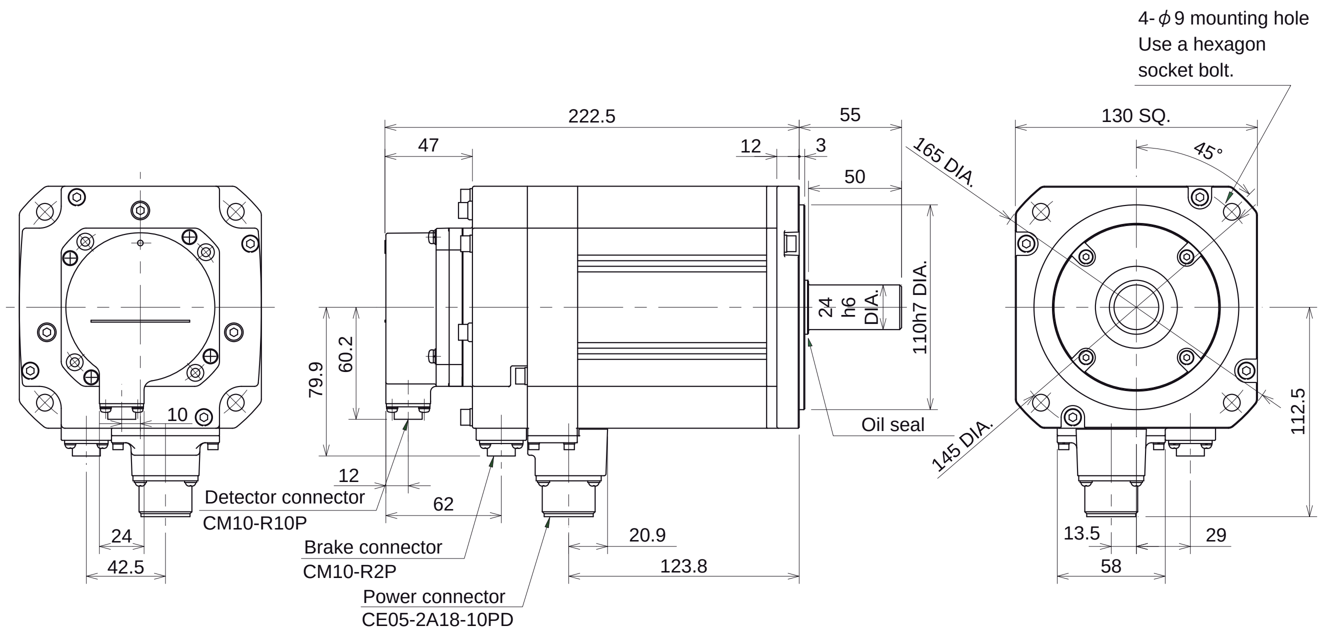

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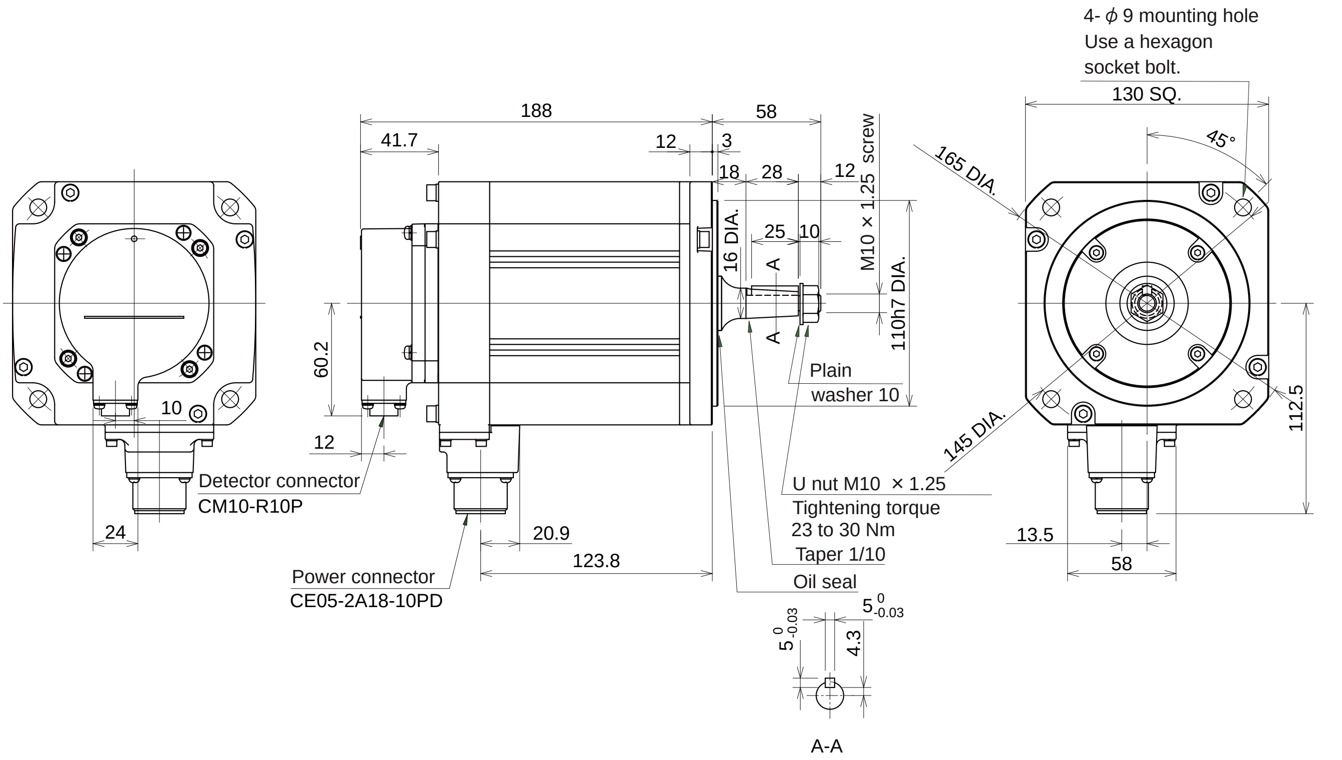
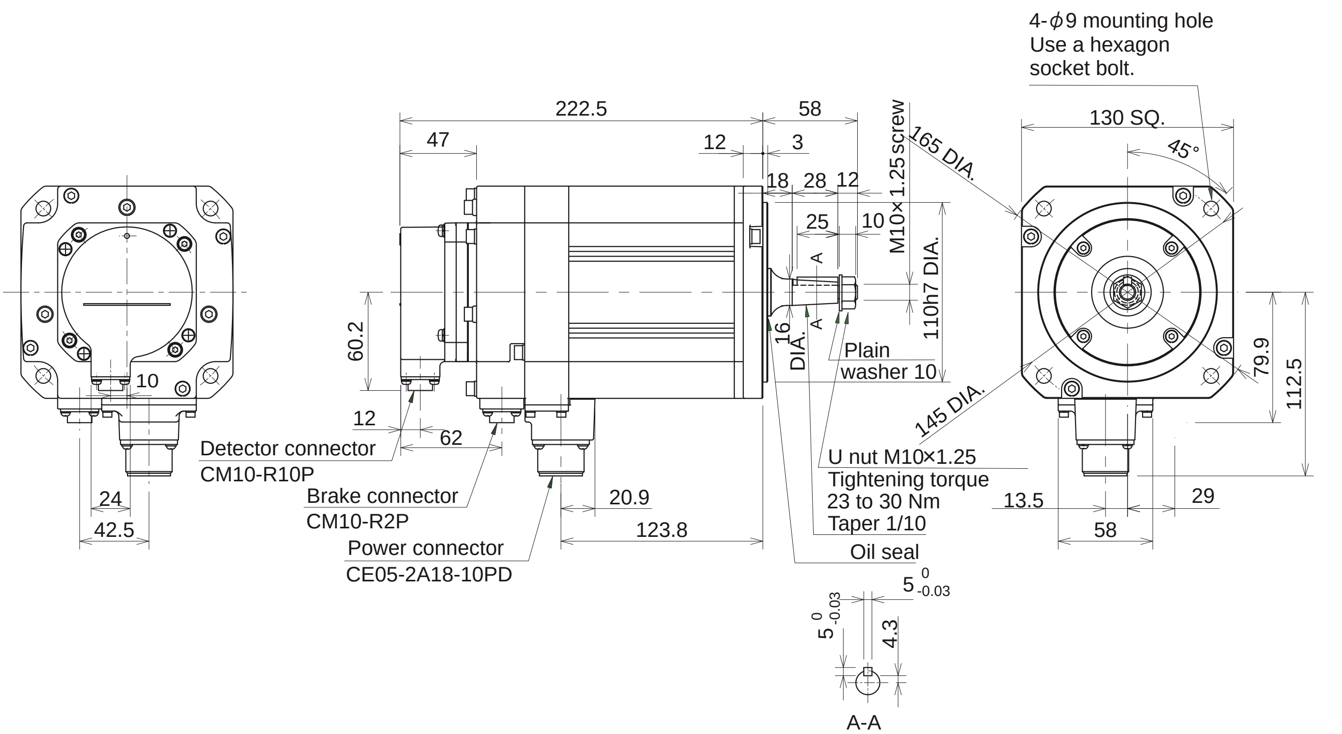
· HF224T-A51



· HF224BT-A51



[Unit:mm]

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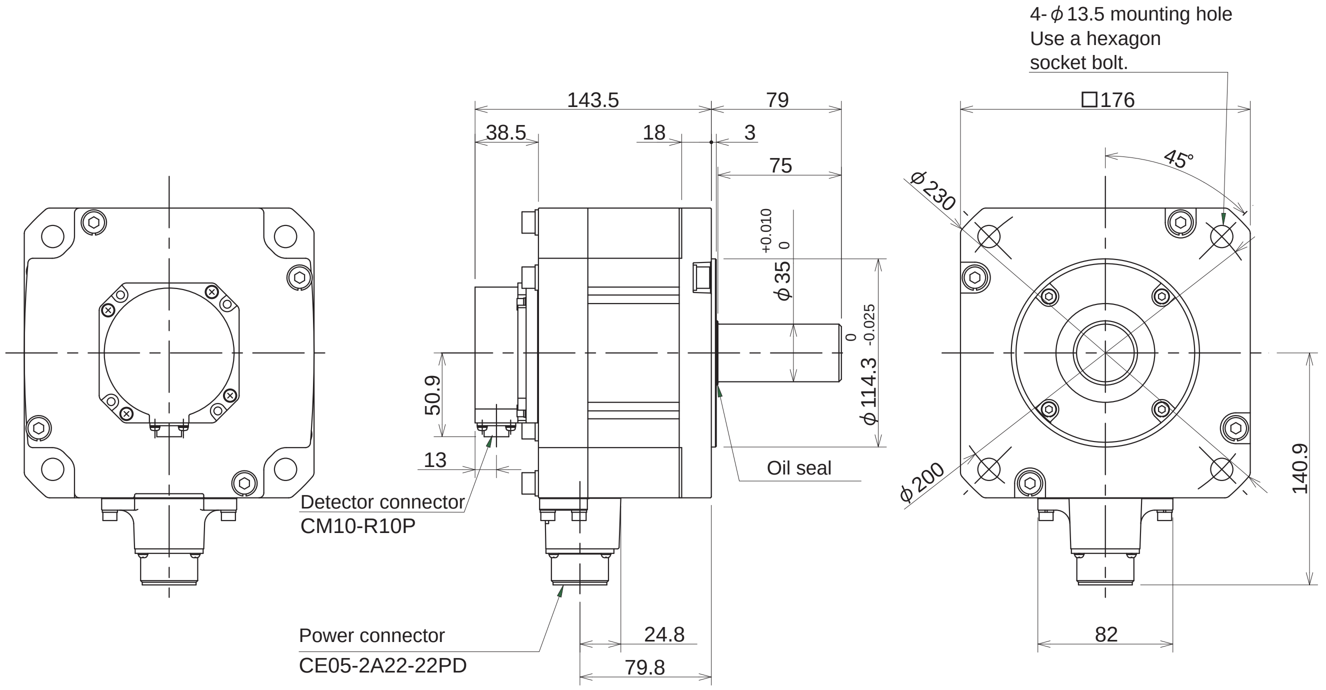
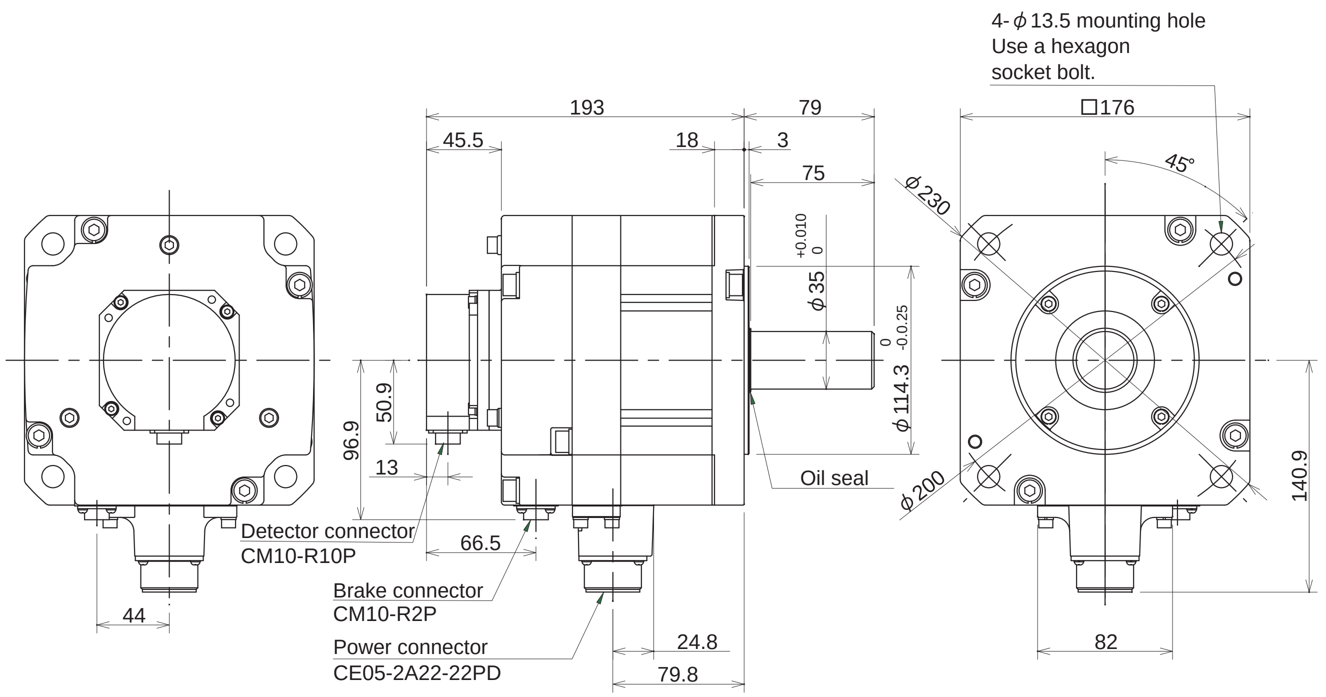


· **HF204BS-A48**



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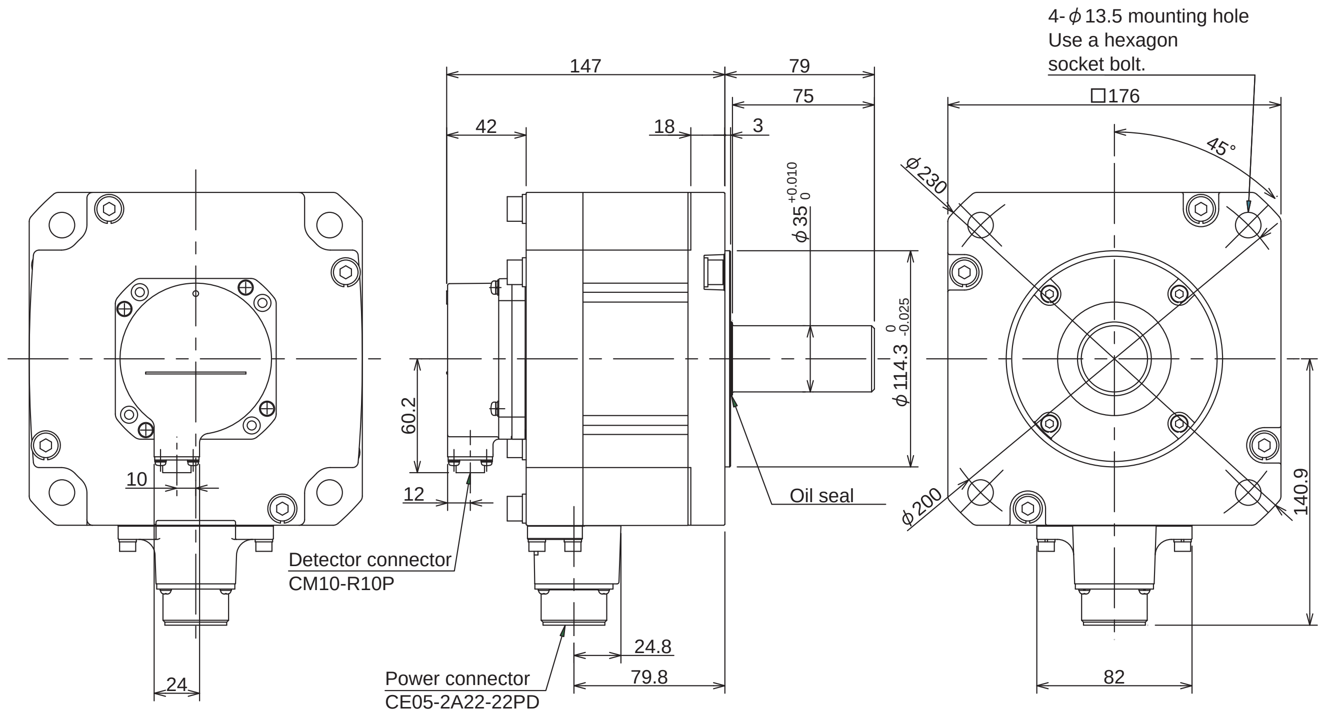
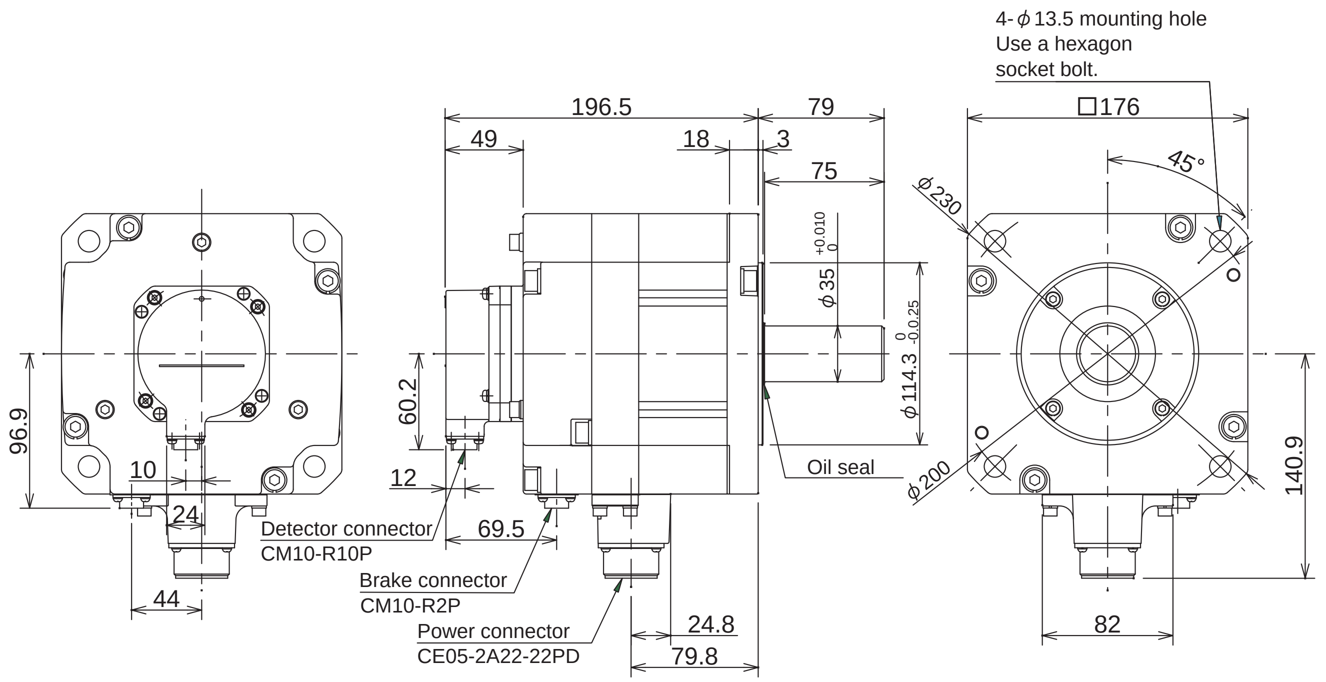


· **HF204BS-A51**



[Unit:mm]

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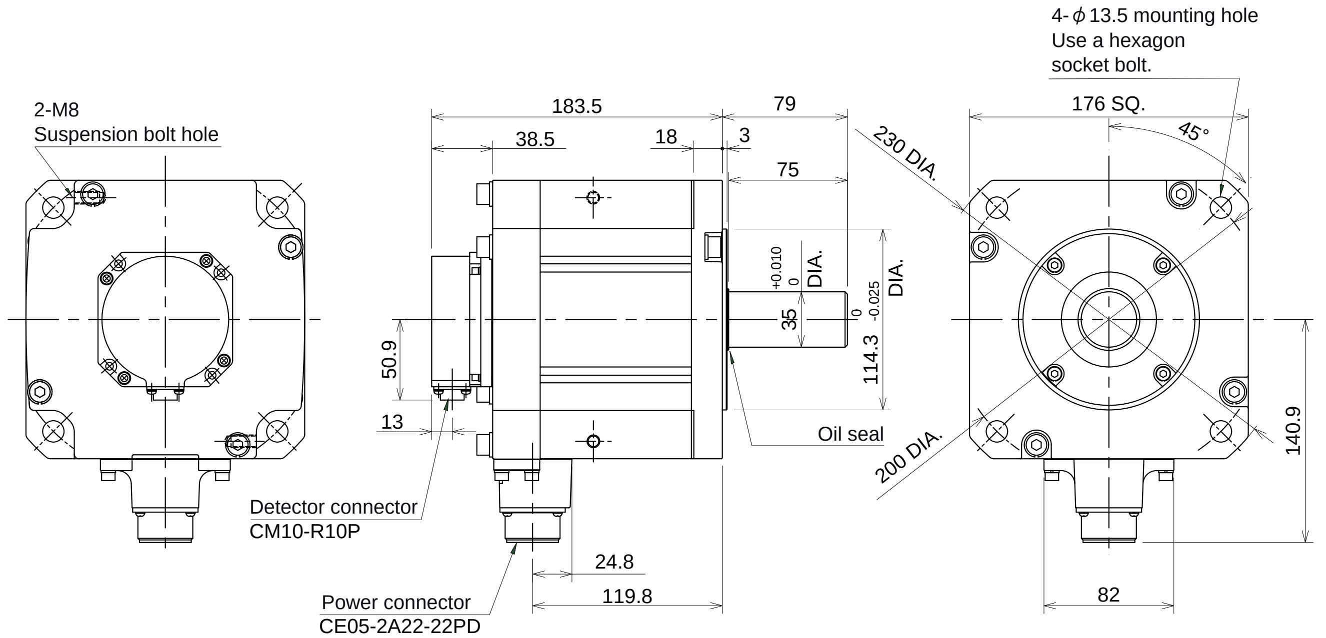

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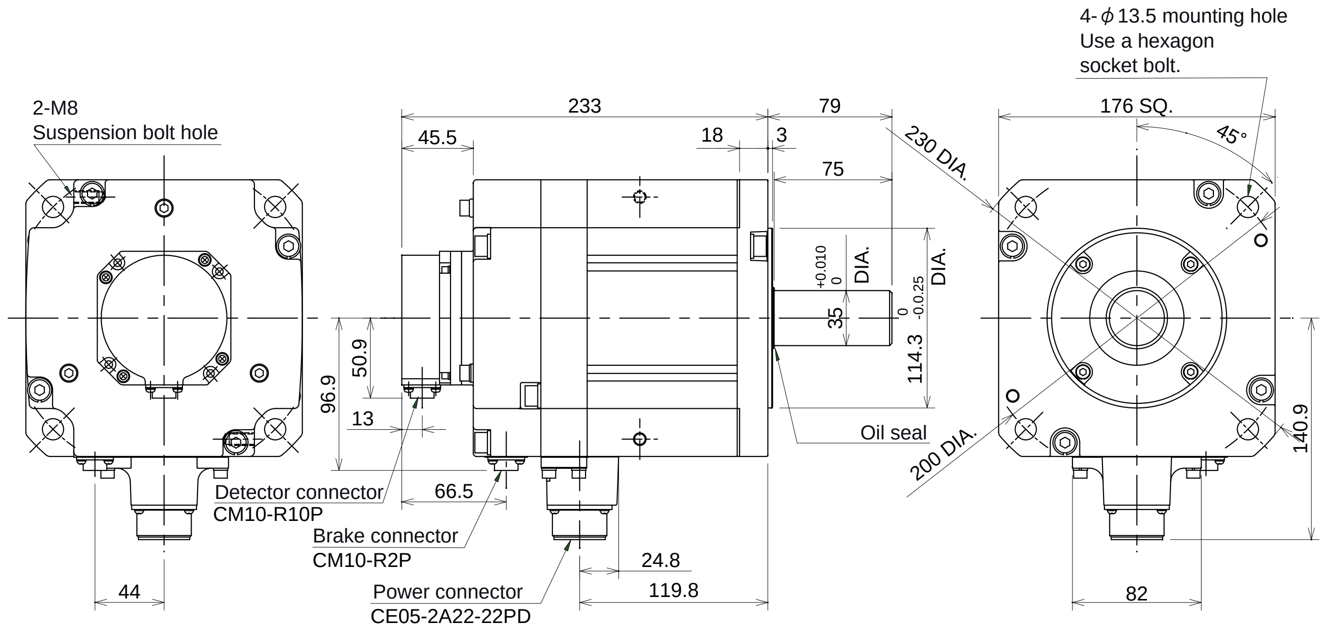

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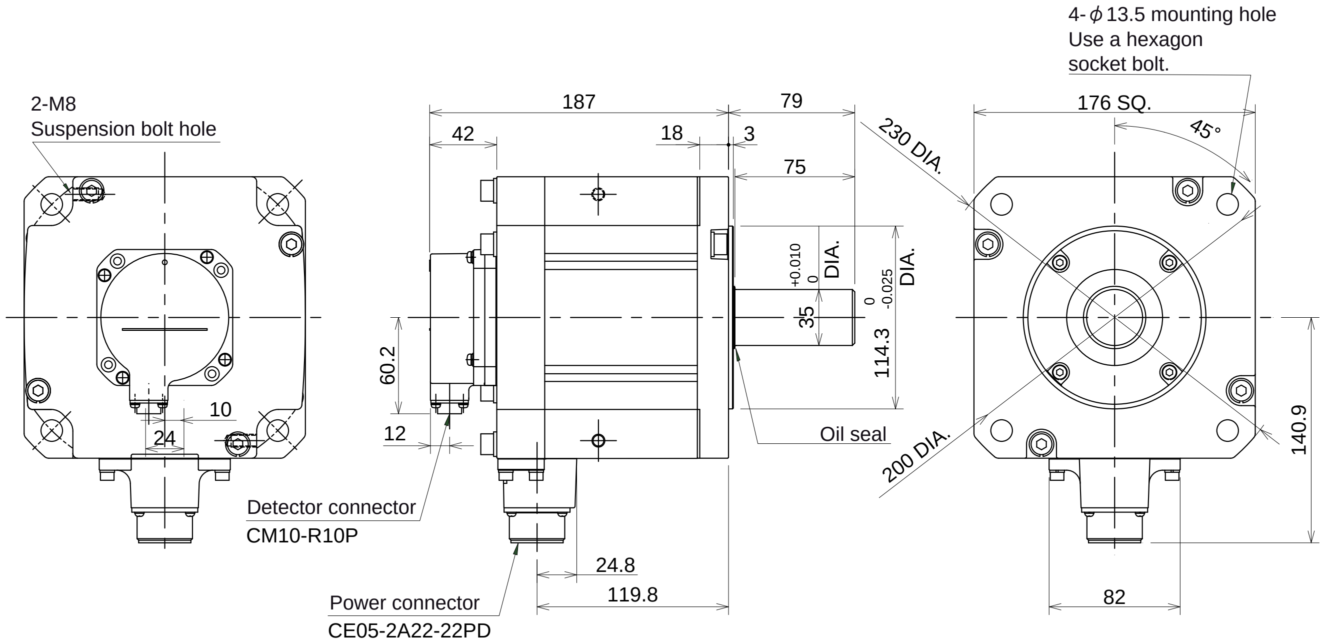
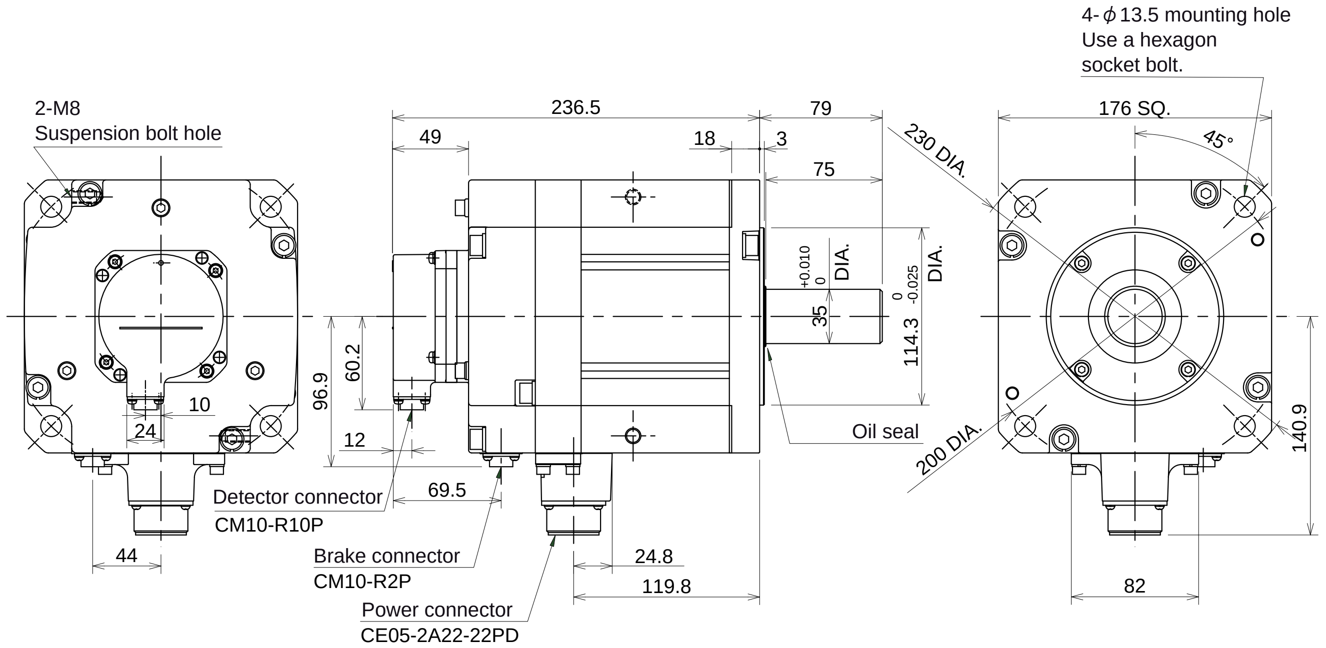


· **HF354BS-A51**



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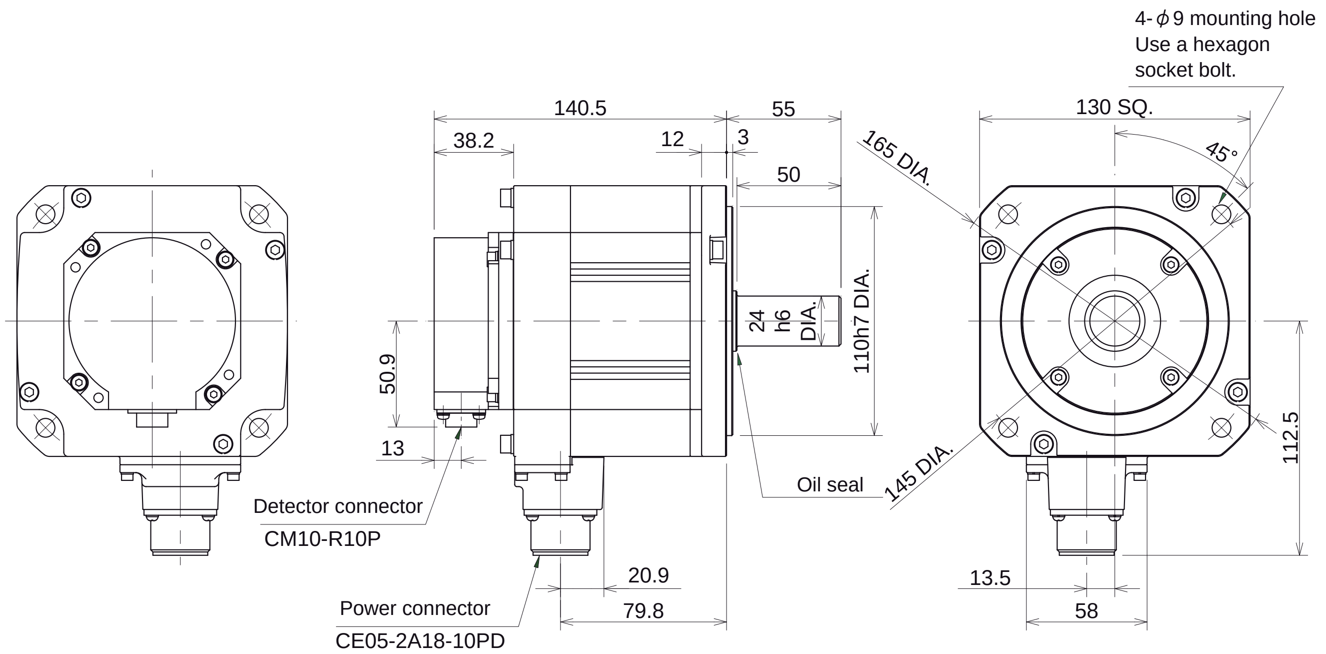
· **HF123S-A48**



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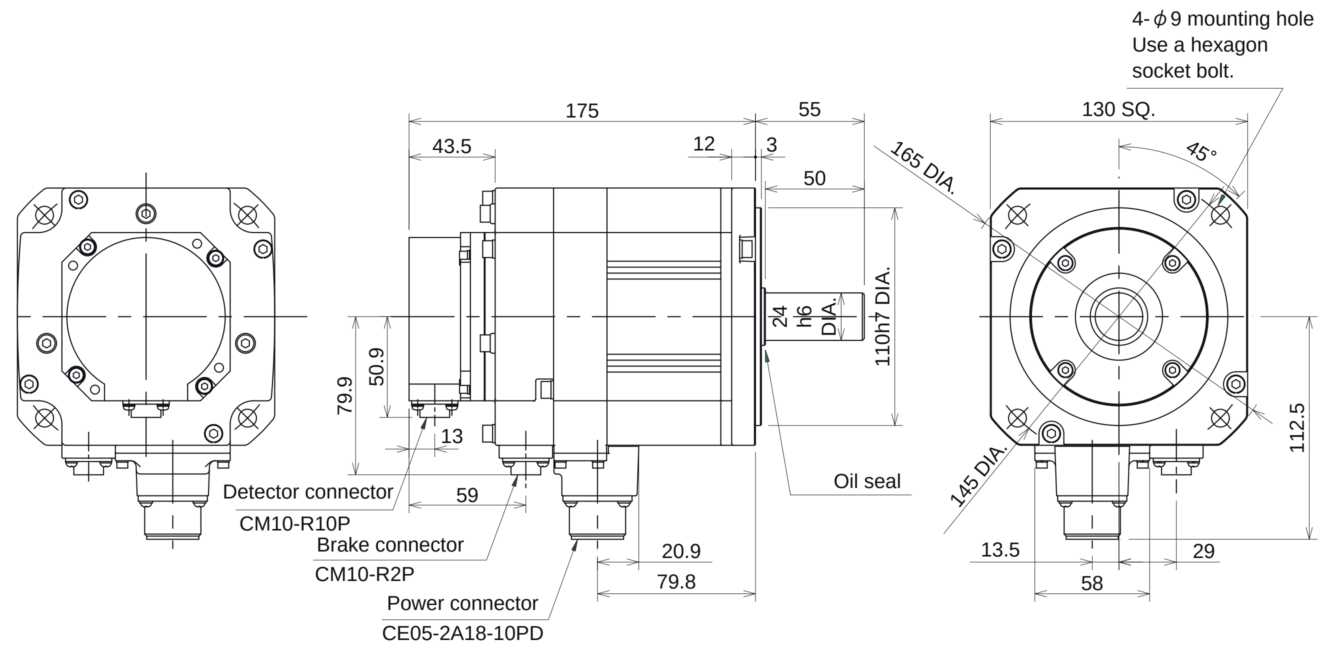
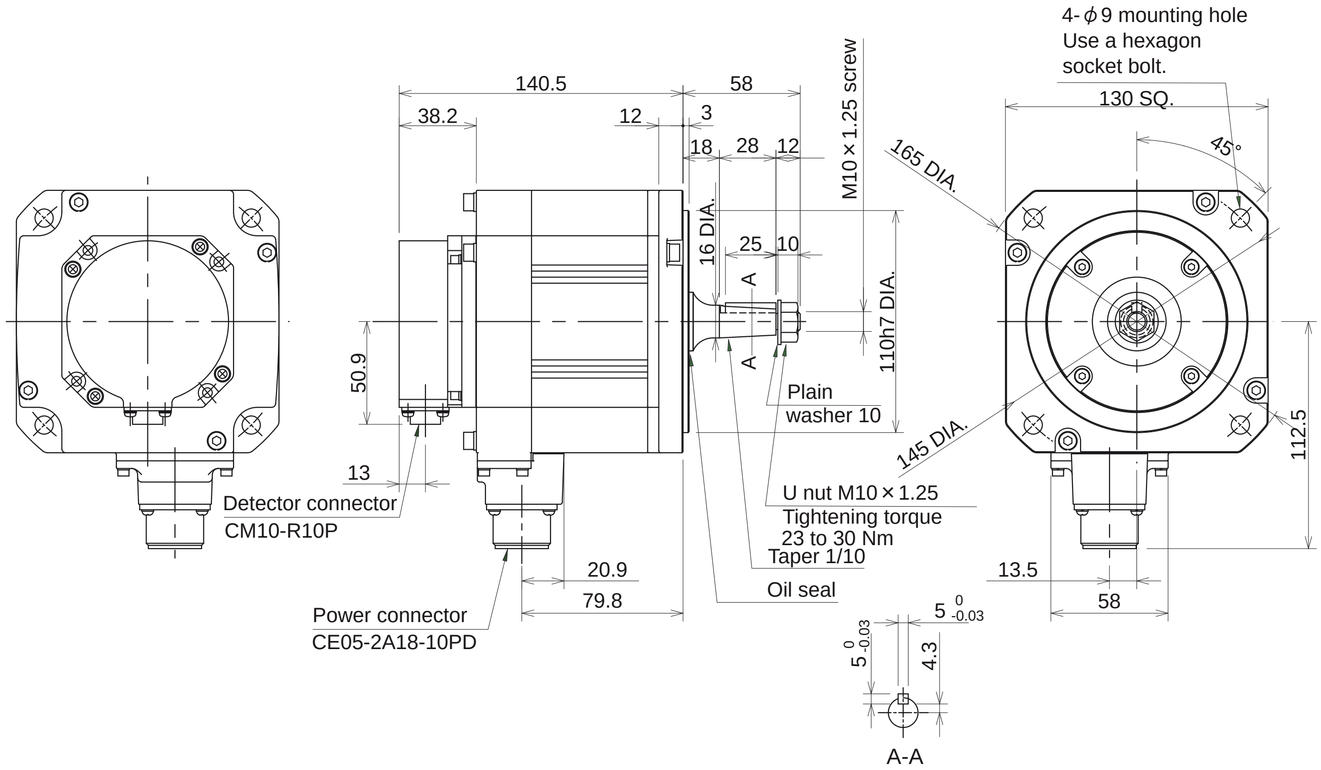
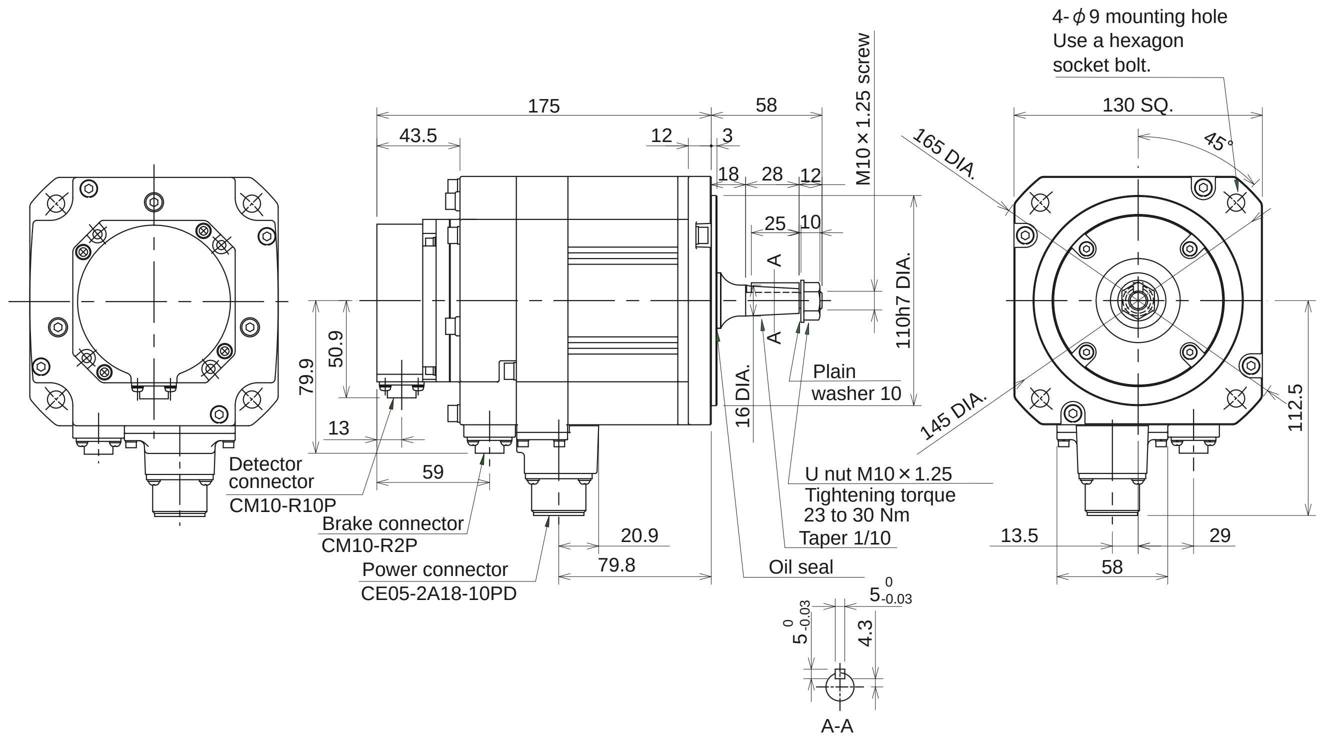


[Unit:mm]

· **HF123T-A48**



· **HF123BT-A48**



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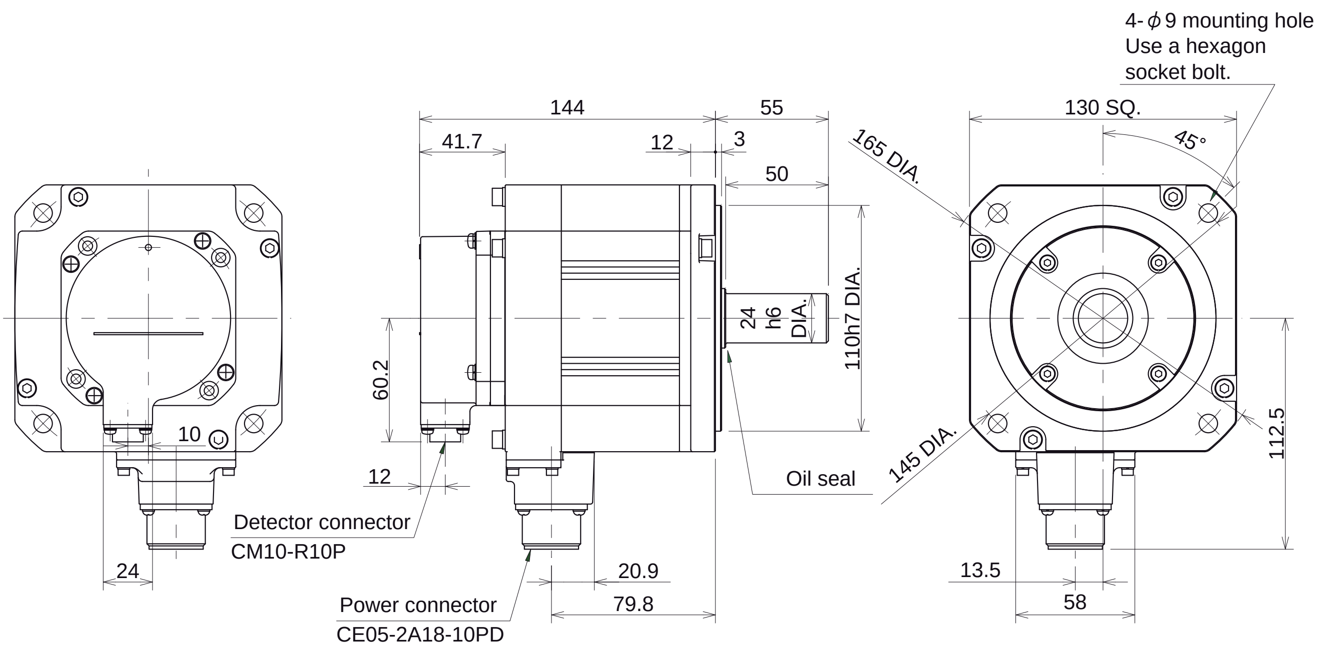

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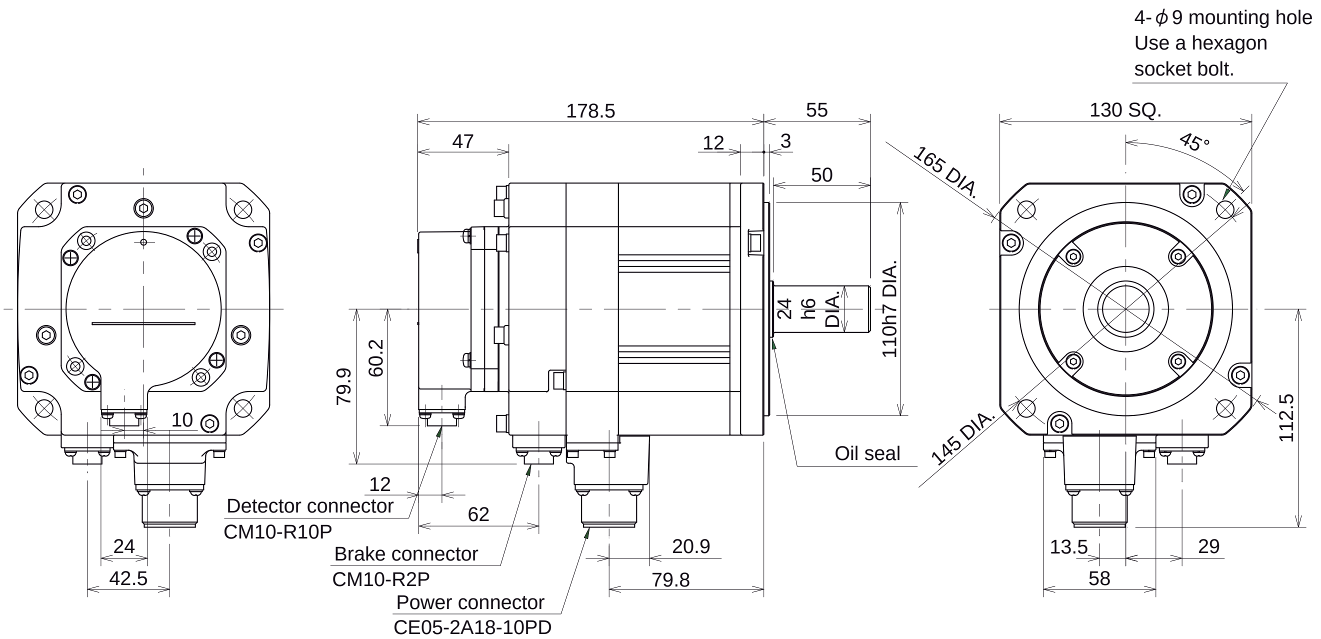

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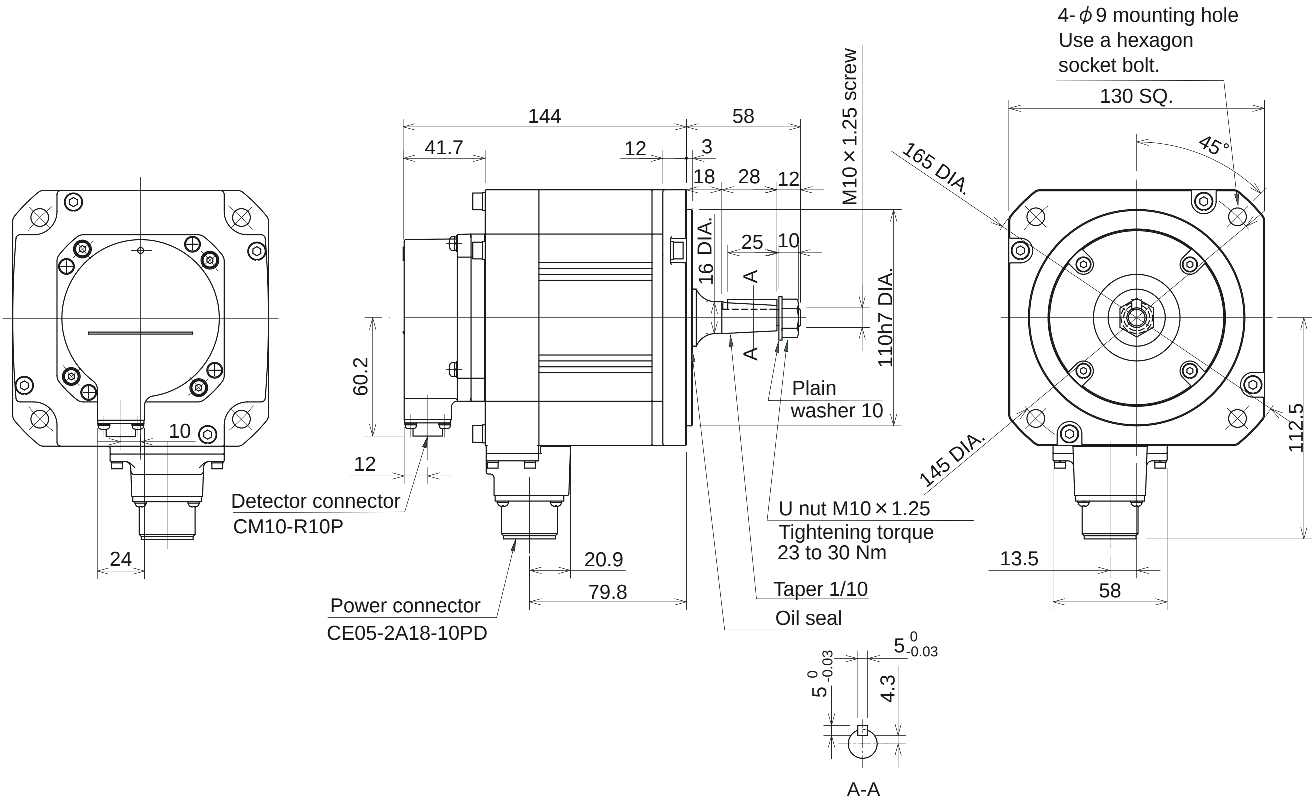
· **HF123T-A51**



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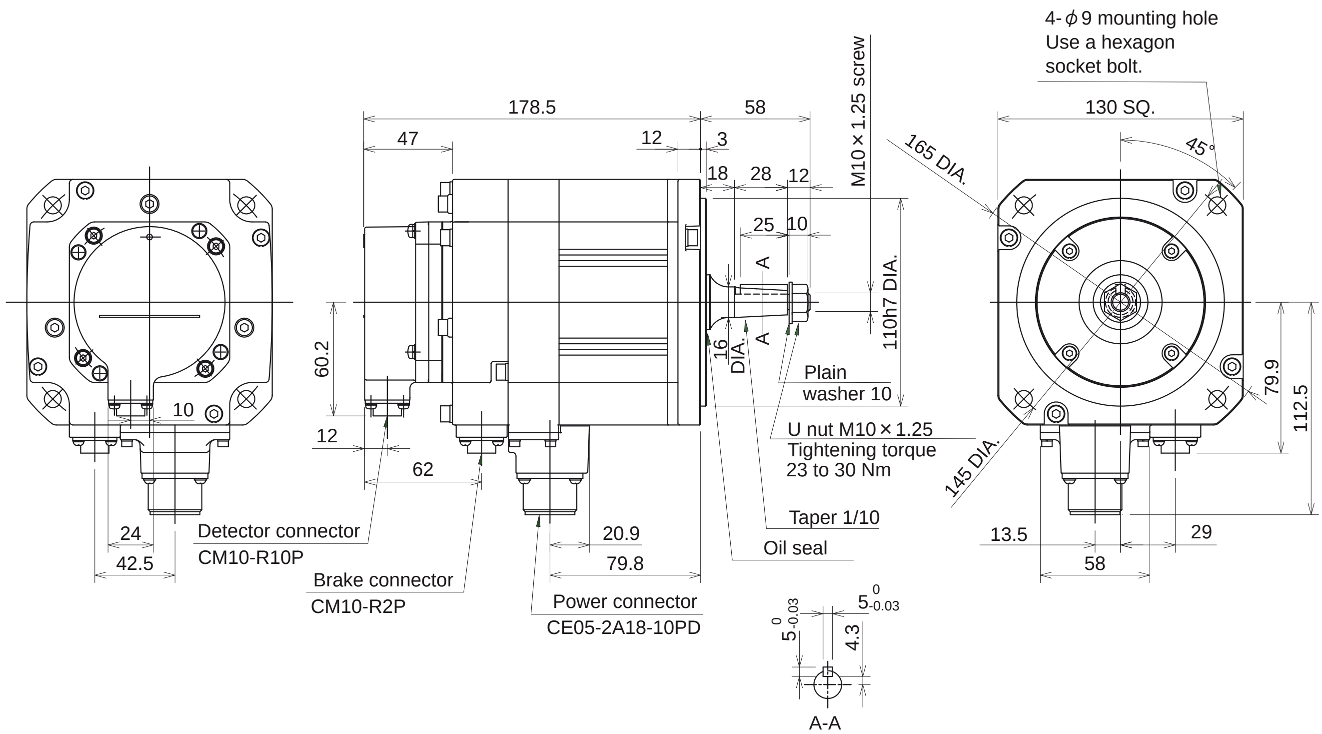

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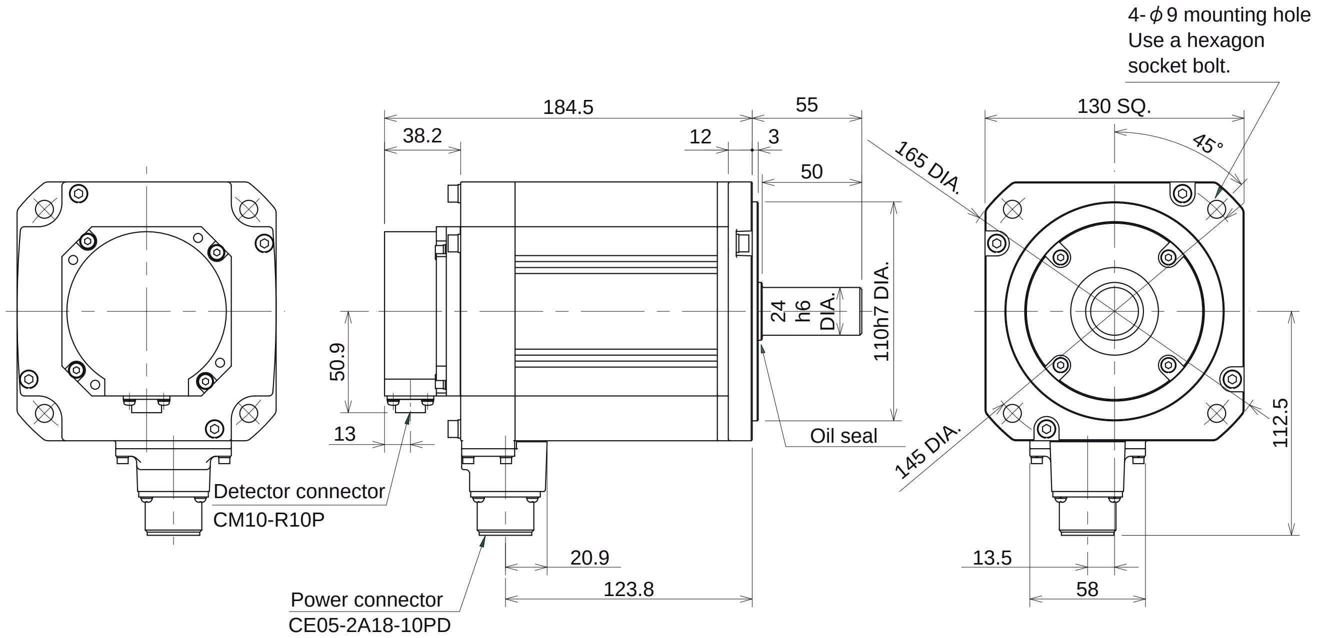
· **HF223S-A48**



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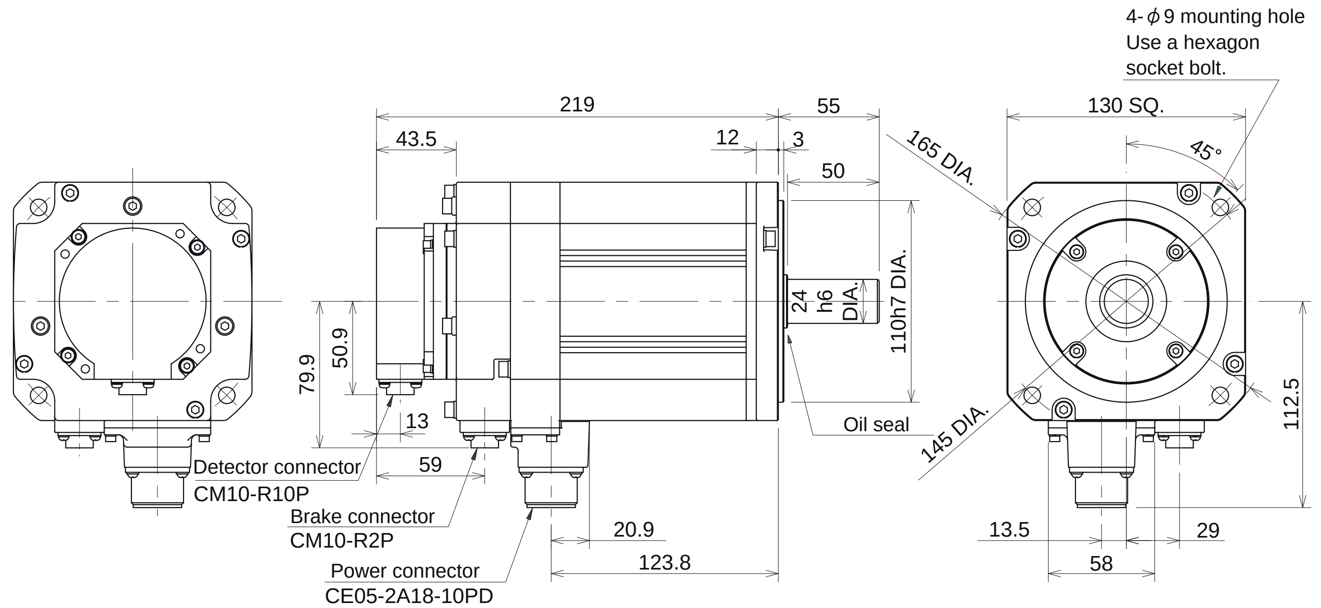

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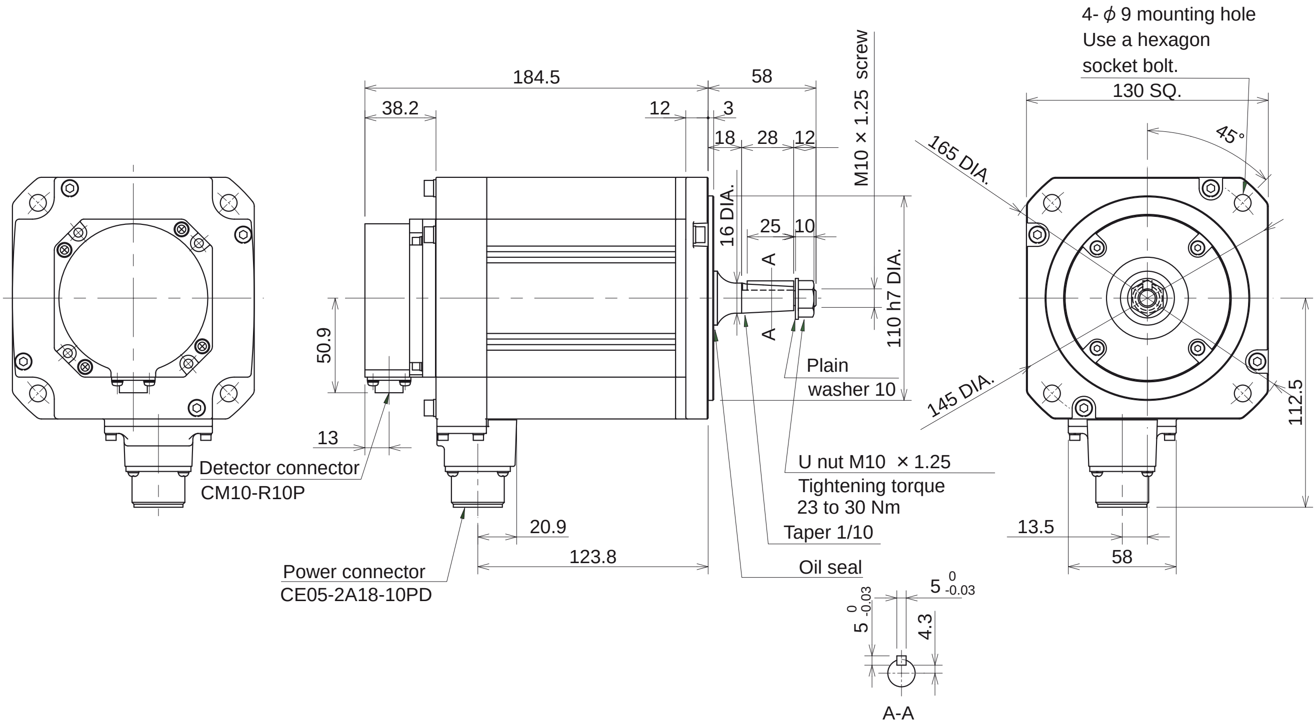

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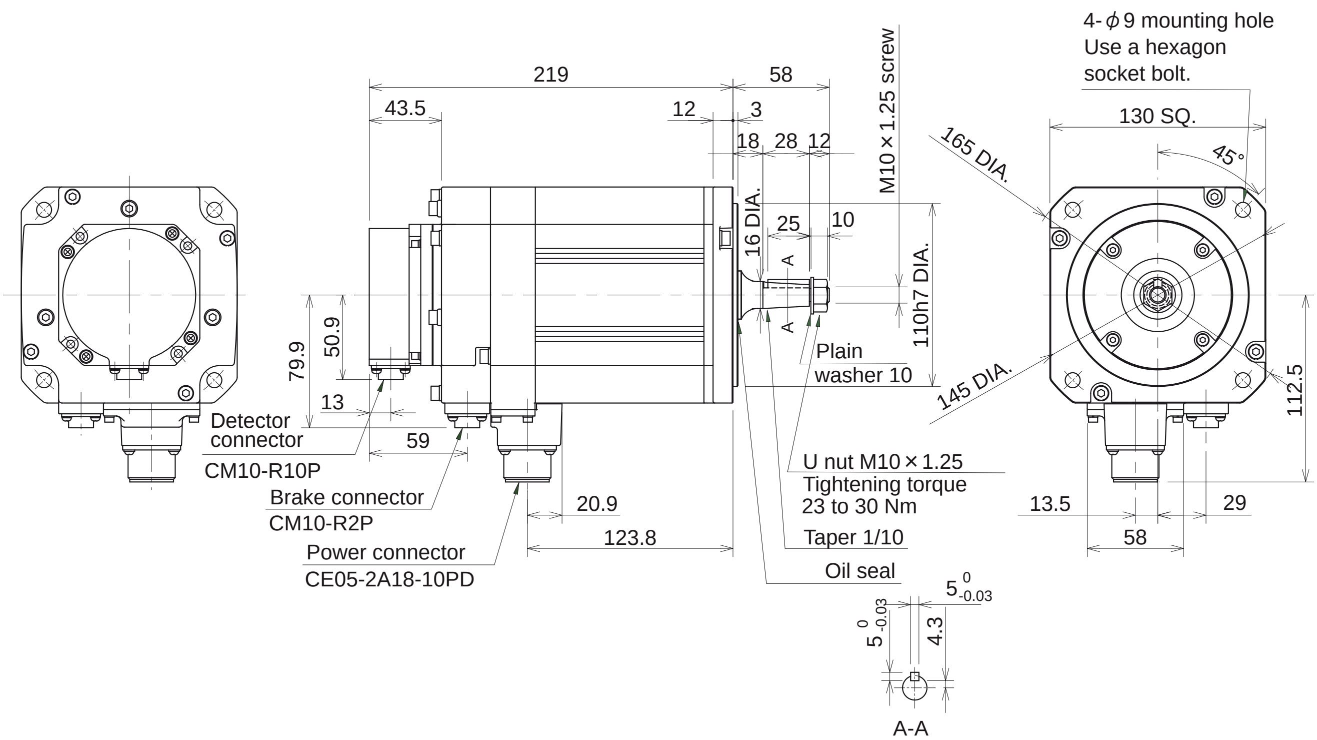

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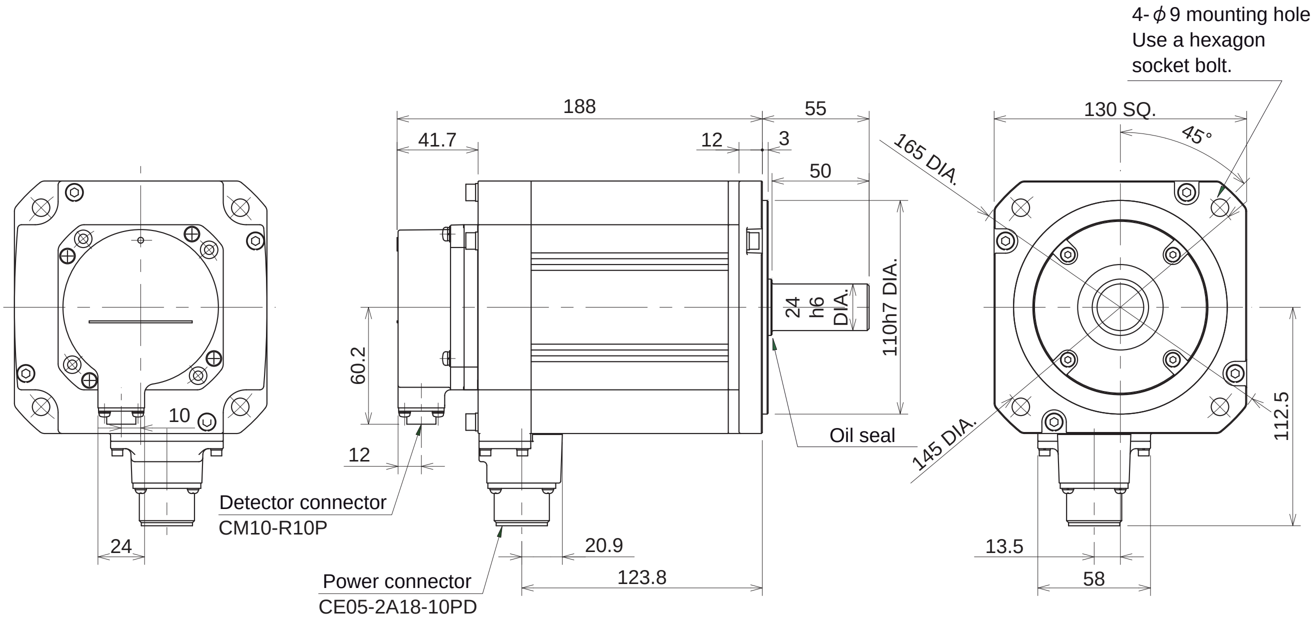

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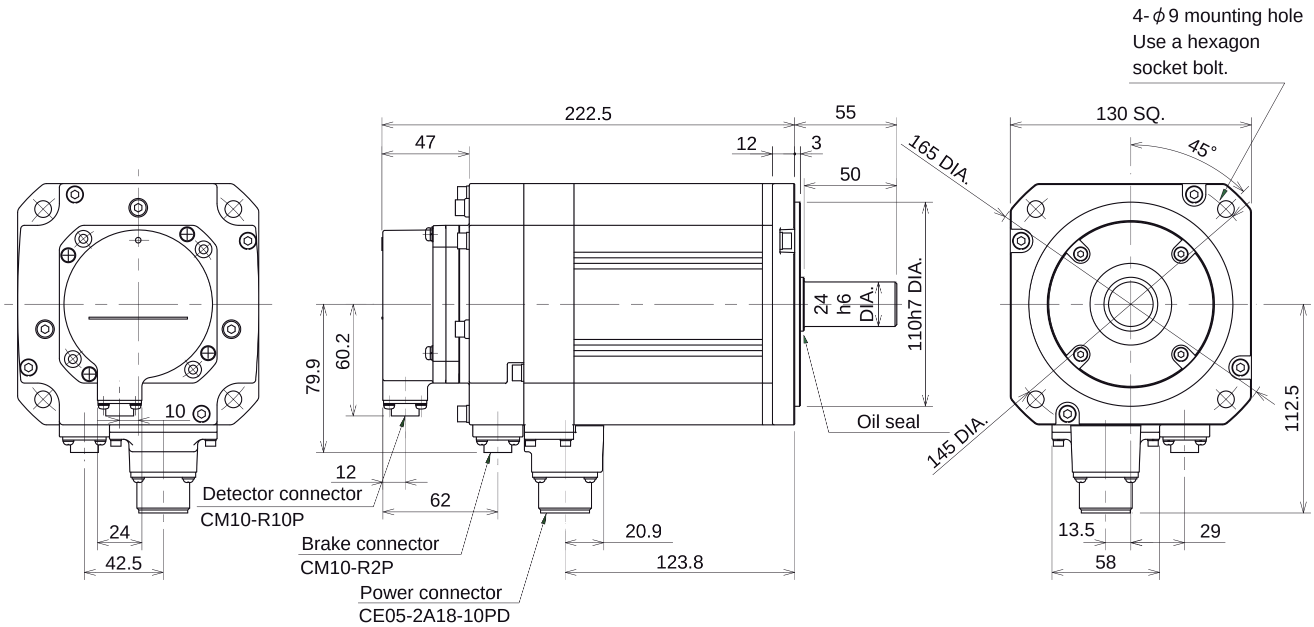

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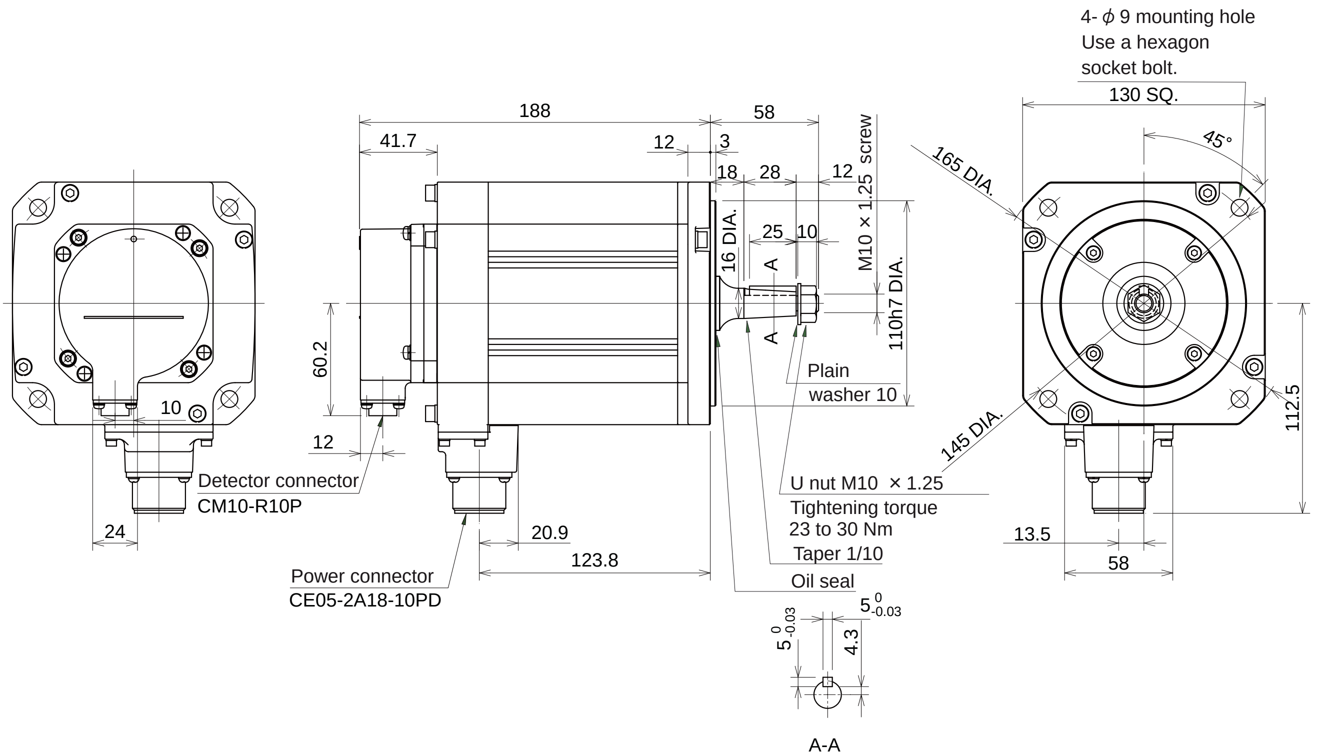

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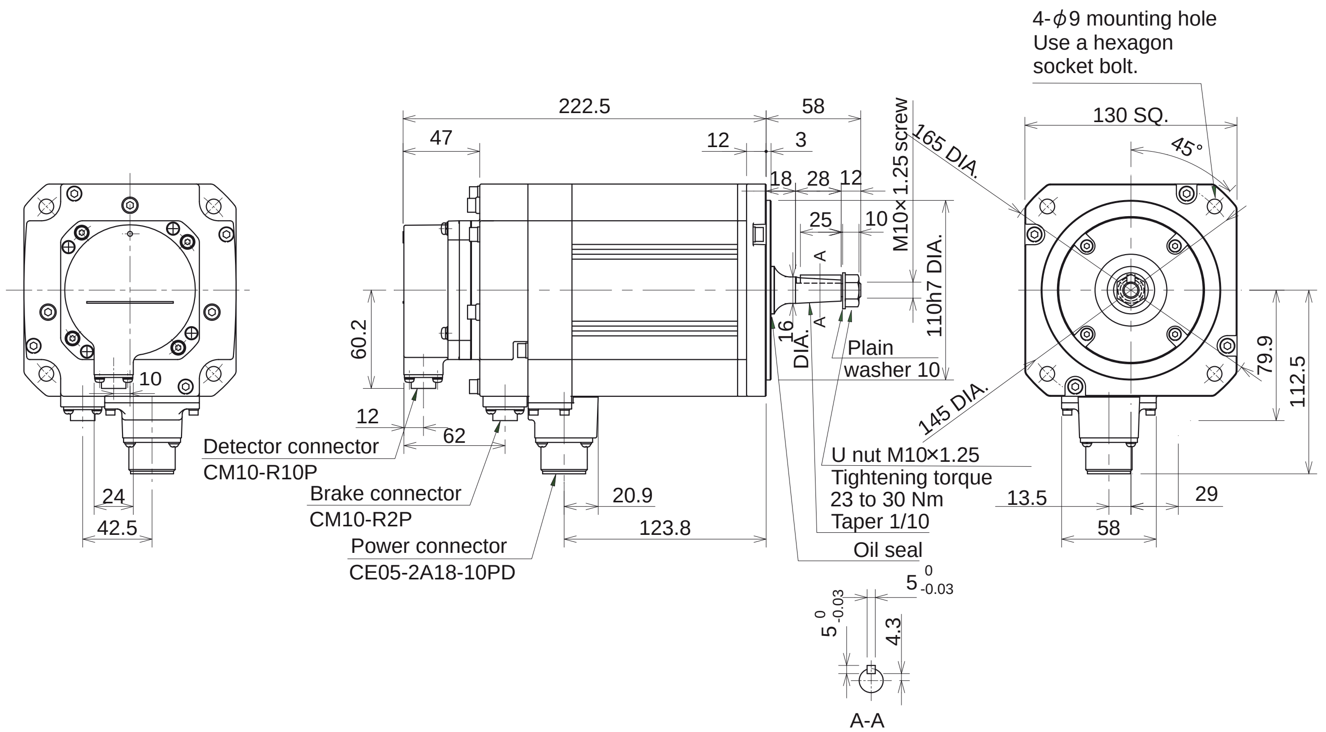

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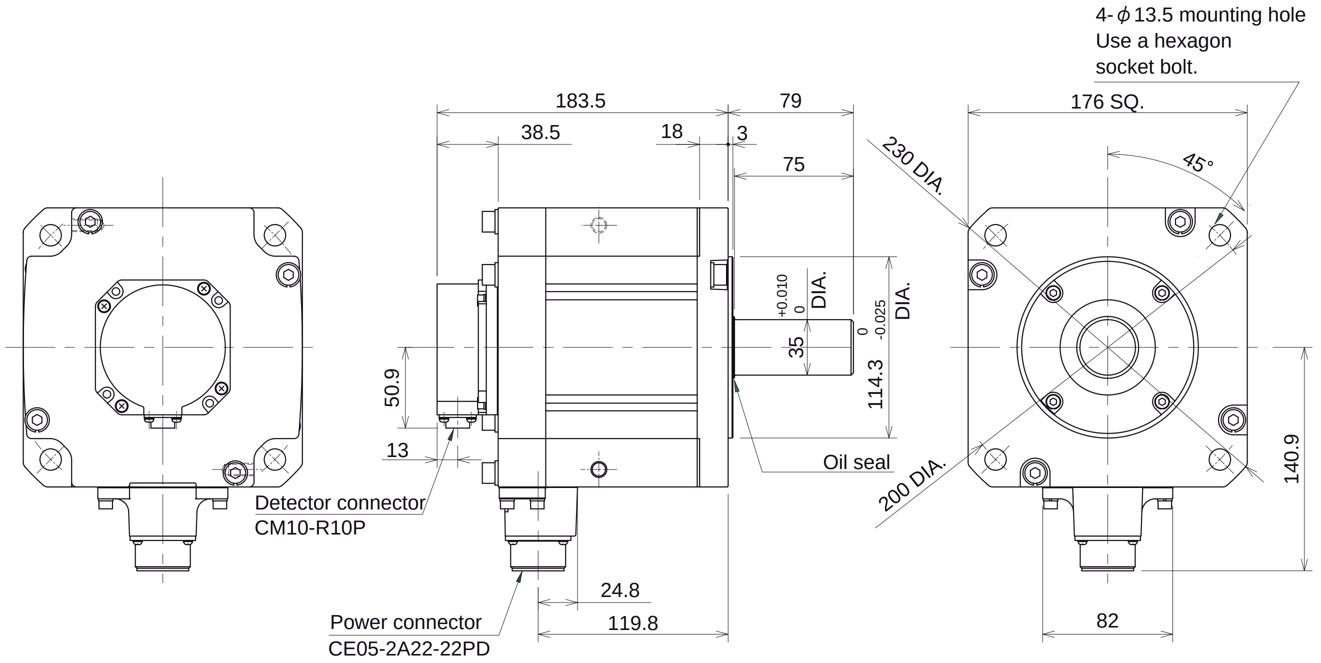

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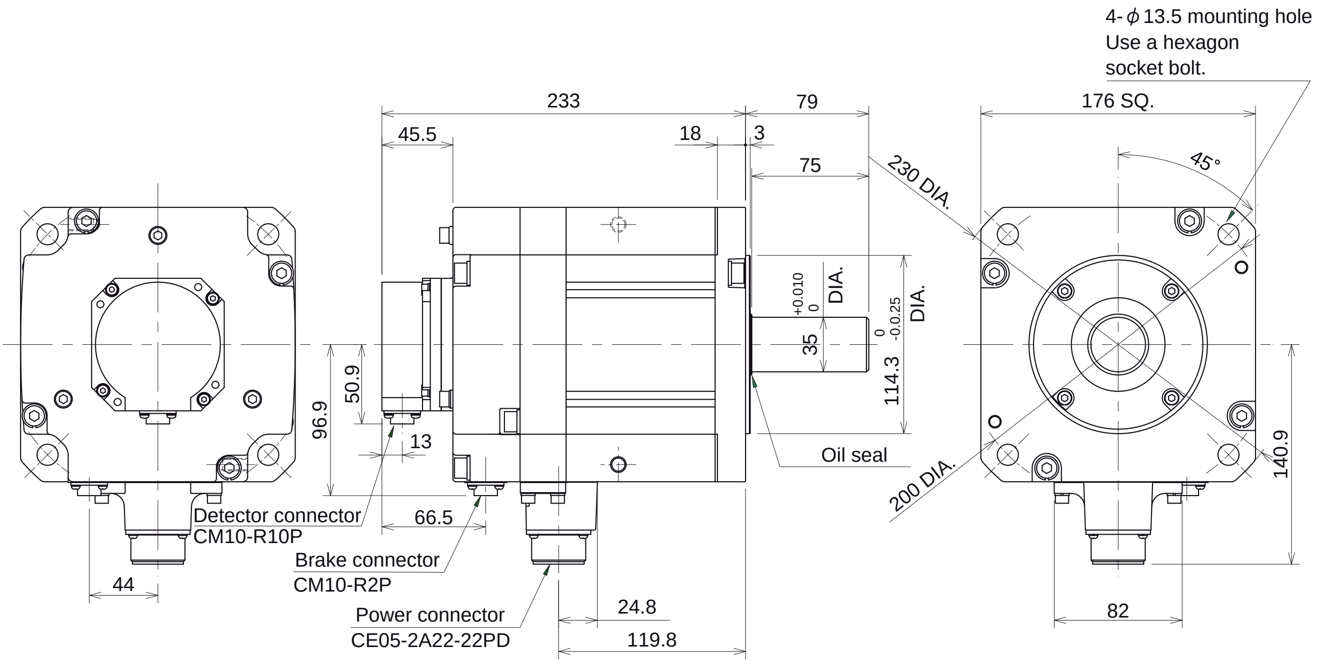

[Unit:mm]

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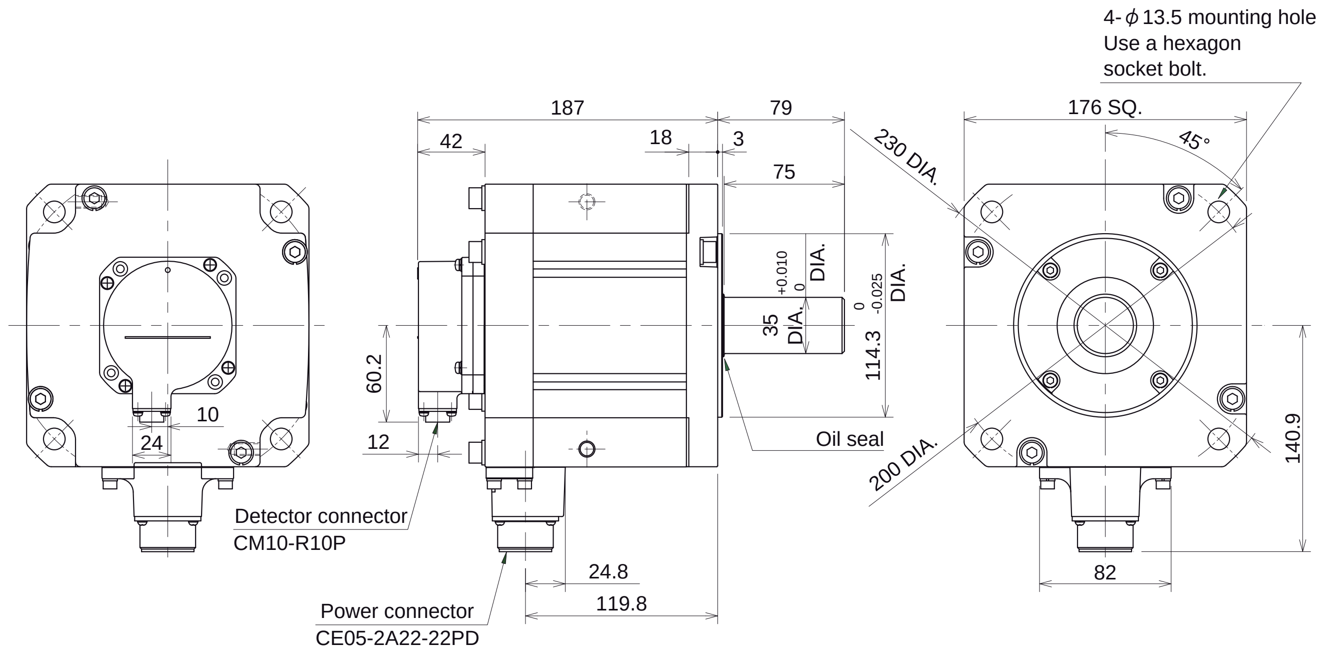

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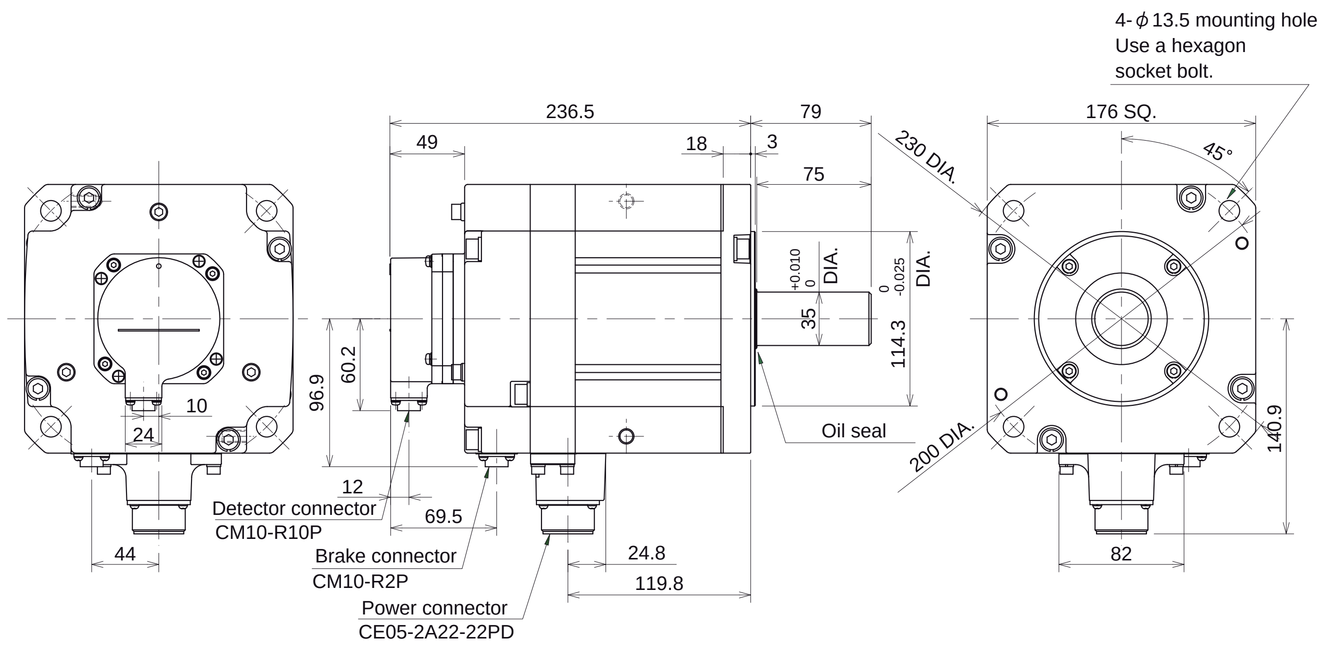

[Unit:mm]

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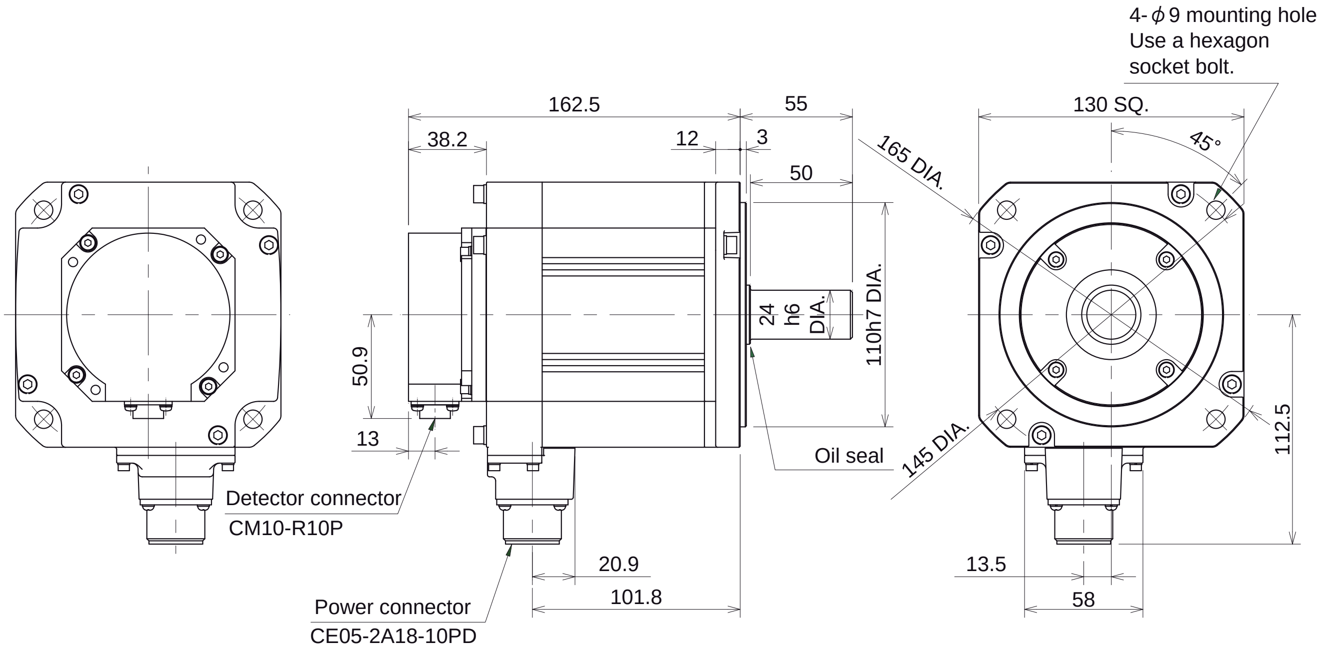

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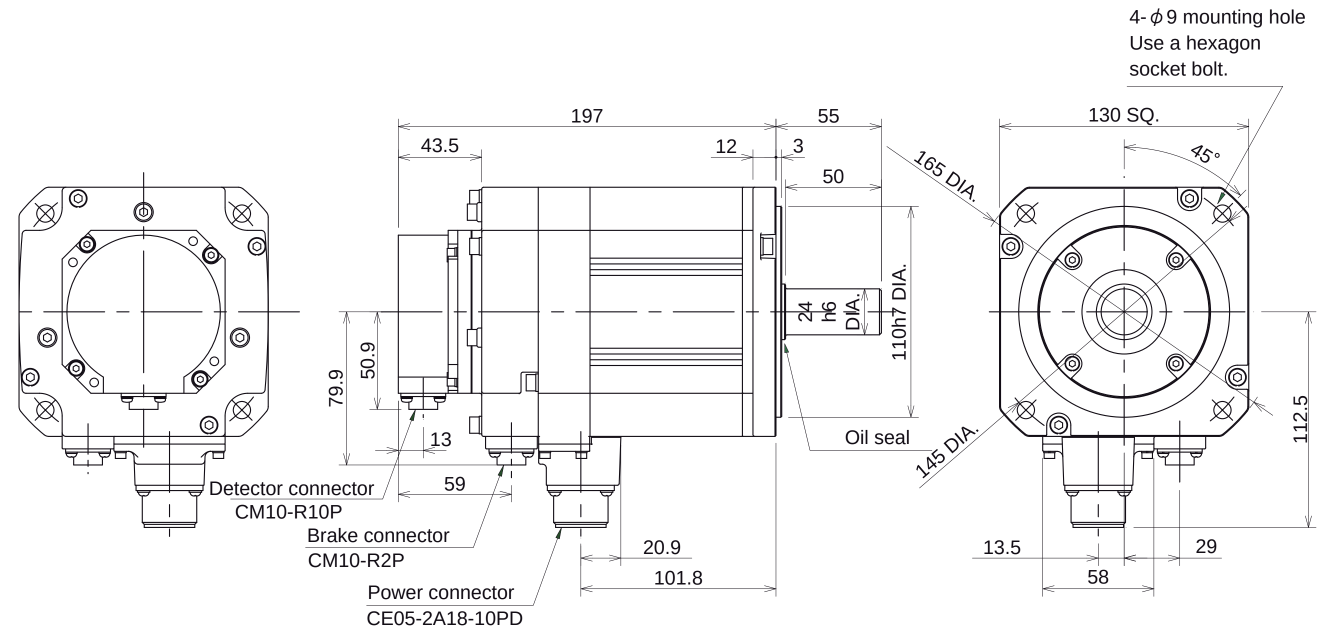

[Unit:mm]

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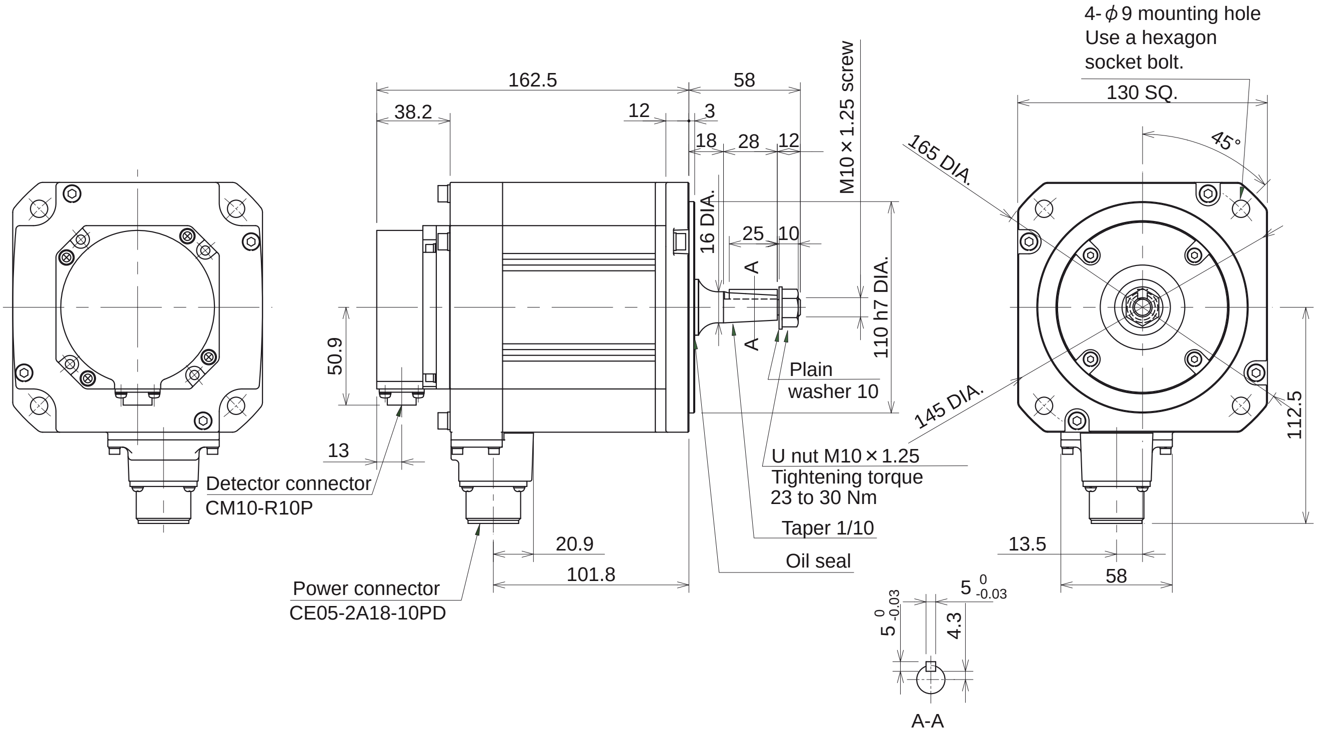

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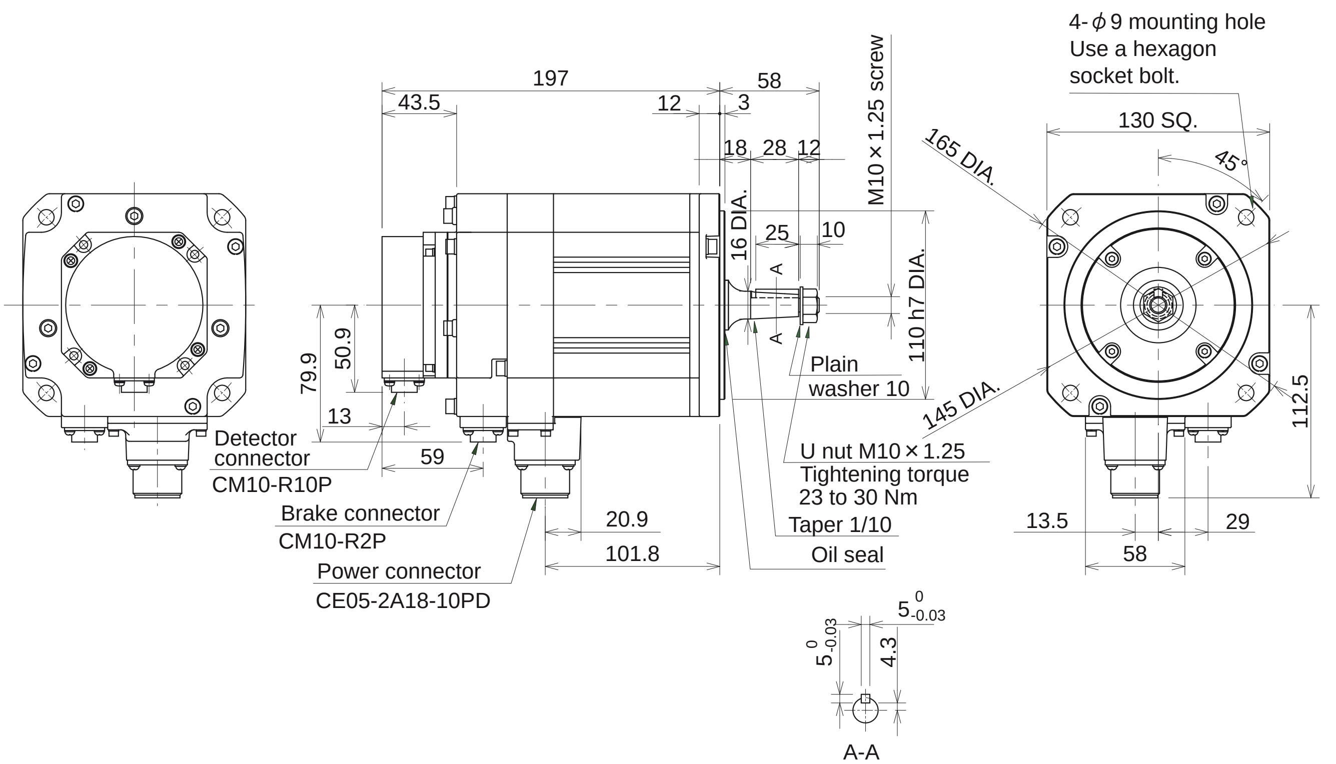

[Unit:mm]

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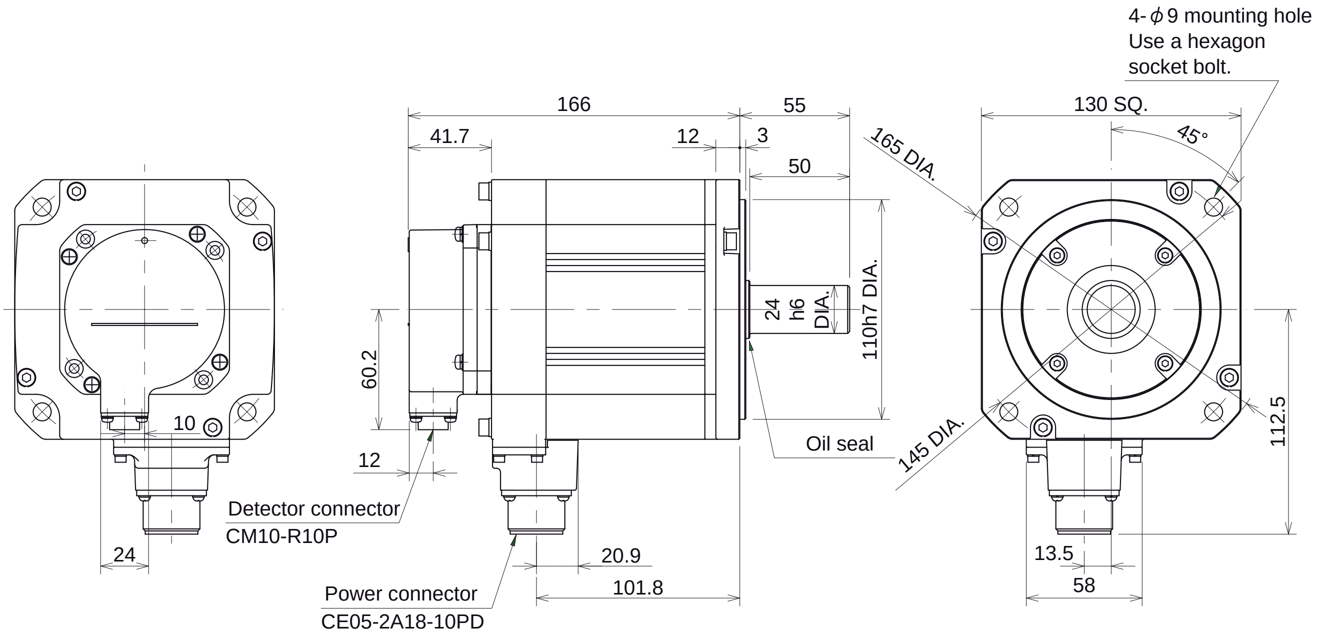

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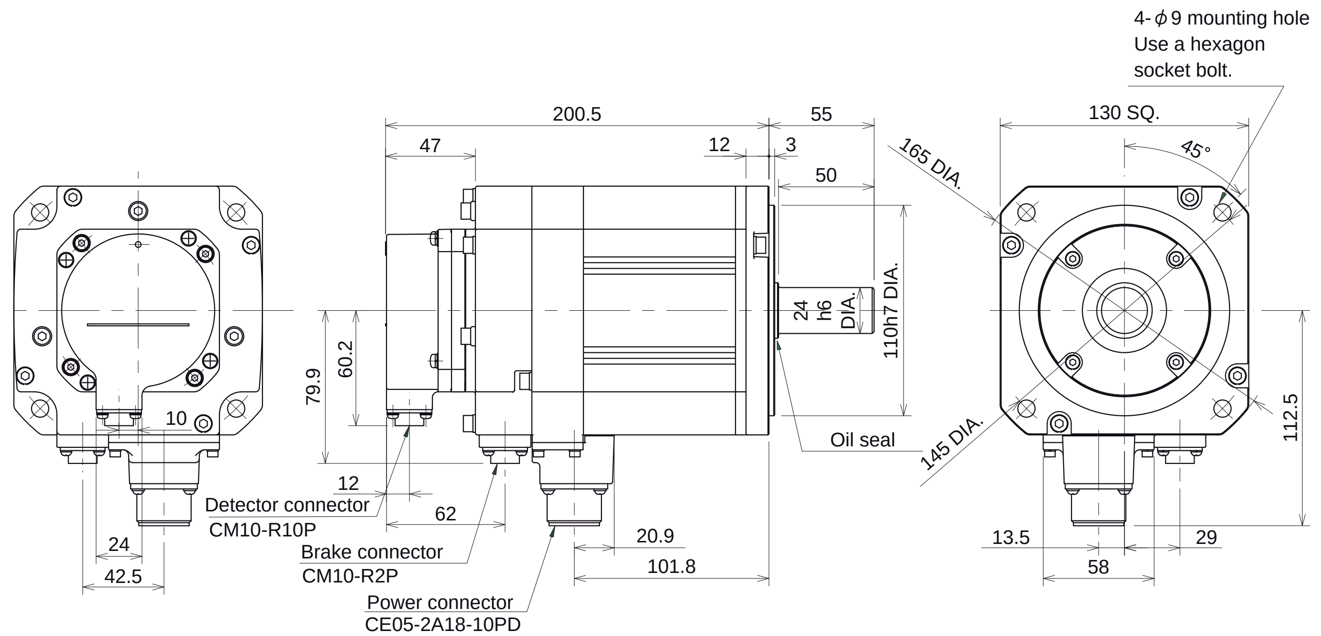

[Unit:mm]

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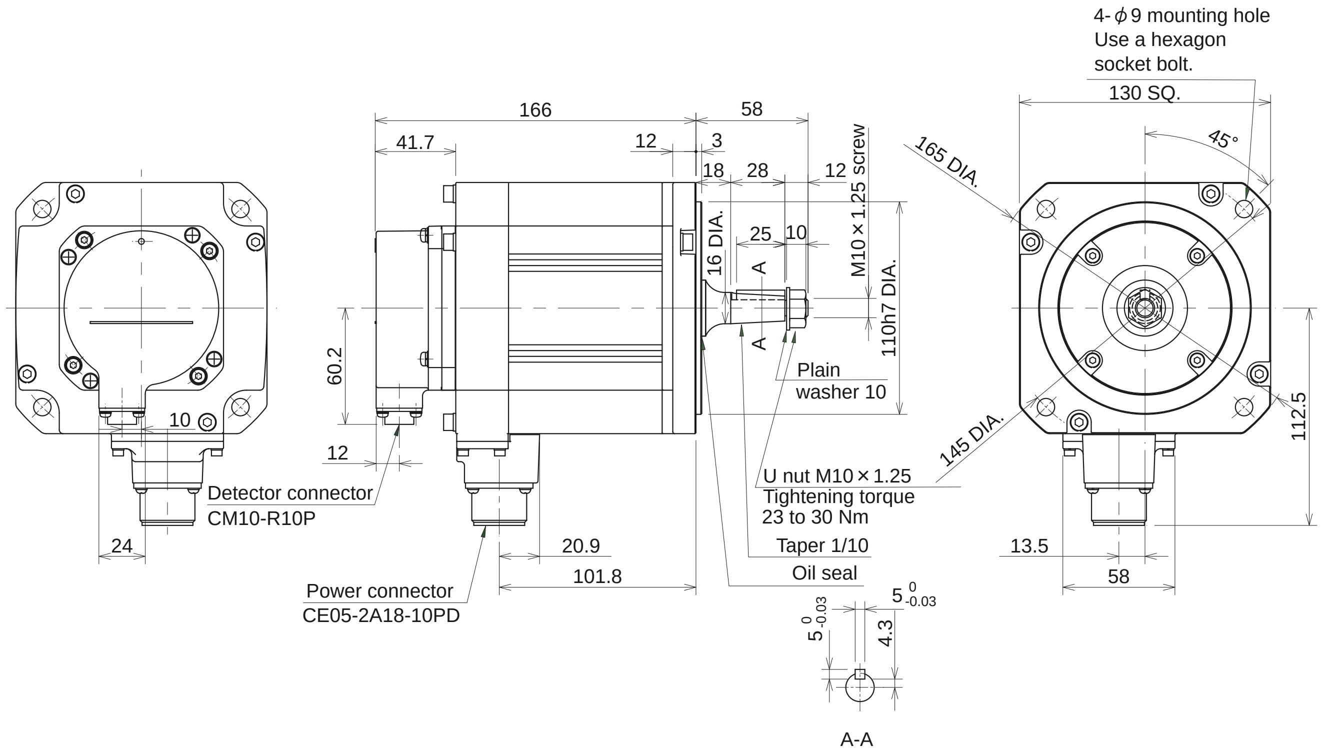

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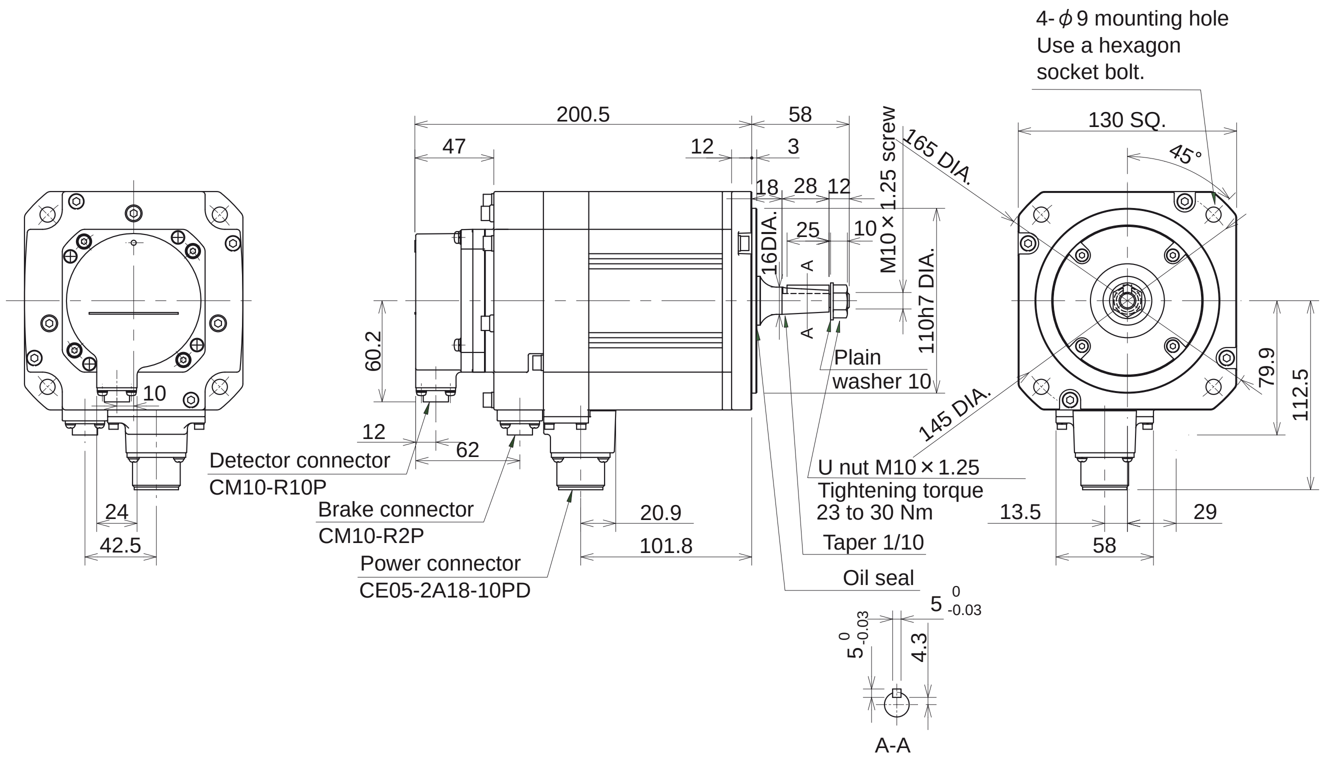
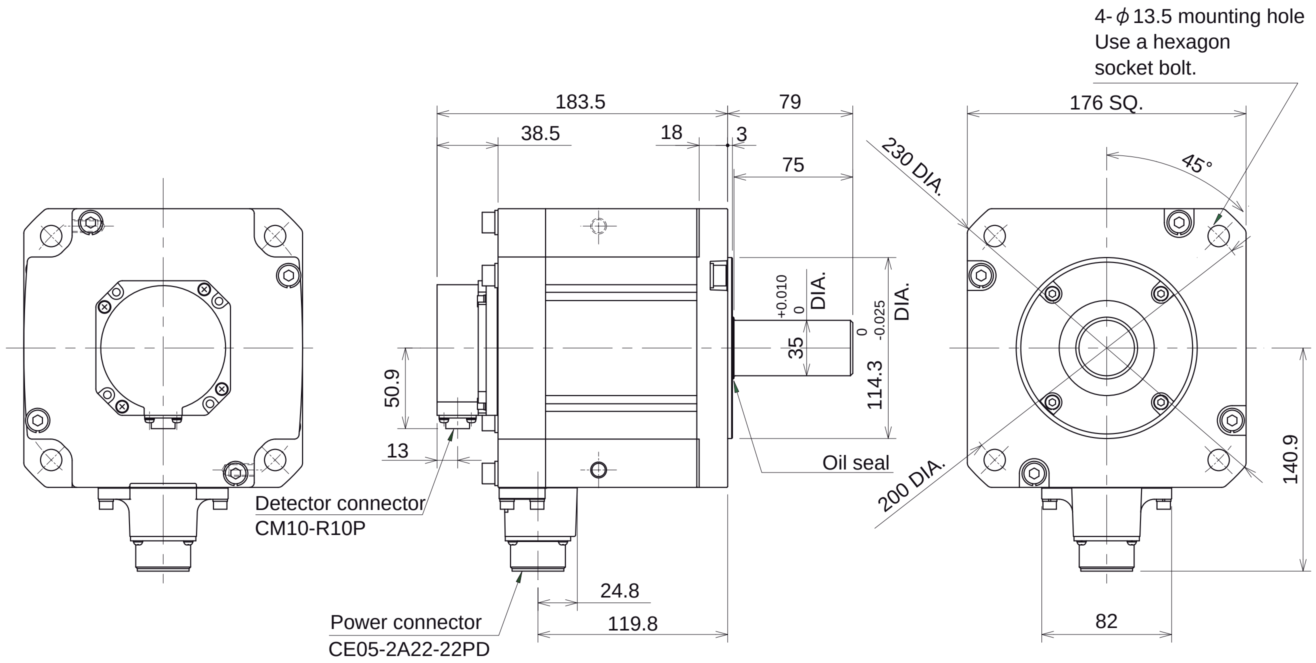
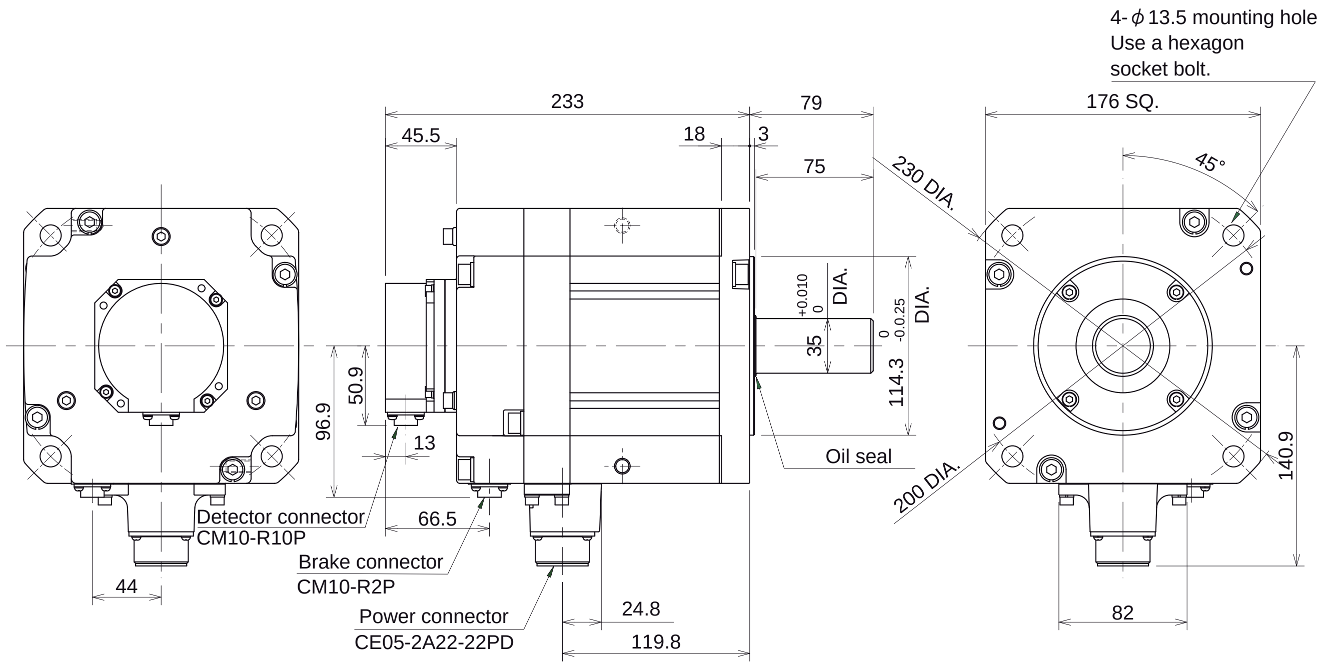


[Unit:mm]

· **HF302S-A48**



· **HF302BS-A48**



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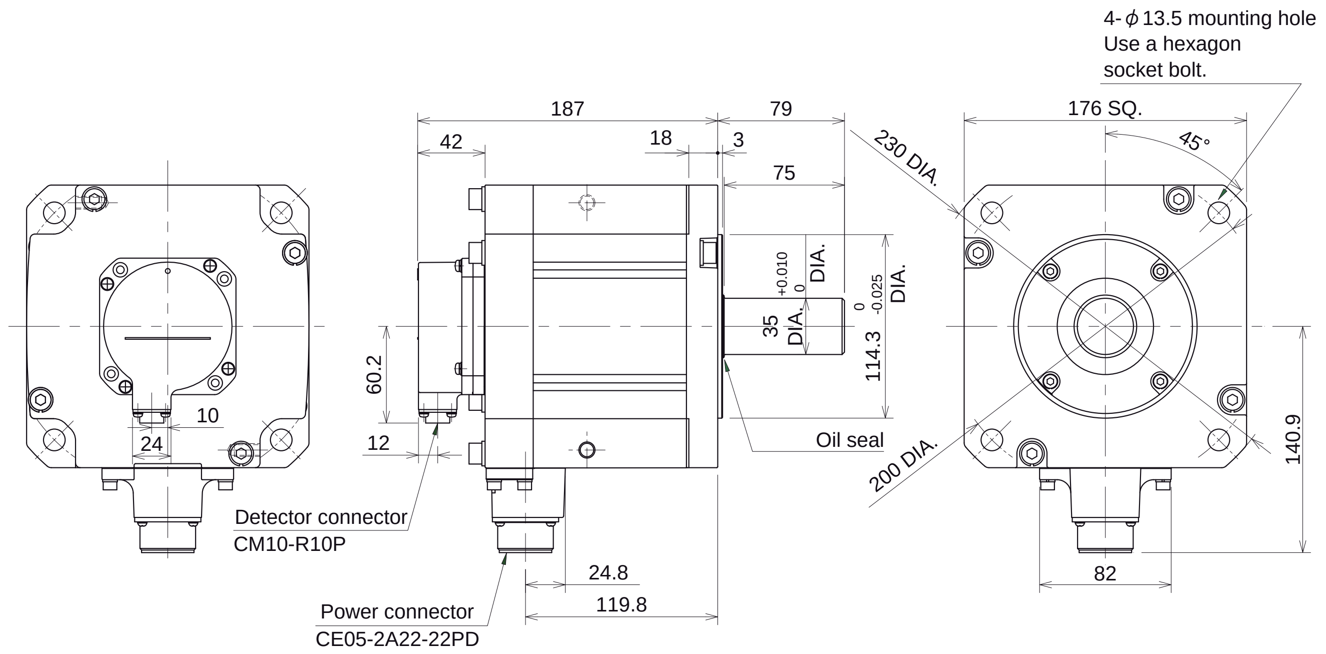

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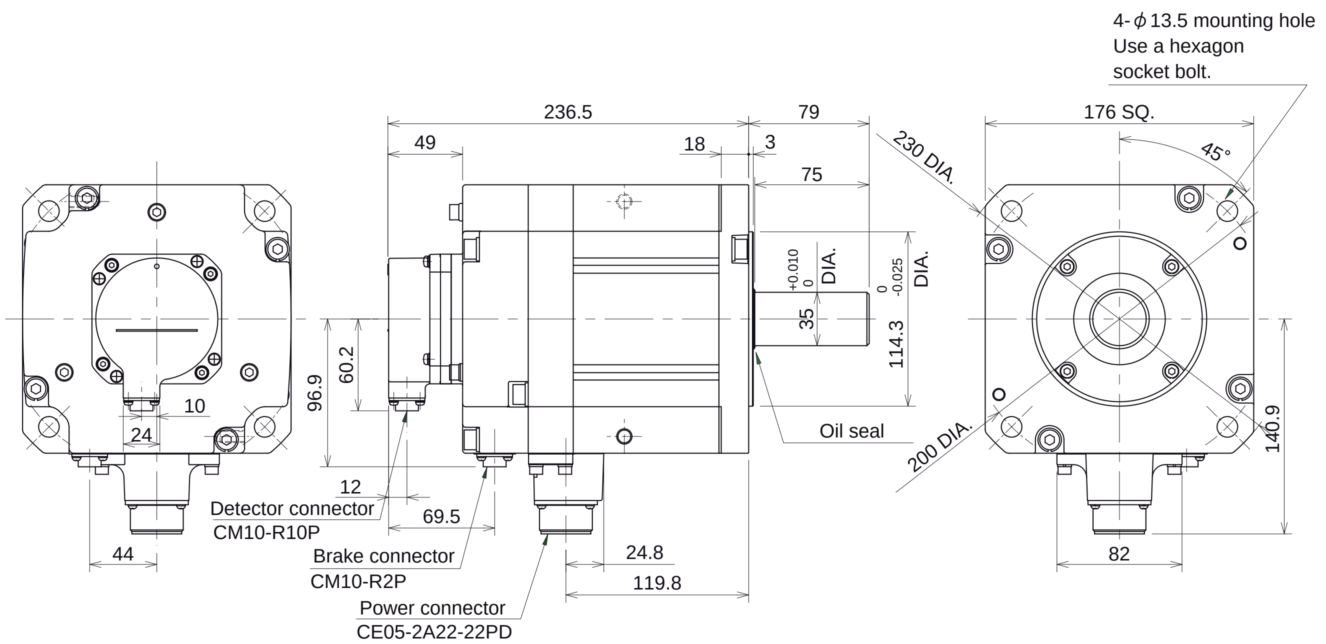


2-2 Servo drive unit

2-2-1 Installation environment conditions

Common installation environment conditions for servo drive unit are shown below.

Environ-ment	Ambient temperature	Operation: 0 to 55°C (with no freezing), Storage / Transportation: -15°C to 65°C (with no freezing)
	Ambient humidity	Operation: 90%RH or less (with no dew condensation) Storage / Transportation: 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: 10000 meters or less above sea level
	Vibration/impact	$5.9m/s^2$ (0.6G)

2-2-2 Specifications list

(1) 1-axis servo drive unit

			1-axis servo drive unit MDS-R-V1 Series			
Servo drive unit type		**MDS-R-V1-**	**20**	**40**	**60**	**80**
Nominal maximum current (peak)		[A]	20	40	60	80
Power facility capacity		[kVA]	1.3	1.9	4.0	5.8
Output	Rated voltage	[V]	155AC			
	Rated current	[A]	3.8	6.6	12.0	17.0
Input	Rated voltage	[V]	3-phase 200 to 230AC			
	Rated current	[A]	3.0	6.0	11.0	15.0
Control power	Voltage	[V]	24DC ±10%			
	Current	[A]	Max. 0.6		Max. 0.8	
	Rush current	[A]	2.4		3.2	
	Rush conductivity time	[ms]	100ms			
Earth leakage current		[mA]	1 (Max. 2)			
Control method			Sine wave PWM control method Current control method			
Braking	Regenerative resistor		External option			
	Dynamic brakes		Built-in			
External analog output			0 to +5V, 2ch (data for various adjustments)			
Structure			Protection type (Protection method: IP10)			
Cooling method			Forced wind cooling (Fin)			
Mass		[kg]	3.3	3.3	5.0	5.0
Heat radiated at rated output		[W]	46	73	101	141
Noise			Less than 55dB			

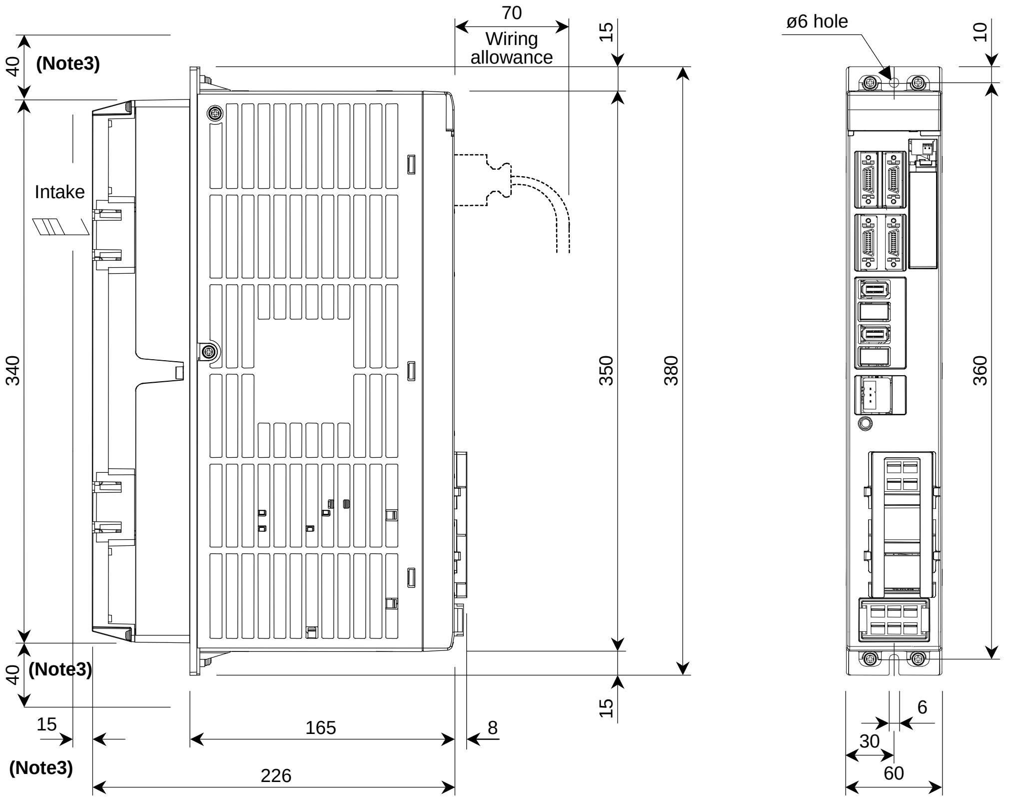
(2) 2-axis servo drive unit

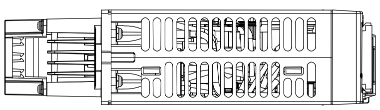
			2-axis servo drive unit MDS-R-V2 Series							
Servo drive unit type		**MDS-R-V2-**	**2020**	**4020**	**4040**	**6040**	**6060**	**8040**	**8060**	**8080**
Nominal maximum current (peak)		[A]	20/20	40/20	40/40	60/40	60/60	80/40	80/60	80/80
Power facility capacity		[kVA]	2.5	3.2	3.9	5.9	8.0	7.8	9.8	11.7
Output	Rated voltage	[V]	155AC							
	Rated current	[A]	3.8 + 3.8	6.6 + 3.8	6.6 + 6.6	12.0 + 6.6	12.0 + 12.0	17.0 + 6.6	17.0 + 12.0	17.0 + 17.0
Input	Rated voltage	[V]	3-phase 200 to 230AC							
	Rated current	[A]	6.0	9.0	12.0	17.0	22.0	21.0	26.0	30.0
Control power	Voltage	[V]	24DC ±10%							
	Current	[A]	Max. 0.9	Max. 1.1		Max. 1.5				
	Rush current	[A]	3.6	4.4		6.0				
	Rush conductivity time	[ms]	100ms							
Earth leakage current		[mA]	1 (Max.4 for 2 axes)							
Control method			Sine wave PWM control method Current control method							
Braking	Regenerative resistor		External option							
	Dynamic brakes		Built-in							
External analog output			0 to +5V, 2ch (data for various adjustments)							
Structure			Protection type (Protection method: IP10)							
Cooling method			Forced wind cooling (Fin)							
Mass		[kg]	3.5	3.5	3.5	5.5	5.5	5.5	5.5	5.5
Heat radiated at rated output		[W]	89	115	143	170	200	218	240	278
Noise			Less than 55dB							

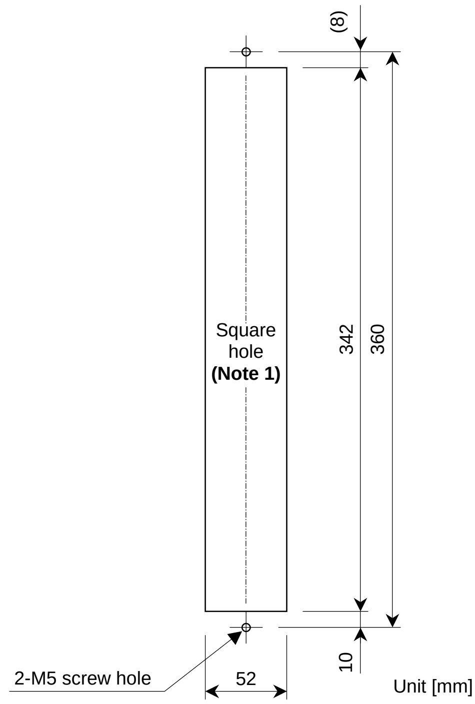
2-2-3 Outline dimension drawings

(1) 1-axis servo drive unit

- MDS-R-V1-20
- MDS-R-V1-40



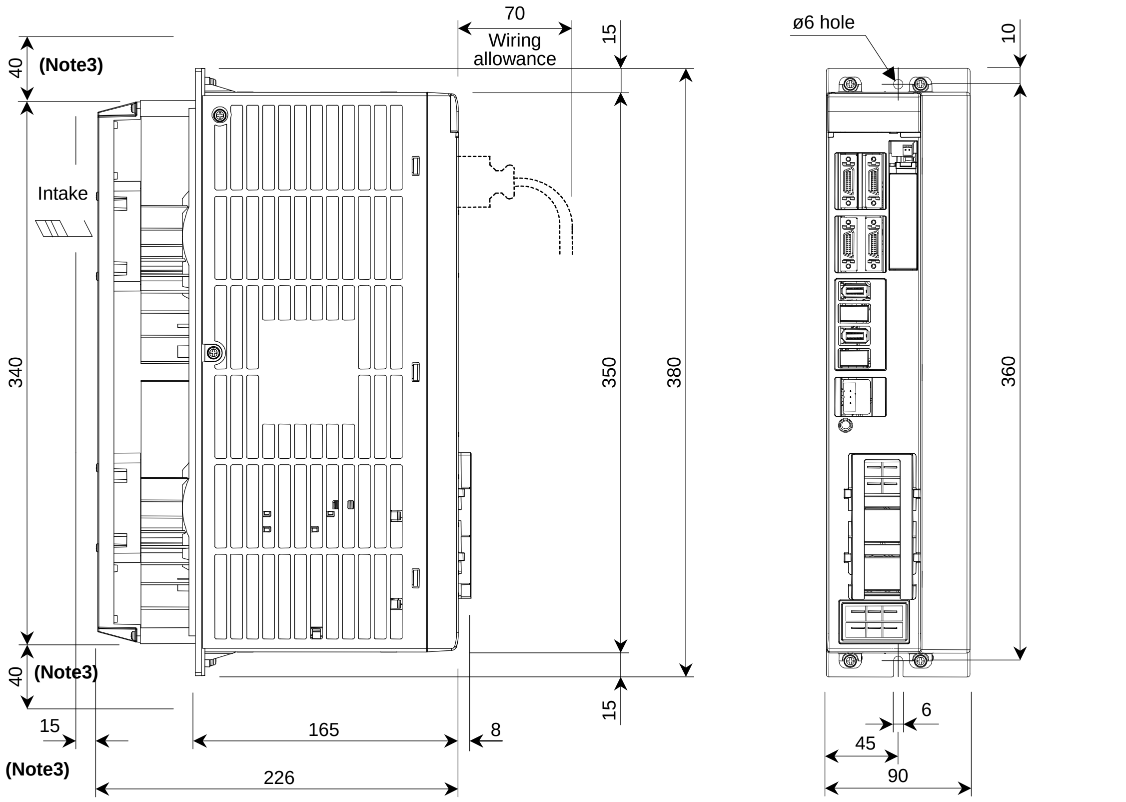


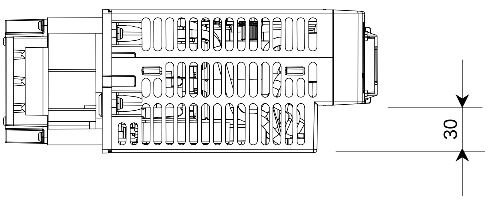


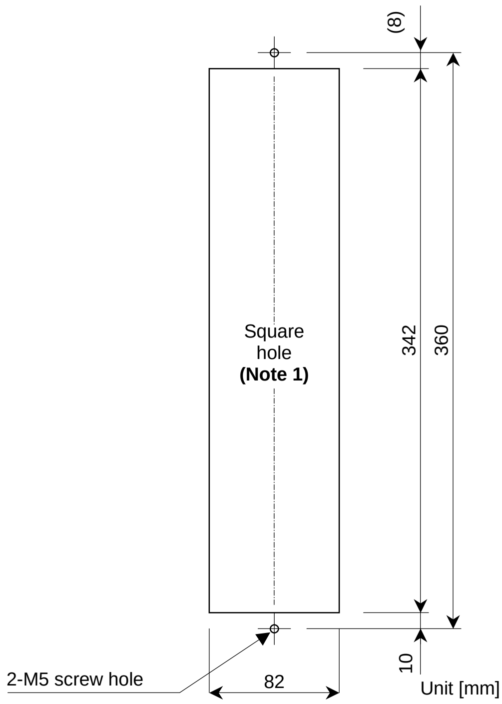
Panel mounting hole machining drawing

(Note 1) Attach packing around the square hole for sealing.
(Note 2) The intake fan can be mounted only at the top as shown above.
(Note 3) Required wind passage space

- MDS-R-V1-60
- MDS-R-V1-80





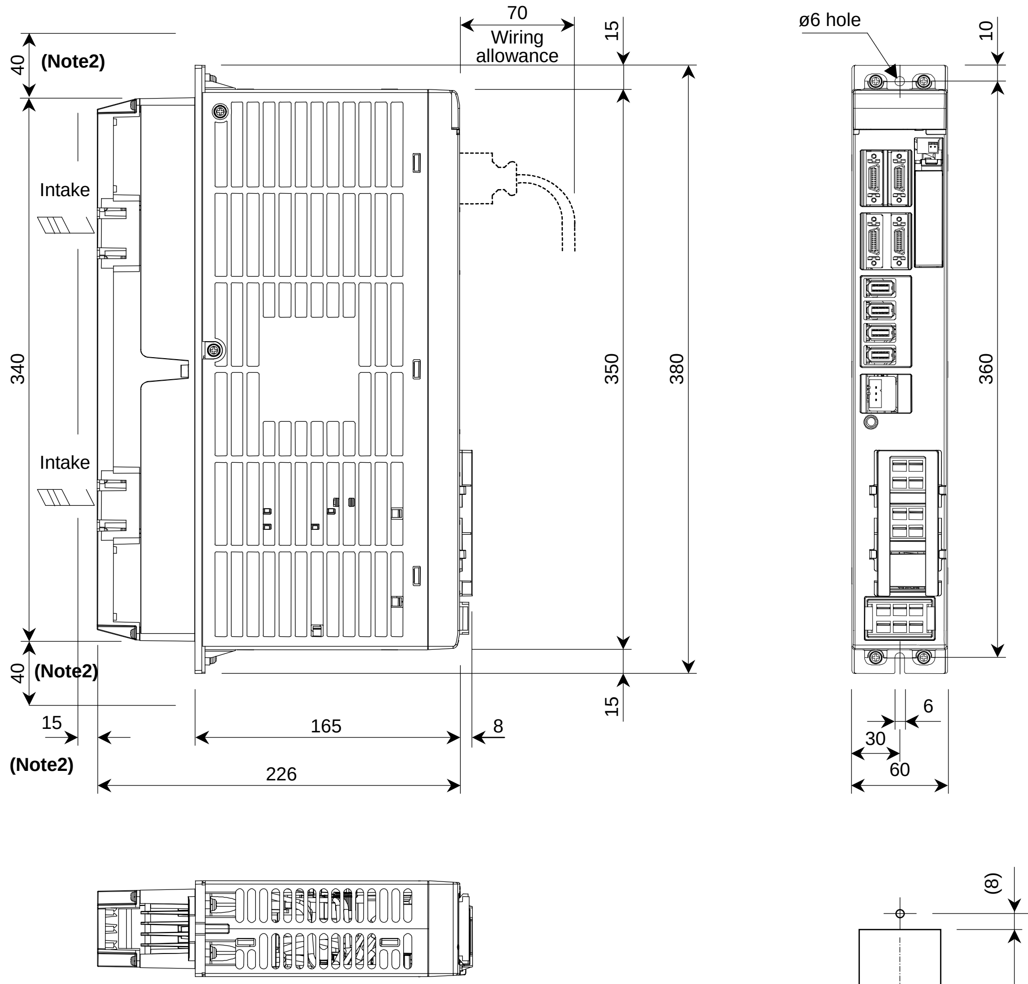


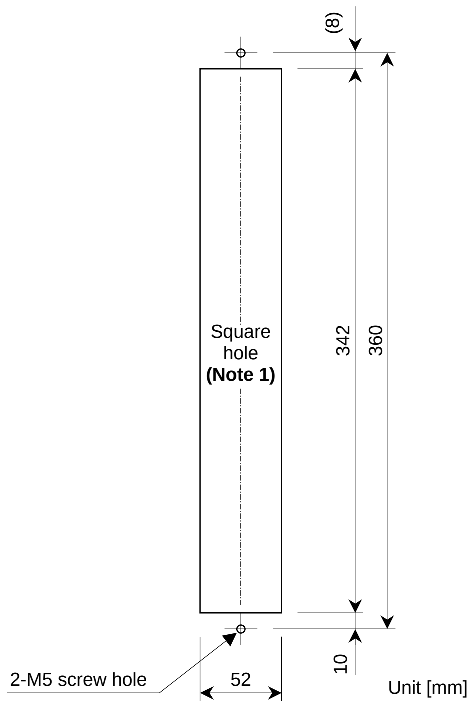
Panel mounting
hole machining drawing

(Note 1) Attach packing around the square hole for sealing.
(Note 2) The intake fan can be mounted only at the top as shown above.
(Note 3) Required wind passage space

(2) 2-axis servo drive unit

- MDS-R-V2-2020
- MDS-R-V2-4040
- MDS-R-V2-4020

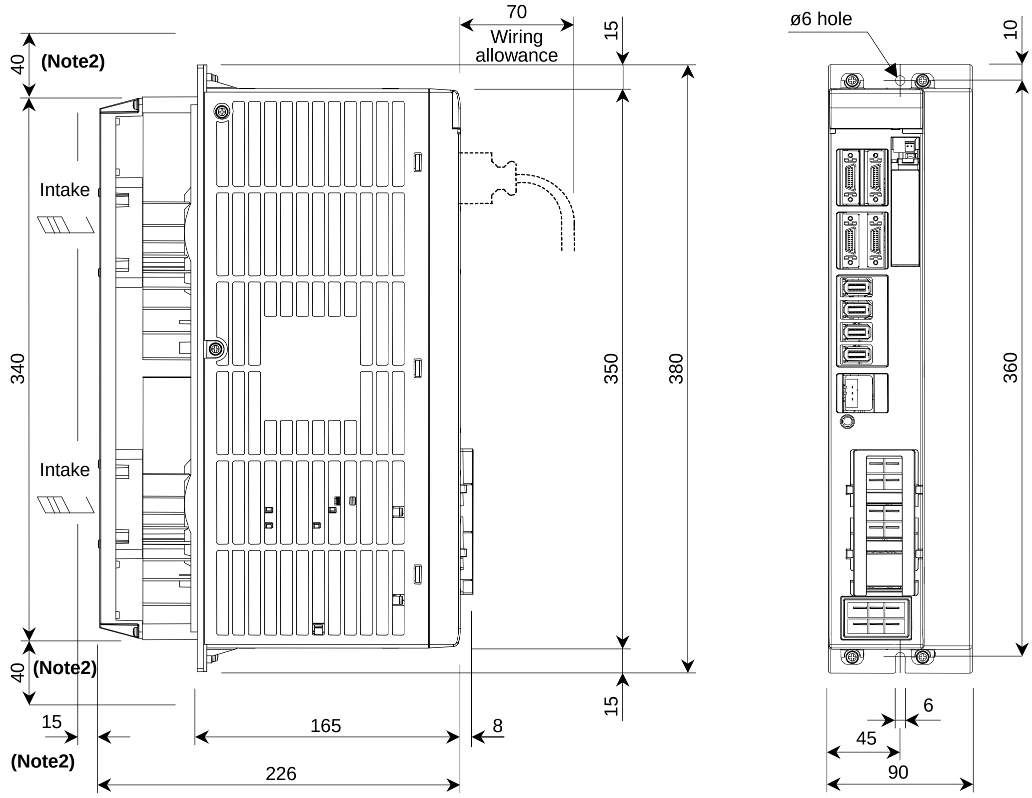


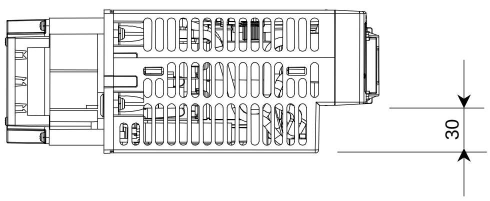


(Note 1) Attach packing around the square hole for sealing.
(Note 2) Required wind passage space

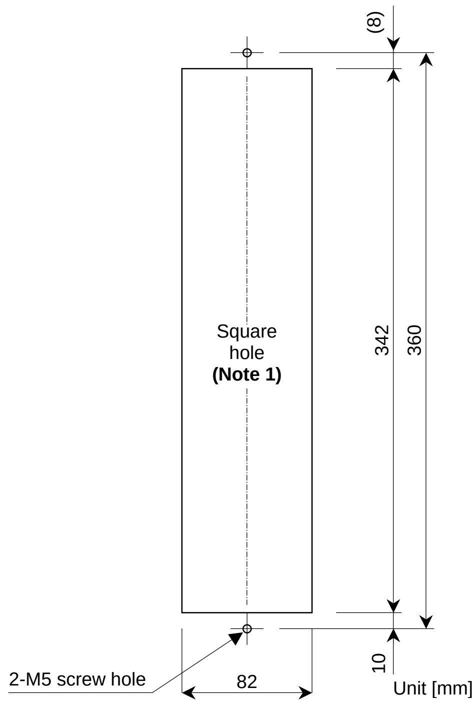
Panel mounting hole machining drawing

- MDS-R-V2-6040
- MDS-R-V2-8040
- MDS-R-V2-8080
- MDS-R-V2-6060
- MDS-R-V2-8060





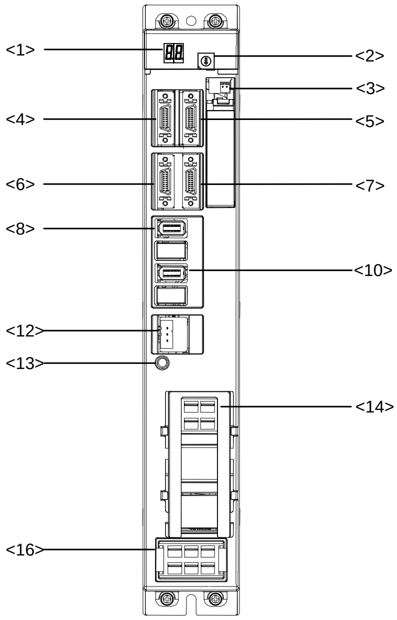
(Note 1) Attach packing around the square hole for sealing.
(Note 2) Required wind passage space



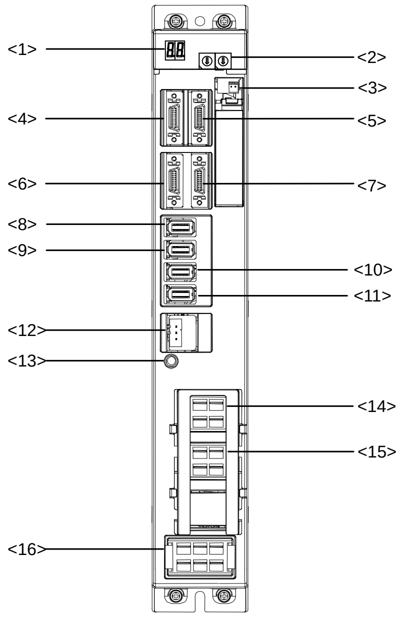
Panel mounting hole machining drawing

2-2-4 Explanation of each part

(1) Explanation of each servo drive unit part



MDS-R-V1 (1-axis servo drive unit)



MDS-R-V2 (2-axis servo drive unit)

The connector layout differs according to the unit being used. Refer to each unit's outline drawing for details.

Each part name

		Name		Description
<1>	Control circuit	LED	---	Unit status indication LED
<2>		SW1	---	Axis No. setting switch (Left: L axis, Right: M axis)
<3>		BT1A	---	Battery connection connector
<4>		CN1A	---	NC or upward axis communication connector
<5>		CN1B	---	Battery unit/Terminator/Lower axis communication connector
<6>		CN9	---	Analog output connector
<7>		CN4	---	Maintenance connector
<8>		CN2L	---	Motor side detector connection connector (L axis)
<9>		CN2M	---	Motor side detector connection connector (M axis)
<10>		CN3L	---	Machine side detector connection connector (L-axis)
<11>		CN3M	---	Machine side detector connection connector (M-axis)
<12>		CN22	---	Control power (24VDC) input connector
<13>		---	CHARGE LAMP	Converter voltage output discharge status indication LED
<14>	Main circuit	CN31L	LU, LV, LW, PE	L axis motor drive output (3-phase AC output) connector
<15>		CN31M	MU, MV, MW, PE	M axis motor drive output (3-phase AC output) connector
<16>		CN30	L1, L2, L3, PE, P, C	Power input (3-phase AC input), regenerative resistor connection connector

(Note) CN2M/CN31M are not mounted with the MDS-R-V1 unit.

3. Characteristics

3-1 Drive unit characteristics

3-1-1 Heating value

The heating value of each servo drive unit is the heating value at stall output.

Servo drive unit type MDS-R-	Heating value [W]	
	Inside panel	Outside panel
V1-20	15	31
V1-40	21	52
V1-60	27	74
V1-80	36	105

Servo drive unit type MDS-R-	Heating value [W]	
	Inside panel	Outside panel
V2-2020	26	63
V2-4020	32	83
V2-4040	38	105
V2-6040	45	125
V2-6060	50	150
V2-8040	53	158
V2-8060	60	180
V2-8080	68	210

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.

Calculation example: When using MDS-R-V1-20 and MDS-R-V2-2020

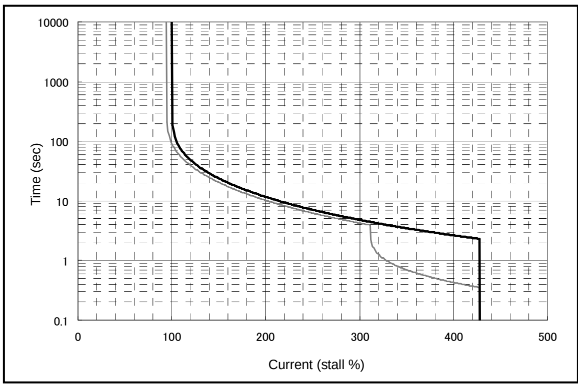
Total heating value = (15 + 31) + (26 + 63) = 135 [W]

Heating value in panel = 15 x 0.5 + 26 x 0.5 = 20.5 [W]

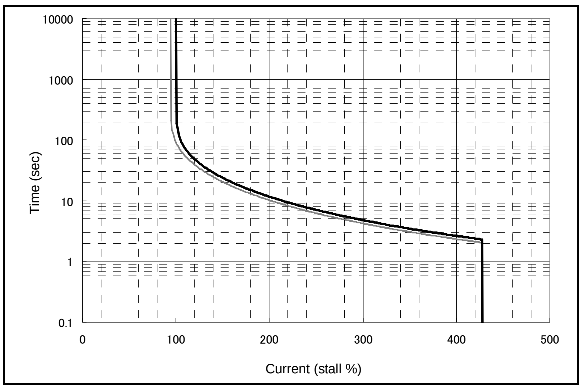
3-1-2 Overload protection characteristics

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.

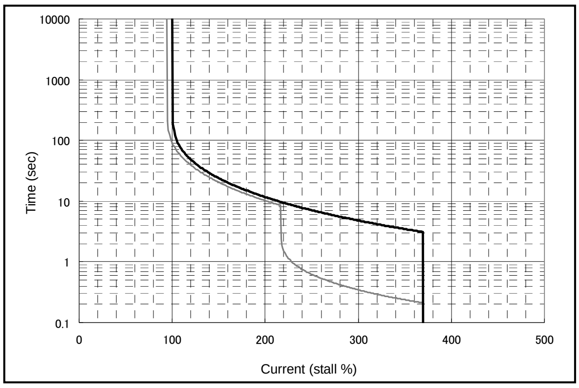
(1) HF-75+V1-20、HF-44+V1-20



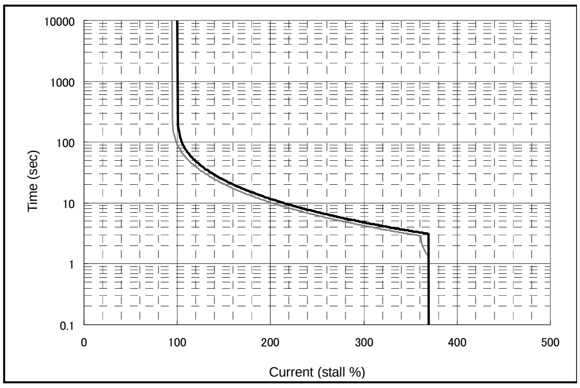
(2) HF75+V1-40、HF44+V1-40



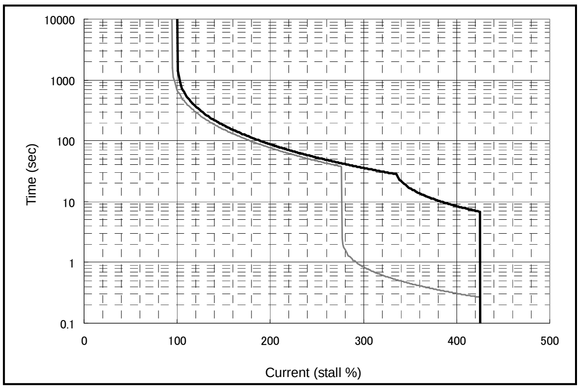
(3) HF105-V1-20、HF74-V1-20



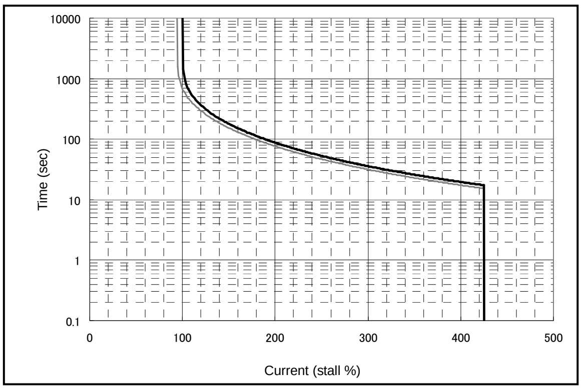
(4) HF-105+V1-40、HF74-V1-40



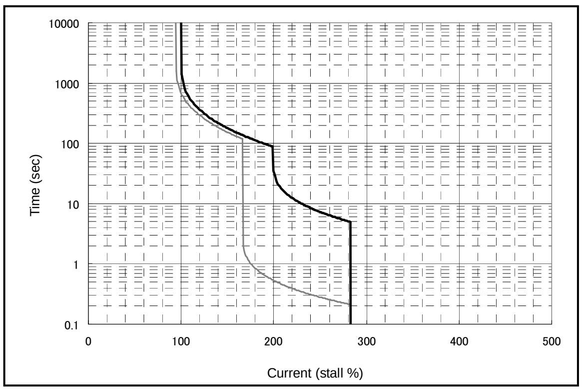
(5) HF-54+V1-20、HF-53+V1-20



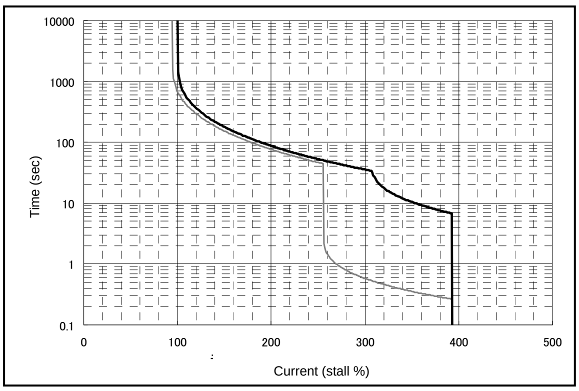
(6) HF-54+V1-40、HF-53+V1-40



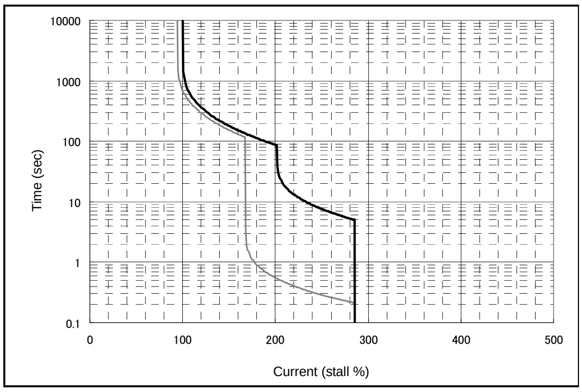
(7) HF-104+V1-20、HF-103+V1-20



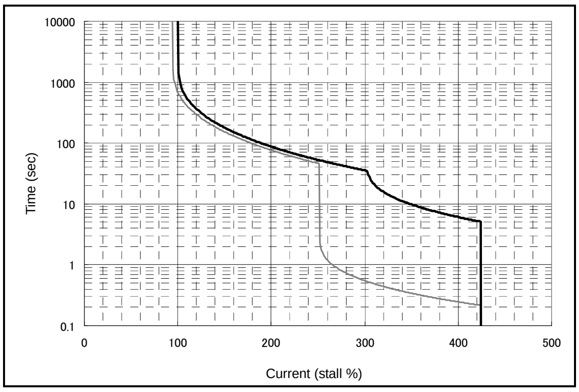
(8) HF-104+V1-40、HF-103+V1-40



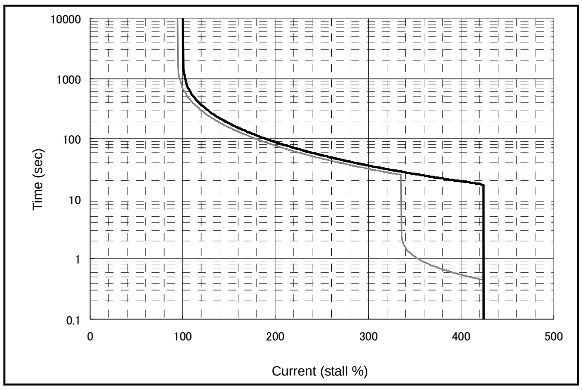
(9) HF-154+V1-40、HF-153+V1-40



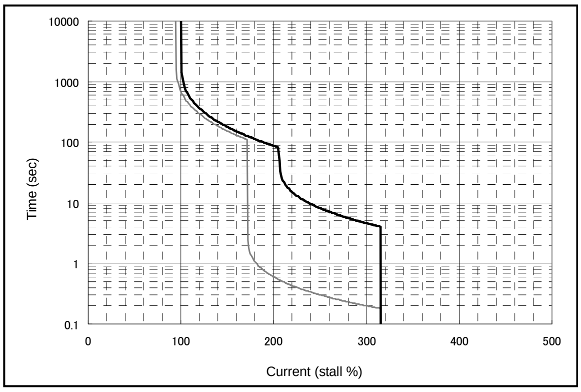
(10) HF-154+V1-60、HF-153+V1-60



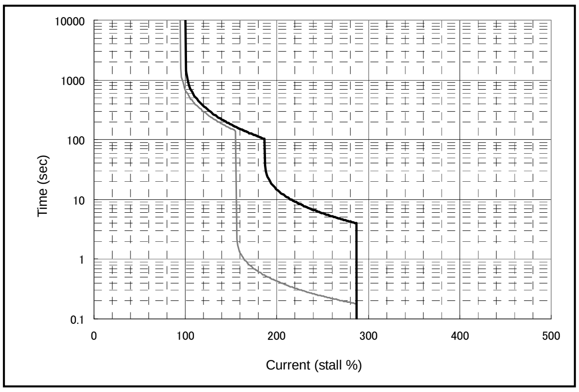
(11) HF-154+V1-80 、HF-153+V1-80



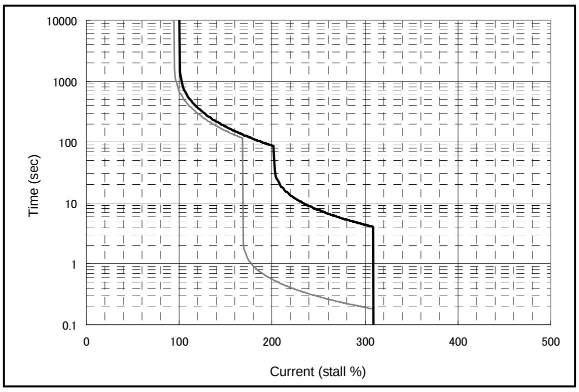
(12) HF-224+V1-60



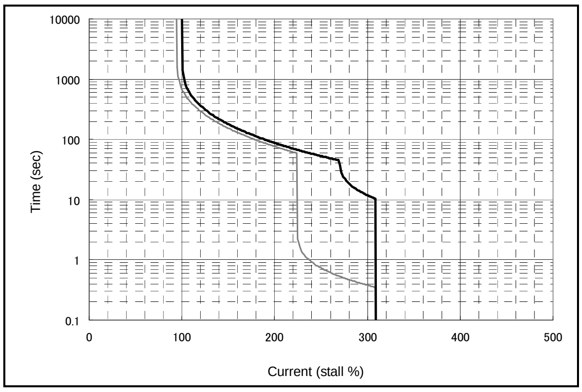
(13) HF-204+V1-40、HF-203+V1-40



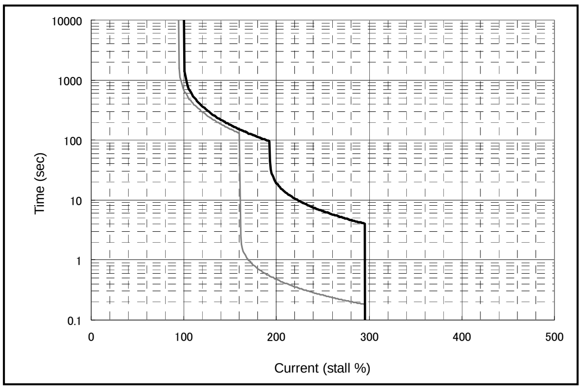
(14) HF-204+V1-60、HF-203+V1-60



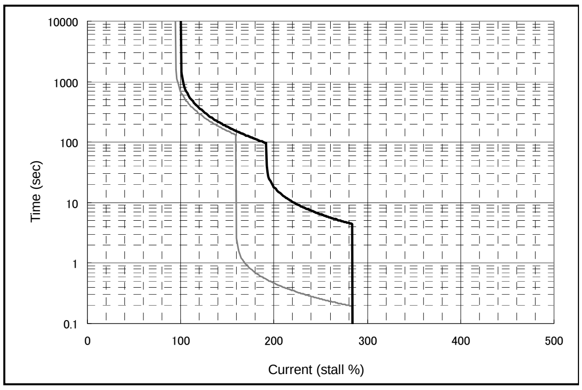
(15) HF-204+V1-80、HF-203+V1-80



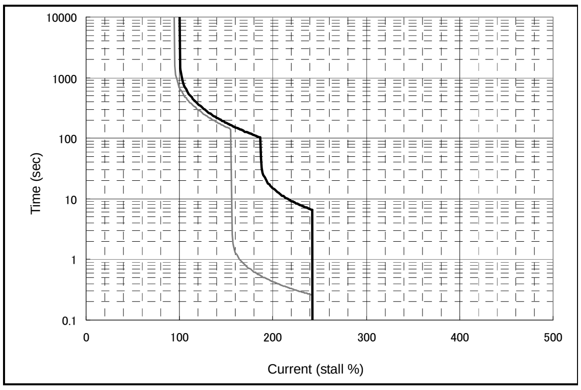
(16) HF-354+V1-60、HF-353+V1-60



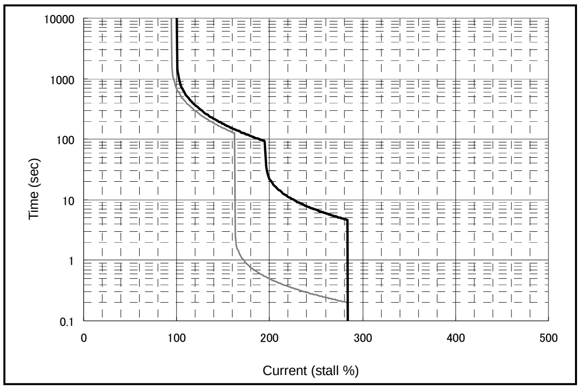
(17) HF-354+V1-80、HF-353+V1-80



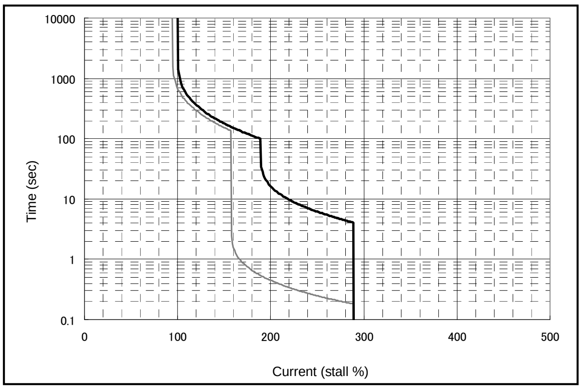
(18) HF-123+V1-20



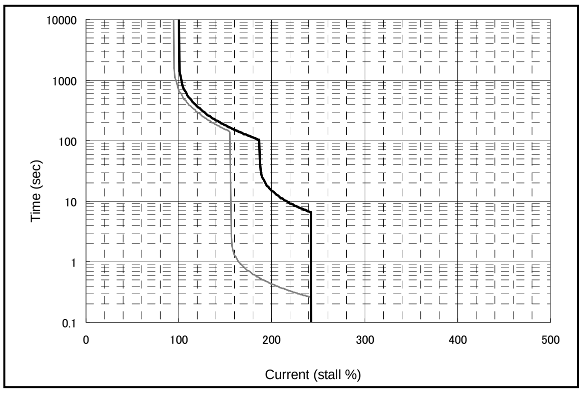
(19) HF-223+V1-40



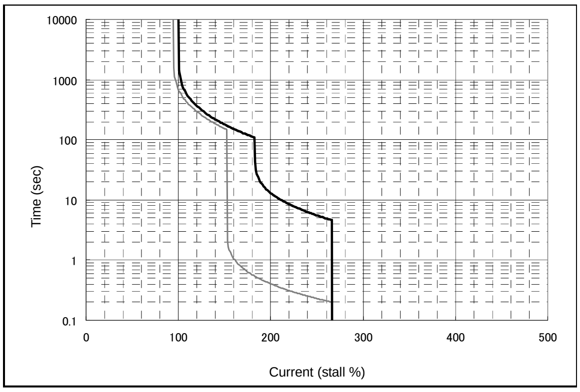
(20) HF-303+V1-60



(21) HF-142+V1-20



(22) HF-302+V1-40



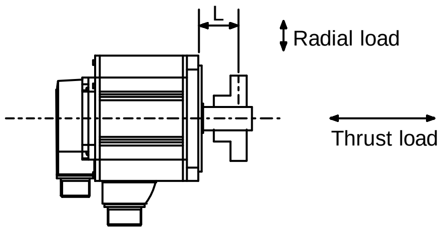
3-2 Servomotor

3-2-1 Shaft characteristics

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 may affect the motor output torque, so consider them when designing the machine.

Servo motor	Tolerable radial load	Tolerable thrust load
HF75T, HF105T（Taper shaft）	245N (L=33)	147N
HF75S, HF105S（Straight shaft）	245N (L=33)	147N
HF54T, HF104T, HF154T, HF224T, HF123T, HF223T, HF142T （Taper shaft）	392N (L=58)	490N
HF54S, HF104S, HF154S, HF224S, HF123S, HF223S, HF142S （Straight shaft）	980N (L=55)	490N
HF204S, HF354S, HF303S, HF302S （Straight shaft）	2058N (L=79)	980N

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



L : Length from flange installation surface to center of load [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.

3-2-2 Magnetic brake

⚠ 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 (CN9) 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

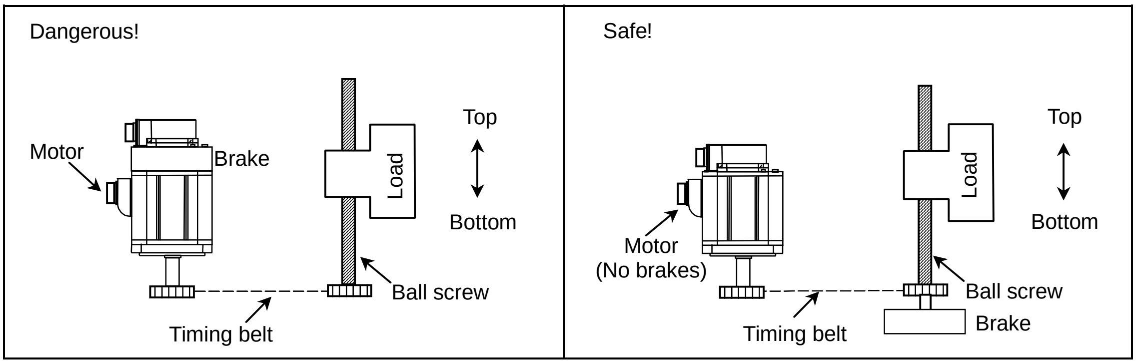
When this type of motor is used for the vertical feed axis in a machining center, etc., slipping and dropping of the spindle head can be prevented even when the hydraulic balancer's hydraulic pressure reaches zero when the power turns OFF. When used with a robot, deviation of the posture when the power 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 (flange size) are the same as the motor without brake.

(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

Item \ Motor type			HF75B, HF105B,	HF54B, HF104B, HF154B, HF224B, HF123B, HF223B, HF142B	HF204B, HF354B, HF303B, HF302B
Type (Note 1)			Spring closed non-exciting operation magnetic brakes (for maintenance and emergency braking)		
Rated voltage			DC24V		
Rated current at 20°C		(A)	0.38	0.8	1.4
Capacity		(W)	9	19	34
Static friction torque		(N･m)	2.4	8.3	43.1
Inertia (Note 2)		(kg･cm^2)	0.2	2.2	9.6
Release delay time (Note 3)		(s)	0.03	0.04	0.1
Braking delay time (Note 3)	DC OFF	(s)	0.03	0.03	0.03
Tolerable braking work amount	Per braking	(J)	64	400	4500
	Per hour	(J)	640	4000	45000
Brake play at motor axis (Note 7)		(degree)	0.1～0.9	0.2～0.6	0.2～0.6
Brake life (Note 4)	No. of braking operations	(times)	20000	20000	20000
	Work amount per braking	(J)	32	200	1000

Notes:

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.
2. These are the values added to the servomotor without a brake.
3. This is the representative value for the initial attraction gap at 20°C.
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.
5. A leakage flux will be generated at the shaft end of the servomotor with a magnetic brake.
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.
7. This is the main default value, and is not a guaranteed value.

(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 arbitrary. Make sure not to mistake the terminals with other circuits.

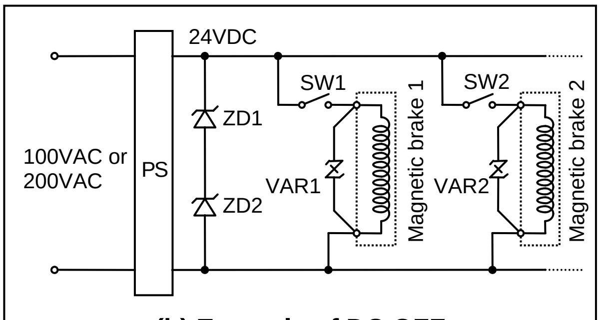
(b) Brake excitation circuit

1) AC OFF and 2) DC OFF can be used to turn OFF the brake excitation power supply (to apply the brake).

1) AC OFF
The braking delay time will be longer, but the excitation circuit will be simple, and the relay cut off capacity can be decreased.

2) DC OFF
The braking delay time can be shortened, but a surge absorber will be required and the relay cut off capacity will be increased.

<Cautions>
- Provide sufficient DC cut off capacity at the contact.
- Always use a 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

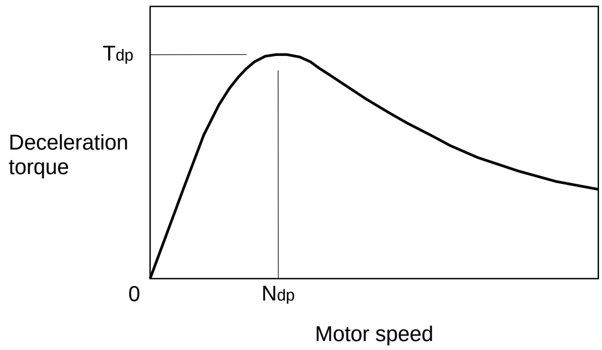
Magnetic brake circuits

3-2-3 Dynamic brake characteristics

If a servo alarm that cannot control the motor occurs, the dynamic brakes will function to stop the servomotor regardless of the parameter settings.

(1) Deceleration torque

The dynamic brake uses 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.



Deceleration torque characteristics of a dynamic brake

Max. deceleration torque of a dynamic brake

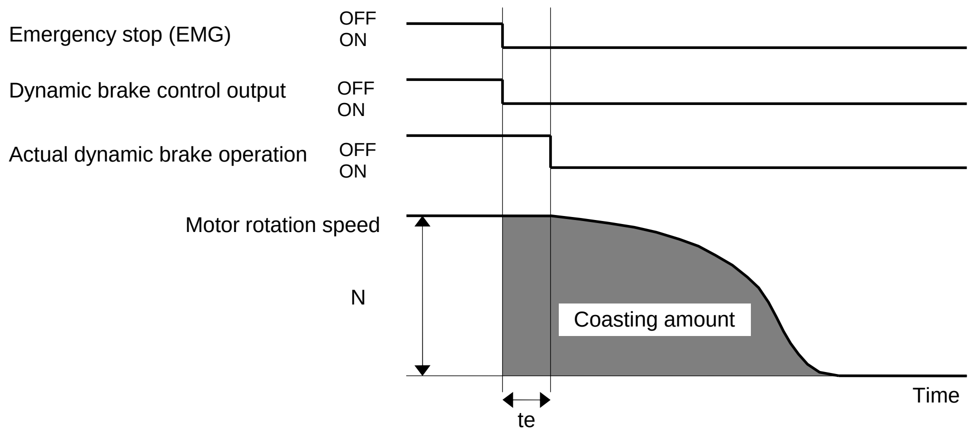
Motor type	Combination unit	Stall torque (N・m)	Ndp (r/min)	Tdp (N・m)
HF75	MDS-R-V1-20 MDS-R-V2-2020/4020	2	1254	5.43
HF105	MDS-R-V1-20 MDS-R-V2-2020/4020	3	1254	5.43
HF54	MDS-R-V1-20 MDS-R-V2-2020/4020	2.94	478	3.96
HF104	MDS-R-V1-40 MDS-R-V2-4020/4040	5.88	409	10.04
	MDS-R-V2-6040/8040	5.88	539	10.04
HF154	MDS-R-V1-60 MDS-R-V2-6040/6060/8060	8.82	541	15.62
HF224	MDS-R-V1-60 MDS-R-V2-6040/6060	12	660	21.77
HF204	MDS-R-V1-60 MDS-R-V2-6040/6060/8060	13.7	367	15.94
HF354	MDS-R-V1-80 MDS-R-V2-8040/8060/8080	22.5	464	35.24
HF123	MDS-R-V1-20 MDS-R-V2-2020/4020	7	370	9.74
HF223	MDS-R-V1-40 MDS-R-V2-4020/4040	12	339	21.56
	MDS-R-V2-6040/8040	12	500	21.56
HF303	MDS-R-V1-60 MDS-R-V2-6040/6060/8060	22.5	357	35.33
HF142	MDS-R-V1-20 MDS-R-V2-2020/4020	11	330	15.46
HF302	MDS-R-V1-40 MDS-R-V2-4020/4040	20	190	35.45
	MDS-R-V2-6040/8040	20	305	35.45

(2) Coasting rotation distance during emergency stop

The distance that the motor coasts (angle for rotary axis) when stopping with the dynamic brakes can be approximated with the following expression.

$$L_{MAX} = \frac{F}{60} \cdot \{te + (1 + \frac{J_L}{J_M}) \cdot (A \cdot N^2 + B)\}$$

L_{MAX}	:	Motor coasting distance (angle)	[mm, (deg)]
F	:	Axis feedrate	[mm/min, (deg/min)]
N	:	Motor rotation speed	[r/min]
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)	



Dynamic brake braking diagram

Coasting amount calculation coefficients table

Motor type	Combination unit	DB resistance value (Ω)	Jm (kg・cm²)	A×10⁻⁹	B×10⁻³
HF75	MDS-R-V1-20 MDS-R-V2-2020/4020	0	2.6	0.67	3.14
HF105	MDS-R-V1-20 MDS-R-V2-2020/4020	0	5.1	1.31	6.16
HF54	MDS-R-V1-20 MDS-R-V2-2020/4020	0	6.1	5.62	3.85
HF104	MDS-R-V1-40 MDS-R-V2-4020/4040	0	11.9	5.06	2.54
	MDS-R-V2-6040/8040	0.2	11.9	3.84	3.35
HF154	MDS-R-V1-60 MDS-R-V2-6040/6060/8060	0.2	17.8	3.68	3.23
HF224	MDS-R-V1-60 MDS-R-V2-6040/6060	0.2	23.7	2.88	3.76
HF204	MDS-R-V1-60 MDS-R-V2-6040/6060/8060	0.2	38.3	11.41	4.62
HF354	MDS-R-V1-80 MDS-R-V2-8040/8060/8080	0.2	75	8	5.17
HF123	MDS-R-V1-20 MDS-R-V2-2020/4020	0	11.9	5.77	2.36
HF223	MDS-R-V1-40 MDS-R-V2-4020/4040	0	23.7	5.66	1.95
	MDS-R-V2-6040/8040	0.2	23.7	3.84	2.88
HF303	MDS-R-V1-60 MDS-R-V2-6040/6060/8060	0.2	75	10.37	3.97
HF142	MDS-R-V1-20 MDS-R-V2-2020/4020	0	17.8	6.09	1.99
HF302	MDS-R-V1-40 MDS-R-V2-4020/4040	0	75	19.45	2.1
	MDS-R-V2-6040/8040	0.2	75	12.11	3.38

4. Dedicated Options

4-1 Regenerative option

For the regenerative option, always select a regenerative resistor unit or regenerative resistor in the correct combination for each servo drive unit. Refer to "Appendix 2-2 Selecting the regenerative resistor" for details on selecting the regenerative option.
The regenerative resistor generates heats, so wire and install the unit while taking care to safety. When using the regenerative resistor, make sure that flammable matters, such as cables, do not contact the resistor, and provide a cover on the machine so that dust or oil does not accumulate on the resistor and ignite.

List of regenerative option correspondence

Regenerative resistor type (Japan Resistor)	GZG80 W26 OHMJ	GZG200 W26 OHMJ	GZG300 W20 OHMJ	GZG400 W13 OHMJ	GZG400 W8 OHMJ	GZG200 W120 OHMJ 3 units connected in parallel	GZG200 W39 OHMJ 3 units connected in parallel	GZG300 W39 OHMJ 3 units connected in parallel	GZG200 W20 OHMJ 3 units connected in parallel	GZG300 W20 OHMJ 3 units connected in parallel	GRZG400-2 OHMJ 4 units connected in serial
Regenerative resistor unit type						MR-RB32	MR-RB30	MR-RB50	MR-RB31	MR-RB51	MR-RB65
Regenerative capacity	40W	100W	150W	200W	200W	300W	300W	500W	300W	500W	800W
Resistance value	26Ω	26Ω	20Ω	13Ω	8Ω	40Ω	13Ω	13Ω	6.7Ω	6.7Ω	8Ω
MDS-R-V1-20	○	○				○					
MDS-R-V1-40	○	○	○	○			○	○			
MDS-R-V1-60	○	○	○		○		○				
MDS-R-V1-80			○		○		○	○			○
MDS-R-V2-2020	○	○				○					
MDS-R-V2-4040			○	○			○	○			
MDS-R-V2-6040					○		○	○			○
MDS-R-V2-6060					○		○	○			○
MDS-R-V2-8040					○		○	○			○
MDS-R-V2-8060					○		Δ	Δ	○	○	○
MDS-R-V2-8080					○		Δ	Δ	○	○	○

Note: Types indicated with a Δ cannot be used when driving the HF353 motor.

Manufacturer: Japan Resistor

No.	Abbrev.	Parameter name	Explanation
SV036	PTYP*	Regenerative resistor type	(see below)

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

bit		Explanation
8, 9, A, B	rtyp	Select the regenerative resistor type.

Setting	Regenerative resistor or regenerative resistor unit
0 to 1	Setting prohibited
2	GZG200W26OHMJ
3	GZG300W20OHMJ
4	MR-RB32 or GZG200W1200HMJ 3 units connected in parallel
5	MR-RB30 or GZG200W39OHMJ 3 units connected in parallel
6	MR-RB50 or GZG300W39OHMJ 3 units connected in parallel
7	MR-RB31 or GZG200W20OHMJ 3 units connected in parallel
8	MR-RB51 or GZG300W20OHMJ 3 units connected in parallel
9	MR-RB65 or GRZG400-20HMJ 4 units connected in serial
A	GZG80W26OHMJ
B	GZG400W13OHMJ
C	GZG400W8OHMJ
D to F	Setting prohibited

⚠ **CAUTION**

1. Only the designated combination can be used for the regenerative option and servo drive unit.
   There is a risk of fire, so always use the designated combination.
2. Correct protection will not be attained if the parameter setting is incorrect.
   Check the regenerative resistor type carefully, and set the parameters.

4-1-1 Regenerative resistor unit

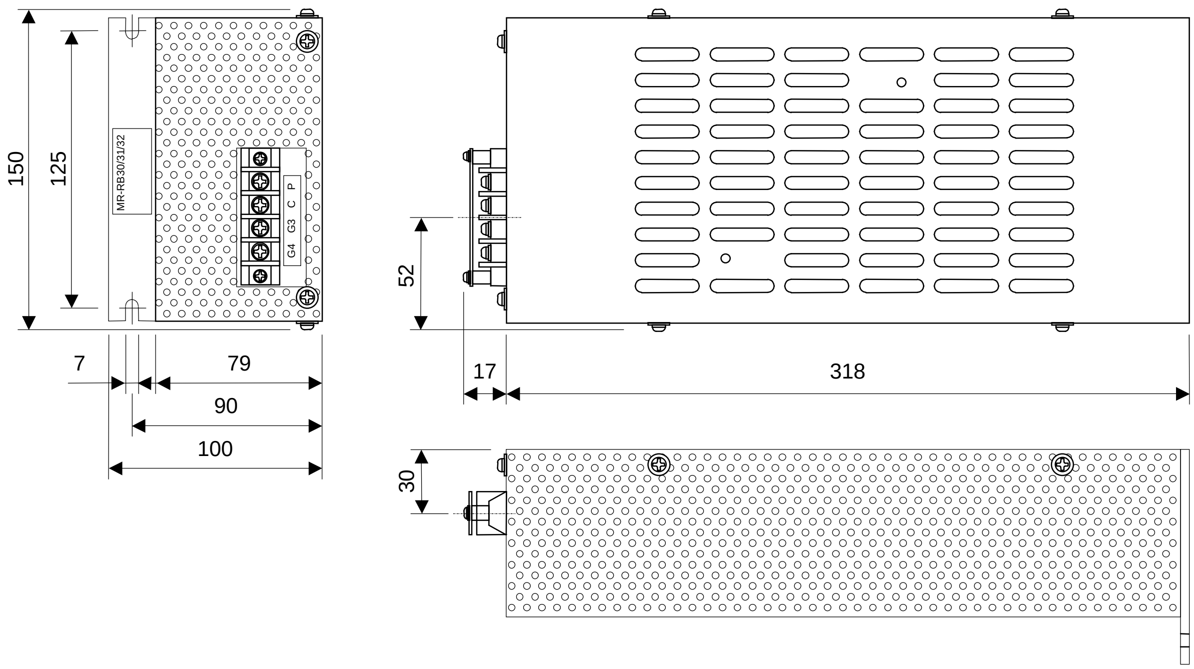
(1) Specifications

Regenerative option type	Regenerative power (W)	Resistance value (Ω)	Mass (kg)
MR-RB30	300	13	2.9
MR-RB31	300	6.7	2.9
MR-RB32	300	40	2.9
MR-RB50	500	13	5.6
MR-RB51	500	6.7	5.6
MR-RB65	800	8	10

(2) Outline dimension drawings

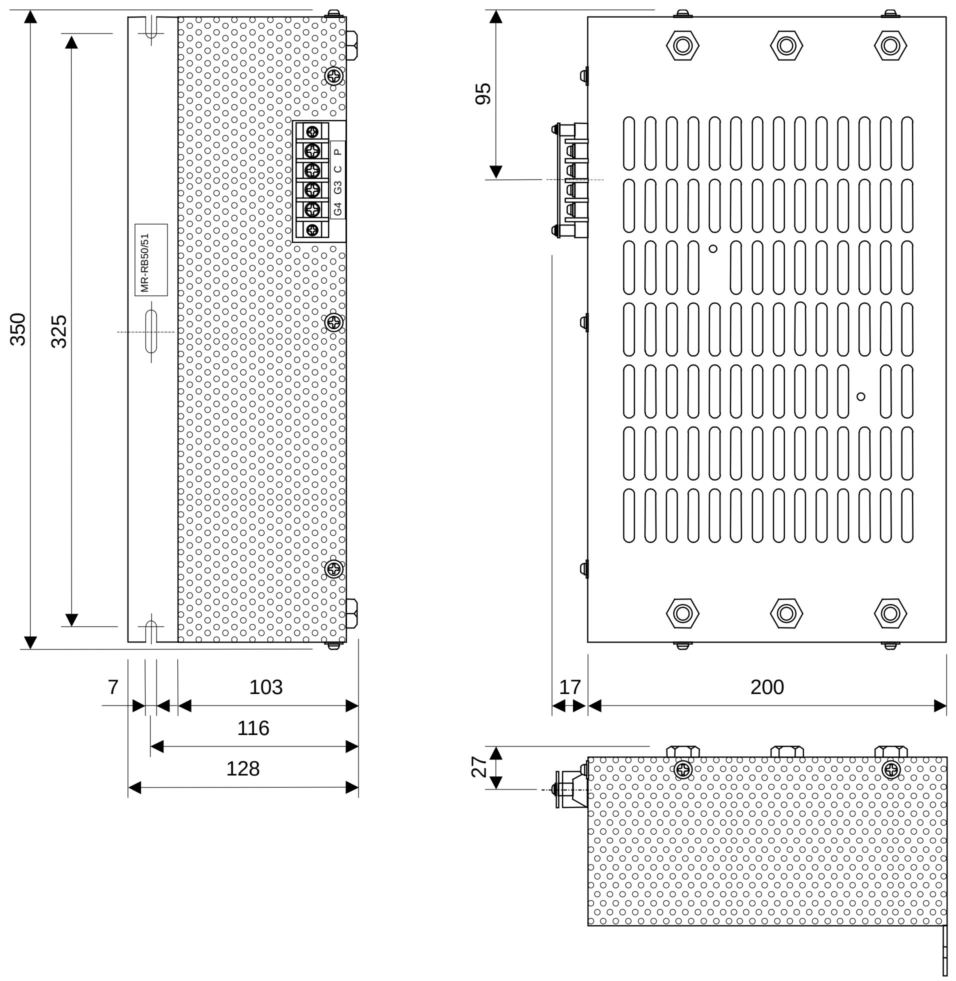
MR-RB30, MR-RB31, MR-RB32

[Unit: mm]



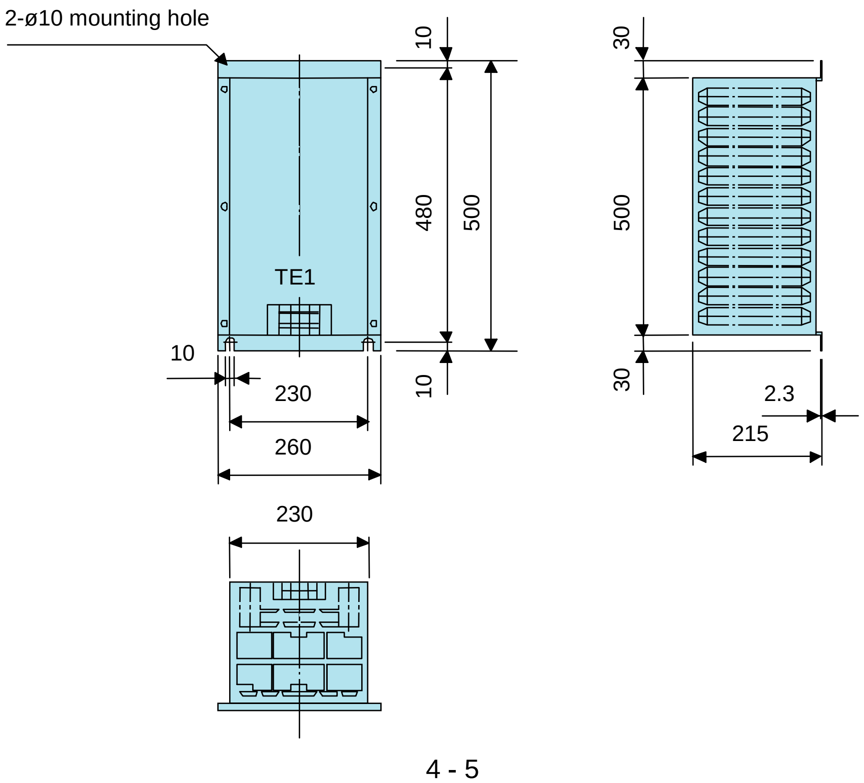
MR-RB50, MR-RB51

[Unit: mm]



MR-RB65

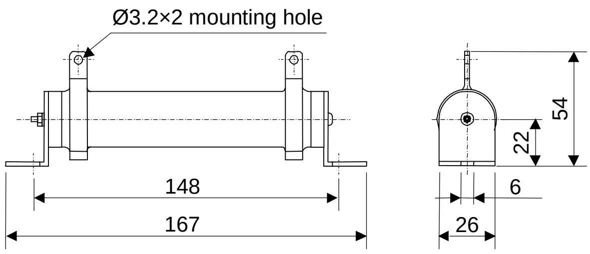
[Unit: mm]



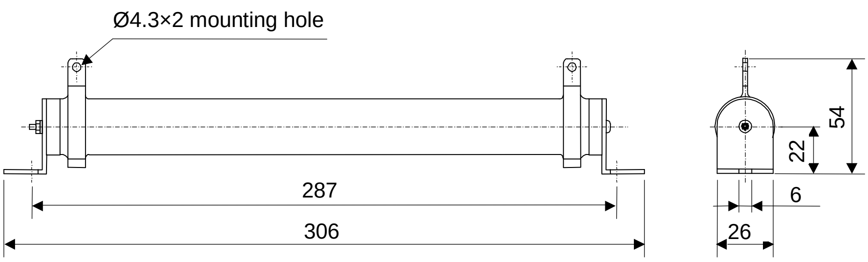
4-1-2 Regenerative resistor

(1) Outline dimension drawings

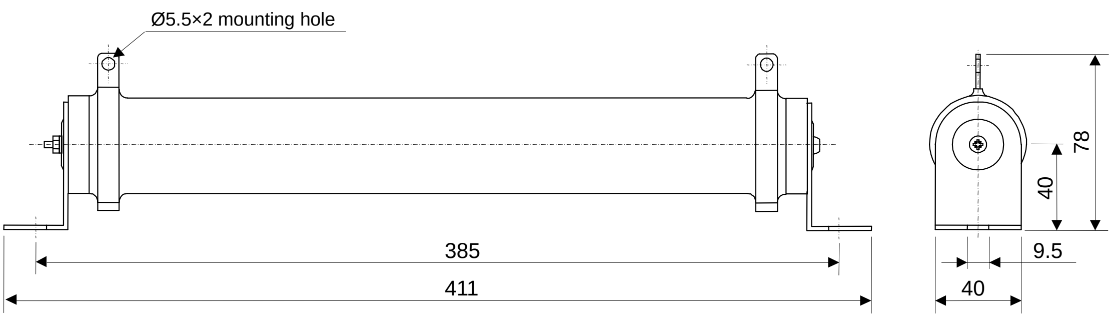
GZG80W26OHMJ [Unit: mm]



GZG200W20OHMJ, GZG200W26OHMJ, GZG200W39OHMJ, GZG200W120OHMJ [Unit: mm]

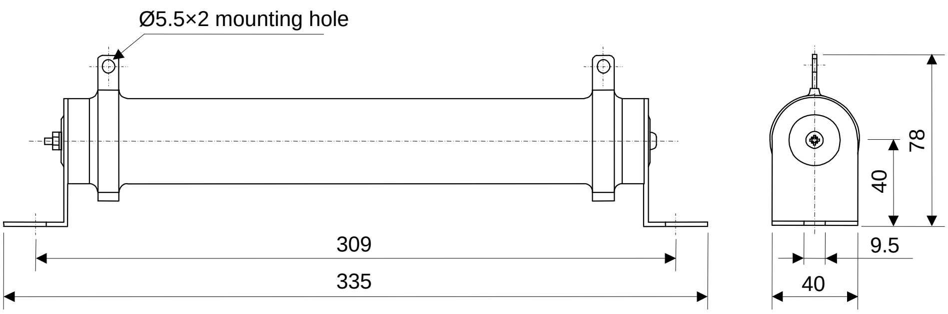


GZG400W13OHMJ, GZG400W8OHMJ [Unit: mm]



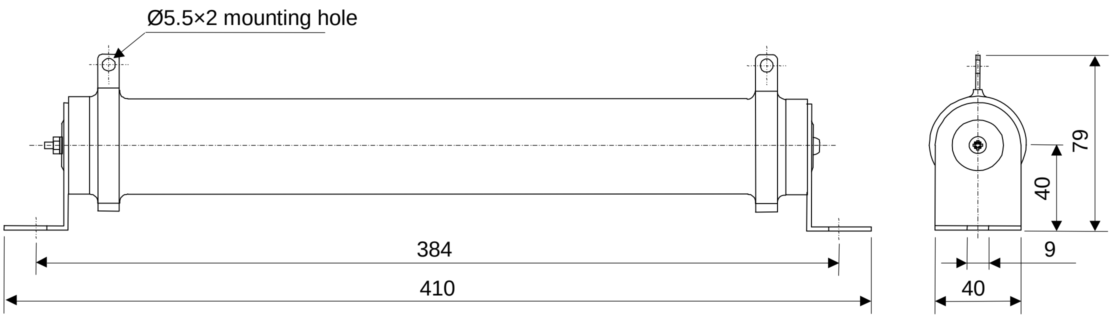
GZG300W20OHMJ, GZG300W39OHMJ

[Unit: mm]



GRZG400-2OHMJ

[Unit: mm]



⚠ **CAUTION**	When using the regenerative resistor, a protective cover must be mounted on the machine side so that flammable matters do not come in contact or adhere on the device.

4-2 Machine side detector

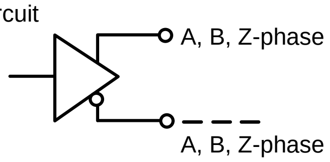
In MDS-R series, the relative position specifications and rectangular wave output linear scale are available.
The machine side detectors are all special order parts, and must be prepared by the user.

Relative position detector

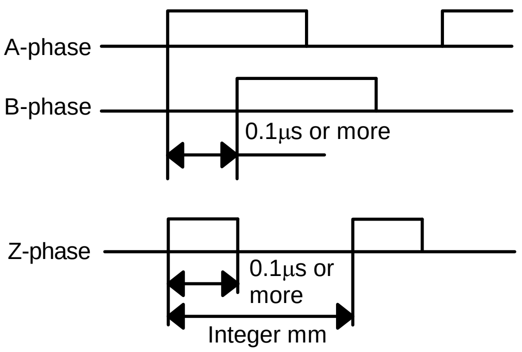
Select a machine side relative position detector that has specifications that are correspond to the following output signal.

Compatible rectangular wave output specifications
Select a relative position detector with an A/B phase difference and Z-phase width at the maximum feedrate that satisfies the following conditions.
Use an A, B, Z-phase signal type with differential output (RS-422 standard product) for the output signal.

Output circuit



Phase difference



For a scale having multiple Z phases, select the neighboring Z phases whose distance is an integral mm.

(Note) The above value is minimum value that can be received normally in the servo drive unit side.
In an actual selection, ensure margin of 20% or more in consideration of degradation of electrical wave and speed overshoot.

<Example of scale specifications >

The example of using representative oblong save scale is shown below.
For specifications of each conversion unit and scale and for purchase, contact each corresponding manufacture directly.

Scale Type	Combination conversion unit	Manufacturer	Minimum resolution	Maximum speed
SR33	CN33	SONY	1μm	150m/min
			0.5μm	120m/min
			0.1μm	24m/min
			0.05μm	12m/min
LS186/LS486	IBV610	HEIDENHAIN	1μm	120m/min
			0.5μm	120m/min
	IBV650		0.1μm	48m/min
	IBV660B		0.1μm	60m/min
			0.05μm	30m/min

4-3 Battery and terminator option

A battery unit must be used with the absolute position system. A battery unit or terminator must be connected on each NC communication bus line. Select the unit according to the system specifications.

- Incremental system
  (a) Terminator (A-TM)
- Absolute position system
  (b) Battery (ER6) + terminator (A-TM)
  (c) Battery unit (MDS-A-BT)

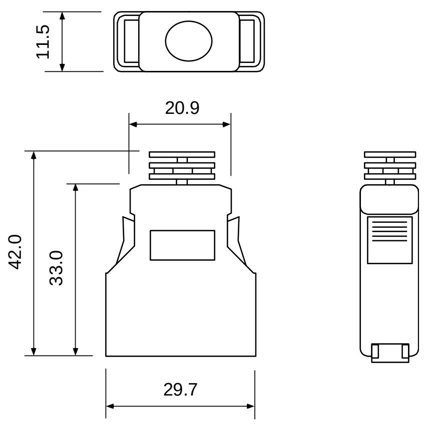
4-3-1 Terminator (A-TM)

Always connect the terminator to the last unit connected to the NC communication bus line. If there are many axes and two NC communication bus line channels are in use, connect a terminator per each channel.

(1) Outline dimension drawing

- **A-TM**

[Unit: mm]



4-3-2 Battery (ER6)

This battery is built into the servo drive unit. One battery is provided for each absolute position control axis' servo drive unit.

(1) Specifications

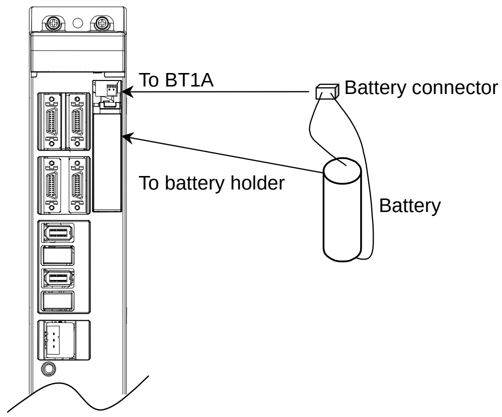
Battery unit specifications

Type	ER6
Nominal voltage	3.6V
Nominal capacity	2000mAh
Battery continuous backup time	Approx. 6,000 hours
Battery useful life	4 years from date of unit manufacture
Data save time during battery replacement	Approx. 20 hours at time of delivery, Approx. 10 hours after 5 years
Back up time from battery warning (9F) to alarm occurrence	Approx. 100 hours
Number of backup axes	2 axes

(2) Mounting

Mount the battery into the servo drive unit with the following procedure.

(a) Remove the battery holder's cover.
(b) Mount the battery into the battery holder.
(c) Securely insert the battery connector into BT1A.
(d) Mount the battery holder's cover.



⚠ CAUTION

1. To protect the absolute position, do not shut off the servo drive unit control power supply if the battery voltage becomes low (warning 9F).
2. The battery life will be greatly affected by the ambient temperature. The above data is the theoretical value for when the battery is used at an ambient temperature of 25°C. If the ambient temperature rises, generally the backup time and useful life will be shorter.
3. The circuits in the servo drive unit could be damaged by static electricity. Always observe the following matters.
   (a) Ground the worker and work table.
   (b) Do not directly touch the conductive sections such as the connector pins or electric parts.

4-3-3 Battery unit (MDS-A-BT)

This battery is installed outside the servo drive unit. This battery unit backs up the absolute position data of the multiple servo axes connected to each NC bus line. This battery unit also functions as a terminator.

(1) Specifications

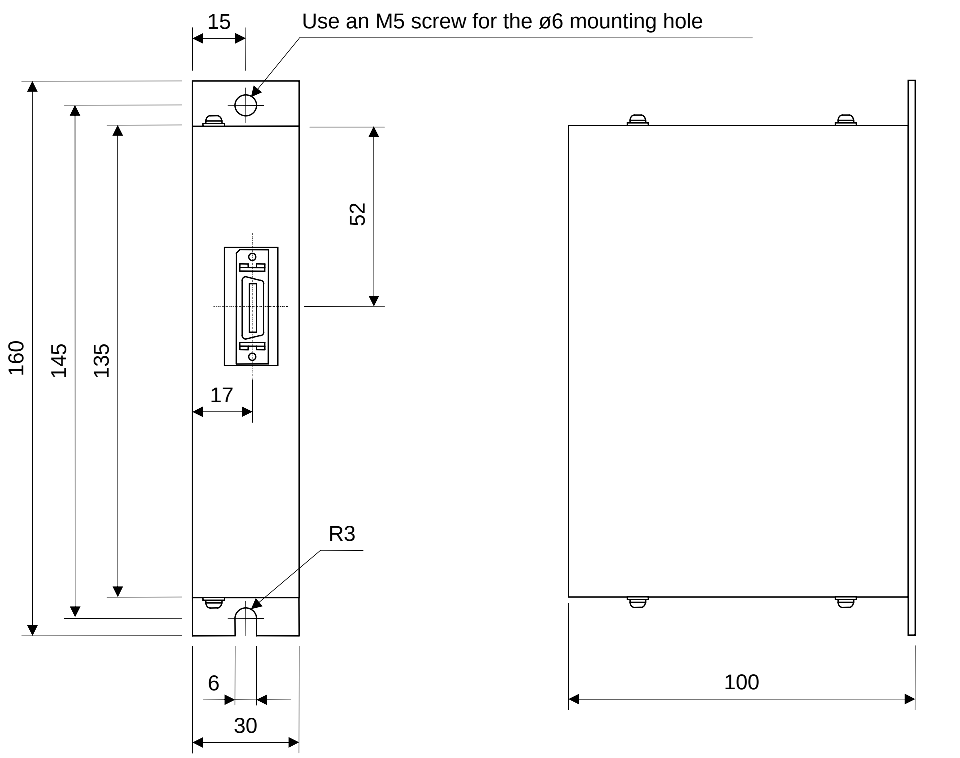
Battery unit specifications

Type	MDS-A-BT-2	MDS-A-BT-4	MDS-A-BT-6	MDS-A-BT-8
Nominal voltage	3.6V			
Nominal capacity	4000mAh	8000mAh	12000mAh	16000mAh
Battery continuous backup time	Approx. 12,000 hours			
Battery useful life	7 years from date of unit manufacture			
Data save time during battery replacement	20 hours at time of delivery, 10 hours after 5 years			
Back up time from battery warning (9F) to alarm occurrence	Approx. 100 hours			
Number of backup axes	2 axes	4 axes	6 axes	7 axes

(2) Outline dimension drawings

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

[Unit: mm]



⚠ CAUTION	1. To protect the absolute position, do not shut off the servo drive unit control power supply if the battery voltage becomes low (warning 9F). 2. The battery life will be greatly affected by the ambient temperature. The above data is the theoretical value for when the battery is used at an ambient temperature of 25°C. If the ambient temperature rises, generally the backup time and useful life will be shorter.

4-4 Relay terminal block (MR-J2CN3TM)

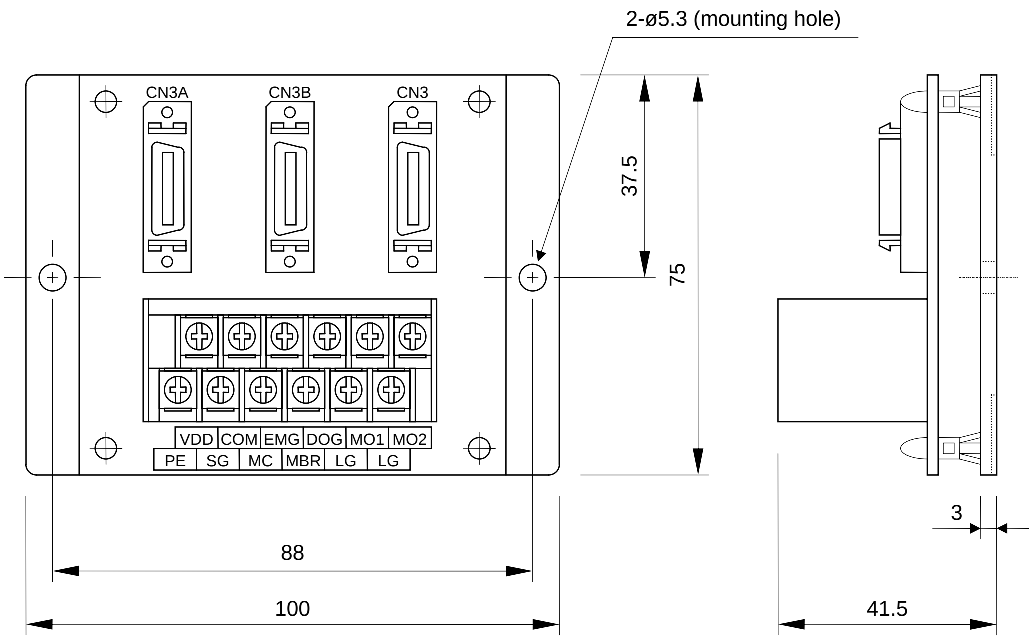
Signals input/output from the CN9 connector on the front of the servo drive unit can be led to the terminal block. Connect the terminal block to the CN9 connector with an SH21 cable.

Abbrev.	Name	Explanation
CN3A	Connector 3 input/output A	Connect from the CN3 connector with an SH21 cable. Common for any connector, so each signal will pass through. When the CN3 control signal is being used, each signal can be output from the relay terminal block by relaying through these connectors.
CN3B	Connector 3 input/output B	
CN3C	Connector 3 input/output C	
VDD	Internal power supply output	This is the 24V power supply output in the drive unit. When using an internal power supply, use relayed once through the COM terminal.
COM	Common power supply	Connect VDD when using the drive unit internal power supply. Connect the + side of the external power supply when using an external power supply.
EMG	External emergency stop input	This is the input terminal for external emergency stops.
DOG	DI contactor B contact	This is not used with the MDS-R.
MO1	Monitor output 1	D/A output ch.1 used to measure the voltage across M01 and LG.
MO2	Monitor output 2	D/A output ch.2 used to measure the voltage across M02 and LG.
PE	Plate ground	This has the same potential as the drive unit FG or cable shield.
SG	24V power supply ground	This is the ground when using digital input/output.
MC	Contactor control output	This is the output terminal for contactor control.
MBR	Motor brake control output	This is the output terminal for motor brake control.
LG	5V power supply ground	This is the ground when using D/A output.

(1) Outline dimension drawings

- **MR-J2CN3TM**

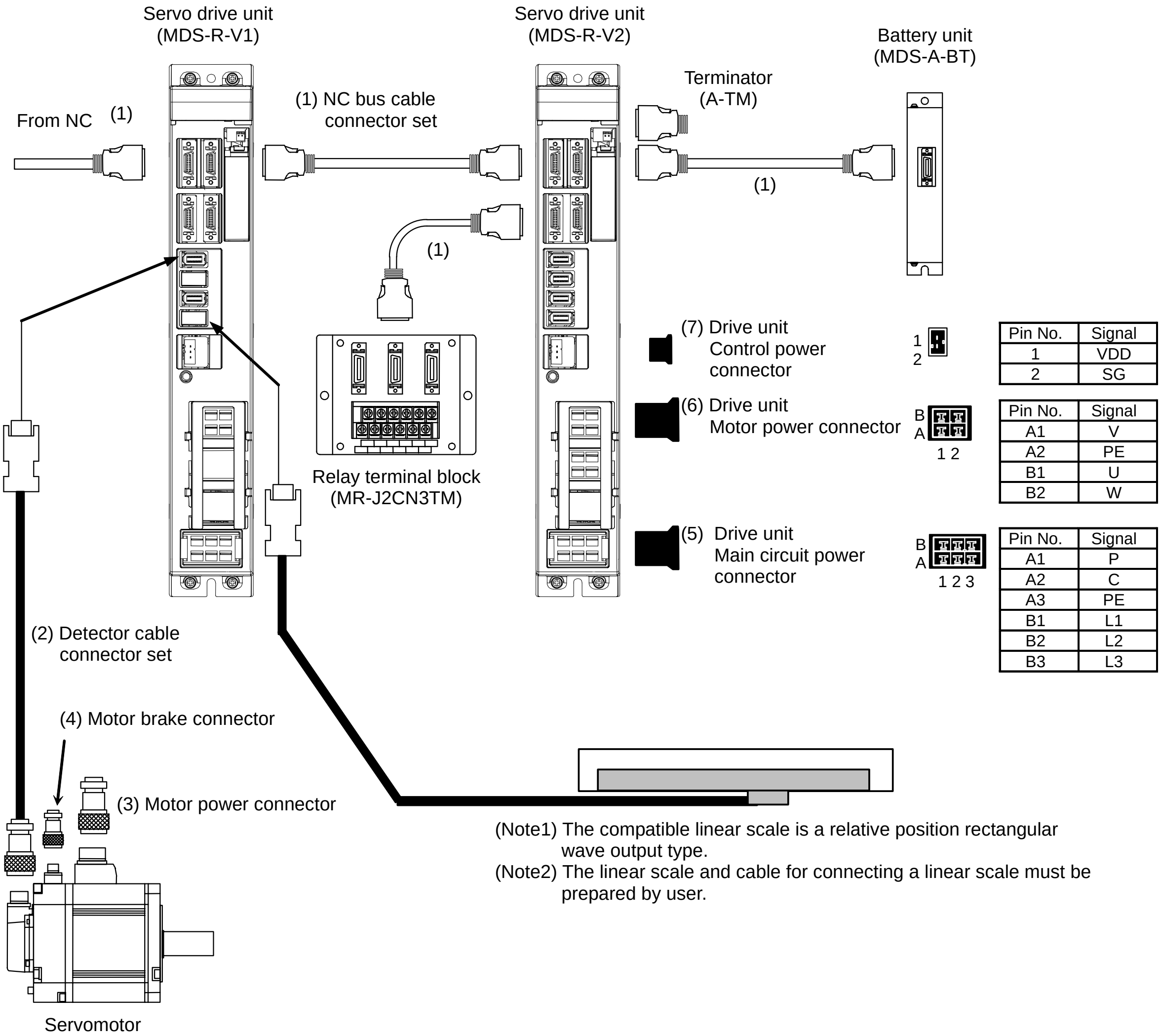
[Unit: mm]



4-5 Cables and connectors

4-5-1 Cable connection diagram

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.



Pin No.	Signal
1	VDD
2	SG

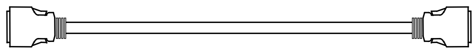
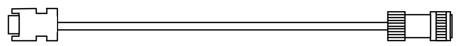
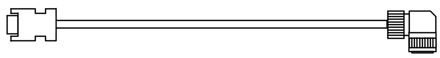
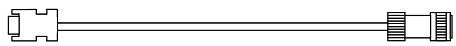
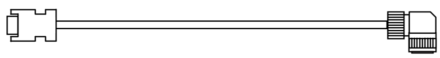
Pin No.	Signal
A1	V
A2	PE
B1	U
B2	W

Pin No.	Signal
A1	P
A2	C
A3	PE
B1	L1
B2	L2
B3	L3

(Note1) The compatible linear scale is a relative position rectangular wave output type.
(Note2) The linear scale and cable for connecting a linear scale must be prepared by user.

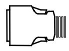
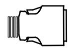
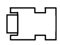
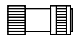
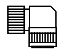
4-5-2 Cable and connector options

(1) Cables

Item				Model	Contents
For CN1A, CN1B	(1) NC bus cable			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, 30 m	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 
For CN2L CN2M	(2) Detector cable for HF□-A51	IP67	Straight	CNV2E-6P-□M □indicates length (m) 2, 3, 4, 5, 7, 10, 15,20,25,30	Servo drive unit side connector (3M) Receptacle：36210-0100PL Shell kit：36310-3200-008 (Molex) Connector set：54599-1019 Servomotor detector side connector (DDK) Plug : CM10-SP10S-M Contact：CM10-#22SC 
			Angle	CNV2E-7P-□M □indicates length (m) 2, 3, 4, 5, 7, 10, 15,20,25,30	Servo drive unit side connector (3M) Receptacle：36210-0100PL Shell kit：36310-3200-008 (Molex) Connector set：54599-1019 Servomotor detector side connector (DDK) Plug : CM10-AP10S-M Contact：CM10-#22SC 
For CN2L CN2M	(2) Detector cable for HF□-A48/A51	IP67	Straight	CNV2E-8P-□M □indicates length (m) 2, 3, 4, 5, 7, 10, 15,20,25,30	Servo drive unit side connector (3M) Receptacle：36210-0100PL Shell kit：36310-3200-008 (Molex) Connector set：54599-1019 Servomotor detector side connector (DDK) Plug : CM10-SP10S-M Contact：CM10-#22SC 
			Angle	CNV2E-9P-□M □indicates length (m) 2, 3, 4, 5, 7, 10, 15,20,25,30	Servo drive unit side connector (3M) Receptacle：36210-0100PL Shell kit：36310-3200-008 (Molex) Connector set：54599-1019 Servomotor detector side connector (DDK) Plug : CM10-AP10S-M Contact：CM10-#22SC 

(Note) The connector manufacturer is subject to change without notice.

(2) Connector sets

<table>
<tr><th colspan="4">Item</th><th>Model</th><th>Contents</th></tr>
<tr><td>For
CN1A,
CN1B,
CN9</td><td colspan="3">(1) NC bus cable connector set</td><td>FCUA-CS000</td><td>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
</td></tr>
<tr><td rowspan="3">For
CN2L
CN2M</td><td colspan="3">(2) Servo detector connector</td><td>CNU2S(AWG18)</td><td>Servo drive unit side connector (3M)
Receptacle：36210-0100PL
Shell kit：36310-3200-008
(Molex)
Connector set：54599-1019
</td></tr>
<tr><td>(2) Motor side detector connector for HF motor</td><td>IP67 compatible</td><td>Straight</td><td>CNE10-R10S(9)
Applicable cable outline
φ6.0～φ9.0mm</td><td>Servomotor detector side connector
(DDK)
Plug : CM10-SP10S-M
Contact：CM10-#22SC
</td></tr>
<tr><td>(2) Motor side detector connector for HF motor</td><td>IP67 compatible</td><td>Angle</td><td>CNE10-R10L(9)
Applicable cable outline
φ6.0～φ9.0mm</td><td>Servomotor detector side connector
(DDK)
Plug : CM10-AP10S-M
Contact：CM10-#22SC
</td></tr>
</table>

(Note) The connector manufacturer is subject to change without notice.

Item		Model	Contents
For CN30	(5) Main circuit power supply connector for MDS-R-V1/V2	RCN30S For AWG14, 16	Drive unit main circuit power supply connector (DDK) Contact : DK-5200S-04R Housing: DK-5RECSLP1-100 
		RCN30M For AWG10, 12	Drive unit motor power supply connector (DDK) Contact : DK-5200M-06R Housing: DK-5RECMLP1-100 
For CN31L, CN31M	(6) Motor power connector for MDS-R-V1/V2	RCN31S For AWG14, 16	Drive unit motor power supply connector (DDK) Contact : DK-5200M-04R Housing: DK-RECSLP1-100 
		RCN31M For AWG10, 12	Drive unit motor power supply connector (DDK) Contact : DK-5200M-04R Housing: DK-5RECMLP1-100 
For CN22	(7) Control power connector common for MDS-R-V1, V2	RCN22	Drive unit control power supply connector (DDK) Contact : DK-3200S-02R Housing: DK-3REC2LLP1-100 

(Note) The connector manufacturer is subject to change without notice.

5. Peripheral Devices

5-1 Selecting the wire size

5-1-1 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		Power input CN30 (L1, L2, L3, ⏚)		Regenerative option CN30 (P, C)		Motor output CN31L、CN31M (LU, LV, LW, ⏚) (MU, MV, MW, ⏚)		Control power (24VDC) CN22 Magnetic brake CN9	
		mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG
Servo drive unit	MDS-R-V1-20	2	14	2	14	2	14	2	14
	MDS-R-V1-40	2	14			2	14		
	MDS-R-V1-60	2	14			3.5	12		
	MDS-R-V1-80	3.5	12			3.5	12		
Servo drive unit (2-axis)	MDS-R-V2-2020	2	14	2	14	2	14	2	14
	MDS-R-V2-4020	2	14			2	14		
	MDS-R-V2-4040	2	14			2	14		
	MDS-R-V2-6040	3.5	12			3.5	12		
	MDS-R-V2-6060	3.5	12			3.5	12		
	MDS-R-V2-8040	3.5	12			3.5	12		
	MDS-R-V2-8060	5.5	10			3.5	12		
	MDS-R-V2-8080	5.5	10			3.5	12		

(2) 600V double (heat proof) vinyl insulated wire (HIV wire) 75 ^{o}C product (Example according to IEC/EN60204-1, UL508C)

Terminal name / Unit type		Power input CN30 (L1, L2, L3, ⏚)		Regenerative option CN30 (P, C)		Motor output CN31L、CN31M (LU, LV, LW, ⏚) (MU, MV, MW, ⏚)		Control power (24VDC) CN22 Magnetic brake CN9	
		mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG
Servo drive unit	MDS-R-V1-20	2	14	2	14	2	14	2	14
	MDS-R-V1-40	2	14			2	14		
	MDS-R-V1-60	2	14			3.5	12		
	MDS-R-V1-80	3.5	12			3.5	12		
Servo drive unit (2-axis)	MDS-R-V2-2020	2	14	2	14	2	14	2	14
	MDS-R-V2-4020	2	14			2	14		
	MDS-R-V2-4040	2	14			2	14		
	MDS-R-V2-6040	3.5	12			3.5	12		
	MDS-R-V2-6060	3.5	12			3.5	12		
	MDS-R-V2-8040	3.5	12			3.5	12		
	MDS-R-V2-8060	5.5	10			3.5	12		
	MDS-R-V2-8080	5.5	10			3.5	12		

(3) 600V bridge polyethylene insulated wire (IC) 105°C product (Example according to JEAC8001)

Unit type \ Terminal name		Power input CN30 (L1, L2, L3, ⏚)		Regenerative option CN30 (P, C)		Motor output CN31L、CN31M (LU, LV, LW, ⏚) (MU, MV, MW, ⏚)		Control power (24VDC) CN22 Magnetic brake CN9	
		mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG
Servo drive unit	MDS-R-V1-20	2	14	2	14	2	14	1.25 to 2	14 to 16
	MDS-R-V1-40	2	14			2	14		
	MDS-R-V1-60	2	14			2	14		
	MDS-R-V1-80	2	14			2	14		
Servo drive unit (2-axis)	MDS-R-V2-2020	2	14	2	14	2	14	1.25 to 2	14 to 16
	MDS-R-V2-4020	2	14			2	14		
	MDS-R-V2-4040	2	14			2	14		
	MDS-R-V2-6040	2	14			2	14		
	MDS-R-V2-6060	2	14			2	14		
	MDS-R-V2-8040	2	14			2	14		
	MDS-R-V2-8060	3.5	12			2	14		
	MDS-R-V2-8080	3.5	12			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. Twist the wire for the regenerative option connection wire.
4. Always wire the grounding wire.

5-2 Selection of circuit protector and contactor

Always select the circuit protector and contactor properly, and install them to each power supply unit to prevent disasters.

5-2-1 Selection of circuit protector

Select the circuit protector as in the expression below.

Unit type MDS-R-	V1-20	V1-40	V1-60	V1-80
Recommended breaker (Mitsubishi Electric Corp.: option part)	NF30-CS3P-15A	NF30-CS3P-20A	NF30-CS3P-30A	NF50-CW3P-40A
Rated current of the recommended breaker	15A	20A	30A	40A

Unit type MDS-R-	V2-2020	V2-4020	V2-4040	V2-6040	V2-6060	V2-8040	V2-8060	V2-8080
Recommended breaker (Mitsubishi Electric Corp.: option part)	NF30-CS3P-20A	NF30-CS3P-30A	NF30-CS3P-30A	NF30-CS3P-30A	NF50-CW3P-40A	NF50-CW3P-40A	NF50-CW3P-40A	NF50-CW3P-40A
Rated current of the recommended breaker	20A	30A	30A	30A	40A	40A	40A	40A

Option part: A breaker is not prepared as an NC unit accessory, so purchase the part from your dealer, etc.

⚠ CAUTION

1. If a circuit protector is shared by several drive units, the circuit protector may not activate when a short-circuit fault occurs in a small capacity drive unit. This is dangerous, so never share the circuit protector by several drive units. Always install the circuit protector for each drive unit.
2. If the control power (CN22) must be protected, select according to the section "5-4 Selection of control power supply".

5-2-2 Selection of contactor

Select the contactor as in the expression below.

Unit type MDS-R-	V1-20	V1-40	V1-60	V1-80
Recommended contactor (Mitsubishi Electric Corp.: option part)	S-N12 -AC200V	S-N18 -AC200V	S-N20 -AC200V	S-N25 -AC200V
Free-air thermal current of the recommended contactor	20A	25A	32A	50A

Unit type MDS-R-	V2-2020	V2-4020	V2-4040	V2-6040	V2-6060	V2-8040	V2-8060	V2-8080
Recommended contactor (Mitsubishi Electric Corp.: option part)	S-N18 -AC200V	S-N20 -AC200V	S-N20 -AC200V	S-N20 -AC200V	S-N25 -AC200V	S-N25 -AC200V	S-N25 -AC200V	S-N25 -AC200V
Free-air thermal current of the recommended contactor	25A	32A	32A	32A	50A	50A	50A	50A

Option part: A breaker is not prepared as an NC unit accessory, so purchase the part from your dealer, etc.

POINT

1. Use an alternating contactor.
2. Select a contactor whose excitation coil does not operate at 15mA or less.

5-3 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 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 drive unit

Drive unit	Earth leakage current	Maximum earth leakage current
MDS-R-V1-20 to 80	1mA	2mA
MDS-R-V2-2020 to 8080	1mA	4mA (for two axes)

(Note1) Maximum earth leakage current: Value that considers wiring length and grounding, etc.
(Commercial frequency 50/60Hz)

(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

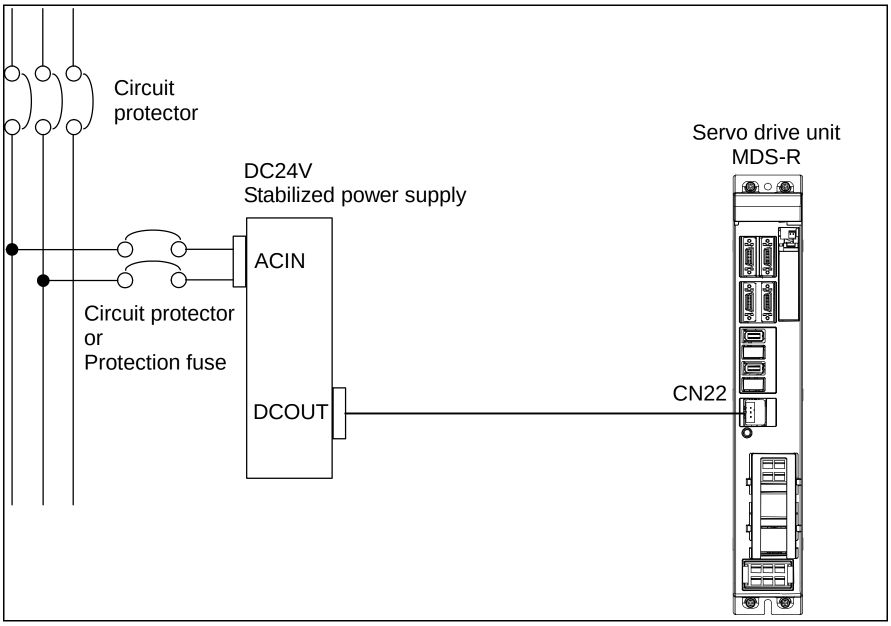
1. The earth leakage current tends to increase as the motor capacity increases.
2. A higher frequency earth leakage current will always be generated because the inverter circuit in the drive unit switches the transistor at high speed. Always ground to reduce the higher frequency earth leakage current 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.
4. For safety, ground the machine with Class C (former class 3) grounding.

5-4 Selection of control power supply

For the control power supply of MDS-R Series, choose the stabilized power supply that satisfies the specifications below.

(1) Power supply specification

	External power supply unit
Output voltage	24VDC ±10%
Ripple	200mV max.
Output current	Select the external power supply unit that satisfies the current or rush current specification of the drive unit control power supply specification. If the power supply is supplied to multiple drive units, select a product that satisfies the total of the drive units.



⚠ **CAUTION**	1. Do not damage, apply excessive stress, place heavy things on or sandwich the cables, as this may lead to electric shocks. 2. Separate the signal wire from the drive line/power line when wiring. 3. Do not connect or disconnect the connection cables between each unit while the power is ON.

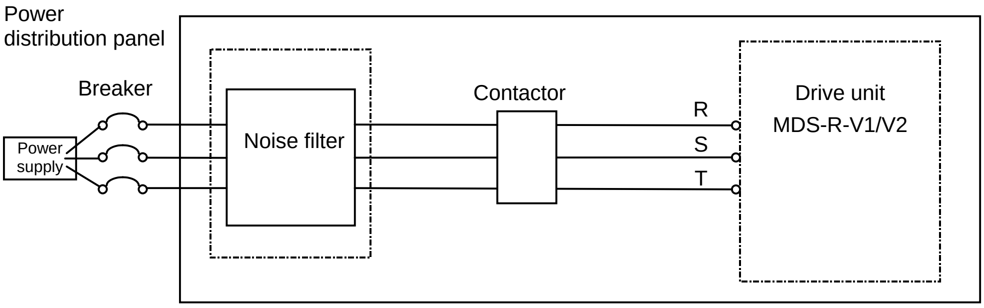
5-5 Noise filter

(1) Selection

Use an EMC noise filter if the noise conducted to the power line must be reduced. Select an EMC noise filter taking the drive unit's input rated voltage and input rated current into consideration.

(2) Noise filter mounting position

Install the noise filter to the drive unit’s power input as the diagram below indicates.



(Note) The noise filter must be prepared by the user.

Recommended devices:	Densei-lambda	MX13 Series
	Soshin Electric	HF3000C-TM Series

Contact:	Densei-lambda Co., Ltd.	TEL0120-507039 http://www.densei-lambda.com
	Soshin Electric Co., Ltd.	TEL03-3775-9112(+81-3-3775-9112) http://www.soshin.co.jp

(Note) The above devices may be changed at the manufacturer's discretion.
Contact each manufacturer for more information.

5-6 Surge absorber

When controlling a magnetic brake of a servomotor in DC OFF circuit, a surge absorber must be installed to protect the relay contacts and brakes. Commonly a varistor is used.

(1) Selection of varistor

When a varistor is installed in parallel with the coil, the surge voltage can be adsorbed as heat to protect a circuit. Commonly a 120V product is applied. When the brake operation time is delayed, use a 220V product. Always confirm the operation with an actual machine.

(2) Specifications

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.

Varistor specifications

Varistor type	Varistor voltage rating (range)	Rating							Max. limit voltage	Electrostatic capacity (reference value)
		Tolerable circuit voltage		Surge current withstand level (A)		Energy withstand level (J)		Power		
	(V)	AC (V)	DC (V)	1 time	2 times	10/1000 μ s	2ms	(W)	(V)	(pF)
ERZV10D121 TNR10V121K	120 (108 to 132)	75	100	3500	2500	20	14.5	0.4	200	1400
ERZV10D221 TNR10V221K	220 (198 to 242)	140	180	3500	2500	39	27.5	0.4	360	410

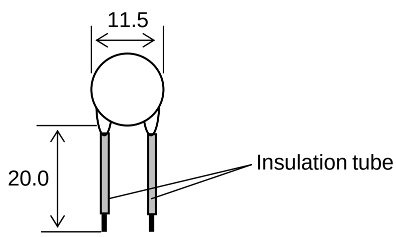
(Note 1) Selection condition: When ON/OFF frequency is 10 times/min or less, and exciting current is 2A or less

(Note 2) ERZV10D121 and ERZV10D221 are manufactured by Matsushita Electric Industrial Co., Ltd.
TNR10V121K and TNR10V221K are manufactured by MARCON Electronics Co., Ltd.
Contact: Matsushita Electronic Components Co., Ltd : http://www.panasonic.co.jp/ maco/
MARCON Electronics Co., Ltd. :Telephone (Kanto)03-3471-7041 (+81-3-3471-7041)
(Kinki) 06-6364-2381 (+81-3-6364-2381)
(Chubu) 052-581-2595 (+81-52-581-2595)

(3) Outline dimension drawing

- ERZV10D121, ERZV10D221

Unit: [mm]



POINT

Normally use a product with 120V varistor voltage. If there is no allowance for the brake operation time, use the 220V product. A varistor whose voltage exceeds 220V cannot be used, as such varistor will exceed the specifications of the relay in the unit.

5-7 Relay

Use the following relays for the input/output interface (contactor control signal or motor break control signal: CN9).

Interface name	Selection example
For digital input signal (CN9)	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> OMRON: G6B type, MY type

6. Installation

6-1 Installing the servomotor

⚠ CAUTION	1. Do not hold the cables, shaft or detector when transporting the motor. Failure to observe this could result in breakage and injury. 2. Securely fix the motor onto the machine. Improper fixing could cause the motor to dislocate and result in injury. 3. Do not apply impact, such as by tapping with a hammer, when connecting the coupling to the servomotor's shaft end. The detector could break. 4. Never touch the motor's rotating sections during operation. Provide a cover, etc., on the shaft. 5. Do not apply a load exceeding the tolerable load on the servomotor shaft. Failure to observe this could result in shaft breakage and injury. 6. Do not connect or disconnect any connector while the power is ON.

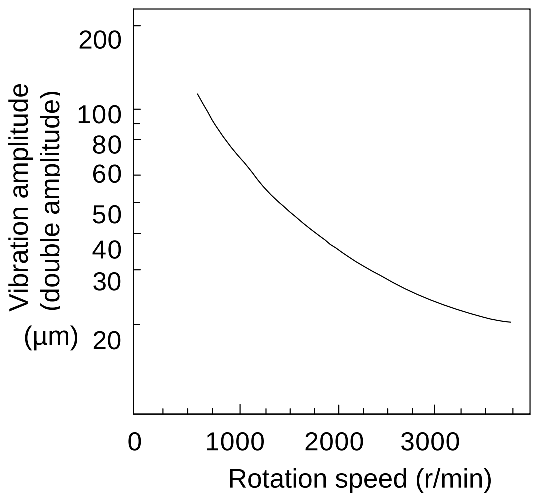
6-1-1 Environmental conditions

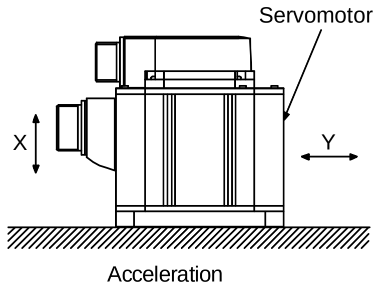
Environment	Conditions
Ambient temperature	0°C to +40°C (with no freezing)
Ambient humidity	80%RH or less (with no dew condensation)
Storage temperature	–15°C to +70°C (with no freezing)
Storage humidity	90%RH or less (with no dew condensation)
Atmosphere	Indoors (Where unit is not subject to direct sunlight) No corrosive gases, inflammable gases, oil mist or dust
Altitude	Operation/storage: 1,000m or less above sea level Transportation: 10,000m or less above sea level

6-1-2 Vibration-resistance strength

Motor type	Acceleration direction	
	Shaft direction (X)	Direction of right angle to the shaft (Y)
HF75, HF105	49m/s2 (5G) or less	49m/s2 (5G) or less
HF54, HF104, HF154, HF224, HF123, HF223, HF142	24.5m/s2 (2.5G) or less	24.5m/s2 (2.5G) or less
HF204, HF354, HF303, HF302	24.5m/s2 (2.5G) or less	49m/s2 (5G) or less

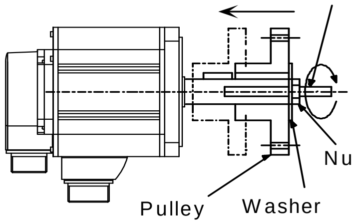
Each vibration condition is as follows.



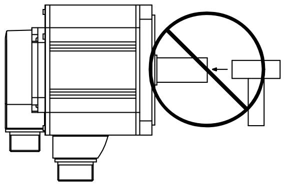


6-1-3 Precautions for mounting load (Preventing impact on shaft)

(1) When using the servomotor with keyway, use the screw hole on the end of the shaft to mount the pulley onto the shaft. When mounting, insert a double-end stud into the shaft's screw hole, and contact a washer against the end of the coupling. Push in so as to tighten with the nut. Use a friction joint for a shaft which does not have a keyway.
(2) When removing the pulley, use a pulley remover, and take care not to apply impact on the shaft.
(3) Provide a protection cover, etc., to ensure safety at the rotating sections, such as the pulley mounted on the shaft.
(4) The direction of the detector mounted on the servomotor cannot be changed.

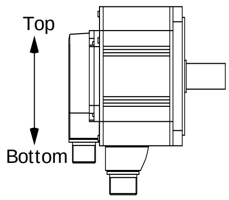


⚠ **CAUTION** Never tap the shaft end with a hammer when assembling, etc.



6-1-4 Installation direction

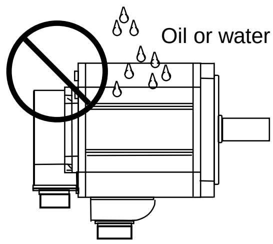
(1) The servomotor can be installed in any direction without limit, but as a standard, the cannon plugs (led out wires) of the motor power supply cable and detector cable should face downward. Installing in the standard direction is effective for drip-proofing. If the servomotor is not to be installed in the standard direction, special caution must be taken for oil and waterproofing. Refer to section "6-2-5 Oil and waterproofing measures" and provide appropriate measures. When installing the servomotor with magnetic brakes with the shaft facing upward, the sound of the brake plates sliding may be heard. This is not an abnormality.



Standard installation direction

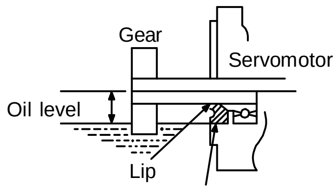
6-1-5 Oil and waterproofing measures

(1) A format based on IEC Standards (IP types) is used as the motor protective format. 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.

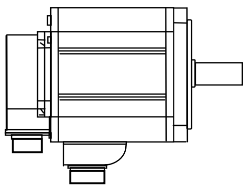


(2) When a gear box is installed on the servomotor, make sure that the oil level height from the center of the shaft is higher than the values given below. Open a breathing hole on the gear box so that the inner pressure does not rise.

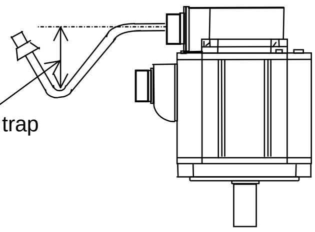
Servomotor	Oil level (mm)
HF75, HF105	15
HF54, HF104, HF154, HF224, HF123, HF223, HF142	22.5
HF204, HF354, HF303, HF302	30



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



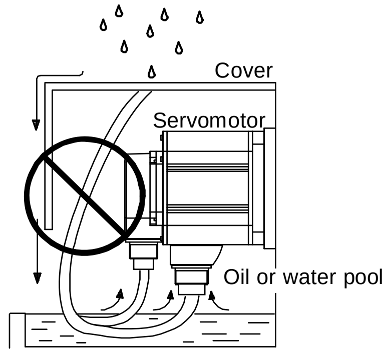
When installed horizontally



When installed vertically

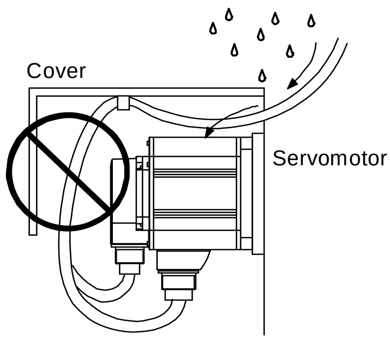
⚠ CAUTION	1. The servomotors, including those having IP67 specifications, do not have a completely waterproof (oil-proof) structure. Do not allow oil or water to constantly contact the motor, enter the motor, or accumulate on the motor. Oil can also enter the motor through cutting chip accumulation,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



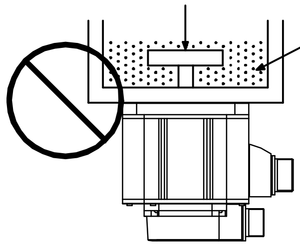
<Fault> Capillary tube Phenomenon

(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.



6-1-6 Cable stress

(1) Carefully 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 section.
(2) 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) When the servomotor is installed on a moving machine, set the bending radius as large as possible.

6-2 Installation of the units

⚠ 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 mass. 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 on 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. 10. Always observe the installation directions. Failure to observe this could lead to faults. 11. Secure the specified distance between the units and panel's inner wall, or between the units and other devices. Failure to observe this could lead to faults.

6-2-1 Environmental conditions

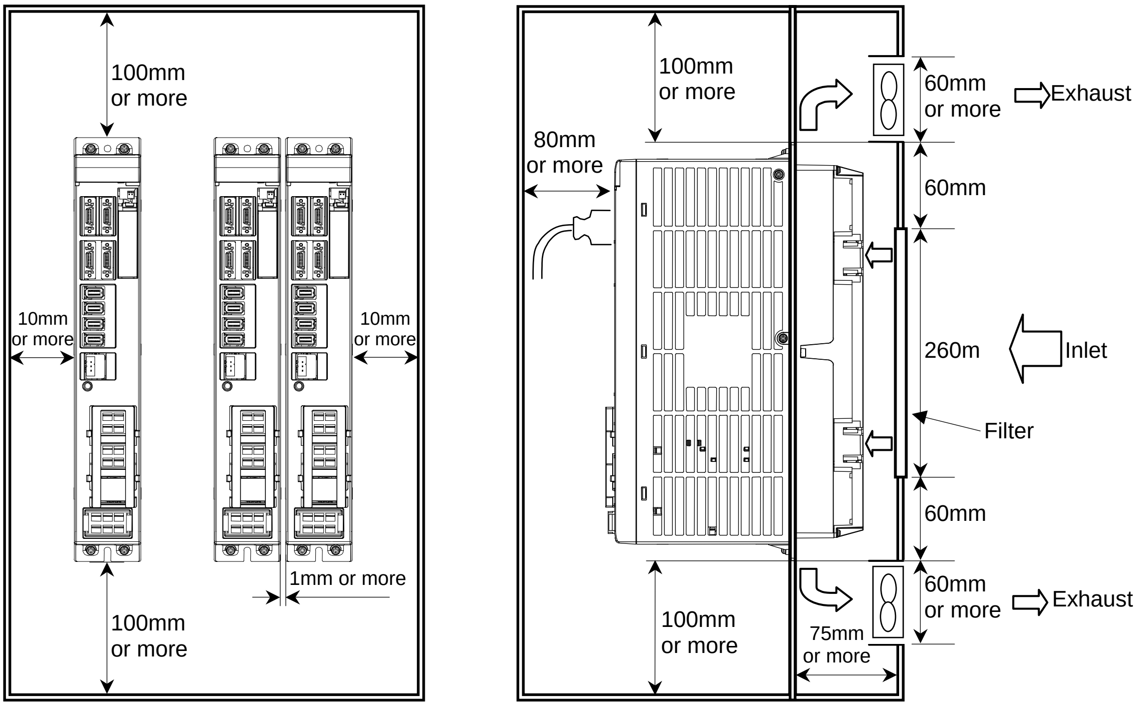
Environment	Conditions
Ambient temperature	0°C to +55°C (with no freezing)
Ambient humidity	90% RH or less (with no dew condensation)
Storage temperature	–15°C to +70°C (with no freezing)
Storage humidity	90% RH or less (with no dew condensation)
Atmosphere	Indoors (Where unit is not subject to direct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

(Note) When installing the machine at 1,000m or more above sea level, the heat dissipation characteristics will drop as the altitude increases. The upper limit of the ambient temperature drops 1°C with every 100m increase in altitude. (The ambient temperature at an altitude of 2,000m is between 0 and +45°C.)

6-2-2 Installation direction and clearance

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

(1) Installation clearance

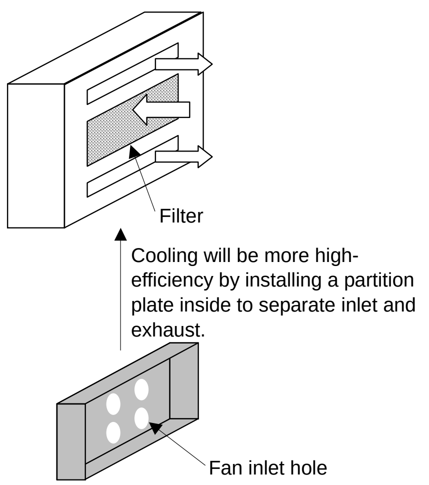


⚠ **CAUTION**	1. The operation ambient temperature for the drive unit is 55ºC or less. 2. Because heat can easily accumulate in the upper portion of the units, give sufficient consideration to heat dissipation when designing the panel. If required, install a fan in the panel to agitate the heat in the upper portion of the units.

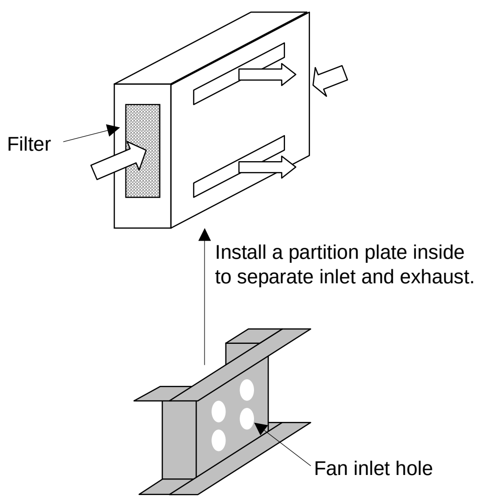
(2) Panel structure of the unit back face

The type "(a)" that has substantial cooling effect is recommended.

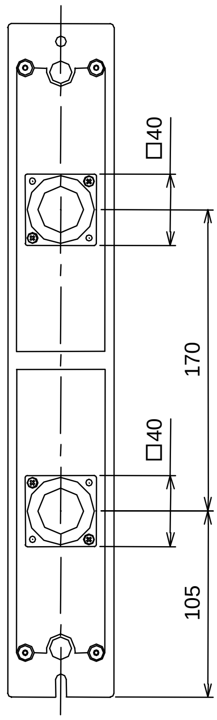
(a) Back face inlet type



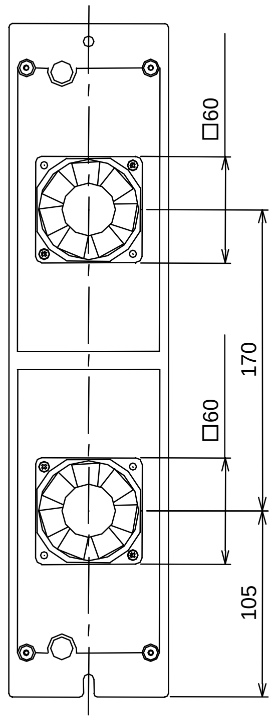
(b) Side face inlet type



(3) Cooling fan position



60mm width
unit



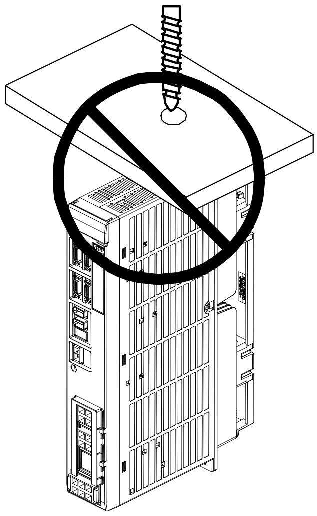
90mm width
unit

⚠ **CAUTION**	1. Design the inlet so that it is the position of the cooling fan. 2. Make the inlet and exhaust size more than the area that is a total of the cooling fan area.

6-2-3 Prevention of foreign matter entry

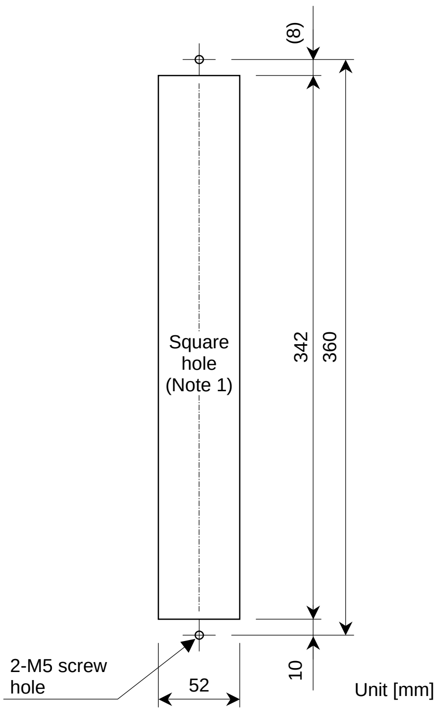
Treat the cabinet with the following items.

- 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 through heat radiating holes, etc.
- Close all clearances of the cabinet.
- 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 packing so that oil does not enter the cabinet from the screw holes.
- After installing each unit, avoid machining in the periphery. If cutting chips, etc., stick onto the electronic parts, trouble may occur.
- When using the unit in an area with toxic gases or high levels of dust, protect the unit with air purging (system to blow clean air so that the panel's inner pressure is higher than the outer pressure).

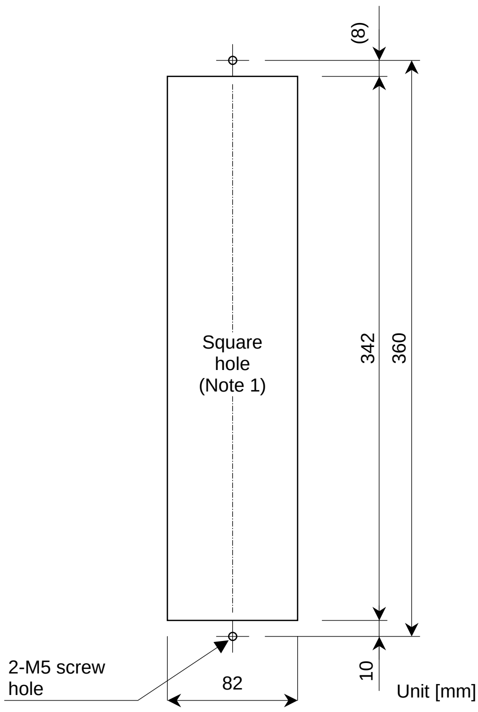


6-2-4 Panel installation hole machining drawings (Panel cut drawings)

Prepare a square hole to match the unit width.



Unit width: 60mm



Unit width: 90mm

(Note 1) Attach packing around the square hole to provide a seal.

6-2-5 Heating value

The heating value of each servo drive unit is the heating value at stall output.

Servo drive unit type MDS-R-	Heating value [W]	
	Inside panel	Outside panel
V1-20	15	31
V1-40	21	52
V1-60	27	74
V1-80	36	105

Servo drive unit type MDS-R-	Heating value [W]	
	Inside panel	Outside panel
V2-2020	26	63
V2-4020	32	83
V2-4040	38	105
V2-6040	45	125
V2-6060	50	150
V2-8040	53	158
V2-8060	60	180
V2-8080	68	210

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.

Calculation example: When using MDS-R-V1-20 and MDS-R-V2-2020

Total heating value = (15 + 31) + (26 + 63) = 135 [W]

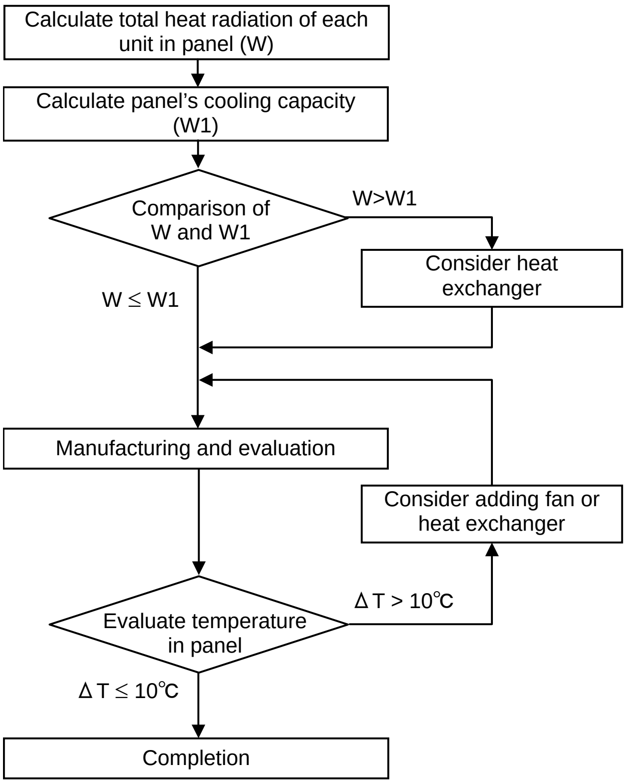
Heating value in panel = 15 x 0.5 + 26 x 0.5 = 20.5 [W]

6-2-6 Heat radiation countermeasures

(1) Heat radiation countermeasures in the control panel

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 the heat accumulates at the top of the unit, etc., install a fan or heat exchanger so that the temperature in the panel remains constant.

Please refer to following method for heat radiation countermeasures.



<Hypothetical conditions>

[1] Average temperature in panel: T ≤ 55°C
[2] Panel peripheral temperature: Ta ≤ 0 to 45°C
[3] Internal temperature rise value: $\Delta T = T - Ta_{max} = 10°C$

<Point>

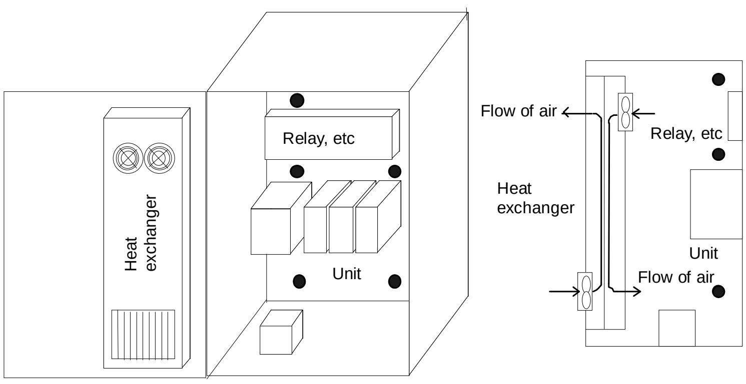
[1] Refer to the section "6-5 Heating value" for the heat generated by each unit.
[2] Refer to the following calculation for calculation W1 of the panel's cooling capacity (thin steel plate).

$W1 = U \times A \times \Delta T$

U: 6W/m^2 x °C (with internal agitating fan)
4W/m^2 x °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 in manufacturing and evaluation
Understanding the temperature rise in the panel, and install a fan or heat exchanger.
ΔT (average value) ≤ 10°C
ΔT_{max} (maximum value) ≤ 15°C

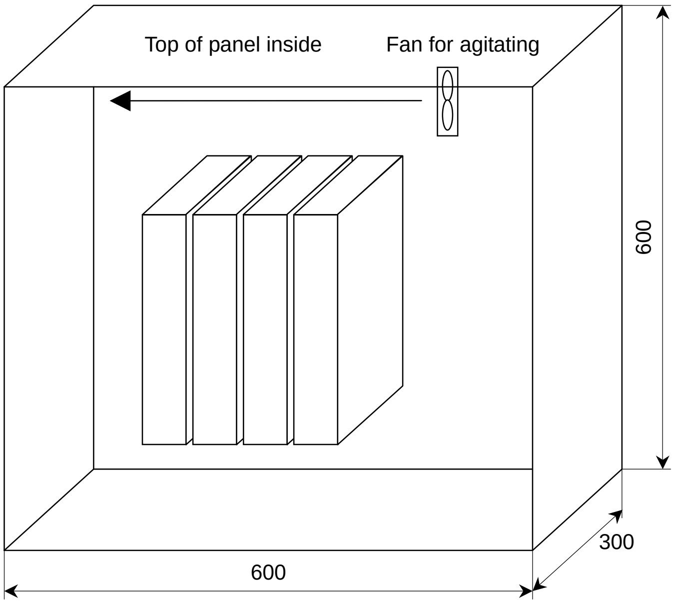
Examples of mounting heat exchanger and temperature measurement positions (reference)



● Temperature measurement positions

The following shows a calculation example for considering heat radiation countermeasures.

<Control panel outline dimension (assumption) >
When installing four units which have the heating value in the panel of 15W



Heat radiation area (A): When a bottom section contacts with a machine

$$A = \underbrace{0.6 \times 0.3}_{\text{(Top face)}} + \underbrace{0.6 \times 0.6 \times 2}_{\text{(Front/back face)}} + \underbrace{0.6 \times 0.3 \times 2}_{\text{(Side face)}} = 1.26\ (m^2)$$

*Actually, sections contacting other objects are excluded.

Heating value in panel (W): when installing four units which are 15W
W = 15 x 4 = 60 (W)

<Considering necessity of agitating fan>
1 Temperature standard
(1) Standard of temperature in panel (around each unit) $T \leq 55°C$
(2) External peripheral temperature $Ta = 0$ to $45°C$
(3) Internal temperature rise value $\Delta T = T - Ta(MAX) = 10°C$

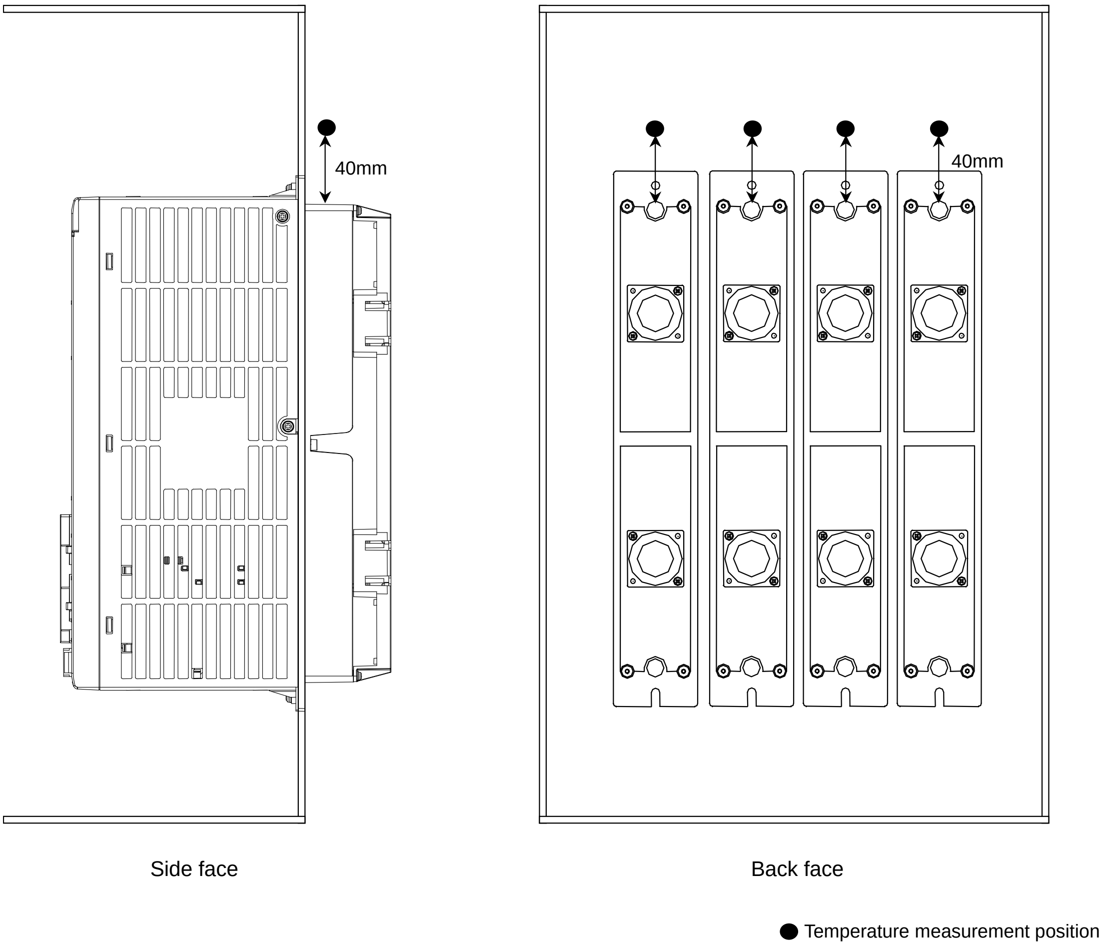
2 Cooling capacity of control panel (W1)
$W1 = U \times A \times \Delta T$ ΔT = Internal temperature rise value (=10°C)
$U = 6W/m^2 \bullet °C$ (with internal agitating fan)
$4W/m^2 \bullet °C$ (without internal agitating fan)
A = Effective heat radiation area (m^2)

$$\left.\begin{array}{ll} \text{(1) With internal agitating fan} & W1 = 6 \times 1.26 \times 10 = 75.6\ (W) > 60\ (W) \\ \text{(2) Without internal agitating fan} & W1 = 4 \times 1.26 \times 10 = 50.4\ (W) < 60\ (W) \end{array}\right\} \text{Internal fan is required.}$$

POINT	Measure an actual internal temperature, and install a fan or heat exchanger which agitates the heat at the top of the unit if the temperature rise exceeds 10°C.

(2) Heat radiation countermeasures outside the control panel

Measure the temperature at 40mm form tops of all units, and design the temperature rise so that it is 20°C or less against the ambient temperature.
If the temperature rise at the temperature measurement position exceeds 20°C, consider adding a fan.



POINT	The temperature of some units may rise locally, because air accumulates at a particular point. Therefore, take a temperature measurement in each unit. If a temperature at even one point exceeds 20°C in the temperature measurements, take a heat radiation countermeasure such as adding fans.

6-3 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. causing the power supply unit or drive unit to malfunction.
If the peripheral devices or units malfunction due to this noise, measures must be taken to suppress the noise. The measures differ according to the noise propagation path, so refer to the following explanations and take appropriate measures.

(1) General noise measures

- Avoid laying the drive unit's power line and signal wire in a parallel or bundled state. Always separate these wires. Use a twisted pair shielded wire for the detector cable and signal wires such as the communication cable connected with the NC unit. Accurately ground the devices.
- Use one-point grounding for the drive unit and motor.
- Accurately ground the AC reactor.

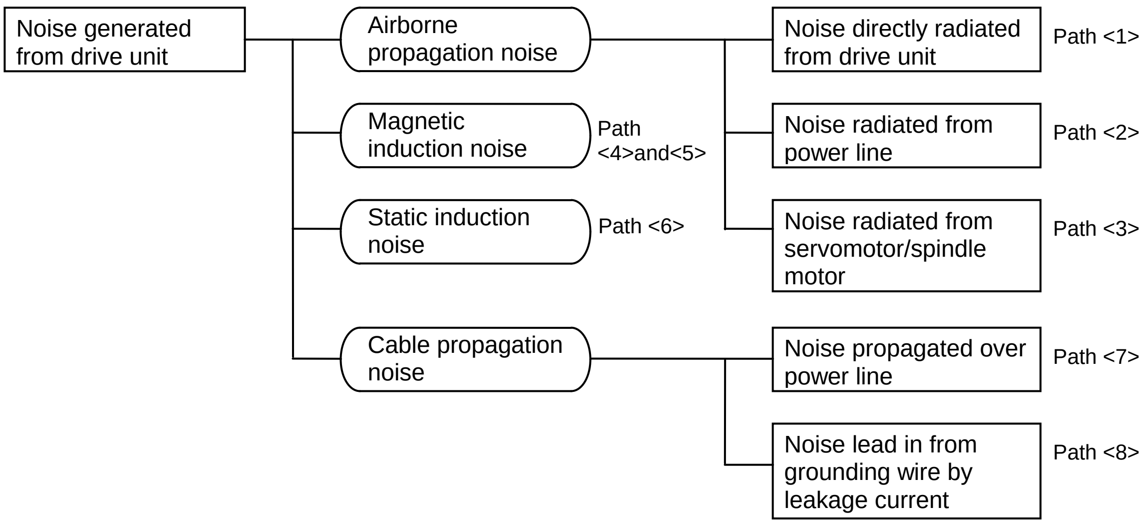
(2) Propagation noise measures

Take the following measures when noise generating devices are installed and the power supply unit or drive unit could malfunction.

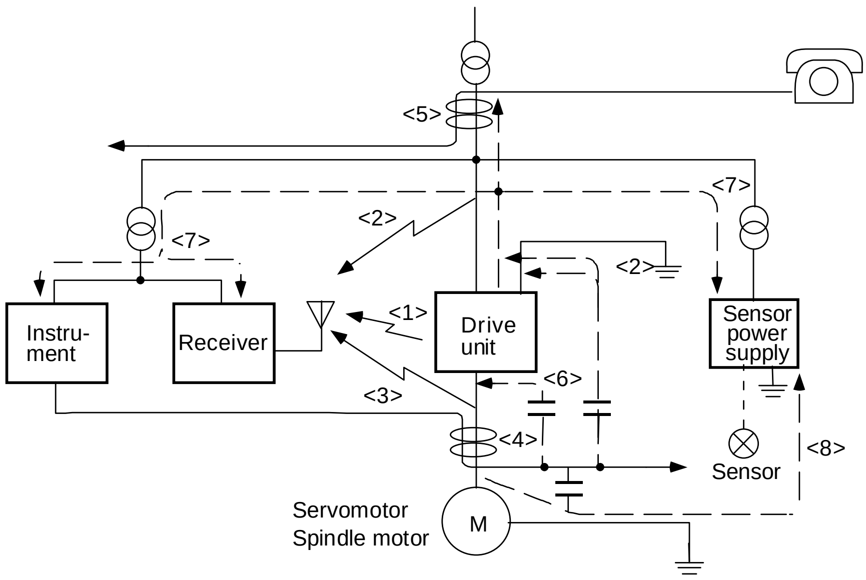
- Install a surge killer on devices (magnetic contactors, relays, etc.) which generate high levels of noise.
- Install a power supply filter.
- Mount a ferrite core on the signal wire.
- Ground the shield of the servo detector's cable with a cable clamp fittings.

(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 or a radio filter on the input 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. (1) Install a radio filter onto the drive unit's power supply wire. (2) Install a power filter onto the drive unit's power supply wire.
<8>	If a closed loop is created by the peripheral device and drive unit grounding wire, the noise current could be run through causing the device to malfunction. In this case, change the device grounding methods and the grounding place.

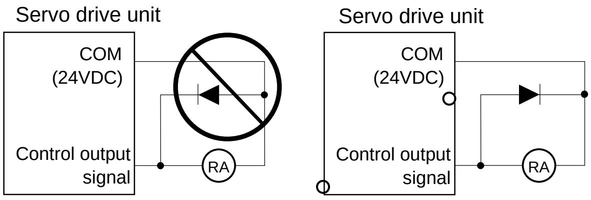
7. Wiring and Connection

⚠ **DANGER**

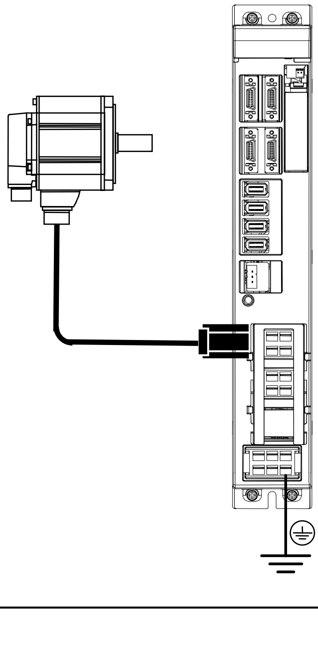
1. Wiring work must be done by a qualified technician.
2. Wait at least 15 minutes after turning the power OFF and check the voltage with a tester, etc. before starting wiring. Failure to observe this could lead to electric shocks.
3. Securely ground the drive units and servo/spindle motor.
4. Wire the 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**

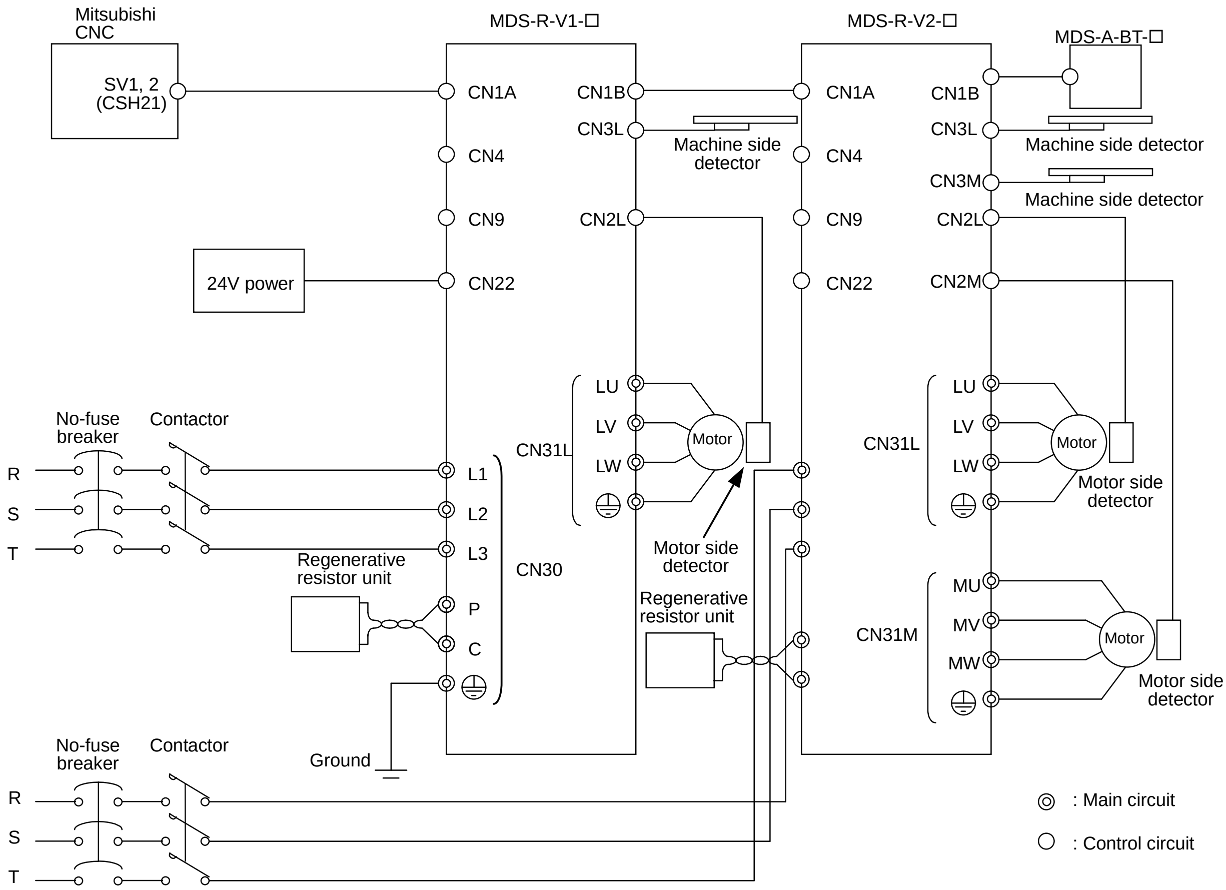
1. Correctly and securely perform the wiring. Failure to do so could lead to runaway of the servo/spindle motor resulting in possible injury.
2. Do not mistake the terminal connections.
   Failure to observe this item could lead to ruptures or damage, etc.
3. Do not mistake the polarity (+ , –). Failure 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 may 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 connectors (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. Do not separately ground the connected motor and drive unit as noise could be generated. To ground the motor, connect to the PE terminal for the drive unit's CN31 connector, and connect to the ground from the other CN30 connector's PE terminal. (Ground to one point)



7-1 Part system connection diagram

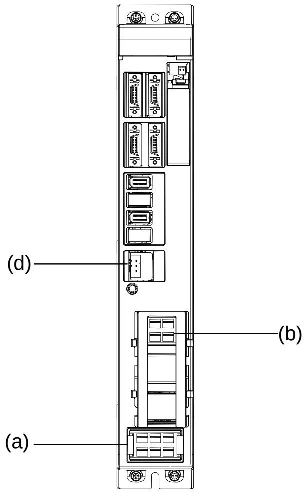
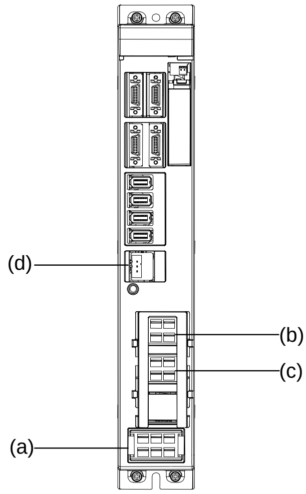
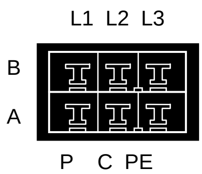
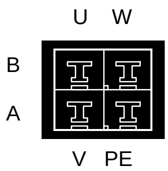


(Note 1) The total length of the SH21 cable must be within 30m.
(Note 2) The connection method will differ according to the motor to be used.
(Note 3) When not using an absolute position detector, connect the terminal connector (A-TM).
(Note 4) The main circuit (◎) and control circuit (○) are safely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

7-2 Main circuit and control circuit connectors

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

7-2-1 Connector pin assignment

Terminal \ Unit			MDS-R-V1-□	MDS-R-V2-□
Connector position				
Terminal specification/ Pin assignment	(a)	CN30		(DDK) Housing : DK-5200M-06R Contact : DK-5RECSLP1-100 for AWG14,16 Contact : DK-5RECMLP1-100 for AWG10,12
	(b) (c)	CN31L CN31M		(DDK) Housing : DK-5200M-04R Contact : DK-5RECSLP1-100 for AWG14,16 Contact : DK-5RECMLP1-100 for AWG10,12
	(d)	CN22		(DDK) Housing : DK-3200S-02R Contact : DK-3REC2LLP1-100 for AWG14

7-2-2 Main circuit and control circuit connector signal names and applications

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

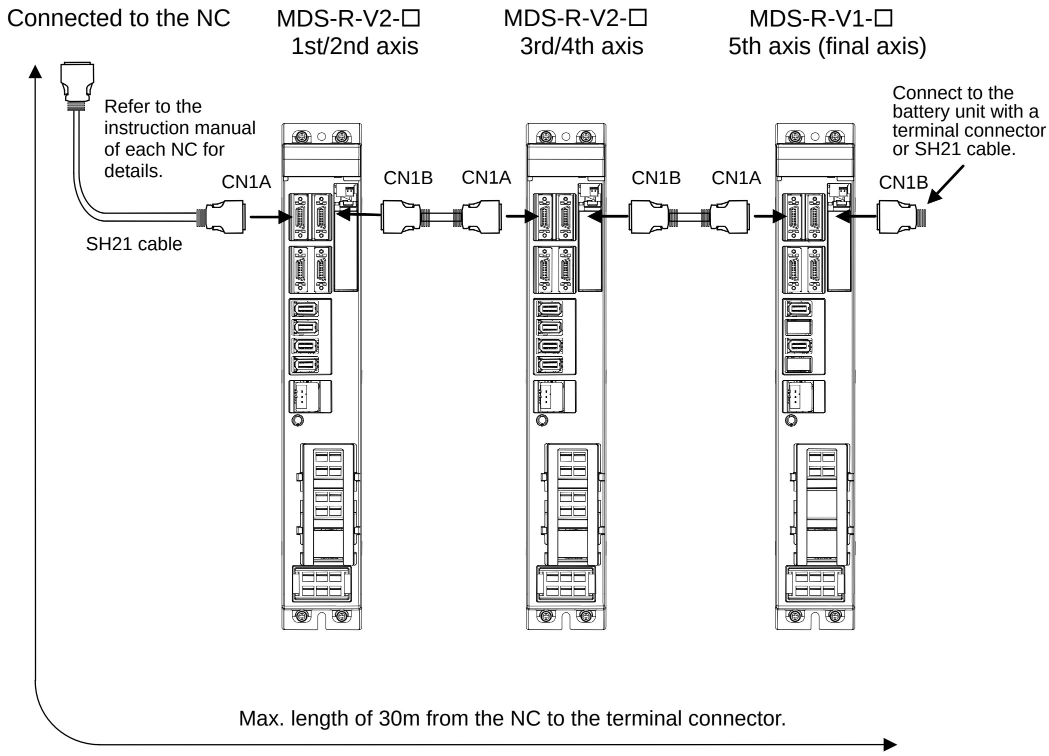
Name	Signal name	Description
L1 · L2 · L3	Main circuit power supply	Main circuit power supply input terminal Connect a 3-phase 200 to 230VAC, 50/60Hz power supply.
P, C	Regenerative resistor	Regenerative resistor connection terminal Connect the regenerative resistor.
U · V · W	Motor output	Servomotor power output terminal The servo/spindle motor power terminal (U, V, W) is connected.
PE	Protective grounding (PE)	Grounding terminal The servomotor/spindle motor grounding terminal is connected and grounded.
VDD, SG	Control circuit power supply	Control circuit power supply input terminal Connect 24VDC.

7-3 NC and drive unit connection

The NC bus cables are connected from the NC to each drive unit so that they are laid 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 5 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)



⚠ 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.

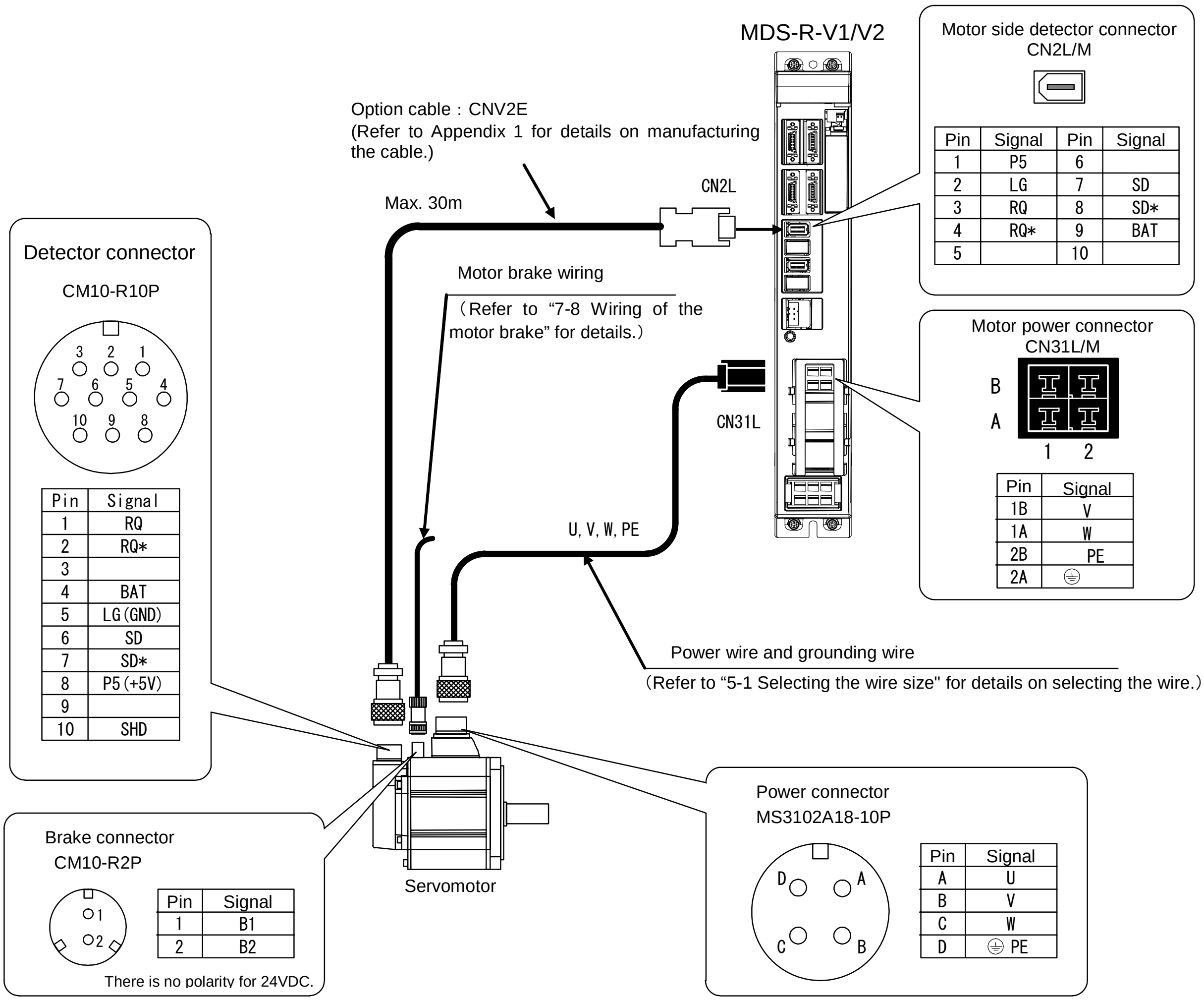
POINT	Axis Nos. are determined by the rotary switch for setting the axis No. (Refer to section "8-1-1 Setting the rotary switch".) The axis No. has no relation to the order for connecting to the NC.

7-4 Motor and detector connection

7-4-1 Connection of servomotor HF Series

(1) Connection of HF75(B)/HF105(B)/HF54(B)/HF104(B)/HF154(B)/HF224(B) /HF123(B) /HF223(B)/HF142(B)

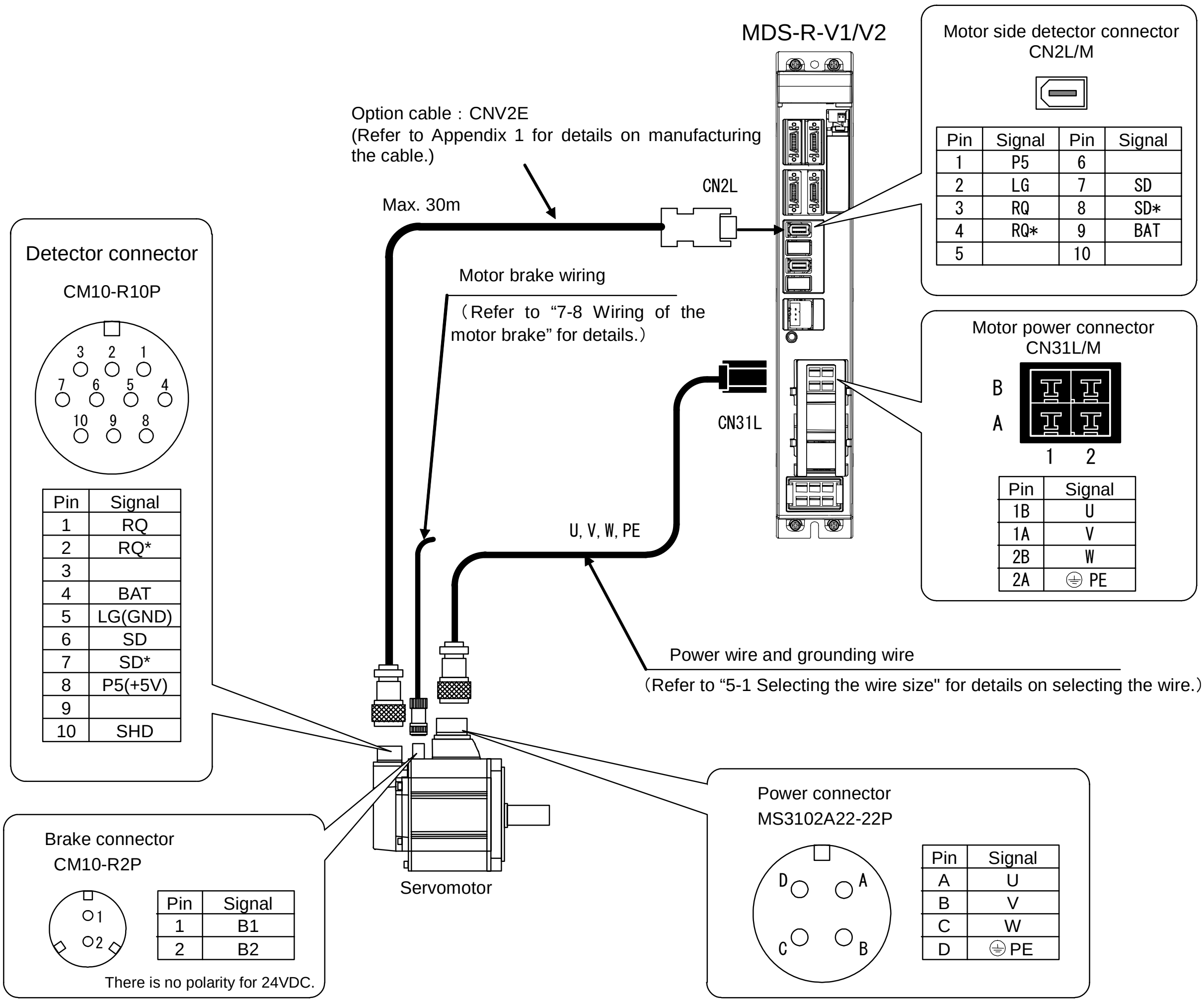
The A48 or A51 detector can be used.



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

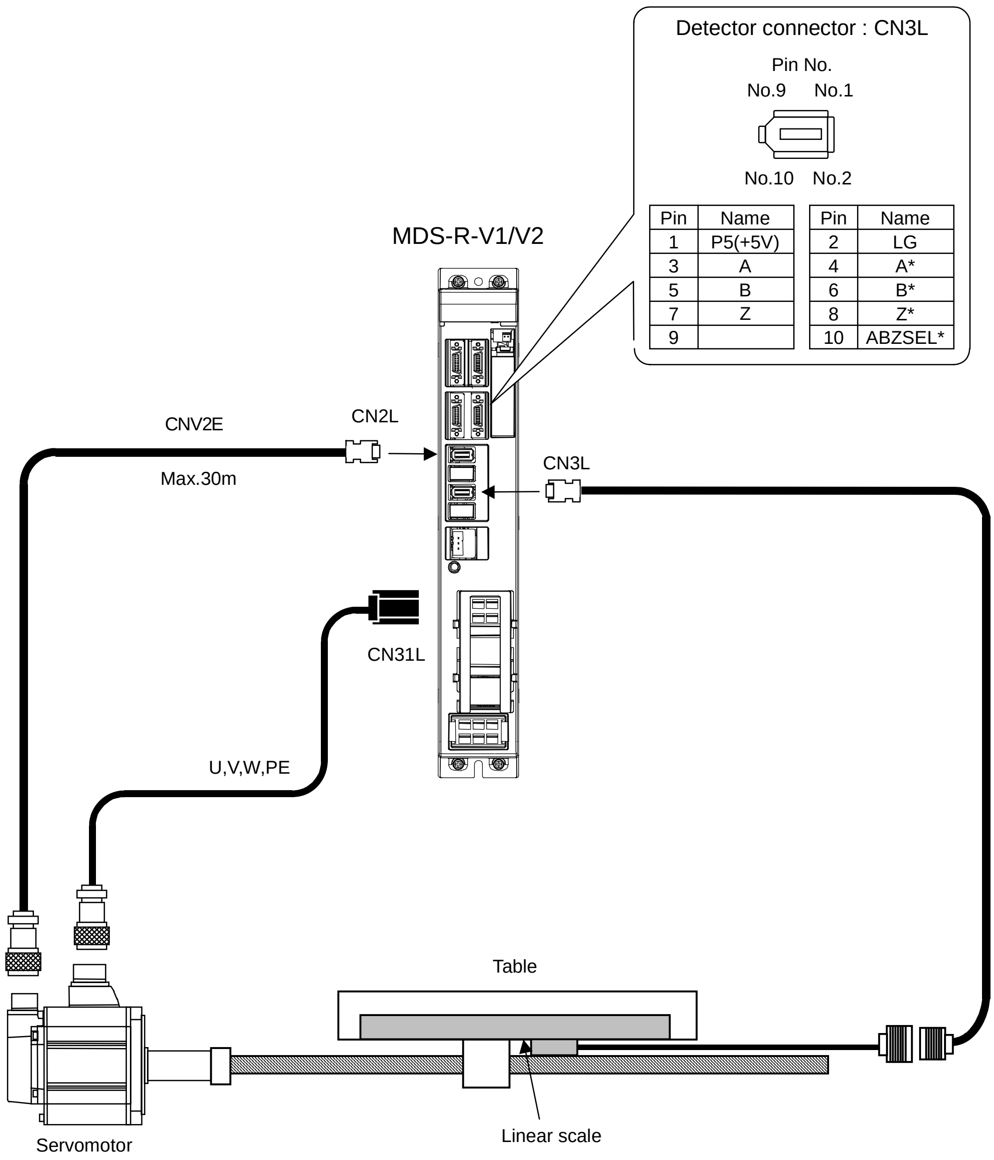
(2) Connection of HF204(B)/HF354(B)/HF303(B)/HF302(B)

The A48 or A51 detector can be used.



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

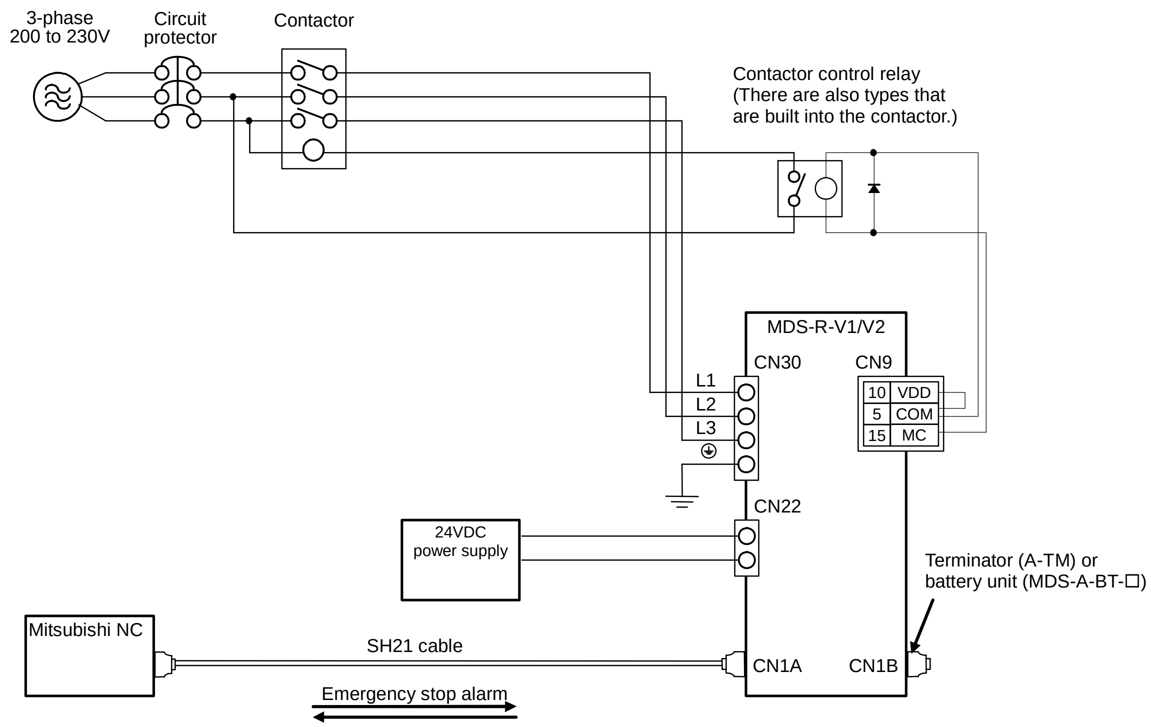
(3) Connecting the linear scale (for rectangular wave data output)



7-5 Connection of main circuit power supply

⚠ **CAUTION**	1. Make sure that the power supply voltage is within the specified range of the servo drive unit. Failure to observe this could lead to damage or faults. 2. For safety purposes, always install a circuit protector, and make sure that the circuit is cut off when an error occurs or during inspections. Refer to Chapter 5 and select a no fuse breaker. 3. The wire size will differ according to each drive unit capacity. Refer to Chapter 5 and select the size. 4. For safety purposes, always install a contactor (magnetic contactor) on the main circuit power supply input. Large rush currents will flow when the power is turned ON. Refer to Chapter 5 and select the correct contactor.

Drive the contactor via the relay from the CN9 connector's contactor control output (MC). Some types of contactors can be directly driven with 24VDC.

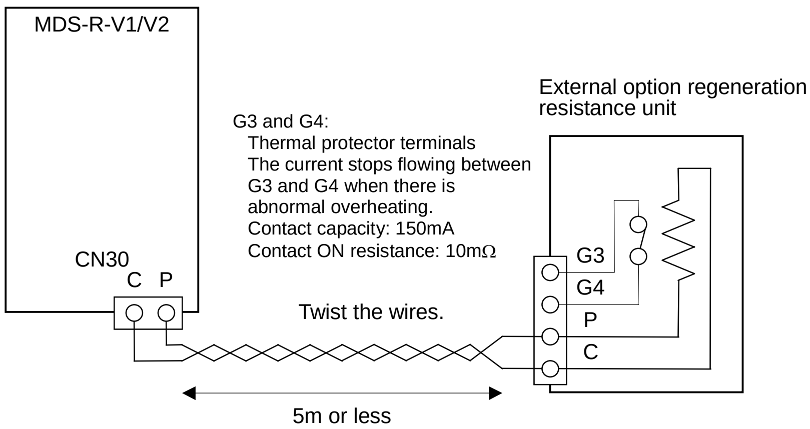


7-6 Connection of regenerative resistor

⚠ CAUTION	The MDS-R Series does not have a built-in regenerative resistor. If the load inertia is small, there will be no problem with the capacitor regeneration (regenerative resistance is not required as the circuit is charged with the capacitor in the drive unit). However, the overvoltage alarm (ALM33) will occur if the load inertia is large. In this case, connect the external option regenerative resistor. Refer to section "Appendix 2-2 Selection of regenerative resistor" for details on making a selection.

7-6-1 Connection of external option regeneration resistance unit

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



◇ DANGER	1. Install the regenerative resistor unit in the control panel or in the place where foreign matter does not enter the regenerative resistor unit. If foreign matter (cutting chips, cutting oil, etc.) enters the regenerative resistor unit, the servo drive unit could be damaged or fires could be caused. 2. Select the installation place so that foreign matter (cutting chips, cutting oil, etc.) do not enter the regenerative resistance unit's terminal block. A short-circuit between the P and C terminals could lead to servo drive unit damage. 3. The regenerative resistor generates heat of approximately 100°C (or higher, depending on the installation conditions). Give sufficient consideration to heat dissipation and installation position. Do not touch the regenerative resistor directly. 4. Use flame retardant wire or provide flame retardant treatment for the wire connected to the regenerative resistance unit.

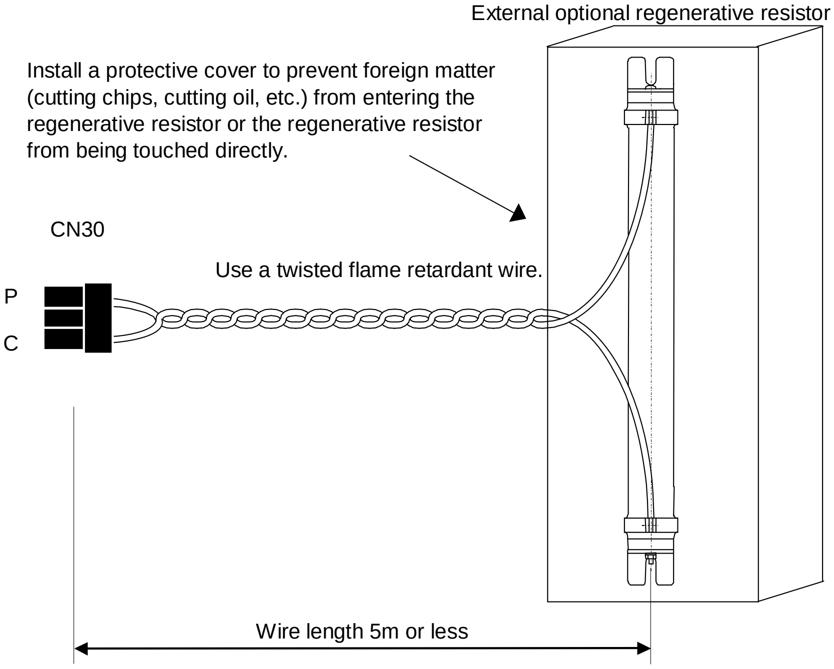
⚠ CAUTION	Always use twisted pair cable to connect to the servo drive unit, and keep the length of the wiring to 5m or less. Refer to section "5-1 Selection of wire" for details on selecting the wire.

7-6-2 Connection of external regenerative resistor

Connect the regenerative resistor across P-C of CN30.

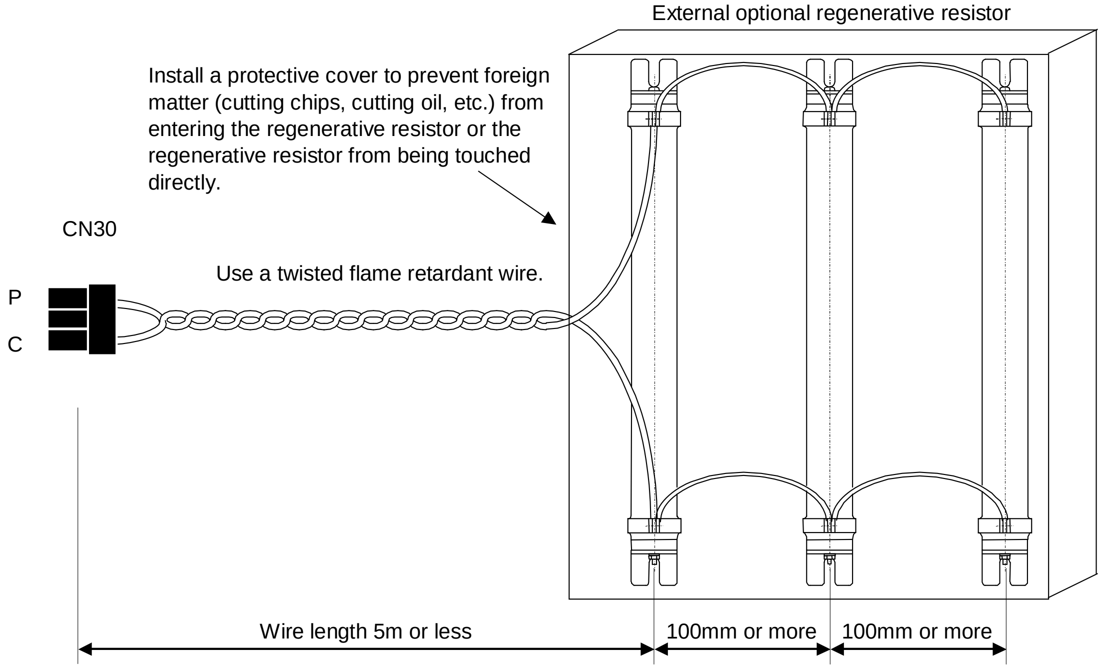
(1) Connection of one resistor

GZG200W26OHMJ, GZG300W20OHMJ
GZG80W26OHMJ, GZG400W13OHMJ, GZG400W8OHMJ



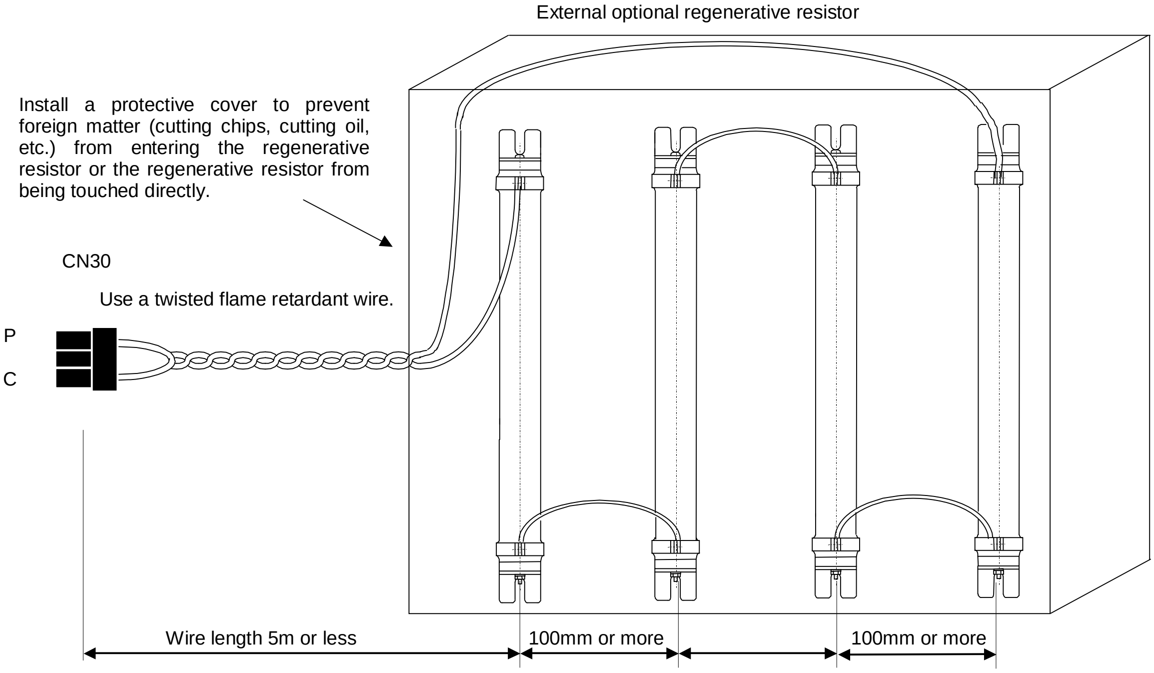
(2) Connection of three resistors in parallel

GZG200W120OHMJ, GZG200W39OHMJ, GZG300W39OHMJ
GZG200W20OHMJ, GZG300W20OHMJ



(3) Connection of four resistors in serial

GRZG400-2OHMJ



DANGER	1. Install the regenerative resistor unit in the control panel or in the place in where foreign matter does not enter the regenerative resistor unit. If foreign matter (cutting chips, cutting oil, etc.) enters the regenerative resistor, the servo drive unit could be damaged or fires could be caused. 2. Always mount a protective cover so that the cables, etc., do not directly contact the regenerative resistor. A short-circuit across P-C could result in servo drive unit damage. 3. The regenerative resistor heats up to approx. 100 degrees. (It may get hotter depending on the installation conditions.) Pay special attention to heat dissipation and the installation position. Do not touch the regenerative resistor directly. 4. Use flame retardant wires or provide flame retardant treatment for the wires connected to the regenerative resistor.

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

7-7 Wiring of contactors

7-7-1 Contactor control

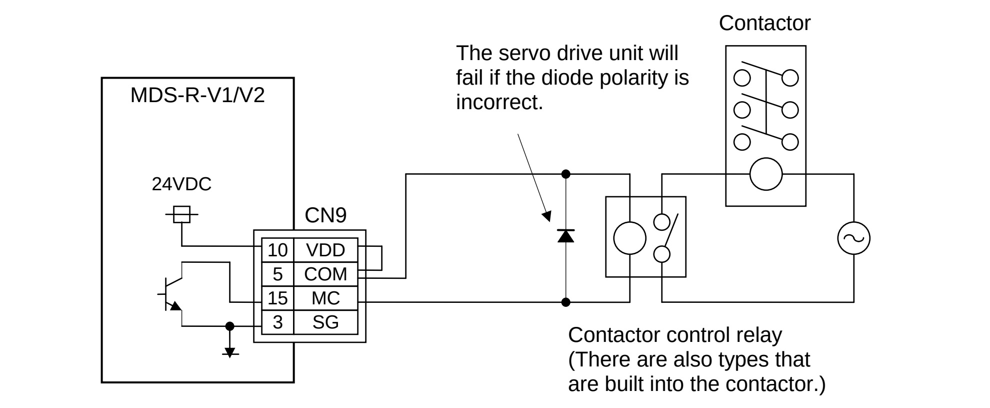
Insert a contactor (magnetic contactor) in the main circuit power supply input (L1, L2, L3) of the servo drive unit, and shut off the power supply input when an emergency stop or servo alarm occurs.
When an emergency stop or servo alarm occurs, the servo drive unit stops the motor using deceleration control or dynamic brakes. The contactors cannot be shut off because the power supply for deceleration to be held. Therefore, the drive unit always controls the contactors. The NC unit confirms the stop of all axes or the dynamic brake operation. Then it outputs a shutoff command to the drive units that drive contactors.

⚠ **CAUTION**	1. The contactors cannot be driven from other than a drive 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. If they are shut off earlier than the emergency stop input, or if the input power supply is shut off during the deceleration control or vertical axis drop prevention control, an undervoltage alarm will occur, and deceleration control or drop hold may not be possible. For double-protection, use a power supply unit external emergency stop input. (Refer to section "7-9 Wiring of an external emergency stop".)

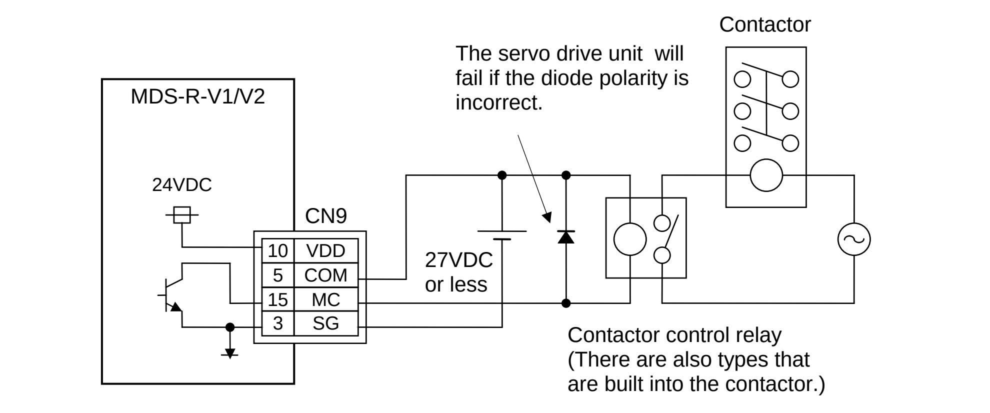
7-7-2 Contactor control signal (MC) output circuit

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

When using an internal power supply



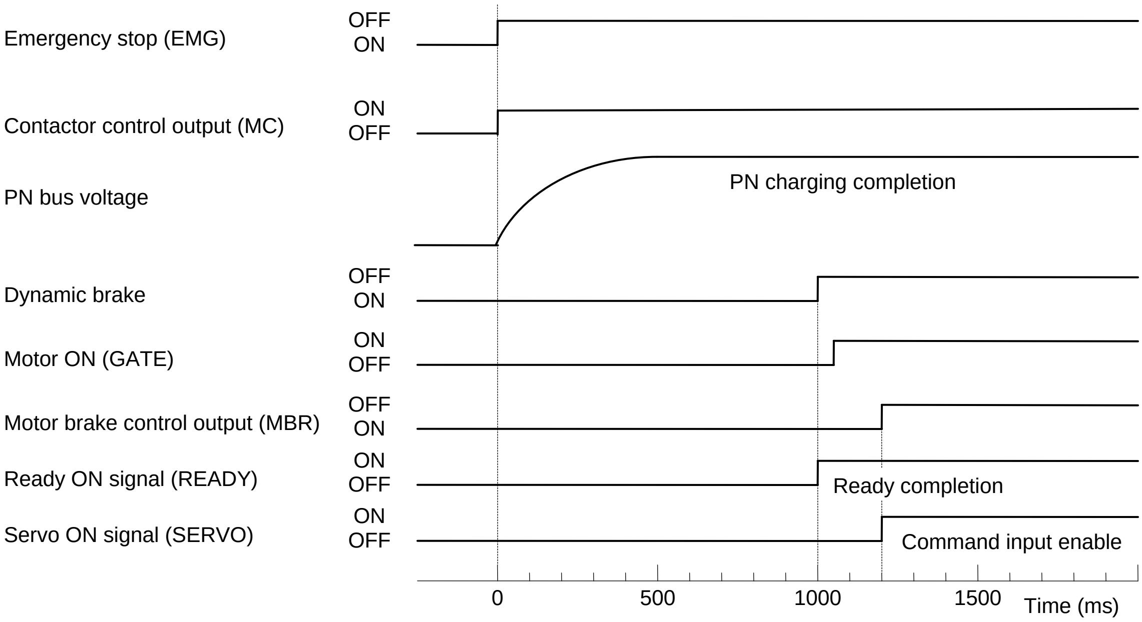
When using an external power supply



POINT	When using the internal power supply, the power can be directly connected to VDD if using only the digital output (MC, MBR). When using the digital input (EMGX), always connect across VDD-COM.

7-7-3 Contactor power ON sequences

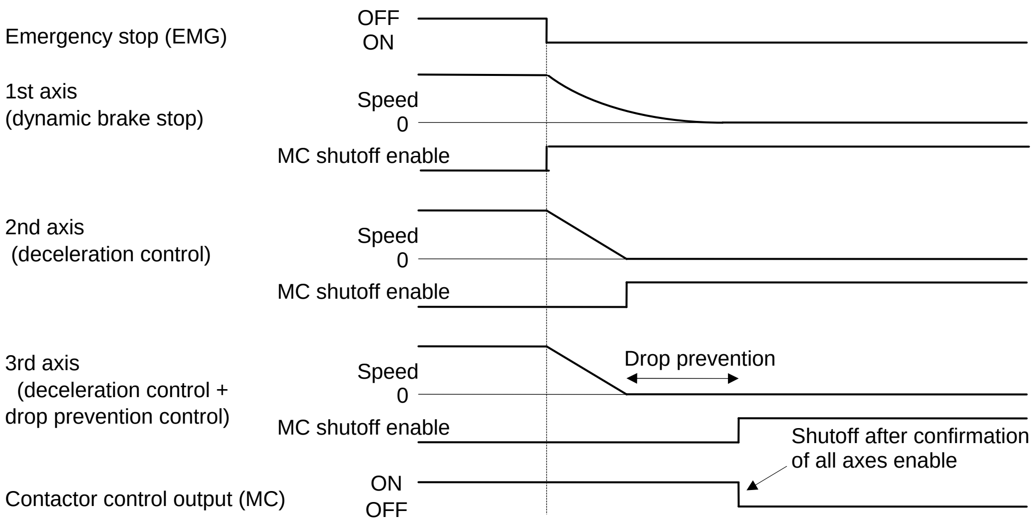
When using the contactor control output (CN9 connector: MC) for the MDS-R-V1/V2 servo drive unit, the main circuit power supply is turned ON with the sequence shown below. In the 200ms interval after the drive unit emergency stop input is canceled, the contactor contact fusion is checked by discharging the PN bus voltage with the regenerative resistor. External contactor fusion (alarm 5F) is detected when the contactor has fusion.



Contactor power ON sequences

7-7-4 Contactor shutoff sequences

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

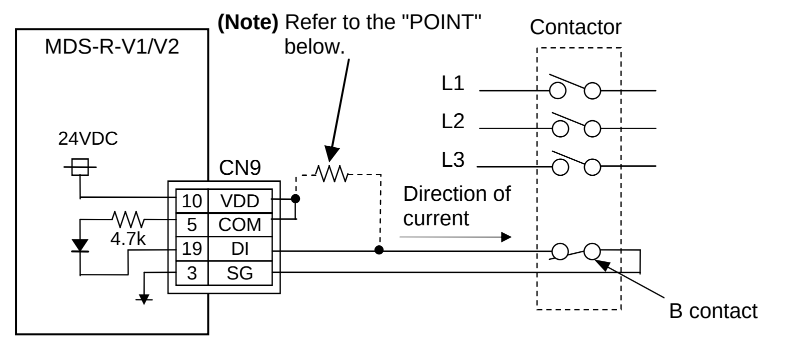


Contactor shutoff sequences

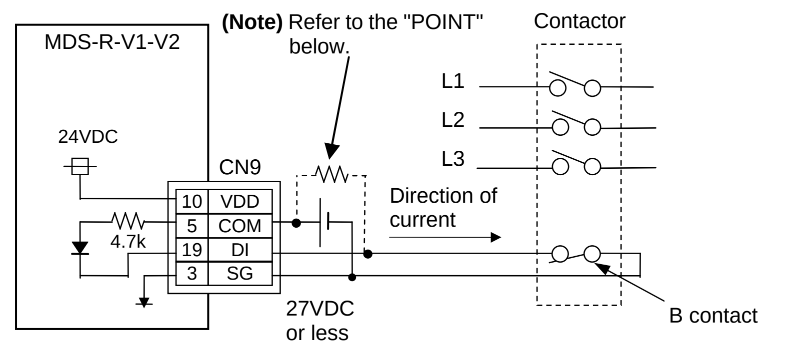
7-7-5 Monitor of contactor operation

The contactor operation can be monitored by inputting the contactor B contact to the MDS-R-V1/V2 DI signal and setting the parameter.
The contactor error alarm (5F) will occur if the contactor turns ON during READY OFF, or if the contactor turns OFF during READY ON.

When using an internal power supply



When using an external power supply



POINT

When the contactor or relay contact is used with a minute load, the contact's contactor resistance will increase, resulting in a higher fault rate. Add appropriate resistors so that the proper current is passed to the contactor in use, and then flow the current to the B contact.
A current of approx. 5mA (at 24VDC) will flow if a resistor is not added.

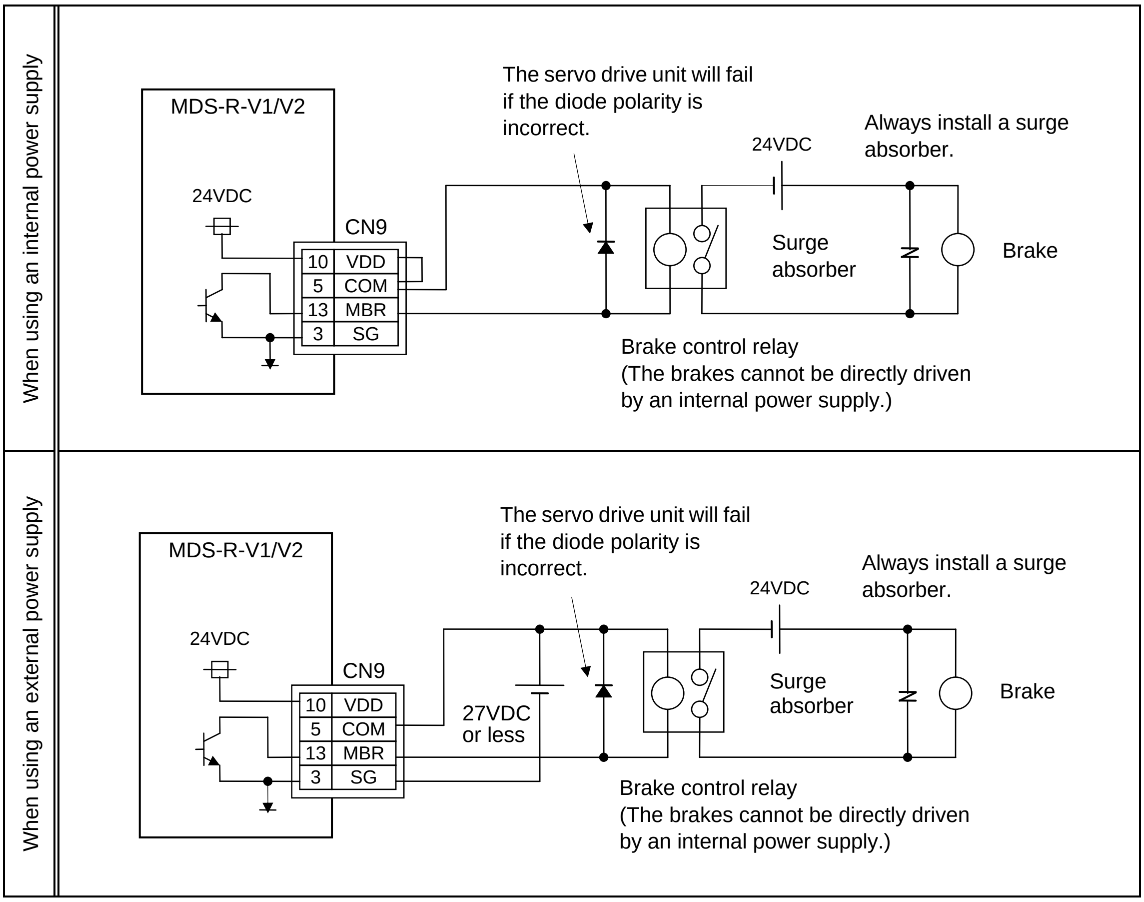
<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV033</td><td>SSF2</td><td>Servo function selection 2</td><td>
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td></td><td>zup</td><td></td><td></td><td colspan="2">dis</td><td></td><td></td><td colspan="3">nfd2</td><td>nf3</td><td colspan="3">nfd1</td><td></td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th colspan="2">Explanation</th></tr>
<tr><td>A
B</td><td>dis</td><td colspan="2">Select the digital signal input.</td></tr>
<tr><td></td><td></td><td>00: DI not used</td><td>10: Reserved</td></tr>
<tr><td></td><td></td><td>01: Contactor B contact input</td><td>11: Reserved</td></tr>
</table>
</td></tr>
</table>

7-8 Wiring of the motor brake

The magnetic brakes of servomotors with magnetic brakes are driven by the control signal (MBR) output by the servo drive unit MDS-R-V1/V2. The servo drive unit releases the brakes when the motor is ON. (Servo ON means when torque is generated in the motor.)
No parameters need to be set to use the motor brake control output (MBR).

7-8-1 Motor brake control signal (MBR) output circuit

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



POINT

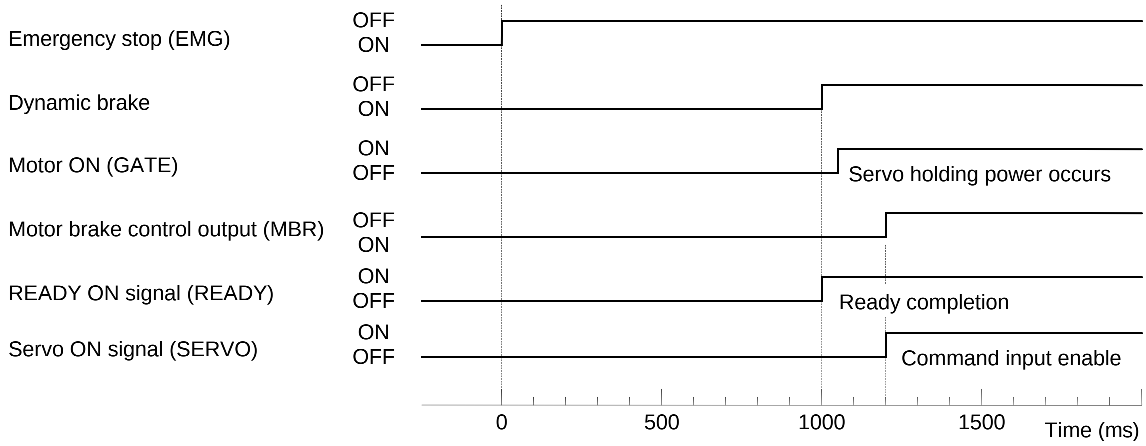
When using the internal power supply, the power can be directly connected to VDD if using only the digital output (MC, MBR). When using the digital input (EMGX), always connect across VDD-COM.

CAUTION

1. Always install a surge absorber near the motor's brake terminal to eliminate noise and protect the contacts. Refer to section "5-4 Surge absorber".
2. The magnetic brakes cannot be directly driven with the output signal from the servo drive unit. Always install a relay.
3. The magnetic brakes cannot be driven by the servo drive unit's VDD (24VDC). Always install a separate power supply.

7-8-2 Motor brake release sequence

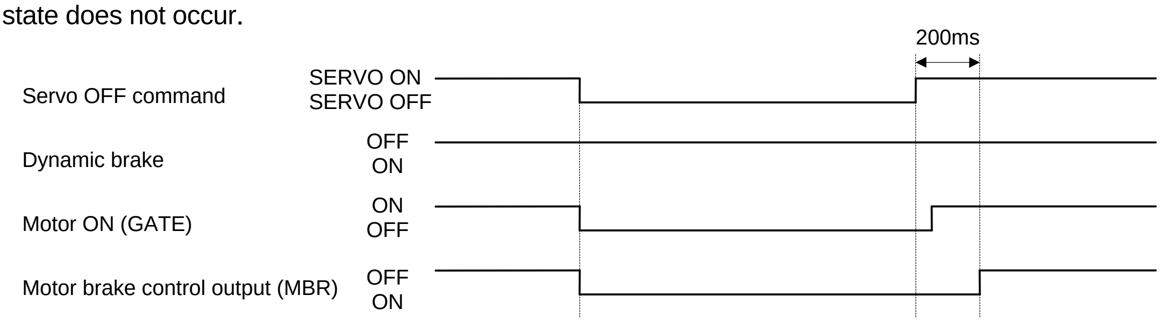
The motor brake control output (CN9 connector: MBR) releases the motor brakes with the sequence shown below when canceling the emergency stop. Because the brake is released after the start of the power ON to the servomotor, dropping due to an uncontrolled state does not occur.



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

7-8-3 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 output operation sequence when a servo OFF command is input

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

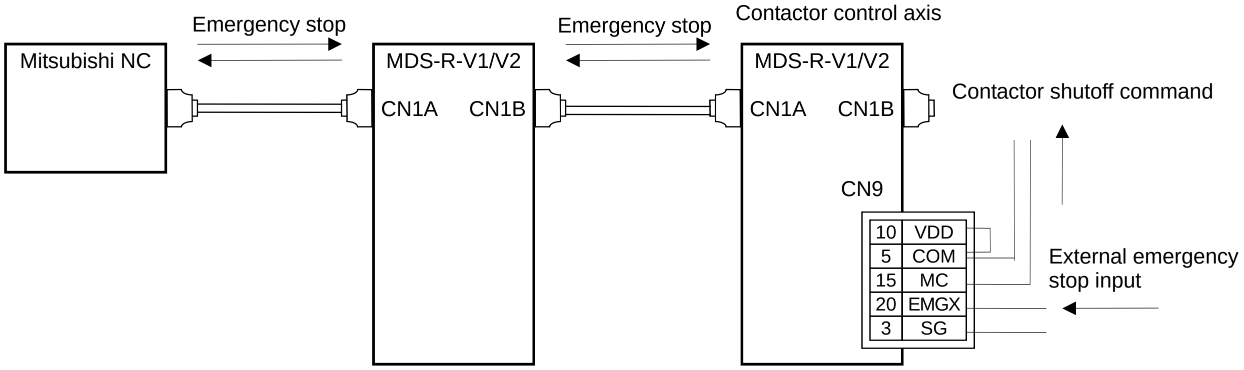
7-8-4 Operation sequences when an emergency stop occurs

The motor brake control output operation when an emergency stop occurs differs according to the motor deceleration stop method. Refer to section "9-4 Setting for emergency stop" for details on the operation sequences for each stop method.

7-9 Wiring of an external emergency stop

7-9-1 External emergency stop setting

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



No.	Abbrev.	Parameter name	Explanation
SV036	PTYP*	Regenerative resistor type	See bit layout and descriptions below

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

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

Setting	Descriptions
0	External emergency stop invalid
4	External emergency stop valid

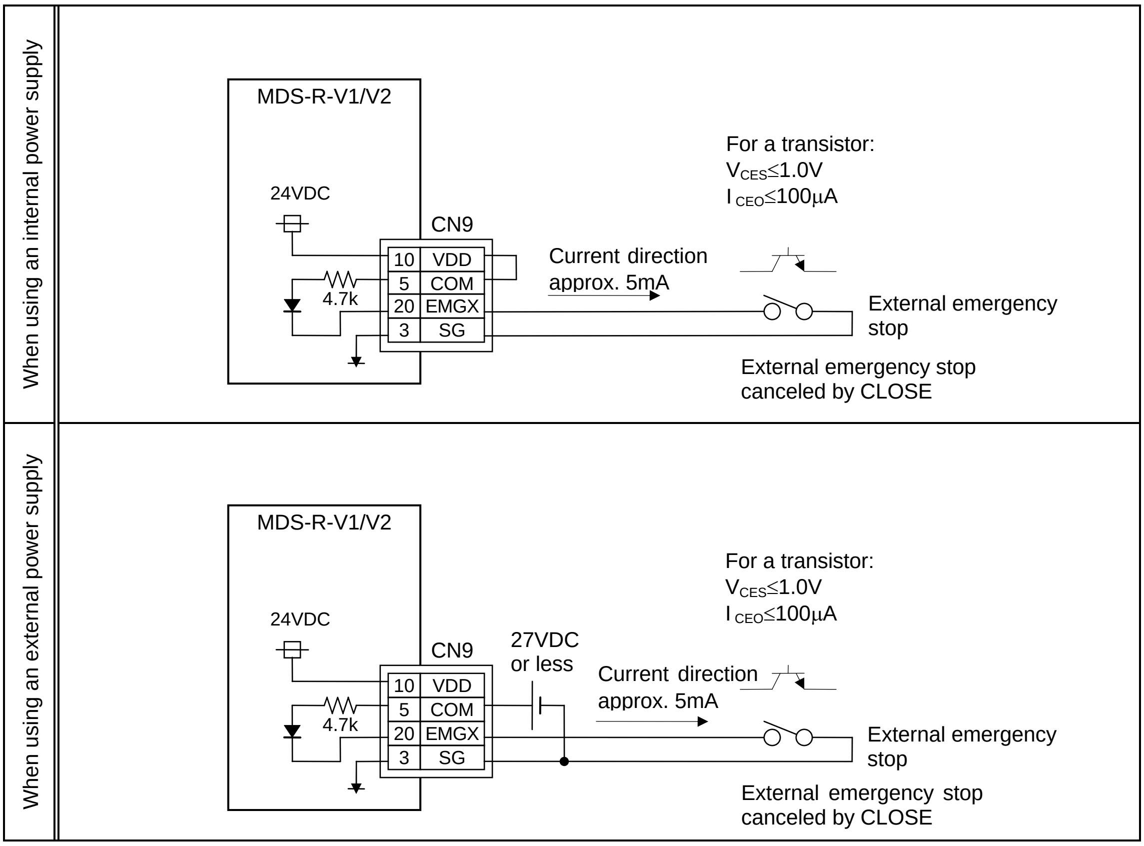
CAUTION Always input the external emergency stop to the servo drive unit controlling the contactors.

POINT

1. When the MDS-R-V1/V2 controls the contactor, the external emergency stop input is validated for the axis receiving the main circuit power supply from that contactor. When the converter controls the contactor, use the external emergency stop input of the converter.
2. The external emergency stop input is merely an auxiliary input, so always input the main emergency stop (NC bus line). An external emergency stop error (alarm 55) will occur if only an external emergency stop is input.

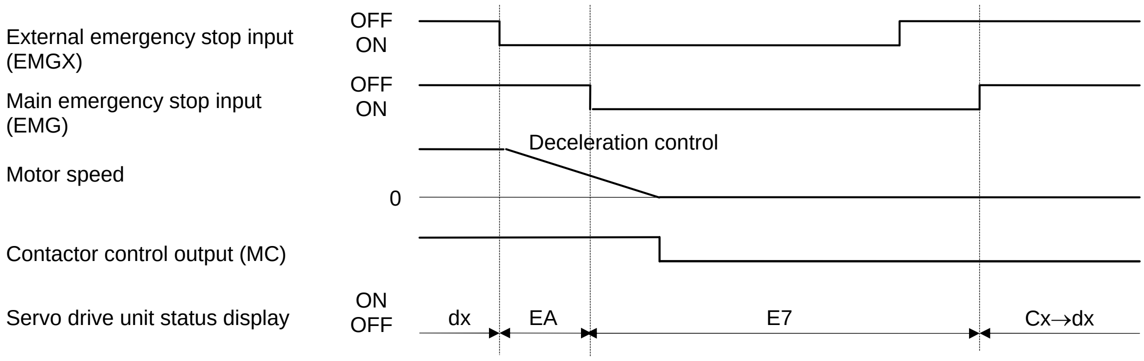
7-9-2 External emergency stop signal (EMGX) input circuit

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

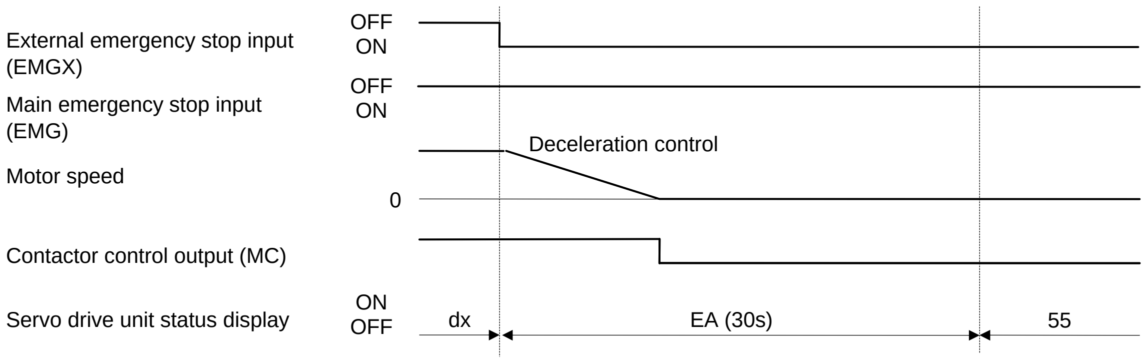


7-9-3 External emergency stop operation sequence

If only an external emergency stop is input when "external emergency stop valid" is set (the main emergency stop is not input), "In external emergency stop state" (warning EA) will be detected. Then, the system will enter the emergency stop state.
If a contactor shutoff command is not issued from the NC unit within 30 seconds after the external emergency stop is input (if the main emergency stop is not input), an external emergency stop error (alarm 55) is detected. If the main emergency stop is input within 30 seconds, the warning EA changes to the "In NC emergency stop state" (warning E7). The normal emergency stop status (warning E7) will result.
Ready ON is possible even if an external emergency stop has been input when the emergency stop is canceled, but an external emergency stop error (alarm 55) will occur after 30 seconds.



External emergency stop input sequences



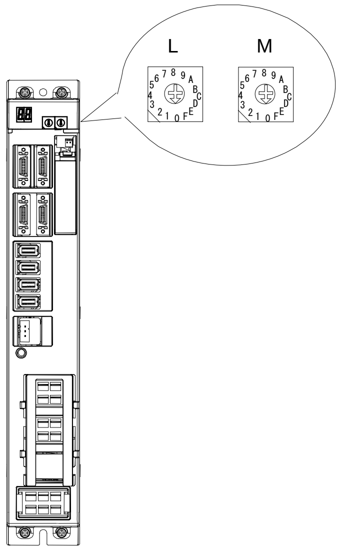
When main emergency stop is not input

8. Setup

8-1 Servo drive unit initial settings

8-1-1 Setting the rotary switch

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



When MDS-R-V2 Series are used

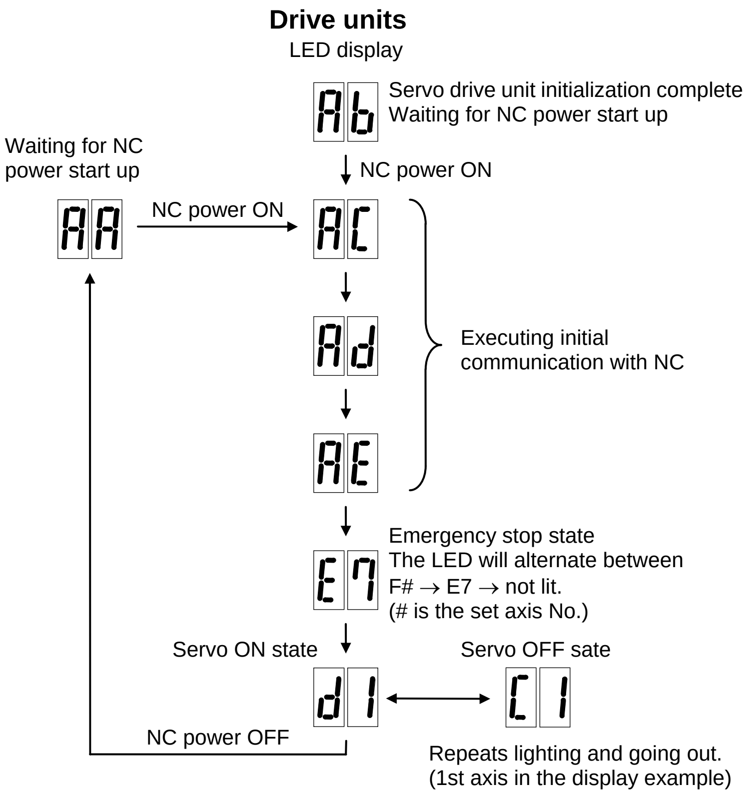
Rotary switch setting	Set axis No.
0	1st axis
1	2nd axis
2	3rd axis
3	4th axis
4	5th axis
5	6th axis
6	7th axis
7	Not usable
8	
9	
A	
B	
C	
D	
E	
F	Axis not used

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.

8-1-2 Transition of LED display after power is turned ON

When NC, 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 10 Troubleshooting" for details on the alarm displays.



8-2 Setting the initial parameters

The servo parameters must be set to startup the servo system. The servo parameters are input from the NC. The input method differs according to the NC, so follow the respective NC instruction manual.

8-2-1 Setting the standard parameters

Always set the standard parameters listed in "8-2-3 Standard parameter list according to servomotor" when starting up the system. Check the machine and servo system specifications, and determine the setting values for the following parameters.

(1) Basic specification parameters

When performing absolute position control, set SV017, bit7=1. This may be automatically set by NC system parameter setting, depending upon NC model. (Setting on the servo parameter screen invalid.)

Setting basic specification parameters

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV017</td><td>SPEC*</td><td>Servo specification selection</td><td>
<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></td><td></td><td>abs</td><td></td><td></td><td>fdir</td><td>vfb</td><td></td><td>dfbx</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>7</td><td>abs</td><td>Incremental control</td><td>Absolute position control</td></tr>
</table>
</td></tr>
</table>

POINT

Setting of absolute position control (SV017.bit7) may be set automatically by NC system parameter setting, depending on NC model. In this case, setting on the servo parameter screen is not valid.

(2) Electronic gear related parameters

The setting range of the following parameters, which configure the electronic gears, may be limited according to the combination.

Setting electronic gear related parameters

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range (Unit)</th></tr>
<tr><td>SV001</td><td>PC1*</td><td>Motor side gear ratio</td><td rowspan="2">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 causes initial parameter error (servo alarm No. 37).</td><td>1 to 32767</td></tr>
<tr><td>SV002</td><td>PC2*</td><td>Machine side gear ratio</td><td>1 to 32767</td></tr>
<tr><td>SV018</td><td>PIT*</td><td>Ball screw pitch</td><td>Set the ball screw pitch. Set to "360" for the rotary axis.</td><td>1 to 32767
(mm/rev)</td></tr>
<tr><td rowspan="2">SV019</td><td rowspan="2">RNG1*</td><td rowspan="2">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
This is available for the relative position rectangular wave output specification linear scale.
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>Relative position rectangular wave output scale</td><td>Refer to detector specification manual.</td><td>SV018 (PIT)(mm)/
Resolution (µm)</td></tr>
</table></td><td>1 to 9999
(kp/PIT)</td></tr>
<tr><td>SV020</td><td>RNG2*</td><td>Speed detector resolution</td><td>Set the number of pulses per one revolution of the motor side detector.
<table>
<tr><th>Motor type</th><th>SV020 setting</th></tr>
<tr><td>HF□□-A42</td><td>100</td></tr>
<tr><td>HF□□-A47</td><td>100</td></tr>
</table></td><td>1 to 9999
(kp/rev)</td></tr>
</table>

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

(3) Detector type related parameters

(a) For semi-closed loop control

Set the following parameter as below when controlling by using only detector of motor.

Setting for semi-closed loop control

<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>
<table>
<tr><th colspan="2">bit</th><th>Explanation</th></tr>
<tr><td>8</td><td rowspan="4">ent</td><td rowspan="8">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".
<table>
<tr><th>Detector model name</th><th>pen setting</th><th>ent setting</th></tr>
<tr><td>A42, A47</td><td>2</td><td>2</td></tr>
</table></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></tr>
<tr><td>D</td></tr>
<tr><td>E</td></tr>
<tr><td>F</td></tr>
</table></td></tr>
</table>

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

(b) For full-closed loop control

Note that when using machine side detector, some parameters must be set depending upon linear scale and installation conditions.

[1] Set SV025 bit8 to B(ent) by following the motor side detector specification as for the semi-closed loop control.

[2] When polarities of the motor side detector and machine side detector do not match, set SV017 bit4=1.

Setting for full-closed loop control

No.	Abbrev.	Parameter name	Explanation
SV017	SPEC*	Servo specification selection	(see bit table below)
SV025	MTYP*	Motor/detector type	(see details below)

SV017 bit layout:

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
spm								abs			fdir	vfb		dfbx	

bit		Meaning when set to 0	Meaning when set to 1
4	fdir	Position feedback forward polarity	Position feedback reverse polarity

SV025:

bit		Details
8–B	ent	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".
C–F	pen	

Detector model name	pen setting	ent setting
	0	Setting impossible
	1	Setting impossible
A51, A74	2 (Note)	2
	3	Setting impossible
	4	Setting impossible
	5	Setting impossible
	6	Setting impossible
	7	Setting impossible
Relative position rectangular wave output scale	8	Setting impossible
	9	Setting impossible
	A	Setting impossible
	B	Setting impossible
	C	Setting impossible
	D	Setting impossible
	E	Setting impossible
	F	Setting impossible

(Note) Setting for semi-closed loop control.

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

(4) Setting of regenerative resistor type

Set the following parameter according to the connected regenerative resistor unit.

No.	Abbrev.	Parameter name	Explanation
SV036	PTYP*	Regenerative resistor type	(see below)

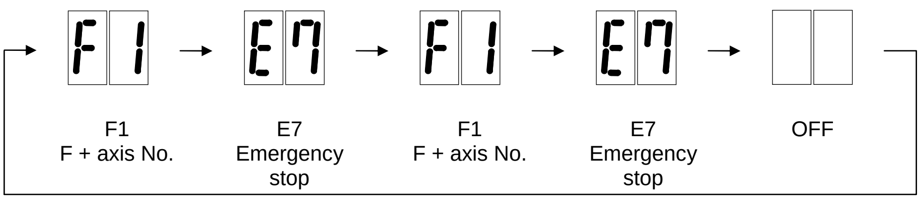
F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
1				rtyp				emgx				0			

bit		Explanation
8, 9, A, B	rtyp	Set the regenerative resistor type.

Setting	Details
0 to 1	Setting prohibited
2	GZG200W26OHMJ
3	GZG300W20OHMJ
4	MR-RB32 or GZG200W120OHMJ 3 units connected in parallel
5	MR-RB30 or GZG200W39OHMJ 3 units connected in parallel
6	MR-RB50 or GZG300W39OHMJ 3 units connected in parallel
7	MR-RB31 or GZG200W20OHMJ 3 units connected in parallel
8	MR-RB51 or GZG300W20OHMJ 3 units connected in parallel
9	MR-RB65 or GRZG400-2OHMJ 4 units connected in serial
A	GZG80W26OHMJ
B	GZG400W13OHMJ
C	GZG400W8OHMJ
D to F	Setting prohibited

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

If the emergency stop state is displayed on the drive unit's LED, the system has started up normally.



Normal LED display at NC power ON (1st axis)

⚠ **CAUTION**	Always input emergency stop when starting up the servo system.

8-2-2 Limitations to electronic gear setting value

The servo drive unit has internal electronic gears. The command value from the NC is converted into a detector resolution unit to carry out position control. The electronic gears are single gear ratios calculated from multiple parameters as shown below. However, each value (ELG1, ELG2) must be less than 32767. If the value overflows, the initial parameter error (alarm 37) or error parameter No. 101 (2301 with M60S/E60 Series NC) will be output.
If an alarm occurs, the mechanical specifications and electrical specifications must be revised so that the electronic gears are within the specified range.

(1) For semi-closed loop control

$$\text{Reduced fraction of } \frac{\text{ELG1}}{\text{ELG2}} = \frac{\text{PC2} \times \text{RNG1}}{\text{PC1} \times \text{PIT} \times \text{IUNIT}} \text{ (reduced fraction)}$$

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

When the above is calculated, the following conditions must be satisfied.
ELG1 ≤ 32767
ELG2 ≤ 32767

(2) For full-closed loop control

$$\text{Reduced fraction of } \frac{\text{PGNX}}{\text{PGNY}} = \frac{\text{PC2} \times \text{RNG2} \times \text{PGN1}}{\text{PC1} \times \text{RNG1} \times 30} \text{ (reduced fraction)}$$

When the above is calculated, the following conditions must be satisfied.
PGNX ≤ 32767
PGNY ≤ 32767

And,

$$\text{Reduced fraction of } \frac{\text{PGNXsp}}{\text{PGNYsp}} = \frac{\text{PC2} \times \text{RNG2} \times \text{PGN1sp}}{\text{PC1} \times \text{RNG1} \times 30} \text{ (reduced fraction)}$$

When the above is calculated, the following conditions must be satisfied.
PGNXsp ≤ 32767
PGNYsp ≤ 32767

POINT	If the electronic gear value in the drive unit overflows, alarm 37 or error parameter No. 101 (2301 with M60S/E60 Series NC) will be output.

8-2-3 Standard parameter list according to servomotor

(1) HF Series

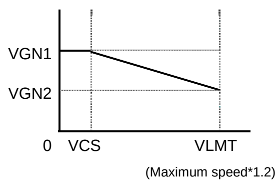
Parameter		Motor	Standard HF motor												
			HF 75	HF 105	HF 54	HF 104	HF 154	HF 224	HF 204	HF 354	HF 123	HF 223	HF 303	HF 142	HF 302
No.	Abbrev.	Details / Unit capacity	20/40	20/40	20/40	20/40	40/60/80	60	40/60/80	60/80	20	40	60	20	40
SV001	PC1	Motor side gear ratio	---	---	---	---	---	---	---	---	---	---	---	---	---
SV002	PC2	Machine side gear ratio	---	---	---	---	---	---	---	---	---	---	---	---	---
SV003	PGN1	Position loop gain 1	33	33	33	33	33	33	33	33	33	33	33	33	33
SV004	PGN2	Position loop gain 2	0	0	0	0	0	0	0	0	0	0	0	0	0
SV005	VGN1	Speed loop gain 1	20	40	50	50	50	70	100	120	70	70	140	70	140
SV006	VGN2	Speed loop gain 2	0	0	0	0	0	0	0	0	0	0	0	0	0
SV007	VIL	Speed loop delay compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
SV008	VIA	Speed loop lead compensation	1364	1364	1364	1364	1364	1364	1364	1364	1364	1364	1364	1364	1364
SV009	IQA	Current loop q axis lead compensation	6144	6144	6144	6144	6144	6144	6144	6144	10240	8192	4096	15360	4096
SV010	IDA	Current loop d axis lead compensation	6144	6144	6144	6144	6144	6144	6144	6144	10240	8192	4096	15360	4096
SV011	IQG	Current loop q axis gain	768	512	1280	1024	1024	768	1024	1024	1280	1024	1280	2048	1280
SV012	IDG	Current loop d axis gain	768	512	1280	1024	1024	768	1024	1024	1280	1024	1280	2048	1280
SV013	ILMT	Current limit value	500	500	500	500	500	500	500	500	500	500	500	500	500
SV014	ILMTsp	Current limit value in special control	500	500	500	500	500	500	500	500	500	500	500	500	500
SV015	FFC	Acceleration rate feed forward gain	0	0	0	0	0	0	0	0	0	0	0	0	0
SV016	LMC1	Lost motion compensation 1	0	0	0	0	0	0	0	0	0	0	0	0	0
SV017	SPEC	Servo specification selection	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
SV018	PIT	Ball screw pitch	---	---	---	---	---	---	---	---	---	---	---	---	---
SV019	RNG1	Position detector resolution	---	---	---	---	---	---	---	---	---	---	---	---	---
SV020	RNG2	Speed detector resolution	---	---	---	---	---	---	---	---	---	---	---	---	---
SV021	OLT	Overload detection time constant	60	60	60	60	60	60	60	60	60	60	60	60	60
SV022	OLL	Overload detection level	150	150	150	150	150	150	150	150	150	150	150	150	150
SV023	OD1	Excessive error detection width during servo ON	6	6	6	6	6	6	6	6	6	6	6	6	6
SV024	INP	In-position detection width	50	50	50	50	50	50	50	50	50	50	50	50	50
SV025	MTYP	Motor/Detector type	221D	221E	2210	2211	2212	2216	2213	2214	2224	2226	2228	2225	2227
SV026	OD2	Excessive error detection width during servo OFF	6	6	6	6	6	6	6	6	6	6	6	6	6
SV027	SSF1	Servo function selection 1	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
SV029	VCS	Speed at the change of speed loop gain	0	0	0	0	0	0	0	0	0	0	0	0	0
SV030	IVC	Voltage non-sensitive compensation	0	0	0	0	0	0	0	0	0	0	0	0	0
SV031	OVS1	Overshooting compensation 1	0	0	0	0	0	0	0	0	0	0	0	0	0
SV032	TOF	Torque offset 1	0	0	0	0	0	0	0	0	0	0	0	0	0
SV033	SSF2	Servo function selection 2	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
SV034	SSF3	Servo function selection 3	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
SV035	SSF4	Servo function selection 4	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
SV036	PTYP	Regenerative resistor type	1x00	1x00	1x00	1x00	1x00	1x00	1x00	1x00	1x00	1x00	1x00	1x00	1x00
SV037	JL	Load inertia scale	0	0	0	0	0	0	0	0	0	0	0	0	0
SV038	FHz1	Notch filter frequency 1	0	0	0	0	0	0	0	0	0	0	0	0	0
SV039	LMCD	Lost motion compensation timing	0	0	0	0	0	0	0	0	0	0	0	0	0
SV040	LMCT	Lost motion compensation non-sensitive band	0	0	0	0	0	0	0	0	0	0	0	0	0
SV041	LMC2	Lost motion compensation 2	0	0	0	0	0	0	0	0	0	0	0	0	0
SV042	OVS2	Overshooting compensation 2	0	0	0	0	0	0	0	0	0	0	0	0	0
SV043	OBS1	Disturbance observer filter frequency	0	0	0	0	0	0	0	0	0	0	0	0	0
SV044	OBS2	Disturbance observer gain	0	0	0	0	0	0	0	0	0	0	0	0	0
SV045	TRUB	Current compensation (the high order 8 bits)	0	0	0	0	0	0	0	0	0	0	0	0	0
SV046	FHz2	Notch filter frequency 2	0	0	0	0	0	0	0	0	0	0	0	0	0
SV047	EC1	Inductive voltage compensation gain	100	100	100	100	100	100	100	100	100	100	100	100	100
SV048	EMGrt	Vertical axis drop prevention time	0	0	0	0	0	0	0	0	0	0	0	0	0
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	15	15	15	15	15	15	15	15	15	15	15	15	15
SV050	PGN2sp	Position loop gain 2 in spindle synchronous control	0	0	0	0	0	0	0	0	0	0	0	0	0
SV051	DFBT	Dual feedback control time constant	0	0	0	0	0	0	0	0	0	0	0	0	0
SV052	DFBN	Dual feedback control non-sensitive band	0	0	0	0	0	0	0	0	0	0	0	0	0
SV053	OD3	Excessive error detection width in special control	0	0	0	0	0	0	0	0	0	0	0	0	0
SV054	ORE	Overrun detection width in closed loop control	0	0	0	0	0	0	0	0	0	0	0	0	0
SV055	EMGx	Max. gate off delay time after emergency stop	0	0	0	0	0	0	0	0	0	0	0	0	0
SV056	EMGt	Deceleration time constant at emergency stop	0	0	0	0	0	0	0	0	0	0	0	0	0
SV057	SHGC	SHG control gain	0	0	0	0	0	0	0	0	0	0	0	0	0
SV058	SHGCsp	SHG control gain in spindle synchronous control	0	0	0	0	0	0	0	0	0	0	0	0	0

Parameter			Motor	Standard HF motor												
				HF 75	HF 105	HF 54	HF 104	HF 154	HF 224	HF 204	HF 354	HF 123	HF 223	HF 303	HF 142	HF 302
No.	Abbrev.	Details	Unit capacity	20/40	20/40	20/40	20/40	40/60 /80	60	40/60 /80	60/80	20	40	60	20	40
SV059				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
SV061	DA1NO	D/A output channel 1 data No.		0	0	0	0	0	0	0	0	0	0	0	0	0
SV062	DA2NO	D/A output channel 2 data No.		0	0	0	0	0	0	0	0	0	0	0	0	0
SV063	DA1MPY	D/A output channel 1 output scale		0	0	0	0	0	0	0	0	0	0	0	0	0
SV064	DA2MPY	D/A output channel 2 output scale		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
		(System parameter area)														
SV081	SPEC2	Servo specification 2		0	0	0	0	0	0	0	0	0	0	0	0	0
SV082 to SV088				0	0	0	0	0	0	0	0	0	0	0	0	0
SV089	TQMAX kq	Torque maximizing control kq gain (For machine tool builder adjustment)		0	0	0	0	0	0	0	0	0	0	0	0	0
SV090	TQMAX kd	Torque maximizing control kd gain (For machine tool builder adjustment)		0	0	0	0	0	0	0	0	0	0	0	0	0
SV091 to SV93				0	0	0	0	0	0	0	0	0	0	0	0	0
SV094	MPV	Magnetic pole position error detection speed		0	0	0	0	0	0	0	0	0	0	0	0	0
SV095 to SV100				0	0	0	0	0	0	0	0	0	0	0	0	0

Parameter			Motor	HF motor						
				44	74	53	103	153	203	353
No.	Abbrev.	Details	Unit capacity	20/40	20/40	20/40	20/40	40/60/80	40/60/80	60/80
SV001	PC1	Motor side gear ratio		---	---	---	---	---	---	---
SV002	PC2	Machine side gear ratio		---	---	---	---	---	---	---
SV003	PGN1	Position loop gain 1		33	33	33	33	33	33	33
SV004	PGN2	Position loop gain 2		0	0	0	0	0	0	0
SV005	VGN1	Speed loop gain 1		20	40	50	50	50	100	120
SV006	VGN2	Speed loop gain 2		0	0	0	0	0	0	0
SV007	VIL	Speed loop delay compensation		0	0	0	0	0	0	0
SV008	VIA	Speed loop lead compensation		1364	1364	1364	1364	1364	1364	1364
SV009	IQA	Current loop q axis lead compensation		6144	6144	6144	6144	6144	6144	6144
SV010	IDA	Current loop d axis lead compensation		6144	6144	6144	6144	6144	6144	6144
SV011	IQG	Current loop q axis gain		768	512	1280	1024	1024	1024	1024
SV012	IDG	Current loop d axis gain		768	512	1280	1024	1024	1024	1024
SV013	ILMT	Current limit value		500	500	500	500	500	500	500
SV014	ILMTsp	Current limit value in special control		500	500	500	500	500	500	500
SV015	FFC	Acceleration rate feed forward gain		0	0	0	0	0	0	0
SV016	LMC1	Lost motion compensation 1		0	0	0	0	0	0	0
SV017	SPEC1	Servo specification selection		1000	1000	1000	1000	1000	1000	1000
SV018	PIT	Ball screw pitch		---	---	---	---	---	---	---
SV019	RNG1	Position detector resolution		---	---	---	---	---	---	---
SV020	RNG2	Speed detector resolution		---	---	---	---	---	---	---
SV021	OLT	Overload detection time constant		60	60	60	60	60	60	60
SV022	OLL	Overload detection level		150	150	150	150	150	150	150
SV023	OD1	Excessive error detection width during servo ON		6	6	6	6	6	6	6
SV024	INP	In-position detection width		50	50	50	50	50	50	50
SV025	MTYP	Motor/Detector type		220D	220E	2200	2201	2202	2203	2204
SV026	OD2	Excessive error detection width during servo OFF		6	6	6	6	6	6	6
SV027	SSF1	Servo function selection 1		4000	4000	4000	4000	4000	4000	4000
SV028				0	0	0	0	0	0	0
SV029	VCS	Speed at the change of speed loop gain		0	0	0	0	0	0	0
SV030	IVC	Voltage non-sensitive compensation		0	0	0	0	0	0	0
SV031	OVS1	Overshooting compensation 1		0	0	0	0	0	0	0
SV032	TOF	Torque offset 1		0	0	0	0	0	0	0
SV033	SSF2	Servo function selection 2		0000	0000	0000	0000	0000	0000	0000
SV034	SSF3	Servo function selection 3		0000	0000	0000	0000	0000	0000	0000
SV035	SSF4	Servo function selection 4		0000	0000	0000	0000	0000	0000	0000
SV036	PTYP	Regenerative resistor type		1x00	1x00	1x00	1x00	1x00	1x00	1x00
SV037	JL	Load inertia scale		0	0	0	0	0	0	0
SV038	FHz1	Notch filter frequency 1		0	0	0	0	0	0	0
SV039	LMCD	Lost motion compensation timing		0	0	0	0	0	0	0
SV040	LMCT	Lost motion compensation non-sensitive band		0	0	0	0	0	0	0
SV041	LMC2	Lost motion compensation 2		0	0	0	0	0	0	0
SV042	OVS2	Overshooting compensation 2		0	0	0	0	0	0	0
SV043	OBS1	Disturbance observer filter frequency		0	0	0	0	0	0	0
SV044	OBS2	Disturbance observer gain		0	0	0	0	0	0	0
SV045	TRUB	Current compensation (the high order 8 bits)		0	0	0	0	0	0	0
SV046	FHz2	Notch filter frequency 2		0	0	0	0	0	0	0
SV047	EC1	Inductive voltage compensation gain		100	100	100	100	100	100	100
SV048	EMGrt	Vertical axis drop prevention time		0	0	0	0	0	0	0
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control		15	15	15	15	15	15	15
SV050	PGN2sp	Position loop gain 2 in spindle synchronous control		0	0	0	0	0	0	0
SV051	DFBT	Dual feedback control time constant		0	0	0	0	0	0	0
SV052	DFBN	Dual feedback control non-sensitive band		0	0	0	0	0	0	0
SV053	OD3	Excessive error detection width in special control		0	0	0	0	0	0	0
SV054	ORE	Overrun detection width in closed loop control		0	0	0	0	0	0	0
SV055	EMGx	Max. gate off delay time after emergency stop		0	0	0	0	0	0	0
SV056	EMGt	Deceleration time constant at emergency stop		0	0	0	0	0	0	0

Parameter		Motor		HF motor						
				33	73	53	103	153	203	353
No.	**Abbrev.**	**Details**	**Unit capacity**	**20/40**	**20/40**	**20/40**	**20/40**	**40/60/80**	**40/60/80**	**60/80**
SV057	SHGC	SHG control gain		0	0	0	0	0	0	0
SV058	SHGCsp	SHG control gain in spindle synchronous control		0	0	0	0	0	0	0
SV059				0	0	0	0	0	0	0
SV060				0	0	0	0	0	0	0
SV061	DA1NO	D/A output channel 1 data No.		0	0	0	0	0	0	0
SV062	DA2NO	D/A output channel 2 data No.		0	0	0	0	0	0	0
SV063	DA1MPY	D/A output channel 1 output scale		0	0	0	0	0	0	0
SV064	DA2MPY	D/A output channel 2 output scale		0	0	0	0	0	0	0
SV065				0	0	0	0	0	0	0
(System parameter area)										
SV081	SPEC2	Servo specification 2		0	0	0	0	0	0	0
SV082 to SV088				0	0	0	0	0	0	0
SV089	TQMAX kq	Torque maximizing control kq gain (For machine tool builder adjustment)		0	0	0	0	0	0	0
SV090	TQMAX kd	Torque maximizing control kd gain (For machine tool builder adjustment)		0	0	0	0	0	0	0
SV091 to SV93				0	0	0	0	0	0	0
SV094	MPV	Magnetic pole position error detection speed		0	0	0	0	0	0	0
SV095 to SV100				0	0	0	0	0	0	0

8-3 List of 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 initial parameter error (servo alarm No. 37).	1 to 32767
SV002	PC2*	Machine side gear ratio		1 to 32767
SV003	PGN1	Position loop gain 1	Set the position loop gain. The standard setting is "33". The higher the setting value is, the more precisely the command can be followed and the shorter the positioning time gets, however, note that a bigger shock is applied to the machine during acceleration/deceleration. When using the SHG control, also set SV004 (PGN2) and SV057 (SHGC).	1 to 200 (rad/s)
SV004	PGN2	Position loop gain 2	When using the SHG control, also set SV003 (PGN1) and SV057 (SHGC). When not using the SHG control, set to "0".	0 to 999 (rad/s)
SV005	VGN1	Speed loop gain 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 999
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 maximum 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. When you set this parameter, make sure to set the torque offset (SV032 (TOF)). When not using, set to “0”.	0 to 32767
SV008	VIA	Speed loop lead compensation	Set the gain of the speed loop integration control. The standard setting is "1364". During the SHG control, the standard setting is "1900". Adjust the value by increasing/decreasing it by about 100 at a time. Raise this value to improve contour tracking precision in high-speed cutting. Lower this value when the position droop vibrates (10 to 20Hz).	1 to 9999
SV009	IQA	Current loop q axis lead compensation	Set the gain of current loop. As this setting is determined by the motor's electrical characteristics, the setting is fixed for each type of motor. Set the standard values for all the parameters depending on each motor type.	1 to 20480
SV010	IDA	Current loop d axis lead compensation		
SV011	IQG	Current loop q axis gain		1 to 4096
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 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 current %)
SV015	FFC	Acceleration rate feed forward gain	When a relative error in the synchronous control is large, apply this parameter to the axis that is delaying. The standard setting value is “0”. For the SHG control, set to "100". To adjust a relative error in acceleration/deceleration, increase the value by 50 to 100 at a time.	0 to 999 (%)

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated 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>SV016</td><td>LMC1</td><td>Lost motion compensation 1</td><td>Set this when the protrusion (that occurs due to the non-sensitive band by friction, torsion, backlash, etc) at quadrant change is too large.
This compensates the torque at quadrant change.
This is valid only when the lost motion compensation (SV027 (SSF1/lmc)) is selected. Only type 2 is compatible with the MDS-R-Vx Series.

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.

When you wish different compensation amount depending on the direction
When SV041 (LMC2) is "0", compensate with the value of SV016 (LMC1) in both of the + and -directions.
If you wish to change the compensation amount depending on the command direction, set this and SV041 (LMC2). (SV016: + direction, SV041: - direction. However, the directions may be opposite depending on other settings.)
When "-1" is set, the compensation won’t be performed in the direction of the command.</td><td>-1 to 200
(Stall current %)</td></tr>
<tr><td>SV017</td><td>SPEC*</td><td>Servo specification selection</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">spm</td><td></td><td></td><td></td><td></td><td>abs</td><td></td><td></td><td>fdir</td><td>vfb</td><td></td><td>dfbx</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>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 start</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></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
D
E
F</td><td>spm</td><td colspan="2">0 : Setting prohibited
1 : HF motor selection (standard)
2 to F : Setting prohibited</td></tr>
</table>
(Note 1) Set to "0" for bits with no particular description.</td><td></td></tr>
<tr><td>SV018</td><td>PIT*</td><td>Ball screw pitch</td><td>Set the ball screw pitch. Set to "360" for the rotary axis.</td><td>1 to 32767
(mm/rev)</td></tr>
</table>

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated 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="2">SV019</td><td rowspan="2">RNG1*</td><td rowspan="2">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
This is available for the relative position rectangular wave output specification linear scale.
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>Relative position rectangular wave output scale</td><td>Refer to detector specification manual.</td><td>SV018 (PIT)(mm)/ Resolution (μm)</td></tr>
</table></td><td>1 to 9999
(kp/PIT)</td></tr>
<tr><td>SV020</td><td>RNG2*</td><td>Speed detector resolution</td><td>Set the number of pulses per one revolution of the motor side detector.
<table>
<tr><th>Motor type</th><th>SV020 setting</th></tr>
<tr><td>HF□□-A42</td><td>100</td></tr>
<tr><td>HF□□-A47</td><td>100</td></tr>
<tr><td>HF□□-A48</td><td>260</td></tr>
<tr><td>HF□□-A51</td><td>1000</td></tr>
</table></td><td>1 to 9999
(kp/rev)</td></tr>
<tr><td>SV021</td><td>OLT</td><td>Overload detection time constant</td><td>Set the detection time constant of Overload 1 (Alarm 50).
Set to "60" as a standard. (For machine tool builder adjustment.)</td><td>1 to 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 current %)</td></tr>
<tr><td>SV023</td><td>OD1</td><td>Excessive error detection width during servo ON</td><td>Set the excessive error detection width when servo ON.
<Standard setting value> $OD1=OD2=\frac{\text{Rapid traverse rate (mm/min)}}{60\times PGN1}/2$ (mm)
When "0" is set, the excessive error detection will not be performed.</td><td>0 to 32767
(mm)</td></tr>
<tr><td>SV024</td><td>INP</td><td>In-position detection width</td><td>Set the in-position detection width.
Set the accuracy required for the machine.
The lower the setting is, the higher the positioning accuracy gets, however, the cycle time (setting time) becomes longer. The standard setting is "50".</td><td>0 to 32767
(μm)</td></tr>
</table>

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

No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)
SV025	MTYP*	Motor/Detector type	(see below)	

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

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

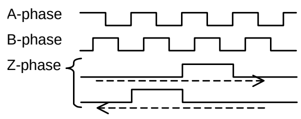
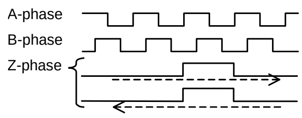
Setting	0x	1x	2x	3x	4x	5x	6x	7x
x0	HF 53	HF54						
x1	HF 03	HF104						
x2	HF153	HF154						
x3	HF203	HF204						
x4	HF353	HF354	HF123					
x5			HF142					
x6		HF224	HF223					
x7			HF302					
x8			HF303					
x9								
xA								
xB								
xC								
xD	HF 44	HF75						
xE	HF74	HF105						
xF								

Setting	8x	9x	Ax	Bx	Cx	Dx	Ex	Fx
x0								
x1								
x2								
x3								
x4								
x5								
x6								
x7								
x8								
x9								
xA								
xB								
xC								
xD								
xE								
xF								

bit		Explanation
8 9 A B	ent	Set the speed detector type. Set "2".
C D E F	pen	Set the position detector type

When applying semi-closed loop control:	Set "2".
Rectangular wave (ABZ) output type When using relative position detector scale:	Set "8".

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>SV026</td><td>OD2</td><td>Excessive error detection width during servo OFF</td><td>Set the excessive error detection width when servo ON.
For the standard setting, refer to the explanation of SV023 (OD1).
When "0" is set, the excessive error detection will not be performed.</td><td>0 to 32767 (mm)</td></tr>
<tr><td>SV027</td><td>SSF1</td><td>Servo function selection 1</td><td>
<table>
<tr><td>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>zrn2</td><td></td><td></td><td colspan="2">ovs</td><td colspan="2">lmc</td><td></td><td>zrn3</td><td colspan="2">vfct</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 rowspan="2">vfct</td><td colspan="2" rowspan="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>5</td></tr>
<tr><td>6</td><td>zrn3</td><td colspan="2">Set depending on the Z-phase output type of scale.</td></tr>
<tr><td></td><td></td><td>Rising edge position of the Z-phase does not depend on the movement direction and is constant.

</td><td>For Z phase, “H” section does not depend on the movement direction and is constant.

</td></tr>
<tr><td>7</td><td></td><td></td><td></td></tr>
<tr><td>8</td><td rowspan="2">lmc</td><td colspan="2" rowspan="2">Set the compensation amount with SV016 (LMC1) and SV041 (LMC2).
00: Lost motion compensation stop 10: Lost motion compensation type 2
01: Setting prohibited 11: Setting prohibited</td></tr>
<tr><td>9</td></tr>
<tr><td>A</td><td rowspan="2">ovs</td><td colspan="2" rowspan="2">Set the compensation amount with SV031 (OVS1) and SV042 (OVS2).
00: Overshooting compensation stop 10: Setting prohibited
01: Setting prohibited 11: Overshooting compensation type 2</td></tr>
<tr><td>B</td></tr>
<tr><td>C</td><td></td><td colspan="2"></td></tr>
<tr><td>D</td><td></td><td colspan="2"></td></tr>
<tr><td>E</td><td>zrn2</td><td colspan="2">Set to "1".</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>SV028</td><td></td><td></td><td>Not used. Set to “0”.</td><td>0</td></tr>
<tr><td>SV029</td><td>VCS</td><td>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>SV030</td><td>IVC</td><td>Voltage non-sensitive 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 200 (%)</td></tr>
<tr><td>SV031</td><td>OVS1</td><td>Overshooting compensation 1</td><td>Set this if overshooting occurs during positioning. This compensates the motor torque during positioning.
This is valid only when the overshooting compensation SV027 (SSF1.ovs) is selected.<hr>Type 3: When SV027 (SSF1)/bitB, A (ovs)=11
Set the compensation amount based on the motor’s stall current.
Increase by 1% and determine the amount that overshooting doesn’t occur.<hr>When you wish different compensation amount depending on the direction
When SV042 (OVS2) is “0”, compensate with the value of SV031 (OVS1) in both of the + and -directions.
If you wish to change the compensation amount depending on the command direction, set this and SV042 (OVS2). (SV031: + direction, SV042: - direction. However, the directions may be opposite depending on other settings.)
When “-1” is set, the compensation won’t be performed in the direction of the command.</td><td>-1 to 100 (Stall current %)</td></tr>
</table>

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range (Unit)</th></tr>
<tr><td>SV032</td><td>TOF</td><td>Torque offset 1</td><td>Set the unbalance torque of vertical axis and slant axis.</td><td>-100 to 100 (Stall current %)</td></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></td><td>zup</td><td></td><td></td><td colspan="2">dis</td><td></td><td></td><td colspan="3">nfd2</td><td>nf3</td><td colspan="3">nfd1</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
2
3</td><td>nfd1</td><td colspan="2">Set the filter depth for Notch filter 1 (SV038).
Value 000 001 010 011 100 101 110 111
Depth (dB) -∞ -18.1 -12.0 -8.5 -6.0 -4.1 -2.5 -1.2
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 operation frequency of Notch filter 2 (SV046).
Value 000 001 010 011 100 101 110 111
Depth (dB) -∞ -18.1 -12.0 -8.5 -6.0 -4.1 -2.5 -1.2
Deep← Shallow→</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
B</td><td>dis</td><td colspan="2">Select the digital signal input.
00: DI not used 10: Reserved
01: Contactor B contact input 11: Reserved</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>zup</td><td>Vertical axis pull up control stop</td><td>Vertical axis pull up control start</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>SV034</td><td>SSF3</td><td>Servo function

selection 3</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">ovsn</td><td></td><td></td><td></td><td></td><td></td><td></td><td>zeg</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>zeg</td><td>Z phase normal edge detection (Setting for normal use)</td><td>Z phase reverse edge detection (Valid only when SV027/bit6=1)</td></tr>
<tr><td>6</td><td>os2</td><td>Setting for normal use</td><td>Overspeed detection level changeover</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
D
E
F</td><td>ovsn</td><td colspan="2">Set the non-sensitive band of the overshooting compensation type 3 in increments of 2μm 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>
</table>
(Note) Set to "0" for bits with no particular description.
</td><td></td></tr>
</table>

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range
(Unit)</th></tr>
<tr><td>SV035</td><td>SSF4</td><td>Servo function selection 4</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 "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></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>

<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>Regenerative resistor type</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">1</td><td colspan="4">rtyp</td><td colspan="4">emgx</td><td colspan="4">0</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
5
6
7</td><td>emgx</td><td colspan="2">Set the external emergency stop function. (Setting is prohibited for values with no description.)
<table>
<tr><th>Setting</th><th>Explanation</th></tr>
<tr><td>0</td><td>External emergency stop invalid</td></tr>
<tr><td>4</td><td>External emergency stop valid</td></tr>
</table></td></tr>
<tr><td>8
9
A
B</td><td>rtyp</td><td colspan="2">Set the regenerative resistor type.
<table>
<tr><th>Setting</th><th>Explanation</th></tr>
<tr><td>0 to 1</td><td>Setting prohibited</td></tr>
<tr><td>2</td><td>GZG200W26OHMJ</td></tr>
<tr><td>3</td><td>GZG300W20OHMJ</td></tr>
<tr><td>4</td><td>MR-RB32 or GZG200W120OHMJ 3 units connected in parallel</td></tr>
<tr><td>5</td><td>MR-RB30 or GZG200W39OHMJ 3 units connected in parallel</td></tr>
<tr><td>6</td><td>MR-RB50 or GZG300W39OHMJ 3 units connected in parallel</td></tr>
<tr><td>7</td><td>MR-RB31 or GZG200W20OHMJ 3 units connected in parallel</td></tr>
<tr><td>8</td><td>MR-RB51 or GZG300W20OHMJ 3 units connected in parallel</td></tr>
<tr><td>9</td><td>MR-RB65 or GRZG400-2OHMJ 4 units connected in serial</td></tr>
<tr><td>A</td><td>GZG80W26OHMJ</td></tr>
<tr><td>B</td><td>GZG400W13OHMJ</td></tr>
<tr><td>C</td><td>GZG400W8OHMJ</td></tr>
<tr><td>D to F</td><td>Setting prohibited</td></tr>
</table></td></tr>
<tr><td>C
D
E
F</td><td>amp</td><td colspan="2">Always set 1 (0001).</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 is turned ON again.

No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)
SV037	JL	Load inertia scale	Set "the motor inertia + motor axis conversion load inertia" in respect to the motor inertia. $SV037(JL) = \frac{Jl+Jm}{Jm} * 100$ Jm : Motor inertia Jl : Motor axis conversion load inertia	0 to 5000 (%)
SV038	FHz1	Notch filter frequency 1	Set the vibration frequency to suppress if machine vibration occurs. (Valid at 36 or more) When not using, set to "0".	0 to 4500 (Hz)
SV039	LMCD	Lost motion compensation timing	Set this when the lost motion compensation timing doest not match. Adjust by increasing the value by 10 at a time.	0 to 2000 (ms)
SV040	LMCT	Lost motion compensation non-sensitive band	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 2μm. Adjust by increasing by 1μm at a time.	0 to 100 (μm)
SV041	LMC2	Lost motion compensation 2	Set this with SV016 (LMC1) only when you wish to set the lost motion compensation amount to be different depending on the command directions. Set to "0" as a standard.	-1 to 200 (Stall current %)
SV042	OVS2	Overshooting compensation 2	Set this with SV031 (OVS1) only when you wish to set the overshooting compensation amount to be different depending on the command directions. Set to “0” as a standard.	-1 to 100 (Stall current %)
SV043	OBS1	Disturbance observer filter frequency	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".	0 to 1000 (rad/s)
SV044	OBS2	Disturbance observer gain	Set the disturbance observer gain. The standard setting is "100" to "300". To use the disturbance observer, also set SV037 (JL) and SV043 (OBS1). When not using, set to "0".	0 to 500 (%)
SV045	TRUB	Current compensation (the high order 8 bits)	Set "0" for the low order 8 bits. Current bias:Use the high order 8 bits.(IB1) Use this in combination with SV030 and the high order 8bits of SV040.	-32768 To 32767
SV046	FHz2	Notch filter frequency 2	Set the vibration frequency to suppress if machine vibration occurs. (Valid at 36 or more) When not using, set to "0".	0 to 4500 (Hz)
SV047	EC	Inductive voltage compensation gain	Set the inductive voltage compensation gain. Set to "100" as a standard. If the current FB peak exceeds the current command peak, lower the gain.	0 to 200 (%)
SV048	EMGrt	Vertical axis drop prevention time	Input a length of time to prevent the vertical axis from dropping by delaying Ready OFF until the brake works when the emergency stop occurs. Increase the setting by 100msec at a time and set the value where the axis does not drop.	0 to 20000 (ms)
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	Set the position loop gain during the spindle synchronous control (synchronous tapping, synchronous control with spindle/C axis). Set the same value as the value of the spindle parameter, position loop gain in synchronous control. When performing the SHG control, set this with SV050 (PGN2sp) and SV058 (SHGCsp).	1 to 200 (rad/s)
SV050	PGN2sp	Position loop gain 2 in spindle synchronous control	Set this with SV049 (PGN1sp) and SV058 (SHGCsp) if you wish to perform the SHG control in the spindle synchronous control (synchronous tapping, synchronous control with spindle/C axis). When not performing the SHG control, set to "0".	0 to 999 (rad/s)
SV051	DFBT	Dual feed back control time constant	Set the control time constant in dual feed back. When “0” is set, the actual value that is set is 1ms. 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.	0 to 9999 (ms)
SV052	DFBN	Dual feedback control dead zone	Set the dead zone in the dual feedback control. Set to “0” as a standard.	0 to 9999 (μm)
SV053	OD3	Excessive error detection width in special control	Set the excessive error detection width when servo ON in a special control (initial absolute position setting, stopper control, etc.). If "0" is set, excessive error detection won’t be performed.	0 to 32767 (mm)
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 the time from when emergency stop is input to when READY is forcibly turned OFF. Normally, set the same value as SV056. When using vertical axis drop prevention control, the gate off will be delayed by the time set in SV048 even if SV055 is smaller than SV048.	0 to 20000 (ms)

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range (Unit)</th></tr>
<tr><td>SV056</td><td>EMGt</td><td>Deceleration time constant at emergency stop</td><td>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.</td><td>0 to 20000 (ms)</td></tr>
<tr><td>SV057</td><td>SHGC</td><td>SHG control gain</td><td>When performing the SHG control, set this with S003 (PGN1) and SV004 (PGN2).
When not performing the SHG control, set to "0".</td><td>0 to 1200 (rad/s)</td></tr>
<tr><td>SV058</td><td>SHGCsp</td><td>SHG control gain in spindle synchronous control</td><td>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".</td><td>0 to 1200 (rad/s)</td></tr>
<tr><td>SV059</td><td></td><td></td><td>Not used. Set to "0".</td><td>0</td></tr>
<tr><td>SV060</td><td></td><td></td><td>Not used. Set to "0".</td><td>0</td></tr>
<tr><td>SV061</td><td>DA1NO</td><td>D/A output channel 1 data No.</td><td rowspan="2">Input the No. of the data to be output to the D/A output channel.</td><td rowspan="2">0 to 102</td></tr>
<tr><td>SV062</td><td>DA2NO</td><td>D/A output channel 2 data No.</td></tr>
<tr><td>SV063</td><td>DA1MPY</td><td>D/A output channel 1 output scale</td><td rowspan="2">When "0" is set, the data is output with the standard output unit.
Set a value other than 0 to change the output unit.
The scale is set with a 1/256 unit. When 256 is set, the unit is the same as the standard output unit.</td><td rowspan="2">-32768 to 32767 (Unit: 1/256)</td></tr>
<tr><td>SV064</td><td>DA2MPY</td><td>D/A output channel 2 output scale</td></tr>
<tr><td>SV065</td><td></td><td></td><td>Not used. Set to "0".</td><td>0</td></tr>
<tr><td>SV066 to SV080</td><td></td><td>System setting parameter</td><td>These parameters are set automatically by the NC system.</td><td></td></tr>
<tr><td>SV081</td><td>SPEC2</td><td>Servo specification 2</td><td colspan="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>sabs</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>sabs</td><td>Setting for normal use</td><td>Absolute position detection semi ABS is valid (Note1)</td></tr>
</table>
(Note 1) When performing by semi ABS method of absolute position detection, set "1". Also set SV017/abs to "1".
(Note 2) Set 0 if there is no particular explanation for the bit.
</td></tr>
</table>

<table>
<tr><th>No.</th><th>Abbr.</th><th>Parameter name</th><th>Details</th><th>Setting range (Unit)</th></tr>
<tr><td>SV082
to
SV088</td><td></td><td></td><td>Not used. Set to "0".</td><td>0</td></tr>
<tr><td>SV089</td><td>TQMAX
kq</td><td>Torque maximizing control
kq gain</td><td>The gain kq of torque maximizing control is set.
When "0" is set, a default gain corresponding to the motor type setting is used inside the driver.
When "-1" is set, the gain become 0 inside the driver.</td><td>-1～1000</td></tr>
<tr><td>SV090</td><td>TQMAX
kd</td><td>Torque maximizing control
kd gain</td><td>The gain kd of torque maximizing control is set.
When "0" is set, a default gain corresponding to the motor type setting is used inside the driver.
When "-1" is set, the gain become 0 inside the driver.</td><td>-1～1000</td></tr>
<tr><td>SV091
to
SV093</td><td></td><td></td><td>Not used. Set to "0".</td><td>0</td></tr>
<tr><td>SV094</td><td>MPV</td><td>Magnetic pole position error detection speed</td><td>When not using, set to "0".
In the magnetic pole position error detection (alarm 3E), as a detection condition, it is monitored that the absolute value of the command motor speed and FB motor speed are above the standard, therefore, the standard of the command motor speed level and FB motor speed level is set. In decimal, the setting values for ones digit to hundreds digit are the FB motor speed level (10r/min), and for thousands digit to ten-thousands digit are the command motor speed level (10r/min).
When the command motor speed level is set to "0", the command motor speed level is set to 10(r/min) inside the driver. When the FB motor speed level is set to "0", magnetic pole position error is not detected.
When Magnetic pole position error detection is validated, set the standard setting value of SV094 to "0". This detects the magnetic pole position error when the FB motor speed level is 100(r/min) and command motor speed level 10(r/min).
<table>
<tr><td>Ten-thousands digit</td><td>Thousands digit</td><td>Hundreds digit</td><td>Tens digit</td><td>Ones digit</td></tr>
<tr><td colspan="2">Command motor speed level (10r/min)</td><td colspan="3">FB motor speed level (10r/min)</td></tr>
</table>
</td><td>0～31999</td></tr>
<tr><td>SV095
to
SV100</td><td></td><td></td><td>Not used. Set to "0".</td><td>0</td></tr>
</table>

9. Adjustment

9-1 Servo adjustment data output function (D/A output)

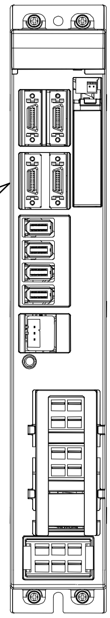
The MDS-R-V1/V2 servo drive unit has a function to D/A output the various control data.
The servo adjustment data required for setting the servo parameters to match the machine can be D/A output. Measure using a high-speed waveform recorder, synchroscope, etc.

9-1-1 D/A output specifications

Item	Explanation
No. of channels	2ch
Output cycle	0.8ms (Min. value)
Output precision	12bit
Output voltage range	0~2.5~5V
Output magnification setting	±1/256 to ±128-fold
Output pins	CN9 connector Channel 1 = Pin 4 Channel 2 = Pin 14 GND (LG) = Pins 1
Function	Phase current feedback output function L axis U phase current FB : pin 6 L axis V phase current FB : pin 16 M axis U phase current FB : pin 7 M axis V phase current FB : pin 17
Option	Relay terminal block: MR-J2CN3TM Lead out with the SH21 cable from the CN9 connector and connect.

CN9 connector

Pin	Signal	Pin	Signal
1	LG	11	
2		12	
3	SG	13	MBR
4	MO1	14	MO2
5	COM	15	MC
6	LUIFB	16	LVIFB
7	MUIFB	17	MVIFB
8		18	
9		19	
10	VDD	20	EMGX



9-1-2 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. **(Note)** When using the 2-axis drive unit (MDS-R-V2), set "0" for the data No. of the other axis in the same drive unit which is not to be D/A output.
SV062	DA2NO	D/A output channel 2 data No.	

No.	Output data	Standard output unit	Output cycle	No.	Output data	Standard output unit	Output cycle
0	D/A output not selected						
1	Speed feedback	1000 r/min / 0.5V	0.8ms	21	Load level	100%/0.5V	0.1s
2	Current feedback	Stall current/0.5V	0.8ms	22			
3	Speed command	1000 r/min / 0.5V	0.8ms	23	Regeneration load level	100%/0.5V	0.9s
4	Current command	Stall current/0.5V	0.8ms	24			
5				25			
6				26			
7	Estimated disturbance torque	Stall current/0.5V	0.8ms	27			
8				28			
9				29			
10				30			
11	Position droop	mm/0.5V	3.5ms	31 ~ 99	No setting		
12	Position droop (×10)	100µm/0.5V	3.5ms				
13	Position droop (×100)	10µm/0.5V	3.5ms				
14	Feedrate (FΔT)	10000(mm/min)/0.5V	0.8ms	100	2.5V test output	–	–
15	Feedrate (FΔT×10)	1000(mm/min)/0.5V	0.8ms	101	Sawtooth wave test output	0 to 5V Cycle 113.7ms	0.8ms
16	Model position droop	mm/0.5V	3.5ms				
17	Model position droop (×10)	100µm/0.5V	3.5ms	102	Short wave test output	0 to 5V Cycle 227.5ms	0.8ms
18	Model position droop (×100)	10µm/0.5V	3.5ms	103 ~	Setting prohibited		
19							
20							

9-1-3 Setting the output magnification

Set as follows to output with a unit other than the standard output unit.

(Example 1) When SV061 = 11 and SV063 = 2560
The position droop is output as a 0.1mm/V unit to D/A output channel 1.

(Example 2) When SV062 = 11 and SV064 = 128
The position droop is output as a 2mm/V unit to D/A output channel 2.

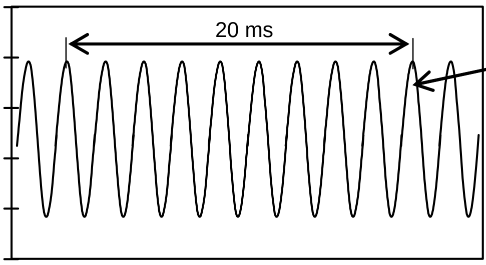
No.	Abbrev.	Parameter name	Explanation	Setting range
SV063	DA1MPY	D/A output channel 1 output magnification	When "0" is set, the data is output with the standard output unit. Set a value other than 0 to change the output unit. The scale is set with a 1/256 unit. When 256 is set, the unit is the same as the standard output unit.	-32768 to 32767
SV064	DA2MPY	D/A output channel 2 output magnification		

9-1-4 Current feedback analog output function

Use this function to measure the resonance frequency when adjusting machine resonance suppression filter.

The phase current is output to the CN9 pin. Connect a high-speed waveform recorder, etc. between the GND (pin 1) and the phase current to be measured, and observe the state.

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



Current feedback: 9 crests

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

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.

9-2 Gain adjustment

9-2-1 Current loop gain

No.	Abbrev.	Parameter name	Explanation	Setting range
SV009	IQA	Current loop q axis leading 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 leading compensation		
SV011	IQG	Current loop q axis gain		1 to 4096
SV012	IDG	Current loop d axis gain		

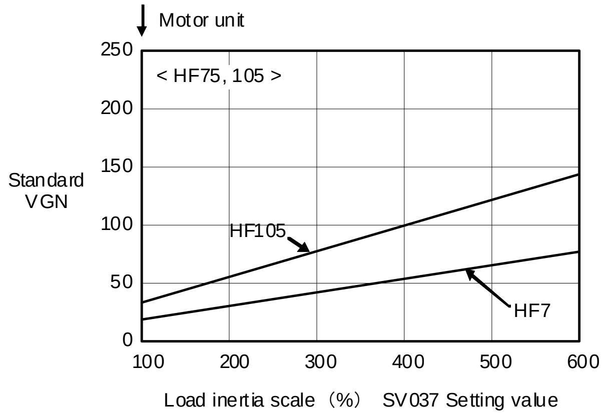
9-2-2 Speed loop gain

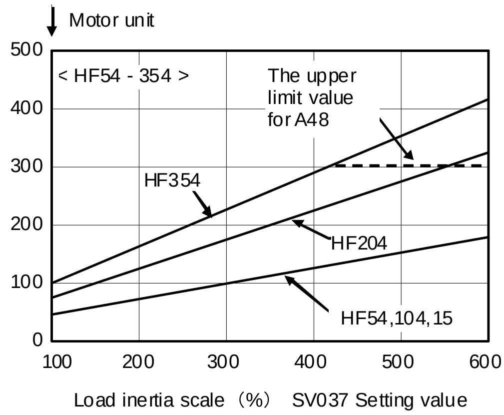
(1) Setting the speed loop gain

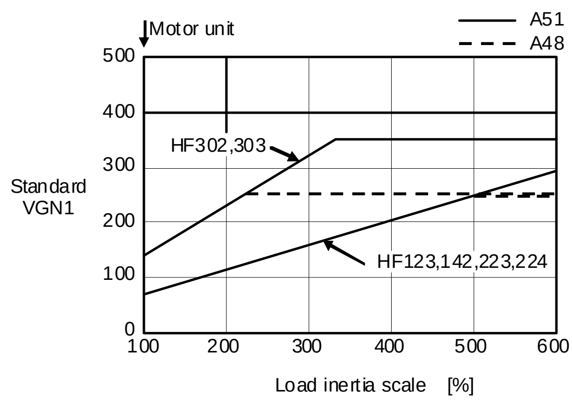
The speed loop gain (SV005 (VGN1)) is an important parameter for determining the responsiveness of the servo control. During servo adjustment, the highest extent that this value can be set to becomes important. The setting value has a large influence on the machine cutting precision and cycle time.

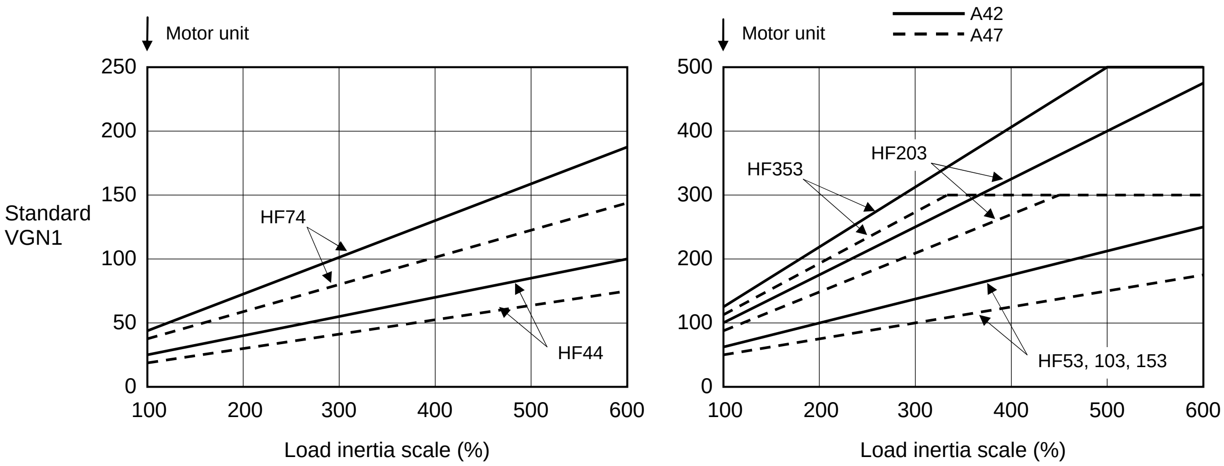
(a) Refer to the following table and set the standard VGN1 according to the size of the entire load inertia (motor and machine load inertia).

(b) 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.









<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 "9-3-2 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 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 999

POINT

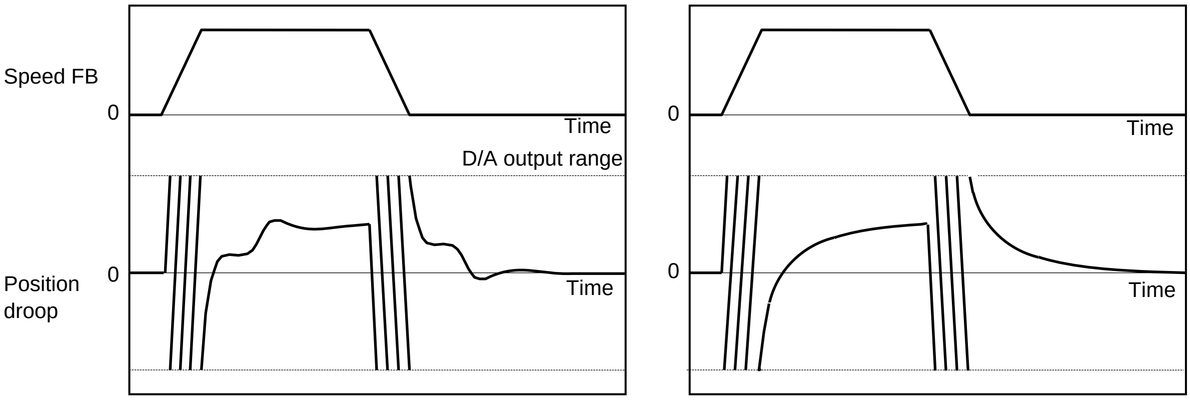
The final VGN1 setting value is 70 to 80% of the maximum value at which the machine does not resonate.
Suppressing the resonance with the vibration suppression function and increasing the VGN1 setting is effective for adjusting the servo later.

(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). For machines which aim to attain a high speed and high accuracy, set VGN1 to a sufficiently large value so that VIA does not need to be lowered. When adjusting, the cutting precision will be better if adjustment is carried out to a degree where overshooting does not occur and a high VIA is maintained, without pursuing position droop smoothness.

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

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

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

No.	Abbrev.	Parameter name	Explanation	Setting range
SV008	VIA	Speed loop lead compensation	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

POINT

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

9-2-3 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 the position loop gain. The standard setting is "33". The higher the setting value is, the more precisely the command can be followed and the shorter the positioning time gets, however, note that a bigger shock is applied to the machine during acceleration/deceleration. When using the SHG control, also set SV004 (PGN2) and SV057 (SHGC).	1 to 200 (rad/s)
SV004	PGN2	Position loop gain 2	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.

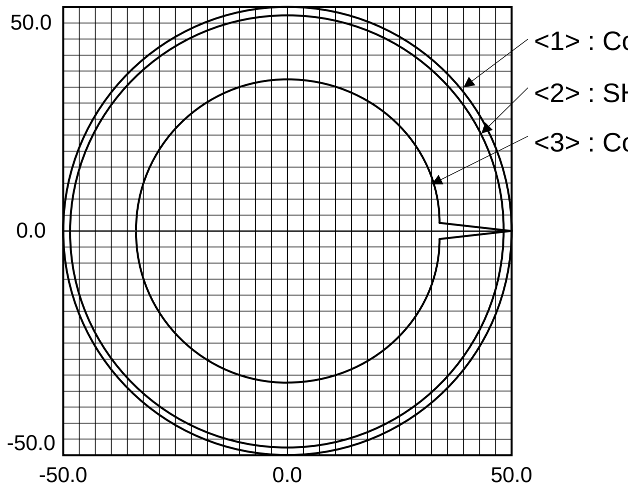
No.	Abbrev.	Parameter name	Explanation		Setting range
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	Set 15 as a standard.	Set the same parameter as the position loop gain for the spindle synchronous control.	1 to 200 (rad/s)
SV050	PGN2sp	Position loop gain 2 in spindle synchronous control	Set 0 as a standard. (For SHG control)		0 to 999
SV058	SHGCsp	SHG control gain in spindle synchronous control	Set 0 as a standard. (For SHG control)		0 to 1200

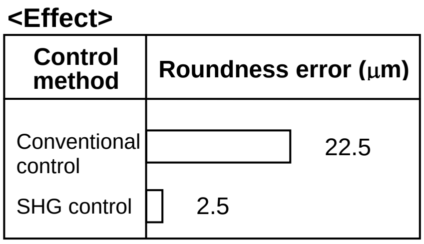
⚠ CAUTION Always set the same value for the position loop gain between the spindle and servo synchronous axes.

(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.





(F=3000mm/min, ERROR=5.0μm/div)

Shape error characteristics

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

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

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

No.	Abbrev.	Parameter name	Setting ratio	Setting example					Explanation	Setting range
SV003 (SV049)	PGN1 (PGN1sp)	Position loop gain 1	1	23	26	33	38	47	Always set a combination of 3 parameters	1 to 200
SV004 (SV050)	PGN2 (PGN2sp)	Position loop gain 2	$\frac{8}{3}$	62	70	86	102	125		0 to 999
SV057 (SV058)	SHGC (SHGCsp)	SHG control gain	6	140	160	187	225	281		0 to 1200
SV008	VIA	Speed loop lead compensation	Set 1900 as a standard for SHG control.							1 to 9999
SV015	FFC	Acceleration rate 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 M60S/ E60 Series NC) will be output.

9-3 Characteristics improvement

9-3-1 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

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. The output torque is limited in areas near the maximum rotation speed, so when adjusting, view the current FB waveform during acceleration/deceleration and adjust so that the torque is within the specified range.
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

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 reciprocating cutting feed operation without dwell at the maximum cutting speed, and adjust the acceleration/deceleration time constant so that the maximum current command value during acceleration/deceleration is within the range shown below.

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

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

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

Maximum current command value when adjusting acceleration/deceleration time constant

Maximum current command value when adjusting acceleration/deceleration time constant

Motor model	Compatible drive unit	Max. current command value (%)	Motor model	Compatible drive unit	Max. current command value (%)
HF75	MDS-R-Vx-20/40	343	HF44	MDS-R-Vx-20/40	343
HF105	MDS-R-Vx-20/40	296	HF74	MDS-R-Vx-20/40	296
HF54	MDS-R-Vx-20/40	340	HF53	MDS-R-Vx-20/40	340
HF104	MDS-R-Vx-40	315	HF103	MDS-R-Vx-20	227
HF104	MDS-R-Vx-20	227	HF103	MDS-R-Vx-40	315
HF154	MDS-R-Vx-60/80	339	HF153	MDS-R-Vx-40	229
HF154	MDS-R-Vx-40	229	HF153	MDS-R-Vx-60/80	339
HF224	MDS-R-Vx-60	253	HF203	MDS-R-Vx-40	230
HF204	MDS-R-Vx-60/80	248	HF203	MDS-R-Vx-60/80	248
HF204	MDS-R-Vx-40	230	HF353	MDS-R-Vx-60	236
HF354	MDS-R-Vx-80	228	HF353	MDS-R-Vx-80	228
HF354	MDS-R-Vx-60	236			
HF123	MDS-R-Vx-20	194			
HF223	MDS-R-Vx-40	227			
HF303	MDS-R-Vx-60	232			
HF142	MDS-R-Vx-20	194			
HF302	MDS-R-Vx-40	213			

(3) Adjusting the in-position width

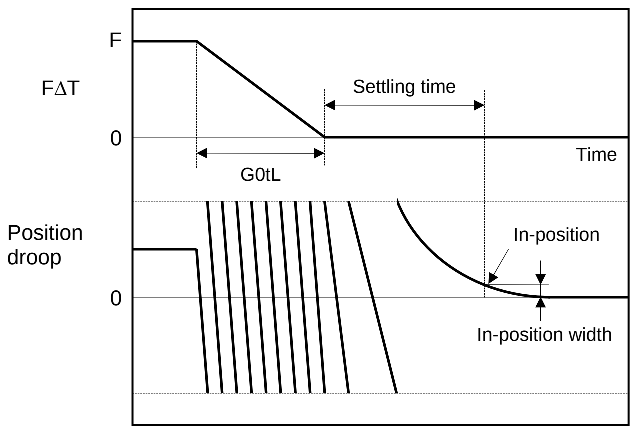
Because there is a response delay in the servomotor drive due to position loop control, a "settling time" is also required for the motor to actually stop after the command speed from the CNC reaches 0. The movement command in the next block is generally started after it is confirmed that the machine 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.
As a standard, the in-position width is valid with the servo parameters. However, there may be cases when the NC parameters must be set. Refer to each NC Instruction Manual and set the value.

No.	Abbrev.	Parameter name	Explanation	Setting range
SV024	INP	In-position detection width	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".	0 to 32767 (μm)

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 $\sqrt{2}$.



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

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)

9-3-2 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 "9-2-2 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) Notch filter

The notch filter operates at the set frequency. Measure the resonance frequency with the current feedback analog output function, and set that frequency in SV038 or SV046.
If the notch filter is set to a particularly low frequency, vibration may occur initially due to another resonance frequency that existed latently. If the notch filter's depth compensation (SV033 (nfd1, nfd2)) is adjusted so that the filter does not operate unless necessary, the servo control will stabilize.
Notch filter 3 (SV033 (bit4)) is a filter with frequency fixed to 1125Hz, and has no depth compensation.

<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. If the vibration cannot be removed completely, use another vibration suppression control (notch filter 3, jitter compensation).

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range</th></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 4500
(Hz)</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 4500
(Hz)</td></tr>
<tr><td>SV033</td><td>SSF2</td><td>Servo function selection 2</td><td colspan="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>zup</td><td></td><td></td><td colspan="2">dis</td><td></td><td></td><td colspan="3">nfd2</td><td>nf3</td><td colspan="3">nfd1</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>1</td><td rowspan="3">nfd1</td><td colspan="2">Set the filter depth for Notch filter 1 (SV038).</td></tr>
<tr><td>2</td><td colspan="2">Value Deep← 000 001 010 011 100 101 110 111 →Shallow</td></tr>
<tr><td>3</td><td colspan="2">Depth (dB) -∞ -18.1 -12.0 -8.5 -6.0 -4.1 -2.5 -1.2</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</td><td rowspan="3">nfd2</td><td colspan="2">Set the operation frequency of Notch filter 2 (SV046).</td></tr>
<tr><td>6</td><td colspan="2">Value Deep← 000 001 010 011 100 101 110 111 →Shallow</td></tr>
<tr><td>7</td><td colspan="2">Depth (dB) -∞ -18.1 -12.0 -8.5 -6.0 -4.1 -2.5 -1.2</td></tr>
</table>
</td></tr>
</table>

The recommended setting value of depth for each setting frequency is shown in the table below.

Setting frequency and recommended setting value of depth for machine resonance suppression filter 1,2

Setting frequency	Recommended setting value	Depth	Setting frequency	Recommended setting value	Depth
2250Hz	0	-∞	281Hz	4	-12.0
1500Hz	0	-∞	264Hz	4	-12.0
1125Hz	0	-∞	250Hz	8	-6.0
900Hz	0	-∞	225Hz	8	-6.0
750Hz	0	-∞	204Hz	8	-6.0
642Hz	0	-∞	187Hz	8	-6.0
562Hz	0	-∞	173Hz	8	-6.0
500Hz	0	-∞	160Hz	8	-6.0
450Hz	0	-∞	150Hz	8	-6.0
409Hz	0	-∞	140Hz	C	-2.5
375Hz	4	-12.0	128Hz	C	-2.5
346Hz	4	-12.0	112Hz	C	-2.5
321Hz	4	-12.0	100Hz	C	-2.5
300Hz	4	-12.0			

(Note1) The setting of the standard depth compensation in the above table indicates the HEX setting value applied when the setting of “bit 0” or “bit 4” is “0”.
(Note2) The recommended setting value in the above table is a guideline. According to the machine characteristic, the depth must be changed in some cases.

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

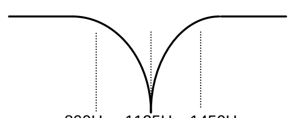
This function is compatible with the MDS-R-V1/V2 Series' machine resonance suppression filter (SV038: FHz1, SV046: FHz2). Some machines have three or more machine resonance points and the resonance cannot be eliminated. Try the following methods in this case.

(a) 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 resonance 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



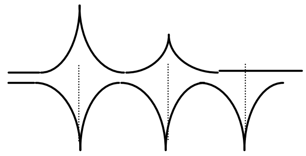
[Example] If the machine resonance is approx. 1100Hz and high, validate the 3rd machine resonance suppression filter. Then, adjust the machine resonance suppression filters (SV038: FHz1, SV046: FHz2).

(b) When there are three or more machine resonance points

With the MDS-R-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 resonance by setting the most effective value.

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

Machine resonance



Machine resonance filter

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

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

The MDS-R-V1/V2 Series machine resonance suppression filter frequency can be set by 1Hz. However, the internal control is operated with the nearest value of the frequency setting range obtained by the following expression.

Frequency setting range (Hz)=4500/N (N: integer)

If the value of the above expression is not the frequency to be set, set a frequency that is 1 part of the odd amount (1/3, etc.). Doing so may be possible to eliminate the machine resonance.

[Example] To set 1350Hz, setting 450Hz may be just as effective.

(2) Jitter compensation (Vibration suppression at motor stopping)

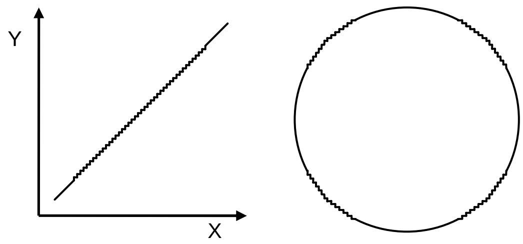
The load inertia becomes much smaller than usual if the motor position enters the machine backlash when the motor is stopped. Because this means that an extremely large VGN1 is set for the load inertia, vibration may occur.
Jitter compensation can suppress the vibration that occurs at the motor stop 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.

<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>
<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>zrn2</td><td></td><td></td><td></td><td></td><td colspan="2">lmc</td><td></td><td></td><td colspan="2">vfct</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>4
5</td><td>vfct</td><td colspan="2">Set the number of compensation pulses for jitter compensation.
00: Jitter compensation invalid 10: 2-pulse jitter compensation
01: 1-pulse jitter compensation 11: 3-pulse jitter compensation</td></tr>
</table>
</td></tr>
</table>

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

9-3-3 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 "9-2-2 (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 "9-2-2 (2) Setting the speed loop leading compensation")

No.	Abbrev.	Parameter name	Explanation	Setting range
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 999
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

(3) Disturbance observer

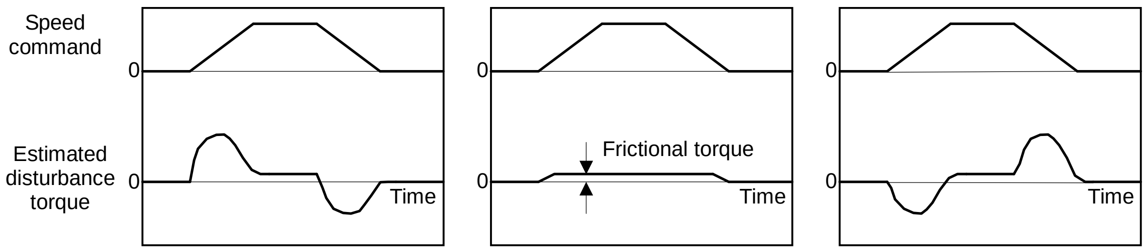
The disturbance observer can reduce the effect caused by disturbance, frictional resistance or torsion vibration during cutting by estimating the disturbance torque and compensating it. It also is effective in suppressing the vibration caused by speed leading compensation control.

<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 "100" 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.

<Measuring the load inertia>

If the load inertia is not clear, it can be estimated with the following method.
<1> Set the torque offset (SV032 (TOF)) for the unbalance axis. (Refer to "9-3-4 (2) Unbalance torque compensation".)
<2> Set JL = 100, OBS1 = 600 and OBS2 =0, and reciprocate the axis within the range that it can be moved smoothly. Set the acceleration/deceleration time constant so that the acceleration/ deceleration torque is larger than the stall (rated) torque (100% or more).
<3> Measure the estimated disturbance torque with the D/A output, and raise JL until the disturbance torque during acceleration/deceleration is small (until it cannot be observed). Even when the torque offset is set and JL is an appropriate value, if the axis has a large friction, the frictional torque will remain in the estimated disturbance torque. Judge the JL setting value, with frictional torque remaining, as the machine's load inertia scale as shown below.



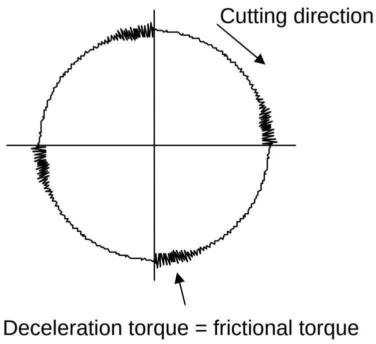
No.	Abbrev.	Parameter name	Explanation	Setting range
SV037	JL	Load inertia scale	Set "the motor inertia + motor axis conversion load inertia" in respect to the motor inertia. $SV037(JL) = \frac{Jl+Jm}{Jm} * 100$ Jm : Motor inertia Jl : Motor axis conversion load inertia	0 to 5000 (%)
SV043	OBS1	Disturbance observer filter frequency	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".	0 to 1000 (rad/s)
SV044	OBS2	Disturbance observer gain	Set the disturbance observer gain. The standard setting is "100" to "300". To use the disturbance observer, also set SV037 (JL) and SV043 (OBS1). When not using, set to "0".	0 to 500 (%)

POINT

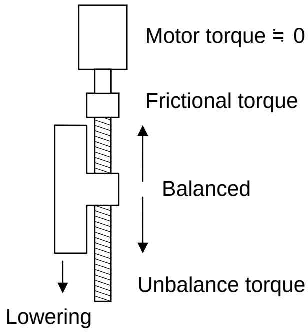
1. The estimated disturbance torque can be output to the D/A output even if the disturbance observer gain is zero (OBS2 = 0), and the disturbance observer is not functioning.
2. Sections at which the machine is not moving smoothly are estimated as the disturbance.
3. The lost motion compensation must be readjusted when the disturbance observer is started.

(4) Voltage dead zone (Td) compensation

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



For circle cutting

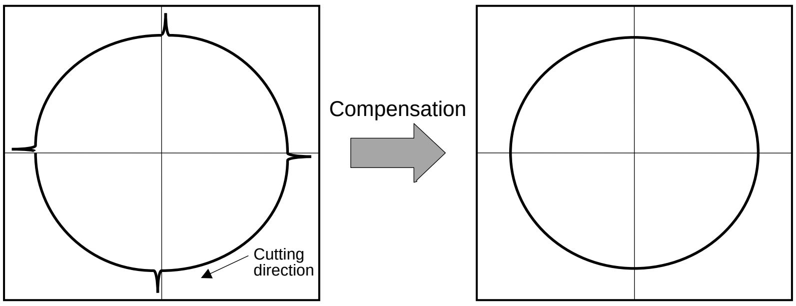


For unbalance axis

No.	Abbrev.	Parameter name	Explanation	Setting range
SV030	IVC	Voltage non-sensitive compensation	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.	0 to 200 (%)

9-3-4 Improvement of protrusion at quadrant changeover

The response delay (caused by non-sensitive band from friction, torsion, expansion/contraction, backlash, etc.) caused when the machine advance direction reverses is compensated with the lost motion compensation (LMC compensation) function.
With this, the protrusions that occur 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

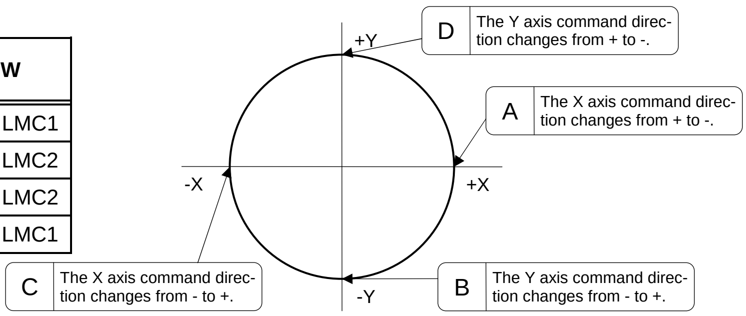
(1) Lost motion compensation (LMC compensation)

LMC compensation compensates the response delay during reversal by adding the torque command set with the parameters when the speed direction changes. There are two types of LMC compensation.

<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><th>Setting range</th></tr>
<tr><td>SV016</td><td>LMC1</td><td>Lost motion compensation 1</td><td>Set the compensation value using the motor's stall current as a reference. The standard setting value is double the friction torque. The compensation amount will be 0 when "0" is set.</td><td>-1 to 200
(Stall current %)</td></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 current %)</td></tr>
<tr><td>SV027</td><td>SSF1</td><td>Special servo function selection 1</td><td colspan="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>zrn2</td><td></td><td></td><td></td><td></td><td colspan="2">lmc</td><td></td><td></td><td colspan="2">vfct</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>8
9</td><td>lmc</td><td colspan="2">Set the compensation amount with SV016 (LCM1) and SV041 (LCM2).
00: Lost motion compensation stop 10: Lost motion compensation type 2
01: Setting prohibited 11: Setting prohibited</td></tr>
</table>
</td></tr>
</table>

<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.

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

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

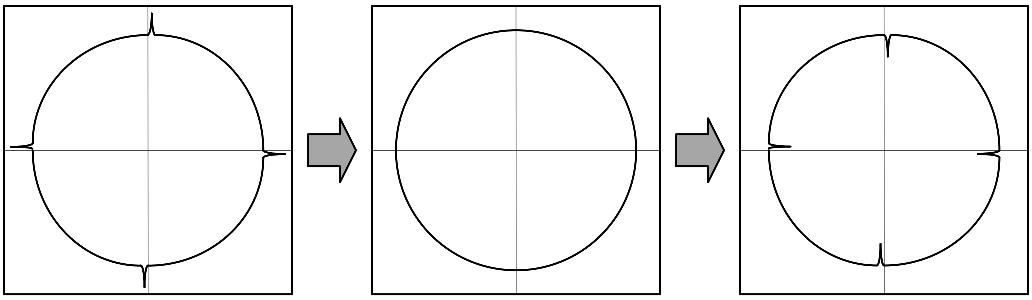
(Example)

Assume that the load current % was 25% in the + direction and -15% in the - direction when JOG feed was carried out at approx. F1000.

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

The frictional torque is as shown above, 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.

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.

(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.

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

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.

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

No.	Abbrev.	Parameter name	Explanation	Setting range
SV032	TOF	Torque offset	Set this to carry out lost motion compensation. Set the unbalance torque for the vertical axis and slant axis.	-100 to 100 (Stall current %)

POINT

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

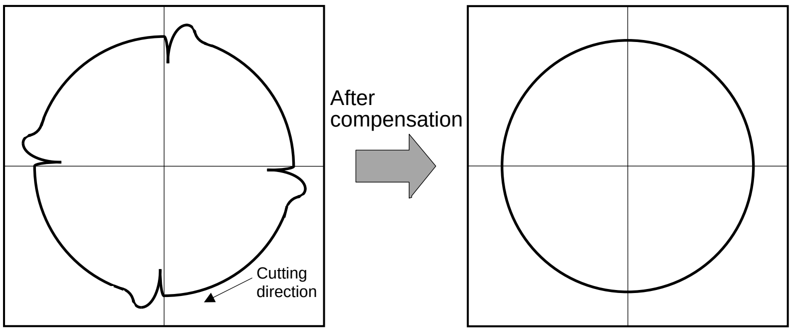
(3) Adjusting the lost motion compensation timing

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 10ms at a time, to find the timing that the protrusion and compensation position match.

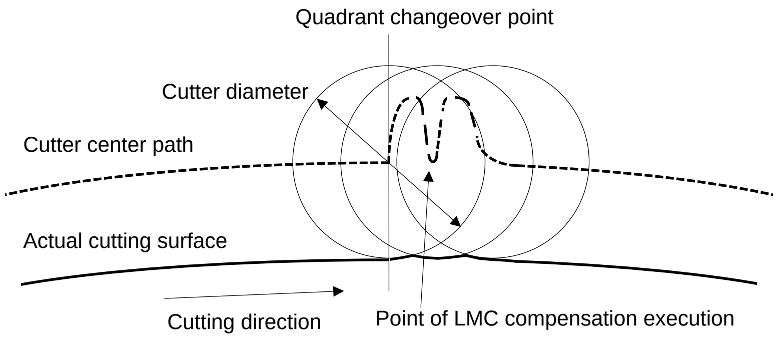


Before timing delay compensation **After timing delay compensation**

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

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

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



(4) Adjusting for feed forward control

In LMC compensation, a model position considering the position loop gain is calculated based on the position command sent from the CNC, and compensation is carried out when the feed changes to that direction. When the CNC carries out feed forward (fwd) control, overshooting equivalent to the operation fraction unit occurs in the position commands, and the timing of the model position direction change may be mistaken. As a result, the LMC compensation timing may deviate, or compensation may be carried out twice or more.
If feed forward control is carried out and the compensation does not operate correctly, Lost motion compensation non-sensitive band (SV040 (LMCT)) during feed forward control. In this non-sensitive 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.

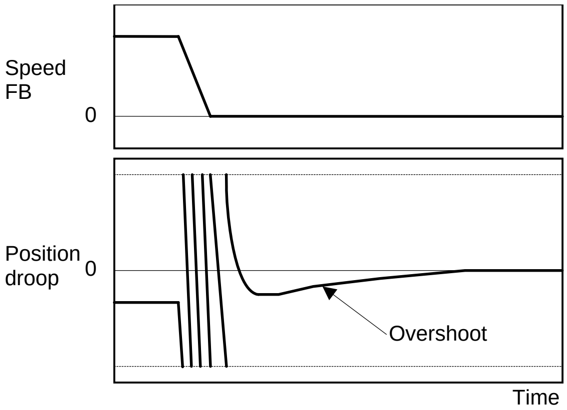
No.	Abbrev.	Parameter name	Explanation	Setting range
SV040	LMCT	Lost motion compensation non-sensitive band	Set the non-sensitive band of the lost motion compensation in the feed forward control. When "0" is set, the actual value that is set is 2μm. Adjust by increasing by 1μm at a time.	0 to 100 (μm)

9-3-5 Improvement of overshooting

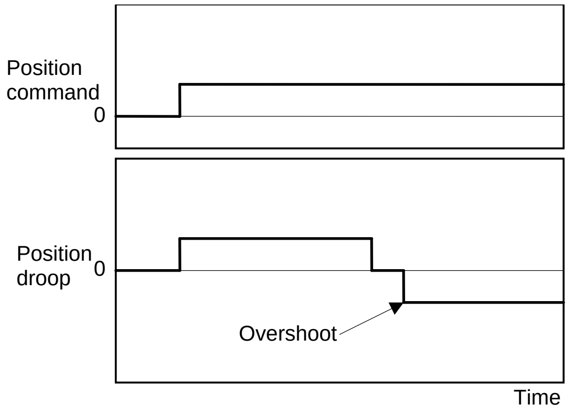
The phenomenon when the machine position goes past or exceeds the command during feed stopping is called overshooting. Overshooting is compensated by overshooting compensation (OVS compensation).
Overshooting occurs due to the following two causes.

<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.

<Setting and adjustment method>

<1> Set the special servo function selection 1 (SV027 (SSF1)) bit 10, 11. (OVS compensation type 3 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.

(2) Adjusting for 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 NC 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.

No.	Abbrev.	Parameter name	Explanation	Setting range
SV027	SSF1	Servo function selection 1	(see bit tables below)	

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
	zrn2			ovs		lmc			zrn3	vfct					

bit		Meaning when "0" is set	Meaning when "1" is set
A B	ovs	Set the compensation amount with SV031 (OVS1) and SV042 (OVS2). 00: Overshooting compensation stop 01: Setting prohibited	 10: Setting prohibited 11: Overshooting compensation type 2

No.	Abbrev.	Parameter name	Explanation	Setting range
SV031	OVS1	Overshooting compensation 1	Set the compensation amount based on the motor's stall current. Increase by 1% and determine the amount that overshooting doesn't occur. When OVS2 is "0", setting values in both of the + and –directions are applied. 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 current %)
SV042	OVS2	Overshooting compensation 2	Set this with SV031 (OVS1) only when you wish to set the overshooting compensation amount to be different depending on the command directions. Set to "0" as a standard.	-1 to 100 (Stall current %)

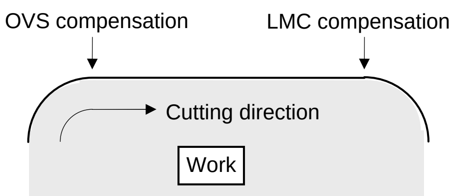
No.	Abbrev.	Parameter name	Explanation	Setting range
SV034	SSF3	Servo function selection 3	(see bit tables below)	

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
ovsn										zeg					

bit		Meaning when "0" is set	Meaning when "1" is set
C D E F	ovsn	Set the non-sensitive band of the overshooting compensation type 3 in increments of 2µm 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.	

POINT

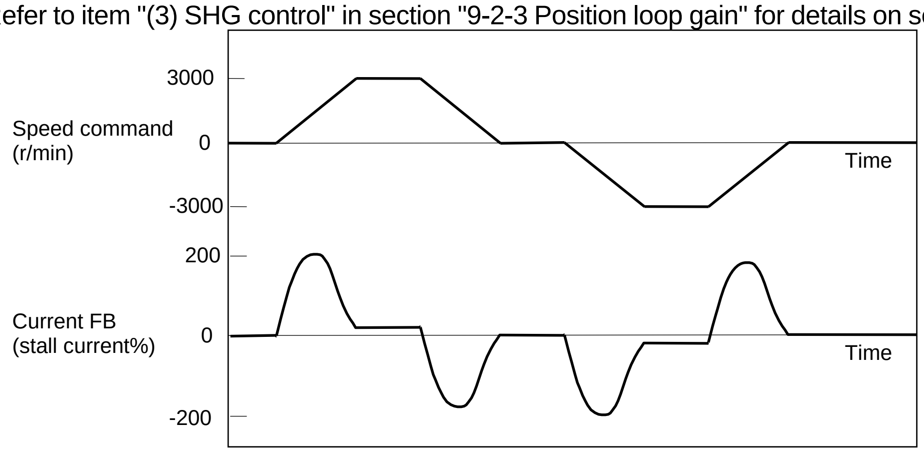
1. When either parameter SV031 (OVS1) or SV042 (OVS2) is set to 0, the same amount of compensation is carried out in both the positive and negative direction.
2. To compensate in only one direction, set -1 in the parameter (OVS1 or OVS2) for the direction in which compensation is prohibited.
3. For contour cutting, the projection at the arc end point is compensated with OVS compensation. LMC compensation is carried out at the arc starting point.



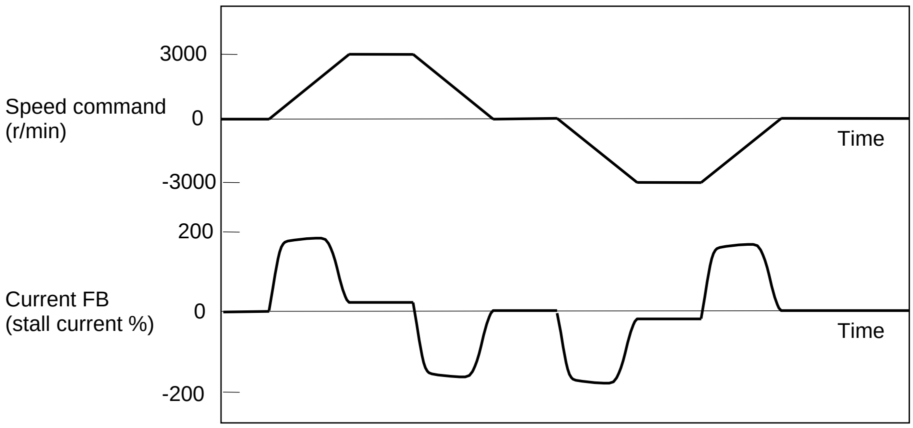
9-3-6 Improvement of characteristics during acceleration/deceleration

(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 "9-2-3 Position loop gain" for details on setting SHG control.



Acceleration/deceleration characteristics during conventional control



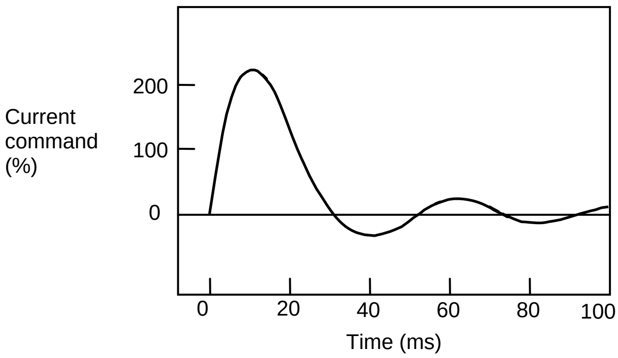
Acceleration/deceleration characteristics during SHG control

No.	Abbrev.	Parameter name	Setting ratio	Setting example					Explanation	Setting range
SV003 (SV049)	PGN1 (PGN1sp)	Position loop gain 1	1	23	26	33	38	47	Always set a combination of 3 parameters.	1 to 200
SV004 (SV050)	PGN2 (PGN2sp)	Position loop gain 2	$\frac{8}{3}$	62	70	86	102	125		0 to 999
SV057 (SV058)	SHGC (SHGCsp)	SHG control gain	6	140	160	187	225	281		0 to 1200
SV008	VIA	Speed loop lead compensation	Set 1900 as a standard value during SHG control.							1 to 9999
SV015	FFC	Acceleration rate feed forward gain	Set 100 as a standard value during SHG control.							0 to 999

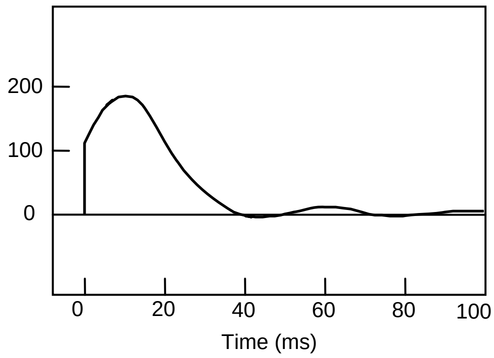
POINT	SHG control is an optional function. If the option setting is not provided with the NC, alarm 37 (at power ON), warning E4, or error parameter No. 104 (2304 for M60S/E60 Series NC) will be output.

(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	Explanation	Setting range
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 (%)

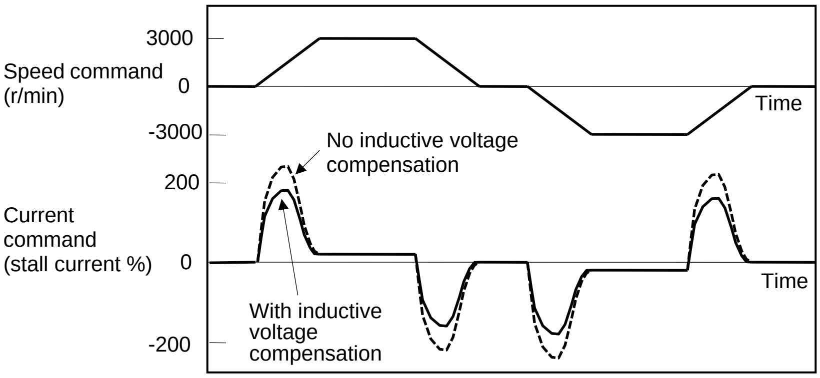
POINT	Overshooting occurs easily when a value above the standard value is set during SHG control.

(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>

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	Explanation	Setting range
SV047	EC	Inductive voltage compensation gain	Set the inductive voltage compensation gain. Set to "100" as a standard. If the current FB peak exceeds the current command peak, lower the gain.	0 to 200 (%)

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.

9-4 Settings for emergency stop

9-4-1 Deceleration control

If the deceleration stop function is validated, the MDS-R-V1/V2 servo drive unit will decelerate to stop the motor according to the set time constants. After stopping, the drive unit enters the ready OFF state and the dynamic brakes will be applied.
If an emergency stop factor occurs, operation will be stopped with the dynamic brakes.

<Features>

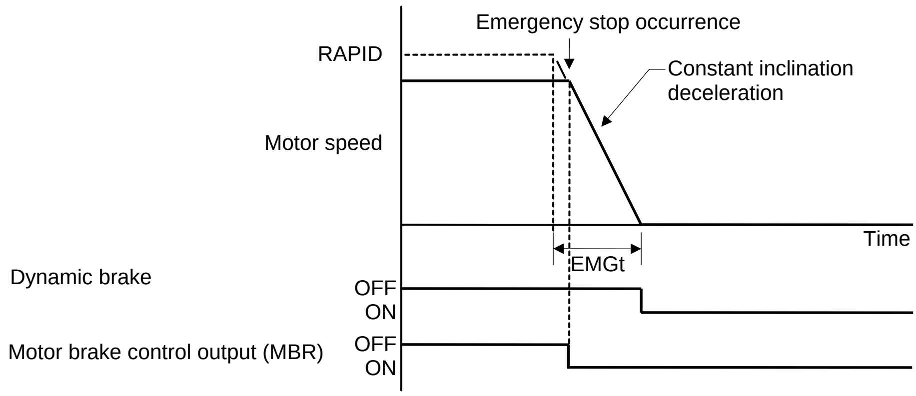
When the load inertia is large, deceleration stop can be executed at a shorter time than the dynamic brakes.
(The stop time for the normal acceleration/deceleration time constants will be achieved.)

(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). The operation stops with the position loop stop when "0" is set.
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	Explanation	Setting range
SV055	EMGx	Max. gate off delay time after emergency stop	Set the maximum delay time from when emergency stop is input to when READY ON is kept. Normally, set the value of SV056x1.1-fold. For contactor control axis, set the maximum value of all connected axes.	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.	0 to 20000 (ms)

POINT

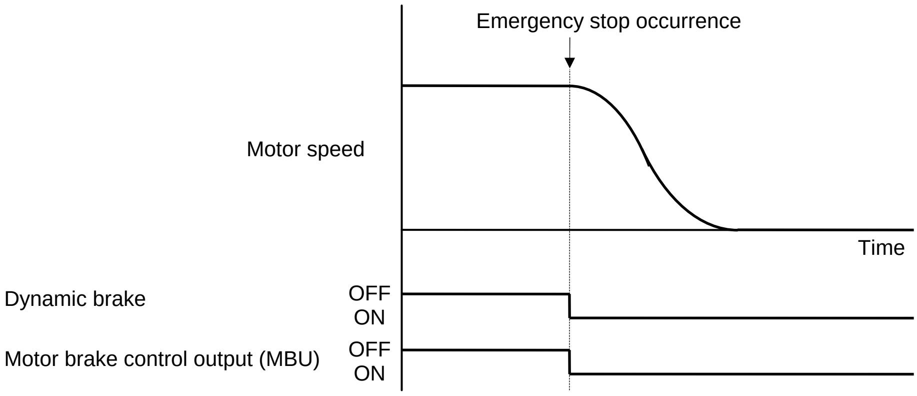
1. Deceleration control will not take place when a servo alarm, for which the stopping method is dynamic, occurs. The motor will stop with dynamic braking regardless of the parameter setting.
2. If the power fails and the deceleration time constant is set to a relatively long time, the braking method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

(2) Dynamic braking stop

Dynamic braking stop takes place if an alarm for which dynamic braking stop is set as the stopping method occurs. With dynamic braking stop, the dynamic brakes activate simultaneously with the occurrence of an emergency stop. The motor brake control output also activates simultaneously.



⚠ **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.

(3) Deceleration control stop distance

The stopping distance LEMG to stop the motor with deceleration control during an emergency stop can be approximated with the following expression. Note that the value will be higher than this if the current is limited during deceleration. Refer to section "3-2-3 (2) Coasting rotation distance during emergency stop" for the stopping distance when using dynamic brakes.

$$\mathrm{LEMG} = \frac{F}{\mathrm{PGN1}\times 60} + \frac{1}{2}\times\frac{F}{60}\times\frac{F\times \mathrm{EMGt}}{\mathrm{rapid}\times 1000} \quad \text{(mm)}$$

F	: Feedrate during emergency stop		(mm/min)
rapid	: Rapid traverse rate		(mm/min)
PGN1	: Position loop gain 1	(SV003)	(rad/s)
EMGt	: Deceleration time constant for emergency stop	(SV056)	(ms)

9-4-2 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.

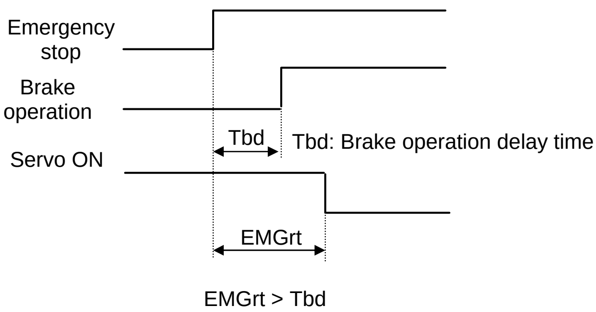
(1) Operating conditions

<1> The emergency stop signal has been input.
<2> The NC power has been turned OFF.
<3> An alarm for which deceleration control is set as the stopping method has occurred. (This differs according to the occurring alarm. Refer to "10-3-1 Alarm list" for details.)

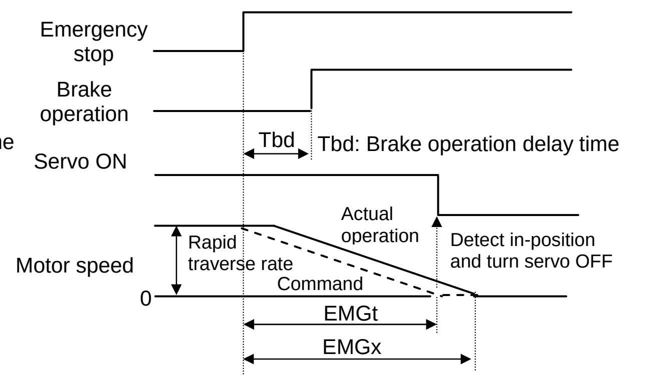
⚠ CAUTION	This drop prevention function does not prevent the axis from dropping under all conditions. To prevent the axis from dropping under all conditions, take measures on the machine such as installing a balance unit.

(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.



Drop prevention function sequence during emergency stop



Deceleration stop function sequence during emergency stop

<Setting method>

<1> Adjust the vertical axis drop prevention time (SV048), and set the minimum value at which the axis does not drop when emergency stop is input.
<2> Set the same value as the adjusted vertical axis drop prevention time (SV048) for the gate cutoff maximum delay time during emergency stop (SV055).
<3> For the axis, for which the vertical drop is to be controlled, set the same value as the acceleration/deceleration time constant for the deceleration control time constant at emergency stop (SV056).
<4> If the vertical axis is MDS-R-V2 (2-axis drive unit), set the servo parameters for the other axis in the same unit.

SV048 = Same value as SV048 for vertical axis
SV055 = Same value as SV055 for vertical axis
SV056 = Same value as that axis' rapid traverse acceleration/deceleration time constant

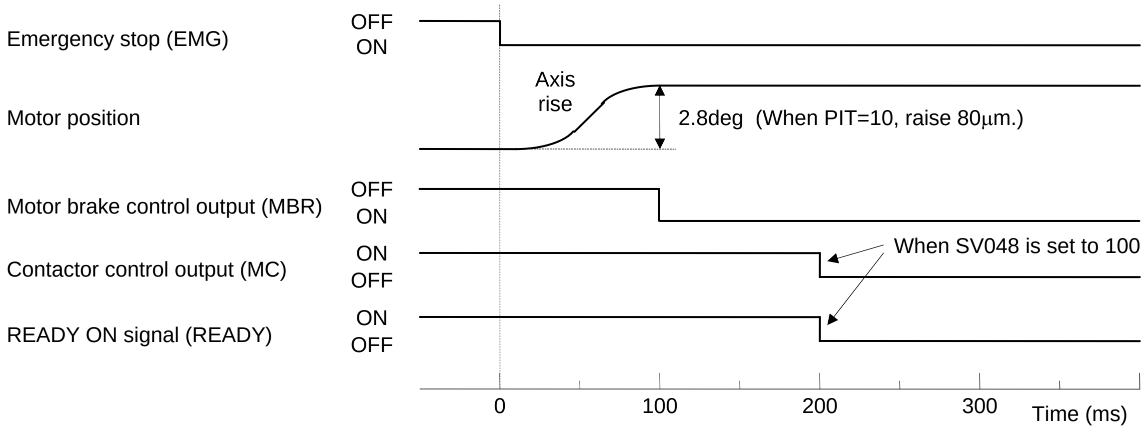
No.	Abbrev.	Parameter name	Explanation	Setting range
SV048	EMGrt	Vertical axis drop prevention time	Input a length of time to prevent the vertical axis from dropping by delaying Ready OFF until the brake works when the emergency stop occurs. Increase the setting by 100msec at a time and set the value where the axis does not drop.	0 to 20000 (ms)
SV055	EMGx	Max. gate off delay time after emergency stop	Set the time from when emergency stop is input to when READY is forcibly turned OFF. Normally, set the same value as SV056. When using vertical axis drop prevention control, the gate off will be delayed by the time set in SV048 even if SV055 is smaller than 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.	0 to 20000 (ms)

⚠ CAUTION

1. SV048 (EMGrt) and SV055 (EMGx) 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.
2. When only SV048 (EMGrt) is set, step stop will be used for deceleration stop.

9-4-3 Vertical axis pull up control

Even when the vertical axis drop prevention control is used, the axis may drop several μm due to mechanical play of the motor brakes. This function raises the axis by a 2.8deg. motor angle before the brakes are activated to retract the vertical axis upward during an emergency stop or power failure.



Vertical axis pull up control operation sequence

<Setting and adjustment method>

<1> Complete the adjustment explained in "9-4-2 Vertical axis drop prevention control".
<2> Increase the vertical axis drop prevention time (SV048) by 100ms from the value adjusted in <1>.
<3> Set SV033.bitE to ON.
<4> Set the torque offset (SV032). (The setting value is the same as the lost motion compensation adjustment.)

No.	Abbrev.	Parameter name	Explanation	Setting range
SV033	SSF2	Servo function selection 2	The vertical axis pull up control starts with the following parameters. F: (blank), E: zup, D: (blank), C: (blank), B–A: dis, 9: (blank), 8: (blank), 7–5: nfd2, 4: nf3, 3–1: nfd1, 0: (blank) bit E zup — Meaning when "0" is set: Vertical axis pull up control stop — Meaning when "1" is set: Vertical axis pull up control start	
SV032	TOF	Torque offset	Set the unbalance torque for the vertical axis and slant axis. The vertical axis pull up control compensation direction is determined by this parameter's sign. Vertical axis pull up control is not carried out when 0 is set.	-100 to 100 (Stall current %)
SV048	EMGrt	Vertical axis drop prevention time	The axis is pulled up during drop prevention time, so set a value of about 100ms.	0 to 20000 (ms)

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

bit		Meaning when "0" is set	Meaning when "1" is set
E	zup	Vertical axis pull up control stop	Vertical axis pull up control start

⚠ **CAUTION**	This function is valid for the Z axis in the vertical machining center. Basically it cannot be used with the horizontal machining center's Y axis or the lathe's X axis as collisions could occur. Check the machine's working conditions carefully before using this function.

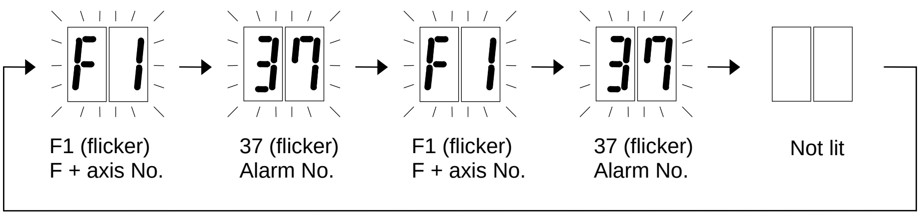
10. Troubleshooting

10-1 Points of caution and confirmation

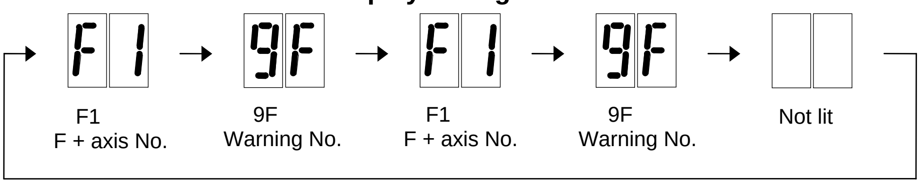
If an error occurs in the servo drive unit, the warning or alarm will occur. When a warning or alarm occurs, check the state while observing the following points, and inspect or remedy the unit according to the details given in this section.

<Points of confirmation>

1. What is the alarm No. 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 reverse 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



LED display during servo warning

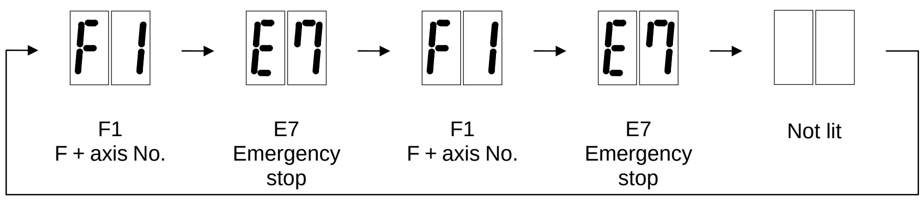
CAUTION	1. This power supply unit uses a large capacity electrolytic capacitor. When the CHARGE LAMP on the front of the power supply unit is lit, voltage is still present at the PN terminal (TE2). Do not touch the terminal block in this state. 2. Before replacing the unit, etc., always confirm that 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.

10-2 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.
12	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.

If the LED on the top of the drive unit shows the emergency stop (E7) warning, the system has started up correctly.



Normal LED display at NC power ON (for 1st axis)

10-3 List of unit protection functions

10-3-1 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.	Alarm name	Alarm details	Stopping method	Reset
10	Insufficient voltage	Insufficient PN bus voltage was detected in main circuit.	Dynamic brakes	PR
11	Axis selection error	Setting of the axis No. selection switch is incorrect.	Initial error	AR
12	Memory error 1	A CPU error or an internal memory error was detected during the power ON self-check.	Initial error	AR
13	Software processing error 1	Software processing has not finished within the specified time.	Dynamic brakes	PR
14	Software processing error 2	Software processing has not finished within the specified time.	Dynamic brakes	PR
17	A/D converter error	An error was detected in the A/D converter for detecting current FB.	Dynamic brakes	PR
18	Motor side detector: Initial communication error	Initial communication with the motor side detector failed.	Initial error	PR
21	No signal 2	In the full-closed loop system, an error was detected in ABZ phase.	Dynamic brakes	PR
24	Grounding	The motor power cable is in contact with FG (Frame Ground).		PR
25	Absolute position data lost	The absolute position was lost, as the backup battery voltage dropped in the absolute position detector.	Initial error	AR
26	Unused axis error	A power module error occurred in the axis whose axis No. selection switch was set to "F"(free axis).	Dynamic brakes	PR
2B	Motor side detector: CPU error 1	An CPU initial error was detected in the motor side detector.	Initial error	PR
2C	Motor side detector: EEPROM/LED error	The LED deterioration was detected in the motor side detector.	Dynamic brakes	PR
2D	Motor side detector: Data error	A data error was detected in the motor side detector.	Dynamic brakes	PR
2F	Motor side detector: Communication error	An error was detected in communication with the motor side detector. Or, the communication was interrupted.	Dynamic brakes	PR
30	Over regeneration	Over-regeneration detection level became over 100%. The regenerative resistor is overloaded.	Dynamic brakes	PR
31	Overspeed	The motor was detected to rotate at a speed exceeding the allowable speed.	Dynamic brakes	PR
32	Power module overcurrent	Overcurrent protection function in the power module has started its operation.	Dynamic brakes	PR
33	Overvoltage	PN bus voltage in main circuit exceeded the allowable value.	Dynamic brakes	PR
34	NC-DRV communication: CRC error	An error was detected in the data received from the CNC.	Deceleration control	PR
35	NC command error	The travel command data that was received from the CNC was excessive.	Deceleration control	PR
36	NC-DRV communication: Communication error	The communication with the CNC was interrupted.	Deceleration control	PR
37	Initial parameter error	An incorrect parameter was detected among the parameters received from the CNC at the power ON.	Initial error	PR
38	NC-DRV communication: Protocol error 1	An error was detected in the communication frames received from the CNC.	Deceleration control	PR
39	NC-DRV communication: Protocol error 2	An error was detected in the axis information data received from the CNC.	Deceleration control	PR
3A	Overcurrent	Excessive current was detected in the motor drive current.	Dynamic brakes	PR
3B	Power module overheat	Thermal protection function in the power module has started its operation.	Dynamic brakes	PR
3C	Regeneration circuit error	An error was detected in the regenerative transistor or in the regenerative resistor.	Dynamic brakes	AR
3D	Power supply voltage error at acceleration/deceleration	A motor control error, due to an input voltage failure, was detected.	Dynamic brakes	PR
3E	Magnetic pole position detection error	The magnetic pole position, detected in the magnetic pole position detection control, is not reliable.	Dynamic brakes	AR

No.	Alarm name	Alarm details	Stopping method	Reset
43	Feedback error 2	An excessive difference in feedback was detected between the sub side detector and the main side detector.	Dynamic brakes	PR
45	Fan stop	A cooling fan built in the drive unit stopped, and the loads on the unit exceeded the specified value.	Deceleration control	NR
46	Motor overheat	Thermal protection function of the motor or in the detector, has started its operation.	Deceleration control	NR
50	Overload 1	Overload detection level became over 100%. The motor or the drive unit is overloaded.	Deceleration control	NR
51	Overload 2	Current command of more than 95% of the unit's max. current was being continuously given for longer than 1 second.	Dynamic brakes	NR
52	Excessive error 1	A difference between the actual and theoretical motor positions during servo ON exceeded the setting value.	Dynamic brakes	NR
53	Excessive error 2	A difference between the actual and theoretical motor positions during servo OFF exceeded the setting value.	Dynamic brakes	NR
54	Excessive error 3	The anomalous motor current was detected at the detection of Excessive error 1.	Dynamic brakes	NR
55	External emergency stop error	There is no contactor shutoff command, even after 30 seconds has passed since the external emergency stop was input.	Dynamic brakes	NR
5F	External contactor error	A contact of the external contactor is welding. Or the contactor fails to be ON during ready ON.	Deceleration control	NR
88	Watchdog	The system does not operate correctly.	Dynamic brakes	AR

(Note) Definitions of terms in the table are as follows.
Main side detector: Detector connected to CN2   Sub side detector: Detector connected to CN3

- Stopping method
  - Deceleration control : The motor stops with the deceleration control time constants set with the parameters (SV056).
  - Dynamic brakes : The dynamic brakes activate simultaneously with the alarm occurrence to stop the motor.
  - Initial error : This alarm is detected before ready ON.

- Resetting method
  - NR : The alarm can be reset with the NC reset button. The alarm can also be reset with the PR and AR resetting conditions.
  - PR : The alarm can be reset by turning the NC power OFF and ON. The alarm can also be reset with the AR resetting conditions.
    If the control axis is removed, the alarm can be reset with the NC reset button. (Excluding alarms 32 and 37.)
  - AR : The alarm can be reset by turning the servo drive unit's power OFF and ON.

10-3-2 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 section.

No.	Alarm name	Alarm details	Stopping method	Reset
93	Initial absolute position fluctuation	The position data have fluctuated during the absolute position initializing.	Does not stop	PR
9E	Absolute position detector: Revolution counter error	An error was detected in the revolution counter of the absolute position detector. The absolute position data cannot be compensated.	Does not stop	*
9F	Battery voltage drop	The battery voltage that is supplied to the absolute position detector dropped. The absolute position data is retained.	Does not stop	*
A6	Fan stop warning	A cooling fan built in the drive unit stopped.	Does not stop	*
E0	Over regeneration warning	Over-regeneration detection level exceeded 80%.	Does not stop	*
E1	Overload warning	Overload detection level exceeded 80%.	Does not stop	*
E4	Set parameter warning	A parameter setting was outside the setting range.	Does not stop	*
E6	Control axis detachment warning	Control axis detachment was commanded.	-	*
E7	In NC emergency stop state	Emergency stop was input from the CNC.	Deceleration control	*
E9	Instantaneous power interruption warning	The power was momentarily interrupted.	Does not stop	NR
EA	In external emergency stop state	External emergency stop signal was input.	Deceleration control	*

- Resetting method
  - * : If the state causing the warning is canceled, the warning will be reset automatically.
  - NR : The warning can be reset with the NC reset button. The warning can also be reset with the PR and AR resetting conditions.
  - PR : The warning can be reset by turning the NC power OFF and ON. The warning can also be reset with the AR resetting conditions.
    If the control axis is removed, the warning can be reset with the NC reset button. (Excluding warning 93.)
  - AR : The alarm can be reset by turning the servo drive unit's power OFF and ON.

10-4 Troubleshooting according to alarm and warning number

Refer to the following section to troubleshoot alarms which occurred during start up or while the machine is operating. If the problem is not improved even after completing the following investigations, the servo drive unit may be faulty. In this case, replace the unit with one having the same capacity, and check whether the state is improved.

10-4-1 Alarms

Alarm No. 10	**Insufficient voltage:** Insufficient PN bus voltage was detected in main circuit.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Contactor operation or continuity is faulty.	Check the output from the drive unit. • Is the connector (CN9) dislocated? • Is the cable broken?	• Correctly connect. • Replace the cable.
		Check the contactor operation and continuity.	Replace the contactor.
		Check the contactor drive relay's operation and continuity.	Replace the relay.
2	Wire is broken or voltage is insufficient.	Check the input voltage. • Is single-phase 200V or 100V input? • Is there a phase failure?	Input 3-phase 200V.
		Check the power capacity.	Review the power.

Alarm No. 11	**Axis selection error:** Setting of the axis No. selection switch is incorrect.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	When using the 2-axis servo drive unit, the same axis No. is selected for the L and M axes.	Check the setting of the axis selection switch on the unit.	Set the correct axis No. 0 = 1st axis, 1 = 2nd axis, ...

Alarm No. 12	**Memory error 1:** A CPU error or an internal memory error was detected during the power ON self-check.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Refer to "10-2 Troubleshooting at power ON".		

Alarm No. 13	**Software processing error 1:** Software processing has not finished within the specified time.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Software operation sequence is incorrect or operation timing is incorrect.	Check whether the servo software version has been changed recently.	Replace with a drive unit containing the original software version.
		Check the repeatability.	If the problem is repeated, replace the drive unit.
		Check for abnormalities in the drive unit's surrounding environment, etc. (Example: Ambient temperature, noise, grounding)	Improve the surrounding environment. Example: High temperature ... Check the cooling fan Incomplete grounding ... Add grounding measures

Alarm No. 14	**Software processing error 2:** Software processing has not finished within the specified time.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Carry out items for alarm No. 13.		

Alarm No. 17	A/D converter error: An error was detected in the A/D converter for detecting current FB.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	CPU peripheral circuit operation is incorrect.	Check for abnormalities in the unit's surrounding environment, etc. (Example: Ambient temperature, noise, grounding)	Improve the surrounding environment.
2	Drive unit is faulty.	Check the repeatability.	If the problem is repeated, replace the drive unit.

Alarm No. 18	Motor side detector: Initial communication error: Initial communication with the motor side detector failed.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Detector input connector is disconnected.	Check whether the drive unit connector (CN2) is disconnected.	Correctly connect.
		Check whether detector connector is disconnected.	Correctly connect.
2	Detector cable is broken.	Exchange with cable for other axis and check repeatability.	Replace the detector cable.
		Check cable continuity.	
3	CPU peripheral circuit operation is incorrect.	Check the repeatability.	If the problem is repeated, replace the drive unit.
		Check for abnormalities in the drive unit's surrounding environment, etc. (Example: Ambient temperature, noise, grounding)	Improve the surrounding environment. Example: High temperature ... Check the cooling fan Incomplete grounding ... Add grounding measures
4	Drive unit input circuit is faulty.	Try connecting the drive unit and detector with another axis, and check the repeatability. **(Note)** Do not release the emergency stop in this case.	Replace the drive unit.
5	Detector is faulty.		Replace the detector. (When using the absolute position system, the zero point must be established again.)

Alarm No. 21	No signal 2: In the full-closed loop system, an error was detected in ABZ phase.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Detector input connector is disconnected.	Check whether the drive unit connector (CN2) is disconnected.	Correctly connect.
		Check whether detector connector is disconnected.	Correctly connect.
2	Detector cable is broken.	Exchange with cable for other axis and check repeatability.	Replace the detector cable.
		Check cable continuity.	
3	Drive unit input circuit is faulty.	Try connecting the drive unit and detector with another axis, and check the repeatability. **(Note)** Do not release the emergency stop in this case.	Replace the drive unit.
4	Detector is faulty.		Replace the detector. (When using the absolute position system, the zero point must be established again.)

Alarm No. 24	Grounding: The motor power cable is in contact with FG (Frame Ground).		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Ground fault in motor power cable (U, V, W phase).	Check the motor power cable connection.	Correctly connect.
		Disconnect the motor's cannon plug, and check the insulation across the power cable and FG.	Replace the power cable.
2	Drive unit is faulty.	Check the repeatability.	If the problem is repeated, replace the drive unit.
3	Ground fault in motor.	Confirm that there is no ground fault in the power cable, and without disconnecting the cannon plug, check the insulation across the power cable and FG.	Replace the motor. (When using the absolute position system, the zero point must be established again.)
4	Motor is faulty.	Check whether the motor is submerged in cutting solution.	Replace the motor and improve the motor installation environment. (When using the absolute position system, the zero point must be established again.)
		Check whether the motor has been subject to high temperatures.	

Alarm No. 25	Absolute position data lost: The absolute position was lost, as the backup battery voltage dropped in the absolute position detector.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Battery voltage has dropped.	Measure the battery voltage with a tester. (Alarm occurs at 3V or less).	Replace the battery and establish the zero point. (The machine operation will not be affected even if there is no battery as long as the power is not turned OFF.)
		Does warning 9F occur at the same time?	
2	Detector cable was disconnected while power was OFF.	Did alarm 18 occur last time power was turned ON?	Correctly connect the detector cable, and establish the zero point.
3	Detector cable is broken.	Check the detector cable continuity with a tester.	Replace the cable and establish the zero point.

Alarm No. 26	Unused axis error: A power module error occurred in the axis whose axis No. selection switch was set to "F"(free axis).		
	Cause of occurrence	**Investigation items**	**Remedy**
1	CPU peripheral circuit operation is incorrect.	Check for abnormalities in the unit's surrounding environment, etc. (Example: Ambient temperature, noise, grounding)	Improve the surrounding environment.
2	Drive unit is faulty.	Check the repeatability.	If the problem is repeated, replace the drive unit.

Alarm No. 2B	Motor side detector: CPU error 1: An initial CPU error was detected in the motor side detector.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Detector internal circuit operation is incorrect.	Check for abnormalities in the detector's surrounding environment, etc. (Example: Ambient temperature, noise, grounding)	Improve the surrounding environment.
2	Detector is faulty.	Check the repeatability. Try connecting the drive unit and detector with another axis, and check the repeatability. **(Note)** Do not release the emergency stop in this case.	Replace the detector. (When using the absolute position system, the zero point must be established again.)

Alarm No. 2C	Motor side detector: EEPROM/LED error: LED deterioration was detected with the motor side detector.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Carry out items for alarm No. 2B.		

Alarm No. 2D	Motor side detector: Data error: A data error was detected with the motor side detector.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Carry out items for alarm No. 2B.		

Alarm No. 2F	Motor side detector: Communication error: An error was detected in the communication with the motor side detector. Or, the communication was cut off.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Electromagnetic noise	Is the detector cable shielded and connected to FG?	Check the cable shield.
		Is the detector cable wired in the same conduit as the motor's power cable or are the two cables laid in parallel near each other?	Do not wire the detector cable and motor's power cable in the same path.
		Is the motor FB wire connected only to the drive unit to be driven? (Is one-point grounding used?)	Connect the motor FG wire to the drive unit, and ground to one point with the drive unit.
2	Carry out items for alarm No. 18.		

Alarm No. 30	Over regeneration: Over-regeneration detection level became over 100%. The regenerative resistor is overloaded.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Regenerative resistor selection is incorrect.	Check the regeneration capacity again.	Change the regeneration resistor.
2	Parameter setting is incorrect.	Check the SV036 setting.	Correctly set the parameters.
3	Regenerative resistor connection is incorrect.	Check the regenerative resistor connection. Is the 3-unit parallel connection connected in serial?	Correctly wire.
4	Power voltage is high.	The regeneration constantly activates when the power voltage is 260V or more.	Review the power supply.

(Note) PR resetting is not possible when the regeneration level is 50% or more. Do not forcibly reset (AR) by turning the unit power OFF. If AR resetting is used at 50% or higher, the level is set to 80% when the power is turned ON next.

Alarm No. 31	**Overspeed:** The motor was detected to rotate at a speed exceeding the allowable speed.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Rapid traverse rate (rapid) setting is incorrect.	Check the motor maximum speed and machine specifications.	Use within the motor's maximum speed.
2	Servo parameter settings are incorrect.	Check the SV001 (PC1), SV002 (PC2), SV018 (PIT) and SV025 (MTYP) settings.	Correctly set.
3	Speed FB is overshooting.	Is acceleration/deceleration time constant too short?	Adjust the acceleration/deceleration time constant so that the current is not limited by the motor's maximum current (torque).
		Is the speed loop gain too low?	Adjust the gain to that operation is stable.
		Is the current limited?	Set SV013 to 500 as the standard.

Alarm No. 32	**Power module overcurrent:** Overcurrent protection function in the power module has started its operation.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	CPU peripheral circuit operation is incorrect.	Check for abnormalities in the unit's surrounding environment, etc. (Example: Ambient temperature, noise, grounding)	Improve the surrounding environment.
2	Short-circuit or ground fault in motor's power wire.	Disconnect the UVW phase connection from the terminal block and the motor's cannon plug. Check the insulation with a tester.	Replace the motor's power wire.
		Check the insulation across the motor's power wire and FG.	
3	Drive unit is faulty.	Check the repeatability. Does the alarm occur before READY ON?	If the alarm occurs before READY ON, replace the drive unit.
4	Ground fault in motor.	Check that there is no ground fault in the power cable. Then, without disconnecting the cannon plug, check the insulation across the power cable and FG.	Replace the motor. (When using the absolute position system, the zero point must be established again.)
5	Motor is faulty.	Check whether the motor is submerged in cutting solution.	Replace the motor and improve the motor installation environment. (When using the absolute position system, the zero point must be established again.)
		Check whether the motor has been subject to high temperatures.	

Alarm No. 33	**Overvoltage:** PN bus voltage in main circuit exceeded the allowable value.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	The regenerative resistor or regenerative resistor cable is broken.	Disconnect the regenerative resistor terminal and check the continuity with a tester.	Replace the regenerative resistor. Replace the cable.
2	Regenerative resistor connection is incorrect.	Check the regenerative resistor connection. Is the 3-unit parallel connection connected in serial?	Correctly wire.
3	Regenerative transistor is faulty.	Regeneration is not taking place when there is no problem with the regenerative resistor.	Replace the drive unit.

Alarm No. 34	NC-DRV communication: CRC error: An error was detected in the data received from the CNC.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Terminator or battery unit is faulty.	Try replacing the terminator or battery unit.	Replace the terminator or battery unit.
2	NC bus communication cable is faulty.	Check the continuity to check for breakage.	Replace the cable.
		Is the communication pair wire connected in reverse?	
		Try changing the order of the connected drive units.	
3	Communication circuit operation is incorrect.	Check for abnormalities in the unit's surrounding environment, etc. (Example: Ambient temperature, noise, grounding)	Improve the surrounding environment.

Alarm No. 35	NC command error: The travel command data that was received from the CNC was excessive.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Movement command data is excessive.	Is the rapid traverse rate large for a submicron system or rotation axis?	Check the feedrate limit.

Alarm No. 36	NC-DRV communication: Communication error: The communication with the CNC was interrupted.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	NC bus communication cable is disconnected.	Check the connector connection (CN1A, CN1B).	Correctly connect.
2	NC bus communication cable is broken.	Check the cable continuity.	Replace the cable.

Alarm No. 37	Initial parameter error: An incorrect parameter was detected among the parameters received from the CNC at the power ON. This is displayed as "S02 initial parameter error ####" on the NC screen. ####: Error parameter No.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Parameter settings exceed the setting range.	Check the setting range of the error parameter No.	Correctly set.
2	Electronic gears are overflowing.	Error parameter No. is 2301. Check SV001, SV002 and SV018.	Review the specifications.
3	Absolute position detection parameter is valid.	Error parameter No. is 2302. Check SV017 (bit7).	Absolute position control cannot be used. If necessary, replace with an absolute position detector.
4	No SHG control option provided.	Error parameter No. is 2304. Check SV057 and SV058.	SHG control cannot be used.
5	No adaptive filter option provided.	Error parameter No. is 2305. Check SV027 (bitF).	Adaptive filter cannot be used.

(Note) Refer to "10-4-3 Parameter numbers at initial parameter error".

Alarm No. 38	NC-DRV communication: Protocol error 1: An error was detected in the communication frames received from the CNC.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Carry out items for alarm No. 34.		

Alarm No. 39	NC-DRV communication: Protocol error 2: An error was detected in the axis information data received from the CNC.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Carry out items for alarm No. 34.		

Alarm No. 3A	Overcurrent: Excessive current was detected in the motor drive current.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Speed lop gain (VGN1) is excessive.	Is the VGN1 value higher than the standard value for the load inertia?	Lower and adjust VGN1 (SV005).
		Is vibration occurring?	
2	Current loop gain is incorrectly set.	Check the current loop gain (SV009, SV010, SV011, SV012).	Set the standard value.
3	Motor power cable connection is incorrect.	Is the U, V, W phase connection correct?	Correctly connect.
		Is the cable connected to another axis' motor?	
4	Current detection circuit operation is incorrect.	Check for abnormalities in the unit's surrounding environment, etc. (Example: Ambient temperature, noise, grounding)	Improve the surrounding environment.
5	Carry out items for alarm No. 32.		

Alarm No. 3B	Power module overheat: Thermal protection function in the power module has started its operation.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	The fan is not rotating correct.	Large amounts of cutting oil or dust, etc., are adhered.	Clean or replace the fan.
		The rotation is slow.	
2	The heat dissipating fins are dirty.	Cutting oil or dust, etc., is adhered and clogging the fins.	Clean the fins.
3	Drive unit's ambient temperature is high.	The temperature exceeds 55ºC.	Take measure to ventilate/cool the panel.
4	Detector circuit operation is incorrect.	Check for abnormalities in the unit's surrounding environment, etc. (Example: Ambient temperature, noise, grounding)	Improve the surrounding environment.
5	Drive unit is faulty.	Problem is repeated even when unit temperature drops.	Replace the drive unit.

Alarm No. 3C	Regeneration circuit error: An error was detected in the regenerative transistor or in the regenerative resistor.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Regenerative resistor is faulty.	Check the regenerative resistor's resistance value.	Replace the regenerative resistor.
2	Regenerative transistor was damaged because of a short-circuit.	Is the regenerative resistor burned?	Replace the drive unit.
		The problem is repeated even when the regenerative resistor is not faulty.	

Alarm No. 45	**Fan stop:** A cooling fan built in the drive unit stopped, and the loads on the unit exceeded the specified value.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	The power is turned ON without assuring more than 10 seconds for the time from when the power is turned OFF till when it is turned ON.	Are more than 10 seconds for the time from when the power is turned OFF till when it is turned ON assured?	Leave for more than 10 seconds, and turn the power ON again. If the fan is not rotating, check the investigation item No. 2.
2	The connector connected to a fan is disconnected.	Is the connector connected to a fan disconnected?	Correctly connect the connector. If it is correctly connected, check the investigation item No. 3.
3	Oil or cutting chips are adhered to the fan.	Is oil or cutting chips adhered to the fan? Is the cable broken?	Improve the use environment and replace the drive unit.

Alarm No. 46	**Motor overheat:** Thermal protection function of the motor or in the detector, has started its operation.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	The ambient temperature is high.	Is there a source of heat near the motor?	Take care when arranging sources of heat. Provide means to shield heat.
2	The motor heat dissipation is poor.	Is the motor mounting flange thermally shielded?	Provide means to dissipate heat from flange.
3	Motor load is large.	Is unbalance torque large?	Select the motor so that the unbalance torque is 60% or less.
		Was the overload alarm (50) forcibly reset by turning the drive unit power OFF?	Review the operation pattern.

Alarm No. 50	**Overload 1:** Overload detection level became over 100%. The motor or the drive unit is overloaded.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Machine resonance is occurring.	Is vibration noise heard? Does the position droop fluctuate even when the motor is stopped?	Adjust the parameters. • Select the notch filter. • Lower VGN1 (SV005).
2	Hunting is occurring.	The axis is swaying or moving even when the motor is stopped.	Adjust the parameters. • Increase VGN1 (SV005). • Lower VIA (SV008).
3	Motor performance is insufficient.	Review the motor capacity selection.	Change the motor capacity.
4	The motor brakes are not released.	Check the brake operation. • Check the brake relay. • Check the connector (CN9) connection.	Correctly any faulty section.
5	An excessive force is applied from the machine.	Check the load current with the NC servo monitor, and investigate the machine load.	Correct any faulty machine section.
		Is the ball screw bent?	
		Is there interference with the positioning pin?	When using the positioning pin, turn the servo OFF while stopped.
6	Parameters are incorrectly set.	Are OLT (SV021) and OLL (SV022) set to the standard values?	Set to the standard values.

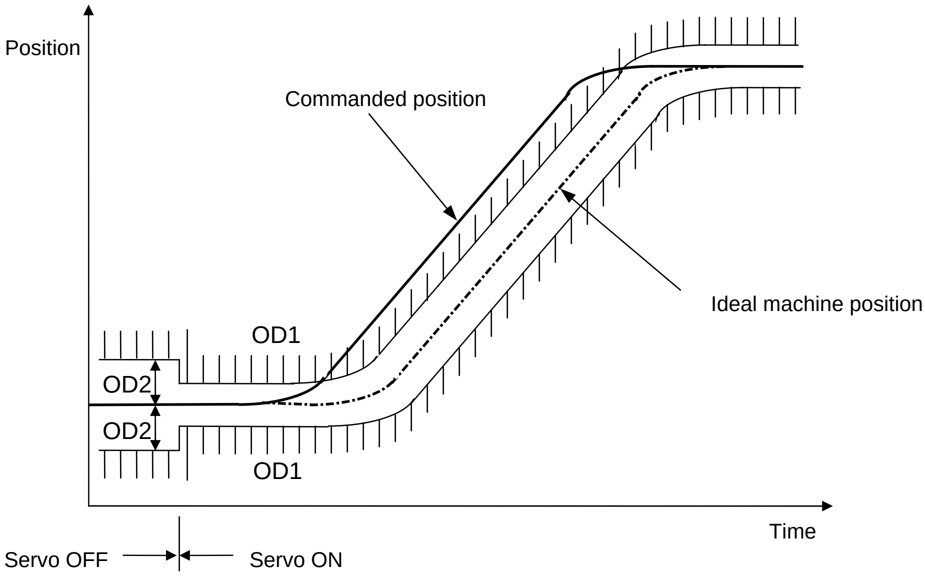
(Note) PR resetting is not possible when the overload level is 50% or more. Do not forcibly reset (AR) by turning the unit power OFF. If AR resetting is used at 50% or higher, the level is set to 80% when the power is turned ON next.

Alarm No. 51	**Overload 2:** Current command of more than 95% of the unit's max. current was being continuously given for longer than 1 second.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	The machine collided.	Check whether the machine collided.	Check the cause of the collision.
2	The acceleration/deceleration time constant is too short.	Is the current value on the NC servo monitor screen abnormally large during acceleration or deceleration?	Adjust the acceleration/deceleration time constant.
3	Motor cable is incorrectly connected.	Check the motor's power wire (U, V, W phases). • The power wire is not connected. • Is the wire connected to another axis' motor?	Correctly connect.
4	Detector is incorrectly connected.	Is the wire connected to another axis' detector?	Correctly connect.
5	Detector is faulty.	Move the axis and check the FB signal.	Replace the detector. (When using the absolute position system, the zero point must be established again.)

Alarm No. 52	**Excessive error 1:** A difference between the actual and theoretical motor positions during servo ON exceeded the setting value.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	The excessive error detection width is too small.	Check the OD1 (SV023) setting value. Is $OD1 = \frac{RAPID}{60 \times PGN1} / 2$ satisfied?	Set the standard value according to the rapid traverse rate and position loop gain.
2	Carry out the items for alarm No. 51.		

Alarm No. 53	Excessive error 2: A difference between the actual and theoretical motor positions during servo OFF exceeded the setting value.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	The axis moved during servo OFF.	Check the motor brake operation.	Correctly and faulty sections.
2	The NC stopped the follow-up function during servo OFF.	Check the NC parameters.	Set the NC parameters according to the machine specifications.
3	The excessive error detection width is too small.	Check the OD1 (SV026) setting value. Is $OD2=\frac{RAPID}{60\times PGN1}$ / 2 satisfied?	Set the standard value according to the rapid traverse rate and position loop gain.

Supplement If the actual machine position is separated by the distance set with OD1 from the ideal machine position in respect to the commanded position, the position will be within the shaded sections shown below.



Alarm No. 55	External emergency stop error: There is no contactor shutoff command, even after 30 seconds has passed since the external emergency stop was input.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	An error occurred during main emergency stop.	Check the emergency stop input and sequence program.	Improve the emergency stop sequence.
2	Parameters are incorrectly set.	Check the PTYP (SV036) external emergency stop setting.	Set correctly.

Alarm No. 5F	External contactor error: A contact of the external contactor is welding. Or the contactor fails to be ON during ready ON.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	The contactor turned ON during READY OFF.	Check whether the contactor contact is melted.	Replace the contactor.
2	The contactor turned OFF during ready ON.	Check whether the contactor control output connector (CN9) is disconnected.	Correctly connect.

Alarm No. 88	**Watchdog:** The system does not operate correctly.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Software operation is incorrect.	Check whether the servo software version was changed recently.	Try returning to the original software version.
2	CPU peripheral circuit operation is incorrect.	Check for abnormalities in the unit's surrounding environment, etc. (Example: Ambient temperature, noise, grounding)	Improve the surrounding environment.
3	Drive unit is faulty.	Check the repeatability.	Replace the drive unit.

10-4-2 Warning

Warning No. 93	**Initial absolute position fluctuation:** The position data have fluctuated during the absolute position initializing.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	The vertical axis or slant axis dropped when the NC power was turned ON.	Check the state of the axis at NC power ON.	Correct the faulty sections.
2	The axis moved with an external force when the NC power was turned ON.		

Warning No. 9E	**Absolute position detector: Revolution counter error:** An error was detected in the revolution counter of the absolute position detector. The absolute position data cannot be compensated.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Detector internal circuit operation is incorrect.	Check for abnormalities in the detector's surrounding environment, etc. (Example: Ambient temperature, noise, grounding)	Improve the surrounding environment.
2	Detector is faulty.	Check the repeatability.	Replace the detector.

Warning No. 9F	**Battery voltage drop:** The battery voltage that is supplied to the absolute position detector dropped. The absolute position data is retained.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Battery is spent.	Measure the battery voltage. (Warning 9F occurs at 3V or less.)	Replace the battery.
2	The cable between the drive unit or battery unit is disconnected.	Check the cable connection.	Correctly connect.
3	The battery connector (inside drive unit) is dislocated.	Check the cable connection.	Correctly connect.
4	Battery line in detector cable is broken.	Check the continuity of the detector cable.	Replace the cable.

(Note) When warning 9F occurs, do not turn OFF the drive power to ensure that the absolute position data is held.

Warning No. A6	**Fan stop warning:** A cooling fan built in the drive unit stopped.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Carry out items for alarm No. 45.		

Warning No. E0	**Over regeneration warning:** Over-regeneration detection level exceeded 80%.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Carry out items for alarm No. 30.		

Warning No. E1	**Overload warning:** Overload detection level exceeded 80%.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Carry out items for alarm No. 50.		

Warning No. E4	Set parameter warning: A parameter setting was outside the setting range. This is displayed as "S51 parameter error ####" on the NC screen. ####: Error parameter No.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	Parameter settings exceed the setting range.	Check the setting range of the error parameter No.	Correctly set.

Warning No. E6	Control axis detachment warning: Control axis detachment was commanded.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	This indicates that the control axis removal was commanded from the NC.		

Warning No. E7	In NC emergency stop state: Emergency stop was input from the CNC.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	The NC emergency stop was input.	This is the state in which the NC emergency stop is correctly input.	
2	An alarm is occurring with another drive unit.	Check whether an alarm is occurring in another drive unit.	Reset the alarm in the other drive unit.
3	Emergency stop cannot be reset.	Check that the terminator or battery unit is connected, and that the cable between the drive unit is not disconnected.	Correctly connect.

Warning No. E9	Instantaneous power interruption warning: The power was momentarily interrupted.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	The control power input was cut off.	Check the control power (24V) input.	Correctly the faulty sections.
2	CPU peripheral circuit operation is incorrect.	Check for abnormalities in the unit's surrounding environment, etc. (Example: Ambient temperature, noise, grounding)	Improve the surrounding environment.

Warning No. EA	In external emergency stop state: External emergency stop signal was input.		
	Cause of occurrence	**Investigation items**	**Remedy**
1	External emergency stop input.	This is the state in which only the external emergency stop was input without the NC emergency stop input.	

10-4-3 Parameter No. during initial parameter error

If an initial parameter error (alarm 37) occurs, the alarm and the parameter No. that may be set incorrectly will appear on the NC Diagnosis screen as shown below. (For M60S, E60 Series NC.)

S02 Initial parameter error ○ ○ ○ ○ □

○ ○ ○ ○ : **Error parameter No.**
□ : **Axis name display**

If a number larger than the parameter No. 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.

Error parameter No.	Details	Related parameter
2269	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
2271	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
2301	The following settings are overflowing. • Electronic gears • Position loop gain • Speed feedback	SV001, SV002 SV003, SV018 SV019, SV020 SV049
2302	Other than the absolute position detection is connected. However, the absolute position detection parameter is valid.	SV017, SV025
2303	The servo option is not available. The closed loop or dual feedback control function is set.	SV025, SV017
2304	The servo option is not available. The SHG control function is set.	SV057, SV058
2305	The servo option is not available.	SV027

11. Inspection

WARNING	1. Turn the main circuit power and control power both OFF before starting maintenance and inspection. It will take approx. 10 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. Failure to observe this could lead to electric shocks. 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.

11-1 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?

11-2 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 unit	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.
	Cooling fan	10,000 to 30,000 hours (2 to 3 years)	
	Battery	10,000 hours	
Servomotor	Bearings	20,000 to 30,000 hours	
	Detector	20,000 to 30,000 hours	
	Oil seal, V-ring	5,000 hours	

<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> Servomotor 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.

Appendix 1. Cable and Connector Specifications

Appendix 1-1 Selection of cable

Appendix 1-1-1 Cable wire and assembly

(1) Cable wire

The specifications of the wire used for each cable, and the machining methods are shown in this section. When manufacturing the detector cable and battery connection cable, use the recommended wires shown below or equivalent products.

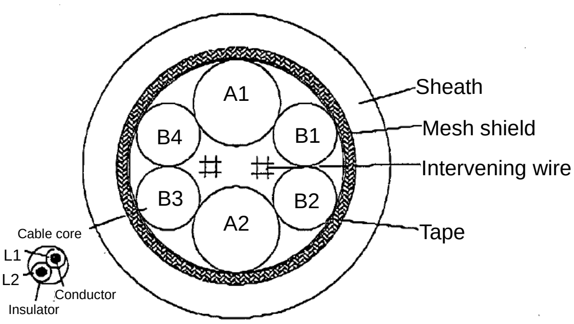
(a) Heat resistant specifications cable

Wire type (special order part)	Finish outer diameter	Sheath material	No. of pairs	Wire characteristics					
				Configuration	Conductive resistor	Withstand voltage	Insulation resistance	Heat resistance temperature	Flexibility
BD20288 Compound 6-pair shielded cable Specification No. Bangishi-17145 (Note 1)	8.7mm	Heat resistant PVC	2 ($0.5mm^2$)	100 strands/ 0.08mm	40.7Ω/km or less	500VAC/ 1min	1000MΩ/km or more	105°C	70×10^4 times or more at R200
			4 ($0.2mm^2$)	40 strands/ 0.08mm	103Ω/km or less				

(b) General-purpose heat resistant specifications cable

Wire type (special order part)	Finish outer diameter	Sheath material	No. of pairs	Wire characteristics					
				Configuration	Conductive resistor	Withstand voltage	Insulation resistance	Heat resistance temperature	Flexibility
BD20032 Compound 6-pair shielded cable Specification No. Bangishi-16903 Revision No. 3 (Note 2)	8.7mm	PVC	2 ($0.5mm^2$)	100 strands/ 0.08mm	40.7Ω/km or less	500VAC/ 1min	1000MΩ/km or more	60°C	100×10^4 times or more at R200
			4 ($0.2mm^2$)	40 strands/ 0.08mm	103Ω/km or less				

(Note 1) Bando Electric Wire (Contact: 81+48-461-0561 http://www.bew.co.jp)
(Note 2) The Mitsubishi standard cable is the (a) Heat resistant specifications cable. For MDS-C1/CH series, (b) or equivalent is used as the standard cable.



Compound 6-pair cable structure drawing

Core identification

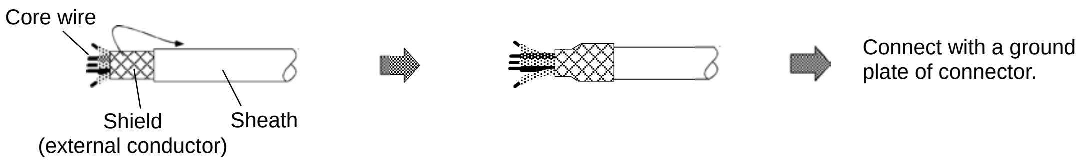
Pair No.	Insulator color	
	L1	L2
A1 ($0.5mm^2$)	Red	White
A2 ($0.5mm^2$)	Black	White
B1 ($0.2mm^2$)	Brown	Orange
B2 ($0.2mm^2$)	Blue	Green
B3 ($0.2mm^2$)	Purple	White
B4 ($0.2mm^2$)	Yellow	White

(2) NC bus cable

Recommended wire model (Cannot be directly ordered from Mitsubishi Electric Corp.)	Finished outside diameter	Sheath material	No. of pairs	Wire characteristics			
				Configuration	Conductor resistance	Withstand voltage	Insulation resistance
UL20276 AWG28 10pair	6.1mm	PVC	10	7 strands/ 0.13mm	222Ω/km or less	AC350/ 1min	1MΩ/km or more

(3) Cable assembly

Assemble the cable with the cable shield wire securely connected to the ground plate of the connector.



(4) 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 due to cutting chips.
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.

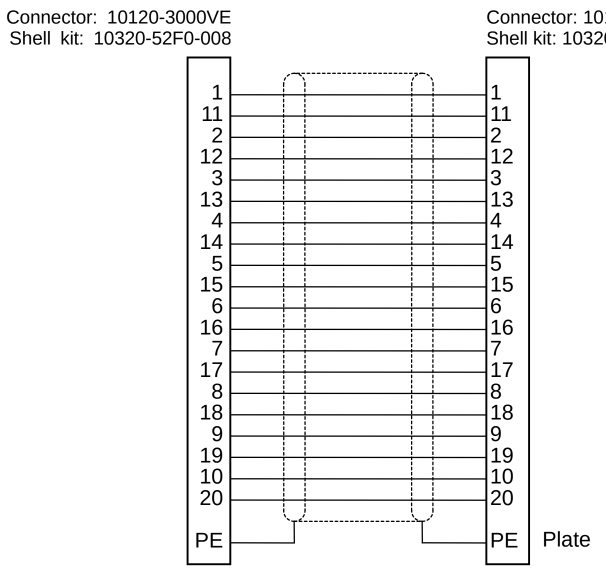
Appendix 1-2 Cable connection diagram

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

(1) NC bus cable

< SH21 cable connection diagram >

This is an actual connection diagram for the SH21 cable supplied by Mitsubishi.
Manufacture the cable as shown below. The cable can be up to 30m long.



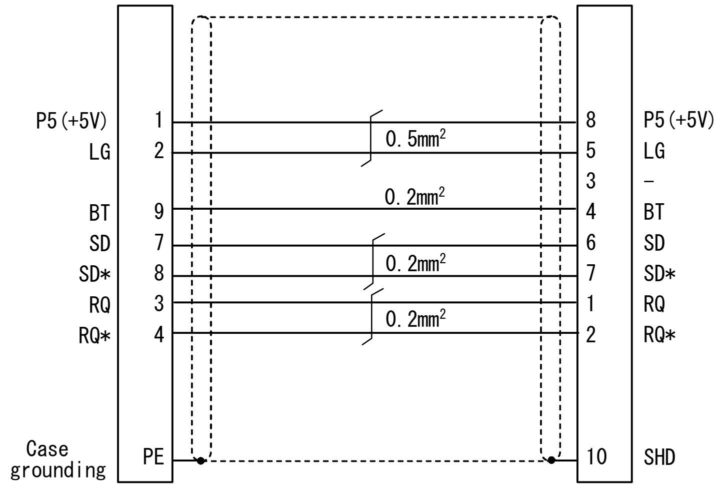
(2) HF□-A51 motor detector cable

< CNV2E-6P/7P cable connection diagram >

This is an actual connection diagram for the CNV2E-6P/7P cable supplied by Mitsubishi.

Servo drive unit side connector
(3M)
Receptacle : 36210-0100PL
Shell kit : 36310-3200-008
(MOLEX)
Connector set : 54599-1019

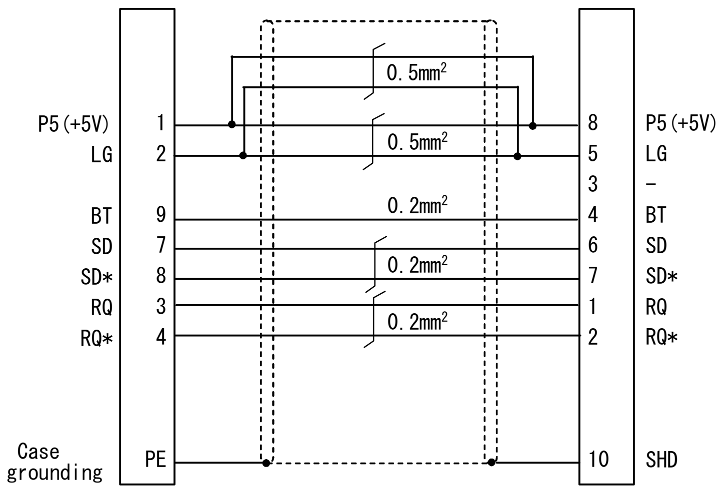
Servo motor detector side connector
Plug: CM10-SP10S-M (Straight)
CM10-AP10S-M (Angle)
Contact: CM10-#22SC



<For 15m or less>

Servo drive unit side connector
(3M)
Receptacle: 36210-0100PL
Shell kit: 36310-3200-008
(MOLEX)
Connector set: 54599-1019

Servo motor detector side connector
Plug: CM10-SP10S-M (Straight)
CM10-AP10S-M (Angle)
Contact: CM10-#22SC



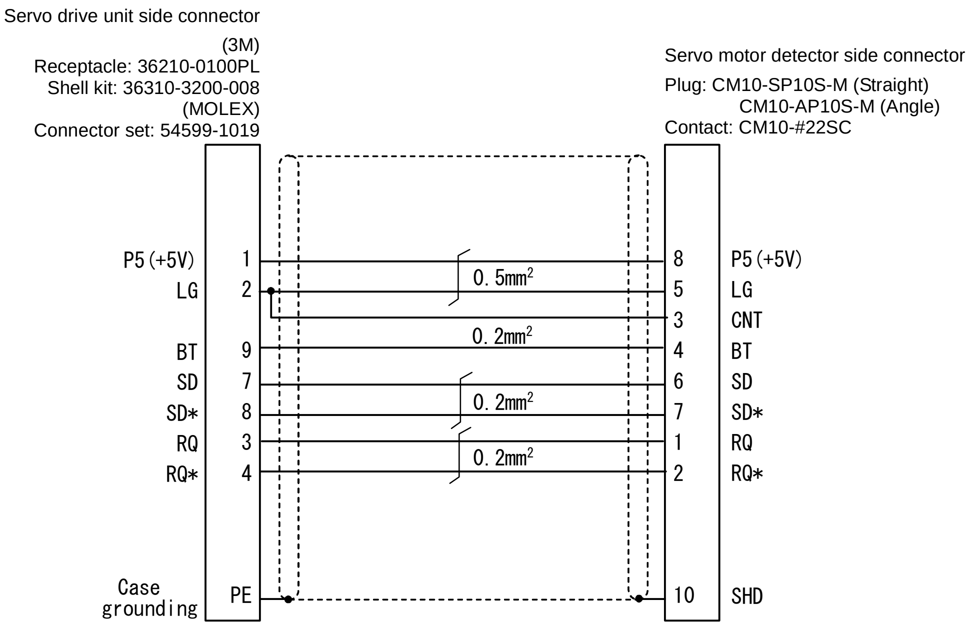
<For 15 to 30m>

⚠ CAUTION	1. Do not connect anything to pins unless particularly specified when manufacturing a cable. (Leave OPEN) 2. Contact Mitsubishi when manufacturing a cable longer than 30m.

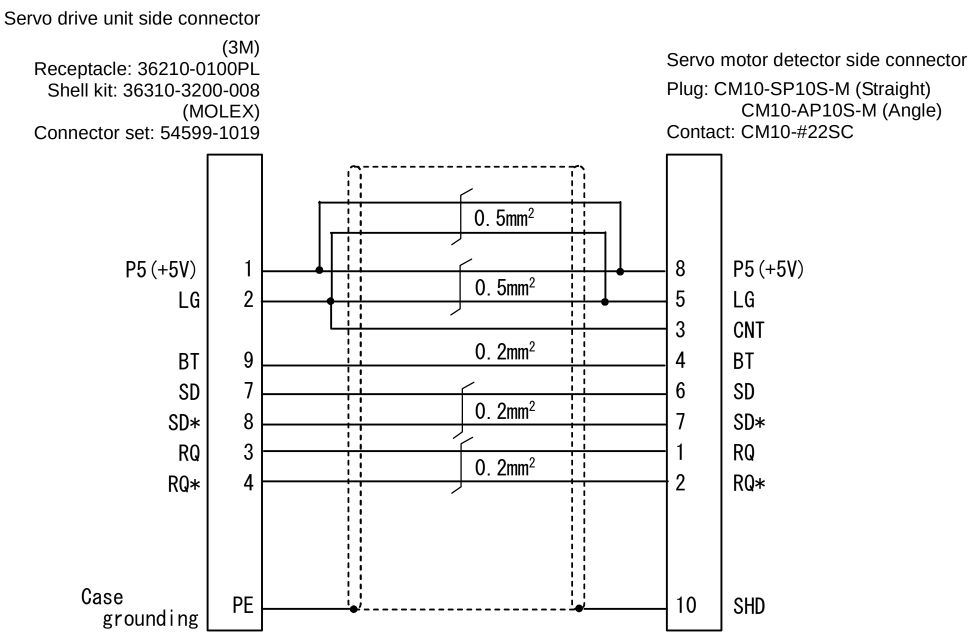
(3) HF□-A48/A51 motor detector cable

< CNV2E-8P/9Pcable connection diagram >

This is an actual connection diagram for the CNV2E-8P/9P cable supplied by Mitsubishi.



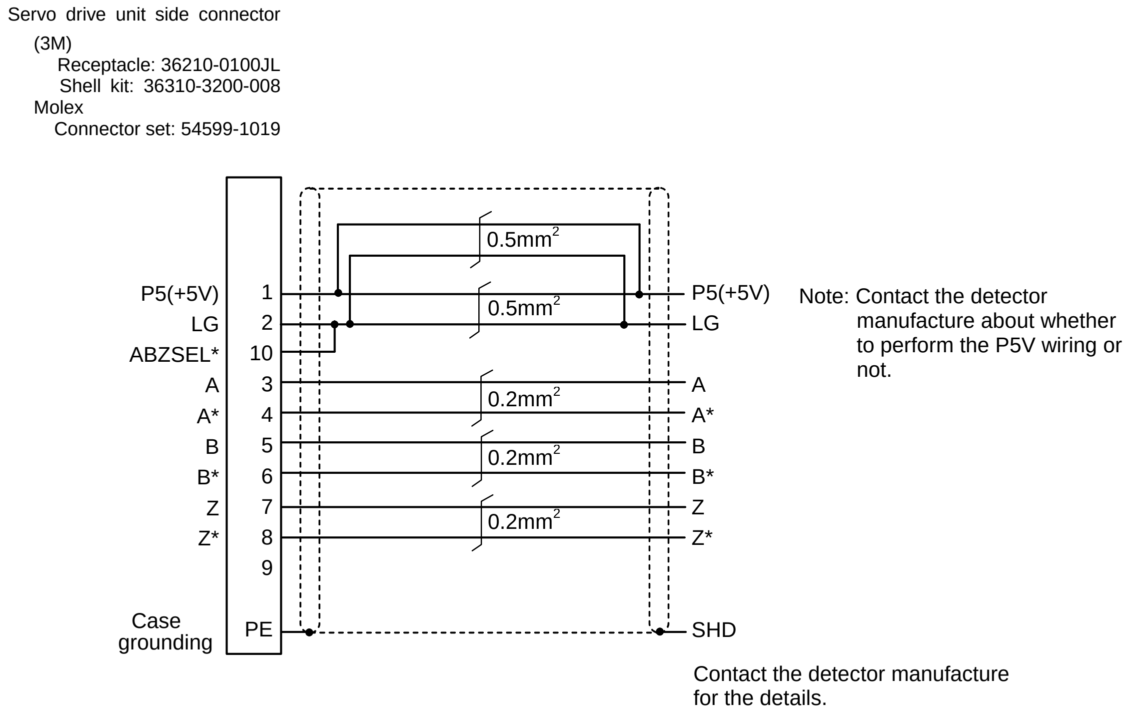
<For 15m or less>



<For 15 to 30m>

⚠ CAUTION	1. Do not connect anything to pins unless particularly specified when manufacturing a cable. (Leave OPEN) 2. Contact Mitsubishi when manufacturing a cable longer than 30m

(4) Rectangular wave communication detector (linear scale, etc.) cable connection diagram



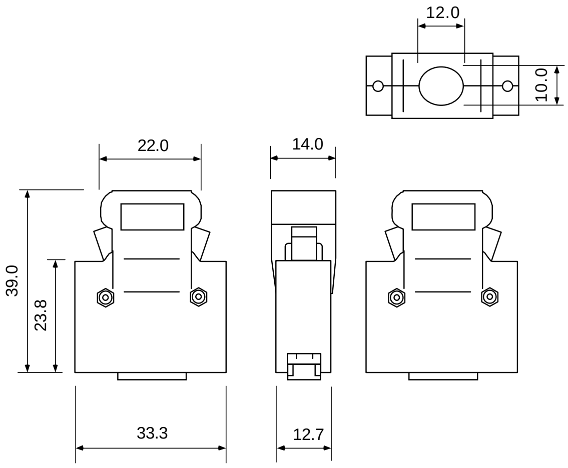
(Note) This cable must be prepared by the user.

Appendix 1-3 Connector outline dimension drawings

Connector for CN1A, CN1B drive unit

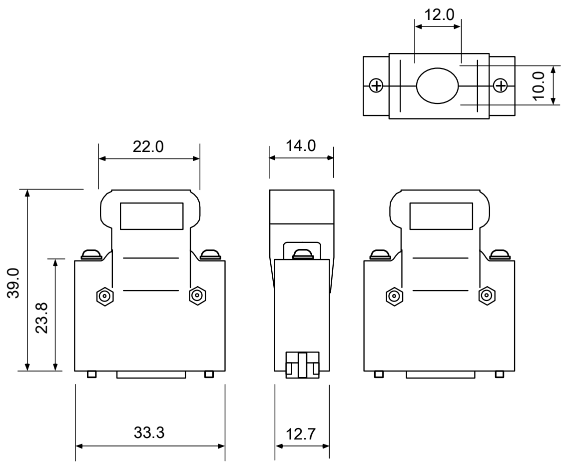
Manufacturer: 3M
<Model>
Connector: 10120-3000VE
Shell kit: 10320-52F0-008

[Unit: mm]



Manufacturer: 3M
<Model>
Connector: 10120-3000VE
Shell kit: 10320-52A0-008

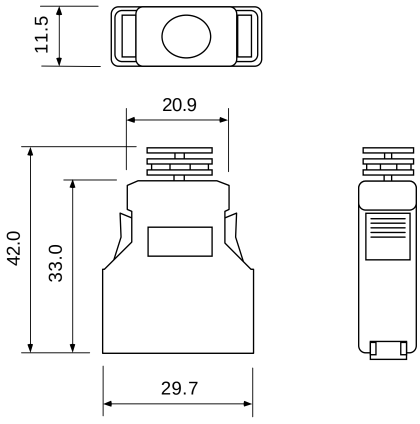
[Unit: mm]



Manufacturer: 3M
<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]



Recommended manufacturer: 3M

Connector for CN2L, CN2M drive unit

Manufacturer: Molex

<Model>

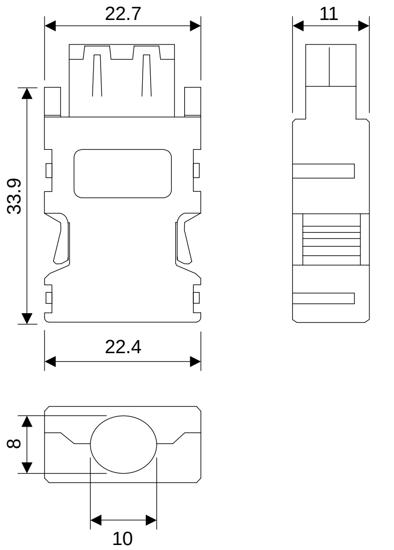
Connector set: 54599-1019

Manufacturer: 3M

<Model>

Receptacle: 36210-0100JL
Shell kit: 36310-3200-008

[Unit: mm]

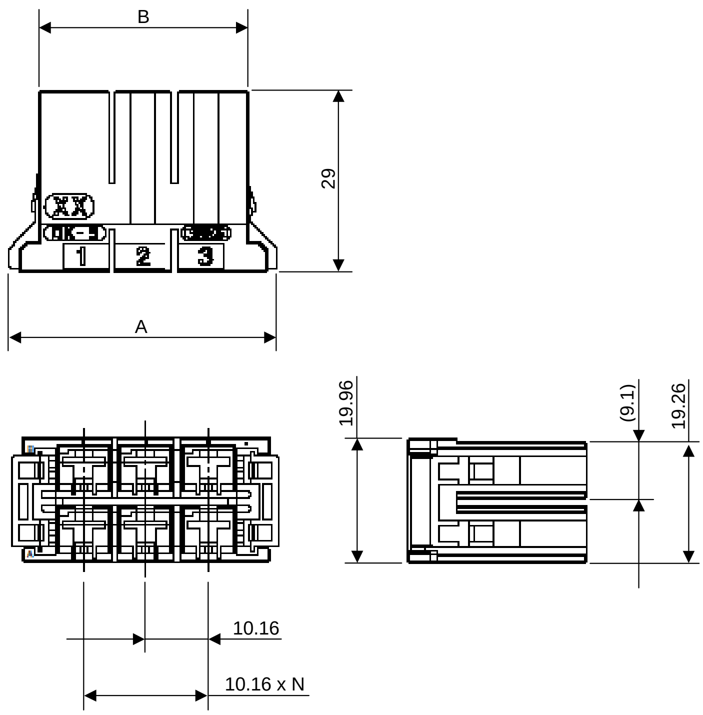


Connector for CN31L, CN31M, CN30 drive unit

Manufacturer: DDK
<Model>
For CN31L, CN31M
Housing: DK-5200M-04R
Contact: DK-5RECSLP1-100
(for AWG14, 16)
DK-5RECMLP1-100
(for AWG10, 12)

For CN30
Housing: DK-5200M-06R
Contact: DK-5RECSLP1-100
(for AWG14, 16)
DK-5RECMLP1-100
(for AWG10, 12)

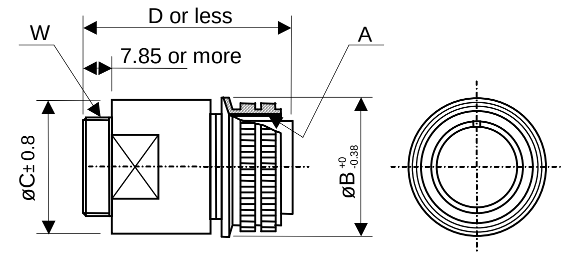
[Unit: mm]



Model	No. of poles	Dimension	
		A	B
DK-5200M-04R	4	33.36	23.76
DK-5200M-06R	6	43.52	33.92

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

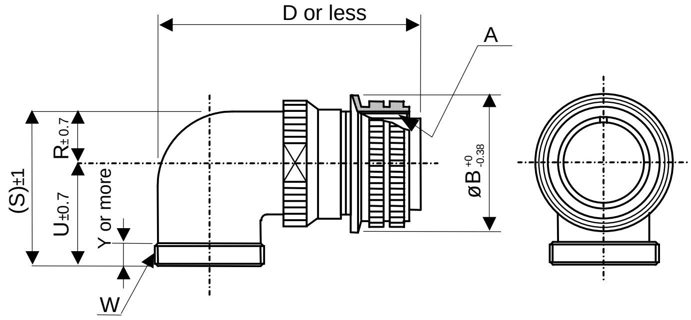
Straight plug
Manufacturer: DDK



[Unit: mm]

Model	A	B $^{+0}_{-0.38}$	C±0.8	D or less	W
CE05-6A18-10SD-B-BSS	$1^1/_8$-18UNEF-2B	34.13	32.1	57	1-20UNEF-2A
CE05-6A22-22SD-B-BSS	$1^3/_8$-18UNEF-2B	40.48	38.3	61	$1^3/_{16}$-18UNEF-2A
CE05-6A22-23SD-B-BSS					

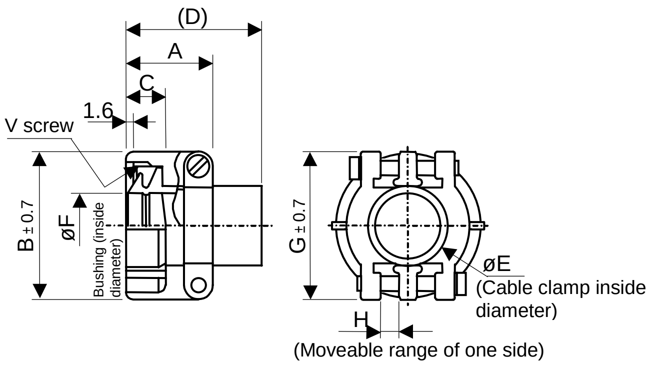
Angle plug
Manufacturer: DDK



[Unit: mm]

Model	A	B $^{+0}_{-0.38}$	D or less	W	R±0.7	U±0.7	(S)±1	Y or more
CE05-8A18-10SD-B-BAS	$1^1/_8$-18UNEF-2B	34.13	69.5	1-20UNEF-2A	13.2	30.2	43.4	7.5
CE05-8A22-22SD-B-BAS	$1^3/_8$-18UNEF-2B	40.48	75.5	$1^3/_{16}$-18UNEF-2A	16.3	33.3	49.6	7.5
CE05-8A22-23SD-B-BAS								

Cable clamp
Manufacturer: DDK



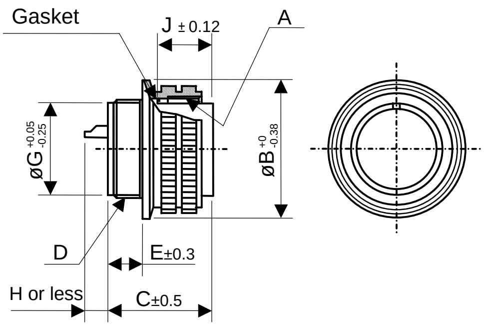
[Unit: mm]

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-1 (D265)	18	23.8	30.1	10.3	41.3	15.9	14.1	31.7	3.2	1-20UNEF-2B	CE3420-10-1	Ø10.5 to ø14.1
CE3057-12A-1 (D265)	20	23.8	35	10.3	41.3	19	16	37.3	4	$1^3/_{16}$-18UNEF-2B	CE3420-12-1	Ø12.5 to ø16
CE3057-12A-2 (D265)	22						13				CE3420-12-2	Ø9.5 to ø13

Recommended manufacturer: DDK

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

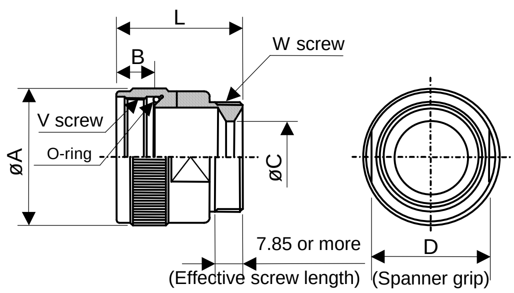
Straight plug
Manufacturer: DDK



[Unit: mm]

Model	A	B $^{+0}_{-0.38}$	C±0.5	D	E±0.3	G $^{+0.05}_{-0.25}$	J±0.12
MS3106A20-29S (D190)	$1^{1}/_{4}$-18UNEF-2B	37.28	34.11	$1^{1}/_{8}$-18UNEF-2A	12.16	26.8	18.26
MS3106A22-14S (D190)	$1^{3}/_{8}$-18UNEF-2B	40.48	34.11	$1^{1}/_{4}$-18UNEF-2A	12.15	29.9	18.26

Straight back shell
Manufacturer: DDK

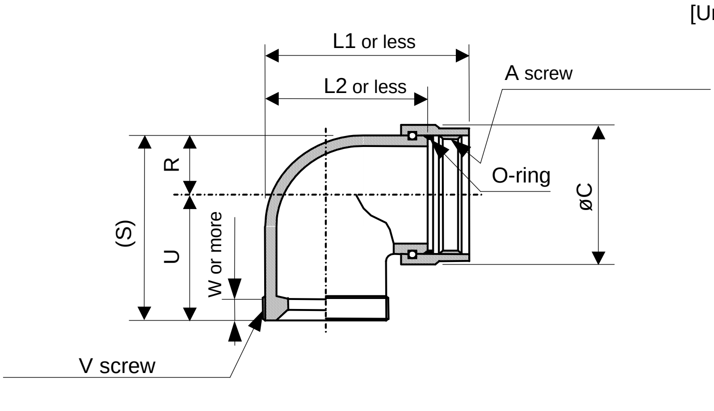


[Unit: mm]

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

Angle back shell
Manufacturer: DDK
Model: CE-22BA-S

[Unit: mm]



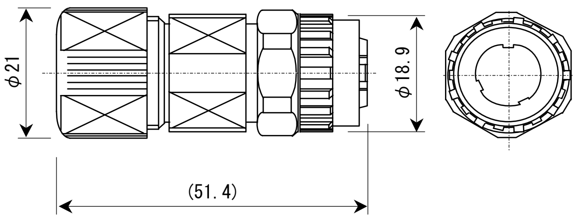
[Unit: mm]

Model	Shell size	Connection screw A	Total length L1	Angle total length L2	Diam- eter C	R	U	(S)	Installation screw V	Effective screw length W
CE-20BA-S	20	$1^{1}/_{8}$-18UNEF-2B	50.5	39.6	36	15	33.3	48.3	$1^{3}/_{16}$-18UNEF-2A	7.5
CE-22BA-S	22	$1^{1}/_{4}$-18UNEF-2B			38.6	16.3		49.6		

Motor side detector connector

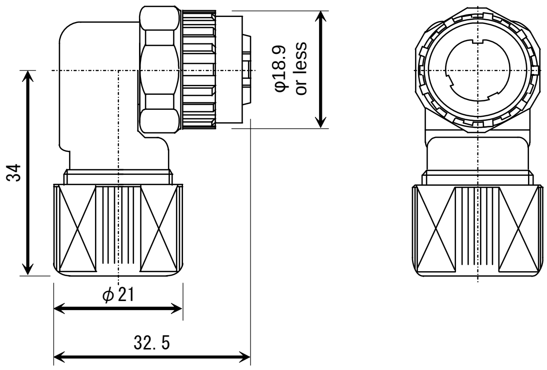
Manufacturer : DDK
＜Model＞
Plug : CM10-SP10S-M

［Unit : mm］

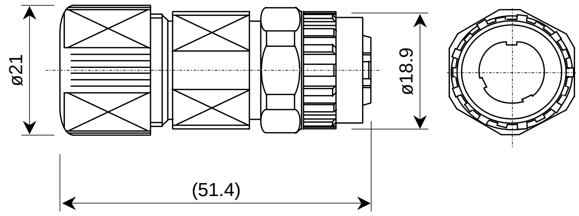
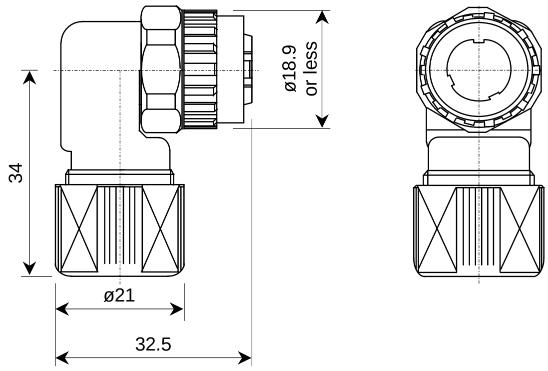


Manufacturer : DDK
＜Model＞
Plug : CM10-AP10S-M

［Unit : mm］



(Note) For the manufacturing method of CM10 series connector, refer to the section "Cable and connector assembly" in Instruction Manual.

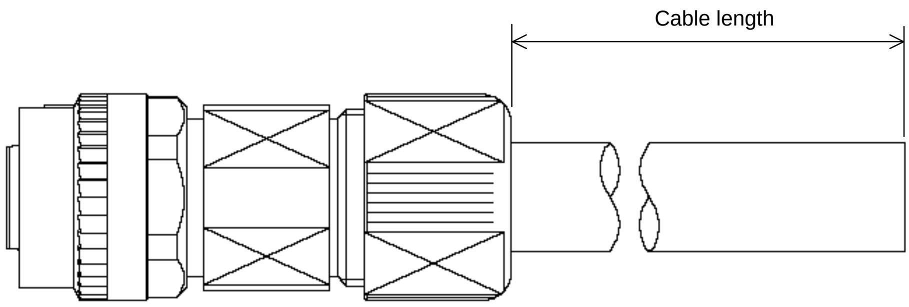
Connector for brake (IP67 and EN standard compatible)
Straight Manufacturer: DDK Model: CM10-SP2S-M [Unit: mm] 
Angle Manufacturer: DDK Model: CM10-AP2S-M [Unit: mm] 

Appendix 1-4 Cable and connector assembly

Appendix 1-4-1 CM10-SP**S plug connector

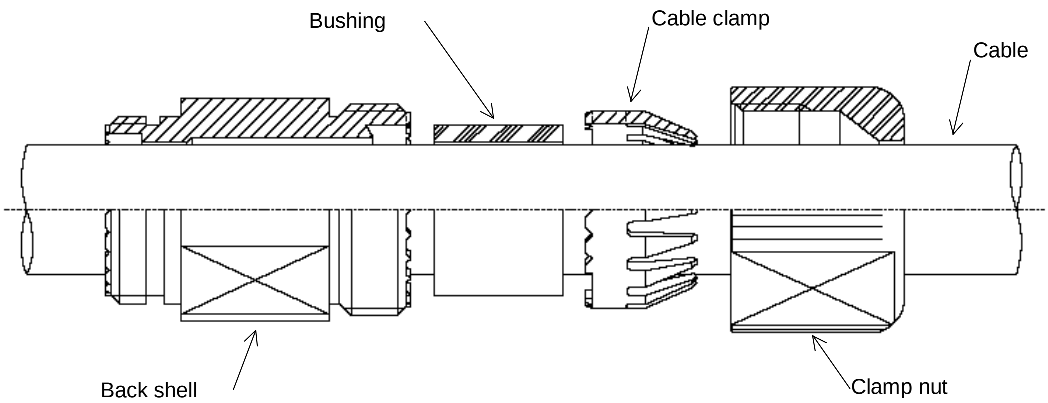
This section explains how to assemble the wire to CM 10 angle plug connector.

(1) Cutting a cable
Cut the cable to the following dimensions:

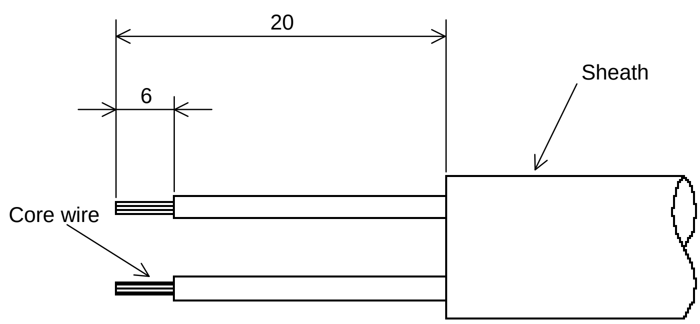


* Cable length after cutting = CM10 - SP**S：35mm + cable length
= 35mm + cable length

(2) Inserting parts
Insert the clamp nut, cable clamp, bushing and back shell in to the cable.
(Note) Take care not to insert them upside down



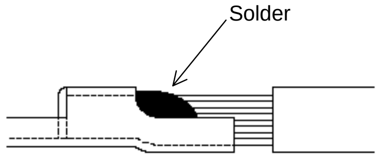
(3) Stripping a cable
Strip the cable to a length 20mm.
Strip the core wire to a length 6mm.



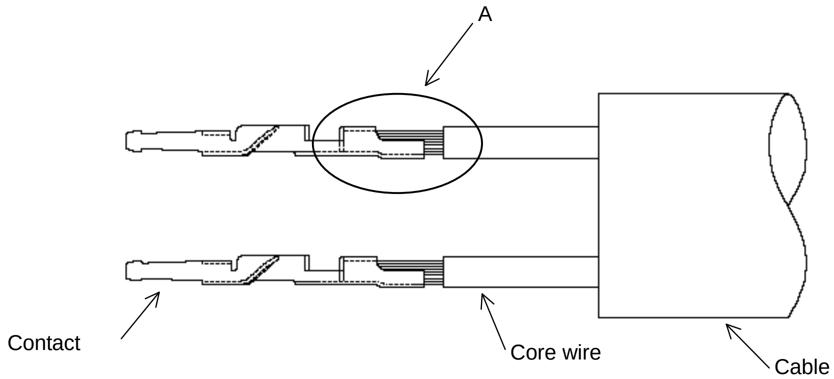
(4) Soldering a contact

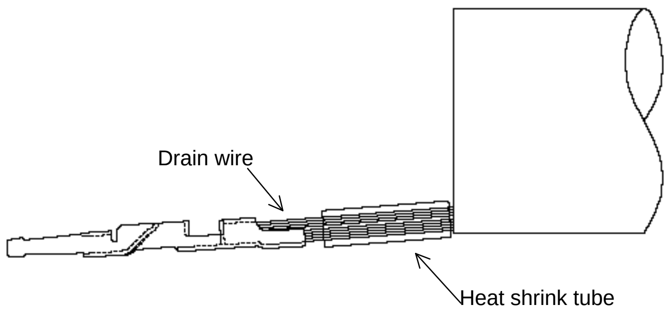
Temporarily solder each contact and core wire, and then solder the core wire on the contact.
When using a drain wire, attach a heat shrink tube on it after soldering.
(Note) Take care not to stick out the core wire from the contact.
Take care to prevent solder from adhering to the edge of solder cup.

Connector name	Applicable contact	Applicable cable
CM10-SP10S	CM10-#22SC-S1	AWG20 or less
CM10-SP2S	CM10-#22SC-S2	AWG16 or less



Detail A



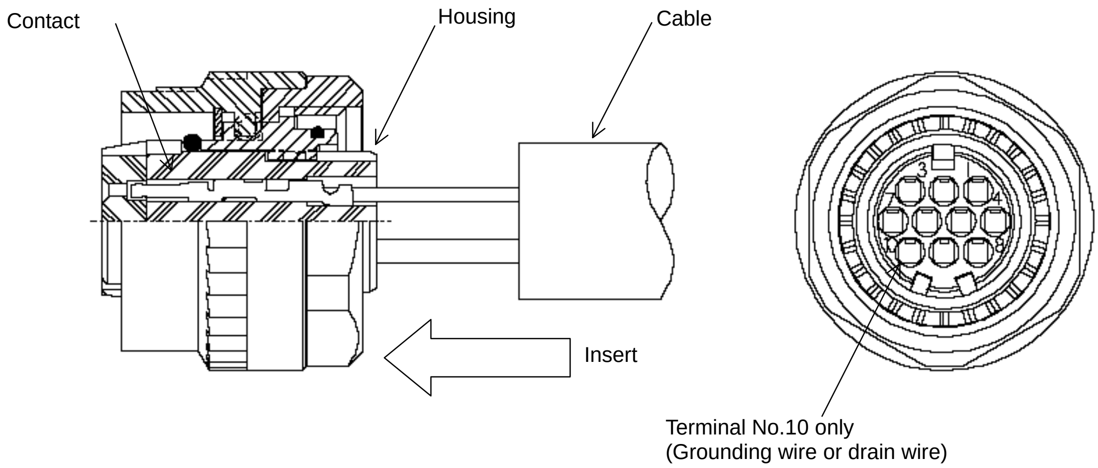


Soldering drain wire

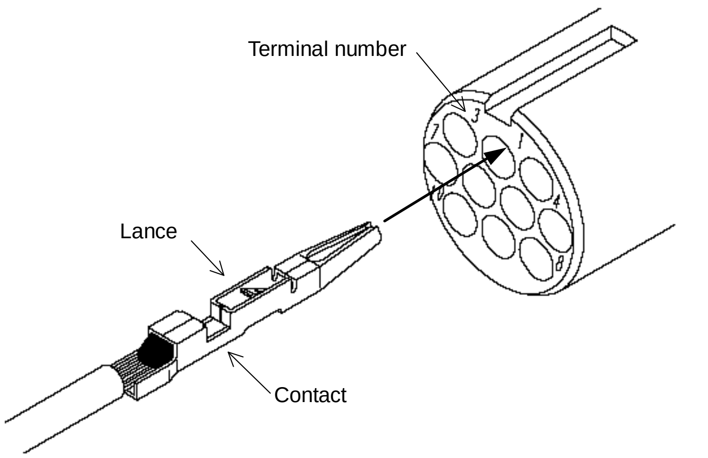
(5) Inserting the contact

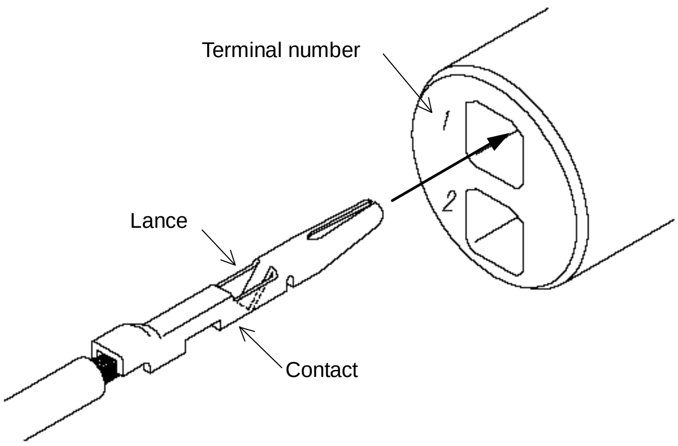
Insert the contact into the specified terminal in the housing.
(Insert grounding wire or drain wire into terminal No.10 in the housing.)
* When the contact catches the housing, you will hear a snap.

(Note) Before inserting the contact, check that the clamp nut, cable clamp, bushing and back shell is inserted.



* Insert the contact so that the lance and the terminal number in the housing face the same direction. However, in case of CM10-SP2S, insert the contact so that the lance and the terminal number in the housing face the opposite direction.





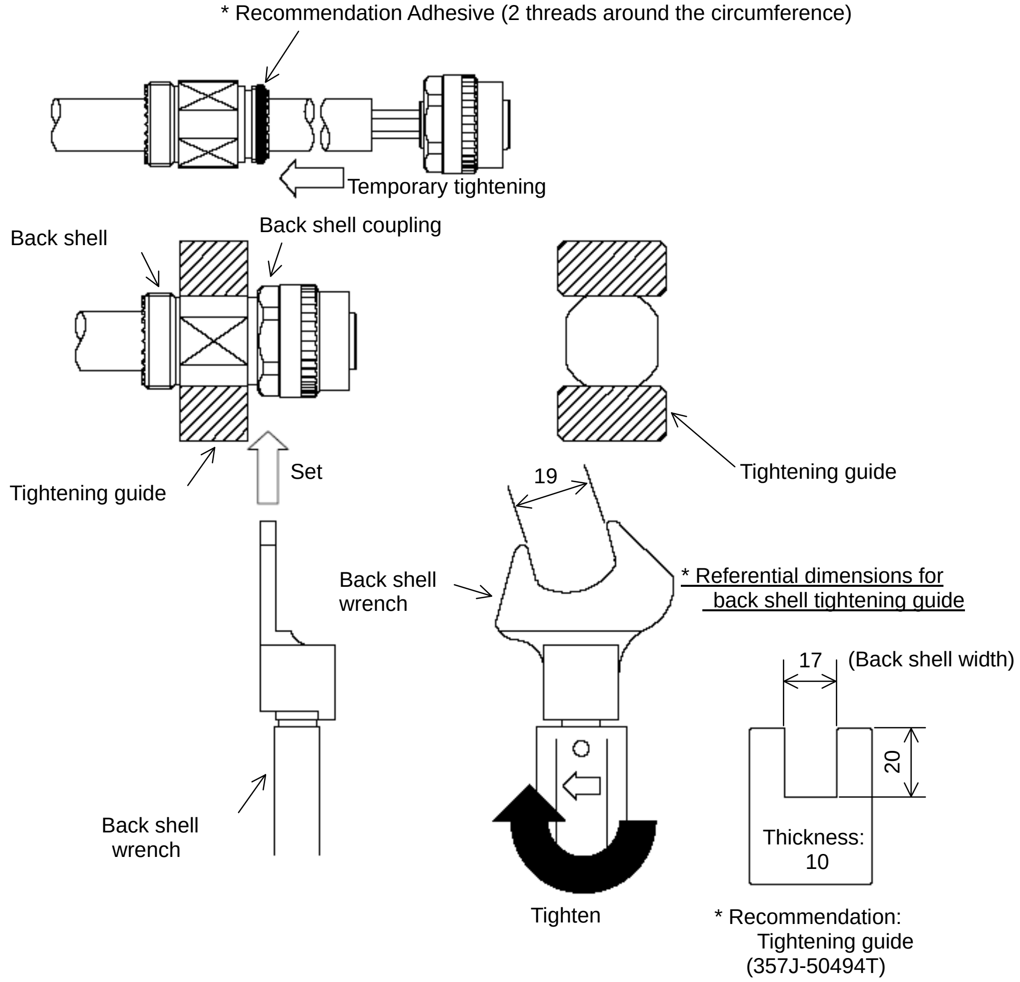
CM10-SP2S

(Note) When pulling out a contact, use dedicated jigs and tools.
Contact removal tool: 357J-50548T-A

(6) Back clamp nut tightening, shell tightening

[1] Temporarily tighten the back shell coupling on the straight back shell.
* To prevent loosening, the adhesive should be applied to the straight back shell.
[2] Set the back shell wrench on the back shell coupling.
[3] With the wrench, tighten the back shell coupling on the straight back shell.
Recommended tightening: 5N•m

(Note) Accurately fit the wrench on the back shell coupling.
To remove, take the reverse steps.



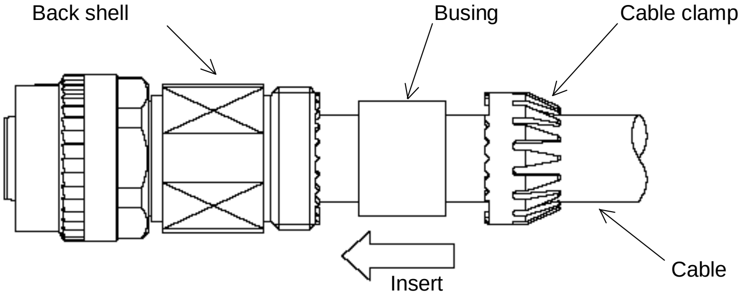
• Recommended jigs and tools : Back shell wrench (357J-51333T)
(Bit (357J-51344T)
Torque wrench (CL6N x 8D,Tonichi Mfg.))

* Recommended tightening guide: (357J-50494T)

* Recommended adhesive: screw lock 1401B (Threee bond Co,Ltd)

(7) Insert a busing and a cable clamp

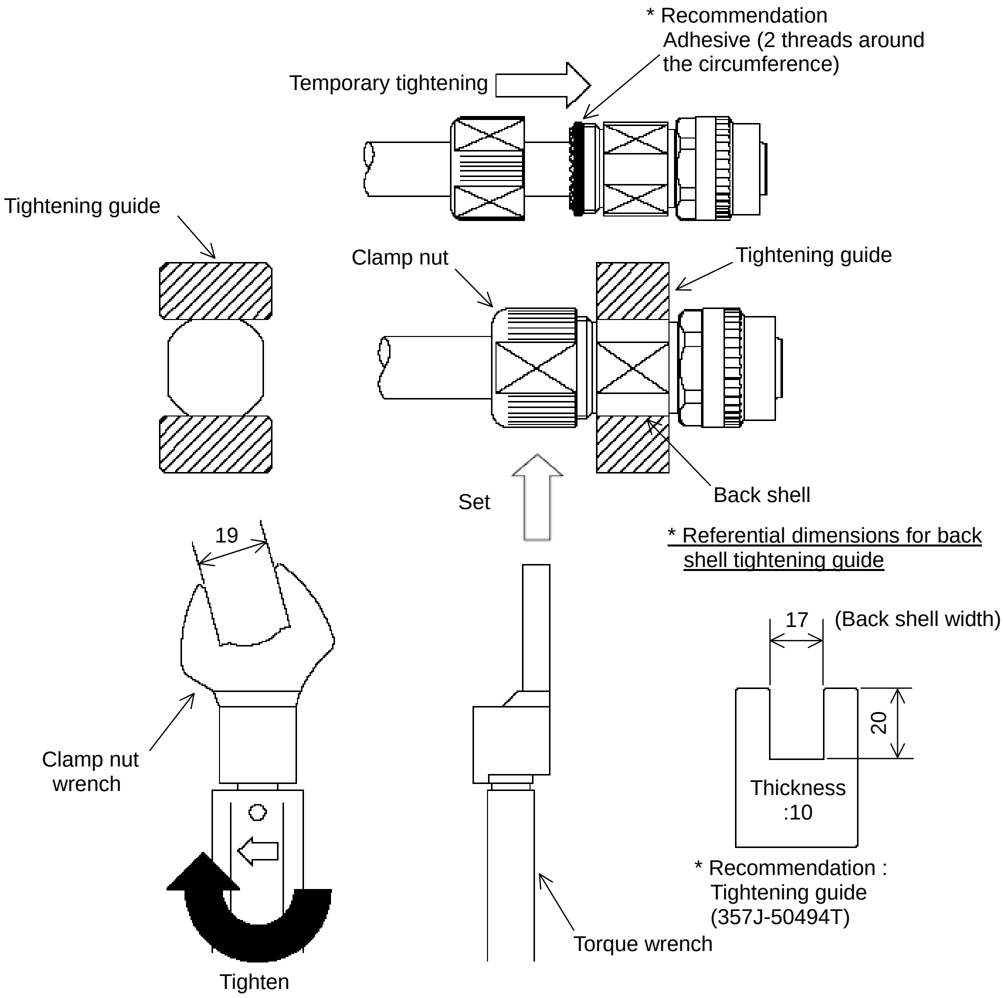
Insert the bushing and the cable clamp into the back shell.



(8) Tightening a clamp nut

[1] Temporarily tighten the clamp nut on the back shell.
  * To prevent loosening, the adhesive should be applied to the back shell.
[2] Set the clamp nut wrench on the clamp nut.
[3] With the wrench, tighten the clamp nut on the straight back shell.
  Recommended tightening: 5N•m

(Note) Accurately fit the wrench on the clamp nut.
  To remove, take the reverse steps.



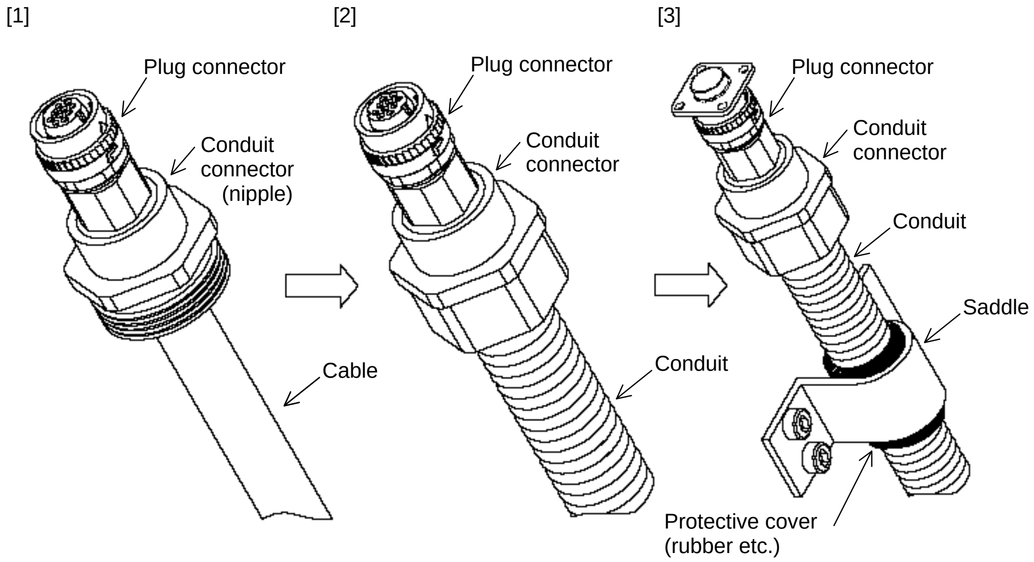
● Recommended jigs and tools : Clamp nut wrench(357J-51334T)
  Bit (357J-51345T)
  Torque wrench (CL6N x 8D, Tonichi Mfg.)

* Recommended tightening jig : (357J-50494T)

* Recommended adhesive : Screw lock 1401B (Three Bond Co,.Ltd)

(9) When using a conduit

[1] Tighten the nipple of conduit connector on the plug connector (CM10).
[2] Set the conduit on the nipple of conduit connector.
[3] When using by moving part, fix conduit on the saddle etc.,
Take care not to damage for plug connector (CM10) and conduit connector.
Set the protective cover (rubber etc.,) on the conduit for takes care not to cable damage.



Recommended conduit
Type: VF Type: SR Type: FBN Type: EM Type: VFS Type: SRK etc

Recommended connector

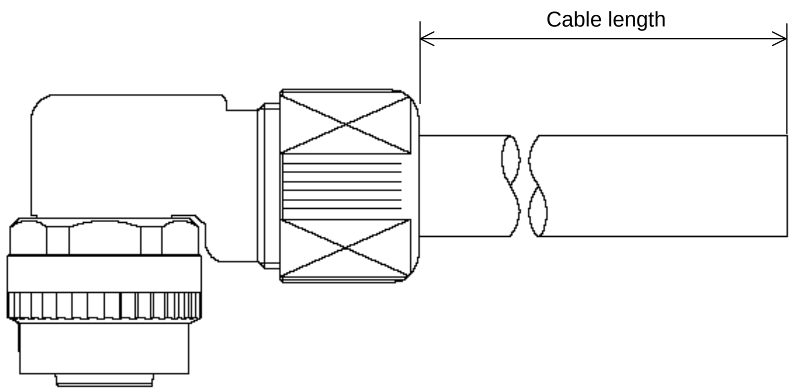
Recommended connector	Applicable connector type	Applicable cable range
RCM103S	CM10-SP10S-S/CM10-AP-10S-S	ϕ 4.0 to ϕ 6.0mm
RCM103M	CM10-SP10S-M/CM10-AP-10S-M	ϕ 6.0 to ϕ 9.0mm
RCM104L	CM10-SP10S-L/CM10-AP-10S-L	ϕ 9.0 to ϕ 12.0mm

Appendix 1-4-2 CM10-AP**S Angle Plug Connector

This section explains how to assemble the wire to CM10 angle plug connector.

(1) Cutting a cable

Cut the cable to the following dimensions:

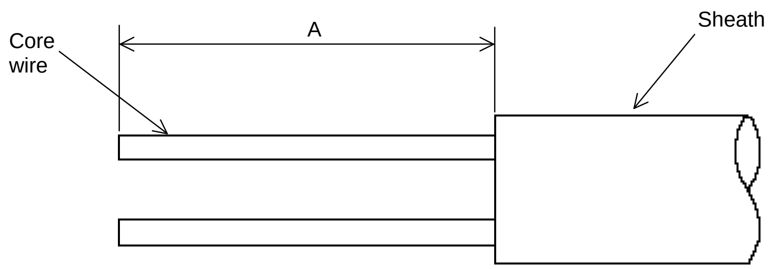


* Cable length after cutting = CM10 - AP**S : A + cable length
= A + cable length

Product name	A
CM10-AP**S-S-**	40mm
CM10-AP**S-M-**	
CM10-AP**S-L-**	55mm

(2) Stripping a cable sheath

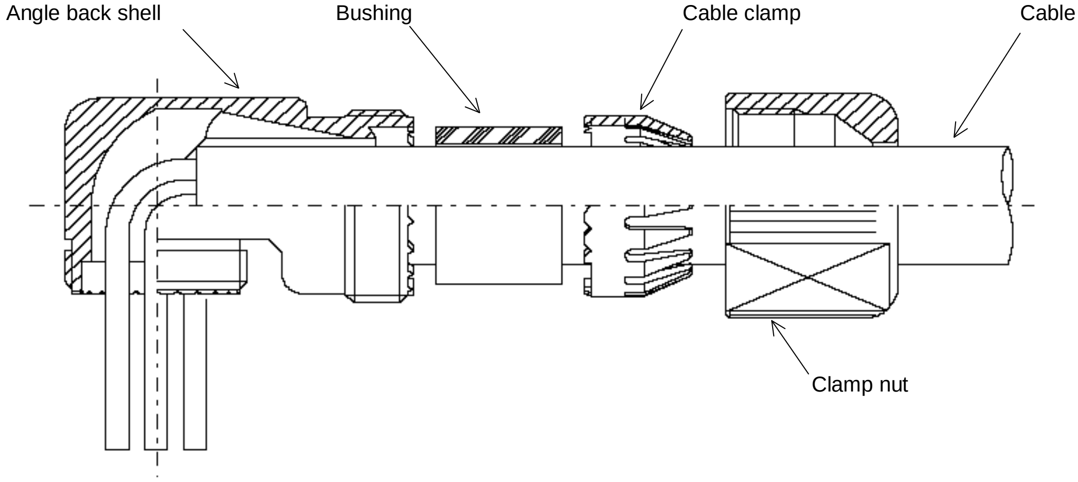
Strip the cable sheath to the following dimensions:



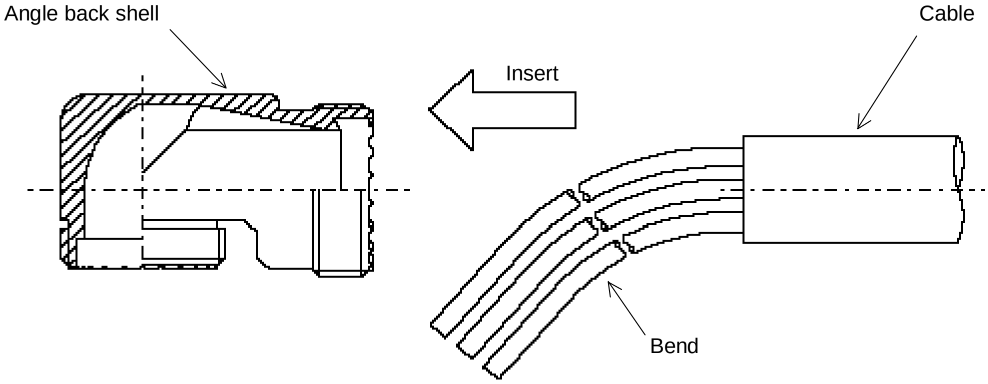
Product name	A
CM10-AP**S-S-**	30mm
CM10-AP**S-M-**	
CM10-AP**S-L-**	45mm

(3) Inserting parts

Insert the clamp nut, cable clamp, bushing and angle back shell in to the cable.
(Note) Take care not to insert them upside down

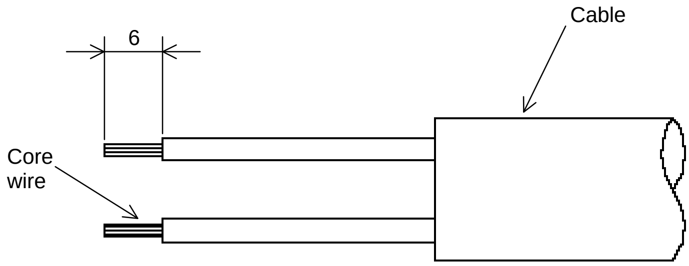


* Bend and insert the cable into angle back shell.



(4) Stripping a cable

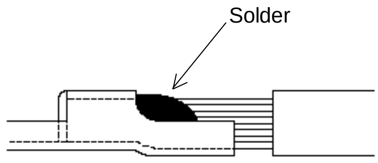
Strip the core wire to a length 6mm.



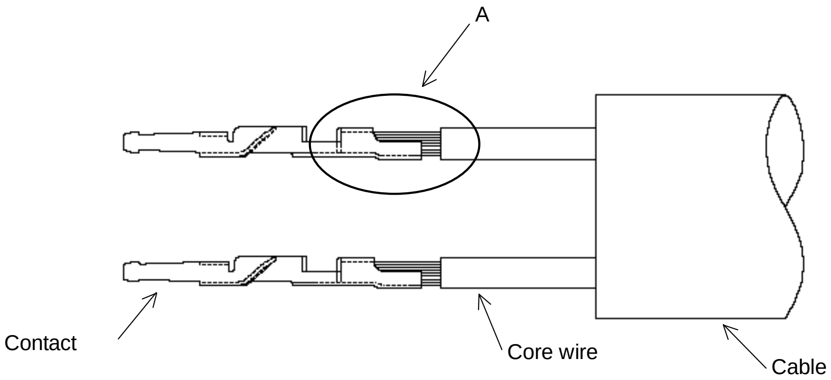
(5) Soldering a contact

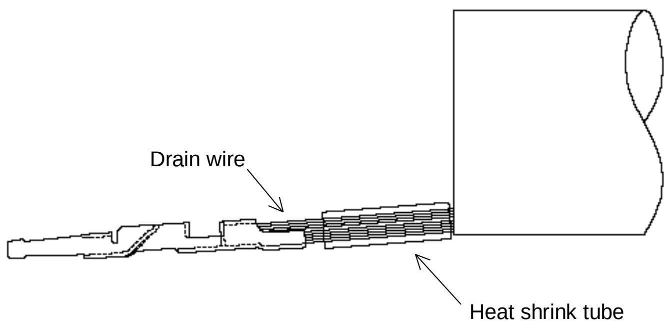
Temporarily solder each contact and core wire, and then solder the core wire on the contact.
When using a drain wire, attach a heat shrink tube on it after soldering.
(Note) Take care not to stick out the core wire from the contact.
Take care to prevent solder from adhering to the edge of solder cup.

Connector name	Applicable contact	Applicable cable
CM10-AP10S	CM10-#22SC-S1	AWG20 or less
CM10-AP2S	CM10-#22SC-S2	AWG16 or less



Detail A



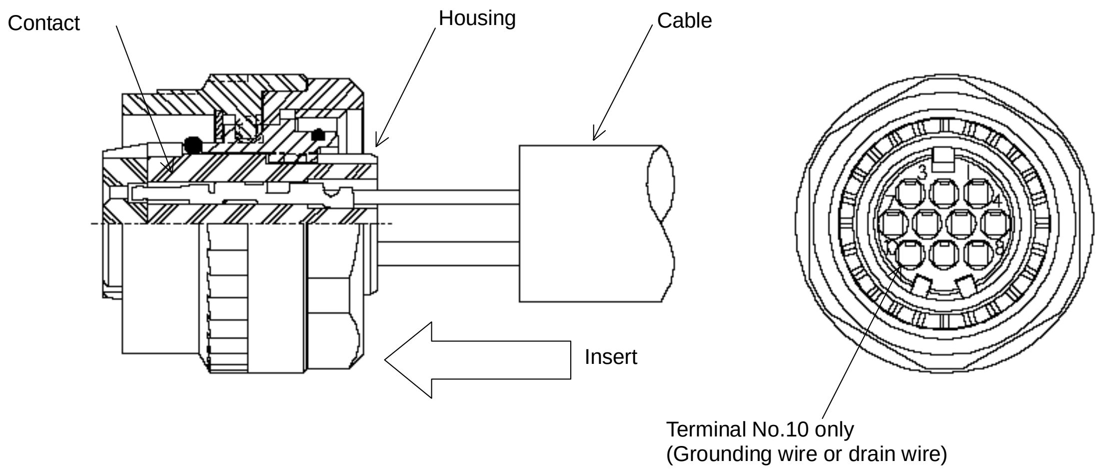


Soldering drain wire

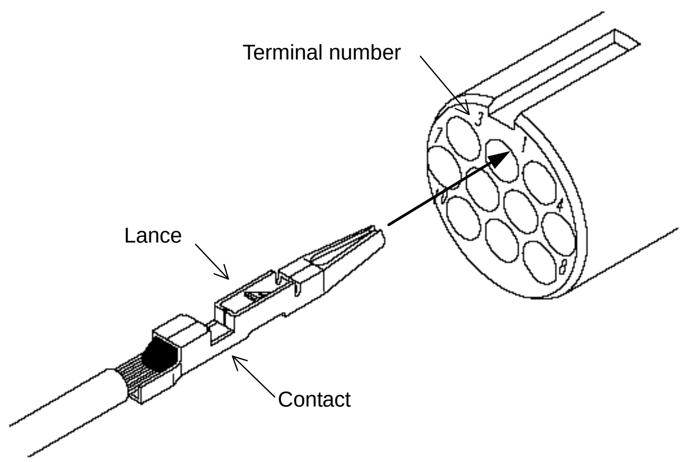
(6) Inserting the contact

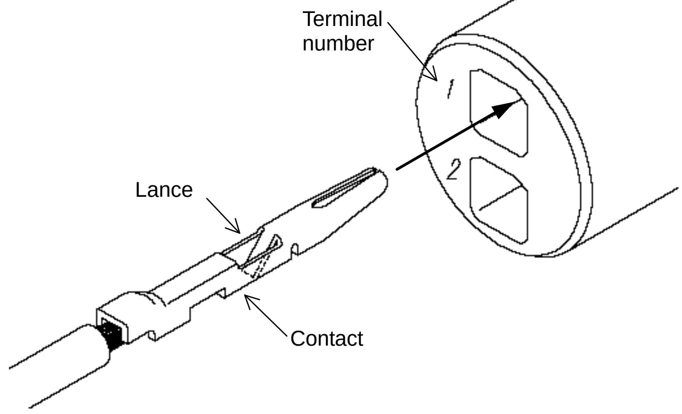
Insert the contact into the specified terminal in the housing.
(Insert grounding wire or drain wire into terminal No.10 in the housing.)
* When the contact catches the housing, you will hear a snap.

(Note) Before inserting the contact, check that the clamp nut, cable clamp, bushing and back shell is inserted.



* Insert the contact so that the lance and the terminal number in the housing face the same direction. However, in case of CM 10-AP2S, insert the contact so that the lance and the terminal number in the housing face the opposite direction.





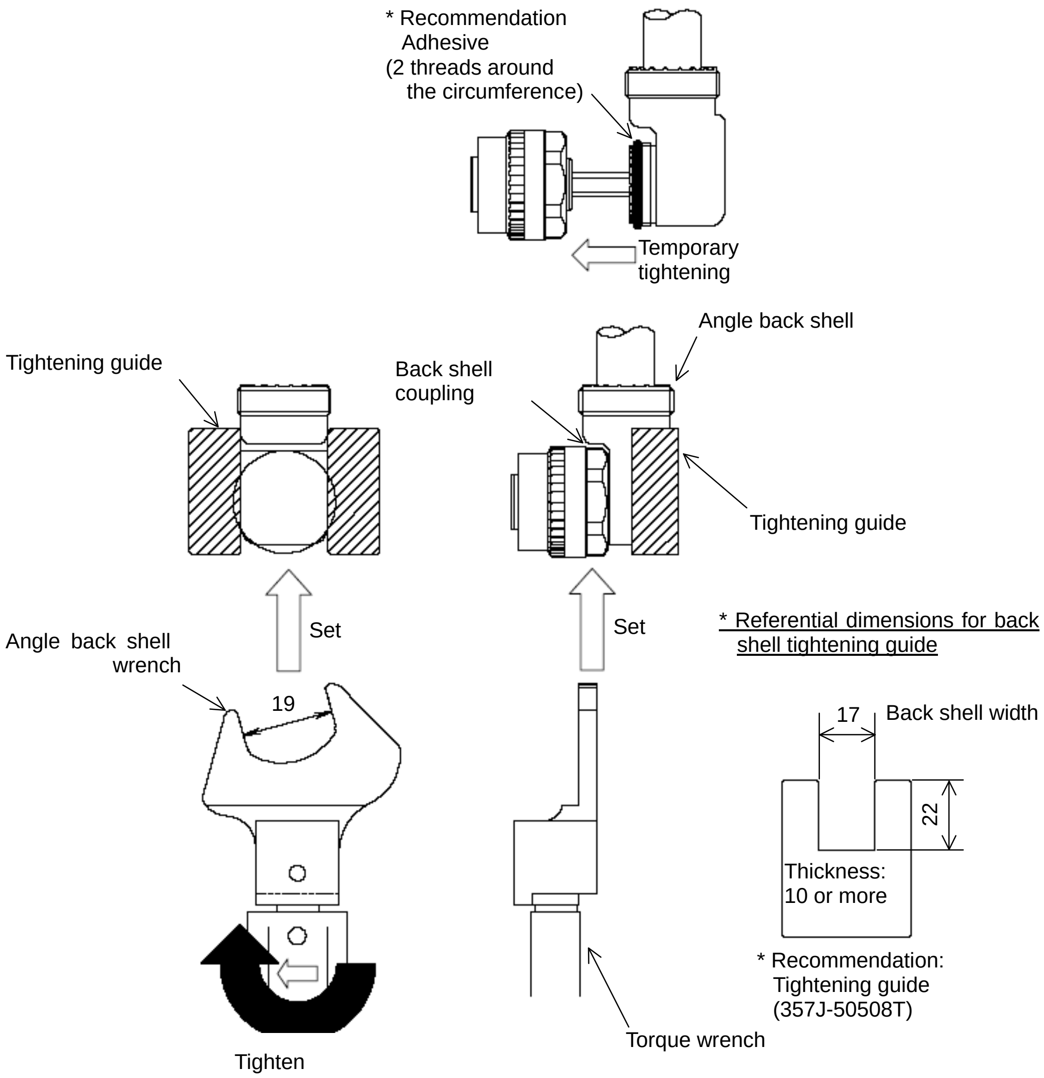
CM10-AP2S

(Note) When pulling out a contact, use dedicated jigs and tools.
Contact removal tool: : 357J-50548T-A

(7) Tightening angle back shell

[1] Temporarily tighten the back shell coupling on the angle back shell.
  * To prevent loosening, Adhesive should be applied to the angle back shell.
[2] Set the angle back shell on the tightening guide.
[3] Set the back shell wrench on the back shell coupling.
[4] With the wrench, tighten the back shell coupling on the angle back shell.
  Recommended tightening torque: 5N•m

(Note) Accurately fit the wrench on the back shell coupling.
To remove, take the reverse steps.

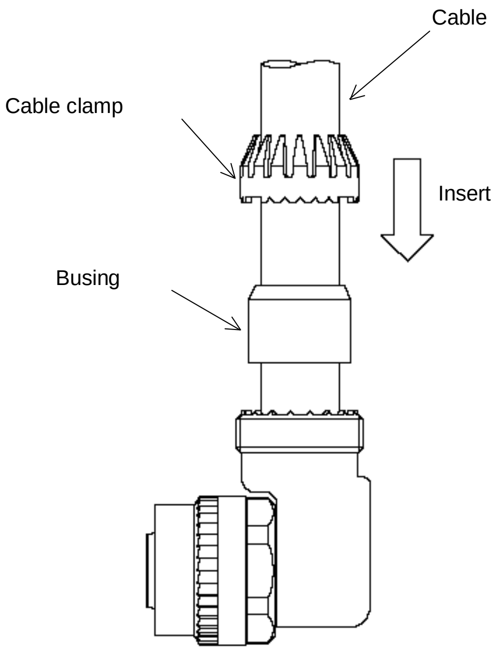


(Note) To change the back shell angle, adjust the toothing position of the plug shell and back shell.

• Recommended jigs and tools: Back shell wrench (357J-51333T)
  Bit (357J-51344T)
  Torque wrench (CL6N x 8D,Tonichi Mfg.)
* Recommended tightening guide: (357J-50508T)
* Recommended adhesive: screw lock 1401B (Threee bond Co,Ltd)

(8) Insert a busing and a cable clamp

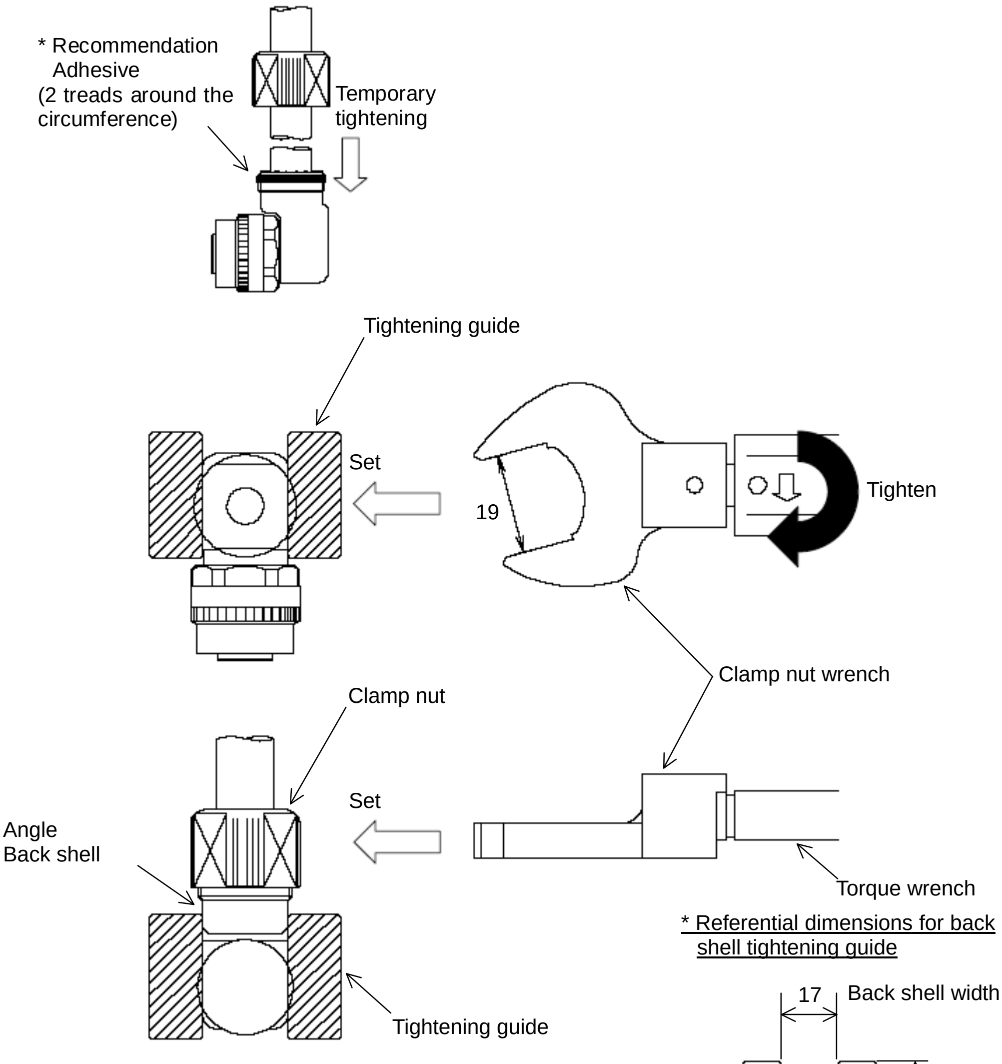
Insert the bushing and the cable clamp into the angle back shell.



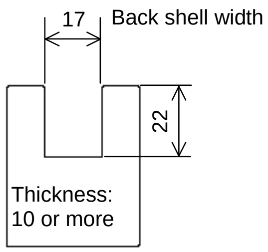
(9) Tightening a clamp nut

[1] Temporarily tighten the clamp nut on the angle back shell.
 * To prevent loosening, the adhesive should be applied to the back shell.
[2] Set the angle back shell on the tightening guide.
[3] Set the clamp nut wrench on the clamp nut.
[4] With the wrench, tighten the clamp nut on the angle back shell.
 Recommended tightening: 5N•m

(Note) Accurately fit the wrench on the clamp nut.
To remove, take the reverse steps.



* Referential dimensions for back shell tightening guide



* Recommendation:
Tightening guide
(357J-50508T)

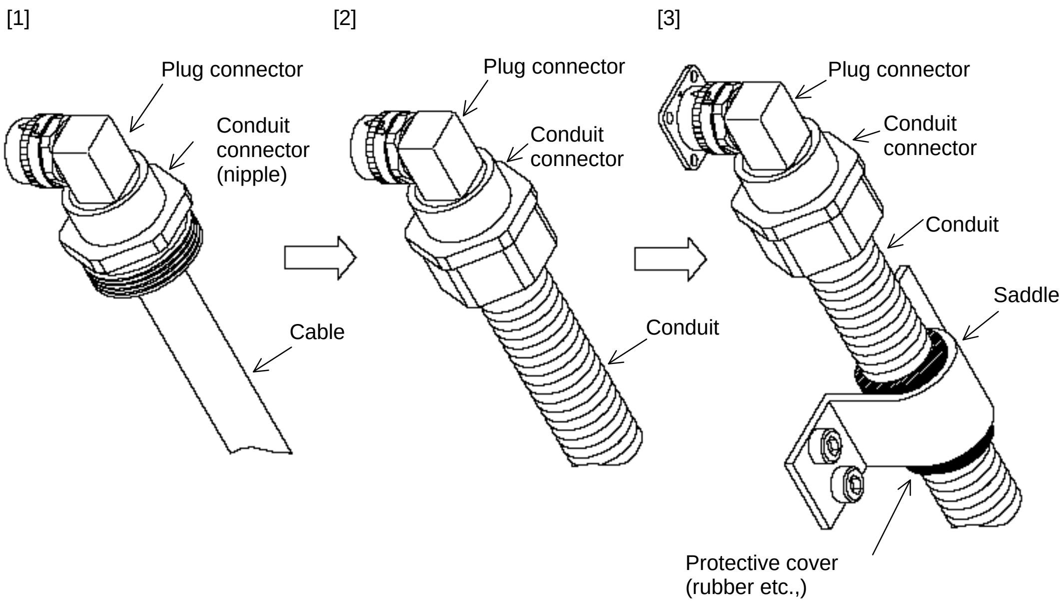
● Recommended jigs and tools: Clamp nut wrench (357J-51334T)
 Bit (357J-51345T)
 Touque wrench (CL6N x 8D,Tonochi Mfg.)

* Recommended tightening guide: (357J-50508T)

* Recommended adhesive: Screw lock 1401B (Tree bond Co.Ltd)

* When using a conduit

[1] Tighten the nipple of conduit connector on the plug connector (CM10).
[2] Set the conduit on the nipple of conduit connector.
[3] When using by moving part, fix conduit on the saddle etc.,
Take care not to damage for plug connector (CM10) and conduit connector.
Set the protective cover (rubber etc.,) on the conduit for takes care not to cable damage.



Recommended conduit
Type: VF   Type: SR   Type: FBN   Type: EM   Type: VFS   Type: SRK etc

Recommended connector

Recommended connector	Applicable connector type	Applicable cable range
RCM103S	CM10-SP10S-S/CM10-AP-10S-S	ϕ 4.0 to ϕ 6.0mm
RCM103M	CM10-SP10S-M/CM10-AP-10S-M	ϕ 6.0 to ϕ 9.0mm
RCM104L	CM10-SP10S-L/CM10-AP-10S-L	ϕ 9.0 to ϕ 12.0mm

Appendix 2. Selection

Appendix 2-1 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.

Appendix 2-1-1 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 positioning 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 and limit the load inertia ratio within the recommended value. Note that the recommended value for the load inertia ratio is strictly one guideline. This does not mean that controlling of the load with inertia exceeding the recommended value is impossible.

POINT

1. 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. Judge the load inertia ratio for the motor with brakes using the motor inertia of motors without brakes as a reference.

Appendix 2-1-2 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 "2-1 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 (2-1). Determine the maximum motor torque required from this expression, and select the motor capacity.

$$ta = \frac{(J_L + J_M) \times N}{95.5 \times (0.8 \times T_{MAX} - T_L)} \text{ (ms)} \qquad \text{..................................} \qquad (2\text{-}1)$$

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)

Appendix 2-1-3 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 (2-2).

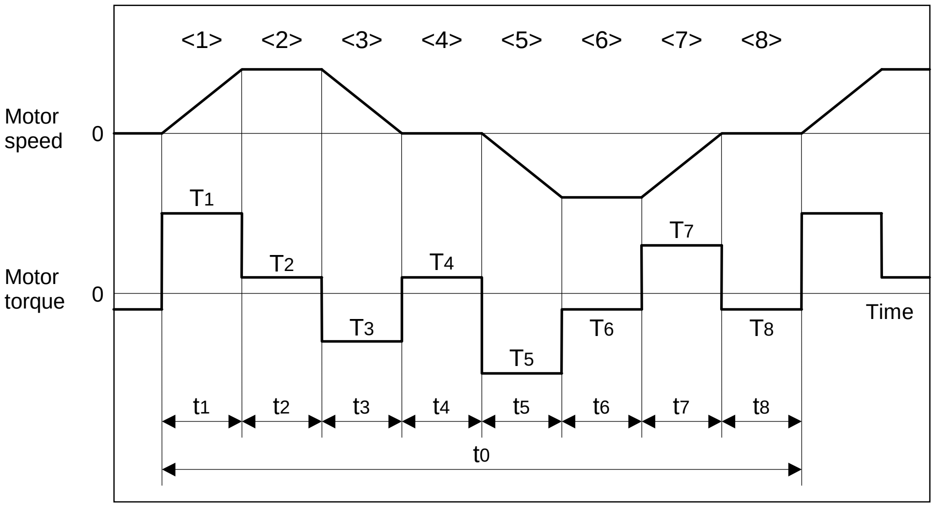


Fig. 1 Continuous operation pattern

$$Trms = \sqrt{\frac{T1^2 \cdot t1 + T2^2 \cdot t2 + T3^2 \cdot t3 + T4^2 \cdot t4 + T5^2 \cdot t5 + T6^2 \cdot t6 + T7^2 \cdot t7 + T8^2 \cdot t8}{t0}} \quad \cdots\cdots\cdots \quad (2\text{-}2)$$

Select a motor so that the continuous effective load torque Trms is 80% or less of the stall torque Tst.

$$Trms \leq 0.8 \cdot Tst \quad \cdots\cdots\cdots \quad (2\text{-}3)$$

The amount of acceleration torque (Ta) shown in tables 2-1 and 2-2 is the torque to accelerate the load inertia in a frictionless state. It can be calculated by the expression (2-4). (For linear acceleration/ deceleration)

$$Ta = \frac{(J_L + J_M) \times N}{95.5 \times ta} \ (N \cdot m) \quad \cdots\cdots\cdots \quad (2\text{-}4)$$

N	:	Motor reach speed	(r/min)
J_L	:	Motor shaft conversion load inertia	($kg \cdot cm^2$)
J_M	:	Motor inertia	($kg \cdot cm^2$)
ta	:	Linear acceleration/deceleration time constant	(ms)

For an unbalance axis, select a motor so that the motor shaft conversion load torque (friction torque + unbalance torque) is 60% or less of the stall.

$$T_L \leq 0.6 \cdot Tst \quad \cdots\cdots\cdots \quad (2\text{-}5)$$

(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 2-1 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 that 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.

(2) Unbalance axis load torque

When operations <1> to <8> are for an unbalance axis, calculate so that the following torques are required in each period. Note that the forward speed shall be an upward movement.

Table 2-2 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 that 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.

Appendix 2-2 Selecting the regenerative resistor

Calculate the regenerative energy for stopping (positioning) from each axis' rapid traverse rate, and select a regenerative resistor having a capacity that satisfies the positioning frequency determined from the machine specifications.

Appendix 2-2-1 Calculating the regenerative energy

(1) For horizontal axis

For the horizontal axis, the regenerative energy E_R consumed by the regenerative resistor can be calculated from expression (2-6). If the E_R value is negative, all of the regenerative energy is absorbed by the capacitor in the drive unit (capacitor regeneration), and the energy consumed by the regenerative resistor is zero (E_R= 0).

$$E_R = 5.48\times10^{-7} \bullet \eta \bullet (J_L+J_M) \bullet N^2 - Ec \quad (J) \qquad \bullet\bullet\bullet (2\text{-}6)$$

η	: Motor reverse efficiency	
J_L	: Motor inertia	(kg•cm^2)
J_M	: Load inertia	(kg•cm^2)
N	: Motor speed	(r/min)
Ec	: Unit charging energy	(J)

(Example)

When a load with the same inertia as the motor is connected to the HF53, determine the regenerative energy to stop from the rated rotation speed. Note that the drive unit is MDS-R-V1-20 in this case.

According to expression (2-6), the regenerative energy E_R is:

$$E_R = 5.48\times10^{-7}\times0.85\times(6.1+6.1)\times3000^2-13 = 38.1 \text{ (J)}$$

Table 2-3 Drive unit charging energy

Drive unit	Charging energy Ec (J)	Drive unit	Charging energy Ec (J)
MDS-R-V1-20	13	MDS-R-V2-2020	26
MDS-R-V1-40	20	MDS-R-V2-4020	30
MDS-R-V1-60	30	MDS-R-V2-4040	30
MDS-R-V1-80	46	MDS-R-V2-6040	46
		MDS-R-V2-6060	46
		MDS-R-V2-8040	66
		MDS-R-V2-8060	66
		MDS-R-V2-8080	66

Table 2-4 Servomotor reverse efficiency

Servomotor	Motor reverse efficiency η	Servomotor	Motor reverse efficiency η
HF75	0.85	HF44	0.85
HF105	0.85	HF74	0.85
HF54	0.85	HF53	0.85
HF104	0.85	HF103	0.85
HF154	0.85	HF153	0.85
HF224	0.85	HF203	0.85
HF204	0.85	HF353	0.85
HF354	0.85		
HF123	0.85		
HF223	0.85		
HF303	0.85		
HF142	0.85		
HF302	0.85		

POINT

The charging energy values apply when the unit input power voltage is 220V. If the input voltage is higher, the charging energy decreases, and the regenerative energy increases.

(2) For unbalance axis

The regenerative energy differs in the upward stop and downward stop for an unbalance axis. A constant regeneration state results during downward movement if the unbalance torque is the same as or larger than the friction torque.

	Regenerative energy
Upward stop	A regenerative state only occurs when deceleration torque (downward torque) is generated. $E_{RU} = 5.24\times10^{-5} \bullet \eta \bullet T_{du} \bullet N \bullet t_d - Ec$ (J) • • • (2-7) η : Motor reverse efficiency T_{du} : Upward stop deceleration torque (N•m) N : Motor speed (r/min) t_d : Deceleration time (time constant) (ms) Ec : Unit charging energy (J)
Downward stop	A regenerative state occurs even during constant rate feed when the upward torque Ts during dropping is generated. Calculate so that Ts = 0 when Ts is downward. $E_{RD} = \dfrac{2\pi \bullet \eta \bullet T_s \bullet L}{\Delta S} + 5.24 \times 10^{-5} \bullet \eta \bullet T_{dd} \bullet N \bullet t_d - Ec$ (J) • • • (2-8) η : Motor reverse efficiency T_s : Upward torque during dropping (N•m) L : Constant speed travel (mm) ΔS : Travel per motor rotation (mm) T_{dd} : Downward stop deceleration torque (N•m) N : Motor speed (r/min) t_d : Deceleration time (time constant) (ms) Ec : Unit charging energy (J)
The regenerative energy per cycle (E_R) is obtained using expression (2-9) using one reciprocation as one cycle. $E_R = E_{RU} + E_{RD}$ (J) • • • (2-9)	

(Example)

Using a machine tool vertical axis driven by an HF153 motor, reciprocation is carried out with F30000 at an acceleration/deceleration time constant of 100ms for a distance of 200mm. Obtain the regenerative energy per reciprocation operation in this case.

Where:
- Servo drive unit : MDS-R-V1-80
- Travel per motor rotation : 10 mm
- Upward stop deceleration torque : 20 N•m
- Downward stop deceleration torque : 30 N•m
- Upward torque during downward movement : 3 N•m

Using expression (2-7), the upward stop regenerative energy E_{RU} is as follows:

$$E_{RU} = 5.24\times10^{-5}\times0.85\times20\times3000\times100 - 46 = 221.2 \text{ (J)}$$

The acceleration/deceleration distance required to accelerate at the 100ms acceleration/deceleration time constant to 30000mm/min. is as follows:

$$\frac{30000\times100}{2\times60\times1000} = 25 \text{ (mm)}$$

Therefore, the constant speed travel is 150mm.
The downward stop regenerative energy E_{RD} is obtained using the following expression (2-8).

$$E_{RD} = \frac{2\pi\times0.85\times3\times150}{10} + 5.24\times10^{-5}\times0.85\times30\times3000\times100 - 46 = 595.2 \text{ (J)}$$

Thus, the regenerative energy per reciprocation operation E_R is as follows:

$$E_R = 221.2 + 595.2 = 816.4 \text{ (J)}$$

Appendix 2-2-2 Calculating the positioning frequency

Select the regenerative resistor so that the positioning frequency DP (times/minute) calculated from the regenerative resistor capacity P_R (W) and regenerative energy E_R (J) consumed by the regenerative resistor is within the range shown in expression (2-10). For the unbalance axis, calculate using the regenerative energy E_R per reciprocation operation, and judge the number of operation cycles for rising and lowering as DP.

$$DP < 48 \bullet \frac{P_R}{E_R} \quad \text{(times/minute)} \qquad \bullet\bullet\bullet (2\text{-}10)$$

Table 2-5 List of regenerative option correspondence

Regenerative resistor type (Japan Resistor)	GZG80 W26 OHMJ	GZG200 W26 OHMJ	GZG300 W20 OHMJ	GZG400 W13 OHMJ	GZG400 W8 OHMJ	GZG200 W120 OHMJ 3 units connected in parallel	GZG200 W39 OHMJ 3 units connected in parallel	GZG300 W39 OHMJ 3 units connected in parallel	GZG200 W20 OHMJ 3 units connected in parallel	GZG300 W20 OHMJ 3 units connected in parallel	GRZG400 -2 OHMJ 4 units connected in serial
Regenerative resistor unit type						MR-RB32	MR-RB30	MR-RB50	MR-RB31	MR-RB51	MR-RB65
Regenerative capacity	40W	100W	150W	200W	200W	300W	300W	500W	300W	500W	800W
Resistance value	26Ω	26Ω	20Ω	13Ω	8Ω	40Ω	13Ω	13Ω	6.7Ω	6.7Ω	8Ω
MDS-R-V1-20	○	○				○					
MDS-R-V1-40	○	○	○	○			○	○			
MDS-R-V1-60	○	○	○		○		○				
MDS-R-V1-80			○		○		○	○			○
MDS-R-V2-2020	○	○				○					
MDS-R-V2-4040			○	○			○	○			
MDS-R-V2-6040					○		○	○			○
MDS-R-V2-6060					○		○	○			○
MDS-R-V2-8040					○		○	○			○
MDS-R-V2-8060					○		Δ	Δ	○	○	○
MDS-R-V2-8080					○		Δ	Δ	○	○	○

(Note) Types indicated with a Δ cannot be used when driving the HF353 motor.

Appendix 2-3 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	5
Ball screw diameter	mm	50	50	50
Ball screw length	mm	1200	1000	1000
Ball screw lead	mm	10	10	10
Deceleration ratio		1	1	2/3
Primary side gear inertia	$kg \cdot cm^2$	–	–	1.6
Secondary side gear inertia	$kg \cdot cm^2$	–	–	8.1
Motor/ball screw connection section inertia	$kg \cdot cm^2$	10.0	10.0	–
Mass of moving object installed on the machine (table, etc.)	kg	600	500	500
Mass 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	100
Rapid traverse positioning frequency	times/min	12	12	12
Motor brake		Without	Without	With

Appendix 2-3-1 Motor selection calculation

The selection calculation is carried out in order using the Z axis as an example.

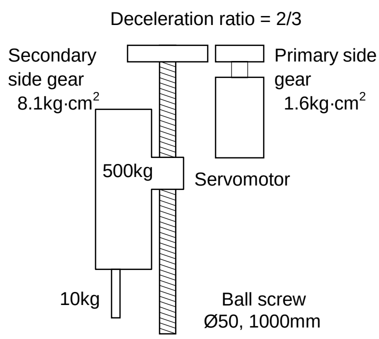


Fig. 11-3 Z axis configuration

(1) Obtaining the load inertia

Calculate the motor shaft conversion load inertia separately for the rotation load and linear movement load. Furthermore, calculate the rotation load inertia separately for the primary and secondary side.

- **Primary side rotation load inertia: J_{R1}**
  This is the primary side gear inertia.

$$J_{R1} = 1.6\ (kg \cdot cm^2)$$

- **Secondary 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 "Appendix 2-5 Expressions for load inertia calculation".

$$J_{R2} = J_B + 8.1 = \frac{\pi \cdot \rho \cdot L}{32} D^4 + 8.1 = \frac{\pi \times 7.80 \times 10^{-3} \times 100}{32} \times 5^4 + 8.1$$
$$= 47.9 + 8.1 = 56.0\ (kg \cdot cm^2)$$

- **Total rotation load inertia: J_R**
  This is the sum of the primary side load inertia and secondary side load inertia. To convert the secondary side load inertia to the motor shaft (primary side), multiply by the square of the deceleration ratio.

$$J_R = J_{R1} + \left(\frac{2}{3}\right)^2 \times J_{R2} = 1.6 + \frac{4}{9} \times 56.0 = 1.6 + 24.9 = 26.5\ (kg \cdot cm^2)$$

- **Linear movement load inertia: J_T**
  The inertia is calculated when a standard workpiece, tool, etc., is attached. The conversion to the motor shaft by the deceleration ratio is included in the movement amount per motor rotation. Refer to section "Appendix 2-5 Expressions for load inertia calculation".

$$J_T = W \cdot \left(\frac{\Delta S}{20\pi}\right)^2 = (500 + 10) \cdot \left(\frac{10 \times 2}{20\pi \times 3}\right)^2 = 5.7\ (\text{kg}\cdot\text{cm}^2)$$

- **Load inertia: J_L**
  This is the sum of the total rotation load inertia and the linear movement load inertia.

$$J_L = 26.5 + 5.7 = 32.2\ (\text{kg}\cdot\text{cm}^2)$$

When looking at the load inertia components, the linear movement mass 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 mass changes greatly in the table axis.

(2) Obtaining unbalance torque

The unbalance torque is obtained from the moving object mass. Here, the drive system efficiency is calculated as 1.
Refer to section "Appendix 2-4 Motor shaft conversion load torque".

$$T_U = \frac{(W_1 - W_2) \cdot g \cdot \Delta S}{2 \times 10^3 \pi \cdot \eta} = \frac{(510 - 0) \times 9.8 \times 10 \times 2}{2 \times 10^3 \pi \times 1 \times 3} = 5.3\ (\text{N}\cdot\text{m})$$

(3) Obtaining friction torque

The friction torque is obtained from the moving object mass and friction coefficient. Here, the drive system efficiency is calculated as 1. Refer to section "Appendix 2-4 Motor shaft conversion load torque".

$$T_F = \frac{F \cdot \Delta S}{2 \times 10^3 \pi \cdot \eta} = \frac{\mu \cdot W \cdot g \cdot \Delta S}{2 \times 10^3 \pi \cdot \eta} = \frac{0.05 \times 510 \times 9.8 \times 10 \times 2}{2 \times 10^3 \pi \times 1 \times 3} = 0.27\ (\text{N}\cdot\text{m})$$

(4) Selecting the appropriate motor from the load inertia ratio

Confirm that the motor speed is 3000r/min based on the rapid traverse rate and gear ratio, and make sure that it is less than the maximum speed. Motor brakes must be provided, so select a motor from the HF☐B Series. Note that even when the motor has brakes, the motor inertia for motors without brakes is used to judge the load inertia ratio.
The motor is judged as appropriate if the capacity is HF103 or more and the load inertia is within 3-fold of the recommended load inertia ratio.

Motor type	Motor inertia ($kg\cdot cm^2$)	Load inertia ($kg\cdot cm^2$)	Load inertia magnification	Judgment
HF53	6.1	32.2	5.29	×
HF103	11.9	32.2	2.71	○
HF153	17.8	32.2	1.81	○
HF203	38.3	32.2	0.84	○
HF353	75.0	32.2	0.43	○

(5) Selecting the appropriate motor from the short time characteristics (acceleration/deceleration time constant)

The acceleration/deceleration time constant is calculated using expression (a), and is judged whether it satisfies the target acceleration/deceleration time constant of 100ms.

HF103B: $$ta = \frac{(J_L+J_M)\times N}{95.5\times(0.8\times T_{MAX}-T_U-T_F)} = \frac{(32.2+14.0)\times 3000}{95.5\times(0.8\times 21.6-5.3-0.27)} = 123.9\ (\text{ms})$$

HF153B: $$ta = \frac{(J_L+J_M)\times N}{95.5\times(0.8\times T_{MAX}-T_U-T_F)} = \frac{(32.2+20.0)\times 3000}{95.5\times(0.8\times 35.3-5.3-0.27)} = 72.3\ (\text{ms})$$

HF203B: $$ta = \frac{(J_L+J_M)\times N}{95.5\times(0.8\times T_{MAX}-T_U-T_F)} = \frac{(32.2+47.9)\times 3000}{95.5\times(0.8\times 41.7-5.3-0.27)} = 90.5\ (\text{ms})$$

HF353B: $$ta = \frac{(J_L+J_M)\times N}{95.5\times(0.8\times T_{MAX}-T_U-T_F)} = \frac{(32.2+84.7)\times 3000}{95.5\times(0.8\times 59.8-5.3-0.27)} = 86.9\ (\text{ms})$$

The motor which satisfies the conditions based on the above calculation results is HF153B or more as shown below.

Motor type	Maximum torque (N·m)	Total inertia (kg·cm^2)	Acceleration/ deceleration time constant [ms]	Judgment
HF103B	21.6	46.2	123.9	×
HF153B	35.3	52.2	72.3	○
HF203B	41.7	80.1	90.5	○
HF353B	59.8	116.9	86.9	○

(6) Selecting the appropriate motor from the continuous characteristics

Generally, the motor is judged following the typical operation pattern. Because the Z axis is the vertical axis here, the motor will be judged by the torque during an upward stop.
The unbalance axis torque during a stop should be 60% or less of the stall torque. This is one of the criteria for motor selection. As shown in the following table, only the HC203B or larger motor satisfies this criterion. Based on the judgment in steps (4) to (6), the "HF203B" motor is appropriate for the Z axis.

Motor type	Stall torque (N·m)	Torque during stop T_U+T_F (kg·cm^2)	Load rate (%)	Judgment
HF153B	8.82	5.57	63.2	×
HF203B	13.7	5.57	40.7	○
HF353B	22.5	5.57	24.8	○

Appendix 2-3-2 Regenerative resistor selection calculation

Calculation is carried out in order with the Z axis as an example.

(1) Obtaining the generated torque

The deceleration torque required to calculate the regenerative energy is obtained.

- **Upward stop deceleration torque:** T_{du}

The amount of deceleration torque (=amount of acceleration torque) is first calculated using expression (2-4).

$$T_a = \frac{(J_L+J_M)\times N}{95.5\times ta} = \frac{(32.2+47.9)\times 3000}{95.5\times 100} = 25.2\ (N\bullet m)$$

The upward stop deceleration torque is obtained from the amount of deceleration torque, unbalance torque and friction torque.

$$T_{du} = T_a - T_U - T_F = 25.2-5.3-0.27 = 19.6\ (N\bullet m)$$

- **Downward stop deceleration torque:** T_{dd}

The downward stop deceleration torque is obtained from the amount of deceleration torque, unbalance torque and friction torque.

$$T_{dd} = T_a + T_U - T_F = 25.2+5.3-0.27 = 30.2\ (N\bullet m)$$

- **Upward torque during dropping:** T_S

The upward torque during dropping is obtained from the unbalance torque and friction torque.

$$T_S = T_U - T_F = 5.3-0.27 = 5.6\ (N\bullet m)$$

- **Constant speed travel:** L

Because the constant speed travel is not clearly described in the specifications, the value used here is 200mm taking the axis stroke, etc., into consideration.

(2) Obtaining the regenerative energy

Because the Z axis is a vertical axis, the regenerative energy is calculated separately for an upward stop and downward stop.

- **Upward stop regenerative energy:** E_{RU}

This is obtained from expression (2-7).

$$E_{RU} = 5.24\times10^{-5} \bullet \eta \bullet T_{du} \bullet N \bullet t_d - Ec = 5.24\times10^{-5}\times0.85\times19.6\times3000\times100-46 = 215.9\ (J)$$

- **Downward stop regenerative energy:** E_{RU}

This is obtained from expression (2-8).

$$E_{RD} = \frac{2\pi \bullet \eta \bullet T_S \bullet L}{\Delta S} + 5.24\times10^{-5} \bullet \eta \bullet T_{dd} \bullet N \bullet t_d - Ec$$

$$= \frac{2\pi\times0.85\times5.6\times200\times3}{10\times2} + 5.24\times10^{-5}\times0.85\times30.2\times3000\times100-46$$

$$= 897.2+403.5-46 = 1254.7\ (J)$$

- **Stop regenerative energy per cycle:** E_R

This is obtained from expression (2-9).

$$E_R = 215.9+1254.7 = 1470.6\ (J)$$

(3) Obtaining the tolerable number of positioning times

The tolerable cycle operation frequency per minute DP is calculated respectively for the standard built-in regenerative resistor and option regenerative resistor.
Refer to expression (2-10).

- MR-RB30 (300W)

$$DP_1 = 48 \bullet \frac{P_R}{E_R} = 48 \times \frac{300}{1470.6} = 9.79 \text{ (times)}$$ Number of positioning times = 19.6 (times)

- MR-RB50 (500W)

$$DP_2 = 48 \bullet \frac{P_R}{E_R} = 48 \times \frac{500}{1470.6} = 16.3 \text{ (times)}$$ Number of positioning times = 32.6 (times)

Because the number of times described above is the number of cycle operations for 1 vertical axis reciprocation, the number of positioning times is 2-fold. Thus, it is apparent that the MR-RB30 (300W) option resistor is required to satisfy the specified positioning frequency of 12 times/min.

POINT	With the vertical axis, the regenerative load tends to increase compared to the horizontal axis, so provide an allowance when making a selection.

Appendix 2-3-3 Servo selection results

As a result of the servo selection calculations, the servo specifications for the Z axis of this machining center have been determined.

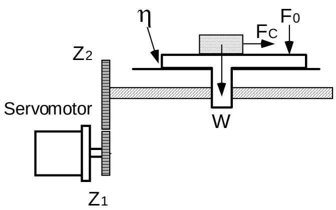
Item	Type
Servo drive unit	MDS-R-V1-80
Servomotor	HF203B☐
Regenerative resistor unit	MR-RB30

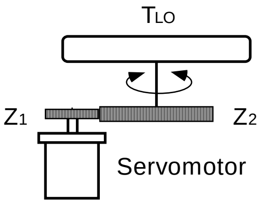
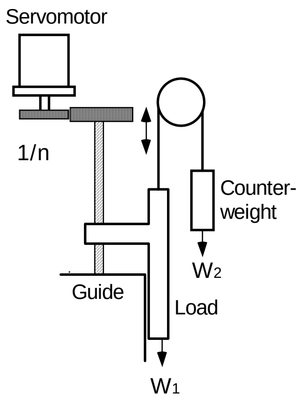
The ☐ in the motor type will be decided based on separate machine specifications such as motor shaft shape and absolute position system.
The following table shows the servo selections for all axes.

Item	Unit	X axis	Y axis	Z axis
Axis type		Linear	Linear	Linear
Movement direction		Horizontal	Horizontal	Vertical
Table support method		Rolling	Rolling	Rolling
Table movement friction coefficient	%	5	5	5
Ball screw diameter	mm	50	50	50
Ball screw length	mm	1200	1000	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	10.0	10.0	–
Mass of moving object installed on the machine (table, etc.)	kg	600	500	500
Mass 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	100
Rapid traverse positioning frequency	times/min	12	12	12
Motor brake		Without	Without	With
Motor shaft conversion rotation load inertia	kg·cm^2	67.4	57.9	26.5
Motor shaft conversion linear movement load inertia	kg·cm^2	17.7	15.2	5.7
Motor shaft conversion total load inertia	kg·cm^2	85.1	73.1	32.2
Motor inertia	kg·cm^2	38.3	38.3	47.9
Motor shaft conversion load inertia magnification	-fold	2.22	1.91	0.84
Motor shaft conversion unbalance torque	N·m	0.0	0.0	5.3
Motor shaft conversion friction torque	N·m	0.55	0.47	0.27
Motor shaft conversion total load torque	N·m	0.55	0.47	5.57
Motor speed during rapid traverse	r/min	3000	3000	3000
Rapid traverse minimum acceleration/deceleration time constant	ms	118.1	106.4	90.5
Maximum torque during motor stop	N·m	0.55	0.47	5.57
Maximum load rate during motor stop	%	4.0	3.4	40.7
Regenerative energy per braking (per cycle)	J	852.3 (total of X, Y axes)		1470.6
MR-RB30 tolerable positioning frequency	times/min	16.8	16.8	19.6
MR-RB50 tolerable positioning frequency	times/min	28.2	28.2	32.6
Servo drive unit type		MDS-R-V2-8080		MDS-R-V1-80
Servomotor type		HF203☐	HF203☐	HF203B☐
Regenerative resistor type		MR-RB30		MR-RB30

Appendix 2-4 Motor shaft conversion load torque

The calculation method for a representative load torque is shown.

<table>
<tr><th>Type</th><th>Mechanism</th><th>Calculation expression</th></tr>
<tr><td>Linear movement</td><td>
</td><td>$T_L = \frac{F}{2\times10^3\pi\eta}\cdot(\frac{V}{N}) = \frac{F\cdot\Delta S}{2\times10^3\pi\eta}$
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 expression below when the table is moved as shown on the left.

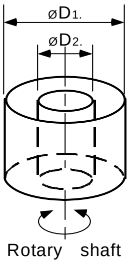
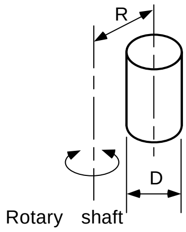
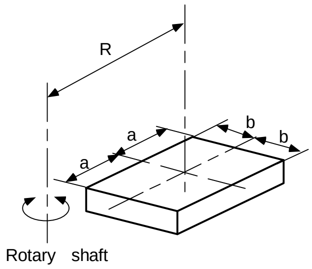
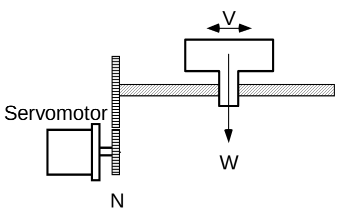
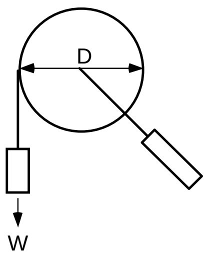
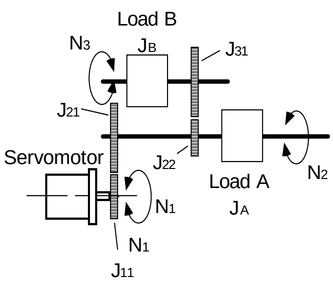
$F = F_c + \mu\,(W\cdot g + F_0)$
F_c : Force applied on axial direction of moving section (N)
F_0 : Tightening force on inner surface of table guide (N)
W : Total mass of moving section (kg)
g : Gravitational acceleration = 9.8 (m/s^2)
μ : Friction coefficient</td></tr>
<tr><td>Rotary movement</td><td>
</td><td>$T_L = \frac{Z_1}{Z_2}\cdot\frac{1}{\eta}\cdot T_{LO} + T_F = \frac{1}{n}\cdot\frac{1}{\eta}\cdot T_{LO} + T_F$
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</td></tr>
<tr><td>Vertical movement</td><td>
</td><td>When rising
$T_L = T_U + T_F$

When lowering
$T_L = -T_U\cdot\eta^2 + T_F$
T_L : Load torque (N·m)
T_U : Unbalanced torque (N·m)
T_F : Friction torque on moving section (N·m)

$T_U = \frac{(W_1 - W_2)\cdot g}{2\times10^3\pi\eta}\cdot(\frac{V}{N}) = \frac{(W_1 - W_2)\cdot g\cdot\Delta S}{2\times10^3\pi\eta}$
$T_F = \frac{\mu\cdot(W_1 + W_2)\cdot g\cdot\Delta S}{2\times10^3\pi\eta}$
W_1 : Load mass (kg)
W_2 : Counterweight mass (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</td></tr>
</table>

Appendix 2-5 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·cm²] ρ : Density of cylinder material [kg·cm³] L : Length of cylinder [cm] D_1 : Outer diameter of cylinder [cm] D_2 : Inner diameter of cylinder [cm] W : Mass of cylinder [kg] **Reference data** Material densities Iron ..... 7.80×10^{-3} [kg/cm³] Aluminum ..... 2.70×10^{-3} [kg/cm³] Copper ..... 8.96×10^{-3} [kg/cm³]
	When rotary shaft and cylinder shaft are deviated 	$J_L = \frac{W}{8} \cdot (D^2 + 8R^2)$ J_L : Load inertia [kg·cm²] W : Mass 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·cm²] W : Mass 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·cm²] W : Mass of object that moves linearly [kg] N : Motor speed [r/min] V : Speed of object that moves linearly [mm/min] ΔS : Object movement amount per motor rotation [mm]
Suspended object		$J_L = W\left(\frac{D}{2}\right)^2 + J_P$ J_L : Load inertia [kg·cm²] W : Object mass [kg] D : Diameter of pulley [cm] J_P : Inertia of pulley [kg·cm²]
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·cm²] J_A,J_B : Inertia of load A, B [kg·cm²] J_{11}~J_{31} : Inertia [kg·cm²] N_1~N_3 : Each shaft's speed [r/min]

Appendix 3. Compliance with European EC Directives

Appendix 3-1 Compliance to EC Directives

Appendix 3-1-1 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.

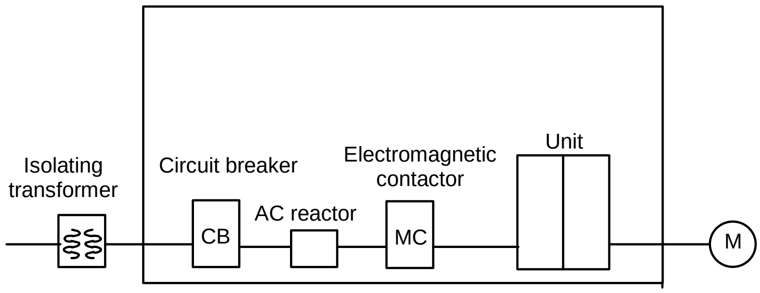
(2) Compliance to Low-voltage Directives

The MDS-R 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.

Appendix 3-1-2 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



Insert a type B circuit breaker (RCD) in the power supply side of the unit.

(2) Environment

Use the units under an Overvoltage Category II and Pollution Class of 2 or less environment as stipulated in IEC60664.

(a) To adjust the units to the Overvoltage Category II, insert an isolating transformer of the star connection complying with EN or IEC standard in the input of the power supply unit.

(b) To adjust the units to the Pollution Class of 2, install the units in a control panel having a structure
(IP54 or higher) in which water, oil, carbon or dust cannot enter.

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

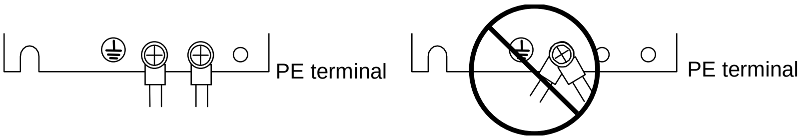
	During operation	Storage	During transportation
Ambient temperature	0°C to 40°C	-15°C to 70°C	-15°C to 70°C
Humidity	80%RH or less	90%RH or less	90%RH or less
Altitude	1000m or less	1000m or less	13000m or less

(3) Power supply

[1] Use the power supply and servo/spindle drive unit under an Overvoltage Category II as stipulated in IEC60664.
[2] Earth the PE terminal of the units to the neutral point of the star connection.
[3] Do not omit the circuit breaker and electromagnetic contactor.

(4) Earthing

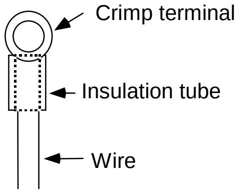
[1] To prevent electric shocks, always connect the servo/spindle drive unit protective earth (PE) terminal (terminal with ⏚ mark) to the protective earth (PE) on the control panel.
[2] When connecting the earthing wire to the protective earth (PE) terminal, do not tighten the wire terminals together.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



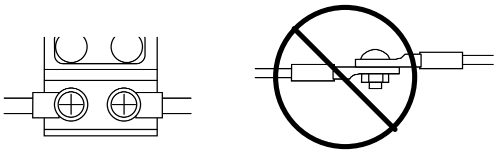
[3] Select the earthing wire size in accordance with Table 1 of EN60204-1.

(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.



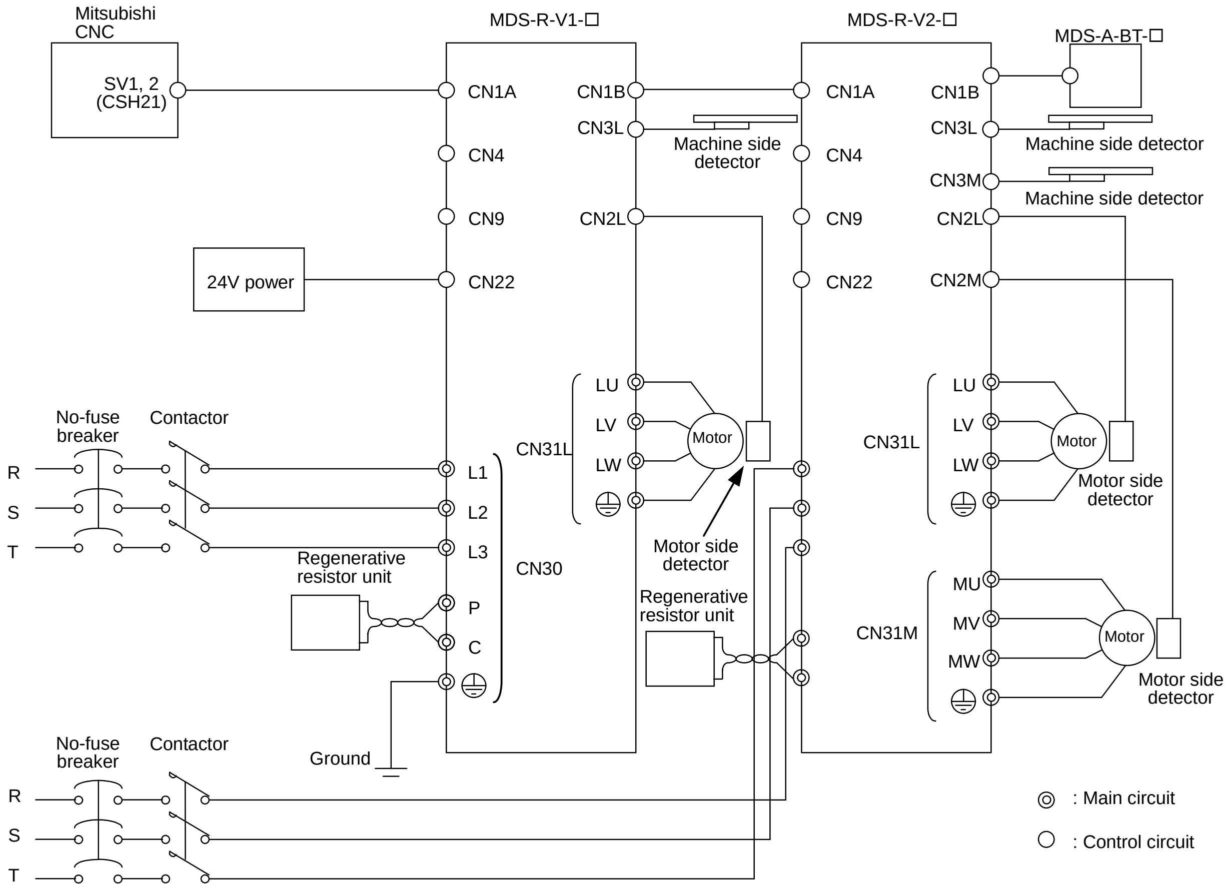
[3] Select the size of the wires for input power supply to Power Supply unit in accordance with Table 4 and 5 of EN60204-1.

(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 4. EMC Installation Guidelines

Appendix 4-1 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 to be out of the 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.
For measures for CNC, refer to "EMC INSTALLATION GUIDELINES" (BNP-B2230).

Appendix 4-2 EMC instructions

The EMC Instructions regulate mainly the following two withstand levels.

Emission ..... Capacity to prevent output of obstructive noise that adversely affects external sources.
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 about 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	EN61000-6-4 EN61800-3 (Industrial environment)	EN55011
	Conductive noise	Electromagnetic noise discharged from power line		
Immunity	Static electricity electrical discharge	**Example)** Withstand level of discharge of electricity charged in a 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

Appendix 4-3 EMC measures

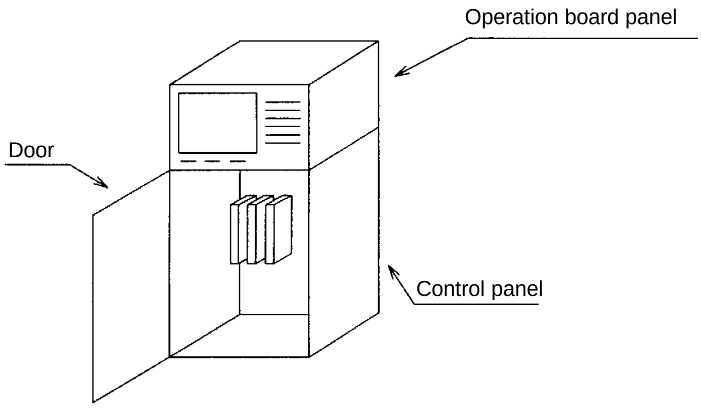
The main items relating to EMC measures include the following.
[1] Store the device in an electrically sealed metal panel.
[2] Earth all conductors that are floating electrically. (Lower the impedance.)
[3] Wire the power line away from the signal wire.
[4] Use shielded wires for the cables wired outside of the panel.
[5] Install a noise filter.

Ensure 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.

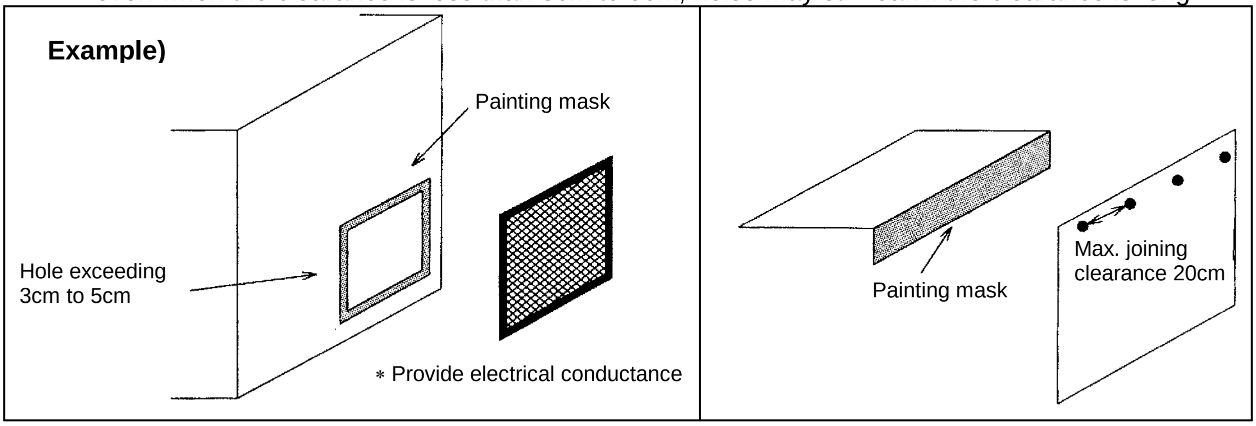
Appendix 4-4 Measures for panel structure

The design of the panel is a very important factor for the EMC measures, so take the following measures into consideration.



Appendix 4-4-1 Measures for control panel unit

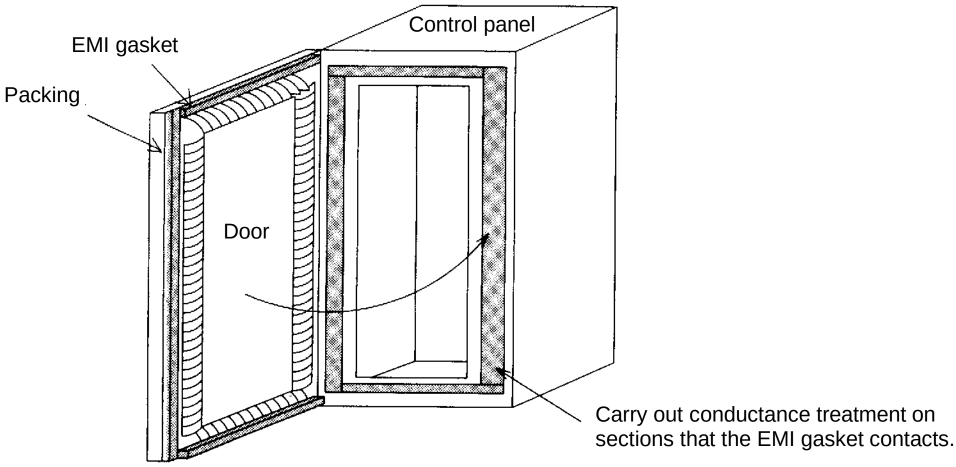
[1] Use metal for all materials configuring the panel.
[2] For the joining of the top plate and side plates, etc., mask the contact surface with paint, and fix with welding or screws.
In either case, keep the joining clearance to a max. of 20cm for a better effect.
[3] Note that if the plate warps due 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 size, 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.



Appendix 4-4-2 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 panel unit.
[3] The EMI gasket or conductive packing must contact at a uniform and correct position of the metal surface of the control panel unit.
[4] The surface of the control panel unit contacted with the EMI gasket or conductive packing must have conductance treatment.

Example) Weld (or screw) a plate that is plated (with nickel, tin).



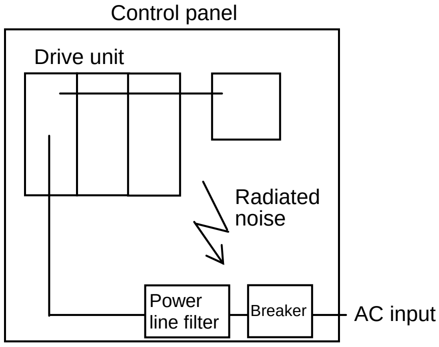
[5] As a method other than the above, the control panel unit and door can be connected with a plain braided wire. In this case, the panel and door should be contacted at as many points as possible.

Appendix 4-4-3 Measures for operation board panel

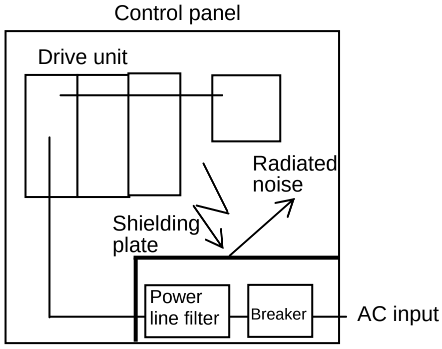
[1] Always connect the operation board and indicator with an earthing wire.
[2] If the operation board panel has a door, use an EMI gasket or conductive packing between the door and panel to provide electrical conductance in the same manner as the control panel.
[3] Connect the operation board panel and control panel with a sufficiently thick and short earthing wire.

Appendix 4-4-4 Shielding of the power supply input section

[1] Separate the input power supply section from other parts in the control panel 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 panel.



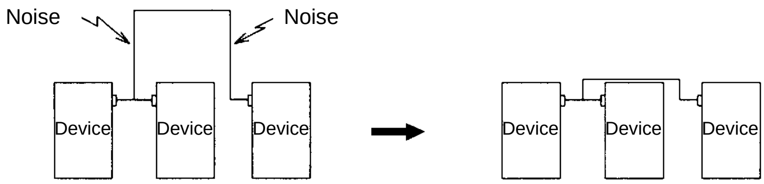
Use a metal plate, etc., for the shielding partition. Make sure not to create a clearance.

Appendix 4-5 Measures for various cables

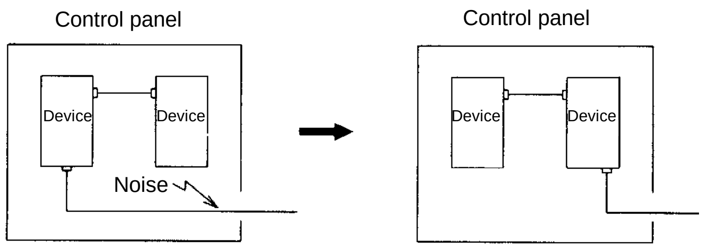
The various cables act as antennas for the noise and discharge the noise externally. Thus appropriate treatment is required to avoid the noise.
The wiring between the drive unit and motor act as an extremely powerful noise source, so apply the following measures.

Appendix 4-5-1 Measures for wiring in panel

[1] If the cables are led unnecessarily in the panel, 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.

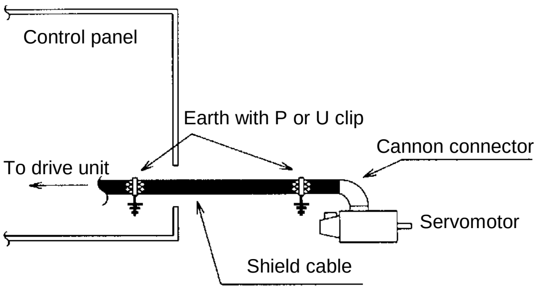
Appendix 4-5-2 Measures for shield treatment

Common items

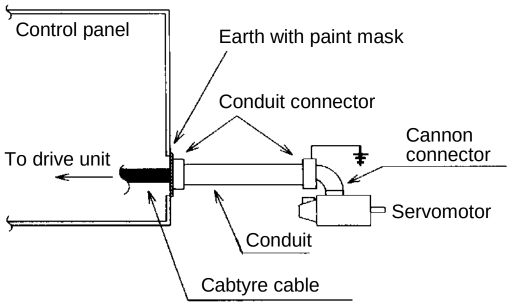
Use of shield clamp fittings is recommended for treating the shields. The fittings are available as options, so order as required.
Clamp the shield at a position within 10cm from the panel lead out port.

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.)

Appendix 4-5-3 Servo/spindle motor power cable

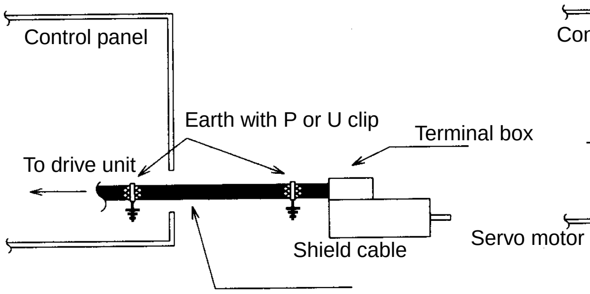


Using shield cable

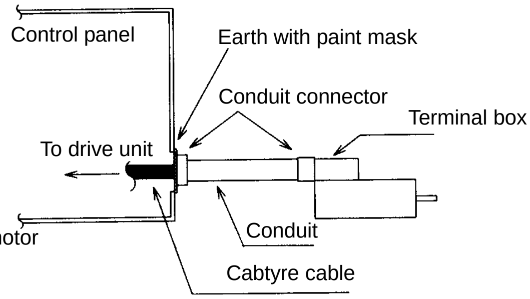


Using conduit

Power cable for servo motor



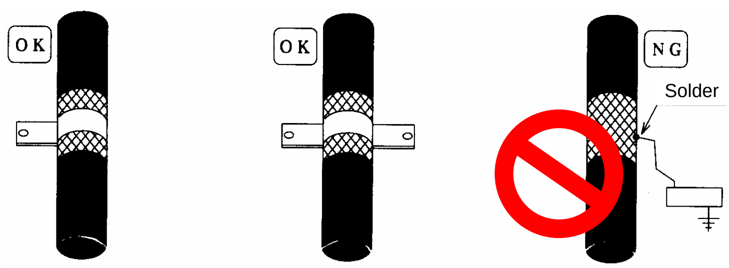
Using shield cable



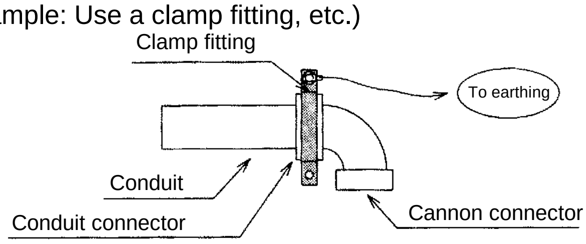
Using conduit

Power cable for spindle motor

[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 panel 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.

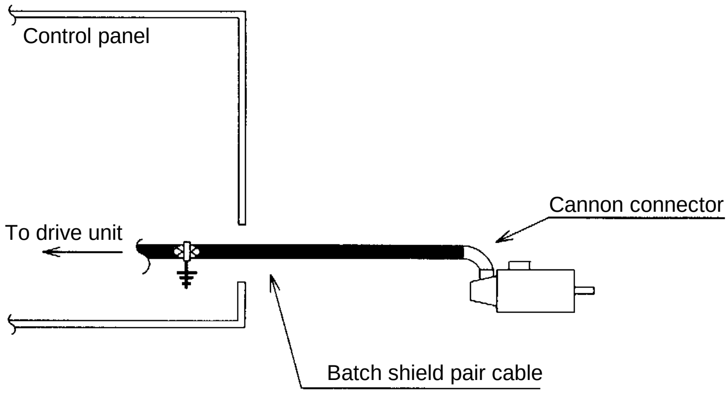


[5] When not using a shield cable for the power cable, use a conventional cabtyre cable. Use a metal conduit outside the cable.
[6] Earth the power cable on the control panel side at the contact surface of the conduit connector and control panel. (Mask the side wall of the control panel with paint.)
[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.)



Appendix 4-5-4 Servo/spindle motor feedback cable

Use a shield pair cable for feed back cable of the servo motor to earth on NC side (inside the control panel.) Mounting a ferrite core directly behind the unit connector is also effective in suppressing noise.

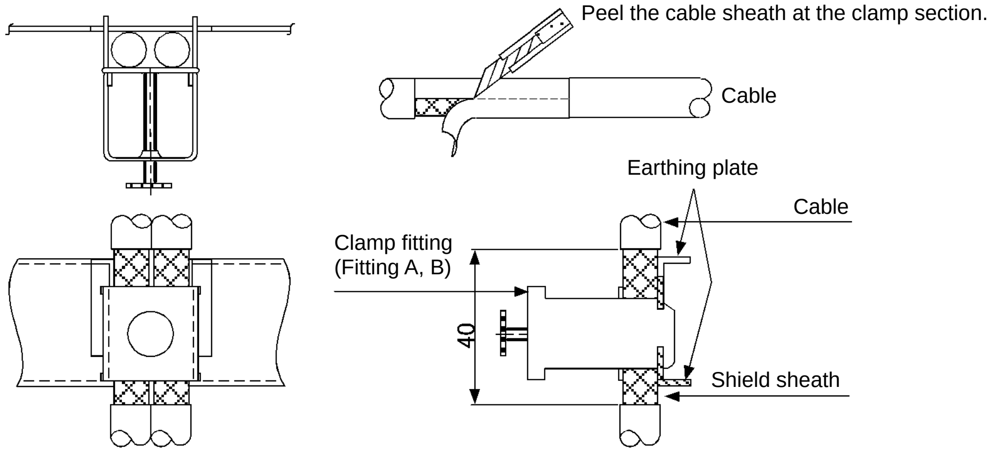


Feed back cable for servomotor

Appendix 4-6 EMC countermeasure parts

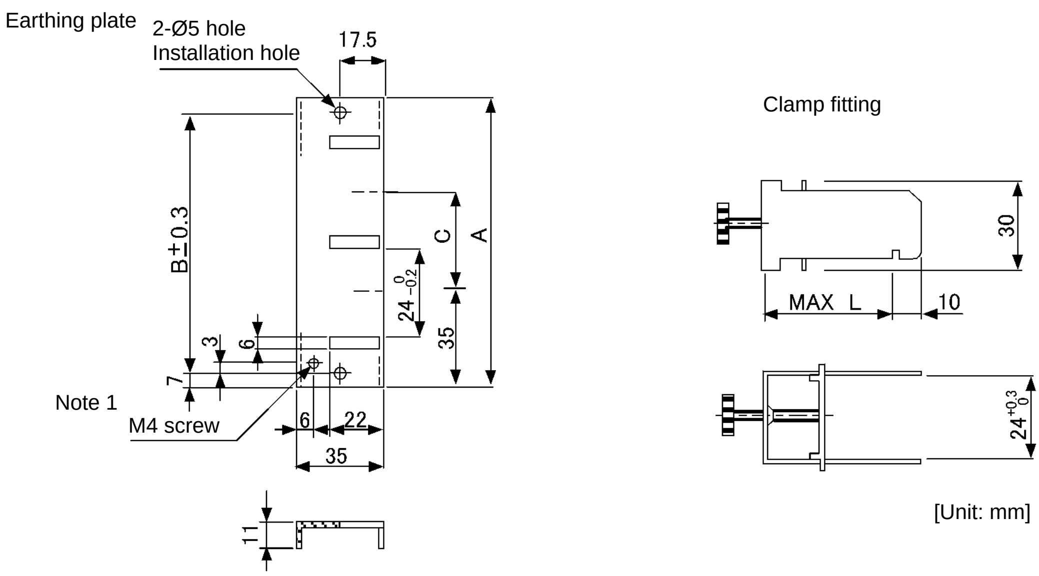
Appendix 4-6-1 Shield clamp fitting

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	Clamp fitting A × 2
AERSBAN-ESET	70	56	-	Clamp fitting B × 1

	L
Clamp fitting A	70
Clamp fitting B	45

⚠ CAUTION	Shield of spindle detector cable is not connected to FG (earth). Do not earth the cable shield with cable clamp, etc.

Appendix 4-6-2 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

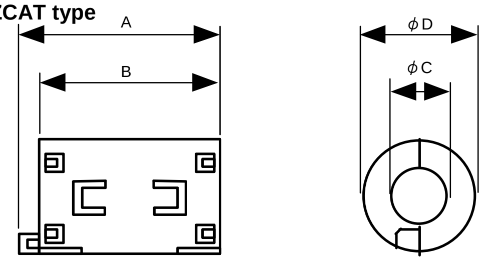


Fig.1

ZCAT-A type

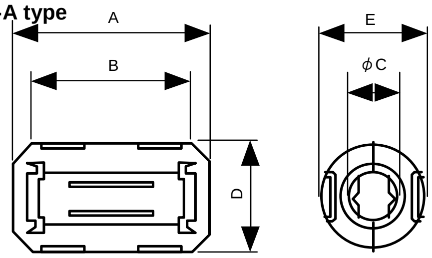


Fig.2

ZCAT-B type

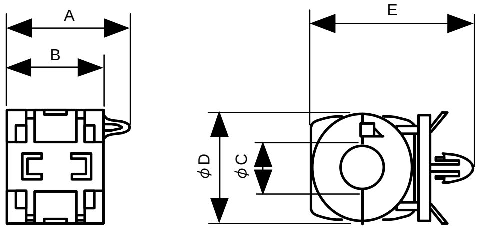


Fig.3

ZCAT-C type

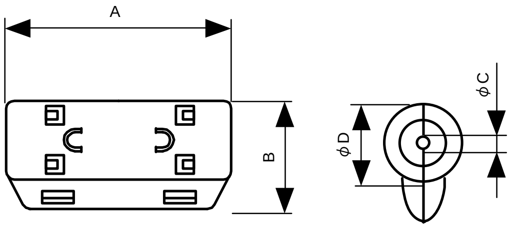


Fig.4

[Unit: mm]

Part name	Fig.	A	B	C	D	E	Applicable cable outline	Mass	Recommended ferrite core
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	
ZCAT2017-0930-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.

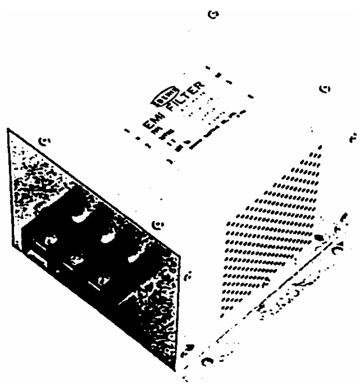
ZCAT-B type: Cabinet fixed type, installation hole ø4.8 to 4.9mm, plate thickness 0.5 to 2mm
ZCAT-C type: Structured so that it cannot be opened easily by hand once closed.

Appendix 4-6-3 Power line filter

(1) Power line filter for 200V

HF3000A-TM Series for 200V

■ **Features**



- 3-phase 3-wire type (250V series, 500V series)
- Compliant with noise standards German Official Notice Vfg243, EU Standards EN55011 (Class B)
- Effective for use with IGBT inverter and MOS-FET inverter.
- Easy mounting with terminal block structure, and outstanding reliability.

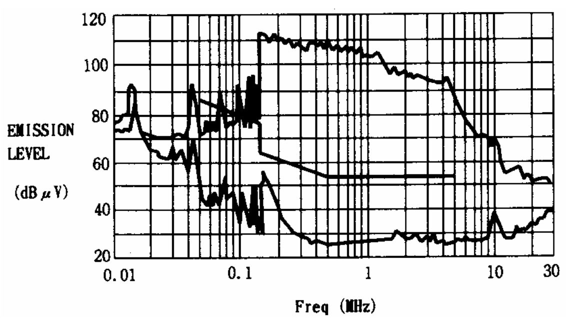
■ **Application**

- Products which must clear noise standards German Official Notice Vfg243 and EU Standards EN55011 (Class B).
- For input of power converter using advanced high-speed power device such as IGBT MOS-FET.

■ **Specifications (250V series)**

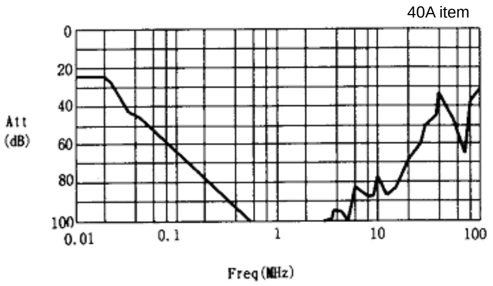
Part name	HF3005A -TM	HF3010A -TM	HF3015A -TM	HF3020A -TM	HF3030A -TM	HF3040A -TM	HF3050A -TM	HF3060A -TM	HF3080A -TM	HF3100A -TM	HF3150A -TM
Rated voltage	250VAC										
Rated current	5A	10A	15A	20A	30A	40A	50A	60A	80A	100A	150A
Leakage current	1.5mA MAX 250VAC 60Hz										

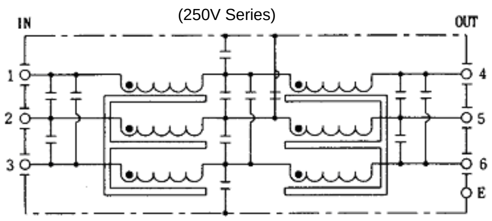
<Example of measuring voltage at noise terminal> ... Measured with IGBT inverter

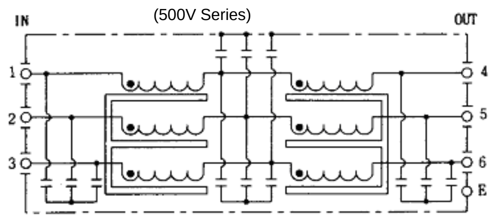


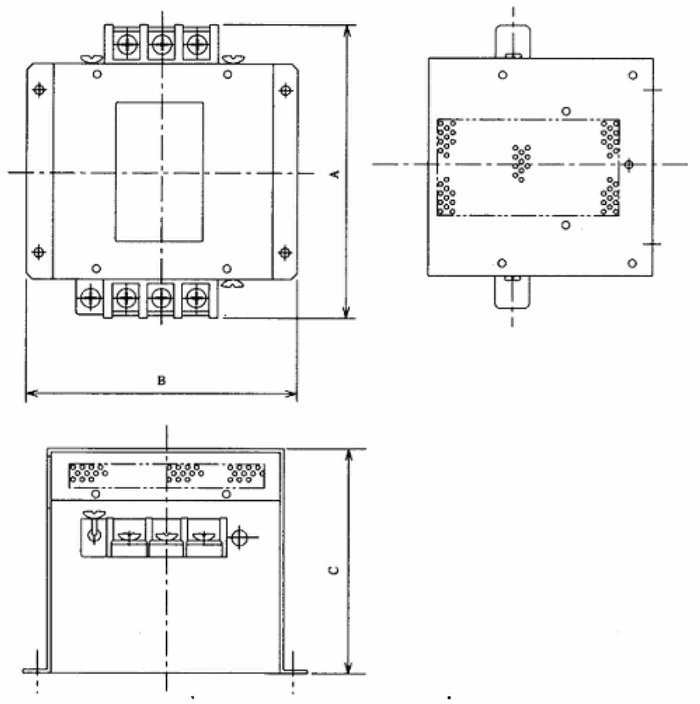
German Official Notice Vfg243 measurement data

EU Standards EN55011 (Class B) measurement data









[Unit: mm]

Model	Dimension A	Dimension B	Dimension C
HF3005A-TM	180	170	130
HF3010A-TM			
HF3015A-TM			
HF3020A-TM			
HF3030A-TM	260	155	140
HF3040A-TM			
HF3050A-TM	290	190	170
HF3060A-TM			230
HF3080A-TM	405	220	210
HF3100A-TM			
HF3150A-TM	570	230	

MX13 Series 3-phase high attenuation noise filter for 200V

■ Features

Perfect for mounting inside control panel:

- Easy mounting and maintenance work:
  Terminals are centrally located on the front
- Complaint with NC servo and AC servo noise:
  High attenuation of 40dB at 150KHz
- Safety Standards:
  UL1283, CSA22.2 No.8, EN133200
- Patent and design registration pending

■ Specifications

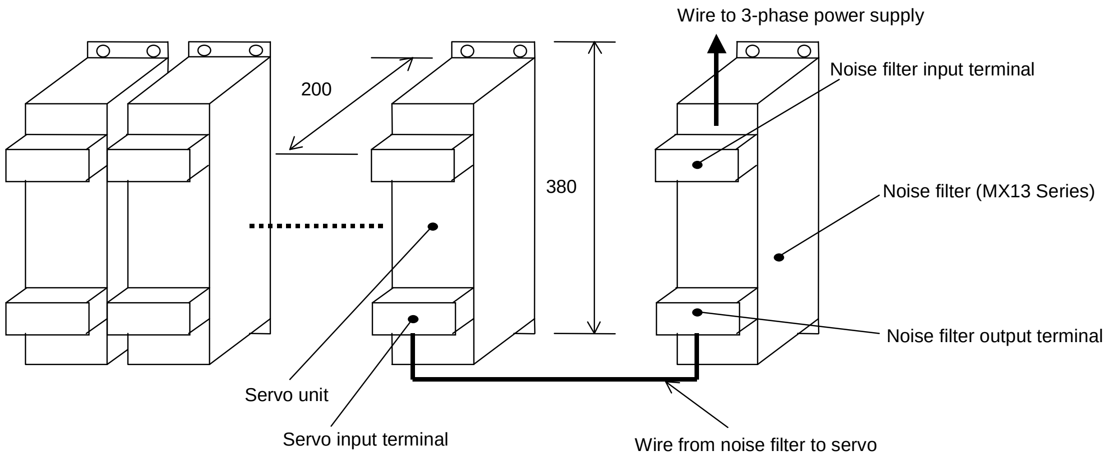
	Item \ Type	MX13030	MX13050	MX13100	MX13150
1	Rated voltage (AC)	3-phase 250VAC (50/60Hz)			
2	Rated current (AC)	30A	50A	100A	150A
3	Test voltage (AC for one minute across terminal and case)	2500VAC (100mA) at 25°C, 70% RH			
4	Insulation resistance (500VDC across terminal and case)	100MΩ min. at 25°C, 70% RH			
5	Leakage current (250V, 60Hz)	3.5 mA max.		8 mA max.	
6	DC resistance	30 mΩ max.	11 mΩ max.	5.5 mΩ max.	3.5 mΩ max.
7	Temperature rise	30°C max			
8	Working ambient temperature	–25°C to +85°C			
9	Working ambient humidity	30% to 95% RH (non condensing)			
10	Storage ambient temperature	–40°C to +85°C			
11	Storage ambient humidity	10% to 95% RH (non condensing)			
12	Mass (typ)	2.8kg	3.9kg	11.5kg	16kg

(Note) This is the value at Ta≤50°C.
Refer to the following output derating for Ta>50°C.

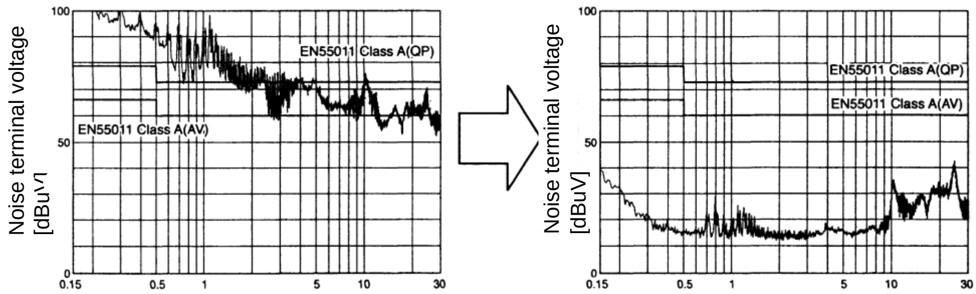
Contact: Densei-lambda Co., Ltd. Telephone: 03-3447-4411 (+81-3-3447-4411)
Fax: 03-3447-7784 (+81-3-3447-7784)
http://www.densei-lambda.com

■ **Example of using MX13 Series**

As with the servo unit, the terminals are arranged on the front enabling ideal wire lead-out. Refer to the following figure for details.



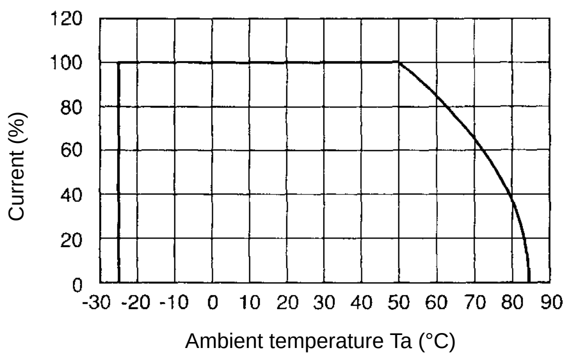
■ **Example of noise terminal voltage attenuation**



EMI data for independent control panel (with six-axis servo unit mounted)

EMI data for control panel + noise filter (MX13030)

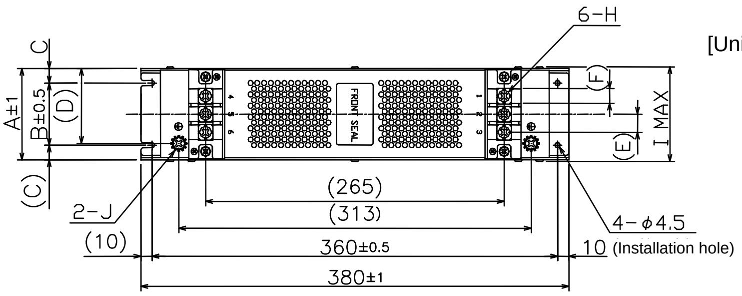
■ **Output derating**

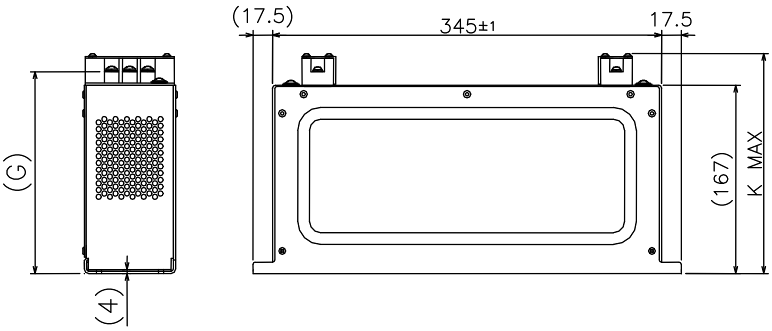


■ Outline dimension drawings

● MX13030, MX13050

[Unit: mm]

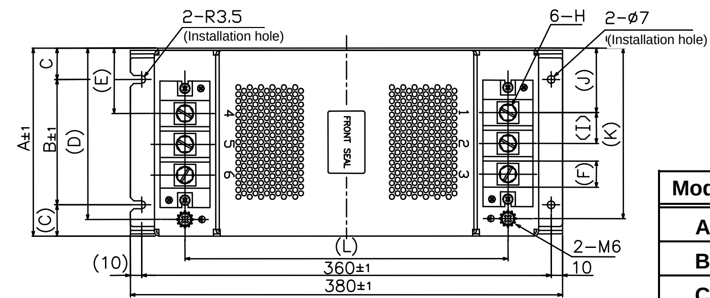


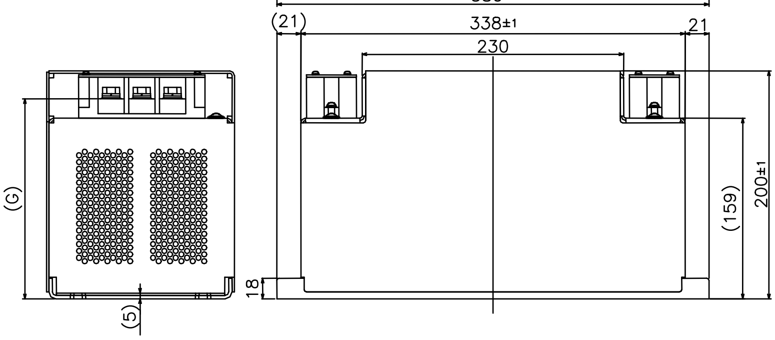


Model	MX13030	MX13050
A	66	81
B	45	55
C	10.5	13
D	50	67
E	13	16
F	10	13
G	177	179
H	M4 screw	M6 screw
I	70	85
J	M4 screw	M6 screw
K	195	200

● MX13100, MX13150

[Unit: mm]





Model	MX13100	MX13150
A	130	165
B	90	110
C	20	27.5
D	115	150.5
E	37.5	57.5
F	18	23
G	174	176
H	M6 screw	M8 screw
I	21	27
J	37.5	56.5
K	115	149.5
L	276	284

Appendix 4-6-4 Surge protector

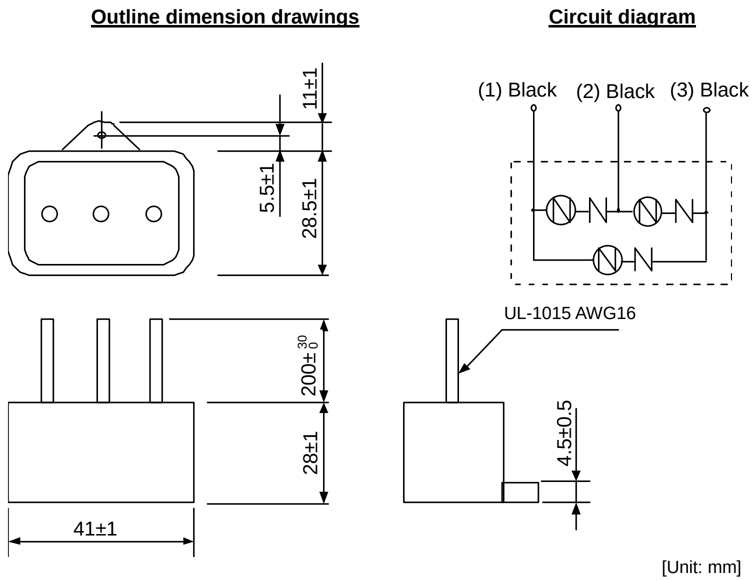
Insert a surge protector in the power input section to prevent damage to the control panel caused by the surge (lightning or sparks, etc.) applied on the AC power line.
Use a surge protector that satisfies the following electrical specifications.

(1) Surge protector for 200V

200V R·A·V BYZ Series (for protection between lines)

Part name	Circuit voltage 50/60Hz	Maximum tolerable circuit voltage	Clamp voltage	Surge withstand level 8/20 μS	Surge withstand voltage 1.2/50 μS	Electrostatic capacity	Service temperature
RAV-781BYZ-2	3AC 250V	300V	783V±10%	2500A	20kV	75pF	-20 to 70°C

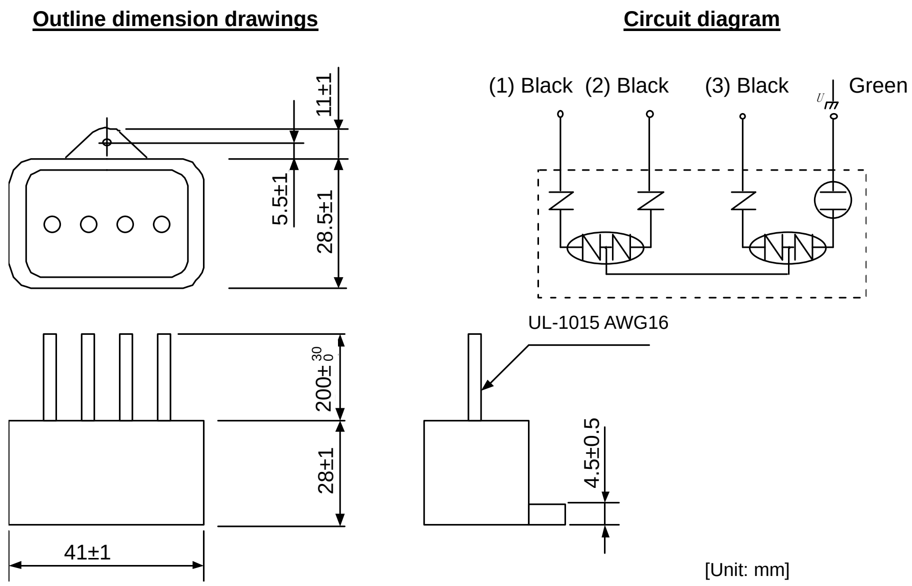
(Note) Refer to the manufacturer's catalog for details on the surge protector's characteristics and specifications.



200V R·A·V BXZ Series (for protection between lines)

Part name	Circuit voltage 50/60Hz	Maximum tolerable circuit voltage	Clamp voltage	Surge withstand level 8/20 μS	Surge withstand voltage 1.2/50 μS	Electrostatic capacity	Service temperature
RAV-781BXZ-4	3AC 250V	300V	1700V±10%	2500A	2kV	75pF	-20 to 70°C

(Note) Refer to the manufacturer's catalog for details on the surge protector's characteristics and specifications.



(2) Surge protector for both between phases and between phase and earth

■ Features

This surge protector can protect both between phases and between phase and earth.
This contains a fuse and has windows to check malfunction or device degradation.

■ Specifications

LT-C Series 200V

Part name	Circuit voltage 50/60Hz	Maximum tolerable circuit voltage	AC operation start voltage (between line and earth)	AC operation start voltage (between lines)	Voltage protection level (Up)	Nominal discharge current (8/20 μs)	Maximum discharge current (8/20 μs)
LT-C32G801WS	3AC 250Vrms	275Vrms	560V±20%	410V±20%	1.5kV	2500A	5000A

(Note) Refer to the manufacturer's catalog for details on the surge protector's characteristics and specifications, etc.

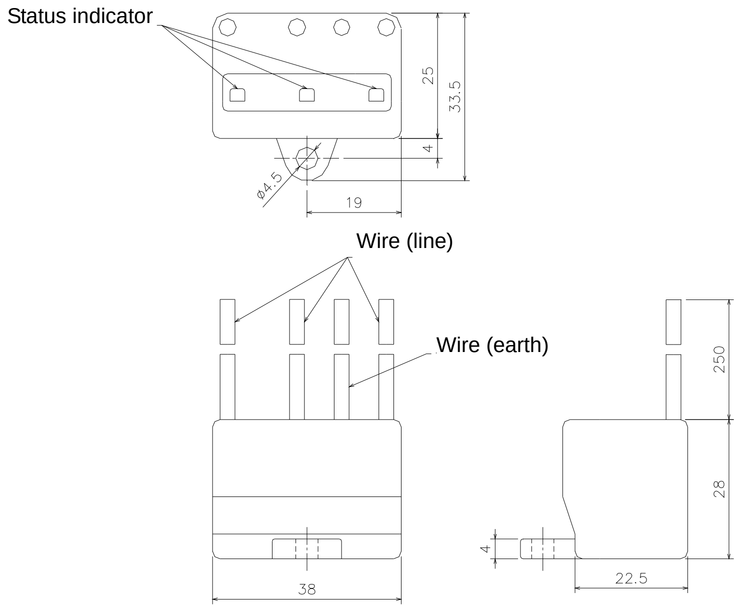
LT-C Series 500V

Part name	Circuit voltage 50/60Hz	Maximum tolerable circuit voltage	AC operation start voltage (between line and earth)	AC operation start voltage (between lines)	Voltage protection level (Up)	Nominal discharge current (8/20 μs)	Maximum discharge current (8/20 μs)
LT-C35G102WS	3AC 500Vrms	550Vrms	700V±20%	800V±20%	2.0kV	2500A	5000A

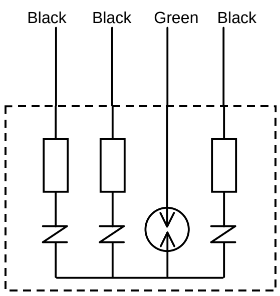
(Note) Refer to the manufacturer's catalog for details on the surge protector's characteristics and specifications, etc.

■ Outline dimensions

Outline dimension drawings

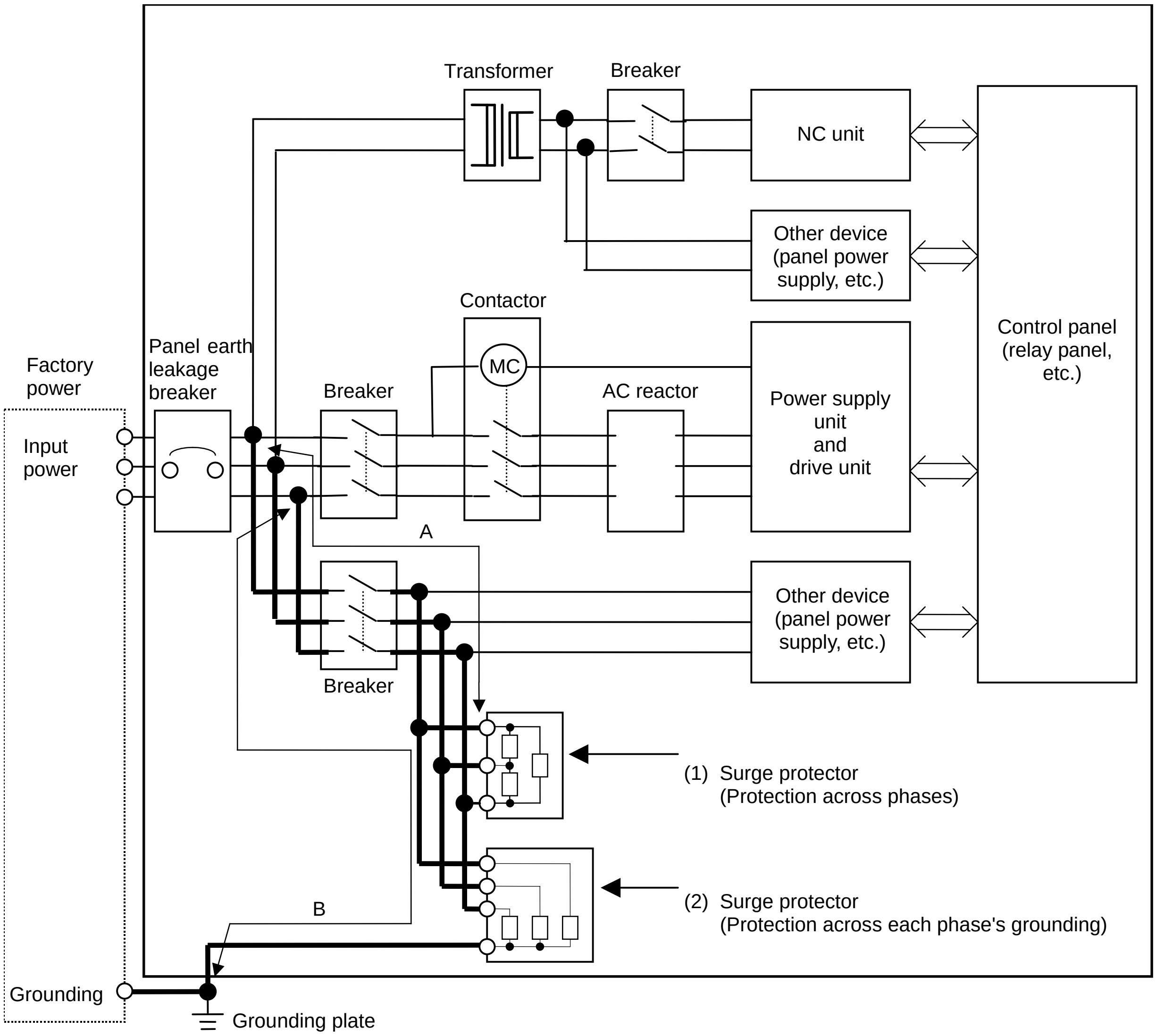


Circuit diagram



(3) 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. 3. Surge protector to be selected varies depending on input power voltage.

Appendix 5. Instruction Manual for Compliance with UL/c-UL Standard

Instruction Manual for Compliance with UL/c-UL Standard

(MDS-R Series)

The instructions of UL/c-UL listed products are 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.

Appendix 5-1 Operation surrounding air ambient temperature

The recognized operation ambient temperatures of each unit 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	0~55°C
	Servo, Spindle drive unit	0~55°C
	Option unit, Battery unit	0~55°C
	Servo motor, Spindle motor	0~40°C

Appendix 5-2 Notes for AC servo system

Appendix 5-2-1 General Precaution

It takes 10 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.

Appendix 5-2-2 Installation

MDS-R 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-R 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.

Appendix 5-2-3 Short-circuit ratings

Suitable for use in a circuit capable of delivering not more than 100 kA rms symmetrical amperes, 500 volts maximum.

Appendix 5-2-4 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)
MDS-R-V1-20	NF30 15A	30A	S-N12
MDS-R-V1-40	NF30 20A	40A	S-N18
MDS-R-V1-60	NF30 30A	60A	S-N20
MDS-R-V1-80	NF30 30A	60A	S-N25
MDS-R-V2-2020	NF30 20A	40A	S-N18
MDS-R-V2-4040	NF30 30A	60A	S-N20
MDS-R-V2-6040	NF30 30A	80A	S-N20
MDS-R-V2-6060	NF50 40A	80A	S-N25
MDS-R-V2-8040	NF50 40A	80A	S-N25
MDS-R-V2-8060	NF50 40A	80A	S-N25
MDS-R-V2-8080	NF50 40A	80A	S-N25

<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.

Appendix 5-2-5 Field Wiring Reference Table for Input and Output

Use the Tyco Electronics Corporation "Dynamic Series" connectors to wire the input and output terminals of MDS-R Series. Crimp the pins with the crimping tool recommended by the manufacturer.
This wire size is each unit maximum rating. The selection method is indicated in each specification manual. (See Manual: No. BNP-C3045)

(1) Input
CN30 (L1, L2, L3)

Capacity [kW]	20	40	60	80
Wire Size (AWG) /Temp Rating Note 1	#14/75°C	#14/75°C	#12/75°C	#12/75°C
Earth Wire Size (AWG)	#14/75°C	#14/75°C	#12/75°C	#12/75°C

Capacity [kW]	2020	4040	6040	6060
Wire Size (AWG) /Temp Rating Note 1	#14/75°C	#14/75°C	#12/75°C	#12/75°C
Earth Wire Size (AWG)	#14/75°C	#14/75°C	#12/75°C	#12/75°C

Capacity [kW]	8040	8060	8080
Wire Size (AWG) /Temp Rating Note 1	#12/75°C	#10/75°C	#10/75°C
Earth Wire Size (AWG)	#12/75°C	#10/75°C	#10/75°C

(2) Output
CN31L, CN31M (U, V, W)

Capacity [kW]	20	40	60	80
Wire Size (AWG) /Temp Rating Note 1	#14/75°C	#14/75°C	#12/75°C	#12/75°C
Earth Wire Size (AWG)	#14/75°C	#14/75°C	#12/75°C	#12/75°C

Appendix 5-2-6 Motor Over Load Protection

Servo drive unit MDS-R-V1 and V2 series have each solid-state motor over load protection. (The motor full load current is the same as rated current.)
When adjusting the level of motor over load, set the parameter as follows.
MDS-R-V1/V2

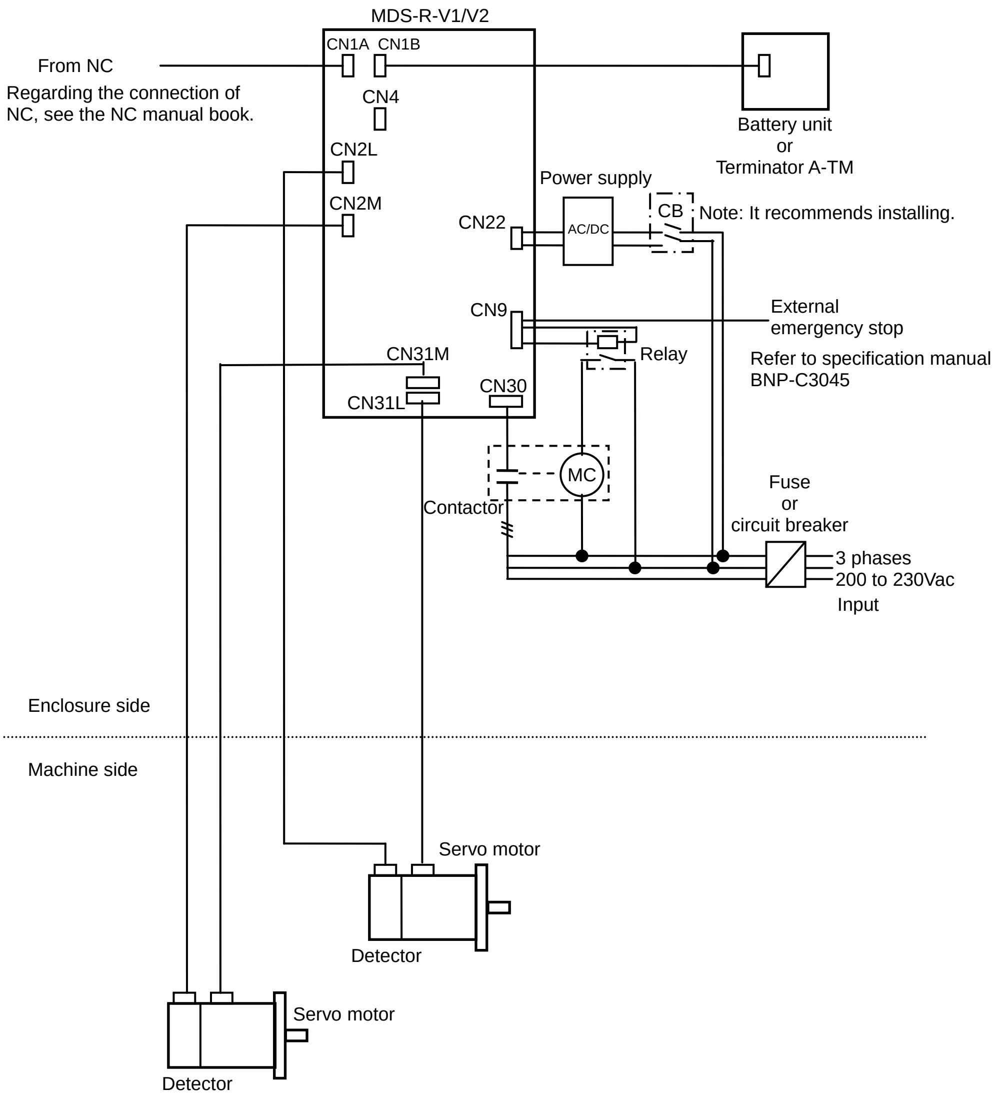
Parameter No.	Parameter abbr.	Parameter name	Setting Procedure	Standard setting value	Setting range
SV021	OLT	Overload time constant	Set the time constant for overload detection. (Unit: 1 second.)	60s	1 to 300s
SV022	OLL	Overload detection level	Set the overload current detection level with a percentage (%) of the stall rating.	150%	1 to 500%

Appendix 5-2-7 Flange of servo motor

Mount the servo motor on a flange which has the following size or produces an equivalent or higher heat dissipation effect:

Flange size (mm)	Servo Motor	
	HF, HC	HC-MF, HA-FF
150x150x6	---	<100 W
250x250x6	---	200, 300 W
250x250x12	0.5 to 1.5 kW	400, 600 W
300x300x12	---	750 W
300x300x20	2.0 to 3.5 kW	---

Appendix 5-3 AC Servo/Spindle System Connection



Appendix 6. Transportation Restrictions for Lithium Batteries

Appendix 6-1 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 the section "Appendix 6-1-2 Handling by user".

Appendix 6-1-1 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. 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.

(1) Products requiring dedicated packaging (Materials falling under Class 9)

Mitsubishi type (Type for arrangement)	Battery type	Lithium metal content	Application	Battery class	Outline dimension drawing
MDS-A-BT-4	ER6-B4-11	2.6g	For servo	Battery	For each outline dimension drawing of servo, refer to the section “4-3 Battery and terminator option”.
MDS-A-BT-6	ER6-B6-11	3.9g	For servo		
MDS-A-BT-8	ER6-B8-11	5.2g	For servo		
FCU6-BT4-D1	Combination of ER6-B4D-11 and ER6	2.6g+0.65g	For NC/ servo		
CR23500SE-CJ5 (Note1)	CR23500SE-CJ5	1.52g	For NC(M500)	Battery cell	

(2) Products not requiring dedicated packaging (Materials not falling under Class 9)

Mitsubishi type (Type for arrangement)	Battery type	Lithium metal content	Application	Battery class	Outline dimension drawing
MDS-A-BT-2	ER6-B2-12	1.3g	For servo	Battery	For each outline dimension drawing of servo, refer to the section “4-3 Battery and terminator option”.
FCU6-BTBOX Series	2CR5	1.96g	For NC/ servo		
CR2032 (for built-in battery)	CR2032	0.067g	For NC	Battery cell	
CR2450 (for built-in battery)	CR2450	0.173g	For NC		
ER6, ER6V series (for built-in battery)	ER6, ER6V	0.7g	For NC/servo		
A6BAT(MR-BAT)	ER17330V	0.48g	For servo		
Q6BAT	Q6BAT	0.49g	For NC		
MR-J3BAT	ER6V	0.65g	For servo		

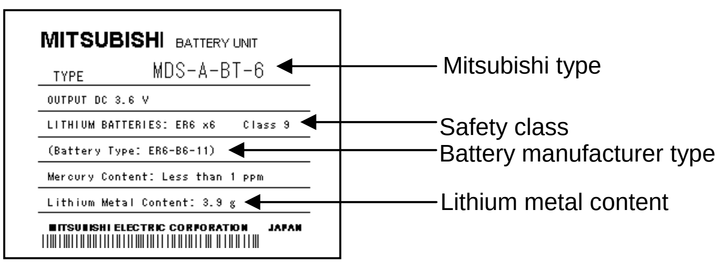
(Note 1) When CR23500SE-CJ5 is incorporated in the unit, this battery is not subject to the regulation.

(Note 2) Dedicated packaging is required if the shipment exceeds 12 batteries/24 battery cells. Package the batteries so that this limit is not exceeded.

(Note 3) The battery units labeled as "FCUA-" instead of "MDS-A-" also use the same battery.

(Note 4) Always use the cell battery (A6BAT) in combination with the dedicated case (MDS-BTCASE). Maximum 8 (either 2, 4, 6 or 8) cell batteries (A6BAT) can be installed to the dedicated case (MDS-BTCASE).

Example) Rating nameplate for battery units



Appendix 6-1-2 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).

■ When shipping isolated lithium battery products (Packing Instruction 903)

(1) Reshipping in Mitsubishi UN packaging

Mitsubishi packing applies the isolated battery's safety test and packaging specifications complying with the UN Regulations (Packing Instruction 903).
The user only needs to add the following details before shipping. (Consult with the shipping company for details.)

(a) 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

(b) Preparation of shipping documents (Declaration of dangerous goods)

(Refer to the section "Appendix 6-3 Example of hazardous goods declaration list")

(2) When packaged by user

The user must follow UN Regulations when packing, preparing for shipping and preparing the indications, etc.

(a) 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

(b) 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.)
- Prepare for the 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".

■ **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.

■ **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.

Appendix 6-1-3 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 6-2 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 ("Appendix 6-2-4 Reference") for details.

Appendix 6-2-1 Outline of regulation

(1) 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 "Appendix 6-1-1 Target products".)

(2) When transporting primary lithium battery by cargo aircraft, indicate that transportation by passenger aircraft is forbidden on the exterior box.

Appendix 6-2-2 Target products

All NC products for which the lithium batteries are used are subject to the regulation.
(Refer to the table "Appendix 6-1-1 Target products".)

Appendix 6-2-3 Handling by user

The "Appendix 6-2-1 Outline of regulation" described above is solely Mitsubishi's opinion. The shipper must confirm orders of "Appendix 6-2-4 Reference" described below for transportation method corresponding the regulation. Actually, these should be checked by the company commissioned for the actual lithium buttery transportation.

(1) 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 mass.
  When the total mass is over 30kg: at least 12mm
  When the total mass is less than 30kg: at least 6mm

Appendix 6-2-4 Reference

(1) Federal Register (Docket No. RSPA-2004-19884 (HM-224E)) PDF format
http://www.regulations.gov/fredpdfs/05-11765.pdf

(2) 49CFR (Code of Federal Regulation, Title49) (173.185 Lithium batteries and cells.)
http://www.access.gpo.gov/nara/cfr/waisidx_00/49cfr173_00.html

(3) DOT regulation body (Department of Transportation)
http://hazmat.dot.gov/regs/rules/final/69fr/docs/69fr-75207.pdf

Appendix 6-3 Example of hazardous goods declaration list

This section describes a general example of the hazardous goods declaration list. For details, please inquire each transportation company.
This will be applied only to the batteries described in "Appendix 6-1 Restriction for Packing".

(1) Outline of hazard

Principal hazard and effect	Not found.
Specific hazard	As the chemical substance is stored in a sealed metal container, the battery itself is not hazardous. But when the internal lithium metal attaches to human skin, it causes a chemical skin burn. As a reaction of lithium with water, it may ignite or forms flammable hydrogen gas.
Environmental effect	Not found.
Possible state of emergency	Damages or short-circuits may occur due to external mechanical or electrical pressures.

(2) First-aid measure

Inhalation	If a person inhales the vapor of the substance due to the battery damage, move the person immediately to fresh air. If the person feels sick, consult a doctor immediately.
Skin contact	If the content of the battery attaches to human skin, wash off immediately with water and soap. If skin irritation persists, consult a doctor.
Eye contact	In case of contact with eyes due to the battery damage, rinse immediately with a plenty of water for at least 15 minutes and then consult a doctor.
Ingestion	If swallowed, consult a doctor immediately.

(3) Fire-fighting measure

Appropriate fire-extinguisher	Dry sand, dry chemical, graphite powder or carbon dioxide gas
Special fire-fighting measure	Keep the battery away from the fireplace to prevent fire spreading.
Protectors against fire	Fire-protection gloves, eye/face protector (face mask), body/skin protective cloth

(4) Measure for leakage

Environmental precaution	Dispose of them immediately because strong odors are produced when left for a long time.
How to remove	Get them absorbed into dry sand and then collect the sand in an empty container.

(5) Handling and storage

Handling	**Cautions for safety handling**	Do not peel the external tube or damage it. Do not dispose of the battery in fire or expose it to heat. Do not immerse the battery in water or get it wet. Do not throw the battery. Do not disassemble, modify or transform the battery. Do not short-circuit the battery.
Storage	**Appropriate storage condition**	Avoid direct sunlight, high temperature and high humidity. (Recommended temp. range: +5 to +35 ^{o}C, humidity: 70%RH or less)
	Material to avoid	Flammable or conductive material (Metal: may cause a short-circuit)

(6) Physical/chemical properties

Appear-ance	**Physical form**	Solid
	Shape	Cylinder type
	Smell	Odorless
	pH	Not applicable (insoluble)
	Boiling point/Boiling range, Melting point, Decomposition temperature, Flash point	No information

(7) Stability and reactivity

Stability	Stable under normal handling condition.
Condition to avoid	Do not mix multiple batteries with their terminals uninsulated. This may cause a short-circuit, resulting in heating, bursting or ignition.
Hazardous decomposition products	Irritative or toxic gas is emitted in the case of fire.

(8) Toxicological information

As the chemical substance is stored in a sealed metal container, the battery has no harmfulness. Just for reference, the table below describes the main substance of the battery.

(Lithium metal)

Acute toxicity	No information
Local effect	Corrosive action in case of skin contact

(9) Ecological information

Mobility, Persistence/Decomposability, Bio-accumulation potential, Ecological toxicity	Not found.

(10) Caution for disposal

Dispose of the battery following local laws or regulations.
Pack the battery properly to prevent a short-circuit and avoid contact with water.

Appendix 7. Compliance with Restriction in China

Appendix 7-1 Compliance with China Compulsory Product Certification System

Appendix 7-1-1 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 7-1-2 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	Compulsory Certification Regulations
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.	CNCA -01C -011: 2001 (Switch and Control Equipment) CNCA -01C -012: 2001 (Installation Protective Equipment)
	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)	CNCA -01C -011: 2001 (Switch and Control Equipment) CNCA -01C -012: 2001 (Installation Protective Equipment)
	Relays (36V < Voltage ≤ 1000V)	CNCA -01C -011: 2001 (Switch and Control Equipment) CNCA -01C -012: 2001 (Installation Protective Equipment)
	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)	CNCA -01C -011: 2001 (Switch and Control Equipment) CNCA -01C -012: 2001 (Installation Protective Equipment)
	Other devices (contactors, motor starters, indicator lights, auxiliary contact assemblies, master controllers, A.C. Semiconductor motor controllers and starters)	CNCA -01C -011: 2001 (Switch and Control Equipment) CNCA -01C -012: 2001 (Installation Protective Equipment)
	Earth leakage protectors	CNCA -01C -011: 2001 (Switch and Control Equipment) CNCA -01C -012: 2001 (Installation Protective Equipment)
	Fuses	CNCA -01C -011: 2001 (Switch and Control Equipment) CNCA -01C -012: 2001 (Installation Protective Equipment)
	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 7-1-3 Precautions for Shipping Products

As indicated in Appendix 7-1-2, 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 7-1-4. 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 7-1-4 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 7-1-5 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

Appendix 7-2 Response to the China environment restrictions

Appendix 7-2-1 Outline of the law on the pollution prevention and control for electronic information products

Ministry of Information Industry (information industry ministry) issued this law on Feb.28, 2006 (Note) (effective from Mar.1, 2007.) in order to protect the environment and the health of the people with restricting and reducing the environmental pollution caused by the electronic information product wastes. The restrictions are applied to containing lead (Pb), hydrargyrum (Hg), cadmium (Cd), hexavalent chromium (Cr (VI)), polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE) in two stages.

(Note) For the details, refer to the following. http://www.mii.gov.cn/art/2006/03/02/art_524_7343.html

(1) First stage: Requirement of indicating contained substance

The producer and importer of the electronic information product are required to indicate the hazardous substance. The concrete categories of the products belonging in the following eleven main categories are described as subjected product list (electronic information product category note).

• Radar device • Communication device • Radio/TV device industry product • Computer product
• Consumer-electronics device • Electronic measuring apparatus
• Electronics industry dedicated device • Electronic parts • Electronics device
• Electronics application product • Electronics dedicated material

(2) Second stage: Suppressing the amount of contained substances and compulsory CCC Certification

The product listed in the "Electronic information product pollution priority control list" cannot be sold in China unless it conforms to the Compulsory Product Certification System (CCC Certification) and its cadmium usage is suppressed to 0.01w% and other substances usage less than 0.1w%. Note that the timing when this is effective is unmentioned.

Appendix 7-2-2 Response to the drive product for Mitsubishi NC

The drive product for NC has no items falling under the subjected product list (electronic information product category note). However, for use with the drive product included in the subjected product or for treating the product properly, information based on the law on the pollution prevention and control for electronic information products are described in the section "Appendix 7-2-3" for reference.

Appendix 7-2-3 Indication based on "Pollution suppression marking request for electronic information product"

(1) Electronic information product pollution suppression marking

This marking indicates the environmental protection expiration date applied to the electronic information products sold in China according to the law on the pollution prevention and control for electronic information products issued on Feb.28, 2006. As long as you keep safety for this product and follow the precautions for use, there are no serious effects on the environment pollution, human body or property within its term reckoned from the manufacturing date.

Note: This symbol mark is for China only.

(Note) Equate the environmental protection expiration date of consumables, such as enclosed battery and cooling fan, with the product life. When disposing the product after using it properly, obey each local laws and restrictions for collecting and recycling of the electronic information product.

(2) The names of contained six hazardous substances and the parts containing them

The names of six substances contained in this product and the parts containing them are shown below.

Parts name	Toxic/hazardous substance or element					
	Lead (Pb)	Hydrargyrum (Hg)	Cadmium (Cd)	Hexavalent chromium (Cr(VI))	(PBB)	(PBDE)
Drive unit	×	○	○	○	○	○
Servo motor/spindle motor	×	○	○	○	○	○
Dedicated options (cable/connector)	×	○	○	×	○	○
Dedicated Options (detector/AC reactor)	×	○	○	×	○	○
Dedicated Options (battery)	×	○	○	○	○	○

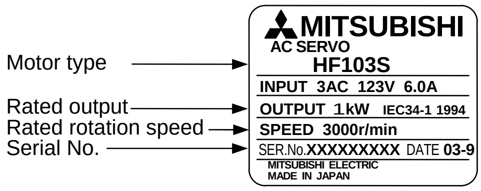
○: This mark means that toxic/hazardous substance content in all homogeneous materials of corresponding parts does not exceed the standard specified in the standard of SJ/T11363-2006.

×: This mark means that toxic/hazardous substance content in the homogeneous materials of corresponding parts exceeds the standard specified in the standard of SJ/T11363-2006.

Appendix 8. Old motor specifications

Appendix 8-1 Servomotor type

HF Series



Motor rating nameplate

HF (1) (2) (3) - (4)

(4)

Sym-bol	Detection method	Resolution
A42	Absolute position	100,000p/rev
A47		100,000p/rev

(3)

Sym-bol	Shaft end structure
S	Straight
T	Taper

(Note) Taper can be selected for the 1.5kW or smaller motor.

(2)

Sym-bol	Magnetic brakes
None	None
B	With magnetic brakes

(1)

HF☐ low-inertia series		HF☐ medium-inertia series	
Rating 3000r/min		Rating 3000r/min	
Sym-bol	**Rated output**	**Sym-bol**	**Rated output**
44	0.4 kW	53	0.5 kW
74	0.75kW	103	1.0 kW
		153	1.5 kW
		203	2.0 kW
		353	3.5 kW

Appendix 8-2 Specifications list

HF Series

Servomotor type			HF□□-A47/A42										
			4000r/min Series		3000r/min Series								
			HF44	HF74	HF53	HF103		HF153		HF203		HF353	
Compatible servo drive unit type **(Note 4)**		MDS-R-V1/V2-	20(40)	20(40)	20(40)	20	40	40	60 (80)	40	60 (80)	60	80
Continuous characteristics	Rated output	[kW]	0.4	0.75	0.5	0.67	1.0	1.0	1.5	1.16	2.0	2.4	3.5
	Rated current	[A]	2.2	3.7	1.9	3.5	3.5	5.3	5.3	6.0	6.9	10.3	10.3
	Rated torque	[N·m]	1.27	2.39	1.59	3.18	3.18	4.77	4.77	5.54	6.37	11.1	11.1
	Stall current	[A]	3.2	4.6	3.6	6.0	6.5	9.9	9.9	10.7	14.8	15.5	20.8
	Stall torque	[N·m]	2.0	3.0	2.94	5.4	5.88	8.82	8.82	9.9	13.7	16.7	22.5
Rated rotation speed		[r/min]	3000	3000	3000	2000	3000	2000	3000	2000	3000	2000	3000
Maximum rotation speed		[r/min]	4000 (-A47) 3000 (-A42)		3000								
Maximum current		[A]	13.7	17.0	15.3	17.0	25.6	28.3	42.0	30.8	45.8	45.8	59.2
Maximum torque		[N·m]	8.0	11.0	11.8	15.3	21.6	25.2	35.3	28.5	41.7	49.0	59.8
Motor inertia		[kg·cm^2]	2.6	5.1	6.1	11.9		17.8		38.3		75.0	
Motor inertia with brake		[kg·cm^2]	2.8	5.3	8.3	14.1		20.0		48.0		84.7	
Maximum motor shaft conversion load inertia rate			Machine tool (Compensation axis): 5 times or less of motor inertia General machine (non-compensation axis): 10 times or less of motor inertia										
Motor side detector resolution			A42: For high-gain 100,000 pulse/rev A47: For general use 100,000 pulse/rev										
Structure			Fully closed, natural-cooling (Protection method: IP67) **(Note 3)**										
Environment	Ambient temperature		Operation: 0 to 40°C (non freezing), Storage: -15 to 70°C (non freezing)										
	Ambient humidity		Operation: 80%RH or less (non condensing), Storage: 90%RH or less (non condensing)										
	Atmosphere		Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust										
	Altitude		Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level										
	Vibration		X:49m/s^2 (5G) Y:49m/s^2 (5G)		X:24.5m/s^2 (2.5G) Y:24.5m/s^2 (2.5G)					X:24.5m/s^2 (2.5G) Y:49m/s^2 (5G)			
Power facility capacity		[kVA]	0.9	1.3	1.0	1.7		2.6		3.5		5.5	
Mass Without/with brake		[kg]	2.5/3.9	4.3/5.7	4.8/6.8	6.5/8.5		8.3/10.3		12/18		19/25	
Armature insulation class			Class F										

(Note 1) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the drive unit.

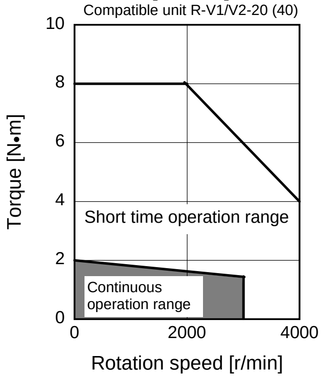
(Note 2) Use the HF motor in combination with the MDS-R Series drive unit compatible with the 200VAC input.
This motor is not compatible with the conventional MDS-B/C1/CH Series.

(Note 3) The shaft-through portion is excluded.

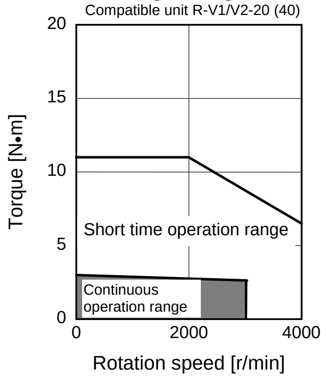
(Note 4) "( )" indicates the combination with the drive unit capacity of one rank up. The motor characteristics are same as the characteristics applied when the drive unit capacity is standard.

Appendix 8-3 Torque characteristics

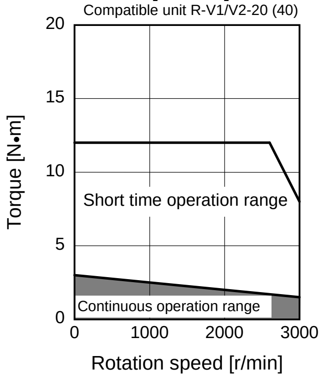
[HF44]
Compatible unit R-V1/V2-20 (40)



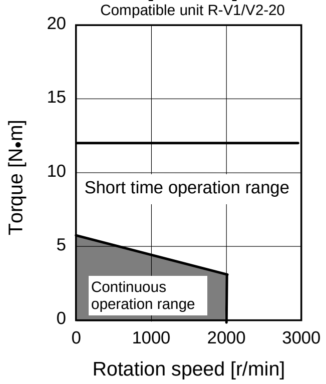
[HF74]
Compatible unit R-V1/V2-20 (40)



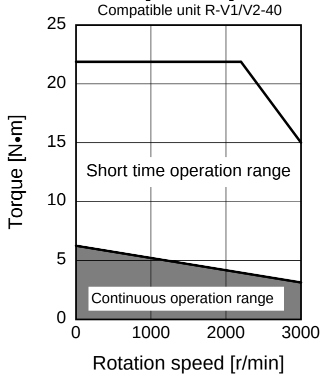
[HF53]
Compatible unit R-V1/V2-20 (40)



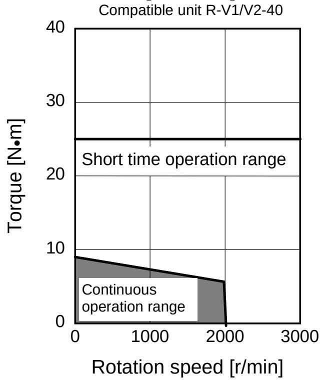
[HF103]
Compatible unit R-V1/V2-20



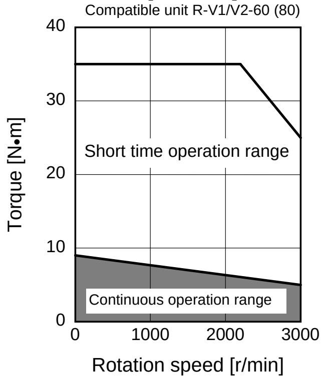
[HF103]
Compatible unit R-V1/V2-40



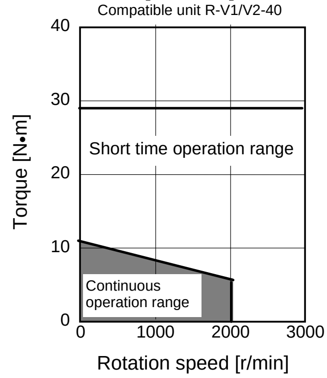
[HF153]
Compatible unit R-V1/V2-40



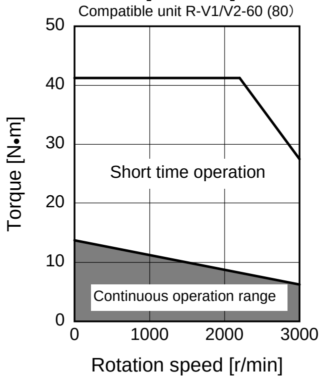
[HF153]
Compatible unit R-V1/V2-60 (80)



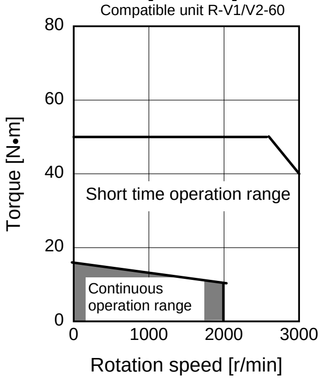
[HF203]
Compatible unit R-V1/V2-40



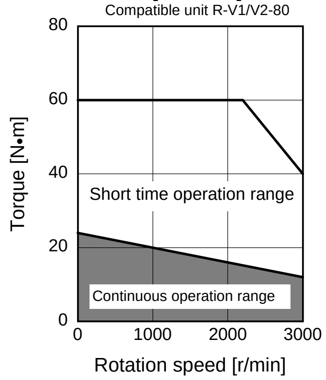
[HF203]
Compatible unit R-V1/V2-60 (80)



[HF353]
Compatible unit R-V1/V2-60



[HF353]
Compatible unit R-V1/V2-80

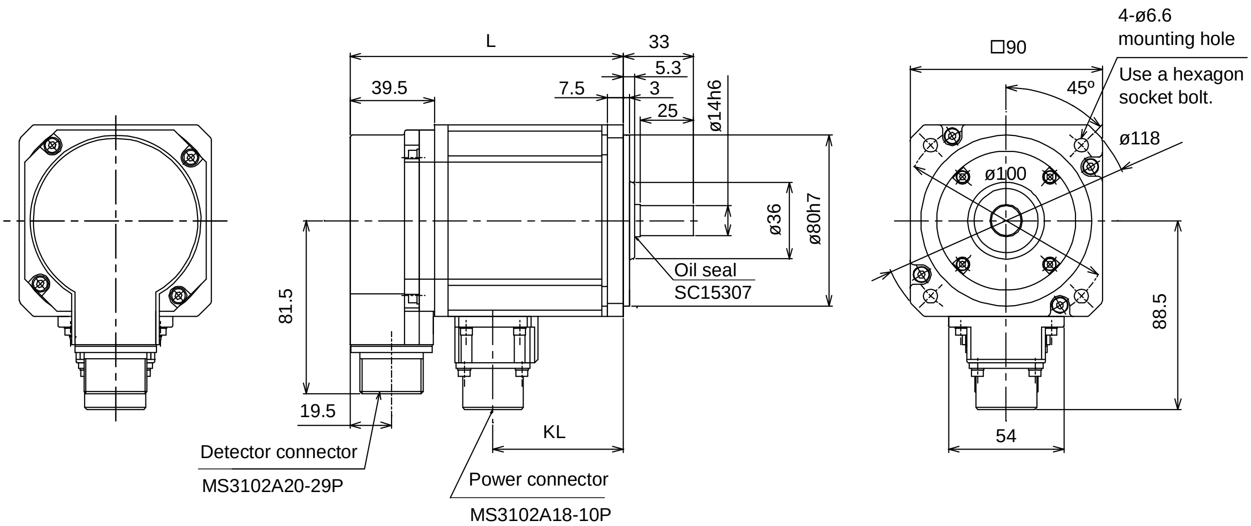


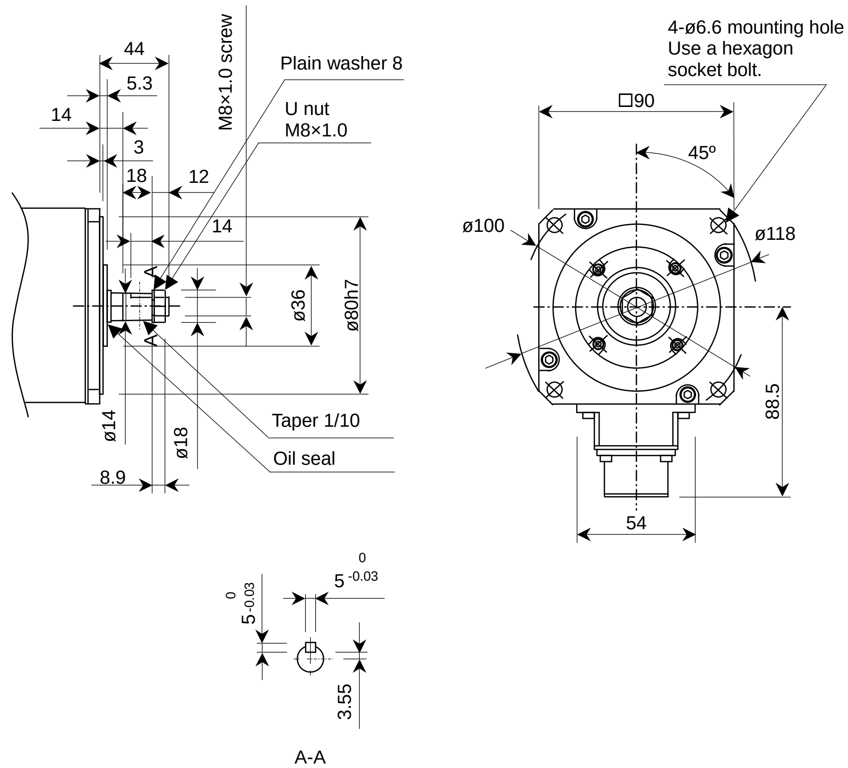
(Note1) The characteristic value in the above graphs is a value applied when the motor is combined with each compatible unit.
(Note2) The above graphs show the data for the input voltage of 200VAC. When the input voltage is 200VAC or less, the short time operation range is limited

Appendix 8-4 Unit outline dimension drawing

HF44S-A47
- HF44T-A47
- HF74S-A47
- HF74T-A47

[Unit: mm]



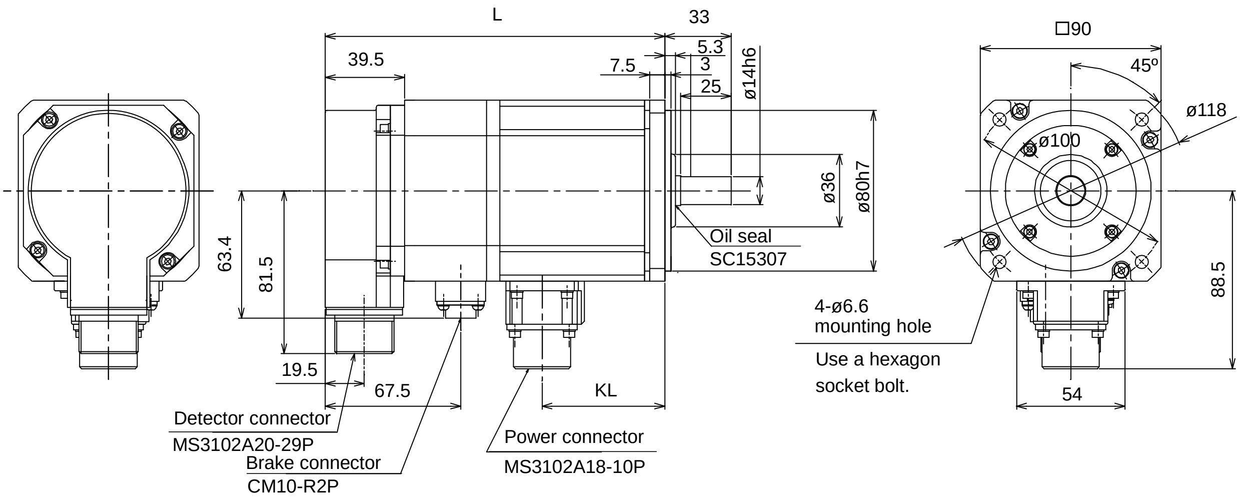


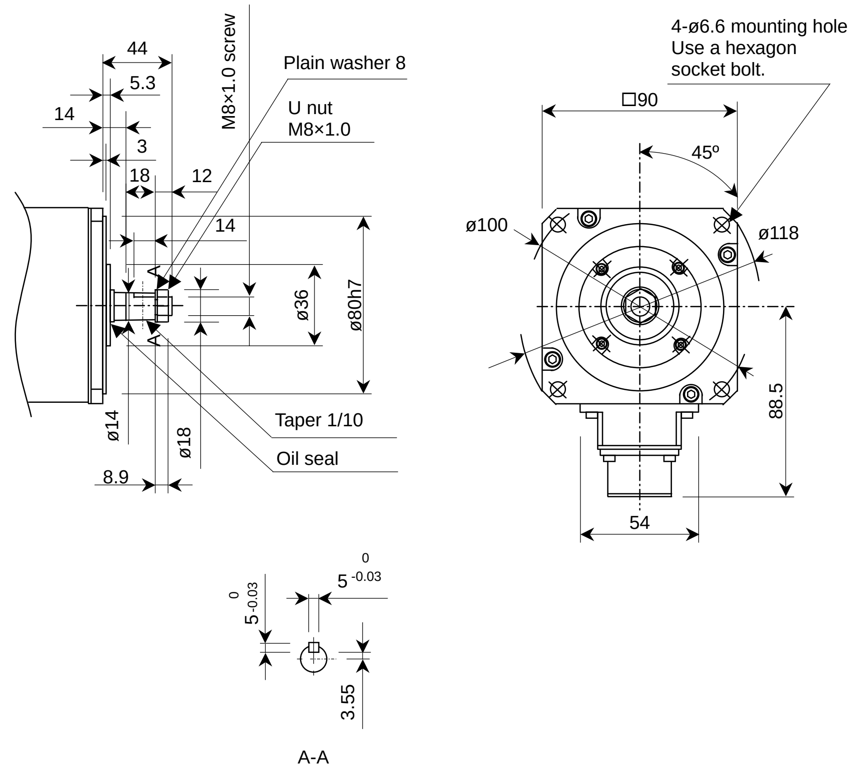
Servomotor type	L	KL
HF44	128	61
HF74	164	97

(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load. (A straight axis.)
(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

- HF44BS-A47
- HF44BT-A47
- HF74BS-A47
- HF74BT-A47

[Unit: mm]



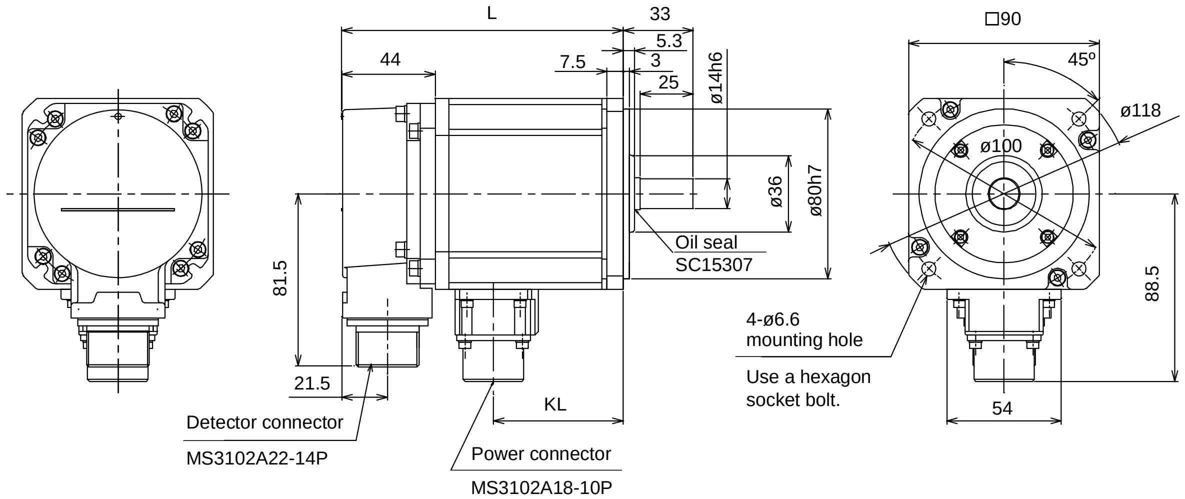


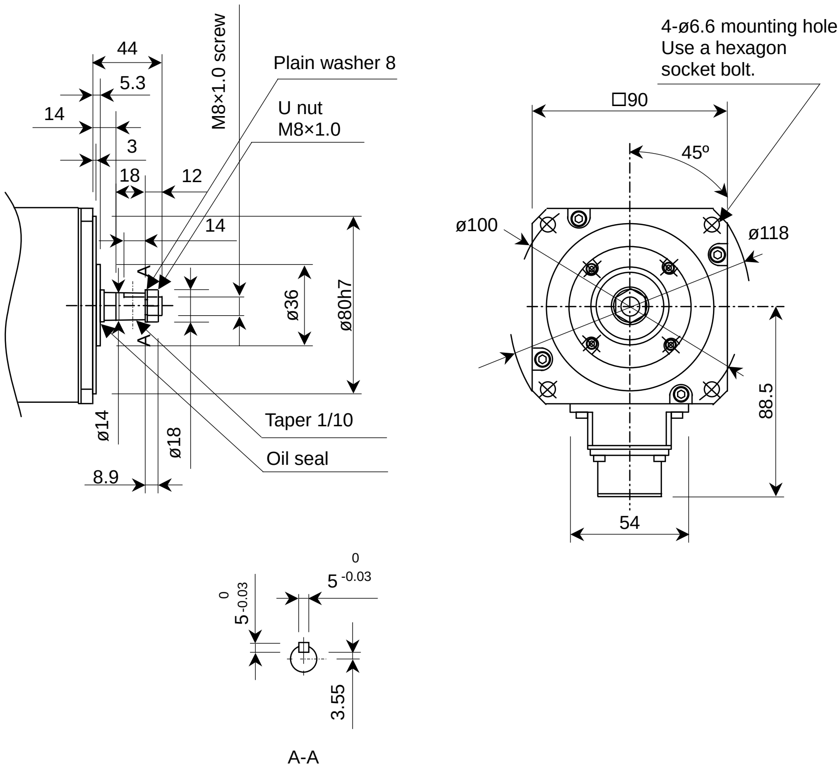
Servomotor type	L	KL
HF44B	169	61
HF74B	205	97

(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load. (A straight axis.)
(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

- HF44S-A42
- HF44T-A42
- HF74S-A42
- HF74T-A42

[Unit: mm]



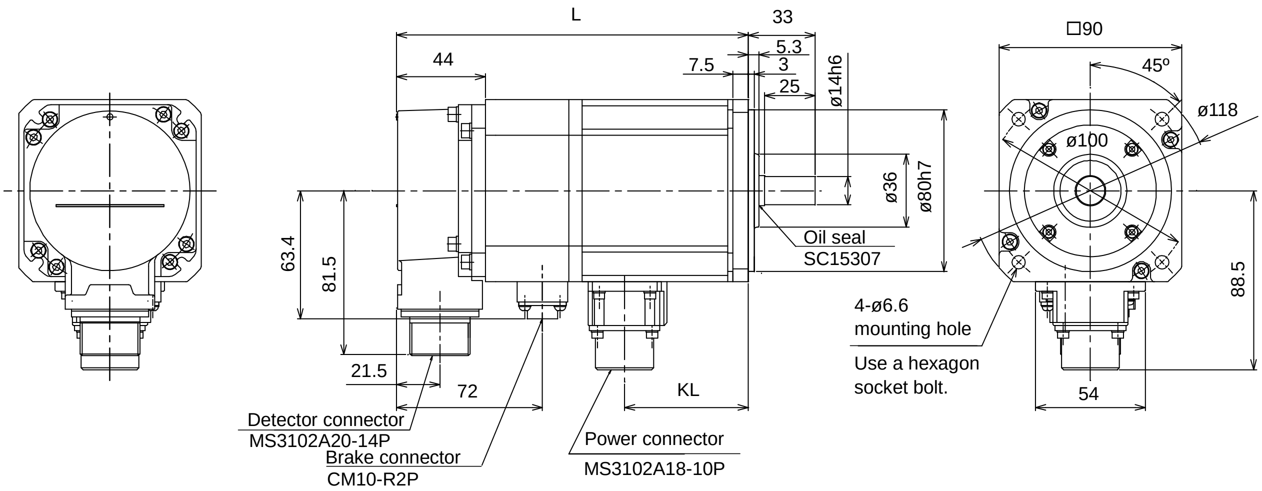


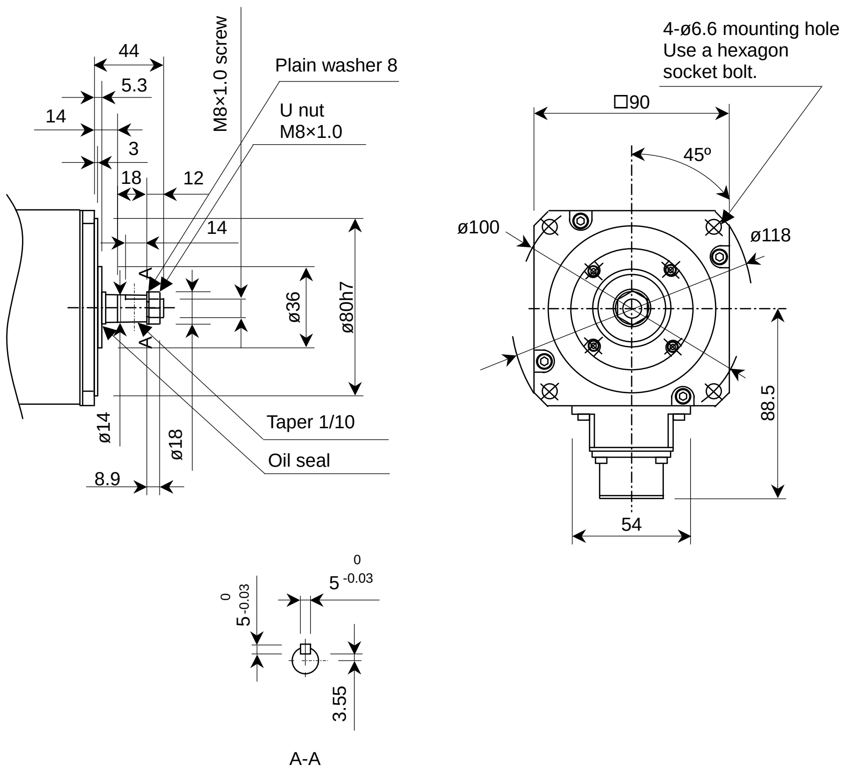
Servomotor type	L	KL
HF44	132.5	61
HF74	168.5	97

(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load. (A straight axis.)
(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

- HF44BS-A42
- HF44BT-A42
- HF74BS-A42
- HF74BT-A42

[Unit: mm]



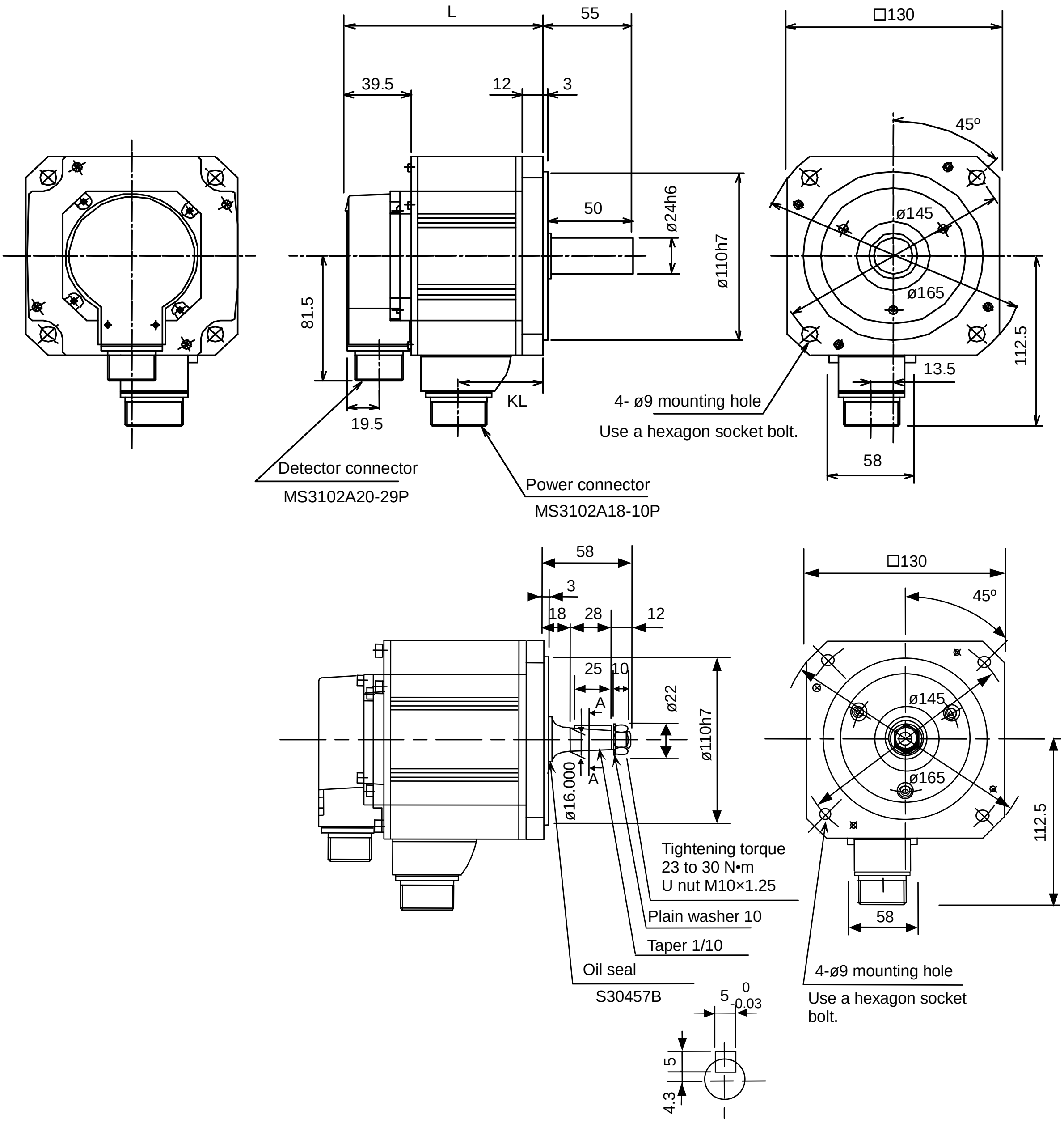


Servomotor type	L	KL
HF44B	173.5	61
HF74B	209.5	97

(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load. (A straight axis.)
(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

- HF53S-A47 • HF103S-A47 • HF153S-A47
- HF53T-A47 • HF103T-A47 • HF153T-A47

[Unit: mm]

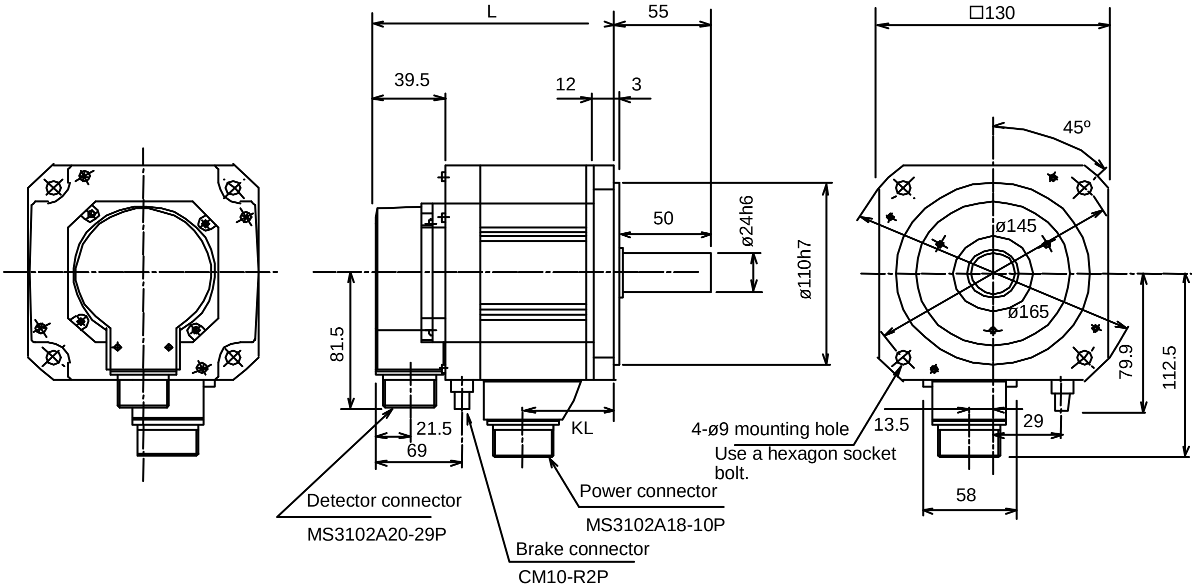


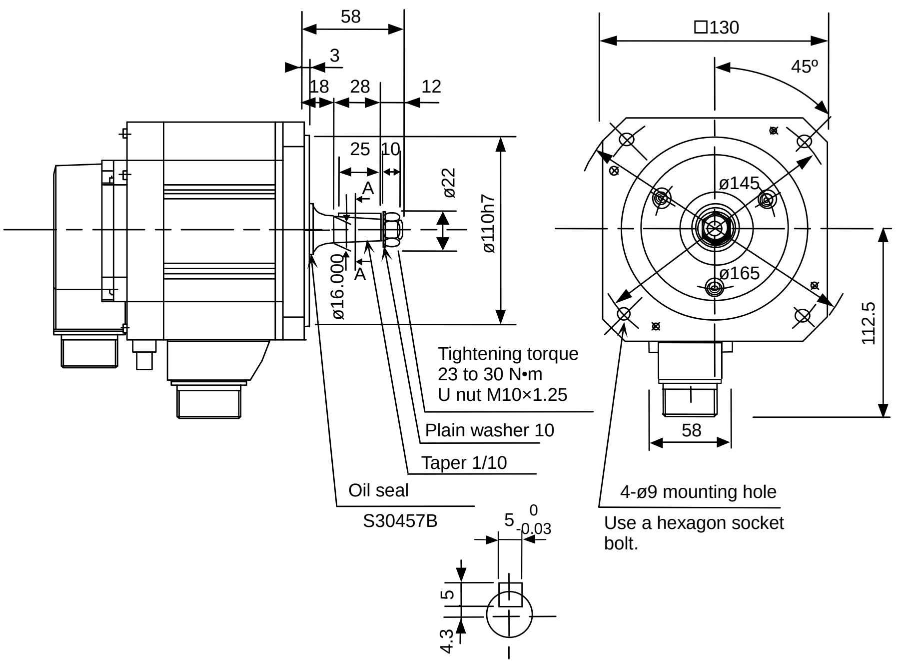
Servomotor type	L	KL
HF53	120	57.8
HF103	142	79.8
HF153	164	101.8

(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load.
(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

- HF53BS-A47 • HF103BS-A47 • HF153BS-A47
- HF53BT-A47 • HF103BT-A47 • HF153BT-A47

[Unit: mm]



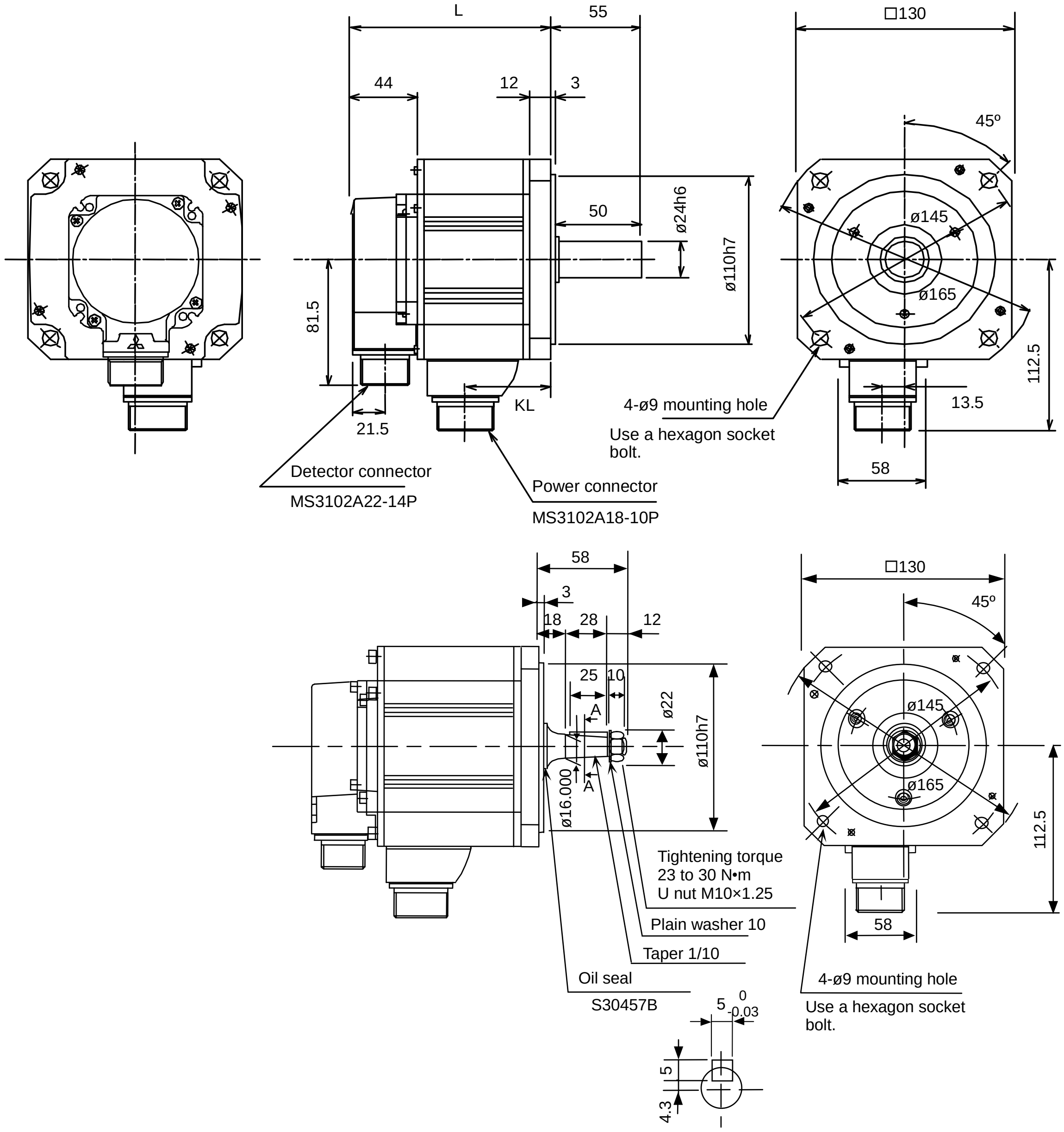


Servomotor type	L	KL
HF53B	158	57.8
HF103B	180	79.8
HF153B	202	101.8

(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load.
(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

- HF53S-A42
- HF53T-A42
- HF103S-A42
- HF103T-A42
- HF153S-A42
- HF153T-A42

[Unit: mm]



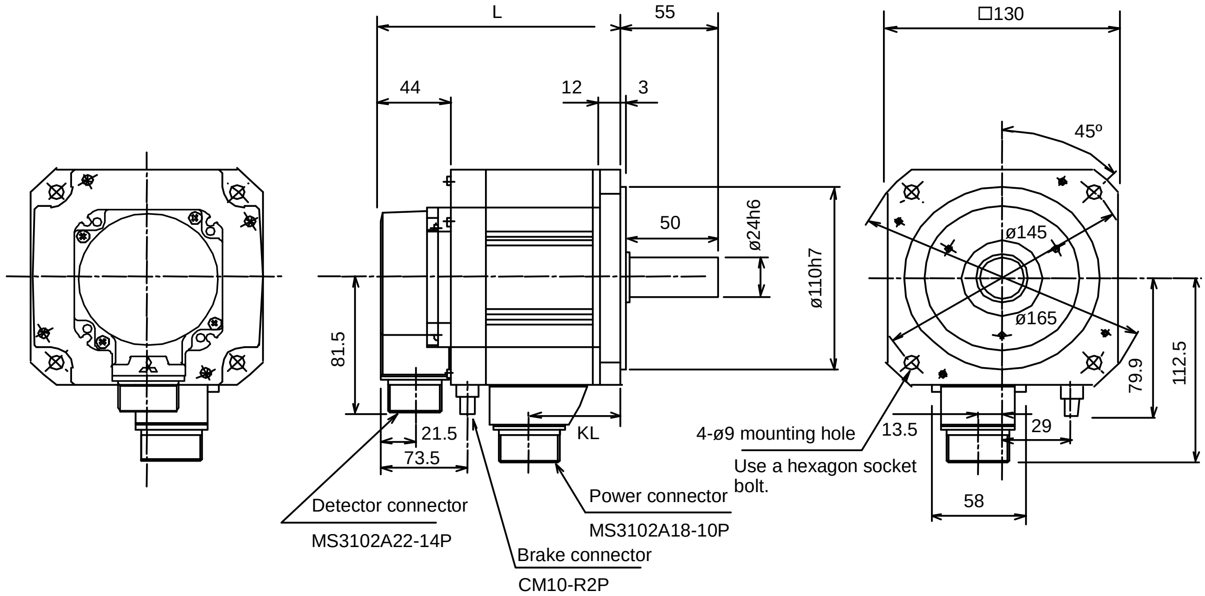
Servomotor type	L	KL
HF53	124.5	57.8
HF103	146.5	79.8
HF153	168.5	101.8

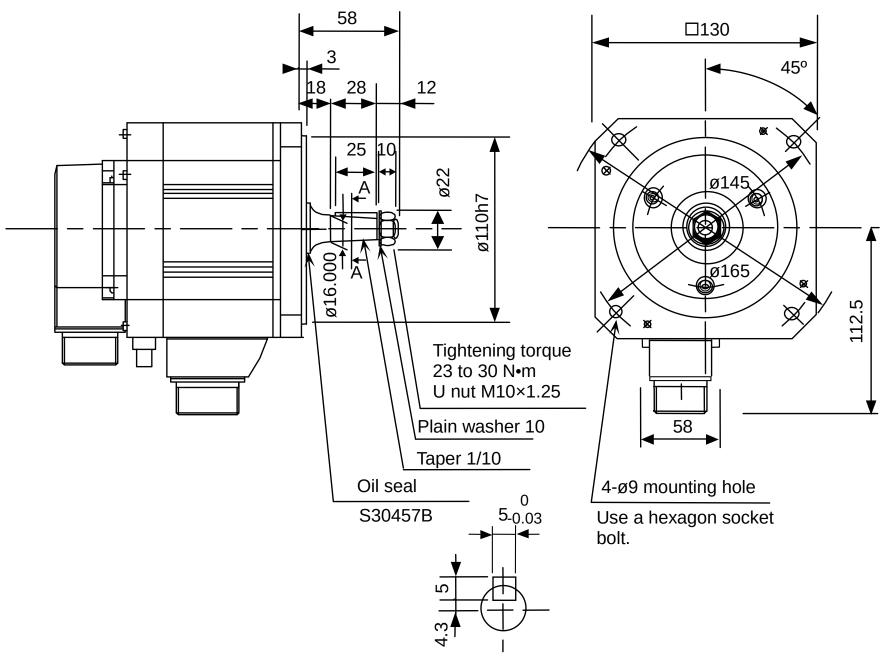
(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load.

(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

- HF53BS-A42
- HF53BT-A42
- HF103BS-A42
- HF103BT-A42
- HF153BS-A42
- HF153BT-A42

[Unit: mm]





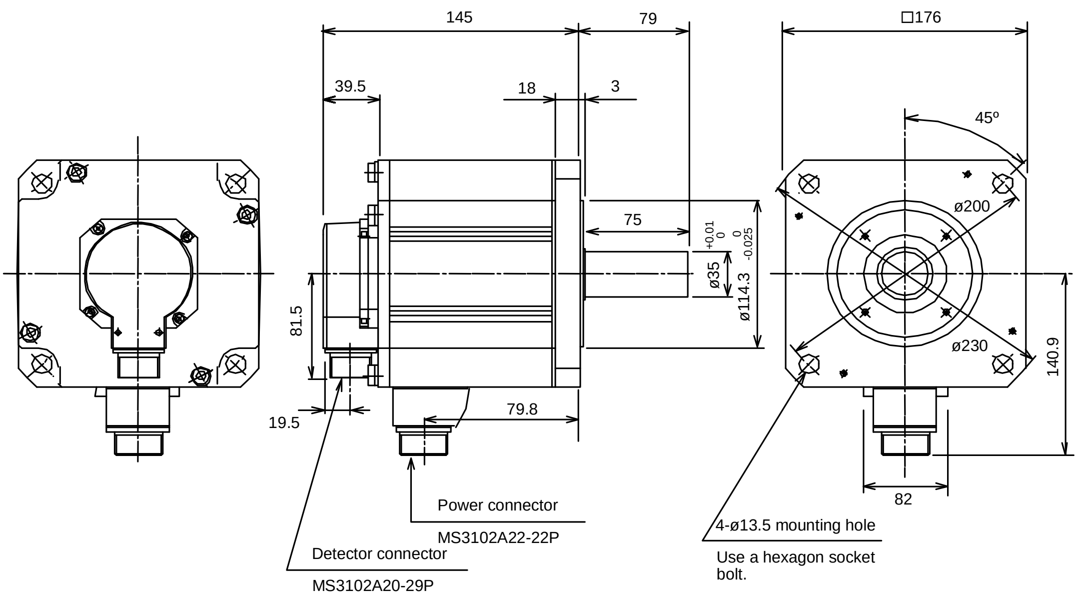
Servomotor type	L	KL
HF53B	162.5	57.8
HF103B	184.5	79.8
HF153B	206.5	101.8

(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load.

(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

• HF203S-A47

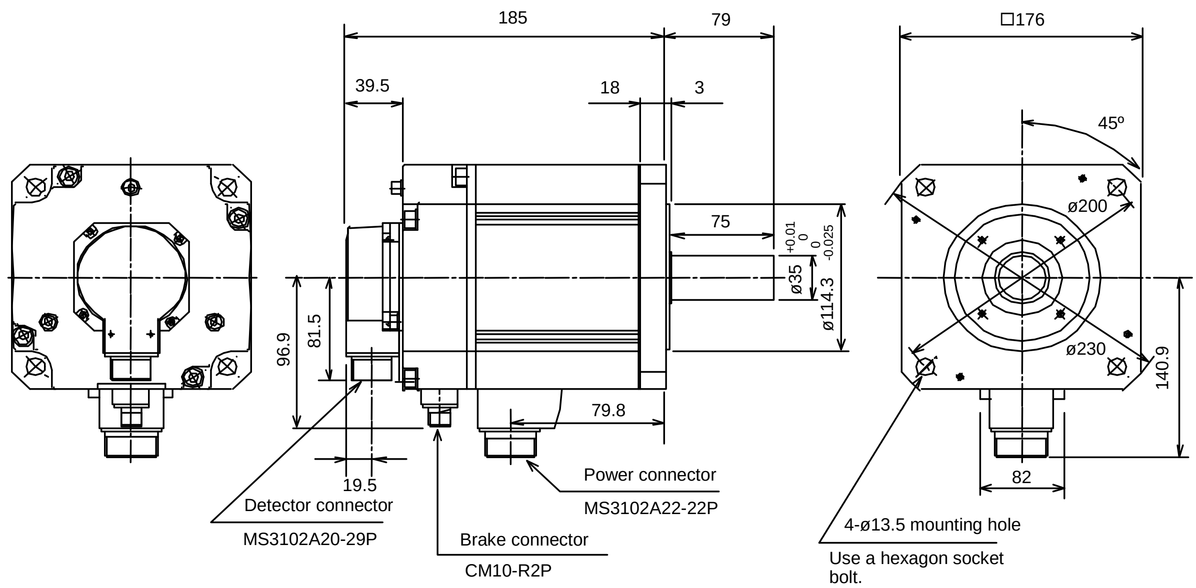
[Unit: mm]



(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load.
(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

• HF203BS-A47

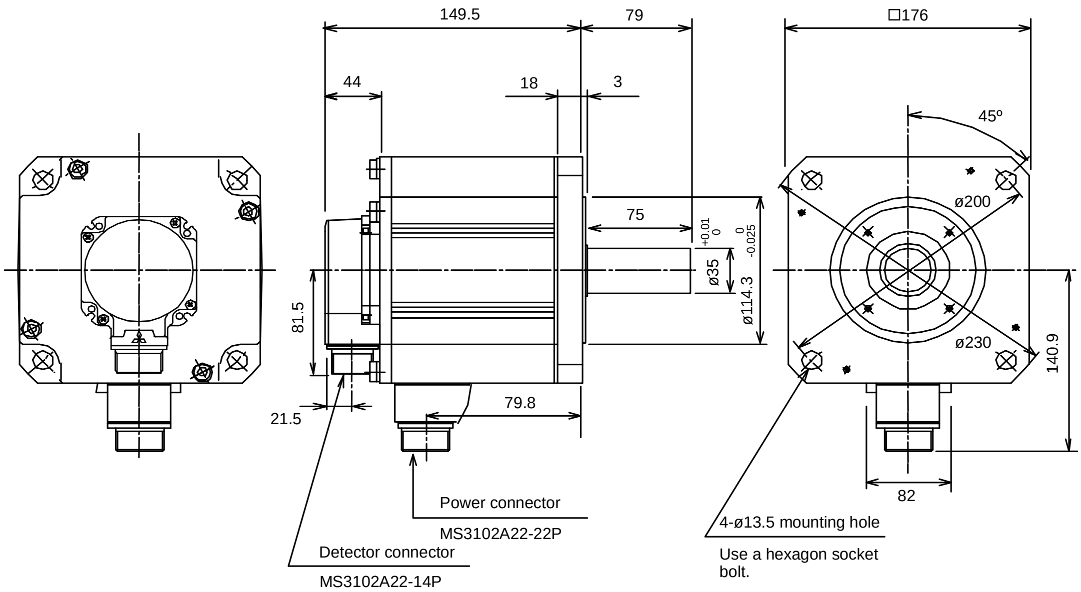
[Unit: mm]



(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load.
(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

- HF203S-A42

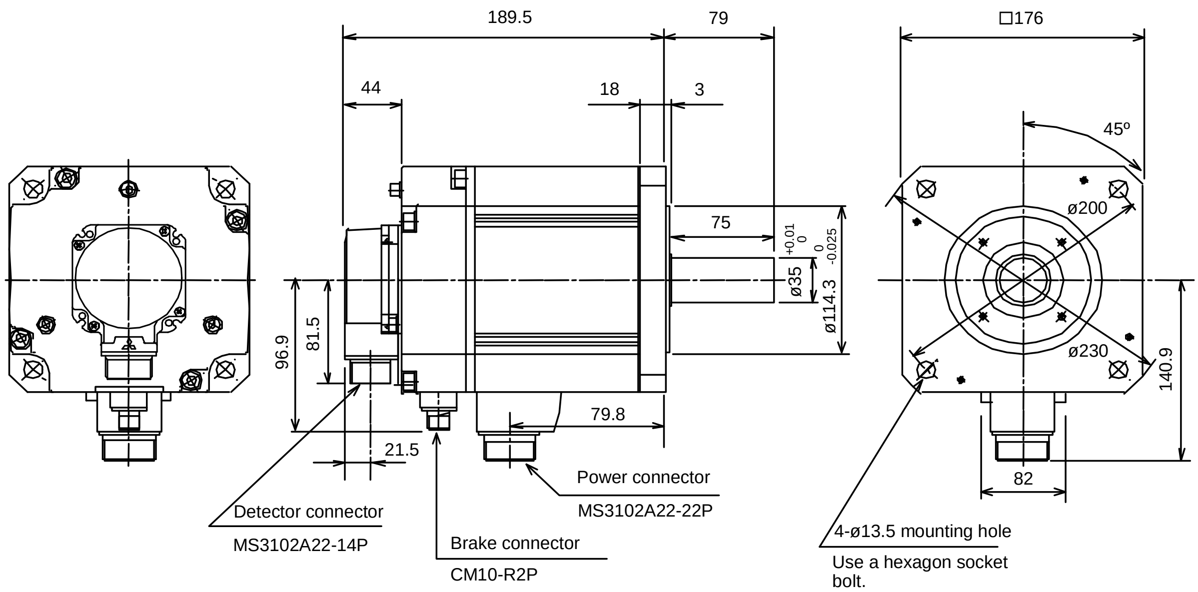
[Unit: mm]



(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load.
(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

- HF203BS-A42

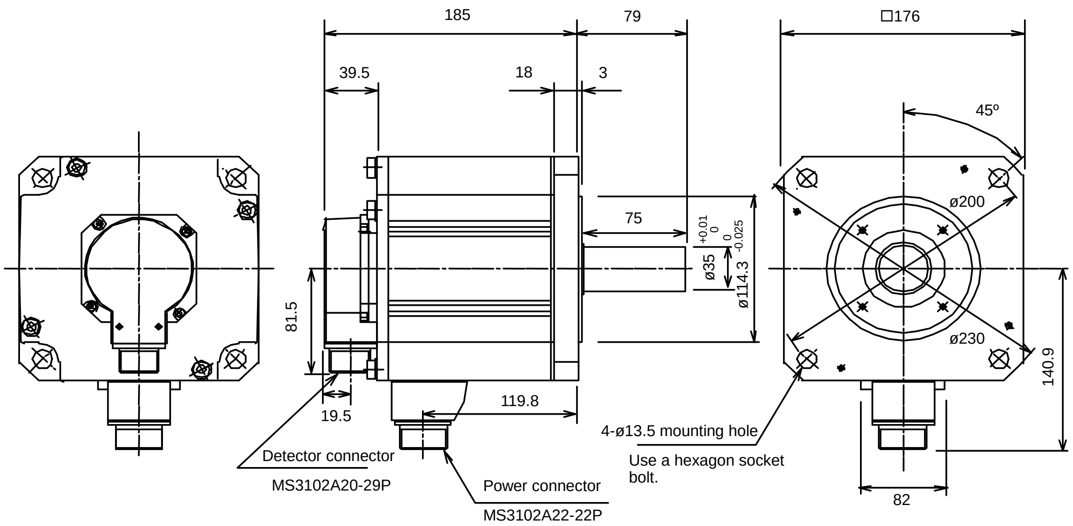
[Unit: mm]



(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load.
(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

• HF353S-A47

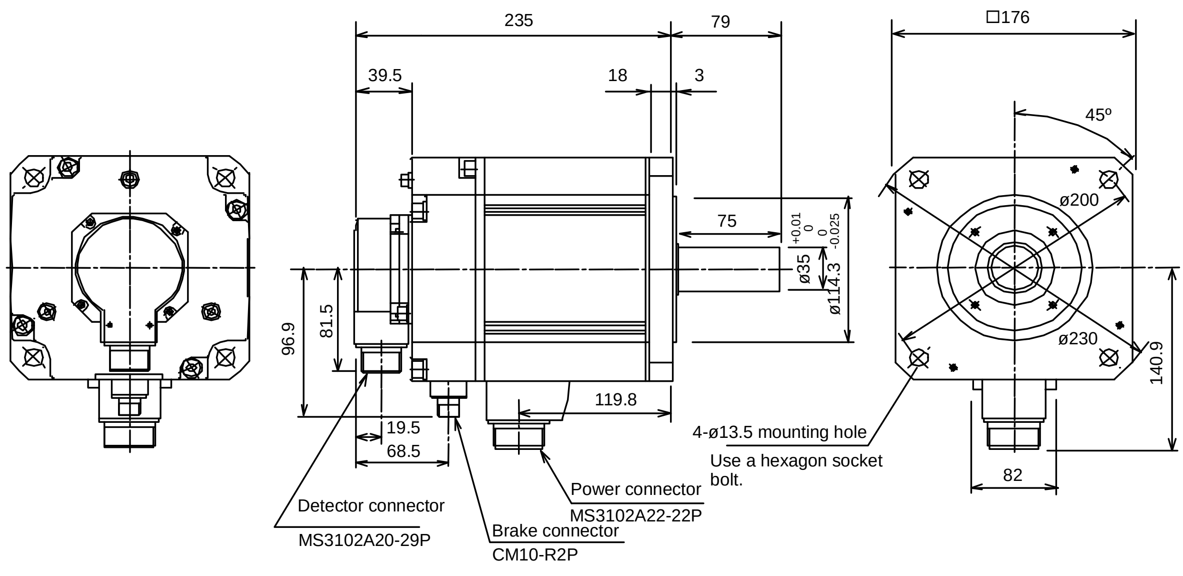
[Unit: mm]



(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load.
(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

• HF353BS-A47

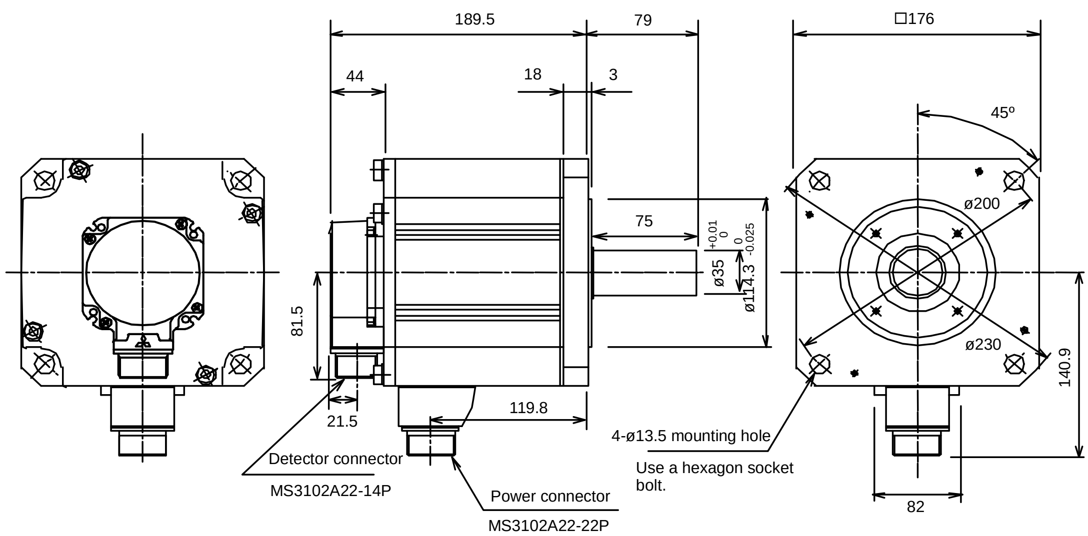
[Unit: mm]



(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load.
(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

• HF353S-A42

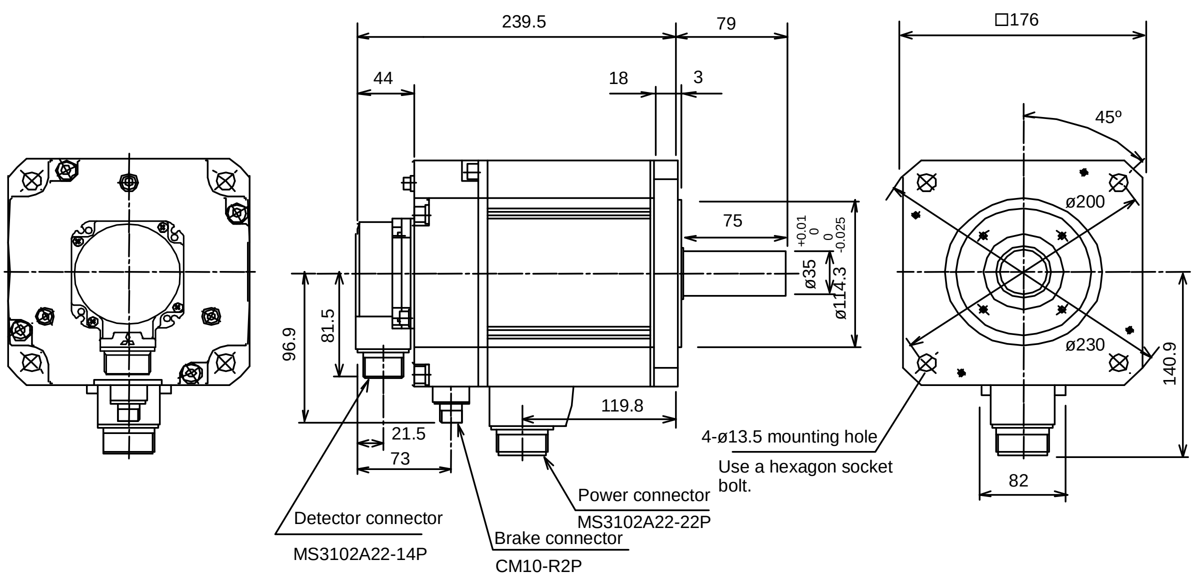
[Unit: mm]



(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load.
(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

• HF353BS-A42

[Unit: mm]

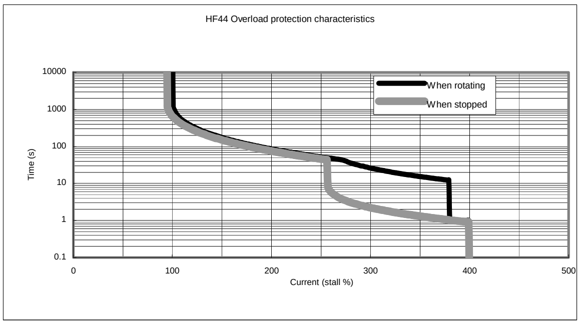


(Note 1) Use a friction coupling (Spun ring, etc.) to connect with the load.
(Note 2) Attach the cannon connector facing downward to improve the splash-proof performance.

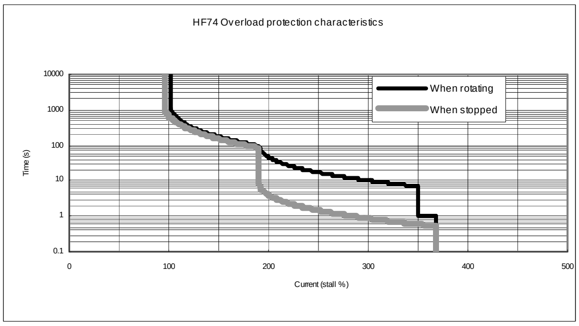
Appendix 8-5 Overload protection characteristics

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 torque is commanded continuously for one second or more due to a machine collision, etc., overload 2 (alarm 51) will occur.

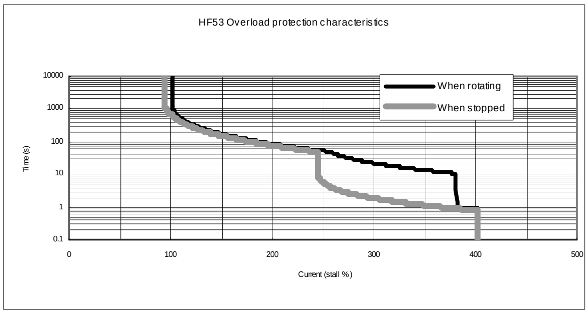
(1) HF44 motor



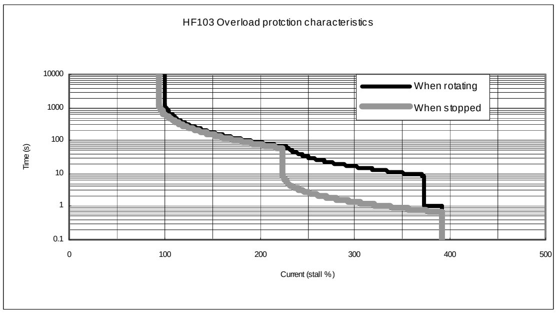
(2) HF74 motor



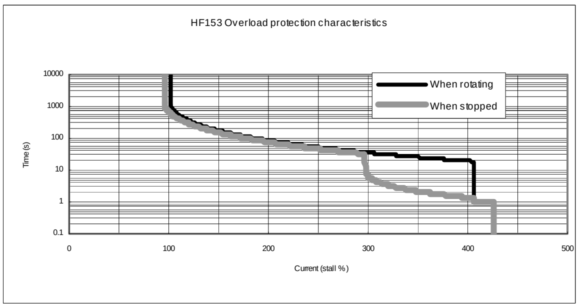
(3) HF53 motor



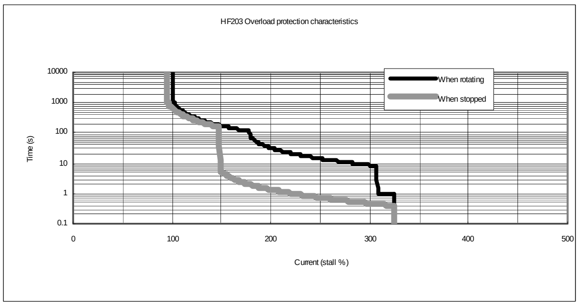
(4) HF103 motor



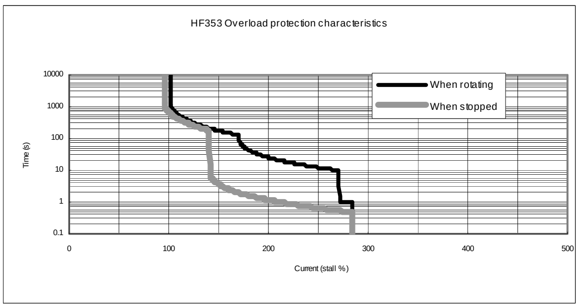
(5) HF153 motor



(6) HF203 motor



(7) HF353 motor



Appendix 8-6 Magnetic brake characteristics

Item \ Motor model			HF44B HF74B	HF53B HF103B HF153B	HF203B HF353B
Type **(Note 1)**			Spring braking type safety brakes		
Rated voltage			24VDC		
Rated current at 20°C		(A)	0.38	0.8	1.4
Capacity		(W)	9	19	34
Static friction torque		(N·m)	2.4	8.3	43.1
Inertia **(Note 2)**		(kg·cm^2)	0.2	2.2	9.6
Release delay time **(Note 3)**		(s)	0.03	0.04	0.1
Braking delay time **(Note 3)**	DC OFF	(s)	0.03	0.03	0.03
Tolerable braking work amount	Per braking	(J)	64	400	4500
	Per hour	(J)	640	4000	45000
Brake play at motor axis		(degree)	0.1 to 0.9	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
	Work amount per braking	(J)	32	200	1000

(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.

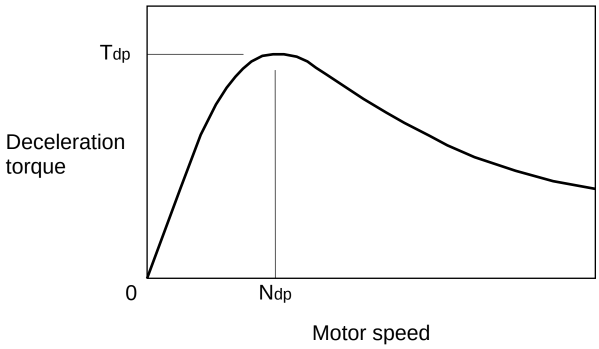
(Note 7) This is the main default value, and is not a guaranteed value.

Appendix 8-7 Dynamic brake characteristics

If a servo alarm that cannot control the motor occurs, the dynamic brakes will function to stop the servomotor regardless of the parameter settings.

(1) Deceleration torque

The dynamic brake uses 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.



Deceleration torque characteristics of a dynamic brake

Max. deceleration torque of a dynamic brake

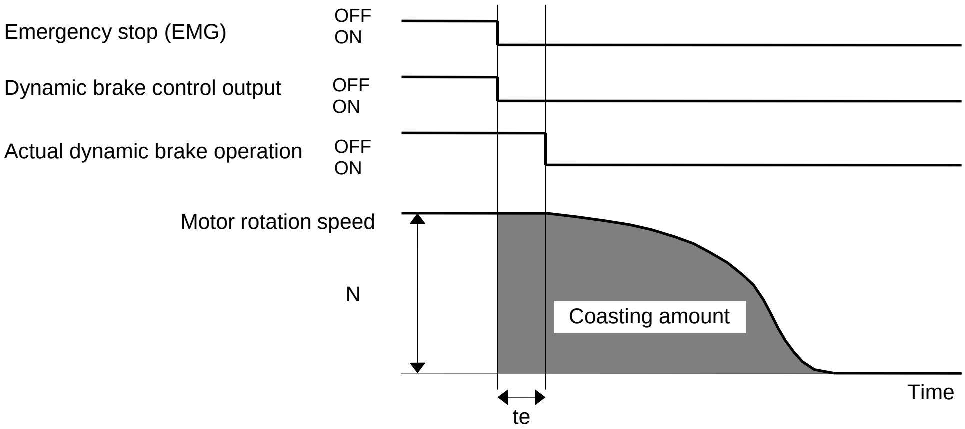
Motor type	Stall torque (N·m)	Combination drive unit type	N_{dp} (r/min)	T_{dp} (N·m)
HF44	2.00	MDS-R-V1-20 to 40 MDS-R-V2-2020 to 4040	1254	5.43
		MDS-R-V2-6040 to 8040	1282	
HF74	3.00	MDS-R-V1-20 to 40 MDS-R-V2-2020 to 4040	1254	5.43
		MDS-R-V2-6040 to 8040	1369	
HF53	2.94	MDS-R-V1-20 to 40 MDS-R-V2-2020 to 4040	478	3.96
		MDS-R-V2-6040 to 8040	534	
HF103	5.88	MDS-R-V1-20 to 40 MDS-R-V2-2020 to 4040	409	10.04
		MDS-R-V2-6040 to 8040	539	
HF153	8.82	MDS-R-V1-60 to 80 MDS-R-V2-6040 to 8080	541	15.62
HF203	13.7		367	15.94
HF353	22.5	MDS-R-V1-60 to 80 MDS-R-V2-6060 to 8080	464	35.24

(2) Coasting rotation distance during emergency stop

The distance that the motor coasts (angle for rotary axis) when stopping with the dynamic brakes can be approximated with the following expression.

$$L_{MAX} = \frac{F}{60} \cdot \{te + (1 + \frac{J_L}{J_M}) \cdot (A \cdot N^2 + B)\}$$

L_{MAX}	:	Motor coasting distance (angle)	[mm, (deg)]
F	:	Axis feedrate	[mm/min, (deg/min)]
N	:	Motor rotation speed	[r/min]
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)	



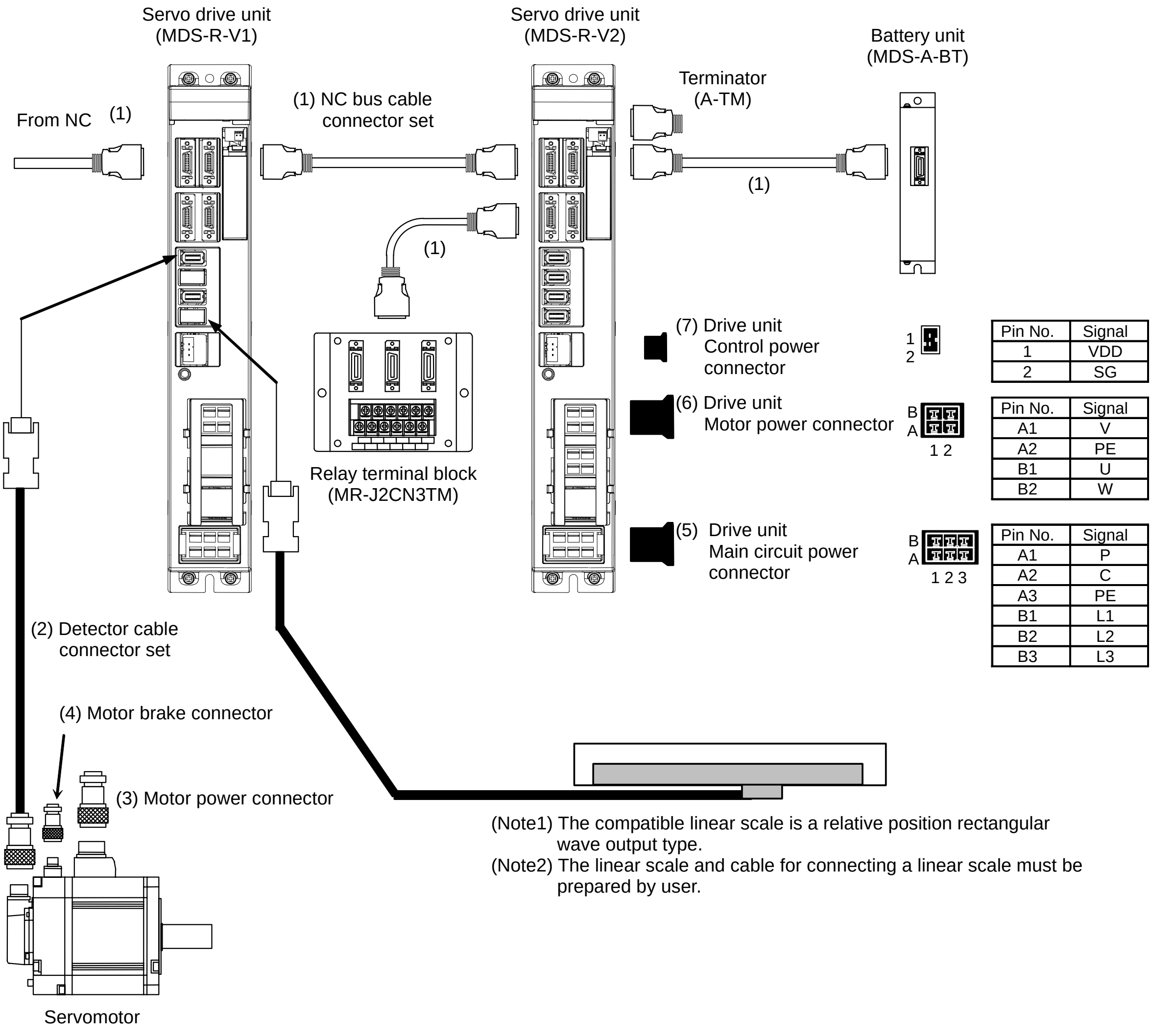
Dynamic brake braking diagram

Coasting amount calculation coefficients table

Motor type	JM (kg·cm^2)	Combination drive unit type	A	B
HF44	2.6	MDS-R-V1-20 to 40 MDS-R-V2-2020 to 4040	0.67×10^{-9}	3.14×10^{-3}
		MDS-R-V2-6040 to 8040	0.65×10^{-9}	3.21×10^{-3}
HF74	5.1	MDS-R-V1-20 to 40 MDS-R-V2-2020 to 4040	1.31×10^{-9}	6.16×10^{-3}
		MDS-R-V2-6040 to 8040	1.20×10^{-9}	6.73×10^{-3}
HF53	6.1	MDS-R-V1-20 to 40 MDS-R-V2-2020 to 4040	5.62×10^{-9}	3.85×10^{-3}
		MDS-R-V2-6040 to 8040	5.03×10^{-9}	4.30×10^{-3}
HF103	11.9	MDS-R-V1-20 to 40 MDS-R-V2-2020 to 4040	5.06×10^{-9}	2.54×10^{-3}
		MDS-R-V2-6040 to 8040	3.84×10^{-9}	3.35×10^{-3}
HF153	17.8	MDS-R-V1-60 to 80 MDS-R-V2-6040 to 8080	3.68×10^{-9}	3.23×10^{-3}
HF203	38.3		11.41×10^{-9}	4.62×10^{-3}
HF353	75.0	MDS-R-V1-60 to 80 MDS-R-V2-6060 to 8080	8.00×10^{-9}	5.17×10^{-3}

Appendix 8-8 Cables and connectors
Appendix 8-8-1 List of 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.



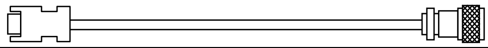
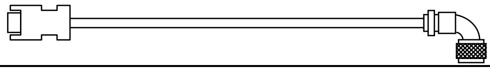
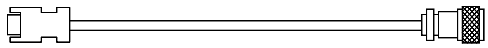
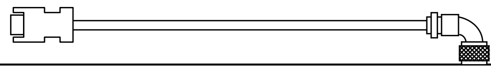
Pin No.	Signal
1	VDD
2	SG

Pin No.	Signal
A1	V
A2	PE
B1	U
B2	W

Pin No.	Signal
A1	P
A2	C
A3	PE
B1	L1
B2	L2
B3	L3

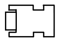
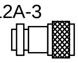
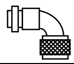
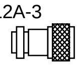
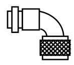
(Note1) The compatible linear scale is a relative position rectangular wave output type.
(Note2) The linear scale and cable for connecting a linear scale must be prepared by user.

(1) Cables

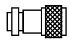
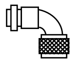
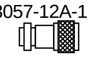
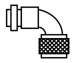
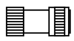
For CN2L, CN2M	(2) Detector cable for HF☐-A47	IP67 compati-ble	Straight	CNV2E-4P-☐M ☐ indicates length (m) 2, 3, 4, 5, 7, 10, 15, 20, 25, 30	Servo drive unit side connector (Molex) Connector set: 54599-1019 or (3M) Receptacle: 36210-0100JL Shell kit: 36310-3200-008 	Servomotor detector side connector (DDK) Connector: MS3106A20-29S (D190) Straight back shell: CE02-20BS-S Clamp: CE3057-12A-3
			Angle	CNV2E-5P-☐M ☐ indicates length (m) 2, 3, 4, 5, 7, 10, 15, 20, 25, 30	Servo drive unit side connector (Molex) Connector set: 54599-1019 or (3M) Receptacle: 36210-0100JL Shell kit: 36310-3200-008 	Servomotor detector side connector (DDK) Connector: MS3106A20-29S (D190) Angle back shell: CE-20BA-S Clamp: CE3057-12A-3
For CN2L, CN2M	(2) Detector cable for HF☐-A42	IP67 compati-ble	Straight	CNV2E-2P-☐M ☐ indicates length (m) 2, 3, 4, 5, 7, 10, 15, 20, 25, 30	Servo drive unit side connector (Molex) Connector set: 54599-1019 or (3M) Receptacle: 36210-0100JL Shell kit: 36310-3200-008 	Servomotor detector side connector (DDK) Connector: MS3106A22-14S (D190) Straight back shell: CE02-22BS-S Clamp: CE3057-12A-3
			Angle	CNV2E-3P-☐M ☐ indicates length (m) 2, 3, 4, 5, 7, 10, 15, 20, 25, 30	Servo drive unit side connector (Molex) Connector set: 54599-1019 or (3M) Receptacle: 36210-0100JL Shell kit: 36310-3200-008 	Servomotor detector side connector (DDK) Connector: MS3106A22-14S (D190) Angle back shell: CE-22BA-S Clamp: CE3057-12A-3

(Note) The connector manufacturer is subject to change without notice.

(2) Connector sets

For CN2L, CN2M	(2) Servo detector connector set			CNU2S (AWG18)	Servo drive unit side connector (Molex) Connector set: 54599-1019 or (3M) Receptacle: 36210-0100JL Shell kit: 36310-3200-008 
	(2) Detector connector set for HF□-A47	IP67 compatible	Straight	CNE20-29S(10) Compliant cable range ø6.8 to ø10mm	Servomotor detector side connector (DDK) Connector: MS3106A20-29S (D190) Straight back shell: CE02-20BS-S Clamp: CE3057-12A-3 
			Angle	CNE20-29L(10) Compliant cable range ø6.8 to ø10mm	Servomotor detector side connector (DDK) Connector: MS3106A20-29S (D190) Angle back shell: CE-20BA-S Clamp: CE3057-12A-3 
	(2) Detector connector set for HF□-A42	IP67 compatible	Straight	CNE22-14S(10) Compliant cable range ø6.8 to ø10mm	Servomotor detector side connector (DDK) Connector: MS3106A22-14S (D190) Straight back shell: CE02-22BS-S Clamp: CE3057-12A-3 
			Angle	CNE22-14L(10) Compliant cable range ø6.8 to ø10mm	Servomotor detector side connector (DDK) Connector: MS3106A22-14S (D190) Angle back shell: CE-22BA-S Clamp: CE3057-12A-3 

(Note) The connector manufacturer is subject to change without notice.

Item				Model	Contents
For motor power supply	(3) Power supply connector set for HF44, 74, HF53, 103, 153	EN, IP67 compatible	Straight	PWCE18-10S Compliant cable range ø10.5 to ø14.1mm	Servomotor side power supply connector (DDK) Plug : CE05-6A18-10SD-B-BSS Clamp : CE3057-10A-1 (D256) 
			Angle	PWCE18-10L Compliant cable range ø10.5 to ø14.1mm	Servomotor side power supply connector (DDK) Plug : CE05-8A18-10SD-B-BAS Clamp : CE3057-10A-1 (D256) 
	(3) Power supply connector set for HF203, 353	EN, IP67 compatible	Straight	PWCE22-22S Compliant cable range ø12.5 to ø16mm	Servomotor side power supply connector (DDK) Plug : CE05-6A22-22SD-B-BSS Clamp : CE3057-12A-1 (D256) 
			Angle	PWCE22-22L Compliant cable range ø12.5 to ø16mm	Servomotor side power supply connector (DDK) Plug : CE05-8A22-22SD-B-BAS Clamp : CE3057-12A-1 (D256) 
For motor brake	(3) Brake connector set for HF44B, 74B, HF53B, 103B, 153B, HF203B, 353B	IP67 compatible	Straight	BRK-CM10S Compliant cable range ø6 to ø9mm	Servomotor side brake connector (DDK) Connector: CM10-SP2S-M-S2 
			Angle	BRK-CM10L Compliant cable range ø6 to ø9mm	Servomotor side brake connector (DDK) Connector: CM10-AP2S-M-S2 

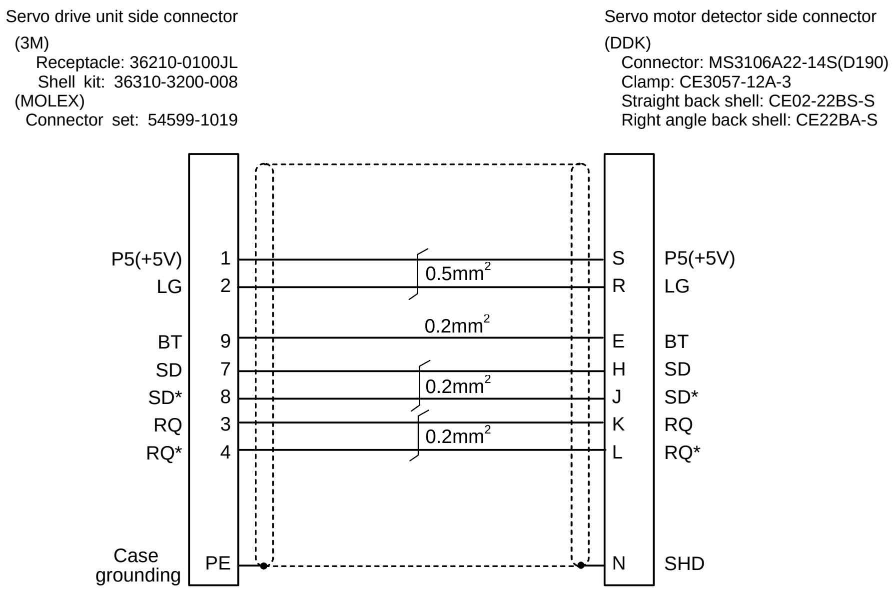
(Note) The connector manufacturer is subject to change without notice.

Appendix 8-8-2 Cable connection diagram

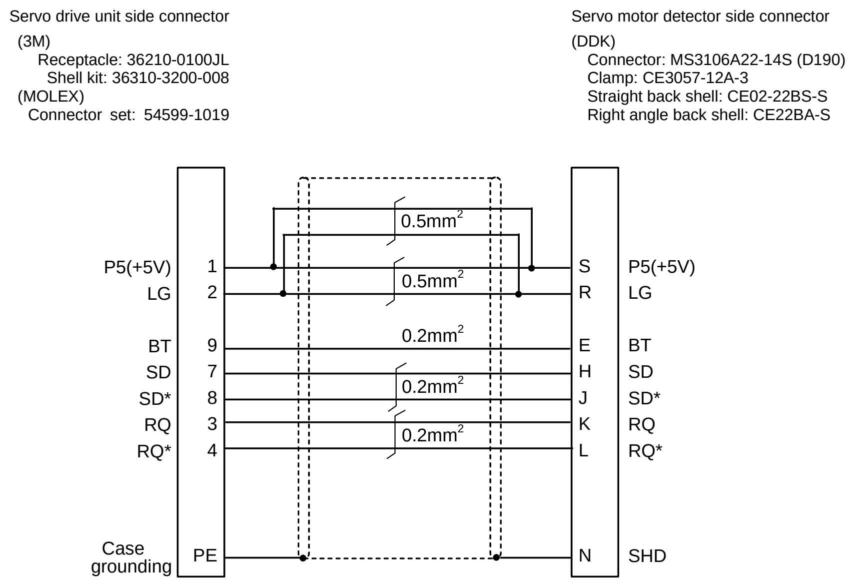
(1) HF□-A42 motor detector cable

< CNV2E-2P/3P cable connection diagram >

This is an actual connection diagram for the CNV2E-2P/3P cable supplied by Mitsubishi.



<For 15m or less>



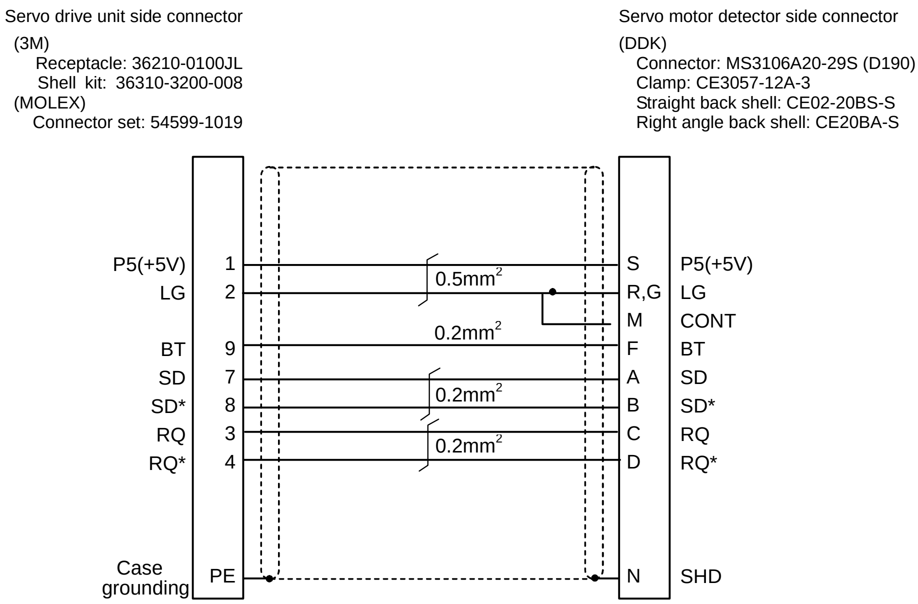
<For 15 to 30m>

⚠ CAUTION	1. Do not connect anything to pins unless particularly specified when manufacturing a cable. (Leave OPEN) 2. Contact Mitsubishi when manufacturing a cable longer than 30m.

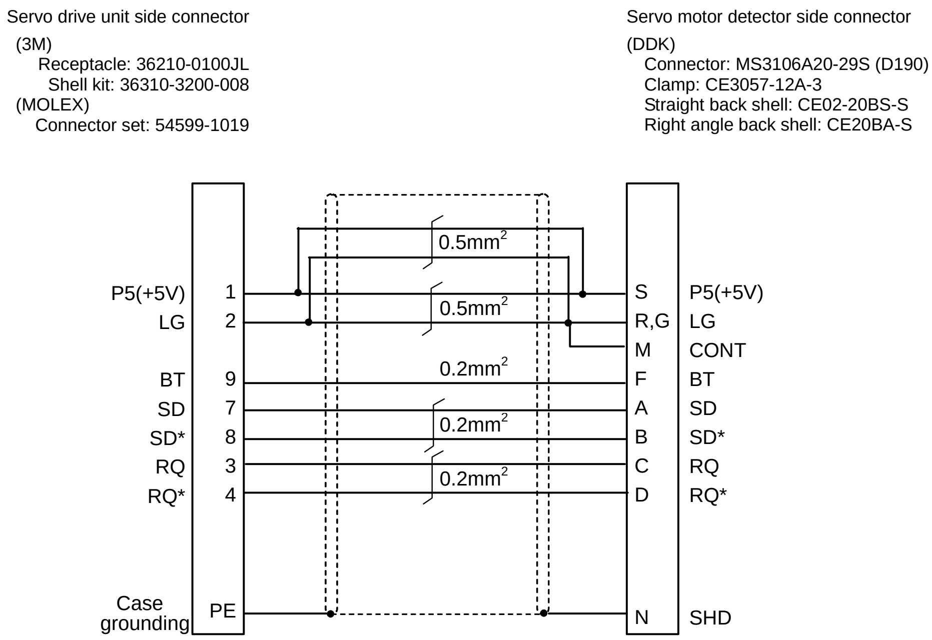
(2) HF□-A47 motor detector cable

< CNV2E-4P/5P cable connection diagram >

This is an actual connection diagram for the CNV2E-4P/5P cable supplied by Mitsubishi.



<For 15m or less>



<For 15 to 30m>

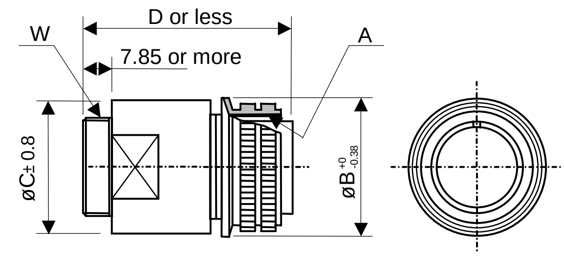
⚠ **CAUTION**

1. Do not connect anything to pins unless particularly specified when manufacturing a cable. (Leave OPEN)
2. Contact Mitsubishi when manufacturing a cable longer than 30m.

Appendix 8-8-3 Connector outline dimension drawings

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

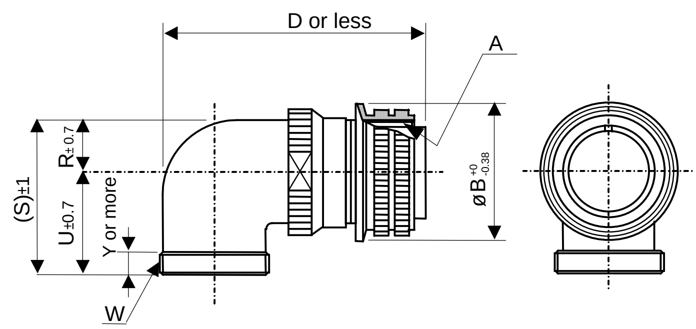
Straight plug
Manufacturer: DDK



[Unit: mm]

Model	A	B $^{+0}_{-0.38}$	C±0.8	D or less	W
CE05-6A18-10SD-B-BSS	$1^{1}/_{8}$-18UNEF-2B	34.13	32.1	57	1-20UNEF-2A
CE05-6A22-22SD-B-BSS	$1^{3}/_{8}$-18UNEF-2B	40.48	38.3	61	$1^{3}/_{16}$-18UNEF-2A
CE05-6A22-23SD-B-BSS					

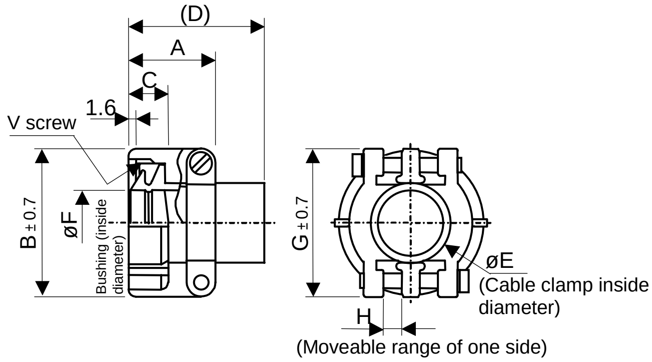
Angle plug
Manufacturer: DDK



[Unit: mm]

Model	A	B $^{+0}_{-0.38}$	D or less	W	R±0.7	U±0.7	(S)±1	Y or more
CE05-8A18-10SD-B-BAS	$1^{1}/_{8}$-18UNEF-2B	34.13	69.5	1-20UNEF-2A	13.2	30.2	43.4	7.5
CE05-8A22-22SD-B-BAS	$1^{3}/_{8}$-18UNEF-2B	40.48	75.5	$1^{3}/_{16}$-18UNEF-2A	16.3	33.3	49.6	7.5
CE05-8A22-23SD-B-BAS								

Cable clamp
Manufacturer: DDK



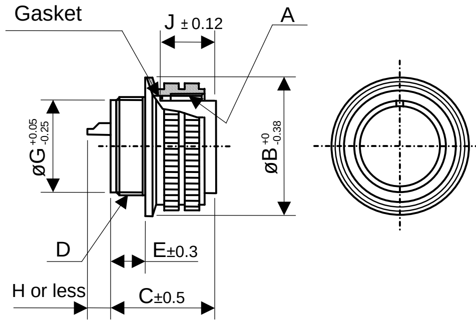
[Unit: mm]

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-1 (D265)	18	23.8	30.1	10.3	41.3	15.9	14.1	31.7	3.2	1-20UNEF-2B	CE3420-10-1	Ø10.5 to ø14.1
CE3057-12A-1 (D265)	20	23.8	35	10.3	41.3	19	16	37.3	4	$1^{3}/_{16}$-18UNEF-2B	CE3420-12-1	Ø12.5 to ø16
CE3057-12A-2 (D265)	22						13				CE3420-12-2	Ø9.5 to ø13

Recommended manufacturer: DDK

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

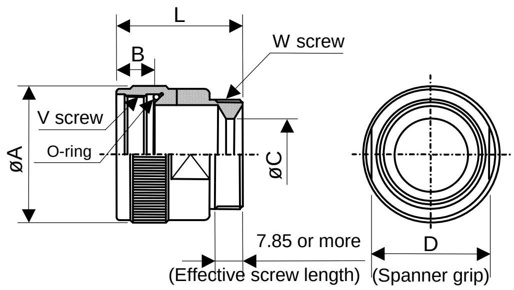
Straight plug
Manufacturer: DDK



[Unit: mm]

Model	A	$B^{+0}_{-0.38}$	C±0.5	D	E±0.3	$G^{+0.05}_{-0.25}$	J±0.12
MS3106A20-29S (D190)	$1^{1}/_{4}$-18UNEF-2B	37.28	34.11	$1^{1}/_{8}$-18UNEF-2A	12.16	26.8	18.26
MS3106A22-14S (D190)	$1^{3}/_{8}$-18UNEF-2B	40.48	34.11	$1^{1}/_{4}$-18UNEF-2A	12.15	29.9	18.26

Straight back shell
Manufacturer: DDK

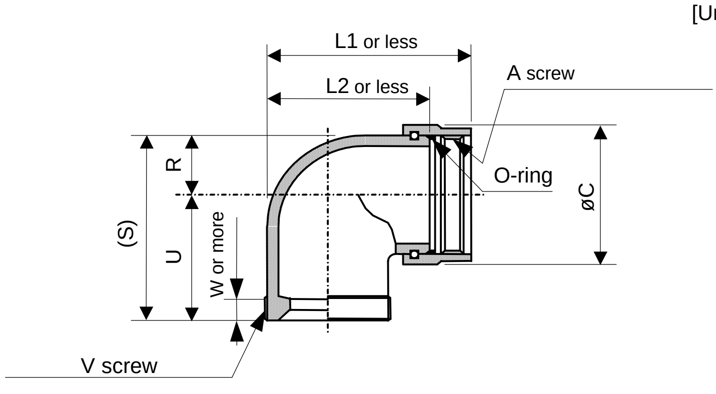


[Unit: mm]

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

Angle back shell
Manufacturer: DDK
Model: CE-22BA-S

[Unit: mm]



[Unit: mm]

Model	Shell size	Connection screw A	Total length L1	Angle total length L2	Diam-eter C	R	U	(S)	Installation screw V	Effective screw length W
CE-20BA-S	20	$1^{1}/_{8}$-18UNEF-2B	50.5	39.6	36	15	33.3	48.3	$1^{3}/_{16}$-18UNEF-2A	7.5
CE-22BA-S	22	$1^{1}/_{4}$-18UNEF-2B			38.6	16.3		49.6		

Revision History

Date of revision	Manual No.	Revision details
Sep. 2004	BNP-C3045*	First edition created.
Sep. 2005	BNP-C3045A	• Servo motor "H44", "H75" specifications were added. • The section "Compliance to EC Directives" was revised. • The section "Transportation Restrictions for Lithium Batteries" was revised. • The section "Compliance with China Compulsory Product Certification (CCC Certification) System" was added. • Miswrite is corrected.
Dec. 2005	BNP-C3045B	Miswrite is corrected.
Mar. 2006	BNP-C3045C	• The drive units "MDS-R-V1-60", "MDS-R-V2-4020", "MDS-R-V2-6040", "MDS-R-V2-6060" and "MDS-R-V2-8060" were added. • The regenerative option "GZG80W26OHMJ", "GZG400W13OHMJ", and "GZG400W8OHMJ" were added. • The heat radiation countermeasures were revised. • The parameters "SV001", "SV002", "SV017", "SV018", "SV019", "SV020", "SV025" and "SV036" were revised. • The parameters "SV089" and "SV090" were added. • The troubleshooting "45" was revised. • The error parameter No. "2269" and "2271" were added. • "Appendix 1. Cable and Connector Specifications" was revised. • "Appendix 4. EMC Installation Guidelines" was revised. • "Appendix 6. Transportation Restrictions for Lithium Batteries" was revised. • Miswrite is corrected.
Feb. 2008	BNP-C3045D	• "Instruction Manual for Compliance with UL/c-UL Standard" was revised.
Sep. 2011	BNP-C3045G	• "Handling of our product" was added. • Specifications of motors were overall revised. • Old motor specifications were moved to Appendix. • The detector names were standardized. • "Global Service Network" was revised. • Miswrite is corrected.

Global Service Network

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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.

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MODEL	MDS-R Series
MODEL CODE	008-337
Manual No.	BNP-C3045(ENG)

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