FANUC

GE Fanuc Automation

Computer Numerical Control Products

Servo Amplifier βi Series

Descriptions Manual

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Warnings, Cautions, and Notes as Used in this Publication

Warning

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

Caution

Caution notices are used where equipment might be damaged if care is not taken.

Note

Notes merely call attention to information that is especially significant to understanding and operating the equipment.

This document is based on information available at the time of its publication. While efforts have been made to be accurate, the information contained herein does not purport to cover all details or variations in hardware or software, nor to provide for every possible contingency in connection with installation, operation, or maintenance. Features may be described herein which are not present in all hardware and software systems. GE Fanuc Automation assumes no obligation of notice to holders of this document with respect to changes subsequently made.

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SAFETY PRECAUTIONS

This "Safety Precautions" section describes the precautions which must be observed to ensure safety when using FANUC servo amplifiers (including spindle amplifiers). Users of any servo amplifier model are requested to read the "Safety Precautions" carefully before first using the amplifier. Users should also read the relevant description in this manual to become fully familiar with the functions of the servo amplifier.
The users are basically forbidden to do any behavior or action not mentioned in the "Safety Precautions." They are invited to ask FANUC previously about what behavior or action is prohibited.

Contents

1.1 DEFINITION OF WARNING, CAUTION, AND NOTE

This manual includes safety precautions for protecting the user and preventing damage to the machine. Precautions are classified into Warning and Caution according to their bearing on safety. Also, supplementary information is described as a Note. Read the Warning, Caution, and Note thoroughly before attempting to use the machine.

> ⚠ **WARNING**
> Applied when there is a danger of the user being injured or when there is a danger of both the user being injured and the equipment being damaged if the approved procedure is not observed.

> ⚠ **CAUTION**
> Applied when there is a danger of the equipment being damaged, if the approved procedure is not observed.

> **NOTE**
> The Note is used to indicate supplementary information other than Warning and Caution.

- Read this manual carefully, and store it in a safe place.

1.2 WARNINGS AND CAUTIONS RELATING TO MOUNTING

1.2.1 Warning

⚠ WARNING

- **Check the specification code of the amplifier.**
  Check that the delivered amplifier is as originally ordered.

- **Mount a ground fault interrupter.**
  To guard against fire and electric shock, fit the factory power supply or machine with a ground fault interrupter (designed for use with an inverter).

- **Securely ground the amplifier.**
  Securely connect the ground terminal and metal frame of the amplifier and motor to a common ground plate of the power magnetic cabinet.

- **Be aware of the weight of the amplifier and other components.**
  Servo amplifiers and AC reactors are heavy. When transporting them or mounting them in the cabinet, therefore, be careful not to injured yourself or damage the equipment. Be particularly carefull not to jam your fingers between the cabinet and amplifier.

- **Never ground or short-circuit either the power supply lines or power lines.**
  Protect the lines from any stress such as bending. Handle the ends appropriately.

- **Ensure that the power supply lines, power lines, and signal lines are securely connected.**
  A loose screw, loose connection, or the like will cause a motor malfunction or overheating, or a ground fault.
  Be extremely careful with power supply lines, motor power lines, and DC link connections through which a large amount of current passes, because a loose screw (or poor contact in a connector or poor connection between a connector terminal and a cable) may cause a fire.

- **Insulate all exposed parts that are charged.**

- **Never touch the regenerative discharge resistor or radiator directly.**
  The surface of the radiator and regenerative discharge resistor become extremely hot. Never touch them directly. An appropriate structure should also be considered.

⚠ WARNING

- **Close the amplifier cover after completing the wiring.**
  Leaving the cover open presents a danger of electric shock.

- **Do not disassemble the amplifier.**

- **Ensure that the cables used for the power supply lines and power lines are of the appropriate diameter and temperature ratings.**

- **Do not apply an excessively large force to plastic parts.**
  If a plastic section breaks, it may cause internal damage, thus interfering with normal operation. The edge of a broken section is likely to be sharp and, therefore, presents a risk of injury.

1.2.2 Caution

⚠ CAUTION

- **Do not step or sit on the amplifier.**
  Also, do not stack unpacked amplifiers on top of each other.

- **Use the amplifier in an appropriate environment.**
  See the allowable ambient temperatures and other requirements, given in the this manual.

- **Protect the amplifier from corrosive or conductive mist or drops of water.**
  Use a filter if necessary.

- **Protect the amplifier from impact.**
  Do not place anything on the amplifier.

- **Do not block the air inlet to the radiator.**
  A deposit of coolant, oil mist, or chips on the air inlet will result in a reduction in the cooling efficiency. In some cases, the required efficiency cannot be achieved. The deposit may also lead to a reduction in the useful life of the semiconductors. Especially, when outside air is drawn in, mount filters on both the air inlet and outlet. These filters must be replaced regularly. So, an easy-to-replace type of filter should be used.

- **Connect the power supply lines and power lines to the appropriate terminals and connectors.**

- **Connect the signal lines to the appropriate connectors.**

- **Before connecting the power supply wiring, check the supply voltage.**
  Check that the supply voltage is within the range specified in this manual, then connect the power supply lines.

- **Ensure that the combination of motor and amplifier is appropriate.**

- **Ensure that valid parameters are specified.**
  Specifying an invalid parameter for the combination of motor and amplifier may not only prevent normal operation of the motor but also result in damage to the amplifier.

- **Ensure that the amplifier and peripheral equipment are securely connected.**
  Check that the magnetic contactor, circuit breaker, and other devices mounted outside the amplifier are securely connected to each other and that those devices are securely connected to the amplifier.

⚠ CAUTION

- **Check that the amplifier is securely mounted in the power magnetic cabinet.**
  If any clearance is left between the power magnetic cabinet and the surface on which the amplifier is mounted, dust entering the gap may build up and prevent the normal operation of the amplifier.

- **Apply appropriate countermeasures against noise.**
  Adequate countermeasures against noise are required to maintain normal operation of the amplifier. For example, signal lines must be routed away from power supply lines and power lines.

1.2.3 Note

NOTE

- **Keep the nameplate clearly visible.**
- **Keep the legend on the nameplate clearly visible.**
- **After unpacking the amplifier, carefully check for any damage.**
- **Mount the amplifier in a location where it can be easily accessed periodic inspection and daily maintenance.**
- **Leave sufficient space around the machine to enable maintenance to be performed easily.**
  Do not place any heavy objects such that they would interfere with the opening of the doors.
- **Keep the parameter table and spare parts at hand.**
  Also, keep the specifications at hand. These items must be stored in a location where they can be retrieved immediately.
- **Provide adequate shielding.**
  A cable to be shielded must be securely connected to the ground plate, using a cable clamp or the like.

1.3 WARNINGS AND CAUTIONS RELATING TO A PILOT RUN

1.3.1 Warning

⚠ WARNING

- **Before turning on the power, check that the cables connected to the power magnetic cabinet and amplifier, as well as the power lines and power supply lines, are securely connected. Also, check that no lines are slack.**

- **Before turning on the power, ensure that the power magnetic cabinet is securely grounded.**

- **Before turning on the power, check that the door of the power magnetic cabinet and all other doors are closed.**
  Ensure that the door of the power magnetic cabinet containing the amplifier, and all other doors, are securely closed. During operation, all doors must be closed and locked.

- **Apply extreme caution if the door of the power magnetic cabinet or another door must be opened.**
  Only a person trained in the maintenance of the corresponding machine or equipment should open the door, and only after shutting off the power supply to the power magnetic cabinet (by opening both the input circuit breaker of the power magnetic cabinet and the factory switch used to supply power to the cabinet). If the machine must be operated with the door open to enable adjustment or for some other purpose, the operator must keep his or her hands and tools well away from any dangerous voltages. Such work must be done only by a person trained in the maintenance of the machine or equipment.

- **When operating the machine for the first time, check that the machine operates as instructed.**
  To check whether the machine operates as instructed, first specify a small value for the motor, then increase the value gradually. If the motor operates abnormally, perform an emergency stop immediately.

- **After turning on the power, check the operation of the emergency stop circuit.**
  Press the emergency stop button to check that the motor stops immediately, and that the power being supplied to the amplifier is shut off by the magnetic contactor.

- **Before opening a door or protective cover of a machine to enable adjustment of the machine, first place the machine in the emergency stop state and check that the motor has stopped.**

1.3.2 Caution

⚠ CAUTION

- **Note whether an alarm status relative to the amplifier is displayed at power-up or during operation.**
  If an alarm is displayed, take appropriate action as explained in the maintenance manual. If the work to be done requires that the door of the power magnetic cabinet be left open, the work must be carried out by a person trained in the maintenance of the machine or equipment. Note that if some alarms are forcibly reset to enable operation to continue, the amplifier may be damaged. Take appropriate action according to the contents of the alarm.

- **Before operating the motor for the first time, mount and adjust the position and speed sensors.**
  Following the instructions given in the maintenance manual, adjust the position and speed sensors for the spindle so that an appropriate waveform is obtained.
  If the sensors are not properly adjusted, the motor may not rotate normally or the spindle may fail to stop as desired.

- **If the motor makes any abnormal noise or vibration while operating, stop it immediately.**
  Note that if operation is continued in spite of there being some abnormal noise or vibration, the amplifier may be damaged. Take appropriate corrective action, then resume operation.

- **Observe the ambient temperature and output rating requirements.**
  The continuous output rating or continuous operation period of some amplifiers may fall as the ambient temperature increases. If the amplifier is used continuously with an excessive load applied, the amplifier may be damaged.

1.4 Warnings and Cautions Relating to Maintenance

1.4.1 Warning

⚠ WARNING

- **Read the maintenance manual carefully and ensure that you are totally familiar with its contents.**
  The maintenance manual describes daily maintenance and the procedures to be followed in the event of an alarm being issued. The operator must be familiar with these descriptions.

- **Notes on replacing a fuse or PC board**
  1) Before starting the replacement work, ensure that the circuit breaker protecting the power magnetic cabinet is open.
  2) Check that the red LED that indicates that charging is in progress is not lit.
     The position of the charging LED on each model of amplifier is given in this manual. While the LED is lit, hazardous voltages are present inside the unit, and thus there is a danger of electric shock.
  3) Some PC board components become extremely hot. Be careful not to touch these components.
  4) Ensure that a fuse having an appropriate rating is used.
  5) Check the specification code of a PC board to be replaced. If a modification drawing number is indicated, contact FANUC before replacing the PC board.
     Also, before and after replacing a PC board, check its pin settings.
  6) After replacing the fuse, ensure that the screws are firmly tightened. For a socket-type fuse, ensure that the fuse is inserted correctly.
  7) After replacing the PC board, ensure that it is securely connected.
  8) Ensure that all power lines, power supply lines, and connectors are securely connected.

- **Take care not to lose any screws.**
  When removing the case or PC board, take care not to lose any screws. If a screw is lost inside the nit and the power is turned on, the machine may be damaged.

⚠ WARNING

- **Notes on replacing the battery of the absolute Pulsecoder**
  Replace the battery only while the power is on. If the battery is replaced while the power is turned off, the stored absolute positioning data will be lost. Some β*i* series servo amplifier modules have batteries in their servo amplifiers. To replace the battery of any of those models, observe the following procedure: Open the door of the power magnetic cabinet; Leave the control power of the power supply module on; Place the machine in the emergency stop state so that the power being input to the amplifier is shut off; Then, replace the battery. Replacement work should be done only by a person who is trained in the related maintenance and safety requirements. The power magnetic cabinet in which the servo amplifier is mounted has a high-voltage section. This section presents a severe risk of electric shock.

- **Check the alarm number.**
  If the machine stops upon an alarm being issued, check the alarm number. Some alarms indicate that a component must be replaced. If the power is reconnected without first replacing the failed component, another component may be damaged, making it difficult to locate the original cause of the alarm.

- **Before resetting an alarm, ensure that the original cause of the alarm has been removed.**

- **Contact FANUC whenever a question relating to maintenance arises.**

- **Notes on removing the amplifier**
  Before removing the amplifier, first ensure that the power is shut off. Be careful not to jam your fingers between the power magnetic cabinet and amplifier.

1.4.2 Caution

⚠ CAUTION

- **Ensure that all required components are mounted.**
  When replacing a component or PC board, check that all components, including the snubber capacitor, are correctly mounted. If the snubber capacitor is not mounted, for example, the IPM will be damaged.

- **Tighten all screws firmly.**

- **Check the specification code of the fuse, PC board, and other components.**
  When replacing a fuse or PC board, first check the specification code of the fuse or PC board, then mount it in the correct position. The machine will not operate normally if a fuse or PC board having other than the correct specification code is mounted, or if a fuse or PC board is mounted in the wrong position.

- **Mount the correct cover.**
  The cover on the front of the amplifier carries a label indicating a specification code. When mounting a previously removed front cover, take care to mount it on the unit from which it was removed.

- **Notes on cleaning the heat sink and fan**
  1) A dirty heat sink or fan results in reduced semiconductor cooling efficiency, which degrades reliability. Periodic cleaning is necessary.
  2) Using compressed air for cleaning scatters the dust. A deposit of conductive dust on the amplifier or peripheral equipment will result in a failure.
  3) To clean the heat sink, do so only after turning the power off and ensuring that the heat sink has cooled to room temperature. The heat sink becomes extremely hot, such that touching it during operation or immediately after power-off is likely to cause a burn. Be extremely careful when touching the heat sink.

- **Unless otherwise specified, do not insert or remove any connector while the power is turned on. Otherwise, the amplifier may fail.**

1.4.3 Note

NOTE

- **Ensure that the battery connector is correctly inserted.**
  If the power is shut off while the battery connector is not connected correctly, the absolute position data for the machine will be lost.

- **Store the manuals in a safe place.**
  The manuals should be stored in a location where they can be accessed immediately it so required during maintenance work.

- **Notes on contacting FANUC**
  Inform FANUC of the details of an alarm and the specification code of the amplifier so that any components required for maintenance can be quickly secured, and any other necessary action can be taken without delay.

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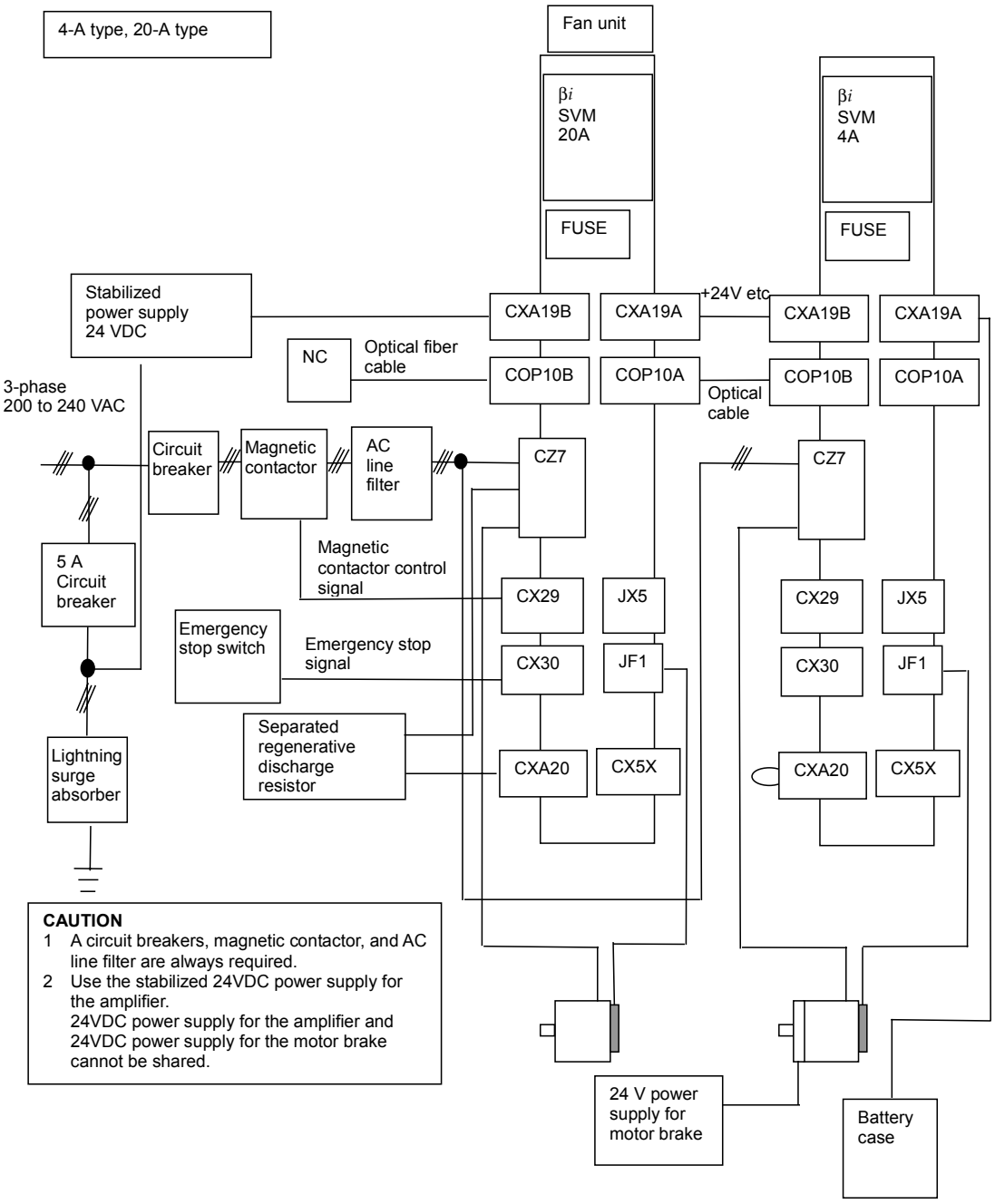
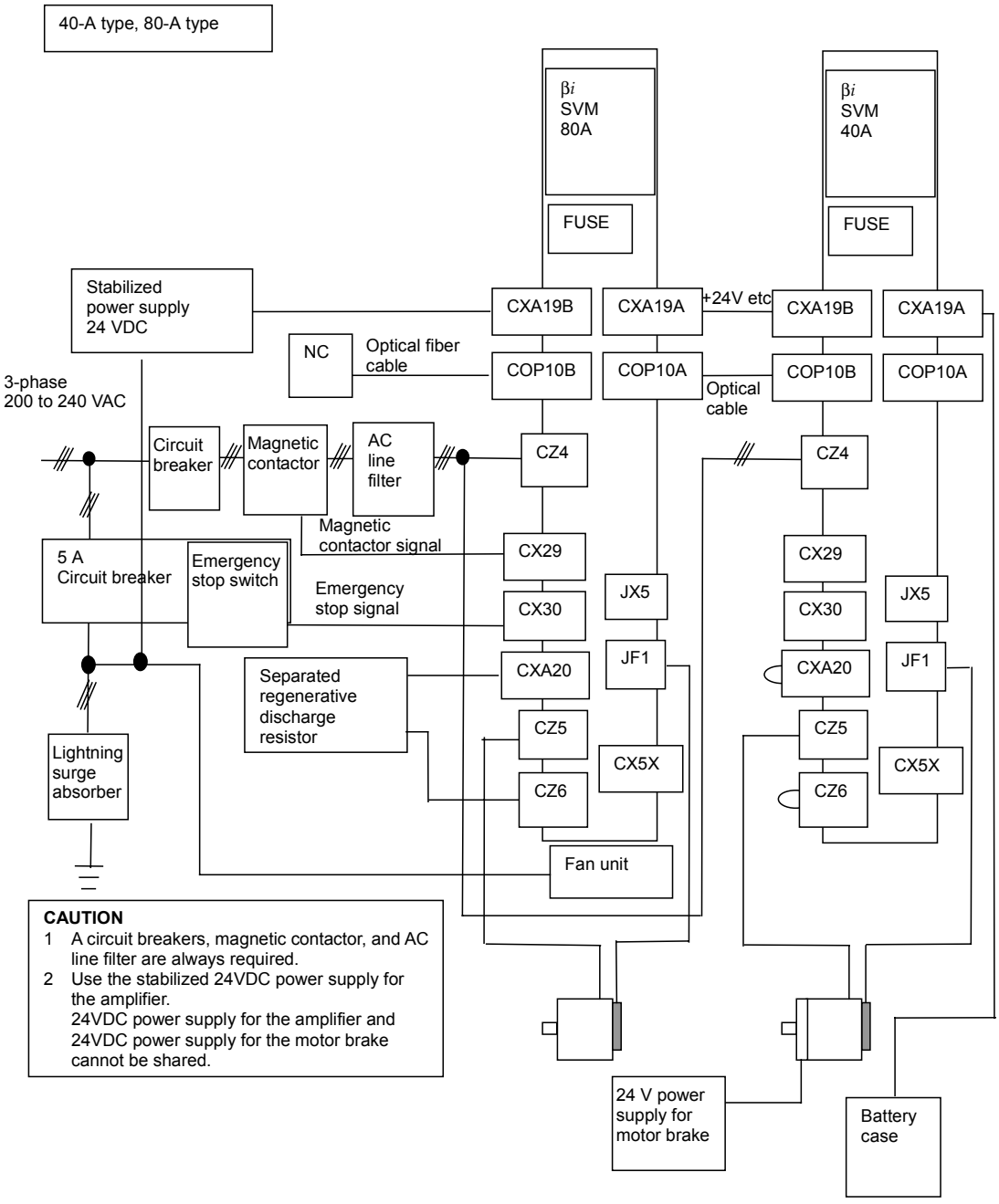
I. SVM

1 CONFIGURATION

1.1 SVM1-4*i* AND SVM1-20*i*



1.2 SVM1-40*i* AND SVM1-80*i*



2 SPECIFICATIONS

2.1 SVM1-4*i* AND SVM1-20*i*

Item	Specification
Power supply voltage (drive)	3-phase 200 to 240 VAC 1-phase 220 to 240 VAC
Power supply voltage (control)	24VDC / 0.9A
Dynamic brake	Built-in

2.2 SVM1-40*i* AND SVM1-80*i*

Item	Specification
Power supply voltage (drive)	3-phase 200 to 240 VAC
Power supply voltage (control)	24VDC / 0.9A
Dynamic brake	Built-in

2.3 APPLICABLE MOTORS

		0.2	0.3	0.4	0.5	1	2	4		8			12		22	
Motor	αi					α1/ 5000i (20A)	α2/ 5000i (20A)		α4/ 4000i (40A)		α8/ 3000i (40A)			α12/ 3000i (80A)		α22/ 3000i (80A)
	αis						α2/ 5000is (20A)	α4/ 5000is (20A)				α8/ 4000is (80A)		α12/ 4000is (80A)		
	βis	β0.2/ 5000is (4A)	β0.3/ 5000is (4A)	β0.4/ 5000is (20A)	β0.5/ 5000is (20A)	β1/ 5000is (20A)	β2/ 4000is (20A)	β4/ 4000is (20A)		β8/ 3000is (20A)			β12/ 3000is (40A)		β22/ 2000is (40A)	
SVM1	SVM1-4i A06B-6130-H001	O	O													
	SVM1-20i A06B-6130-H002			O	O	O	O	O		O						
	SVM1-40i A06B-6130-H003								O		O		O		O	
	SVM1-80i A06B-6130-H004											O		O		O

2.4 COOLING FAM MOTORS

The combinations listed below require cooling fan motors.

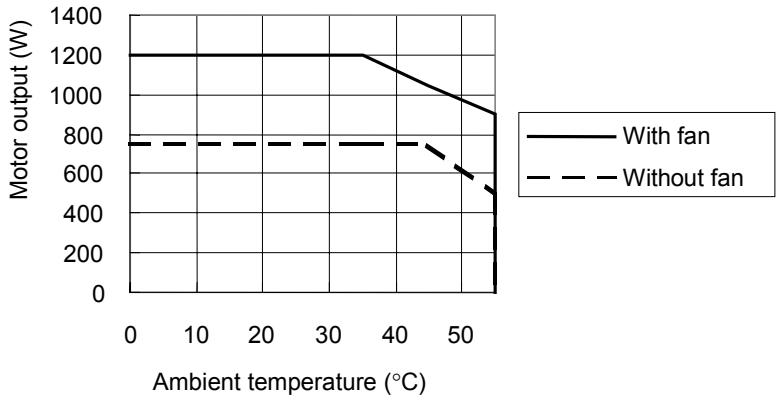
Ordering number	Amplifier	Combined motor
A06B-6134-K002	SVM1-80*i*	General 80-A class motors
A06B-6134-K003	SVM1-20*i* Running on 3-phase 200-240 VAC power	α4/5000*i*s β8/3000*i*s
	SVM1-20*i* Running on 1-phase 220-240 VAC power	α2/5000*i* α2/5000*i*s α4/5000*i*s β4/4000*i*s β8/3000*i*s

2.5 DERATING

Consider derating as shown below, according to ambient temperatures.

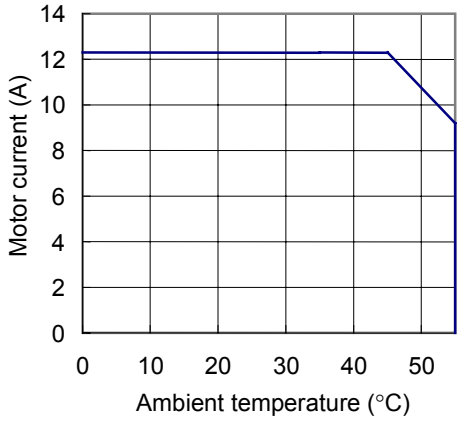
SVM1-20*i*

Output derating for single-phase input



SVM1-40*i*

Current derating



2.6 SEPARATED REGENERATIVE DISCHARGE RESISTOR

2.6.1 When No Separated Regenerative Discharge Resistor Is Needed

No separated regenerative discharge resistor is needed if the energy regenerated per regeneration cycle is not higher than the amount [J] of energy listed below.

Note in mind that an incorrect connection can damage the amplifier.

Table 2.6.1 Maximum regenerative energy amount permitted for individual amplifier models

Amplifier model	Permissible regenerative energy amount
SVM-4*i* SVM-20*i*	16 [J]

How to calculate the amount of energy regenerated per regeneration cycle - For horizontal movement

(a) SI unit system

$$P = (5.48\times10^{-3}\cdot(Jm+JL)\cdot Vm^2 - 5.23\times10^{-2}\cdot ta\cdot Vm\cdot TL)\,[J] \qquad \text{(Expression 1)}$$

Jm: Rotor inertia of the motor [kg·m^2]
JL: Motor-shaft-converted inertia of the load [kg·m^2]
Vm: Motor speed at rapid traverse [min^{-1}]
ta: Rapid traverse acceleration/deceleration time [sec]
TL: Machine frictional torque (motor-converted value) [N·m]

(b) CGS unit system

$$P = (5.37\times10^{-4}\cdot(Jm+JL)\cdot Vm^2 - 5.13\times10^{-3}\cdot ta\cdot Vm\cdot TL)\,[J] \qquad \text{(Expression 1)}$$

Jm: Rotor inertia of the motor [kgf·cm·sec^2]
JL: Motor-shaft-converted inertia of the load [kgf·cm·sec^2]
Vm: Motor speed at rapid traverse [min^{-1}]
ta: Rapid traverse acceleration/deceleration time [sec]
TL: Machine frictional torque (motor-converted value) [kg·cm]

- For vertical movement

(a) SI unit system

$Q = 1.047 \times 10^{-1} \cdot Th \cdot Vm \cdot ta \ [J]$ (Expression 2)

Th: Upward torque that the motor applies at the time of downward rapid traverse [N·m]
Vm Motor speed at rapid traverse [min^{-1}]
ta : Rapid traverse acceleration/deceleration time [sec]

(b) CGS unit system

$Q = 1.026 \times 10^{-2} \cdot Th \cdot Vm \cdot ta \ [J]$ (Expression 2)

Th: Upward torque that the motor applies at the time of downward rapid traverse [kg·cm]
Vm: Motor speed at rapid traverse [min^{-1}]
ta : Rapid traverse acceleration/deceleration time [sec]

If the motor load moves up and down, the sum of expressions 1 and 2 gives the amount of energy regenerated per regeneration cycle.

R = P + Q [J] (Expression 3)

2.6.2 When a Separated Regenerative Discharge Resistor Is Needed

If the amount of energy regenerated per regeneration cycle exceeds the maximum amount of energy that a servo amplifier can handle, a DC link overvoltage alarm occurs. In this case, a separated regenerative discharge resistor is needed.
Note in mind that an incorrect connection can damage the amplifier.

Selecting a regenerative discharge resistor

First obtain how much regenerative energy occurs.

- For horizontal movement

Servo motor (for horizontal movement)
Amount of regenerative discharge (power [W]) when rapid traverse acceleration/deceleration is performed once every F sec

(a) SI unit system

$$w = \frac{1}{F} \times (5.48 \times 10^{-3} \cdot (Jm + JL) \cdot Vm^2 - 5.23 \times 10^{-2} \cdot ta \cdot Vm \cdot TL)\,[W] \quad \text{(Expression 4)}$$

F : Frequency of rapid traverse acceleration/deceleration [sec/number of times]
Unless otherwise specified, rapid traverse acceleration/deceleration is assumed to be performed about once every 5 seconds.
Jm: Rotor inertia of the motor [kg·m^2]
JL: Motor-shaft-converted inertia of the load [kg·m^2]
Vm: Motor speed at rapid traverse [min^{-1}]
ta: Rapid traverse acceleration/deceleration time [sec]
TL: Machine frictional torque (motor-converted value) [N·m]

(b) CGS unit system

$$w = \frac{1}{F} \times (5.37 \times 10^{-4} \cdot (Jm + JL) \cdot Vm^2 - 5.13 \times 10^{-3} \cdot ta \cdot Vm \cdot TL)\,[W] \quad \text{(Expression 4)}$$

F : Frequency of rapid traverse acceleration/deceleration [sec/number of times]
Unless otherwise specified, rapid traverse acceleration/deceleration is assumed to be performed about once every 5 seconds.
Jm: Rotor inertia of the motor [kgf·cm·sec^2]
JL: Motor-shaft-converted inertia of the load [kgf·cm·sec^2]
Vm: Motor speed at rapid traverse [min^{-1}]
ta: Rapid traverse acceleration/deceleration time [sec]
TL: Machine frictional torque (motor-converted value) [kg·cm]

- For vertical movement

The amount of regenerative discharge (power [W]) when the operation duty for downward rapid traverse is D(%)

(a) SI unit system

$$w = 1.047 \times 10^{-1} \cdot Th \cdot Vm \times \frac{D}{100} \ [W] \quad \text{(Expression 5)}$$

Th: Upward torque that the motor applies at the time of downward rapid traverse [N·m]
Vm: Motor speed at rapid traverse [min^{-1}]
D : Operation duty [%] for downward rapid traverse
D is set to 50% maximum. Usually, D is less than 50%.

(b) CGS unit system

$$w = 1.026 \times 10^{-2} \cdot Th \cdot Vm \times \frac{D}{100} \ [W] \quad \text{(Expression 5)}$$

Th Upward torque that the motor applies at the time of downward rapid traverse [kg·cm]
Vm Motor speed at rapid traverse [min^{-1}]
D : Operation duty [%] for downward rapid traverse
D is set to 50% maximum. Usually, D is less than 50%.

If the motor load moves up and down, the sum of expressions 4 and 5 gives the amount of energy regenerated per regeneration cycle.

R' = P' + Q' [W] (Expression 6)

From Table 2.6.2, select a separated regenerative discharge resistor whose regenerative discharge capacity is larger than the regenerative energy obtained in expressions 1 to 6.

Table 2.6.2 Regenerative discharge capacity of separated regenerative discharge resistors

Separated regenerative discharge resistor	Regenerative discharge capacity	Condition
A06B-6130-H401 (30 Ω)	20 W	Wind speed of 0 m/s
(Caution) A06B-6130-H402 (30 Ω)	100 W	

⚠ CAUTION
Do not use a regenerative resistor cable longer than 1 m. Otherwise, it is likely that the regenerative circuit in the amplifier may malfunction or the amplifier may be damaged.

NOTE
If the permissible value of a separated regenerative discharge resistor is exceeded during use, the unit overheats, resulting in the built-in thermostat operating to issue an overheat alarm.

2.6.3 When Amplifier Models SVM-40*i* and SVM-80*i* Are Used

If the amount of regenerative discharge from a servo motor exceeds the regenerative discharge capacity of the regenerative discharge resistor incorporated in the corresponding servo amplifier, a separated regenerative discharge resistor is needed.
If the motor regenerative discharge amount R obtained in Subsection 2.6.2 exceeds the corresponding value listed in Table 2.6.3 (a), "Regenerative discharge capacity of the regenerative discharge resistor incorporated in servo amplifiers," use a separated regenerative discharge resistor.

Table 2.6.3 (a) Regenerative discharge capacity of the regenerative discharge resistor incorporated in servo amplifiers

Servo amplifier	Capacity
A06B-6130-H003	50 W
A06B-6130-H004	130 W

The following table lists the separated regenerative discharge resistors that are available.
Select a separated regenerative discharge resistor whose discharge capacity satisfies your requirement.

Table 2.6.3(b) Regenerative discharge capacity of regenerative discharge resistors installed separately from servo amplifiers

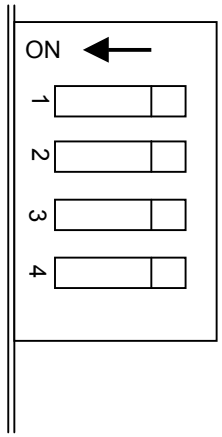
Separated regenerative discharge resistor	Wind speed of 0 m/s	Wind speed of 2 m/s	Wind speed of 4 m/s
A06B-6089-H500	R = 200W	R = 400 W	R = 600 W
A06B-6089-H713	Incorporates a cooling fan motor.		R = 800 W
A06B-6089-H714	Incorporates a cooling fan motor.		R = 1200 W

Set-up switch (for changing the DC alarm level)

Switch setting (for the SVM1-40*i* and SVM1-80*i*)
The SVM1-40*i* and SVM1-80*i* each have four switches on their front panel for protecting regenerative resistors. Be sure to set these switches to the positions that match the resistors used.

> ⚠ **CAUTION**
> An incorrect switch setting may damage the regenerative resistor.

These switches are numbered 1 to 4. The one on top is No. 1, the one below it is No. 2, and so on. When the lever of a switch is at the left, the switch is on. When it is at the right, the switch is off.



(1) Setting of switches 3 and 4
The setting of switches 3 and 4 varies depending on what regenerative discharge resistor is used.
⇒ If a switch is incorrectly set up, it is impossible to detect a regenerative overheat alarm normally.

Switch 3	Switch 4	Regenerative discharge resistor
ON	ON	Incorporated in the amplifier
OFF	ON	Separate unit A06B-6089-H500
OFF	OFF	Separate unit A06B-6089-H713, A06B-6089-H714

(2) Setting of switches 1 and 2
Neither switch 1 nor 2 is used. Leave them off.

Cautions for selecting a regenerative discharge resistor

⚠ CAUTION
1 Regenerative discharge resistors may become very hot (100 to 200 °C). Be careful not to touch them.
2 Before touching a regenerative discharge resistor, for example, for maintenance purposes, turn off all power to the amplifier, wait for at least 30 minutes, and make sure that the DC link charge indicator LED (CAUTION CHARGE) is off and the regenerative resistor is sufficiently cold.
3 When mounting a regenerative resistor, keep it sufficiently far from any flammable.

(1) Related ordering numbers

Ordering number of regenerative discharge resistor	Resistance	Capacity			Remarks
		Wind speed			
		0 m/s	2 m/s	4 m/s	
A06B-6130-H401	30 Ω	20 W	-	-	For 4/20 A
A06B-6130-H402	30 Ω	100 W	-	-	For 4/20 A
A06B-6089-H500	16 Ω	200 W	400 W	600 W	For 40/80 A
A06B-6089-H713	16 Ω	Incorporates a cooling fan motor.		800 W	For 40/80 A
A06B-6089-H714	16 Ω	Incorporates a cooling fan motor.		1200 W	For 40/80 A

(2) Mounting requirements
(a) Cautions in mounting

A06B-6130-H401	Install these models in a completely sealed cabinet.
A06B-6130-H402	
A06B-6089-H500	Place the pin side and resistor side (heat generating section) of these models, respectively, in a completely sealed cabinet and an exhaust air duct. (a) Use accompanying gaskets. (b) Make arrangements so that the pin side and resistor side (heat generating section) can be kept from coolant, oil mist, and cuttings. (c) When taking in fresh air to the resistor (heat generating section), use an air filter at the air inlet. Also seal the cable inlets, cable outlets and doors securely.
A06B-6089-H713	
A06B-6089-H714	

(b) Ambient temperature
0 to 55 °C (at operation)
-20 to 60 °C (at keeping and transportation)
(c) Humidity
Normally 90 % RH or below, and condensation-free
(d) Vibration
In operation : Below 0.5 G
(e) Mounting direction:
Mount the unit securely while referring to the mounting diagram given below.

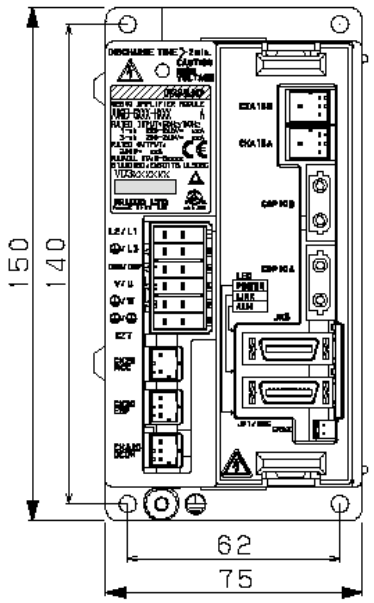
3 ORDERING INFORMATION

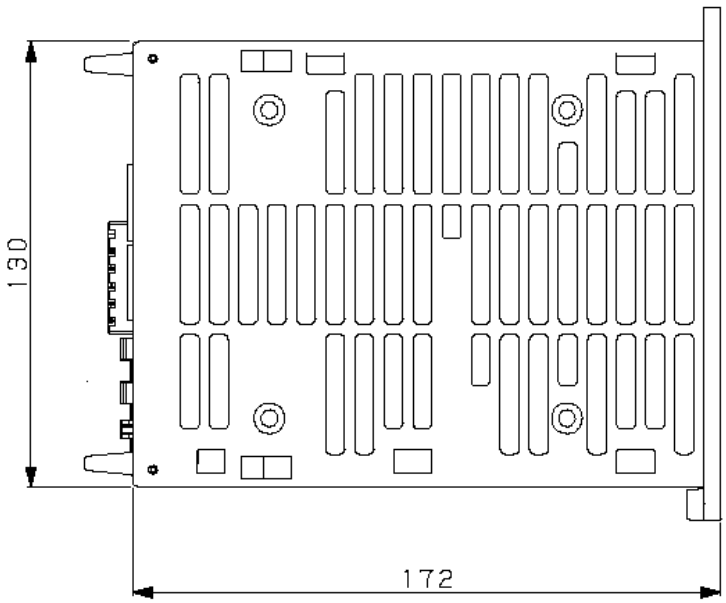
Refer to the order list (B-65321EN).

4 EXTERNAL DIMENSIONS / PANEL CUT-OUT DRAWINGS / MAINTENANCE AREA

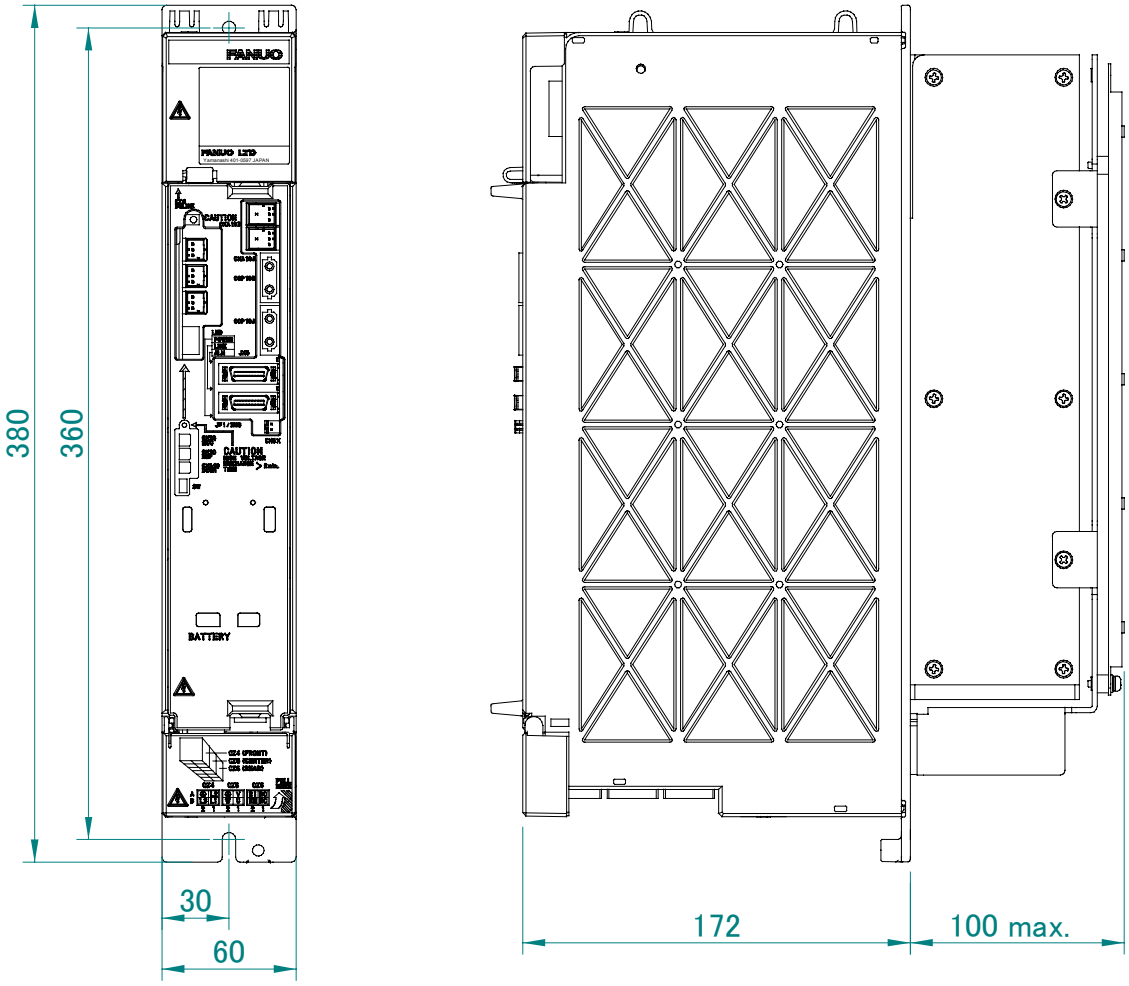
4.1 EXTERNAL DIMENSIONS

4.1.1 External Dimensions of SVM1-4*i* and SVM1-20*i*

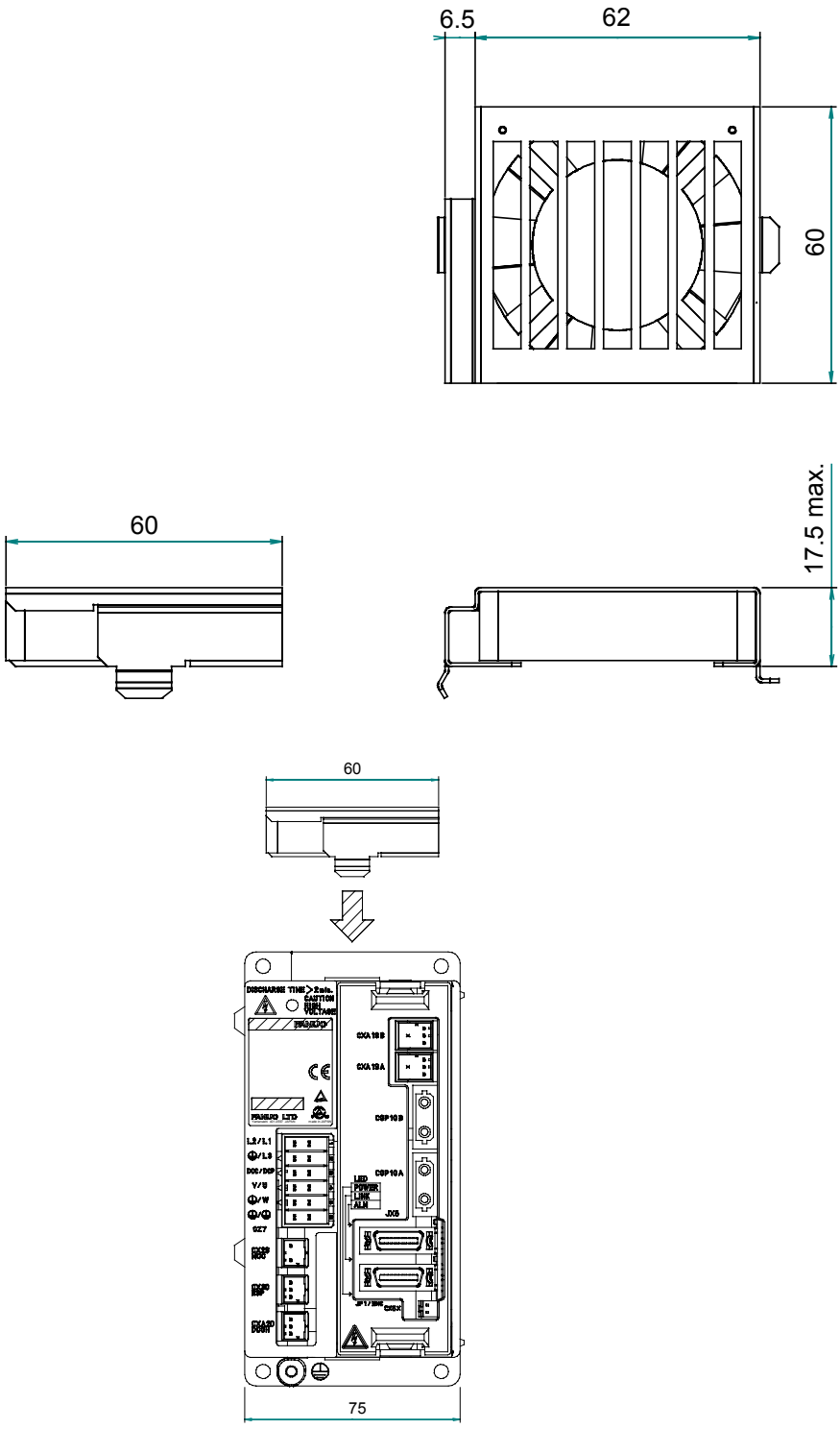




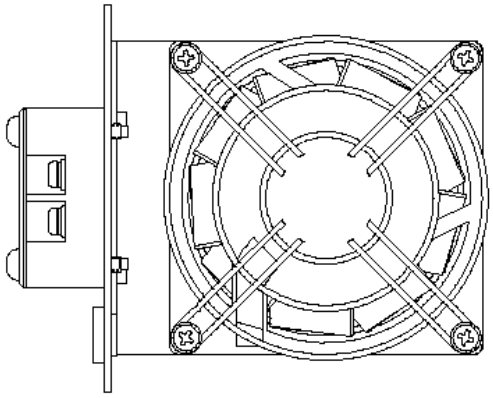
4.1.2 External Dimensions of SVM1-40*i* and SVM1-80*i*

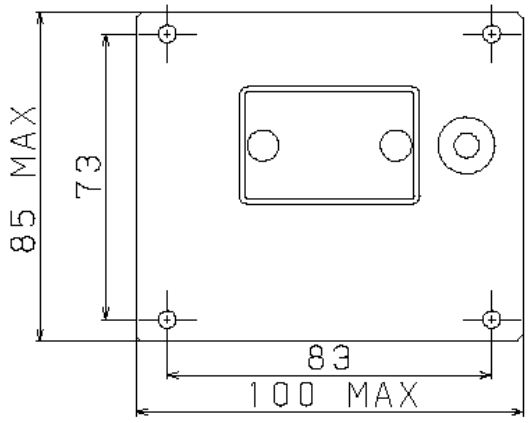


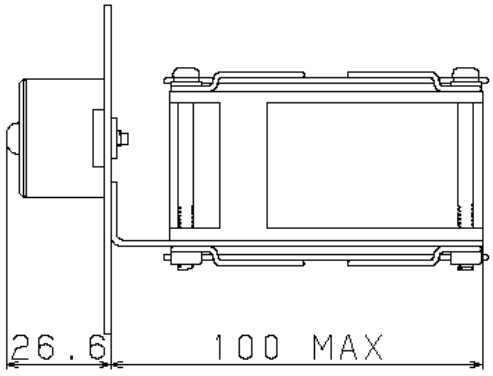
4.1.3 External Dimensions of Fan Unit (A06B-6134-K003)



4.1.4 External Dimensions of Fan Unit (A06B-6134-K002)

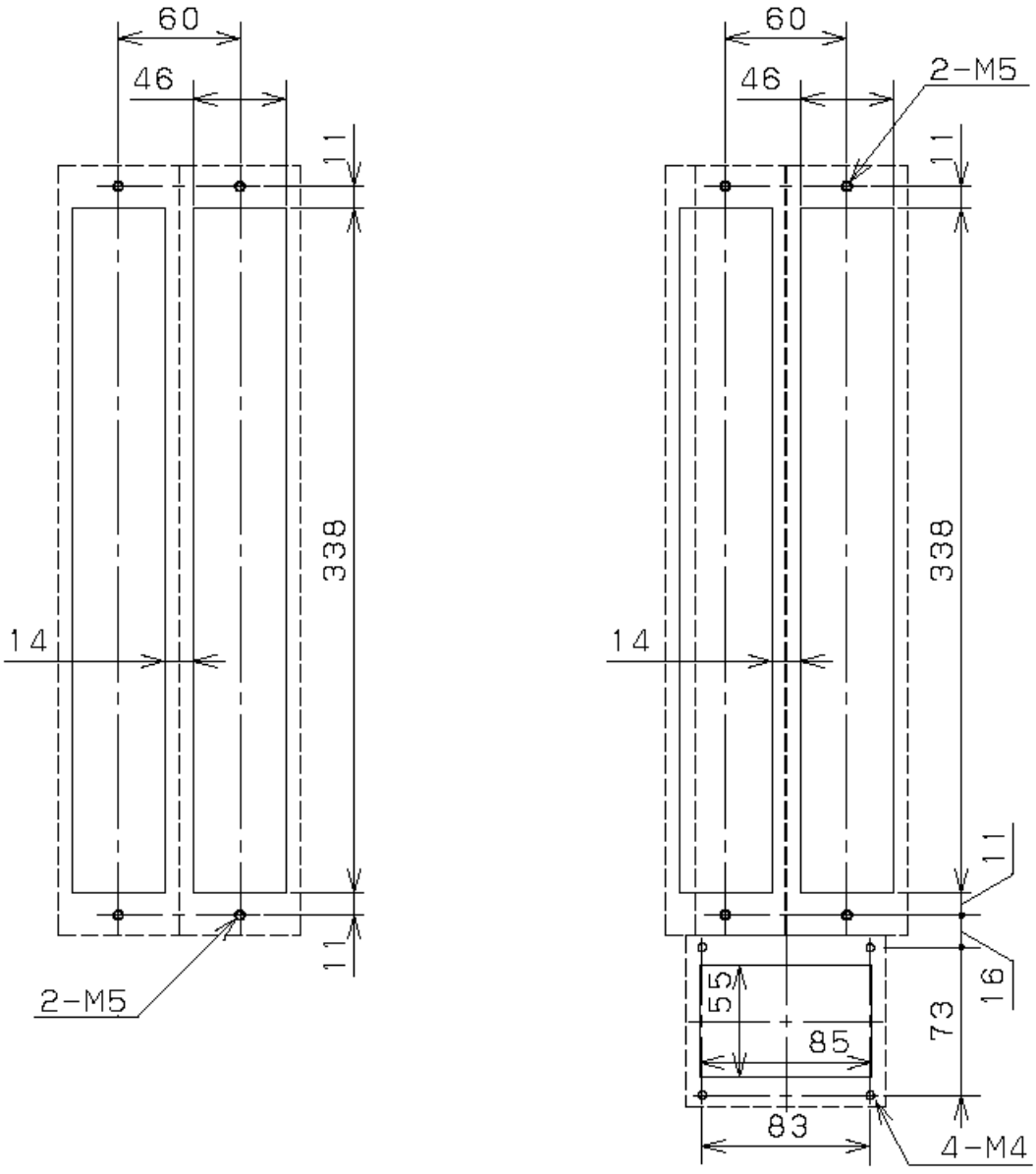






4.2 PANEL CUT-OUT DRAWINGS

4.2.1 SVM1-40*i* and SVM1-80*i*

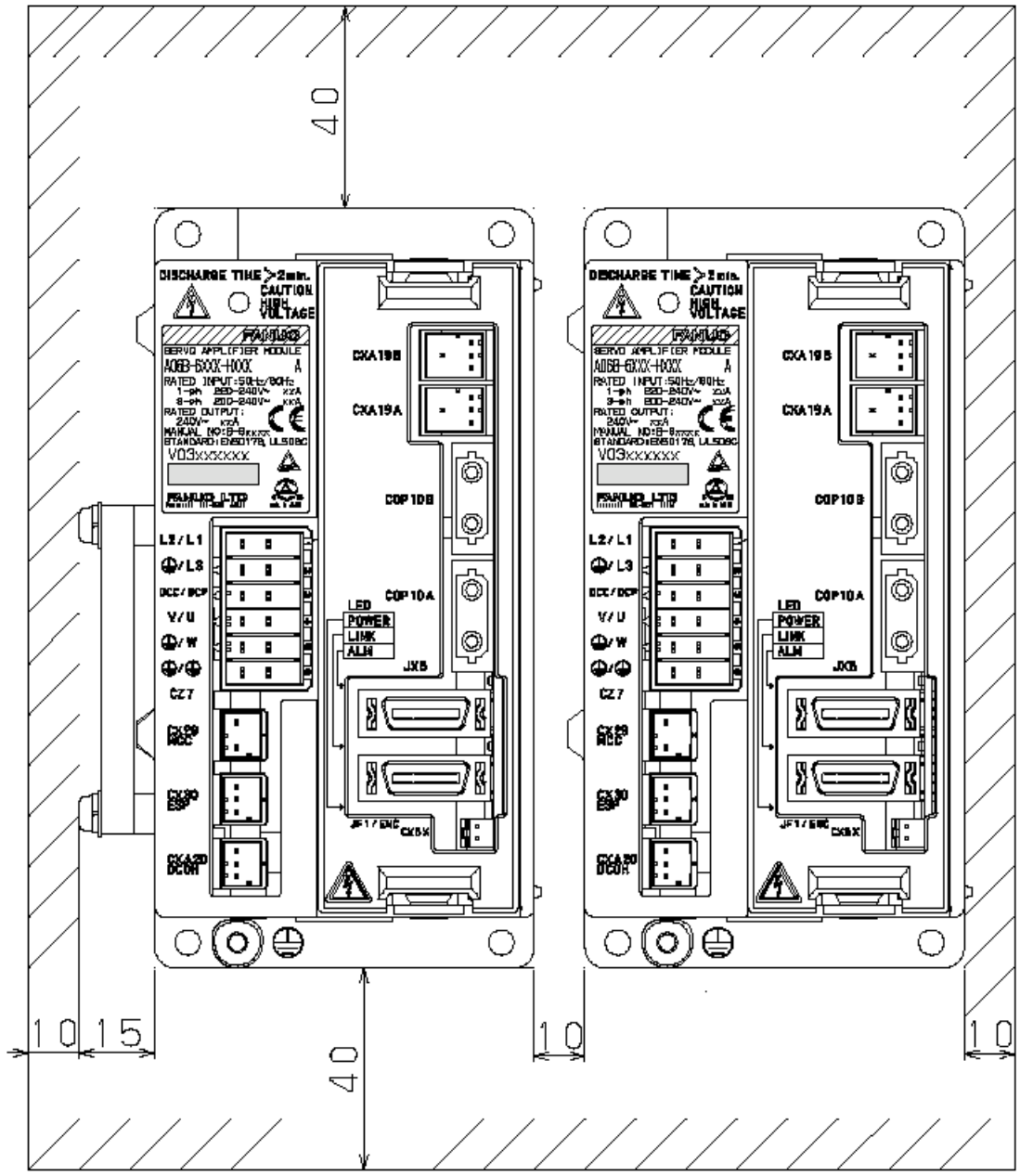


NOTE

Attach the accompanying gasket around the panel cut-out to prevent oil and dust from getting into it. Reinforce the right and left sides of the panel cut-out in the power magnetics cabinet by using fittings such as angles to maintain satisfactory contact between the power magnetics cabinet andthe amplifier.

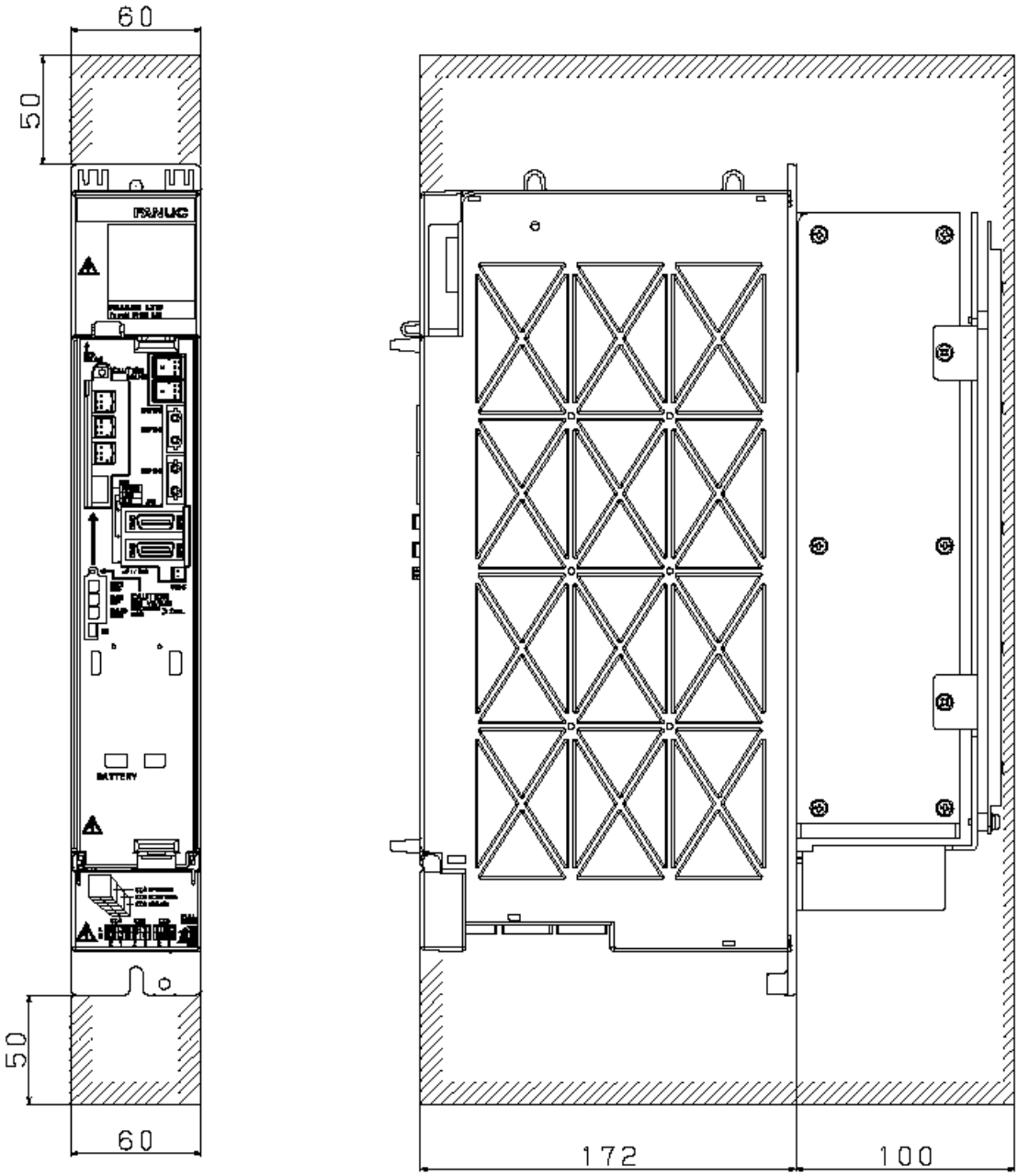
4.3 MAINTENANCE AREA

4.3.1 Maintenance Area for the SVM1-4*i* and SVM1-20*i*

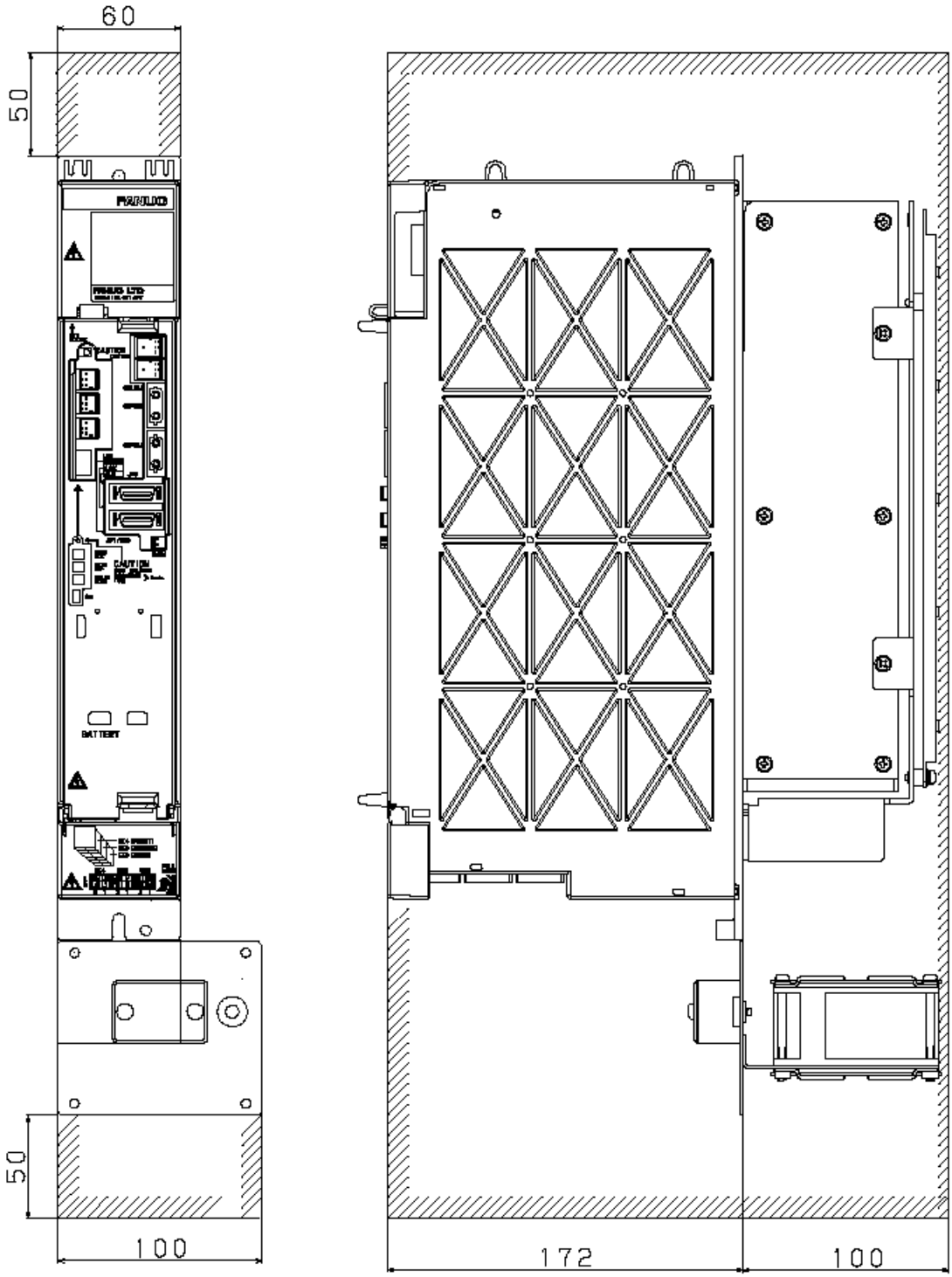


4.3.2 Maintenance Area for the SVM1-40*i* and SVM1-80*i*

When no cooling fan AC motor (A06B-6134-K002) is used to cool the heat sink



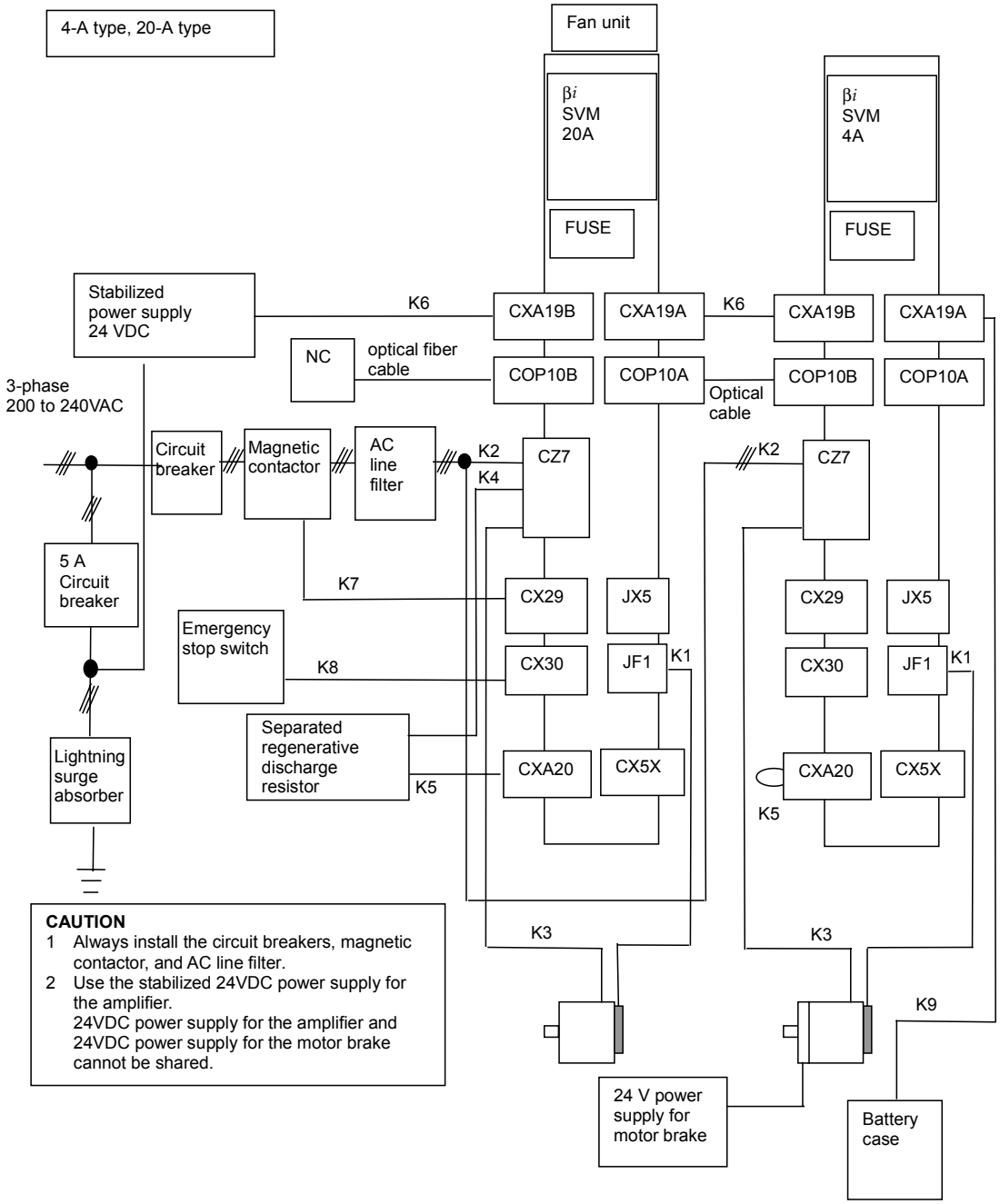
When the cooling fan AC motor (A06B-6134-K002) is used to cool the heat sink



5 TOTAL CONNECTION DIAGRAM

5.1 CONNECTION DIAGRAM

5.1.1 SVM1-4*i* and SVM1-20*i*



NOTE

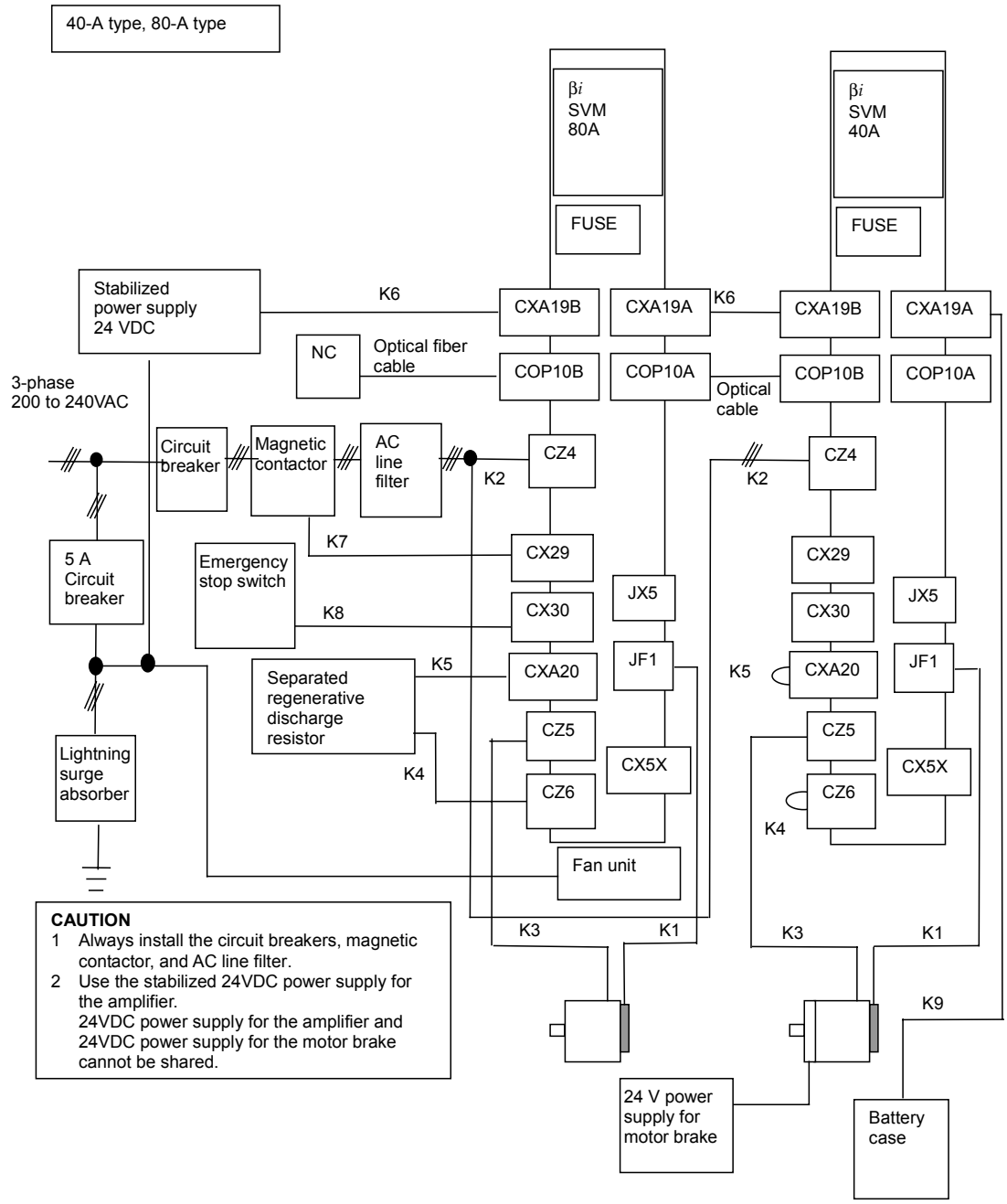
1 Always install the circuit breakers, magnetic contactor, and AC line filter.
2 To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.

⚠ **WARNING**

Defects, such as a loose screw and an incorrectly inserted connector, can lead to a motor malfunction, excessive heat generation, and a ground fault. Exercise adequate care in installing servo amplifiers.

A loose screw (or, if a connector is used, a loose connector contact or an incorrect connector pin-to-cable connection) on high-current carrying power supply wires or motor power wires can lead to fire. Exercise adequate care in wiring.

5.1.2 SVM1-40*i* and SVM1-80*i*



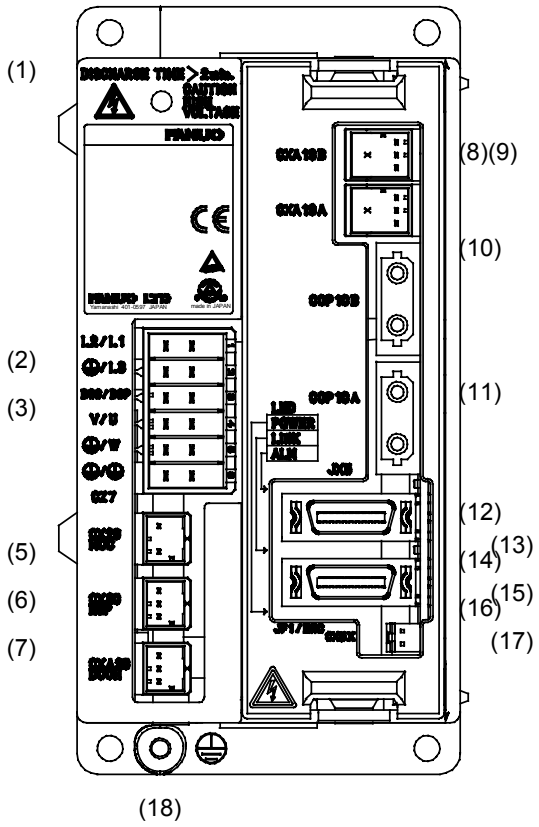
NOTE
1 Always install the circuit breakers, magnetic contactor, and AC line filter.
2 To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.

> ⚠ **WARNING**
> Defects, such as a loose screw and an incorrectly inserted connector, can lead to a motor malfunction, excessive heat generation, and a ground fault. Exercise adequate care in installing servo amplifiers.
> A loose screw (or, if a connector is used, a loose connector contact or an incorrect connector pin-to-cable connection) on high-current carrying power supply wires or motor power wires can lead to fire. Exercise adequate care in wiring.

5.2 CONNECTOR LOCATION

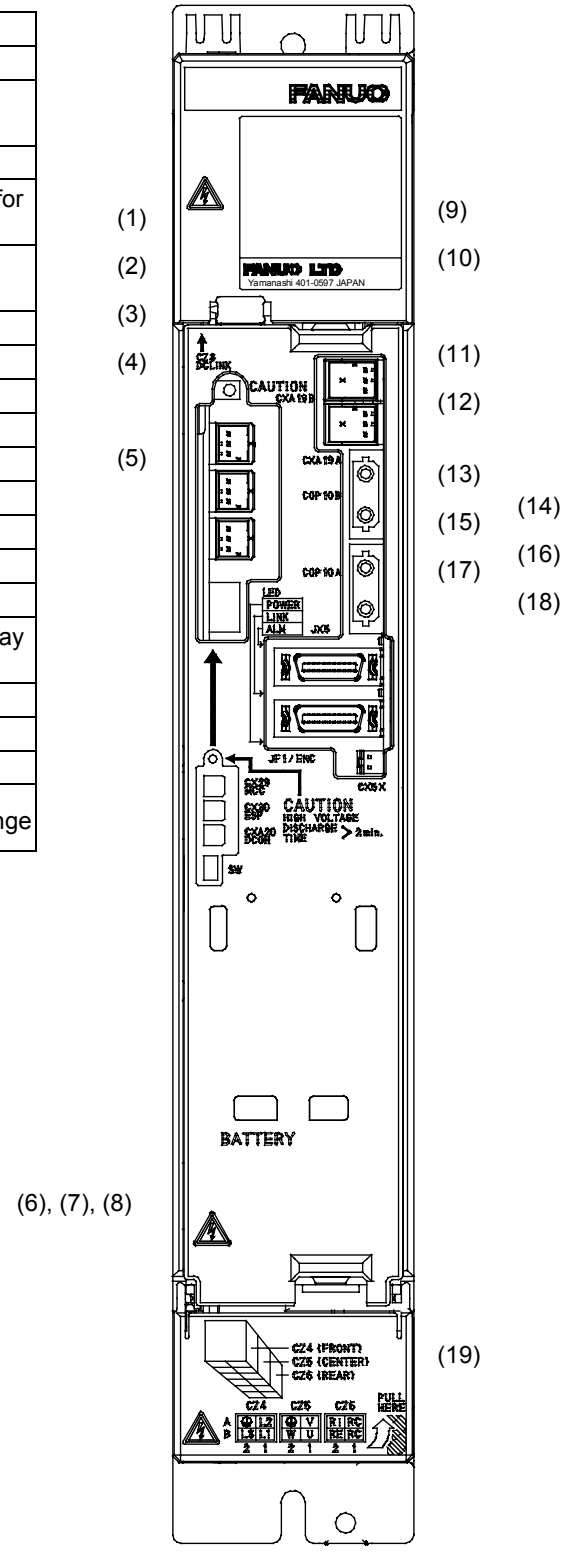
5.2.1 SVM1-4*i* and SVM1-20*i*

No.	Name	Remarks
1		DC link charge LED
2	CZ7-1	Main power input connector
3	CZ7-2	Discharge register connector
4	CZ7-3	Motor power connector
5	CX29	Connector for main power MCC control signal
6	CX30	ESP signal connection connector
7	CXA20	Regenerative resistor connector (for alarms)
8	CXA19B	24VDC power input
9	CXA19A	24VDC power input
10	COP10B	Servo FSSB I/F
11	COP10A	Servo FSSB I/F
12	ALM	Servo alarm status display LED
13	JX5	Connector for signal check
14	LINK	FSSB communication status display LED
15	JF1	Pulsecoder
16	POWER	Control power status display LED
17	CX5X	Absolute Pulsecoder battery
18	⏚	Tapped hole for grounding the flange



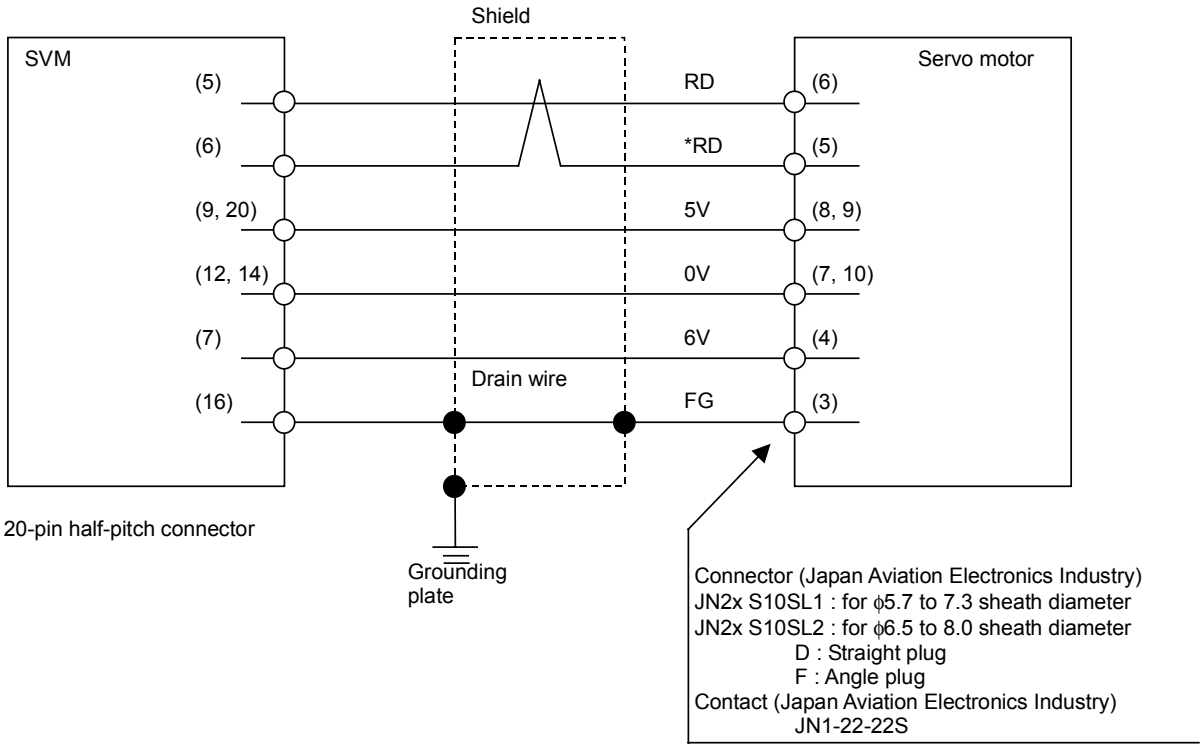
5.2.2 SVM1-40*i* and SVM1-80*i*

No.	Name	Remarks
1		DC link charge LED
2	CX29	Connector for main power MCC control signal
3	CX30	ESP signal connection connector
4	CXA20	Regenerative resistor connector (for alarms)
5	SW	Setting switch (DC alarm level)
6	CZ4	Main power input connector
7	CZ5	Motor power connector
8	CZ6	Discharge register connector
9	CXA19B	24VDC power input
10	CXA19A	24VDC power input
11	COP10B	Servo FSSB I/F
12	COP10A	Servo FSSB I/F
13	ALM	Servo alarm status display LED
14	JX5	Connector for signal check
15	LINK	FSSB communication status display LED
16	JF1	Pulsecoder
17	POWER	Control power status display LED
18	CX5X	Absolute Pulsecoder battery
19	⏚	Tapped hole for grounding the flange



5.2.3 Details of Cable K1

5.2.3.1 Servo motor αi, αis series, Servo motor βis series (β0.4/5000is to β22/2000is)



Using cable conductor

Cable length	28 m or less	50 m or less
5V, 0V,6V	0.3mm^2 × 5 Wire construction 12/0.18 or 60/0.08 Insulation outer diameter ϕ1.5 or less	0.5mm^2 × 5 Wire construction 20/0.18 or 104/0.08 Insulation outer diameter ϕ1.5 or less
RD, *RD	0.18mm^2 or more Twisted-pair wire	0.18mm^2 or more Twisted-pair wire
Drain wire	0.15mm^2 or more	0.15mm^2 or more

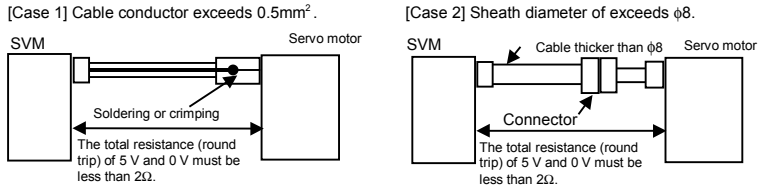
NOTE
The ground plate to which the shield is connected must be placed as close as possible to the servo amplifier so that distance between the ground plate and the servo amplifier becomes shortest.

* This applies also to the αM*i* and αC*i* series servo motors.

NOTE

1 In case that the cable is prepared by MTB, total resistance of 5V and 0V must be less than 2Ω.

2 Pulsecoder side connector can accept maximum 0.5mm^2 (wire construction 20/0.18 or 104/0.08, insulation outer diameter φ1.5 or less) wire and sheath diameter is φ5.7 to φ8.0. In case of using thicker wire or cable, take measures described below.



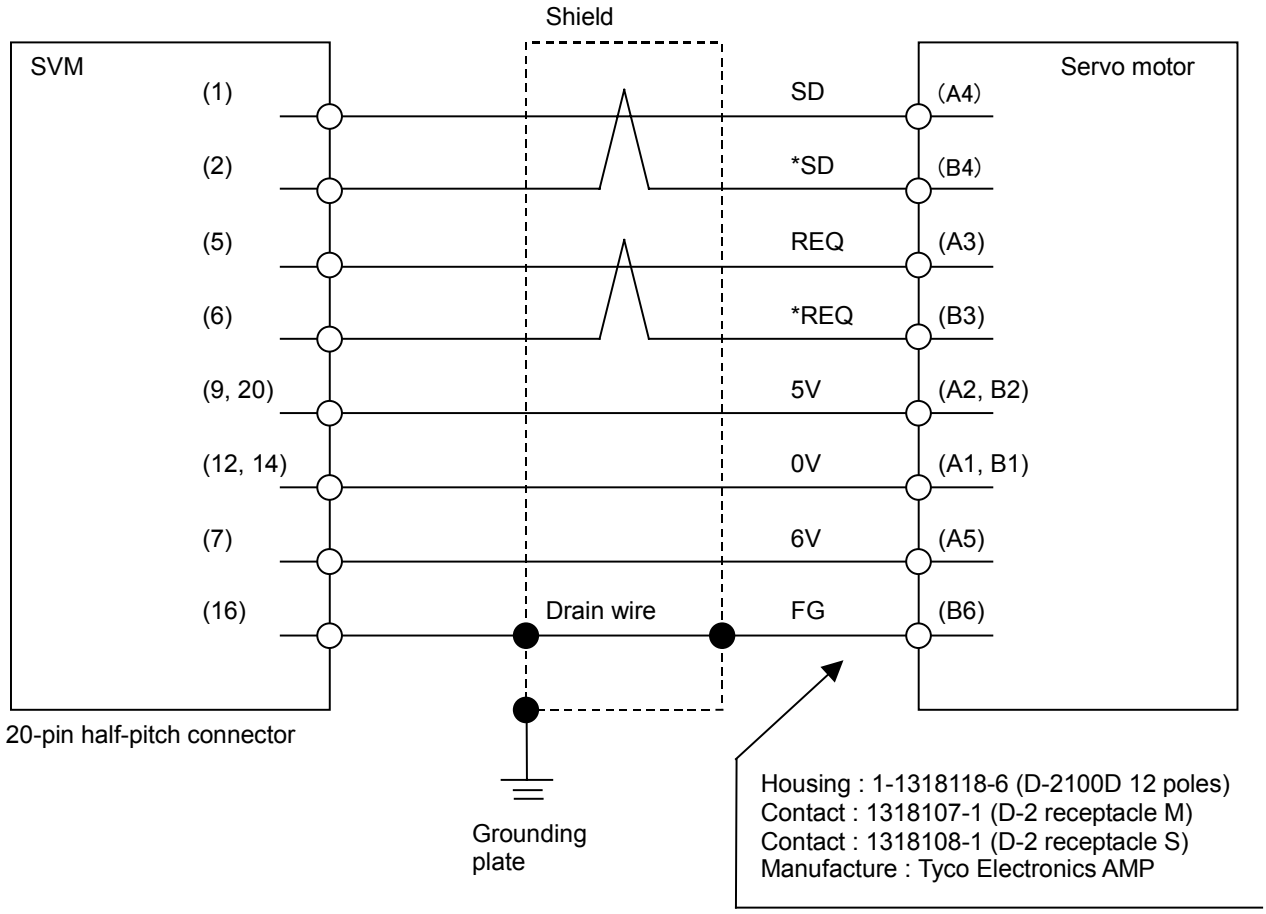
3 In case of incremental Pulsecoder, 6V is not necessary to be connected.

- Crimp tool specification
  A06B-6114-K201/JN1S : For 0.3 mm^2
  A06B-6114-K201/JN1L : For 0.18 mm^2 or 0.5 mm^2

- Connector kit specification
  A06B-6114-K204/S : Straight plug (including a contact)
  A06B-6114-K204/E : Elbow plug (including a contact)

- Recommended cable
  A66L-0001-0460 : Flexible cable 28 m or less long
  A66L-0001-0462 : Flexible cable 50 m or less long
  A66L-0001-0481 : Fixed cable 28m or less long
  A66L-0001-0491 : Fixed cable 50m or less long

5.2.3.2 Servo motor β*i*s series (β0.2/5000*i*s, β0.3/5000*i*s)



Using cable conductor

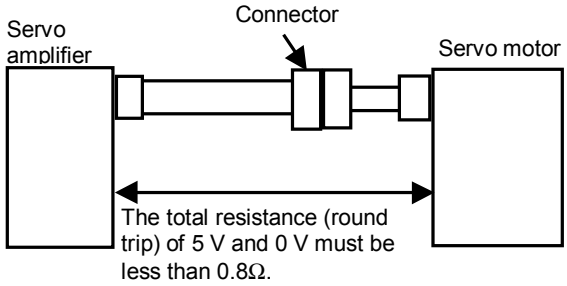
Cable length	20 m or less
5V, 0V, 6V	0.5 mm^2 (AWG21) × 5 Wire construction 20/0.18 Insulation outer diameter ϕ0.88 to ϕ1.5
SD, *SD, REQ, *REQ	0.18mm^2(AWG25) or more Twisted-pair wire Wire construction 7/0.18 Insulation outer diameter ϕ0.88 to ϕ1.5
Drain wire	0.15mm^2 or more
Recommended wire	0.5mm^2 × 5 + 0.18mm^2 × two-pair (For a fixed cable) Hitachi Cable, Ltd. : UL20276-SB (0) 5X21AWG+2PX25AWG (For a flexible cable) Hitachi Cable, Ltd. : UL20276-SB (FLEX) 5X20AWG+2PX25AWG

NOTE

1 The ground plate to which the shield is connected must be placed as close as possible to the servo amplifier so that distance between the ground plate and the servo amplifier becomes shortest.

2 In case that the cable is prepared by the user, the total resistance (round trip) of 5 V and 0 V must be less than 0.8 Ω.

3 The maximum applicable wire diameter of the cable connector on the motor side is 0.5 mm^2 (when crimping tool 1463475-1 is used) or 0.85 mm^2 (when crimping tool 1276654-1 is used).In case of using thicker wire or cable, take measures described below.



4 In case of incremental Pulsecoder, 6 V is not necessary to be connected.

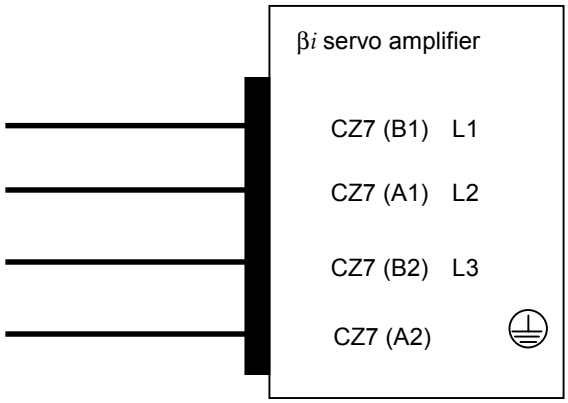
5.2.4 Details of Cable K2

The following items related to servo amplifier input cables are explained below in the stated order.

(1) Details of connectors
(2) Selecting input cables (general)
(3) Details of input cables

5.2.4.1 Details of connectors

(a) SVM1-4, SVM1-20



[Receptacle housing]
Use the following receptacle housing.

Manufacturer-defined model	Specification of the key	Manufacture
175363-3	Incorrect-insertion prevent key	Tyco Electronics AMP

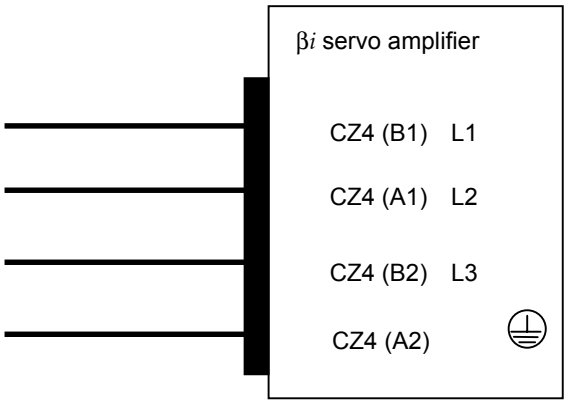
[Receptacle contact]
Two receptacle contact types are available, so as to support different conductor diameters. Be sure to select the receptacle contact that matches the servo axis you use.

Rectangle contact model number		Conductor size (mm^2)	Conductor size AWG	Insulation outer diameter (mm)	Manual tool model number	Manufacture
L size	1-175218-2	0.5- 1.25	20/18/16	1.8-2.8	91558-1	Tyco Electronics AMP

[Connector and tool ordering information]
Connectors (including housings and contacts) and tools can be purchased directly from Tyco Electronics AMP. They can be ordered as options also from FANUC as listed below.

Ordering number	Description
A06B-6130-K200	Housing : Incorrect-insertion prevent key 175363-3 (1pcs.) Incorrect-insertion prevent key 1318095-2 (1pcs.) Contact : L size 1-175218-2 (10pcs.) Applicable wire diameter: 0.5-1.25mm^2, AWG20/18/16 Applicable tool: 91558-1 (not included in this kit)

(b) SVM1-40, SVM1-80



[Receptacle housing]
Use the following receptacle housing.

Manufacturer-defined model	Specification of the key	Manufacture
1-917807-2	XX	Tyco Electronics AMP

[Receptacle contact]

Rectangle contact model number		Conductor size (mm^2)	Conductor size AWG	Insulation outer diameter (mm)	Manual tool model number	Manufacture
S size	316040-6	1.25 – 2.20	16/14	3.0-3.8	234170-1	Tyco Electronics AMP
M size	316041-6	3.50 – 5.50	12/10	4.0-5.2	234171-1	Tyco Electronics AMP

[Connector and tool ordering information]
Connectors (including housings and contacts) and tools can be purchased directly from Tyco Electronics AMP. They can be ordered as options also from FANUC as listed below.

Ordering number	Description
A06B-6110-K200#XXS	Housing : XX key 1-917807-2 (1pcs.) Contact : S size 316040-6 (4pcs.) Applicable wire diameter : 1.25-2.20mm^2, AWG16/14 Applicable tool: 234170-1 (not included in this kit)
A06B-6110-K200#XXM	Housing : XX key 1-917807-2 (1pcs.) Contact : M size 316041-6 (4pcs.) Applicable wire diameter : 3.50-5.50mm^2, AWG12/10 Applicable tool : 234171-1 (not included in this kit)

[Crimping tool]

Ordering number	Description
A06B-6110-K220#D5S	Applicable tool : 234170-1 Contact : S size 316040-6 Applicable wire diameter : 1.25-2.2mm^2, AWG16/14
A06B-6110-K220#D5M	Tool : 234171-1 Contact : M size 316041-6 Applicable wire diameter: 3.50-5.50mm^2, AWG12/10
A06B-6110-K220#D5R	Extractor : 409158-1

5.2.4.2 Selecting cables (general)

Select the cable specification by considering the following conditions for use:

(1) Motor current rating or current needed in use on a real machine
(2) Cable type (heat resistance temperature, etc.)
(3) Environment in which the cable is installed (operating ambient temperature, etc.)
(4) Certification for CE marking (compliance with various safety standards and EMC standard)

Examples of selecting a heavy-duty power cable are shown below. Fully check the cable specifications based on the actual use conditions and use an example below.
The cable diameters are determined based on JCS No. 168 D (1980), "Allowable Currents for Power Cables (1)."

Selection example of power line (reference)

[Selection example 1]

- Heavy-duty power cable specification :
  Maximum allowable conductor temperature 60°C
- Environment temperature : 30°C

Cable diameter [mm^2]	Allowable current value [Arms]	Receptacle contact specification
0.75	Less than 11	L size 1-175218-2
1.25	Less than 15	L size 1-175218-2 S size 316040-6
2	Less than 19	S size 316040-6
3.5	Less than 27	M size 316041-6
5.5	Less than 35	M size 316041-6

[Selection example 2]

- Heavy-duty power cable specification :
  Maximum allowable conductor temperature 80°C
- Environment temperature : 55°C

Cable diameter [mm^2]	Allowable current value [Arms]	Receptacle contact specification
0.75	Less than 9.2	L size 1-175218-2
1.25	Less than 12.7	L size 1-175218-2 S size 316040-6
2	Less than 16.3	S size 316040-6
3.5	Less than 23.4	M size 316041-6
5.5	Less than 31.2	M size 316041-6

5.2.4.3 Details of input cables

Select cables by taking the following conditions for use into account.

[Example combinations of input cables for servo motors running with continuous-rating output (reference only)]

Servo motor	Continuous current rating for three-phase input [Arms] (reference only)	Continuous current rating for single-phase input [Arms] (reference only)	[Example 1.] Cable wire diameter [mm^2]	[Example 2.] Cable wire diameter [mm^2]
β0.2/5000*i*s	0.2	0.5	0.75 (0.75)	0.75 (0.75)
β0.3/5000*i*s	0.5	1.1	0.75 (0.75)	0.75 (0.75)
β0.4/5000*i*s	0.7	1.4	0.75 (0.75)	0.75 (0.75)
β0.5/5000*i*s	1.1	2.2	0.75 (0.75)	0.75 (0.75)
β1/5000*i*s	2.1	4.3	0.75 (0.75)	0.75 (0.75)
β2/4000*i*s	2.6	5.4	0.75 (0.75)	0.75 (0.75)
β4/4000*i*s	3.9	8.1	0.75 (0.75)	0.75 (0.75)
β8/3000*i*s	6.3	9.7	0.75 (0.75)	0.75 (1.25)
β12/3000*i*s	9.4	-	0.75	1.25
β22/2000*i*s	13.1	-	1.25	2
α1/5000*i*	2.6	5.4	0.75 (0.75)	0.75 (0.75)
α2/5000*i*	3.9	8.1	0.75 (0.75)	0.75 (0.75)
α4/4000*i*	7.3	-	0.75	0.75
α8/3000*i*	8.4	-	0.75	0.75
α12/3000*i*	15.7	-	2	2
α22/3000*i*	21.0	-	3.5	3.5
α2/5000*i*s	3.9	8.1	0.75 (0.75)	0.75 (0.75)
α4/5000*i*s	5.2	9.7	0.75 (0.75)	0.75 (1.25)
α8/4000*i*s	13.1	-	1.25	2
α12/4000*i*s	14.2	-	1.25	2

5.2.5 Details of Cable K3

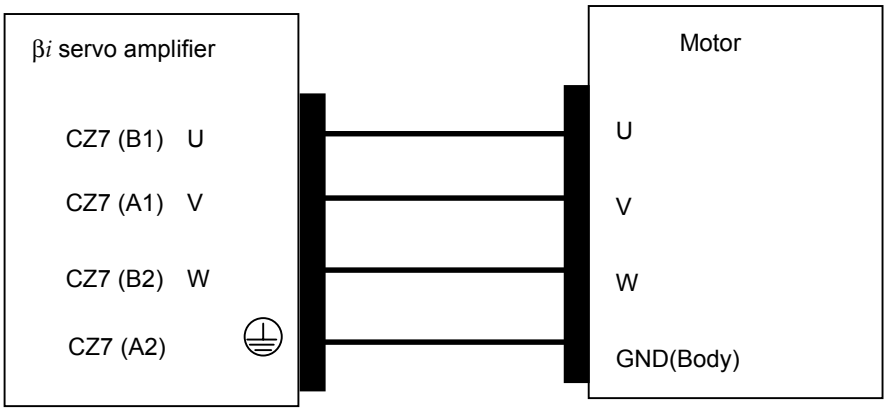
The following items related to servo motor/amplifier power cables are explained below in the stated order.

(1) Details of connectors
(2) Selecting power cables (general)
(3) Power cable for servo motor

5.2.5.1 Details of connectors

The D-3000 and -5000 connector series (manufactured by Tyco Electronics AMP.) are used for power cable connection in the β series. The specifications of a receptacle housing and contact vary depending on the model for which they are used as stated below.

(a) SVM1-4, SVM1-20



[Receptacle housing]
Use the following receptacle housing.

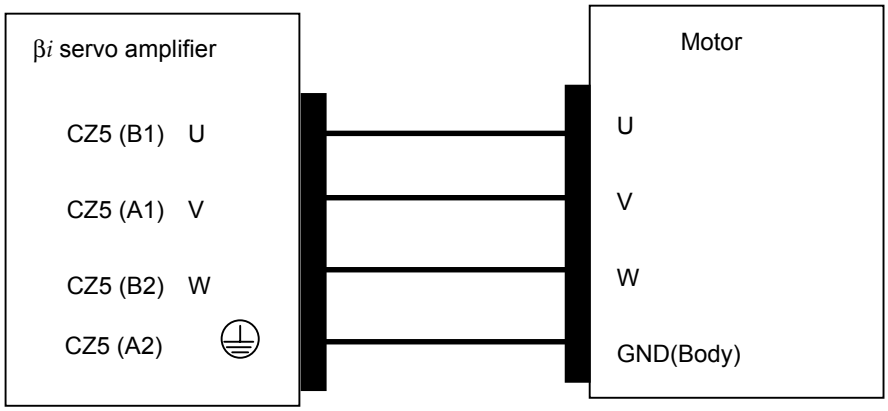
Manufacturer-defined model	Manufacture
1318095-2	Tyco Electronics AMP

[Receptacle contact]
Two receptacle contact types are available, so as to support different conductor diameters. Be sure to select the receptacle contact that matches the servo axis you use.

Rectangle contact model number		Conductor size (mm^2)	Conductor size AWG	Insulation outer diameter (mm)	Manual tool model number	Manufacture
L size	1-175218-2	0.5-1.25	20/18/16	1.8-2.8	91558-1	Tyco Electronics AMP

[Connector and tool ordering information]
Connectors (including housings and contacts) and tools can be purchased directly from Tyco Electronics AMP. They can be ordered as options also from FANUC as listed below.
See Subsection 5.2.4 “Details of Cable K2.”

(b) SVM1-40, SVM1-80



[Receptacle housing]
Use the following receptacle housing.

Manufacturer-defined model	Specification of the key	Manufacture
2-917807-2	YY	Tyco Electronics AMP

[Receptacle contact]

Rectangle contact model number		Conductor size (mm^2)	Conductor size AWG	Insulation outer diameter (mm)	Manual tool model number	Manufacture
S size	316040-6	1.25–2.2	16/14	3.0-3.8	234170-1	Tyco Electronics AMP
M size	316041-6	3.5–5.5	12/10	4.0-5.2	234171-1	Tyco Electronics AMP

[Connector and tool ordering information]
Connectors (including housings and contacts) and tools can be purchased directly from Tyco Electronics AMP. They can be ordered as options also from FANUC as listed below.

Ordering number	Description
A06B-6110-K202#YYS	Housing : YY key 2-917807-2 (1pcs.) Contact : S size 316040-6 (4pcs.) Applicable wire diameter : 1.25-2.20mm^2, AWG16/14 Applicable tool : 234170-1 (not included in this kit)
A06B-6110-K202#YYM	Housing : YY key 2-917807-2 (1pcs.) Contact : M size 316041-6 (4pcs.) Applicable wire diameter : 3.50-5.50mm^2, AWG12/10 Applicable tool : 234171-1 (not included in this kit)

5.2.5.2 Details of cables (general)

See Subsection 5.2.4 “Details of Cable K2.”

5.2.5.3 Power cable for servo motor

A servo motor power cable assembly consists of:
(a) Power cable
(b) Motor-side connector

(a) Power cable
Examples of combining a servo motor and power cable are described below according to Subsection 5.2.4.2, "Selecting cables (general)."

[Example combination of servo motor and power cable (reference only)]

Servo motor	Continuous current rating [Arms] (reference only)	[Example 1.] Cable wire diameter [mm^2]	[Example 2.] Cable wire diameter [mm^2]
β0.2/5000*i*s	0.84	0.75	0.75
β0.3/5000*i*s	0.84	0.75	0.75
β0.4/5000*i*s	3.5	0.75	0.75
β0.5/5000*i*s	3.0	0.75	0.75
β1/5000*i*s	2.7	0.75	0.75
β2/4000*i*s	3.2	0.75	0.75
β4/4000*i*s	4.7	0.75	0.75
β8/3000*i*s	6.0	0.75	0.75
β12/3000*i*s	10.2	0.75	1.25
β22/2000*i*s	11.3	1.25	1.25
α1/5000*i*	2.7	0.75	0.75
α2/5000*i*	3.5	0.75	0.75
α4/4000*i*	7.7	0.75	0.75
α8/3000*i*	8.4	0.75	0.75
α12/3000*i*	18.1	2	3.5
α22/3000*i*	18.4	2	3.5
α2/5000*i*s	3.3	0.75	0.75
α4/5000*i*s	4.6	0.75	0.75
α8/4000*i*s	11.1	1.25	1.25
α12/4000*i*s	13.4	1.25	2

(b) Motor-side connector
The specifications of a motor-side connector vary depending on the motor model for which it is used.
Refer to "FANUC AC SERVO MOTOR β*i*s series Descriptions" (B-65302EN) for detailed descriptions about motor-side connectors for the β*i*s series servo motors.
Refer to "FANUC AC SERVO MOTOR α*i*s/α*i* series Descriptions" (B-65262EN) for detailed descriptions about motor-side connectors for the α*i*s/α*i* series servo motors.

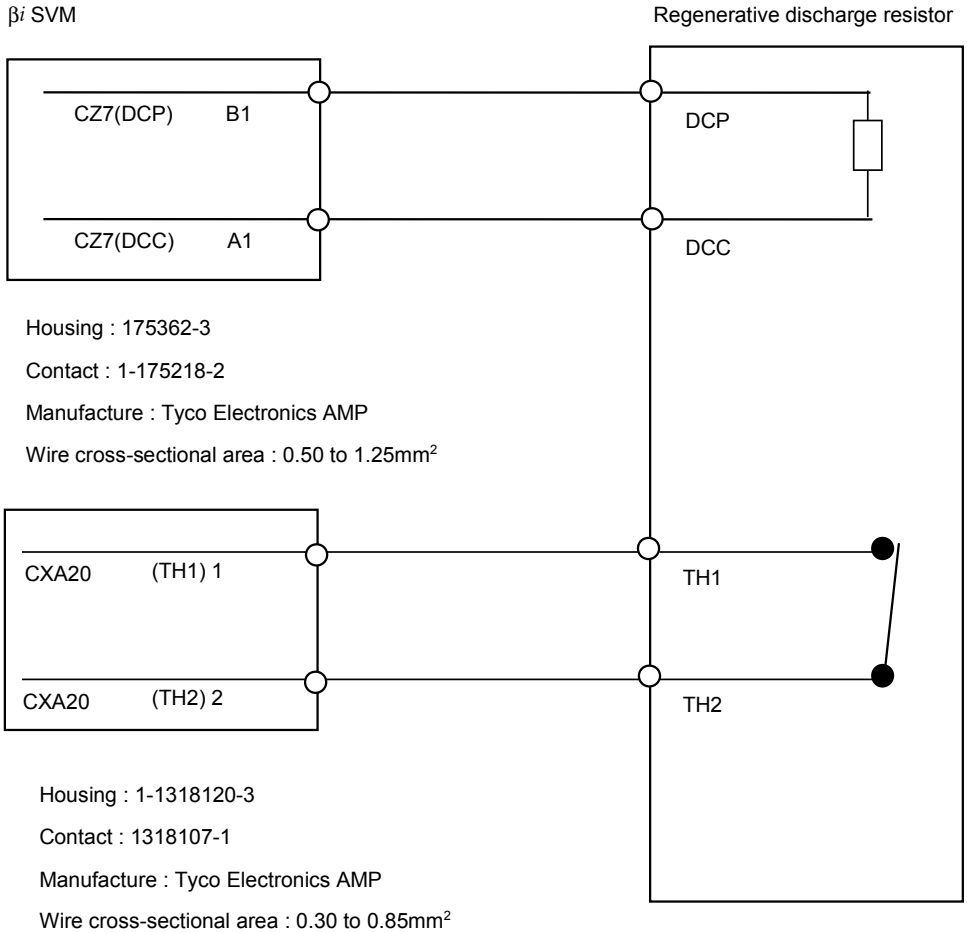
5.2.6 Details of Cables K4 and K5

5.2.6.1 SVM1-4*i* and SVM1-20*i*

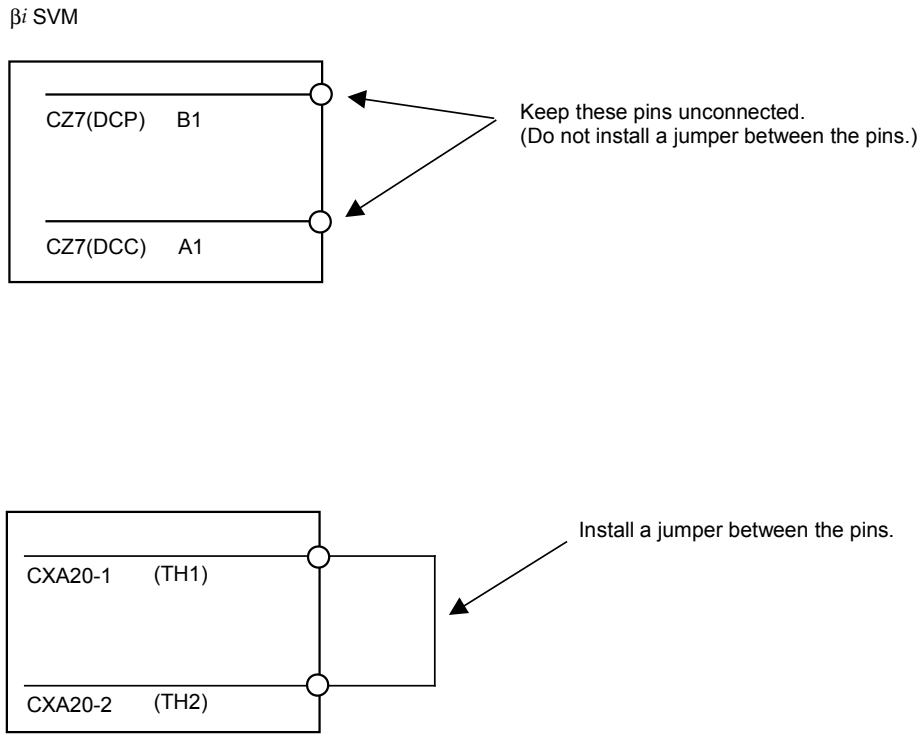
When a regenerative discharge resistor is used

The following regenerative discharge resistor models are available.

A06B-6130-H401	The following housing and contact are connected to the resistor.
A06B-6130-H402	The following housing and contact are connected to the resistor.



When no regenerative discharge resistor is used



Housing : 1-1318120-3

Contact : 1318107-1

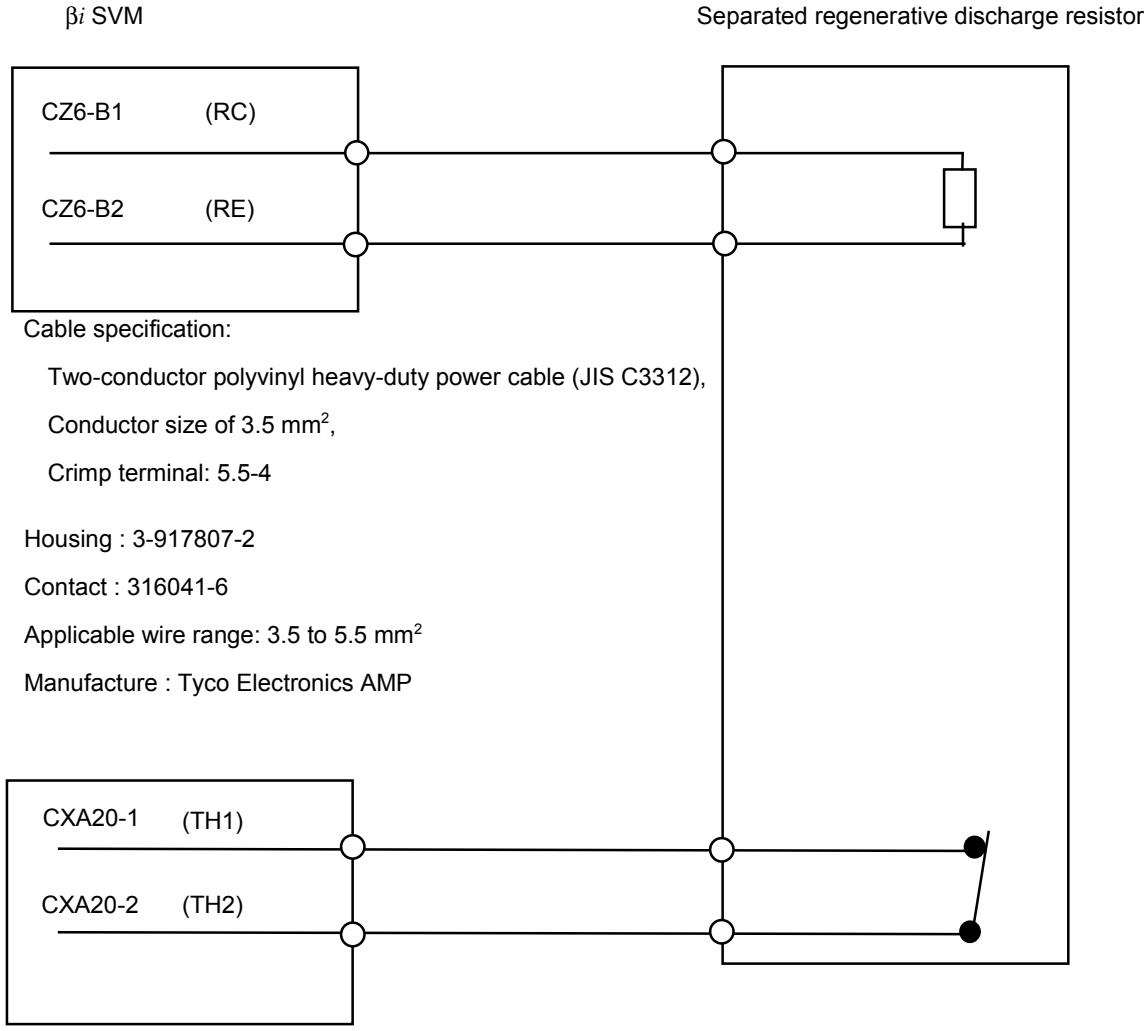
Manufacture : Tyco Electronics AMP

Wire cross-sectional area : 0.30 to 0.85mm^2

> ⚠ **CAUTION**
> Do not connect the DCP and DCC pins to each other.
> It is recommended that the housing 1313182-2 be inserted to prevent incorrect insertion.

5.2.6.2 SVM1-40*i* and SVM1-80*i*

When a separated regenerative discharge resistor is used



Cable specification:

Two-conductor polyvinyl heavy-duty power cable (JIS C3312),

Conductor size of 3.5 mm^2,

Crimp terminal: 5.5-4

Housing : 3-917807-2

Contact : 316041-6

Applicable wire range: 3.5 to 5.5 mm^2

Manufacture : Tyco Electronics AMP

Cable specification:

Two-conductor polyvinyl heavy-duty power cable (JIS C3312),

Conductor size of 0.75 mm^2,

Crimp terminal: 1.25-4

Housing : 1-1318120-3

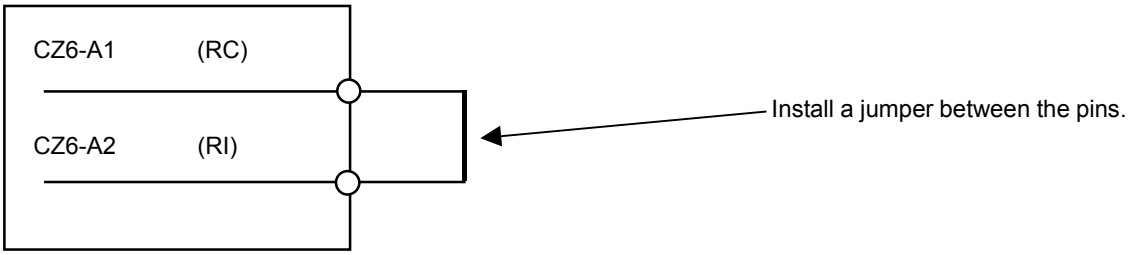
Contact : 1318107-1

Applicable wire: 0.3 to 0.85 mm^2

Manufacture : Tyco Electronics AMP

When a built-in regenerative discharge resistor is used

βi SVM



Cable specification:

Two-conductor polyvinyl heavy-duty power cable (JIS C3312),

Conductor size of 3.5 mm^2,

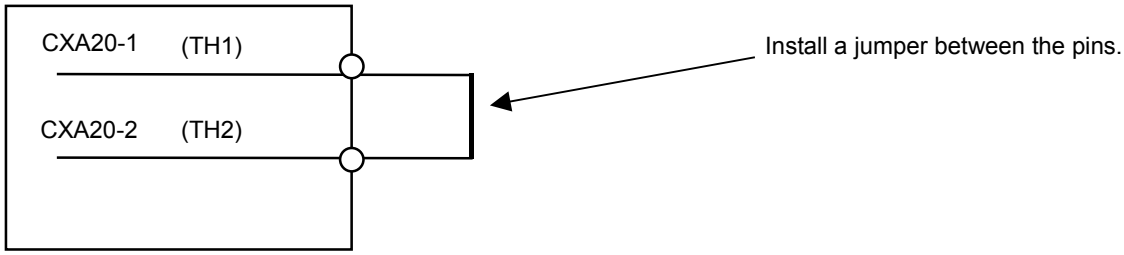
Crimp terminal: 5.5-4

Housing : 3-917807-2

Contact : 316041-6

Applicable wire range: 3.5 to 5.5 mm^2

Manufacture : Tyco Electronics AMP



Cable specification:

Two-conductor polyvinyl heavy-duty power cable (JIS C3312),

Conductor size of 0.75 mm^2,

Crimp terminal: 1.25-4

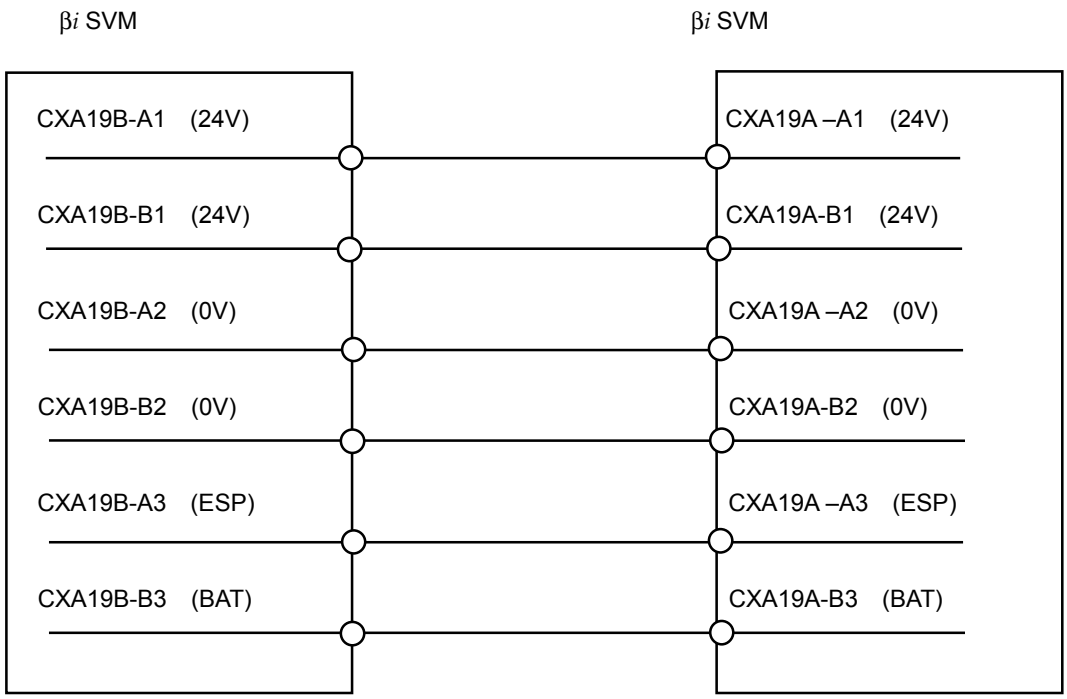
Housing : 1-1318120-3

Contact : 1318107-1

Applicable wire: 0.3 to 0.85 mm^2

Manufacture : Tyco Electronics AMP

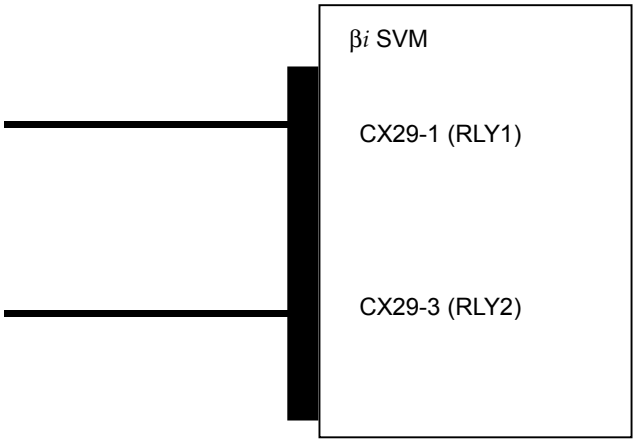
5.2.7 Details of Cable K6



Housing : 1-1318119-3
Contact : 1318107-1
Applicable wire: 0.3 to 0.85 mm^2
Manufacture : Tyco Electronics AMP

Housing : 1-1318119-3
Contact : 1318107-1
Applicable wire: 0.3 to 0.85 mm^2
Manufacture : Tyco Electronics AMP

5.2.8 Details of Cable K7



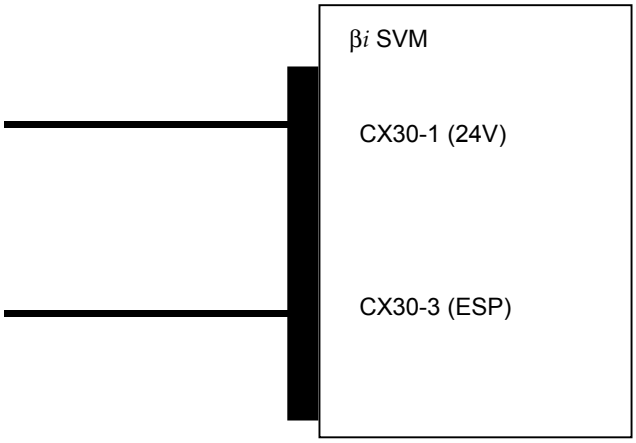
Housing : 3-1318130-3

Contact : 1318107-1

Applicable wire: 0.3 to 0.85 mm^2

Manufacture : Tyco Electronics AMP

5.2.9 Details of Cable K8



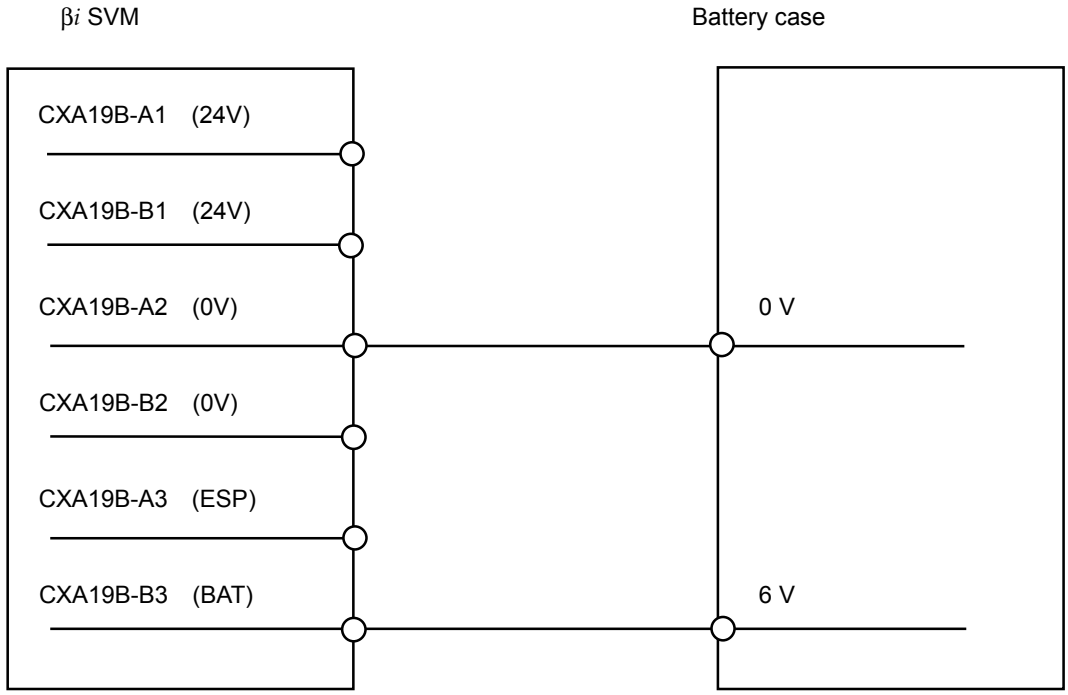
Housing : 2-1318120-3

Contact : 1318107-1

Applicable wire: 0.3 to 0.85mm^2

Manufacture : Tyco Electronics AMP

5.2.10 Details of Cable K9



Housing : 1-1318119-3

Contact : 1318107-1

Applicable wire : 0.3 to 0.85mm^2

Manufacture : Tyco Electronics AMP

Crimp terminal : 1.25-2

Applicable wire : 0.3 to 0.85mm^2

6 HEAT DISSIPATION

The amount of heat dissipation depends on the SVM model and the current that flows through the servo motor. For the current that flows through a servo motor, reference the continuous rated current of each servo motor. (For the continuous rated current of each servo motor, refer to the servo motor descriptions.) As the current that flows through a servo motor, the root-mean-square value of the current that flows through an actual servo motor on a machine can be used. The amount of heat dissipation indicated below assumes the use of HRV2.

(1) Total amount of heat dissipation
The total amount of heat dissipation is calculated according to the following expression:

Total amount of heat dissipation
$= a + Ka1 \times b1 + Ka2 \times b2 + Ka3 \times b3$

a : Amount of heat dissipation determined by the SVM model [W]
Ka1 : Coefficient determined by the SVM [W/Arms]
b1 : Current flowing through the servo motor [Arms]
Ka2 : Coefficient determined by the SVM [W/Arms]
b2 : Current flowing through the servo motor [Arms]
Ka3 : Coefficient determined by the SVM [W/Arms]
b3 : Current flowing through the servo motor [Arms]

Total amount of heat dissipation

Name	Specification	a [W]	K [W/Arms]
SVM1-4*i*	H001	20	Ka1: 8.1
SVM1-20*i*	H002	20	Ka1: 7.7
SVM1-40*i*	H003	20	Ka1: 7.1
SVM1-80*i*	H004	20	Ka1: 6.7

(2) Residual amount of heat in the cabinet
By placing the heat sink section outside the cabinet, the residual amount of heat in the cabinet can be calculated according to the expression below.

Residual amount of heat in the cabinet
= a + Kb1 × b1 + Kb2 × b2 + Kb3 × b3

a : Amount of heat dissipation determined by the SVM model [W]
Kb1 : Coefficient determined by the SVM [W/Arms]
b1 : Current flowing through the servo motor [Arms]
Kb2 : Coefficient determined by the SVM [W/Arms]
b2 : Current flowing through the servo motor [Arms]
Kb3 : Coefficient determined by the SVM [W/Arms]
b3 : Current flowing through the servo motor [Arms]

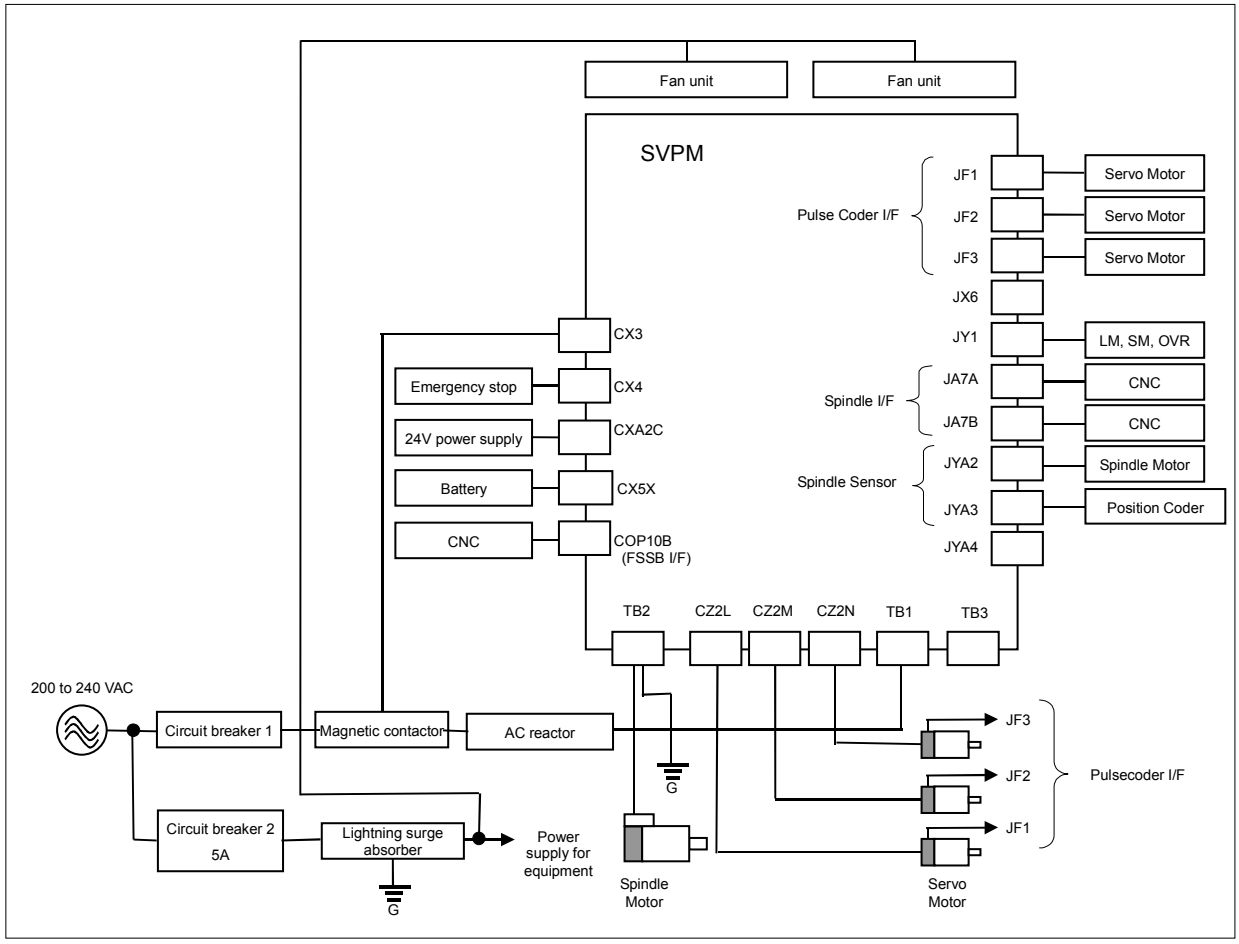
Residual amount of heat in the cabinet

Name	Specification	a [W]	K [W/Arms]
SVM1-4*i*	H001	20	Kb1: 8.1
SVM1-20*i*	H102	20	Kb1: 7.7
SVM1-40*i*	H003	20	Kb1: 1.4
SVM1-80*i*	H004	20	Kb1: 0.7

II. SVPM

1 CONFIGURATION

Configuration of the β*i* series servo amplifier SVPM

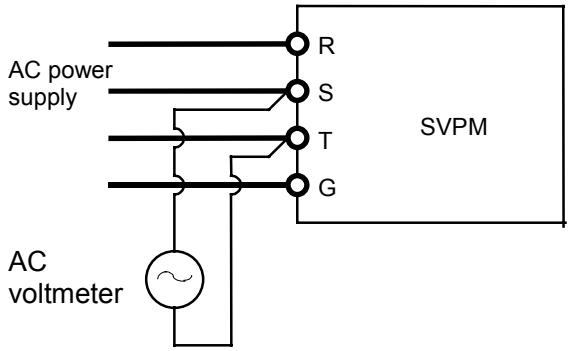


2 SPECIFICATIONS

Item	Specification
Power supply voltage (drive)	3-phase 200 to 240 VAC
Power supply voltage (control)	24VDC / 1.5A
Dynamic brake	Built-in
Spindle sensor	TYPE A : SVPM*-**i/A Without feedback : SVPM*-**i/C
Applicable CNC	FS0*i*-MODEL B, FS0*i* Mate-MODEL B

(1) When the power supply impedance is high, and the voltage variation exceeds the specified values, a SVPM alarm (DC link undervoltage alarm or DC link overvoltage alarm) can be issued, or the output of the motor can decrease.
Connect the SVPM to a power supply whose input voltage variation does not exceed 7% when the motor is accelerated.

[Method of checking power supply impedance]



$$\frac{|E0-E1|}{E0}\times 100(\%) < 7(\%)$$

E0: Voltage at non-load time
E1: Voltage at maximum output time (power running and regeneration)

(2) Turn on the power (CXA2C power input) to the SVPM control circut before or within at least 500 ms after the power for the CNC is turned on.
(3) It is recommended that a capacitor unit for power-factor improvement not be installed. This is because the capacitor unit for power-factor improvement may adversely affect power regeneration.
(4) The rated output of the motor is guaranteed for the rated input voltage. If the input voltage changes, the rated output may not appear even when the input voltage change is within the allowable range.

Cooling fan motor

Install a cooling fan motor listed below.
Otherwise, make arrangements so that the required air flow can be obtained.

Ordering number		Optional fan	Required air flow
SVPM2-5.5*i* A06B-6134-H201#*	SVPM3-5.5*i* A06B-6134-H301#*	A06B-6134-K001 One unit	2 m/s
SVPM2-11*i* A06B-6134-H202#*	SVPM3-11*i* A06B-6134-H302#*	A06B-6134-K001 One unit	
SVPM2-15*i* A06B-6134-H203#*	SVPM3-15*i* A06B-6134-H303#*	A06B-6134-K001 One unit	

[How to obtain a power supply capacity]

- Output capacity -

The output capacity is the sum of the total spindle motor continuous output rating multiplied by a coefficient (1.15) and the servo motor continous output rating multiplied by a coefficient (0.6).

-Power supply capacity-

SVPM*-5.5*i*

Power supply capacity (kVA) = output capacity (kW) × 1.64

SVPM*-11*i*

Power supply capacity (kVA) = output capacity (kW) × 1.55

SVPM*-15*i*

Power supply capacity (kVA) = output capacity (kW) × 1.47

[How to obtain the input current so units to be installed at the input section can be selected]

Obtain the SVPM input current, using the following expression. Use it as a reference value in selecting a circuit breaker, magnetic contactor, and power cable.
(Margin for selection: 1 to 1.5 times)

$$SVPM \text{ input current } (Arms) = \frac{\text{Power supply capacity } (kVA)}{\sqrt{3} \times \text{nominal power supply voltage } (Vrms)} \times 1.2 \text{ (margin)}$$

(Assume the nominal power supply voltage (Vrms) is usually 200 Vrms.)

Applicable motors

		Spindle Motor				Servo Motor				
		β3/10000*i*	β6/10000*i*	β8/8000*i*	β12/7000*i*	β2/4000*i*s	β4/4000*i*s	β8/3000*i*s	β12/3000*i*s	β22/2000*i*s
SVPM2-5.5*i* A06B-6134-H201#*	Spindle	O								
	Servo L axis					O	O	O		
	Servo M axis					O	O	O		
SVPM2-11*i* A06B-6134-H202#*	Spindle	**	O	O						
	Servo L axis					O	O	O		
	Servo M axis					O	O	O		
SVPM2-15*i* A06B-6134-H203#*	Spindle	**	**	**	O					
	Servo L axis					**	**	**	O	O
	Servo M axis					**	**	**	O	O
SVPM3-5.5*i* A06B-6134-H301#*	Spindle	O								
	Servo L axis					O	O	O		
	Servo M axis					O	O	O		
	Servo N axis					**	**	**	O	O
SVPM3-11*i* A06B-6134-H302#*	Spindle	**	O	O						
	Servo L axis					O	O	O		
	Servo M axis					O	O	O		
	Servo N axis					**	**	**	O	O
SVPM3-15*i* A06B-6134-H303#*	Spindle	**	**	**	O					
	Servo L axis					**	**	**	O	O
	Servo M axis					**	**	**	O	O
	Servo N axis					**	**	**	O	O

⚠ CAUTION

** Combining with this motor requires changing the motor control parameter.
An incorrect parameter setting may damage the motor.

Spindle axis types (#A and #C) and applicable sensors

Two models (#A and #C) are available for each sensor for spindles. The following table lists combinations of applicable sensors and functions.

			Configuration							Remarks
			1	2	3	4	5	6		
Spindle system configuration	Ordering number A06B-6134-H***#A, #C	#A (TYPE A)	○	○	○	○				
		#C (TYPE C)					○	○		
	Sensor on the motor	M*i* sensor	○		○	○				
		MZ*i* sensor		○						
		Without sensor					○	○		
	Sensor on the spindle	α position coder			○			○		*3
		External one-rotation				○				*3
Function	Rigid tapping		○ *1	○	○	○ *2		○		
	Orientation by a position coder			○	○			○		
	Orientation by the external one-rotation signal					○ *2				*5
	Spindle synchronization	Velocity synchronization	○ *2	○	○	○ *2		○		*4
		Phase synchronization		○	○			○		*4
	Threading			○	○			○		
	Cs contouring control			○						*6

*1 The spindle and motor must be interconnected with a timing belt or gear. No orientation is available to adjust the tapping start position.

*2 The spindle and motor must be interconnected with a timing belt or gear.

*3 The spindle and sensor must be interconnected in one-to-one connection mode.

*4 Two motor amplifiers are required.

*5 Note that the stop position moves by a backlash between the spindle and motor because of the theory of operation.

*6 This function is enabled on the machine that the spindle motor is directly connected to a spindle.

Other spindle axis functions

○ : Applicable

	#A	#C	Remarks
Analog output of load meter and speedometer	○		Connector JY1
Analog output of either load meter or speedometer		○	Connector JY1
Analog override input	○	○	Connector JY1

Environmental conditions

Install the servo amplifier in a completely sealed cabinet so that the following environmental requirements can be satisfied.

(1) Ambient temperature
Amp ambient temperature :
0 to 55 °C (at operation)
-20 to 60 °C (at keeping and transportation)
Cabinet ambient temperature : 0 to 45 °C

(2) Humidity
Normally 90% RH or below, and condensation-free

(3) Vibration
In operation : Below 0.5 G

(4) Atmosphere
No corrosive or conductive mists or drops should deposit directly on the electronic circuits.

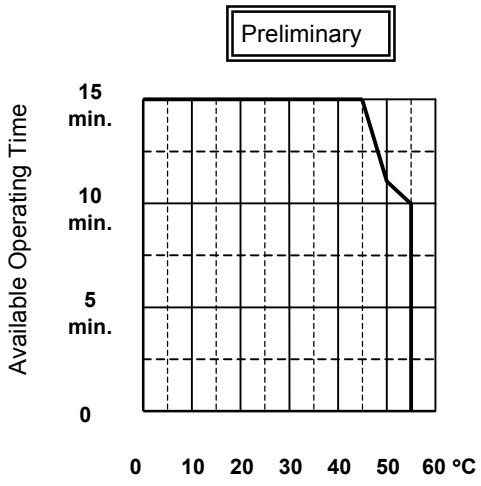
NOTE
Install the electronic circuits in an environment of contamination level 2 as defined in IEC 60664-1. To achieve contamination level 2 in a severe environment where machine tools are used, electronic circuits generally need to be installed in a cabinet complying with IP54.

(5) Notes on Installation
The servo amplifier is designed to be installed in the power magnetics cabinet, with its heat sink projecting through the back of the cabinet. This carries away the heat generated by the semi-conductors, thus preventing heat from building up in the cabinet as much as possible. Therefore, note the following when installing the amplifier.
(a) The heat sink must not be subjected to coolant, oil mist, or cutting chips. Otherwise, the cooling efficiency will be reduced so that the characteristics of the amplifier cannot be guaranteed. This may also shorten the life of the semiconductors. When installing the amplifier in a power magnetics cabinet which is designed to draw in air, fit an air filter to the air inlet. In addition, completely seal all cable holes and doors.
(b) No dust or coolant must be able to enter through the exhaust port. The flow of cooling air must not be obstructed.
(c) The amplifier must be installed where it can be easily inspected, removed, and remounted for maintenance.

(d) Current lines and signal lines must be separated and noise must be suppressed. See the section 5.3 and the connection manual for each CNC for details.
(f) Each amplifier must be installed vertically.
(g) Servo amplifiers are to be arranged horizontally. When arranging servo amplifiers vertically from necessity, note the following:
    1) Ensure that cooling air from a lower amplifier does not blow directly against the upper amplifier. Otherwise, radiation performance can degrade and the rated output may not be satisfied.
    2) Ensure that the flow of cooling air of a lower amplifier is not impeded.
(h) Maintenance areas must be reserved for each servo amplifier.

(6) Derating
Consider derating as shown below, according to ambient temperatures.

Target models: All SVPM models



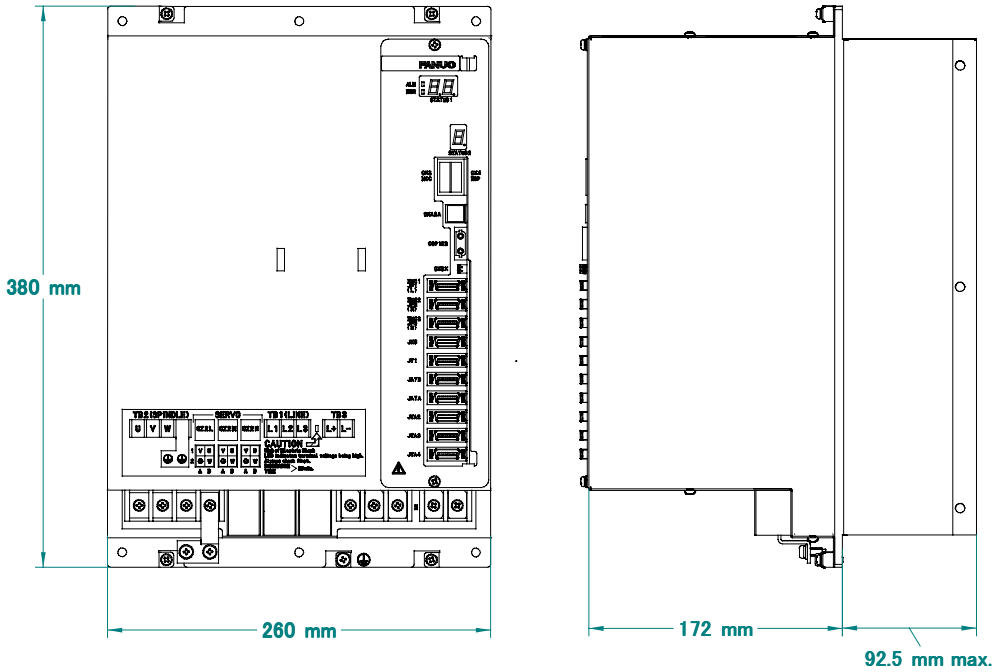
3 ORDERING INFORMATION

Refer to the order list (B-65321EN).

4 EXTERNAL DIMENSIONS / PANEL CUT-OUT DRAWINGS / MAINTENANCE AREA

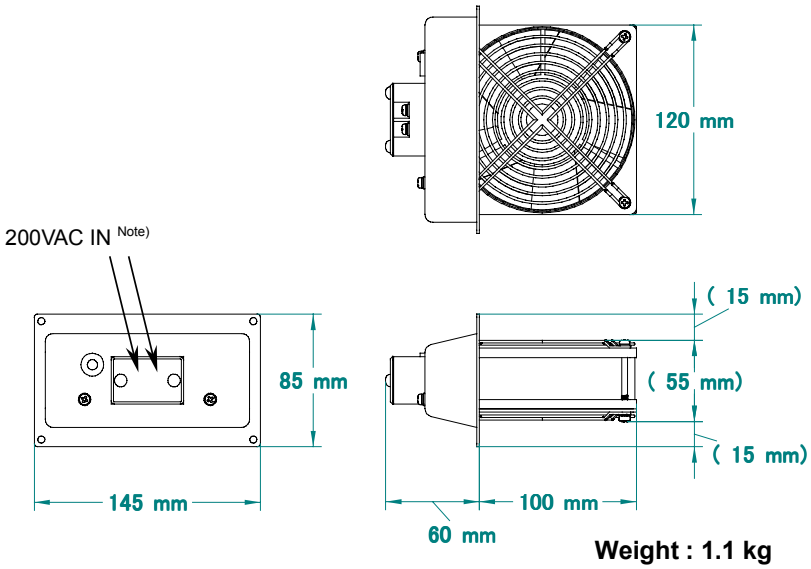
4.1 EXTERNAL DIMENSIONS

4.1.1 External Dimensions of SVPM



Weight : 14.8 kg

4.1.2 External Dimensions of Fan Unit (A06B-6134-K001)



Weight : 1.1 kg

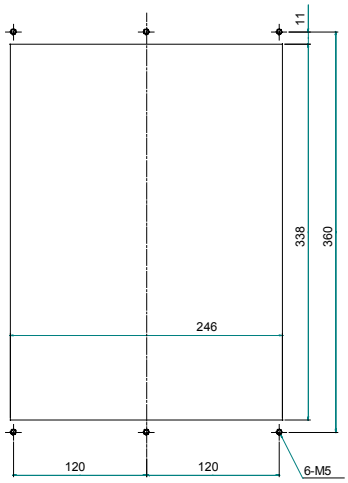
NOTE
Use a 2-A fuse or circuit breaker to prevent a motor burnout.

4.2 PANEL CUT-OUT DRAWINGS

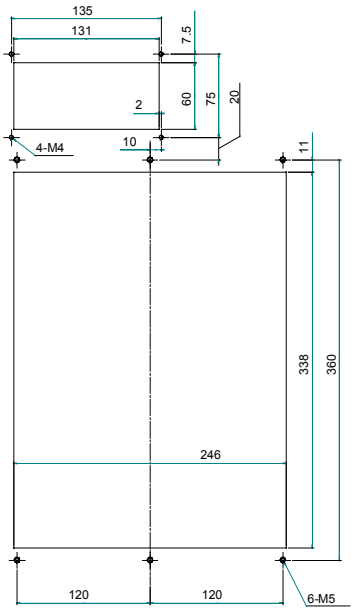
Panel cut-outs that apply when a FANUC fan unit (A06B-6134-K001) is used and when not used are shown below. A fan unit can be placed either on top of or below the servo amplifier.

NOTE
1 Attach the accompanying gasket around the panel cut-out to prevent oil and dust from getting into it.
2 Reinforce the right and left sides of the panel cut-out in the power magnetics cabinet by using fittings such as angles to maintain satisfactory contact between the power magnetics cabinet andthe amplifier.
3 Placing a FANUC fan unit on top of the servo amplifier requires installing a duct.
Refer to the “Example Duct Structure for Using a FANUC Fan Unit (A06B-6134-K001)” for descriptions about the structure of the duct.
4 Placing a FANUC fan unit below the servo amplifier does not require installing a duct.
If no FANUC fan unit is used, the user is requested to install a fan motor that can generate an air flow of at least 2 m/s at the heat sink.

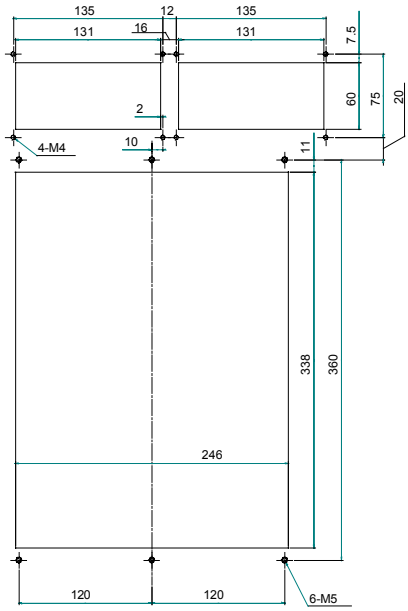
(1) When no FANUC fan unit is used



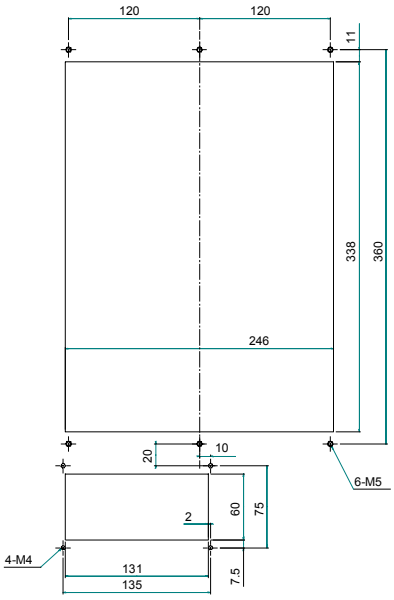
(2) When one FANUC fan unit is used (placed on top of the servo amplifier)



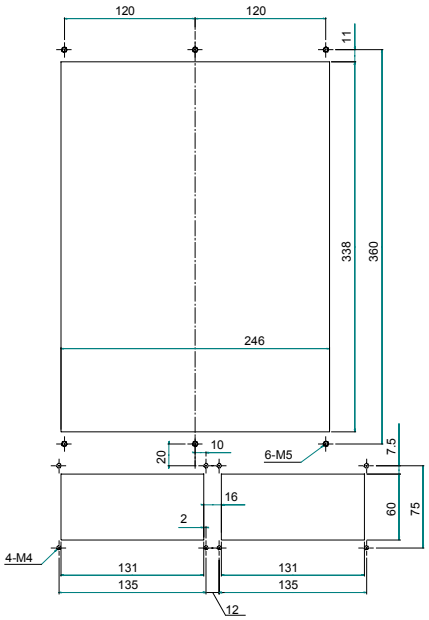
(3) When two FANUC fan units are used (placed on top of the servo amplifier)



(4) When one FANUC fan unit is used (placed below the servo amplifier)

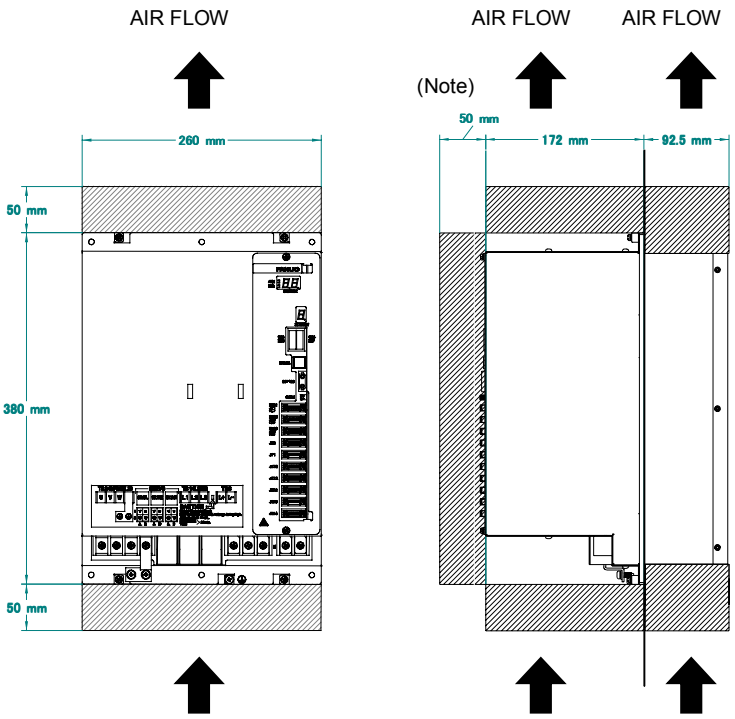


(5) When two FANUC fan units are used (placed below the servo amplifier)



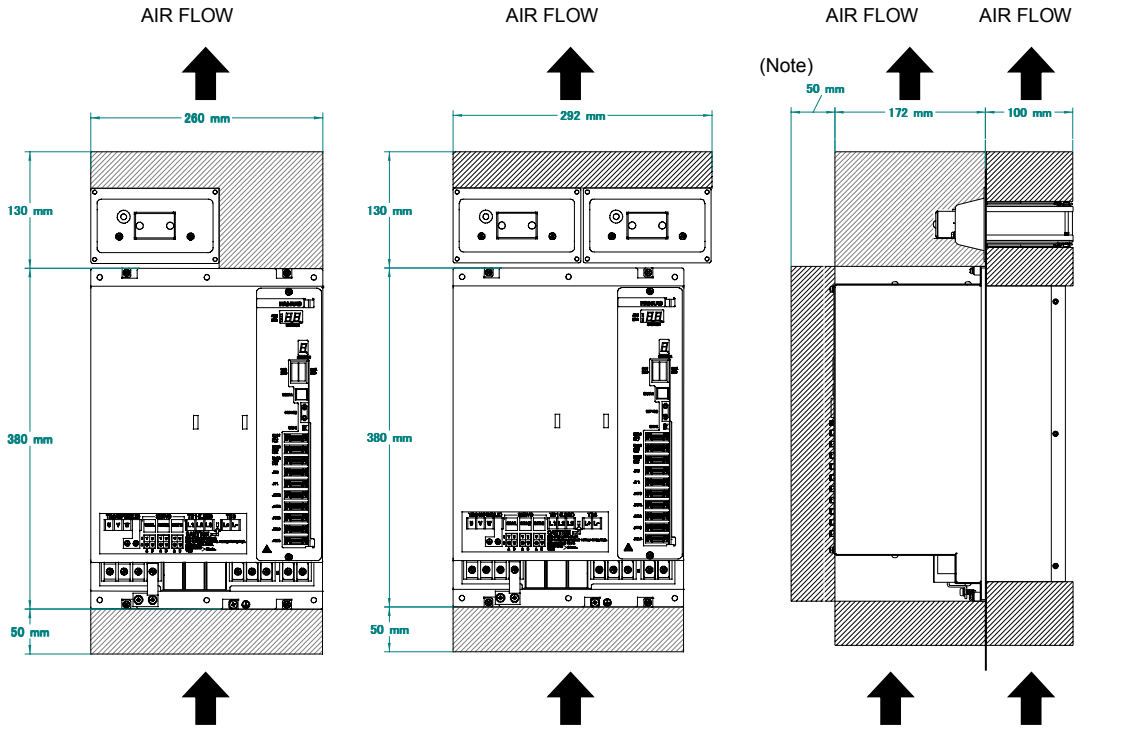
4.3 MAINTENANCE AREA

(1) When no fan unit is used



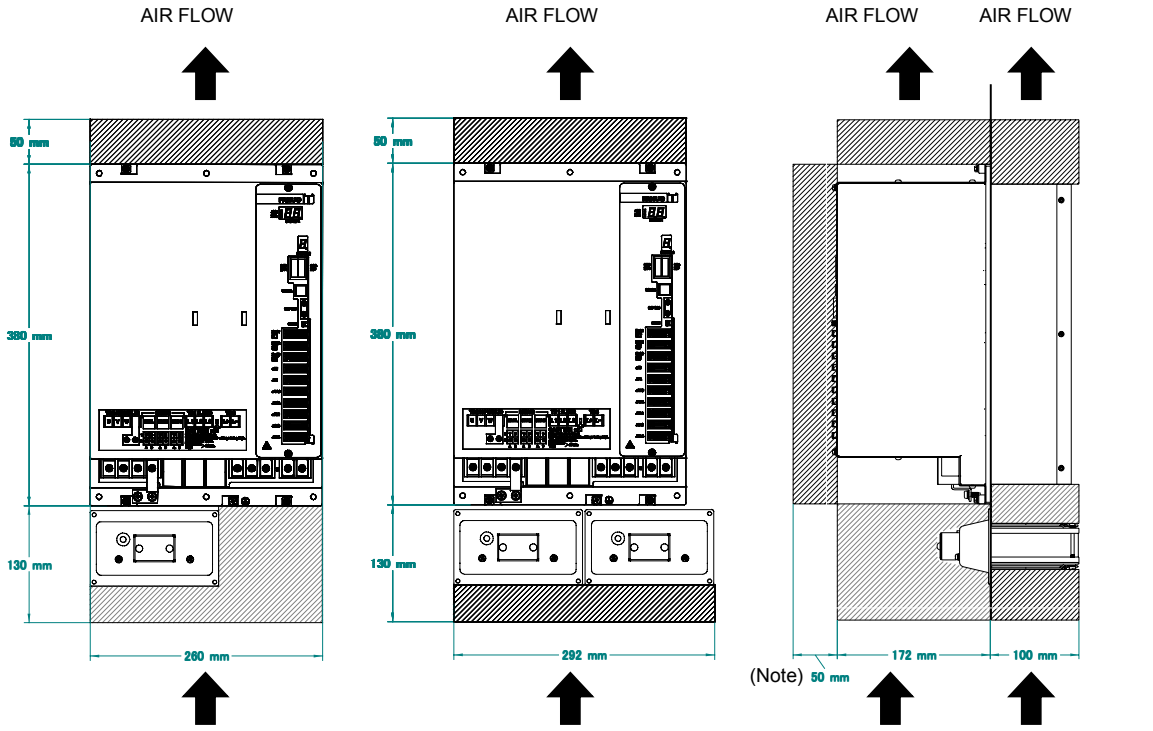
(NOTE) When a right-angle type cable connector is used (+30 mm when a straight type cable connector is used)

(2) When a fan unit used (placed on top of the servo amplifier)



(NOTE) When a right-angle type cable connector is used (+30 mm when a straight type cable connector is used)

(3) When a fan unit used (placed below the servo amplifier)



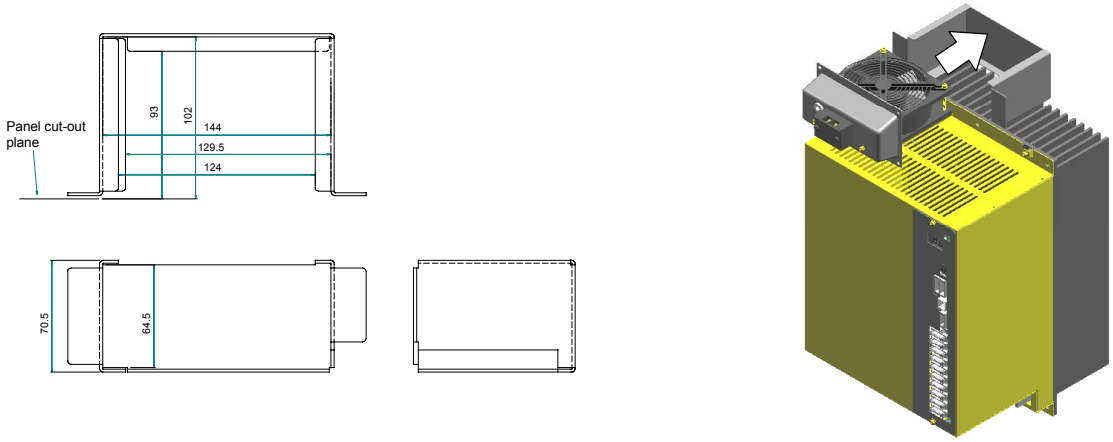
(NOTE) When a right-angle type cable connector is used (+30 mm when a straight type cable connector is used)

4.4 DUCT

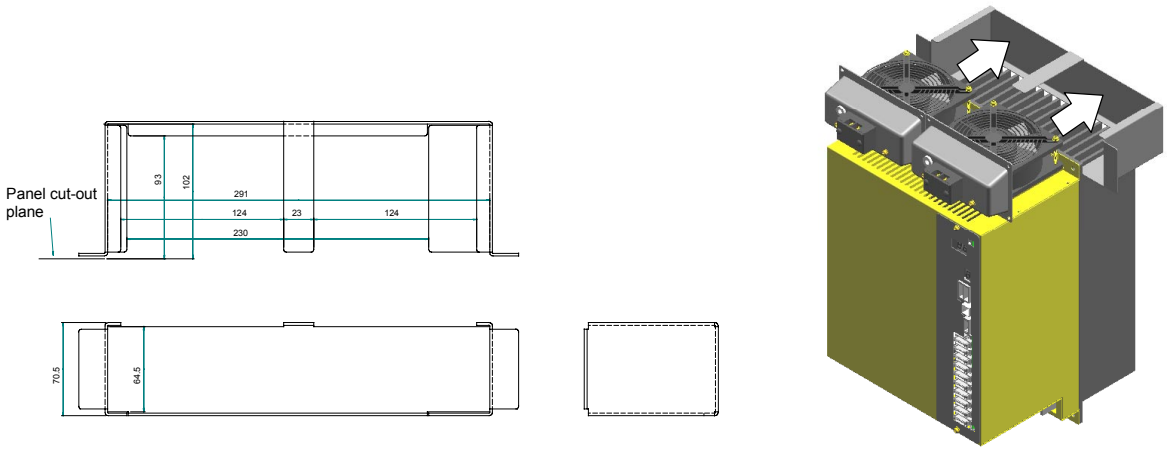
Shown below is an example duct structure where a FANUC fan unit (A06B-6134-K001) is used.

NOTE
1 Install a duct having the shape shown below between the fan unit and heat sink to provide a ventilation flue.
2 Weld the duct to the cabinet.
3 If the fan unit is placed below the servo amplifier, no duct is needed.

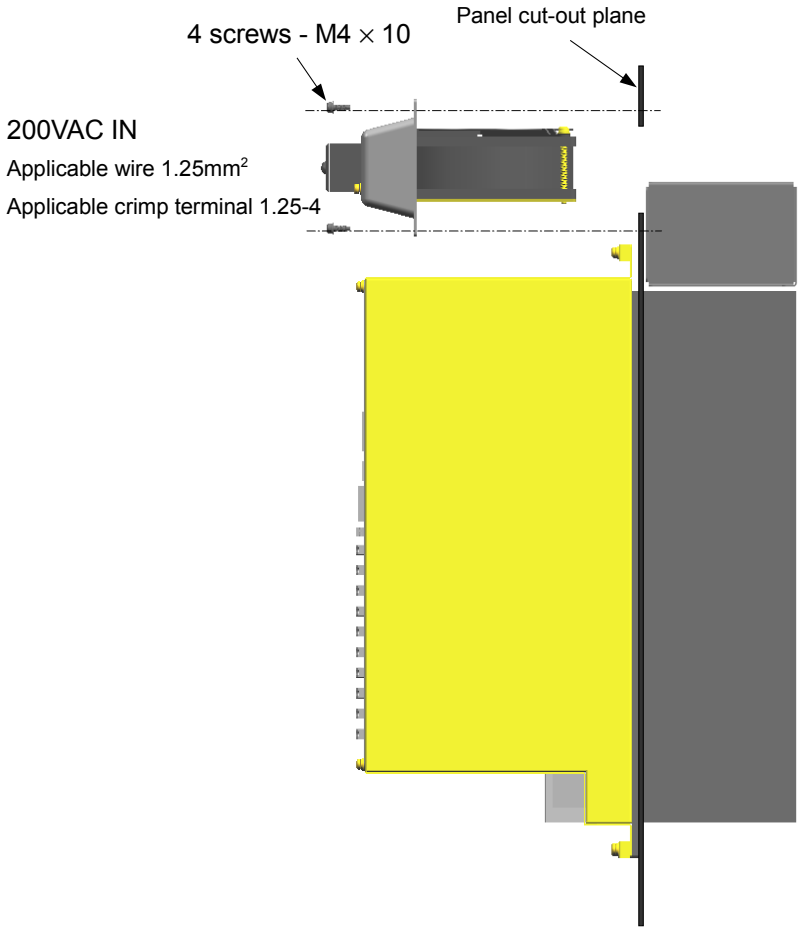
(1) When one fan unit is used



(2) When two fan units are used

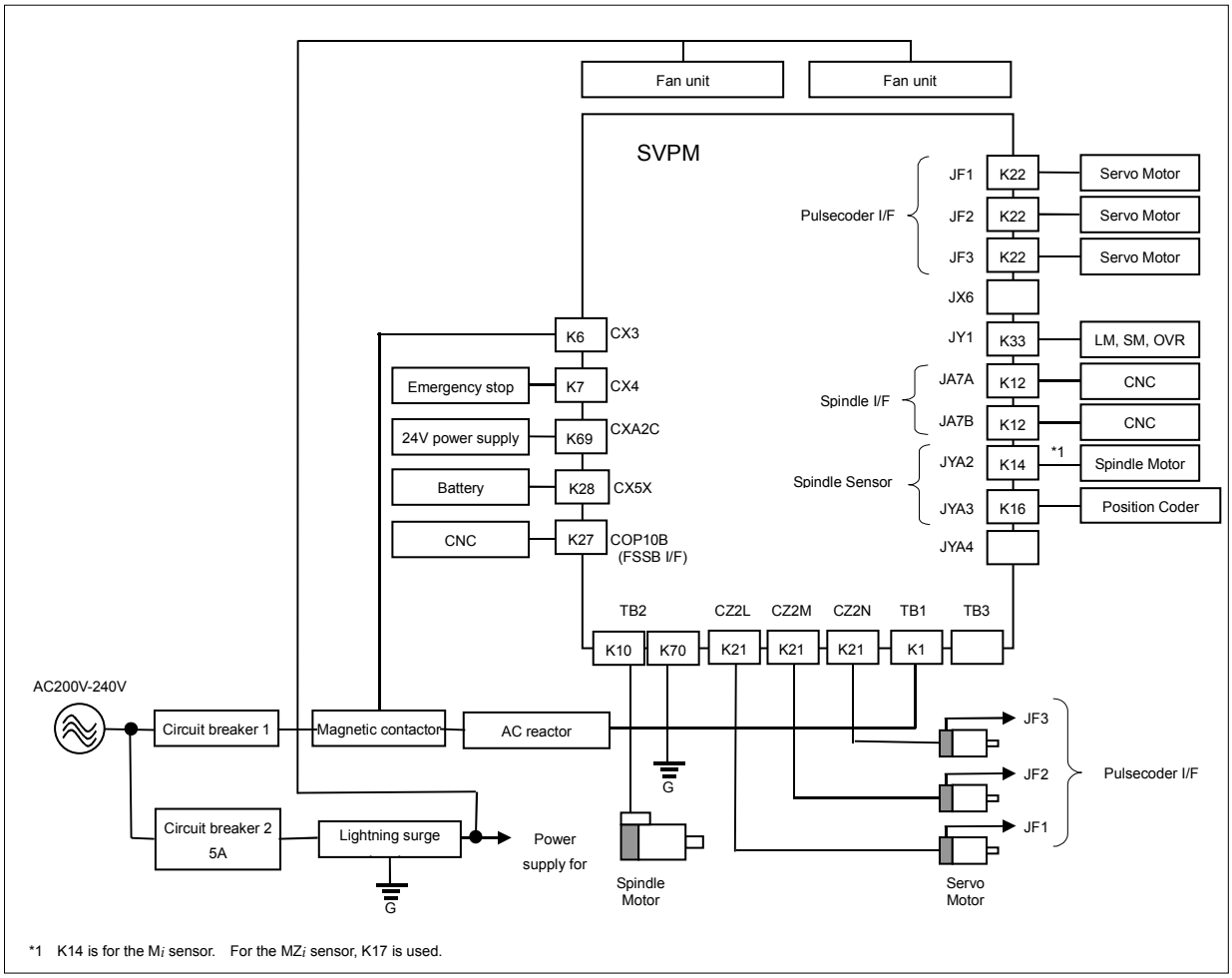


How to mount a fan unit (A06B-6134-K001)



5 TOTAL CONNECTION DIAGRAM

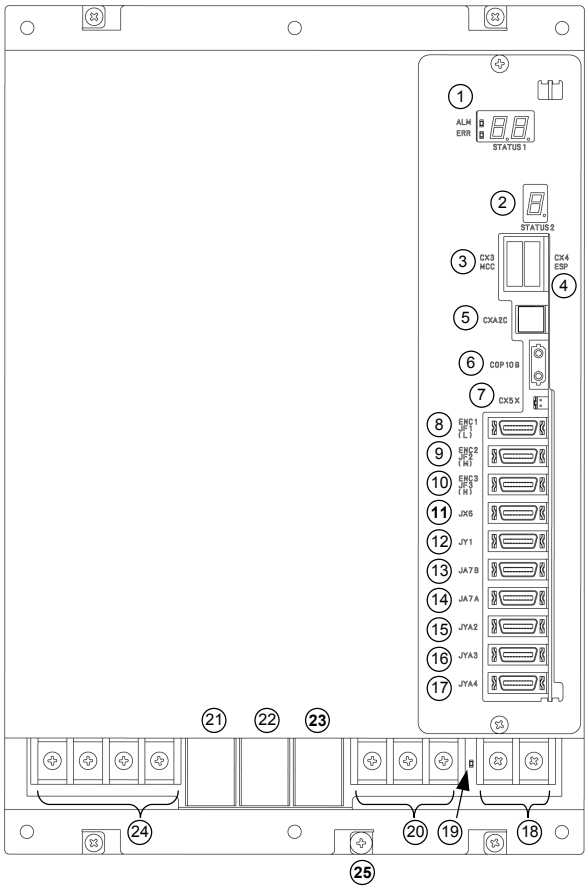
5.1 CONNECTION DIAGRAM



*1 K14 is for the M*i* sensor. For the MZ*i* sensor, K17 is used.

NOTE
1 Always install the circuit breakers, magnetic contactor, and AC reactor.
2 To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.
3 Be sure to connect the grounding terminal (G) on TB2 to a substantial ground.

5.2 CONNECTOR LOCATION



No.	Name	Remarks
1	STATUS1	Status LED : spindle
2	STATUS2	Status LED : servo
3	CX3	Main power MCC control signal
4	CX4	Emergency stop signal (ESP)
5	CXA2C	24VDC power input
6	COP10B	Servo FSSB I/F
7	CX5X	Absolute Pulsecoder battery
8	JF1	Pulsecoder : L axis
9	JF2	Pulsecoder : M axis
10	JF3	Pulsecoder : N axis
11	JX6	Power outage backup module
12	JY1	Load meter, speedometer, analog override
13	JA7B	Spindle interface input
14	JA7A	Spindle interface output
15	JYA2	Spindle sensor M*i*, MZ*i*
16	JYA3	α position coder External one-rotaion signal
17	JYA4	(Unused)
18	TB3	DC link terminal block
19		DC link charge LED (Warning)
20	TB1	Main power supply cnnection terminal board
21	CZ2L	Servo motor power line : L axis
22	CZ2M	Servo motor power line : M axis
23	CZ2N	Servo motor power line : N axis
24	TB2	Spindle motor power line
25	⏚	Tapped hole for grounding the flange

⚠ WARNING
Do not touch any component in the module or any connected cable when LED 19 is on, because it is dangerous.

5.3 DETAILED DESCRIPTONS OF CONNECTIONS

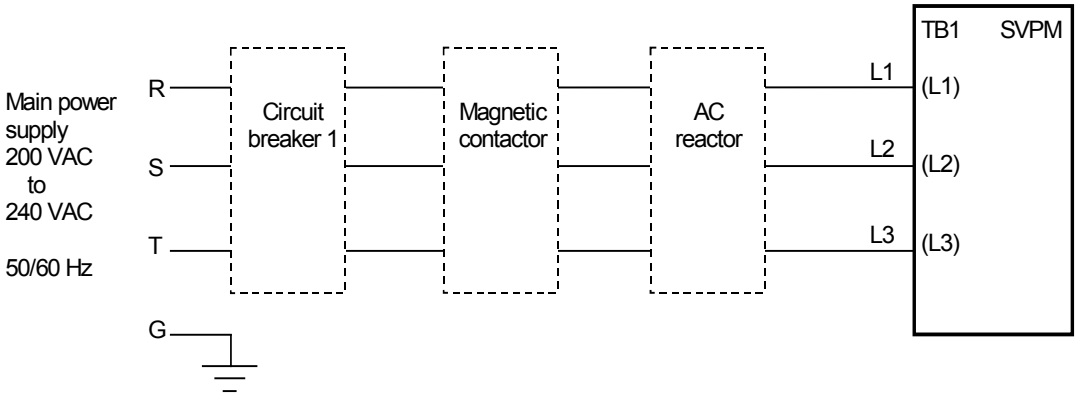
5.3.1 Common

5.3.1.1 Details of cable K1

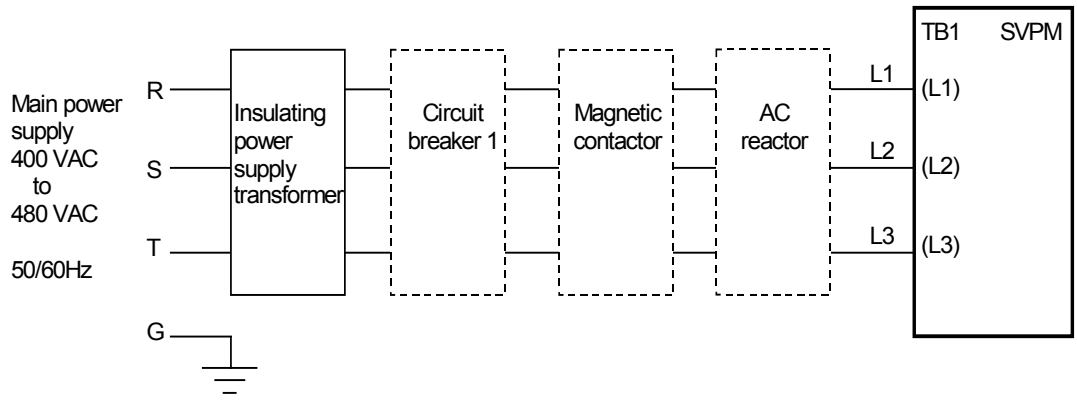
Cable K1 is used to supply main power to the SVPM.

(1) Configuration

(a) For a power supply voltage of 200 to 240 VAC



(b) For a power supply voltage of 400 to 480 VAC (an insulating transformer is needed)



(2) Cable specifications

Model	Applicable cable		Terminal screw	Tightening torque
	Heavy-duty power cable (Note 1)	Heat-resistant cable (Note 2)		
SVPM*-5.5*i*	5.5 mm^2 or more	5.5 mm^2 or more	M5	2.0 to 2.5 N·m
SVPM*-11*i*	8 mm^2 or more	8 mm^2 or more	M5	2.0 to 2.5 N·m
SVPM*-15*i*	14 mm^2 or more	14 mm^2 or more	M5	2.0 to 2.5 N·m

NOTE

1 Four-conductor polyvinyl heavy-duty power cable (JIS C3312) (VCT : heat-resistant 60 °C)

2 Fire-retardant polyflex wire (heat-resistant 105 °C) or equivalent to LMFC manufactured by The Furukawa Electric Co., Ltd.

3 The cross-section area of each cable is determined under the following conditions:
(1) At SVPM rated output
(2) Environment temperature of cable : 30°C
(3) Number of harnesses
3 (No current flows through the ground wire during normal operation.)
The required cross-section area of a cable varies depending on the environment and requirements of the user. Select an appropriate cable size.

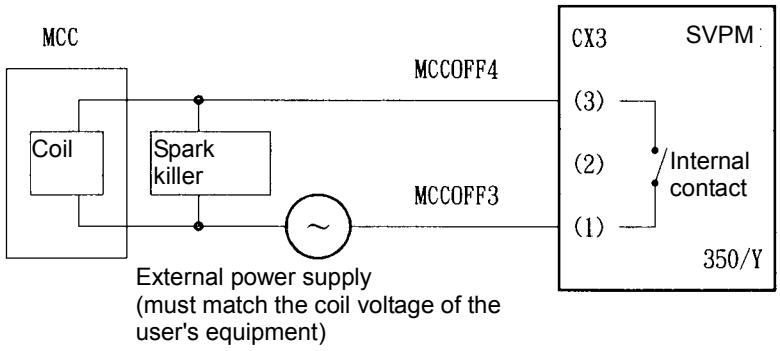
⚠ WARNING

1 Defects, such as a loose screw, an incorrectly inserted connector, and a poorly crimped terminal, can lead to a motor malfunction, excessive heat generation, and a ground fault. Exercise adequate care in installing servo amplifiers.

2 A loose screw and a poorly crimped terminal (or, if a connector is used, a loose connector contact or an incorrect connector pin-to-cable connection) on high-current carrying power supply wires or motor power wires can lead to fire. Exercise adequate care in wiring.

5.3.1.2 Details of cable K6

Cable K6 is used to control the magnetic contactor if it is installed outside the unit.



Connector	Manufactured by Tyco Electronics AMP D-3200 series Housing 2-178128-3 (1 pcs.) Contact 1-175218-2 (2 pcs.) (FANUC ordering information: A06B-6134-K201)
Cable	Two-conductor polyvinyl heavy-duty power cable (JIS C3312), conductor size of 1.25 mm^2 (50/0.18), PVC sheath 9.6 mm in diameter

Internal-contact specification:

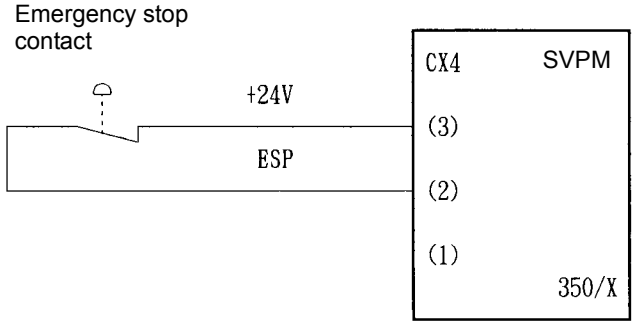
	Resistive load (cosϕ=1)	**Inductive load (cosϕ=0.4, L/R=7msec)**
Rated load	250VAC, 5A / 30VDC, 5A	250VAC, 2A / 30VDC, 2A
Maximum contact rating	5A	5A

NOTE
Always install a spark killer (CR) that matches the magnetic contactor to protect the internal contacts. The following table lists the recommended capacitances and resistances.

Coil voltage	**C**	**R**
24 VDC	0.22 μF	22 Ω
100 to 230 VAC	0.1 μF	220 Ω

5.3.1.3 Details of cable K7

Cable K7 is used to supply an emergency stop signal to the SVPM.



Connector	Manufactured by Tyco Electronics AMP D-3200 series Housing 2-178128-3 (1 pcs.) Contact 1-175218-2 (2 pcs.) (FANUC ordering information: A06B-6134-K201)
Cable	Two-conductor polyvinyl heavy-duty power cable (JIS C3312), conductor size of 1.25 mm^2 (50/0.18), PVC sheath 9.6 mm in diameter

(1) When the contact is ON (closed), the spindle motor and servo motor are enabled.
When the contact is OFF (open), the external magnetic contactor (MCC) is in the off state, and the spindle motor and servo motor do not operate.

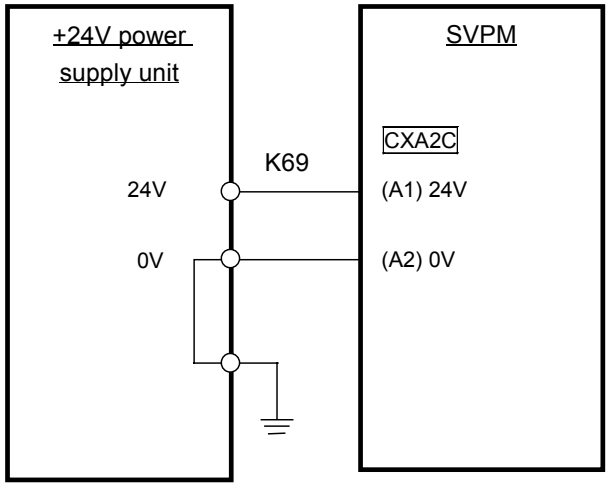
(2) When the contact is set to OFF (open) during motor rotation, the spindle motor decelerates, then stops, and the servo motor is stopped by the dynamic brake.

(3) The contact input signal is specified as follows:
<1> As the external contact capacity, a voltage of at least 30 VDC and a current of at least 100 mA are required.
<2> Significant levels (with the voltage between input pins) when the contactless signal input mode is used:
Low level "logic 0": Up to 2 V
High level "logic 1": At least 20 V

(4) When the SVPM main power is turned off for safety in such a case that the machine protection door is open, the contact of the ESP signal (CX4), which is input to the SVPM, must be set to OFF (open) within 200 ms after turn-off of the SVPM main power.
When the contact of the ESP signal (CX4) remains ON (closed) after the SVPM main power is turned off, a DC link low-voltage alarm occurs in the SVPM.

5.3.1.4 Details of cable K69

Cable K69 is used to supply control power (+24 V) to the SVPM.



Connector	Manufactured by Tyco Electronics AMP D-2100 series Housing 1-1318119-4 (1 pcs.) Contact 1318107-1 (2 pcs.) (FANUC ordering information:A06B-6134-K201)
Cable	Conductor size : 0.5mm^2, AWG20 Instruction outer diameter : 1.08-2.83 mm

5.3.1.5 Details of cable K70

Cable K70 is used to ground the SVPM.

Grounding cable conductor diameter

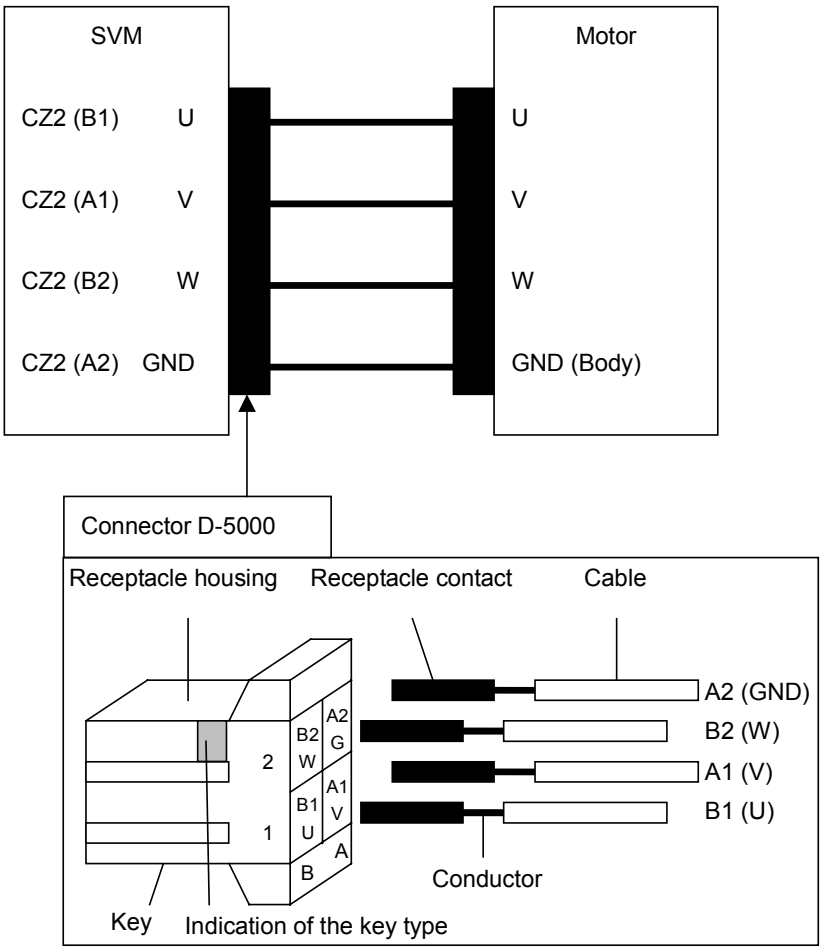
Motor power cable cross-section S (mm^2)	Grounding cable cross-section (mm^2)
S ≤ 5.5	5.5 or greater
5.5 < S ≤ 16	S or greater
16 < S ≤ 35	16 or greater
35 < S	S/2 or greater

NOTE
The following M5 crimp terminal can be used with a cable having a large conductor diameter.
Nichifu Co., Ltd. CB22-5S
Overall conductor size range : 16.78 to 22.66 mm^2

5.3.2 Servo Motor

5.3.2.1 Details of cable K21

The cable K21 is a power cable used between the SVPM and motor. The cable is attached to the SVPM through the connector D-5000.



- About the receptacle housing of the SVPM-side connector
  The SVPM-side connector is a key type. The key is intended to prevent incorrect connection between the axes. Select the receptacle housing that matches the SVPM and its axis that are to be used.

Specification of the key	Applicable SVPM
XX	CZ2L
XY	CZ2M
YY	CZ2N

- About the receptacle contact of the SVPM-side connector
  Four types receptacle contacts are prepared for the different line diameter of the cable. Please use the receptacle contact which suits the line diameter of the cable.

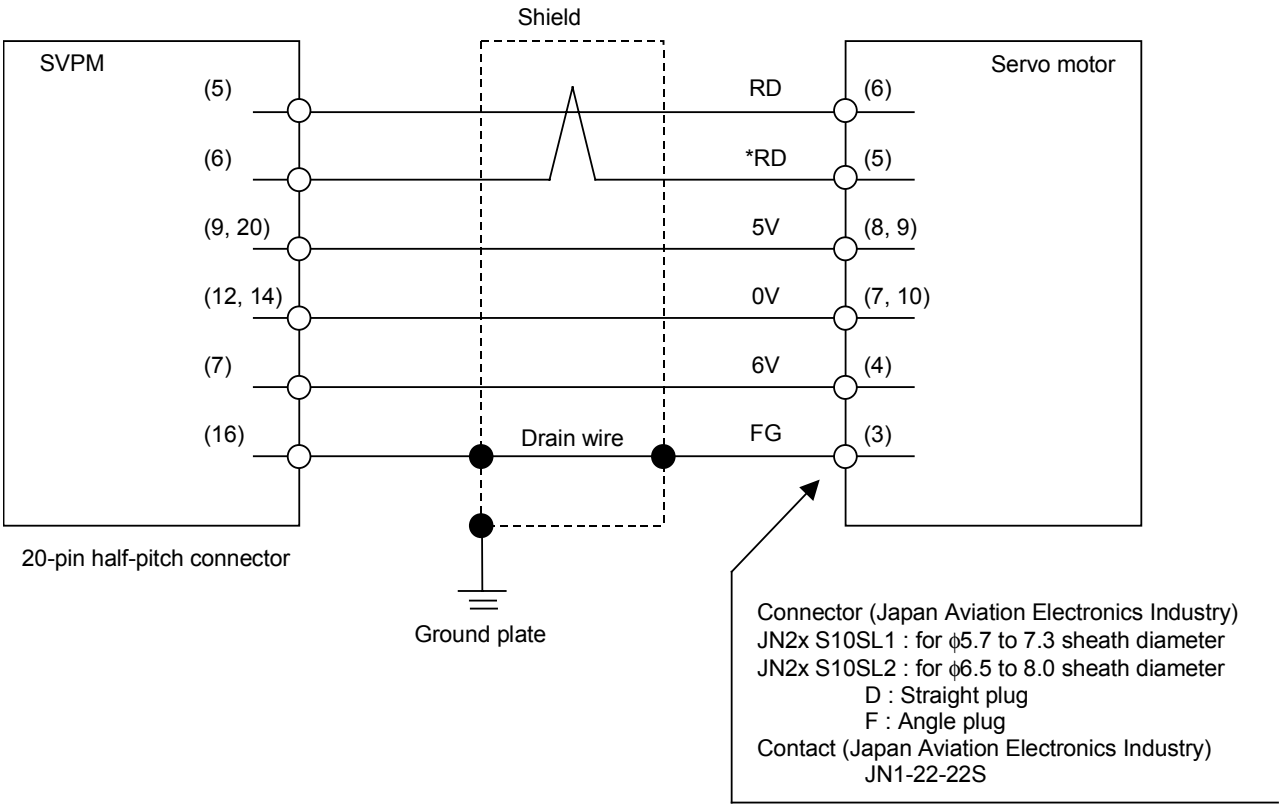
- About the cable specification
  Select the cable specification by considering the following conditions for use.
  <1> Motor current rating or current needed in use on a real machine
  <2> Cable type (heat resistance temperature, etc.)
  <3> Environment in which the cable is installed (operating ambient temperature, etc.)
  <4> Need of water proofing (pay attention to the diameter of the applicable cable clamp)
  <5> Certification for CE marking (compliance with various safety standards and EMC standard)
  <6> Securing insulation space among the cable pins at the time of cabling

- About the motor-side connector
  The specification of the motor-side connector varies from one motor model to another.
  Refer to "FANUC AC SERVO MOTOR β*i*s series Descriptions (B-65302EN)" for explanations about the specification of the motor-side connector.

5.3.2.2 Details of cable K22

The cable K22 is used to connect the SVPM and Pulsecoder.

For servo motor β*i*s series (β2/4000*i*s to β22/2000*i*s)



Using cable conductor

Signal name	Cable length : 28m or less	Cable length : 50m or less
5V, 0V, 6V	$0.3mm^2 \times 5$ (Note 4) Wire construction 12/0.18 or 60/0.08 Insulation outer diameter ϕ0.8 to ϕ1.5	$0.5mm^2 \times 5$ (Note 4) Wire construction 20/0.18 or 104/0.08 Insulation outer diameter ϕ0.8 to ϕ1.5
RD, *RD	$0.18mm^2$ or more Twisted-pair wire Insulation outer diameter ϕ0.8 to ϕ1.5	$0.18mm^2$ or more Twisted-pair wire Insulation outer diameter ϕ0.8 to ϕ1.5
Drain wire	$0.15mm^2$ or more	$0.15mm^2$ or more

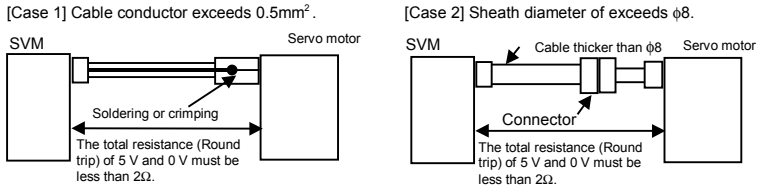
See Subsection 5.4.1 for explanations about the SVPM-side connector that matches the recommended cable.

NOTE

1 The ground plate to which the shield is connected must be placed as close as possible to the servo amplifier so that distance between the ground plate and the servo amplifier becomes shortest.

2 In case that the cable is prepared by MTB, total resistance of 5V and 0V must be less than 2Ω.

3 Pulsecoder side connector can accept maximum 0.5mm^2 (wire construction 20/0.18 or 104/0.08, diameter ϕ1.5 or less) wire and sheath diameter is ϕ5.7 to ϕ8.0. In case of using thicker wire or cable, take measures described below.



4 In case of incremental Pulsecoder, 6V is not necessary to be connected.

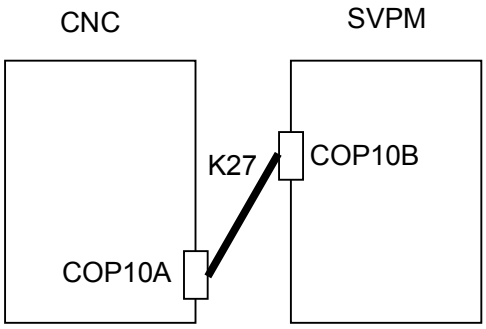
- Crimp tool specification
  A06B-6114-K201/JN1S : For 0.3 mm^2
  A06B-6114-K201/JN1L : For 0.18 mm^2 or 0.5 mm^2

- Connector kit specification
  A06B-6114-K204/S : Straight plug (including a contact)
  A06B-6114-K204/E : Elbow plug (including a contact)

- Recommended cable
  A66L-0001-0460 : Flexible cable 28m or less long
  A66L-0001-0462 : Flexible cable 50m or less long
  A66L-0001-0481 : Fixed cable 28m or less long
  A66L-0001-0491 : Fixed cable 50m or less long

5.3.2.3 Details of cable K27

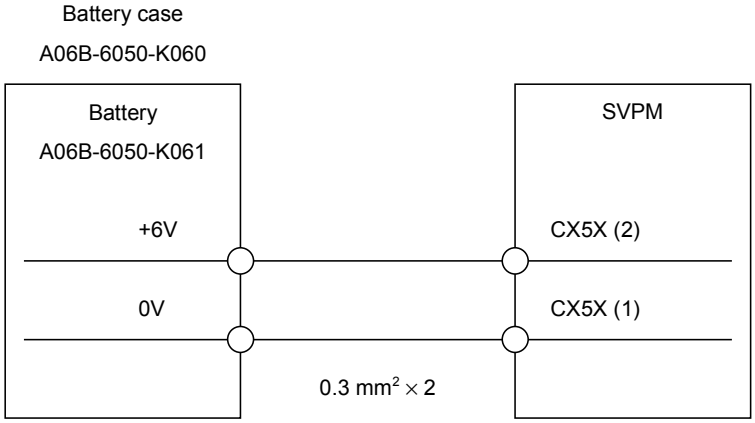
Cable K27 is an optical fiber cable used in the FSSB interface.



- The cable is run from connector COP10A to connector COP10B in the SVPM.
- Refer to the applicable CNC connection manual for detailed specifications of the optical fiber cable.

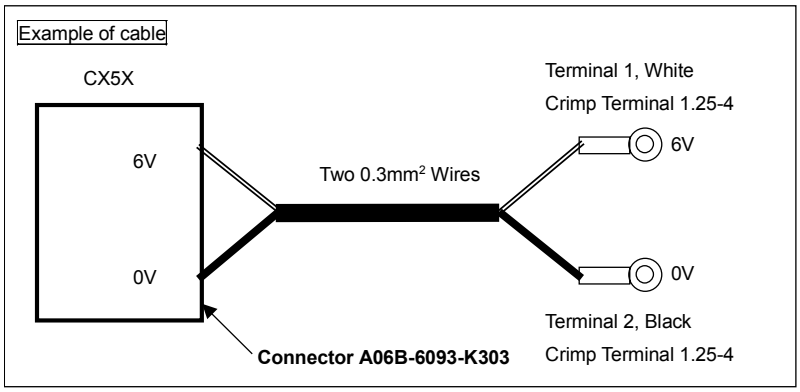
5.3.2.4 Details of cable K28

When a battery box is used)

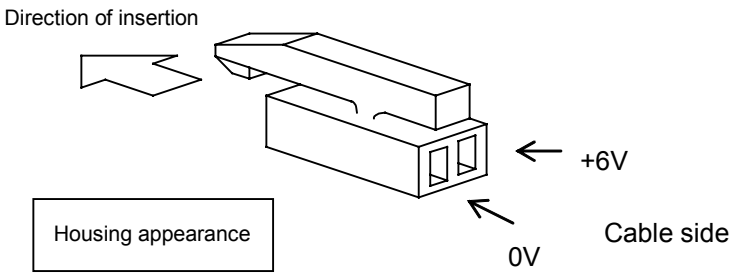


Screw terminal : M3
Crimp terminal : 1.25-4

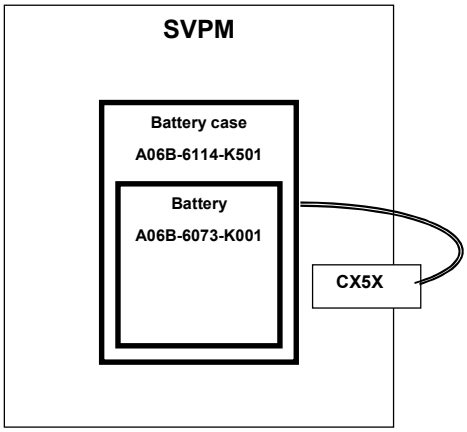
Housing : IL-L2S-S3L-B(N)
Contact : IL-C2-1-00001
Manufacture :
Japan Aviation Electronics Industry



- A connector (A06B-6093-K303) is optionally available.



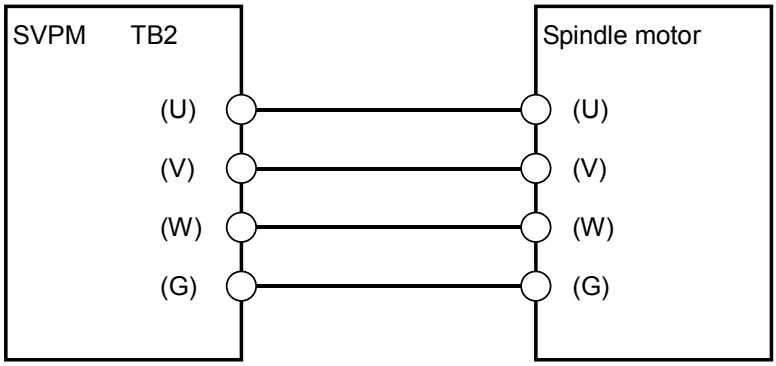
When the built-in battery is used)



- Using the built-in battery (A06B-6073-K001) always requires the battery case (A06B-6114-K501).

5.3.3 Spindle Motor

5.3.3.1 Details of cable K10



To connect the cable to the SVPM, use a crimp terminal selected according to the following table.

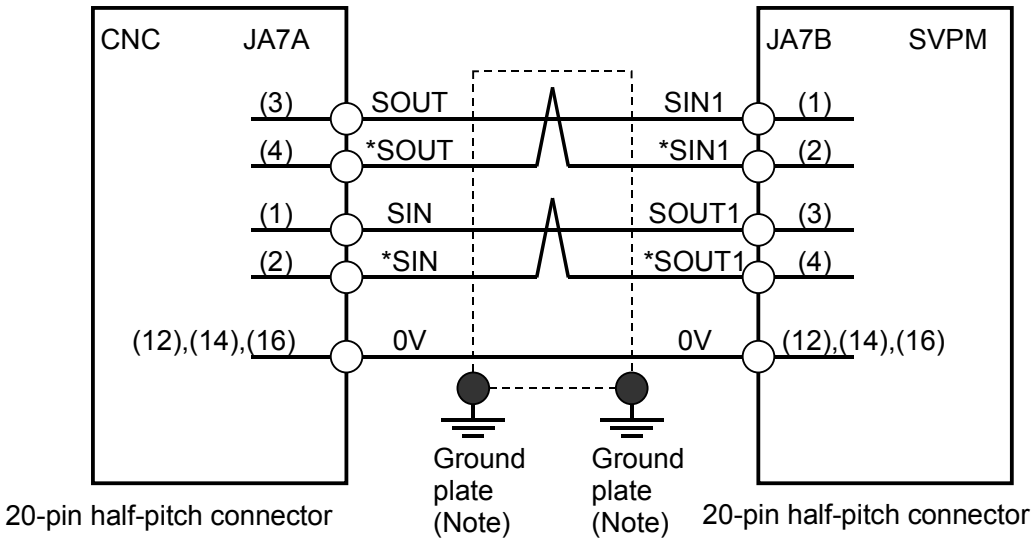
Amplifier model	Terminal screw	Tightening torque
SVPM2-5.5*i* to 15*i* SVPM3-5.5*i* to 15*i*	M5	2.0 to 2.5 N·m

About the cable specification

Select the cable specification by considering the following conditions for use.

<1> Motor current rating or current needed in use on a real machine
<2> Cable type (heat resistance temperature, etc.)
<3> Environment in which the cable is installed (operating ambient temperature, etc.)
<4> Need of water proofing (pay attention to the diameter of the applicable cable clamp)
<5> Certification for CE marking (compliance with various safety standards and EMC standard)
<6> Securing insulation space among the cable pins at the time of cabling

5.3.3.2 Details of cable K12



Cable specification: 0.09 mm^2 twisted pair with common shielded
Recommended cable (wire only): A66L-0001-0284#10P
See Section 5.4.1 for details of connectors applied to recommended cable.

NOTE
If cable K12 is installed near the likes of a power cable, its shielding wire must be connected to a ground plate. If an SVPM is installed near the CNC, however, it is not necessary to connect the shielding wire to a ground plate.

Connector pin assignment

JA7A and JA7B

9	5V (Note 1)	10		19		20	5V (Note 1)
7		8		17		18	5V (Note 1)
5		6		15		16	0V
3	SOUT	4	*SOUT	13		14	0V
1	SIN	2	*SIN	11		12	0V

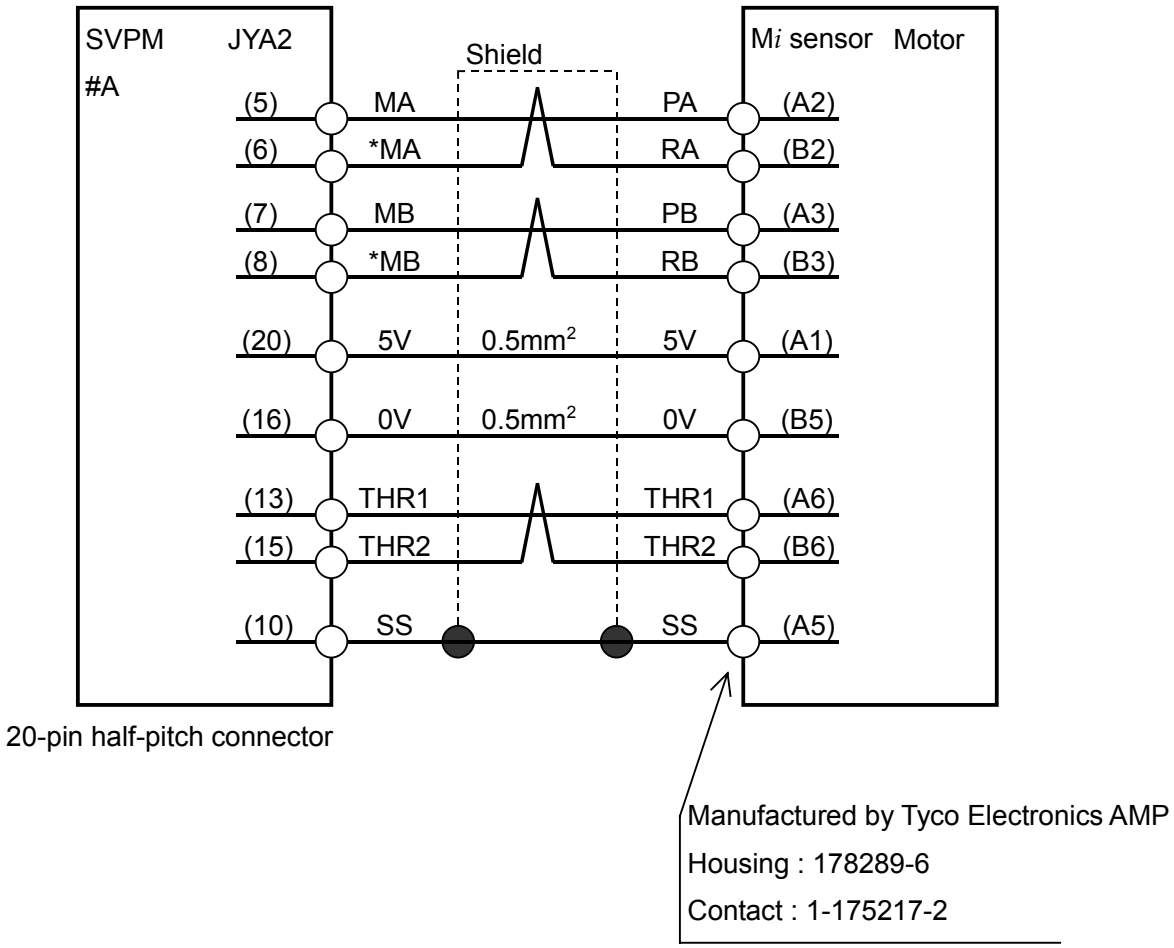
NOTE

1 The +5V pin is intended for optical link transmission based on the optical I/O link adapter. Do not use it when a metal cable is being used; otherwise, the +5V line of the CNC will be short-circuited with that of the SVPM.

2 SVPM serial interface connection using an optical fiber cable
The use of an optical I/O link adapter with the SVPM serial interface extends the maximum allowable length of the optical fiber cable to up to 200 m.
Use optical fiber cables in the following cases:
- When the required cable length is 20 m or longer.
- When the cable must be extended across multiple cabinets, and the cabinets cannot be connected with a grounding wire 5.5 mm^2 or larger.
- The cable may be affected by noise, for example, if the cable is laid near a strong magnetic noise source like a welding machine or in parallel with a power line over a long distance.

5.3.3.3 Details of cable K14

(1) For the motor with M*i* sensor



Cable specification : 6 common shielded cable
(Three 0.18mm^2 twisted pairs + 0.5mm^2 wires)
Recommended cable conductor : A66L-0001-0368
See Section 5.4.1 for explanations about the JYA2-side connector that matches the recommended cable.

NOTE
If only one 5V line and only one 0V line are used, use pins 20 and 16 for them, so that, if the connector is attached the wrong way, the sensor can be prevented from being damaged.

Connector pin assignment

JYA2

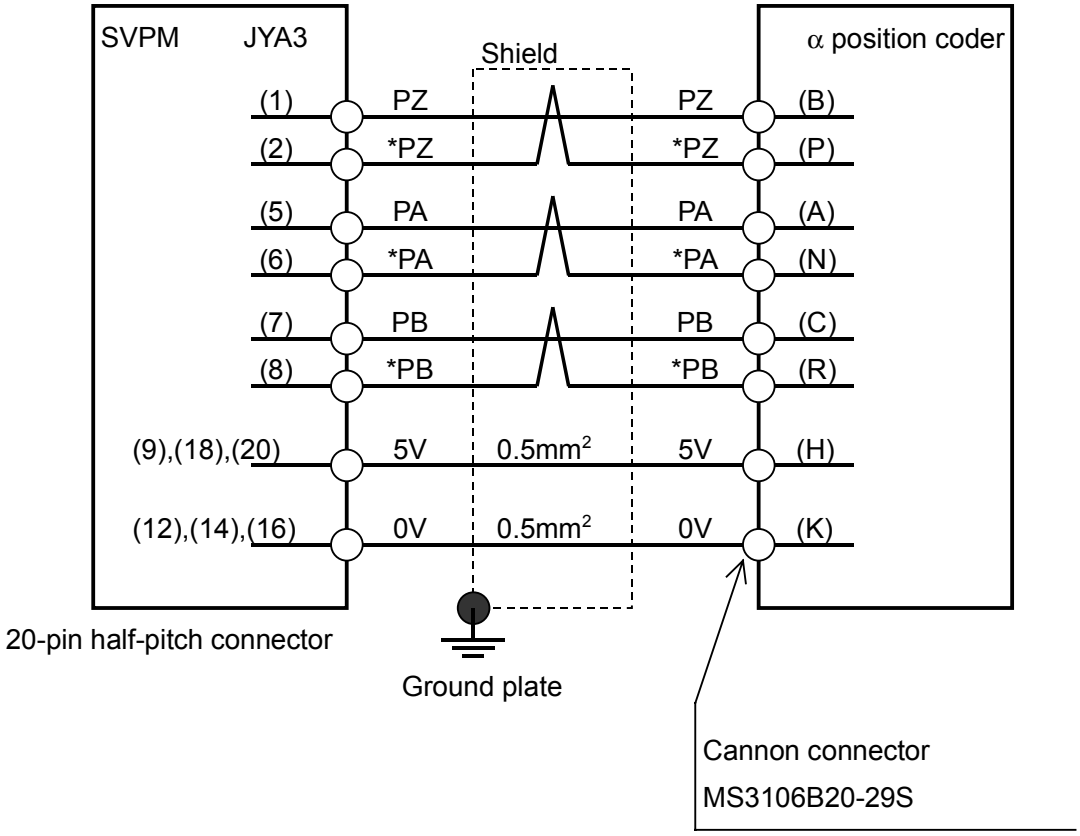
9	5V	10	SS	19	#	20	5V
7	MB	8	*MB	17	#	18	5V
5	MA	6	*MA	15	THR2	16	0V
3	#	4	#	13	THR1	14	0V
1	MZ	2	*MZ	11	#	12	0V

NOTE
Do not use any pin that is marked #, because they may already be in use for input/output signals for an optional PCB.

Pin arrangement of the connector (manufactured by Tyco Electronics AMP) on the motor side

A1	+5V	B1	
A2	PA	B2	RA
A3	PB	B3	RB
A4		B4	
A5	SS	B5	0V
A6	THR1	B6	THR2

5.3.3.4 Details of cable K16



Cable specification : 6 common shielded cable
(Three 0.18mm^2 twisted pairs + 0.5mm^2 wires)
Recommended cable conductor : A66L-0001-0286
See Section 5.4.1 for explanations about the JYA3-side connector that matches the recommended cable.

NOTE
If only one 5V line and only one 0V line are used, use pins 20 and 16 for them, so that, if the connector is attached the wrong way, the sensor can be prevented from being damaged.

Connector pin assignment

JYA3

9	5V	10	#	19	#	20	5V
7	PB	8	*PB	17	#	18	5V
5	PA	6	*PA	15	EXTSC	16	0V
3	#	4	#	13	SCCOM	14	0V
1	PZ	2	*PZ	11	24V	12	0V

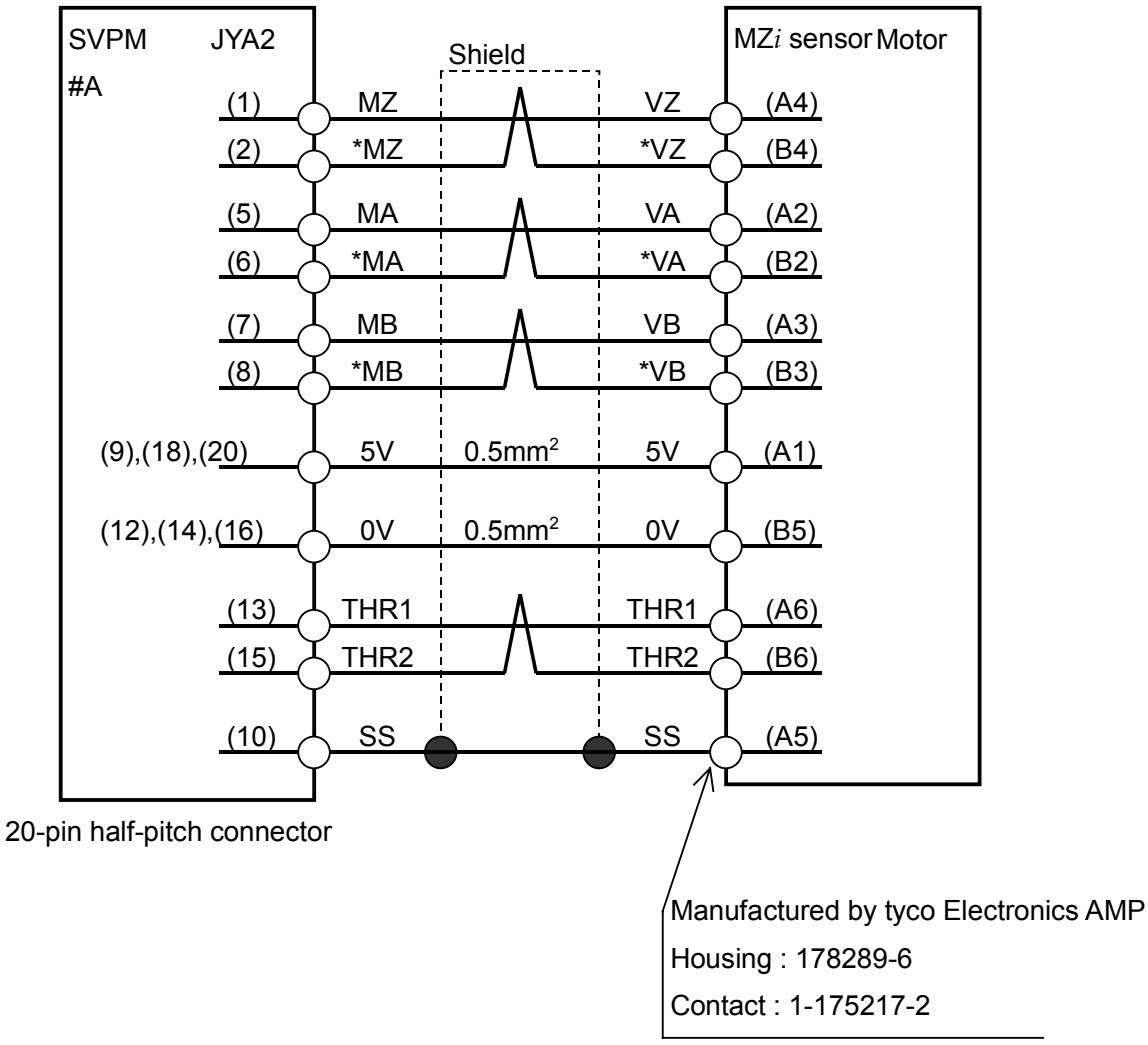
NOTE
Do not use any pin that is marked #.

Pin arrangement of the cannon connector on the position coder side

A	PA	B	PZ	C	PB
D		E		F	
G		H	+5V	J	
K	0V	L		M	
N	*PA	P	*PZ	R	*PB
S		T			

5.3.3.5 Details of cable K17

(1) For the motor with MZ*i* sensor



Cable specification : 6 common shielded cable
(Four 0.18mm^2 twisted pairs + 0.5mm^2 wires)
Recommended cable conductor : A66L-0001-0368
See Section 5.4.1 for explanations about the JYA2-side connector that matches the recommended cable.

NOTE
If only one 5V line and only one 0V line are used, use pins 20 and 16 for them, so that, if the connector is attached the wrong way, the sensor can be prevented from being damaged.

Connector pin assignment

JYA2

9	5V	10	SS	19	#	20	5V
7	MB	8	*MB	17	#	18	5V
5	MA	6	*MA	15	THR2	16	0V
3	#	4	#	13	THR1	14	0V
1	MZ	2	*MZ	11	#	12	0V

JYA4

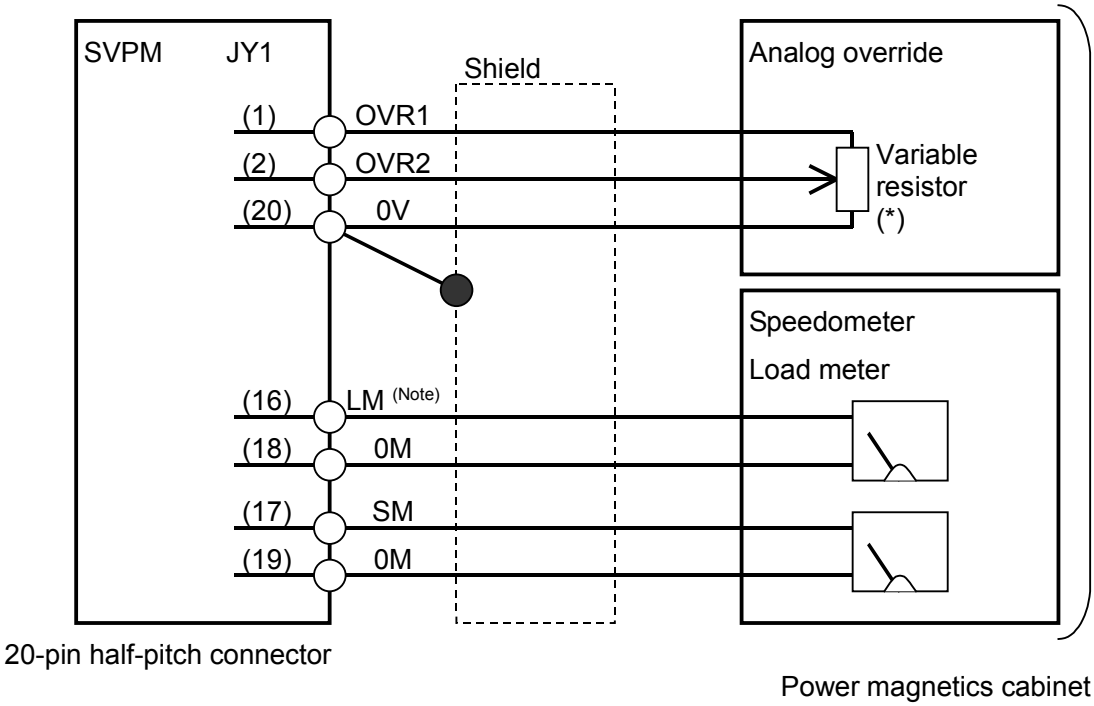
9	5V	10	SS	19	#	20	5V
7	MB	8	*MB	17	#	18	5V
5	MA	6	*MA	15		16	0V
3	#	4	#	13		14	0V
1	MZ	2	*MZ	11	#	12	0V

NOTE
Do not use any pin that is marked #, because they may already be in use for input/output signals for an optional PCB.

Pin arrangement of the connector (manufactured by Tyco Electronics AMP) on the motor side

A1	+5V	B1	
A2	VA	B2	*VA
A3	VB	B3	*VB
A4	VZ	B4	*VZ
A5	SS	B5	0V
A6	THR1	B6	THR2

5.3.3.6 Details of cable K33



Cable specification : 0.09mm^2 common shielded cable
Recommended cable conductor : A66L-0001-0284#10P
See Section 5.4.1 for explanations about the JY1-side connector that matches the recommended cable.

NOTE
1 Select such an external resistance such that VR+R1 falls within the range between 2 kΩ and 10 kΩ .
2 No LM output is included in the #C specification. For the SM output, select the load meter or speedometer by parameter setting.

Connector pin assignment

JY1

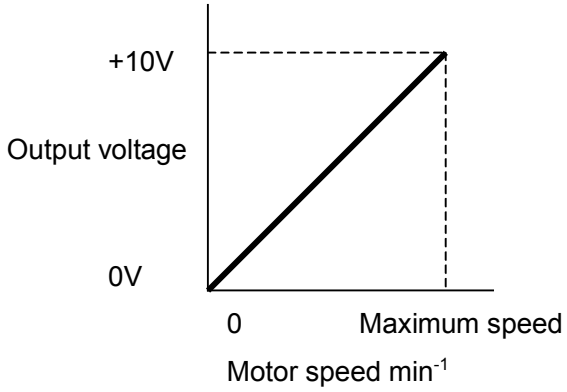
9	#	10	#	19	0M	20	0V
7	#	8	#	17	SM	18	0M
5	#	6	#	15	#	16	LM
3	#	4	#	13	#	14	#
1	OVR1	2	OVR2	11	#	12	#

NOTE
Pins indicated # are intended to input or output signals used on a spindle check board. Do not connect any other signal line to them.

Voltage signal for the speedometer (SM)

By externally connecting a tachometer, the speed of the spindle motor can be indicated. The voltage (DC) proportional to the speed (for the #C specification, an estimated speed) is output, regardless of the rotation direction of the motor. At the maximum motor speed, +10 V is output.

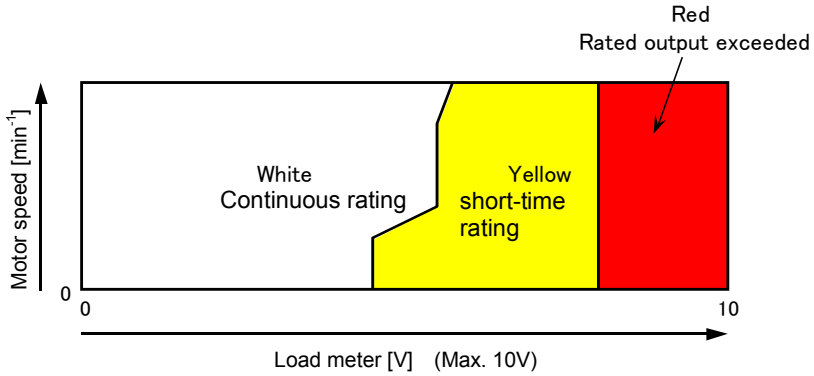
The output voltage of the speedometer in the forward direction and reverse direction is calibrated using a parameter. The precision is ±3% Max.



Voltage signal for the load meter (LM)

The load meter indicates the percentage of the load to the maximum motor output (load ratio). A voltage of 10 V is output at the maximum output.

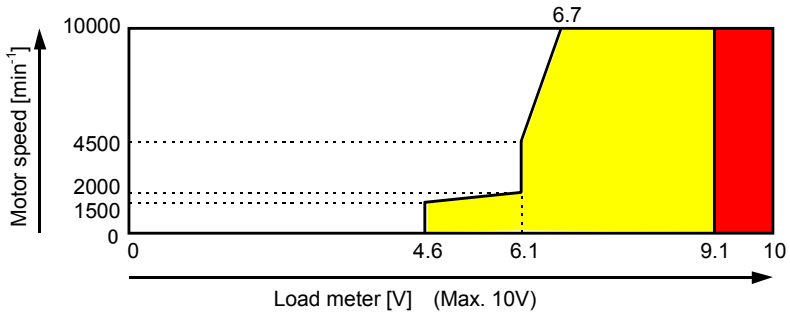
• Legend



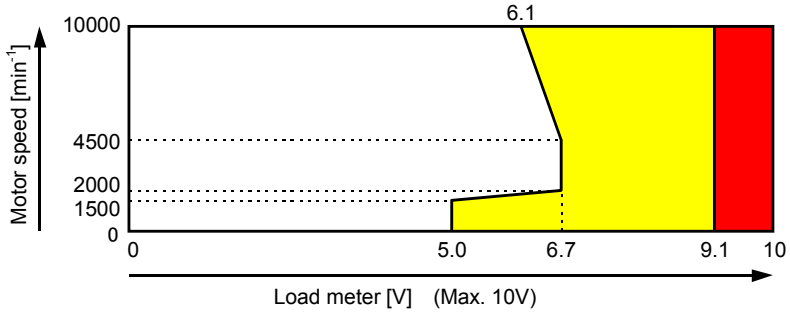
NOTE

1 The vertical axis represents the motor speed. If the spindle-to-motor speed ratio is not 1:1, it is recommended to convert the motor speed to the spindle speed.
2 The precision of load meter voltage depends on the used speed and input voltage. The maximum error is about ±15%.

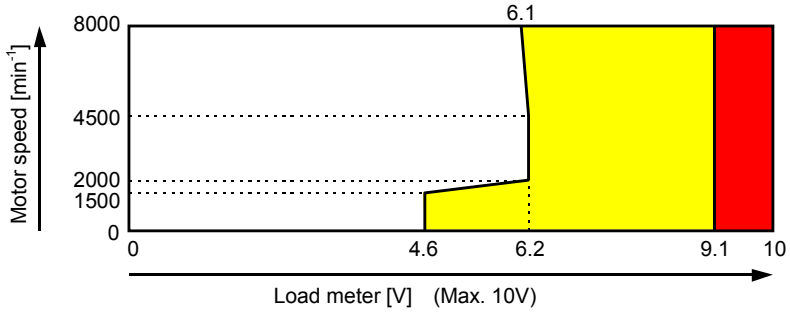
- **β3/10000*i***



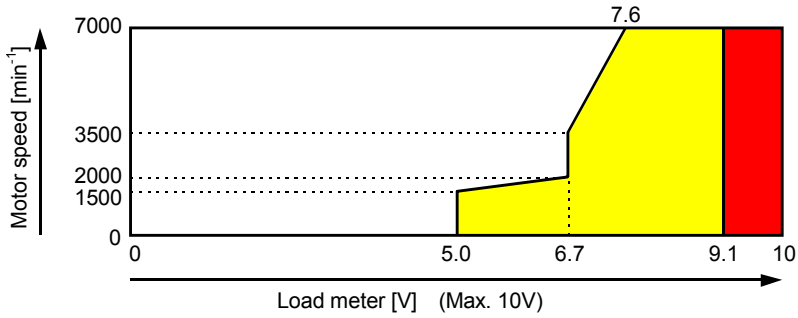
- **β6/10000*i***



- **β8/8000*i***

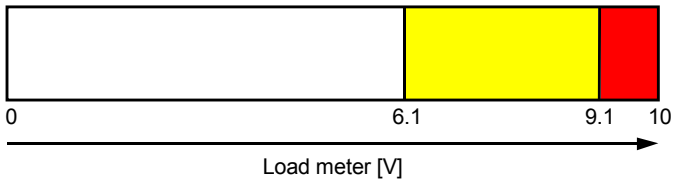


- **β12/7000*i***

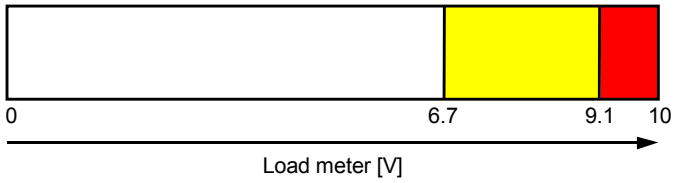


If the motor is often used at a speed of 2000 min^{-1} or higher, a simplified version of the load meter shown below could be used.

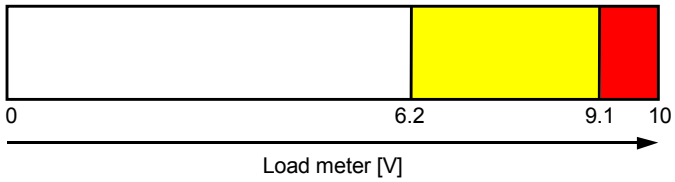
- **β3/10000*i***



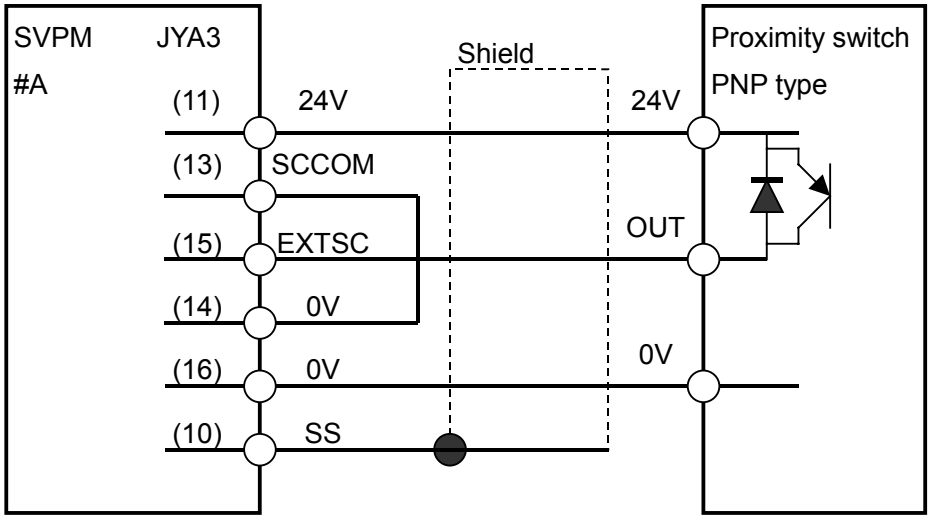
- **β6/10000*i*, β12/7000*i***



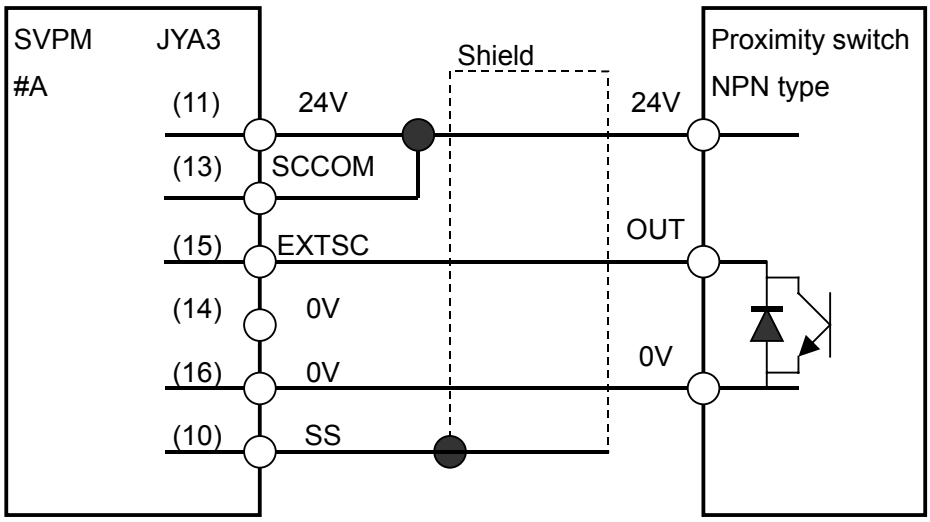
- **β8/8000*i***



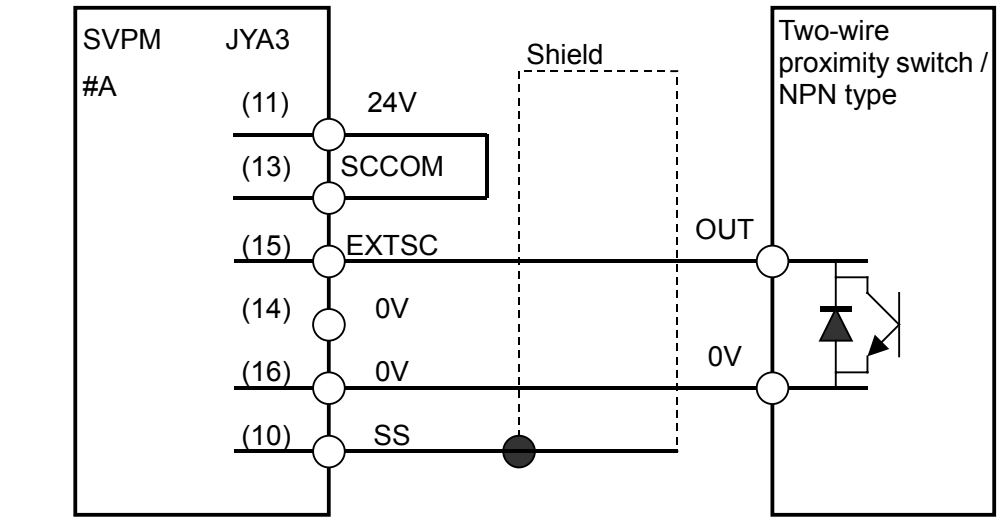
5.3.3.7 Details of cable K71



20-pin half-pitch connector



20-pin half-pitch connector



20-pin half-pitch connector

Cable specification : 0.09mm^2 common shielded cable
Recommended cable conductor : A66L-0001-0284#10P
See Section 5.4.1 for explanations about the JYA3-side connector that matches the recommended cable.

Connector pin assignment

See Subsection 5.3.3.4 “Details of cable K16.”

External one-rotation signal switch (proximity switch)

Use an external one-rotation signal switch (proximity switch) that satisfies the specifications indicated below.

(a) DC two-wire proximity switch

Item	Specification
Supply voltage	24 VDC ±1.5 V (24 VDC is fed from the SVPM.)
Response frequency	400 Hz or higher
Load current	16 mA or higher
Residual voltage	4 V or higher
Supply (leakage) current	1.5 mA or lower

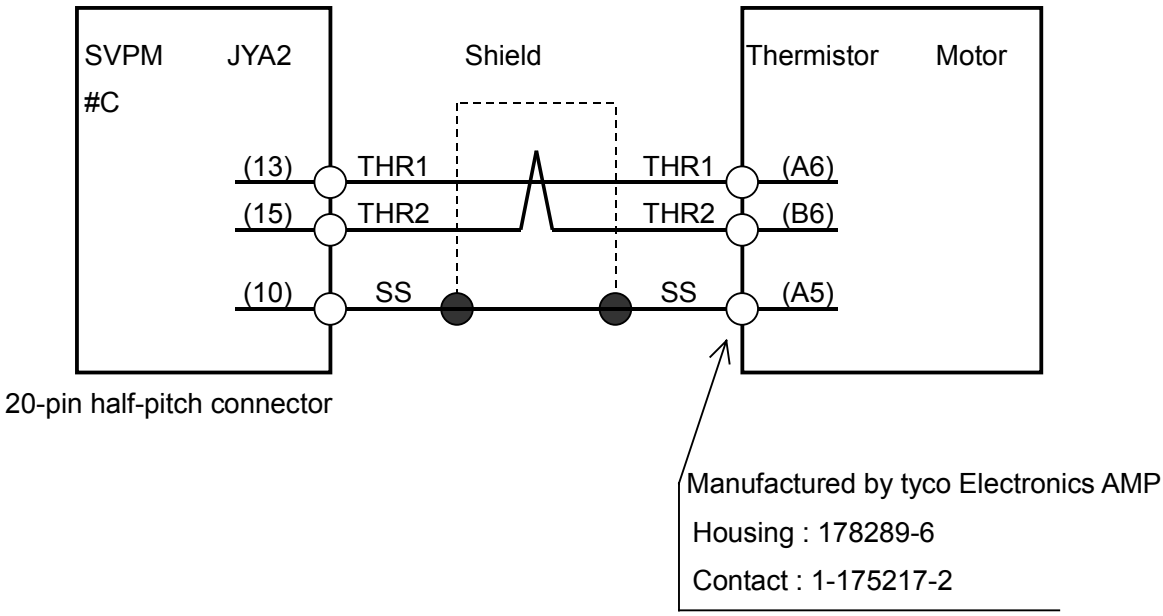
(b) DC three-wire proximity switch

Item	Specification
Supply voltage	24 VDC ±1.5 V (24 VDC is fed from the SVPM.)
Response frequency	400 Hz or higher
Load current	16 mA or higher
Residual voltage	4 V or higher
Supply current	50mA or lower

NOTE

The location where a proximity switch signal occurs depends on the temperature. So, consider the ambient temperature when selecting a proximity switch.

5.3.3.8 Details of cable K79



Cable specification : 0.18 mm^2 twisted pair with common shielded
Recommended cable conductor : A66L-0001-0368
See Section 5.4.1 for explanations about the JYA2-side connector that matches the recommended cable.

5.4 DETAILS OF CONNECTORS

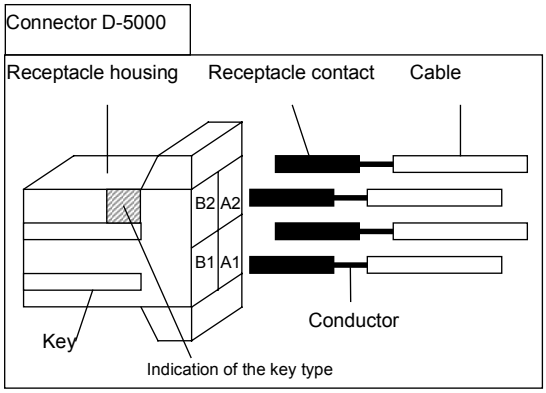
5.4.1 20-Pin Half-Pitch Connectors

The following table lists the 20-pin half-pitch connectors used for the β*i* series servo amplifier and the recommended cables for these connectors.
Use connectors that match the recommended cables specified on the applicable connection diagram in detail.

Recommended-cable specification	Applicable connector	Connector model number	Housing model number	Connector + housing
A66L-0001-0284#10P	Crimp type	Hirose Electric Co., Ltd. FI30-20S	Sideways cable slot type FI-20-CVS2	Sideways cable slot type FI30-20S-CVS2
		Honda Tsushin Kogyo Co., Ltd. PCR-E20FA	PCR-V20LA	
	Soldering type	Hirose Electric Co., Ltd. FI40B-20S	Sideways cable slot type FI-20-CVS2	Sideways cable slot type FI40B-20S-CVS2
		Honda Tsushin Kogyo Co., Ltd. PCR-E20FS	PCR-V20LA	
A66L-0001-0286 A66L-0001-0460 A66L-0001-0462 A66L-0001-0481 A66L-0001-0491	Soldering type Note that this connector does not have pin No. 11, 13, 15, 17, or 19.	Hirose Electric Co., Ltd. FI40B-2015S	Sideways cable slot type FI-2015-CVS	Sideways cable slot type FI40B-2015S-CVS
A66L-0001-0368	Soldering type	Hirose Electric Co., Ltd. FI40B-20S	Sideways cable slot type FI-20-CVS5	Sideways cable slot type FI40B-20S-CVS5

5.4.2 Tyco Electronics AMP D-5000 Series Connector

The βi series uses the D-5000 series connector (manufactured by Tyco Electronics AMP) for the motor power cable.
The connector is provided with three keys that assure it is inserted in the correct direction. In addition, four types of receptacle contacts are available, from which the user can select the suitable one depending on the amount of current to use (size of the conductor).
Connectors and tools can be ordered directly from Tyco Electronics AMP. FANUC also furnishes options. For details, see "Order List (B-65321EN)".



Receptacle housing

There are three different key types for the receptacle housing. Be sure to select the receptacle housing of the key type that matches the servo axis you use.

Receptacle housing model number	Specification of the key	Applicable servo amplifier
1-917807-2	XX	Servo L-axis
3-917807-2	XY	Servo M-axis
2-917807-2	YY	Servo N-axis

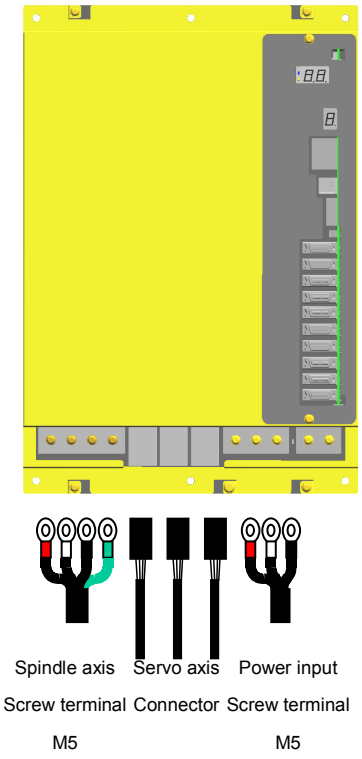
(Reference)

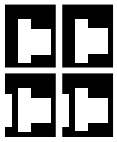
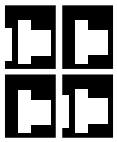
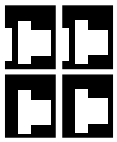
There is a cable-end connectors which are inserted no matter what key is used. Contact the connector manufacturer (Tyco Electronics AMP) for details.

Receptacle contact

Four receptacle contact types are available, so as to support different conductor diameters. Be sure to select the receptacle contact (silver plating) that matches the servo axis you use.

Rectangle contact model number		Conductor size (mm^2)	Conductor size AWG	Insulation outer diameter (mm)	Manual tool model number
SS size	1318986-6	0.50 – 1.42	20/18	1.08-3.23	1366656-1
S size	316040-6	1.23 – 2.27	16/14	3.0-3.8	234170-1
M size	316041-6	3.08 – 5.50	12/10	4.0-5.2	234171-1
L size	1318697-6	7.27 – 8.92	8	4.9-7.8	1366044-1



Applied	Connector key
Servo L-axis	XX  1-917807-2
Servo M-axis	XY  3-917807-2
Servo N-axis	YY  2-917807-2

Contact
SS  1318986-6
S  316040-6
M  316041-6
L  1318697-6

6 HEAT DISSIPATION

The amount of heat generated in an SVPM varies depending on its model, the current flowing through the motor, and the motor output. (Refer to the respective motor description manuals for the current and output of each motor.)

(1) Total amount of heat dissipation

The total amount of heat dissipation by the SVPM is calculated according to the following expression:

Total amount of heat dissipation
= a + Ka1×b1 + Ka2×b2 + Ka3×b3 + Ka4×b4 + Ka5×b5

a : Amount of heat dissipation determined by the SVPM model [W]
Ka1 to Ka5 : Coefficient determined by the SVPM
b1 : Total output of motors connected to the SVPM [kW]
b2 : Current flowing through the spindle motor [Arms]
b3 : Current flowing through the servo motor of L-axis [Arms]
b4 : Current flowing through the servo motor of M-axis [Arms]
b5 : Current flowing through the servo motor of N-axis [Arms]

SVPM (total amount of heat dissipation)

Name	Specification	a [W]	Coefficient	
SVPM2-5.5*i*	H201	22	Ka1	14.3
			Ka2	5.8
			Ka3	5.0
			Ka4	5.0
SVPM2-11*i*	H202	22	Ka1	14.3
			Ka2	5.4
			Ka3	5.0
			Ka4	5.0
SVPM2-15*i*	H203	22	Ka1	13.1
			Ka2	5.5
			Ka3	4.6
			Ka4	4.6
SVPM3-5.5*i*	H301	24	Ka1	14.3
			Ka2	5.8
			Ka3	5.0
			Ka4	5.0
			Ka5	4.6
SVPM3-11*i*	H302	24	Ka1	14.3
			Ka2	5.4
			Ka3	5.0
			Ka4	5.0
			Ka5	4.6

SVPM (total amount of heat dissipation)

Name	Specification	a [W]	Coefficient	
SVPM3-15*i*	H303	24	Ka1	13.1
			Ka2	5.5
			Ka3	4.6
			Ka4	4.6
			Ka5	4.6

AC reactor

Name	Ordering number	Rated output	Total amount of heat dissipation
For SVPM2-5.5*i* For SVPM3-5.5*i*	A81L-0001-0155	5.5 kW	16 W
For SVPM2-11*i* For SVPM3-11*i*		11 kW	38 W
For SVPM2-15*i* For SVPM3-15*i*	A81L-0001-0156	15 kW	50 W

(2) Residual amount of heat in the cabinet

By placing the heat sink section of the SVPM outside the cabinet, the residual amount of heat in the cabinet can be calculated according to the expression below.

Residual amount of heat in the cabinet
= a + Ka1×b1 + Ka2×b2 + Ka3×b3 + Ka4×b4 + Ka5×b5

a : Amount of heat dissipation determined by the SVPM model [W]
Ka1 to Ka5 : Coefficient determined by the SVPM
b1 : Total output of motors connected to the SVPM [kW]
b2 : Current flowing through the spindle motor [Arms]
b3 : Current flowing through the servo motor of L-axis [Arms]
b4 : Current flowing through the servo motor of M-axis [Arms]
b5 : Current flowing through the servo motor of N-axis [Arms]

SVPM (residual amount of heat in the cabinet)

Name	Specification	a [W]	Coefficient	
SVPM2-5.5*i*	H201	22	Ka1	2.1
			Ka2	0.9
			Ka3	0.8
			Ka4	0.8
SVPM2-11*i*	H202	22	Ka1	2.1
			Ka2	0.8
			Ka3	0.8
			Ka4	0.8
SVPM2-15*i*	H203	22	Ka1	1.3
			Ka2	0.6
			Ka3	0.5
			Ka4	0.5
SVPM3-5.5*i*	H301	24	Ka1	2.1
			Ka2	0.9
			Ka3	0.8
			Ka4	0.8
			Ka5	0.7
SVPM3-11*i*	H302	24	Ka1	2.1
			Ka2	0.8
			Ka3	0.8
			Ka4	0.8
			Ka5	0.7
SVPM3-15*i*	H303	24	Ka1	1.3
			Ka2	0.6
			Ka3	0.5
			Ka4	0.5
			Ka5	0.5

7 POWER CABLE FOR SERVO MOTOR AND AMPLIFIER

7.1 SELECTING A POWER CABLE

Select the cable specification by considering the following conditions for use:

<1> Motor current rating or current needed in use on a real machine
<2> Cable type (heat resistance temperature, etc.)
<3> Environment in which the cable is installed (operating ambient temperature, etc.)
<4> Need of water proofing (pay attention to the diameter of the applicable cable clamp)
<5> Certification for CE marking (compliance with various safety standards and EMC standard)
<6> Insulation distance between the cable and terminal is secured at the time of wiring.

Examples of selecting a heavy-duty power cable are shown below. Fully check the cable specifications based on the actual use conditions and use an example below.
The cable diameters are determined based on JCS No. 168 D (1980), "Allowable Currents for Power Cables (1)."

Selection example of power line (reference)

[Selection example 1]

- Heavy-duty power cable specification :
  Maximum allowable conductor temperature 60 °C
- Environment temperature : 30 °C

Cable diameter [mm^2]	Allowable current value [Arms]	Receptacle contact specification
0.75	Less than 11	SS size 1318986-6
1.25	Less than 15	S size 316040-6
2	Less than 19	S size 316040-6
3.5	Less than 27	M size 316041-6
5.5	Less than 35	M size 316041-6
8	Up to 43	L size 1318697-6

[Selection example 2]

- Heavy-duty power cable specification :
  Maximum allowable conductor temperature 80 °C
- Environment temperature : 55 °C

Cable diameter [mm^2]	Allowable current value [Arms]	Receptacle contact specification
0.75	Less than 9.2	SS size 1318986-6
1.25	Less than 12.7	S size 316040-6
2	Less than 16.3	S size 316040-6
3.5	Less than 23.4	M size 316041-6
5.5	Less than 31.2	M size 316041-6
8	Less than 38.3	L size 1318697-6

[Selection example 3]

- Fire-retardant polyflex wire or equivalent to LMFC manufactured by The Furukawa Electric Co., Ltd.: Maximum allowable conductor temperature 105°C
- Environment temperature : 30°C

Cable diameter [mm^2]	Allowable current value [Arms]
0.75	Less than 12
1.25	Less than 16
2	Less than 21
3.5	Less than 32
5.5	Less than 43
8	Less than 55
14	Less than 79
22	Less than 113
30	Less than 137

[Selection example 2]

- Fire-retardant polyflex wire or equivalent to LMFC manufactured by The Furukawa Electric Co., Ltd.: Maximum allowable conductor temperature 105 °C
- Environment temperature : 55 °C

Cable diameter [mm^2]	Allowable current value [Arms]
0.75	Less than 10
1.25	Less than 13
2	Less than 17
3.5	Less than 26
5.5	Less than 35
8	Less than 44
14	Less than 64
22	Less than 92
30	Less than 112
38	Less than 131

7.2 SAMPLE POWER CABLES SELECTED FOR SERVO MOTORS (REFERENCE)

Examples of selections when a heavy-duty power cord is used

Servo motor	Continuous rated current [Arms] (reference value)	Cable diameter [mm^2] when environment temperature 30°C	Cable diameter [mm^2] when environment temperature 55°C
β2/4000*i*s	3.3	0.75	0.75
β4/4000*i*s	4.7	0.75	0.75
β8/3000*i*s	6.0	0.75	0.75
β12/3000*i*s	10.2	0.75	1.25
β22/2000*i*s	11.3	0.75	1.25

7.3 SAMPLE POWER CABLES SELECTED FOR SPINDLE MOTORS (REFERENCE)

Environment temperature : 30°C

SVPM model	Motor model	Applicable cable		Terminal size	
		Heat-resistant 60°C (Note 1)	Heat-resistant 105°C (Note 2)	Amplifier side	Motor side
SVPM-5.5*i*	β3*i*	5.5 mm^2	3.5 mm^2	M5	M5
SVPM-11*i*	β6*i*	8 mm^2	5.5 mm^2	M5	M5
	β8*i*	14 mm^2	5.5mm^2	M5	M5
SVPM-15*i*	β12*i*	14 mm^2	8mm^2	M5	M5

Environment temperature : 55°C

SVPM model	Motor model	Applicable cable		Terminal size	
		Heat-resistant 60°C (Note 1)	Heat-resistant 105°C (Note 2)	Amplifier side	Motor side
SVPM-5.5*i*	β3*i*	5.5 mm^2	3.5 mm^2	M5	M5
SVPM-11*i*	β6*i*	8 mm^2	5.5 mm^2	M5	M5
	β8*i*	14 mm^2	8mm^2	M5	M5
SVPM-15*i*	β12*i*	14 mm^2	8mm^2	M5	M5

NOTE
1 Equivalent to four-conductor polyvinyl heavy-duty power cable (JIS C3312)
2 Fire-retardant polyflex wire or equivalent to LMFC manufactured by The Furukawa Electric Co., Ltd.

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Revision Record

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