CHAPTER 2: INSTALLATION

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SureServo2™ Installation

Please follow the instructions in this chapter during installation. This chapter includes information about the circuit breaker, fuse, EMI filter selection, and the regenerative resistor. For drive dimensions and mounting holes, please see Appendix A.

Safety Precautions

If the connection between the servo drive and servo motor is over 20 meters, please increase the gauge of the UVW connecting wire and the encoder cable. Please refer to Section 3.2.3 for the wire specification.

2.1 - Ambient Storage Conditions

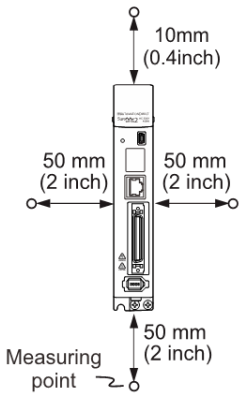
Before installation, this product must be kept in the shipping carton. In order to retain the warranty coverage and for maintenance, please follow the instructions below for storage.

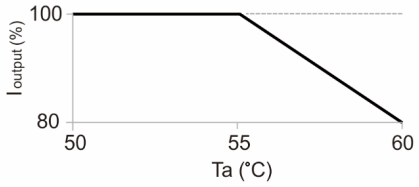
While the product is temporarily not in use:

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

2.2 - Ambient Installation Conditions

The ambient temperature for the servo drive should be between 0°C and 55°C. If the temperature is over 45°C, please place the product in a well-ventilated environment. During long-term operation, the ambient temperature should be under 45°C to ensure the servo drive's performance. If the product is installed in an electric box, make sure the servo drive is vertically mounted with a fan installed on the box. For SV2A-2040 and all 460V drives, keep a clearance of at least 10mm above the drives and keep the air flow above 0.5 m/s. For SV2A-2075, SV2A-2150, SV2A-2200, SV2A-2300, SV2A-2550, SV2A-2750, and SV2A-2F00, keep the speed of air flow above 1 m/s. Allow 5 cm of clearance beneath and on both sides of the servo drive. Its temperature must be kept under 55°C and it must be kept clear of heat sources. Ensure the size of the electric box and ventilation to prevent overheating and endangering the internal electronics of the device. In addition, check if the machine's vibration affects the electrical devices in the electric box.





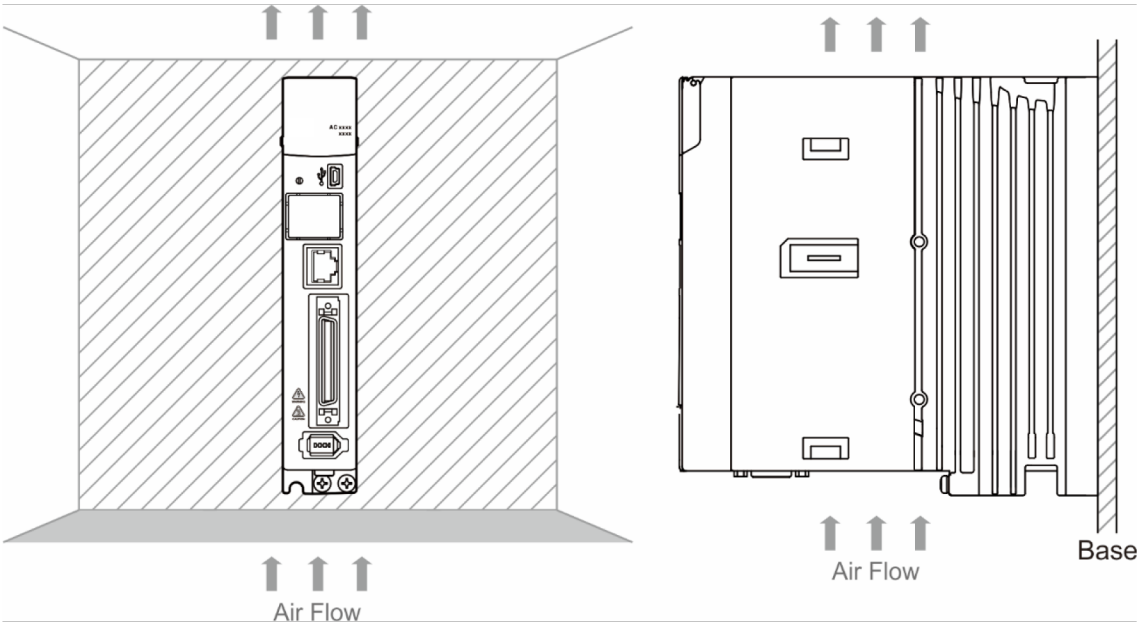
I output (%) is the current output in percent
Ta (°C) is the operation temperature

Note: The maximum operation temperature of models of 750W (or above) is 60°C, but the output current is reduced as shown in the figure above; the maximum operation temperature for models of 400W (or below) is 55°C.

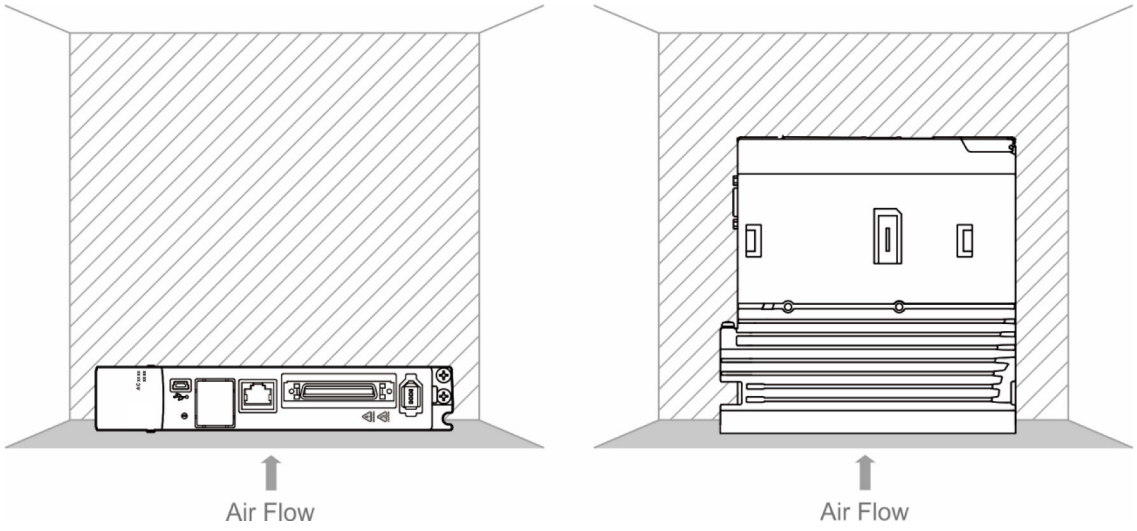
2.3 - Mounting direction and space

Attention:

- *Mount the servo drive according to the illustration below. The base of heat sink must be mounted vertically on the wall. Incorrect installation may result in a drive malfunction.*
- *For better ventilation and cooling, make sure there is sufficient space between the adjacent objects and the wall; otherwise, product malfunction may occur.*
- *Do not obstruct the ventilation holes when mounting the servo drive. Make sure you mount it in the correct orientation or malfunction may occur.*



CORRECT



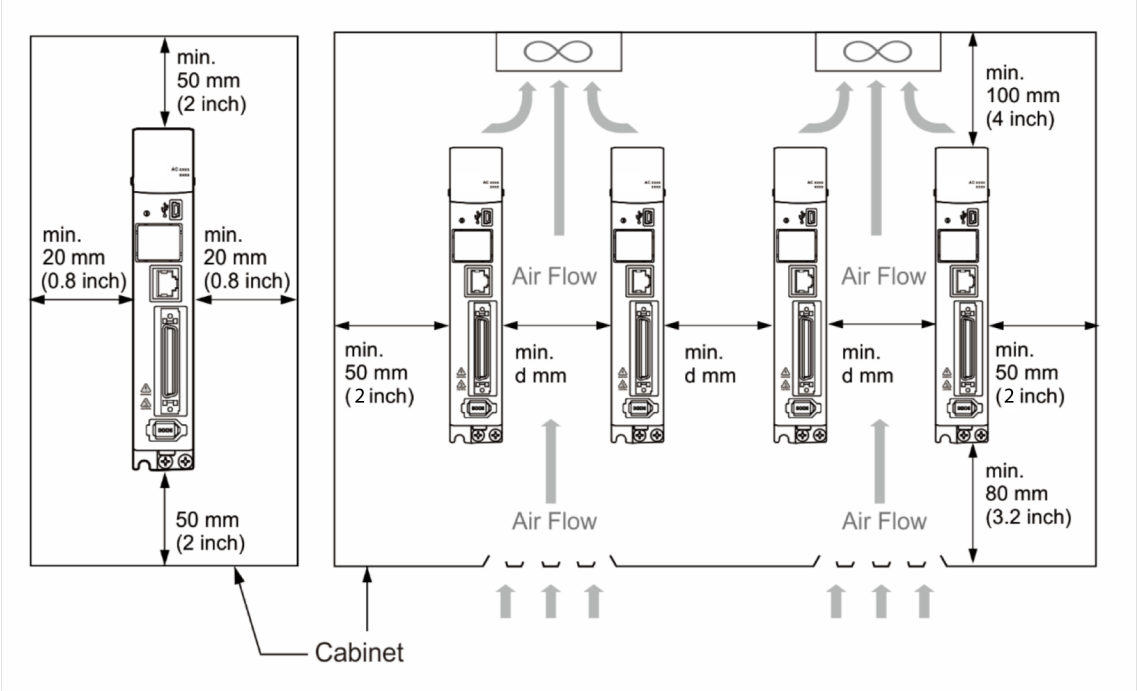
INCORRECT

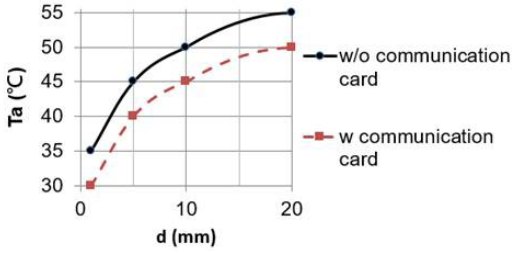
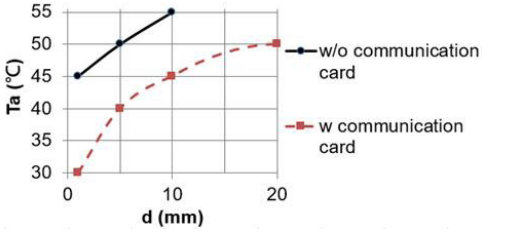
2.3.1 - Heat dissipation requirements:

In order to have adequate air flow for ventilation, please follow the suggested clearances when installing one or more servo drives (refer to the following diagrams). Avoid mounting one servo drive above 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 diagrams below are not to scale. Please refer to the annotations on the diagrams.

Single Servo Drive **Multiple Servo Drives**



Servo Drive Model	Cooling Method	Operating temperature (Ta) corresponding to minimum clearance (d)*
SV2A-2040	Natural cooling	
SV2A-2075, 2150, 2200, 2300, 2550, 2750, 2F00, 4040, 4075, 4150, 4200, 4300, 4550, 4750, 4F00	Natural cooling and forced cooling	

** Due to the assembly tolerance, the minimum clearance for the servo drive is 1mm.*

2.4 - Safety precautions for using motors

The SureServo2 AC servo motor is designed for industrial applications. It is necessary that you fully understand the motor specifications and operation manual. For your safety and correct use, please carefully read the manual, specifications, and precautions for the motor before connecting the motor to any equipment.

The safety precautions are as follows:

Handling, mounting, and storage

- *When removing or installing a servo motor, please 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 encoder that is attached at the rear end of shaft.*
- *Keep the axial or radial load within the allowable range listed in the specifications.*
- *Do not use, install, or store the servo motor in a humid environment that contains water, oil, corrosive gases, or liquids.*
- *The material of motor shaft is not rust-proof. Although the rust-proof oil has been applied to the shaft during the manufacturing process, you must check the shaft condition and apply rust-proof oil every three (3) months if storing the motor for more than six (6) 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; please take the necessary steps to avoid electric interference, vibration, and abnormal temperature changes.*

Wiring

- *If the current exceeds the maximum current in the Specifications, the internal parts of the motor may lose their magnetism.*
- *Please check that the motor wiring and the voltage of the motor brake are correct. Also, ensure that the wiring of the encoder signal and power cables is correct. Incorrect wiring will lead to abnormal operation of motor, malfunction, or damage.*
- *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 component test because it will damage the encoder.*
- *When the motor or brake is undergoing high-voltage component tests, please cut off the power supply of the controller. You should perform this kind of test only when necessary so as to protect the product lifespan.*

Note: For more information on best wiring practices, please refer to the Applied EMI/RFI Techniques PDF on the technical support page.

Operation

- *AC servo motor operation is controlled by the servo drive. Do not directly connect a commercial type power source (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's operation temperature must not exceed the specified range.*
- *The material of the motor shaft is not rust-proof. To ensure a longer motor life, please apply rust-proof oil during operation.*
- *The built-in brake is for clamping or holding rotor or shaft stationary. Do not use it for stopping or decelerating the motor.*

- *If any odor, noise, smoke, vapor, or abnormal vibration occurs during motor operation, please stop the motor and turn off the power immediately.*

Others

- *SureServo2 servo motors have no user-replaceable parts.*
- *Do not disassemble the motor or change its parts. Permanent damage or malfunction of the motor may occur. This will void the warranty.*
- *Do not splash water or oil on the product.*

2.5 - Specifications for the Circuit Breaker and Fuse

Servo Drive Model	Main Voltage Level	Drive Rated Input	Circuit Breaker	Fuse	Fuse Class (current limiting)
SV2A-2040	100–120 VAC 1-phase 200–230 VAC 1-phase	3.98 A 4.69 A	10A	15A	Class CC
	200–230 VAC 3-phase	2.76 A	10A	10A	
SV2A-2075	100–120 VAC 1-phase 200–230 VAC 1-phase	7.73 A 8.71 A	20A	20A	
	200–230 VAC 3-phase	5.09 A	13A	15A	
SV2A-2150	100–120 VAC 1-phase 200–230 VAC 1-phase	12.56 A 14.82 A	30A	30A	
	200–230 VAC 3-phase	8.09 A	20A	25A	
SV2A-2200	100–120 VAC 1-phase 200–230 VAC 1-phase	18.03 A 20.83 A	40A	40A	Class J or High Speed J*
	200–230 VAC 3-phase	11.36 A	30A	35A	
SV2A-2300	200–230 VAC 3-phase	14.52 A	35A	50A	
SV2A-2550		27.06 A	60A	70A	
SV2A-2750		37.33 A	70A	80A	
SV2A-2F00		69.95 A	120A	125A	
SV2A-4040	380–480 VAC 3-phase	1.49 A	10A	10A	Class CC
SV2A-4075		2.31 A	10A	15A	
SV2A-4150		4.98 A	15A	20A	
SV2A-4200		6.29 A	20A	25A	Class J or High Speed J*
SV2A-4300		9.92 A	20A	30A	
SV2A-4550		16.83 A	35A	35A	
SV2A-4750		23.06 A	45A	45A	
SV2A-4F00		36.65 A	60A	90A	

Note: The values in the table above are maximum allowable values to be used with the listed drives. The maximum values are well above the drive rated input current. Most applications can use much lower fuse/breaker values. A smaller value of 125% - 175% of rated input current is recommended. This allows for temporary motor overloads without tripping the circuit protection. For lower rated fuse protection, please see section 3.2.4.

The SureServo2 drives have an SCCR rating of 5kA. For short circuit protection, choose a current-limiting fuse that limits the let-through current (at your installation's available fault current level) to less than 5,000 Amps. For SureServo2, ADC recommends Class CC or JHL High Speed Class J current-limiting fuses.

Example:

The time-current chart for JHL drive-rated fuses shows that a 30A JHL fuse will allow 50A for an extended period of time before blowing.

A smaller fuse/breaker rating also helps with SCCR. The 30A JHL fuse above has a peak let-through of less than 2,500A when connected to 100,000A RMS available fault current. A 60A JHL would allow a 5,000A peak with the same available RMS fault current. Using a smaller fuse is better for device protection and SCCR ratings.

Notes:

- *Operation mode: General*
- *If the servo drive is equipped with a residual-current circuit breaker for current leakage protection, to avoid incorrect operation of the RCD (Residual Current Device), please select a circuit breaker with sensitivity of at least 200mA and with minimum 0.1 sec working time.*
- *Select Type B residual-current circuit breaker (with time delay) ONLY if the system ground wire may contain DC electricity.*
- *Please use the circuit breaker and fuse that comply with the UL/CSA standard.*

2.6 - Ferrite Ring

The movable or round-shaped 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 a low-frequency signal; however, when the frequency of the signal increases, the impedance may increase dramatically. Use the ferrite ring to optimize signal transmission and suppress high-frequency noise, and reduce high-frequency interference in the power and signal cables.

Ferrite Ring Model	Applicable Servo Drive Model
SV2-TOR1	All

Installation Precautions

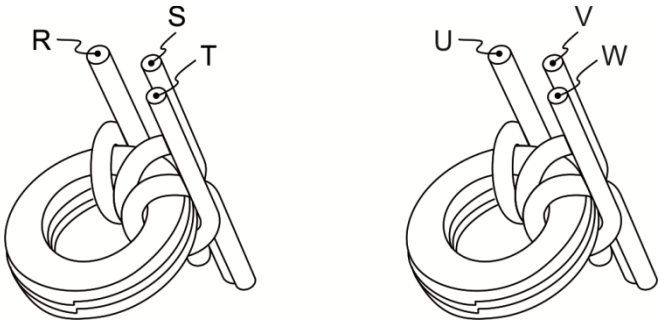
The ferrite ring is commonly used when peripheral devices (such as a controller) are affected by noise from conduction and radiation when the servo motor is in the Servo On state. The parasitic capacitance between the cables in the wiring panel and the ground is typically small. As the frequency of the signal increases (Servo On state), the resistance of the parasitic capacitance becomes small enough to let common-mode current flow through. Normally, common-mode current only leads to common-mode interference due to an unstable circuit caused by a poor connection between the power circuit and 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 the high-frequency signal and transforms it 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.

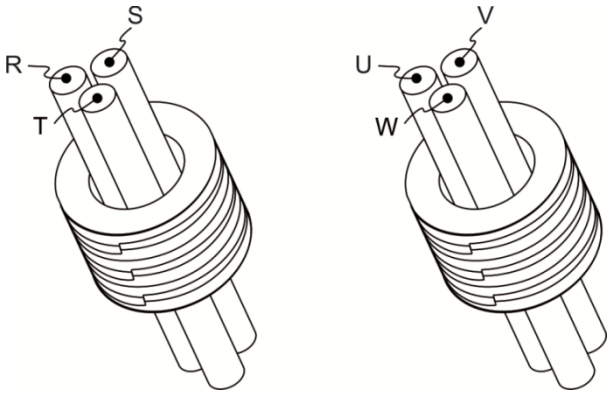
The suggested winding methods are shown below:

1) When the wire size (AWG) is small enough to wrap around the ferrite core at least once:



Recommended for up to 4.5 kW systems

2) When the wire size (AWG) is too large to wrap around the ferrite core at least once:



Recommended for 5.5 kW and larger systems

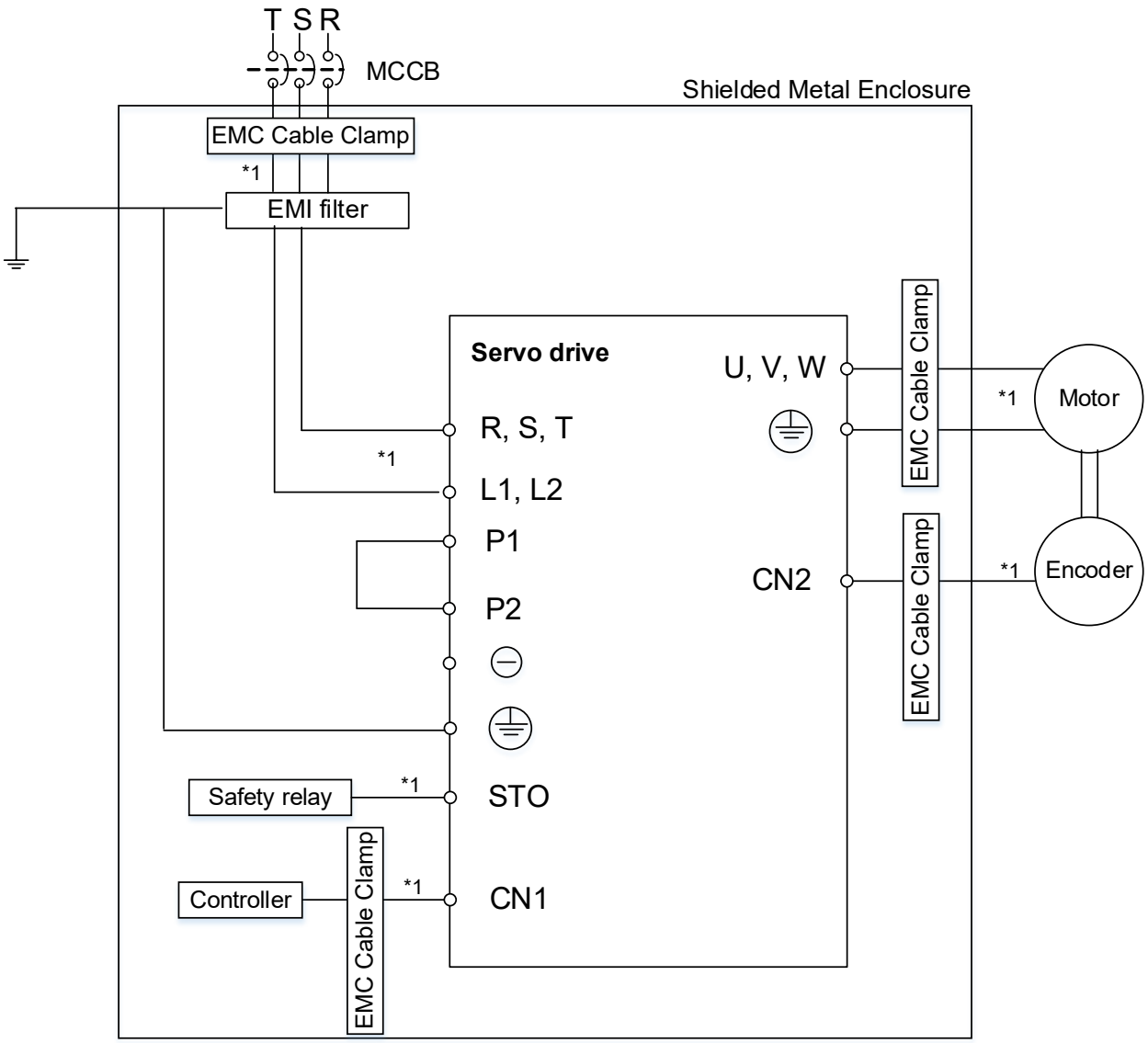
Notes:

- *Please refer to Section 3.2 for the selection of the motor power cable.*
- *Only the motor power cable or drive power cable can run through ferrite ring. If needed, please prepare extra ferrite rings for grounding.*
- *An EMI filter may be required for the drive input power for absorbing radiation when using a longer motor power cable.*

2.7 - Installation Requirements for EMC

This section illustrates the installation requirements for passing the EMC test. Please note that the EMC rating varies based on the installation structure or wiring. SureServo2 products are designed to conform to the specifications of the EMC test. Please refer to the following diagram for the standard installation. For further information and techniques on reducing EMI and its affects please see the EMI best practices paper here:

https://support.automationdirect.com/docs/emi_mitigation.pdf



*Note *1: Use of shielded cables is highly recommended.*

2.7.1 - EMI Filters

All electronic equipment (including servo drives) generates high or low frequency noise during operation, which interferes with peripheral equipment through conduction or radiation. With an EMI filter and the correct installation, you can eliminate much of the interference. For better performance, using an EMI filter to suppress the interference is recommended.

Servo Drive Model	Main Voltage Level	Recommended EMI Filter		
		Standard Performance GS Series	Good Performance Roxburgh	High Performance Roxburgh
SV2A-2040	100-120VAC 1-phase	EMF11AM21A	RES90F10	MIF10
	200-230VAC 1-phase	EMF11AM21A	RES90F10	MIF10
	200-230VAC 3-phase	EMF10AM23A	KMF306A	MIF310
SV2A-2075	100-120VAC 1-phase	EMF27AM21B	RES90F16	MIF16
	200-230VAC 1-phase	EMF27AM21B	RES90F16	MIF16
	200-230VAC 3-phase	EMF10AM23A	KMF310A	MIF310
SV2A-2150	100-120VAC 1-phase	EMF27AM21B	RES90S20	MIF23
	200-230VAC 1-phase	EMF27AM21B	RES90S20	MIF23
	200-230VAC 3-phase	EMF24AM23B	KMF318A	MIF316
SV2A-2200	100-120VAC 1-phase	EMF27AM21B	RES90S30	MIF330B
	200-230VAC 1-phase	EMF27AM21B	RES90S30	MIF330B
	200-230VAC 3-phase	EMF24AM23B	KMF325A	MIF323
SV2A-2300	200-230VAC 3-phase	EMF24AM23B	KMF336A	MIF330B
SV2A-2550	200-230VAC 3-phase	n/a	KMF350A	MIF350
SV2A-2750	200-230VAC 3-phase	n/a	KMF350A	MIF350
SV2A-2F00	200-230VAC 3-phase	n/a	KMF3100A	MIF3100
SV2A-4040	460V 3-phase	EMF6A0M43A	KMF306A	MIF310
SV2A-4075	460V 3-phase	EMF6A0M43A	KMF306A	MIF310
SV2A-4150	460V 3-phase	EMF12AM43B	KMF310A	MIF310
SV2A-4200	460V 3-phase	EMF12AM43B	KMF318A	MIF316
SV2A-4300	460V 3-phase	EMF23AM43B	KMF325A	MIF323
SV2A-4550	460V 3-phase	NA	KMF336A	MIF330B
SV2A-4750	460V 3-phase	NA	KMF350A	MIF350
SV2A-4F00	460V 3-phase	NA	KMF370A	MIF375

General precautions for installation

To ensure the best performance of the EMI filter, apart from the instructions on installation and wiring of servo drive, please observe the precautions below:

- *The servo drive and EMI filter should be mounted on the same unpainted metal plate.*
- *The wiring should be as short as possible.*
- *The metal plate should be well grounded.*

More specifications for mounting the servo drive are listed below:

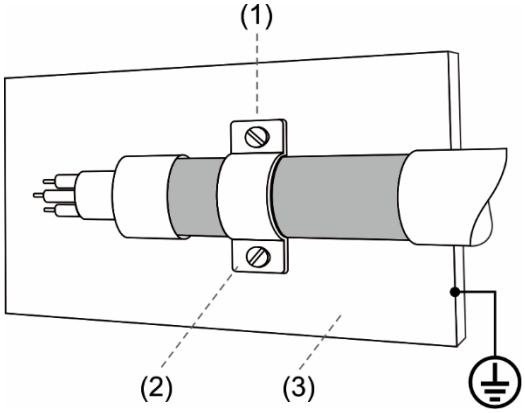
- *EN61000-6-4 (2001)*
- *EN61800-3 (2004) PDS of category C2*
- *EN55011+A2 (2007) Class A Group 1*

Motor cable selection and installation precautions

The selection of motor cables (please refer to Appendix B Accessories) and installation determines the performance of the EMI filter. Please follow the precautions below.

- *Use a cable that has braided shielding (the effect of double shielding is better).*
- *The shield on both ends of the motor cable should be grounded with the shortest cable length and the largest contact area.*

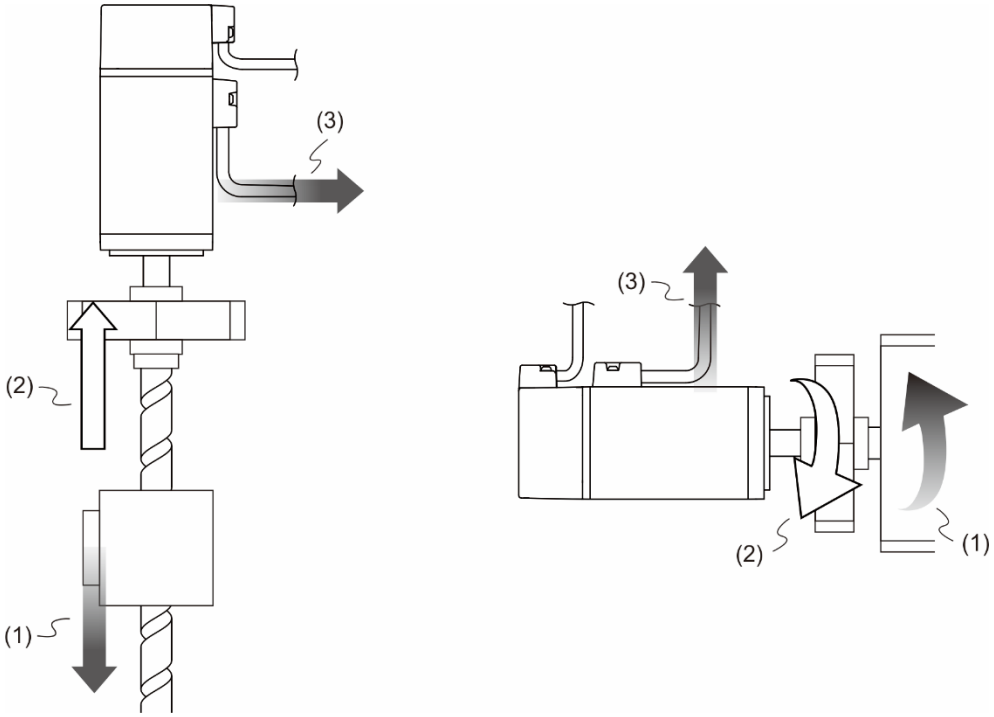
- *Remove the any protective paint on the U-shape saddle EMC cable clamp and metal plate in order to ensure good contact. Please see the figure below.*
- *A correct connection between the braided shielding of the motor cable and the metal plate is required. The braided shielding on both ends of the motor cable should be fixed by the EMC cable clamp U-shape saddle and metal plate. Please see the figure below for the correct connection.*



1) Any protective paint of the U-shape saddle EMC cable clamp and metal plate should be removed in order to ensure good contact.
2) EMC cable clamp U-shape saddle
3) Well-grounded metal plate

2.8 - Selecting the regenerative resistor for dynamic braking

When the direction of torque is different from the direction of rotation, the energy generated returns to the servo drive from the load. This energy is turned into electricity in the capacitor bank of the DC Bus and thus increases the voltage. When the voltage reaches a given value, it is consumed by a regenerative resistor. 230V servo drives up to 3kW and 460V servo drives up to 1.5 kW have a built-in regenerative resistor. You can also use the external regenerative resistor if needed. See the table on the following page for allowable external braking resistor values.



1) Moving direction of the object

2) Direction of torque
3) Regenerative energy

The built-in regenerative resistor in the SureServo2 is as follows:

110/230V Series Drives				
Servo Drive (W)	Built-in Regenerative Resistor Specifications		Regenerative Resistor Wattage for Internal Calculations (P1.053/2)(Watt)	Minimum Allowable Resistance* (Connected to external resistor) (Ohm)
	Resistance (P1.052) (Ohm)	Watts (P1.053)		
400W	100	10	5	60
750W	100	28	14	60
1500W	100	28	14	30
2000W	30	40	20	15
3000W	20	40	20	15
5500W**	n/a	n/a	See calculations below for recommended value	10
7500W**	n/a	n/a		10
15000W**	n/a	n/a		5

** Using a resistance value lower than the minimum specified can cause too high of a current draw for the drive to handle. Note that there is no maximum resistance limit.*

*** 5.5 kW, 7.5 kW, and 15kW drives do not have an internal resistor. Enter your external resistance and wattage values here.*

460V Series Drives				
Servo Drive (W)	Built-in Regenerative Resistor Specifications		Regenerative Resistor Wattage for Internal Calculations (P1.053/2)(Watt)	Minimum Allowable Resistance* (Connected to external resistor) (Ohm)
	Resistance (P1.052) (Ohm)	Watts (P1.053)		
400W	80	20	10	80
750W	80	20	10	60
1500W	80	20	10	40
2000W**	n/a	n/a	See calculations below for recommended value	40
3000W**	n/a	n/a		30
5500W**	n/a	n/a		20
7500W**	n/a	n/a		15
15000W**	n/a	n/a		12

** Using a resistance value lower than the minimum specified can cause too high of a current draw for the drive to handle. Note that there is no maximum resistance limit.*

*** 2kW, 3kW, 5.5 kW, 7.5 kW, and 15kW drives do not have an internal resistor. Enter your external resistance and wattage values here.*

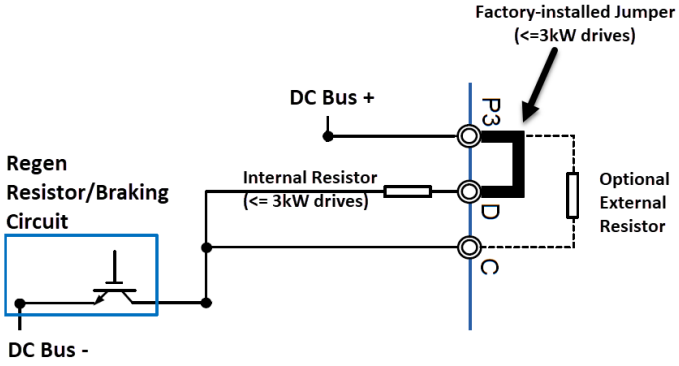
When the regenerative energy exceeds the capacity of built-in regenerative resistor, you should use an external regenerative resistor. Please pay special attention to the following when using an external regenerative resistor.

- *Please choose the correct resistance (P1.052) and wattage (P1.053) for the regenerative resistor; otherwise it might influence the performance, damage the drive, or overheat the resistor. For drives up to and including 3kW, the drives include a built-in resistor. For heat dissipation reasons the Wattage of the actual resistor is decreased in P1.053 vs. what is actually printed on the resistor. If the resistor was externally mounted with good airflow then the full Watt value of the resistor can be entered in P1.053. For further drive and resistor protection the drive's firmware uses half that value (P1.053/2) for energy regeneration calculations.*

- *When using an external regenerative resistor, please note that its resistance must be greater than the minimum allowable resistance for the servo drive in the table above. For general application, you can connect more than one resistor in series or in parallel depending on the resistance and wattage required. If you want to connect the resistors in parallel to increase the power of the regenerative resistor, please make sure the wattage and resistance capacity meet the requirements.*
  See the following diagram and settings for connecting the regenerative resistors in serial and parallel.

Note: If the internal AND an external resistor are both used (the P3-D jumper is NOT removed), make sure that the parallel resistance is still within the specified range for the drive in the table above).

This simplified diagram of the braking resistor circuitry shows the connections and usage of the internal regen resistor and factory-installed P3-D jumper (pre-installed on ≤ 3kW drives), and how the optional external resistor is used. External resistors are recommended (disconnect the P3-D jumper) in regen applications to remove heat from the drive that would be generated by using the internal regen resistor.



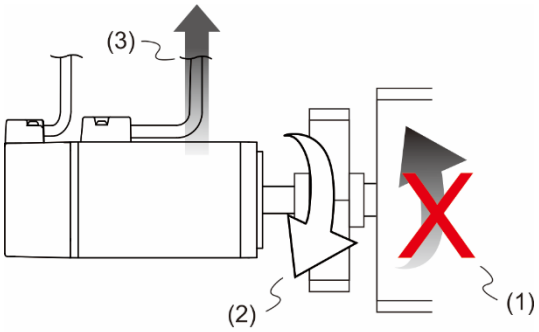
FOR 3KW AND SMALLER DRIVES, REMOVE THE P3-D JUMPER TO DISCONNECT THE INTERNAL RESISTOR		
	Connect to one external regenerative resistor P3 — 1 kW, 10Ω — C	Settings: P1.052 = 10 (Ω) P1.053 = 1000 (W)
	Connect to external regenerative resistors (serial connection) P3 — 1 kW, 10Ω — 1 kW, 10Ω — C	Settings: P1.052 = 20 (Ω) P1.053 = 2000 (W)
	Connect to external regenerative resistors (parallel connection) P3 — 1 kW, 10Ω / 1 kW, 10Ω — C	Settings: P1.052 = 5 (Ω) P1.053 = 2000 (W)

- *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 or even higher (under the condition that the regenerative energy continues to be absorbed). For safety reasons, please use forced air cooling in order to reduce the temperature of the regenerative resistor. Alternatively, you can use regenerative resistors that are equipped with thermal switches.*

- *When installing an external regenerative resistor, connect the external resistor to P3 and C contacts. The P3 and D contacts are left open. It is recommended that you choose external regenerative resistor values equal to or greater than those listed in the table on the previous page. For easy calculation of the regenerative resistor capacity, there are two ways provided to calculate the capacity according to the selected motor.*

Rotary Motor:

Calculation of the regenerative power when there is no external torque, rotor inertia only



1) Direction of motion of the object
2) Direction of the motor torque
3) Regenerative power generated while the motor decelerates

If the motor is making a reciprocating motion, the regenerative resistor consumes energy quickly on each decel cycle. You can select the regenerative resistor by calculating the regenerative power. Refer to the following two tables when calculating and selecting the required regenerative resistor.

110/230V Series Drives				
Servo Drive (W)	***Motor***	***Rotor Inertia J (x 10^{-4} kg·m^2)***	***Max Regenerative Power Generated when the Motor Decelerates from Rated Speed to 0 RPM without Load E_0 (joule)***	***Max Regenerative Absorbable Power of the Capacitor Bank E_c (joule)***
Low Inertia				
400	SV2L-201N	0.0627	0.20	6.24
	SV2L-201B	0.0689		
	SV2L-202N	0.25	0.43	
	SV2L-202B	0.28		
	SV2L-204N	0.45	0.74	
	SV2L-204B	0.48		
750	SV2L-207N	1.51	2.54	19.4
	SV2L-207B	1.66		
1500	SV2L-210N	2.65	13.1	19.4
	SV2L-210B	3.33		
Medium Inertia				
1500	SV2M-210N	8.41	18.48	19.4
	SV2M-210B	9.14		
	SV2M-215N	11.2	24.62	19.4
	SV2M-215B	11.9		
2000	SV2M-220N	34.7	76.26	24.95
	SV2M-220B	37.8		
3000	SV2M-230N	55	67.99	24.96
	SV2M-230B	57.1		
High Inertia				
5500	SV2H-245N	77.75	99.2	47.36
	SV2H-245B	80.65		
	SV2H-255N	99.78	126.23	47.36
	SV2H-255B	102.70		
7500	SV2H-275N	142.7	178.84	69.3
	SV2H-275B	145.55		

110/230V Series Drives				
Servo Drive (W)	**Motor**	**Rotor Inertia J (x 10^{-4} kg·m^2)**	**Max Regenerative Power Generated when the Motor Decelerates from Rated Speed to 0 RPM without Load E_0 (joule)**	**Max Regenerative Absorbable Power of the Capacitor Bank E_c (joule)**
15000	SV2H-2B0N	338	428.37	155.93
	SV2H-2B0B	346.5		
	SV2H-2F0N	451	570.91	155.93
	SV2H-2F0B	461.8		

460V Series Drives				
Servo Drive (W)	**Motor**	**Rotor Inertia J (x 10^{-4} kg·m^2)**	**Max Regenerative Power Generated when the Motor Decelerates from Rated Speed to 0 RPM without Load E_0 (joule)**	**Max Regenerative Absorbable Power of the Capacitor Bank E_c (joule)**
Low Inertia				
400	SV2L-404N	0.45	2.37	7.82
	SV2L-404B	0.48		
750	SV2L-407N	1.51	9.34	
	SV2L-407B	1.66		
1500	SV2L-410N	2.65	16.47	11.14
	SV2L-410B	3.33		
	SV2L-415N	11.2	26.15	
	SV2L-415B	11.9		
2000	SV2L-420N	34.7	83.08	22.28
	SV2L-420B	37.8		
Medium Inertia				
1500	SV2M-410N	8.41	20.09	11.14
	SV2M-410B	9.14		
High Inertia				
3000	SV2H-430N	54.95	70.59	26.54
	SV2H-430B	57.1		
5500	SV2H-445N	77.75	99.70	53.09
	SV2H-445B	80.65		
	SV2H-455N	99.78	126.96	
	SV2H-455B	102.70		
7500	SV2H-475N	142.7	179.94	77.74
	SV2H-475B	145.55		
15000	SV2H-4B0N	338	428.37	118.50
	SV2H-4B0B	346.5		
	SV2H-4F0N	451	570.91	
	SV2H-4F0B	461.8		

Assume that the load inertia is N times the motor inertia, and when motor decelerates from 3000 rpm to 0, the regenerative power is (N+1) × E_0 and the regenerative resistor needs to consume (N+1) × E_0-E_c joules. Assume that the reciprocate operation cycle is T sec, then the required power of regenerative resistor (P1.053) is Watts = 2 × (((N+1) × E_0) - E_c) / T. Note that the leading "2" in the equation is due to the drive firmware halving the Watt value.

The calculation is as follows:

Step	What to Do	Calculation and Setting Method
1	Set the wattage of the regenerative resistor to the maximum	Set P1.053 to the maximum value
2	Set the operation cycle (T)	Manual input (T=seconds)
3	Set the rotation speed in RPMs (wr)	Manual input or read the status with P0.002 Code (09h)
4	Set the load / motor inertia ratio (N)	Manual input or read the status with P0.002
5	Calculate the maximum regenerative resistor (E_0)	E_0= J * wr^2/182 Note, the value 182 comes from the formula below: $182 = \frac{1}{1/2 \times (2\pi/60)^2}$
6	Find the regenerative power that can be absorbed by the capacitor (E_C)	Refer to the table above
7	Calculate the required capacity (in Watts) of the regenerative resistor	2 ×((N+1) × E_0-E_C) / T

Example 1:

For SV2L-204B (400W), the reciprocating motion cycle is T = 0.4 sec. One motion cycle here is defined as two complete moves, an acceleration followed by deceleration to a stop in the forward direction, then an immediate acceleration followed by deceleration to a stop in the reverse direction. Then repeat.

Its maximum speed is 3000 rpm and the load inertia is 15 times of the motor inertia.

Servo Drive (W)	Motor	Rotor Inertia J (x 10-4kg.m²)	Regenerative Power Generated when the Motor Decelerates from 3000RPM to 0 without Load E_0 (joule)	Max Regenerative Power of the Capacitance E_C (joule)
400	SV2L-204x	0.15	0.74	6.24

Find the maximum regenerative power: E_0 = 0.74 joules (from the table).

Find the regenerative power that can be absorbed by the capacitor; E_C = 6.24 joules (from the table).

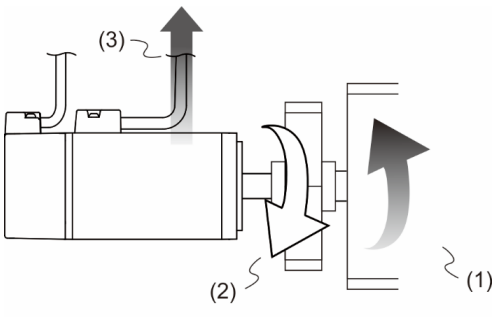
The required capacity of the regenerative resistor = $\frac{2 \times (N+1) \times E_0 - E_C}{T}$

Inserting the values for the variables gives:

$$\frac{2 \times ((15+1) \times 0.74) - 6.24}{0.4} = 43.6 \text{ W}$$

From the calculation above, the required power of regenerative resistance is 43.6 W, which is slightly greater than the specified capacity. In this case, a built-in 40W regenerative resistor does not quite fulfill the need. In general, the built-in regenerative resistor can meet the requirement when the external load is not too great. The leading "2" in the equation is for the protection of the resistor sizing and is why P1.053 is double what the drive uses for regen calculations.

Calculation of the regenerative power when there is external torque and the motor does the negative work.



1) Direction of motion of the object
2) Force direction of the motor
3) Regenerative power

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

Example 2:

For a 400W motor (SV2L-204B) with an external torque load +70% of the rated torque (1.27 N·m), with rotation speed up to 3000 rpm, the required external regenerative resistance is:

$$2 \times (0.7 \times 1.27\ \text{Nm}) \times \frac{3000\ \text{rev/min} \times 2 \times \pi}{60\ \text{sec/min}} = 560\text{W}$$

So, a minimum regenerative resistor of 560W and 60Ω is needed.

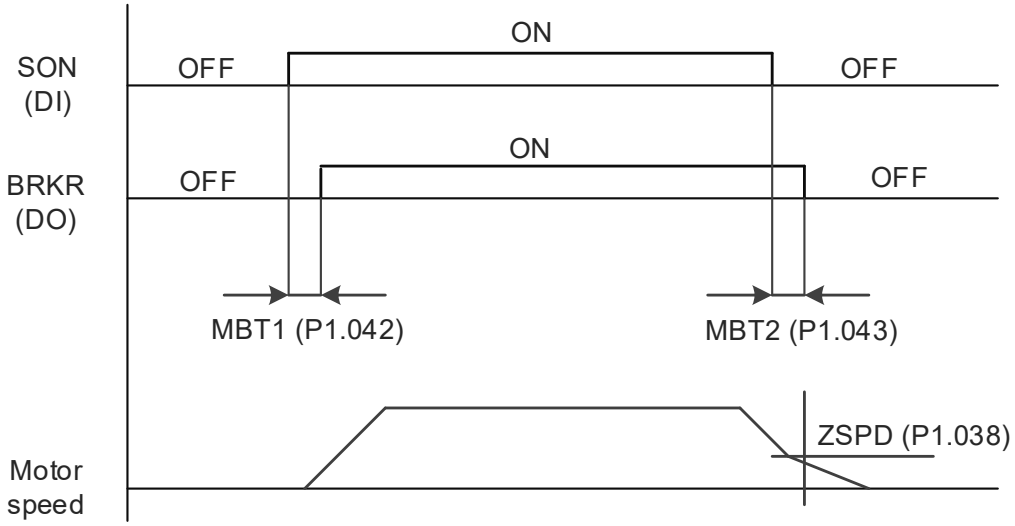
2.9 - The Use of Braking

A brake is usually used for motions in Z-axis direction because gravity causes the mechanism to fall. A brake can prevent the mechanism from falling and greatly reduce the motor's resistance output. The motor lifespan could be reduced due to resistance and excessive heat generation. To avoid incorrect operation, the brake should be enabled only when the servo is disabled. The brake is engaged (holding the motor) when no power is applied to the brake wires. The brake is disengaged (allowing the motor to spin) when power is applied to the brake wires.

The servo drive can control the brake with a digital output (DO). If DO.BRKR (Brake Relay - always use a relay to provide the higher current required by the brake) is set to off, it means the brake is engaged and the motor is clamped. If DO.BRKR is set to on, it means the brake is not engaged and the motor can run freely. You can use MBT1 (P1.042) and MBT2 (P1.043) to set the delay time. The timing diagrams below assume the DO definition code = 0x108. The output definition of 0x108 in P2.018 - P2.022 means that the DO is set for the Magnetic Brake and that the output functions as "Normally Open" (current is flowing when ON, and current is not flowing when OFF).

Timing diagram of brake control:

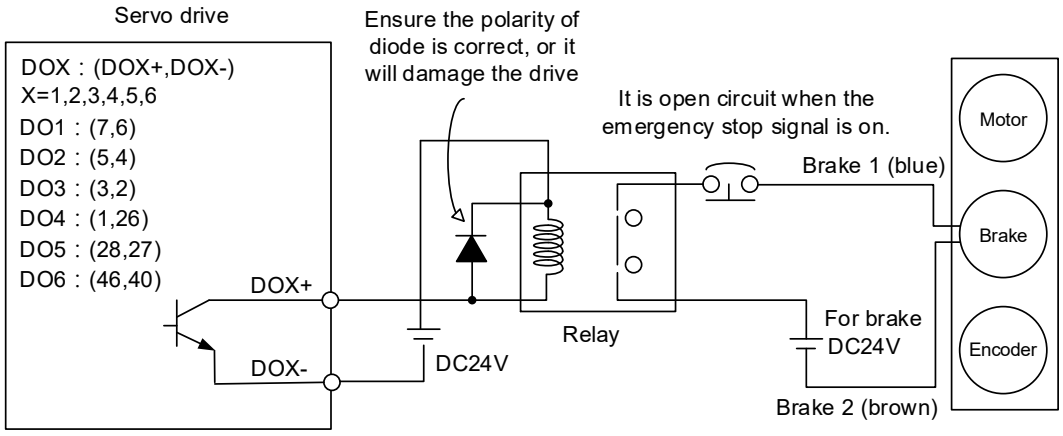
Brake Disable Delay Time or Zero Speed (whichever occurs first) will cause the brake to clamp.



Output timing of the BRKR signal:

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

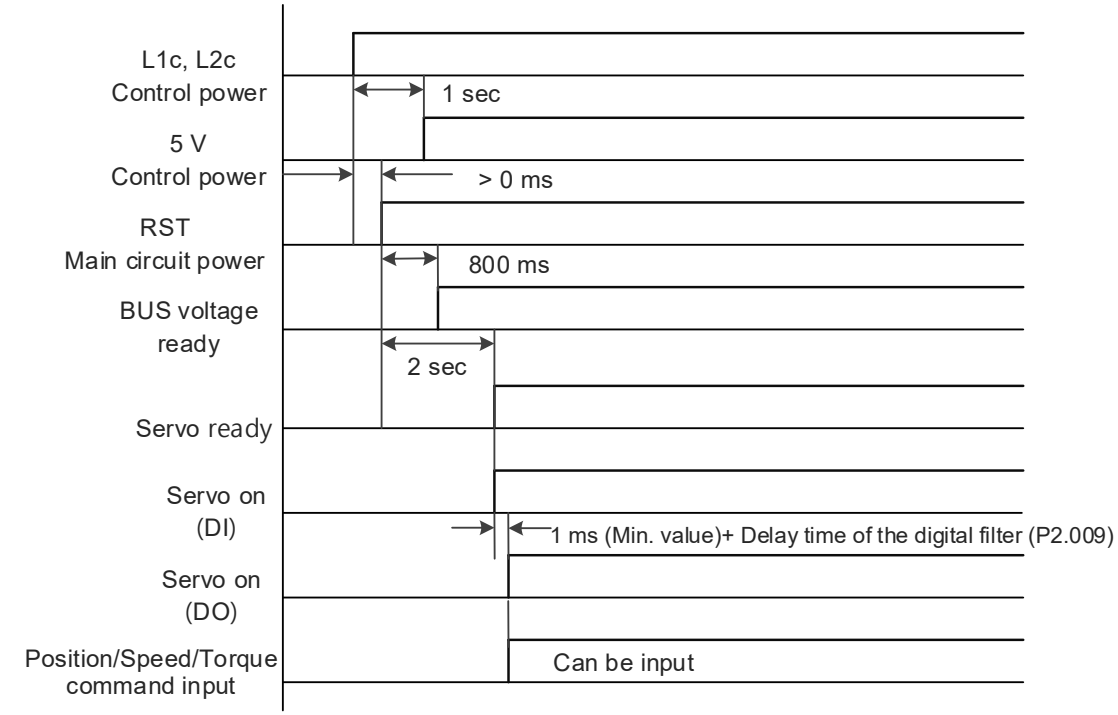
Wiring of the Brake:



Notes:

- *Please refer to Chapter 3 Wiring.*
- *Please use relay part number 781-1C-24D or equivalent.*
- *Please use diode part number AD-ASMD-250 or equivalent.*
- *The brake signal controls the solenoid, providing power to the brake and enabling the brake.*
- *Please note that there is no polarity for the coil brake. DC+ and DC- voltage can be connected to either the blue or brown wires.*

Timing diagram of control power and main power:



Calculating the brake's rated current (SV2L-204N is used as an example here).
Power consumption of the brake (20°C) = 6.5 W (refer to Appendix A Motor specifications), so the brake's rated current = (6.5 W)/24V = 0.27 A.