YASKAWA

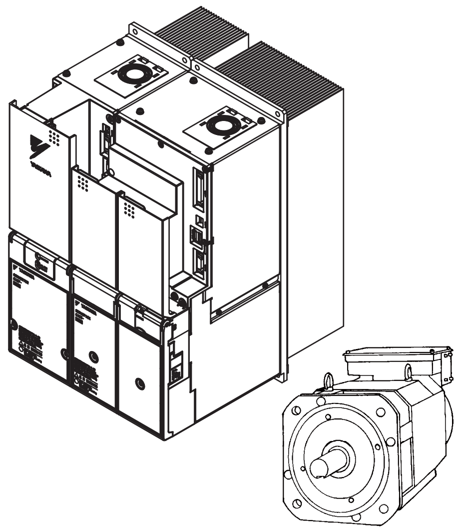
AC Servo Drives

Σ-V-SD Series

USER'S MANUAL

Speed Reference with Analog Voltage

UAK□J-□□C□□ Spindle Motor
CACP-JU□□□3□ Power Regeneration Converter
CACR-JU□□□□□D□ SERVOPACK



MANUAL NO. SIEP S800000 85E

About this Manual

This manual describes information required for designing, testing, adjusting, and maintaining Σ-V-SD Series servo drives.

Keep this manual in a location where it can be accessed for reference whenever required. Manuals outlined on the following page must also be used as required by the application.

■ Description of Technical Terms

The following table shows the meanings of terms used in this manual.

Term	Meaning
Spindle Motor or Motor	Σ-V-SD Series UAKAJ and UAKBJ motor
Power Regeneration Converter	Σ-V-SD Series CACP-JU converter
SERVOPACK	Σ-V-SD Series CACR-JU servo amplifier
Σ-V-SD Driver	A power regeneration converter and a SERVOPACK
Servo Drive	A set including a spindle motor and a Σ-V-SD driver
Servo System	A complete system that consists of a servo drive, a host controller, and peripheral devices
Servo ON	The power to the motor ON
Servo OFF	The power to the motor OFF
Base Block (BB)	The power supply to motor is turned OFF by shutting off the base current to the power transistor in the current amplifier.
Servo Lock	A state in which the motor is stopped and is in position loop with a position reference of 0.
DC-bus Voltage	The main circuit DC voltage (between P and N terminals) in a power regeneration converter and a SERVOPACK

■ IMPORTANT Explanations

The following icon is displayed for explanations requiring special attention.

IMPORTANT	• Indicates important information that should be memorized, as well as precautions, such as alarm displays, that do not involve potential damage to equipment.

■ Notation Used in this Manual

- Notation for Reverse Signals

The names of reverse signals (i.e., ones that are valid when low) are written with a forward slash (/) before the signal name.

Notation Example

$\overline{\text{HWBB1}}$ = /HWBB1

- Notation for Parameters

The notation depends on whether the parameter requires a value setting (parameter for numeric settings) or requires the selection of a function (parameter for selecting functions).

- Parameters for Numeric Settings

Control methods for which the parameter applies.
Speed : Speed control Position : Position control Torque : Torque control

Pn304	Jog Speed Speed Position Torque				Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	0 to 10000	1 min^{-1}	500	Immediately	Setup

Parameter number

Indicates the setting range for the parameter.

Indicates the minimum setting unit for the parameter.

Indicates the parameter setting before shipment.

Indicates when a change to the parameter will be effective.

Indicates the parameter classification.

- Parameters for Selecting Functions

Parameter		Meaning	When Enabled	Classification
Pn460	n.□□□0	Does not adjust 1st step notch filter automatically using utility function.	Immediately	Tuning
	n.□□□1 [Factory Setting]	Adjust 1st step notch filter automatically using utility function.		
	n.□0□□	Does not adjust 2nd step notch filter automatically using utility function.		
	n.□1□□ [Factory Setting]	Adjust 2nd step notch filter automatically using utility function.		

Parameter number

The notation "n.□□□□" indicates a parameter for selecting functions. Each □ corresponds to the setting value of that digit. The notation shown here means that the third digit is 1.

This section explains the selections for the function.

■ Manuals Related to the Σ-V-SD Series

Refer to the following manuals as required.

Name	Selecting Models and Peripheral Devices	Ratings and Specifications	System Design	Panels and Wiring	Trial Operation	Trial Operation and Servo Adjustment	Maintenance and Inspection
Σ-V-SD Series User's Manual Speed Reference with Analog Voltage (this manual)	✓	✓	✓	✓	✓	✓	✓
Σ-V-SD Series Safety Precautions (TOBP C710829 04)	✓	–	–	✓	–	–	✓
AC Servo Drives Σ-V-SD Series SAFETY PRECAUTIONS Base Mounting Unit (TOMP C710829 08)	✓	–	–	✓	–	–	✓
AC SPINDLE MOTOR/ AC SERVOMOTOR INSTRUCTIONS (TOE-C235-2)	✓	–	–	–	–	–	✓

■ Safety Information

The following conventions are used to indicate precautions in this manual. Failure to heed precautions provided in this manual can result in serious or possibly even fatal injury or damage to the products or to related equipment and systems.

⚠ WARNING	Indicates precautions that, if not heeded, could possibly result in loss of life or serious injury.
⚠ CAUTION	Indicates precautions that, if not heeded, could result in relatively serious or minor injury, damage to the product, or faulty operation. In some situations, the precautions indicated could have serious consequences if not heeded.
PROHIBITED	Indicates prohibited actions that must not be performed. For example, this symbol would be used to indicate that fire is prohibited as follows: 
MANDATORY	Indicates compulsory actions that must be performed. For example, this symbol would be used to indicate that grounding is compulsory as follows: 

Safety Precautions

This section describes important precautions that must be followed during storage, transportation, installation, wiring, operation, maintenance, inspection, and disposal. Be sure to always observe these precautions thoroughly.

⚠ WARNING

- Never touch any rotating motor parts while the spindle motor is running.
  Failure to observe this warning may result in injury.
- Before starting operation with a machine connected, make sure that an emergency stop can be applied at any time.
  Failure to observe this warning may result in injury or damage to the product.
- Never touch the inside of the power regeneration converters and SERVOPACKs.
  Failure to observe this warning may result in electric shock.
- Do not remove the cover of power supply terminal while the power is ON.
  Failure to observe this warning may result in electric shock.
- Do not touch terminals before the main-circuit capacitor has had time to discharge after the power has been turned OFF because high voltage may still remain in the power regeneration converter and SERVOPACK. Refer to *5.2.1 Main Circuit Power Supply* for the details of discharge time of main-circuit capacitor.
  Residual voltage may cause electric shock.
- Do not touch terminals while the charge indicator is lit.
  Residual voltage may cause electric shock.
  First make sure the charge indicator is turned OFF and that the DC-bus (symbol: P and N) voltage value is correct by using a tester or other device before wiring or starting an inspection.
- Do not touch terminals before the main-circuit capacitor has had time to discharge after voltage resistance test. Refer to *5.2.1 Main Circuit Power Supply* for the details of discharge time of main-circuit capacitor.
  Residual voltage may cause electric shock.
- Follow the procedures and instructions for the trial operation as noted in the applicable manual for that product.
  Malfunctions that occur after the motor is connected to the equipment not only damage the equipment, but may also cause an accident resulting in death or injury.
- Do not remove the front cover, cables, connectors, or optional items on the foreside while the power is ON.
  Failure to observe this warning may result in electric shock.
- Do not damage, press, exert excessive force or place heavy objects on the cables.
  Failure to observe this warning may result in electric shock, stopping operation of the product, or fire.
- Do not modify the product.
  Failure to observe this warning may result in injury, damage to the product, or fire.
- Provide an appropriate braking device on the machine side to ensure safety.
  Failure to observe this warning may result in injury.
- Do not come close to the machine immediately after resetting momentary power loss to avoid an unexpected restart. Take appropriate measures to ensure safety against an unexpected restart.
  Failure to observe this warning may result in injury.
- Check the following items and settings before you use the anti-resonance control adjustment function.
  - Make sure that trial operation was completed successfully.
  - Set the moment of inertia ratio (Pn103) correctly.
  - Check the SigmaWin for Σ-V-SD (MT) Operation Manual.

  There is a risk of injury or equipment damage if the above checks and settings are not performed.
- Connect the ground terminal to electrical codes (ground resistance: 100 Ω or less for a power regeneration converter and a SERVOPACK with a 200 V power supply. 10 Ω or less for a power regeneration converter and a SERVOPACK with a 400 V power supply).
  Improper grounding may result in electric shock or fire.

⚠ WARNING

- Installation, disassembly, or repair must be performed only by authorized personnel.
  Failure to observe this warning may result in electric shock or injury.
- The person who designs a system using the Hard Wire Base Block function must have full knowledge of the related safety standards and full understanding of the instructions in this manual.
  Failure to observe this warning may result in injury or damage to the product.

■ Storage and Transportation

⚠ CAUTION

- Do not store or install the product in the following places.
  - Locations subject to direct sunlight.
  - Locations subject to temperatures outside the range specified in the storage/installation temperature conditions.
  - Locations subject to humidity outside the range specified in the storage/installation humidity conditions.
  - Locations subject to condensation as the result of extreme changes in temperature.
  - Locations subject to corrosive or flammable gases.
  - Locations subject to dust, salts, or iron dust.
  - Locations subject to exposure to water, oil, or chemicals.
  - Locations subject to shock or vibration.

  Failure to observe this caution may result in fire, electric shock, or damage to the product.
- Do not hold the spindle motors by the cable, motor shaft, or encoder while transporting it.
  Failure to observe this caution may result in injury or malfunction.
- Do not hold the power regeneration converters and SERVOPACKs by the front cover or terminal cover while moving them.
  Failure to observe this caution may result in damage to the covers or in a greater possibility of the products being dropped and damaged.
- Do not place any load exceeding the limit specified on the packing box.
  Failure to observe this caution may result in injury or malfunction.
- If disinfectants or insecticides must be used to treat packing materials such as wooden frames, pallets, or plywood, the packing materials must be treated before the product is packaged, and methods other than fumigation must be used.
  Example: Heat treatment, where materials are kiln-dried to a core temperature of 56°C for 30 minutes or more.
  If the electronic products, which include stand-alone products and products installed in machines, are packed with fumigated wooden materials, the electrical components may be greatly damaged by the gases or fumes resulting from the fumigation process. In particular, disinfectants containing halogen, which includes chlorine, fluorine, bromine, or iodine can contribute to the erosion of the capacitors.

■ Installation

⚠ CAUTION

- Never use the products in an environment subject to water, corrosive gases, inflammable gases, or combustibles.

  Failure to observe this caution may result in electric shock or fire.
- Do not step on or place a heavy object on the product.

  Failure to observe this caution may result in injury or malfunction.
- Do not cover the inlet or outlet ports and prevent any foreign objects from entering the product.

  Failure to observe this caution may cause internal elements to deteriorate resulting in malfunction or fire.
- Be sure to install the product in the correct direction.

  Failure to observe this caution may result in malfunction.
- Provide the specified clearances between the power regeneration converter and the inside surface of the control panel and between the SERVOPACK and the inside surface of the control panel, and keep both the converter and the SERVOPACK sufficiently separated from all other devices.

  Failure to observe this caution may result in fire or malfunction.
- Do not apply any strong impact.

  Failure to observe this caution may result in malfunction.
- Provide sufficient space so that cooling air will be provided to the cooling fan. Keep a space of at least 100 mm between the machine and the ventilation outlet of the motor.

  If ventilation is not proper, the motor temperature fault protective function will work regardless of whether or not the load is at the rated value or not.
- Install the motor in a clean location free from oil mist and water drops. If the motor is likely to come in contact with water or oil, protect the motor with a cover.

  The intrusion of water or dirty oil into the interior of the motor will decrease the insulation resistance, which may result in a ground fault.
- Check that the mounting bed, base, or stand of the motor is of robust construction.

  The weight of the motor as well as the dynamic load of the motor in operation will be imposed on it, possibly causing vibration.

■ Wiring

⚠ CAUTION

- Be sure to wire correctly and securely.
  Failure to observe this caution may result in motor overrun, injury, or malfunction.
- Do not bundle the main circuit cable and the encoder cable together.
  Failure to observe this caution may result in malfunction.
- The maximum wiring length is 3 m for I/O signal cables, 20 m for encoder cables or motor main circuit cables, and 10 m for control power supply cables (+24 V, 0 V).
- Take appropriate and sufficient countermeasures for each when installing systems in the following locations.
  - Locations subject to static electricity or other forms of noise.
  - Locations subject to strong electromagnetic fields and magnetic fields.
  - Locations subject to possible exposure to radioactivity.
  - Locations close to power supplies.

  Failure to observe this caution may result in damage to the product.
- Wiring or inspection must be performed by a technical expert.
- Do not connect a commercial power supply to the U, V, or W motor connection terminals.
  Failure to observe this caution may result in injury or fire.
- Do not connect the spindle motor directly to an industrial power supply.
  Failure to observe this caution may damage the spindle motor. Connect the spindle motor to the correct SERVOPACK.
- Securely connect the power supply terminal screws and motor connection terminal screws.
  Failure to observe this caution may result in fire.
- Do not touch the power terminals before the main-circuit capacitor has had time to discharge because high voltage may still remain in the power regeneration converter and SERVOPACK. Refer to *5.2.1 Main Circuit Power Supply* for the details of discharge time of main-circuit capacitor.
  First make sure the charge indicator is turned OFF and that the DC-bus (symbol: P and N) voltage value is correct by using a tester or other device before wiring or starting an inspection.
- Observe the following precautions when wiring main circuit terminal blocks.
  - Do not turn the servo drive power ON until all wiring, including the main circuit terminal blocks has been completed.
  - If the main circuit terminal is the connector, remove the connector from the SERVOPACK before wiring.
  - Insert only one wire per insertion slot on the terminal block and the connector.
  - Make sure that the core wire is not electrically shorted to adjacent core wires.
- Always use the specified power supply voltage.
  An incorrect voltage may result in fire.
- Make sure that the polarity is correct.
  Incorrect polarity may cause ruptures or damage.
- Take appropriate measures to ensure that the input power supply is supplied within the specified voltage fluctuation range. Be particularly careful in places where the power supply is unstable.
  An incorrect power supply may result in damage to the product.
- Install external breakers or other safety devices against short-circuiting in external wiring.
  Failure to observe this caution may result in fire.
- For the control power supply, use a 24-VDC power supply with double insulation or reinforced insulation against primary. Make sure that the output holding time is 100 ms or more.
- Use twisted-pair shielded wires or multi-core twisted pair shielded wires for input/output signal cables and the encoder cables.

Operation

⚠ CAUTION

- Always use the spindle motor and SERVOPACK in one of the specified combinations.
  Failure to observe this caution may result in fire or malfunction.
- Conduct trial operation on the motor alone with the motor shaft disconnected from machine to avoid any unexpected accidents.
  Failure to observe this caution may result in injury.
- Secure system safety against problems such as signal line disconnection.
  Failure to observe this caution may result in injury or damage to the product.
- Before starting operation with a machine connected, change the settings to match the parameters of the machine.
  Starting operation without matching the proper settings may cause the machine to run out of control or malfunction.
- Avoid frequently turning the power ON and OFF.
  Since the Σ-V-SD driver have a capacitor in the power supply, a high charging current flows when power is turned ON. Frequently turning the power ON and OFF causes main power devices like capacitors and fuses in the power regeneration converter and the SERVOPACK to deteriorate more quickly, resulting in unexpected problems.
- Make sure that the motor constants for the spindle motors being used match the parameters of the SERVOPACKs before supplying power when driving spindle motors.
  Failure to observe this caution may result in injury, fire, and damage to the product.
- Do not use the spindle motor for a vertical axis.
  Failure to observe this caution may damage the Servo Drive.
- Do not touch the power regeneration converter and SERVOPACK heat sinks or spindle motor while the power is ON or soon after the power is turned OFF.
  Failure to observe this caution may result in burns due to high temperatures.
- Do not make any extreme adjustments or setting changes of parameters.
  Failure to observe this caution may result in injury or damage to the product.
- When an alarm occurs, remove the cause, clear the alarm after confirming safety, and then resume operation.
  Failure to observe this caution may result in damage to the product, fire, or injury.
- Do not use the servo drive under a load moment of inertia exceeding the maximum allowable value.
  Failure to observe this caution may result in damage or malfunction of resistors and power devices in the SERVOPACK.

Maintenance and Inspection

⚠ CAUTION

- Do not disassemble the power regeneration converter and SERVOPACK.
  Failure to observe this caution may result in electric shock or injury.
- Do not attempt to change wiring while the power is ON.
  Failure to observe this caution may result in electric shock or injury.
- When replacing the SERVOPACK, resume operation only after transferring the previous SERVOPACK parameters to the new SERVOPACK.
  Failure to observe this caution may result in damage to the product.

Disposal

⚠ CAUTION

- When disposing of the products, treat them as ordinary industrial waste.

■ General Precautions

Observe the following general precautions to ensure safe application.
• The products shown in illustrations in this manual are sometimes shown without covers or protective guards. Always replace the cover or protective guard as specified first, and then operate the products in accordance with the manual. • The drawings presented in this manual are typical examples and may not match the product you received. • If the manual must be ordered due to loss or damage, inform your nearest Yaskawa representative or one of the offices listed on the back of this manual.

Warranty

(1) Details of Warranty

■ Warranty Period

The warranty period for a product that was purchased (hereinafter called “delivered product”) is one year from the time of delivery to the location specified by the customer or 18 months from the time of shipment from the Yaskawa factory, whichever is sooner.

■ Warranty Scope

Yaskawa shall replace or repair a defective product free of charge if a defect attributable to Yaskawa occurs during the warranty period above. This warranty does not cover defects caused by the delivered product reaching the end of its service life and replacement of parts that require replacement or that have a limited service life.

This warranty does not cover failures that result from any of the following causes.

1. Improper handling, abuse, or use in unsuitable conditions or in environments not described in product catalogs or manuals, or in any separately agreed-upon specifications
2. Causes not attributable to the delivered product itself
3. Modifications or repairs not performed by Yaskawa
4. Abuse of the delivered product in a manner in which it was not originally intended
5. Causes that were not foreseeable with the scientific and technological understanding at the time of shipment from Yaskawa
6. Events for which Yaskawa is not responsible, such as natural or human-made disasters

(2) Limitations of Liability

1. Yaskawa shall in no event be responsible for any damage or loss of opportunity to the customer that arises due to failure of the delivered product.
2. Yaskawa shall not be responsible for any programs (including parameter settings) or the results of program execution of the programs provided by the user or by a third party for use with programmable Yaskawa products.
3. The information described in product catalogs or manuals is provided for the purpose of the customer purchasing the appropriate product for the intended application. The use thereof does not guarantee that there are no infringements of intellectual property rights or other proprietary rights of Yaskawa or third parties, nor does it construe a license.
4. Yaskawa shall not be responsible for any damage arising from infringements of intellectual property rights or other proprietary rights of third parties as a result of using the information described in catalogs or manuals.

(3) Suitability for Use

1. It is the customer's responsibility to confirm conformity with any standards, codes, or regulations that apply if the Yaskawa product is used in combination with any other products.
2. The customer must confirm that the Yaskawa product is suitable for the systems, machines, and equipment used by the customer.
3. Consult with Yaskawa to determine whether use in the following applications is acceptable. If use in the application is acceptable, use the product with extra allowance in ratings and specifications, and provide safety measures to minimize hazards in the event of failure.
   - Outdoor use, use involving potential chemical contamination or electrical interference, or use in conditions or environments not described in product catalogs or manuals
   - Nuclear energy control systems, combustion systems, railroad systems, aviation systems, vehicle systems, medical equipment, amusement machines, and installations subject to separate industry or government regulations
   - Systems, machines, and equipment that may present a risk to life or property
   - Systems that require a high degree of reliability, such as systems that supply gas, water, or electricity, or systems that operate continuously 24 hours a day
   - Other systems that require a similar high degree of safety
4. Never use the product for an application involving serious risk to life or property without first ensuring that the system is designed to secure the required level of safety with risk warnings and redundancy, and that the Yaskawa product is properly rated and installed.
5. The circuit examples and other application examples described in product catalogs and manuals are for reference. Check the functionality and safety of the actual devices and equipment to be used before using the product.
6. Read and understand all use prohibitions and precautions, and operate the Yaskawa product correctly to prevent accidental harm to third parties.

(4) Specifications Change

The names, specifications, appearance, and accessories of products in product catalogs and manuals may be changed at any time based on improvements and other reasons. The next editions of the revised catalogs or manuals will be published with updated code numbers. Consult with your Yaskawa representative to confirm the actual specifications before purchasing a product.

Contents

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Outline

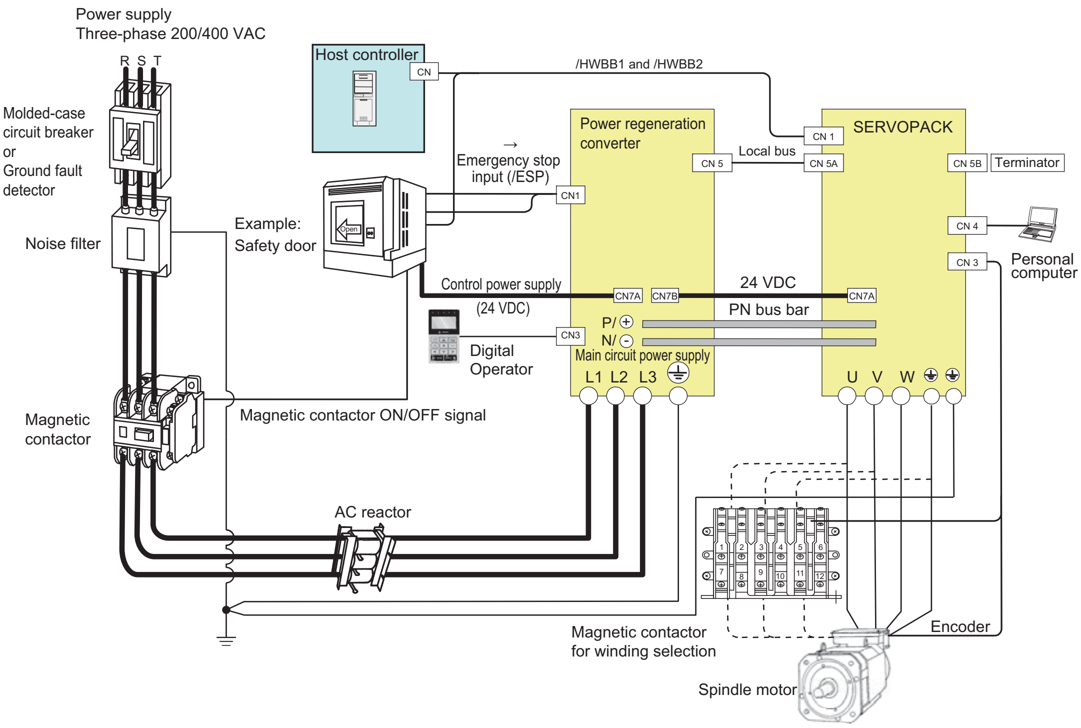
1.1 The Σ-V-SD Series

Σ-V-SD-series SERVOPACKs are designed for machine tool applications that require high-precision machining and saving energy.

They enable maximum utilization of machine performance in minimal time while contributing to increased productivity and equipment downsizing.

Σ-V-SD-series SERVOPACKs are available for power regeneration converters and spindle operation.

1.2 System Configurations



1.3 Model Designation

1.3.1 Spindle Motor

Number of Digits: 1 2 3 4 5 6 7 8 9 10 11 12 13 14

U A K A J - 2 2 C Z 1 O O E

1st + 2nd digits:
Motor Type

Code	Specifications
UA	AC Spindle Motor

3th digit: Cooling Method

Code	Specifications
K	External fan cooled

4th digit: Winding System

Code	Specifications
A	Single winding
B	Winding selection

5th digit: Series

Code	Specifications
J	Σ-V-SD Series

7th + 8th digits:
50% ED Rating (S3)

Code	Specifications (kW)
04*1	3.7
06	5.5
08	7.5
11	11
15	15
19	18.5
22	22
30*2	30
37*1, *2	37
45*1, *2	45

9th digit:
Design Revision Order

Code	Specifications
C	Standard

10th digit: Encoder Specifications

Code	Specifications
Z	Pulse encoder

11th digit: Mounting

Code	Specifications
1	Flange type
3	Foot-mounted type

12th digit: Shaft End

Code	Specifications
O Blank	Straight with key and tap
N	Straight without key and tap

13th digit: Lead Wire Orientation

Code	Specifications
O Blank	Left when viewed from the load side

14th digit: Input Voltage

Code	Specifications
Blank	Three-phase 200 VAC
E	Three-phase 400 VAC

*1. Available only for single winding models.
*2. Available only for three-phase 200 VAC models.

1.3.2 Σ-V-SD Series Driver

(1) Power Regeneration Converter

Number of Digits: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

CACP-JU22A3□□□□□□□□

1st + 2nd + 3rd + 4th + 5th + 6th + 7th digits: Series

Code	Specifications
CACP-JU	Σ-V-SD Series Power Regeneration Converter

8th + 9th digits: 50% ED Rating

Code	Specifications (kW)
15	15
19	18.5
22	22
30*1	30
37*1	37
45*1	45

10th digit: Input Voltage

Code	Specifications
A	Three-phase 200 VAC
D	Three-phase 400 VAC

11th digit: Regeneration Method

Code	Specifications
3	120-degree conduction

12th digit: Design Revision Order *2
A, B, C • • •

13th digit: Mounting

Code	Specifications
Blank	Duct-ventilated
B*3	Base-mounted

14th to 19th digits: Custom-made *4

Code	Specifications
Blank	Standard

*1. Available only for three-phase 200 VAC models.
*2. Models that conform to UL standards have design revision order B or later. For details, refer to *12.2 Models That Are Compliant with International Standards*.
*3. Applicable only for CACP-JU□□A3BB using three-phase, 200 VAC input voltage.
*4. For details about custom-made converters, contact your Yaskawa representative.

(2) SERVOPACK

Number of Digits: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

CACR-JU102ADA□□□□□□□

1st + 2nd + 3rd + 4th + 5th + 6th + 7th digits: Series

Code	Specifications
CACR-JU	Σ-V-SD Series SERVOPACK

8th + 9th + 10th digits: Rated Output Current

Code	Specifications (Arms)	Input Voltage
028	28	270 VDC
036	36	
065	65	
084	84	
102	102	
125	125	
196	196	
014	14	540 VDC
018	18	
033	32.5	
042	42	
051	51	

11th digit: Input Voltage

Code	Specifications
A	270 VDC
D	540 VDC

12th digit: Interface Specifications

Code	Specifications
D	Analog speed reference

13th digit: Design Revision Order
A, B, C • • •

14th digit: Mounting

Code	Specifications
Blank	Duct-ventilated
B*1	Base-mounted

15th to 20th digits: Custom-made *2

Code	Specifications
Blank	Standard

*1. Available only for CACR-JU□□□ADAB model.
*2. For details about custom-made converters, contact your Yaskawa representative.

2

Compatible Devices

2.1 Combinations

2.1.1 SERVOPACK and Spindle Motor

Model	Input Voltage	Spindle Motor	
		UAKAJ-	UAKBJ-
		Single Winding	Winding Selection
CACR-JU028ADA	270 VDC	04, 06	06
CACR-JU036ADA		08	08
CACR-JU065ADA		11, 15	11, 15
CACR-JU084ADA		19	19
CACR-JU102ADA		22	22
CACR-JU125ADA		30	30
CACR-JU196ADA		37, 45	–
CACR-JU014DDA	540 VDC	04, 06	06
CACR-JU018DDA		08	08
CACR-JU033DDA		11, 15	11, 15
CACR-JU042DDA		19	19
CACR-JU051DDA		22	22

2.1.2 Power Regeneration Converter, SERVOPACK, and Spindle Motor

Use one of each of the following power regeneration converter, SERVOPACK, and spindle motor.
Some restrictions apply when using these combinations. Use the information in the following table when determining the combination of devices.

- The continuous output of spindle motor ≤ the continuous output capacity of the power regeneration converter.
- The output of spindle motor < the instantaneous maximum output capacity of the power regeneration converter.
- The continuous rated output capacity of SERVOPACK ≤ the continuous output capacity of the power regeneration converter.

*1. The continuous output capacity and the instantaneous maximum output capacity for individual models of power regeneration converters are shown in this table.

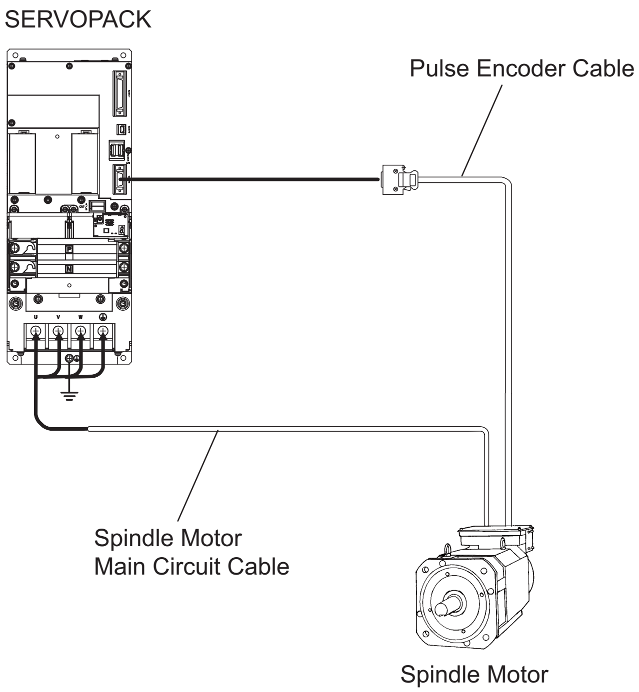
Power Regeneration Converter Model	Continuous Output Capacity (kW)		Instantaneous Maximum Output Capacity (kW)
	Ambient Temperature 40°C or less	Ambient Temperature 40 to 55°C	
CACP-JU15A3☐	11	7.7	37.5
CACP-JU19A3☐	15	10.5	46.3
CACP-JU22A3☐	18.5	12.95	55
CACP-JU30A3☐	22	15.4	75
CACP-JU45A3B	37	25.9	112.5
CACP-JU37A3B	30	23.1	92.5
CACP-JU15D3☐	11	7.7	37.5
CACP-JU19D3☐	15	10.5	46.3
CACP-JU22D3☐	18.5	12.95	55

*2. The continuous rated capacity for individual models of SERVOPACKs is shown in this table. These are not product specifications. Use this information to calculate to determine whether or not the selected combination of devices complies with the recommended operating conditions described above.

SERVOPACK Model	Continuous Rated Capacity (kW)
CACR-JU028ADA	3.7
CACR-JU036ADA	5.5
CACR-JU065ADA	11
CACR-JU084ADA	15
CACR-JU102ADA	18.5
CACR-JU125ADA	22
CACR-JU196ADA	37
CACR-JU014DDA	3.7
CACR-JU018DDA	5.5
CACR-JU033DDA	11
CACR-JU042DDA	15
CACR-JU051DDA	18.5

2.2 Selecting Cables

2.2.1 Spindle Motor



(1) Main Circuit Cable

The main circuit cable for the spindle motor must be assembled by customers. The main circuit cable for the spindle motor consists of the following two parts.

- Cable-end connectors to SERVOPACKs
- Cable

Note: All models of spindle motors have screw terminals for the connection of main-circuit cables. For details, refer to *5.1.2 (1) Main Circuit Cable Wiring*.

Use the following information on specifications to select appropriate parts.

■ Specifications for Cable-end Connectors to SERVOPACKs

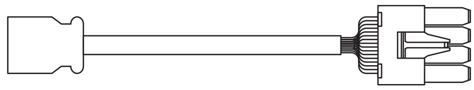
SERVOPACK Model	Connector Housing Model	Electrical Contact Model	Wire Size	Manufacturer
CACR-JU028ADA	1-917807-2	1318697-6	AWG8	Tyco Electronics Japan G.K.
CACR-JU036ADA	DK-5200S-04R	DK-5RECLLP1 (D3)	AWG8	DDK Ltd.
CACR-JU014DDA	1-917807-2	316041-6	AWG12	Tyco Electronics Japan G.K.
CACR-JU018DDA	DK-5200S-04R	DK-5RECMLP1-100	AWG10	DDK Ltd.

Note: For other SERVOPACKs, they have screw terminals. For details, refer to *5.2.1 (1) Wire Sizes and Tightening Torques*.

■ Cables

A 600 V heat-resistant vinyl cable is recommended. Select an appropriate size of cable for the spindle motor and the SERVOPACK used. For details, refer to *5.1.2 (1) Main Circuit Cable Wiring* and *5.2.1 (1) Wire Sizes and Tightening Torques*.

(2) Pulse Encoder Cable

Name	Length	Order No.	External Appearance
Pulse Encoder Cable for Spindle Motor	2 m	JZSP-CJP00-02-E	
	3 m	JZSP-CJP00-03-E	
	5 m	JZSP-CJP00-05-E	
	10 m	JZSP-CJP00-10-E	
	15 m	JZSP-CJP00-15-E	
	20 m	JZSP-CJP00-20-E	

Use the following information to select appropriate parts when assembling a pulse encoder cable.

■ Specifications for Cable-end Connectors to SERVOPACKs

Name	Model	Manufacturer
Connector Plug	54331-0201	Molex Japan LLC
Electrical Contact	54306-2019	

Note: This cable-end connector is equivalent to and can be used as substitute for the 10120-6000LE connector made by 3M Japan Limited.

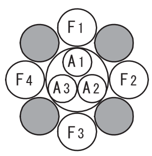
■ Specifications for Cable-end Connectors to Spindle Motors

The cable-end connector to the spindle motor is stored in the motor's terminal box upon delivery.

Name		Model	Manufacturer
Connector		ELP-12V	J.T.S Mfg. Co., Ltd.
Electrical Contact	Other pins	LLF-01T-P1.3E*	
	No.10 pin	LLF-41T-P1.3E*	

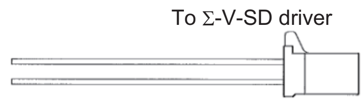
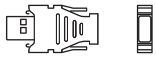
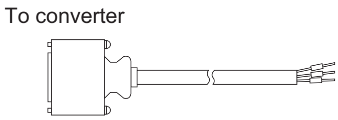
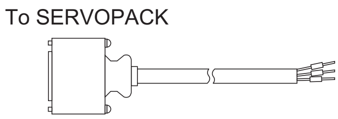
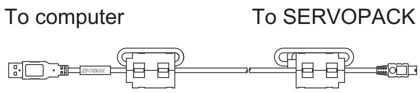
* The YC-202 crimping tool is required. Contact J.T.S. Mfg. Co., Ltd. for more information.

■ Cable Specifications

Items	Standard Type
Order No.	B9400064-1-E (3 m)
	B9400064-2-E (5 m)
	B9400064-3-E (10 m)
	B9400064-4-E (15 m)
	B9400064-5-E (20 m)
General Specifications	KQVV-SW: AWG22 × 3 (three colors) AWG26 × 4 (four twisted-pair)
Finished Dimensions	7.5 mm dia.
Internal Configuration and Lead Color	 A1: Red A2: Black A3: Yellow green F1: Blue and white - twisted-pair wire F2: Yellow and white - twisted pair wire F3: Green and white - twisted pair wire F4: Orange and white - twisted pair wire
Available Cable Lengths (Yaskawa Standards)	3 m, 5 m, 10 m, 15 m, 20 m

2.2.2 Σ-V-SD Driver

(1) Cables for Σ-V-SD Drivers

Name	Length	Order No.	External Appearance	Reference
Cable for 24-volt control power supply • With loose leads on one end • Connects one Σ-V-SD driver to 24-volt control power supply	1 m	JZSP-CNG00-01-E		2.2.2 (2)
	2 m	JZSP-CNG00-02-E		
	3 m	JZSP-CNG00-03-E		
Cable for 24-volt control power supply • With connectors on both ends • Connects two Σ-V-SD drivers	0.2 m	JZSP-CNG01-A2-E		2.2.2 (3)
	0.3 m	JZSP-CNG01-A3-E		
Cables for local bus communications	0.5 m	JUPIT-W6004-A5		2.2.2 (4)
Terminating resister for local bus	–	JUPIT-W6024		2.2.2 (5)
Cable for converter I/O	1 m	JZSP-CJI01-1-E		2.2.2 (6)
	2 m	JZSP-CJI01-2-E		
	3 m	JZSP-CJI01-3-E		
Cable for SERVOPACK I/O*1	1 m	JZSP-CSI01-1-E		2.2.2 (7)
	2 m	JZSP-CSI01-2-E		
	3 m	JZSP-CSI01-3-E		
Cable for analog monitor*2	1 m	JZSP-CA01-E		2.2.2 (8)
Cable for personal computer connection*2	2.5 m	JZSP-CVS06-02-E		2.2.2 (9)

∗1. When customers assembly the SERVOPACK I/O cable, refer to *2.2.2 (7) I/O Cable Specifications for SERVOPACKs* to select appropriate parts.
∗2. Required for maintenance work.

(2) Cable Specifications for 24-V Control Power Supply (With loose leads at one end and connects a Σ-V-SD driver to a 24-V control power supply)

Items	Specifications
Order No. *	JZSP-CNG00-□□-E
Cable Length	1 m, 2 m, 3 m
Cable and Connector	Cable : UL1015 AWG14 Cable-end connector to driver : 175362-1 (PIN: 353717-2)

∗ Specify the cable length in □□ of the order number.
Example: JZSP-CNG00-01-E (1 m)

(3) Cable Specifications for 24-volt Control Power Supply (With connectors on both ends and connects two Σ-V-SD drivers)

Items	Specifications
Order No. *1	JZSP-CNG01-A□-E
Cable Length*2	0.2 m, 0.3 m
Cable and Connector	Cable : UL1015 AWG14 Connector : 175362-1 (PIN: 353717-2) Connector manufacturer : Tyco Electronics Japan G.K.

∗1. Specify the cable length in □ of the order number.
Example: JZSP-CNG01-A2-E (0.2 m)
∗2. When using CACP-JU45A3B converter, use 0.3 m-cable.

(4) Cable Specifications for Local Bus Communications

Items	Specifications
Order No.	JUPIT-W6004-A5
Cable Length	0.5 m
Cable	HRZFVV-ESB (20276)
Remarks	The total number of cables must equal to the total number of SERVOPACKs used.

(5) Cable Specifications for Terminating Resistor of the Local Bus

Items	Specifications
Order No.	JUPIT-W6024
Remarks	Connect the terminating resistor only to the SERVOPACK on the far right.

(6) Cable Specifications for Converter I/O Signals

Items	Specifications
Order No. *	JZSP-CJI01-□-E
Cable Length	1 m, 2 m, 3 m
Cable and Connector	Cable : HP-SB/20276SR #28 × 6P Cable-end connector for external device : 10114-6000EL (Crimping type)
Remarks	Used for emergency stop.

∗ Specify the cable length in □ of the order number.
Example: JZSP-CJI01-1-E (1 m)

(7) I/O Cable Specifications for SERVOPACKs

Items	length	Specifications
Order No.	1 m	JZSP-CSI01-1-E
	2 m	JZSP-CSI01-2-E
	3 m	JZSP-CSI01-3-E
Cable and connector		Cable : SSRFPVV-SB AWG#28 × 25P UL20276 VW-1SC Shell : 10350-52A0-008 (3M Japan Limited) Connector : 10150-6000EL (Crimping type, 3M Japan Limited)*
Remarks		Used for input signals

* The soldered type is 10150-3000PE (3M Japan Limited).

(8) Cable Specifications for Use with an Analog Monitor

Items	Specifications
Order No.	JZSP-CA01-E
Cable length	1 m
Connectors	Cable : STYLE 1007 AWM E74037 AWG24 VW-1 Connector : DF11-4DS-2C
Remarks	Used for analog output signals, such as speed reference and torque reference.

(9) Cable Specifications for Use with a Computer

Items	Specifications
Order No.	JZSP-CVS06-02-E
Cable length	2.5 m
Connectors	Cable-end connector to SERVOPACK : USB Type miniB Cable-end connector to computer : USB Type A
Remarks	Used to connect a SERVOPACK with a personal computer in which SigmaWin for Σ-V-SD (MT) is installed.

2.3 Peripheral Devices

2.3.1 Molded-case Circuit Breakers, Ground Fault Detectors, and Magnetic Contactors

Always install a circuit breaker to protect the main circuits. The type of circuit breaker that is required depends on what you need to detect.

Detecting only overcurrent: Use a molded-case circuit breaker.

Detecting overcurrent and leakage current: Use a ground fault detector that detects overloads and leakage current. Or, use a molded-case circuit breaker together with a ground fault detector that detects only leakage current.

⚠ WARNING

- Always install a molded-case circuit breaker or ground fault detector in the main circuit.
  Failure to observe this warning may result in electric shock, equipment damage, or fire.

(1) Molded-case Circuit Breaker

A molded-case circuit breaker shuts OFF the power supply when it detects an overcurrent. Install a molded-case circuit breaker between the power supply and the main circuit power supply input terminals (R/L1, S/L2, and T/L3).

Select the molded-case circuit breaker based on the information of power supply capacity per power regeneration converter, input current (50%ED, continuous ratings), and inrush current in *(4) Converter Input Current and Inrush Current*.

(2) Ground Fault Detector

A ground fault detector detects leakage current. Some models will also detect overcurrent in addition to leakage current. Use the type that is suitable for your application. Install a ground fault detector between the power supply and the main circuit power supply input terminals (R/L1, S/L2, and T/L3).

Recommended ground fault detector: A ground fault detector with harmonic countermeasures and a rated sensed current of 30 mA or higher for each power regeneration converter. A ground fault detector with harmonic countermeasures removes leakage current for harmonics and detects only leakage current in the frequency range that presents a hazard to humans. If you use a ground fault breaker that does not have harmonic countermeasures, the leakage current from the harmonics will increase the chance of malfunctions.

Select the ground fault detector based on the information of power supply capacity per power regeneration converter, input current (50%ED, continuous ratings), and inrush current in *(4) Converter Input Current and Inrush Current*.

(3) Magnetic Contactors

The magnetic contactor for the control circuit power supply turns the control circuit power supply ON and OFF. The magnetic contactor for the main circuit power supply turns the main circuit power supply ON and OFF. Use a magnetic contactor (MC) to turn OFF the control power supply or main circuit power supply sequence.

Note: If the magnetic contactor on the main circuit power supply input is turned ON and OFF frequently, the Σ-V-SD servo driver may be damaged. Do not turn the power supply ON and OFF with the magnetic contactor more than one time every 30 minutes.

Select the magnetic contactor based on the information of power supply capacity per power regeneration converter, input current (50%ED, continuous ratings), and inrush current in *(4) Converter Input Current and Inrush Current*.

(4) Converter Input Current and Inrush Current

Voltage	Capacity (50%ED) kW	Capacity (Continuous Ratings) kW	Power Regeneration Converter Model	Power Supply Capacity per Power Regeneration Converter (kVA)	Input Current (50%ED) Arms	Input Current (Continuous Ratings) Arms	Inrush Current (Main Circuit) $A_{0\text{-}P}$
200 V	15	11	CACP-JU15A3□	22.5	73	54	83
	18.5	15	CACP-JU19A3□	30.5	90	73	83
	22	18.5	CACP-JU22A3□	37.5	107	90	83
	30	22	CACP-JU30A3□	45.0	145	107	178
	37	30	CACP-JU37A3B	61.5	179	145	178
	45	37	CACP-JU45A3B	75.0	218	179	178
400 V	15	11	CACP-JU15D3□	22.5	36	27	173
	18.5	15	CACP-JU19D3□	30.5	45	36	173
	22	18.5	CACP-JU22D3□	37.5	53	45	173

2.3.2 Surge Absorbers

A surge absorber absorbs the energy that is stored in the coil of an inductive load to suppress noise. Always use surge absorbers or diodes on all inductive loads that are connected near the Σ-V-SD servo driver. (Inductive loads include magnetic contactors, magnetic relays, magnetic valves, solenoids, and magnetic brakes.)

IMPORTANT

- Select a surge absorber with a capacity that is sufficient for the coil in the inductive load.
- Always install surge absorbers. If you do not install surge absorbers, the surge voltage from the coil that occurs when the inductive load is turned ON and OFF will affect the SERVOPACK control signal lines and could cause incorrect signals.

2.3.3 AC Reactor

Make sure to install an AC reactor, which corresponds to the capacity of the individual power regeneration converter, to each power regeneration converter.
Do not connect any equipment other than the power regeneration converter to the secondary side of the AC reactor. If this caution is not observed, an overcurrent may occur in the power regeneration converter. An AC reactor is effective in improving the power factor of the power supply side.

Select an AC reactor based on the following table.

Power Regeneration Converter		AC Reactor Model
Input Voltage	Model	
Three-phase, 200 VAC	CACP-JU15A3□	X008017
	CACP-JU19A3□	X008018
	CACP-JU22A3□	X008019
	CACP-JU30A3□	X008020
	CACP-JU37A3B	X008029
	CACP-JU45A3B	X008022
Three-phase, 400 VAC	CACP-JU15D3□	X008010*
		X008023
	CACP-JU19D3□	X008011
	CACP-JU22D3□	X008012

* This AC reactor does not comply with UL standards.

2.3.4 Magnetic Contactor for Winding Selection

A magnetic contactor for winding selection is needed only if a winding selection motor is used as the spindle motor.

Select a magnetic contactor for winding selection based on the following table.

SERVOPACK		Magnetic Contactor* for Winding Selection	
		Model	
Input Voltage	Model	Standard	For UL Compliance
270 VDC	CACR-JU028ADA	HV-75AP4	HV-75AP4/UL
	CACR-JU036ADA		
	CACR-JU065ADA		
	CACR-JU084ADA	HV-150AP4	HV-150AP4/UL
	CACR-JU102ADA		
	CACR-JU125ADA		
	CACR-JU196ADA	HV-200AP4	HV-200AP4/UL
540 VDC	CACR-JU014DDA	HV-75AP4	HV-75AP4/UL
	CACR-JU018DDA		
	CACR-JU033DDA		
	CACR-JU042DDA	HV-150AP4	HV-150AP4/UL
	CACR-JU051DDA		

* Model numbers for contactors with safety covers are HV-□AP4S and HV-□AP4S/UL.

2.3.5 Noise Filter

A noise filter installed on the power supply side eliminates noise leaking from the main circuit power line to the Σ-V-SD driver. The filter also reduces the noise leaking from the Σ-V-SD driver to the main circuit power line.

Use a noise filter designed to suppress harmonic noise. Do not use general-purpose noise filters, because their effectiveness is minimal when used with the Σ-V-SD driver.

Install a noise filter at the input side of the power regeneration converter.

Yaskawa recommends the following noise filters.

Power Regeneration Converter		Noise Filter
Input Voltage	Model	Model
Three-phase 200 VAC	CACP-JU15A3□	HF3060C-SZC-47EDD
	CACP-JU19A3□	HF3080C-SZC-47EDD
	CACP-JU22A3□	HF3100C-SZC-47EDD
	CACP-JU30A3□	HF3150C-SZC-47EDD
	CACP-JU37A3B	HF3150C-SZC-47EDD
	CACP-JU45A3B	HF3200C-SZC-49EDE*
Three-phase 400 VAC	CACP-JU15D3□	HF3030C-SZC-47EDD
	CACP-JU19D3□	HF3040C-SZC-47EDD
	CACP-JU22D3□	HF3050C-SZC-47EDD

* Also use the following compact AC power supply block-type capacitor (X capacitor).
Compact AC power supply block-type capacitor (X capacitor) model: LDA106M-AA (Soshin Electric Co., Ltd.)

IMPORTANT

Some noise filters have large leakage currents. Leakage current is also greatly affected by ground conditions. If you use a ground fault detector, consider the ground conditions and the leakage current of the noise filter when you select one.

Ask the manufacturer of the noise filter for details.

2.3.6 Base Mounting Units

When mounting Servo Drives to bases, mount them together with the following Base Mounting Units.

(1) Power Regeneration Converters

Power Regeneration Converter		Base Mounting Unit
Input Voltage	Model*	Model
Three-phase 200 VAC	CACP-JU15A3☐	JUSP-JUBM100AA
	CACP-JU19A3☐	
	CACP-JU22A3☐	
	CACP-JU30A3☐	JUSP-JUBM150AA
	CACP-JU37A3B	
	CACP-JU45A3B	JUSP-JUBM250AA
Three-phase 400 VAC	CACP-JU15D3☐	JUSP-JUBM100AA
	CACP-JU19D3☐	
	CACP-JU22D3☐	

* The box at the end of the model numbers indicates the design order (A, B, C, etc.). Compliance with UL standards starts with design order B.

(2) SERVOPACK

SERVOPACK		Base Mounting Unit
Input Voltage	Model	Model
270 VDC	CACR-JU028ADA	JUSP-JUBM050AA
	CACR-JU036ADA	
	CACR-JU065ADA	JUSP-JUBM075AA
	CACR-JU084ADA	JUSP-JUBM150AA
	CACR-JU102ADA	
	CACR-JU125ADA	
	CACR-JU196ADA	JUSP-JUBM250AA
540VDC	CACR-JU014DDA	JUSP-JUBM050AA
	CACR-JU018DDA	
	CACR-JU033DDA	JUSP-JUBM075AA
	CACR-JU042DDA	JUSP-JUBM150AA
	CACR-JU051DDA	

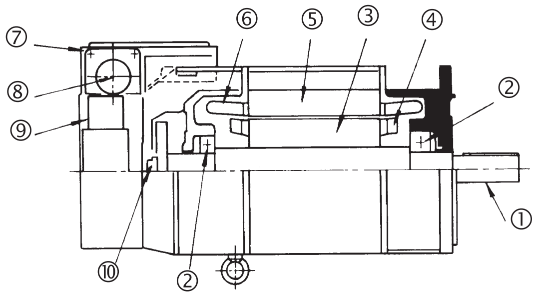
3

Specifications and External Dimensions

3.1 Spindle Motor

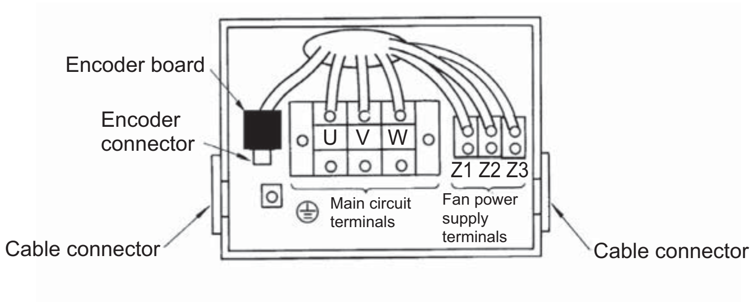
(1) Configuration

The motor configuration is shown in the following diagram.



Motor Configuration

Number	Name	Number	Name
①	Output shaft (Motor shaft)	⑥	Stator winding
②	Bearings	⑦	Terminal box
③	Rotor	⑧	Cable socket
④	Rotor short-circuit ring	⑨	Cooling fan
⑤	Stator	⑩	Encoder



Terminal and Connector Arrangement

Encoder Connector

Number	Terminal	Number	Terminal
1	DC+5 V	7	PC
2	0 V	8	/PC
3	PA	9	FG (Frame Ground)
4	/PA	10	SS (Shield)
5	PB	11	TS
6	/PB	12	

Model: ELR-12V
Manufacturer: J.S.T.Mfg.Co.,Ltd.
Note: A crimp tool is required.

Motor Connector

(2) Ratings and Specifications

■ Single-winding Motor

Items		Model: UAKAJ-□□C (200 V), -□□C□□□□E (400 V)									
		04	06	08	11	15	19	22	30 *2	37 *2	45 *2
50% ED Rating (S3) *1	kW	3.7	5.5	7.5	11	15	18.5	22	30	37	45
Continuous Rating (S1)	kW	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37
Continuous Rated Torque	N·m	14	24	35	48	70	96	118	183	249	307
Base Speed	min^{-1}	1500							1150		
Maximum Speed	min^{-1}	10000				7000			6000		5000
Moment of Inertia	$\times 10^{-3}$ $kg{\cdot}m^2$	7.1	14.0	21.0	25.0	69.0	69.0	89.0	231	266	398
Vibration		V5									V10
Noise	dB (A)	75 or less							80 or less		
Cooling Method		Totally enclosed, external fan cooled									
Protection Class		IP44 (IEC34-5)									
Cooling Fan Motor		Equipped with thermostat (automatic reset) 200 V class: Three-phase 200 V 50/60 Hz, 220 V 50/60 Hz, 230 V 60 Hz 400 V class: Three-phase 400 V 50/60 Hz, 440 V 50/60 Hz, 460 V 60 Hz									
Encoder (Magnetic)		Pulse encoder (1024 p/r) (standard)									
Overheating Protection		NTC thermistor									
Installation		Flange type: IM B5, IM V1 (output shaft from horizontal to vertically down) Foot-mounted type: IM B3 (installed on floor)									
Overload Capacity		200% of continuous rated (S1) output for 10 s (UAKAJ-08, -37: 180% of continuous rated (S1) output for 10 s)									
Thermal Class		F									
Withstand Voltage		200 V class: 1500 VAC for one minute 400 V class: 1800 VAC for one minute									
Insulation Resistance		500 V DC 10 MΩ min.									
Ambient Temperature and Ambient Humidity		0°C to 40°C, 20% to 80% RH (no condensation)									
Altitude		1000 m or less									
Bearing Lubrication		Grease									
Paint Color		Munsell N1.5									
Compliant Standards		JIS, JEC									
Applicable SERVOPACK CACR-JU□□□	Three-phase 200 V AC	028A	028A	036A	065A	065A	084A	102A	125A	196A	196A
	Three-phase 400 V AC	014D	014D	018D	033D	033D	042D	051D	–	–	–

∗1. The 50% ED rating (S3) is for a 10 minute cycle consisting of 5 minutes of operation and 5 minutes stopped.
∗2. Available only for three-phase, 200 VAC models.

■ Winding Selection Motor

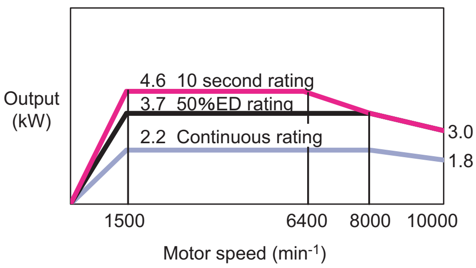
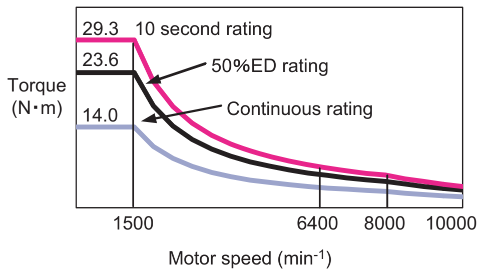
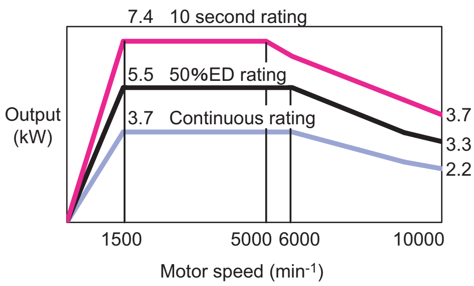
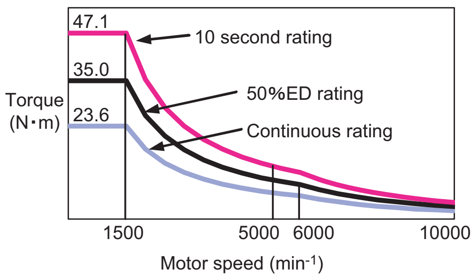
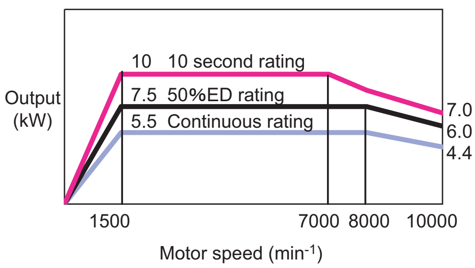
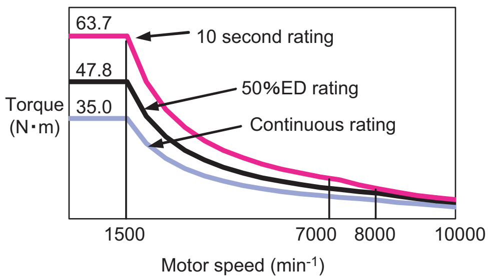
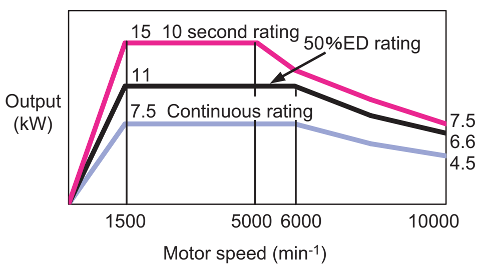
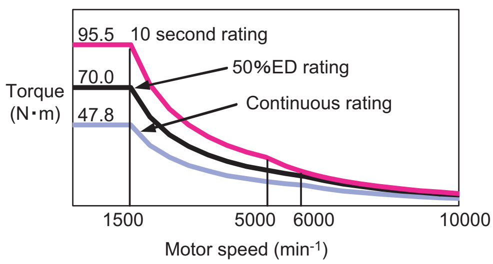
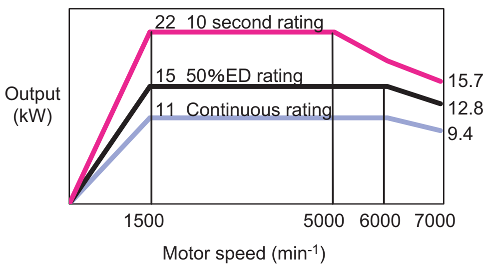
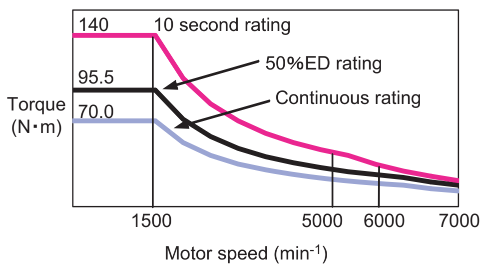
Items			Model: UAKBJ-□□C (200 V), -□□C□□□□E (400 V)						
			06	08	11	15	19	22	30*2
50% ED Rating (S3)*1		kW	5.5	7.5	11	15	18.5	22	30
Continuous Rating (S1)		kW	3.7	5.5	7.5	11	15	18.5	20
Continuous Rated Torque		N·m	71	105	143	263	249	307	332
Base Speed		min^{-1}	500			400	575		
Maximum Speed		min^{-1}	7000			6000			5000
Moment of Inertia		$\times 10^{-3}$ $kg \cdot m^2$	69.0	69.0	89.0	231.0	231.0	266.0	398.0
Vibration			V5						V10
Noise		dB (A)	75 or less			80 or less			
Cooling Method			Totally enclosed, external fan cooled						
Protection Class			IP44 (IEC34-5)						
Cooling Fan Motor			Equipped with thermostat (automatic reset) 200 V class: Three-phase 200 V 50/60 Hz, 220 V 50/60 Hz, 230 V 60 Hz 400 V class: Three-phase 400 V 50/60 Hz, 440 V 50/60 Hz, 460 V 60 Hz						
Encoder (Magnetic)			Pulse encoder (1024 p/r) (standard)						
Overheating Protection			NTC thermistor						
Installation			Flange type: IM B5, IM V1 (output shaft from horizontal to vertically down) Foot-mounted type: IM B3 (installed on floor)						
Overload Capacity			200% of continuous rated (S1) output for 10 s						
Thermal Class			F						
Withstand Voltage			200 V class: 1500 VAC for one minute 400 V class: 1800 VAC for one minute						
Insulation Resistance			500 V DC 10 MΩ min.						
Ambient Temperature and Ambient Humidity			0°C to 40°C, 95% RH or less (no condensation)						
Altitude			1000 m or less						
Bearing Lubrication			Grease						
Paint Color			Munsell N1.5						
Compliant Standards			JIS, JEC						
Applicable SERVOPACK CACR-JU□□□	Three-phase 200 V AC		028A	036A	065A	065A	084A	102A	125A
	Three-phase 400 V AC		014D	018D	033D	033D	042D	051D	–

∗1. The 50% ED rating (S3) is for a 10 minute cycle consisting of 5 minutes of operation and 5 minutes stopped.
∗2. Available only for three-phase, 200 VAC models.

(3) Output and Torque Characteristics

The output and torque characteristics for spindle motors are shown below.

■ Single-winding Motors

Model UAKAJ-	Output Characteristics	Torque Characteristics
04C		
06C		
08C		
11C		
15C		

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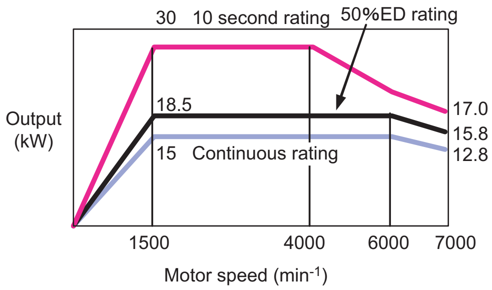
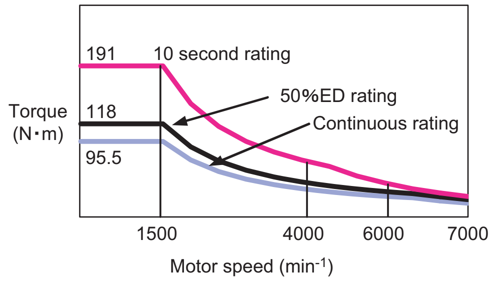
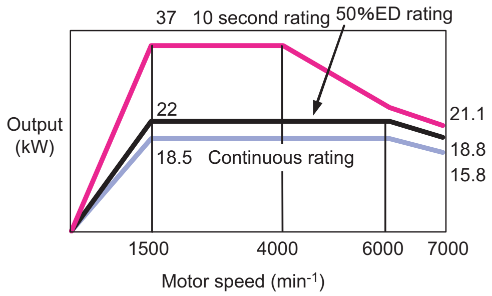
Model UAKAJ-	Output Characteristics	Torque Characteristics

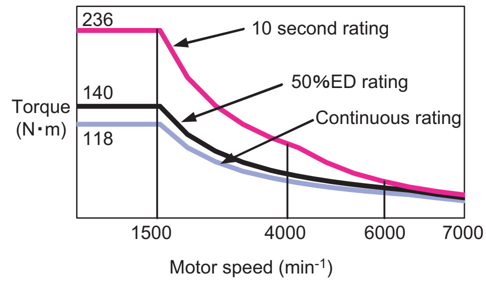
19C



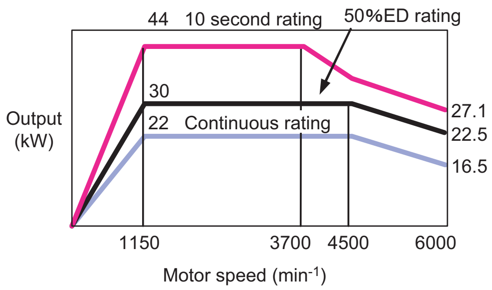


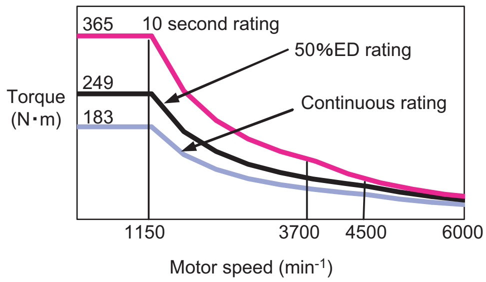
22C



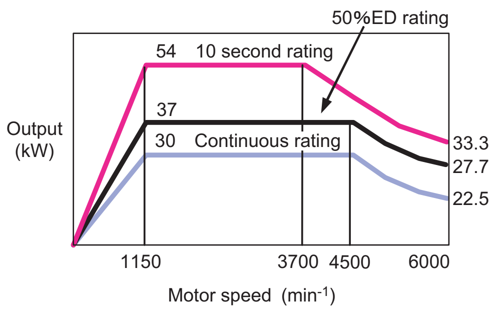


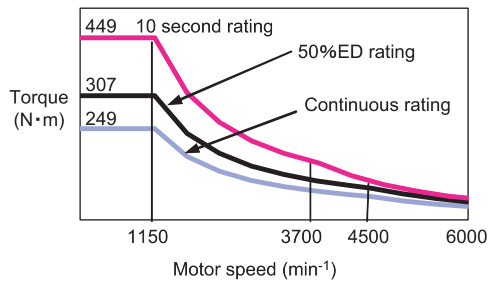
30C



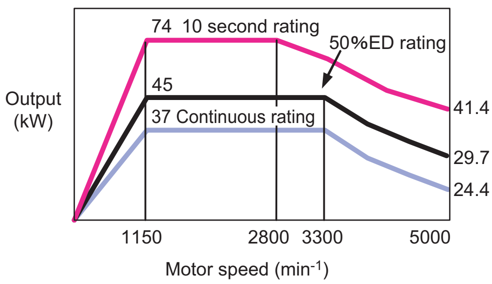


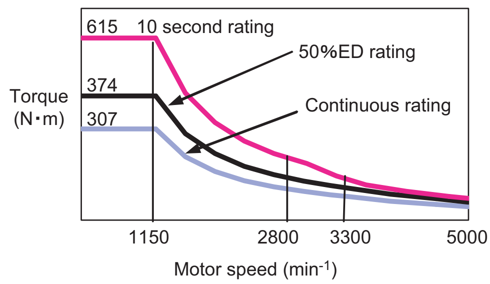
37C





45C





■ Winding Selection Motors

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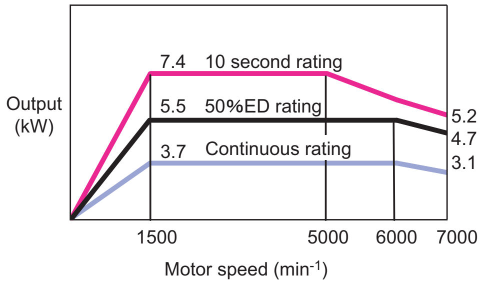
<tr><th>Model
UAKBJ-</th><th>Output Characteristics</th><th>Torque Characteristics</th></tr>
<tr><td rowspan="2">06C</td><td>High-speed winding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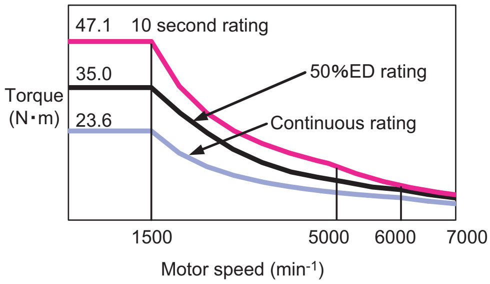
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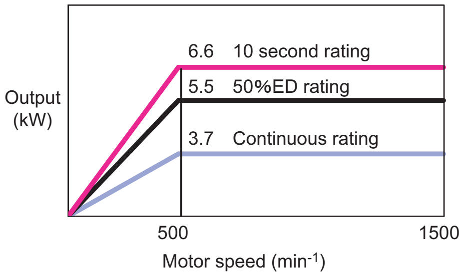
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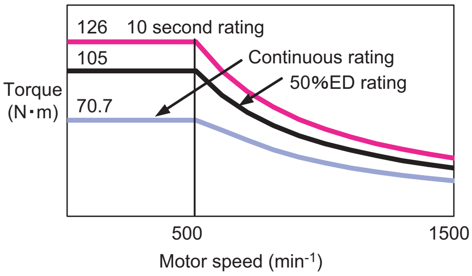
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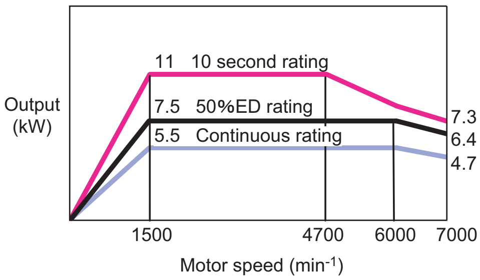
<tr><td rowspan="2">08C</td><td>High-speed winding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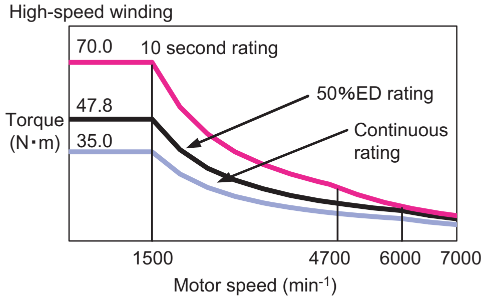
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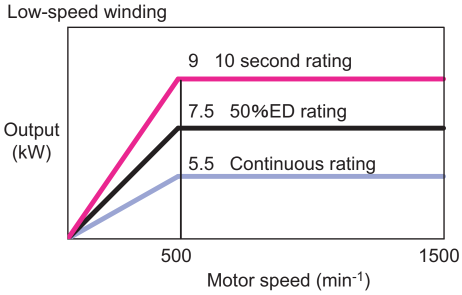
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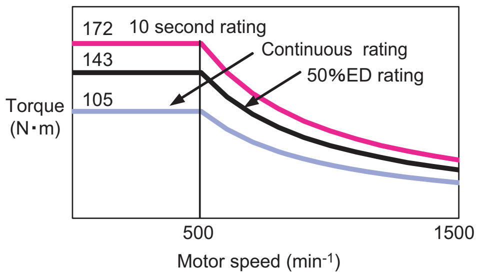
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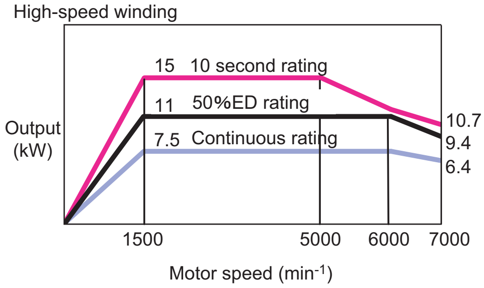
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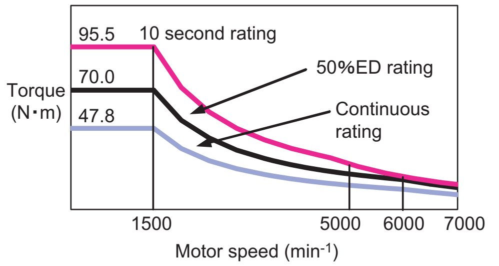
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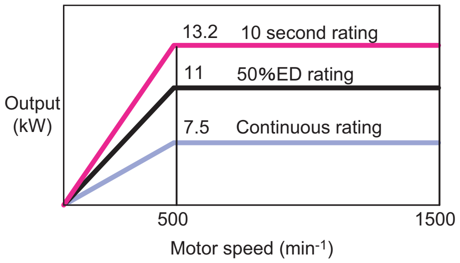
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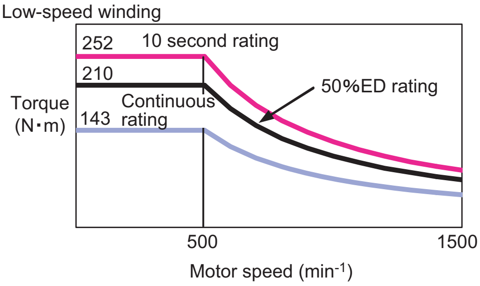
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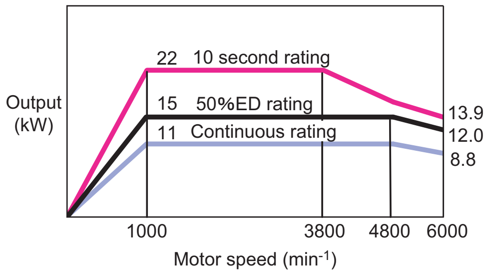
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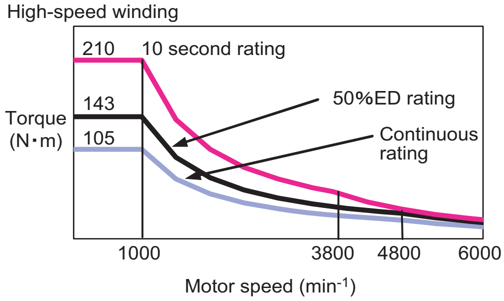
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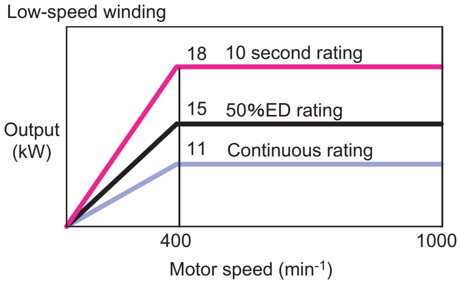
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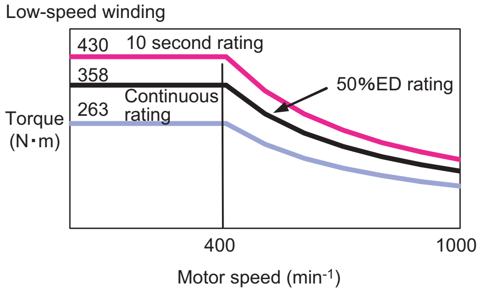
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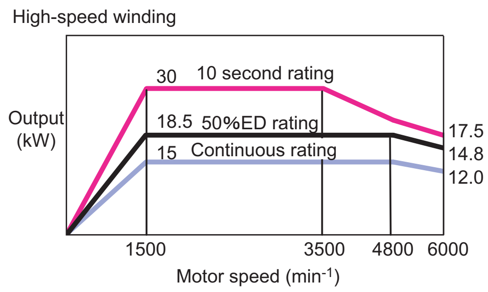
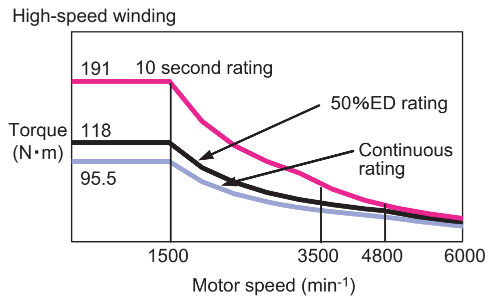
<tr><td rowspan="2">19C</td><td>
</td><td>
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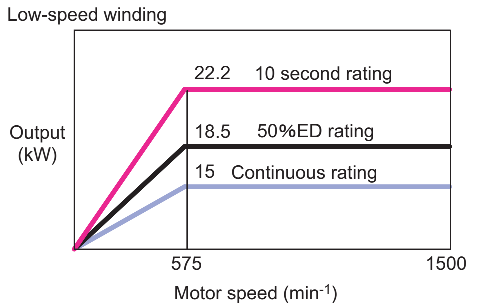
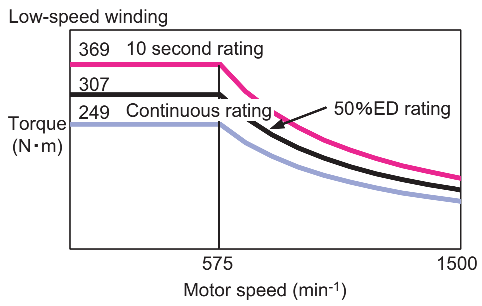
<tr><td>
</td><td>
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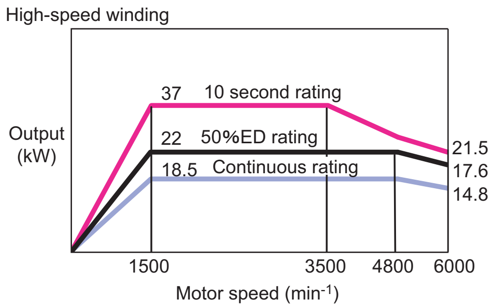
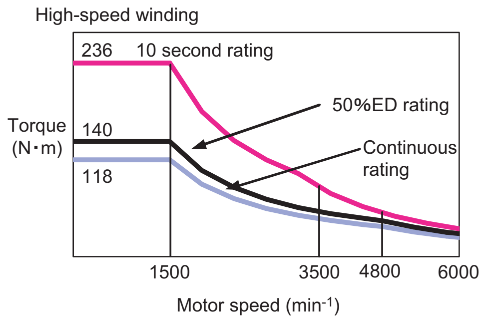
<tr><td rowspan="2">22C</td><td>
</td><td>
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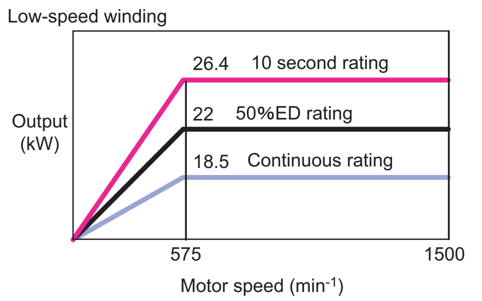
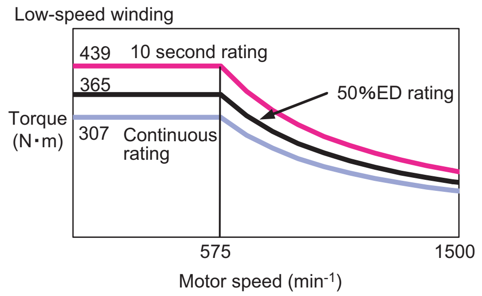
<tr><td>
</td><td>
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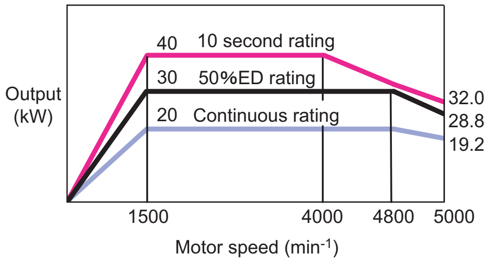
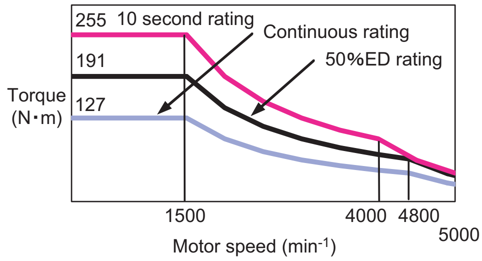
Model UAKBJ-	Output Characteristics	Torque Characteristics
30C	(see below)	(see below)

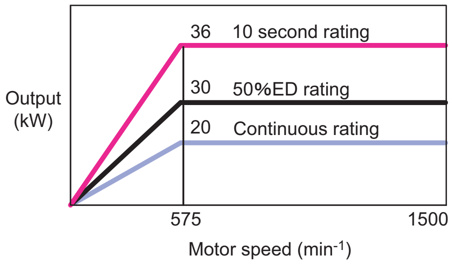
30C — Output Characteristics — High-speed winding



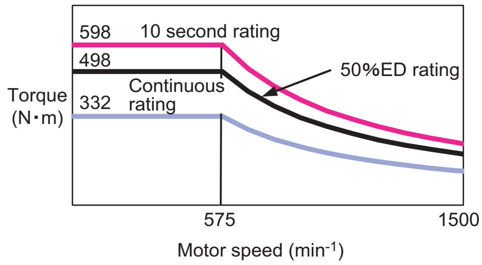
30C — Torque Characteristics — High-speed winding



30C — Output Characteristics — Low-speed winding



30C — Torque Characteristics — Low-speed winding



(4) Tolerance Radial Loads

The tolerance radial loads for spindle motors are shown in the following table.

Model: UAKAJ-, UAKBJ-	Rated Output (kW) 50%ED Rating/ Continuous Rating	Tolerance Radial Load (N)	
		Single-winding Motor Model: UAKAJ-□□C	Winding Selection Motor Model: UAKBJ-□□C
04	3.7/2.2	1180	–
06	5.5/3.7	1180	2940
08	7.5/5.5	1470	2940
11	11/7.5	1470	3530
15	15/11	2940	4410
19	18.5/15	2940	4410
22	22/18.5	3530	4900
30*1	30/22*2	4410	5200
37*1	37/30	4900	–
45*1	45/37	5200	–

∗1. Available only for three-phase, 200 VAC models.
∗2. The rated output for the winding selection motor is 30/20 kW.

(5) Motor Total Indicator Readings

The motor TIR (Total Indicator Reading) are shown in the following tables.

■ Flange Type

Item	Model		Accuracy
	Single-winding Motor: UAKAJ-□□	Winding Selection Motor: UAKBJ-□□	
Right Angle to the Flange Output Shaft	04 to 22	06 to 11	0.04 mm
	30, 37	15	0.06 mm
	45	19 to 30	0.072 mm
Coaxiality of Flange External Diameter to the Output Shaft	04 to 11	–	0.04 mm
	15 to 22	06 to 11	0.046 mm
	30, 37	15	0.048 mm
	45	19 to 30	0.070 mm
Shaft Vibration	04 to 08	–	0.02 mm
	11 to 22	06 to 11	0.022 mm
	30 to 45	15 to 30	0.028 mm

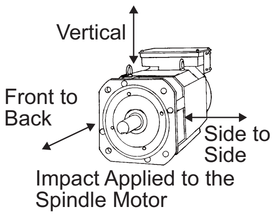
■ Foot-mounted Type

Item	Model		Accuracy
	Single-winding Motor: UAKAJ-□□	Winding Selection Motor: UAKBJ-□□	
Shaft Parallelism	04 to 08	–	0.03 mm
	11 to 22	06 to 11	0.033 mm
	30 to 45	15 to 30	0.042 mm
Shaft Vibration	04 to 08	–	0.02 mm
	11 to 22	06 to 11	0.022 mm
	30 to 45	15 to 30	0.028 mm

(6) Rotation Direction

Forward rotation of the spindle motor is counterclockwise when viewed from the load. For more information on how to change the direction of rotation, refer to *9.2.2 Spindle Motor Rotation Direction*.

(7) Vibration Resistance



The spindle motor will withstand the following vibration acceleration in three directions: Vertical, side to side, and front to back.

Spindle Motor		Vibration Acceleration at Flange	Vibration Frequency	
Winding System	Model		Constant Amplitude	Constant Acceleration
Single winding	UAKAJ-04 to -22	24.5 m/s^2	10 to 60 Hz	6 to 2500 Hz
	UAKAJ-30, 37	19.6 m/s^2		
	UAKAJ-45	4.9 m/s^2		
Winding Selection	UAKBJ-06, 08, -11	24.5 m/s^2		
	UAKBJ-15 to -22	19.6 m/s^2		
	UAKBJ-30	4.9 m/s^2		

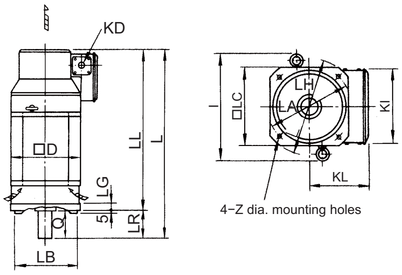
IMPORTANT

The amount of vibration the spindle motor endures will vary depending on the application. Check the vibration acceleration being applied to your motor for each application.

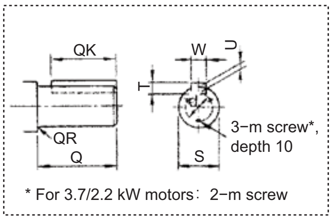
(8) External Dimensions

■ Single-winding Motors

• Flange type



Shaft Extension



Unit: mm

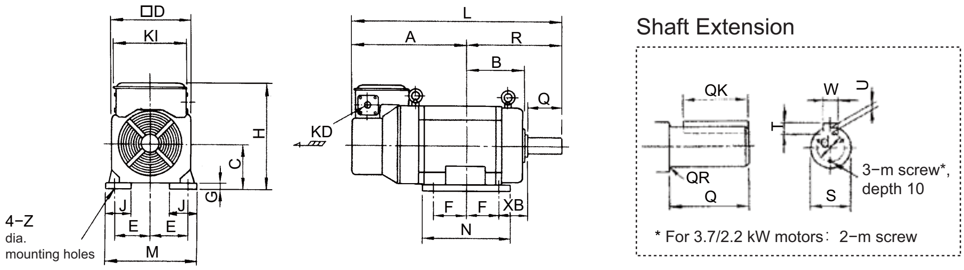
Unit: mm

Model UAKAJ-	L	LA	LB	LC	LG	LH	LL	LR	Z	D	I	KD	KL	KI
04	375	185	$150^{0}_{-0.04}$	174	12	220	315	60	11	174	–	34	142	174
06	467	185	$150^{0}_{-0.04}$	174	12	220	407	60	11	174	–	34	142	174
08	496	215	$180^{0}_{-0.04}$	204	16	250	416	80	15	204	270	42.5	158	207
11	556	215	$180^{0}_{-0.04}$	204	16	250	446	110	15	204	270	42.5	158	207
15	568	265	$230^{0}_{-0.046}$	250	20	300	458	110	15	260	343	42.5	181	250
19	568	265	$230^{0}_{-0.046}$	250	20	300	458	110	15	260	343	42.5	181	250
22	632	265	$230^{0}_{-0.046}$	250	20	300	522	110	15	260	343	42.5	181	250
30	769	350	$300^{0}_{-0.052}$	320	20	385	629	140	19	320	440	61	227	320
37	809	350	$300^{0}_{-0.052}$	320	20	385	669	140	19	320	440	61	227	320
45	797	400	$350^{0}_{-0.057}$	370	22	450	657	140	24	380	504	61	315	388

Model UAKAJ-	Shaft End Dimensions									Approx. Mass kg
	Q	QK	QR	S	T	U	W	d	m	
04	60	45	1	$28^{0.009}_{-0.004}$	7	4	8	16	M6	29
06	60	45	1	$28^{0}_{-0.013}$	7	4	8	22	M4	47
08	80	70	2	$32^{0}_{-0.016}$	8	5	10	22	M5	52
11	110	90	0.5	$48^{0}_{-0.016}$	9	5.5	14	40	M5	59
15	110	90	1	$48^{0}_{-0.016}$	9	5.5	14	40	M5	94
19	110	90	1	$48^{0}_{-0.016}$	9	5.5	14	40	M5	94
22	110	90	1	$55^{0.030}_{0.011}$	10	6	16	45	M5	120
30	140	110	2	$60^{0.030}_{0.011}$	11	7	18	50	M6	220
37	140	110	2	$60^{0.030}_{0.011}$	11	7	18	50	M6	250
45	140	110	1	$70^{0.030}_{0.011}$	12	7.5	20	60	M6	310

Note 1. The shaft key and the keyway are standard JIS B 1301-1996 models.
2. The figures are provided only to explain the dimensions. The actual appearance of the spindle motor may vary.

• Foot-mounted type`



Unit: mm

Unit: mm

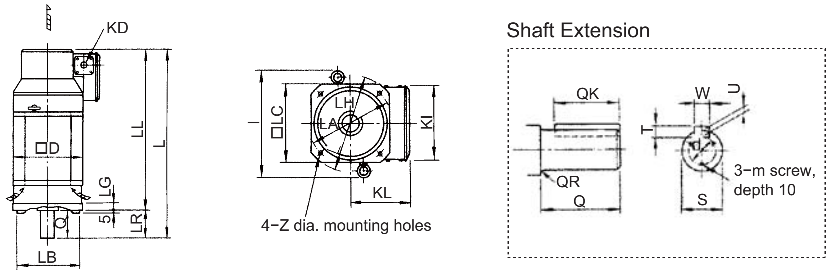
Model UAKAJ-	A	B	C	D	E	F	G	H	J	KD	L	M	N	R
04	230	83	$100^{0}_{-0.5}$	174	80	40	9	242	34	34	375	188	106	145
06	292	113	$100^{0}_{-0.5}$	174	80	70	9	242	34	34	467	188	168	175
08	286	117	$112^{0}_{-0.5}$	204	95	50	10	269	75	42.5	486	220	129	200
11	296	137	$112^{0}_{-0.5}$	204	95	70	10	269	75	42.5	546	220	177	250
15	261	196	$160^{0}_{-0.5}$	260	127	89	16	341	55	42.5	568	290	223	307
19	261	196	$160^{0}_{-0.5}$	260	127	89	16	341	55	42.5	568	290	223	307
22	307	212	$160^{0}_{-0.5}$	260	127	105	16	341	55	42.5	630	290	255	323
30	381	246	$180^{0}_{-0.5}$	320	139.5	127	16	407	55	61	769	320	298	388
37	421	246	$180^{0}_{-0.5}$	320	139.5	127	16	407	55	61	809	320	298	388
45	377	273	$225^{0}_{-0.5}$	380	178	127	21	540	75	61	793	420	370	416

Model UAKAJ-	XB	Z	KI	Shaft End Dimensions									Approx. Mass kg
				Q	QK	QR	S	T	U	W	d	m	
04	45	12	174	60	45	1	$28^{0.009}_{-0.004}$	7	4	8	16	M6	30
06	45	12	174	60	45	1	$28^{0}_{-0.013}$	7	4	8	22	M4	49
08	70	12	207	80	70	2	$32^{0}_{-0.016}$	8	5	10	22	M5	56
11	70	12	207	110	90	0.5	$48^{0}_{-0.016}$	9	5.5	14	40	M5	64
15	108	15	250	110	90	1	$48^{0}_{-0.016}$	9	5.5	14	40	M5	110
19	108	15	250	110	90	1	$48^{0}_{-0.016}$	9	5.5	14	40	M5	110
22	108	15	250	110	90	1	$55^{0.030}_{0.011}$	10	6	16	45	M5	130
30	121	19	320	140	110	2	$60^{0.030}_{0.011}$	11	7	18	50	M6	230
37	121	19	320	140	110	2	$60^{0.030}_{0.011}$	11	7	18	50	M6	260
45	149	24	388	140	110	1	$70^{0.030}_{0.011}$	12	7.5	20	60	M6	320

Note 1. The shaft key and the keyway are standard JIS B 1301-1996 models.
2. The figures are provided only to explain the dimensions. The actual appearance of the spindle motor may vary.

■ Winding Selection Motors

• Flange type



Unit: mm

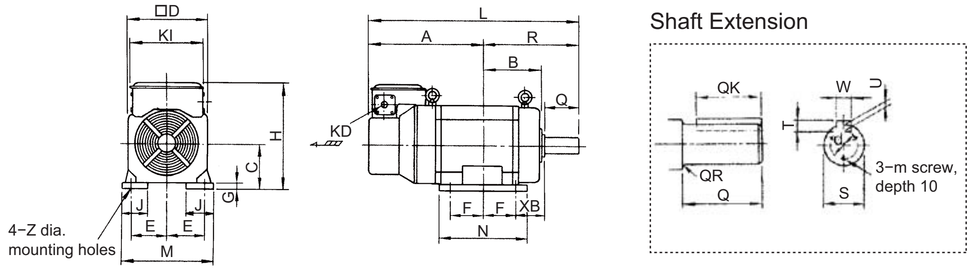
Unit: mm

Model UAKBJ-	L	LA	LB	LC	LG	LH	LL	LR	Z	D	I	KD	KL	KI
06	568	265	$230^{0}_{-0.046}$	250	20	300	458	110	15	260	343	42.5	181	250
08	568	265	$230^{0}_{-0.046}$	250	20	300	458	110	15	260	343	42.5	181	250
11	632	265	$230^{0}_{-0.046}$	250	20	300	522	110	15	260	343	42.5	181	250
15	769	350	$300^{0}_{-0.052}$	320	20	385	629	140	19	320	440	61	227	320
19	769	350	$300^{0}_{-0.052}$	320	20	385	629	140	19	320	440	61	227	320
22	809	350	$300^{0}_{-0.052}$	320	20	385	669	140	19	320	440	61	227	320
30	797	400	$350^{0}_{-0.057}$	370	22	450	657	140	24	380	504	61	315	388

Model UAKBJ-	Shaft End Dimensions									Approx. Mass kg
	Q	QK	QR	S	T	U	W	d	m	
06	110	90	1	$48^{0}_{-0.016}$	9	5.5	14	40	M5	94
08	110	90	1	$48^{0}_{-0.016}$	9	5.5	14	40	M5	94
11	110	90	1	$55^{0.030}_{0.011}$	10	6	16	45	M5	120
15	140	110	2	$60^{0.030}_{0.011}$	11	7	18	50	M6	220
19	140	110	2	$60^{0.030}_{0.011}$	11	7	18	50	M6	220
22	140	110	2	$60^{0.030}_{0.011}$	11	7	18	50	M6	250
30	140	110	1	$70^{0.030}_{0.011}$	12	7.5	20	60	M6	310

Note 1. The shaft key and the keyway are standard JIS B 1301-1996 models.
2. The figures are provided only to explain the dimensions. The actual appearance of the spindle motor may vary.

- Foot-mounted type



Unit: mm

Unit: mm

Model UAKBJ-	A	B	C	D	E	F	G	H	J	KD	L	M	N	R
06	261	196	$160^{0}_{-0.5}$	260	127	89	16	341	55	42.5	568	290	223	307
08	261	196	$160^{0}_{-0.5}$	260	127	89	16	341	55	42.5	568	290	223	307
11	307	212	$160^{0}_{-0.5}$	260	127	105	16	341	55	42.5	630	290	255	323
15	381	246	$180^{0}_{-0.5}$	320	139.5	127	16	407	55	61	769	320	298	388
19	381	246	$180^{0}_{-0.5}$	320	139.5	127	16	407	55	61	769	320	298	388
22	421	246	$180^{0}_{-0.5}$	320	139.5	127	16	407	55	61	809	320	298	388
30	376.5	273	$225^{0}_{-0.5}$	380	178	127	21	540	75	61	792.5	420	370	416

Model UAKBJ-	XB	Z	KI	Shaft End Dimensions									Approx. Mass kg
				Q	QK	QR	S	T	U	W	d	m	
06	108	15	250	110	90	1	$48^{0}_{-0.016}$	9	5.5	14	40	M5	110
08	108	15	250	110	90	1	$48^{0}_{-0.016}$	9	5.5	14	40	M5	110
11	108	15	250	110	90	1	$55^{0.030}_{0.011}$	10	6	16	45	M5	130
15	121	19	320	140	110	2	$60^{0.030}_{0.011}$	11	7	18	50	M6	230
19	121	19	320	140	110	2	$60^{0.030}_{0.011}$	11	7	18	50	M6	230
22	121	19	320	140	110	2	$60^{0.030}_{0.011}$	11	7	18	50	M6	260
30	149	24	388	140	110	1	$70^{0.030}_{0.011}$	12	7.5	20	60	M6	320

Note 1. The shaft key and the keyway are standard JIS B 1301-1996 models.
2. The figures are provided only to explain the dimensions. The actual appearance of the spindle motor may vary.

3.2 Σ-V-SD Driver

3.2.1 Power Regeneration Converter

(1) Basic Specifications

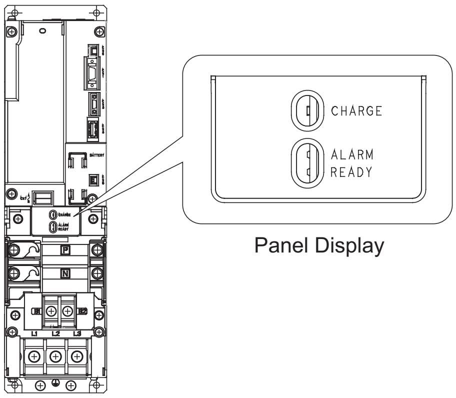
<table>
<tr><th colspan="4">Item</th><th colspan="6">Specifications</th></tr>
<tr><th colspan="4">Model: CACP-JU□□A3□,
CACP-JU□□D3□</th><th>15</th><th>19</th><th>22</th><th>30*</th><th>37*</th><th>45*</th></tr>
<tr><td colspan="3">50% ED Rating</td><td>kW</td><td>15</td><td>18.5</td><td>22</td><td>30</td><td>37</td><td>45</td></tr>
<tr><td colspan="3">Continuous Rating</td><td>kW</td><td>11</td><td>15</td><td>18.5</td><td>22</td><td>30</td><td>37</td></tr>
<tr><td rowspan="7">Basic Specifications</td><td rowspan="2">Input Power</td><td colspan="2">Main Circuits L1, L2, and L3</td><td colspan="6">CACP-JU□□A3□: Three-phase 200 V to 230 V (50/60 Hz)
CACP-JU□□D3□: Three-phase 380 V to 480 V (50/60 Hz)
Allowable voltage fluctuation: +10% to –15%
Allowable frequency fluctuation: ±5%
Line voltage unbalance: 5% max.</td></tr>
<tr><td colspan="2">Control Power</td><td colspan="6">24 VDC
Allowable voltage fluctuation: ±15%
Output holding time: 100 ms min.</td></tr>
<tr><td rowspan="2">Output Power</td><td colspan="2">Main Circuit Power Output +/–</td><td colspan="6">CACP-JU□□A3□: 270 to 310 VDC +10% to –15%
CACP-JU□□D3□: 520 to 650 VDC +10% to –15%</td></tr>
<tr><td colspan="2">Control Power Output</td><td colspan="6">24 VDC ±15% (connector pass current: 10 A)</td></tr>
<tr><td>Input Signals</td><td colspan="2">Sequence Input Signals</td><td colspan="6">Emergency stop input signal
Input power voltage: 24 VDC ±5%
Required current per channel: 3 mA</td></tr>
<tr><td colspan="3">Connections between Axes</td><td colspan="6">Local bus and absolute encoder battery</td></tr>
<tr><td colspan="3">Maximum Number of Connectable SERVOPACKs</td><td colspan="6">Differs in accordance with combinations of a power generation converter, SERVOPACKs and motors. Refer to 2.1.2 Power Regeneration Converter, SERVOPACK, and Spindle Motor.</td></tr>
<tr><td rowspan="5">Functions</td><td colspan="3">Indications</td><td colspan="6">CHARGE (orange), ALARM (red), and READY (green)</td></tr>
<tr><td colspan="3">Regeneration Control Method</td><td colspan="6">Power regeneration control (120-degree conduction)</td></tr>
<tr><td colspan="3">Protective Functions</td><td colspan="6">Main circuit fuse, overload, overvoltage, insufficient voltage, overcurrent, frequency error, heat sink overheating, etc.</td></tr>
<tr><td colspan="3">Battery</td><td colspan="6">The battery for the absolute encoder must be provided by the user.</td></tr>
<tr><td colspan="3">Allowable Power Loss Time</td><td colspan="6">5 ms (at 70% load)</td></tr>
</table>

* Available only for three-phase 200 VAC models.

■ Panel Display

The status of power regeneration converter can be checked on the panel display.

Name	LED Color	Meaning
CHARGE	Orange	Lit when main circuit power is on. Not lit when main circuit power is off.
ALARM	Red	Lit when alarm occurs. Not lit when no alarm occurs.
READY	Green	Lit when CPU of power regeneration converter works normally. Not lit when CPU of power regeneration converter not working.



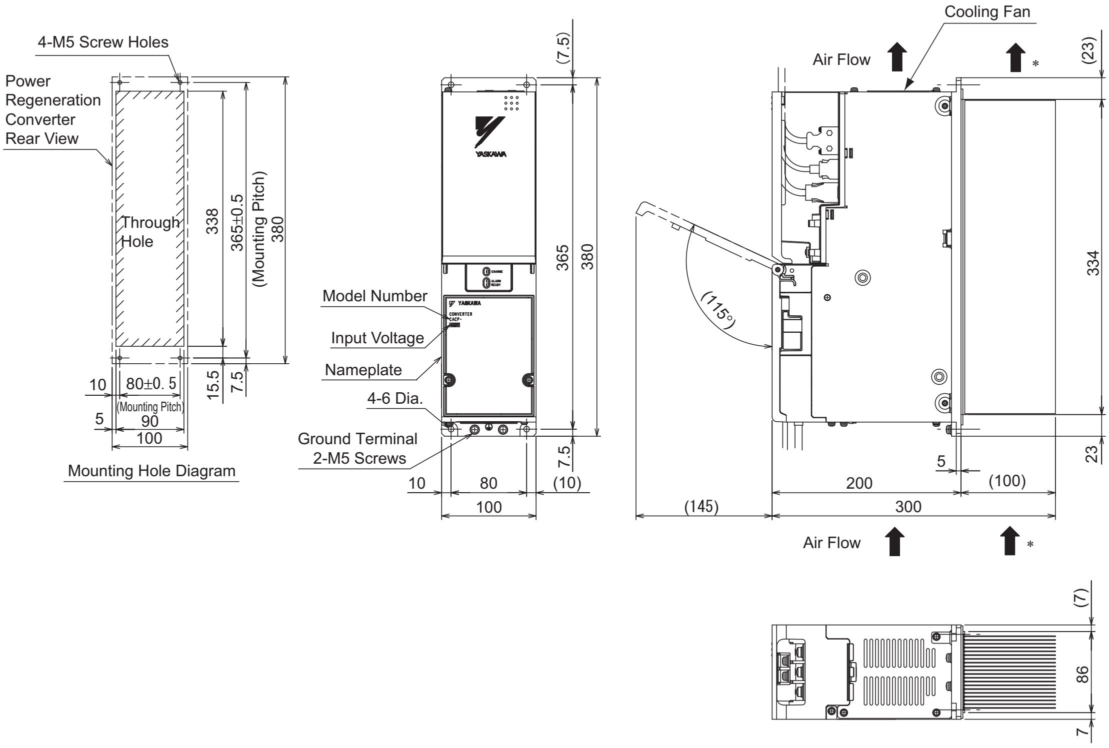
Power Regeneration Converter

(2) I/O Current and Inrush Current

Voltage	Capacity (50%ED) kW	Capacity (Continu-ous Ratings) kW	Model	Input Current (50%ED) Arms	Input Current (Continu-ous Ratings) Arms	Output Current (50%ED) Arms	Output Current (Continu-ous Ratings) Arms	Inrush Current (Main Circuit) A_{0-P}
200 V	15	11	CACP-JU15A3□	73	54	69	51	83
	18.5	15	CACP-JU19A3□	90	73	85	69	83
	22	18.5	CACP-JU22A3□	107	90	102	85	83
	30	22	CACP-JU30A3□	145	107	138	102	178
	37	30	CACP-JU37A3B	179	145	170	138	178
	45	37	CACP-JU45A3B	218	179	207	170	178
400 V	15	11	CACP-JU15D3□	36	27	36	27	173
	18.5	15	CACP-JU19D3□	45	36	45	36	173
	22	18.5	CACP-JU22D3□	53	45	53	45	173

(3) External Dimensions

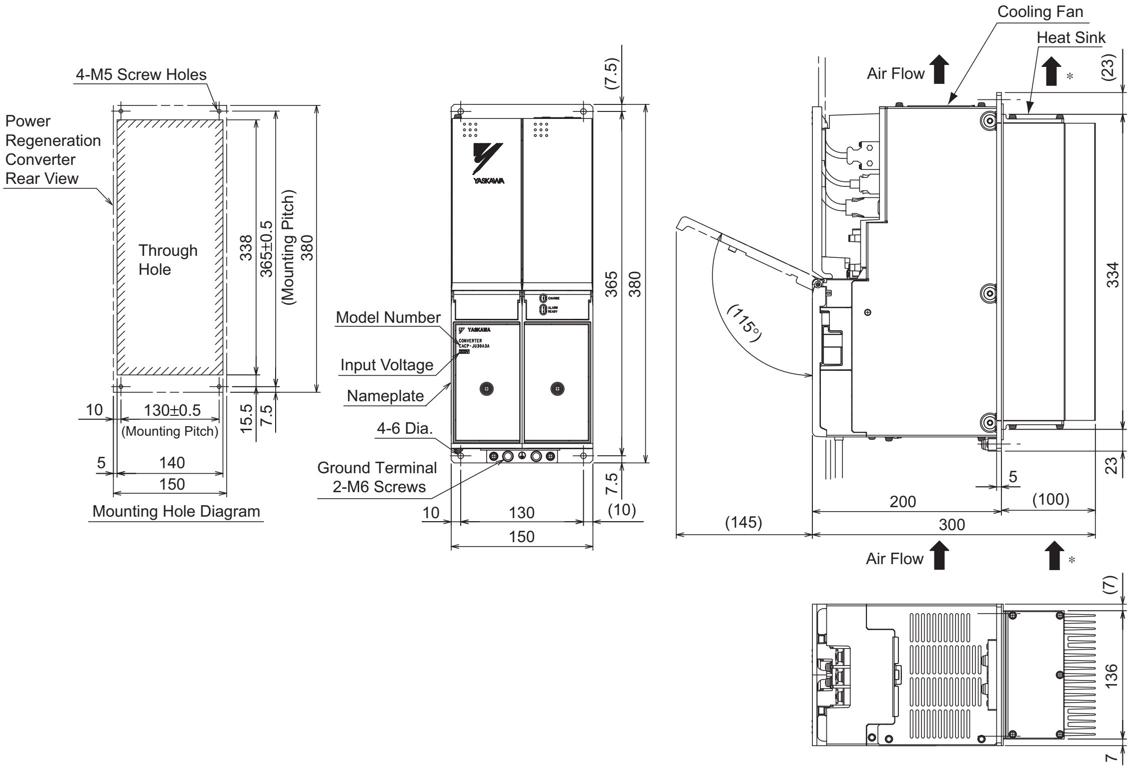
■ Model: CACP-JU15□3□, -JU19□3□, -JU22□3□



Unit: mm
Approx. Mass: 8.3 kg

∗ The cooling air speed of heat sink must be at least 2.5 m/s at the point closest to the heat sink.
Note: □: A = Three-phase 200 VAC, D = Three-phase 400 VAC

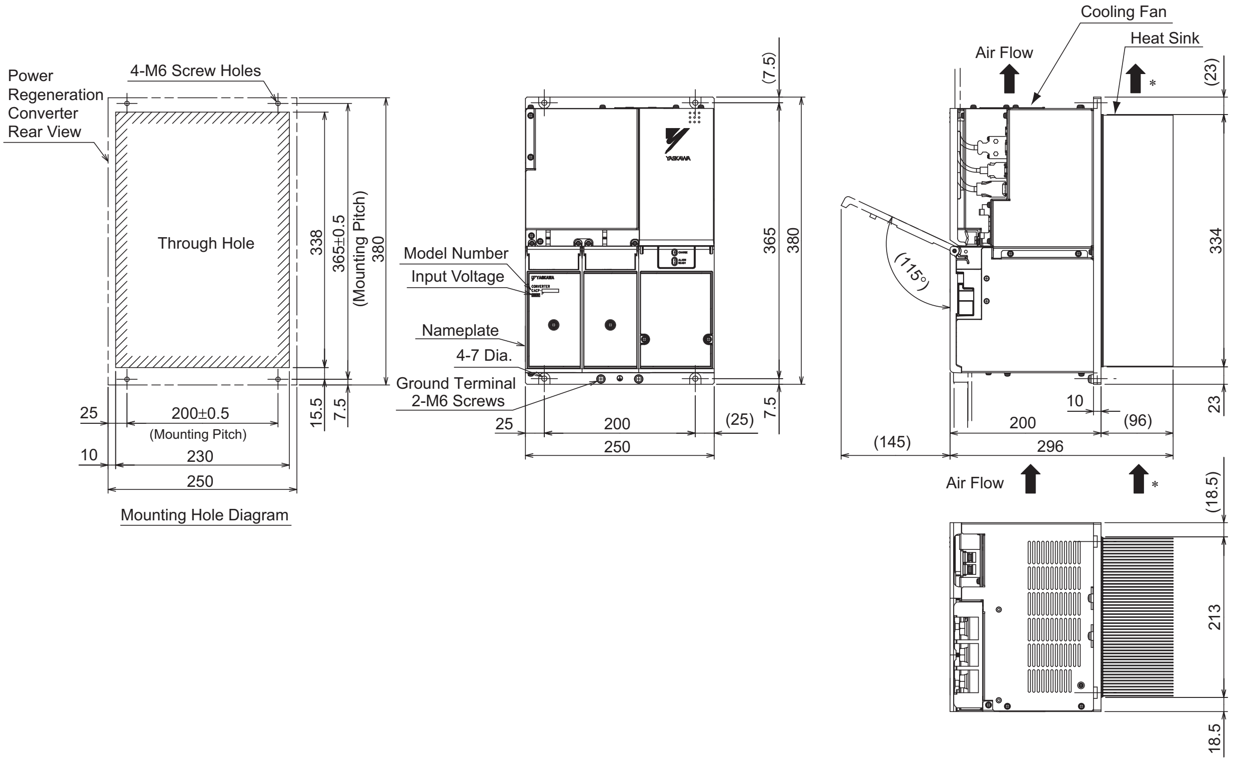
■ Model: CACP-JU30A3□, -JU37A3B



Unit: mm
Approx. Mass: 11.1 kg (CACP-JU30A3□)
12.0 kg (CACP-JU37A3B)

∗ The cooling air speed of heat sink must be at least 2.5 m/s at the point closest to the heat sink.
Note: Available only for three-phase 200 VAC models.

■ Model: CACP-JU45A3B



Unit: mm
Approx. Mass: 20.0 kg

* The cooling air speed of heat sink must be at least 2.5 m/s at the point closest to the heat sink.
Note: Available only for three-phase 200 VAC models.

3.2.2 SERVOPACK

(1) Basic Specifications

Item				Specifications
Control Method				Sine-wave current drive with PWM control of IGBT
Applicable Motors Model				UAK□J
Functions	Feedback[*1]			Pulse encoder (phases A, B, and Z)
	Indications			CHARGE (orange), RDY (green), and ERR (red) 7-segment LED × 1 digit
	Fuses			Main circuit power: Not available (built into power regeneration converter) Control power: Built in
	Protective Functions			Overcurrent, overload, main circuit voltage error, heat sink overheating, overspeed, encoder error, CPU error, etc.
	Control		Speed Loop	Integral-proportional control and torque control
	Analog Monitor (Built-in)[*2]		Number of Channels	2 for each axis
			Output Power Range	±10 V (linear range: ±8 V)
			Response Frequency	1 kHz
	USB Communications		Connected Device	Personal computer (application: SigmaWin for Σ-V-SD (MT) compatible)
			Communica-tion Standard	USB 1.1 compliant, 12 Mbps (full speed support)
			Functions	Status displays, parameter setting, and adjustment function
	Sequence Signal	External Input Power	Input Power Voltage	24 VDC ±5%
			Current Required per Channel	4 mA
		Input Signals	Number of Channels	7 for each axis (isolated)
		Output Signals	Number of Channels	5 for each axis (isolated)
			Maximum Output Current	50 mA
			Maximum Applicable Voltage	30 V
			Delay	Depends on relay circuit.
		Error Signals (Relays)	Number of Channels	1 channel (SPDT contacts)
			Maximum Load Current	1 A
			Maximum Applicable Voltage	30 V

∗1. Not available for serial encoder.
∗2. Do not use an analog monitor signal for system control. Use an analog monitor signal only for adjusting the motor or obtaining data for maintenance purpose.

(cont'd)

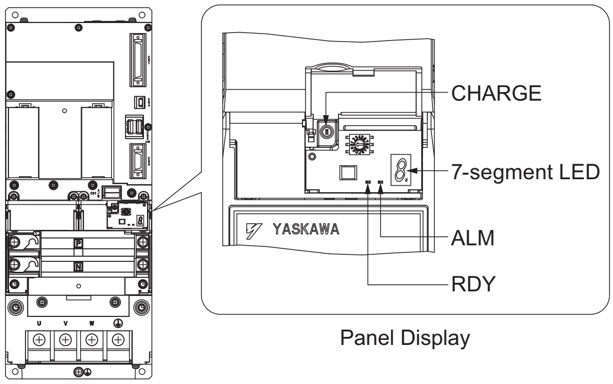
Item				Specifications
Functions (cont'd)	HWBB Signal	External Input Power	Input Power Voltage	24 VDC ±5%
			Current Required per Channel	4 mA
		Input Signals	Number of Channels	2 for each axis (isolated)
		Output Signal	Number of Channels	1 for each axis (isolated)
			Maximum Output Current	50 mA
			Maximum Applicable Voltage	30 V
			When an HWBB signal is input	Output ON when inputs of two channels are OFF.
	Load Factor Meter Output		Output Voltage Range	0 V to 10 V
			Maximum Output Current	2 mA
	Motor Winding Temperature Detection		Number of Channels	1 for each axis
			Temperature Sensor	NTC thermistor
	Motor Winding Selection		Number of Channels	1ch
			Output Voltage	+24 V
			Allowable Output Current	50 mA
			Answerback Function	Supported
	Orientation			Encoder orientation
	Speed Control Range			40 min^{-1} to motor max. speed

■ Panel Display

The SERVOPACK status can be checked on the panel display.

Name	LED Color	Meaning
CHARGE	Orange	Lit when main circuit power is on. Not lit when main circuit power is off.
RDY	Green	Lit when CPU of SERVOPACK works normally. Blink when the digital operator is connected. Not lit when CPU of SERVOPACK not working.
ALM	Red	Lit when alarm occurs. Not lit when no alarm occurs.
7-segment LED*	Red	Shows the status of the SERVOPACK such as alarms.

* For details on the panel indicator and its meanings, refer to *9.1 Panel Display*.



Panel Display

SERVOPACK

(2) I/O Current

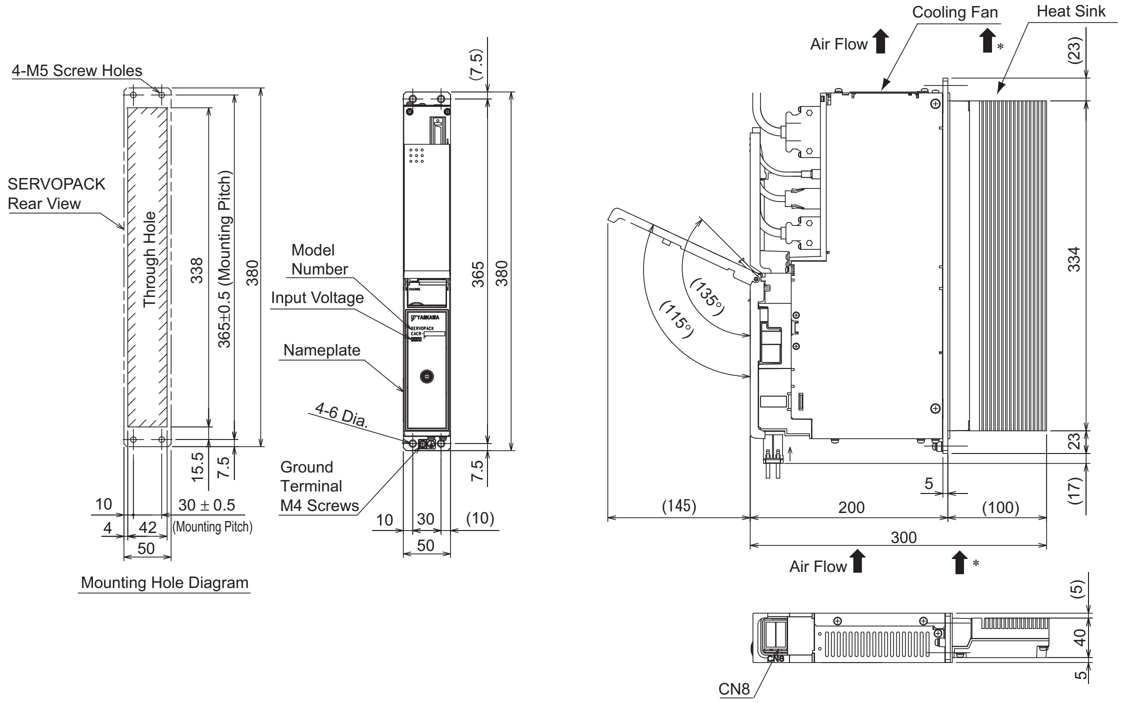
Voltage	Capacity (50%ED) kW	Capacity (Continuous Ratings) kW	Model	Input Current (50%ED) Arms	Input Current (Continuous Ratings) Arms	Output Current (50%ED) Arms	Output Current (Continuous Ratings) Arms
270 VDC	5.5	3.7	CACR-JU028ADA	26	17	34	28
	7.5	5.5	CACR-JU036ADA	35	26	46	36
	15	11	CACR-JU065ADA	69	51	82	65
	18.5	15	CACR-JU084ADA	85	69	100	84
	22	18.5	CACR-JU102ADA	102	85	116	102
	30	22	CACR-JU125ADA	138	102	160	125
	45	37	CACR-JU196ADA	207	170	240	196
540 VDC	5.5	3.7	CACR-JU014DDA	13	9	17	14
	7.5	5.5	CACR-JU018DDA	18	13	23	18
	15	11	CACR-JU033DDA	36	27	41	32.5
	18.5	15	CACR-JU042DDA	45	36	50	42
	22	18.5	CACR-JU051DDA	53	45	58	51

Specifications and External Dimensions

3

(3) External Dimensions

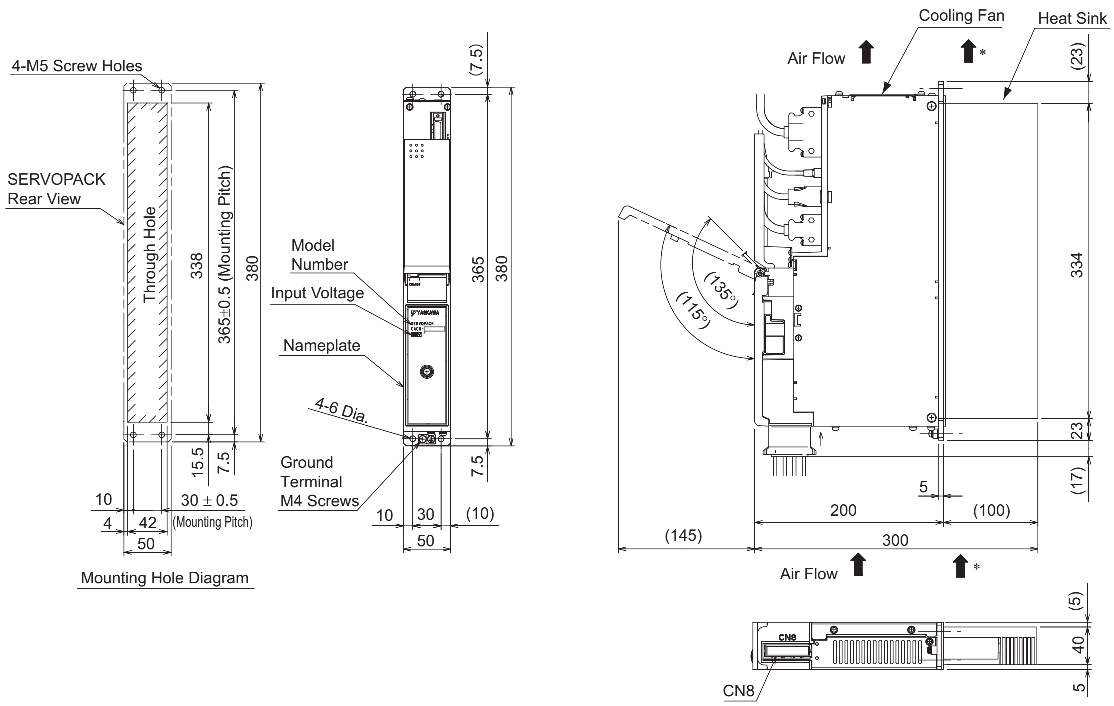
■ Model: CACR-JU028ADA, -JU014DDA



Unit: mm
Approx. mass: 4.3 kg

∗ The cooling air speed of heat sink must be at least 2.5 m/s at the point closest to the heat sink.

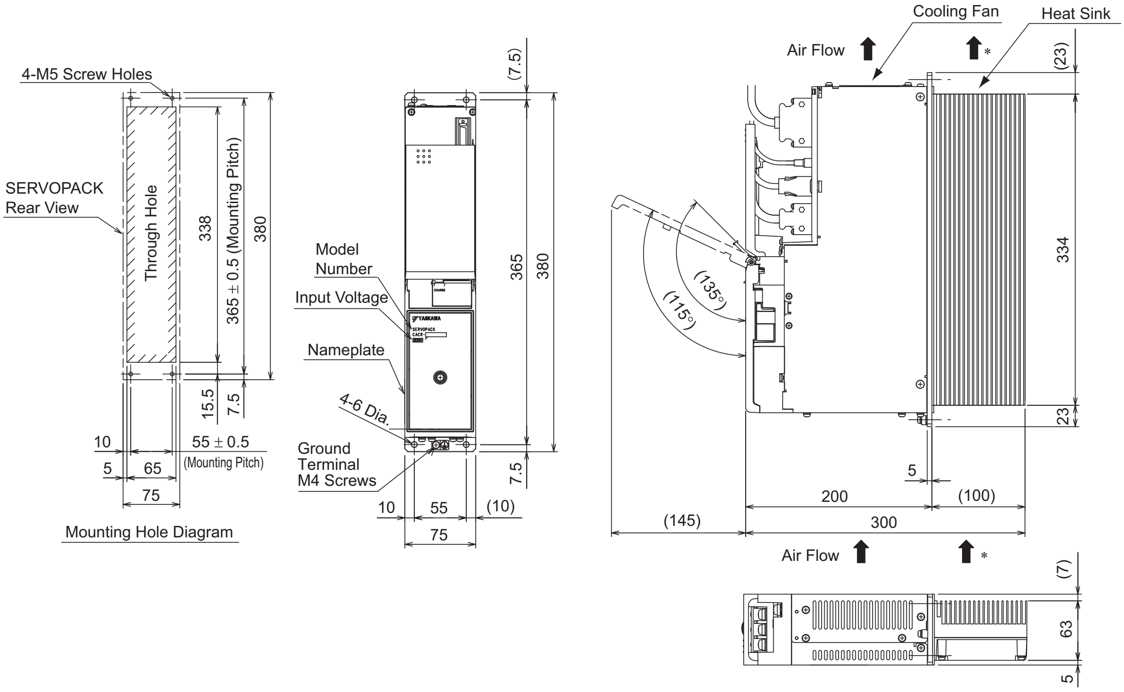
■ Model: CACR-JU036ADA, -JU018DDA



Unit: mm
Approx. mass: 5.0 kg

∗ The cooling air speed of heat sink must be at least 2.5 m/s at the point closest to the heat sink.

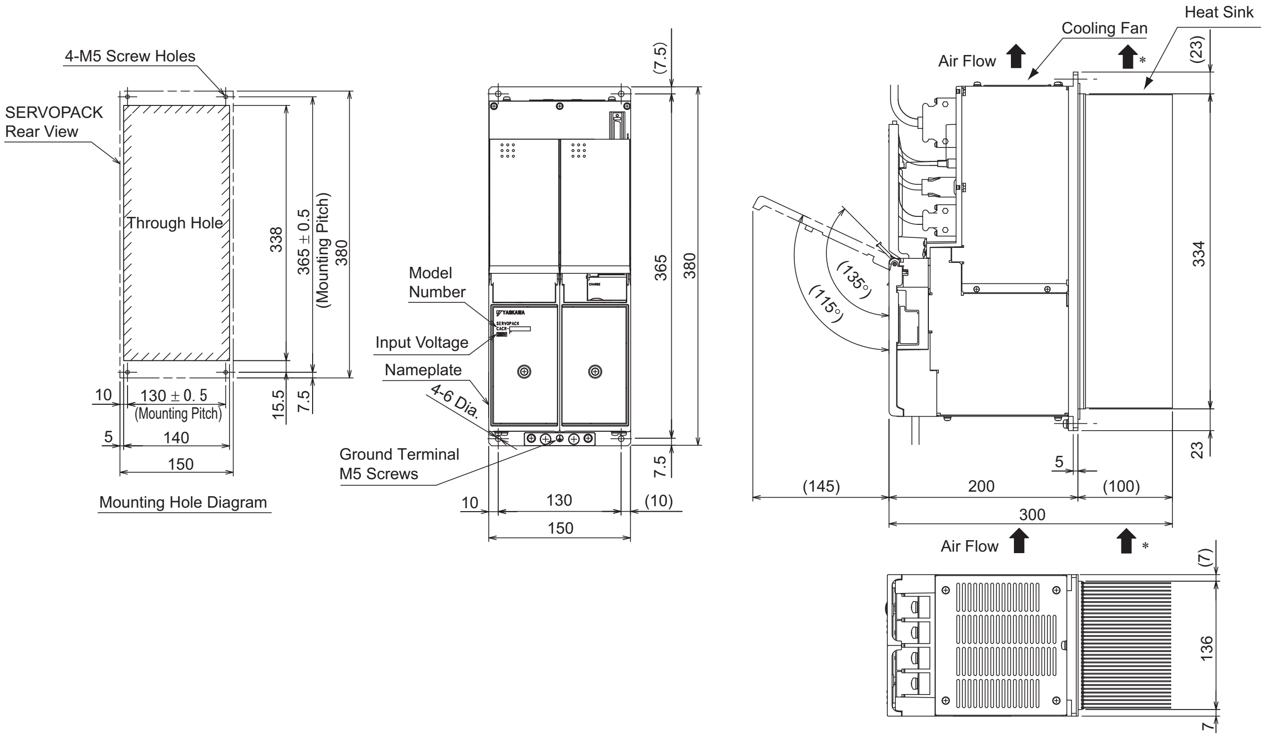
■ Model: CACR-JU065ADA, -JU033DDA



Unit: mm
Approx. mass: 6.4 kg

* The cooling air speed of heat sink must be at least 2.5 m/s at the point closest to the heat sink.

■ Model: CACR-JU084ADA, -JU102ADA, -JU042DDA, -JU051DDA



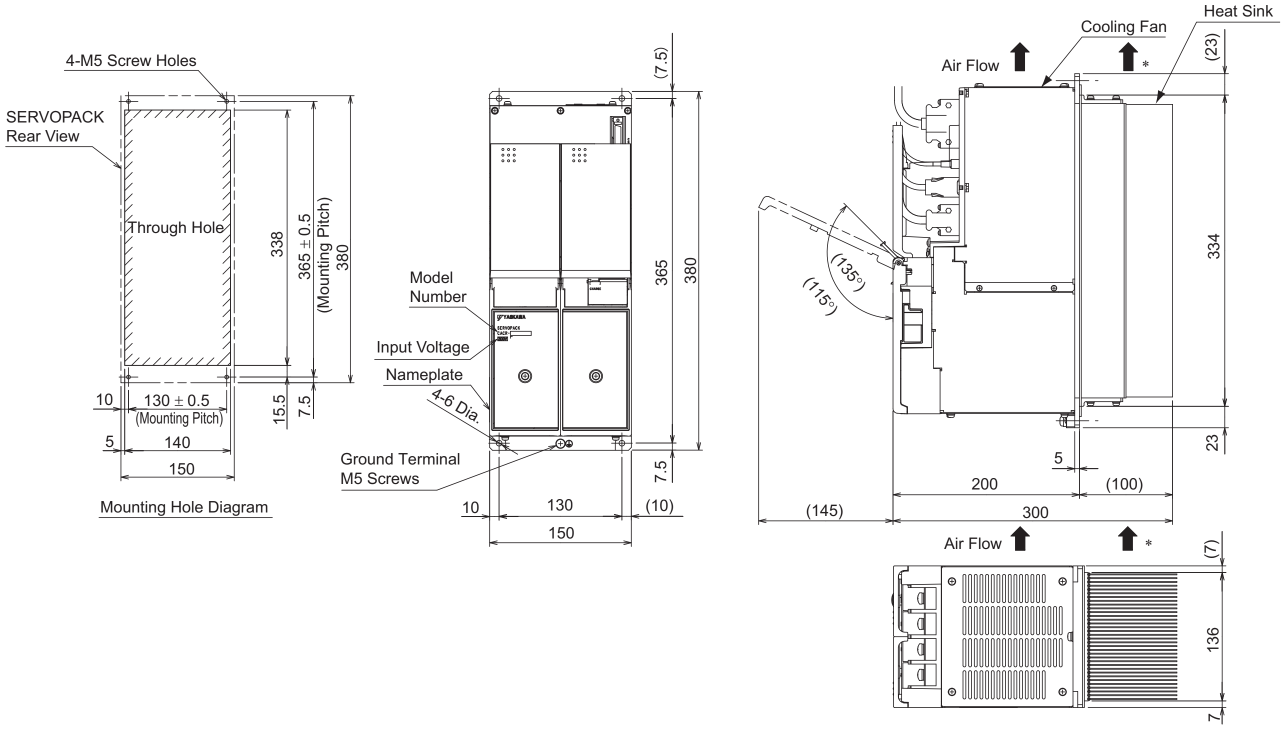
Unit: mm
Approx. mass: 11.8 kg

* The cooling air speed of heat sink must be at least 2.5 m/s at the point closest to the heat sink.

Specifications and External Dimensions

3

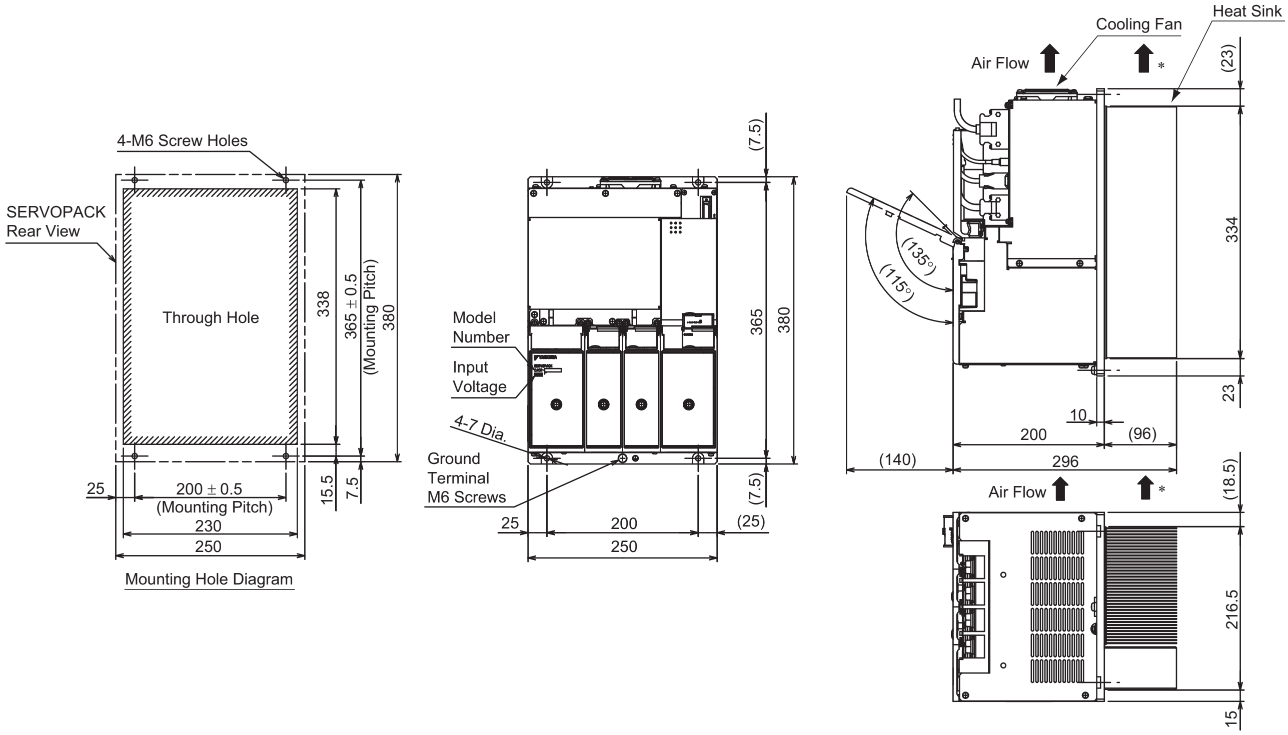
■ Model: CACR-JU125ADA



Unit: mm
Approx. mass: 12.0 kg

* The cooling air speed of heat sink must be at least 2.5 m/s at the point closest to the heat sink.

■ Model: CACR-JU196ADA



Unit: mm
Approx. mass: 20.0 kg

* The cooling air speed of heat sink must be at least 2.5 m/s at the point closest to the heat sink.

3.3 Peripheral Devices

3.3.1 AC Reactor

(1) Specifications

Power Regeneration Converter Model	AC Reactor Model	Rated Voltage (V)	Frequency (Hz)	Rated Current (A)	Inductance (mH)	Insulation Class (class)	Watt Data Loss (W)	Ambient Tem-perature	Storage Tem-perature	Approx. Mass (kg)
CACP-JU15A3☐	X008017	230	50/60	56	0.21	H	55	-10°C to 55°C	-20°C to 85°C	8
CACP-JU19A3☐	X008018	230	50/60	73	0.17	H	70	-10°C to 55°C	-20°C to 85°C	8
CACP-JU22A3☐	X008019	230	50/60	90	0.14	H	80	-10°C to 55°C	-20°C to 85°C	12
CACP-JU30A3☐	X008020	230	50/60	107	0.1	H	85	-10°C to 55°C	-20°C to 85°C	12
CACP-JU37A3B	X008029	230	50/60	145	0.09	H	93	-10°C to 55°C	-20°C to 85°C	12
CACP-JU45A3B	X008022	230	50/60	179	0.07	H	130	-10°C to 55°C	-20°C to 85°C	25
CACP-JU15D3☐	X008010* / X008023	480	50/60	27	0.82	H	70	-10°C to 55°C	-20°C to 85°C	5
CACP-JU19D3☐	X008011	480	50/60	36	0.67	H	80	-10°C to 55°C	-20°C to 85°C	7.3
CACP-JU22D3☐	X008012	480	50/60	45	0.56	H	120	-10°C to 55°C	-20°C to 85°C	11.2

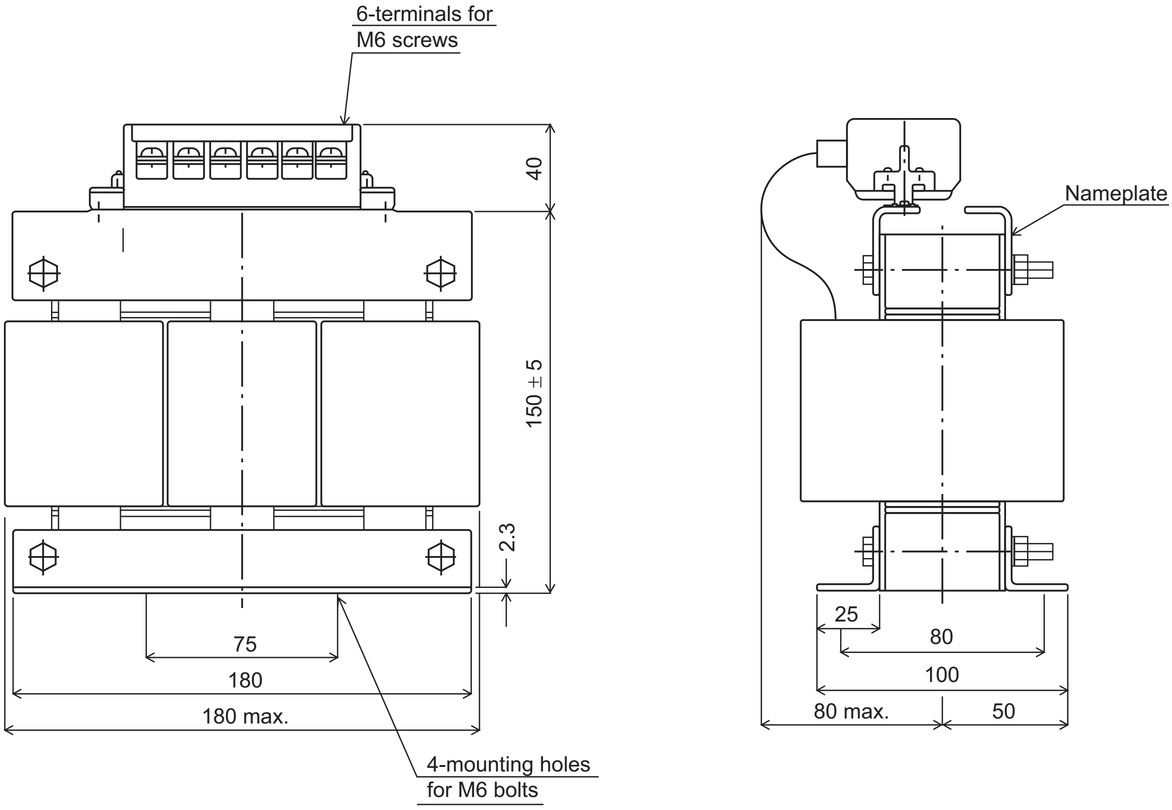
* This AC reactor does not comply with UL standards.

Specifications and External Dimensions

3

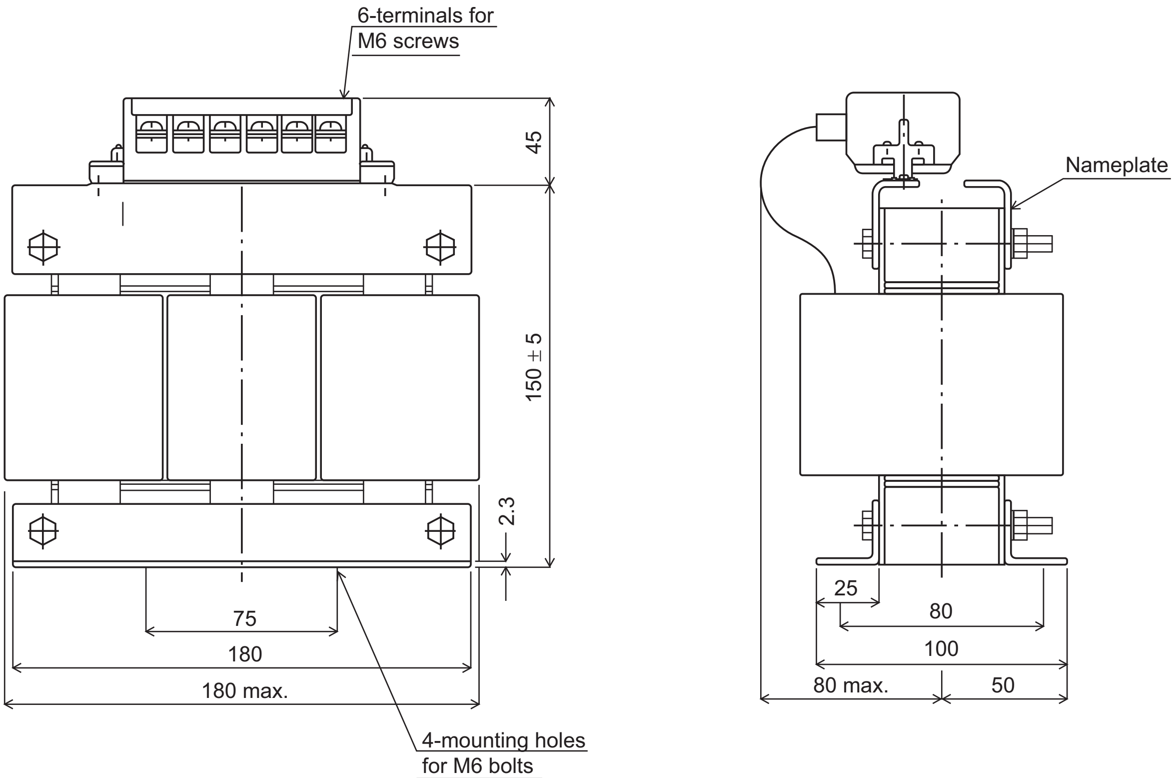
(2) External Dimensions

■ Model: X008017



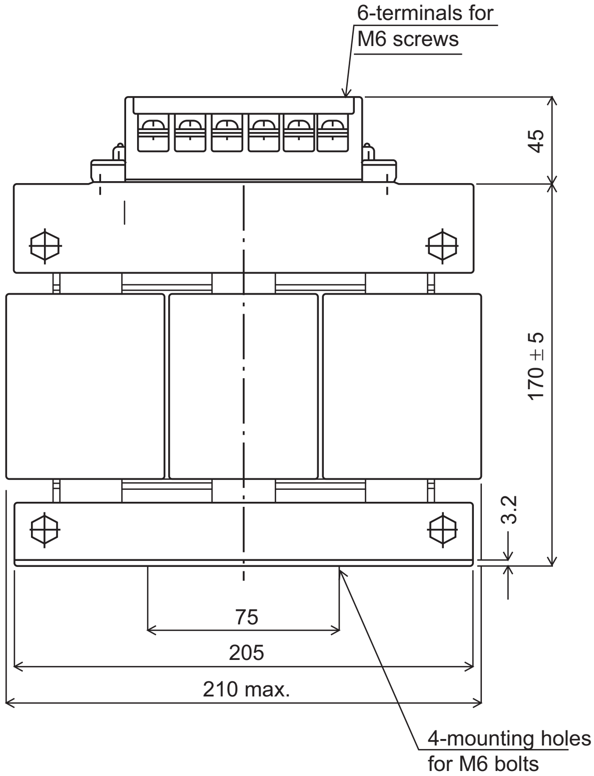
Unit: mm

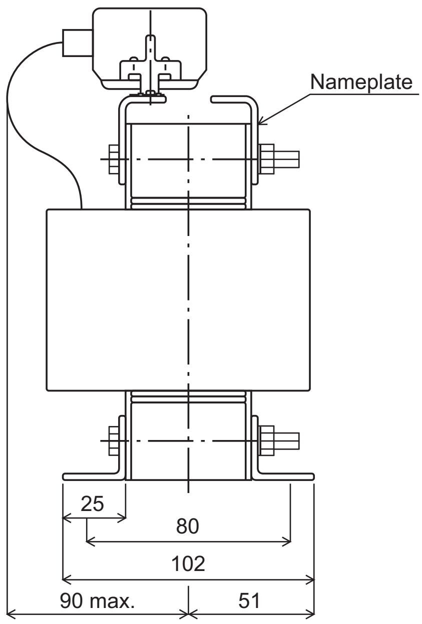
■ Model: X008018



Unit: mm

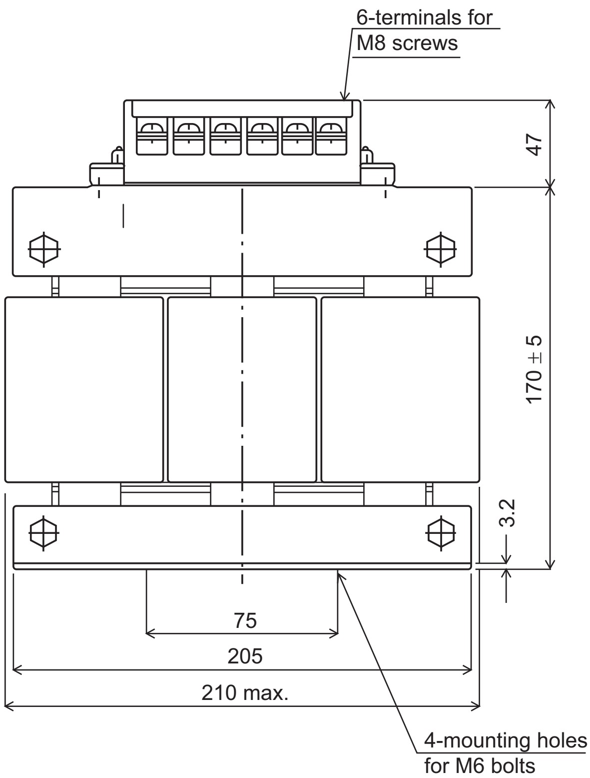
■ Model: X008019

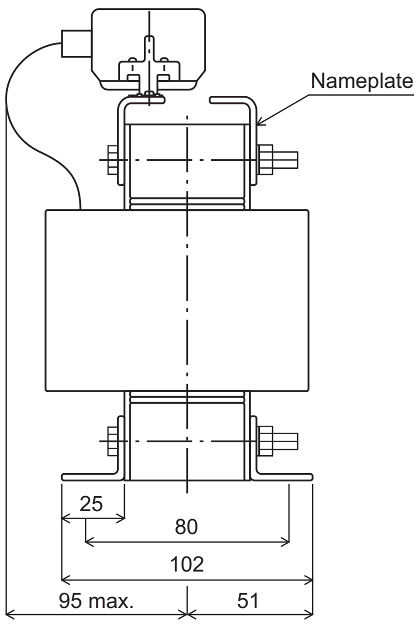




Unit: mm

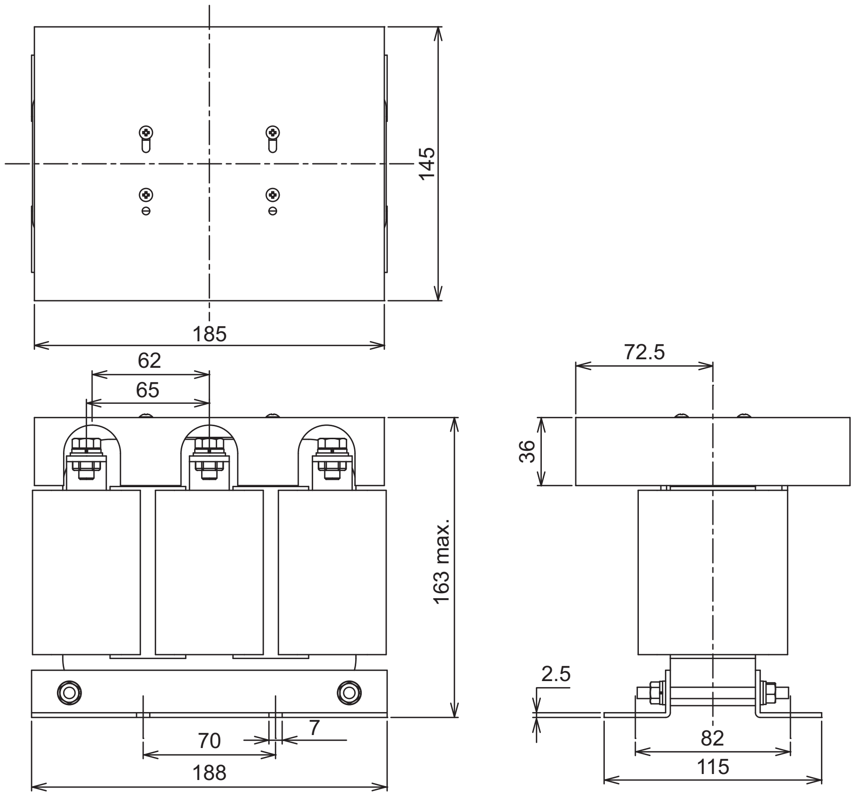
■ Model: X008020





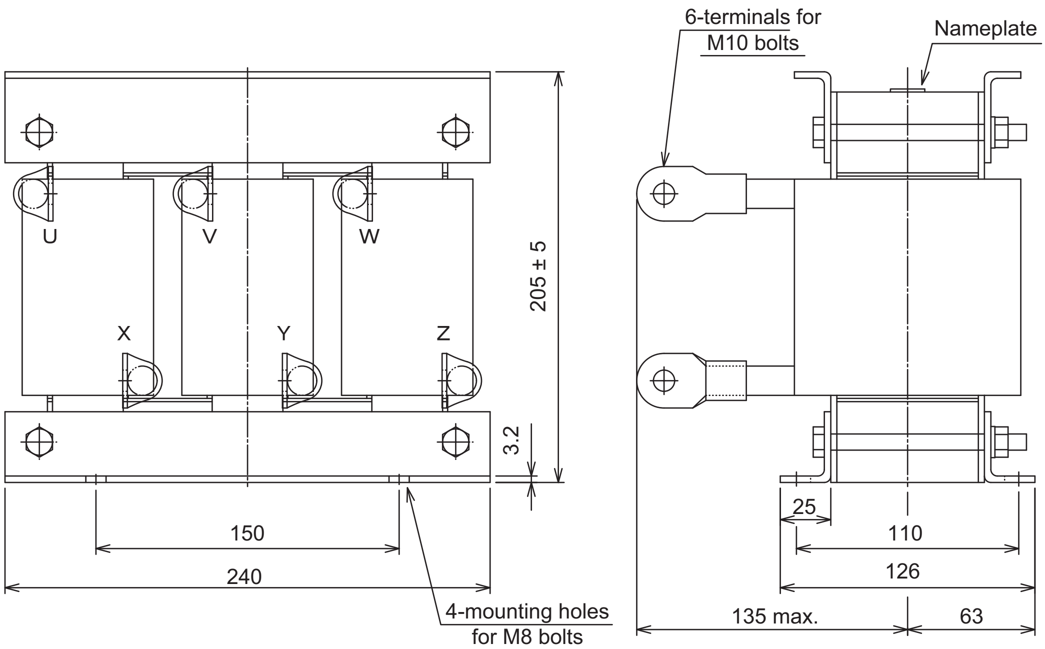
Unit: mm

■ Model: X008029



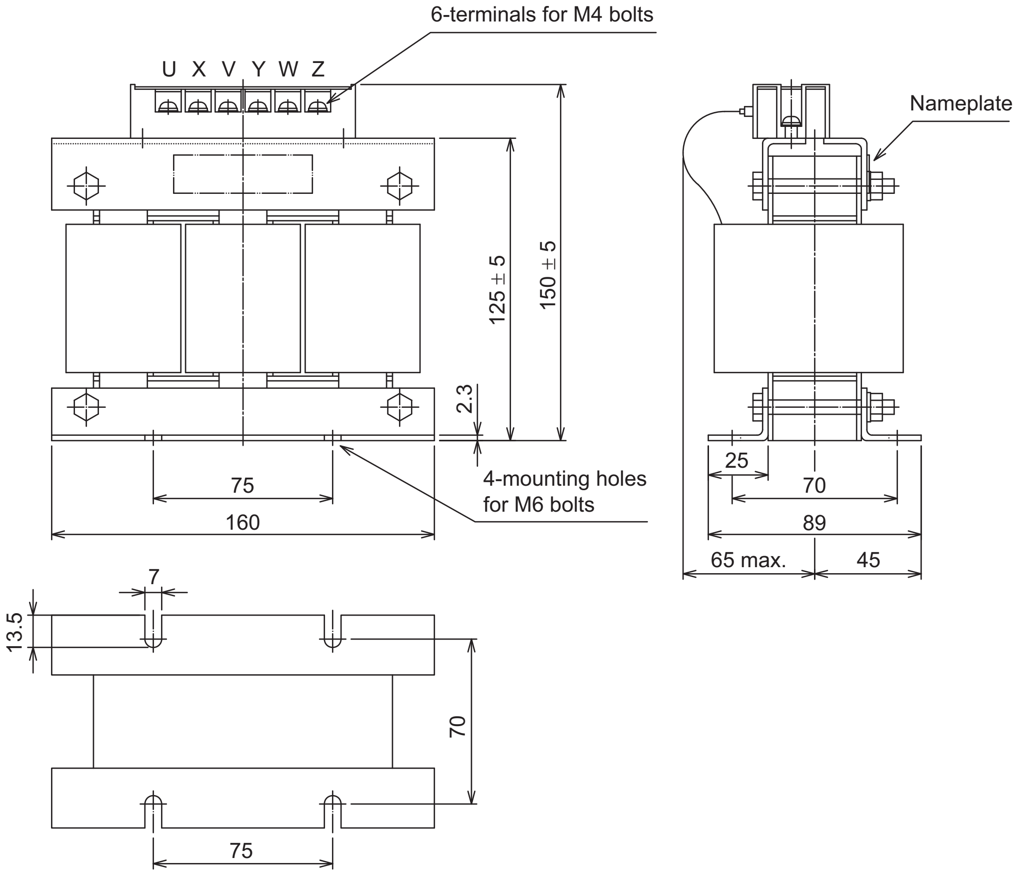
Unit: mm

■ Model: X008022



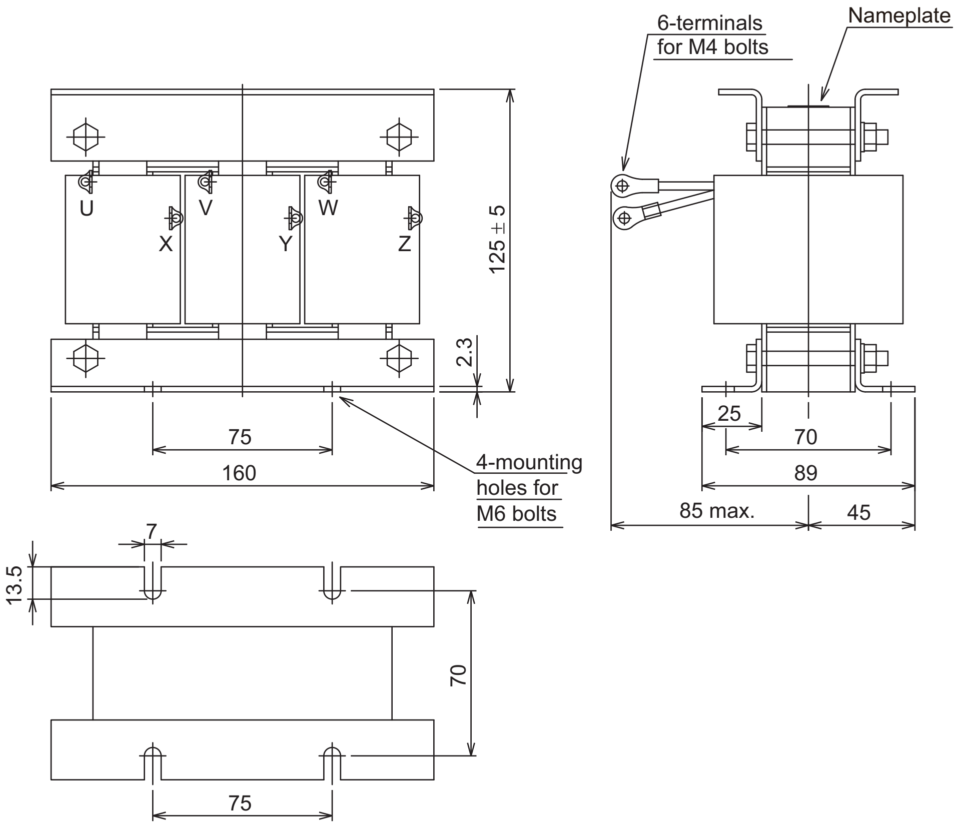
Unit: mm

■ Model: X008010



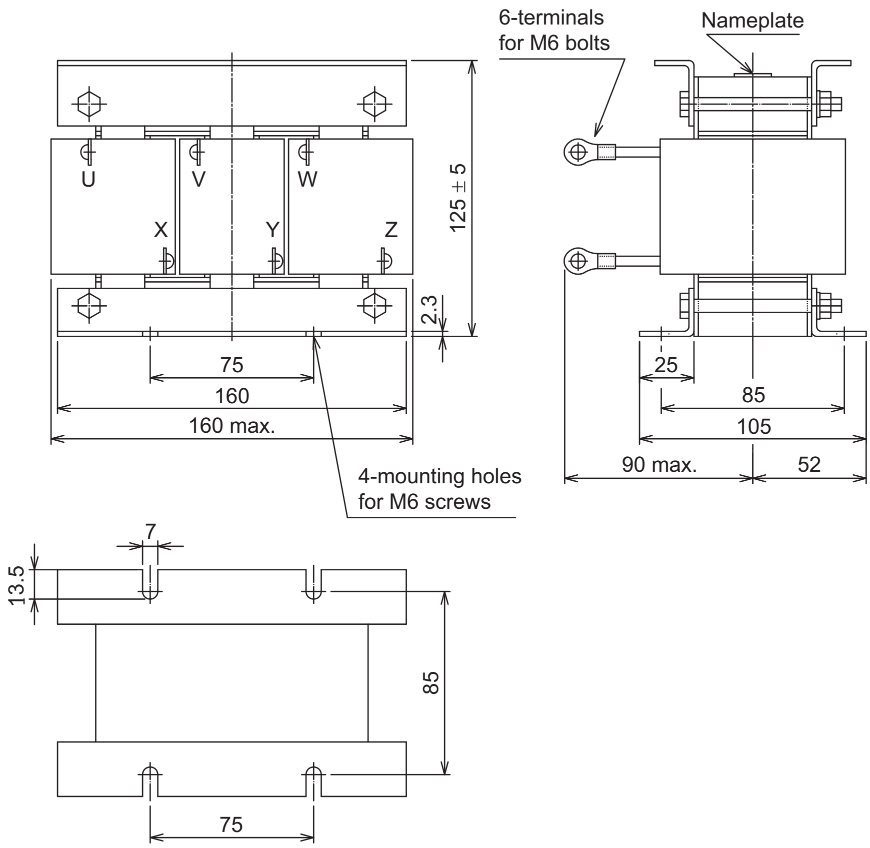
Unit: mm

■ Model: X008023



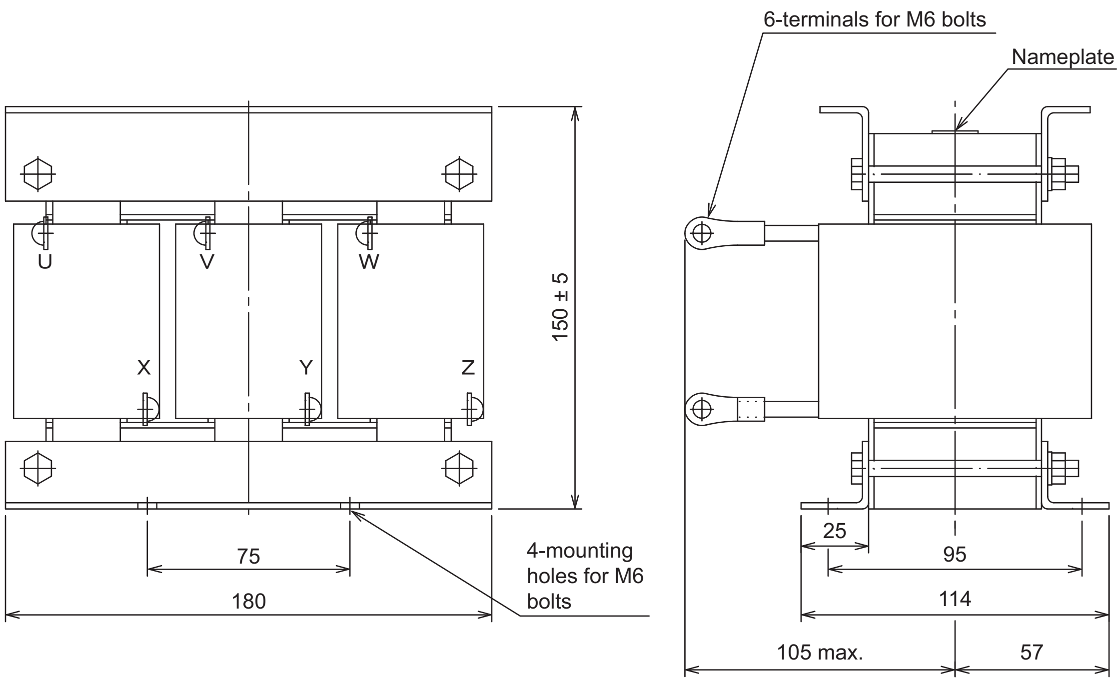
Unit: mm

■ Model: X008011



Unit: mm

■ Model: X008012



Unit: mm
Unit: mm

3.3.2 Magnetic Contactor for Winding Selection

(1) Specifications

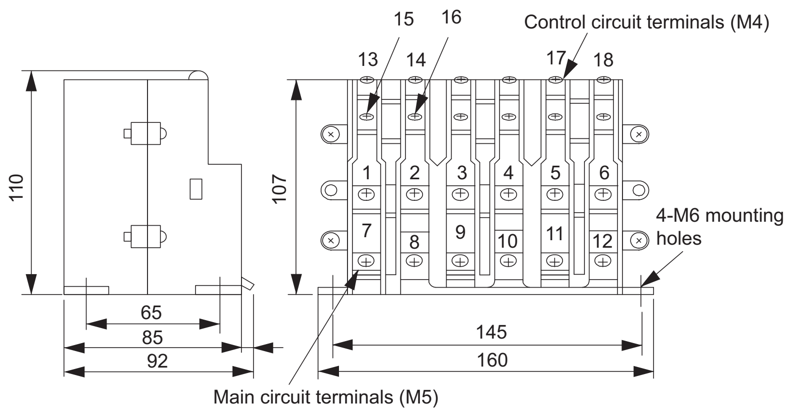
Model*1	Standard	HV-75AP4	HV-150AP4	HV-200AP4
	For UL Compliance	HV-75AP4/UL	HV-150AP4/UL	HV-200AP4/UL
Contact		Main contact: 3NO, 3NC, auxiliary contact: 1NC		
Rated Insulation Voltage		600 V		
Rated Applying Current	Continuous	75 A	150 A	200 A
	30 minutes*2	87 A	175 A	226 A
Breaking Current Capacity	220 V	200 A	400 A	
	440 V	150 A	300 A	
Open/Close Frequency		600 times/hour		
Mechanical Duration of Life		5 million times		
Control Magnetic Coil Rating		200 V 50/60 Hz, 220 V 50/60 Hz, 230 V 60 Hz		
Mass		2.5 kg	5.0 kg	
Ambient Temperature		–10°C to 55°C		
Storage Temperature		–20°C to 85°C		
Humidity		10% to 95% RH (non-condensing)		
Spindle Motor Capacity (50%ED)		5.5 kW to 15 kW	18.5 kW to 30 kW	37 kW to 45 kW

*1. Model numbers for contactors with safety covers are HV-□AP4S and HV-□AP4S/UL.
*2. A dwell time of 1 hour or more is required after applying power supply for 30 minutes.

(2) External Dimensions

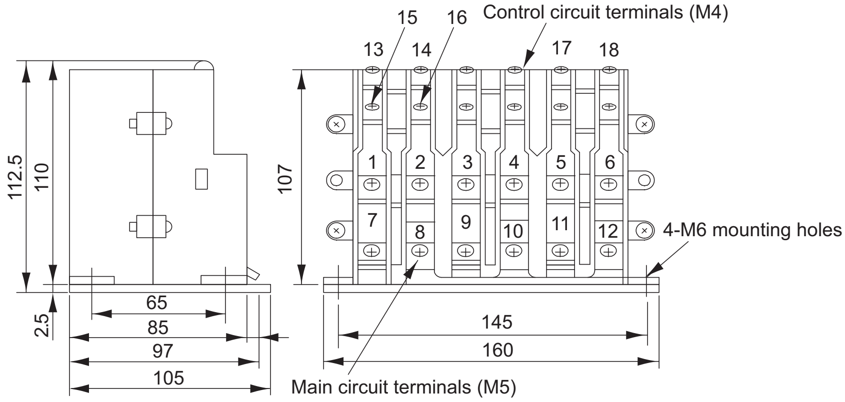
The external dimensions are shown below.

■ Model: HV-75AP4



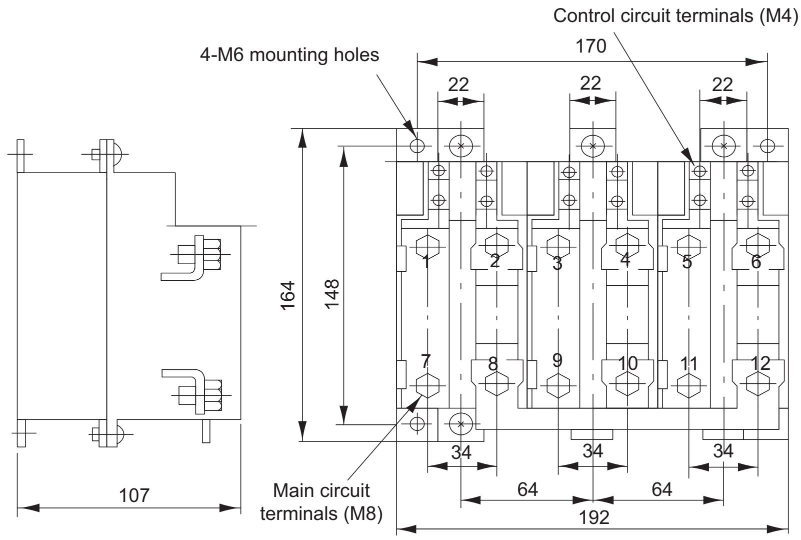
Unit: mm

■ Model: HV-75AP4/UL



Unit: mm

■ Model: HV-150AP4, HV-150AP4/UL, HV-200AP4, HV-200AP4/UL

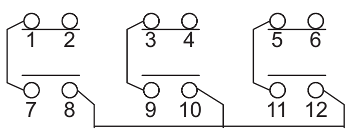


Unit: mm

(3) Terminal Descriptions

The terminal name and operation status are shown below. For mounting direction, refer to *3.3.2 (4) Installation Orientation*.

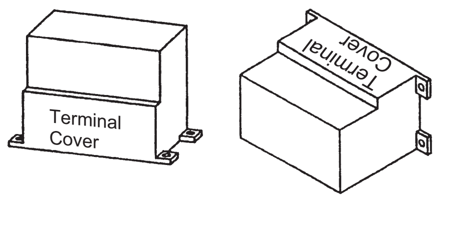
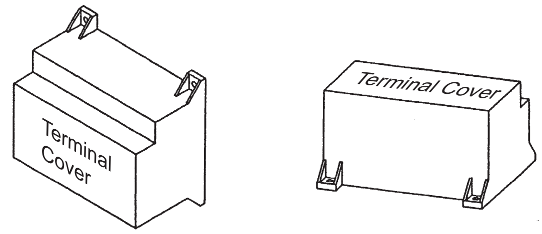
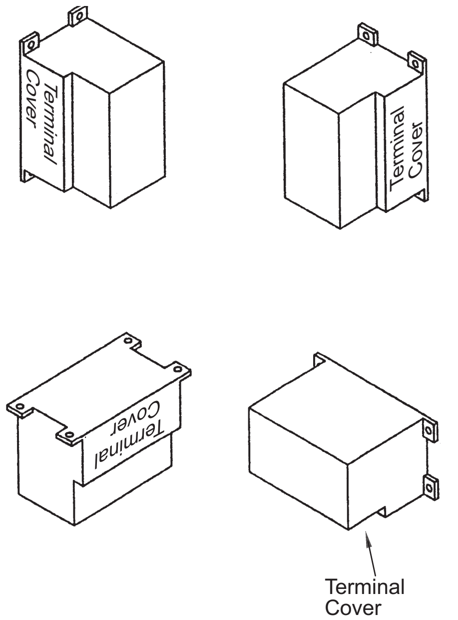
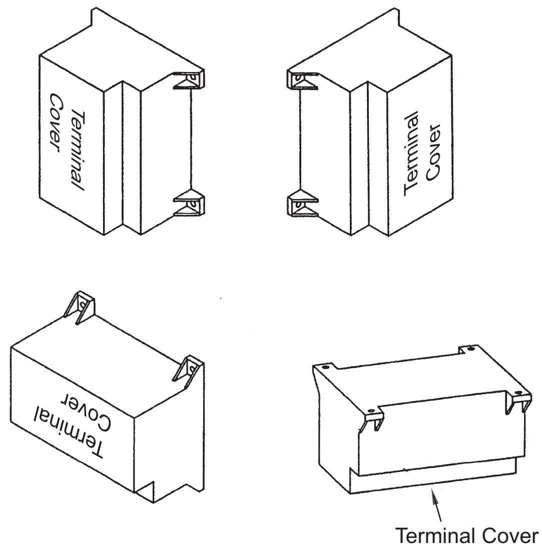
Terminal	Name	Operation Status	
13–14	Selection signal	+24 V (Low-speed winding)	0 V (High-speed winding)
1–2 3–4 5–6	Main contact: 3NC	Open	Closed
7–8 9–10 11–12	Main contact: 3NO	Closed	Open
15–16	Auxiliary contact: 1NC	Open	Closed
17–18	Single-phase 200 V power supply	–	–



HV-□AP4, HV-□AP4X/UL

(4) Installation Orientation

Use the following method to install a magnetic contactor for winding selection.

Mounting	Model: HV-75AP4, HV-75AP4/UL	Model: HV-150AP4, HV-150AP4/UL, HV-200AP4, HV-200AP4/UL
Possible		
Not possible		

3.3.3 Noise Filter

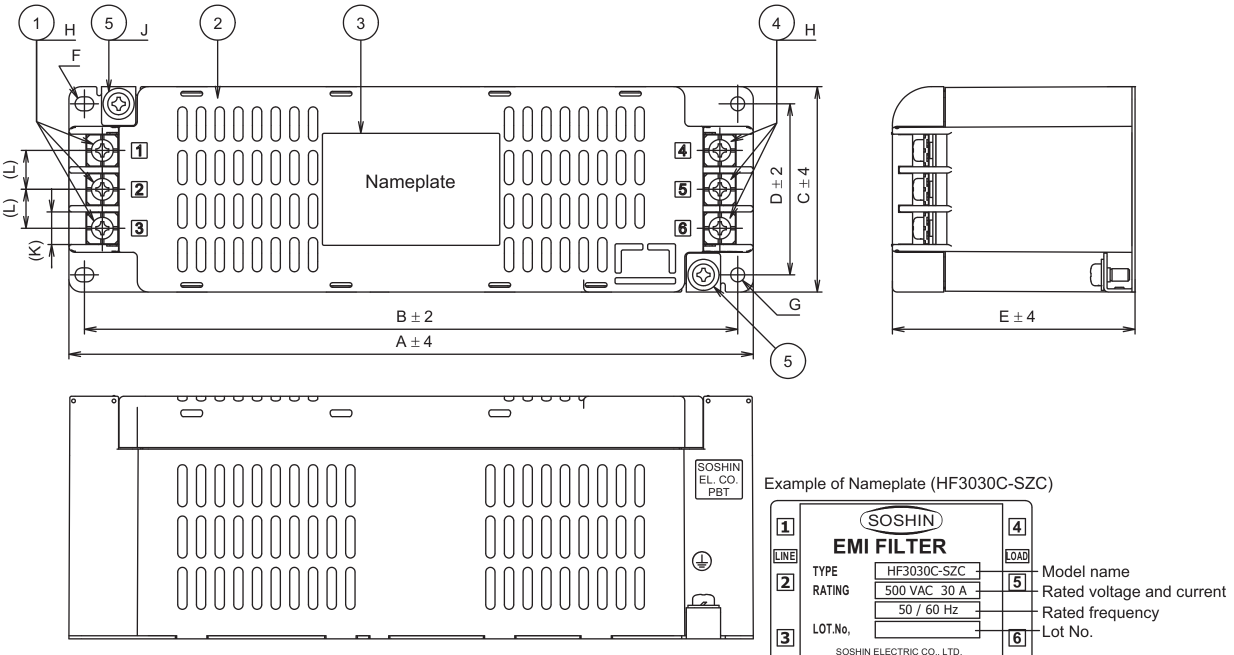
(1) Specifications

Power Regeneration Converter		Noise Filter					
Input Voltage	Model	Model	Rated Current (A)	Classification	Rated Voltage	Leakage Current (mA)	Manufacturer
Three-phase 200 VAC	CACP-JU15A3□	HF3060C-SZC-47EDD	60	Three-phase three-wire	480 VAC	8 (for 200 VAC, 60 Hz)	SOSHIN ELECTRIC CO., LTD
	CACP-JU19A3□	HF3080C-SZC-47EDD	80				
	CACP-JU22A3□	HF3100C-SZC-47EDD	100				
	CACP-JU30A3□	HF3150C-SZC-47EDD	150				
	CACP-JU37A3B	HF3150C-SZC-47EDD	150				
	CACP-JU45A3B	HF3200C-SZC-49EDE*	200			25 (for 200 VAC, 60 Hz)	
Three-phase 400 VAC	CACP-JU15D3□	HF3030C-SZC-47DDD	30	Three-phase three-wire	480 VAC	13 (for 400 VAC, 50 Hz)	SOSHIN ELECTRIC CO., LTD
	CACP-JU19D3□	HF3040C-SZC-47EDD	40				
	CACP-JU22D3□	HF3050C-SZC-47EDD	50				

* Also use the following compact AC power supply block-type capacitor (X capacitor).
Compact AC power supply block-type capacitor (X capacitor) model: LDA106M-AA (Soshin Electric Co., Ltd.)
For installation locations, refer to *12.3.1 EMC Installation Conditions*.

(2) External Dimensions

■ Model: HF3030C-SZC-47DDD, HF3040C-SZC-47EDD, HF3050C-SZC-47EDD



1 Input terminal
2 Case
3 Nameplate
4 Output terminal
5 Earth terminal

Unit: mm

Unit: mm

<table>
<tr><th>Noise Filter Model</th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>G</th><th>H</th><th>J</th><th>K</th><th>L</th></tr>
<tr><td>HF3030C-SZC-47DDD</td><td>220</td><td>210</td><td>66</td><td>55</td><td>78</td><td>R2.25 × 6</td><td>4.5 dia.</td><td>M4</td><td>M4</td><td>10.5</td><td>12.5</td></tr>
<tr><td>HF3040C-SZC-47EDD</td><td rowspan="3">270</td><td rowspan="3">260</td><td rowspan="3">80</td><td rowspan="3">70</td><td rowspan="3">84</td><td rowspan="3">R2.75 × 7</td><td rowspan="3">5.5 dia.</td><td rowspan="3">M5</td><td rowspan="3">M4</td><td rowspan="3">13</td><td rowspan="3">16</td></tr>
<tr><td>HF3050C-SZC-47EDD</td></tr>
<tr><td>HF3060C-SZC-47EDD</td></tr>
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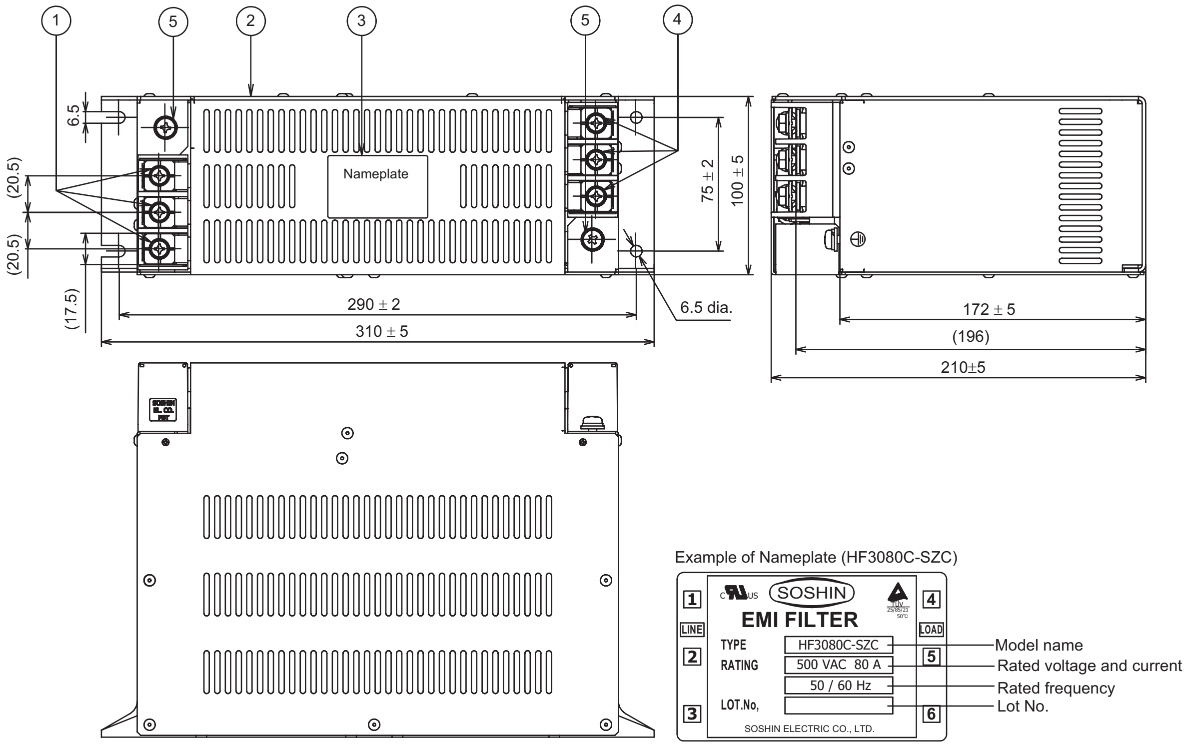
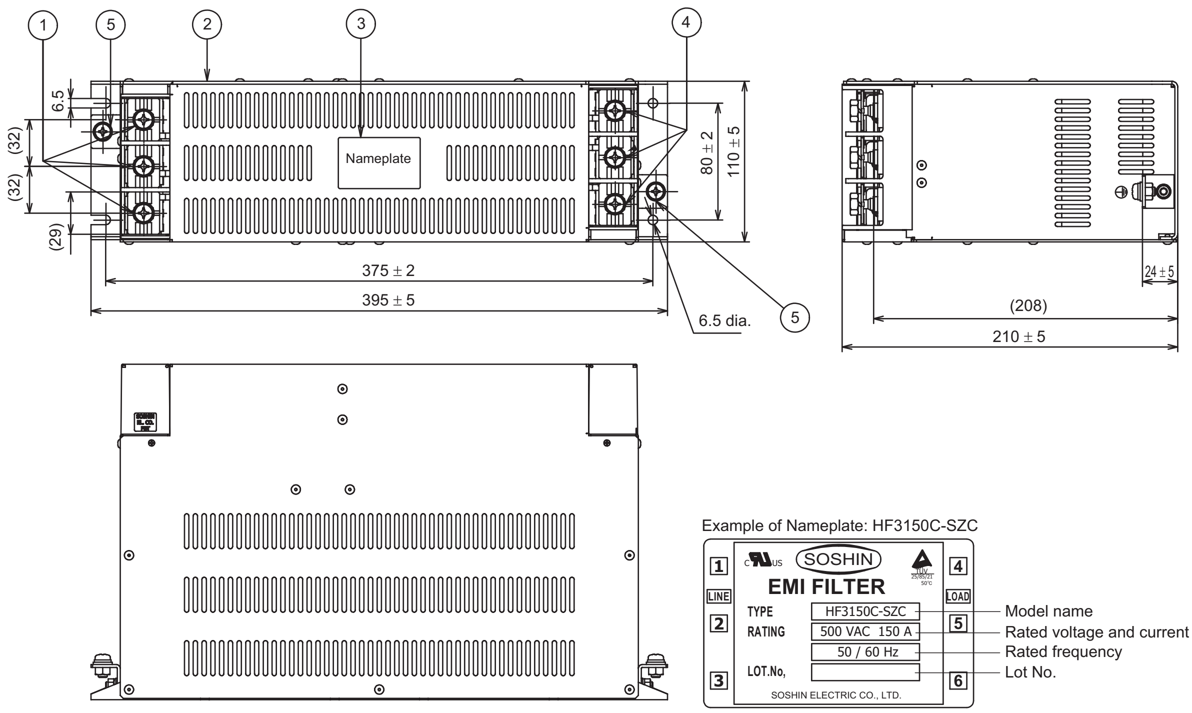
■ Model: HF3080C-SZC-47EDD, HF3100C-SZC-47EDD



1 Input terminal: M6
2 Case
3 Nameplate
4 Output terminal: M6
5 Earth terminal: M6

Unit: mm

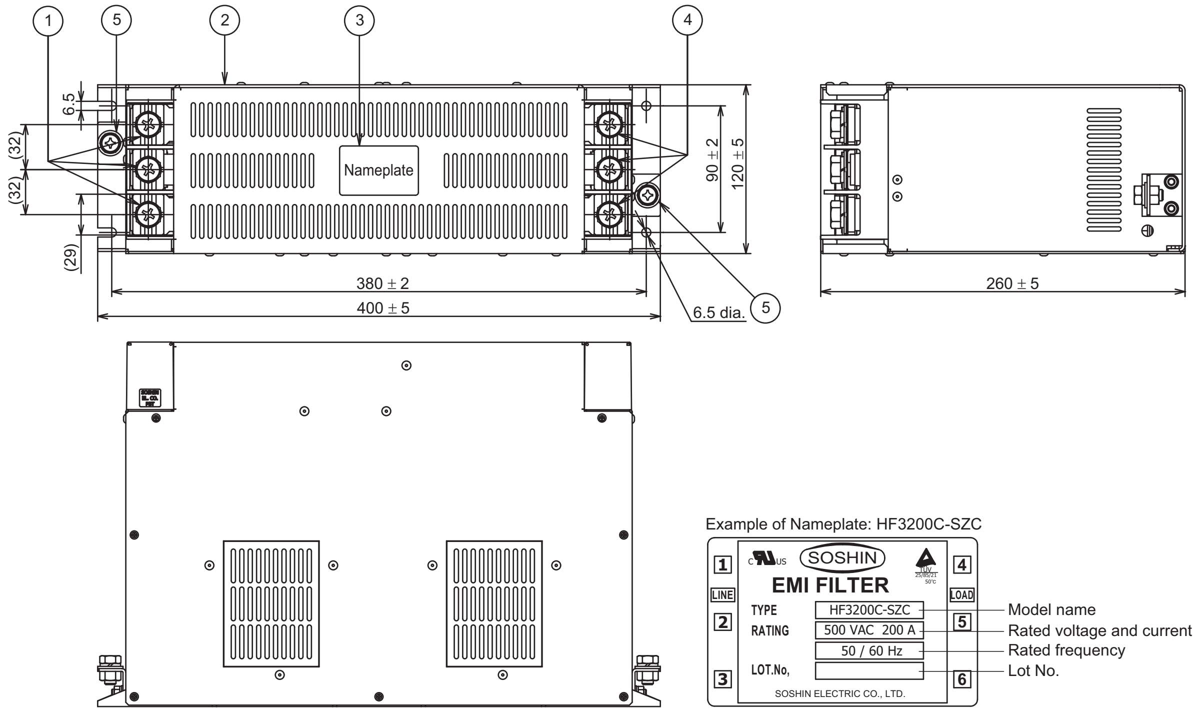
■ Model: HF3150C-SZC-47EDD



1 Input terminal: M8
2 Case
3 Nameplate
4 Output terminal: M8
5 Earth terminal: M6

Unit: mm

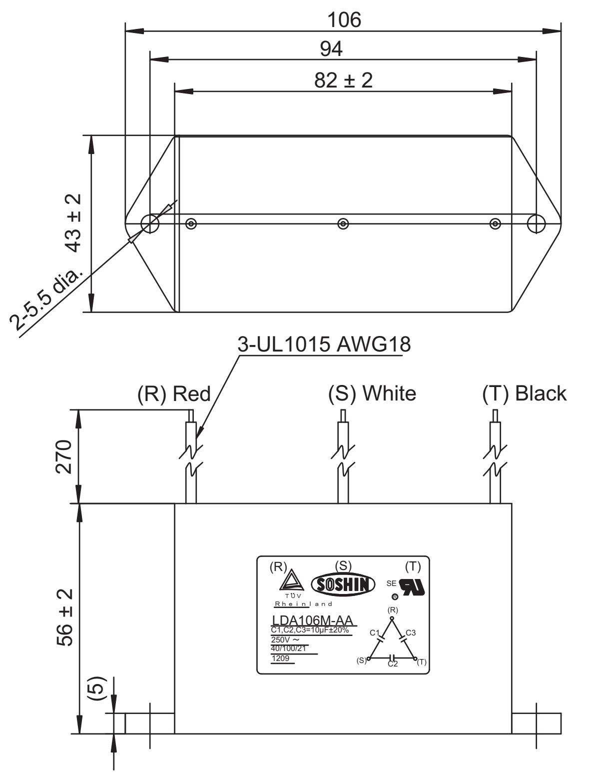
■ Model: HF3200C-SZC-49EDE



1. Input terminal: M10
2. Case
3. Nameplate
4. Output terminal: M10
5. Earth terminal: M8

Unit: mm

- Compact AC power supply block-type capacitor (X capacitor)
  Model: LDA106M-AA



Unit: mm

3.3.4 Base Mounting Units

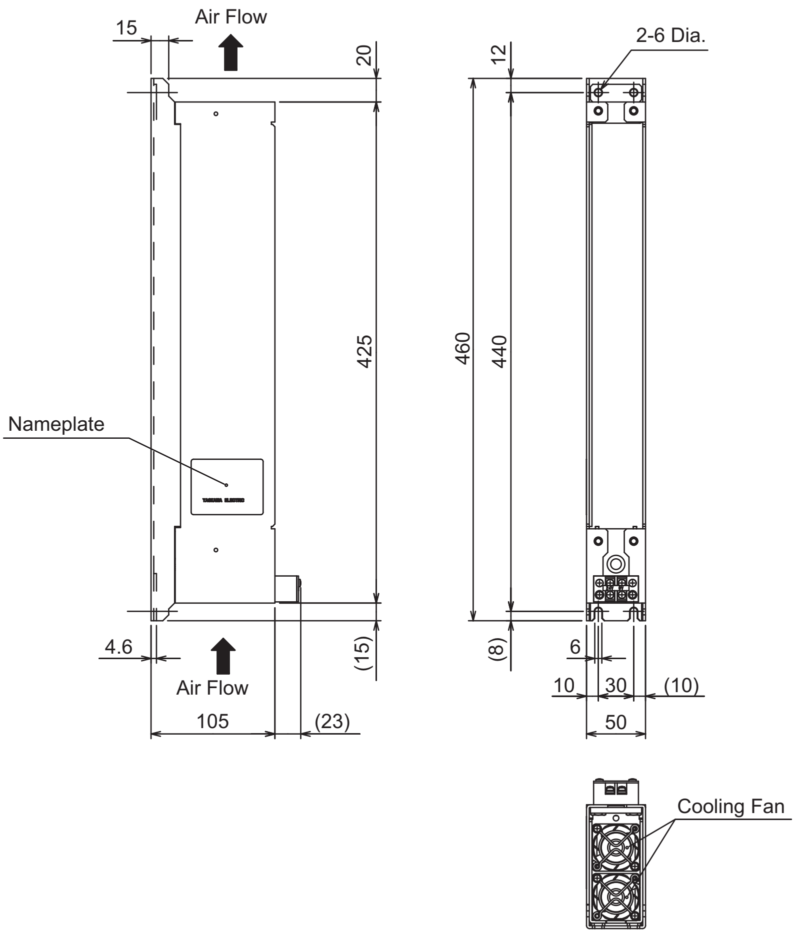
(1) Specifications

Model	Unit Width (mm)	Cooling Fan		Terminal Block		
		Input Voltage (VDC)	Input Current (A)	Terminal Screw	Wire Sizes (AWG)	Tightening Torque (N·m)
JUSP-JUBM050AA	50	24	0.42	M3.5	24 to 12	0.8 to 1.2 N·m (7.1 to 10.6 lbf·in)
JUSP-JUBM075AA	75		0.94			
JUSP-JUBM100AA	100		0.94			
JUSP-JUBM150AA	150		1.88			
JUSP-JUBM250AA	250		1.24			

Note: The input current that is given above is the current for one base mounting unit.

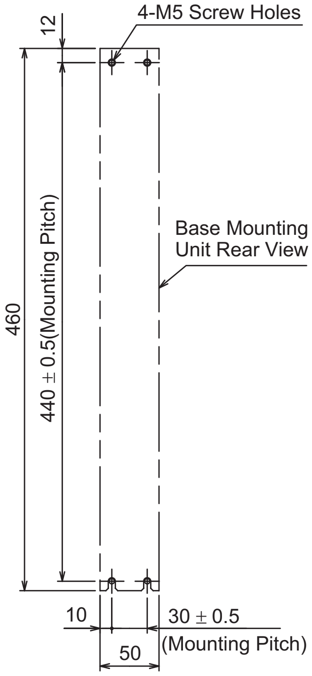
(2) External Dimensions

■ JUSP-JUBM050AA

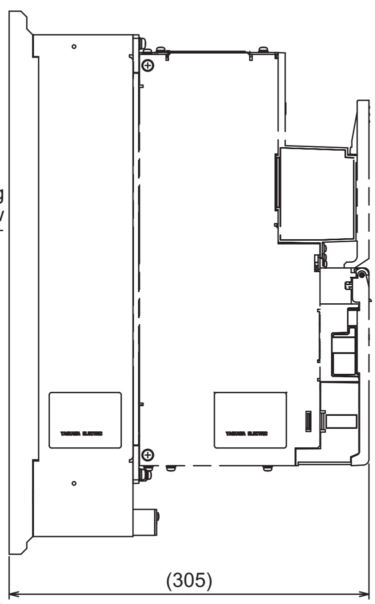


Approx. Mass: 2.7 kg

<Mounting Hole Diagram>

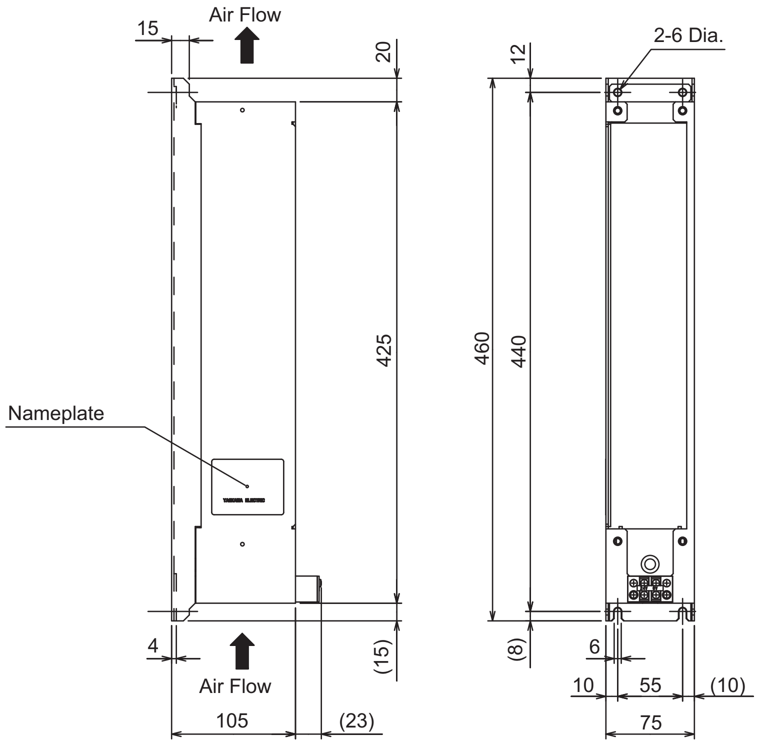


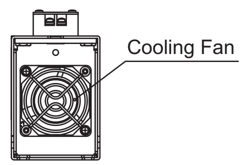
<Unit Mounted Diagram>



Unit: mm

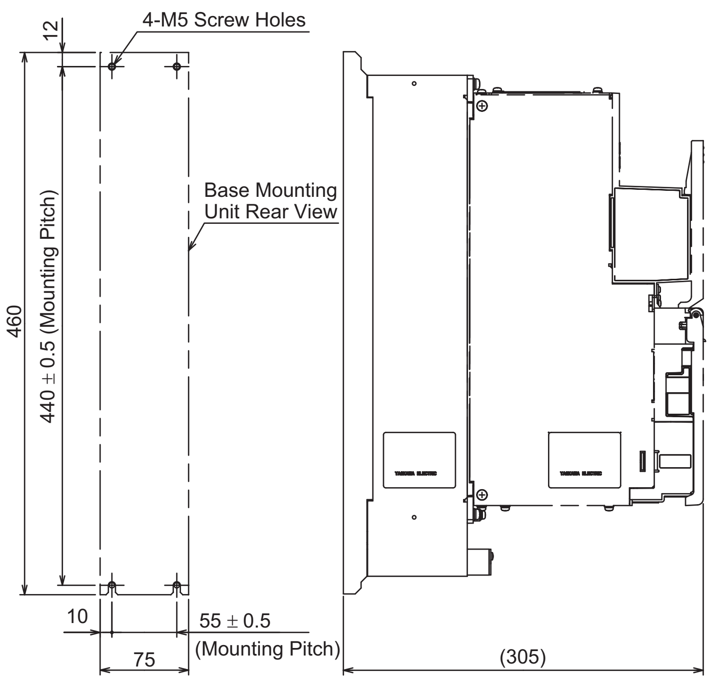
■ JUSP-JUBM075AA





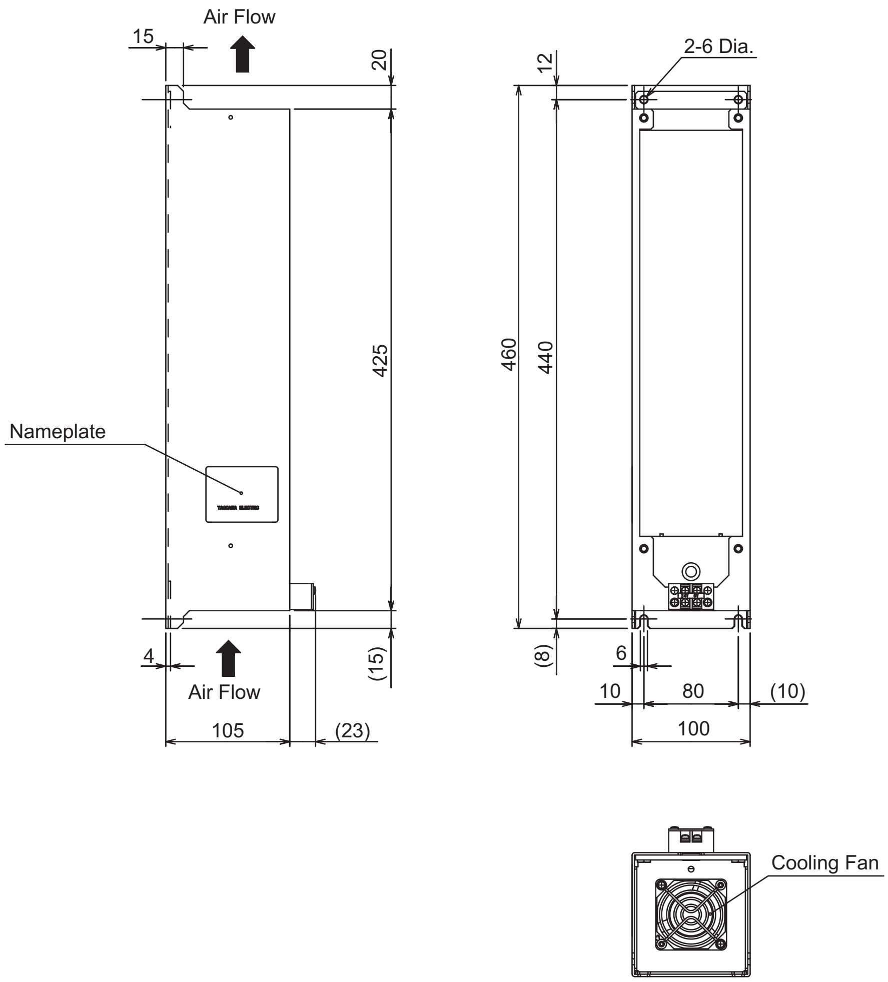
Approx. Mass: 2.7 kg

<Mounting Hole Diagram>   <Unit Mounted Diagram>



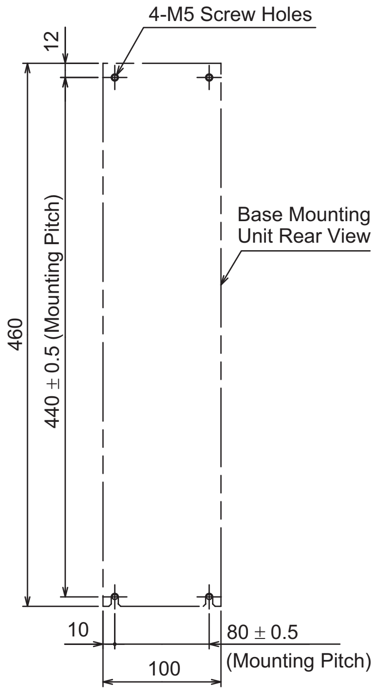
Unit: mm

■ JUSP-JUBM100AA

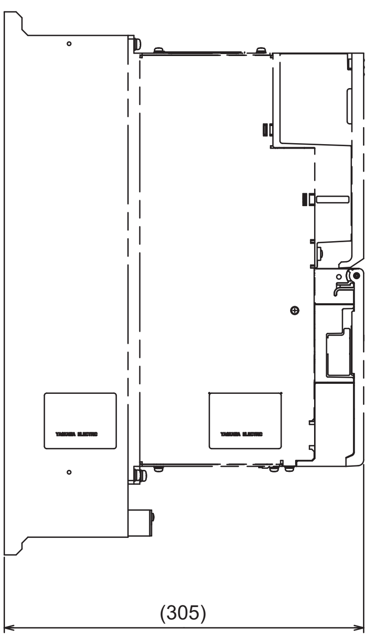


Approx. Mass: 2.8 kg

<Mounting Hole Diagram>

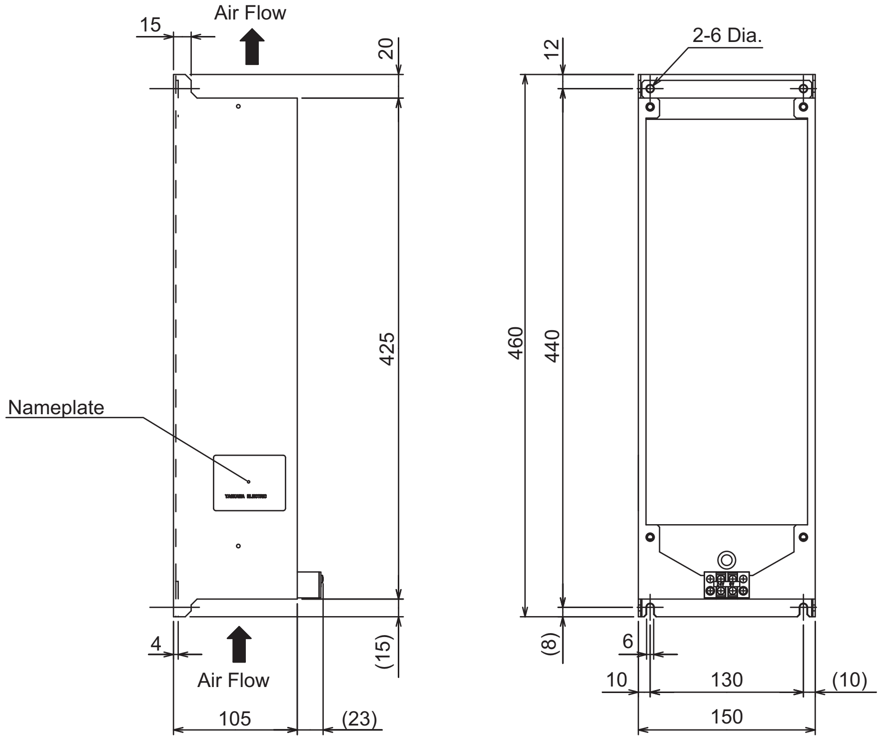


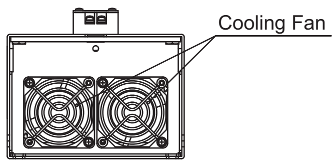
<Unit Mounted Diagram>



Unit: mm

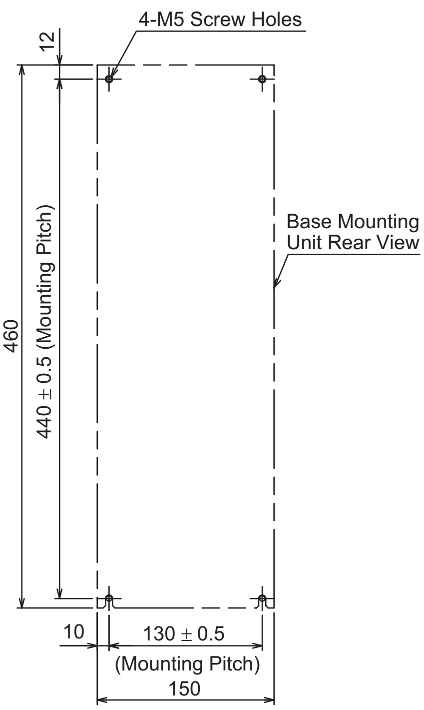
■ JUSP-JUBM150AA



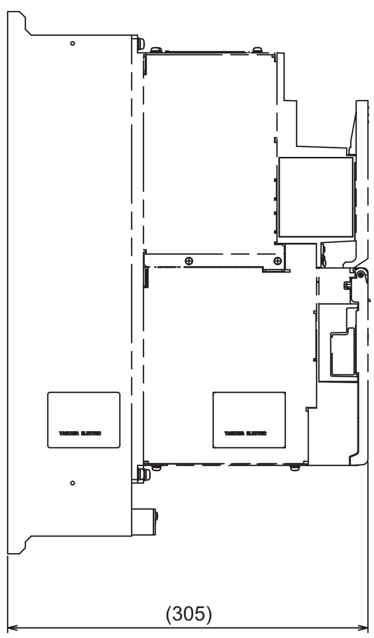


Approx. Mass: 3.5 kg

<Mounting Hole Diagram>

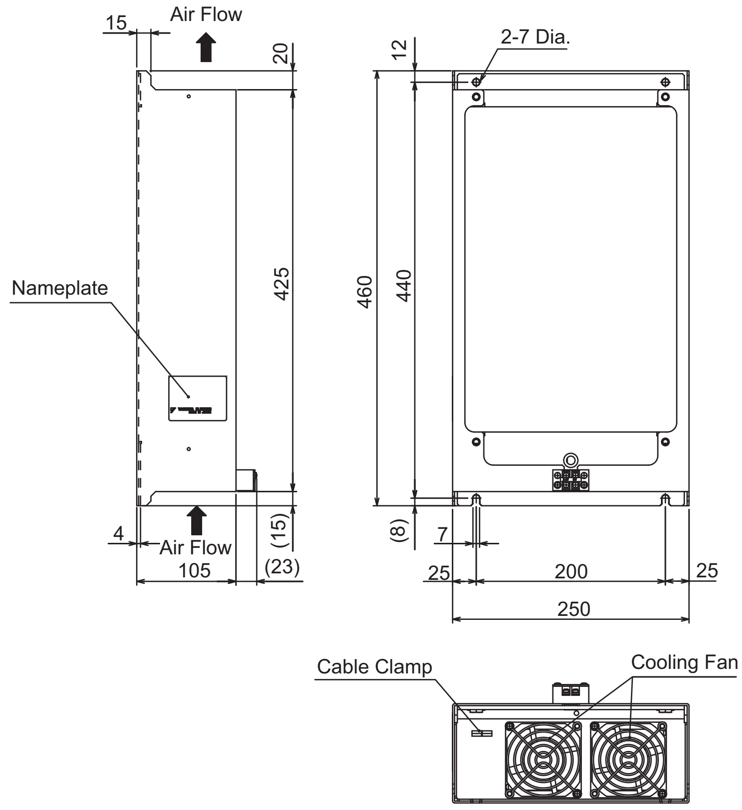


<Unit Mounted Diagram>



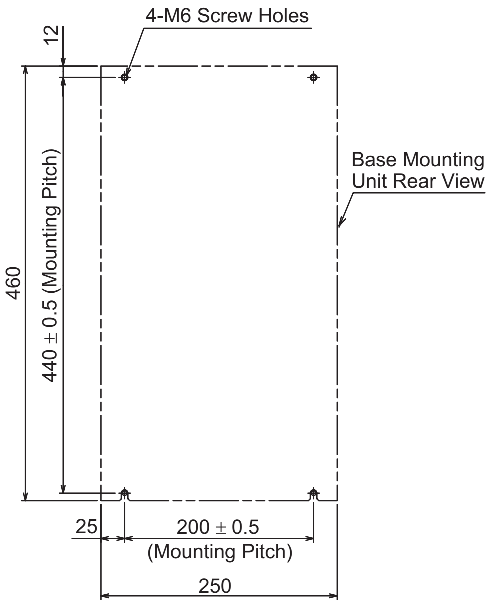
Unit: mm

■ JUSP-JUBM250AA

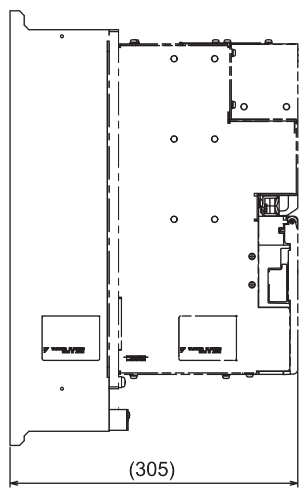


Approx. Mass: 4.9 kg

<Mounting Hole Diagram>



<Unit Mounted Diagram>

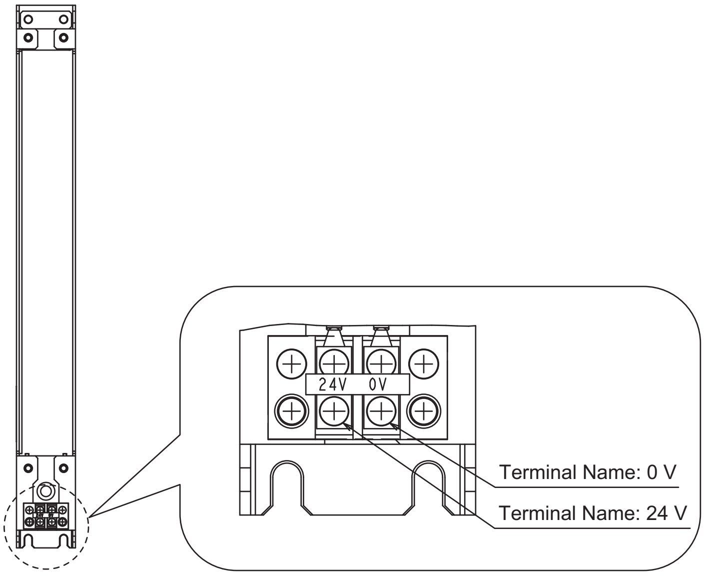


Unit: mm

3.3.5 Wiring

Connect the 24-VDC and 0-VDC lines to the terminals on the base mounting unit to power the cooling fan.

Note 1. The power supply for the cooling fan on the base mounting unit is separate from the control power supply for the power regeneration converter and SERVOPACK and separate from the power supply for the sequence signals.
2. The output current that is required from the power supply when one power supply is connected to more than one base mounting unit is the total input current for all of the connected units. Use a suitable wire size for the required current and do not exceed the wire size range of the terminal block.



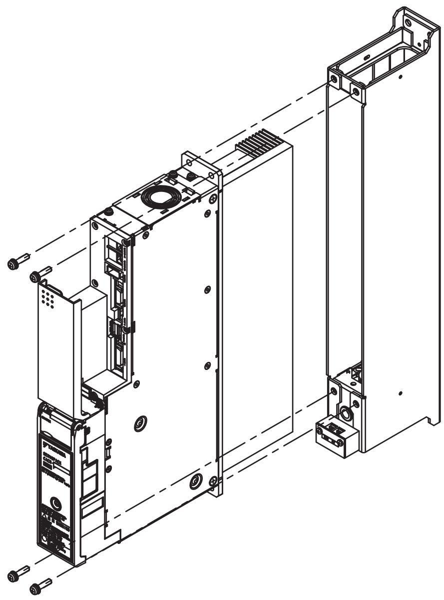
3.3.6 Mounting Method

Mount the power regeneration converter and SERVOPACK to the base mounting units as described in this section.

As shown in the following figure, insert the heat sink on the power regeneration converter or SERVOPACK into the base mounting unit and secure it with the enclosed screws (four).

The side of the base mounting unit with the terminal block is the bottom of the unit.

For instructions on installation in a control panel, refer to *1.3.2 Σ-V-SD Series Driver*.



Model	Size of Enclosed Screws	Tightening Torque
JUSP-JUBM050AA	M5	2.6 to 3.2 N·m (23.0 to 28.3 lbf·in)
JUSP-JUBM075AA		
JUSP-JUBM100AA		
JUSP-JUBM150AA		
JUSP-JUBM250AA	M6	4.3 to 4.9 N·m (38.1 to 43.4 lbf·in)

4

Installation

4.1 Spindle Motors

The service life of the spindle motor will be shortened or unexpected problems will occur if the spindle motor is installed incorrectly or in an inappropriate location. Always observe the following installation instructions.

4.1.1 Installation Environment

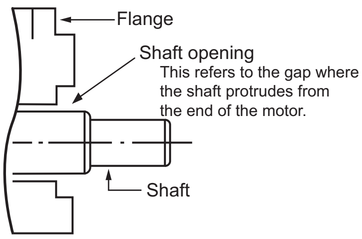
Item	Condition
Ambient Temperature	0°C to 40°C (no freezing)
Ambient Humidity	20% to 80%RH (no condensation)
Installation Site	• Indoor, free of corrosive or explosive gases • Well-ventilated and free of dust and moisture • Facilitates inspection and cleaning. • Elevation:1,000 m max. • Free of high magnetic field • Free of oil
Storage Environment	Store the motor in the following environment if it is stored with the power cable disconnected. Ambient temperature during storage: –20°C to +60°C (no freezing) Ambient humidity during storage: 20% to 80%RH (no condensation)

⚠ CAUTION

- **Provide sufficient space so that cooling air will be provided to the cooling fan. Keep a space of at least 100 mm between the machine and the ventilation outlet of the motor.**
  If ventilation is not proper, the motor temperature fault protective function will work regardless of whether or not the load is at the rated value or not.
- **Install the motor in a clean location free from oil mist and water drops. If the motor is likely to come in contact with water or oil, protect the motor with a cover.**
  The intrusion of water or dirty oil into the interior of the motor will decrease the insulation resistance, which may result in a ground fault.
- **Check that the mounting bed, base, or stand of the motor is of robust construction because the weight of the motor as well as the dynamic load of the motor in operation will be imposed on it, possibly causing vibration.**
- **Use seal connectors, conduits, or similar devices to seal the cable openings of the motor terminal box.**
  Failure to observe this caution may result in cuttings, cutting oil mist, or other foreign matter entering the motor through the cable opening, possibly causing malfunction.
- **When vertically mounting the motor with the shaft on the bottom, the motor shaft must not touch the stand, the ground, or other surfaces.**
  If the shaft touches these surfaces, the shaft is pushed into the motor and the bearing may be damaged.

4.1.2 Enclosure

The protective structure of the spindle motor when the special cable is used provides IP44 protection. However, this does not apply to the shaft opening. (Refer to the following figure.)



If you need to use the motor in a location where oil will come into contact with the shaft opening, contact a Yaskawa sales representative.

4.1.3 Installation Orientation

(1) Flange type

- Mount the motor with the motor shaft on the load side at any angle between horizontal and the downward vertical direction. If the motor shaft is facing up, excessive force will be imposed on the motor shaft. As a result, the service life of the motor will be adversely affected.
- Use the spindle motor UAKAJ-45 or UAKBJ-30 (outer diameter □380) with the terminal box facing upward and the motor shaft facing horizontal. If the terminal box is in the horizontal or downward direction, dust may intrude from the ventilation mouth on the bottom of the load-side bracket. As a result, the motor may fail to operate or unexpected accidents may occur.

(2) Foot-mounted type

- Mount the legs on the floor. If the legs are installed upward, excessive force will be imposed on the legs. As a result, the service life of the spindle motor will be adversely affected.

4.1.4 Coupling Motor and Machinery

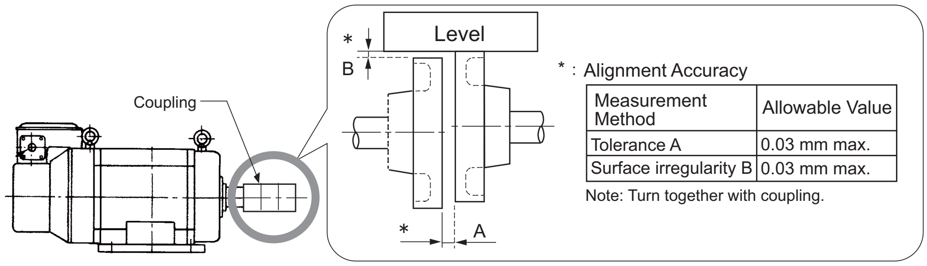
Consider the following conditions when coupling the spindle motor with the machinery.

(1) Direct Coupling

Couple the motor with the machinery so that the center of the motor shaft and that of the machinery shaft are on a straight line. Insert a liner for adjustment, if necessary.

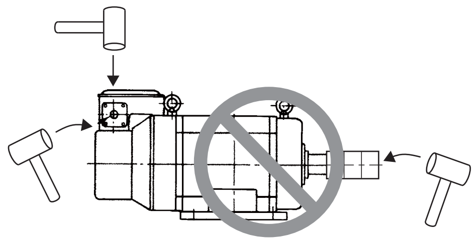
IMPORTANT

- Install the motor so that alignment accuracy falls within the following range. Vibration that will damage the bearings and encoders if the shafts are not properly aligned.

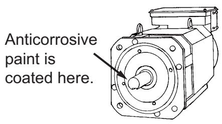


Measurement Method	Allowable Value
Tolerance A	0.03 mm max.
Surface irregularity B	0.03 mm max.

- Do not allow any direct impact to the shafts when installing the couplings. Do not hit the area near encoders with a hammer etc., as impacts may damage the encoders.

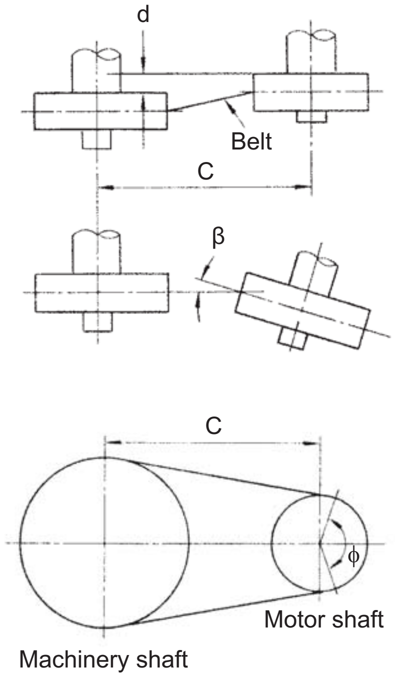


- Before installation, thoroughly remove the anticorrosive paint from the flange surface and the end of the motor shaft. Only after removing the paint can motors be installed on the machines.



(2) Belt Coupling

- Check that the motor shaft is parallel to the machinery shaft and that the line connecting the centers of the pulleys and the shafts are at right angles to each other. If the angularity of the belt is improper, the belt will vibrate or slip.
- The radial load imposed on the motor shaft edge must not exceed the permissible value. If an excessive radial load is imposed on the motor shaft, the motor bearings will be adversely affected and the service life of the bearings will be decreased.
  For details, refer to *3.1(4) Tolerance Radial Loads*.
- Be sure that no axial load is imposed on the motor shaft.
- Make sure that the contact angle of the belt with the pulley is 140° or more. If not, the belt may slip.



- If C is 1,000 mm or less, d < 1 mm.
- If C is more than 1,000 mm, d/C < 1/1000.
- β < 1/3°
- Contact angle ϕ > 140°

Belt Installation

(3) Gear Coupling

Check that the motor shaft is parallel to the machinery shaft and that the centers of the gears are engaged properly. Refer to *3.1(5) Motor Total Indicator Readings* for the precision of the peripheral parts connecting to the motor shaft. The gears may grate if they do not engage properly.

Be sure that no axial load is imposed on the motor shaft.

(4) Mounting a Pulley or Gear to the Motor Shaft

When mounting a pulley or gear to the motor shaft, consider the mounting balance of the motor. The dynamic balance of the motor is kept with a half key (for motors with a keyway), which is a half as thick as the key (T) specified in the motor shaft dimensional drawing. The motor rotates at high speed and a little imbalance in the mechanism may cause the motor to vibrate.

4.2 Σ-V-SD Driver

4.2.1 Installation Requirements

<table>
<tr><th>Item</th><th colspan="2">Specifications</th></tr>
<tr><td>Ambient Air Temperature</td><td colspan="2">0°C to 40°C: at 100% load
0°C to 55°C: at 70% load</td></tr>
<tr><td>Storage Temperature</td><td colspan="2">–20°C to 85°C</td></tr>
<tr><td>Ambient/ Storage Humidity</td><td colspan="2">90%RH or less (with no freezing or condensation)</td></tr>
<tr><td>Vibration Resistance</td><td colspan="2">4.9 m/s²</td></tr>
<tr><td>Shock Resistance</td><td colspan="2">19.6 m/s²</td></tr>
<tr><td>Protection Class</td><td>IP10</td><td rowspan="2">An environment that satisfies the following conditions.
• Free of corrosive or flammable gases
• Free of exposure to water, oil, or chemicals
• Free of dust, salts, or iron dust</td></tr>
<tr><td>Pollution Degree</td><td>2</td></tr>
<tr><td>Altitude</td><td colspan="2">1000 m or less</td></tr>
<tr><td>Others</td><td colspan="2">Free of static electricity, strong electromagnetic fields, magnetic fields or exposure to radioactivity</td></tr>
</table>

4.2.2 Thermal Design of Control Panel

Install the Σ-V-SD drivers, host controllers, and other units in a control panel.
Use a control panel with an enclosed structure that provides protection against corrosive gases, water, and oil. Also, design the system so that the temperature rise in the control panel does not cause the temperature to exceed the ambient operating temperature.

(1) Calorific Value

■ Power Regeneration Converter

Model	Calorific Value at Continuous Rated Operation				
	Total (W)	Loss of Control Block (W)	Loss of Power Block (W)		
			Total	Inside	Duct
CACP-JU15A3☐	116.4	13.1	103.3	10.3	93.0
CACP-JU19A3☐	154.3	13.1	141.2	14.1	127.1
CACP-JU22A3☐	183.8	13.1	170.7	17.1	153.6
CACP-JU30A3☐	247.2	14.7	232.5	23.2	209.3
CACP-JU37A3B	276.2	14.7	261.5	26.2	235.3
CACP-JU45A3B	394.7	14.7	380	38.0	342.0
CACP-JU15D3☐	66.8	13.1	53.7	5.4	48.4
CACP-JU19D3☐	90.5	13.1	77.4	7.7	69.7
CACP-JU22D3☐	104.8	13.1	91.7	9.1	82.6

■ SERVOPACK

Model	Calorific Value at Continuous Rated Operation				
	Total (W)	Loss of Control Block (W)	Loss of Power Block (W)		
			Total	Inside	Duct
CACR-JU028ADA	149.6	14.5	135.1	27.0	108.1
CACR-JU036ADA	176.5	14.5	162.0	32.4	129.6
CACR-JU065ADA	319.7	14.4	305.3	30.5	274.8
CACR-JU084ADA	420.1	17.1	403.0	40.3	362.7
CACR-JU102ADA	474.3	17.1	457.2	45.7	411.5
CACR-JU125ADA	610.0	24.1	585.9	58.6	527.3
CACR-JU196ADA	1317.9	25.3	1292.6	129.3	1163.3
CACR-JU014DDA	137.6	15.1	122.5	24.5	98.0
CACR-JU018DDA	164.1	15.1	149.0	29.8	119.2
CACR-JU033DDA	303.8	14.5	289.4	28.9	260.5
CACR-JU042DDA	364.0	17.1	346.9	34.7	312.2
CACR-JU051DDA	420.4	17.1	403.3	40.3	363.0

(2) Air Temperature Rise inside Control Panel (Average Temperature Rise)

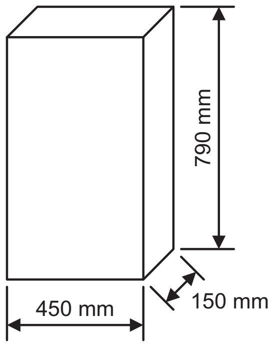
Design the control panel so that the internal air temperature will be no more than 10°C higher than the reference value. If the rise in air temperature in the control panel exceeds 10°C, a cooling system must be installed. For details, refer to *4.2.2 (3) Cooling System Installation*.

The calculation formula for internal temperature rise for a control panel made of metal sheets is as follows:

$$\Delta T = \frac{P}{qe} = \frac{P}{k \cdot A}$$

- ΔT: Temperature rise in the control panel (°C)
- P: Calorific value in the control panel (W)
- qe: Heat flow through ratio of the control panel (W/°C)
- k: Heat pass through ratio of a metal plate (W/m^2°C)
  With a stirring fan: 6 W/m^2°C
  Without a stirring fan: 4 W/m^2°C
- A: Effective radiation area of the control panel (m^2)*
  * Radiation available area of the control panel surface area (Exclude the surface which contacts other object)

<Example>
Allowable Watt Data Loss for a Control Panel with a Stirring Fan



- Effective radiation area of the control panel: A=1.0155 (m^2)
  (Exclude the base area because control panel is type of putting on the floor.)
- Calorific value in the control panel: P=60 (W)
- Temperature rise value in the control panel: $\Delta T = \frac{P}{qe} = \frac{P}{k \cdot A} = \frac{60}{6 \times 1.0155} = 9.8$ (°C)

In the above example, the rise in the air temperature inside the control panel, ΔT, is 9.8°C. The criteria of 10°C has therefore been met.

(3) Cooling System Installation

Use the following calculation formula to select a cooling system and install it in the control panel so that the air temperature in the control panel will be no more than 10°C higher than the reference value.

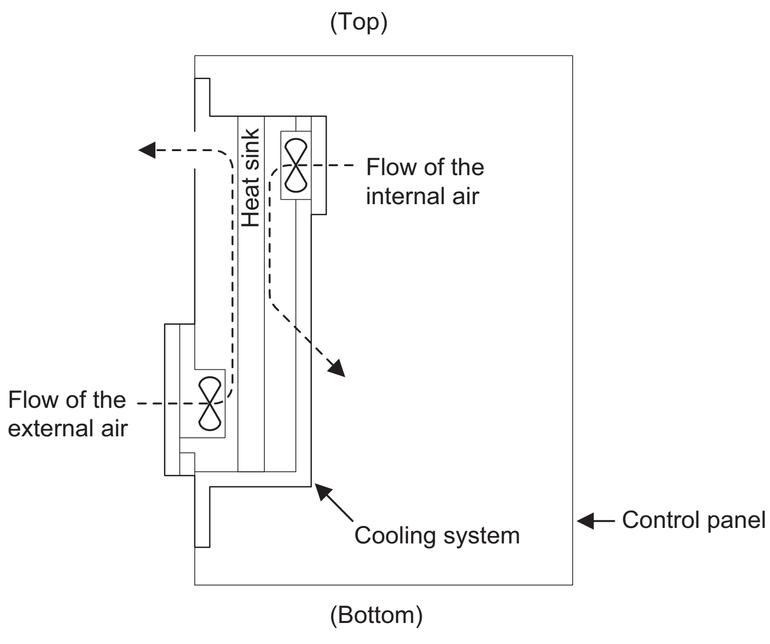
$$\Delta T = \frac{P}{qe} = \frac{P}{k \cdot (A-B)+qh}$$

- ΔT: Temperature rise in the control panel (°C)
- P: Calorific value in the control panel (W)
- qe: Heat flow through ratio of the control panel (W/°C)
- qh: Heat flow through ratio of the cooling system (W/°C)
- k: Heat pass through ratio of a metal plate ($W/m^2°C$)
  With a stirring fan: 6 $W/m^2°C$
  Without a stirring fan: 4 $W/m^2°C$
- A: Effective radiation area of the control panel (m^2)*
- B: Installation area of the cooling system (m^2)

  * Radiation available area of the control panel surface area (Exclude the surface which contacts other object)

An installation example is given below.

Install the cooling system so that internal air is taken into the control panel at the top and returned at the bottom, and so that the external air is taken in at the bottom and exhausted at the top.

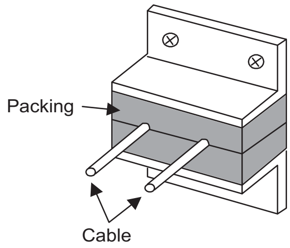


Cooling System Installation

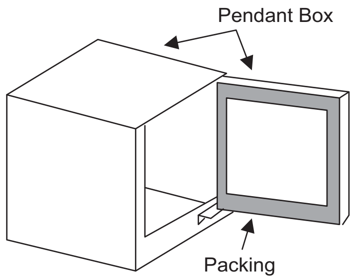
4.2.3 Control Panel Dust-proof Design

The host controller and other printed circuit boards mounted in the control panel may malfunction due to the effects of airborne particles (dust, cuttings, oil mist, etc.). Observe the following precautions to prevent airborne particles from entering the control panel.

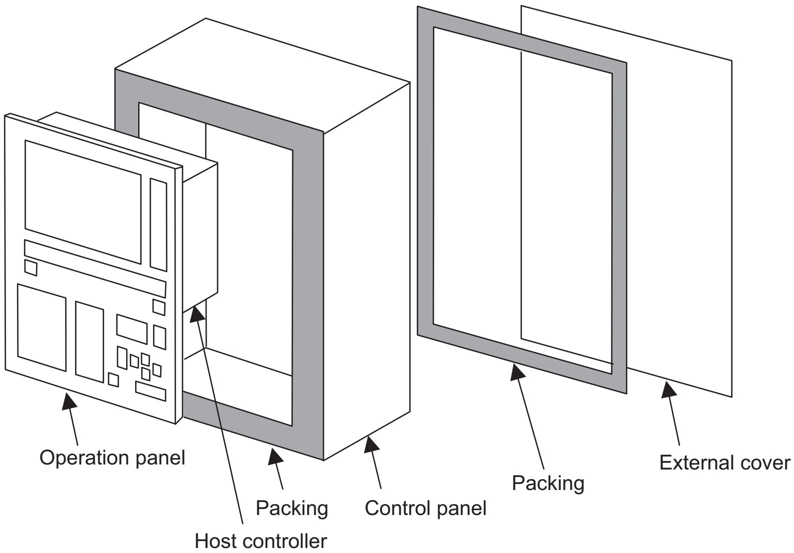
- Always use a sealed structure for the control panel.
- Block cable openings with packing. (Refer to the figure labeled Cable Openings given below.)
- Install packing on the door and external cover to seal them. (Refer to the figure labeled Door Packing given below.)
- Block all gaps.
- Oil may collect on the top surface and may enter the control panel through screw holes. Take special countermeasures, such as using oil-proof packing.



Cable Openings



Door Packing



Operation Box

4.2.4 Installation Precautions

Observe the following precautions when designing the control panel.

(1) General Precautions

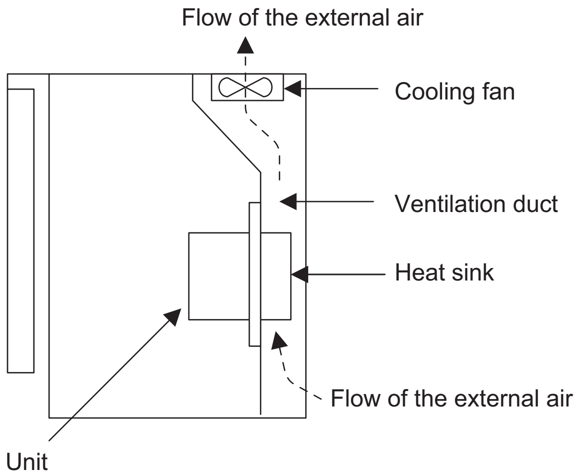
General precautions are given below.

- Always use a sealed structure for the control panel.
- Install the units so that maintenance inspections, removal, and installation can be performed easily.
- Provide about 100 mm of space between components and the control panel surfaces so that the flow of air is not blocked inside the control panel.
- Design the control panel so that the average internal air temperature will be no more than 10°C higher than the external air.
- We recommend the use of a fan to stir the air to increase cooling efficiency and prevent localized temperature increases in the sealed control panel.
- Separate the units from cables or components of 90 VDC or higher and cables or components for AC power supply by at least 10 mm to help prevent malfunction due to noise.
- Separate the primary and secondary sides of transformer and noise filters.

(2) Installation Precautions

Precautions for installing the Σ-V-SD driver are given below.

- Always secure the Σ-V-SD driver on a vertical surface using screws or bolts.
- Provide the specified space on the left, right, top, and bottom of the driver to enable maintenance and ventilation. For details, refer to *4.2.5 Installation Orientation and Space*.
- Place the heat sink of the Σ-V-SD driver outside of the ventilation ducts to allow external air flow through the heat sink. The loss from the control panel will be reduced, and the majority of the loss from the unit will be cooled directly by the external air.
- Cooling the heat sink requires an air flow of 2.5 m/s in the ventilation duct.
- Make sure that cooling air flows through the heat sink for each Σ-V-SD driver.
- We recommend a metal cooling fan. Plastic fans will deteriorate when exposed to cutting oil, which may cause Σ-V-SD driver failure or other problems.

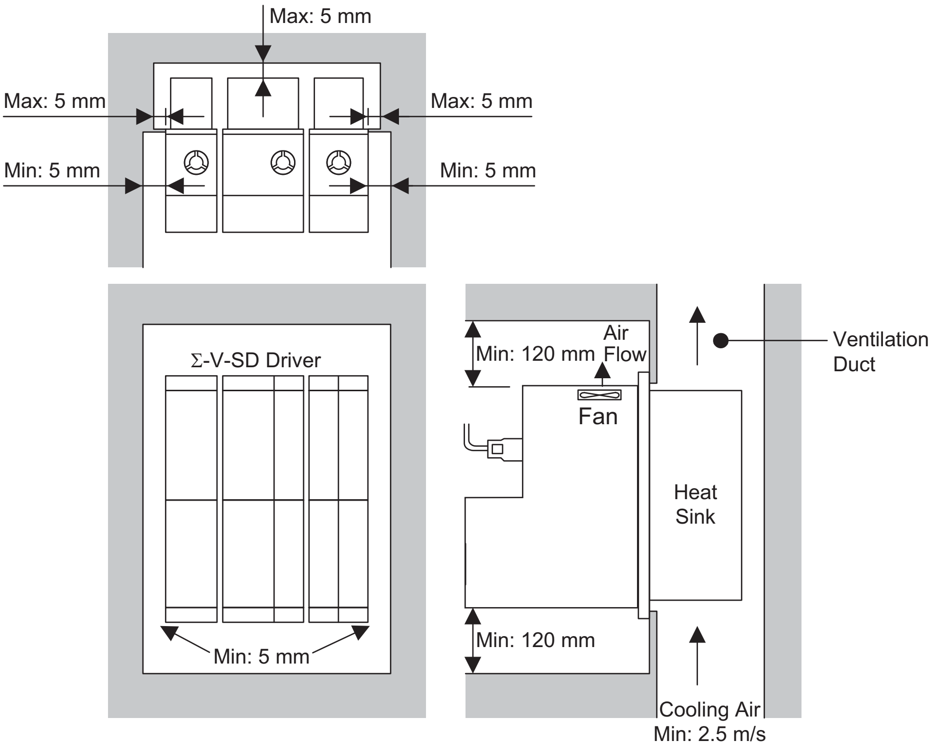


Σ-V-SD Driver Installation

4.2.5 Installation Orientation and Space

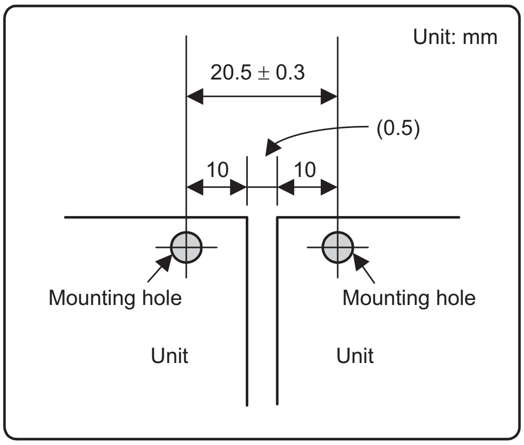
Precautions for the mounting the Σ-V-SD driver, including the mounting orientation and mounting space, are given below.

Note: The figure is an example of a duct-ventilated type driver. Dimensions for base-mounted type drivers are the same (ventilation duct is not required).



Installation Orientation and Space for Σ-V-SD Driver

- Always install the power regeneration converter on the left side of the SERVOPACK.
- We recommend that you install the SERVOPACKs in order of capacity, with the SERVOPACK with the largest capacity closest to the power regeneration converter.
- Refer to the external dimension diagrams for external dimensions and mounting dimensions of the products (*3.2.1 (3) External Dimensions* and *3.2.2 (3) External Dimensions*).
- Make sure that the ambient air temperature of the Σ-V-SD driver is 0 to 55°C near the heat sink and inside the control panel at a 70% load, and 0 to 40°C near the heat sink and inside the control panel at a 100% load.
- To prevent oil penetration, seal the mounting screw sections of the power regeneration converter and the SERVOPACK.
- Always install the Σ-V-SD driver with the fan at the top to ensure efficient cooling.
- When mounting the Σ-V-SD driver, allow space above and below it to prevent heat buildup.
- When stirring the air inside the control panel, do not allow the airflow to fall directly on the Σ-V-SD driver to prevent dirt from collecting on the Σ-V-SD driver.
- Provide the following spaces between the units.



Installation

4

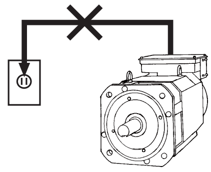
5

Wiring

5.1 Spindle Motors

CAUTION

- Do not bundle the main circuit cable and the encoder cable together.
  Failure to observe this caution may result in malfunction.
- The maximum wiring length is 3 m for I/O signal cables, 20 m for encoder cables or motor main circuit cables, and 10 m for control power supply cables (+24 V, 0 V).
- Do not connect the spindle motor directly to an industrial power supply.
  Failure to observe this caution may damage the spindle motor. Connect the spindle motor to the correct SERVOPACK.



5.1.1 Precautions on Wiring

(1) Cables

Standard motor main circuit cables, encoder cables, and relay cables cannot be used in cases where high flexibility is needed, as when the cables themselves move or are twisted or turned. Use flexible cables for flexible applications.

(2) Cable Stress

Make sure there is no bending or tension on the cables themselves, the connections, or the cable lead inlets. Be especially careful to wire encoder cables so that they are not subject to stress because the core wires of encoder cables are very thin at only 0.2 mm^2 to 0.3 mm^2.

(3) Connectors

Observe the following precautions:

- Connect the main circuit cable, and then connect the encoder cable. If you connect the encoder cable first, the encoder may be damaged due to the difference in electrical potential from the FG.
- Make sure there is no foreign matters such as dust and metal chips in the connector before connecting.
- Do not apply shock to resin connectors. Otherwise, they may be damaged.
- Make sure of the pin arrangement.
- When handling a motor with its cables connected, hold the motor or the connectors and cables will be damaged.

5.1.2 Wirings for Spindle Motors

(1) Main Circuit Cable Wiring

■ Terminal Screws and Tightening Torques (200 V)

Model		Terminal Symbols	Terminal Screw	Tightening Torque [N·m]	Wire Sizes
UAKAJ-□□CZ (Single winding)	04	U, V, W, FG	M5	2.0 to 2.4	AWG8
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	06	U, V, W, FG	M5	2.0 to 2.4	AWG8
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	08	U, V, W, FG	M5	2.0 to 2.4	AWG8
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	11	U, V, W, FG	M5	2.0 to 2.4	AWG6
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	15	U, V, W, FG	M8	6.0 to 9.0	AWG4
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	19	U, V, W, FG	M8	6.0 to 9.0	AWG2
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	22	U, V, W, FG	M8	6.0 to 9.0	AWG1
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	30	U, V, W, FG	M10	10.0 to 15.0	AWG2/0
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	37	U, V, W, FG	M10	10.0 to 15.0	AWG4/0
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	45	U, V, W, FG	M10	10.0 to 15.0	AWG4/0
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
UAKBJ-□□CZ (Winding selection)	06	U1, V1, W1, U2, V2, W2, FG	M6	2.5 to 3.75	AWG8
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	08	U1, V1, W1, U2, V2, W2, FG	M6	2.5 to 3.75	AWG8
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	11	U1, V1, W1, U2, V2, W2, FG	M6	2.5 to 3.75	AWG6
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	15	U1, V1, W1, U2, V2, W2, FG	M8	6.0 to 9.0	AWG4
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	19	U1, V1, W1, U2, V2, W2, FG	M8	6.0 to 9.0	AWG2
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	22	U1, V1, W1, U2, V2, W2, FG	M8	6.0 to 9.0	AWG1
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	30	U1, V1, W1, U2, V2, W2, FG	M10	10.0 to 15.0	AWG2/0
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14

Wiring

5

■ Terminal Screws and Tightening Torques (400 V)

Model		Terminal Symbols	Terminal Screw	Tightening Torque [N·m]	Wire Sizes
UAKAJ-□□CZ (Single winding)	06	U, V, W, FG	M5	2.0 to 2.4	AWG12
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	08	U, V, W, FG	M5	2.0 to 2.4	AWG10
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	11	U, V, W, FG	M5	2.0 to 2.4	AWG10
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	15	U, V, W, FG	M8	6.0 to 9.0	AWG8
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	19	U, V, W, FG	M8	6.0 to 9.0	AWG6
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	22	U, V, W, FG	M8	6.0 to 9.0	AWG6
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
UAKBJ-□□CZ (Winding selection)	06	U1, V1, W1, U2, V2, W2, FG	M6	2.5 to 3.75	AWG12
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	08	U1, V1, W1, U2, V2, W2, FG	M6	2.5 to 3.75	AWG10
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	11	U1, V1, W1, U2, V2, W2, FG	M6	2.5 to 3.75	AWG10
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	15	U1, V1, W1, U2, V2, W2, FG	M8	6.0 to 9.0	AWG8
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	19	U1, V1, W1, U2, V2, W2, FG	M8	6.0 to 9.0	AWG6
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14
	22	U1, V1, W1, U2, V2, W2, FG	M8	6.0 to 9.0	AWG6
		Z1, Z2, Z3	M4	1.2 to 1.8	AWG14

■ Wiring

- CACR-JU028ADA, -JU014DDA

SERVOPACK End (CN8)			Motor End
Pin No.	Signal Name		Terminal Name
A1	U	—	U
B1	V	—	V
B2	W	—	W
A2	⏚	—	⏚

- CACR-JU036ADA, -JU018DDA

SERVOPACK End (CN8)			Motor End
Pin No.	Signal Name		Terminal Name
1	U	—	U
2	V	—	V
3	W	—	W
4	⏚	—	⏚

- CACR-JU065ADA, -JU084ADA, -JU102ADA, -JU125ADA, -JU196ADA, -JU033DDA, -JU042DDA, -JU051DDA

SERVOPACK End		Motor End
Terminal Name		Terminal Name
U	—	U
V	—	V
W	—	W
⏚	—	⏚

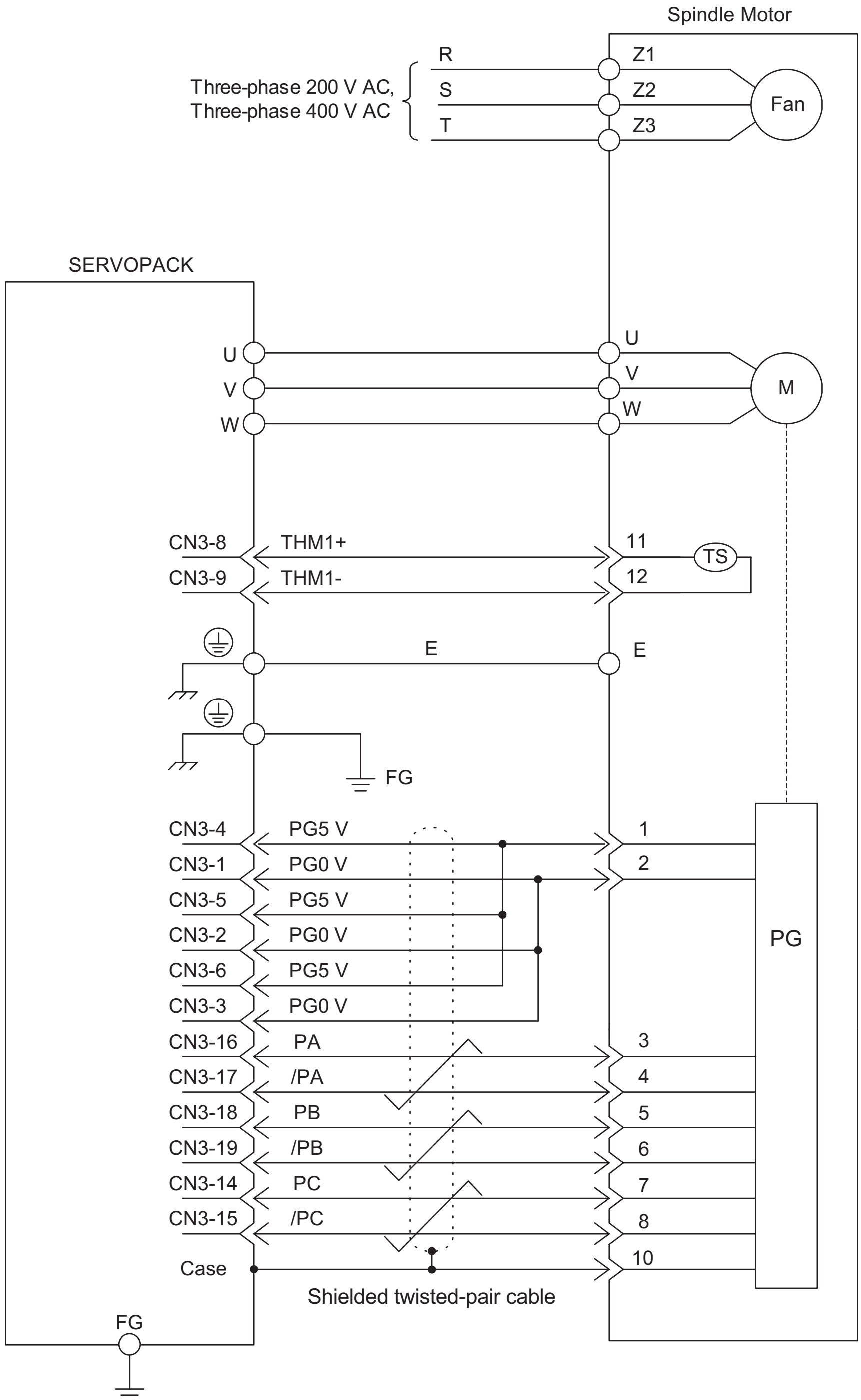
(2) Encoder Wiring

■ Pulse Encoder (SERVOPACK-end connector: CN3)

- Connections

Pin No.	Signal Name	I/O	Function	Pin No.	Signal Name	I/O	Function
1	PG0V	–	Power supply for encoder 0 V	11	CC	O	Common for magnetic contactor for winding selection
2	PG0V	–	Power supply for encoder 0 V	12	CA1	I	Winding selection status signal
3	PG0V	–	Power supply for encoder 0 V	13	CA2	I	
4	PG5V	O	Power supply for encoder +5 VDC	14	PC	I	Encoder phase C signal input
5	PG5V	O	Power supply for encoder +5 VDC	15	/PC	I	
6	PG5V	O	Power supply for encoder +5 VDC	16	PA	I	Encoder phase A signal input
7*	(NC)	–	–	17	/PA	I	
8	THM1+	I	Motor winding temperature detection	18	PB	I	Encoder phase B signal input
9	THM1–	I	Ground for temperature detection	19	/PB	I	
10	C24V	O	+24 VDC power supply for magnetic contactor for winding selection	20*	(NC)	–	–

* Do not use NC signal.



Connecting Diagram of Pulse Encoder for Spindle Motor

5.2 Σ-V-SD Driver

5.2.1 Main Circuit Power Supply

IMPORTANT

- Do not touch the power terminals before the main-circuit capacitor has had time to discharge because high voltage may still remain in the converter and SERVOPACK after the power supply is turned OFF. Refer to the following table for the discharge time of main-circuit capacitor.
- When two or more SERVOPACKs are used in combination, use the longest discharge time of those SERVOPACKs for the main-circuit capacitor.

Input Voltage	SERVOPACK Model	Discharge Time Needed for Main-Circuit Capacitor (min)
Three-phase 200 VAC	CACR-JU028ADA	15
	CACR-JU036ADA	20
	CACR-JU065ADA	20
	CACR-JU084ADA	20
	CACR-JU102ADA	25
	CACR-JU125ADA	25
	CACR-JU196ADA	25
Three-phase 400 VAC	CACR-JU014DDA	10
	CACR-JU018DDA	15
	CACR-JU033DDA	15
	CACR-JU042DDA	15
	CACR-JU051DDA	15

- First make sure the charge indicator is turned OFF and that the DC-bus (symbol: P and N) voltage value is correct by using a tester or other device before wiring or starting an inspection.

(1) Wire Sizes and Tightening Torques

■ Power Regeneration Converter

Input Voltage	Model: CACP-JU	Terminal Symbols	Terminal Screw	Tightening Torque [N·m]	Wire Sizes
Three-phase, 200 VAC	15A3□	L1, L2, L3	M6	2.5 to 3.0	AWG6
		B1, B2	M5	2.0 to 2.4	AWG14
		⏚	M5	2.0 to 2.4	AWG6
	19A3□	L1, L2, L3	M6	2.5 to 3.0	AWG4
		B1, B2	M5	2.0 to 2.4	AWG14
		⏚	M5	2.0 to 2.4	AWG4
	22A3□	L1, L2, L3	M6	2.5 to 3.0	AWG3
		B1, B2	M5	2.0 to 2.4	AWG14
		⏚	M5	2.0 to 2.4	AWG4
	30A3□	L1, L2, L3	M6	2.5 to 3.0	AWG2
		B1, B2	M5	2.0 to 2.4	AWG14
		⏚	M6	2.5 to 3.0	AWG4
	37A3B	L1, L2, L3	M8	2.5 to 3.0	AWG1/0
		B1, B2	M5	2.0 to 2.4	AWG14
		⏚	M6	2.5 to 3.0	AWG2
	45A3B	L1, L2, L3	M10	30	AWG3/0
		B1, B2	M5	2.0 to 2.4	AWG14
		⏚	M6	2.5 to 3.0	AWG1/0
Three-phase, 400 VAC	15D3□	L1, L2, L3	M6	2.5 to 3.0	AWG8
		B1, B2	M5	2.0 to 2.4	AWG14
		⏚	M5	2.0 to 2.4	AWG7
	19D3□	L1, L2, L3	M6	2.5 to 3.0	AWG8
		B1, B2	M5	2.0 to 2.4	AWG14
		⏚	M5	2.0 to 2.4	AWG7
	22D3□	L1, L2, L3	M6	2.5 to 3.0	AWG7
		B1, B2	M5	2.0 to 2.4	AWG14
		⏚	M5	2.0 to 2.4	AWG7

■ SERVOPACK

Input Voltage	Model: CACR-JU	Terminal Symbols	Terminal Screw	Tightening Torque [N·m]	Wire Sizes
Three-phase, 200 VAC	028ADA	U, V, W	(connector)	–	AWG8
		motor ⏚	(connector)	–	AWG8
		⏚	M4	1.2 to 1.4	AWG8
	036ADA	U, V, W	(connector)	–	AWG8
		motor ⏚	(connector)	–	AWG8
		⏚	M4	1.2 to 1.4	AWG8
	065ADA	U, V, W	M6	2.5 to 3.0	AWG4 (AWG6)*1
		motor ⏚	M6	2.5 to 3.0	AWG4 (AWG6)*1
		⏚	M4	1.2 to 1.4	AWG4 (AWG6)*1
	084ADA	U, V, W	M6	2.5 to 3.0	AWG2
		motor ⏚	M6	2.5 to 3.0	AWG2
		⏚	M5	2.0 to 2.4	AWG4
	102ADA	U, V, W	M6	2.5 to 3.0	AWG1
		motor ⏚	M6	2.5 to 3.0	AWG1
		⏚	M5	2.0 to 2.4	AWG4
	125ADA	U, V, W	M8	2.5 to 3.0	AWG2/0
		motor ⏚	M8	2.5 to 3.0	AWG2/0
		⏚	M6	2.5 to 3.0	AWG2
	196ADA	U, V, W	M10	30	AWG4/0
		motor ⏚	M10	30	AWG4/0
		⏚	M6	2.5 to 3.0	AWG1/0
Three-phase, 400 VAC	014DDA	U, V, W	(connector)	–	AWG12
		motor ⏚	(connector)	–	AWG12
		⏚	M4	1.2 to 1.4	AWG12
	018DDA	U, V, W	(connector)	–	AWG10
		motor ⏚	(connector)	–	AWG10
		⏚	M4	1.2 to 1.4	AWG10
	033DDA	U, V, W	M6	2.5 to 3.0	AWG8 (AWG10)*2
		motor ⏚	M6	2.5 to 3.0	AWG8 (AWG10)*2
		⏚	M4	1.2 to 1.4	AWG8 (AWG10)*2
	042DDA	U, V, W	M6	2.5 to 3.0	AWG6
		motor ⏚	M6	2.5 to 3.0	AWG6
		⏚	M5	2.0 to 2.4	AWG6
	051DDA	U, V, W	M6	2.5 to 3.0	AWG6
		motor ⏚	M6	2.5 to 3.0	AWG6
		⏚	M5	2.0 to 2.4	AWG6

∗1. For motor model: UAK☐J-11CZ (Input voltage: Three-phase 200 VAC)
∗2. For motor model: UAK☐J-11CZ (Input voltage: Three-phase 400 VAC)

(2) Installation of Molded-case Circuit Breaker (MCCB)

Make sure to connect MCCB between the power supply and the main circuit power supply input terminals R/L1, S/L2 and T/L3 to protect wiring.

(3) Installation of Ground Fault Interrupter

The output of the Σ-V-SD driver is switched at high speed, which results in high-frequency leakage current. When connecting a ground fault interrupter to the input terminals of the power regeneration converter, select an one designed for Σ-V-SD driver that eliminates the high-frequency leakage current and detects only the leakage current in frequency bands that are harmful to the human body.

- Use a ground fault interrupter designed for Σ-V-SD driver for each power regeneration converter, with a minimum sensing current of 30 mA.
- A standard ground fault interrupter can be used for each power regeneration converter provided that it has a minimum sensing current of 200 mA with a minimum response time of 0.1 s.

(4) Installation of Magnetic Contactor

When the main circuit power supply is shut OFF in the sequence, a magnetic contactor (MC) can be used instead of a molded-case circuit breaker (MCCB). However, when a magnetic contactor is switched OFF at the main circuit power supply input side, regenerative braking does not function and the motor coasts to a stop. (At this time, protective function activates to display a fault.)
Frequent turning ON and OFF the magnetic contactor for the main circuit power supply input may cause the Σ-V-SD driver to malfunction. Turn the magnetic contactor ON and OFF once every 30 minutes at most.

(5) Terminal Block Connection Sequence

Main circuit power supply input phases can be connected to any terminal regardless of the order of R/L1, S/L2 and T/L3 on the terminal block.

(6) Installation of Surge Absorber

For inductive loads (magnetic contactors, magnetic relays, magnetic valves, solenoids, magnetic brakes, etc.) connected near the Σ-V-SD driver, install a surge absorber.

IMPORTANT	A surge absorber is used to absorb energy accumulated in the coil of an inductive load. Use a surge absorber with a capacity suitable for the coil. Do not, however, connect surge absorbers to output terminals U, V, W of the SERVOPACK. If a surge absorber is not used, the generated surge voltage of the coil will affect the control signal line of the SERVOPACK when the inductive load is turn ON and OFF. As a result, the control signal may malfunction.

(7) Prohibition of Installation of Phase Advancing Capacitor

Do not connect a phase advancing capacitor or surge absorber to main circuit power supply input (R/L1, S/L2, or T/L3) of a power regeneration converter. The phase advancing capacitor or surge absorber may become overheated and damaged by the harmonic components of the Σ-V-SD driver. Also, the Σ-V-SD driver may malfunction because of overcurrent.

(8) Designing the Power ON Sequence

Take the following points into consideration when designing the power ON sequence.

- The main circuit power supply must turn ON only after it has been confirmed that no servo alarm has occurred.
- The main circuit power supply must turn OFF when a servo alarm occurs during operation. The state of the motor must be considered when the main circuit power supply is turned OFF during operation. For details, refer to *5.2.1 (9) Typical Main Circuit Wiring Example*.

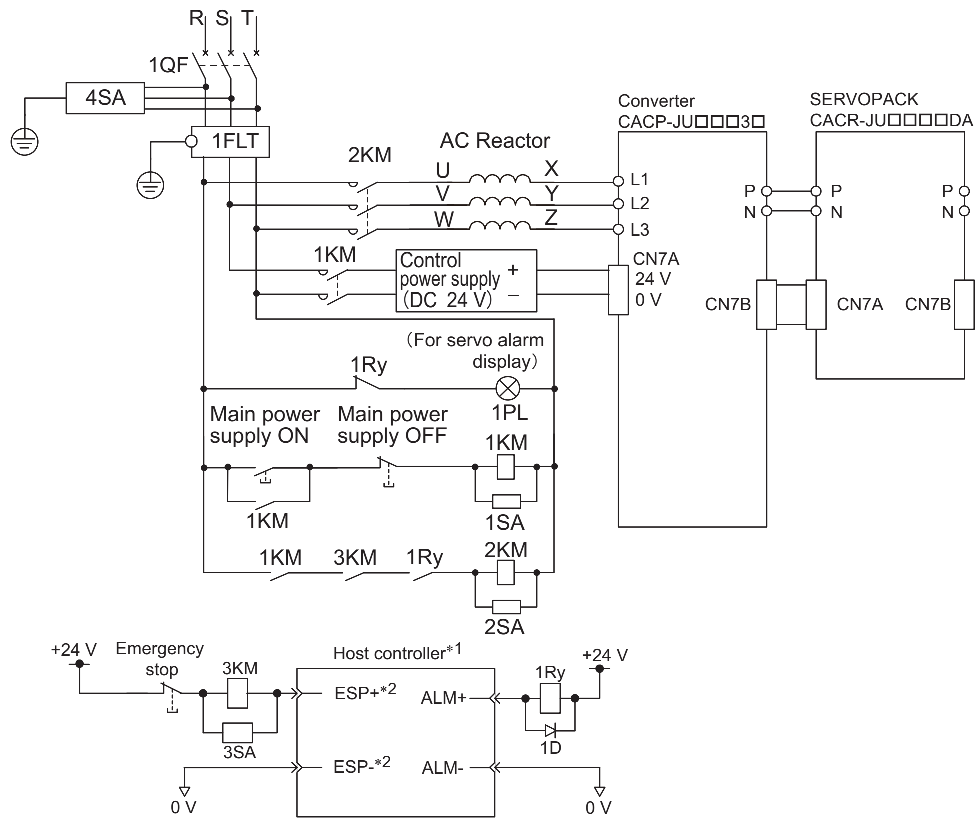
(9) Typical Main Circuit Wiring Example

The typical main circuit wiring examples is shown below.

⚠ WARNING

- Do not touch the power terminals before the main-circuit capacitor has had time to discharge because high voltage may still remain in the converter and SERVOPACK. Refer to this section for the details of discharge time of main-circuit capacitor.
  There is a risk of electrical shock due to residual voltage.
- Do not touch any terminals while the CHARGE lamp is lit.
  There is a risk of electrical shock due to residual voltage.
  First make sure the charge indicator is turned OFF and that the DC-bus (symbol: P and N) voltage value is correct by using a tester or other device before wiring or starting an inspection.

■ Three-phase 200 V, 400 V



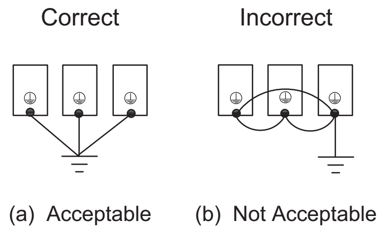
1QF: Molded-case circuit breaker
1FIL: Noise filter
1KM: Magnetic contactor
(for control power supply)
2KM: Magnetic contactor
(for main circuit power supply)
3KM: Magnetic contactor
(for emergency stop)
1Ry: Relay
1PL: Indicator lamp
1SA: Surge absorber
2SA: Surge absorber
3SA: Surge absorber
4SA: Surge absorber
1D: Flywheel diode

*1. A host controller is not provided by Yaskawa.
*2. These are the signals of a host controller.
For emergency stop signal (ESP) of Σ-V-SD driver, refer to *6.1.3 (7) Emergency Stop Signal (/ESP)*.

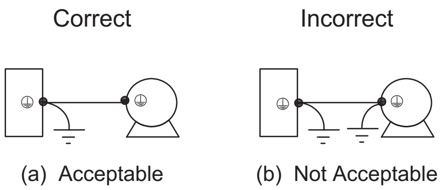
(10) Grounding

Use the following information to ensure that the ground is sufficient.

- Make sure to ground the ground terminal (⏚).
  200 V class: Ground to 100 Ω or less
  400 V class: Ground to 10 Ω or less
- Never ground the Σ-V-SD driver in common with welding machines, motors, or other large current electrical equipment. Wiring for grounding cable must be separated from the large-current electrical equipment.
- Always use a ground wire that complies with technical standards on electrical equipment. Minimize the length of the ground wire. Leakage current flows through the Σ-V-SD driver. Therefore, if the distance between the ground terminal and the ground terminal is too long, the potential on the ground terminal of the Σ-V-SD driver will become unstable.
- Always ground Σ-V-SD driver and motors using a ground terminal even when equipment is grounded through sill channel or steel plate.
- Ground each Σ-V-SD driver directly to the ground as shown in the following figure (a) of "Grounding." Do not make a loop as shown in (b). Ground the Σ-V-SD driver and motor as shown in the following figure (a) of "Grounding of Motor and Σ-V-SD Driver." Do not ground both the Σ-V-SD driver and motor as shown in (b).



Grounding



Grounding of Motor and Σ-V-SD Driver

5.2.2 Control Circuit Power Supply

(1) Specifications

■ Voltage

24 VDC ± 15%

■ Current

• Power Regeneration Converter

<table>
<tr><th>Input Voltage</th><th>Model</th><th>Specification</th></tr>
<tr><td rowspan="6">Three-phase, 200 VAC</td><td>CACP-JU15A3□</td><td rowspan="5">1A</td></tr>
<tr><td>CACP-JU19A3□</td></tr>
<tr><td>CACP-JU22A3□</td></tr>
<tr><td>CACP-JU30A3□</td></tr>
<tr><td>CACP-JU37A3B</td></tr>
<tr><td>CACP-JU45A3B</td><td>1.5A</td></tr>
<tr><td rowspan="3">Three-phase, 400 VAC</td><td>CACP-JU15D3□</td><td rowspan="3">1A</td></tr>
<tr><td>CACP-JU19D3□</td></tr>
<tr><td>CACP-JU22D3□</td></tr>
</table>

• SERVOPACK

<table>
<tr><th>Input Voltage</th><th>Model</th><th>Specification</th></tr>
<tr><td rowspan="7">270 VDC</td><td>CACR-JU028ADA</td><td rowspan="3">1.2A</td></tr>
<tr><td>CACR-JU036ADA</td></tr>
<tr><td>CACR-JU065ADA</td></tr>
<tr><td>CACR-JU084ADA</td><td rowspan="3">1.5A</td></tr>
<tr><td>CACR-JU102ADA</td></tr>
<tr><td>CACR-JU125ADA</td></tr>
<tr><td>CACR-JU196ADA</td><td>2A</td></tr>
<tr><td rowspan="5">540 VDC</td><td>CACR-JU014DDA</td><td rowspan="3">1.2A</td></tr>
<tr><td>CACR-JU018DDA</td></tr>
<tr><td>CACR-JU033DDA</td></tr>
<tr><td>CACR-JU042DDA</td><td rowspan="2">1.5A</td></tr>
<tr><td>CACR-JU051DDA</td></tr>
</table>

IMPORTANT

- The allowable current for the control power supply is 10 A. Perform wiring so that the total current when combined with the Σ-V-SD driver is 10 A or less.
- Refer to *2.1.2 Power Regeneration Converter, SERVOPACK, and Spindle Motor* for the maximum number of connected drives.

Wiring
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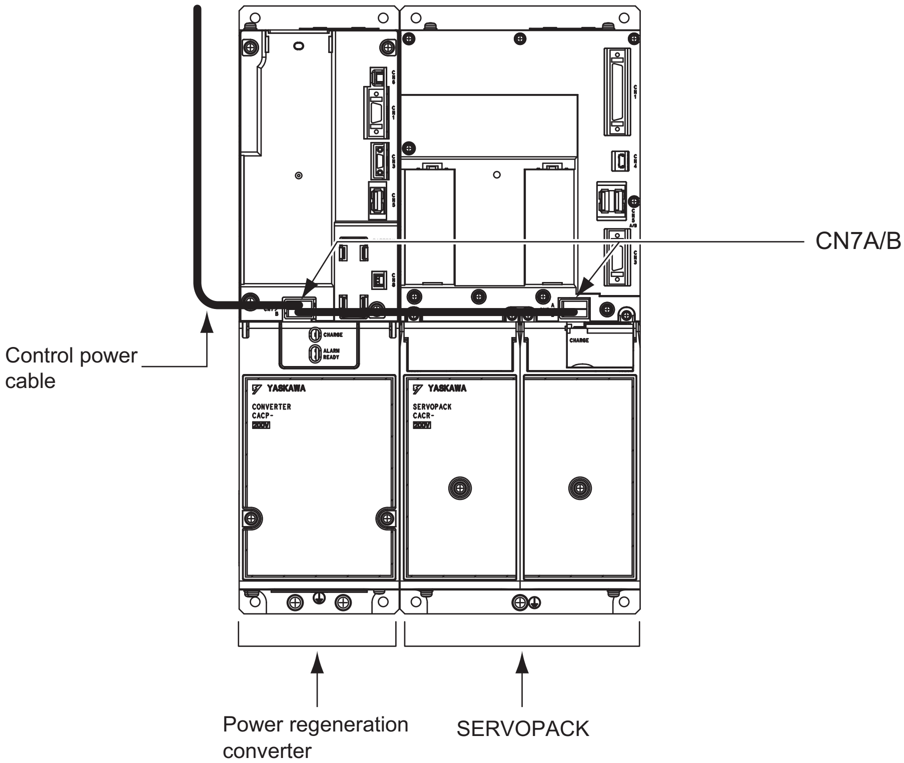
(2) Connections



Pin No.	Signal Name	I/O	Function	Pin No.	Signal Name	I/O	Function
A	24 VDC	I/O	+24 VDC	B	0 V	I/O	0 V

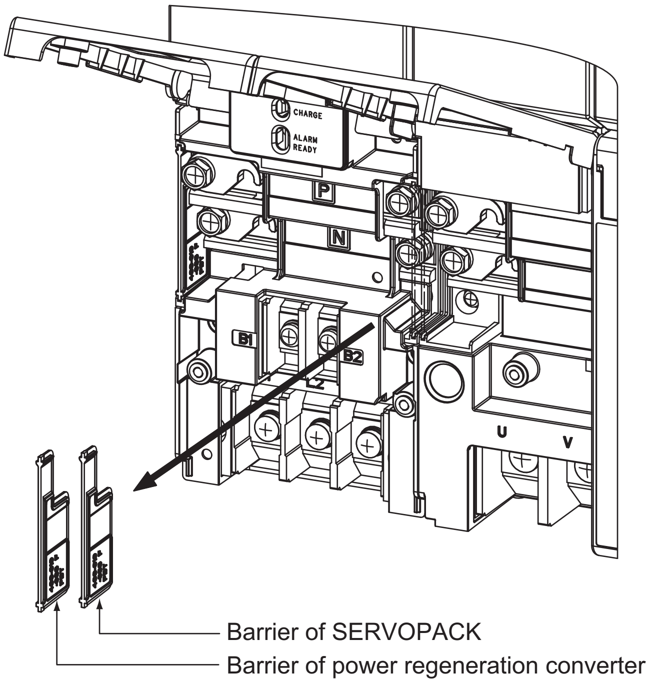
CN7A/B			CN7A/B	
Pin No.	Signal Name		Pin No.	Signal Name
A	24 VDC	—	A	24 VDC
B	0 V	—	B	0 V

5.2.3 DC-bus

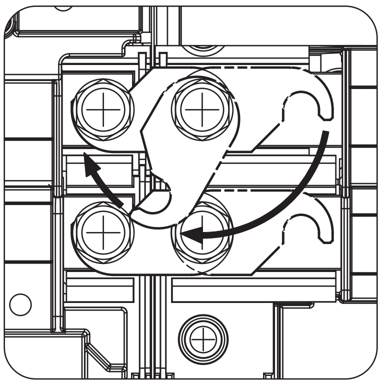
A bus bar built into the Σ-V-SD driver connects the power regeneration converter and a SERVOPACK or two SERVOPACKs.

The bus bar connection procedure is given below.

1. Remove the barriers between the devices to connect.



2. Rotate the bus bar of the device on the right 180° clockwise, and then hook it on the terminals of the device on the left.



Wiring

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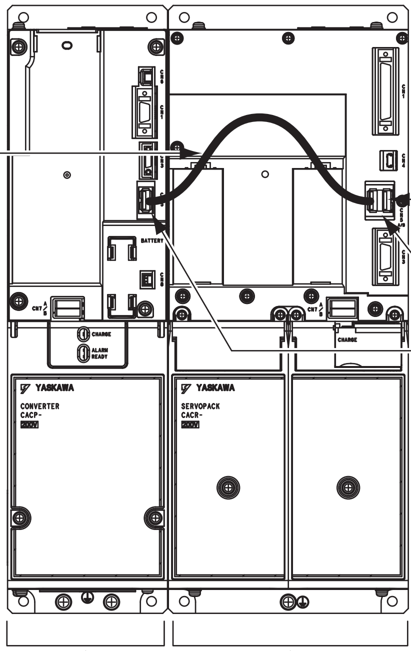
5.2.4 Local Bus

A local bus communication cable connects the power regeneration converter (CN5) and SERVOPACK (CN5A and CN5B).
Only one spindle SERVOPACK can be connected to one converter.



5.2.5 I/O Signals

IMPORTANT

Do not use CN1 on the SERVOPACK as the I/O signal for an emergency stop.
Use CN1 on the power regeneration converter.

(1) Connections

■ Connector Pin Arrangement (CN1) for I/O Signals of the Power Regeneration Converter

Pin No.	Signal Name	I/O	Function	Pin No.	Signal Name	I/O	Function
1*	(NC)	–	–	8*	(NC)	–	–
2*	(NC)	–	–	9*	(NC)	–	–
3*	(NC)	–	–	10*	(NC)	–	–
4*	(NC)	–	–	11	/ESP+	I	Emergency stop input
5*	(NC)	–	–	12	/ESP–	I	Emergency stop input
6*	(NC)	–	–	13*	(NC)	–	–
7*	(NC)	–	–	14*	(NC)	–	–

* Do not use NC signal.
Note: Connect the shielded wires to the CN1 connector shell.

■ Connector Pin Arrangement (CN1) for I/O Signals of the SERVOPACK

Pin No.	Signal Name	I/O	Function	Pin No.	Signal Name	I/O	Function
1	EXTCOM0	–	Sequence input signal power supply common	26*1	(NC)	–	–
2	/FWD	I	Forward signal	27*2	(NC)	–	–
3	/REV	I	Reverse signal	28*2	(NC)	–	–
4	/SV	I	Servo mode signal	29	/HWBB1+	I	HWBB1
5	/RST	I	Error reset signal	30	/HWBB1-	I	HWBB1
6	/CHW	I	Winding selection signal	31	/HWBB2+	I	HWBB2
7	/ORT	I	Orientation signal	32	/HWBB2-	I	HWBB2
8	/LGR	I	L gear selection signal	33	EDM1	O	HWBB status monitor
9*1	(NC)	–	–	34	EDM2	O	HWBB status monitor
10*1	(NC)	–	–	35	PCO	O	Encoder phase C signal output
11*1	(NC)	–	–	36	/PCO	O	Encoder phase C signal output
12*1	(NC)	–	–	37	PBO	O	Encoder phase B signal output
13*1	(NC)	–	–	38	/PBO	O	Encoder phase B signal output
14	SCOM	I	Analog speed reference input	39	PAO	O	Encoder phase A signal output
15	GND	–	Analog speed reference 0 V	40	/PAO	O	Encoder phase A signal output
16*1	(NC)	–	–	41	/ZSPD	O	Zero speed signal
17	LM	O	Load ratio meter signal output	42	/AGR	O	Speed coincidence signal
18	GND	–	Load ratio meter signal 0 V	43	/SDET	O	Speed detection signal
19*1	(NC)	–	–	44	/ORE	O	Orientation completed signal
20*1	(NC)	–	–	45	/CHWE	O	Winding selection completed signal
21*1	(NC)	–	–	46*1	(NC)	–	–
22*1	(NC)	–	–	47	COM	–	Sequence output signal common
23*1	(NC)	–	–	48*1	(NC)	–	–
24	FLTNC	O	Error contact output (OFF for error)	49	FLTCOM	–	Error contact output common
25*1	(NC)	–	–	50	FLTNO	O	Error contact output (ON for error)

∗1. Do not use NC signal.
∗2. Do not normally connect these terminals. However, you can connect CN1-27 and CN1-28 when you do not use the HWBB. For details, refer to *5.2.5 (2) Connection Diagrams*.
Note: Connect the shielded wires to the CN1 connector shell.

Wiring

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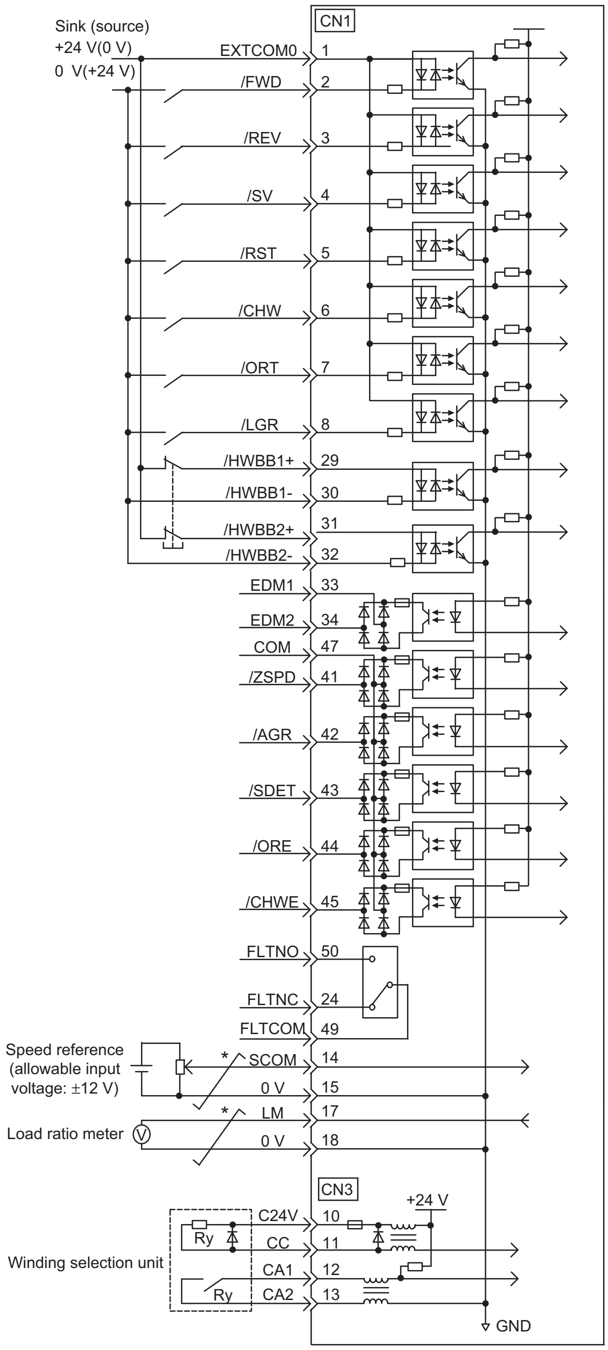
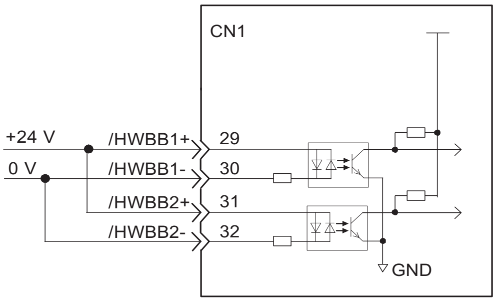
(2) Connection Diagrams

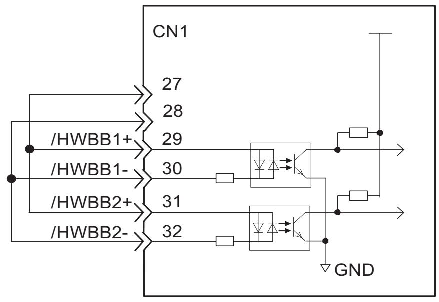


* Twisted-pair wire

Note 1. If you do not use the HWBB, use the connections shown in one of the following diagrams.

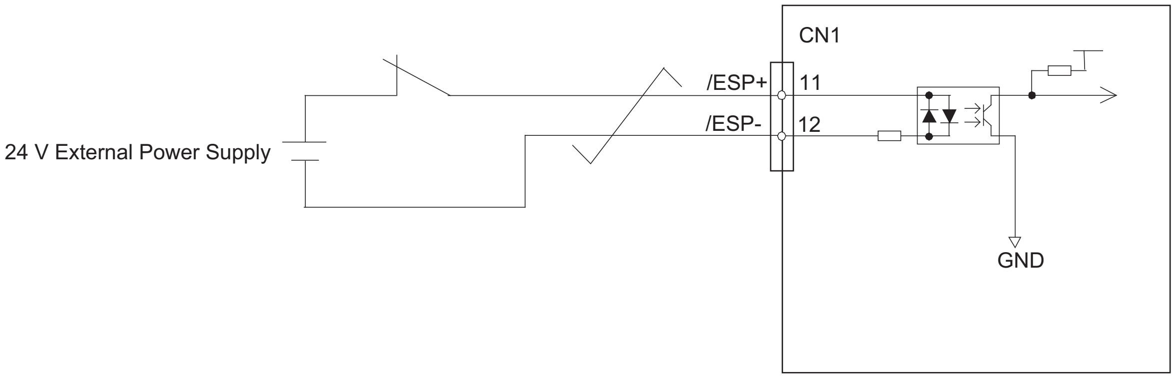


Connection Example 1
When Not Using the HWBB Function



Connection Example 2
When Not Using the HWBB Function

2. To use the emergency stop signal, enable it in the parameter. For details, refer to *6.1 Sequence Input Signals*.



Converter I/O Connection

3. Connect the shielded wires from the I/O signal cables to the CN1 connector shells on the SERVOPACK and converter and also ground the shielded wires at the host controller.

Wiring

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6

Control Signals

6.1 Sequence Input Signals

This section lists the sequence input signals and provides details on the status indications and signals.

6.1.1 Sequence Input Signals

Input signals are input on the CN1 and CN3 connectors on the SERVOPACK and on the CN1 connector on the Power Regeneration Converter. The sequence input signals are listed below.

(1) Input Signals on SERVOPACK CN1 Connector

CN1 Connector Pin No.	Signal Name	Function	Related Parameters
2	/FWD	Forward signal	Pn300 (Speed Reference Input Gain 1) Pn800 (Forward/Reverse Signal Acceleration Constant) Pn802 (Forward/Reverse Signal Deceleration Constant) Pn900 (Acceleration Basic Unit Selection)
3	/REV	Reverse signal	
4	/SV	Servo mode signal	Pn432 (Motor Flux Lower Level) Pn433 (Servo Mode Flux Level for High-speed Winding) Pn434 (Servo Mode Base Speed Ratio for High-speed Winding) Pn435 (Servo Mode Flux Level for Low-speed Winding) Pn436 (Servo Mode Base Speed Ratio for Low-speed Winding)
5	/RST	Error reset signal	–
6	/CHW	Winding selection signal	Pn01E.1 (Winding Selection)
7	/ORT	Orientation signal	Pn810 (Orientation Target Position) Pn812 (Orientation Target Speed) Pn813 (Orientation Acceleration Constant) Pn815 (Orientation Deceleration Constant) Pn817 (Reference Pulses per Machine Rotation) Pn900 (Acceleration Basic Unit Selection)
8	/LGR	L gear selection signal	–

(2) Input Signals on SERVOPACK CN3 Connector

CN3 Connector Pin No.	Signal Name	Function	Related Parameter
12, 13	CA1, CA2	Answer from winding selection device	Pn01E.1 (Winding Selection)

(3) Input Signals on Power Regeneration Converter CN1 Connector

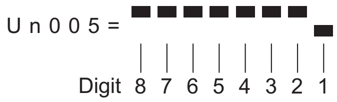
CN1 Connector Pin No.	Signal Name	Function	Related Parameters
11, 12	/ESP+, /ESP-	Emergency stop signal	Pn01B.0 (Emergency Stop Signal Selection) Pn406 (Emergency Stop Torque) Pn630 (Emergency Stop Execution Delay Time)

6.1.2 Status Display of Sequence Input Signals

The status of the input signals can be checked with the input signal monitor (Un005) or the input signal monitor 2 (Un033) from the Digital Operator. The status of the input signal monitor (Un005) and the input signal monitor 2 (Un033) are displayed as shown in the following figure. The top row indicates signals that are OFF (high level) and the bottom row indicates signals that are ON (low level). For details, refer to *11.3 Monitor Mode (Un□□□)*.

(1) Input Signals (Un005)

Un005 shows the status of the SERVOPACK input signals.

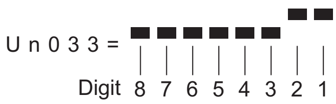


Digit Number	Signal Name (Function)
1	/FWD (forward signal)
2	/REV (reverse signal)
3	/SV (servo mode signal)
4	/RST (error reset signal)
5	/CHW (winding selection signal)
6	/ORT (orientation signal)
7*	/HWBB□ (hard wire base block signal)
8	/Answer from CA1 and CA2 winding selectors

* The HWBB has two channels. If either channel is OFF, the display will show OFF.

(2) Input Signals (Un033)

Un033 shows the status of the Power Regeneration Converter input signals.



Digit Number	Signal Name (Function)
1	/LGR (L Gear Selection Signal)
2	/ESP+ and /ESP- (Emergency Stop Signal)
3	–
4	–
5	–
6	–
7	–
8	–

Refer to *Chapter 11 Digital Operator* for the procedure on the Digital Operator.

6.1.3 Details on Sequence Input Signals

This section provides information on each signal of sequence input.

(1) Forward Signal and Reverse Signal (/FWD, /REV)

The /FWD and the /REV signals determine the rotation direction of the spindle motor.

■ Signal Specifications

Type	Signal Name	Pin No.	Output Status	Meaning
Input	/FWD	CN1-2	ON (closed)	The spindle motor can perform forward operation.
			OFF (open)	The spindle motor is stopped.
	/REV	CN1-3	ON (closed)	The spindle motor can perform reverse operation.
			OFF (open)	The spindle motor is stopped.

■ Related Parameters

Parameter No.	Name	Setting Range	Units	Factory Setting	When Enabled	Classification
Pn300	Speed Reference Input Gain 1	50 to 3000	0.01 V/ Base speed	600	Immediately	Setup
Pn800	Forward/Reverse Signal Acceleration Constant	1 to 4294967295	[10^n pulse/s^2]	100	Immediately	Setup
Pn802	Forward/Reverse Signal Deceleration Constant	1 to 4294967295	[10^n pulse/s^2]	100	Immediately	Setup
Pn900	Acceleration Basic Unit Selection	0003 to 0006	–	0004	After Restart	Setup

■ Spindle Motor Rotation Direction

The rotation direction of the spindle motor depends on the combination of the /FWD signal, the /REV signal, and the polarity of the speed reference voltage (SCOM).

Polarity of Speed Reference Voltage (SCOM)		+	–
Operation Signals	/FWD signal ON	CCW (forward)	CW (reverse)
	/REV signal ON	CW (reverse)	CCW (forward)

For details on the speed reference voltage (SCOM), refer to *6.2 Analog Speed Reference*.

■ Stopping the Spindle Motor

If the /FWD or /REV signal turns OFF while the spindle motor is operating, the spindle motor will stop due to regenerative braking. When the speed of the motor reaches zero, a base block is implemented and the current to the spindle motor is turned OFF.

■ Setting of Forward/Reverse Signal Acceleration/Deceleration Constant

To adjust the acceleration time from a stopped condition to the rated speed and the deceleration time until the spindle motor stops from the rated speed, change the set values of the following parameters.

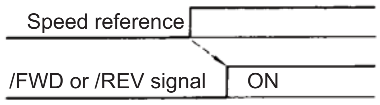
- Pn800 (Forward/Reverse Signal Acceleration Constant)
- Pn802 (Forward/Reverse Signal Deceleration Constant)

These parameters set the rate of acceleration and the rate of deceleration. They do not set the times directly.

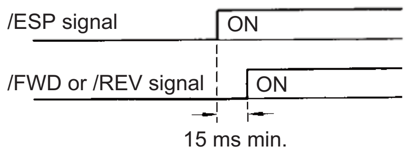
<Supplementary Note>
Set 0 to Pn305 (Soft Start Acceleration Time) and Pn306 (Soft Start Deceleration Time).

■ Precautions on Signals

- The spindle motor will stop if both the /FWD signal and the /REV signal are ON simultaneously. Operation will restart if either signal then turns OFF. Take suitable precautions. For details on signal combinations and the motor operation status, refer to *9.2.3 (1) Stopping Method for Spindle Motor after SV_OFF Command is Received*.
- The spindle motor will operate according to the speed reference if the /FWD or /REV signal turns ON. Always set the speed reference before starting operation.



- If an error occurs during operation, a base block is immediately implemented for the spindle motor and the current to the spindle motor is turned OFF.
- Before you turn ON the power supply, turn OFF both the /FWD and /REV signals. If the power supply is turned ON when either of these signals is ON, the spindle motor will not be able to operate.
- Wait at least 15 ms after the ESP signal turns ON before you turn ON the /FWD or /REV signal. The signal will not be accepted if either of these signals is turned ON before the /ESP signal.



(2) Servo Mode Signal (/SV)

The /SV signal serves as a command to change to servo mode.
When the /SV signal turns ON, servo mode is entered and the speed loop gain and other values are changed to the parameters for servo mode.
Refer to *14.1 Operation Modes and Applicable Parameters* for the parameters that change for the /SV signal.

Servo Mode: Establishes and maintains feed linearity and continuously provides excitation current, even when the motor is stopped. It is used to preserve the control loop response and to increase the constraint when the motor is stopped, in the same way as a servo.

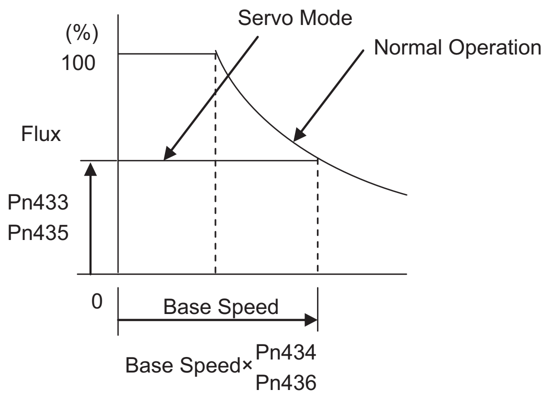
■ Signal Specifications

Type	Signal Name	Pin No.	Output Status	Meaning
Input	/SV	CN1-4	ON (closed)	Servo mode is entered and the parameters are changed.
			OFF (open)	Standard mode (normal operation)

■ Related Parameters

Parameter No.	Name	Setting Range	Units	Factory Setting	When Enabled	Classification
Pn432	Motor Flux Lower Level	10 to 100	%	15	Immediately	Setup
Pn433	Servo Mode Flux Level for High-speed Winding	30 to 100	%	100	Immediately	Setup
Pn434	Servo Mode Base Speed Ratio for High-speed Winding	100 to 500	%	100	Immediately	Setup
Pn435	Servo Mode Flux Level for Low-speed Winding	30 to 100	%	100	Immediately	Setup
Pn436	Servo Mode Base Speed Ratio for Low-speed Winding	100 to 500	%	100	Immediately	Setup

These parameters are used to increase the rated torque control range, such as for tapping. As shown in the following diagram, set them according to the relationship between the flux levels (Pn433 and Pn435) and the base speed ratios (Pn434 and Pn436).



Parameter No.		Description	When Enabled	Classification
Pn031	n.□□□0 [Factory Setting]	Uses Speed Reference Input Gain 1 (Pn300).	After restart	Setup
	n.□□□1	Uses Speed Reference Input Gain 2 (Pn30A).		
	n.□0□□ [Factory Setting]	Does not switch speed reference gain at servo mode.		
	n.□1□□	Switches speed reference gain at servo mode.		

Parameter No.	Name	Setting Range	Units	Factory Setting	When Enabled	Classification
Pn300	Speed Reference Input Gain 1	50 to 3000	0.01 V/ Base speed	600	Immediately	Setup
Pn30A	Speed Reference Input Gain 2	500 to 30000	0.001 V	10000	Immediately	Setup
Pn541	Rated Speed Setting	100 to 65535	1 min^{-1}	65535	After restart	Setup
Pn43D	Servo Mode Speed Reference Gain 1	0 to 10000	0.01%	10000	After restart	Setup

In servo mode, use Pn031 to set a factor to multiply with the base speed for analog speed references.
If you use servo mode speed reference gain 1, always set Pn031.2 to 1 (Switches Speed Reference Gain.).

Note: The motor will not operate if you set Pn43D (Servo Mode Speed Reference Gain 1) to 0.

- When Pn031.0 = 0
  The speed reference is determined from the spindle motor base speed for high-speed winding and the setting of Pn300.
  Analog speed reference = (Setting of Pn300)/(Base speed × Pn43D/100) min^{-1}
- When Pn031.0 = 1
  The speed reference is determined from the spindle motor base speed for high-speed winding and the setting of Pn30A.
  Analog speed reference = (Setting of Pn30A)/(Rated speed × Pn43D/100) min^{-1}

■ Precautions on Signals

- If /SV is ON, the soft start that is set with Pn800 (Forward/Reverse Signal Acceleration Constant) and Pn802 (Forward/Reverse Signal Deceleration Constant) is canceled.
- If /ORT is ON, servo mode is used regardless of the signal specifications.
- If you create a position loop with the servo drive (spindle motor) and change to the position loop to perform tapping, use servo mode. To achieve a 100% excitation current, provide a delay of 200 to 300 ms. (Set this time on a timer in the host controller.)
  If a position reference is received during this time, accurate operation will not be possible and vibration will occur.
- When feeding the spindle, e.g., for tapping, the tapping command is sent 200 to 300 ms after changing to /SV. Therefore, to continue tapping, a continuous command is used without turning /SV ON and OFF.

(3) Fault Reset Signal (/RST)

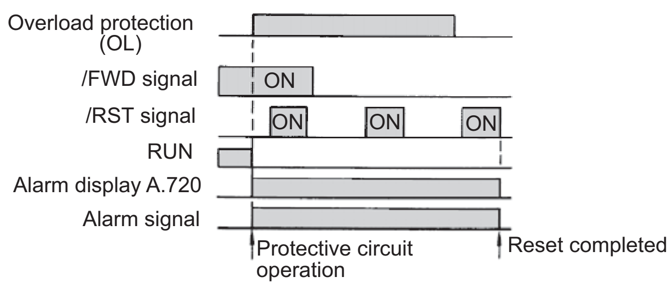
The /RST signal is used to reset the system after the protective circuit operates for overload protection and the probable cause is eliminated.

■ Signal Specifications

Type	Signal Name	Pin No.	Output Status	Meaning
Input	/RST	CN1-5	ON (closed)	The errors are reset.
			OFF (open)	The errors are not reset.

■ Precautions on Signals

- The /RST signal is enabled only after the protective circuit operates.
- The errors cannot be reset with the /RST signal while the /FWD, /REV, or /ORT signal is ON.
- The ALARM RESET switch on the Digital Operator has the same function as the /RST signal except that it can be used to reset errors when the /FWD, /REV, or /ORT signal is ON. However, to restart operation, the /FWD, /REV, and /ORT signals must all be turned OFF first.
- The reset operation is perform when the /RST signal turns OFF after turning ON. Always turn OFF the /RST signal after you turn it ON.
- In the protective circuit sequence, errors take priority. The following figure shows a timing chart for the reset operation.



(4) Winding Selection Signal (/CHW)

The /CHW signal serves as a command to select the winding when using motor winding selection control. The winding can be selected even during operation.

■ Signal Specifications

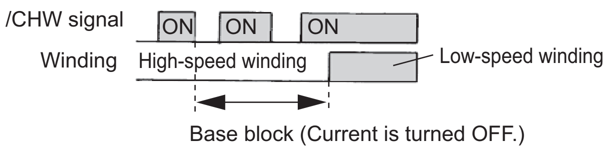
Type	Signal Name	Pin No.	Output Status	Meaning
Input	/CHW	CN1-6	ON (closed)	Selects the low-speed winding.
			OFF (open)	Selects the high-speed winding.

■ Related Parameter

Parameter No.		Description	When Enabled	Classification
Pn01E	n.□□0□ [Factory setting]	–	After restart	Setup
	n.□□1□	Mechanical winding selection		

■ Precautions on Signals

- After the /CHW signal is turned ON to select the winding, a base block will be maintained until the winding is actually changed. If this status continues for more than the preset time, a winding selection fault (A.690) will result and the spindle motor will stop.
- If the winding does not agree with the /CHW signal when the power supply is turned ON, the winding will be changed so that it agrees with the /CHW signal.



- When you turn ON the control power supply, check to make sure that switching the contacts in the winding selection device operates normally. Confirm that you can hear the sound of the contacts switching in the winding selection device.
- The windings are not changed in the following cases.
  - During position control
  - When the spindle motor speed exceeds the maximum speed of the low-speed winding when switching from the high-speed to the low-speed winding.
  - When there is an alarm (However, the winding is changed automatically under certain conditions when an alarm occurs.)
  - During a zero speed stop

(5) Orientation Signal (/ORT)

The /ORT signal serves as a command to start the orientation operation. The orientation operation causes the load shaft to promptly move to the preset position.
When the /ORT signal turns ON, orientation mode is entered and the speed loop gain and other values are changed to the parameters for orientation.
Refer to *14.1 Operation Modes and Applicable Parameters* for the parameters that change for the /ORT signal.

■ Signal Specifications

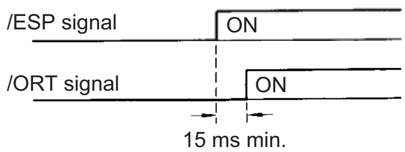
Type	Signal Name	Pin No.	Output Status	Meaning
Input	/ORT	CN1-7	ON (closed)	Starts orientation mode and the orientation operation.
			OFF (open)	Speed control mode

■ Related Parameters

Parameter No.	Name	Setting Range	Units	Factory Setting	When Enabled	Classification
Pn810	Orientation Target Position	0 to 1073741823	1 [pulse]	0	Immediately	Setup
Pn812	Orientation Target Speed	0 to 40960	10 [pulse/s]	3413	Immediately	Setup
Pn813	Orientation Acceleration Constant	1 to 4294967295	10^n [pulse/s^2]	70	Immediately	Setup
Pn815	Orientation Deceleration Constant	1 to 4294967295	10^n [pulse/s^2]	70	Immediately	Setup
Pn817	Reference Pulses per Machine Rotation	1 to 1073741823	1 [pulse]	4096	After Restart	Setup Setup
Pn900	Acceleration Basic Unit Selection	0003 to 0006	–	0004	After Restart	Setup Setup

■ Precautions on Signals

- Turn OFF the /ORT signal after completing tool or workpiece replacement for positioning.
- To perform an emergency stop during orientation, turn OFF the /ORT signal. Operation cannot be restarted after the emergency stop if the /ORT signal is ON.
- Make sure that the /ORT signal is OFF when the power supply is turned ON. Operation cannot be restarted if the /ORT signal is ON.
- Keep CN1-7 turned OFF if the ORT signal is not used.
- Do not perform winding selection during orientation. You cannot perform winding selection with the speed which is under the orientation target speed.
- Wait at least 15 ms after the /ESP signal turns ON before you turn ON the /ORT signal. The signal will not be accepted if this signal is turned ON before the /ESP signal.



(6) L Gear Selection Signal (/LGR)

The /LGR signal is used to change parameters, such as the gear ratio and gain, to ensure the optimum control of the load according to the gear selection of the load shaft.

Refer to *14.1 Operation Modes and Applicable Parameters* for the parameters that change for the /LGR signal.

■ Signal Specifications

Type	Signal Name	Pin No.	Output Status	Meaning
Input	/LGR	CN1-8	ON (closed)	Selects the L gear.
			OFF (open)	Selects the H gear.

(7) Emergency Stop Signal (/ESP)

The /ESP signal is used to perform an emergency stop of the spindle motor.
After the emergency stop waiting time elapses, the spindle motor performs a zero-speed stop. After the motor stops, the servo is turned OFF.

■ Signal Specifications

Type	Signal Name	Pin No.	Output Status	Meaning
Input	/ESP+, /ESP-	CN1-11*, CN1-12	ON (closed)	Normal operation
			OFF (open)	After the emergency stop waiting time elapses, the spindle motor performs a zero-speed stop. After the motor stops, the servo is turned OFF.

* This is connector pin number for the power supply regenerative converter.

Parameter No.		Description	When Enabled	Classification
Pn01B	n.□□□0 [Factory setting]	Disables the emergency stop signal.	After restart	Setup
	n.□□□1	Enables the emergency stop signal.		

Parameter No.	Name	Setting Range	Units	Factory Setting	When Enabled	Classification
Pn406	Emergency Stop Torque	0 to 800	1%	800	Immediately	Setup
Pn630	Emergency Stop Execution Delay Time	0 to 10000	ms	0	Immediately	Setup

■ Precautions on Signals

- To enable this signal, set Pn01B.0 to 1. (The default setting is 0.)
- To cancel the emergency stop operation and enable operation, turn ON the /EPS signal and turn OFF the /FWD, /REV, and /ORT signals.
- If you turn OFF the /ESP signal during operation, the motor will decelerate to a stop at the torque that is set in Pn406. The upper limit is 120% of the maximum output of the spindle motor.
  If the spindle motor does not stop within 10 seconds of the /ESP signal input, an A.6B0 alarm (Emergency Stop Failure) will occur and the motor will coast to a stop.

6.2 Analog Speed Reference

This section describes the analog speed reference (SCOM).

The SCOM reference is an analog voltage that provides the speed reference for the spindle motor.

■ Speed Reference Specifications

Item	Specification
Connector Pin Number	CN1-14
Allowable Input Voltage	± 12 VDC
Input Impedance	60 kΩ

■ Spindle Motor Rotation Direction

The rotation direction of the spindle motor depends on the combination of the /FWD signal, the /REV signal, and the polarity of the speed reference voltage (SCOM).

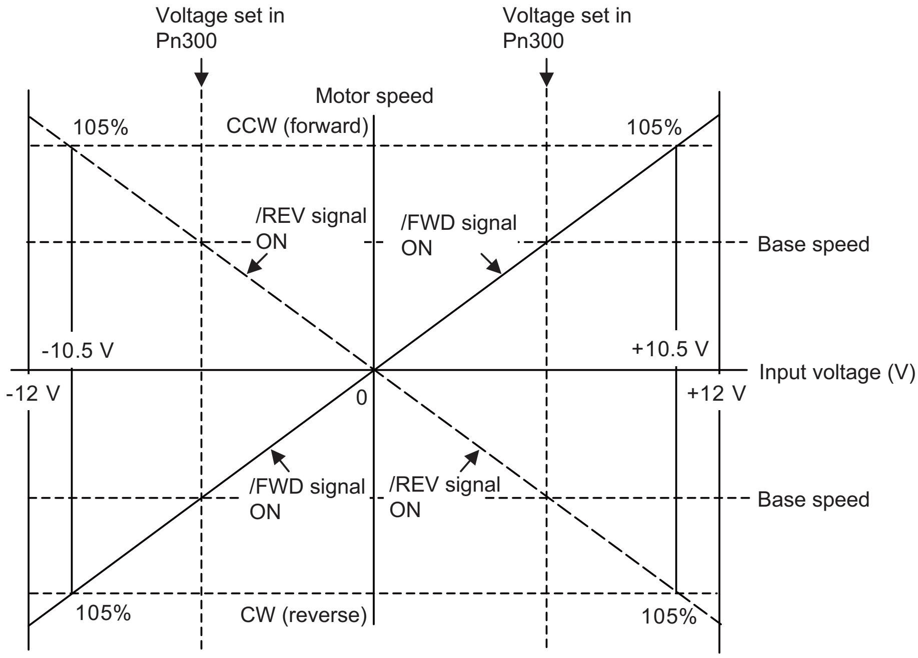
Polarity of Speed Reference Voltage (SCOM)		+	–
Operation Signals	/FWD signal ON	CCW (forward)	CW (reverse)
	/REV signal ON	CW (reverse)	CCW (forward)

■ Related Parameters

Parameter No.		Description	When Enabled	Classification
Pn031	**n.□□□0 [Factory Setting]**	Uses Speed Reference Input Gain 1 (Pn300).	After restart	Setup
	n.□□□1	Uses Speed Reference Input Gain 2 (Pn30A).		
	n.□□0□ [Factory Setting]	The upper limit is 105% of the rated speed.		
	n.□□1□	The upper limit is 110% of the rated speed.		

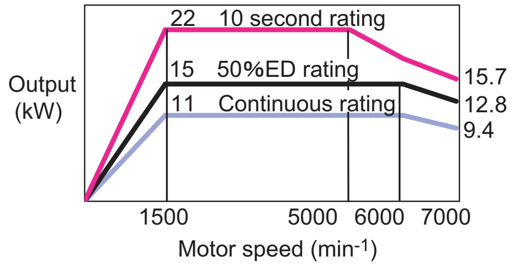
Parameter No.	Name	Setting Range	Units	Factory Setting	When Enabled	Classification
Pn300	Speed Reference Input Gain 1	50 to 3000	0.01 V/ Base speed	600	Immediately	Setup
Pn30A	Speed Reference Input Gain 2	50 to 30000	0.001 V	10000	Immediately	Setup
Pn541	Rated Speed Setting	100 to 65535	$1\ min^{-1}$	65535	After restart	Setup

- When Using Pn300 (Speed Reference Input Gain 1)
  The input voltage that is set for Pn300 (Speed Reference Input Gain 1) is added to operate the motor at the spindle motor base speed for high-speed winding.
  The allowable input voltage is ±12 VDC. The upper limit of the motor speed depends on the setting of Pn031.1 (Speed Limit Level Selection). (When Pn031.1 is 0, the upper limit is 105% of the rated speed. When Pn031.1 is 1, the upper limit is 110% of the rated speed.)



For details on the /FWD and /REV signals, refer to *6.1.3 Details on Sequence Input Signals*.

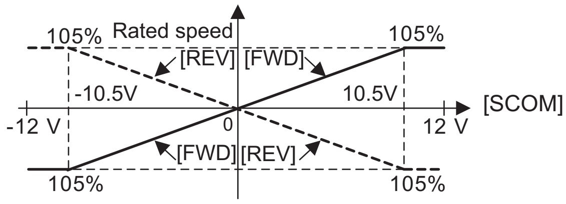
Parameter Setting Example (When the following spindle motor is used)



The speed reference input gain 1 is calculated as follows when 10 V is set as the speed reference voltage for the maximum speed:

Speed reference input gain 1 = (10 V × 1500 min^{-1}) ÷ 7000 min^{-1} = 2.14 V
Set Pn300 to 214. (The setting unit for Pn300 is 0.01 V/base speed.)

- When Using Pn30A (Speed Reference Input Gain 2)
  - Set the motor speed at the rated input voltage (at 100% speed reference) in Pn541 (Rated Speed Setting).
    Example: If Pn30A is 10000 and Pn541 is 10000, the motor will operate at 10000 min^{-1} for a speed reference voltage of 10 V. If the motor does not operate at the maximum speed even when Pn30A (Speed Reference Input Gain 2) is set to 10 V, increase the set value of Pn30A.
  - Set Pn541 (Rated Speed Setting) according to the motor specifications but not exceeding the maximum motor speed. If Pn541 (Rated Speed Setting) is set to a value that exceeds the maximum motor speed, the motor will operate at the maximum motor speed.
  - The allowable input voltage is ±12 VDC. The upper limit of the motor speed depends on the setting of Pn031.1 (Speed Limit Level Selection). (When Pn031.1 is 0, the upper limit is 105% of the rated speed. When Pn031.1 is 1, the upper limit is 110% of the rated speed.)



■ Precautions on Reference

- The set value of the SCOM reference is enabled by turning ON the /FWD or /REV signal.
- If the /FWD or /REV signal is ON, the spindle motor may not be completely stopped even if the SCOM references is set to 0 V. To stop the spindle motor completely, turn OFF both the /FWD and /REV signals.
- Use a shielded cable to wire the SCOM reference to improve noise immunity.

6.3 Sequence Output Signals

This section lists the sequence output signals and provides details on the status indications and signals.
The output signals are output from the CN1 and CN3 connectors on the SERVOPACK.
The sequence output signals are listed below.

6.3.1 Sequence Output Signals

(1) Output Signals on SERVOPACK CN1 Connector

CN1 Connector Pin No.	Signal Name	Function	Related Parameters
41	/ZSPD	Zero speed signal	Pn541 (Rated Speed Setting) Pn543 (Speed Detection Level) Pn544 (Speed Detection Hysteresis)
42	/AGR	Speed coincidence signal	Pn542 (Speed Coincidence Detection Width)
43	/SDET	Speed detection signal	Pn820 (Speed Detection Level) Pn822 (Speed Detection Hysteresis)
44	/ORE	Orientation completed signal	Pn522 (Positioning Completed Width) Pn524 (NEAR Signal Width)
45	/CHWE	Winding selection completed signal	–
24 (50), 49	FLT*	Alarm signal	–

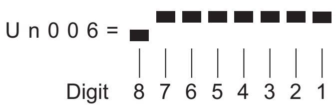
* The contact is changeover contact.

(2) Output Signals on SERVOPACK CN3 Connector

CN3 Connector Pin No.	Signal Name	Function	Related Parameters
10, 11	CC	Output to winding selection device	–

6.3.2 Status Display of Sequence Output Signals

The status of the output signals can be checked with the output signal monitor (Un006).
The output signal monitor (Un006) status is displayed as shown in the following figure. The top row indicates signals that are OFF (high level) and the bottom row indicates signals that are ON (low level). The bottom (ON) indicator is lit for all undefined digits. For details, refer to *11.3 Monitor Mode (Un□□□)*.



Digit Number	Signal Name (Function)
1	/ZSPD (zero speed signal)
2	/AGR (speed coincidence signal)
3	CC (Output to the winding selector)
4	/SDET (speed detection signal)
5	/ORE (orientation completed signal)
6	/CHWE (winding selection completed signal)
7	FLT (alarm signal)
8	– (Not set.)

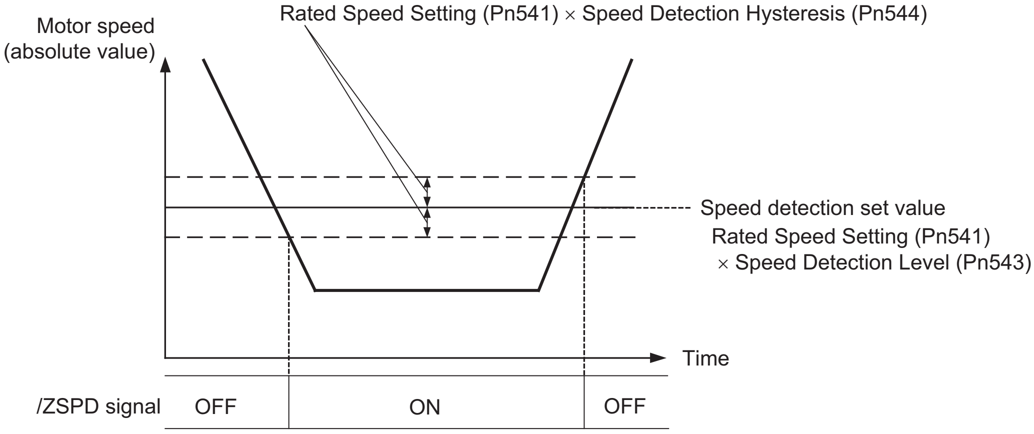
Refer to *Chapter 11 Digital Operator* for the procedure on the Digital Operator.

6.3.3 Details on Sequence Output Signals

This section provides information on each of sequence output signal. Pin numbers are given for independent drive operation. Refer to the manual for the NC machine for sequence output signals and output addresses.

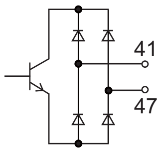
(1) Zero-speed Signal (/ZSPD)

The /ZSPD signal turns ON when the motor speed drops to below the speed that is set in Pn543 (Speed Detection Level). It will remain ON for at least 50 ms.



■ Signal Specifications

Type	Specification	Pin No.	Output Status	Meaning
Output	/ZSPD	CN1-41	ON (closed)	The motor speed is below the set value.
			OFF (open)	The motor speed exceeds the set value.



Output Circuit

■ Related Parameters

Parameter No.	Name	Setting Range	Units	Factory Setting	When Enabled	Classification
Pn541*	Rated Speed Setting	100 to 65535	1 min^{-1}	65535	After restart	–
Pn543	Speed Detection Level	0 to 10000	0.01%	100	Immediately	–
Pn544	Speed Detection Hysteresis	0 to 10000	0.01%	10	Immediately	–

* Motor speed should be set according to the machine specifications at maximum speed or less. Under normal conditions, motor speed should be set at the maximum speed.

■ Parameter Setting Example

Example: Maximum speed of spindle motor:12,000 min^{-1}
Speed detection level: 12 min^{-1}
Speed detection hysteresis: 6 min^{-1}

1) Set Pn541 to 12,000 min^{-1}.

2) Use the following formula to calculate the set value of Pn543 (Speed Detection Level [%]).

$$\begin{aligned}\text{Speed detection level} &= \frac{\text{(Speed detection set value)}}{\text{Pn541}} \times 100\ [\%] \\ &= \frac{12}{12000} \times 100 \\ &= 0.1\end{aligned}$$

Set Pn543 to 10.
(The setting unit for Pn543 is 0.01%.)

3) Use the following formula to calculate the set value of Pn544 (Speed Detection Hysteresis [%]).

$$\begin{aligned}\text{Speed detection hysteresis} &= \frac{\text{(Speed detection hysteresis)}}{\text{Pn541}} \times 100\ [\%] \\ &= \frac{6}{12000} \times 100 \\ &= 0.05\end{aligned}$$

Set Pn544 to 5.
(The setting unit for Pn544 is 0.01%.)

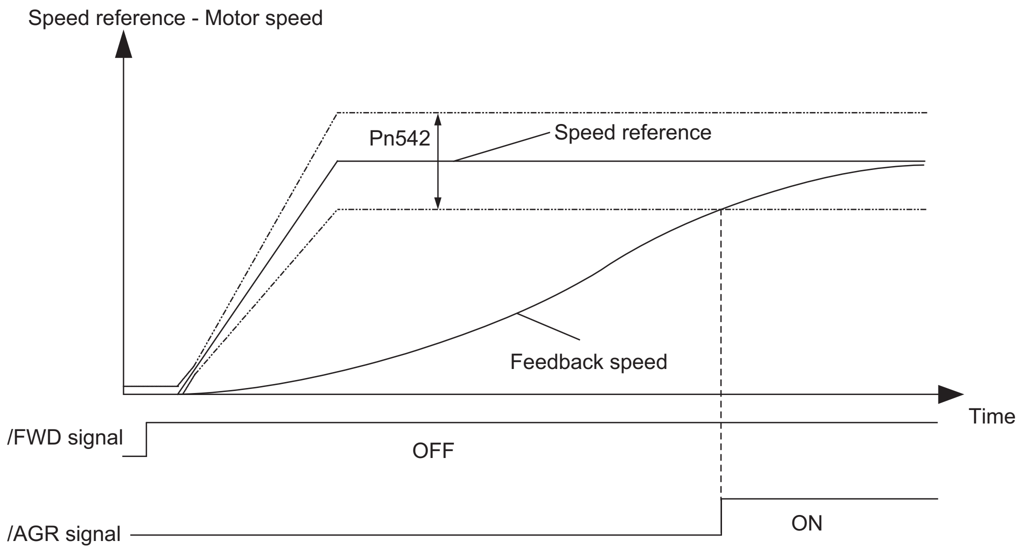
■ Precautions on Signals

- Set the zero speed detection level in Pn543 (Speed Detection Level) to a value within the setting range Pn544 (Speed Detection Hysteresis).
- Set Pn543 and Pn544 to percentages of Pn541 (Rated Speed Setting).
- The /ZSPD signal is output regardless of the status of the /FWD or /REV output. Therefore, the /ZSPD signal can be used as an interlock signal for hazard prevention.
- If Pn541 is set to a value that exceeds the maximum speed, the actual speed will be clamped to the maximum speed of the motor.

(2) Speed Coincidence Signal (AGR)

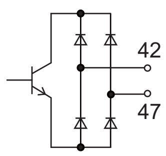
The /AGR signal turns ON when the motor speed enters the range that is set in Pn542 (Speed Coincidence Detection Width) based on the analog speed reference (SCOM). The /AGR signal will not turn ON during a base block or while the winding is being changed.

Set the range for the /AGR signal in Pn542 (Speed Coincidence Detection Width). (Set a value from ±10% to ±50% of rated speed.)



■ Signal Specifications

Type	Signal Name	Pin No.	Output Status	Meaning
Output	/AGR	CN1-42	ON (closed)	The motor speed is within the set range.
			OFF (open)	The motor speed exceeds the set range.

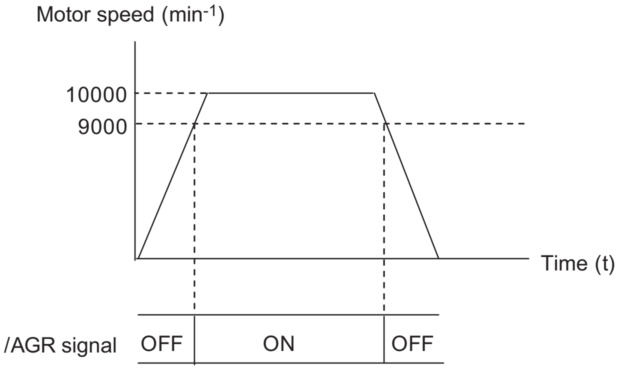


Output Circuit

■ Related Parameters

Parameter No.	Name	Setting Range	Units	Factory Setting	When Enabled	Classification
Pn542	Speed Coincidence Detection Width	10 to 50	%	15	Immediately	Setup

Setting example of Pn542
Maximum speed of spindle motor: 10000 min^{-1}
Pn542 = 10% setting

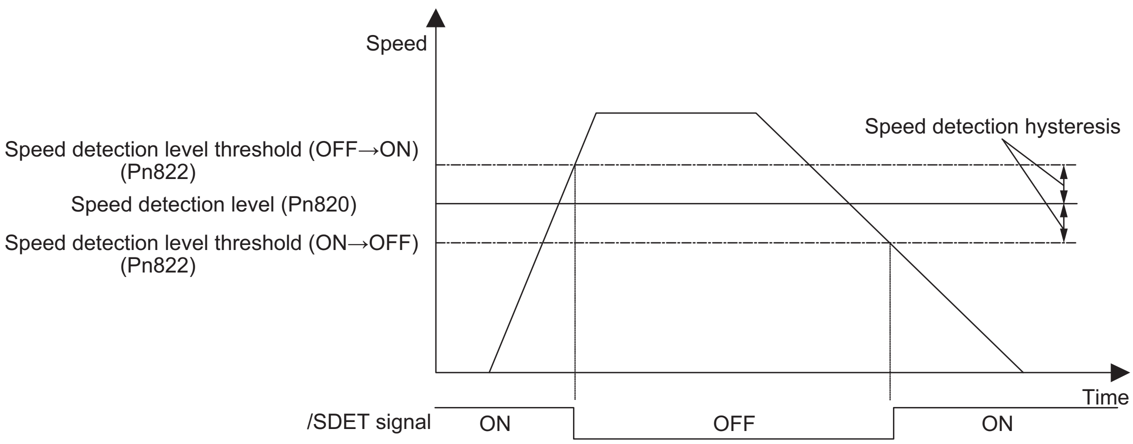


■ Precautions on Signals

- The /AGR signal is turned OFF when the control power supply is turned ON because a base block is implemented.
- When the /AGR signal turns ON, it will remain ON for at least 50 ms.
- For operation with an NC program, the /AGR signal serves as the answer to the S signal (spindle rotation reference) to move to the next step.

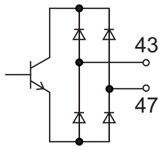
(3) Speed Detection Signal (/SDET)

The /SDET signal will turn OFF when the motor speed exceeds the upper limit of the speed detection level threshold and it will turn ON when the motor speed goes below the lower limit of the speed detection level threshold.



■ Signal Specifications

Type	Signal Name	Pin No.	Output Status	Meaning
Output	/SDET	CN1-43	ON (closed)	The motor speed is below the speed that is set in Pn820.
			OFF (open)	The motor speed is equal to or above the speed that is set in Pn820.



Output Circuit

■ Related Parameters

Parameter No.	Name	Setting Range	Units	Factory Setting	When Enabled	Classification
Pn820	Speed Detection Level	2097152000	1 pulse/s	40960	After restart	Setup
Pn822	Speed Detection Hysteresis	0 to 10000	0.01%	1000	After restart	Setup

Use the following formulas to calculate the settings for the upper and lower limits of the speed detection level threshold.

Upper limit of the speed detection level threshold
= Speed detection level [pulses/s] + (Speed detection level [pulses/s] × Speed detection hysteresis [%]/100)

Lower limit of the speed detection level threshold
= Speed detection level [pulses/s] – (Speed detection level [pulses/s] × Speed detection hysteresis [%]/100)

The upper limit of the speed detection level is the maximum speed of the motor and the lower limit is a motor speed of 0 min^{-1}.

■ Parameter Setting Example

The following example shows how to set the speed detection level to the equivalent of a motor speed of 1000 min^{-1}.

Pn820 (Speed Detection Level) = 1000[min^{-1}] × 4096[pulse] / 60[s] = 68266.7≒68267[pulse/s]

When Pn822 (Speed Detection Hysteresis) is set to 10%, the following formulas are used to calculate the settings for the upper and lower limits of the speed detection level threshold for the speed detection level that was calculated above.

Upper limit of the speed detection level threshold
= 68267[pulse/s] + (68267[pulse/s] × 10[%] / 100) = 68335.3[pulse/s] (Equivalent to 1100[min^{-1}])

Lower limit of the speed detection level threshold
= 68267[pulse/s] - (68267[pulse/s] × 10[%] / 100) = 68198.7[pulse/s] (Equivalent to 900[min^{-1}])

■ Precautions on Signals

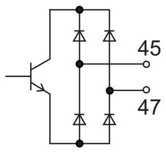
The operation of the /SDET signal is not affected by the settings of the /FWD and /REV signals.

(4) Winding Selection Completion Signal (/CHWE)

The /CHWE signal is ON when the low-speed motor winding is selected and OFF when the high-speed motor winding is selected.
The status of the /CHWE signal changes after the winding switching operation has been completed.

■ Signal Specifications

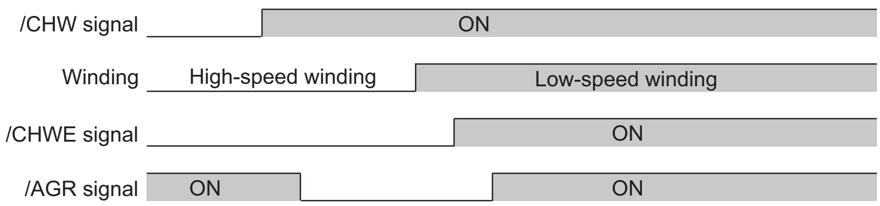
Type	Specification	Pin No.	Output Status	Meaning
Output	/CHWE	CN1-45	ON (closed)	Low-speed winding selected.
			OFF (open)	High-speed winding selected.



Output Circuit

■ Precautions on Signals

- If the /CHWE signal does not change within the preset time after the /CHW signal turns ON, a winding selection fault (A.690) will result and the spindle motor will stop.
- If the winding selection operation is performed during constant-speed operation, the /AGR signal will also turn OFF during the winding selection operation.

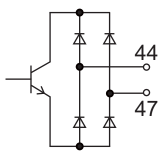


(5) Orientation Completion Signal (/ORE)

The /ORE signal turns ON when the load shaft approaches the preset stop position after the /ORT signal is turned ON. While the /ORE signal is ON, resistive torque to external force will be generated and position offset will be compensated. Replace tools or workpieces while the /ORE signal is ON.

■ Signal Specifications

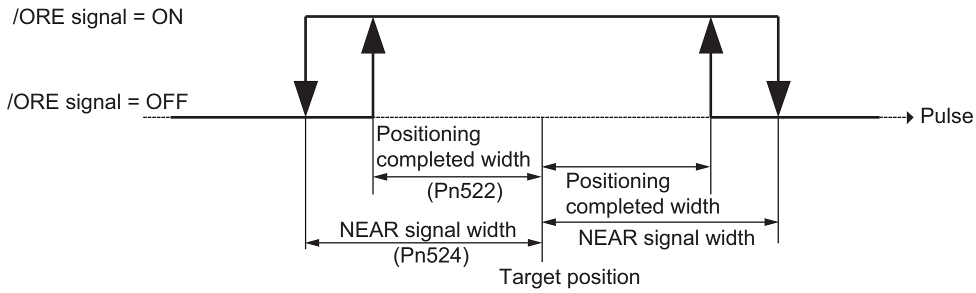
Type	Signal Name	Pin No.	Output Status	Meaning
Output	/ORE	CN1-44	ON (closed)	The load shaft has approached the preset position in orientation mode.
			OFF (open)	• The mode is not orientation mode. • The load shaft has not approached the preset position in orientation mode.



Output Circuit

■ Related Parameters

Parameter No.	Name	Setting Range	Units	Factory Setting	When Enabled	Classification
Pn522	Positioning Completed Width	0 to 1073741824	1[pulse]	5	Immediately	Setup
Pn524	NEAR Signal Width	1 to 1073741824	1[pulse]	10	Immediately	Setup



■ Precautions on Signals

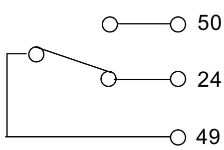
The /ORE signal will turn OFF if the external force is high and the deviation of the position is excessive. In that case, arrange a sequence to result an orientation fault.

(6) Fault Bit Signal (FLT)

If a protective circuit operates for an overcurrent or an overload, the current to the spindle motor is immediately turned OFF and the spindle motor coasts to a stop. The /FLT signal turns ON as soon as the current is turned ON. The contact of the FLT relay changes only when a protective circuit operates. Changeover contacts are used.

■ Signal Specifications

Type	Signal Name	Pin No.	Meaning
Output	FLT	CN1-24 [FLTNC]	ON: Normal operation OFF: An error was detected.
		CN1-50 [FLTNO]	ON: An error was detected. OFF: Normal operation
		CN1-49 [FLTCOM]	–



Output Circuit

■ Precautions on Signals

- When the FLT signal turns ON, turn OFF the /FWD, /REV, and /ORT signals and display a failure at the host system.
- When a protective circuit operates, the FLT signal turns ON and an alarm will occur. Check the alarm number.

6.4 Load Ratio Meter Signal Output

(1) Load Ratio Meter Signal Output Signal (LM)

The LM signal is an analog voltage output that is used to display the load ratio.

■ Signal Specifications

Type	Signal Name	Pin No.	Output Status	Meaning
Output	LM	CN1-17	Analog voltage	Gives the spindle motor load ratio.

■ Load Ratio Meter Specifications

The output standard for the load ratio meter can be changed in the setting of Pn01C.0. With the default setting, a load ratio of 120% is displayed for the maximum motor output. Use the following specifications to select the voltmeter.

Item	Specification
Type	Voltmeter
Operating Principle	Movable coil
Rating	10 V full scale
Internal Resistance	10 kΩ
Class	2.5 or higher

■ Related Parameters

Parameter No.		Meaning	When Enabled	Classification
Pn01C	n.□□□0 [Factory Setting]	Outputs a load ratio of 120% for the maximum spindle motor output.	After restart	Setup
	n.□□□1	Outputs a load ratio of 100% for the maximum spindle motor output.		
	n.□□□2	Outputs a load ratio of 100% for the instantaneous rated output of spindle motor.		
	n.□□□3	Outputs a load ratio of 100% for the continuous rated output of spindle motor.		

Parameter No.	Name	Setting Range	Units	Factory Setting	When Enabled	Classification
Pn43F	Load Ratio Meter Filter Time Constant	0 to 5000	ms	100	Immediately	Setup
Pn84D	Load Ratio Gain Adjustment	90 to 150	0.01%	100	Immediately	Setup
Pn84E	Load Ratio Meter Full Scale Value	100 to 1000	1%	200	Immediately	Setup

The level for the LM signal can be adjusted in Pn84E (Load Ratio Meter Full Scale Value). The output will be 10 V for the load rate that is set in Pn84E. The maximum output voltage is 10 V. The slope of the voltage output can be adjusted in the setting of Pn84D (Load Ratio Meter Gain Adjustment).

<Supplementary Note>

- Use CN1-18 for the 0 V from the voltmeter.
- You cannot set an offset with the SERVOPACK. If an offset is required for the output, adjust it at the meter.

6.5 Encoder Pulse Input Circuit

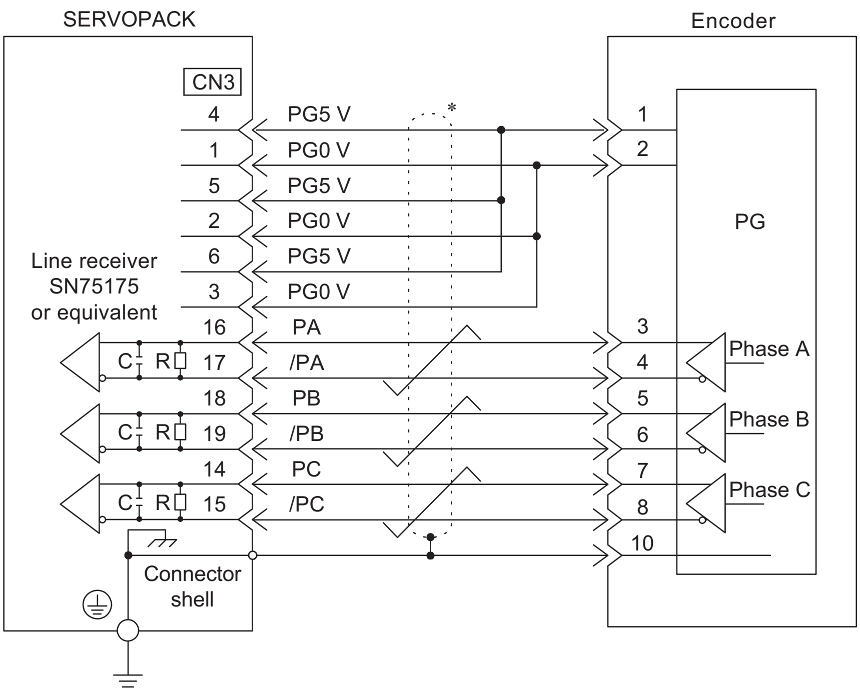
Phase A, B, and C (origin) signals (PA, /PA, PB, /PB, PC, /PC) are input into the CN3 connector on the SERVOPACK from the 1024 P/R motor encoder.
The input signals have the following specifications.

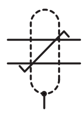
(1) Signal Configuration

90° phase-difference, two-phase pulse (A and B), and marker pulse (C)

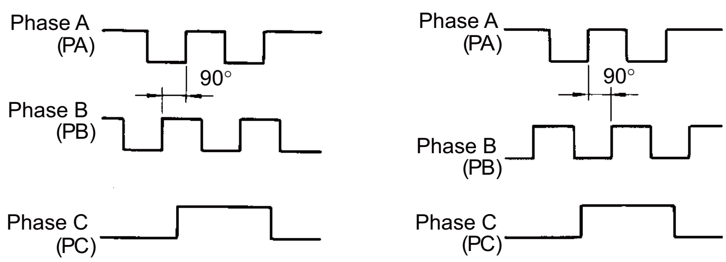
(2) Input Circuit Configuration

The input circuit is a line receiver with RS-422-A specifications.



*  indicates twisted-pair shielded wires.

(3) Input Phase



(a) Forward (b) Reverse

6.6 Encoder Pulse Output Circuit

Phase A, B, and C (origin) signals (PAO, /PAO, PBO, /PBO, PCO, /PCO) are output from the motor encoder. The output signals have the following specifications and can be used for position feedback.

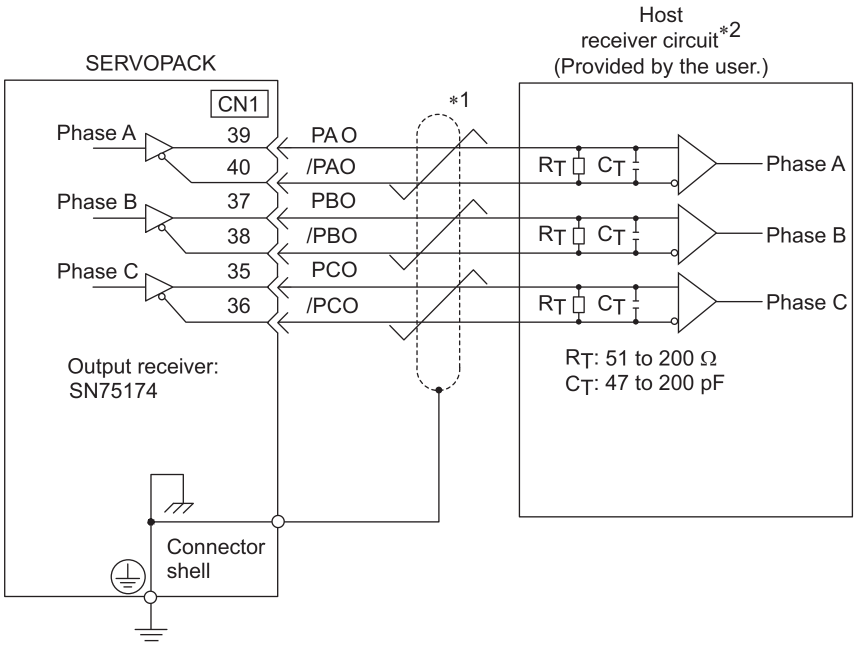
The pulse output will change when the power supply is turned ON. Do not count these output pulses at the external device.

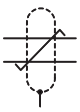
(1) Signal Configuration

90° phase-difference, two-phase pulse (A and B), and marker pulse (C)

(2) Output Circuit Configuration

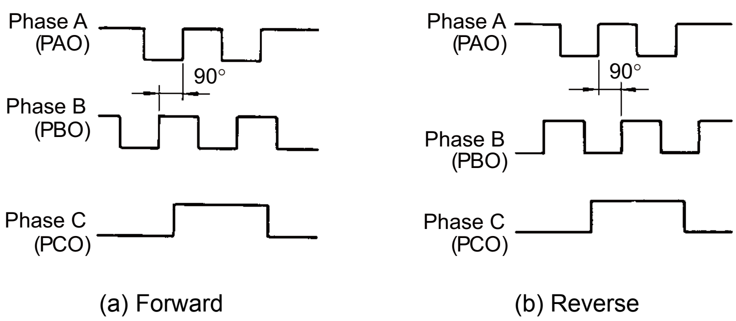
The output circuit is a line receiver with RS-422-A specifications. Use a line receiver with specifications matching the RS-422-A specifications for signal exchange as shown in the following connection example.



*1.  indicates twisted-pair shielded wires.

*2. Use an SN75175 receiver or other receiver that is suitable for EIA RS-422-A.

(3) Output Phase



7

Winding Selection Control

7.1 Features of the Winding Selection Wide Constant Power Drive

Winding selection for the spindle motor is an effective way to extend the constant output control range of the Servo Drive that drives the main shaft. Winding selection control provides the following features.

■ Wide Constant Power Control Range

A constant power range of 1:12 can be obtained without using a gearbox.

■ Small Controller Capacity

When expanding the constant power control range using the AC main shaft drive, the Motor current must also be expanded in the low-speed area, and the controller capacity must also be increased. When using winding selection, a constant power control of 1:12 can be obtained using a standard controller capacity, simply by changing the Motor winding connections.

■ Good Control Stability

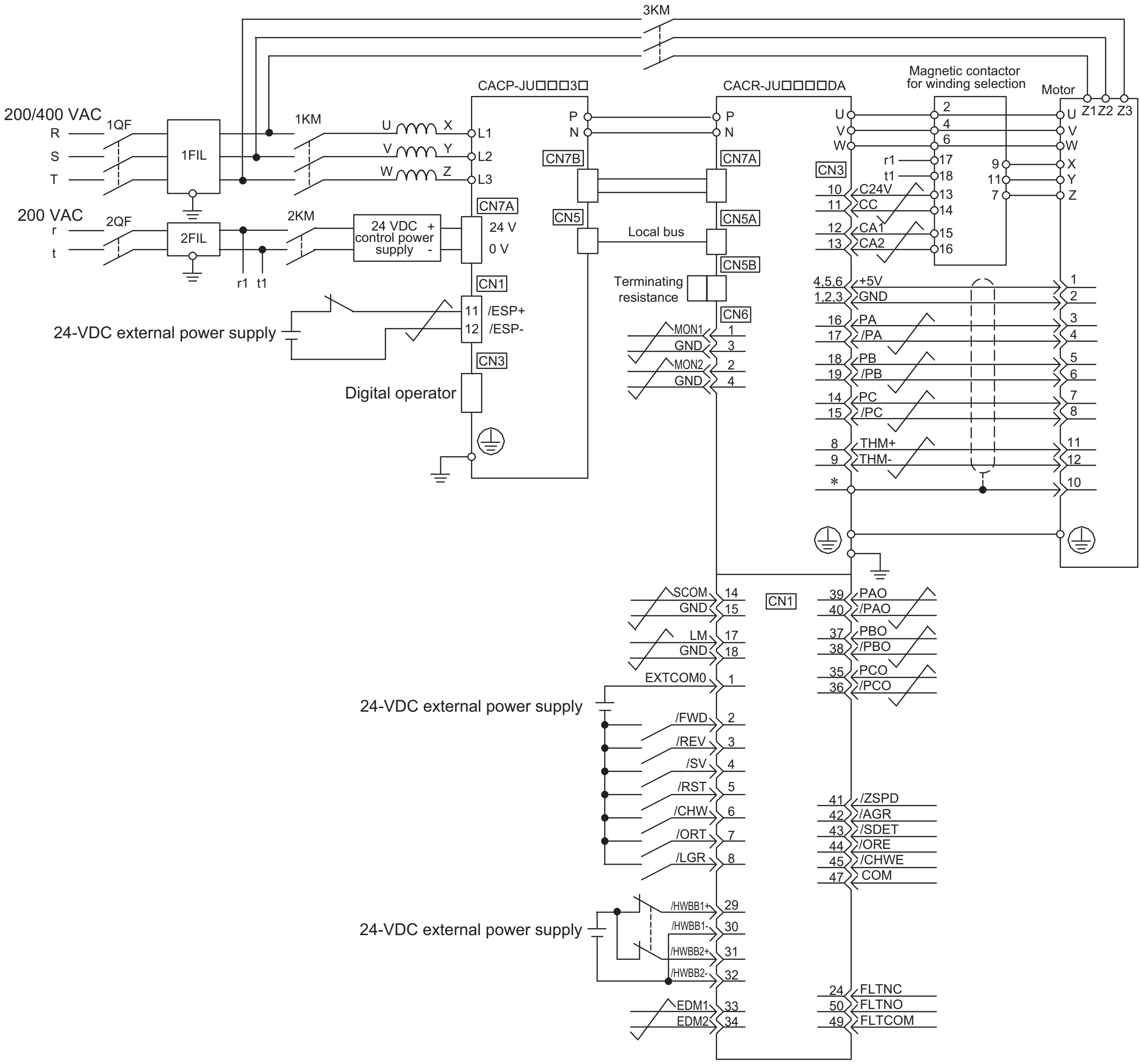
Winding selection enables optimum control by dividing the constant power control range into low-speed coils and high-speed coils. Consequently, stable control can be obtained by increasing the loop gain as well.

■ Special Magnetic Contactor for Winding Selection

The magnetic contactor is a compact model developed for winding selection. The contactor has a mechanical life of 5 million operations minimum.

7.2 Connection Diagram

As shown in the following diagram, this system requires winding selection signals in addition to speed reference signals such as the FWD and REV signals. A special magnetic contactor that can be driven directly from the SERVOPACK with transfer contacts is also used to switch the winding.



* Connected to the CN3 connector shell.

7.3 Spindle Motor Characteristics

Motors with switchable windings with a 1:12 constant power range have a 1:4 constant power range for both the low-speed and high-speed windings, as shown in the following diagram.

This can be written as $S_{ML}/S_{BL} = S_{MH}/S_{BH} = 4$. Also, the base speed ratio and maximum speed ratio are set to $S_{BH}/S_{BL} = S_{MH}/S_{ML} = 3$ to optimize the motor characteristics.

Consequently, the rated output will occur for both the low-speed and high-speed windings between S_{BH} and S_{ML}, so winding selection is performed within this speed range.

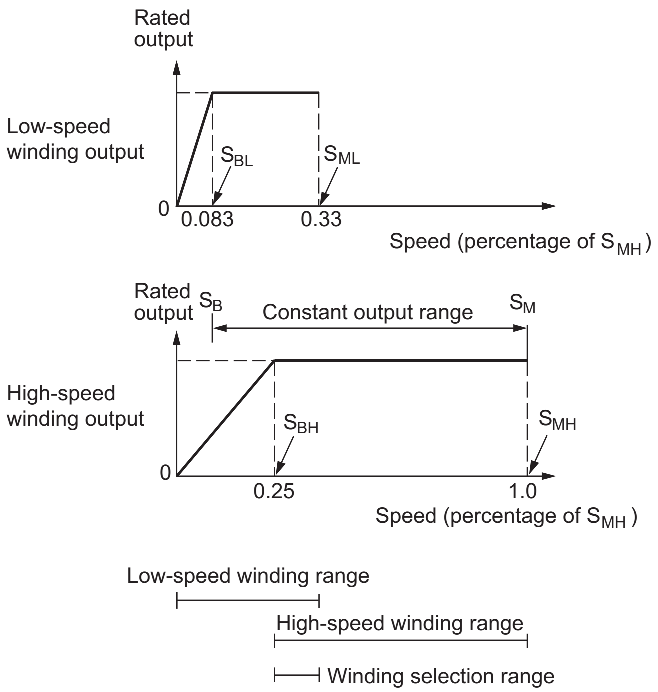
Note 1. If the same output occurs in both the low-speed and high-speed windings between S_{BH} and S_{ML}, the load ratio meter signal may be offset by approximately ±10%.

2. S_{BL}: The base speed of the low-speed windings.
   S_{ML}: The maximum speed of the low-speed windings.
   S_{BH}: The base speed of the high-speed windings.
   S_{MH}: The maximum speed of the high-speed windings.

IMPORTANT

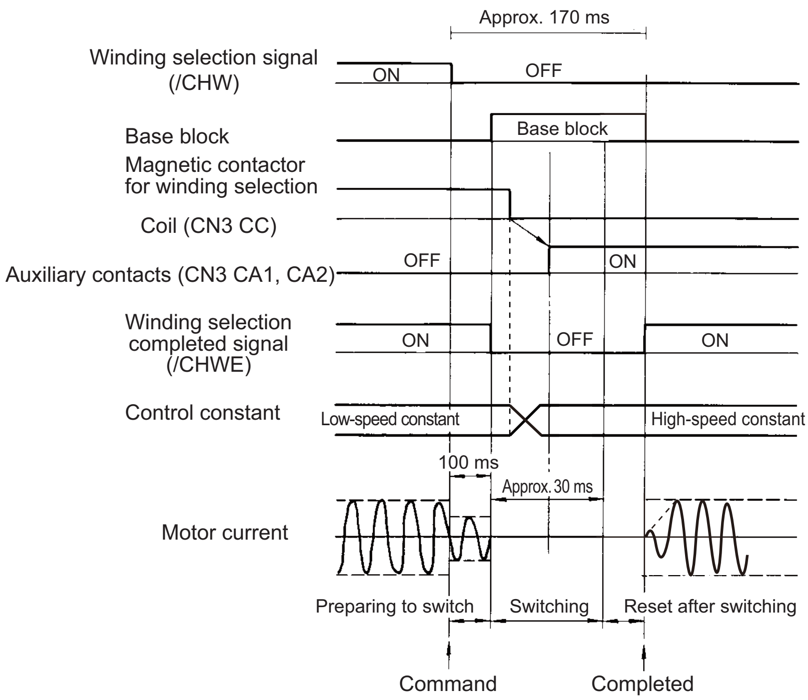
■ Low-speed Winding Application Precautions
The characteristics may not be achieved if the speed range exceeds the S_{ML} for the low-speed windings. Do not allow the speed to exceed the S_{ML} with the low-speed windings.

The following diagram shows the characteristics of the motor output.



7.4 Winding Selection Operation

The timing chart for switching from low-speed to high-speed windings is shown in the following diagram.



Note: The status of the auxiliary contacts (CN3 CA1, CA2) of the magnetic contactor for winding selection can be checked with the input signal monitor (Un005) from the Digital Operator. When the auxiliary contacts are ON, the 8th digit of Un005 will show ON (i.e., the bottom indicator will be lit).

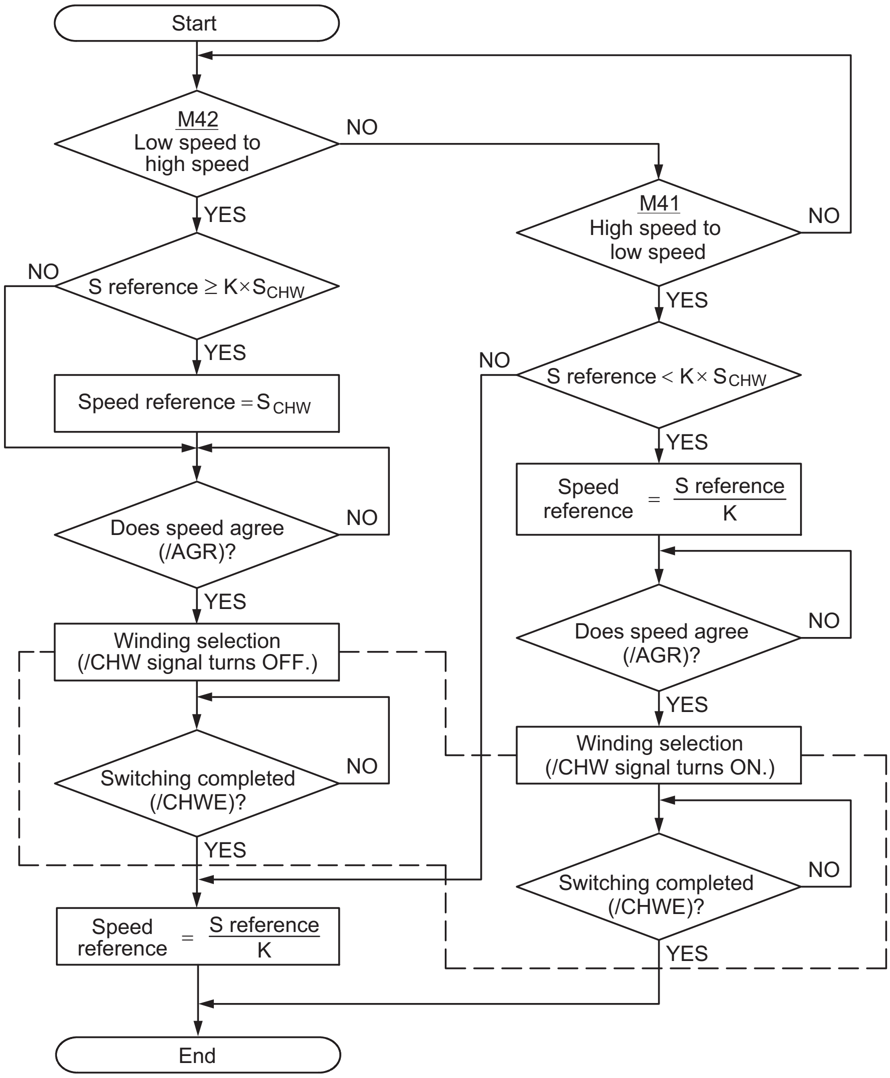
7.5 Winding Selection Methods

When performing winding selection, design the reference circuits referring to the following three methods, to make sufficient use of the spindle motor characteristics.

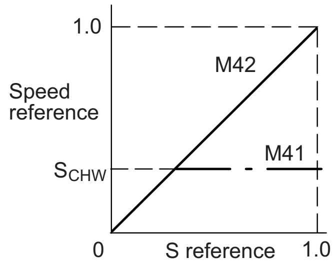
7.5.1 M Code Winding Selection Method

The numeric control M codes (M41: Low-speed winding and M42: High-speed winding) are used to switch the windings. The winding selection is treated as an electric gear. This is shown in the following flowchart and timing chart.

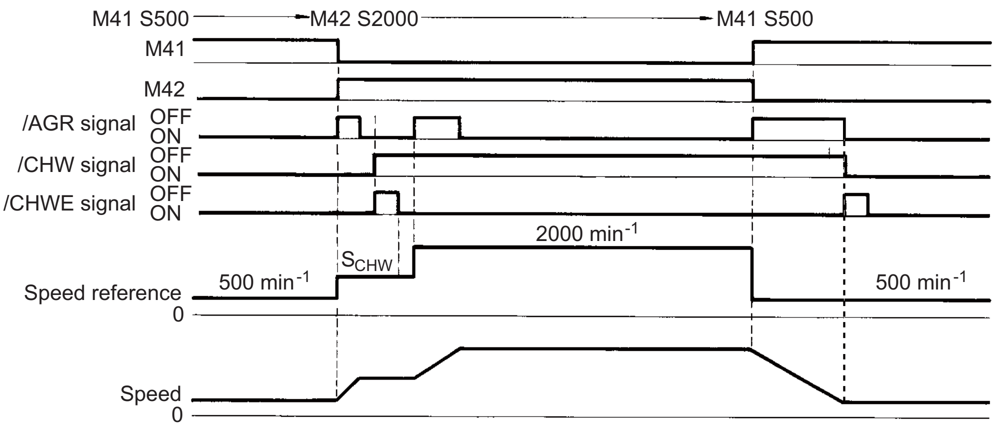
(1) Flowchart



∗1. Operations within the dotted lines are SERVOPACK internal signal processes.
∗2. M41: Low-speed winding selection
M42: High-speed winding selection
S reference: Main shaft rotation speed reference (main shaft)
S_{CHW}: Winding selection speed (spindle motor)
(In the diagram, $S_{BH} \geq S_{CHW} \leq S_{ML}$)
K: Gearbox ratio (When main shaft is traveling at 4,000 min^{-1},
if the spindle motor is operating at 5,000 min^{-1}, K = 0.8.)
Speed reference: Motor speed reference.
The relationship between the speed reference and S reference for M41 and M42 is shown in the diagram on the right.



(2) Timing Chart



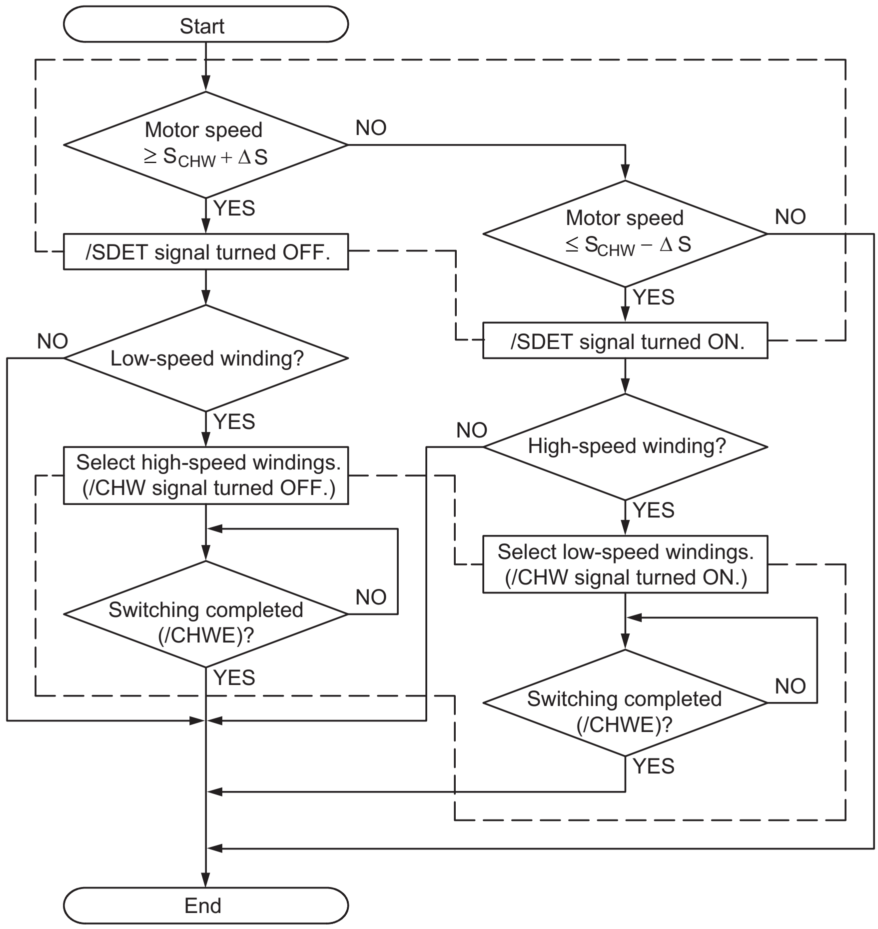
7.5.2 Automatic Winding Selection Methods

This section explains the automatic winding selection methods. There are two methods.

(1) Using the SERVOPACK Speed Detection Signal

The flowchart and timing chart for performing automatic winding selection judging from the actual motor speed alone using the SERVOPACK speed detection signal (/SDET) are shown below.

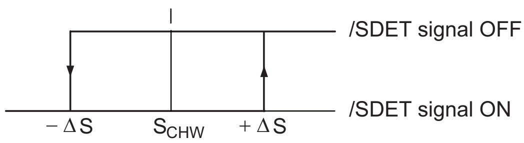
■ Flowchart



*1. Operations within the dotted lines are SERVOPACK internal signal processes.
*2. S_{CHW}: Winding selection speed (spindle motor)
ΔS: Switching speed hysteresis width
Set S_{CHW} and ΔS as shown below.
Within the diagram,
$S_{CHW} - \Delta S \geq S_{BH}$
$S_{CHW} + \Delta S \leq S_{BH}$

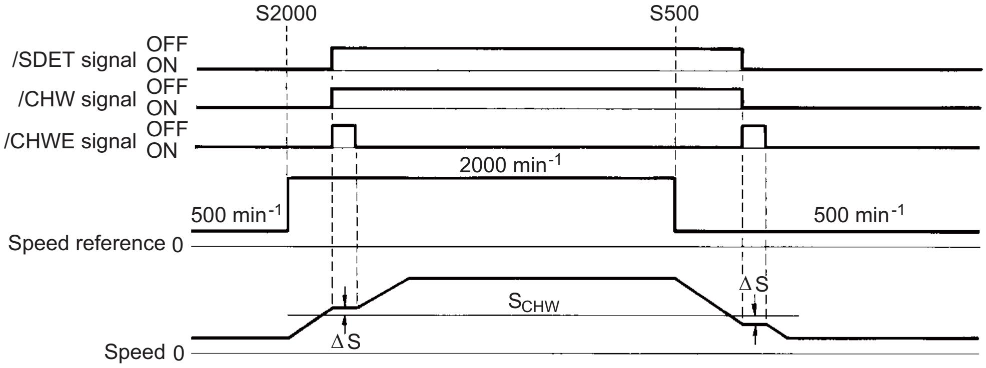
$$\text{Pn820 } (SD_{LVL}) = \frac{S_{CHW}}{\text{Pn541 (S100)}} \times 100\ (\%)$$

$$\text{Pn822 } (SD_{HYS}) = \frac{\Delta S}{\text{Pn541 (S100)}} \times 100\ (\%)$$



Refer to *Chapter 11 Digital Operator* for details on the setting parameters.

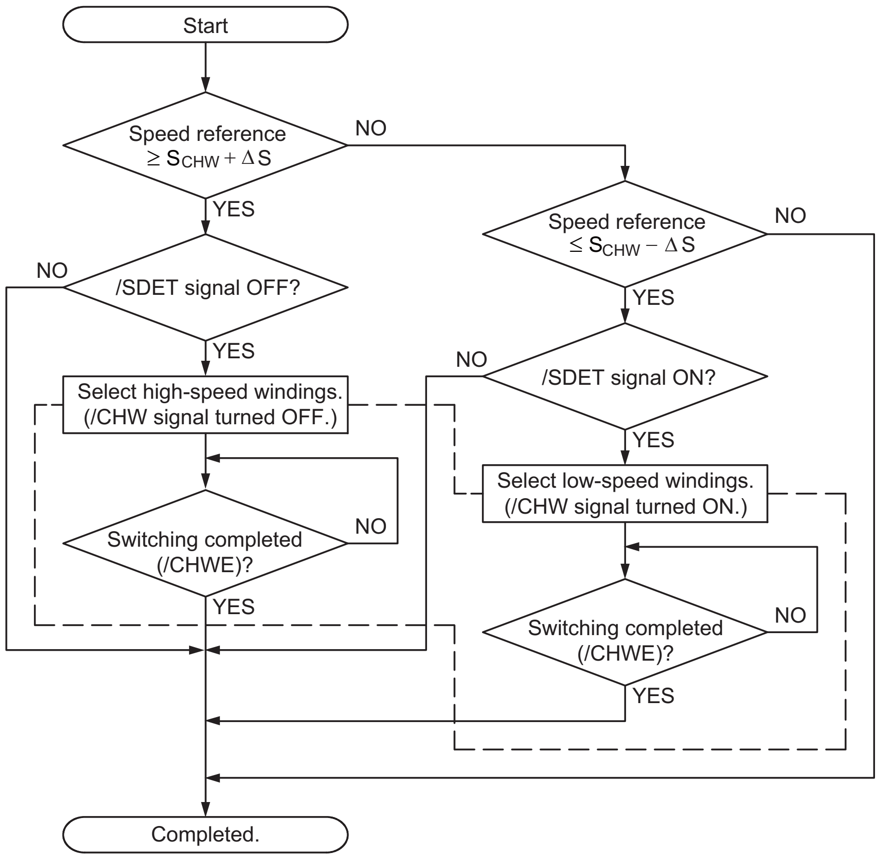
■ Timing Chart



(2) Using Speed Reference and the SERVOPACK Speed Detection Signal

This method performs winding selection by judging whether the speed reference and actual motor speed are within the high-speed winding selection range or the low-speed winding selection range, using the speed reference and the SERVOPACK speed detection signal (/SDET). Compared with the changing method that uses only the speed detection signal, signal processing is increased, but the frequency of magnetic contactor changing can be reduced. The flowchart and timing chart are shown below.

■ Flowchart



Note 1. [dashed box]: Indicates signal processing that is performed inside the SERVOPACK.
2. Set the same values in Pn543 (SD_{LVL}: Speed Detection Level) and Pn544 (SD_{HYS}: Speed Detection Hysteresis) in the SERVOPACK as for the S_{CHW} (winding selection speed) and SΔ (switching speed hysteresis width) in the host controller.

Winding Selection Control

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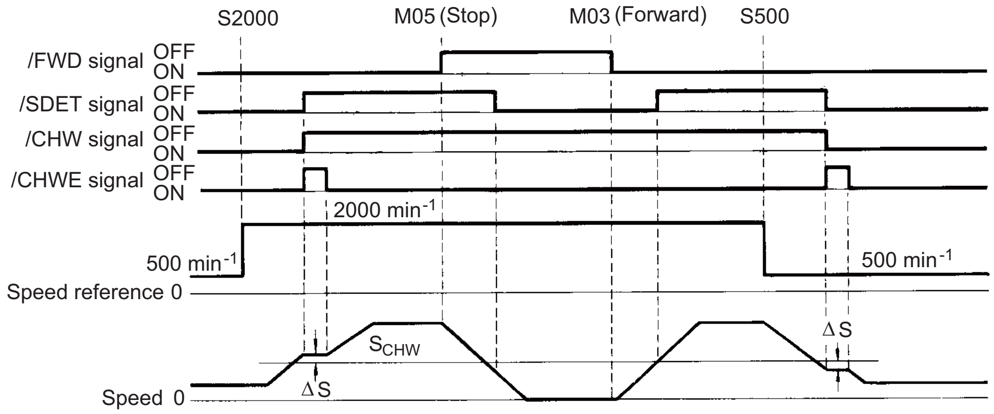
■ Winding Selection Conditions

Speed	Speed Reference	
	≥ S_{CHW} – ΔS	≤ S_{CHW} – ΔS
Speed ≥ S_{CHW} – ΔS (/SDET OFF)	High-speed winding selected	Winding selection not performed
Speed ≤ S_{CHW} – ΔS (/SDET ON)	Winding selection not performed	Low-speed winding selected

■ Timing Chart

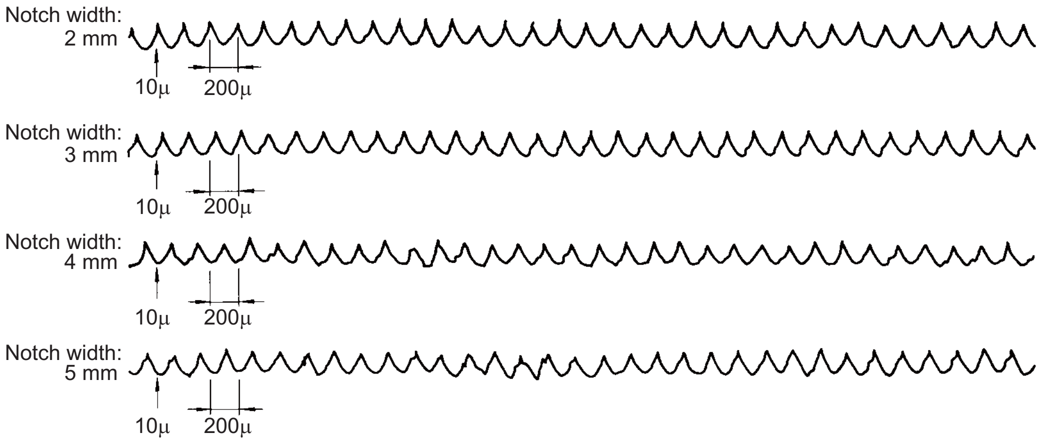


7.6 Winding Selection Control Precautions

Refer to the following precautions when designing winding selection control.

- If the signal wire breaks or the magnetic contactor for winding selection malfunctions, the motor will stop, and the operation program will not proceed. At this time, perform an overtime check after the set time, notify the operators immediately, and stop the winding selection operation by judging it to be defective (alarm A.690: Winding Selection Operation Fault).
- For automatic changing using motor speed detection, winding selection will be performed whenever the changing speed S_{CHW} is passed, so the frequency of magnetic contactor operations will be high.
- If using the main shaft drive on the lathe, automatic winding selection will be performed when changing speed is reached even during cutting. As shown in the following diagram, during rough cutting, considerable roughness will occur during changing, but as the cutting approaches completion, the difference will be lost. As this data also makes clear, there are several characteristics in actual use, but if accuracy in particular is essential, check the accuracy of the cut surface.

- Cutting Surface Accuracy for a Lathe



Note: Test conditions
Cut object: S45C (ϕ100 round bar)
Cutting tool: Ultra-hard cutting tool
Cutting speed: 150 m/min
Cutting feed: 0.2 mm/revolution

Winding Selection Control

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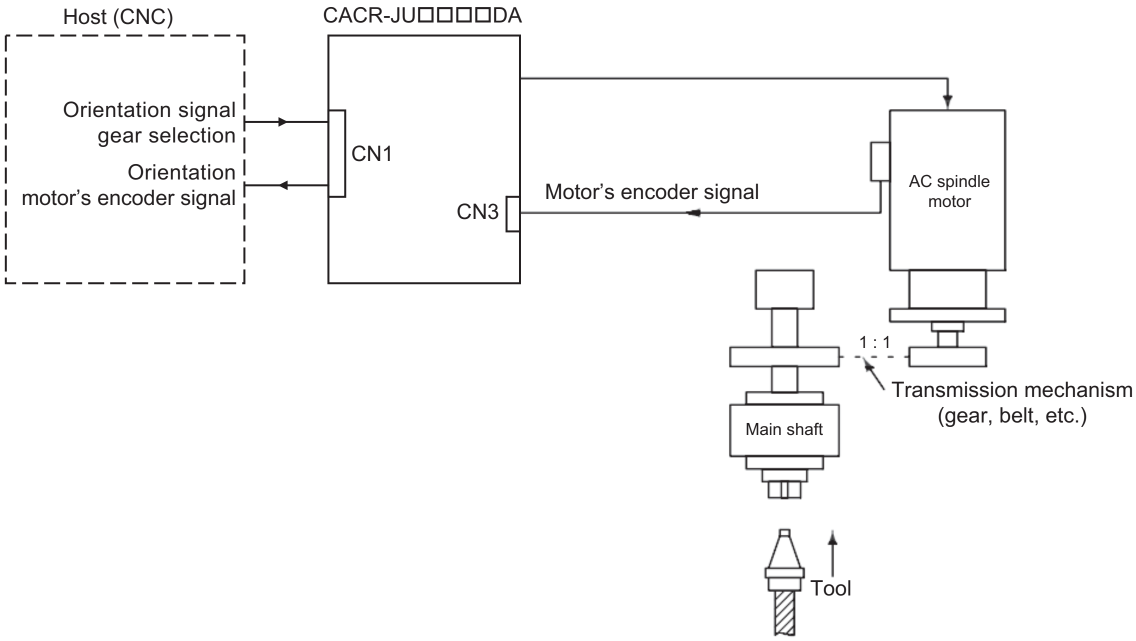
Orientation Control

8.1 Device Configuration

Orientation control is used to position a machine to any position within one revolution.
It is designed to be used for replacing tools and workpieces.
The motor's encoder signal is used to divide 1 revolution into 4,096 steps (i.e., a resolution of 0.088°).
Positioning is performed to the orientation target position as set in Pn810.

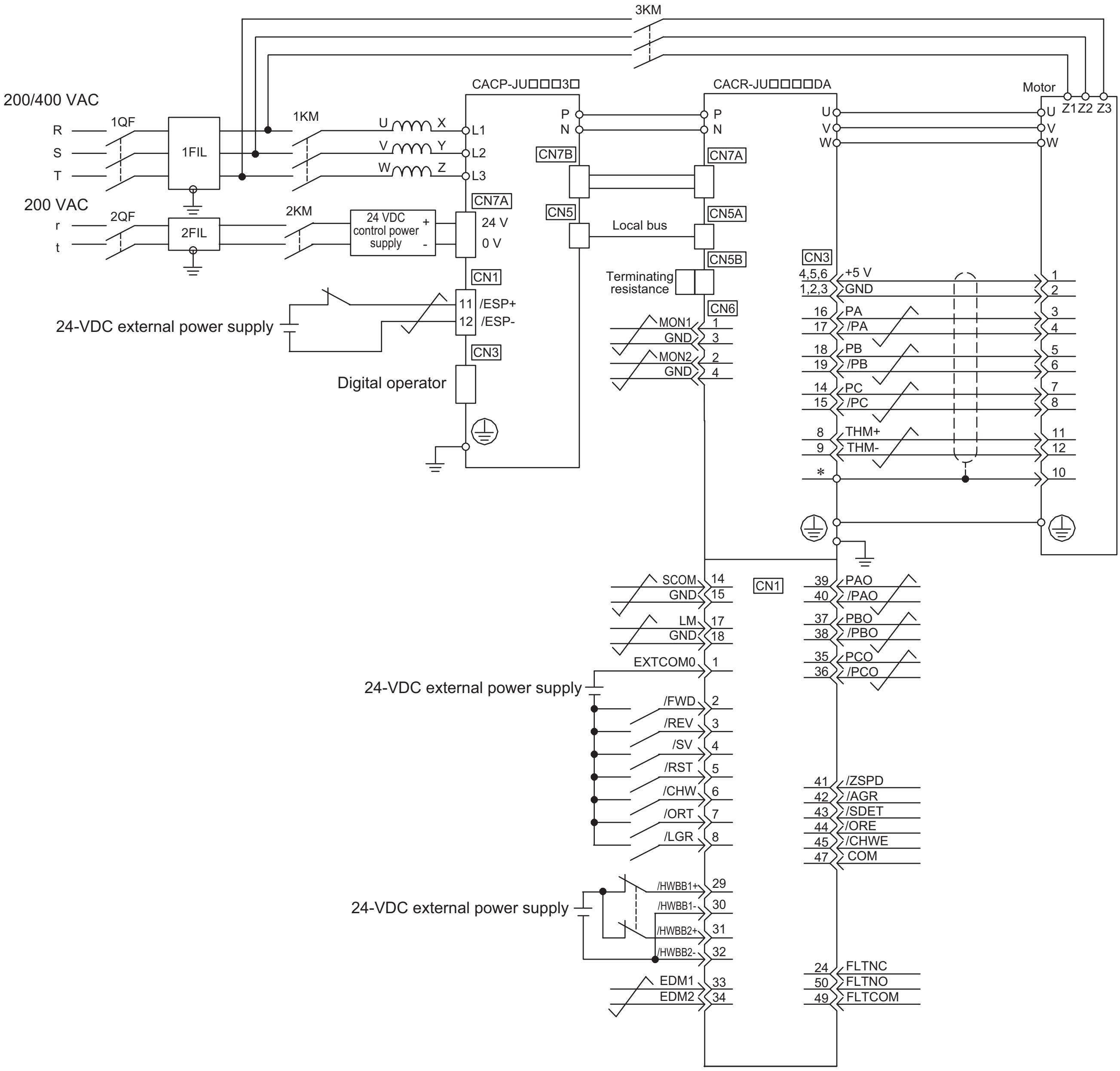
The device configuration diagram is shown below. The load shaft and motor shaft must be coupled 1:1 and there must be no play.



8.2 Connection Diagram

The connection diagram for orientation control is shown below.

Note 1. For a connection diagram that uses a winding selection device, refer to *7.2 Connection Diagram*.
2. Do not change the winding while executing orientation. Refer to *6.1 Sequence Input Signals* for details.



∗ Connected to the CN3 connector shell.

Orientation Control

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8.3 Orientation Control Details

This section provides detailed information on orientation control.

8.3.1 Orientation Signal (/ORT)

This section describes the input signals that are used to perform orientation control.

Type	Signal Name	Pin No.	Meaning	Changes during Operation
Input	/ORT	CN1-7	The orientation operation starts when CN1-7 turns ON.	Possible

Note 1. As long as the /ORT signal remains ON for orientation control, the Servo will remain ON and position control will remain in effect even after positioning has been completed. Therefore, do not turn OFF the ORT signal until replacement of the tool or workpiece has been completed. Regardless of the status of the /FWD and /REV signals, orientation will be performed according to the current speed.

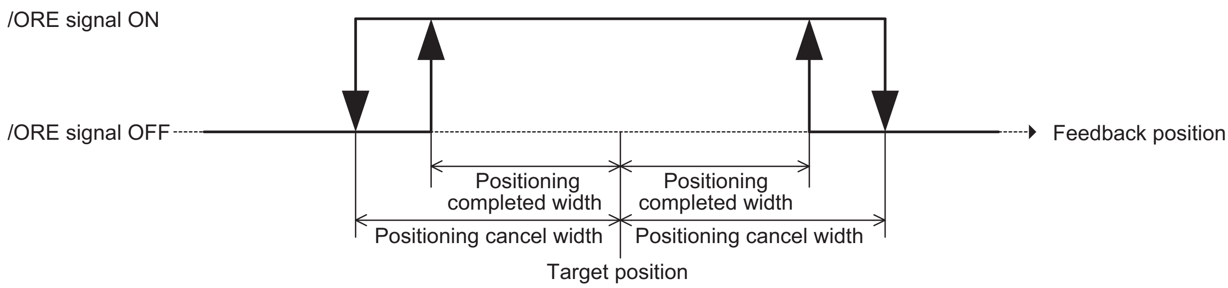
2. For details on operation for the combination of the /FWD, /REV, and /ORT signals, refer to *6.1.3 Details on Sequence Input Signals*.

8.3.2 Orientation Completed Signal (/ORE)

The ORE signal is output when orientation control has been completed.

Type	Signal Name	Pin No.	Meaning
Output	/ORE	CN1-44	Turns ON when orientation has been completed normally.

The /ORE signal turns ON after pulse distribution for motion processing has been completed and the difference between the target position and the current position is within the positioning completed width continuously for 60 ms. The /ORE signal turns OFF when the difference between the target position and the current position is equal to or greater than the positioning cancel width.



The /ORE signal is output only when the /ORT signal is ON.

8.3.3 Orientation Operation

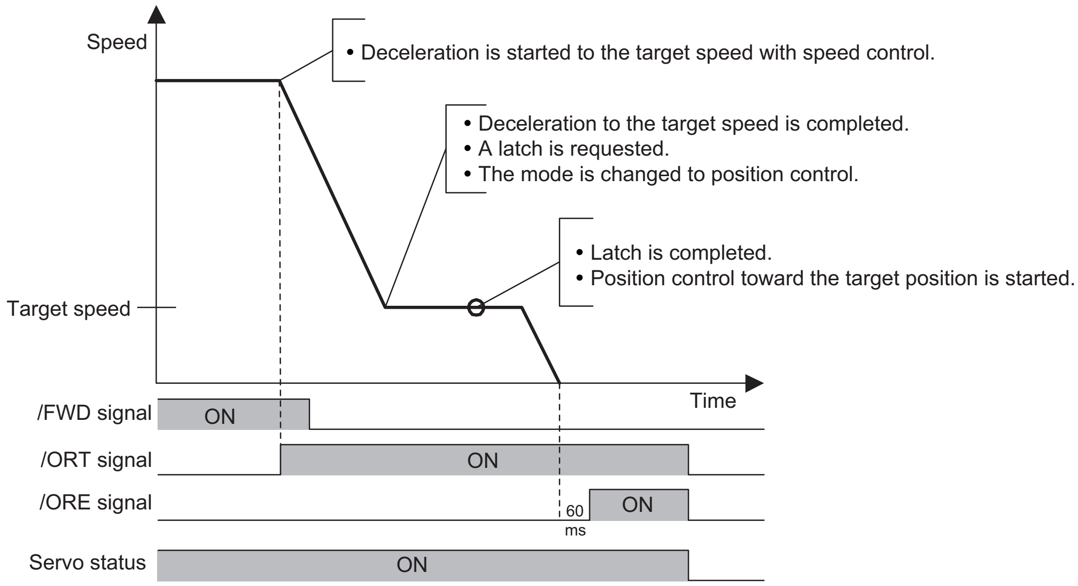
The operation that is performed for orientation control depends on the motor speed as described in the following table.

Absolute Speed	Basic Operation	Latch Operation	Control Mode
Current speed > Target speed	The speed is decelerated to the target speed by using speed control according to the deceleration rate that is specified in the parameters. Then, positioning is performed to the target position using the operation for when the current speed is less than or equal to the target speed.	Not executed.	Speed control
Current speed ≤ Target speed	The speed is accelerated to the target speed by using position control according to the acceleration rate that is specified in the parameters. After the target position is reached, a latch is requested for the phase-C signal. After the latch is completed, positioning is performed toward the target position. However, if the latch is not completed within one revolution of the latch request, deceleration is started.	Execution is started.	Position control

Note 1. The target position, target speed, and acceleration/deceleration rates are set in the parameters.
2. Positioning is performed in the current direction of rotation of the spindle motor. If the motor is stopped, positioning is performed in the forward direction of rotation.

The /ORE signals turns ON when orientation has been completed normally. If the phase-C latch cannot be performed for some reason, the motor decelerates to a stop. The /ORE signal remains OFF. If that occurs, timeout processing must be performed at the host.
An example of the orientation operation that uses the /ORT signal is given below. This examples uses forward operation, but reverse operation is essentially the same.

- From /FWD Signal ON to /ORT Signal ON When Current Speed > Target Speed



If the /ORT signal turns ON when the motor is operating for the /FWD signal at a speed that is higher than the target speed, the spindle motor performs the following operations.

1. The axis decelerates with speed control according to Pn815 (Orientation Deceleration Constant).
2. After Pn812 (Orientation Target Speed) is reached, control is changed to position control. A latch request is issued in the SERVOPACK and the motor waits for completion of the latch.
3. After the latch is completed, positioning is performed toward Pn810 (Orientation Target Position). If position offset does not occur for 60 ms after positioning is completed, the /ORE signal turns ON.

Note: If the /ORT signal is turned OFF when both the /FWD and the /REV signals are OFF, the /ORE signal is turned OFF and the power supply to the motor is turned OFF (Servo OFF).

Orientation Control

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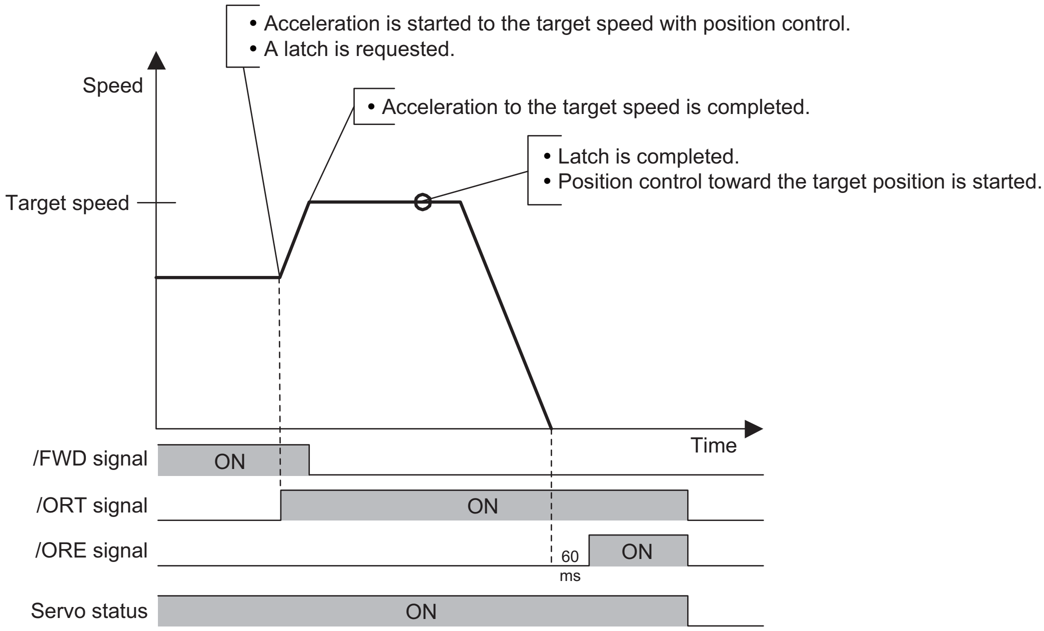
- From /FWD Signal ON to /ORT Signal ON When Current Speed ≤ Target Speed

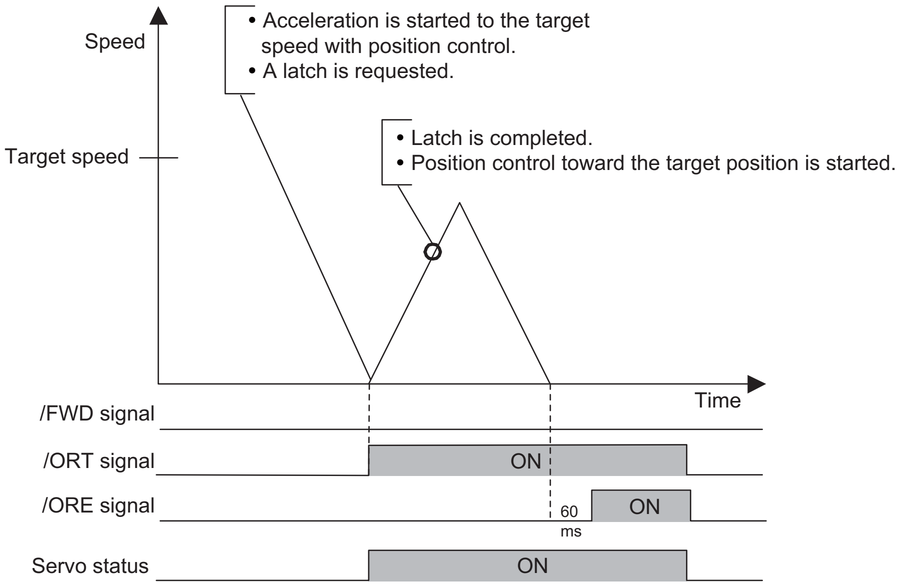


If the /ORT signal turns ON when the motor is operating for the /FWD signal at a speed that is equal to or lower than the target speed, the spindle motor performs the following operations.

1. The axis accelerates with position control according to Pn813 (Orientation Acceleration Constant). A latch request is issued in the SERVOPACK and the motor waits for completion of the latch.
2. After Pn812 (Orientation Target Speed) is reached, the target speed is maintained.
3. After the latch is completed, positioning is performed toward Pn810 (Orientation Target Position). If position offset does not occur for 60 ms after positioning is completed, the /ORE signal turns ON.

Note 1. If the /ORT signal is turned OFF when both the /FWD and the /REV signals are OFF, the /ORE signal is turned OFF and the power supply to the motor is turned OFF (Servo OFF).
2. If the latch is completed before the target speed is reached, positioning is started toward Pn810.

• From /FWD Signal OFF Status to /ORT Signal ON Status (Current Speed = 0)



If the /ORT signal turns ON when the motor is stopped (i.e., when both the /FWD and /REV signals are OFF), the spindle motor performs the following operations.

1. The axis accelerates with position control according to Pn813 (Orientation Acceleration Constant). A latch request is issued in the SERVOPACK and the motor waits for completion of the latch.
2. After Pn812 (Orientation Target Speed) is reached, the target speed is maintained.
3. After the latch is completed, positioning is performed toward Pn810 (Orientation Target Position). If a position offset does not occur for 60 ms after positioning is completed, the /ORE signal turns ON.

Note 1. If the /ORT signal is turned OFF when both the /FWD and the /REV signals are OFF, the /ORE signal is turned OFF and the power supply to the motor is turned OFF (Servo OFF).
2. If the latch is completed before the target speed is reached, positioning is started toward Pn810.

8.4 Related Parameters

The parameters that must be set for orientation control are listed in the following table.

Pn810	Orientation Target Position				Classification
	Setting Range	Unit	Factory Setting	When Enabled	
	0 to 1073741823	1 pulse	0	Immediately	Setup
Pn812	Orientation Target Speed				Classification
	Setting Range	Unit	Factory Setting	When Enabled	
	0 to 40960	10 pulse/s	3413	Immediately	Setup
Pn813	Orientation Acceleration Constant				Classification
	Setting Range	Unit	Factory Setting	When Enabled	
	1 to 4294967295	10^n pulse/s^2	70	Immediately	Setup
Pn815	Orientation Deceleration Constant				Classification
	Setting Range	Unit	Factory Setting	When Enabled	
	1 to 4294967295	10^n pulse/s^2	70	Immediately	Setup
Pn817	Reference Pulses per Machine Rotation				Classification
	Setting Range	Unit	Factory Setting	When Enabled	
	1 to 1073741823	1 pulse	4096	After restart	Setup
Pn900	Acceleration Basic Unit Selection (acceleration rate multiplier selection)				Classification
	Setting Range	Unit	Factory Setting	When Enabled	
	0003 to 0006	–	0004	After restart	Setup
Pn522	Positioning Completed Width				Classification
	Setting Range	Unit	Factory Setting	When Enabled	
	0 to 1073741824	1 pulse	5	Immediately	Setup
Pn524	NEAR Signal Width (Positioning Cancel Width)				Classification
	Setting Range	Unit	Factory Setting	When Enabled	
	1 to 1073741824	1 pulse	10	Immediately	Setup

Note: Do not change Pn810 to Pn815 during execution of orientation.

■ Setting Pn812 (Orientation Target Position)

The setting range of Pn812 (Orientation Target Position) is the value that is set in Pn817 (Reference Pulses per Machine Rotation). If you set a value that is larger than the value of Pn817, alarm A.681 (Orientation Target Position Setting Error) will occur.

■ Orientation Speed Setting Example

The setting is as follows for 500 min^{-1} with a 12-bit encoder (4,096 pulses):

Target speed = 500[min^{-1}] × 4096[pulse]/60[s] = 34133.3[pulse/s]

The setting unit for the parameter is 10 pulses/s, so set Pn812 to 3,413. The target speed is clamped to the maximum speed if the setting exceeds the maximum speed.

■ Orientation Acceleration Rate Setting Example

The setting is as follows with a 12-bit encoder (4,096 pulses) to accelerate to 10,000 min^{-1} in 5 seconds when the motor is stopped:

Acceleration = (10000[min^{-1}] × 4096[pulse]/60[s])/5[s] = 136533.3[pulse/s^2]

The setting unit for the parameter is 10^4 pulses/s^2 (Pn900 default setting is 4), so set Pn813 to 14. If a more precise setting is required, set Pn900 to 3.

<table>
<tr><th>Parameters</th><th>Names</th><th>Set Values</th><th>Operation for Parameter Setting</th></tr>
<tr><td rowspan="6">Pn813
Pn815</td><td rowspan="6">Acceleration Rate
Deceleration Rate
(position control)</td><td colspan="2">Set the acceleration and deceleration rates as four unsigned bytes.
Unit: $\times 10^n$ pulse/s^2</td></tr>
<tr><td>1 to 2147483647</td><td>Operation is performed according to the settings.
However, the acceleration/deceleration rates are clamped to the maximum acceleration/deceleration rate (8,388,608,000,000 pulses/s^2). The minimum acceleration/deceleration rate is 7,812 pulse/s^2.</td></tr>
<tr><td>2147483648 to 4294967294</td><td>The acceleration/deceleration rates are clamped to 2147483647.</td></tr>
<tr><td>4294967295</td><td>Operation is performed at the maximum acceleration/deceleration rates.</td></tr>
<tr><td>0</td><td>This value is lower than the lower limit and cannot be set.</td></tr>
<tr style="display:none"></tr>
<tr><td rowspan="5">Pn800
Pn802
Pn813
Pn815</td><td rowspan="5">Acceleration Rate
Deceleration Rate
(speed control)</td><td colspan="2">Set the acceleration and deceleration rates as four unsigned bytes.
Unit: $\times 10^n$ pulse/s^2</td></tr>
<tr><td>1 to 2147483647</td><td>Operation is performed according to the settings.
The minimum acceleration/deceleration rate is 7,812 pulse/s^2.</td></tr>
<tr><td>2147483648 to 4294967294</td><td>The acceleration/deceleration rates are clamped to 7FFFFFFFh.</td></tr>
<tr><td>4294967295</td><td>Operation is performed at the maximum acceleration/deceleration rates.</td></tr>
<tr><td>0</td><td>This value is lower than the lower limit and cannot be set.</td></tr>
</table>

■ Positioning Completed Width and Positioning Cancel Width

If the positioning cancel width is smaller than the positioning completed width, the same value as the positioning completed width will be used internally.

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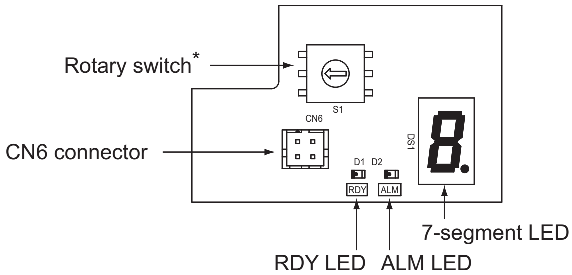
Operation

9.1 Panel Display

The servo status can be checked on the panel display of the SERVOPACK.
Also, if an alarm or warning occurs, its alarm or warning number is displayed.
For the panel display of the converter, refer to the *3.2.1 Power Regeneration Converter*.



* Leave the rotary switch set to 3 (factory setting).

9.1.1 Status Display

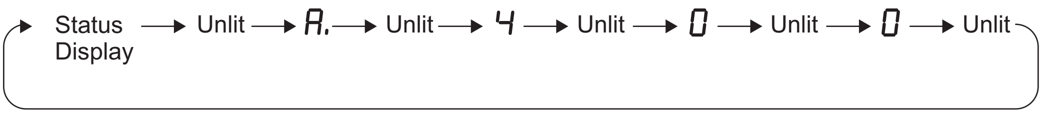
The display shows the following status.

Display	Meaning
	Rotation Detection (/TGON) Lights if motor speed exceeds the value set in Pn502. (Factory setting: 20 min^{-1})
	Baseblock Lights for baseblock (Motor power OFF).
	Reference Input Lights when a reference is being input.

9.1.2 Alarm and Warning Display

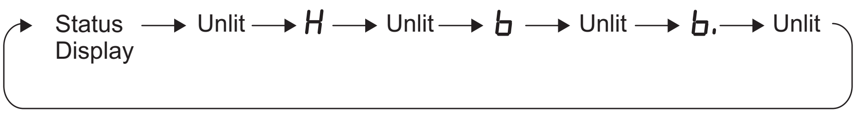
If an alarm or warning occurs, the display will change in the following order.

Example: Alarm A.400



9.1.3 Hard Wire Base Block Display

If a hard wire base block (HWBB) occurs, the display will change in the following order.



9.1.4 RDY and ALM LEDs

The following table shows the meanings of the RDY and ALM lights.

Name	Color	Meaning
Ready (RDY)	Green	Lit: Control CPU operates normally. Blink: The digital operator is connected.
Alarm (ALM)	Red	During an alarm occurrence.

9.2 Basic Functions Settings

9.2.1 Spindle Motor Settings

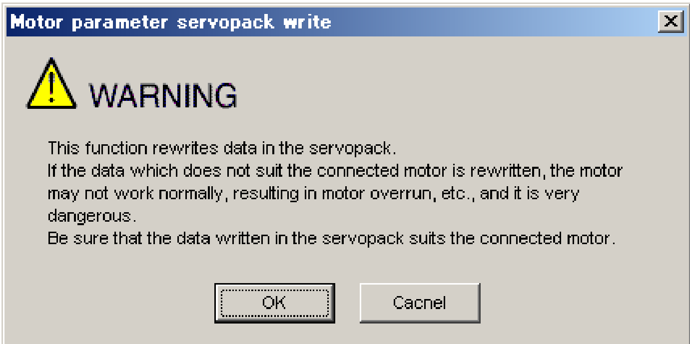
If a spindle motor is used, set the parameters as given below by using SigmaWin for Σ-V-SD (MT).

> **IMPORTANT**
> Make the correct settings for the items described in this section.
> An incorrect setting may result in spindle motor operation failure or incorrect operation.

(1) Spindle Motor Constant Settings

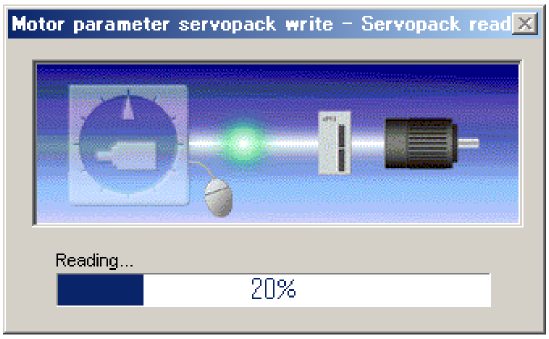
Write the motor constants of the spindle motor to use to the SERVOPACK using the following procedures.

1. Ask your Yaskawa representative how to obtain the motor parameter file.
2. In the SigmaWin for Σ-V-SD (MT) component main window, click **Setup**, and then click **Motor Parameter SERVOPACK Write**. A warning message appears, reminding you of the possible danger.

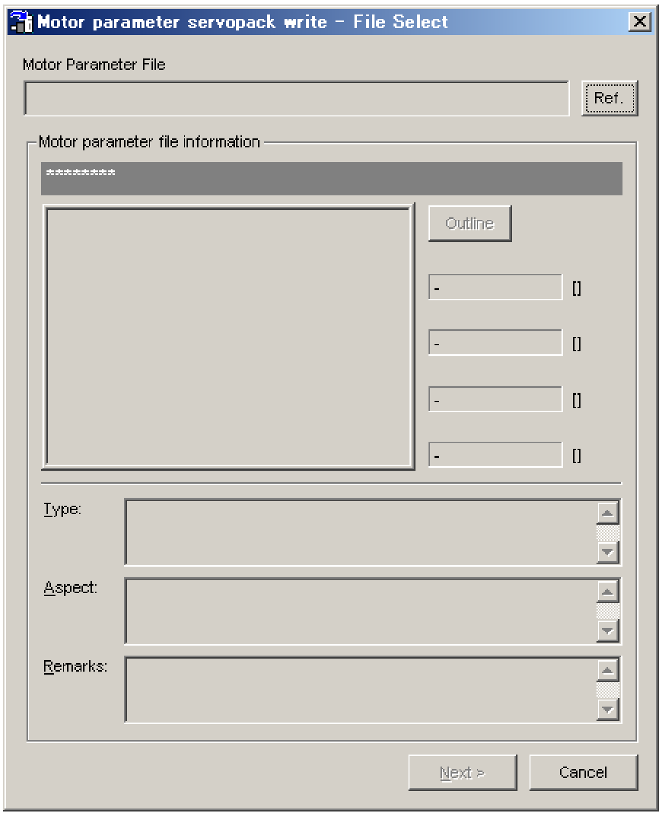


Click **Cancel** to return to the main window without writing motor parameters in the SERVOPACK.

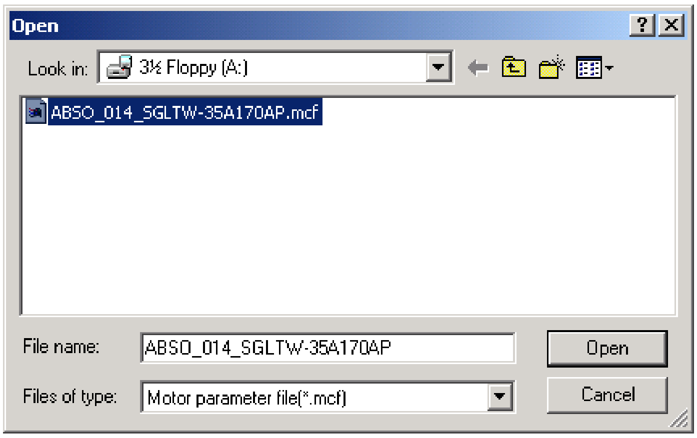
3. Click **OK**. The following box appears, and the SERVOPACK starts reading the parameter information.



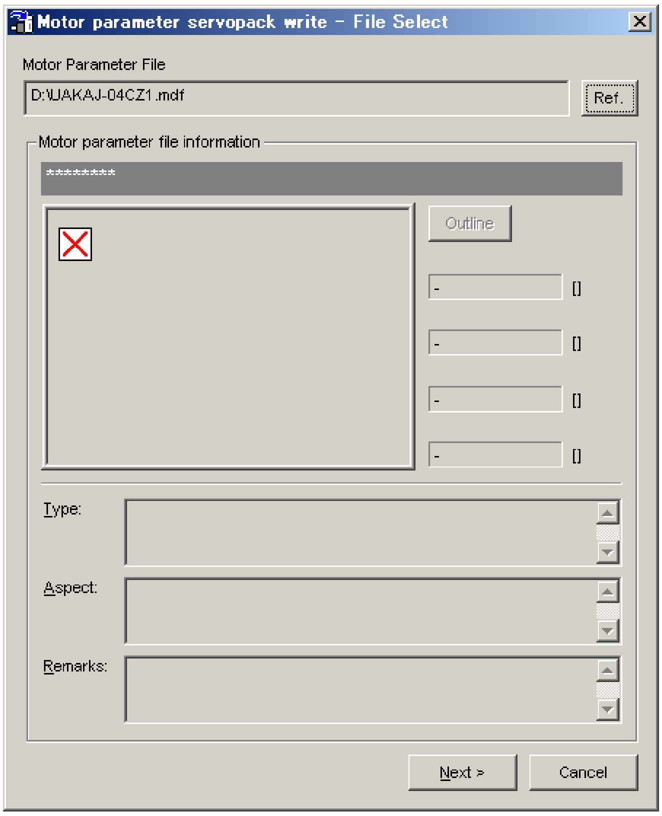
When the reading was completed successfully, the following box appears.



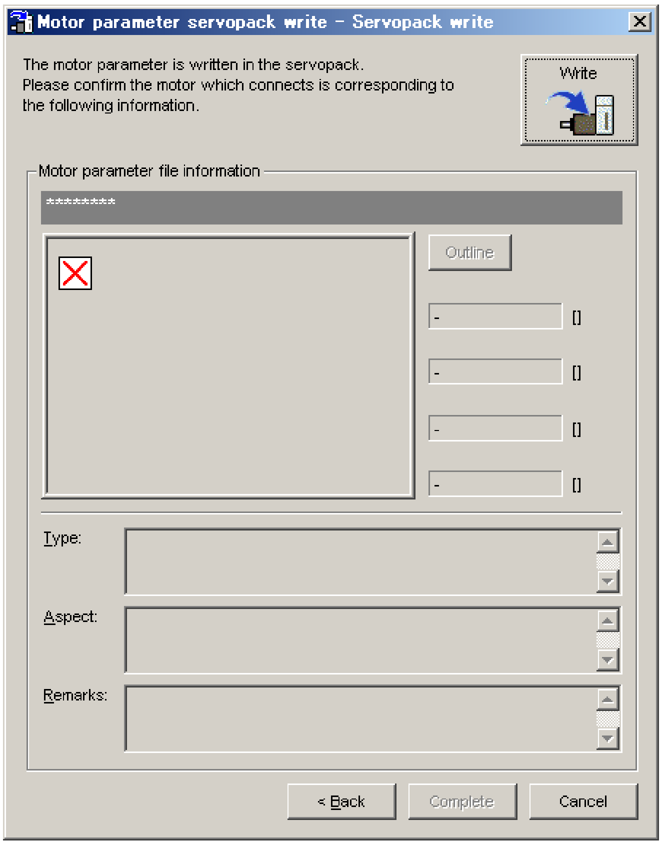
4. Click **Ref.**, and the following box appears.



5. Select the motor parameter file from Yaskawa, and then click **Open**. No information is displayed in the Motor parameter SERVOPACK write - File Select box.

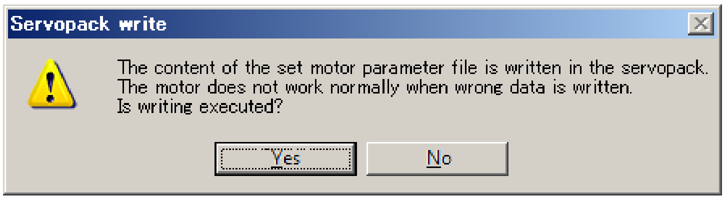


6. Click **Next**. The following box appears.



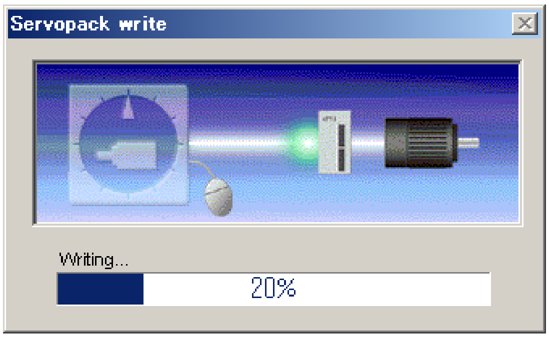
Click **Cancel** to return to the main window without writing motor parameters in the SERVOPACK. Click **Back** to return to the Motor parameter SERVOPACK write - File select box.

7. Click **Write**. The following message appears.

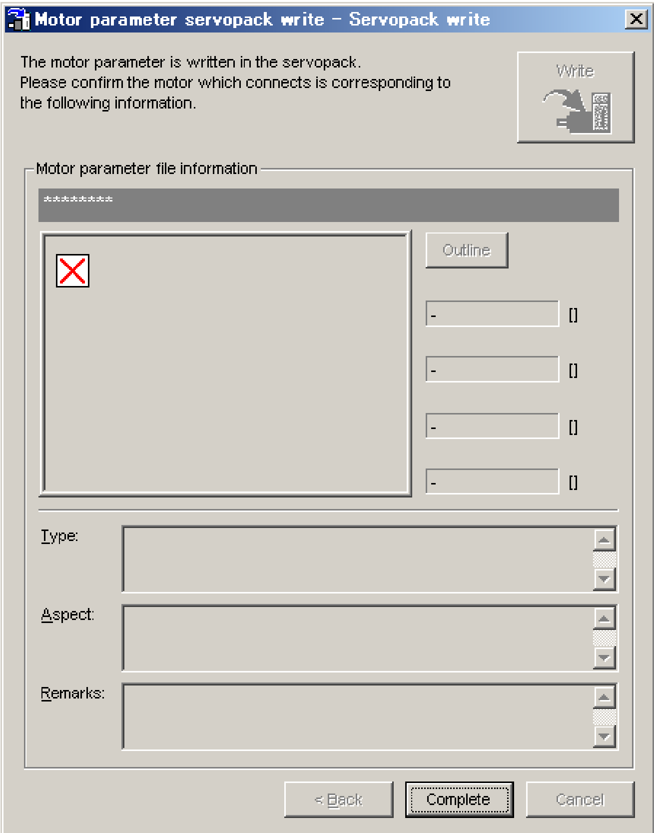


Click **No** to cancel writing.

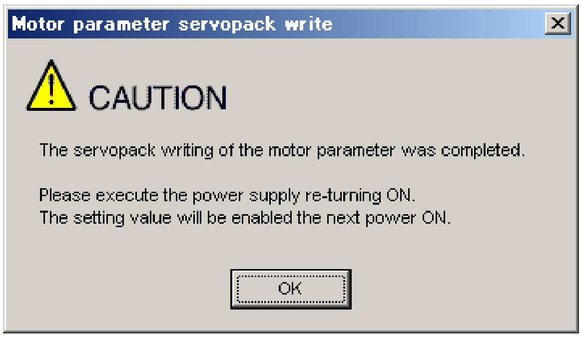
8. Click **Yes**. The following box appears, and the motor parameter scale writing starts.



If the motor parameters were written normally, the following box appears.



9. Click **Complete**, and the following box appears.



10. Click **OK**. Turn OFF the power and then ON again to validate the written data.

(2) Settings for the Winding Selection

Set the winding selection in Pn01E.1 to match the specifications of the spindle motor.

Parameter			Meaning
No.	Name	Setting	
Pn01E.1	Winding Selection	n.□□0□ [Factory setting]	None
		n.□□1□	Mechanical winding selection

9.2.2 Spindle Motor Rotation Direction

The direction of the motor's rotation can be determined by the combination of the /FWD signal, the /REV signal, and the speed reference voltage (SCOM).

Polarity of Speed Reference Voltage (SCOM)		Positive (+)	Negative (–)
Operation Signal	/FWD signal ON	CCW (Forward)	CW (Reverse)
	/REV signal ON	CW (Reverse)	CCW (Forward)

9.2.3 Stopping Spindle Motor after SV_OFF Command or Alarm Occurrence

The stopping method can be selected after the SV_OFF command is received or an alarm occurs.

IMPORTANT

- Do not use the servo drive with a load inertia that exceeds the allowable value. Doing so may result in damage or failure of the resistors or power elements in the SERVOPACK.
- Parameters cannot be used to set the stopping method for the motor if the main circuit power supply (L1, L2, L3) or the control power supply (24 V or 0 V) is turned OFF during operation without turning OFF the servo. The stopping method depends on the conditions, as given below.
  - Turning OFF the main circuit power supply without turning OFF the servo: The alarm stopping method is used. For details, refer to *13.2.1 List of Alarms*.
  - Turning OFF the control power supply without turning OFF the servo: The spindle motor will coast to a stop.

(1) Stopping Method for Spindle Motor after SV_OFF Command is Received

Whether the servo is ON or OFF is determined by the status of the /FWD and /REV signals.

- When Servo Is ON
  - /FWD signal is ON and /REV signal is OFF.
  - /FWD signal is OFF and /REV signal is ON.
- When Servo Is OFF
  - /FWD and /REV signals are both ON.
  - /FWD and /REV signals are both OFF.

The following table shows the status of the spindle motor for various combinations of the /FWD and /REV signals and the servo ON/OFF status.

/FWD Signal	/REV Signal	Servo ON/OFF	Spindle Motor Status
ON	ON	Servo turns OFF.	Decelerates to a stop. The current is then turned OFF.
ON	OFF	Servo ON	Operation is possible.*
OFF	ON	Servo ON	Operation is possible.*
OFF	OFF	Servo turns OFF.	Decelerates to a stop. The current is then turned OFF.

* Spindle motor operation will start when a speed reference is input while operation is enabled.

(2) Stopping Method for Spindle Motor When an Alarm Occurs

There are two types of alarms: Gr.1 and Gr.2.

Gr.1: The motor coasts to a stop.

Gr.2: The motor is stopped according to the setting in Pn00B.1 if an alarm occurs. Pn00B.1 is factory-set to stop the motor by setting the speed reference to "0." By setting Pn00B.1 to 1, the motor stops using the same method as Gr.1.

Refer to *13.2.1 List of Alarms* to determine if the alarm that occurred is Gr.1 or Gr.2.

■ Stopping Method for Spindle Motor for Gr.1 Alarms

The stopping method of the motor when a Gr.1 alarm occurs is coasting to a stop.

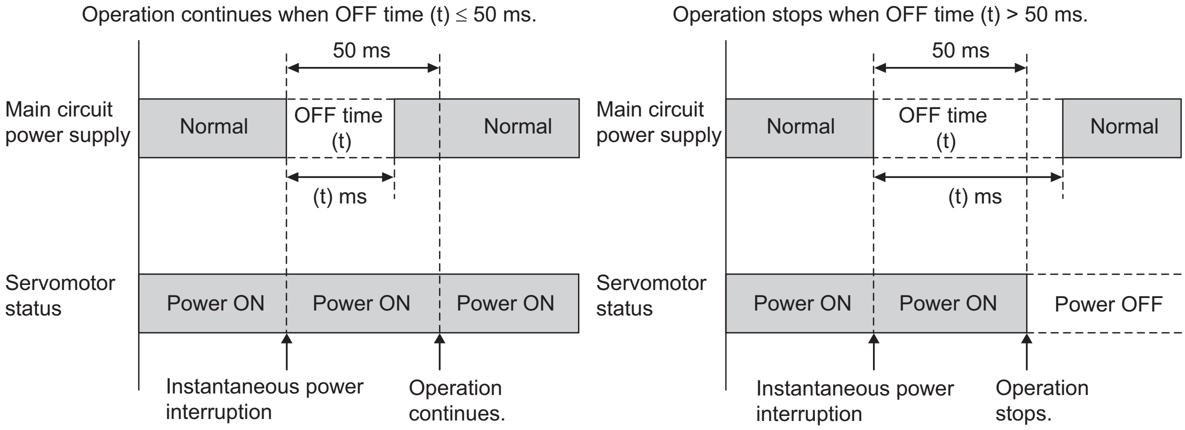
■ Stopping Method for Spindle Motor for Gr.2 Alarms

Parameter Pn00B	Stop Mode	Mode After Stopping	When Enabled	Classification
n.□□0□ [Factory setting]	Zero-speed stopping*	Coast	After restart	Setup
n.□□1□	Coast			

* Zero-speed stopping: The speed reference is set to 0 to stop quickly.

9.2.4 Instantaneous Power Interruption Settings

If the power interruption time is shorter than 50 ms, the motor will continue operation. If it is longer than 50 ms, a power failure during converter drive operation alarm (A.41C) will occur and the motor's power will be turned OFF.



IMPORTANT

- The holding time of the control power supply (24 VDC) depends on the capability of the power supply (provision of power supply: user's responsibility). Check the power supply before using the application.
- If the load on the motor during the power interruption is large, an undervoltage alarm (A.410) or a converter DC undervoltage alarm (A.41A) may occur.

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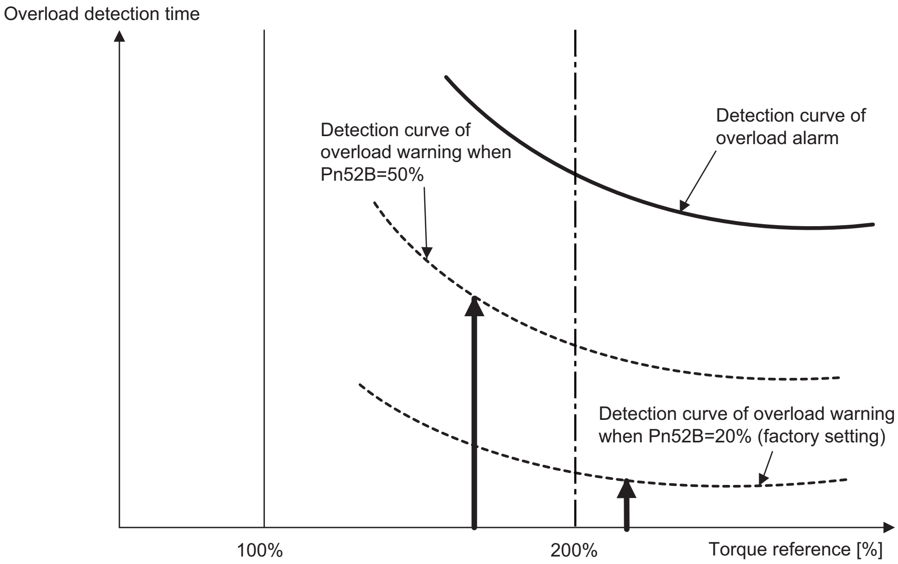
9.2.5 Setting Motor Overload Detection Level

In this SERVOPACK, the detection timing of the warnings and alarms can be changed by changing how to detect an overload warning (A.910) and overload (low load) alarm (A.720).
The overload characteristics and the detection level of the overload (high load) alarm (A.710) cannot be changed.

(1) Changing Detection Timing of Overload Warning (A.910)

The overload warning level is set by default to 20% so that an overload warning is detected in 20% of the time required to detect an overload alarm. The time required to detect an overload warning can be changed by changing the setting of the overload warning level (Pn52B). This protective function enables the warning output signal (/WARN) to serve as a protective function and to be output at the best timing for your system.
The following graph shows an example of the detection of an overload warning when the overload warning level (Pn52B) is changed from 20% to 50%. An overload warning is detected in half of the time required to detect an overload alarm.



Pn52B	Overload Warning Level (Speed, Position)				Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	1 to 100	1%	20	Immediately	Setup

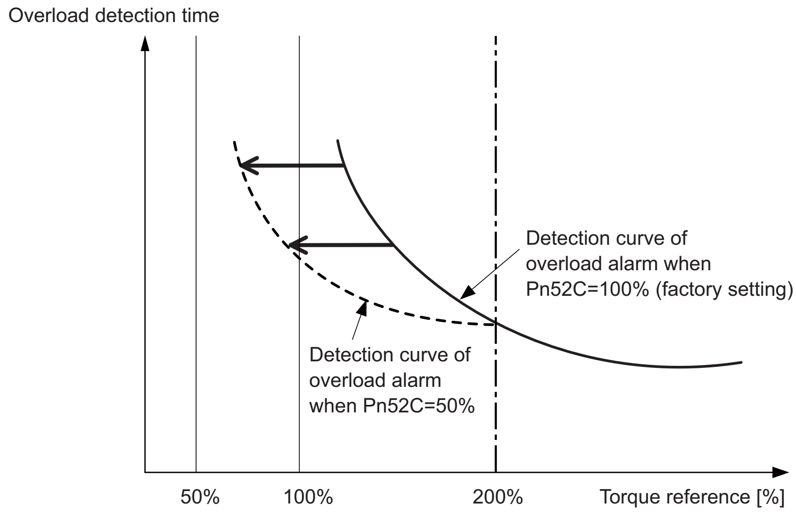
(2) Changing Detection Timing of Overload (Low Load) Alarm (A.720)

An overload (low load) alarm (A.720) can be detected earlier to protect the motor from overloading.
The time required to detect an overload alarm can be shortened by using the derated motor base current obtained with the following equation. The detection level of the overload (high load) alarm (A.710) cannot be changed.

Motor base current × Derating of base current at detecting overload of motor (Pn52C)
= Derated motor base current

Motor base current: Threshold value of motor current to start calculation for overload alarm
Derating of base current at detecting overload of motor (Pn52C): Derating of motor base current

The following graph shows an example of the detection of an overload alarm when Pn52C is set to 50%.
The calculation for the overload of motors starts at 50% of the motor base current and then an overload alarm will be detected earlier.
Changing the setting of Pn52C will change the detection timing of the overload alarm, so the time required to detect the overload warning will also be changed.



Pn52C	Derating of Base Current at Detecting Overload of Motor Speed Position				Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	10 to 100	1%	100	After restart	Setup

9.2.6 Limiting Torque

This function limits the output torque to protect the machine.

Set the torque limit for motor acceleration in Pn430. Set the torque limit for motor deceleration in Pn431. The direction of motor rotation is not affected.

Pn430	Torque Limit (Powering)		Speed Position		Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	0 to 800	1%	150	Immediately	Setup
Pn431	Torque Limit (Regeneration)		Speed Position		Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	0 to 800	1%	150	Immediately	Setup

The setting unit is a percentage of the rated torque.

Note 1. If the setting is too low, the torque may be insufficient for acceleration or deceleration of the motor.
2. The maximum torque of the motor is used whenever the value exceeds the maximum torque.

9.3 Trial Operation

This section describes a trial operation.

9.3.1 Preparations for Trial Operation

Perform the following preparations before you perform trial operation.

Step	Item	Description	Reference
1	Installation and mounting	Install the SERVOPACK and converter according to the installation conditions and confirm that the installation conditions have been met.	*4.2.1 Installation Requirements*
2	Wiring and connections	Connect the power supply and peripheral devices to the SERVOPACK and converter. Be particularly careful of the following points. • Select peripheral devices that meet the specifications and wire them correctly. • Wire the main circuit power input terminals (L1, L2, and L3) and control power input terminals (CN7A and CN7B) correctly. • Connect the motor output terminals (U, V, and W) and motor correctly. • Connect the ground terminal (⏚) correctly. • Connect the converter and SERVOPACK correctly (including the main circuit DC power supply (P and N), control power supply (CN7A and CN7B), and local bus (CN5 and CN5A)). • Make sure that there are no loose parts on the servomotor. Note: If the spindle motor has been stored for a long time before trial operation, inspect the spindle motor according to the maintenance and inspection procedures. For information on maintenance and inspections, refer to *13.1 Inspection and Maintenance*.	*1.1 The Σ-V-SD Series*, *Chapter 5 Wiring*
3	Checking the power supply voltage	Confirm that the power supply voltage is correct. • Main Circuit Power Supply Voltage 200 V Class: Three-phase 200 to 230 VAC, 50/60 Hz 400 V Class: Three-phase 380 to 480 VAC, 50/60 Hz Allowable voltage fluctuation: +10% to –15% Allowable frequency fluctuation: ±5% Line voltage unbalance: 5% max. • Control Power Supply Voltage 24 DVC Allowable voltage fluctuation: ±15% Output hold time: 100 ms min.	*3.2.1 Power Regeneration Converter*
4	Turning ON the control power supply	Turn ON the control power supply. An alarm will occur in the SERVOPACK.	*■ Panel Display in 3.2.1 (1) Basic Specifications,* *9.1 Panel Display*
5	Setting spindle motor parameters	Use the SigmaWin for Σ-V-SD (MT) to set the motor constants.	*9.2.1 (1) Spindle Motor Constant Settings*

(cont'd)

Step	Item	Description	Reference
6	Turning the control power supply OFF and back ON	Turn the control power supply OFF and back ON. Normal Startup The indicators will be as follows: Converter: The READY indicator will light in green. (This indicates that the CPU in the power regeneration converter has started normally.) SERVOPACK: The RDY indicator will light in green. (This indicates that the CPU in the SERVOPACK has started normally.) The RDY indicator will blink in green. (This indicates that the digital operator is connected.) Error during Startup The indicators will be as follows: Converter: The READY indicator will not light. (This indicates that the CPU in the power regeneration converter did not start normally.) The ALARM indicator will light in red (This indicates that an alarm occurred.) SERVOPACK: The RDY indicator will not light. (This indicates that the CPU in the SERVOPACK did not start normally.) The ALM indicator will light in red (This indicates that an alarm occurred.) Check the 7-segment display and the data display on the digital operator, or check the error information on the SigmaWin for Σ-V-SD (MT).* For details, refer to *Chapter 13 Inspection, Maintenance, and Troubleshooting*. * If the RDY indicator (green) on SERVOPACK is not lit, communications with the SigmaWin for Σ-V-SD (MT) may not be possible.	*■ Panel Display in 3.2.1 (1) Basic Specifications, 9.1 Panel Display*
7	Setting the spindle motor	Set the winding selection in Application Function Select Switch 1E (Pn01E.1) based on the spindle motor specifications.	*9.2.1 Spindle Motor Settings*
8	Checking for alarms	Confirm that no alarms have occurred in the converter or SERVOPACK.	–
9	Turning ON the main circuit power supply	Turn ON the main circuit power supply. Confirm that the converter or SERVOPACK are in the following condition. The CHARGE indicator must be lit in orange. (This indicates that the main circuit power supply is ON.) Note: The indicators that lit when the control power supply was turned ON should still be lit.	*■ Panel Display in 3.2.1 (1) Basic Specifications*
10	Checking the spindle motor cooling fan	Confirm that the air direction for the spindle motor cooling fan is correct.	–

9.3.2 Trial Operation Example

An example of trial operation is given below.

Step	Operation	Reference
1	Check the power supply and input signal circuits again, and then turn ON the control power supply to the SERVOPACK and the power supply regenerative converter.	–
2	Adjust the speed reference input gain 1 (Pn300).	*14.2 List of Parameters*
3	Turn ON the main circuit power supply to the SERVOPACK.	–
4	Make sure that the analog speed reference (SCOM) is 0 V and then turn ON the /FWD or /REV signal. The servo will turn ON. Note: If the spindle motor shaft rotates a little even when the speed reference input is 0 V, adjust the reference offset so that the spindle motor shaft does not rotate at all.	*6.1 Sequence Input Signals* *6.2 Analog Speed Reference*
5	Gradually increase the analog speed reference (SCOM) voltage from 0 V. The default setting is for 6 V/base speed.	
6	Check the speed reference value in the speed reference monitor (Un001).	*11.3 Monitor Mode (Un□□□)*
7	Check the motor speed in the motor speed monitor (Un000).	
8	Make sure that the values in steps 6 and 7 (i.e., Un001 and Un000) are equivalent.	
9	Check the direction of motor rotation.	–
10	Return the speed reference input to 0 V.	*6.2 Analog Speed Reference*
11	Turn OFF the /FWD or /REV signal. The servo will turn OFF.	–

9.4 Safety Function

The safety function is incorporated in the SERVOPACK to reduce the risk associated with the machine by protecting workers from injury and by securing safe machine operation. Especially when working in hazardous areas inside the safeguard, as for machine maintenance, it can be used to avoid adverse machine movement.

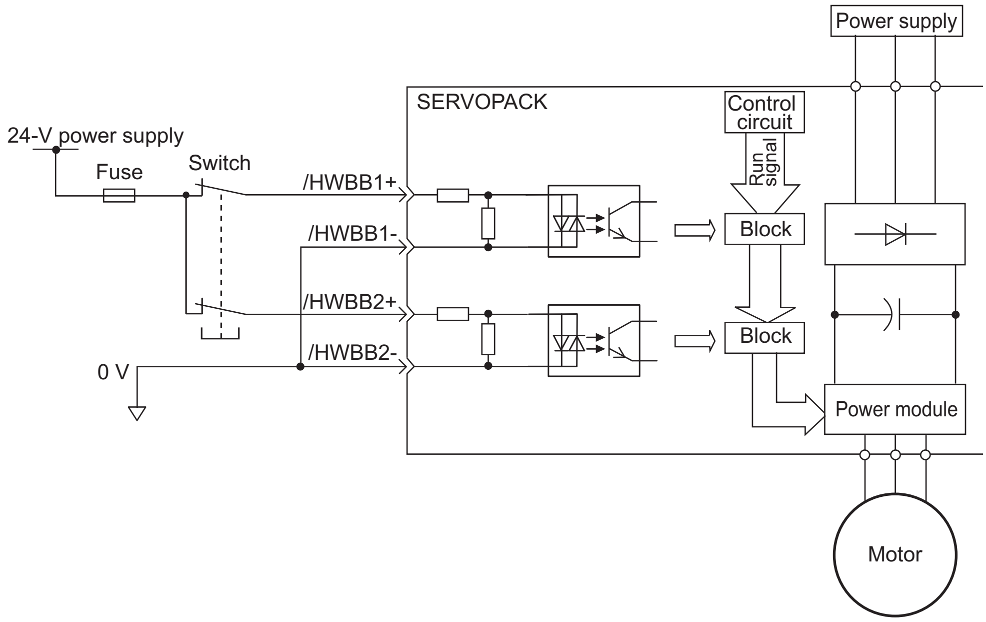
9.4.1 Precautions for Safety Functions

⚠ WARNING

- To check that the HWBB function satisfies the safety requirements of the system, be sure to conduct a risk assessment of the system.
  Incorrect use of the machine may cause injury.
- The servomotor rotates if there is external force (e.g., gravity in a vertical axis) when the HWBB function is operating. Therefore, use an appropriate device independently, such as a mechanical brake, that satisfies safety requirements.
  Incorrect use of the machine may cause injury.
- While the HWBB function is operating, the motor may rotate within an electric angle of 180° or less as a result of a SERVOPACK failure. Use the HWBB function for applications only after checking that the rotation of the motor will not result in a dangerous condition.
  Incorrect use of the machine may cause injury.
- Connect devices meeting safety standards for the signals for safety functions.
  Incorrect use of the machine may cause injury.
- If the HWBB function is used for an emergency stop, turn OFF the power supply to the servomotor with independent electric or mechanical parts.
  Incorrect use of the machine may cause injury.
- The HWBB function does not shut off the power to the SERVOPACK or electrically isolate it. Take measures to shut off the power to the SERVOPACK when performing maintenance on it.
  Failure to observe this warning may cause an electric shock.

9.4.2 Hard Wire Base Block (HWBB) Function

The Hard Wire Base Block function (hereinafter referred to as HWBB function) is a function designed to baseblock the motor (shut off the motor current) by using the hardwired circuits.
Each circuit for two channel input signals blocks the run signal to turn off the power module that controls the motor current, and the motor current is shut off. (Refer to the diagram below.)



Note: For HWBB function signal connections, the input signal is the 0 V common and the output signal is the source output. This is opposite to other signals described in this manual. To avoid confusion, the ON and OFF status of signals for HWBB function are defined as follows:
ON: The state in which the relay contacts are closed or the transistor is ON and current flows into the signal line.
OFF: The state in which the relay contacts are open or the transistor is OFF and no current flows into the signal line.

(1) Risk Assessment

When using the HWBB function, be sure to perform a risk assessment of the servo system in advance.
Make sure that the safety level of the standards is met. For details about the standards, refer to *12.1 Harmonized Standards* at the front of this manual.

Note: To meet the performance level d (PLd) in EN ISO 13849-1, the EDM signal must be monitored by a host controller. If the EDM signal is not monitored by a host controller, the system only qualifies for the performance level c (PLc).

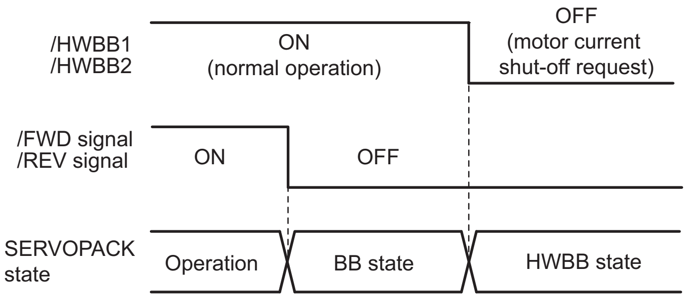
The following risks can be estimated even if the HWBB function is used. These risks must be included in the risk assessment.

- The motor will rotate in an application where external force is applied to the motor (for example, gravity on the vertical axis). Take measures to secure the motor, such as installing a mechanical brake.
- The spindle motor coasts to a stop if an error occurs such as the power module failure. Make sure that safety is ensured even in that situation.
- The HWBB function does not shut off the power to the SERVOPACK or electrically isolate it. Take measures to shut off the power to the SERVOPACK when performing maintenance on it.

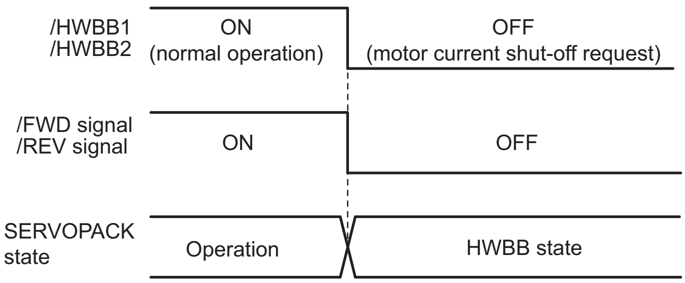
(2) Hard Wire Base Block (HWBB) State

The SERVOPACK will be in the following state if the HWBB function operates. If the /HWBB1 or /HWBB2 signal is OFF, the HWBB function will operate and the SERVOPACK will enter a hard wire baseblock (HWBB) state.

The HWBB function operates after the motor power is turned OFF.

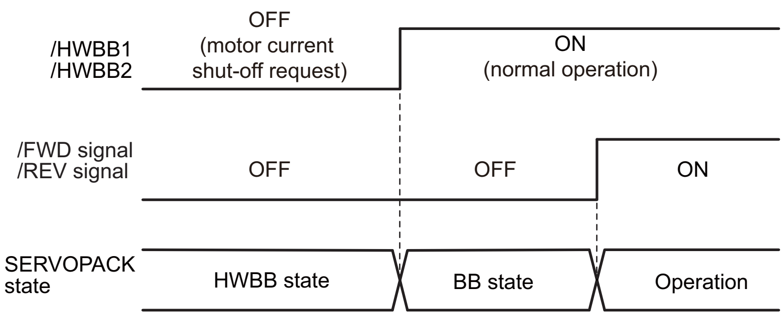


The HWBB function operates while the motor power is ON.

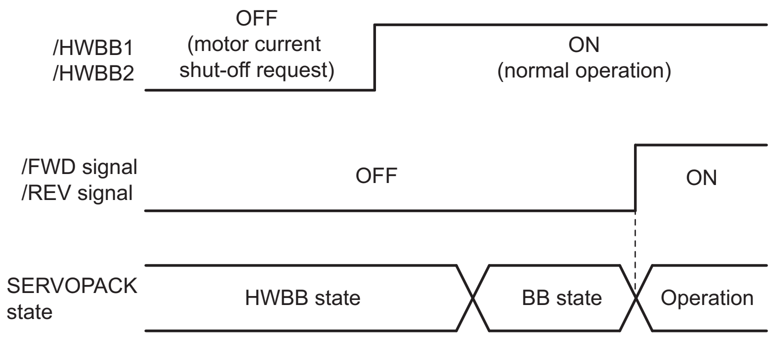


(3) Resetting the HWBB State

Usually after the /FWD and the /REV signals are turned OFF and then the spindle motor power is turned OFF, the SERVOPACK will then enter a hard wire baseblock (HWBB) state with the /HWBB1 and /HWBB2 signals turned OFF. By then turning the /HWBB1 and /HWBB2 signals ON in this state, the SERVOPACK will enter a baseblock (BB) state and can receive the /FWD and the /REV signals.



If the /HWBB1 and /HWBB2 signals are OFF but the /FWD signal or the /REV signal is ON, the HWBB state will be maintained after the /HWBB1 and /HWBB2 signals are turned ON.
Turn both the /FWD signal and the /REV signal OFF, so the SERVOPACK will be in a BB state. Then turn the /FWD signal or the /REV signal ON again.



Note: Even if the motor power is turned OFF by turning OFF the main circuit power, the HWBB status is retained until the /FWD and the /REV signals are turned OFF.

(4) Error Detection in HWBB Signal

If only the /HWBB1 or /HWBB2 signal is input, an A.EB1 alarm (Safety Function Signal Input Timing Error) will occur unless the other signal is input within 10 seconds. This makes it possible to detect failures, such as disconnection of the HWBB signals.

⚠ CAUTION

- The safety function signal input timing error alarm (A.EB1) is not a safety-related part of a control system. Keep this in mind in the system design.

(5) Connection Example and Specifications of Input Signals (HWBB Signals)

The input signals must be redundant. A connection example and specifications of input signals (HWBB signals) are shown below.

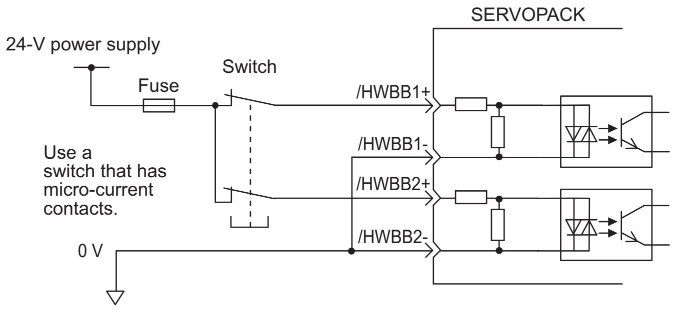
IMPORTANT

For HWBB function signal connections, the input signal is the 0 V common and the output signal is the source output. This is opposite to other signals described in this manual. To avoid confusion, the ON and OFF status of signals for HWBB function are defined as follows:

ON: The state in which the relay contacts are closed or the transistor is ON and current flows into the signal line.

OFF: The state in which the relay contacts are open or the transistor is OFF and no current flows into the signal line.

■ Connection Example



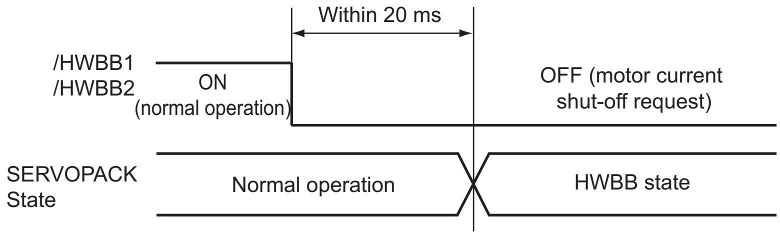
■ Specifications

Type	Signal Name	Pin Number	Status	Meaning
Input	/HWBB1	CN1-29	ON	Does not use the HWBB function. (normal operation)
		CN1-30	OFF	Uses the HWBB function. (motor current shut-off request)
	/HWBB2	CN1-31	ON	Does not use the HWBB function. (normal operation)
		CN1-32	OFF	Uses the HWBB function. (motor current shut-off request)

The input signals (HWBB signals) have the following electrical characteristics.

Items	Characteristics	Remarks
Internal Impedance	6.8 kΩ	–
Operation Movable Voltage Range	+24 V±5%	–
Maximum Delay Time	20 ms	Time from the /HWBB1 and /HWBB2 signals are OFF to the HWBB function operates.

If the HWBB function is requested by turning OFF the /HWBB1 and /HWBB2 input signals on the two channels, the power supply to the motor will be turned OFF within 20 ms (see below).



Note: The OFF status is not recognized if the total OFF time of the /HWBB1 and /HWBB2 signals is 0.5 ms or shorter.

(6) Operation with SigmaWin for Σ-V-SD (MT)

The HWBB function works while the SERVOPACK operates with SigmaWin for Σ-V-SD (MT).

If any of the following utility functions is being used with the /HWBB1 and /HWBB2 signals turned OFF, the SERVOPACK cannot be operated by turning ON the /HWBB1 and /HWBB2 signals. Cancel the utility function first, and then set the SERVOPACK to the utility function mode again and restart operation.

- JOG operation
- Origin search
- Program JOG operation
- Automatic offset-adjustment of motor current detection signal

9.4.3 External Device Monitor (EDM)

The external device monitor (EDM) functions to monitor failures in the HWBB function. Connect the monitor to feedback signals to the safety function device.

Note: To meet the performance level d (PLd) in EN ISO13849-1, the EDM signal must be monitored by a host controller. If the EDM signal is not monitored by a host controller, the system only qualifies for the performance level c (PLc).

■ Failure Detection Signal for EDM Signal

The relation of the EDM, /HWBB1, and /HWBB2 signals is shown below.

Detection of failures in the EDM circuit can be checked using the following four status of the EDM signal in the table. Failures can be detected if the failure status can be confirmed, e.g., when the power supply is turned ON.

Signal Name	Logic			
/HWBB1	ON	ON	OFF	OFF
/HWBB2	ON	OFF	ON	OFF
EDM	OFF	OFF	OFF	ON

⚠ WARNING

- The EDM signal is not a safety output. Use it only for monitoring a failure.

■ Connection Example

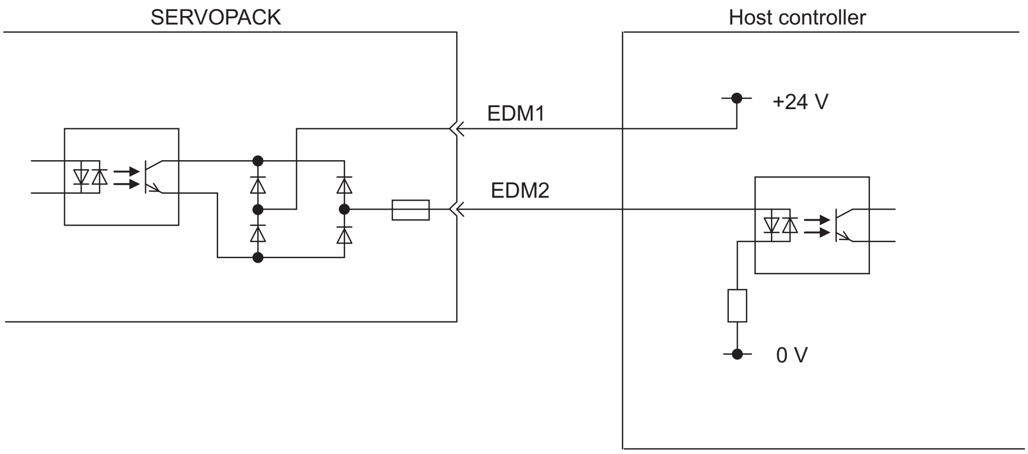
IMPORTANT

For HWBB function signal connections, the input signal is the 0 V common and the output signal is the source output. This is opposite to other signals described in this manual. To avoid confusion, the ON and OFF status of signals for HWBB function are defined as follows:

ON: The state in which the relay contacts are closed or the transistor is ON and current flows into the signal line.

OFF: The state in which the relay contacts are open or the transistor is OFF and no current flows into the signal line.

The connection example of EDM signal is shown below.



■ Specifications

Type	Signal Name	Pin Number	Status	Meaning
Out-put	EDM	CN1-33 CN1-34	ON	The base blocks established by both the /HWBB1 and the /HWBB2 signals are working normally.
			OFF	One of the following conditions: • The base block for the /HWBB1 or /HWBB2 signal is not operating. • The base blocks for the /HWBB1 and /HWBB2 signals are not operating.

Electrical characteristics of EDM signal are as follows.

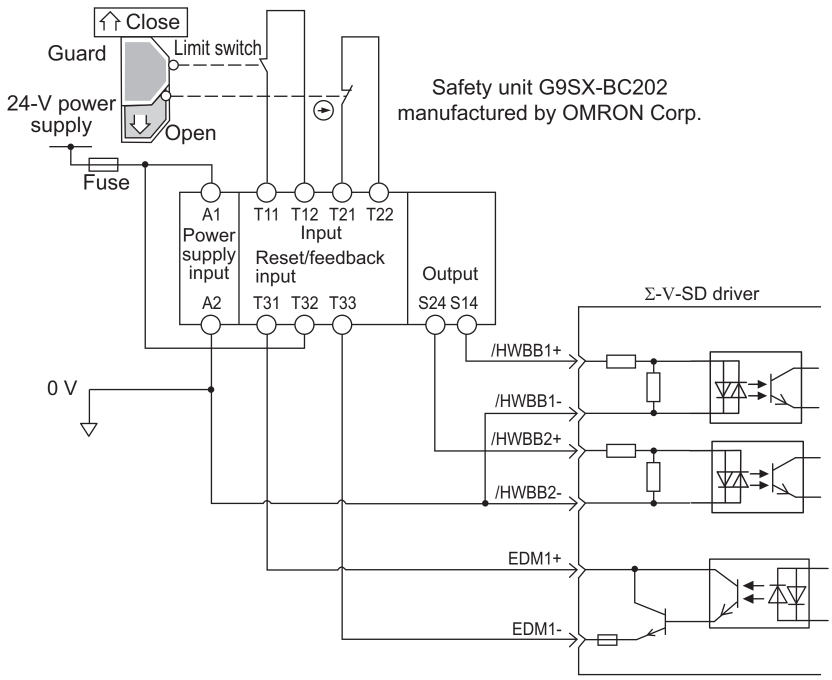
Items	Characteristics	Remarks
Maximum Allowable Voltage	30 VDC	–
Maximum Current	50 mADC	–
Maximum Voltage Drop at ON	3.5 V	Voltage between EDM1 and EDM2 when current is 50 mA
Maximum Delay Time	20 ms	Time from the change in /HWBB1 or /HWBB2 until the change in EDM

Note: The EDM signal is used as a sourcing output. For details, refer to *(1) Connection Example* in *9.4.4 Safety Function Application Example*.

9.4.4 Safety Function Application Example

This section provides an application example for the safety function.

(1) Connection Example



When a guard opens, both of signals, the /HWBB1 and the /HWBB2, turn OFF, and the EDM1 signal is ON. Since the feedback is ON when the guard closes, the device is reset, and the /HWBB1 and the /HWBB2 signals turn ON, and the operation becomes possible.

(2) Failure Detection Method

In case of a failure such as the /HWBB1 or the /HWBB2 signal remains ON, the device is not reset when the guard closes because the EDM signal keeps OFF. Therefore starting is impossible, then the failure is detected.

In this case, an error in the external device, disconnection or short-circuiting of the external wiring, or a failure in the SERVOPACK must be considered. Find the cause and correct the problem.

(3) Usage Example

1	Request to open the guard.
2	When the motor is operating, the host controller stops the motor and sends servo OFF command (SV_OFF).
3	Open the guard and enter.
4	The /HWBB1 and /HWBB2 signals are OFF and HWBB function operates. (The operation in the guard is available.)
5	After completing the operation, leave and close the guard.
6	The host controller sends servo ON command (SV_ON).

9.4.5 Confirming Safety Functions

When starting the equipment or replacing the SERVOPACK for maintenance, be sure to conduct the following confirmation test on the HWBB function after wiring.

- When the HWBB signals turn OFF, check that the system monitor of the SigmaWin for Σ-V-SD (MT) displays “Hbb” and that the servomotor does not operate.
- Check the ON/OFF states of the HWBB signals with the input signal field ESTP (HWBB).
  → If the ON/OFF states of the signals do not coincide with the ESTP (HWBB), an error in the external device, disconnection or short-circuiting of the external wiring, or a failure in the SERVOPACK must be considered. Find the cause and correct the problem.
- Check with the display of the feedback circuit input of the connected device to confirm that the EDM signal is OFF while in normal operation.

10

Adjustments

10.1 Adjustments

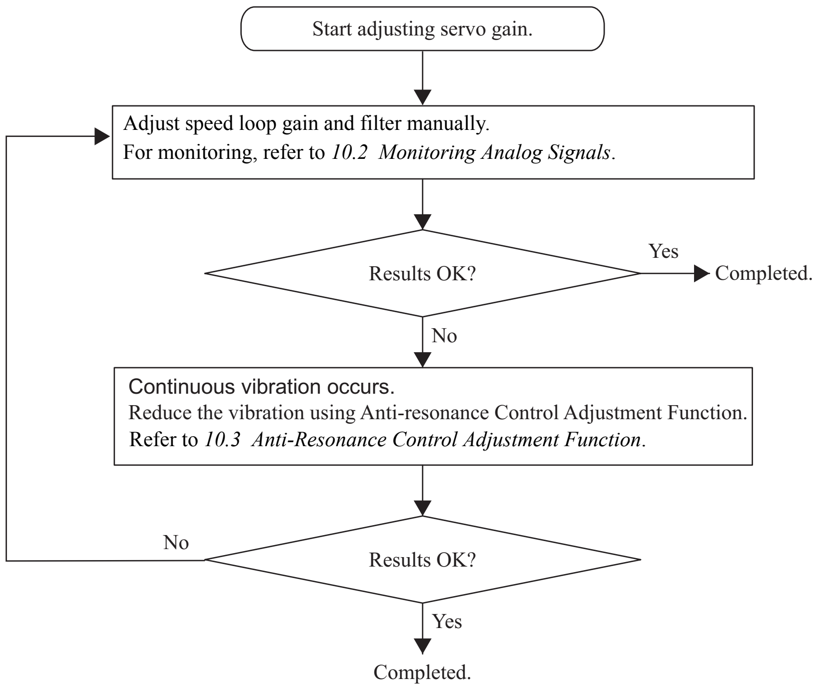
Adjustments (tuning) are performed to optimize the responsiveness of the SERVOPACK.

The responsiveness is determined by the servo gain that is set in the SERVOPACK.

The servo gain is set using a combination of parameters, such as speed loop gain, filters, moment of inertia ratio. These parameters influence each other. Therefore, the servo gain must be set considering the balance between the set values.

Generally, the responsiveness of a machine with high rigidity can be improved by increasing the servo gain. If the servo gain of a machine with low rigidity is increased, however, the machine will vibrate and the responsiveness may not be improved. In such case, it is possible to suppress the vibration with a variety of vibration suppression functions in the SERVOPACK.

The servo gain is adjusted at the factory. You normally do not need to adjust it, but sometimes adjustment is required depending on the condition of your machine.
If necessary, use the following flowchart to make the adjustment.



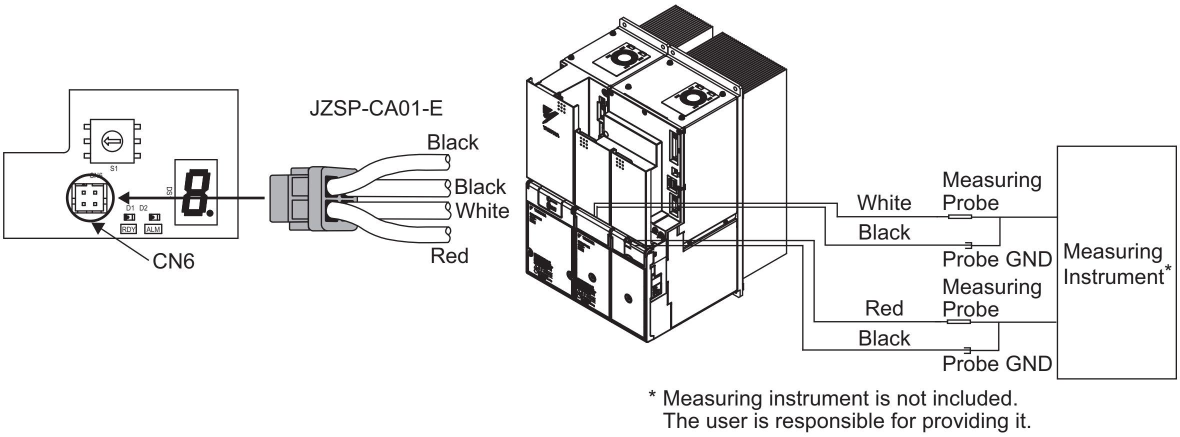
10.2 Monitoring Analog Signals

Check the operating status of the machine and signal waveform when adjusting the servo gain. Connect a measuring instrument, such as a memory recorder, to analog monitor connector (CN6) on the SERVOPACK to monitor analog signal waveform.

The settings and parameters for monitoring analog signals are described in the following sections.

10.2.1 CN6 Connector for Analog Monitor

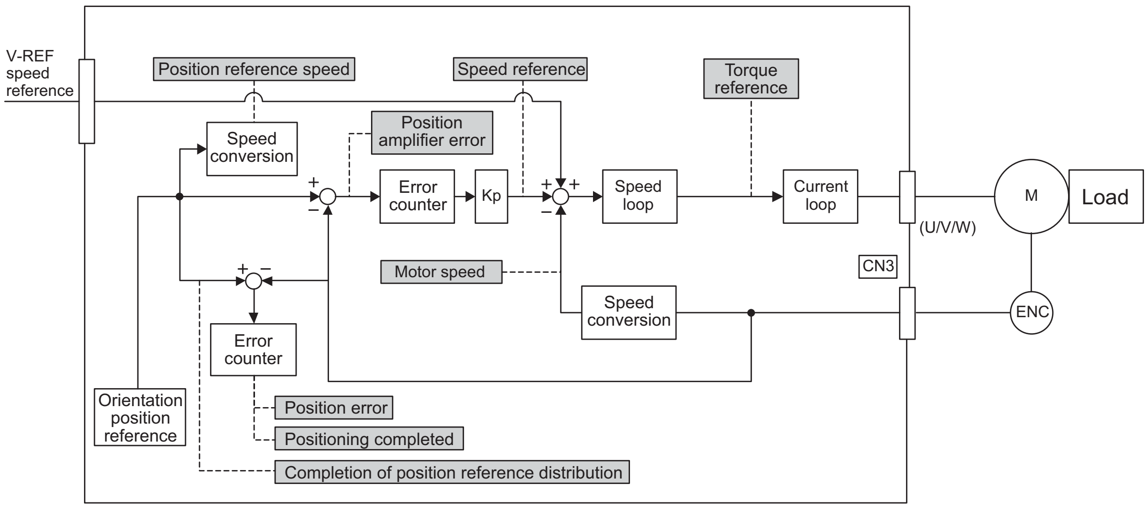
To monitor analog signals, connect a measuring instrument with cable (JZSP-CA01-E) to the CN6 connector.



Line Color	Signal Name	Factory Setting
White	Analog monitor 1	Torque reference: 1 V/100% rated torque
Red	Analog monitor 2	Motor speed: 1 V/1000 min^{-1}
Black (2 lines)	GND	Analog monitor GND: 0 V

10.2.2 Monitor Signal

The shaded parts in the following diagram indicate analog output signals that can be monitored.



The following signals can be monitored by selecting functions with parameters Pn006 and Pn007. Pn006 is used for analog monitor 1 and Pn007 is used for analog monitor 2.

Parameter		Description		
		Monitor Signal	Unit	Remarks
Pn006 Pn007	n.□□00 [Pn007 Factory Setting]	Motor speed	1 V/1000 min^{-1}	–
	n.□□01	Speed reference	1 V/1000 min^{-1}	–
	n.□□02 [Pn006 Factory Setting]	Torque reference	1 V/ (Max. torque/1.2)	–
	n.□□03	Position error	0.05 V/1 pulse	0 V at speed/torque control
	n.□□05	Position reference speed	1 V/1000 min^{-1}	–
	n.□□06	Reserved	–	–
	n.□□08	Positioning completed	Completed: 5 V Not completed: 0 V	Completion indicated by output voltage.
	n.□□0B	Reserved	–	–
	n.□□0C	Completion of position reference	Completed: 5 V Not completed: 0 V	Completion indicated by output voltage.
	n.□□46	Load meter	6 V/100%	–

10.2.3 Setting Monitor Factor

The output voltages on analog monitors 1 and 2 are calculated by the following equations.

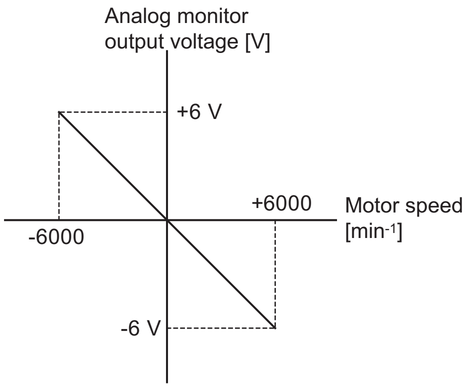
Analog monitor 1 output voltage = (-1) × (Signal selection (Pn006=n.00□□) × Multiplier (Pn552) + Offset voltage [V] (Pn550))

Analog monitor 2 output voltage = (-1) × (Signal selection (Pn007=n.00□□) × Multiplier (Pn553) + Offset voltage [V] (Pn551))

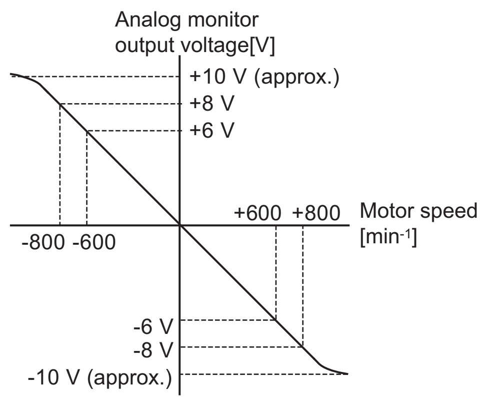
<Example>

Analog monitor output at n.□□00 (motor speed setting)

When multiplier is set to × 1:



When multiplier is set to × 10:



Note: Linear effective range: within ± 8 V
Output resolution: 16-bit

10.2.4 Related Parameters

Use the following parameters to change the monitor factor and the offset.

Pn550	Analog Monitor 1 Offset Voltage		Speed Position		Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	-10000 to 10000	0.1 V	0	Immediately	Setup

Pn551	Analog Monitor 2 Offset Voltage		Speed Position		Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	-10000 to 10000	0.1 V	0	Immediately	Setup

Pn552	Analog Monitor Magnification (× 1)		Speed Position		Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	-10000 to 10000	× 0.01	100	Immediately	Setup

Pn553	Analog Monitor Magnification (× 2)		Speed Position		Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	-10000 to 10000	× 0.01	100	Immediately	Setup

10.3 Anti-Resonance Control Adjustment Function

This section describes the anti-resonance control adjustment function.

Note: Anti-resonance control adjustment function can be executed from the SigmaWin for Σ-V-SD (MT)* or from a Digital Operator. This section provides details on anti-resonance control adjustment function and describes how to perform it with the SigmaWin for Σ-V-SD (MT).* Refer to *11.4.18 Anti-Resonance Control Adjustment Function (Fn204)* for the procedure to execute anti-resonance control adjustment with the Digital Operator.

* Anti-resonance control adjustment function with the SigmaWin for Σ-V-SD (MT) is currently under development.

10.3.1 Anti-Resonance Control Adjustment Function

The anti-resonance control adjustment function increases the effectiveness of the vibration suppression after adjusting servo gains. This function is effective in supporting anti-resonance control adjustment if the vibration frequencies are from 100 Hz to 1,000 Hz.

Use this function only if fine-tuning is required, or vibration detection is failed and readjustment is required.

Adjust servo gains to increase the responsiveness after performing this function.

IMPORTANT

- This function detects vibration between 100 and 1,000 Hz. Vibration will not be detected for frequencies outside of this range, and instead, "F----" will be displayed.
- Vibration can be reduced more effectively by increasing the anti-resonance damping gain (Pn163). The amplitude of vibration may become larger if the damping gain is excessively high. Increase the damping gain from about 0% to 200% in 10% increments while checking the effect of vibration reduction. If the effect of vibration reduction is still insufficient at a gain of 200%, cancel the setting, and lower the servo gain.

(1) Preparation

⚠ WARNING

- Before you execute anti-resonance adjustment function, make sure that the moment of inertia ratio (Pn103) is set correctly.
  If the setting of the moment of inertia is not correct, normal control may not be possible and vibration may occur.
- Make sure that a trial operation has been performed without any trouble.
  Failure to observe this warning may result in injury or damage to the product.
- Install a safety brake on the machine.
  Failure to observe this warning may result in injury or damage to the product.

Check the following settings before performing anti-resonance control adjustment function.
The message “NO-OP” indicating that the settings are not appropriate will be displayed, if the following condition is not met.

- The write prohibited setting (Fn010) must not be set to write-protect parameters.
- The main circuit power supply must be ON.
- All alarms must be cleared.
- The hard wire base block (HWBB) must be disabled.
- Torque limit is set correctly.
  For details, refer to *9.2.6 Limiting Torque*.

(2) Anti-Resonance Control Adjustment Function Operating Procedure

With this function, an operation reference is sent, and the function is executed while vibration is occurring.

Anti-resonance control adjustment function is performed from the SigmaWin for Σ-V-SD (MT).
The following methods can be used for the anti-resonance control adjustment function.

- With Undetermined Vibration Frequency
- With Determined Vibration Frequency

The operating procedure from the SigmaWin for Σ-V-SD (MT) is described here.

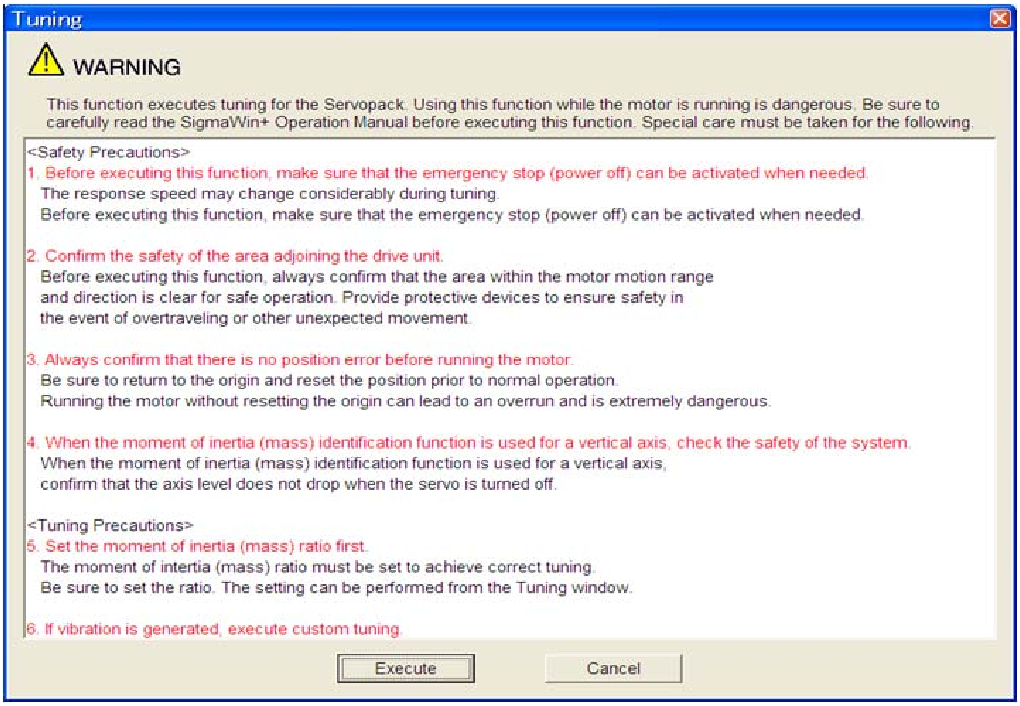
⚠ WARNING

- **When this function is executed, the related parameters will be set automatically. This may cause the response characteristics to vary greatly before and after execution of this function. To ensure safety, make sure that an emergency stop can be applied at any time.**
  Failure to observe this warning may result in injury or damage to the product.
- **Do not touch the rotating section of the motor while power is being supplied to the motor.**
  Failure to observe this warning may result in injury or damage to the product.
- **Be sure to carefully read the SigmaWin for Σ-V-SD (MT) Operation Manual before executing this function.**
  Special care must be taken for the following.
  - Before executing this function, make sure that the emergency stop (power off) can be activated when needed.
    This function will automatically set parameters when used. As a result, the response speeds may change considerably after execution. Before executing this function, make sure that the emergency stop (power off) can be activated when needed.
  - The moment of inertia (mass) must be correctly set to execute this function.
    If it is not correctly set, satisfactory anti-resonance control cannot be achieved.
  - This function is generally only used to adjust the servo gain, as you should avoid considerable change in the frequency.
    If the frequency is changed while the anti-resonance control adjustment function is being used, the current anti-resonance control effect will be lost. Care must be taken when automatic frequency detection is executed in Auto Detect mode.
  - If vibration cannot be suppressed by executing this function, cancel execution and reduce the servo gain by other methods such as custom tuning.
  - Use an adjustment method such as custom tuning to improve response characteristics after executing this function.
    When the servo gain is increased during an adjustment such as custom tuning, vibration may be generated again. In this case, execute the anti-resonance control adjustment function again for fine adjustment.

The anti-resonance control adjustment function supports the adjustment of anti-resonance control effective for vibration frequencies from 100 to 1,000 Hz when servo gain is increased. Vibration can be suppressed by setting vibration frequency by auto detection or by manual setting to adjust damping gain. Input a reference and execute this function when there is vibration.

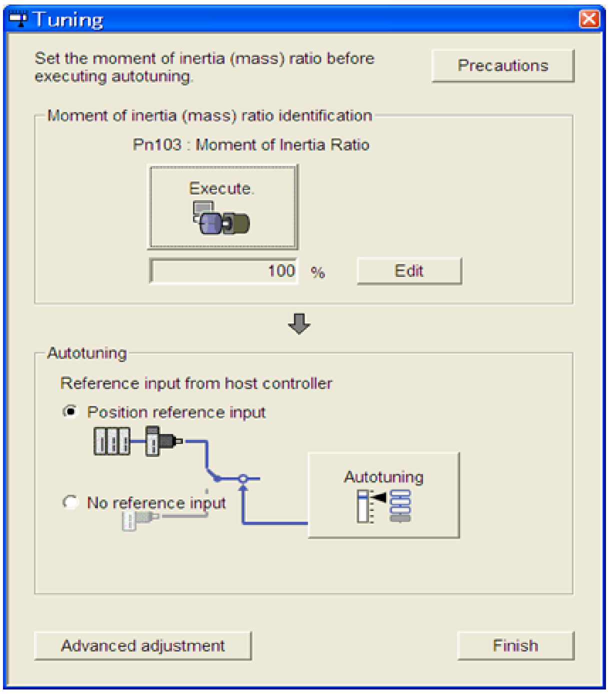
■ With Undetermined Vibration Frequency

1. In the SigmaWin for Σ-V-SD (MT) component main window, click **Tuning** and then click **Tuning**.

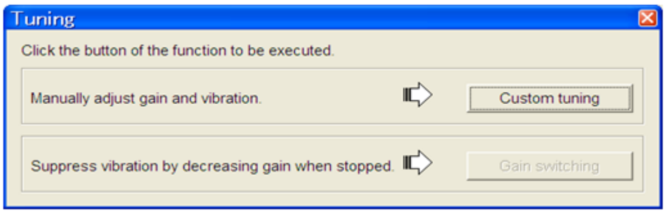


Click **Cancel** to return to the SigmaWin for Σ-V-SD (MT) component main window without executing tuning.

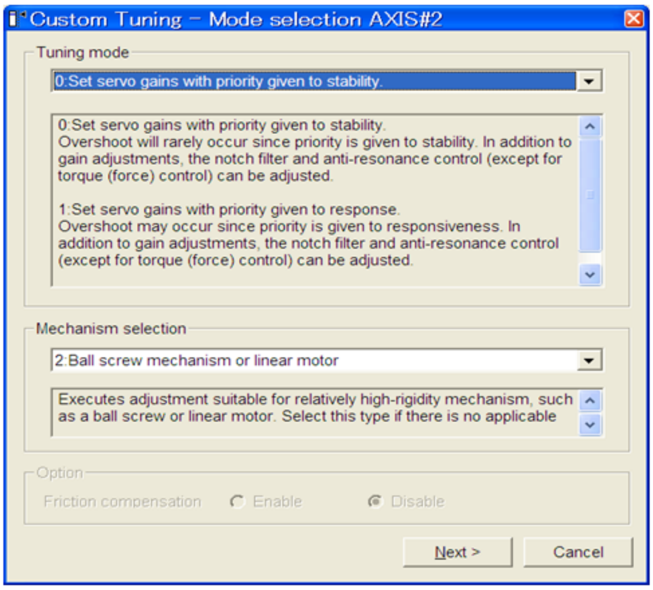
2. Click **Execute**. The following window appears.



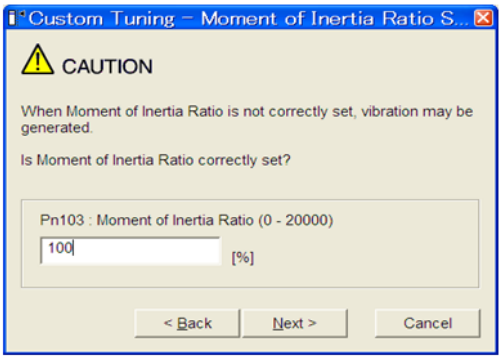
3. Click **Advanced adjustment**. The following box appears.



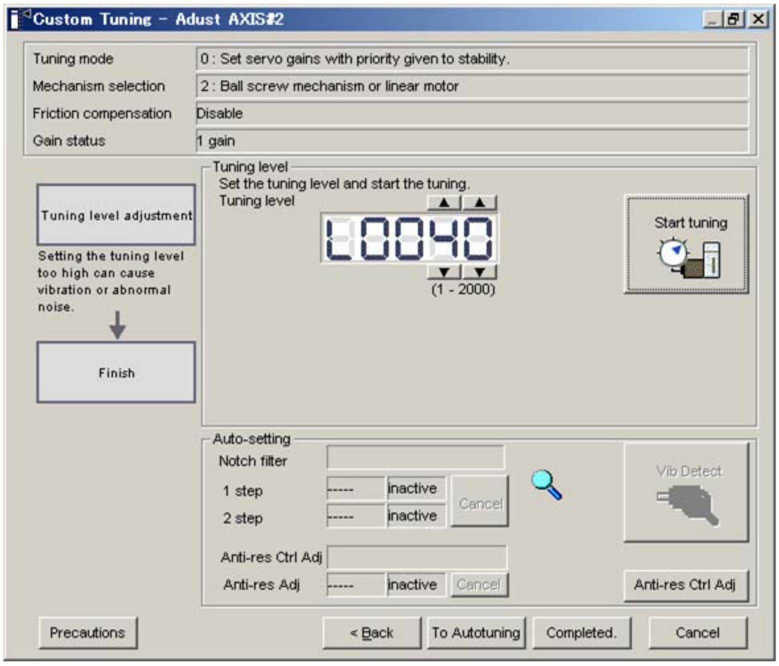
4. Click **Custom tuning**. The following box appears.



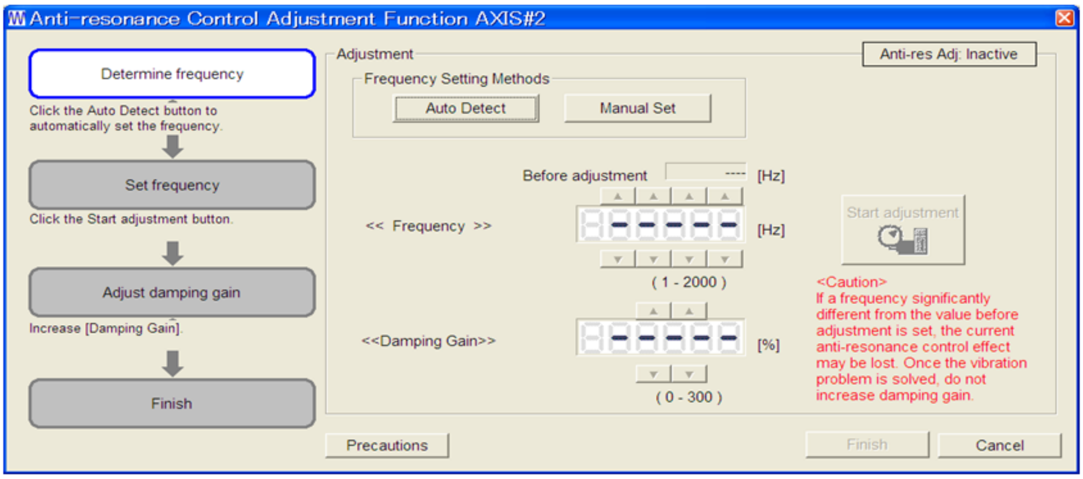
5. Select the tuning mode from the **Tuning mode** box and the mechanism from the **Mechanism selection** box, and then click **Next**. The following box appears.



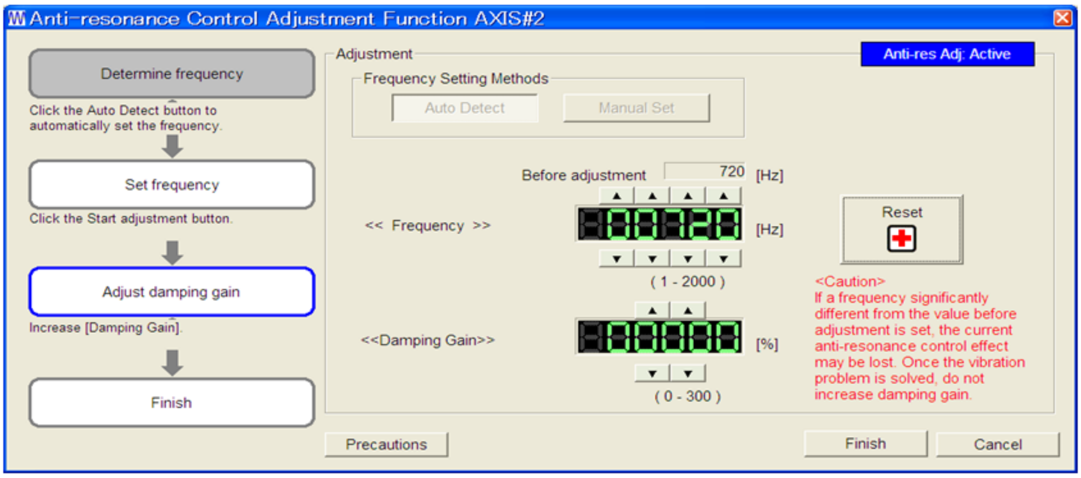
6. Enter the correct moment of inertia ratio and then click **Next**. The following window appears.



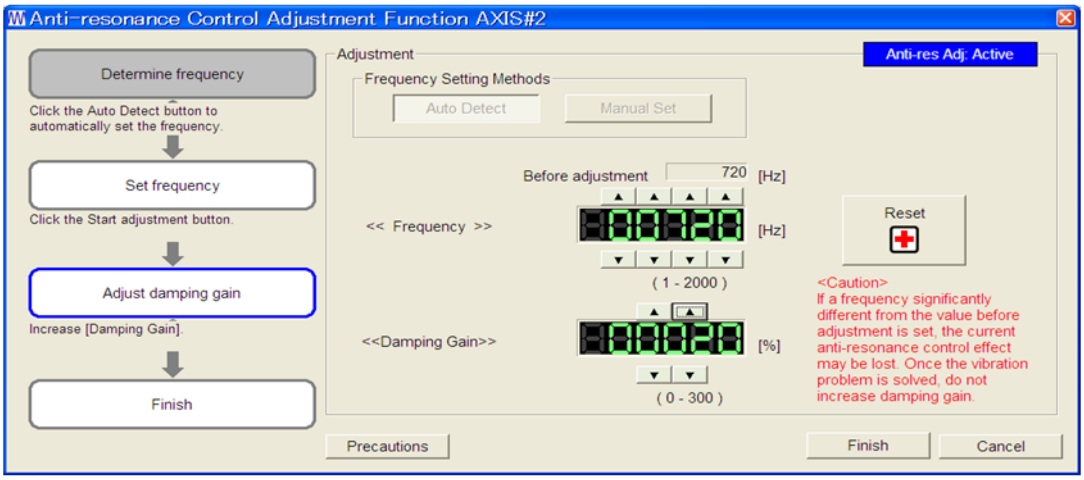
7. Click **Anti-res Ctrl Adj**. The following window appears.



8. Click **Auto Detect** to set the frequency and click **Start adjustment**. The following window appears.



9. Adjust the damping gain by clicking the setting arrows.

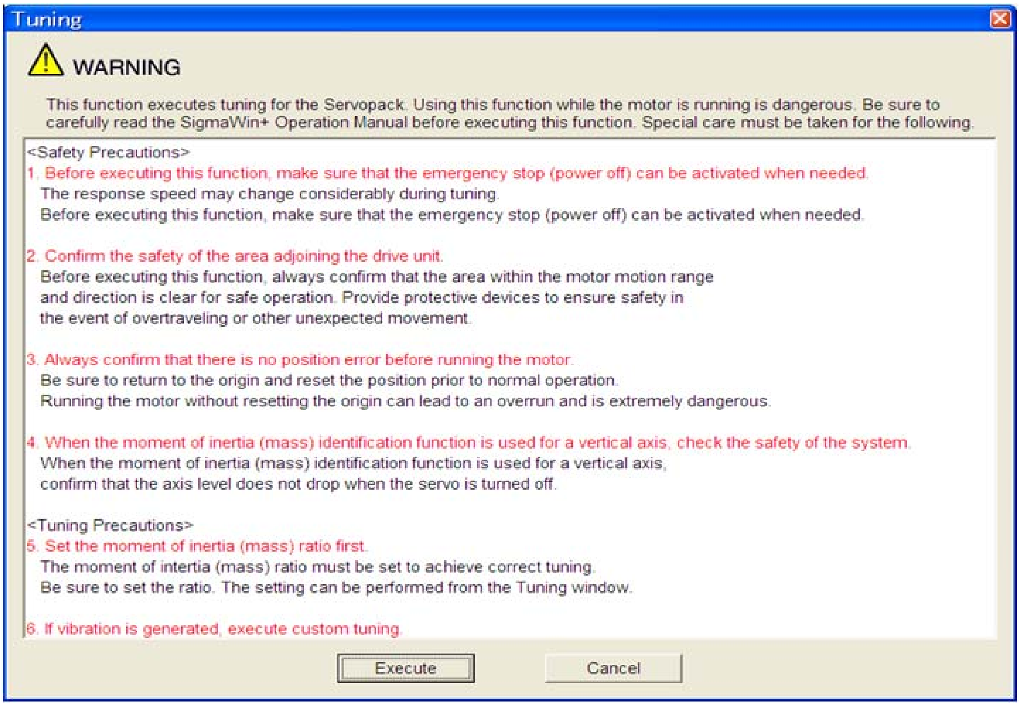


Click **Reset** to reset the settings to their original values during adjustment.

10. When tuning is completed, click the **Finish** Button. The settings that were changed will be saved in the SERVOPACK, and the main Tuning Dialog Box will appear again.

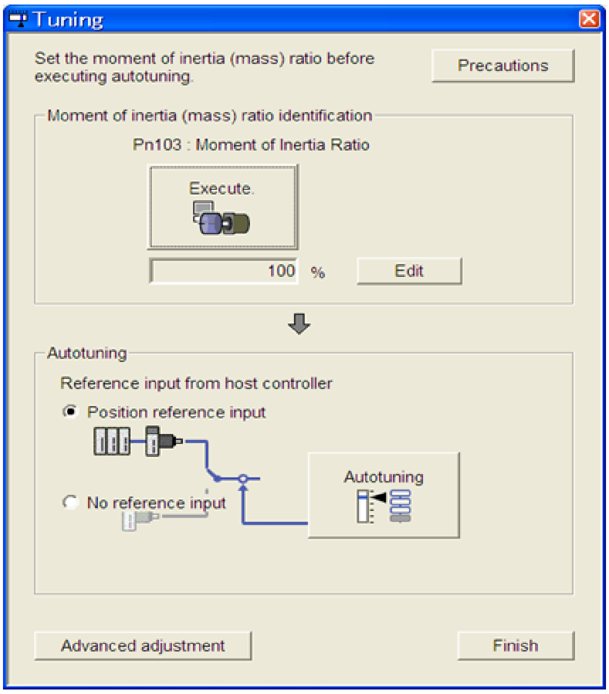
■ With Determined Vibration Frequency

1. In the SigmaWin for Σ-V-SD (MT) component main window, click **Tuning** and then click **Tuning**.

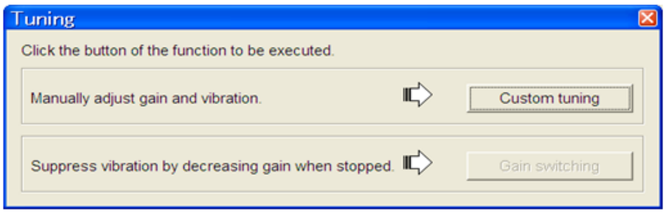


Click **Cancel** to return to the SigmaWin for Σ-V-SD (MT) component main window without executing tuning.

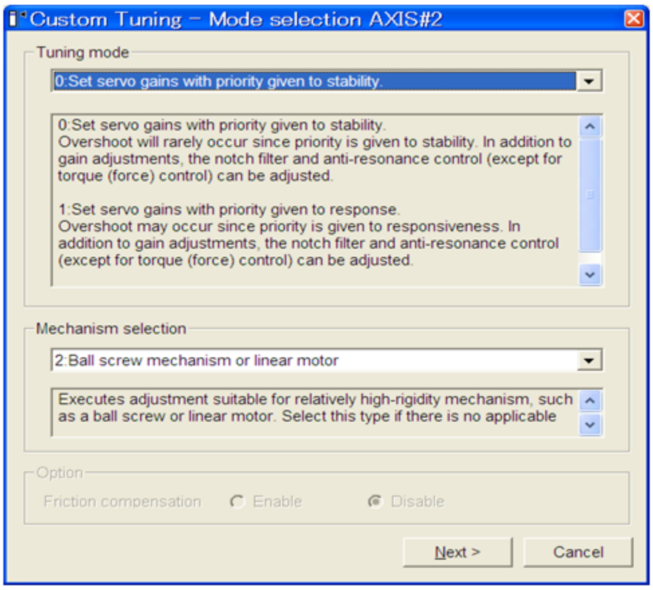
2. Click **Execute**. The following window appears.



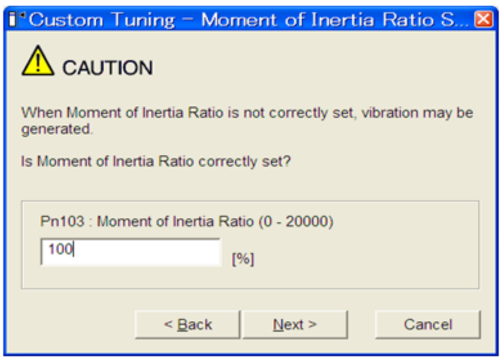
3. Click **Advanced adjustment**. The following box appears.



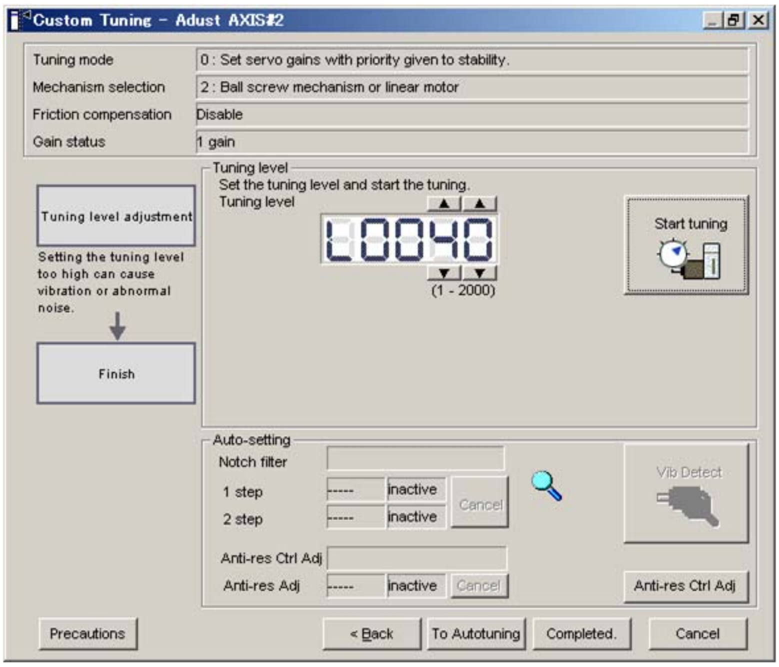
4. Click **Custom tuning**. The following box appears.



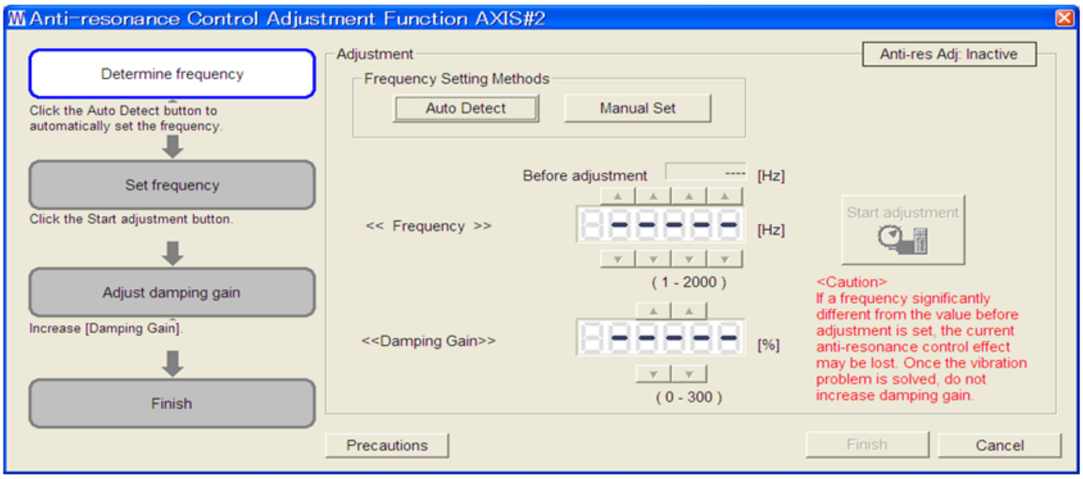
5. Select the tuning mode from the **Tuning mode** box and the mechanism from the **Mechanism selection** box, and then click **Next**. The following box appears.



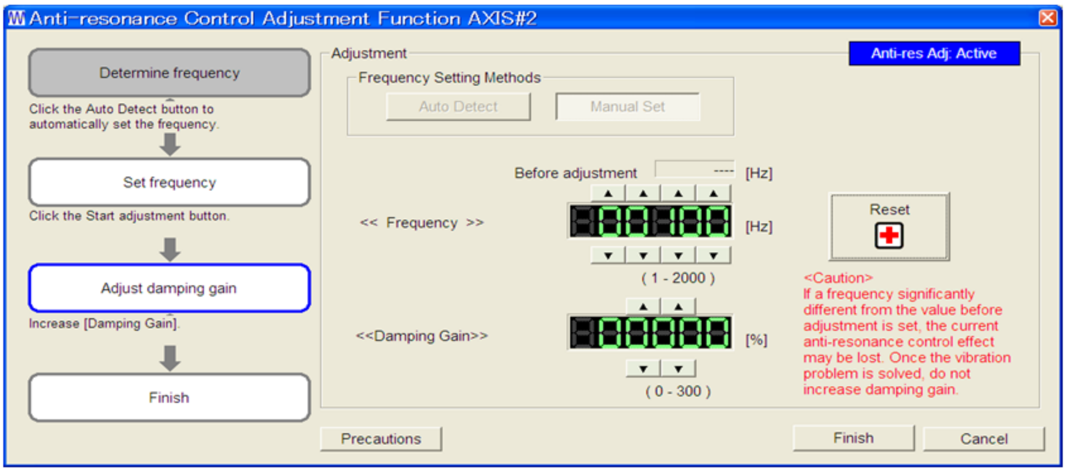
6. Enter the correct moment of inertia ratio and then click **Next**. The following window appears.



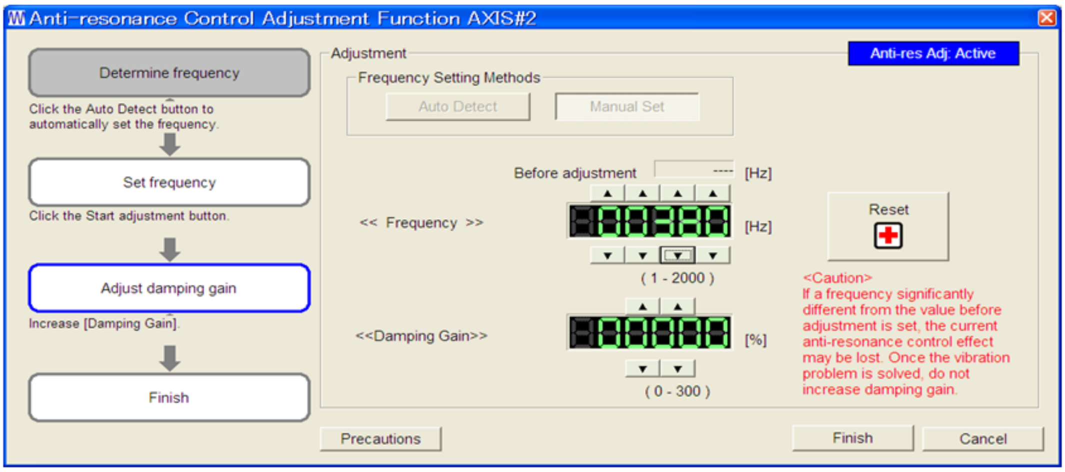
7. Click **Anti-res Ctrl Adj**. The following window appears.



8. Click **Manual Set** to set the frequency and click **Start adjustment**. The following window appears.

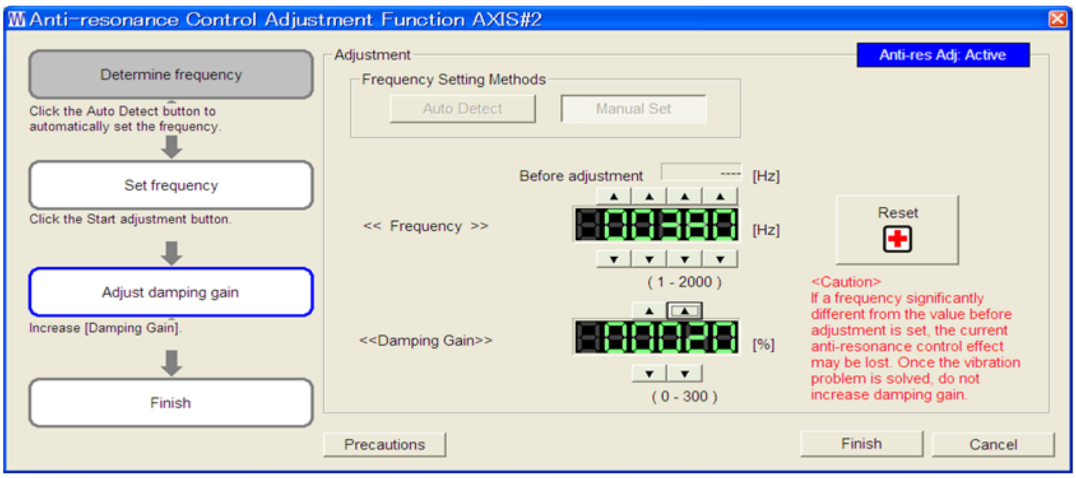


9. Adjust the frequency by clicking the setting arrows.



Click **Reset** to reset the settings to their original values during adjustment.

10. Adjust the damping gain by clicking the setting arrows.



Click **Reset** to reset the settings to their original values during adjustment.

11. When tuning is completed, click the **Finish** Button. The settings that were changed will be saved in the SERVOPACK, and the main dialog box in step 6 will appear again.

10.3.2 Related Parameters

The following table lists parameters related to this function and their possibility of being changed while executing this function or of being changed automatically after executing this function.

• Parameters related to this function
These are parameters that are used or referenced when executing this function.

• Allowed changes during execution of this function
Yes : Parameters can be changed using SigmaWin for Σ-V-SD (MT) while this function is being executed.
No : Parameters cannot be changed using SigmaWin for Σ-V-SD (MT) while this function is being executed.

• Automatic changes after execution of this function
Yes : Parameter set values are automatically set or adjusted after execution of this function.
No : Parameter set values are not automatically set or adjusted after execution of this function.

Parameter	Name	Mid-execution Changes	Automatic Changes
Pn160	Anti-Resonance Control Related Switch	Yes	Yes
Pn161	Anti-Resonance Frequency	No	Yes
Pn162	Anti-Resonance Gain Compensation	Yes	No
Pn163	Anti-Resonance Damping Gain	No	Yes
Pn164	Anti-Resonance Filter Time Constant 1 Compensation	Yes	No
Pn165	Anti-Resonance Filter Time Constant 2 Compensation	Yes	No

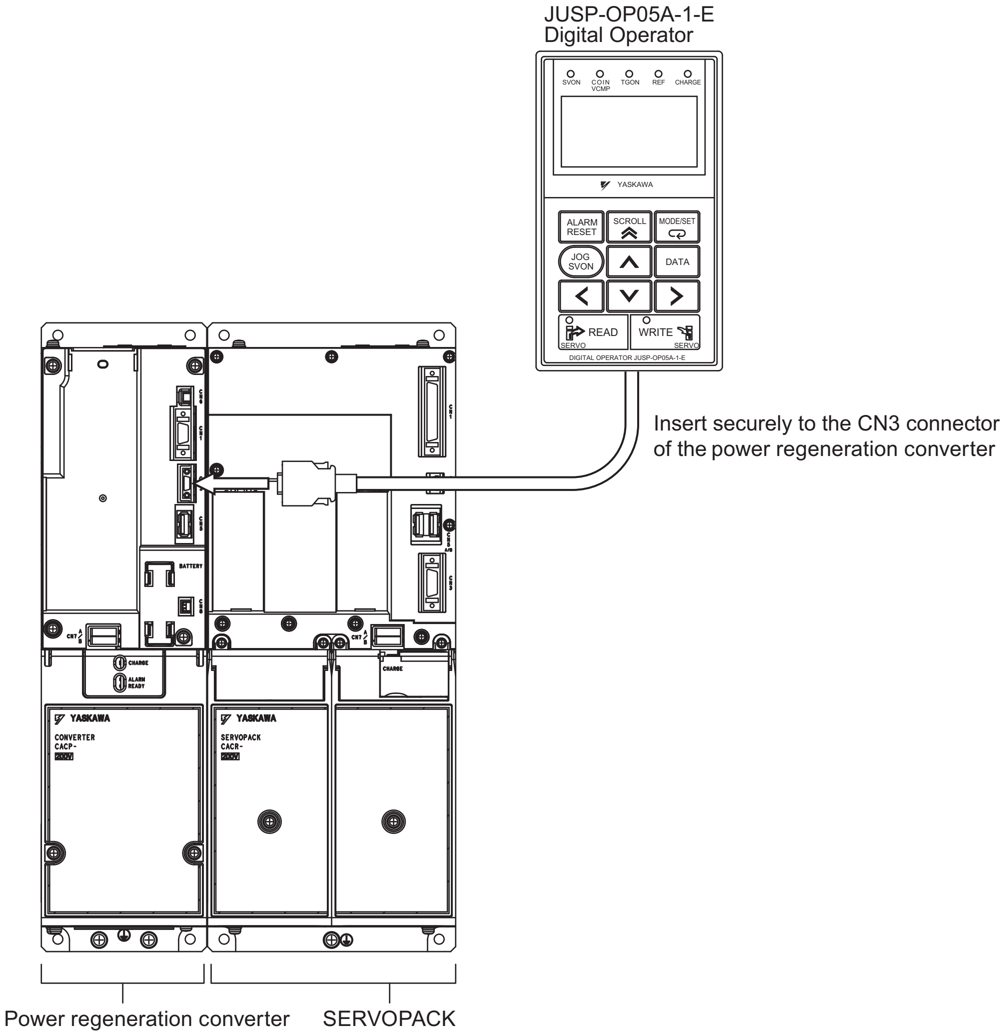
11

Digital Operator

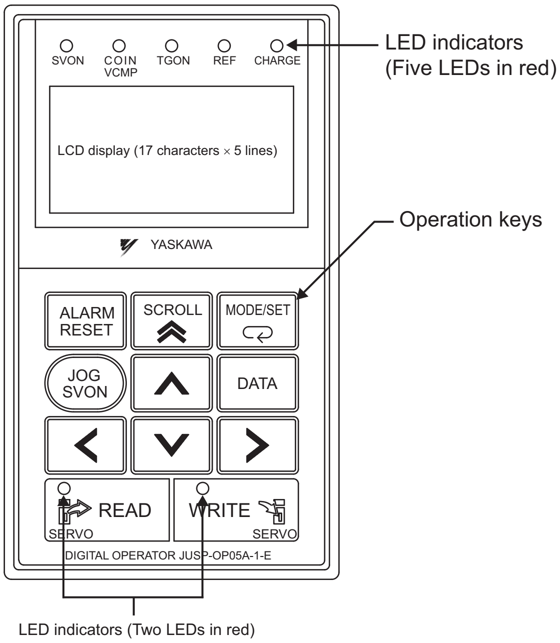
11.1 Overview

The JUSP-OP05A-1-E digital operator is used to set and display the SERVOPACK parameters.

Note: Connect the digital operator to the CN3 connector of the power regeneration converter.



11.1.1 Part Names and Functions



(1) LED Display

The digital operator has an LCD display with a maximum of 17 characters for each of the 5 lines. It also has 7 LED indicators to show the status of the servo ON, positioning completion, and others. Details of the LED indicators are as follows.

Name	Function
SVON	Lit when the servo is ON. Unlit when the servo is OFF.
COIN VCMP	Lit when positioning is completed. Lit when the speed is coincident.
TGON	Lit while the motor is running.
REF	Lit when the speed reference input is greater than the setting value of Pn502.
CHARGE	Lit when the main circuit power supply is ON.
READ	This LED cannot be used for a Σ-V-SD series SERVOPACK for speed reference with analog voltage.
WRITE	This LED cannot be used for a Σ-V-SD series SERVOPACK for speed reference with analog voltage.

(2) Operation Keys

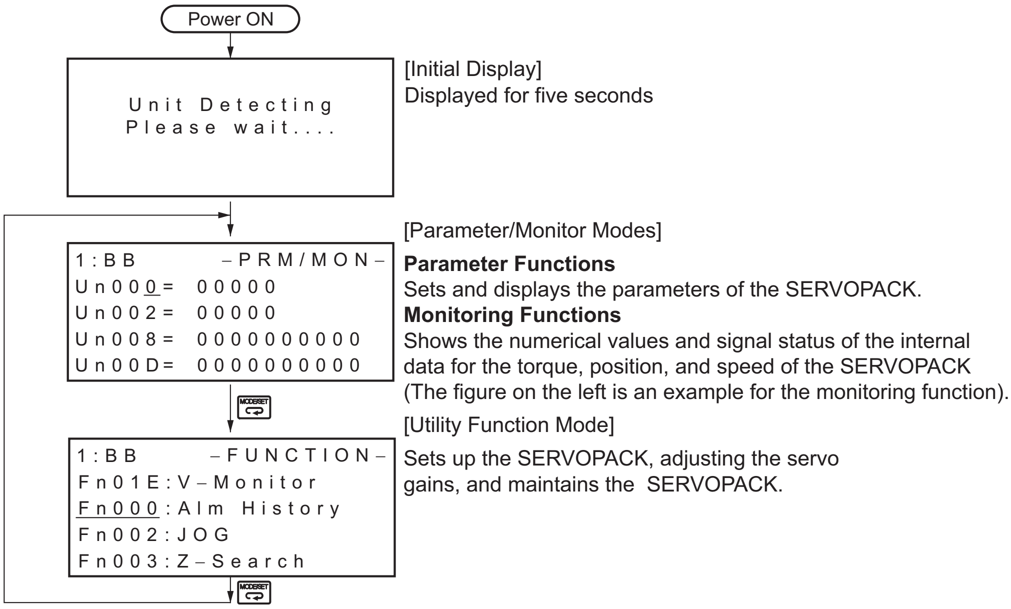
Operation Key	Main Function
ALARM RESET	Resets the alarm. (The alarm cannot be reset unless the cause of the alarm is removed.)
MODE/SET	Switches the display mode of digital operator.
DATA	• Switches the cursor position between the parameter number and the setting when setting a parameter. • Saves the parameter setting in the SERVOPACK. • Opens the selected utility function display in the utility function mode.
SCROLL	• Moves the cursor up or down in parameter/monitor mode. • Moves the cursor four lines up in the utility function mode.
JOG SVON	Switches between the servo ON and servo OFF signals while executing a utility function. Example: JOG operation
< >	Moves the cursor to left or right in parameter/monitor mode.
∧ ∨	• Switches between parameters (Pn) and monitors (Un). • Increases or decreases the parameter number, setting data, monitor number, and utility function number. • Rotates the motor in a forward or reverse direction at a JOG operation.
SERVO READ	This operation key cannot be used for a Σ-V-SD series SERVOPACK for speed reference with analog voltage.
WRITE SERVO	Saves the status of the current display. The initial display will be recorded when the power supply is turned ON again.

Note: A cursor is a pointer that is flashing on the screen.

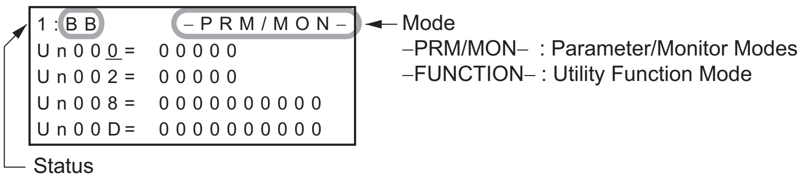
11.1.2 Switching Mode

Connect the digital operator to the power regeneration converter, and turn ON the power to the power regeneration converter. The initial display appears, and then the parameter/monitor mode display appears.

Press the MODE/SET Key to change the mode.



An abbreviation of the name of the active mode is displayed in the upper right, and the SERVOPACK status is displayed in the upper left.



Status
BB: Base blocked
RUN: Motor is ON
A.☐☐☐: An alarm occurs (☐☐☐: Alarm code)
NO-OP: Setting disabled or setting error
HBB: During hard wire base block

Note: Alarm Display for Communication Errors

If a communications error occurs between the Σ-V-SD Driver and digital operator, the following communications error codes are displayed. These errors may be caused by incorrect connector connection. Check the connection and correct it. Then, turn the power OFF and ON. If the communications error message still appears, replace the digital operator or the Σ-V-SD Driver.

CPF00 COM–ERR(OP&SV)	CPF01 COM–ERR(OP&SV)

Digital Operator

11

11.2 Parameter Mode

This section describes how to display and set parameters in the parameter/monitor mode.
There are two types of notation used for parameters, one for parameter that requires a value setting (parameter for numeric settings) and one for parameter that requires the selection of a function (parameter for selecting functions).

Note 1. For details on the parameters, refer to *14.2 List of Parameters*.
2. To indicate a specific digit of a parameter that must be set or that has a specific meaning, the digit number is added to the parameter number. For example, Pn006.0 indicates the 1st digit of parameter Pn006.

11.2.1 Parameter Setting

(1) Operation Example 1: Setting the Parameters for Selecting Functions

There are some parameters which require the setting of each digit such as Pn01E (Application Function Select Switch 1E).
This example shows the operation procedure to set “1” (Mechanical winding selection) for Pn01E.1 (Winding Selection) of Pn01E (Application Function Select Switch 1E).

Step	Display after Operation	Keys	Operation
1	1:BB –PRM/MON– Un000= 00000 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	MODE/SET	Press the MODE/SET Key to select the parameter/monitor mode.
2	1:BB –PRM/MON– Un000= 00000 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	< >	Press the < or > Key to move the cursor to “Un.”
3	1:BB –PRM/MON– Pn000=n.0000 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	∧ ∨	Press the ∧ or ∨ Key to switch “Un” to “Pn.”
4	1:BB –PRM/MON– Pn000=n.0000 Un002= 00000 Un008= 00000pulse Un00D= 0000000000	>	Press the > Key once to move the cursor to the digit on the right side of “Pn.”
5	1:BB –PRM/MON– Pn01E=00500 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	< > ∧ ∨	Use the following keys to display Pn01E. To move to another digit: < and > Keys To change the numeric value: ∧ and ∨ Keys
6	1:BB –PRM/MON– Pn01E=n.0003 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	DATA	Press the DATA Key to move the cursor to the setting side (to the position of the first digit of Pn01E.1).
7	1:BB –PRM/MON– Pn01E=n.0003 Un002= 0000 Un008= 0000000000 Un00D= 0000000000	< >	Click the < or > Key to move the cursor to the first digit.

(cont'd)

Step	Display after Operation	Keys	Operation
8	1:BB –PRM/MON– Pn01E=n.0013 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	Λ	Press the Λ Key once to set "1" for the first digit of Pn01E.1.
9	1:A.941 –PRM/MON– Pn01E=n.0013 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	DATA	Press the DATA Key. The new setting of Pn01E is written to the SERVOPACK. The cursor moves to the parameter number side and the warning A.941 is displayed.
10	To enable the change in the setting, turn the power OFF and ON again.*		

* If you change the setting of a parameter that requires the power supply to be restarted to apply the change, the warning A.941 (Parameter Needing Power Restart After Change) is displayed. Restart the power supply to enable the new setting. The warning will no longer be displayed.

(2) Operation Example 2: Setting the Parameters for Numeric Settings

This example shows the operation procedure to set “1000” (min^{-1}) for Pn304 (JOG speed).

Step	Display after Operation	Keys	Operation
1	1:BB –PRM/MON– Un000= 00000 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	MODE/SET	Press the MODE/SET Key to select the parameter/monitor mode.
2	1:BB –PRM/MON– Un000= 00000 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	< >	Press the < or > Key to move the cursor to “Un.”
3	1:BB –PRM/MON– Pn000=n.0000 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	∧ ∨	Press the ∧ or ∨ Key to switch “Un” to “Pn.”
4	1:BB –PRM/MON– Pn000=n.0000 Un002= 00000 Un008= 00000pulse Un00D= 0000000000	>	Press the > Key once to move the cursor to the right side of “Pn.”
5	1:BB –PRM/MON– Pn304=00500 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	< > ∧ ∨	Press the arrow keys to display “Pn304.” To move the cursor to different columns: <, > Key To change the settings: ∧ or ∨ Key
6	1:BB –PRM/MON– Pn304=00500 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	DATA	Press the DATA Key. The cursor moves to the setting side (to the position of the first digit of Pn304).
7	1:BB –PRM/MON– Pn304=00500 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	<	Press the < Key twice to move the cursor to the third digit of Pn304.
8	1:BB –PRM/MON– Pn304=01000 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	∧	Press the ∧ Key five times to change the setting to “1000.”
9	1:BB –PRM/MON– Pn304=01000 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	DATA	Press the DATA Key to write the settings. The cursor moves to the parameter number side.

Note: If the DATA Key has not been pressed but the MODE/SET Key has been pressed to select another mode such as the utility function mode, any changes that have been made to the parameter will be saved in the SERVOPACK.

11.3 Monitor Mode (Un□□□)

This section describes available monitor modes and operation procedures in the parameter/monitor mode.

11.3.1 Monitor Items

Parameter No	Content of Display	Unit
Un000	Motor rotating speed	min^{-1}
Un001	Speed reference	min^{-1}
Un002	Internal torque reference (in percentage to the maximum torque (120% of the rated torque))	%
Un003	Electric angle 1 (32-bit decimal notation)	Encoder pulse
Un005	Input signal monitor *1	–
Un006	Output signal monitor*2	–
Un007	Input reference pulse speed (Valid only for the orientation operation.)	min^{-1}
Un008	Position error amount (Valid only for the orientation operation.)	Pulse
Un009	Accumulated load ratio (in percentage to the maximum torque (120% of the rated torque): effective torque in cycle of 10 seconds)	%
Un00C	Input reference pulse counter	Pulse
Un00D	Feedback pulse counter	Encoder pulse
Un012	Total run time	100 ms
Un013	Feedback pulse counter	Pulse
Un014	Effective gain monitor (gain settings 1 = 1, gain settings 2 = 2)	–
Un030	Motor temperature	0.1°C
Un032	Load meter	0.1%
Un033	Input signal monitor 2*3	–
Un134	Winding selection internal signal monitor	–

(1) Input Signal Monitor (Un005) ON/OFF Status

U n 0 0 5 = ▬▬▬▬▬▬▬▬

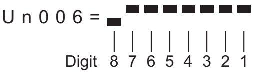
Digit 8 7 6 5 4 3 2 1

The LED of digital operator shows signal status as follows.

Digit number	8	7	6	5	4	3	2	1
Function	CA1,CA2*	HWBB	/ORT	/CHW	/RST	/SV	/REV	/FWD
Upper portion	Low-speed winding	HWBB	OFF	High-speed winding	OFF	OFF	OFF	OFF
Lower portion	High-speed winding	Normal	ON	Low-speed winding	ON	ON	ON	ON

* CA1, CA2: Answer from winding select

(2) Output Signal Monitor (Un006) ON/OFF Status

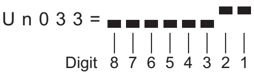


The LED of digital operator shows signal status as follows. The undefined digits are displayed in the lower portion.

Digit number	8	7	6	5	4	3	2	1
Function		FLT	/CHWE	/ORE	/SDET	CC*1	/AGR	/ZSPD
Upper portion		Alarm	Low-speed winding	Completed	ON*2	Low-speed winding	Speed agreed	Detected
Lower portion		Normal	High-speed winding	Not completed	OFF*3	High-speed winding	Speed not agreed	Not detected

∗1. CC: Output to winding selection device
∗2. ON: Indicates that the motor is rotating below the set value for the motor speed.
∗3. OFF: Indicates that the motor is rotating at or above the set value for the motor speed.

(3) Input Signal Monitor (Un033) ON/OFF Status



The LED of digital operator shows signal status as follows. The undefined digits are displayed in the lower portion.

Digit number	8	7	6	5	4	3	2	1
Function							/ESP	/LGR
Upper portion							Emergency stop release	ON
Lower portion							Emergency stop	OFF

11.3.2 Monitor Mode Display

• Operation Example

Select Un000 (Motor speed) on the first line, Un002 (Internal torque reference) on the second line, Un005 (Input signal monitor) on the third line, and Un006 (Output signal monitor) on the fourth line, and then save the display.
The following example shows when changing the displayed factory setting items.

```
1:BB        –PRM/MON–
Un000=  00000          ← Motor speed
Un002=  00000          ← Internal torque reference
Un005=■■■■■■■■         ← Input signal monitor
Un006=▄■■■■■■■         ← Output signal monitor
```

Step	Display after Operation	Keys	Operation
1	1:BB –PRM/MON– Un00<u>0</u>= 00000 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	MODE/SET	Press the MODE/SET Key to select the parameter/ monitor mode.
2	1:BB –PRM/MON– Un000= 00000 Un002= 00000 Un008= 0000000000 Un00<u>D</u>= 0000000000	SCROLL	Press the SCROLL Key once to move the cursor to the fourth line.
3	1:BB –PRM/MON– Un000= 00000 Un002= 00000 Un008= 0000000000 Un00<u>6</u>=▄■■■■■■■	∧ or ∨	Press the ∧ or ∨ Key to display Un006 (Output signal monitor).
4	1:BB –PRM/MON– Un000= 00000 Un002= 00000 Un00<u>8</u>= 0000000000 Un006=▄■■■■■■■	SCROLL	Press the SCROLL Key once to move the cursor to the line above.
5	1:BB –PRM/MON– Un000= 00000 Un002= 00000 Un00<u>5</u>=■■■■■■■■ Un006=▄■■■■■■■	∧ or ∨	Press the ∧ or ∨ Key to display Un005 (Input signal monitor). The desired items are displayed.
6	1:BB –PRM/MON– Un000= 00000 Un002= 00000 Un00<u>5</u>=■■■■■■■■ Un006=▄■■■■■■■	WRITE SERVO	Press the WRITE SERVO Key. The LED on the key blinks and the display with selected items is saved. Note: Do not turn OFF the SERVOPACK's control power while saving.

11.4 Utility Functions (Fn□□□)

Utility functions are used to execute the functions related to spindle motor operation and adjustment. This section explains the settings and the operations of the utility functions.

11.4.1 Utility Functions List

The following table shows a list of utility functions.

Note: The utility function marked with a "✓" in Servo ON column is disabled when the /S-ON (Servo ON) input signal is ON. "NO-OP" is displayed when the Utility Function Mode main menu display is switched to each utility function display.

Function No.	Name	Function	Servo ON Status
Fn000	Alarm history display	Displays the history up to the last 10 alarms.	–
Fn002	JOG operation	Runs the motor using the operation keys on the digital operator.	✓
Fn003	Origin search	Runs the motor using the operation keys on the digital operator and stop the motor at the detected phase-C position.	✓
Fn004	Program JOG operation	Runs the motor in the pre-programmed motion pattern.	✓
Fn005	Initializing parameter settings	Initializes the settings of parameters to the factory setting.	✓
Fn006	Clearing alarm history	Clears the alarm history.	–
Fn008*	Initializing absolute encoder and resetting encoder alarm	–	–
Fn009	Automatic tuning of analog speed reference offset	Adjusts automatically the speed analog reference offset.	✓
Fn00A	Manual servo turning of speed reference offset	Adjusts manually the speed reference offset.	–
Fn00B*	Manual servo turning of torque reference offset	–	–
Fn00C	Offset adjustment of analog monitor output	Adjusts manually the analog monitor output offset.	–
Fn00D	Gain adjustment of analog monitor output	Adjusts manually the analog monitor output gain.	–
Fn00E	Automatic offset-signal adjustment of the motor current detection signal	Adjusts automatically the motor current detection offset.	✓
Fn00F	Manual offset-signal adjustment of the motor current detection signal	Adjusts manually the motor current detection offset.	–
Fn010	Write prohibited setting	Prohibits or permits overwriting the parameter.	–
Fn011*	Motor model display	–	–
Fn012	Software version display	Displays the software version number of the SERVOPACK.	–
Fn013*	Multiturn limit value setting change when a multiturn limit disagreement alarm (A.CC0) occurs	–	–
Fn014*	Resetting configuration error in option modules	–	–
Fn01B*	Vibration detection level initialization	–	–

(cont’d)

Function No.	Name	Function	Servo ON Status
Fn01E	Display of SERVOPACK and motor ID	Displays the SERVOPACK ID, motor ID, and encoder ID that are stored in the SERVOPACK.	–
Fn01F*	Display of motor ID in feedback option module	–	–
Fn020*	Origin setting	–	–
Fn030*	Software reset	–	–
Fn080*	Polarity detection	–	–
Fn200*	Tuning-less levels setting	–	–
Fn201*	Advanced autotuning	–	–
Fn202*	Advanced autotuning by reference	–	–
Fn204	Anti-resonance control adjustment function	Suppresses continuous vibration (trembling) of approximately 100 Hz to 1,000 Hz.	–
Fn205*	Vibration suppression function	–	–
Fn206*	EasyFFT	–	–
Fn207*	Online vibration monitor	–	–

* These functions are disabled in the Σ-V-SD SERVOPACK with analog voltage/speed references.

11.4.2 Operations

This section describes the operation method on the execution display selected from the main menu of the utility function.

Press the MODE/SET Key in the parameter/monitor mode to display the main menu of utility function mode.

Press the ∨ or ∧ Key to select a utility function to be executed, and then press the DATA Key to display the execution display of selected utility function.

Press the SCROLL Key to scroll up or down four lines at a time.

```
1:BB       -FUNCTION-
Fn207:V-Monitor
Fn000:Alm History      ← The selected utility function blinks.
Fn002:JOG
Fn003:Z-Search
```

Utility Function Mode Main Menu Display

If the utility function that cannot be executed is selected and the DATA or JOG SVON Key is pressed, “NO-OP” is displayed for one second.

```
                                      Blink
1:BB       -FUNCTION-           NO-OP     -FUNCTION-
Fn000:Alm History       DATA    Fn000:Alm History
Fn002:JOG               ---->   Fn002:JOG
Fn003:Z-Search          <----   Fn003:Z-Search
Fn004:Program JOG       After   Fn004:Program JOG
                        about
                        one sec.
```

<Example>

This status will occur if you attempt to perform a jog operation (Fn002) when the write prohibited setting (Fn010) parameter is set to prohibit writing.

Note: The following terms are used with the given meanings unless otherwise specified.
Servo OFF: Both the /FWD and /REV signals are OFF.

11.4.3 Alarm History Display (Fn000)

This function displays the last ten alarms that have occurred in the SERVOPACK.
The latest ten alarm numbers and time stamps* can be checked.

* Time Stamps
A function that measures the ON times of the control power supply and main circuit power supply in 100-ms units and displays the total operating time when an alarm occurs. The time stamp operates around the clock for approximately 13 years.

<Example of Time Stamps>
If 36000 is displayed,
3600000 [ms] = 3600 [s] = 60 [min] = 1 [h]
Therefore, the total number of operating hours is 1 hour.

(1) Preparation

There are no tasks that must be performed before displaying the alarm history.

(2) Operating Procedure

Use the following procedure.

Step	Display after Operation	Keys	Operation
1	1:BB —FUNCTION— Fn207:V—Monitor Fn000:Alm History Fn002:JOG Fn003:Z-Search	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list and select Fn000.
2	A.D00 —ALARM— 0:D00 00001207196 1:720 00000032651 2:511 00000009043 3:———	DATA	Press the DATA Key. The display changes to the Fn000 execution display.
3	A.D00 –ALARM– 1:720 00000032651 2:511 00000009043 3:––– 4:––– Time stamp Alarm no. Alarm history no. 0: Latest 9: Oldest	∧ ∨	Press the ∧ or ∨ Key to scroll through the alarm history. The alarm history can be viewed.
4	1:BB —FUNCTION— Fn207:V—Monitor Fn000:Alm History Fn002:JOG Fn003:Z-Search	MODE/SET	Press the MODE/SET Key. The display returns to the main menu of the utility function mode.

Note 1. If the same alarm occurs after more than one hour, the alarm will be saved.
If it occurs in less than one hour, it will not be saved.
2. The display "□.---" means no alarm occurs.
3. Delete the alarm history using the parameter Fn006. The alarm history is not cleared on alarm reset or when the SERVOPACK main circuit power is turned OFF.
4. CPF00 and CPF01 alarms are related to the Digital Operator. They are not recorded in the alarm history.
5. Warnings are not recorded in the alarm history.

11.4.4 JOG Operation (Fn002)

JOG operation is used to check the operation of the spindle motor under speed control without connecting the SERVOPACK to the host controller.

(1) Preparation

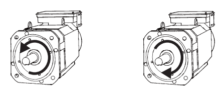
The following conditions must be met to perform a jog operation.

- The write prohibited setting (Fn010) must not be set to write-protect parameters.
- The main circuit power supply must be ON.
- All alarms must be cleared.
- The hardwire baseblock (HWBB) must be disabled.
- The servo must be OFF.
- The JOG speed must be set considering the operating range of the machine.
  Set the jog speed in Pn304.

Pn304	Jog Speed		Speed Position Torque		Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	0 to 10000	1 min^{-1}	500	Immediately	Setup

(2) Operating Procedure

Use the following procedure.

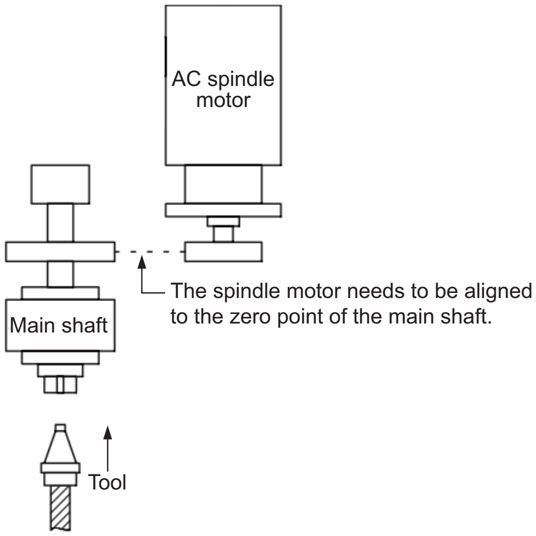
Step	Display after Operation	Keys	Operation
1	1:BB −FUNCTION− Fn000:Alm History Fn002:JOG Fn003:Z−Search Fn004:Program JOG	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list and select Fn002.
2	1:BB −JOG− Pn304=00500 Un000= 00000 Un002= 00000 Un00D= 0000000000	DATA	Press the DATA Key. The display changes to the Fn002 execution display.
3	1:BB −JOG− Pn304=00500 Un000= 00000 Un002= 00000 Un00D= 0000000000	DATA	Press the DATA Key. The cursor moves to the setting side (the right side) of Pn304 (JOG speed).
4	1:BB −JOG− Pn304=01000 Un000= 00000 Un002= 00000 Un00D= 0000000000	< > ∧ ∨	Press the < or > Key and the ∧ or ∨ Key to set the JOG speed to 1000 min^{-1}.
5	1:BB −JOG− Pn304=01000 Un000= 00000 Un002= 00000 Un00D= 0000000000	DATA	Press the DATA Key. The setting value is entered, and the cursor moves to the parameter number side (the left side).
6	1:RUN −JOG− Pn304=01000 Un000= 00000 Un002= 00000 Un00D= 0000000000	JOG SVON	Press the JOG SVON Key. The status display changes from “BB” to “RUN”, and the motor power turns ON.
7	1:RUN −JOG− Pn304=01000 Un000= 00000 Un002= 00000 Un00D= 0000000000	∧ ∨	The spindle motor will rotate at the present speed set in Pn304 while the ∧ Key (for forward rotation) or ∨ Key (for reverse rotation) is pressed. 
8	1:BB −JOG− Pn304=01000 Un000= 00000 Un002= 00000 Un00D= 0000000000	JOG SVON	After having confirmed the correct motion of the spindle motor, press the JOG SVON Key. The status display changes from “RUN” to “BB”, and the motor power turns OFF.
9	1:BB −FUNCTION− Fn000:Alm History Fn002:JOG Fn003:Z−Search Fn004:Program JOG	MODE/SET	Press the MODE/SET Key. The display returns to the main menu of the utility function mode.
10	Turn the power supply OFF and ON again after executing JOG operation.		

11.4.5 Origin Search (Fn003)

The origin search is designed to position the zero pulse position of the incremental encoder (phase C) and to clamp the motor at that position.

Note: Perform origin searches without connecting the coupling.

This function is used when the spindle motor needs to be aligned to the zero point of the main shaft.
The motor speed when the operation is executed is 60 min^{-1}.



(1) Preparation

The following conditions must be met to perform the origin search.

- The write prohibited setting (Fn010) must not be set to write-protect parameters.
- The main circuit power supply must be ON.
- All alarms must be cleared.
- The hardwire baseblock (HWBB) must be disabled.
- The servo must be OFF.

(2) Operating Procedure

Use the following procedure.

Step	Display after Operation	Keys	Operation
1	1:BB —FUNCTION— Fn002:JOG Fn003:Z-Search Fn004:Program JOG Fn005:Prm Init	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list and select Fn003.
2	1:BB —Z-Search— Un000= 00000 Un002= 00000 Un003= 0000000774 Un00D= 0000000000	DATA	Press the DATA Key. The display changes to the Fn003 execution display.
3	1:RUN —Z-Search— Un000= 00000 Un002= 00000 Un003= 0000000774 Un00D= 0000000000	JOG SVON	Press the JOG SVON Key. The status display changes from "BB" to "RUN, " and the motor power turns ON. Note: If the motor is already at the zero position, "-Complete-" is displayed.
4	1:RUN —Complete— Un000= 00000 Un002= 00000 Un003= 0000000000 Un00D= 0000001D58	∧ ∨	Pressing the ∧ Key will rotate the motor in the forward direction. Pressing the ∨ Key will rotate the spindle motor in the reverse direction. Press the ∧ or ∨ Key until the motor stops. If the origin search completed normally, "-Complete-" is displayed on the right top on the screen.
5	1:BB —Z-Search— Un000= 00000 Un002= 00000 Un003= 0000000000 Un00D= 0000001D58	JOG SVON	When the origin search is completed, press the JOG SVON Key. The status display changes from "RUN" to "BB," and the spindle motor power turns OFF. The display "-Complete-" changes to "-Z-Search-."
6	1:BB —FUNCTION— Fn002:JOG Fn003:Z-Search Fn004:Program JOG Fn005:Prm Init	MODE/SET	Press the MODE/SET Key. The display returns to the main menu of the utility function mode.
7	Turn the power supply OFF and ON again after executing origin search.		

11.4.6 Program JOG Operation (Fn004)

This function allows continuous operation determined by the preset operation pattern, movement distance, movement speed, acceleration/deceleration time, waiting time, and number of times of movement.

In the same way as for the jog operation (Fn002), this function can be used during setup procedures to perform simple positioning operations without connecting the motor to the host controller for the machine.

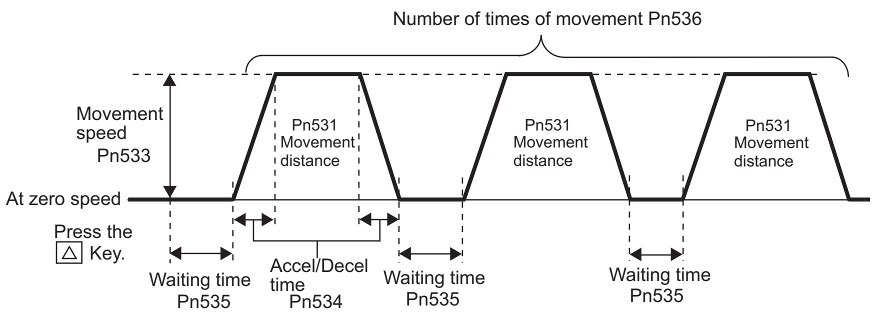
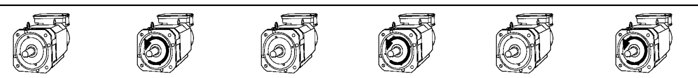
(1) Preparation

The following conditions must be met to perform the program JOG operation.

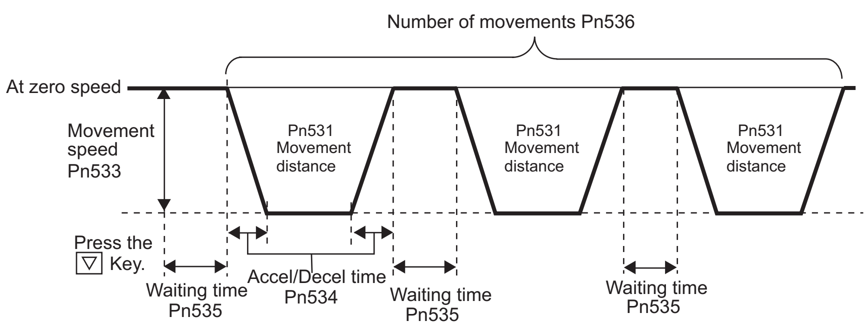
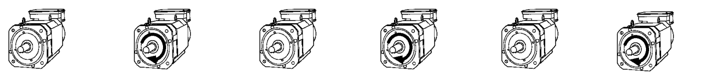
- The write prohibited setting (Fn010) must not be set to write-protect parameters.
- The main circuit power supply must be ON.
- All alarms must be cleared.
- The hardwire baseblock (HWBB) must be disabled.
- The servo must be OFF.
- The speed must be set correctly considering the safety of the machine.

(2) Program JOG Operation Patterns

The following describes an example of program JOG operation pattern. The following example is given when the rotating direction of the motor is set as Pn000.0 = 0 (Forward rotation by forward reference).

Pn530.0 = 0	(Waiting time Pn535 → Forward movement Pn531) × Number of movements Pn536
Speed Diagram	
Motor Run Status	 (Stop) (Forward) (Stop) (Forward) (Stop) (Forward)

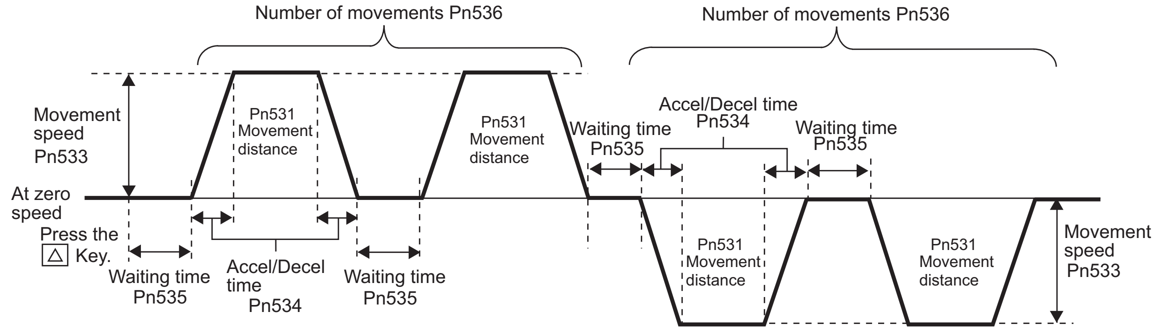
Note: When Pn536 (number of times of program JOG movement) is set to 0, infinite time operation is enabled. To stop infinite time operation, press the JOG/SVON Key of digital operator to turn the servo OFF.

Pn530.0 = 1	(Waiting time Pn535 → Reverse movement Pn531) × Number of movements Pn536
Speed Diagram	
Motor Run Status	 (Stop) (Reverse) (Stop) (Reverse) (Stop) (Reverse)

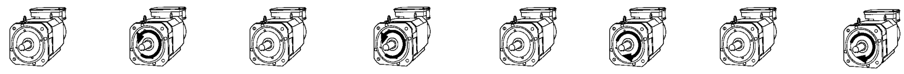
Note: When Pn536 (Number of Times of Program JOG Movement) is set to 0, infinite time operation is enabled. To stop infinite time operation, press the JOG/SVON Key of digital operator to turn the servo OFF.

Pn530.0 = 2	(Waiting time Pn535 → Forward movement Pn531) × Number of movements Pn536 (Waiting time Pn535 → Reverse movement Pn531) × Number of movements Pn536

Speed Diagram



Motor Run Status

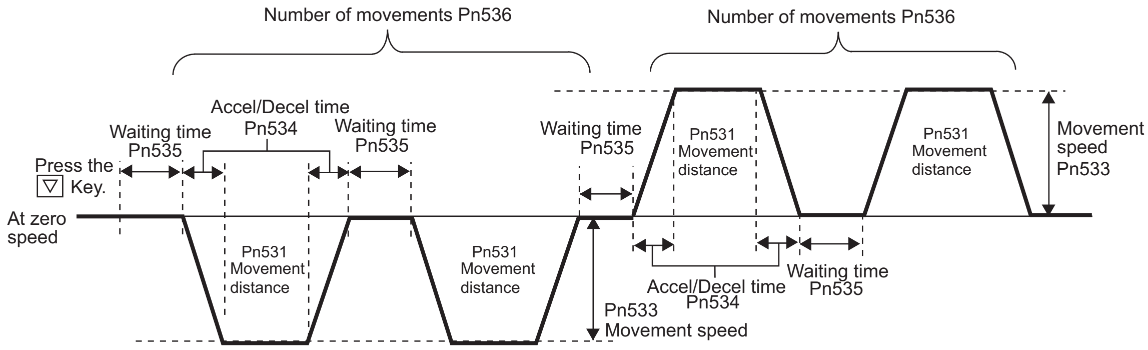


(Stop) (Forward) (Stop) (Forward) (Stop) (Reverse) (Stop) (Reverse)

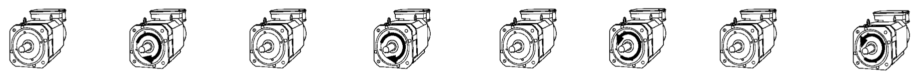
Note: When Pn530.0 is set to 2, infinite time operation is disabled.

Pn530.0 = 3	(Waiting time Pn535 → Reverse movement Pn531) × Number of movements Pn536 (Waiting time Pn535 → Forward movement Pn531) × Number of movements Pn536

Speed Diagram



Motor Run Status

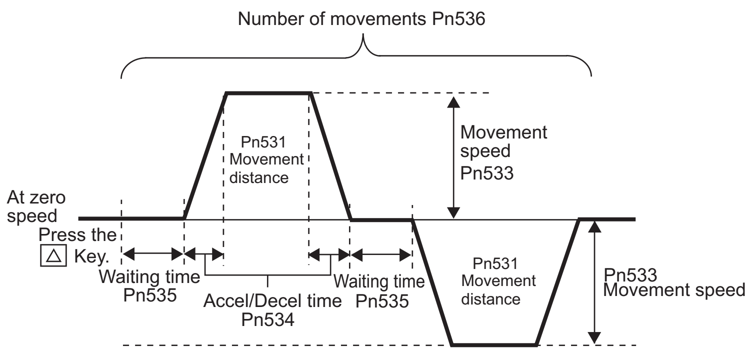


(Stop) (Reverse) (Stop) (Reverse) (Stop) (Forward) (Stop) (Forward)

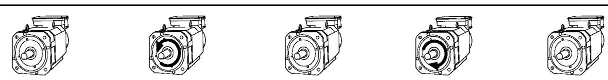
Note: When Pn530.0 is set to 3, infinite time operation is disabled.

Pn530.0 = 4	(Waiting time Pn535 → Forward movement Pn531 → Waiting time Pn535 → Reserve movement Pn531) × Number of movements Pn536

Speed Diagram



Motor Run Status



(Stop) (Forward) (Stop) (Reverse) (Stop)

Note: When Pn536 (number of times of program JOG movement) is set to 0, infinite time operation is enabled. To stop infinite time operation, press the JOG/SVON Key of digital operator to turn the servo OFF.

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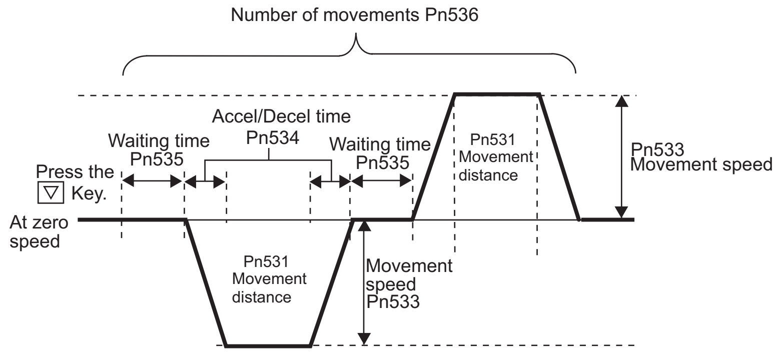
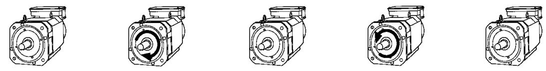
Pn530.0 = 5	(Waiting time Pn535 → Reverse movement Pn531 → Waiting time Pn535 → Forward movement Pn531) × Number of movements Pn536
Speed Diagram	
Motor Run Status	 (Stop) (Reverse) (Stop) (Forward) (Stop)

Note: When Pn536 (number of times of program JOG movement) is set to 0, infinite time operation is enabled. To stop infinite time operation, press the JOG/SVON Key of digital operator to turn the servo OFF.

(3) Related Parameters

The following parameters set the program JOG operation pattern. Do not change the settings while the program JOG operation is being executed.

Pn530	Program JOG Operation Related Switch Speed Position Torque				Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	0000 to 0005	–	0000	Immediately	Setup

Pn531	Program JOG Movement Distance Speed Position Torque				Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	1 to 1073741824	1 pulse	32768	Immediately	Setup

Pn533	Program JOG Movement Speed Speed Position Torque				Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	1 to 10000	1 min^{-1}	500	Immediately	Setup

Pn534	Program JOG Acceleration/Deceleration Time Speed Position Torque				Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	2 to 10000	1 ms	100	Immediately	Setup

Pn535	Program JOG Waiting Time Speed Position Torque				Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	0 to 10000	1 ms	100	Immediately	Setup

Pn536	Number of Times of Program JOG Movement Speed Position Torque				Classification
	Setting Range	Setting Unit	Factory Setting	When Enabled	
	0 to 1000	1 time	1	Immediately	Setup

(4) Operating Procedure

Use the following procedure to perform the program JOG operation after setting a program JOG operation pattern.

Step	Display after Operation	Keys	Operation
1	1:BB −FUNCTION− Fn003:Z-Search Fn004:Program JOG Fn005:Prm Init Fn006:AlmHist Clr	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list and select Fn004.
2	1:BB −PRG JOG− Pn531=00032768 Pn533=00500 Pn534=00100 Pn536=00001	DATA	Press the DATA Key. The display changes to the Fn004 execution display.
3	1:BB −PRG JOG− Pn531=00032768 Pn533=00500 Pn534=00100 Pn536=00010	∧ ∨	Confirm that the parameters have been set. Press the ∨ Key to view Pn530. Press the ∧ Key to view the parameters in the following order: Pn530 → Pn531 → Pn533 → Pn534 → Pn535 → Pn536.
4	1:RUN −PRG JOG− Pn531=00032768 Pn533=00500 Pn534=00100 Pn536=00010	JOG SVON	Press the JOG SVON Key. The status display changes from “BB” to “RUN”, and the motor power turns ON.
5	1:RUN −PRG JOG− Pn531=00032768 Pn533=00500 Pn534=00100 Pn536=00010	∧ ∨	Press the ∧ (forward movement start) or ∨ (reverse movement start) Key according to the first movement direction of the preset operation pattern. The motor starts moving after the preset waiting time in Pn535. Note: Pressing the JOG SVON Key again changes the status to “BB” (baseblocked status) and stops movement even during operation.
6	1:RUN −PRG JOG− Pn531=00032768 Pn533=00500 Pn534=00100 Pn536=00010	MODE/SET	When the set program JOG operation movement is completed, “END” is displayed for one second, and then “RUN” is displayed. Press the MODE/SET Key. The motor becomes baseblocked status. The display returns to the main menu of the utility function mode.
7	Turn the power supply OFF and ON again after executing program JOG operation.		

Note: When you check the settings of the parameters at step 3, you can also change the settings.

11.4.7 Initializing Parameter Settings (Fn005)

This function is used when returning to the factory settings after changing parameter settings.

IMPORTANT

- Be sure to initialize the parameter settings while the motor power is OFF.
- After initialization, turn OFF the power supply and then turn ON again to validate the settings.

Note: Any value adjusted with Fn00C, Fn00D, Fn00E, and Fn00F cannot be initialized by Fn005.

(1) Preparation

The following conditions must be met to initialize the parameter values.

- The write prohibited setting (Fn010) must not be set to write-protect parameters.
- The servo must be OFF.

(2) Operating Procedure

Use the following procedure.

Step	Display after Operation	Keys	Operation
1	1:BB −FUNCTION− Fn004:Program JOG Fn005:Prm Init Fn006:AlmHist Clr Fn008:Mturn Clr	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list and select Fn005.
2	1:BB Parameter Init Start :[DATA] Return:[SET]	DATA	Press the DATA Key. The display changes to the Fn005 execution display.
3	1:BB Parameter Init Start :[DATA] Return:[SET]	DATA MODE/SET	Press the DATA Key to initialize parameters. During initialization, “Parameter Init” is flashing in the display. After the initialization is completed, “Parameter Init” stops flashing and the status display changes as follows: “BB” to “DONE” to “A.941.” Note: Press the MODE/SET Key not to initialize parameters. The display returns to the main menu of the utility function mode.
4	Turn the power supply OFF and ON again after initializing parameter settings.		

11.4.8 Clearing Alarm History (Fn006)

This function deletes all of the alarm history recorded in the SERVOPACK.

Note: The alarm history is not deleted when the alarm reset is executed or the main circuit power supply of the SERVOPACK is turned OFF.

(1) Preparation

The follow conditions must be met to clear the alarm history.

• The write prohibited setting (Fn010) must not be set to write-protect parameters.

(2) Operating Procedure

Use the following procedure.

Step	Display after Operation	Keys	Operation
1	1:BB —FUNCTION— Fn005:Prm Init Fn006:AlmHist Clr Fn008:Mturn Clr Fn009:Ref Adj	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list and select Fn006.
2	1:BB Alarm History Data Clear Start : [DATA] Return: [SET]	DATA	Press the DATA Key. The display changes to the Fn006 execution display.
3	1:BB Alarm History Data Clear Start : [DATA] Return: [SET]	DATA MODE/SET	Press the DATA Key to clear the alarm history. While clearing the data, “DONE” is displayed in the status display. After the data has been successfully cleared, “BB” is displayed. Note: Press the MODE/SET Key not to clear the alarm history. The display returns to the main menu of the utility function mode.

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11.4.9 Automatic Tuning of Analog Speed Reference Offset (Fn009)

This function measures the amount of offsets and adjusts the reference voltage automatically.
The amount of offsets measured is saved in the SERVOPACK.

> **IMPORTANT**
> Always turn OFF the servo before you automatically adjust the reference offset.

Note 1. You cannot use this function if you implement a position loop in the host controller. Use the manual servo tuning of speed reference offset (Fn00A) for the adjustment.
2. The offset value will not be initialized when parameter settings are initialized by using Fn005.

(1) Preparation

The following conditions must be met to adjust the offsets of speed or torque analog reference automatically.

- The write prohibited setting (Fn010) must not be set to write-protect parameters.
- The servo must be OFF.

(2) Operating Procedure

Use the following procedure.

Step	Display after Operation	Keys	Operation
1	1:BB −PRM/MON− Un000= 00000 Un002= 00000 Un008= 0000000000 Un00D= 0000000000	–	Turn OFF the servo and input a reference voltage of 0 V from the host controller or from an external circuit.
2	1:BB −FUNCTION− Fn008:Mturn Clr Fn009:Ref Adj Fn00A:Vel Adj Fn00B:Trq Adj	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu of the utility function mode. Use the ∧ or ∨ Key to move through the list and select Fn009.
3	1:BB Ref Adjust Start : [DATA] Return: [SET]	DATA	Press the DATA Key. The display changes to the Fn009 execution display.
4	1:BB Ref Adjust Start : [DATA] Return: [SET]	DATA or MODE/SET	Press the DATA Key to execute the automatic adjustment of analog voltage reference (speed) offset. "DONE" will flash for approximately 1 second after the write is completed normally, and then the "BB" display will return. Press the MODE/SET Key not to execute the automatic adjustment. The display returns to the main menu of the utility function mode.

11.4.10 Manual Servo-tuning of Speed Reference Offset (Fn00A)

This function allows you to directly input the reference offset. Use this function in the following cases.

- To deliberately set the offset amount to some value.
- To check the offset amount calculated in the automatic adjustment mode.

<Supplementary Note>

The offset value will not be initialized when parameter settings are initialized by using Fn005.

(1) Preparation

The following conditions must be met to adjust the offsets of speed reference manually.

- The write prohibited setting (Fn010) must not be set to write-protect parameters.
- The main circuit power supply must be ON.
- All alarms must be cleared.
- The hard wire base block (HWBB) must be disabled.

(2) Operating Procedure

Use the following procedure.

Step	Display after Operation	Keys	Operation
1	–	–	Input a reference voltage of 0 V from the host controller or from an external circuit.
2	1:BB −FUNCTION− Fn009:Ref Adj Fn00A:Vel Adj Fn00B:Trq Adj Fn00C:MonZero Adj	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu of the utility function mode. Use the ∧ or ∨ Key to move through the list and select Fn00A.
3	1:BB Velocity Adjust ZADJV= 00000 Vref = 00000	DATA	Press the DATA Key. The display changes to the Fn00A execution display.
4	1:RUN Velocity Adjust ZADJV= 00000 Vref = 00000	–	Turn ON the /FWD or /REV signal. The servo will turn ON.
5	1:RUN Velocity Adjust ZADJV=+00012 Vref = 00000	∧ or ∨	Press the ∧ or ∨ Key to adjust the reference speed offset value. Note: Adjust the value until the speed of the spindle motor goes to zero.
6	1:RUN Velocity Adjust ZADJV=+00015 Vref = 00000	DATA	Press the DATA Key to write the speed reference offset value into the SERVOPACK. When the writing is completed, the status display shows “DONE” for one second.
7	1:RUN −FUNCTION− Fn009:Ref Adj Fn00A:Vel Adj Fn00B:Trq Adj Fn00C:MonZero Adj	MODE/SET	Press the MODE/SET Key. The display returns to the main menu of the utility function mode. The status display then returns to show “RUN” again.

11.4.11 Offset Adjustment of Analog Monitor Output (Fn00C)

This function is used to manually adjust the offsets for the analog monitor outputs (torque reference monitor and motor speed monitor). The offsets are adjusted at the factory. You normally do not need to use this function.

<Supplementary Note>
- The offset value will not be initialized when parameter settings are initialized by using Fn005.
- If you adjust the offsets, connect the measuring instrument that you will actually use with the analog monitor output adjusted to zero. The following are setting examples for a zero output.
  - Turn OFF the servo and set the monitor signal to a torque reference.
  - Set the monitor signal to position error when using speed control.

(1) Preparation

The following condition must be met to adjust the offsets of the analog monitor output.

- The write prohibited setting (Fn010) must not be set to write-protect parameters.

(2) Operating Procedure

Use the following procedure.

Step	Display after Operation	Keys	Operation
1	1:BB −FUNCTION− Fn00B:Trq Adj Fn00C:MonZero Adj Fn00D:MonGain Adj Fn00E:Cur AutoAdj	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list and select Fn00C.
2	1:BB −Zero ADJ− CH1=−00002 CH2= 00001 Un002= 00000 Un000= 00000	DATA	Press the DATA Key. The display changes to the Fn00C execution display.
3	1:BB −Zero ADJ− CH1=−00005 CH2= 00001 Un002= 00000 Un000= 00000	∧ ∨	Press the ∧ or ∨ Key to adjust the offset of CH1 (torque reference monitor). Adjust the offset so that the measurement instrument reading is as close to 0 V as possible.
4	1:BB −Zero ADJ− CH1=−00005 CH2= 00001 Un002= 00000 Un000= 00000	SCROLL	After the offset adjustment of CH1 has completed, adjust the offset of CH2 (motor speed monitor). Press the SCROLL Key. The cursor moves to CH2 side.
5	1:BB −Zero ADJ− CH1=−00005 CH2= 00006 Un002= 00000 Un000= 00000	∧ ∨	Adjust the offset of CH2 in the same way as for CH1. Press the ∧ or ∨ Key to adjust the offset of CH2. Adjust the offset so that the measurement instrument reading is as close to 0 V as possible.
6	1:BB −Zero ADJ− CH1=−00005 CH2= 00006 Un002= 00000 Un000= 00000	DATA	After having completed the offset adjustment both for CH1 and CH2, press the DATA Key. The adjustment results are saved in the SERVOPACK, and the status display shows “DONE” for one second. The status display then returns to show “BB” again.
7	1:BB −FUNCTION− Fn00B:Trq Adj Fn00C:MonZero Adj Fn00D:MonGain Adj Fn00E:Cur AutoAdj	MODE/SET	Press the MODE/SET Key. The display returns to the main menu of the utility function mode.

11.4.12 Gain Adjustment of Analog Monitor Output (Fn00D)

This function is used to manually adjust the gains for the analog monitor outputs (torque reference monitor output and motor speed monitor output). The gain values are factory-set before shipping. Therefore, the user need not usually use this function.
The setting range of the gain adjustment width for analog monitor output is
-128 to +127 (× 0.4%).
The setting of gain adjustment width is made on the base of 100%. For example, the setting "-125" makes 100% - (125 × 0.4%) = 50%, which means that the monitor output voltage is 1/2. The setting "125" makes 100% + (125 × 0.4%) = 150%, which means that the monitor output voltage is 1.5 times.

Note: The adjustment value will not be initialized when parameter settings are initialized using Fn005.

(1) Preparation

The following condition must be met to adjust the gain of the analog monitor output.

- The write prohibited setting (Fn010) must not be set to write-protect parameters.

(2) Operating Procedure

Use the following procedure.

Step	Display after Operation	Keys	Operation
1	1:BB −FUNCTION− Fn00C:MonZero Adj Fn00D:MonGain Adj Fn00E:Cur AutoAdj Fn00F:Cur ManuAdj	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list and select Fn00D.
2	1:BB −Gain ADJ− CH1=−00001 CH2=−00001 Un002= 00000 Un000= 00000	DATA	Press the DATA Key. The display changes to the Fn00D execution display.
3	1:BB −Gain ADJ− CH1= 00125 CH2=−00001 Un002= 00000 Un000= 00000	∧ ∨	Press the ∨ or ∧ Key to adjust the gain adjustment width of CH1 (torque reference monitor).
4	1:BB −Gain ADJ− CH1= 00125 CH2=−00001 Un002= 00000 Un000= 00000	SCROLL	After the gain adjustment of CH1 has completed, adjust the gain adjustment width of CH2 (motor speed monitor). Press the SCROLL Key. The cursor moves to CH2 side.
5	1:BB −Gain ADJ− CH1= 00125 CH2=−00125 Un002= 00000 Un000= 00000	∧ ∨	Adjust the gain of CH2 in the same way as for CH1. Press the ∧ or ∨ Key to adjust the gain adjustment width of CH2 (motor speed monitor).
6	1:BB −Gain ADJ− CH1= 00125 CH2=−00125 Un002= 00000 Un000= 00000	DATA	After having completed the adjustment both for CH1 and CH2, press the DATA Key. The adjustment results are saved in the SERVOPACK, and the status display shows "DONE" for one second. The status display then returns to show "BB" again.
7	1:BB −FUNCTION− Fn00C:MonZero Adj Fn00D:MonGain Adj Fn00E:Cur AutoAdj Fn00F:Cur ManuAdj	MODE/SET	Press the MODE/SET Key. The display returns to the main menu of the utility function mode.

11.4.13 Automatic Offset-Signal Adjustment of the Motor Current Detection Signal (Fn00E)

Perform this adjustment only if highly accurate adjustment is required for reducing torque ripple caused by current offset. The user need not usually use this function.

IMPORTANT

- Be sure to perform this function while the servo is OFF.
- Execute the automatic offset adjustment if the torque ripple is too big when compared with those of other SERVOPACKs.

Note: Fn005 cannot initialize any value adjusted with Fn00E.

(1) Preparation

The following conditions must be met to automatically adjust the offset of the motor current detection signal.

- The write prohibited setting (Fn010) must not be set to write-protect parameters.
- The main circuit power supply must be ON.
- All alarms must be cleared.
- The hard wire base block (HWBB) must be disabled.
- The servo must be OFF.

(2) Operating Procedure

Use the following procedure.

Step	Display after Operation	Keys	Operation
1	1:BB −FUNCTION− Fn00D:MonGain Adj Fn00E:Cur AutoAdj Fn00F:Cur ManuAdj Fn010:Prm Protect	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list and select Fn00E.
2	1:BB Auto Offset−ADJ of Motor Current Start :[DATA] Return:[SET]	DATA	Press the DATA Key. The display changes to the Fn00E execution display.
3	1:BB Auto Offset−ADJ of Motor Current Start :[DATA] Return:[SET]	DATA MODE/SET	Press the DATA Key to start the automatic offset-signal adjustment of motor current detection. When the adjustment is completed, the status display shows “DONE” for one second. The status display then returns to show “BB” again. Note: Press the MODE/SET Key to cancel the automatic adjustment. The display returns to the main menu of the utility function mode.

11.4.14 Manual Offset-Signal Adjustment of the Motor Current Detection Signal (Fn00F)

Use this function only if the torque ripple is still high after the automatic offset-signal adjustment of the motor current detection signal (Fn00E).

IMPORTANT

If this function is executed carelessly, it may worsen the characteristics.

Observe the following precautions when performing manual servo tuning.

- Run the spindle motor at a speed of approximately 100 min^{-1}.
- Adjust the offset while monitoring the torque reference with the analog monitor until the ripple of torque reference monitor's waveform is minimized.
- Adjust the phase-U and phase-V offset amounts alternately several times until these offsets are well balanced.

Note: Fn005 cannot initialize any value adjusted with Fn00F.

(1) Preparation

The following condition must be met to manually adjust the offset of the motor current detection signal.

- The write prohibited setting (Fn010) must not be set to write-protect parameters.
- The main circuit power supply must be ON.
- All alarms must be cleared.
- The hardwire baseblock (HWBB) must be disabled.

(2) Operating Procedure

Use the following procedure.

Step	Display after Operation	Keys	Operation
1	1:BB −FUNCTION− Fn00F:Cur ManuAdj Fn010:Prm Protect Fn011:Motor Info Fn012:Soft Ver	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list and select Fn00F.
2	1:BB Manual Offset−ADJ of Motor Current ZADJIU= 00009 ZADJIV= 00006	DATA	Press the DATA Key. The display changes to the Fn00F execution display.
3	1:RUN Manual Offset−ADJ of Motor Current ZADJIU= 00009 ZADJIV= 00006	–	Input the /FWD or /REV signal from the host controller.
4	1:RUN Manual Offset−ADJ of Motor Current ZADJIU= 00019 ZADJIV= 00006	∧ ∨	Adjust the phase-U offset. Press the ∨ or ∧ Key to adjust the offset amount. Adjust the offset amount by 10 in the direction that the torque ripple is reduced. Adjustment range: -512 to +511 (ZADJIU: Offset value of phase-U current)
5	1:RUN Manual Offset−ADJ of Motor Current ZADJIU= 00019 ZADJIV= 00006	SCROLL	Adjust the phase-V offset. Press the SCROLL Key. The cursor moves to the phase-V side.
6	1:RUN Manual Offset−ADJ of Motor Current ZADJIU= 00019 ZADJIV= 00016	∧ ∨	Press the ∨ or ∧ Key to adjust the offset amount. Adjust the offset amount by 10 in the direction that the torque ripple is reduced. (ZADJIV: Offset value of phase-V current)
7	1:RUN Manual Offset−ADJ of Motor Current ZADJIU= 00019 ZADJIV= 00016	DATA	Press the DATA Key to save the result of adjustment in the SERVOPACK. When the saving is completed, the status display shows “DONE” for one second. The status display then returns to show “RUN” again.
8	1:RUN −FUNCTION− Fn00F:Cur ManuAdj Fn010:Prm Protect Fn011:Motor Info Fn012:Soft Ver	MODE/SET	Press the MODE/SET Key. The display returns to the main menu of the utility function mode.

Note: Repeat the operations of steps 4 to 6 (phase-U and-V alternately) until adjusting the offset amounts both for phase-U and -V in both directions cannot reduce the torque ripple any more.
Then, perform the same operation by adjusting by smaller amount.

11.4.15 Write Prohibited Setting (Fn010)

This function prevents changing parameters by mistake and sets restrictions on the execution of the utility function.

Parameter changes and execution of the utility function become restricted in the following manner when the write prohibited setting is set.

- Parameters: Cannot be changed. If you attempt to change it, “NO-OP” will flash on the display and the screen will return to the main menu.
- Utility Function: Some functions cannot be executed. (Refer to the following table.) If you attempt to execute these utility functions, “NO-OP” will flash on the display and the screen will return to the main menu.

Parameter No.	Function	Write Prohibited Setting
Fn000	Alarm history display	Executable
Fn002	JOG operation	Cannot be executed
Fn003	Origin search	Cannot be executed
Fn004	Program JOG operation	Cannot be executed
Fn005	Initializing parameter settings	Cannot be executed
Fn006	Clearing alarm history	Cannot be executed
Fn009	Automatic tuning of analog speed reference offset	Cannot be executed
Fn00A	Manual servo turning of speed reference offset	Cannot be executed
Fn00C	Offset adjustment of analog monitor output	Cannot be executed
Fn00D	Gain adjustment of analog monitor output	Cannot be executed
Fn00E	Automatic offset-signal adjustment of the motor current detection signal	Cannot be executed
Fn00F	Manual offset-signal adjustment of the motor current detection signal	Cannot be executed
Fn010	Write prohibited setting	–
Fn012	Software version display	Executable
Fn01E	Display of SERVOPACK and motor ID	Executable
Fn204	Anti-resonance control adjustment function	Cannot be executed

(1) Preparation

There are no tasks that must be performed before the execution.

(2) Operating Procedure

A setting example for prohibiting and permitting changes is given below.

The following set values are used:
- P.0000: Changes permitted (prohibit canceled) (default)
- P.0001: Changed prohibited (Changes are prohibited from the next time the power supply is restarted.)

Step	Display after Operation	Keys	Operation
1	1:BB –FUNCTION– Fn00F:Cur ManuAdj Fn010:Prm Protect Fn011:Motor Info Fn012:Soft Ver	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list and select Fn010.
2	1:BB Parameter Write Protect P. 0000	DATA	Press the DATA Key. The display changes to the Fn010 execution display.
3	1:BB Parameter Write Protect P. 0001	∧ ∨	Press the ∧ or ∨ Key to select one of the following settings. P.0000: Write permitted [Factory setting] P.0001: Write prohibited
4	1:BB Parameter Write Protect P. 0001	DATA	Press the DATA Key. The setting value is written into the SERVOPACK, and the status display changes as follows: "DONE" to "BB." Note: Saved settings will be enabled after the SERVOPACK is restarted.
5	Turn the power supply OFF and ON again after executing write prohibited setting.		

Note: To make the setting available, change the setting to P.0000 as shown in step 3.

11.4.16 Software Version Display (Fn012)

This function displays the software version of the SERVOPACK.

(1) Preparation

There are no tasks that must be performed before the execution.

(2) Operating Procedure

Use the following procedure.

Step	Display after Operation	Keys	Operation
1	1:BB —FUNCTION— Fn011:Motor Info Fn012:Soft Ver Fn013:MturnLmSet Fn014:Opt Init	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list and select Fn012.
2	1:BB —Soft Ver— DRIVER Ver.=0001 ENCODER Ver.=0000	DATA	Press the DATA Key. The display changes to the Fn012 execution display. The software versions of the SERVOPACK will appear. Note: The software version of the encoder is always displayed as 0000.
3	1:BB —FUNCTION— Fn011:Motor Info Fn012:Soft Ver Fn013:MturnLmSet Fn014:Opt Init	MODE/SET	Press the MODE/SET Key. The display returns to the main menu of the utility function mode.

11.4.17 Display of SERVOPACK and Motor ID (Fn01E)

This function displays information that was written to the SERVOPACK for the SERVOPACK ID, motor ID, and encoder ID. The following items can be displayed.

ID	Items to be Displayed
SERVOPACK ID	• SERVOPACK model • SERVOPACK serial number • SERVOPACK manufacturing date • SERVOPACK input voltage (V) • Maximum applicable motor capacity (W) • Maximum applicable motor rated current (Arms)
Motor ID	• Motor model • Motor input voltage (V) • Motor capacity (W) • Motor rated current (Arms)
Encoder ID	• Encoder model • Encoder type/resolution

(1) Preparation

There are no tasks that must be performed before the execution.

(2) Operating Procedure

Use the following procedure.

Step	Display after Operation	Keys	Operation
1	1:RUN -FUNCTION- Fn01B:Viblvl Init Fn01E:SvMotOp ID Fn01F:FBOpMot ID Fn020:S-Orig Set	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list and select Fn01E.
2	Serial number SERVOPACK model 1:BB -SvMotOp ID- Driver CACR-JU065ADA D00241234590001 11.04 200V,15000W Manufacturing date Capacity Input voltage	DATA < >	Press the DATA Key. The display changes to the Fn01E execution display. The SERVOPACK ID information is displayed. Use the < or > Key to scroll left and right and to view other information.
3	Motor model 1:BB -SvMotOp ID- Motor UAKAJ-15CZC100 200V,15000W Capacity Input voltage	DATA < >	Press the DATA Key. The motor ID information is displayed. Use the < or > Key to scroll left and right and to view other information.
4	Encoder model 1:BB -SvMotOp ID- Encoder UTMSI-10AAGAZA 12bit-INC Encoder type Encoder resolution	DATA < >	Press the DATA Key. The encoder ID information is displayed. Use the < or > Key to scroll left and right and to view other information.
5	1:RUN -FUNCTION- Fn01B:Viblvl Init Fn01E:SvMotOp ID Fn01F:FBOpMot ID Fn020:S-Orig Set	MODE/SET	Press the MODE/SET Key. The display returns to the main menu of the utility function mode.

11.4.18 Anti-Resonance Control Adjustment Function (Fn204)

This function increases the effectiveness of the vibration suppression after adjusting servo gains.

Note: Anti-resonance control adjustment function can be executed from the SigmaWin for Σ-V-SD (MT)* or from a Digital Operator. This section provides the adjustment procedure for a Digital Operator. Refer to *10.3 Anti-Resonance Control Adjustment Function* for details on anti-resonance control adjustment function and the procedure to execute anti-resonance control adjustment with the Digital Operator.

* Anti-resonance control adjustment function with the SigmaWin for Σ-V-SD (MT) is currently under development.

WARNING

- When this function is executed, the related parameters will be set automatically. This may cause the response characteristics to vary greatly before and after execution of this function. To ensure safety, make sure that an emergency stop can be applied at any time.
  Failure to observe this warning may result in injury or damage to the product.
- Before you execute anti-resonance adjustment function, make sure that the moment of inertia ratio (Pn103) is set correctly.
  If the setting of the moment of inertia is not correct, normal control may not be possible and vibration may occur.

IMPORTANT

- This function detects vibration between 100 and 1,000 Hz. Vibration will not be detected for frequencies outside of this range, and instead, “F----” will be displayed. If that occurs, set a notch filter manually.
- Vibration can be reduced more effectively by increasing the anti-resonance damping gain (Pn163). The amplitude of vibration may become larger if the damping gain is excessively high. Increase the damping gain from about 0% to 200% in 10% increments while checking the effect of vibration reduction. If the effect of vibration reduction is still insufficient at a gain of 200%, cancel the setting, and lower the servo gain.

(1) Preparation

The following conditions must be met to perform the anti-resonance control adjustment function.
The message “NO-OP” indicating that the settings are not appropriate will be displayed, if all of the following conditions are not met.

- The write prohibited setting (Fn010) must not be set to write-protect parameters.
- The main circuit power supply must be ON.
- All alarms must be cleared.
- The hardwire baseblock (HWBB) must be disabled.

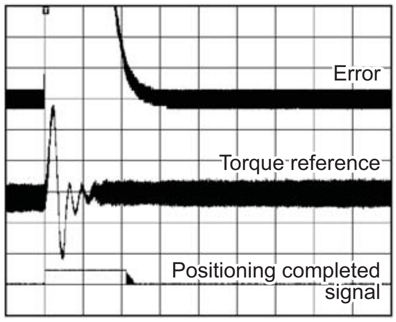
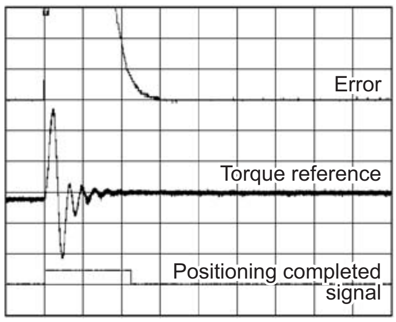
(2) Operating Procedure

With this function, an operation reference is sent, and the function is executed while vibration is occurring.

- Using Anti-Resonance Control for the first time
  - With undetermined vibration frequency
  - With determined vibration frequency
- For fine-tuning after adjusting the Anti-Resonance Control

■ Using Anti-Resonance Control for the First Time

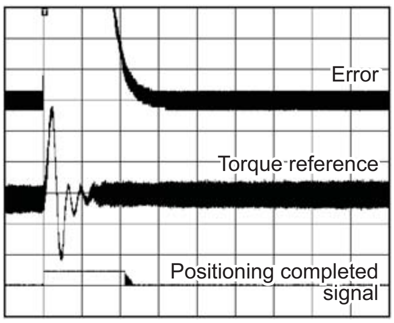
• With Undetermined Vibration Frequency

Step	Display after Operation	Keys	Operation
1	1:RUN —FUNCTION— Fn203:OnePrmTun Fn204:A-Vib Sup Fn205:Vib Sup Fn206:Easy FFT	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list, select Fn204.
2	Status Display 1:RUN —Vib Sup— Tuning Mode = 0	DATA	Press the DATA Key to display the initial setting screen for tuning mode.
3	1:RUN —Vib Sup— Tuning Mode = 0	∧ ∨	Press the ∧ or ∨ Key and set the tuning mode "0."
4	1:RUN —Vib Sup— freq = ---- Hz damp = 0000	DATA	Press the DATA Key while "Tuning Mode = 0" is displayed. The screen shown on the left will appear. The detection of vibration frequencies will start and "freq" will flash. Return to step 3 if vibration is not detected.
5	1:RUN —Vib Sup— freq = 0400 Hz damp = 0000	–	The vibration frequency will be displayed in "freq" if vibration is detected.  Example of measured waveform
6	1:RUN —Vib Sup— freq = 0400 Hz damp = 0000	DATA	Press the DATA Key. The cursor will move to "damp," and the flashing of "freq" will stop.
7	1:RUN —Vib Sup— freq = 0400 Hz damp = 0120	< > ∧ ∨	Select the digit with the < or > Key, and press the ∧ or ∨ Key to set the damping gain.  Example of measured waveform Note: Increase the damping gain from about 0% to 200% in 10% increments while checking the effect of vibration reduction. If vibration reduction is still insufficient at a gain of 200%, cancel the setting, and lower the servo gain.

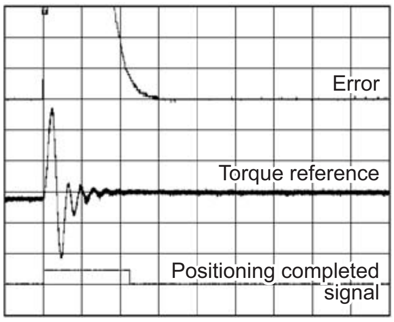
(cont'd)

Step	Display after Operation	Keys	Operation
8	1:RUN —Vib Sup— freq = 0400 Hz damp = 0120	SCROLL	If fine tuning of the frequency is necessary, press the SCROLL Key. The cursor will move from "damp" to "freq." If fine-tuning is not necessary, skip step 9 and go to step 10.
9	1:RUN —Vib Sup— freq = 0420 Hz damp = 0120	< > ∧ ∨	Select the digit with the < or > Key, and press the ∧ or ∨ Key to fine-tune the frequency.
10	1:RUN —Vib Sup— freq = 0420 Hz damp = 0120	DATA	Press the DATA Key to save the settings. "DONE" will flash for approximately two seconds and "RUN" will be displayed.
11	1:RUN —FUNCTION— Fn203:OnePrmTun Fn204:A-Vib Sup Fn205:Vib Sup Fn206:Easy FFT	MODE/SET	Press the MODE/SET Key to complete the anti-resonance control adjustment function. The display returns to the main menu of the utility function mode.

- With Determined Vibration Frequency

Step	Display after Operation	Keys	Operation
1	1:RUN —FUNCTION— Fn203:OnePrmTun Fn204:A-Vib Sup Fn205:Vib Sup Fn206:Easy FFT	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list, select Fn204.
2	1:RUN —Vib Sup— Tuning Mode = 0	DATA	Press the DATA Key to display the initial setting screen for tuning mode.
3	1:RUN —FUNCTION— Tuning Mode = 1	∧ ∨	Press the ∧ or ∨ Key and set the tuning mode "1."
4	1:RUN —Vib Sup— freq = 0100 Hz damp = 0000	DATA	Press the DATA Key while "Tuning Mode = 1" is displayed. The screen shown on the left will appear and "freq" will flash.  Example of measured waveform
5	1:RUN —Vib Sup— freq = 0100 Hz damp = 0000	< > ∧ ∨	Select the digit with the < or > Key, and press the ∧ or ∨ Key to adjust the frequency.

(cont'd)

Step	Display after Operation	Keys	Operation
6	1:RUN —Vib Sup— freq = 0400 Hz damp = 0000	SCROLL	Press the SCROLL Key. The cursor will move to "damp."
7	1:RUN —Vib Sup— freq = 0400 Hz damp = 0020	< > ∧ ∨	Select the digit with the < or > Key, and press the ∧ or ∨ Key to adjust the damping gain.  Example of measured waveform Note: Increase the damping gain from about 0% to 200% in 10% increments while checking the effect of vibration reduction. If vibration reduction is still insufficient at a gain of 200%, cancel the setting, and lower the servo gain.
8	1:RUN —Vib Sup— freq = 0400 Hz damp = 0120	SCROLL	If fine tuning of the frequency is necessary, press the SCROLL Key. The cursor will move from "damp" to "freq." If fine-tuning is not necessary, skip step 9 and go to step 10.
9	1:RUN —Vib Sup— freq = 0400 Hz damp = 0120	< > ∧ ∨	Select the digit with the < or > Key, and press the ∧ or ∨ Key to fine-tune the frequency.
10	1:RUN —Vib Sup— freq = 0400 Hz damp = 0120	DATA	Press the DATA Key to save the settings. "DONE" will flash for approximately two seconds and "RUN" will be displayed.
11	1:RUN —FUNCTION— Fn203:OnePrmTun Fn204:A-Vib Sup Fn205:Vib Sup Fn206:Easy FFT	MODE/SET	Press the MODE/SET Key to complete the anti-resonance control adjustment function. The display returns to the main menu of the utility function mode.

■ For Fine-tuning After Adjusting the Anti-Resonance Control

Step	Display after Operation	Keys	Operation
1	1:RUN —FUNCTION— Fn203:OnePrmTun Fn204:A-Vib Sup Fn205:Vib Sup Fn206:Easy FFT	MODE/SET ∧ ∨	Press the MODE/SET Key to view the main menu for the utility function mode. Use the ∧ or ∨ Key to move through the list, select Fn204.
2	1:RUN —FUNCTION— Tuning Mode = 1	DATA	Press the DATA Key to display the "Tuning Mode = 1" as shown on the left.
3	1:RUN — Vib Sup— freq = 0400 Hz damp = 0120	DATA	Press the DATA Key while "Tuning Mode = 1" is displayed. The screen shown on the left will appear and "damp" will flash.
4	1:RUN — Vib Sup— freq = 0400 Hz damp = 0150	< > ∧ ∨	Select the digit with the < or > Key, and press the ∧ or ∨ Key to set the damping gain. Note: Increase the damping gain from about 0% to 200% in 10% increments while checking the effect of vibration reduction. If vibration reduction is still insufficient at a gain of 200%, cancel the setting, and lower the servo gain.
5	1:RUN — Vib Sup— freq = 0400 Hz damp = 0150	SCROLL	If fine tuning of the frequency is necessary, press the SCROLL Key. The cursor will move from "damp" to "freq." If fine-tuning is not necessary, skip step 6 and go to step 7.
6	1:RUN — Vib Sup— freq = 0420 Hz damp = 0150	< > ∧ ∨	Select the digit with the < or > Key, and press the ∧ or ∨ Key to fine-tune the frequency.
7	1:RUN — Vib Sup— freq = 0420 Hz damp = 0150	DATA	Press the DATA Key to save the settings. "DONE" will flash for approximately two seconds and "RUN" will be displayed.
8	1:RUN —FUNCTION— Fn203:OnePrmTun Fn204:A-Vib Sup Fn205:Vib Sup Fn206:Easy FFT	MODE/SET	Press the MODE/SET Key to complete the anti-resonance control adjustment function. The display returns to the main menu of the utility function mode.

12

Standards Compliance

12.1 Harmonized Standards

Certification marks for the standards for which the product has been certified by certification bodies are shown on nameplate. Products that do not have the marks are not certified for the standards.

(1) North American Safety Standards (UL)

Products and Models	UL Standards (UL File No.)
Power regeneration converter (CACP-JU□□□3□), SERVOPACK (CACR-JU□□□□D□)	UL508C (E147823)

(2) EU Directives

Products and Models	EU Directives	Harmonized Standards
Power regeneration converter (CACP-JU□□□3□), SERVOPACK (CACR-JU□□□□D□)	Machinery Directive 2006/42/EC	EN ISO13849-1: 2008/AC: 2009*
	EMC Directive 2014/30/EU	EN 55011 group1 classA EN 61000-6-2 EN 61000-6-4 EN 61800-3 (Category C2, Second Environment)
	Low Voltage Directive 2014/35/EU	EN 61800-5-1
	RoHS Directive 2011/65/EU	EN 50581

* For details, refer to *(3) Safety Standards*.

(3) Safety Standards

Products and Models	Safety Standards	Standards
SERVOPACK (CACR-JU□□□□D□)	Safety of Machinery	EN ISO13849-1: 2008/AC: 2009 IEC 60204-1 (Stop Category 0)
	Functional Safety	IEC 61508 series IEC 62061 IEC 61800-5-2
	EMC	IEC 61326-3-1

■ Safety Performance

Items	Standards	Performance Level
Safety Integrity Level	IEC 61508	SIL2
	IEC 62061	SILCL2
Probability of Dangerous Failure per Hour	IEC 61508 IEC 62061	PFH = 3.95×10^{-9} [1/h]
Performance Level	EN ISO 13849-1	PL d (Category 3)
Mean Time to Dangerous Failure of Each Channel	EN ISO 13849-1	MTTFd: High
Average Diagnostic Coverage	EN ISO 13849-1	DCavg: Low
Stop Category	IEC 60204-1	Stop category 0
Safety Function	IEC 61800-5-2	STO
Proof test Interval	IEC 61508	10 years

12.2 Models That Are Compliant with International Standards

The models that are compliant with international standards are listed in the following table.

Note: Contact your Yaskawa representative for details on models scheduled for certification.

■ Power Regeneration Converter

Model	North American Safety Standards (UL)	EU Directives
CACP-JU15A3A	Not available	Complied
CACP-JU19A3A		
CACP-JU22A3A		
CACP-JU30A3A		
CACP-JU15D3A		
CACP-JU19D3A		
CACP-JU22D3A		
CACP-JU15A3B	Certified	
CACP-JU19A3B		
CACP-JU22A3B		
CACP-JU30A3B		
CACP-JU37A3B		
CACP-JU45A3B		
CACP-JU15D3B		
CACP-JU19D3B		
CACP-JU22D3B		

■ SERVOPACK for One Axis

Model	North American Safety Standards (UL)	EU Directives	Safety Standards and Safety Performance
CACR-JU028ADA	Certified	Complied	Certified
CACR-JU036ADA			
CACR-JU065ADA			
CACR-JU084ADA			
CACR-JU102ADA			
CACR-JU125ADA			
CACR-JU196ADA			
CACR-JU014DDA			
CACR-JU018DDA			
CACR-JU033DDA			
CACR-JU042DDA			
CACR-JU051DDA			

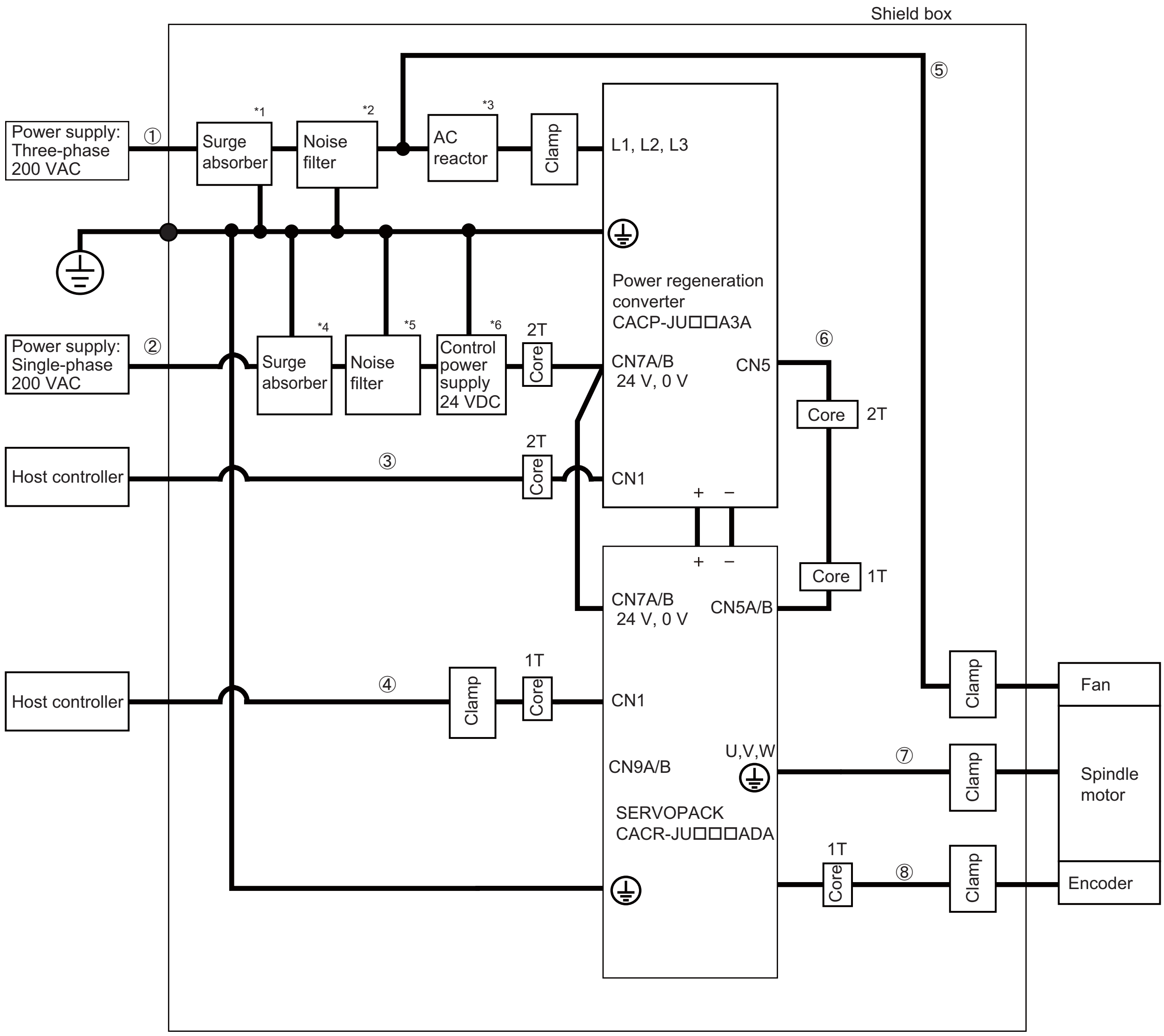
12.3 Precautions for Complying with European Standards

12.3.1 EMC Installation Conditions

This section describes the recommended installation conditions that satisfy EMC guidelines for the Σ-V-SD driver.

This section describes the EMC installation conditions satisfied in test conditions prepared by Yaskawa. The actual EMC level may differ depending on the actual system's configuration, wiring, and other conditions. However, because this product is built-in, check that the following conditions are still met after being installed in the user's product.

The harmonized standards are EN 55011 group1 classA, EN 61000-6-2, EN 61000-6-4 and EN 61800-3 (Category C2, Second Environment).

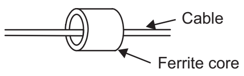
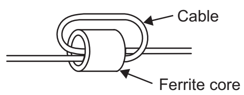


Symbol	Cable Name	Specification
①	Main circuit cable	Shield cable
②	Control power cable	Shield cable
③	I/O signal cable (for converter)	Shield cable
④	I/O signal cable (for SERVOPACK)	Shield cable
⑤	Spindle motor fan cable	Shield cable
⑥	Local bus communication cable	Shield cable
⑦	Spindle motor main circuit cable	Shield cable
⑧	Spindle motor encoder cable	Shield cable

∗1. Recommended surge absorber model: LT-C32G801WS (Soshin Electric Co., Ltd.)
∗2. For more information on this noise filter, refer to *3.3.3 Noise Filter*.
∗3. For more information on this AC reactor, refer to *3.3.1 AC Reactor*.
∗4. Use an LT-C12G801WS Surge Absorber (from Soshin Electric Co., Ltd.) in the input section for the 24-VDC power supply.
∗5. Use an HF2005A-UP Noise Filter (from Soshin Electric Co., Ltd.) in the input section for the 24-VDC power supply.
∗6. Use a 24-VDC control power supply with double insulation against primary or reinforced insulation.

12.3.2 Precautions

(1) Attachment Methods of Ferrite Cores

One turn	Two turn
	

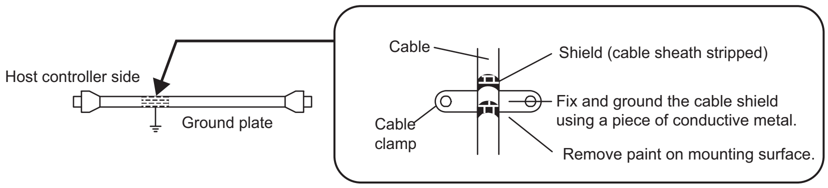
(2) Recommended Ferrite Core

Cable Name	Ferrite Core Model	Manufacturer
Control power cable	SFT72SN	TAKEUCHI INDUSTRY Co., Ltd.
I/O signal cable		
Local bus communication cable		
Encoder cable		

(3) Fixing the Cable

Fix and ground the cable shield using a piece of conductive metal.

• Example of Cable Clamp



(4) Shield Box

A shield box, which is a closed metallic enclosure, is effective as reinforced shielding against electromagnetic interference (EMI) from SERVOPACKs. The structure of the box should allow the main body, door, and cooling unit to be attached to the ground. The box opening should be as small as possible.

Note: Do not connect the analog monitor cable to the SERVOPACK during operations.
Connect them only when the machinery is stopped during maintenance.

12.3.3 Compliance with Low Voltage Directive

This drive has been tested according to European standard IEC61800-5-1, and it fully complies with the Low Voltage Directive.

To comply with the Low Voltage Directive, be sure to meet the following conditions when combining this drive with other devices.

(1) Installation Location

Install the servo drive in a location with an overvoltage category of 3 and a pollution degree of 2 or lower according to IEC 664 specifications. Install at an altitude of 1000 m max.

(2) Protection against Foreign Matter

The degree of protection of the servo drives is IP10.

(3) Grounding

Ground the neutral point of the 400-V power supply. The leakage current may exceed 3.5 mA. Therefore, use a 10-mm^2 or thicker copper grounding wire.

(4) 24-VDC Control Power Supply

Use a 24-VDC control power supply with double insulation or reinforced insulation against primary.

12.4 Precautions for Complying with UL Standards

This drive has been tested according to UL standard UL508C, and it fully complies with the UL requirements.

To comply with the UL standard, be sure to meet the following conditions when combining this drive with other devices.

(1) Installation Location

Install the servo drive in a location with a pollution degree of 2 or lower according to UL specifications. Install at an altitude of 1000 m max.

(2) Wiring the Main Circuit Terminals

Wire the main circuit terminals with the maximum tightening toque that is given in *5.2.1 (1) Wire Sizes and Tightening Torques*.

(3) Short-circuit Rating

This servo drive has undergone UL short-circuit testing using a power supply with a current of 31,000 A maximum and a voltage of 480 V maximum.

(4) 24-VDC Control Power Supply

Use a 24-VDC control power supply with double insulation or reinforced insulation.

(5) AC Reactor

Use an AC reactor for UL compliance according to *3.3.1 (1) Specifications*.

(6) Magnetic Contactor for Winding Selection

Use a magnetic contactor for winding selection for UL compliance according to *3.3.2 (1) Specifications*.

(7) Heat Sink Cooling

To cool the heat sink, provide an air flow of 2.5 m/s in the ventilation duct or use the Base Mounting Unit from Yaskawa.
Refer to *2.3.6 Base Mounting Units* and *3.3.4 Base Mounting Units* for information on the Base Mounting Units.

(8) Grounding

Ground the neutral point of a 400-V power supply.
The leakage current may exceed 3.5 mA. Therefore, use a 10-mm^2 or thicker copper grounding wire.

13

Inspection, Maintenance, and Troubleshooting

13.1 Inspection and Maintenance

13.1.1 Spindle Motor

(1) Inspection

The following table provides explanations about the inspections required for the spindle motor. The inspection and maintenance frequencies in the table are only guidelines. Increase or decrease the frequency to suit the operating conditions and environment.

Item	Frequency	Procedure	Comments
Vibration and Noise	Daily	Touch and listen. There is no problem as long as vibration and the sound level do not increase over normal levels.	–
Exterior	According to degree of contamination	Clean with cloth or compressed air.	–
Insulation Resistance Measurement	At least once a year	Disconnect the SERVOPACK and test the insulation resistance with a 500-V resistance meter between each of the phases U, V, and W in the motor's main circuit cable and FG. Must exceed 10 MΩ.	Contact your Yaskawa representative if the insulation resistance is below 10 MΩ .
Overhaul	At least once every 12,000 hours or 2 years.	Contact your Yaskawa representative.	–

IMPORTANT

During inspection and maintenance, do not disassemble the motor.

(2) Replacement Schedule

The parts of the spindle motor have a limited service life due to mechanical wear. Perform periodic inspections for preventive maintenance. The part replacement period varies with the usage condition and usage environment. A part must be replaced if there is any problem, even if it is not yet time to replace it. Contact your Yaskawa representative if a part needs to be replaced or if the standard replacement period has elapsed.

Part	Standard Replacement Period	Remarks
Cooling fan	12,000 hours or 2 years	A part must be replaced if there is any problem, even if the standard replacement period has not yet elapsed.
Bearing		

13.1.2 Σ-V-SD Driver

(1) Inspection

For inspections and maintenance of the Σ-V-SD Driver, follow the inspection procedures in the table below at least once every year.

Item	Frequency	Procedure	Remedy
Exterior	At least once a year	Check for dust, dirt, and oil on surfaces.	Clean with compressed air or cloth.
Loose screws		Check for loose terminal block and connector screws.	Tighten any loose screws.

(2) Replacement Schedule

The following electric or electronic parts are subject to mechanical wear or deterioration over time. To avoid failure, replace these parts at the frequency indicated.

Refer to the standard replacement period in the following table, contact your Yaskawa representative. After an examination of the part in question, we will determine whether the parts should be replaced or not.

> **IMPORTANT**
> The parameters of any SERVOPACKs overhauled by Yaskawa are reset to the factory settings before shipping. The motor constants are also reset to the factory settings at the same time. Before you start operation again, make sure that you reset the parameters that are required for operation.

Part	Standard Replacement Period	Operating Conditions
Cooling Fan	4 to 5 years	• Surrounding Air Temperature: Annual average of 30°C • Load Factor: 80% max. • Operation Rate: 20 hours/day max.
Smoothing Capacitor	7 to 8 years	
Relays	–	
Fuses	10 years	
Aluminum Electrolytic Capacitor on Circuit Board	5 years	

Note: If the above operating conditions are not used, replacement may be required sooner than the standard replacement period. To extend the life of the parts, reduce the ambient temperature. Contact your Yaskawa representative if you require more-detailed information.

13.2 Troubleshooting

The following sections describe troubleshooting in response to alarm displays.

The alarm name, alarm meaning, alarm stopping method and alarm reset capability are listed in order of the alarm numbers in *13.2.1 List of Alarms*.

The causes of alarms and troubleshooting methods are provided in *13.2.2 Troubleshooting of Alarms*.

13.2.1 List of Alarms

If an alarm occurs, the motor can be stopped by doing either of the following operations.

Gr.1: The motor coasts to a stop.
Gr.2: The motor is stopped according to the setting in Pn00B.1 if an alarm occurs. Pn00B.1 is factory-set to stop the motor by setting the speed reference to "0." By setting Pn00B.1 to 1, the motor stops using the same method as Gr.1.

Available: Removing the cause of alarm and then executing the alarm reset can clear the alarm.
N/A: Executing the alarm reset cannot clear the alarm.

Alarm Display	Alarm Name	Meaning	Motor Stop Method	Alarm Reset
A.020	Parameter Checksum Error	The data of the parameter in the SERVOPACK is incorrect.	Gr.1	N/A
A.021	Parameter Format Error	The data format of the parameter in the SERVOPACK is incorrect.	Gr.1	N/A
A.022	System Checksum Error	The data of the parameter in the SERVOPACK is incorrect.	Gr.1	N/A
A.029	Motor Parameter Checksum Error	The motor parameter data in the SERVOPACK is corrupted.	Gr.1	N/A
A.02C	Converter Parameter Checksum Error	The data of the parameter in the power regeneration converter is incorrect.	Gr.1	N/A
A.02D	Converter Parameter Format Error	The format of the parameter in the power regeneration converter is incorrect.	Gr.1	N/A
A.02E	Converter System Checksum Error	The data of the parameter in the power regeneration converter is incorrect.	Gr.1	N/A
A.030	Main Circuit Detector Error	Detection data for main circuit is incorrect.	Gr.1	Available
A.040	Parameter Setting Error	The parameter setting in the SERVOPACK is outside the allowable setting range.	Gr.1	N/A
A.042	Parameter Combination Error	Combination of some parameters exceeds the setting range.	Gr.1	N/A
A.04B	Converter Parameter Setting Error	The parameter setting in the power regeneration converter is outside the allowable setting range.	Gr.1	N/A
A.050	Combination Error	The SERVOPACK and the motor capacities do not match each other.	Gr.1	Available
A.051	Unsupported Device Alarm	The device unit unsupported was connected.	Gr.1	N/A
A.052	Motor Type Setting Mismatch	The motor type/Application selection setting (Pn01E.0) does not match the motor constant written inside the SERVOPACK.	Gr.1	N/A
A.053	Winding Selection Setting Mismatch	The Winding Change Setting (Pn01E.1) does not match the motor constant written inside the SERVOPACK.	Gr.1	N/A
A.054	Unsupported Winding Selection Alarm	The combination of the SERVOPACK and spindle motor does not support winding selection.	Gr.1	N/A
A.05A	Induction Motor Combination Error	The capacity of the spindle motor is outside of the range that can be combined.	Gr.1	N/A
A.05B	Converter Combination Error	The converter and SERVOPACK are not combined correctly.	Gr.1	N/A
A.0B0	Cancelled Servo ON Command Alarm	/FWD or /REV signal was input from the host controller after the Servo ON function was used with the utility function.	Gr.1	Available

(cont'd)

Alarm Display	Alarm Name	Meaning	Motor Stop Method	Alarm Reset
A.100	Overcurrent	An overcurrent flowed through the IGBT. Heat sink of the SERVOPACK was overheated.	Gr.1	N/A
A.10A	Converter Overcurrent	An overcurrent flowed through the power transistor inside the power regeneration converter.	Gr.1	N/A
A.11A	Converter Ground Fault	A ground fault occurred inside the power regeneration converter.	Gr.1	N/A
A.22A	Converter Fuse Blowout	The fuse of the main power supply inside the power regeneration converter is blown out.	Gr.1	N/A
A.400	Overvoltage	The main circuit DC voltage inside the SERVOPACK is excessively high.	Gr.1	Available
A.40A	Converter Overvoltage	The main circuit DC voltage inside the power regeneration converter is abnormally high.	Gr.1	Available
A.40B	Converter AC Overvoltage	The AC power supply voltage inside the power regeneration converter is abnormally high.	Gr.1	Available
A.40C	Abnormal Voltage in Converter Main Circuit	An error occurred in the main circuit of the power regeneration converter.	Gr.1	Available
A.410	Undervoltage	Main circuit DC voltage is excessively low.	Gr.2	Available
A.41A	Converter DC Undervoltage	The main circuit DC voltage inside the power regeneration converter is abnormally low.	Gr.2	Available
A.41B	Converter AC Undervoltage	The AC voltage inside the power regeneration converter is abnormally low.	Gr.1	Available
A.41C	Power Failure While Motor Running	The AC power supply was cut off while the motor was running.	Gr.1	Available
A.42C	Converter Initial Charging Error	The charging of the main circuit capacitor did not finish within the specified period of time.	Gr.1	Available
A.450	Main Circuit Capacitor Overvoltage	The capacitor of the main circuit has deteriorated or is faulty.	Gr.1	N/A
A.510	Overspeed	The motor speed is excessively high.	Gr.1	Available
A.531	Excessive Speed Deviation	The deviation between the speed reference and the actual motor speed is abnormal.	Gr.1	Available
A.540	Overspeed (During Low-speed Winding)	The low-speed winding maximum rotation speed was exceeded during low-speed winding.	Gr.1	Available
A.681	Orientation Target Position Setting Error	The orientation target position (Pn810) was set outside of the setting range.	Gr.1	Available
A.690	Winding Selection Operation Fault	• During the winding selection operation check that is performed when the power is turned ON, the electromagnetic contactor for winding selection did not change according to the internal command. • Winding selection was not completed within two seconds of receiving the winding selection command. • Chattering occurred in the electromagnetic contactor for winding selection when the winding selection command was not received.	Gr.1	N/A
A.710	Overload: High Load	The motor was operating for several seconds to several tens of seconds under a torque largely exceeding ratings.	Gr.2	Available
A.720	Overload: Low Load	The motor was operating continuously under a torque largely exceeding ratings.	Gr.1	Available
A.72A	Converter Electric Operation Overload	Continuous electrical operation was performed that exceeded the rated output of the power supply regenerative converter.	Gr.2	Available
A.72B	Converter Power Supply Regenerative Overload	Continuous regenerative operation was performed that exceeded the ratings of the power regenerative converter.	Gr.1	Available
A.74A	Converter Inrush Resistance Overload	The main circuit power supply turned ON and OFF frequently.	Gr.1	Available
A.790	Motor Overheated	The motor temperature exceeded the upper limit.	Gr.1	Available

(cont'd)

Alarm Display	Alarm Name	Meaning	Motor Stop Method	Alarm Reset
A.791	Motor Temperature Detection Error	The motor thermistor is either disconnected or is damaged.	Gr.1	N/A
A.7A0	Heat Sink in SERVOPACK Overheated	The temperature of the heat sink in the SERVOPACK exceeded 100°C, or the thermistor in the SERVOPACK was disconnected or damaged.	Gr.2	Available
A.7AB	Built-in Fan in SERVOPACK Stopped*	The fan inside the SERVOPACK stopped.	Gr.1	Available
A.7AC	Built-in Fan in Converter Stopped*	The fan inside the power regeneration converter stopped.	Gr.1	Available
A.7BA	Converter Heat Sink Overheated	The heat sink inside the power regeneration converter exceeded 100°C, or the thermistor in the converter was disconnected or damaged.	Gr.2	Available
A.B11	Speed Reference A/D Data Error	A malfunction occurred in the speed reference A/D data detection section.	Gr.2	Available
A.B31	Current Detection Error1 (Phase-U)	The current detection circuit for phase-U is faulty.	Gr.1	N/A
A.B32	Current Detection Error 2 (Phase-V)	The current detection circuit for phase-V is faulty.	Gr.1	N/A
A.B33	Current Detection Error 3 (Current detector)	The detection circuit for the current is faulty.	Gr.1	N/A
A.B4A	Converter Gate Drive Output Error	An error occurred in the gate drive signal of power transistor of the power regeneration converter.	Gr.1	N/A
A.BDA	Converter CPU: AD Conversion Circuit Error	An error occurred in the A/D conversion circuit inside the power regeneration converter.	Gr.1	Available
A.BDB	Converter Reference Voltage Error 1	An error occurred in the reference voltage output inside the power regeneration converter.	Gr.1	Available
A.BDC	Converter Reference Voltage Error 2	An error occurred in the reference voltage output inside the power regeneration converter.	Gr.1	Available
A.BDD	Converter System Error 0	Internal program error 0 occurred inside the power regeneration converter.	Gr.1	N/A
A.BE0	Firmware Error	An internal program error occurred in the SERVOPACK.	Gr.1	N/A
A.BEA	Converter System Error 1	Internal program error 1 occurred inside the power regeneration converter.	Gr.1	N/A
A.BEB	Converter System Error 2	Internal program error 2 occurred inside the power regeneration converter.	Gr.1	N/A
A.BF0	System Alarm 0	Internal program error 0 occurred in the SERVOPACK.	Gr.1	N/A
A.BF1	System Alarm 1	Internal program error 1 occurred in the SERVOPACK.	Gr.1	N/A
A.BF2	System Alarm 2	Internal program error 2 occurred in the SERVOPACK.	Gr.1	N/A
A.BF3	System Alarm 3	Internal program error 3 occurred in the SERVOPACK.	Gr.1	N/A
A.BF4	System Alarm 4	Internal program error 4 occurred in the SERVOPACK.	Gr.1	N/A
A.C10	Servo Overrun Detected	The motor ran out of control.	Gr.1	Available
A.C2A	Pulse Encoder Phase C Error/ Pulse Error	The number of pulses per revolution exceeded the setting range.	Gr.1	N/A
A.C3A	Pulse Encoder Phase A Disconnection	The signal line for phase A of the pulse encoder is disconnected.	Gr.1	N/A
A.C3B	Pulse Encoder Phase B Disconnection	The signal line for phase B of the pulse encoder is disconnected.	Gr.1	N/A
A.C3C	Pulse Encoder Phase C Disconnection	The signal line for phase C of the pulse encoder is disconnected.	Gr.1	N/A

* If the fan stops, an alarm or a warning will issued in accordance with the setting of SERVOPACK parameter Pn00D.2.

(cont'd)

Alarm Display	Alarm Name	Meaning	Motor Stop Method	Alarm Reset
A.C50	Phase C Not Detected	Phase C was not detected during the first two rotations after the power supply was turned ON.	Gr.1	N/A
	Magnetic Pole Incorrect Detection	The magnetic pole could not be detected.	Gr.1	N/A
A.D00	Position Error Pulse Overflow	Position error pulses exceeded parameter (Pn520).	Gr.1	Available
A.D01	Position Error Pulse Overflow Alarm at Servo ON	Position error pulses accumulated too much.	Gr.1	Available
A.D02	Position Error Pulse Overflow Alarm by Speed Limit at Servo ON	After a position error pulse has been input, Pn529 limits the speed if the SV_ON command is received. If Pn529 limits the speed in such a state, this alarm occurs when the position references are input and the number of position error pulses exceeds the value set for parameter Pn520 (Excessive Position Error Alarm Level).	Gr.2	Available
A.E02	System Alarm 6	Internal program error 6 occurred in the SERVOPACK.	Gr.1	Available
A.EA0	SERVOPACK Failure (DRV alarm 0)	SERVOPACK alarm 0 occurred.	Gr.1	N/A
A.EA1	SERVOPACK Initial Access Error	The SERVOPACK initial access alarm occurred.	Gr.1	N/A
A.EA2	DRV Alarm 2 (SERVOPACK WDC error)	A SERVOPACK DRV alarm 0 occurs.	Gr.2	Available
A.EB1	Safety Function Signal Input Timing Error	The safety function signal input timing is faulty.	Gr.1	N/A
A.EEA	Converter Local Bus WD Error	A power regeneration converter local bus WD alarm occurred.	Gr.1	N/A
A.EEB	Converter Local Bus Communications Error	A communications error occurred during the power regeneration converter local bus communications.	Gr.1	Available
A.EF0	Local Bus Connection Error	The local bus is not connected.	Gr.1	Available
A.EF2	Local Bus Drive WD Error	A local bus watchdog alarm occurred in the SERVOPACK.	Gr.2	N/A
A.EF4	Local Bus Communications Error	An error occurred during local bus communications.	Gr.2	Available
A.F1A	Converter AC Power Supply Open Phase	The voltage was low for one second in phase L1, L2, or L3 when the main power supply was turned ON.	Gr.1	Available
A.F2A	Converter AC Power Supply Frequency Error	The power supply frequency is faulty.	Gr.1	Available
A.F2B	Converter AC Power Supply Frequency Detection Time Exceeded	The detection of the AC power supply input frequency was not completed within the set time.	Gr.1	Available
A.F3B	Converter AC Power Supply Phase Sequence Error	An error occurred in the AC power supply phase sequence.	Gr.1	N/A

13.2.2 Troubleshooting of Alarms

When an error occurs in the servo drives, LEDs on the panel operator will light up. Refer to the following table to identify the cause of an alarm and the action to be taken.

Contact your Yaskawa representative if the problem cannot be solved by the described corrective action.

Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.020: Parameter Checksum Error (The parameter data in the SERVOPACK is incorrect.)	The power supply voltage suddenly dropped.	Measure the power supply voltage.	Set the power supply voltage within the specified range, and set Fn005 to initialize the parameter.
	The power supply went OFF while changing a parameter setting.	Note the circumstances when the power supply went OFF.	Set Fn005 to initialize the parameter and then set the parameter again.
	The number of times that parameters were written exceeded the limit.	Check to see if the parameters were frequently changed through the host controller.	The SERVOPACK may be faulty. Replace the SERVOPACK. Reconsider the method of writing parameters.
	Malfunction caused by noise from the AC power supply or grounding line, static electricity noise, etc.	Turn the power supply ON and OFF several times. If the alarm still occurs, there may be noise interference.	Take countermeasures against noise.
	Gas, water drops, or cutting oil entered the SERVOPACK and caused failure of the internal components.	Check the installation conditions.	The SERVOPACK may be faulty. Replace the SERVOPACK.
	SERVOPACK failure	Turn the power supply ON and OFF several times. If the alarm still occurs, the SERVOPACK is faulty.	The SERVOPACK may be faulty. Replace the SERVOPACK.
A.021: Parameter Format Error (The data format of the parameter in the SERVOPACK is incorrect.)	The software version of SERVOPACK that caused the alarm is older than that of the written parameter.	Check SigmaWin for the Σ-V-SD (MT) to see if the set software version agrees with that of the SERVOPACK. If not, an alarm may occur.	Write the parameter of another SERVOPACK of the same model with the same software version. Then turn the power OFF and then ON again.
	SERVOPACK failure	–	The SERVOPACK may be faulty. Replace the SERVOPACK.
A.022: System Checksum Error (The parameter data in the SERVOPACK is incorrect.)	The power supply voltage suddenly dropped.	Measure the power supply voltage.	The SERVOPACK may be faulty. Replace the SERVOPACK.
	The power supply went OFF while setting an utility function.	Note the circumstances when the power supply went OFF.	The SERVOPACK may be faulty. Replace the SERVOPACK.
	SERVOPACK failure	Turn the power supply ON and OFF several times. If the alarm still occurs, the SERVOPACK is faulty.	The SERVOPACK may be faulty. Replace the SERVOPACK.

(cont'd)

Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.029: Motor Parameter Checksum Error (The motor parameter data in the SERVO-PACK is corrupted.)	Writing the motor parameters failed.	Check to see if write processing ended before the write was completed.	Write the motor parameters again.
	Motor Parameter Error	Check to see if suitable motor parameters were written.	Write suitable motor parameters.
	The power supply voltage suddenly dropped.	Measure the power supply voltage.	Set the power supply voltage within the specified range.
	The power supply went OFF while changing a motor parameter setting.	Note the circumstances when the power supply went OFF.	Write the motor parameters again.
	The number of times that motor parameters were written exceeded the limit.	Check to see if the parameters were frequently changed.	The SERVOPACK may be faulty. Repair or replace the SERVOPACK.
	Malfunction caused by noise from the AC power supply or grounding line, static electricity noise, etc.	Turn the power supply ON and OFF several times. If the alarm still occurs, there may be noise interference.	Take countermeasures against noise.
	Gas, water drops, or cutting oil entered the SERVOPACK and caused failure of the internal components.	Check the installation conditions.	The SERVOPACK may be faulty. Replace the SERVOPACK.
	SERVOPACK failure	Turn the power supply ON and OFF several times. If the alarm still occurs, the SERVOPACK is faulty.	The SERVOPACK may be faulty. Replace the SERVOPACK.
A.02C: Converter Parameter Checksum Error (The parameter data in the power regeneration converter is incorrect.)	Power regeneration converter failure	–	The power regeneration converter may be faulty. Replace the power regeneration converter.
A.02D: Converter Parameter Format Error (The parameter format in the power regeneration converter is incorrect.)	Power regeneration converter failure	–	The power regeneration converter may be faulty. Replace the power regeneration converter.
A.02E: Converter System Checksum Error (The parameter data in the power regeneration converter is incorrect.)	Power regeneration converter failure	–	The power regeneration converter may be faulty. Replace the power regeneration converter.
A.030: Main Circuit Detector Error	SERVOPACK failure	–	The SERVOPACK may be faulty. Replace the SERVOPACK.
A.040: Parameter Setting Error (The parameter setting was out of the allowable setting range.)	The SERVOPACK and motor capacities do not match each other.	Check the combination of SERVOPACK and motor capacities.	Select the proper combination of SERVOPACK and spindle motor capacities.
	SERVOPACK failure	–	The SERVOPACK may be faulty. Replace the SERVOPACK.
	The parameter setting is out of the specified range.	Check the setting ranges of the parameters that have been changed.	Set the parameter to a value within the specified range.

(cont'd)

Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.042: Parameter Combination Error	The speed of program JOG operation is lower than the setting range after having changed the setting of Pn533 "Program JOG Movement Speed."	Check that the detection conditions* is satisfied.	Increase the setting for Pn533 "Program JOG Movement Speed."
A.04B: Converter Parameter Setting Error (The parameter data in the power regeneration converter is incorrect.)	Power regeneration converter failure	–	The power regeneration converter may be faulty. Replace the power regeneration converter.
A.050: Combination Error (The SERVOPACK and motor capacities do not correspond.)	The SERVOPACK and motor capacities do not match each other.	Check the capacities to see if they satisfy the following condition: $1/4 \leq \frac{\text{Motor capacity}}{\text{SERVOPACK capacity}} \leq 4$	Select the proper combination of SERVOPACK and spindle motor capacities.
	Encoder failure	Replace the motor and see if the alarm occurs again.	Replace the spindle motor (encoder).
	SERVOPACK failure	–	The SERVOPACK may be faulty. Replace the SERVOPACK.
A.051: Unsupported Device Alarm	An unsupported pulse encoder is connected to the SERVOPACK.	Check the product specifications, and select the correct model.	Select the correct combination of units.
A.052: Motor Type Setting Mismatch (The Motor Type/Application Selection Setting (Pn01E.0) does not match the motor constant written inside the SERVOPACK.)	The Motor Type Setting (Pn01E.0) is wrong.	Check the parameter setting (Pn01E.0) and the motor that is used in combination with the SERVOPACK.	Correct the Motor Type Setting (Pn01E.0) according to the combined spindle motor.
	A mistake occurred in writing the motor constant file.	Check the model of the combined motor from the product information monitor in SigmaWin for the Σ-V-SD (MT).	Write the motor constant file in the SERVOPACK according to the combined spindle motor.
A.053: Winding Selection Setting Mismatch (The Winding Change Setting (Pn01E.1) does not match the motor constant written inside the SERVOPACK.)	The Motor Type Setting (Pn01E.0) is wrong.	Check the parameter setting (Pn01E.0) and the motor that is used in combination with the SERVOPACK.	Correct the Motor Type Setting (Pn01E.0) according to the combined spindle motor.
	The Winding Change Setting (Pn01E.1) is wrong.	Check the parameter setting (Pn01E.1) and the motor that is used in combination with the SERVOPACK.	Correct the Winding Change Setting (Pn01E.1) according to the combined motor.
	A mistake occurred in writing the motor constant file.	Check the model of the combined motor from the product information monitor in SigmaWin for the Σ-V-SD (MT).	Write the motor constant file in the SERVOPACK according to the combined spindle motor.
A.054: Unsupported Winding Selection Alarm (The combination of the SERVOPACK and motor does not support winding selection)	The combination of the SERVOPACK and motor does not allow winding selection.	–	Change the combination of the SERVOPACK and spindle motor.

* Detection Condition Formulas
An alarm is detected if either of the following two conditions is met.

- $\text{Pn533 [min}^{-1}] \times \frac{\text{Encoder resolution}}{6\times10^5} \leq 1$
- $\text{Motor max. speed [min}^{-1}] \times \frac{\text{Encoder resolution}}{\text{Approx } 3.66 \times 10^{12}} \geq 1$

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Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.05A: Induction Motor Combination Error (The capacity of the spindle motor is outside of the range that can be combined.)	The SERVOPACK capacity and spindle motor capacity are not compatible.	Check the combination of the SERVOPACK capacity and servomotor capacity.	Align the SERVOPACK capacity and spindle motor capacity.
A.05B: Converter Combination Error (The converter and SERVOPACK are not combined correctly.)	A converter that does not support an emergency stop was used with Pn01B.0 set to 1.	–	Replace the converter.
A.0B0: Cancelled Servo ON Command Alarm	After executing the utility function to turn ON the power to the motor, /FWD or /REV signal was input from the host controller.	–	Turn the SERVOPACK power supply OFF and then ON again.
A.100: Overcurrent (An overcurrent flowed through the IGBT or heat sink of SERVOPACK overheated.)	Incorrect wiring or contact fault of main circuit cable or motor main circuit cable.	Check the wiring.	Correct the wiring.
	Short-circuit or ground fault of main circuit cable or motor main circuit cable.	Check for short-circuits across the cable phase-U, -V, and -W, or between the grounding and terminal U, V, or W.	Some cables may be damaged. Replace damaged cables.
	Short-circuit or ground fault inside the motor.	Check for short-circuits across the motor terminal phase-U, -V, and -W, or between the grounding and motor terminal U, V, or W.	The motor may be faulty. Replace the spindle motor.
	Short-circuit or ground fault inside the SERVOPACK.	Check for short-circuits across the motor connection terminals U, V, and W on the SERVOPACK, or between the grounding and terminal U, V, or W.	The SERVOPACK may be faulty. Replace the SERVOPACK.
	A heavy load was applied while the motor was stopped or running at a low-speed.	Check to see if the operating conditions are outside servo drive specifications.	Reduce the load applied to the spindle motor or increase the operation speed.
	Malfunction caused by noise interference.	Improve the wiring or installation environment, such as by reducing noise, and check to see if the alarm recurs.	Take countermeasures for noise, such as correct wiring of the FG. Use an FG wire size equivalent to the SERVOPACK main circuit wire size.
	SERVOPACK failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.

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Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.10A: Converter Overcurrent (An overcurrent flowed through the power transistor inside the power regeneration converter.)	A mistake occurred when selecting the power regeneration converter capacity.	Check the power regeneration converter capacity and the total output capacity of the SERVOPACK.	Change the power regeneration converter capacity.
	An unmatched AC reactor is used.	–	Use the specified AC reactor.
	The main circuit cable is either incorrectly wired or has a contact fault.	Make sure the wiring is correct.	Correct the wiring.
	A short-circuit or ground fault occurred in the main circuit cable.	Check for short-circuits across phase R, S, and T of the cable, or between the ground and phase R, S, or T.	The cable may have short-circuited. Replace the cable.
	A short-circuit or ground fault occurred in the power regeneration converter.	Check for short-circuits across phase R, S, and T of the main circuit power supply connection terminal of the power regeneration converter, or between the ground and phase R, S, or T.	The power regeneration converter may be faulty. Replace the power regeneration converter.
	Malfunction caused by noise.	Improve the noise environment, including the wiring and installation, and check to see if the alarm occurs again.	Take measures against noise, such as wiring the FG correctly. Match the FG wire size with the SERVOPACK main circuit wire size.
	A short-circuit or ground fault occurred in the AC reactor.	–	The AC reactor may be faulty. Replace the AC reactor.
	Power regeneration converter failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
A.11A: Converter Ground Fault (A ground fault occurred.)	Ground fault of motor cable	Check for short-circuits between the cable phase-U, -V, and -W and the grounding.	The cable may be faulty. Replace the cable.
	Ground fault inside the motor	Check for short-circuits between the motor terminals U, V, and W and the grounding.	The motor may be faulty. Replace the spindle motor.
	Ground fault of main circuit in the SERVOPACK	Check for short-circuits between the motor connection terminals U, V, and W on the SERVOPACK and the grounding, or between terminals P and N and the grounding.	The SERVOPACK may be faulty. Replace the SERVOPACK.
	Ground fault of main circuit in the power regeneration converter	Check for short-circuits between the power connection terminals L1, L2, and L3 on the power regeneration converter and the grounding, or between terminals P and N and the grounding.	The power regeneration converter may be faulty. Replace the power regeneration converter.
	Power regeneration converter failure	Turn the control power ON and check if an alarm occurs.	If an alarm occurs after turning the control power ON, the power regeneration converter may be faulty. Replace the power regeneration converter.
A.22A: Converter Fuse Blowout (The fuse of the main power supply inside the power regeneration converter is blown out.)	The fuse of the main power supply inside the power regeneration converter is blown out.	–	Replace the power regeneration converter.

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Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.400: Overvoltage (The main circuit DC voltage inside the SERVOPACK is abnormally high.)	• For 200 VAC SERVOPACKs with DC power supply input: The power supply voltage exceeded 410 V. • For 400 VAC SERVOPACKs with DC power supply input: The power supply voltage exceeded 820 V.	Measure the power supply voltage.	Set AC/DC power supply voltage within the specified range.
	The power supply is unstable, or was influenced by a lightning surge.	Measure the power supply voltage.	Improve the power supply conditions, and turn the power supply ON again after installing a surge absorber. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
	Acceleration/deceleration was executed under the following conditions. • The AC power supply voltage of 200 VAC SERVOPACK was in the range between 230 V and 270 V. • The AC power supply voltage of 400 VAC SERVOPACK was in the range between 480 V and 560 V.	Check the power supply voltage and the speed and torque during operation.	Set AC power supply voltage within the specified range.
	The moment of inertia exceeded the allowable value.	Confirm that the moment of inertia ratio is within the allowable range.	Increase the deceleration time, or reduce the load.
	SERVOPACK failure	–	Turn the control power OFF and then ON again while the main circuit power supply is OFF. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.

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Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.40A: Converter Overvoltage (The main circuit DC voltage inside the converter is abnormally high.)	• For 200 V power regeneration converter with DC power supply input: The power voltage exceeded 410 V. • For 400 V power regeneration converter with DC power supply input: The power voltage exceeded 820 V.	Measure the power supply voltage.	Set the AC/DC power supply voltage within the specified range.
	The power supply is unstable, or was influenced by a lightening surge.	Measure the power supply voltage.	Improve the power supply conditions, and turn ON the power supply again after installing a surge absorber. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
	Acceleration/deceleration was executed under the following conditions. • The AC power supply voltage of 200 VAC SERVOPACK was in the range between 230 V and 270 V. • The AC power supply voltage of 400 VAC SERVOPACK was in the range is between 480 V and 560 V.	Check the power supply voltage and the speed and torque during operation.	Set the AC power supply voltage within the specified range.
	The moment of inertia exceeded the allowable value in the SERVOPACK connected to the power regeneration converter.	Make sure the moment of inertia ratio is within the allowable range.	Increase the deceleration time, or reduce the load.
	A mistake occurred when selecting the power regeneration converter capacity.	Check the power regeneration converter capacity and the total output capacity of the SERVOPACK.	Change the power regeneration converter capacity.
	Power regeneration converter failure	–	Turn OFF the control power and then turn it ON again while the main circuit power supply is OFF. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
A.40B: Converter AC Overvoltage (The AC power supply voltage inside the converter is abnormally high.)	The main circuit cable is either incorrectly wired or has a contact fault.	Make sure the wiring is correct.	Correct the wiring.
	The main circuit power supply voltage is higher than the specified range.	Measure the AC power supply voltage.	Set the voltage to an appropriate value.
	An error occurred in the AC voltage detection circuit inside the power regeneration converter.	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.

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Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.40C: Abnormal Voltage in Converter Main Circuit (An error occurred in the main circuit of the power regeneration converter.)	The AC voltage is unstable.	Measure the AC power supply voltage.	Improve the power supply conditions.
	The DC bus voltage is unstable, or an error occurred in the main circuit in the SERVOPACK.	Measure the DC bus power supply voltage.	The SERVOPACK may be faulty. Replace the SERVOPACK.
	The DC bus voltage is unstable, or an error occurred in the main circuit in the power regeneration converter.	Measure the DC bus power supply voltage.	The power regeneration converter may be faulty. Replace the power regeneration converter.
	An error occurred in the AC/DC voltage detection circuit in the power regeneration converter.	–	The power regeneration converter may be faulty. Replace the power regeneration converter.
A.410: Undervoltage (The DC voltage inside the SERVOPACK is low.)	• For 200 VAC SERVOPACKs: The power supply voltage was in the range between 125 V and 170 V. • For 400 VAC SERVOPACKs: The power supply voltage was in the range between 250 V and 323 V.	Measure the power supply voltage.	Set the power supply voltage within the specified range.
	The power supply voltage dropped during operation.	Measure the power supply voltage.	Increase the power supply capacity.
	Occurrence of instantaneous power interruption.	Measure the power supply voltage.	Improve the power supply conditions.
	SERVOPACK failure	–	The SERVOPACK may be faulty. Replace the SERVOPACK.
A.41A: Converter DC Undervoltage (The DC voltage inside the power regeneration converter is low.)	• For 200 VAC power regeneration converter: The power supply voltage was in the range between 125 V and 170 V. • For 400 VAC power regeneration converter: The power supply voltage was in the range between 250 V and 323 V.	Measure the power supply voltage.	Set the power supply voltage within the specified range.
	The wiring of the main circuit DC bus is incorrect.	Check the wiring.	Correct the wiring of the main circuit DC bus.
	An error occurred in the main circuit of the SERVOPACK connected to the converter.	Separate the main circuit DC bus of the SERVOPACK.	Separate the SERVOPACK and then turn ON the power supply again. If an alarm does not occur, the SERVOPACK may be faulty. Replace the SERVOPACK.
	Power regeneration converter failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.

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Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.41B: Converter AC Undervoltage (The AC voltage inside the power regeneration converter is low.)	• For 200 VAC power regeneration converter: The power supply was in the range between 50 V to 125 V. • For 400 VAC power regeneration converter: The power supply was in the range between 100 V to 250 V.	Measure the power supply voltage.	Set AC power supply voltage within the specified range.
	Power regeneration converter failure	–	If an alarm occurs after turning the correct power ON, the power regeneration converter may be faulty. Replace the power regeneration converter.
A.41C: Power Failure While Motor Running (The AC power supply was cut off while the motor was running.)	A power failure occurred.	–	Turn the power supply OFF and then ON again.
	The AC power supply was disconnected by the main circuit contactor.	Check the main circuit contactor and NFB.	Turn OFF the AC power supply and then turn it ON again.
	The AC voltage is unstable during the operation. • For 200 VAC power regeneration converter: The power supply was 50 V or less. • For 400 VAC power regeneration converter: The power supply was 100 V or less.	Measure the power supply voltage.	Set AC power supply voltage within the specified range.
	Power regeneration converter failure	–	If an alarm occurs after turning the correct power ON, the power regeneration converter may be faulty. Replace the power regeneration converter.
A.42C: Converter Initial Charging Error (Charging of the main circuit capacitor did not finish within the specified period of time.)	The main circuit cable is either incorrectly wired or has a contact fault.	Make sure the wiring is correct.	Correct the wiring.
	The wiring of the main circuit DC bus is incorrect.	Check the wiring.	Correct the wiring of the main circuit DC bus.
	An error occurred in the main circuit of the SERVOPACK connected to the converter.	Separate the main circuit DC bus of the SERVOPACK.	Separate the SERVOPACK and then turn ON the power supply again. If an alarm does not occur, the SERVOPACK may be faulty. Replace the SERVOPACK.
	Converter rapid discharge circuit failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
	The AC-DC conversion circuit inside the power regeneration converter has failed.	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
A.450: Main Circuit Capacitor Overvoltage (The capacitor of the main circuit has deteriorated or is faulty.)	Main circuit capacitor failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
	An error occurred in the main circuit detection circuit.		

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Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.510: Overspeed (The motor speed exceeds the maximum.)	The order of phases U, V, and W in the motor wiring is incorrect.	Check the motor wiring.	Confirm that the spindle motor is correctly wired.
	A reference value exceeding the overspeed detection level was input.	Check the input value.	Reduce the reference value or adjust the gain.
	The motor speed exceeded the maximum.	Check the motor speed waveform.	Adjust the servo gain, or reconsider the operation conditions.
	SERVOPACK failure	–	The SERVOPACK may be faulty. Replace the SERVOPACK.
A.531: Excessive Speed Deviation (The deviation between the speed reference and actual motor speed is abnormal.)	The motor main circuit cable is either incorrectly wired or has a contact fault.	Make sure the wiring is correct.	Correct the wiring.
	A short-circuit or ground fault occurred in the motor main circuit cable.	Check for short-circuits across phase U, V, and W of the cable, or between the ground and phase U, V, or W.	The cable may have short-circuited. Replace the cable.
	The load is heavy (for example, the cutting resistance may be high).	Check to see if the load friction is high and the moment of inertia of the load is too high.	Remove the load.
A.540: Overspeed (During Low-speed Winding) (The low-speed winding maximum speed was exceeded during low-speed winding.)	The sequence of phase U, V, and W motor lines is incorrect.	Check the wiring of the motor and of the electromagnetic contactor for winding selection.	Correct the spindle motor wiring.
	The reference input value exceeds the maximum speed of the low-speed winding.	Check the input reference.	Reduce the reference value, or adjust the gain.
	The low-speed winding maximum rotation speed was exceeded during low-speed winding.	Check the motor speed from the motor speed monitor in SigmaWin for the Σ-V-SD (MT).	Adjust the gain, or revise the operating conditions.
	SERVOPACK failure	–	The SERVOPACK may be faulty. Replace the SERVOPACK.
A.681: Orientation Target Position Setting Error (The orientation target position (Pn810) was set outside of the setting range.)	The setting exceeds the reference pulses per machine rotation (Pn817).	–	Correct the value of Pn810. (Change it to a value that is equal to or less than Pn817.)
A.690: Winding Selection Operation Fault	During the winding selection check that is performed when the power is turned ON, the electromagnetic contactor for winding selection did not change according to the internal command.	Check the wiring of the SERVOPACK and of the electromagnetic contactor for winding selection.	Correct the wiring of the winding selection signal.
	Winding selection was not completed within two seconds of receiving the winding selection command.	Check the wiring of the electromagnetic contactor for winding selection.	Correct the wiring of the electromagnetic contactor for winding selection.
	Chattering occurred in the electromagnetic contactor for winding selection when the winding selection command was not received.	Check the wiring of the electromagnetic contactor for winding selection.	Correct the wiring of the electromagnetic contactor for winding selection, or replace the electromagnetic contactor for winding selection.

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Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.710: A.720: Overload A.710: High Load A.720: Low Load	Incorrect wiring or contact fault of motor and encoder.	Check the wiring.	Confirm that the motor and encoder are correctly wired.
	Operation beyond the overload protection characteristics.	Check the motor overload characteristics and command.	Reconsider the load conditions and operation conditions. Or, increase the spindle motor capacity.
	Excessive load was applied during operation because the motor was not driven due to mechanical problems.	Check the command and motor speed.	Remove the mechanical problems.
	SERVOPACK failure	–	The SERVOPACK may be faulty. Replace the SERVOPACK.
A.72A: Converter Electric Operation Overload (A continuous operation drew power at a rate that exceeded the rated output of the power regeneration converter.)	The sequence of phase U, V, and W motor lines is incorrect.	Check the wiring of the motor's main circuit cable.	Correct the motor wiring.
	The motor main circuit cable is either incorrectly wired or has a contact fault.	Make sure the wiring is correct.	Correct the wiring.
	A mistake occurred when selecting the power regeneration converter capacity.	Check the power regeneration converter capacity and the total output capacity of the SERVOPACK.	Change the power regeneration converter capacity.
	Converter current detection circuit failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
	The AC power supply voltage is low.	Measure the power supply voltage.	Set AC power supply voltage within the specified range.
A.72B: Converter Power Supply Regenerative Overload (Continuous power regeneration exceeded the ratings of the power regeneration converter.)	A mistake occurred when selecting the power regeneration converter capacity.	Check the power regeneration converter capacity and the total output capacity of the SERVOPACK.	Change the power regeneration converter capacity.
	The AC power supply voltage is low.	Measure the power supply voltage.	Set AC power supply voltage within the specified range.
	Power regeneration converter failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
A.74A: Converter Inrush Resistance Overload (The main circuit power supply turned ON and OFF frequently.)	The main circuit power supply turned ON and OFF frequently.	Check the ON/OFF sequence of the main circuit power supply.	Change the sequence and operation pattern such that the main circuit power supply does not turn ON and OFF frequently.
	Inrush limit circuit failure	–	Turn the power supply OFF and then ON again after cooling the power regeneration converter to the ambient temperature. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
A.790: Motor Overheated (The motor temperature has exceeded the upper limit.)	The ambient temperature around the motor is high.	Check the ambient temperature around the motor.	Make sure the ambient temperature around the motor does not increase.
	Acceleration and deceleration were repeated frequently.	–	Make the acceleration/deceleration of the motor smoother, or change the operation pattern.

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Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.791: Motor Temperature Detection Error (The motor thermistor is either disconnected or is damaged.)	The cable between the SERVOPACK and spindle motor is either disconnected or has a contact fault.	Make sure the wiring is not disconnected and no contact fault exists.	Correct the wiring.
	The thermistor wiring in the spindle motor is disconnected.	–	The spindle motor may be faulty. Replace the spindle motor.
	The thermistor has failed.	–	The spindle motor may be faulty. Replace the spindle motor.
A.7A0: Heat Sink in SERVOPACK Overheated (The temperature of the heat sink in the SERVOPACK exceeded 100°C, or the thermistor in the SERVOPACK was disconnected or damaged.)	The operating ambient temperature is too high.	Check the ambient temperature using a thermometer.	Improve the installation conditions of the SERVOPACK and reduce the operating ambient temperature.
	The overload alarm has been reset by turning OFF the power too many times.	Check the alarm history to see if the overload alarm of the SERVOPACK was reported.	Change the method for resetting the alarm.
	The installation orientation of the SERVOPACK is incorrect or the distance from other equipment is insufficient.	Check the installation conditions of the SERVOPACK.	Install the SERVOPACK correctly as specified.
	SERVOPACK failure	–	The SERVOPACK may be faulty. Replace the SERVOPACK.
A.7AB: Built-in Fan in SERVOPACK Stopped	The fan inside the SERVOPACK stopped.	Check for foreign matter or debris inside the SERVOPACK.	Remove foreign matter. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
A.7AC: Built-in Fan in Converter Stopped (The fan inside the power regeneration converter stopped.)	The fan inside the power regeneration converter stopped.	Check for foreign matter or debris inside the power regeneration converter.	Remove the foreign matter. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
A.7BA: Converter Heat Sink Overheated (The temperature of the heat sink inside the power regeneration converter exceeded 100°C, or the thermistor in the converter was disconnected or damaged.)	The operating ambient temperature is high.	Check the operating ambient temperature using a thermometer.	Improve the installation conditions of the power regeneration converter and reduce the operating ambient temperature.
	The overload alarm has been reset by turning OFF the power too many times.	–	Remove the cause of the overload alarm.
	Either the load is in excess or operation is performed beyond the power regeneration processing capacity.	–	Review the load and operation conditions.
	The installation orientation of the power regeneration converter is incorrect or the distance from other equipment is insufficient.	Check the installation conditions of the power regeneration converter.	Install the power regeneration converter correctly as specified.
	Power regeneration converter failure	–	The power regeneration converter may be faulty. Replace the power regeneration converter.
A.B11: Speed Reference A/D Data Error (A malfunction occurred in the speed reference A/D data detection section.)	A malfunction occurred in the speed reference input section.	–	Reset the alarm and restart operation.
	SERVOPACK failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
A.B31: Current Detection Error 1 (Phase-U)	The current detection circuit for phase U is faulty.	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.

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Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.B32: Current Detection Error 2 (Phase-V)	The current detection circuit for phase V is faulty.	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
A.B33: Current Detection Error 3 (Current detector)	The detection circuit for the current is faulty.	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
	The motor main circuit cable is disconnected.	Check for disconnection of the motor main circuit cable.	Correct the motor wiring.
A.B4A: Converter Gate Drive Output Error	The gate drive signal output circuit of power transistor of the power regeneration converter has failed.	–	The power regeneration converter may be faulty. Replace the power regeneration converter.
A.BDA: Converter CPU: AD Conversion Circuit Error (An error occurred in the A/D conversion circuit inside the power regeneration converter.)	Power regeneration converter failure	–	The power regeneration converter may be faulty. Replace the power regeneration converter.
A.BDB: Converter Reference Voltage Error 1 (An error occurred in the reference voltage output in the power regeneration converter.)	Power regeneration converter failure	–	The power regeneration converter may be faulty. Replace the power regeneration converter.
A.BDC: Converter Reference Voltage Error 2 (An error occurred in the reference voltage output inside the power regeneration converter.)	Power regeneration converter failure	–	The power regeneration converter may be faulty. Replace the power regeneration converter.
A.BDD: Converter System Error 0	Power regeneration converter failure	–	The power regeneration converter may be faulty. Replace the power regeneration converter.
A.BE0: Firmware Error	SERVOPACK failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
A.BEA: Converter System Error 1	Power regeneration converter failure	–	The power regeneration converter may be faulty. Replace the power regeneration converter.
A.BEB: Converter System Error 2	Power regeneration converter failure	–	The power regeneration converter may be faulty. Replace the power regeneration converter.
A.BF0: System Alarm 0	SERVOPACK failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
A.BF1: System Alarm 1	SERVOPACK failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.

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Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.BF2: System Alarm 2	SERVOPACK failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
A.BF3: System Alarm 3	SERVOPACK failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
A.BF4: System Alarm 4	SERVOPACK failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
A.C10: Servo Overrun Detected (Detected when the motor power is ON.)	The order of phases U, V, and W in the motor wiring is incorrect.	Check the motor wiring.	Confirm that the spindle motor is correctly wired.
	Encoder failure	–	If the alarm still occurs after turning the power OFF and then ON again, even though the spindle motor is correctly wired, the spindle motor may be faulty. Replace the spindle motor.
	SERVOPACK failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
A.C2A: Pulse Encoder Phase C Error/Pulse Error	An error occurred in the feedback pulse count of the pulse encoder.	Check the signal wiring of the pulse encoder.	Correct the wiring of the pulse encoder.
	Malfunction caused by noise.	Improve the noise environment, including the wiring and installation, and check to see if the alarm occurs again.	Install the pulse encoder cable away from the peripheral equipment, or add a ferrite core.
A.C3A: Pulse Encoder Phase A Disconnection	The signal line for phase A of the pulse encoder is disconnected.	Check the signal wiring of the pulse encoder.	Correct the wiring of the pulse encoder.
A.C3B: Pulse Encoder Phase B Disconnection	The signal line for phase B of the pulse encoder is disconnected.	Check the signal wiring of the pulse encoder.	Correct the wiring of the pulse encoder.
A.C3C: Pulse Encoder Phase C Disconnection	The signal line for phase C of the pulse encoder is disconnected.	Check the signal wiring of the pulse encoder.	Correct the wiring of the pulse encoder.

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Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.C50: Phase C Not Detected	The phase C signal of the pulse encoder is not wired correctly.	Check the signal wiring of the pulse encoder.	Correct the wiring of the pulse encoder.
	Pulse encoder error	Check the phase C signal of the pulse encoder.	The pulse encoder may have failed. Replace the motor.
A.C50: Magnetic Pole Incorrect Detection	The parameters are not set correctly.	Check the encoder specifications and the feedback signal status.	Set the power torque limit in Pn430 and the regeneration torque limit in Pn431 correctly.
	Noise is entering on the encoder signal.	Check to see if the FG on the servomotor is connected to the FG on the SERVOPACK and that the FG on the SERVOPACK is connected to the FG on the power supply. Also, make sure that the encoder cable is shielded properly. Check to see if the detection command is being given repeatedly in the same direction.	Correct the shield on the encoder cable. Correct the FG wiring.
	An external force was applied to the motor's rotor.	–	Reduce the external force to about 10% or less of the motor's rated torque.
	The resolution of the encoder is too low.	–	Increase the magnetic pole detection command speed in Pn493.
A.D00: Position Error Pulse Overflow (Position error exceeded the value set in the excessive position error alarm level (Pn520))	The contact in the motor U, V, and W wirings is faulty.	Check the motor main circuit cable connection.	Confirm that there is no contact fault in the motor wiring of encoder wiring.
	The set value of the Orientation Acceleration Constant (Pn813) or the Orientation Deceleration Constant (Pn815) is too large.	–	Set suitable values for the Pn813 and Pn815 parameters.
	Setting of the Pn520 (Excessive Position Error Alarm Level) is low against the operating condition.	Check the alarm level (Pn520) to see if it is set to an appropriate value.	Set the Pn520 to proper value.
	SERVOPACK failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
A.D01: Position Error Pulse Overflow Alarm at Servo ON	The SV_ON command is received when the number of position error pulses is greater than the set value of Pn526 while the motor power is OFF.	Check the error counter monitor in SigmaWin for the Σ-V-SD (MT) while the motor power is OFF.	Correct the excessive position error alarm level at servo ON (Pn526).
A.D02: Position Error Pulse Overflow Alarm by Speed Limit at Servo ON	After a position error pulse has been input, Pn529 limits the speed if the SV_ON command is received. If Pn529 limits the speed in such a state, this alarm occurs when the position references are input and the number of position error pulses exceeds the value set for parameter Pn520 (Excessive Position Error Alarm Level).	–	Correct the excessive position error alarm level (Pn520). Or, adjust the speed limit level at servo turns ON (Pn529).
A.E02: System Alarm 6	SERVOPACK failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.

(cont'd)

Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.EA0: SERVOPACK Failure (DRV alarm 0) (SERVOPACK alarm 0 occurred.)	SERVOPACK failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
A.EA1: SERVOPACK Initial Access Error (The SERVOPACK initial access alarm occurred.)	SERVOPACK failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
A.EA2: DRV Alarm 2 (SERVOPACK WDC error)	SERVOPACK failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
A.EB1: Safety Function Signal Input Timing Error	The lag between activations of the two input signals /HWBB1 and /HWBB2 for the HWBB function is 10 seconds or more.	Measure the time lag between the /HWBB1 and /HWBB2 signals.	The output signal circuits or devices for /HWBB1 and /HWBB2 or the SERVOPACK input signal circuits may be faulty. Alternatively, the input signal cables may be disconnected. Repair or replace them.
A.EEA: Converter Local Bus WD Error (A power regeneration converter local bus WD alarm occurred.)	The local bus cable of the power regeneration converter is either disconnected or a has a contact fault.	Check the local bus cable.	Either re-install the local bus cable or replace it.
	Malfunction caused by noise	Improve the noise environment, including the wiring and installation, and check to see if the alarm occurs again.	Install the local bus cable away from the peripheral equipment, or replace it with a cable that has a ferrite core.
	The terminator circuit inside the power regeneration converter has failed.	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
A.EEB: Converter Local Bus Communications Error (A communications error occurred in the power regeneration converter local bus.)	The local bus cable of the power regeneration converter is either disconnected or a has a contact fault.	Check the local bus cable.	Either re-install the local bus cable or replace it.
	Malfunction caused by noise	Improve the noise environment, including the wiring and installation, and check to see if the alarm occurs again.	Install the local bus cable away from the peripheral equipment, or replace it with a cable that has a ferrite core.
	The terminator circuit inside the power regeneration converter has failed.	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.

(cont'd)

Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.EF0: Local Bus Connection Error (An error occurred in the local bus connection.)	The local bus cable is either disconnected or has a contact fault.	Check the local bus cable.	Either re-install the local bus cable or replace it.
	Malfunction caused by noise	Improve the noise environment, including the wiring and installation, and check to see if the alarm occurs again.	Install the local bus cable away from the peripheral equipment, or replace it with a cable that has a ferrite core.
	The local bus terminator is not installed.	Make sure the local bus terminator is installed at the terminal SERVOPACK.	Install the terminator.
	Terminator circuit failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter or the terminator may be faulty. Replace the power regeneration converter or the terminator.
A.EF2: Local Bus Drive WD Error (A local bus watchdog alarm occurred in the SERVOPACK.)	Malfunction caused by noise	Improve the noise environment, including the wiring and installation, and check to see if the alarm occurs again.	Install the local bus cable away from the peripheral equipment, or replace it with a cable that has a ferrite core.
	The local bus terminator is not installed.	Make sure the local bus terminator is installed at the terminal SERVOPACK.	Install the terminator.
	Terminator circuit failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter or the terminator may be faulty. Replace the power regeneration converter or the terminator.
A.EF4: Local Bus Communications Error (An error occurred during the local bus communications.)	An error occurred during local bus communications.	Check the insertion of connector of the local bus cable and the cable wiring.	The local bus cable may be faulty. Replace the local bus cable.
			The SERVOPACK may be faulty. Replace the SERVOPACK.
A.F1A: Converter AC Power Supply Open Phase (The voltage was low for one second on phase L1, L2, or L3 when the main power supply was turned ON.)	The three-phase power supply wiring is faulty.	Check the power supply wiring.	Make sure the power supply wiring is correct.
	The three-phase power supply is unbalanced.	Measure the voltage for each phase of the three-phase power supply.	Balance the power supply by changing phases.
	Power regeneration converter failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
A.F2A: Converter AC Power Supply Frequency Error (The deviation in the power supply frequency is large.)	The three-phase power supply wiring is faulty.	Check the power supply wiring.	Make sure the power supply wiring is correct.
	The three-phase power supply is unbalanced.	Measure the voltage for each phase of the three-phase power supply.	Balance the power supply by changing phases.
	An error occurred in the frequency of the three-phase power supply.	Measure the frequency of the three-phase power supply.	Make sure the power supply wiring is correct.
	Power regeneration converter failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.

(cont'd)

Alarm: Alarm Name	Cause	Investigative Actions	Corrective Actions
A.F2B: Converter AC Power Supply Frequency Detection Time Exceeded (The detection of the AC power supply input frequency was not completed within the set time.)	The three-phase power supply wiring is faulty.	Check the power supply wiring.	Make sure the power supply wiring is correct.
	The three-phase power supply is unbalanced.	Measure the voltage for each phase of the three-phase power supply.	Balance the power supply by changing phases.
	An error occurred in the frequency of the three-phase power supply.	Measure the frequency of the three-phase power supply.	Make sure the power supply wiring is correct.
	Power regeneration converter failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
A.F3B: Converter AC Power Supply Phase Sequence Error (An error occurred in the AC power supply phase sequence.)	The three-phase power supply wiring is faulty.	Check the power supply wiring.	Make sure the power supply wiring is correct.
	The phases of the three-phase power supply was different before and after an instantaneous power interruption.	–	Modify the power supply so that the phases remain fixed.
	Power regeneration converter failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.

13.3 Warning Displays

The following sections describe troubleshooting in response to warning displays.

The warning name and warning meaning are listed in order of the warning numbers in *13.3.1 List of Warnings*.

The causes of warnings and troubleshooting methods are provided in *13.3.2 Troubleshooting of Warnings*.

13.3.1 List of Warnings

This section provides list of warnings.

Warning Number	Warning Name	Meaning	Reset
A.900	Position Error Overflow	Position error exceeded the parameter setting (Pn520×Pn51E/100).	Required
A.901	Position Error Overflow Alarm at Servo ON	When the motor power turns ON, the position error exceeded the parameter setting (Pn526×Pn528/100).	Required
A.910	Overload	This warning occurs before the overload alarms (A.710 or A.720) occur. If the warning is ignored and operation continues, an overload alarm may occur.	Required
A.91A	Converter Electric Operation Overload	This warning occurs before the converter electric operation overload alarm (A.72A) occurs. If the warning is ignored and operation continues, a converter electric operation overload alarm may occur.	Required
A.91B	Converter Power Supply Regenerative Overload	This warning occurs before the converter power supply regenerative overload alarm (A.72B) occurs. If the warning is ignored and operation continues, a converter power supply regenerative overload alarm may occur.	Required
A.923[*1]	Built-in Fan in SERVOPACK Stopped	The fan inside the SERVOPACK stopped.	Required
A.92B[*2]	Built-in Fan in Converter Stopped	The fan inside the power regeneration converter stopped.	Required
A.941	Parameter Needing Power Restart After Change	A parameter that requires restarting the power of the SERVOPACK to update was changed.	Required
A.971	Undervoltage	This warning occurs before undervoltage alarm (A.410) occurs. If the warning is ignored and operation continues, an undervoltage alarm may occur.	Required
A.97D	Converter Heat Sink Overheated	This warning occurs before the converter heat sink overheated alarm (A.7BA) occurs. If the warning is ignored and operation continues, a converter heat sink overheated alarm may occur.	Required
A.980	Motor Overheated	This warning occurs before the motor overheated alarm (A.790) occurs. If the warning is ignored and operation continues, a motor overheated alarm may occur.	Required

*1. This warning will occur only when PN00D.2 is set to 1 in the SERVOPACK.
*2. This warning will occur only when PN00D.2 is set to 1 in the SERVOPACK. If Pn00D.2 is set to 1 in any of the SERVOPACKs, this warning is detected for all axes when the servo is turned ON.
Note: If Pn008.2 = 1 (does not detect warning) is selected, any warnings from the SERVOPACK will be ignored.

13.3.2 Troubleshooting of Warnings

Refer to the following table to identity the cause of a warning and the action to be taken. Contact your Yaskawa representative if the problem cannot be solved by the described corrective action.

Warning No.: Warning Name (Warning Description)	Cause	Investigative Actions	Corrective Actions
A.900: Position Error Overflow	The motor U, V, and W wirings is faulty.	Check the motor main circuit cable connection.	Confirm that there is no contact fault in the motor wiring or encoder wiring.
	The SERVOPACK gain is too low.	Check the SERVOPACK gain.	Increase the servo gain.
	The position reference acceleration is too fast.	Reduce the reference acceleration, and operate the SERVOPACK.	Reduce the reference acceleration.
	Setting of the excessive position error alarm level (Pn520) is low against the operating condition.	Check the alarm level (Pn520) to see if it is set to an appropriate value.	Set the Pn520 to proper value.
	SERVOPACK failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
A.901: Position Error Overflow Alarm at Servo ON	When the spindle motor power turns ON, the position error exceeded the parameter setting (Pn526 × Pn528/100).	–	Correct the excessive position error warning level at servo ON (Pn528).
A.910: Overload (Warning before alarm A.710 or A.720 occurs)	Incorrect wiring or contact fault of spindle motor and encoder.	Check the wiring.	Confirm that the spindle motor and encoder are correctly wired.
	Operation beyond the overload protection characteristics.	Check the spindle motor overload characteristics and executed run command.	Reconsider the load conditions and operating conditions. Or, increase the motor capacity.
	Excessive load was applied during operation because the spindle motor was not driven due to mechanical problems.	Check the executed operation reference and motor speed.	Remove the mechanical problems.
	SERVOPACK failure	–	The SERVOPACK may be faulty. Replace the SERVOPACK.

(cont'd)

Warning No.: Warning Name (Warning Description)	Cause	Investigative Actions	Corrective Actions
A.91A: Converter Electric Operation Overload	The sequence of phase U, V, and W motor lines is incorrect.	Check the wiring of the motor's main circuit cable.	Correct the motor wiring.
	The motor main circuit cable is either incorrectly wired or has a contact fault.	Make sure the wiring is correct.	Correct the wiring.
	A mistake occurred when selecting the power regeneration converter capacity.	Check the power regeneration converter capacity and the total output capacity of the SERVOPACK.	Change the power regeneration converter capacity.
	Converter current detection circuit failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
	The AC power supply voltage is low.	Measure the power supply voltage.	Set AC power supply voltage within the specified range.
A.91B: Converter Power Supply Regenerative Overload	A mistake occurred when selecting the power regeneration converter capacity.	Check the power regeneration converter capacity and the total output capacity of the SERVOPACK.	Change the power regeneration converter capacity.
	The AC power supply voltage is low.	Measure the power supply voltage.	Set AC power supply voltage within the specified range.
	Power regeneration converter failure	–	Turn the power supply OFF and then ON again. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
A.923: Built-in Fan in SERVOPACK Stopped	The fan inside the SERVOPACK stopped.	Check for foreign matter or debris inside the SERVOPACK.	Remove foreign matter. If the alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.
A.92B: Built-in Fan in Converter Stopped	The fan inside the power regeneration converter stopped.	Check for foreign matter or debris inside the power regeneration converter.	Remove the foreign matter. If the alarm still occurs, the power regeneration converter may be faulty. Replace the power regeneration converter.
A.941: Parameter Needing Power Restart After Change	A parameter that requires restarting the power of the SERVOPACK to update was changed.	–	Restart the power supply.

(cont'd)

Warning No.: Warning Name (Warning Description)	Cause	Investigative Actions	Corrective Actions
A.971: Undervoltage	• For 200-VAC SERVOPACKs: The AC power supply voltage was in the range between 125 V and 170 V. • For 400-VAC SERVOPACKs: The AC power supply voltage was in the range between 250 V and 323 V.	Measure the power supply voltage.	Set the power supply voltage within the specified range.
	The power supply voltage dropped during operation.	Measure the power supply voltage.	Increase the power supply capacity.
	Occurrence of instantaneous power interruption.	Measure the power supply voltage.	Improve the power supply conditions.
	SERVOPACK failure	–	The SERVOPACK may be faulty. Replace the SERVOPACK.
A.97D: Converter Heat Sink Overheated	The operating ambient temperature is high.	Check the operating ambient temperature using a thermometer.	Improve the installation conditions of the power regeneration converter and reduce the operating ambient temperature.
	The overload alarm has been reset by turning OFF the power too many times.	–	Remove the cause of the overload alarm.
	Either the load is in excess or operation is performed beyond the power regeneration processing capacity.	–	Review the load and operation conditions.
	The installation orientation of the power regeneration converter is incorrect or the distance from other equipment is insufficient.	Check the installation conditions of the power regeneration converter.	Install the power regeneration converter correctly as specified.
	Power regeneration converter failure	–	The power regeneration converter may be faulty. Replace the power regeneration converter.
A.980: Motor Overheated	The ambient temperature around the motor is high.	Check the ambient temperature around the motor.	Make sure the ambient temperature around the motor does not increase.
	Acceleration and deceleration were repeated frequently.	–	Make the acceleration/deceleration of the motor smoother, or change the operation pattern.

13.4 Troubleshooting Malfunction Based on Operation and Conditions of the Spindle Motor

Troubleshooting for the malfunctions based on the operation and conditions of the spindle motor is provided in this section.

Be sure to turn OFF the servo system before troubleshooting items shown in bold lines in the table.

Problem	Probable Cause	Investigative Actions	Corrective Actions
Motor Does Not Start	The control power supply is not ON.	Check voltage between control power terminals.	Correct the wiring.
	The main circuit power supply is not ON.	Check the voltage between main circuit power terminals.	Correct the wiring.
	Wiring of I/O signal connector CN1 faulty or disconnected.	Check if the connector CN1 is properly inserted and connected.	Correct the connector CN1 connection.
	Motor or encoder wiring disconnected.	Check the wiring.	Correct the wiring.
	Overloaded	Run under no load and check the load status.	Reduce load or replace with larger capacity motor.
	Motor type differs from parameter setting (Pn01E.0).	Check the settings for parameter Pn01E.0.	Set parameter Pn01E.0 to the motor type being used.
	The safety input signal (/HWBB1 or /HWBB2) remains OFF.	Check the /HWBB1 and /HWBB2 input signal.	Set the /HWBB1 and /HWBB2 input signal to ON.
	SERVOPACK failure	–	Replace the SERVOPACK.
Motor Moves Instantaneously, and then Stops	Motor wiring is incorrect.	Check the motor wiring.	Correct the wiring.
	Encoder wiring is incorrect.	Check the encoder wiring.	Correct the wiring.
Motor Speed Unstable	Wiring connection to motor is defective.	Check connections of power line (phases U, V, and W) and encoder connectors.	Tighten any loose terminals or connectors and correct the wiring.
Motor Rotates Without Reference Input	SERVOPACK failure	–	Replace the SERVOPACK.

(cont'd)

Problem	Probable Cause	Investigative Actions	Corrective Actions
Abnormal Noise from Motor	Mounting is not secured.	Check if there are any loose mounting screws.	Tighten the mounting screws.
		Check if there is misalignment of couplings.	Align the couplings.
		Check if there are unbalanced couplings.	Balance the couplings.
	Bearings are defective.	Check for noise and vibration around the bearings.	Replace the motor.
	Vibration source at the driven machine	Check for any foreign matter, damage, or deformations on the machinery's movable parts.	Contact the machine manufacturer.
	Noise interference due to incorrect I/O signal cable specifications	The I/O signal cable must be tinned annealed copper shielded twisted-pair or screened unshielded twisted-pair cable with a core of 0.12 mm^2 min.	Use the specified I/O signal cable.
	Noise interference due to length of I/O signal cable	Check the length of the I/O signal cable.	The I/O signal cable length must be no more than 3 m.
	Noise interference due to incorrect encoder cable specifications	The encoder cable must be tinned annealed copper shielded twisted-pair or screened unshielded twisted-pair cable with a core of 0.12 mm^2 min.	Use the specified encoder cable.
	Noise interference due to length of encoder cable	Check the length of the encoder cable.	The length of the encoder cable must be no more than 20 m.
	Noise interference due to damaged encoder cable	Check if the encoder cable is bent and the sheath is damaged.	Replace the encoder cable and modify the encoder cable layout.
	Excessive noise to the encoder cable	Check if the encoder cable is bundled with a high-current line or near a high-current line.	Correct the encoder cable layout so that no surge is applied.
	The FG potential varies because of influence from machines on the motor side, such as the welder.	Check if the machines are correctly grounded.	Properly ground the machines to separate from the encoder FG.
	SERVOPACK pulse counting error due to noise interference	Check if there is noise interference on the I/O signal line from the encoder.	Take measures against noise in the encoder wiring.
	Excessive vibration and shock to the encoder	Check if vibration from the machine occurred or motor installation is incorrect (mounting surface accuracy, fixing, alignment, etc.).	Reduce vibration from the machine, or secure the motor installation.
	Encoder failure	–	Replace the motor.
Motor Vibrates at Frequency of Approx. 200 to 400 Hz.	Unbalanced servo gains	Check to see if the servo gains have been correctly adjusted.	Adjust servo gains.
	Speed loop gain value (Pn100) too high	Check the speed loop gain (Pn100). Factory setting: Kv = 40.0 Hz	Reduce the speed loop gain (Pn100).
	Incorrect speed loop integral time constant (Pn101)	Check the speed loop integral time constant (Pn101). Factory setting: Ti = 20.0 ms	Correct the speed loop integral time constant (Pn101).
	Incorrect moment of inertia ratio (Pn103)	Check the moment of inertia ratio (Pn103).	Correct the moment of inertia ratio (Pn103).

(cont'd)

Problem	Probable Cause	Investigative Actions	Corrective Actions
Position Error (Without Alarm)	Noise interference due to incorrect encoder cable specifications	The encoder cable must be tinned annealed copper shielded twisted-pair or screened unshielded twisted-pair cable with a core of 0.12 mm^2 min.	Use the specified encoder cable.
	Noise interference due to length of encoder cable	Check the length of the encoder cable.	The encoder cable must be no more than 20 m.
	Noise influence due to damaged encoder cable	Check if the encoder cable is bent and its sheath is damaged.	Replace the encoder cable and modify the encoder cable layout.
	Excessive noise to encoder cable	Check if the encoder cable is bundled with a high-current line or near a high-current line.	Change the encoder cable layout so that no surge is applied.
	The FG potential varies because of influence from machines on the motor side such as the welder.	Check if the machines are correctly grounded.	Properly ground the machines encoder FG.
	SERVOPACK pulse count error due to noise	Check if the I/O signal line from the encoder is influenced by noise.	Take measures against noise in the encoder wiring.
	Excessive vibration and shock to the encoder	Check if vibration from the machine occurred or motor installation is incorrect (mounting surface accuracy, fixing, alignment, etc.).	Reduce the machine vibration or mount the motor securely.
	Unsecured coupling between machine and motor	Check if a position error occurs at the coupling between machine and motor.	Secure the coupling between the machine and motor.
	Noise interference due to improper I/O signal cable specifications	The I/O signal cable must be tinned annealed copper shielded twisted-pair or screened unshielded twisted-pair cable with a core of 0.12 mm^2 min.	Use input signal cable with the specified specifications.
	Noise interference due to length of I/O signal cable	Check the I/O signal cable length.	The I/O signal cable length must be no more than 3 m.
	Encoder failure (The pulse count does not change.)	–	Replace the motor.
	SERVOPACK failure	–	Replace the SERVOPACK.
Motor Overheated	Ambient operating temperature too high	Measure the motor ambient operating temperature.	Reduce the ambient operating temperature to 40°C or less.
	Motor surface dirty	Visually check the surface.	Clean dust and oil from the surface.
	Motor overloaded	Check the load status with monitor.	If overloaded, reduce load or replace with larger capacity SERVOPACK and motor.

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Appendix

14.1 Operation Modes and Applicable Parameters

The gain parameters are changed for each operation mode.

The signals that are used to select operations and the parameters that are applied are given in the following table.

Winding Selection Motor (Winding Selection Signal (CHW))	Operation Mode	Orientation Signal (/ORT)	Servo Mode Signal (/SV)	L Gear Selection Signal (/LGR)	Applied Parameters				
					Speed Loop Gain	Speed Loop Integral Time Constant	Position Loop Gain	Torque Reference Filter Time Constant	Base Speed Ratio
High-speed winding selected.*1 (/CHW signal: OFF)	Standard Mode	OFF	OFF	OFF	Pn100	Pn101	Pn102	Pn401	*4
				ON	Pn104	Pn105	Pn106	Pn412	
	Servo Mode	OFF	ON	OFF	Pn12B	Pn12C	Pn12D	Pn413	Pn434
				ON	Pn12E	Pn12F	Pn130	Pn414	Pn434
	Orientation Mode	ON	*2	OFF	Pn830	Pn831	Pn832	Pn833	Pn434
				ON	Pn834	Pn835	Pn836	Pn837	
Low-speed winding selected. (/CHW signal: ON)	Standard Mode	OFF	OFF	*3	Pn104	Pn105	Pn106	Pn412	*5
	Servo Mode	OFF	ON		Pn12E	Pn12F	Pn130	Pn414	Pn436
	Orientation Mode	ON	*2		Pn834	Pn835	Pn836	Pn837	Pn436

*1. For a motor with only one winding, the parameters are the same as when the high-speed winding is selected on a winding selection motor. However, the gain parameters are not changed even if the /CHW signal changes.
*2. When orientation is executed, servo mode is used regardless of the setting of the /SV signal.
*3. When the low-speed winding is selected, the L gear is used regardless of the setting of the /LGR signal.
*4. The base speed of the motor is applied. (There is no parameter to set.)
*5. The base speed of the low-speed winding of the motor is applied. (There is no parameter to set.)

14.2 List of Parameters

This section contains a tables of parameters.

Note: Do not change the following parameters from the factory settings.
- Reserved parameters
- Parameters not described in this manual

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn006	2	Application Function Select Switch 6	0000h to 005Fh	–	0002h	Immedi-ately	Setup	–

4th digit 3rd digit 2nd digit 1st digit
n.□□□□

1st and 2nd digits: Analog Monitor 1 Signal Selection

00	Motor speed (1 V / 1000 min^{-1})
01	Speed reference (1 V / 1000 min^{-1})
02	Torque reference (1 V/ (Max. torque/1.2))
03	Position error (0.05 V/1 pulse)
05	Position reference speed (1 V / 1000 min^{-1})
06	Reserved (Do not change.)
08	Positioning completion (positioning completed: 5 V, positioning not completed: 0 V)
0B	Reserved (Do not change.)
0C	Completion of position reference (completed: 5 V, not completed: 0 V)
46	Load meter (6 V/100%)

3rd digit: Reserved (Do not change.)

4th digit: Reserved (Do not change.)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn007	2	Application Function Select Switch 7	0000h to 005Fh	–	0000h	Immedi-ately	Setup	–

4th digit 3rd digit 2nd digit 1st digit
n.□□□□

1st and 2nd digits: Analog Monitor 2 Signal Selection

00	Motor speed (1 V / 1000 min^{-1})
01	Speed reference (1 V / 1000 min^{-1})
02	Torque reference (1 V/ (Max. torque/1.2))
03	Position error (0.05 V/1 pulse)
05	Position reference speed (1 V / 1000 min^{-1})
06	Reserved (Do not change.)
08	Positioning completion (positioning completed: 5 V, positioning not completed: 0 V)
0B	Reserved (Do not change.)
0C	Completion of position reference (completed: 5 V not completed: 0 V)
46	Load meter (6 V/100%)

3rd digit: Reserved (Do not change.)

4th digit: Reserved (Do not change.)

(cont'd)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn008	2	Application Function Select Switch 8	0000h to 7121h	–	0000h	After restart	Setup	–
	n.□□□□ (4th digit, 3rd digit, 2nd digit, 1st digit) 1st digit: Reserved (Do not change.) 2nd digit: Function Selection for UnderVoltage 0: Does not detect warning for undervoltage. 1: Detects warning for undervoltage. 2: Reserved (Do not change.) 3rd digit: Warning Detection Selection 0: Detects warning. 1: Does not detect warning. 4th digit: Reserved (Do not change.)							
Pn00B	2	Application Function Select Switch B	0000h to 0111h	–	0001h	After restart	Setup	–
	n.□□□□ (4th digit, 3rd digit, 2nd digit, 1st digit) 1st digit: Reserved (Do not change.) 2nd digit: Alarm Gr.2 Stop Method Selection 0: Stops the motor by setting the speed reference to "0". 1: Stops the motor by applying DB or by coasting. 3rd digit: Reserved (Do not change.) 4th digit: Reserved (Do not change.)							
Pn00D	2	Application Function Select Switch D	0000h to 1101h	–	0000h	After restart	Setup	–
	n.□□□□ (4th digit, 3rd digit, 2nd digit, 1st digit) 1st digit: Reserved (Do not change.) 2nd digit: Reserved (Do not change.) 3rd digit: Fan Stop Error Detection Selection 0: Issues an alarm after the fan stops. 1: Issues a warning for a specified time and then an alarm after the fan stops. 4th digit: Reserved (Do not change.)							

(cont'd)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn01B	2	Application Function Select Switch 1B	0000h to 0011h	–	0000h	After restart	Setup	–

n.□□□□ (4th digit, 3rd digit, 2nd digit, 1st digit)

1st digit: Emergency Stop Signal Selection

0	Disables the emergency stop signal.
1	Enables the emergency stop signal.

2nd digit: Reserved (Do not change.)

3rd digit: Reserved (Do not change.)

4th digit: Reserved (Do not change.)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn01C	2	Application Function Select Switch 1C	0000h to 1003h	–	0000h	After restart	Setup	–

n.□□□□ (4th digit, 3rd digit, 2nd digit, 1st digit)

1st digit: Load Ratio Output Level Selection

0	A load ratio of 120% is output for the maximum spindle motor output.
1	A load ratio of 100% is output for the maximum spindle motor output.
2	A load ratio of 100% is output for the instantaneous rated output.
3	A load ratio of 100% is output for the continuous rated output.

2nd digit: Reserved (Do not change.)

3rd digit: Reserved (Do not change.)

4th digit: Reserved (Do not change.)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn01E	2	Application Function Select Switch 1E	0000h to 0036h	–	0003h	After restart	Setup	–

n.□□□□ (4th digit, 3rd digit, 2nd digit, 1st digit)

1st digit: Reserved (Do not change.)

2nd digit: Winding Selection

0	None
1	Mechanical winding selection
2, 3	Reserved (Do not use.)

3rd digit: Reserved (Do not change.)

4th digit: Reserved (Do not change.)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn030	2	Reserved (Do not change.)	–	–	0000	–	Setup	–

(cont'd)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn031	2	Application Function Select Switch 31	0000h to 0111h	–	0000h	After Restart	Setup	–

4th digit 3rd digit 2nd digit 1st digit

n.□□□□

1st digit: Analog Speed Reference Input Selection

0	Uses Speed Reference Input Gain 1 (Pn300).
1	Uses Speed Reference Input Gain 2 (Pn30A).

2nd digit: Speed Limit Selection

0	The upper limit is 105% of the rated speed.
1	The upper limit is 110% of the rated speed.

3rd digit: Speed Reference Gain Selection at Servo Mode

0	Does not switch speed reference gain.
1	Switches speed reference gain.

4th digit: Reserved (Do not change.)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn100	2	Speed Loop Gain	10 to 20000	0.1 Hz	100	Immediately	Tuning	–
Pn101	2	Speed Loop Integral Time Constant	15 to 51200	0.01 ms	3000	Immediately	Tuning	–
Pn102	2	Position Loop Gain	10 to 20000	0.1/s	100	Immediately	Tuning	–
Pn103	2	Moment of Inertia Ratio	0 to 20000	1%	100	Immediately	Tuning	–
Pn104	2	2nd Speed Loop Gain	10 to 20000	0.1 Hz	100	Immediately	Tuning	–
Pn105	2	2nd Speed Loop Integral Time Constant	15 to 51200	0.01 ms	3000	Immediately	Tuning	–
Pn106	2	2nd Position Loop Gain	10 to 20000	0.1/s	100	Immediately	Tuning	–
Pn12B	2	3rd Speed Loop Gain	10 to 20000	0.1 Hz	100	Immediately	Tuning	–
Pn12C	2	3rd Speed Loop Integral Time Constant	15 to 51200	0.01 ms	3000	Immediately	Tuning	–
Pn12D	2	3rd Position Loop Gain	10 to 20000	0.1/s	100	Immediately	Tuning	–
Pn12E	2	4th Speed Loop Gain	10 to 20000	0.1 Hz	100	Immediately	Tuning	–
Pn12F	2	4th Speed Loop Integral Time Constant	15 to 51200	0.01 ms	3000	Immediately	Tuning	–
Pn130	2	4th Position Loop Gain	10 to 20000	0.1/s	100	Immediately	Tuning	–

(cont'd)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn160	2	Anti-Resonance Control Related Switch	0000h to 0011h	–	0010h	Immediately	Tuning	–
		n.□□□□ (4th digit, 3rd digit, 2nd digit, 1st digit) 1st digit: Anti-Resonance Control Selection (refer to 10.3 and 11.4.18) 0: Does not use anti-resonance control. 1: Uses anti-resonance control. 2nd digit: Reserved (Do not change.) 3rd digit: Reserved (Do not change.) 4th digit: Reserved (Do not change.)						
Pn161	2	Anti-Resonance Frequency	10 to 20000	0.1 Hz	1000	Immediately	Tuning	–
Pn162	2	Anti-Resonance Gain Compensation	1 to 1000	1%	100	Immediately	Tuning	–
Pn163	2	Anti-Resonance Damping Gain	0 to 300	1%	0	Immediately	Tuning	–
Pn164	2	Anti-Resonance Filter Time Constant 1 Compensation	-1000 to 1000	0.01 ms	0	Immediately	Tuning	–
Pn165	2	Anti-Resonance Filter Time Constant 2 Compensation	-1000 to 1000	0.01 ms	0	Immediately	Tuning	–
Pn20E	4	Reserved (Do not change.)	–	–	1	After restart	Setup	–
Pn210	4	Reserved (Do not change.)	–	–	1	After restart	Setup	–
Pn230	4	Number of Encoder Pulse	100 to 1048576	Pitch/Rev	1024	After restart	Setup	–
Pn232	2	C-Phase Compensation Width	-200 to 200	pulse	0	After restart	Setup	–
Pn234	2	Pulse Encoder Stop Vibration Suppression	0000h to 0001h	–	0000h	Immediately	Setup	–
		n.□□□□ (4th digit, 3rd digit, 2nd digit, 1st digit) 1st digit: Pulse Encoder Stop Vibration Suppression 0: Does not use stop vibration suppression. 1: Uses stop vibration suppression. 2nd digit: Reserved (Do not change.) 3rd digit: Reserved (Do not change.) 4th digit: Reserved (Do not change.)						
Pn300	2	Speed Reference Input Gain 1	50 to 3000	0.01V/ Base speed	600	After restart	Setup	–
Pn304	2	JOG Speed	0 to 10000	1 min^{-1}	500	Immediately	Setup	–
Pn305	2	Soft Start Acceleration Time	0 to 10000	1 ms	0	Immediately	Setup	–
Pn306	2	Soft Start Deceleration Time	0 to 10000	1 ms	0	Immediately	Setup	–

(cont'd)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn30A	2	Speed Reference Input Gain 2	500 to 30000	0.001 V	10000	Immedi-ately	Setup	–
Pn324	2	Moment of Inertia Calculating Start Level	0 to 20000	1%	300	Immedi-ately	Setup	–
Pn401	2	1st Step 1st Torque Reference Filter Time Constant	0 to 65535	0.01 ms	397	Immedi-ately	Tuning	–
Pn406	2	Emergency Stop Torque	0 to 800	1%	800	Immedi-ately	Setup	–
Pn408	2	Torque Related Function Switch	0000h to 1111h	–	0000h	Immedi-ately	Setup	–

4th digit 3rd digit 2nd digit 1st digit

n.□□□□

1st Step Notch Filter Selection	
0	Disables 1st step notch filter for torque reference.
1	Uses 1st step notch filter for torque reference.

Reserved (Do not change.)

2nd Step Notch Filter Selection	
0	Disables 2nd step notch filter for torque reference.
1	Uses 2nd step notch filter for torque reference.

Reserved (Do not change.)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn409	2	1st Notch Filter Frequency	50 to 2000	1 Hz	2000	Immedi-ately	Tuning	–
Pn40A	2	1st Notch Filter Q Value	50 to 1000	0.01	70	Immedi-ately	Tuning	–
Pn40B	2	1st Notch Filter Depth	0 to 1000	0.001	0	Immedi-ately	Tuning	–
Pn40C	2	2nd Notch Filter Frequency	50 to 2000	1 Hz	2000	Immedi-ately	Tuning	–
Pn40D	2	2nd Notch Filter Q Value	50 to 1000	0.01	70	Immedi-ately	Tuning	–
Pn40E	2	2nd Notch Filter Depth	0 to 1000	0.001	0	Immedi-ately	Tuning	–
Pn412	2	1st Step 2nd Torque Reference Filter Time Constant	0 to 65535	0.01 ms	397	Immedi-ately	Tuning	–
Pn413	2	1st Step 3rd Torque Reference Filter Time Constant	0 to 65535	0.01 ms	397	Immedi-ately	Tuning	–
Pn414	2	1st Step 4th Torque Reference Filter Time Constant	0 to 65535	0.01 ms	397	Immedi-ately	Tuning	–

(cont'd)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn416	2	Torque Related Function Switch 2	0000h to 0011h	–	0000h	Immedi-ately	Setup	–

n.□□□□ (4th digit, 3rd digit, 2nd digit, 1st digit)

1st digit: **3rd Step Notch Filter Selection**

0	Disables 3rd step notch filter for torque reference.
1	Uses 3rd step notch filter for torque reference.

2nd digit: **4th Step Notch Filter Selection**

0	Disables 4th step notch filter for torque reference.
1	Uses 4th step notch filter for torque reference.

3rd digit: Reserved (Do not change.)

4th digit: Reserved (Do not change.)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn417	2	3rd Notch Filter Frequency	50 to 2000	1 Hz	2000	Immedi-ately	Tuning	–
Pn418	2	3rd Notch Filter Q Value	50 to 1000	0.01	70	Immedi-ately	Tuning	–
Pn419	2	3rd Notch Filter Depth	0 to 1000	0.001	0	Immedi-ately	Tuning	–
Pn41A	2	4th Notch Filter Frequency	50 to 2000	1 Hz	2000	Immedi-ately	Tuning	–
Pn41B	2	4th Notch Filter Q Value	50 to 1000	0.01	70	Immedi-ately	Tuning	–
Pn41C	2	4th Notch Filter Depth	0 to 1000	0.001	0	Immedi-ately	Tuning	–
Pn430	2	Torque Limit (Powering)	0 to 800	1%	150	Immedi-ately	Setup	–
Pn431	2	Torque Limit (Regeneration)	0 to 800	1%	150	Immedi-ately	Setup	–
Pn432	2	Motor Flux Lower Level	10 to 100	1%	15	Immedi-ately	Setup	–
Pn433	2	Servo Mode Flux Level (for High-speed Winding)	30 to 100	1%	100	Immedi-ately	Setup	–
Pn434	2	Servo Mode Base Speed Ratio (for High-speed Winding)	100 to 500	1%	100	Immedi-ately	Setup	–
Pn435	2	Servo Mode Flux Level (for Low-speed Winding)	30 to 100	1%	100	Immedi-ately	Setup	–
Pn436	2	Servo Mode Base Speed Ratio (for Low-speed Winding)	100 to 500	1%	100	Immedi-ately	Setup	–
Pn43D	2	Servo Mode Speed Reference Gain 1	0 to 10000	0.01%	10000	After restart	Setup	–
Pn43F	2	Load Ratio Meter Filter Time Constant	0 to 5000	ms	100	Immedi-ately	Setup	–
Pn456	2	Sweep Torque Reference Amplitude	1 to 800	1%	15	Immedi-ately	Tuning	–

(cont'd)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn460	2	Notch Filter Adjustment Switch	0000h to 0101h	–	0101h	Immedi-ately	Tuning	–
	n.□□□□ (4th digit, 3rd digit, 2nd digit, 1st digit) **1st digit – Notch Filter Adjustment Selection 1** 0: Does not adjust 1st step notch filter automatically using utility function. 1: Adjust 1st step notch filter automatically using utility function. **2nd digit – Reserved (Do not change.)** **3rd digit – Notch Filter Adjustment Selection 2** 0: Does not adjust 2nd step notch filter automatically using utility function. 1: Adjust 2nd step notch filter automatically using utility function. **4th digit – Reserved (Do not change.)**							
Pn502	2	Rotation Detection Level	1 to 10000	1 min^{-1}	20	Immedi-ately	Setup	–
Pn503	2	Speed Coincidence Signal Output Width	0 to 100	1 min^{-1}	10	Immedi-ately	Setup	–
Pn51E	2	Excessive Position Error Warning Level	10 to 100	1%	100	Immedi-ately	Setup	13.3.1
Pn520	4	Excessive Position Error Alarm Level	1 to 1073741823	1 pulse	5242880	Immedi-ately	Setup	13.2.1
Pn522	4	Positioning Completed Width	0 to 1073741824	1 pulse	5	Immedi-ately	Setup	–
Pn524	4	NEAR Signal Width	1 to 1073741824	1 pulse	10	Immedi-ately	Setup	–
Pn526	4	Excessive Position Error Alarm Level at Servo ON	1 to 1073741823	1 pulse	5242880	Immedi-ately	Setup	13.2.1
Pn528	2	Excessive Position Error Warning Level at Servo ON	10 to 100	1%	100	Immedi-ately	Setup	13.3.1
Pn529	2	Speed Limit Level at Servo ON	0 to 10000	1 min^{-1}	10000	Immedi-ately	Setup	13.2.1
Pn52B	2	Overload Warning Level	1 to 100	1%	20	Immedi-ately	Setup	9.2.5
Pn52C	2	Derating of Base Current at Detecting Overload of Motor	10 to 100	1%	100	After restart	Setup	9.2.5

(cont'd)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn530	2	Program JOG Operation Related Switch	0000h to 0005h	–	0000h	Immedi-ately	Setup	–

n.□□□□ (4th digit, 3rd digit, 2nd digit, 1st digit)

1st digit: Program JOG Operation Switch

0	(Waiting time Pn535 → Forward movement Pn531) × Number of movements Pn536
1	(Waiting time Pn535 → Reverse movement Pn531) × Number of movements Pn536
2	(Waiting time Pn535 → Forward movement Pn531) × Number of movements Pn536 (Waiting time Pn535 → Reverse movement Pn531) × Number of movements Pn536
3	(Waiting time Pn535 → Reverse movement Pn531) × Number of movements Pn536 (Waiting time Pn535 → Forward movement Pn531) × Number of movements Pn536
4	(Waiting time Pn535 → Forward movement Pn531 → Waiting time Pn535 → Reverse movement Pn531) × Number of movements Pn536
5	(Waiting time Pn535 → Reverse movement Pn531 → Waiting time Pn535 → Forward movement Pn531) × Number of movements Pn536

2nd digit: Reserved (Do not change.)

3rd digit: Reserved (Do not change.)

4th digit: Reserved (Do not change.)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn531	4	Program JOG Movement Distance	1 to 1073741824	1 pulse	32768	Immedi-ately	Setup	–
Pn533	2	Program JOG Movement Speed	1 to 10000	1 min^{-1}	500	Immedi-ately	Setup	–
Pn534	2	Program JOG Acceleration/Deceleration Time	2 to 10000	1 ms	100	Immedi-ately	Setup	–
Pn535	2	Program JOG Waiting Time	0 to 10000	1 ms	100	Immedi-ately	Setup	–
Pn536	2	Number of Times of Program JOG Movement	0 to 1000	1 time	1	Immedi-ately	Setup	–
Pn541	2	Rated Speed Setting	100 to 65535	1 min^{-1}	65535	After restart	–	–
Pn542	2	Speed Coincidence Detection Width	10 to 50	1%	15	Immedi-ately	–	–
Pn543	2	Speed Detection Level	0 to 10000	0.01%	100	Immedi-ately	–	–
Pn544	2	Speed Detection Hysteresis	0 to 10000	0.01%	10	Immedi-ately	–	–

(cont'd)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn545	2	Speed Error Excessive Protection Select Switch	0000h to 0031h	–	0000h	Immediately	–	–

n. □ □ □ □ (4th digit, 3rd digit, 2nd digit, 1st digit)

1st digit:

Detection Range of Speed Error Excessive Protection	
0	1/2 or less of speed reference
1	1/4 or less of speed reference

2nd digit:

Delay Time of Speed Error Excessive Protection	
0	0 ms
1	300 ms
2	400 ms
3	500 ms

3rd digit: Reserved (Do not change.)

4th digit: Reserved (Do not change.)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn550	2	Analog Monitor 1 Offset Voltage	-10000 to 10000	0.1 V	0	Immediately	Setup	10.2
Pn551	2	Analog Monitor 2 Offset Voltage	-10000 to 10000	0.1 V	0	Immediately	Setup	
Pn552	2	Analog Monitor Magnification (×1)	-10000 to 10000	×0.01	100	Immediately	Setup	
Pn553	2	Analog Monitor Magnification (×2)	-10000 to 10000	×0.01	100	Immediately	Setup	
Pn630	2	Emergency Stop Execution Delay Time	0 to 10000	ms	0	Immediately	Setup	–
Pn800	4	Forward/Reverse Signal Acceleration Constant	1 to FFFFFFFF	10^n pulse/s^2	100	Immediately	Setup	–
Pn802	4	Forward/Reverse Signal Deceleration Constant	1 to FFFFFFFF	10^n pulse/s^2	100	Immediately	Setup	–
Pn810	4	Orientation Target Position	0 to 1073741823	1 pulse	0	Immediately	Setup	–
Pn812	2	Orientation Target Speed	0 to 40960	10 pulse/s	3413	Immediately	Setup	–
Pn813	4	Orientation Acceleration Constant	1 to 4294967295	10^n pulse/s^2	70	Immediately	Setup	–
Pn815	4	Orientation Deceleration Constant	1 to 4294967295	10^n pulse/s^2	70	Immediately	Setup	–
Pn817	4	Reference Pulses per Machine Rotation	1 to 1073741823	1 pulse	4096	After restart	Setup	–
Pn820	4	Speed Detection Level	0 to 2097152000	1 pulse/s	40960	After restart	Setup	–
Pn822	2	Speed Detection Hysteresis	0 to 10000	0.01%	1000	After restart	Setup	–
Pn830	2	5th Speed Loop Gain	0.1 Hz	10 to 20000	100	Immediately	Tuning	–

(cont'd)

Parameter No.	Size	Name	Setting Range	Units	Factory Setting	When Enabled	Classification	Reference Section
Pn831	2	5th Speed Loop Integral Time Constant	0.01 ms	15 to 51200	3000	Immediately	Tuning	–
Pn832	2	5th Position Loop Gain	0.1/s	10 to 20000	100	Immediately	Tuning	–
Pn833	2	1st Step 5th Torque Reference Filter Time Constant	0.01 ms	0 to 65535	397	Immediately	Tuning	–
Pn834	2	6th Speed Loop Gain	0.1 Hz	10 to 20000	100	Immediately	Tuning	–
Pn835	2	6th Speed Loop Integral Time Constant	0.01 ms	15 to 51200	3000	Immediately	Tuning	–
Pn836	2	6th Position Loop Gain	0.1/s	10 to 20000	100	Immediately	Tuning	–
Pn837	2	1st Step 6th Torque Reference Filter Time Constant	0.01 ms	0 to 65535	397	Immediately	Tuning	–
Pn84D	2	Load Ratio Gain Adjustment	90 to 150	0.01	100	Immediately	Setup	–
Pn84E	2	Load Ratio Meter Full Scale Value	100 to 1000	1%	200	Immediately	Setup	–
Pn900	2	Acceleration Basic Unit Selection	0003 to 0006	–	0004	After restart	Setup	–
Pn910	2	Reserved (Do not change.)	–	–	1810	–	Setup	–

14.3 Parameter Recording Table

Use the following form to record parameter settings for maintenance or other applications.

Parameter	Factory Setting						Name	When Enabled
Pn006	0002h						Application Function Select Switch 6	Immediately
Pn007	0000h						Application Function Select Switch 7	Immediately
Pn008	0000h						Application Function Select Switch 8	After restart
Pn00B	0001h						Application Function Select Switch B	After restart
Pn00D	0000h						Application Function Select Switch D	After restart
Pn01B	0000h						Application Function Select Switch 1B	After restart
Pn01C	0000h						Application Function Select Switch 1C	After restart
Pn01E	0003h						Application Function Select Switch 1E	After restart
Pn030	0000						Reserved (Do not change.)	–
Pn031	0000h						Application Function Select Switch 31	After restart
Pn100	100						Speed Loop Gain	Immediately
Pn101	3000						Speed Loop Integral Time Constant	Immediately
Pn102	100						Position Loop Gain	Immediately
Pn103	100						Moment of Inertia Ratio	Immediately
Pn104	100						2nd Speed Loop Gain	Immediately
Pn105	3000						2nd Speed Loop Integral Time Constant	Immediately
Pn106	100						2nd Position Loop Gain	Immediately
Pn12B	100						3rd Speed Loop Gain	Immediately
Pn12C	3000						3rd Speed Loop Integral Time Constant	Immediately
Pn12D	100						3rd Position Loop Gain	Immediately
Pn12E	100						4th Speed Loop Gain	Immediately
Pn12F	3000						4th Speed Loop Integral Time Constant	Immediately
Pn130	100						4th Position Loop Gain	Immediately
Pn160	0010h						Anti-Resonance Control Related Switch	Immediately
Pn161	1000						Anti-Resonance Frequency	Immediately
Pn162	100						Anti-Resonance Gain Compensation	Immediately
Pn163	0						Anti-Resonance Damping Gain	Immediately
Pn164	0						Anti-Resonance Filter Time Constant 1 Compensation	Immediately
Pn165	0						Anti-Resonance Filter Time Constant 2 Compensation	Immediately
Pn20E	0001						Reserved (Do not change.)	–
Pn210	1						Reserved (Do not change.)	–
Pn230	1024						Number of Encoder Pulse	After restart
Pn232	0						C-Phase Compensation Width	After restart
Pn234	0000h						Pulse Encoder Stop Vibration Suppression	Immediately
Pn300	600						Speed Reference Input Gain 1	After restart

(cont'd)

Parameter	Factory Setting						Name	When Enabled
Pn304	500						JOG Speed	Immediately
Pn305	0						Soft Start Acceleration Time	Immediately
Pn306	0						Soft Start Deceleration Time	Immediately
Pn30A	10000						Speed Reference Input Gain 2	Immediately
Pn324	300						Moment of Inertia Calculating Start Level	Immediately
Pn401	397						Torque Reference Filter Time Constant	Immediately
Pn406	800						Emergency Stop Torque	Immediately
Pn408	0000h						Torque Related Function Switch	Immediately
Pn409	2000						1st Notch Filter Frequency	Immediately
Pn40A	70						1st Notch Filter Q Value	Immediately
Pn40B	0						1st Notch Filter Depth	Immediately
Pn40C	2000						2nd Notch Filter Frequency	Immediately
Pn40D	70						2nd Notch Filter Q Value	Immediately
Pn40E	0						2nd Notch Filter Depth	Immediately
Pn412	397						1st Step 2nd Torque Reference Filter Time Constant	Immediately
Pn413	397						1st Step 3rd Torque Reference Filter Time Constant	Immediately
Pn414	397						1st Step 4th Torque Reference Filter Time Constant	Immediately
Pn416	0000h						Torque Related Function Switch 2	Immediately
Pn417	2000						3rd Notch Filter Frequency	Immediately
Pn418	70						3rd Notch Filter Q Value	Immediately
Pn419	0						3rd Notch Filter Depth	Immediately
Pn41A	2000						4th Notch Filter Frequency	Immediately
Pn41B	70						4th Notch Filter Q Value	Immediately
Pn41C	0						4th Notch Filter Depth	Immediately
Pn430	150						Torque Limit (Powering)	Immediately
Pn431	150						Torque Limit (Regeneration)	Immediately
Pn432	15						Motor Flux Lower Level	Immediately
Pn433	100						Servo Mode Flux Level (for High-speed Winding)	Immediately
Pn434	100						Servo Mode Base Speed Ratio (for High-speed Winding)	Immediately
Pn435	100						Servo Mode Flux Level (for Low-speed Winding)	Immediately
Pn436	100						Servo Mode Base Speed Ratio (for Low-speed Winding)	Immediately
Pn43D	10000						Servo Mode Speed Reference Gain 1	After restart
Pn43F	100						Load Ratio Meter Filter Time Constant	Immediately
Pn456	15						Sweep Torque Reference Amplitude	Immediately
Pn460	0101h						Notch Filter Adjustment Switch	Immediately
Pn502	20						Rotation Detection Level	Immediately
Pn503	10						Speed Coincidence Signal Output Width	Immediately

(cont'd)

Parameter	Factory Setting						Name	When Enabled
Pn51E	100						Excessive Position Error Warning Level	Immediately
Pn520	5242880						Excessive Position Error Alarm Level	Immediately
Pn522	5						Positioning Completed Width	Immediately
Pn524	10						NEAR Signal Width	Immediately
Pn526	5242880						Excessive Position Error Alarm Level at Servo ON	Immediately
Pn528	100						Excessive Position Error Warning Level at Servo ON	Immediately
Pn529	10000						Speed Limit Level at Servo ON	Immediately
Pn52B	20						Overload Warning Level	Immediately
Pn52C	100						Derating of Base Current at Detecting Overload of Motor	After restart
Pn530	0000h						Program JOG Operation Related Switch	Immediately
Pn531	32768						Program JOG Movement Distance	Immediately
Pn533	500						Program JOG Movement Speed	Immediately
Pn534	100						Program JOG Acceleration/Deceleration Time	Immediately
Pn535	100						Program JOG Waiting Time	Immediately
Pn536	1						Number of Times of Program JOG Movement	Immediately
Pn541	65535						Rated Speed Setting	After restart
Pn542	15						Speed Coincidence Detection Width	Immediately
Pn543	100						Speed Detection Level	Immediately
Pn544	10						Speed Detection Hysteresis	Immediately
Pn545	0000h						Speed Error Excessive Protection Select Switch	Immediately
Pn550	0						Analog Monitor 1 Offset Voltage	Immediately
Pn551	0						Analog Monitor 2 Offset Voltage	Immediately
Pn552	100						Analog Monitor Magnification (×1)	Immediately
Pn553	100						Analog Monitor Magnification (×2)	Immediately
Pn630	0						Emergency Stop Execution Delay Time	Immediately
Pn800	100						Forward/Reverse Signal Acceleration Constant	Immediately
Pn802	100						Forward/Reverse Signal Deceleration Constant	Immediately
Pn810	0						Orientation Target Position	Immediately
Pn812	3413						Orientation Target Speed	Immediately
Pn813	70						Orientation Acceleration Constant	Immediately
Pn815	70						Orientation Deceleration Constant	Immediately
Pn817	4096						Reference Pulses per Machine Rotation	After restart
Pn820	40960						Speed Detection Level	After restart
Pn822	1000						Speed Detection Hysteresis	After restart
Pn830	100						5th Speed Loop Gain	Immediately

(cont'd)

Parameter	Factory Setting						Name	When Enabled
Pn831	3000						5th Speed Loop Integral Time Constant	Immediately
Pn832	100						5th Position Loop Gain	Immediately
Pn833	397						1st Step 5th Torque Reference Filter Time Constant	Immediately
Pn834	100						6th Speed Loop Gain	Immediately
Pn835	3000						6th Speed Loop Integral Time Constant	Immediately
Pn836	100						6th Position Loop Gain	Immediately
Pn837	397						1st Step 6th Torque Reference Filter Time Constant	Immediately
Pn84D	100						Load Ratio Gain Adjustment	Immediately
Pn84E	200						Load Ratio Meter Full Scale Value	Immediately
Pn900	0004						Acceleration Basic Unit Selection	After restart
Pn910	1810						Reserved (Do not change.)	–

14.4 Determining Drive Capacity

When controlling machine speed, a servo drive must supply torque to match the characteristics of the machine that makes up the motor load, as well as torque to accelerate and decelerate the drive system (couplings, machine, and motor). Consider the following points when determining drive capacity.

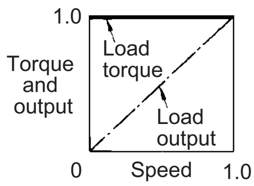
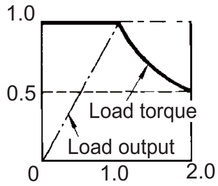
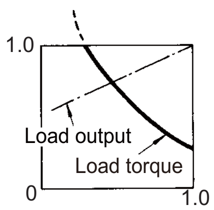
- Make clear the ratings to be used (continuous rating, short-time rating, and repetitive rating) to suit the load characteristics.
- Consider the efficiency of the motive force transmission mechanism and the load dispersion, and select a drive capacity greater than the motive force required by the load.
- Select a capacity that can sufficiently provide the startup torque and maximum torque required by the load. Use the following equation to select the drive capacity.

Drive load ≥ Motive force to drive the load mechanism + Motive force to accelerate and decelerate the load mechanism to the required speed

The above equation shows the method for calculating load drive force and acceleration/deceleration motive force.

14.4.1 Load Drive Capacity

The following table shows the torque-speed characteristics of the load mechanism that uses the servo drive.

<table>
<tr><th colspan="2">Load Characteristics</th><th>Load Examples</th><th>Speed-Torque Characteristics</th><th>Motor Capacity</th></tr>
<tr><td>Fixed Torque Load</td><td>Load torque over speed is a fixed load. (Usually a friction load.)</td><td>• Conveyers
• Cranes
• Winches
• Other friction loads and gravity loads</td><td>• Load torque is fixed regardless of speed.
• Output is proportional to speed.

</td><td>Motor capacity is the same as the maximum speed load capacity.</td></tr>
<tr><td>Fixed Output Load</td><td>Required output over speed is a fixed load.</td><td rowspan="2">• Center drive constant tension winders
• Main axis of machine-tool
• Veneer rotary lathe</td><td>Within fixed torque range:
• Load torque is fixed regardless of speed.
• Output is proportional to speed.
Within fixed output range:
• Output required by load is fixed.
• Load torque is inversely proportional to speed.

</td><td>Required rated output when using a drive with fixed torque characteristics is as follows:
Required output = Load output × Fixed output control ratio$^{1/2}$</td></tr>
<tr><td>Reduced Output Load</td><td>• Load torque overspeed is a variable load.
• Load has the intermediate characteristics of fixed output load and fixed torque load.</td><td>Intermediate speed-torque and output characteristics of fixed torque load and fixed output load

</td><td>Motor capacity is the same as the maximum speed load capacity.</td></tr>
</table>

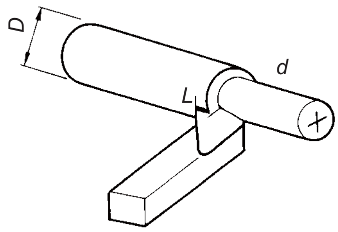
(1) Servo Drives for Main Axes of Machine Tools

The cutting force determines the required force for a Servo Drive for the main axis of a lathe or machining center. Constant output characteristics are required for cutting, and a constant output control range of 1: 10 to 1: 30 is required. The method to calculate the required force is given for the following lathe processing, machine center milling, and drilling examples.

Note: The cutting oil conditions, the cutting tool material and shape, the hardness of the material being cut, and other factors that affect the cutting resistance must also be considered to accurately calculate the required force.

■ Lathe Processing Example

For lathe cutting, the object to be cut is rotated and the blade is pressed against it to cut the object, as shown in the following diagram.



The force, P_C, that is required to cut the object is calculated with the following formula.

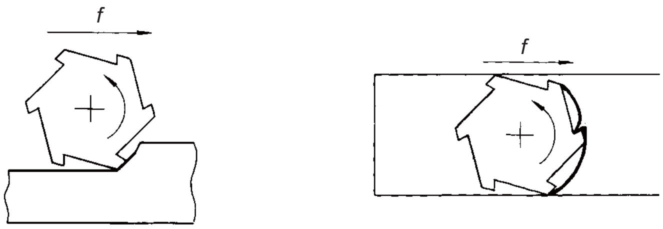
$$P_C = \frac{K_S\, dLV}{60 \times 1000 \times \eta_C} = \frac{dLV}{S_C \cdot \eta_C} \text{ (kW)}$$

$$V = \frac{\pi D N s}{1000} \text{ (m/min)}$$

K_S: Cutting resistance (N/mm^2)
d: Cutting depth (mm)
L: Length of blade actually performing cutting (i.e., amount of feed per rotation) (mm)
D: Diameter of object being processed (mm)
N_S: Main axis speed (min^{-1})
η_C: Machine efficiency 0.7 to 0.85
S_C: Cutting efficiency (i.e., cutting amount per 1 kW per minute) (CC/kW/min.)

■ Milling Example

For milling, the blade is mounted to the main axis and rotated to cut the object being processed.



(a) Side Milling　　(b) Front Milling

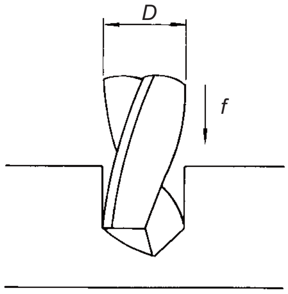
The force, P_F, that is required to cut the object is calculated with the following formula.

$$P_F = \frac{K_S\, \delta W f}{60 \times 1000^2 \times \eta_F} = \frac{\delta W f}{1000^2\, S_F\, \eta_F} \text{ (kW)}$$

K_S: Cutting resistance (N/mm^2)
δ: Cutting depth (mm)
W: Cutting width (mm)
f: Feed speed (mm/min.)
S_F: Cutting efficiency (i.e., cutting amount per 1 kW per minute) (CC/kW/min.)
η_F: Machine efficiency 0.7 to 0.85

■ Drilling Example

For drilling, the drill is mounted to the main axis and rotated, opening a hole in the material being processed.



The force, P_D, that is required is calculated with the following formula.

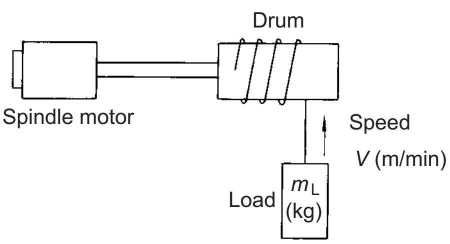
Note: The load torque, M, varies with the material, the drilling diameter (D), and the feed speed.

$$P_D = \frac{M \cdot 2\pi n}{60 \times 100 \times 1000 \times \eta_D} = \frac{\pi D^2 f}{4 \times 1000 \times S_D \eta_D} \text{ (kW)}$$

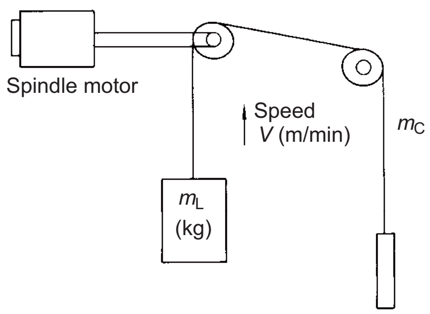
M: Drill load torque (N·cm)
n: Main axis speed (min^{-1})
η_D: Machine efficiency 0.7 to 0.85
D: Drilling diameter (mm)
f: Feed speed (mm/min.)
S_D: Cutting efficiency (i.e., cutting amount per 1 kW per minute) (CC/kW/min.)

(2) Servo Drivers with a Gravity Load

The force required to vertically move a load, such as with a crane or loader, differs greatly depending on whether a counterweight is used.



(a)Without counterweight



(b) With counterweight

The force that is required for each is calculated with the following formulas.

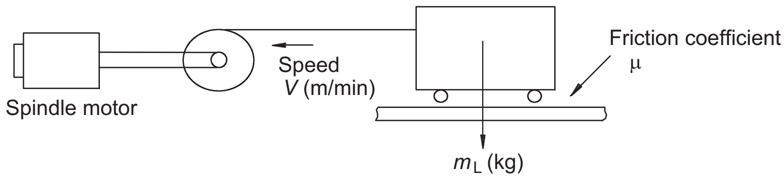
Without counterweight: $P_{GL} = \frac{m_L V}{6120\eta}$ (kW)

With counterweight: $P_{GLC} = \frac{(m_L - m_C) V}{6120\eta}$ (kW)

V: Vertical travel speed (m/min.)
η: Machine efficiency
m_L: Load mass (kg)
m_C: Counterweight mass (kg)

(3) Servo Drives with Friction Loads

Cranes, tables, and other horizontal conveyance equipment are friction loads.

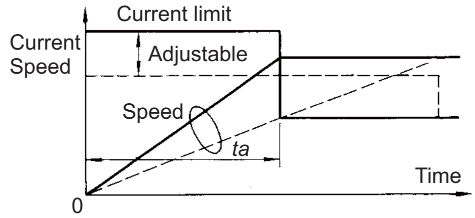
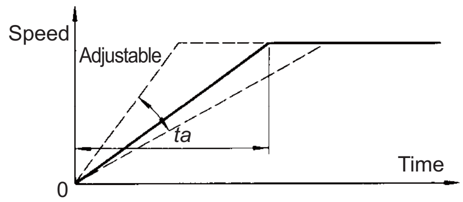
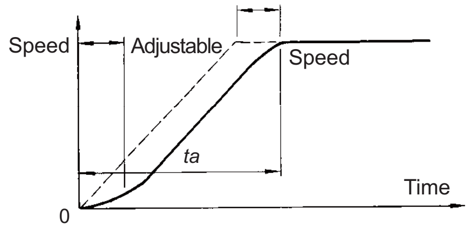


The force, P_F, that is required is calculated with the following formula, where μ is the friction coefficient.

$$P_F = \frac{\mu m_L V}{6120\eta} \text{(kW)}$$

14.4.2 Acceleration/deceleration Capacity

When stopping machinery operation, the acceleration method can be selected from rapid acceleration/deceleration to smooth acceleration/deceleration, depending on the application. A comparison of these acceleration methods is shown in the following table.

Acceleration Method	Control Method	Explanatory Diagram	Remarks
Current-limited Acceleration	This method suppresses the current during acceleration to a fixed value to protect the drive unit and machinery.		Fixes the torque generated by the motor during acceleration.
Time-limited Acceleration	This method suppresses the acceleration rate so that there is linear acceleration change over time, against rapid speed reference changes.		Fixes the acceleration torque.
S-curve Acceleration	This method further suppresses torque over the above method, to perform smooth acceleration.		Suppresses the rate of change in the torque at the start and end of acceleration.

Calculate the acceleration/deceleration capacity using the severest current-limiting acceleration according to capacity. The formula for calculating the drive capacity required from the acceleration time t (s) is shown below.

- Required drive capacity of the fixed torque characteristics range ($0 \le N_M \le N_B$)

$$P_M = \left(\frac{2\pi}{60}\right)^2 \frac{J_M N_M^2}{1000\,t} \text{ (kW)}$$

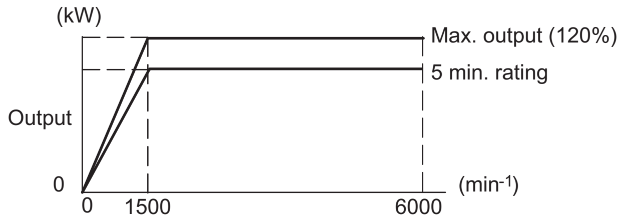
- Required drive capacity of the fixed torque characteristics + the fixed output characteristics range ($0 \le N_M \le N_{MAX}$)

$$P_M = \left(\frac{2\pi}{60}\right)^2 \frac{J_M (N_M^2 + N_B^2)}{2000\,t} \text{ (kW)}$$

J_M: Motor axis conversion inertial moment (kg·m^2)
P_M: Motor output at base speed (kW)
N_M: Operation speed (min^{-1})
N_B: Base speed (min^{-1})
N_{MAX}: Maximum speed (min^{-1})

■ Calculation Conditions

An example of calculations based on standard drive and machinery specifications is shown below. With actual machinery, the calculated values may vary slightly due to mechanical loss, fluctuations in the power supply voltage, and machine noise and motor magnetic field noise countermeasures.

Item	Value
Acceleration Time	2.5 s (0 to 6,000 min^{-1}) 0.5 s (0 to 1,500 min^{-1})
Inertial Moment J_M	0.13 $kg \cdot m^2$ Load: 0.10 $kg \cdot m^2$ Spindle motor: 0.03 $kg \cdot m^2$ (assuming load to be × 0.3)
Output Characteristics (5 min. Rating)	Base speed N_B: 1500 min^{-1} 
Maximum Output During Acceleration/ deceleration	120% of 5 min. rated output

■ Calculations

As a result of performing the calculations in *■ Calculation Conditions*, the motive force required from the acceleration/deceleration time is as follows: Upper formula: 5 min. rated 7.5 kW (47.7 N·m); Lower formula: 15 kW (95.0 N·m).

- At 0 to 1,500 min^{-1}

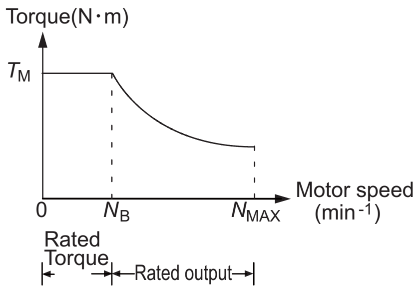
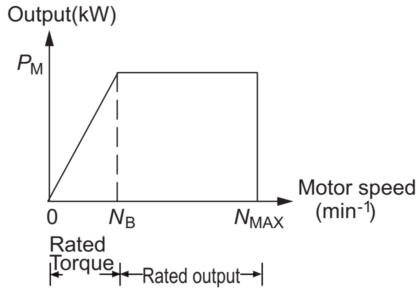
$$P_M = \left(\frac{2\pi}{60}\right)^2 \frac{0.13 \times 1500^2}{1000 \times 0.5} = 6.41 \text{ (kW)}$$

- At 0 to 6,000 min^{-1}

$$P_M = \left(\frac{2\pi}{60}\right)^2 \frac{0.13 \times (6000^2 + 1500^2)}{2000 \times 2.5} = 10.89 \text{ (kW)}$$

14.4.3 Calculating Start and Stop Times

After selecting the machine characteristics and servo drive capacity, the start and stop times can be calculated using formulas in the following table.

Item	Calculating from Torque	Calculating from Output
Motor Characteristics		
Fixed Torque Characteristics ($0 \leq N_M \leq N_B$) $0 \leftrightarrow N_M$ Acceleration/ deceleration Time	$t = \frac{2\pi}{60} \cdot J_M \cdot N_M \cdot \frac{1}{T_M}$	$t = \left(\frac{2\pi}{60}\right)^2 \cdot \frac{J_M}{1000P_M} \cdot N_B \cdot N_M$
Fixed Output Characteristics ($N_B \leq N_M \leq N_{MAX}$) $N_B \leftrightarrow N_M$ Acceleration/ deceleration Time	$t = \frac{2\pi}{60} \cdot J_M \cdot \frac{1}{T_M} \cdot \frac{N_M^2 - N_B^2}{2N_B}$	$t = \left(\frac{2\pi}{60}\right)^2 \cdot \frac{J_M}{1000P_M} \cdot \frac{N_M^2 - N_B^2}{2}$
Fixed Torque + Fixed Output Characteristics ($N_B \leq N_M \leq N_{MAX}$) $0 \leftrightarrow N_M$ Acceleration/ deceleration Time	$t = \frac{2\pi}{60} \cdot J_M \cdot \frac{1}{T_M} \cdot \frac{N_M^2 + N_B^2}{2N_B}$	$t = \left(\frac{2\pi}{60}\right)^2 \cdot \frac{J_M}{1000P_M} \cdot \frac{N_M^2 + N_B^2}{2}$

Note: The values obtained from actual machinery may differ from calculated values due to mechanical losses, fluctuation in supply voltages, mechanical noise, and measures taken for motor's magnetic noise.

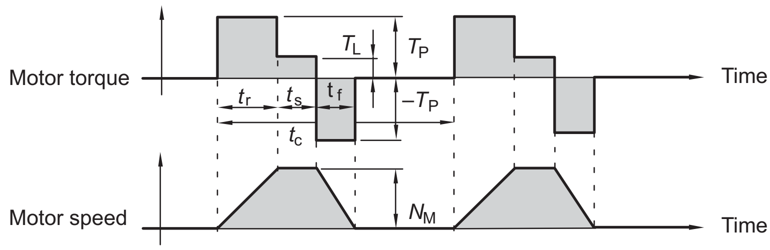
N_M: Operation speed (min^{-1})
N_B: Base speed (min^{-1})
M_{MAX}: Maximum speed (min^{-1})
J_M: Motor axis conversion inertial moment (kg·m^2) (= Motor inertial moment + motor axis conversion load inertial moment)
T_M: Motor axis maximum torque at base speed (N·m) (For a standard motor, max. torque = 5 min. rated torque × 1.2)
P_M: Motor maximum output at base speed (kW) (For a standard motor, max. output = 5 min. rated output × 1.2)

14.4.4 Intermittent Load Operating Capacity

If operations, such as tapping a machine-tool or driving a conveyer table, are frequently reversed, care must be taken in selecting the capacity. When using an operation cycle that includes acceleration/deceleration operations as follows, select so that the motor equivalence efficiency torque T_R is less than the servo drive continuous rated torque. (The maximum value of T_P will be 120% of the servo drive 5 min. rating.)

- Motor Torque and Speed Timechart

$$T_R = \sqrt{\frac{T_P^2\ (t_r + t_f) + T_L^2\ t_s}{t_C}}\ (\text{N} \cdot \text{m})$$



The motor reverse rating is the rating over the load where the motor load changes cyclically. When the reverse rated output is taken to be t_1 and with no load is taken to be t_2, α that is expressed in the following equation is called %ED (Einschalt Dauer). In this equation, $t_1 + t_2$ is always equal to 10 minutes.

$$\alpha = \frac{t_1}{t_1 + t_2} \times 100\ (\%)$$

Revision History

The revision dates and numbers of the revised manuals are given on the bottom of the back cover.

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Revision number

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Date of publication

Date of Publication	Rev. No.	Section	Revised Content
January 2018	<4>	All chapters	Partly revised
		Back cover	Revision: Address
April 2017	<3>	2.3.3, 3.3.1	Addition: X008023 AC reactor
		3.3.1 (1)	Revision: Approx. mass of X008010 AC reactor
		10.2	Revision: Information on certification for international standards
		Back cover	Revision: Address
January 2016	<2>	Front cover	Revision: Format
		–	Based on Japanese user’s manual, SIJP S800000 85F<5>, published in December 2015.
		All chapters	Completely revised
		Back cover	Revision: Format and address
October 2013	<1>	All chapters	Completely revised
March 2012	–	–	First edition

AC Servo Drives

Σ-V-SD Series

USER'S MANUAL

Speed Reference with Analog Voltage

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