Installation 2

Follow the instructions in this chapter during installation. This chapter includes information about the circuit breaker, magnetic contactor, fuse, and the selection for EMI filter and regenerative resistor.

2.1 Ambient storage conditions

2

Before installation, this product must be kept in the shipping carton. In order to retain the warranty coverage and for maintenance, follow these instructions for storage. While the product is temporarily not in use:

- Store the product in an ambient temperature range of -20°C (-4°F) to +65°C (+149°F).
- Store the product in a relative humidity range of 0% to 90% (non-condensing).
- Avoid storing the product in an environment containing corrosive gas.

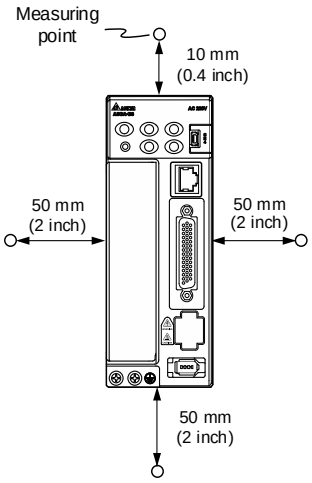
2.2 Ambient installation conditions

B3 servo drive: the environment should be free of devices that generate excessive heat; no water, water vapor, dust, and oily dust; no corrosive and inflammable gas or liquids; no airborne dust or metal particles; and the environment should be solid without vibration and interference of electromagnetic noise.

WARNING

Motor: the ambient temperature for the location of the ECM-A3 and ECMC motors should be between 0°C (32°F) and 40°C (104°F). The ambient temperature for the location of the ECM-B3 motors should be between -20°C (-4°F) and +60°C (+140°F)*. The environment should be free of devices that generate excessive heat; no water, water vapor, dust, and oily dust; no corrosive and inflammable gas or liquids; and no airborne dust or metal particles.

Note: if the ambient temperature for the location of the ECM-B3 motors is over 40°C, refer to Section A.2.3 Power derating curves of the B3 motors.



- The ambient temperature of the operating environment for the servo drive is between 0°C (32°F) and 55°C (131°F). During long-term operation, the suggested temperature of the operating environment should be under 45°C (113°F) to ensure the servo drive's performance.

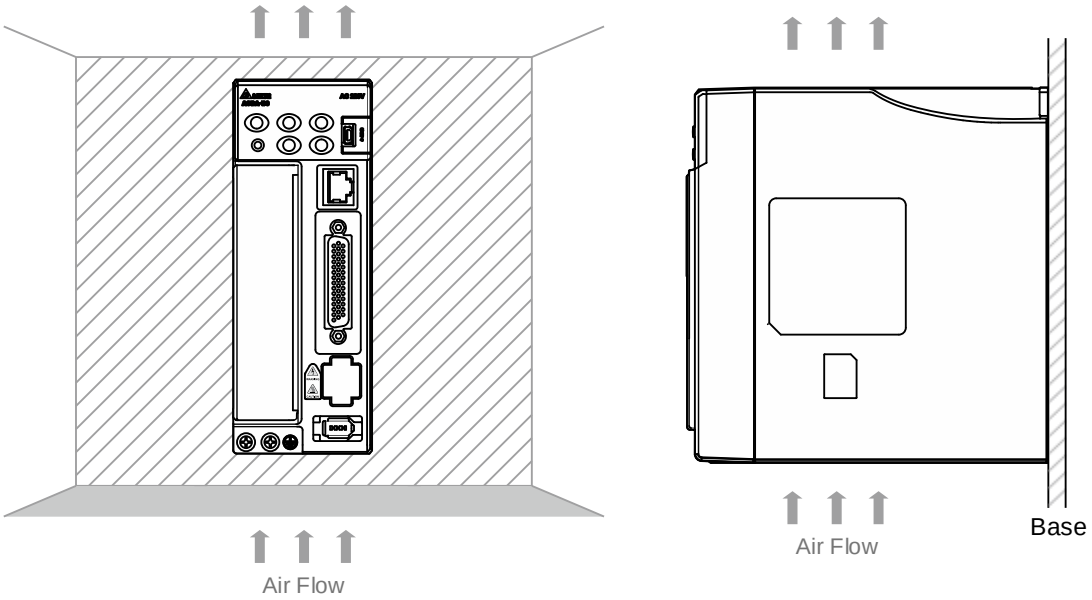
- For the 220V models, if the ambient temperature is over 45°C (113°F), place the product in a well-ventilated environment.
- For the 400V models, if the ambient temperature is over 45°C (113°F), keep the average load rate at 80% or less, and place the product in a well-ventilated environment.
- Mount the product vertically in the cabinet (see the illustration of the correct mounting direction in Section 2.3).
- Install a fan on the cabinet for heat dissipation. Make sure the size of the cabinet and its ventilation condition can prevent the internal electrical devices from overheating.
- Check if the vibration of the machine affects the electrical devices in the cabinet. Ensure that the temperature for the clearance of 5 cm (1.97 inches) beneath and on both sides of the servo drive is kept under 55°C (131°F), and the servo drive must be kept clear of heat sources.
- For the 400V models, the airflow velocity at the measuring point which is 10 mm (0.4 inches) above the servo drive has to be 0.5 m/s or higher.

2.3 Mounting direction and space

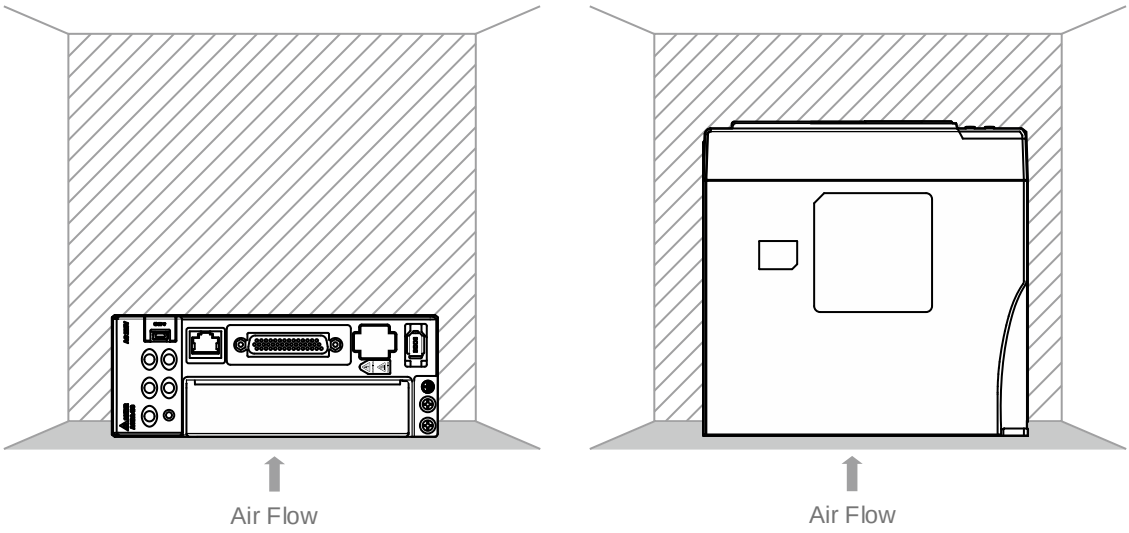
Important:

- Mount the servo drive in the correct direction according to the following illustrations with the base of the heat sink vertically installed on the wall. Incorrect mounting direction may result in malfunction.
- For better ventilation and cooling, allow sufficient clearance space between the AC servo drive and the adjacent objects and the wall, or overheating may result in malfunction.
- Do not block the ventilation holes of the servo drive, and do not mount the servo drive in the incorrect direction, or it may result in malfunction.

Correct

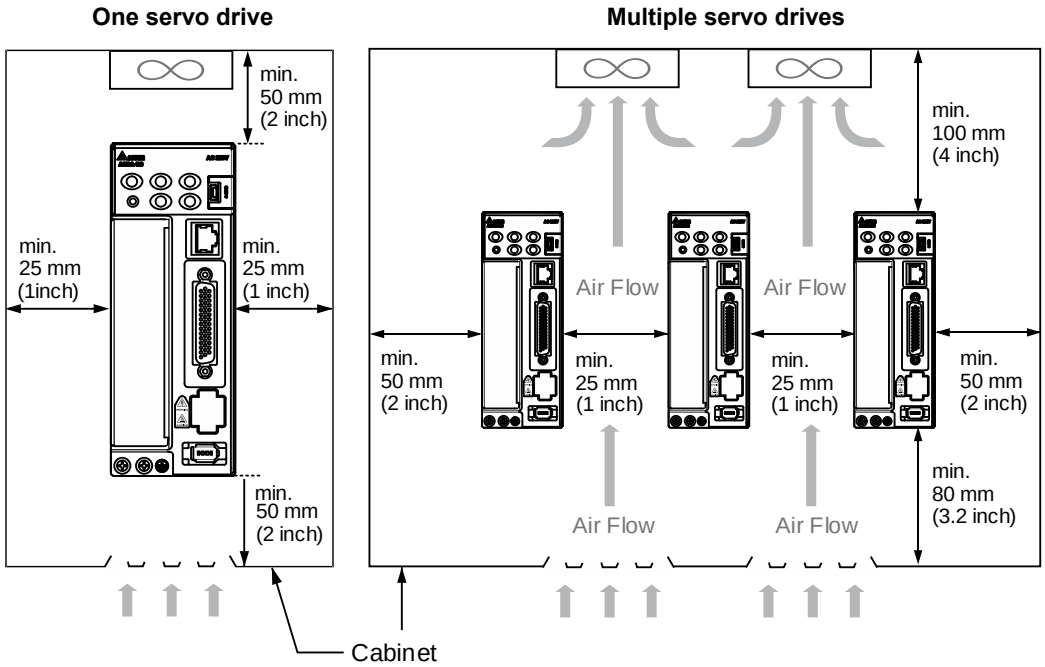


Incorrect



Heat dissipation requirements

- In order to have adequate air flow for ventilation, follow the suggested clearances when installing one or multiple servo drives.
- Avoid mounting one servo drive above one another. Keep the bottom of the servo drive clear because the generated heat rises and causes higher temperature for the drives mounted above.



Note: the preceding diagrams are not accurately scaled. Refer to the annotations on the diagrams.

2.4 Safety precautions for using motors

The Delta AC servo motor is designed for industrial applications. It is necessary that you fully understand the motor specifications and the content of the operation manual. For your safety and correct use, read the manual, specifications, and precautions for the motor carefully before connecting the motor to any equipment.

The safety precautions are as follows:

Handling, mounting, and storage

- When taking out or placing the servo motor, hold the whole motor instead of holding the cable or only the motor shaft.
- Do not hit the motor shaft. Impact force will damage the shaft and the encoder that is attached at the rear end of the shaft.
- Keep the axial or radial load on the shaft within the allowable range listed in the specifications.
- The shaft of the servo motor is not water- or oil-proof. Do not use, install, or store the servo motor in an environment that contains water, oily liquids, corrosive and inflammable gases, or is with high humidity.
- The material of the motor shaft is not rustproof. Although rustproof oil has been applied to the shaft during the manufacturing process, you must check the shaft condition every three months and apply rustproof oil if storing the motor for more than six months.
- Ensure that the environmental conditions for storing the servo motor conform to the specifications in the instruction sheet.
- The encoder attached to the motor is easily damaged; take the necessary measures to avoid electromagnetic interference, vibration, and abnormal temperature changes.
- The magnetic field for placing or installing the motor should be below 10 mT.

Wiring

- If the current exceeds the maximum current in the specifications, the internal parts of the motor may lose their magnetism. Contact the distributor or local Delta sales representative if this problem occurs.
- Check if the motor wiring and the voltage of the motor brake are correct. Also, make sure that the wiring of the encoder power and signal cables is correct. Incorrect wiring will lead to abnormal operation, malfunction, or damage of the motor.
- To avoid capacitive coupling and noise, isolate the motor power cable from the encoder power and signal cables. Do not connect them to the same circuit.
- The AC servo motor must be correctly grounded.
- The encoder connector must not undergo any high voltage test because it will damage the encoder.
- When the motor or brake is undergoing high voltage tests, cut off the power supply for the controller. To maintain the product lifespan, do not perform this kind of test unless necessary.

Operation

- AC servo motor operation is controlled by the servo drive. Do not directly connect a commercial power supply (100/200V, 50/60 Hz) to the servo motor circuit; otherwise the motor cannot operate normally and may be permanently damaged.
- Follow the motor specifications when using the product. The motor temperature during operation must not exceed the specified range.
- The material of the motor shaft is not rustproof. To ensure a longer motor life, apply rustproof oil during operation.
- The built-in brake is for clamping, not for stopping the motor. Note that the built-in brake is not a device for safely stopping the machine. Install another safety device for stopping the machine. When the built-in brake is clamping the motor, rotation backlash can still occur and the maximum rotation is 1° to 2°. When a motor with a brake is operating, the brake lining sometimes generates a noise (a swishing or clicking sound) caused by the structure of brake module, which is not a malfunction. It will not affect the motor’s function.
- When using a servo motor with a brake, do not use the built-in brake for dynamic braking.
- If any odor, noise, smoke, heat, or abnormal vibration occurs during motor operation, stop the motor and turn off the power immediately.

Others

- Delta AC servo motors have no user-replaceable parts.
- Do not disassemble the motor or change its parts, or it will void the warranty.
- Do not disassemble the motor by yourself, or it may lead to permanent malfunction or damage.
- Do not splash any water or oil on the product.

2.4.1 Troubleshooting for the motor operation and status

When the servo motor makes abnormal noises:

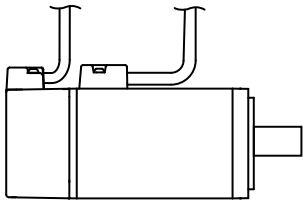
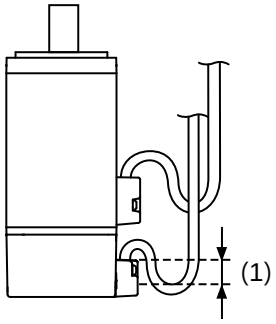
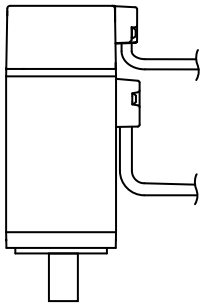
Possible cause	Checking method	Corrective action
There is a source of vibration in the connecting component.	Check if there is any foreign object, damage, or deformation in the movable parts of the connecting component.	Replace the connecting component (such as the coupling) or contact the manufacturer.
The encoder is subject to excessive vibration or shocks.	1. Check if the servo motor has been subject to impact force or vibration which causes damage to the encoder. 2. Remove and shake the motor to see if there are any abnormal noises (disk damage). 3. Visually inspect the encoder's rear cover for dust (encoder damage).	Replace the servo motor.

When the servo motor is overheating:

Possible cause	Checking method	Corrective action
Mounting surface of the servo motor has poor thermal conductivity.	Measure the temperatures of the servo motor frame and the mounting surface (metal). The temperature difference should not exceed 20°C (68°F).	Make sure the installation surface is flat. If there is any substance (such as paint or gasket) between the mounting surface and motor surface resulting in poor heat dissipation, remove the substance or use other methods to help heat dissipation (such as forced air cooling for the servo motor).

2.4.2 Mounting directions and precautions for the servo motor

You can install the servo motor horizontally or vertically.

Mounting direction	Precautions
Horizontal 	If you are using a servo motor with an oil seal, refer to Section 2.4.5 for oil and water prevention measures for the servo motor.
Vertical - shaft end up 	■ When wiring, you need to install an oil trap (marked as (1) in the figure on the left) to prevent water vapor from entering the motor. ■ When installing the servo motor in a machine (such as in a gearbox), you must adhere to the measures in Section 2.4.5 to prevent oil and gas from entering the servo motor.
Vertical - shaft end down 	If you are using a servo motor with an oil seal, refer to Section 2.4.5 for oil and water prevention measures for the servo motor.

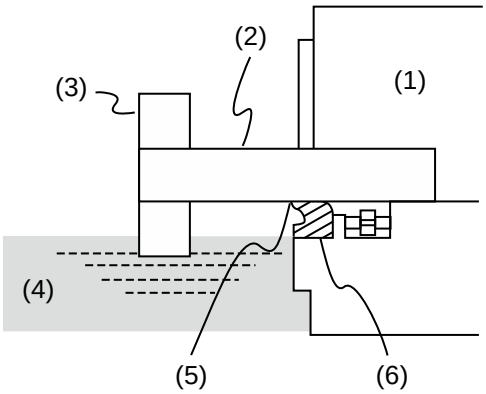
Note: if you desire to install gears on the servo motor, follow the manufacturer's instructions for installation.

2.4.3 Precautions for using servo motor with oil seal

This section defines the operating conditions for using the servo motor with an oil seal:

2

- In the operating environment, keep the oil level lower than the oil seal lip. If the oil seal lip is lower than the oil level, the oil will enter the servo motor and cause damage to the motor.

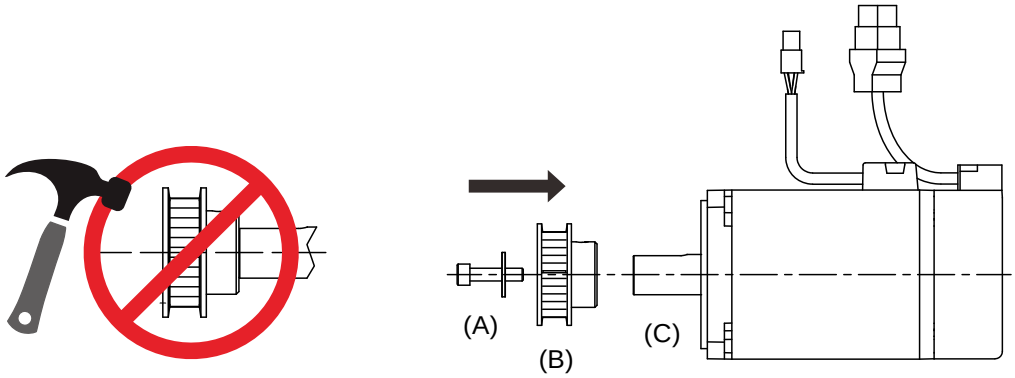


(1) Servo motor; (2) Motor shaft; (3) Gear; (4) Oil; (5) Oil seal lip; (6) Oil seal

- The oil seal cannot be submerged in liquid. It can only withstand splashes of oil.
- The oil seal lip cannot be soaked in oil.

2.4.4 Precautions for installing servo motor accessories

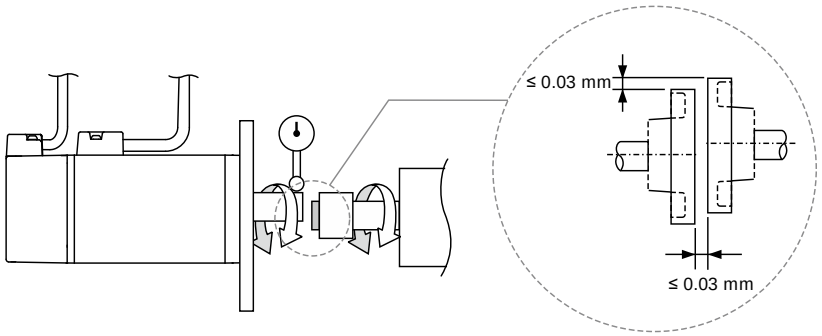
- Wipe off the rustproof coating or oil on the motor shaft.
- If you use a servo motor with a keyway, install the attached key or a key matching the specified dimensions on the motor shaft.
- When you install the key or the motor shaft accessories (such as a belt pulley or gear) to the servo motor, do not apply excessive impact force to the keyway. Use a screwdriver and screws when installing the motor shaft or motor shaft accessories.



(A) Screw and gasket; (B) Belt pulley; (C) Servo motor shaft

Installation safety precautions for coupling applications

- It is suggested that you use the flexible couplings specifically designed for servo motors, especially the double spring couplings, which provide some buffer tolerance during eccentric motion and deflection of the motor. Select couplings of appropriate size for the operating conditions. Improper use or connection may cause damage to the motor.
- Use the dial gauge or other methods to ensure the centering precision is within the specifications. If you are not allowed to use the dial gauge or other methods in the environment, slide the coupling along both axes and adjust it until it does not get stuck.

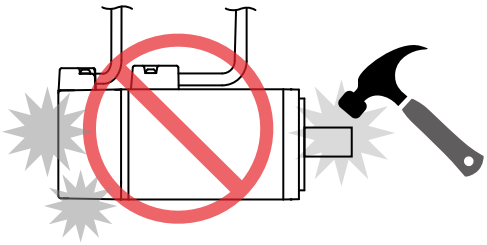


As shown in the previous figure, the distance is measured at four different positions on the circumference for the centering precision. The difference between the maximum and minimum measurements should be 0.03 mm or less. Even within this range, you can make adjustments to increase the centering precision.

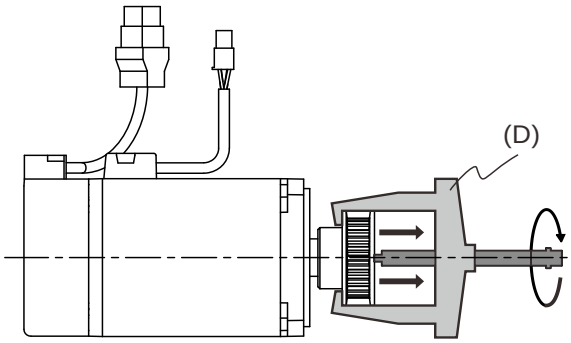
Important: when you are doing the measurements, rotate the coupling and the motor shaft together.

Installation safety precautions for motor shaft accessories

- When connecting the shaft, make sure that the required centering precision is reached. If the shaft is not correctly centered, vibration may damage the bearings and encoder.
- When installing the coupling, do not apply excessive force to the shaft or the area around the encoder, as the impact may damage the encoder.



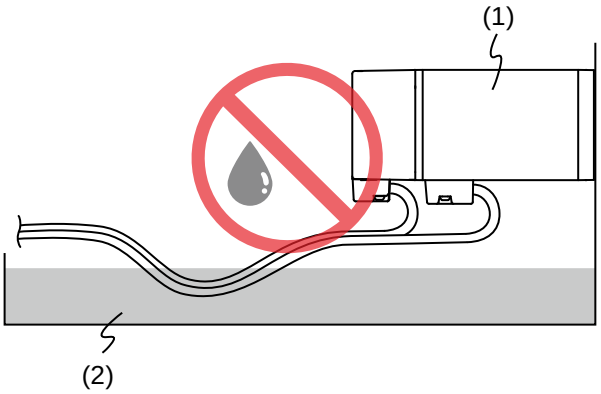
- If the coupling makes any abnormal noise, realign the shaft until the noise disappears.
- Ensure the axial load and radial load are within the specifications. Refer to the specifications for the maximum axial load (N) and maximum radial load (N) for each servo motor.
- Use a bearing puller (D) to remove the motor shaft accessories (such as a coupling, gear or belt pulley). Do not tug or apply excessive force.



2.4.5 Oil and water prevention measures for the servo motor

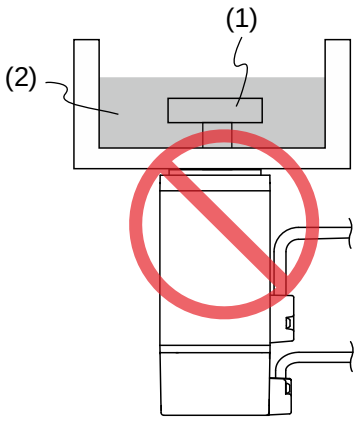
Follow these precautions and do not allow water, oil, or other foreign objects to enter the servo motor.

- Do not submerge the cable in oil or water.



(1) Servo motor; (2) Oil

- If oil or water is unavoidable, use oil-resistant cables. Delta does not provide oil-resistant cables.
- If the servo motor must be mounted with the shaft end up, do not use it in a machine, gearbox, or other environment where the servo motor may have contact with oil or water.



(1) Gear; (2) Oil

- Do not use the servo motor in an environment with cutting fluids. Depending on the type of cutting fluids, the sealing materials, coated colloids, cables, or other components may be affected or even deteriorated.
- Do not continuously expose the servo motor to oil mist, water vapor, oil, water, or grease.

If you cannot avoid using the servo motor under the preceding conditions, take prevention measures to avoid dirt and water from entering the machine.

2.4.6 Measures to suppress temperature increase of the servo motor

- When installing the servo motor, pay attention to the cooling conditions (such as size of the heat sink) provided in the specifications of each servo motor type.
- The heat generated during motor operation is dissipated to the heat sink through the motor mounting surface. Therefore, if the surface area of the heat sink is too small, the temperature of the servo motor may increase abnormally.
- If it is difficult to apply large heat sinks in the operating environment or if the ambient air temperature or altitude exceeds the given specifications, take the following measures:
  (1) Reduce the full-load rating of the servo motor. For more details, refer to the specifications of each servo motor type. When selecting servo motors, consider motors with the power capacity 1 to 2 levels higher.
  (2) Reduce the acceleration and deceleration of the work cycle to lower the motor load.
  (3) Apply external forced air cooling to the servo motor by using cooling fans or other methods.

Important: do not place a gasket or other insulating materials between the servo motor and heat sink, as it may cause motor temperature increase and poor noise immunity, and result in malfunction.

2.5 Specifications for the circuit breaker, magnetic contactor and fuse

220V models

Servo drive model	Circuit breaker	Magnetic contactor	Fuse (Class T)
ASD-B3[1]-0121-[2]	5 A	5 A	10 A
ASD-B3[1]-0221-[2]	5 A	5 A	10 A
ASD-B3[1]-0421-[2]	10 A	10 A	10 A
ASD-B3[1]-0721-[2]	10 A	10 A	20 A
ASD-B3[1]-1021-[2]	15 A	15 A	30 A
ASD-B3[1]-1521-[2]	20 A	20 A	30 A
ASD-B3[1]-2023-[2]	30 A	30 A	50 A
ASD-B3[1]-3023-[2]	30 A	30 A	50 A

400V models

Servo drive model	Circuit breaker	Magnetic contactor	Fuse (Class T)
ASD-B3[1]-1043-[2]	10 A	10 A	10 A
ASD-B3[1]-1543-[2]	15 A	15 A	15 A
ASD-B3[1]-2043-[2]	20 A	20 A	20 A
ASD-B3[1]-3043-[2]	35 A	35 A	35 A
ASD-B3[1]-4543-[2]	40 A	40 A	50 A
ASD-B3[1]-5543-[2]	60 A	60 A	60 A
ASD-B3[1]-7543-[2]	60 A	60 A	80 A

Note:

1. In the servo drive model number, [1] represents the product series and [2] represents the model type. The preceding table includes the B3 and B3A series.
2. Operation mode: standard.
3. If the servo drive is equipped with a residual-current device (RCD) for electricity leakage protection, select a circuit breaker with sensitivity of at least 200 mA and with minimum 0.1 sec working time to avoid incorrect operation of the RCD.
4. Select the Type B residual-current device (RCD) with time delay, as the system ground wire may contain DC electricity.
5. Use the fuse and circuit breaker that comply with the UL / CSA standard.

2.6 Ferrite ring

The ferrite ring suppresses high-frequency noise, reducing high-frequency interference in the power cable, signal cable, and connectors. The ferrite ring is usually made of Mn-Zn ferrite. The impedance of the ferrite ring varies with frequency. Normally, its impedance is relatively small to low-frequency signals; however, when the frequency of the signal increases, the impedance increases dramatically, which optimizes signal transmission. The suggested ferrite ring models are as follows.

Ferrite ring model	Applicable servo drive model
ASD-ACFC7K00	ASD-B3[1]-1043-[2], ASD-B3[1]-1543-[2], ASD-B3[1]-2043-[2], ASD-B3[1]-3043-[2], ASD-B3[1]-4543-[2], ASD-B3[1]-5543-[2], ASD-B3[1]-7543-[2]

Note: in the servo drive model number, [1] represents the product series and [2] represents the model type.

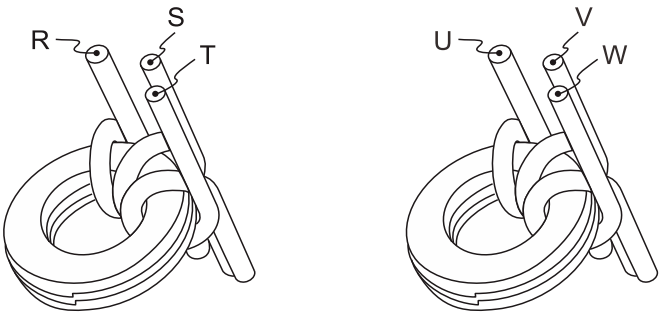
Installation precautions

The ferrite ring is commonly used when peripheral devices (such as the controller) are affected by noise from conduction and radiation when the servo motor is in the Servo On state. The parasitic capacitance between the cables in the wiring panel and the ground is typically small, but as the frequency of the signal increases (in the Servo On state), the resistance of the parasitic capacitance becomes small enough for the common-mode current to flow through. Normally, common-mode current only leads to common-mode interference due to an unstable circuit caused by a poor connection in the power circuit or between the servo drive and the ground. If the common-mode current flows through the external cables, common-mode interference may also happen due to electrical interference caused by unstable electric potential.

The ferrite ring causes eddy current losses to high-frequency signals and transforms them into heat when suppressing common-mode interference. The ferrite ring acts as a low-pass filter to effectively suppress high-frequency noise and ensure the stability of the circuit while the impedance to low-frequency signals is relatively small.

Winding several turns of wire onto the ferrite ring can increase inductance and the ability to filter out high-frequency noise. The suggested winding methods are shown as follows:

- For 400V models



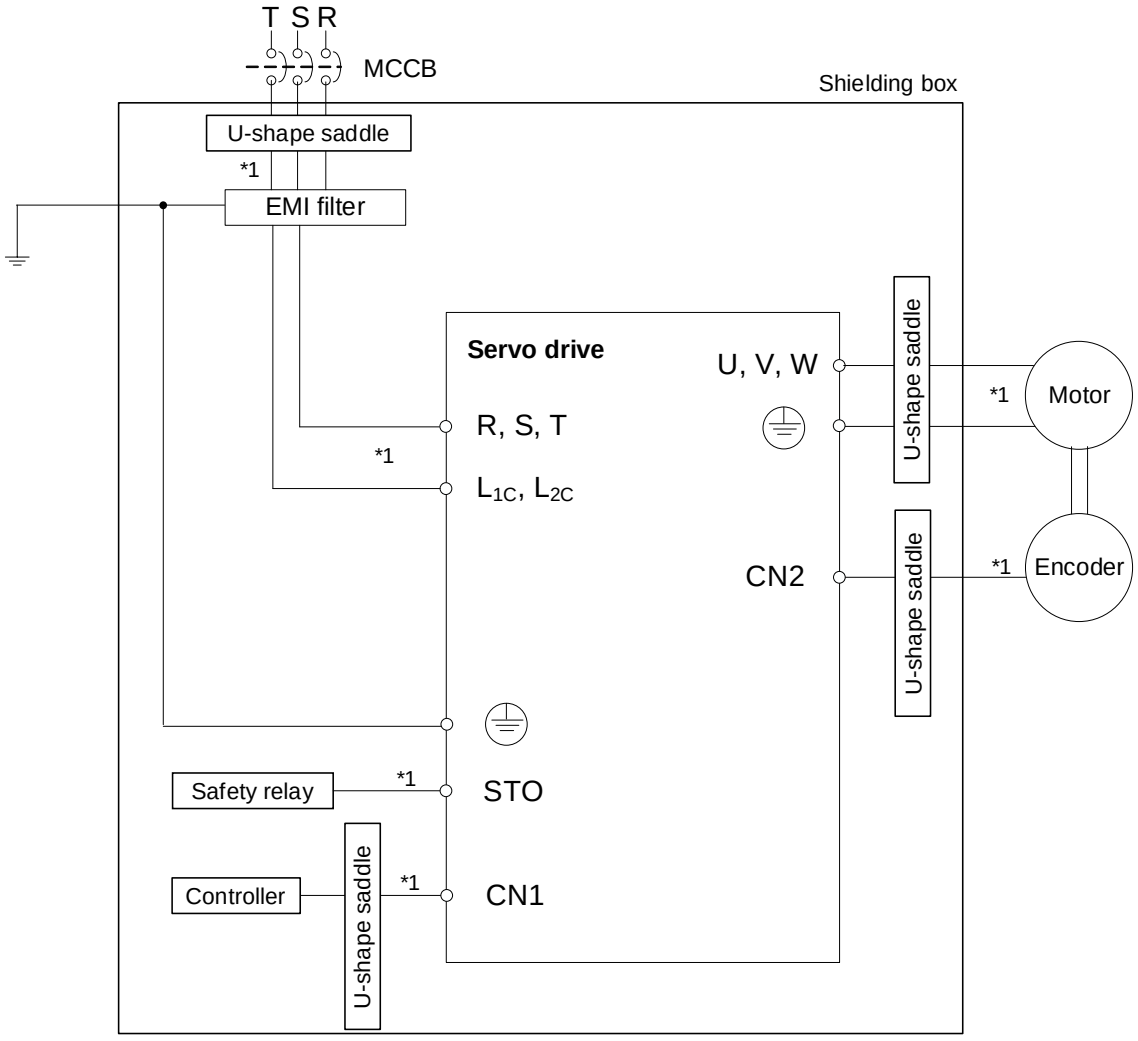
Note:

1. Refer to Chapter 3 for the selection of the motor power cable.
2. Only the motor power cable or servo drive power cable can run through the ferrite ring. If needed, prepare extra ferrite rings for grounding.
3. An EMI filter for absorbing radiation may be required when a longer motor power cable is used.

2.7 Installation requirements for EMC

2

This section illustrates the installation requirements for passing the EMC test. Note that the EMC rating varies based on the installation structure or wiring. Delta servo products are designed in accordance with the EMC standards. Refer to the following diagram for the standard installation, through which Delta servo products passed the EMC test.



Note:

1. Use shielded wires.

2.7.1 EMI filters

All electronic equipment (including servo drives) generate high or low frequency noise during operation, which interferes with peripheral equipment through conduction or radiation. With an EMI filter correctly installed and used, you can eliminate much of the interference. For optimized performance, it is recommended that you use Delta's EMI filter for suppressing the interference.

220V models

Power	Servo drive model	Recommended EMI filter	
		1PH	3PH
100 W	ASD-B3[1]-0121-[2]	EMF023A21A	EMF10AM23A
200 W	ASD-B3[1]-0221-[2]	EMF023A21A	EMF10AM23A
400 W	ASD-B3[1]-0421-[2]	EMF023A21A	EMF10AM23A
750 W	ASD-B3[1]-0721-[2]	EMF023A21A	EMF10AM23A
1 kW	ASD-B3[1]-1021-[2]	EMF023A21A	EMF10AM23A
1.5 kW	ASD-B3[1]-1521-[2]	EMF023A21A	EMF10AM23A
2 kW	ASD-B3[1]-2023-[2]	-	EMF021A23A
3 kW	ASD-B3[1]-3023-[2]	-	EMF021A23A

400V models

Power	Servo drive model	Recommended EMI filter
		3PH
1 kW	ASD-B3[1]-1043-[2]	EMF018A43A
1.5 kW	ASD-B3[1]-1543-[2]	EMF018A43A
2 kW	ASD-B3[1]-2043-[2]	EMF018A43A
3 kW	ASD-B3[1]-3043-[2]	EMF018A43A
4.5 kW	ASD-B3[1]-4543-[2]	EMF033A43A
5.5 kW	ASD-B3[1]-5543-[2]	EMF033A43A
7.5 kW	ASD-B3[1]-7543-[2]	EMF033A43A

Note: in the servo drive model number, [1] represents the product series and [2] represents the model type. The preceding table includes the B3 and B3A series.

General precautions for installation

To ensure the best performance of the EMI filter, apart from the installation and wiring instructions of the servo drive in the user manual, refer to these precautions:

1. The servo drive and EMI filter must be mounted on the same metal plate.
2. The wiring should be as short as possible.
3. The metal plate must be well grounded.
4. It is recommended that you install one servo drive with one EMI filter.

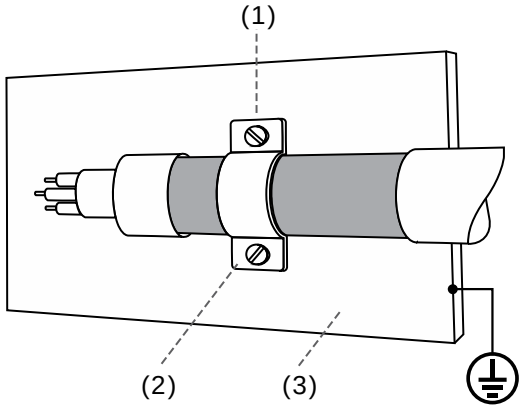
More specifications for mounting the servo drive are listed as follows:

1. EN61000-6-4 (2001)
2. EN61800-3 (2004) PDS of category C2
3. EN55011+A2 (2007) Class A Group 1

Motor power cable selection and installation precautions

The selection of motor power cable and installation accuracy determine the performance of the EMI filter. Follow these precautions:

1. Use a cable that has braided shielding (the effect of double shielding is better).
2. The shield on both ends of the power cable should be grounded with the shortest distance and the largest contact area.
3. Remove the protective paint on the U-shape saddle and metal plate to ensure good contact. See the following figure.
4. Correctly connect the braided shielding of the power cable and the metal plate: fix the braided shielding on both ends of the power cable with the U-shape saddle and metal plate. See the following figure.



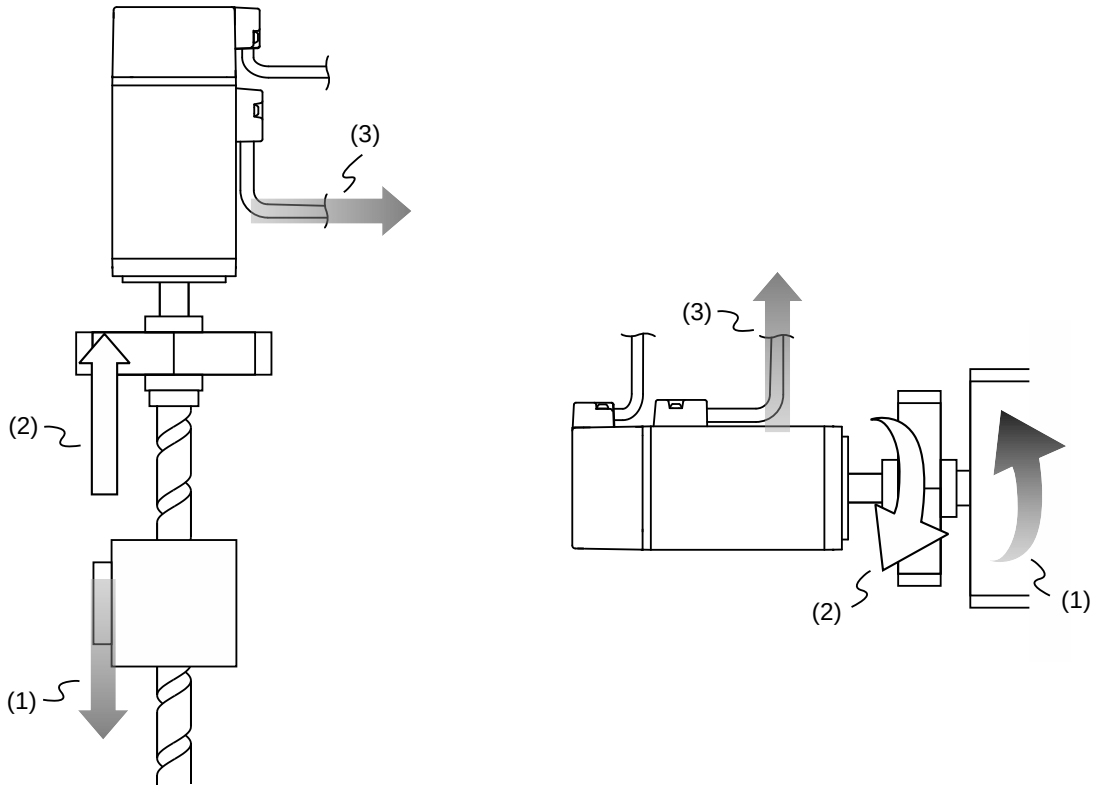
(1) Remove the protective paint on the U-shape saddle and metal plate to ensure good contact

(2) U-shape saddle

(3) Well-grounded metal plate

2.8 Selecting the regenerative resistor

Some of the Delta servo drive models have a built-in regenerative resistor, and you can use an external regenerative resistor if needed. When the direction of torque is opposite to the direction of rotation, the energy generated returns to the servo drive from the load. This energy is turned into electricity in the capacitor of the DC Bus and thus increases the voltage. When the voltage reaches a given value, the excess energy is consumed by a regenerative resistor. Refer to the following table to select the suitable regenerative resistor.



(1) Moving direction of the object; (2) Direction of torque; (3) Regenerative energy

Specifications of the built-in regenerative resistor of the servo drive are as follows:

220V models

Servo drive (kW)	Specifications of the built-in regenerative resistor		Capacity of the built-in regenerative resistor (Watt)	Minimum allowable resistance value (reference for external resistors) (Ohm)
	Resistance (Ohm)	Capacity (Watt)		
0.1	-	-	-	60
0.2	-	-	-	60
0.4	100	40	20	60
0.75	100	40	20	60
1.0	100	40	20	30
1.5	100	40	20	30
2.0	20	80	40	15
3.0	20	80	40	15

400V models

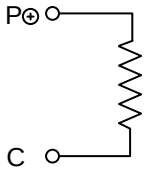
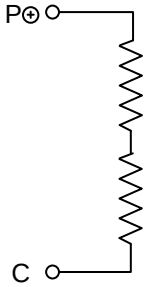
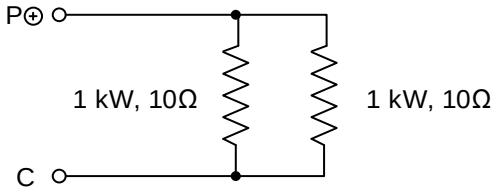
Servo drive (kW)	Specifications of the built-in regenerative resistor		Capacity of the built-in regenerative resistor (Watt)	Minimum allowable resistance value (reference for external resistors) (Ohm)
	Resistance (Ohm)	Capacity (Watt)		
1.0	100	80	40	80
1.5	100	80	40	60
2.0	50	80	40	45
3.0	50	80	40	40
4.5	35	100	50	35
5.5	35	100	50	25
7.5	35	100	50	25

When the regenerative energy exceeds the capacity of the built-in regenerative resistor, use an external regenerative resistor. Pay special attention to the following when using a regenerative resistor:

1. Correctly set the resistance value (P1.052) and capacity (P1.053) for the regenerative resistor; otherwise it might affect the performance.
2. When using an external regenerative resistor, ensure the total resistance value is greater than the minimum allowable resistance value of the servo drive.

3. For general applications, you can connect more than one resistor in series. If the resistance value (from resistors connected in series) exceeds the rated range, you can reduce the value by connecting the resistors in parallel. If you want to connect the resistors in parallel to increase the power of the regenerative resistors, make sure the resistance value meets the requirements.

   See the following diagrams and settings for connecting the regenerative resistors in series and in parallel.

Connect to one external regenerative resistor	
	P1.052 = 10 (Ω) P1.053 = 1000 (W)
Connect to external regenerative resistors (serial connection)	
	P1.052 = 20 (Ω) P1.053 = 2000 (W)
Connect to external regenerative resistors (parallel connection)	
	P1.052 = 5 (Ω) P1.053 = 2000 (W)

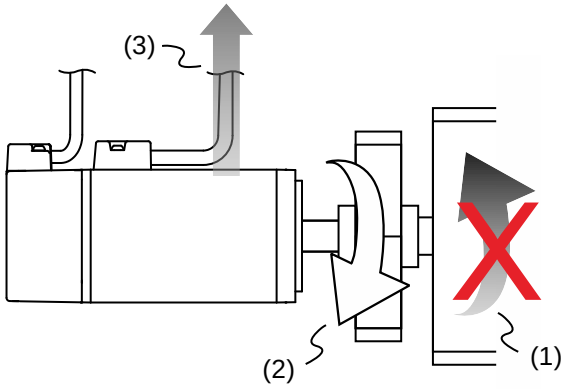
4. Normally, if the capacity of the regenerative resistor (the average value) is within the rated capacity, the temperature of the resistor can increase to 120°C (248°F) or even higher under the condition that the regenerative energy continues to function. For safety reasons, apply forced cooling to reduce the temperature of the regenerative resistor. Alternatively, you can use the regenerative resistors equipped with thermal switches. Contact the manufacturer for the load characteristics of the regenerative resistor.

2

When installing an external regenerative resistor, connect the resistor to P⊕ and C contacts, and leave the P⊕ and D contacts open. It is recommended that you choose external regenerative resistors of the resistance values specified in the table on page 22. For easy calculation of the required regenerative resistor capacity, regardless of the energy consumed by IGBT, select the capacity of the external regenerative resistor according to the selected rotary motor.

Selecting the regenerative energy

(a) Calculation of the regenerative energy when there is no external torque



(1) Moving direction of the object; (2) Direction of torque;

(3) Regenerative energy generated when the motor decelerates

If the motor is making a reciprocating motion, the regenerative resistor consumes the excess return energy. Refer to the following table when making calculations and selecting the required regenerative resistor.

220V models

Servo drive (kW)	Motor		Rotor inertia ($\times 10^{-4}$kg·m^2)	Regenerative energy generated when the motor decelerates from the rated speed to a stop without load Eo (joule)	Maximum regenerative energy that can be absorbed by the capacitor Ec (joule)
0.1	Low inertia	ECM-A3L-C2040F345	0.0229	0.11	4.21
0.1		ECM-A3L-C20401345	0.04	0.20	4.21
0.2		ECM-A3L-C20602345	0.09	0.45	5.62
0.4		ECM-A3L-C20604345	0.15	0.74	8.42
0.4		ECM-A3L-C20804345	0.352	1.74	8.42
0.75		ECM-A3L-C20807345	0.559	2.76	18.25
0.1		ECM-B3L-C20401345	0.0299	0.15	4.21
0.2	Medium inertia	ECM-B3M-C20602345	0.141	0.70	5.62
0.4		ECM-B3M-C20604345	0.254	1.26	8.42
0.4		ECM-B3M-C20804345	0.648	3.20	8.42
0.75		ECM-B3M-C20807345	1.07	5.29	18.25
1.0		ECM-B3M-C20810345	1.37	6.77	26.21
1.0		ECM-B3M-E21310345	7.79	17.12	26.21
1.5		ECM-B3M-E21315345	11.22	24.66	34.94
2.0		ECM-B3M-E21320345	14.65	32.20	26.21
2.0		ECM-B3M-E21820345	29.11	63.98	26.21
3.0		ECM-B3M-F21830345	53.63	66.3	31.82

Servo drive (kW)	Motor		Rotor inertia ($\times 10^{-4}$kg·m^2)	Regenerative energy generated when the motor decelerates from the rated speed to a stop without load Eo (joule)	Maximum regenerative energy that can be absorbed by the capacitor Ec (joule)
0.1	High inertia	ECM-A3H-C2040F345	0.0455	0.23	4.21
0.1		ECM-A3H-C20401345	0.0754	0.37	4.21
0.2		ECM-A3H-C20602345	0.25	1.24	5.62
0.4		ECM-A3H-C20604345	0.45	2.23	8.42
0.4		ECM-A3H-C20804345	0.92	4.55	8.42
0.75		ECM-A3H-C20807345	1.51	7.47	18.25
0.2		ECM-B3H-C20602345	0.265	1.31	5.62
0.4		ECM-B3H-C20604345	0.523	2.59	8.42
0.75		ECM-B3H-C20807345	1.55	7.66	18.25
1.0		ECM-B3H-F21308345	12.44	15.38	26.21
1.5		ECM-B3H-F21313345	18.00	22.25	34.94
2.0		ECM-B3H-F21318345	22.60	27.94	26.21

400V models

Servo drive (kW)	Motor		Rotor inertia ($\times 10^{-4}$kg·m^2)	Regenerative energy generated when the motor decelerates from the rated speed to a stop without load Eo (joule)	Maximum regenerative energy that can be absorbed by the capacitor Ec (joule)
1.0	Low inertia	ECM-B3M-J21010345	2.78	13.75	14.66
1.5		ECM-B3M-J21015345	3.69	18.25	17.47
2.0		ECM-B3M-J21020345	4.68	23.14	29.33
1.0		ECM-B3M-K21310345	7.79	17.12	14.66
1.5		ECM-B3M-K21315345	11.22	24.66	17.47
2.0		ECM-B3M-K21320345	14.65	32.2	29.33
2.0	Medium inertia	ECM-B3M-K21820345	29.11	92.09	29.33
3.0		ECM-B3M-L21830345	53.63	66.3	34.94
4.5		ECM-B3M-L21845345	67.73	83.73	42.43
5.5		ECM-B3M-L21855345	98.88	122.24	51.17
7.5		ECM-B3M-L21875345	134.95	166.83	62.40
1.0	High inertia	ECM-B3H-L21308345	12.44	15.38	14.66
1.5		ECM-B3H-L21313345	18.00	22.25	17.47
2.0		ECM-B3H-L21318345	22.60	27.94	29.33

Note: in the servo motor model number, 2 represents the encoder type; 3 represents the brake or keyway / oil seal type; 4 represents the shaft diameter and connector type; and 5 represents the special code.

Assuming that the load inertia is N times the motor inertia, when the motor decelerates from 3,000 rpm to a stop, the regenerative energy is (N+1) × Eo and the regenerative resistor needs to consume (N+1) × Eo - Ec joules. Assuming that the reciprocating motion cycle is T sec, then the required power of regenerative resistor = 2 × ((N+1) × Eo - Ec) / T. The calculation is as follows:

Step	Item	Calculation and setting method
1	Set the capacity of the regenerative resistor to the maximum.	Set P1.053 to the maximum value.
2	Set the motion cycle (T).	Manual input.
3	Set the rotation speed (wr).	Manual input or read the status with P0.002.
4	Set the ratio (N) of the load inertia to the motor inertia.	Manual input or read the status with P0.002.
5	Calculate the maximum regenerative energy (Eo).	Eo = J × wr^2 / 182
6	Find the regenerative energy that can be absorbed by the capacitor (Ec).	Refer to the preceding table.
7	Calculate the required capacity of the regenerative resistor.	2 × ((N+1) × Eo - Ec) / T

Take the 400 W motor (ECM-A3L-CY0604RS1) for example. When the reciprocating motion cycle (T) is 0.4 sec, the maximum rotation speed is 3,000 rpm, and the load inertia is 15 times of the motor inertia.

Servo drive (kW)	Motor	Rotor inertia J (× 10^{-4}kg·m^2)	Regenerative energy generated when the motor decelerates from the rated speed to a stop without load Eo (joule)	Maximum regenerative energy that can be absorbed by the capacitor Ec (joule)
0.4	ECM-A3L-CY0604RS1	0.15	0.74	8.42

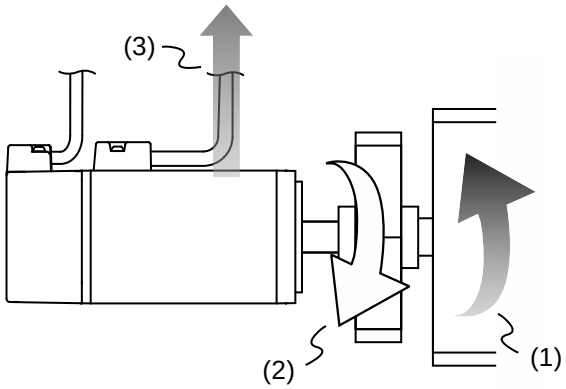
Find the maximum regenerative energy: Eo = 0.74 joules (from the preceding table).

Find the regenerative energy that can be absorbed by the capacitor: Ec = 8.42 joules (from the preceding table).

The required capacity of the regenerative resistor = $\frac{2 \times ((N + 1) \times E_O - E_c)}{T} = \frac{2 \times ((15 + 1) \times 0.74 - 8.42)}{0.4}$ = 17.1 W.

From the preceding calculation, the required power of the regenerative resistor is 17.1 W, which is smaller than the specified capacity. In this case, the built-in regenerative resistor of 40 W fulfills the need. In general, the built-in regenerative resistor can meet the requirement when the external load is not too great.

(b) Calculation of the regenerative energy when there is external torque and the motor does the negative work



(1) Moving direction of the object; (2) Direction of torque; (3) Regenerative energy

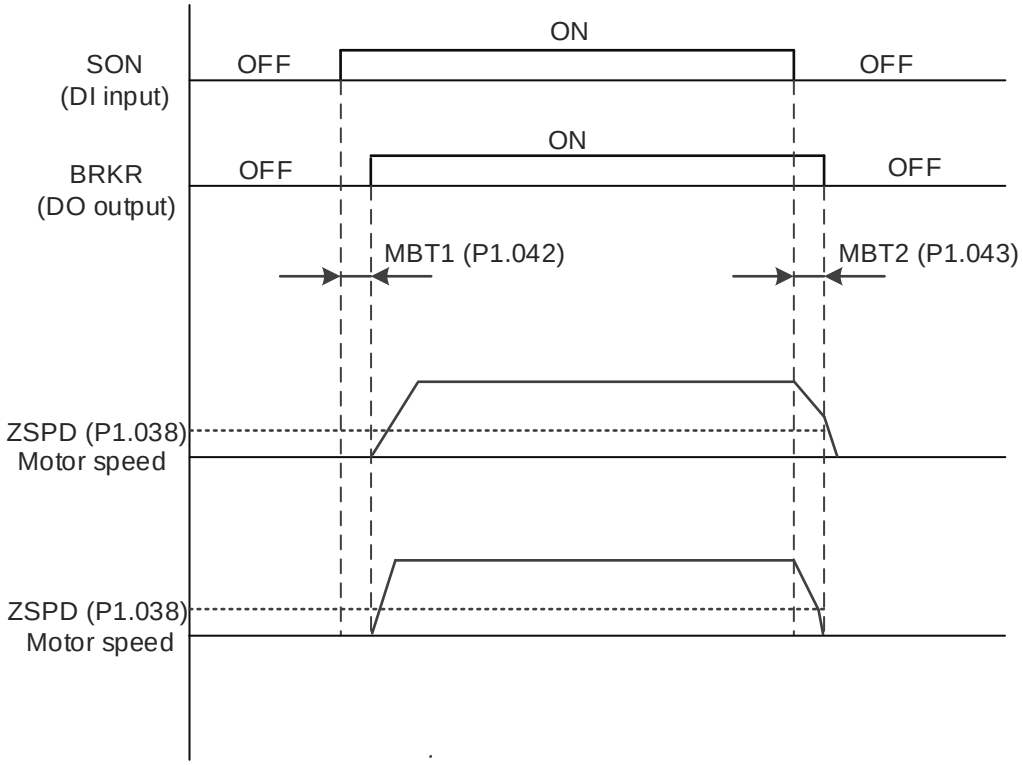
Usually, when the motor does positive work, the motor's torque direction is identical to the rotation direction. However, in some circumstances, the motor's torque direction is opposite to the rotation direction. This means the motor is doing negative work and the external energy is applied to the servo drive through the motor. For instance, if the external force direction is identical to the rotation direction (such as downward motion of the vertically-mounted machine), the servo system outputs more power to counterbalance the excessive external force (the weight of the vertically-mounted machine) in order to keep up with the specified target speed. In this case, considerable energy returns to the servo drive. When the DC Bus is full and cannot store more energy, the excess energy is consumed by the regenerative resistor.

Take the 400 W motor (ECM-A3L-CY0604RS1) for example. When the torque of the external load is +70% of the rated torque (1.27 N-m) with the rotation speed up to 3,000 rpm, the required external regenerative resistor is: $2 \times (0.7 \times 1.27) \times (\frac{3000 \times 2 \times \pi}{60}) = 558$ W.
Therefore, a regenerative resistor of 560 W and 40 Ω is needed.

2.9 The use of braking

A brake is usually used for motions in the Z-axis direction because gravity causes the machine to fall. A brake can prevent the machine from falling and reduce the motor's excessive resistance. The motor lifespan could be reduced due to the excessive heat generated by continuous resistance. To avoid incorrect operation, the brake can be enabled only when the servo is switched off. The drive controls the brake with DO. If DO.BRKR is set to off, it means the brake is not operating and the motor is clamped; if DO.BRKR is set to on, it means the brake is operating and the motor can run freely. You can use MBT1 (P1.042) and MBT2 (P1.043) for the delay time settings.

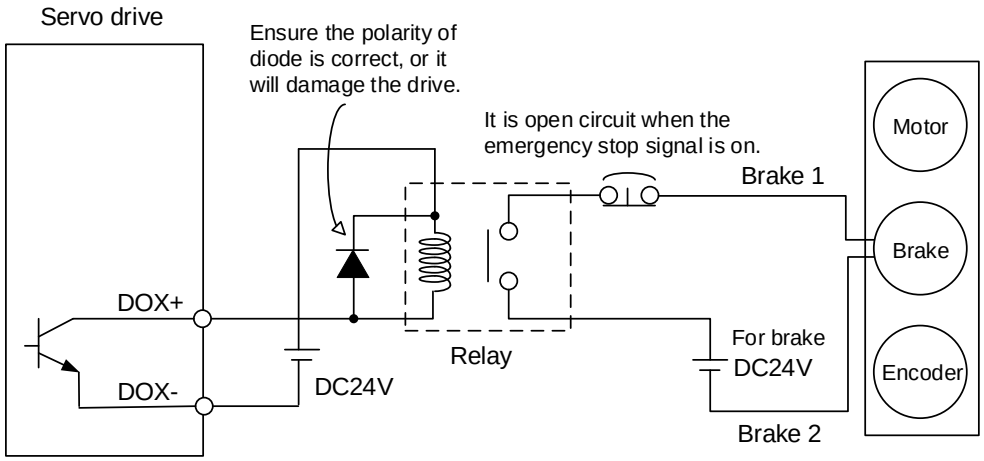
Timing diagram of brake control:



Output timing of the BRKR signal:

1. When the servo drive is off and the time set by P1.043 is exceeded, but the motor speed is still higher than the speed set by P1.038, DO.BRKR is off (the motor is clamped).
2. When the servo drive is off and the time set by P1.043 is not yet reached, but the motor speed is already lower than the speed set by P1.038, DO.BRKR is off (the motor is clamped).

Wiring of the brake:



Note:

1. Refer to Chapter 3 Wiring.
2. The brake signal controls the solenoid valve, providing power to the brake and enabling the brake.
3. There is no polarity for the brake coil.

Calculate the brake's rated current (ECM-A3L-CY0604RS1 is used as an example here).

Power consumption of the brake (at 20°C or 68°F) = 6.5 W (refer to Appendix A Specifications), so the brake's rated current = $\frac{6.5\ W}{24V}$ = 0.27 A.

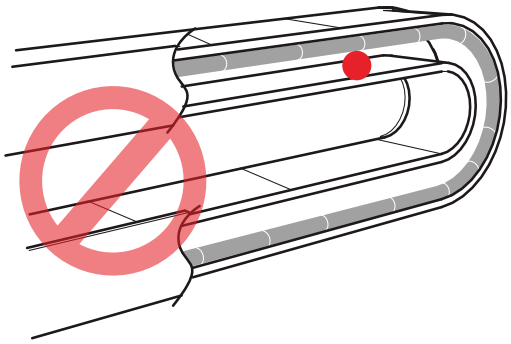
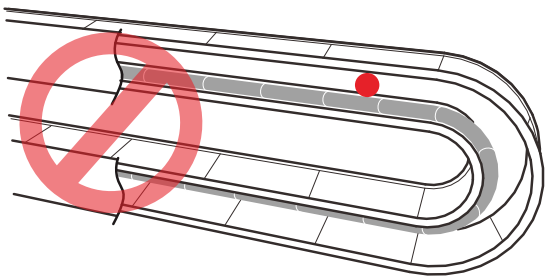
2.10 The use of cable

Precautions for using standard cable:

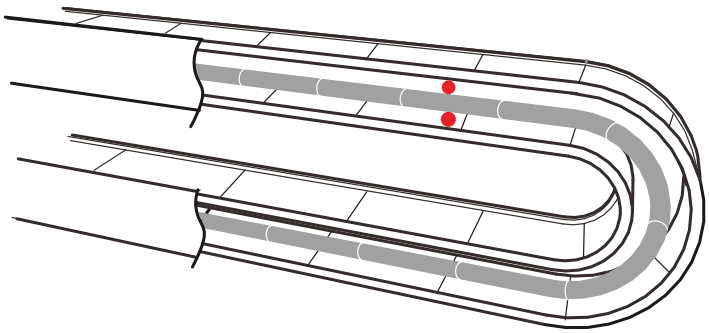
- Do not use the standard cable when the application requires the cable to move or bend. If required, use a flexible cable instead.

Precautions for using flexible cable:

- Inappropriate installation and wrong usage shorten the cable lifetime.
- Do not twist the cable when installing.
- Do not fix the cable on or near the bending part, otherwise the cable may break.
- After cable fixation, make sure the cable can be moved with ease, so that it does not create excessive tension on the bending or fixation part.
- Prevent the connectors of the cable from being subject to stress.
- Excessive cable length causes unnecessary bending, while insufficient cable length leads to breakage due to the excessive tension on the cable fixation part. Estimate the suitable cable length by dragging the cable carrier to the longest and shortest possible.

Cable is too long	Cable is too short
	

Appropriate cable length, with clearance on both sides of cable



- When installing the cable carrier, avoid contact between the cables. Do not stack the cables one above the other; use dividers to prevent cable entanglement instead.
- Avoid scraping, crushing, or stepping on the cable. This can damage the inner wires even when the cable seems intact on the outside.
- Do not bend the flexible cable under any normal circumstances. Refer to Section 3.1.6.4 for detailed flexible cable specifications.