FANUC SERVO AMPLIFIER α series

DESCRIPTIONS

B-65162E/03

The export of this product is subject to the authorization of the government of the country from where the product is exported.

In this manual we have tried as much as possible to describe all the various matters.
However, we cannot describe all the matters which must not be done, or which cannot be done, because there are so many possibilities.
Therefore, matters which are not especially described as possible in this manual should be regarded as ''impossible'

FANUC SERVO AMPLIFIER series

SAFETY PRECAUTIONS

This ”Safety Precautions” section describes the precautions which must be observed to ensure safety when using FANUC servo amplifiers. Users of any control motor 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.

Contents

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.**

2 WARNINGS AND CAUTIONS RELATING TO MOUNTING

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 magnetics cabinet.

- **Be aware of the weight of the amplifier and other components.**

  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.

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

- **Never touch the regenerative discharge resistor or radiator directly.**

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

- **Close the amplifier cover after completing the wiring.**

  Leaving the cover open presents a danger of electric shock.

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 corresponding descriptions.

- **Protect the amplifier from impact.**

  Do not place anything on the amplifier.

- **Do not disassemble the amplifier.**

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

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

- **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.

- **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.

CAUTION

- **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.

- **Check that the amplifier is securely mounted in the power magnetics cabinet.**

  If any clearance is left between the power magnetics 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.

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 to allow 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.

3 WARNINGS AND CAUTIONS RELATING TO A PILOT RUN

WARNING

- **Before turning on the power, check that the cables connected to the power magnetics 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 magnetics cabinet is securely grounded.**

- **Before turning on the power, check that the door of the power magnetics cabinet and all other doors are closed.**

  Ensure that the door of the power magnetics 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 magnetics 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 magnetics cabinet (by opening both the input circuit breaker of the power magnetics 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.**

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 magnetics 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 detectors.**

  Following the instructions given in the maintenance manual, adjust the position and speed detectors for the spindle so that an appropriate waveform is obtained. If the detectors 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.

4 WARNINGS AND CAUTIONS RELATING TO MAINTENANCE

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 magnetics 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.

- **Notes on replacing the battery of the absolute pulse coder**

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 α 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 magnetics 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 magnetics cabinet in which the servo amplifier is mounted has a high–voltage section. This section presents a severe risk of electric shock.

WARNING

- **Check the number of any alarm.**

  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.**

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.

● Notes on removing the amplifier

Before removing the amplifier, first ensure that the power is shut off and the DC link charging LED is not lit. Be careful not to jam your fingers between the power magnetics cabinet and amplifier.

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.

Table of Contents

1 GENERAL

This specification describes the configuration, dimensions, combination, and connection of the servo amplifier α series. The servo amplifier α series consists of the modules explained in this chapter.

1.1 POWER SUPPLY MODULE

The power supply module provides the main power supply and control power supply. Select a power supply module according to the capacities of the servo motors and spindle motors being used. A single power supply module can be used to drive both the servo and spindle motors provided the capacity of the power supply module is not exceeded.

There are four types of power supply module, as follows:

(1) Power supply module (PSM)

This power supply module is designed to provide a main power supply of 200V/230V. The module uses power regeneration that returns energy to the power supply during motor deceleration (regeneration).

(2) Power supply module (PSMR)

This power supply module is designed to provide a main power supply of 200V/230V. The module uses resistance regeneration that allows energy to be consumed by resistance during motor deceleration (regeneration).

Regenerative discharge unit

This unit is a resistance used to consume energy during motor deceleration (regeneration). This unit is required whenever the PSMR is used.

(3) Power supply module (PSM–HV)

This power supply module can be connected to a main power supply of 400V/460V without a transformer. The module uses power regeneration that returns energy to the power supply during motor deceleration (regeneration). It is used together with a servo amplifier module (SVM–HV) and spindle amplifier module (SPM–HV) of the 400–V input series.

Capacitor module (PSMC–HV)

This module is designed for DC voltage smoothing. It is required whenever the PSM–HV is used.

(4) Power supply module (PSMV–HV)

This power supply module can be connected to a main power supply of 400V/460V without a transformer. The output voltage is held at 300VDC by a voltage conversion type converter. This unit uses a power regeneration method that returns energy to the power supply during motor deceleration (regeneration). The module is used together with a servo amplifier module (SVM) and spindle amplifier module (SPM) of the 200V input series.

AC reactor unit

This unit is a reactor designed for a PSMV–HV. It contains a fuse.

Naming convention

PSM □–□ □
(1) (2) (3) (4)

(1) Power supply module

(2) Type
None = power regeneration, R = resistance regeneration,
V = voltage conversion type, power regeneration,
C = capacitor module

(3) Motor output

(4) Input voltage
None = 200V, HV = 400V

1.2 SERVO AMPLIFIER MODULE

The servo amplifier module drives a servo motor. Select a servo amplifier module according to the servo motor being used.
There are two types of servo amplifier module, as follows:

(1) Servo amplifier module (SVM)

This module drives a servo motor of the 200–V input series. Modules for one axis, two axes, and three axes are available. As the interface with the CNC, three types of interface are used: Type A, type B, and FSSB.

(2) Servo amplifier module (SVM–HV)

This module drives a servo motor of the 400–V input series. Modules for one axis and two axes are available. As the interface with the CNC, three types of interface are used: Type A, type B, and FSSB.

Check the interface of the CNC being used, and select an appropriate servo amplifier module.

Naming convention

SVM □–□ / □ / □ □
(1) (2) (3) (4) (5) (6)

(1) Servo amplifier module

(2) Number of axes
1 = 1–axis amplifier, 2 = 2–axis amplifier, 3 = 3–axis amplifier

(3) Maximum current for the L–axis

(4) Maximum current for the M–axis

(5) Maximum current for the N–axis

(6) Input voltage
None = 200V, HV = 400V

1.3 SPINDLE AMPLIFIER MODULE

The spindle amplifier module drives a spindle motor. Select a spindle amplifier module according to the spindle motor being used.
There are three types of spindle amplifier module, as follows:

(1) Spindle amplifier module (SPM)

This module drives a spindle motor of the 200–V input series.

(2) Spindle amplifier module (SPMC)

This module drives the αC series spindle motor.

(3) Spindle amplifier module (SPM–HV)

This module drives a spindle motor of the 400V input series.

Naming convention

SPM □–□ □
(1) (2) (3) (4)

(1) Spindle amplifier module

(2) Motor type
None = α series, C = αC series

(3) Rated motor output

(4) Input voltage
None = 200V, HV = 400V

Related manuals

The following six kinds of manuals are available for FANUC SERVO AMPLIFIER α series. In the table, this manual is marked with an asterisk (*).

<table>
<tr><th>Document name</th><th>Document number</th><th>Major contents</th><th>Major usage</th><th></th></tr>
<tr><td>FANUC AC SERVO MOTOR α series DESCRIPTIONS</td><td>B–65142E</td><td>● Specification
● Characteristics
● External dimensions
● Connections</td><td rowspan="2">● Selection of motor
● Connection of motor</td><td></td></tr>
<tr><td>FANUC AC SPINDLE MOTOR α series DESCRIPTIONS</td><td>B–65152E</td><td>● Specification
● Characteristics
● External dimensions
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<tr><td>FANUC SERVO AMPLIFIER α series DESCRIPTIONS</td><td>B–65162E</td><td>● Specifications and functions
● Installation
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● Connections</td><td>● Selection of amplifier
● Connection of amplifier</td><td>*</td></tr>
<tr><td>FANUC SERVO α series MAINTENANCE MANUAL</td><td>B–65165E</td><td>● Start up procedure
● Troubleshooting
● Maintenance of motor</td><td>● Start up the system (Hardware)
● Troubleshooting
● Maintenance of motor</td><td></td></tr>
<tr><td>FANUC AC SERVO MOTOR α series PARAMETER MANUAL</td><td>B–65150E</td><td>● Initial setting
● Setting parameters
● Description of parameters</td><td rowspan="2">● Start up the system (Software)
● Turning the system (Parameters)</td><td></td></tr>
<tr><td>FANUC AC SPINDLE MOTOR α series PARAMETER MANUAL</td><td>B–65160E</td><td>● Initial setting
● Setting parameters
● Description of parameters</td><td></td></tr>
</table>

2 CONFIGURATION AND ORDERING INFORMATION

2.1 CONFIGURATION

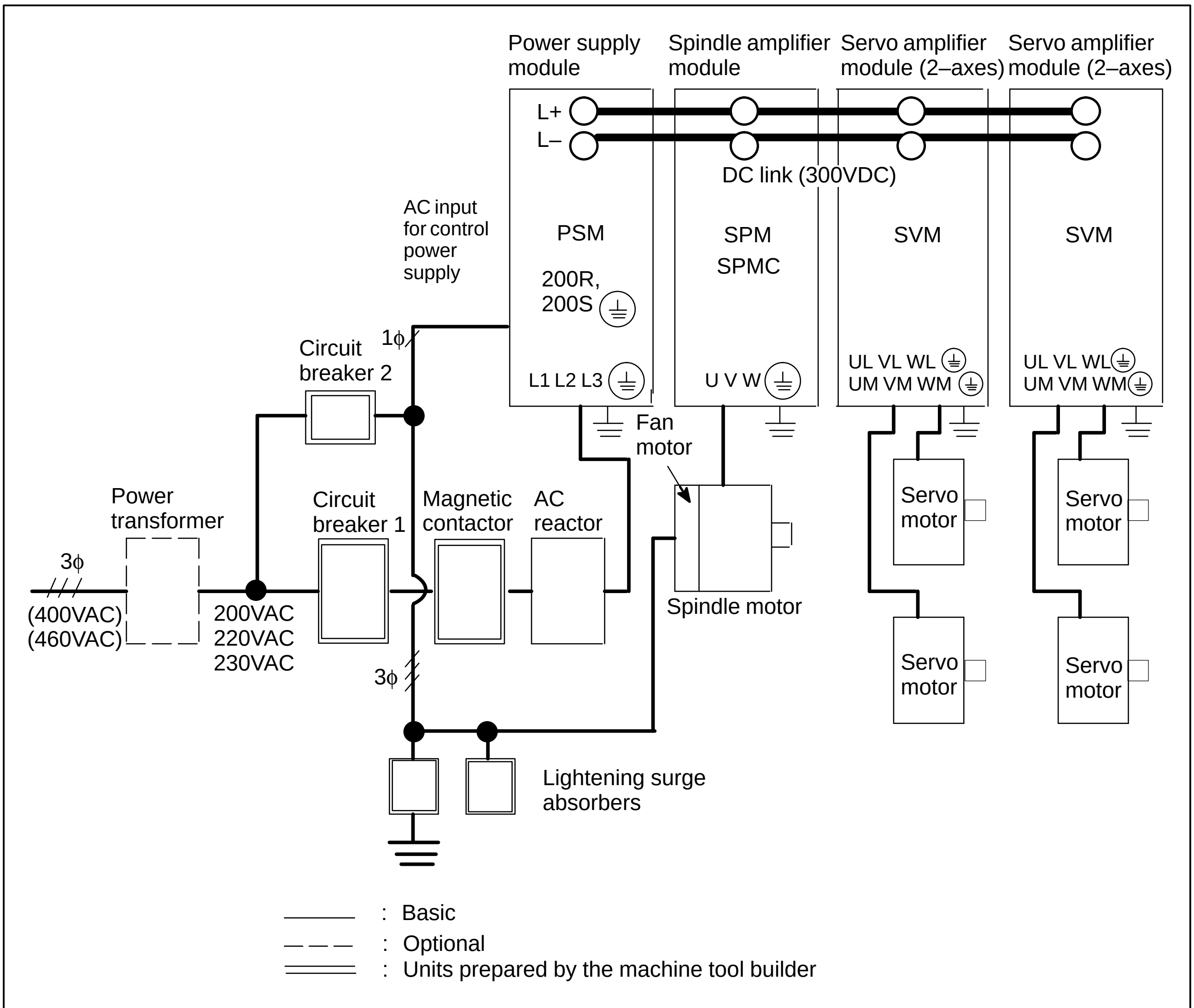
The FANUC series consists of the following units and parts:

2.1.1 200–V Input Series

(1) Power supply module (PSM) (Basic)
(2) Power supply module (register discharge type) (PSMR) (Basic)
(3) Servo amplifier module (SVM) (Basic)
(4) Spindle amplifier module (SPM) (Basic)
(5) Spindle amplifier module (SPMC) (Basic)
(6) AC reactor (Basic)
(7) Connectors (for connection cables) (Basic)
(8) Fuses (Basic)
(9) Power transformer (Optional)
(10) Fan adaptor (Optional)
(11) AC line filter (Basic)
(12) Regenerative discharge unit (Basic)
(13) Dynamic brake module (DBM) (Basic)

(a) Basic configuration using PSM

The basic configuration is shown below.
(Example having two 2–axes servo amplifier modules and a spindle amplifier module)

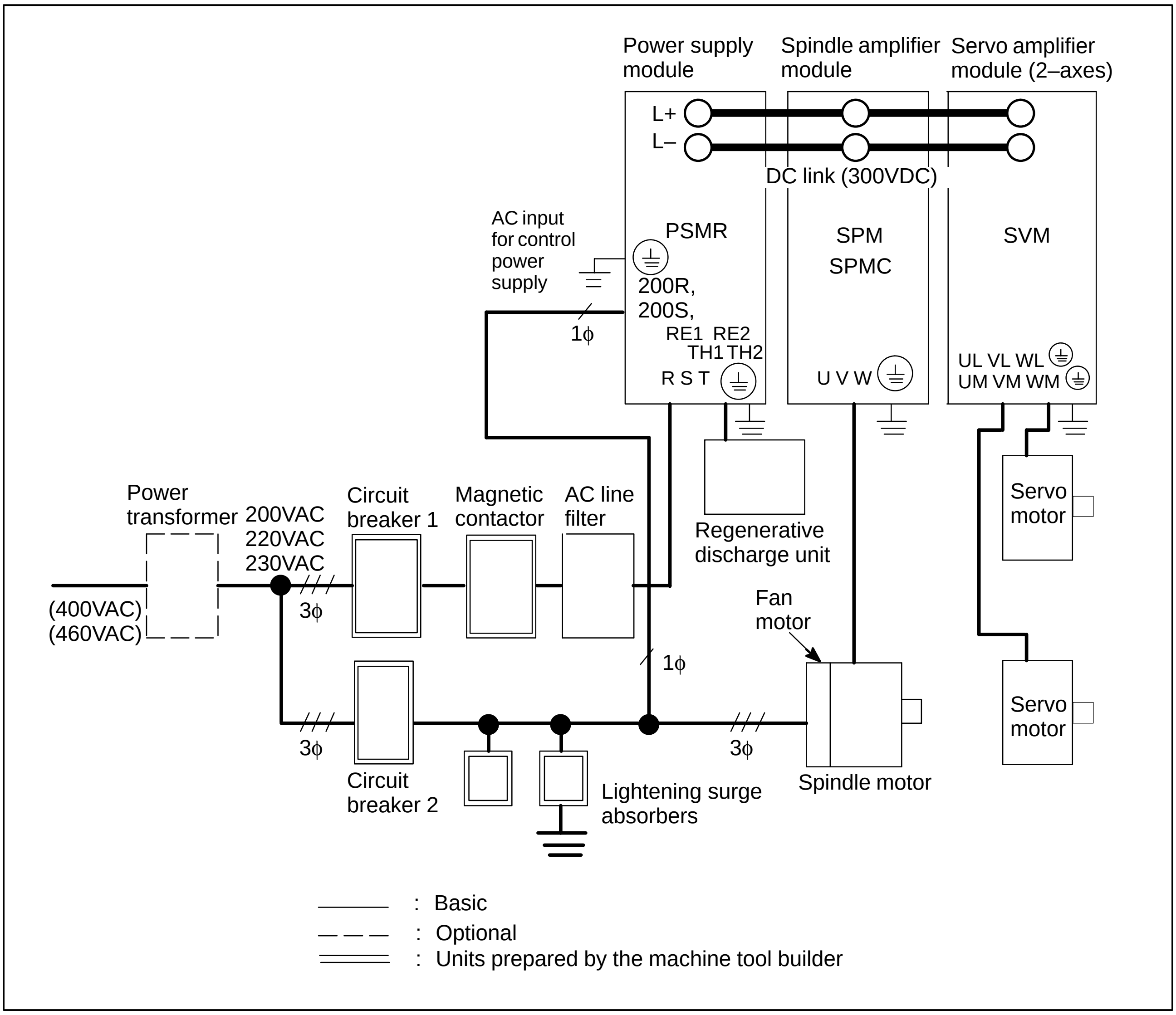


NOTE

1 See Chapter 3 for details of how to combine the power supply module, servo amplifier modules, and spindle amplifier modules.
2 A magnetic contactor, AC reactor, and circuit breakers are always required.
3 To protect the unit from surge currents caused by lightning, connect surge absorbers between lines, and between the lines and ground, at the power inlet of the power magnetics cabinet. See APPENDIX A for details.

(b) Basic configuration using PSMR

(Example hausing one 2–axes servo amplifier modules and a spindle amplifier module)



NOTE

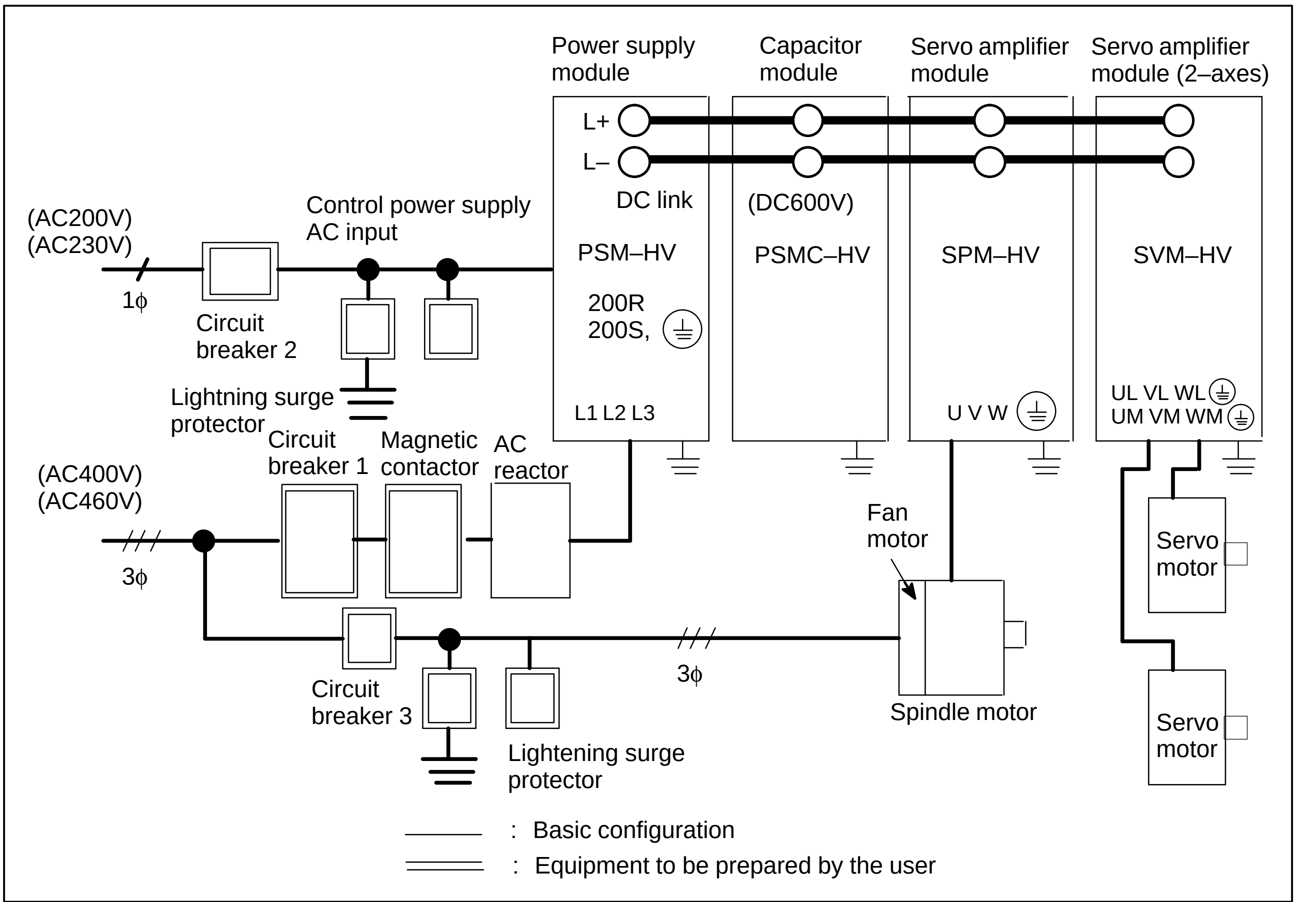
1 See Chapter 3 for details of how to combine the power supply module, servo amplifier modules, and spindle amplifier modules.
2 A magnetic contactor, AC line filter, regenerative discharge unit, and circuit breakers are always required.
3 To protect the unit from surge currents caused by lightning, connect surge absorbers between lines, and between the lines and ground, at the power inlet of the power magnetics cabinet. See APPENDIX A for details.
4 When an insulating transformer is installed, high–frequency noise to the power supply is reduced, so the AC line filter is not required. If the insulating transformer is installed outside the power magnetics cabinet, and the cable connecting the amplifier is exposed, the cable must be covered with a grounded metal duct, or an AC line filter must be installed.

2.1.2
400–V Input Series

(a) Basic configuration using a PSM–HV

(1) Power supply module (PSM–HV) (Basic)
(2) Capacitor module (PSMC–HV) (Basic)
(3) Servo amplifier module (SVM–HV) (Basic)
(4) Spindle amplifier module (SPM–HV) (Basic)
(5) AC reactor (Basic)
(6) Connectors (for cables) (Basic)
(7) Fuses (Basic)
(8) Fan adaptor (Optional)

(The following example uses one 2–axis servo amplifier module and one spindle amplifier module.)



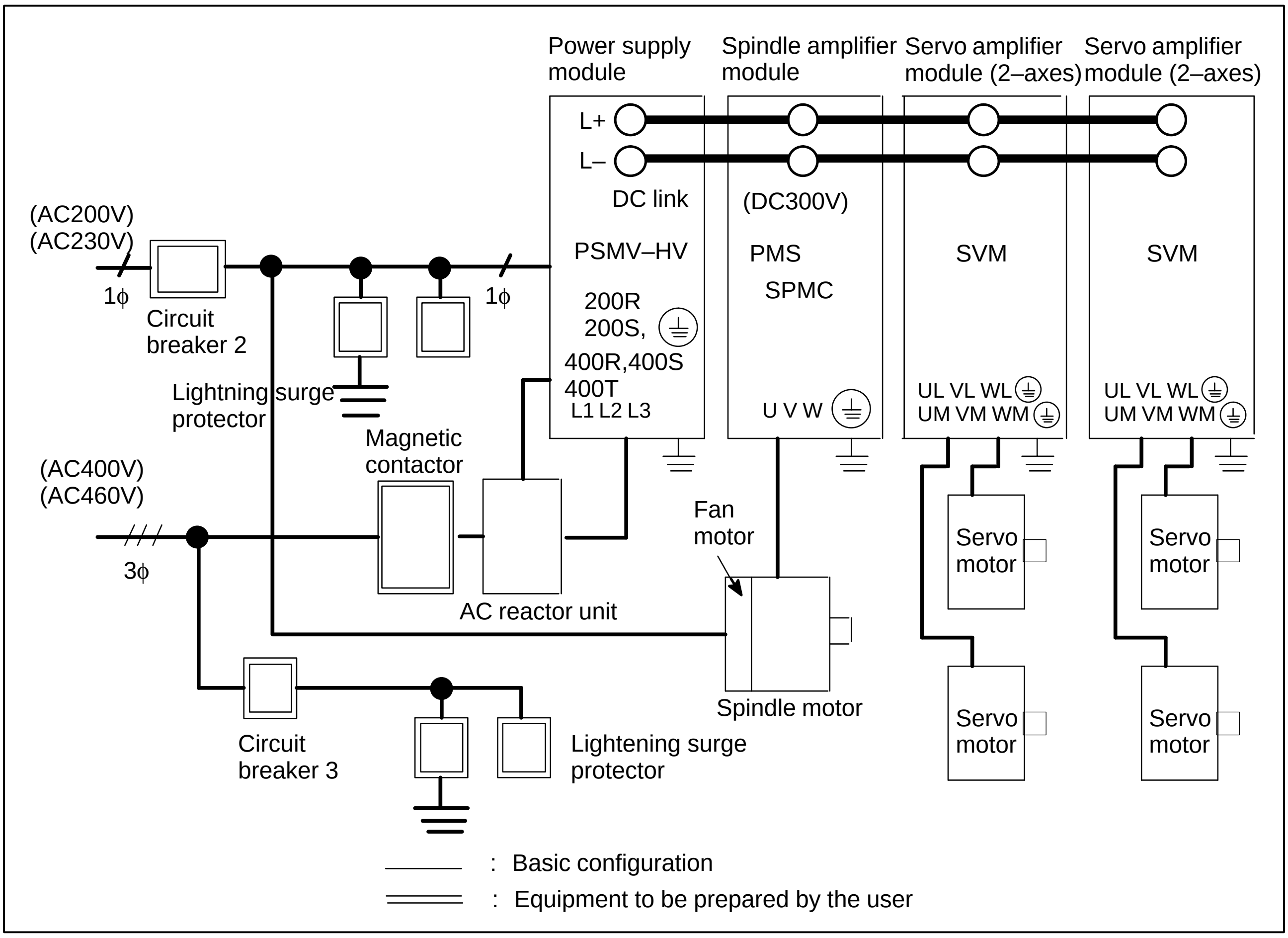
NOTE

1 For the control power supply, single–phase 200VAC is required.
2 Install circuit breakers, a magnetic contactor, and AC reactor.
3 At the power supply inlet of the power magnetics cabinet, install lightning surge protectors between the lines and between a line and ground to protect the equipment from surge voltages caused by lightning. For details, see Appendix A.
4 Note that when PSM–75HV is used, the position of the PSMC–HV differs from the above diagram. For the position of the PSMC–HV, see (5) in Section 5.1.
5 Measures must be taken to detect the operation (trip) of circuit breaker 3.

(b) Basic configuration using a PSMV–HV

(1) Power supply module (PSMV–HV) (Basic)
(2) Servo amplifier module (SVM) (Basic)
(3) Spindle amplifier module (SPM) (Basic)
(4) Spindle amplifier module (SPMC) (Basic)
(5) AC reactor unit (Basic)
(6) Connectors (for cables) (Basic)
(7) Fuses (Basic)
(8) Fan adaptor (Optional)
(9) Dynamic brake module (DBM) (Basic)

(The following example uses two 2–axis servo amplifier modules and one spindle amplifier module.)



NOTE
1 For the control power supply, single–phase 200VAC is required.
2 Install a magnetic contactor and AC reactor. Always connect the magnetic contactor closer to the input power supply than the AC reactor unit.
3 At the power supply inlet of the power magnetics cabinet, install lightning surge protectors between the lines and between a line and ground to protect the equipment from surge voltages caused by lightning. For details, see Appendix A.
4 Measures must be taken to detect the operation (trip) of circuit breaker 3.

2.2 ORDERING INFORMATION

2.2.1 200–V Input Series

(1) Power Supply Module (PSM)

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	PSM–5.5	A06B–6077–H106	380 × 90 × 307	
	PSM–11	A06B–6077–H111	380 × 90 × 307	(Note)
	PSM–15	A06B–6087–H115	380 × 90 × 307	
	PSM–26	A06B–6087–H126		
	PSM–30	A06B–6087–H130		
	PSM–37	A06B–6087–H137		
	PSM–45	A06B–6087–H145	380 × 300 × 307	(Note)

See Section 3.3 for details of how to select the power supply module.

NOTE
PSM–11 and PSM–45 require forced air cooling from the outside. See (7) in Section 2.2.3 and Chapter 7.

(2) Power Supply Module (PSMR)

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	PSMR–3	A06B–6081–H103	380 × 60 × 172	
	PSMR–5.5	A06B–6081–H106	380 × 60 × 307	

When selecting a PSMR, see Section 3.4.

NOTE
For the PSMR, a regenerative discharge unit is required. See (8) in Section 2.2.3, Section 3.4.5, and Section 8.1.7.

(3) Servo Amplifier Module (SVM)

The ordering drawing number differs depending on the interface with the CNC. Specify an appropriate SVM for the interface between the CNC and SVM.

– 1–axis servo amplifier module

(a) TYPE A and TYPE B interface

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SVM1–12	A06B–6079–H101	380 × 60 × 172	
	SVM1–20	A06B–6079–H102		
	SVM1–40S	A06B–6079–H103	380 × 60 × 307	
	SVM1–40L	A06B–6079–H104		
	SVM1–80	A06B–6079–H105		
	SVM1–130	A06B–6079–H106	380 × 90 × 307	(Note 1)
	SVM1–240	A06B–6079–H107	380 × 150 × 307	(Note 2)
	SVM1–360	A06B–6079–H108		(Note 2)
	DBM	A06B–6079–H401	380 × 100 × 172	(Note 2)

(b) FSSB interface

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SVM1–12	A06B–6096–H101	380 × 60 × 172	
	SVM1–20	A06B–6096–H102		
	SVM1–40S	A06B–6096–H103	380 × 60 × 307	
	SVM1–40L	A06B–6096–H104		
	SVM1–80	A06B–6096–H105		
	SVM1–130	A06B–6096–H106	380 × 90 × 307	(Note 1)
	SVM1–240	A06B–6096–H107	380 × 150 × 307	(Note 2)
	SVM1–360	A06B–6096–H108		(Note 2)
	DBM	A06B–6079–H401	380 × 100 × 172	(Note 2)

NOTE

1 For the SVM1–130, forced air cooling may be required depending on the motor used. See (7) in Section 2.2.3 and Chapter 7.

2 A dynamic brake module (DBM) is required whenever the SVM1–240 or SVM1–360 is used. In the event of an emergency stop, for example, the dynamic brake module stops the motor immediately by short–circuiting the power line of the motor without PWM control. SVMs other than SVM1–240 and SVM1–360 have the dynamic brake function built in.

– 2–axis servo amplifier module

(a) TYPE A and TYPE B interface

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SVM2–12/12	A06B–6079–H201	380 × 60 × 172	
	SVM2–12/20	A06B–6079–H202		
	SVM2–20/20	A06B–6079–H203		
	SVM2–12/40	A06B–6079–H204	380 × 60 × 307	
	SVM2–20/40	A06B–6079–H205		
	SVM2–40/40	A06B–6079–H206		
	SVM2–40/80	A06B–6079–H207	380 × 90 × 307	
	SVM2–80/80	A06B–6079–H208		
	SVM2–40L/40L	A06B–6079–H209		

(b) FSSB interface

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SVM2–12/12	A06B–6096–H201	380 × 60 × 172	
	SVM2–12/20	A06B–6096–H202		
	SVM2–20/20	A06B–6096–H203		
	SVM2–12/40	A06B–6096–H204	380 × 60 × 307	
	SVM2–20/40	A06B–6096–H205		
	SVM2–40/40	A06B–6096–H206		
	SVM2–40/80	A06B–6096–H207	380 × 90 × 307	
	SVM2–80/80	A06B–6096–H208		
	SVM2–40L/40L	A06B–6096–H209		

– 3–axis servo amplifier module

(a) TYPE A interface

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SVM3–12/12/12	A06B–6079–H301	380 × 60 × 172	
	SVM3–12/12/20	A06B–6079–H302		
	SVM3–12/20/20	A06B–6079–H303		
	SVM3–20/20/20	A06B–6079–H304		
	SVM3–12/12/40	A06B–6079–H305	380 × 60 × 307	
	SVM3–12/20/40	A06B–6079–H306		
	SVM3–20/20/40	A06B–6079–H307		

(b) TYPE B interface

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SVM3–12/12/12	A06B–6080–H301	380 × 90 × 172	
	SVM3–12/12/20	A06B–6080–H302		
	SVM3–12/20/20	A06B–6080–H303		
	SVM3–20/20/20	A06B–6080–H304		
	SVM3–12/12/40	A06B–6080–H305	380 × 90 × 307	
	SVM3–12/20/40	A06B–6080–H306		
	SVM3–20/20/40	A06B–6080–H307		

(c) FSSB interface

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SVM3–12/12/12	A06B–6096–H301	380 × 90 × 172	
	SVM3–12/12/20	A06B–6096–H302		
	SVM3–12/20/20	A06B–6096–H303		
	SVM3–20/20/20	A06B–6096–H304		
	SVM3–12/12/40	A06B–6096–H305	380 × 90 × 307	
	SVM3–12/20/40	A06B–6096–H306		
	SVM3–20/20/40	A06B–6096–H307		

(4) Spindle Amplifier Module (SPM)
Ordering numbers depend on the detectors being used (function).

(a) Type 1 (standard specifications)
Detectors used
1. M sensor, position coder, magnetic sensor (for orientation)
2. MZ sensor, BZ sensor (built–in motor)

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SPM–2.2	A06B–6078–H202#H500	380 × 60 × 307	
	SPM–5.5	A06B–6078–H206#H500	380 × 90 × 307	
	SPM–11	A06B–6078–H211#H500	380 × 90 × 307	(Note)
	SPM–15	A06B–6088–H215#H500	380 × 150 × 307	
	SPM–22	A06B–6088–H222#H500		
	SPM–26	A06B–6088–H226#H500		
	SPM–30	A06B–6088–H230#H500		
	SPM–45	A06B–6088–H245#H500	380 × 300 × 307	(Note)

(b) Type 2 (specifications for Cs–axis contouring control or BZ (spindle) sensor)
Applicable detectors :
1. M sensor + BZ sensor (using position coder signals only)
2. High–resolution magnetic pulse coder (for motors only)
3. High–resolution magnetic pulse coder (for motors and spindles)
4. High–resolution position coder + high–resolution magnetic pulse coder (for motors only)

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SPM–2.2	A06B–6078–H302#H500	380 × 60 × 307	
	SPM–5.5	A06B–6078–H306#H500	380 × 90 × 307	
	SPM–11	A06B–6078–H311#H500	380 × 90 × 307	(Note)
	SPM–15	A06B–6088–H315#H500	380 × 150 × 307	
	SPM–22	A06B–6088–H322#H500		
	SPM–26	A06B–6088–H326#H500		
	SPM–30	A06B–6088–H330#H500		
	SPM–45	A06B–6088–H345#H500	380 × 300 × 307	(Note)

(c) Type 3 (specifications for spindle switching control or differential speed control)
Applicable detectors :

1. Spindle switching control
(switching the speed only, or switching both the speed and position)
2. Differential speed control (input circuit for position coder signals)

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SPM–11	A06B–6078–H411#H500	380 × 150 × 307	
	SPM–15	A06B–6078–H415#H500		
	SPM–22	A06B–6078–H422#H500		
	SPM–26	A06B–6078–H426#H500		
	SPM–30	A06B–6078–H430#H500		
	SPM–45	A06B–6088–H445#H500	380 × 300 × 307	(Note)

(d) Type 4 (high–resolution internal circuit incorporation specification)
Function used
1. α spindle sensor Cs contour control

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SPM–2.2	A06B–6078–H102#H500	380 × 60 × 307	
	SPM–5.5	A06B–6078–H106#H500	380 × 90 × 307	
	SPM–11	A06B–6078–H111#H500		(Note)
	SPM–15	A06B–6088–H115#H500	380 × 150 × 307	
	SPM–22	A06B–6088–H122#H500		
	SPM–26	A06B–6088–H126#H500		
	SPM–30	A06B–6088–H130#H500		
	SPM–45	A06B–6088–H145#H500	380 × 300 × 307	(Note)

NOTE
SPM–11 (except type 3) and SPM–45 require forced air cooling from the outside. See (7) in Section 2.2.3 and Chapter 7.

(5) αC series Spindle Amplifier Module (SPMC)

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SPMC–2.2	A06B–6082–H202#H512	380 × 60 × 307	
	SPMC–5.5	A06B–6082–H206#H512	380 × 90 × 307	
	SPMC–11	A06B–6082–H211#H512		(Note)
	SPMC–15	A06B–6082–H215#H512	380 × 150 × 307	
	SPMC–22	A06B–6082–H222#H512		
	SPMC–26	A06B–6082–H226#H512		

NOTE
SPMC–11 requires forced air cooling from the outside. See (7) in Section 2.2.3 and Chapter 7.

2.2.2 400–V Input Series

(1) Power supply module (PSM–HV)

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	PSM–18HV	A06B–6091–H118	380 × 150 × 307	(Note 1)
	PSM–30HV	A06B–6091–H130		(Note 1)
	PSM–45HV	A06B–6091–H145		(Note 1)
	PSM–75HV	A06B–6091–H175	380 × 300 × 307	(Note 1, 2)

For how to select a PSM, see Section 3.5.

NOTE
1 The PSM–HV requires a capacitor module (PSMC–HV). Specify an appropriate capacitor module for the PSM–HV being used, according to (2) in Section 2.2.2.
2 The PSM–75HV requires forced air cooling from the outside. See (7) in Section 2.2.3 and Chapter 7.

(2) Capacitor module (PSMC–HV)
When using a PSM–HV, specify a capacitor module (PSMC–HV).

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	PSMC–18HV	A06B–6083–H218	380 × 90 × 172	For PSM–18HV
	PSMC–30HV	A06B–6083–H230		For PSM–30HV
	PSMC–45HV	A06B–6083–H245	380 × 150 × 222	For PSM–45HV and PSM–75HV

(3) Power supply module (PSMV–HV)

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	PSMV–11HV	A06B–6098–H111	380 × 150 × 307	

NOTE
No capacitor module (PSMC–HV) is required.

(4) Servo amplifier module (SVM–HV)
The ordering drawing number differs depending on the interface with the CNC.
Specify an appropriate SVM–HV for the interface between the CNC and SVM–HV.

– Servo amplifier module (one axis)

(a) TYPE A and TYPE B interfaces

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SVM1–20HV	A06B–6085–H102	380 × 90 × 307	
	SVM1–40HV	A06B–6085–H103		
	SVM1–60HV	A06B–6085–H104		

(b) FSSB interface

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SVM1–20HV	A06B–6097–H102	380 × 90 × 307	
	SVM1–40HV	A06B–6097–H103		
	SVM1–60HV	A06B–6097–H104		

– Servo amplifier module (two axes)

(a) TYPE A and TYPE B interfaces

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SVM2–20/20HV	A06B–6085–H201	380 × 90 × 307	
	SVM2–20/40HV	A06B–6085–H202		
	SVM2–20/60HV	A06B–6085–H203		
	SVM2–40/40HV	A06B–6085–H204		
	SVM2–40/60HV	A06B–6085–H205		
	SVM2–60/60HV	A06B–6085–H206		

(b) FSSB interface

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SVM2–20/20HV	A06B–6097–H201	380 × 90 × 307	
	SVM2–20/40HV	A06B–6097–H202		
	SVM2–20/60HV	A06B–6097–H203		
	SVM2–40/40HV	A06B–6097–H204		
	SVM2–40/60HV	A06B–6097–H205		
	SVM2–60/60HV	A06B–6097–H206		

(5) Spindle amplifier module (SPM–HV)
The ordering drawing number differs depending on the detector (function) being used.

(a) Type 1 (standard specification)
Detectors used
1 M sensor, position coder, magnetic sensor (for orientation)
2 MZ sensor, BZ sensor (built–in motor)

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SPM–11HV	A06B–6092–H211#H500	380 × 90 × 307	(Note)
	SPM–15HV	A06B–6092–H215#H500	380 × 150 × 307	
	SPM–26HV	A06B–6092–H226#H500		
	SPM–45HV	A06B–6092–H245#H500		
	SPM–75HV	A06B–6092–H275#H500	380 × 300 × 307	(Note)

(b) Type 2 (Cs contour control/BZ sensor (spindle) specification)

Detectors used

1. M sensor (motor) + BZ sensor (spindle) (using position coder signals only)
2. High–resolution magnetic pulse coder (motor only)
3. High–resolution magnetic pulse coder (motor and spindle)
4. High–resolution position coder (spindle) + high–resolution magnetic pulse coder (motor)

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SPM–11HV	A06B–6092–H311#H500	380 × 90 × 307	(Note)
	SPM–15HV	A06B–6092–H315#H500	380 × 150 × 307	
	SPM–26HV	A06B–6092–H326#H500		
	SPM–45HV	A06B–6092–H345#H500		
	SPM–75HV	A06B–6092–H375#H500	380 × 300 × 307	(Note)

(c) Type 3 (spindle switch control/differential speed control specification)

Functions used

1. Spindle switch control (switches between speeds only or between speeds and positions)
2. Differential speed control (position coder signal input circuit)

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SPM–75HV	A06B–6092–H475#H500	380 × 300 × 307	(Note)

(d) Type 4 (high–resolution internal circuit incorporation specification)

Function used

1. α spindle sensor Cs contour control

Category	Name	Ordering number	External dimensions (H x W x D mm)	Remarks
Standard	SPM–11HV	A06B–6092–H111#H500	380 × 90 × 307	(Note)
	SPM–15HV	A06B–6092–H115#H500	380 × 150 × 307	
	SPM–26HV	A06B–6092–H126#H500		
	SPM–45HV	A06B–6092–H145#H500		
	SPM–75HV	A06B–6092–H175#H500	380 × 300 × 307	

NOTE

SPM–11HV and SPM–75HV require forced air cooling from the outside. See (7) in Section 2.2.3 and Chapter 7.

2.2.3 Others

(1) AC reactor

Category	Name	Ordering number	Remarks
Standard	For PSM–5.5 or PSM–11	A81L–0001–0122	
	For PSM–15	A81L–0001–0123	
	For PSM–26	A81L–0001–0120	
	For PSM–30	A81L–0001–0124	
	PSM–45, 75HV	A81L–0001–0133	
	PSM–18HV, 30HV, 45HV	A81L–0001–0127	

For the dimensions of the AC reactors, see Section 8.1.3.

(2) AC reactor unit

Category	Name	Ordering number	Remarks
Standard	PSMV–11HV	A06B–6098–H001	

For the dimensions of the AC reactor unit, see Section 8.1.2.

(3) AC line filter

Category	Name	Ordering number	Remarks
Standard	For PSMR–3	A81L–0001–0083#3C	
	For PSMR–5.5	A81L–0001–0101#C	

For the dimensions of the AC line filters, see Section 8.1.4.

(4) Connectors

The ordering drawing number of the connectors required for connection of input/output signals of each module, and the configuration of each connector, are shown below. For the connector dimensions, see Appendix D.

– For power supply module (PSM, PSMR)

Category	Name	Ordering number	Remarks
Standard	CX1A, CX3, CX4	A06B–6071–K203	For PSM, PSMR

– Connectors for the power supply module (PSMV)

Category	Name	Ordering number	Remarks
Standard	CX1A, CX3, CX4, CX10	A06B–6098–K200	For PSMV

– For servo amplifier module (SVM)

Category	Name		Ordering number	Remarks
Standard	Connectors	Between PSM and SVM or between SVMs	A06B–6073–K210	Solder type
			A06B–6073–K211	Crimp type
		Between PSM–SVM, SVM–SVM (for SVM1–240 and SVM1–360)	A06B–6078–K210	Crimp type
			A06B–6078–K211	Solder type
		Between NC to SVM	A06B–6073–K212	Solder type
			A06B–6073–K213	Crimp type
		For pulse coder	A06B–6073–K214	Solder type
		Between SVM–DBM (for SVM1–240 and SVM1–360)	A06B–6073–K216	

– For spindle amplifier module (For SPM)

Category	Name		Ordering number	Remarks
Standard	Connectors	Between PSM and SPM or between SPMs	A06B–6078–K210	Crimp type
			A06B–6078–K211	Solder type
		For M sensor or MZ sensor or BZ sensor	A06B–6078–K212	Solder type
		Between NC and SPM For load meter or speed meter	A06B–6078–K213	Crimp type
			A06B–6078–K214	Solder type
		For position coder or magnetic sensor	A06B–6078–K215	Solder type

– For spindle amplifier module (For SPMC)

Category	Name		Ordering number	Remarks
Standard	Connectors	Between PSM and SPMC or between SPM and SPMC	A06B–6073–K210	Solder type
			A06B–6073–K211	Crimp type
		Between PSM–SPMC, SPM–SPMC (for SPMC–15, 22, 26)	A06B–6078–K210	Crimp type
			A06B–6078–K211	Solder type
		For connecting speed meter and thermostat	A06B–6078–K212	Solder type
		Between NC and SPMC	A06B–6078–K213	Crimp type
			A06B–6078–K214	Solder type
		For position coder	A06B–6078–K215	Solder type

NOTE

1 Connectors are classified into either the press–mount type or solder type, depending on the method used for attaching a cable to a connector. When a connector is specified, therefore, care is necessary.

2 When attaching a cable to a press–mount type connector, use the special tools prepared by the manufacturer of the connector. For the tool specifications, see "Connection tools" described later.

– Connector configuration

Configuration of A06B–6071–K203

Connector name	Manufacturer	Part number	Quantity	Use	Dimensions
CX1A	AMP Japan, Ltd.	1–178128–3 (housing)	1	For control, single–phase 200VAC input	D (1)
		1–175218–2 (contact)	3		D (5)
CX4	AMP Japan, Ltd.	1–178128–3 (housing)	1	For emergency stop signal	D (1)
		1–175218–2 (contact)	2		D (5)
CX3	AMP Japan, Ltd.	2–178128–3 (housing)	1	For ON/OFF control for external MCC	D (2)
		1–175218–2 (contact)	2		D (5)

Configuration of A06B–6073–K210 (solder type)

Connector name	Manufacturer	Part number	Quantity	Use	Dimensions
CX2A CX2B	AMP Japan, Ltd.	1–178288–3 (housing)	2	For control, 24VDC input	D (3)
		1–175218–2 (contact)	6		D (5)
JX1A JX1B	Honda Tsushin Kogyo Co., Ltd.	PCR–E20FS (connector)	2	For PSM–SVM and SVM–SVM communication	D (7)
		PCR–V20LA (case)	2		D (10)

Configuration of A06B–6073–K211 (press–mount type)

Connector name	Manufacturer	Part number	Quantity	Use	Dimensions
CX2A CX2B	AMP Japan, Ltd.	1–178288–3 (housing)	2	For control, 24VDC input	D (3)
		1–175218–2 (contact)	6		D (5)
JX1A JX1B	Honda Tsushin Kogyo Co., Ltd.	PCR–E20FA (connector)	2	For PSM–SVM and SVM–SVM communication	D (6)
		PCR–V20LA (case)	2		D (10)

Configuration of A06B–6073–K212 (solder type)

Connector name	Manufacturer	Part number	Quantity	Use	Dimensions
JV□A (*1) JS□B (*2)	Honda Tsushin Kogyo Co., Ltd.	PCR–E20FS (connector)	1	For CNC–SVM communication	D (7)
		PCR–V20LA (case)	1		D (10)

Configuration of A06B–6073–K213 (press–mount type)

Connector name	Manufacturer	Part number	Quantity	Use	Dimensions
JV□A (*1)	Honda Tsushin Kogyo Co., Ltd.	PCR–E20FA (connector)	1	For CNC–SVM communication	D (6)
JS□B (*2)		PCR–V20LA (case)	1		D (10)

Configuration of A06B–6073–K214 (solder type)

Connector name	Manufacturer	Part number	Quantity	Use	Dimensions
JF□B (*2)	Hirose Electric Co., Ltd.	FI40–2015S (connector)	1	For pulse coder	D (8)
		FI–20–CV (case)	1		D (11)

NOTE
1 Type A interface
2 Type B interface

Configuration of A06B–6073–K215

Connector name	Manufacturer	Part number	Quantity	Use	Dimensions
CX8	AMP Japan, Ltd.	2–178128–3 (housing)	1	For DB interlock signals	D (2)
		1–175218–2 (contact)	2		D (5)
CX9	AMP Japan, Ltd.	1–178128–3 (housing)	1	For DB driving coil	D (1)
		1–175218–2 (contact)	2		D (5)

Configuration of A06B–6078–K210 (press–mount type)

Connector name	Manufacturer	Part number	Quantity	Use	Dimensions
CX1A	AMP Japan, Ltd.	1–178128–3 (housing)	2	For fan motor, 200VAC input	D (1)
CX1B		1–175218–2 (contact)	4		D (5)
CX2A	AMP Japan, Ltd.	1–178288–3 (housing)	2	For control, 24VDC input	D (3)
CX2B		1–175218–2 (contact)	6		D (5)
JX1A	Honda Tsushin Kogyo Co., Ltd.	PCR–E20FA (connector)	2	For PSM–SPM and SPM–SPM communication	D (6)
JX1B		PCR–V20LA (case)	2		D (10)

Configuration of A06B–6078–K211 (solder type)

Connector name	Manufacturer	Part number	Quantity	Use	Dimensions
CX1A	AMP Japan, Ltd.	1–178128–3 (housing)	2	For fan motor, 200VAC input	D (1)
CX1B		1–175218–2 (contact)	4		D (5)
CX2A	AMP Japan, Ltd.	1–178288–3 (housing)	2	For control, 24VDC input	D (3)
CX2B		1–175218–2 (contact)	6		D (5)
JX1A	Honda Tsushin Kogyo Co., Ltd.	PCR–E20FS (connector)	2	For PSM–SPM and SPM–SPM communication	D (7)
JX1B		PCR–V20LA (case)	2		D (10)

Configuration of A06B–6078–K212 (solder type)

Connector name	Manufacturer	Part number	Quantity	Use	Dimensions
JY2, JY4 JY5, JY6 αC series JY1	Hirose Electric Co., Ltd.	FI40B–20S (connector)	1	See below.	D (9)
		FI–20–CV5 (case)	1		D (12)

Use: For the M sensor, MZ sensor, BZ sensor, high–resolution position coder, or high–resolution magnetic pulse coder
α C series: For the speed meter, analog override, or motor overheat

Configuration of A06B–6078–K213 (press–mount type)

Connector name	Manufacturer	Part number	Quantity	Use	Dimensions
JA7B	Honda Tsushin Kogyo Co., Ltd.	PCR–E20FA (connector)	1	For CNC–SPM and CNC–SPMC communication	D (6)
		PCR–V20LA (case)	1		D (10)

Configuration of A06B–6078–K214 (solder type)

Connector name	Manufacturer	Part number	Quantity	Use	Dimensions
JA7B	Honda Tsushin Kogyo Co., Ltd.	PCR–E20FS (connector)	1	See below.	D (7)
JY1		PCR–V20LA (case)	1		D (10)

Use JY7B: For CNC–SPM and CNC–SPMC communication
JY1: For the load meter and speed meter (except SPMC)

Configuration of A06B–6078–K215 (solder type)

Connector name	Manufacturer	Part number	Quantity	Use	Dimensions
JY3	Hirose Electric Co., Ltd.	FI40B–2015S (connector)	1	See below.	D (8)
JY4		FI–20–CV(10) (case)	1		D (11)

Use JY3: For the magnetic sensor and proximity switch
JY4: For the position coder

Configuration of A06B–6098–K200

Connector name	Manufacturer	Part number	Quantity	Use	Dimensions
CX1A	AMP Japan, Ltd.	1–178128–3 (housing)	1	For control, single–phase 200VAC input	D (1)
		1–175218–2 (contact)	3		D (5)
CX4	AMP Japan, Ltd.	1–178128–3 (housing)	1	For emergency stop signal	D (1)
		1–175218–2 (contact)	2		D (5)
CX3	AMP Japan, Ltd.	2–178128–3 (housing)	1	For ON/OFF control for external MCC	D (2)
		1–175218–2 (contact)	2		D (5)
CX10	AMP Japan, Ltd.	2–178129–6 (housing)	1	For phase detection, 400VAC input	D (4)
		1–175218–2 (contact)	3		D (5)

– Connection tools

Manufacturers of press–mount type connectors provide special tools for attaching the connectors to cables.

(a) Connectors manufactured by AMP Japan, Ltd.

Name	Manufacturer part number
Contact crimping tool	914596–3
Contact extractor	914677–1

(b) Connectors manufactured by Honda Tsushin Kogyo Co., Ltd. (press–mount type connectors only)

Name	Manufacturer part number
Wire placement cassette	JGPS–015–1/1–20
Wire placement cassette mounting base	JGPS–014
Press–mount locator	PCS–K1
Hand press	MFC–K1

(5) Fuses

Fuses are specified as spare parts of the fuses used in modules. The ordering drawing number of the fuses required for each module and the fuse configuration are shown below.

– For power supply module

Category	Name	Ordering number	Remarks
Standard	PSM	A06B–6077–K250	5A/250V, 2A/250V
	PSMR	A06B–6081–K250	5A/250V
	PSMV	A06B–6098–K250	5A/250V, 2A/250V, 100A/600V

– For servo amplifier module

Category	Name	Ordering number	Remarks
Standard	Other than SVM1–240, 360	A06B–6073–K250	3.2A/48V
	SVM1–240, 360	A06B–6073–K252	3.2A/48V,0.5A/250V

– Fuse configuration

Configuration of A06B–6073–K250

Manufacturer	Part number	Specification	Use
Daito Communication Apparatus Co., Ltd.	LM32C	3.2A/48V	For short–circuit protection of 24–VDC control power supply

Configuration of A06B–6073–K252

Manufacturer	Part number	Specification	Use
Daito Communication Apparatus Co., Ltd.	LM32C	3.2A/48V	For short–circuit protection of 24–VDC control power supply
Daito Communication Apparatus Co., Ltd.	HM05	0.5A/250V	For short–circuit protection of 200VAC for cooling fan

Configuration of A06B–6077–K250

Manufacturer	Part number	Specification	Use
Daito Communication Apparatus Co., Ltd.	HM20	2A/250V	For short–circuit protection of 200VAC for cooling fan
Daito Communication Apparatus Co., Ltd.	HM50	5A/250V	For short–circuit protection of 200–VAC control power supply

Configuration of A06B–6081–K250

Manufacturer	Part number	Specification	Use
Daito Communication Apparatus Co., Ltd.	HM50	5A/250V	For short–circuit protection of 200–VAC control power supply

Configuration of A06B–6098–K250

Manufacturer	Part number	Specification	Use
Daito Communication Apparatus Co., Ltd.	HM20	2A/250V	For short–circuit protection of 200VAC for cooling fan
Daito Communication Apparatus Co., Ltd.	HM50	5A/250V	For short–circuit protection of 200–VAC control power supply
Fuji Electric Co., Ltd.	CR6L–100UL	100A/600V	For short–circuit protection of 400–VAC main circuit (Note)

NOTE

For the AC reactor unit

(6) Power transformer

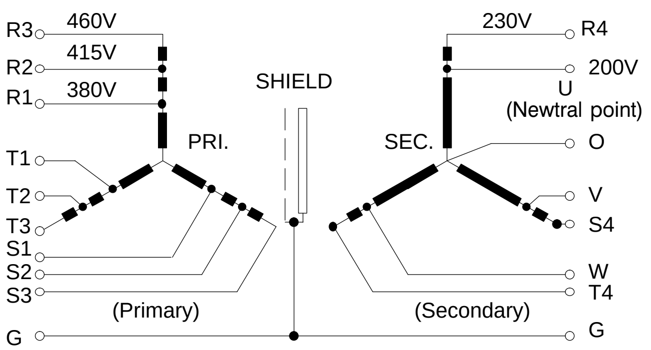
When a power supply module of the 200–V input series is used in an area where the input voltage is not within the range of 200 to 230VAC, a power transformer is required. The ordering drawing numbers and specifications of power transformers manufactured by FANUC are listed below.
When other than a FANUC power transformers is to be prepared by the user, it must satisfy the transformer specifications indicated in (1) of Section 5.2.1.

– Ordering drawing numbers of power transformers manufactured by FANUC

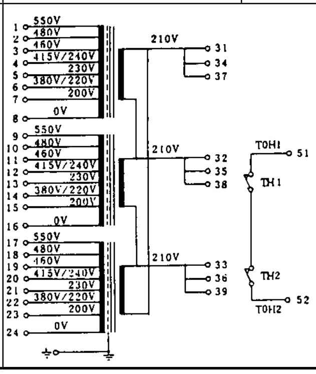
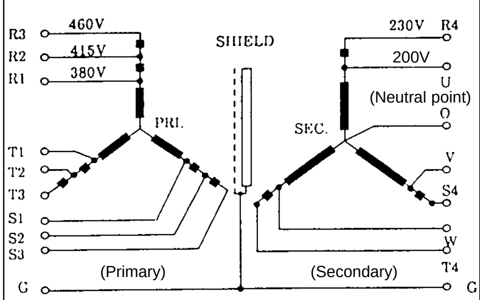
<table>
<tr><th>Category</th><th colspan="2">Name</th><th>Ordering number</th><th>Remarks</th></tr>
<tr><td rowspan="7">Optional</td><td rowspan="7">Power transformer
Power transformer</td><td>For PSMR–3
(at 2kw output)</td><td>A80L–0024–0006</td><td rowspan="7">Primary 380/415/460VAC
Secondary 200VAC
Primary 380/415/460VAC
Secondary 200VAC</td></tr>
<tr><td>For PSMR–3
(at 3kw output)</td><td>A80L–0026–0003</td></tr>
<tr><td>For PSM–5.5
For PSMR–5.5
(at 5.5kw output)</td><td>A06B–6052–J001</td></tr>
<tr><td>For PSM–11
For PSMR–5.5
(at 7.5kw output)</td><td>A06B–6044–J006</td></tr>
<tr><td>For PSM–15</td><td>A06B–6044–J007</td></tr>
<tr><td>For PSM–26, 30</td><td>A06B–6044–J010</td></tr>
<tr><td>For PSM–37, 45</td><td>A06B–6044–J015</td></tr>
</table>

– Specifications of power transformers manufactured by FANUC

Power transformers for PSM

Item \ Model	PSM–5.5	PSM–11	PSM–15	PSM–26, 30	PSM–37, 45
Ordering drawing number	A06B–6052–J001	A06B–6044–J006	A06B–6044–J007	A06B–6044–J010	A06B–6044–J015
FANUC drawing number	A80L–0001–0496	A80L–0001–0313	A80L–0001–0314	A80L–0001–0352	A80L–0001–0452
Rated capacity	10kVA	20kVA	30kVA	45kVA	64kVA
Rated primary voltage	380/415/460VAC 230VAC (The secondary is used as an autotransformer.) +10% –15%, 50/60 ± 1Hz, 3Φ				
Rated primary current	15A (at 380V) 14A (at 415V) 13A (at 460V)	30A (at 380V) 28A (at 415V) 25A (at 460V)	46A (at 380V) 42A (at 415V) 38A (at 460V)	68A (at 380V) 63A (at 415V) 56A (at 460V)	97A (at 380V) 89A (at 415V) 80A (at 460V)
Rated secondary voltage	AC200V				
Rated secondary current	29A	58A	87A	130A	185A
Voltage regulation at the secondary	5%				
Voltage deviation at the secondary	± 3%				
Connection	Y–Y connection				
Insulation	Class H (maximum allowable temperature: 180°C)				
Ambient temperature	0 to 45°C				
Allowable temperature rise	135deg				
Relative humidity	Max. 95%RH				
Type	Dry type, natural air cooling type				
Dielectric withstand voltage	2000VAC, for 1 minute				
Weight	Max. 61kg	Max. 115kg	Max. 165kg	Max. 260kg	Max. 375kg
Outline drawing	Fig. 8.1.5 (a)	Fig. 8.1.5 (b)	Fig. 8.1.5 (c)	Fig. 8.1.5 (d)	Fig. 8.1.5 (f)
Connection diagram					

Power transformer for PSMR

Item \ Model	PSMR–3 (at 2 kW output)	PSMR–3 (at 3 kW output)	PSMR–5.5 (at 5 kW output)	PSMR–5.5 (at 7.5 kW output)
Ordering drawing number	A80L–0024–0006	A80L–0026–0003	A06B–6052–J001	A06B–6044–J006
FANUC drawing number	A80L–0024–0006	A80L–0026–0003	A80L–0001–0496	A80L–0001–0313
Rated capacity	3.5kVA	5kVA	10kVA	20kVA
Rated primary voltage	200/220/230/240VAC, Δ connection 380/415/460/480/550VAC, Y connection ±15%, 50/60Hz±2Hz; 3Φ		380/415/460VAC 230VAC (The secondary is used as an auto-transformer.) +10% –15%, 50/60±1Hz, 3Φ	
Rated primary current	5.3A (at 380V)	7.6A (at 380V)	15A (at 380V) 14A (at 415V) 13A (at 460V)	30A (at 380V) 28A (at 415V) 25A (at 460V)
Rated secondary voltage	AC210V		AC200V	
Rated secondary current	9.6A	13.7A	29A	58A
Voltage regulation at the secondary	2%		5% (See Fig. 2.2.3 (1).)	
Voltage deviation at the secondary	±3%			
Connection	Δ–Δ connection or Y–Δ connection		Y–Y connection	
Insulation	Class B (maximum allowable temperature: 130°C)		Class H (maximum allowable temperature: 180°C)	
Ambient temperature	–20 to 55°C		0 to 45°C	
Allowable temperature rise	135deg			
Thermostat	Normally closed contact (operating temperature: 135°C)		None	
Relative humidity	Max. 95%RH			
Type	Dry type, natural air cooling type			
Dielectric withstanding voltage	2300VAC, for 1 minute		2000VAC, for 1 minute	
Weight	Max. 27kg	Max. 36kg	Max. 61kg	Max. 115kg
Outline drawing	Fig. 8.1.5 (e)	Fig. 8.1.5 (a)	Fig. 8.1.5 (b)	Connection diagram
Connection diagram				

– Connecting a power transformer

Power transformers must be set according to the supply voltage used.

(a) Connection points of power transformers (A80L–0024–0006 and A80L–0026–0003) for PSMR–3

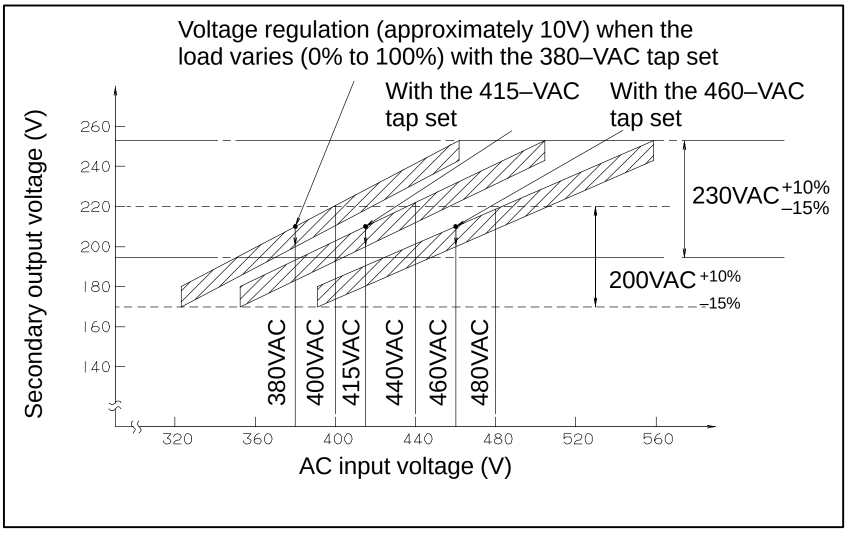
Supply voltage	Connection points at the primary	Other connection points
AC380V	R – 6, S – 14, T – 22	Make 8–16 and 16–24 connections by using supplied cables.
AC400V	R – 4, S – 12, T – 20	
AC415V	R – 4, S – 12, T – 20	
AC440V	R – 3, S – 11, T – 19	
AC460V	R – 3, S – 11, T – 19	
AC480V	R – 2, S – 10, T – 18	

Transformer (A80L–0024–0006 and A80L–0026–0003) accessories

Part name	Drawing number	Quantity
Cable	A660–8001–T532	2
Cable	A660–8004–T926	2
Bolt	A30L–0001–0021	4

(b) Connection points of power transformers for PSMR–5.5, PSM–5.5, PSM–11, PSM–15, PSM–26, PSM–30, PSM–37, and PSM–45

Supply voltage	Connection points at the primary	Remarks
AC380V	R – R1, S – S1, T – T1 (380–V tap)	
AC400V	R – R1, S – S1, T – T1 (380–V tap)	
AC415V	R – R2, S – S2, T – T2 (415–V tap)	
AC440V	R – R2, S – S2, T – T2 (415–V tap)	
AC460V	R – R3, S – S3, T – T3 (460–V tap)	
AC480V	R – R3, S – S3, T – T3 (460–V tap)	



NOTE

1 When installing a transformer in a cabinet, be careful to ensure that the transformer does not thermally affect other equipment. For example, separate the transformer from the other equipment.
2 When installing a transformer outside the cabinet, make sure that the transformer is not directly exposed to cutting chips or coolant.
3 If there is a possibility of the transformer falling, secure the transformer with bolts or similar.

(7) Fan adaptor

When the following modules are used, forced air cooling is required:
PSM–11, SPM–11, SPM–11HV, SVM1–130(*), SPMC–11, PSM–45, SPM–45, PSM–75HV, SPM–75HV
For the cooling conditions, see Chapter 7.
The use of a fan adaptor allows the desired cooling performance to be obtained. When the fan adaptor is installed, the panel cut–out must be partially modified. For those modifications, see Section 8.2.

Category	Name		Ordering number	Remarks
Optional	Fan adaptor	For PSM–11 or SPM–11 or SPM–11HV	A06B–6078–K001	
		For SVM1–130 or SPMC–11	A06B–6078–K002	
		PSM–45, SPM–45, PSM–75HV, SPM–75HV	A06B–6078–K003	(Note)

For the dimensions of fan adaptors, see Section 8.1.6.

NOTE

SVM1–130 requires forced air cooling only when it is being used to drive the α22/3000, α30/3000, α40/2000 (with a fan), αL25/3000, αL50/2000, or αM40/3000.

(8) Regenerative discharge unit

Whenever a PSM4 (resistance regeneration type power supply module) is used, a regenerative discharge unit must be specified. For how to select the regenerative discharge unit, see Section 3.4.5.

Category	Name		Ordering number	Remarks
Standard	Regenerative discharge unit	For PSMR–3	A06B–6081–H050	16Ω/100W (at natural cooling)
		For PSMR–3, 5.5	A06B–6066–H500	16Ω/200W (at natural cooling)
			A06B–6066–H713	16Ω/800W (Forced cooling fan motor is included)
		For PSMR–5.5	A06B–6066–H711	8Ω/800W (Forced cooling fan motor is included)
			A06B–6066–H712	16Ω/1200W (Forced cooling fan motor is included)

See Section 8.1.7, ”SELECTING A REGENERATIVE DISCHARGE UNIT” for details of selection.

(9) Cables

– DC link short bar

Category	Name	Between terminals	Ordering number	Applicable terminal–to–terminal distance
Optional	DC link short bar	124mm	A06B–6078–K800	120mm – 128mm
		90mm	A06B–6078–K801	86mm – 94mm
		131mm	A06B–6078–K802	127mm – 135mm
		64mm	A06B–6078–K803	60mm – 68mm
		85mm	A06B–6078–K804	81mm – 89mm
		102mm	A06B–6078–K805	98mm – 106mm
		146mm	A06B–6078–K823	143mm – 151mm
		182mm	A06B–6078–K826	180mm – 185mm
		144mm	A06B–6078–K827	142mm – 146mm
		305mm	A06B–6078–K828	303mm – 308mm
		267mm	A06B–6078–K829	265mm – 269mm
		120mm	A06B–6078–K830	118mm – 123mm

See 9.2.1 (2) for details.

NOTE
K823 to K830 are used for 300–mm–wide modules.

– Cables for connection of modules

Category	Name	Ordering number	Cable length	Remarks
Optional	Cable for connection of modules	A06B–6078–K808	200mm	(Note 1)
		A06B–6078–K809	150mm	
		A06B–6078–K810	100mm	
		A06B–6082–K808	200mm	(Note 2)
		A06B–6082–K809	150mm	
		A06B–6082–K810	100mm	

NOTE

1 The following three cables are supplied together. The ordering drawing number differs depending on the cable length.

K4: For 200–VAC power supply for cooling fan (between CX1B and CX1A)
K5: For 24–VDC control power supply (between CX2B and CX2A)
K8: For interface between modules (between JX1B and JX1A)

2 The following two cables are supplied together. The ordering drawing number differs depending on the cable length.

K5: For 24–VDC control power supply (between CX2B and CX2A)
K8: For interface between modules (between JX1B and JX1A)

– Cables for connection of detectors

Category	Name	Ordering number	Remarks
Optional	For M sensor, MZ sensor or BZ sensor	A06B–6078–K811	
	For magnetic sensor	A06B–6078–K813	
	For position coder	A06B–6078–K814	Canon : Straight
		A06B–6078–K815	Canon : Elbow
	For high resolution magnetic pulse coder	A06B–6078–K816	
	For high resolution position coder	A06B–6078–K817	Canon : Straight
		A06B–6078–K818	Canon : Elbow

NOTE

Each cable is 7 m long.

– FSSB interface cables

Category	Name	Ordering number	Cable length	Remarks
Optional	FSSB interface cables	A66L–6001–0023#L150R0	15cm	Internal optical cables (Note 1)
		A66L–6001–0023#L300R0	30cm	
		A66L–6001–0026#L1R003	1m	External optical cables (Note 2)
		A66L–6001–0026#L5R003	5m	
		A66L–6001–0026#L7R003	7m	
		A66L–6001–0026#L10R03	10m	
		A66L–6001–0026#L20R03	20m	
		A66L–6001–0026#L30R03	30m	
		A66L–6001–0026#L50R03	50m	

NOTE
1 Optical cables for connecting SVMs.
SVM (COP10A) – SVM(COP10B)
2 Optical cables for connecting the CNC and SVM.
CNC (COP10A) – SVM (COP10B)

(10) Breaker, Magnetic contactor, Lightning surge absorber

The circuit breaker and magnetic contactor capacities are determined by the power supply module specifications. The ordering drawing numbers and specifications of the circuit breakers and magnetic contactors are shown below. For dimensions, see Sections 8.1.9 and 8.1.10.

When this equipment is to be prepared by the user, it must satisfy the circuit breaker and magnetic contactor specifications indicated below.

– Circuit breaker and magnetic contactor specifications
For PSM and PSMR

PSM name	Circuit breaker 1	Circuit breaker 2	Magnetic contactor	Remarks
PSM–5.5	30A	5A	30A	
PSM–11	55A		55A	
PSM–15	70A		70A	
PSM–26	120A		120A	
PSM–30	140A		140A	
PSM–37	175A		175A	
PSM–45	220A		220A	
PSMR–3	20A		20A	
PSMR–5.5	30A		30A	(Note 4)
	50A		50A	(Note 5)

NOTE

1 For the installation positions of the circuit breakers and magnetic contactor, see Section 2.1.
2 Circuit breakers 1 and 2 must have a rated voltage of 200VAC or higher.
3 The current and voltage of the operation coil of the magnetic contactor must be within the rating of the internal contact [CX3 (MCC)] of the PSM. For details, see (6) in Section 9.2.1.
4 When PSMR–5.5 is used with a rated output capacity of 5.5 kW
5 When PSMR–5.5 is used with a rated output capacity of 7.5 kW

For PSM–HV and PSMV–HV

PSM name	Circuit breaker 1	Circuit breaker 2	Circuit breaker 2	Magnetic contactor	Remarks
PSM–18HV	45A	3A	3A	45A	
PSM–30HV	75A			75A	
PSM–45HV	125A			135A	
PSM–75HV	200A			200A	
PSMV–11HV	–	5A	5A	60A	

NOTE

1 For the installation positions of the circuit breakers and magnetic contactor, see Section 2.1.
2 Circuit breakers 1 and 3 must have a rated voltage of 400VAC or higher.
3 Circuit breaker 2 must have a rated voltage of 200VAC or higher.
4 The current and voltage of the operation coil of the magnetic contactor must be within the ratings of the internal contact [CX3 (MCC)] of the PSM. For details, see (6) in Section 9.2.1.

– Ordering drawing numbers of circuit breakers

Category	Model	Ordering number	Outline drawing	Circuit breaker specification	Circuit breaker cover specification
Optional	PSMR–3	A06B–6077–K101	8–1–9–(a)	Fuji Electric EA53B/30	Fuji Electric BZ–TB20B–3
	PSMR–5.5, PSM–5.5 PSM–18HV	A06B–6077–K102	8–1–9–(b)	Fuji Electric EA103B/50	Fuji Electric BZ–TB20B–3
	PSM–11	A06B–6077–K103	8–1–9–(c)	Fuji Electric EA103B/60	Fuji Electric BZ–TB20B–3
	PSM–15, PSM–30HV	A06B–6077–K104	8–1–9–(d)	Fuji Electric EA103B/75	Fuji Electric BZ–TB20B–3
	PSM–45HV	A06B–6077–K108	8–1–9–(e)	Fuji Electric EA203B/125	Fuji Electric BZ–TB40B
	PSM–26, PSM–30	A06B–6077–K105	8–1–9–(f)	Fuji Electric EA203B/150	Fuji Electric BZ–TB40B
	PSM–37	A06B–6077–K110	8–1–9–(g)	Fuji Electric EA203B/175	Fuji Electric BZ–TB40B
	PSM–75HV	A06B–6077–K109	8–1–9–(h)	Fuji Electric EA203B/200	Fuji Electric BZ–TB40B
	PSM–45	A06B–6077–K107	8–1–9–(i)	Fuji Electric EA203B/225	Fuji Electric BZ–TB40B
	For control power supply	A06B–6077–K106	8–1–9–(j)	Fuji Electric EA33/5	Fuji Electric BZ–TB10B–503

– Ordering drawing numbers of magnetic contactors

Category	Model	Ordering number	Outline drawing	Magnetic contactor specification	Magnetic contactor cover specification
Optional	PSMR–3	A06B–6077–K121	8–1–10–(a)	Fuji Electric SC–5–1	Fuji Electric SZ–JC4
	PSMR–5.5, PSM–5.5 PSM–18HV	A06B–6077–K122	8–1–10–(b)	Fuji Electric SC–1N	Fuji Electric SZ–1N/T
	PSM–11, PSM–30HV PSMV–11HV	A06B–6077–K123	8–1–10–(b)	Fuji Electric SC–2N	Fuji Electric SZ–1N/T
	PSM–15	A06B–6077–K124	8–1–10–(c)	Fuji Electric SC–2SN	Fuji Electric SZ–2SN/T
	PSM–26, PSM–45HV	A06B–6077–K125	8–1–10–(d)	Fuji Electric SC–4N	Fuji Electric SZ–4N/T
	PSM–30	A06B–6077–K126	8–1–10–(e)	Fuji Electric SC–5N	Fuji Electric SZ–5N/T
	PSM–37, PSM–75HV	A06B–6077–K128	8–1–10–(g)	Fuji Electric SC–7N	Fuji Electric SZ–5N/T
	PSM–45	A06B–6077–K127	8–1–10–(f)	Fuji Electric SC–8N	Fuji Electric SZ–8N/T

NOTE
The coil voltage specification of the magnetic contactor is 200VAC.

– Recommended parts

Parts manufactured by Fuji Electric Co., Ltd.

<table>
<tr><th>PSM name</th><th>Circuit breaker 1</th><th>Circuit breaker 2</th><th>Circuit breaker 2</th><th>Magnetic contactor</th><th>Remarks</th></tr>
<tr><td>PSM–5.5</td><td>EA103B/50</td><td rowspan="9">EA33/5</td><td rowspan="9">–</td><td>SC–1N</td><td rowspan="14"></td></tr>
<tr><td>PSM–11</td><td>EA103B/60</td><td>SC–2N</td></tr>
<tr><td>PSM–15</td><td>EA103B/75</td><td>SC–2SN</td></tr>
<tr><td>PSM–26</td><td>EA203B/150</td><td>SC–4N</td></tr>
<tr><td>PSM–30</td><td>EA203B/150</td><td>SC–5N</td></tr>
<tr><td>PSM–37</td><td>EA203B/175</td><td>SC–7N</td></tr>
<tr><td>PSM–45</td><td>EA203B/225</td><td>SC–8N</td></tr>
<tr><td>PSMR–3</td><td>EA53B/30</td><td>SC–5–1</td></tr>
<tr><td>PSMR–5.5</td><td>EA103B/50</td><td>SC–1N</td></tr>
<tr><td>PSM–18HV</td><td>EA103B/50</td><td rowspan="4">EA33/3</td><td rowspan="4">EA33/3</td><td>SC–1N</td></tr>
<tr><td>PSM–30HV</td><td>EA103B/75</td><td>SC–2SN</td></tr>
<tr><td>PSM–45HV</td><td>EA203B/125</td><td>SC–4N</td></tr>
<tr><td>PSM–75HV</td><td>EA203B/200</td><td>SC–7N</td></tr>
<tr><td>PSMV–11HV</td><td>–</td><td>EA33/5</td><td>EA33/5</td><td>SC–2N</td></tr>
</table>

NOTE

For details, see the brochures available from Fujitsu Electric Co., Ltd. Note that the specification of the coil voltage of a magnetic contactor may differ depending on the supply voltage and frequency used.

(11) Lightning surge protector

To protect equipment from surge voltages caused by lightning, install a lightning surge protector between lines and between a line and ground. For how to install protectors, see Appendix A. For the outline drawings of lightning surge protectors, see Section 8.1.11.

<table>
<tr><th>Category</th><th>Ordering number</th><th>Specification</th><th>Outline drawing</th><th>Remarks</th></tr>
<tr><td rowspan="2">Optional</td><td>A06B–6077–K142</td><td>For line–to–line installation:
RAV–781BYZ–2
For line–to–ground installation:
RAV–781BXZ–4</td><td>Fig. 8.1.11 (a)</td><td>AC200V
For 200–VAC line
(Note 1)</td></tr>
<tr><td>A06B–6077–K143</td><td>For line–to–line installation:
RAV–152BYZ–2A
For line–to–ground installation:
RAV–801BXZ–4</td><td>Fig. 8.1.11 (b)</td><td>AC400V
For 400–VAC line
(Note 2)</td></tr>
</table>

NOTE
1 For the 200–V input series main power supply and control power supply, and the 400–V input series control power supply
2 For the 400–V input series main power supply
3 Tüv approved products

– Recommended products

Line–to–line	Line–to–ground	Remarks
RAV–781BYZ–2 manufactured by Okaya Electric Industries Co., Ltd.	RAV–781BXZ–4 manufactured by Okaya Electric Industries Co., Ltd.	For 200–VAC line
RAV–152BYZ–2A manufactured by Okaya Electric Industries Co., Ltd.	RAV–801BYZ–4 manufactured by Okaya Electric Industries Co., Ltd.	For 400–VAC line

(12) Noise filter

A noise filter must be installed in the PSM input section to satisfy the requirements of the EMC Directives which are now being enforced in the EU countries. For how to select the current capacity and noise filter installation, see Section 5.3.
Recommended noise filters are listed below.

HF3000C–TMA series manufactured by SOSHIN ELECTRIC CO., LTD.

Part number (SOSHIN ELECTRIC)	Rated current	Rated voltage	Remarks
HF3005C–TMA	5A	AC460V	Leakage current: 5.3 mA max at 460VAC, 60 Hz
HF3010C–TMA	10A		
HF3015C–TMA	15A		
HF3020C–TMA	20A		
HF3030C–TMA	30A		
HF3040C–TMA	40A		
HF3050C–TMA	50A		
HF3060C–TMA	60A		
HF3080C–TMA	80A		
HF3100C–TMA	100A		
HF3150C–TMA	150A		
HF3200C–TMA	200A		
HF3250C–TMA	250A		

For details, refer to the brochures supplied by SOSHIN ELECTRIC CO., LTD.

3SUP–AH series and 3SUP–DH series manufactured by Okaya Electric Industries Co., Ltd.

Part number (Okaya Electric Industries)	Rated current	Rated voltage	Remarks
3SUP–A30H–ER–6	30A	AC250V	Leakage current: 4 mA max at 500VAC, 60 Hz
3SUP–D75H–ER–4	75A	AC500V	
3SUP–D100H–ER–4	100A		
3SUP–D150H–ER–4	150A		
3SUP–D200H–ER–4	200A		

For details, refer to the brochures supplied by Okaya Electric Industries Co., Ltd.

NF3000C–TX series manufactured by SOSHIN ELECTRIC CO., LTD.

Part number (SOSHIN ELECTRIC)	Rated current	Rated voltage	Remarks
NF3020C–TX	20A	AC460V	Leakage current: 250 mA max at 460VAC, 60 Hz (Note)
NF3030C–TX	30A		
NF3050C–TX	50A		
NF3080C–TX	80A		
NF3100C–TX	100A		
NF3150C–TX	150A		
NF3200C–TX	200A		

For details, refer to the brochures supplied by SOSHIN ELECTRIC CO., LTD.

FN258 series manufactured by SCHAFFNER

Part number (SCHAFFNER)	Rated current	Rated voltage	Remarks
FN258–7	7A	AC480V	Leakage current: 150 mA max at 250VAC, 50 Hz (Note)
FN258–16	16A		
FN258–30	30A		
FN258–42	42A		
FN258–55	55A		
FN258–75	75A		
FN258–100	100A		
FN258–130	130A		
FN258–180	180A		

For details, refer to the brochures supplied by SCHAFFNER.
Agency in Japan: UNIDUX INC.

NOTE

The NF3000C–TX series manufactured by SOSHIN ELECTRIC CO., LTD. and the FN258 series manufactured by SCHAFFNER have a large line–to–ground capacitor capacitance, allowing a very high leakage current. Therefore, they can be used only for neutral grounding type power supplies.

(13) Detectors

α position coder

Category	Name	Ordering number	Remarks
Optional	α position coder	A860–0309–T302	□68, 10,000min^{-1}
	Connector kit	A06B–6088–K211	Straight type

High–resolution position coder

Category	Name	Ordering number	Remarks
Optional	High–resolution position coder	A860–0319–T002	□68, 8,000min^{-1}

BZ sensor

Category	Name	Ordering number	Remarks
Optional	BZ sensor 128	A860–0392–T012	128 teeth / 20,000min^{-1}
	BZ sensor 256	A860–0392–T011	256 teeth / 15,000min^{-1}
	BZ sensor 256S	A860–0392–T014	256 teeth / 15,000min^{-1}
	BZ sensor 384	A860–0392–T018	384 teeth / 15,000min^{-1}
	BZ sensor 512	A860–0392–T013	512 teeth / 10,000min^{-1}
	BZ sensor 128H	A860–0392–T082	128 teeth / 50,000min^{-1}
	BZ sensor 256H	A860–0392–T081	256 teeth / 30,000min^{-1}

High–resolution magnetic pulse coder

Category	Name	Ordering number	Remarks
Optional	High–resolution magnetic pulse coder	A860–0382–T121	Outside diameter of drum: ϕ 65
		A860–0382–T122	Outside diameter of drum: ϕ 97.5
		A860–0382–T123	Outside diameter of drum: ϕ 130
		A860–0382–T124	Outside diameter of drum: ϕ 195

Magnetic sensor for orientation

Category	Name	Ordering number	Remarks
Optional	Not specified, standard	A57L–0001–0037	Type II, 12,000min^{-1}
	Magnetic sensor N	A57L–0001–0037#N	Type II, 12,000min^{-1}
	Magnetic sensor NIP	A57L–0001–0037#NIP	Type II, 12,000min^{-1} Water–proof connector specification
	Magnetic sensor P	A57L–0001–0037#P	Type III, 12,000min^{-1}
	Magnetic sensor PIP	A57L–0001–0037#PIP	Type III, 12,000min^{-1} Water–proof connector specification
	Magnetic sensor Q	A57L–0001–0037#Q	Type IV, 20,000min^{-1}
	Magnetic sensor QIP	A57L–0001–0037#QIP	Type IV, 20,000min^{-1} Water–proof connector specification
	Magnetic sensor R	A57L–0001–0037#R	Type V, 20,000min^{-1}
	Magnetic sensor RIP	A57L–0001–0037#RIP	Type V, 20,000min^{-1} Water–proof connector specification
	Magnetic sensor S	A57L–0001–0037#S	Type VI, 15,000min^{-1}
	Magnetic sensor SIP	A57L–0001–0037#SIP	Type VI, 15,000min^{-1} Water–proof connector specification
	Magnetic sensor T	A57L–0001–0037#T	Type VII, 15,000min^{-1}
	Magnetic sensor TIP	A57L–0001–0037#TIP	Type VII, 15,000min^{-1} Water–proof connector specification
	Magnetic sensor U	A57L–0001–0037#U	Type VIII, 20,000min^{-1}
	Magnetic sensor UIP	A57L–0001–0037#UIP	Type VIII, 20,000min^{-1} Water–proof connector specification
	Magnetic sensor U1	A57L–0001–0037#U1	Type IX, 15,000min^{-1}
	Magnetic sensor U1IP	A57L–0001–0037#U1IP	Type IX, 15,000min^{-1} Water–proof connector specification
	Magnetic sensor U2	A57L–0001–0037#U2	Type X, 15,000min^{-1}
	Magnetic sensor U2IP	A57L–0001–0037#U2IP	Type X, 15,000min^{-1} Water–proof connector specification

(14) Others

Category	Name	Ordering number	Remarks
Optional	Battery	A06B–6073–K001	For SVM (Note)
	Battery	A06B–6050–K061	For SVM (Note)
	Battery case	A06B–6050–K060	For SVM (Note)
	Cable for battery connection	A06B–6093–K810	For SVM (Note)
	Connector for battery connection	A06B–6093–K303	For SVM (Note)
	Check pin board	A06B–6071–K290	For SVM
	Spindle check board	A06B–6078–H001	For SPM and SPMC

NOTE

These parts are required when the interface with the CNC is type B or FSSB, and absolute–position detection is performed. The battery for the absolute pulse coder can be connected using one of following two methods:

Connection method 1: A special lithium battery is installed in the α amplifier.
– Use A06B–6073–K001.

Connection method 2: A battery case (A06B–6050–K060) is used.
– Use A06B–6050–K061 or a commercially available size–D battery.
– A cable (A06B–6093–K810) is required.

3 HOW TO SELECT THE POWER SUPPLY MODULE

3.1 HOW TO SELECT THE SERVO AMPLIFIER MODULE

First, select a servo motor, based on the machine specifications. Then, select an appropriate servo amplifier module for the selected servo motor.

For combinations of servo motors and servo amplifier modules, see Sections 3.1.1 and 3.1.2.

Table.3.1 (a) Specifications

No.	Specification	Number of connected axes	Input voltage	Interface with CNC (Note)
1	A06B–6079–H1□□	1	200V	TYPE A & B
2	A06B–6079–H2□□	2	200V	TYPE A & B
3	A06B–6079–H3□□	3	200V	TYPE A
4	A06B–6080–H3□□	3	200V	TYPE B
5	A06B–6096–H1□□	1	200V	FSSB
6	A06B–6096–H2□□	2	200V	FSSB
7	A06B–6096–H3□□	3	200V	FSSB
8	A06B–6085–H1□□	1	400V	TYPE A & B
9	A06B–6085–H2□□	2	400V	TYPE A & B
10	A06B–6097–H1□□	1	400V	FSSB
11	A06B–6097–H2□□	2	400V	FSSB

NOTE

There are three interfaces with the CNC: Type A, Type B, and FSSB. Check the interface with the CNC being used, then select an appropriate servo amplifier module.

Table.3.1 (b) Names

200–V input series for 1 axes	200–V input series for 2 axes	200–V input series for 3 axes	400–V input series for 1 axes	400–V input series for 2 axes
SVM1–12	SVM2–12/12	SVM3–12/12/12	SVM1–20HV	SVM2–20/20HV
SVM1–20	SVM2–12/20	SVM3–12/12/20	SVM1–40HV	SVM2–20/40HV
SVM1–40S	SVM2–20/20	SVM3–12/20/20	SVM1–60HV	SVM2–20/60HV
SVM1–40L	SVM2–12/40	SVM3–20/20/20		SVM2–40/40HV
SVM1–80	SVM2–20/40	SVM3–12/12/40		SVM2–40/60HV
SVM1–130	SVM2–40/40	SVM3–12/20/40		SVM2–60/60HV
SVM1–240	SVM2–40/80	SVM3–20/20/40		
SVM1–360	SVM2–80/80			
	SVM2–40L/40L			

Naming convention

SVM □–□ / □ / □ □
(1) (2) (3) (4) (5) (6)

(1) Servo amplifier module

(2) Number of axes
1 = 1–axis amplifier, 2 = 2–axis amplifier, 3 = 3–axis amplifier

(3) Maximum current for the L–axis

(4) Maximum current for the M–axis

(5) Maximum current for the N–axis

(6) Input voltage
None = 200 V, HV = 400 V

3.1.1
200–V Input Series

(1) One–axis amplifier

One–axis amplifiers (200–V input series)

Product name	Specification																		
		α		1	2				3		6		12			22			30
				3000	2000	3000			3000		2000	3000		2000	3000	1500	2000	3000	1200
		α M					2	2.5				6			9			22	
							3000	3000				3000			3000			3000	
		α L										6			9				
												3000			3000				
		α C						3		6			12			22			
								2000		2000			2000			1500			
		β	0.5	1		2		3		6									
			3000	3000		3000		3000		2000									
SVM1–12	H101		○	○	○	○													
SVM1–20	H102						○	○		○			○						
SVM1–40S	H103								(Note)○		○								
SVM1–40L	H104								(Note)○		○			○		○			
SVM1–80	H105											○			○		○		○

Product name	Specification											
		α	22	30		40		65	100	150	300	400
			3000	2000	3000	2000		2000	2000	2000	1200	1200
		α M	22		30		40					
			3000		3000		3000					
		α L			25	50						
					3000	2000						
SVM1–130	H106		○	○	○	○	○					
SVM1–240	H107						○	○				
SVM1–360	H108						○		○	○		
SVM1–240 (2 units)	H107										○	○

NOTE
The servo motor for the SVM1–40S can be used together with SVM1–40L. In this case, however, the servo amplifier capacity specification is large for the servo motor capacity. When the servo motor for the SVM1–40S is being used, therefore, the use of SVM1–40S is recommended.

(2) Two–axis amplifier

Two-axis amplifier (200-V input series)

Product name	Specification																		
		α		1	2				3		6			12			22		30
				3000	2000	3000			3000		2000	3000		2000	3000		1500	2000	1200
		α M					2	2.5				6			9				
							3000	3000				3000			3000				
		α L										6			9				
												3000			3000				
		α C						3		6			12			22			
								2000		2000			2000			1500			
		β	0.5	1		2		3		6									
			3000	3000		3000		3000		2000									
SVM2-12/12	H201	L	○	○	○	○													
		M	○	○	○	○													
SVM2-12/20	H202	L	○	○	○	○													
		M					○	○		○			○						
SVM2-20/20	H203	L					○	○		○			○						
		M					○	○		○			○						
SVM2-12/40	H204	L	○	○	○	○													
		M							○		○			○		○			
SVM2-20/40	H205	L					○	○		○			○						
		M							○		○			○		○			
SVM2-40/40	H206	L							○		○			○		○			
		M							○		○			○		○			
SVM2-40/80	H207	L							○		○			○		○	○		
		M										○			○			○	○
SVM2-80/80	H208	L										○			○			○	○
		M										○			○			○	○
SVM2-40L/40L	H209	L							○		○			○		○	○		
		M							○		○			○		○	○		

(3) Three–axis amplifier

Two–axis amplifier (200–V input series)

Product name	Specification													
		α		1	2	2			3		6		12	
				3000	2000	3000			3000		2000		2000	
		αM					2	2.5						
							3000	3000						
		αL												
		αC						3		6		12		22
								2000		2000		2000		1500
		β	0.5	1		2		3		6				
			3000	3000		3000		3000		2000				
SVM3–12/12/12	H301	L	○	○	○	○								
		M	○	○	○	○								
		N	○	○	○	○								
SVM3–12/12/20	H302	L	○	○	○	○								
		M	○	○	○	○								
		N					○	○		○		○		
SVM3–12/20/20	H303	L	○	○	○	○								
		M					○	○		○		○		
		N					○	○		○		○		
SVM3–20/20/20	H304	L					○	○		○		○		
		M					○	○		○		○		
		N					○	○		○		○		
SVM3–12/12/40	H305	L	○	○	○	○								
		M	○	○	○	○								
		N							○		○		○	○
SVM3–12/20/40	H306	L	○	○	○	○								
		M					○	○		○		○		
		N							○		○		○	○
SVM3–20/20/40	H307	L					○	○		○		○		
		M					○	○		○		○		
		N							○		○		○	○

3.1.2 400–V Input Series

(1) One–axis and two–axis amplifiers

One–axis amplifier (400–V input series)

Product name	Specification	αHV	3	6		12	22	30
			3000	3000		3000	3000	3000
		αM HV			6	9	22	30
					3000	3000	3000	3000
SVM1–20HV	H102		○	○				
SVM1–40HV	H103				○	○		
SVM1–60HV	H104						○	○

Two–axis amplifier (400–V input series)

Product name	Specification	αHV	3	6		12	22	30
			3000	3000		3000	3000	3000
		αM HV			6	9	22	30
					3000	3000	3000	3000
SVM2–20/20HV	H201	L	○	○				
		M	○	○				
SVM2–20/40HV	H202	L	○	○				
		M			○	○		
SVM2–20/60HV	H203	L	○	○				
		M					○	○
SVM2–40/40HV	H204	L			○	○		
		M			○	○		
SVM2–40/60HV	H205	L			○	○		
		M					○	○
SVM2–60/60HV	H206	L					○	○
		M					○	○

3.2 SELECTING A SPINDLE AMPLIFIER MODULE

First, select a spindle motor, based on the machine specification. Then, select an appropriate spindle amplifier module for the selected spindle motor.

Spindle amplifier modules and standard motors that can be used together are shown below. When using a built–in motor or a motor with special specifications, refer to relevant specifications, and select a spindle amplifier module accordingly.

Table.3.2 (a) 200–V Input Series

Model	Example of motors used
SPM–2.2	α0.5, α1
SPM–5.5	α1.5, α2, α3
SPM–11	α6, α8, αP8, αP12
SPM–15	α12, αP15, αP18
SPM–22	α15, α18, αP22, αP30
SPM–26	α22, αP40, αP50
SPM–30	αP60
SPM–45	α30, α40
SPMC–2.2	αC1
SPMC–5.5	αC1.5, αC2, αC3
SPMC–11	αC6, αC8
SPMC–15	αC12
SPMC–22	αC15, αC18
SPMC–26	αC22

Table.3.2 (b) 400–V Input Series

Model	Example of motors used
SPM–11HV	α6HV, α8HV
SPM–15HV	α12HV
SPM–26HV	α15HV, α18HV, α22HV
SPM–45HV	α30HV, α40HV
SPM–75HV	α60HV

3.3 HOW TO SELECT THE POWER SUPPLY MODULE (PSM)

Select a power supply module that satisfies the rated output capacity and maximum output capacity, calculated as follows:

3.3.1 Rated Output Capacity

Select a power supply module with a rated output not less than the sum of the total continuous rated output of the spindle motors times 1.15, plus the total continuous rated output of the servo motors times 0.6.

$$\text{Rated output capacity of power supply module} \geqq \Sigma\,\text{Continuous rated output of spindle motor} \times 1.15 + \Sigma\,\text{Continuous rated output of servo motor} \times 0.6$$

When only one spindle amplifier module is to be connected to a power supply module, select the power supply module so that the 30–minute rated output of the spindle motor does not exceed the rated output capacity of the power supply module.

> Rated output capacity of a power supply module ≧ 30– minute rated output of a spindle motor

Table 4.1.1 (a) lists the rated output capacities of the power supply modules. Table 3.7.1 lists the continuous rated outputs of the servo motors. Table 3.7.2 list the continuous rated outputs of the spindle motors.

3.3.2 Maximum Output Capacity of Power Supply Module

Select a power supply module with a maximum output not less than the sum of the total accelerating maximum output of the spindle motors and the total accelerating maximum output of those servo motors that accelerate/decelerate at the same time.

When the rated output capacity is 11 kW or less, calculate the maximum output capacity according to 3.3.2–(1), below. When the rated output capacity is 12 kW or more, calculate according to 3.3.2–(2).

(1) For a rated output capacity of 11 kW or less

$$\text{Maximum output of power supply module} \geqq \Sigma\,\text{Accelerating maximum output of spindle motor} \times 1.15 + \Sigma\,\text{Accelerating maximum output of servo motor (for simultaneous acceleration/deceleration axis)} \times 0.6$$

When the obtained value at the right–hand side is 20 kW or more, calculate the maximum output capacity according to 3.3.2–(2).

(2) For a rated output capacity of 12 kW or more

$$\text{Maximum output of power supply module} \geqq \Sigma\,\text{Accelerating maximum output of spindle motor} + \Sigma\,\text{Accelerating maximum output of servo motor (for simultaneous acceleration/deceleration axis)}$$

Table 4.1.1 (a) lists the maximum output capacities of the power supply modules. Table 3.7.1 lists the accelerating maximum outputs of the servo motors. Table 3.7.2 lists the accelerating maximum outputs of the spindle motors.

3.3.3 Number of Connected Servo Amplifier Modules and Spindle Amplifier Modules

Multiple servo amplifier modules and spindle amplifier modules can be connected to a single power supply module, provided the above output capacity conditions are satisfied.
The table below lists the maximum number of modules which can be connected.

Maximum number of modules that can be connected

SPM SPMC	SVM		
	SVM1	SVM2	SVM3
2	6		
		4	
			3

NOTE
1 When different types of servo amplifier modules are connected, the following condition must be satisfied:
$6 \geqq$ Number of SVM1s$\times$1+
Number of SVM2s$\times$1.5+Number of SVM3s$\times$2
The maximum number of servo amplifier modules that can be connected is the same when a spindle amplifier module is not used.
2 When SPM–30 is used, PSM–26 and power supply modules with a capacity less than or equal to the capacity of PSM–26 cannot be used.
When using SPM–45, use PSM–45.

3.3.4 Selecting a Power Supply Module When the Machining Cycle Frequency is High

When a machine, such as a press, with which a machining cycle is performed frequently is used, select a PSM so that the total maximum output of those axes that are accelerated/decelerated simultaneously does not exceed the value 1.5 times greater than the rated continuous output.

Therefore, the PSM is selected as follows:

Examples

Motor	PSM+SVM
α300/1200	PSM–37+SVM1–240 $\times$ 2
α400/1200	(PSM–30+SVM1–240) $\times$ 2

3.3.5 Example of Selecting a Power Supply Module (PSM)

(1) When two α22/2000 servo motors and one αP50 spindle motor are used

Servo motor α22/2000
Continuous rated output : 3.8 kW
Maximum output at acceleration : 7.5 kW
Spindle motor αP50
Continuous rated output : 22 kW
Maximum output at acceleration : 36 kW

Rated output capacity of power supply module ≧ Σ spindle motor continuous rated output × 1.15 + Σ servo motor continuous rated output × 0.6
= 22 × 1.15 + 3.8 × 2 × 0.6
= 29.86 Condition 1

Maximum output capacity of the power supply module ≧ Σ maximum output of the spindle motor at acceleration + Σ maximum output of the servo motors at acceleration (simultaneous acceleration/deceleration)
= 36 + 7.5 × 2
= 51.0 Condition 2

According to conditions 1 and 2, PSM–30 is selected as the power supply module.

(2) When two α6/3000 servo motors and one α22/2000 servo motor, and one α3 spindle motor are used

Servo motor α6/3000
Continuous rated output : 1.4 kW
Maximum output at acceleration : 6.2 kW
Servo motor α22/2000
Continuous rated output : 3.8 kW
Maximum output at acceleration : 7.5 kW
Spindle motor α3
Continuous rated output : 3.7 kW
Maximum output at acceleration : 6.6 kW

Rated output capacity of power supply module ≧ Σ spindle motor continuous rated output × 1.15 + Σ servo motor continuous rated output × 0.6
= 3.7 × 1.15 + (1.4 × 2 + 3.8) × 0.6
= 8.215 Condition 3

Since the rated output capacity of the power supply module is not higher than 11kW, the maximum output capacity can be obtained from the following expression:

Maximum output capacity of the power supply module ≧ Σ maximum output of the spindle motor at acceleration + Σ maximum output of the servo motors at acceleration (simultaneous acceleration/deceleration) × 0.6
$= 6.6 + (6.2 \times 2 + 7.5) \times 0.6$
$= 18.54$ Condition 4
According to conditions 3 and 4, PSM–11 is selected as the power supply module.

3.4 HOW TO SELECT THE POWER SUPPLY MODULE (PSMR)

Select a power supply module that satisfies the rated output capacity and maximum output capacity, calculated as follows :

3.4.1 Rated Output Capacity (PSMR)

Select a power supply module (PSMR) with a rated output not less than the sum of the total continuous rated output of the spindle motors times 1.15, plus the total continuous rated output of the servo motors times 0.6.

Rated output capacity of power supply module (PSMR)	≧Σ	Continuous rated output of spindle motor	×1.15
	+Σ	Continuous rated output of servo motor	×0.6

When only one spindle amplifier module is connected to a power supply module, the power supply module must be selected so that the 30–minute rated output of the spindle motor does not exceed the rated output capacity of the power supply module.

Rated output capacity of a power supply module ≧ 30– minute rated output of a spindle motor

Table 4.1.1 (b) lists the rated output capacities of the power supply modules (PSMR). Table 3.7.1 lists the continuous rated outputs of the servo motors. Table 3.7.2 list the continuous rated outputs of the spindle motors.

3.4.2 Maximum Output Capacity of Power Supply Module (PSMR)

Select a power supply module (PSMR) with a maximum output not less than the sum of the total accelerating maximum output of the spindle motors and the total accelerating maximum output of those servo motors that accelerate/decelerate at the same time.

Maximum output of power supply module (PSMR)	≧Σ	Accelerating maximum output of spindle motor
	+Σ	Accelerating maximum output of servo motor (for simultaneous acceleration/deceleration axis)

Table 4.1.1 (b) lists the maximum output capacities of the power supply modules. Table 3.7.1 lists the accelerating maximum outputs of the servo motors. Table 3.7.2 list the accelerating maximum outputs of the spindle motors.

3.4.3 Number of Connected Servo Amplifier Modules and Spindle Amplifier Modules

Multiple servo amplifier modules and spindle amplifier modules can be connected to a single power supply module, provided the above output capacity conditions are satisfied.
The table below lists the maximum number of modules which can be connected.

Maximum number of modules that can be connected

SPM SPMC	SVM		
	SVM1	SVM2	SVM3
0	4		
	1	2	
	2	1	
		1	1
1	2		
	1	1	
			1

3.4.4 Example of Selecting a Power Supply Module (PSMR)

(1) When two α1/3000 servo motors and one α2 spindle motor are used

Servo motor α1/3000
- Continuous rated output : 0.3 kW
- Maximum output at acceleration : 0.9 kW

Spindle motor α2
- Continuous rated output : 2.2 kW
- Maximum output at acceleration : 4.44 kW

Rated output capacity of a power supply module ≧ Σ spindle motor continuous rated output × 1.15 + Σ servo motor continuous rated output × 0.6
= 2.2 × 1.15 + 0.3 × 2 × 0.6
= 2.89 Condition 1

Maximum output capacity of the power supply module ≧ Σ maximum output of the spindle motor at acceleration + Σ maximum output of the servo motors at acceleration (simultaneous acceleration/deceleration)
= 4.44 + 0.9 × 2
= 6.24 Condition 2

According to conditions 1 and 2, PSMR–3 is selected as the power supply module.

(2) When two α2/2000 servo motor and one α6/2000 servo motor, and one α3 spindle motor are used

Servo motor α2/2000
- Continuous rated output : 0.4 kW
- Maximum output at acceleration : 1.1 kW

Servo motor α6/2000

Continuous rated output : 1.0 kW

Maximum output at acceleration : 3.8 kW

Spindle motor α3

Continuous rated output : 3.7 kW

Maximum output at acceleration : 6.6 kW

Rated output capacity of power supply module ≧ Σ spindle motor continuous rated output × 1.15 + Σ servo motor continuous rated output × 0.6

= 3.7 × 1.15 + (0.4 × 2 + 1.0) × 0.6

= 5.335   Condition 3

Maximum output capacity of the power supply module ≧ Σ maximum output of the spindle motor at acceleration + Σ maximum output of the servo motors at acceleration (simultaneous acceleration/deceleration)

= 6.6 + (1.1 × 2 + 3.8)

= 12.6   Condition 4

According to conditions 3 and 4, PSMR–5.5 is selected as the power supply module.

3.4.5 Selecting a Regenerative Discharge Unit

In the power supply module (PSMR), the regenerative discharge unit (regenerative resistor) dissipates the energy generated during deceleration of a motor (regeneration). The amount of heat generated by the regenerative discharge unit varies with the motor type, rotation speed, load inertia, and continuous repetition cycle (duty cycle). Use a regenerative discharge unit of a suitable capacity for the load and operation cycle time.

(1) How to Calculate the Required Capacity for the Regenerative Discharge Unit

Select a regenerative discharge unit having a capacity greater than or equal to the total rotation energy of all the servo motors and the spindle motor. How to calculate the rotation energy is described in below.

Capacity of regenerative discharge unit	≧Σ	Rotation energy of motor

See Table 3.4.5 for details of the capacity of the regenerative discharge unit.

1. 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

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

F : Frequency of rapid traverse acceleration/deceleration [sec/ number of times]
Note) 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

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

F : Rapid traverse acceleration/deceleration cycle [s/number of times]
Note) About once every five seconds unless otherwise specified
Jm : Rotor inertia of motor [kg·cm·s^2]
JL : Load inertia (value for motor shaft) [kg·cm·s^2]
Vm : Motor rotation speed for rapid traverse [rpm]
ta : Rapid traverse acceleration/deceleration time [s]
TL : Friction torque of machine (value for motor) [kg·cm]

2. Servo motor (for vertical movement)
The amount of regenerative discharge (power [W]) when the operation duty for downward rapid traverse is D(%)

(a) SI unit system

$$W = 1.047 \times 10^{-1} \cdot Th \cdot Vm \times \frac{D}{100}[W]$$

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

$$W = 1.026 \times 10^{-2} \cdot Th \cdot Vm \times \frac{D}{100}[W]$$

Th : Upward torque of motor during lowering by rapid traverse [kg·cm]
Vm : Motor rotation speed for rapid traverse [rpm]
D : Downward operation duty during lowering by rapid traverse [%]
Note) D is a maximum of 50% and usually less.

3. Spindle motor

(a) SI unit system

$$W = 5.48 \times 10^{-3} \cdot (Jm + JL) \cdot N^2 \times \frac{1}{Dt} [W]$$

Jm : Rotor inertia of the motor [kg·m^2]
JL : Motor–shaft–converted inertia of the load [kg·m^2]
N : Motor speed [min^{-1}]
Dt : Duty cycle [sec]

(b) CGS unit system

$$W = 5.37 \times 10^{-2} \cdot (Jm + JL) \cdot N^2 \times \frac{1}{Dt} \ [W]$$

Jm : Rotor inertia of motor [kg·cm·s^2]
JL : Load inertia (value for motor shaft) [kg·cm·s^2]
N : Motor rotation speed [rpm]
Dt : Duty cycle [s]

Table.3.4.5 Required capacity for the Regenerative Discharge unit

Regenerative discharge unit	Capacity			Remarks
	Wind speed			
	0m/sec	2m/sec	4m/sec	
A06B–6081–H050	100W	250W	–	Registance : 16Ω
A06B–6066–H500	200W	400W	600W	Registance : 16Ω
A06B–6066–H713	–	–	800W	Forced cooling fan motor is included Registance : 16Ω
A06B–6066–H711	–	–	800W	Forced cooling fan motor is included Registance : 8Ω
A06B–6066–H712	–	–	1,200W	Forced cooling fan motor is included Registance : 8Ω

NOTE

1 The ”maximum output at acceleration” value is provided only to aid in the selection of a power supply module; this is not a guaranteed value.
2 When a spindle motor with a maximum output of 5kW or more is used, the resistance of the regenerative discharge unit must be 8Ω. If a regenerative discharge unit with a resistance of 16Ω is used for a spindle motor with a maximum output of 5 kW or more , a regeneration excess alarm (alarm No. 08) may be generated in the PSMR when the spindle is decelerated.

3.5 SELECTING A POWER SUPPLY MODULE (PSMV–HV)

For how to select a power supply module (PSMV–HV), see Section 3.3, and for the rated output capacity, see Table 4.2.1 (3).

3.5.1 Example of Selecting a Power Supply Module (PSMV–HV)

When two α6/3000 servo motors, one α22/2000 servo motor and one α3 spindle motor are used

α6/3000 servo motor
- Continuous rated output : 1.4 kW
- Accelerating maximum output : 6.2 kW

α22/2000 servo motor
- Continuous rated output : 3.8 kW
- Accelerating maximum output : 7.5 kW

α3 spindle motor
- Continuous rated output : 3.7 kW
- Accelerating maximum output : 6.6 kW

Rated output capacity of power supply module

$$\geqq \Sigma \begin{array}{l}\text{Continuous rated output}\\ \text{of spindle motor}\end{array} \times 1.15 + \Sigma \begin{array}{l}\text{Continuous rated output}\\ \text{of servo motor}\end{array} \times 0.6$$

$= 3.7 \times 1.15 \backslash (1.4 \times 2 + 3.8) \times 0.6$

$= 8.215$ - - - - - - - - - - - (1)

As the rated output capacity of the power supply module is less than 11 kW, the following formula is used for calculating the maximum output capacity:

Maximum output capacity of power supply module

$$\geqq \Sigma \begin{array}{l}\text{Accelerating maximum}\\ \text{output of spindle motor}\end{array} + \Sigma \begin{array}{l}\text{Accelerating maximum output}\\ \text{of servo motor (for simultaneous}\\ \text{acceleration/deceleration axis)}\end{array} \times 0.6$$

$= 6.6 \times (6.2 \times 2 + 7.5) \times 0.6$

$= 18.54$ - - - - - - - - - - - (2)

Based on (1) and (2), the PSM–11HV is selected.

3.6 SELECTING A POWER SUPPLY MODULE (PSM–HV)

When selecting a power supply module (PSM–HV), calculate the rated output capacity and maximum output capacity as explained below, then select an appropriate PSM–HV that satisfies these calculated values.

3.6.1 Obtaining the Rated Output Capacity of a Power Supply Module

Multiply the total continuous rated output of the spindle motors by a coefficient (1.15), and also multiply the total continuous rated output of the servo motors by a coefficient (0.6). Then, select a power supply module so that the sum of the multiplication results does not exceed the rated output capacity of the power supply module.

Rated output capacity of power supply module ≧Σ Spindle motor continuous rated output ×1.15

+Σ Servo motor continuous rated output ×0.6

When only one spindle amplifier module is connected to a power supply module, the power supply module must be selected so that the 30–minute rated output of the spindle motor does not exceed the rated output capacity of the power supply module.

Rated output capacity of a power supply module ≧ 30– minute rated output of a spindle motor

For the rated output capacities of the power supply modules, see Table 4.2.1 (a). For the continuous rated outputs of the servo motors, see Table 3.7.1. For the continuous rated outputs of spindle motors, see Table 3.7.2.

3.6.2 Obtaining the Maximum Output Capacity of a Power Supply Module

Select a power supply module so that the sum of the total maximum output of the spindle motors at acceleration and the total maximum output of simultaneously accelerated/decelerated servo motors at acceleration does not exceed the maximum output capacity of the power supply module.

Maximum output capacity of power supply module ≧Σ maximum output of spindle motors at acceleration

+Σ maximum output of servo motors at acceleration (simultaneously accelerated/decelerated axes)

For the maximum output capacities of the power supply modules, see Table 4.2.1 (a). For the maximum outputs of the servo motors at acceleration, see Table 3.7.1. For the maximum outputs of the spindle motors at acceleration, see Table 3.7.2.

3.6.3 Number of Connected Servo Amplifier Modules and Spindle Amplifier Modules

Multiple servo amplifier modules and spindle amplifier modules can be connected to a single power supply module (PSM–HV) provided the capacity of the power supply module is not exceeded.

For the number of units that can be connected, see the following table:

Table.3.6.3 Maximum Number of Modules That Can be Connected

SPM–HV	SVM–HV	
	SVM1–HV	SVM2–HV
2	6	
		4

NOTE

When the two types of servo amplifier module are used together, the result of the following expression must not exceed 6:

Total number of connected modules (6)   Number of SVM1s x 1 + number of SVM2s x 1.5

Even when no spindle amplifier module is used, the number of servo amplifier modules that can be connected remains unchanged.

3.6.4 Example of Selecting a Power Supply Module (PSM–HV)

(1) When two α12/3000HV servo motors and one α22HV spindle motor are used

Servo motor α12/3000HV

Continuous rated output : 2.8 kW

Maximum output at acceleration : 6.3 kW

Spindle motor α22HV

Continuous rated output : 22 kW

Maximum output at acceleration : 31.2 kW

Rated output capacity of power supply module ≧ Σ spindle motor continuous rated output × 1.15 + Σ servo motor continuous rated output × 0.6

$= 22 \times 1.15 + 2.8 \times 2 \times 0.6$

$= 28.66$ Condition 1

Maximum output capacity of power supply module ≧ Σ maximum output of the spindle motor at acceleration + Σ maximum output of the servo motors at acceleration (simultaneous acceleration /deceleration)

$= 31.2 + 6.3 \times 2$

$= 43.8$ Condition 2

According to conditions 1 and 2, PSM–30HV is selected as the power supply module.

3.7 LIST OF MOTOR OUTPUT CAPACITIES FOR POWER SUPPLY SELECTION

3.7.1 Servo Motor

This section gives the maximum output data at servo motor acceleration. This data is used for selecting a power supply module of the α series servo amplifier. The maximum output data at acceleration is classified into case 1 and case 2.
Case 1 is used for selection for normal (ordinary) operation.
Case 2 is used in the following cases:

(1) When the time constant is set to a value as short as the limit of motor capability
(2) When the motor is operated at the maximum allowable speed defined in the specifications

If the conventional time constant is used even when HRV control is used, case 1 is used.

Table.3.7.1 Servo Motor Continuous Rated Outputs and Maximum Outputs at Acceleration (kW) (1/2)

Motor model	Continuous rated output	Maximum output at acceleration Case 1	Maximum output at acceleration Case 2
α1/3000	0.3kW	1.0kW	1.2kW
α2/2000	0.4kW	1.3kW	1.6kW
α2/3000	0.5kW	1.4kW	1.7kW
α3/3000	0.9kW	3.0kW	3.4kW
α6/2000	1.0kW	3.8kW	4.5kW
α6/3000	1.4kW	6.9kW	8.0kW
α12/2000	2.1kW	3.3kW	3.7kW
α12/3000	2.8kW	6.2kW	6.2kW
α22/1500	2.9kW	4.3kW	6.0kW
α22/2000	3.8kW	7.5kW	9.6kW
α22/3000	4.4kW	12.3Kw	16.0kW
α30/1200	3.3kW	5.9kW	7.2kW
α30/2000	4.5kW	9.8kW	12.0kW
α30/3000	4.8kW	14.8kW	19.0kW
α40/2000	5.9kW	14.8kW	16.5kW
α40/2000 (with fan)	7.3kW	14.8kW	16.5kW
α65/2000	8.2kW	14.2kW	24.8kW

NOTE
The maximum output at acceleration is provided as data for selecting a power supply module; it is not a guaranteed value.

Table.3.7.1 Servo Motor Continuous Rated Outputs and Maximum Outputs at Acceleration (kW) (2/2)

Motor model	Continuous rated output	Maximum output at acceleration Case 1	Maximum output at acceleration Case 2
α100/2000	10.3kW	21.8kW	35.1kW
α150/2000	12.5kW	26.8kW	38.0kW
α300/1200	30kW	54kW	61kW
α400/1200	35kW	59kW	67kW
αM2/3000	0.7kW	1.9kW	2.2kW
αM2.5/3000	0.8kW	2.3kW	2.7kW
αM6/3000	1.4kW	4.8kW	5.6kW
αM9/3000	1.8kW	7.4kW	8.5kW
αM22/3000	3.8kW	11.1kW	12.6kW
αM30/3000	3.8kW	17.6kW	19.9kW
αM40/3000 (130A)	7.0KW	18.4Kw	20.7kW
αM40/3000 (with fan) (240A, 360A)	10KW	30.2kW	34kW
αC3/2000	0.3kW	1.7kW	2.0kW
αC6/2000	0.6kW	2.4kW	2.8kW
αC12/2000	1.0kW	2.0kW	2.3kW
αC22/1500	1.5kW	4.3kW	6.0kW
αL6/3000	1.4kW	2.5kW	4.2kW
αL9/3000	2.0kW	5.0kW	8.9kW
αL25/3000	3.5kW	9.8kW	17.4kW
αL50/2000	6.0kW	12.3kW	20.3kW
β0.5/3000	0.2kW	0.5kW	0.7kW
β1/3000	0.3kW	0.8kW	1.0kW
β2/3000	0.5kW	1.2kW	1.4kW
β3/3000	0.5kW	1.6kW	2.2kW
β6/2000	0.9kW	2.4kW	2.8kW
α3/3000HV	0.9kW	2.8kW	4.3kW
α6/3000HV	1.4kW	3.8kW	5.5kW
α12/3000HV	2.8kW	6.3kW	7.1kW
α22/3000HV	4.0kW	10.1kW	12.6kW
α30/3000HV	4.0kW	11.3kW	13.5kW
αM6/3000HV	1.4kW	5.0kW	5.5kW
αM9/3000HV	1.8kW	8.4kW	9.6kW
αM22/3000HV	3.8kW	11.1kW	11.2kW
αM30/3000HV	3.8kW	14.8kW	17.8kW

NOTE

The maximum output at acceleration is provided as data for selecting a power supply module; it is not a guaranteed value.

3.7.2 Spindle Motor

This section gives the maximum output data at spindle motor acceleration/deceleration. This data is used for selecting a power supply module of the α series servo amplifier. For built–in motors and motors with special specifications, refer to the relevant specifications.

Table.3.7.2 Spindle Motor Continuous Rated Outputs and Maximum Outputs at Acceleration (kW) (1/2)

Motor model	Continuous rated output	30–minute rated output	Maximum output at acceleration
α0.5	0.55kW	1.1kW (15–minute rating)	1.32kW
α1	1.5kW	2.2kW (15–minute rating)	2.64kW
α1.5	1.1kW	3.7kW (10–minute rating)	4.44kW
α2	2.2kW	3.7kW (15–minute rating)	4.44kW
α3	3.7kW	5.5kW	6.6kW
α6	5.5kW	7.5kW	9.0kW
α8	7.5kW	11.0kW	13.2kW
α12	11.0kW	15.0kW	18.0kW
α15	15.0kW	18.5kW	22.2kW
α18	18.5kW	22.0kW	26.4kW
α22	22.0kW	26.0kW	31.2kW
α30	30.0kW	37.0kW	44.4kW
α40	37.0kW	45.0kW	54.0kW
αP8	3.7kW	5.5kW	8.3kW
αP12	5.5kW	7.5kW	12.3kW
αP15	7.5kW	9.0kW	13.5kW
αP18	9.0kW	11.0kW	15.1kW
αP22	11.0kW	15.0kW	20.0kW
αP30	15.0kW	18.5kW	25.0kW
αP40	18.5kW	22.0kW	29.0kW
αP50	22.0kW	30.0kW	35.4kW
αP60	22.0kW	30.0kW	36.0kW
αC1	1.5kW	2.2kW (15–minute rating)	2.64kW
αC1.5	1.1kW	3.7kW (10–minute rating)	4.44kW
αC2	2.2kW	3.7kW (15–minute rating)	4.44kW
αC3	3.7kW	5.5kW	6.6kW
αC6	5.5kW	7.5kW	9.0kW
αC8	7.5kW	11.0kW	13.2kW
αC12	11.0kW	15.0kW	18.0kW
αC15	15.0kW	18.5kW	22.2kW
αC18	18.5kW	22.0kW	26.4kW

NOTE

The maximum output at acceleration is provided as data for selecting a power supply module; it is not a guaranteed value.

Table.3.7.2 Spindle Motor Continuous Rated Outputs and Maximum Outputs at Acceleration (kW) (2/2)

Motor model	Continuous rated output	30–minute rated output	Maximum output at acceleration
αC22	22.0kW	26.0kW	31.2kW
α6HV	5.5kW	7.5kW	9.0kW
α8HV	7.5kW	11.0kW	13.2kW
α12HV	11.0kW	15.0kW	18.0kW
α15HV	15.0kW	18.5kW	22.2kW
α18HV	18.5kW	22.0kW	26.4kW
α22HV	22.0kW	26.0kW	31.2kW
α30HV	30.0kW	37.0kW	44.4kW
α40HV	37.0kW	45.0kW	54.0kW
α60HV	60.0kW	75.0kW	90.0kW

NOTE

The maximum output at acceleration is provided as data for selecting a power supply module; it is not a guaranteed value.

4 SPECIFICATIONS

4.1 200–V INPUT SERIES

4.1.1 Power Supply Module

Table.4.1.1 (a) Power Supply Module (PSM)

Item \ Model		PSM–5.5	PSM–11 (Note1)	PSM–15	PSM–26	PSM–30	PSM–37	PSM–45 (Note1)
Power supply (Note 2)	Main circuit	AC200V/220V/230V +10%, –15%, 3ϕ 50/60Hz, ±1Hz						
	Control power	AC200V/220V/230V +10%, –15%, 1ϕ 50/60Hz, ±1Hz						
Power equipment capacity	Main circuit	9kVA	17kVA	22kVA	37kVA	44kVA	54kVA	64kVA
	Control power	0.7kVA						
Rated output capacity		5.5kW	11kW	15kW	26kW	30kW	37kW	45kW
Maximum output capacity		11kW	20kW	28kW	40kW	53kW	70kW	85kW
Control method		Regenerative control (power supply regeneration)						

NOTE
1 The PSM–11 or PSM–45 requires forced air cooling (see 2.2.3 (7) and sec.7).
2 A power transformer is necessary for voltages other than those listed in Table 4.1.1 (a).

Table.4.1.1 (b) Power Supply Module (PSMR)

Item \ Model		PSMR–3	PSMR–5.5
Power supply (Note 2)	Main circuit	AC200V/220V/230V +10%, –15%, 3ϕ 50/60Hz, ±1Hz	
	Control power	AC200V/220V/230V +10%, –15%, 1ϕ 50/60Hz, ±1Hz	
Power equipment capacity	Main circuit	5.0kVA	12kVA
	Control power	0.5kVA	
Rated output capacity		3.0kW	7.5kW
Maximum output capacity		12kW	20kW
Control method		Regenerative control (power supply regeneration) (Note 1)	

NOTE
1 The PSMR–3 and PSMR–5.5 require regenerative discharge unit.
2 A power transformer is necessary for voltages other than those listed in Table 4.1.1 (b).

[How to calculate the power equipment capacity]

Calculate the power equipment capacity using the formula below.

$$\text{Power supply capacity (kVA)} = \frac{\text{Rated capacity calculated in Section 3.3 or 3.4 (kW)}}{\text{Rated capacity of power supply module (kW)}} \times \text{Power supply capacity of power supply module having rated output (kVA)}$$

(See Table 4.1.1 (a), (b))

> **NOTE**
> Select a power supply for which, when the motor is accelerated, the input voltage variation does not exceed 7% (see Subsection 5.2.1 for details).

[How to calculate the input current of the PSM (PSMR)]

Calculate the input current of the PSM (PSMR) by using the formula below. Refer to the result when selecting the MCC, power cable, and circuit breaker 1, to be connected to the PSM input section.

$$\text{PSM input current (Arms)} = \frac{\text{Power equipment capacity (kVA)}}{\sqrt{3} \times \text{Nominal supply voltage (Vrms)}} \times 1.2 \text{ (margin)}$$

> **NOTE**
> Normally, assume the nominal supply voltage (Vrms) to be 200Vrms.

4.1.2 Servo Amplifier Module (SVM)

Table.4.1.2 (a) Specifications (common)

Item	Specifications
Main circuit control method	Sine–wave PWM control with transistor (IGBT) bridge

Table.4.1.2 (b) Specifications (individual) (1/2)

Servo amplifier module		Applicable motor model	Rated output current [Arms]	Nominal current limit [Ap]
Model name	Connection axis			
SVM1–12 SVM2–12/12 SVM2–12/20 SVM2–12/40 SVM3–12/12/12 SVM3–12/12/20 SVM3–12/20/20 SVM3–12/12/40 SVM3–12/20/40	 L, M L L L, M, N L, M L L, M L	α1/3000 α2/2000 α2/3000 β0.5/3000 β1/3000 β2/3000	3.0	12
SVM1–20 SVM2–12/20 SVM2–20/20 SVM2–20/40 SVM3–12/12/20 SVM3–12/20/20 SVM3–20/20/20 SVM3–12/20/40 SVM3–20/20/40	 M L, M L N M, N L, M, N M L, M	αM2/3000 αM2.5/3000 αC3/2000 αC6/2000 αC12/2000 β3/3000 β6/2000	5.9	20
SVM1-40S		α3/3000 α6/2000	5.9	40
SVM2-12/40 SVM2-20/40 SVM2-40/40 SVM3-12/12/40 SVM3-12/20/40 SVM3-20/20/40	M M L, M N N N	α3/3000 α6/2000 α12/2000 αC22/1500	12.5	40
SVM1-40L SVM2-40/80 SVM2–40L/40L	 L L, M	α3/3000 α6/2000 α12/2000 α22/1500 αC22/1500	12.5	40

Table.4.1.2 (b) Specifications (individual) (continued) (2/2)

Servo amplifier module: Model name	Servo amplifier module: Con-nection axis	Applicable motor model	Rated output current [Arms]	Nominal current limit [Ap]
SVM1-80 SVM2-40/80 SVM2-80/80	 M L, M	α6/3000 α12/3000 α22/2000 α30/1200 αM6/3000 αM9/3000 αL6/3000 αL9/3000	18.7	80
SVM1-130		α30/2000 α40/2000 αM22/3000 αM30/3000	27.9	130
		α22/3000 α30/3000 α40/2000 (with FAN) αL25/3000 αL50/2000 αM40/3000 (Note 3)	52.2	
SVM1–240		α65/2000 αM40/3000 (Note 3)	98.0	240
SVM1–240 (2 units used)		α300/1200 α400/1200	98.0	240
SVM1–360		α100/2000 α150/2000 αM40/3000 (Note 3)	115.0	360

NOTE

1 The current limit (peak value) is a standard value. It varies by about ±10%, depending on the circuit constants.

2 The SVM1–130 requires forced air cooling when driving the α22/3000, α30/3000, α40/2000 (with a fan), αL25/3000, or αL50/2000 or αM40/3000. In this case, the rated output current is 52.2Arms. See 2.2.3 (7) and section 7.

3 αM40/3000 can be driven by several servo amplifier models. For selection, refer to ”FANUC AC Servo Motor α Series” (B–65142E).

4.1.3 Spindle Amplifier Module

Table.4.1.3 (a) Spindle amplifier module

Item \ Model	SPM–2.2	SPM–5.5	SPM–11 (Note)	SPM–15	SPM–22	SPM–26	SPM–30	SPM–45 (Note)
Rated output	13A	27A	48A	63A	95A	111A	133A	198A
Main circuit control method	Sine–wave PWM control with transistor (IGBT) bridge							
Feedback method	Velocity feedback with pulse generator							
Speed control range	Speed ratio 1:100							
Speed variation rate	0.1% or less of maximum speed (load variation: 10% to 100%)							
Applicable motors (typical examples)	α0.5 α1	α1.5 to α3	α6 α8 αP12	α12 αP15 αP18	α15 α18 αP22 αP30	α22 αP40 αP50	αP60	α30 α40

NOTE
The SPM–11 or SPM–45 requires forced air cooling (See 2.2.3 (7) and sec. 7.1).

Table.4.1.3 (b) αC Series Spindle Amplifier Modules (SPMC)

Item \ Model	SPMC–2.2	SPMC–5.5	SPMC–11 (Note)	SPMC–15	SPMC–22	SPMC–26
Rated output	13A	27A	48A	63A	95A	111A
Main circuit control method	Sine–wave PWM control with transistor (IGBT) bridge					
Speed control range	Speed ratio 1:50					
Speed variation rate	1% or less of maximum speed (load variation: 10% to 100%)					
Applicable motors (typical examples)	αC1	αC1.5 αC2 αC3	αC6 αC8	αC12	αC15 αC18	αC22

NOTE
When SPMC–11 is used, forced air cooling from the outside is required. See Chapter 7.

4.2 400–V INPUT SERIES

4.2.1 Power Supply Module

Table.4.2.1 (a) Power Supply Module (PSM–HV)

Item \ Model		PSM–18HV	PSM–30HV	PSM–45HV	PSM–75HV (Note1)
Power supply (Note 2)	Main circuit	AC400V/460V +10%, –15%, 3ϕ 50/60Hz, ±1Hz			
	Control power	AC200V/220V/230V +10%, –15%, 1ϕ 50/60Hz, ±1Hz			
Power equipment capacity	Main circuit	26kVA	44kVA	64kVA	107kVA
	Control power	0.7kVA			
Rated output capacity		18kW	30kW	45kW	75kW
Maximum output capacity		35kW	60kW	85kW	120kW
Control method		Regenerative control (power supply regeneration)			

NOTE
1 When the PSM–75HV is being used, forced air cooling from the outside is required. See (7) in Section 2.2.3 and Chapter 7.
2 If the power supply voltage is beyond the indicated range, a power transformer is required.
3 The PSM–HV models always require a capacitor module (PSMC–HV) listed below.

Table.4.2.1 (b) Capacitor Modules (PSMC–HV)

Item \ Model	PSMC–18HV	PSMC–30HV	PSMC–45HV
Rated voltage	AC566V/650V +10%,–15%		
Applicable PSM	PSM–18HV	PSM–30HV	PSM–45HV PSM–75HV

Table.4.2.1 (c) Power Supply Module (PSMV–HV)

Item		PSMV–11HV (Note 2)
Power supply (Note 1)	Main circuit	AC400V/460V +10%,–15%, 3φ 50/60Hz, ±1Hz
	Control power	AC200V/220V/230V +10%, –15%, 1φ 50/60Hz, ±1Hz
Power equipment capacity	Main circuit	31kVA
	Control power	0.7kVA
Rated output capacity		11kW
Maximum output capacity		20kW
Control method		Regenerative control (power supply regeneration)

NOTE
1 If the power supply voltage is beyond the indicated range, a power transformer is required.
2 PSMV–HV always requires an AC reactor unit.

[How to calculate the power equipment capacity]

Calculate the power equipment capacity using the formula below.

$$\text{Power supply capacity (kVA)} = \frac{\text{Rated capacity calculated in Section 3.5 or 3.6 (kW)}}{\text{Rated capacity of power supply module (kW)}} \times \text{Power supply capacity of power supply module having rated output (kVA) (See Table 4.2.1 (a), (c))}$$

NOTE
Select a power supply for which, when the motor is accelerated, the input voltage variation does not exceed 7% (see Subsection 5.2.1 for details).

[How to calculate the input current of the PSM (PSMR) – HV]

Calculate the input current of a PSM(PSMV)HV from the expression below. Based on the obtained input current value, select the equipment to be installed in the PSM input section, such as circuit breaker 1, MCC, and power cable. (Margin for selection: 1 to 1.5 times)

$$\text{PSM input current (Arms)} = \frac{\text{Power equipment capacity (kVA)}}{\sqrt{3} \times \text{Nominal supply voltage (Vrms)}} \times 1.2 \text{ (margin)}$$

NOTE
Normally, assume the nominal supply voltage (Vrms) to be 400Vrms.

4.2.2 Servo Amplifier Module (SVM–HV)

Table.4.2.2 (a) Specifications (common)

Item	Specifications
Main circuit control method	Sine–wave PWM control with transistor (IGBT) bridge

Table.4.2.2 (b) Specifications (individual)

Servo amplifier module		Applicable motor model	Rated output current [Arms]	Nominal current limit [Ap]
Model name	Connection axis			
SVM1–20HV SVM2–20/20HV SVM2–20/40HV SVM2–20/60HV	 L–and M–axes L–axes L–axes	α3/3000HV α6/3000HV	3.6	20
SVM1–40HV SVM2–20/40HV SVM2–40/40HV SVM2–40/60HV	 M–axes L–and M–axes L–axes	α12/3000HV αM6/3000HV αM9/3000HV	12.6	40
SVM1–60HV SVM2–20/60HV SVM2–40/60HV SVM2–60/60HV	 M–axes M–axes L–and M–axes	α22/3000HV α30/3000HV αM22/3000HV αM30/3000HV	16.3	60

NOTE

The current limit (peak value) is the standard setting. The operating value variation due to, for example, a circuit constant is approximately ± 10%.

4.2.3 Spindle Amplifier Module

Table.4.2.3 Spindle amplifier module

Item \ Model	SPM–11HV (Note)	SPM–15HV	SPM–26HV	SPM–45HV	SPM–75HV (Note)
Rated output	23A	32A	55A	100A	170A
Main circuit control method	Sine–wave PWM control with transistor (IGBT) bridge				
Feedback method	Velocity feedback with pulse generator				
Speed control range	Speed ratio 1:100				
Speed variation rate	0.1% or less of maximum speed (load variation: 10% to 100%)				
Applicable motors	α6HV α8HV	α12HV	α15HV α18HV α22HV	α30HV α40HV	α60HV

NOTE

When SPM–11HV or SPM–75HV is used, forced air cooling from the outside is required. See (7) in Section 2.2.3 and Chapter 7.

4.3 WEIGHT

4.3.1 Power Supply Modules

Table.4.3.1 (a) Power Supply Modules

Model	Weight
PSM–5.5	6.3kg
PSM–11	5.4kg
PSM–15,26,30,37	10.7kg
PSM–45	22.0kg
PSMR–3	2.6kg
PSMR–5.5	4.3kg
PSM–18HV,30HV,45HV	11.0kg
PSM–75HV	22.0kg
PSMV–11HV	10.5kg

Table.4.3.1 (b) Capacitor Modules

Model	Weight
PSMC–18HV,30HV	4.0kg
PSMC–45HV	6.5kg

Table.4.3.1 (c) AC Reactors and AC Line Filters

Model	Weight
A81L–0001–0122 (For PSM–5.5, 11)	4.5kg
A81L–0001–0123 (For PSM–15)	6.5kg
A81L–0001–0120 (For PSM–26)	9.5kg
A81L–0001–0124 (For PSM–30)	9.2kg
A81L–0001–0147 (For PSM–37)	16.5kg
A81L–0001–0133 (For PSM–45, 75HV)	38.0kg
A81L–0001–0127 (For PSM–18HV, 30HV, 45HV)	15.0kg
A81L–0001–0083#3C (For PSMR–3)	1.1kg
A81L–0001–0101#C (For PSMR–5.5)	3.0kg

Table.4.3.1 (d) AC Reactor Unit

Model	Weight
A06B–6098–H001 (For PSMV–11HV)	17.0kg

4.3.2 Servo Amplifier Modules

Table.4.3.2 Servo Amplifier Modules

Model	Weight
SVM1–12,20	2.2Kg
SVM1–40S,40L,80	4.8Kg
SVM1–130	6.5Kg
SVM1–240,360	10.7Kg
Dynamic brake module (DBM) for SVM1–240, 360	5.4Kg
SVM2–12/12,12/20,20/20	2.8Kg
SVM2–12/40,20/40,40/40	5.5Kg
SVM2–40/80,80/80,40L/40L	7.0Kg
SVM3–12/12/12,12/12/20,12/20/20,20/20/20	4.1Kg
SVM3–12/12/40,12/20/40,20/20/40	6.5Kg
SVM1–20HV,40HV,60HV	6.0Kg
SVM2–20/20HV,20/40HV SVM2–20/60HV,40/40HV,40/60HV,60/60HV	7.5Kg

4.3.3 Spindle Amplifier Modules

Table.4.3.3 Spindle Amplifier Modules

Model	Weight
SPM–2.2 (TYPE1, 2, 4), SPMC–2.2	4.9Kg
SPM–5.5 (TYPE1, 2, 4), SPMC–5.5, 11	6.1Kg
SPM–11 (TYPE1, 2, 4)	5.4Kg
SPM–15, 26, 30 (TYPE1, 2, 3, 4), SPM–11 (TYPE3) SPMC–15, 22, 26	10.7Kg
SPM–45 (TYPE1, 2, 3, 4)	22Kg
SPM–11HV (TYPE1, 2, 4)	4.6Kg
SPM–15HV, 26HV, 45HV (TYPE1, 2, 4)	11Kg
SPM–75HV (TYPE1, 2, 3, 4)	22Kg

5 INSTALLATION

5.1 ENVIRONMENTAL CONDITIONS

The servo amplifier α series must be installed in a sealed type cabinet to satisfy the following environmental requirements:

(1) Ambient Temperature

Ambient temperature of the unit : 0 to 55°C (at operation)
–20 to 60°C
(at keeping and transportation)
Ambient temperature of the storage cabinet : 0 to 45°C

(2) Humidity

Normally 90% RH or below, and condensation–free

(3) Vibration

In operation : Below 0.5G

(4) Atmosphere

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

(5) Notes on Installation

The αseries 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 cutting fluid, 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.

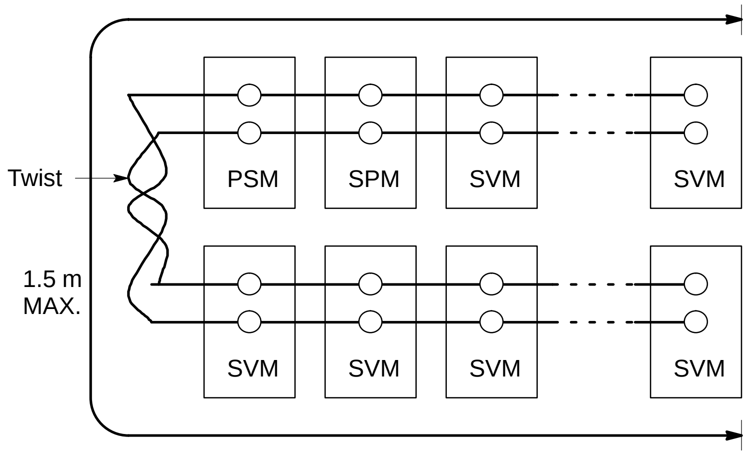
NOTE
Install the electronic circuits in an environment of contamination level 2 as defined in IEC 60664–1. To achieve contamination level 2 in a severe environment where machine tools are used, electronic circuits generally need to be installed in a cabinet complying with IP54.

(b) No dust or cutting fluid 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.

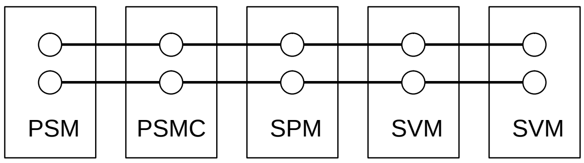
(e) The length of the DC link cable must not exceed 1.5 m (see the figure below).



(f) Each amplifier must be installed vertically.

(g) When a PSM–HV is used, the following module layout restrictions are imposed:

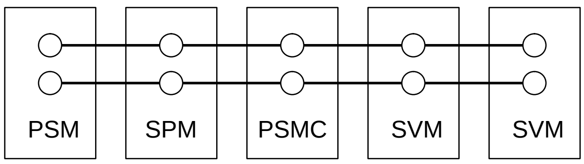
- When PSM–18HV, PSM–30HV, or PSM–45HV is used



Install modules in the order of the PSM, PSMC, SPM, then SVM.

Do not install the modules for apart from each other; install them side–by–side.

- When the PSM–75HV is used



Install modules in the order of the PSM, SPM, PSMC, then SVM.

Do not install the modules far apart from each other; install them in series.

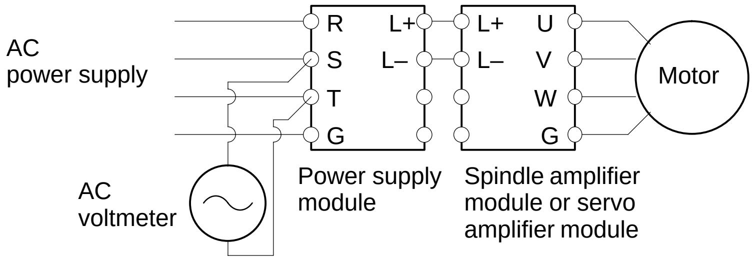
5.2 INPUT POWER AND GROUNDING

5.2.1 Input Power

(1) 200–V power supply

- Nominal voltage rating : 200/220/230 VAC
- Allowable voltage deviation : –15% to +10% (including Voltage deviation due to load)
- Power frequency : 50/60 Hz
- Allowable frequency deviation : +1 Hz
- Power supply unbalance : ±5% of the rated voltage or less
- Power supply inpedance : Voltage deviation due to load (at maximum output) shall be 5% or less.

[Method to check power impedance]



$$\frac{E_0 - E_1}{E_0} \times 100(\%) < 7(\%)$$

where,
E_0 : Voltage at motor stop
E_1 : Voltage during motor acceleration or voltage immediately before the start of speed reduction with the application of load

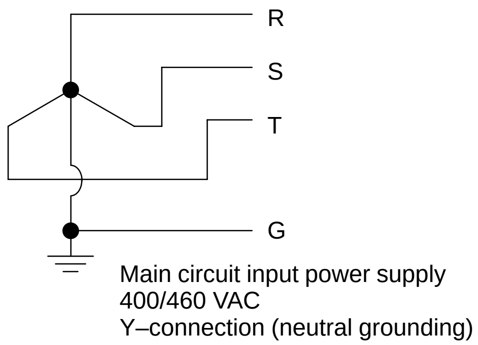
- Turn on the control power supply (CX1A power supply input) of the power supply module (PSM or PSMR) at the same time or earlier than the CNC.
- It is recommended that a capacitor unit for power–factor improvement not be installed. This is because the capacitor unit for power–factor improvement may adversely affect power regeneration.
- 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.
- When the power supply is used in an area where the input voltage is not within the range of 200 to 230 VAC, a power transformer is required. When a power transformer is to be provided by the user, the power must satisfy the specifications listed below. For transformers manufactured by FANUC, see (6) in Section 2.2.3.

Table.5.2.1 Transformer Specifications

	PSMR–3 (2 kW output)	PSMR–3 (3 kW output)	PSM–5.5 PSMR–5.5 (5.5 kW output)	PSM–11 PSMR–5.5 (7.5 kW output)	PSM–15	PSM–26	PSM–30	PSM–37 PSM–45
Rated capacity kVA	3.5	5	9	17	22	37	44	64
Secondary current A	10	14	26	48	62	105	130	185
Secondary output voltage	200V							
Secondary voltage regulation	5%							
Secondary voltage deviation	±3%							

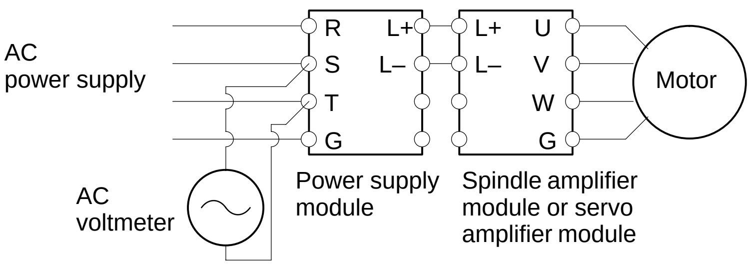
(2) 400–V power supply

- Nominal rated voltage : 400/460 VAC
  Neutral grounding is required.



- Allowable voltage change width : –15% to +10% (including voltage change due to the load)
- Power supply frequency : 50/60 Hz
- Allowable change width : ± 1 Hz
- Power supply unbalance : ± 5% of the rated voltage or less
- Power supply impedance : Voltage change due to the load (at maximum output) is 7% or less.

[Method to check power impedance]



$$\frac{E_0 - E_1}{E_0} \times 100(\%) < 7(\%)$$

where,
E_0 : Voltage at motor stop
E_1 : Voltage during motor acceleration or voltage immediately before the start of speed reduction with the application of load

- Turn on the control power supply (CX1A power supply input) of a power supply module (PSM–HV or PSMV–HV) at the same time or earlier than the CNC.
- The motor rated output 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.
- 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.

5.2.2 Leakage Current

The servo amplifier α series drives the motor by using the transistor PWM inverter method. This causes a high–frequency leakage current to flow via the ground drift capacitance in the motor winding, power cable, and amplifier. This may cause a device installed on the power supply side, such as a ground fault interrupter or leakage–protection relay, to malfunction.

When a circuit breaker with a ground fault interrupter is used, it must be selected so that the sum of the values calculated according to (a) and (b) described below is not greater than the non–operating current value.

(a) Selection criterion per amplifier

Model : SVM and SPM (both except the HV series) (NOTE 1), SPMC

Criterion for selection : 2 mA per amplifier (NOTE 2)

(b) Selection criterion per motor

Criterion for selection : 1 mA per motor (NOTE 2)

The following example shows how to use selection criteria (a) and (b):

Example : When the system consists of SMV1 × 1, SVM3 × 1 (three motors), and SPM × 1

2 mA × 3 (for the amplifiers) + 1 mA × 5 (for the motors) = 11 mA

→ Select a circuit breaker (NOTE 3) with a non–operating current of 11 mA or higher. (A general ground fault interrupter that can be used for the above example is the one with a rated sensitivity current of 30 mA and a non–operating current of 15 mA.)

NOTE

1 In the 400–V input series, the power supply is grounded by neutral grounding, so there is no leakage current that would cause a circuit breaker with a ground fault interrupter, connected on the power supply side, to malfunction.

2 These criteria are for selecting a circuit breaker with a ground fault interrupter; they do not indicate accurate leakage currents.

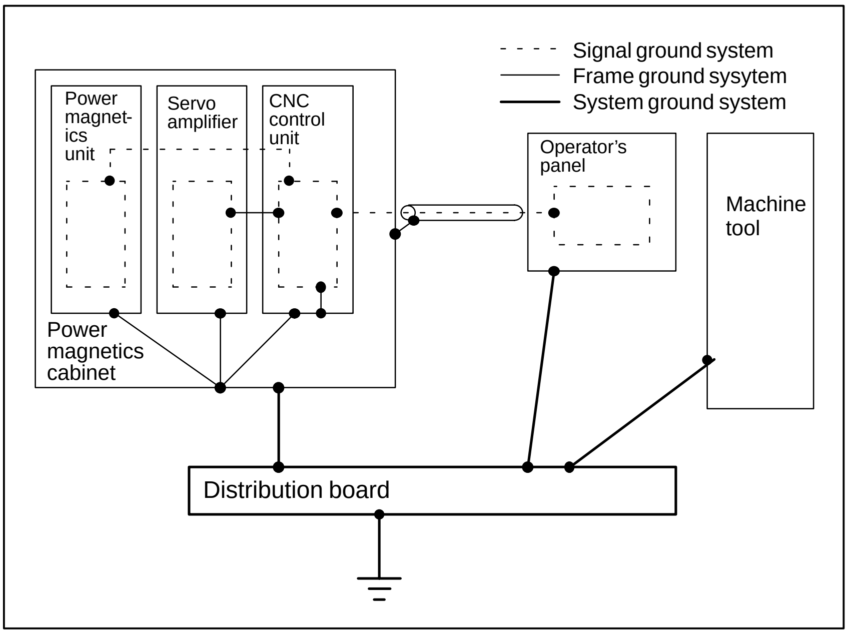
3 A circuit breaker may malfunction depending on the frequency characteristic of the ground fault interrupter. Therefore, use a ground fault interrupter supporting the use of inverters.

4 The above criteria are values in the commercial frequency band. Some measuring instruments for measuring leakage current may sense a high frequency band, thus showing a larger value.

5.2.3 Ground

The following ground systems are provided for the CNC machine tool:

- **Signal ground system (SG)**
  The signal ground (SG) supplies the reference voltage (0 V) of the electrical signal system.
- **Frame ground system (FG)**
  The frame ground system (FG) is used for safety, and suppressing external and internal noises. In the frame ground system, the frames, cases of the units, panels, and shields for the interface cables between the units are connected.
- **System ground system**
  The system ground system is used to connect the frame ground systems connected between devices or units with the ground.



[Notes on connecting the ground systems]

- Connect the signal ground with the frame ground (FG) at only one place in the power supply module.
- The grounding resistance of the system ground shall be 100 ohms or less (class 3 grounding).
- The system ground cable must have enough cross–sectional area to safely carry the accidental current flow into the system ground when an accident such as a short circuit occurs.
  (Generally, it must have the cross–sectional area of the AC power cable or more.)
- Use the cable containing the AC power wire and the system ground wire so that power is supplied with the ground wire connected.

(1) Grounding of each module

(a) Power supply module

Connect the ground terminal of connector CX1A to the frame ground. This acts as the signal ground. Connect the ground terminal of the metal frame to the frame ground.

(b) Servo amplifier module and spindle amplifier module

Connect the ground cable of the motor power cable to a ground terminal of the terminal block of the module. Connect the other ground terminal of the terminal block to the frame ground. Connect the ground terminal of the metal frame to the frame ground.

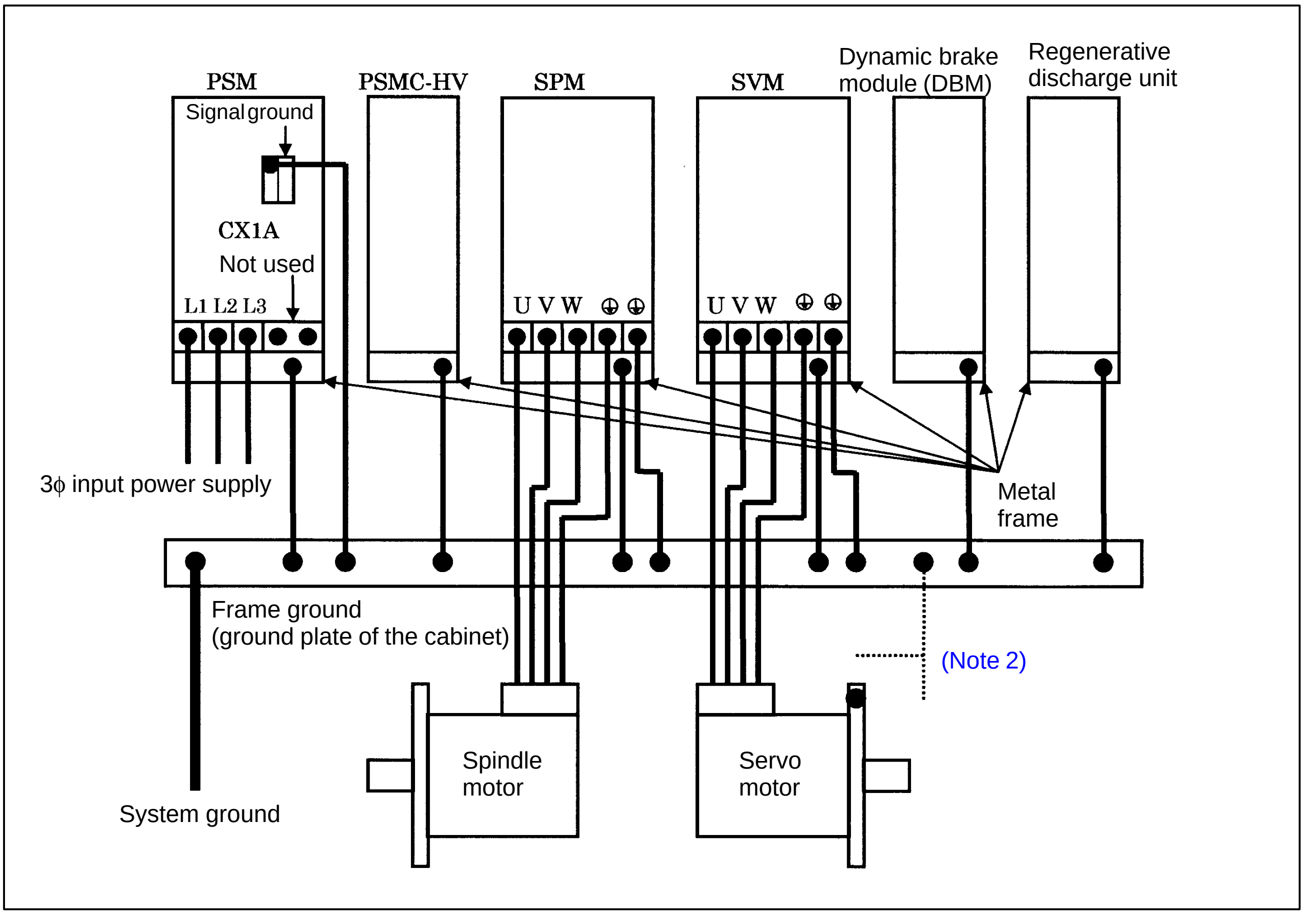
(c) PSMC–HV, regenerative discharge unit, and DBM

Connect the ground terminal of the metal frame to the frame ground.

NOTE

1 Securing the ground terminal and a cable together is not permitted.

2 When using an SVM–HV, always attach the motor flange to the cabinet (machine) connected to the system ground. In cases where it is difficult to attach the motor flange to the cabinet (machine) connected to the system ground, connect the motor flange and frame ground (the ground plate of the cabinet) with a 1.25–mm^2 or larger cable which should be separated from the power cable as far as possible. (The dotted line in the figure below)



(2) Grounding the power supply module

Detailed examples of grounding the power supply module are given on the following pages. The cable thickness specifications are as follows:

(a) Cable between connector CX1A and the frame ground of the cabinet: 1.25 mm^2

(b) Cable between the metal frame of the module and the frame ground of the cabinet: As indicated in the table below.

Table.5.2.3 (a) Diameter of PSM ground cable (between the metal frame of the module and the frame ground)

Cross–sectional area of power line	Cross–sectional area of ground cable
S≦5.5	5.5 or more
5.5<S≦16	S or more
16<S≦35	16 or more
S>35	S/2 or more

(c) Cables connecting the terminal blocks and metal frames of the servo amplifier and spindle amplifier modules to the cabinet frame ground.

Determine the cross–sectional area of the cables according to Table 5.2.3 (b).

Table.5.2.3 (b) Cross–Sectional Areas of SPM and SVM Ground Cables

Cross–sectional area of power cable S (mm^2)	Cross–sectional area of ground cable (mm^2)
S≦5.5	5.5 or more
5.5<S≦16	S or more
16<S≦35	16 or more
S>35	S/2 or more

(d) Cable connecting the metal frame of the dynamic brake module (DBM) to the frame ground of the cabinet

Determine the cross–sectional area according to Table 5.2.3 (b). The cross–sectional area of the power cable in the table matches the cross–sectional area of the power cable used in the unit to which the DBM is connected.

> **NOTE**
> The following M5 crimp terminal can be used for thick cables:
> CB22–5S manufactured by NICHIFU Co., Ltd.
> Applicable cable thickness: 16.78 to 22.66 mm^2

(3) Examples of grounding

PSM–5.5, PSM–11

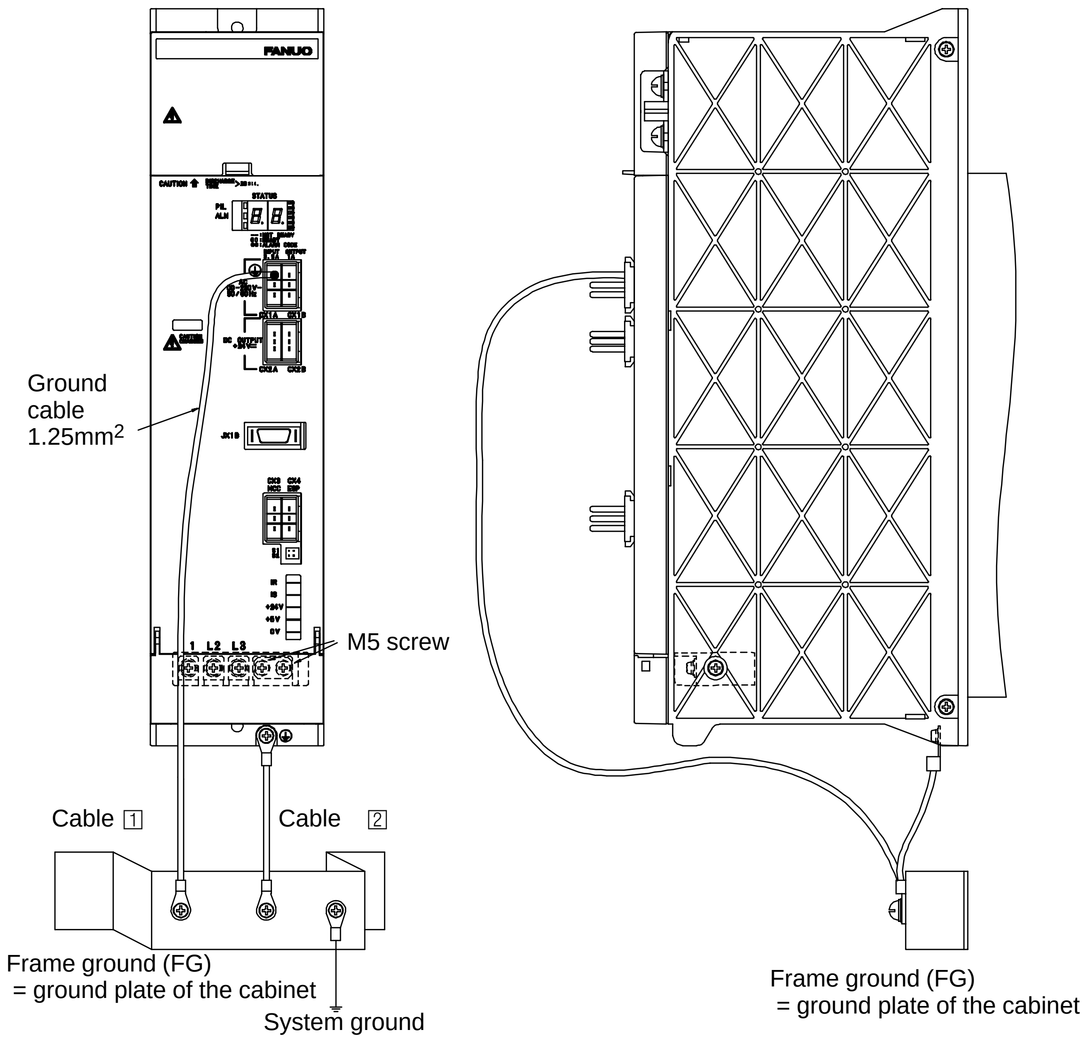


Fig.5.2.3 (a) Ground Cable Connection (PSM–5.5, 11)

PSM–15 to 37, 18HV to 45HV, PSMV–11HV

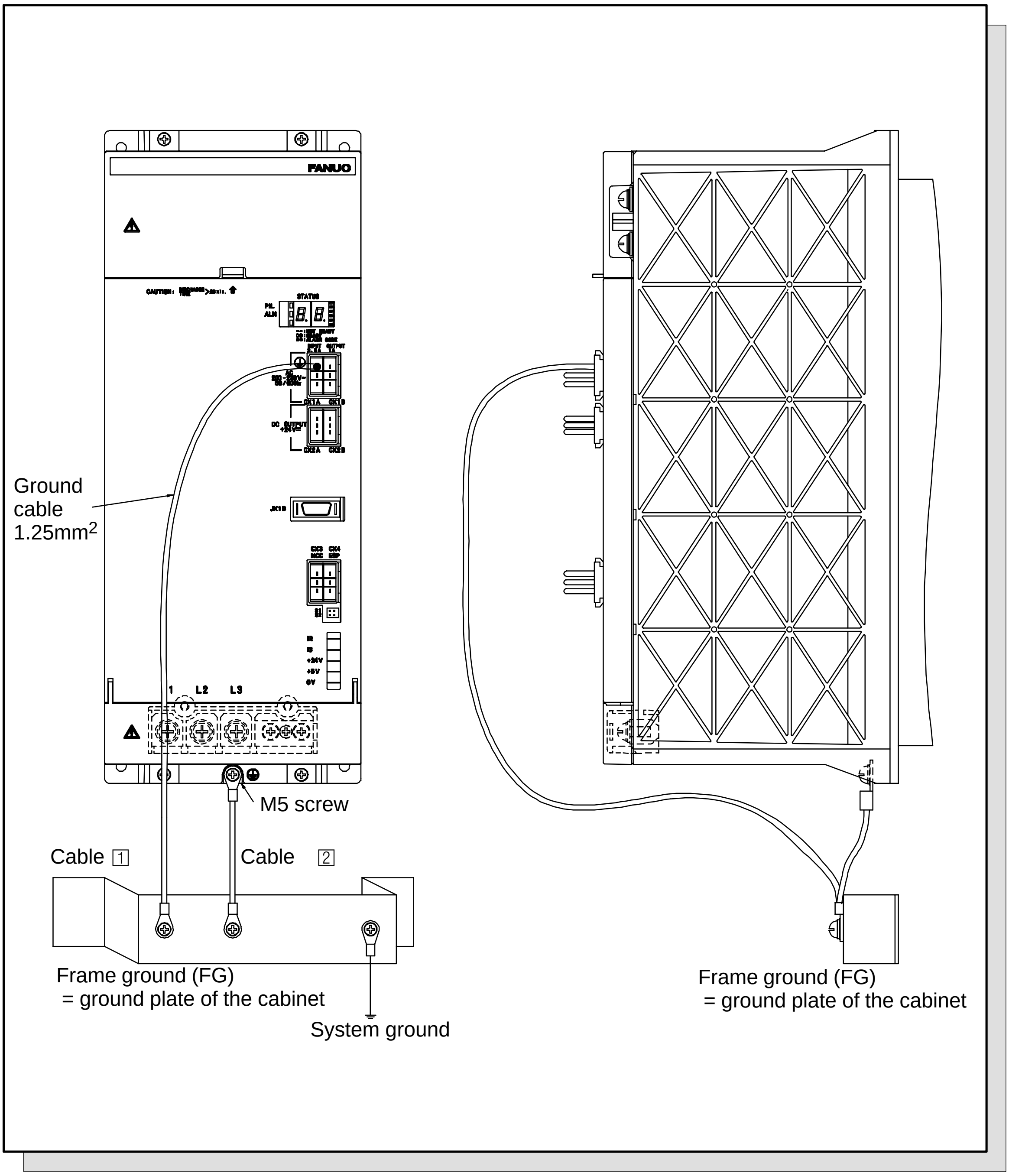


Fig.5.2.3 (b) Ground Cable Connection (PSM–15 to 37, 18HV to 45HV, and PSMV–11HV)

Ground Cable Connection (PSM–45, 75HV)

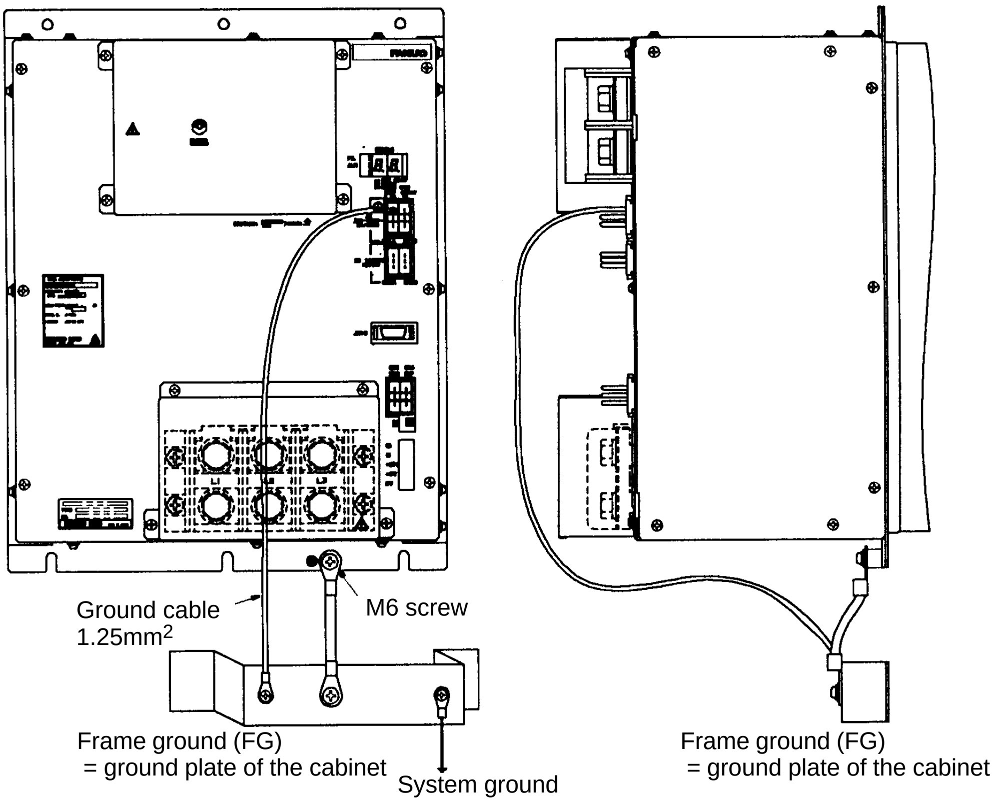


Fig.5.2.3 (c) Ground Cable Connection (PSM–45, 75HV)

PSMR–3, PSMR–5.5

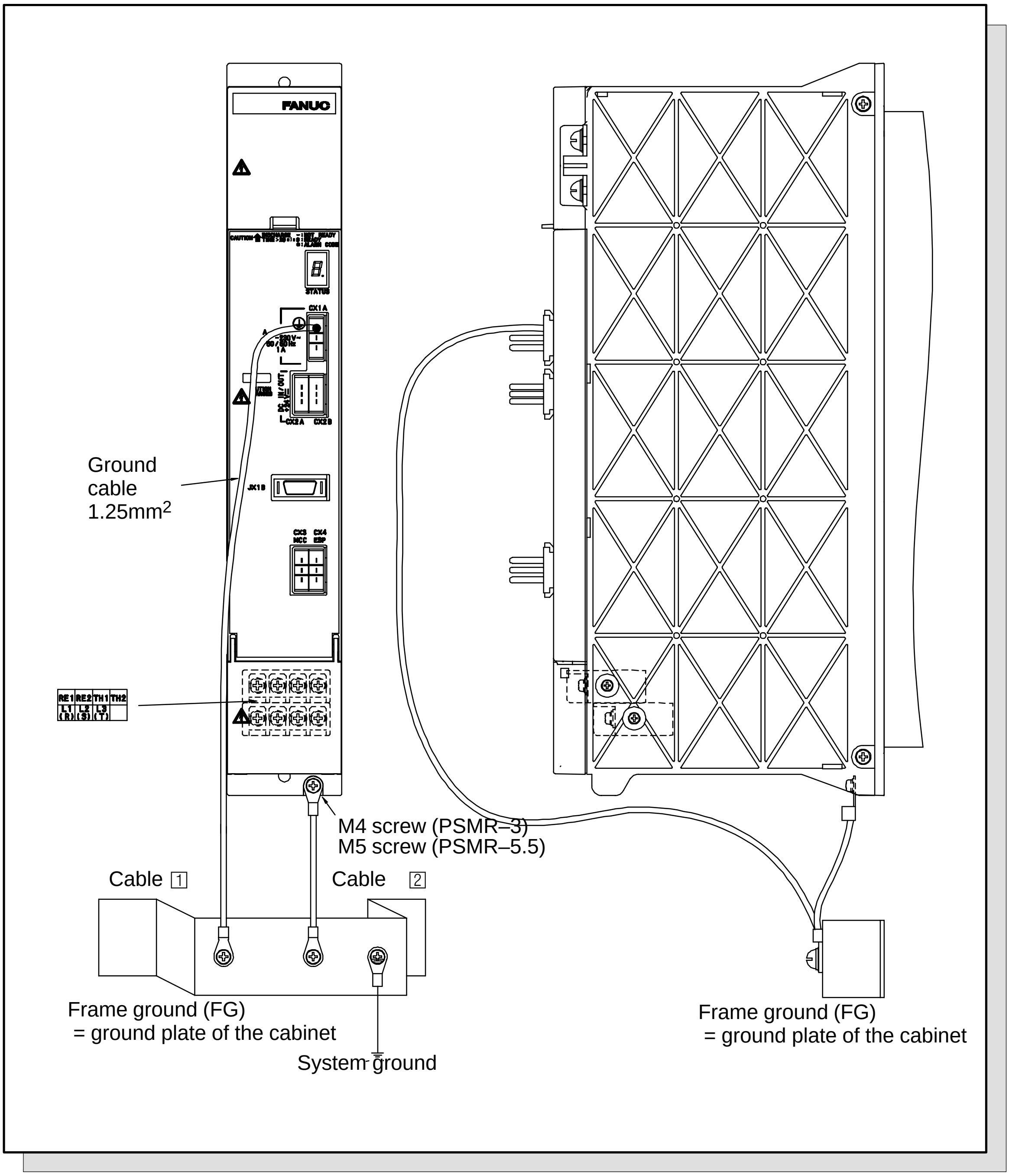


Fig.5.2.3 (d) Ground Cable Connection (PSMR–3, 5.5)

> **NOTE**
> For the PSMR–3, the heat sink is not exposed.

Ground Cable Connection (SVM1–12, 20, 40S, 40L, 80)

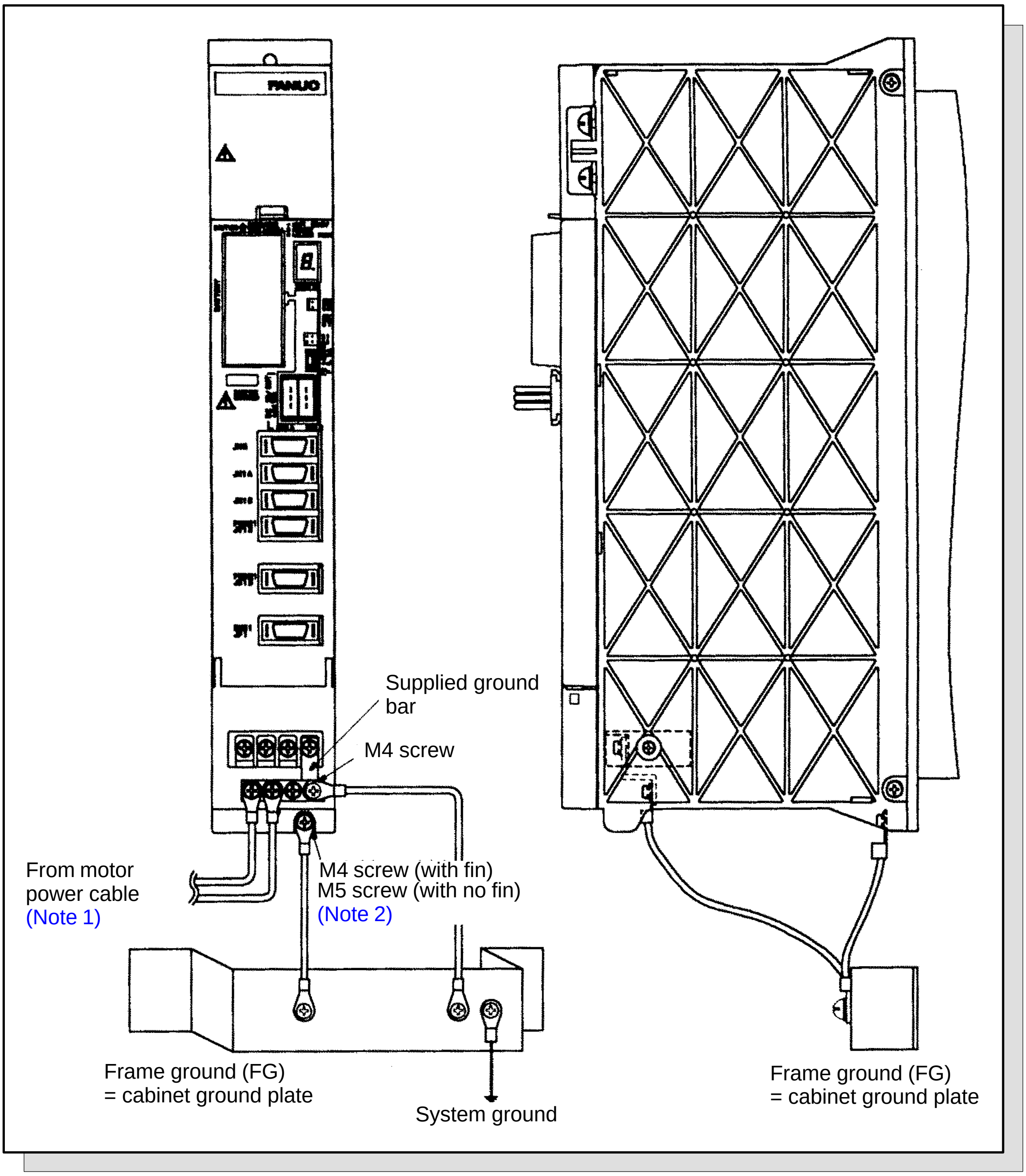


Fig.5.2.3 (e) Ground Cable Connection (SVM1–12, 20, 40S, 40L, 80)

NOTE
1 A motor has one or two ground cables.
2 Type with no external fin: SVM1–12, 20
Type with external fin: SVM1–40S, 40L, 80

Ground Cable Connection (SVM1–130, 20HV, 40HV, 60HV)

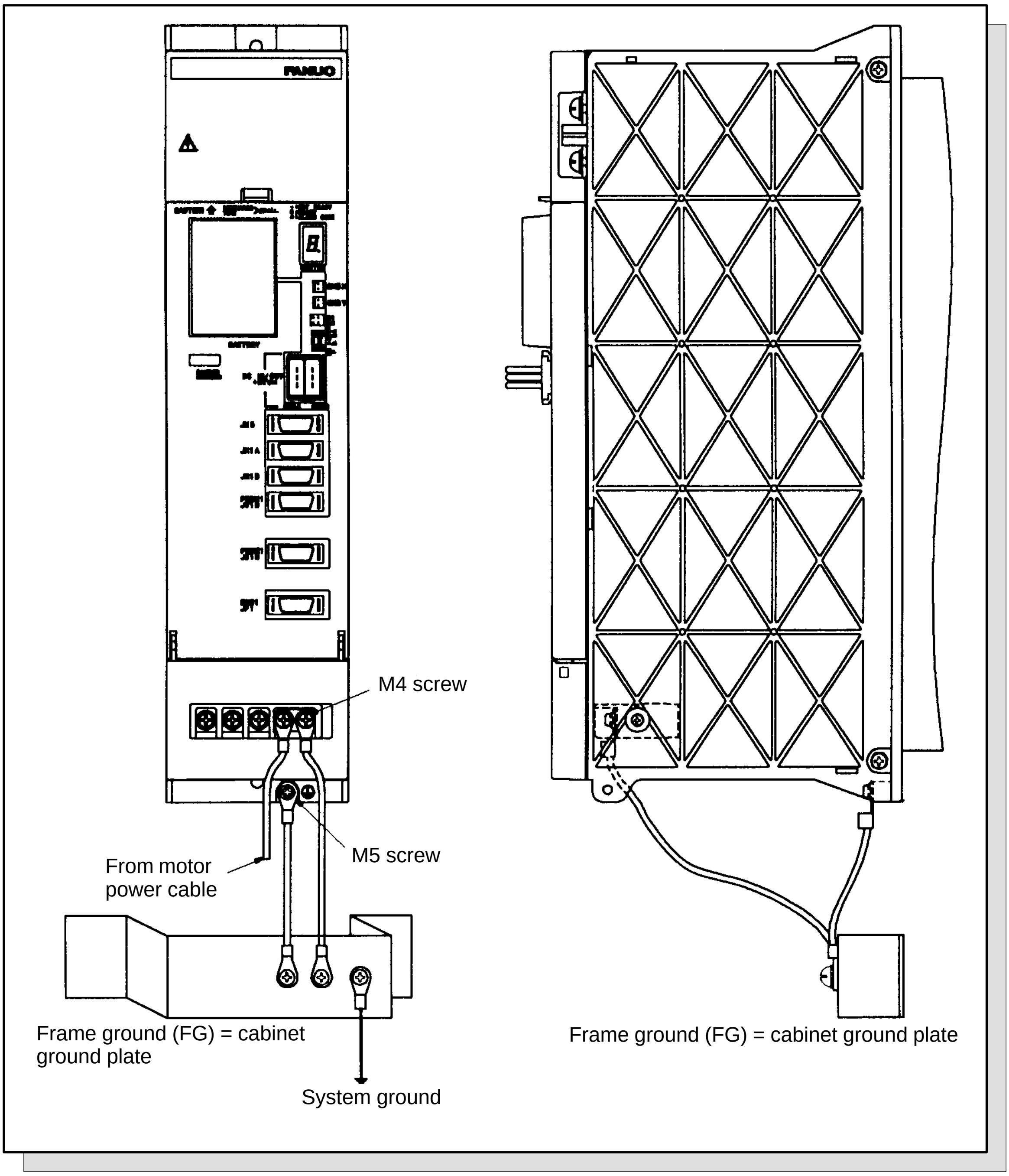


Fig.5.2.3 (f) Ground Cable Connection (SVM1–130, 20HV, 40HV, 60HV)

Ground Cable Connection (SVM1–240, 360)

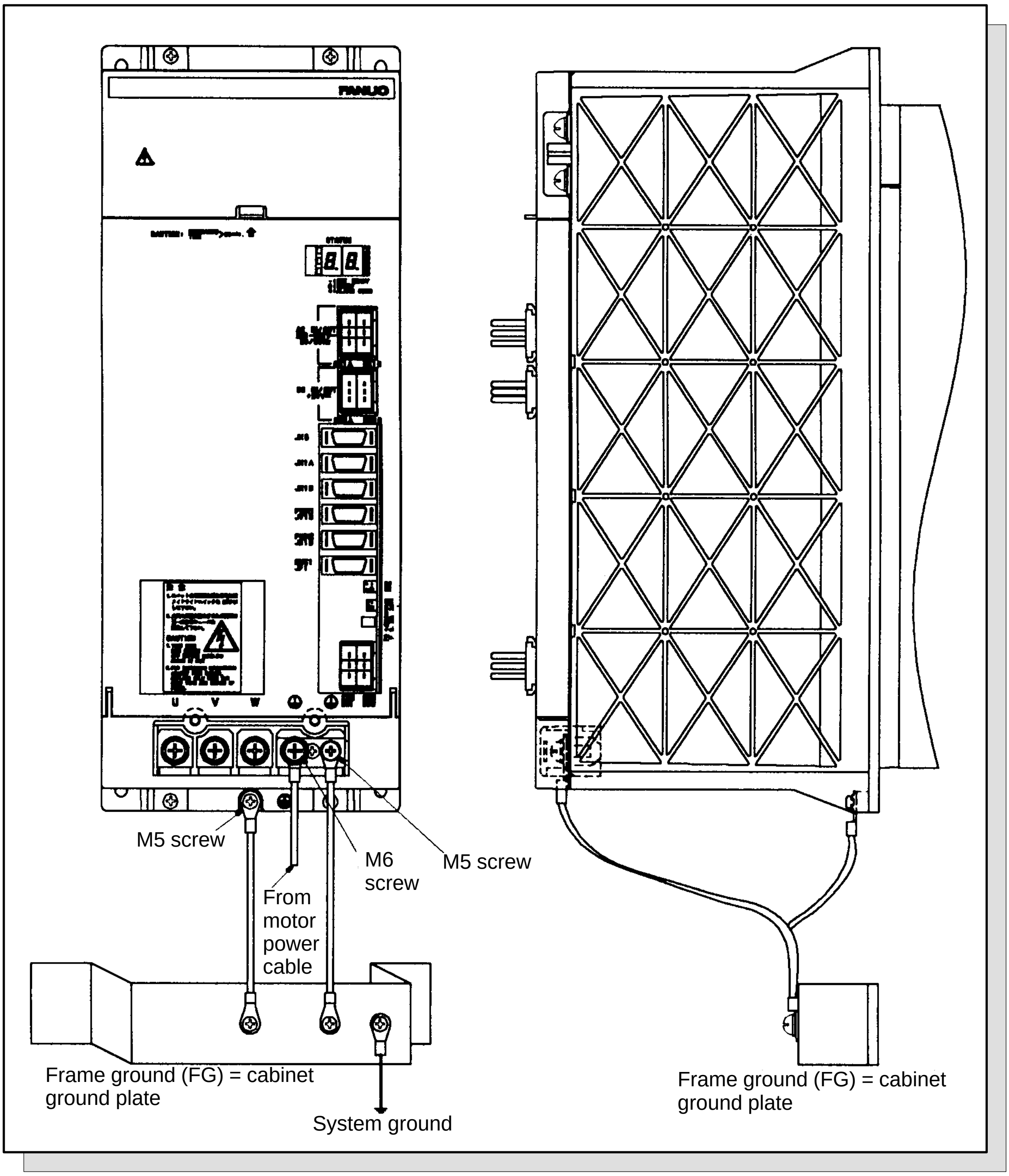


Fig.5.2.3 (g) Ground Cable Connection (SVM1–240, 360)

Ground Cable Connection (SVM2–12/12, 12/20, 20/20, 12/40, 20/40, 40/40)

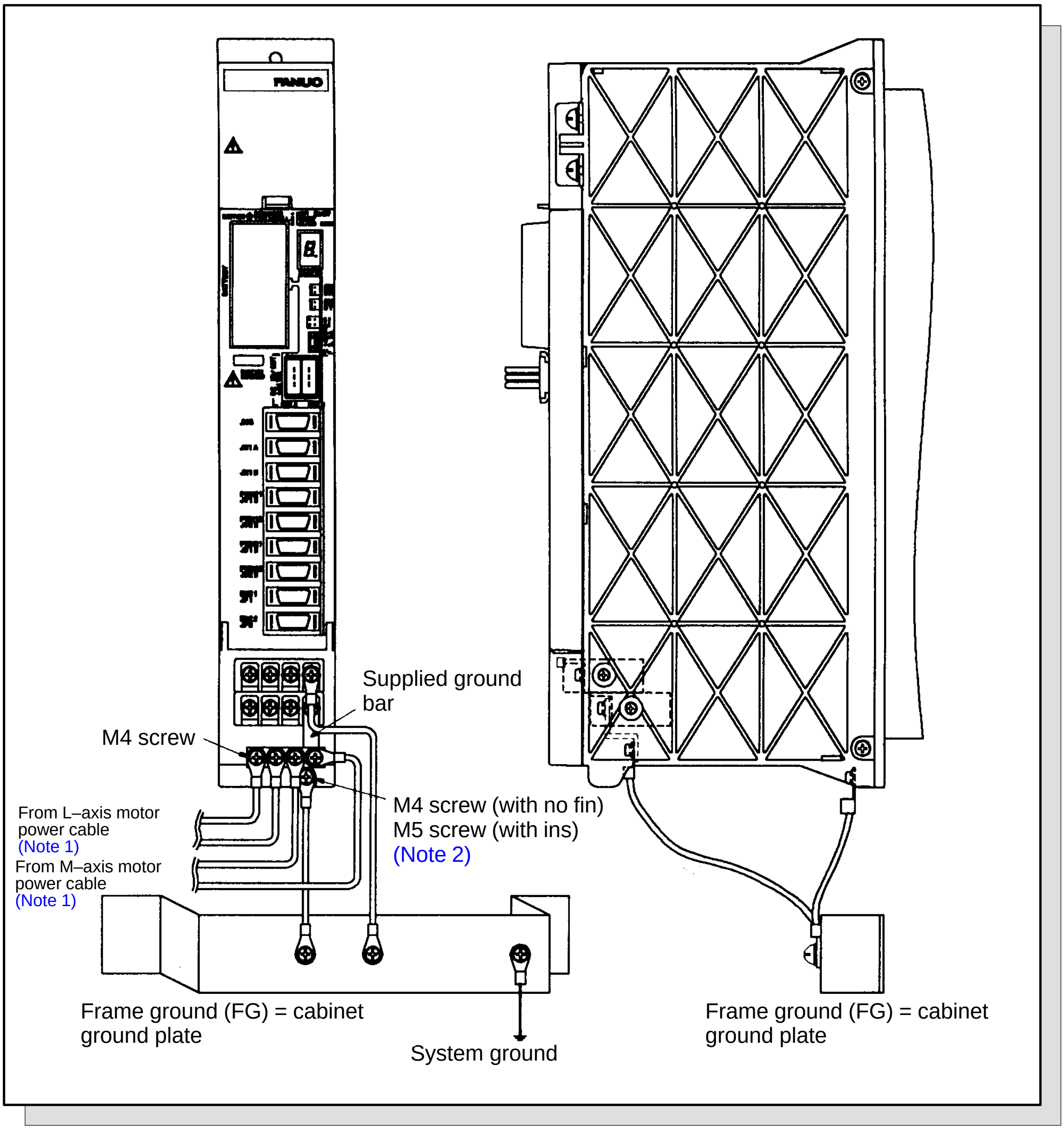


Fig.5.2.3 (h) Servo amplifier module (SVM2–12/12, 12/20, 20/20, 12/40, 20/40, 40/40)

> **NOTE**
> 1 A motor has one or two ground cables.
> 2 Type with no external fin: SVM2–12/12, 12/20, 20/20
> Type with external fin: SVM2–12/40, 20/40, 40/40

Ground Cable Connection (SVM2–40/80, 80/80, 40L/40L, 20/20HV, 20/40HV, 20/60HV, 40/40HV, 40/60HV, 60/60HV)

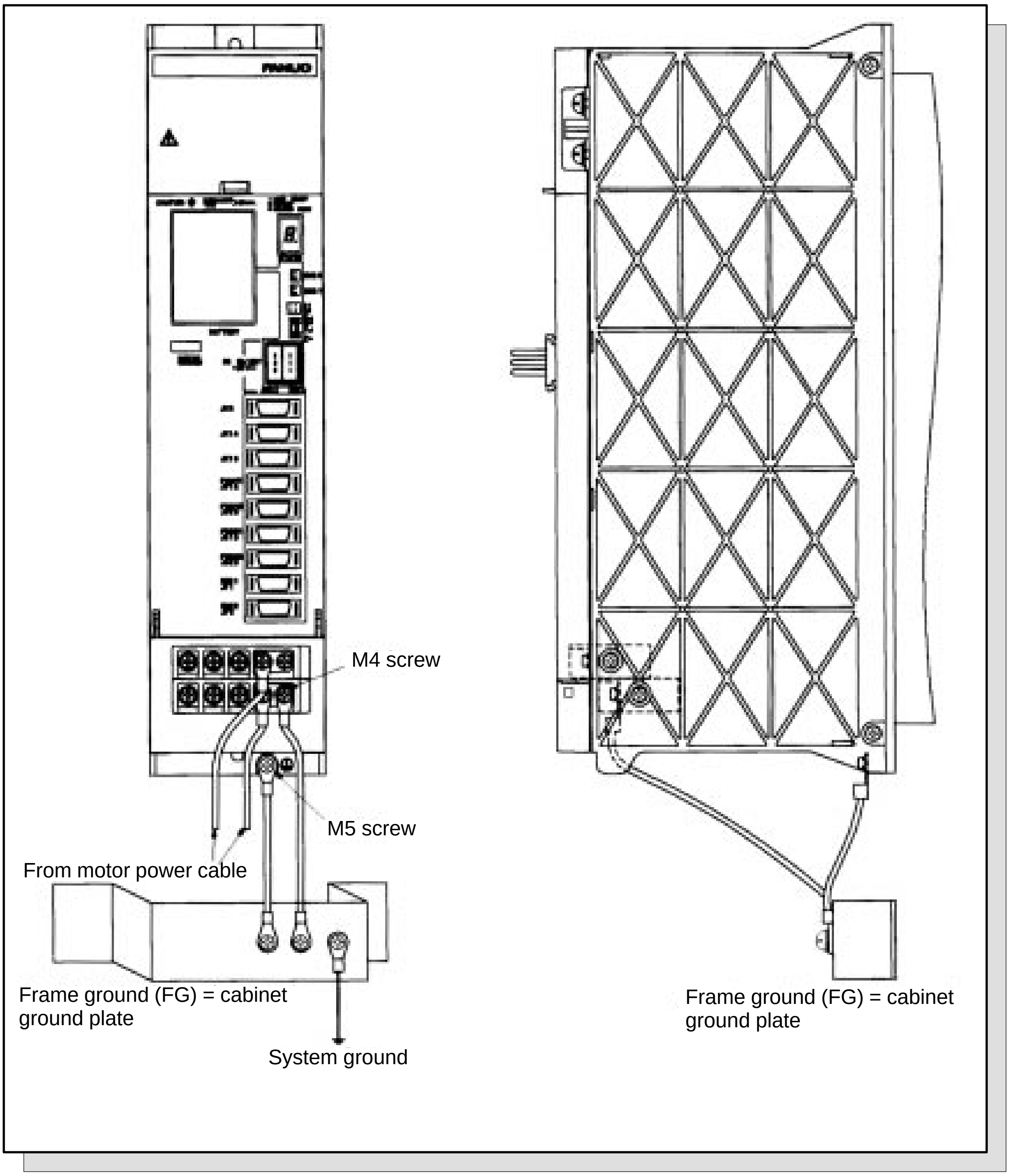


Fig.5.2.3 (i) Ground Cable Connection (SVM2–40/80, 80/80, 40L/40L, 20/20HV, 20/40HV, 20/60HV, 40/40HV, 40/60HV, 60/60HV)

Ground Cable Connection (SVM3)

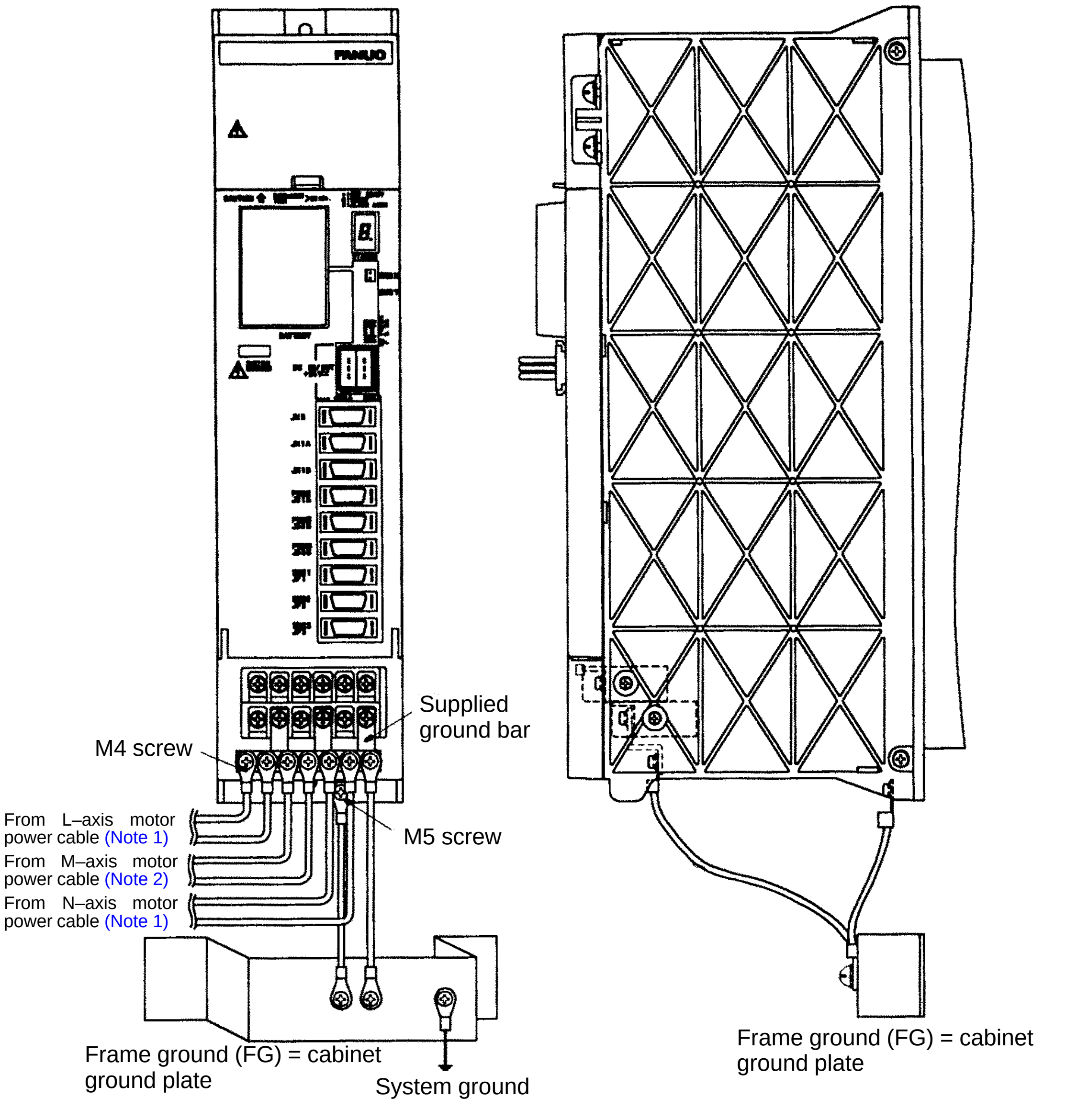


Fig.5.2.3 (j) Ground Cable Connection (SVM3)

NOTE
1 A motor has one or two ground wires.
2 The heatsink of SVM3–12/12/12, 12/12/20, 12/20/20, and 20/20/20 is not exposed externally.

Ground Cable Connection (SPM–2.2, SPMC–2.2)

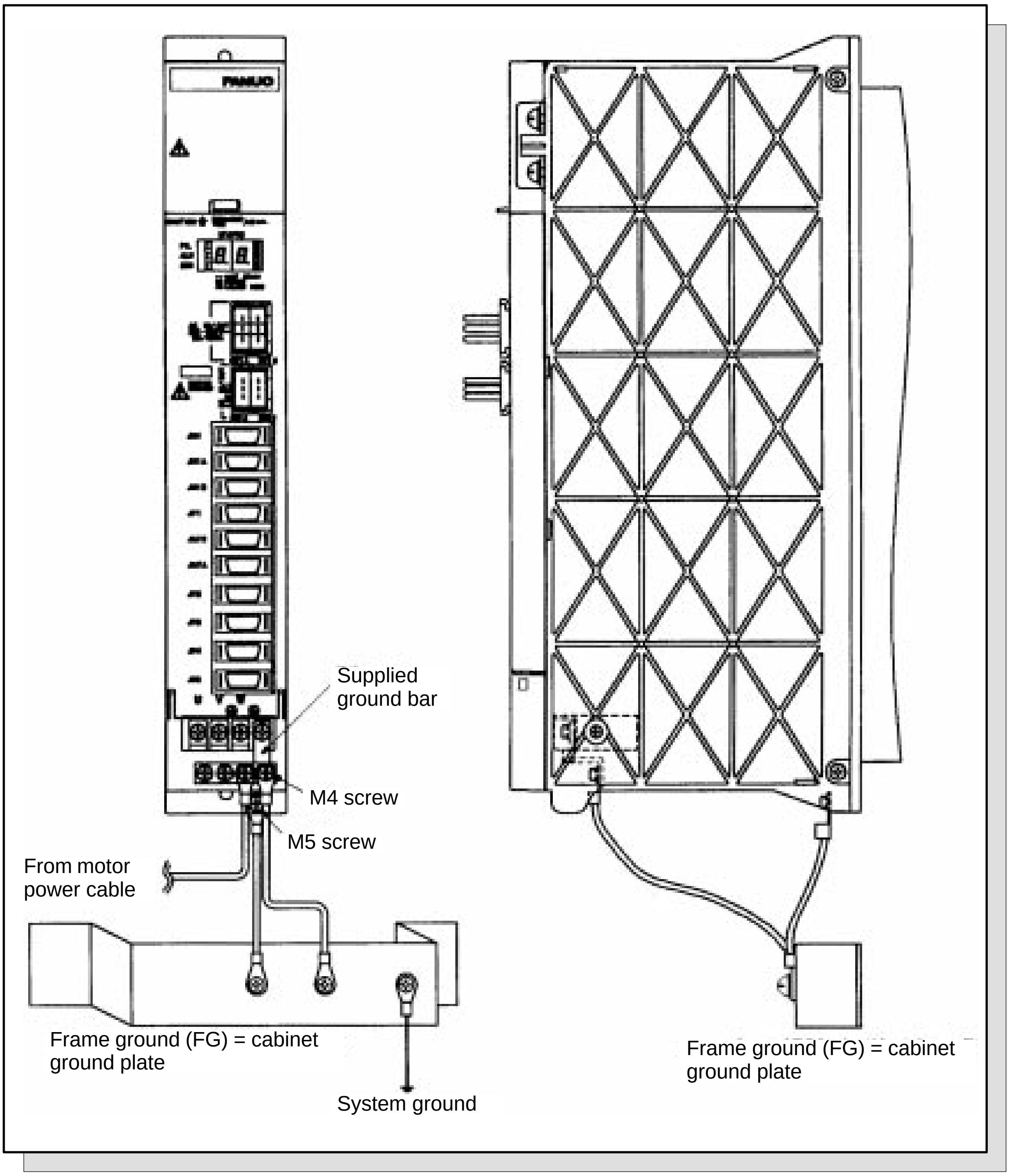


Fig.5.2.3 (k) Ground Cable Connection (SPM–2.2, SPMC–2.2)

Ground Cable Connection (SPM–5.5, 11, 11HV, SPMC–5.5, 11)

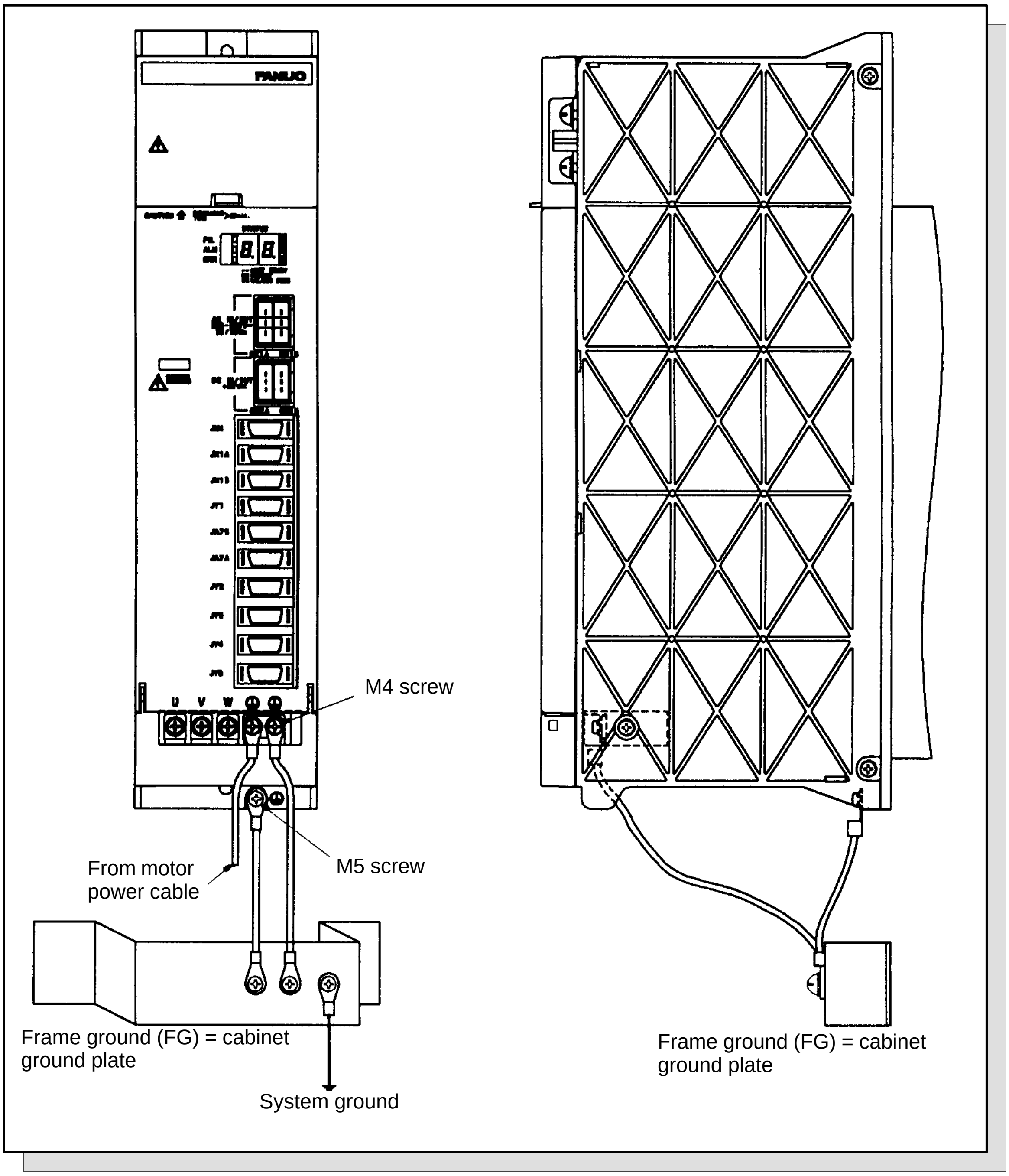


Fig.5.2.3 (l) Ground Cable Connection (SPM–5.5, 11, 11HV, SPMC–5.5, 11)

Spindle amplifier module SPM–15 to 30, 15HV to 45HV, SPMC–15 to 26

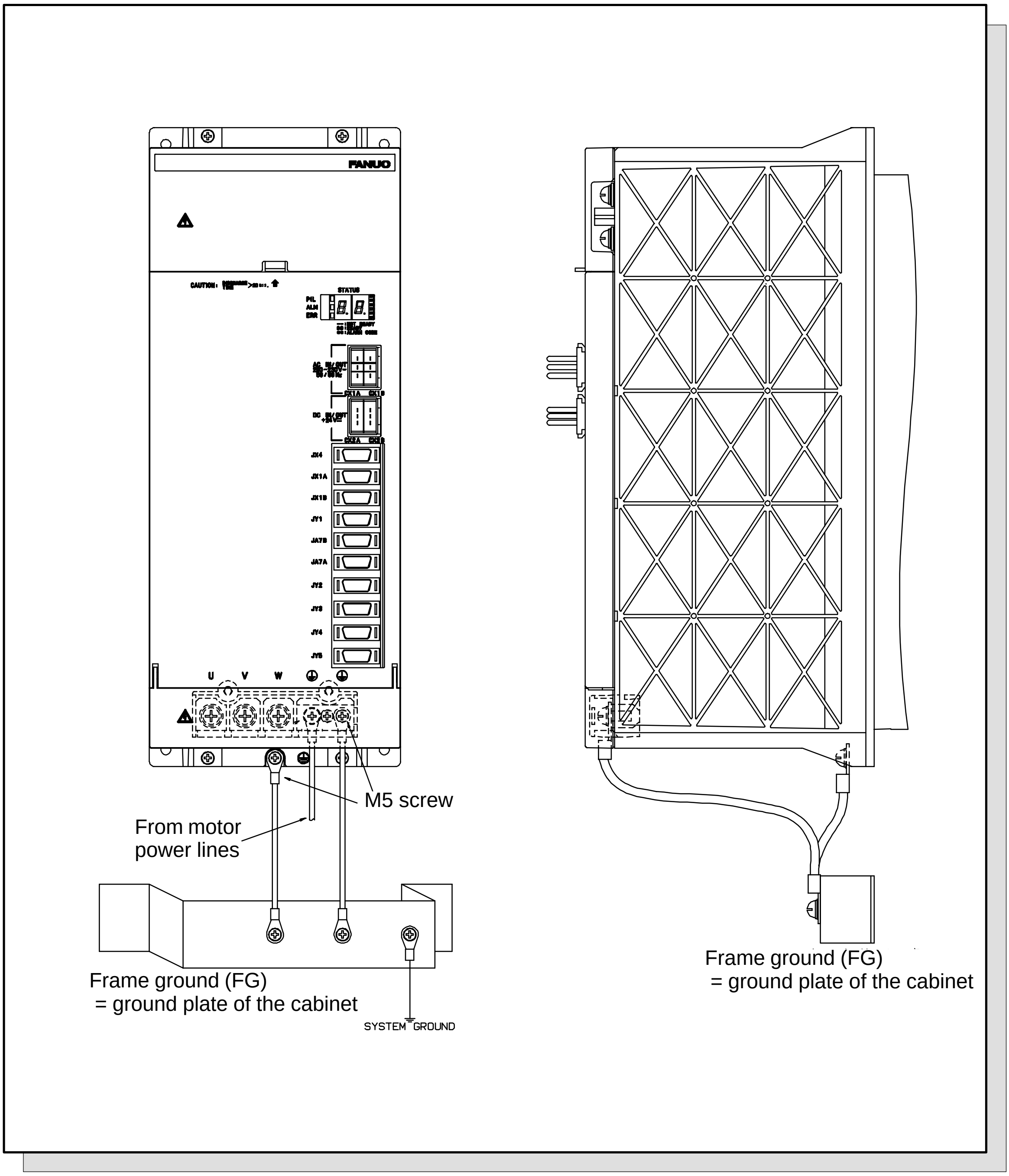


Fig.5.2.3 (m) Ground Cable Connection (SPM–15 to 30, 15HV to 45HV, SPMC–15 to 26)

Ground Cable Connection (SPM–45, 75HV)

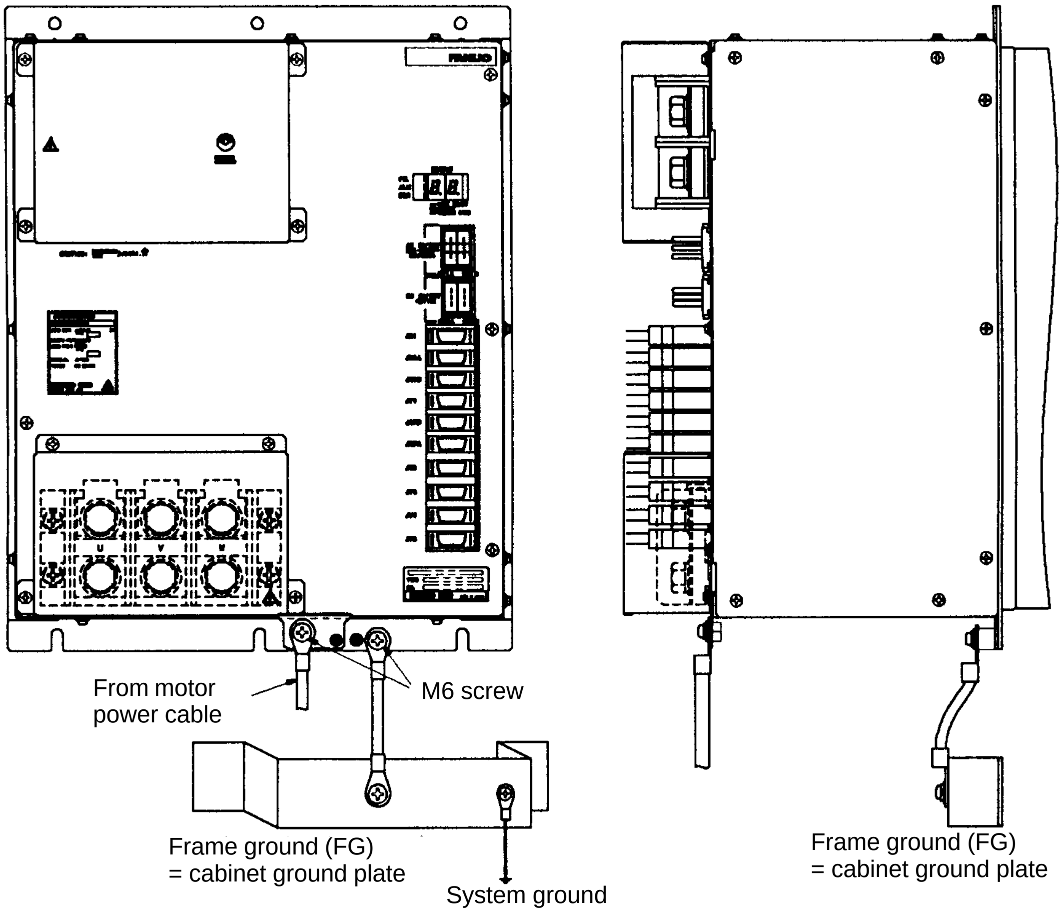


Fig.5.2.3 (n) Ground Cable Connection (SPM–45, 75HV)

Ground Cable Connection (PSMC–18HV, 30HV)

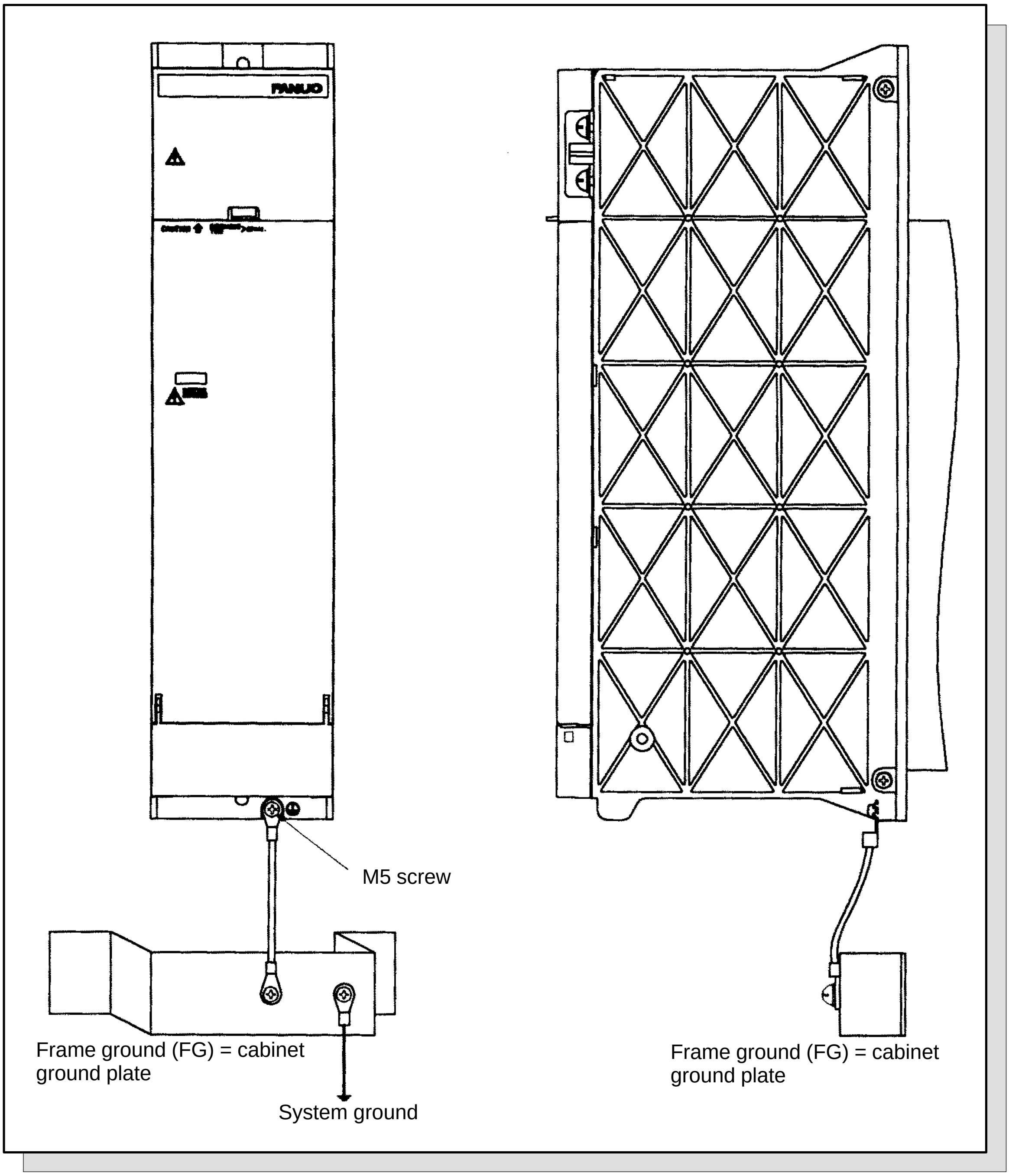


Fig.5.2.3 (o) Ground Cable Connection (PSMC–18HV, 30HV)

Ground Cable Connection (PSMC–45HV)

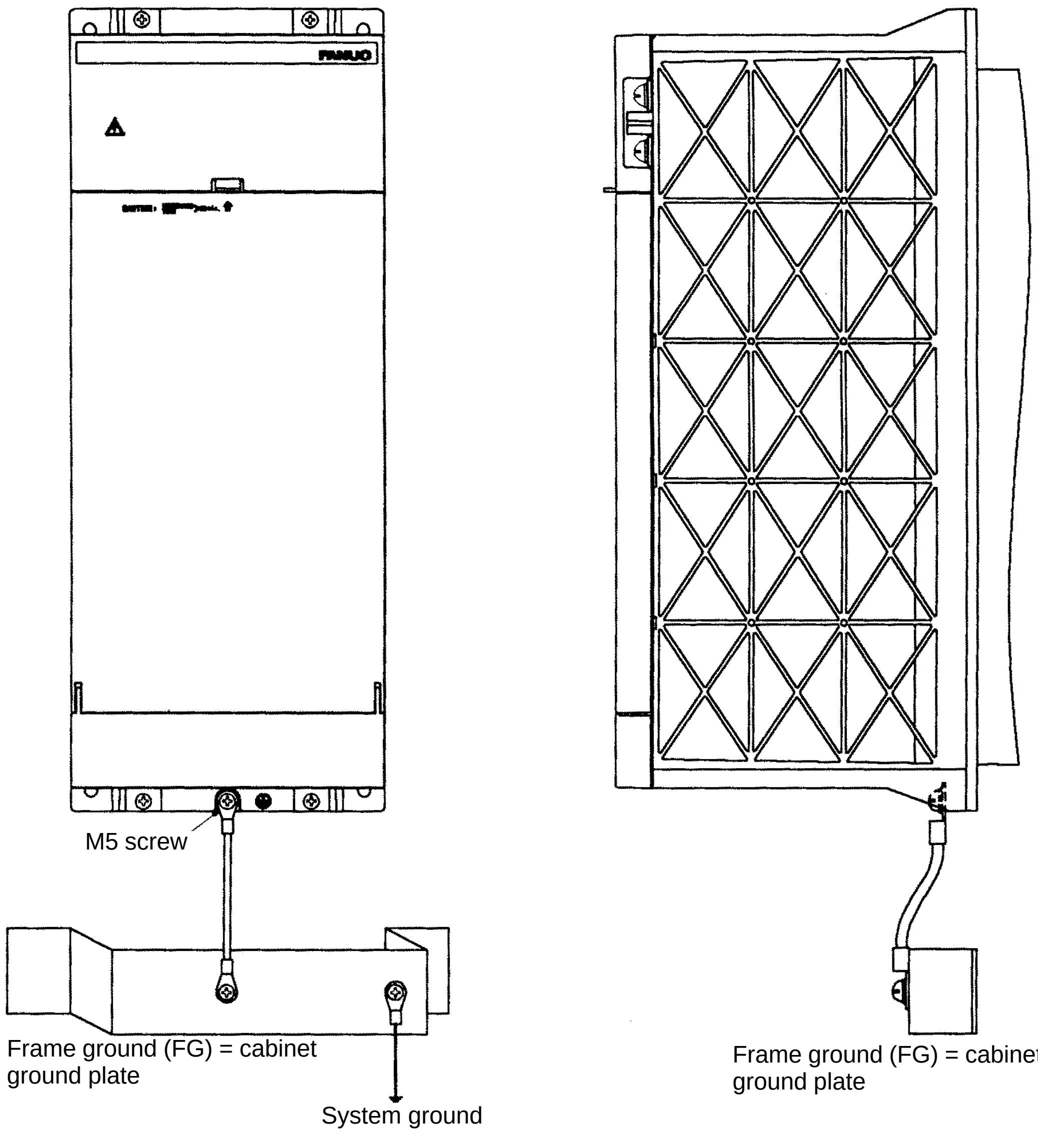


Fig.5.2.3 (p) Ground Cable Connection (PSMC–45HV)

Ground Cable Connection (Dynamic Brake Module DBM)

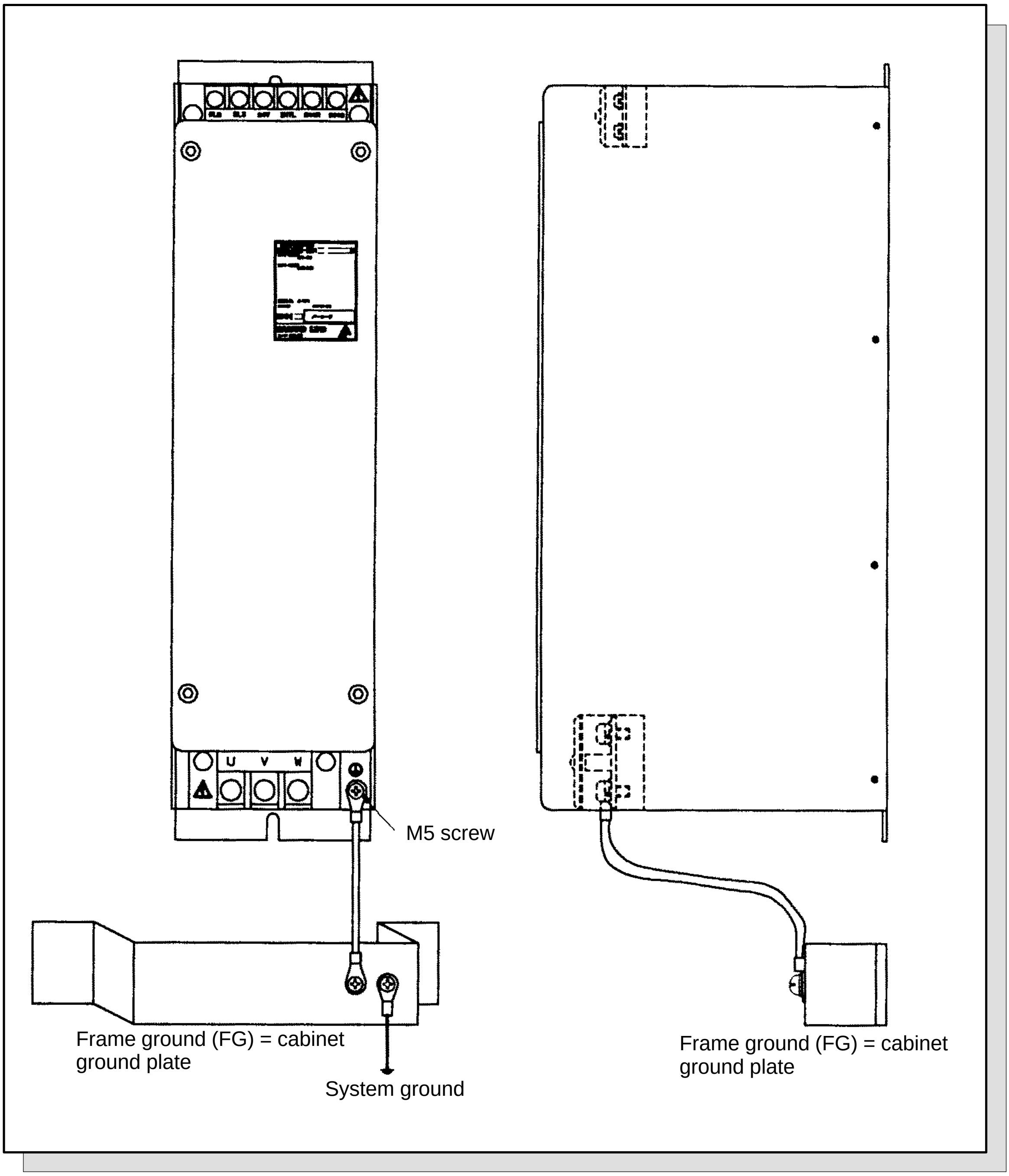


Fig.5.2.3 (q) Ground Cable Connection (Dynamic Brake Module DBM)

Ground Cable Connection (Resistance Discharge Unit)

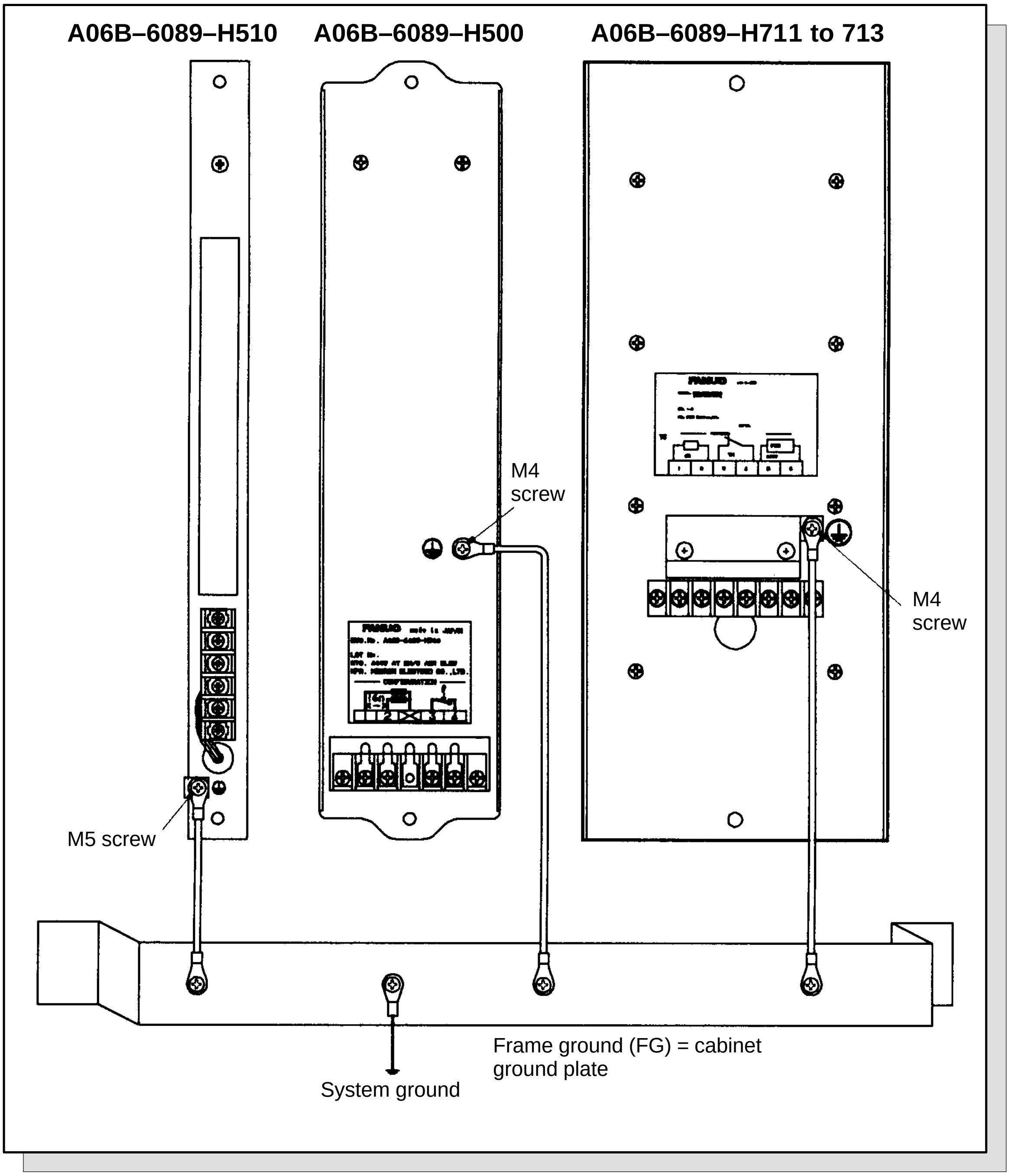


Fig.5.2.3 (r) Ground Cable Connection (Resistance Discharge Unit)

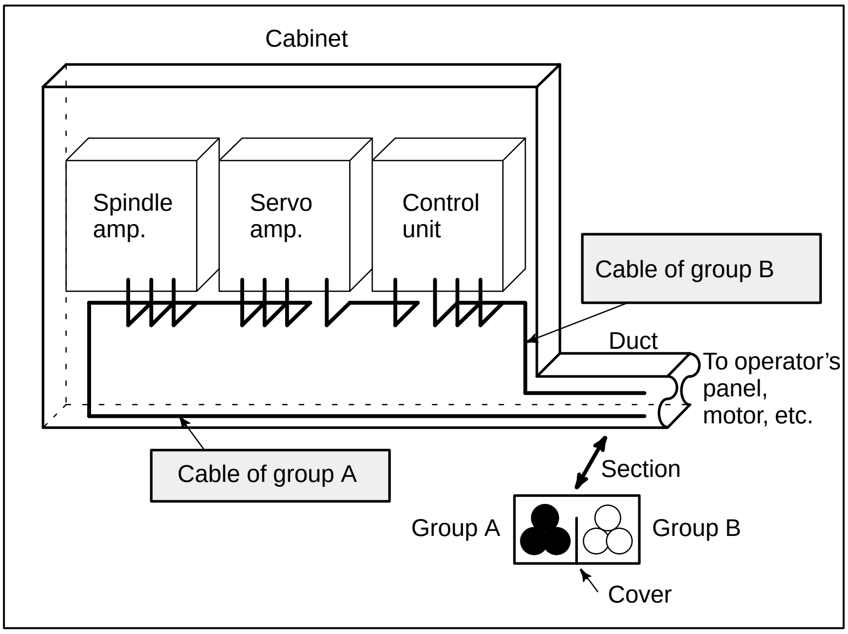
5.3 NOISE PREVENTION

5.3.1 Separation of Signal Lines

Signal lines must be separated from amplifier input power lines and motor power lines. The table below lists the signal types.

Group	Signal type	Action
A	Amplifier input power line	Separate binding (Note 1) or electromagnetic shielding (Note 2) is necessary for group B cables.
	Motor power line	
	Magnetic contactor driving coil (Note 3)	
B	Cable between CNC and SVM	Separate binding or electromagnetic shielding is necessary for group A cables. All cables must be shielded.
	Cable between CNC and SPM	
	Cable for position feedback or velocity feedback	
	Cable for position coder	
	Cable for magnetic sensor	
	Other cable related to sensor	

NOTE
1 The groups must be 10 cm or more apart from one another when binding the cables in each group.
2 The electromagnetic shield refers to shielding between groups with grounded steel plates.
3 Attach a noise suppressor such as a spark killer to the magnetic contactor driving coil.



5.3.2 Cable Clamp and Shield Processing

Perform terminal processing of the shield sheaths of the signal wires according to the description in Section 9.2.

The cables that run into the amplifier and which require shield processing, with the exception of K14, K15, K17, K18, K19, K31, and K33, must be clamped as indicated in Fig. 5.3.2 (1). Clamping secures a cable and also provides shielding. Clamping must always be performed since it is very important for stable system operation.
Strip part of the cable jacket to expose the shield sheath, as shown in the figure below. Secure that part of the cable to the ground plate by using a clamp.
The ground plate must be created and installed by the user as shown in Figs 5.3.2 (2), (3), (4), and (5).

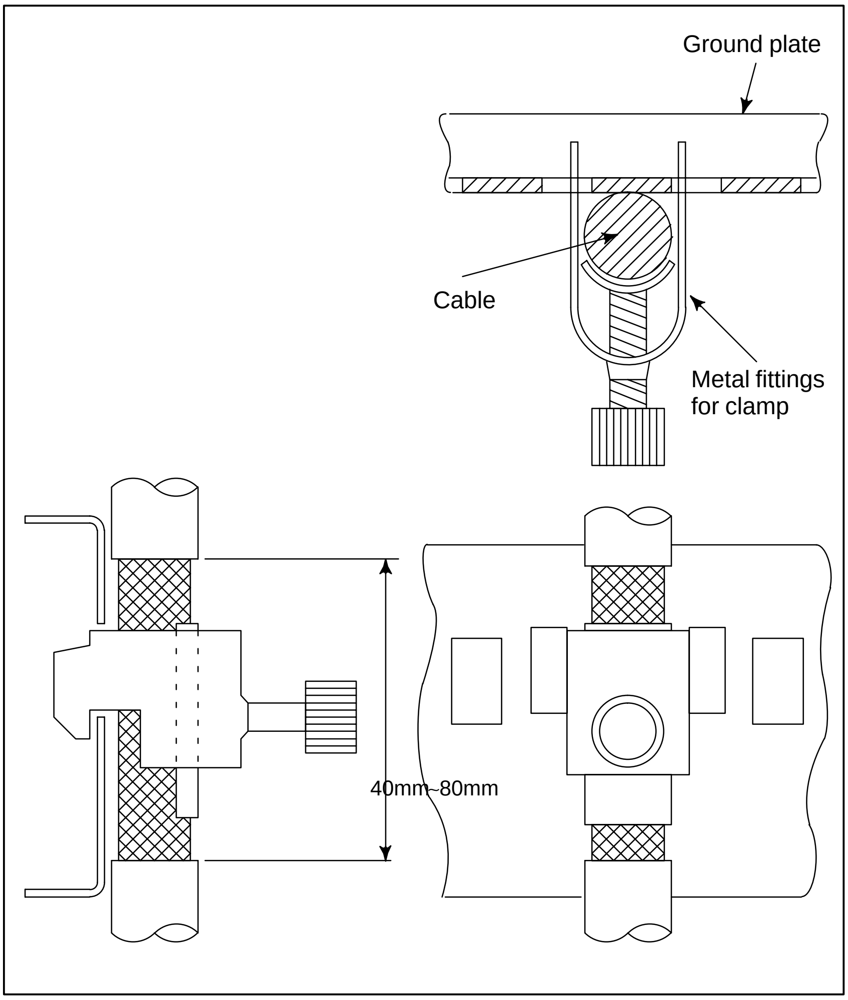


Fig.5.3.2 (a) Cable clamp (1)

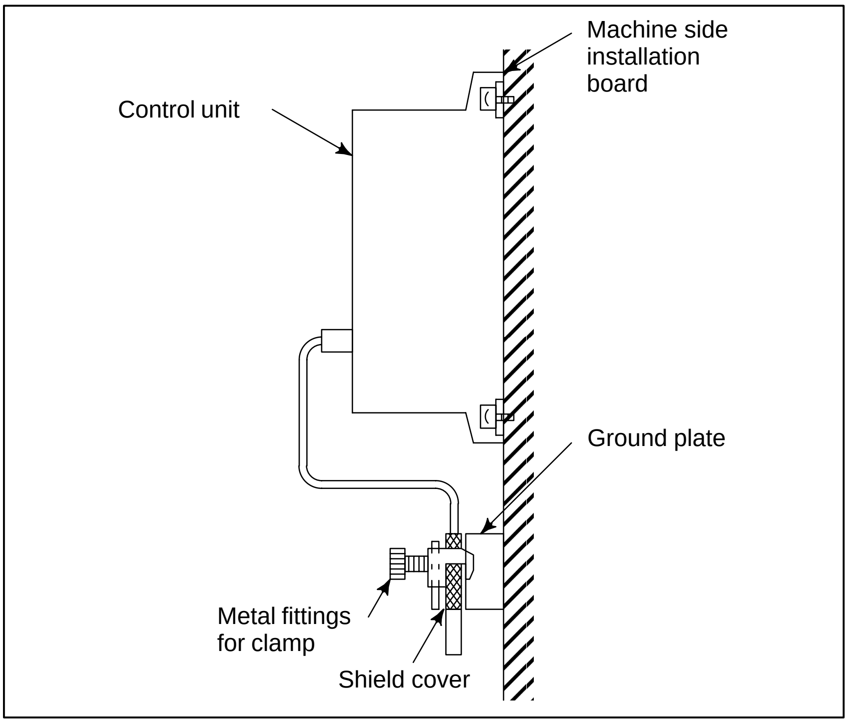


Fig.5.3.2 (b) Cable clamp (2)

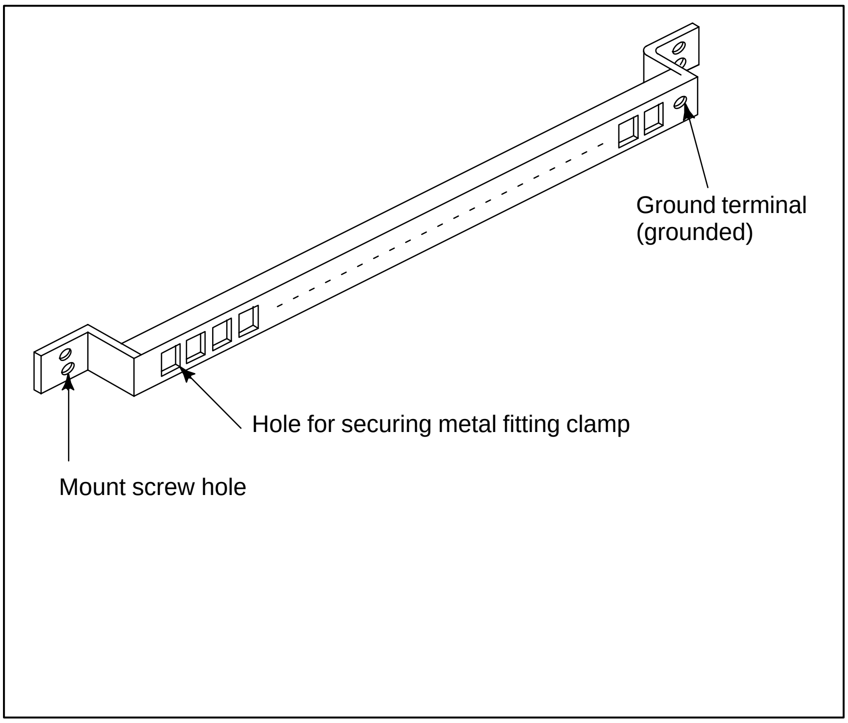


Fig.5.3.2 (c) Ground plate

For the ground plate, use a metal plate of 2 mm or thicker, which surface is plated with nickel.

NOTE

Connect each shield cable to the ground plate installed near the cabinet inlet by using a ground clamp. This prevents noise generated in the panel from being emitted to external devices.

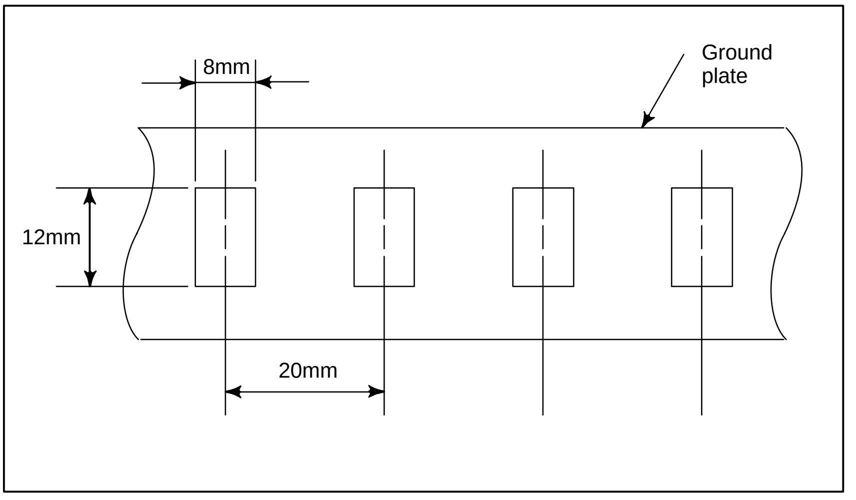


Fig.5.3.2 (d) Ground plate holes

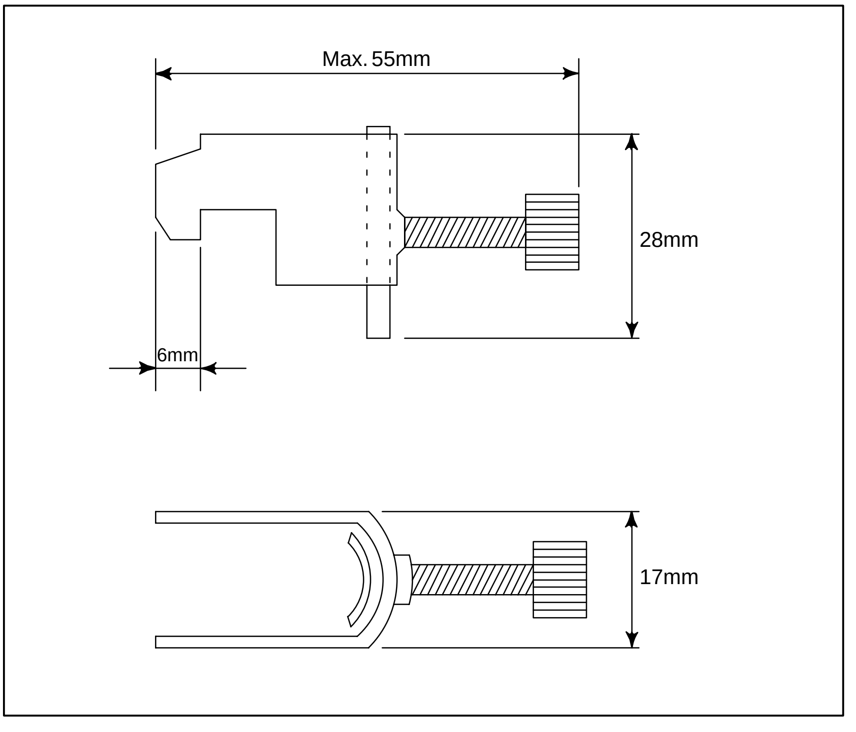


Fig.5.3.2 (e) Outer drawings of metal fittings for clamp

5.3.3 Protecting External Electronic Devices from Noise

Driving a servo motor or spindle motor may generate noise that could affect external general electronic devices (such as AM radios and telephones).

Preventive measures against noise, including those for external electronic devices affected by noise, must be taken from the viewpoint of an entire system. See Appendix G, which describes the principle of noise generation and which provides examples of preventive measures.

5.3.4 CE Marking Requirements

CE marking requires compliance with the EMC Directive. FANUC's products have all been granted a certificate of conformity to the EMC Directive (EC Directive 89/336/EEC) by a third–party certification organization.

For CE marking, special considerations are required to satisfy the installation requirements described in the following guideline:

A–72937E: To satisfy the requirement of the EMC Directive

For details of the above guideline, contact your local FANUC office.

5.3.5 Selecting a Noise Filter

To satisfy the EMC Directive, the installation of a noise filter is required in the input section of the power magnetics cabinet.

The rated current of the noise filter being used is determined according to the type of the CNC that is connected, the type and number of motors, and the power consumption of the other peripheral devices. Using the expression given below, calculate the noise filter load current, and select a noise filter so that the load current does not exceed the rated current of the filter. Recommended noise filters are given in (12) of Section 2.2.3.

Obtaining the load current of a noise filter

The load current of a noise filter is the sum of the CNC input current, PSM input current, and current consumption under the other loads.

Load current (Arms)	=	CNC input current (Arms)	+ Σ	PSM input current (Arms)	+	Current con-sumption under other loads (Arms)
		(Note 1)		(Note 2)		

NOTE

1 The CNC input current is determined by the number of PSUs (power supply units). Calculate the CNC input current from the following expression:
CNC input current (Arms) = 5 (Arms) x number of PSUs
Normally, a CNC has one PSU. The FS15 multiaxis control system has two PSUs.

2 For details of how to obtain the PSM input current, see Sections 4.1.1 or 4.2.1.

3 Attach a noise suppressor such as a spark killer to the magnetic contactor driving coil. When more than one PSM is connected, sum the input currents of the PSMs.

5.4 NOTES ON AMPLIFIER INSTALLATION RELATED TO SAFETY STANDARDS

5.4.1 Overview

The servo amplifier α series is designed to conform to the following European safety standard:

DIN VDE 0160 1988/1:1989

(Electronic devices used in a power facility and their incorporation into the facility)

To certify conformity to the standard, FANUC has obtained certification from Tüv Rheinland, a third–party certification organization for European standards.
In power magnetics cabinet design when the machine is to be CE–marked, the installation conditions described in the following sections should be considered carefully, based on the EC Machine Directives (directives based on 89/392/EEC).

[Remarks]

CE marking requires compliance with a related EN standard [EN 60204–1] (Electric Devices in Industrial Machines, Part 1: General Requirements).
If an EN standard (or an IEC standard if no EN standard exists) exists for a component in the machine, the component must conform to that EN standard.
At present, however, no EN standard (or IEC standard) is defined for amplifiers. Based on the results of an investigation made by Tüv Rheinland, an approved certification organization for the machine directives, FANUC set the above VDE standard as a target standard and designed the servo amplifier α series to conform to the standard.
Therefore, this amplifier series satisfies the amplifier requirements for CE marking. The user can use these amplifiers without having to be concerned about safety.

5.4.2 Standard Class of Insulation Design

(1) Insulation of circuits and protective ground

According to DIN VDE 0160, the insulation design of this amplifier series conforms to DIN VDE 0110 Part 1 and other related standards.

- The primary (power supply and main circuit) and the secondary (control circuit) are separated from each other by reinforced insulation.
- Basic insulation is used on the protective ground side.

Basic insulation is also used between the power supply main circuit and aluminum flange (integrated with a heatsink). Connect the protective ground wire to the ground terminal of the lower aluminum flange as described in Section 5.2.3.

(2) Installation category (overvoltage category)

DIN VDE 0110 [Insulation coordination of electric apparatuses] classifies power supply facilities by the impulse voltage (relative to ground) in the power supply to which the amplifier is connected.
This amplifier series is designed as a device of installation category (overvoltage category) II.
The layout of this amplifier series has been designed on the assumption that the rated impulse withstand voltage (impulse voltage relative to ground) in the power supply to which the amplifier is connected is 2.5 kV or lower.
If an impulse greater than 2.5 kV, relative to ground, appears in the power supply, it must be suppressed.
Generally, this requirement is considered to be satisfied if an insulated transformer is used in the power supply input section of a machine.
If an insulated transformer is not used, install a surge protector (lightning surge absorber) between the facility and ground to suppress any impulse higher than 2.5 kV, relative to ground.

(3) Contamination class of the installation environment and power magnetics cabinet protection level

EN 60204–1 (13. Control devices/13.3 Protection level) requires that, when a machine is installed in an environment equivalent to the general plant level, the protection level against dust, coolant, chips, and so forth be IP54 or higher.
For a power magnetics cabinet that satisfies this requirement, the contamination class within the cabinet is considered to be class 2.
The insulation of this amplifier series has been designed on the assumption that the amplifier is installed in an environment of contamination class 2.
When using the amplifier in a general machine installation environment, install the amplifier in a power magnetics cabinet that satisfies the requirements of protection level IP54.
The IP level, however, depends on the environment (atmosphere) in which a machine is installed. Select the protection level of the power magnetics cabinet according to the environment.
For an external heatsink cooling type amplifier with a heatsink fin protruding from the rear of the mounting flange, the fin section should be in a cooling area (duct) of about IP22 to 33, and special considerations should be taken not to protect the fin from direct coolant splashes or chips.

5.4.3 Protection Against Electric Shock

(1) Protection against direct contact to a charged part

The protection level against electric shock after the installation of this amplifier series is equivalent to IP1X (hand protection). Thus, no live part can be touched unconsciously or carelessly.
This amplifier series must always be installed in a power magnetics cabinet. According to Item 6.2.1 of EN 60204–1 ”Electric Shock Protection by Using a Cabinet,” lock the power magnetics cabinet so that, while the amplifier is on, the cabinet cannot be opened by persons except special maintenance personnel or a person qualified for maintenance who has been trained in protective measures against electric shock.
When a machine operator needs to open the power magnetics cabinet to perform a certain operation, the operator must have received sufficient safety education, or a protection cover must be installed to prevent the operator from touching the amplifier.

(2) Checking discharge of an electrolytic capacitor

This amplifier series contains a large–capacitance electrolytic capacitor for the power supply smoothing circuit. Even after the power supply input circuit is turned off, this capacitor remains charged for a while.
When it proves necessary to touch the amplifier for maintenance and so forth, do not start maintenance work immediately; wait for the discharge time indicated on the face plate of the amplifier. Alternatively, measure the residual voltage at the DC link section by using a volt–ohm meter and check that the LED (red) for indicating the charge state is off to ensure safety.
Standards define voltages exceeding 60 VDC as hazardous voltages.

(3) Leakage current flowing to the protective ground wire

Motors are controlled by applying a voltage to the armature with the mean amplitude and frequency of the voltage changed by pulse width modulation. For this pulse width modulation, a chopper voltage is applied to the power line of the motor to provide a carrier frequency of several kilohertz.
Ground drift capacitance mainly between the motor armature winding and case and between the power line of the motor power cable and protective ground wire causes a leakage current to flow into the protective ground wire of the motor power cable and the machine ground. Part of the leakage current also flows into the protective ground wire of the machine.
The resultant leakage current is about 1 to 2 mA per motor shaft at the commercial power supply frequency (50/60 Hz). With the measurement circuit defined by EN 60950, the leakage current is allowed to be much higher than 3.5 mA; this is because the high–frequency component sensitivity cannot be fully reduced.

Unless a machine is grounded, touching the machine may cause electric shock. Take one of the following protective measures against electric shock:

(a) Use a protective ground wire with a copper wire cross–sectional area of no less than 10 mm^2.

(b) Install a ground fault interrupter so that the power supply can be disconnected immediately if a ground fault occurs.

(c) Add a protective grounding terminal to the cabinet to make a double ground wire connection.

When using a ground fault interrupter, select an electromagnetic ground fault interrupter with a low high–frequency component sensitivity, or an electronic ground fault interrupter that can be used with inverters.

5.4.4 Protective Installation

Amplifiers have multiple protective grounding terminals (marked as defined by 417–IEC–5019). These terminals are used to prevent electric shock in case of dielectric breakdown, and are also used for functional grounding to prevent noise.

All protective ground terminals must be connected to the protective ground (PE) connection terminals in the power magnetics cabinet.

For how to connect the protective ground wires and the cross–sectional areas of these wires, see Section 5.2.3.

Note that cables from cable terminals cannot be secured together with protective ground terminals.

5.4.5 Notes on the Emergency Stop Circuit Configuration

The amplifier uses IGBT (transistors) as an internal means of turning off the power system; it does not use an electromechanical means.

Therefore, when an emergency stop circuit is configured, a line contactor enabling electromechanical disconnection must be installed on the power input line for feeding power to the power supply module so that a voltage is applied to the control coil of the contactor via the contactor control output of the power supply module.

Some amplifier failures may prevent the output relay of the power supply module from being turned off even when the amplifier emergency stop command input (*ESP) is driven low, thus disabling disconnection by the line contactor.

The emergency stop circuit must disconnect power without fail. It must have a redundant circuit configuration having a route through which the line contactor is disconnected directly by the command generated by the emergency stop operation switch, independent of the disconnection function provided by the amplifier.

If the power line is disconnected during spindle rotation when a spindle amplifier module is used, the spindle may not be able to be stopped immediately by the power regeneration function, and may keep rotating by the force of inertia. Therefore, on the redundant circuit side, a delay function must be provided which is based on an off–delay timer considering a normal stop time.

For detailed notes on the safety circuits, refer to the following document:

A–71429–S13J : Safety Circuit Requirements and Configuration Examples

To obtain this document, contact your local FANUC office.

5.4.6 Decrease in Load Factor for Given Ambient Temperature

Some amplifier models are certified as conforming to standards, with the load reduction factors shown below being set.

If such an amplifier is used with a load factor exceeded, the allowable temperature range of a component may be exceeded, which may cause an overheat alarm or a decrease in the component life. Therefore, use the amplifier within the decrease characteristic.

(1) Power supply module time rating decrease with temperature

See Fig. 5.4.6 (a).

(2) Servo amplifier module time rating decrease with temperature

See Fig. 5.4.6 (b).

(3) Spindle amplifier module time rating decrease with temperature

See Fig. 5.4.6 (c).

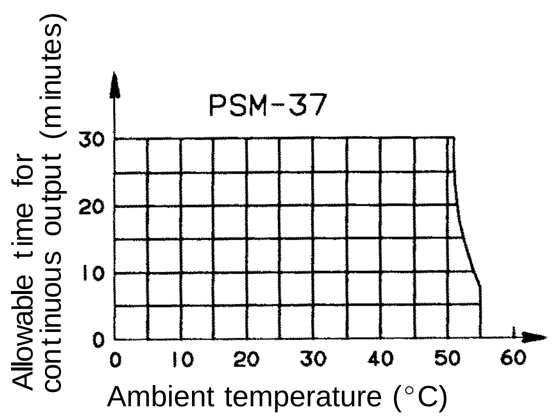


Fig.5.4.6 (a) Decreasing Curve of Power Supply Module Time Rating Dependent on Temperature

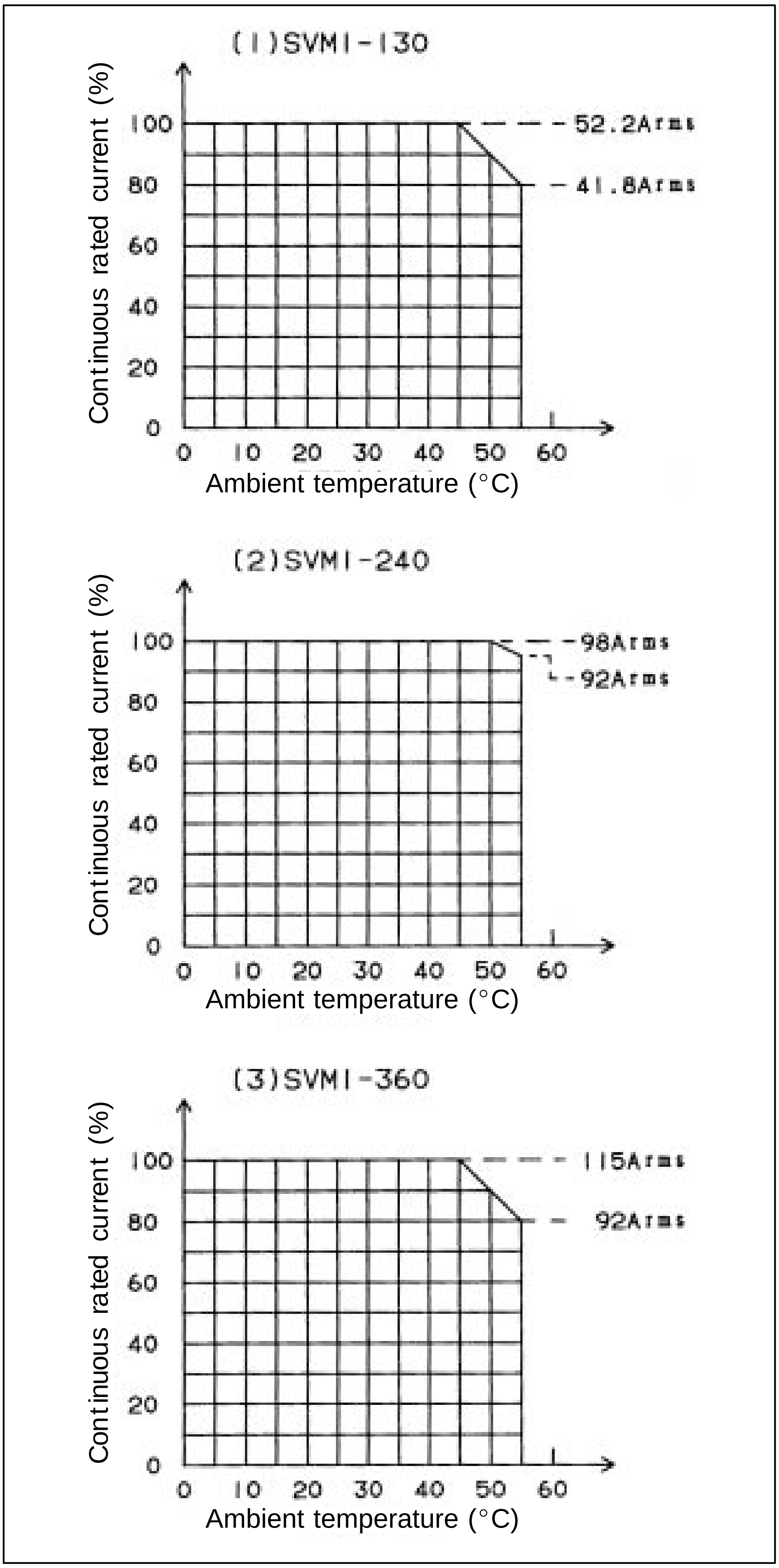


Fig.5.4.6 (b) Decreasing Curve of Servo Amplifier Module Time Rating Dependent on Temperature (Single–Axis Amplifiers)

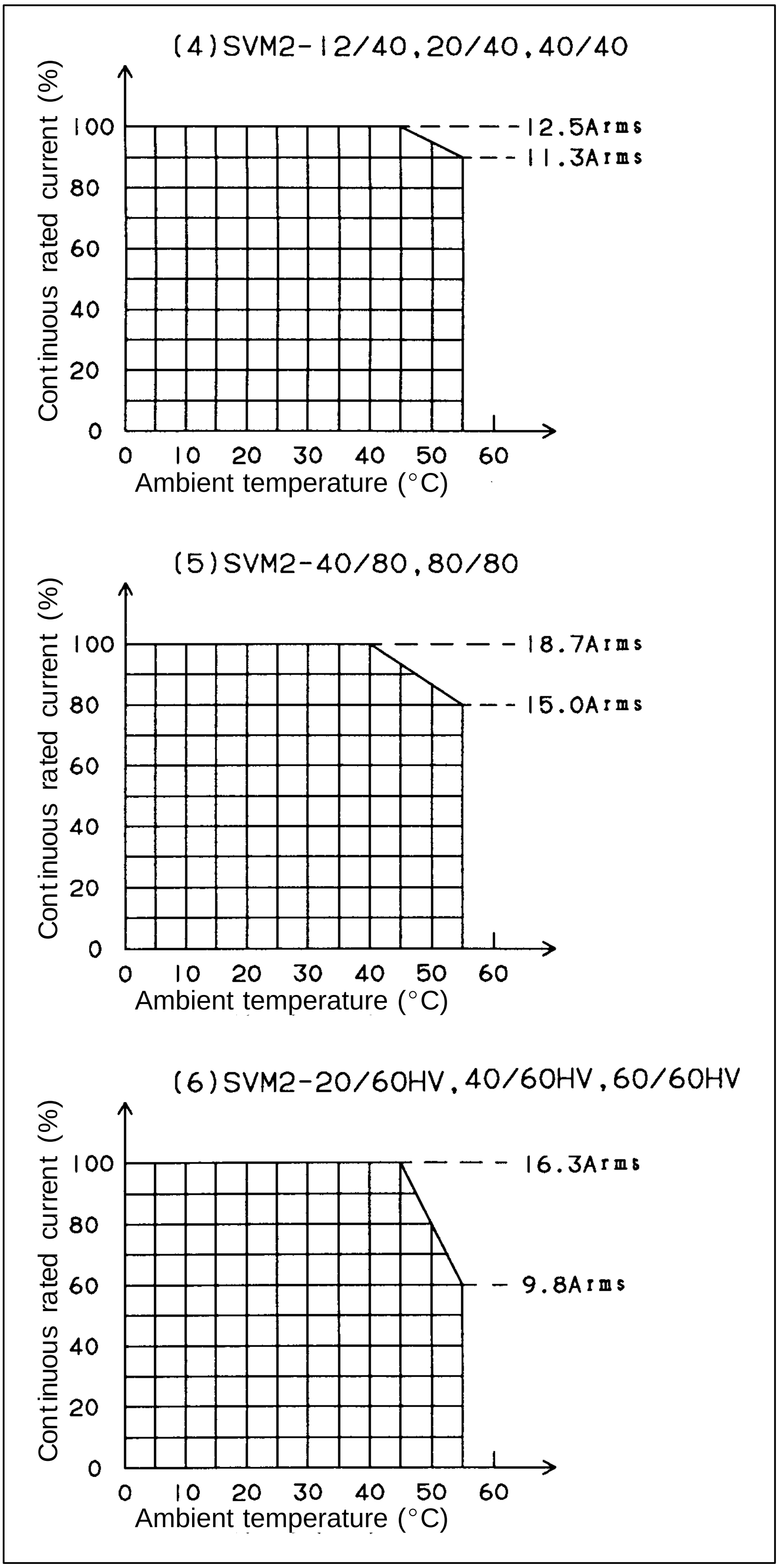


Fig.5.4.6 (c) Decreasing Curve of Servo Amplifier Module Time Rating Dependent on Temperature (Two–Axes Amplifiers)

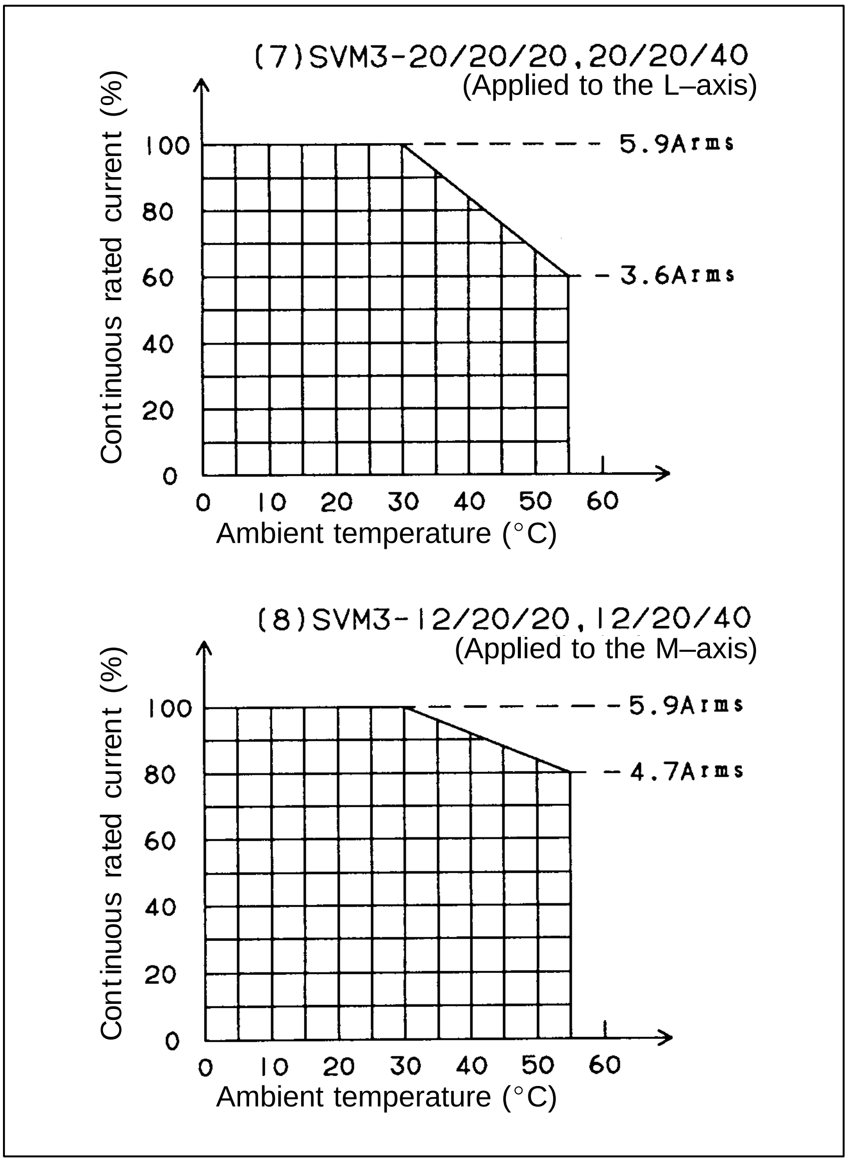


Fig.5.4.6 (d) Decreasing Curve of Servo Amplifier Module Time Rating Dependent on Temperature (Three–Axes Amplifiers)

The allowable continuous output time for 30–minute rated output decreases depending on the ambient temperature as follows:

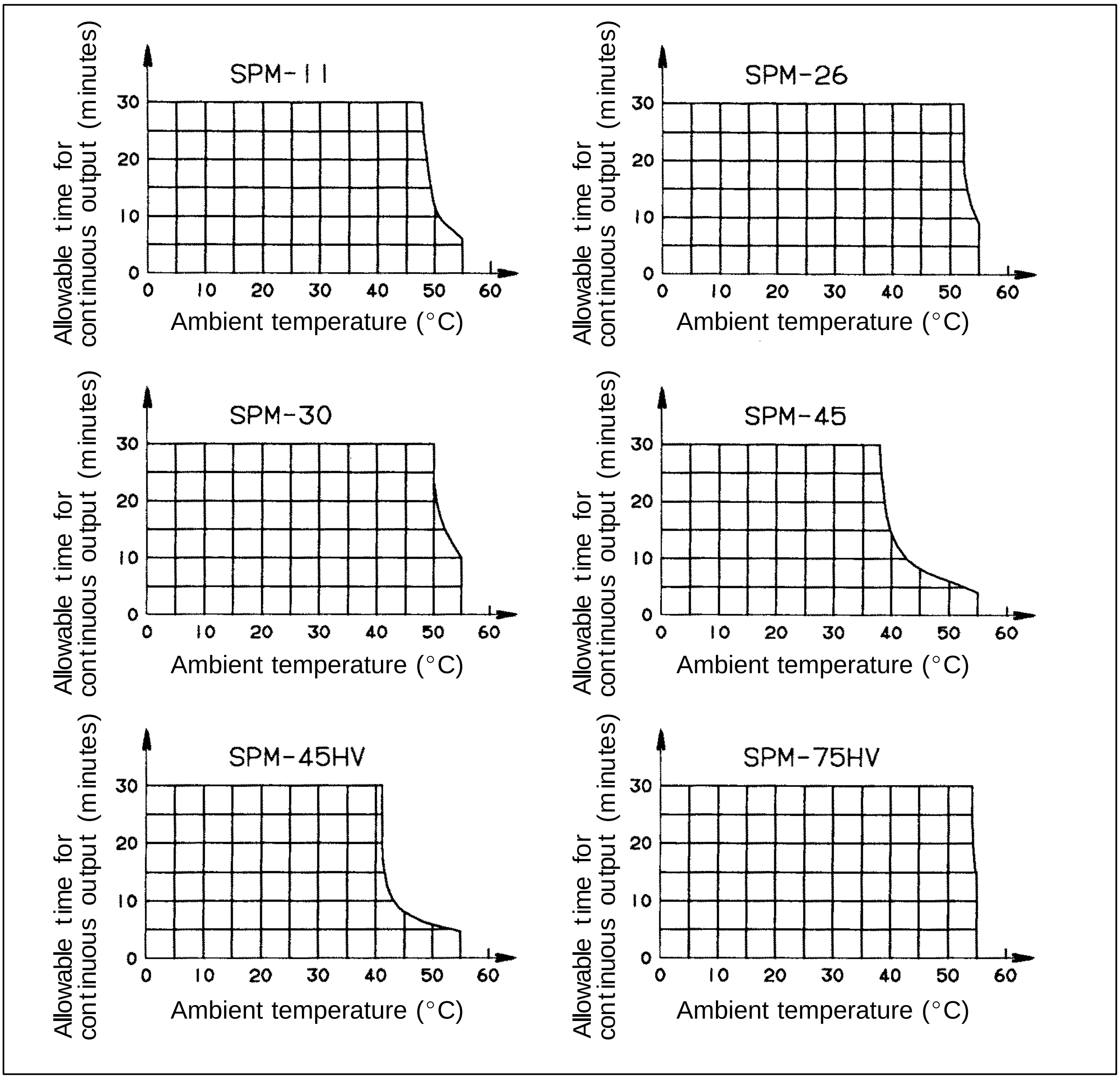


Fig.5.4.6 (e) Decreasing Curve of Spindle Amplifier Module Time Rating Dependent on Temperature

6 HEAT DISSIPATION

6.1 200–V INPUT SERIES

The heat dissipated by each α series control motor amplifier module is as follows:

6.1.1 Power Supply Module

Table.6.1.1 (a) PSM Heat Out Put

Name	Ordering number	Rated output	Total heat dissipation	Remaining heat in cabinet	
				Natural ventilation	Forced air cooling (Note 1)
PSM–5.5	A06B–6077–H106	5.5kW	100W	53W	(47W)
PSM–11	A06B–6077–H111	11kW	158W	—	53W (Note 2)
PSM–15	A06B–6087–H115	15kW	333W	—	61W
PSM–26	A06B–6087–H126	26kW	597w	—	75W
PSM–30	A06B–6087–H130	30kW	681W	—	79W
PSM–37	A06B–6087–H137	37kW	706W	—	81W
PSM–45	A06B–6081–H106	45kW	921W	—	93W (Note 3)

NOTE
1 A vaule enclosed by parentheses indicates the remaining heat when the module is forcibly air–cooled with an air flow of 2m/s or more.
2 Requires forced air cooling, equivalent to fan adaptor unit A06B–6078–K001.
3 Forced air cooling by fan adaptor unit A06B–6078–K003 or equivalent (2 m/s or more) is required.

Table.6.1.1 (b) PSMR Heat Output

Name	Ordering number	Rated output	Total heat dissipation	Remaining heat in cabinet	
				Natural ventilation	Forced air cooling
PSMR–3	A06B–6081–H103	3.0kW	60W	60W	—
PSMR–5.5	A06B–6081–H106	5.5kW	105W	55W	—
		7.5kW	130W	60W	—

Table.6.1.1 (c) AC Reactor

Name	Ordering number	Total heat dissipation	Remarks
For PSM–5.5, 11	A81L–0001–0122	7W	When PSM–5.5 is used
		23W	When PSM–11 is used
For PSM–15	A81L–0001–0123	33W	
For PSM–26	A81L–0001–0120	42W	
For PSM–30	A81L–0001–0124	42W	
For PSM–37	A81L–0001–0147	72W	
For PSM–45	A81L–0001–0133	67W	

Table.6.1.1 (d) AC Line Filter

Name	Ordering number	Total heat dissipation	Remarks
For PSMR–3	A81L–0001–0083#3C	10W	At 2.0kW output
		15W	At 3.0kW output
For PSMR–5.5	A81L–0001–0101#C	40W	At 5.5kW output
		50W	At 7.5kW output

6.1.2 Servo Amplifier Module

When a motor other than those listed below is used, its heat output should be assumed to be that of a listed motor with a higher rated current.

Table.6.1.2 (a) SVM1 (1–AXIS)

Name	Ordering number	Motor used			Total heat dissipation	Remaining heat in cabinet	
		L axis	M axis	N axis		Natural ventilation	Forced air cooling (Note 1)
SVM1–12	A06B–6079–H101 A06B–6096–H101	α2/3000			31W	–	–
SVM1–20	A06B–6079–H102 A06B–6096–H102	αC6/2000			34W	–	–
SVM1–40S	A06B–6079–H103 A06B–6096–H103	α6/2000			47W	32W	(30W)
SVM1–40L	A06B–6079–H104 A06B–6096–H104	α22/1500			80W	45W	(41W)
SVM1–80	A06B–6079–H105 A06B–6096–H105	α6/3000			70W	39W	(36W)
		α12/3000			91W	47W	(42W)
		α22/2000			106W	54W	(47W)
SVM1–130	A06B–6079–H106 A06B–6096–H106	α40/2000			144W	66W	(56W)
	A06B–6079–H106 A06B–6096–H106 + A06B–6078–K002	α30/3000			167W	–	62W (Note 2)
		α40/2000 (with a fan)			198W	–	72W (Note 2)
		αL50/2000			229W	–	81W (Note 2)
SVM1–240	A06B–6079–H107 A06B–6096–H107	α6/3000			553W	134W	(56W)
SVM1–360	A06B–6079–H108 A06B–6096–H108	α100/2000			643W	152W	(56W)
		α150/2000			643W	152W	(60W)

NOTE

1 A vaule enclosed by parentheses indicates the remaining heat when the module is forcibly air–cooled with an air flow of 2m/s or more.

2 Requires forced air cooling equivalent to fan adaptor unit A06B–6078–K002.

Table.6.1.2 (b) SVM2 (2–AXES)

Name	Ordering number	Motor used			Total heat dissipation	Remaining heat in cabinet	
		L axis	M axis	N axis		Natural ventilation	Forced air cooling (Note)
SVM2–12/12	A06B–6079–H201 A06B–6096–H201	α2/3000	α2/3000		54W	–	–
SVM2–12/20	A06B–6079–H202 A06B–6096–H202	α2/3000	αC12/2000		68W	–	–
SVM2–20/20	A06B–6079–H203 A06B–6096–H203	αC12/2000	αC12/2000		82W	–	–
SVM2–12/40	A06B–6079–H204 A06B–6096–H204	α2/3000	α6/2000		64W	41W	(38W)
		α2/3000	αC22/1500		97W	54W	(49W)
SVM2–20/40	A06B–6079–H205 A06B–6096–H205	αC12/2000	α6/2000		77W	45W	(41W)
		αC12/2000	αC22/1500		111W	60W	(53W)
SVM2–40/40	A06B–6079–H206 A06B–6096–H206	α6/2000	α6/2000		73W	43W	(39W)
		α6/2000	αC22/1500		107W	57W	(51W)
		αC22/1500	αC22/1500		141W	72W	(63W)
SVM2–40/80	A06B–6079–H207 A06B–6096–H207	α6/2000	α6/3000		96W	50W	(45W)
		α6/2000	α12/3000		118W	59W	(52W)
		α6/2000	α22/2000		133W	65W	(57W)
		αC22/1500	α6/3000		130W	65W	(57W)
		αC22/1500	α12/3000		151W	73W	(63W)
		αC22/1500	α22/2000		166W	79W	(68W)
SVM2–80/80	A06B–6079–H208 A06B–6096–H208	α6/3000	α6/3000		119W	58W	(50W)
		α6/3000	α12/3000		141W	67W	(57W)
		α6/3000	α22/2000		156W	73W	(63W)
		α12/3000	α12/3000		162W	75W	(64W)
		α12/3000	α22/2000		177W	81W	(69W)
		α22/2000	α22/2000		192W	87W	(74W)
SVM2–40L/ 40L	A06B–6079–H209 A06B–6096–H209	α6/2000	α22/1500		107W	57W	(51W)
		α12/2000	α22/1500		123W	63W	(56W)
		α22/1500	α22/1500		141W	72W	(63W)

NOTE
A vaule enclosed by parentheses indicates the remaining heat when the module is forcibly air–cooled with an air flow of 2m/s or more.

Table.6.1.2 (c) SVM3 (3–AXES)

Name	Ordering number	Motor used			Total heat dissipa- tion	Remaining heat in cabinet	
		L axis	M axis	N axis		Natural ventilation	Forced air cooling (Note)
SVM3–12/12/12	A06B–6079–H301 A06B–6096–H301	α2/3000	α2/3000	α2/3000	79W	–	–
SVM3–12/12/20	A06B–6079–H302 A06B–6096–H302	α2/3000	α2/3000	αC12/2000	93W	–	–
SVM3–12/20/20	A06B–6079–H303 A06B–6096–H303	α2/3000	αC12/2000	αC12/2000	106W	–	–
SVM3–12/20/20	A06B–6079–H304 A06B–6096–H304	αC12/2000	αC12/2000	αC12/2000	120W	–	–
SVM3–20/20/20	A06B–6079–H305 A06B–6096–H305	α2/3000	α2/3000	α6/2000	89W	58W	(54W)
		α2/3000	α2/3000	αC22/1500	122W	71W	(65W)
SVM3–12/20/40	A06B–6079–H306 A06B–6096–H306	α2/3000	αC12/2000	α6/2000	102W	62W	(57W)
		α2/3000	αC12/2000	αC22/1500	136W	77W	(69W)
SVM3–20/20/40	A06B–6079–H307 A06B–6096–H307	αC12/2000	αC12/2000	α6/2000	116W	68W	(62W)
		αC12/2000	αC12/2000	αC22/1500	150W	82W	(74W)

NOTE

A vaule enclosed by parentheses indicates the remaining heat when the module is forcibly air–cooled with an air flow of 2m/s or more.

6.1.3 Spindle Amplifier Module

Table.6.1.3 (a) SPM

Name	Ordering number	Continuous rated output of motor (Note 4)	Total heat dissipation	Remaining heat in cabinet	
				Natural ventilation	Forced air cooling (Note 1)
SPM–2.2	A06B–6078–H202#H500	1.5kW	75W	37W	(32W)
SPM–5.5	A06B–6078–H206#H500	2.2kW	112W	44W	(36W)
		3.7kW	120W	46W	(36W)
SPM–11	A06B–6078–H211#H500	5.5kW	171W	——	41W (Note 2)
		7.5kW	218W	——	46W (Note 2)
SPM–15	A06B–6088–H215#H500	11kW	273W	——	45W
SPM–22	A06B–6088–H222#H500	15kW	435W	——	53W
		18.5kW	515W	——	57W
SPM–26	A06B–6088–H226#H500	22kW	684W	——	62W
SPM–30	A06B–6088–H230#H500	26kW	739W	——	65W
SPM–45	A06B–6088–H245#H500	30kW	911W	——	75W (Note 3)
		37kW	1123W	——	85W (Note 3)

NOTE

1 A vaule enclosed by parentheses indicates the remaining heat when the module is forcibly air–cooled with an air flow of 2m/s or more.
2 Requires forced air cooling equivalent to fan adaptor unit A06B–6078–K001 (with air flow of 2 m/s or greater).
3 Forced air cooling by fan adaptor unit A06B–6078–K003 or equivalent (2 m/s or more) is required.
4 The rated output is the continuous rated output of the motor.

Table.6.1.3 (b) SPMC

Name	Ordering number	Continuous rated output of motor (Note 3)	Total heat dissipation	Remaining heat in cabinet	
				Natural ventilation	Forced air cooling (Note 1)
SPMC–2.2	A06B–6082–H202#H510	1.5kW	75W	37W	(32W)
SPMC–5.5	A06B–6082–H206#H510	2.2kW	112W	44W	(36W)
		3.7kW	120W	46W	(36W)
SPMC–11	A06B–6082–H211#H510	5.5kW	171W	-	41W (Note 2)
		7.5kW	218W	-	53W (Note 2)
SPMC–15	A06B–6082–H215#H512	11kW	273W	-	45W
SPMC–22	A06B–6087–H222#H512	15kW	435W	-	53W
		18.5kW	515W	-	57W
SPMC–26	A06B–6087–H226#H512	22kW	684W	-	62W

NOTE
1 A vaule enclosed by parentheses indicates the remaining heat when the module is forcibly air–cooled with an air flow of 2m/s or more.
2 Requires forced air cooling equivalent to fan adaptor unit A06B–6078–K002 (with air flow of 2 m/s or greater).
3 The rated output is the continuous rated output of the motor.

6.2 400–V INPUT SERIES

6.2.1 Power Supply Modules

Table.6.2.1 (a) PSM–HV

Name	Ordering number	Continuous rated output of motor	Total heat dissipation	Remaining heat in cabinet	
				Natural ventilation	Forced air cooling
PSM–18HV	A06B–6091–H118	18kW	274W	___	57W
PSM–30HV	A06B–6091–H130	30kW	380W	___	64W
PSM–45HV	A06B–6091–H145	30kW	394W	___	64W
		37kW	475W	___	68W
		45kW	567W	___	75W
PSM–75HV	A06B–6091–H175	60kW	600W	___	75W (Note)
		75kW	738W	___	82W (Note)

NOTE
Forced air cooling by fan adaptor unit A06B–6078–K003 or equivalent (2 m/s or more) is required.

Table.6.2.1 (b) PSMC–HV

Name	Ordering number	Continuous rated output of motor	Total heat dissipation	Remaining heat in cabinet	
				Natural ventilation	Forced air cooling
PSMC–18HV	A06B–6091–H118	___	10W	10W	___
PSMC–30HV	A06B–6091–H130	___	10W	10W	___
PSMC–45HV	A06B–6091–H145	___	5W	5W	___

Table.6.2.1 (c) PSMV–HV

Name	Ordering number	Continuous rated output of motor	Total heat dissipation	Remaining heat in cabinet	
				Natural ventilation	Forced air cooling
PSMV–11HV	A06B–6098–H111	3.0kW	60W	60W	___

Table.6.2.1 (d) AC Reactor

Name	Ordering number	Total heat dissipation	Remarks
For PSM–18, 30, 45HV	A81L–0001–0127	12W	When PSM–18HV is used
		30W	When PSM–30HV is used
		67W	When PSM–45HV is used
For PSM–75HV	A81L–0001–0133	47W	

Table.6.2.1 (e) AC Reactor Unit

Name	Ordering number	Total heat dissipation	Remarks
For PSMV–11HV	A06B–6098–H001	56W	At 11kW output

6.2.2 Servo Amplifier Modules

When a motor other than those listed below is used, its heat output should be assumed to be that of a listed motor with a higher rated current.

Table.6.2.2 (a) SVM1–HV (One Axis)

Name	Ordering number	Motor used		Total heat dissipation	Remaining heat in cabinet	
	A06B–6085 A06B–6097	L–axis	M–axis		Natural ventilation	Forced air cooling
SVM1–20HV	–H102	α6/3000HV		32W	22W	___
SVM1–40HV	–H103	α12/3000HV		57W	34W	___
SVM1–60HV	–H104	αM30/3000HV		88W	45W	___

Table.6.2.2 (b) SVM2–HV (Two Axes)

Name	Ordering number	Motor used		Total heat dissipation	Remaining heat in cabinet	
	A06B–6085 A06B–6097	L–axis	M–axis		Natural ventilation	Forced air cooling
SVM2–20/20HV	–H201	α6/3000HV	α6/3000HV	55W	36W	___
SVM2–20/40HV	–H202	α6/3000HV	α12/3000HV	75W	42W	___
SVM2–20/60HV	–H203	α6/3000HV	αM30/3000HV	111W	58W	___
SVM2–40/40HV	–H204	α12/3000HV	α12/3000HV	95W	48W	___
SVM2–40/60HV	–H205	α12/3000HV	αM30/3000HV	131W	65W	___
SVM2–60/60HV	–H206	αM30/3000HV	αM30/3000HV	161W	75W	___

6.2.3 Spindle Amplifier Modules

Table.6.2.3 SPM–HV

Name	Ordering number	Continuous rated output of motor (Note 3)	Total heat dissipation	Remaining heat in cabinet	
				Natural ventilation	Forced air cooling
SPM–11HV	A06B–6092–H211#H500	5.5kW	122W	___	37W (Note 1)
		7.5kW	156W	___	41W (Note 1)
SPM–15HV	A06B–6092–H215#H500	11kW	189W	___	37W
SPM–26HV	A06B–6092–H226#H500	15kW	247W	___	40W
		18.5kW	298W	___	42W
		22kW	349W	___	45W
SPM–45HV	A06B–6092–H245#H500	30kW	482W	___	52W
		37kW	588W	___	57W
SPM–75HV	A06B–6092–H275#H500	60kW	1264W	___	91W (Note 2)

NOTE
1 Forced air cooling by fan adaptor unit A06B–6078–K001 or equivalent (2m/s or more) is required.
2 Forced air cooling by fan adaptor unit A06B–6078–K003 or equivalent (2m/s or more) is required.
3 The rated output is the continuous rated output of the motor.

7 COOLING

The use of an amplifier module listed below requires forced air cooling. In this case, provide a fan motor.

When forced air cooling is provided, the power magnetics cabinet should be designed so that cooling air from the fan motor does not leak out from the cabinet.

Because of its operating environment, the fan motor may have to be maintained or replaced. Therefore, special considerations should be given to the installation and construction of the fan motor so that maintenance work can be performed easily.

Table.7 AC Reactor

Model	Required wind speed	Usable fan adaptor (Note)	Manufacturer part number
PSM–11, SPM–11, SPM–11HV	2 m/sec or more	A06B–6078–K001	ROYAL ELECTRIC UT857CG (R)
SVM1–130 (When motor α22/3000, α30/3000, α40/2000 (with fan), αL25/3000, αL50.2000, or αM40/3000 is used) SPMC–11	2 m/sec or more	A06B–6078–K002	ROYAL ELECTRIC UT857CG (R)
PSM–45,SPM–45, PSM–75HV,SPM–75HV	2 m/sec or more	A06B–6078–K003	ROYAL ELECTRIC UTHC457C STYLE ELEC-TRONICS US12D23

NOTE

Using a fan adaptor enables the desired cooling performance to be obtained. For details of the fan adaptor, see (7) in Section 2.2.3.

8 EXTERNAL DIMENSIONS AND MAINTENANCE AREA

8.1 OUTLINE DRAWINGS

8.1.1 Outline Drawings of Modules

(1) Power supply modules

Table.8.1.1 (a) Power Supply Modules

Model			Outline drawing
Power regeneration type	200–V input series	PSM–5.5	Outline drawing 4
		PSM–11	
		PSM–15	Outline drawing 5
		PSM–26	
		PSM–30	
		PSM–37	
		PSM–45	Outline drawing 6
	400–V input series	PSMV–11HV	Outline drawing 5
		PSM–18HV	
		PSM–30HV	
		PSM–45HV	
		PSM–75HV	Outline drawing 6
Resistance regeneration type	200–V input series	PSMR–3	Outline drawing 1
		PSMR–5.5	Outline drawing 2

(2) Capacitor modules

Table.8.1.1 (b) Capacitor Modules

Amplifier model used	Model		Outline drawing
PSM–18HV	400–V input series	PSMC–18HV	Outline drawing 3
PSM–30HV		PSMC–30HV	
PSM–45HV		PSMC–45HV	Outline drawing 7
PSM–75HV			

(3) Servo amplifier modules

Table.8.1.1 (c) Servo Amplifier Modules (1/2)

Model			Outline drawing
200–V input series	One axis	SVM1–12	Outline drawing 1
		SVM1–20	

Table.8.1.1 (c) Servo Amplifier Modules (2/2)

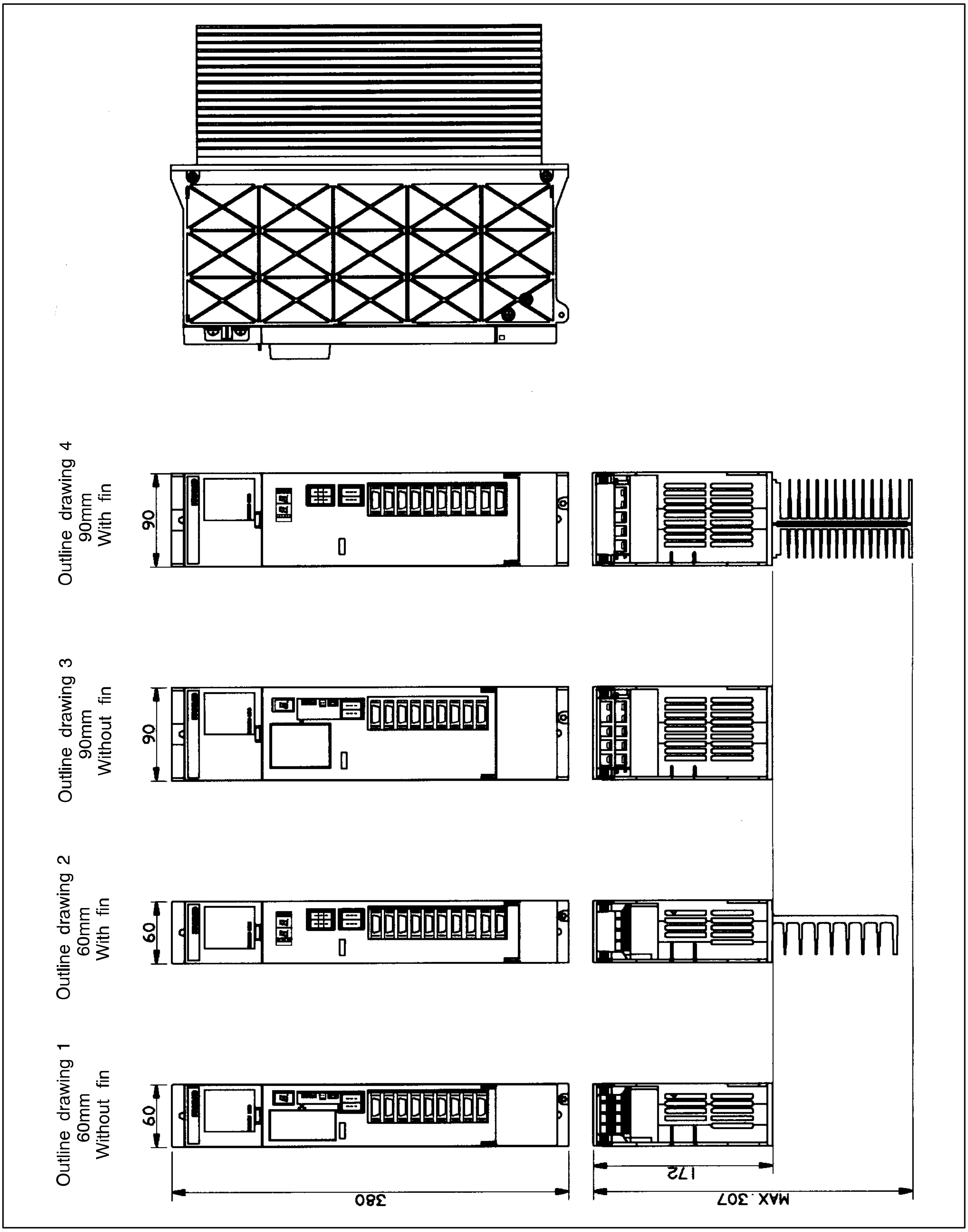
Model			Outline drawing
200–V input series	One axis	SVM1–40S	Outline drawing 2
		SVM1–40L	
		SVM1–80	
		SVM1–130	Outline drawing 4
		SVM1–240	Outline drawing 5
		SVM1–360	
	Two axes	SVM2–12/12	Outline drawing 1
		SVM2–12/20	
		SVM2–20/20	
		SVM2–12/40	Outline drawing 2
		SVM2–20/40	
		SVM2–40/40	
		SVM2–40L/40L	Outline drawing 4
		SVM2–40/80	
		SVM2–80/80	
	Three axes	SVM3–12/12/12	Outline drawing 3
		SVM3–12/12/20	
		SVM3–12/20/20	
		SVM3–20/20/20	
		SVM3–12/12/40	Outline drawing 4
		SVM3–12/20/40	
		SVM3–20/20/40	
400–V input series	One axis	SVM1–20HV	Outline drawing 4
		SVM1–40HV	
		SVM1–60HV	
	Two axes	SVM2–20/20HV	Outline drawing 4
		SVM2–20/40HV	
		SVM2–40/40HV	
		SVM2–20/60HV	
		SVM2–40/60HV	
		SVM2–60/60HV	

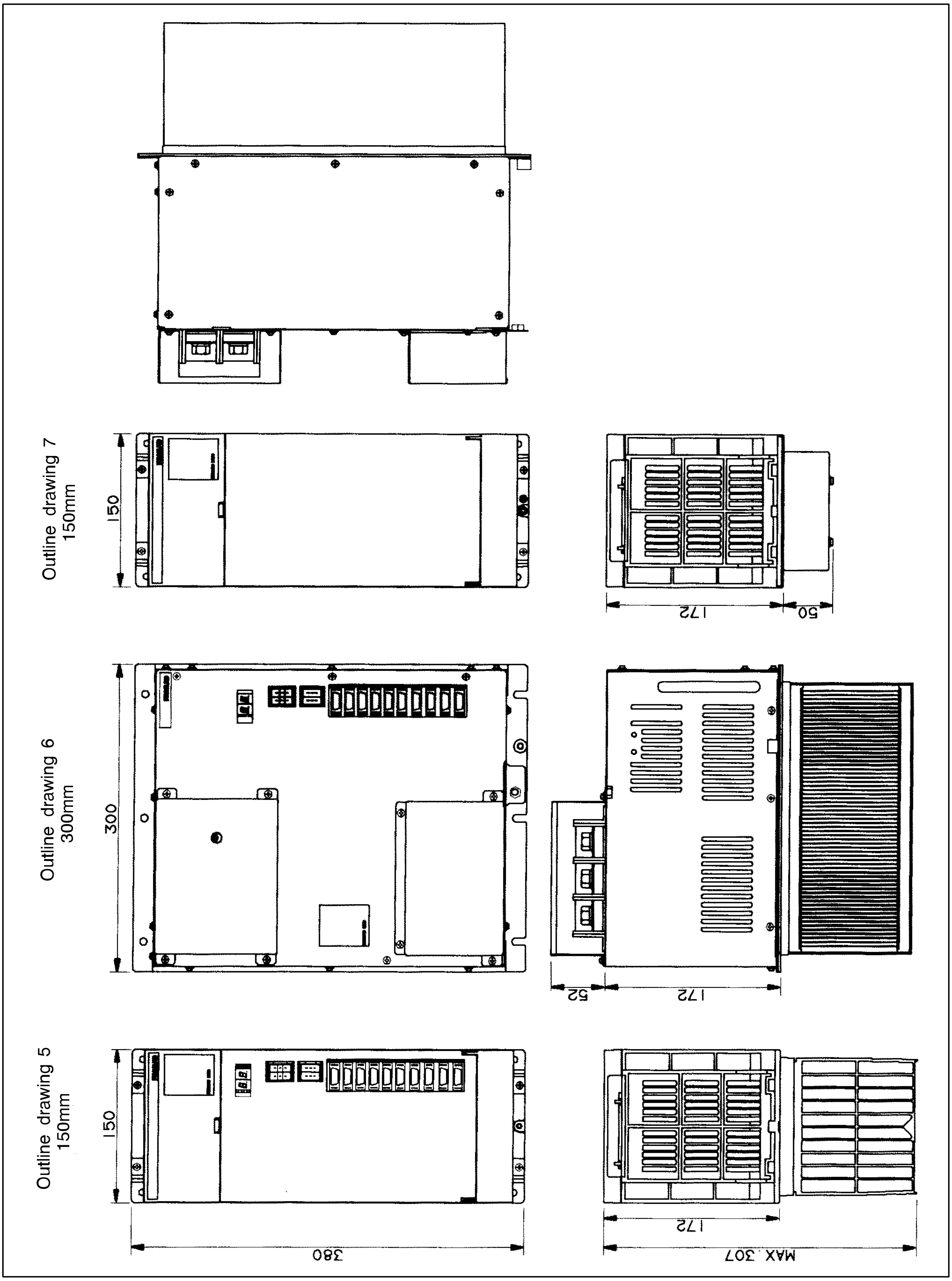
(4) Spindle amplifier modules

Table.8.1.1 (d) Spindle Amplifier Modules

<table>
<tr><th colspan="3">Model</th><th>Outline drawing</th></tr>
<tr><td rowspan="14">α series</td><td rowspan="9">200–V input series</td><td>SPM–2.2(TYPE1,2,4)</td><td>Outline drawing 2</td></tr>
<tr><td>SPM–5.5(TYPE1,2,4)</td><td rowspan="2">Outline drawing 4</td></tr>
<tr><td>SPM–11(TYPE1,2,4)</td></tr>
<tr><td>SPM–11(TYPE3)</td><td rowspan="5">Outline drawing 5</td></tr>
<tr><td>SPM–15(TYPE1,2,3,4)</td></tr>
<tr><td>SPM–22(TYPE1,2,3,4)</td></tr>
<tr><td>SPM–26(TYPE1,2,3,4)</td></tr>
<tr><td>SPM–30(TYPE1,2,3,4)</td></tr>
<tr><td>SPM–45(TYPE1,2,3,4)</td><td>Outline drawing 6</td></tr>
<tr><td rowspan="5">400–V input series</td><td>SPM–11HV(TYPE1,2,4)</td><td>Outline drawing 4</td></tr>
<tr><td>SPM–15HV(TYPE1,2,4)</td><td rowspan="3">Outline drawing 5</td></tr>
<tr><td>SPM–26HV(TYPE1,2,4)</td></tr>
<tr><td>SPM–45HV(TYPE1,2,4)</td></tr>
<tr><td>SPM–75HV(TYPE1,2,3,4)</td><td>Outline drawing 6</td></tr>
<tr><td rowspan="6">αC serie</td><td rowspan="6">200–V input series</td><td>SPMC–2.2</td><td>Outline drawing 2</td></tr>
<tr><td>SPMC–5.5</td><td rowspan="2">Outline drawing 4</td></tr>
<tr><td>SPMC–11</td></tr>
<tr><td>SPMC–15</td><td rowspan="3">Outline drawing 5</td></tr>
<tr><td>SPMC–22</td></tr>
<tr><td>SPMC–26</td></tr>
</table>

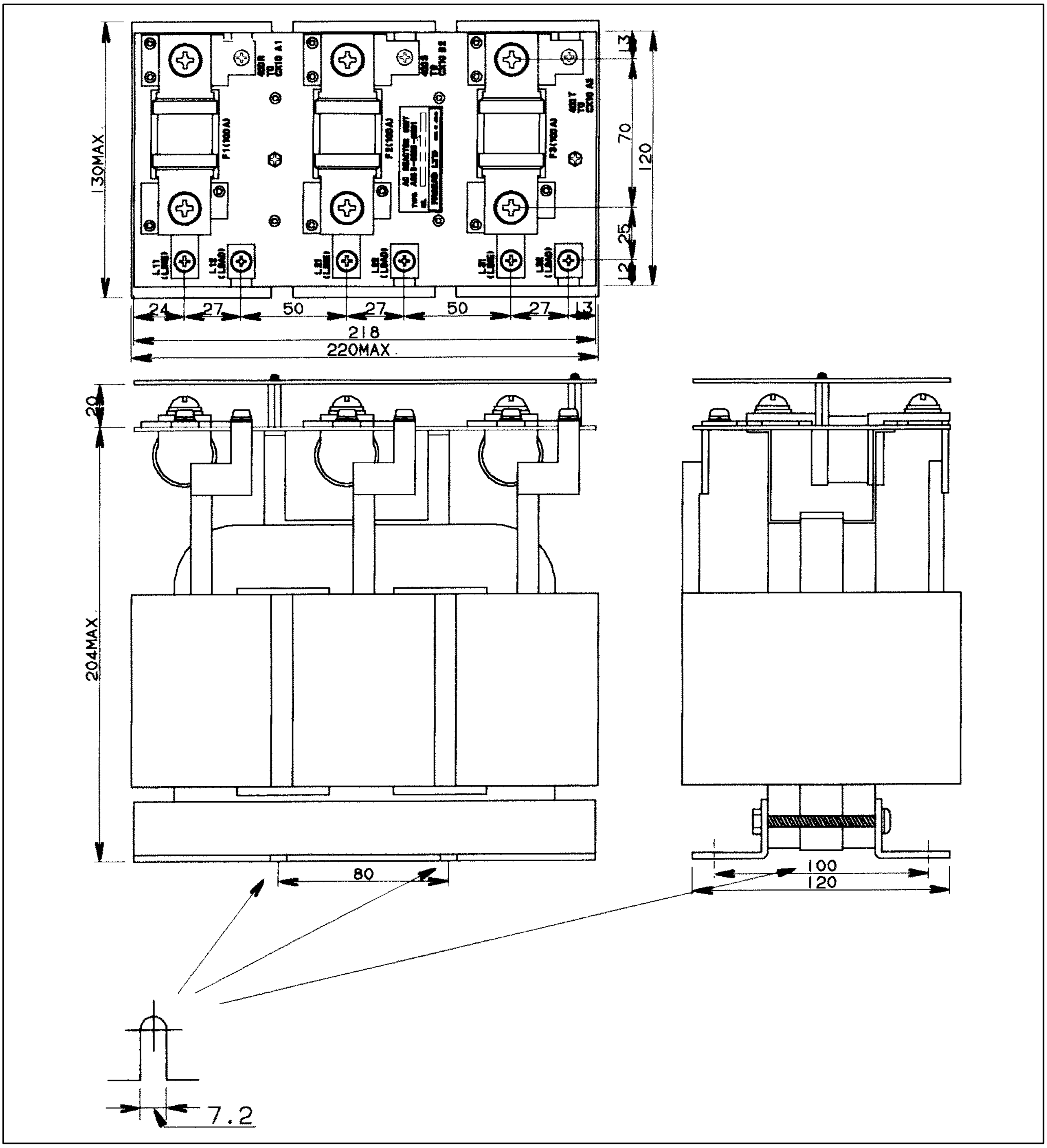
(5) Module outline drawings




Outline drawing 7
150mm
150
172
50
Outline drawing 6
300mm
300
52
172
Outline drawing 5
150mm
150
380
172
MAX. 307

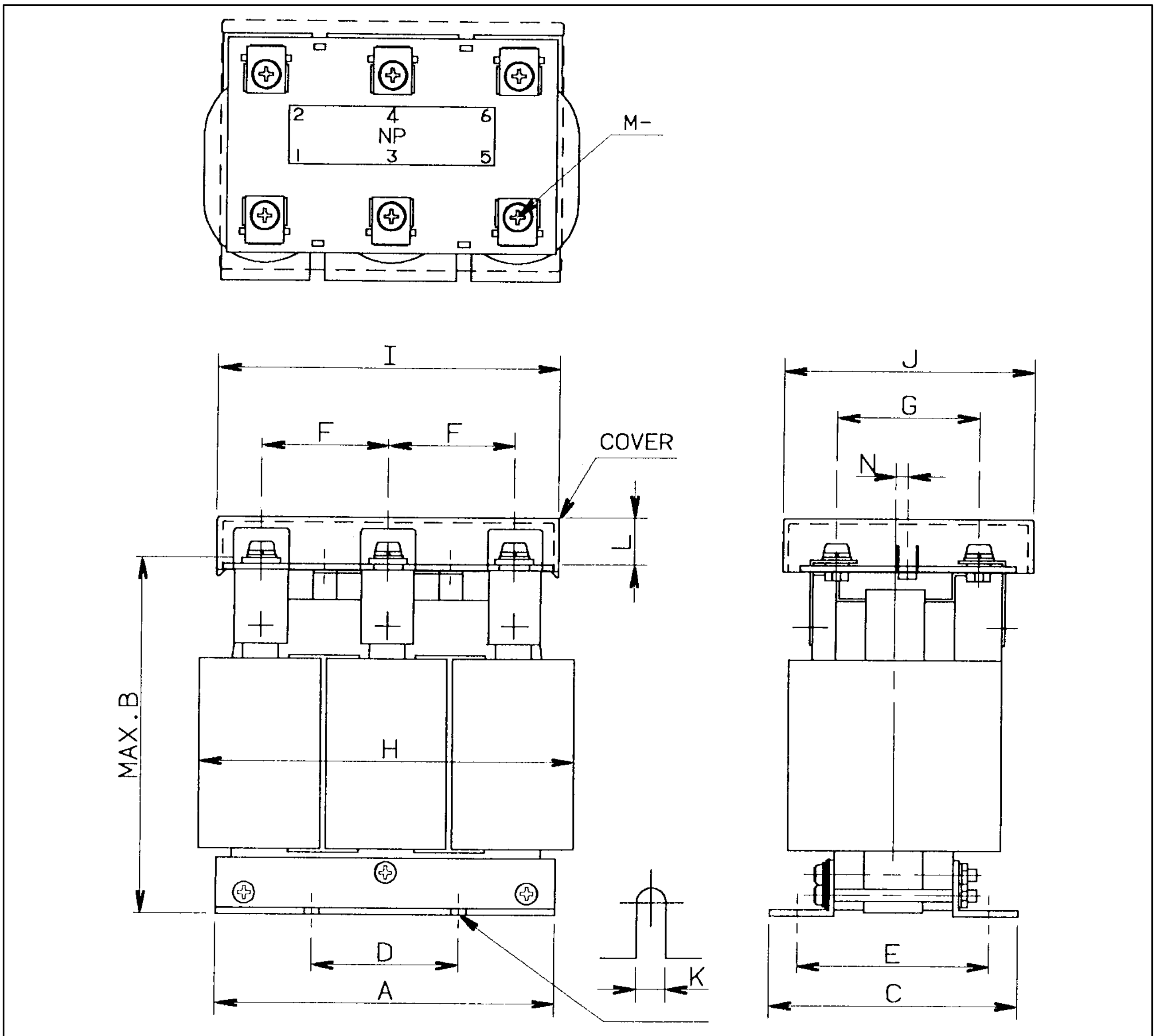
8.1.2
AC Reactor Unit

(For the panel cut–out drawing, see Section 8.2 (k).)

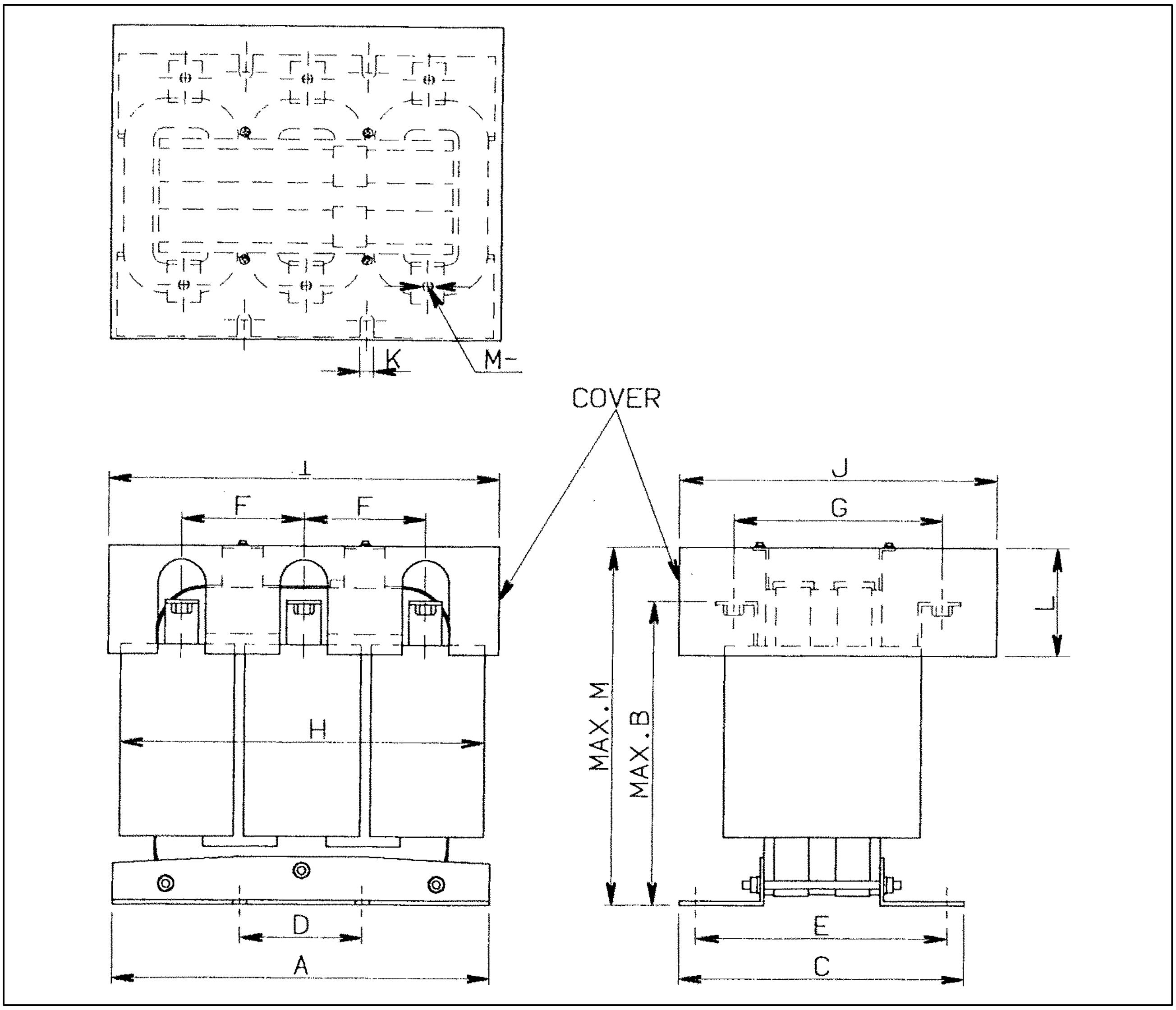


8.1.3
AC Reactor

		A	B	C	D	E	M–	F	G	H	I	J	K	L	Weight
(a)	For PSM–5.5, 11 A81L–0001–0122	115	127	84	50	65	M5	47	48	135	125	85	5	17	4.5kg
(b)	For PSM–15 A81L–0001–0123	135	145	105	50	80	M5	47	48	155	125	85	7.2	17	6.5kg
(c)	For PSM–26 A81L–0001–0120	188	160	115	70	95	M5	65	59	195	161	96	7.2	20	9.5kg
(d)	For PSM–30 A81L–0001–0124														9.2kg
(e)	For PSM–18 to 45HV A81L–0001–0127	218	175	120	80	100	M5	75	70	220	192	106	7.2	13.5	15kg

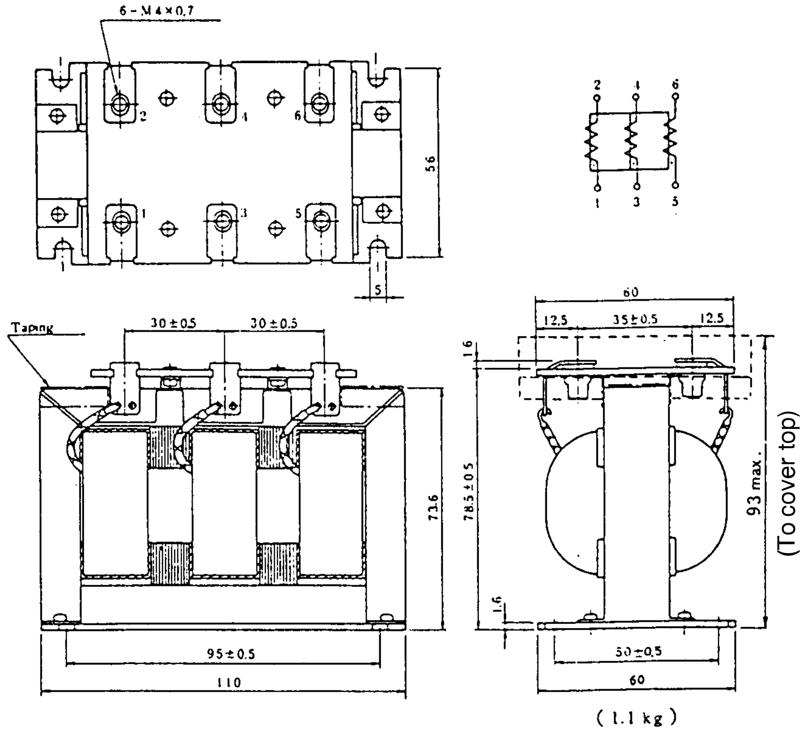


		A	B	C	D	E	M–	F	G	H	I	J	K	L	M	Weight
(f)	For PSM–37 A81L–0001–0147	218	145	120	80	100	M8	75	112	220	212	150	7.2	43	172	16.5kg
(g)	For PSM–45, 75HV A81L–0001–0133	280	225	210	90	185	M8	90	154	270	290	234	10	55	280	38kg

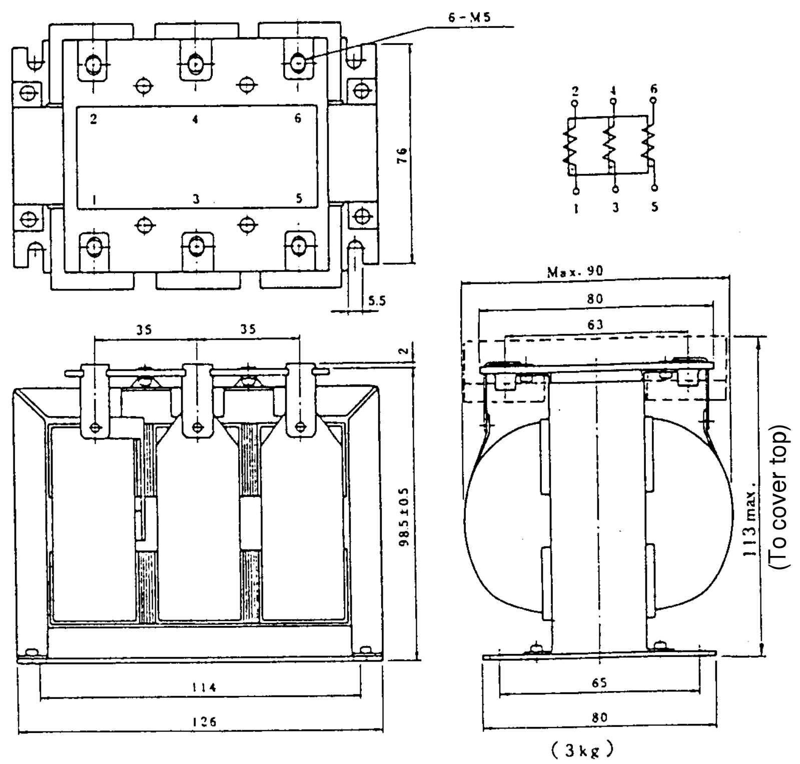


8.1.4 AC Line Filter

(a) A81L–0001–0083#3C

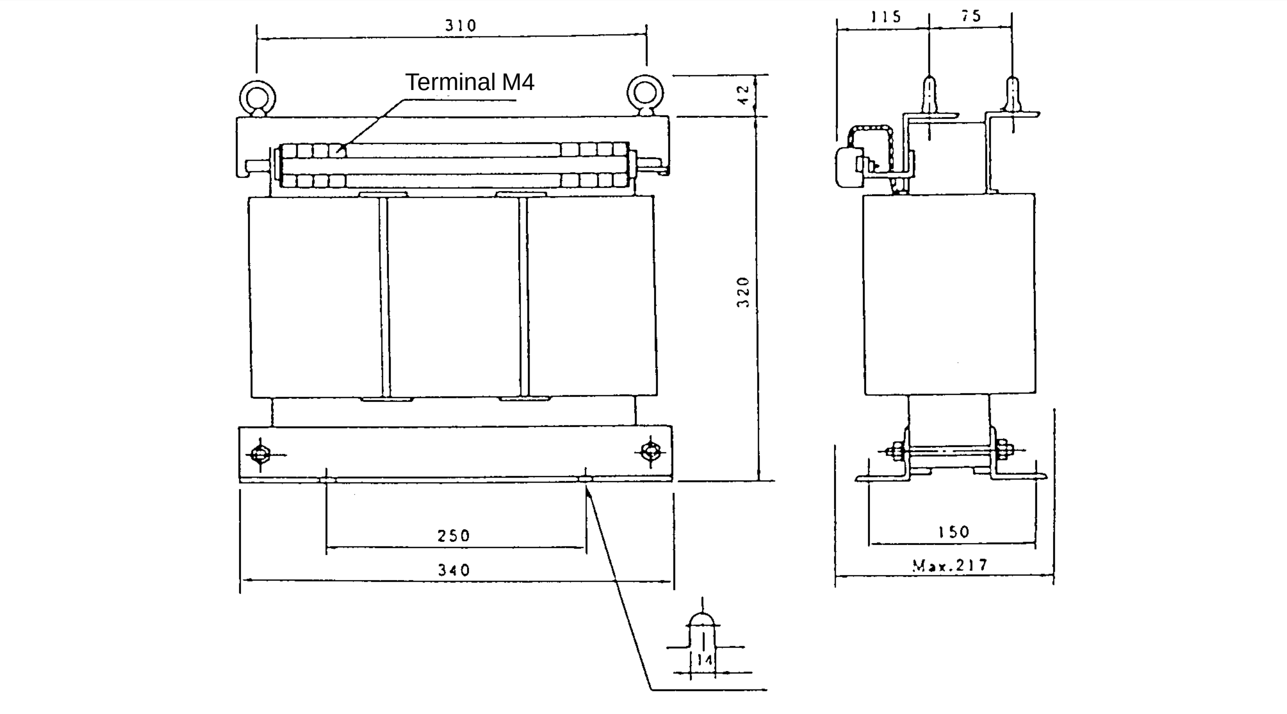


(b) A81L–0001–0101#C

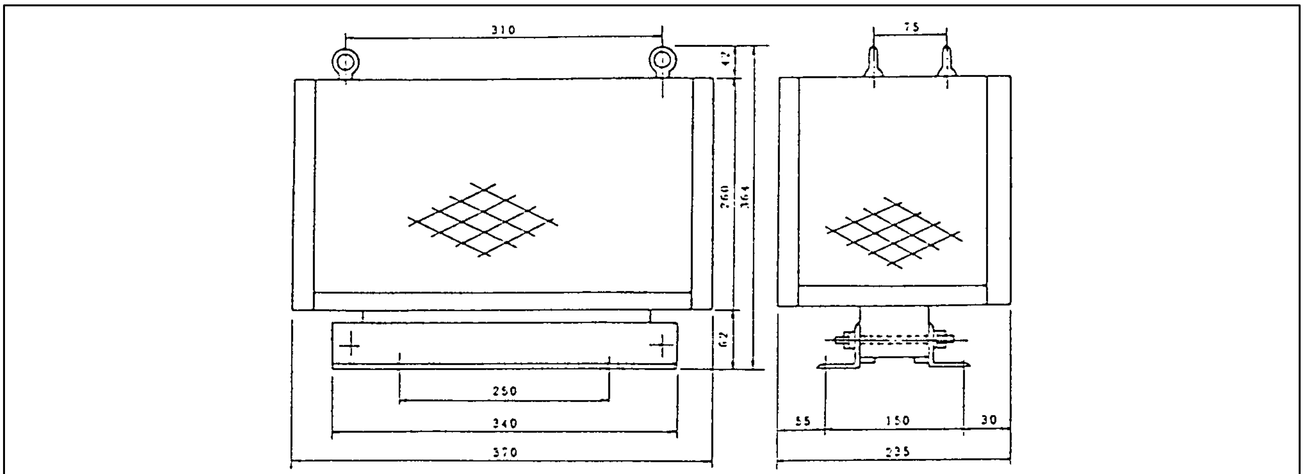


8.1.5 Power Transformer

(a) For PSM–5.5, PSMR–5.5 (5.5 kW output) (A06B–6052–J001)



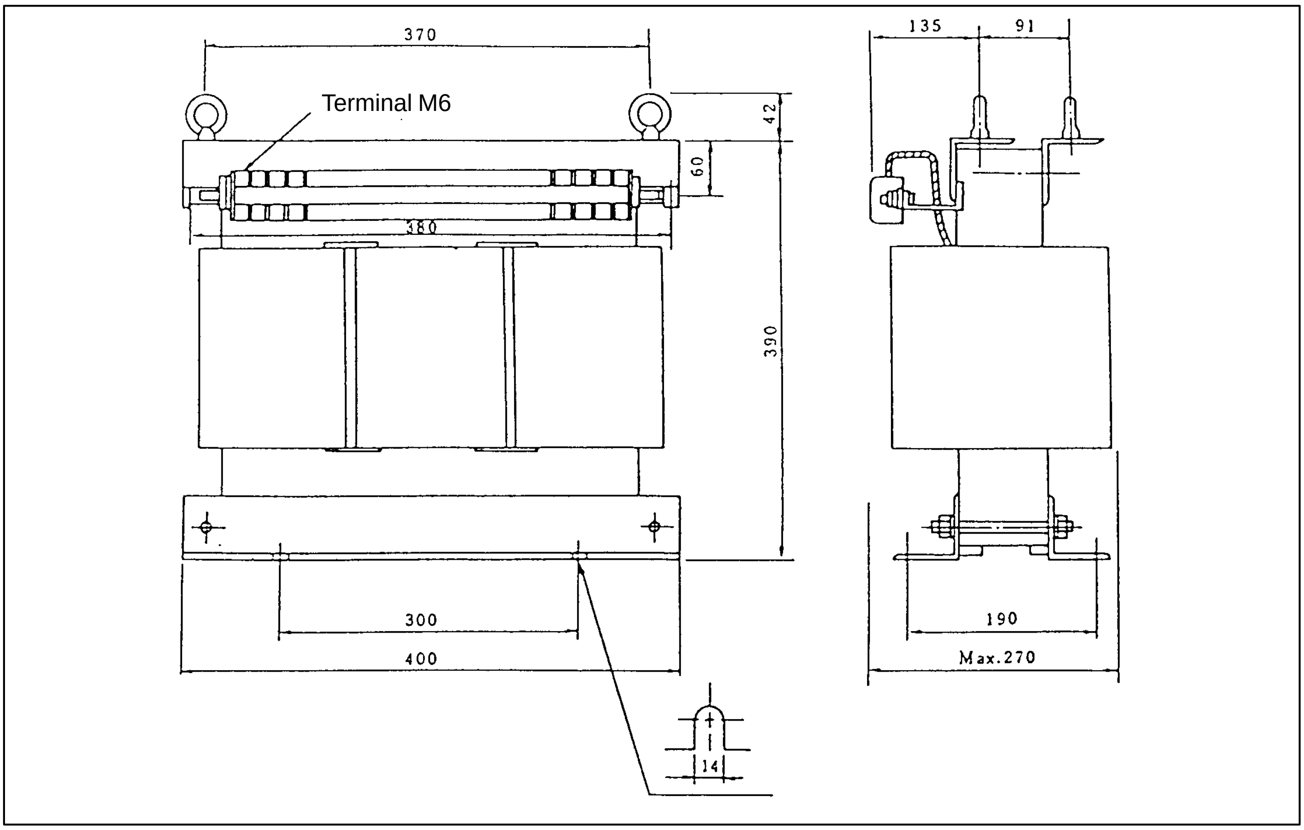
Outline Drawing of Power Transformer with no Cover



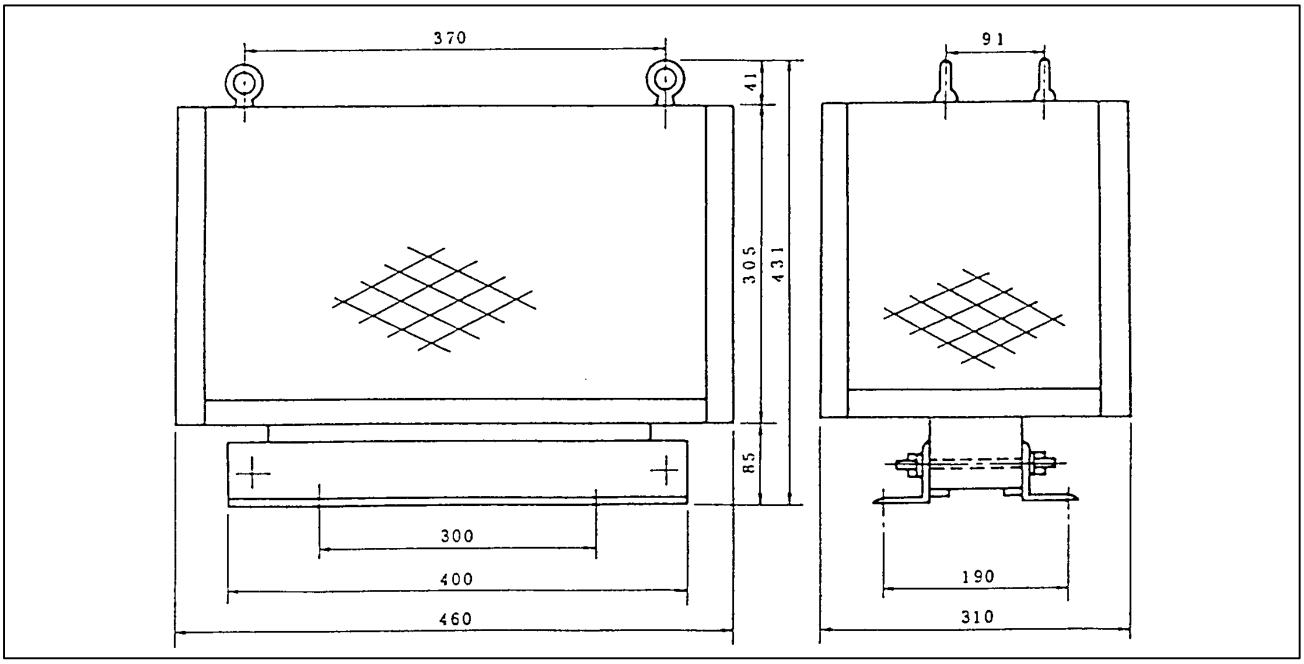
NOTE
The four side panels are all meshed, while the top is a solid plate.

Outline Drawing of Power Transformer with Cover

(b) For PSM–11, PSMR–5.5 (7.5 kW output) (A06B–6044–J006)



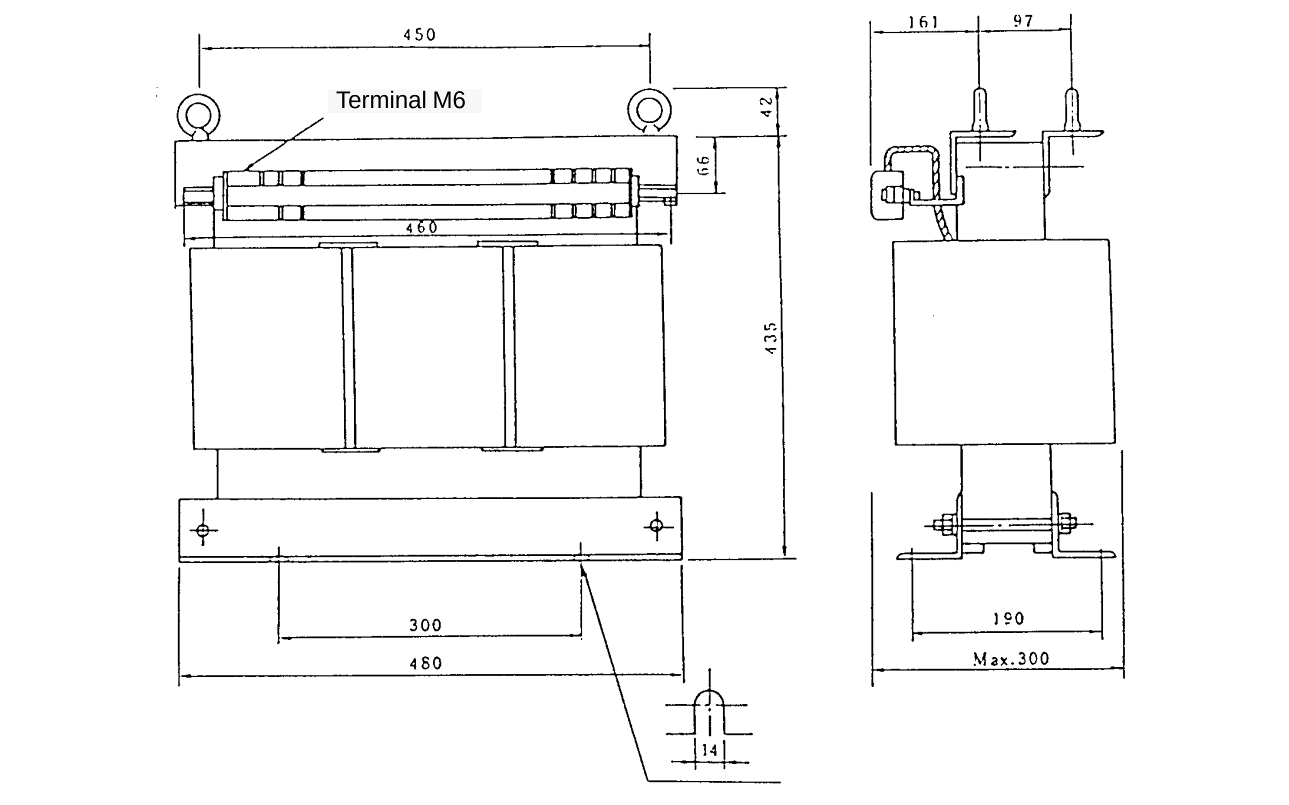
Outline Drawing of Power Transformer with no Cover



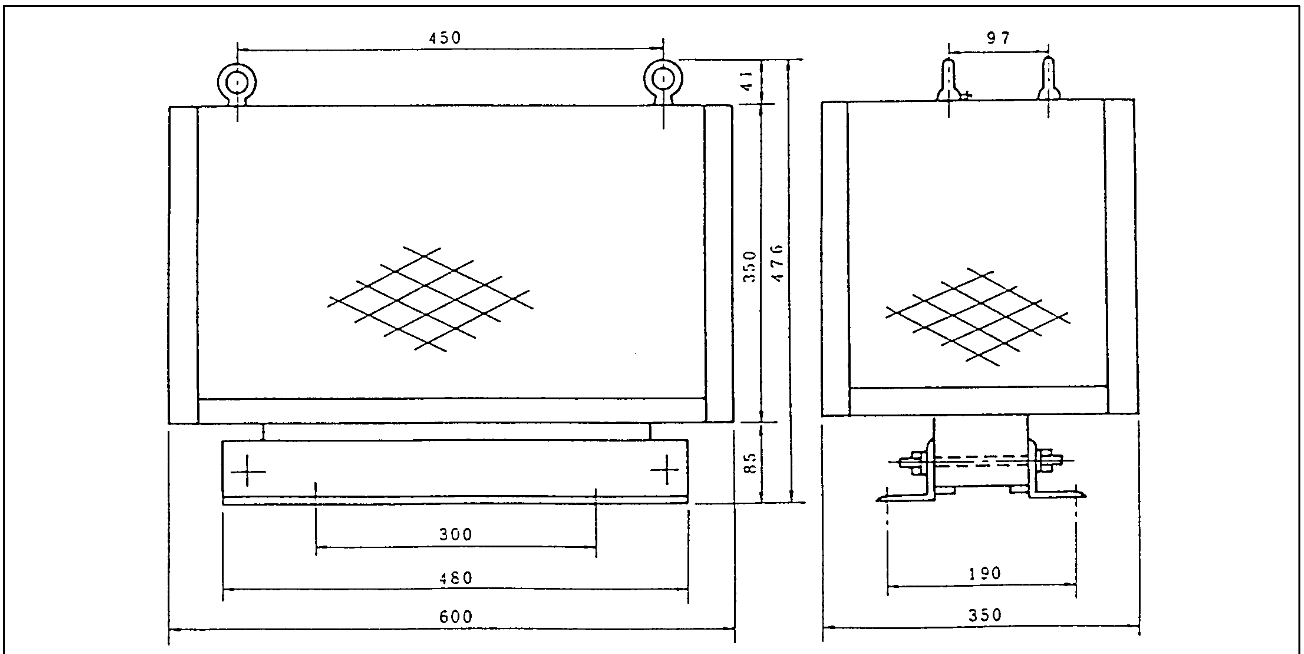
NOTE
The four side panels are all meshed, while the top is a solid plate.

Outline Drawing of Power Transformer with Cover

(c) For PSM–15 (A06B–6044–J007)



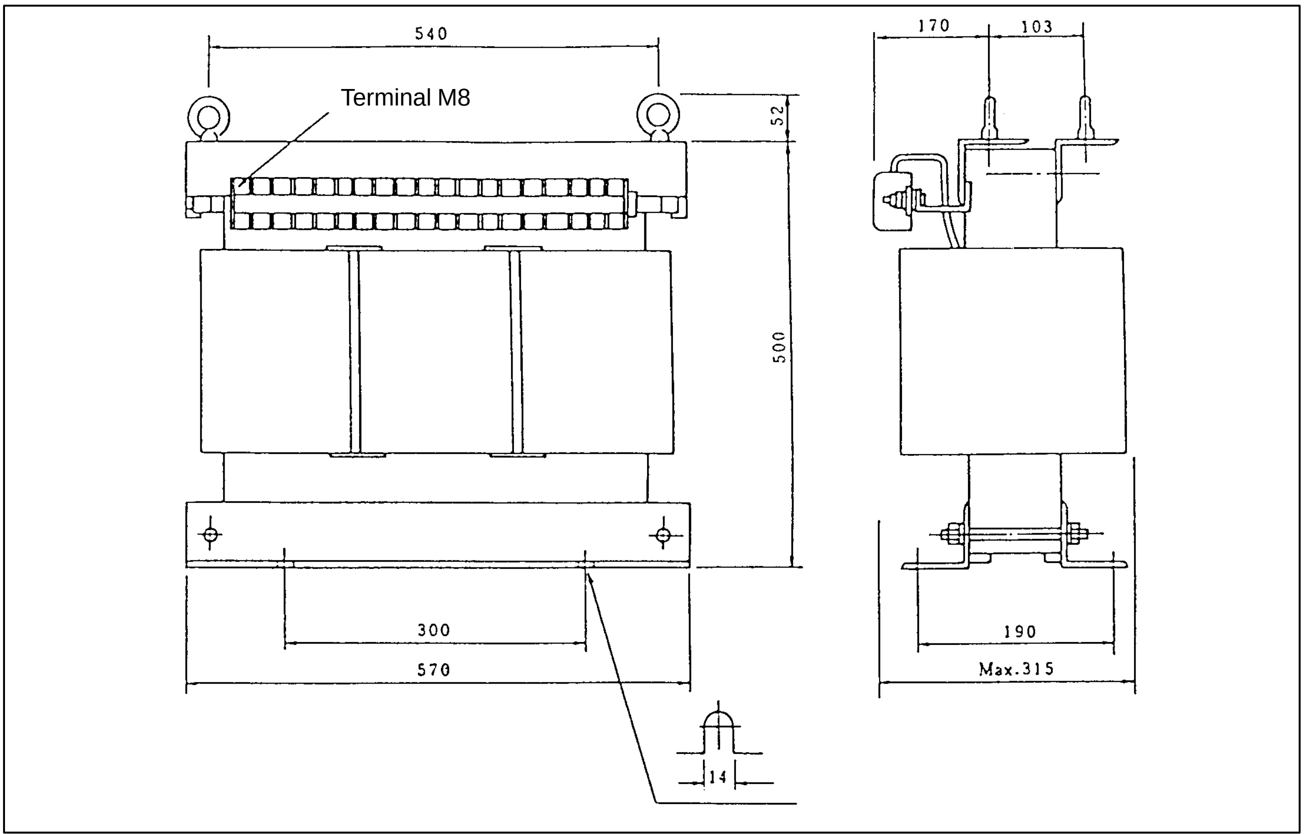
Outline Drawing of Power Transformer with no Cover



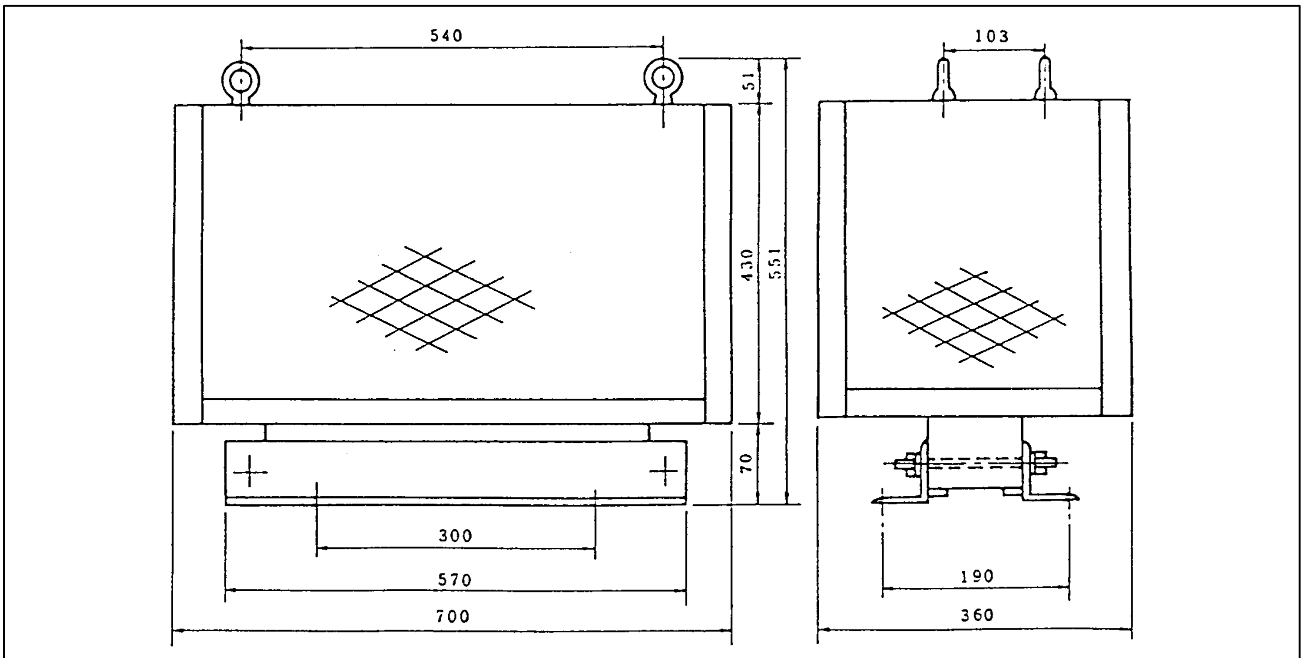
NOTE
The four side panels are all meshed, while the top is a solid plate.

Outline Drawing of Power Transformer with Cover

(d) For PSM–26, 30 (A06B–6044–J010)



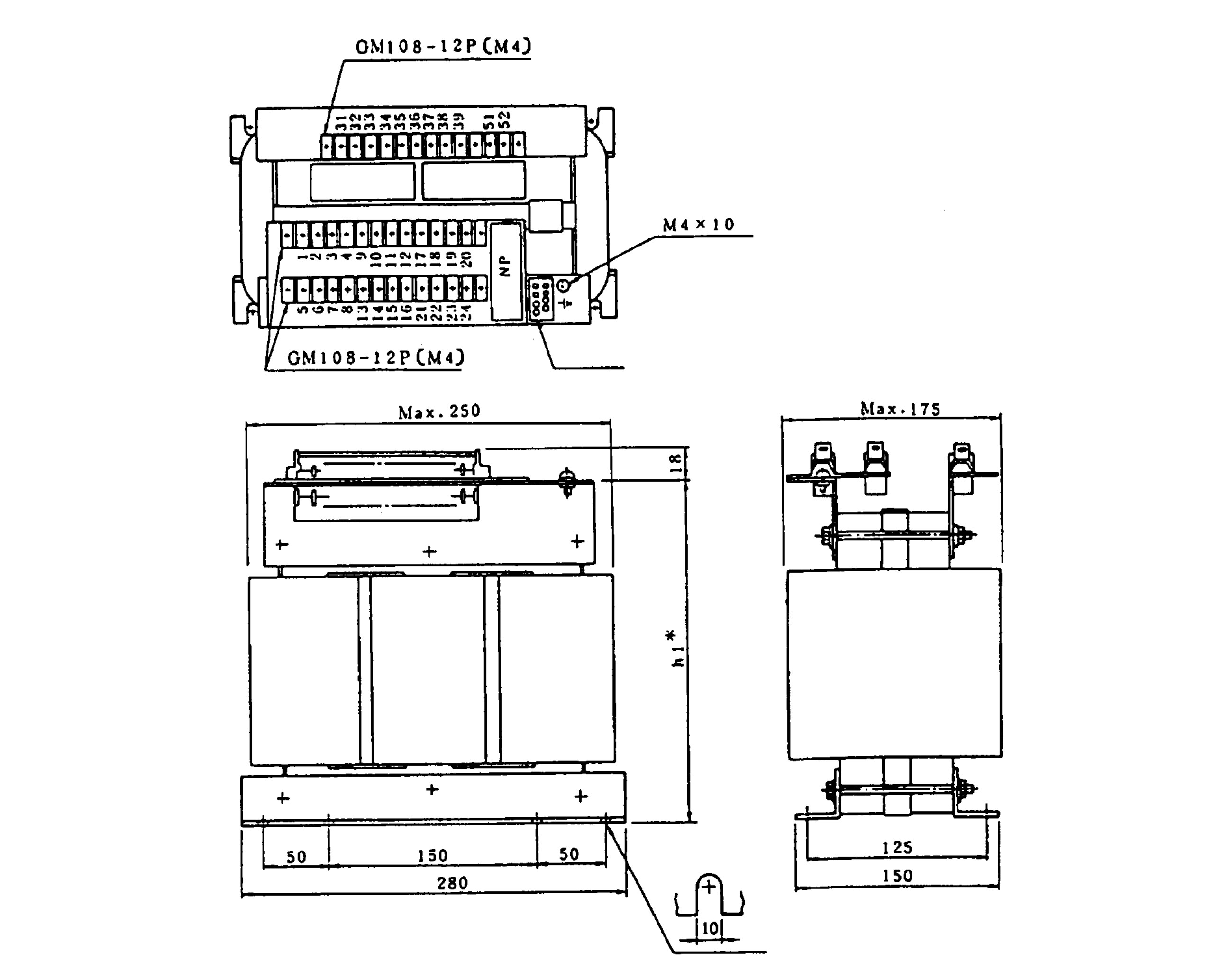
Outline Drawing of Power Transformer with no Cover



NOTE
The four side panels are all meshed, while the top is a solid plate.

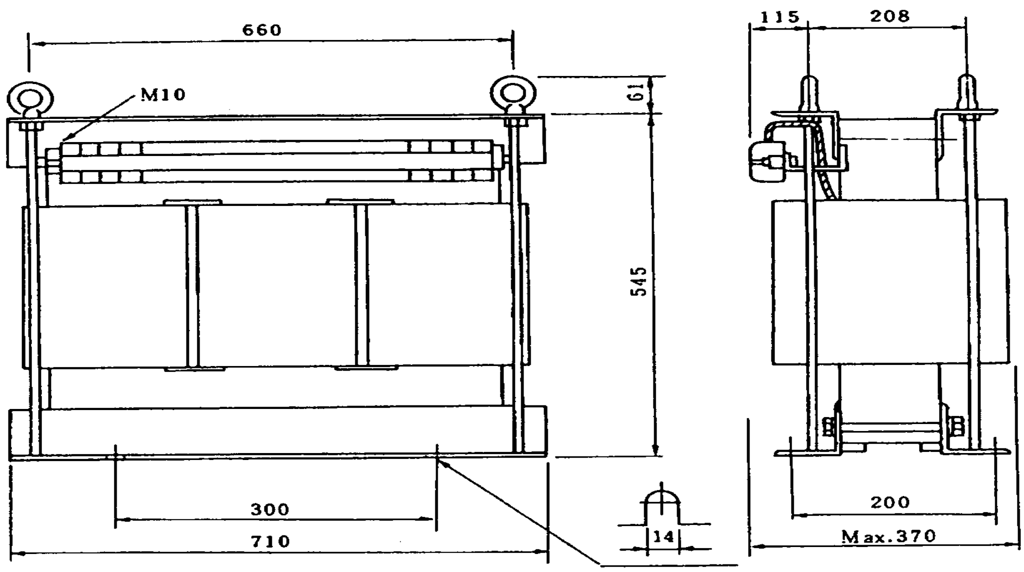
Outline Drawing of Power Transformer with Cover

(e) For PSMR3 (2 kW output) (A80L–0024–0006), for PSMR3 (3 kW output) (A80L–0026–0003)

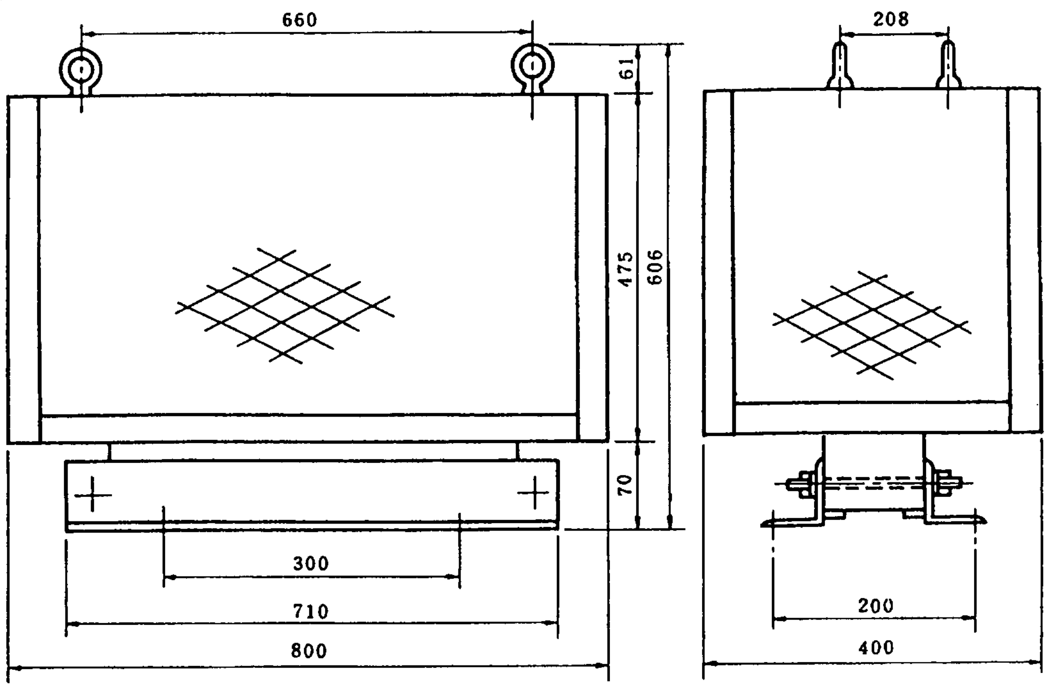


Drawing number	A80L–0024–0006	A80L–0026–0003
Type (name)	SBE	SCE
Weight	27kg	36kg
hl* (height of transformer)	217mm max	247mm max

(f) For PSM–37. 45 (A06B–6044–J015)



Outline Drawing of Power Transformer with no Cover

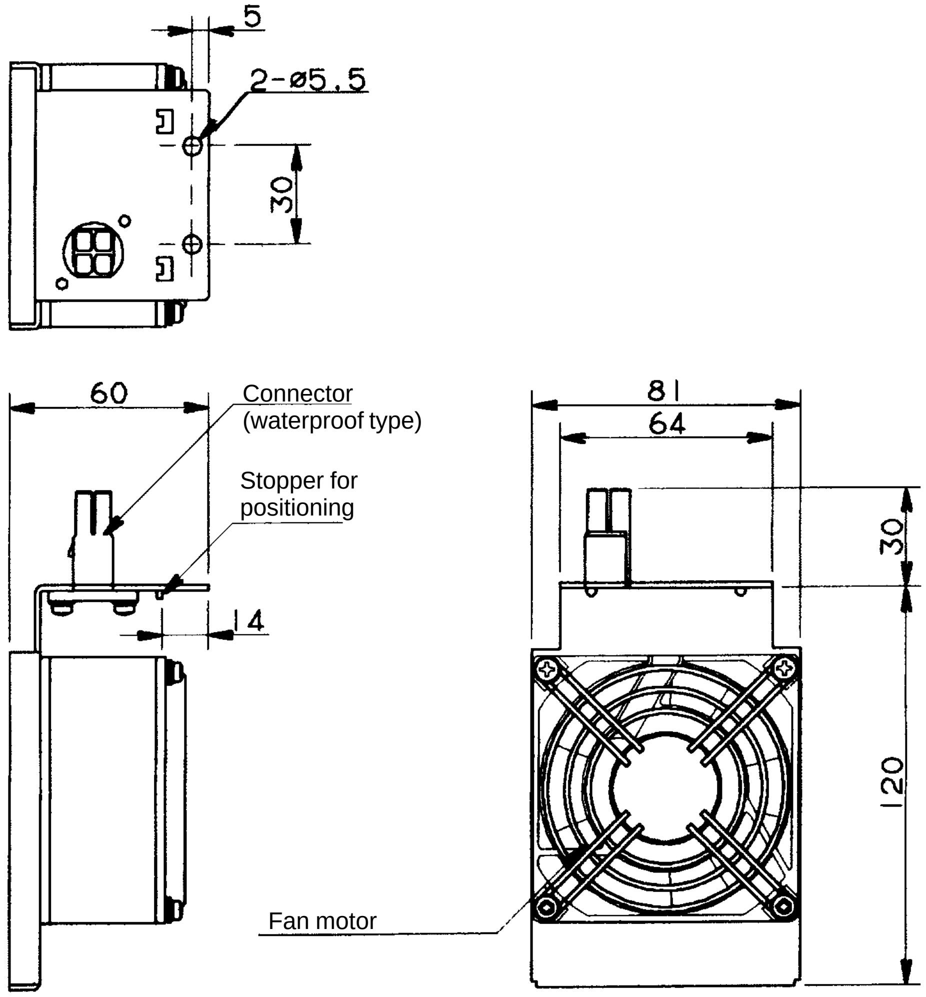


NOTE
The four side panels are all meshed, while the top is a solid plate.

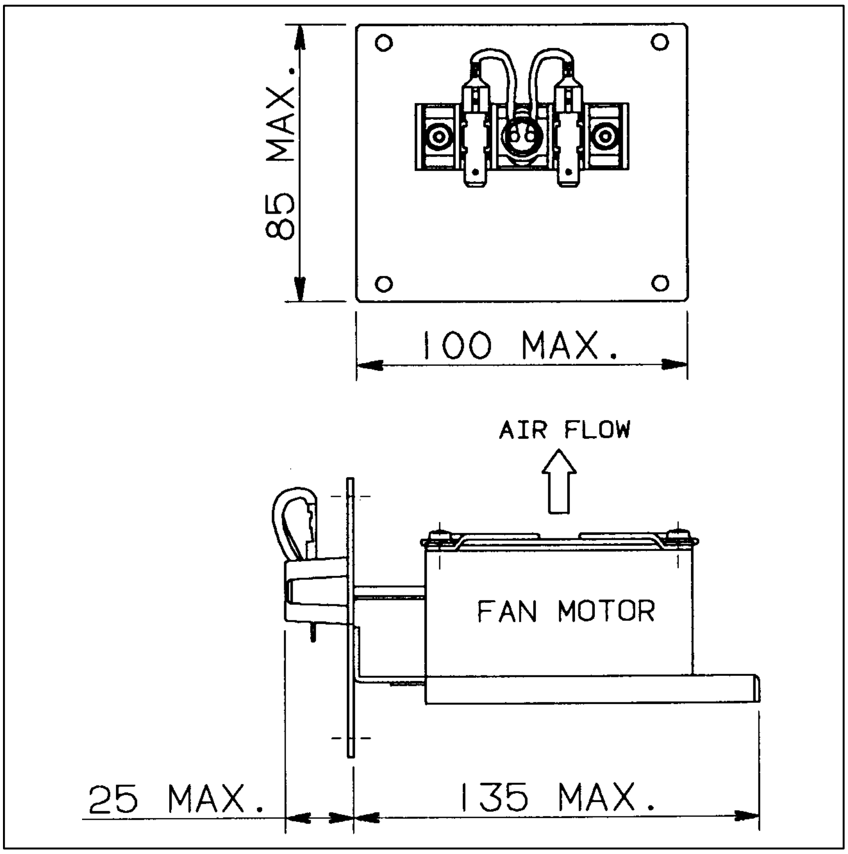
Outline Drawing of Power Transformer with Cover

8.1.6 Fan Adaptor

(a) For PSM–11, SPM–11, and SPM–11HV (A06B–6078–K001)



(b) For SVM1–130. and SPMC–11 (A06B–6078–K002)



Specifications of the input section

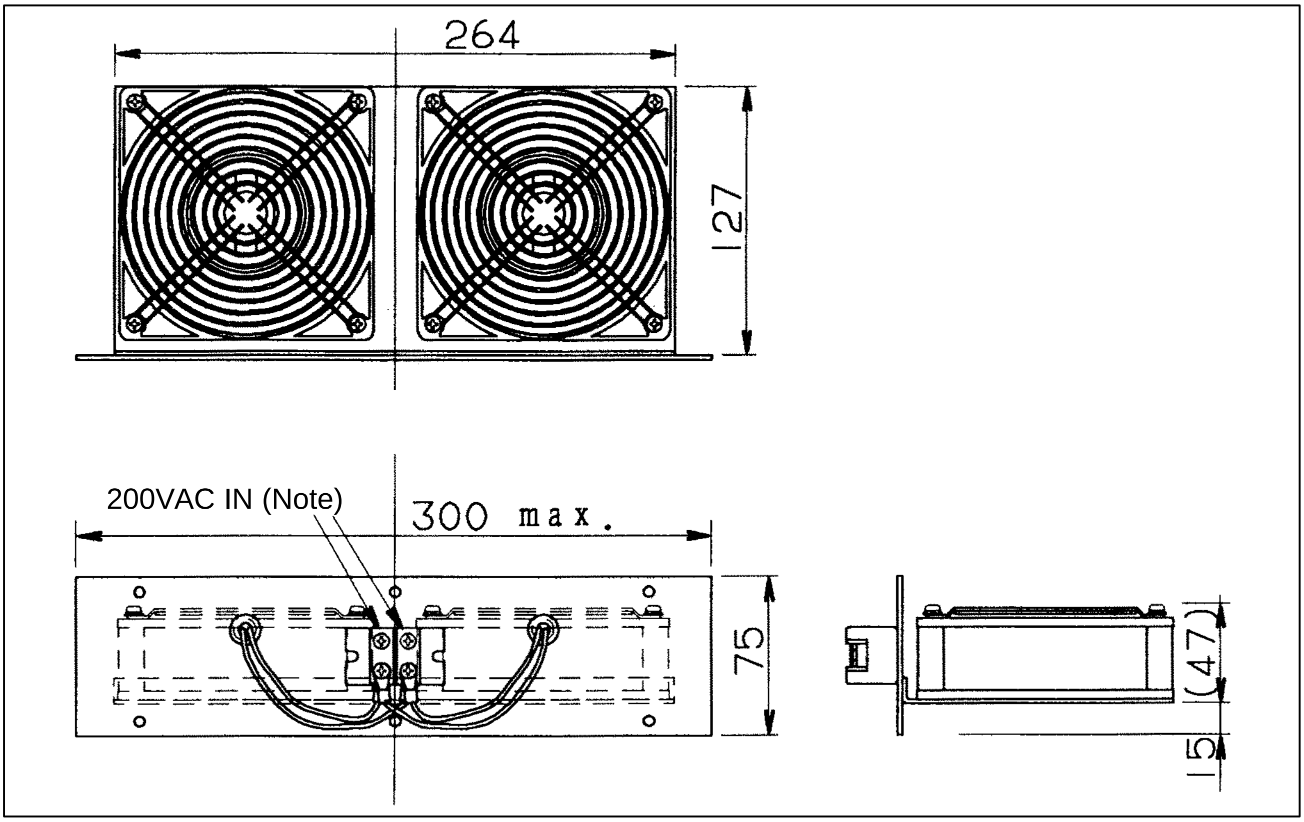
Faston terminal: 6.3 mm (0.250 in) series

Applicable receptacle terminal: 6.3 mm (0.250 in) series
Cables used: Vinyl heavy–duty power cord (JIS C 3312), two cores
Conductor 1.25 mm^2 (50/0.18), sheath PVC 9.6 in diameter

NOTE

1. When SVM1–130 is used together with the following motors, this fan adaptor is required:
   α22/3000, α30/3000, α40/2000, αL25/3000, αL50/2000, αM40/3000
2. To prevent fan motor burn–out, use a 2–A fuse or circuit breaker.

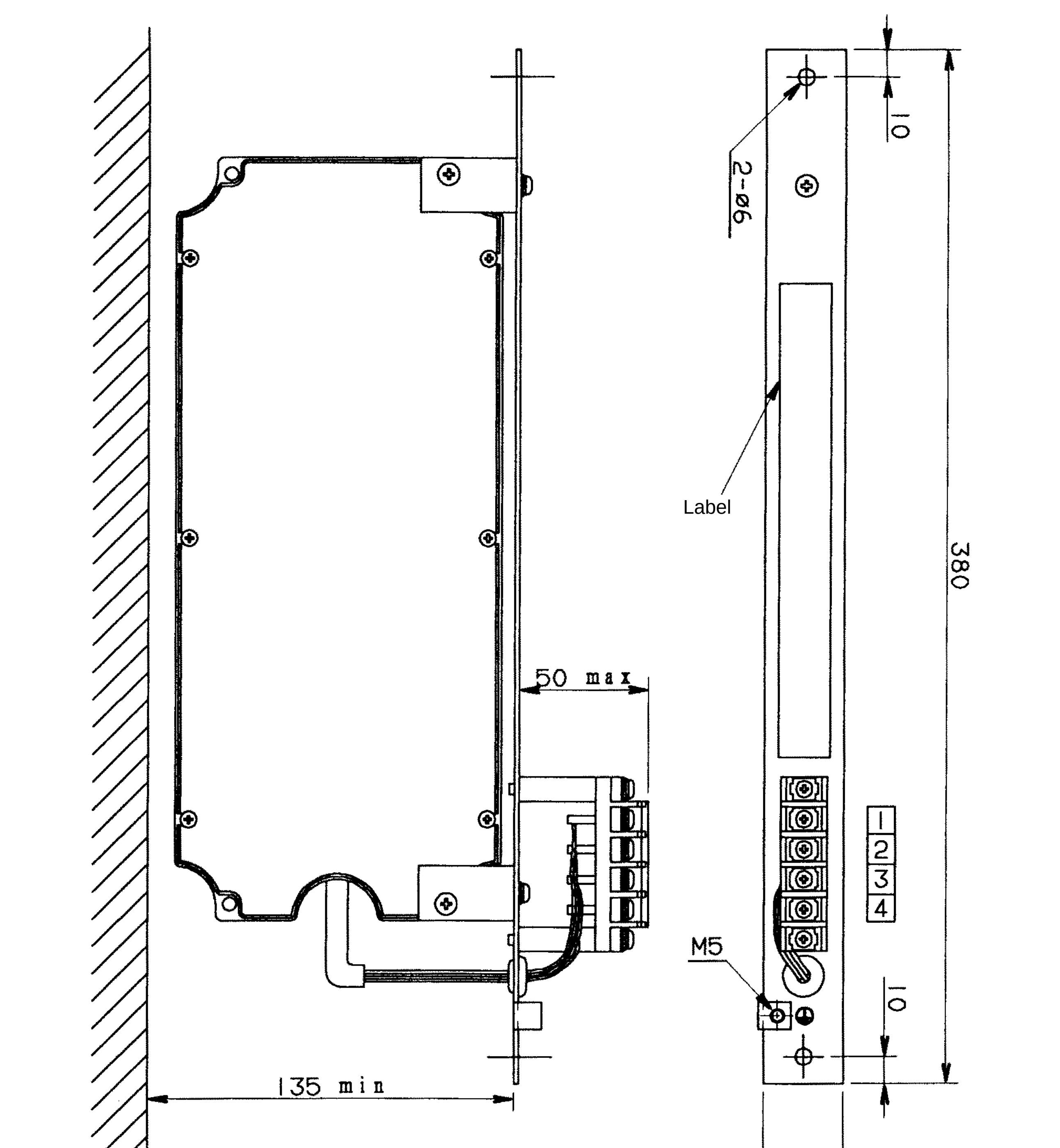
(c) For PSM–45, PSM–75HV, SPM–45, and SPM–75HV (A06B–6078–K003)



NOTE
To prevent fan motor burn–out, use a 2–A fuse or circuit breaker.

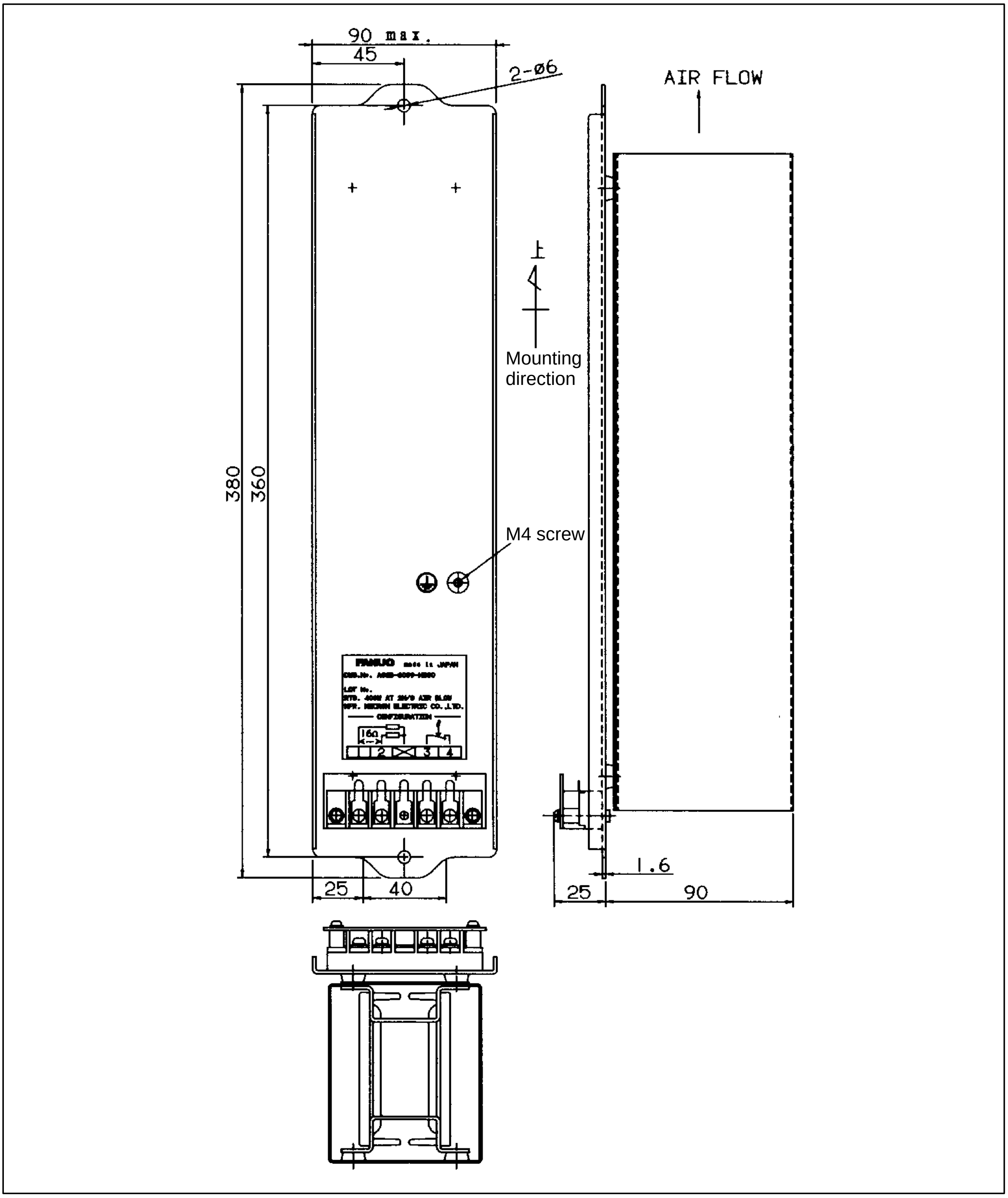
8.1.7 Regenerative Discharge Unit

(a) A06B–6089–H510 (For the panel cut–out drawing, see Section 8.2 (g).)

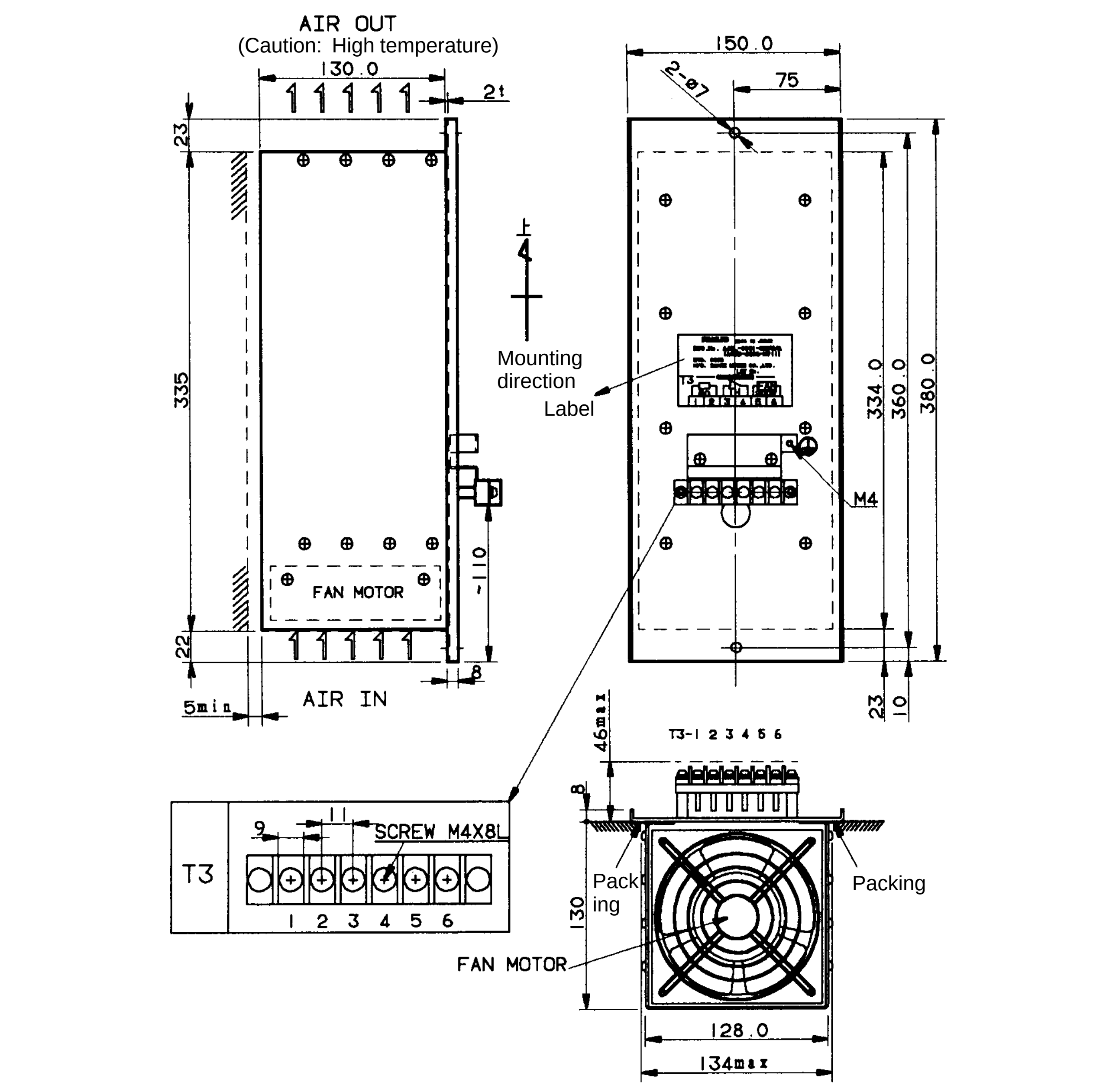


Terminal block: M4 × 4
Weight: 0.8 kg

(b) A06B–6089–H500 (For the panel cut–out drawing, see Section 8.2 (h).)



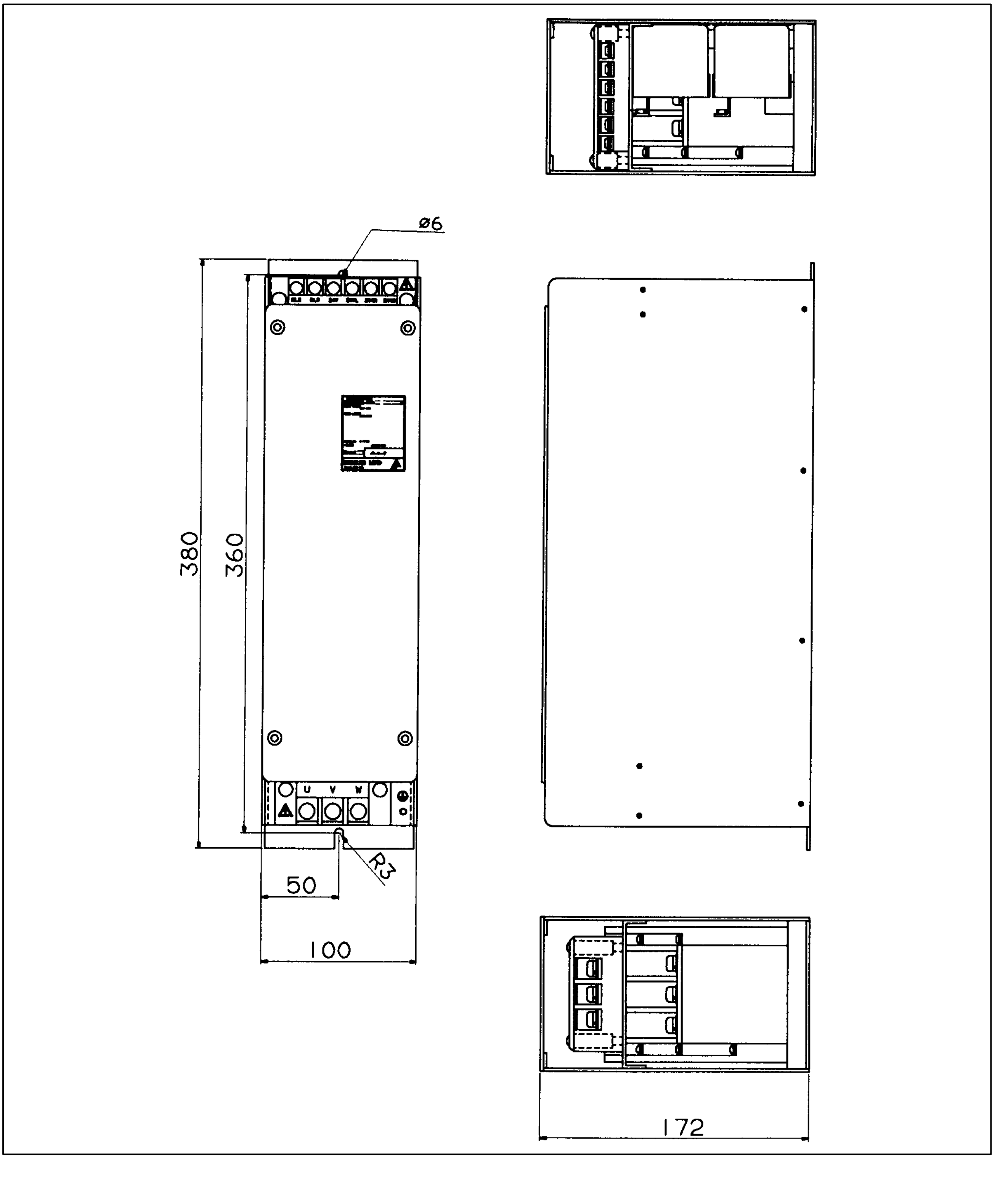
(c) A06B–6089–H711 to H713 (For the panel cut–out drawing, see Section 8.2 (i).)



Drawing number	Weight
A06B–6089–H711	5Kg
A06B–6089–H712	6Kg
A06B–6089–H713	5Kg

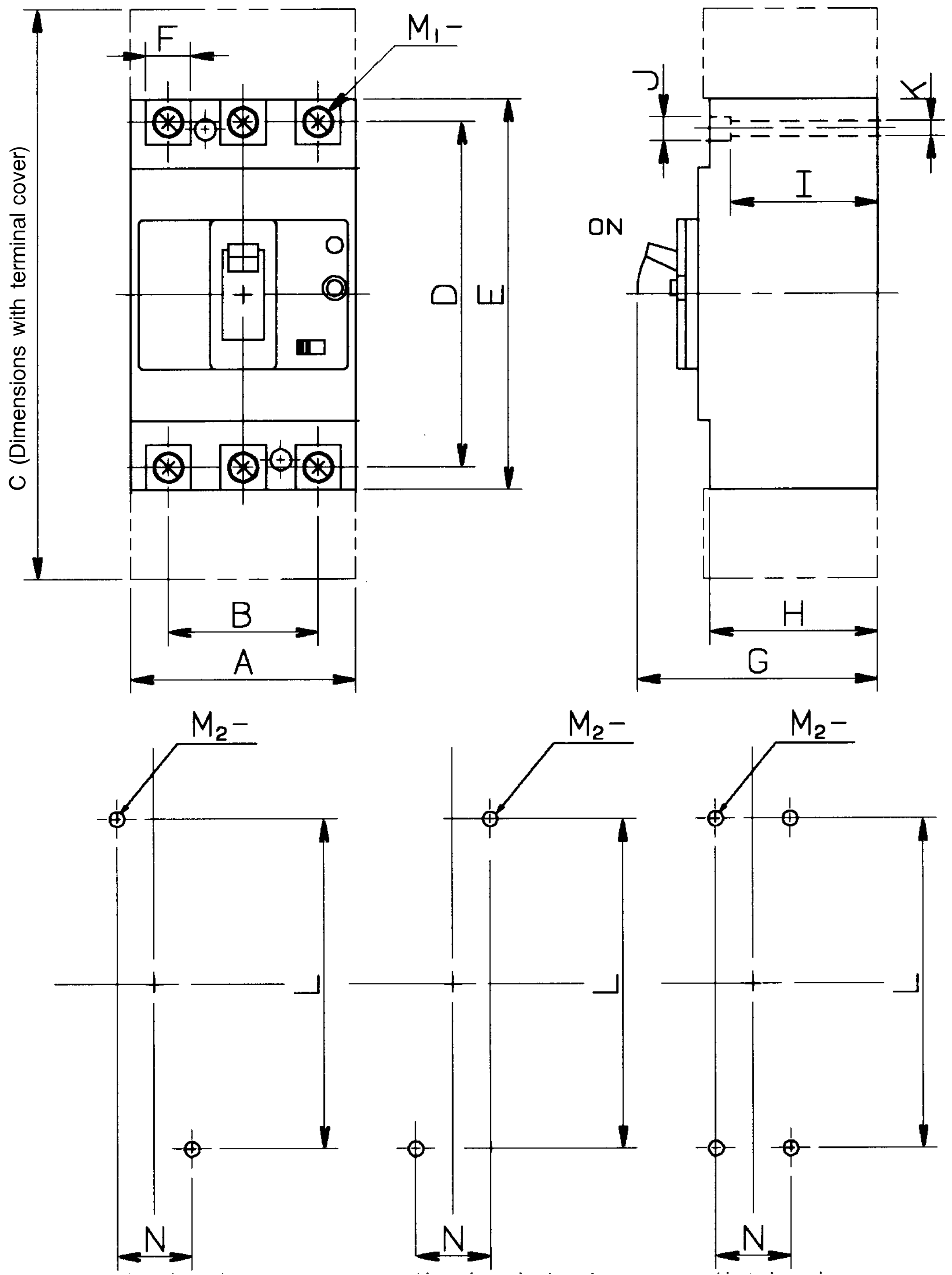
8.1.8 Dynamic Brake Module (DBM)

(For the panel cut–out drawing, see Section 8.2 (j).)



8.1.9 Circuit Breaker

	Ordering drawing number	A	B	C	D	E	M_1–	F	G	H	I	J	K	L	M_2–	N	Mounting
(a)	A06B–6077–K101	75	50	190	115	130	M5	17	80	56	49	φ8	φ5	110	M4	25	2 positions (1)
(b)	A06B–6077–K102																
(c)	A06B–6077–K103	75	50	190	115	130	M8	17	80	56	49	φ8	φ5	110	M4	25	2 positions (1)
(d)	A06B–6077–K104																
(e)	A06B–6077–K108																
(f)	A06B–6077–K105																
(g)	A06B–6077–K110	105	70	265	144	165	M8	25.5	84	56	47	φ8.5	φ4.5	126	M4	35	4 positions
(h)	A06B–6077–K109																
(i)	A06B–6077–K107																
(j)	A06B–6077–K106	75	50	156	80	96	M5	12.5	80	41	14	φ8.5	φ4.5	80–84	M4	25	2 positions (2)

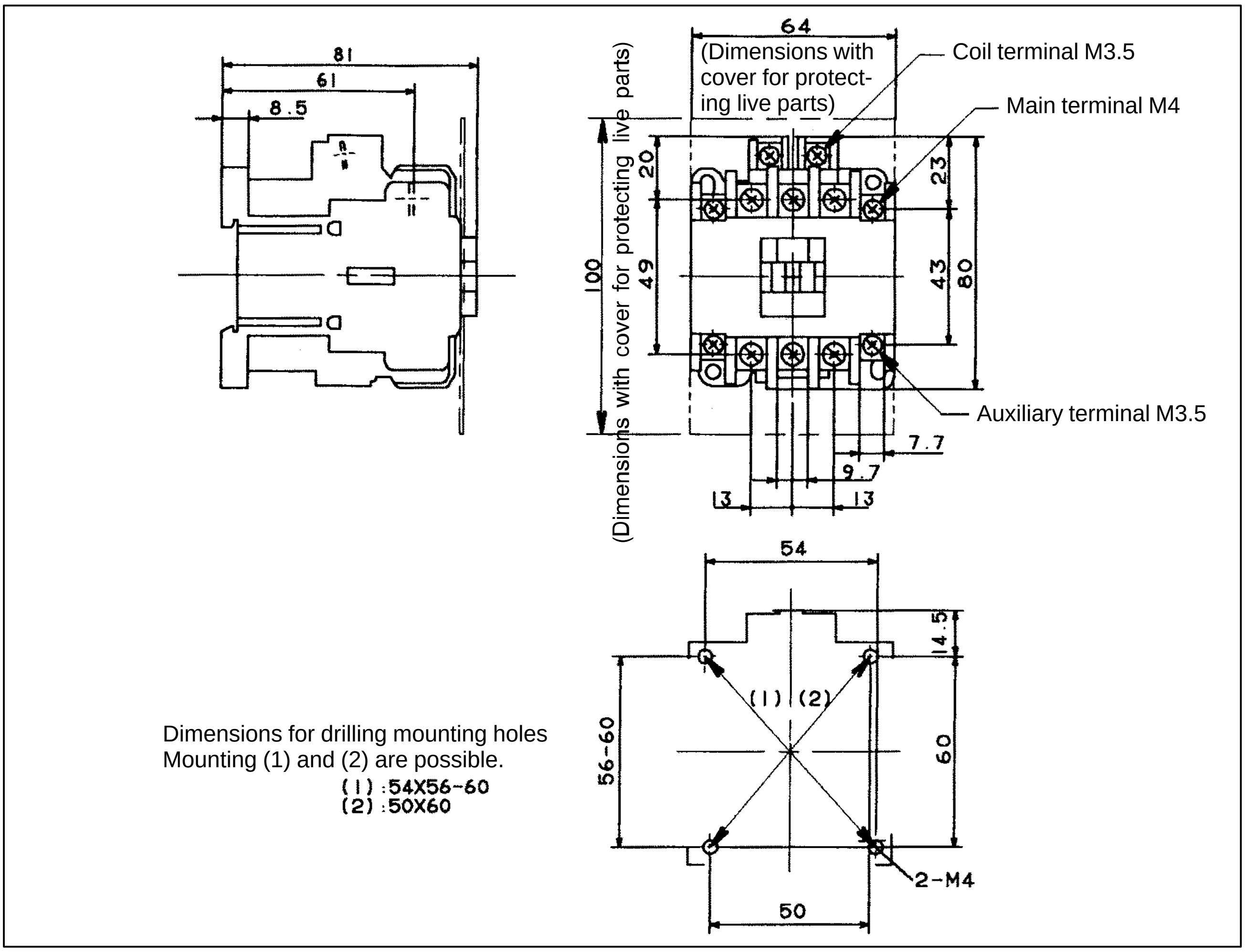


Two mounting holes (1)   Two mounting holes (2)   Four mounting holes

The circuit breakers have two or four mounting holes.

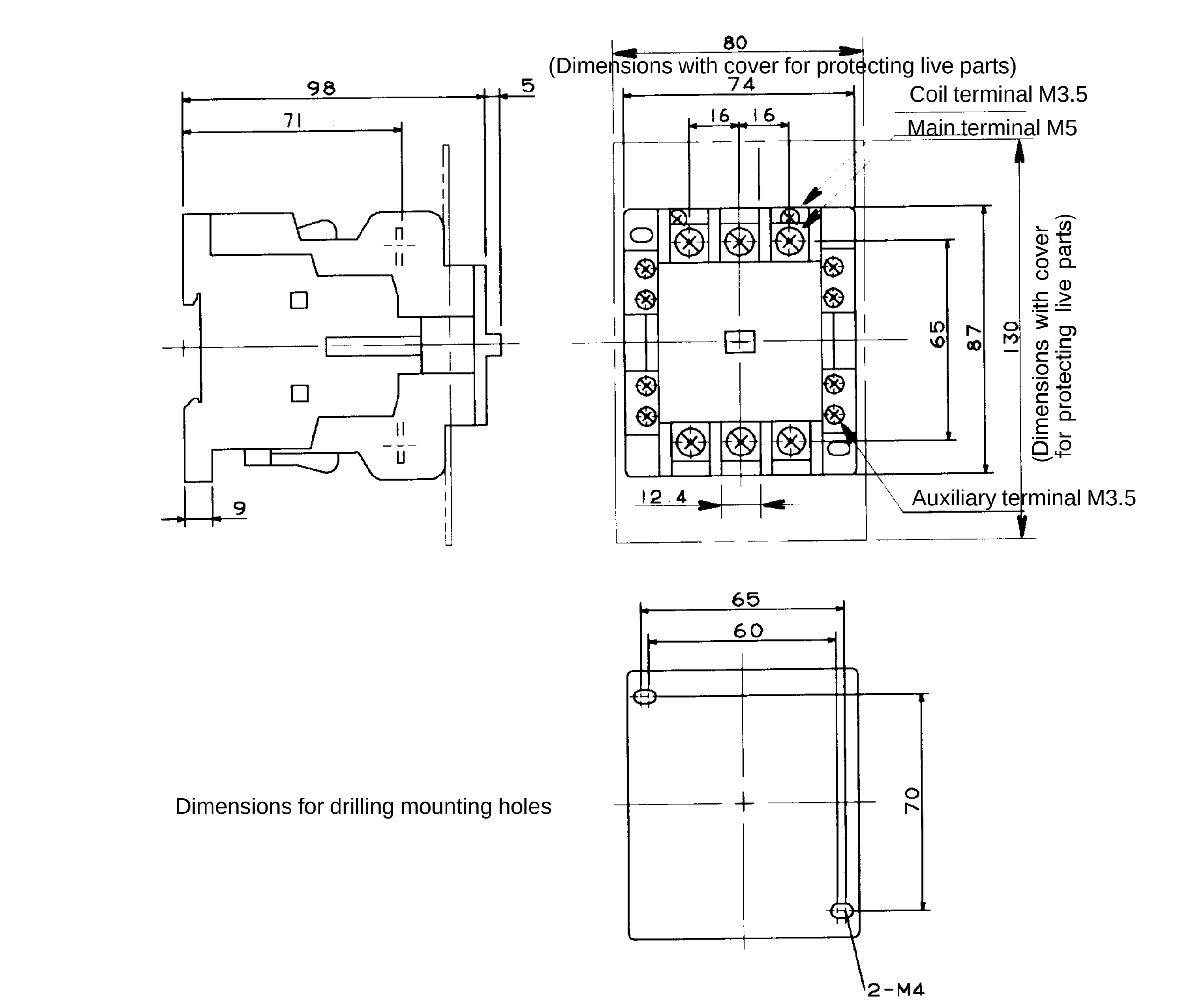
8.1.10 Magnetic Contactors

(a) A06B–6077–K121



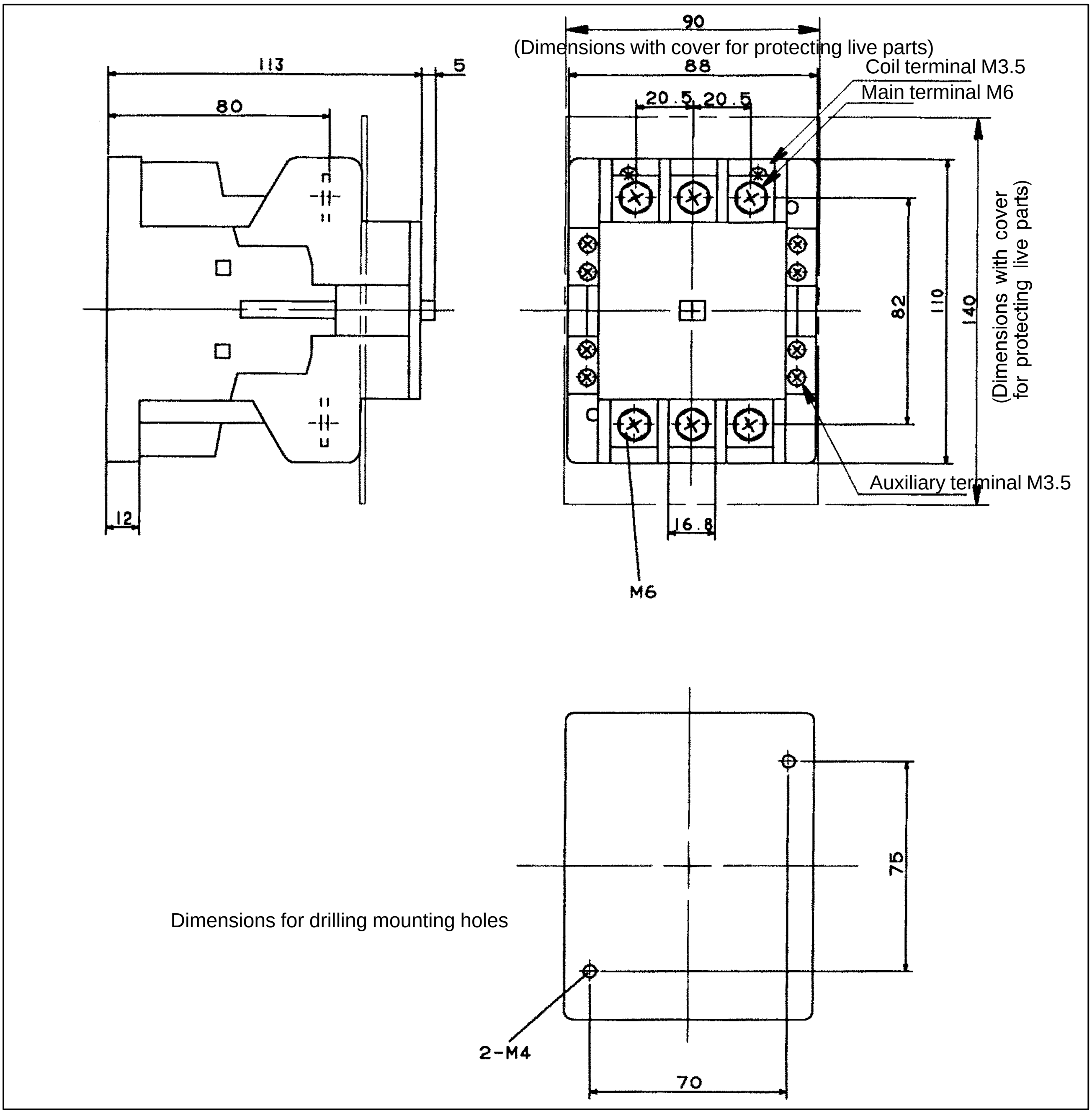
Ordering drawing number	Fuji Electric part number		Operation coil voltage	Auxiliary contact structure	Weight
	Body	Cover			
A06B–6077–K121	SC–5–1	SZ–JC4	200V/50Hz 200–220V/60Hz	1a1b	0.38Kg

(b) A06B–6077–K122, A06B–6077–K123



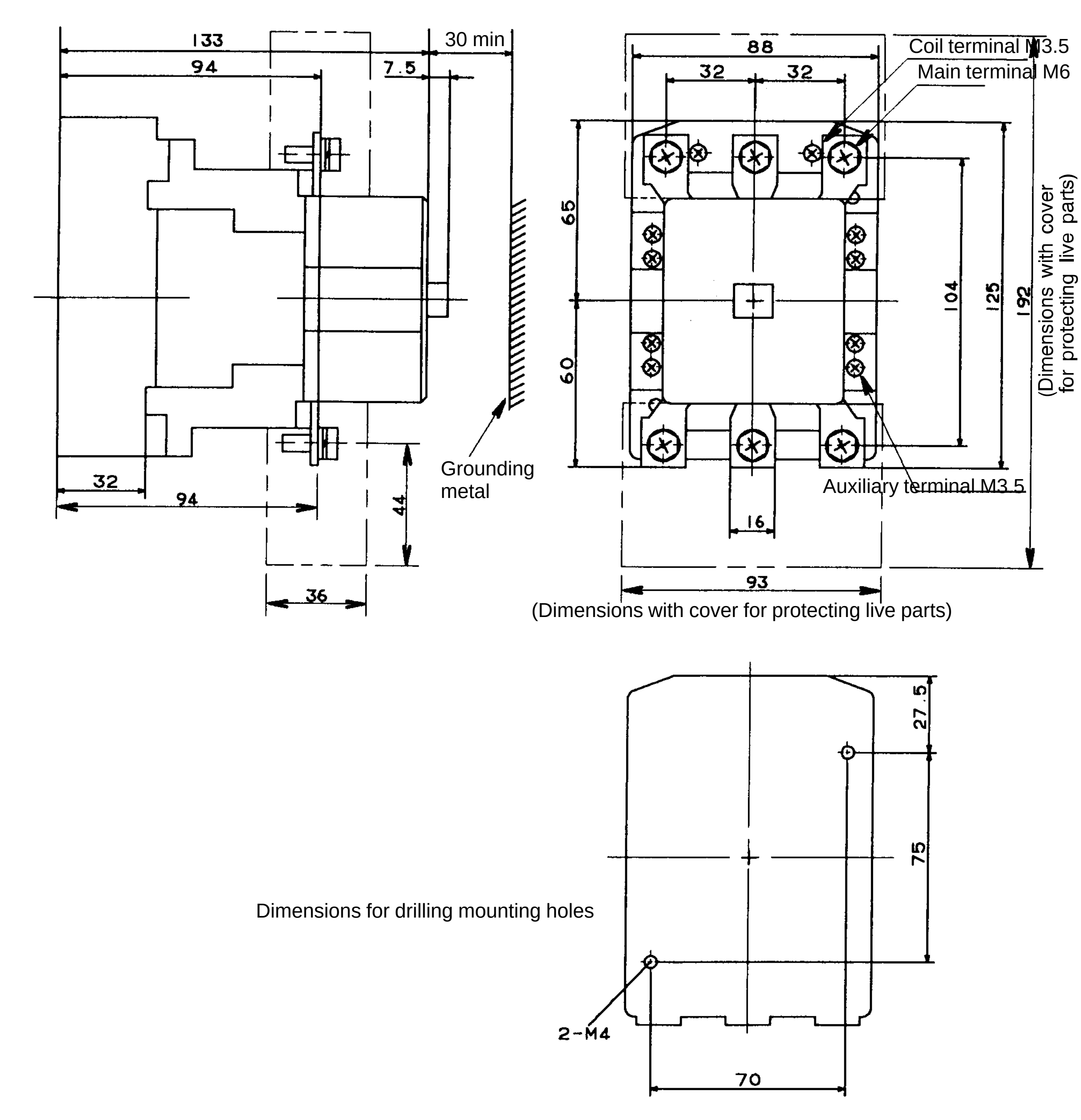
Ordering drawing number	Fuji Electric part number		Operation coil voltage	Auxiliary contact structure	Weight
	Body	Cover			
A06B–6077–K122	SC–1N	SZ–1N/T	200V/50Hz 200–220V/60Hz	2a2b	0.68Kg
A06B–6077–K123	SC–2N	SZ–1N/T			0.68Kg

(c) A06B–6077–K124



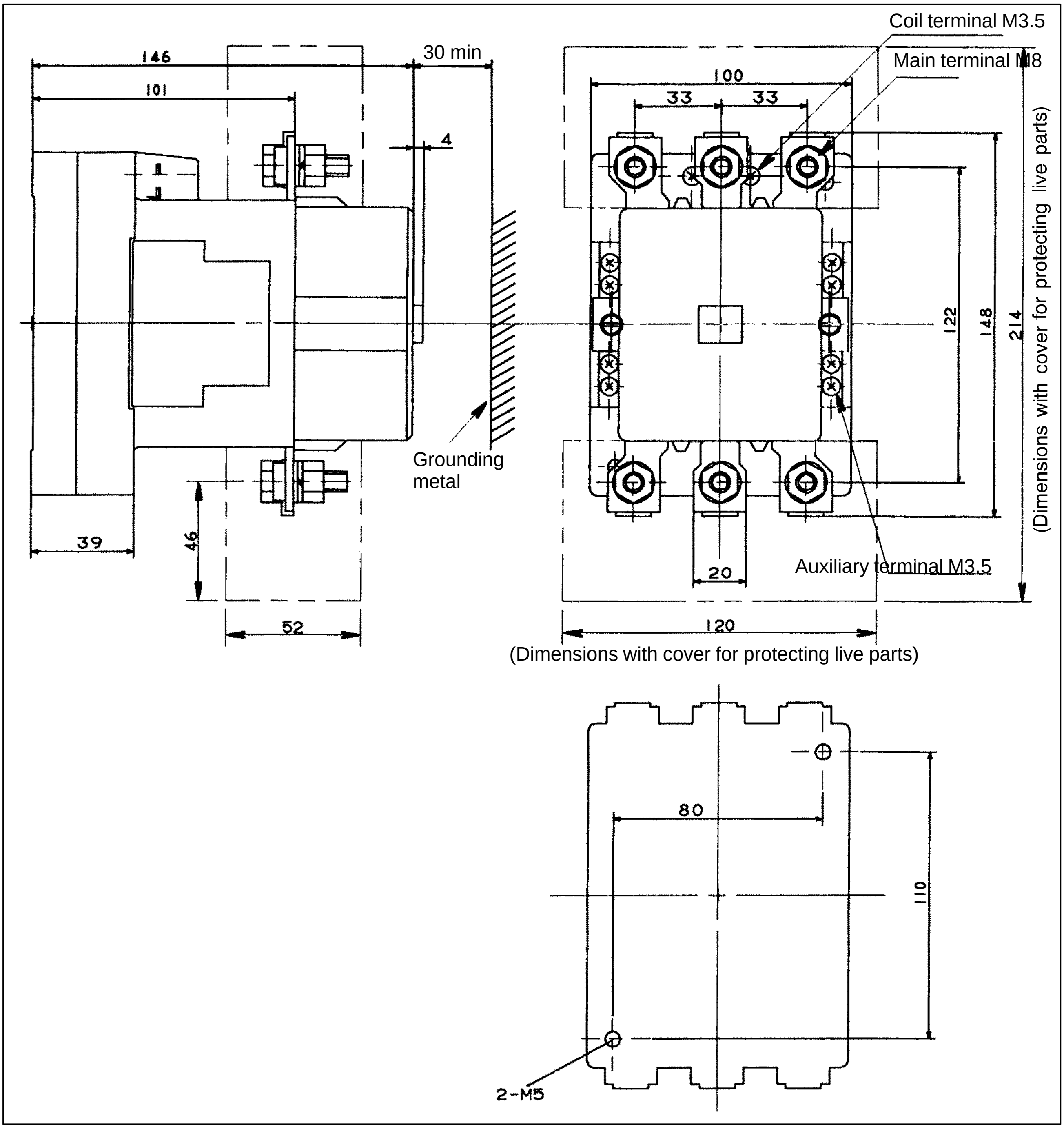
<table>
<tr><th rowspan="2">Ordering drawing number</th><th colspan="2">Fuji Electric part number</th><th rowspan="2">Operation coil voltage</th><th rowspan="2">Auxiliary contact structure</th><th rowspan="2">Weight</th></tr>
<tr><th>Body</th><th>Cover</th></tr>
<tr><td>A06B–6077–K124</td><td>SC–2SN</td><td>SZ–2SN/T</td><td>200V/50Hz
200–220V/60Hz</td><td>2a2b</td><td>1.3Kg</td></tr>
</table>

(d) A06B–6077–K125



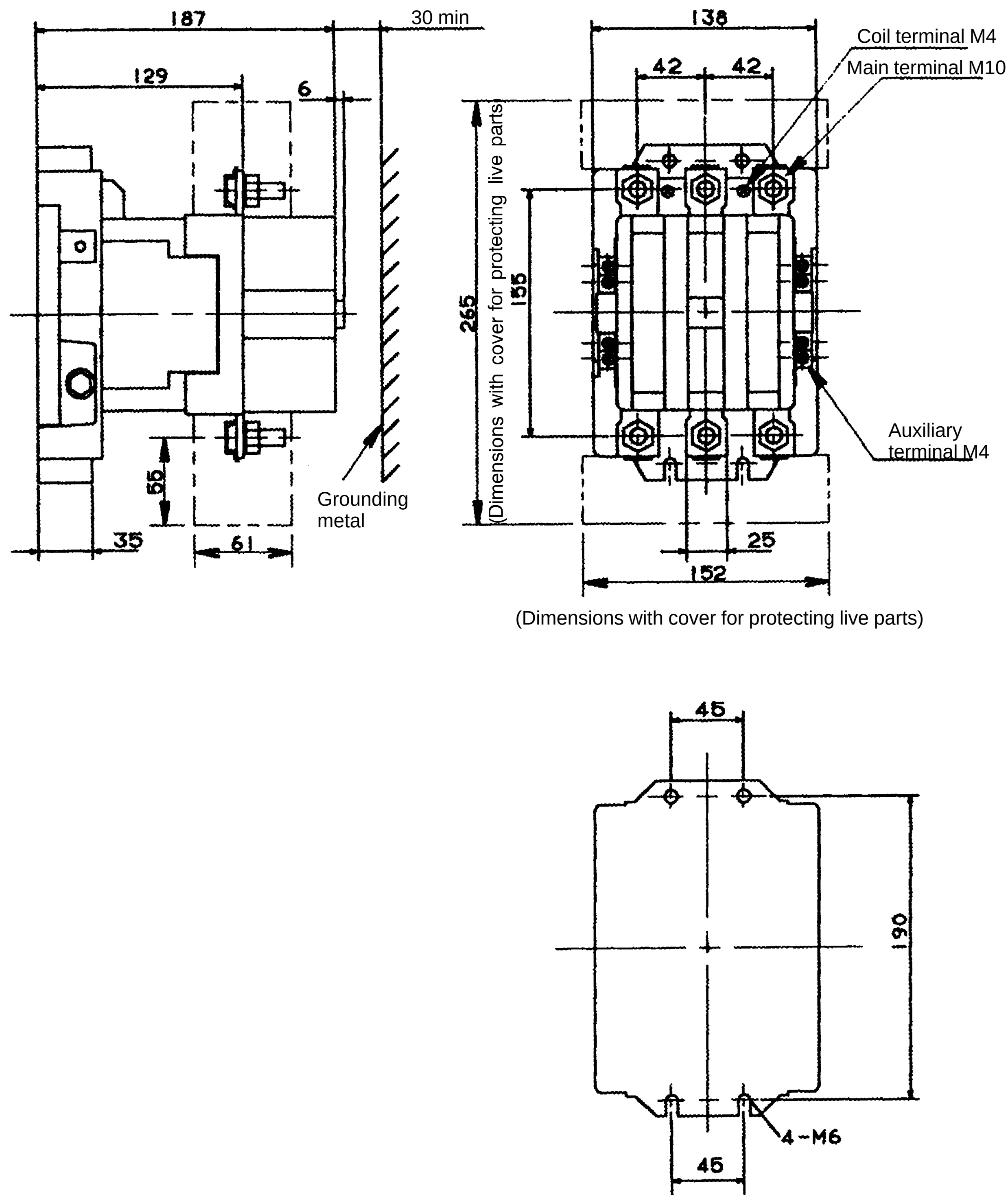
Ordering drawing number	Fuji Electric part number		Operation coil voltage	Auxiliary contact structure	Weight
	Body	Cover			
A06B–6077–K124	SC–2SN	SZ–2SN/T	200V/50Hz 200–220V/60Hz	2a2b	1.5Kg

(e) A06B–6077–K126



Ordering drawing number	Fuji Electric part number		Operation coil voltage	Auxiliary contact structure	Weight
	Body	Cover			
A06B–6077–K126	SC–5N	SZ–5N/T	200V/50Hz 200–220V/60Hz	2a2b	2.5Kg

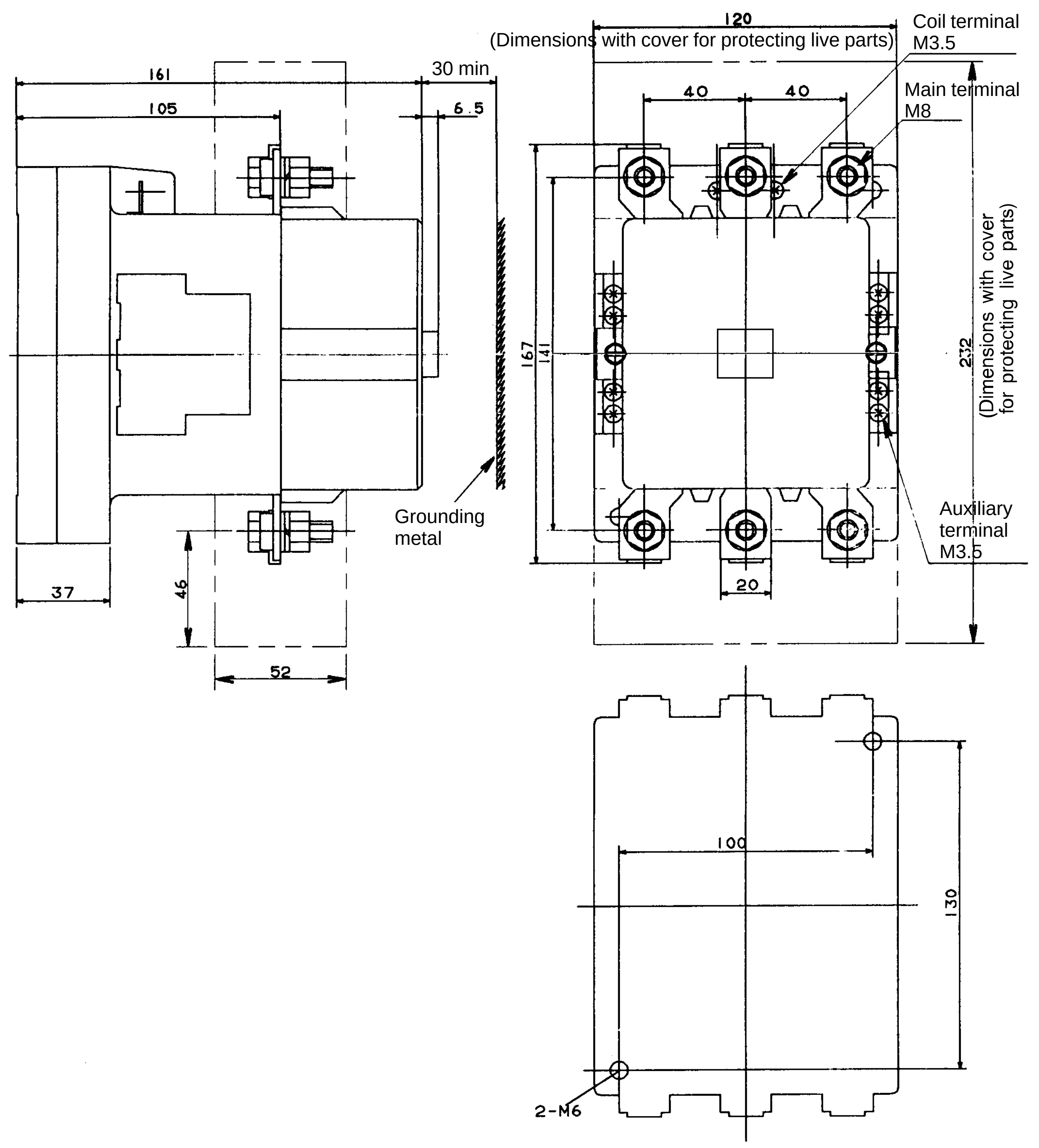
(f) A06B–6077–K127



(Dimensions with cover for protecting live parts)

Ordering drawing number	Fuji Electric part number		Operation coil voltage	Auxiliary contact structure	Weight
	Body	Cover			
A06B–6077–K127	SC–8N	SZ–8N/T	200V/50Hz 200–220V/60Hz	2a2b	5.2Kg

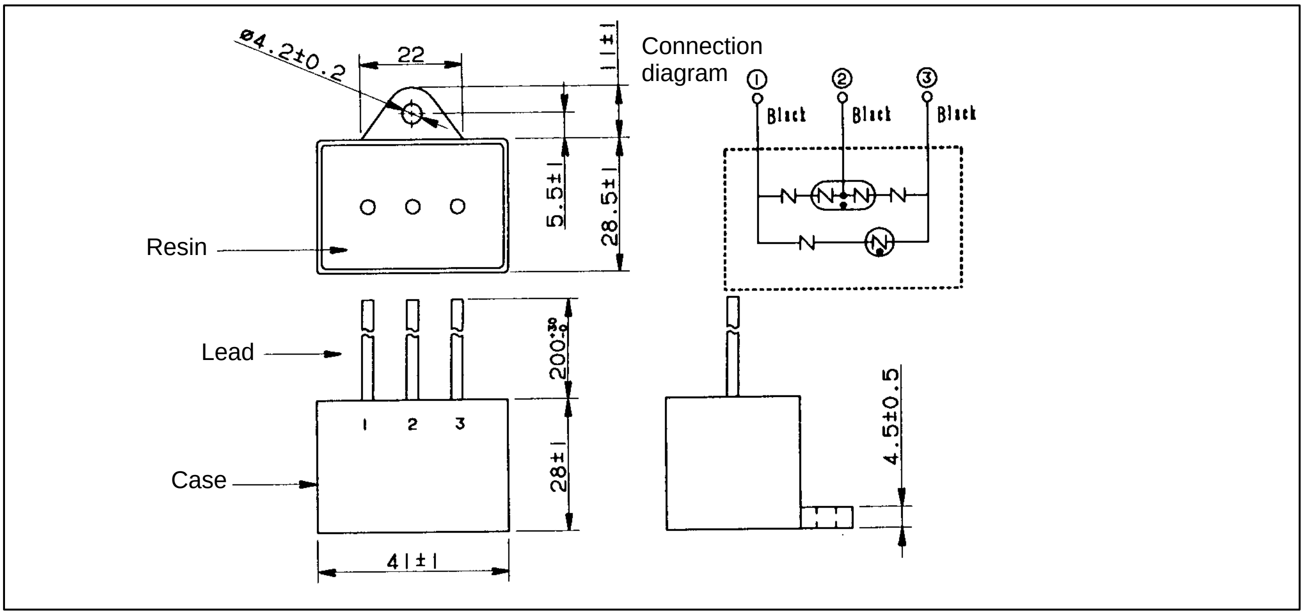
(g) A06B–6077–K128



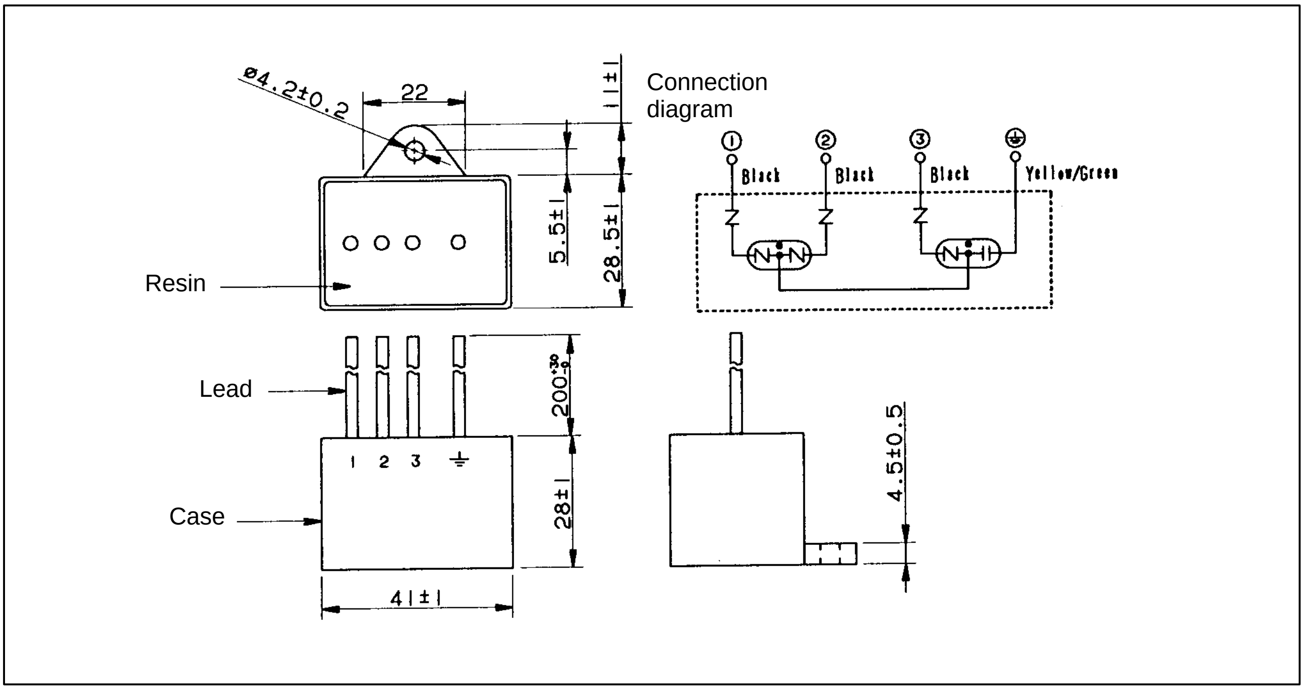
<table>
<tr><th rowspan="2">Ordering drawing number</th><th colspan="2">Fuji Electric part number</th><th rowspan="2">Operation coil voltage</th><th rowspan="2">Auxiliary contact structure</th><th rowspan="2">Weight</th></tr>
<tr><th>Body</th><th>Cover</th></tr>
<tr><td>A06B–6077–K128</td><td>SC–7N</td><td>SZ–5N/T</td><td>200V/50Hz
200–220V/60Hz</td><td>2a2b</td><td>3.4Kg</td></tr>
</table>

8.1.11 Lightning Surge Protector

(a) A06B–6077–K142



(1) For line–to–line installation: RAV–781BYZ–2

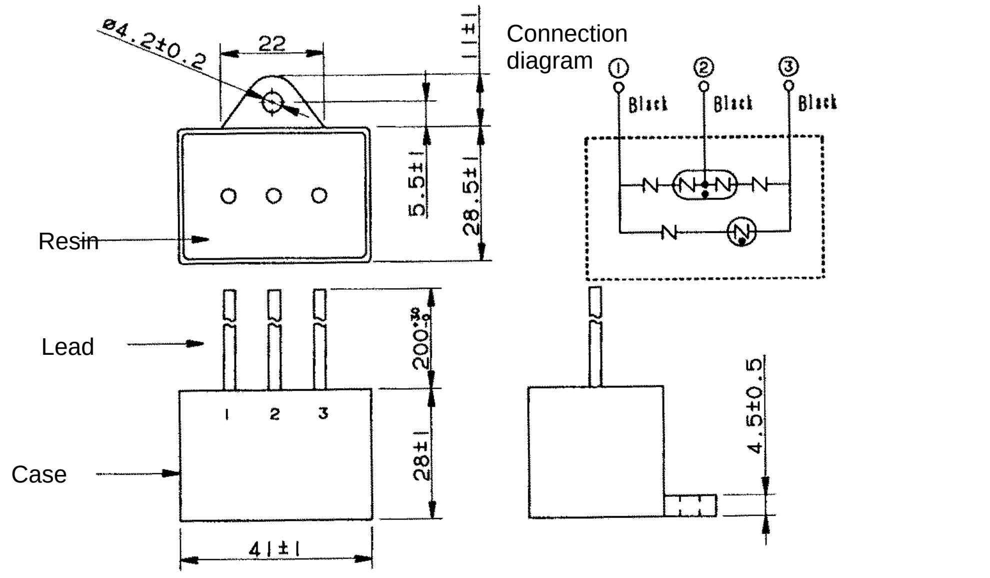


(2) For line–to–ground installation: RAV–781BXZ–4

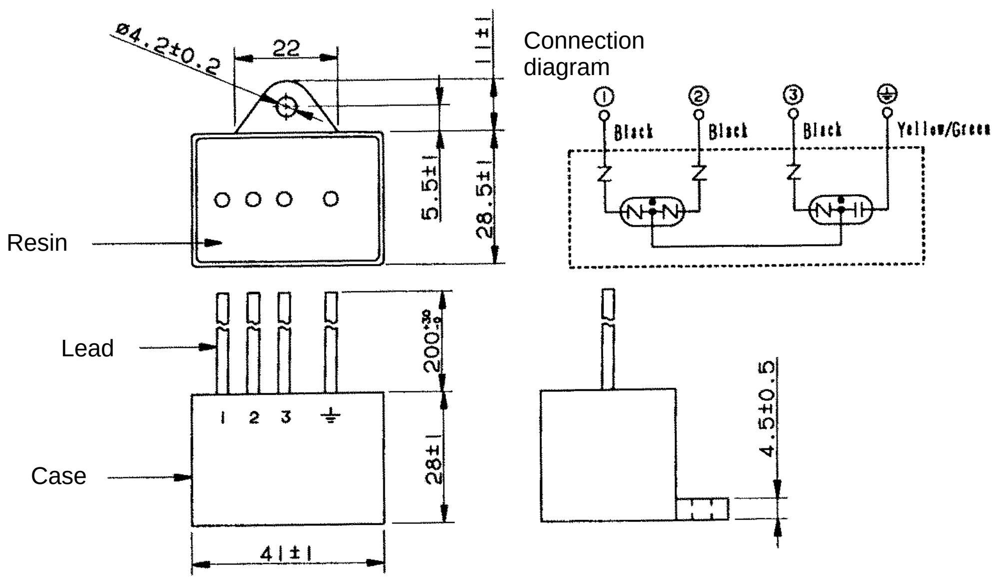
Specification	Rated voltage	Clamp voltage	Surge withstand current	Surge withstand voltage
R·A·V–781BYZ–2	AC250V	DC783V ± 10% (V1.0)	2500A (8/20µS)	20kV (1.2/50µS)

Specification	Rated voltage	Clamp voltage	Surge withstand current	Surge withstand voltage
R·A·V–781BXZ–4	line–to–line: 430VAC, line–to–ground: 250VAC	AC700V ± 20% (Ua)	2500A (8/20µS)	2.0kV (1.2/50µS)

(b) A06B–6077–K143



(1) For line–to–line installation: RAV–152BYZ–2A



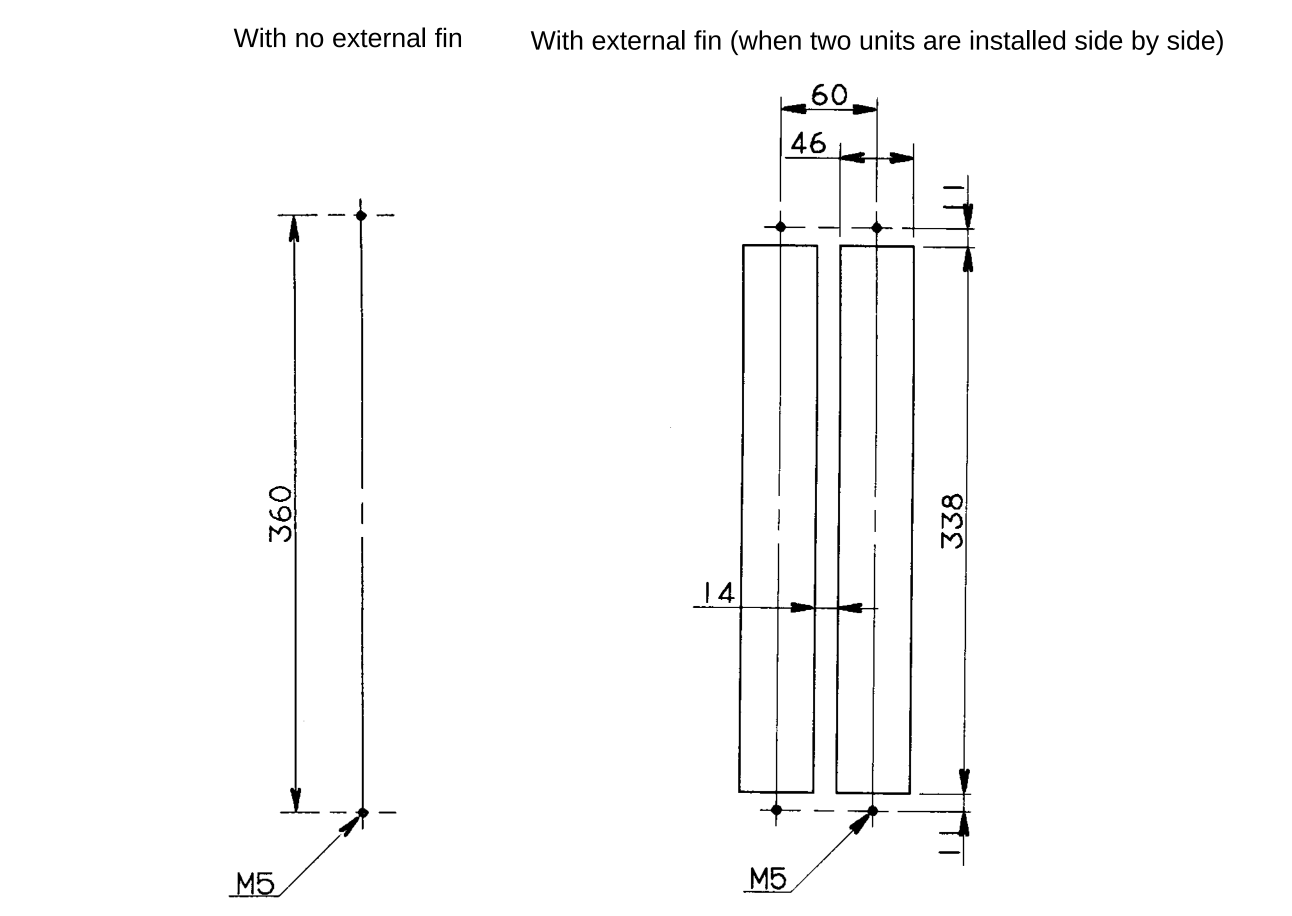
(2) For line–to–ground installation: RAV–801BXZ–4

Specification	Rated voltage	Clamp voltage	Surge withstand current	Surge withstand voltage
R·A·V–152BYZ–2A	AC460V	1470V ± 10% (V1.0)	2500A (8/20µS)	20kV (1.2/50µS)

Specification	Rated voltage	Clamp voltage	Surge withstand current	Surge withstand voltage
R·A·V–801BXZ–4	line–to–line: 500VAC, line–to–ground: 290VAC	AC800V ± 20% (Ua)	2500A (8/20µS)	2.32kV (1.2/50µS)

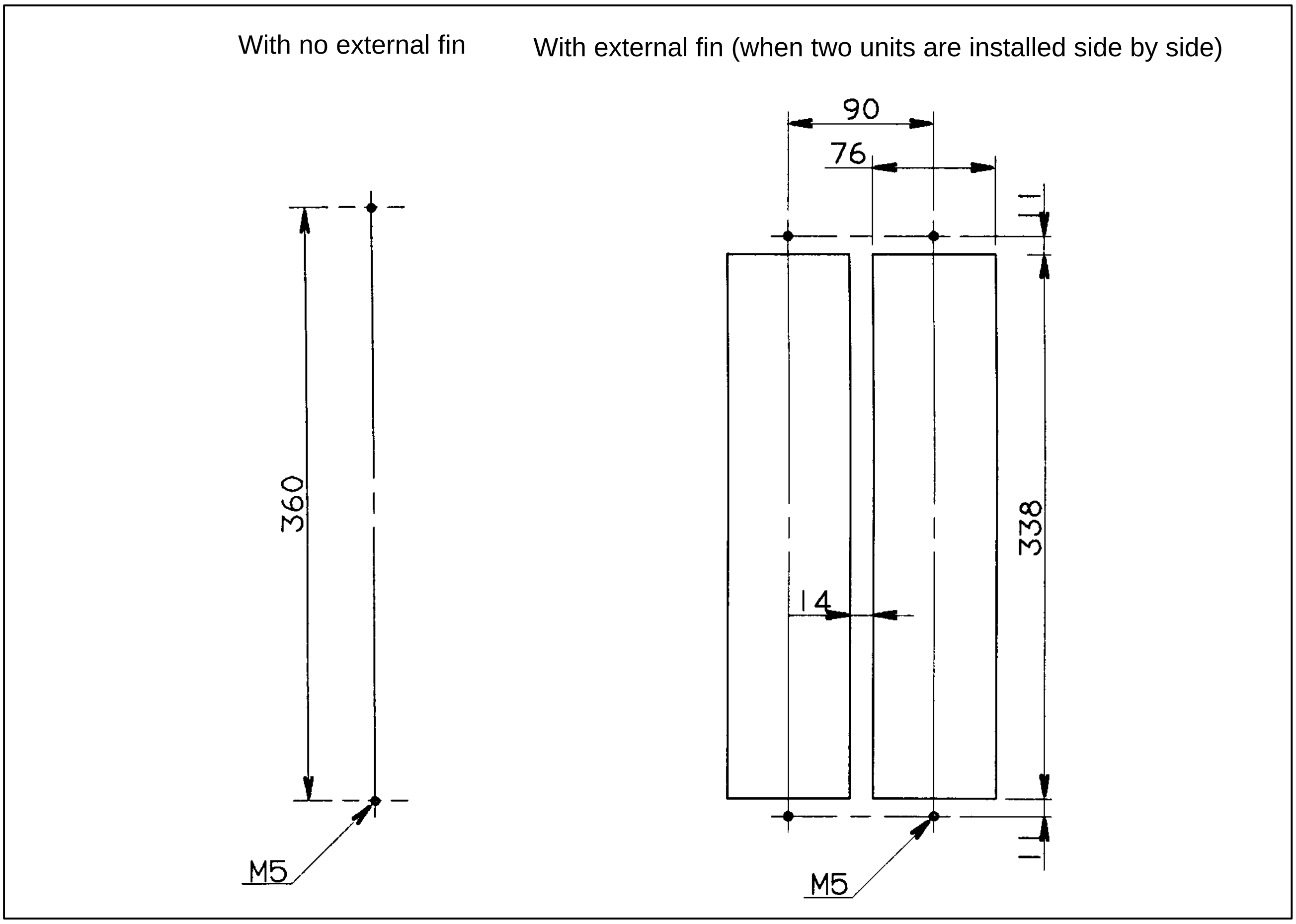
8.2
PANEL CUT–OUT DIAGRAMS

(a) 60–mm–wide amplifier



NOTE
1 When an external fin is provided, attach a packing (acrylonitrile–butadiene rubber, NBR [soft type]) to the fin to protect it against oil and dust.
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 sheet metal of the power magnetics cabinet and the flange of the amplifier.

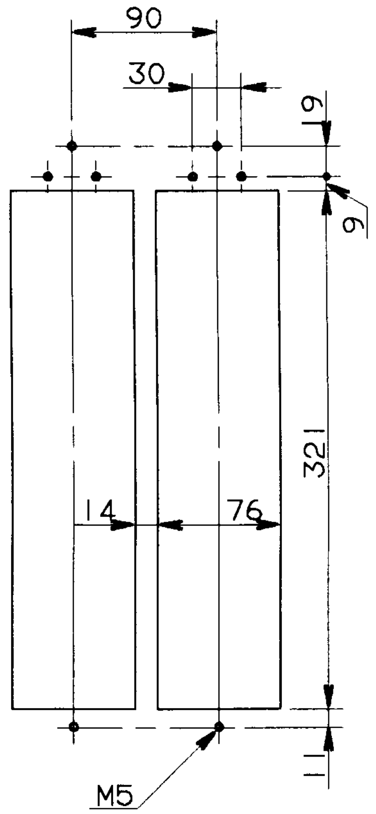
(b) 90–mm–wide amplifier (when no forced air cooling is required)



NOTE

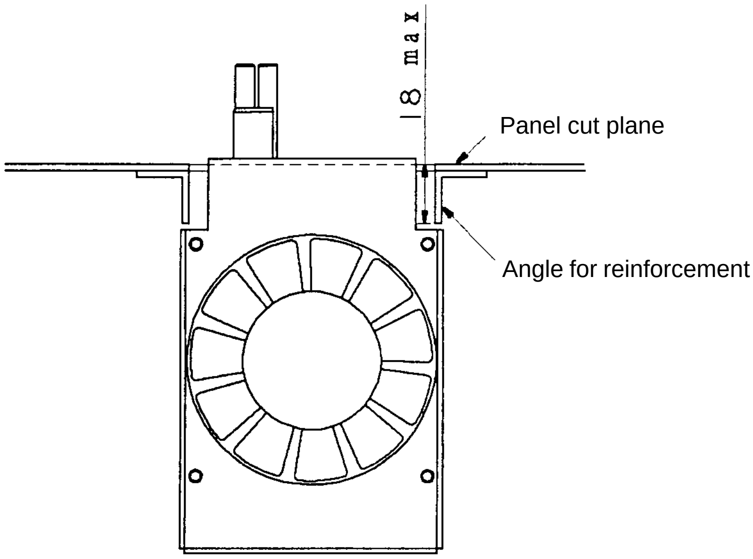
1 When an external fin is provided, attach a packing (acrylonitrile–butadiene rubber, NBR [soft type]) to the fin to protect it against oil and dust.
2 Reinforce the right and left sides of the panel cut hole in the power magnetics cabinet by using fittings such as angles to maintain satisfactory contact with the amplifier.

(c) 90–mm–wide amplifier (when fan adaptor A06B–6078–K001 is installed in PSM–11, SPM–11, and SPM–11HV; two units are installed side–by–side)



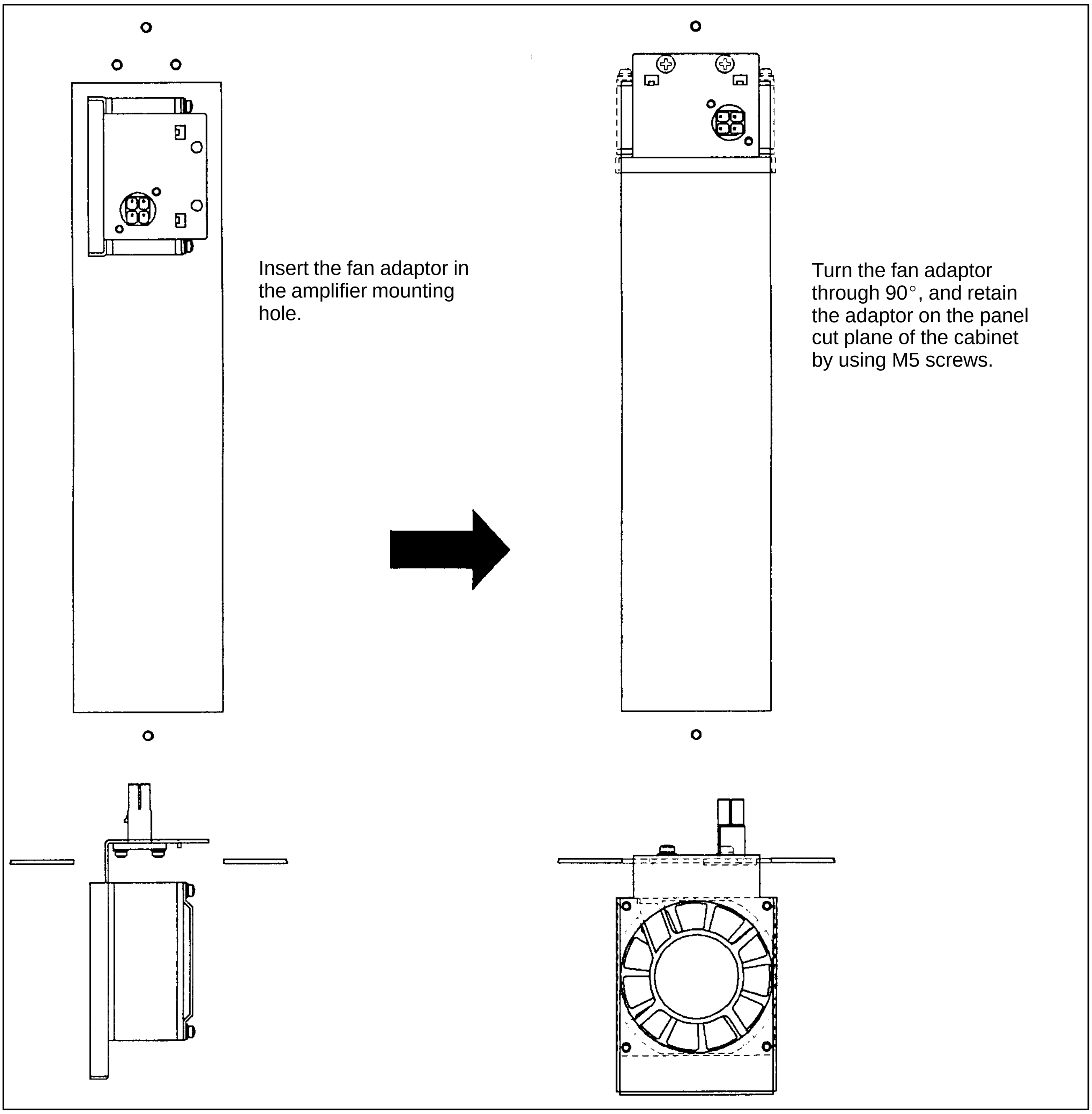
NOTE

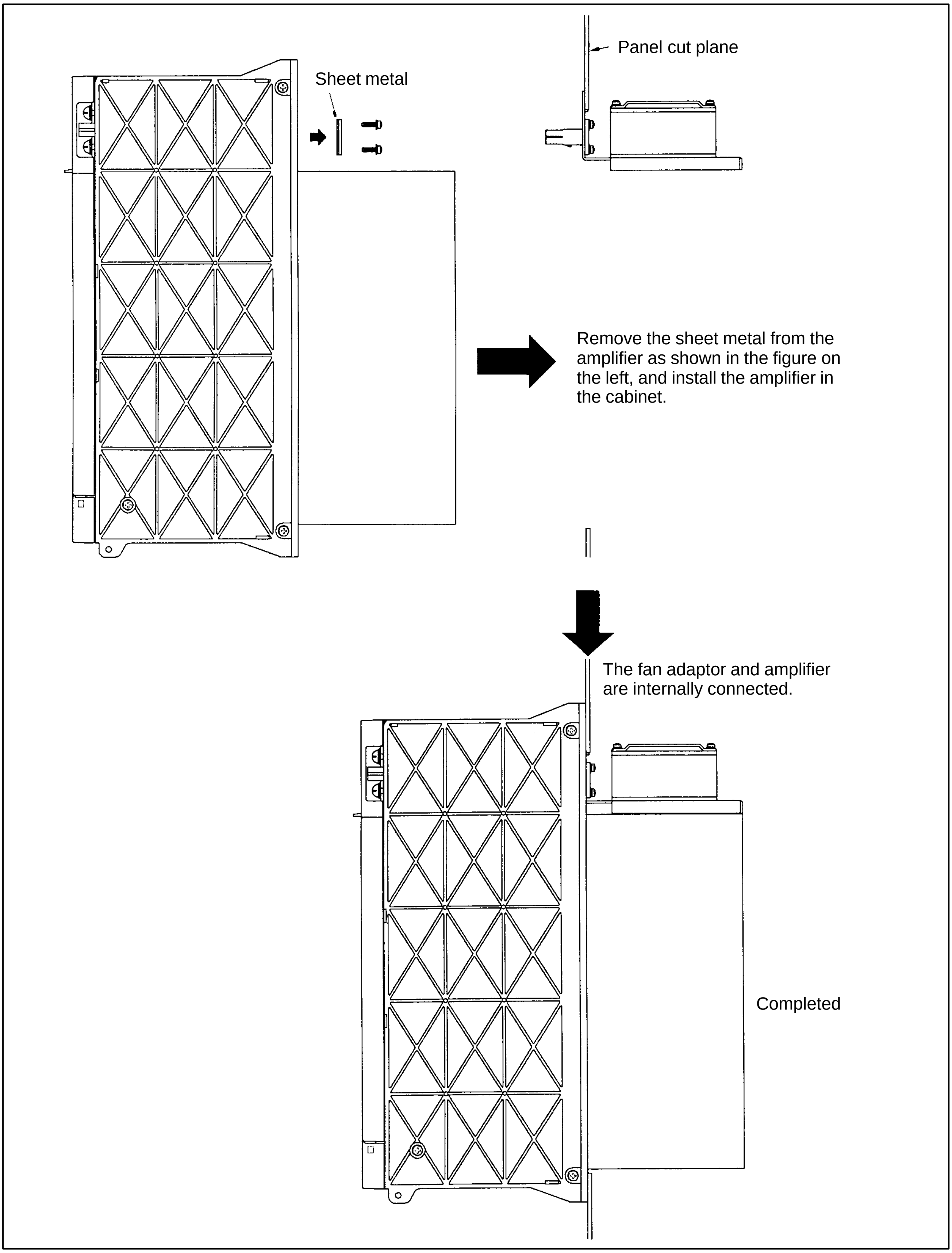
1 The above panel cut–out drawing is used when a fan adaptor for forced air cooling is used. When a fan motor for forced air cooling is provided by the user, the same panel cut–out drawing as (b) is used.
2 Attach a packing (acrylonitrile–butadiene rubber, NBR [soft type]) for protection against oil and dust.
3 Reinforce the right and left sides of the panel cut hole in the power magnetics cabinet by using fittings such as angles to maintain satisfactory contact with the amplifier.
(When the fan adaptor is used, the depth of the angle must be 18 mm or less to prevent interference with the outer shape of the adaptor.)


18 max
Panel cut plane
Angle for reinforcement

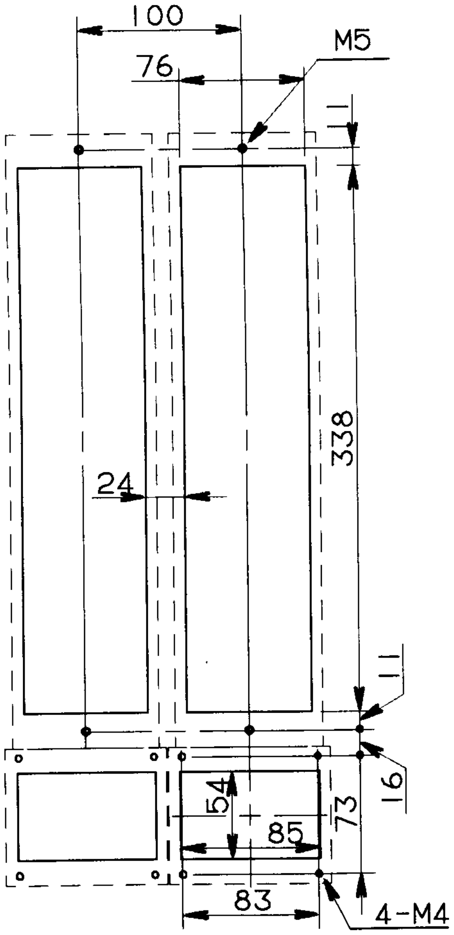
Installing a fan adaptor

A06B–6078–K001 (For PSM–11, SPM–11, and SPM–11HV)




Panel cut plane
Sheet metal
Remove the sheet metal from the amplifier as shown in the figure on the left, and install the amplifier in the cabinet.
The fan adaptor and amplifier are internally connected.
Completed

(d) 90–mm–wide amplifier (when fan adaptor A06B–6078–K002 is installed in SVM1–130 and SPMC–11; two units are installed side–by–side)

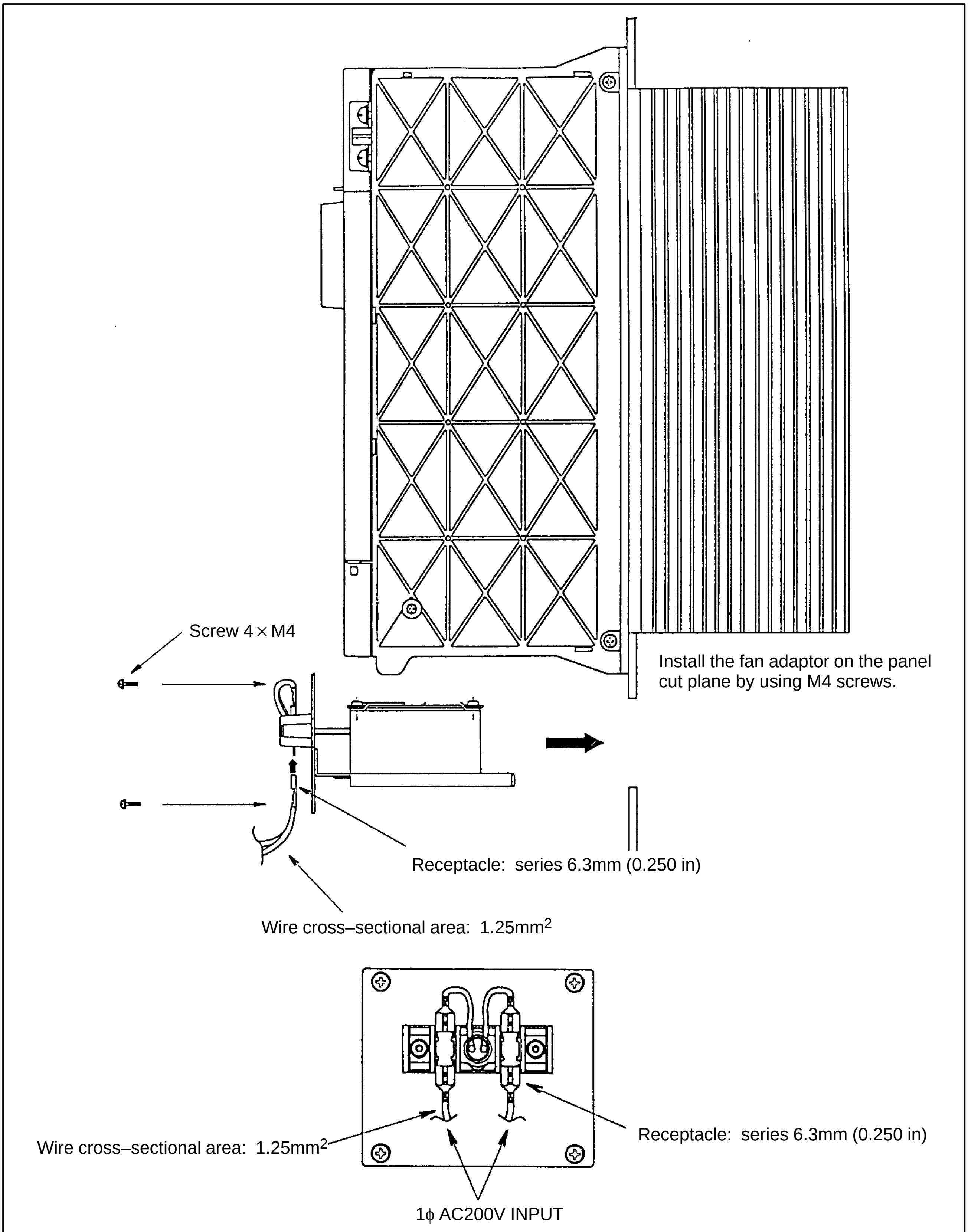


NOTE

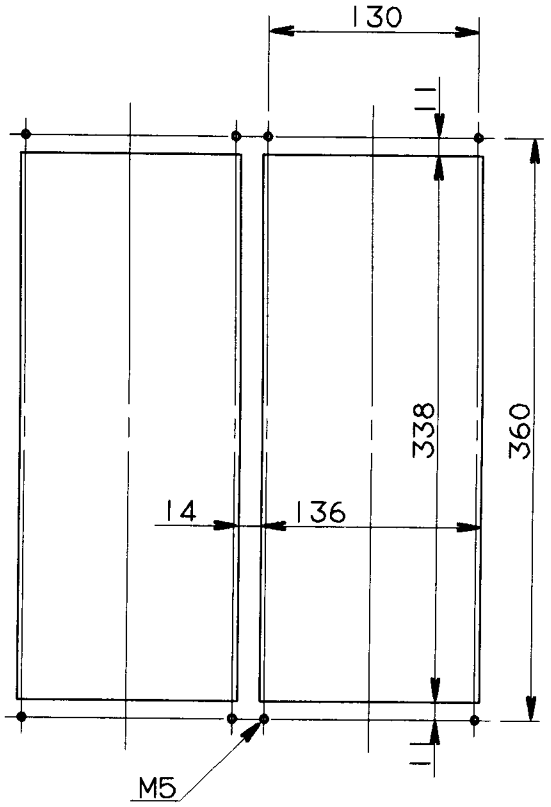
1 The above panel cut–out drawing is used when a fan adaptor for forced air cooling is used. When forced air cooling is to be performed without using FANUC's fan adaptor, the same panel cut–out drawing as (b) is used.
2 When two fan adaptors (A06B–60780K002) are installed side–by–side (for example, when SPMC–11 and SVM1–130 are used), separate the modules by at least 100 mm. A short bar (F) can be used when the modules are separated from each other by 100 mm.
3 Attach a packing (acrylonitrile–butadiene rubber, NBR [soft type]) for protection against oil and dust.
4 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 with the amplifier.

Installing a fan adaptor

A06B–6078–K002 (For SVM1–130 and SPMC–11)



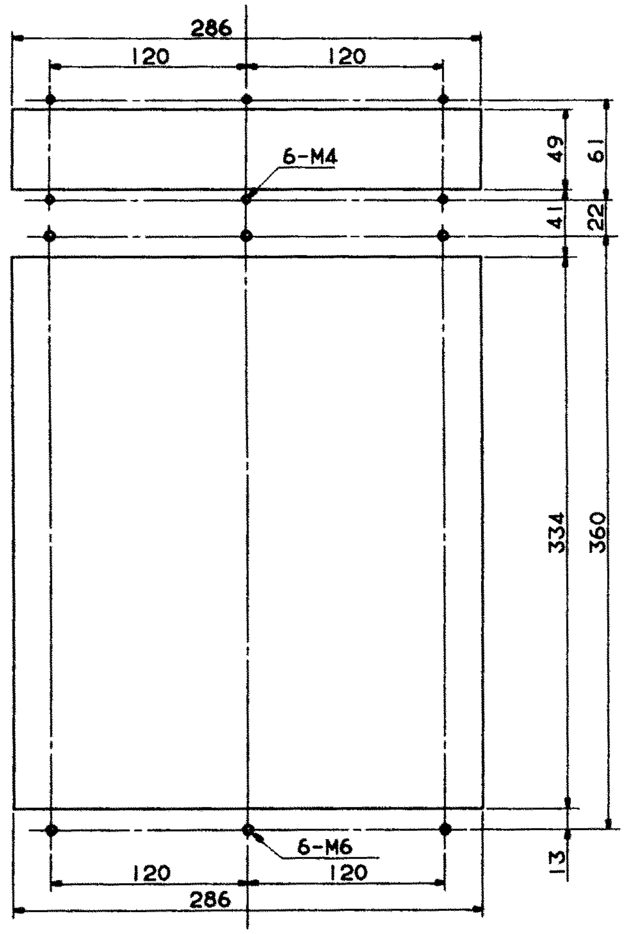
(e) 150–mm–wide amplifier (when two units are installed side–by–side)



NOTE

1 Attach a packing (acrylonitrile–butadiene rubber, NBR [soft type]) for protection against oil and dust.
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 with the amplifier.

(f) 300–mm–wide amplifier (when fan adaptor A06B–6078–K003 is installed in PSM–45, SPM–45, PSM–75HV, and SPM–75HV)

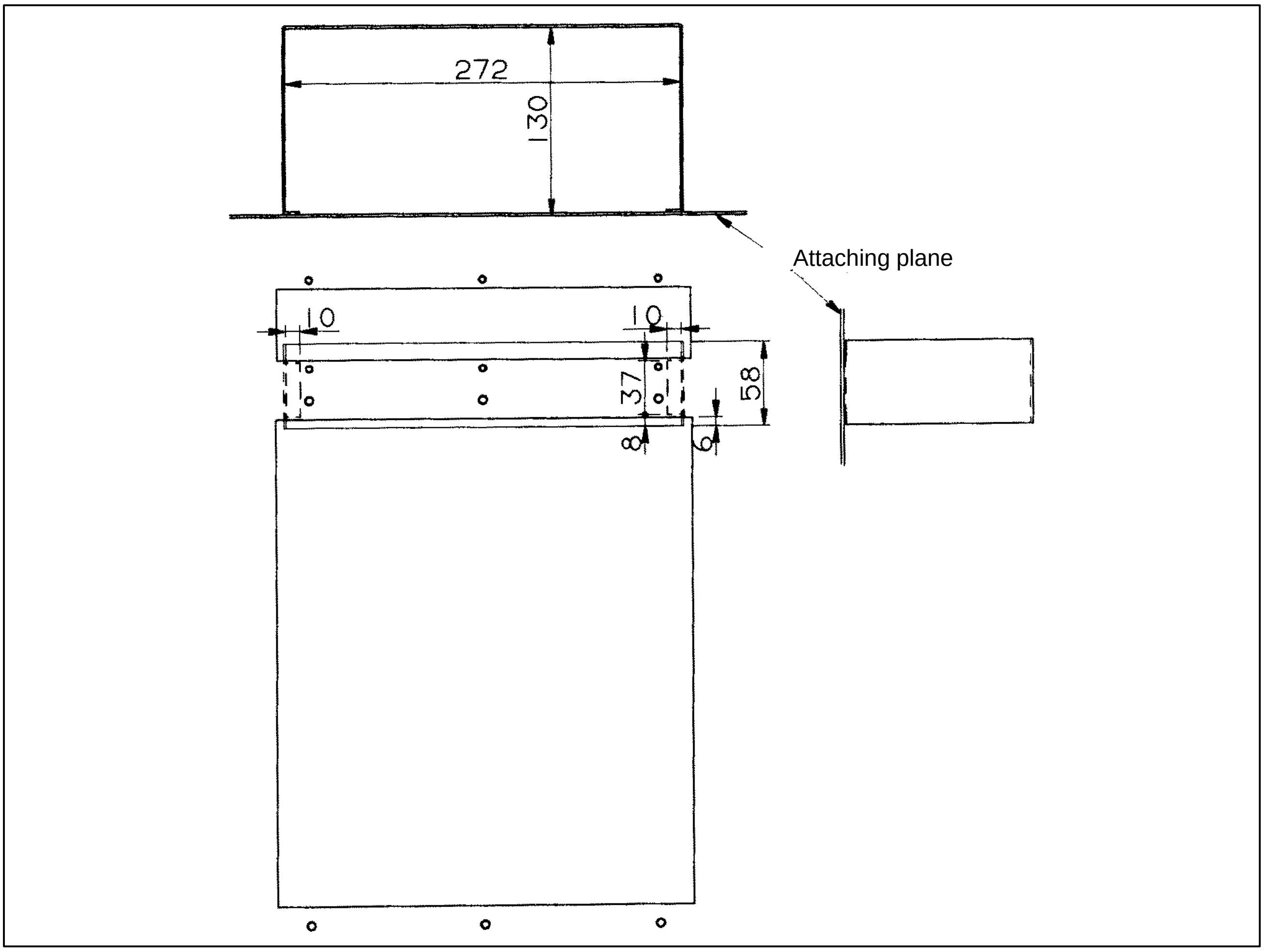


NOTE

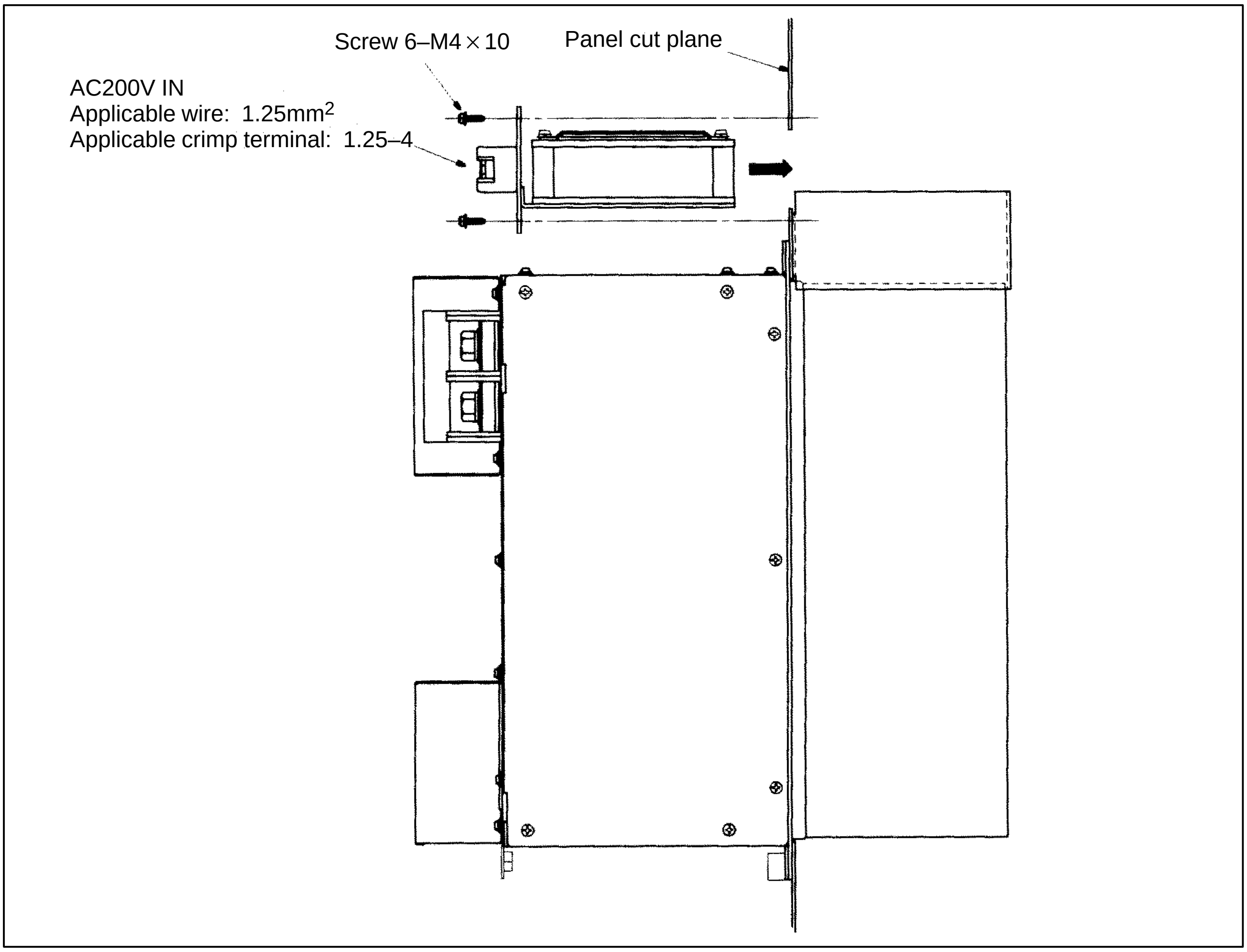
Attach a packing (acrylonitrile–butadiene rubber, NBR [soft type]) for protection against oil and dust.
Reinforce the right and left sides of the panel cut hole in the power magnetics cabinet by using fittings such as angles to maintain satisfactory contact with the amplifier.
When this fan adaptor is used, a duct is always required. For the duct structure, see the example given on the next page.

Example of a duct structure when FANUC's fan adaptor (A06B–6078–K003) is used

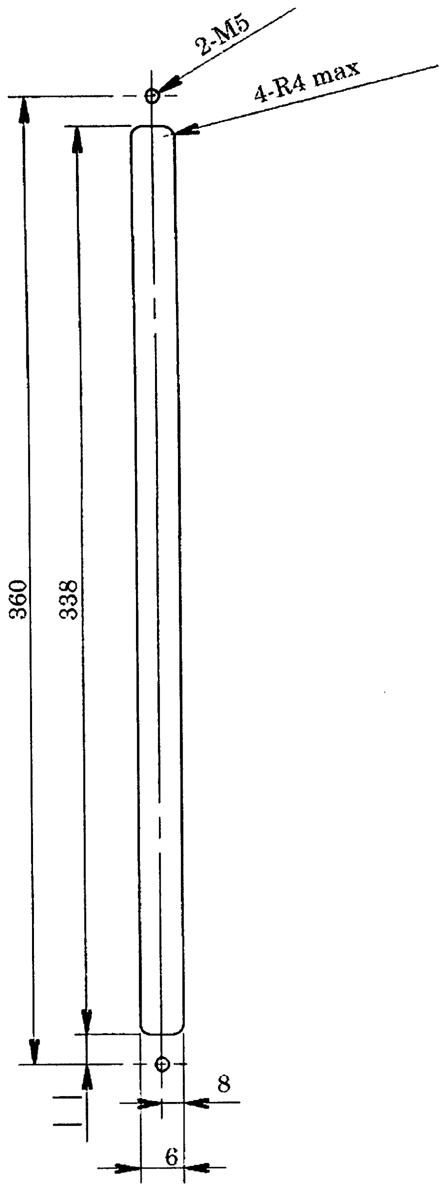
To allow ventilation, install a duct shown below between the fan adaptor and heatsink. Weld the duct to the cabinet.



Installing fan adaptor A06B–6078–K003 (PSM–45, SPM–45, PSM–75HV, and SPM–75HV)

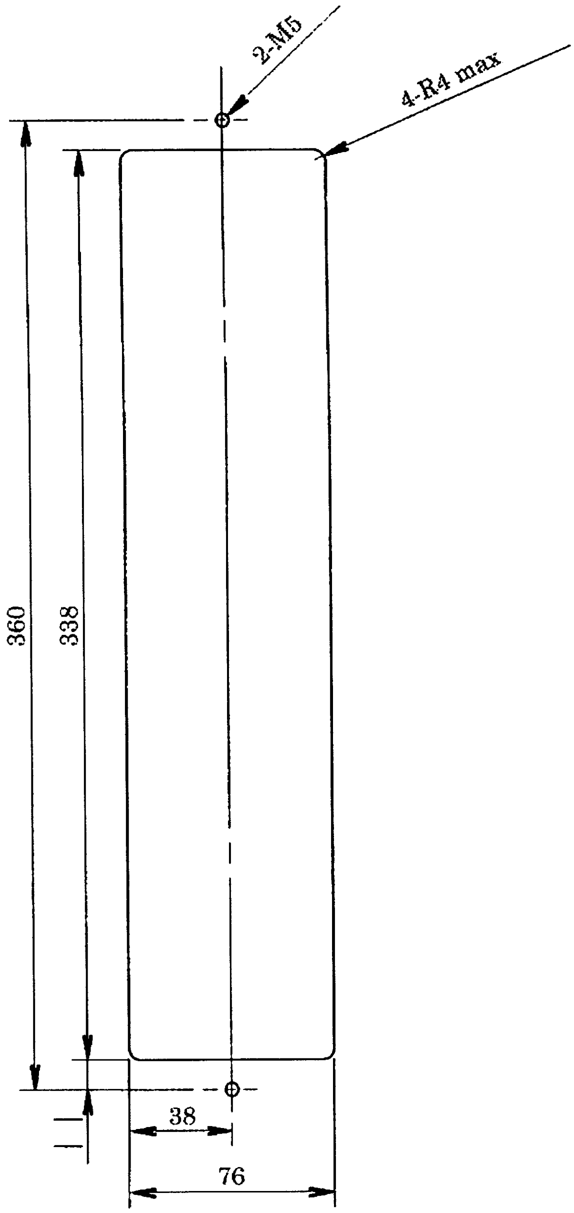


(g) Regenerative discharge unit (A06B–6089–H510)



NOTE
Attach a packing (acrylonitrile–butadiene rubber, NBR [soft type]) for protection against oil and dust.

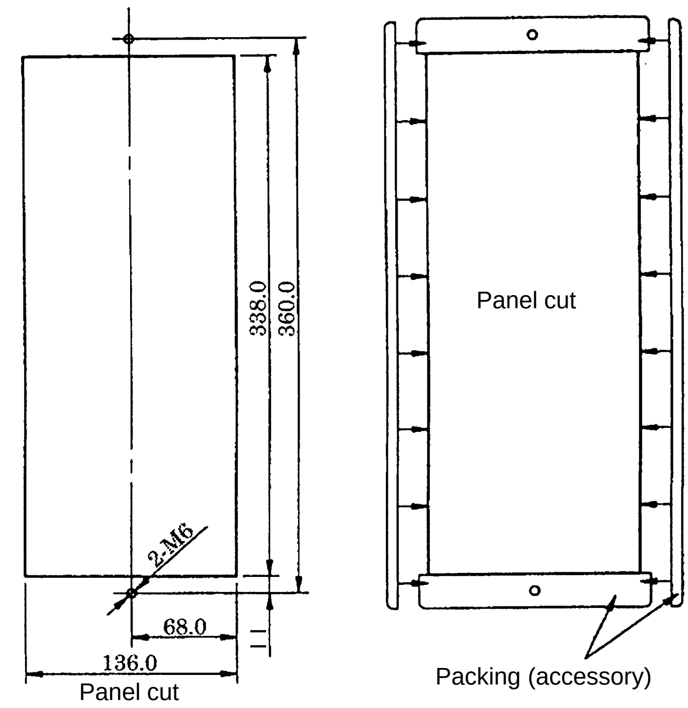
(h) Regenerative discharge unit (A06B–6089–H500)



NOTE

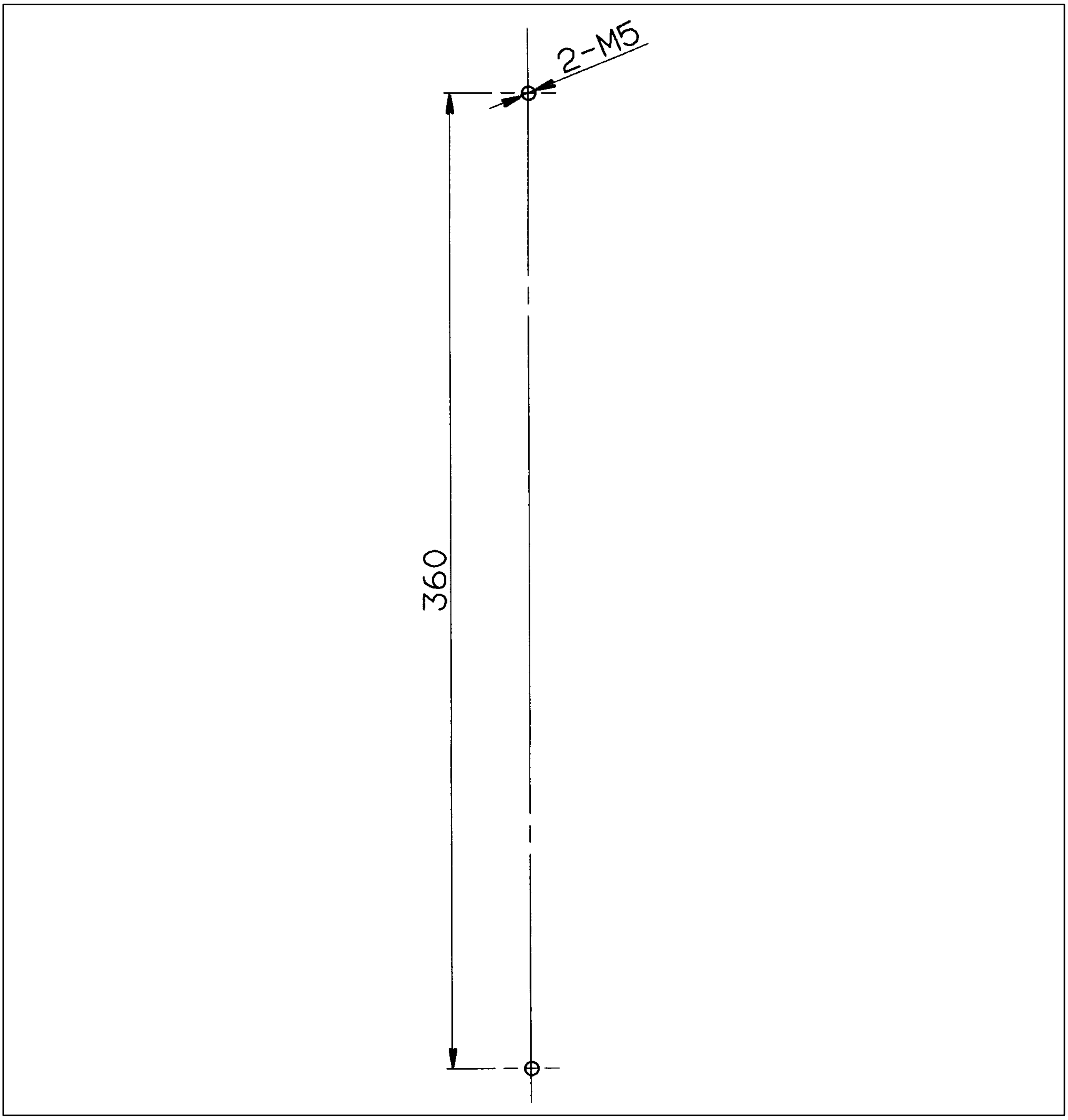
Attach a packing (acrylonitrile–butadiene rubber, NBR [soft type]) for protection against oil and dust.

(i) Regenerative discharge unit (A06B–6089–H711 to H713)

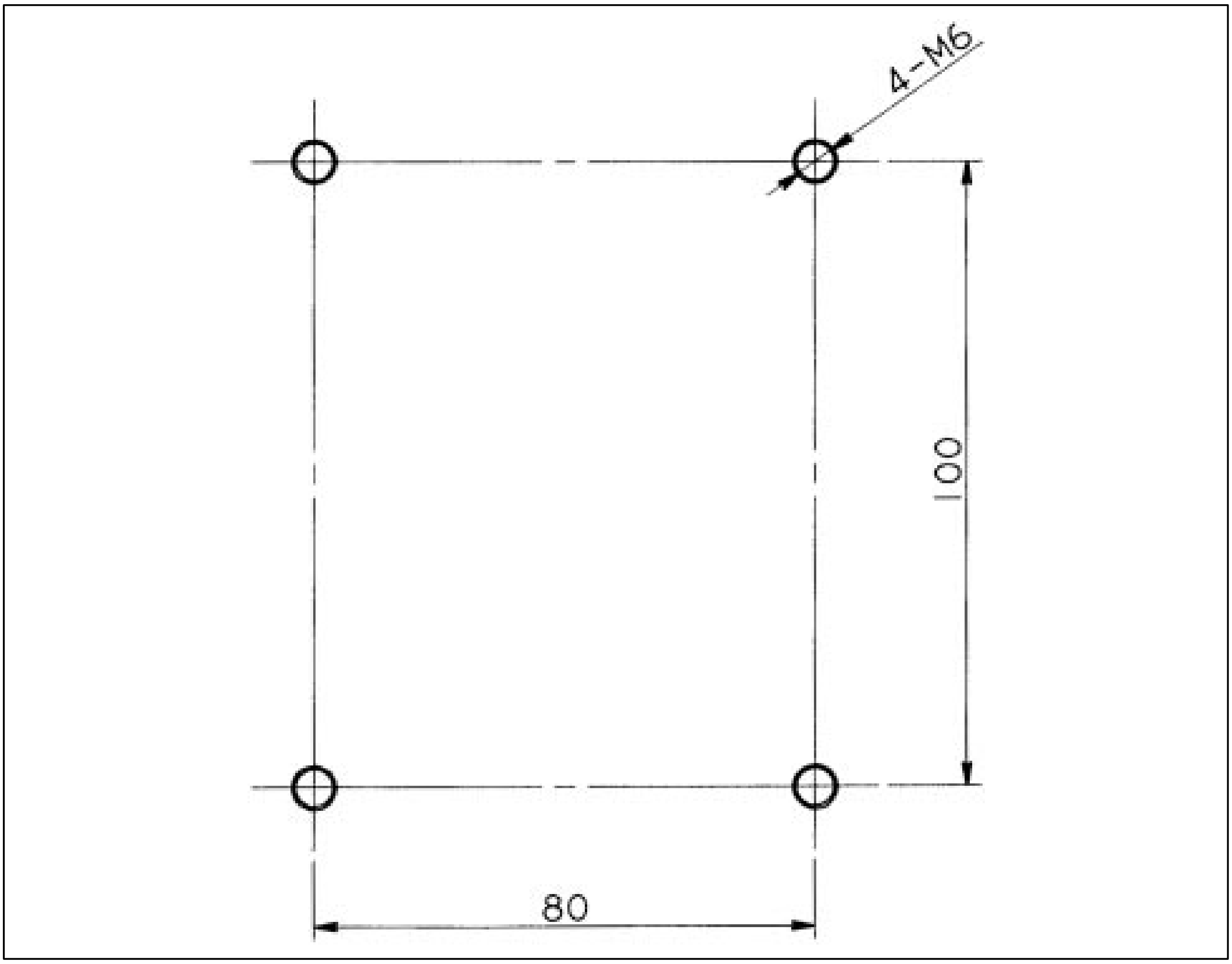


NOTE
Attach a packing (acrylonitrile–butadiene rubber, NBR [soft type]) for protection against oil and dust.

(j) Dynamic brake module (A06B–6079–H410)

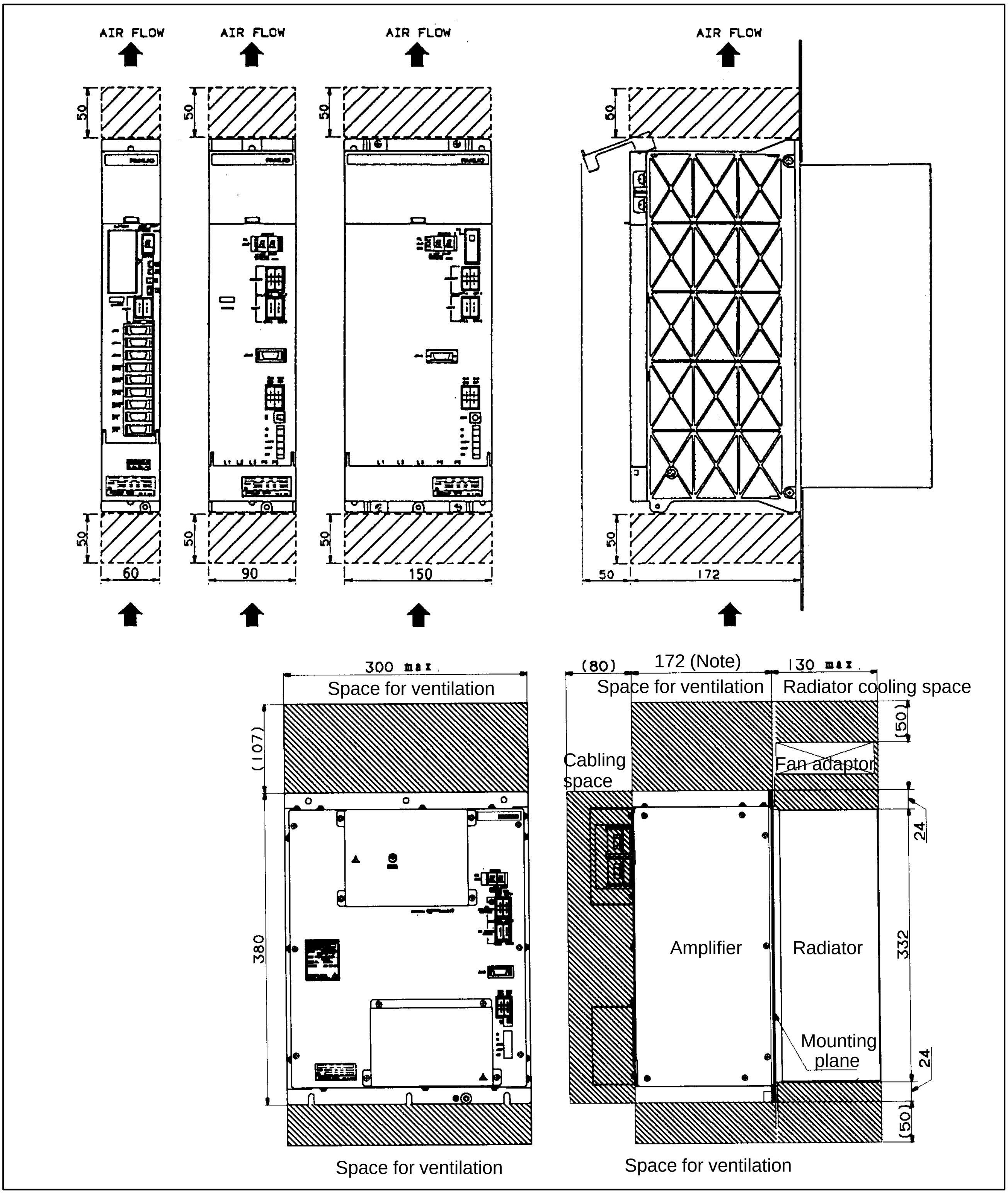


(k) AC reactor unit (A06B–6098–H001)



8.3 MAINTENANCE AREAS

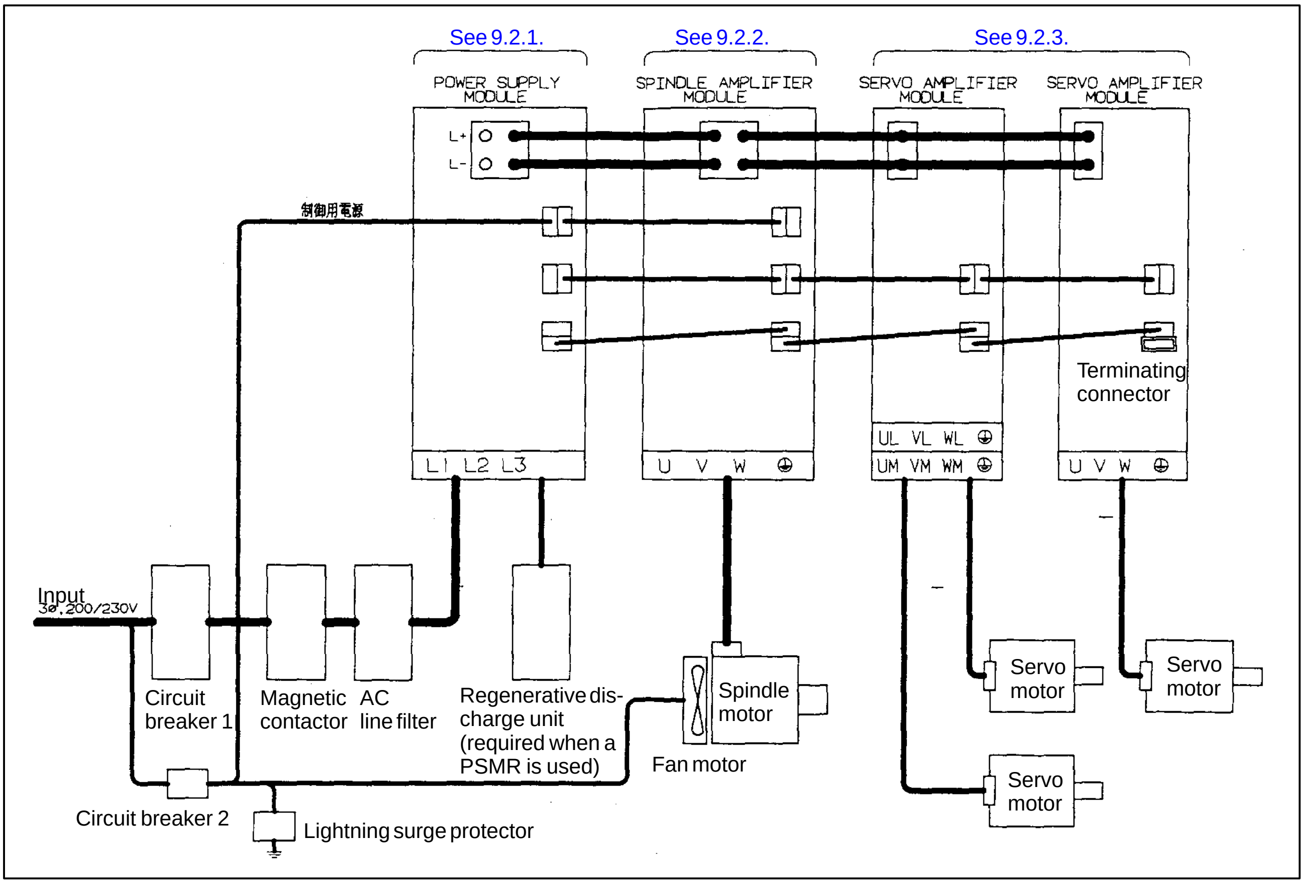
The amplifiers contain a fan motor to maintain an internal airflow. To ensure that air can flow, the space indicated by shading in the figure below is required:



9 CONNECTION

9.1 COMPLETE CONNECTION DIAGRAM

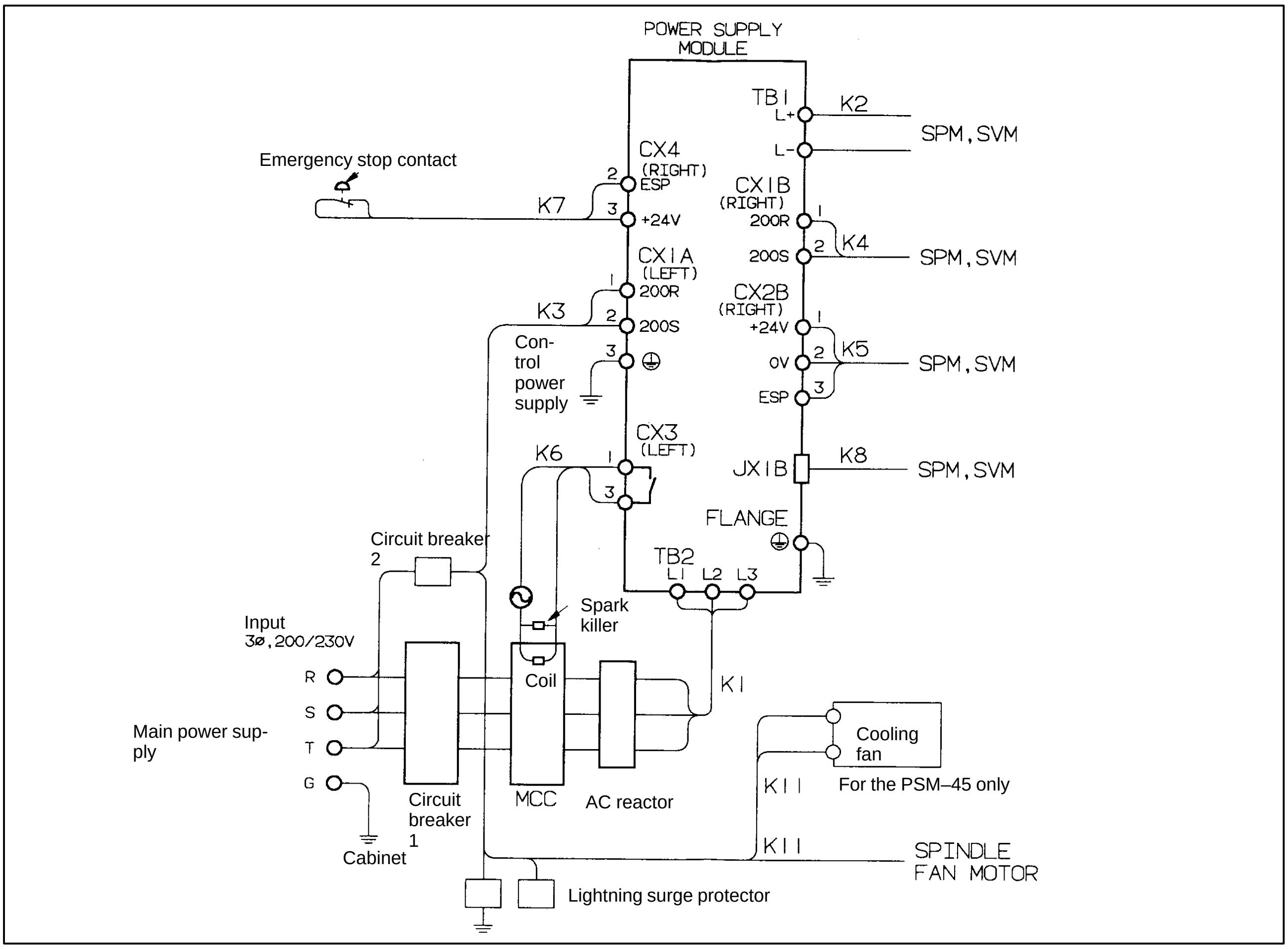
The following connection diagram is an example of combining a PSC, SPM, 2–axis SVM, and a 1–axis SVM. For detailed descriptions about how to connect these units, see their respective connection diagrams.



9.2 CABLE CONNECTION DETAILS

9.2.1 Power Supply Module Connection Diagram

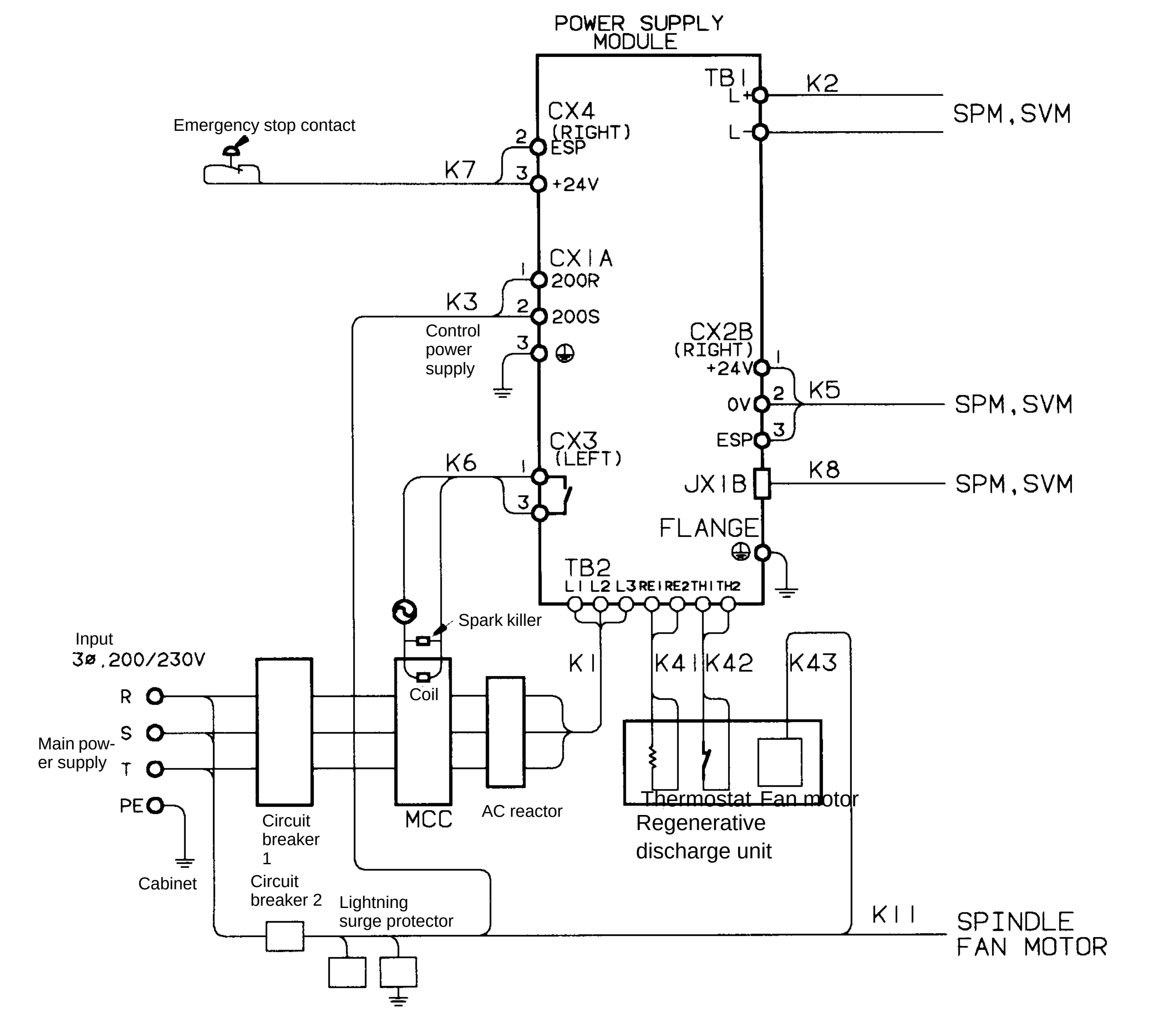
Power supply module (PSM)



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 protector across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet. See Appendix A for details.
3 Always connect the control power supply cable to the CX1A. If it is connected to the CX1B, fuses inside the unit may blow.
4 See Section 5.2.3 for the type of the cable to be used for making a connection to a frame ground.
5 Using a fan adapter in the SPM–11 requires cable K4 (across the CX1B and CX1A).

Power supply module (PSMR)



NOTE

1 Always install the circuit breakers, magnetic contactor, and AC reactor.

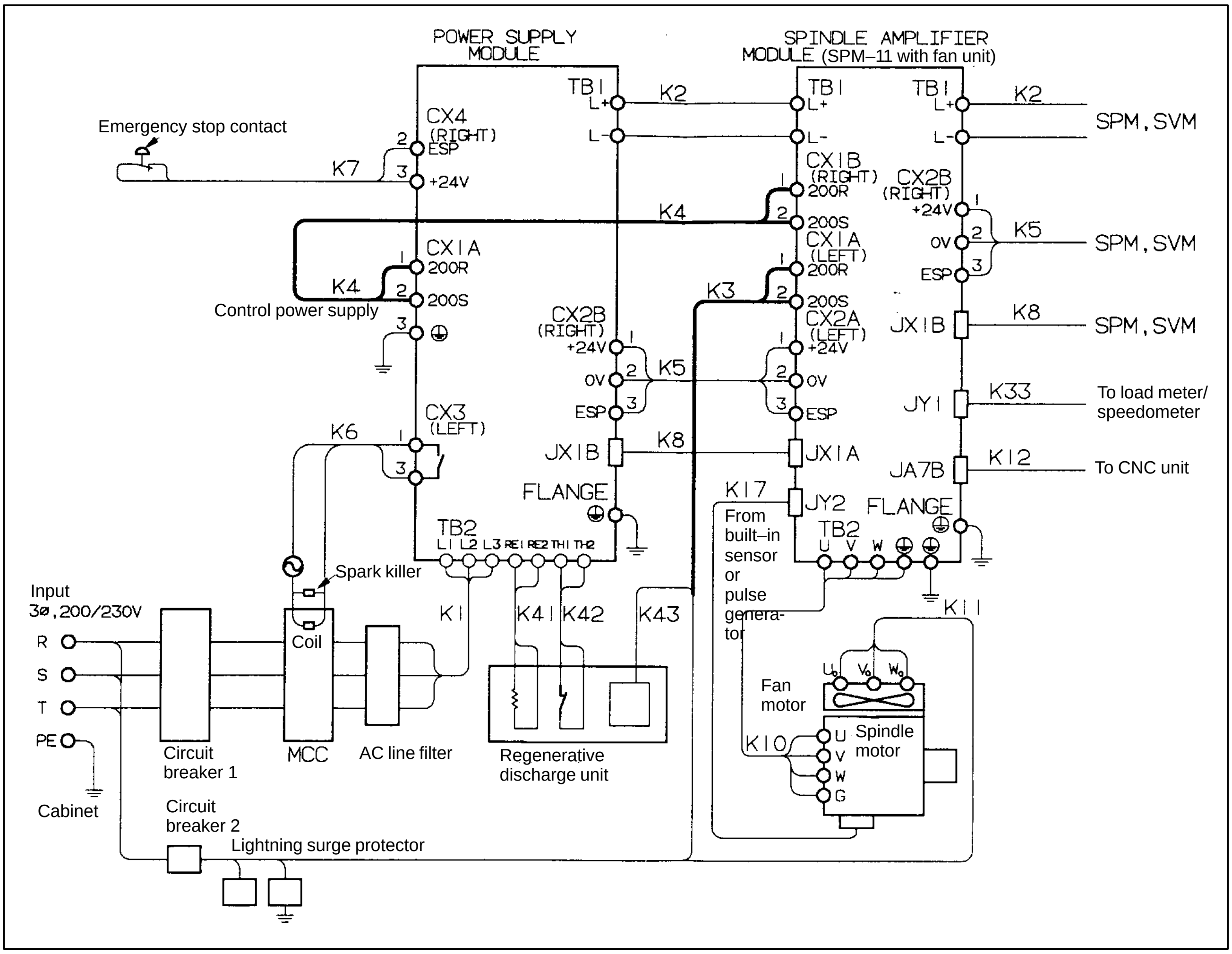
2 To protect the equipment from lightning surge voltages, install a lightning surge protector across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet. See Appendix A for details.

3 Always connect the control power supply cable to the CX1A. If it is connected to the CX1B, fuses inside the unit may blow.

4 See Section 5.2.3 for the type of the cable to be used for making a connection to a frame ground.

5 If the PSMR is combined with the SPM–11 (with the fan adapter), the way cables K3 and K4 are connected will vary from that shown in this diagram. See the diagram on the next page.

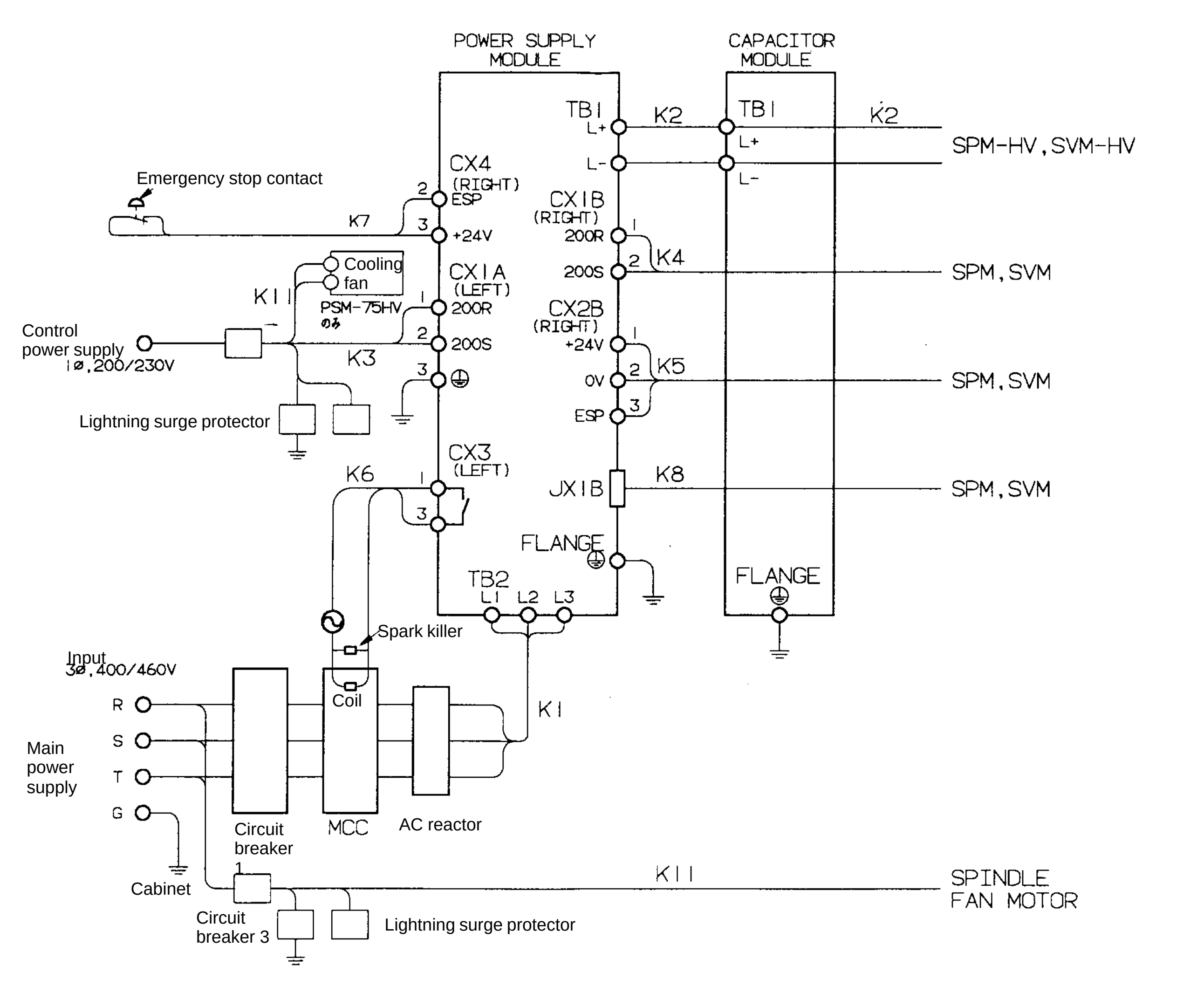
Power supply module (PSMR)
Connected to the SPM–11 (with fan adapter)



NOTE

1 Connect cable K3 to the CX1A (LEFT) of the SPM. See 9.2.1–(3).
2 Connect cable K4 across the CX1B (RIGHT) of the SPM and the CX1A of the PSMR. See 9.2.1–(4).
3 Always install the circuit breakers, magnetic contactor, and AC line filter.
4 To protect the equipment from lightning surge voltages, install a lightning surge protector across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet. See Appendix A for details.
5 See Section 5.2.3 for the type of the cable to be used for making a connection to a frame ground.

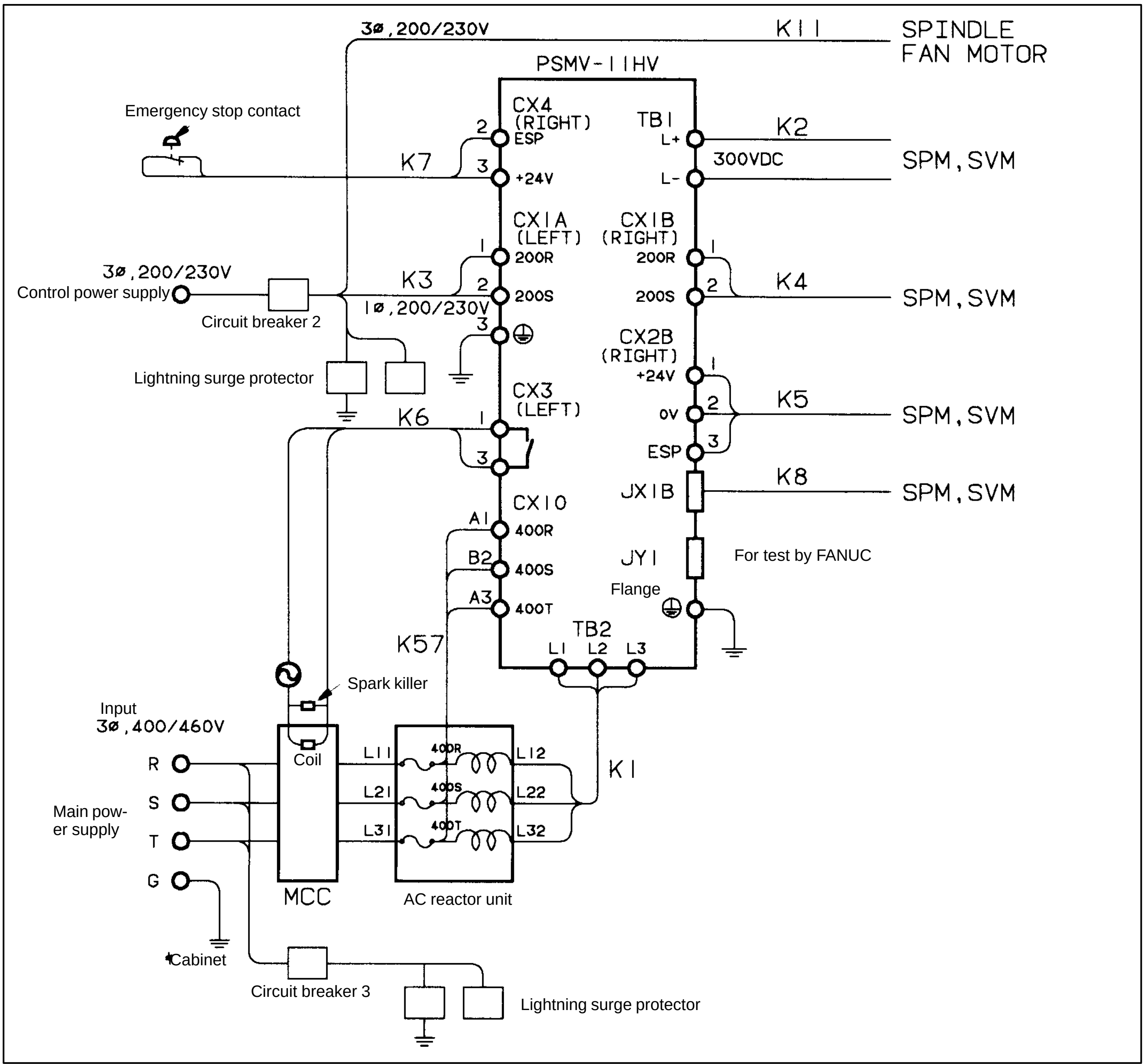
Power supply module (PSM–HV)



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 protector across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet. See Appendix A for details.
3 Always connect the control power supply cable to the CX1A. If it is connected to the CX1B, fuses inside the unit may blow.
4 See Section 5.2.3 for the type of the cable to be used for making a connection to a frame ground.
5 Using a fan adapter in the SPM–11 requires cable K4 (across the CX1B and CX1A).
6 Provide a means of detecting whether circuit breaker 3 has tripped.

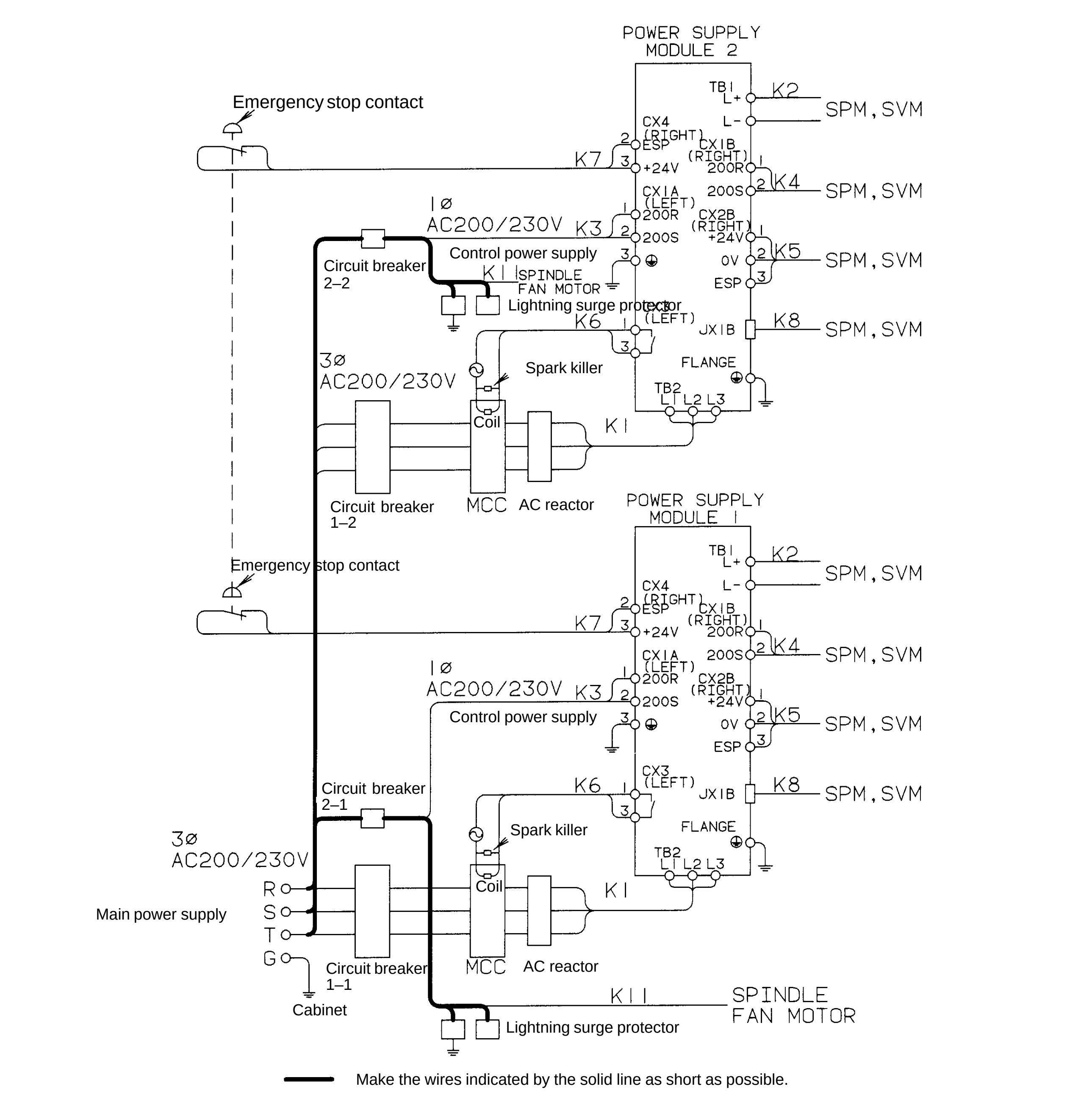
Power supply module (PSMV–HV)



NOTE

1 Always install the magnetic contactor and AC reactor unit.
2 To protect the equipment from lightning surge voltages, install a lightning surge protector across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet. See Appendix A for details.
3 Always connect the control power supply cable to the CX1A. If it is connected to the CX1B, fuses inside the unit may blow.
4 See Section 5.2.3 for the type of the cable to be used for making a connection to a frame ground.
5 The use of a fan adapter in the SPM–11 requires cable K4 (across the CX1B and CX1A).
6 Provide a means of detecting whether circuit breaker 3 has tripped.

Connection diagram for using two power supply modules



NOTE

1 Circuit breakers 1 and 2, the magnetic contactors, and the AC reactors cannot be shared. They must have the rating that matches each power supply module.

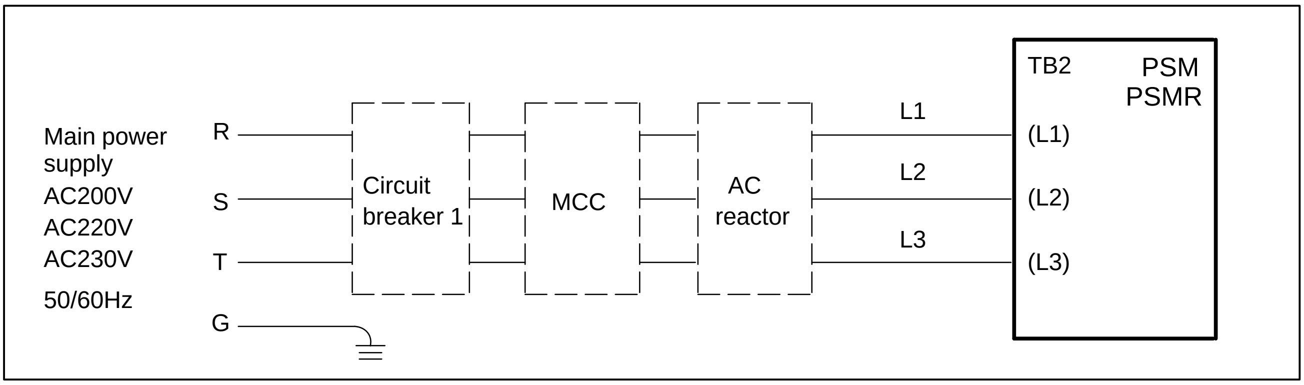
2 The lightning surge protector can be shared. Make the wires indicated by the solid line as short as possible.

(1) Detailed descriptions about the connection of cable K1 (power supply line)

Cable K1 is used to supply main power to the power supply module. Make sure that the cable used between the power supply and power supply module satisfies the requirements listed in Table 9.2.1.

– Connection with the PSM and PSMR

(a) For a power supply voltage of 200 to 230 VAC



(b) For a power supply voltage that falls outside the range of 200 to 230 VAC

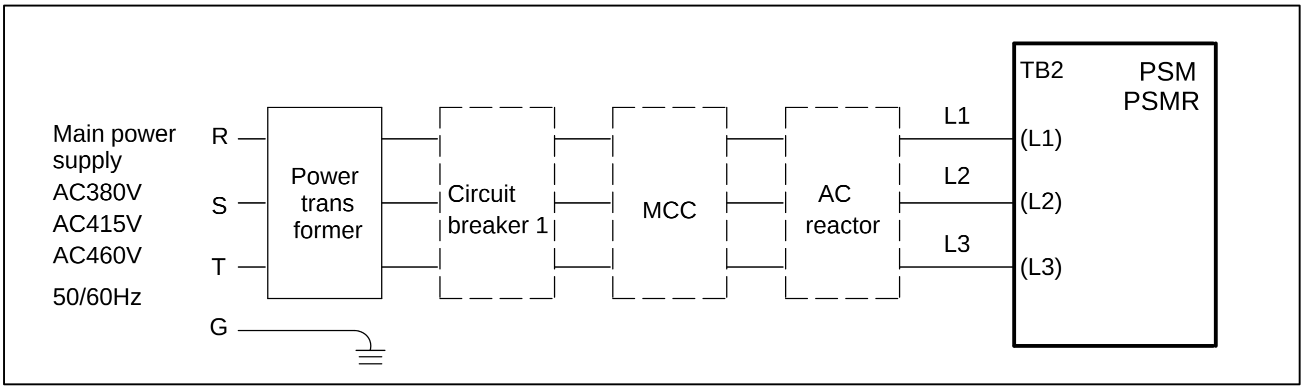


Table.9.2.1 (a) Cable K1 Specifications

Model	Applicable cable			Terminal screw
	Heavy–duty power cable (Note 1)	Heat–resistant cable (Note 2)		
PSMR–3	3.5 mm^2 or larger	3.5 mm^2 or larger		M4 (Note 3)
PSMR–5.5	5.5 mm^2 or larger	5.5 mm^2 or larger		
PSM–5.5	5.5 mm^2 or larger	5.5 mm^2 or larger		M4
PSM–11	——	8 mm^2 or larger		M4 (Note 3)
PSM–15	14 mm^2 or larger	14 mm^2 or larger		M6
PSM–26	——	22 mm^2 or larger		M6
PSM–30	——	22 mm^2 or larger		M6
PSM–37	——	R, S, and T phase lines	38mm^2 or larger	M6 (Note 3)
		Ground line	22mm^2 or larger	
PSM–45	——	R, S, and T phase lines	50mm^2 or larger	M10
		Ground line	22mm^2 or larger	M6 (Note 3)

NOTE
1 Four–conductor polyvinyl heavy–duty power cable (JIS C3312)
2 Fire–retardant polyflex wire (maximum conductor temperature 105°C) or equivalent to LMFC manufactured by The Furukawa Electric Co., Ltd.
3 Applicable crimp terminals: 5.5–4S for the PSMR–3 and –5.5
8–4S for the PSM–11
38–6S for the PSM–37

– Connection with the PSM–HV

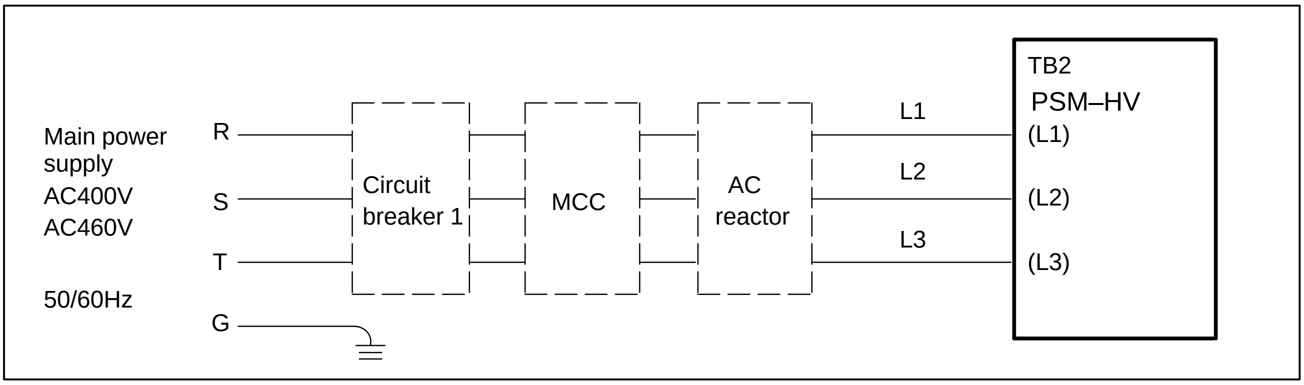


Table.9.2.1 (b) Cable K1 Specifications

Model	Applicable cable		Terminal screw
	Heat–resistant cable (Note 1)		
PSM–18HV	R, S, and T phase lines and grounding line	8mm^2 or larger	M6
PSM–30HV	R, S, and T phase lines and grounding line	14mm^2 or larger	M6
PSM–45HV	R, S, and T phase lines and grounding line	22mm^2 or larger	M6
PSM–75HV	R, S, and T phase lines	38mm^2 or larger	M10
	Ground line	22mm^2 or larger	M6

NOTE
1 Four–conductor polyvinyl heavy–duty power cable (JIS C3312)
2 Fire–retardant polyflex wire (maximum conductor temperature 105°C) or equivalent to LMFC manufactured by The Furukawa Electric Co., Ltd.

– Connection with the PSMV–HV

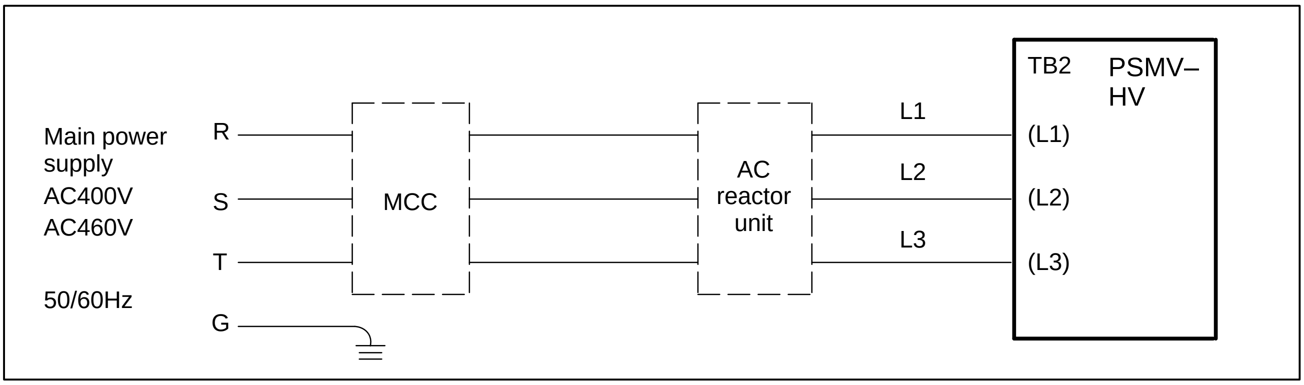


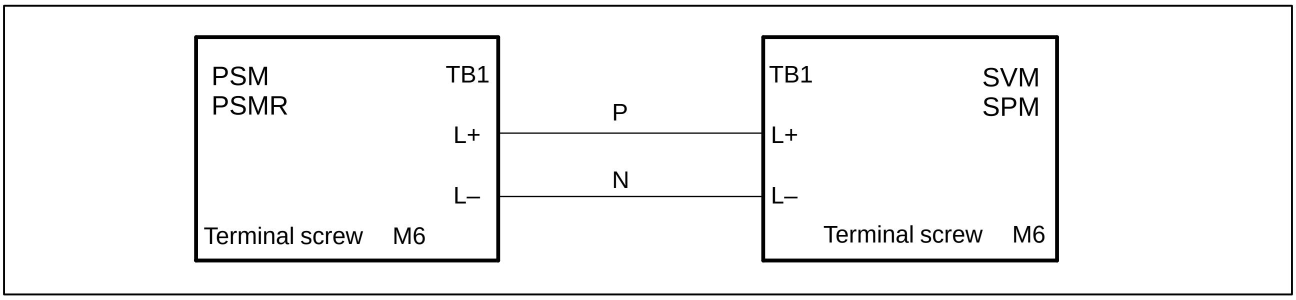
Table.9.2.1 (c) Cable K1 Specifications

Model	Applicable cable		Terminal screw
	Heavy–duty power cable (Note 1)	Heat–resistant cable (Note 2)	
PSMV–11HV	14 mm^2 or larger	8 mm^2 or larger	M6

NOTE
1 Four–conductor polyvinyl heavy–duty power cable (JIS C3312)
2 Fire–retardant polyflex wire (maximum conductor temperature 105°C) or equivalent to LMFC manufactured by The Furukawa Electric Co., Ltd.

(2) Detailed description of the connection of short bar K2

Short bar K2 is used to supply the DC link voltage generated in each power supply module to other modules. When designing a short bar for connecting modules placed close to each other, refer to the ”Specifications of short bars for connecting modules placed close to each other.”
To determine the length of a short bar to be used for connecting modules placed separately, refer to ”Location of terminal board TB1.”
Optional short bars are available from FANUC. Refer to the ”FANUC Short Bar Specifications.”



– Specifications of short bars for connecting modules placed close to each other

(1) Specifications of short bars for connecting other than 300–mm–wide modules

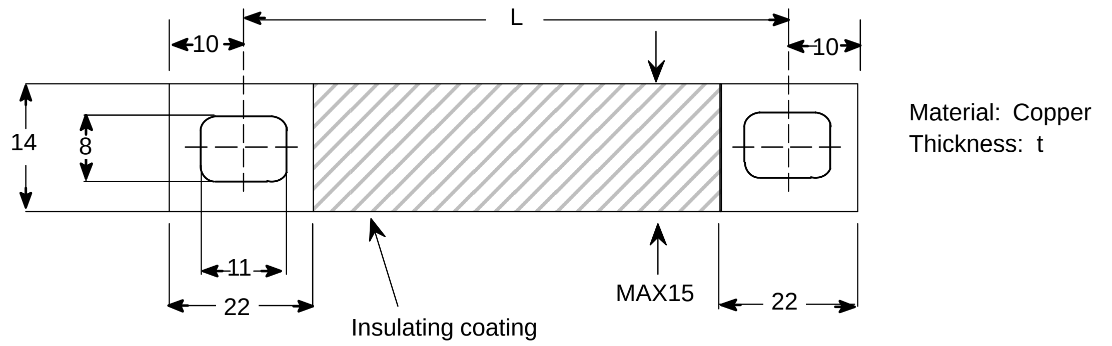


Table.9.2.1 (d) Short Bar K2 Specifications

Module location		Short bar length L	Short bar thickness t	Cross–section area (Note)
Module on the left	Module on the right			
Unit of 150mm wide	Unit of 150mm wide	124mm	1.5mm	21mm^2
Unit of 150mm wide	Unit of 90mm wide	85mm	1.5mm	21mm^2
Unit of 150mm wide	Unit of 60mm wide	81mm	1.0mm	14mm^2
Unit of 90mm wide	Unit of 150mm wide	129mm	1.5mm	21mm^2
Unit of 90mm wide	Unit of 90mm wide	90mm	1.0mm	14mm^2
Unit of 90mm wide	Unit of 60mm wide	85mm	1.0mm	14mm^2
Unit of 60mm wide	Unit of 150mm wide	103mm	1.0mm	14mm^2
Unit of 60mm wide	Unit of 90mm wide	64mm	1.0mm	14mm^2
Unit of 60mm wide	Unit of 60mm wide	60mm	1.0mm	14mm^2

NOTE

Modules need not necessarily be connected with a short bar (copper plate). If you connect them with a power cable, however, the cable may not be thinner than indicated below and must be insulated with heat–resistant polyvinyl.

(2) Specifications of short bars for connecting 300–mm–wide modules

The following table lists the specifications of short bar K2, used for connecting a 300–mm–wide module to another 300–mm–wide module or a 150–, 90–, or 60–mm–wide module

Table.9.2.1 (e) Short Bar K2 Specifications

Applicable terminal–to–terminal distance (Note)	Module on the left	Module on the right	Outline drawing
143 to 151mm	300mm wide PSM	300mm wide SPM	Fig. 9.2.1 (a)
184.5mm	300mm wide PSM	150mm wide	Fig. 9.2.1 (b)
141.5 to 145.5mm	300mm wide PSM	90 or 60mm wide	Fig. 9.2.1 (c)
307.5mm	300mm wide SPM	150mm wide	Fig. 9.2.1 (d)
264.5 to 268.5mm	300mm wide SPM	90 or 60mm wide	Fig. 9.2.1 (e)
122.5mm	150mm wide PSM	300mm wide SPM	Fig. 9.2.1 (f)

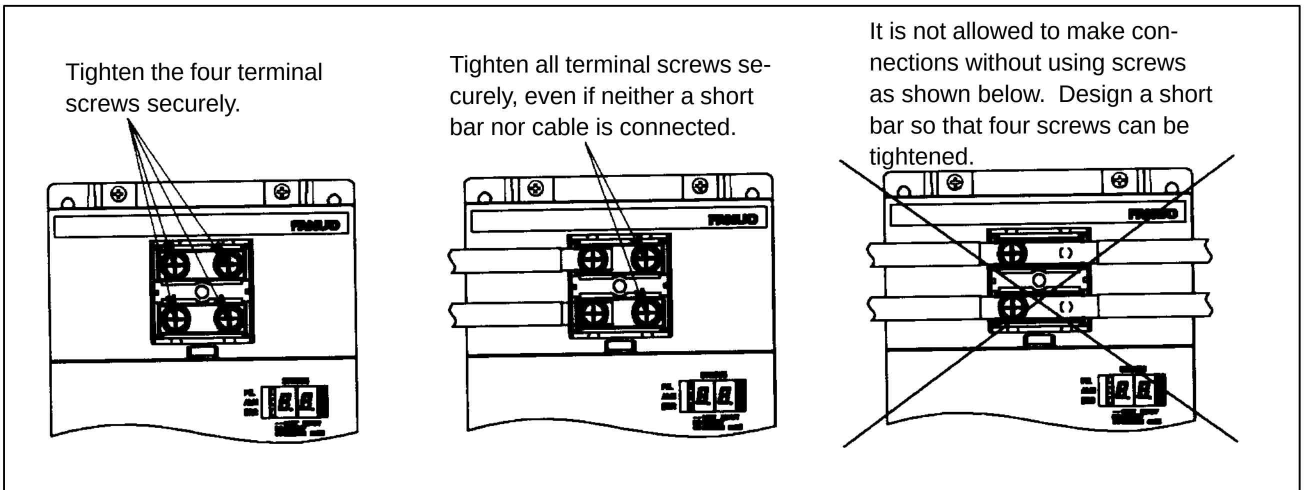
NOTE

Place a 300–mm–wide module 20 mm apart from a 150–, 90–, or 60–mm–wide module.

– Cautions on connecting a 150–mm–wide module

NOTE

The terminal board (TB1) on the 150–mm–wide module has four terminal screws. Tighten all these screws securely.



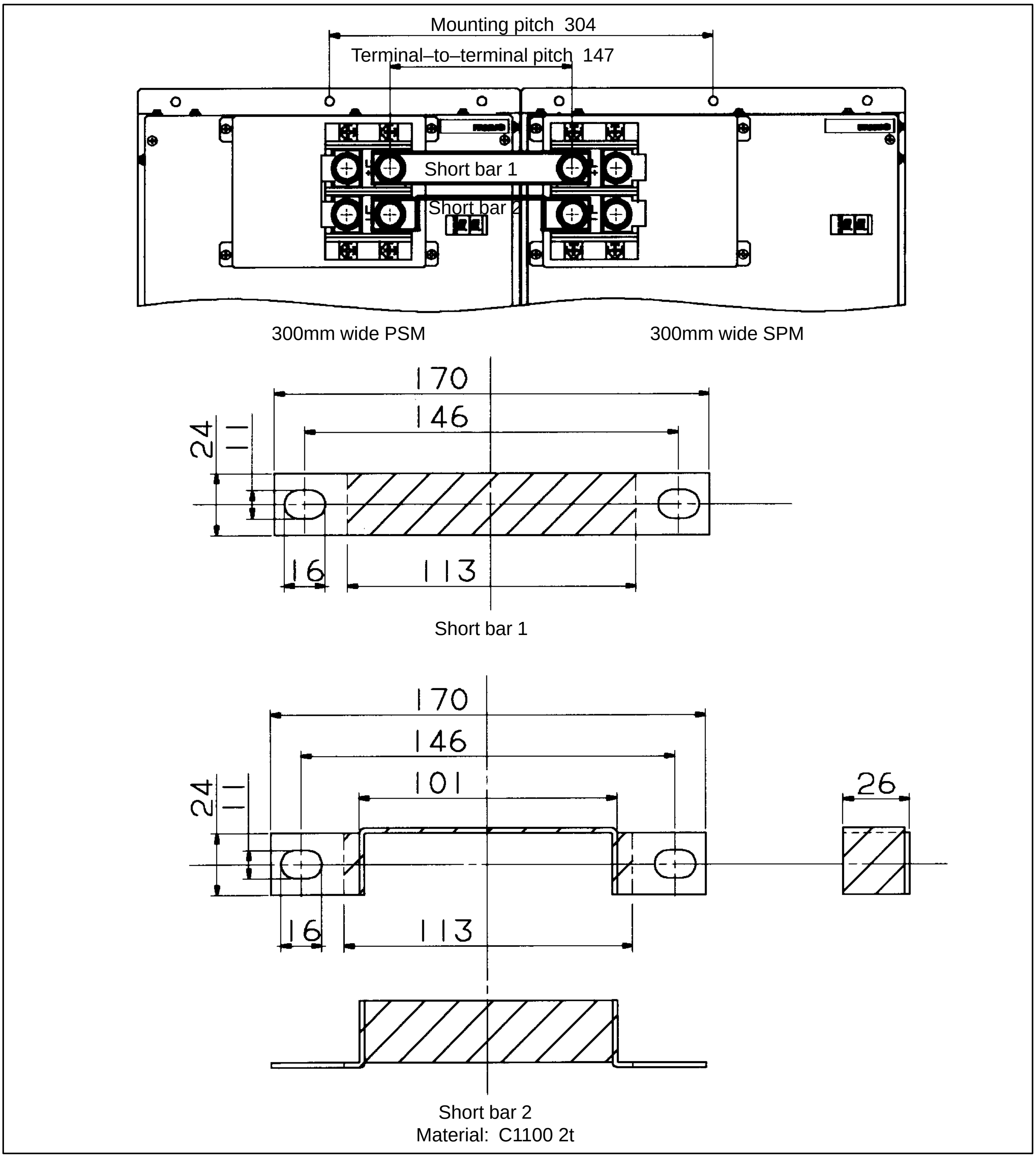


Fig.9.2.1 (a) Short Bar Outline Drawing (for Use Between a 300–mm–Wide PSM and SPM)
Ordering information: A06B–6078–K823

NOTE

If the user prepares a short bar:

– Plate the short bar to protect it against corrosion.
– Insulate the short bar portions indicated by hatching.
– Keep the thickness of the insulation within 1 mm.

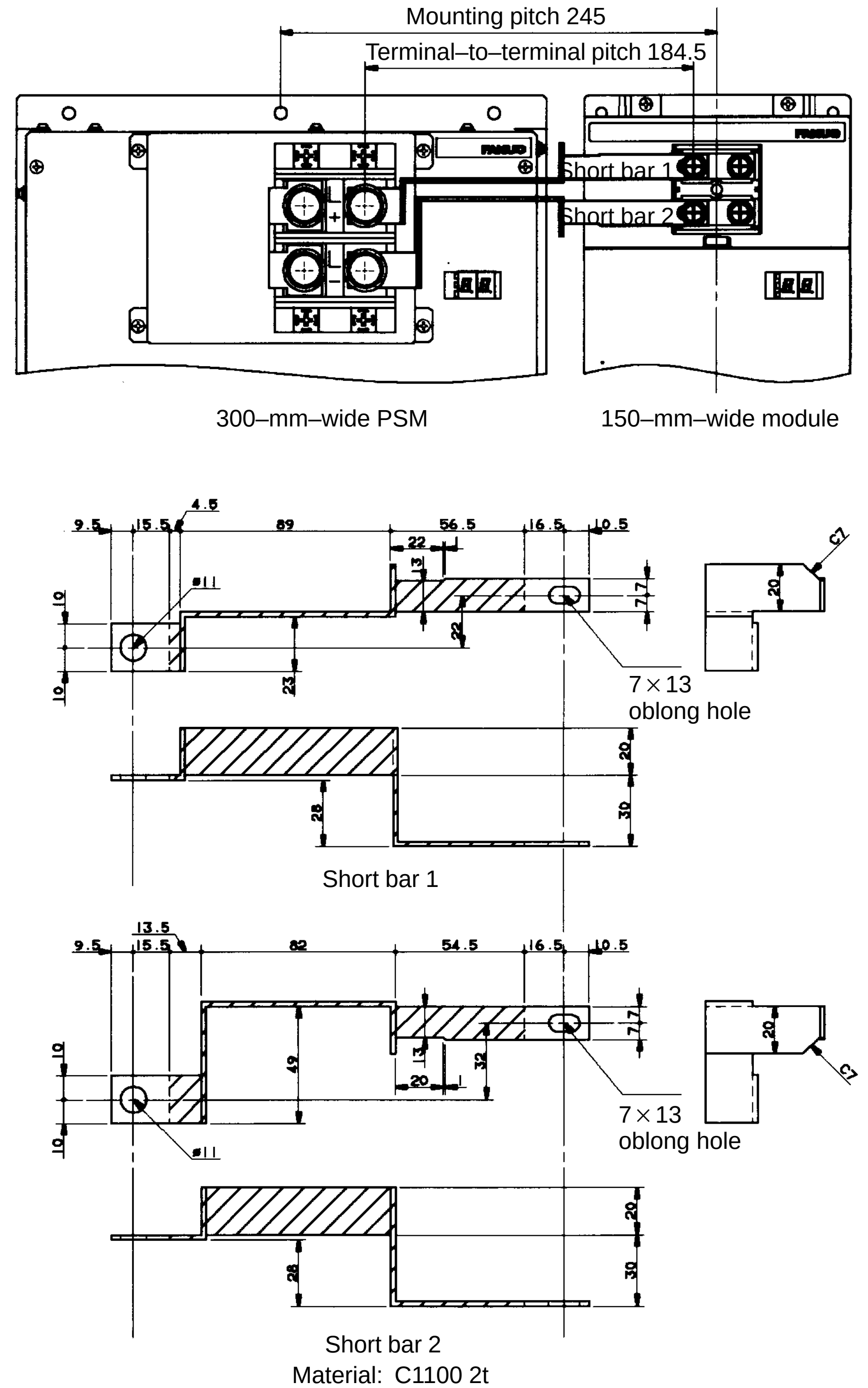


Fig.9.2.1 (b) Short Bar Outline Drawing (for Use Between a 300–mm–Wide PSM and 150–mm–Wide Module) Ordering information: A06B–6078–K826

NOTE

If the user prepares a short bar:

– Plate the short bar to protect it against corrosion.
– Insulate the short bar portions indicated by hatching.
– Keep the thickness of the insulation within 1 mm.

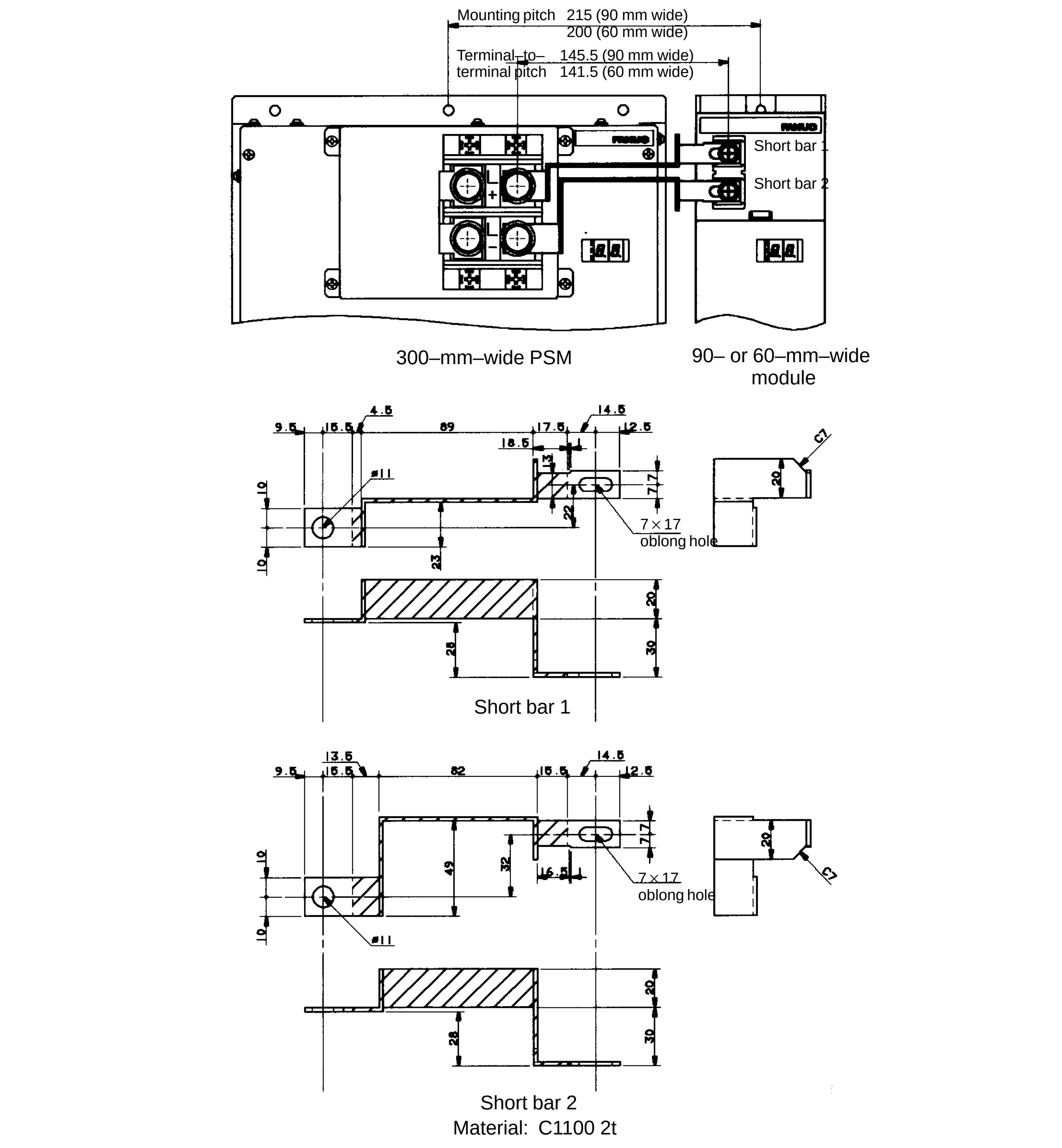


Fig.9.2.1 (c) Short Bar Outline Drawing (for Use Between a 300–mm–Wide PSM and 90– or 60–mm–Wide Module) Ordering information: A06B–6078–K827

NOTE

If the user prepares a short bar:

– Plate the short bar to protect it against corrosion.

– Insulate the short bar portions indicated by hatching.

– Keep the thickness of the insulation within 1 mm.

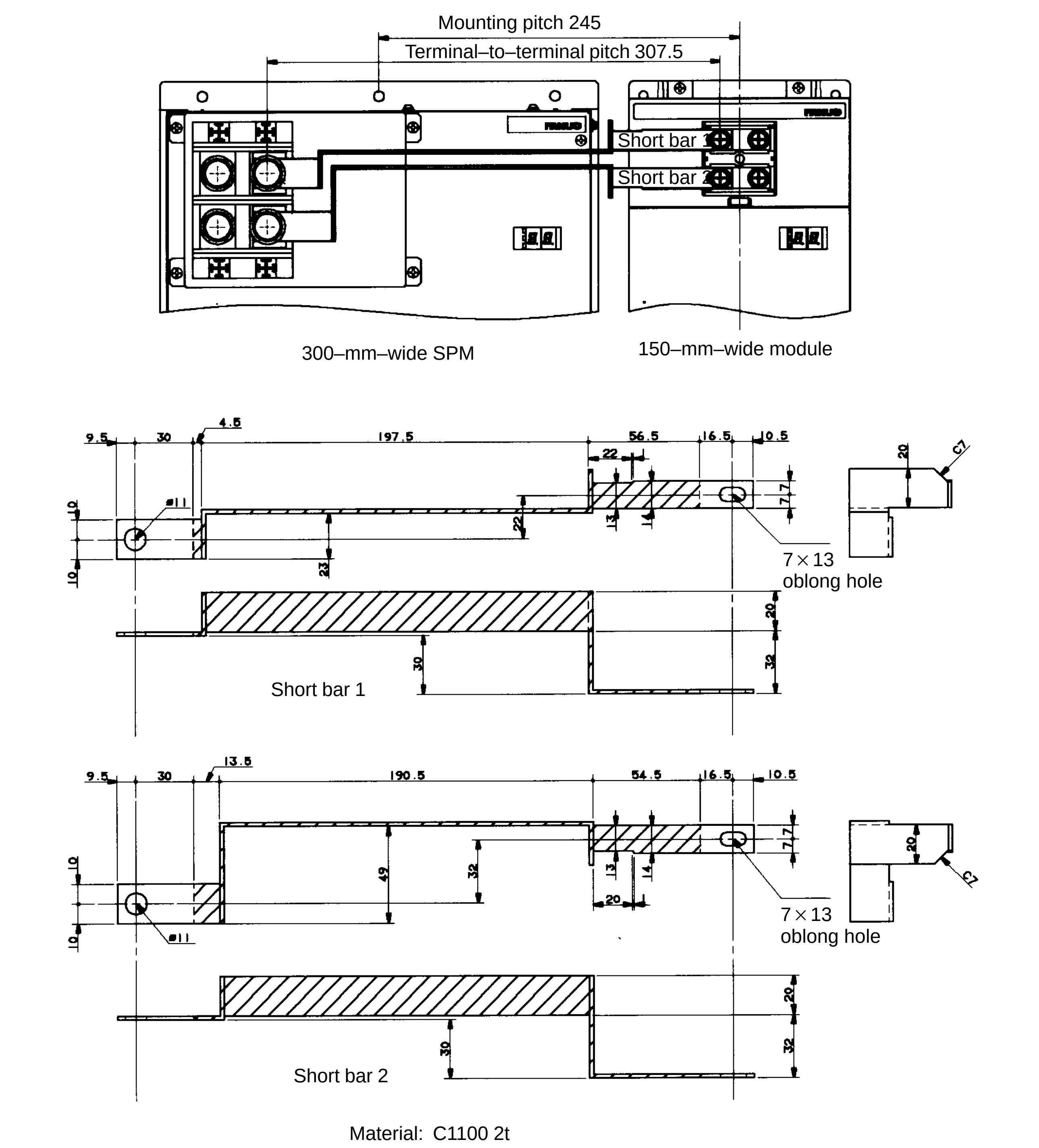


Fig.9.2.1 (d) Short Bar Outline Drawing (for Use Between 300–mm–Wide SPM and 150–mm–Wide Module) Ordering information: A06B–6078–K828

NOTE

If the user prepares a short bar:

– Plate the short bar to protect it against corrosion.
– Insulate the short bar portions indicated by hatching.
– Keep the thickness of the insulation within 1 mm.

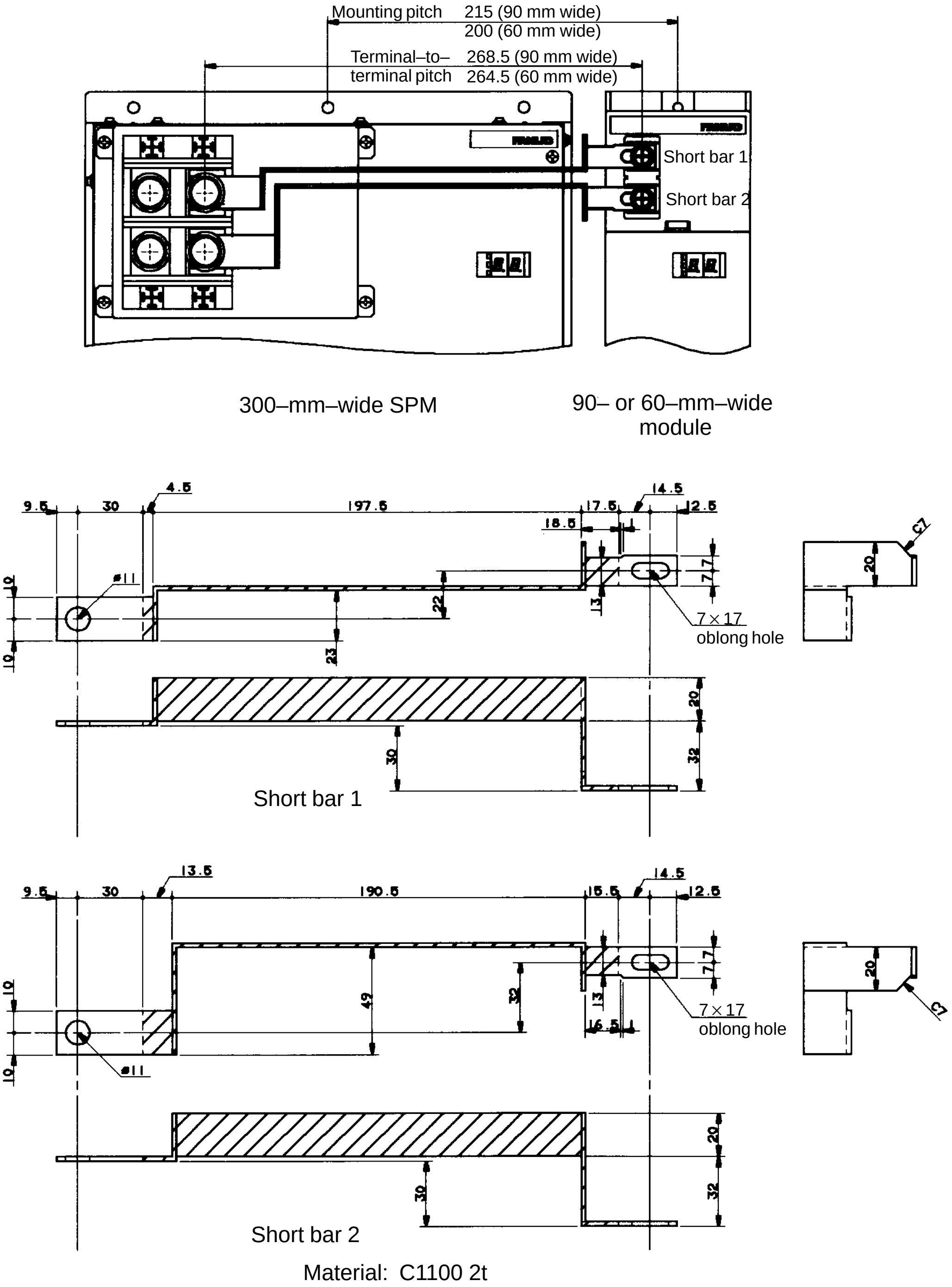


Fig.9.2.1 (e) Short Bar Outline Drawing (for Use Between 300–mm–Wide SPM and 90– or 60–mm Wide Module) Ordering information: A06B–6078–K829

NOTE
If the user prepares a short bar:
– Plate the short bar to protect it against corrosion.
– Insulate the short bar portions indicated by hatching.
– Keep the thickness of the insulation within 1 mm.

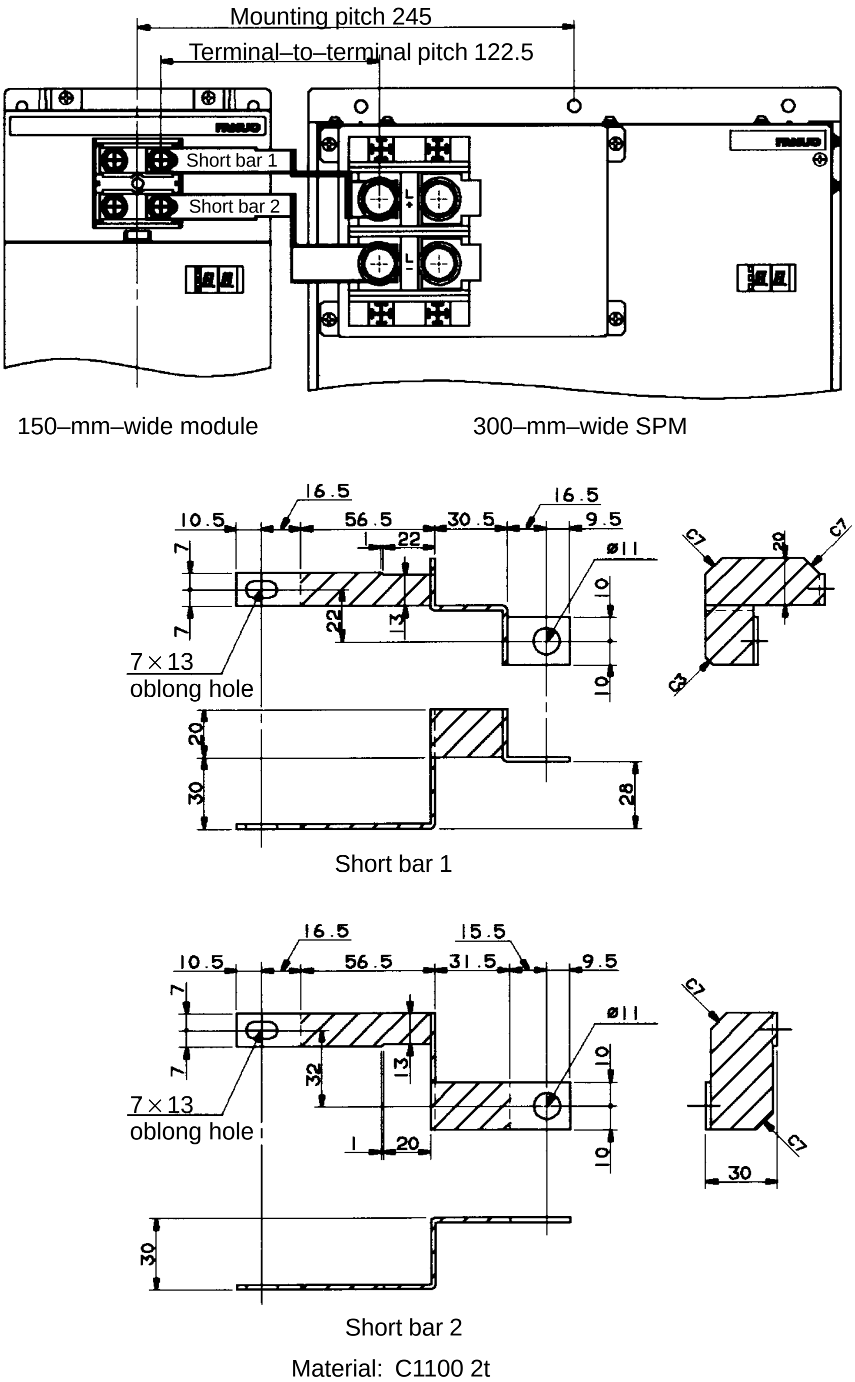


Fig.9.2.1 (f) Short Bar Outline Drawing (for Use Between 150–mm–Wide PSM and 300–mm–Wide SPM) Ordering information: A06B–6078–K830

NOTE

If the user prepares a short bar:
- Plate the short bar to protect it against corrosion.
- Insulate the short bar portions indicated by hatching.
- Keep the thickness of the insulation within 1 mm.

– Location of terminal board TB1 on each module

Figures 9.2.1 (g) and (h) show the location of terminal board TB1 on each module. If you want to install modules at distances not specified herein, design short bars by referring to the dimensions shown below.

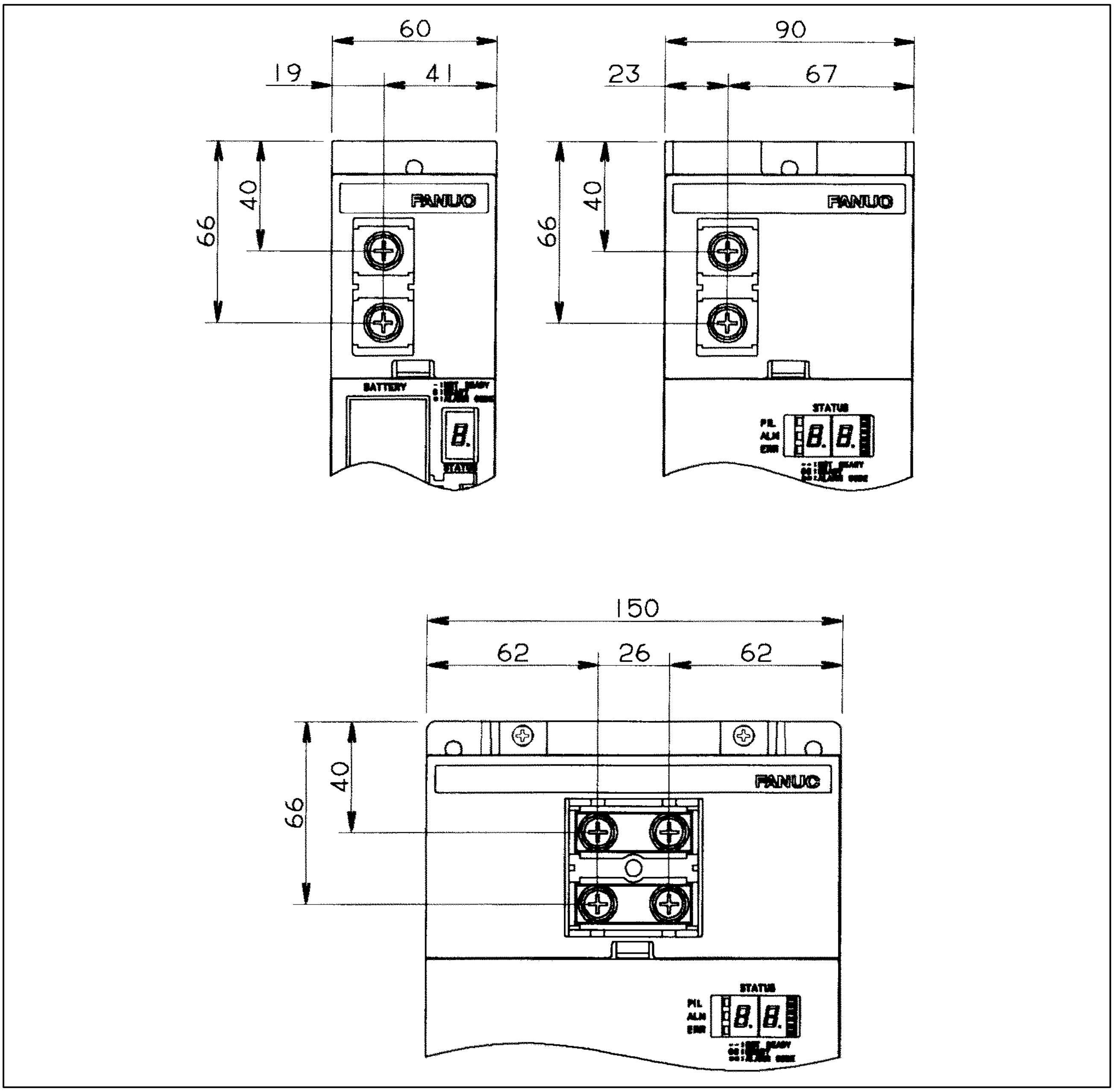
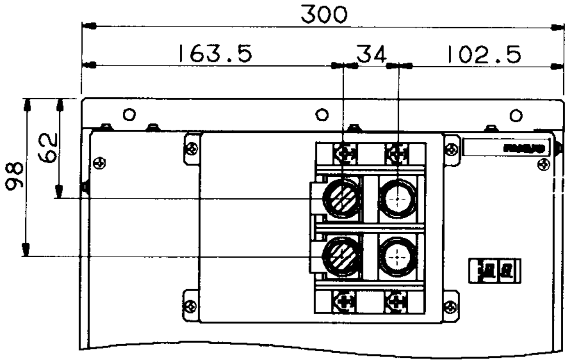
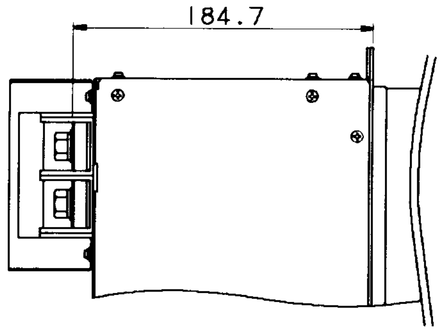


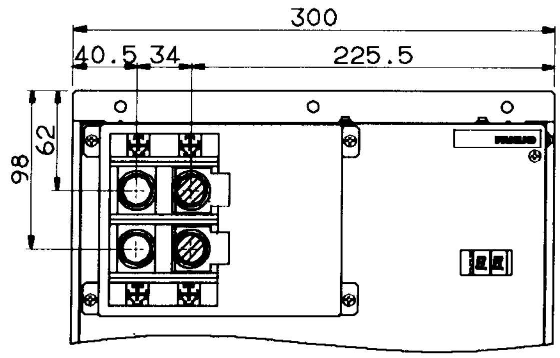
Fig.9.2.1 (g) Location of Terminal Board TB1 on the 60–, 90–, and 150–mm–Wide Modules



300–mm–wide PSM



Common to 300–mm–wide PSM and SPM



300–mm–wide SPM

Fig.9.2.1 (h) Location of Terminal Board TB1 on the 300–mm–Wide Module

NOTE
1 If a short bar is installed on a terminal indicated by hatching, it is fastened together with a 2t short bar connected to the inside of the module, so the total height is 186.7 mm.
2 Terminal board TB1 on any of the 60–, 90–, or 150–mm modules is 156.6 mm high.
4. 300–mm–wide SPM

– FANUC Short Bar Specifications

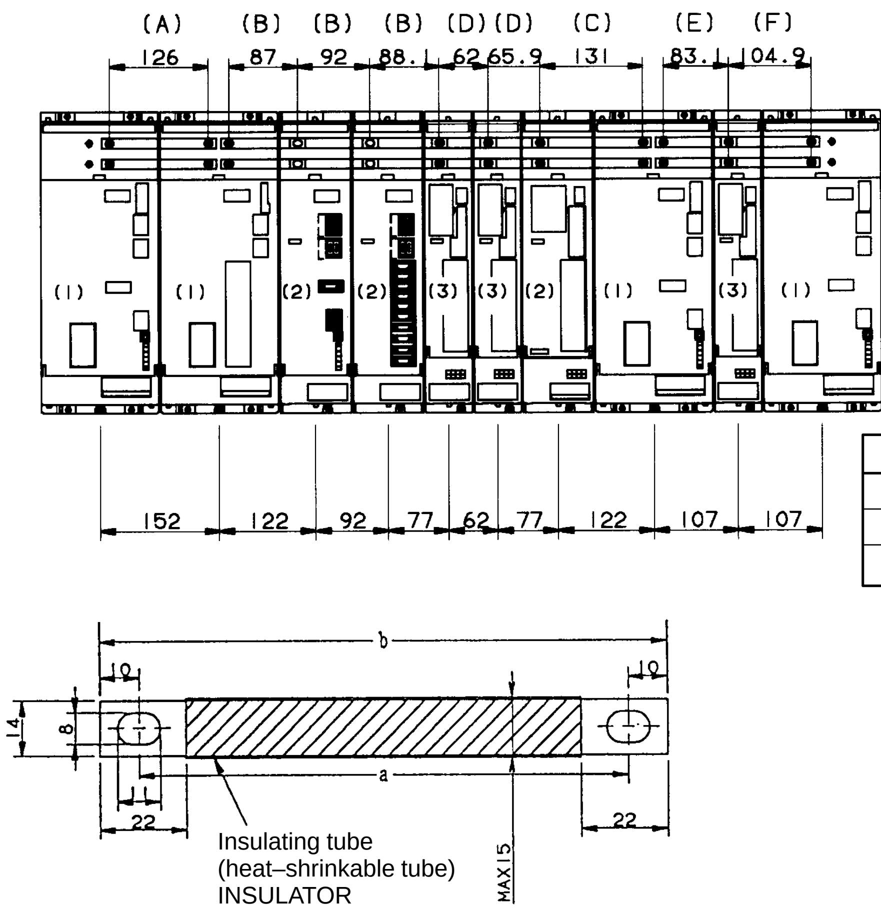
(1) Specifications of short bars for connecting other than 300mm wide modules

The short bars listed in Tables 9.2.1 (f) and (i) can be used to install modules placed 2 mm apart from each another.

Table.9.2.1 (f) Short Bar Specifications

Symbol	Ordering information	Dimension of part a	Dimension of part b	Usable range	Thickness
(A)	A06B–6078–K800	124mm	144mm	120 to 128mm	1.5mm
(B)	A06B–6078–K801	90mm	110mm	86 to 94mm	
(C)	A06B–6078–K802	131mm	151mm	127 to 135mm	
(D)	A06B–6078–K803	64mm	84mm	60 to 68mm	
(E)	A06B–6078–K804	85mm	105mm	81 to 89mm	
(F)	A06B–6078–K805	102mm	122mm	98 to 106mm	

NOTE
Short bars are ordered in pairs.



	Module width
1	150mm
2	90mm
3	60mm

Fig.9.2.1 (i) Short Bar Outline Drawing

(2) Specifications of short bars for connecting 300–mm–wide modules

The short bars listed in Table 9.2.1 (g) and shown in Figures 9.2.1 (a) to (f) can be used to connect modules placed 20 mm (or 2 mm between a 300–mm–wide PSM and 300–mm SPM) apart from each other.

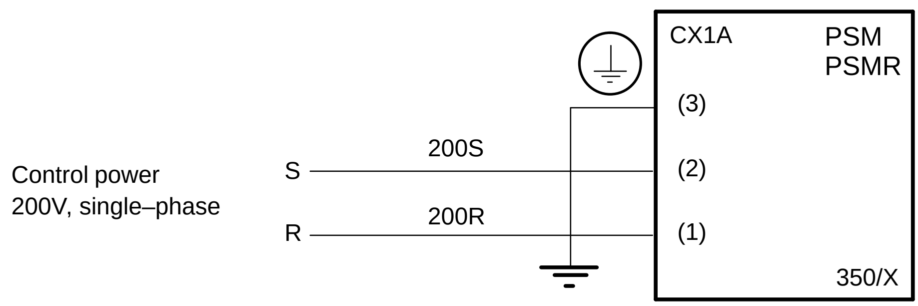
Table.9.2.1 (g) Short Bar Specifications

Symbol	Ordering information	Module on the left	Module on the right	Outline drawing
(G)	A06B–6078–K823	300mm wide PSM	300mm wide SPM	Fig. 9.2.1 (a)
(H)	A06B–6078–K826	300mm wide PSM	150mm wide	Fig. 9.2.1 (b)
(I)	A06B–6078–K827	300mm wide PSM	90 or 60 mm wide	Fig. 9.2.1 (c)
(J)	A06B–6078–K828	300mm wide SPM	150mm wide	Fig. 9.2.1 (d)
(K)	A06B–6078–K829	300mm wide SPM	90 or 60 mm wide	Fig. 9.2.1 (e)
(L)	A06B–6078–K830	150mm wide PSM	300mm wide SPM	Fig. 9.2.1 (f)

NOTE
Short bars are ordered in pairs.

(3) Detailed description of the connection of cable K3

Cable K3 is used to supply control power to the power supply module. Note that if the PSMR is combined with the SPM–11 (with a fan adapter), the connection will differ from that explained below.

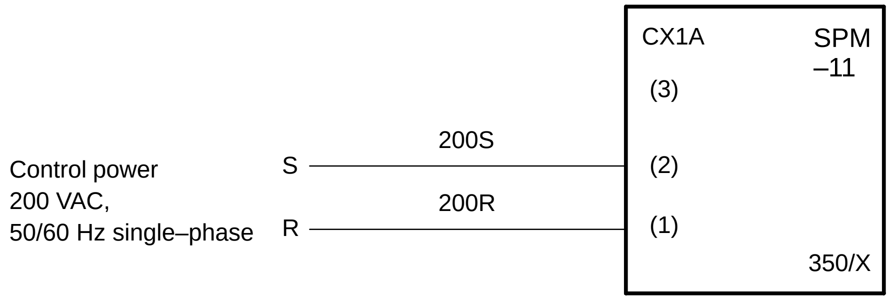


Cable specification: Two–conductor polyvinyl heavy–duty power cable (JIS C3312), conductor size of 1.25 mm^2 (50/0.18), PVC sheath 9.6 mm in diameter

Connector specification: AMP connector with receptacle housing 1–178128–3 and receptacle contact 1–175218–2

NOTE
Always connect cable K3 to the CX1A. If it is connected to the CX1B, fuses inside the unit may blow.

– Cable K3 for combining the PSMR and the SPM–11 (with a fan adapter)



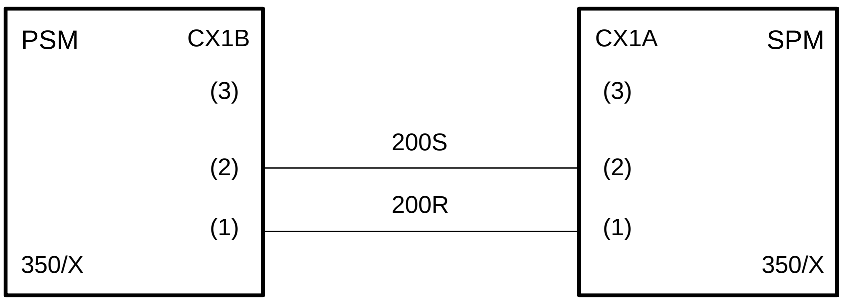
Cable specification: Two–conductor polyvinyl heavy–duty power cable (JIS C3312), conductor size of 1.25 mm^2 (50/0.18), PVC sheath 9.6 mm in diameter
Connector specification: AMP connector with receptacle housing 1–178128–3 and receptacle contact 1–175218–2

NOTE
If the PSMR is combined with the SPM–11 (with a fan adapter), the position at which cable K3 is connected differs from other combinations. See the connection diagram under "Power supply module (PSMR); connected with the SPM–11 (with a fan adapter)" in Section 9.2.1 for details.

(4) Detailed description of the connection of cable K4

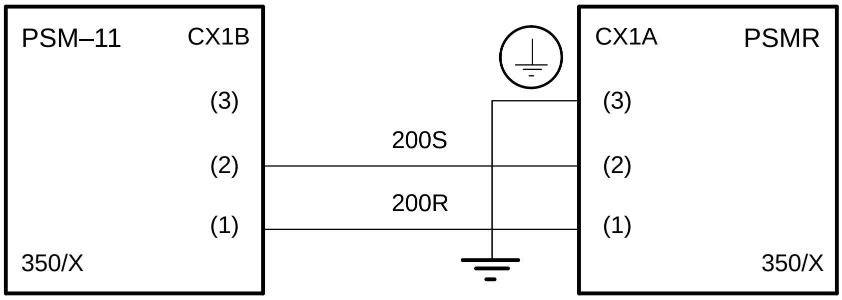
Cable K4 is used to supply power to the cooling fan of a module. Use this cable to connect the power supply module to a spindle amplifier module or servo amplifier module having a built–in cooling fan (see below).

Modules to be connected using cable K4
- SPM–11 (required only when TYPE 3 or a fan adapter is used)
- SPM–15 to SPM–30
- SPM–11HV (required only when a fan adapter is used)
- SPM–15HV to SPM–45HV
- SVM1–240 and SVM1–360



Cable specification: 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
Connector specification: AMP connector with receptacle housing 1–178128–3 and receptacle contact 1–175218–2

– Combination of the PSMR and the SPM–11 (with a fan adapter)



Cable specification: 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

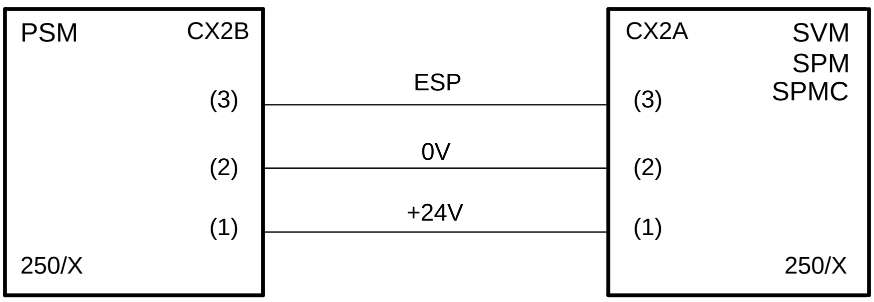
Connector specification: AMP connector with receptacle housing 1–178128–3 and receptacle contact 1–175218–2

NOTE

If the PSMR is combined with the SPM–11 (with a fan adapter), the position at which to connect cable K4 differs from the connection for other combinations. See the connection diagram under ”Power supply module (PSMR); connected with the SPM–11 (with a fan adapter)” in Section 9.2.1 for details.

(5) Detailed description of the connection of cable K5

Cable K5 is used to connect 24 VDC control power to each module.

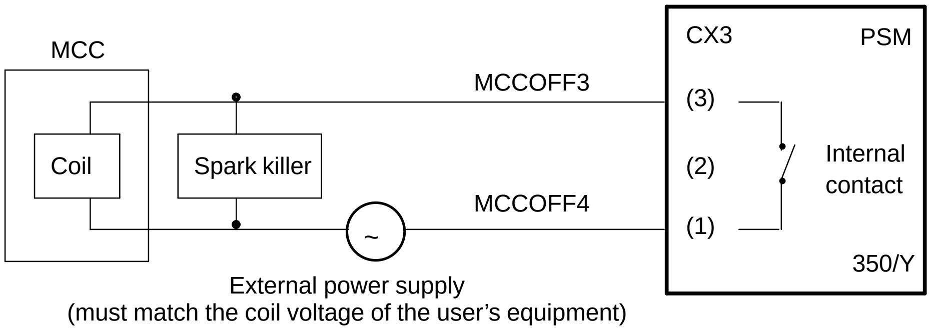


Cable specification: Three–conductor polyvinyl heavy–duty power cable (JIS C3312), conductor size of 1.25 mm^2 (50/0.18), PVC sheath 10.5 mm in diameter

Connector specification: AMP connector with receptacle housing 1–178288–3 and receptacle contact 1–175218–2

(6) Detailed description of the connection of cable K6

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



Cable specification: 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

Connector specification: AMP connector with receptacle housing 2–178128–3 and receptacle contact 1–175218–2

Internal–contact specification:

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

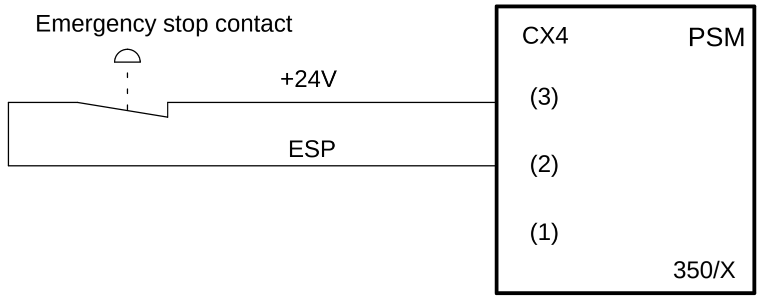
NOTE

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	0.22μF	22Ω
100 VAC to 240 VAC	0.1μF	220Ω

(7) Detailed description of the connection of cable K7

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

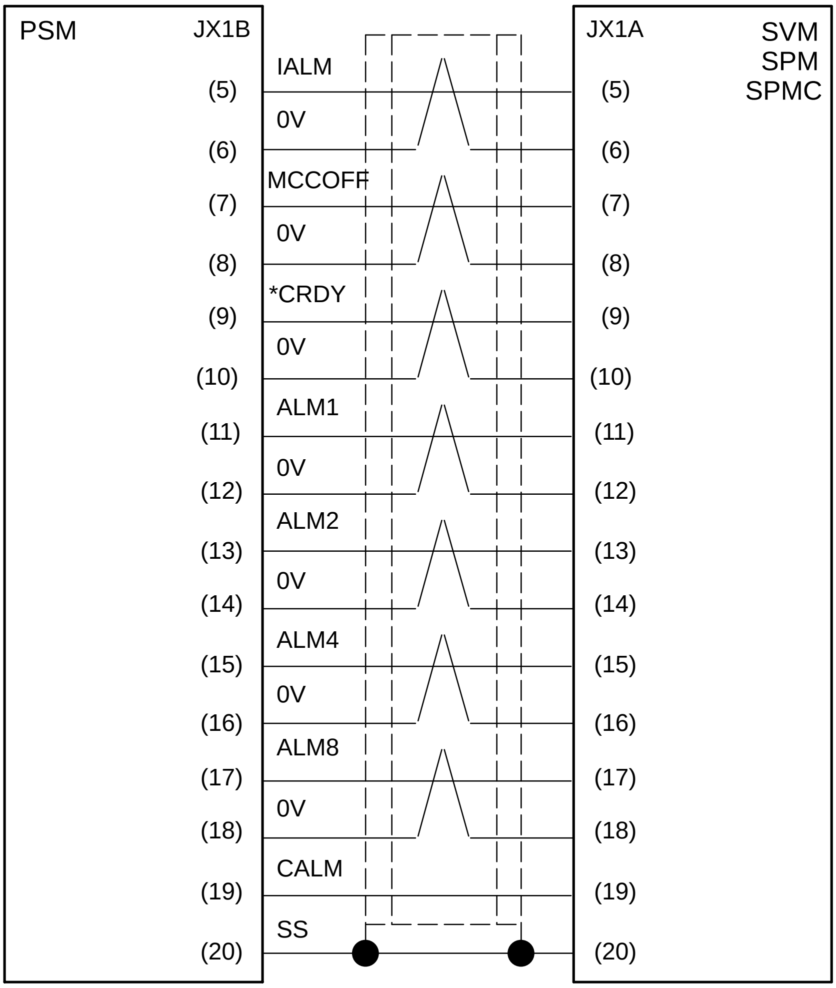


Cable specification: Two–conductor polyvinyl heavy–duty power cable (JIS C3312), conductor size of 1.25 mm^2 (50/0.18), PVC sheath 9.6 mm in diameter

Connector specification: AMP connector with receptacle housing 1–178128–3 and receptacle contact 1–175218–2

(8) Detailed description of the connection of cable K8

Cable K8 is used to exchange interface signals between modules.



Example of usable connector
(HONDA)
Connector PCR–E20FA
Housing PCR–V20LA

Example of usable connector
(HONDA)
Connector PCR–E20FA
Housing PCR–V20LA

Cable specification: 0.09 mm^2 twisted pair with common shielded

Recommended cable (wire only): A66L–0001–0284#10P

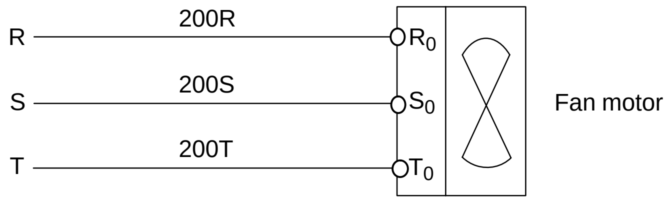
See Appendix C for details.

Pin arrangement of connectors JX1B and JX1A

9	*CRDY	10	0V	19	CALM	20	SS
7	MCCOFF	8	0V	17	ALM8	18	0V
5	IALM	6	0V	15	ALM4	16	0V
3		4		13	ALM2	14	0V
1		2		11	ALM1	12	0V

(9) Detailed description of the connection of cable K11

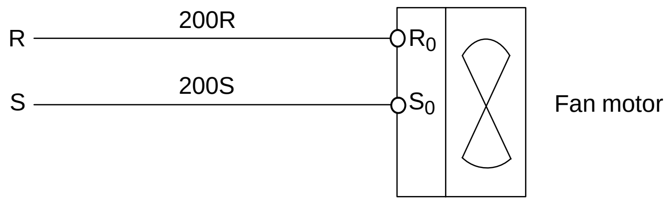
Power for fan motor
200V, three–phase



Cable specification: Use a three–conductor polyvinyl heavy–duty power cable (JIS C3312) having a conductor size of 2 mm^2 or larger.

Fan motor terminal screw: M4

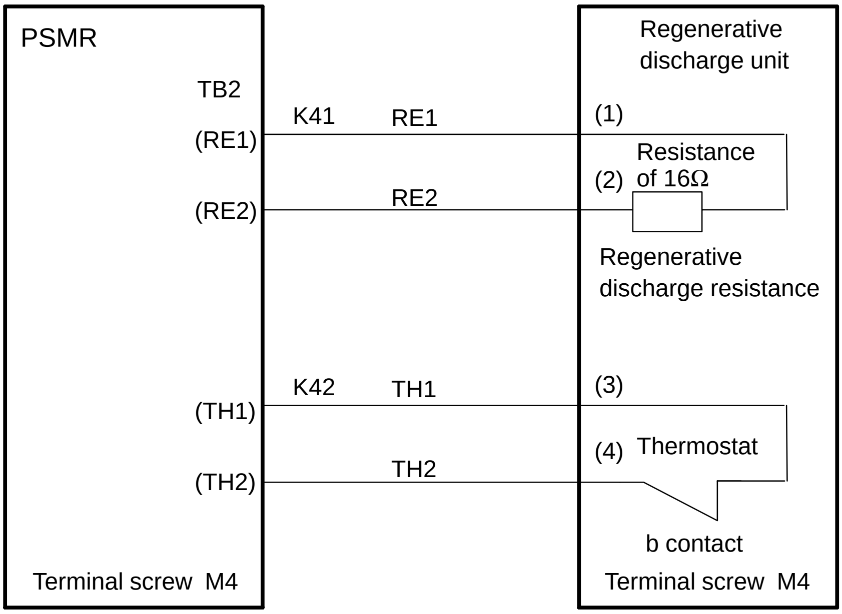
Power for cooling fan (for the PSM–45 and PSM–75HV only)
200V, three–phase



Cable specification: 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

(10) Detailed description of the connection of cables K41 (for regenerative discharge resistance), K42 (for thermostat), and K43 (for fan motor)

(a) A06B–6089–H510 and A06B–6089–H500

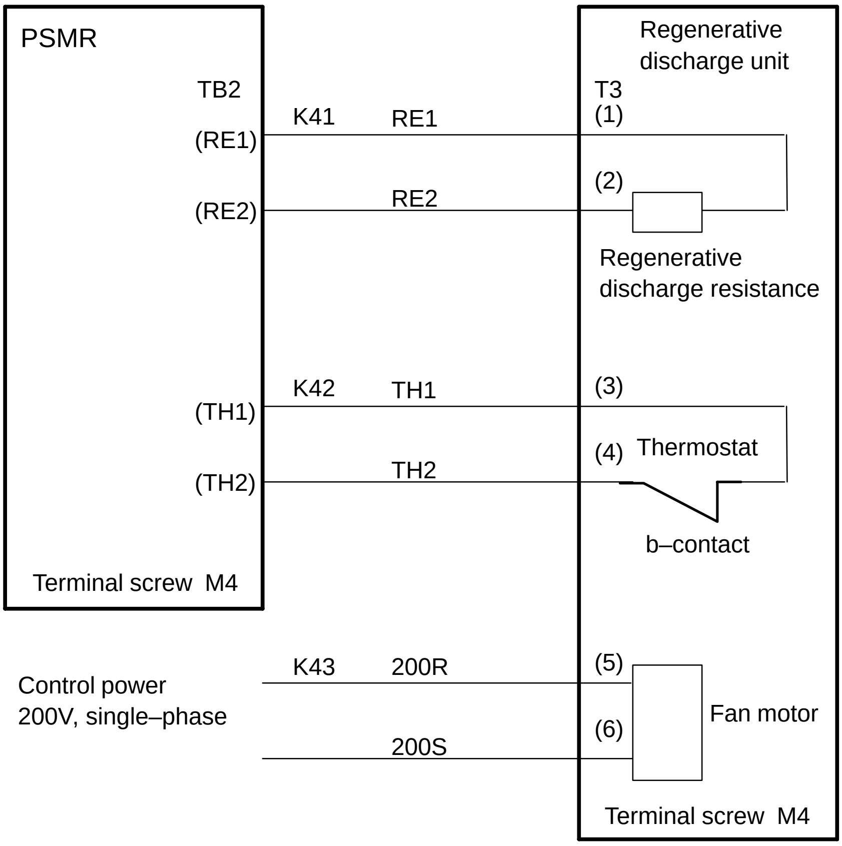


Cable specification

K41 : Two–conductor polyvinyl heavy–duty power cable, conductor size of 2.0 mm^2 (37/0.26), PVC sheath 10.5 mm in diameter

K42 : Two–conductor polyvinyl heavy–duty power cable, conductor size of 0.75 mm^2 (30/0.18), PVC sheath 8.8 mm in diameter

(b) A06B–6089–H711 to –H713



Cable specification

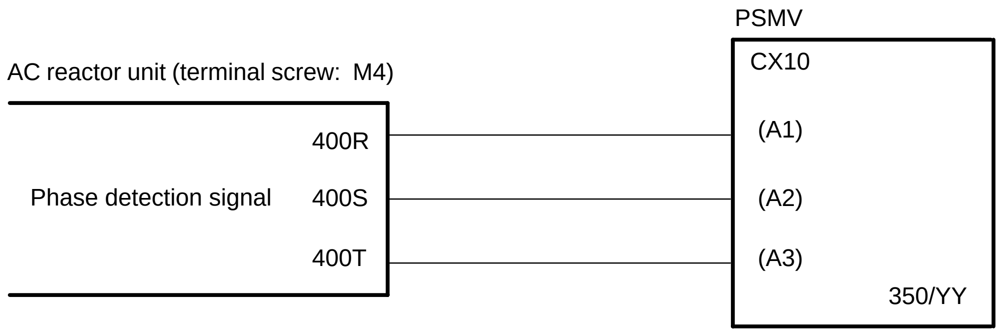
K41 : Two–conductor polyvinyl heavy–duty power cable (JIS C3312), conductor size of 2.0 mm^2 (37/0.26), PVC sheath 10.5 mm in diameter

K42 : Two–conductor polyvinyl heavy–duty power cable (JIS C3312), conductor size of 0.75 mm^2 (30/0.18), PVC sheath 8.8 mm in diameter

K43 : Two–conductor polyvinyl heavy–duty power cable (JIS C3312), conductor size of 2.0 mm^2 (37/0.28), PVC sheath 10.5 mm in diameter

(11) Detailed description of the connection of cable K57

Cable K57 is used to feed a phase detection signal to the PSMV–HV.



Cable specification: Three–conductor polyvinyl heavy–duty power cable (JIS C3312), conductor size of 1.25 mm^2 (50/0.18), PVC sheath 10.5 mm in diameter

Connector specification: AMP connector with receptacle housing 2–178129–6 and receptacle contact 1–175218–2

9.2.2 Servo Amplifier Module Connection Diagram

Three different types of interfaces (TYPE A, TYPE B, and FSSB) are available for servo amplifier modules. First determine which type of interface is used in the CNC unit, then select a servo amplifier module that matches the interface type.

Model/drawing number	TYPE A	TYPE B	FSSB
SVM1, SVM2 A06B–6079–H1□□ A06B–6079–H2□□	○	○	×
SVM3 A06B–6079–H3□□	○	×	×
SVM3 A06B–6080–H3□□	×	○	×
SVM1–HV, SVM2–HV A06B–6085–H□□□	○	○	×
SVM1, SVM2, SVM3 A06B–6096–H□□□	×	×	○
SVM1–HV, SVM2–HV A06B–6097–H□□□	×	×	○

○ : Supported × : Not supported

NOTE

1 The A06B–6079–H □□□ (excluding the SVM3) and the A06B–6085–H □□□ have two interfaces (TYPE A and TYPE B). Either can be selected, using interface switching connector S1/S2 on the front of the servo amplifier modules.
   TYPE A interface : S1
   TYPE B interface : S2

2 The drawing number of the SVM3 (three–axes servo amplifier module) varies according to the interface it supports.
   TYPE A interface : A06B–6079–H3□□
   TYPE B interface : A06B–6080–H3□□
   FSSB interface : A06B–6096–H3□□

For an explanation of how to connect each model, see the corresponding description, below.

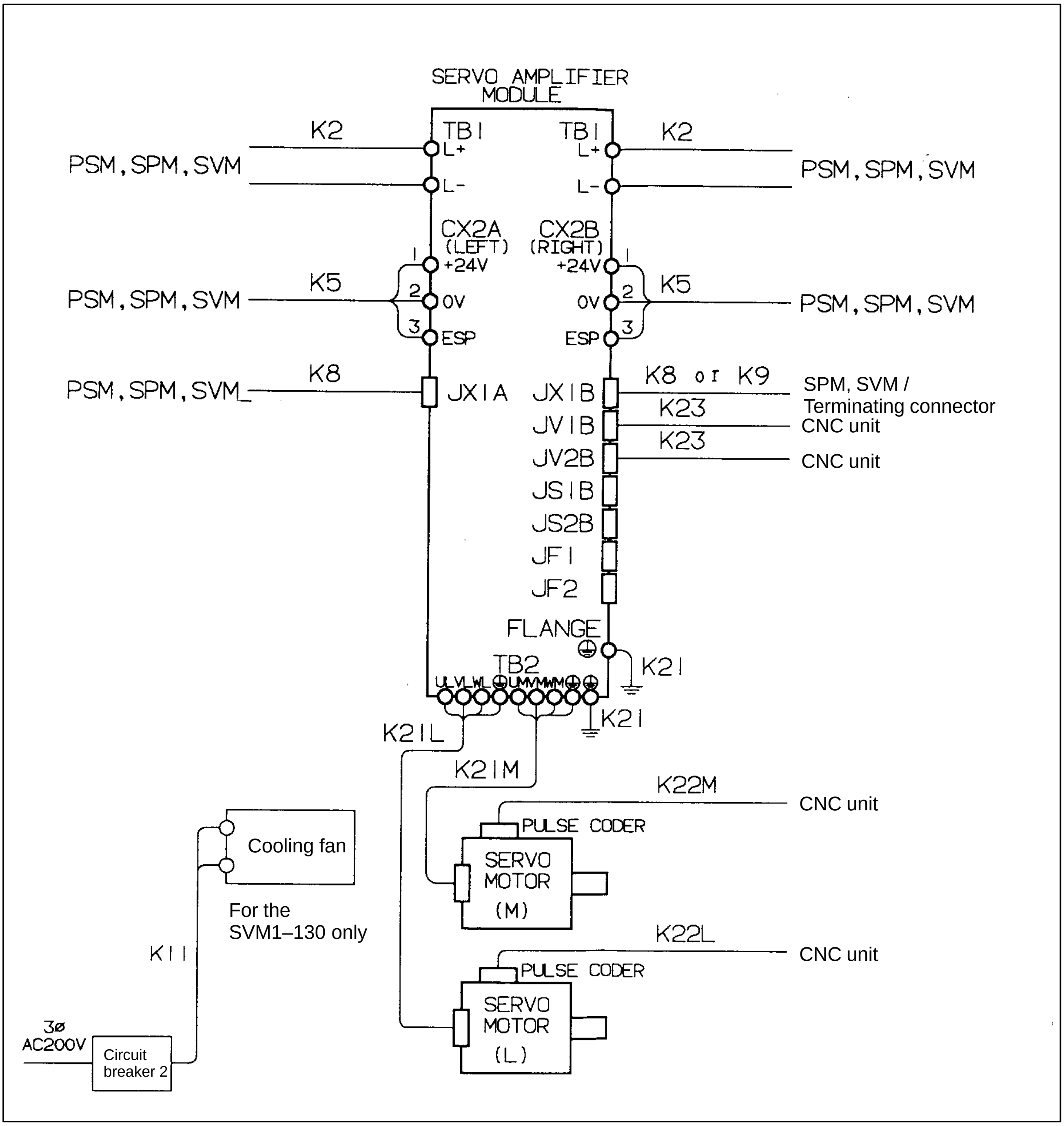
Model/drawing number	TYPE A	TYPE B	FSSB
SVM1 (excluding the SVM1–240 and –360) A06B–6079–H1□□	(A)	(B)	—
SVM1–240, SVM1–360 A06B–6079–H107, H108	(A), (D)	(B), (D)	—
SVM1–240 (two of which are used) A06B–6079–H107	(A), (E)	(B), (E)	
SVM2 A06B–6079–H2□□	(A)	(B)	—
SVM3 A06B–6079–H3□□	(A)	—	—
SVM3 A06B–6080–H3□□	—	(B)	—
SVM1–HV A06B–6085–H1□□	(A)	(B)	—
SVM2–HV A06B–6085–H2□□	(A)	(B)	—
SVM1 (excluding the SVM1–240 and –360) A06B–6096–H1□□	—	—	(C)
SVM1–240, SVM1–360 A06B–6096–H107, H108	—	—	(D)
SVM1–240 (two of which are used) A06B–6096–H107	—	—	(E)
SVM2 A06B–6096–H2□□	—	—	(C)
SVM3 A06B–6096–H3□□	—	—	(C)
SVM1–HV A06B–6097–H1□□	—	—	(C)
SVM2–HV A06B–6097–H2□□	—	—	(C)

NOTE

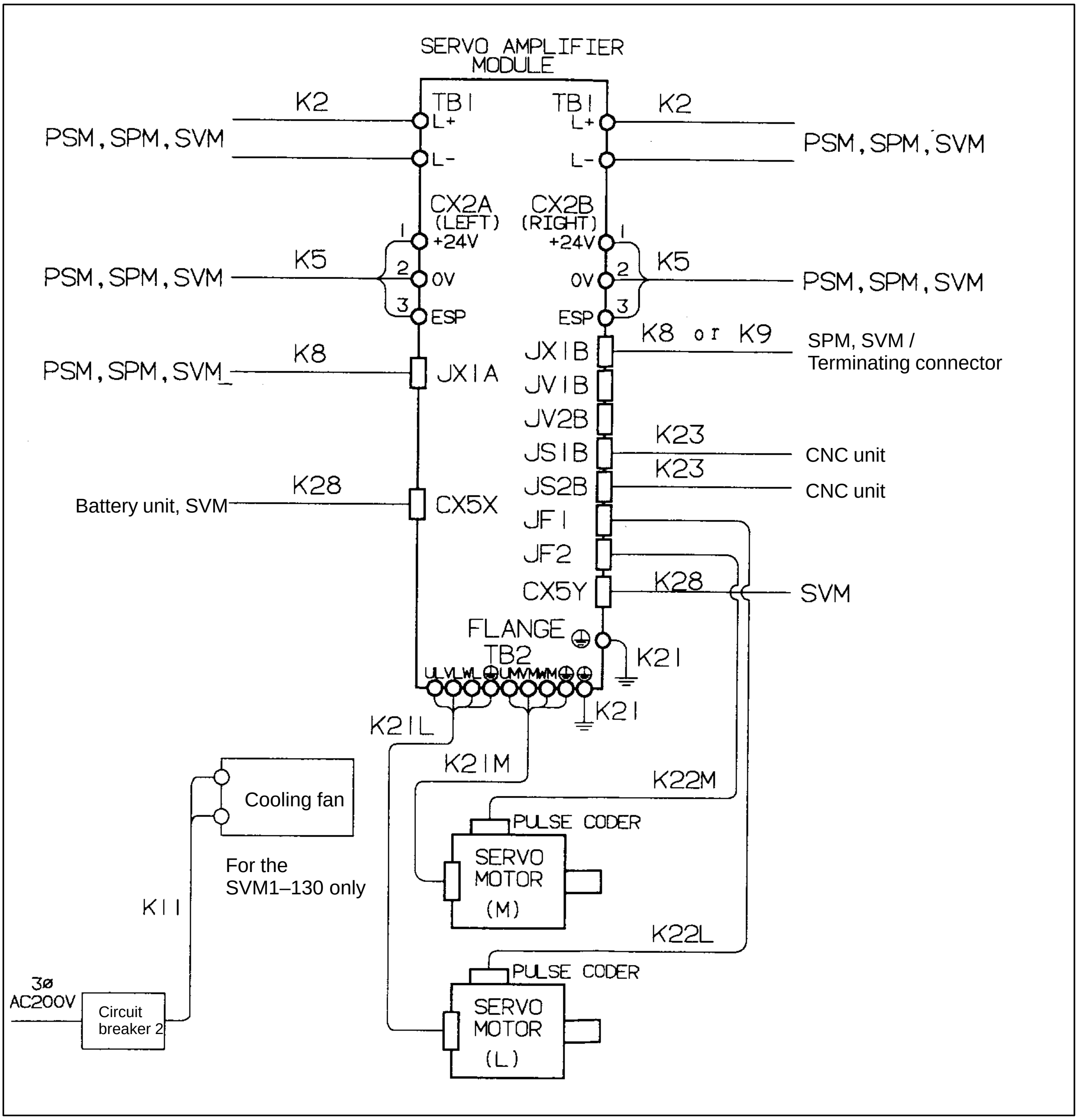
Items (A) to (E) are described on the following pages.

(A) TYPE A interface (Example: SVM2)
(B) TYPE B interface (Example: SVM2)
(C) FSSB interface (Example: SVM2)
(D) FSSB interface (Example: SVM1–240 and –360)
(E) FSSB interface (Example: Two SVM1–240 units are used.)

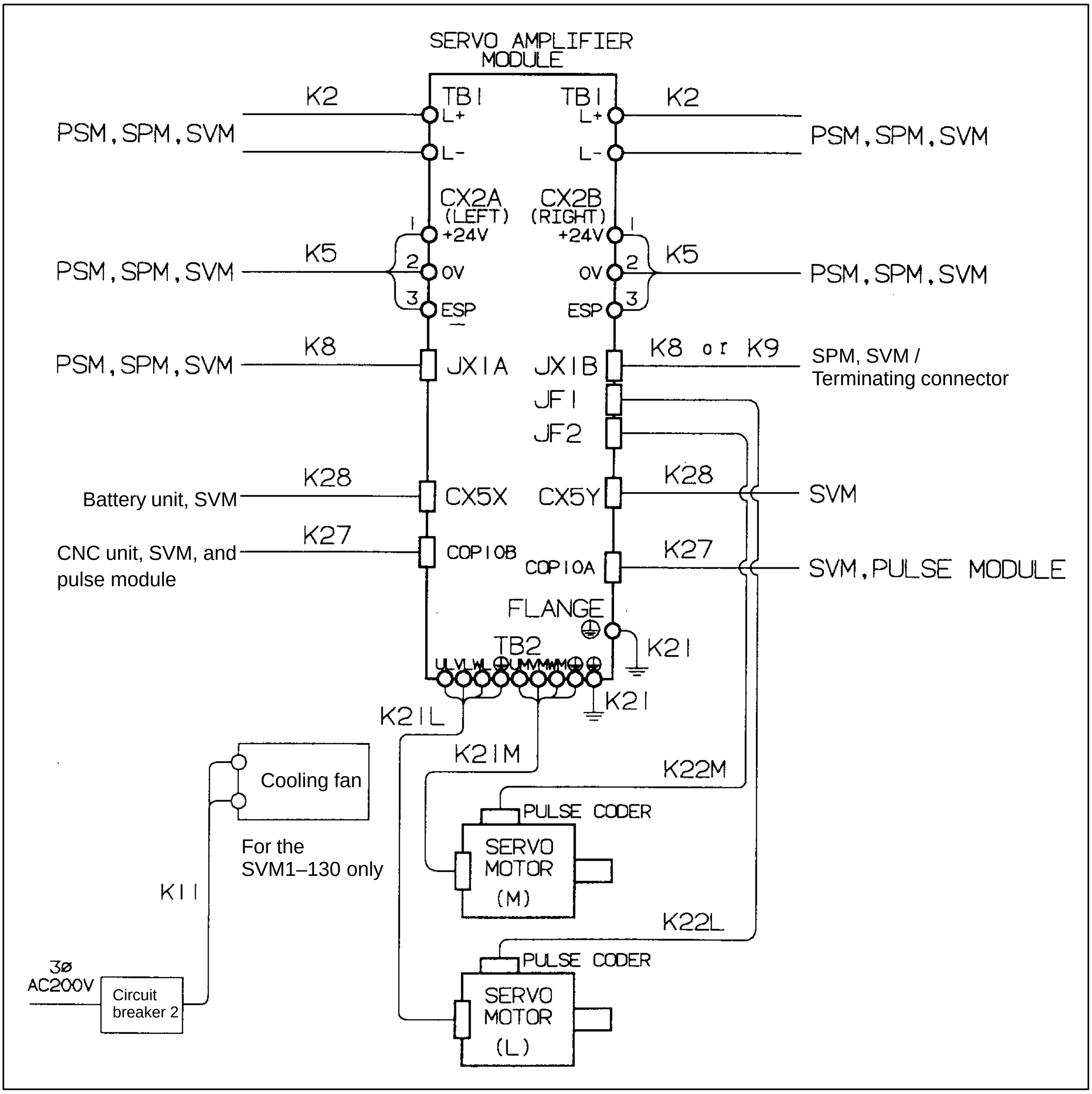
(A) TYPE A interface (Example: SVM2)



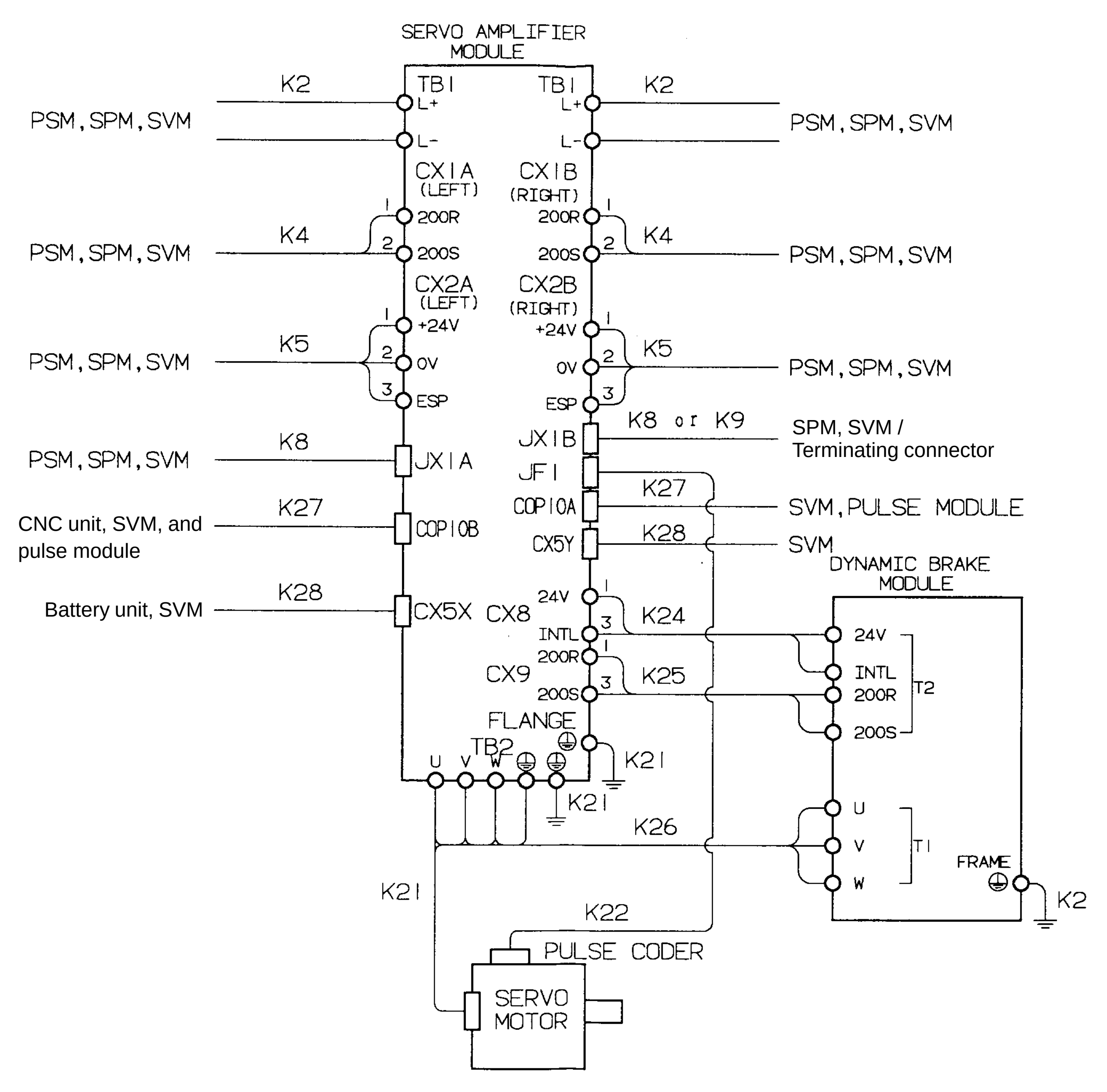
(B) TYPE B interface (Example: SVM2)



(C) FSSB interface (Example: SVM2)

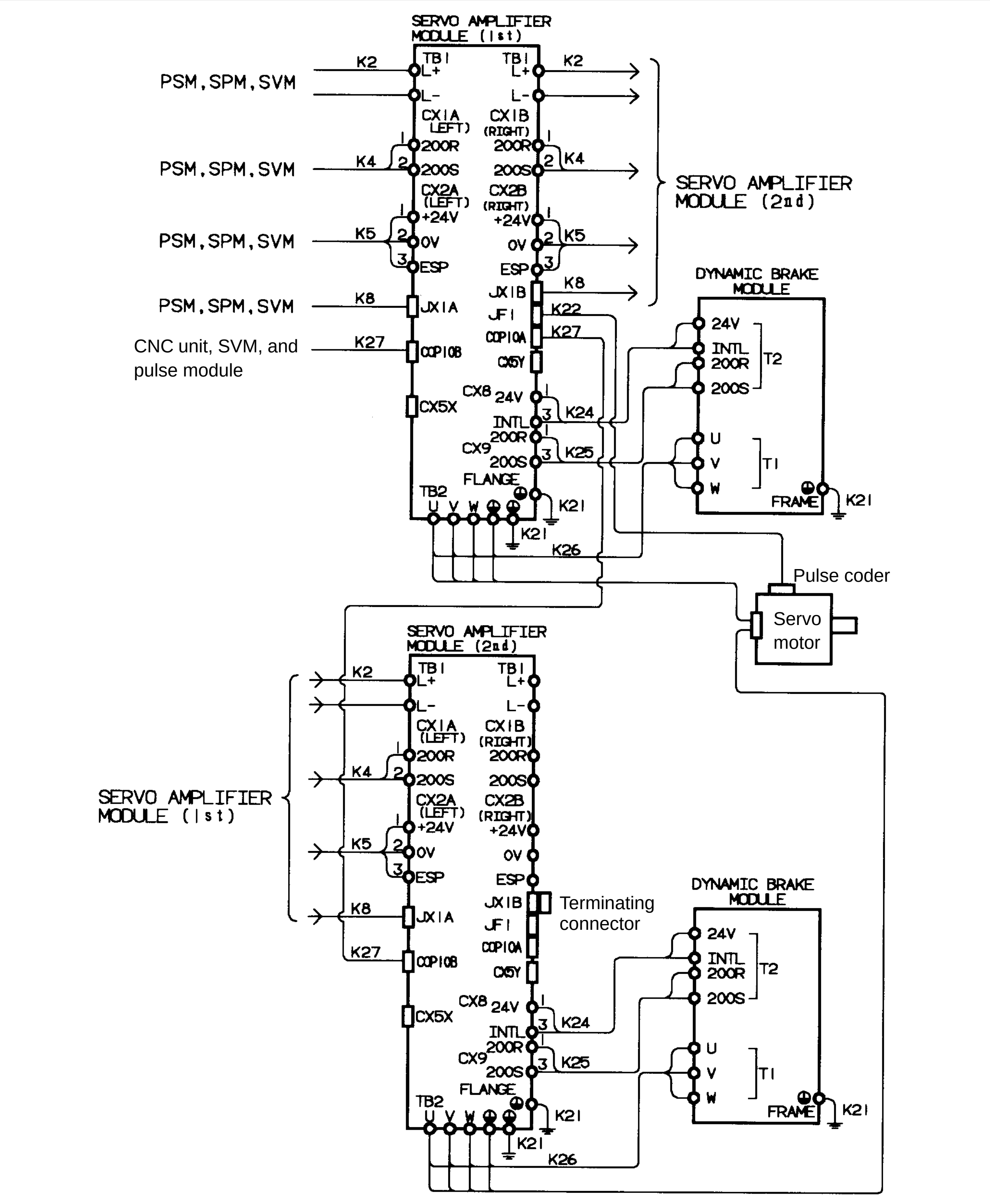


(D) FSSB interface (Example: SVM1–240 and SVM1–360)



NOTE
Each of the SVM1–240 and SVM1–360 requires one dynamic brake module.

(E) FSSB interface (Example: Two SVM1–240 units are used.)



NOTE
Each SVM may require one PSM depending on the service condition of the motor.

(1) Detailed description of the connection of cable K2

See 9.2.1 (2).

(2) Detailed description of the connection of cable K5

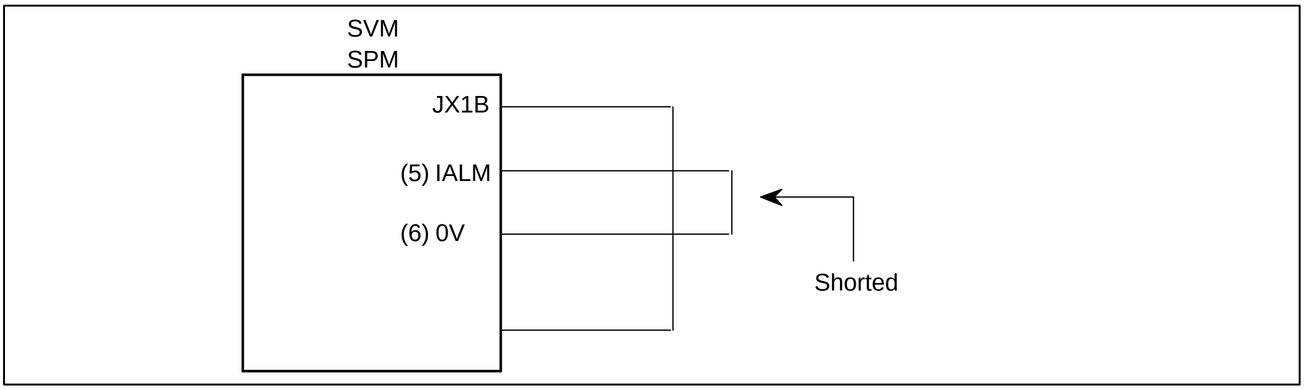
See 9.2.1 (5).

(3) Detailed description of the connection of cable K8

See 9.2.1 (8).

(4) Detailed description of the connection of cable K9

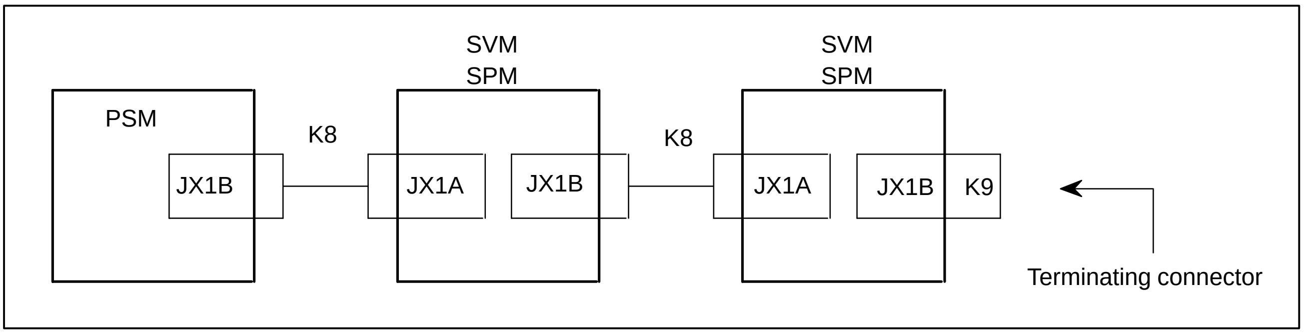
Cable K9 is a terminating connector. Its connection is shown below.



Pin arrangement of terminating connector K9

		10				20	
09		08		19		18	
07		06	0V	17		16	
05	IALM	04		15		14	
03		02		13		12	
01				11			

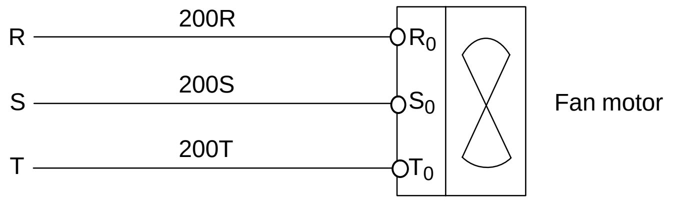
[Terminating connector K9]
Terminating connector K9 is shipped together with the PSM. K9 must be inserted into the SVM/SPM at JX1B when the unit is installed.



NOTE
1 Alarm signals are sent from the PSM to SVM/SPM units connected in series using cable K8. Terminating connector K9 must be attached to the K8 cable connector of the SVM/SPM at the farthest end. If no terminating connector is attached, the magnetic contactor (MCC) outside these units cannot be turned on, so that the motors can not be driven.
2 Terminating connector K9 is shipped together with the PSM; it does not have to be ordered separately. When cabling the units, insert the terminating connector into connector JX1B of the SVM/SPM at the farthest end.

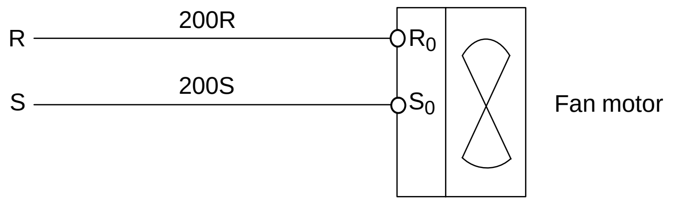
(5) Detailed description of the connection of cable K11

Power for fan motor
200V, three–phase



Cable specification: Use a three–conductor polyvinyl heavy–duty power cable (JIS C3312) having a conductor size of 2 mm^2 or larger.
Fan motor terminal screw: M4

Power for cooling fan (for the SVM–130 only)
200V, single–phase

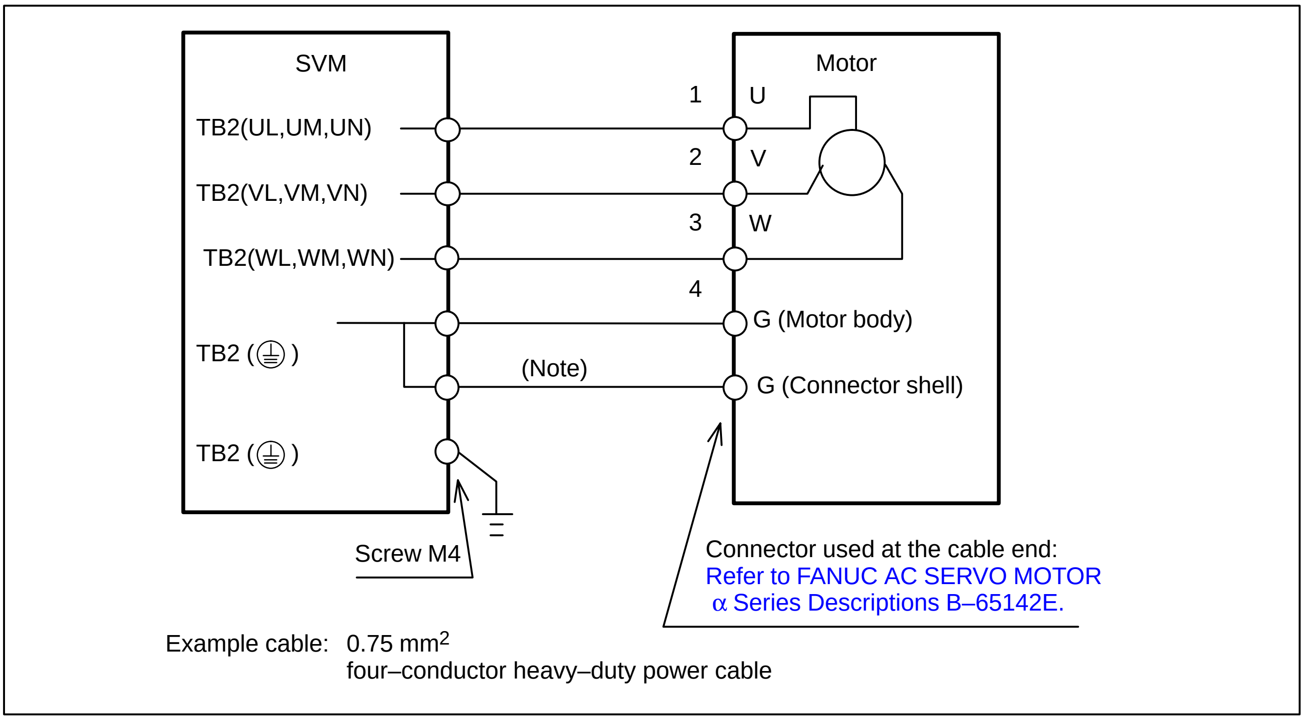


Cable specification: Two–conductor polyvinyl heavy–duty power cable (JIS C3312), conductor size of 1.25 mm^2 (50/0.18), PVC sheath 9.6 mm in diameter
Applicable receptacle terminal: 6.3 mm (0.250 in.) series

(6) Detailed description of the connection of cable K11

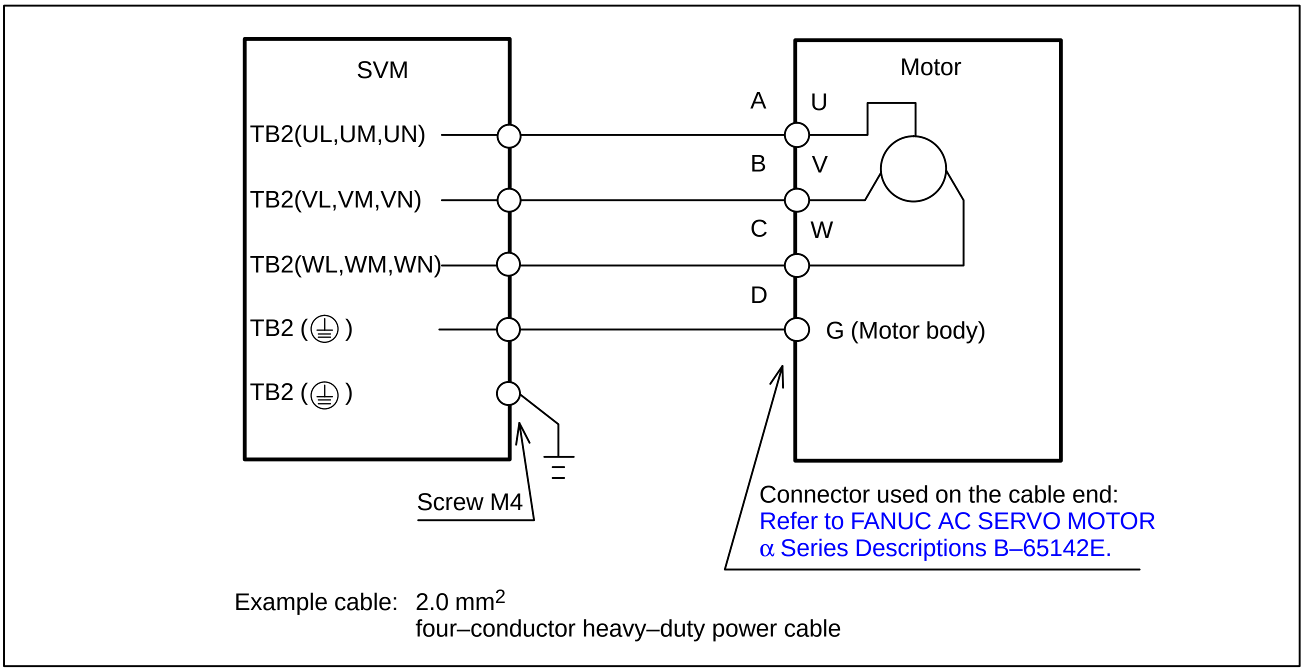
Note that the type of the cable K21 connector on the motor side varies with the motor model.
The conductors of cable K21 must be thick enough to carry the rated current of the corresponding motor. To make the connection waterproof, select a connector diameter that matches the cable clamp. To make it comply with the CE marking standard, observe the related cautions. (Refer to the FANUC AC SERVO MOTOR α Series Descriptions B–65142E for details).
For an explanation of how to connect a model having a brake, refer also to the FANUC AC SERVO MOTOR α Series Descriptions B–65142E.

(a) Models α1/3000, α2/2000, α2/3000, αM2/3000, and αM2.5/3000

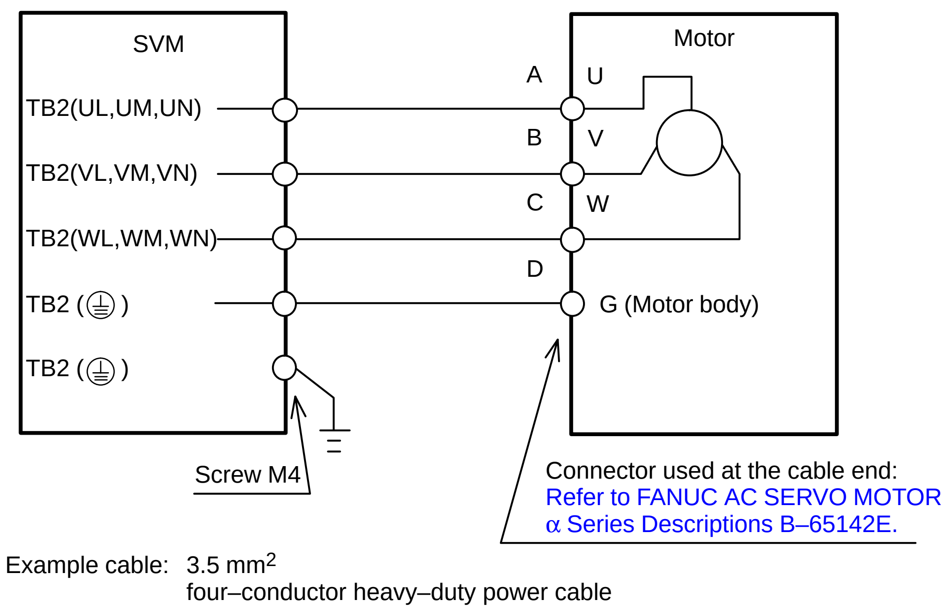


NOTE
To satisfy the CE marking requirements, it is necessary to ground the connector shell at the cable end. In this case, the specification of the connector will be different. Refer to ”Requirements for Compliance with the IEC34 Standards” and ”Connectors” in the FANUC AC SERVO MOTOR α Series Descriptions B–65142E for details.

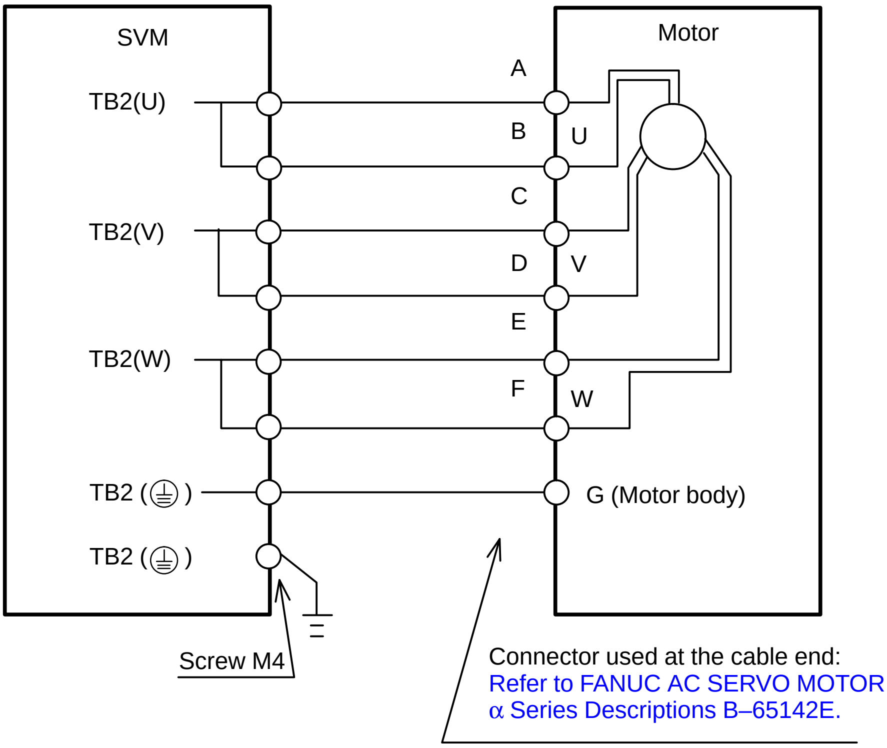
(b) Models α3/3000, α6/2000, α6/3000, αC3/2000, αC6/2000, αM6/3000, αM9/3000, αL6/3000, and αL9/3000



(c) Models α12/2000, α12/3000, α22/1500, α22/2000, α30/1200, αC12/2000, and αC22/1500



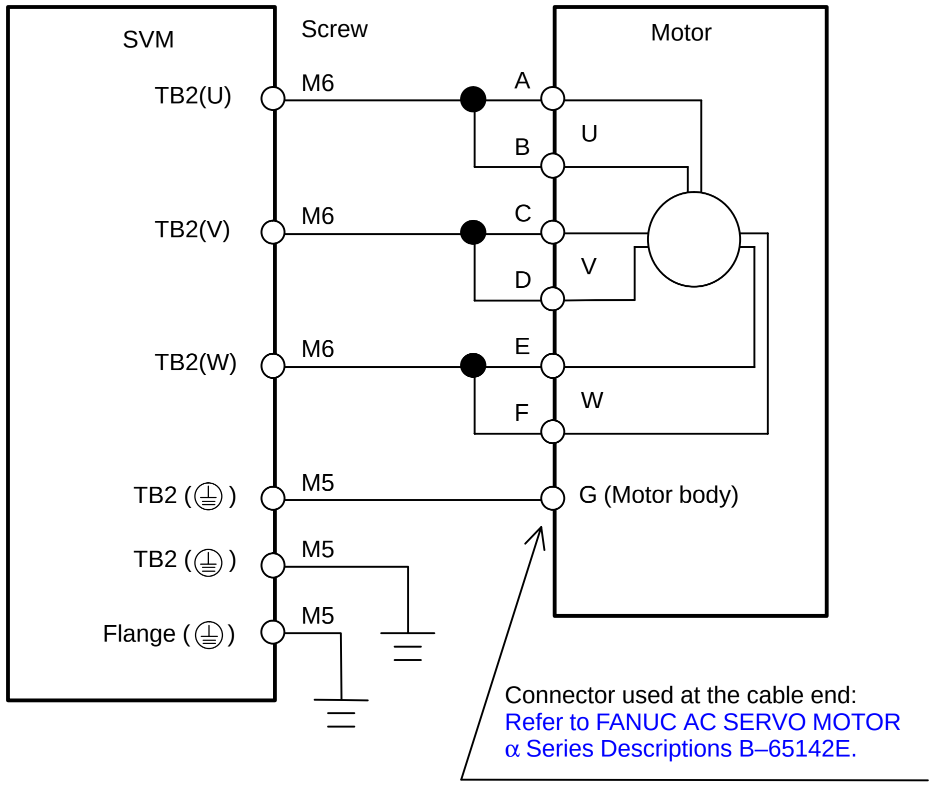
(d) Models α22/3000, α30/2000, α30/3000, α40/2000, α40/2000 with fan, αM22/3000, αM30/3000, αM40/3000 (with SVM1–130 used), αM40/3000 with fan (with SVM1–130 in use), αL25/3000, and αL50/2000



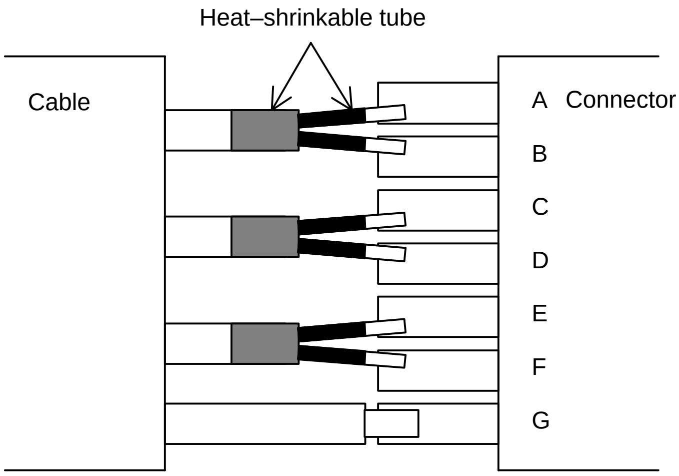
Example cable: 3.5 mm² × 2 (7 mm²) or 8 mm²
(PE (ground)) complex seven–conductor heavy–duty power cable

NOTE
Applicable crimp terminal: 8–4S

(e) Models αM40/3000 (with SMV1–240 and –360 used) and αM40/3000 with a fan (with the SVM1–240 and –360 used)



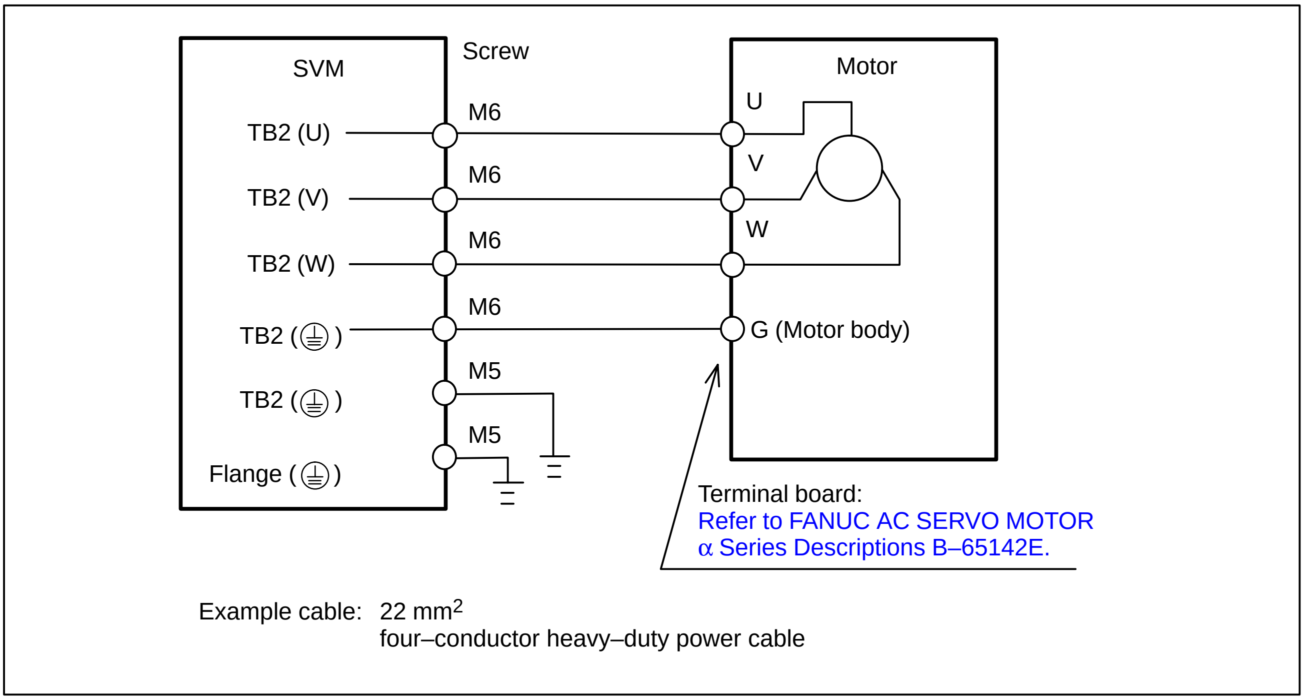
Example of a cable: 10 mm^2 × 4



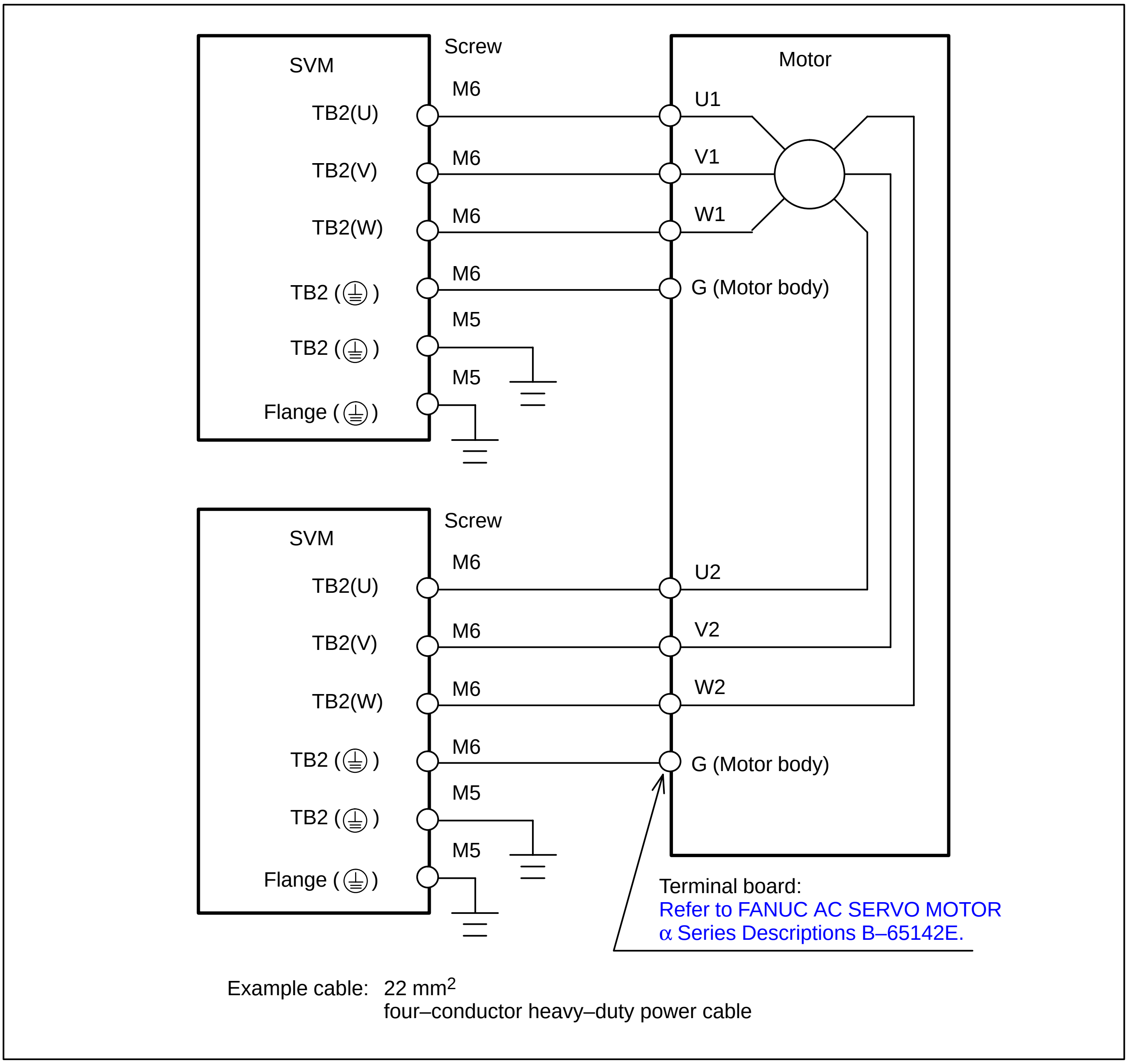
Divide the strands into two groups, and cover each strand group with heat–shrinkable tube. Also cover the branching portion of the strands with heat–shrinkable tube

Cover all solder joints on the connector with nylon tube..

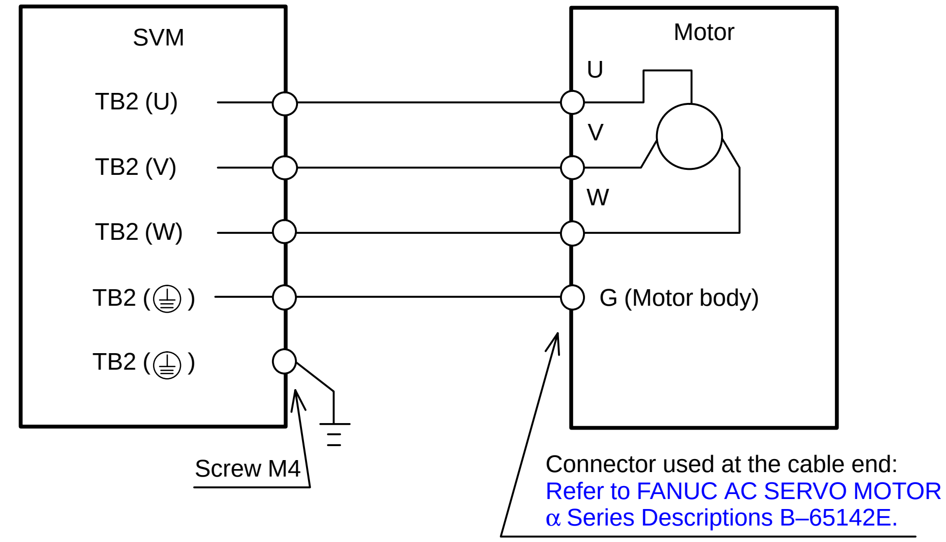
(f) Models α65/2000, α100/2000, and α150/2000



(g) Models α300/1200 and α400/1200



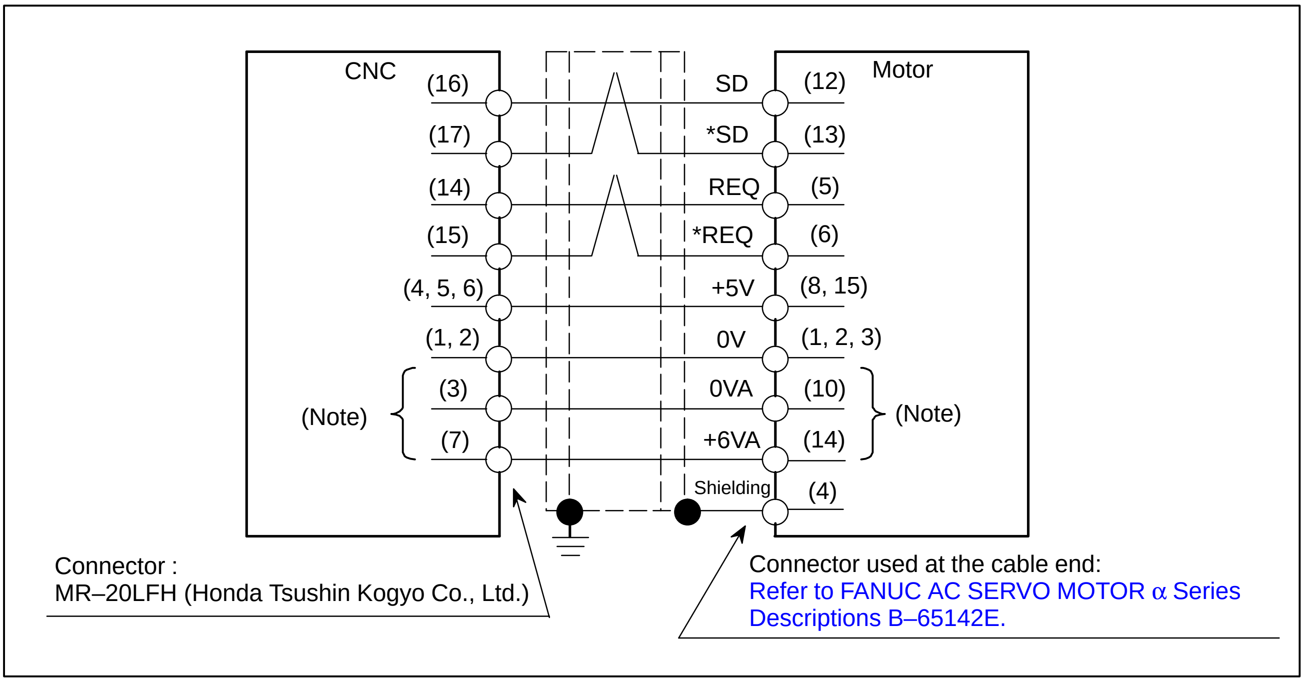
(h) Models α3/3000HV, α6/3000HV, α12/3000HV, α22/3000HV, α30/3000HV, αM6/3000HV, αM9/3000HV, αM22/3000HV, and αM30/3000HV



Example cable: 3.5 mm²
four–conductor heavy–duty power cable

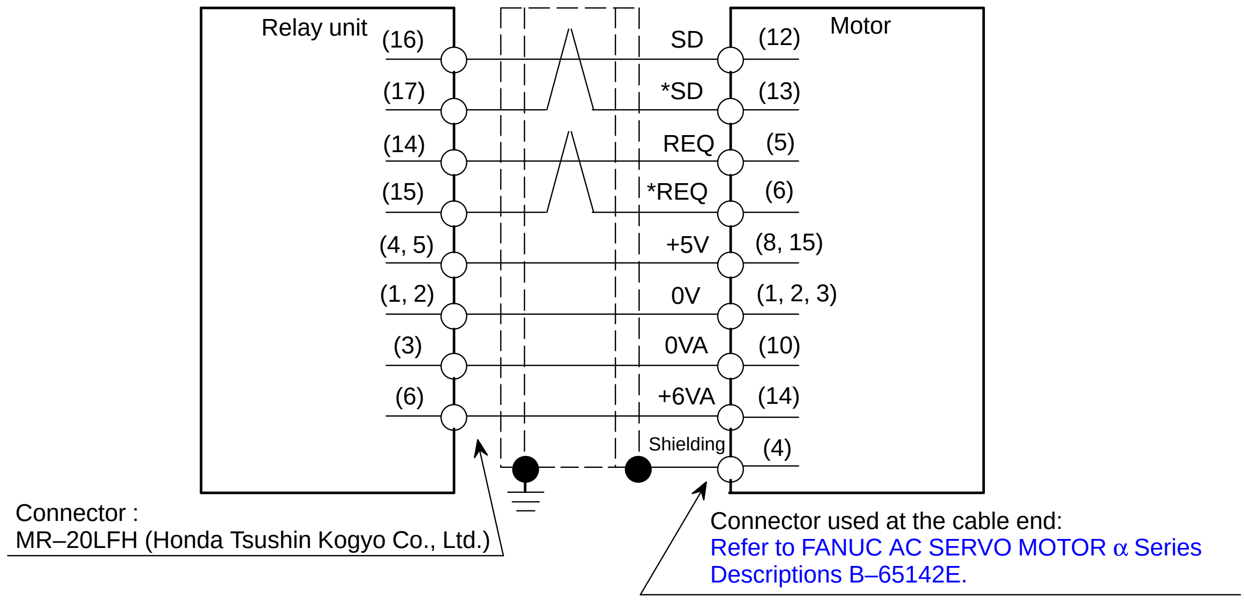
(7) Detailed description of the connection of cable K22
Connection with the FS0–C or FS15–A

(a) Models α1/3000, α2/2000, α2/3000, αM2/3000, and αM2.5/3000



NOTE

For the incremental pulse coder, it is not necessary to connect pins 3 and 7 of the connector on the CNC side to pins 10 and 14 of the connector on the motor side. No problem will result if they are connected, however. So, a cable for the absolute pulse coder can also be used for the incremental pulse coder.



NOTE

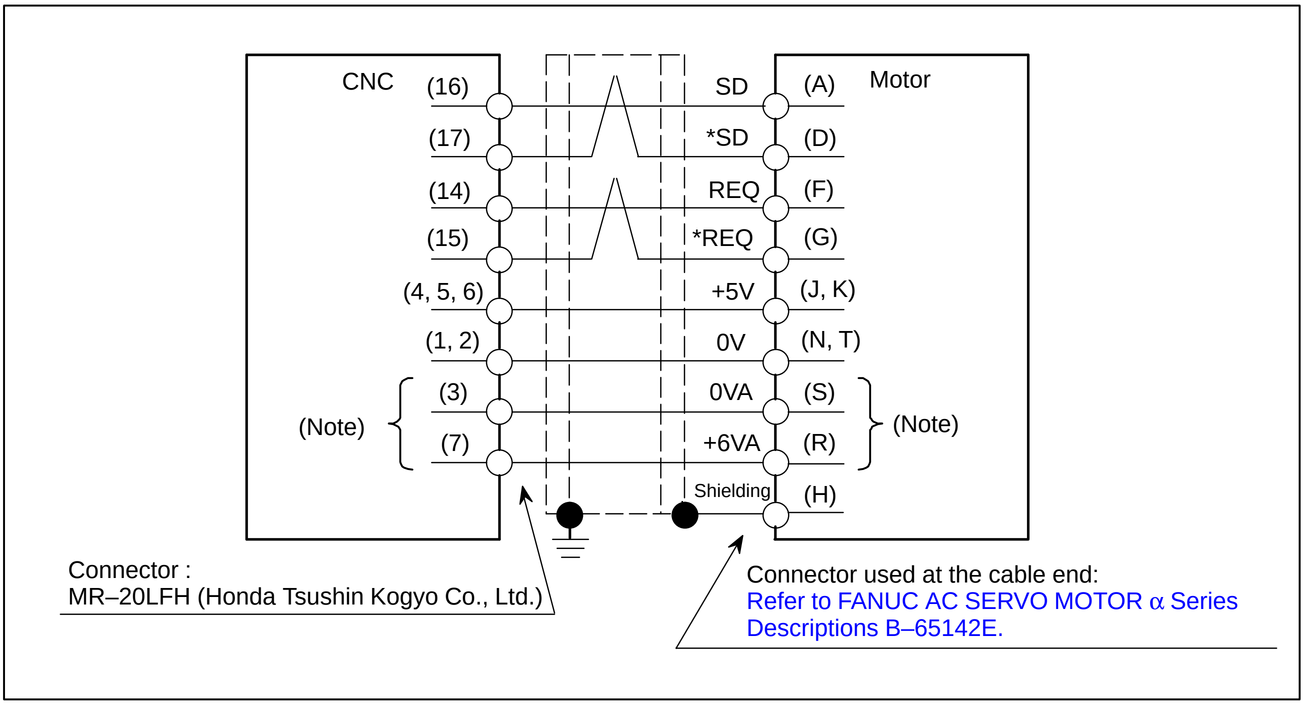
Cables used in common for (a) and (b) : +5V, 0V...0.5 mm^2 or larger × 2 (for length of 14 m or less)

: +6VA, 0VA...0.5 mm^2 or larger

: SD, *SD, REQ, *REQ...twisted pair 0.18 mm^2 or larger

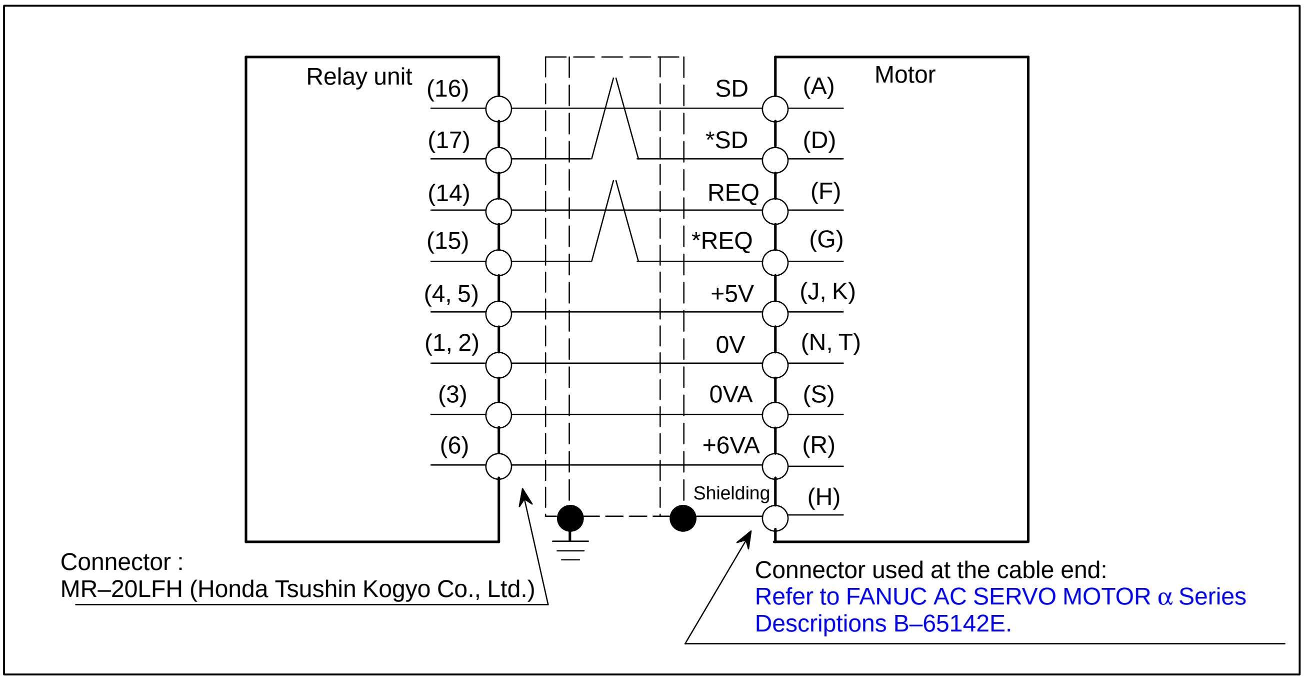
If the cable is 14 m or longer, keep the electrical resistance across each of the 0V and +5V lines to within 0.5Ω .

(b) Models α3/3000 to α40/2000, α65/2000 to α150/2000, αC3/3000 to αC22/1500, αM6/3000 to αM40/3000, and αL6/3000 to αL50/2000



NOTE

For the incremental pulse coder, it is not necessary to connect pins 3 and 7 of the connector on the CNC side to pins R and S of the connector on the motor side. No problem will result if they are connected, however. So, a cable for the absolute pulse coder can also be used for the incremental pulse coder.



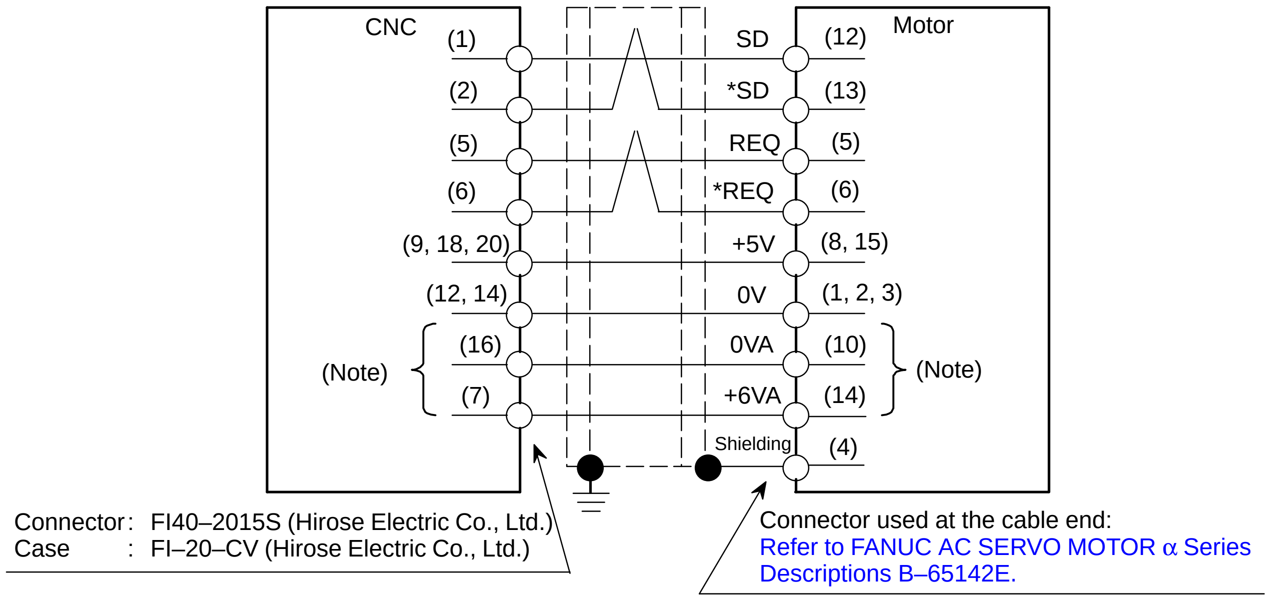
NOTE

Cables used in common for (a) and (b) : +5V, 0V...0.5 mm^2 or larger $\times$ 2 (for length of 14 m or less)
: +6VA, 0VA...0.5 mm^2 or larger
: SD, *SD, REQ, *REQ...twisted pair 0.18 mm^2 or larger

If the cable is 14 m or longer, keep the electrical resistance across each of the 0V and +5V lines to within 0.5Ω .

TYPE A interface

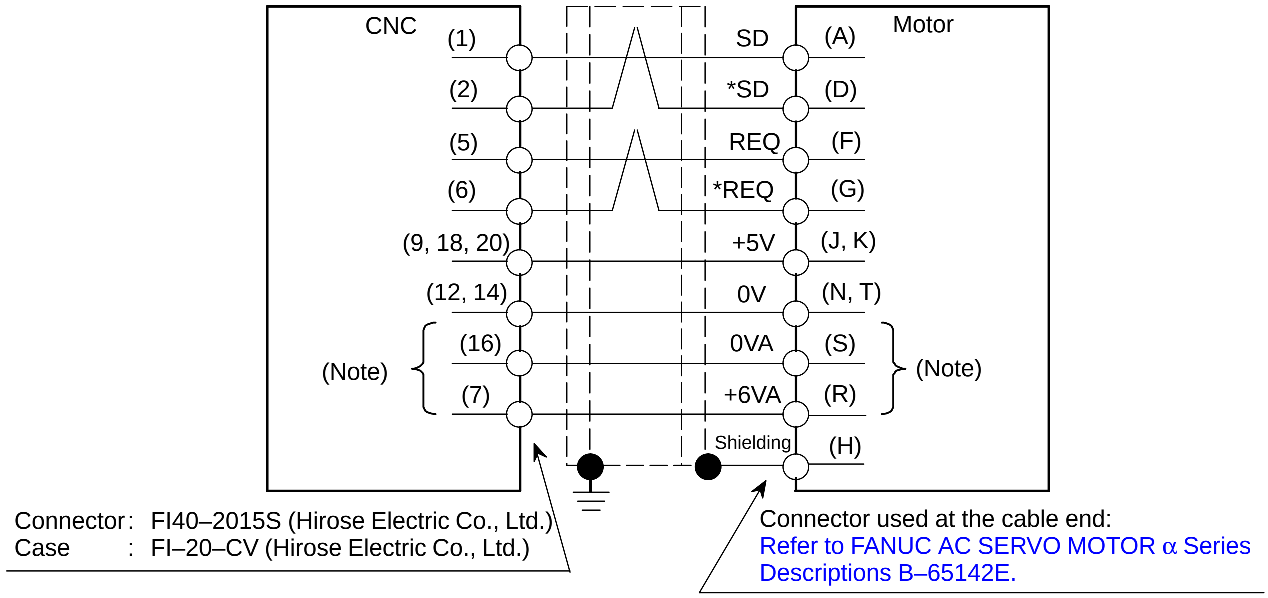
(a) Models α1/3000, α2/2000, α2/3000, αM2/3000, and αM2.5/3000



NOTE

For the incremental pulse coder, it is not necessary to connect pins 7 and 16 of the connector on the CNC side to pins 10 and 14 of the connector on the motor side. No problem will result if they are connected, however. So, a cable for the absolute pulse coder can also be used for the incremental pulse coder.

(b) Models α3/3000 to α40/2000, α65/2000 to α150/2000, α300/1200 to α400/1200, αC3/3000 to αC22/1500, αM6/3000 to αM40/3000, and αL6/3000 to αL50/2000



NOTE

For the incremental pulse coder, it is not necessary to connect pins 7 and 16 of the connector on the CNC side to pins R and S of the connector on the motor side. No problem will result if they are connected, however. So, a cable for the absolute pulse coder can also be used for the incremental pulse coder.

NOTE

Cables used in common for (a) and (b) : +5V, 0V...0.5 mm^2 or larger × 2 (for length of 14 m or less)

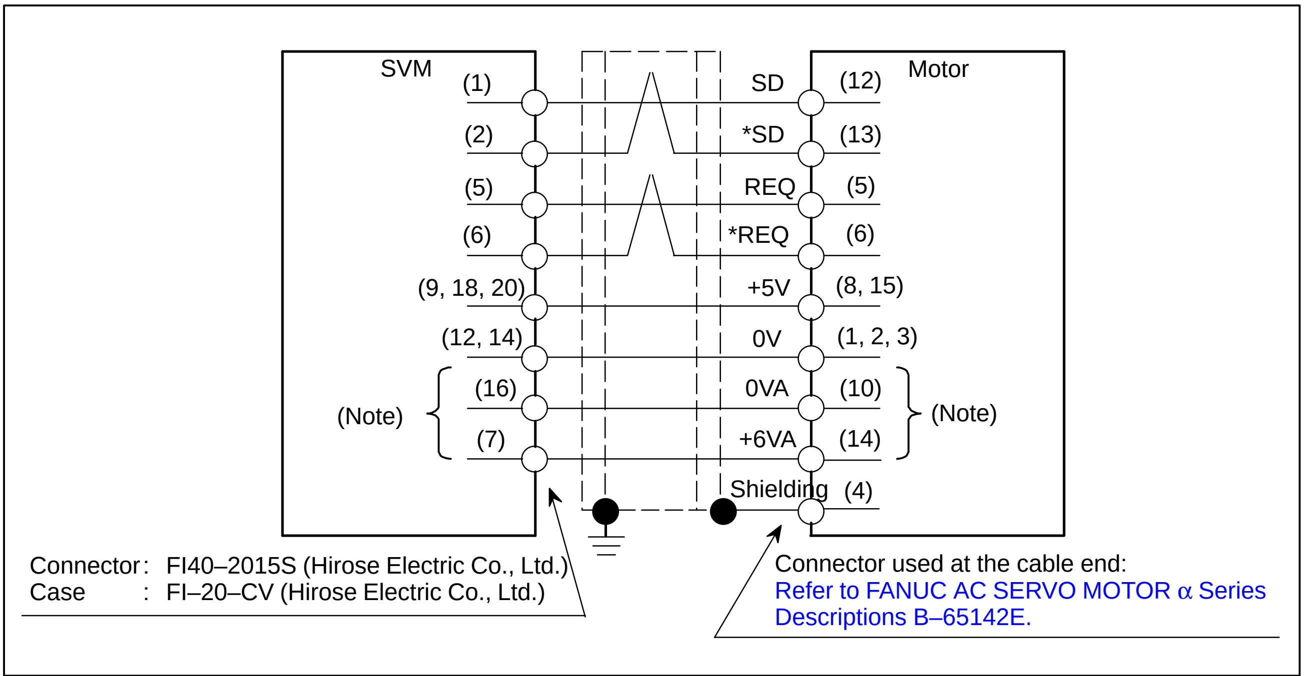
: +6VA, 0VA...0.5 mm^2 or larger

: SD, *SD, REQ, *REQ...twisted pair 0.18 mm^2 or larger

If the cable is 14 m or longer, keep the electrical resistance across each of the 0V and +5V lines to within 0.5Ω .

TYPE B and FSSB interfaces

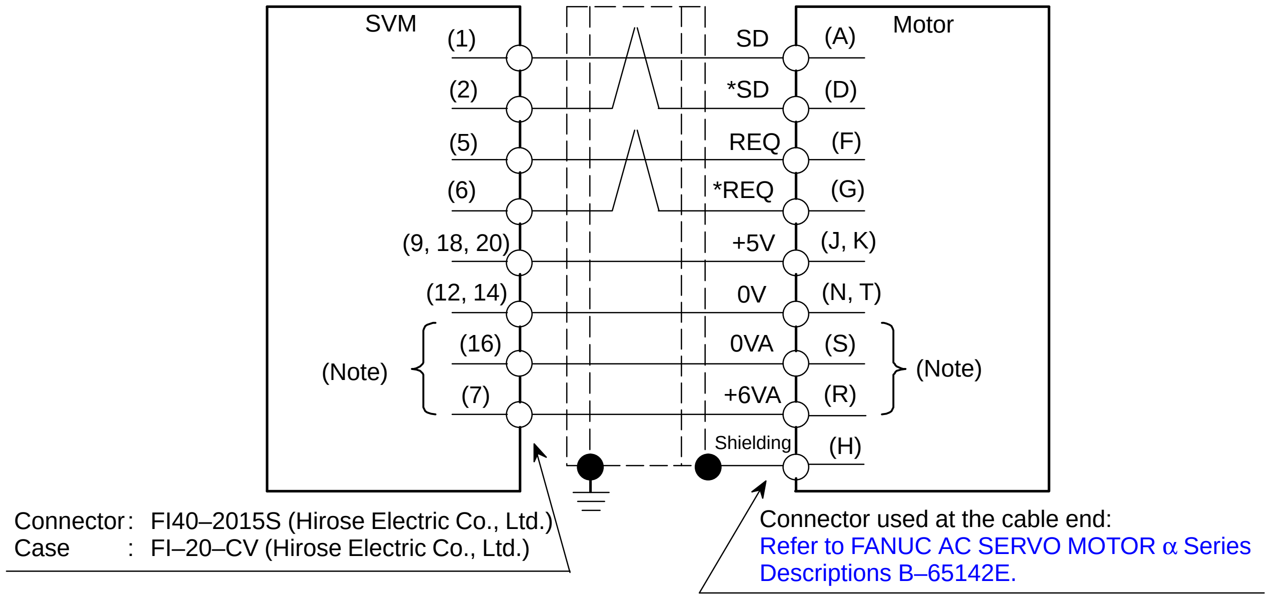
(a) Models α1/3000, α2/2000, α2/3000, αM2/3000, and αM2.5/3000



NOTE

For the incremental pulse coder, it is not necessary to connect pins 7 and 16 of the connector on the CNC side to pins 10 and 14 of the connector on the motor side. No problem will result if they are connected, however. So, a cable for the absolute pulse coder can also be used for the incremental pulse coder.

(b) Models α3/3000 to α40/2000, α65/2000 to α150/2000, α300/1200 to α400/1200, αC3/2000 to αC22/1500, αM6/3000 to αM40/3000, and αL6/3000 to αL50/2000



NOTE

For the incremental pulse coder, it is not necessary to connect pins 7 and 16 of the connector on the CNC side to pins R and S of the connector on the motor side. No problem will result if they are connected, however. So, a cable for the absolute pulse coder can also be used for the incremental pulse coder.

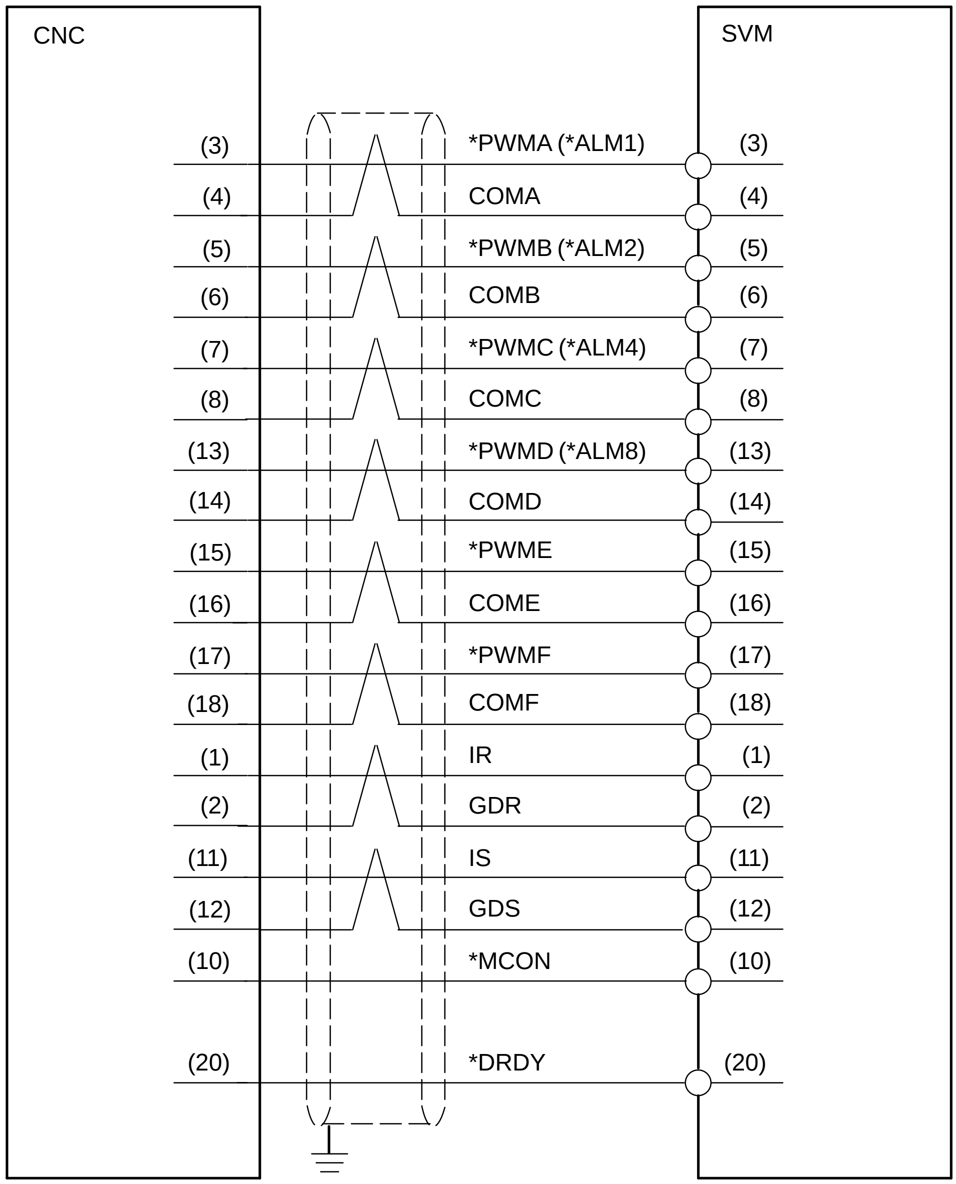
NOTE

Cables used in common for (a) and (b) : +5V, 0V...0.5 mm^2 or larger × 2
(for length of 14 m or less)
: +6VA, 0VA...0.5 mm^2 or larger
: SD, *SD, REQ, *REQ...twisted pair 0.18 mm^2 or larger

If the cable is 14 m or longer, keep the electrical resistance across each of the 0V and +5V lines to within 0.5Ω.

(8) Detailed description of the connection of cable K23

(a) TYPE A interface (for other than the FS–0C or FS–15A)

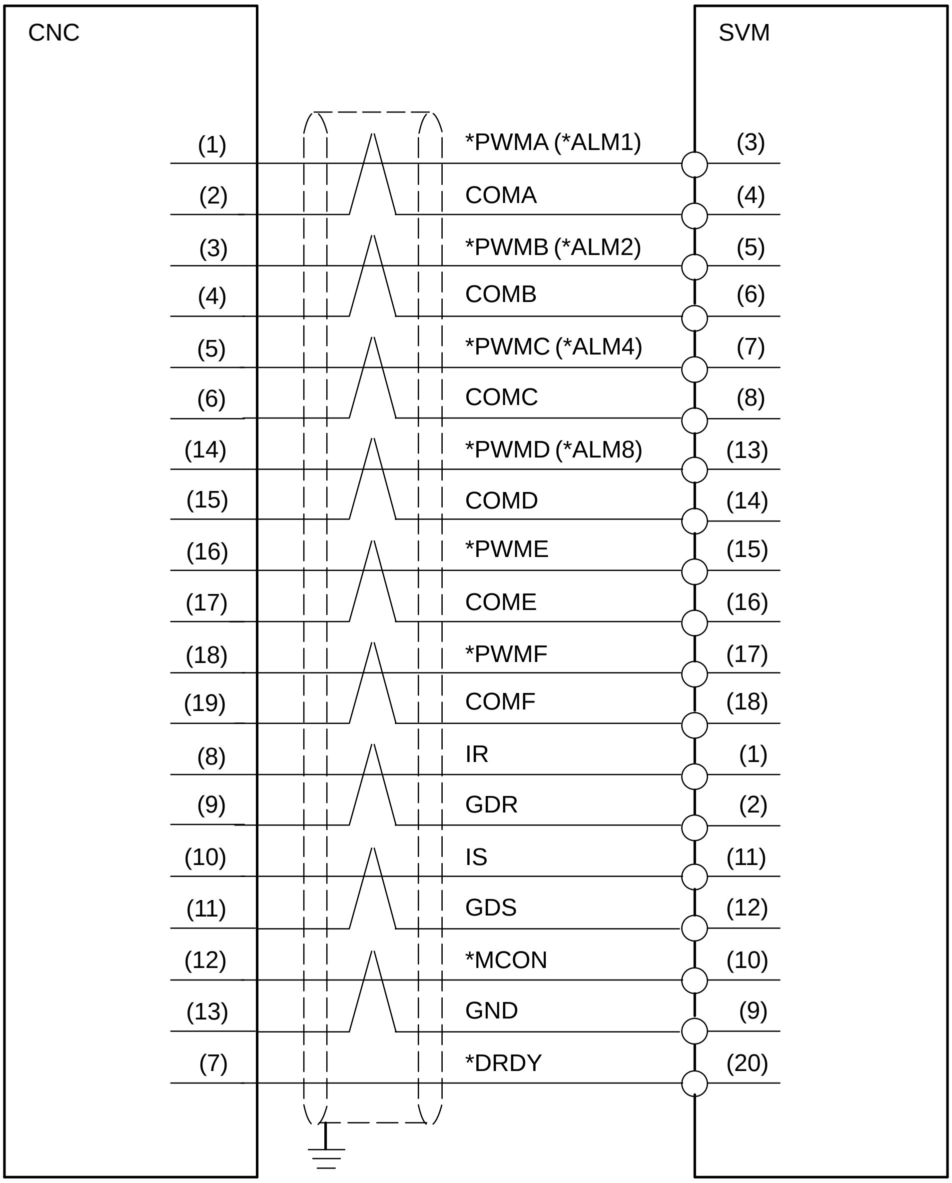


(Connector : PCR–E20FA or others)

(Connector : PCR–E20FA or others)
Connector name
JV1B : L axis (first axis)
JV2B : M axis (second axis)
JV3B : N axis (third axis)

NOTE
Use inner conductors as pairs (1–2 and 11–12) for current feedback signals (IR and IS) to avoid any external influence. Connector pins 9 and 19 are not used on either the CNC or SVM.

(b) TYPE A interface (for the FS–0C and FS–15A)

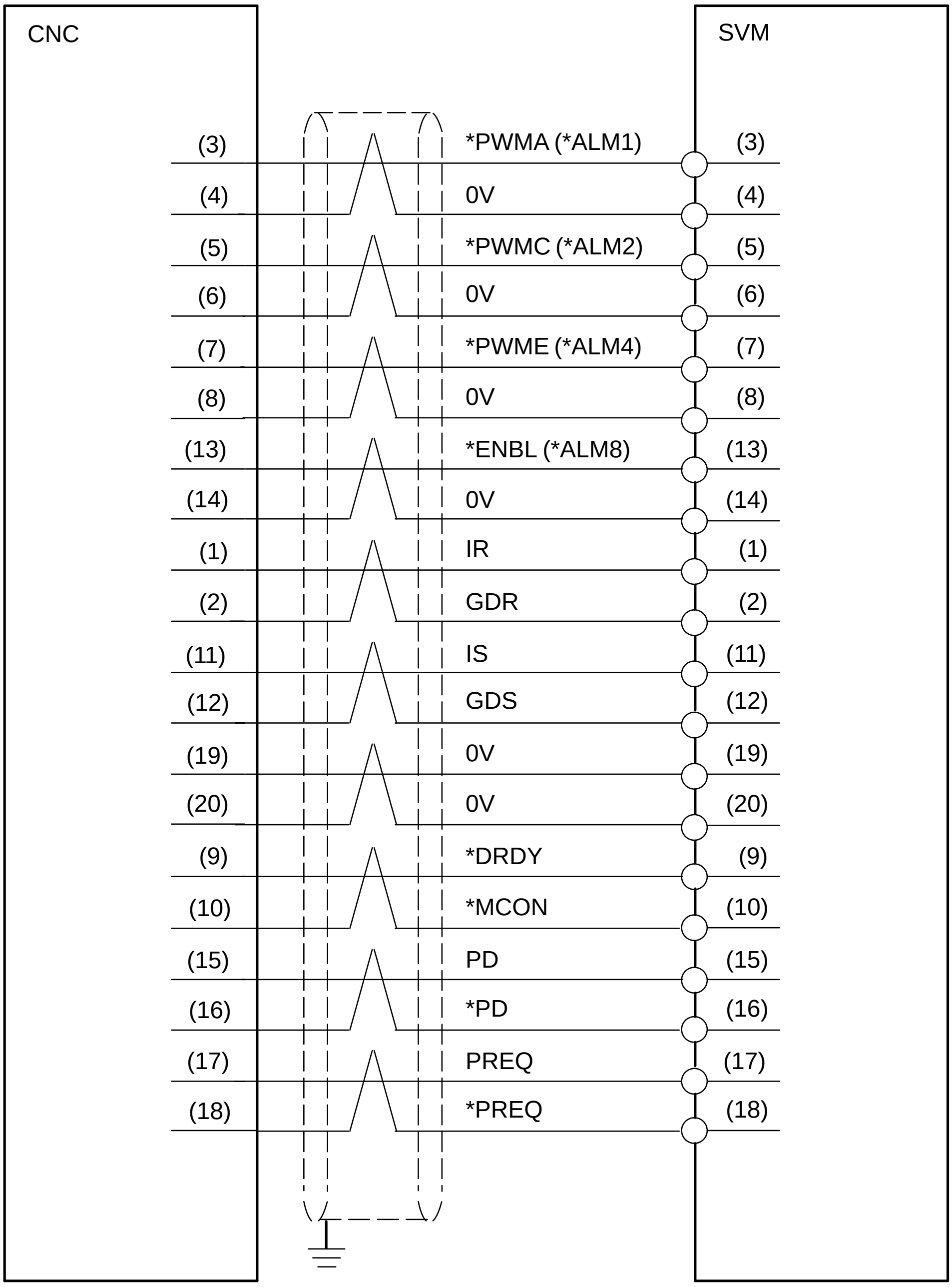


(Connector : MR–20RD or others)

(Connector : PCR–E20FA or others)
Connector name
JV1B : L axis (first axis)
JV2B : M axis (second axis)
JV3B : N axis (third axis)

NOTE
The wire (GND) connected to pin 13 of the connector on the CNC is paired with the *MCON signal wire. This wire is not grounded on the SVM side.
Use inner conductors as pairs (1–2 and 11–12) for current feedback signals (IR and IS) to avoid any external influence.

(c) TYPE B interface



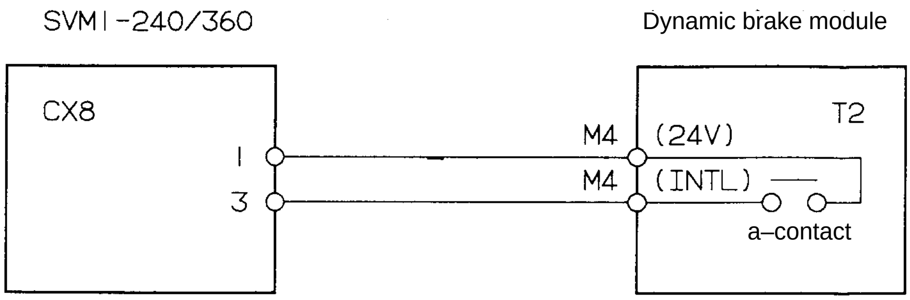
(Connector : PCR–E20FA or others)

(Connector : PCR–E20FA or others)
Connector name
JS1B : L axis (first axis)
JS2B : M axis (second axis)
JS3B : N axis (third axis)

NOTE

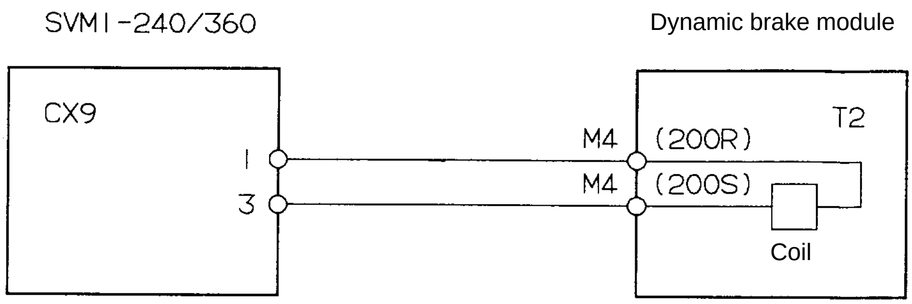
Use inner conductors as pairs (1–2 and 11–12) for current feedback signals (IR and IS) to avoid any external influence.

(9) Detailed description of the connection of cable K24



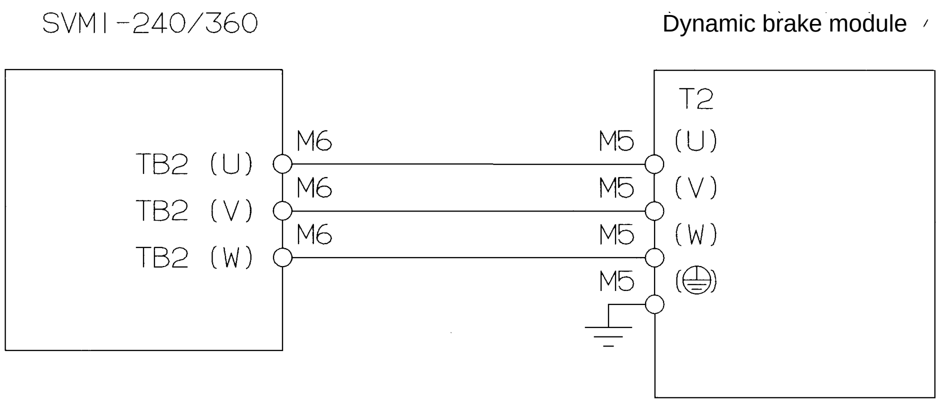
Cable: Two–conductor polyvinyl heavy–duty power cable (JIS C3312), 1.25 mm^2 (50/0.18), PVC sheath 9.6 mm in diameter
Connector: AMP connector with receptacle housing 1–178128–3 and receptacle contact 1–178128–2
Crimp terminal: 2–4

(10) Detailed description of the connection of cable K25



Cable: Two–conductor polyvinyl heavy–duty power cable (JIS C3312), 1.25 mm^2 (50/0.18), PVC sheath 9.6 mm in diameter
Connector: AMP connector with receptacle housing 1–178128–3 and receptacle contact 1–178128–2
Crimp terminal: 2–4

(11) Detailed description of the connection of cable K26

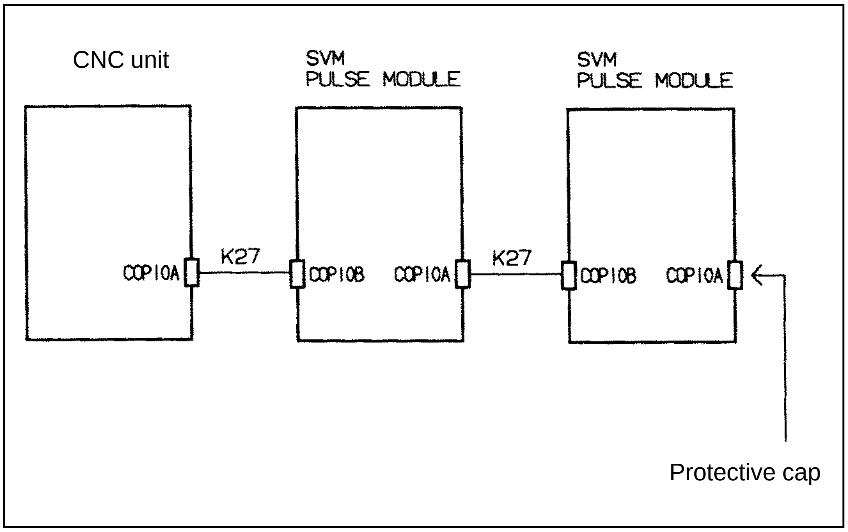


Cable: Fire–retardant polyflex wire (maximum conductor temperature 105°C) or equivalent to LMFC manufactured by The Furukawa Electric Co., Ltd., 5.5 mm^2 or larger
Crimp terminal: 5.5–5
Crimp terminal: 5.5–6

(12) Detailed description of the connection of cable K27

Cable K27 is an optical fiber cable used in the FSSB interface.
The cable is run from connector COP10A in the CNC, SVM, or pulse module to connector COP10B in the SVM or pulse module.
Connector COP10A of a module at the end of the cable chain must be covered with the cap supplied with the module.

Refer to the applicable CNC connection manual for detailed specifications of the optical fiber cable.



(1) Connection between two SVM units or between the SVM and pulse module (optical cable extension)

Specification	Cable length
A66L–6001–0023#L150R0	15cm
A66L–6001–0023#L300R0	30cm

(2) Connection between the CNC and SVM or between the CNC and pulse module (optical cable subscriber line)

Specification	Cable length
A66L–6001–0026#L1R003	1m
A66L–6001–0026#L5R003	5m
A66L–6001–0026#L7R003	7m
A66L–6001–0026#L10R003	10m
A66L–6001–0026#L20R003	20m
A66L–6001–0026#L30R003	30m
A66L–6001–0026#L50R003	50m

(13) Detailed description of the connection of cable K28

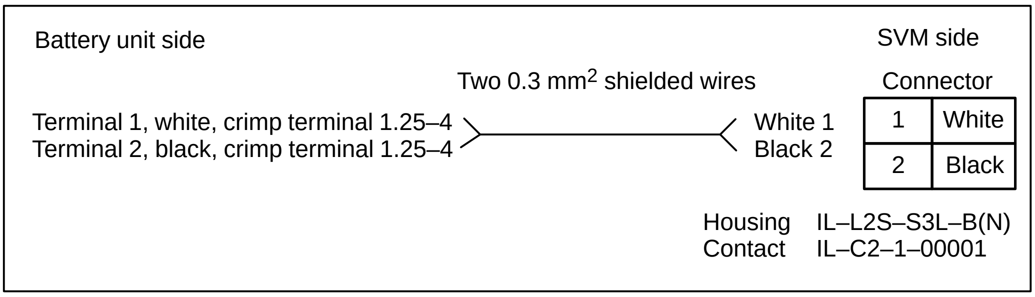
Cable K28 is used to connect a battery to the ABS pulse coder.
One battery can be connected to multiple servo amplifier modules in series, using the following connector with a lock.

Connector with lock

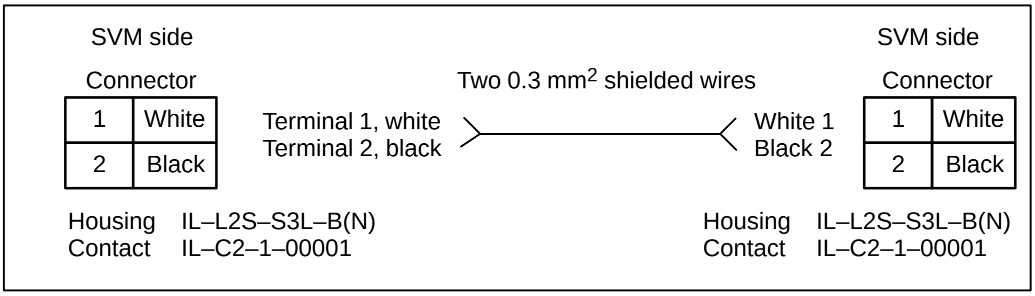
Drawing number	Manufacturer	Manufacturer's model code	Product name	Quantity
A06B–6093–K303	Japan Aviation Electronics Industry, Ltd.	IL–L2S–S3L–B(N)	Housing	1
		IL–C2–1–00001	Contact	2

A special crimping tool is necessary to attach contacts to a cable. It should be ordered from the manufacturer (Japan Aviation Electronics Industry, Ltd.) separately.

(1) Connection between the battery unit and SVM

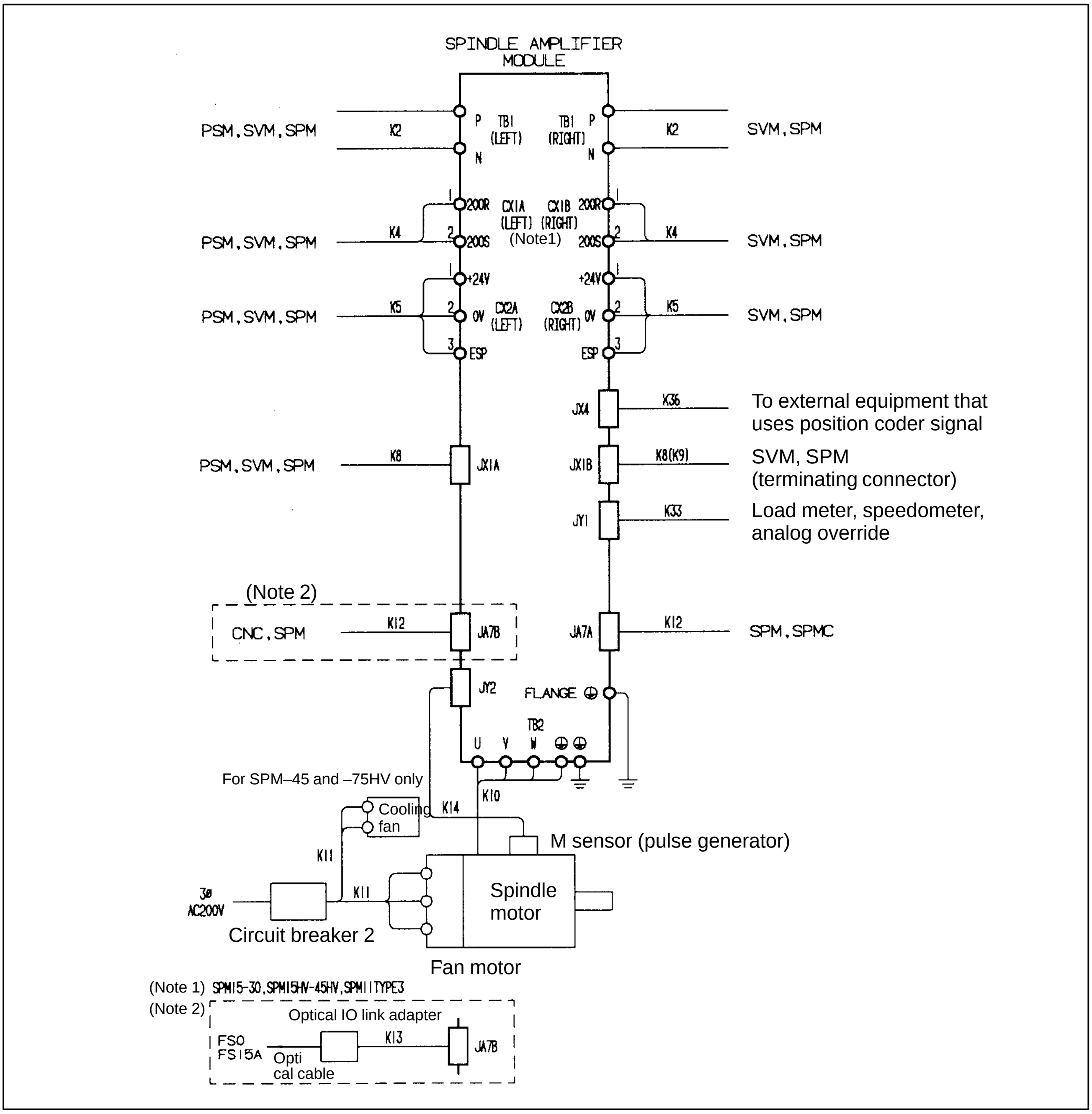


(2) Connection between two SVM units



9.2.3 Spindle Amplifier Module Connection Diagram

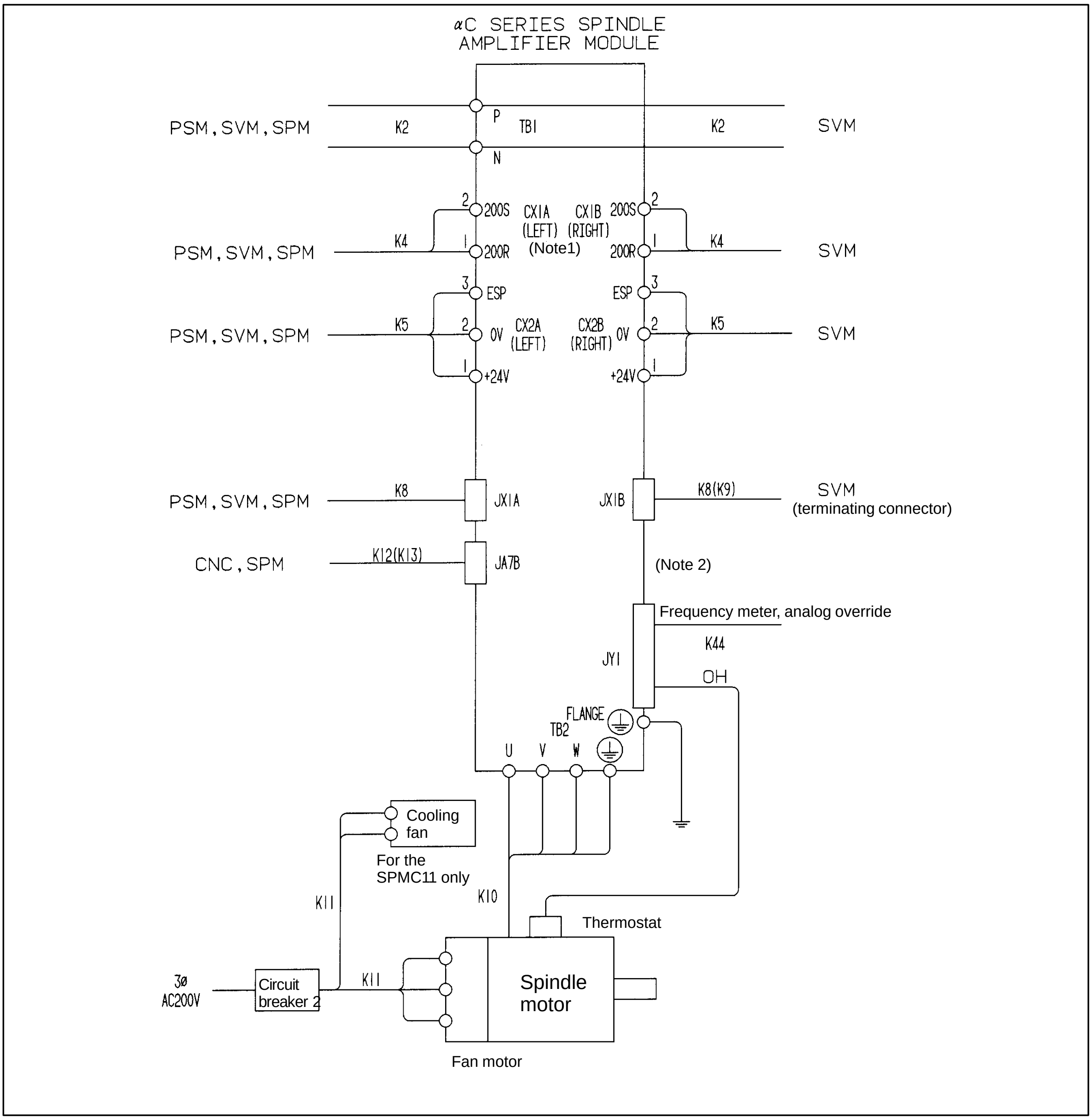
Spindle amplifier module (SPM)



The connector to be used varies according to the type of the detector being used. The interfaces for individual detectors are explained separately later.

See Section 5.2.3 for information about the cable used for the connection to a frame ground.

αC series spindle module (SPMC)



NOTE
1 SPMC15–26
2 Note that the SPMC is not provided with the JA7A (the second spindle connection function).

The connector to be used varies according to the type of the detector being used. The interfaces for individual detectors are explained separately later.

(1) Detailed description of the connection of cable K2

See 9.2.1 (2).

(2) Detailed description of the connection of cable K4

See 9.2.1 (4).

(3) Detailed description of the connection of cable K5

See 9.2.1 (5).

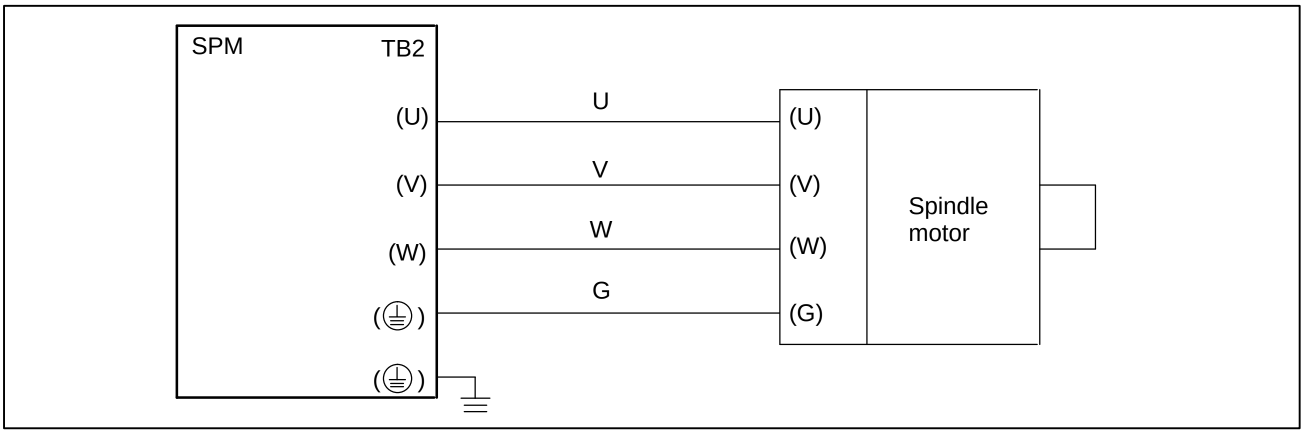
(4) Detailed description of the connection of cable K8

See 9.2.1 (8).

(5) Detailed description of the connection of cable K9

See 9.2.2 (4).

(6) Detailed description of the connection of cable K10 (power line)



Cables should be connected to the SPM and spindle motor using crimp terminals that match the motor, as listed in the following table.

Cable K10 (power line) specification

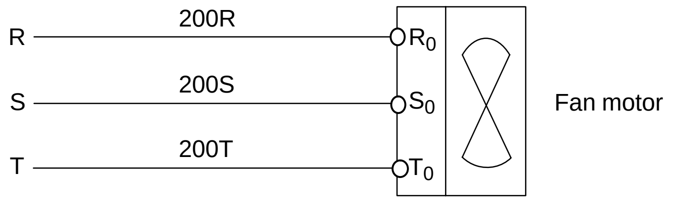
Motor model				Applicable cable		Terminal screw	
αseries	**αP series**	**α (HV) series**	**αC series**	**Heavy–duty power cable (Note 1)**	**Heat–resistant cable (Note 2)**	**Amplifier side**	**Motor side**
α0.5	—	—	—	0.75mm^2 or larger	—	M4	(Note 3)
α1	—	—	αC1	2mm^2 or larger	—	M4	M5
α1.5, α2	—	—	αC1.5, αC2	3.5mm^2 or larger	3.5mm^2 or larger	M4	M5
α3	—	—	αC3	5.5mm^2 or larger	3.5mm^2 or larger	M4	M5
α6	αP8, αP12	—	αC6	—	3.5mm^2 or larger	M4	M5
α8	αP15	—	αC8	—	5.5mm^2 or larger	M4	M5
α12	αP18	—	αC12	14mm^2 or larger	8mm^2 or larger	M6	M5
α15	αP22	—	αC15	—	14mm^2 or larger	M6	M5
α18	αP30	—	αC18	—	14mm^2 or larger	M6	M8
α22	αP40, αP50, αP60	—	αC22	—	22mm^2 or larger	M6	M8
α30	—	—	—	—	38mm^2 or larger	M10	M10
α40	—	—	—	—	50mm^2 or larger	M10	M10
—	—	α6HV, α8HV, α12HV	—	—	3.5mm^2 or larger	M6	M5
—	—	α15HV, α18HV	—	—	5.5mm^2 or larger	M6	M5
—	—	α22HV	—	—	8mm^2 or larger	M6	M5
—	—	α30HV	—	—	14mm^2 or larger	M6	M10
—	—	α40HV	—	—	22mm^2 or larger	M6	M10
—	—	α60HV	—	—	50mm^2 or larger	M10	M10

NOTE

1 Four–conductor polyvinyl heavy–duty power cable (JIS C3312)
2 Fire–retardant polyflex wire (maximum conductor temperature 105°C) or equivalent to LMFC manufactured by The Furukawa Electric Co., Ltd.
3 Use the following AMP connector kit: A63L–0001–0428/CT

(7) Detailed description of the connection of cable K11

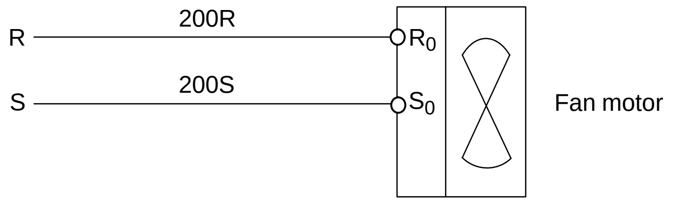
Power for fan motor
200V, three–phase



Cable specification: Use a three–conductor polyvinyl heavy–duty power cable (JIS C3312) having a conductor size of 2 mm^2 or larger.

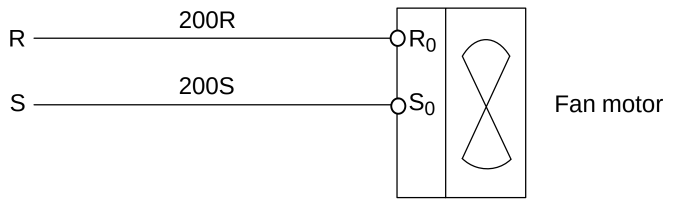
Fan motor terminal screw: M4

Power for cooling fan (for the SPMC11 only)
200V, single–phase



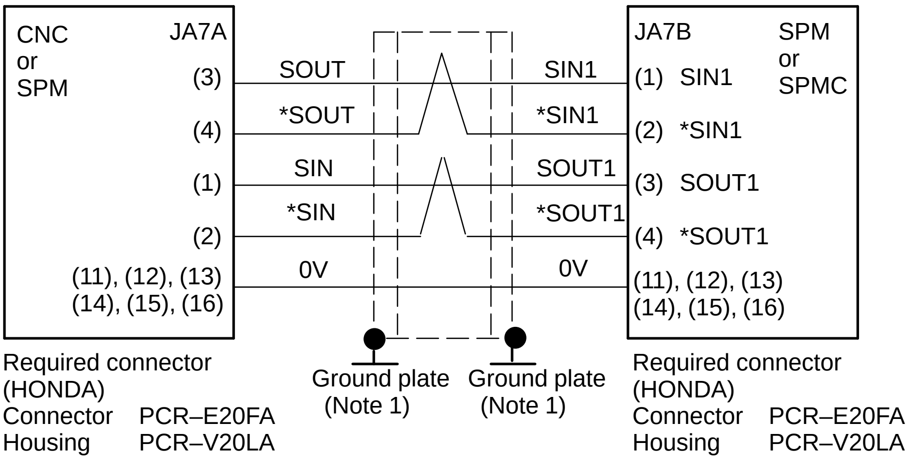
Cable specification: Two–conductor polyvinyl heavy–duty power cable (JIS C3312), conductor size of 1.25 mm^2 (50/0.18), PVC sheath 9.6 mm in diameter
Applicable receptacle terminal: 6.3 mm (0.250 in.) series

Power for cooling fan (for the SPM45 and SPM–75HV only)
200V, single–phase



Cable specification: 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

(8) Detailed description of the connection of cable K12



Cable specification: 0.09 mm^2 twisted pair with common shielded
Recommended cable (wire only): A66L–0001–0284#10P
See Appendix C for details.

NOTE

1 If cable K12 is installed near the likes of a power cable, its shielding wire must be connected to a grounding plate. If an SPM is installed near the CNC or another SPM, however, it is not necessary to connect the shielding wire to a grounding plate.

Pin assignment for connector JA7B

		10				20	(+5V) Note 2
9	(+5V) Note 2			19			
		8				18	(+5V) Note 2
7				17			
		6				16	0V
5				15	0V		
		4	*SOUT1			14	0V
3	SOUT1			13	0V		
		2	*SIN1			12	0V
1	SIN1			11	0V		

Pin arrangement of the connector on the CNC unit and connector JA7A

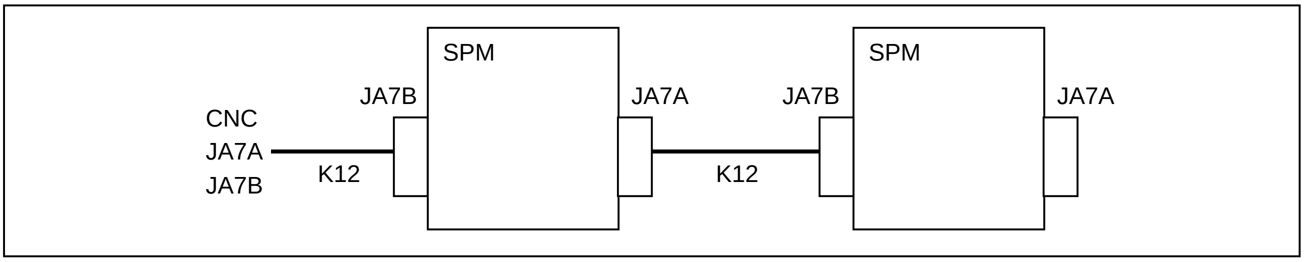
		10				20	(+5V) Note 2
9	(+5V) Note 2			19			
		8				18	(+5V) Note 2
7				17			
		6				16	0V
5				15	0V		
		4	*SOUT			14	0V
3	SOUT			13	0V		
		2	*SIN			12	0V
1	SIN			11	0V		

NOTE

2 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 +5 V line of the CNC will be short–circuited with that of the SPM.

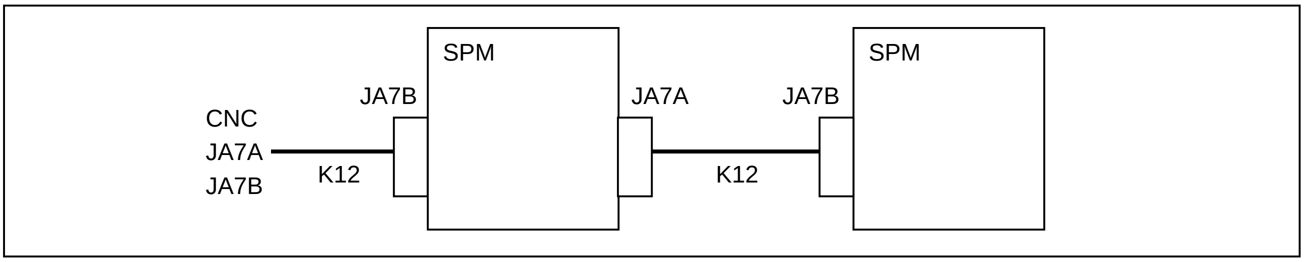
3 SPM serial interface connection using an optical fiber cable
The use of an optical I/O link adapter with the SPM serial interface extends the maximum allowable length of the optical fiber cable to up to 200 m.
Use optical fiber cables in the following cases:
- When the required cable length is 20 m 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.

– Electrical interface connection between two SPM units



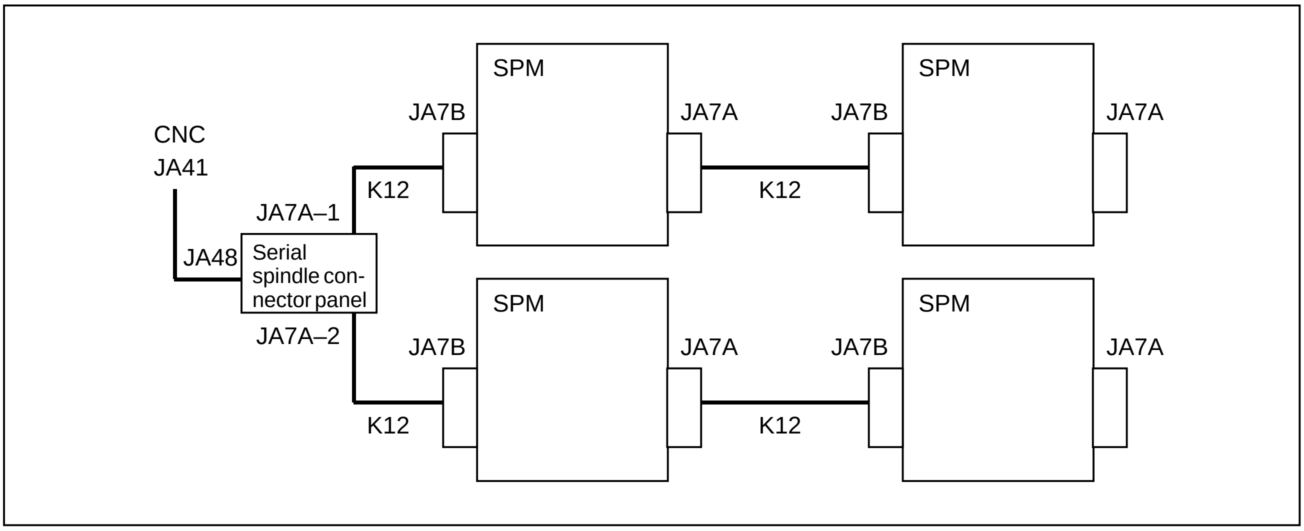
– Electrical interface connection from the SPM to the SPMC

Cable K12 cannot be used to make a reverse connection (from the SPMC to the SPM).

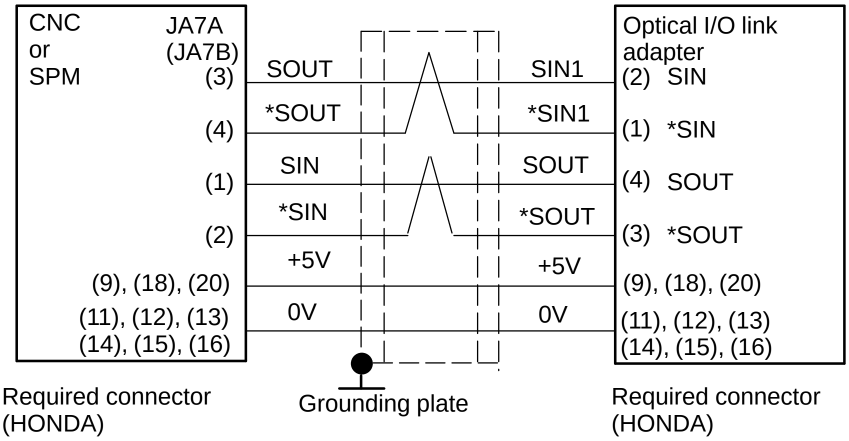


– Electrical interface connection between four SPM units in *i* series

Refer to the applicable CNC connection manual or technical report A–73123–014JA for a detailed description of the serial spindle connector panel.



(9) Detailed description of the connection of cable K13



Required connector
(HONDA)
Connector PCR–E20FA
Housing PCR–V20LA

Required connector
(HONDA)
Connector PCR–E20FA
Housing PCR–V20LA

Cable specification: 0.09 mm^2 twisted pair with common shielded
Recommended cable (wire only): A66L–0001–0284#10P
See Appendix C for details.

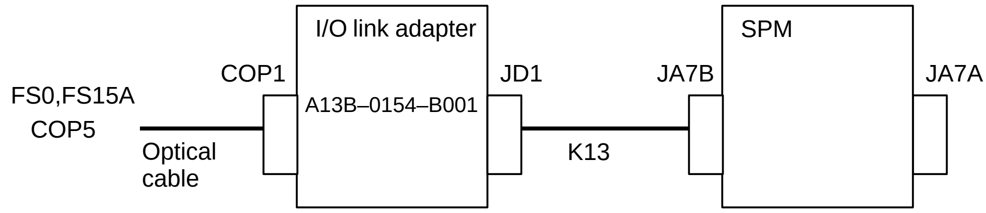
Pin assignment for connector JA7A

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

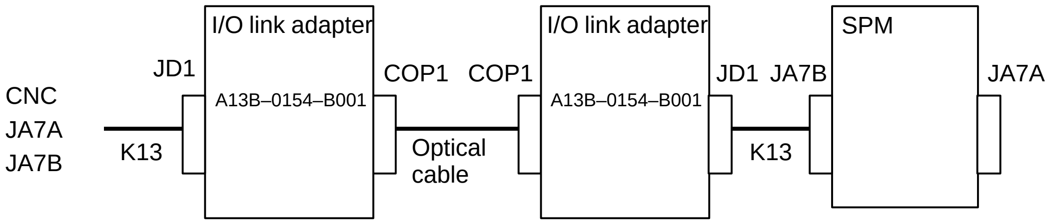
Pin arrangement of the connector on the optical I/O link adapter side

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

– Connection with the FS0 or FS15A



– Connection in which the required cable length is 20 m or more and in which an optical fiber cable is used

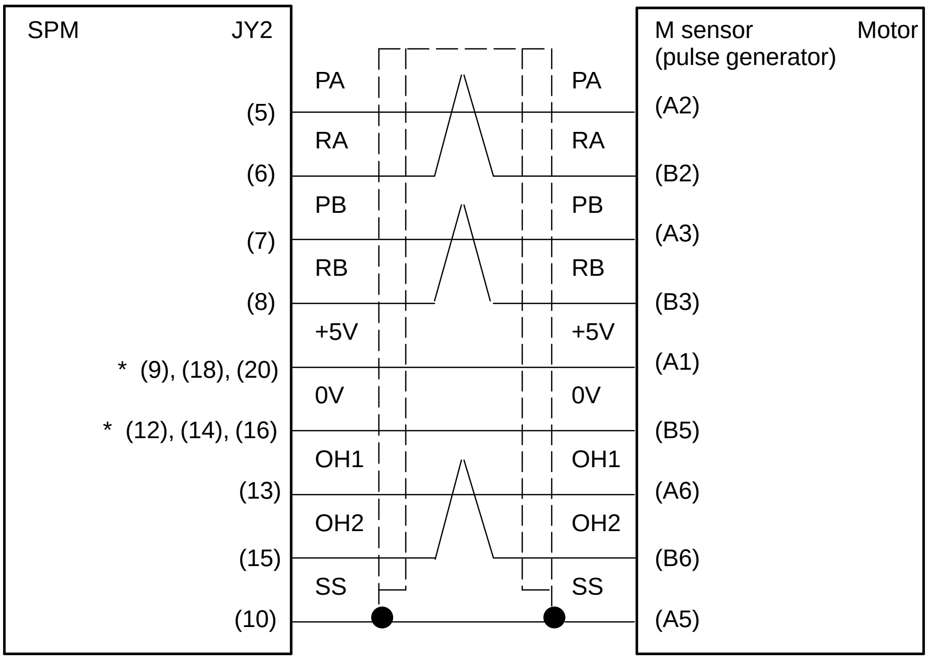


The specification drawing number of the optical fiber cable shown above is as follows:

A66L–6001–0009#L□□R003

(□□ represents a cable length, such as 5, 10, 15, 20, 30, 40, 50, 60, 80, 90, or 100 m.)

(10) Detailed description of connection of cable K14



Required connector
Connector FI40B–20S
Housing FI–20–CV5
FI40B–20S–CV5

Required connector (AMP)
Connector housing 178289–6
Contact 1–175217–2

Cable specification : Three $0.18mm^2$ twisted pairs
Two $0.5mm^2$ wires
Common shielded cable

Cable: +5V, 0V...0.5 mm^2
PA, RA, PB, RB, OH1, OH2...0.18 mm^2 twisted pair

Recommended cable (wire only): A66L–0001–0368
See Appendix C for details.

NOTE
Connect pin 16 to a 0 V potential; otherwise, a sensor may be damaged if the cable is attached to connector JY3 and power is supplied.

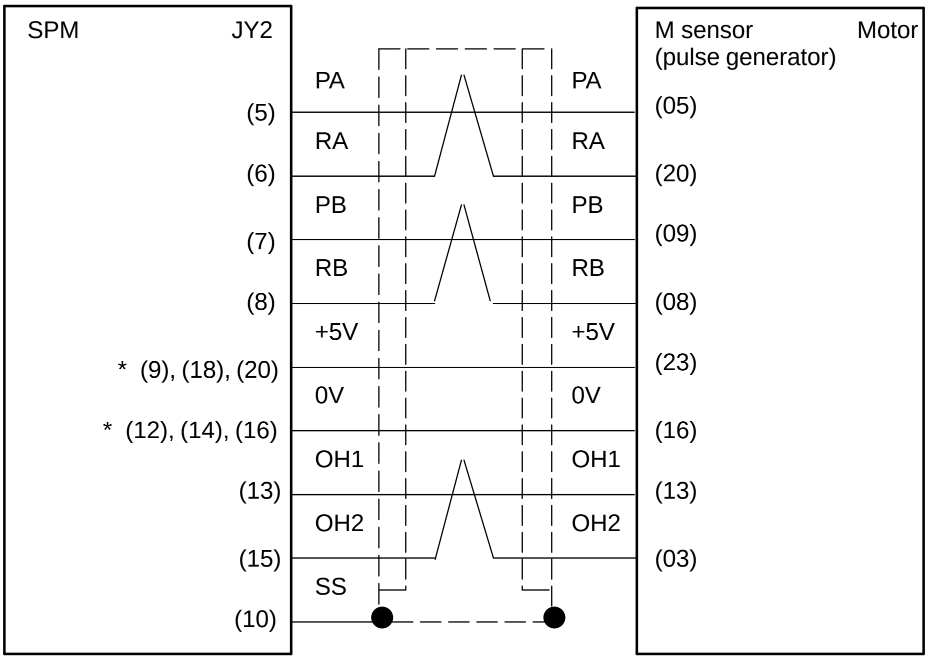
Pin assignment of connector JY2

9	+5V	10	SS	19		20	+5V
7	PB	8	RB	17		18	+5V
5	PA	6	RA	15	OH2	16	0V
3		4		13	OH1	14	0V
1		2		11		12	0V

Pin arrangement of the AMP connector on the motor side

B1	B2	B3	B4	B5	B6
	RA	RB		0V	OH2
A1	A2	A3	A4	A5	A6
+5V	PA	PB		SS	OH1

(11) Detailed description of connection of cable K14 (for spindle motor α0.5)



Required connector (Hirose Electric Co., Ltd.)
Connector FI40B–20S
Housing FI–20–CV5
FI40B–20S–CV5

Required connector (Hirose Electric Co., Ltd.)
Connector HDBB–25S
Contactor cover GDBW–25–CV

Cable specification : Three 0.18mm^2 twisted pairs
Two 0.5mm^2 wires
Common shielded cable

Cable: +5V, 0V...0.5 mm^2
PA, RA, PB, RB, OH1, OH2...0.18 mm^2 twisted pair

Recommended cable (wire only): A66L–0001–0368
See Appendix C for details.

NOTE
Connect pin 16 to a 0 V potential; otherwise, a sensor may be damaged if the cable is attached to connector JY3 and power is supplied.

Pin arrangement of connector JY2

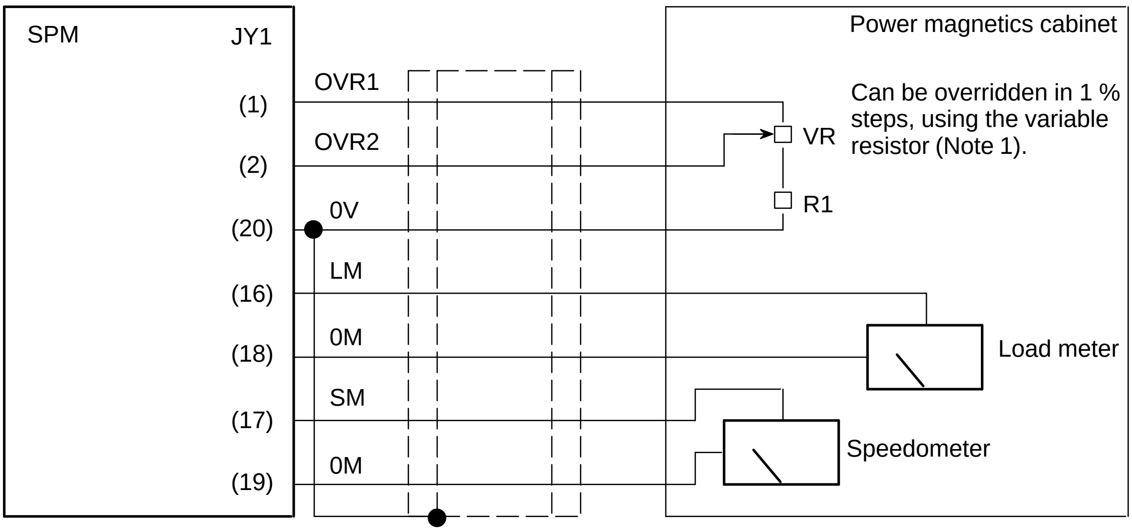
		10	SS			20	+5V
9	+5V	8	RB	19		18	+5V
7	PB	6	RA	17		16	0V
5	PA	4		15	OH2	14	0V
3		2		13	OH1	12	0V
1				11			

Pin arrangement of the connector on the motor side

		01	
14		02	
15		03	OH2
16	0V	04	
17		05	PA
18		06	
19		07	
20	RA	08	RB
21		09	PB
22		10	
23	+5V	11	
24		12	
25		13	OH1

(12) Detailed description of connection of cable K33

(a) Use for load meter or speedometer



Required connector (HONDA)
Connector PCR–E20FS
Housing PCR–V20LA
(solder type)

Required connector (HONDA)
Connector PCR–E20FA
Housing PCR–V20LA

Cable specification: 0.09mm^2 common shielded cable
Recommended cable (wire only): A66L–0001–0284#10P
See Appendix C for details.

Connect the shielded wire to a 0 V potential (pin 20).

Pin assignment of connector JY1

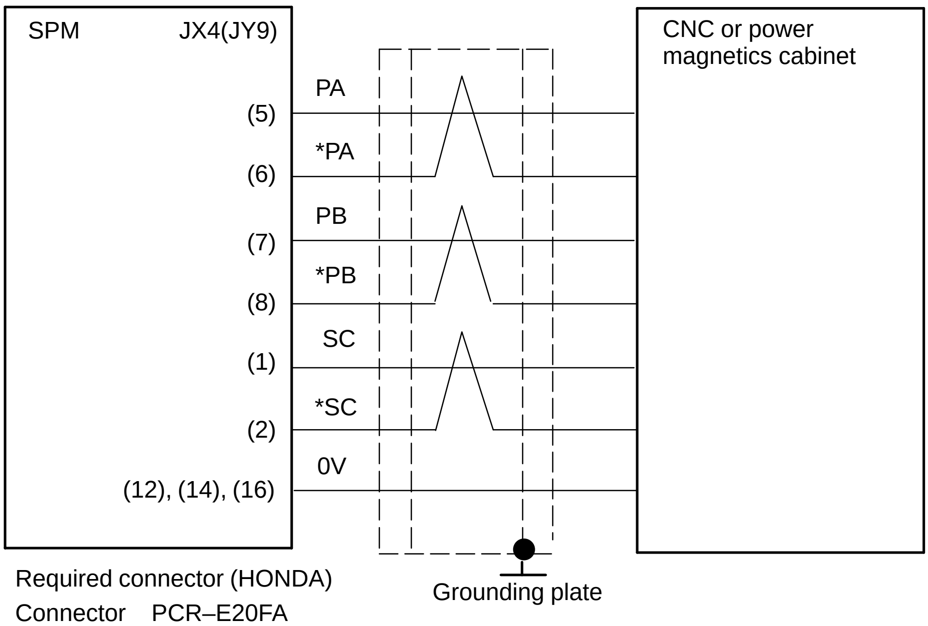
9	*(Note 2)	10		19	0M	20	0V
7	*	8		17	SM	18	0M
5	*	6		15	*	16	LM
3		4		13		14	*
1	OVR1	2	OVR2	11	*	12	*

NOTE

1 Select such an external resistance such that VR + R1 falls within the range between 2 kΩ and 10 kΩ .
2 Pins indicated * are intended to input or output signals used on a spindle check board. Do not connect any other signal line to them.

(13) Detailed description of connection of cable K36

(a) Use for position coder signals (equivalent to the output of line driver 75113)



Required connector (HONDA)
Connector PCR–E20FA
Housing PCR–V20LA

Cable specification: $0.09mm^2$ common shielded cable
Recommended cable (wire only): A66L–0001–0284#10P
See Appendix C for details.

Pin assignment of connector JY4 (JY9)

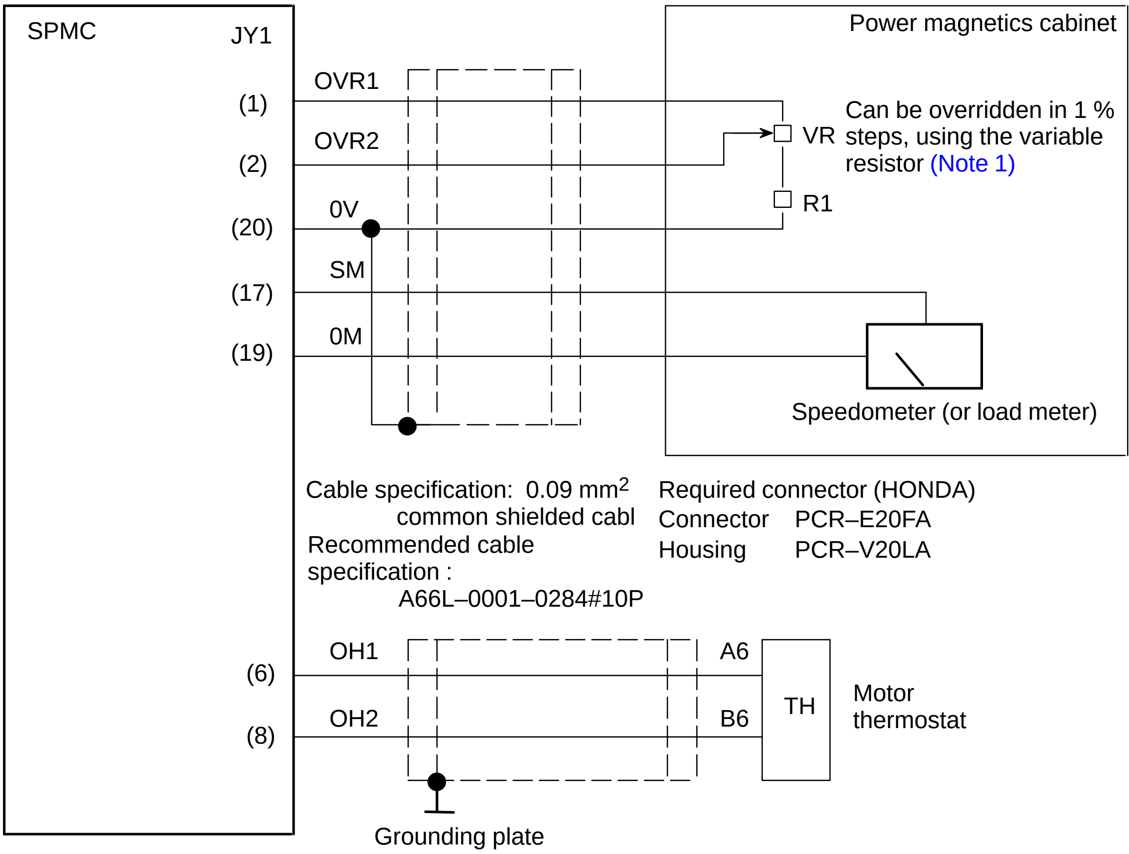
9		10		19		20	
7	PB	8	*PB	17		18	
5	PA	6	*PA	15		16	0V
3		4		13		14	0V
1	SC	2	*SC	11		12	0V

Output connector of each SPM model

Model	Specification drawing number (old model)	Connector	Specification drawing number (current model)	Connector
SPM–2.2 to 11 (TYPE 1)	—–	—–	A06B–6078–H2**#H500	JX4
SPM–15 to 30 (TYPE 1)	A06B–6078–H2**#H500	—–	A06B–6088–H2**#H500	JX4
SPM–2.2 to 11 (TYPE 2)	—–	—–	A06B–6078–H3**#H500	JX4
SPM–15 to 30 (TYPE 2)	A06B–6078–H3**#H500	JY9	A06B–6088–H3**#H500	JX4
SPM–11 to 30 (TYPE 3)	A06B–6078–H4**#H500	JY9	A06B–6088–H4**#H500	JX4

Usually, position coder signals are sent serially. So, K36 need not be connected.
K36 is used for position coder signals in a unit (for example, PMC or speed difference control unit) other than the CNC.

(14) Detailed description of the connection of cable K44



Required connector (HIROSE)
Connector FI40B–20S
Housing FI–20–CV5

Cable specification: 0.18 mm^2 common shielded cable
Recommended cable specification : A66L–0001–0275

Required connector (AMP):
Supplied with the module
Housing 178289–6
Contact 1–175217–2

Pin assignment of connector JY1

9	* (Note 2)	10		19	0M	20	0V
7	*	8	OH2	17	SM	18	0M
5	*	6	OH1	15	*	16	
3		4		13		14	*
1	OVR1	2	OVR2	11	*	12	*

NOTE

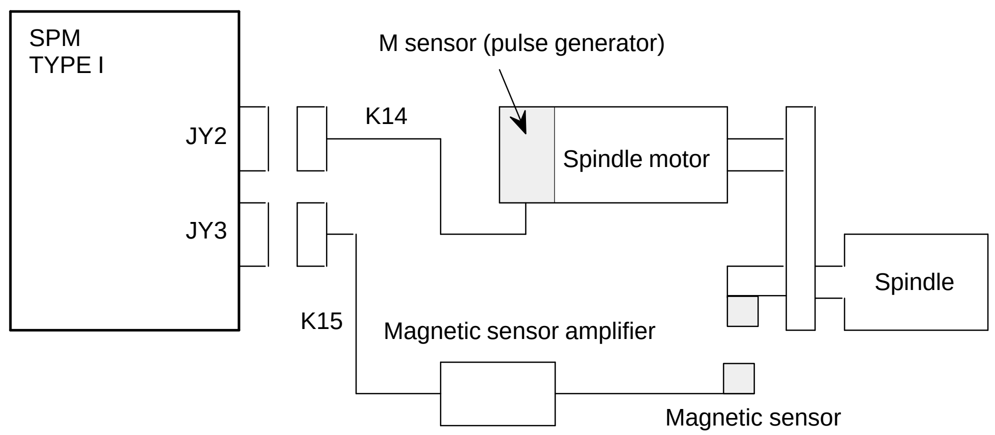
1 Select an external resistance such that VR + R1 falls within the range between 2kΩ and 10kΩ.

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

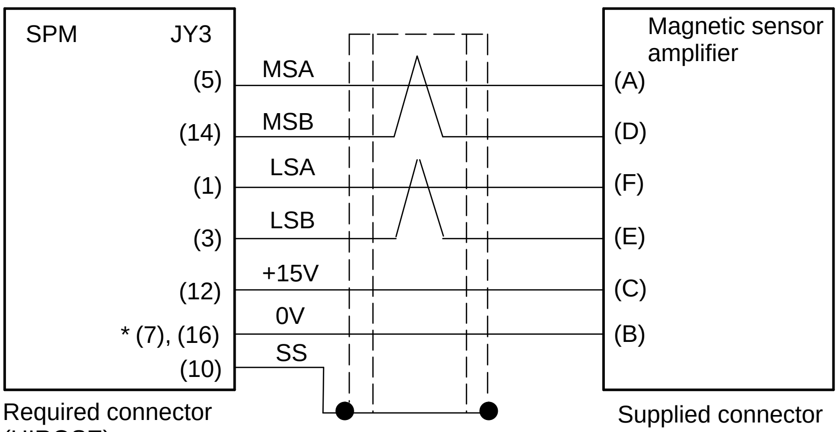
Pin arrangement of AMP connector on the motor side

B1	B2	B3	B4	B5	B6
					OH2
A1	A2	A3	A4	A5	A6
					OH1

(15) Combined use of the M sensor (pulse generator) and magnetic sensor



Detailed description of the connection of cable K15



Required connector (HIROSE)
Connector FI40A–2015S
Housing FI–20–CV

Supplied connector metal receptacle

Cable specification : Three 0.18mm^2 twisted pairs, Two 0.5mm^2 wires — Common shielded cable

Cable: +15V, 0V...0.5 mm^2 (for 0V, any one of those indicated *)
MSA, MSB, LSA, LSB...0.18 mm^2 twisted pair

Recommended cable: A66L–0001–0286
See Appendix C for details.

Connect the shielded wire to SS (pin 10).

NOTE
Use the supplied rubber sleeve to eliminate any gap between the cable and connector.

Pin assignment of connector JY3

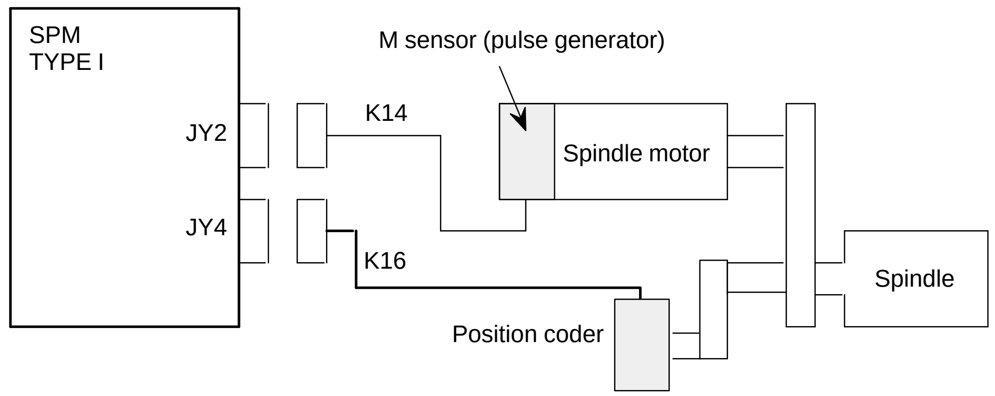
9		10	SS	19		20	
7	0V	8		17		18	(EXTSC)
5	MSA	6		15		16	0V
3	LSB	4		13	(PU/PD)	14	MSB
1	LSA	2		11	(+24V)	12	+15V

> **NOTE**
> Pin 11 of connector JY3 outputs +24 V. If a sensor is connected to it, the sensor may be damaged. Before supplying power, make sure that the sensor is not connected to +24 V.

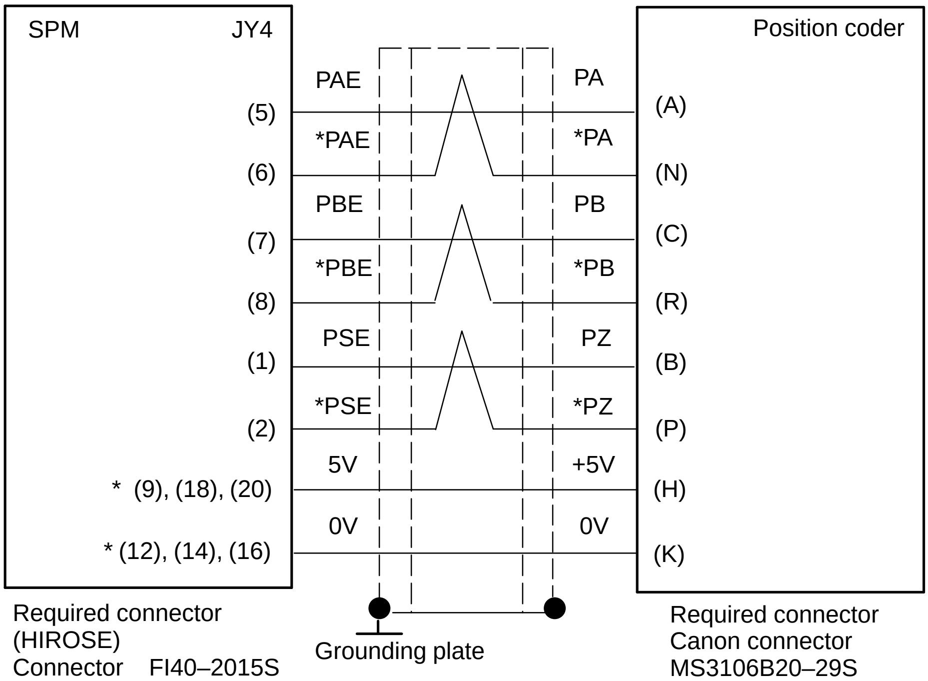
Pin arrangement of the metal receptacle

A	MSA	B	0V	C	+15V
D	MSB	E	LSB	F	LSA
G					

(16) Combined use of the M sensor (pulse generator) and position coder



Detailed description of the connection of cable K16



Required connector
(HIROSE)
Connector FI40–2015S
Housing FI–20–CV

Required connector
Canon connector
MS3106B20–29S

Cable specification : Three 0.18mm^2 twisted pairs / Two 0.5mm^2 wires — Common shielded cable

Cable: +5V, 0V...0.5 mm^2 (any one of those indicated *)
PAE, *PAE, PBE, *PBE, PSE, *PSE...0.18 mm^2 twisted pair

Recommended cable: A66L–0001–0286
See Appendix C for details.

Pin arrangement of connector JY4

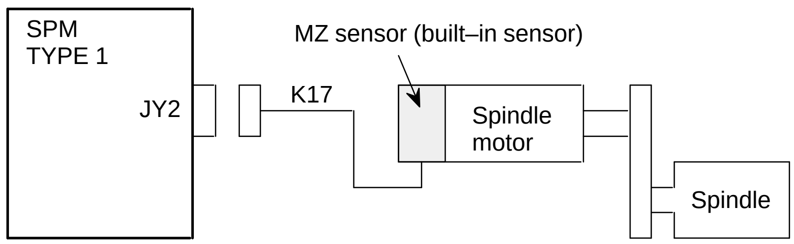
		10				20	5V
9	5V	8	*PBE	19		18	5V
7	PBE	6	*PAE	17		16	0V
5	PAE	4		15		14	0V
3		2	*PSE	13		12	0V
1	PSE			11			

Pin arrangement of the connector on the position coder side

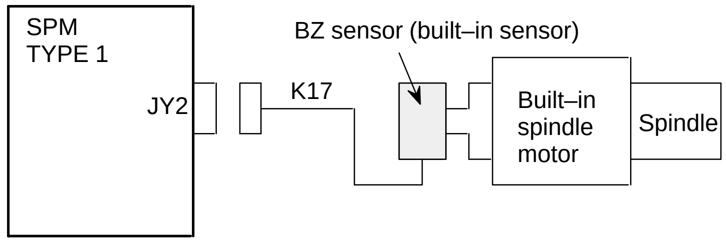
A	PA	B	PZ	C	PB
D		E		F	
G		H	+5V	J	
K	0V	L		M	
N	*PA	P	*PZ	R	*PB
S		T			

(17) Combined use of the MZ and BZ sensors (built–in sensors)

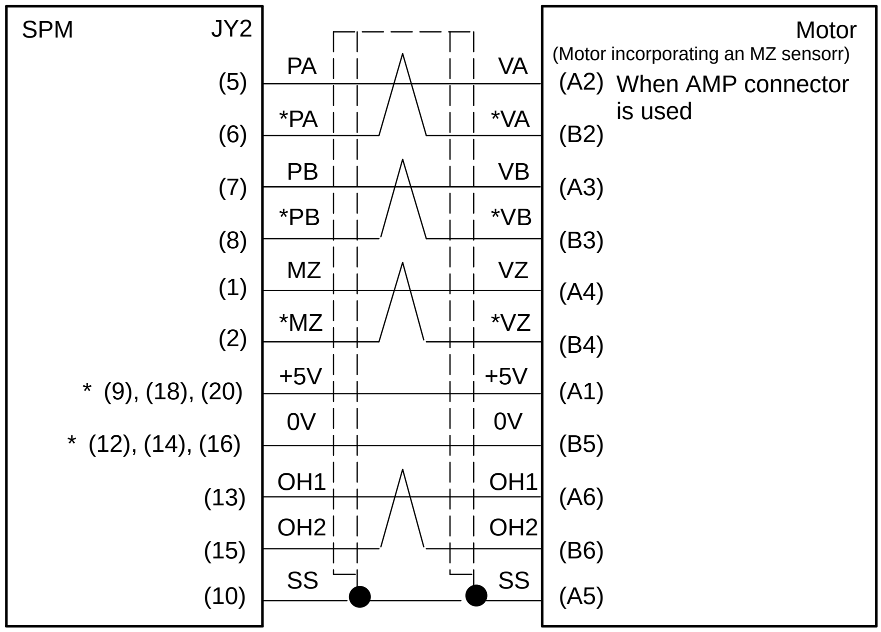
Example 1)



Example 2)



Detailed descriptions of the connection of cable K17 (for motor incorporating an MZ sensor)



Required connector (HIROSE)
Connector FI40B–20S
Housing FI–20–CV5
FI40B–20S–CV5

Required connector (AMP)
Connector 178289–6
Contact 1–175217–2

Cable specification : Four $0.18mm^2$ twisted pairs; Two $0.5mm^2$ wires — Common shielded cable

Cable: +5V, 0V...0.5 mm^2 (if any pin indicated * is to be used, use pin 16 so that the sensor can be protected against burn–out resulting from incorrect connection.)
PA, *PA, PB, *PB, MZ, *MZ, OH1, OH2...0.18 mm^2 twisted pair

Recommended cable: A66L–0001–0368
See Appendix C for details.

Pin arrangement of connector JY2

		10	SS			20	+5V
9	+5V	8	*PB	19		18	+5V
7	PB	6	*PA	17		16	0V
5	PA	4		15	OH2	14	0V
3		2	*MZ	13	OH1	12	0V
1	MZ			11			

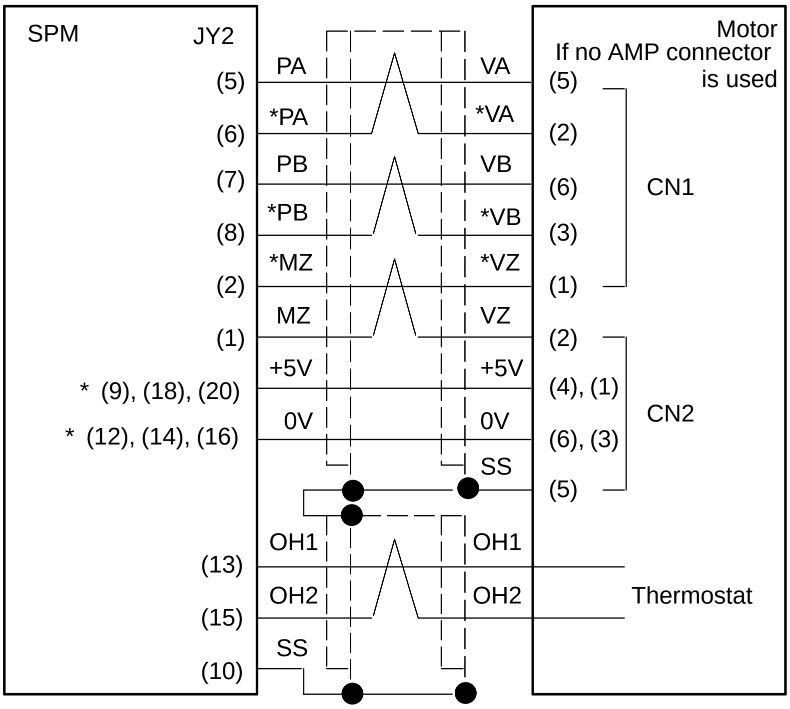
Pin arrangement of the AMP connector on the MZ sensor (built–in sensor) side

B1	B2	B3	B4	B5	B6
	*VA	*VB	*VZ	0V	OH2
A1	A2	A3	A4	A5	A6
+5V	VA	VB	VZ	SS	OH1

NOTE

If the sensor is connected to other connector, it may be damaged when the power is supplied.

Detailed description of the connection of cable K17 (connection of a built–in motor) without using an AMP connector



Required connector (HIROSE)
Connector FI40B–20S
Housing FI–20–CV5
FI40B–20S–CV5

Cable specification: (HONDA)
Connector Z–374
Contact HKP–F413

Cable specification : Four 0.18mm^2 twisted pairs
Two 0.5mm^2 wires
Common shielded cable (Note)

Cables used : +5V, 0V…0.18mm^2 (for any one of the three pins indicated with *)
PA, *PA, PB, *PB, MZ, *MZ, OH1, OH2…0.18mm^2 twisted pair

Recommended cable (without shield) : A66L–0001–0367
See Appendix C for details.

Pin arrangement of connector JY2

		10	SS			20	+5V
9	+5V	8	*PB	19		18	+5V
7	PB	6	*PA	17		16	0V
5	PA	4		15	OH2	14	0V
3		2	*MZ	13	OH1	12	0V
1	MZ			11			

Connector CN1

1	*MZ	4	
2	*VA	5	VA
3	*VB	6	VB

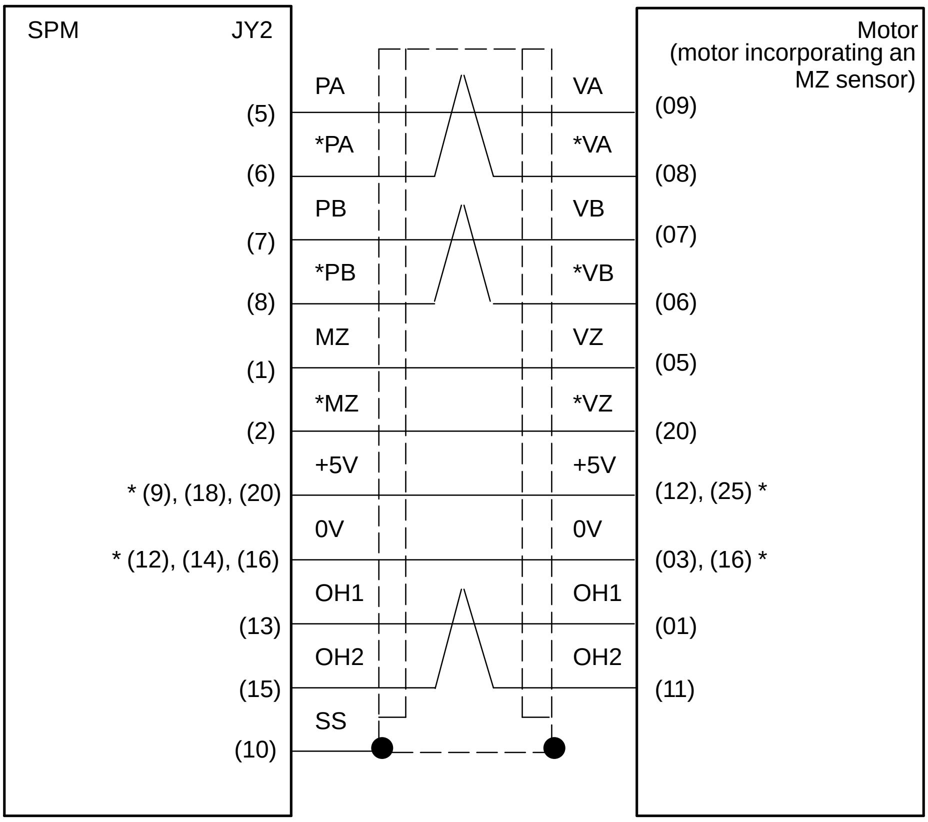
Connector CN2

1	(5V)	4	5V
2	VZ	5	SS
3	(0V)	6	0V

NOTE

If the sensor is connected to other connector, it may be damaged when the power is supplied.

Detailed description of the connection of cable K17 (connection of spindle motor α0.5)



Required connector (HIROSE)
Connector FI40B–20S
Housing FI–20–CV5
FI40B–20S–CV5

Required connector (HIROSE)
Connector HDBB–25S
Contactor cover GDBW–25–CV

Cable specification : Four 0.18mm^2 twisted pairs
Two 0.5mm^2 wires
Common shielded cable

Cable: +5V, 0V...0.5 mm^2 (if pins indicated by * are to be used, use pins 16, 14, and 12 in the stated order so that the sensor is protected against burn–out resulting from incorrect connection.

Recommended cable: A66L–0001–0368
See Appendix C for details.

Pin arrangement of connector JY2

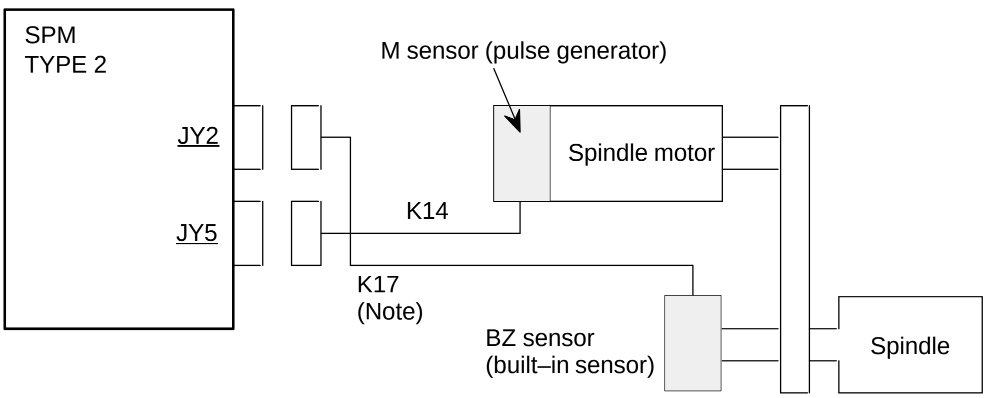
		10	SS			20	+5V
9	+5V	8	*PB	19		18	+5V
7	PB	6	*PA	17		16	0V
5	PA	4		15	OH2	14	0V
3		2	*MZ	13	OH1	12	0V
1	MZ			11			

Pin arrangement of the connector on the motor side

		01	OH1
14		02	
15		03	0V
16	0V	04	
17		05	VZ
18		06	*VB
19		07	VB
20	*VZ	08	*VA
21		09	VA
22		10	
23		11	OH2
24		12	+5V
25	+5V	13	

NOTE
If the sensor is connected to other connector, it may be damaged when the power is supplied.

(18) Combined use of the M sensor (pulse generator) and BZ sensor (separate built–in sensor)

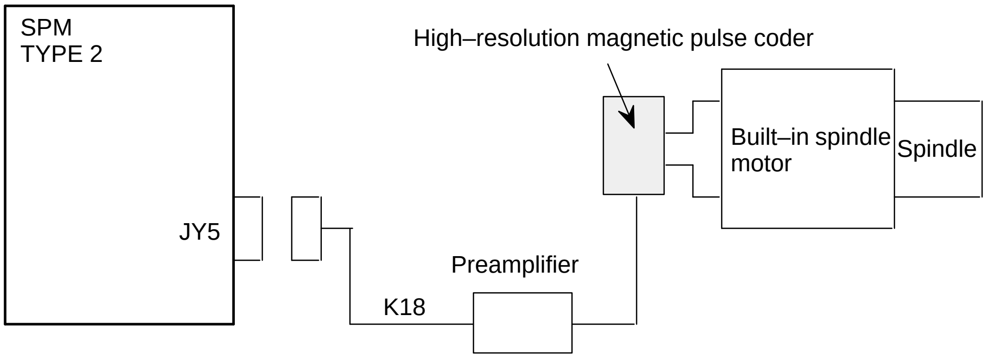


If the BZ sensor is to be wired as shown above, such that it uses only the position coder signal, a different connector is required. No change is made to the specification of cables K14 or K17.

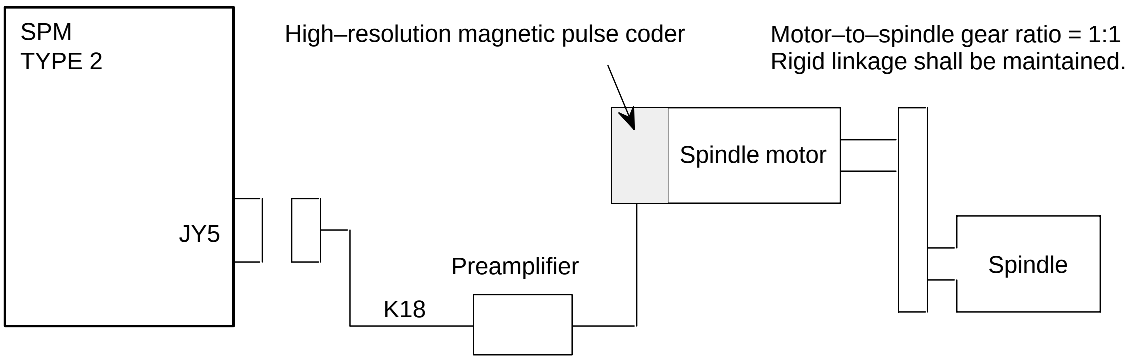
NOTE
If the BZ sensor is to be wired as shown above, such that it uses only the position coder signal, neither OH1 or OH2 of cable K17 need be connected.

(19) Use of high–resolution magnetic pulse coder (with motor only)

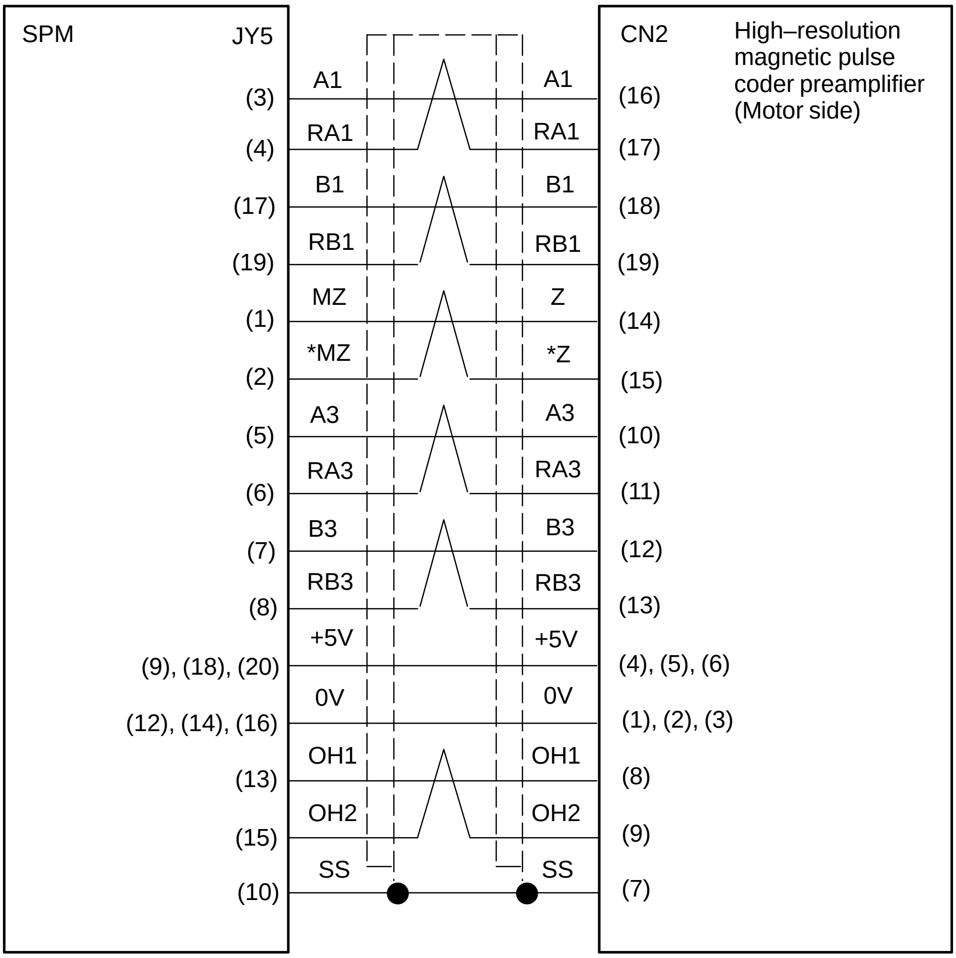
Example 1) Built–in spindle motor



Example 2) Motor incorporating magnetic pulse coder



Detailed description of the connection of cable K18



Required connector (HIROSE)
Connector FI40B–20S
Housing FI–20–CV5
FI40B–20S–CV5

Required connector (HIROSE)
HR22–12WTPA–20S (Note)

Cable specification : Six 0.18mm^2 twisted pairs — Common shielded cable
Six 0.5mm^2 wires

Cable: +5V, 0V...three 0.18 mm^2 wires each
PA, *PA, PB, *PB, MZ, *MZ, VA2, *VA2, VB2, *VB2, OH1, OH2...0.18 mm^2 twisted pair

Recommended cable specification (wire only): A66L–0001–0367
See Appendix C for details.

(Note)In addition to a soldering type, a crimping type can be selected.

- Crimping type
  - Crimp pin : HR22–SC–122 (20 pins are required for each connector.)
  - Connector housing: HR22–12WTPA–20SC
- Soldering type : HR22–12WTPA–20S

Crimping type connectors require the use of the following crimping tool:
Crimping tool specification: HR22–TA–2428HC (HIROSE)

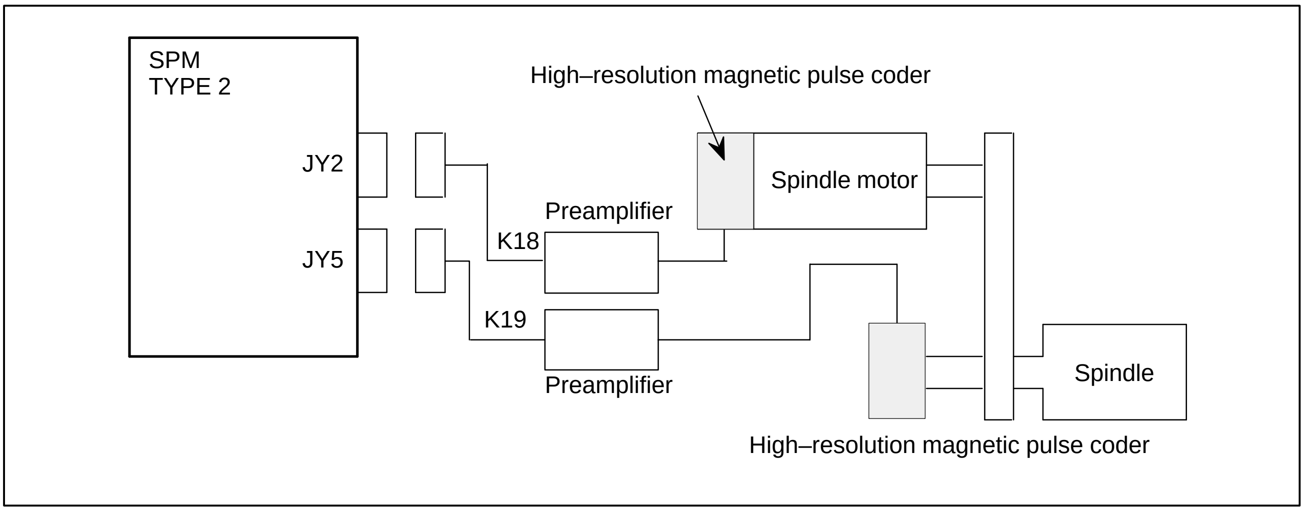
Pin arrangement of connector JY5

9	+5V	10	SS	19	RB1	20	+5V
7	B3	8	RB3	17	B1	18	+5V
5	A3	6	RA3	15	OH2	16	0V
3	A1	4	RA1	13	OH1	14	0V
1	Z	2	*Z	11		12	0V

Pin arrangement of connector for the high–resolution magnetic pulse coder preamplifier

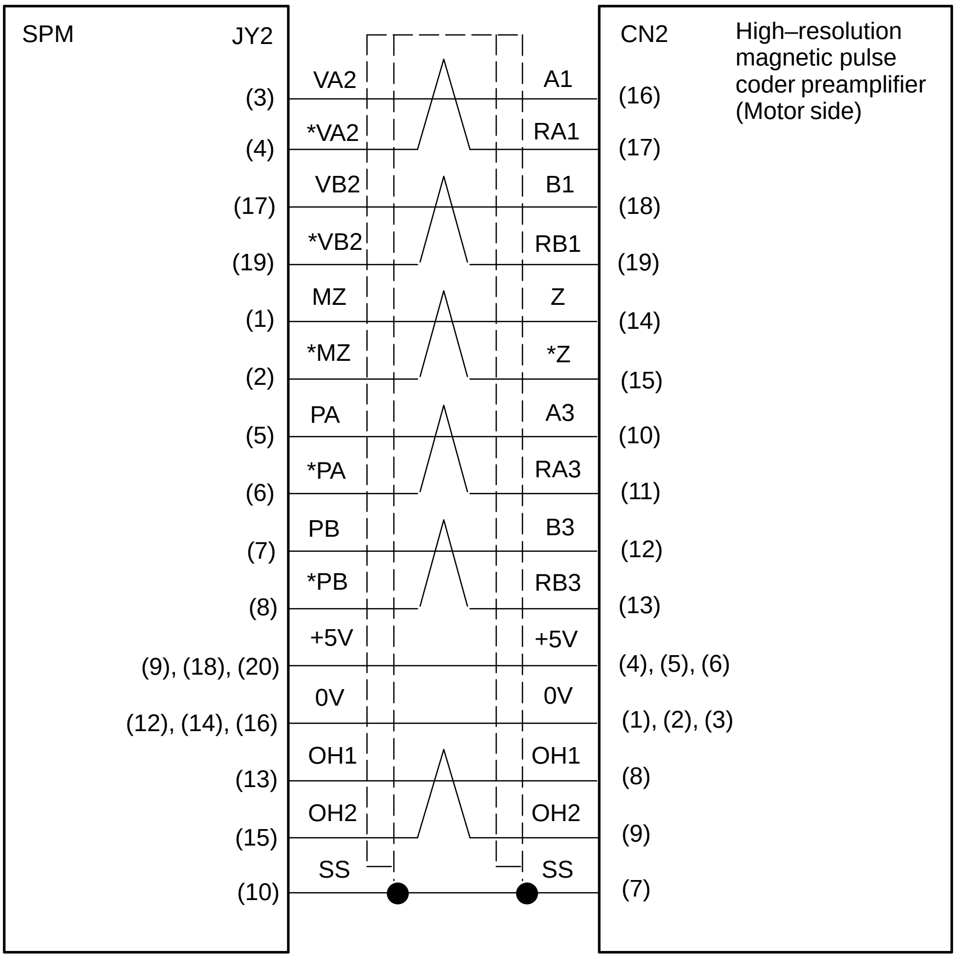
1	0V	2	0V	3	0V	4	+5V
5	+5V	6	+5V	7	G	8	OH1
9	OH2	10	A3	11	RA3	12	B3
13	RB3	14	Z	15	*Z	16	A1
17	RA1	18	B1	19	RB1	20	

(20) Use of high–resolution magnetic pulse coders (for the spindle and motor separately)



NOTE
If one high–resolution magnetic pulse coder is used for the spindle and another for the motor, cable K18 must be attached to connector JY2.

Detailed description of the connection of cable K18



Required connector (HIROSE)
Connector FI40B–20S
Housing FI–20–CV5
FI40B–20S–CV5

Required connector (HIROSE)
HR22–12WTPA–20S (Note)

Cable specification : Six 0.18mm^2 twisted pairs — Common shielded cable
Six 0.5mm^2 wires

Cable: +5V, 0V...three 0.18 mm^2 wires each
PA, *PA, PB, *PB, MZ, *MZ, VA2, *VA2, VB2, *VB2, OH1, OH2...0.18 mm^2 twisted pair

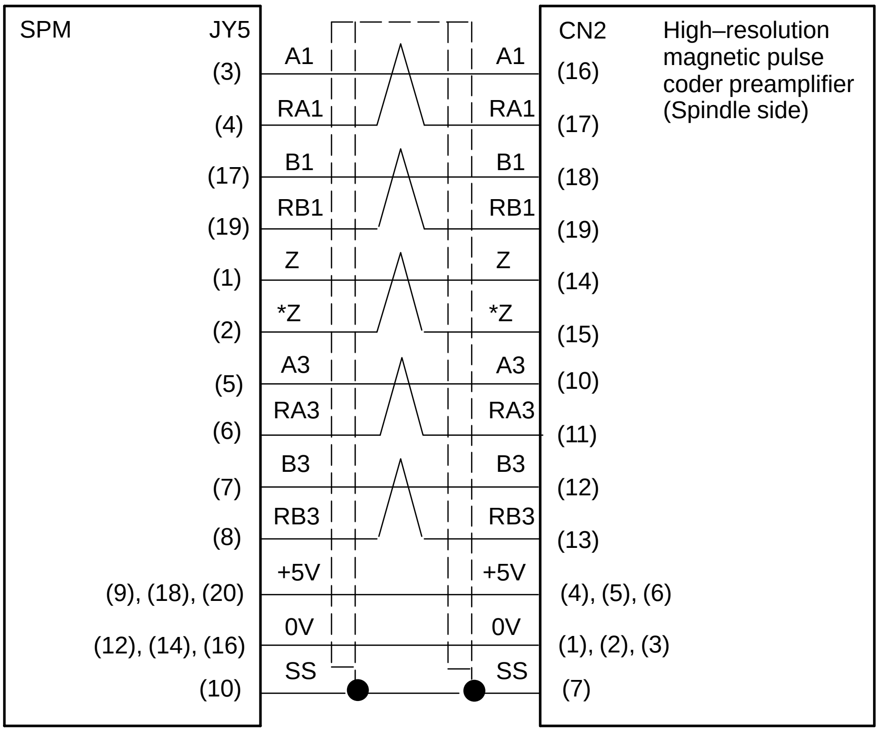
Recommended cable specification (wire only): A66L–0001–0367
See Appendix C for details.

(Note)In addition to a soldering type, a crimping type can be selected.

- Crimping type
  - Crimp pin : HR22–SC–122 (20 pins are required for each connector.)
  - Connector housing: HR22–12WTPA–20SC
- Soldering type : HR22–12WTPA–20S

Crimping type connectors require the use of the following crimping tool:
Crimping tool specification: HR22–TA–2428HC (HIROSE)

Detailed description of the connection of cable K19



Required connector (HIROSE)
Connector FI40A–20S
Housing FI–20–CV5 } FI40A–20S–CV5

Required connector (HIROSE)
HR22–12WTPA–20S (Note)

Cable specification : Five 0.18mm^2 twisted pairs
Six 0.5mm^2 wires } Common shielded cable

Cable: +5V, 0V...three 0.18 mm^2 wires each
A1, RA1, B1, RB1, Z, *Z, A3, RA2, B3, RB3...0.18 mm^2 twisted pair

Recommended cable (wire only): A66L–0001–0367
See Appendix C for details.

(NOTE) In addition to the soldering type, a crimping type can also be selected.

- Crimping type
  - Crimp pin : HR22–SC–122 (20 pins are required for each connector.)
  - Connector housing : HR22–12WTPA–20SC
- Soldering type : HR22–12WTPA–20S

Crimping type connectors require the use of the following crimping tool:
Crimping tool specification: HR22–TA–2428HC (HIROSE)

Pin arrangement of connector JY2

9	+5V	10	SS	19	*VB2	20	+5V
7	PB	8	*PB	17	VB2	18	+5V
5	PA	6	*PA	15	OH2	16	0V
3	VA2	4	*VA2	13	OH1	14	0V
1	MZ	2	*MZ	11		12	0V

Pin arrangement of the connector for the high–resolution magnetic pulse coder preamplifier (on the motor side)

1	0V	2	0V	3	0V	4	+5V
5	+5V	6	+5V	7	G	8	OH1
9	OH2	10	A3	11	RA3	12	B3
13	RB3	14	Z	15	*Z	16	A1
17	RA1	18	B1	19	RB1	20	

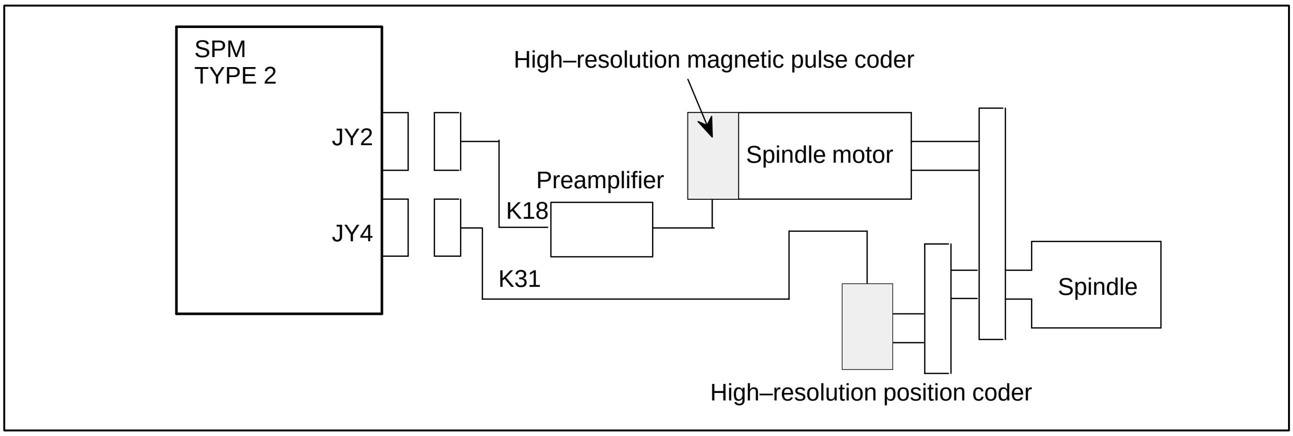
Pin arrangement of connector JY5

9	+5V	10	SS	19	RB1	20	+5V
7	B3	8	RB3	17	B1	18	+5V
5	A3	6	RA3	15		16	0V
3	A1	4	RA1	13		14	0V
1	Z	2	*Z	11		12	0V

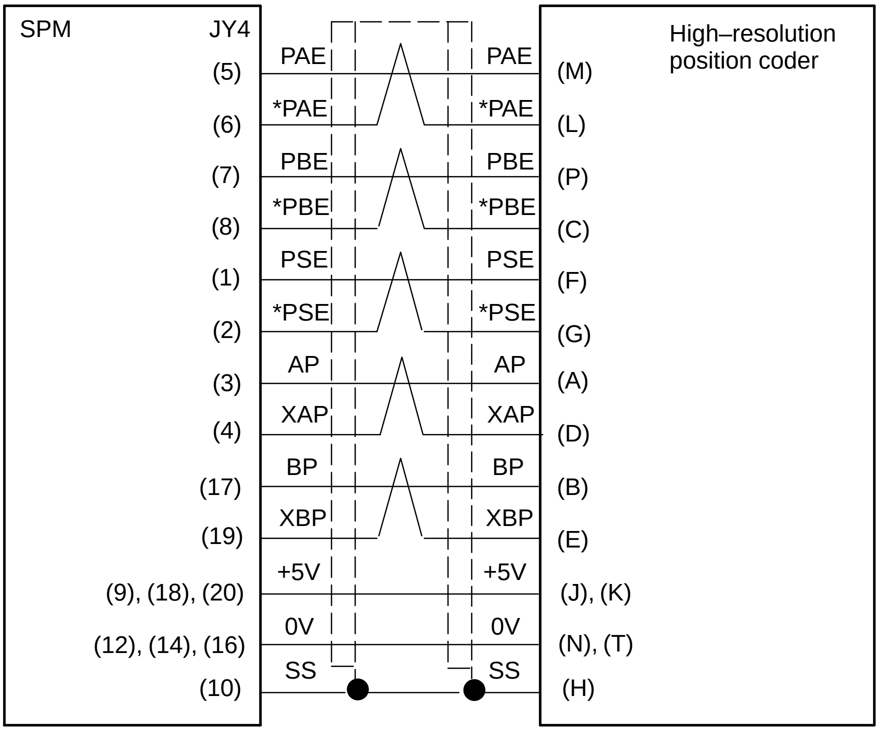
Pin arrangement of the connector for the high–resolution magnetic pulse coder preamplifier (on the spindle side)

1	0V	2	0V	3	0V	4	+5V
5	+5V	6	+5V	7	G	8	
9		10	A3	11	RA3	12	B3
13	RB3	14	Z	15	*Z	16	A1
17	RA1	18	B1	19	RB1	20	

(21) Combined use of the high–resolution magnetic pulse coder incorporated into the motor and the high–resolution position coder



Detailed description of the connection of cable K31



Required connector (HIROSE)
Connector FI40B–20S
Housing FI–20–CV5
FI40B–20S–CV5

Required connector Canon connector (HIROSE ELECTRIC)
MS3106A20–29SW

Cable specification : Five $0.18mm^2$ twisted pairs
Six $0.5mm^2$ wires
Common shielded cable

Cable +5V, 0V...three 0.5 mm^2 wires each
PAE, *PAE, PBE, *PBE, PSE, *PSE, AP, XAP, BP, XBP...0.18 mm^2 twisted pair

Recommended cable: A66L–0001–0368
See Appendix C for details.

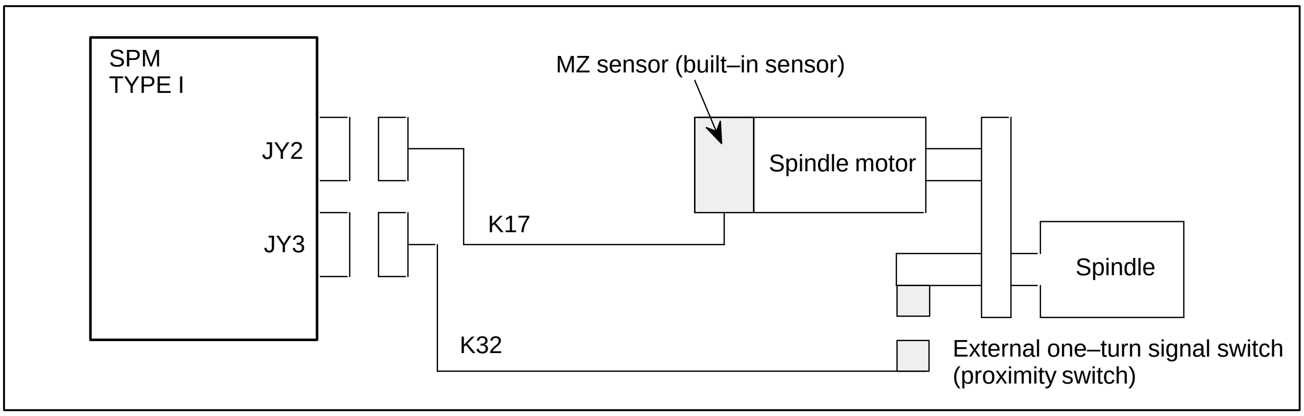
Pin arrangement of connector JY4

9	5V	10	SS	19	XBP	20	+5V
7	PBE	8	*PBE	17	BP	18	+5V
5	PAE	6	*PAE	15		16	0V
3	AP	4	XAP	13		14	0V
1	PSE	2	*PSE	11		12	0V

Pin arrangement of the connector for the high–resolution pulse coder

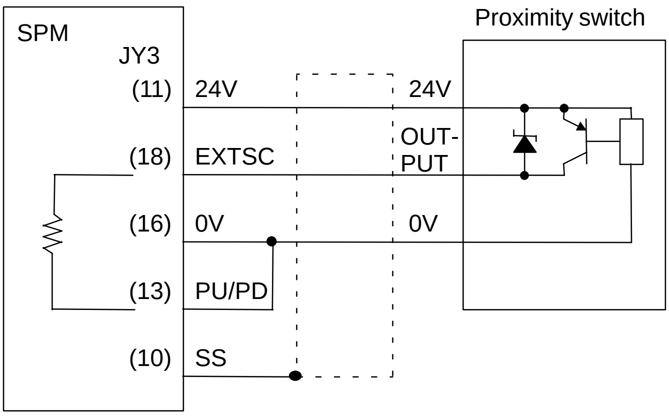
A	AP	B	BP	C	*PBE
D	XAP	E	XBP	F	PSE
G	*PSE	H	SS	J	+5V
K	+5V	L	*PAE	M	PAE
N	0V	P	PBE	R	
S		T	0V		

(22) Combined use of the MZ sensor (built–in sensor) and external one–turn signal switch



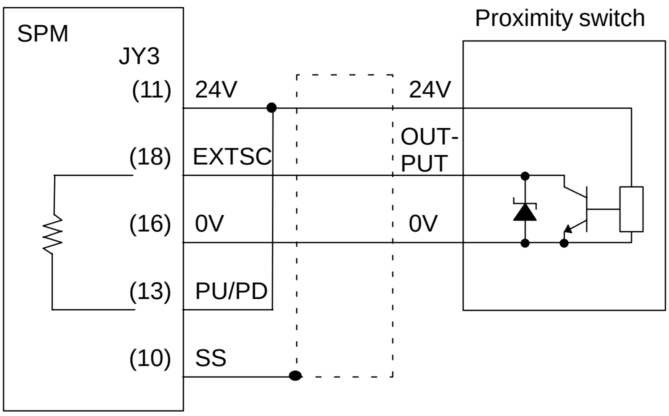
Detailed descriptions about the connection of cable K32

Three–wire proximity switch/PNP type



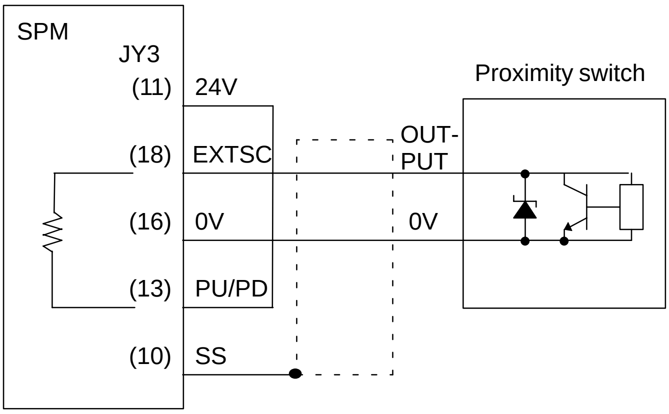
Required connector (HIROSE)
Connector FI40A–2015S
Housing FI–20–CV

Three–wire proximity switch/NPN type



Required connector (HIROSE)
Connector FI40A–2015S
Housing FI–20–CV

Two–wire proximity switch/NPN type

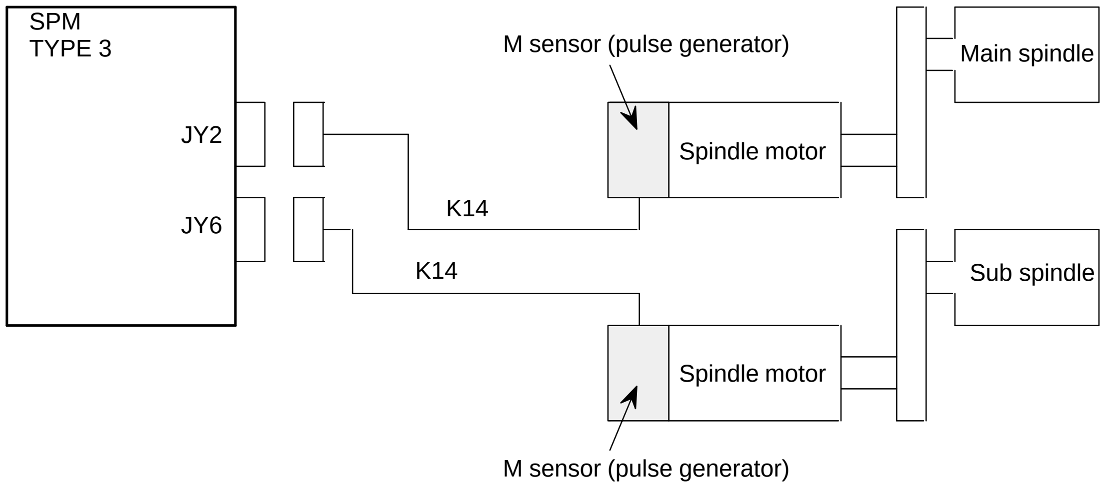


Required connector (HIROSE)
Connector FI40A–2015S
Housing FI–20–CV

(23) Spindle switch control (TYPE 3 only)

Shown below are examples of spindle switch control connection.

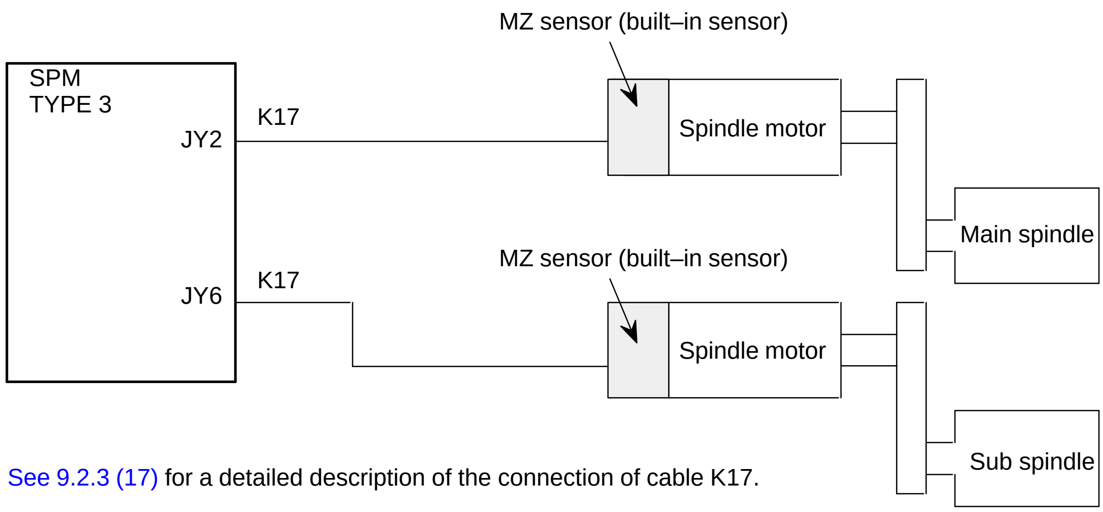
Example 1) Switching the speed feedback signal



See 9.2.3 (10) and (11) for a detailed description of the connection of cable K14.

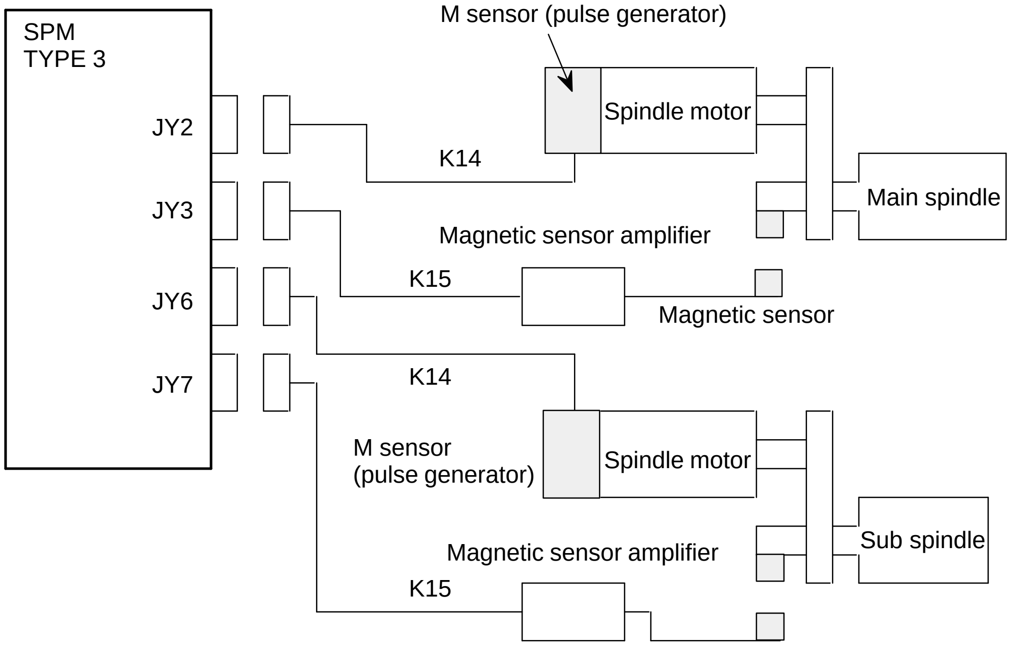
Example 2) Switching the speed and position feedback signals

Example 2–1) Both main spindle and subspindle motors incorporating an MZ sensor



See 9.2.3 (17) for a detailed description of the connection of cable K17.

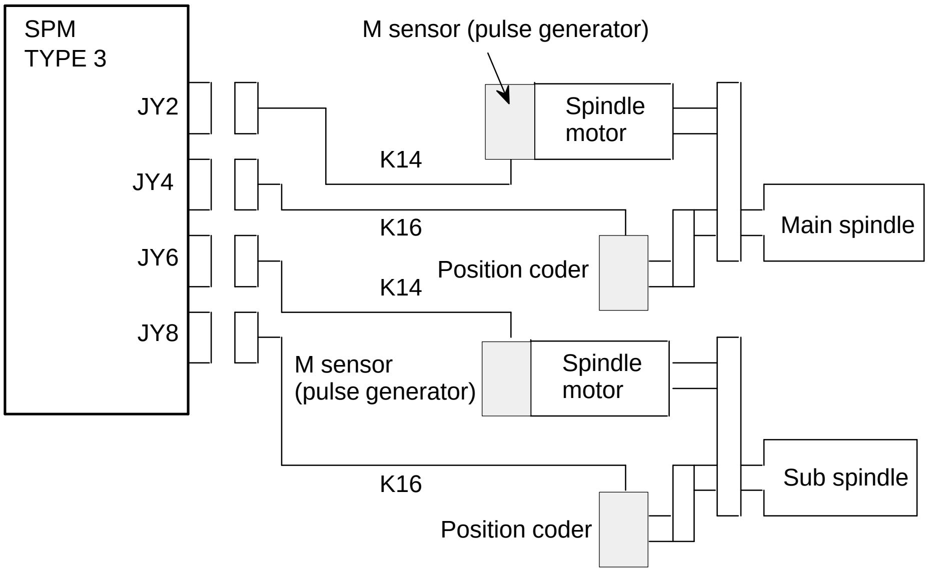
Example 2–2) Using a magnetic sensor for orientation



See 9.2.3 (10) and (11) for a detailed description of the connection of cable K14.

See 9.2.3 (15) for a detailed description of the connection of cable K15.

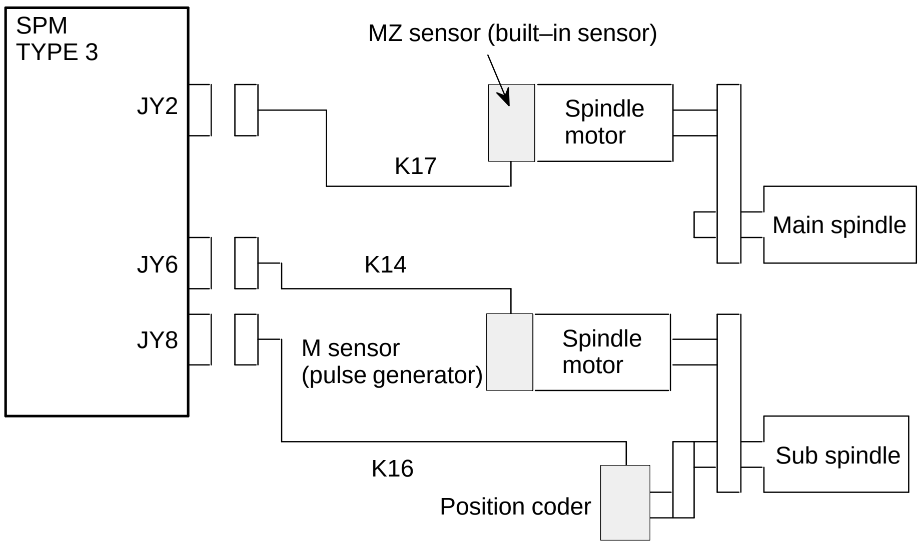
Example 2–3) Using a position coder for the position feedback signal



See 9.2.3 (10) and (11) for a detailed description of the connection of cable K14.

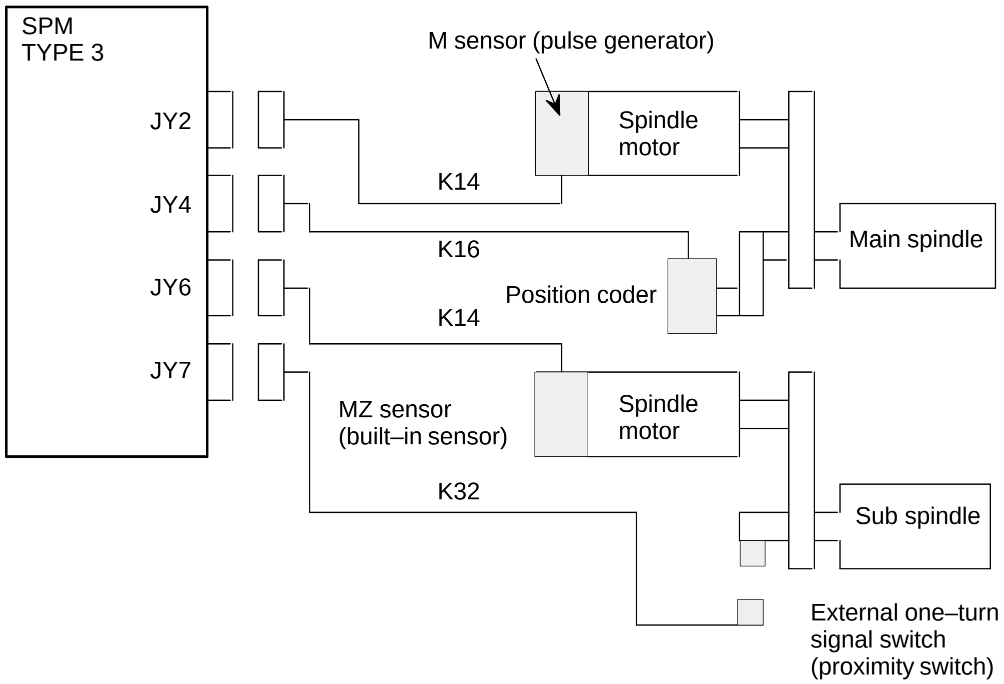
See 9.2.3 (16) for a detailed description of the connection of cable K16.

Example 2–4) **Using a motor incorporating an MZ sensor (built–in sensor) for the main spindle and a position coder for the subspindle**



See 9.2.3 (10) and (11) for a detailed description of the connection of cable K14.
See 9.2.3 (16) for a detailed description of the connection of cable K16.
See 9.2.3 (17) for a detailed description of the connection of cable K17.

Example 2–5) **Using a position coder for the main spindle, the MZ sensor incorporated into the motor, and an external one–turn signal switch for the subspindle**

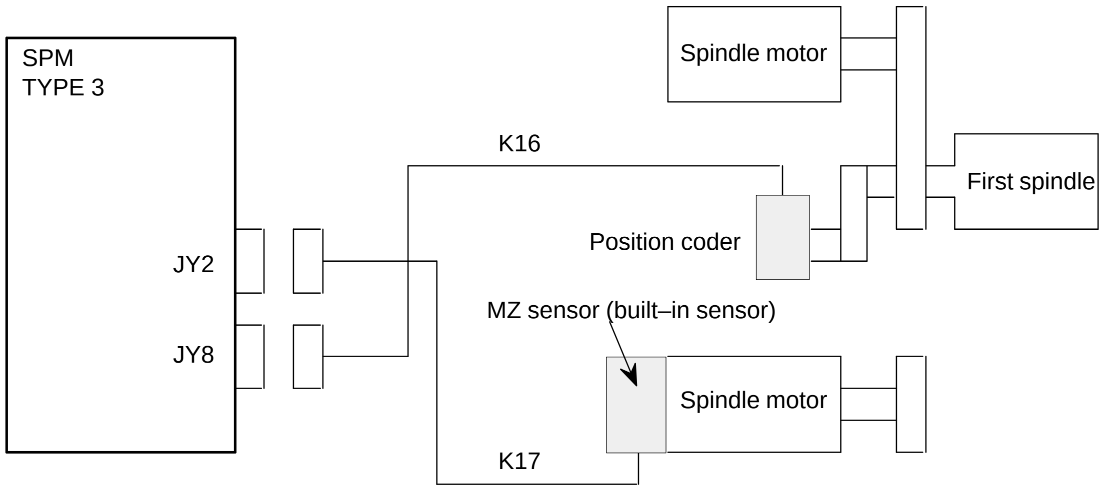


See 9.2.3 (10) and (11) for a detailed description of the connection of cable K14.
See 9.2.3 (16) for a detailed description of the connection of cable K16.
See 9.2.3 (22) for a detailed description of the connection of cable K32.

(24) Speed difference control (TYPE 3 only)

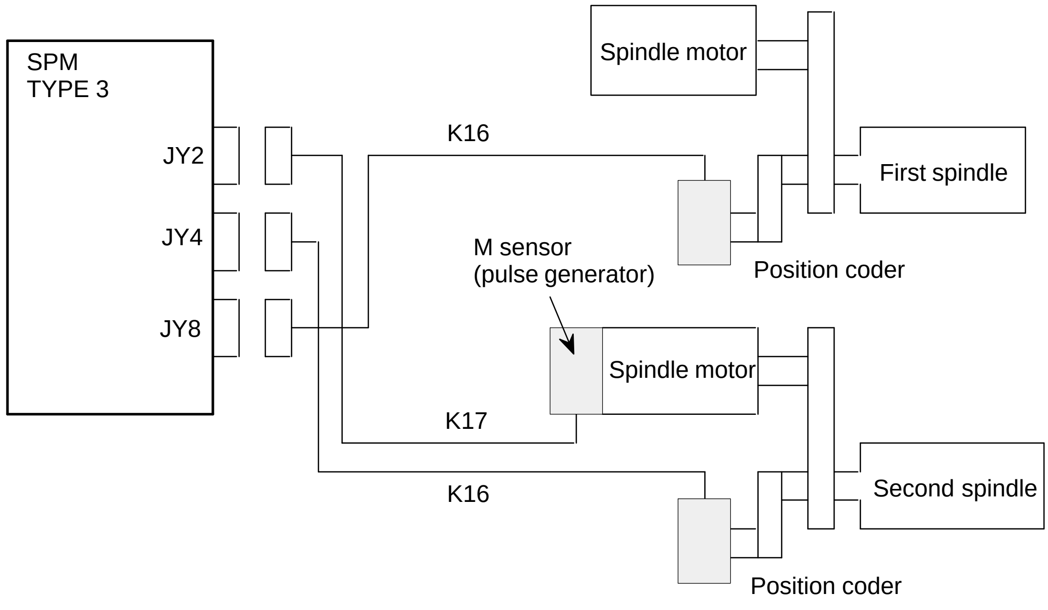
Shown below are examples of speed difference control connection.

Example 1) Using a motor incorporating an MZ sensor for the second spindle



See 9.2.3 (16) for a detailed description of the connection of cable K16.
See 9.2.3 (17) for a detailed description of the connection of cable K17.

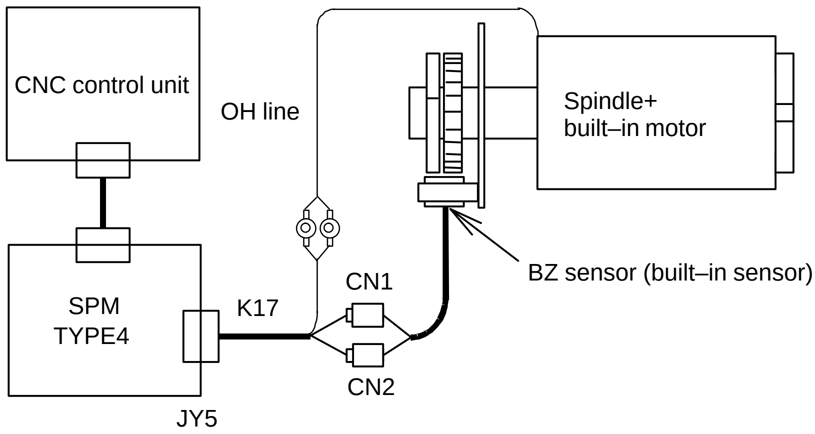
Example 2) Using a position coder for the second spindle



See 9.2.3 (16) for a detailed description of the connection of cable K16.
See 9.2.3 (10) and (11) for a detailed description of the connection of cable K14.

(25) Using the α sensor Cs contour control function

(1) If the spindle–to–motor gear ratio is 1:1
(the spindle is linked directly to the built–in motor or AC spindle motor)



JY5

9	+5V	10	SS	19		20	5V
7	PB	8	*PB	17		18	5V
5	PA	6	*PA	15	OH2	16	0V
3		4		13	OH1	14	0V
1	MZ	2	*MZ	11		12	0V

CN1

1	*VZ	4	
2	*VA	5	VA
3	*VB	6	VB

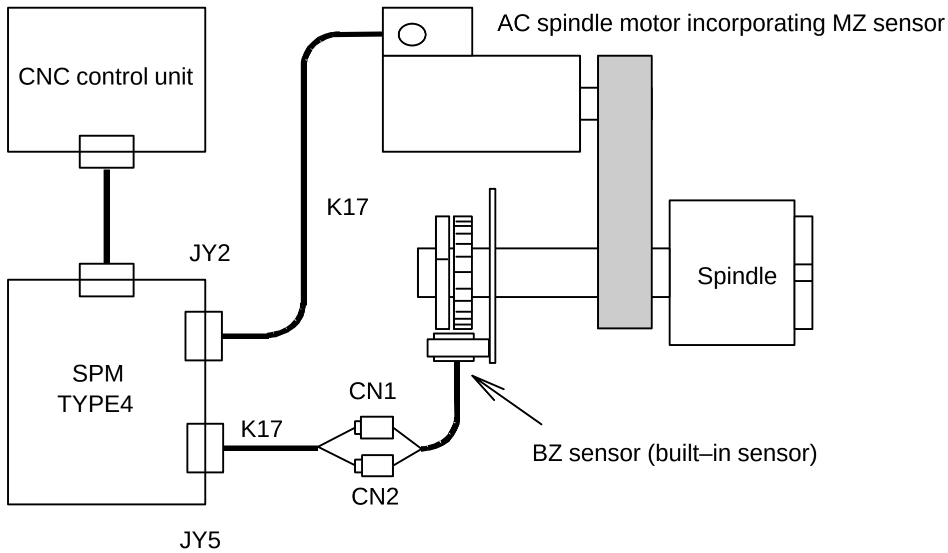
CN1,2
HONDA: Connector Z–374
Contact HKP–F413

CN2

1	5V	4	5V
2	VZ	5	SS
3	0V	6	0V

JY5
HIROSE: Connector FI40A–20S
Housing FI–20–CV5

(2) There is a reduction gear ratio between the spindle and motor (AC spindle motor incorporating MZ sensor + BZ sensor)



JY2, JY5

9	+5V	10	SS	19		20	5V
7	PB	8	*PB	17		18	5V
5	PA	6	*PA	15	OH2	16	0V
3		4		13	OH1	14	0V
1	MZ	2	*MZ	11		12	0V

CN1

1	*VZ	4	
2	*VA	5	VA
3	*VB	6	VB

CN1,2

HONDA: Connector Z–374
Contact HKP–F413

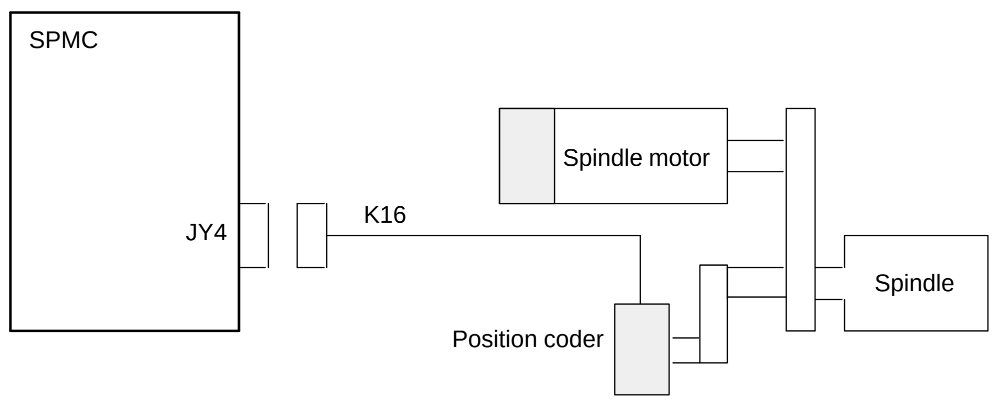
CN2

1	5V	4	5V
2	VZ	5	SS
3	0V	6	0V

JY2, JY5

HIROSE: Connector FI40A–20S
Housing FI–20–CV5

(26) Using a position coder in the SPMC



See 9.2.3 (16) for a detailed description of the connection of cable K16.

(27) Spindle Motor Feedback Cable Connection

1) Outline

An error relating to the feedback signal may occur, depending on the wiring of the connectors in the motor terminal box or the transit box used for connecting the spindle motor feedback cable. To prevent such an error from occurring, observe the following:

2) Description

(1) Error description

If an unshielded portion of the spindle motor feedback cable is long and routed close to a power line in the motor terminal box or transit box, switching of the power transistor may induce noise in the feedback signal, resulting in the following intermittent symptoms:

M sensor (Pulse generator) :
Large speed variation at low speed

MZ sensor, BZ sensor (Built–in sensor) :
Large speed variation at low speed
AL–41 (detection error of one–rotation signal) lights in error
AL–47 (position coder signal error) lights in error

(2) Example of wiring likely to cause faults/recommend wiring method

1 When the unshielded portion is routed through the motor terminal box

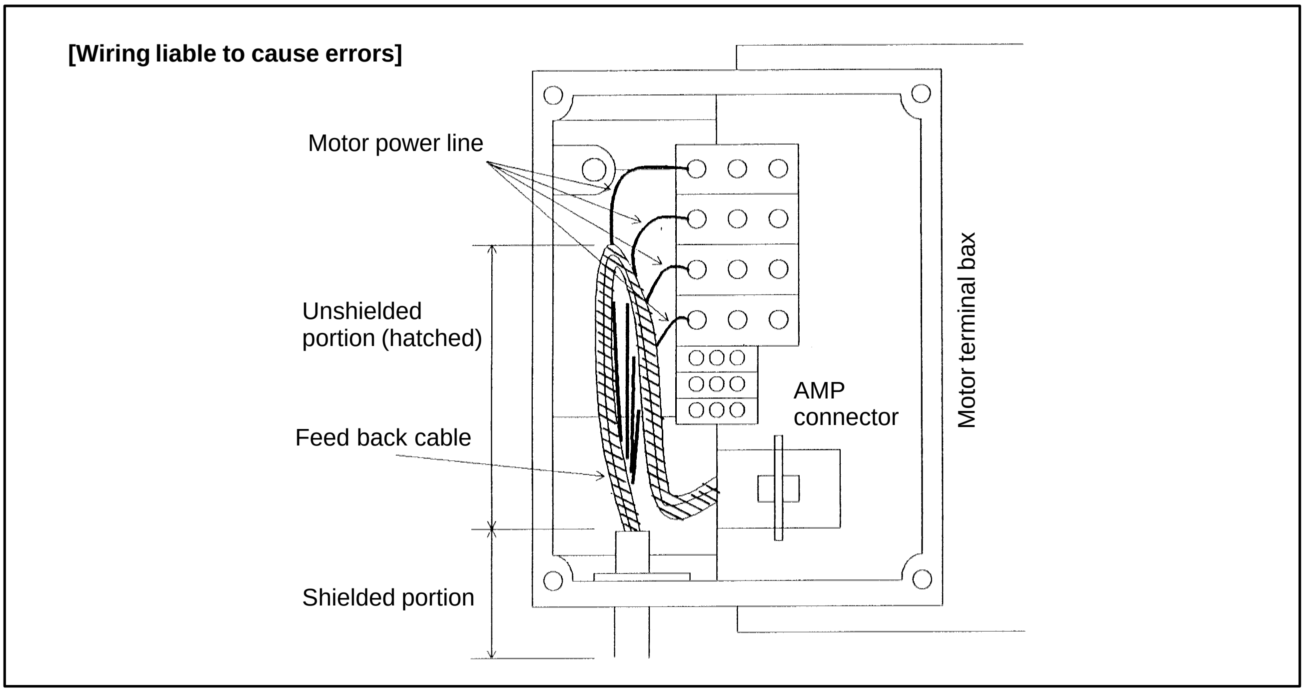


Fig.1

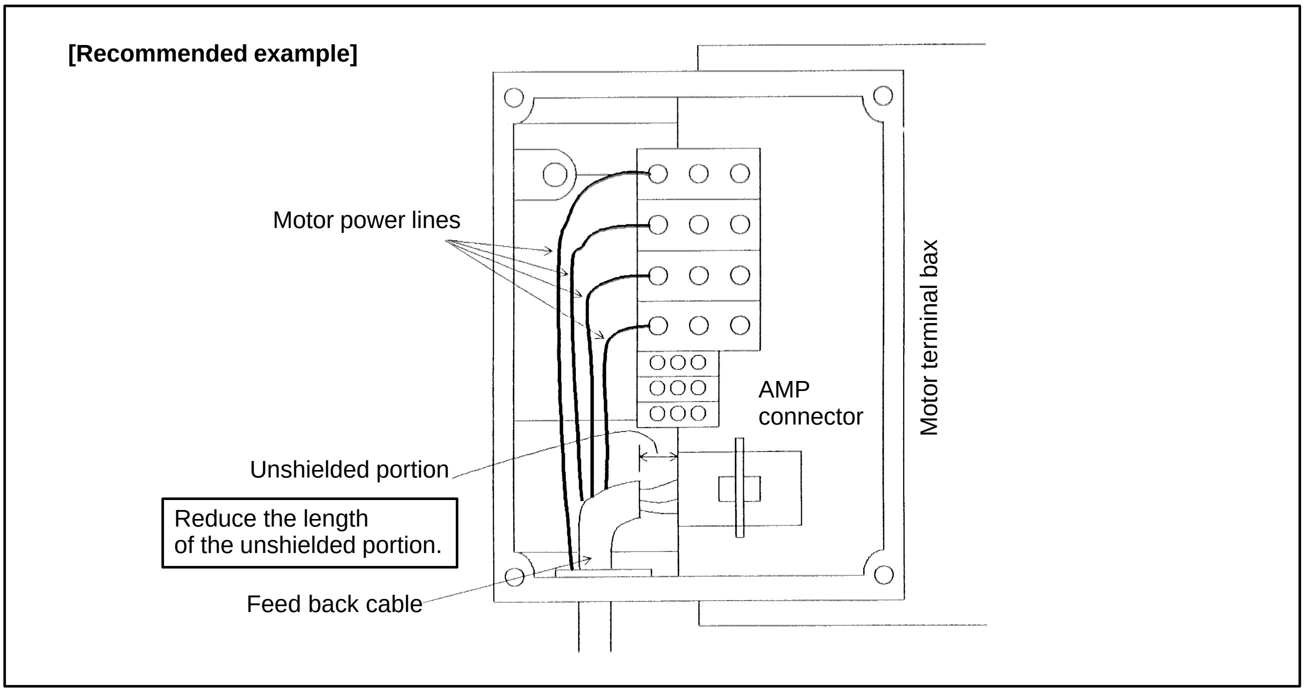


Fig.2

2 When the unshielded portion is routed through the transit box

[Wiring liable to cause errors]

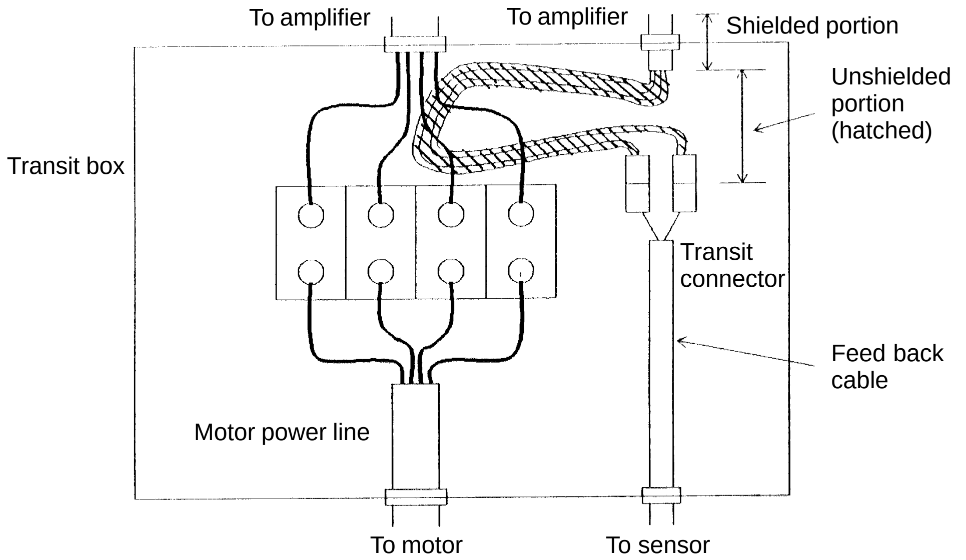


Fig.3

[Recommended example]

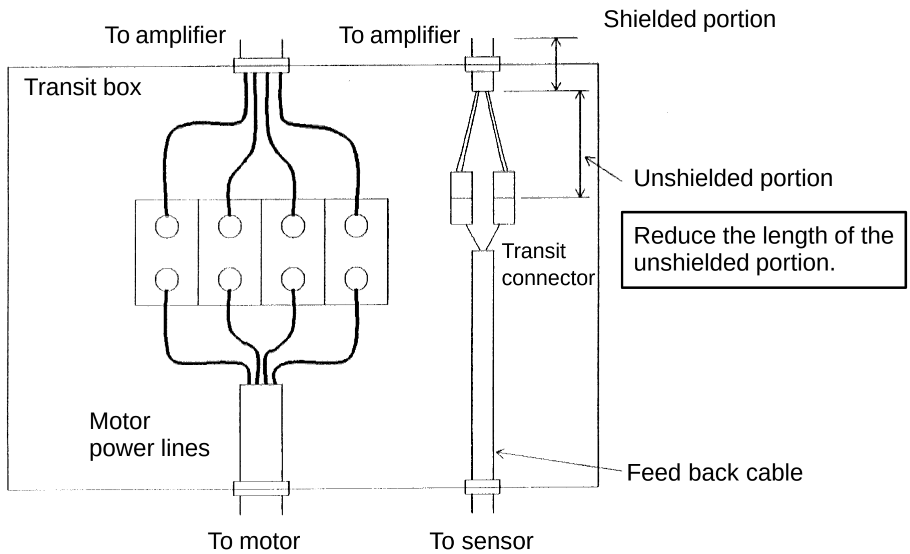


Fig.4

9.3 CONNECTOR LOCATION

9.3.1 Power Supply Module

(a) PSM–5.5, PSM–11

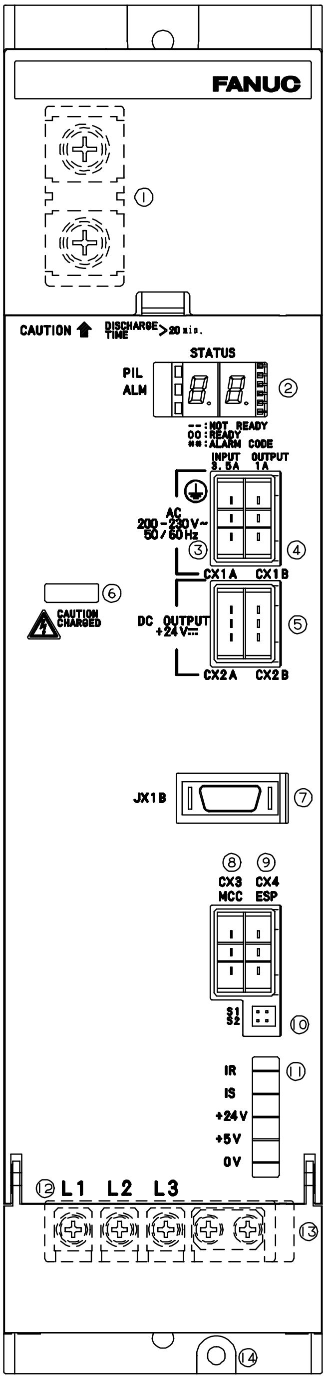


Table.9.3.1 (a) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block	TB1	Display the terminal block TB1
2	Status LED	STATUS	
3	200VAC input connector	CX1A	
4	200VAC output connector	CX1B	
5	24VDC output connector	CX2A/CX2B	Both connectors have same function.
6	DC link charge LED		(Warning)
7	Output connector for interface between modules	JX1B	
8	Connector for main power MCC control signal	CX3	
9	Connector for ESP signal	CX4	
10	Regeneration phase switch	S1/S2	Factory–set to S1
11	Check pin		See (Note) for details
12	Terminal names for terminal block for motor power line		
13	Terminal block for motor power line		Display the terminal block TB2
14	Tapped hole for grounding the flange		

WARNING
Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

NOTE
Detailed functions of check pin
IR : Waveform of R–phase input current
IS : Waveform of S–phase input current
+24V : +24V power supply
+5V : +5V power supply
0V : 0V

(b) PSM–15, PSM–26, PSM–30, PSM–37, PSM–18HV, PSM–30HV, PSM–45HV

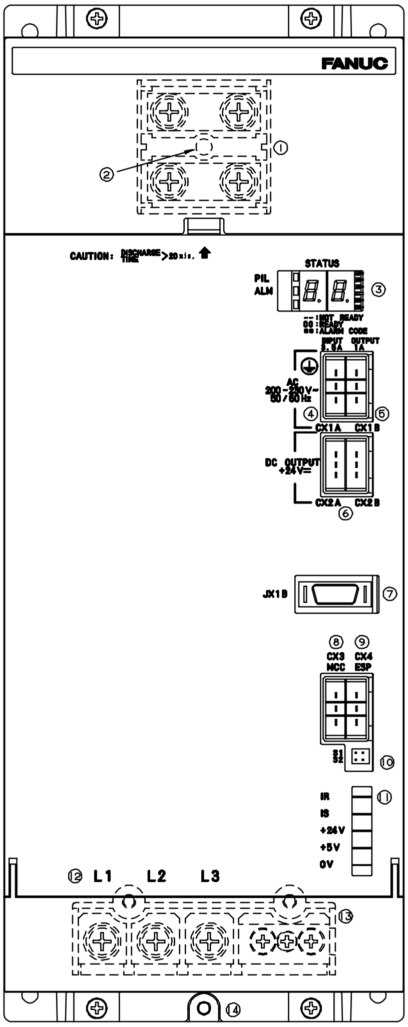


Table.9.3.1 (b) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	DC link charge LED		(Warning)
3	Status LED	STATUS	
4	200VAC input connector	CX1A	
5	200VAC output connector	CX1B	
6	24VDC output connector	CX2A/CX2B	Both connectors have same function.
7	Output connector for inter-face between modules	JX1B	
8	Connector for main power MCC control signal	CX3	
9	Connector for ESP signal	CX4	
10	Regeneration phase switch	S1/S2	Factory–set to S1
11	Check pin		See (Note) for details
12	Terminal names for termi-nal block for motor power line		
13	Terminal block for motor power line	TB2	Display the terminal block TB2
14	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

NOTE

Detailed functions of check pin

IR : Waveform of R–phase input current
IS : Waveform of S–phase input current
+24V : +24V power supply
+5V : +5V power supply
0V : 0V

(c) PSMR–3, 5.5

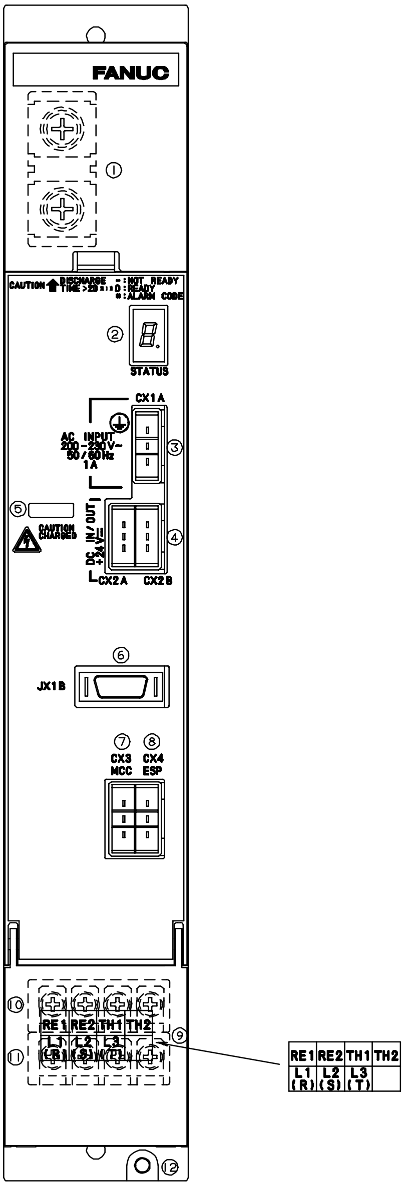


Table.9.3.1 (c) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	Status LED	STATUS	
3	200VAC input connector	CX1A	
4	24VDC output connector	CX2A/CX2B	Both connectors have same function.
5	DC link charge LED		(Warning)
6	Output connector for interface between modules	JX1B	
7	Connector for main power MCC control signal	CX3	
8	Connector for ESP signal	CX4	
9	Terminal block, Terminal names		
10	Terminal for separate type regenerative resistor connection		Display the terminal block TB2
11	Terminal for main power supply connection		Display the terminal block TB2
12	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(d) PSM–45, PSM–75HV

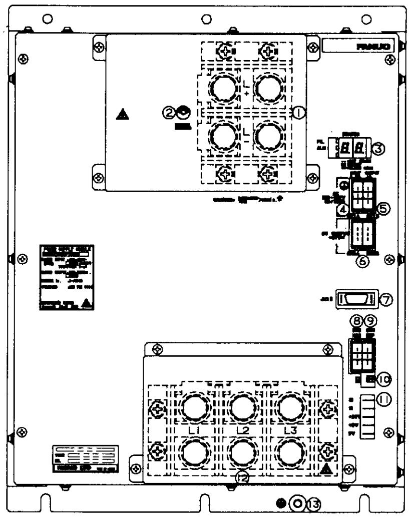


Table.9.3.1 (d) Connector and Terminal Board Names

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	DC link charge LED		(Warning)
3	Status LED	STATUS	
4	200VAC input connector	CX1A	
5	200VAC output connector	CX1B	
6	24VDC output connector	CX2A/CX2B	Both connectors have same function.
7	Output connector for interface between modules	JX1B	
8	Connector for main power MCC control signal	CX3	
9	Connector for ESP signal	CX4	
10	Regeneration phase switch	S1/S2	Factory–set to S1
11	Check pin		See (Note) for details
12	Terminal block for motor power line		Display the terminal block TB2
13	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

NOTE

Detailed functions of check pin

IR : Waveform of R–phase input current
IS : Waveform of S–phase input current
+24V : +24V power supply
+5V : +5V power supply
0V : 0V

(e) PSMV–11HV

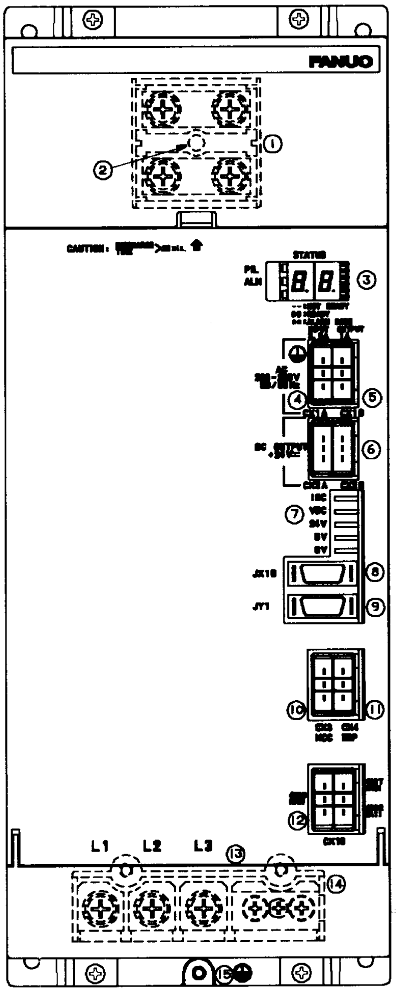


Table.9.3.1 (e) Connector and Terminal Board Names

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	DC link charge LED		(Warning)
3	Status LED	STATUS	
4	200VAC input connector	CX1A	
5	200VAC output connector	CX1B	
6	24VDC output connector	CX2A/CX2B	Both connectors have same function.
7	Check pin		See (Note) for details
8	Output connector for interface between modules	JX1B	
9	Connector for test by FANUC	JY1	
10	Connector for main power MCC control signal	CX3	
11	Connector for ESP signal	CX4	
12	Connector for phase detection signal	CX10	
13	Terminal names for terminal block for motor power line		
14	Terminal block for motor power line		Display the terminal block TB2
15	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

NOTE

Detailed functions of check pin

IDC : DC link current waveform
VDC : DC link voltage waveform
+24V : +24V power supply
+5V : +5V power supply
0V : 0V

9.3.2 Servo Amplifier Module

1. TYPE A, TYPE B Interface

(a) SVM1–12, SVM1–20, SVM1–40S, SVM1–40L,SVM1–80

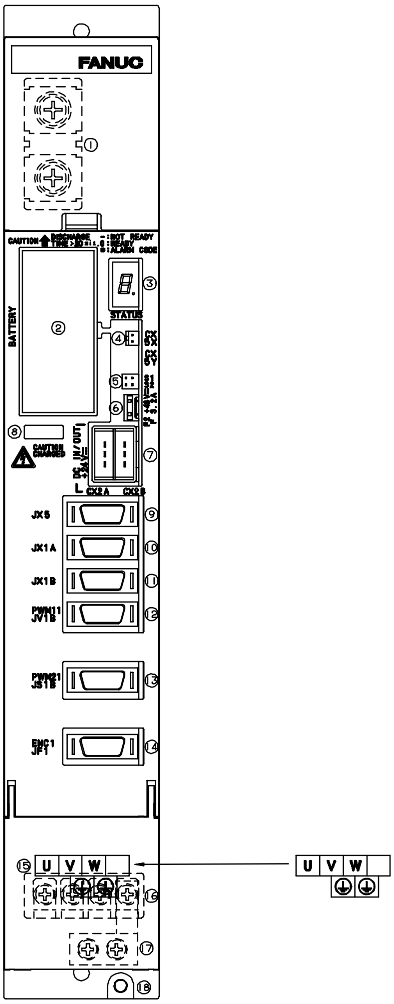


Table.9.3.2 (a) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		M6
2	Battery for ABS pulse coder	BATTERY	A06B–6073–K001
3	Status LED	STATUS	
4	Power connector for ABS pulse coder battery	CX5X	
5	Interface switching connector	S1/S2	Type–A interface: S1 Type–B interface: S2
6	Fuse for 24V power	F2	
7	24V power I/O connector	CX2A/CX2B	Both connectors have same function.
8	DC link charge LED		(Warning)
9	Signal check connector	JX5	Use an SVM check board.
10	Input connector for interface between modules	JX1A	
11	Output connector for interface between modules	JX1B	
12	NC interface connector for type–A interface	PWM11/JV1B	FS16, FS18, FS15, FS0, etc.
13	NC interface connector for type–B interface	PWM21/JS1B	FS20, FS21–G, etc.
14	Pulse coder connector	ENC1/JF1	Only for type–B interface
15	Terminal names for terminal block for motor power line		
16	Terminal block for motor power line		Display the terminal block TB2
17	Earth plate		Attached to amplifier
18	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(b) SVM1–130

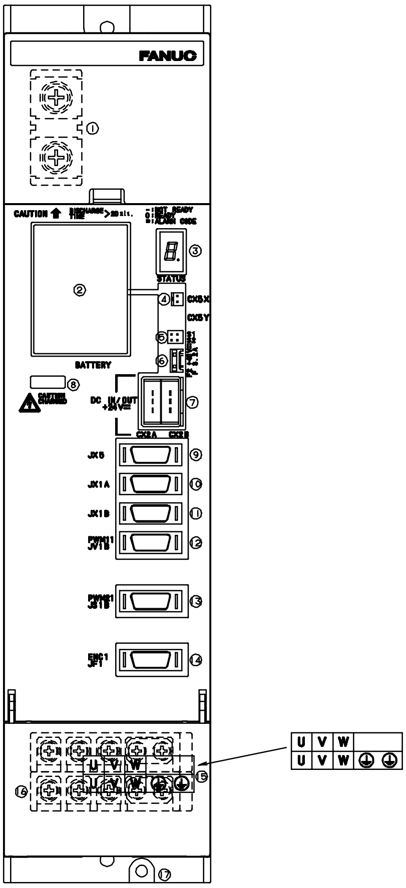


Table.9.3.2 (b) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB2
2	Battery for ABS pulse coder	BATTERY	A06B–6073–K001
3	Status LED	STATUS	
4	Power connector for ABS pulse coder battery	CX5X	
5	Interface switching connector	S1/S2	Type–A interface: S1 Type–B interface: S2
6	Fuse for 24V power	F2	3.2A, 48VDC
7	24V power I/O connector	CX2A/CX2B	Both connectors have same function.
8	DC link charge LED		(Warning)
9	Signal check connector	JX5	Use an SVM check board.
10	Input connector for interface between modules	JX1A	
11	Output connector for interface between modules	JX1B	
12	NC interface connector for type–A interface	PWM11/JV1B	FS16, FS18, FS15, FS0, etc.
13	NC interface connector for type–B interface	PWM21/JS1B	FS20, FS21–G, etc.
14	Pulse coder connector	ENC1/JF1	Only for type–B interface
15	Terminal names for terminal block for motor power line		
16	Terminal block for motor power line		Display the terminal block TB2
17	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(c) SVM1–130, SVM1–20HV, SVM1–40HV, SVM1–60HV

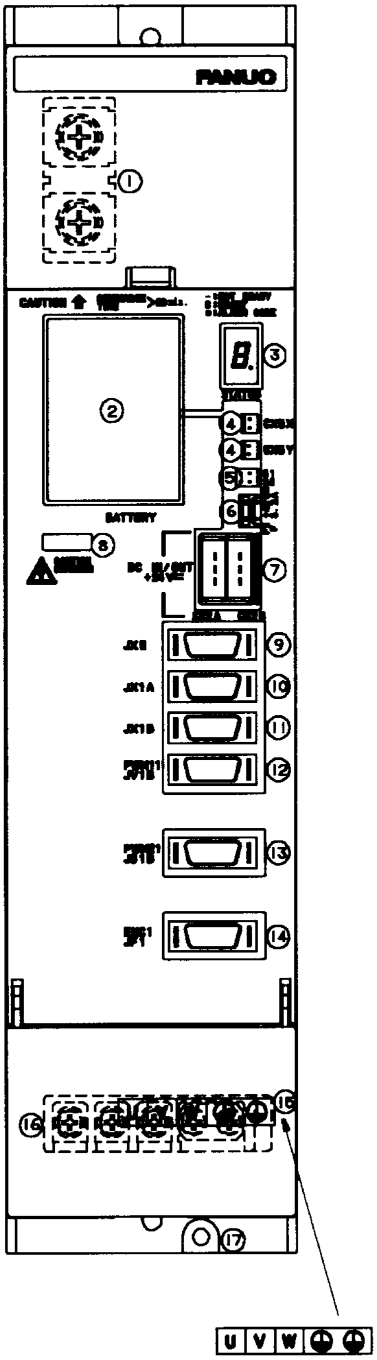


Table.9.3.2 (c) Connector and Terminal Board Names

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB2
2	Battery for ABS pulse coder	BATTERY	A06B–6073–K001
3	Status LED	STATUS	
4	Power connector for ABS pulse coder battery	CX5X	
5	Interface switching connector	S1/S2	Type–A interface: S1 Type–B interface: S2
6	Fuse for 24V power	F2	3.2A, 48VDC
7	24V power I/O connector	CX2A/CX2B	Both connectors have same function.
8	DC link charge LED		(Warning)
9	Signal check connector	JX5	Use an SVM check board.
10	Input connector for interface between modules	JX1A	
11	Output connector for interface between modules	JX1B	
12	NC interface connector for type–A interface	PWM11/JV1B	FS16, FS18, FS15, FS0, etc.
13	NC interface connector for type–B interface	PWM21/JS1B	FS20, FS21–G, etc.
14	Pulse coder connector	ENC1/JF1	Only for type–B interface
15	Terminal names for terminal block for motor power line		
16	Terminal block for motor power line		Display the terminal block TB2
17	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(d) SVM2–12/12, SVM2–12/20, SVM2–20/20,SVM2–12/40, SVM2–20/40, SVM2–40/40

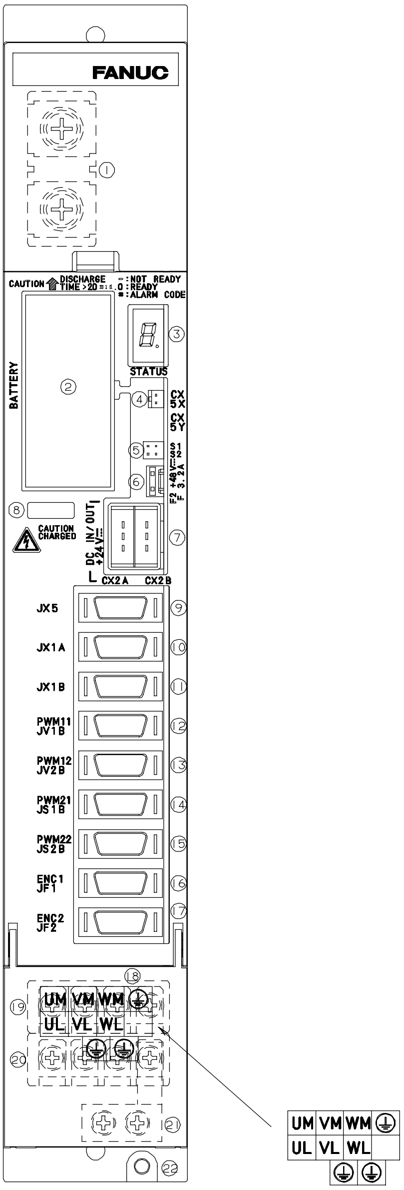


Table.9.3.2 (d) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB2
2	Battery for ABS pulse coder	BATTERY	A60B–6073–K001
3	Status LED	STATUS	
4	Power connector for ABS pulse coder battery	CX5X	
5	Interface switching connector	S1/S2	Type–A interface: S1 Type–B interface: S2
6	Fuse for 24V power	F2	3.2A, 48VDC
7	24V power I/O connector	CX2A/CX2B	
8	DC link charge LED		(Warning)
9	Signal check connector	JX5	Use an SVM check board.
10	Input connector for interface between modules	JX1A	
11	Output connector for interface between modules	JX1B	
12	NC interface connector : L axis for type–A interface	PWM11/JV1B	FS16,FS18,FS15,FS0,etc
13	NC interface connector : M axis for type–A interface	PWM12/JV2B	FS16, FS18, FS15, FS0, etc
14	NC interface connector : L axis for type–B interface	PWM21/JS1B	FS20, FS21–G, etc.
15	NC interface connector : M axis for type–B interface	PWM22/JS2B	FS20, FS21–G, etc.
16	Pulse coder connector : L axis	ENC1/JF1	Only for type–B interface
17	Pulse coder connector : M axis	ENC2/JF2	Only for type–B interface
18	Terminal names for terminal block for motor power line		
19	Terminal block for motor power line : M axis		Display the terminal block TB2
20	Terminal block for motor power line : L axis		Display the terminal block TB2
21	Earth plate		Attatched to amplifier
22	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(e) SVM2–40/80, SVM2–80/80, SVM2–20/20HV, SVM2–20/40HV, SVM2–20/60HV, SVM2–40/40HV, SVM2–40/60HV, SVM2–60/60HV

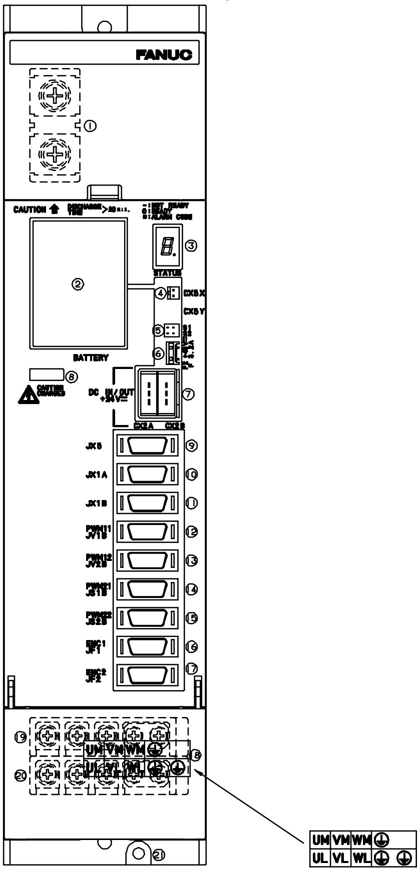


Table.9.3.2 (e) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB2
2	Battery for ABS pulse coder	BATTERY	A06B–6073–K001
3	Status LED	STATUS	
4	Power connector for ABS pulse coder battery	CX5X	
5	Interface switching connector	S1/S2	Type–A interface: S1 Type–B interface: S2
6	Fuse for 24V power	F2	32A, 48VDC
7	24V power I/O connector	CX2A/CX2B	Both connectors have same function.
8	DC link charge LED		(Warning)
9	Signal check connector	JX5	Use an SVM check board.
10	Input connector for interface between modules	JX1A	
11	Output connector for interface between modules	JX1B	
12	NC interface connector : L axis for type–A interface	PWM11/JV1B	FS16, FS18, FS15, FS0, etc
13	NC interface connector : M axis for type–A interface	PWM12/JV2B	FS16, FS18, FS15, FS0, etc
14	NC interface connector : L axis for type–B interface	PWM21/JS1B	FS20, FS21–G, etc.
15	NC interface connector : M axis for type–B interface	PWM22/JS2B	FS20, FS21–G, etc.
16	Pulse coder connector : L axis	ENC1/JF1	Only for type–B interface
17	Pulse coder connector : M axis	ENC2/JF2	Only for type–B interface
18	Terminal names for terminal block for motor power line		
19	Terminal block for motor power line : M axis		Display the terminal block TB2
20	Terminal block for motor power line : L axis		Display the terminal block TB2
21	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(f) SVM3–12/12/12,SVM3–12/12/20, SVM3–12/20/20, SVM3–20/20/20, SVM3–12/12/40 SVM3–12/20/40, SVM3–20/20/40

(f)–1 TYPE A

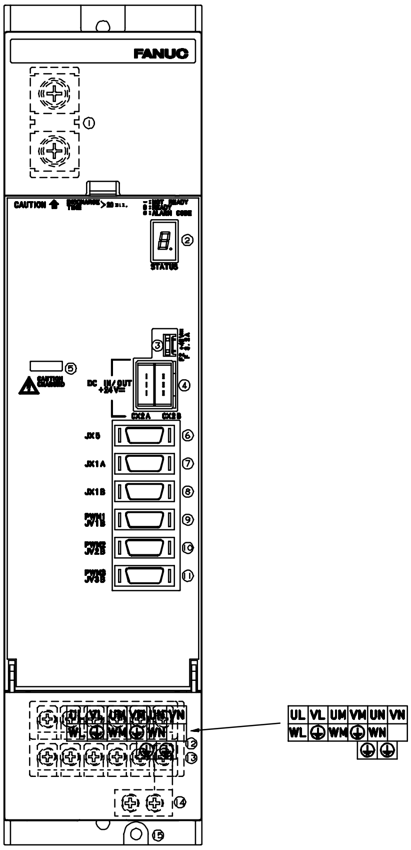


Table.9.3.2 (f) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	Status LED	STATUS	
3	Fuse for 24V power	F2	3.2A, 48VDC
4	24V power I/O connector	CX2A/CX2B	Both connectors have same function.
5	DC link charge LED		(Warning)
6	Signal check connector	JX5	Use an SVM check board.
7	Input connector for interface between modules	JX1A	
8	Output connector for interface between modules	JX1B	
9	NC interface connector : L axis for type–A interface	PWM1/JV1B	
10	NC interface connector : M axis for type–A interface	PWM2/JV2B	
11	NC interface connector : N axis for type–A interface	PWM3/JV3B	
12	Terminal block for motor power line		
13	Terminal names for terminal block for motor power line		Display the terminal block TB2
14	Earth plate		Attatched tp amplifier
15	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(g)–2 TYPE B

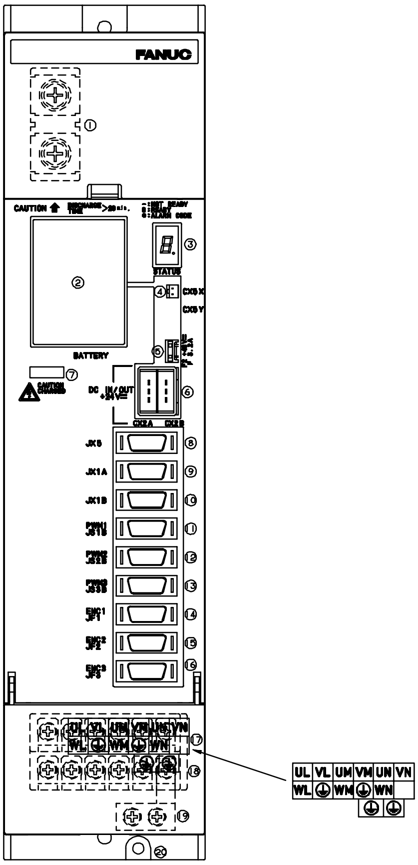


Table.9.3.2 (g) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	Battery for ABS pulse coder	BATTERY	A06B–6073–K001
3	Status LED	STATUS	
4	Power connector for ABS pulse coder battery	CX5X	Both connectors have same function.
5	Fuse for 24V power	F2	3.2A, 48VDC
6	24V power I/O connector	CX2A/CX2B	Both connectors have same function.
7	DC link charge LED		(Warning)
8	Signal check connector	JX5	Use an SVM check board.
9	Input connector for interface between modules	JX1A	
10	Output connector for interface between modules	JX1B	
11	NC interface connector : L axis for type–B interface	PWM1/JS1B	
12	NC interface connector : M axis for type–B interface	PWM2/JS2B	
13	NC interface connector : N axis for type–B interface	PWM3/JS3B	
14	Pulse coder connector : L axis	ENC1/JF1	
15	Pulse coder connector : M axis	ENC2/JF2	
16	Pulse coder connector : N axis	ENC3/JF3	
17	Terminal block for motor power line		
18	Terminal names for terminal block for motor power line		Display the terminal block TB2
19	Earth plate		Attatched to amplifier
20	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(h)–2 SVM1–240 SVM1–360

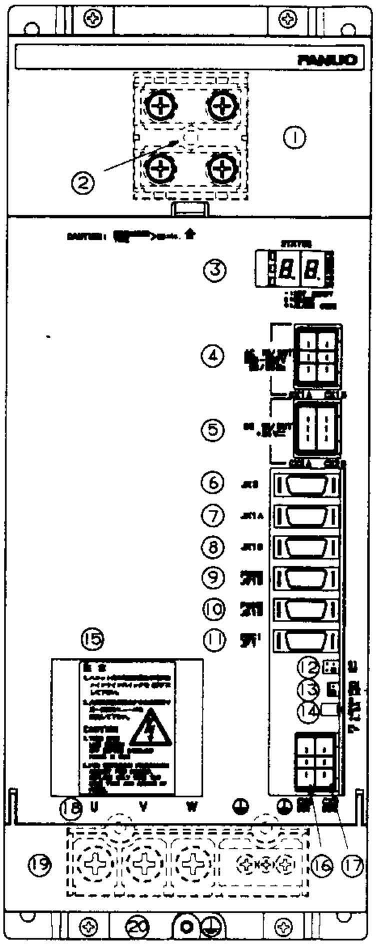


Table.9.3.2 (h) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	DC link charge LED		(Warning)
3	Status LED	STATUS	
4	24VDC power I/O connector	CX1A/CX1B	
5	24V power I/O connector	CX2A/CX2B	Both connectors have same function.
6	Signal check connector	JX5	Use an SVM check board.
7	Input connector for interface between modules	JX1A	
8	Output connector for interface between modules	JX1B	
9	CNC interface connector TYPE A interface	PWM11/JV1B	
10	CNC interface connector TYPE B interface	PWM11/JS1B	
11	Pulse coder connector	JF1	For TYPE B interface only
12	Interface changeover connector	S1 S2	TYPE A Interface : S1 TYPE B Interface : S2
13	Power connector for ABS pulse coder battery	CX5X	
14	Fuse for 24V power		
15	Battery for ABS pulse coder	BATTERY	A06B–6073–K001
16	Dynamic brake interface connector	CX8	
17	Dynamic brake drive coil connector	CX9	
18	Terminal block for motor power line		
19	Terminal names for terminal block for motor power line		Display the terminal block TB2
20	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

2. FSSB Interface

(a) SVM1–12, SVM1–20, SVM1–40S, SVM1–40L, SVM1–80

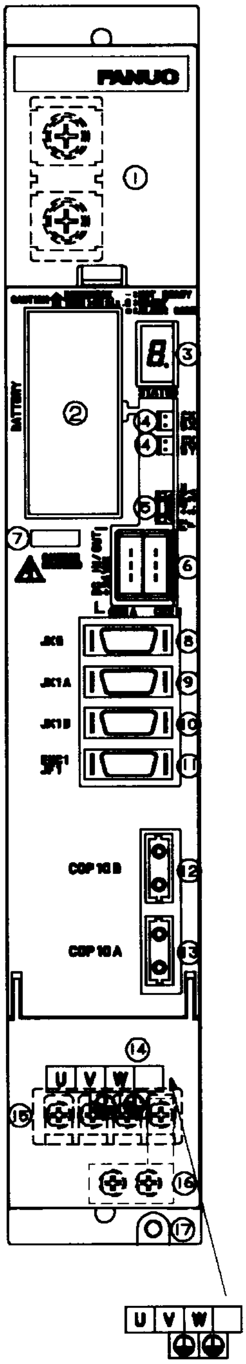


Table.9.3.2 (i) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	Battery for ABS pulse coder	BATTERY	A06B–6073–K001
3	Status LED	STATUS	
4	Power connector for ABS pulse coder battery	CX5X CX5Y	Both connectors have same function.
5	Fuse for 24V power	F2	3.2A, 48VDC
6	24V power I/O connector	CX2A CX2B	Both connectors have same function.
7	DC link charge LED		(Warning)
8	Signal check connector	JX5	Use an SVM check board.
9	Input connector for interface between modules	JX1A	
10	Output connector for interface between modules	JX1B	
11	Pulse coder connector	ENC1/JF1	
12	FSSB optical input connector	COP10B	
13	FSSB optical output connector	COP10A	
14	Terminal block for motor power line		
15	Terminal names for terminal block for motor power line		Display the terminal block TB2
16	Earth plate		Attatched to amplifier
17	Tapped hole for grounding the flange		

WARNING
Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(b) SVM1–130

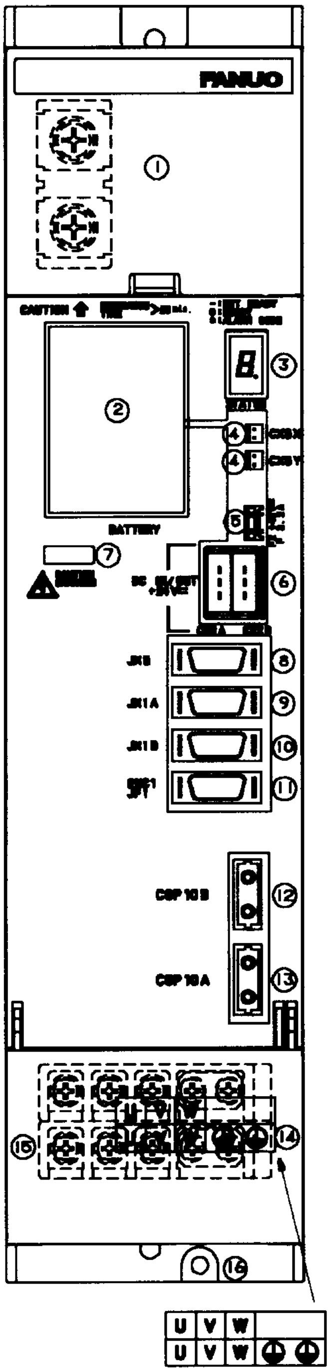


Table.9.3.2 (j) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	Battery for ABS pulse coder	BATTERY	A06B–6073–K001
3	Status LED	STATUS	
4	Power connector for ABS pulse coder battery	CX5X CX5Y	Both connectors have same function.
5	Fuse for 24V power	F2	3.2A, 48VDC
6	24V power I/O connector	CX2A CX2B	Both connectors have same function.
7	DC link charge LED		(Warning)
8	Signal check connector	JX5	Use an SVM check board.
9	Input connector for interface between modules	JX1A	
10	Output connector for interface between modules	JX1B	
11	Pulse coder connector	ENC1/JF1	
12	FSSB optical input connector	COP10B	
13	FSSB optical output connector	COP10A	
14	Terminal block for motor power line		
15	Terminal names for terminal block for motor power line		Display the terminal block TB2
16	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(c) SVM1–20HV, SVM1–40HV, SVM1–60HV

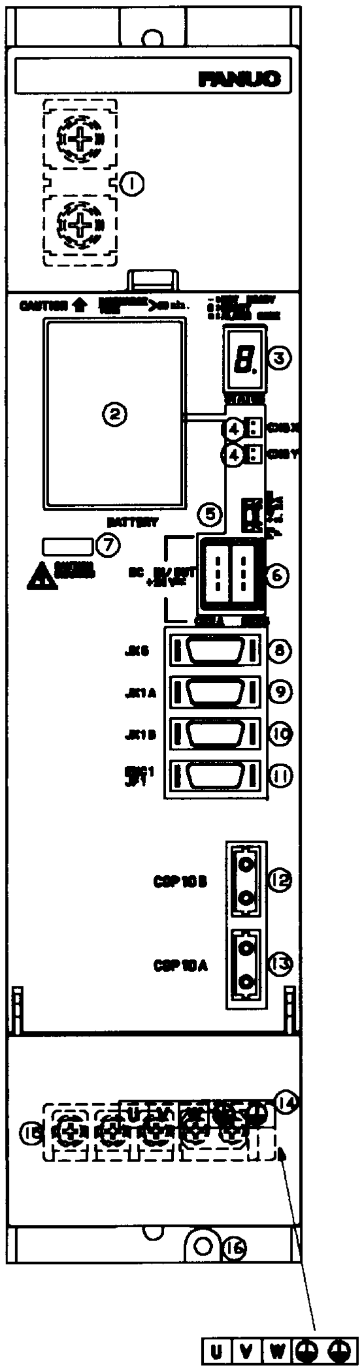


Table.9.3.2 (k) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	Battery for ABS pulse coder	BATTERY	A06B–6073–K001
3	Status LED	STATUS	
4	Power connector for ABS pulse coder battery	CX5X CX5Y	Both connectors have same function.
5	Fuse for 24V power	F2	3.2A, 48VDC
6	24V power I/O connector	CX2A CX2B	Both connectors have same function.
7	DC link charge LED		(Warning)
8	Signal check connector	JX5	Use an SVM check board.
9	Input connector for interface between modules	JX1A	
10	Output connector for interface between modules	JX1B	
11	Pulse coder connector	ENC1/JF1	
12	FSSB optical input connector	COP10B	
13	FSSB optical output connector	COP10A	
14	Terminal block for motor power line		
15	Terminal names for terminal block for motor power line		Display the terminal block TB2
16	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(d) SVM2–12/12, SVM2–12/20, SVM2–20/20, SVM2–12/40, SVM2–20/40, SVM2–40/40

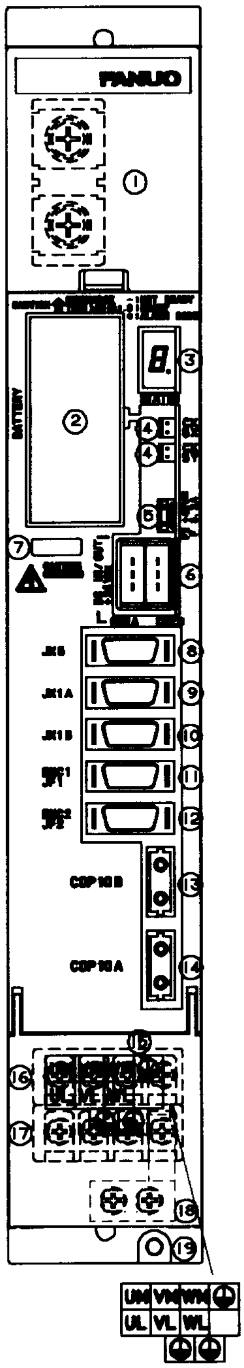


Table.9.3.2 (l) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	Battery for ABS pulse coder	BATTERY	A06B–6073–K001
3	Status LED	STATUS	
4	Power connector for ABS pulse coder battery	CX5X CX5Y	Both connectors have same function.
5	Fuse for 24V power	F2	3.2A, 48VDC
6	24V power I/O connector	CX2A/CX2B	Both connectors have same function.
7	DC link charge LED		(Warning)
8	Signal check connector	JX5	Use an SVM check board.
9	Input connector for interface between modules	JX1A	
10	Output connector for interface between modules	JX1B	
11	Pulse coder connector for the L–axis	ENC1/JF1	
12	Pulse coder connector for the M–axis	ENC2/JF2	
13	FSSB optical input connector	COP10B	
14	FSSB optical output connector	COP10A	
15	Terminal block for motor power line		
16	Motor power line terminal board for the M–axis		Display the terminal block TB2
17	Motor power line terminal board for the L–axis		Display the terminal block TB2
18	Earth plate		Attatched to amplifier
19	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(e) SVM2–12/12, SVM2–12/20, SVM2–20/20, SVM2–12/40, SVM2–20/40, SVM2–40/40

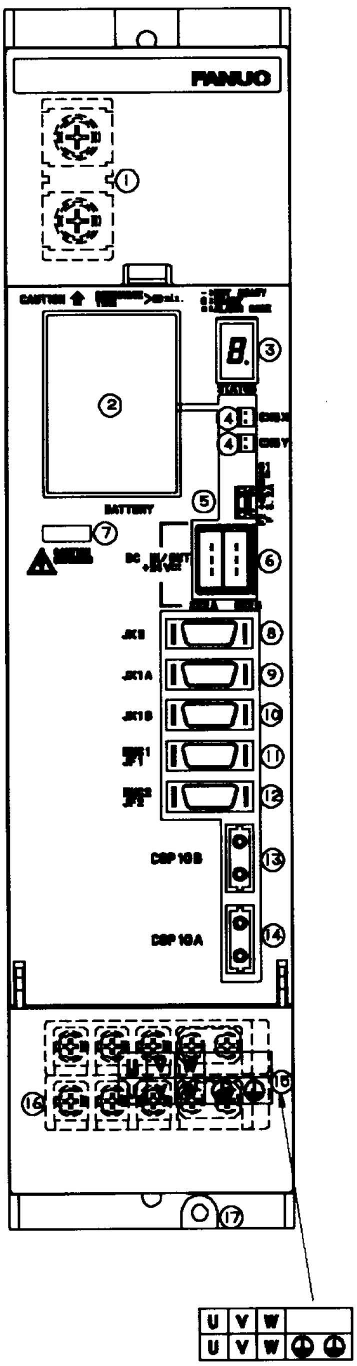


Table.9.3.2 (m) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	Battery for ABS pulse coder	BATTERY	A06B–6073–K001
3	Status LED	STATUS	
4	Power connector for ABS pulse coder battery	CX5X/CX5Y	Both connectors have same function.
5	Fuse for 24V power	F2	3.2A, 48VDC
6	24V power I/O connector	CX2A/CX2B	Both connectors have same function.
7	DC link charge LED		(Warning)
8	Signal check connector	JX5	Use an SVM check board.
9	Input connector for interface between modules	JX1A	
10	Output connector for interface between modules	JX1B	
11	Pulse coder connector for the L–axis	ENC1/JF1	
12	Pulse coder connector for the M–axis	ENC2/JF2	
13	FSSB optical input connector	COP10B	
14	FSSB optical output connector	COP10A	
15	Terminal block for motor power line		
16	Motor power line terminal board for the M–axis		Display the terminal block TB2
17	Motor power line terminal board for the L–axis		Display the terminal block TB2
18	Tapped hole for grounding the flange		

WARNING
Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(f) SVM3–12/12/12, SVM3–12/12/20, SVM3–12/20/20, SVM3–20/20/20, SVM3–12/12/40, SVM3–12/20/40, SVM3–20/20/40

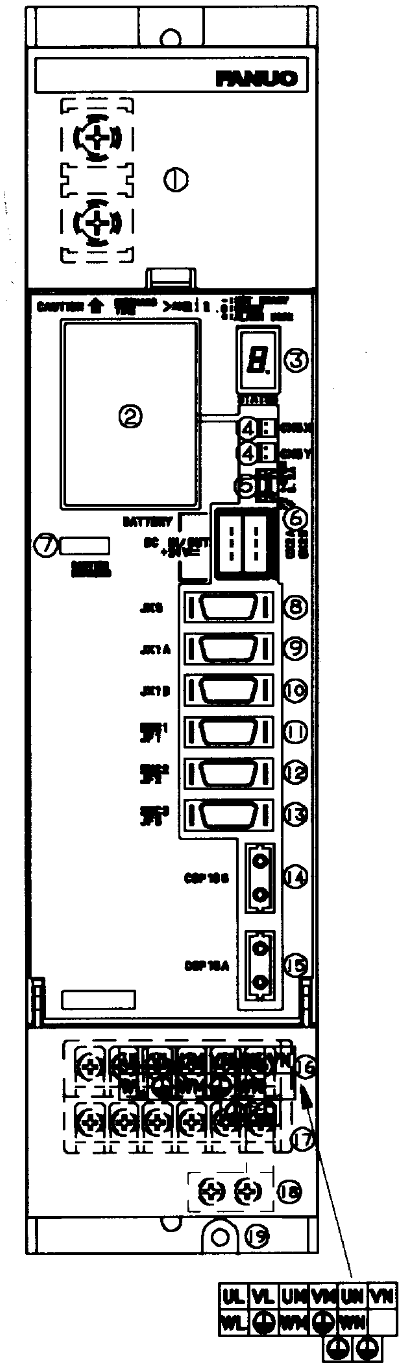


Table.9.3.2 (n) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	Battery for ABS pulse coder	BATTERY	A06B–6073–K001
3	Status LED	STATUS	
4	Power connector for ABS pulse coder battery	CX5X CX5Y	Both connectors have same function.
5	Fuse for 24V power	F2	3.2A, 48VDC
6	24V power I/O connector	CX2A/CX2B	Both connectors have same function.
7	DC link charge LED		(Warning)
8	Signal check connector	JX5	Use an SVM check board.
9	Input connector for interface between modules	JX1A	
10	Output connector for interface between modules	JX1B	
11	Pulse coder connector for the L–axis	ENC1/JF1	
12	Pulse coder connector for the M–axis	ENC2/JF2	
13	Pulse coder connector for the N–axis	ENC3/JF3	
14	FSSB optical input connector	COP10B	
15	FSSB optical output connector	COP10A	
16	Terminal block for motor power line		
17	Terminal names for terminal block for motor power line		Display the terminal block TB2
18	Earth plate		Attatched to amplifier
19	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(g) SVM1–240, SVM1–360

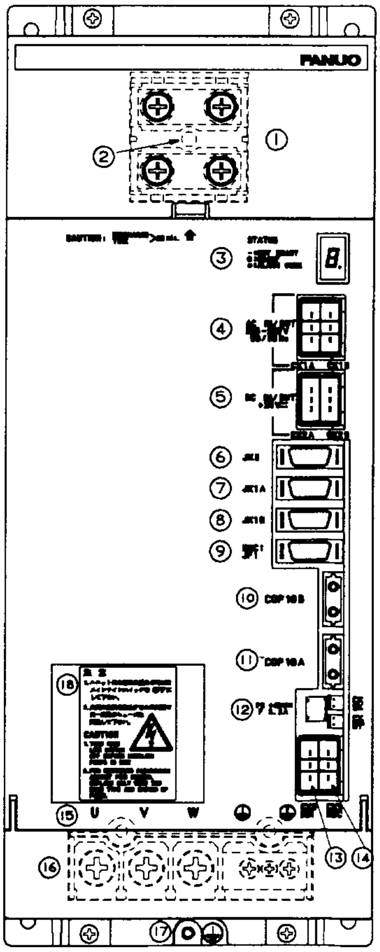


Table.9.3.2 (o) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	DC link charge LED		(Warning)
3	Status LED	STATUS	
4	200 VAC power input/output connector	CX1A/CX1B	
5	24 VDC power input/output connector	CX2A/CX2B	Both connectors have same function.
6	Signal check connector	JX5	
7	Input connector for interface between modules	JX1A	
8	Output connector for interface between modules	JX1B	
9	Pulse coder connector	JF1	
10	FSSB optical input connector	COP10B	
11	FSSB optical output connector	COP10A	
12	Power connector for ABS pulse coder battery	CX5X CX5Y	
13	Dynamic brake interface connector	CX8	
14	Dynamic brake drive coil connector	CX9	
15	Terminal block for motor power line		
16	Terminal names for terminal block for motor power line		Display the terminal block TB2
17	Tapped hole for grounding the flange		
18	Battery for ABS pulse coder		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

9.3.3 Spindle Amplifier Module

(a) SPM–2.2

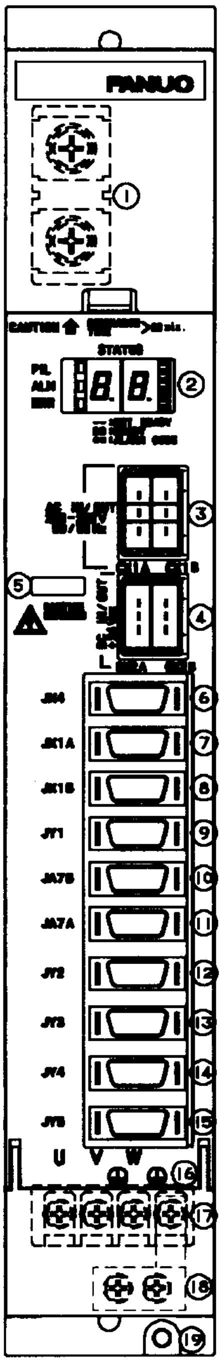


Table.9.3.3 (a) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	Status LED	STATUS	
3	200VAC I/O connector	CX1A/CX1B	Both connectors have same function.
4	24 VDC connector	CX2A/CX2B	
5	DC link charge LED		(Warning)
6	Connector for signal check, pulse generator signal output, and position coder signal output	JX4	Use an SPM check board.
7	Output connector for interface between modules	JX1A	
8	Input connector for interface between modules	JX1B	
9	Connector for load meter and speedometer	JY1	
10	Input connector for electric serial interface	JA7B	
11	Output connector for electric serial interface	JA7A	
12	Connector for pulse generator, built–in sensor, and Cs axis sensor for motor	JY2	
13	Connector for magnetic sensor and external single rotation signal	JY3	
14	Connector for position coder and high–resolution position coder	JY4	
15	Connector for Cs–axis sensor for spindle and built–in Cs–axis sensor	JY5	TYPE 2, 4
16	Terminal names for terminal block for motor power line		
17	Terminal block for motor power line	TB2	Display the terminal block TB2
18	Earth plate		Attatched to amplifier
19	Tapped hole for grounding the flange		

WARNING
Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(b) SPM–5.5, SPM–11, SPM–11HV (TYPE 1, 2, 4)

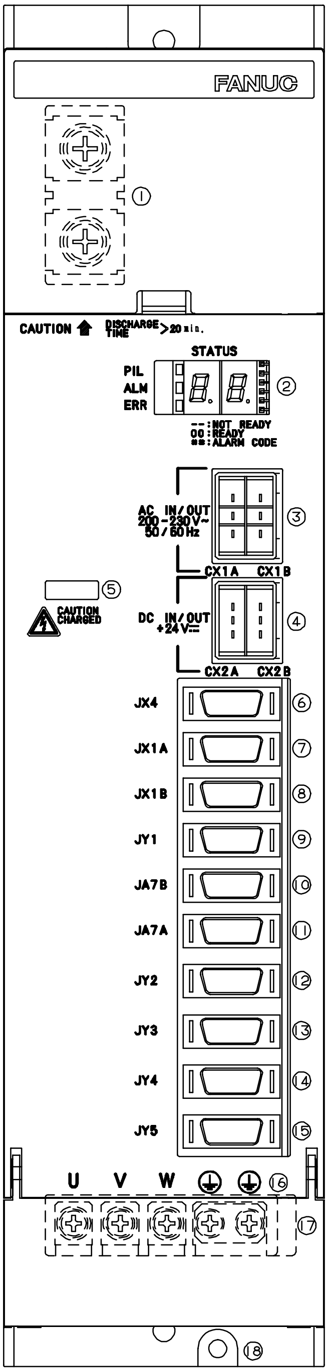


Table.9.3.3 (b) Names of connectors and terminal blocks

	Name	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	Status LED	STATUS	
3	200VAC I/O connector	CX1A/CX1B	Both connectors have same function.
4	24 VDC connector	CX2A/CX2B	
5	DC link charge LED		(Warning)
6	Connector for signal check, pulse generator signal output, and position coder signal output	JX4	Use an SPM check board.
7	Output connector for interface between modules	JX1A	
8	Input connector for interface between modules	JX1B	
9	Connector for load meter and speedometer	JY1	
10	Input connector for electric serial interface	JA7B	
11	Output connector for electric serial interface	JA7A	
12	Connector for pulse generator, built–in sensor, and Cs axis sensor for motor	JY2	
13	Connector for magnetic sensor and external single rotation signal	JY3	
14	Connector for position coder and high–resolution position coder	JY4	
15	Connector for Cs–axis sensor for spindle and built–in Cs–axis sensor	JY5	Only for TYPE II
16	Terminal names for terminal block for motor power line		
17	Terminal block for motor power line		Display the terminal block TB2
18	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(c) SPM–15, 22, 26, 30, SPM–15HV, 26HV, 45HV (TYPE 1, 2, 4)

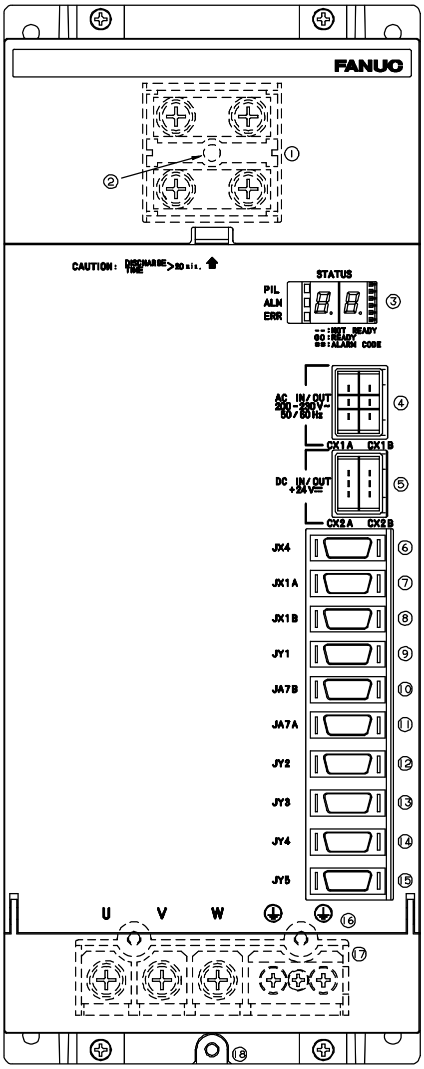


Table.9.3.3 (c) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	DC link charge LED		(Warning)
3	Status LED	STATUS	
4	200VAC I/O connector	CX1A/CX1B	Both connectors have same function.
5	24 VDC I/O connector	CX2A/CX2B	
6	Signal check connector	JX4	Use an SPM check board.
7	Output connector for interface between modules	JX1A	
8	Input connector for interface between modules	JX1B	
9	Connector for load meter and speedometer	JY1	
10	Input connector for electric serial interface	JA7B	
11	Output connector for electric serial interface	JA7A	
12	Connector for pulse generator, built–in sensor	JY2	
13	Connector for magnetic sensor and external single rotation signal	JY3	
14	Connector for position coder and high–resolution position coder	JY4	
15	Connector for Cs–axis sensor for spindle and built–in Cs–axis sensor	JY5	Only for TYPE 2, 4
16	Terminal names for terminal block for motor power line		
17	Terminal block for motor power line		Display the terminal block TB2
18	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(d) SPM–45, SPM–75HV, (TYPE 1, 2, 4)

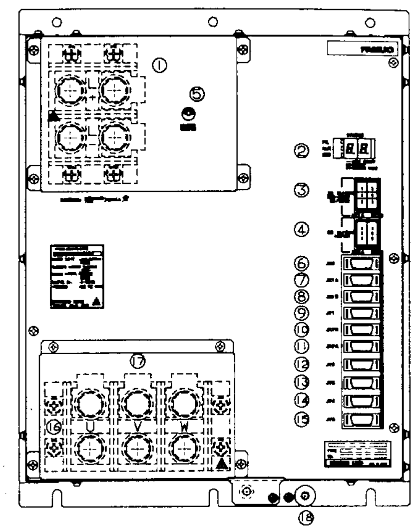


Table.9.3.3 (d) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	Status LED	STATUS	
3	200VAC I/O connector	CX1A/CX1B	Both connectors have same function.
4	24 VDC I/O connector	CX2A/CX2B	Both connectors have same function.
5	DC link charge LED		(Warning)
6	Signal check connector	JX4	Use an SPM check board.
7	Output connector for interface between modules	JX1A	
8	Input connector for interface between modules	JX1B	
9	Connector for load meter and speedometer	JY1	
10	Input connector for electric serial interface	JA7B	
11	Output connector for electric serial interface	JA7A	
12	Connector for pulse generator, built–in sensor	JY2	
13	Connector for magnetic sensor and external single rotation signal	JY3	
14	Connector for position coder and high–resolution position coder	JY4	
15	Connector for Cs–axis sensor for spindle and built–in Cs–axis sensor	JY5	Only for TYPE 2, 4
16	Terminal names for terminal block for motor power line		
17	Terminal block for motor power line		Display the terminal block TB2
18	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(e) SPM–11, 15, 22, 26, 30 (TYPE 3)

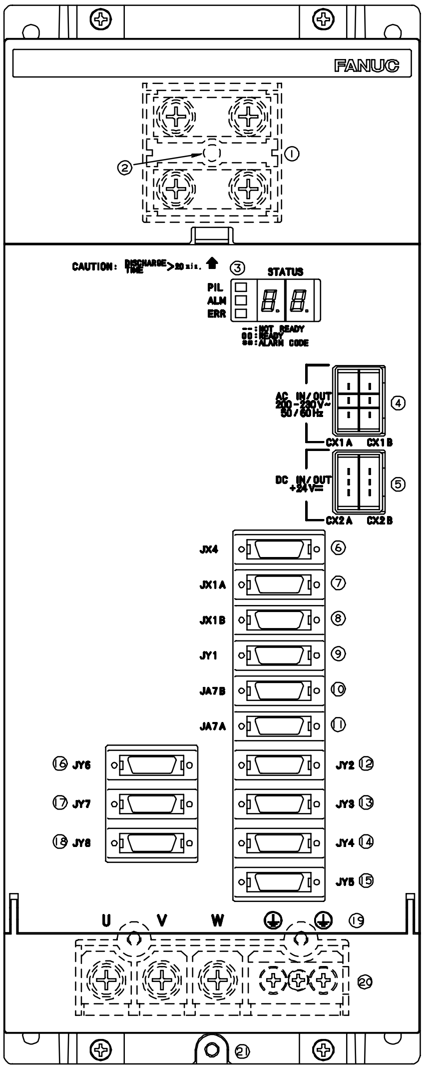


Table.9.3.3 (e) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	DC link charge LED		(Warning)
3	Status LED	STATUS	
4	200VAC I/O connector	CX1A/CX1B	Both connectors have same function.
5	24 VDC I/O connector	CX2A/CX2B	
6	Signal check connector	JX4	Use an SPM check board.
7	Input connector for interface between modules	JX1A	
8	Output connector for interface between modules	JX1B	
9	Connector for load meter and speedometer	JY1	
10	Input connector for electric serial interface	JA7B	
11	Output connector for electric serial interface	JA7A	
12	Connector for pulse generator, built–in sensor	JY2	
13	Connector for magnetic sensor and external single rotation signal	JY3	
14	Connector for position coder and high–resolution position coder	JY4	
15	Connector for Cs–axis sensor for spindle and built–in Cs–axis sensor	JY5	
16	Same as JY2	JY6	For spindle switching differential speed tapping.
17	Same as JY3	JY7	
18	Same as JY4	JY8	
19	Terminal names for terminal block for motor power line		
20	Terminal block for motor power line	TB2	Display the terminal block TB2
21	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(f) SPM–45, SPM–75HV (TYPE 3)

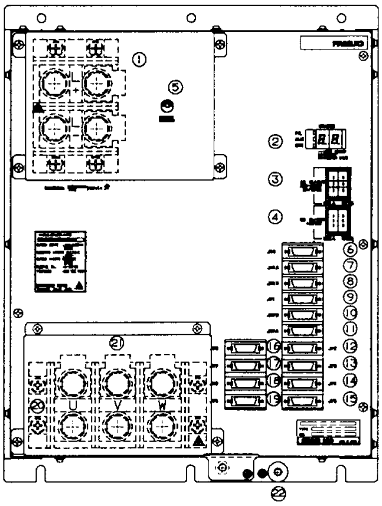


Table.9.3.3 (f) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	Status LED	STATUS	
3	200VAC I/O connector	CX1A/CX1B	Both connectors have same function.
4	24 VDC I/O connector	CX2A/CX2B	
5	DC link charge LED		(Warning)
6	Signal check connector	JX4	Use an SPM check board.
7	Input connector for interface between modules	JX1A	
8	Output connector for interface between modules	JX1B	
9	Connector for load meter and speedometer	JY1	
10	Input connector for electric serial interface	JA7B	
11	Output connector for electric serial interface	JA7A	
12	Connector for pulse generator, built–in sensor	JY2	
13	Connector for magnetic sensor and external single rotation signal	JY3	
14	Connector for position coder and high–resolution position coder	JY4	
15	Connector for Cs–axis sensor for spindle and built–in Cs–axis sensor	JY5	
16	Same as JY2	JY6	
17	Same as JY3	JY7	
18	Same as JY4	JY8	
19	Connector for position coder signal output	JY9	
20	Terminal names for terminal block for motor power line		
21	Terminal block for motor power line		Display the terminal block TB2
22	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(g) SPMC–2.2

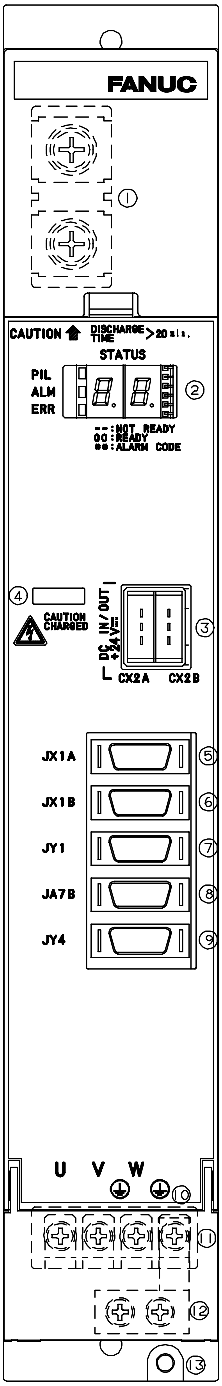


Table.9.3.3 (g) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	Status LED	STATUS	
3	24VDC I/O connector	CX2A/CX2B	Both connectors have same function
4	DC link charge LED		(Warning)
5	Output connector for interface between modules	JX1A	
6	Input connector for interface between modules	JX1B	
7	Frequency meter analog override connector for motor thermostat connection	JY1	
8	Input connector for electric serial interface	JA7B	
9	Connector for position coder	JY4	
10	Terminal names for terminal block for motor power line		
11	Terminal block for motor power line		Display the terminal block TB2
12	Earth plate		Attatched to amplifier
13	Tapped hole for grounding the flange		

WARNING
Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(h) SPMC–5.5, 11

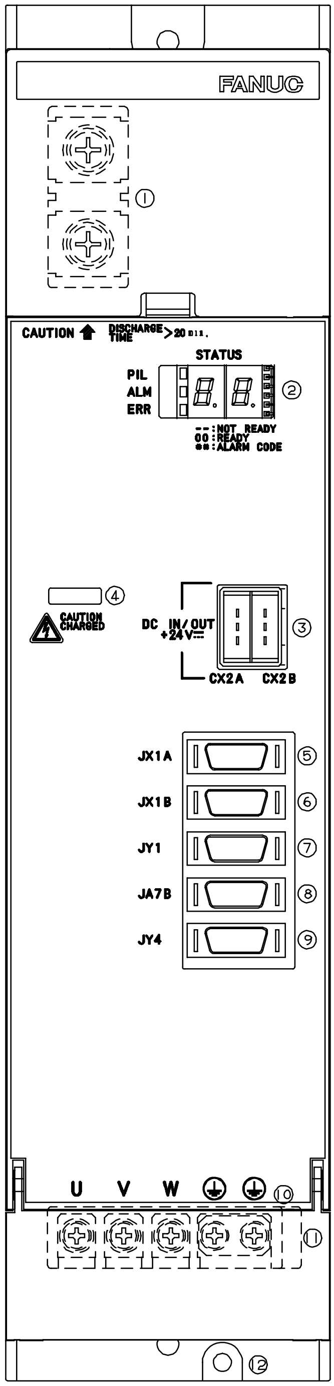


Table.9.3.3 (h) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	Status LED	STATUS	
3	24VDC I/O connector	CX2A/CX2B	Both connectors have same function
4	DC link charge LED		(Warning)
5	Output connector for interface between modules	JX1A	
6	Input connector for interface between modules	JX1B	
7	Frequency meter analog override connector for motor thermostat connection	JY1	
8	Input connector for electric serial interface	JA7B	
9	Connector for position coder	JY4	
10	Terminal names for terminal block for motor power line		
11	Terminal block for motor power line		Display the terminal block TB2
12	Tapped hole for grounding the flange		

WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

(i) SPMC–15, –22, –26

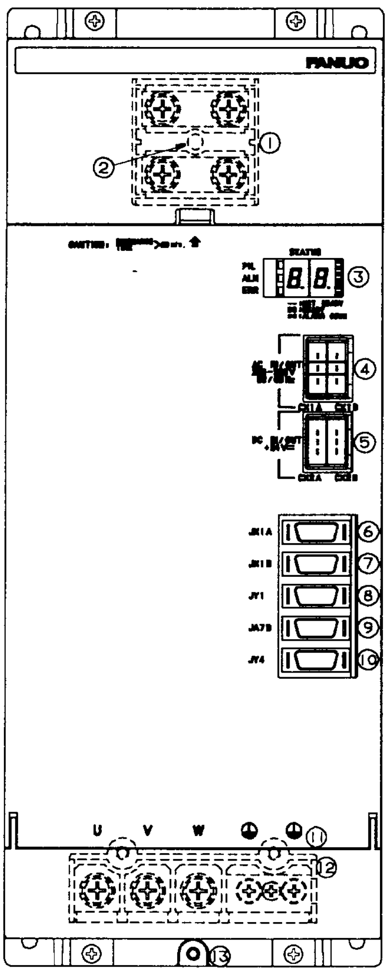


Table.9.3.3 (i) Names of connectors and terminal blocks

	Names	Display	Remarks
1	DC link terminal block		Display the terminal block TB1
2	DC link charge LED		(Warning)
3	Status LED	STATUS	
4	200VAC I/O connector	CX1A/CX1B	Both connectors have same function.
5	24VDC I/O connector	CX2A/CX2B	Both connectors have same function
6	Output connector for interface between modules	JX1A	
7	Input connector for interface between modules	JX1B	
8	Frequency meter analog override connector for motor thermostat connection	JY1	
9	Input connector for electric serial interface	JA7B	
10	Connector for position coder	JY4	
11	Terminal names for terminal block for motor power line		
12	Terminal block for motor power line		Display the terminal block TB2
13	Tapped hole for grounding the flange		

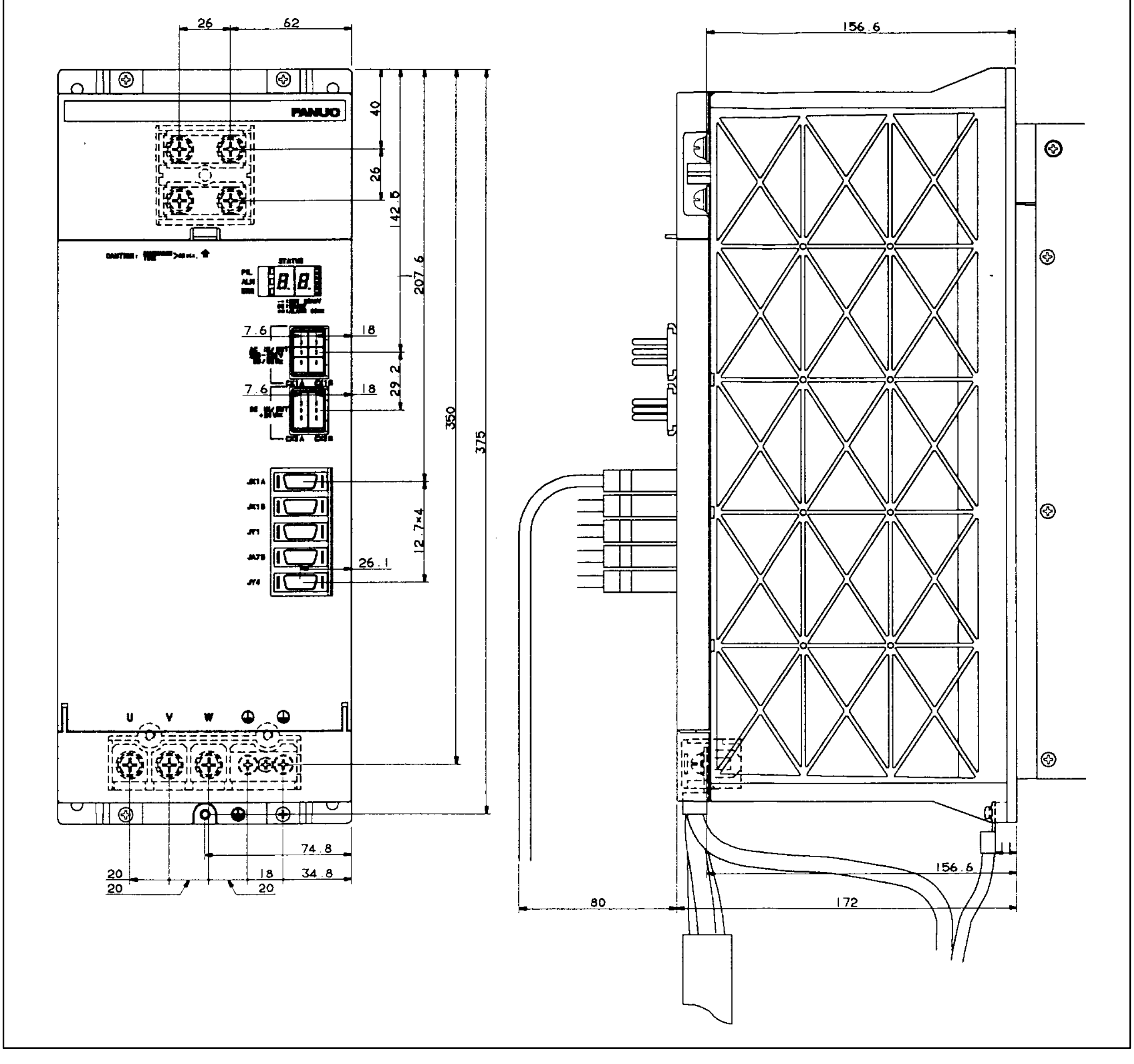
WARNING

Do not touch module components or connected cables while this LED is lit. There is a danger of electric shock.

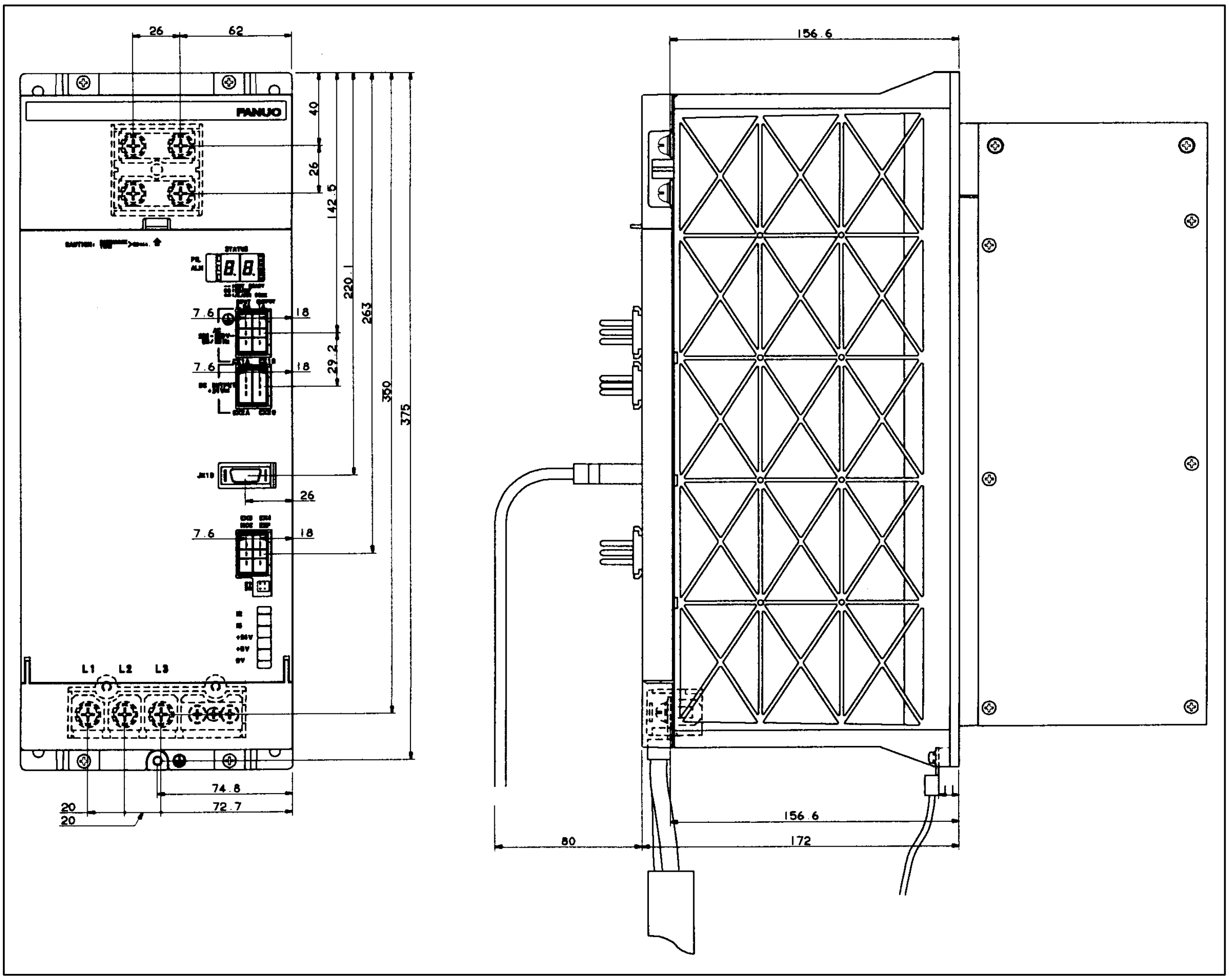
9.4 CABLE LEAD–IN DIAGRAMS

9.4.1 Power Supply Modules

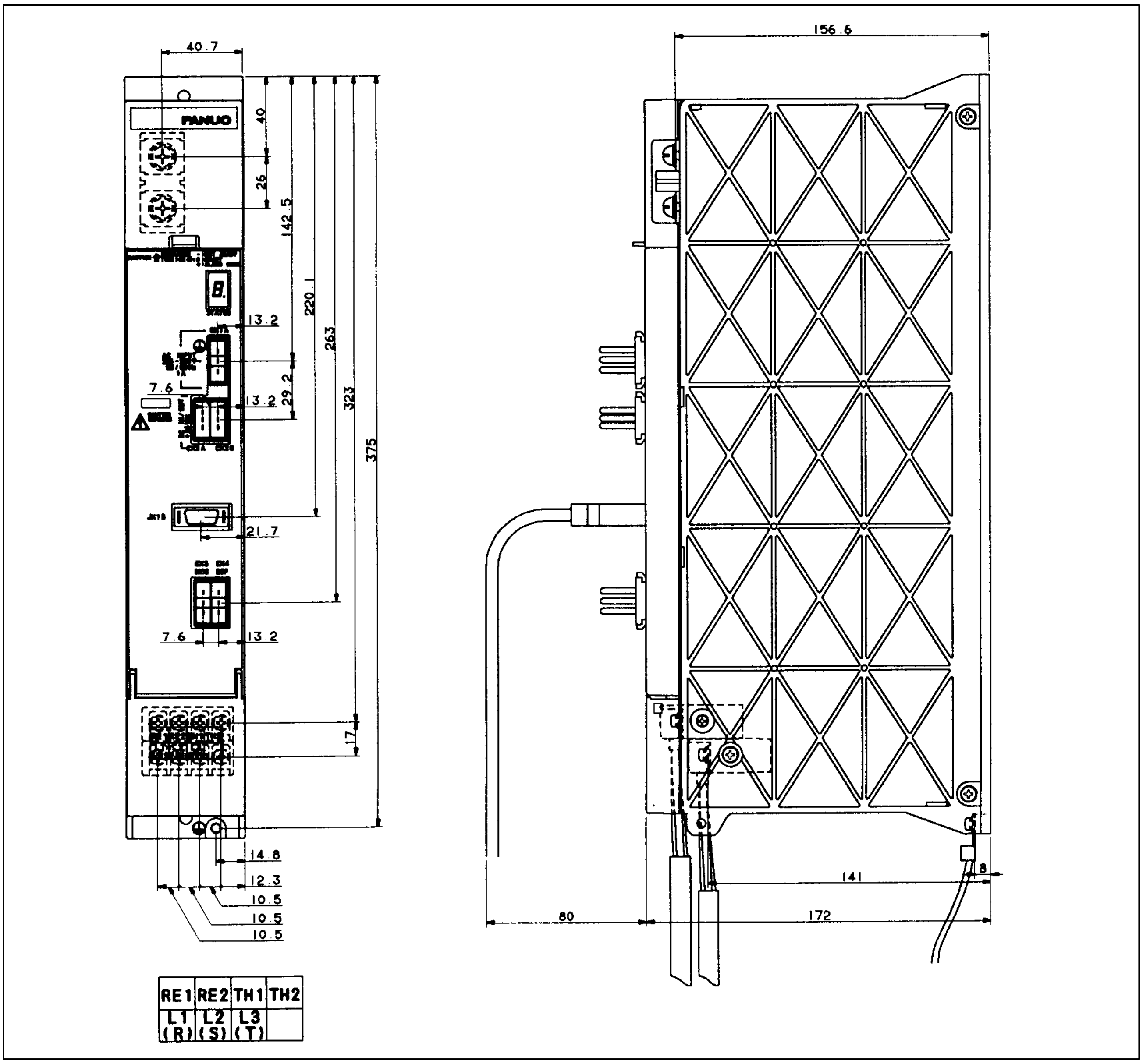
(a) PSM–5.5, PSM–11



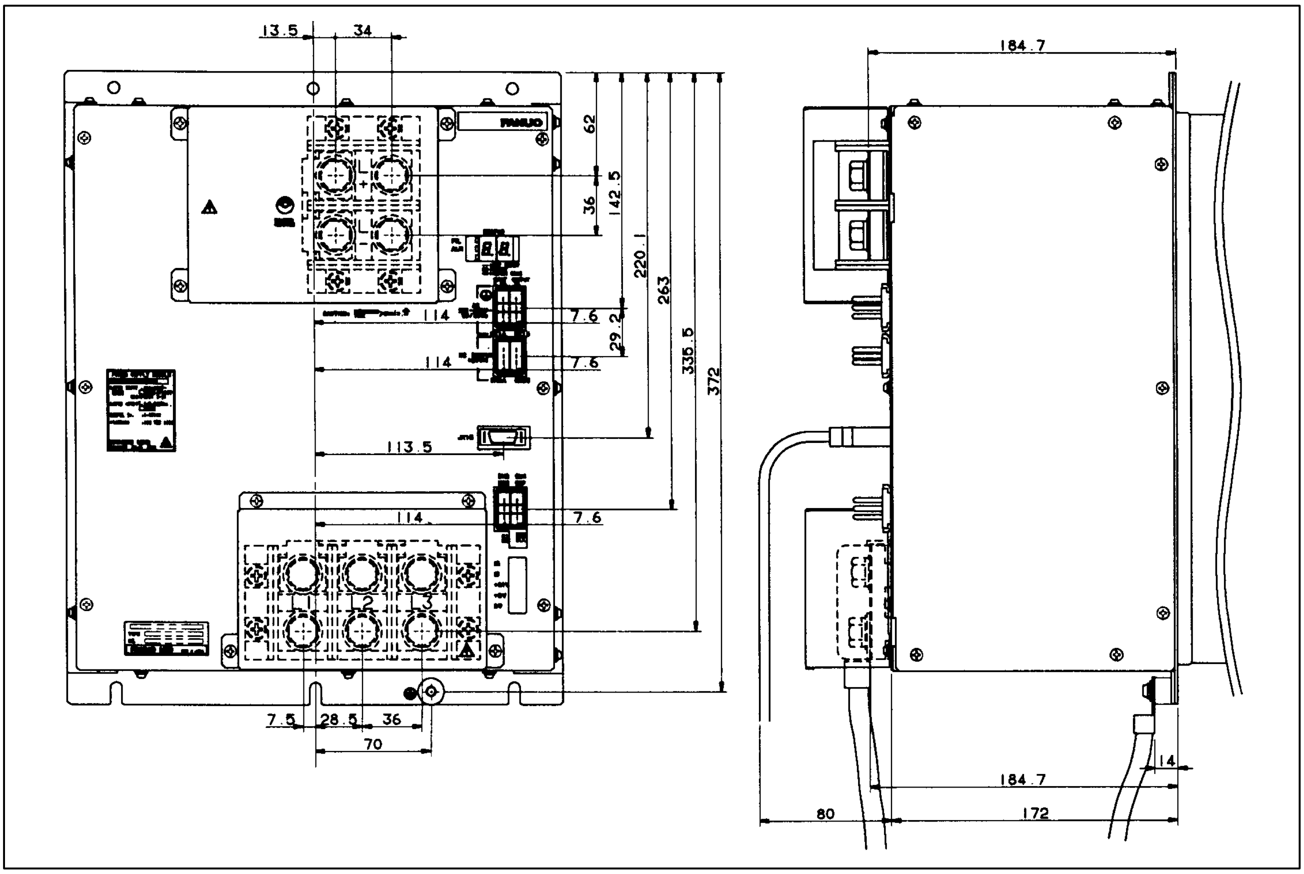
(b) PSM–15, PSM–26, PSM–30, PSM–37, PSM–18HV, PSM–30HV, PSM–45HV



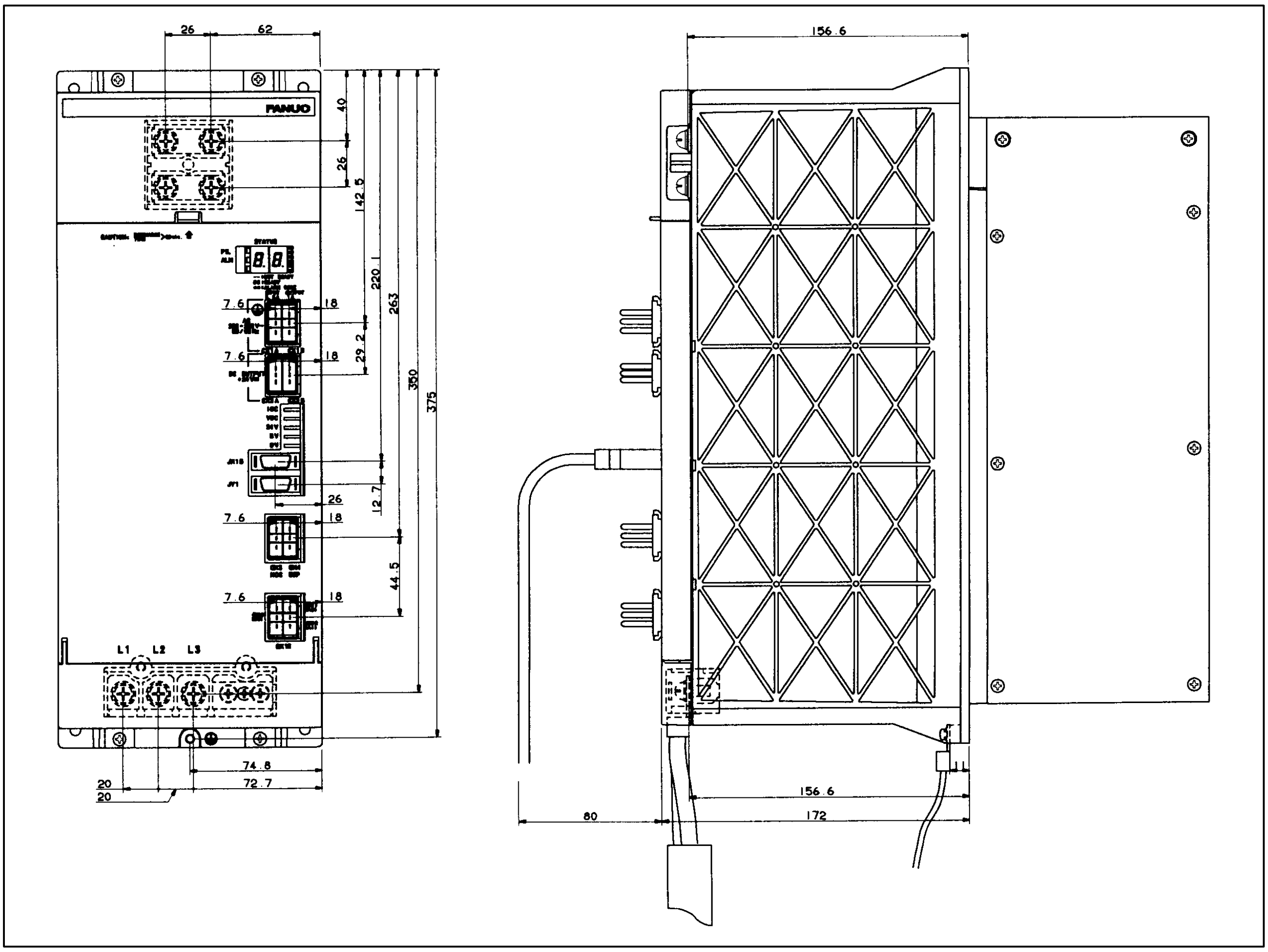
(c) PSMR–3, PSMR–5.5



(d) PSM–45, PSM–75HV



(e) PSMV–11HV


26
62
FANUC
40
26
142.5
220.1
263
350
375
7.6
18
29.2
26
12.7
44.5
L1
L2
L3
74.8
72.7
20
20
156.6
80
172

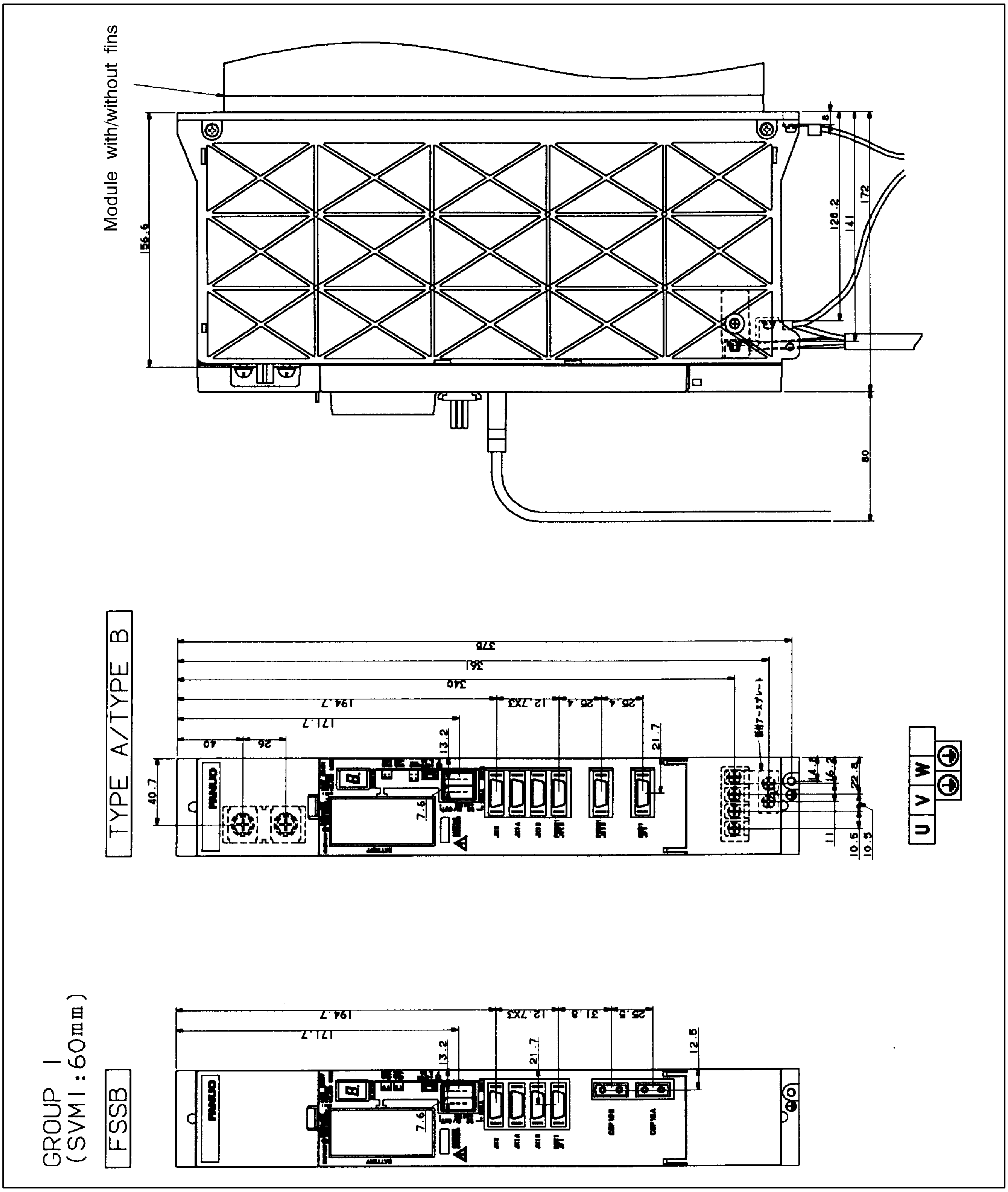
9.4.2 Servo Amplifier Modules

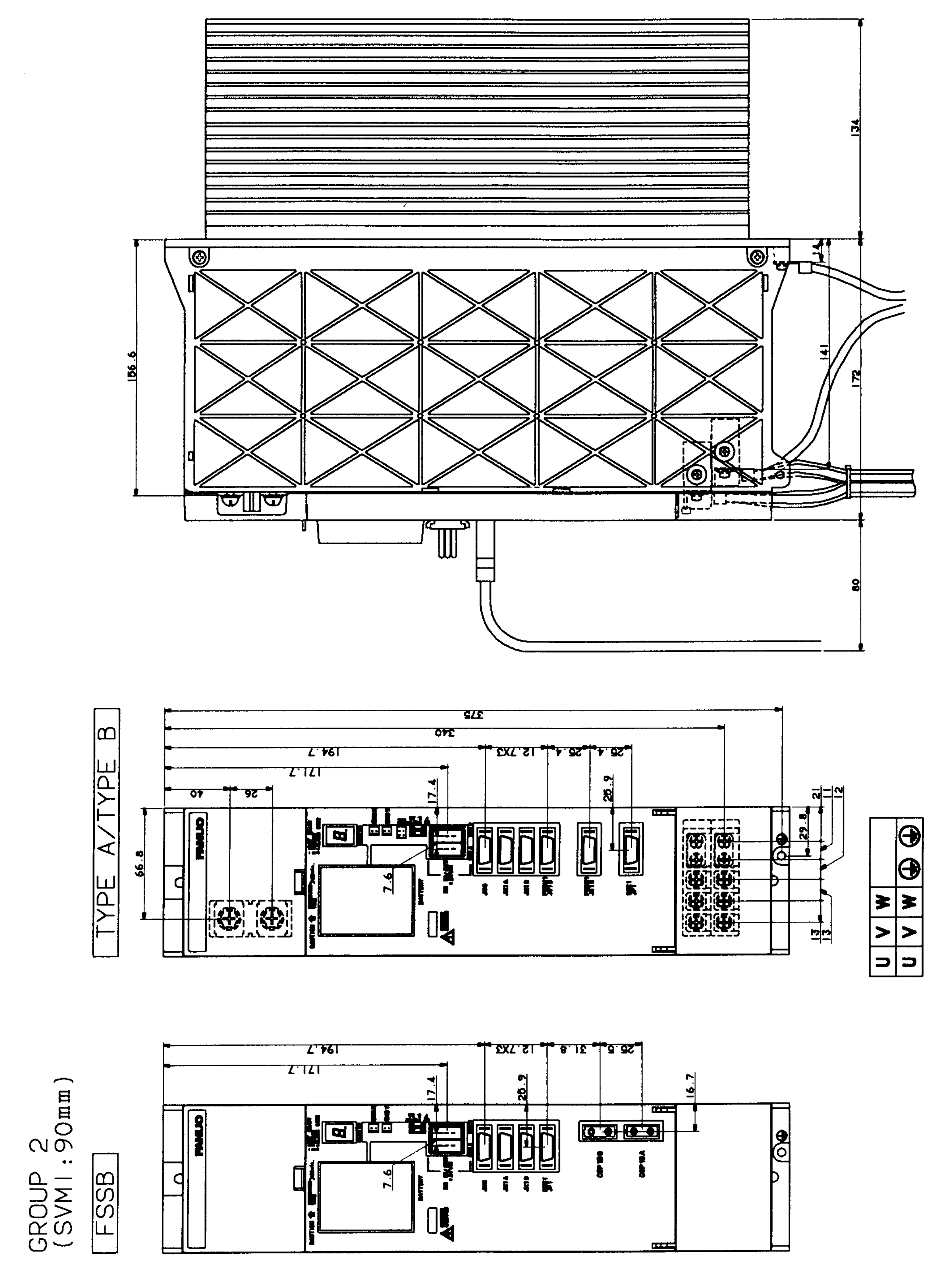
Select a group of cable lead–in drawings corresponding to your module from the following table.

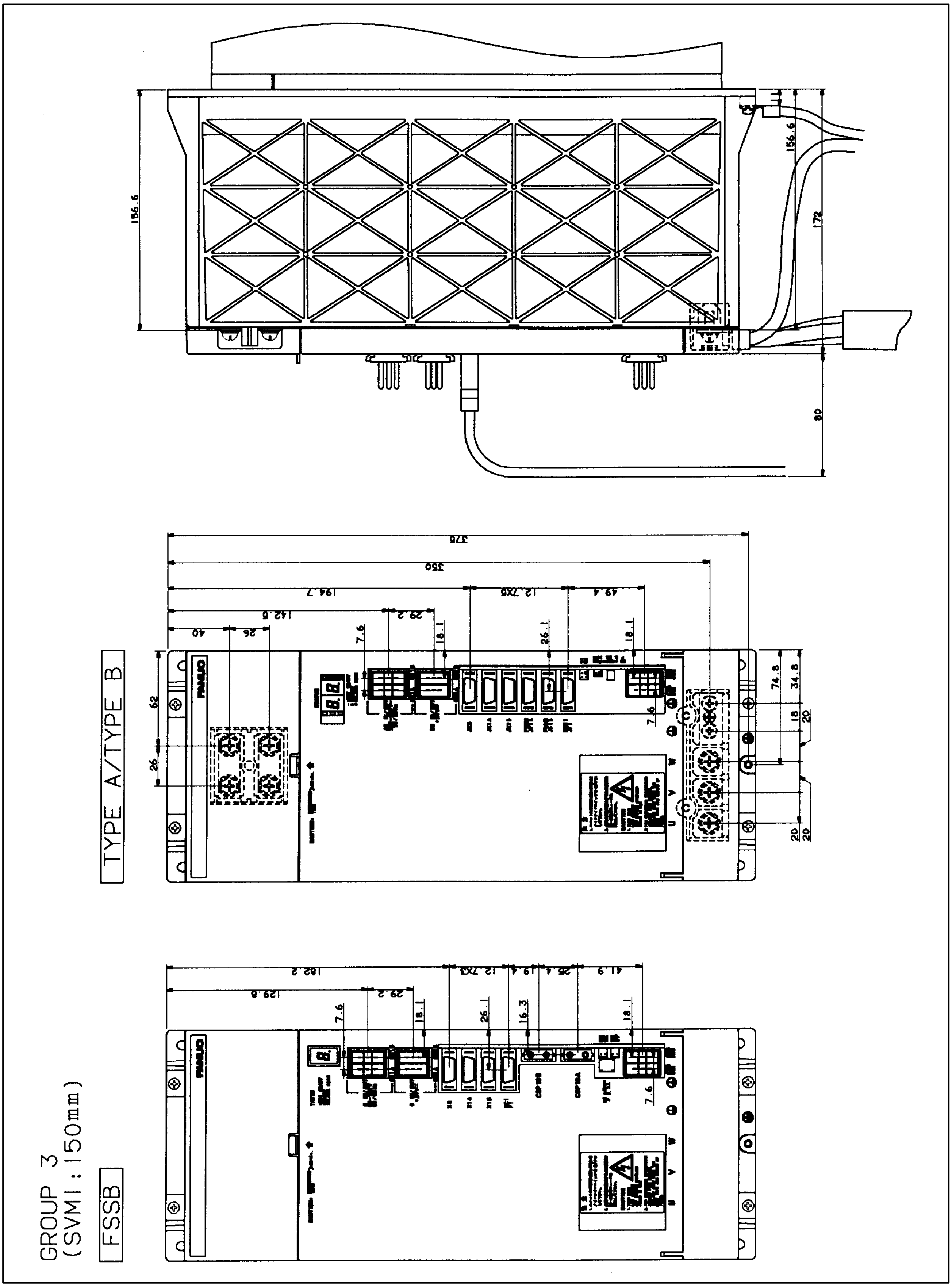
Table.9.4.2 Cable Lead–in Drawing Groups

Group	Interface	Name
GROUP 1 (SVM1:60mm)	TYPE A/TYPE B FSSB	– Module without fins SVM1–12, SVM1–20 – Module with fins SVM1–40S, SVM1–40L, SVM1–80
GROUP 2 (SVM1:90mm)	TYPE A/TYPE B FSSB	SVM1–130 SVM1–☐HV
GROUP 3 (SVM1:150mm)	TYPE A/TYPE B FSSB	SVM1–240, SVM1–360
GROUP 4	——	Dynamic brake module (DBM) for the SVM1–240 and SVM1–360
GROUP 5 (SVM2:60mm)	TYPE A/TYPE B FSSB	– Module without fins SVM2–12/12, SVM2–12/20 SVM2–20/20 – Module with fins SVM2–40/40
GROUP 6 (SVM2:90mm)	TYPE A/TYPE B FSSB	SVM2–40/80, SVM2–80/80 SVM2–40L/40L SVM2–☐/☐HV
GROUP 7 (SVM3:90mm)	TYPE A TYPE B FSSB	– Module without fins SVM3–12/12/12, SVM3–12/12/20 SVM3–12/20/20, SVM3–20/20/20 – Module with fins SVM3–12/12/40, SVM3–12/20/40 SVM3–20/20/40

NOTE
(SVM*: ☐mm): ☐mm is the width of a servo amplifier (where * represents 1, 2, or 3.)

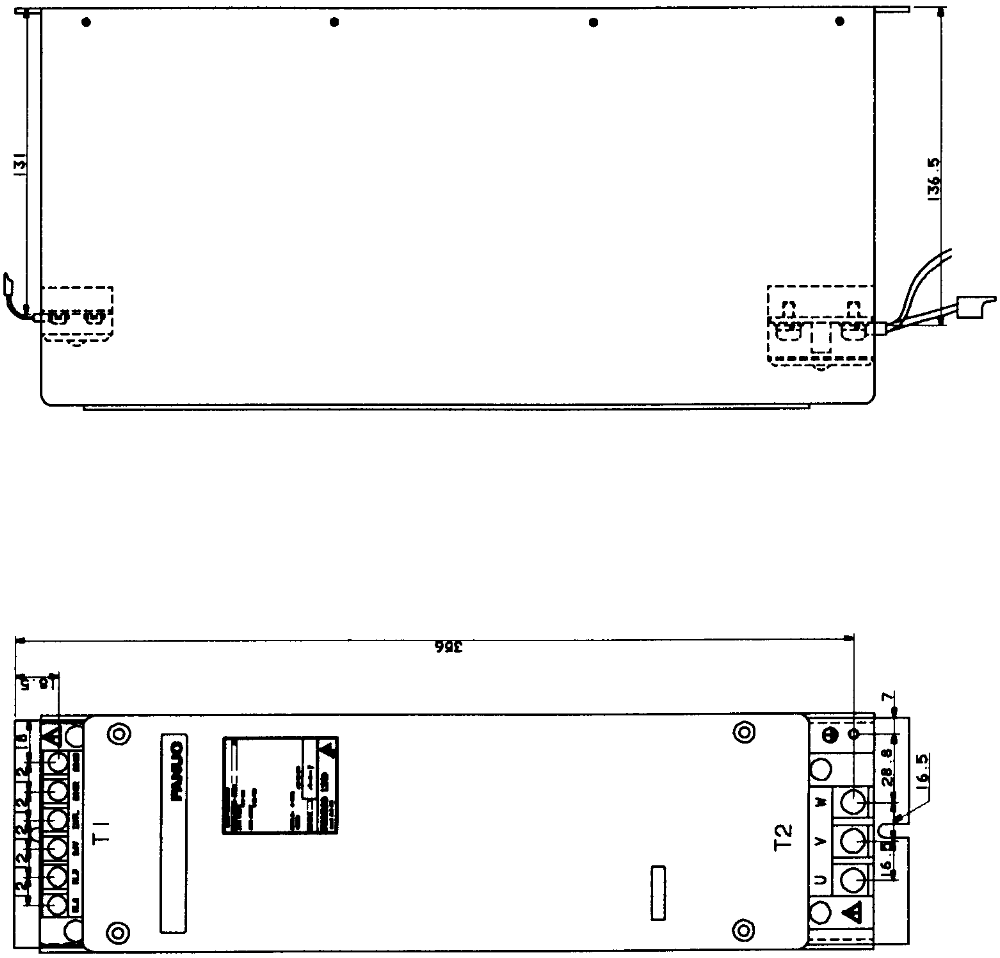

Module with/without fins
TYPE A/TYPE B
GROUP 1
(SVM1:60mm)
FSSB
U
V
W

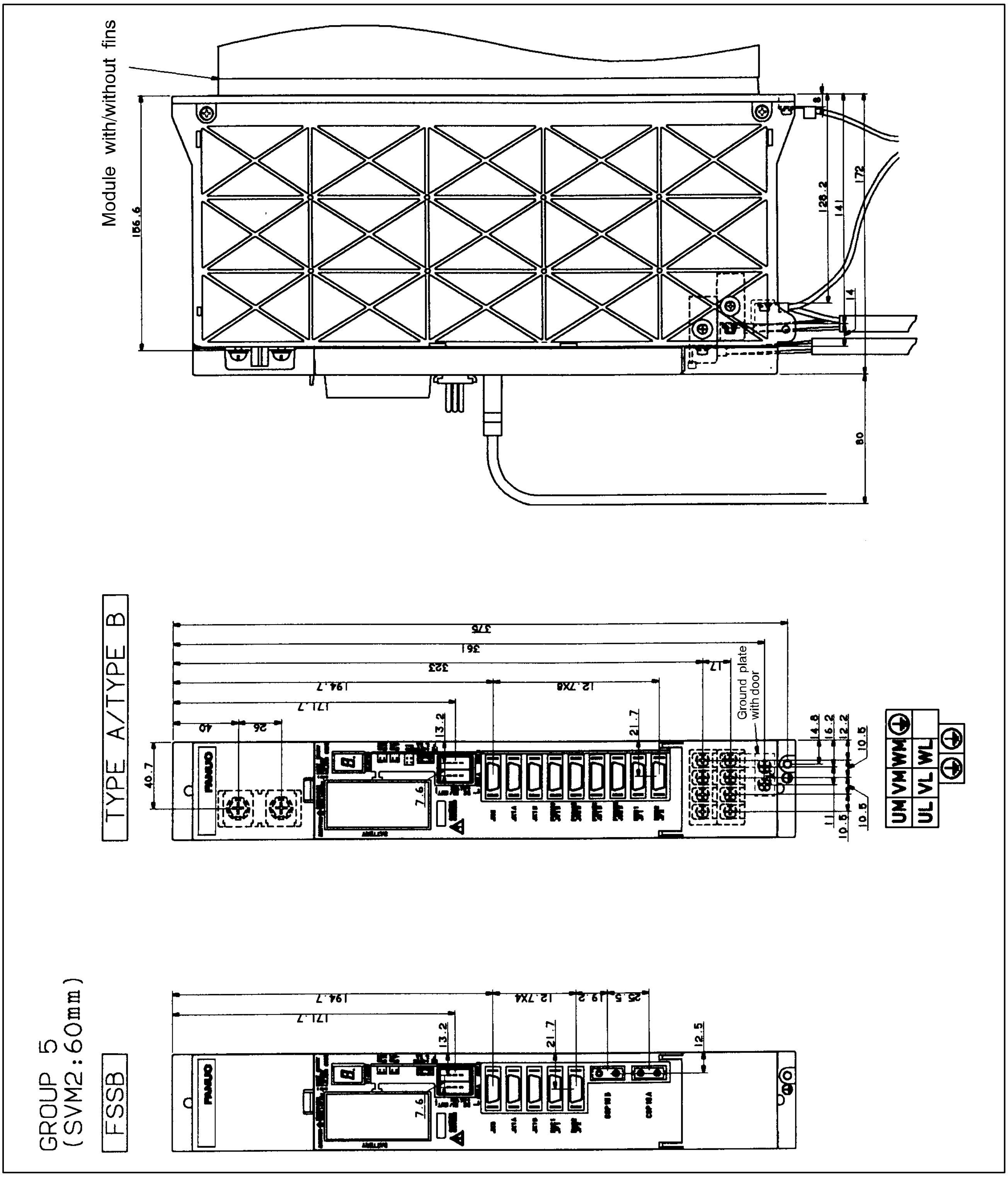

GROUP 2
(SVM1:90mm)
FSSB
TYPE A/TYPE B
U V W
U V W
134
172
141
14
80
156.6
375
340
194.7
171.7
12.7X3
25.4
25.4
25.9
40
26
17.4
66.8
7.6
29.8
21
11
12
13
13
31.8
25.5
16.7

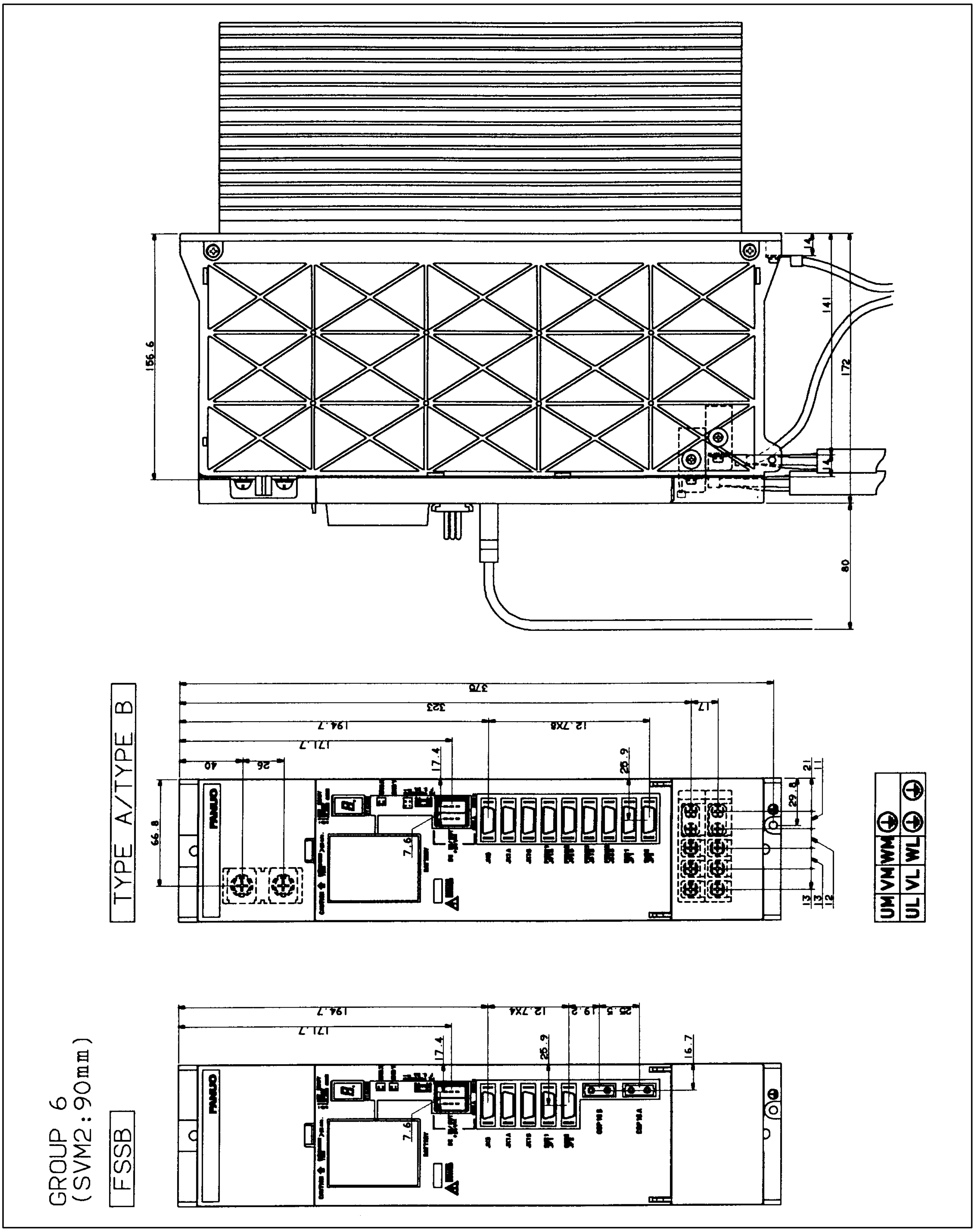

GROUP 3
(SVM1 : 150mm)
FSSB
TYPE A/TYPE B
FANUC

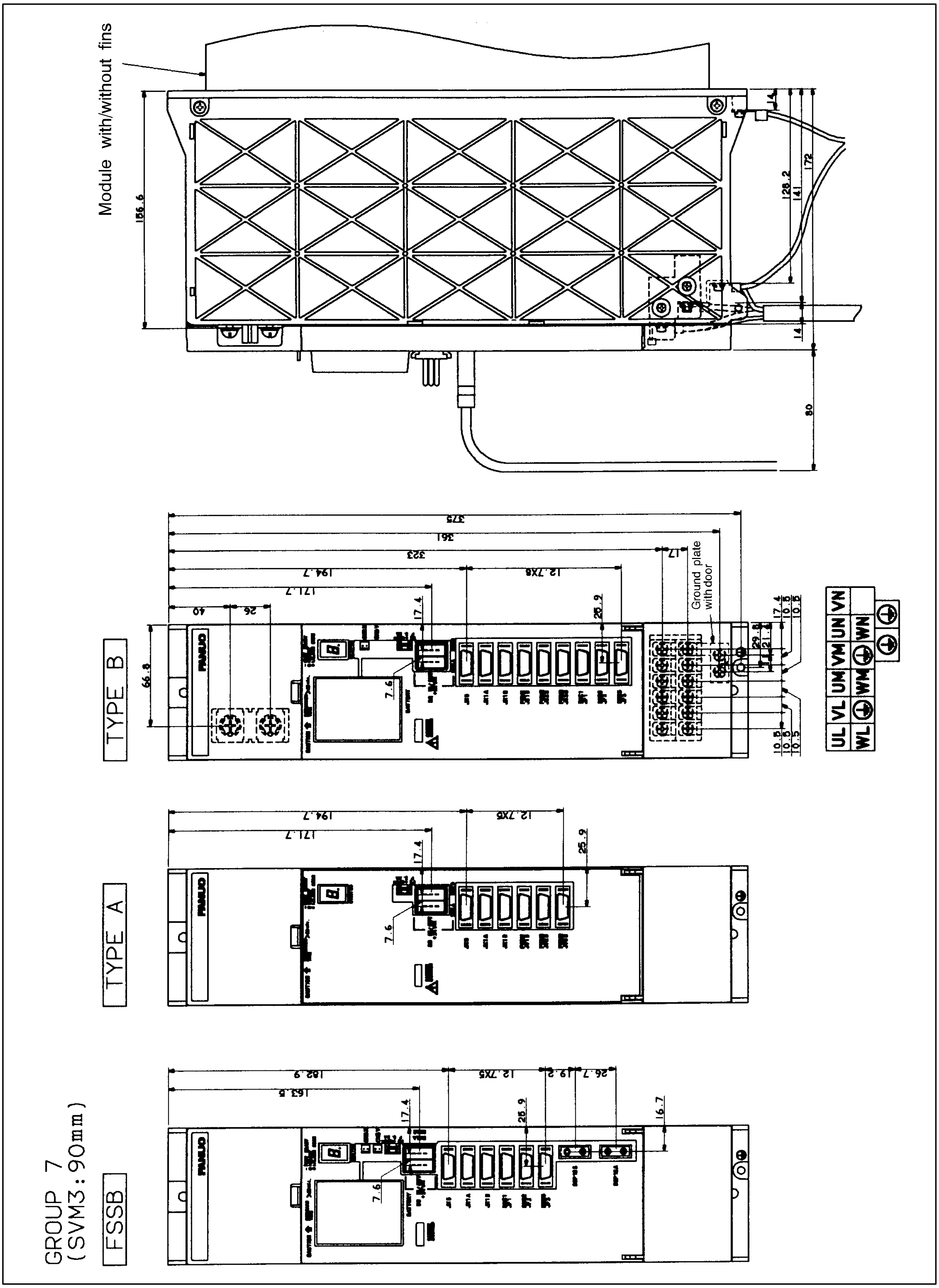
GROUP 4

Dynamic brake module (DBM)



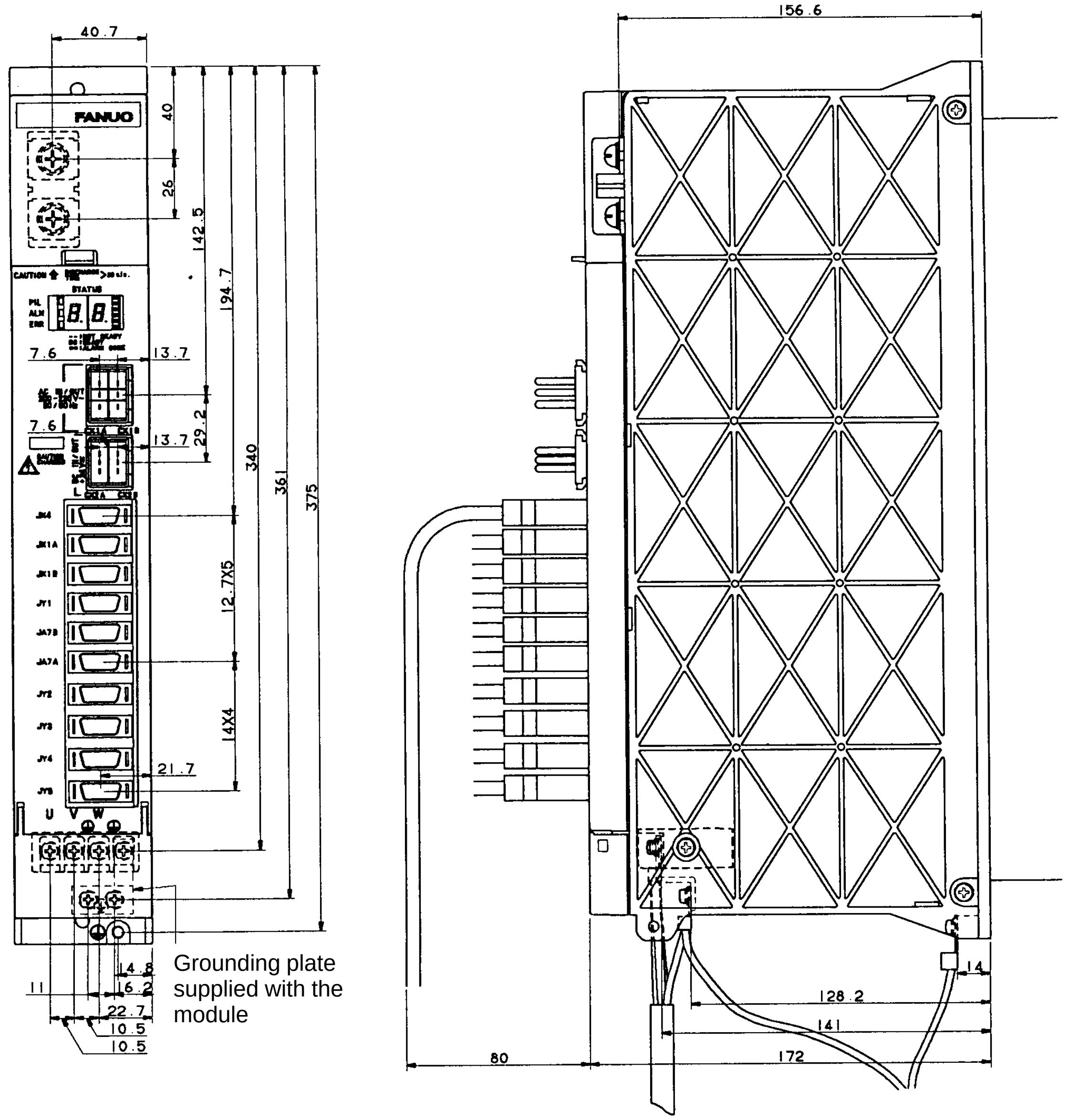

Module with/without fins
156.6
128.2
141
172
14
8
80
TYPE A/TYPE B
375
361
323
17
194.7
12.7X8
171.7
40
26
13.2
21.7
40.7
7.6
Ground plate with door
14.8
16.2
12.2
10.5
11
10.5
10.5
UM
VM
WM
UL
VL
WL
GROUP 5
(SVM2:60mm)
FSSB
194.7
12.7X4
19.2
25.5
171.7
13.2
21.7
12.5
7.6


GROUP 6
(SVM2 : 90mm)
FSSB
TYPE A/TYPE B
UM VM WM
UL VL WL


Module with/without fins
GROUP 7
(SVM3:90mm)
FSSB
TYPE A
TYPE B
Ground plate with door
UL
VL
UM
VM
UN
VN
WL
WM
WN

9.4.3 Spindle Amplifier Modules

(1) SPM–2.2 (TYPE 1, 2, 4)

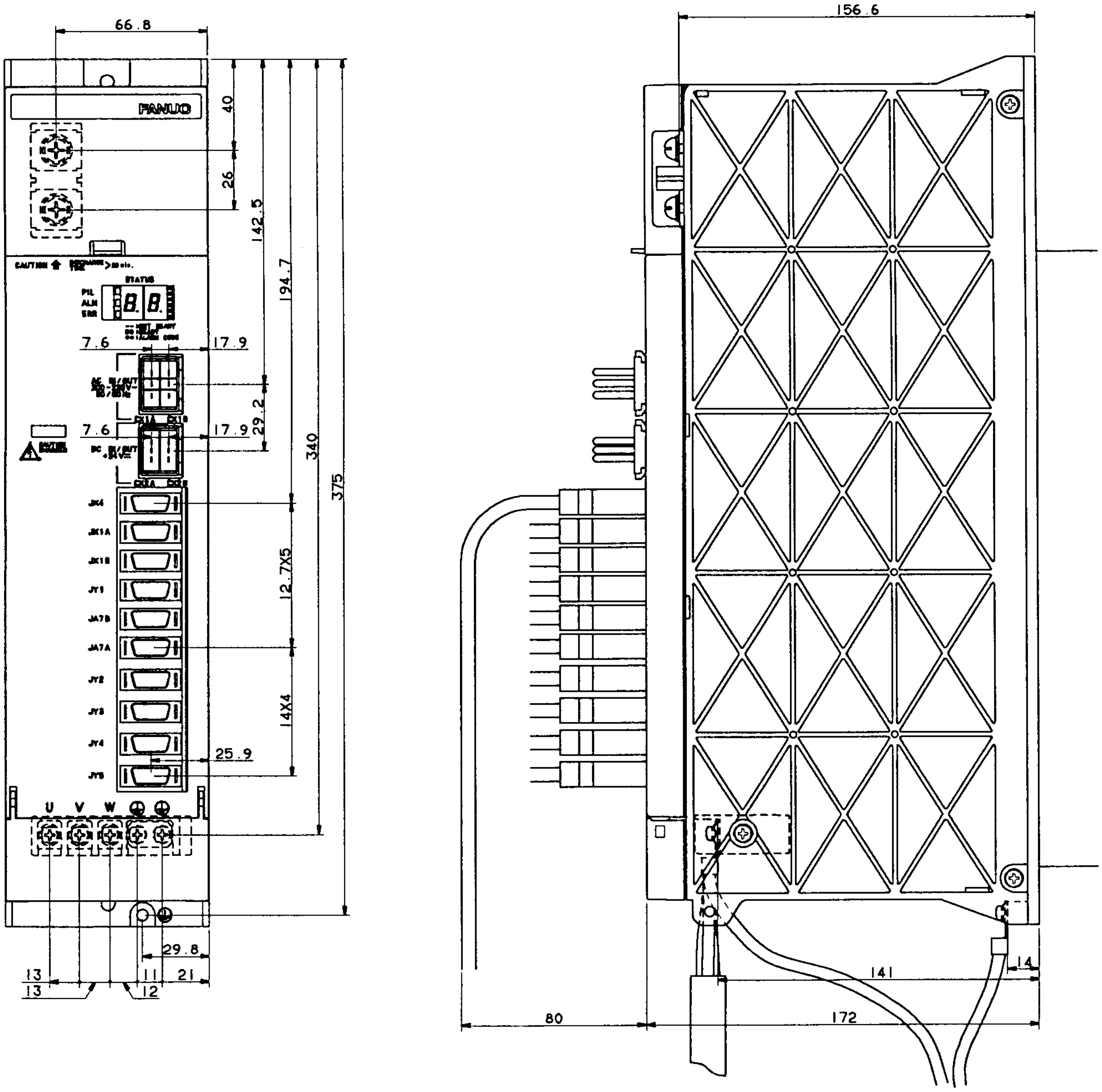


Terminal board (TB2)

U	V	W	
	⏚	⏚	

NOTE
Type 1 is not equipped with connector JY5.

(2) SPM–5.5, 11, SPM–11HV (TYPE 1, 2, 4)

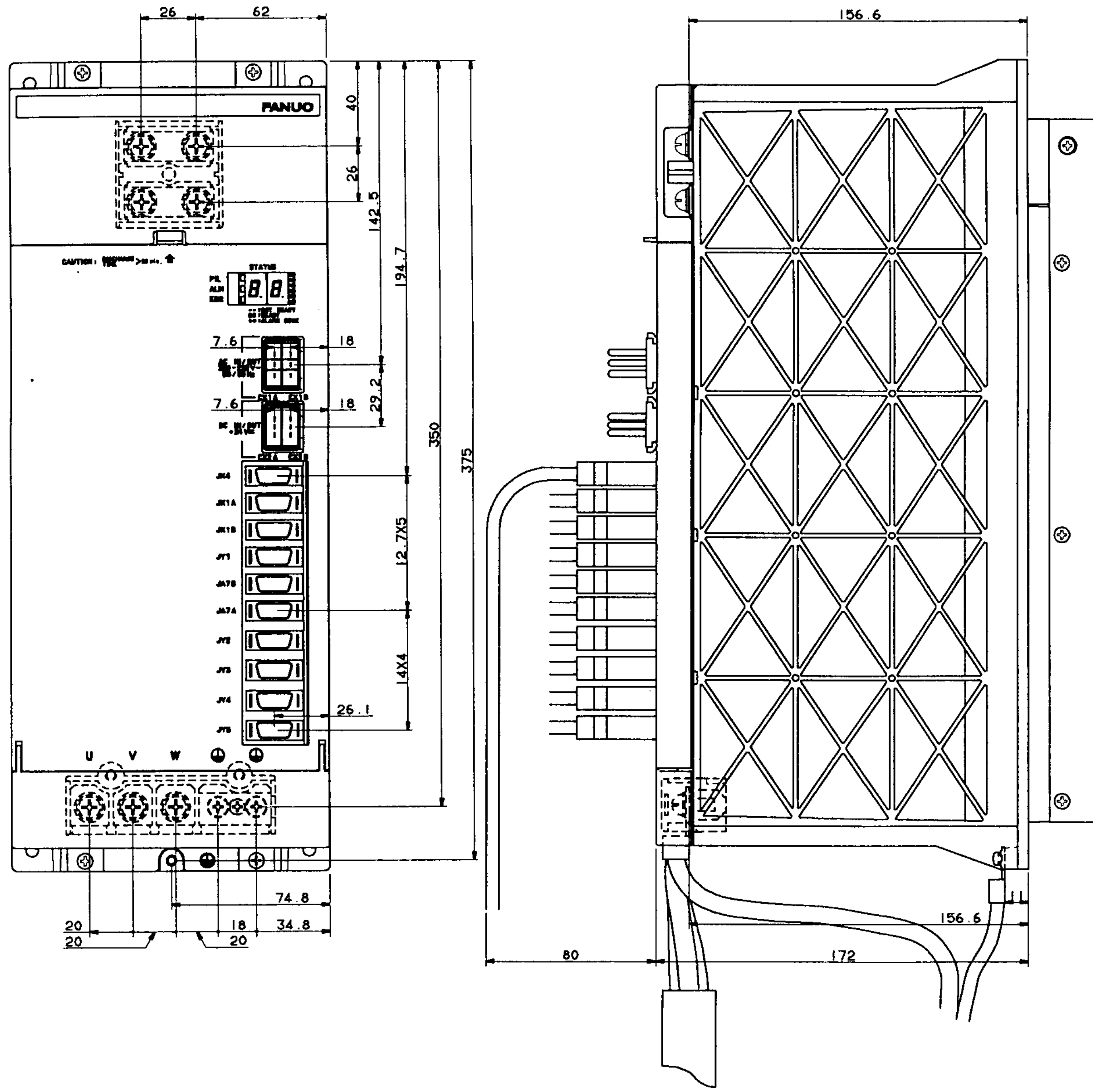


Terminal board (TB2)

U	V	W	⏚	⏚

NOTE
Type 1 is not equipped with connector JY5.

(3) SPM–15, 22, 26, 30, SPM–15HV, 26HV, 45HV (TYPE 1, 2, 4)



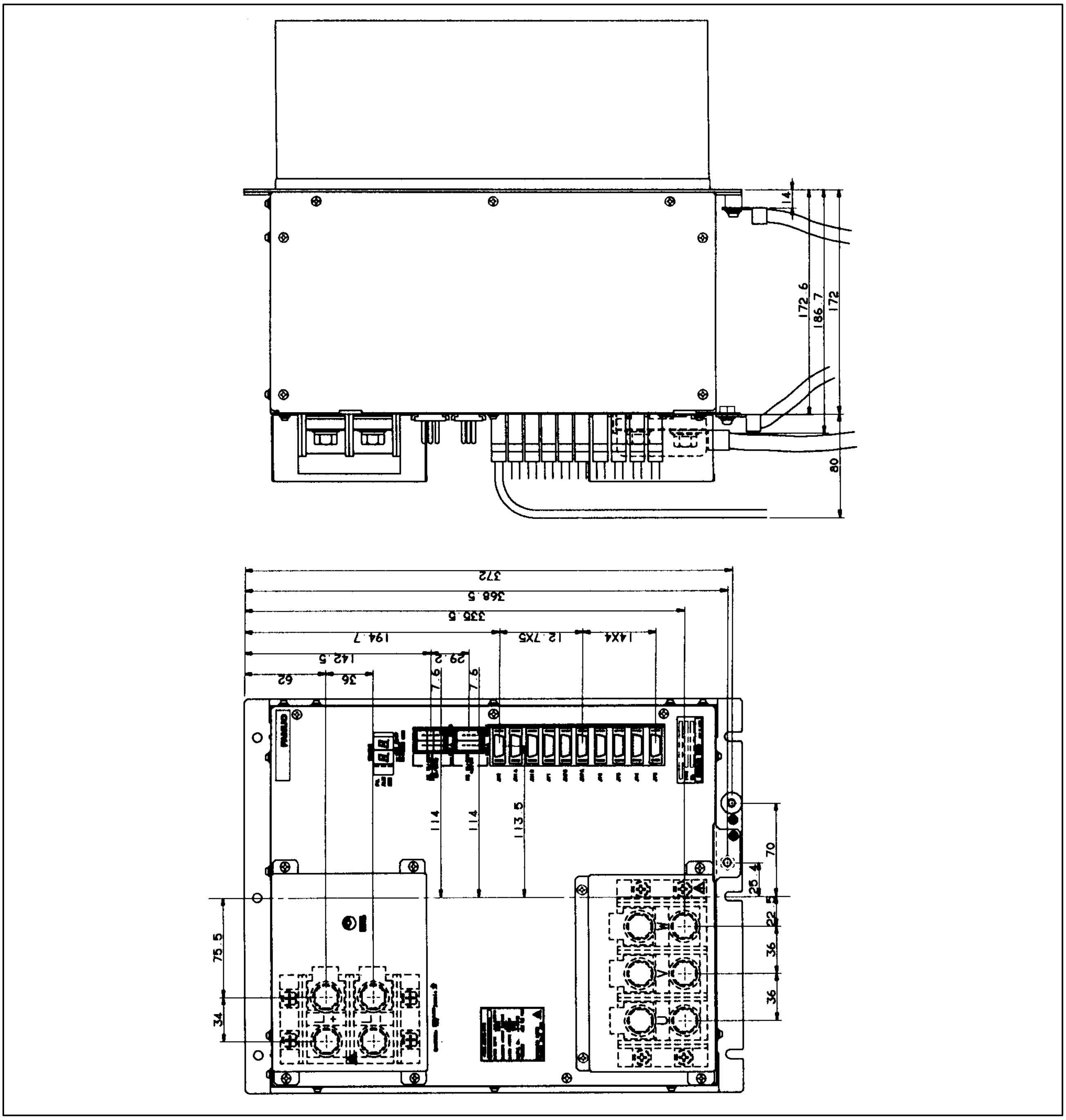
Terminal board (TB2)

U	V	W	⏚	⏚

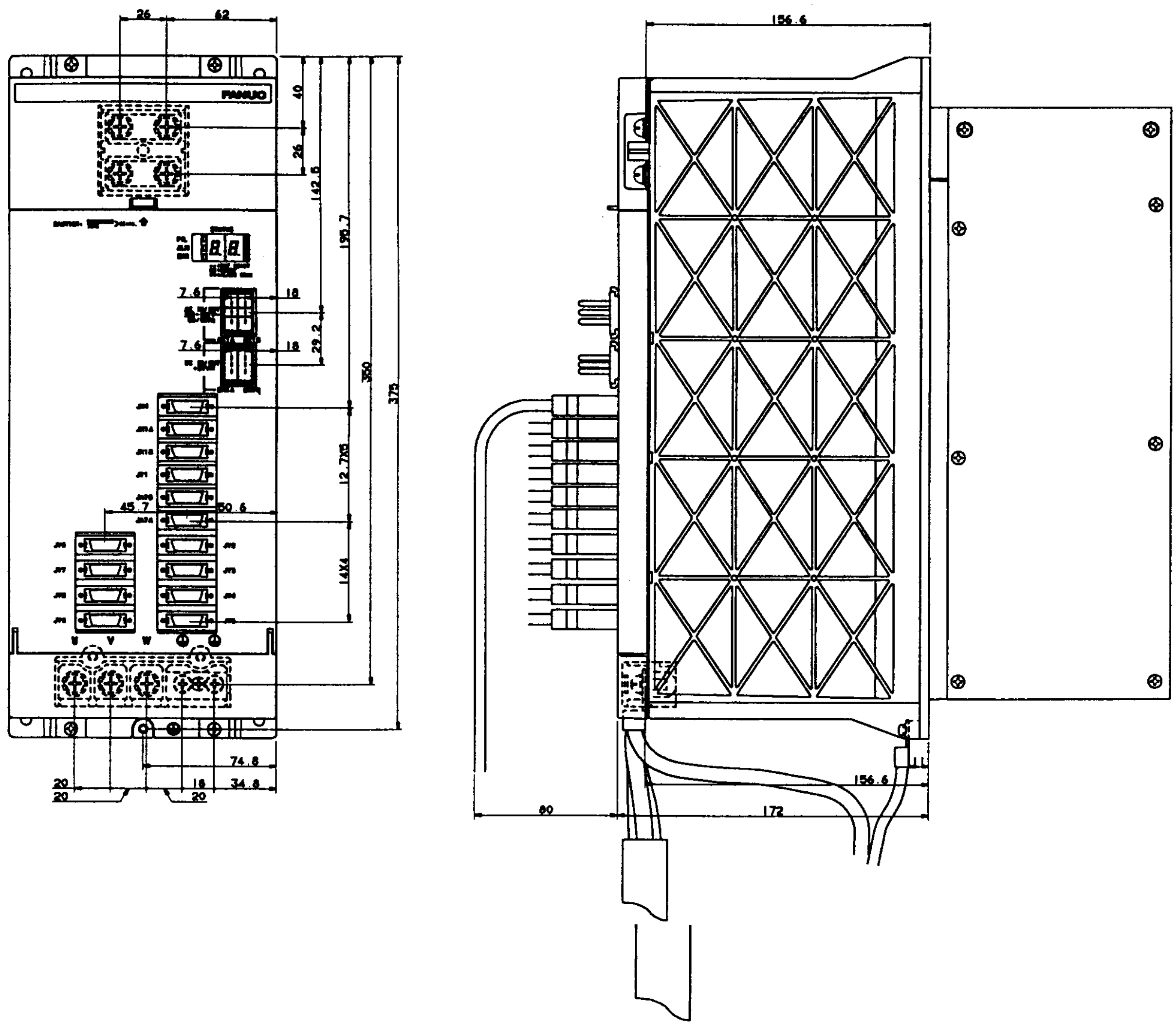
NOTE

Type 1 is not equipped with connector JY5.

(4) SPM–45, SPM–75HV (TYPE 1, 2, 4)



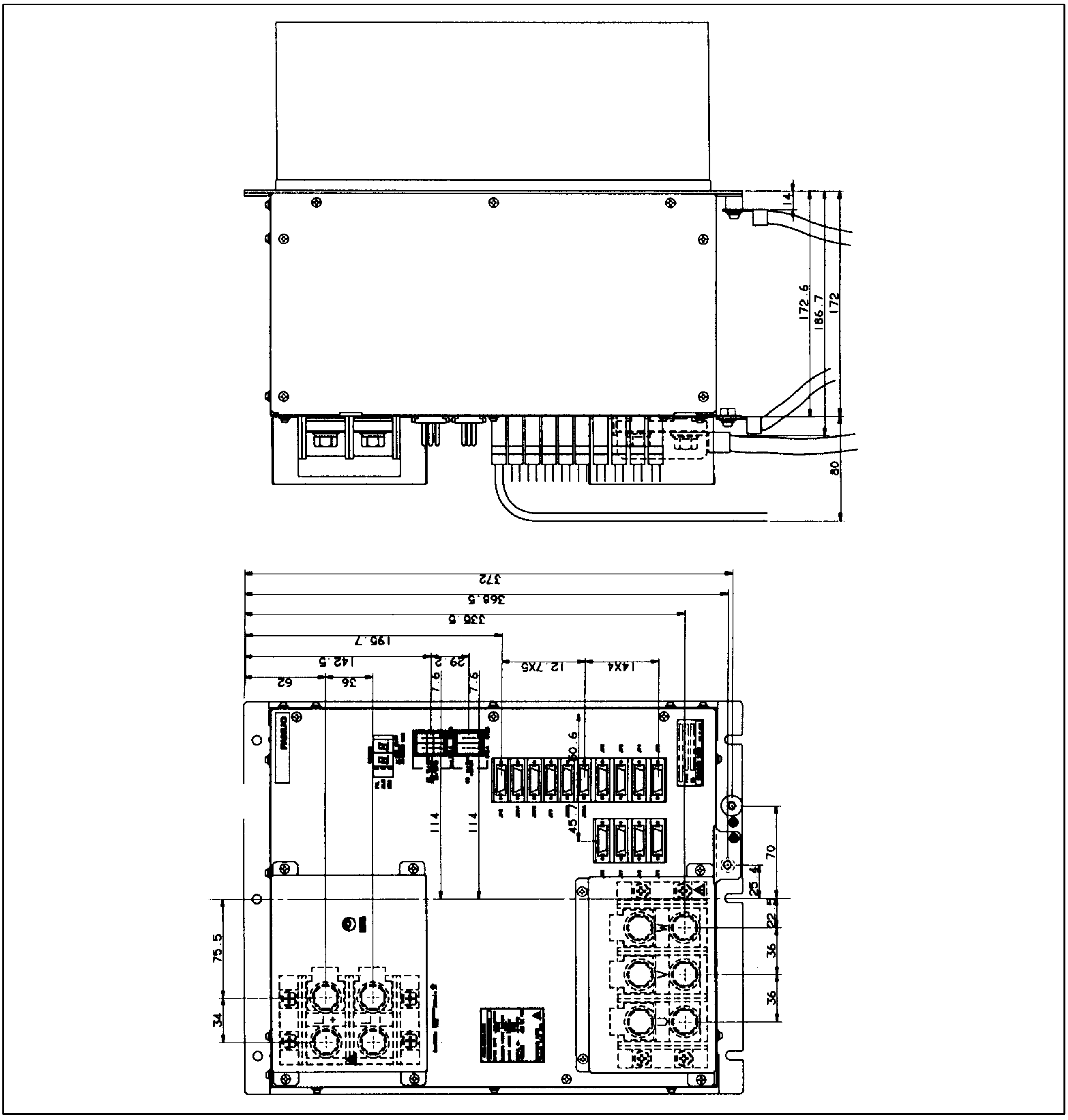
(5) SPM–11, 15, 22, 26, 30 (TYPE 3)



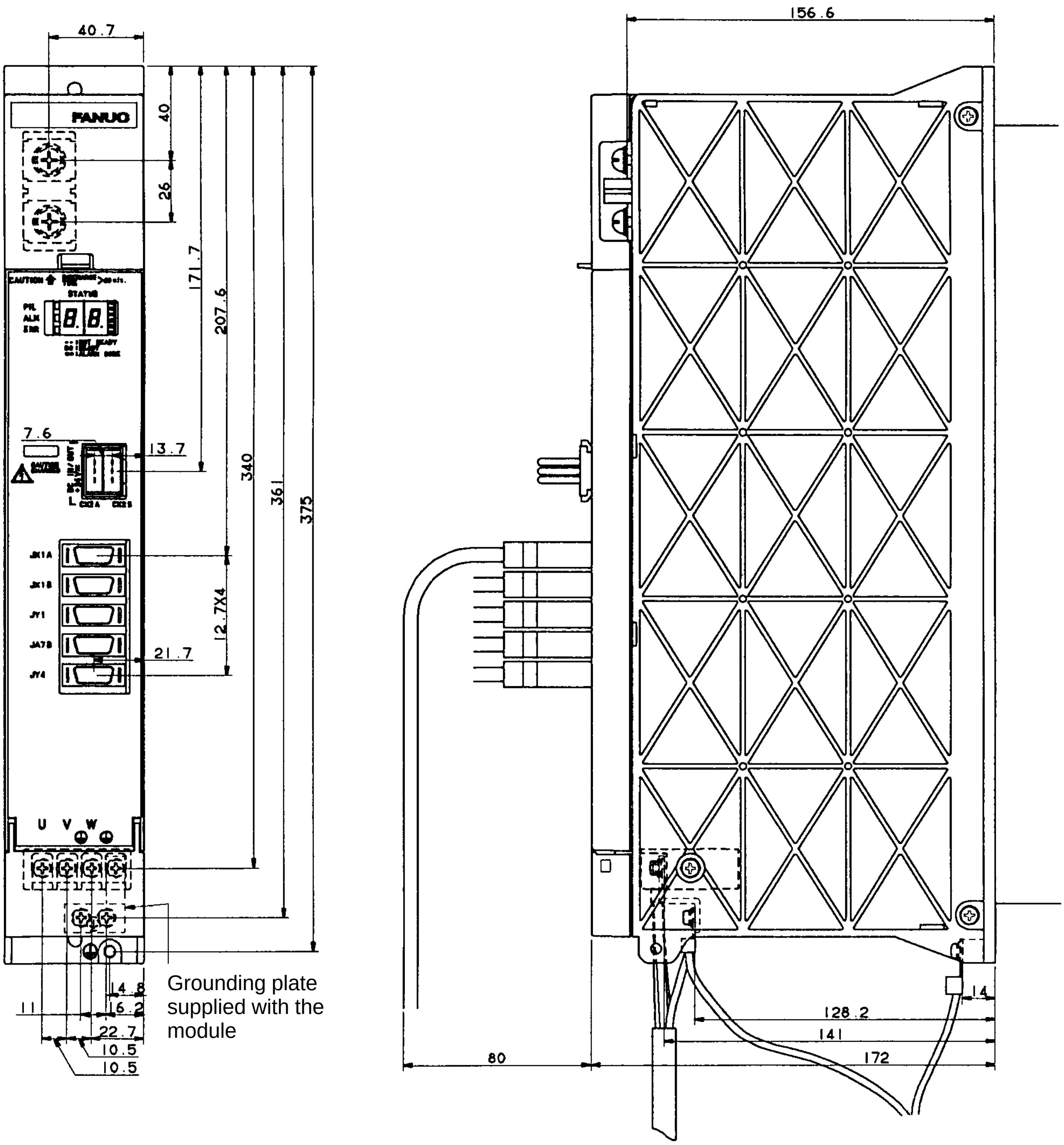
Terminal board (TB2)

U	V	W	⏚	⏚

(6) SPM–45, SPM–75HV (TYPE 3)



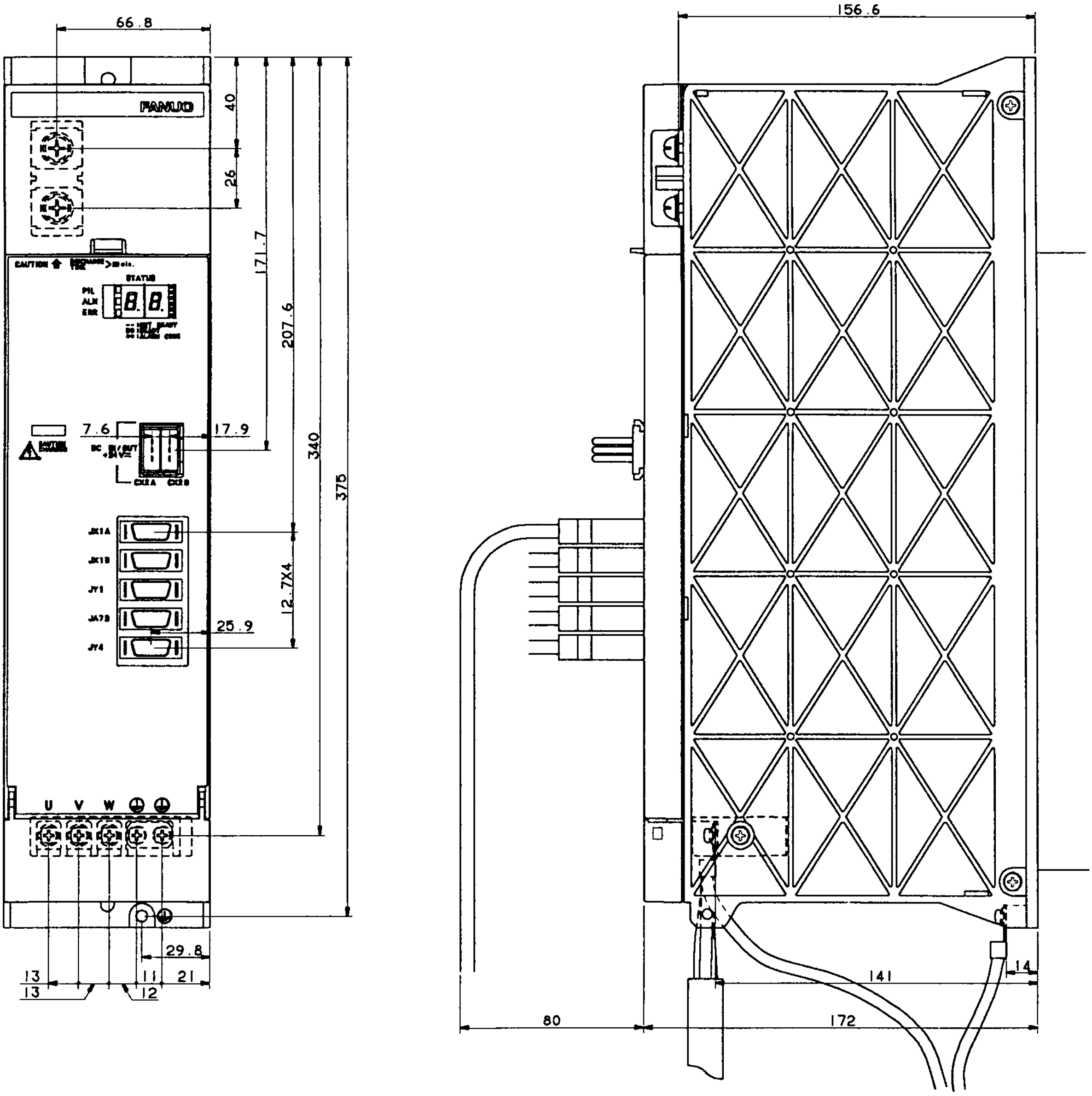
(7) SPMC–2.2



Terminal board (TB2)

U	V	W	
	⏚	⏚	

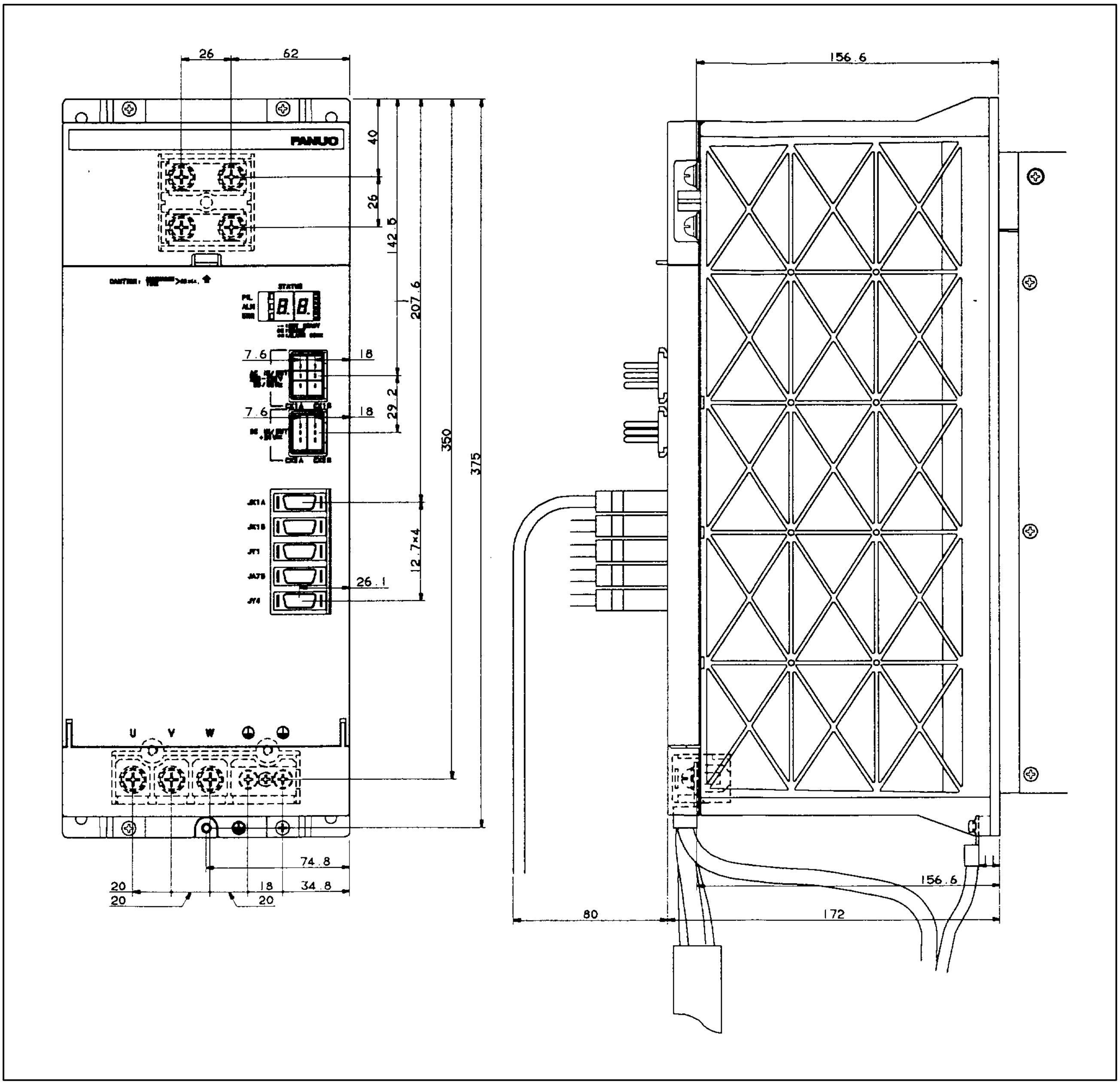
(8) SPMC–5.5, 11



Terminal board (TB2)

U	V	W	⏚	⏚

(9) SPMC–15, 22, 26



10 INTERFACE SIGNALS

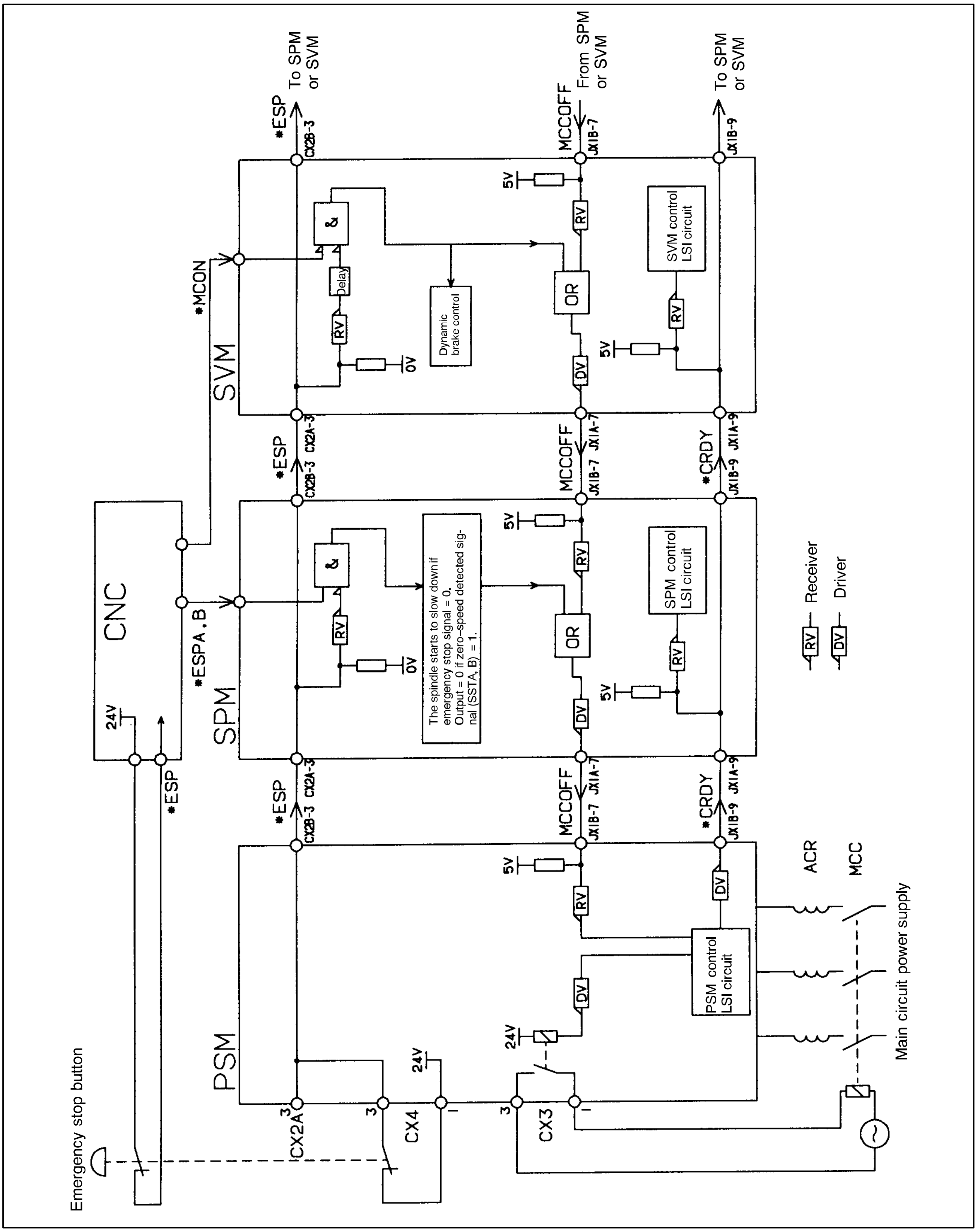
10.1 EMERGENCY STOP SIGNAL (*ESP) – CONTACT INPUT SIGNAL –

The α series servo amplifier has a terminal for the emergency stop signal on the power supply module (connector: CX4). Always use the emergency stop signal.

- When the contact is closed (on), the spindle motors and servo motors can operate. When the contact is open (off), the external magnetic contactor is turned off, preventing operation of the spindle motors and servo motors.
- When the contact is opened (turned off) while a motor is rotating, a spindle motor will decelerate naturally and stop, while a servo motor will stop by the application of its dynamic brake.
- The contact input signal has the following specifications:
  - ❑ External contact capacity: 30 VDC or higher, 100 mA or higher
  - ❑ Significant levels for contactless input (voltage between input terminals)

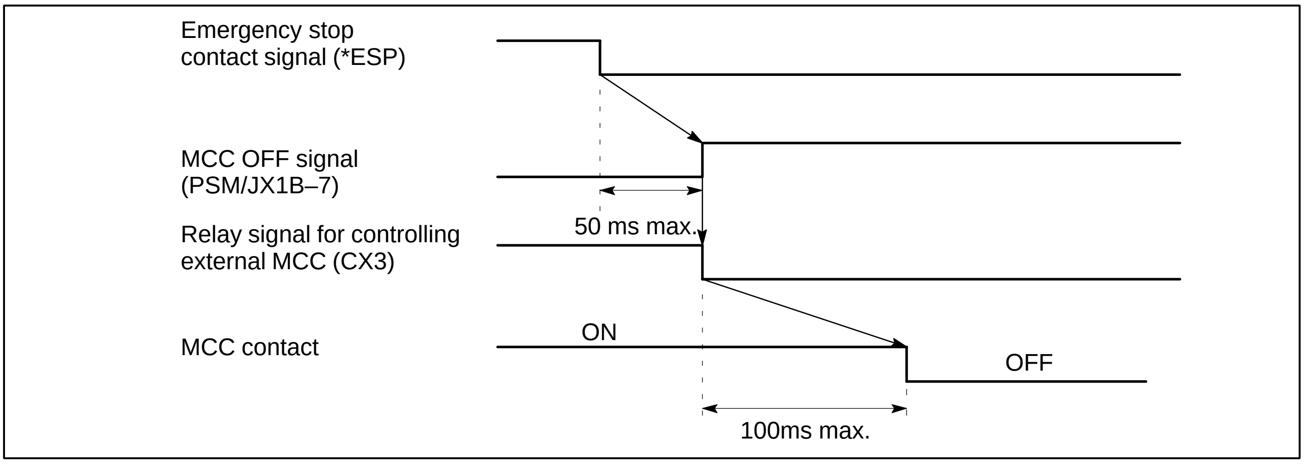
    Low (logical 0) : 2 V or lower
    High (logical 1) : 20 V or higher

10.1.1 Emergency Stop Signal (*ESP) Block Diagram



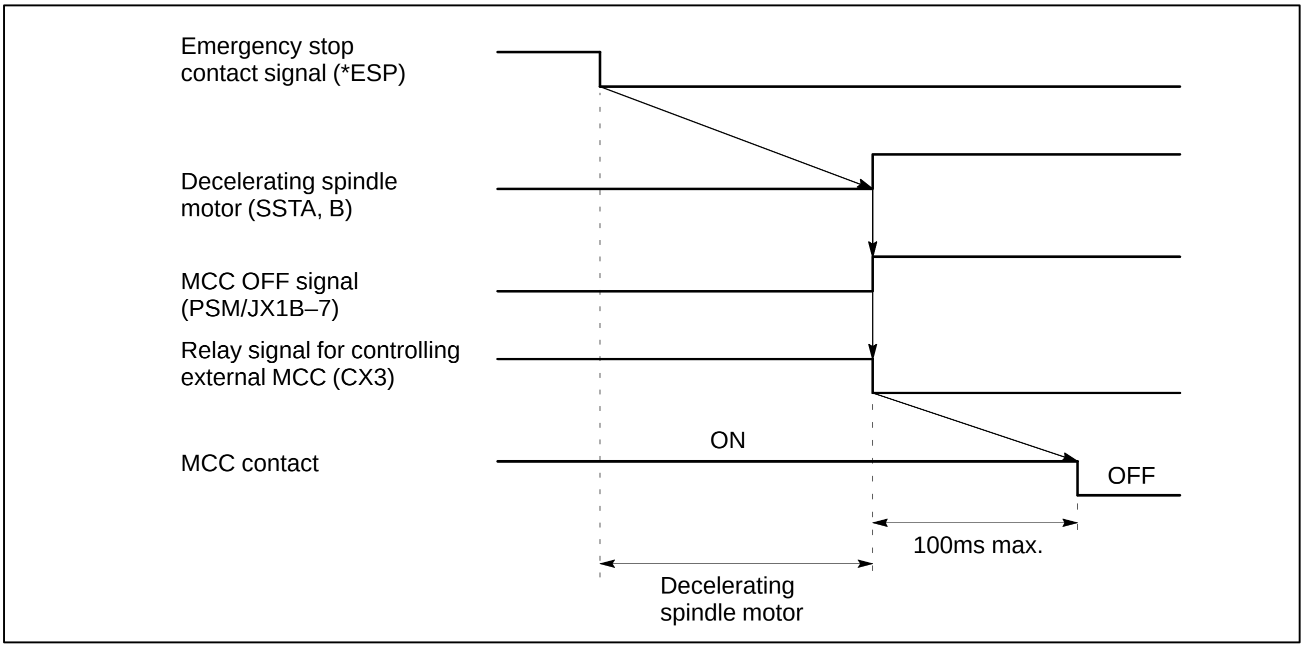
10.1.2 Sequence for Emergency Stop

Without SPM



NOTE
The emergency stop signal triggers the DB stop sequence of the servo motor. At the same time, each SVM outputs the MCCOFF signal to shut down the external MCC.

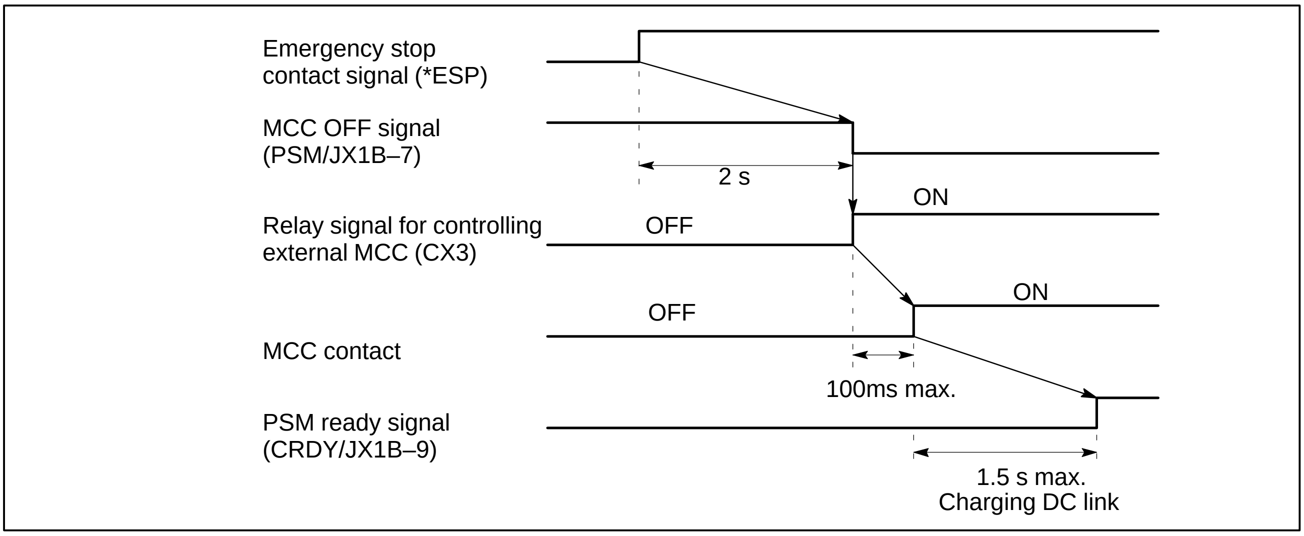
With SPM



NOTE
The emergency stop signal brings the servo motor to a DB stop. It also decelerates the spindle motor until it stops. Once the spindle motor has stopped, and the spindle zero–speed detected signal has been output, the external MCC is shut down.

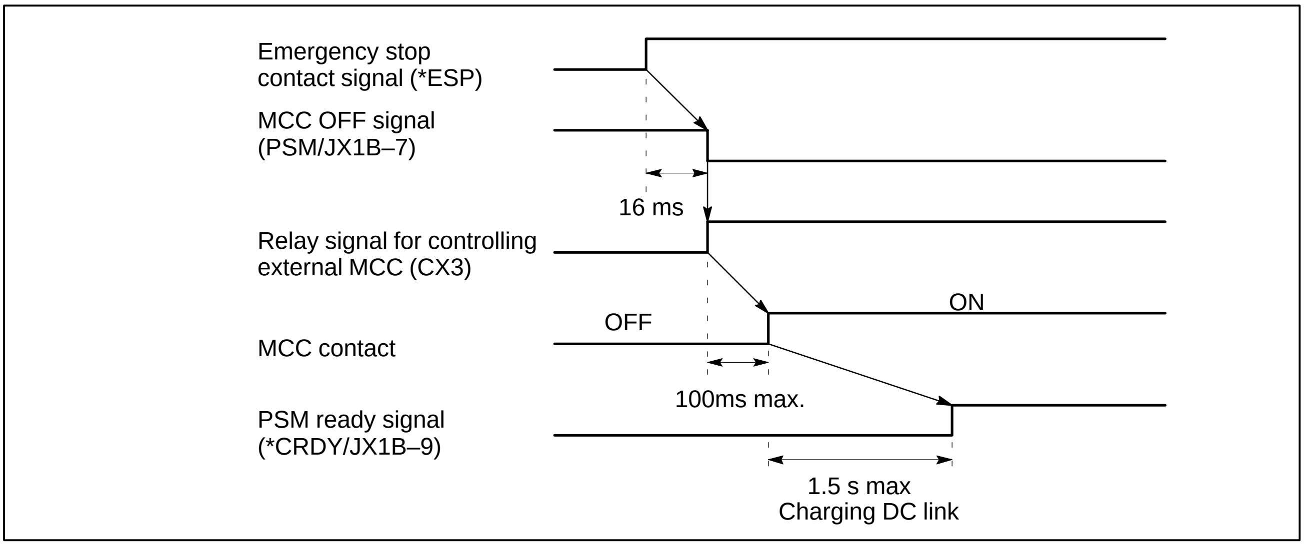
10.1.3 Sequence for Releasing Emergency Stop

Without SPM



NOTE
When the PSM ready (*CRDY) signal = 0, the servo motor is ready to operate.

With SPM



NOTE
When the PSM ready (*CRDY) signal = 0, the servo motor and spindle motor are ready to operate. Even if there is an SPM, a no–SPM sequence is used, if the spindle emergency stop signals (*ESPA and *ESPB) are not reset.

10.2 SPINDLE CONTROL SIGNALS (α series spindle)

10.2.1 Spindle Control DI Signal (PMC to CNC)

(1) 1st Spindle Signal Address

FS0	FS0–TT HEAD2	FS15 (Note 1)	FS16 Path 1	Path 2	#7	#6	#5	#4	#3	#2	#1	#0
G229	G1429	G227	G070	G1070	MRDYA	ORCMA	SFRA	SRVA	CTH1A	CTH2A	TLMHA	TLMLA
G230	G1430	G226	G071	G1071	RCHA	RSLA	INTGA	SOCNA	MCFNA	SPSLA	*ESPA	ARSTA
G231	G1431	G229	G072	G1072	RCHHGA	MFNHGA	INCMDA	OVRA	DEFMDA	NRROA	ROTAA	INDXA
G232	G1432	G228	G073	G1073				DSCNA	SORSLA	MPOFA	SLVA	MORCMA
G124	G1324		G032	G1032	R08I	R07I	R06I	R05I	R04I	R03I	R02I	R01I
G125	G1325		G033	G1033	SIND	SSIN	SGN		R12I	R11I	R10I	R09I
		G024			RISGN			RI12	RI11	RI10	RI09	RI08
		G025			RI07	RI06	RI05	RI04	RI03	RI02	RI01	RI00
G110	G1310	G231	G078	G1078	SHA07	SHA06	SHA05	SHA04	SHA03	SHA02	SHA01	SHA00
G111	G1311	G230	G079	G1079					SHA11	SHA10	SHA09	SHA08
G103	G1303						SPC	SPB	SPA			
		G029								SPC	SPB	SPA
			G030	G1030	SOV7	SOV6	SOV5	SOV4	SOV3	SOV2	SOV1	SOV0
G120	G1320					*SSTP	SOR	SAR	FIN			
		G005									FIN	
			G029	G1029		*SSTP	SOR	SAR				
			G004	G1004					FIN			
G123 (Note 2)	G1323				CON(M)	SPSTP	*SCPF	*SUCPF	GR2	GR1		COFF(T)
G118 (Note 1)	G1318								GR2	GR1		
			G027	G1027	CON							
		G067, 071, ...			SCNTR 1, 2, ...							
G146			G038	G1038					SPPHS	SPSYC		
		G111			SPPHS	SPSYC						
G123 (Note 3)											RGTP	
G135 (Note 3)			G061	G1061								RGTAP
		G026				GS4	GS2	GS1	*SECLP	*SEUCL		SPSTP

NOTE

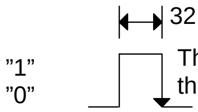
1 The addresses listed under "FS15" are for the PMC–NA. Refer to the FS15 Connection Manual for the PMC–NB addresses.
2 Bit 5 (ADDCF) of parameter No. 31 applies here.
3 Bit 4 (SRGTP) of parameter No. 19 applies here.

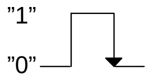
FS0	FS0–TT HEAD2	FS15 (Note 1)	FS16 Path 1	Path 2	#7	#6	#5	#4	#3	#2	#1	#0
			G028	G1028		SPSTP	*SCPF	*SUCPF		GR2	GR1	
G104								ESRSYC				
G145	G1345				GR31	GR21	*SSTP3	*SSTP2	*SSTP1	SWS3	SWS2	SWS1
			G027	G1027			*SSTP3	*SSTP2	*SSTP1	SWS3	SWS2	SWS1
			G029	G1029						GR31		GR21
G146	G1346		G028	G1028	PS2SLC							

(2) 2nd Spindle Signal Address

FS0	FS0–TT HEAD2	FS15 (Note 1)	FS16 Path 1	Path 2	#7	#6	#5	#4	#3	#2	#1	#0
G233	G1433	G235	G074	G1074	MRDYB	ORCMB	SFRB	SRVB	CTH1B	CTH2B	TLMHB	TLMLB
G234	G1434	G234	G075	G1075	RCHB	RSLB	INTGB	SOCNB	MCFNB	SPSLB	*ESPB	ARSTB
G235	G1435	G237	G076	G1076	RCHHGB	MFNHGB	INCMDA	OVRB	DEFMDB	NRROB	ROTAB	INDXB
G236	G1436	G236	G077	G1077					SORSLB	MPOFB	SLVB	MORCMB
G112	G1312	G239	G080	G1080	SHB07	SHB06	SHB05	SHB04	SHB03	SHB02	SHB01	SHB00
G113	G1313	G238	G081	G1081					SHB11	SHB10	SHB09	SHB08
			G034	G1034	R08I2	R07I2	R06I2	R05I2	R04I2	R03I2	R02I2	R01I2
			G035	G1035	SIND2	SSIN2	SGN2		R12I2	R11I2	R10I2	R09I2
		G232			RISGNB			RIB12	RIB11	RIB10	RIB9	RIB8
		G233			RIB7	RIB6	RIB5	RIB4	RIB3	RIB2	RIB1	RIB0
G106	G1306				M2R08I	M2R07I	M2R06I	M2R05I	M2R04I	M2R03I	M2R02I	M2R01I
G107	G1307				M2SIND	M2SSIN	M2SGN		M2R12I	M2R11I	M2R10I	M2R09I

(3) Spindle control DI signals

Symbol	Signal	Description
TLMLA, B	Torque limit command (low)	Limits the output torque of the spindle motor. Set the limit using the spindle parameter. TLML TLMH 0 0 : No torque limit 0 1 : Limits the torque to the value specified with the parameter. 1 0 : Limits the torque to half of the value specified with the parameter. 1 1 : Limits the torque to half of the value specified with the parameter.
TLMHA, B	Torque limit command (high)	
CTH1, 2A, B	Clutch or gear signal	Specify one of the following conditions according to the clutch or gear status. Used to select a spindle control parameter. CTH1 CTH2 0 0 : High gear 0 1 : Medium high gear 1 0 : Medium low gear 1 1 : Low gear
SRVA, B	Reverse rotation command	Specifies the rotation direction when the spindle motor is viewed from the shaft. SRV SFR 0 0 : Stop 0 1 : Normal rotation (CCW: Counterclockwise) 1 0 : Reverse rotation (CW: Clockwise) 1 1 : Stop
SFRA, B	Normal rotation command	
ORCMA, B	Orientation command	Used for spindle orientation control. 0 : – 1 : Spindle orientation control is performed.
MRDYA, B	Machine ready signal	0 : Motor is not excited. 1 : Motor is ready for operation.
ARSTA, B	Alarm reset signal	Used to reset the spindle alarm.  The alarm is reset when the level of the signal is changed from 1 to 0.
*ESPA, B	Emergency stop signal	0 : Emergency stop 1 : Normal operation
SPSLA, B	Spindle selection request signal	Used to select the spindle motor by spindle switcing control. 0 : Main spindle 1 : Sub spindle
MCFNA, B	Power line status check signal	Used for the spindle switching control. 0 : Main spindle 1 : Sub spindle
SOCNA, B	Soft start/stop cancel signal	0 : The soft start/stop function is canceled. 1 : The soft start/stop function is enabled.
INTGA, B	Velocity integral control signal	0 : Velocity integral control is enabled. 1 : Velocity integral control is disabled.

Symbol	Signal	Description
RSLA, B	Speed range switching request signal	Used to select the output characteristics in speed range swiching control. 0 : High-speed range 1 : Low-speed range
RCHA, B	Power line status check signal	Used for the speed range switching function. 0 : High-speed range 1 : Low-speed range
INDXA, B	Orientation stop position change signal	 Used for the stop position external setting type orientation. New stop position data is obtained when the level of the signal is changed from 1 to 0. Then, the spindle is moved to the new stop position, and is stopped.
ROTAA, B	Rotation direction command while changing the orientation stop position	Used for the stop position external setting type orientation. 0 : CCW (counterclockwise) 1 : CW (clockwise)
NRROA, B	Short-distant movement command while changing the orientation stop position	Used for the stop position external setting type orientation. 0 : The rotation direction depends on the setting of ROTA (= bit 1) 1 : Short-distance movement control (within $\pm 180°$)
DEFMDA, B	Differential mode command	Used for the spindle differential control mode 1 : Differential control mode
OVRA, B	Analog override command	0 : Analog override is disabled. 1 : Analog override is enabled.
INCDA, B	Incremental command	1 : Incremental command spindle orientation 0 : Normal orientation
MFNHGA, B	Main-spindle MCC status signal while changing spindles	0 : The MCC in the main spindle is opened. 1 : The MCC in the main spindle is closed.
RCHHGA, B	High–speed MCC status signal while changing speed range	0 : The MCC for high speed is opened. 1 : The MCC for high speed is closed.
MORCMA, B	Command for spindle orientation with a magnetic sensor	1 : Spindle orientation with the magnetic sensor is controlled.
SLVA, B	Slave operation command	0 : Slave operation control is disable. 1 : Slave operation control is enable.
MPOFA, B	Motor power stop signal	1 : Motor power stop

Symbol	Signal	Description
DSCNA, B	Broken–wire detection disable signal	Used if a feedback loop between the amplifier and motor is to be disconnected. 0 : Enables broken–wire and overheat detection. 1 : Disables broken–wire and overheat detection.
R12I - R01I SGN, SSIN SIND RI12 - RI00 RISGN	Spindle speed command	Specifies a spindle speed command.
SHA11 - SHA00 SHB11 - SHB00	Stop position command for spindle orientation with a position coder	The stop position is specified externally spindle orientation with the position coder.
*SSTP	Spindle stop signal	0 : Velocity command voltage = 0 1 : Velocity command voltage = specified value
SOR	Spindle orientation in progress	1 : Outputs the velocity command specified with the parameter.
SAR	Velocity reached signal	1 : The actual spindle speed reaches the specified speed.
FIN	M function completion signal	1 : The M function is completed.
CON, COFF SCNTR1, 2 . .	Cs contour control command	Specifies the Cs contour control mode .
GR1, 2 GS1, 2, 4	Gear select signal (T-series)	Used for velocity command calculation under constant surface speed control
*SUCPF *SEUSL	Spindle unclamp signal	Used for spindle positioning control
*SCPF *SEUCL	Spindle clamp signal	
SPSTP	Spindle stop check signal	
SPSYC	Spindle speed synchronization control command	1 : Spindle speed synchronization control
SPPHS	Spindle phase synchronization control command	1 : Spindle phase synchronization control
RGTP RGTAP	Rigid tapping command	1 : Rigid tapping control

10.2.2 Spindle Control DO Signals (CNC to PMC)

(1) 1st Spindle Signal Address

FS0	FS0–TT HEAD2	FS15 (Note 1)	FS16 Path 1	Path 2	#7	#6	#5	#4	#3	#2	#1	#0
F281	F1481	F229	F045	F1045	ORARA	TLMA	LDT2A	LDT1A	SARA	SDTA	SSTA	ALMA
F282	F1482	F228	F046	F1046	MOAR2A	MOAR1A	POAR2A	SLVSA	RCFNA	RCHPA	CFINA	CHPA
F283	F1483	F231	F047	F1047				EXOFA	SORENA	MSOVRA	INCSTA	PC1DTA
F172	F1372		F036	F1036	R08O	R07O	R06O	R05O	R04O	R03O	R02O	R01O
F173	F1373		F037	F1037					R12O	R11O	R10O	R09O
		F010 (F006) (Note 2)			RO15	RO14	RO13	RO12	RO11	RO10	RO09	RO08
		F001 (F001)			RO07	RO06	RO05	RO04	RO03	RO02	RO01	RO00
F150	F1350		F007	F1007						SF		MF
											SF	MF
F149	F1349		F001	F1001				ENB				
F164	F1364		F038	F1038					ENB3	ENB2	SCLP	SUCLP
						SPCO	SPBO	SPAO		SPAL	SSLP	SUCLP
F154	F1354		F035	F1035								SPAL
F152	F1352		F034	F1034						GR30	GR20	GR10
		F001			CSS							
			F002	F1002						CSS		
F178			F044	F1044				SYCAL	FSPPH	FSPSY	FSCSL	
		F67, 71, ...			MCNTR1, 2, ...							
		F111			MSPPHS	MSPSYC	SPSYAL					
		F040						RTAP				
		F020	F025	F1025	S31	S30	S29	S28	S27	S26	S25	S24
		F021	F024	F1024	S23	S22	S21	S20	S19	S18	S17	S16
		F022	F023	F1023	S15	S14	S13	S12	S11	S10	S09	S08
		F023	F022	F1022	S07	S06	S05	S04	S03	S02	S01	S00
		F012	F041	F1041	AR15	AR14	AR13	AR12	AR11	AR10	AR09	AR08
		F013	F040	F1040	AR07	AR06	AR05	AR04	AR03	AR02	AR01	AR00
		F232			SLDM15	SLDM14	SLDM13	SLDM12	SLDM11	SLDM10	SLDM09	SLDM08
		F233			SLDM07	SLDM06	SLDM05	SLDM04	SLDM03	SLDM02	SLDM01	SLDM00
		F234			SSPD15	SSPD14	SSPD13	SSPD12	SSPD11	SSPD10	SSPD09	SSPD08
		F235			SSPD07	SSPD06	SSPD05	SSPD04	SSPD03	SSPD02	SSPD01	SSPD00
		F236			SSPAA7	SSPAA6	SSPAA5	SSPAA4	SSPAA3	SSPAA2	SSPAA1	SSPAA0

NOTE

1 The addresses listed under ”FS15” are for the PMC–NA. Refer to the FS15 Connection Manual for the PMC–NB addresses.

2 The addresses in parentheses are used for 15–TT.

(2) 2nd Spindle Signal Address

FS0	FS0–TT HEAD2	FS15 (Note 1)	FS16 Path 1	Path 2	#7	#6	#5	#4	#3	#2	#1	#0
F285	F1485	F245	F049	F1049	ORARB	TLMB	LDT2B	LDT1B	SARB	SDTB	SSTB	ALMB
F286	F1486	F244	F050	F1050	MOAR2B	MOAR1B	POAR2B	SLVSB	RCFNB	RCHPB	CFINB	CHPB
F287	F1487	F247	F051	F1051				EXOFB	SORENB	MSOVRB	INCSTB	PC1DTB
		F248			SLDMB15	SLDMB14	SLDMB13	SLDMB12	SLDMB11	SLDMB10	SLDMB9	SLDMB8
		F249			SLDMB7	SLDMB6	SLDMB5	SLDMB4	SLDMB3	SLDMB2	SLDMB1	SLDMB0
		F250			SSPDB15	SSPDB14	SSPDB13	SSPDB12	SSPDB11	SSPDB10	SSPDB9	SSPDB8
		F251			SSPDB7	SSPDB6	SSPDB5	SSPDB4	SSPDB3	SSPDB2	SSPDB1	SSPDB0
		F252			SSPAB7	SSPAB6	SSPAB5	SSPAB4	SSPAB3	SSPAB2	AAPAB1	SSPAB0

(3) Spindle control DO signals

Symbol	Signal	Description
ALMA, B	Alarm signal	Output when a spindle alarm occurs. 0 : Normal state 1 : Alarm state
SSTA, B	Speed zero detection signal	Output when the actual spindle motor speed does not exceed the speed zero detection level. 1 : Zero speed
SDTA, B	Speed detection signal	Output when the actual spindle motor speed does not exceed the preset speed. 1 : Less than preset speed
SARA, B	Speed match signal	Output to the velocity command when the actual spindle motor speed reaches the preset range. 1 : Speed match
LDT1A, B	Load detection signal 1	Output when the detected load is greater than the specified load detection level. LDT1 and LDT2 can be set to a different level. 1 : Greater than the specified load
LDT2A, B	Load detection signal 2	Output when the detected load is greater than the specified load detection level. 1 : Greater than the specified load
TLMA, B	Torque limiting signal	1 : The limit is applied to the torque.
ORARA, B	Orientation complete signal	Output when the spindle stops near the specified position after the orientation command is entered. 1 : Orientation is completed.
CHPA, B	Power line change signal	Used for spindle switching control. 0 : Main spindle 1 : Sub spindle
CFINA, B	Spindle switching completion signal	Used for spindle switching control. 0 : Main spindle 1 : Sub spindle
RCHPA, B	Power line change signal	Used for speed range switching control. 0 : High-speed range 1 : Low-speed range
RCFNA, B	Speed range switching completion signal	Used for speed range switching control. 0 : High-speed range 1 : Low-speed range

Symbol	Signal	Description
SLVSA, B	Slave operation status	1 : Slave operation status
POAR2A, B	Signal for approximate spindle orientation with a position coder	1 : Near the orientation stop position
MOAR1A, B	Signal for completion of spindle orientation with a magnetic sensor	1 : Completion of orientation
MOAR2A, B	Signal for approximate spindle orientation with a magnetic sensor	1 : Near the orientation stop position
PC1DTA, B	Signal indicating the status of the detected one-rotation position coder signal	1 : Status of the detected one-rotation position coder signal
INCSTA, B	Incremental method orientation signal	1 : Under incremental method spindle orientation
R12O-R01O RO15-RO00	Spindle speed command	Outputs the spindle speed command.
MF	M function strobe signal	1 : The M code is effective.
SF	Spindle function strobe signal	1 : The S code is effective.
ENB	Spindle enable signal	0 : The velocity command indicates 0. 1 : The velocity command indicates other than 0.
SUCLP	Spindle unclamp completion signal	1 : Unclamping the spindle is completed.
SCLP	Spindle clamp completion signal	1 : Clamping the spindle is completed.
SPAL	Spindle fluctuation alarm signal	1 : The actual speed of the spindle is out of the allowed range.
SPAO, SPBO SPCO	Spindle speed override check signal	
GR10, 20, 30	Gear select signal	
CSS	Constant surface speed control signal	1 : Under constant surface speed control
FSCSL NCBTR1, 2	Cs contour control signal	1 : Under Cs contour control
FSPSY MSPSYC	Spindle synchronization control signal	1 : Under spindle synchronization control

Symbol	Signal	Description
FSPPH MSPPHS	Spindle phase synchronization control signal	1 : Under spindle phase synchronization control
SYCAL SPSYAL	Spindle synchronization control alarm signal	1 : Spindle synchronization control alarm
RTAP	Rigid tapping signal	1 : Rigid tapping in progress
S31 - S00	Spindle function code signal	Sxxxx
AR15 - AR00	Actual spindle speed signal	min^{-1}
SLDM15 - SLDM00	Load meter data	0 to 32737 (+10 V)
SSPD15 - SSPD00	Motor speed data	0 to ±16384 (maximum motor speed)
SSPAA7 - SSPAA0	Spindle alarm data	Alarm number

10.2.3 Emergency Stop Signal (*ESPA)

- Spindle motor and spindle amplifier module enter the operable state by *ESPA = 1. When *ESPA is set to 0, the spindle amplifier module outputs the MCOFF signal and the spindle motor does not operate.
- If *ESPA = 0 is set during the motor rotation, the spindle motor smoothly decelerates to a stop. Then, it outputs the MCOFF signal.
- If *ESPA = 1 then occurs again, the spindle motor enters the rotateable state, and so will begin to rotate as soon as a rotation command is issued. For this reason, the command signal (speed command, normal operation command, or reverse operation command) to the spindle amplifier module should be reset at the same time an emergency stop signal is input.

10.2.4 Machine Ready Signal (MRDYA)

- The table contents result from the parameter setting.

<table>
<tr><th rowspan="2">Mode</th><th>Parameter setting</th><th rowspan="2" colspan="2">Contents</th></tr>
<tr><th>Series15:3001-bit0
Series0:6501-bit0
Series16:4001-bit0</th></tr>
<tr><td>A</td><td>0</td><td colspan="2">Machine ready signal is not used.
At this time, the spindle motor enters the operable state only when emergency stop signal is input.</td></tr>
<tr><td>B</td><td>1</td><td>Uses the machine ready signal to create operable state by double signal.</td><td>Intercepts power by turning off the transistor excitation signal for the inverter with MRDYA = 0.</td></tr>
</table>

Mode A

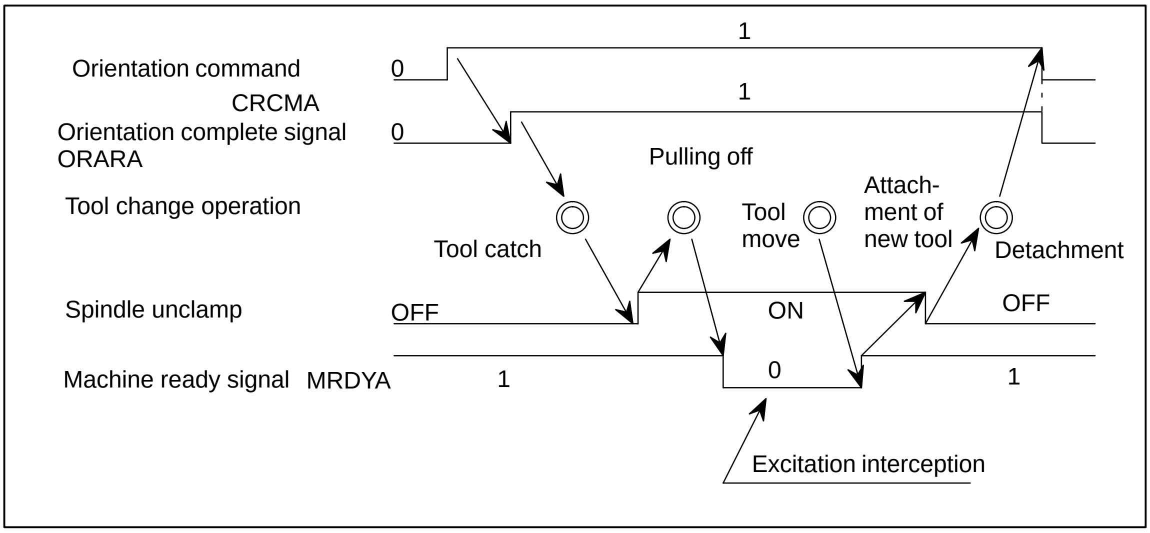
Used when minimizing the input signal.

Mode B

1 During the automatic tool change (ATC) orientation operation, in a machine where the spindle motor is restrained by the tool unclamp signal,there are cases where the load meter indication becomes large and a large motor current flows by a slight slip from the orientation stop position.
In order to prevent this, set MRDYA = 0 and release the orientation state during tool unclamp.
If MRDYA = 1 is set at tool unclamp end, it is possible to re-enter the orientation state.

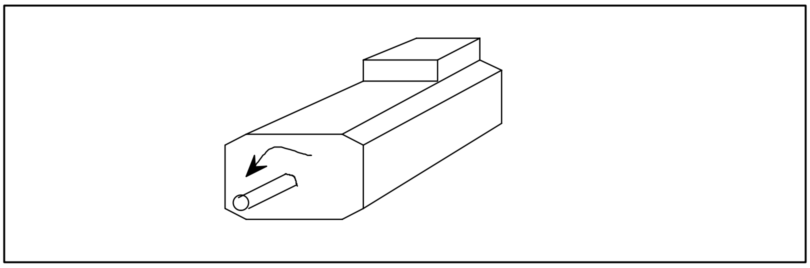
2 Regarding the purpose of the above described **1**, if the orientation command signal remains at ORCMA = 1, even if the machine ready signal is set to MRDYA = 0/1, there is no orientation again after 1 rotation as it only moves by the amount of the stop position slip.

Timing chart



10.2.5 Normal Rotation Command Signal (SFRA)

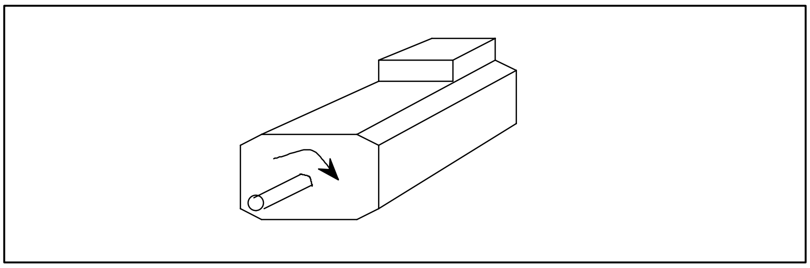
- When the following four conditions hold, the spindle motor starts a normal rotation corresponding to the speed command (positive value).
  - ❑ Emergency stop signal *ESPA is 1
  - ❑ Machine ready signal MRDYA is 1
  - ❑ Normal rotation command signal SFRA is 1
  - ❑ Contact signal ESP is connected to 24 V (at CX4 of the PSM)
- While SFRA = 1, the spindle motor rotates in an counterclockwise direction (CCW) viewed from the shaft side according to the commanded speed (positive value).



- If SFRA = 0 occurs, the spindle motor stops by the regenerative braking. After stopping, it cuts the power supply to the spindle motor by intercepting the transistor excitation signal.

10.2.6 Reverse Rotation Command Signal (SRVA)

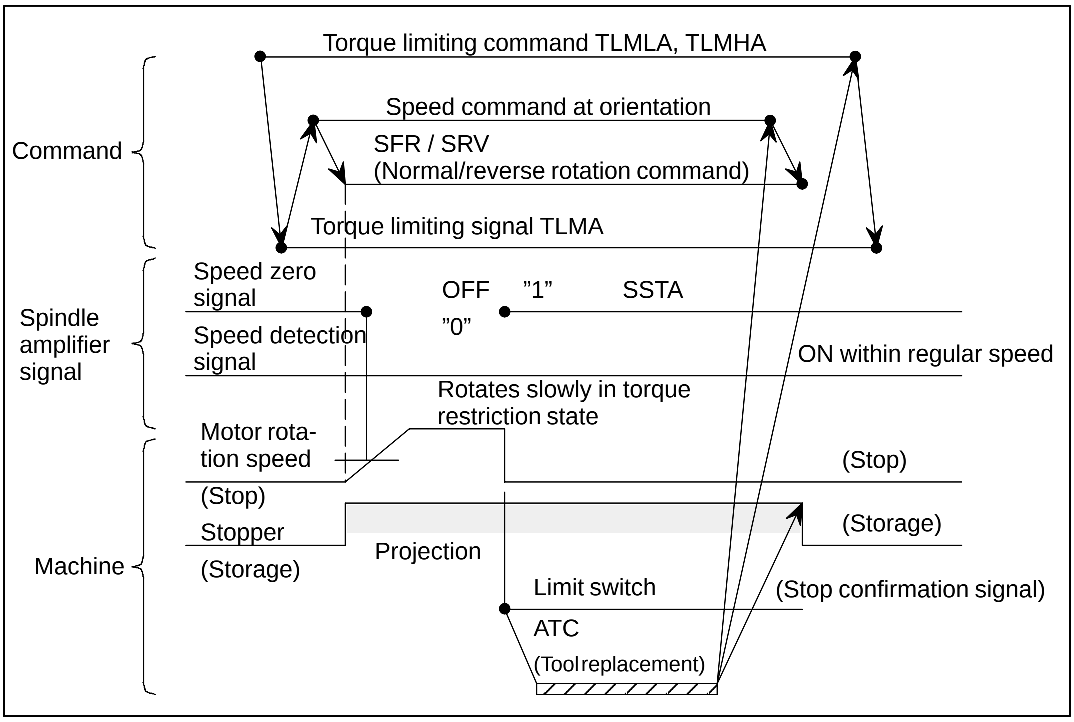
- When the following four conditions hold, the spindle motor starts a reverse rotation corresponding to the speed command (positive value).
  - ❑ Emergency stop signal *ESPA is 1
  - ❑ Machine ready signal MRDYA is 1
  - ❑ Reverse rotation command signal SRVA is 1
  - ❑ Contact signal ESP is connected to 24 V (at CX4 of the PSM)
- While SRVA=1, the spindle motor rotats in a clockwise direction (CW) looked at from the shaft side according to the speed command (Positive value).



- If SFRA = 0 occurs, the spindle motor stops by the regenerative braking. After stopping, it cuts the power supply to the spindle motor by intercepting the transistor excitation signal.
- When the Normal rotation command signal (SFRA) and the reverse rotation command signal (SRVA) are simultaneiusly ON, the spindle motor stops.

10.2.7 Torque Limiting Command Signal (TLMLA, TLMHA)

- The torque restriction (torque limit) is used in order to rotate the spindle motor to temporarily reduce the spindle motor output torque at such times as machine type spindle orientation.
- Set the rotation speed at orientation and the output torque at orientation of each machine type at the machine manufacture in order to lessen shocks even when hitting the machine stopper.
- It is possible to adjust the output torque at orientation by parameter.
- If the torque limiting command is 1, the torque limit state occurs. Even if commanded during motor rotation it will be immediately enabled. If the torque limit state occurs, the torque limiting signal (TLMA) is immediately transmitted to the outside.
- At the time of performing machine type orientation at the machining center ATC, consider the following points when designing the magnetics cabinet sequence such that damage does not occur to the machine stopper.
  - ❑ The output torque at orientation should not be excessive.
  - ❑ The rotation speed at orientation should not be excessive. For example, when the rotation speed is excessive at the speed detection signal, the interlock should be set such that the stopper does not emerge.
  - ❑ When the torque limit is released, the stopper should be securely stored.



Example of machine type orientation sequence

When the conditions desicribed on the privious page are difficult, use the purely electric type spindle orientation (option) which does not use a stopper.

10.2.8 Alarm Reset Signal (ARSTA)

- After removing the various alarm causes such as motor overheating, excess speed deviation, short-circuiting, excess speed, excess voltage, excess current, excess load, and voltage drop, if the alarm reset signal is input, the alarm is released and the usable state occurs.
- Even if this signal isinputted when there is no alarm, it is disabled.
- The alarm detected by power supply module is not released.
  (Such alarms reset by turning off the power.)

10.2.9 Spindle Alarm Signal (ALMA)

- If the state occurs in which the spindle motor operation cannot be continuously executed, the power to the spindle motor will become OFF and the spindle motor will be stopped.
- At the same time the alarm signal ALMA = 1 occurs. Regarding the alarm contents, confirm by the display section of the spindle amplifier.
- Set the command signal to the spindle amplifier (speed command, forward/reverse rotation command, torgue limit command, spindle orientation command) in the reset state using the alarm signal output. If it is not in the reset state (state that signal from PMC is all clear), when the alarm on the spindle amplifier is released there is a danger that the spindle motor may rotate.

- Because the spindle motor enters the power OFF, coasting operates at the same time as the alarm signal is output, it is necessary to set in an emergency stop state and to set the feedhold state at the CNC or magnetics cabinet side.
- When the alarm state has occurred, ALMA = 1 occurs.
  While the alarm signal is 1, the spindle motor enters coasting operates state regardless of any command from the outside.
- The relationship between the alarm signal and the alarm reset signal is as shown in Fig. 10.2.9.

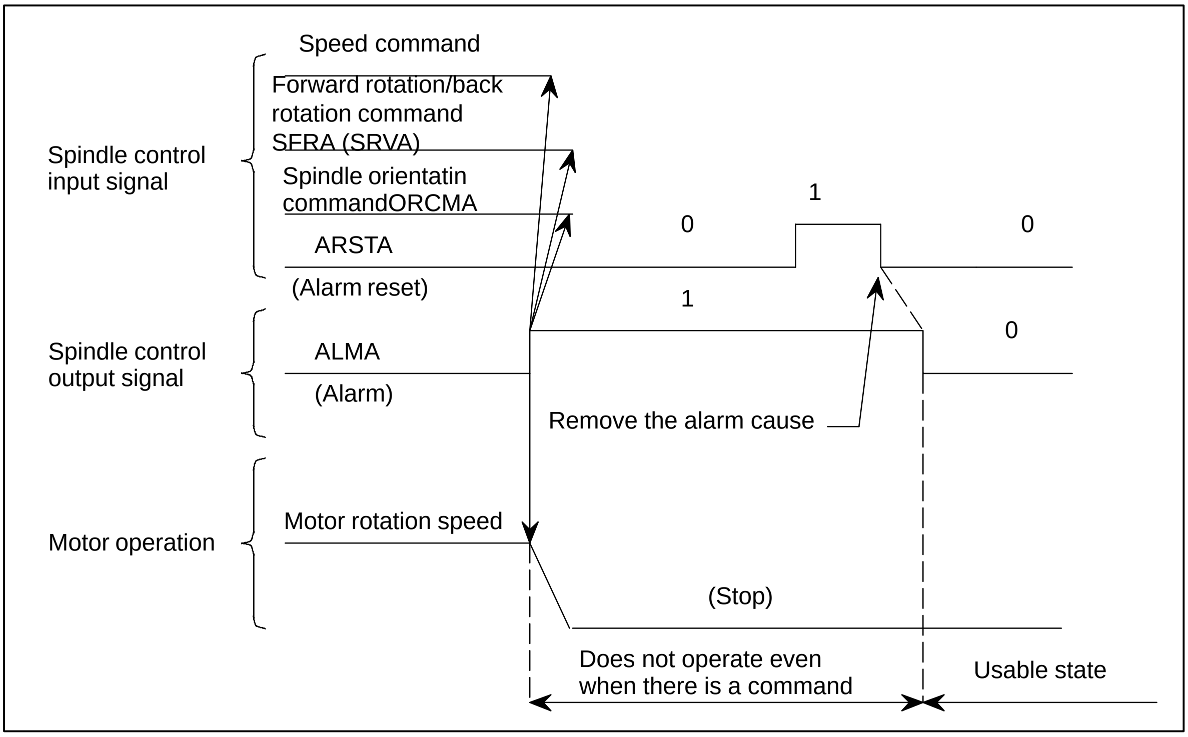


Fig.10.2.9 Timing Chart of the Spindle Alarm Signal

10.2.10 Zero-speed Detecting Signal (SSTA)

- If the actual rotation speed of the spindle motor is reduced to be lower than the zero-speed detection point for the stop command, SSTA = 1 occurs.

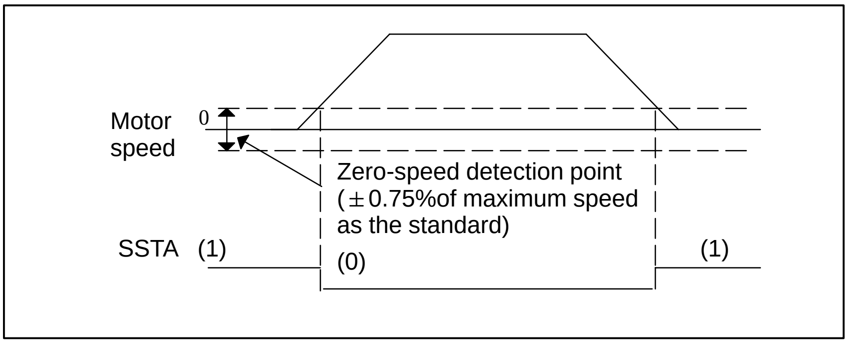


Fig.10.2.10 Signal Indicating that the spindlespeed dropped to close to zero

- The zero–speed detection point is 0.75% of the maximum speed (standard initial setting for the parameter).
  In other words, the zero-speed detection signal becomes SSTA = 1 when the rotation speed is 45 min^{-1} case of the maximum speed 6000 min^{-1}.
- This signal is output when the above condition is satisfied, irrespective of rotation commands (SFR, SRV).
- The minimum pulse width value of this signal is about 40 ms.

10.2.11 Speed Detecting Signal (SDTA)

- SDTA = 1 occurs when the motor speed is lower than the speed which is set by parameter.
- This signal is used to detect that the rotation speed has become lower than a certain speed set such as clutch selectable speed or gear selectable speed.
- The speed detecting level can be set by parameter.
  It is usually set 3% of the maximum speed in the case of gear change or 30% of the maximum speed in the case of clutch change.

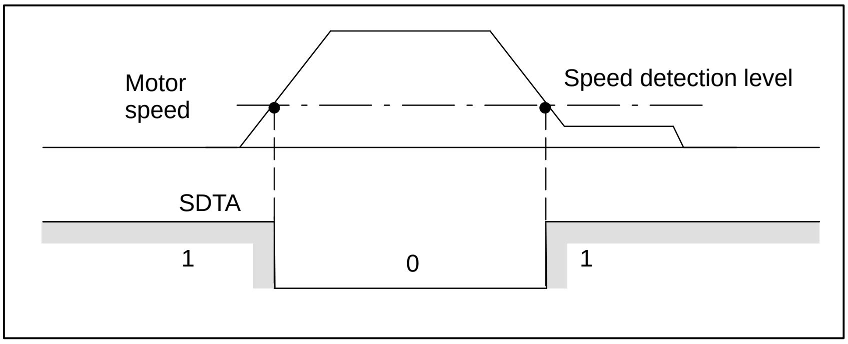


Fig.10.2.11 (a) Speed Detection Signal

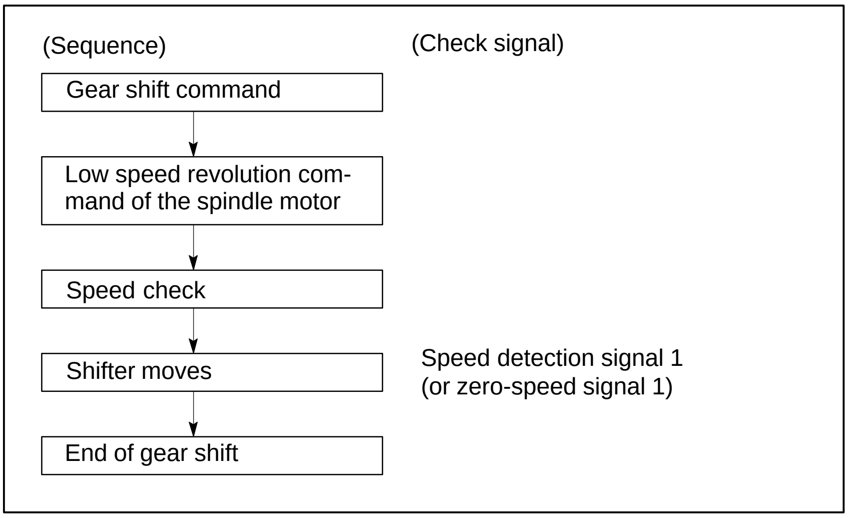
- For this signal, SDTA = 1 occurs when the absolute value of the motor speed is reduced to be lower than the preset detection level, irrespective of rotation commands (SFR, SV).

Reference

- **Sequence of the gear shift**

The gear shift in the CNC machine tool is one of the sequence controls. The electric circuit signal in the sequence is used to move the spindle gear, which is an important component of the machine. It is then necessary to check that the spindle motor revolution is in low speed to switch the gear safely.
The following is an example of sequence at gear shift, when the speed detection signal (gear selectable signal) was used. This example can be referred to when designing the magnetics sequencer.

- **An example of gear shift sequence using speed detection signal**



To change the gear safely, it must be checked that the spindle motor revolution is low enough before moving the shifter. If the zero-speed signal is also applied, the safety can be doubly checked.

Essential reason

If the shifter moves when the spindle motor is rotating at high speed, the gear will break.

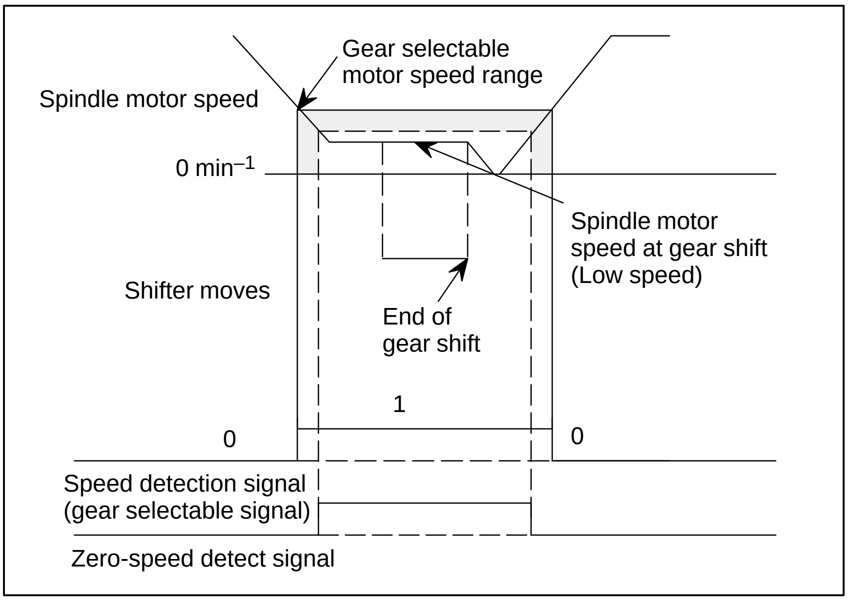


Fig.10.2.11 (b) Speed Detection Signal

10.2.12 Speed Arrival Signal (SARA)

- SARA = 1 occurs when the actual rotation speed of the spindle motor arrives within the range set by the speed command.

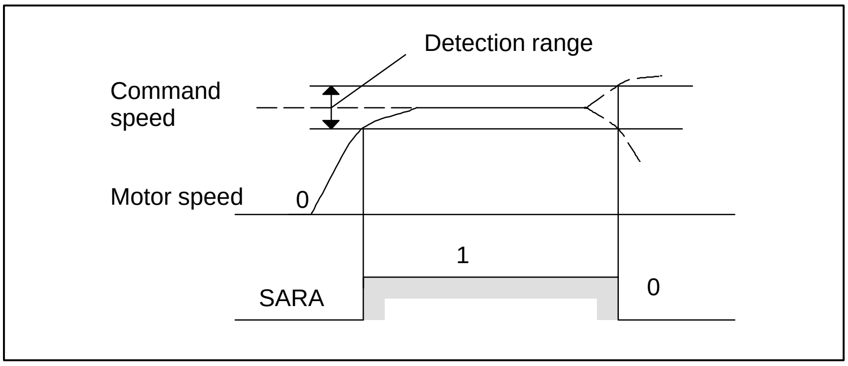


Fig.10.2.12 (a) Speed Arrival Signal 1

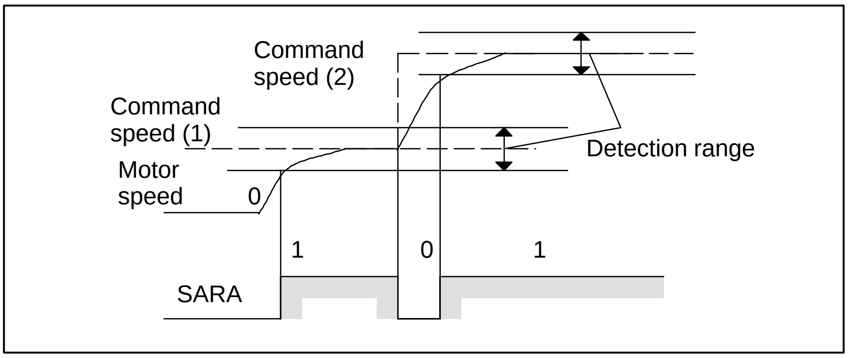


Fig.10.2.12 (b) Speed Arrival Signal 2

- The setting range is ±1 to 100% of the command speed. However, when the speed is less than 10% of the maximum rotation speed, the detection range becomes wider than the preset range.
- The standard setting at shipment is ±15%. However, the detection range of this speed arrival signal at low speed widens as shown in the diagram below.

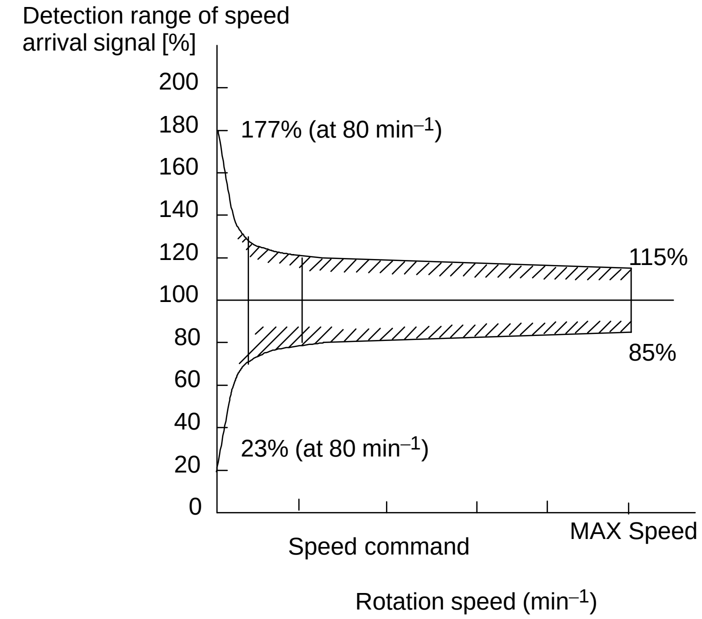
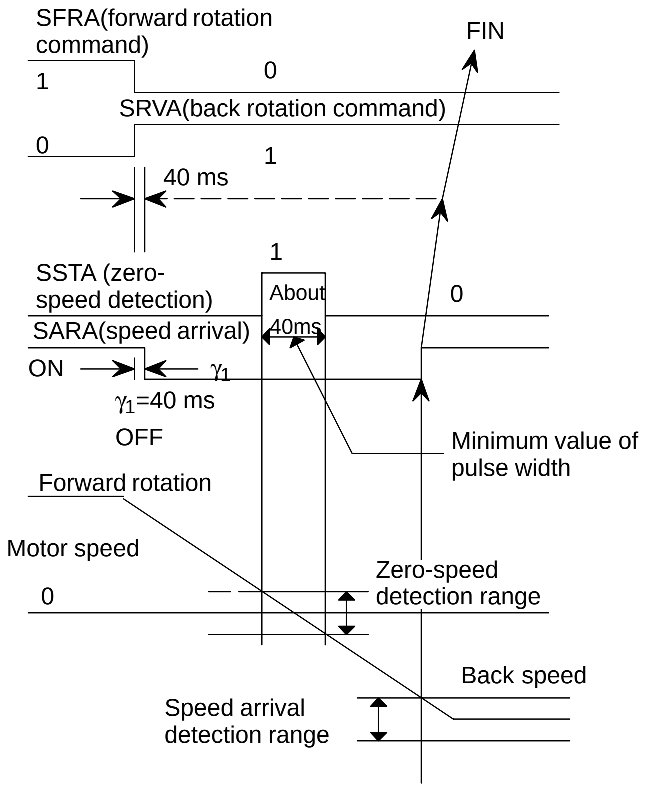


Fig.10.2.12 (c) Detection Range of the Speed-Arrival Signal

- If one of these signals, SFRA or SRVA, is not 1, it is not outputted.
- It is possible to control the back rotation of the tapping cycle in the following manner by using this signal.



Note) The time γ_1 is delayed until the SARA signal becomes 0.

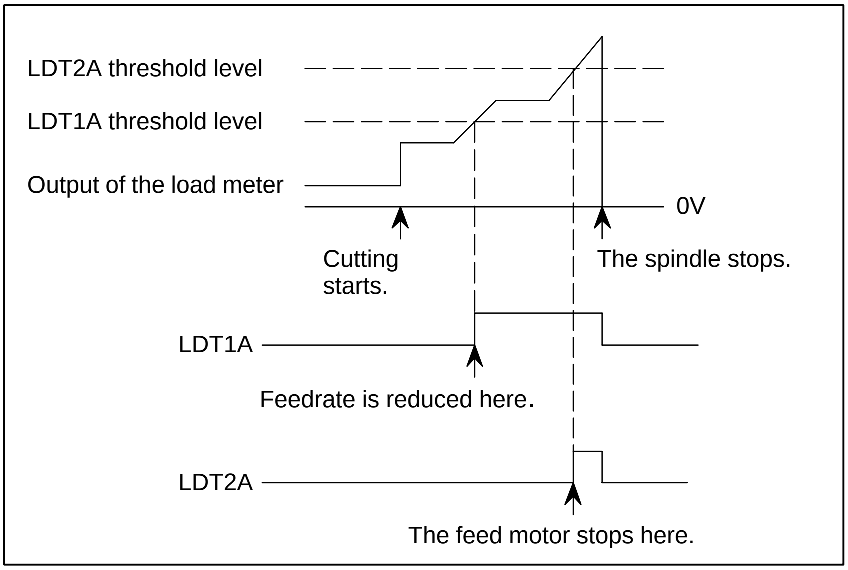
Fig.10.2.12 (d) Timing Chart of the Speed-reached Signal

If the back rotation command is transmitted, the spindle motor starts deceleration and, because the arrival signal becomes 0 at under 40 ms, it next detects the speed arrival signal has again become 1 via speed zero and sets the end of the back command.

- This signal is used as the confirmation signal (FIN signal) for the forward rotation (M03) and back rotation (M04) commands.

10.2.13 Load Detection Signal (LDT1A, LDT2A)

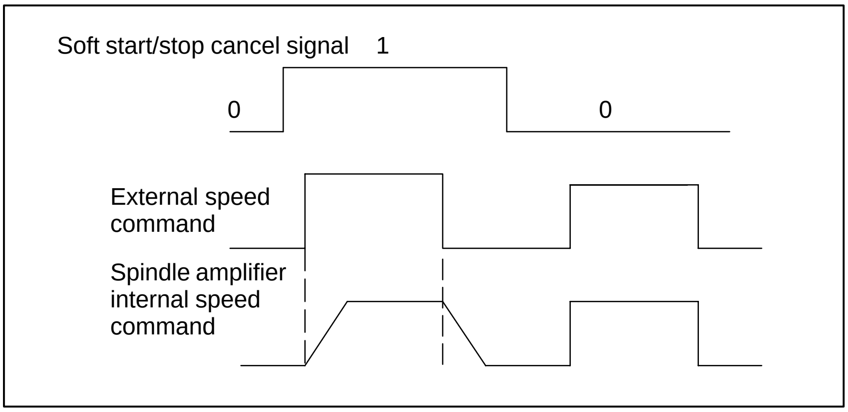
- Assume that the maximum output (10 V) of the load meter (LM) is 100%. When the output of the load meter reaches the parameter settings (%), load detection signal is set to 1.
- Parameter settings for these signals are set independently.
- Using these signals, the PMC reduces the feedrate or stops the feed to prevent the spindle from stopping when cutting overload is applied to the spindle.
- The following example shows the case in which the spindle is controlled with two load-detection levels set.



- When using only one load-detection level to stop the feed motor, perform spindle control according to the specifications.
- After the speed command is changed, this signal is not output until 10 seconds elapse. (The delay is specified by parameter. (For FS–16, this parameter is 4082))

10.2.14 Soft Start Stop Cancel Signal (SOCAN)

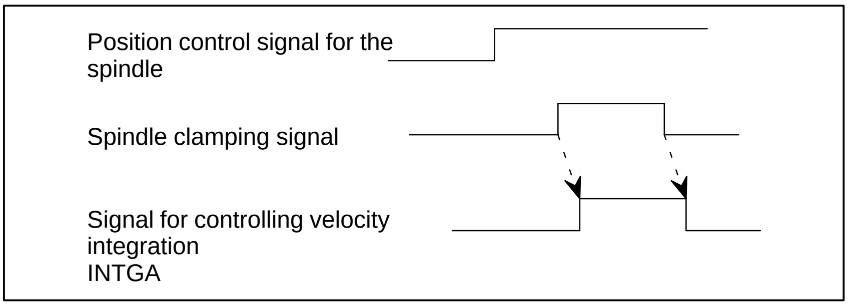
- In the state that the soft start/stop cancel signal is 1, the soft start/stop function is enabled and the gradient of the speed command changing at acceleration/deceleration can be set in the following manner.



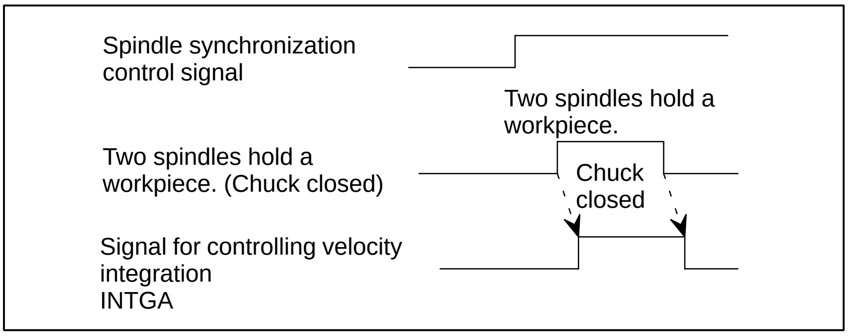
- If the emergency stop signal input is set to ∗ESPA=0, the soft start/stop function is automatically disabled.
- The change in the speed to be specified is set by parameters. (For FS-16, this parameter is 4030.)
  Setting parameter is 0, the soft start/stop function is disable.

10.2.15 Signal For Controlling Velocity Integration (INTGA)

- When the position of the spindle is being controlled in a mode such as spindle orientation control, spindle index control, or Cs contouring control mode, the spindle may be clamped with a brake.
  If the spindle is kept clamped with a small positional deviation, the integration control for the velocity attempts to correct the deviation to zero, resulting in excessive flow of current into the motor.
  Disabling the integration control for the velocity by setting this signal prevents excessive current from flowing into the motor when a small positional deviation exists.



- When two spindles hold a workpiece in the spindle synchronization control mode with a small synchronous error, the integration control for the velocity attempts to correct the error to zero, resulting in excessive flow of current into the motor.
  Disabling the integration control for the velocity by setting this signal prevents excessive current from flowing into the motor when a small synchronous error exists.



10.2.16 Spindle Override Command (Function) With Analog Input Voltage (OVRA)

- In the normal speed control mode (including when the soft start/stop function is used), this function overrides speed, with analog voltage input from an external unit to the spindle amplifier.
- The override function with analog input voltage is enabled when this signal is set to 1 in the normal speed control mode (including when the soft start/stop function is used).

- A limit (100% or 120%) of this function should be assigned to the following parameters:

FS0	FS15	FS16	Contents of parameter
6506#5	3006#5	4006#5	Setting of input range of spindle analog override: 0 : 0 to 100% 1 : 0 to 120%

The maximum analog input voltage is +4.5 V. If an override speed exceeds the maximum speed, it is clamped by the maximum speed.

- An override type is specified using the following parameter.

FS0	FS15	FS16	Contents of parameter
6506#6	3009#5	4009#6	Override type setting 0 : Linear function type 1 : Quadratic function type

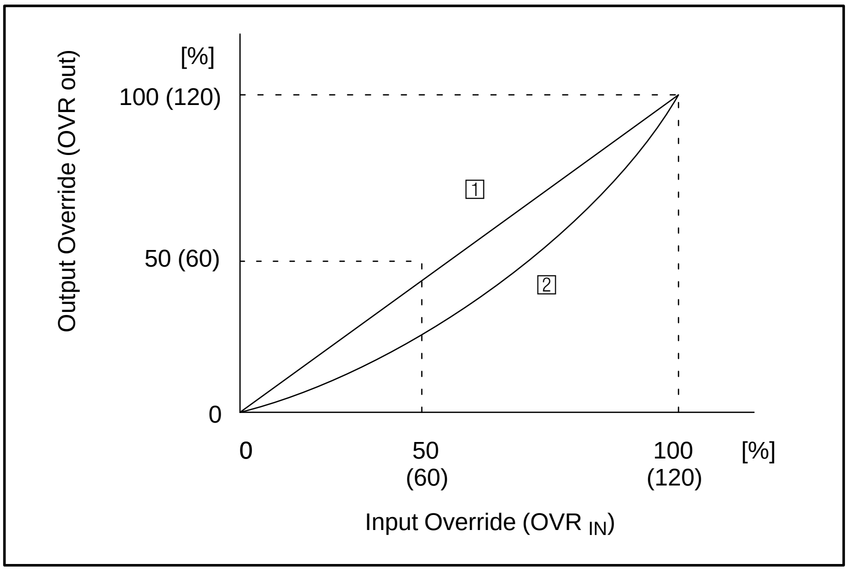
1 Linear function type override
An actual override value corresponds to the entered override value on a one–to–one basis.

$$OVR_{OUT} = OVR_{IN}$$

2 Quadratic function type override
An actual override value corresponds to the entered override value on the quadratic function basis. The speed resolution of quadratic function type override is low in a high speed range and high in a low speed range, as compared with that of linear function type override.

$$OVR_{OUT} = OVR_{MAX} \times \left(\frac{OVR_{IN}}{OVR_{MAX}}\right)^2$$

OVR_{MAX} : Max of override



- The following figure shows a system configuration in terms of this function.

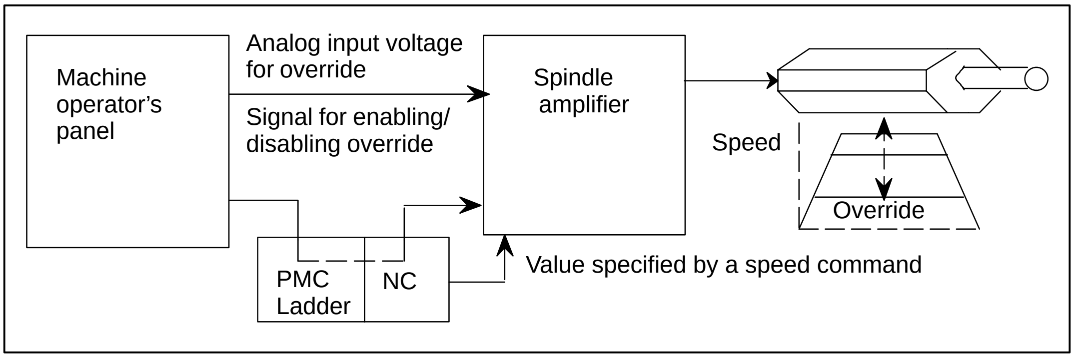


Fig.10.2.16 (a) System Configuration

- The following figure shows the connection of units when analog voltage is input.
  The limit (Override 100 or 120%) for voltage input into the OVR2 terminal is 4.5 V.
  Override can be set in increments of 1%.
  Total resistance of resistors VR and R1 must be 1 kΩ to 10 kΩ.
  The following values are examples for the conventional analog spindle:
  VR = 1.0 kΩ, R1 = 1.0 kΩ or 2.4 kΩ

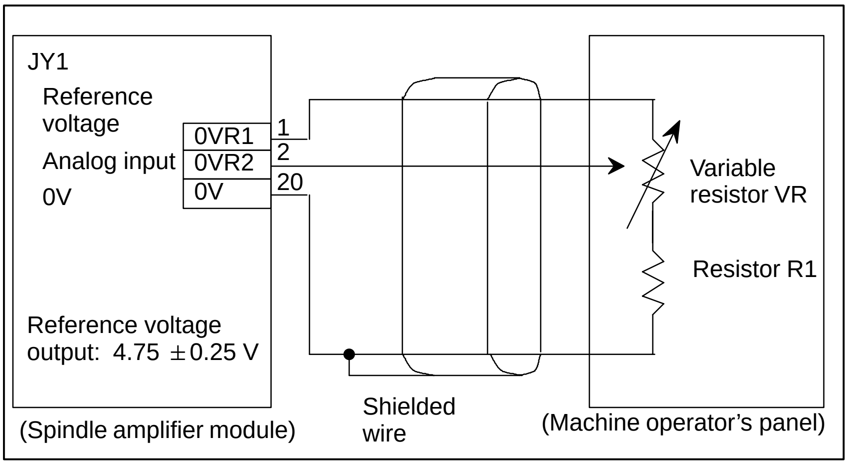


Fig.10.2.16 (b) Connection between a Spindle Amplifier and Machine Operator's Panel

- When the signal for enabling/disabling this override function is set, or the parameter for an override limit is changed, the speed of the motor may change substantially. Stop the motor first, and then set the signal or change the parameter.

10.2.17 Motor Power Off Signal (MPOFA)

- This signal is used to cut the power of the motor when a failure occurs while the spindle synchronization control or the gear cutting machine is operating. When the power is cut, the motor runs free.
- This signal only cuts the power of the motor.
- The power can be restored to the motor again after the motor stops (zero speed signal, SSTA = 1).

  If the signal is canceled, the power cannot be restored to the motor while the motor is operating (SSTA = 0).
- After the power of the motor is cut, all the operation modes(∗1) must be canceled for safety.

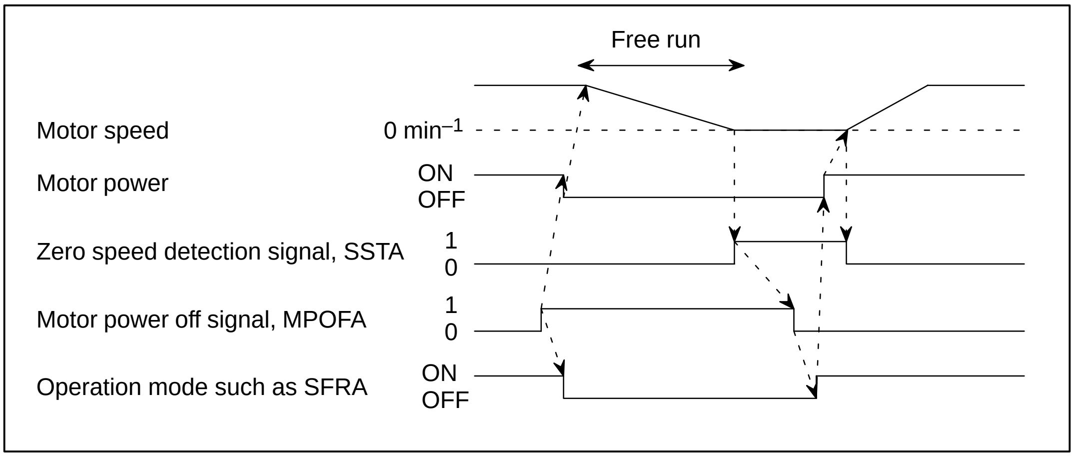
  After the motor stops (SSTA = 1), set the operation modes again.

  When the power is cut during position control, an alarm such as excessive deviation may occur because position control remains effective.

(∗1) Example of operation modes:

❑ Forward rotation command (SFRA)
❑ Reverse rotation command (SRVA)
❑ Spindle orientation (ORCMA)
❑ Rigid tapping (RGPT, RGTAP)
❑ Spindle synchronization control (SPSYC, SPPHS)
❑ Cs-axis control
❑ Cs contouring control (COFF, CON, SCNTR1, SCNTR2, etc.)
❑ Differential mode (DEFMDA)

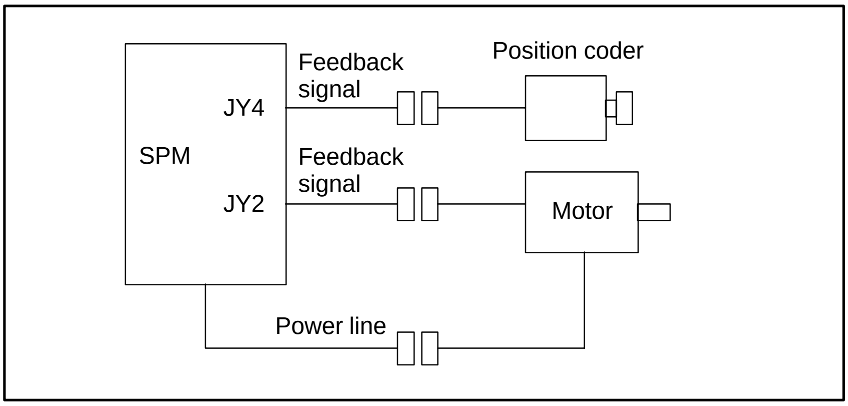
- **Example of the sequence**



- Setting bit 2 of parameter 4069 (FS16) to 1 cuts off the power of the motor as soon as the AL-24 spindle alarm (serially transmitted data error) occurs. The motor usually decelerates and stops when the alarm occurs.

10.2.18 Disconnection Annulment Signal (DSCNA)

(1) This signal is used when it is necessary to disconnect a spindle amplifier from a spindle motor temporarily.

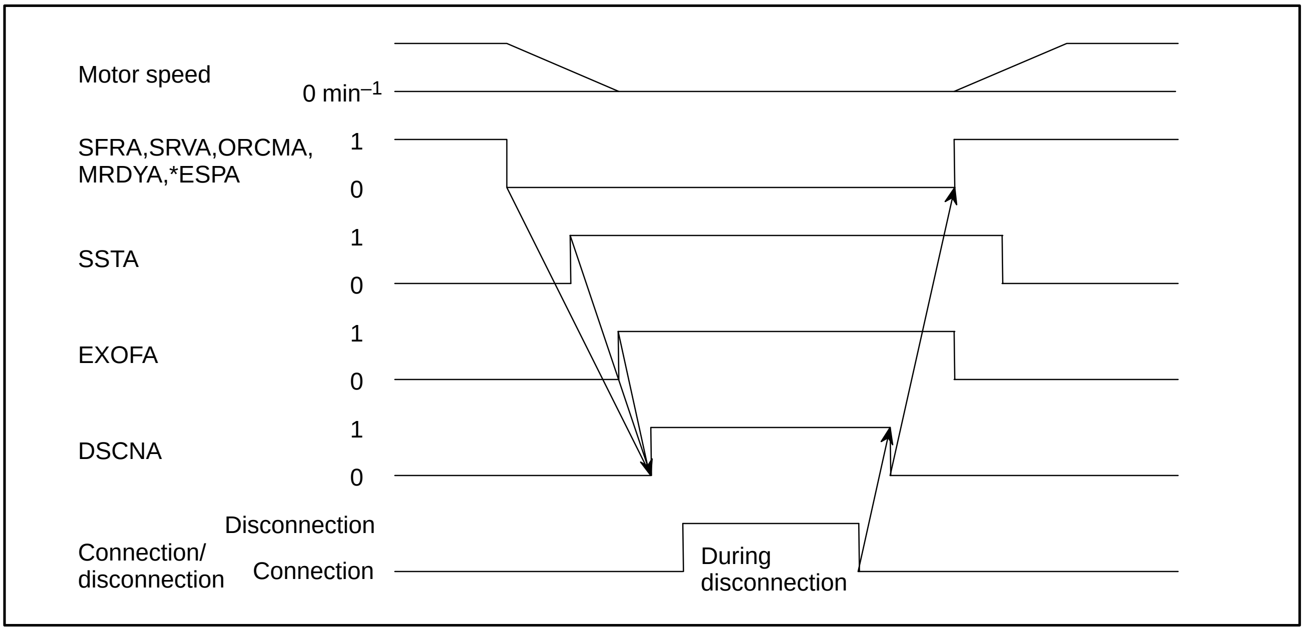


(2) Using this signal enables preventing a motor overheat or feedback signal disconnection alarm condition when the feedback signal is disconnected.

(3) Before the power line is disconnected, the motor excitation off affirmation (EXOFA) signal can be used to check that the motor is not energized.

(4) Before disconnecting the feedback signal and power line, set all of the SFRA, SRVA, ORCMA, MRDYA, and *ESPA commands to 0, and check that the EXOFA signal is 1, then set this signal to 1. After reconnection is completed, reset the signal to 0.

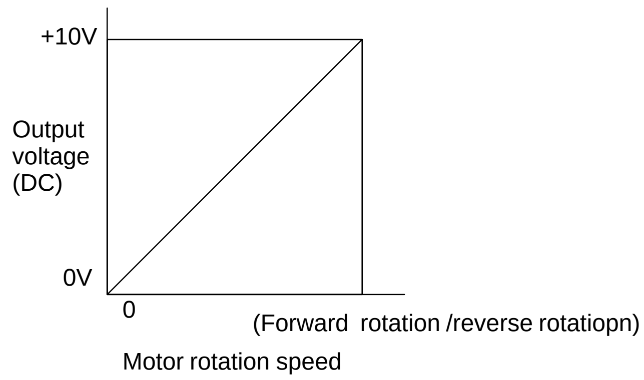
(5) Sequence example



10.3 SPINDLE AMPLIFIER OUTPUT SIGNALS (α SERIES SPINDLES)

10.3.1 Speed Meter Voltage Signal (SM)

- The rotation speed of the AC spindle motor can be indicated by externally connecting a speedmeter.
  A voltage (DC) proportional to the rotation speed is output, irrespective of the forward or reverse rotation of the motor. A +10V is output at the maximum revolution.



- Use the following speedmeter
  (DC voltmeter)

❑ One-sided deflection DC voltmeter

❑ DC voltage 10V full scale

❑ Internal resistance higher than 10 kΩ

Example)
DC voltmeter LM-80: Kuwano Electrical Manufacturing Co., Ltd.

- With respect to the speed indication voltage, the forward rotation/reverse rotation output voltage is calibrated by a parameter. The voltage accuracy is max. ±3%.

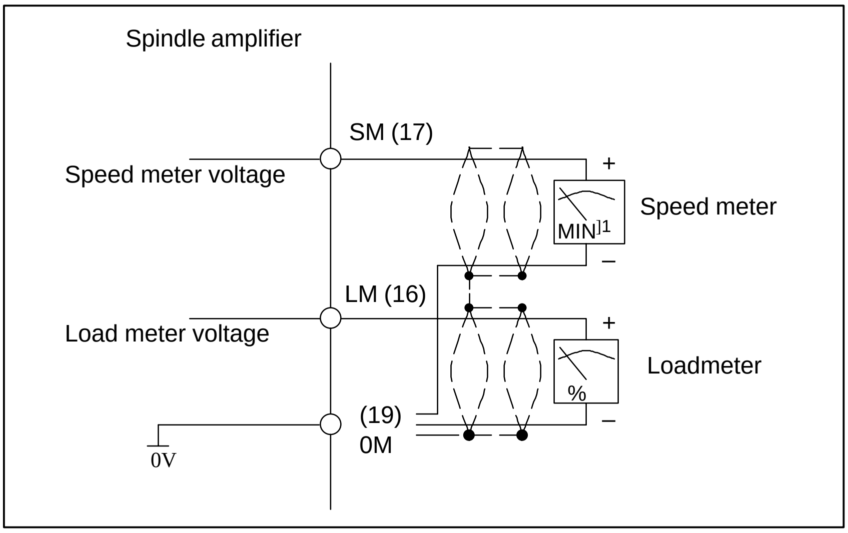


Fig.10.3.1 Connecting the Spindle Servo Unit to a Speedmeter and a Load Meter

- Use a 2-core shielded cable.

10.3.2 Load Meter Voltage (LM)

- The load meter indicates the load factor, which is the ratio of the load to the maximum output obtainable by the spindle motor at the input voltage and working revolutions when the machine tool spindle is rotating without load or when cutting is in progress.
- When the rated input voltage is applied, the revolutions-to-spindle motor output relation, revolutions-to-torque relation and revolutions-to-indicating voltage relation are as shown in Figs. 10.3.2 (a), 10.3.2 (b), and 10.3.2 (c).

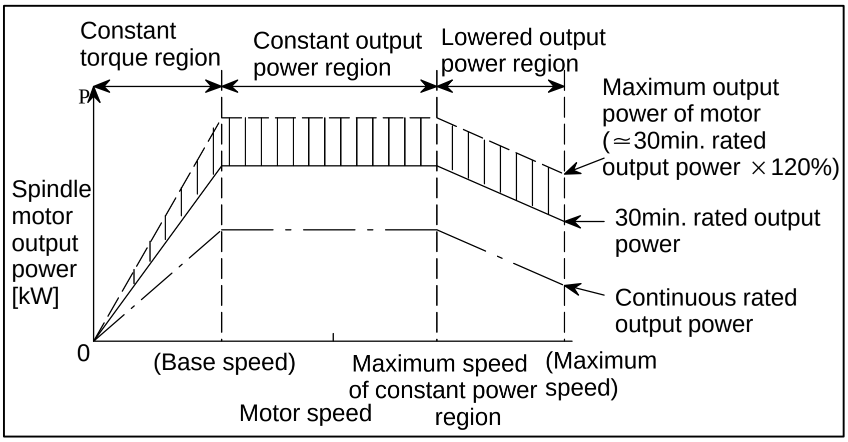


Fig.10.3.2 (a) Spindle Motor Output

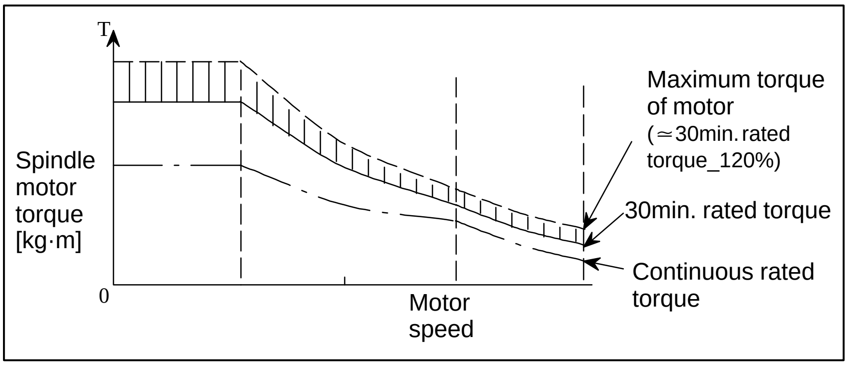


Fig.10.3.2 (b) Spindle Motor Torque

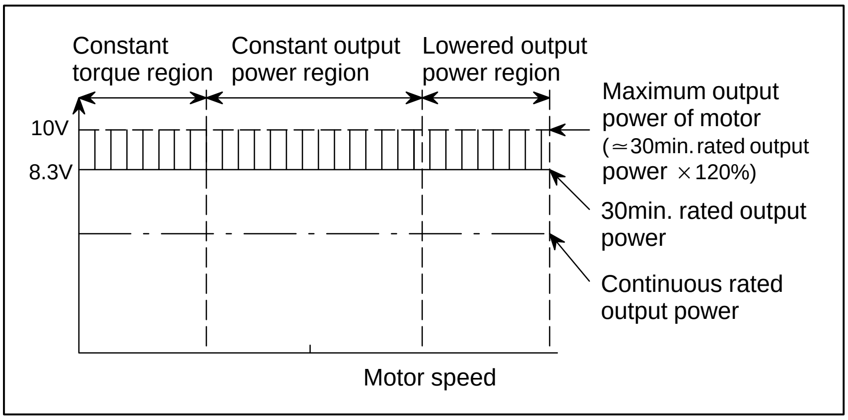


Fig.10.3.2 (c) Voltage Used for Operating a Load Meter

- The relation between each spindle motor output and the indicating voltage of the load meter is as shown in Table 10.3.2 (a), assuming that the continuous rated output of the spindle motor is 100%.
- Four types of indications of the load meter may be considered approximately from Table 10.3.2 (a). For the indication of the load meter in this case, refer to examples shown in Table 10.3.2 (b).
- Machine tool builders are requested to prepare a load meter (DC voltmeter) which complies with the following specification.
  - ❑ One-side deflecting DC voltmeter
  - ❑ DC voltage 10V, full scale
  - ❑ Internal resistance 10 kΩ

  Example)

  DC voltmeter LM-80 made by KUWANO DENKI
- Use a 2-core shielded cable.

Table.10.3.2 (a) Relation between each spindle motor output and indicating voltage of load meter

Model	Output (kw)	Indicating voltage of load meter (V) (Note)	Ratio asuming that continuous rated is 100% (%)	Example of load meter	
				Type of applicable load meter	Ratio to full scale (%)
α0.5	0.55	4.2	100	E	100
	1.1	8.3	200		200
	1.32	10.0	240		240
α1, α1/15000	1.5	5.7	100	A	102.2
	2.2	8.3	147		150
	2.64	10.0	176		180
α1.5	1.1	2.5	100	D	100
	3.7	8.4	338		338
	4.4	10.0	400		400
α2, α2/15000	2.2	5.0	100	C	101
	3.7	8.4	166		166
	4.4	10.0	200		200
α3, α3/12000	3.7	5.6	100	A	100.8
	5.5	8.3	148		150
	6.6	10.0	178		180
α6, α6/12000	5.5	6.1	100	A	109.8
	7.5	8.3	136		150
	9.0	10.0	164		180
α8, α8/8000	7.5	5.7	100	A	102.6
	11.0	8.3	146		150
	13.2	10.0	175		180
α12, α12/8000	11	6.1	100	A	109.8
	15	8.3	136		150
	18	10.0	164		180
α15, α15/8000	15	6.7	100	B	100.5
	18.5	8.3	124		125
	22.2	10.0	149		150
α18, α18/8000	18.5	7.0	100	B	105
	22.0	8.3	118		125
	26.4	10.0	142		150
α22, α22/8000	22.0	7.0	100	B	105
	26.0	8.3	118		125
	26.0	10.0	142		150
α30, α30/6000	30.0	6.7	100	B	105.0
	37.0	8.3	124		125
	44.4	10.0	149		150
α40	37.0	6.8	100	B	103
	45.0	8.3	122		125
	54.0	10.0	146		150

NOTE

Accuracy of the load meter voltage depends upon the speed used or the input voltage. The maximum deviation is approximately ±15%.

Table.10.3.2 (b) Examples of load meter type (1/2)

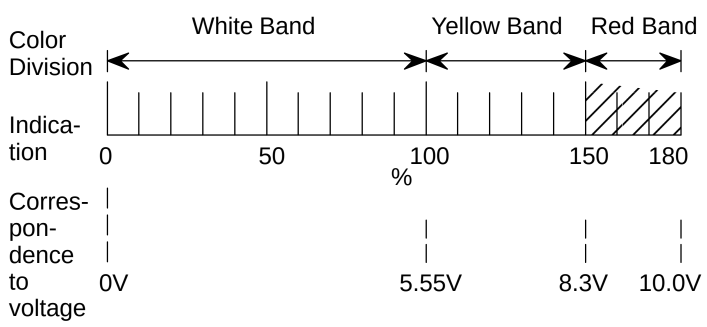
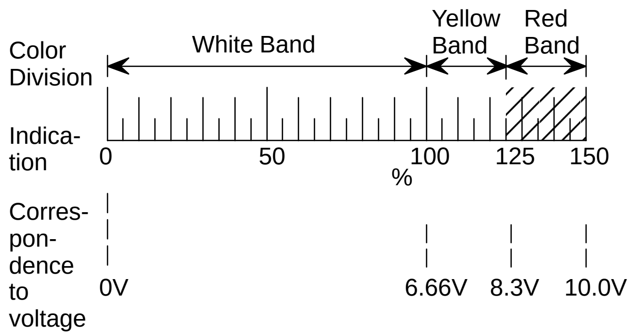
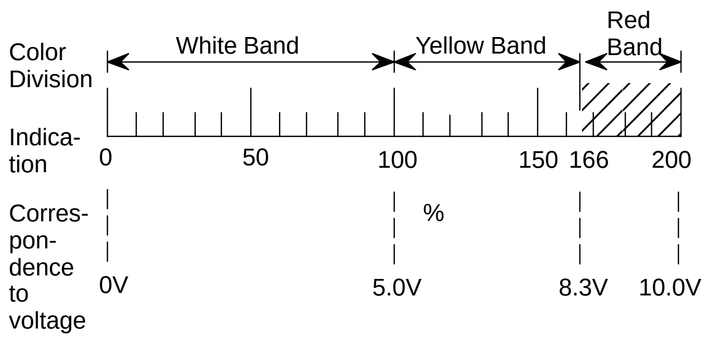
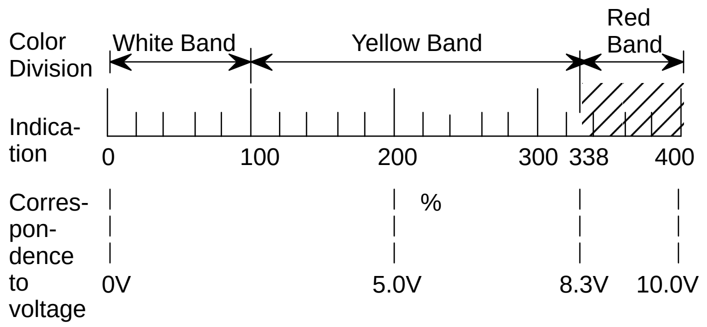
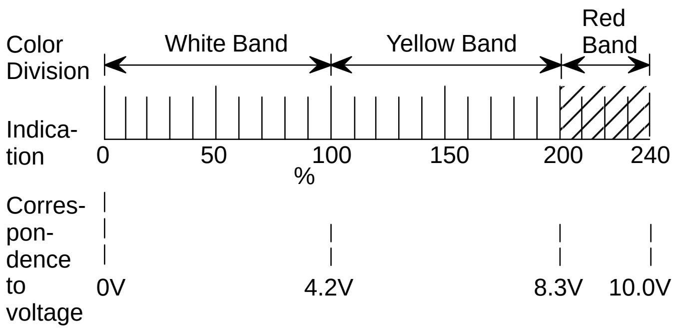
Type	Indication of load meter	Remarks
A		Motor Models α1, α1/15000, α3, α3/12000, α6, α6/12000, α8, α8/8000, α12, α12/8000, αP8, αP8/8000, αP12, αP12/8000, αP22, αP22/8000, αP50, α6HV, α8HV, α12HV
B		Motor Models α15, α15/8000, α18, α18/8000, α22, α22/8000, α30, α30/6000, α40, αP15, αP15/8000, αP18, αP18/8000, αP30, αP30/6000, αP40, αP40/6000, α15HV, α18HV, α22HV, α30HV, α40HV, α60HV
C		Motor Model α2, α2/15000
D		Motor Model α1.5

Table.10.3.2 (b) Examples of load meter type (2/2)

Type	Indication of load meter	Remarks
E		Motor Models α0.5

10.4 SPINDLE CONTROL SIGNALS (αC SERIES SPINDLE)

The abbreviations used in this manual stand for the following:

FS0 : Series 0-MC or 0-TC
FS0–TT Head 2 : Head 2 of Series 0-TTC
FS15 : Series 15
FS16 : Series 16, Series 18, Series 20, Series 21

10.4.1 Spindle Control DI Signal (PMC to CNC)

(1) 1st Spindle Signal Address

FS0	FS0–TT HEAD2	FS15	FS16 (Note 2)	#7	#6	#5	#4	#3	#2	#1	#0
G229	G1429	G227	G070	MRDYA	ORCMA	SFRA	SRVA	CTH1A	CTH2A	TLMHA	
G230	G1430	G226	G071							*ESPA	ARSTA
G231	G1431	G229	G072				OVRA				INDXA (*)
G232	G1432	G228	G073						MPOFA		
G124	G1324		G032	R08I	R07I	R06I	R05I	R04I	R03I	R02I	R01I
G125	G1325		G033	SIND	SSIN	SGN		R12I	R11I	R10I	R09I
		G024		RISGN			RI12	RI11	RI10	RI09	RI08
		G025		RI07	RI06	RI05	RI04	RI03	RI02	RI01	RI00
G110	G1310	G231	G078	SHA07	SHA06	SHA05	SHA04	SHA03	SHA02	SHA01	SHA00
G111	G1311	G230	G079					SHA11	SHA10	SHA09	SHA08
G120	G1320				*SSTP	SOR	SAR	FIN			
		G005								FIN	
			G029		*SSTP	SOR	SAR				
			G004					FIN			
G123 (Note 1)	G1323							GR2	GR1		
G118 (Note 1)	G1318							GR2	GR1		
		G026			GS4	GS2	GS1				
			G028						GR2	GR1	
G146			G038					SPPHS (*)	SPSYC (*)		
		G111		SPPHS (*)	SPSYC (*)						
G123 (Note 3)										RGTP (*)	
G135 (Note 3)			G061								GRTAP (*)

NOTE
1. Depends on bit 5 (ADDCF) of parameter 31
2. Refer to the connection manual B-61803E/03 or later for DI/DO address of series 16-TT on the HEAD2 side.
3. Bit 4 (SRGTP) of parameter No. 19 applies here.

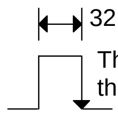
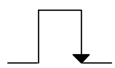
* Valid only for αC spindle software 9D12 series.

(2) 2nd Spindle Signal Address

FS0	FS0–TT HEAD2	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
G223	G1429	G235	G074	MRDYB	ORCMB	SFRB	SRVB	CTH1B	CTH2B	TLMHB	
G234	G1433	G234	G075			INTGB				*ESPB	ARSTB
G235	G1434	G237	G076				OVRB				
G236	G1435	G236	G077						MPOFB		
G112	G1316	G239	G080	SHB07	SHB06	SHB05	SHB04	SHB03	SHB02	SHB01	SHB00
G113	G1312	G238	G081					SHB11	SHB10	SHB09	SHB08
			G034	R0812	R0712	R06I2	R05I2	R04I2	R03I2	R02I2	R01I2
			G035	SIND2	SSIN2	SGN2		R12I2	R11I2	R10I2	R09I2
		G232		RISGNB			RIB12	RIB11	RIB10	RIB9	RIB8
		G233		RIB7	RIB6	RIB5	RIB4	RIB3	RIB2	RIB1	RIB0
G106	G1306			M2R08I	M2R07I	M2R06I	M2R05I	M2R04I	M2R03I	M2R02I	M2R01I
G107	G1307			M2SIND	M2SSIN	M2SGN		M2R12I	M2R11I	M2R10I	M2R09I

* Valid only for αC spindle software 9D12 series.

(3) Spindle control DI signals

Symbol	Signal	Description
TLMHA, B	Torque limit command (under development)	Limits the output torque of the spindle motor. Set the limit using the spindle parameter. TLMHA 0 : No torque limit 1 : Limits the torque to the value specified with the parameter.
CTH1A, B CTH2A, B	Clutch or gear signal	Specify one of the following conditions according to the clutch or gear status. Used to select a spindle control parameter. CTH1 CTH2 0 0 : High gear 0 1 : Medium high gear 1 0 : Medium low gear 1 1 : Low gear
SRVA, B	Reverse rotation command	Specifies the rotation direction when the spindle motor is viewed from the shaft. SRV SFR 0 0 : Stop 0 1 : Normal rotation (CCW: Counterclockwise) 1 0 : Reverse rotation (CW: Clockwise) 1 1 : Stop
SFRA, B	Normal rotation command	
ORCMA, B	Orientation command	Used for spindle orientation control. 0 : – 1 : Spindle orientation control is performed.
MRDYA, B	Machine ready signal	Used for motor exectation ON and OFF of spindle amplifier module (No electro–magnetic contactor turned no nor off) 0 : Motor is not excited. 1 : Motor is ready for operation.
ARSTA, B	Alarm reset signal	Used to reset the spindle alarm. 32 ms min. "1" "0"  The alarm is reset when the level of the signal is changed from 1 to 0.
*ESPA, B	Emergency stop signal	0 : Emergency stop 1 : Normal operation
INTGA, B	Speed integral control signal	0 : Enables speed integral control. 1 : Disables speed integral control.
INDXA, B (*)	Orientation stop position change command	"1" "0"  Used for orientation in which the stop position is specified externally. When a change from 1 to 0 occurs, new stop position data is acquired to move the machine to the newly acquired position and stop it there.
ROTAA, B	Orientation stop position change rotational direction command	Used for orientation in which the stop position is specified externally. 0 : Counterclockwise (CCW) 1 : Clockwise (CW)

Symbol	Signal	Description
NRROA, B	Orientation stop position change short–cut command	Used for orientation in which the stop position is specified externally. 0 : Rotational direction is set according to ROTA (= BIT01) 1 : Short–cut control (within 180 degrees)
OVRA, B	Analog override command	0 : Analog override is disabled. 1 : Analog override is enabled.
MPOFA, B	Motor power stop signal	1 : Motor power stop
R12I - R01I SGN, SSIN SIND RI12 - RI00 RISGN	Spindle speed command	Specifies a spindle speed command.
SHA11 - SHA00 SHB11 - SHB00	Stop position command for spindle orientation with a position coder	The stop position is specified for the external setting type spindle orientation with the position coder.
*SSTP	Spindle stop signal	0 : Velocity command voltage = 0 1 : Velocity command voltage = specified value
SOR	Spindle orientation in progress	1 : Outputs the velocity command specified with the parameter.
SAR	Specified speed reached signal	1 : The spindle speed has reached the specified speed.
FIN	M function completion signal	1 : The M function is completed.
GR1, 2 GS1, 2, 4	Gear select signal (T-system)	Used for velocity command calculation under constant surface speed control
SPSYC	Spindle speed synchronization control command (Under development)	1 : Spindle speed synchronization control
SPPHS	Spindle phase synchronization control command (Under development)	1 : Spindle phase synchronization control
RGTP RGTAP	Rigid tapping command	1 : Rigid tapping control

* Valid only for αC spindle software 9D12 series.

10.4.2 Spindle Control DO Signals (CNC to PMC)

(1) 1st Spindle Signal Address

FS0	FS0–TT HEAD2	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
F281	F1481	F229	F045	ORARA	TLMA		LDTA	SARA	SDTA	SSTA	ALMA
F282	F1482	F228	F046								
F283	F1483	F231	F047								
F172	F1372		F036	R08O	R07O	R06O	R05O	R04O	R03O	R02O	R01O
F173	F1373		F037					R12O	R11O	R10O	R09O
		F010 (F006)		RO15	RO14	RO13	RO12	RO11	RO10	RO09	RO08
		F011 (F007)		RO07	RO06	RO05	RO04	RO03	RO02	RO01	RO00
F150	F1350		F007						SF		MF
		F008								SF	MF
F149	F1349		F001				ENB				
F164	F1364		F038					ENB3	ENB2		
		F042			SPCO	SPBO	SPAO		SPAL		
F154	F1354		F035								SPAL
F152	F1352		F034						GR30	GR20	GR10
		F001		CSS							
			F002						CSS		
F178			F044				SYCAL	FSPPH	FSPSY		
		F111		MSPPHS	MSPSYC	SPSYAL					
		F020	F025	S31	S30	S29	S28	S27	S26	S25	S24
		F021	F024	S23	S22	S21	S20	S19	S18	S17	S16
		F022	F023	S15	S14	S13	S12	S11	S10	S09	S08
		F023	F022	S07	S06	S05	S04	S03	S02	S01	S00
		F040					RTAP				
		F012	F041	AR15	AR14	AR13	AR12	AR11	AR10	AR09	AR08
		F013	F040	AR07	AR06	AR05	AR04	AR03	AR02	AR01	AR00
		F232		SLDM15	SLDM14	SLDM13	SLDM12	SLDM11	SLDM10	SLDM09	SLDM08
		F233		SLDM07	SLDM06	SLDM05	SLDM04	SLDM03	SLDM02	SLDM01	SLDM00
		F234		SSPD15	SSPD14	SSPD13	SSPD12	SSPD11	SSPD10	SSPD09	SSPD08
		F235		SSPD07	SSPD06	SSPD05	SSPD04	SSPD03	SSPD02	SSPD01	SSPD00
		F236		SSPAA7	SSPAA6	SSPAA5	SSPAA4	SSPAA3	SSPAA2	SSPAA1	SSPAA0

NOTE
The addresses in parentheses are used for 15–TT.

(2) 2nd Spindle Signal Address

FS0	FS0–TT HEAD2	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
F281	F1481	F229	F045	ORARB	TLMB		LDTB	SARB	SDTB	SSTB	ALMB

(3) Spindle control DO signals

Symbol	Signal	Description
ALMA, B	Alarm signal	Output when a spindle alarm occurs. 0 : Normal state 1 : Alarm state
SSTA, B	Frequency stop detection signal	Output when the output frequency of actual spindle amplifier module becomes lower than the frequency stop detection level. 0 : Rotation state 1 : Frequency stop
SDTA, B	Frequency detection signal	Output when the output frequency of actual spindle amplifier module does not exceed the preset amplifier frequency. 0 : Higher than the specified speed 1 : Less than preset frequency
SARA, B	Frequency match signal	Output when the output frequency of actual spindle amplifier module reaches the preset range. 0 : Specified speed has yet to be reached 1 : Frequency match
LDTA, B	Load detection signal	Output when the detected load is greater than the specified load detection level. 0 : Lower than the specified load 1 : Greater than the specified load
TLMA, B	Torque limiting signal (Under development)	1 : The limit is applied to the torque.
ORARA, B	Orientation complete signal	Output when orientation was specified and the spindle has stopped in the specified range. 1 : Orientation completed
R12O-R01O RO15-RO00	Spindle speed command	Outputs the spindle speed command.
MF	M function strobe signal	1 : The M code is effective.
SF	Spindle function strobe signal	1 : The S code is effective.
ENB	Spindle enable signal	0 : The velocity command indicates 0. 1 : The velocity command indicates other than 0.
SPAL	Spindle fluctuation alarm signal	1 : The actual speed of the spindle is out of the allowed range.
SPAO, SPBO SPCO	Spindle speed override check signal	
GR10, 20, 30	Gear select signal	

Symbol	Signal	Description
CSS	Constant surface speed control signal	1 : Under constant surface speed control
FSPSY MSPSYC	Spindle synchronization control signal (Under development)	1 : Under spindle synchronization control
FSPPH MSPPHS	Spindle phase synchronization control signal (Under development)	1 : Under spindle phase synchronization control
SYCAL SPSYAL	Spindle synchronization control alarm signal (Under development)	1 : Spindle synchronization control alarm
S31 - S00	Spindle function code signal	Sxxx
AR15 - AR00	Actual spindle speed signal	
SLDM15 - SLDM00	Load meter data	0 to 32767 (+10 V)
SSPD15 - SSPD00	Motor frequency data	0 to 16383 (maximum motor speed)
SSPA07 - SPMA00	Spindle alarm data	Alarm number
RTAP	Rigid tapping–in–progress signal	1 : Rigid tapping in progress

10.4.3 Emergency Stop Signal (*ESPA)

- Spindle motor and spindle amplifier module enter the operable state by ∗ESPA = 1. When *ESPA is set to 0, the spindle amplifier module outputs the MCOFF signal and the spindle motor does not operate.
- If ∗ESPA = 0 is set during the motor rotation, the spindle motor smoothly decelerates to a stop. Then, it outputs the MCOFF signal.
- If ∗ESPA = 1 then occurs again, the spindle motor enters the rotateable state, and so will begin to rotate as soon as a rotation command is issued. For this reason, the command signal (speed command, normal operation command, or reverse operation command) to the spindle amplifier module should be reset at the same time an emergency stop signal is input.

10.4.4 Machine Ready Signal (MRDYA)

- The table contents result from the parameter setting.

<table>
<tr><th rowspan="2">Mode</th><th>Parameter setting</th><th rowspan="2" colspan="2">Contents</th></tr>
<tr><th>FS0 : 6501#0
FS12 : 3001#0
FS16 : 4001#0</th></tr>
<tr><td>A</td><td>0</td><td colspan="2">Machine ready signal is not used.
At this time, the spindle motor enters the operable state only when emergency stop signal is input.</td></tr>
<tr><td>B</td><td>1</td><td>Uses the machine ready signal to create operable state by double signal.</td><td>Intercepts power by turning off the transistor excitation signal for the inverter with MRDYA = 0.</td></tr>
</table>

Mode A

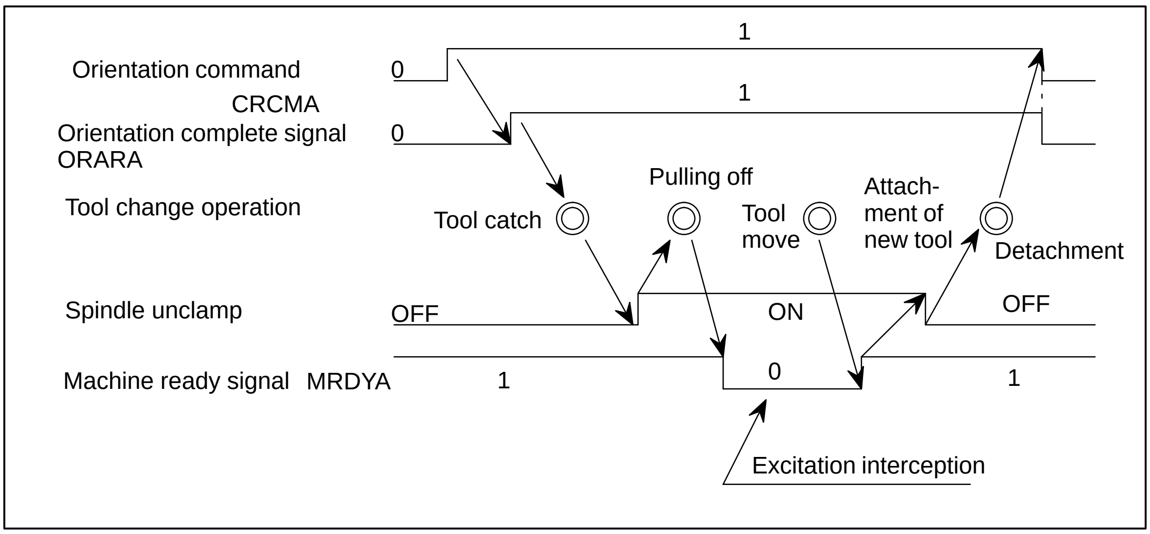
Used when minimizing the input signal.

Mode B

1 During the automatic tool change (ATC) orientation operation, in a machine where the spindle motor is restrained by the tool unclamp signal,there are cases where the load meter indication becomes large and a large motor current flows by a slight slip from the orientation stop position.
In order to prevent this, set MRDYA = 0 and release the orientation state during tool unclamp.
If MRDYA = 1 is set at tool unclamp end, it is possible to re-enter the orientation state.

2 Regarding the purpose of the above described **1**, if the orientation command signal remains at ORCMA = 1, even if the machine ready signal is set to MRDYA = 0/1, there is no orientation again after 1 rotation as it only moves by the amount of the stop position slip.

Timing chart



10.4.5 Normal Rotation Command Signal (SFRA)

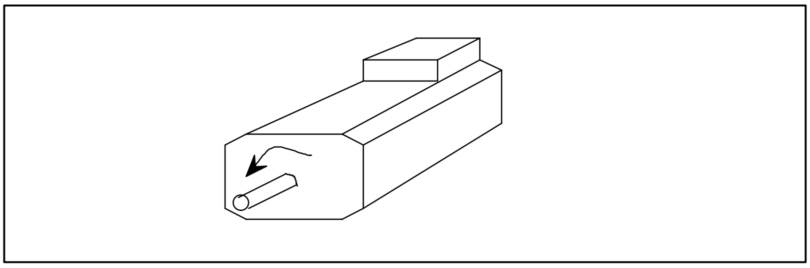
- When the following four conditions hold, the spindle motor starts a normal rotation corresponding to the speed command (positive value).

  During acceleration/deceleration (before a specified speed is reached), the motor speed increases or decreases according to an acceleration/deceleration constant specified in the parameters listed below. The acceleration/deceleration constant can take four different values depending on the clutch/gear signals (CTH1 and CTH2).

  ❑ Emergency stop signal *ESPA is 1
  ❑ Machine ready signal MRDYA is 1
  ❑ Normal rotation command signal SFRA is 1
  ❑ Contact signal ESP is connected to 24 V (at CX4 of the PSM)

Parameter			DI signal		Contents
FS0	FS15	FS16	CTH 1A	CTH 2A	
6569 6709	3069 3209	4069	0	0	An acceleration/deceleration constant is specified. It can take four different values depending on the CTH1 and CTH2 signals. Unit : 1rpm/sec (Series16: 10 rpm unit when 4006#bit2=1) Data range : 0 to 32767 (Motor does not rotate when 0 is set) Standard setting : Depends on motor model (Initial setting=900)
6570 6710	3070 3210	4070	0	1	
6571 6711	3071 3211	4071	1	0	
6572 6712	3072 3212	4072	1	1	

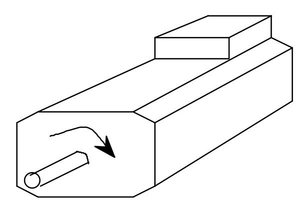
- While SFRA = 1, the spindle motor rotates in the counterclockwise direction (CCW) viewed from the shaft side according to the commanded speed (positive value).



- If SFRA = 0 occurs, the spindle motor stops by the regenerative braking. After stopping, it cuts the power supply to the spindle motor by intercepting the transistor excitation signal.

10.4.6 Reverse Rotation Command Signal (SRVA)

- When the following four conditions hold, the spindle motor starts a reverse rotation by the positive speed command.
  During acceleration/deceleration (before a specified speed is reached), the motor speed increases or decreases according to an acceleration /deceleration constant specified in parameters. See Section 10.4.5 for detailed descriptions about acceleration/deceleration constants.
  - ❑ Emergency stop signal *ESPA is 1
  - ❑ Machine ready signal MRDYA is 1
  - ❑ Reverse rotation command signal SRVA is 1
  - ❑ Contact signal ESP is connected to 24 V (at CX4 of the PSM)
- While SRVA=1, the spindle motor rotates in a clockwise direction (CW) looked at from the shaft side according to the speed command (Positive value).



- When SRVA = 0, the spindle motor is stopped by regenerative discharge braking. When the spindle motor comes to a stop, the exciting signal for the power device is turned off to shut off the power to the spindle motor.

10.4.7 Torque Limiting Command Signal (TLMHA) (Under development)

- The torque restriction (torque limit) is used in order to rotate the spindle motor to temporarily reduce the spindle motor output torque.
- The torque limit value change with parameter (Series 16 : PRM4025) and DI signal.

Torque limit command TLMHA	Torque limit value
0	Without torque limit
1	Limit to the parameter value

10.4.8 Alarm Reset Signal (ARSTA)

- After removing the various alarm causes such as motor overheating, excess speed deviation, short-circuiting, excess speed, excess voltage, excess current, excess load, and voltage drop, if the alarm reset signal is input, the alarm is released and the usable state occurs.
- Even if this signal is inputted when there is no alarm, it is disabled.
- This signal can reset only alarms related to the spindle amplifier module. It cannot reset alarms related to the power supply module (such as DC link overvoltage or undervoltage); such alarms are reset by turning off the power.

10.4.9 Spindle Alarm Signal (ALMA)

- If the state occurs in which the spindle motor operation cannot be continuously executed, the power to the spindle motor will become OFF and the spindle motor will be stopped.
- At the same time the alarm signal ALMA = 1 occurs. Regarding the alarm contents, confirm by the display section of the spindle amplifier.
- Set the command signal to the spindle amplifier (speed command, forward/reverse rotation command, torgue limit command, spindle orientation command) in the reset state using the alarm signal output. If it is not in the reset state (state that signal from PMC is all clear), when the alarm on the spindle amplifier is released there is a danger that the spindle motor may rotate.
- Because the spindle motor enters the power OFF, coasting operates at the same time as the alarm signal is output, it is necessary to set in an emergency stop state and to set the feedhold state at the CNC or magnetics cabinet side.
- When the alarm state has occurred, ALMA = 1 occurs.
  While the alarm signal is 1, the spindle motor enters coasting operates state regardless of any command from the outside.
- The relationship between the alarm signal and the alarm reset signal is as shown in Fig. 10.4.9.

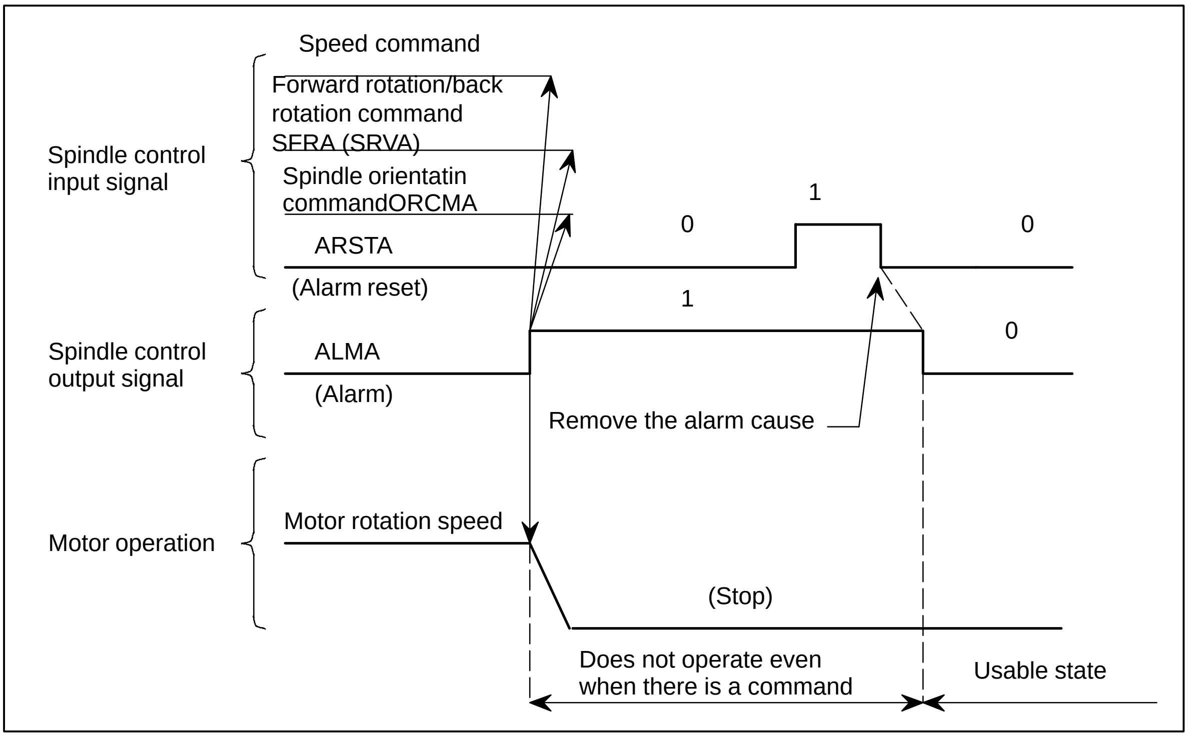


Fig.10.4.9 Timing Chart of the Spindle Alarm Signal

10.4.10 Frequency–stop Detecting Signal (SSTA)

- If the output frequency of the actual spindle amplifier module is reduced to be lower than the frequency stop detection point for the stop command, SSTA = 1 occurs.

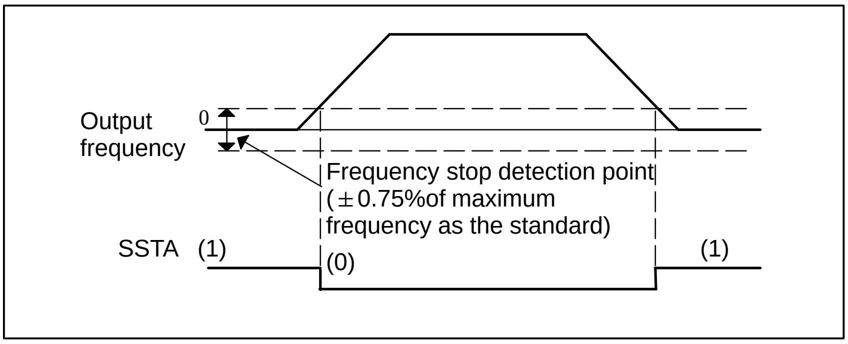


Fig.10.4.10 Signal Indicating that the frequency dropped to close to zero

- The frequency stop detection point is 0.75% of the maximum frequency (standard initial setting for the parameter).
  In other words, the frequency stop detection signal becomes SSTA = 1 when the frequency is lower than the detection level.
- This signal is output when the above condition is satisfied, irrespective of rotation commands (SFRA, SRVA).
- The minimum pulse width value of this signal is about 40 ms.

10.4.11 Frequency Detecting Signal (SDTA)

- SDTA = 1 occurs when the frequency is lower than the one which is set by parameter.
- This signal is used to detect that the output frequency has become lower than a certain frequency set such as clutch selectable speed or gear selectable speed.
- The frequency detecting level can be set by parameter.
- For this signal, SDTA = 1 occurs when the absolute value of the output frequency is reduced to be lower than the preset detection level, irrespective of rotation commands (SFRA, SRVA).

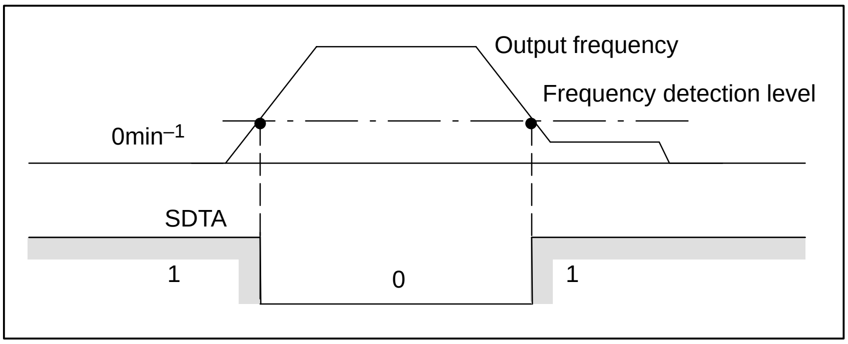


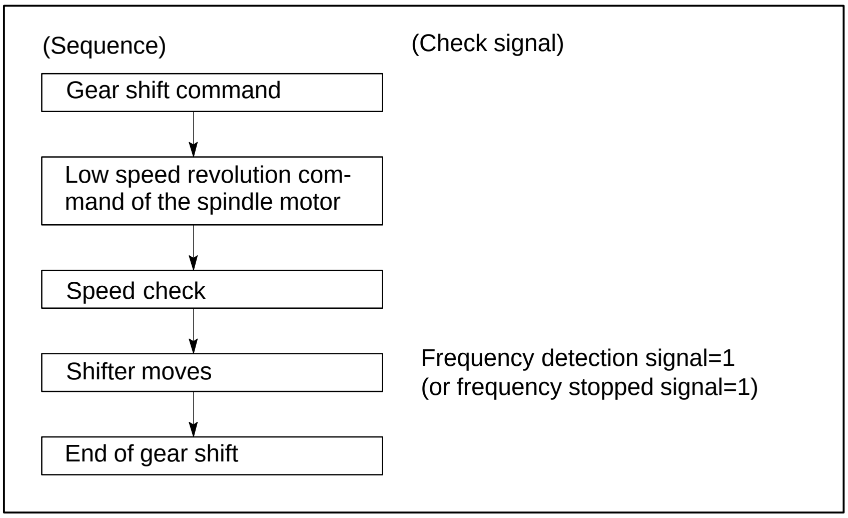
Fig.10.4.11 (a) Speed Detection Signal

Reference

- **Sequence of the gear shift**

The gear shift in the CNC machine tool is one of the sequence controls. The electric circuit signal in the sequence is used to move the spindle gear, which is an important component of the machine. It is then necessary to check that the spindle motor speed is in low speed to switch the gear safely.
The following is an example of sequence at gear shift, when the frequency detection signal (gear selectable signal) was used. This example can be referred to when designing the magnetics sequencer.

- **An example of gear shift sequence using frequency detection signal**



To change the gear safely, it must be checked that the spindle motor speed is low enough before moving the shifter. If the frequency stop signal is also applied, the safety can be doubly checked.

Essential reason to confirm the spindle motor speed :
If the shifter moves when the spindle motor is rotating at high speed, the gear will break.

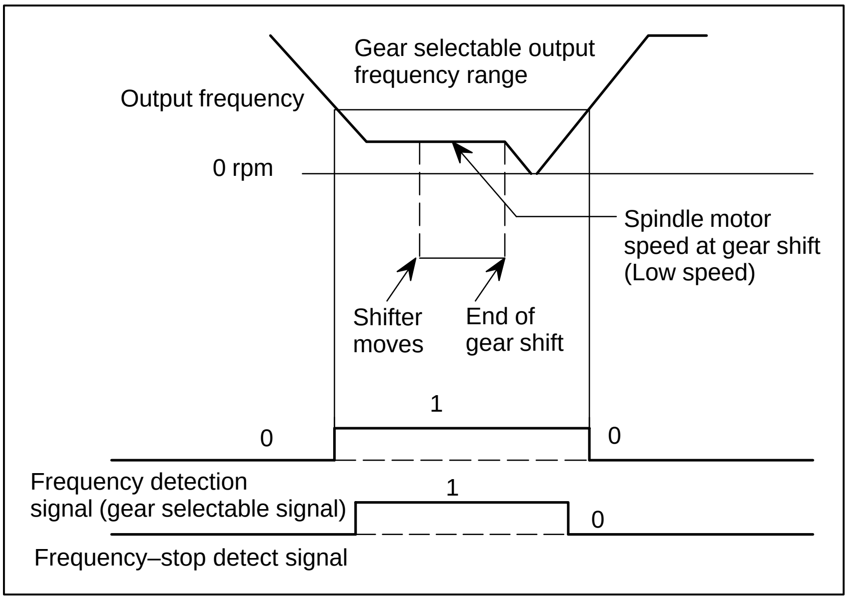


Fig.10.4.11 (b) Frequency Detection Signal

10.4.12 Frequency Arrival Signal (SARA)

- SARA = 1 occurs when output frequency of the actual spindle motor module arrives within the range set by the frequency command.

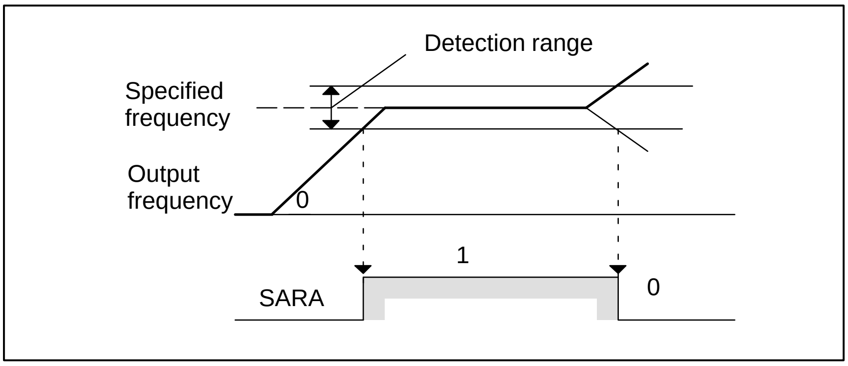


Fig.10.4.12 (a) Frequency Arrival Signal

- The setting range is ±1 to 100% of the command frequency. However, when the speed is less than 10% of the maximum frequency, the detection range becomes wider than the preset range.
- The standard setting at shipment is ±15%. However, the detection range of this frequency arrival signal at low speed widens as shown in the diagram below.

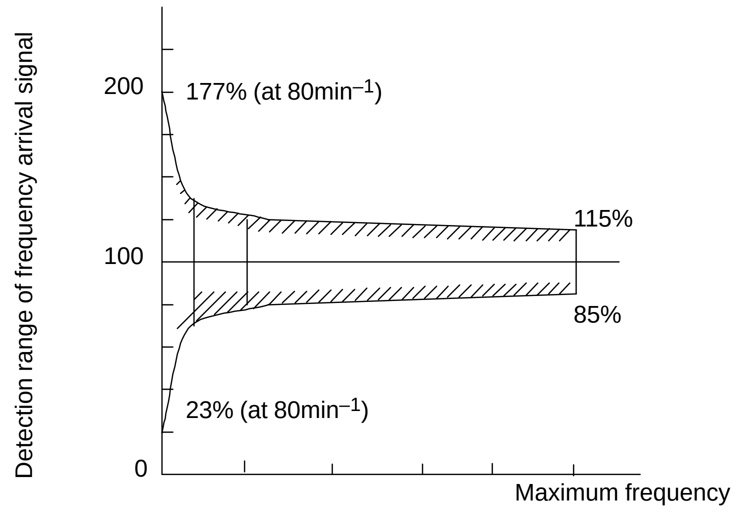


Fig.10.4.12 (b) Detection Range of the Speed-Arrival Signal

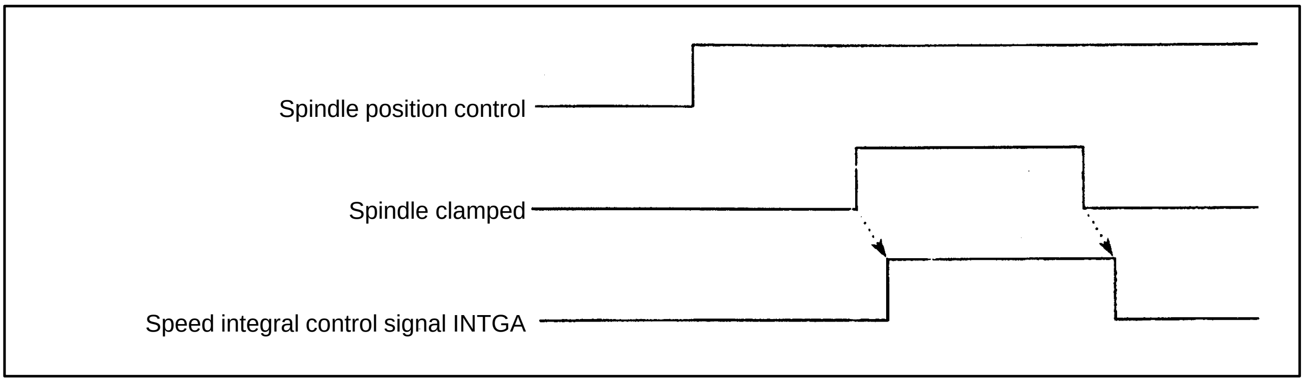
- If one of these signals, SFRA or SRVA, is not 1, it is not outputted.

10.4.13 Load Detection Signal (LDTA)

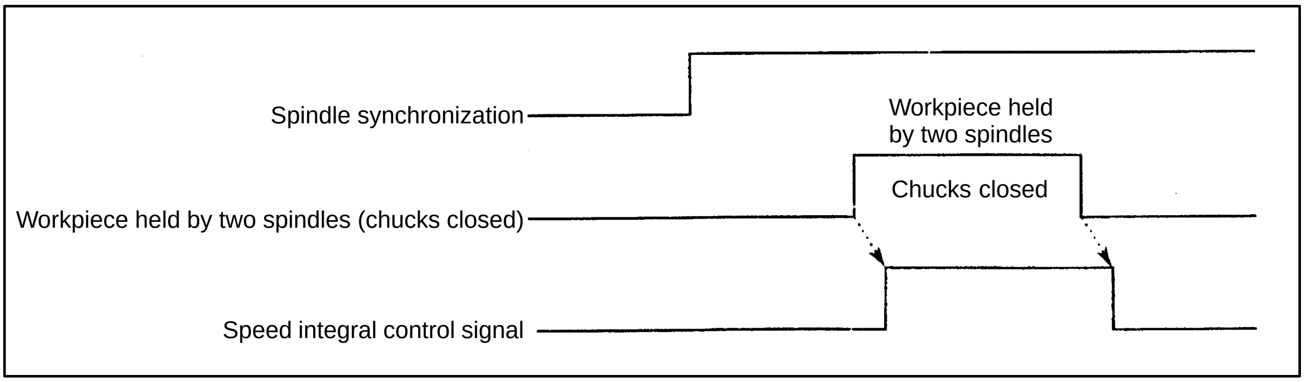
- Assume that the maximum output (10 V) of the load meter (LM) is 100%. When the output of the load meter reaches the parameter settings (%), load detection signal is set to 1.
- The PMC can reduce the feedrate or stop the feed to prevent the spindle from stopping when cutting overload is applied to the spindle by using this signal.
- This signal is not output for 10 seconds (by PRM4082 of series 16) after the speed command has changed.

10.4.14 Speed Integral Control Signal (INTGA)

- During spindle position control (such as spindle orientation control), the spindle may be clamped when a brake is applied. If the spindle is clamped with a small displacement remaining, an excessive current may flow through the motor in order to eliminate the displacement by performing speed integral control. In this case, this signal can be used to nullify speed integral control so as to prevent an excessive current from flowing through the motor.



- If a very small synchronization error occurs between two spindles when they are used to hold a workpiece in spindle synchronization, an excessive current may flow through the motor in order to eliminate the error by performing speed integral control. In this case, this signal can be used to nullify speed integral control so as to prevent an excessive current from flowing through the motor.



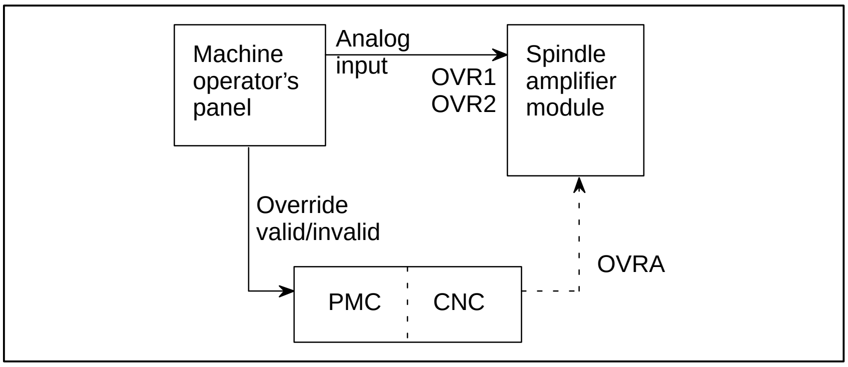
10.4.15 Spindle Analog Override Command (OVRA)

- This function allows an analog voltage input to the spindle amplifier to apply an override to the frequency command.
- The analog override function is valid only in the normal control mode.
- The analog override function is valid when this signal is 1.
- The following parameter sets the upper limit of the analog override. The input voltage value that corresponds with the frequency of the upper limit of analog override is 4.5 V across OVR2 and 0V. (An input more than 4.5 V does not make excess of the maximum frequency). Even if an overridden frequency command exceeds the value set with the max. frequency parameter, the frequency is clamped to the maximum frequency.

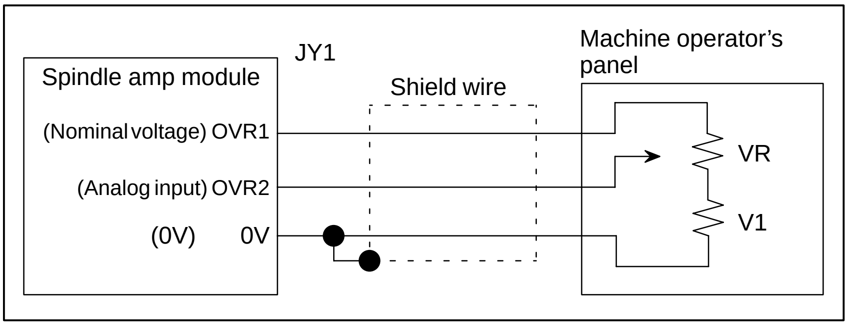
(Parameter No.) FS0 / FS15 / FS16	#7	#6	#5	#4	#3	#2	#1	#0
1st Spindle : 6506 / 3006 / 4006 2nd Spindle: 6646 / 3146			ALGOVR					

ALG OVR =0 : Upper limit 100%
=1 : Upper limit 120%

- A system configuration in relation with the analog override function is as follows:



Connection about the analog override input is as follows:
The override unit is 1%.



Use the resistor(VR + R1) of 2 kΩ to 10 kΩ .

- When the analog override function valid/invalid switch signal is switched, or when the override upper limit parameter is switched, the motor speed may change radically. Therefore switch the signal or parameter when the spindle is stopped.

10.4.16 Motor Power Off Signal (MPOFA)

- This signal is used to cut the power of the motor when a failure occurs while the spindle synchronization control or the gear cutting machine is operating. When the power is cut, the motor runs free.
- This signal only cuts the power of the motor.
- Supply the motor with power after enough time has passed to completely stop the motor.

  If the signal is released, the power cannot be restored to the motor while the motor is operating (SSTA = 0).
- After the power of the motor is cut, all the operation modes(∗1) must be canceled for safety.

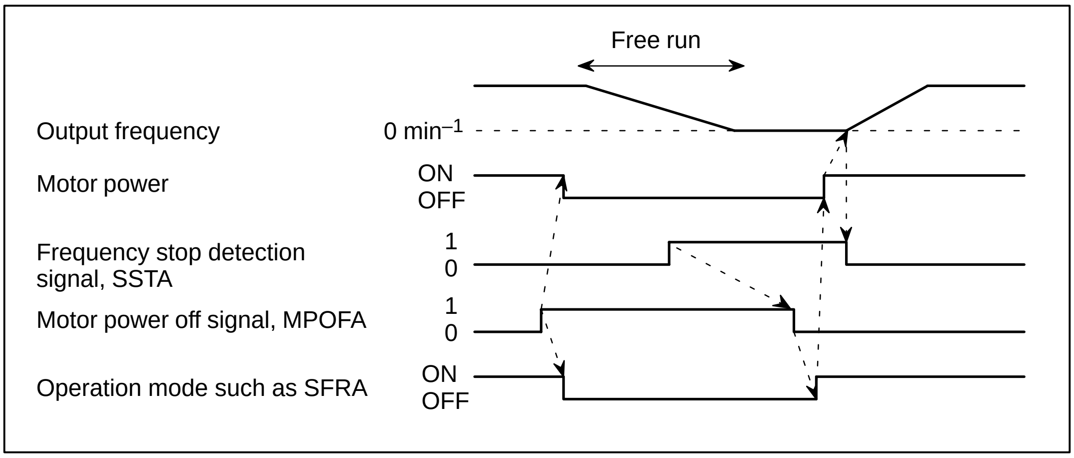
  After the motor stops (SSTA = 1), set the operation modes again.

  When the power is cut during position control, an alarm such as excessive deviation may occur because position control remains effective.

(∗1) Example of operation modes:

❑ Forward rotation command (SFRA)
❑ Reverse rotation command (SRVA)
❑ Spindle orientation (ORCMA)
❑ Spindle synchronization control (SPSYC, SPPHS)
❑ Rigid tap (RGTP, RGTAP

- **Example of the sequence**

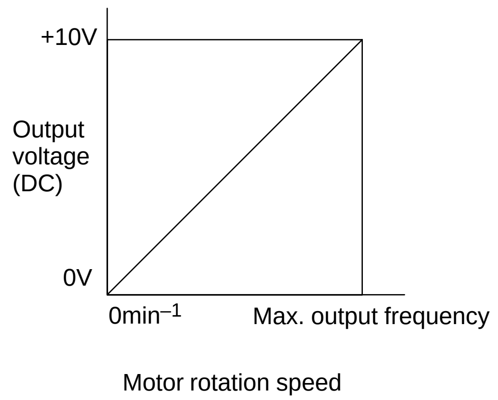


- Setting bit 2 of parameter 4009 (series 16) to 1 cuts off the power of the motor as soon as the AL-24 spindle alarm (serially transmitted data error) occurs. The motor usually decelerates and stops when the alarm occurs.

10.5 SPINDLE AMPLIFIER OUTPUT SIGNALS (αC SERIES SPINDLE)

10.5.1 Output Frequency Display Signal (SM) (Usable as Load Meter Voltage Signal According to Parameter Setting)

- The output frequency of the AC spindle motor can be indicated by externally connecting a speedmeter.
  A voltage (DC) proportional to the rotation speed is output, irrespective of the forward or reverse rotation of the motor. A +10V is output at the maximum frequency.



- Use the following speedmeter
  (DC voltmeter)

  ❑ One-sided deflection DC voltmeter

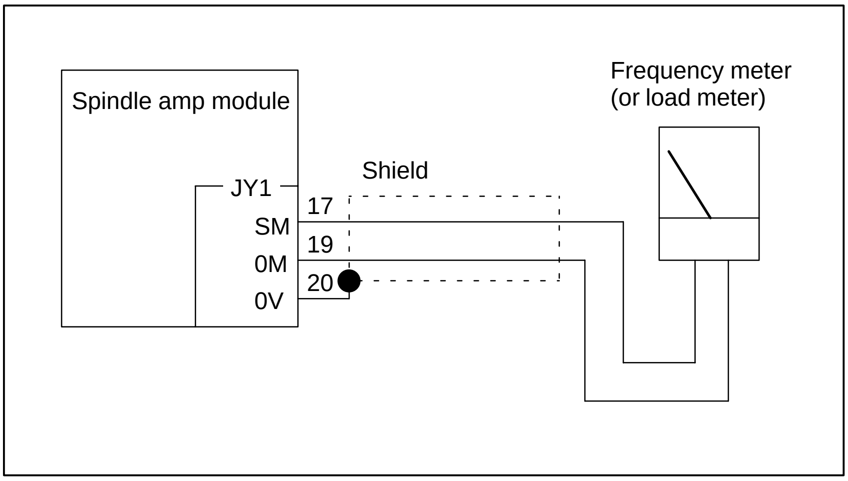
  ❑ DC voltage 10V full scale

  ❑ Internal resistance higher than 10 kΩ

  Example)
  DC voltmeter LM-80: Kuwano Electrical Manufacturing Co., Ltd.

  - For deteils of connection cable and connectors, refer to 9.3.6(3).
  - Due to the construction of internal circuit, there exists about 10mV (0.1%) ripple at the output of SM terminal
  - This signal can be used for load meter by setting the parameter (PRM4007#4=1 : series 16). The load meter outputs +10V when the spindle motor exhibits its maximum output.

Parameter			Contents
FS0	FS15	FS16	
6507#4 6607#4	3007#4 3147#4	4007#4	Selects type of data output from SM terminal 0 : Frequency data 1 : Load meter data



10.5.2 Load Meter Voltage (LM) (Either Speedometer Data or Load Meter Data is Selected According to Parameter Setting)

- When the SM terminal output is used for load meter by parameter the rated input voltage is applied, the frequency-to-spindle motor output relation, frequency-to-torque relation and frequency-to-load meter relation are as shown in Figs. 10.5.2 (a), 10.5.2 (b), and 10.5.2 (c).
- The load meter indicates the load factor, which is the ratio of the load to the maximum output of the spindle motor.

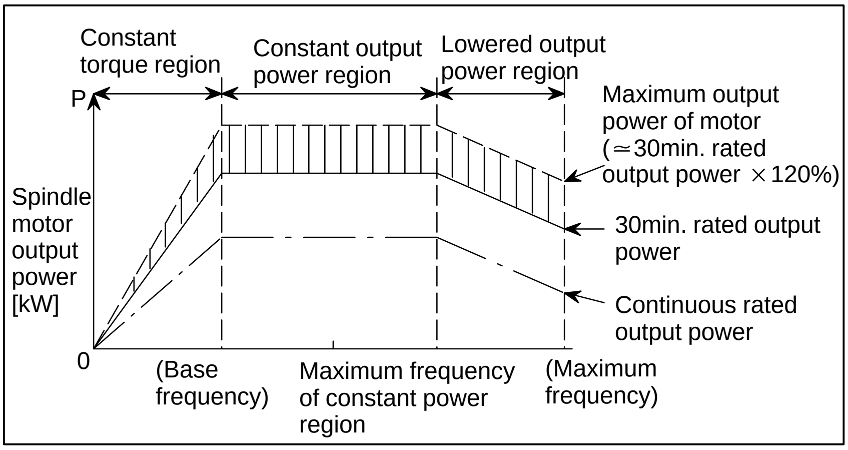


Fig.10.5.2 (a) Spindle Motor Output

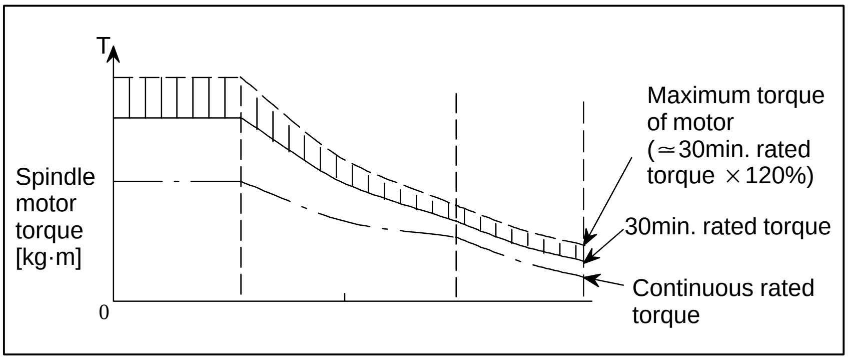


Fig.10.5.2 (b) Spindle Motor Torque

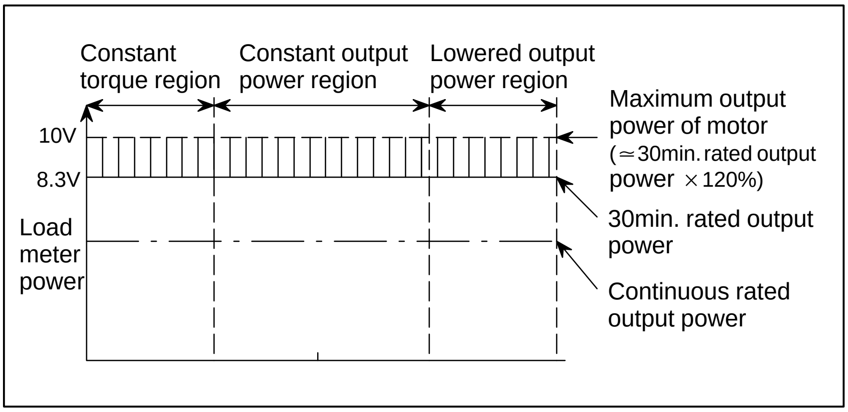


Fig.10.5.2 (c) Voltage Used for Operating a Load Meter

- The relation between each spindle motor output and the indicating voltage of the load meter is as shown in Table 10.5.2 (a), assuming that the continuous rated output of the spindle motor is 100%.
- Three types of indications of the load meter may be considered approximately from Table 10.5.2 (a). For the indication of the load meter in this case, refer to examples shown in Table 10.5.2 (b).
- The load meter (DC voltmeter) being used shall satisfy the following requirements:
  - One–side deflection DC voltmeter
  - 10 VDC full–scale
  - Internal resistance of 10kΩ or higher

  Example)

  DC voltmeter LM–80 produced by Kuwano Denki
- Use two–conductor shielded cables.

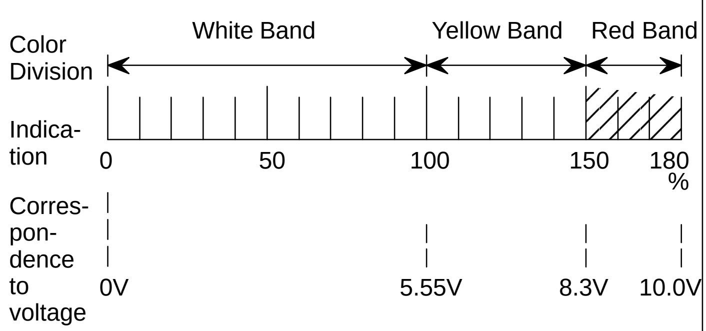
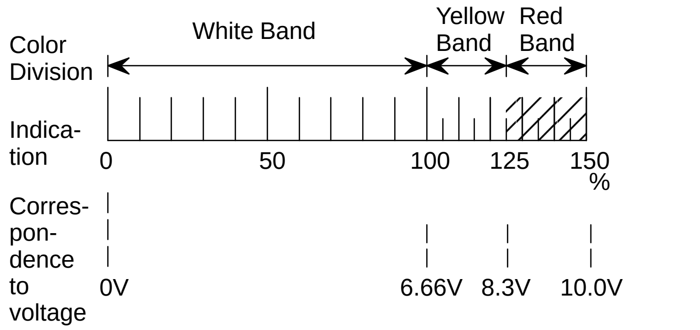
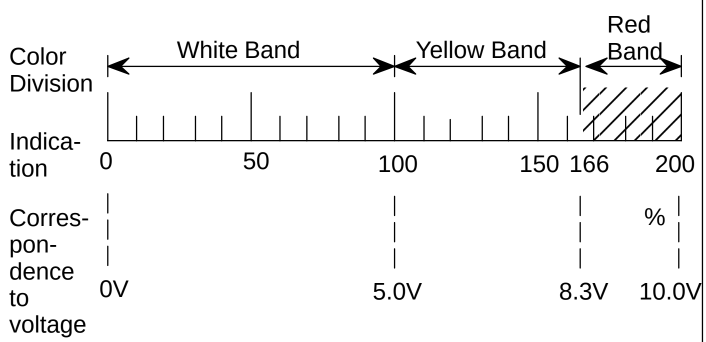
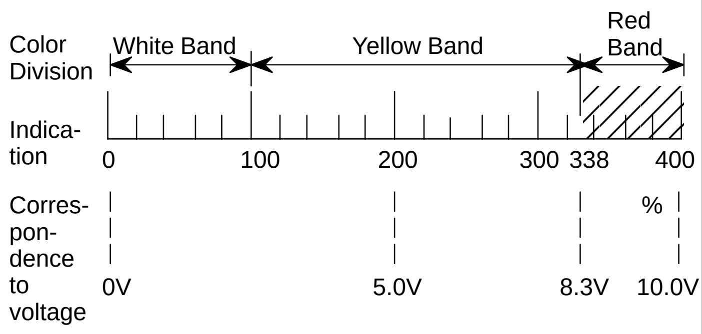
Table.10.5.2 (a) Relation between each spindle motor output and indicating voltage of load meter

Model	Output (kw)	Indicating voltage of load meter (V) (Note)	Ratio asuming that continuous rating is 100% (%)	Example of load meter	
				Type of applicable load meter	Ratio to full scale (%)
αC1	1.5	5.7	100	A	102.2
	2.2	8.3	147		150
	2.64	10.0	176		180
αC1.5	1.1	2.5	100	D	100
	3.7	8.4	338		338
	4.4	10.0	400		400
αC2	2.2	5.0	100	C	101
	3.7	8.3	166		166
	4.4	10.0	200		200
αC3	3.7	5.6	100	A	100.8
	5.5	8.3	148		150
	6.6	10.0	178		180
αC6	5.5	6.1	100	A	109.8
	7.5	8.3	136		150
	9.0	10.0	164		180
αC8	7.5	5.7	100	A	102.6
	11.0	8.3	146		150
	13.2	10.0	175		180
αC12	11.0	6.1	100	A	109.8
	15.0	8.3	136		150
	18.0	10.0	164		180
αC15	15.0	6.7	100	B	100.5
	18.5	8.3	124		125
	22.2	10.0	149		150
αC18	18.5	7.0	100	B	105
	22.0	8.3	118		125
	26.4	10.0	142		150
αC22	22.0	7.0	100	B	105
	26.0	8.3	118		125
	31.2	10.0	142		150

NOTE

Accuracy of the load meter voltage depends upon the frequency used or the input voltage. The maximum deviation is approximately ±15%.

Table.10.5.2 (b) Examples of load meter type

Type	Indication of load meter	Remarks
A		Motor Models αC1, αC3, αC6, αC8, αC12
B		Motor Models αC15, αC18, αC22
C		Motor Model αC2
D		Motor Model αC1.5

11 OPTION RELATED TO SPINDLE

11.1 SPINDLE ORIENTATION

11.1.1 Position Coder Methed Spindle Orientation (αC Series Spindle)

11.1.1.1 General

Unlike conventional mechanical spindle orientation using a stopper, etc., the spindle orientation stops the spindle at a fixed position by directly feeding back position signals from the position coder directly connected to the machine spindle.

11.1.1.2 Features

Mechanical parts are not required.

This orientation is accomplished simply by connecting the position coder to the spindle without any need of mechanical orientation mechanism (stopper, pin, etc.) for spindle orientation.

Reduction of orientation time

Since the spindle motor connected to the spindle is utilized and the orientation can be performed directly from high-speed rotation, irrespective of gear shift, the orientation time is largely reduced.

Simplified power magnetic sequence control

This sequence consists of the spindle orientation command, its completion signal, spindle clutch/gear only without any need of other signals. Neither orientation speed command sequence nor torque limit command sequence is needed.

High reliability

Electrical system assures improved reliability without any damage to the mechanical section against an external impact.

High accuracy and rigidity

The spindle orientation accuracy and rigidity are enough to execute automatic tool exchange (ATC).

Positioning of workpiece

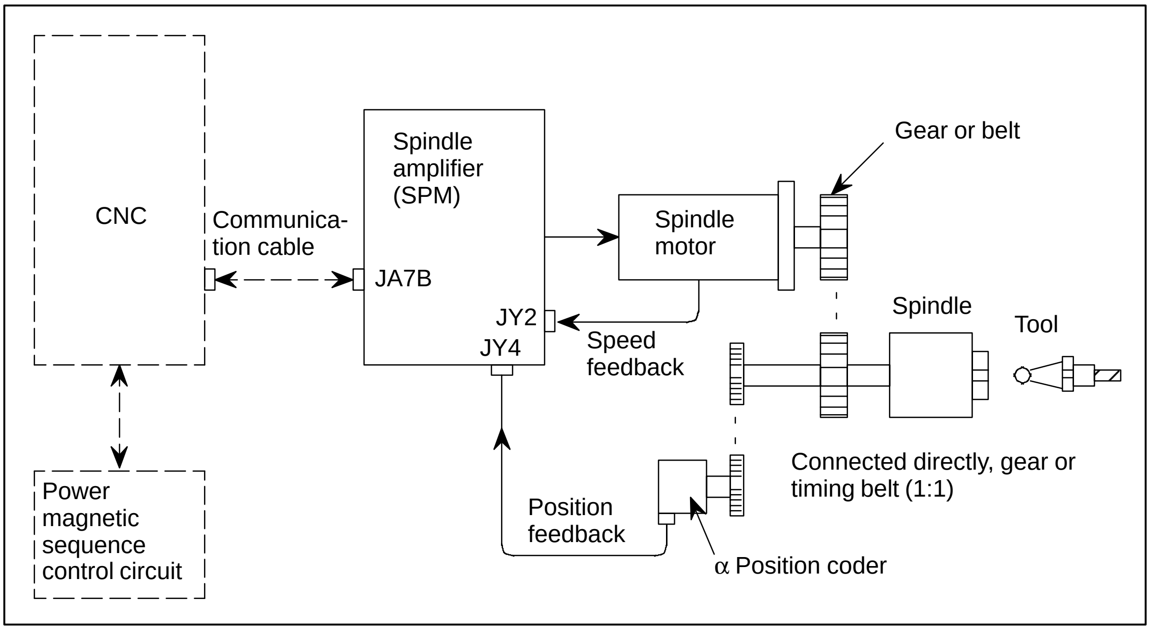
Workpieces can be positioned to arrange their loading and unloading directions in lathe.

Reduction of the number of processes in boring

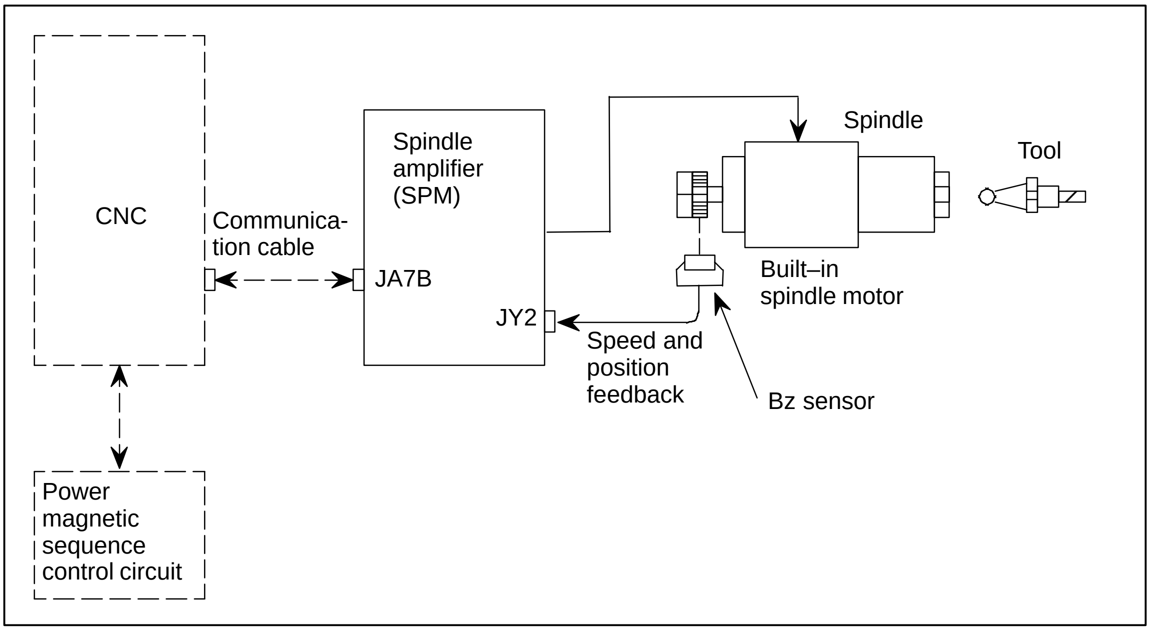
Since the spindle orientation can be done in the same direction as the rotating direction of the spindle when boring ends, workpieces will not be damaged by tool blades.
Since these tool blades can be mounted or dismounted in a fixed direction with reference to the workpieces, programming is easy.

11.1.1.3 Configuration and Order Drawing Number

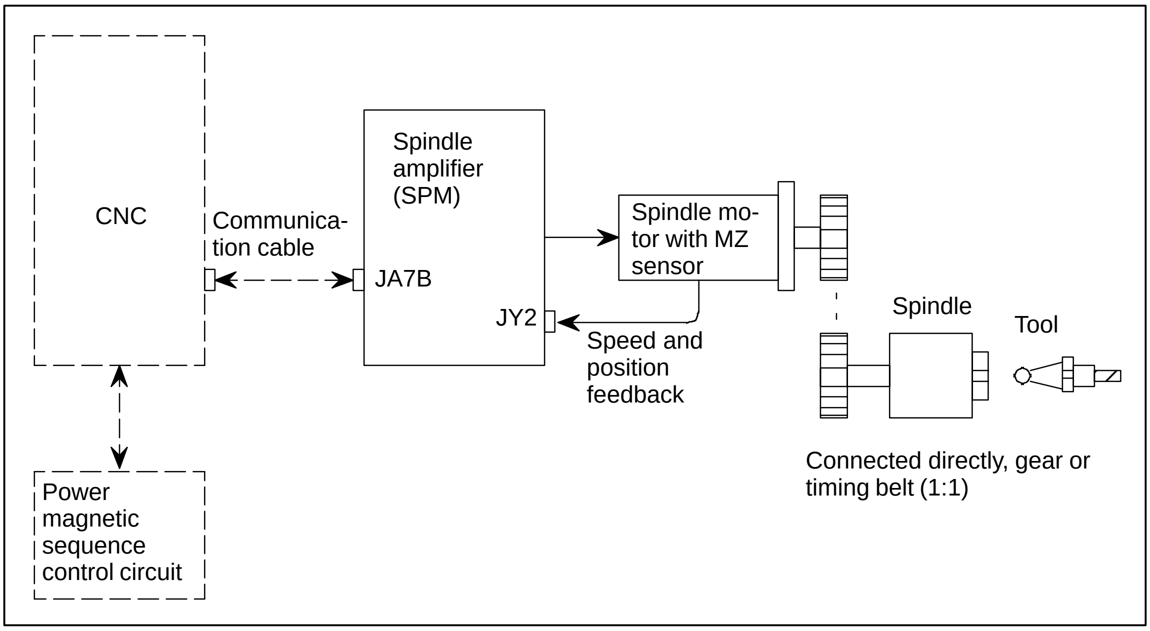
(1) Orientation Using Position Coder



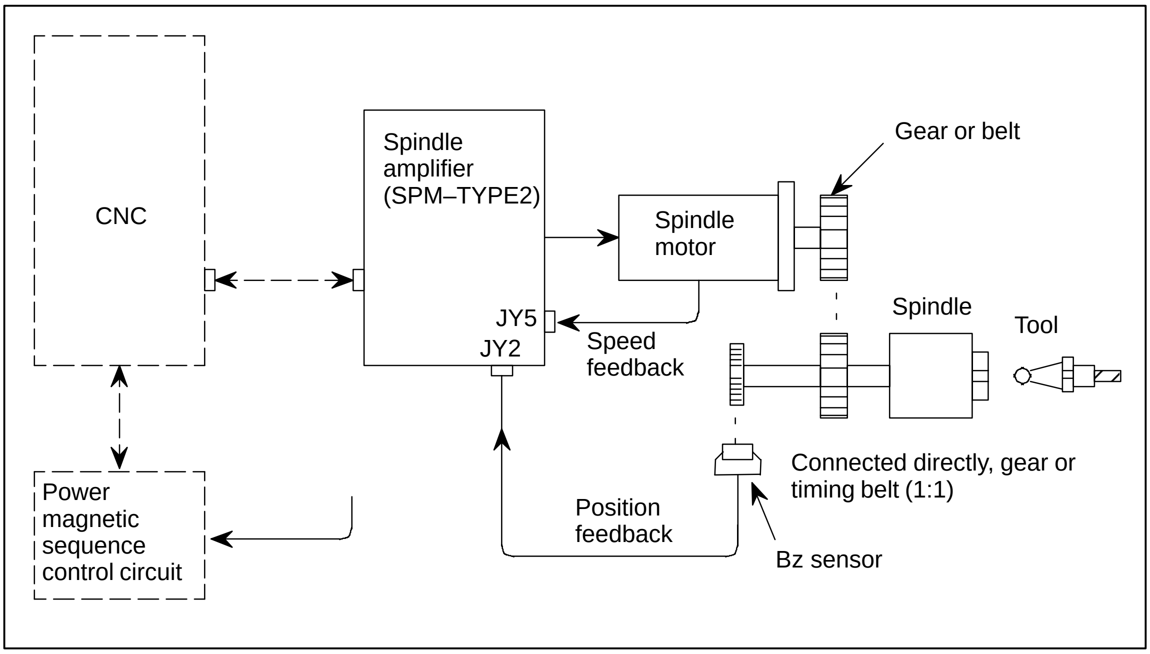
(2) Orientation Using Built-in Motor



(3) Orientation Using a Motor with Mz Sensor



(4) Orientation Using Bz Sensor on the Spindle



11.1.1.4 Specifications

(1) Detector

Detector	Description
Position coder	Connected to a spindle on a one–to–one basis (directly, or via a gear or timing belt) 1024 pulses/rev (phase A signal, phase B signal) 1 pulse/rev (one–rotation signal)
MZ sensor BZ sensor (Built–in sensor)	Connected to a spindle on a one–to–one basis
High–resolution position coder	Connected to a spindle on a one–to–one basis (directly, or via a gear or timing belt)
High–resolution magnetic pulse coder	Connected to a spindle on a one–to–one basis

(2) Detection Unit and Positioning Repeatability

Detector	Number of feedback signals	Detection unit	Positioning repeatability (Note)
Position coder	1024p/rev	0.088°	±0.2°
MZ sensor BZ sensor (Built–in sensor)	64λ/rev	0.167°	±0.4°
	128λ/rev	0.167°	±0.4°
	256λ/rev	0.088°	±0.2°
	384λ/rev	0.088°	±0.2°
	512λ/rev	0.088°	±0.2°
High–resolution position coder	1024p/rev	0.088°	±0.2°
High–resolution magnetic pulse coder	128λ/rev	0.088°	±0.2°
	192λ/rev	0.088°	±0.2°
	256λ/rev	0.088°	±0.2°
	384λ/rev	0.088°	±0.2°

NOTE
Machine error factors are excluded.

(3) Method of stop position specification

Method of stop position specification	Description
Parameter–based specification	Specify the number of pulses (±4095 pulses) from a one–rotation signal to a stop position with a parameter (360° = 4096 pulses).
External stop position setting type	Specify the number of pulses (±4095 pulses) from a one–rotation signal to a stop position with a PMC signal (360° = 4096 pulses). The sum of the number of pulses specified with the parameter and the number of pulses specified with the PMC signal represents a final stop position.

11.1.1.5 Signal Explanation

(1) DI Signals (PMC to CNC)

(a) Signal address

First spindle control input signal

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
G229	G227	G070	MRDYA	ORCMA	SFRA	SRVA	CTH1A	CTH2A	TLMHA	TLMLA
G231	G229	G072	RCHHGA	MFNHGA	INCMDA	OVRA	DEFMDA	NRROA	ROTAA	INDXA
G110	G231	G078	SHA07	SHA06	SHA05	SHA04	SHA03	SHA02	SHA01	SHA00
G111	G230	G079					SHA11	SHA10	SHA01	SHA00

Second spindle control input signals

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
G223	G235	G074	MRDYB	ORCMB	SFRB	SRVB	CTH1B	CTH2B	TLMHB	TLMLB
G235	G237	G076	RCHHGB	MFNHGB	INCMDB	OVRB	DEFMDB	NRROB	ROTAB	INDXB
G112	G239	G080	SHB07	SHB06	SHB05	SHB04	SHB03	SHB02	SHB01	SHB00
G113	G238	G081					SHB11	SHB10	SHB09	SHB08

Details of signals

(b) Orientation (fixed position stop) command (ORCMA)

- This command signal is used to stop spindle movement at the preset position to allow tool change and workpiece loading/unloading.
- When this signal is specified as ”1” while the spindle is rotating, the rotation decelerates immediately and the spindle stops at the preset position.
- When the orientation command is issued, set the spindle forward/reverse rotation command (SFRA, SRVA) to ”0” for safety. By means of this, the spindle will not start to rotate even in the unlikely event ORCMA becomes ”0” during tool change.
- Set this signal to ”0” by the tool change completion signal or workpiece loading/unloading completion signal.
- Always set the orientation command signal to ”0” when turning on power.
- When an emergency stop occurs during orientation, the orientation command signal must be reset (”0”).
  Return the ATC arm to the safe position so that it will not be damaged if the spindle or tool rotates when the power is turned on.

(c) Gear/clutch signal (CTH1A, CTH2A)

- These signals are used for switching the speed range between high speed and low speed, or when there are two or more gear steps between the spindle and spindle motor.

- Set the following conditions corresponding to the clutch or gear state. They are used in order to select the spindle control parameter (Position gain, Gear ratio, velocity loop gain).

CTH1A	CTH2A		
0	0	:	HIGH GEAR
0	1	:	MEDIUM HIGH GEAR
1	0	:	MEDIUM LOW GEAR
1	1	:	LOW GEAR

(d) Command for changing the stop position in spindle orientation (INDXA)

- This command is used when the orientation position is changed again immediately after spindle orientation was just performed.
  This command is valid when the spindle orientation command (ORCMA) is issued.
- Changing this signal from 1 to 0 orients the spindle within one rotation to a new position (absolute position within one rotation) specified by new stop position data (SHA11 to SHA00).
- The direction of spindle rotation is specified by the direction command for the shorter route (NRROA) or the command specifying the direction of rotation (ROTTA).
- This function is valid when the CNC parameter corresponding to the spindle orientation function in which the stop position is specified externally is set.

(e) Direction command for the shorter route when the stop position changes in spindle orientation (NRROA)

- This command is used for specifying the direction of rotation, whichever is shortest, (within ± 180 degrees) when the orientation position is changed again immediately after spindle orientation has just been performed.
- When this signal is set to 1, positioning is performed in the direction that provides a shorter route, irrespective of the command specifying the direction of rotation when the stop position changes in spindle orientation.

(f) Command specifying the direction of rotation when the stop position changes in spindle orientation (ROTAA)

- This command is used for specifying the direction of rotation when the orientation position is changed again immediately after the spindle orientation was just performed.
  When the signal is 0, the spindle rotates counterclockwise to the specified position and stops.
  When the signal is 1, the spindle rotates clockwise to the specified position and stops.
- This command is valid when the direction command for the shorter route when the stop position changes in spindle orientation (NRROA) is 0.

(g) Spindle orientation command in which the stop position is specified externally (SHA11 to SHA00)

- This command is used for specifying a stop position with an absolute position within one rotation in the following equation:

$$\text{Stop position (degrees)} = \frac{360}{4096} \times \sum_{i=0}^{11} (2^i \times P_i)$$

where
Pi = 0 when SHAi = 0
Pi = 1 when SHAi = 1

- When this command is used, the stop position parameters in spindle orientation with a position coder (In case of Series 16 : No. 4031) are invalid.

(2) Output Signals (CNC to PMC)

(a) Signal addresses

First spindle control output signal

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
: F281	F229	F405	ORARA	TLMA	LDT2A	LDT1A	SARA	SDTA	SSTA	ALMA

Second spindle control output signals

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
: F285	F245	F049	ORARB	TLMB	LDT2B	LDT1B	SARB	SDTB	SSTB	ALMB

(b) Orientation (fixed position stop) completion signal (ORARA)

- When the orientation command is input and the spindle has stopped near the preset fixed position (for example, within $\pm 1°$), it becomes ”1”.

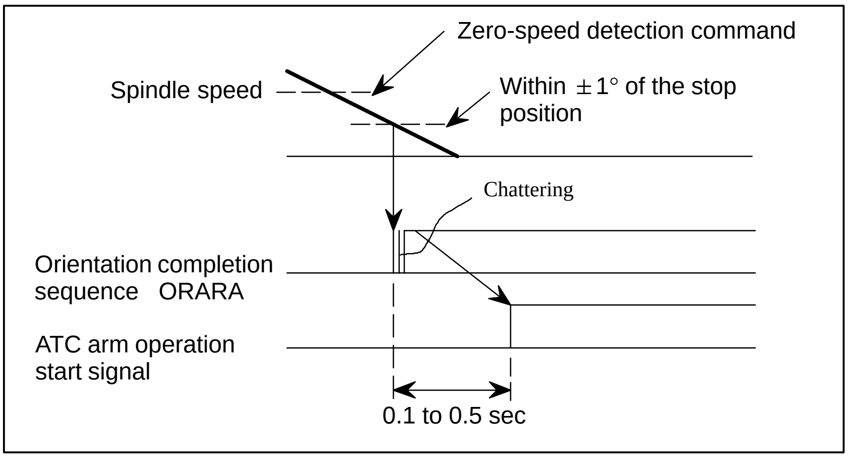
Condition for ORARA to become ”1”

$$= \frac{\text{(ORCMA is ”1”)} \times \text{(zero-speed signal SSTA is ”1”)}}{\text{Near to fixed position}}$$

Near to fixed position is set to the parameter in case of Series 16 (PRM4075=Orientation complete signal detection level).
If the above 3 conditions are satisfied, the orientation complete signal is output.
If the orientation completion signal is not issued within a set period of time after the orientation command signal is input, it is considered to be abnormal. So it should be detected by the power magnetic sequence and an orientation alarm should be issued.

- Tool change or workpiece loading/ unloading operations can be started when this signal is ”1”.

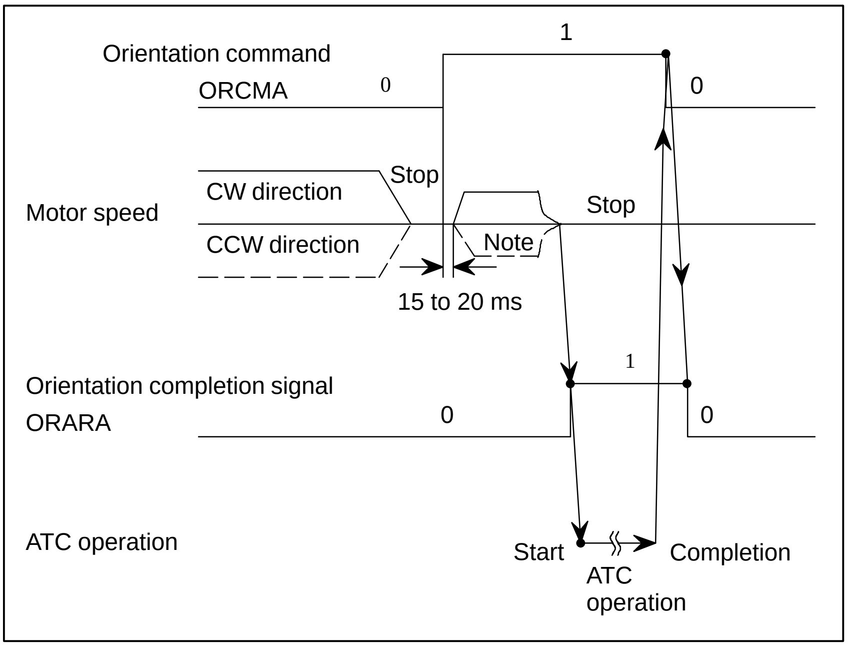
- The spindle orientation completion signal is issued when the spindle is within $\pm 1°$ of the preset position and so it does not always indicate that the spindle has stopped completely. Some machines allow a very short operation time for the ATC arm to grip the tool. In this case, start the ATC arm operation after a short time (0.1 to 0.5 sec.) so that the arm will grip the tool when the spindle has stopped completely.



- This signal will become ”0” during a tool change if the spindle is pushed away from the preset position by external force.
  In this case, design a power magnetic sequence so that the tool change operation is interrupted.
  However, do not release the orientation command, and if the orientation completion signal is issued again, perform a tool change.
- If the automatic tool change (ATC) structure is such that it may cause serious damage if a malfunction occurs, install a proximity switch to generate a verification signal when the ATC enters an area in which the automatic tool change operation can be performed. In addition to this, perform a double safety check by the power magnetic sequence and carry out a tool change.

11.1.1.6 Sequences

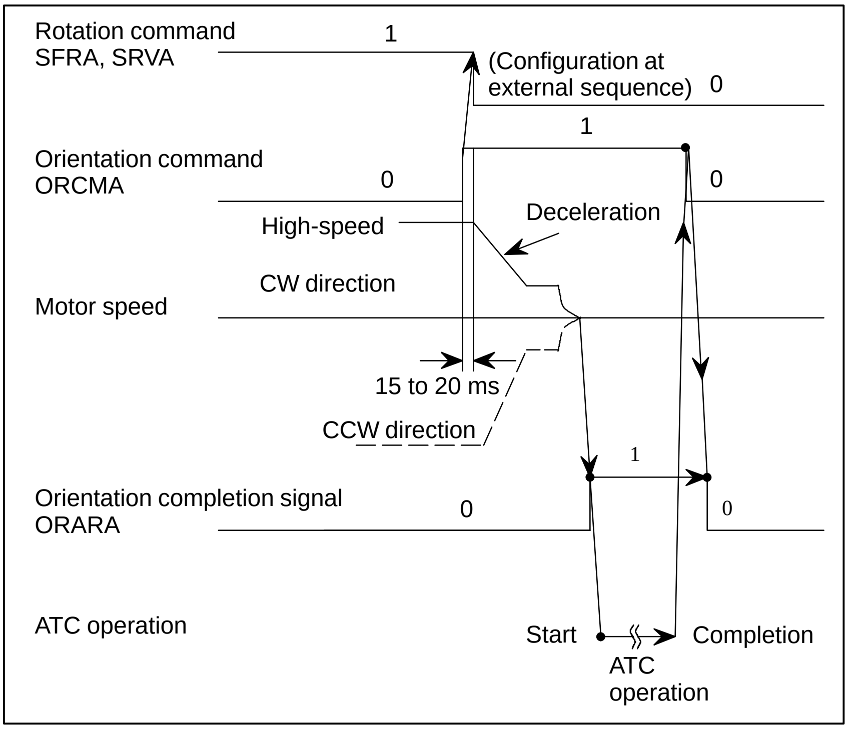
(1) Orientation Command while Stopping



NOTE

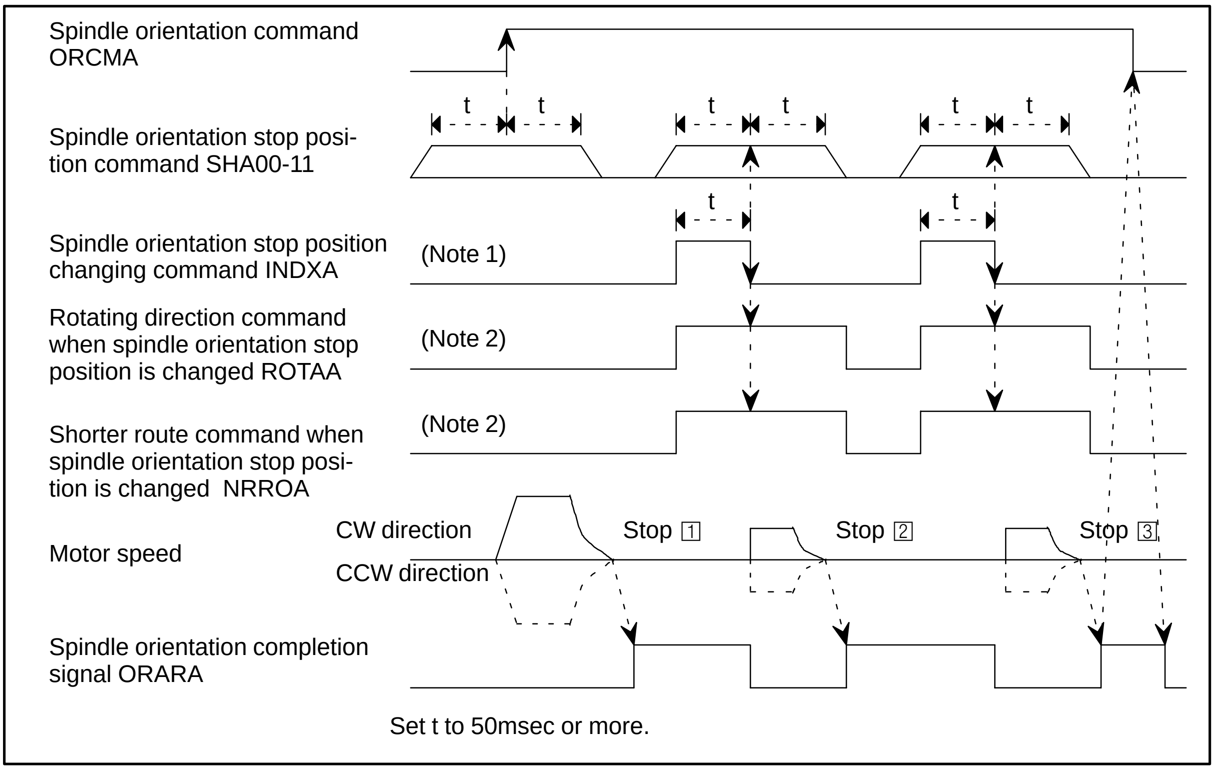
The spindle motor rotation direction can be changed by setting. In standard setting, the spindle motor will stop at the fixed position in the direction the spindle motor was rotating before this orientation command signal was generated.

(2) Orientation Command During High-speed Rotation



(3) When Stop Position External Setting Type Spindle Orientation Function is Used

- **Sequence**



Stop 1

- Stopping in a specified position through a normal orientation command

- The rotating direction of the spindle motor is specified by setting a parameter.
- When the motor rotates first after the power has been turned on, it rotates at the orientation speed and stops in a specified position after the one rotation signal has been captured. When it rotates next or later, it stops in the specified position within one rotation.
- With the spindle orientation function in which a stop position is externally specified, if the data of SHA11-00 (spindle orientation stop position command) is decided in a second or later stop operation, the motor stops at a position ([one-rotation signal position] + [data specified by SHA11-00] + [PRM4077]) shifted by the value seized on a rising edge of ORCMA (spindle orientation command).

Stop 2 and 3

- Stopping in a specified position using the stop position external setting type spindle orientation function
- The rotating direction of the spindle motor is specified by the following command: (1) rotating direction command when spindle orientation stop position is changed (ROTA) or, (2) shortcut command when spindle orientation stop position is changed (NRROA).

> **NOTE**
> The spindle orientation stop position change command INDXA is valid only when the spindle orientation command ORCMA is set to 1.

11.1.1.7 Parameters

The table below lists the parameters related to spindle orientation using a position coder. Refer to the Parameter Manual for details.

Parameter No.			Description
FS0	FS15	FS16	
Orientation function setting			
6515#0	3015#0	4015#0	Whether spindle orientation is used (Set to 1.) (CNC software option is necessary.)
0080 #3,#2	5609 #3,#2	3702 #3,#2	Whether to use the spindle orientation function of external stop position setting type. (#2: First spindle, #3: Second spindle)
Setting related to the position coder signal			
6501#2	3001#2	4001#2	Whether a position coder signal is used (Set to 1.)
6500#2	3000#2	4000#2	Mounting orientation for the position coder
6500#0	3000#0	4000#0	Rotational direction of the spindle and motor
6503#0	3003#0	4003#0	Selection of position coder method or magnetic sensor method spindle orientation (0 for a position coder method)
6503 #7, 6, 4	3003 #7, 6, 4	4003# 7, 6, 4	Setting of the position coder signal
6517#2	3017#2	4017#2	Function for detecting position coder one–rotation signal at normal rotation
6598	3098	4098	Position coder signal detection maximum speed

Parameter No.			Description
FS0	FS15	FS16	
Gear ratio setting			
6556 to 6559	3056 to 3059	4056 to 4059	Gear ratio between the spindle and motor (selected by DI signals CTH1A and CTH2A)
Setting of a rotation direction at orientation time			
6503 #3, 2	3003 #3, 2	4003 #3, 2	Rotational direction for spindle orientation
Setting of a stop position shift amount			
6531	3031	4031	Stop position for position coder method orientation (This parameter is invalid when the function for externally setting the stop position or externally setting incremental commands is used.)
6577	3077	4077	Shift of spindle orientation stop position
Setting related to gain at orientation time			
6560 to 6563	3060 to 3063	4060 to 4063	Position gain for orientation (selected by DI signals CTH1A and CTH2A)
6542 6543	3042 3043	4042 4043	Velocity loop proportional gain for orientation (selected by DI signal CTH1A)
6550 6551	3050 3051	4050 4051	Velocity loop integral gain for orientation (selected by DI signal CTH1A)
6564	3064	4064	Change rate for the position gain after spindle orientation
Setting related to gain at orientation time (Continued)			
6584	3084	4084	
Setting related to orientation speed			
6538	3038	4038	Orientation speed
6576	3076	4076	Orientation–time motor speed limit ratio
Setting related to the orientation completion signal			
6575	3075	4075	Detection level for the spindle orientation completion signal
6276	3456	4312	Detection level for the approach signal for position coder method orientation
Others			
6517#7	3017#7	4017#7	Shorter route function for orientation from stop state

11.1.1.8 High–speed Orientation

(1) Overview

The high–speed orientation function reduces spindle orientation time by:

1 Making full use of the motor deceleration capability

2 Increasing the gain of the position loop

NOTE
1 This function can also be used for spindle orientation of external stop position setting type and incremental command type.
2 This function cannot be used for orientation during spindle synchronization.

(2) System configuration

The high–speed orientation function can be used with the following system configurations:
1) System in which a position coder connected to a spindle on a one–to–one basis is installed
2) Motor system built into a spindle
3) System in which a motor with a built–in MZ sensor is connected to a spindle on a one–to–one basis

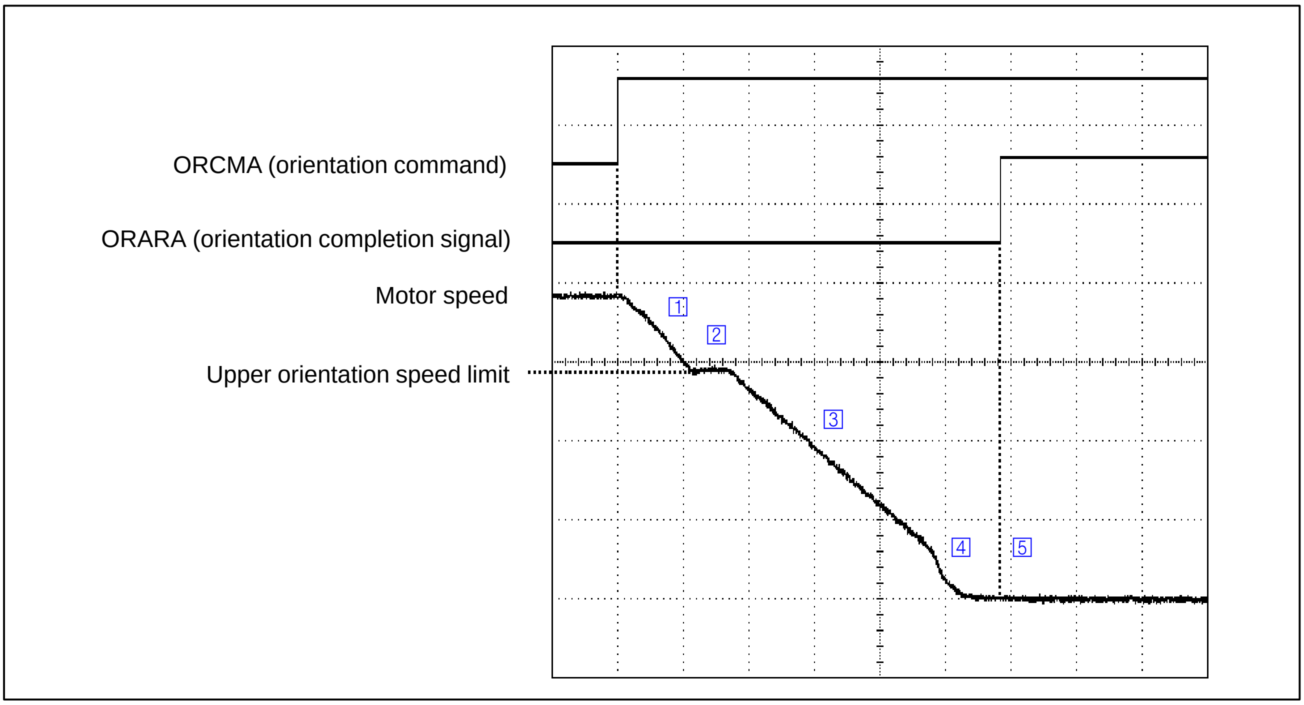
NOTE
This function cannot be used with an orientation system of external one–rotation signal type that uses a proximity switch.

(3) Signal

See Section 11.1.1.5.

(4) Description of operation

1) When orientation operation is started from a speed higher than the upper orientation speed limit



1 If a spindle orientation command (ORCMA) is entered when the speed is higher than the upper orientation speed limit set with parameter No. 4038 (FS16), the speed is reduced to the upper orientation speed limit.

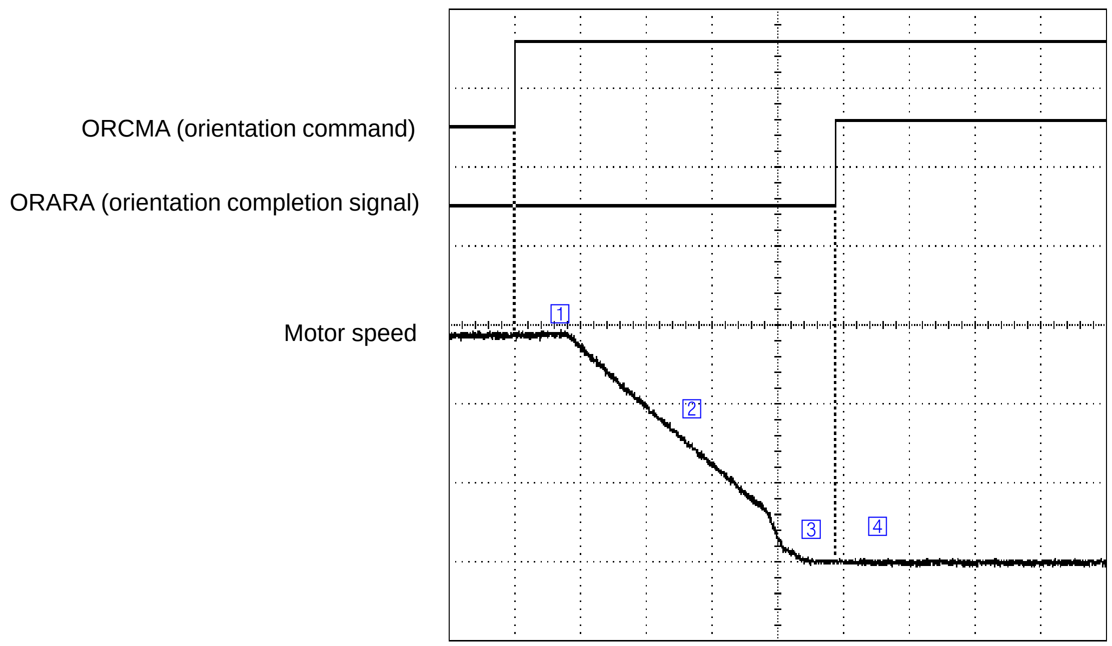
2 A one–rotation signal is detected (only for the first orientation after power–on).

3 The speed is reduced according to the motor deceleration time constant set with parameter No. 4320 to No. 4323 (FS16).

4 When the speed becomes equal to or less than a value calculated internally by software, the position loop is controlled according to the orientation–time position gain set with parameter No. 4060 to No. 4063 (FS16).

5 When the positional deviation becomes equal to or less than the number or pulses set with parameter No. 4075 (FS16) for specifying an orientation completion signal level, the spindle orientation completion signal (ORARA) is output.

2) When orientation operation is started from a speed between the lower orientation speed limit and higher orientation speed limit



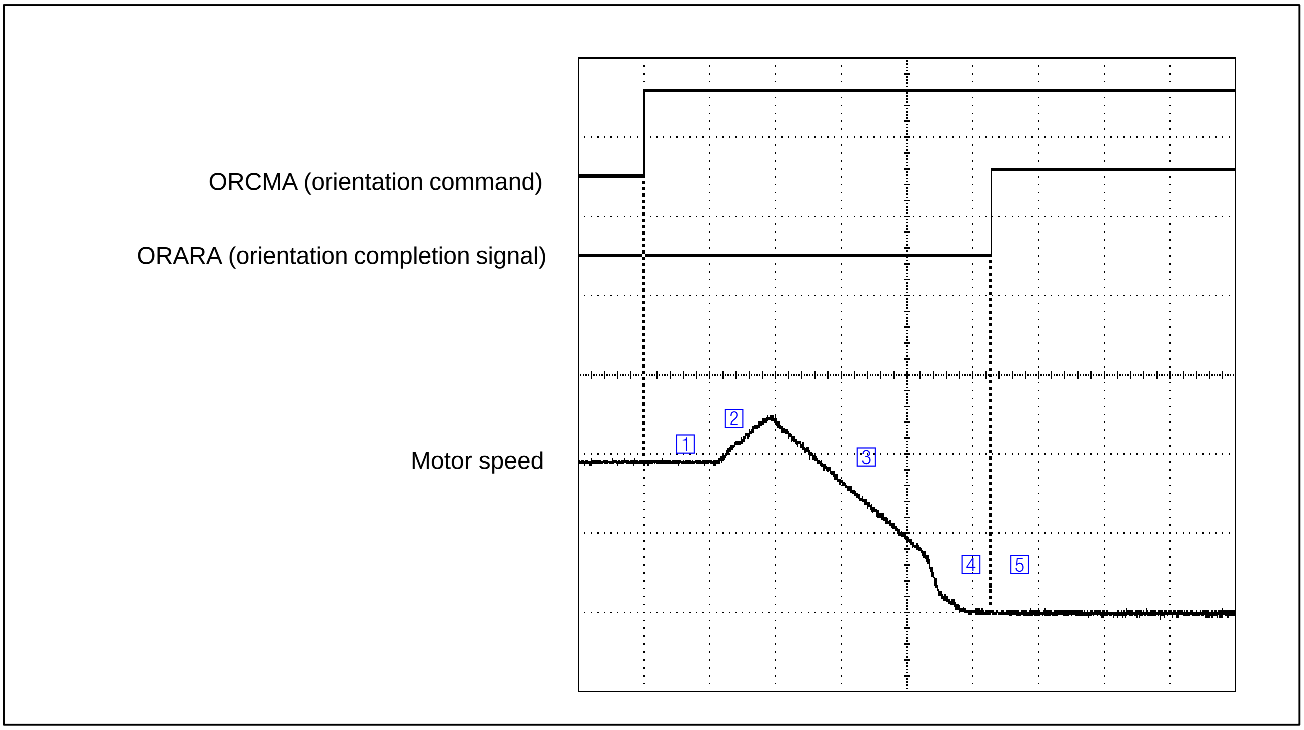
1 If a spindle orientation command (ORCMA) is entered when the speed is between the upper orientation speed limit set with parameter No. 4038 (FS16) and the lower orientation speed limit (calculated internally by software), a one–rotation signal is detected (only for the first orientation after power–on).

2 The speed is reduced according to the motor deceleration time constant set with parameter No. 4320 to No. 4323 (FS16).

3 When the speed becomes equal to or less than a value calculated internally by software, the position loop is controlled according to the orientation–time position gain set with parameter No. 4060 to No. 4063 (FS16).

4 When the positional deviation becomes equal to or less than the number or pulses set with a parameter (orientation completion signal level [parameter No. 4075 for FS16]), the spindle orientation completion signal (ORARA) is output.

3) When an orientation operation is started from a speed lower than the lower orientation speed limit



1 If a spindle orientation command (ORCMA) is entered when the speed is lower than the lower orientation speed limit (calculated internally by software), a one–rotation signal is detected (only for the first orientation after power–on).

2 The speed is increased according to the motor deceleration time constant set with parameter No. 4320 to No. 4323 (FS16).

3 The speed is reduced according to the motor deceleration time constant set with parameters No. 4320 to No. 4323 (FS16).

4 When the speed becomes equal to or less than a value calculated internally by software, the position loop is controlled according to the orientation–time position gain set with parameters No. 4060 to No. 4063 (FS16).

5 When the positional deviation becomes equal to or less than the number or pulses set with a parameter (parameter No. 4075 for FS16) for specifying an orientation completion signal level, the spindle orientation completion signal (ORARA) is output.

(5) Parameter list

The table lists the parameters to be newly set to use the high–speed orientation function.

Parameter No.			Description
FS0	FS15	FS16	
6518#6	3018#6	4018#6	High–speed orientation function
6518#5	3018#5	4018#5	Whether to perform speed command compensation at high–speed orientation
6538	3038	4038	Upper spindle orientation speed limit
6564	3064	4064	Deceleration time constant limit ratio
6284 to 6287	3464 to 3467	4320 to 4323	Motor deceleration time constant (Parameters are selected by input signals CTH1A and CTH2A.)
6290 6294	3470 3474	4326 4330	Deceleration time constant limit start speed (Parameters are selected by input signal CTH1A.)

11.1.2 Spindle Orientation of Position Coder Type (αC Series)

11.1.2.1 Overview

Unlike methods that use a stopper and so forth to stop the spindle mechanically at a specified position, orientation of position coder type stops the spindle at a specified position by collecting position feedback data directly from the position coder that is connected to the spindle.

11.1.2.2 Features

(1) Elimination of the mechanical section

Spindle orientation is enabled simply by connecting a position coder to the spindle. The mechanical stop mechanism (stopper, pin, and so forth) is not required for orientation.

(2) Reduced orientation time

A spindle motor connected with a spindle is used. So, orientation is possible at high speed, regardless of the gear shift. This significantly reduces orientation time.

(3) Simplified power magnetics sequence

The sequence consists of an orientation command, orientation completion command, and clutch/gear signal. It does not require any other signals. This means that sequences for orientation speed specification and torque limit specification are not required.

(4) Improved reliability

This type of spindle orientation does not depend on mechanical components, and therefore is not subject to mechanical damage due to external shock. Thus, a higher level of reliability is possible.

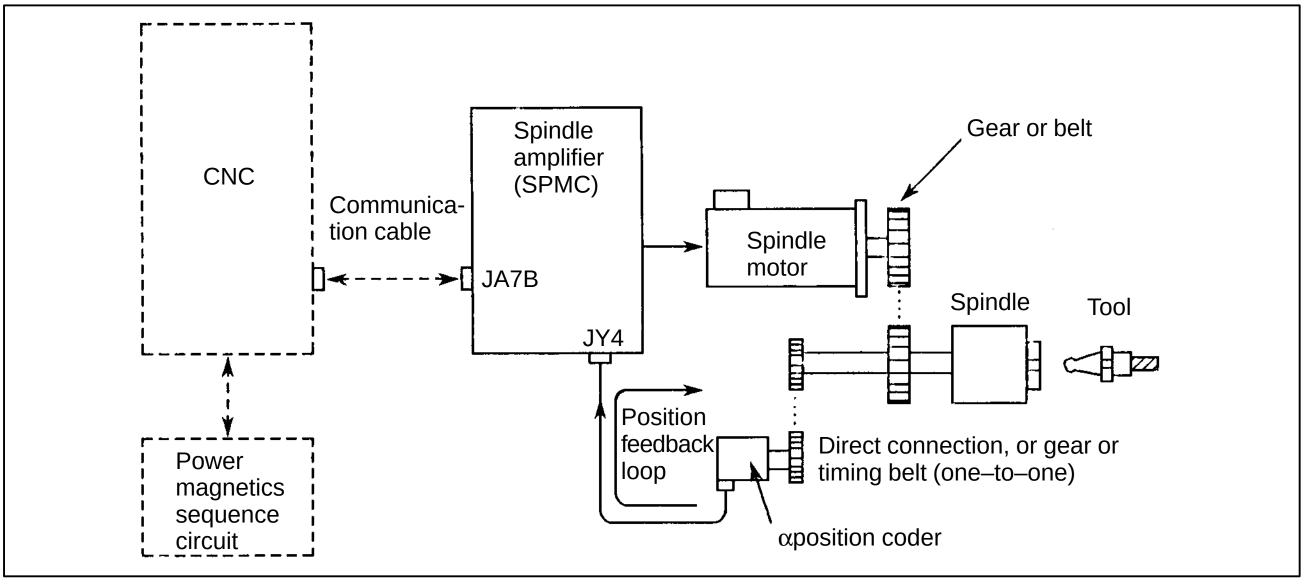
(5) Workpiece positioning enabled

On a lathe, a workpiece can be positioned for workpiece attachment/detachment direction alignment.

(6) Reduced number of boring steps

Positioning from the same direction as the spindle direction is possible upon the completion of boring, so that the workpiece is not damaged by the tool tip. In addition, a tool tip can be attached/detached in one direction with respect to the workpiece, so that programs can be created easily.

11.1.2.3
System Configuration



NOTE

When an αC series spindle is used, orientation is possible only with a system where the spindle is connected to a position coder on a one–to–one basis. (Orientation is not possible when other detectors and connection ratios are involved.)

11.1.2.4 Specifications

No.	Item	Description
1	Position coder	Connected to a spindle on a one–to–one basis. 1024 pulses/rev (phase A signal, phase B signal) 1 pulse/rev (one–rotation signal)
2	Detection unit	0.088° One spindle rotation (360°) is divided by 1024×4 (4096) pulses, and one pulse unit (0.088°) is used as the detection unit. 360°/ 4096 pulses = 0.088°/ pulses
3	Positioning repeatability	±0.4° (spindle angle) This value does not include mechanical errors (such as the coupling backlash between the spindle and position coder). Depending on the position gain adjustment, an error of one detection unit (0.088°) may occur after orientation.
4	Torque maintained at orientation stop time	None
5	Orientation of external stop position setting type	Enabled. However, the INDX signal is valid only with the 9D12 series.
6	Spindle orientation of incremental command type	Disabled

11.1.2.5 Signals

(1) Input Signals (PMC to CNC)

(a) Signal address

First spindle control input signal

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
G229	G227	G070	MRDYA	ORCMA	SFRA	SRVA	CTH1A	CTH2A	TLMHA	
G231	G229	G072				OVRA		NRROA	ROTAA	INDXA
G110	G231	G078	SHA07	SHA06	SHA05	SHA04	SHA03	SHA02	SHA01	SHA00
G111	G230	G079					SHA11	SHA10	SHA09	SHA08

Second spindle control input signals

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
G223	G235	G074	MRDYB	ORCMB	SFRB	SRVB	CTH1B	CTH2B	TLMHB	
G235	G237	G076				OVRB		NRROB	ROTAB	INDXB
G112	G239	G080	SHB07	SHB06	SHB05	SHB04	SHB03	SHB02	SHB01	SHB00
G113	G238	G081					SHB11	SHB10	SHB09	SHB08

(b) Orientation command (ORCMA)

- This signal is used to stop the spindle at a specified position to attach/detach a workpiece.
- When this signal is set to 1, the spindle, if rotating, is decelerated immediately and stops at a specified position.
- If an orientation command is issued for safety, set the spindle forward rotation/reverse rotation command (SFRA/SFRA) to 0. Then, the spindle does not start rotating even if ORCMA is set to 0 during tool replacement.
- Ensure that this signal is set to 0 by the workpiece attachment / detachment completion signal.
- Ensure that the orientation command signal is set to 0 when the power is turned on.
- Reset the orientation command signal to 0 when an emergency stop is initiated during orientation.

(c) Clutch/gear signals (CTH1A, CTH2A)

- When there are two or more speed change gear stages between the spindle and spindle motor, these signals are used to select a spindle control parameter (position gain, gear ratio, velocity loop gain).
- Depending on the clutch or gear state, make settings according to the table below. Names such as HIGH GEAR are given only for convenience. Arbitrary names may be assigned to the actual gears.

CTH1A	CTH2A	
0	0	HIGH GEAR
0	1	MEDIUM HIGH GEAR
1	0	MEDIUM LOW GEAR
1	1	LOW GEAR

(d) Spindle orientation stop position change command (INDXA)

- In orientation of external stop position setting type, this signal is used to orient the spindle to a different position immediately after spindle orientation.
  This signal is valid when the spindle orientation command (ORCMA) is set to 1.
- When this signal makes a transition from 1 to 0, the spindle is oriented within one rotation to the position specified by new stop position data (SHA11 to SHA00) (arbitrary position within one rotation specified by an absolute position command).
- The direction of orientation is specified by the shortcut rotation command (NRROA) or rotation direction command (ROTAA).
- This function is enabled when the CNC parameter for an orientation function of external stop position setting type is set.

(e) Shortcut rotation command for spindle orientation stop position modification (NRROA)

- This signal is used to specify a rotation direction when the spindle is oriented to a different position immediately after spindle orientation. This signal is used for shortcut rotation (within $\pm 180°$) to the next stop position.

- When this signal is set to 1, the spindle is oriented by shortcut rotation, regardless of the specification of the rotation direction command for spindle orientation stop position modification (ROTAA).

(f) Rotation direction command for spindle orientation stop position modification (ROTAA)

- This signal is used to specify a rotation direction when the spindle is oriented to a different position immediately after spindle orientation. When this signal is set to 0, the spindle rotates counterclockwise and stops.
  When this signal is set to 1, the spindle rotates clockwise and stops.
- This signal is valid when the shortcut rotation command for spindle orientation stop position modification (NRROA) is set to 0.

(g) Spindle orientation external–type stop position command (SHA11 to SHA00)

- This signal is used to specify a stop position when the orientation function of external stop position setting type is used. A stop position is determined using the formula below. This command specifies an absolute position within one rotation.

  $$\text{Stop position (degrees)} = \frac{360}{4096} \times \sum_{i=0}^{11} (2^i \times P_i)$$

  Note that Pi = 0 when SHAi =0, and Pi = 1 when SHAi = 1.
- When a spindle orientation function of external stop position setting type is used, the parameter (parameter No. 4031 (FS16)) for setting a stop position in spindle orientation of position coder type is disabled.

(2) Output Signals (CNC to PMC)

(a) Signal addresses

First spindle control output signal

	FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
1st :	F281	F229	F405	ORARA	TLMA		LDTA	SARA	SDTA	SSTA	ALMA

Second spindle control output signals

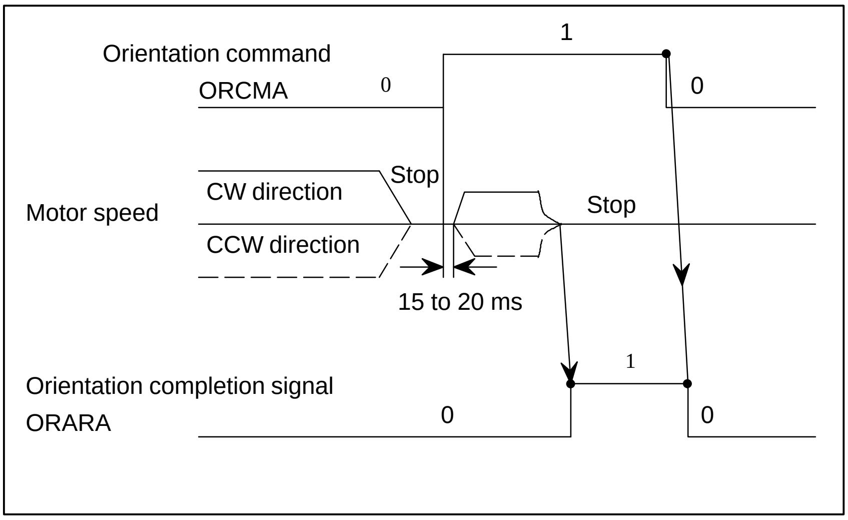
	FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
1st :	F285	F245	F049	ORARB	TLMB		LDTB	SARB	SDTB	SSTB	ALMB

(b) Orientation completion signal (ORARA)

- This signal is set to 1 when the spindle stops near a specified position (within $\pm 1°$, for example) after an orientation command is entered. ORARA is set to 1 when the following conditions are satisfied:
  – ORCMA = 1
  – Speed zero signal = 1
  – The spindle stops near a specified position.
  The third condition (near a specified position) is set using parameter No. 4075 (FS16) for orientation completion signal detection level specification. When all of the three conditions above are satisfied, the orientation completion signal is output. If the orientation completion signal is not issued despite sufficient time having elapsed after the input of an orientation command, an error is assumed. Ensure that such an error is detected with the power magnetics sequence, and that an orientation alarm is issued.
- Only after this signal is set to 1, start workpiece attachment or detachment.
- The orientation completion signal is output when the spindle is within about $\pm 1°$ of a specified position. This means that this signal does not represent a complete stop.
- When the spindle is displaced from a point near a specified position by an external force, this signal is set to 0.

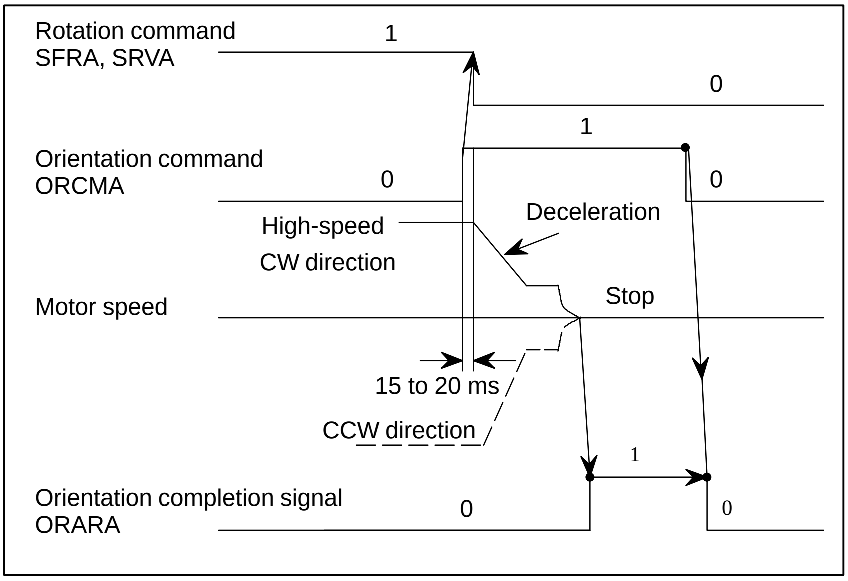
11.1.2.6 Sequence

(1) Orientation from Stop State

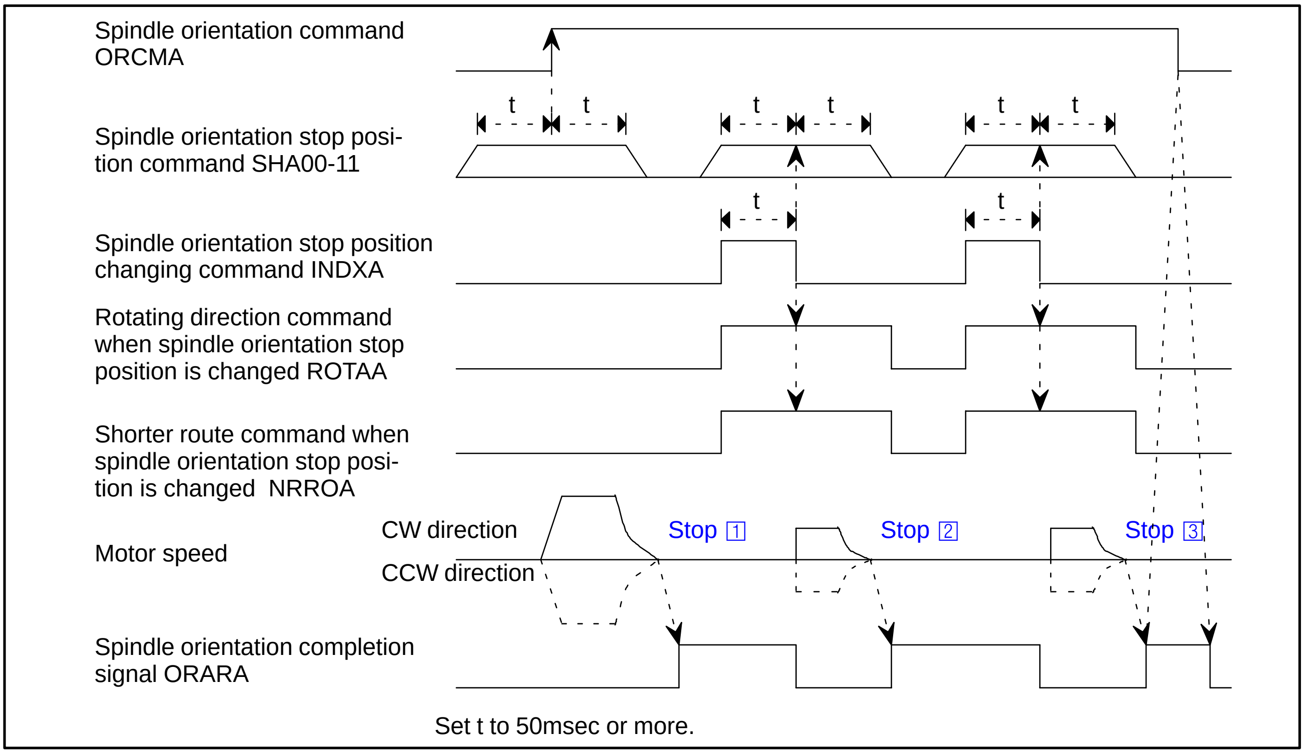


NOTE
The rotation direction of the spindle motor can be selected by parameter setting. The standard setting stops the spindle at a specified position after rotating the spindle in the same direction as that before the command signal for stopping the spindle at a specified position is issued.

(2) Orientation command during high–speed rotation



(3) Orientation of external stop position setting type



Stop 1

- Spindle stop at a specified position by a normal orientation command
- The rotation direction of the spindle motor is specified by parameter setting.
- After power–on, the spindle first stops at a specified position after rotating at the orientation speed and reading a one–rotation signal. After the first stop, the spindle turns within one rotation before stopping at a specified position.
- When an orientation function of external stop position setting type is used, the spindle stops at a specified position by shifting by the stop position data read on the rising edge of the spindle orientation command signal (ORCMA) if the data of the spindle orientation stop position command (SHA00–SHA11) is determined for a second and subsequent stop.

Stop 2 and 3

- The spindle stops at a specified position according to an orientation function of external stop position setting type.
- The rotation direction of the spindle motor depends on the rotation direction command for spindle orientation stop position modification (ROTAA) or the shortcut rotation command for spindle orientation stop position modification (NRROA).

NOTE
The spindle orientation stop position change command (INDXA) is enabled only when the spindle orientation command (ORCMA) is set to 1.

11.1.2.7 Parameter List

The table below lists the parameters used with an orientation function of position coder type. For details of the parameters, see the parameter manual.

Parameter No.					Description
FS0		FS15		FS16	
First spindle	Second spindle	First spindle	Second spindle		
Orientation function setting					
6515#0	6655#0	3015#0	3155#0	4015#0	Whether to use the spindle orientation function. (To be set to 1). (The CNC software option is required.)
0080 #2	0080 #3	5609 #2	5609 #3	3702 #3,#2	Whether to use the spindle orientation function of external stop position setting type. (#2: First spindle, #3: Second spindle)
Setting related to the position coder signal					
6501#2	6641#2	3001#2	3141#2	4001#2	Whether to use the position coder signal. (To be set to 1)
6500#2	6640#2	3000#2	3140#2	4000#2	Position coder mounting direction
6500#0	6640#0	3000#0	3140#0	4000#0	Spindle and motor rotation direction
6598	6738	3098	3238	4098	Position coder signal detection maximum speed
Gear ratio setting					
6556 to 6559	6696 to 6699	3056 to 3059	3196 to 3199	4056 to 4059	Gear ratio between the spindle and motor (to be selected with CTH1A and CTH2A)
Setting of a rotation direction at orientation time					
6503 #3,#2	6643 #3,#2	3003 #3,#2	3143 #3,#2	4003 #3,#2	Rotation direction at spindle orientation time
Setting of a stop position shift amount					
6531	6671	3031	3171	4031	Stop position in orientation of position coder type (This parameter is ignored for orientation of external stop position setting type.)
6577	6717	3077	3217	4077	Spindle orientation stop position shift amount
Setting related to gain at orientation time					
6560 to 6563	6700 to 6703	3060 to 3063	3200 to 3203	4060 to 4063	Position gain at orientation time (to be selected with CTH1A and CTH2A)
6542 6543	6682 6683	3042 3043	3182 3183	4042 4043	Velocity loop proportional gain at orientation time (to be selected with CTH1A)
6550 6551	6690 6691	3050 3051	3190 3191	4050 4051	Velocity loop integral gain at orientation time (to be selected with CTH2A)
6554	6694	3054	3194	4054	Velocity loop incomplete integral coefficient at orientation time
6579	6719	3079	3219	4079	Position gain broken line speed at orientation time
6584	6724	3084	3224	4084	Motor voltage setting at spindle orientation time
6592 to 6595	6732 to 6735	3092 to 3095	3232 to 3235	4092 to 4095	Orientation deceleration constant (to be selected with CTH1A/1B, CTH2A/2B).
Setting related to orientation speed					
6576	6716	3076	3216	4076	Motor speed limit ratio at spindle orientation time
6538	6678	3038	3178	4038	Spindle orientation speed

Parameter No.					Description
FS0		FS15		FS16	
First spindle	Second spindle	First spindle	Second spindle		
Setting related to the orientation completion signal					
6575	6715	3075	3215	4075	Spindle orientation completion signal detection level
Others					
6517#7	6657#7	3017#7	3157#7	4017#7	Shortcut rotation function for orientation from stop state

11.1.3 Spindle Orientation of Incremental Command Type (Spindle Speed Control)

11.1.3.1 Overview

The spindle orientation function of incremental command type is an extended function of the spindle orientation function of external stop position setting type based on a position coder.

This function moves the spindle to a position specified by an incremental command from the position where the spindle is placed when a spindle orientation command is entered. That is, from the position where the spindle is placed when a spindle orientation command is entered, the spindle rotates by the amount specified by an incremental command issued from the PMC through the CNC. Upon the completion of positioning, the completion signal is returned to the PMC through the CNC. This function enables the following:

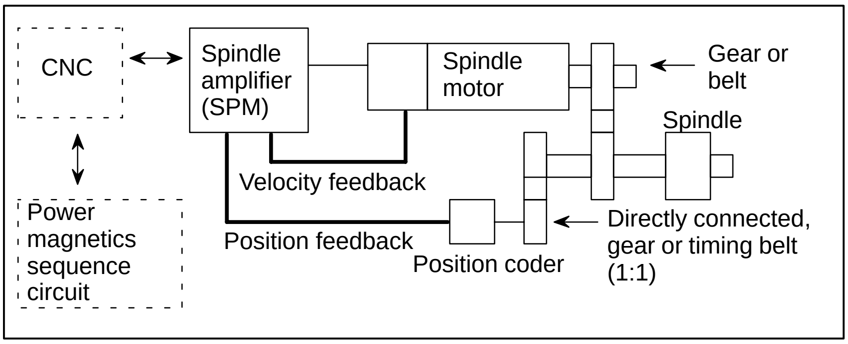
- Operations such as turret indexing using a spindle motor.
- The speed of the spindle can be controlled by setting the command multiplier (parameter setting value) to 4096.

NOTE
This function is not available with the αC series spindle.

11.1.3.2 System Configurations

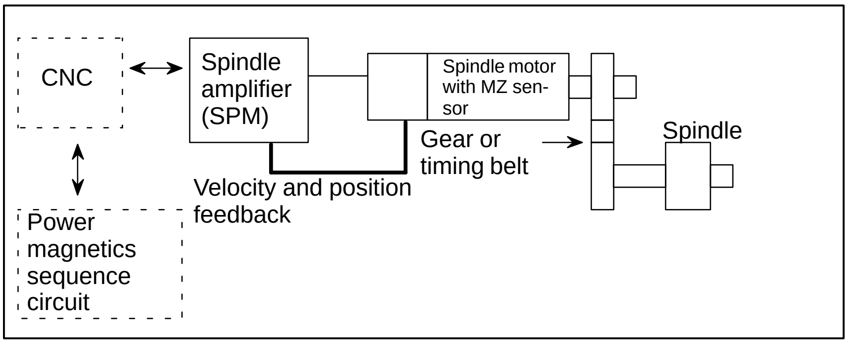
The spindle orientation function with the incremental command set externally can be executed in the following system configurations:

- **System in which the position coder is linked to the spindle**

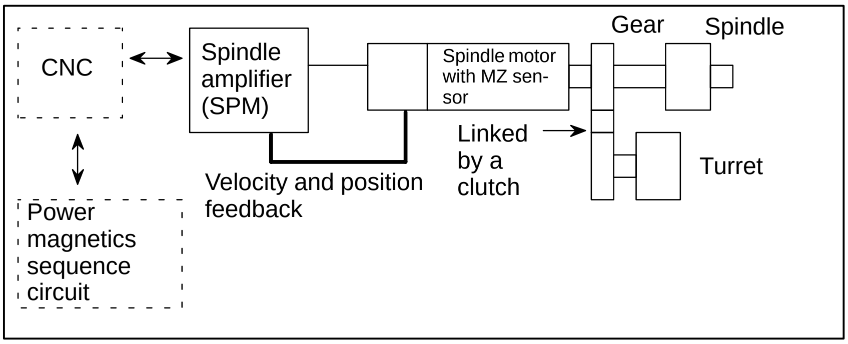


- **Motor system built into the spindle**

- **System in which the spindle and the motor having a MZ sensor are linked by a gear or timing belt**



- **System in which the turret and the motor having a MZ sensor are linked by gears and clutches (for turret positioning)**



11.1.3.3 Signals

(1) Input Signals (PMC to CNC)

(a) Signal address

First spindle control input signal

	FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
:	G229	G227	G070	MRDYA	ORCMA	SFRA	SRVA	CTH1A	CTH2A	TLMHA	TLMLA
:	G231	G229	G072	RCHHGA	MFNHGA	INCMDA	OVRA	DEFMDA	NRROA	ROTAA	INDXA
:	G110	G231	G078	SHA07	SHA06	SHA05	SHA04	SHA03	SHA02	SHA01	SHA00
:	G111	G230	G079					SHA11	SHA10	SHA09	SHA08

Second spindle control input signals

	FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
:	G223	G235	G074	MRDYB	ORCMB	SFRB	SRVB	CTH1B	CTH2B	TLMHB	TLMLB
:	G235	G237	G076	RCHHGB	MFNHGB	INCMDB	OVRB	DEFMDB	NRROB	ROTAB	INDXB
:	G112	G239	G080	SHB07	SHB06	SHB05	SHB04	SHB03	SHB02	SHB01	SHB00
:	G113	G238	G081					SHB11	SHB10	SHB09	SHB08

(b) Orientation command signal (ORCMA)

A spindle orientation function of external incremental command setting type is enabled during spindle orientation.

1: Performs orientation.

(c) Clutch/gear signals (CTH1A, CTH2A)

These signals are used to select a spindle control parameter (position gain, gear ratio, velocity loop gain) that matches a selected clutch/gear. Names such as High Gear are assigned only for convenience.

CTH1A	CTH2A	Gear/clutch state	
0	0	High Gear	(High)
0	1	Medium High Gear	(High)
1	0	Medium Low Gear	(Low)
1	1	Low Gear	(Low)

(d) Incremental command data selection signal (INCMDA)

This signal is used to determine whether externally set data (SHA00–SHA11) is used as stop position data or incremental command data.

0: Uses SHA00–SHA11 as stop position data.

1: Uses SHA00–SHA11 as incremental command data.

(e) Shortcut rotation command (NRROA)

When stop position data is selected (INCMDA = 0) for stop position modification, this signal rotates the spindle in the shortcut direction to the target position. This signal is invalid when INCMDA = 1.

0:Rotates the spindle in the direction based on the parameter setting (bits 2 and 3 of parameter No. 4003 (FS16) and ROTAA state.

1:Rotates the spindle in the shortcut direction.

(f) Rotation direction command signal (ROTAA)

This signal is used to specify the direction in which the spindle is rotated from the stop state to another stop position.

0: Rotates the spindle counterclockwise.
1: Rotates the spindle clockwise.

(g) Stop position change command signal (INDXA)

This signal is used to change the stop position. On the rising edge of this signal, INCMDA, ROTAA, and stop position (incremental command) data are read.

1 → 0: Stop position change command

(h) Incremental command data (stop position data) (SHA11 to SHA00)

These signals (12 bits) are used to specify incremental command data or stop position data. INCMDA determines which data to use. A command of 0 to +4095 pulses can be entered.

(2) Output Signals (CNC to PMC)

(a) Signal addresses

First spindle control output signal

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
: F281	F229	F405	ORARA	TLMA	LDT2A	LDTA	SARA	SDTA	SSTA	ALMA
: F283	F221	F047				EXOFA	SORENA	MSOVRA	INCSTA	PC1DTA

Second spindle control output signals

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
: F285	F245	F049	ORARB	TLMB	LDT2B	LDT1B	SARB	SDTB	SSTB	ALMB
: F287	F247	F051				EXOFB	SORENB	MSOVRB	INCSTB	PC1DTB

(b) Orientation completion signal (ORARA)

This signal is used to indicate the orientation completion state. This signal is output when the following three conditions are satisfied:

a. The spindle is near a specified stop position (in–position) (parameter No. 4075 (FS16).
b. The spindle is being oriented (ORCMA = 1).
c. The spindle is in the speed zero state (SSTA = 1).

(c) Incremental command mode state signal (INCSTA)

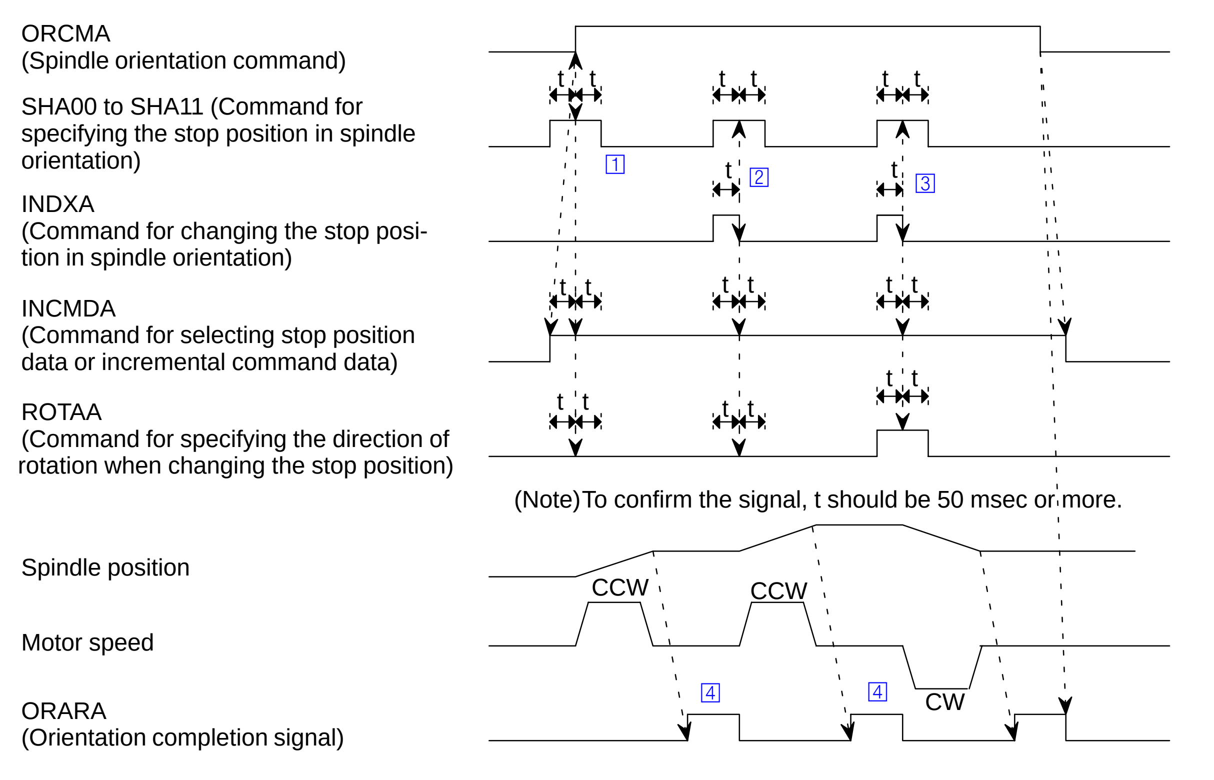
This signal is used to indicate the state of INCMDA (incremental command data selection signal).

1: INCMDA = 0
0: INCMDA = 1

11.1.3.4

Control Sequence

(1) Incremental Action



Notes

Set t to 50 ms or more. The signals require this time period to stabilize.

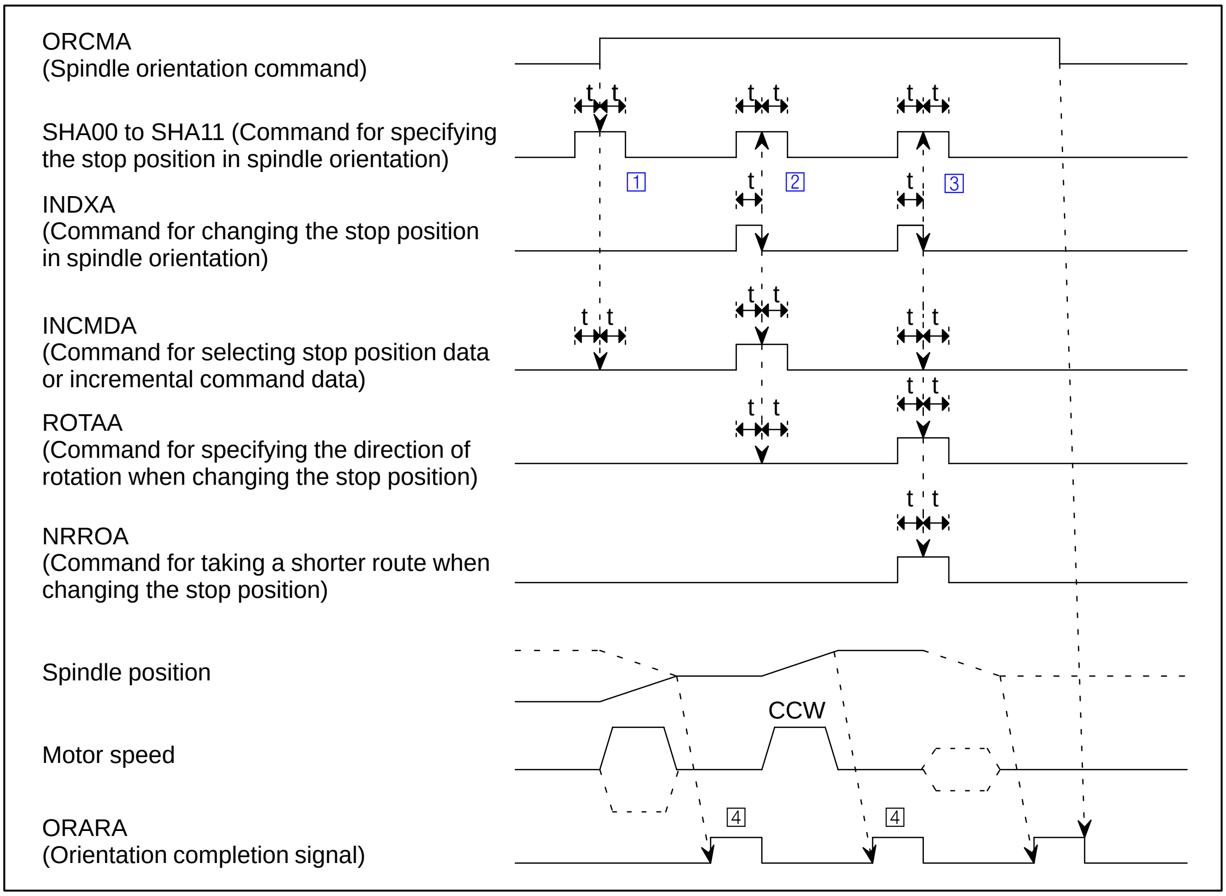
1 If the rising edge of ORCM is detected when the spindle stops (zero speed detection signal SSTA is set to 1) and INCMDA is set to 1, the data of SHA00 to SHA11 is read as incremental command data. The spindle starts rotating as specified by the incremental command and stops. ROTAA determines the direction of rotation.

2 Another incremental action can then be executed. If the falling edge of INDXA is detected when both ORCM and INCMDA are set to 1, the data of SHA00 to SHA11 is read as incremental command data. The spindle starts rotating as specified by the incremental command and stops. ROTAA determines the direction of rotation.

3 The incremental command data is specified in units of pulses. The data range is 0 to +4095 pulses. ROTAA determines the direction of rotation. When a command multiplication parameter (Series 16: PRM4328) is specified, the spindle stops rotating after reaching the value obtained by the following expression: [Command multiplication parameter] × [Incremental command data]. During incremental motion, the parameter indicating the direction of rotation, NRROA (Series 16: PRM4003, bits 2 and 3), is invalid.

4 When the position error comes within the range specified by the parameter (Series 16: PRM4075), ORARA is output.

(2) When Spindle Orientation and Incremental Motion are both Executed



1 Stopping the spindle in place using the usual orientation command

◇ In the first orientation after the power is turned on, the spindle rotates at the orientation speed. After a one rotation signal is detected, the spindle stops in place. In the second and subsequent orientations, the spindle stops in place within rotation

◇ The parameter specifying the direction of rotation (Series 16: PRM4003, bits 2 and 3) applies to the spindle motor.

◇ If the rising edge of ORCMA is detected when INCMDA is set to 0, the data of SHA00 to SHA11 is read as stop position data. The spindle stops after shifting by the distance obtained by the following expression: [Value of SHA00 to SHA11] + [Parameter of shift distance of the stop position in orientation (Series 16: PRM4077)]

2 Stopping the spindle in place by an incremental command

◇ For incremental motion, see item " Incremental action" above.

◇ When the command multiplication parameter (Series 16: PRM4328) is set to 4096, the spindle rotation can be controlled.

3 Stopping the spindle in place by setting the stop position externally

◇ If the falling edge of INDXA is detected when ORCMA is set to 1 and INCMDA is set to 0, the data of SHA00 to SHA11 is read as stop position command data. The spindle rotates and stops at the specified position.

◇ NRROA and ROTAA determine the direction of rotation. When NRROA is set to 1, the spindle rotates from the current stop position to the specified stop position by taking the shorter route (within ±180°). When NRROA is set to 0, ROTAA determines the direction of rotation.

11.1.3.5 Parameters

The following parameters are added when the function for externally setting incremental commands is used for position coder method spindle orientation Refer to the Parameter Manual and each CNC manual for details.

Parameter No.			Description
FS0	FS15	FS16	
0080 #3, 2	5609 #3, 2	3702 #3, 2	Whether the function for externally setting incremental commands is used (#2: First spindle, #3: Second spindle)
6292	3472	4328	Command multiplication for data for externally setting incremental commands

11.1.4 Spindle Orientation by External One Rotation Signal

11.1.4.1 General

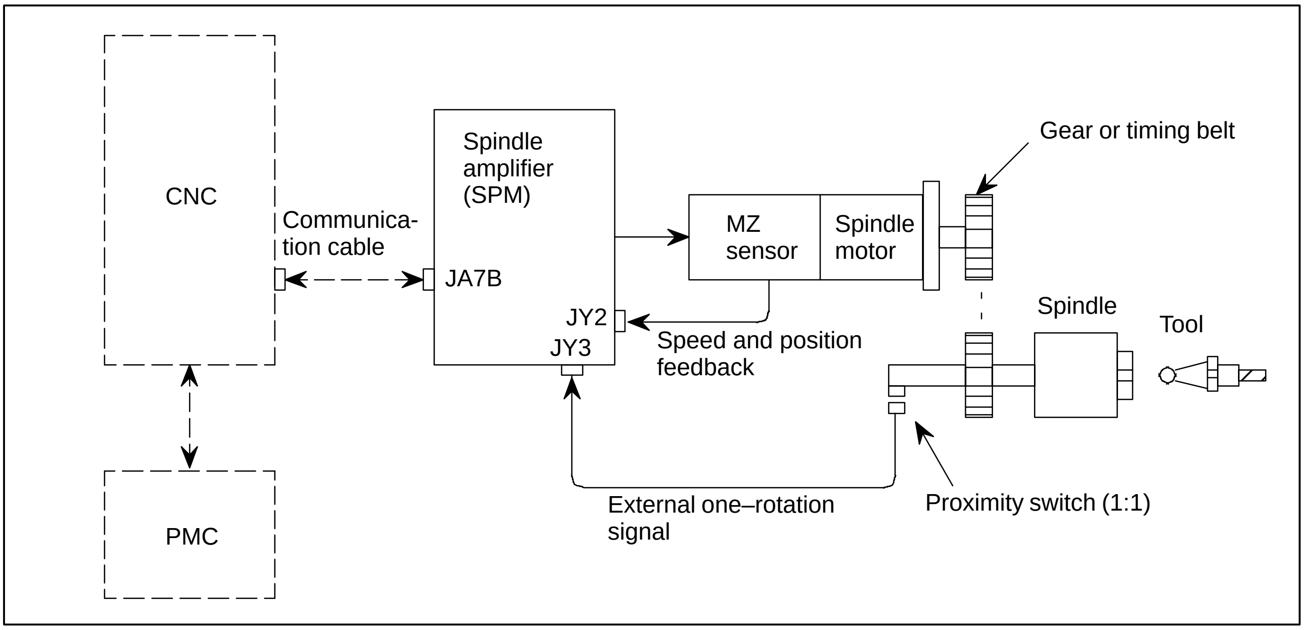
This section describes a spindle orientation function. This function is implemented in a system consisting of an external one–rotation signal switch (proximity switch) mounted on the spindle, and a spindle motor having a built–in sensor and connected to the spindle with an arbitrary gear ratio.

This function is similar to the position coder–based spindle orientation function except for the items listed below.

1) A fixed orientation must be specified by setting 1 in bit 3 of parameter No. 4003.
2) The detection of a one–rotation signal begins after the orientation speed is reached.

NOTE
1 See Section 11.1.1 for descriptions about anything other than external one–rotation signal handling (position coder – based spindle orientation).
2 The αC series does not support this function.

11.1.4.2 System Configuration



11.1.4.3 Specifications

(1) Positioning repeatability

When the spindle is connected to the spindle motor with an arbitrary gear ratio of m:n, the positioning repeatability is calculated as follows:

(χ = factor used to determine positioning repeatability)
(spindle–to–motor rotation ratio = m:n)

$$\chi = \frac{1024}{\text{(number of feedback pulses per motor rotation}} \times \frac{m}{n}$$

(where χ is rounded up to the nearest integer.)
Positioning repeatability = $\pm(\chi \times 0.2)$ [°]

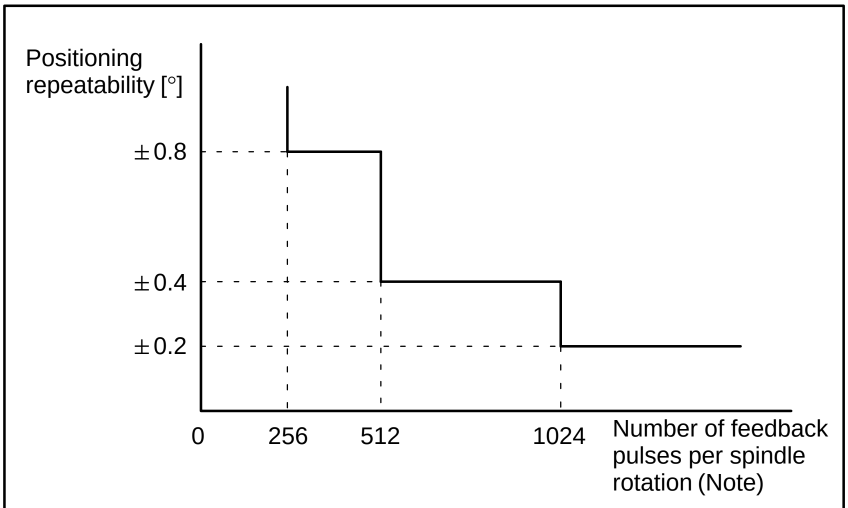
(Reference)

The table below lists the relationships between the number of detected gear teeth per rotation and the number of feedback pulses per motor rotation.

Number of detected gear teeth per rotation	Number of feedback pulses per motor rotation
512 teeth	1024
256 teeth	
128 teeth	512
64 teeth	

NOTE
These values exclude influence by the machine and the external one–rotation signal switch.

(Reference)



NOTE
number of feedback pulses per spindle rotation = number of feedback pulses per motor rotation $\times \frac{n}{m}$

Example of calculation

(1) Number of feedback pulses per motor rotation = 1024

Spindle–to–motor speed ratio (m/n) = 1:3 (speed reduction)

$\chi=\frac{1024}{1024} \times \frac{1}{3} = 0.3$

Thus, χ is rounded up to 1.

Hence, positioning repeatability = $\pm$(1 x 0.2) = $\pm$0.2°

(2) Number of feedback pulses per motor rotation = 512

Spindle–to–motor speed ratio (m/n) = 2:1 (speed up)

$\chi=\frac{1024}{512} \times \frac{2}{1} = 4$

Thus, χ = 4

Hence, positioning repeatability = $\pm$(4 x 0.2) = $\pm$0.8°

(3) Number of feedback pulses per motor rotation = 512

Spindle–to–motor speed ratio (m/n) = 1:2 (speed reduction)

$\chi= \frac{1024}{512} \times \frac{1}{2} = 1$

Thus, χ = 1

Hence, positioning repeatability = $\pm$(1 x 0.2) = $\pm$0.2°

(4) Number of feedback pulses per motor rotation = 512

Spindle–to–motor speed ratio (m/n) = 1:1

$\chi= \frac{1024}{512} \times \frac{1}{1} = 2$

Thus, χ = 2

Hence, positioning repeatability = $\pm$(2 x 0.2) = $\pm$0.4°

11.1.4.4 Signals

(1) Input Signals (PMC to CNC)

(a) Signal address

First spindle control input signal

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
: G229	G227	G070	MRDYA	ORCMA	SFRA	SRVA	CTH1A	CTH2A	TLMHA	TLMLA
: G110	G231	G078	SHA07	SHA06	SHA05	SHA04	SHA03	SHA02	SHA01	SHA00
: G111	G230	G079					SHA11	SHA10	SHA09	SHA08

Second spindle control input signals

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
: G223	G235	G074	MRDYB	ORCMB	SFRB	SRVB	CTH1B	CTH2B	TLMHB	TLMLB
: G112	G239	G080	SHB07	SHB06	SHB05	SHB04	SHB03	SHB02	SHB01	SHB00
: G113	G238	G081					SHB11	SHB10	SHB09	SHB08

(b) Spindle orientation command (ORCMA)

1: Performs spindle orientation.

(c) Clutch/gear signals (CTH1A, CTH2A)

These signals are used to select a spindle parameter (position gain, velocity loop gain, and so forth). Names such as High gear are assigned only for convenience.

CTH1A	CTH2A	Gear/clutch state	
0	0	High Gear	(High)
0	1	Medium High Gear	(High)
1	0	Medium Low Gear	(Low)
1	1	Low Gear	(Low)

(d) Stop position data (SHA11 to SHA00)

These signals are used to specify stop position data when the spindle is oriented with a spindle orientation function of external stop position type. Stop position data is read on the rising edge of ORCMA.

(2) Output Signals (CNC to PMC)

(a) Signal addresses

First spindle control output signal

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
: F281	F229	F405	ORARA	TLMA	LDT2A	LDT1A	SARA	SDTA	SSTA	ALMA

Second spindle control output signals

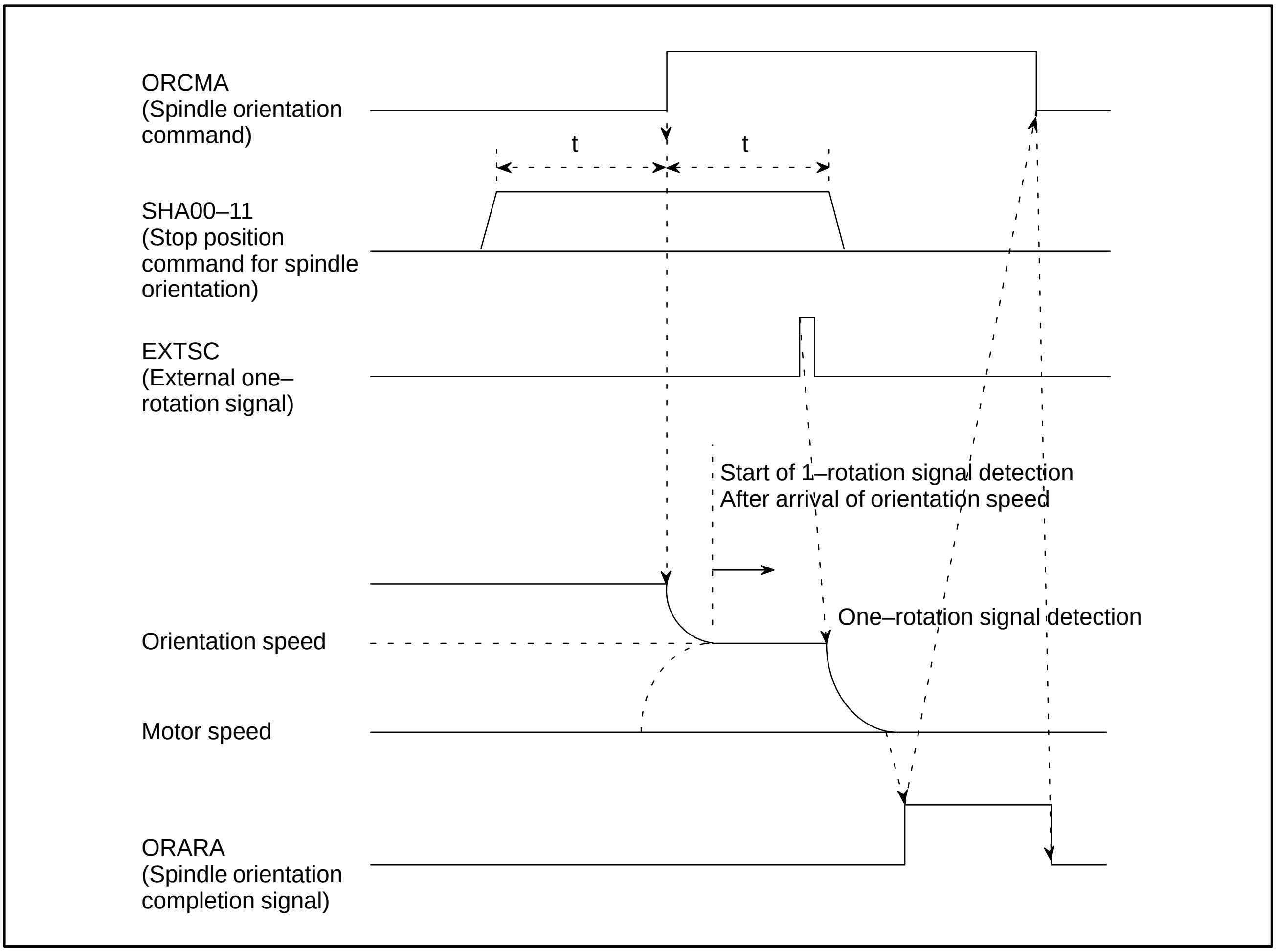
FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
: F285	F245	F049	ORARB	TLMB	LDT2B	LDT1B	SARB	SDTB	SSTB	ALMB

(b) Spindle orientation completion signal (ORARA)

This signal is used to indicate the spindle orientation completion state. This signal is set to 1 when the following three conditions are satisfied:

a. The spindle is being oriented (ORCMA = 1).
b. The spindle is in the speed zero state (SSTA = 1).
c. The spindle is near a specified stop position (in–position).

11.1.4.5 Control Sequence



> **NOTE**
> To confirm the signal, t should be 50 msec or more.

(1) Orientation function

- To detect a one–rotation signal securely, it is necessary to fix the orientation (by setting bit 3 andt 2 of parameter No. 4003 to 1, 0 or 1, 1; see descriptions about parameter setting).
- After the orientation of the spindle is fixed and the orientation speed is reached, a one–rotation signal is detected to cause the spindle to stop at a position determined by the following stop position data (Series16:4077).

  Stop position data is (parameter No. 4031 + 4077)

  Case of external stop position setting type, Stop position data is (SHA00–11 + 4077)
- The orientation resolution of the spindle is 1/4096 rev (4096p/rev).
- If the stop position data (No. 4031 + No. 4077) or (SHA00–11 + No. 4077) is 0, the spindle stops at the edge of the output signal from the one–rotation signal switch.

11.1.4.6 Parameters List

The table blow lists the parameters used with the spindle orientation function based on the external one–rotation signal. For details of the parameters, see the parameter manual.

Parameter No.			Description
FS0	FS15	FS16	
Orientation function setting			
6515#0	3015#0	4015#0	Whether spindle orientation is used (Set to 1.) (CNC software option is necessary.)
0080 #3,#2	5609 #3,#2	3702 #3,#2	Whether to use the spindle orientation function of external stop position setting type. (#2: First spindle, #3: Second spindle)
Setting related to the position coder signal			
6501#2	3001#2	4001#2	Whether a position coder signal is used (Set to 1.)
6500#2	3000#2	4000#2	Mounting orientation for the position coder
6500#0	3000#0	4000#0	Rotational direction of the spindle and motor
6503#0	3003#0	4003#0	Selection of position coder method or magnetic sensor method spindle orientation (0 for a position coder method)
6503 #7, 6, 4	3003 #7, 6, 4	4003# 7, 6, 4	Setting of the position coder signal
6513#0	3013#0	4013#0	Setting of a position coder one–rotation signal detection edge. (To be set to 1)
6517#2	3017#2	4017#2	Position coder one–rotation signal detection function in normal rotation. (To be set to 0)
6598	3098	4098	Position coder signal detection maximum speed
Setting related to the external one–rotation signal			
6504#3	3004#3	4004#3	Setting of reverse/nonreverse rotation of the external one–rotation signal
6504#2	3004#2	4004#2	Whether to use the external one–rotation signal. (To be set to 1)
6509#3	3009#3	4009#3	Setting of orientation based on the external one–rotation signal. (To be set to 1)
Gear ratio setting			
6556 to 6559	3056 to 3059	4056 to 4059	Gear ratio between the spindle and motor (selected by DI signals CTH1A and CTH2A)
Setting of an arbitrary gear ratio between the spindle and position coder			
6935 6937	3315 3317	4171 4173	Number of gear teeth on the spindle side. (A parameter is selected with input signal CTH1A).
6936 6938	3316 3318	4172 4174	Number of gear teeth on the position detector side. (A parameter is selected with input signal CTH1A.)
Setting of a rotation direction at orientation time			
6503 #3, #2	3003 #3, #2	4003 #3, #2	Rotation direction at orientation time
Setting of a stop position shift amount			

11.1.4.7 Specification of the External One–rotation Signal Switch

The external one–rotation signal switch (proximity switch) should satisfy the following conditions.

(1) Two–wire DC proximity switch

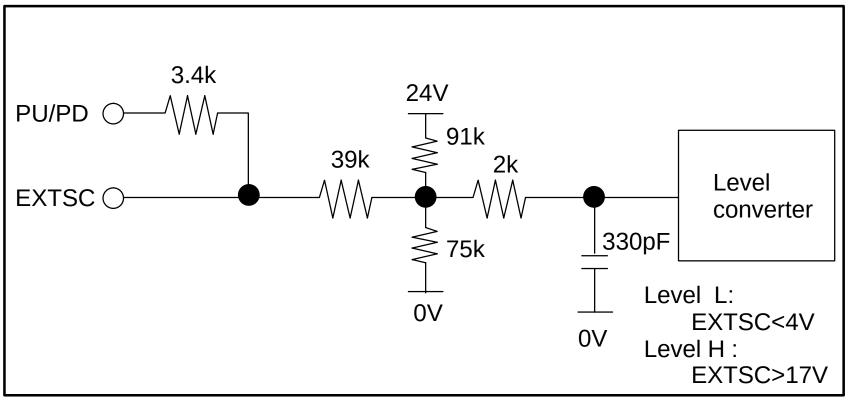
NOTE
The proximity switch depends on the temperature. So, when selecting an proximity switch, consider the ambient temperature.

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

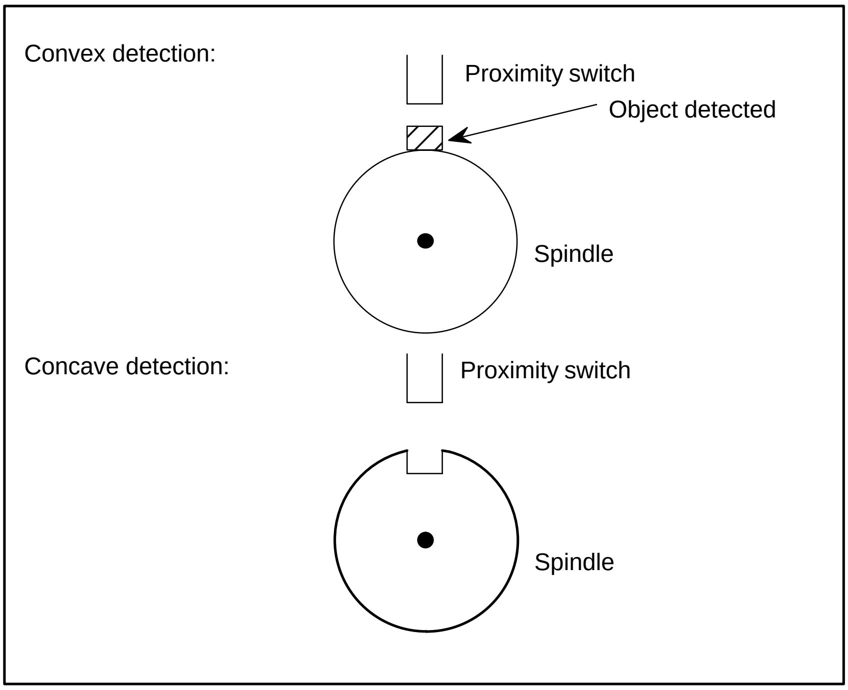
(2) Three–wire DC proximity switch

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

(3) Receiver circuit



Proximity switch	**Detection method**	**Proximity switch type**		**PU/PD pin of connector JY3**	**Parameters** **Bit 3 of parameter No. 4004 (FS16)** **Bit 3 of parameter No. 3004 (FS15)** **Bit 3 of parameter No. 6504 (FS0)**
Two–wire type	Convex detection	Normally open		Connected to 24V	0
		Normally closed			
	Concave detection	Normally open			
		Normally closed			
Three–wire type	Convex detection	Normally open	NPN	Connected to 24V	0
			PNP	Connected to 0V	1
		Normally closed	NPN	Connected to 24V	1
			PNP	Connected to 0V	0
	Concave detection	Normally open	NPN	Connected to 24V	0
			PNP	Connected to 0V	1
		Normally closed	NPN	Connected to 24V	1
			PNP	Connected to 0V	0



11.1.4.8 Notes

(1) Ensure that the spindle orientation command (ORCMA) is set to 0 when the power is turned on.

(2) For safety, set the forward/reverse rotation command (SFRA/SRVA) and speed command to 0 when performing spindle orientation.

(3) When an emergency stop is initiated during spindle orientation, reset the spindle orientation command (ORCMA) to 0.

(4) The precision of the edge of the signal output from the external one–rotation signal switch (proximity switch) affects the positional accuracy. So, use an external one–rotation signal switch (proximity switch) that has a stable edge.

(5) The position at which the signal is output from the external one–rotation signal switch (proximity switch) depends on the temperature. So, when selecting an external one–rotation signal switch (proximity switch), consider the ambient temperature.

11.1.5 Magnetic Sensor Method Spindle Orientation

11.1.5.1 General

Unlike conventional mechanical spindle orientation using a stopper, etc., the spindle orientation stops the spindle at a fixed position by directly feeding back position signals from the magnetic sensor directly connected to the machine spindle.

NOTE
This function is not available for αC sereis.

11.1.5.2 Features

Mechanical parts are not required.

This orientation is accomplished simply by connecting the magnetic sensor to the spindle without any need of mechanical orientation mechanism (stopper, pin, etc.) for spindle orientation.

Reduction of orientation time

Since the spindle motor connected to the spindle is utilized and the orientation can be performed directly from high-speed rotation, irrespective of gear shift, the orientation time is largely reduced.

Simplified power magnetic sequence control

This sequence consists of the spindle orientation command, its completion signal, clutch/gear speed signal only without any need of other signals. Neither orientation speed command sequence nor torque limit command sequence is needed.

High reliability

Electrical system assures improved reliability without any damage to the mechanical section against an external impact.

High accuracy and rigidity

The spindle orientation accuracy and rigidity are enough to execute automatic tool change (ATC).

Positioning of workpiece

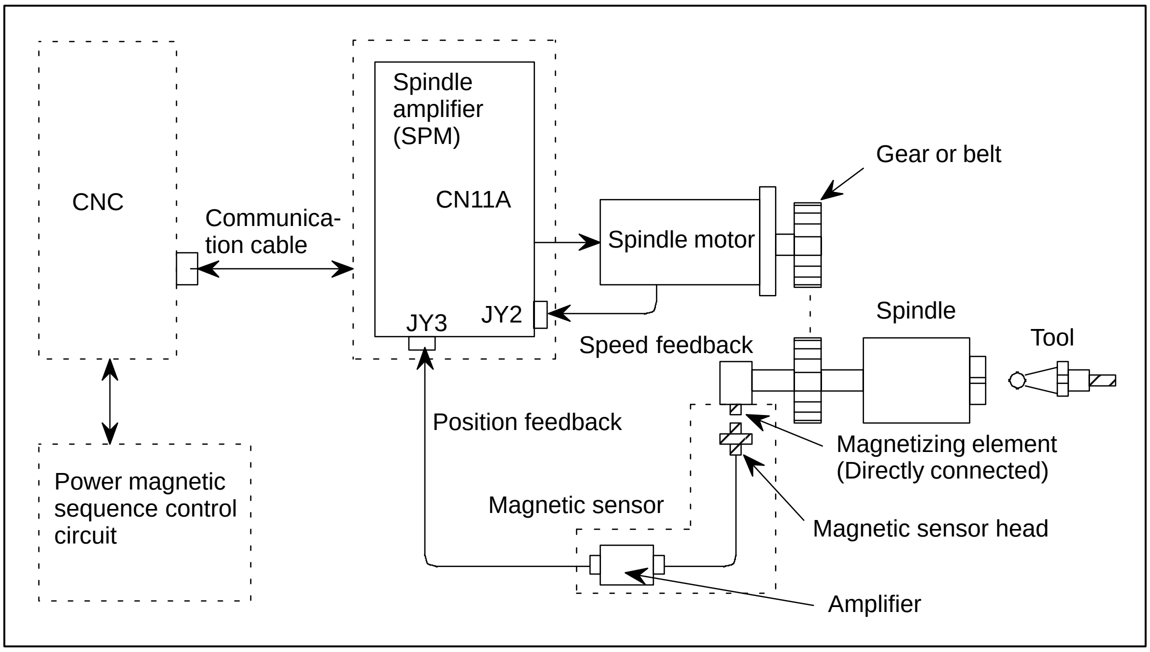
Workpieces can be positioned to arrange their loading and unloading directions in lathe.

Reduction of the number of processes in boring

Since the spindle orientation can be done in the same direction as the rotating direction of the spindle when boring ends, workpieces will not be damaged by tool blades.
Since these tool blades can be mounted or dismounted in a fixed direction with reference to the workpieces, programming is easy.

11.1.5.3 Configuration and Order Drawing Number

Configuration



11.1.5.4 Specifications

No.	Item	Description
1	Magnetic sensor	Refer to item 12.3.2.
2	Stop position	Stops when the center of the sensor head faces the center of the magnetizing element or the stop position check scale of the magnetizing element. The stop position can be adjusted to within $\pm 1°$ by the circuit.
3	Repeatability	$\pm 0.2°$ or less. Excluding factors such as errors from the machine side, for example, setting errors.
4	Max. hold torque at orientation	Continuous rated torque of the AC spindle motor.
5	Range where spindle can be orientated	Orientation stop position $\pm 240°$

11.1.5.5 Signal Explanation

(1) DI SIGNALS (PMC to CNC)

(a) Spindle control signals

First spindle control input signal

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
: G229	G227	G070	MRDYA	ORCMA	SFRA	SRVA	CTH1A	CTH2A	TLMHA	TLMLA

Second spindle control input signal

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
: G223	G235	G074	MRDYB	ORCMB	SFRB	SRVB	CTH1B	CTH2B	TLMHB	TLMLB

(b) Orientation (fixed position stop) command (ORCMA)

- This command signal is used to stop spindle movement at the preset position to allow tool change and workpiece loading/unloading.
- When this signal is specified as ”1” while the spindle is rotating, the rotation decelerates immediately and the spindle stops at the preset position.
- When the orientation command is issued, set the spindle forward/reverse rotation command (SFRA, SRVA) to ”0” for safety. By means of this, the spindle will not start to rotate even in the unlikely event ORCMA becomes ”0” during tool change.
- Set this signal to ”0” by the tool change completion signal or workpiece loading/unloading completion signal.
- Always set the orientation command signal to ”0” when turning on power.

- When an emergency stop occurs during orientation, the orientation command signal must be reset (”0”).
  Return the ATC arm to the safe position so that it will not be damaged if the spindle or tool rotates when the power is turned on.

(c) Clutch/gear signals (CTH1A, CTH2A)

- When there are two or more speed change gear stages between the spindle and spindle motor, these signals are used to select a spindle control parameter (position gain, gear ratio, velocity loop gain).
- Depending on the clutch or gear state, make settings according to the table below. Names such as HIGH GEAR are assigned only for convenience. Arbitrary names may be assigned to the actual gears.

CTH1A	CTH2A		
0	0	:	HIGH GEAR
0	1	:	MEDIUM HIGH GEAR
1	0	:	MEDIUM LOW GEAR
1	1	:	LOW GEAR

(2) DO Signals (CNC to PMC)

(a) Spindle control signals

First spindle control output signal

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
F281	F229	F405	ORARA	TLMA	LDT2A	LDT1A	SARA	SDTA	SSTA	ALMA

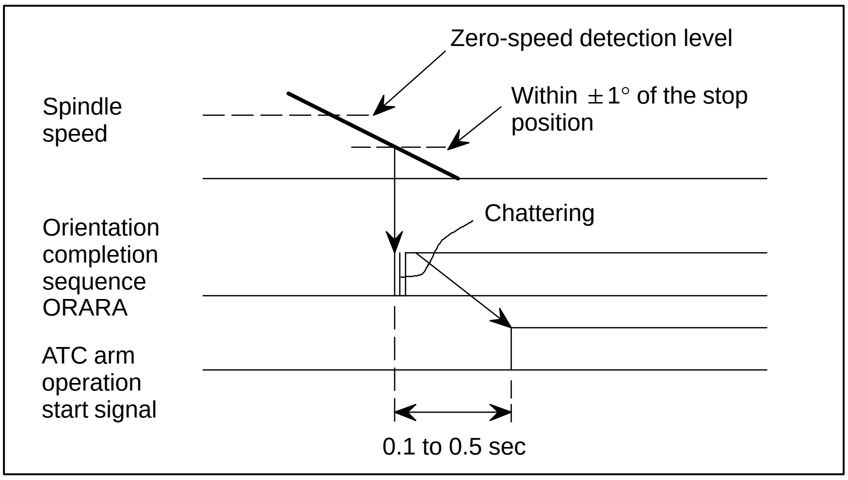
Second spindle control output signals

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
F285	F245	F049	ORARB	TLMB	LDT2B	LDT1B	SARB	SDTB	SSTB	ALMB

(b) Orientation (fixed position stop) completion signal (ORARA)

- When the orientation command is input and the spindle has stopped near the preset fixed position (for example, within ±1°), it becomes ”1”.
  Condition for ORARA to become ”1”
  Near to fixed position is set to the parameter.
  If the above 3 conditions are satisfied, the orientation complete signal is output.
  If the orientation completion signal is not issued within a set period of time after the orientation command signal is input, it is considered to be abnormal. So it should be detected by the power magnetic sequence and an orientation alarm should be issued.
  Set the condition for judging that the spindle is near the fixed position in the parameter used to specify the detection level for orientation completion.
- Tool change or workpiece loading /unloading operations can be started when this signal is ”1”.

- The spindle orientation completion signal is issued when the spindle is within $\pm 1^\circ$ of the preset position and so it does not always indicate that the spindle has stopped completely. Some machines allow a very short operation time for the ATC arm to grip the tool. In this case, start the ATC arm operation after a short time (0.1 to 0.5 sec.) so that the arm will grip the tool when the spindle has stopped completely.



- This signal will become ”0” during a tool change if the spindle is pushed away from the preset position by external force.

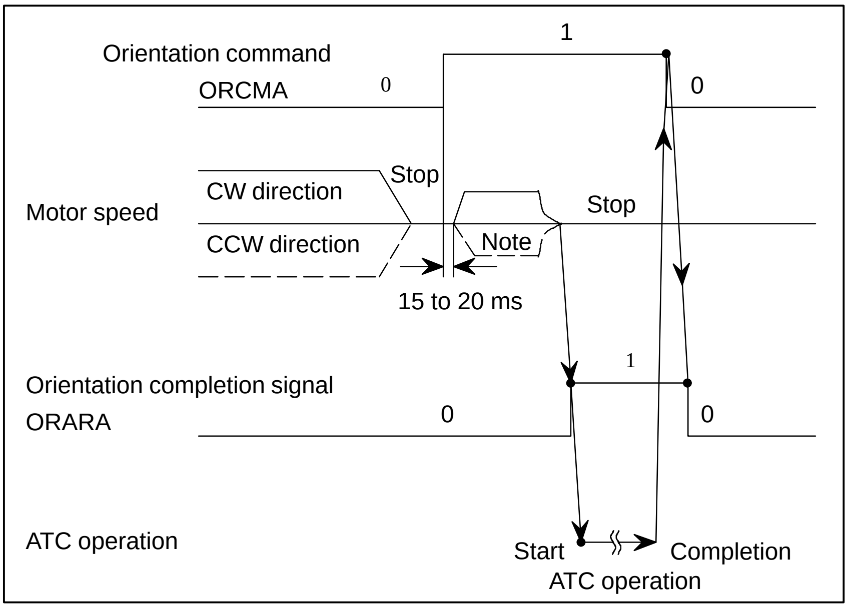
  In this case, design a power magnetic sequence so that the tool change operation is interrupted.

  However, do not release the orientation command, and if the orientation completion signal is issued again, perform a tool change.

- If the automatic tool change (ATC) structure is such that it may cause serious damage if a malfunction occurs, install a proximity switch to generate a verification signal when the ATC enters an area in which the automatic tool change operation can be performed. In addition to this, perform a double safety check by the power magnetic sequence and carry out a tool change.

11.1.5.6 Sequences

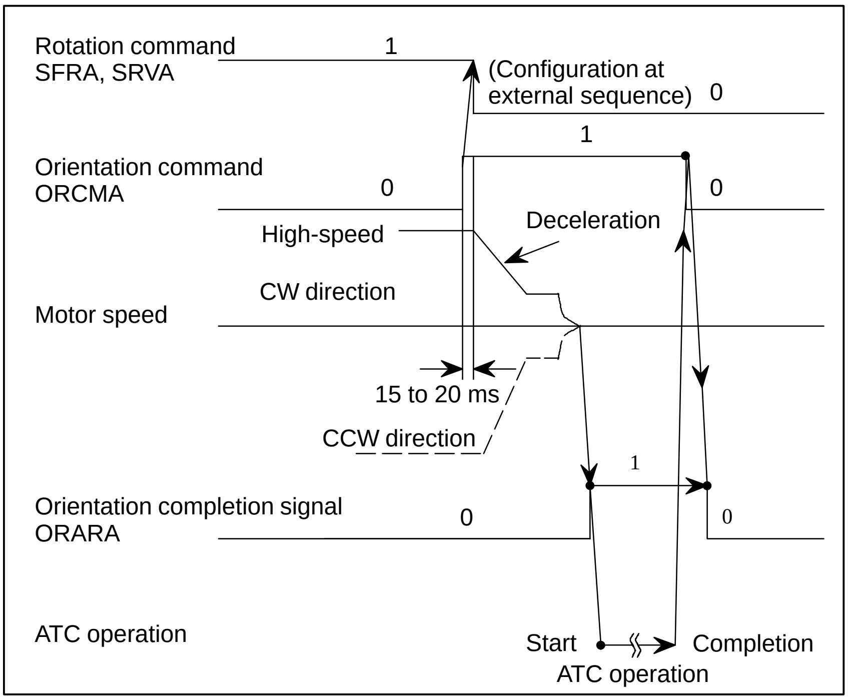
(1) Orientation Command while Stopping



NOTE

The spindle motor rotation direction can be changed by setting. In standard setting, the spindle motor will stop at the fixed position in the direction the spindle motor was rotating before this orientation command signal was generated.

(2) Orientation Command During High-speed Rotation



11.1.5.7 Parameters

The table below lists the parameters related to spindle orientation using a magnetic sensor. Refer to the Parameter Manual for details.

Parameter No.			Description
FS0	FS15	FS16	
Orientation function setting			
6515#0	3015#0	4015#0	Whether spindle orientation is used (Set to 1.) (CNC software option is necessary.)
Setting related to the magnetic sensor signal			
6501#3	3001#3	4001#3	Mounting orientation for the magnetic sensor
6500#0	3000#0	4000#0	Rotational direction of the spindle and motor
6503#0	3003#0	4003#0	Selection of a position coder method magnetic sensor method spindle orientation (1 for a magnetic sensor method)
6578	3078	4078	MS signal constant
6579	3079	4079	MS signal gain adjustment
Gear ratio setting			
6556 to 6559	3056 to 3059	4056 to 4059	Gear ratio between the spindle and motor (selected by DI signals CTH1A and CTH2A)
Setting of a rotation direction at orientation time			
6503 #3, 2	3003 #3, 2	4003 #3, 2	Rotational direction for spindle orientation
Setting of a stop position shift amount			
6577	3077	4077	Shift of spindle orientation stop position
Setting related to gain at orientation time			
6560 to 6563	3060 to 3063	4060 to 4063	Position gain for orientation (selected by DI signals CTH1A and CTH2A)
6542 6543	3042 3043	4042 4043	Velocity loop proportional gain for orientation (selected by DI signal CTH1A)
6550 6551	3050 3051	4050 4051	Velocity loop integral gain for orientation (selected by DI signal CTH1A)
6564	3064	4064	Change rate for the position gain after spindle orientation
6584	3084	4084	Motor voltage for spindle orientation
Setting related to orientation speed			
6576	3076	4076	Motor speed regulation rate for spindle orientation
Setting related to the orientation completion signal			
6575	3075	4075	Detection level for the spindle orientation completion signal

11.2 RIGID TAPPING

11.2.1 Overview

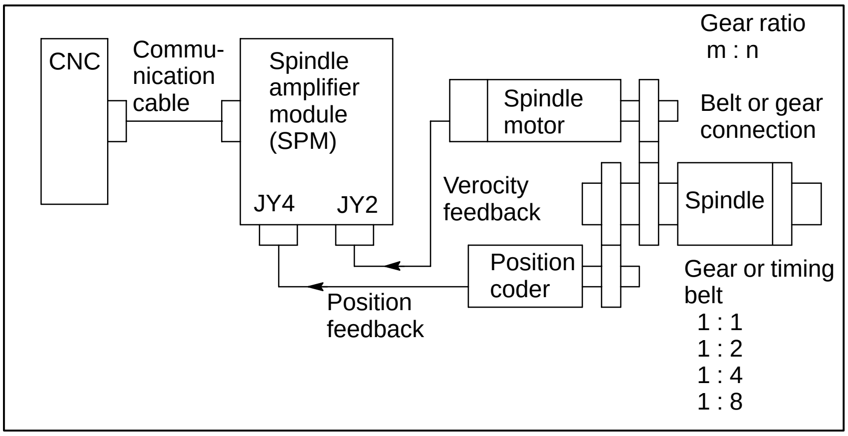
Rigid tapping is a function for tapping based on synchronous control over spindle and tapping axis operation.

This section describes the rigid tapping function associated with the spindle.

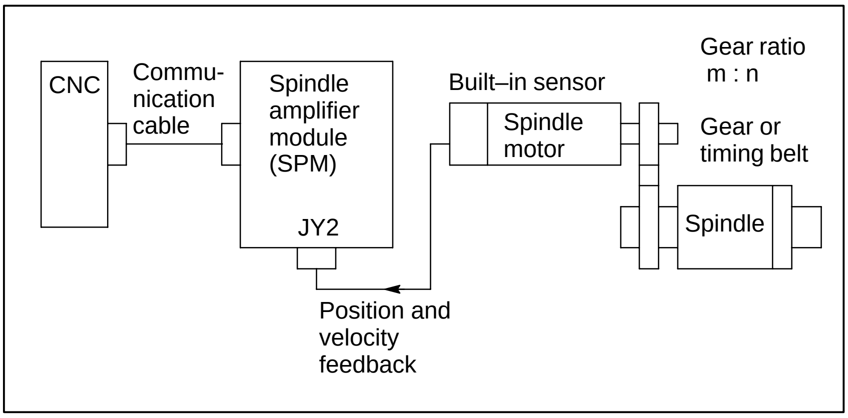
11.2.2 System Configuration

(1) αC Series Spindle

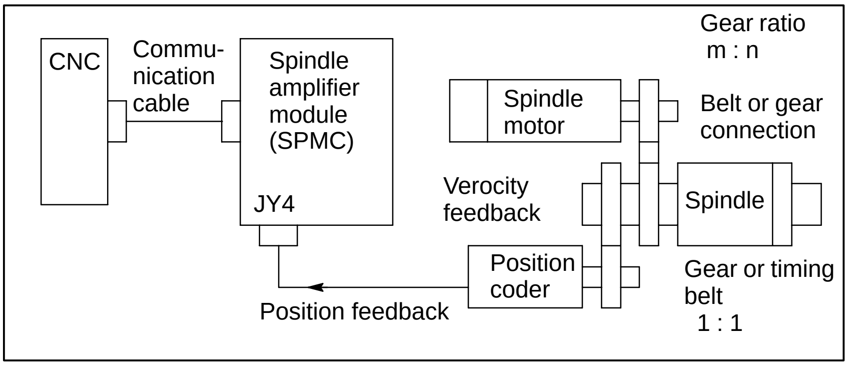
(a) System where a position coder is attached to the spindle



(b) System where a spindle motor with a built–in MZ sensor is used (including that case where a built–in motor is used)



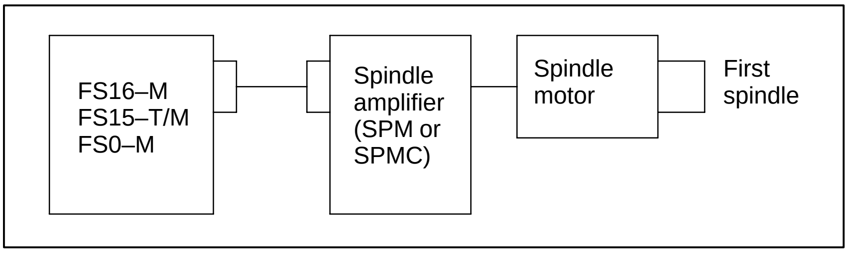
(2) αC Series Spindle



> **NOTE**
> Only 1:1 is allowed between the spindle and position coder. A motor used with the αC series spindle has no speed sensor, so that the acceleration/deceleration capability and synchronization control precision are degraded relative to the α series.

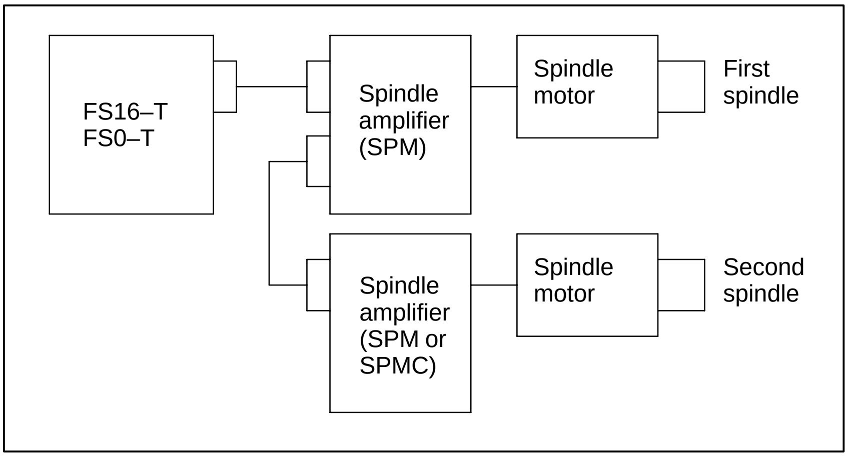
(3) CNC–based Classification of System Configurations

(a) When FS16–M, FS15–T/M, or FS0–M is used

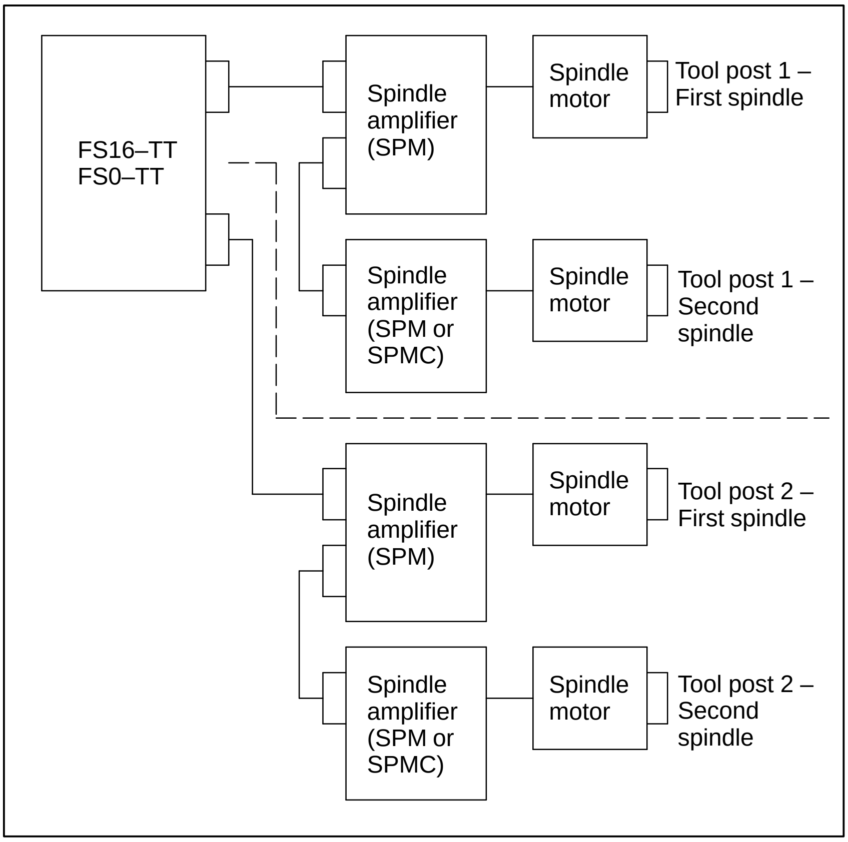


(b) When FS16–T or FS0–T is used

When rigid tapping is performed using the second spindle, the multi–spindle control function option is required.



(c) When FS16–TT or FS0–TT is used



11.2.3 Signals

(1) Signal Addresses

(a) Input signals (PMC to CNC)

[When FS16 is used]

	TT HEAD2	#7	#6	#5	#4	#3	#2	#1	#0
G028	G1028						GR2	GR1	
G061	G1061								RGTAP
G027	G1027							SWS2 (Note 1)	SWS1 (Note 1)
G029	G1029								GR21 (Note 2)
G070	G1070			SFRA		CTH1A	CTH2A		

NOTE

1 The multi–spindle control function allows rigid tapping to be performed using the second spindle.
When SWS1 = 1, rigid tapping is performed using the first spindle (regardless of the setting of SWS2).
When SWS1 = 0, and SWS2 = 1, rigid tapping is performed using the second spindle.

2 The signal is used as the gear signal when rigid tapping is performed using the second spindle. Depending on the GR21 signal, the first and second rows of the gear–by–gear parameters common to those of the first spindle are used.

[When FS15 is used]

	#7	#6	#5	#4	#3	#2	#1	#0
G026								SPSTP
G227			SFRA		CTH1A	CTH2A		

[When FS0 is used]

	0TTC HEAD2	#7	#6	#5	#4	#3	#2	#1	#0
G118	G1318					GR2 (Note 1)	GR1 (Note 1)		
G123	G1323					GR2 (Note 2)	GR1 (Note 2)	RGTPN (Note 3)	
G135	G1335								RGTAP (Note 4)
G145	G1345		GR21 (Note 6)					SWS2 (Note 5)	SWS1 (Note 5)
G229	G1429			SFRA		CTH1A	CTH2A		

NOTE

1 The signals at these addresses are valid when the T series is used, and bit 5 of parameter No. 0031 is set to 0.
2 The signals at these addresses are valid when the T series is used and bit 5 of parameter No. 0031 is set to 1. The signals at these addresses are also valid when the M series is used, and the constant surface speed option is selected.
3 The signal at this address is valid when bit 4 of parameter No. 0019 is set to 0. (With the T and TT series, only this signal is valid at all times.)
4 The signal at this address is valid when bit 4 of parameter No. 0019 is set to 1. (With the T and TT series, this signal is invalid.)
5 The multi–spindle control function allows rigid tapping to be performed using the second spindle.
When SWS1 = 1, rigid tapping is performed using the first spindle (regardless of the setting of SWS2).
When SWS1 = 0, and SWS2 = 1, rigid tapping is performed using the second spindle.
6 The signal is used as the gear signal when rigid tapping is performed using the second spindle. Depending on the GR21 signal, the first and second rows of the gear–by–gear parameters common to those of the first spindle are used.

(b) Output signals (CNC to PMC)

[When FS16 is used]

	#7	#6	#5	#4	#3	#2	#1	#0
F034 (Note)						GR30	GR20	GR10

NOTE
Valid only with the M series.

[When FS15 is used]

	#7	#6	#5	#4	#3	#2	#1	#0
F040				RTAP				

[When FS0 is used]

	#7	#6	#5	#4	#3	#2	#1	#0
F152 (Note)						GR30	GR20	GR10

NOTE
Valid only with the M series.

(2) Main Signals

The main signals used for rigid tapping are listed below.

(a) Signals used to specify rigid tapping mode (RGTAP, RGTPN)

(b) Gear selection signals indicating the gear state that allows gear–dependent parameter selection (GR1, GR2, GR21, GR10, GR20, GR30)

(c) Signal for activating a spindle motor (Forward spindle rotation signal: SFR)

NOTE
1 With the analog interface spindle, the TLML signal is entered for rigid tapping. With the α series and αC series spindles, however, set the TLML signal to 0.
2 For details of the signals, refer to the CNC connection manual.

(3) Gear Switch Signals for FS16 and FS0

With FS16 and FS0, two methods of gear switching are supported.

(a) T–type gear switching (T/TT series, or M series with the constant surface speed option)
With this method, parameters used internally by the CNC are switched according to the GR1 and GR2 signals (GR21 when the second spindle is used) sent from the PMC to the CNC.

(b) M–type gear switching (standard M series)
With this method, the CNC determines the number of gear stages from the CNC parameter setting and specified S value, and the parameters used internally by the CNC are switched. Moreover, the number of gear stages to be switched is sent from the CNC to the PMC with the GR10, GR20, and GR30 signals.
For details, refer to the description of S the function in the connection manual for each CNC. For details of the parameters, refer to the parameter manual.

The table below lists the parameters related to the gear switch signals.

Item	FS0–M	FS16–M
Maximum gear–dependent spindle speed (When the motor rotates at maximum speed = 10V)	0541 0539 0555	3741 3742 3743
Maximum spindle motor clamp speed	0542	3736
Minimum spindle motor clamp speed	0543	3735
Gear switch method selection Spindle motor speed at gear 1–2 switch point Spindle motor speed at gear 2–3 switch point	0035#6 0585 0586	3706#2 3751 3752
Gear switch point change selection at tapping time Spindle motor speed at gear 1–2 switch point Spindle motor speed at gear 2–3 switch point	0012#6 0540 0556	3706#3 3761 3762

(4) Rigid Tapping Using the Second Spindle with the T/TT Series of FS16 and FS0

The multi–spindle control function option is required.

(a) The following selection is made according to the SWS1 and SWS2 signals of the multi–spindle control function:
When SWS = 1 (regardless of the setting of SWS2)
→ Rigid tapping using the first spindle
When SWS = 1 and SWS2 = 1
→ Rigid tapping using the second spindle

(b) The GR21 signal (two gear stages only) is used as the gear switch signal for rigid tapping using the second spindle.
For the second spindle, the first and second rows of the parameters common to the first spindle are used, depending on the state of the GR21 signal.

11.2.4 Sequence

For details of the sequence, refer to the CNC connection manual.

(1) For the Series 16*i*/18*i*/21*i*, refer to the following manual:
Section 9.11 of the FANUC Series 16i/18i/21i Connection Manual (Function) (B–63003EN–1)

(2) For the Series 16/18, refer to the following manual:
Section 9.11 of the FANUC Series 16/18 Connection Manual (Mechanical) (B–62753EN–1)

(3) For the Series 15, refer to the following manual:
Section 2.3.51 of the FANUC Series 15 Connection Manual (BMI Interface) (B–61213E–2)

(4) For the Series 0–C, refer to the following manual:
Appendix D and Section 1.2 of the FANUC Series 0 Connection Manual (B–61393E)

11.2.5 Parameter List

The table lists the parameters related to rigid tapping using the α series and αC series spindles. For details of these parameters, refer to the parameter manual and the manual for each CNC.

Parameter No.				Description
FS0 M/T/TT		FS15 M/T	FS16 M/T	
First spindle	Second spindle			
M code setting for rigid tapping				
(M series) 0256	(T series) 0253	—	5210 5212	M code for specifying rigid tapping mode
Setting related to the position coder signal				
6501#2	6641#2	3001#2	4001#2	Whether to use the position coder signal. (To be set to 1)
6500#0	6640#0	3000#0	4000#0	Spindle and motor rotation direction
6500#2	6640#2	3000#2	4000#2	Position coder mounting direction
0028#7,6 0003#7,6	0064#7,6	5610	3706#1,0 3707#1,0	Gear ratio between the spindle and position coder (×1, ×2, ×4, ×8) (×1 only for the αC series)
6503 #7,6,4	6643 #7,6,4	3003 #7,6,4	4003 #7,6,4	Position coder signal setting
Setting related to arbitrary gear ratios (only for the α series)				
6506#7	6646#7	3006#7	4006#7	Setting for rigid tapping that is based on an arbitrary gear ratio (CMR) on the command side and uses a motor with a built–in MZ sensor
0063#3 (M series) 0063#6 (T series)		5604#2,1	5200#1	Whether to use the arbitrary gear ratio (CMR) function on the command side
(M series) 0663 0664 0665	(T series) 0427 to 0430	5703 5771 to 5774	5221 5222 5223 5224	Number of gear teeth on the spindle side when an arbitrary gear ratio (CMR) is used on the command side
(M series) 0666 0667 0668	(T series) 0431 to 0434	5704 5781 to 5784	5231 5232 5233 5234	Number of gear teeth on the position coder side when an arbitrary gear ratio (CMR) is used on the command side
6935 6937	6975 6977	3315 3317	4171 4173	Number of gear teeth on the spindle side when an arbitrary gear ratio (DMR) is used on the detection side (to be selected by CTH1A)
6936 6938	6976 6978	3316 3318	4172 4174	Number of gear teeth on the position detector side when an arbitrary gear ratio (DMR) is used on the detection side (to be selected by CTH1A)
Gear ratio data between the spindle and motor				
6556 to 6559	6696 to 6699	3056 to 3059	4056 to 4059	Gear ratio data between the spindle and motor (to be selected by CTH1A and CTH2A)

Parameter No. FS0 M/T/TT First spindle	Parameter No. FS0 M/T/TT Second spindle	FS15 M/T	FS16 M/T	Description
Position gain				
(M series) 0615 0669 0670 0671	(T series) 0406 0407 to 0410	3065 to 3068	5280 5281 to 5284	Tapping axis position gain at rigid tapping time
6565 to 6568	6705 to 6708	3065 to 3068	4065 to 4068	Spindle position gain at rigid tapping time (to be selected by CTH1A and CTH2A)
Setting related to acceleration/deceleration time constants				
0037#6 (M series)		——	——	Selection of acceleration/deceleration time constant non–stage switching. (To be set to 1)
0254 (M series)		5605#1	——	Acceleration/deceleration type setting (When set to 1: Linear acceleration/deceleration)
(M series) 0077#1 0613 0692 0693	(T series) 0415 to 0418	5605#2 5751 5760 5762 5764	5261 5262 5263 5264	Acceleration/deceleration time constant
(M series) 0077#1 0617 0694 0695	(T series) 0423 to 0426	5605#2 5757 5758 5759	5241 5242 5243 5244	Maximum spindle speed at rigid tapping time
0063#4		——	5200#4	Selection of an override at extraction time
0258 (M series) 0254 (T series)		——	5211	Override value at extraction time
(M series) 0035#1 0400 to 0402	(T series) 0029#3 0419 to 0422	——	5201#2 5271 to 5274	Acceleration/deceleration time constant at extraction time
Setting of velocity loop gain and motor voltage				
6544 6545	6684 6685	3044 3045	4044 4045	Velocity loop proportional gain at rigid tapping time (to be selected by CTH1A)
6552 6553	6692 6693	3052 3053	4052 4053	Velocity loop integral gain at rigid tapping time (to be selected by CTH1A)
6585	6725	3085	4085	Setting of motor voltage at rigid tapping time
6901	6941	3281	4137	Setting of motor voltage at rigid tapping time (for low–speed characteristics) (only for the α series)
In–position width, positional deviation limit				
(M series) 0618	(T series) 0400	1827	5300	Tapping axis in–position width

Parameter No.				Description
FS0 M/T/TT		FS15 M/T	FS16 M/T	
First spindle	Second spindle			
In–position width, positional deviation limit (Continued)				
(M series) 0619	(T series) 0401	5755	5301	Spindle in–position width
(M series) 0620	(T series) 0402	1837	5310 (5314)	Positional deviation limit during movement on the tapping axis
(M series) 0621	(T series) 0403	5754	5311	Positional deviation limit during spindle movement
(M series) 0622	(T series) 0404	1829	5312	Positional deviation limit when the tapping axis is stopped
(M series) 0623	(T series) 0405	——	5313	Positional deviation limit when the spindle is stopped
Setting related to orientation operation (reference position return) at the start of rigid tapping				
(M series) 0388#3		Based on machin-ing pro-grams	(M series) 5202#0	Whether to perform spindle orientation at the start of rigid tap-ping
6574		3074	4074	Reference position return feedrate at rigid tapping time
6500#4		3000#4	4000#4	Reference position return direction at rigid tapping time
6573		3073	4073	Grid shift amount at rigid tapping time
6591		3091	4091	Position gain change ratio in reference position return opera-tion at rigid tapping time
Others				
6599	6939	3099	4099	Delay for motor activation (α series)
6597	6937	3097	4097	Delay for motor activation (αC series)
(M series) 0255	(T series) 0214 to 0217	5604#2 5756 5791 to 5794	5321 to 5324	Spindle backlash amount
——	——	——	5214	Setting of a synchronization error at rigid tapping time
——	——	——	5204#0	Indication of a synchronization error at rigid tapping time. (To be set to 0)

11.3 Cs CONTOURING CONTROL

11.3.1 Outline

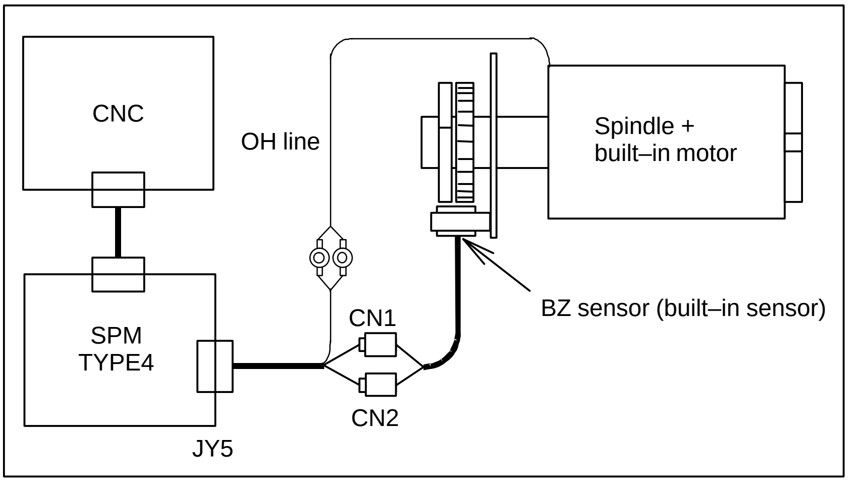
Cs contouring control is a function enabling servo control of the spindle using a high–resolution magnetic pulse coder or high–resolution position coder.
This function can be used for positioning the spindle and the interpolation between the spindle and another servo axis. Linear interpolation and circular interpolation are supported.

NOTE
This function is not supported for the αC series spindle.

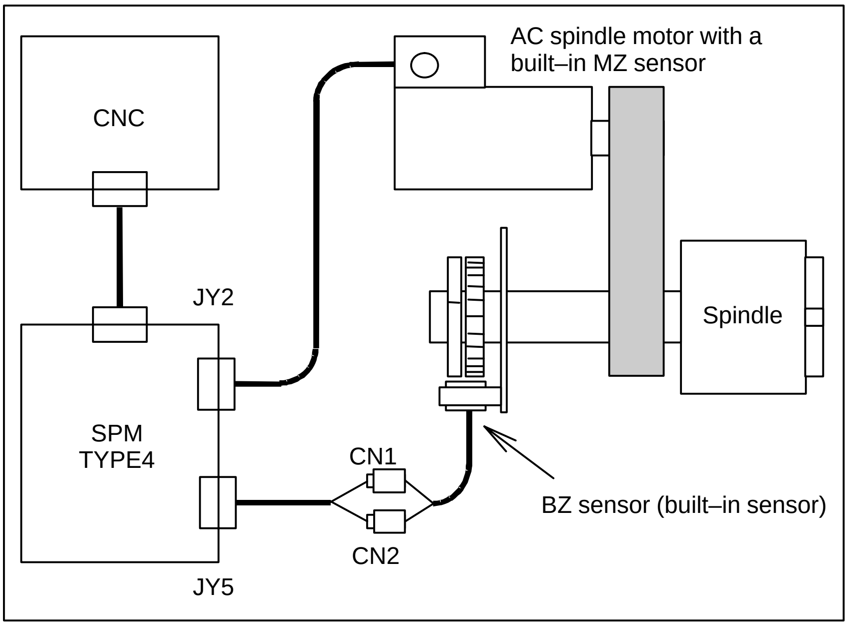
11.3.2 System Configuration

(1) For the α Spindle Sensor

(a) When a built–in spindle motor is used

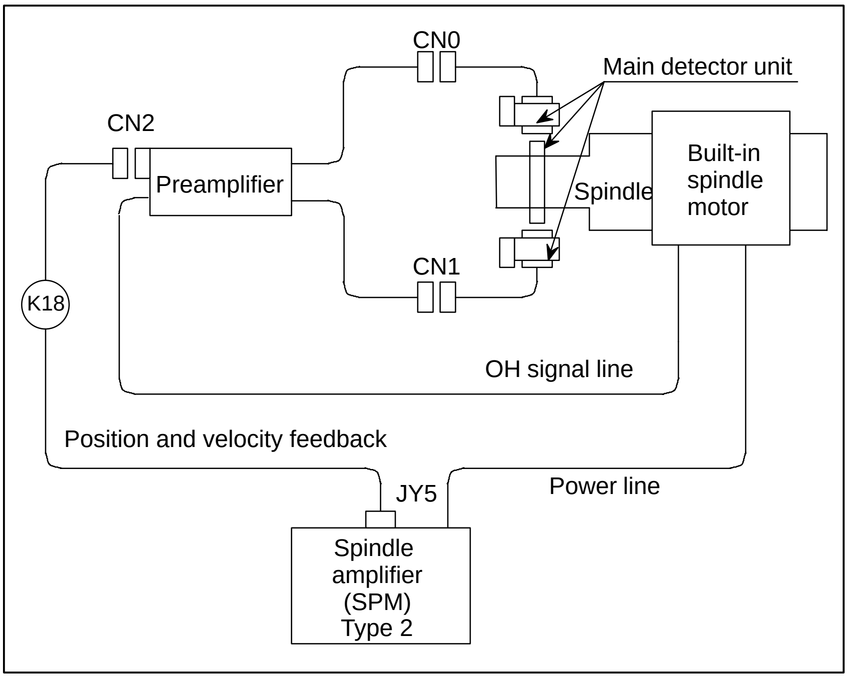


(b) When a motor is connected to the spindle via a belt

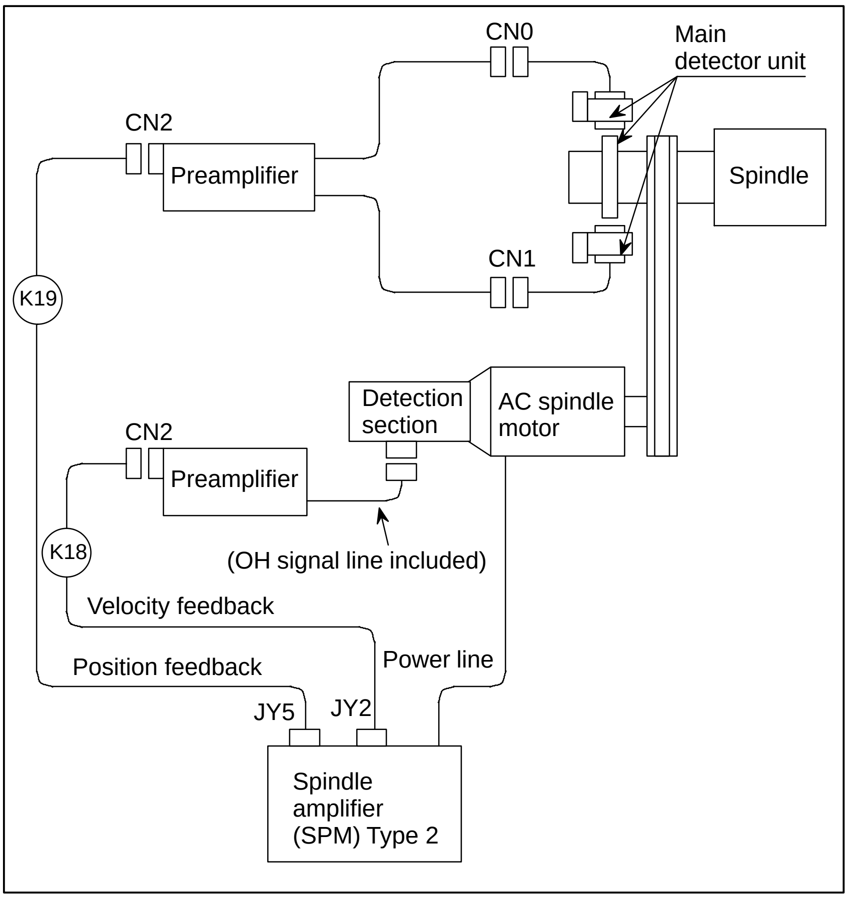


(2) For a High–resolution Magnetic Pulse Coder

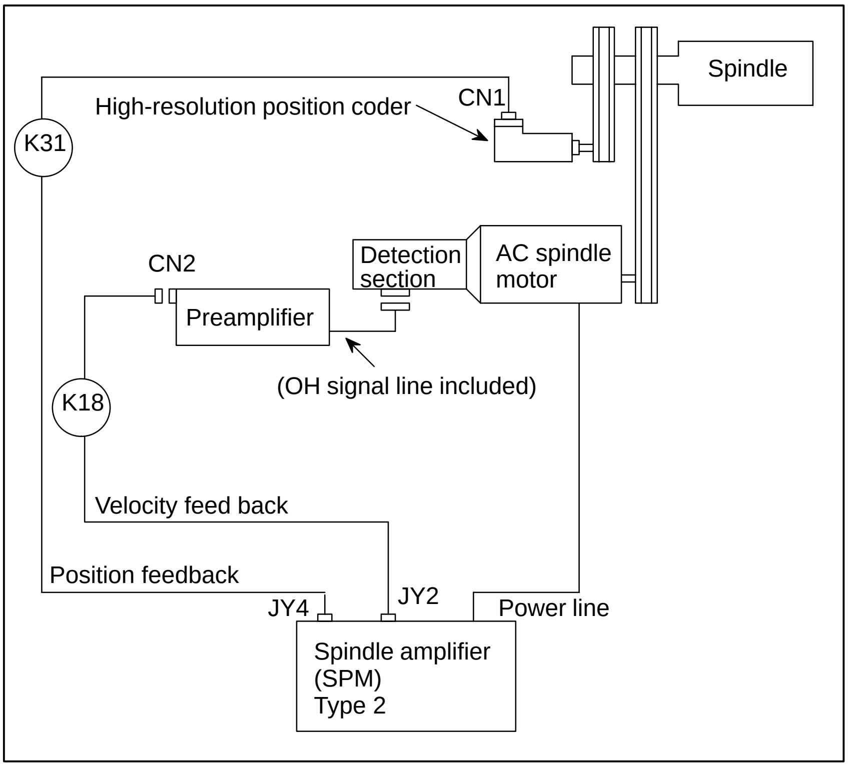
(a) When a built–in spindle motor is used



(b) When a motor is connected to a spindle via a belt



(3) For a High–resolution Position Coder



11.3.3 Specifications

(1) For the α Spindle Sensor

(a) Detection resolution and precision of BZ sensor + internal high–resolution circuitry

No.	Item	BZ sensor			
		128/128H	256/256H	384	512
1	Resolution [Typ.]	0.0016°	0.0008°	0.0006°	0.0004°
2	Precision [Typ.] (Note)	0.04°	0.03°	0.04°	0.04°

NOTE
It is assumed that the fluctuation of the shrink–fit section of the spindle is within 5μm, and errors on the machine are excluded. (The precision depends on the mounting accuracy of the detector.)

(Tip)
The precision is determined by the sum of previsions 1 through 3.

No.	Item	BZ sensor			
		128/128H	256/256H	384	512
1	Electrical division precision of one gear tooth and gear pitch precision [Typ.]	0.015°			
2	Gear pitch circular fluctuation precision [Typ.]	0.02°	0.01°	0.02°	0.02°
3	Machine side shaft fluctuation precision [Typ.]	A fluctuation can be converted to a precision according to the following formula: Precision (°) = Vibration (mm) × 360 (°)/gear circumference (mm) Example: When there are 256 teeth and a fluctuation of 0.005 mm Precision = 0.005 × 360/103.2/π ≒ 0.005°			

(b) Detection resolution and precision of MZ sensor + internal high–resolution circuitry

No.	Item	BZ sensor		
		α0.5 motor (64 teeth)	α1 to α3 motor (128 teeth)	α6 motor or up (256 teeth)
1	Resolution [Typ.]	0.0032°	0.0016°	0.0008°
2	Precision [Typ.]	The precision depends on the detector of (1)–(a) mounted onto the spindle.		

(2) For a High–resolution Magnetic Pulse Coder and High–resolution Position Coder

No.	Item	
1	Resolution [Typ.]	0.001°

11.3.4 DI and DO Signals

(1) DI Signal (PMC to CNC)

(a) Signal Addresses

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
G123			CON(M)							COFF(T)
		G027	CON(T/M)							
	G67, G71 . .		SCTR1, 2 .							
G229	G227	G070	MRDYA	ORCMA	SFRA	SRVA	CTH1A	CTH2A	TLMHA	TLMLA
G230	G226	G071	RCHA	RSLA	INTGA	SOCNA	MCFNA	SPSLA	*ESPA	ARSTA

This signal switches between the spindle rotation control mode and Cs contouring control mode.
Before switching from the Cs contouring control mode to the spindle rotation control mode, check that the spindle move command has terminated. Switching from the spindle rotation control mode to the Cs contouring control mode is enabled even when the spindle is rotating.
In this case, spindle rotation is decelerated then stopped, and the modes are changed. For safe operation, be sure to reset the spindle speed command (S command).

COFF (FS0)
0 : Cs contouring control mode
1 : Spindle rotation control mode

CON (FS0, FS16)
0 : Spindle rotation control mode
1 : Cs contouring control mode

SCNTR1, 2, ... (FS15)
0 : Spindle rotation control mode
1 : Cs contouring control mode

(2) DO Signal (CNC to PMC)

(b) Signal Addresses

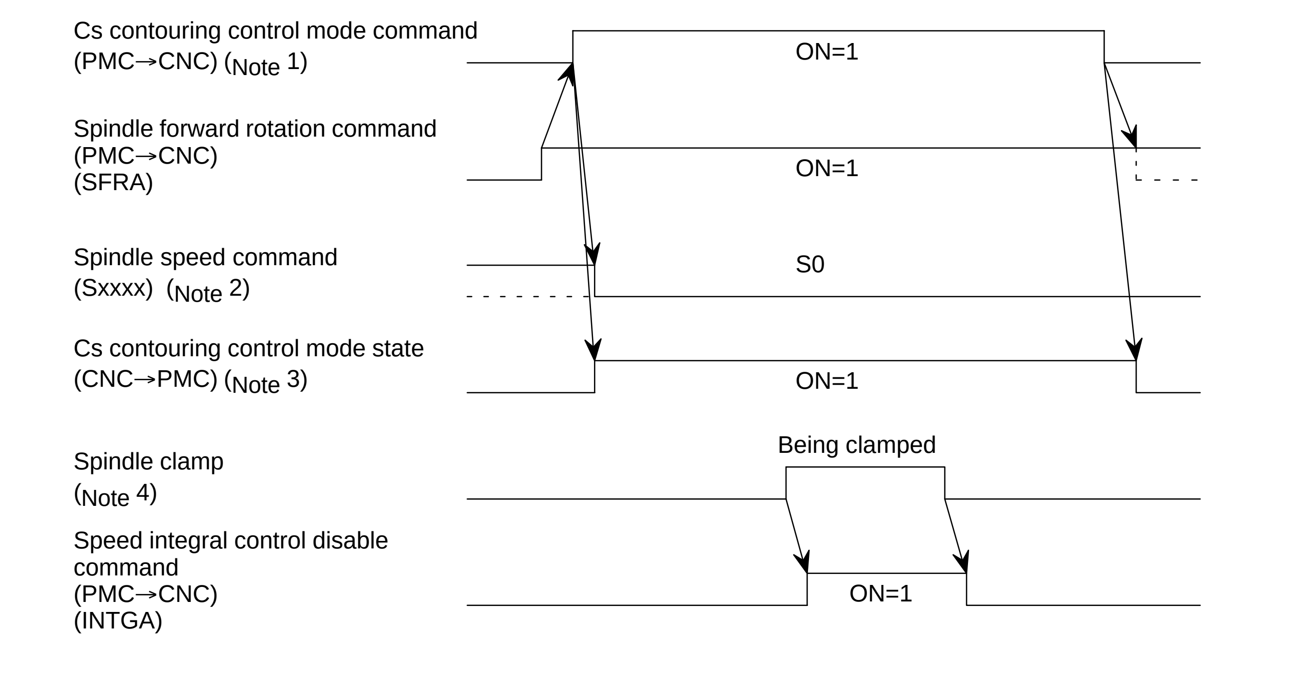
FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
F178		F004							FSCDL	
	F67, F71 . .		MCNTR1, 2 .							

This signal posts the completion of switching between the spindle rotation control mode and Cs contouring control mode.

FSCSL (FS0C, FS16)
0 : Spindle rotation control mode
1 : Cs contouring control mode

MCNTR1, 2, ... (FS15)
0 : Spindle rotation control mode
1 : Cs contouring control mode

11.3.5 Sample Sequence



NOTE

1 For Series 16 :
   Setting CON to 1 enters the Cs contouring control mode.
   For series 15 :
   Setting SCNTR to 1 enters the Cs contouring control mode.
   For Series 0–TC :
   Setting COFF to 0 enters the Cs contouring control mode.
   For Series 0–MC :
   Setting CON to 1 enters the Cs contouring control mode.

2 When specifying the Cs contouring control mode, reset the spindle speed command (S0 command) for safe operation.

3 For Series 16 :
   Setting FSCSL to 1 enters the Cs contouring control mode.
   For Series 15 :
   Setting MCNTR to 1 enters the Cs contouring control mode.
   For Series 0–C :
   Setting FSCSL to 1 enters the Cs contouring control mode.

4 When the spindle is clamped after it is positioned to perform machining such as drilling in the Cs contouring control mode, the clamp position of the spindle may deviate a little from a specified position. If it deviates, the speed integral function works. The function attempts to move the spindle to the specified position. As a result, excessive current may flow in the motor. To prevent this, the speed integral function must be disabled while the spindle is being clamped.

11.3.6 Parameters

The tables below list the parameters relating to Cs contouring control. Refer to the Parameter Manual and each CNC manual for details.

Parameter No.				Description
FS0		FS15	FS16	
Setting of axis allocation and so forth				
3rd axis	4th axis	1804#7	1023	Setting of the axis for which Cs contouring control is performed
0037#7		1804#0	——	Select "High–resolution pulse coder not used."
0037#3, 2		1815#1	1815#1	Select "Separate pulse coder not used".
0021#3, 2		1815#5	1815#5	Select "Other than absolute position detector."
0102	0103	1820	1820	Set the command multiplication to 2 (that is, x1)
Setting of an in–position width and positional deviation limit				
0502	0503	1827	1826	In–position width
0506	0507	1828	1828	Limit on position error during moving
0595	0596	1829	1829	Limit on position error during stop
——	——	1830	——	Limit on position error during servo off
0332	0333	1832	1832	Limit on position error for feed stop
Setting of a feedrate and acceleration/deceleration time constant				
0520	0521	1420	1420	Rapid feed rate
0527		1422	1422	Maximum cutting feedrate
0561	0562	1423	1423	Jog feedrate
0524	0525	1620	1620	Time constant for linear acceleration/deceleration in rapid feed
0635		1622	1628	Time constant for linear acceleration/deceleration in cutting feed (option)
0603	0604	1624	1624	Time constant for exponential acceleration/deceleration in jog feed
αSetting related to the spindle sensors (MZ sensor, BZ sensor)				
-		3001#5	4001#5	Whether to use a high–resolution magnetic pulse coder. (To be set to 0)
-		3001#6	4001#6	Setting for using a position detection signal for speed detection
-		3001#7	4001#7	Position detector mounting direction
-		3000#0	4000#0	Spindle and motor rotation direction
-		3003#1	4003#1	Use of an MZ sensor or BZ sensor (built–in motor). (To be set to 1)
-		3003 #7,6,4	4003 #7,6,4	Position detector type setting
-		3004#1	4004#1	Whether to use a BZ sensor on the spindle side

Parameter No.			Description
FS0	FS15	FS16	
–	3018#4	4018#4	Use of the α spindle sensor Cs contour control function. (To be set to 1)
–	3719	4355	Amplitude ratio compensation (motor side)
–	3720	4356	Phase difference compensation (motor side)
–	3721	4357	Amplitude ratio compensation (spindle side)
–	3722	4358	Phase difference compensation (spindle side)
Setting related to the high–resolution magnetic pulse coder and high–resolution position coder			
6501#5	3001#5	4001#5	Whether a high–resolution magnetic pulse coder is used (Set to 1.)
6501#6	3001#6	4001#6	Setting for using the position signal from a high–resolution magnetic pulse coder for speed detection
6501#7	3001#7	4001#7	Mounting orientation for the high–resolution magnetic pulse coder
6504#0	3004#0	4004#0	Whether a high–resolution position coder is used
6500#0	3000#0	4000#0	Rotational direction of the spindle and motor
6503 #7,6,4	3003 #7,6,4	4003 #7,6,4	Position detector type setting
6502 #2, 1, 0	3002 #2, 1, 0	4002 #2, 1, 0	Setting for Cs contouring control resolution (Normally, set 0, 0, 0.)
Setting of a maximum spindle speed under Cs contour control			
6521	3021	4021	Maximum spindle speed for Cs contouring control
Setting of a gear ratio between the spindle and motor			
6556 to 6559	3056 to 3059	4056 to 4059	Gear ratio between spindle and motor (selected by DI signals CTH1A and CTH2A)
Position gain setting			
6569 to 6572	3069 to 3072	4069 to 4072	Position gain for the axis for which Cs contouring control is performed (selected by DI signals CTH1A and CTH2A)
——	5609 #1, 0	——	Whether position gain is automatically set for axes for which Cs contouring control is not performed
6780 to 6799	5609 #0, 1	3900 to 3944	Position gain for axes for which Cs contouring control is not performed (selected by DI signals CTH1A and CTH2A)
Setting related to reference position return			
6574	3074	4074	Zero point return speed in Cs contouring control
6592	3092	4092	Position gain change rate for zero position return in Cs contouring control
6500#3	3000#3	4000#3	Direction of zero point return at the first Cs contouring control after power on
0065#1	1005#0	3700#1	Whether the zero point return function is used for the first G00 command after switching to Cs contouring control mode

Parameter No.			Description
FS0	**FS15**	**FS16**	
Grid shift setting			
6635	3135	4135	Grid shift for Cs contouring control
Rotation direction setting			
6500#1	3000#1	4000#1	Rotational direction of the spindle for + motion commands in Cs contouring control
6502#4	3002#4	4002#4	Rotational direction signal function for Cs contouring control
Setting of a velocity loop gain and motor voltage			
6546 6547	3046 3047	4046 4047	Velocity loop proportional gain for Cs contouring control (selected by DI signal CTH1A)
6554 6555	3054 3055	4054 4055	Velocity loop integral gain for Cs contouring control (selected by DI signal CTH1A)
6594	3094	4094	Compensation constant for external disturbance torque (acceleration feedback gain)
6586	3086	4086	Motor voltage for Cs contouring control (Normally, set to 100.)
6516#4	3016#4	4016#4	Setting for control characteristics for Cs contouring control (Normally, set 0.)
6519#0	3019#0	4019#0	Whether dead zone compensation is performed in Cs contouring control
6597	3097	4097	Spindle speed feedback gain
Others			
6599	3099	4099	Delay time for exciting the motor

11.4 SPINDLE SYNCHRONIZATION CONTROL

11.4.1 Outline

On a machine having two spindles (such as a lathe), the rotational spindle speed of both spindles must be the same in the following cases:

– When a workpiece on the 1st spindle is passed to the 2nd spindle while the spindles are rotating

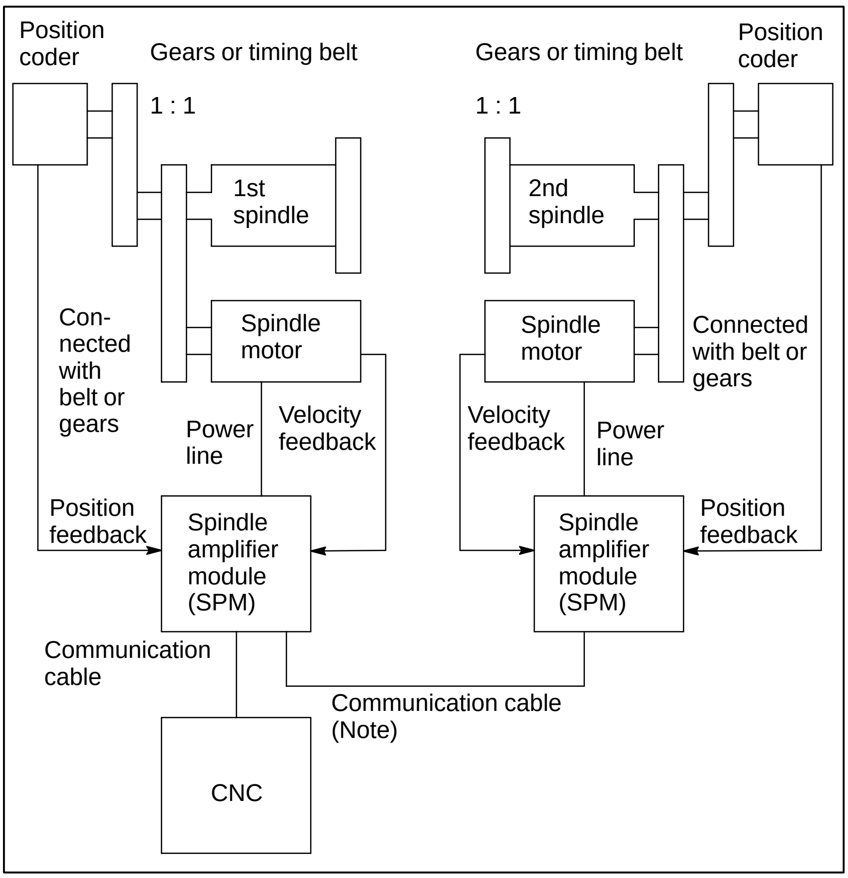
– When a workpiece is held by both the 1st and 2nd spindles and the spindles are accelerated or decelerated

The rotation phase (angle) of the spindles must also be the same when a workpiece of a special shape is passed between the spindles.
The spindle synchronization control function is used to synchronize the two spindles in the above cases.

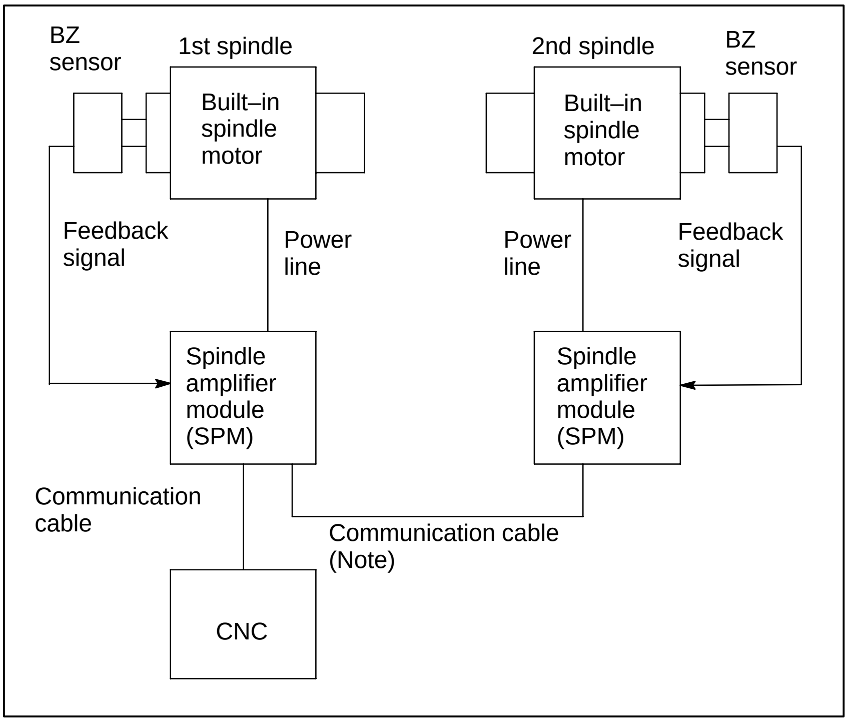
11.4.2 System Configuration

(1) αC Series Spindle

(a) When the spindle and spindle motor are connected by a belt or gears

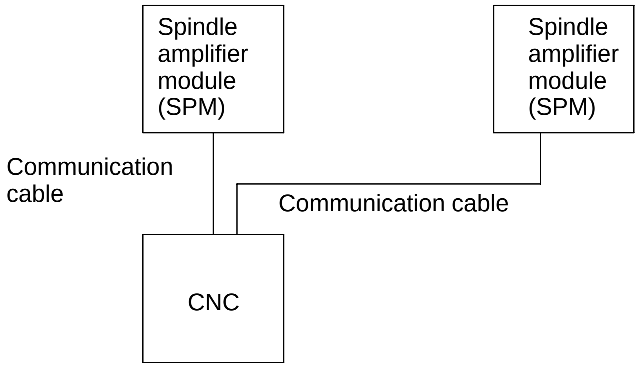


(b) When built–in spindle motors are used

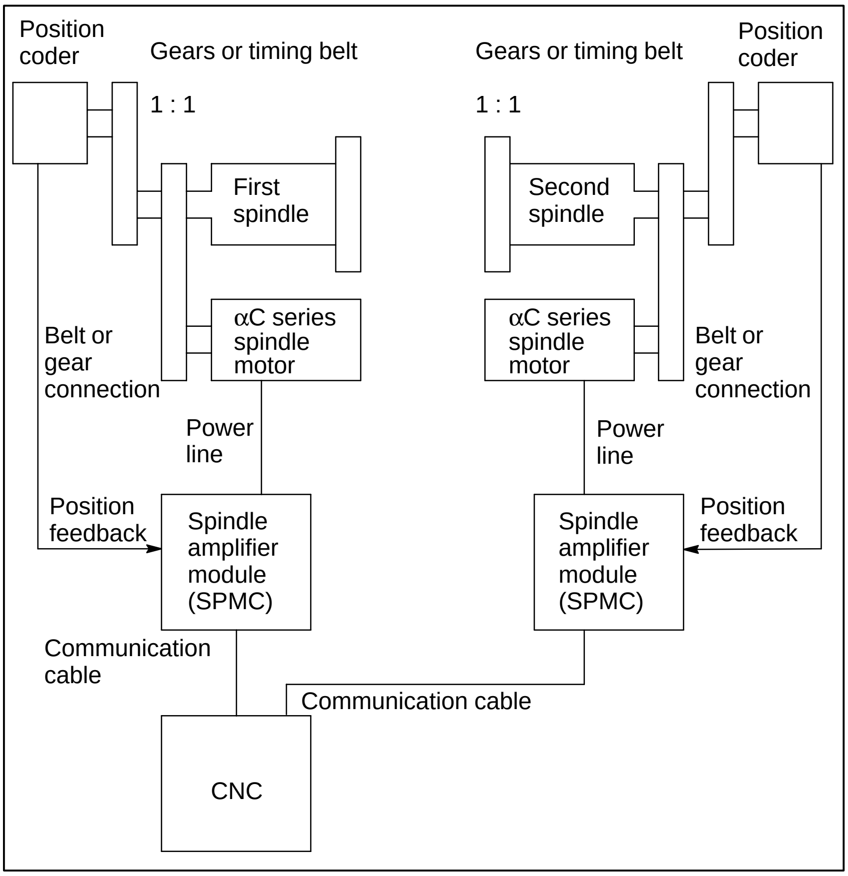


NOTE

For the Series 16–TT and Series 0–TT, the CNC and spindle amplifier modules are connected as follows:



(2) αC Series Spindle motor



11.4.3 Explanation of Spindle Synchronization Control

- When the command for spindle synchronization control is issued while the two spindles are rotating at different speeds or stopped, each spindle increases or decreases its speed to the specified speed. The two spindles are then controlled in synchronization.
- If the synchronization speed is changed after the synchronization control of the two spindles is started, the spindles increase or decrease their speed to the new speed. The spindles are synchronized during the acceleration or deceleration as the speed is increased or decreased according to the time constant specified in the parameter. When the specified synchronization speed is 0 min^{-1}, the two spindles stop at the same time.
- When the command for spindle synchronization control is issued with the synchronization speed specified as 0 min^{-1} when both spindles are stopped, the spindles rotate two or three times. After detecting the one rotation signal of the position coder (required for synchronization control of spindle phase), the spindles stop and enter the synchronization control state. If the synchronization speed is changed after the synchronous control state is established, the spindles increase or decrease their speed to the new speed. The spindles are synchronized during acceleration or deceleration as the speed is increased or decreased according to the time constant specified in the parameter.
- To handle a workpiece with a unique shape, the spindles need to rotate to keep the phases (angles) of rotation synchronous. When the command for spindle phase synchronization is issued when the spindles are already rotating in synchronization, each spindle is adjusted to the rotation phase specified in the parameter. At this time, the speed changes for a moment. Then the two spindles return to the synchronization control state. Rotation phase synchronization can be established by setting the parameters in advance so that the reference points of the two spindles match with each other.
- When the command for spindle phase synchronization is issued when the spindles are controlled in synchronization at 0 min^{-1}, each spindle is rotated and adjusted to the phase specified in the parameter then stops. It is similar to when the spindles are positioned in the stop state (spindle orientation). This causes the reference points of the spindles to match with each other (phase synchronization). If the synchronization speed is changed after a workpiece with a unique shape is held with the two spindles, the spindles increase or decrease their speed to the new speed. The spindles are synchronized during acceleration or deceleration as the speed is increased or decreased according to the time constant specified in the parameter.
- Constant surface speed control can be executed while a workpiece is being held with the two spindles in the synchronous control state. However, the time constant specified in the parameter is not exceeded even when a command for a larger increment or decrement in speed is specified.
- Do not switch the rotation direction command (SFR/SRV) during synchronization control.

> **NOTE**
> Refer to the following CNC manuals as well:
> Section 9.12 of FS 16*i*/18*i*/21*i* Connection Manual (Function) (B–63003EN–1)
> Section 9.12 of FS 16/18 Connection Manual (Function) (B–62753EN–1)

11.4.4 DI/DO Signals

(1) DI Signals (PMC to CNC)

(a) Signal address

	FS0–T	FS0–TT Head2	FS15	FS16	FS16–TT Head2	#7	#6	#5	#4	#3	#2	#1	#0
		G146	G146		G038					SPPHS	SPSYC		
		G124	G124		G032	R08I	R07I	R06I	R05I	R04I	R03I	R02I	R01I
		G125	G125		G033			SSGN		R12I	R11I	R10I	R09I
				G025		RI07	RI06	RI05	RI04	RI03	RI02	RI01	RI00
				G024		RISGN			RI12	RI11	RI10	RI09	RI08
				G111		SPPHS	SPSYS						
1st :	G229	G1429	G227	G070	G1070			SFRA	SRVA	CTH1A	CTH2A		
1st :	G230	G1430	G226	G071	G1071			INTGA					
2nd :	G233		G235	G074				SFRB	SRVB	CTH1B	CTH2B		
2nd :	G234		G234	G075				INTGB					

(b) Signal for spindle synchronization control (SPSYC)

[Function] Selects the spindle synchronization control mode.

[Operation] When the signal is set to 1, spindle synchronization control mode is selected.
When the signal is set to 0, spindle synchronization control mode is released.

(c) Signal for spindle phase synchronization control (SPPHS)

[Function] Selects the spindle phase synchronization mode. It becomes effective when the signal for spindles synchronization control (SPSYC) is set to 1. Enter this signal after the signal that indicates that synchronization control of spindle speed is completed has been set to 1. Synchronization control of spindle phase is started at the rising edge of this signal. Even when this signal is set to 0, the synchronized phase does not change. When the signal is changed again from 0 to 1, phase synchronization is executed again.

[Operation] At the rising edge of the signal changing from 0 to 1, synchronization control of the spindle phase begins.

(d) Signal for integral speed control (INTGA)

[Function] Enables or disables integral speed control.

[Operation] When this signal is set to 1, integral speed control is disabled. (Same effect as when the integral gain of the velocity loop is set to 0.) When the signal is set to 0, integral speed control is enabled.
When the two spindles are mechanically connected with each other, this signal is set to 1 for both spindles so that integral speed control is disabled.

- When a cylindrical workpiece is held with the two spindles after they are synchronized in speed
- When a workpiece with a unique shape is held with the two spindles after they are synchronized in phase

(2) DO Signals (CNC to PMC)

(a) Signal address

	FS0–T	FS0–TT Head2	FS15	FS16	FS16–TT Head2	#7	#6	#5	#4	#3	#2	#1	#0
		F178		F044					SYCAL	FSPPH	FSPSY		
			F111			MSPPHS	MSPSYC	SPSYAL					
1st :	F281	F1481	F229	F045	F1045					SARA			
2nd :	F285		F245	F049						RCFNA			

(b) Signal indicating that synchronization control of spindle speed is completed (FSPSY)

[Function] Reports that synchronization control of spindle speed is completed.

[Output conditions] This signal is set to 1 when the following conditions are satisfied:

- In spindle synchronization control mode, the two spindles reach the speed specified by the signal for specifying the spindle speed in synchronization, and the difference between the speeds of the two spindles is not more than the value specified in parameter 4033(FS16).

This signal is set to 0 when any of the following conditions is satisfied:

- In spindle synchronization control mode, the two spindles have not yet reached the speed specified by the signal for specifying spindle speed in synchronization.
- In spindle synchronization control mode, the difference between the speeds of the two spindle is larger than the value specified in parameter 4033 (FS16).
- The spindles are not in spindle synchronization control mode.

NOTE
The signal changes from 1 to 0 when the difference in spindle speed exceeds the value specified in parameter 4033(FS16) due to changes in the cutting load, etc.

(c) Signal indicating that synchronization control of spindle phase is completed (FSPPH)

[Function] Reports that synchronization control of spindle phase (control of phase difference) is completed.

[Output conditions] This signal is set to 1 when the following conditions are satisfied:

- In spindle synchronization control mode, the two spindles reach the speed specified by the signal for specifying the spindle speed in synchronization, and the spindles are synchronized in phase by the signal for spindle phase synchronization. (The difference between the error pulses of the two spindles is not greater than the value set in parameter 4810(FS16).)

This signal is set to 0 when any of the following conditions is satisfied:

- In spindle synchronization control mode, the two spindles have not yet been synchronized in phase.
- In spindle synchronization control mode, the difference between the error pulses of the two spindles is larger than the value specified in parameter 4810 (FS16).
- The spindles are not in spindle phase synchronization control mode.

NOTE
The signal changes from 1 to 0 when the difference in the error pulses exceeds the value specified in parameter 4810(FS16) due to changes in the cutting load, etc.

(d) Signal for issuing an alarm detected in spindle synchronization control (SYCAL)

[Function] Reports that the difference between the error pulses of the two spindles exceeds the value specified in the parameter for spindle synchronization control mode. This signal is used for error handling in spindle synchronization control.

[Output conditions] The signal is set to 1 when the following conditions are satisfied:

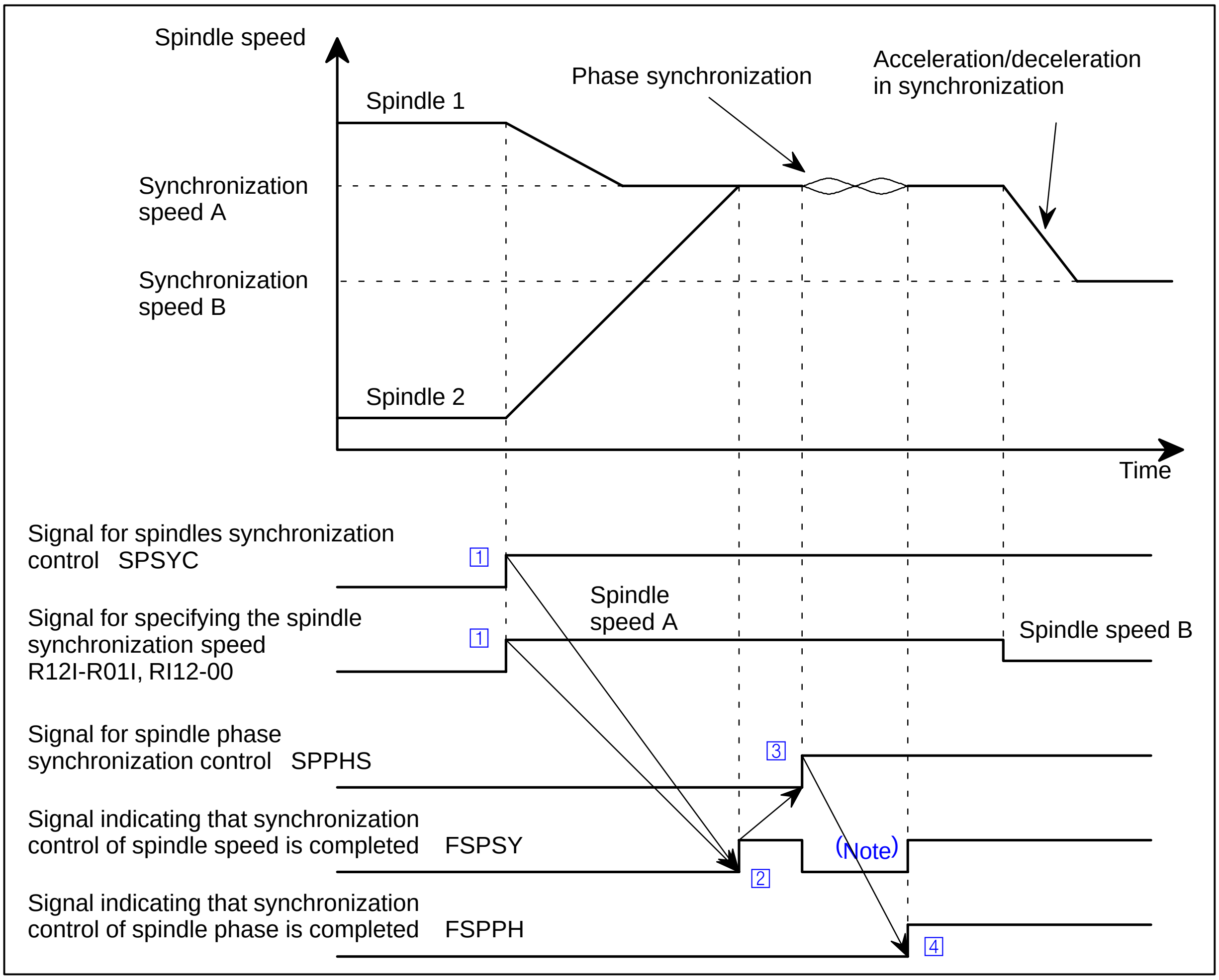
- In spindle synchronization control mode, the difference between the error pulses of the two spindles exceeds the value specified in parameter 4811(FS16), after spindle synchronization control has been put in effect.

The signal is set to 0 when any of the following conditions is satisfied:

- The spindles are not in spindle synchronization control mode.
- In spindle synchronization control mode, the difference between the error pulses of the two spindles is not greater than the value specified in parameter 4811(FS16).

11.4.5 Sample Sequence

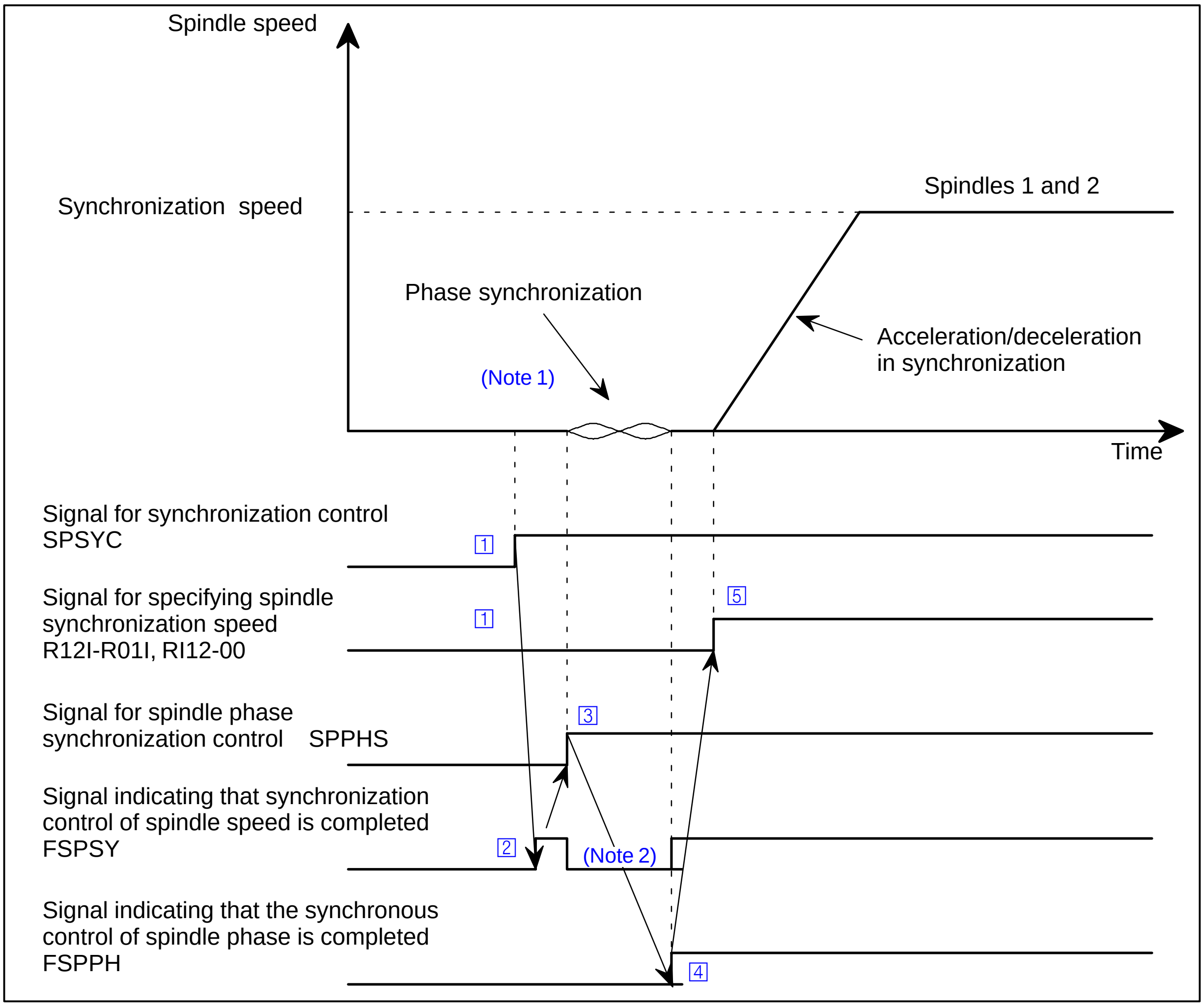
- While spindle 1 is rotating, spindle 2 is accelerated to reach the speed of spindle 1. The phase of spindle 2 is synchronized with that of spindle 1. Then the synchronization speed is changed, and the two spindles increase or decrease their speed in synchronization.



1. Enter the signal for specifying spindle synchronization speed and set the signal for spindle synchronization control to 1.
2. Wait until the signal indicating that synchronization control of spindle speed is completed is set to 1.
3. Set the signal for spindle phase synchronization to 1.
4. Wait until the signal indicating that synchronization control of spindle phase is completed is set to 1.

NOTE
The signal indicating that synchronization control of spindle speed is completed is set to 0 when the signal for spindle phase synchronization control is entered. It is changed to 1 when phase synchronization is completed.

- While spindles 1 and 2 are stopped, their phases are synchronized and their speeds are increased in synchronization.



1 Set the signal for specifying the spindle synchronization speed to 0 and the signal for spindle synchronization control to 1.

2 Wait until the signal indicating that synchronization control of spindle speed is completed is set to 1.

3 Set the signal for spindle phase synchronization control to 1.

4 Wait until the signal indicating that synchronization control of spindle phase is completed is set to 1.

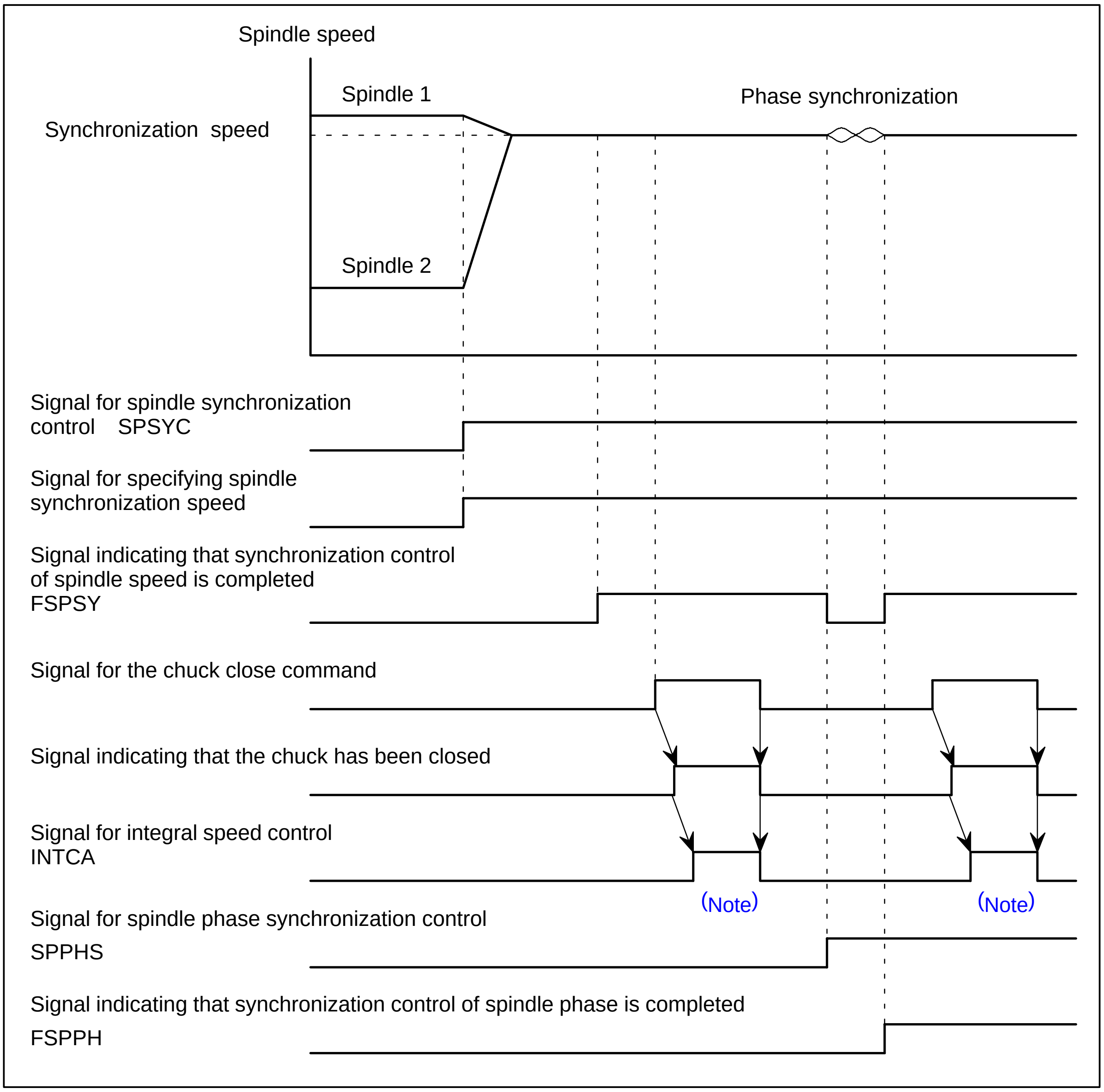
5 Enter the signal for specifying the spindle synchronization speed.

NOTE

1 When the spindle synchronization mode is switched (after power is supplied), each spindle automatically rotates several turns to detect one–rotation signals even if the program does not request so. If this operation causes a problem (for example, because two spindles are connected mechanically), or spindle phase synchronization is not to be performed, the operation can be disabled using parameters (No.4006#3 (FS16)).

2 The signal indicating that synchronization control of spindle speed is completed is set to 0 when the signal for spindle phase synchronization control is entered. It is changed to 1 when phase synchronization is completed.

● Using the signal for integral speed control



NOTE

Set the signal for integral speed control to 1 while a workpiece is being held with the two spindles.

11.4.6 Parameters

The tables below list the parameters related to spindle synchronization control. Refer to the Parameter Manual and each CNC manual for details.

Parameter No.						Description
FS0		FS0–TT	FS15–TT		FS16	
1st	2nd		1st	2nd		
Rotation direction setting						
0080#6	____	0086#6	5820#0	____	4800#0	Rotational direction of spindle motor for spindle synchronization control (1st spindle)
____	0080#7	0080#6	____	5820#1	4800#1	Rotational direction of spindle motor for spindle synchronization control (2nd spindle)
Setting related to output signals for spindle synchronization						
6533	6673	6533	3033	3173	4033	Target level for the spindle speed synchronization control
0303		0303	5810		4810	Difference between error pulses for the two spindles, regarded as spindle phase synchronization completion signal
0576		0576	5811		4811	Difference between error pulses for the two spindles, regarded as an alarm during spindle synchronization control
Setting of gear ratio data between the spindle and motor						
6506#1	6646#1	6506#1	3006#1	3146#1	4006#1	Increment system for gear ratios
6556 to 6559	6696 to 6699	6556 to 6559	3056 to 3059	3196 to 3199	4056 to 4059	Gear ratio between the spindle and motor (selected by DI signals CTH1A and CTH2A from the PMC)
Setting related to a shift amount and phase synchronization						
6534	6674	6534	3034	3174	4034	Shift for spindle phase synchronization control
6535	6675	6535	3035	3175	4035	Compensation data for spindle phase synchronization control
6506#3	6646#3	6506#3	3006#3	3146#3	4006#3	Setting to disable automatic one–rotation signal detection when the spindle synchronization mode is switched
Position gain setting						
6565 to 6568	6705 to 6708	6565 to 6568	3065 to 3068	3205 to 3208	4065 to 4068	Position gain for spindle synchronization control (The same value must be set for both spindles.) (selected by DI signals CTH1A and CTH2A from the PMC)
Setting of acceleration/deceleration time constants						
6532	6672	6532	3032	3172	4032	Acceleration/deceleration time constant for spindle synchronization control (The same value must be set for the 1st and 2nd spindles.)

Parameter No.						Description
FS0		FS0–TT	FS15–TT		FS16	
1st	2nd		1st	2nd		
Setting of acceleration/deceleration time constants (Continued)						
6300	6480	6300	3480	3700	4336	Flux switching point for calculating the acceleration/deceleration time constant for spindle synchronization control (The same value must be set for both spindles.)
6304	6484	6304	3484	3704	4340	Bell–shaped acceleration/deceleration time constant for spindle synchronization control (The same value must be set for the 1st and 2nd spindles.)
Setting of a velocity loop gain and motor voltage						
6544 6545	6684 6685	6544 6545	3044 3045	3184 3185	4044 4045	Velocity loop proportional gain for spindle synchronization control (selected by DI signal CTH1A from the PMC)
6552 6553	6692 6693	6552 6553	3052 3053	3192 3193	4052 4053	Velocity loop integral gain for spindle synchronization control (selected by DI signal CTH1A from the PMC)
6585	6725	6585	3085	3225	4085	Motor voltage for spindle synchronization control
6310	6490	6310	3490	3710	4346	Incomplete integral coefficient

11.5 SPEED RANGE SWITCHING CONTROL

11.5.1 General

Speed range control conducts switching of speed range in one motor (motor designed specifically for speed range switching control) using the FANUC SERVO AMPLIFIER α series SPINDLE AMPLIFIER MODULE.

NOTE
This function is not available for αC series.

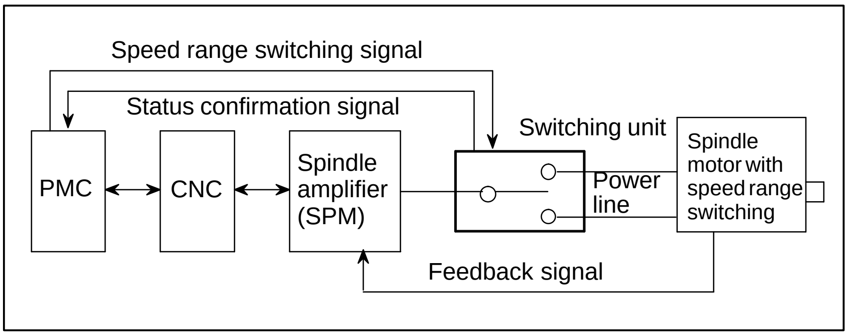
11.5.2 Configuration and Order Drawing Number

Configuration

The following items are needed in addition to the spindle amplifier module.

- Speed range switching control software (option)
- Relay circuit (including electromagnetic contactor and drive relay)
- Switching signal from PMC

Configuration of the components is shown in following fig.



11.5.3 Specifications

- On a spindle motor with the output switch function, the user can switch between two types of windings: one for the low–speed output characteristics and the other for the high–speed output characteristics. Switching is possible even while the motor is rotating.
- A spindle amplifier (SPM) is usable regardless of its type.
- To check the status of the power line, check the statuses of the magnetic contactors for both high–speed range and low–speed range.

  This function can be selected by the parameter setting:

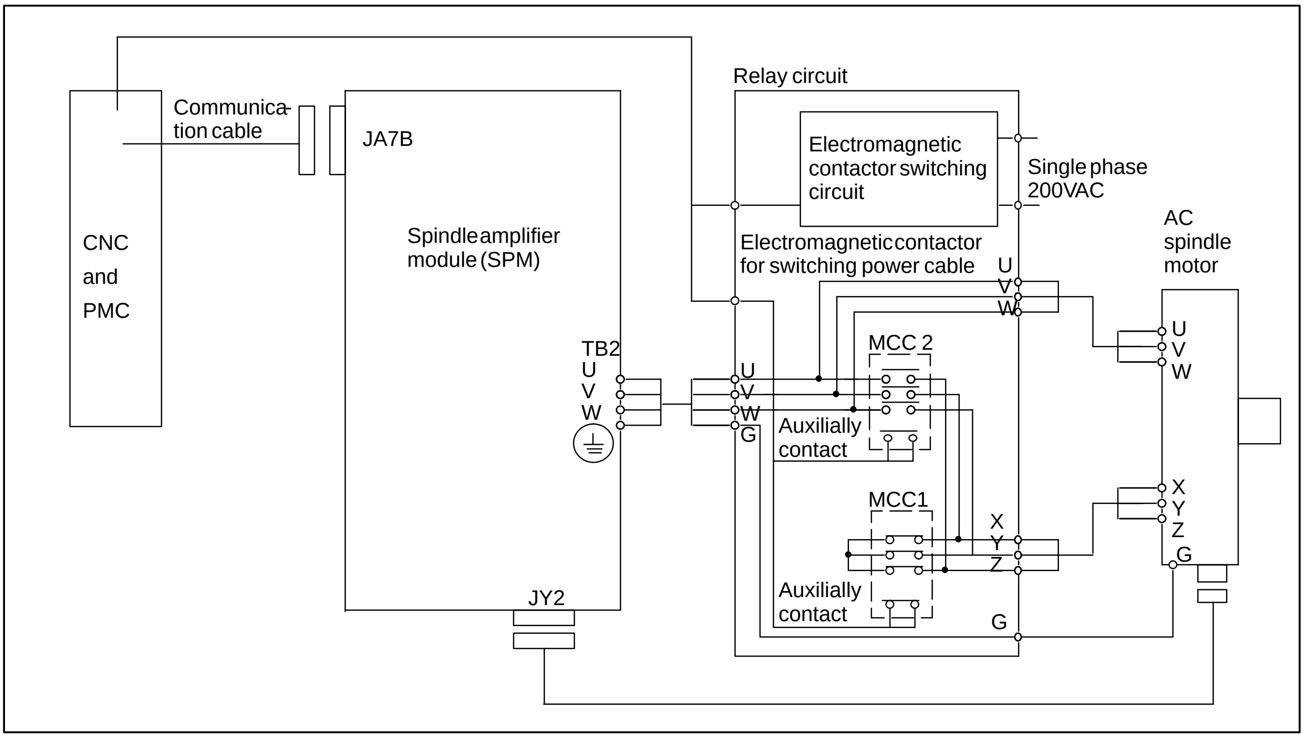
FS16	:	No. 4014 #3=1
FS15	:	No. 3014 #3=1
FS0	:	No. 6514 #3=1

- As the speed detecting signal (SDTA) is used for switching speed detection, it cannot be used for gear change speed detection, etc.
- As the error detection function for switching operation, the alarm (AL–15) is issued if the magnetic contactor signal (RCHA, RCHHGA) is not applied within 1 second of the power line switch signal (RCHPA) being output.

11.5.4 Connections

The connections of Type A and Type B, below, depend on the specification of a spindle motor with the output switch function. When low–speed output characteristics mode is selected, MCC1 is on, and MCC2 is off. When high–speed output characteristics mode is selected, MCC1 is off, and MCC2 is on.

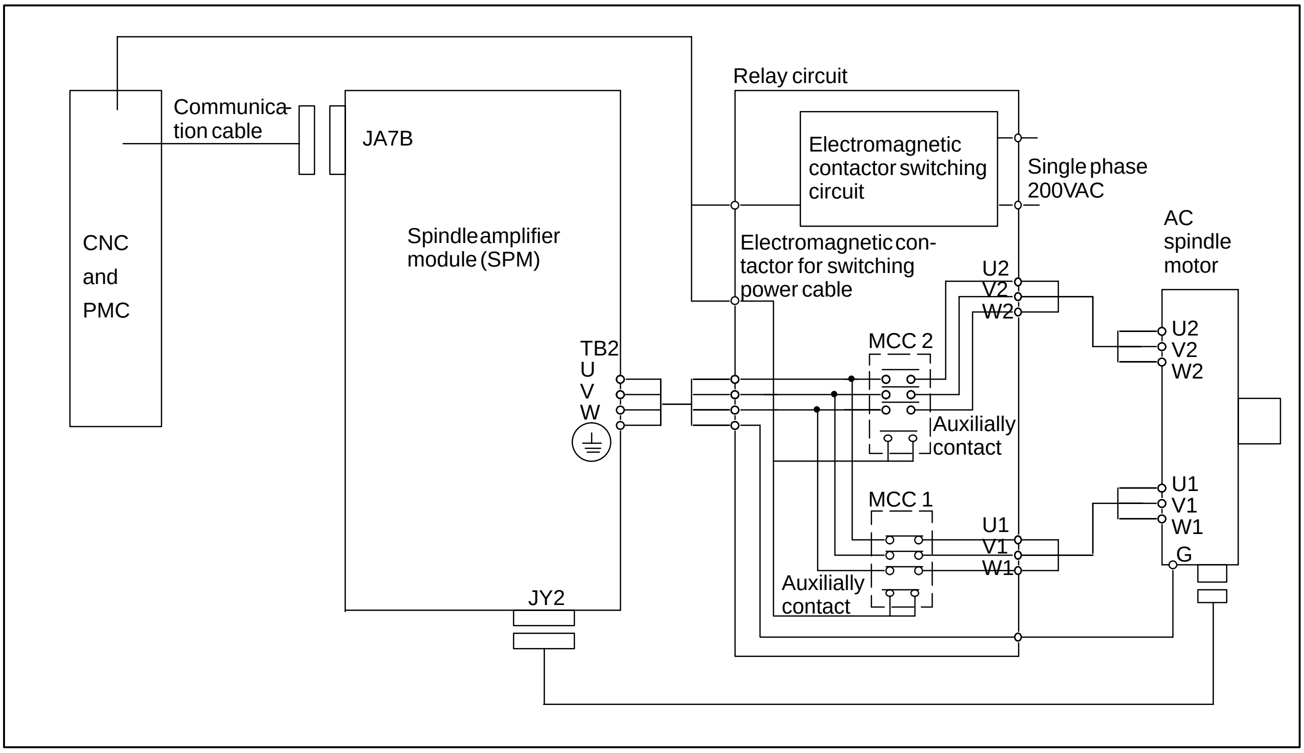
(1) Type A



NOTE

The power supply module is omitted from the figure.
Items such as units and cables other than the spindle amplifier module and, AC spindle motor, which are surrounded by the unbroken line, must be provided by the machine tool builder.

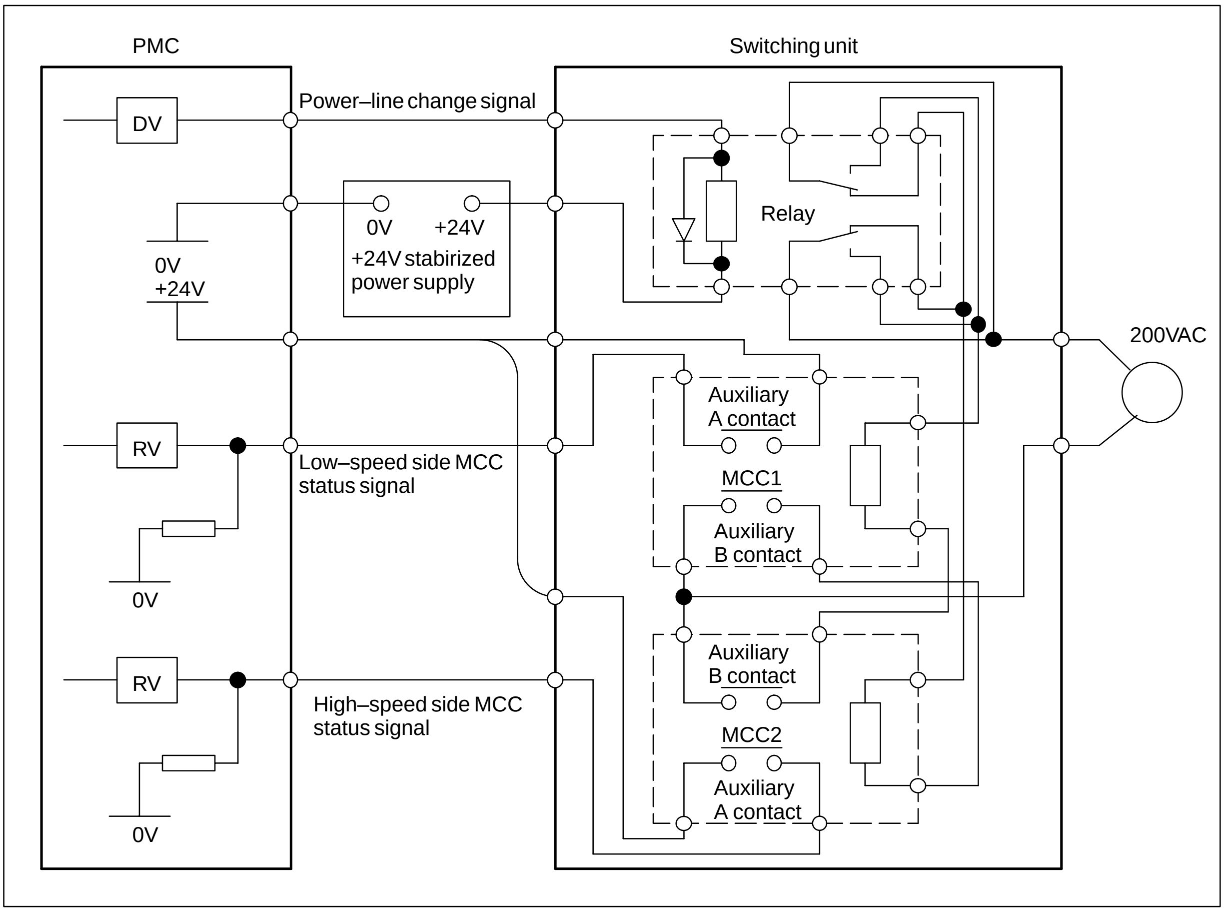
(2) Type B



NOTE
The power supply module is omitted from the figure.
Items such as units and cables other than the spindle amplifier module and, AC spindle motor, which are surrounded by the unbroken line, must be provided by the machine tool builder.

(3) Details of Connection between PMC and Switching Unit

It shows the case that the status of the electromagnetic contactors both for the high-speed range and for the low-speed range is input.



NOTE

1. The main contact terminals and power line in contact are omitted.
2. Add a surge absorber to the electromagnetic contactor operation coil as necessary.
3. Use a power-line switching electromagnetic contactor with the proper capacity for each spindle motor.

11.5.5 Spindle Control Signals

(1) Input Signals (DI Signals) PMC to CNC

(a) Signal addresses

First spindle control input signal

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
G230	G226	G071	RCHA	RSLA	INTGA	SOCNA	MCFNA	SPSLA	*ESPA	ARSTA
G231	G229	G072	RCHHGA	MFNHGA	INCMDA	OVRA	DEFMDA	NRROA	ROTAA	INDXA

Second spindle control input signals

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
G234	G234	G075	RCHB	RSLB	INTGB	SOCNB	MCFNB	SPSLB	*ESPB	ARSTB
G235	G237	G076	RCHHGB	MFNHGB	INCMDB	OVRB	DEFMDB	NRROB	ROTAB	INDXB

(b) Switching request signal (RSLA)

[Function] It is used as an instruction signal which selects power characteristics.

0 : The high-speed range is selected.

1 : The low-speed range is selected.

[Usage] This instruction is usually set according to the velocity command (S instruction). In this case, parameter No. 4019 #4=1 (FS16) is set to work the switching operation after speed detecting signal (SDTA) is confirmed on the spindle side, because a low-speed range is selected immediately after the velocity command changes from a high speed to a low speed above the switching point.

In addition, there is a method that this instruction is selected by the speed detecting signal (SDTA) which is one of output signals of CNC (DO signal). But, please note that this method changes the speed detecting signal in the following cases.

- When the motor speed crosses the speed detection level in the constant surface speed control.
  At using a low-speed range, the switching-operation can be prevented by clamping at the switching speed with the instruction (G50, G92) that clamps the maximum spindle speed at the constant surface speed control.
- In the case that the motor speed crosses the speed detection level when the speed is changed by a spindle override.

Since the power of motor is turned off in switching-operation when the speed range switching control works in the following control modes, please select either speed range beforehand, and please do not change the switching request signal while working.

- Rigid tapping mode
- Cs contouring control mode
- Spindle synchronization control mode

- Spindle indexing mode
- The spindle orientation is completed.

(c) Electromagnetic contactor for the speed range switching status signal (RCHA)

[Function] The opening and closing status signal of the electromagnetic contactor for a low-speed range of the spindle motor is input.

0 : The low-speed range side electromagnetic contactor is open.

1 : The low-speed range side electromagnetic contactor is closed.

[Usage] The status of the auxiliary contact (”A” contact) of electromagnetic contactor for a low-speed is usually input.
The status of the low-speed range side electromagnetic contactor is input as this signal for parameter NO. 4014 #3=1 (FS16).

[Function] The selection status signal of the electromagnetic contactor for the spped range switching of the spindle motor is inputted.

0 : The high-speed range is selected.

1 : The low-speed range is selected.

[Usage] When the electromagnetic contactor changes from the low-speed side to the high-speed side, this signal is set from ”1” to ”0” after it is confirmed that the electromagnetic contactor on the low-speed side is off and that the electromagnetic contactor on the high-speed side is on.
When the electromagnetic contactor changes from the high-speed side to the low-speed side, this signal is set from ”0” to”1” after it is confirmed that the electromagnetic contactor on the high-speed side is off and that the electromagnetic contactor on the low-speed side is on.

(d) High-speed range side electromagnetic contactor status signal (RCHHGA)

[Function] The opening and closing status signal of the electromagnetic contactor for a high-speed range of the spindle motor is input.

0 : The high-speed range side electromagnetic contactor is open.

1 : The high-speed range side electromagnetic contactor is closed.

[Usage] The status of the auxiliary contact (”A” contact) of the electromagnetic contactor for a high-speed range is usually input.

This signal is effective for parameter NO. 4014 #3=1 (FS16).

(2) Output Signal (DO signal) CNC to PMC

(a) Signal addresses

First spindle control output signal

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
F281	F229	F045	ORARA	TLMA	LDT2A	LDT1A	SARA	SDTA	SSTA	ALMA
F282	F228	F046	MOAR2A	MOAR1A	POAR2A	SLVSA	RCFNA	RCHPA	CFINA	CHPA

Second spindle control output signals

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
F285	F245	F049	ORARB	TLMB	LDT2B	LDT1B	SARB	SDTB	SSTB	ALMB
F286	F244	F050	MOAR2B	MOAR1B	POAR2B	SLVSB	RCFNB	RCHPB	CFINB	CHPB

(b) Power-line switching signal (RCHPA)

[Function] It is an instruction signal to select the electromagnetic contactor for the speed range switching of the spindle motor.

0 : The electromagnetic contactor for a high-speed range should be selected.

1 : The electromagnetic contactor for a low-speed range should be selected.

[Usage] When switching request signal (RSLA) changes, the power supply to the motor is automatically turned off.
Power supply OFF status continues until the switching completion signal (RCFNA) changes.
At changing from the low-speed side to the high-speed side, this signal changes from ”1” to ”0” after the switching request signal (RSLA) is received. As a result, the electromagnetic contactor for a low-speed range is first turned off. After it is confirmed to have turned off the electromagnetic contactor for a low-speed range, the electromagnetic contactor for a high-speed range is turned on.
At changing from the high-speed side to the low-speed side, this signal changes from ”0” to ”1” after the switching request signal (RSLA) is received. As a result, the electromagnetic contactor for a high-speed range is first turned off. After it is confirmed to have turned off the electromagnetic contactor for a high-speed range, the electromagnetic contactor for a low-speed range is turned on.

(c) Switching completion signal (RCFNA)

[Function] This signal shows by which speed range the spindle motor is controlled.

0 : It is controlled by a high-speed range.

1 : It is controlled by a low-speed range.

[Usage] Switching request signal (RSLA) changes. And after it is confirmed that this signal is corresponding to the switching request signal (RSLA), it moves to the next movement.
Since the motor power is turned off until this signal is corresponding to the switching request signal (RSLA) after the change of the switching request signal (RSLA), please note not to apply the cutting load, etc. to the spindle in the switching-operation.

(d) Speed detecting signal (SDTA)

[Function] It becomes ”1” while the motor speed is below the level (the switching point is normally set.) that is set by parameter (No.4023 (FS16)).

0 : Motor speed is above the switching point.

1 : Motor speed is below the switching point.

[Usage] It can be used for the switching point detection.
However, in the case that switching-operation is done according to this signal, please note that this signal is changed by speed's changing when driven near the switching point and switching-operation is occasionally done.
In this case, please do the switching control with the velocity command (S instruction).
Hysteresis is given to this signal.
Quantity of hysteresis is set to 20 min^{-1} as an initial parameter. And it can be changed by the parameter (NO. 4160 (FS16)).
This width of hysteresis is set to the value with margin, which is two times value of measured speed change at switching-operation.
It is calculated by the following equation as a standard of the set data.

(Width of hysteresis) =

$$\frac{\text{(Switching-operation time)}}{\text{(Acceleration time up to the max. speed)}} \times \text{(Max. speed)}min^{-1} \times \underbrace{0.2}_{} :min^{-1}$$

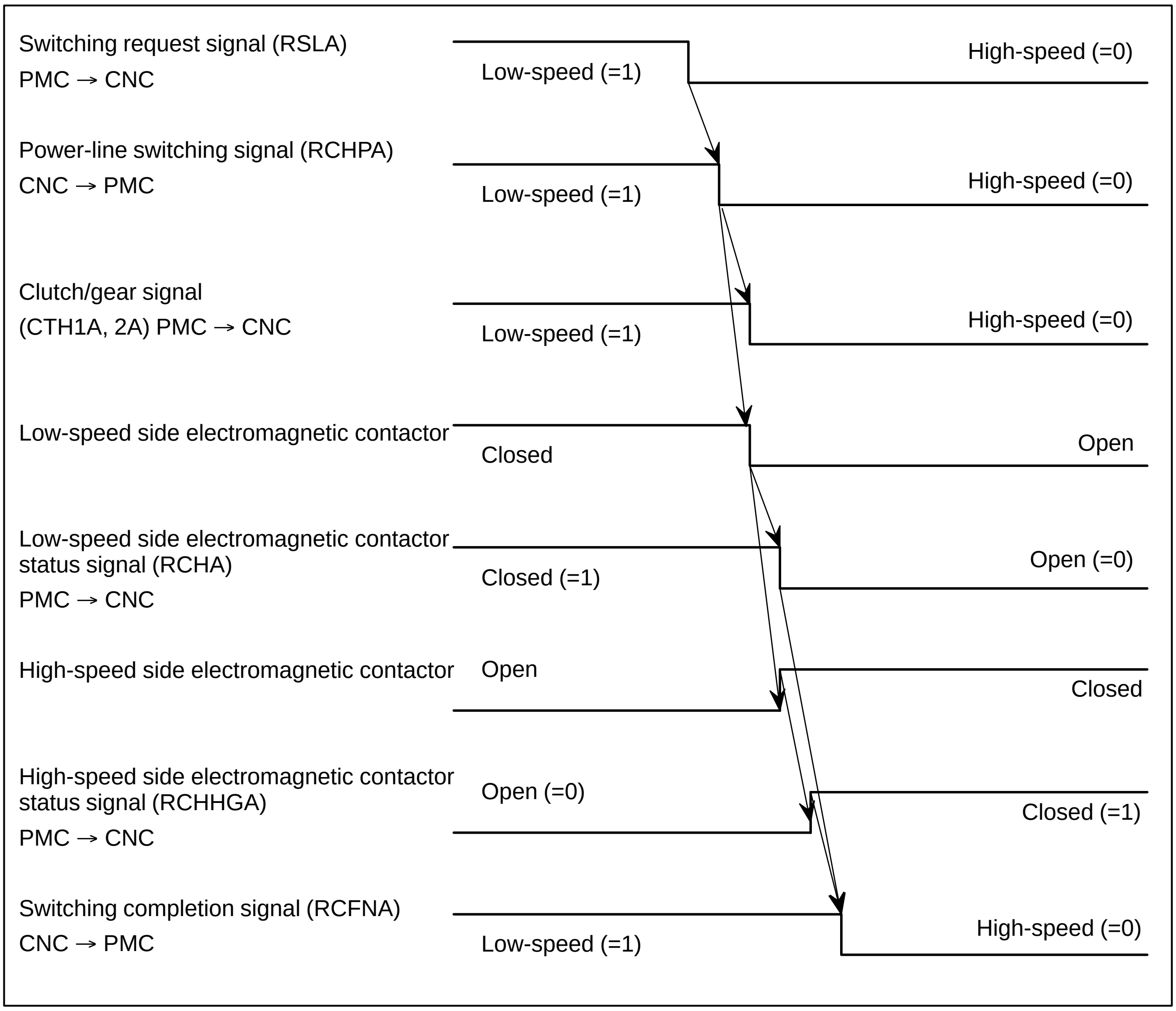
When motor load at switching-operation is supposed to be 20 percent of maximum output torque

11.5.6 Sequence

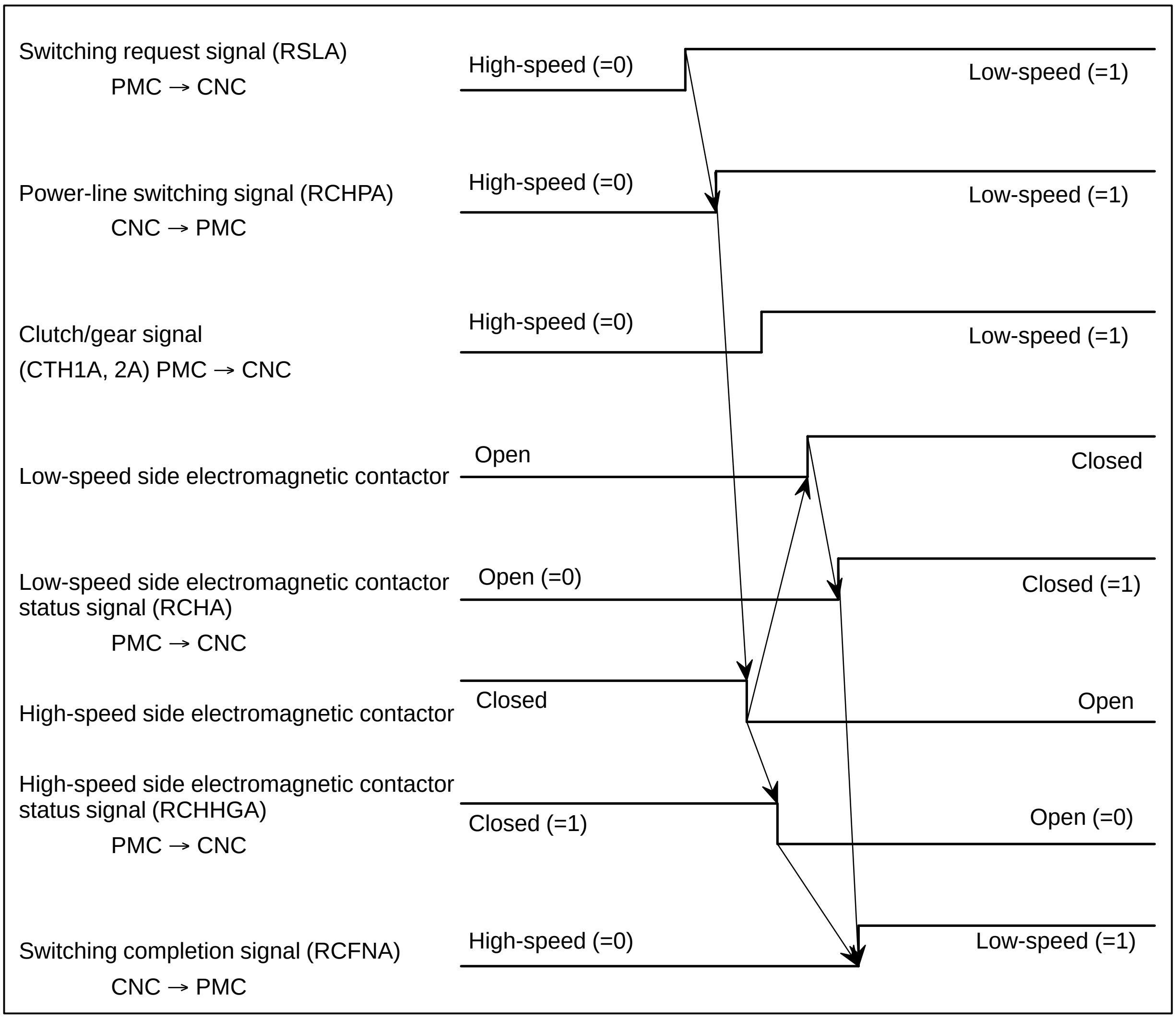
(1) When the Status of both Electromagnetic Contactors for a Low-speed Range (RCHA) and for a High-speed Range (RCHHGA) is Confirmed and the Speed Range Switching Control Works

Parameter No. 4014 #3=1 (FS16)

(a) Switching-operation of a low-speed range → a high-speed range



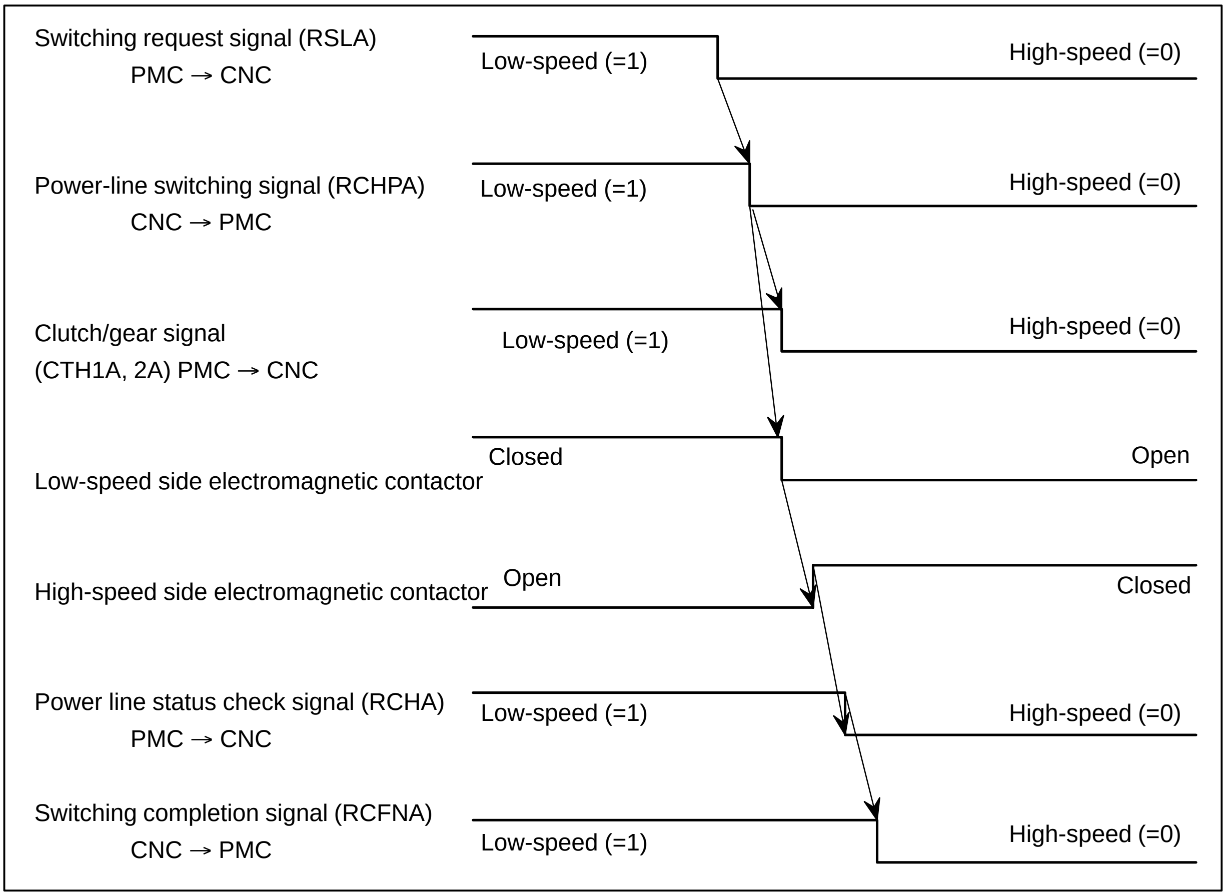
(b) Switching-operation of a high-speed range → a low-speed range



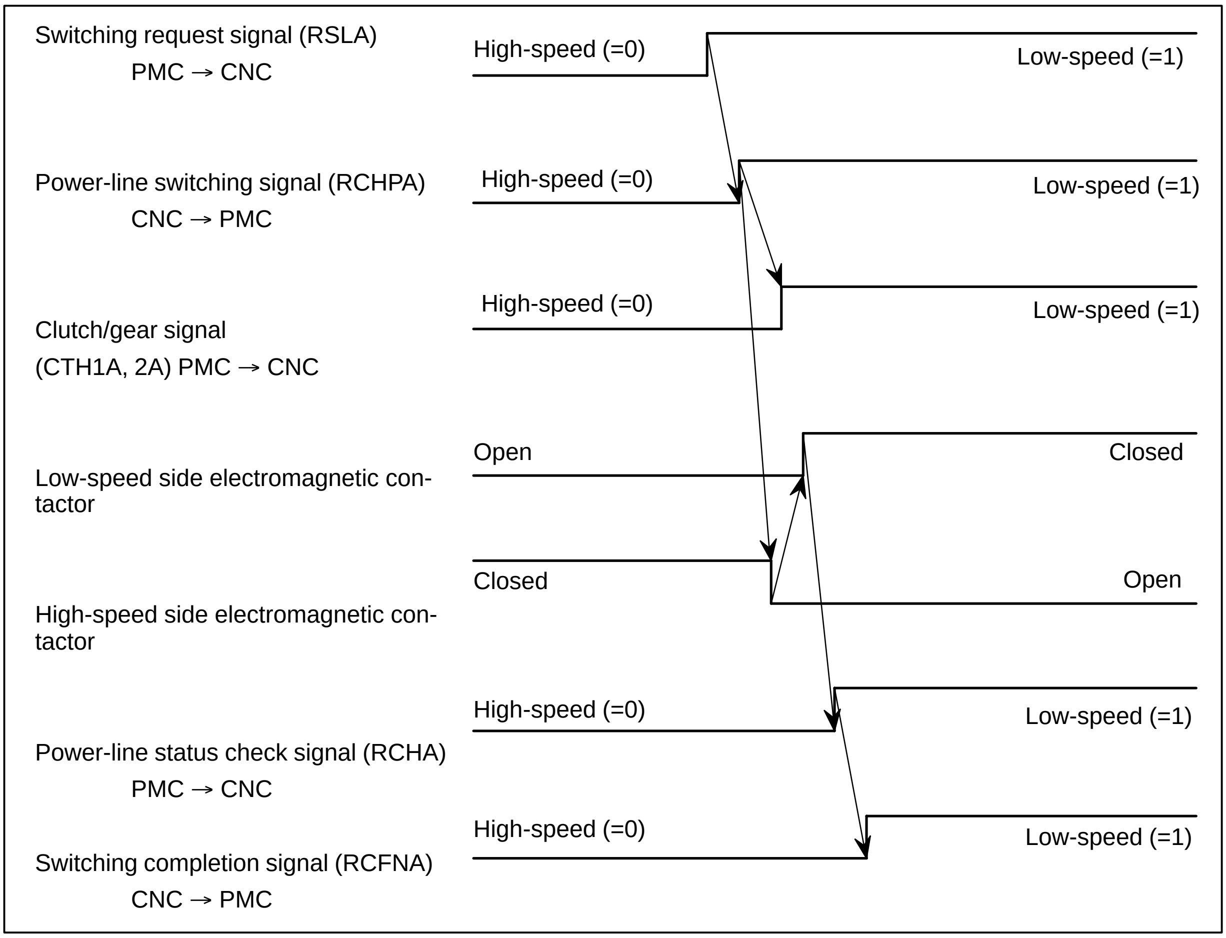
(2) When the Speed Range Switching Control Works by Confirming Only the Power-line Status Check Signal (RCHA)

For parameter No. 4014 #3=0 (FS16)

(a) Switching-operation of a low-speed range → a high-speed range



(b) Switching operation of a high speed range → a low-speed range



NOTE

1 A parameter is provided to disable switching from high–speed range to low–speed range at speeds exceeding the switchable speed (speed detection signal SDTA = 0).
2 Switch the clutch/gear signals (CTH1A, CTH2A) so that data such as velocity loop gain can be set separately for low–speed characteristics mode and high–speed characteristics mode.
3 An alarm (AL–15) is issued if the magnetic contactor signal is not applied within one second of the power line switch signal being output. Ensure that the magnetic contactor signal is applied within one second of the power line switch signal being output.
4 Because there are electromagnetic contactor operation delays etc. when checking electromagnetic contactor MCC1, MCC2 selection conditions in electromagnetic contactor MCC1 only, auxiliary contacts make sure that there is a minimum time lag of 50msec between operating the MCC1, MCC2 switch and changing the power cable condition verification signal (RCHA) with the power cable switching cable (RCHPA).

11.5.7 Parameters

The table below lists the parameters related to the speed range switching control function. Refer to the Parameter manual for details.

Parameter No.			Description
FS0	FS15	FS16	
6515#2	3015#2	4015#2	Whether the speed range switching control function is used (Set to 1.) (CNC software option is necessary.)
6514#3	3014#3	4014#3	Function for checking the statuses of the magnetic contactors for both high–speed range and low–speed range
6519#4	3019#4	4019#4	Function for checking the speed detection signal when switching from high–speed range to low–speed range
6523	3023	4023	Speed detection level
6924	3304	4160	Hysteresis for the speed detection level

11.5.8 Cautions in Use

- Use an electromagnetic contactor for speed range switching whose capacity is suited for the spindle amplifier module
  For the sake of reference, the table below lists the model ratings of electromagnetic contactors made by Fuji electric and Telemechanic.

Applicable spindle amplifier module	30-minute rated current of the amplifier (A)	Electromagnetic contactor	
		Model ratings	Flowing current (A)
SPM–2.2	13.4	SC–4–0	22
SPM–5.5	30	SC–1N	50
SPM–11	48	SC–2N	60
SPM–15	63	SC–2SN	80
SPM–22	95	SC–4N	135
SPM–26	111	SC–5N	150
SPM–30	133	SC–6N	150
SPM–45	198	SC–8N	260

- In order to suppress electrical noise generated at switching in the electromagnetic contactor for speed range switching, use a surge absorber containing resistor and capacitor.
- Setting the machine ready signal (MRDYA)
  For the purpose of safety, use two signals in the sequence that makes the system operable. These are the emergency stop signal (*ESPA) and machine ready signal (MRDYA). Set the machine ready signal (MRDYA) to 1 to allow operation of the machine.
- When conducting rigid tapping, set the desired speed range in advance and do not perform switching.
  Accordingly, when conducting rigid tapping, although the speed detection signal (SDTA) will be output from the spindle amplifier, be sure that this signal is ignored.

- Speed detection signal (SDTA) and selection signal
  Two windings are installed within the AC spindle motor. Output power characteristics can be changed by switching these two windings.
  When conducting this speed range switching (during rotation) and the rigid tapping, the control may be limited by only the high-speed winding.
  Ensure a sequence in the PMC that allows selection of 2 output power characteristics and enables selection of a switching sequence during rotation.
- Use gear/clutch signal CTH1A and CTH2A to be able to set different velocity loop gains for low-speed and high-speed.

11.6 SPINDLE SWITCHING CONTROL

11.6.1 General

Spindle switching control uses a spindle amplifier module TYPE III in a machine that has two spindle motors but does not move both simultaneously. Furthermore, it has an electromagnetic contactor to change power lines on the outside of the spindle amplifier. The function works by switching between motors with the same characteristics or two motors that have different output power characteristics.
It has the following uses.

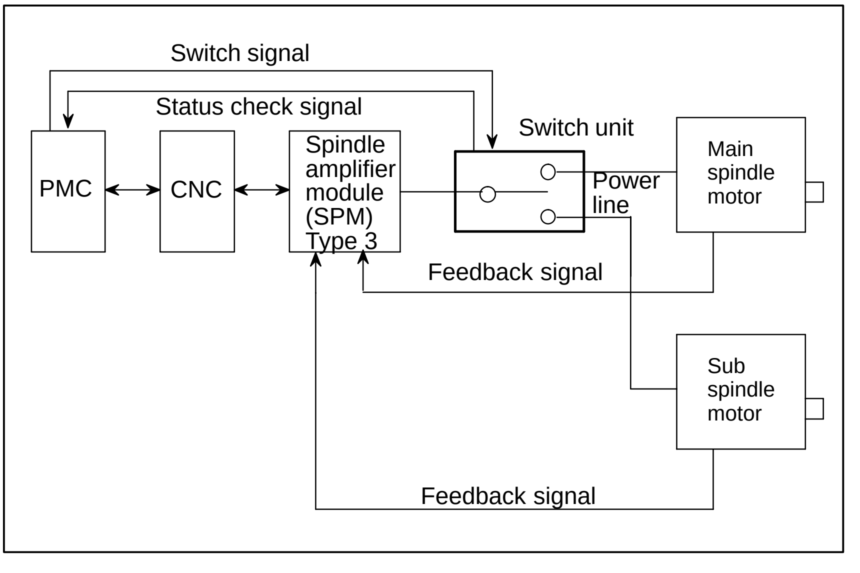
- In turning centers etc. it uses a single spindle amplifier to switch the power line, velocity feedback signal line and the orientation signal line using the Main Spindle Motor for turning and the Sub Spindle Motor for rotation tools.
- It uses a single spindle unit to switch the power line, velocity feedback signal line and the orientation signal line using the vertical axis motor and horizontal axis motor of the machine tool with five- surface machining capability.

NOTE
This function is not available for αC series.

11.6.2 Configuration

To control two spindle motors with one spindle amplifier, the following are additionally required:

- Magnetic contactor (switch unit) for power line switching
- Signals between the PMC and switch unit



11.6.3 Specifications

- By using a spindle amplifier module (SPM) of Type 3, two spindle motors are driven. The two spindle motors are switched; the two spindle motors cannot be driven at the same time.
- A combination of a main spindle motor and sub spindle motor can be selected freely from those spindle motors that can be driven by the spindle amplifier module. From the spindle amplifier modules that match two spindle motors, select that spindle amplifier module that has the larger capacity. Depending on the combination of spindle motors and spindle amplifier module, the parameters may have to be modified.
- The smallest Type 3 spindle amplifier module is SPM–11. Use SPM–11 even when small spindle motors are used.
- The feedback signals of the following detectors are switched:
  Detector built into a motor: M sensor, MZ sensor, BZ sensor (for a built–in motor)
  Detector attached to the spindle: Position coder, magnetic sensor (for orientation), proximity switch (external one–rotation signal)
- Output switch control can be applied to the main spindle motor and sub spindle motor.
- Rigid tapping can be performed with the main spindle motor and sub spindle motor.
- Orientation of position coder type can be performed with the main spindle motor and sub spindle motor when a stop position is specified by a parameter.
- Orientation of magnetic sensor type can be performed with the main spindle motor and sub spindle motor.
- To check the power line state more precisely, the state of the magnetic contactor of the main spindle motor and sub spindle motor can be entered. The following parameter settings are used for this purpose:
  FS16: Bit 2 of parameter No. 4014 = 1
  FS15: Bit 2 of parameter No. 3014 = 1
  FS0: Bit 2 of parameter No. 6514 = 1
- As the error detection function for switching operation, the alarm (AL–5) is issued if the magnetic contactor state signal (MCFNA, MFNHGA) is not applied within one second of the power line switch signal (CHPA) being output.

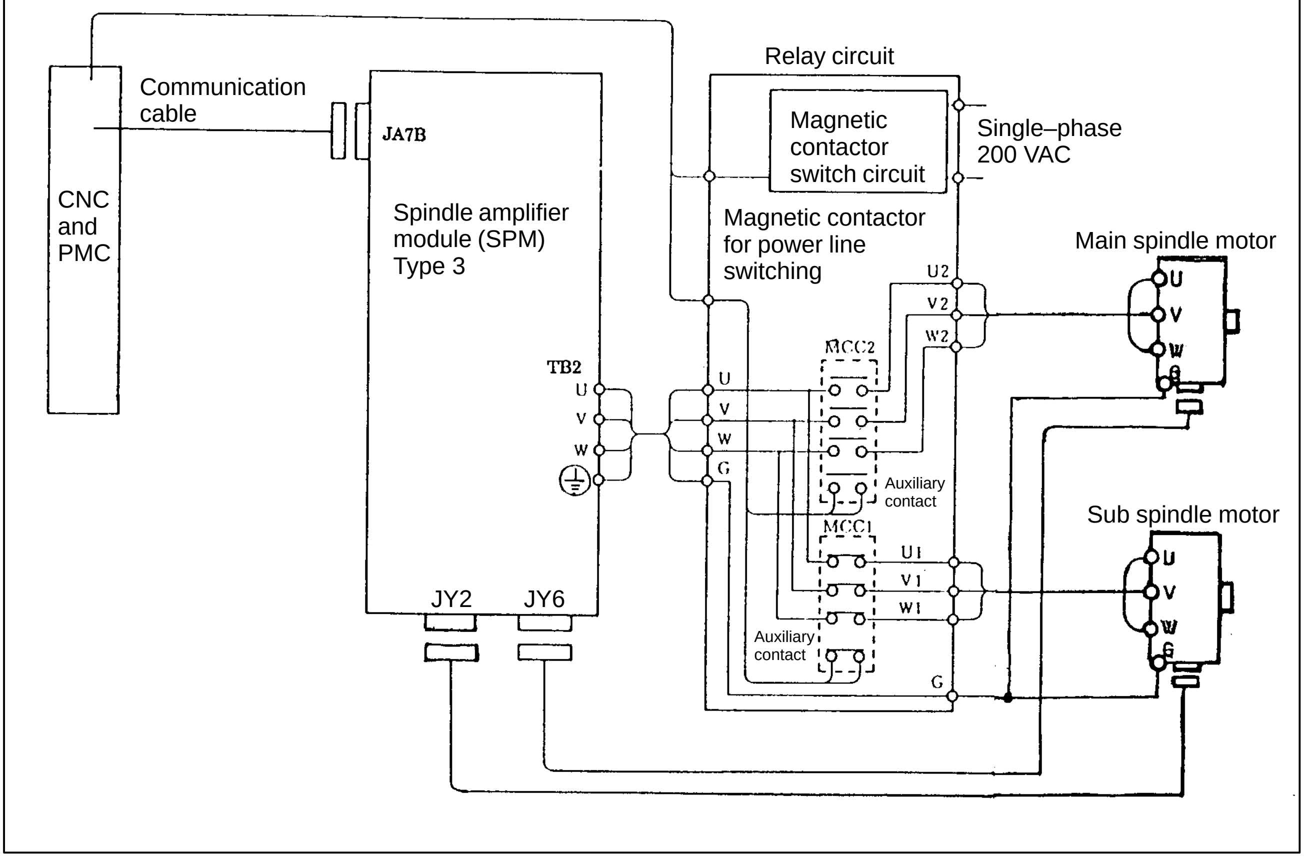
11.6.4 Restrictions

- With the spindle switch control function, the method of mounting a BZ sensor instead of a position coder onto the spindle cannot be used.
- The stop position external setting type position coder method spindle orientation can be used only on MAIN side. It is not available on SUB side.
- Spindle synchronization control is only available on the MAIN side. It is not available on the SUB side.
- The spindle index function (Cs axis control) is only available on the MAIN side. It is not available on the SUB side.

- Cs contouring control cannot be used both MAIN and SUB side.
- Gear change on the SUB side can be set to 2 stages.
- The spindle switching function can be used for the Power Mate D/F.
- The spindle switching function cannot be used for αC series.

11.6.5 Connection

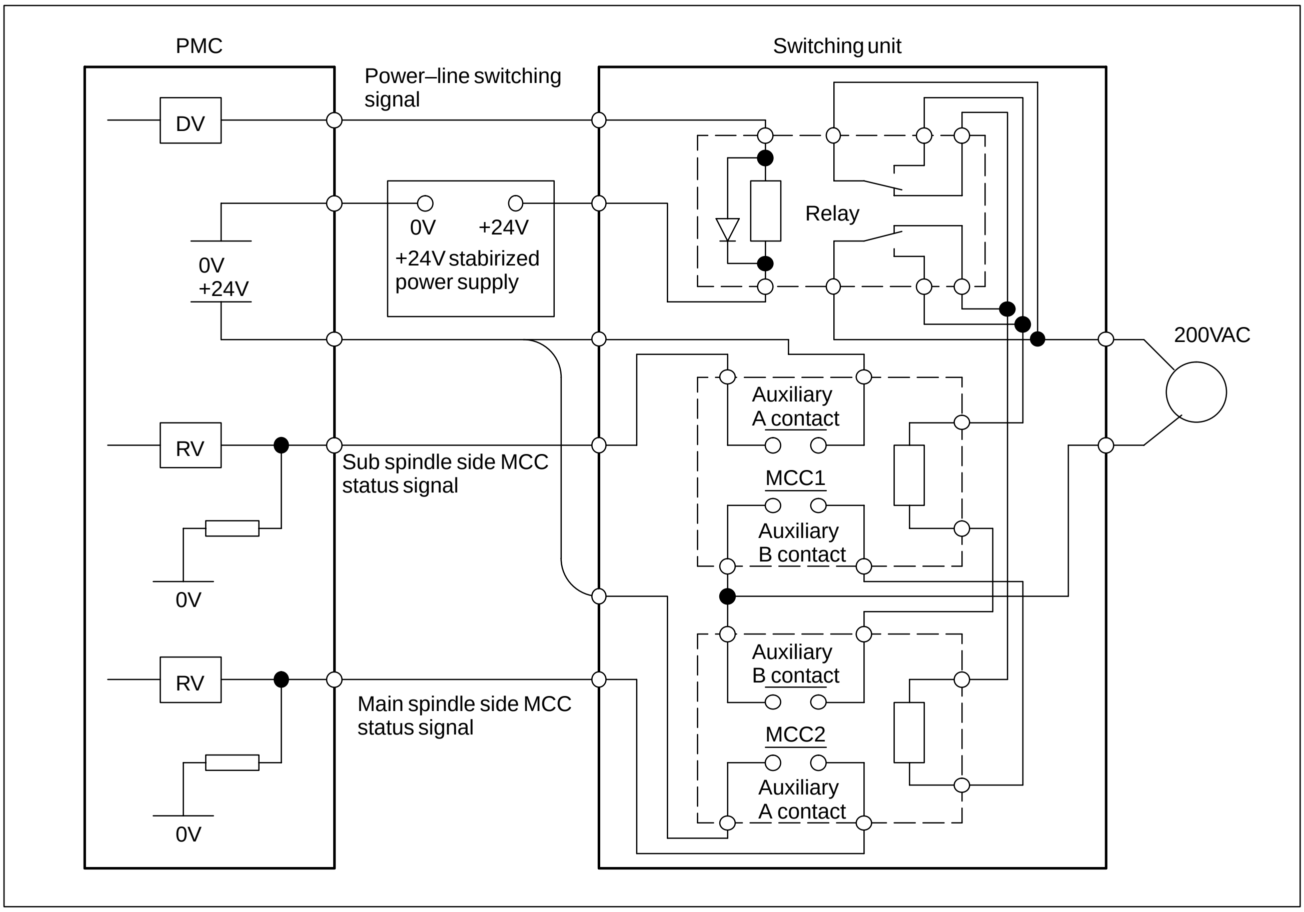
(1) Connection



> **NOTE**
> In this figure, the power supply module is omitted. The machine tool builder is to provide all units and cables other than the spindle amplifier and AC spindle motors.

(2) Details of Connections for the PMC and Switching Unit

It shows the case that the status of the electromagnetic contactors both on the MAIN spindle side and on the SUB spindle side is input.



NOTE

1 The main contact terminals and power line in contact are omitted.
2 Add a surge absorber to the electromagnetic contactor operation coil as necessary.
3 Use a power-line switching electromagnetic contactor with the proper capacity for each spindle motor.

11.6.6 Spindle Control Signals

(1) Input Signals (DI Signals) PMC to CNC

(a) Signal addresses

First spindle control input signal

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
G230	G226	G071	RCHA	RSLA	INTGA	SOCNA	MCFNA	SPSLA	*ESPA	ARSTA
G231	G229	G072	RCHHGA	MFNHGA	INCMDA	OVRA	DEFMDA	NRROA	ROTAA	INDXA

Second spindle control input signals

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
G234	G234	G075	RCHB	RSLB	INTGB	SOCNB	MCFNB	SPSLB	*ESPB	ARSTB
G235	G237	G076	RCHHGB	MFNHGB	INCMDB	OVRB	DEFMDB	NRROB	ROTAB	INDXB

(b) Switching request signal (SPSLA)

[Function] It is used as an instruction signal which selects the spindle motor.

0 : The main spindle motor is selected.

1 : The sub spindle motor is selected.

[Usage] This signal is changed after stopping the spindle motor.
Speed zero signal (SSTA) is used for confirming that a spindle motor is stopping.
Since it is necessary that motor power is off for spindle changing, please set off the spindle rotation command (SFRA/SRVA) and the spindle orientatation command (ORCMA) at switching spindle motors.

(c) Power-line status check signal (MCFNA)

[Function] The selection status signal of the electromagnetic contactor for switching the spindle motor power-lines is input.

0 : The main spindle is selected.

1 : The sub spindle is selected.

[Usage] Usually, the state of the auxiliary contact (contact A) of the magnetic contactor for the sub spindle motor is entered directly.

[Function] When bit 2 of parameter No. 4014 (FS16) is set to 0, this signal is used as the power line state check signal. So, the state of selection by the magnetic contactor for spindle motor power line switching is entered.
0: The main spindle motor is selected.
1: The sub spindle motor is selected.

[Usage] In the case of changing from the main spindle to the sub spindle, this signal is set from ”1” to ”0” after confirming that the electromagnetic contactor on the main spindle side is off and that the electromagnetic contactor on the sub spindle side is on.
In the case of changing from the sub spindle to the main spindle, this signal is set from ”0” to ”1” after confirming that the electromagnetic contactor on the sub spindle side is off and that the electromagnetic contactor on the main spindle side is on.

(d) Main spindle side electromagnetic contactor status signal (MFNHGA)

This signal is effective for parameter NO.4014 #2=1 (FS16)

[Function] The opening and closing status signal of the electromagnetic contactor for power-line on the main spindle side is input.

0 : The electromagnetic contactor on the main spindle side is open.

1 : The electromagnetic contactor on the main spindle side is closed.

[Usage] The status of the auxiliary contact (”A” contact) of the electromagnetic contactor on the main spindle side is input.
This signal is valid when bit 2 of parameter No. 4014 (FS16) is set to 1.

(2) Output Signal (DO signal) CNC to PMC

(a) Signal addresses

First spindle control output signal

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
F281	F229	F045	ORARA	TLMA	LDT2A	LDT1A	SARA	SDTA	SSTA	ALMA
F282	F228	F049	MOAR2A	MOAR1A	POAR2A	SLVSA	RCFNA	RCHPA	CFINA	CHPA

Second spindle control output signals

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
F285	F245	F049	ORARB	TLMB	LDT2B	LDT1B	SARB	SDTB	SSTB	ALMB
F286	F244	F050	MOAR2B	MOAR1B	POAR2B	SLVSB	RCFNB	RCHPB	CFINB	CHPB

(b) Power-line switching signal (CHPA)

[Function] It is an instruction signal to select the electromagnetic contactor for switching the spindle motor power-line.

0 : The electromagnetic contactor for the main spindle should be selected.

1 : The electromagnetic contactor for the sub spindle should be selected.

[Usage] This signal is output after receiving the switching request signal (SPSLA).
This signal selects the electromagnetic contactor for switching the spindle motor power-line.
At changing from the sub spindle to the main spindle, this signal changes from ”1” to ”0” after the switching request signal (SPSLA) is received. As a result, the electromagnetic contactor for the sub spindle is first turned off. After it is confirmed to have turned off the electromagnetic contactor for the sub spindle, the electromagnetic contactor for the main spindle is turned on.
At changing from the main spindle to the sub spindle, this signal changes from ”0” to ”1” after the switching request signal (SPSLA) is received. As a result, the electromagnetic contactor for the main spindle is first turned off. After it is confirmed to have turned off the electromagnetic contactor for the sub spindle is turned on.

(c) Switching completion signal (CFINA)

[Function] This signal shows by which spindle characteristic the spindle motor is controlled.

0 : It is controlled by a main spindle characteristic.

1 : It is controlled by a sub spindle characteristic.

[Usage] The switching request signal (SPSLA) changes, and after it is confirmed that this signal is corresponding to the switching request signal (SPSLA), it moves to the next movement.
Since it is necessary that the motor power is off until this signal is corresponding to the switching request signal (SPSLA) after the change of the switching request signal (SPSLA), please set off the spindle rotation command (SFRA/SRVA) and the spindle orientation command (ORCM) at the switching operation.

(d) Speed zero signal (SSTA)

[Function] It becomes ”1” while the motor speed is below the speed zero detection level which is set by parameter.

0 : It is above the speed zero detection level.

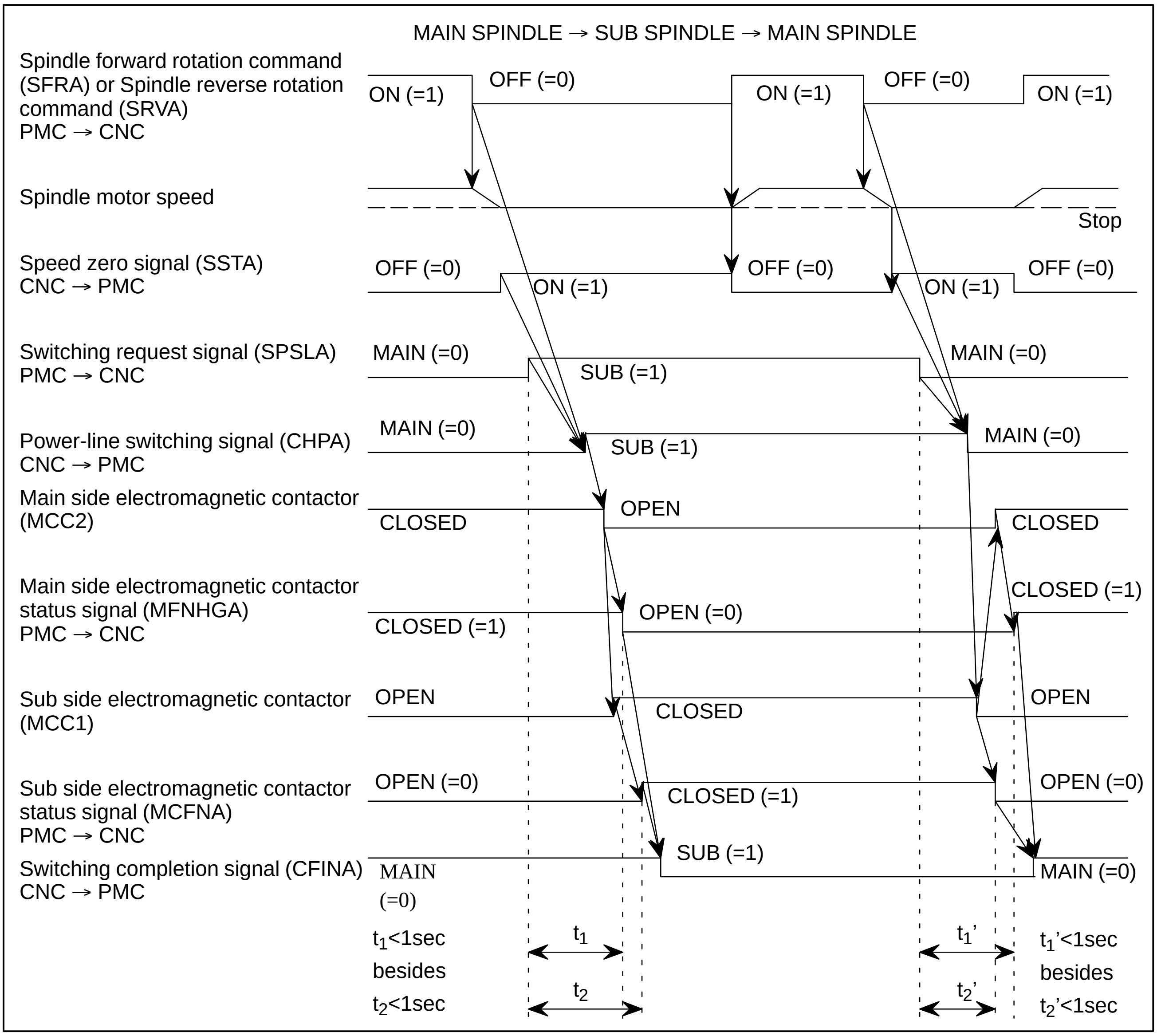
1 : It is below the speed zero detection level.

[Usage] At switching the spindle, it is necessary both that the motor power is off and that the motor is stopping.
This signal is used for confirming whether the motor is stopping.

11.6.7 Sequence

(1) When the Status of both Electromagnetic Contactors for the Sub Spindle (MCFNA) and for the Main Spindle (MFNHGA) is Confirmed on the Spindle Side and the Spindle Switching Control Works

Parameter NO.4014 #2=1 (FS16)

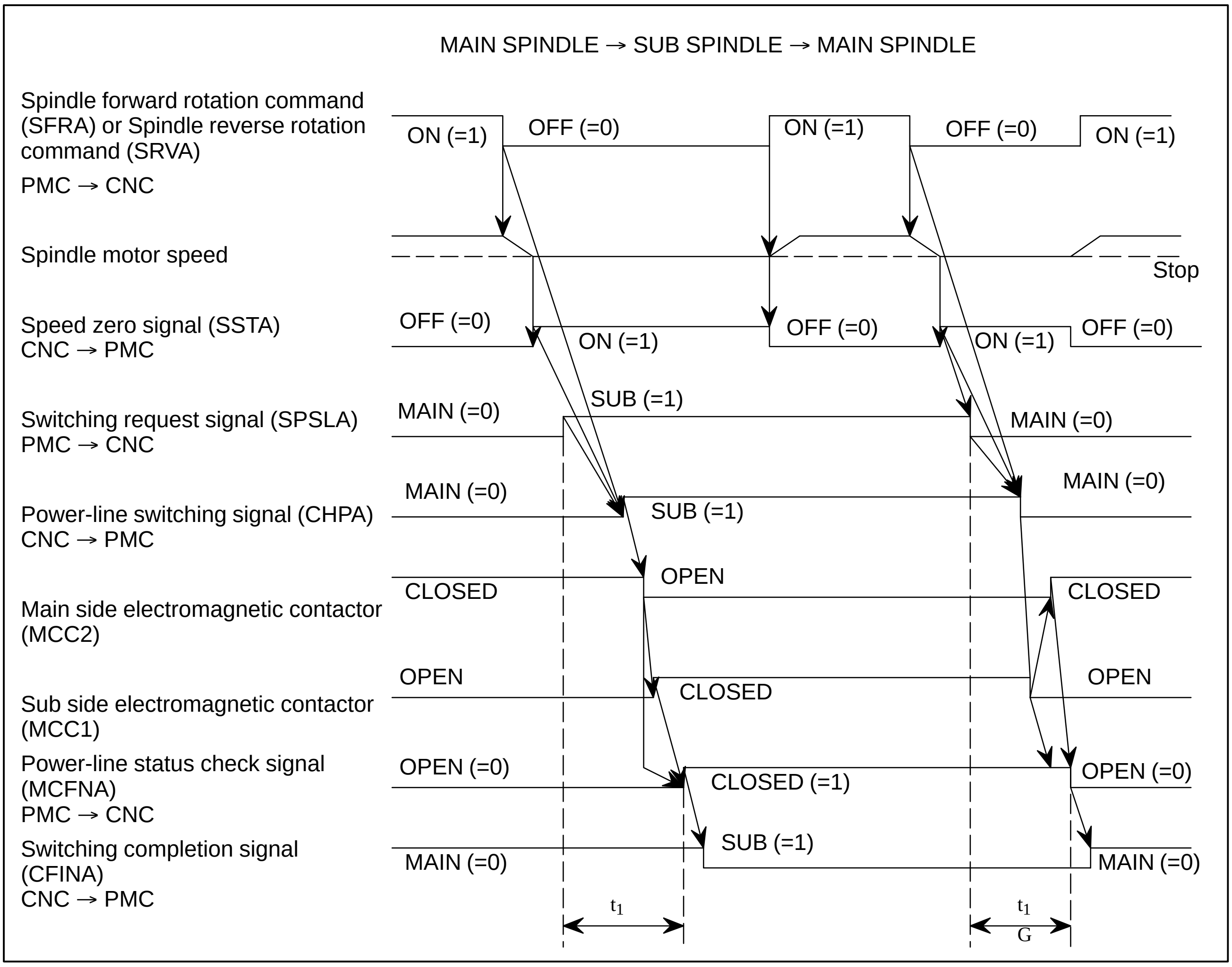


NOTE

If the electromagnetic contactor status check signals for the main spindle (MFNHGA) and for the sub spindle (MCFNA) do not change within 1 second after the switching request signal (SPSLA) is changed, the alarm occurs.

(2) When the Spindle Switching Control Works by Confirming Only the Power-line Status Check Signal (MCFNA)

For parameter No. 4014#2=0 (FS16)



NOTE

1 Because there are electromagnetic contactor operation delays etc. when checking electromagnetic contactor MCC1, MCC2 selection conditions in electromagnetic contactor MCC1 (see PMC and switching unit contact details) only, auxiliary contacts make sure that there is a minimum time lag of 50 msec between operating the MCC1, MCC2 switch and changing the power cable condition verification signal (MCFN) with the power cable switching signal (CHP).

2 If the power-line status signal (MCFNA) doesnot change within 1 second after the switching request signal (SPSLA) is changed, the alarm occurs.

11.6.8 Parameters

Refer to the Parameter manual for details of parameters.

- Automatic initial setting of spindle parameters can also be performed for the sub spindle.
- The table below lists the parameters related to the spindle switching control function.

Parameter No.			Description
FS0	FS15	FS16	
6514#0	3014#0	4014#0	Whether the spindle switching control function is used (Set to 1.)
6514#1	3014#1	4014#1	Whether the spindle switching control function is enabled during rotation of the sub spindle
6514#2	3014#2	4014#2	Function for checking the statuses of the magnetic contactors both for the main spindle and for the sub spindle
6524	3024	4024	Zero speed detection level (for the main spindle)
6163	3343	4199	Zero speed detection level (for the sub spindle)

- The following parameters may have to be changed depending on the combination of the two motors and the spindle switching control. Manually change the parameters after automatic parameter setting.

Parameter No.						Description
FS0		FS15		FS16		
Main	Sub	Main	Sub	Main	Sub	
6513 #6 to 2	6153 #6 to 2	3013 #6 to 2	3333 #6 to 2	4013 #6 to 2	4189 #6 to 2	Data on dead zone for current
6610	6228	3110	3408	4110	4264	Current conversion constant
6612	6230	3112	3410	4112	4266	Current prediction constant

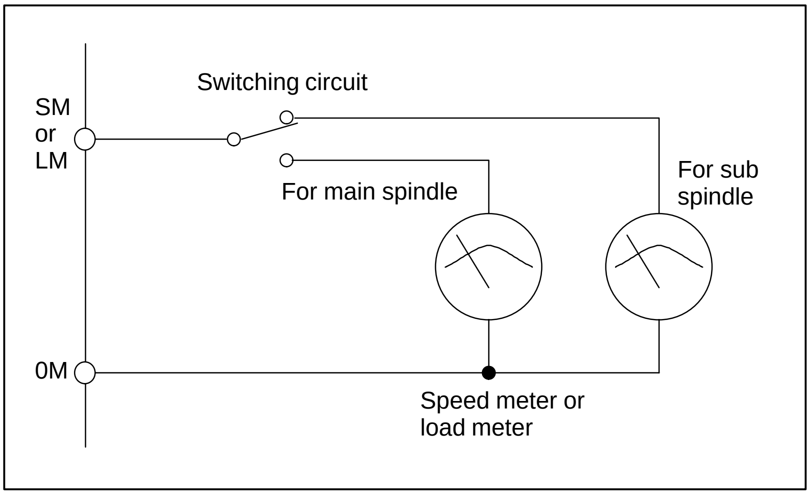
11.6.9 Cautions in Use

- The magnetic contact for switching the power line must have an adequate capacity for the spindle amplifier module.
  The example given below shows the model codes of Fuji Electric Co., Ltd.

Applicable spindle amplifier	30min. rated current for amplifier (A)	Magnetic contactor	
		Model code	Flowing current (A)
SPM–11	48	SC–2N	60
SPM–15	63	SC–2SN	80
SPM–22	95	SC–4N	135
SPM–26	111	SC–5N	150
SPM–30	133	SC–6N	150
SPM–45	198	SC–8N	260

- To suppress electrical noise generated while the magnetic contact switches power lines, use a surge absorber containing resistors and capacitors.

- The indicated voltages for the speed meter and load meter of the main spindle may differ from those of the sub spindle. In this case, switch between the speed meter or load meter for the main spindle and sub spindle as follows.



11.7 SWITCHING UNIT

11.7.1 General

The switching unit uses an electromagnetic contactor outside the spindle amplifier module to switch power lines for spindle switching control for two motors or for speed range switching control for a motor in the following cases:

- Switching a power line from one motor to another motor (spindle switching control)
- Switching a power line for a motor which has two types of windings (speed range switching control)

> **NOTE**
> This unit cannot be used for αC series.

11.7.2 Specification No.

Specification No.	Application	Applicable amplifier
A06B–6078–K034	For spindle switching control and for speed range switching control (Type B)	SPM–15 or less
A06B–6078–K035	For speed range switching control (Type A)	
A06B–6078–K036	For spindle switching control and for speed range switching control (Type B)	SPM–30 or less
A06B–6078–K037	For speed range switching control (Type A)	

> **NOTE**
> Type A : Switching the 人-△ connection for the motor winding.
>
> Type B : Switching the 人-人 connection for the motor winding.

11.7.3 Specifications

(1) Specifications of Electromagnetic Contactors

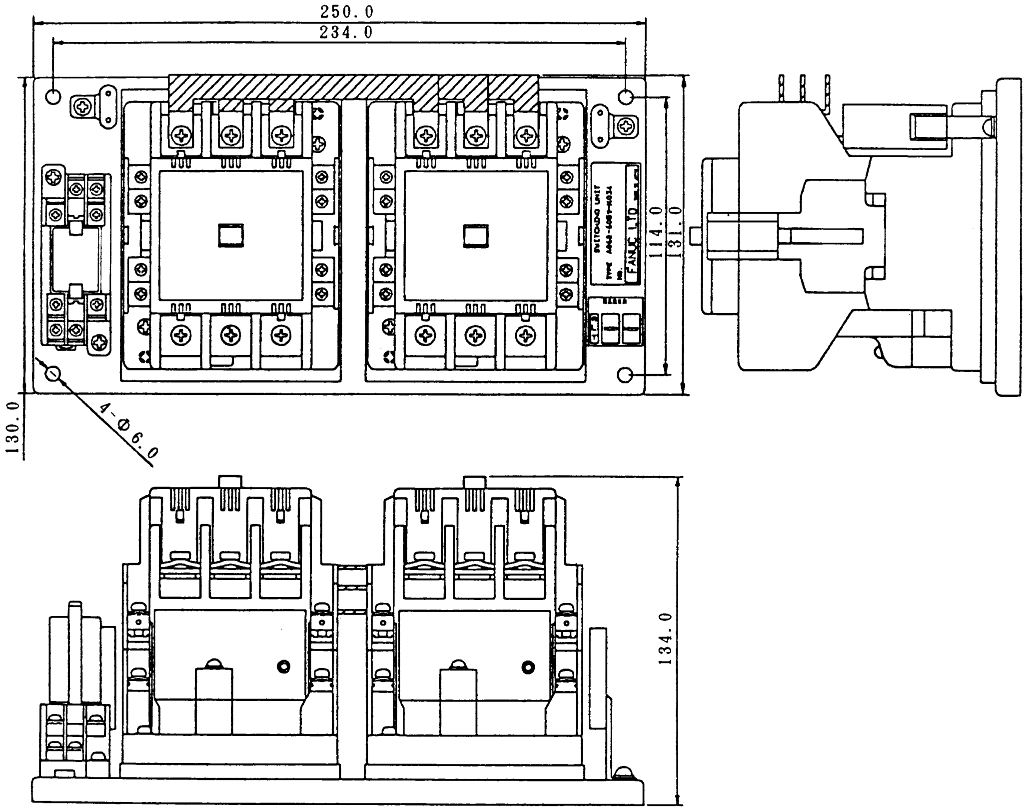
FANUC purchase code No.	A58L-0001-0306 (SC-3N manufactured by Fuji Electric)		A58L-0001-0312 (SC-6N manufactured by Fuji Electric)	
Rated operating voltage	220 V		220 V	
Rated operating current	65 A		125 A	
Current capacity for the closed circuit and shut-off	Closed circuit	780A	Closed circuit	1500A
	Shut-off	650A	Shut-off	1250A
Frequency of switching operation	1200 times/hour or more			
Life expectancy of the switching operation	Mechanical	5 million times or more		
	Electrical	1 million times or more		
Rating of the electromagnetic operation coil	200/220 V, –15%, +10%, 50/60 ± 1 Hz			
Applicable spindle amplifier module	SPM–15 or less		SPM–30 or less	

(2) Specifications of the Relay

FANUC purchase code No.	A58L-0001-0307 (LY2-D manufactured by Omron)
Rated voltage	24V ± 10%
Rated current	36.9 mA

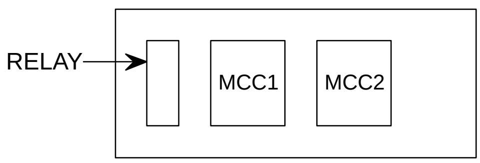
11.7.4 External Dimensions and Dimensions for Mounting

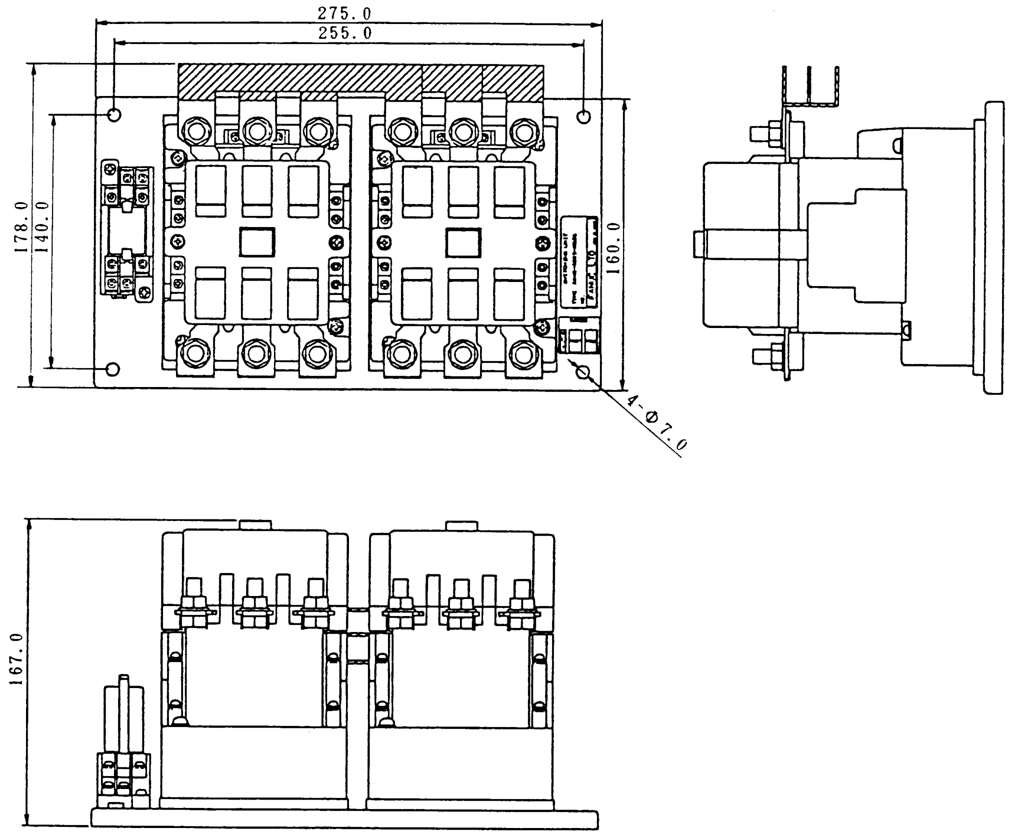
(1) External Dimensions and Dimensions for Mounting the Switching Unit for the Spindle Switching Control and Speed Range Switching Control (Type B: Y-Y Connection)



A06B-6059-K034

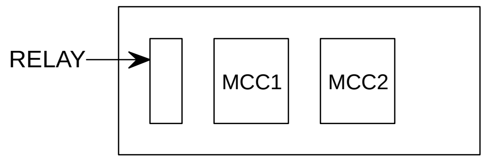
Layout Drawing



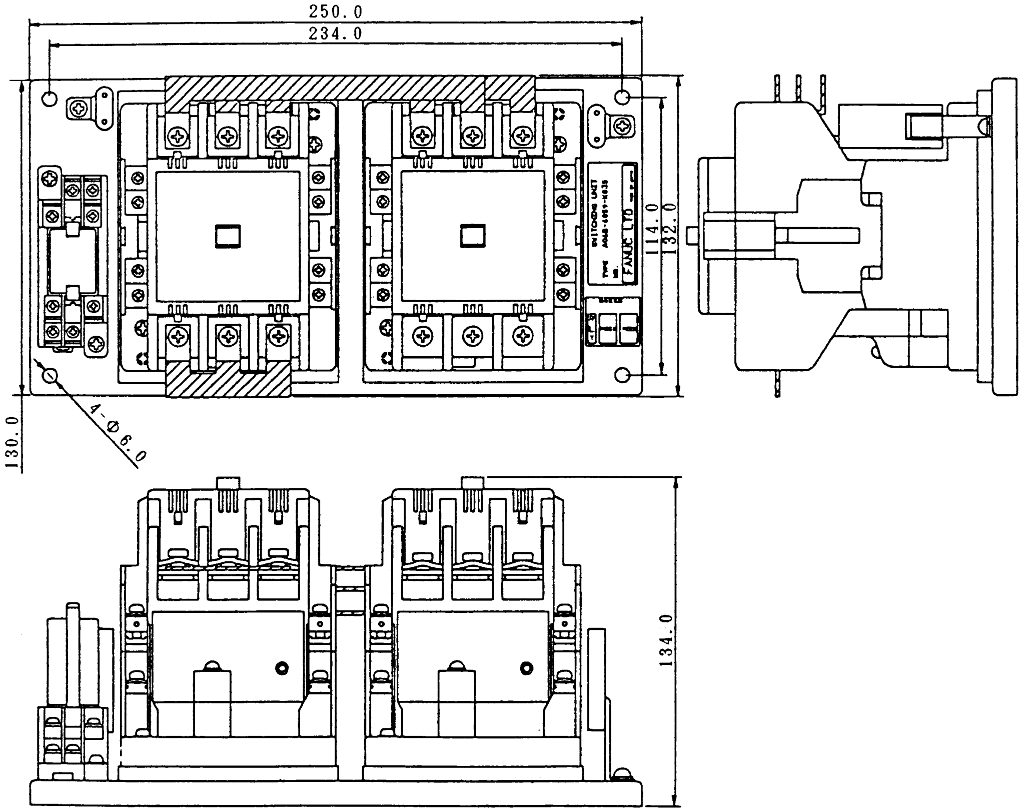


A06B-6059-K036

Layout Drawing

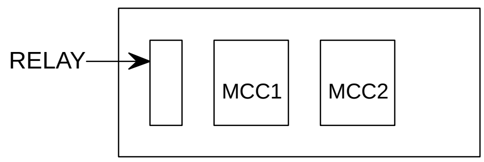


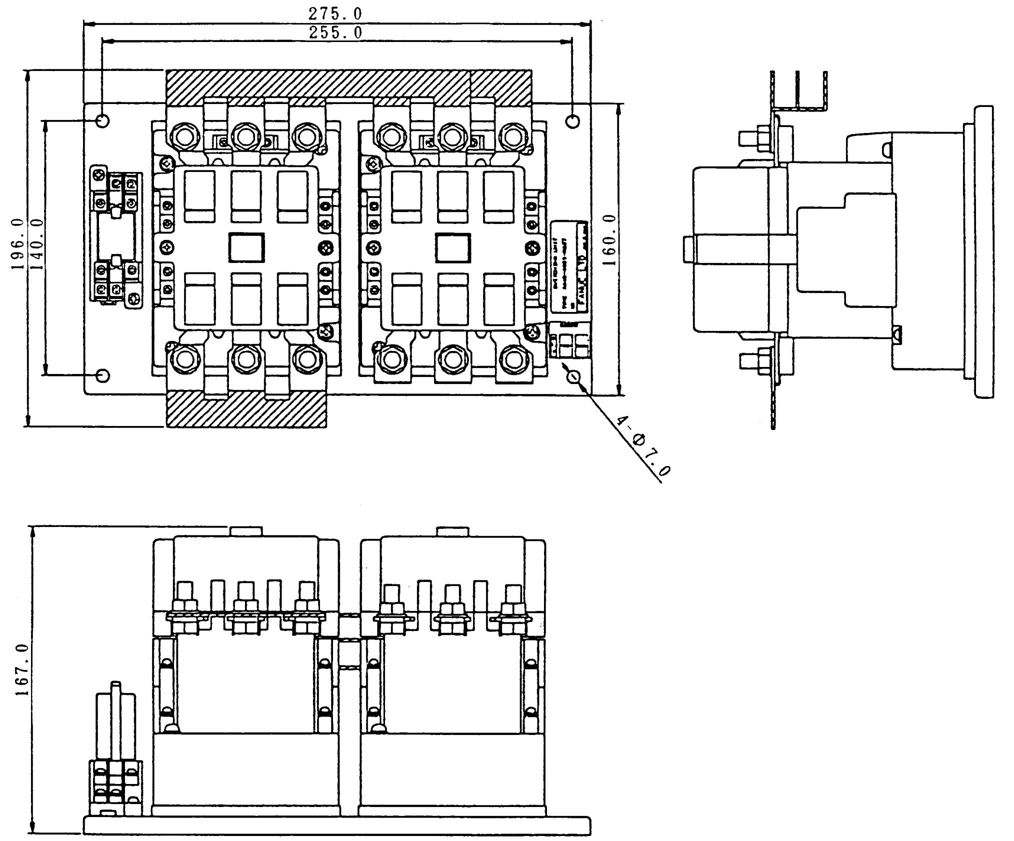
(2) Outside Dimensions and Dimensions for Mounting the Switching Unit for Speed Range Switching Control (Type A: 人-Δ Connection)



A06B-6059-K035

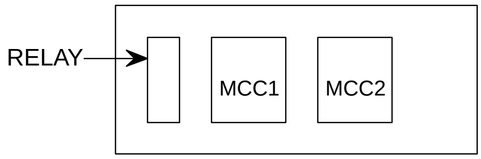
Layout Drawing





A06B-6059-K037

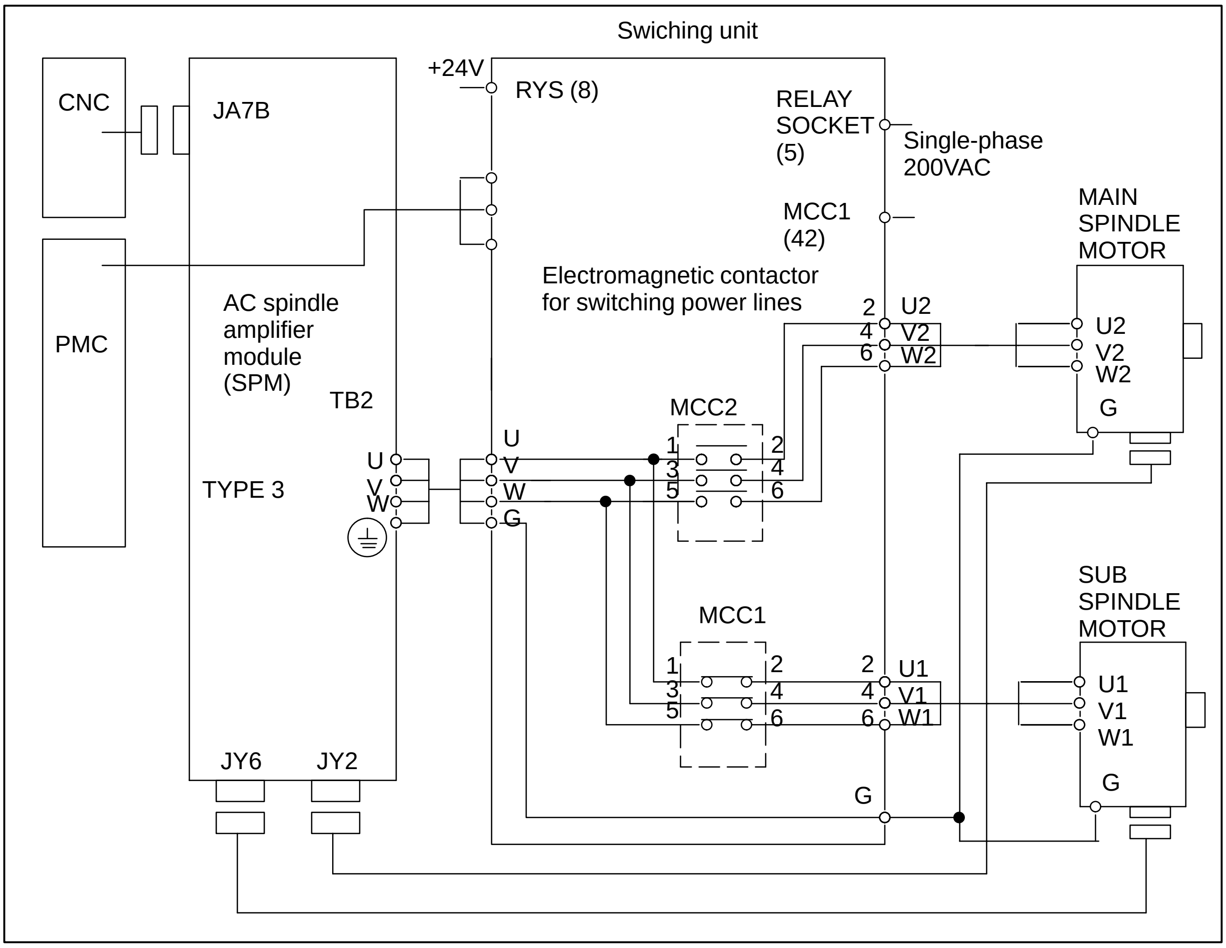
Layout Drawing



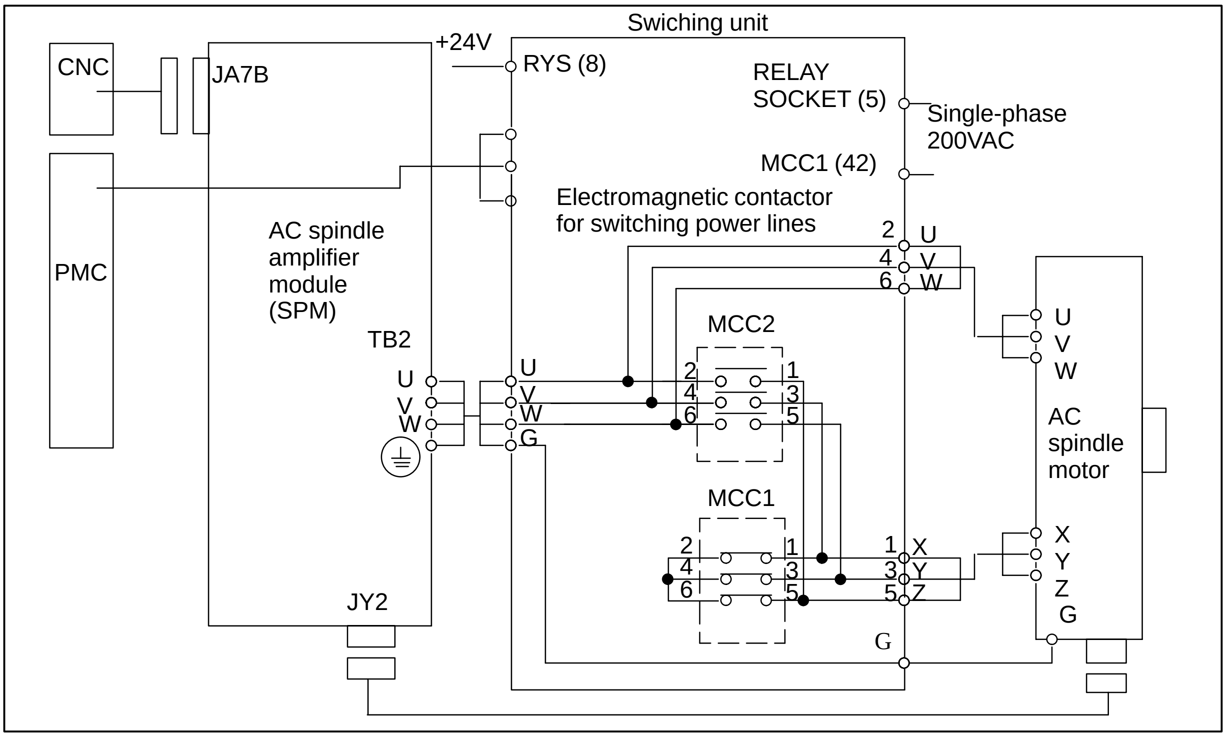
11.7.5 Connection

Complete Schematic Drawing

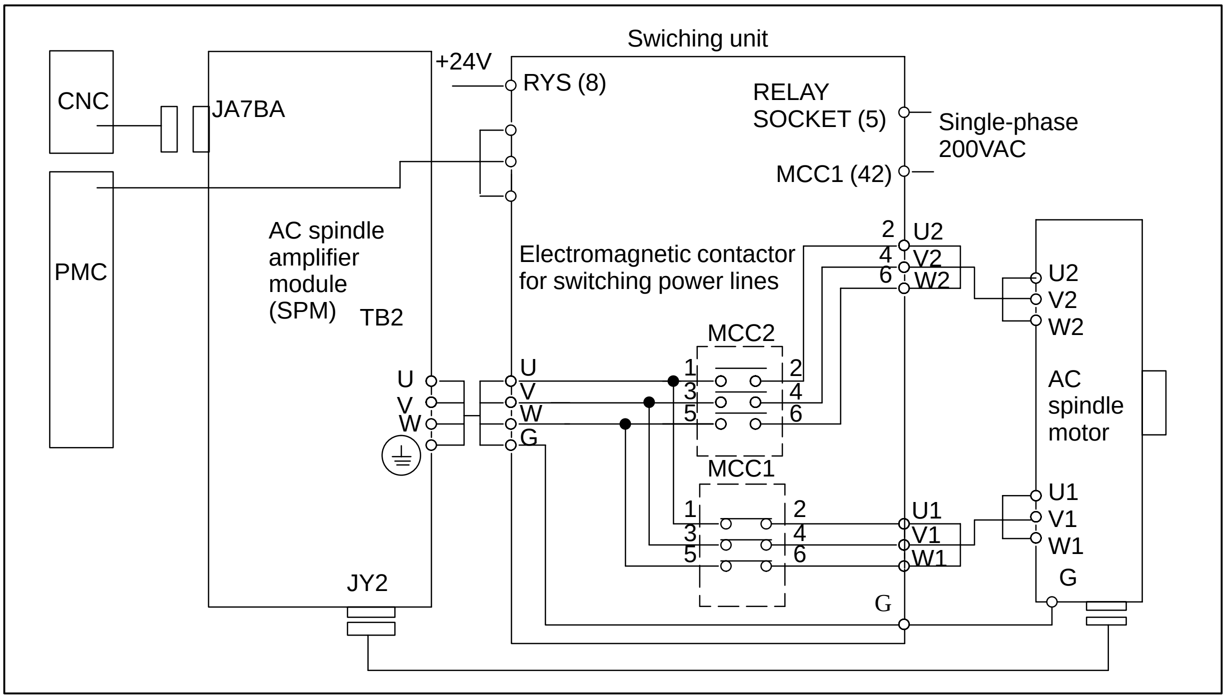
(1) Schematic Drawing of the Switching Unit for Spindle Switching Control



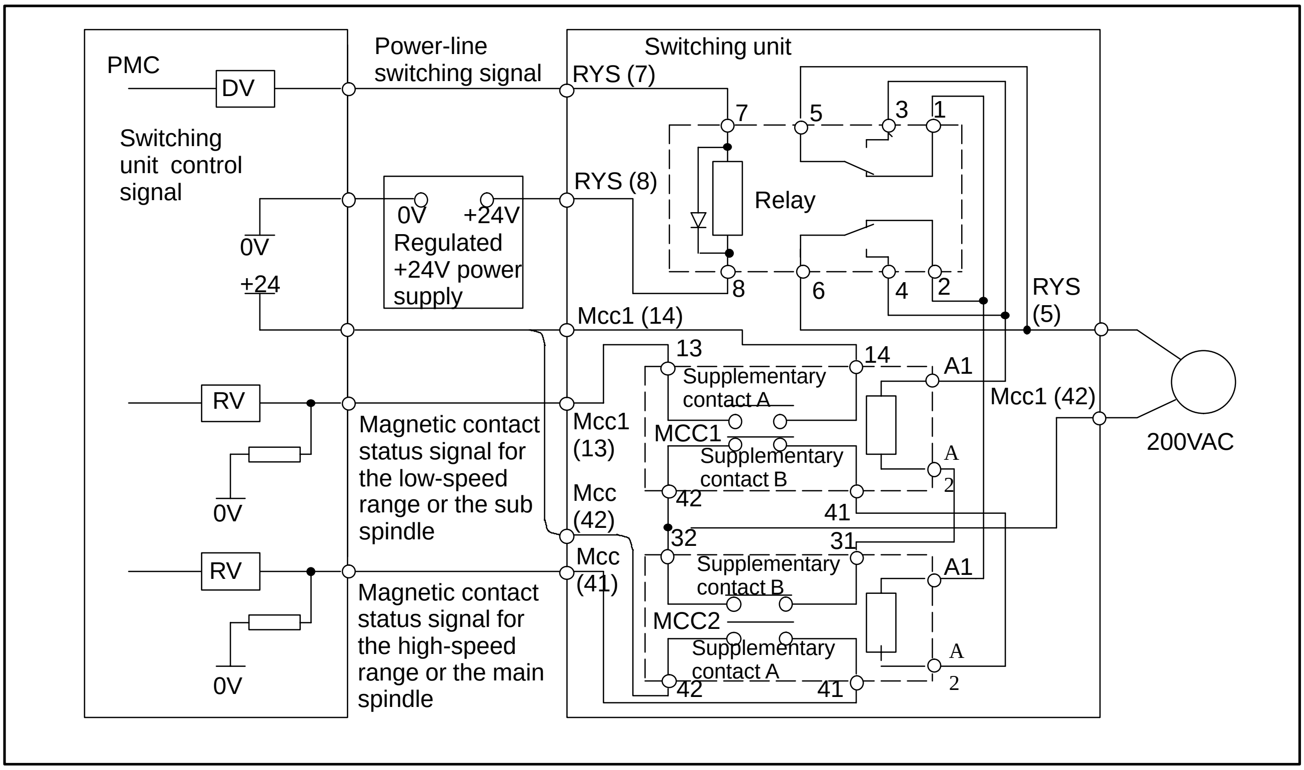
(2) Schematic Drawing of the Switching Unit for Speed Range Switching Control (Type A: ⅄-Δ Connection)



(3) Schematic Drawing of the Switching Unit for Speed Range Switching Control (Type B: ⅄-⅄ Connection)



(4) Detailed Diagram of Connections between the PMC and the Switching Unit



NOTE
1 Connect the PMC to the switching unit at the screw terminals of the electromagnetic contactor and relay socket with screws.
2 For information on interface signals, see sections 11.5 and 11.6.

11.7.6 Caution in Use

- Install the switching unit under the same conditions as for a spindle amplifier.

  Conditions for installing the switching unit

  ❑ Ambient temperature:
  0 to 55°C for the unit
  0 to 45°C for the cabinet

  ❑ Ambient humidity: 90%RH or less, no condensation

  ❑ Vibration : 0.5 G or less during operation

  ❑ Ambient air : Corrosive, conductive mist or water drops must not come into direct contact with electronic circuits.

- Install the switching unit according to Fig. 11.7.6 (a). An inclination of 15 degrees is permitted in the right, left, front, and back.

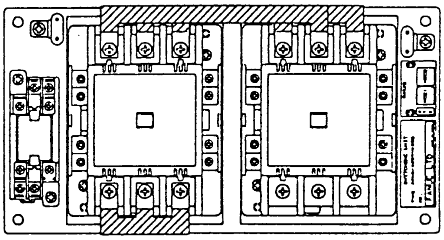


Fig.11.7.6 (a) Standard Installation (for A06B-6078-K035)

- It may be necessary to install the unit on its side as shown in Fig. 11.7.6 (b), due to wiring or space limitations. The characteristics of the electromagnetic contactor will not be affected, however, the mechanical life of the unit and the number of times the contactor can be opened and closed will be decreased.

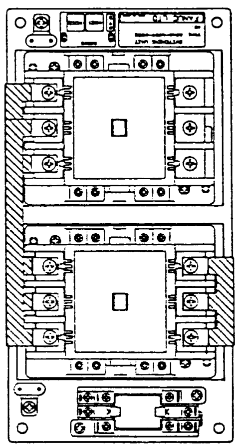


Fig.11.7.6 (b) Non-standard Installation (for A06B-6078-K035)

- Leave enough space to prevent arc from affecting other units, as shown in Fig. 11.7.6 (c).

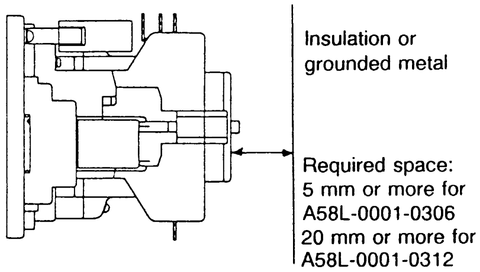


Fig.11.7.6 (c) Required Space

- If an electromagnetic contactor is installed incorrectly, contacts may jump at power on or its life may be decreased. If a cable is not connected to the contactor securely, the connected part may generate heat or the cable may loosen and come off, resulting in a serious accident.

❑ Tightening torque

◆ Electromagnetic contactor

Item	Tightening torque (kg · cm)	
	A58L-0001-0306	A58L-0001-0312
MCC main terminal	62.0 (M6.0)	84.0 (M8.0)
MCC supplementary terminal	14.0 (M3.5)	14.0 (M3.5)

◆ Relay socket

Item	Tightening torque (kg · cm)
Relay socket	14.0 (M3.5)

11.8 DIFFERENTIAL SPINDLE SPEED CONTROL

11.8.1 Outline

Differential spindle speed control relatively controls the rotation speed of spindle 2 for the rotation speed of spindle 1.

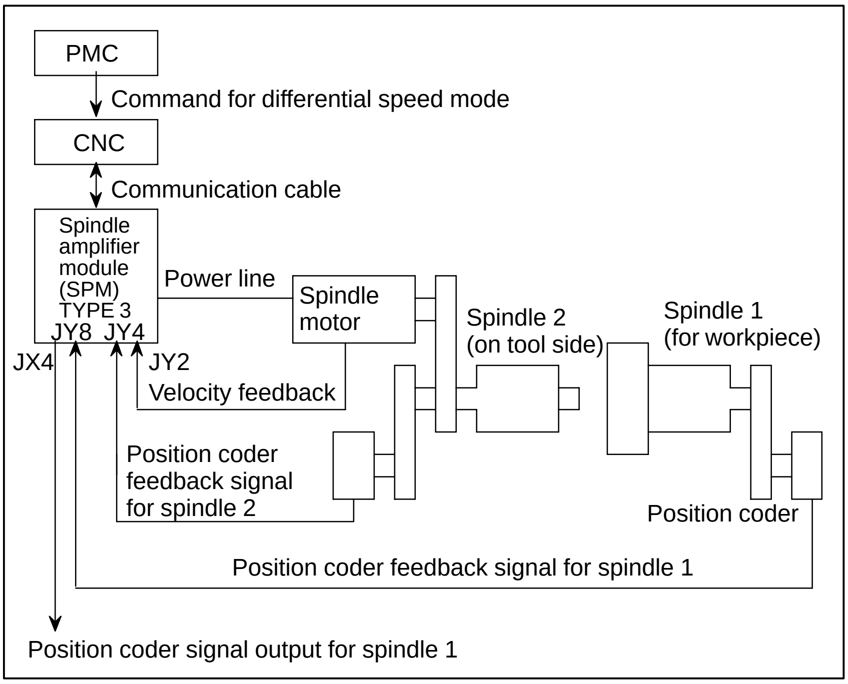
NOTE
This function is not available for αC series.

11.8.2 Characteristic

The Rigid Tap movement can be done without stopping the rotation of work (Spindle 1). So far, to do the Rigid Tap, it was necessary to stop spindling it temporarily. It is possible to shorten the time by using this function.

11.8.3 Configuration and Ordering Number

Configuration



11.8.4 Specifications of the Position Coder Signal

- The position coder signal for spindle 1, input to connector JY8, is output from connector JX4.
- High resolution magnetic pulse coder can't be used when you use this differential speed control function.
- Unite position coders by 1:1 against Spindle 1
- Use the position coders of the signal 1024p/rev or 512p/rev output. (set with parameters)
- At the differential speed Rigid Tap, a rotating speed of spindle 2 (commanded speed at Rigid Tap + rotating speed of Spindle 1) must not be over the maximum speed range.
  In the range where the rotating speed is high, the output torque of the motor becomes small generally. For that set acceleration/deceleration time constant at the Rigid Tap more largely than usually.
- Refer to the item of the Rigid Tap of the operator's manual of CNC for use concerning the Rigid Tap.

11.8.5 Signal Explanation

(1) DI Signal (PMC to CNC)

First spindle control input signal

FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
G231	G229	G072	RCHHGA	MFNHGA	INCMDA	OVRA	DEFMDA	NRROA	ROTAA	INDXA

Second spindle control input signals

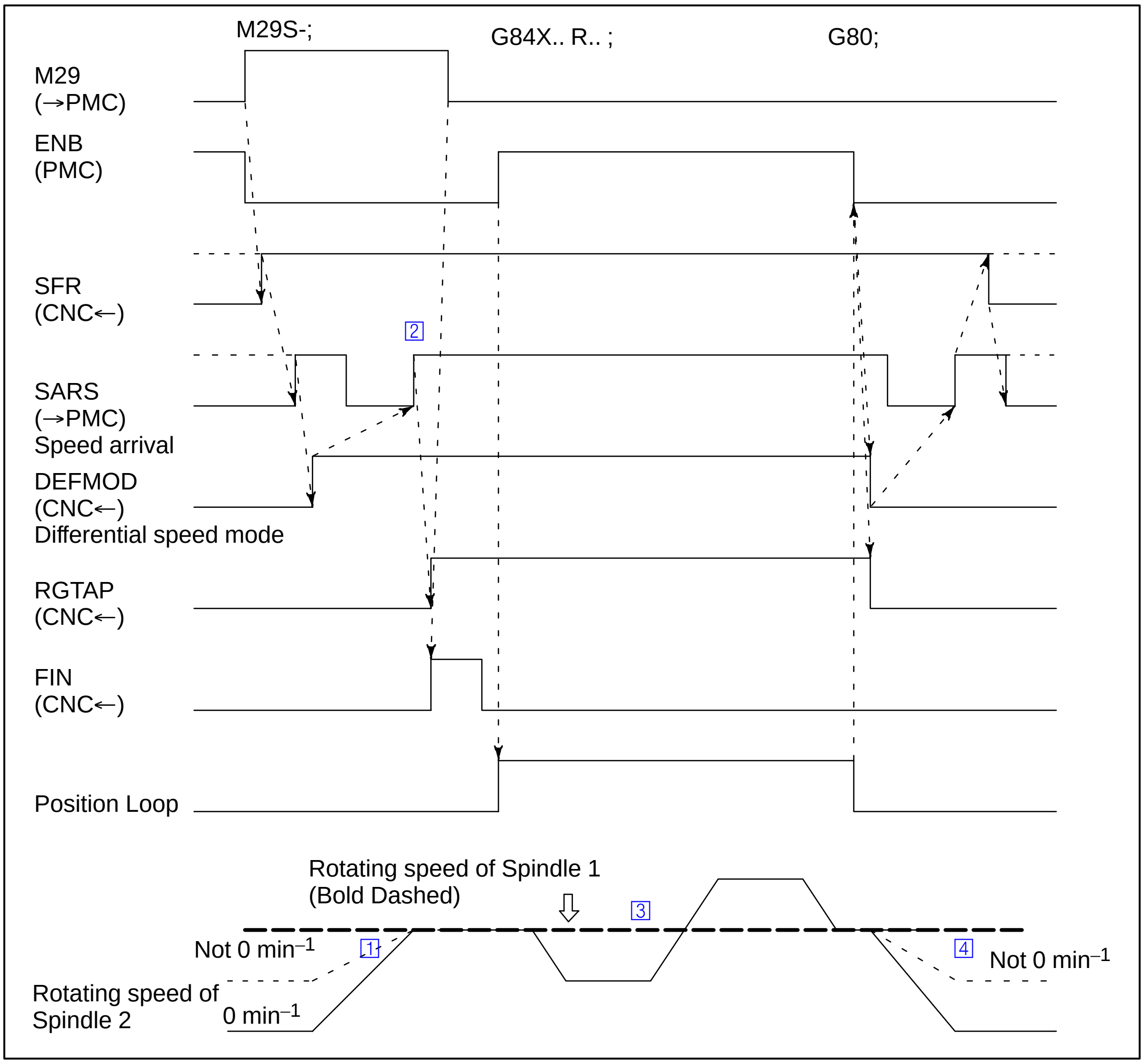
FS0	FS15	FS16	#7	#6	#5	#4	#3	#2	#1	#0
G235	G237	G076	RCHHGB	MFNHGB	INCMDB	OVRB	DEFMDB	NRROB	ROTAB	INDXB

Differential speed mode command DEFMDA

[FUNCTION] Differential speed mode is specified for the spindle amplifier.
0: Normal mode
1: Differential speed mode

[MOVEMENT] While this signal is set to 1, the second spindle is controlled in differential speed mode. In differential speed mode, the second spindle is controlled so that its speed is the sum of the specified speed of the second spindle and that of the first spindle.

11.8.6 Example of Sequence of Differential Speed Rigid Tap



1 When differential speed mode is commanded to Spindle 2, Spindle 2 is accelerated to reach to a speed of Spindle 1. (Solid line indicates the case that the command of rotating speed of Spindle 2 is 0 min^{-1})

2 After confirming that Spindle 2 reaches to the speed of Spindle 1, Go to rigid Tap sequences.

3 Doing Differential speed Rigid Tapping.

4 After finishing Rigid Tap sequences, in the case of command of speed of Spindle 2 is 0 min^{-1}, Spindle 2 is stopped. (Solid line) If command of Spindle 2 is not 0 min^{-1}, Spindle 2 is accelerated /decelerated to reach to the command. (Dashed line)

NOTE
1 When applying differential speed control to rigid tapping (differential speed rigid tapping), ensure that the sum of the speed specified for rigid tapping and that of the first spindle does not exceed the maximum speed of the second spindle.
2 The output torque of a motor generally decreases in high speed areas. So, a larger acceleration/deceleration time constant must be set for rigid tapping.
3 For the method of rigid tapping, refer to the CNC manual.

11.8.7 Parameters

The table below lists the parameters related to the differential speed control function. Refer to the Parameter manual for details.

Parameter No.			Description
FS0	FS15	FS16	
6500#5	3000#5	4000#5	Whether the differential speed control function is used (Set to 1.)
6500#6	3000#6	4000#6	Setting of the differential speed direction
6500#0	3000#0	4000#0	Rotational direction of the spindle and motor
6500#2	3000#2	4000#2	Mounting orientation of the position coder
6500#7	3000#7	4000#7	Setting of the number of position coder feedback pulses for spindle 1.
6501#2	3001#2	4001#2	Whether the position coder signal is used
6502#5	3002#5	4002#5	Setting of the rotation direction signal function in the servo mode
6503 #7, 6, 4	3003 #7, 6, 4	4003 #7, 6, 4	Setting of the position coder signal

12 DETECTORS FOR THE SPINDLE

12.1 POSITION CODERS

12.1.1 α Position Coder

(1) Name and Drawing Number

Table.12.1.1 (a) Name and Drawing Number

Name	Drawing No.	Remarks
α position coder	A860–0309–T302	Mounted with □68 flange, 10,000 min^{-1}

(2) Absolute Maximum Ratings

Table.12.1.1 (b) Absolute Maximum Ratings

Item	Specifications
Power supply voltage	–0.5V to +7.0V
Operating temperature	0°C to +50°C
Humidity	95% RH or less

(3) Electrical Specifications

Table.12.1.1 (c) Electrical Specifications

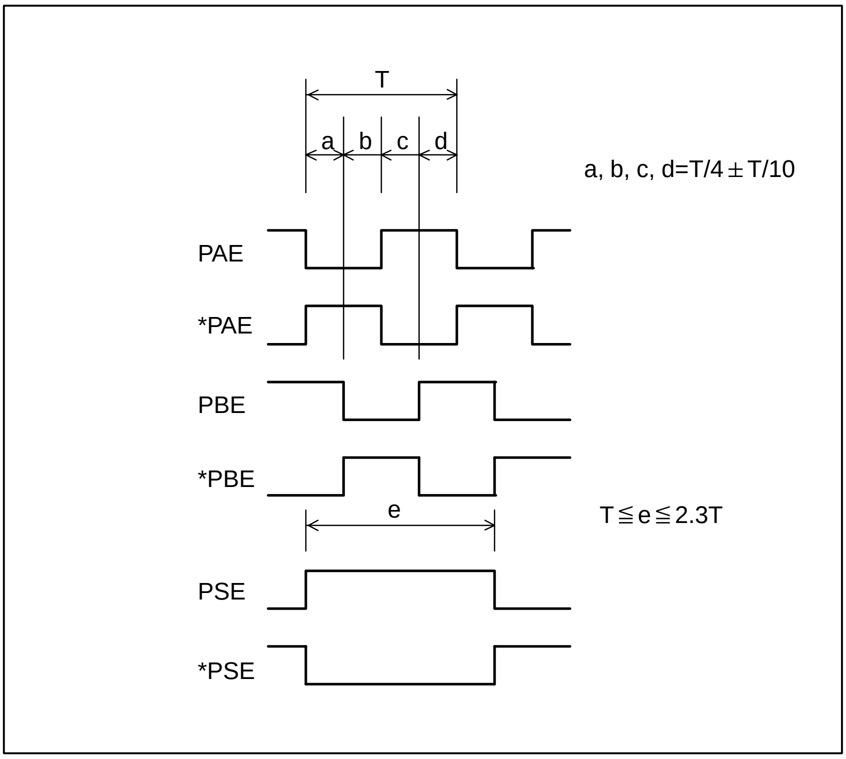
Item		Specifications
Power supply voltage		5V ± 5%
Current consumption		350mA or less
Output signal	PAE,*PAE,PBE,*PBE	1,024 pulses/rev
	PSE,*PSE	1 pulse/rev

(4) Mechanical Specifications

Table.12.1.1 (d) Mechanical Specifications

Item	Specifications		
Input axis inertia	1×10^{-3}kg cm s^2 or less		
Input axis start torque	1,000g cm or less		
Allowable input axis load	Radial load	Operating	10kg
		Stopped	20kg
	Thrust load	Operating	5kg
		Stopped	10kg
Maximum speed	10,000min^{-1}		
Structure	Dust–proof and drip–proof structure (equivalent to IP55: when a waterproof connector is fitted)		
Tolerable vibration acceleration/deceleration	10G (10 to 500Hz)		
Weight	Approx. 750kg		

(5) Phase Relationship of Signals (Timing Chart)

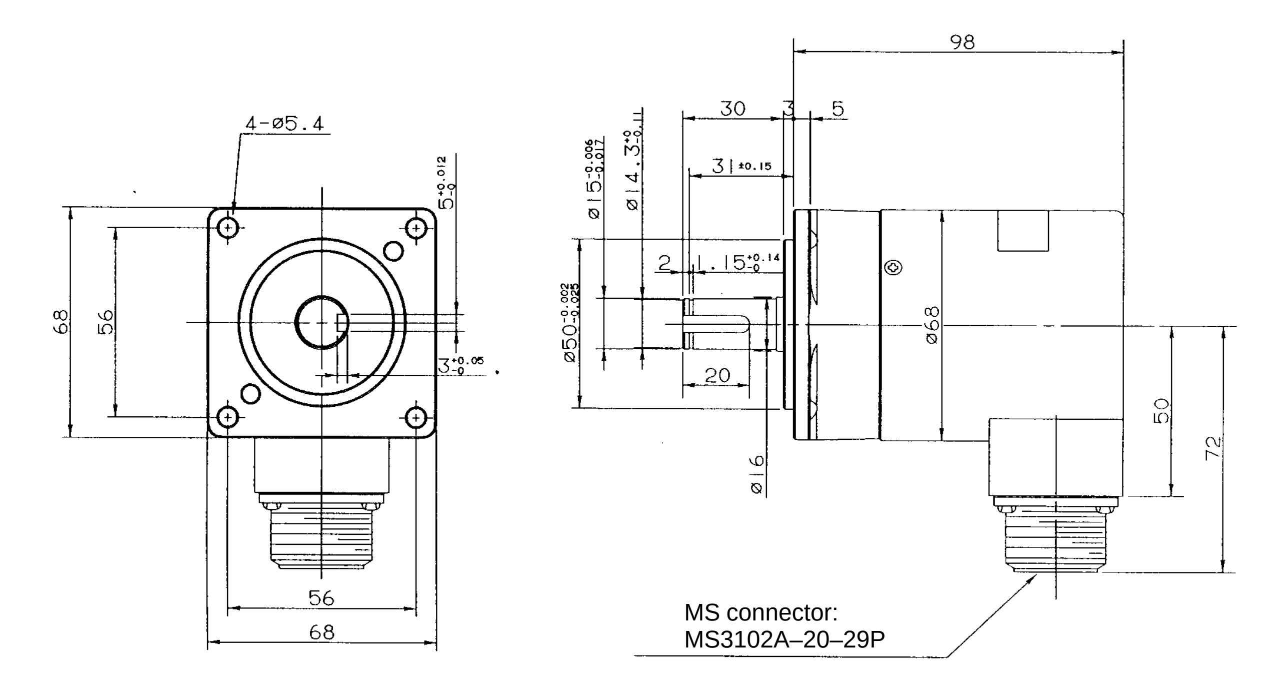


(6) Output pin configuration

Table.12.1.1 (e) Output Pin Configuration

A	B	C	D	E	F	G	H	J
PAE	PSE	PBE					+5V	
K	**L**	**M**	**N**	**P**	**R**	**S**	**T**	
0V			*PAE	*PSE	*PBE			

(7) Outline Drawing



12.1.2 High–resolution Position Coder

(1) Name and Drawing Number

Table.12.1.2 (a) Name and Drawing Number

Name	Drawing No.	Remarks
High–resolution position coder	A860–0319–T002	Mounted with □68 flange,8,000 min^{-1}

(2) Absolute Maximum Ratings

Table.12.1.2 (b) Absolute Maximum Ratings

Item	Specifications
Power supply voltage	–0.5V to +7.0V
Operating temperature	0°C to +50°C
Humidity	95% RH or less

(3) Electrical Specifications

Table.12.1.2 (c) Electrical Specifications

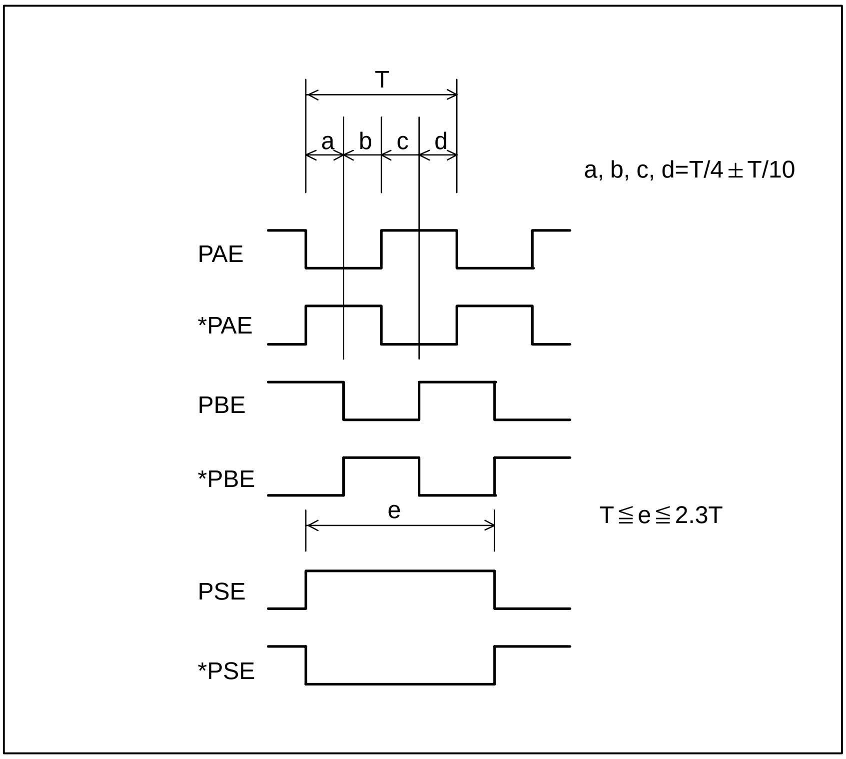
Item		Specifications
Power supply voltage		5V ± 5%
Current consumption		350mA or less
Output signal	PAE,*PAE,PBE,*PBE	1,024 pulses/rev
	PSE,*PSE	1 pulse/rev
	AP,XAP,BP,XBP	3,000 λ/rev

(4) Mechanical Specifications

Table.12.1.2 (d) Mechanical Specifications

Item	Specifications		
Input axis inertia	1×10^{-3}kg cm s^2 or less		
Input axis start torque	1,000g cm or less		
Allowable input axis load	Radial load	Operating	10kg
		Stopped	20kg
	Thrust load	Operating	5kg
		Stopped	10kg
Maximum speed	8,000min^{-1}		
Structure	Dust–proof and drip–proof structure (equivalent to IP55: when a waterproof connector is fitted)		
Tolerable vibration acceleration/deceleration	10G (10 to 500Hz)		
Weight	Approx. 750kg		

(5) Phase Relationship of Signals (Timing Chart)

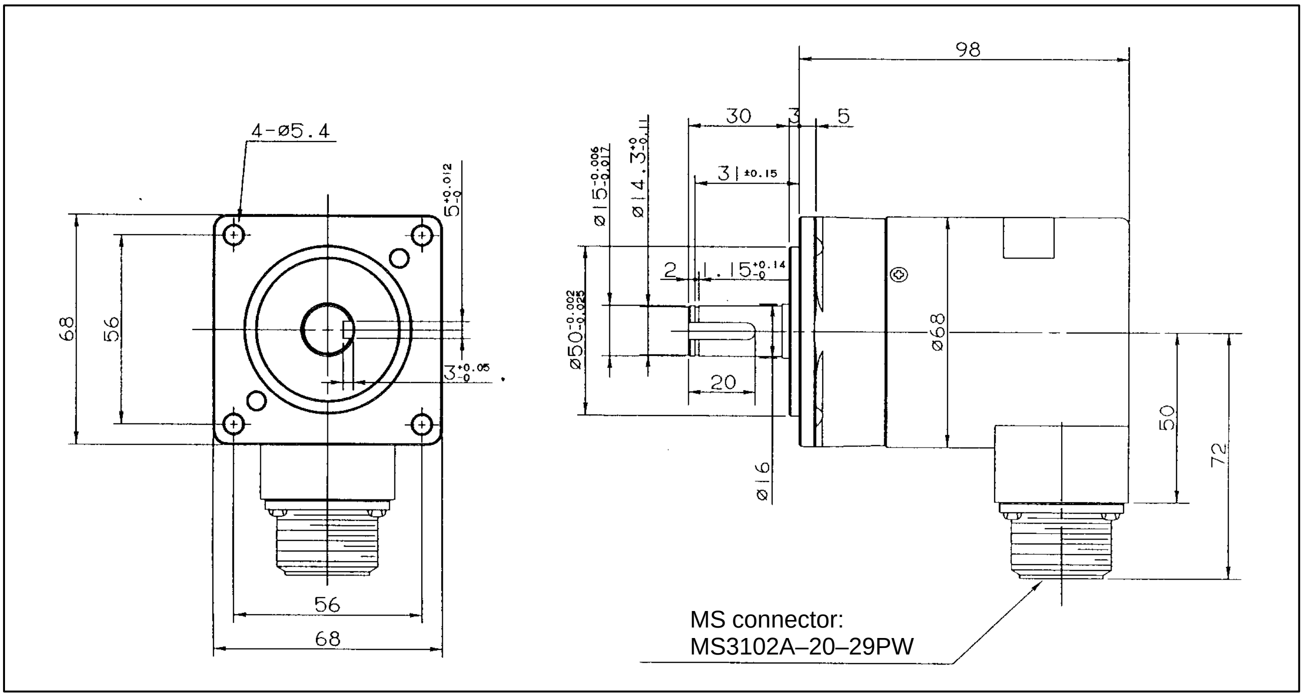


(6) Output pin configuration

Table.12.1.2 (e) Output Pin Configuration

A	B	C	D	E	F	G	H	J
AP	BP	*PBE	XAP	XBP	PSE	*PSE	SS	+5V
K	**L**	**M**	**N**	**P**	**R**	**S**	**T**	
+5V	*PAE	PAE	0V	PBE			0V	

(7) Outline Drawing



12.1.3 Mounting Conditions and Notes

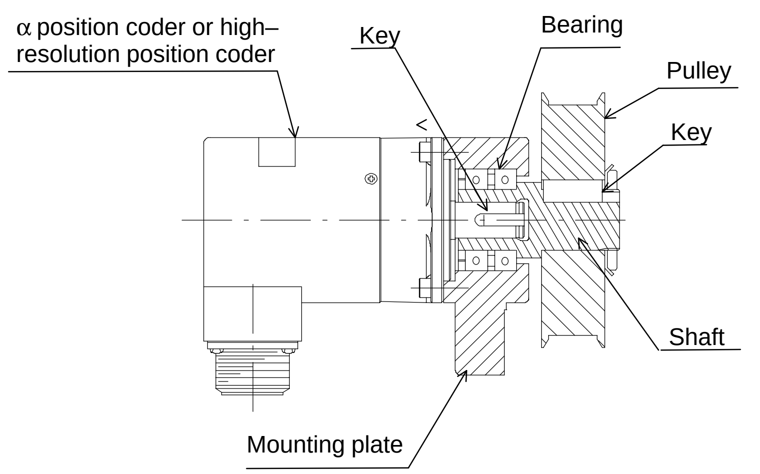
(a) Method of connection

There are two methods of connecting an α position coder or high–resolution position coder with the spindle.

(1) Connecting a position coder to the back of the spindle with a flexible joint

This method conveys the rotation of the spindle precisely to the position coder, so that the positioning precision of the position coder is high. However, this method imposes a restriction on the location of the installation. So, some modifications to the mechanical section may become necessary.

(2) As shown below, fit the shaft for holding the pulley onto the shaft of the position coder, and hold the shaft with double bearings. Thus, the pulley of the position coder is connected to the pulley mounted on the spindle via a timing belt.



This connection method is generally used to connect a conventional position coder to the spindle. When using this method, note the points below.

1) If there is any play between the shaft for holding the pulley and the shaft of the position coder, fretting can occur on the position coder shaft, and the key can become loose, thus resulting in degraded precision of the position coder positioning. So, fit the components together accurately to ensure that there is no play between the position coder shaft and shaft holding the pulley, or between the key and key groove.

2) If the axis center of the position coder shaft is not aligned with the axis center of the circumference of the position coder pulley, or if the axis center of the spindle is not aligned with the axis center of the pulley fitted onto the spindle, the positioning precision of the spindle degrades in proportion to the magnitude of the eccentricity. So, minimize these eccentricities.

(b) Shock

The position coders are precision detectors. So, be careful to protect the position coders from shock.

(c) Atmosphere

The position coders conform to protection class IP55. However, this class specifies short–term performance. So, ensure that the position coders are not exposed to coolant or lubricant, and that oil does not build up on the position coders. If a position coder is exposed to coolant or lubricant, place a protection cover over the position coder.

12.2 BZ SENSOR

(1) Names and Drawing Numbers

Table.12.2 (a) Names and Drawing Numbers

Name	Drawing No.	Remarks			
		Number of teeth	Maximum speed	Gear	
				Inner diameter	Outer diameter
BZ sensor 128	A860–0392–T012	128	20,000min^{-1}	ϕ40	ϕ52
BZ sensor 128H	A860–0392–T082	128	50,000min^{-1}	ϕ40	ϕ52
BZ sensor 256	A860–0392–T011	256	15,000min^{-1}	ϕ82	ϕ103.2
BZ sensor 256S	A860–0392–T014	256	15,000min^{-1}	ϕ88	ϕ103.2
BZ sensor 236H	A860–0392–T081	256	30,000min^{-1}	ϕ82	ϕ103.2
BZ sensor 384	A860–0392–T018	384	15,000min^{-1}	ϕ125	ϕ154.4
BZ sensor 512	A860–0392–T013	512	10,000min^{-1}	ϕ160	ϕ205.6

(2) Absolute Maximum Ratings

Table.12.2 (b) Absolute Maximum Ratings

Item	Specifications
Power supply voltage	–0.5V to +7.0V
Operating temperature	0°C to +80°C
Humidity	95% RH or less

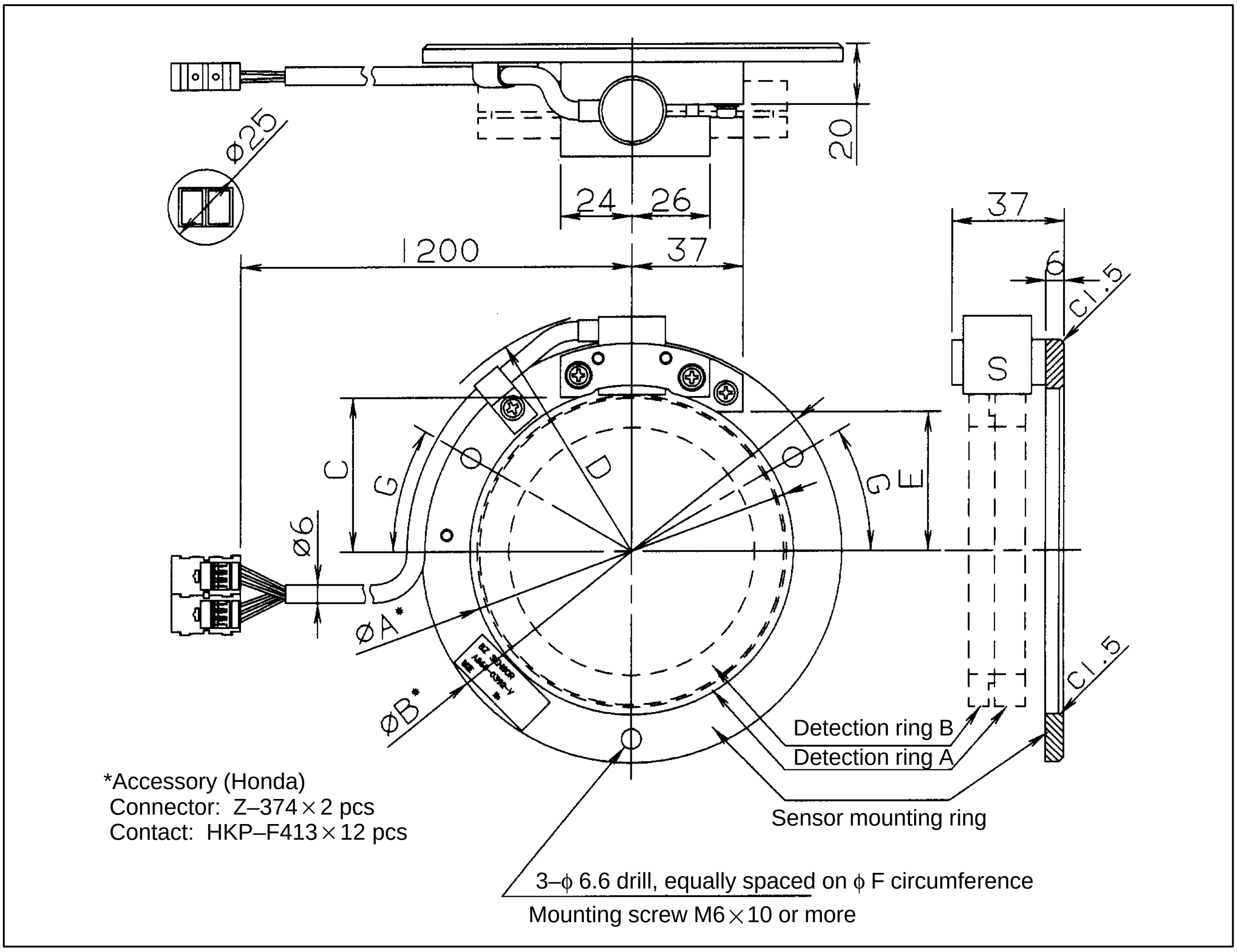
(3) Electrical Specifications

Table.12.2 (c) Electrical Specifications

Item			Specifications
Power supply voltage			5V ± 5%
Current consumption			200mA or less
Output signals	VA,*VA VB,*VB	BZ sensor 128/128H	128 λ/rev
		BZ sensor 256/256S/256H	256 λ/rev
		BZ sensor 384	384 λ/rev
		BZ sensor 512	512 λ/rev
	VZ,*VZ	Common to all models	1 λ/rev

(4) Outline Drawing

(a) BZ sensor (with mounting ring)



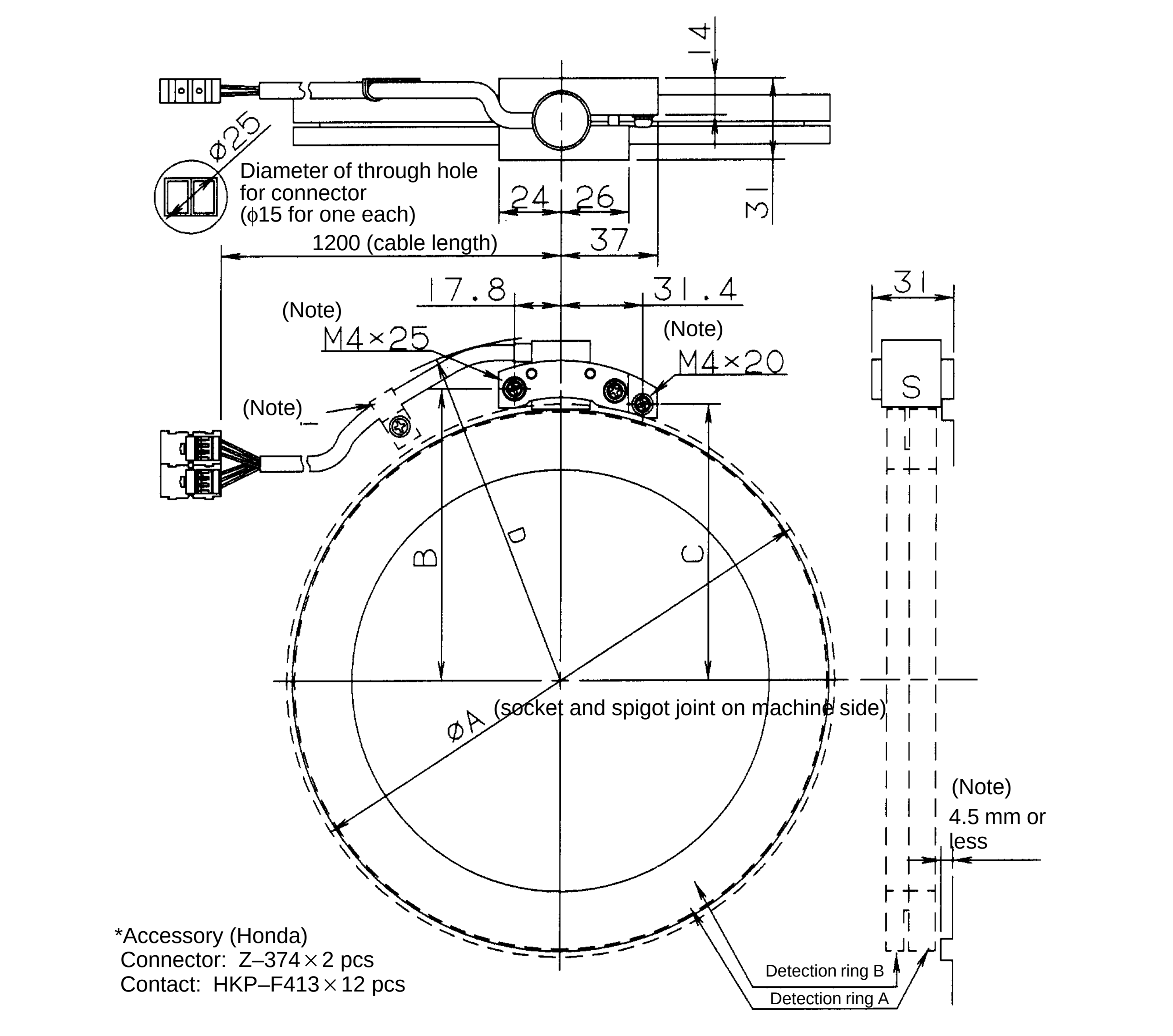
Sensor drawing No.	Detection ring	Number of teeth	ϕA*	ϕB*	C	D	E	ϕF	G
A860–0392–T011 A860–0392–T014 A860–0392–T081	Ring 1 Ring 4 Ring 6	256	$108\ ^{+0.040}_{+0.020}$	$140h6\ ^{+0.0}_{-0.025}$	51	R80	46	124	30°
A860–0392–T012 A860–0392–T082	Ring 2 Ring 7	128	$56H6\ ^{+0.019}_{-0.0}$	$100h6\ ^{+0.0}_{-0.022}$	25	R57	20	78	10°

For the outside dimensions of the detection rings, see Item (c).

NOTE

- Use the BZ sensor at temperatures not exceeding 80°C.
- The BZ sensor is a precision device. It must be handled with care. In particular, ensure that no force is applied to the S section.
- The sensor is an electronic device. Provide dust and drip protection on the machine so that the sensor is not exposed to chips, oil, water, or any other harmful substance.
- Those dimensions that are marked with an asterisk (*) are the dimensions of the sensor mounting ring. Design a socket and spigot joint on the machine side to match the dimensions. If a socket joint on the machine side is designed incorrectly, an incorrect signal may be output.
- The gap between the sensor and detection ring is adjusted beforehand. However, an output signal may not satisfy the specified value due to a socket and spigot joint error. Check the output signals when mounting a sensor. If an output signal does not satisfy a specified value, adjust the gap. For information about the output signal level for gap adjustment, refer to Part II of ”FANUC Built–in AC Spindle Motor α Series Descriptions (B–65202EN).”
- Make a shielded wire connection.
- To ensure ease of maintenance, install a sensor in a location where it can be replaced easily.
- The detection ring of a sensor can be exchanged with another sensor provided the sensors have the same drawing number.
- A sensor and detection ring cannot be combined if the detection ring is designed for a drawing number different from that of the sensor.
- A mating connector (accessory) is provided with the BZ sensor.

(b) BZ sensor (with no mounting ring)



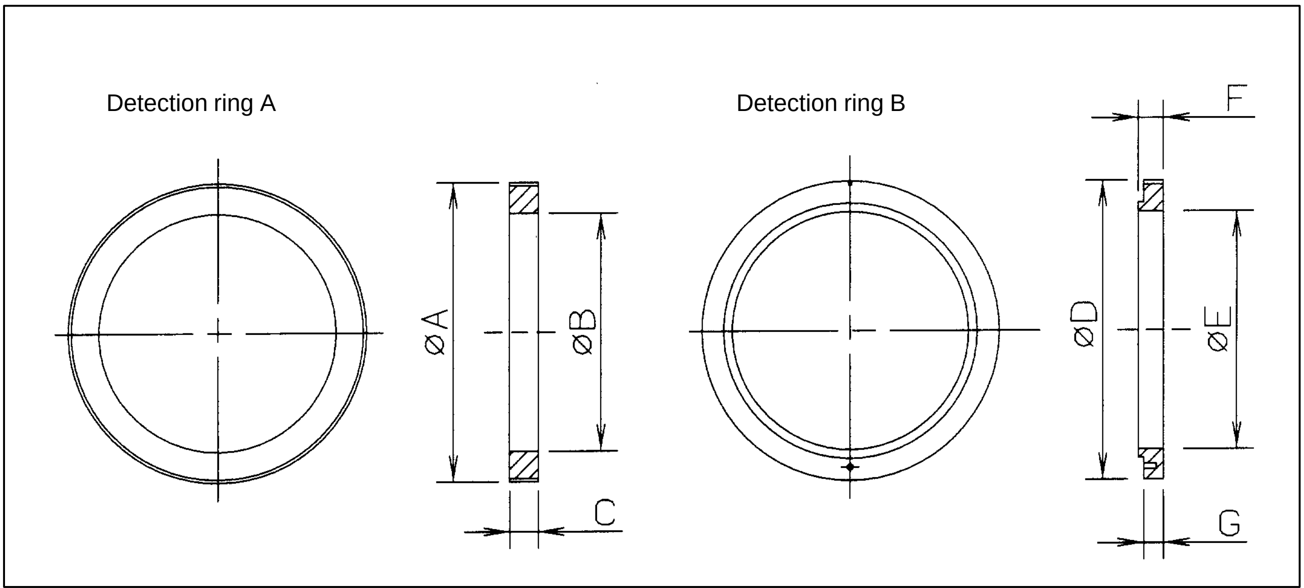
Sensor drawing No.	Detection ring	Number of teeth	φA	B	C	D
A860–0392–T013	Ring 3	512	210 $^{+0.0}_{-0.030}$	110.8	104.8	R140
A860–0392–T018	Ring 5	384	158 $^{+0.0}_{-0.025}$	84.3	78.3	R110

For the outside dimensions of the detection rings, see Item (c).

NOTE

– Use the BZ sensor at temperatures not exceeding 80°C.
– The BZ sensor is a precision device. It must be handled with care. In particular, ensure that no force is applied to the S section.
– The sensor is an electronic device. Provide dust and drip protection on the machine so that the sensor is not exposed to chips, oil, water, or any other harmful substance.
– When installing a BZ sensor, press it against the machine–side socket and spigot joint (A in size). (The machine–side socket and spigot joint is 4.5 mm high.) The gap between the sensor and detection ring is adjusted beforehand. However, an output signal may not satisfy the specified value due to a socket and spigot joint error. Check the output signals when mounting a sensor. If an output signal does not satisfy the specified value, adjust the gap. For information about the output signal level for gap adjustment, refer to Part II of "FANUC Built–in AC Spindle Motor α Series Descriptions (B–65202EN)."
– To mount the BZ sensor, use screws of M4 x 20 mm and M4 x 25 mm.
– Secure the cable at appropriate locations so that, when the cable is pulled, no force is directly applied to the BZ sensor.
– Make a shielded wire connection.
– To ensure ease of maintenance, install a sensor in a location where the sensor can be replaced easily.
– The detection ring of a sensor can be exchanged with another sensor provided the sensors are of the same drawing number.
– A sensor cannot be combined with a detection ring if the detection ring is designed for a drawing number different from that of the sensor.
– A mating connector (accessory) is provided with the BZ sensor.

(c) Detection ring



Detection ring dimensions

	Detection ring A			Detection ring B			
	φA	φB	C	φD	φE	F	G
Ring 1, 6	$103.2^{+0.0}_{-0.020}$	$82^{+0.0}_{-0.018}$	10 ± 0.1	$103.2^{+0.0}_{-0.020}$	$82^{+0.0}_{-0.018}$	8.6 ± 0.1	6.7
Ring 2, 7	$52^{+0.0}_{-0.020}$	$40^{+0.016}_{-0.0}$	10 ± 0.1	$52^{+0.0}_{-0.020}$	$40^{+0.016}_{-0.0}$	8.6 ± 0.1	6.7
Ring 3	$205.6^{+0.0}_{-0.020}$	$160^{+0.020}_{-0.0}$	10 ± 0.1	$205.6^{+0.0}_{-0.020}$	$160^{+0.020}_{-0.0}$	8.6 ± 0.1	6.7
Ring 4	$103.2^{+0.0}_{-0.020}$	$88^{+0.0}_{-0.018}$	10 ± 0.1	$103.2^{+0.0}_{-0.020}$	$88^{+0.0}_{-0.018}$	8.6 ± 0.1	6.7
Ring 5	$154.4^{+0.0}_{-0.020}$	$125^{+0.025}_{-0.0}$	10 ± 0.1	$154.4^{+0.0}_{-0.020}$	$125^{+0.025}_{-0.0}$	8.6 ± 0.1	6.7

For the outside dimensions of the sensor, see Item (4) above.

NOTE

– Before mounting a ring on the spindle, press the ring into the sleeve.
– A ring can be reused only once.
– The outer tooth shape is special. So, ensure that the teeth are not deformed or chipped by an external force.
– Check the output signal of the sensor. For output signal adjustment, refer to Part II of ”FANUC Built–in AC Spindle Motor α Series Descriptions (B–65202EN).”

Maximum detection ring speed

Ring	Ring 1	Ring 2	Ring 3	Ring 4	Ring 5	Ring 6	Ring 7
Sensor drawing No.	T011	T012	T013	T014	T018	T081	T082
Number of teeth	256 teeth	128 teeth	512 teeth	256 teeth	384 teeth	256 teeth	128 teeth
Maximum speed (min^{-1})	15,000	20,000	10,000	15,000	15,000	30,000	50,000

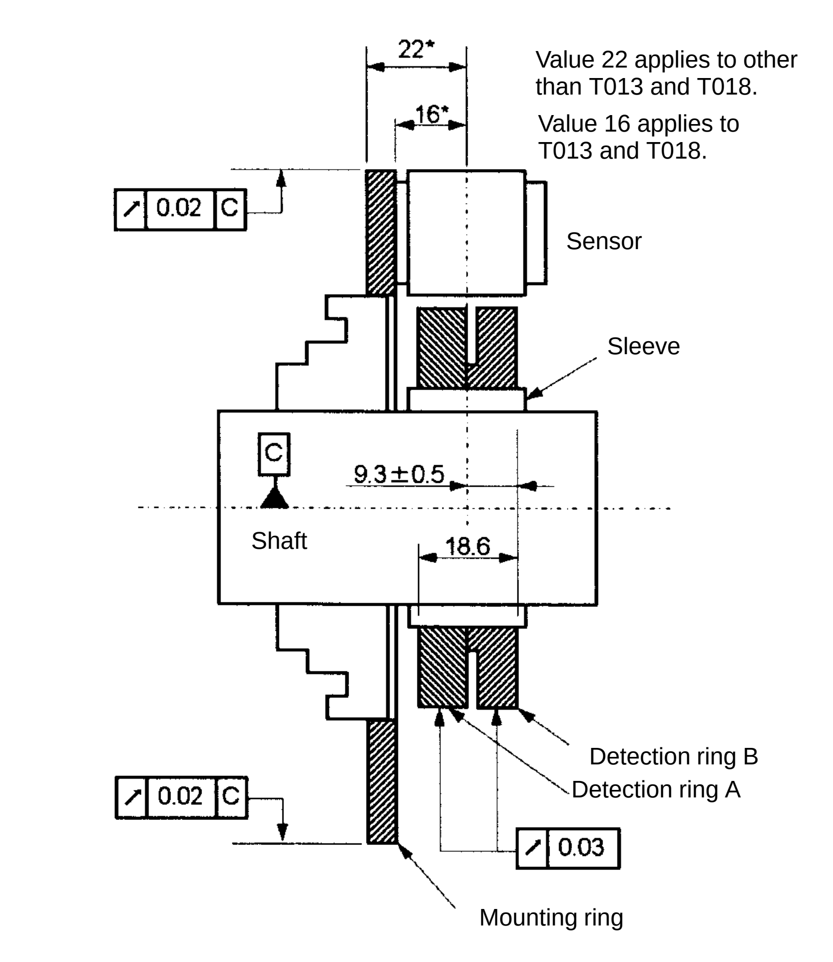
NOTE

The allowance for shrink fitting depends on the maximum speed. For design, see Item (6).

(5) Mounting the BZ Sensor

Mount ring A and ring B as shown below.

- Press–fit the rings into the sleeve, then press–fit the sleeve into the spindle. Ensure that ring A and ring B fit snugly.
- Ensure that a half point (9.3 mm) of the thickness of ring A plus ring B is aligned with the center of the sensor within an error of 0.5 mm.
- Ensure that the fluctuation of the rings with respect to the sensor is within 0.03 mm.
- The fluctuation of the mounting ring with respect to the center of the shaft is within 0.02 mm.



(6) Allowance for Shrink Fitting

The table below indicates the allowances for detection ring shrink fitting for each of the maximum speeds.

Unit: µm

Maximum speed (min^{-1})	T011	T012	T013	T014	T018	T081	T082
	Ring 1	Ring 2	Ring 3	Ring 4	Ring 5	Ring 6	Ring 7
3000	φ7 to φ35	φ6 to φ32	φ11 to φ41	φ7 to φ35	φ8 to φ43	φ7 to φ35	φ6 to φ32
3500	↓	↓	φ13 to φ43	↓	φ9 to φ44	↓	↓
4500	↓	↓	φ19 to φ49	↓	φ11 to φ46	↓	↓
6000	φ9 to φ37	↓	φ29 to φ59	φ9 to φ37	φ15 to φ50	φ9 to φ37	↓
8000	φ11 to φ39	↓	φ47 to φ77	φ11 to φ39	φ24 to φ59	φ11 to φ39	↓
10000	φ14 to φ42	↓	φ71 to φ101	φ15 to φ43	φ35 to φ70	φ14 to φ42	↓
12000	φ18 to φ46	φ7 to φ33		φ19 to φ47	φ47 to φ82	φ18 to φ46	φ7 to φ33
15000	φ26 to φ54	φ8 to φ34		φ28 to φ56	φ71 to φ106	φ26 to φ54	φ8 to φ34
20000		φ10 to φ36				φ41 to φ69	φ10 to φ36
25000						φ62 to φ90	φ12 to φ38
30000						φ87 to φ115	φ15 to φ41
40000							φ23 to φ49
50000							φ33 to φ59

NOTE

– From the table above, select the shrink fitting allowance that matches a maximum speed and type of ring being used. If an incorrect allowance is employed, idle rotation or damage can result.

– The rings cannot be used at a maximum speed that does not appear in the table above. For the maximum allowable speed of each ring, see Item (C).

12.3 OTHER DETECTORS

12.3.1 High–resolution Magnetic Pulse Coder

(1) Names and Drawing Numbers

Table.12.3.1 (a) Names and Drawing Numbers

Name	Drawing No.	Remarks		
		Maximum speed	Drum	
			Inner diameter	Outer diameter
65 drums	A860–0382–T121	15,000min^{-1}	ϕ50	ϕ65
97.5 drums	A860–0382–T122	13,000min^{-1}	ϕ70	ϕ97.5
130 drums	A860–0382–T123	10,000min^{-1}	ϕ105	ϕ130
195 drums	A860–0382–T124	6,500min^{-1}	ϕ160	ϕ195

(2) Absolute Maximum Ratings

Table.12.3.1 (b) Absolute Maximum Ratings

Item	Specifications
Power supply voltage	–0.5V to +7.0V
Operating temperature	0°C to +50°C
Humidity	95% RH or less

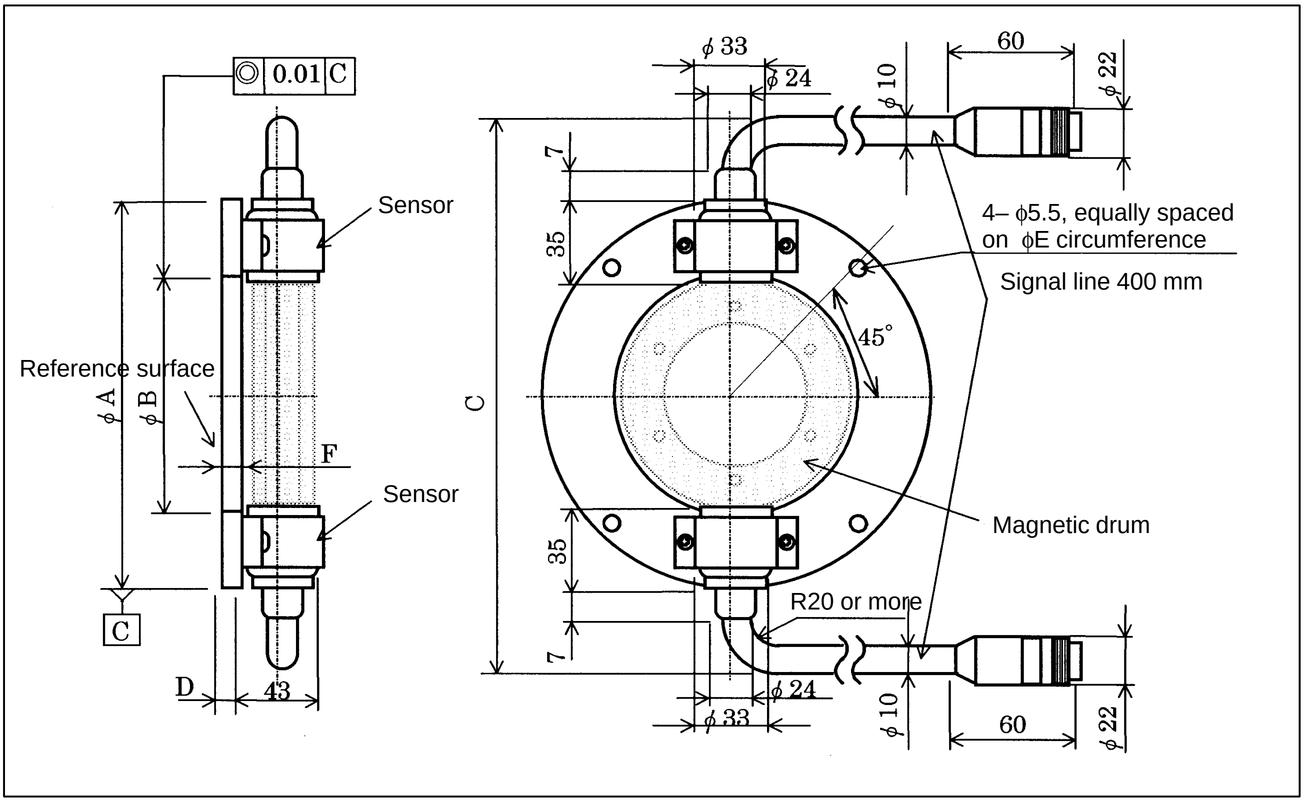
(3) Electrical Specifications

Table.12.3.1 (c) Electrical Specifications

<table>
<tr><th colspan="3">Item</th><th>Specifications</th></tr>
<tr><td colspan="3">Power supply voltage</td><td>5V ± 5%</td></tr>
<tr><td colspan="3">Current consumption</td><td>150mA or less</td></tr>
<tr><td rowspan="9">Output signals</td><td rowspan="4">Cs contour control sig-nals A1,RA1 B1,RB1</td><td>A860–0382–T121</td><td>1,000 /rev</td></tr>
<tr><td>A860–0382–T122</td><td>1,500 /rev</td></tr>
<tr><td>A860–0382–T123</td><td>2,000 /rev</td></tr>
<tr><td>A860–0382–T124</td><td>3,000 /rev</td></tr>
<tr><td rowspan="4">Signals equivalent to position coder sig-nals A3,RA3 B3,RB3</td><td>A860–0382–T121</td><td>128 pulses/rev</td></tr>
<tr><td>A860–0382–T122</td><td>192 pulses/rev</td></tr>
<tr><td>A860–0382–T123</td><td>256 pulses/rev</td></tr>
<tr><td>A860–0382–T124</td><td>384 pulses/rev</td></tr>
<tr><td colspan="2">One–rotation signals Z,*Z</td><td>1 pulse/rev</td></tr>
<tr><td rowspan="2">Resolution (com-bination with SPM Type 2)</td><td colspan="2">Cs contour control signal</td><td>360,000 divisions/rev</td></tr>
<tr><td colspan="2">Position coder signal</td><td>4,096 divisions/rev</td></tr>
</table>

(4) Outline Drawing

(a) High–resolution magnetic pulse coder (Cs axis sensor)



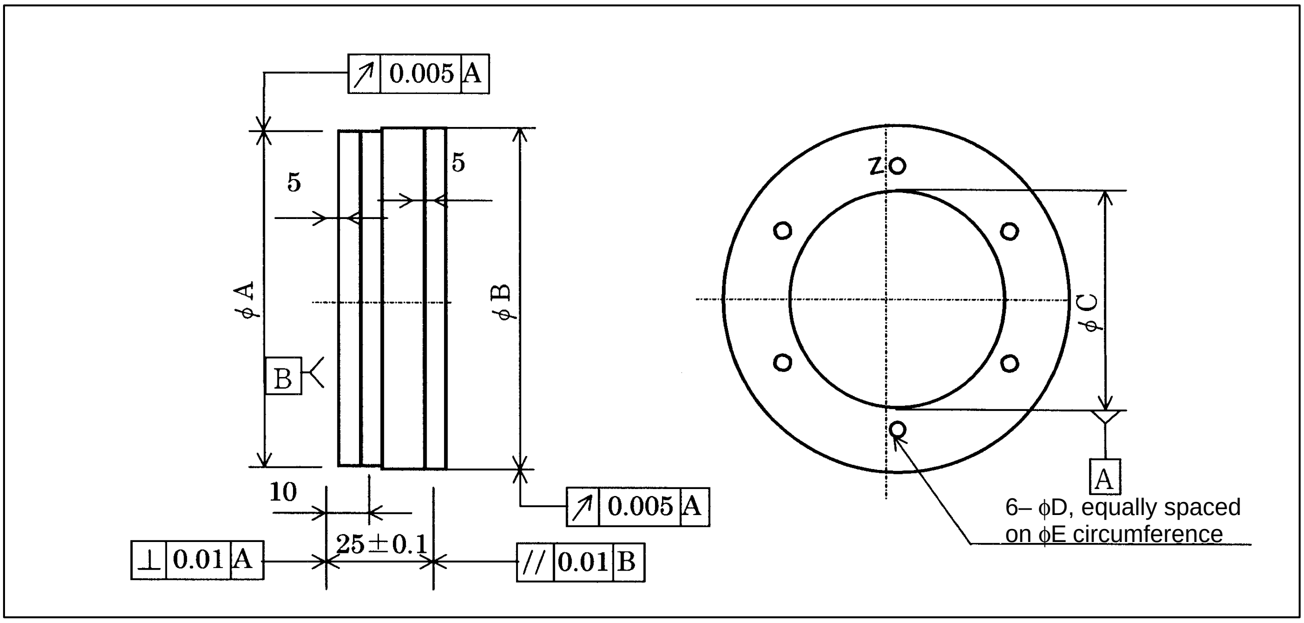
Sensor drawing No.	Detection ring	Resolu-tion	ϕA	ϕB	C	D	ϕE	F
A860–0382–T121	Drum 1	360,000	$140^{+0.0}_{-0.015}$	$70^{+0.0}_{-0.011}$	191	6	130	15±0.2
A860–0382–T122	Drum 2	360,000	$170^{+0.0}_{-0.015}$	$110^{+0.015}_{-0.0}$	224	10	160	19±0.2
A860–0382–T123	Drum 3	360,000	$200^{+0.0}_{-0.015}$	$140^{+0.015}_{-0.0}$	256	10	190	19±0.2
A860–0382–T124	Drum 4	360,000	$270^{+0.0}_{-0.015}$	$210^{+0.015}_{-0.0}$	321	10	260	19±0.2

For the dimensions of the drums, see Item (b).

NOTE

– Use this sensor at temperatures not exceeding 50°C.
– The high–resolution magnetic pulse coder is equipped with a preamplifier.
– A sensor set consisting of a magnetic drum, sensor, and preamplifier is adjusted prior to shipment, and the same serial number is stamped onto each of the components constituting that set. When using this sensor, check the serial numbers to ensure that the sensor set does not include a component having a different serial number. Moreover, never detach the sensor from its mounting plate.
– This sensor consists of electronic circuits and includes many magnetic components. Never expose the sensor to a magnetic field of 20 gauss or more. Be careful not to place the sensor in a magnetic field. Never place a magnet or magnetized object near this sensor.
– Check the output signals of this sensor. For output signal adjustment, refer to Part II of the ”FANUC Built–in AC Spindle Motor α Series Descriptions (B–65202EN).”

(b) Magnetic drum



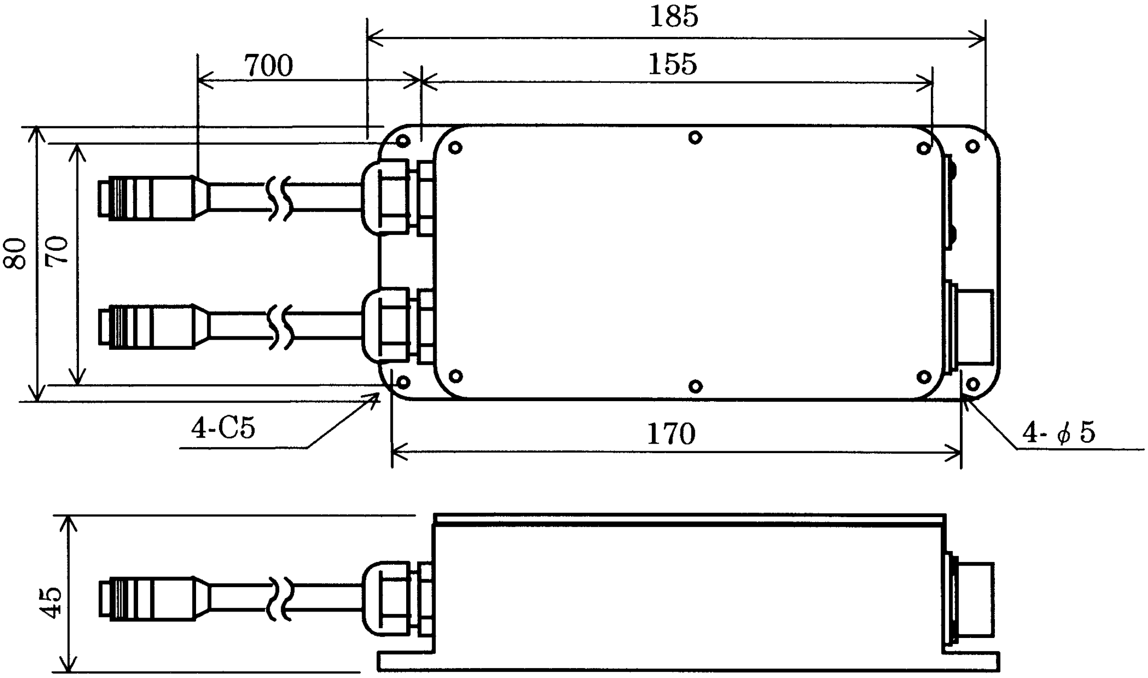
Sensor drawing No.	Detection ring	φA	φB	φC	φD	φE
A860–0382–T121	Drum 1	64.05 ± 0.01	65 $^{+0.0}_{-0.015}$	50 $^{+0.0}_{-0.011}$	——	——
A860–0382–T122	Drum 2	96.55 ± 0.01	97.5 $^{+0.0}_{-0.015}$	70 $^{+0.015}_{-0.0}$	5.5	80
A860–0382–T123	Drum 3	129.05 ± 0.01	130 $^{+0.0}_{-0.015}$	105 $^{+0.015}_{-0.0}$	5.5	115
A860–0382–T124	Drum 4	194.05 ± 0.01	195 $^{+0.0}_{-0.015}$	160 $^{+0.015}_{-0.0}$	6.5	175

For the outside dimensions of the sensor, see Item (a).

Maximum drum speed

Sensor drawing No.	T121	T122	T123	T124
Drum	Drum 1	Drum 2	Drum 3	Drum 4
Maximum speed (min^{-1})	15,000	13,000	10,000	6,500
Drum material	SUS303			

(c) Preamplifier

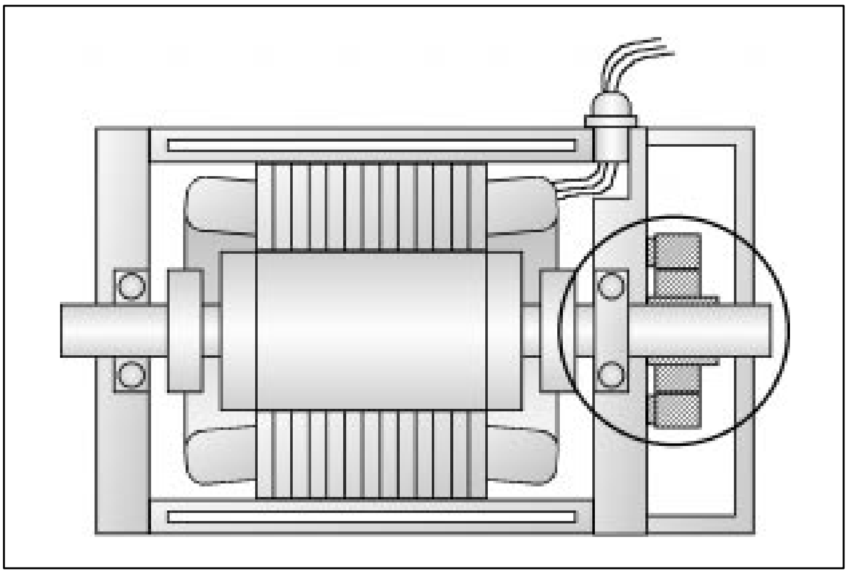


NOTE

– Use this preamplifier at temperatures not exceeding 50°C.
– This preamplifier is required when the high–resolution magnetic pulse coder is used.
– A sensor set consisting of a magnetic drum, sensor, and preamplifier is adjusted prior to shipment, and the same serial number is stamped onto each of the components constituting a set. When using this sensor, check the serial numbers to ensure that the sensor set does not include a component having a different serial number. Moreover, never detach the sensor from its mounting plate.
– Ensure that a vibration of no more than 1 G is applied to the preamplifier.
– The waterproofing of the preamplifier case satisfies IP55. However, if this preamplifier is exposed to coolant, for example, at all times, or is always wet, it may fail. Be careful, therefore, not to expose the preamplifier to coolant and so forth.
– Check the output signals of this sensor. For output signal adjustment, refer to Part II of the ”FANUC Built–in AC Spindle Motor α Series Descriptions (B–65202EN).”

(5) Mounting the High–resolution Magnetic Pulse Coder

The high–resolution magnetic pulse coder is mounted on the rotation axis of the spindle on the motor power line side. If the high–resolution magnetic pulse coder is mounted incorrectly, the motor cannot be controlled correctly. Mount the high–resolution magnetic pulse coder correctly. In addition, mount a cover or attach a sheet to protect against the ingress of foreign matter.



1 Mounting a magnetic drum

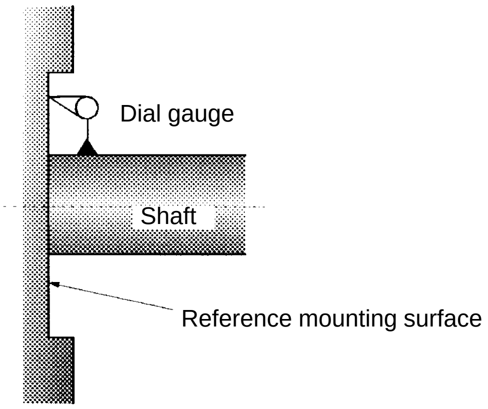
Sensor	A860–0382–T121	A860–0382–T122 A860–0382–T123 A860–0382–T124
Mounting a drum	Mount the drum by shrink fitting the drum or expansion fitting the sleeve. For information about the fitting allowance for each speed, see Item (5).5.	Secure the drum by installing screws in the 6–5.5 holes on the drum. Until centering is completed, to not tighten the screws fully.
Drum mounting direction	Mount the drum so that the reference surface of the drum faces the nose of the spindle. The reference surface of the drum is on the opposite side to the surface on which Z is printed.	

NOTE

– Use a magnetic material for the motor housing to minimize magnetic leakage from the motor.
– Ensure that the motor housing is at least 15 mm thick at the sensor mounting section.
– After assembling the drum with the sleeve, mount the drum onto the spindle. Use a configuration where the sleeve holds the drum on the motor side (left side in the figure above). If this configuration is impossible, use a non–magnetic material (such as stainless steel) for the sleeve.
– If a magnetic substance is placed at the back of the magnetic drum (on the right side in the figure above), allow a clearance of 30 mm.

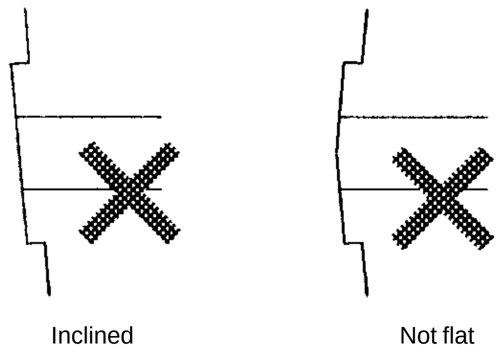
2 Flatness of the sensor mounting plane

The table below indicates the maximum allowable flatness values. Adjust the flatness to satisfy these requirements.



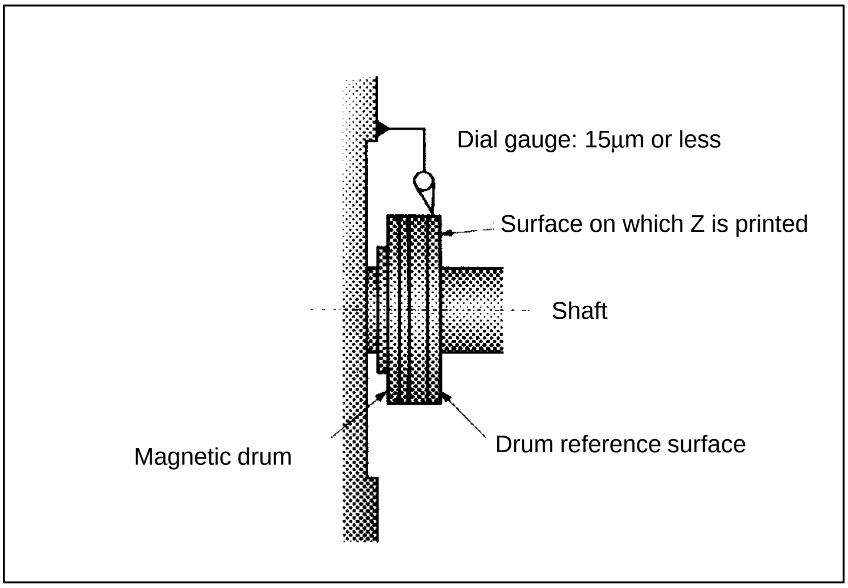
Sensor drawing No.	Maximum fluctuation (μm)
A860–0382–T121	20
A860–0382–T122	25
A860–0382–T123	30
A860–0382–T124	40

If the reference surface is inclined or is not flat, an abnormal signal may be detected.



3 Fluctuation of the circumference of the drum

Ensure that the fluctuation of the circumference of the drum is within 15 μ m.

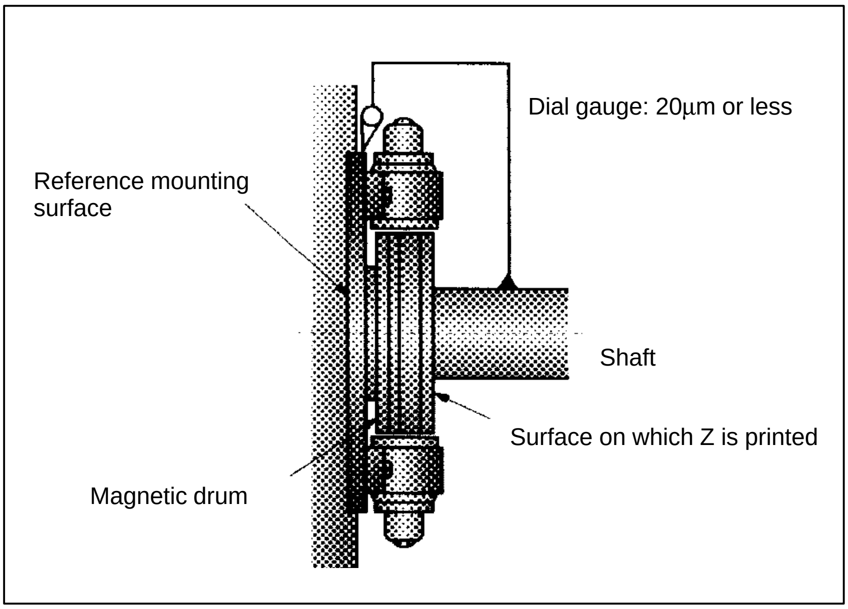


NOTE

When touching the cylindrical drum surface with a dial gauge, touch an area within 5 mm of the surface on which Z is printed. The other area on the drum surface holds magnetic information, so that information may be lost if the other area is touched with a dial gauge.

4 Fluctuation of the mounting plate socket and spigot joint

Ensure that the fluctuation of the mounting plate socket and spigot joint is within 20 µ m with respect to the shaft.



5 Fitting allowance (A860–0382–T121)

The drum for the A860–0382–T121 is mounted by shrink fitting (or expansion fitting of the shaft). (The other types of drums are mounted by screwing. See Item (5).1 above.) The table below lists the fitting allowances.

Maximum speed (min^{-1})	Allowance (μm)
6000	φ26 to φ47
8000	φ27 to φ48
10000	φ27 to φ48
12000	φ28 to φ49
15000	φ30 to φ51

NOTE
– From the table above, select the allowance that matches the maximum speed being used. If an incorrect allowance is employed, idle rotation or deformation can result.
– The drum may be heated up to 100°C. Never heat the drum to temperatures in excess of 100°C.

12.3.2 Magnetic Sensor (for Orientation)

(1) Names and Drawing Numbers

Table.12.3.2 (a) Names and Drawing Numbers

Name	Drawing No.	Maximum speed	Shape
Not specified (standard)	A57L–0001–0037	12,000min^{-1}	30 × 50
Magnetic sensor N, NIP	A57L–0001–0037#N,#NIP	12,000min^{-1}	30 × 50
Magnetic sensor P, PIP	A57L–0001–0037#P,#PIP	12,000min^{-1}	10 × 50
Magnetic sensor Q, QIP	A57L–0001–0037#Q,#QIP	20,000min^{-1}	Inner diameter φ40
Magnetic sensor R, RIP	A57L–0001–0037#R,#RIP	20,000min^{-1}	Inner diameter φ50
Magnetic sensor S, SIP	A57L–0001–0037#S,#SIP	15,000min^{-1}	Inner diameter φ60
Magnetic sensor T, TIP	A57L–0001–0037#T,#TIP	15,000min^{-1}	Inner diameter φ70
Magnetic sensor U, UIP	A57L–0001–0037#U,#UIP	20,000min^{-1}	36 × 50
Magnetic sensor U1, U1IP	A57L–0001–0037#U1,#U1IP	15,000min^{-1}	Inner diameter φ80
Magnetic sensor U2, U2IP	A57L–0001–0037#U2,#U2IP	15,000min^{-1}	Inner diameter φ90

NOTE
With #*IP, the connector is waterproof.
The outer diameter of a cable usable with a waterproof connector is φ8.5 to φ9.7 (including tolerance).
A waterproof connector, when fitted, satisfies IP64.

(2) Absolute Maximum Ratings

Table.12.3.2 (b) Absolute Maximum Ratings

Item	Specifications
Power supply voltage	0V to +18V
Operating temperature	0°C to +50°C
Humidity	30% to 90% RH (no condensation)

(3) Electrical Specifications

Table.12.3.2 (b) Absolute Maximum Ratings

Item	Specifications
Power supply voltage	DC15V ± 5%
Current consumption	100mA or less

Table.12.3.2 (c) Electrical Specifications

Channel	Signal
CH 1	1/rev (MSA–MSB)
CH 2	1/rev (LSA–LSB)

(4) Output Pin Configuration

Table.12.3.2 (d) Output Pin Configuration

Pin	A	B	C	D	E	F
Signal name	MSA	0V	+15V	MSB	LSB	LSA

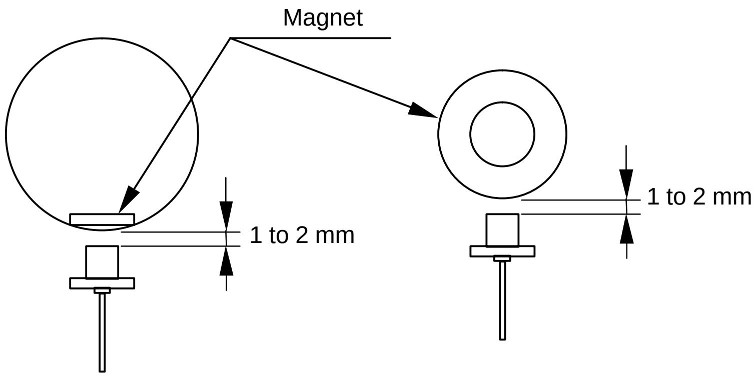
(5) Types of Magnets

Table.12.3.2 (e) Types of Magnets

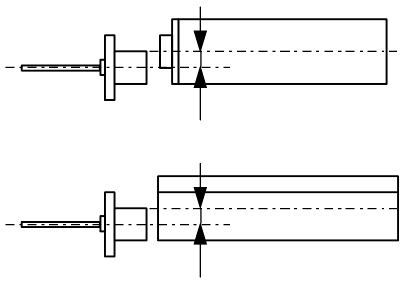
Item	Unit	Sensor N	Sensor P	Sensor U	Sensor Q	Sensor R	Sensor S	Sensor T	Sensor U1	Sensor U2
Maximum spindle speed	min^{-1}	Surface speed: 3770/m/min or less		20,000			15,000			
Magnet weight	g	33 ± 1.5	14.8 ± 0.7	100 ± 3	315 ± 10	460 ± 10	770 ± 15	1000 ± 20	1540 ± 25	1700 ± 30
Gap between magnet and sensor (Note 1)	mm	1.0 to 2.0								
Displacement between magnet center and sensor center (Note 2)	mm	0 to ± 2.0								
Operating temperature	n	0 to 50								
Applicable axis dimensions	mm	—			$40^{+0}_{-0.025}$	$50^{+0}_{-0.025}$	$60^{+0}_{-0.025}$	$70^{+0}_{-0.025}$	$80^{+0}_{-0.025}$	$90^{+0}_{-0.025}$

NOTE

1



2

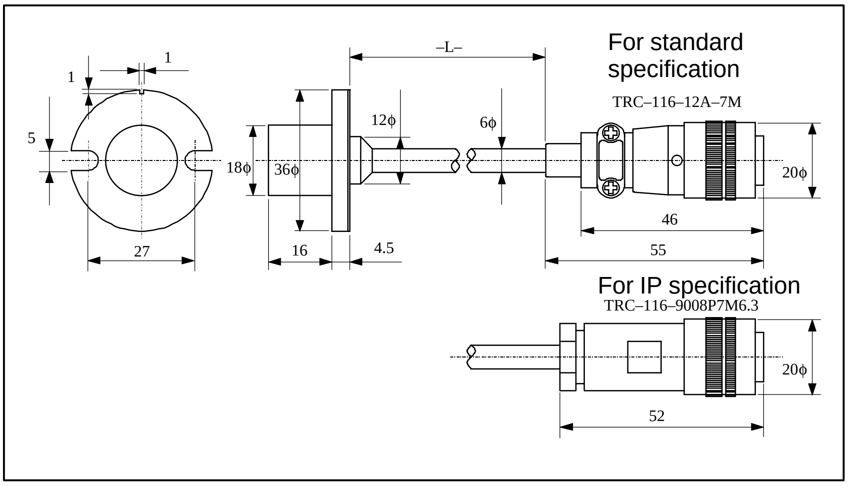


3 If the distance from the center to the location where a magnet is installed is large, the maximum speed is limited by centrifugal force.

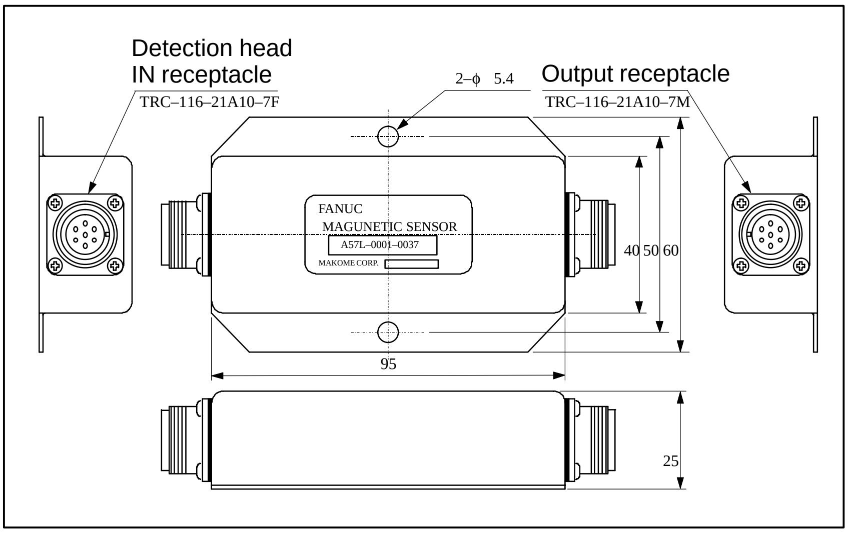
4 The use of high–tensile screws is recommended for magnet installation.

(6) Outline Drawing

1 Detection head

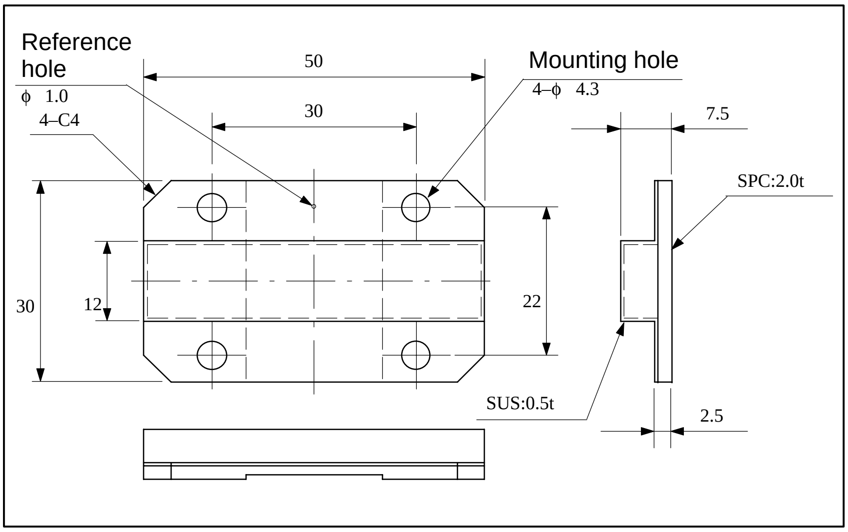


2 Detector

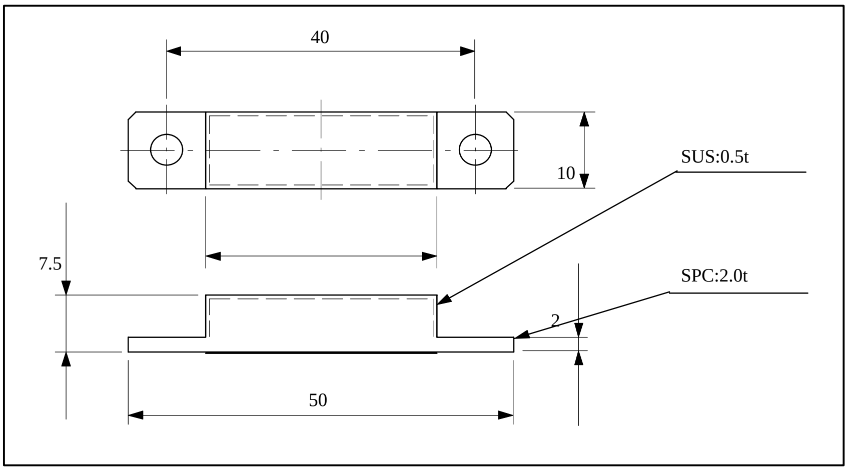


3 Magnet

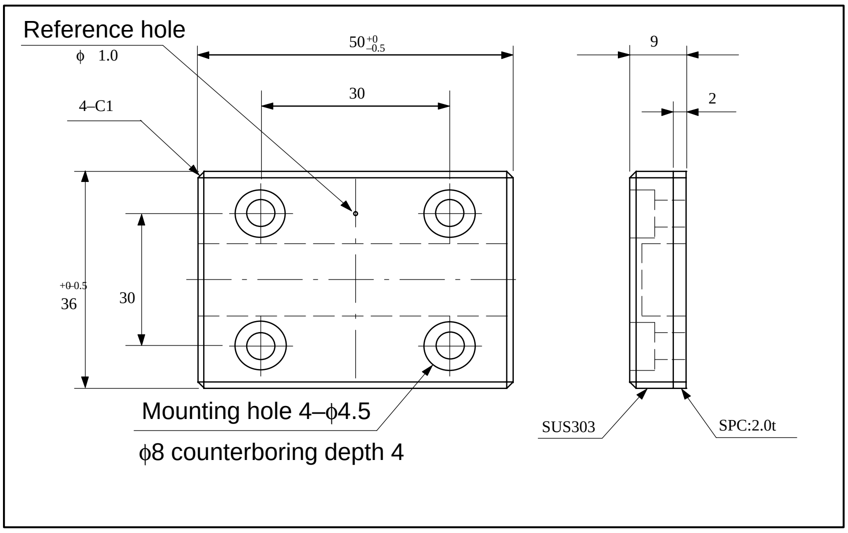
(1) Magnet for N



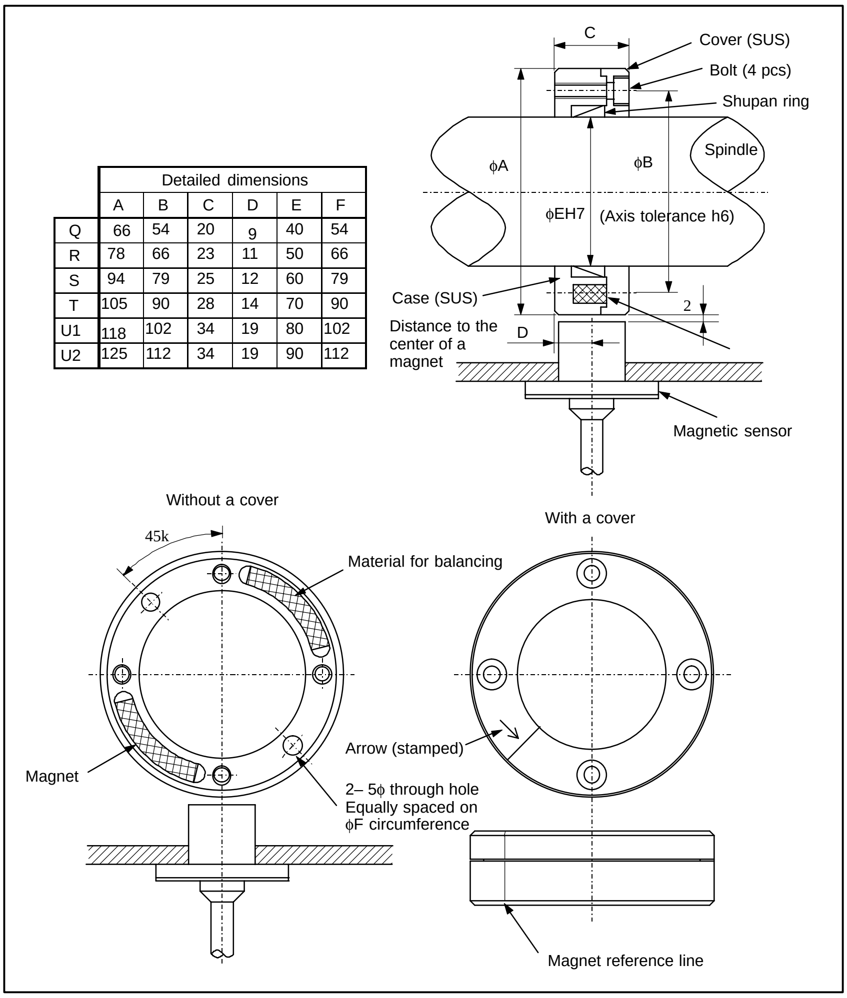
(2) Magnet for P



(3) Magnet for U



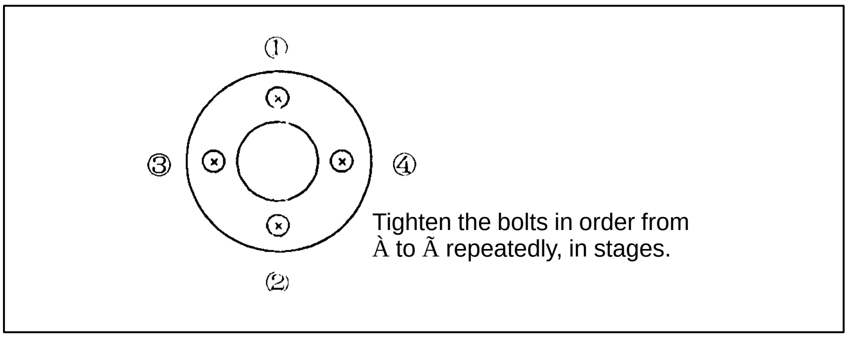
(4) Magnet for Q, R, S, T, U1, and U2



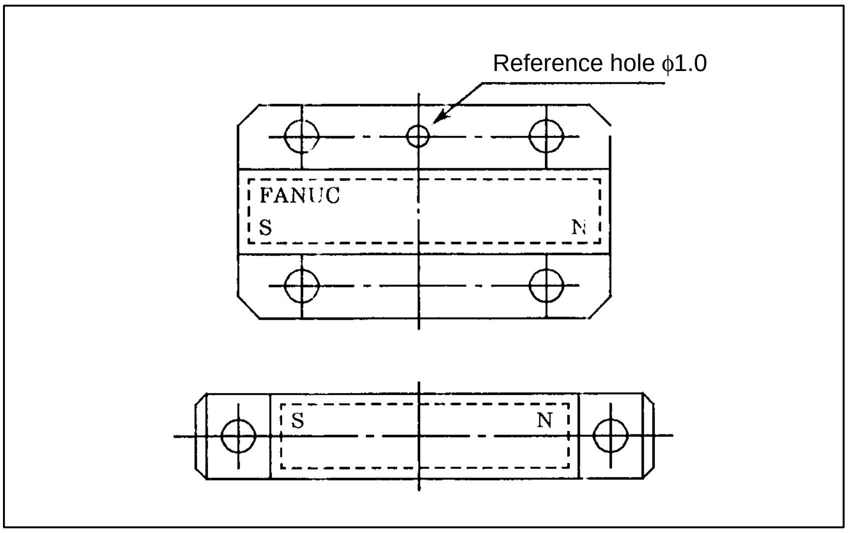
	Detailed dimensions					
	A	B	C	D	E	F
Q	66	54	20	9	40	54
R	78	66	23	11	50	66
S	94	79	25	12	60	79
T	105	90	28	14	70	90
U1	118	102	34	19	80	102
U2	125	112	34	19	90	112

(7) Notes on Use

- A Shupan ring (ring–feeder) is used in a magnet. So, tighten the four bolts evenly.



- The reference hole and polarity of a magnet are related to each other as shown below.



- The two holes (ϕ5.0) on the side opposite the side on which magnetic sensor Q, R, S, or T is installed with screws should be used for a jig for orientation position setting.

(8) Mounting a Magnetic Sensor

Fig.12.3.2 (a), (b), and (d) show how to mount a magnetic sensor.

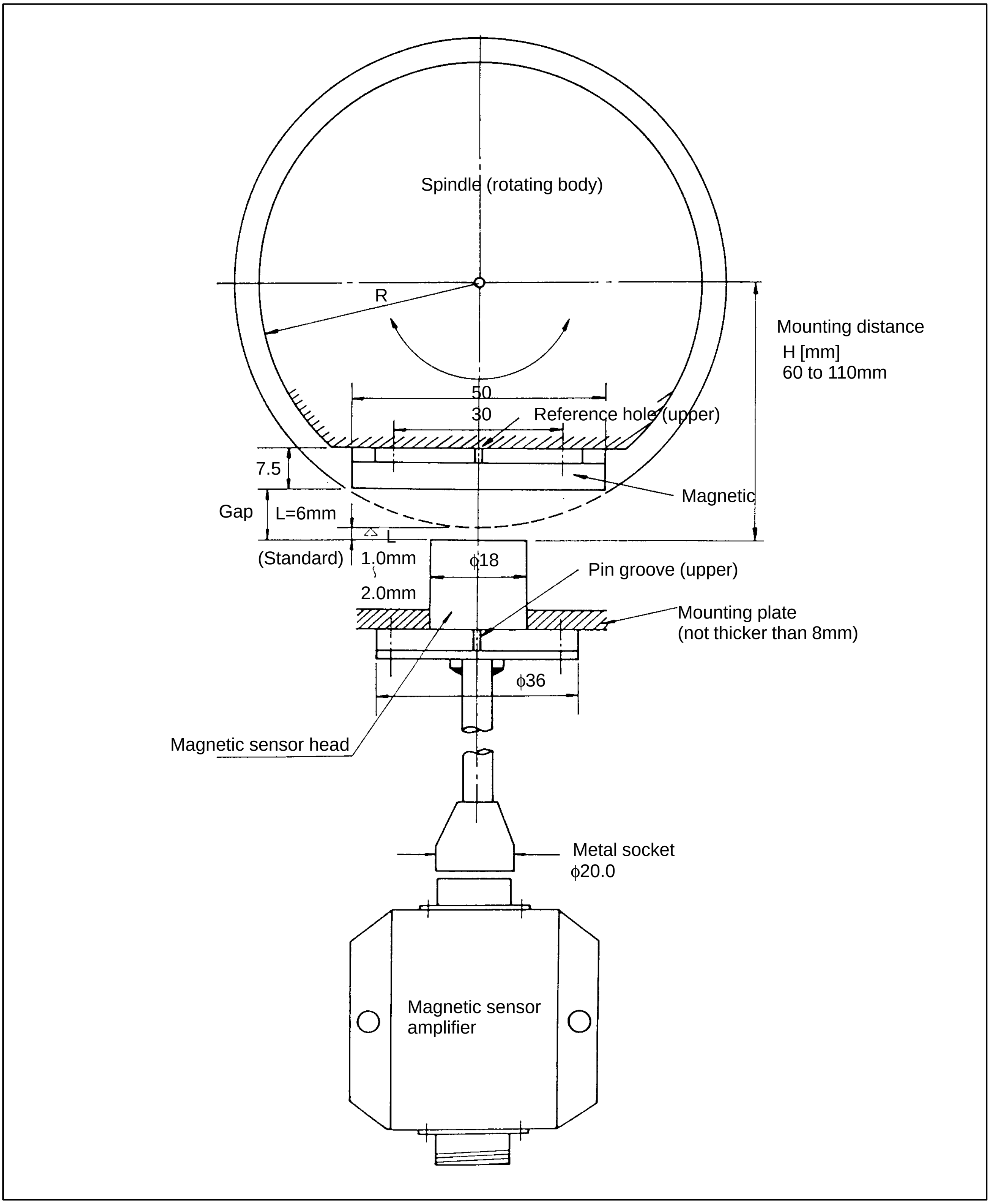


Fig.12.3.2 (a) Example of Mounting a Magnetic Sensor (1)

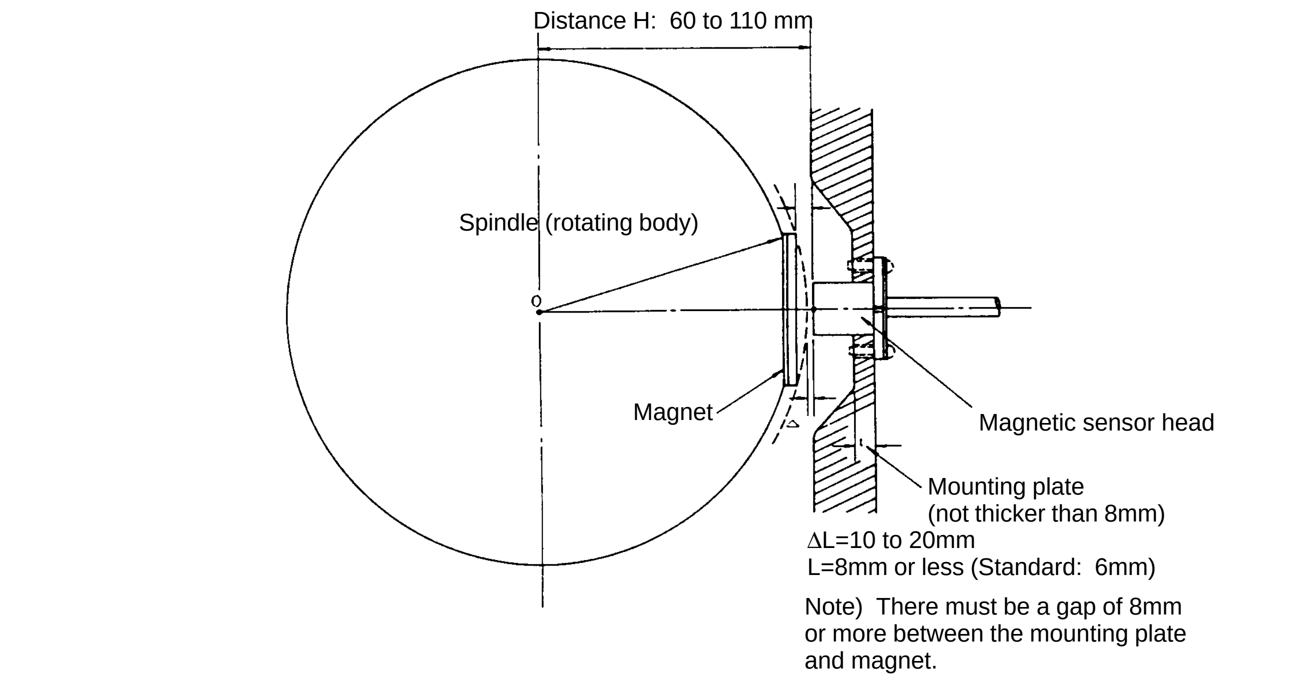


Fig.12.3.2 (b) Example of Mounting a Magnetic Sensor (2) (Mounting a Magnetic Sensor on a Cylinder)

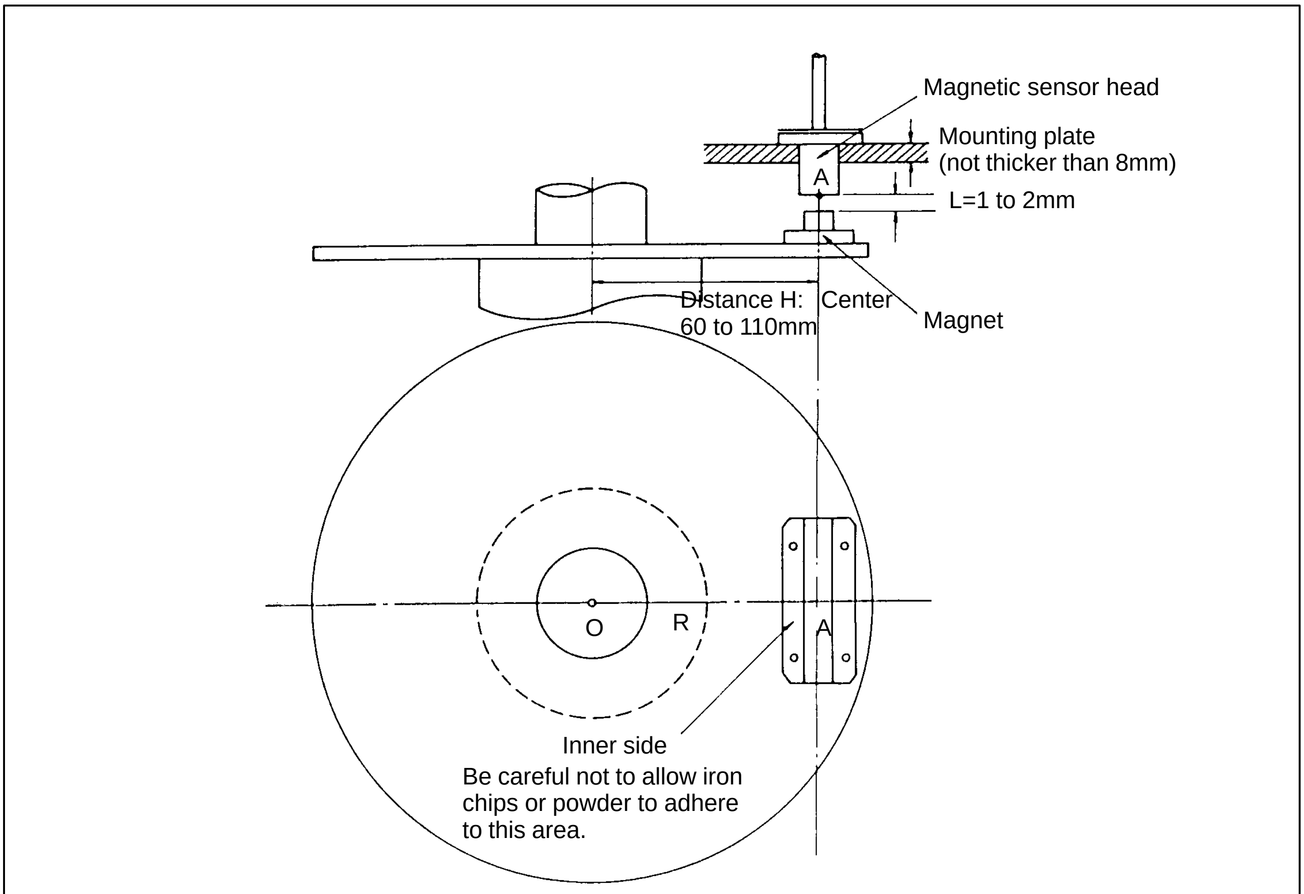


Fig.12.3.2 (c) Example of Mounting a Magnetic Sensor (3) (Mounting a Magnetic Sensor on a Disk)

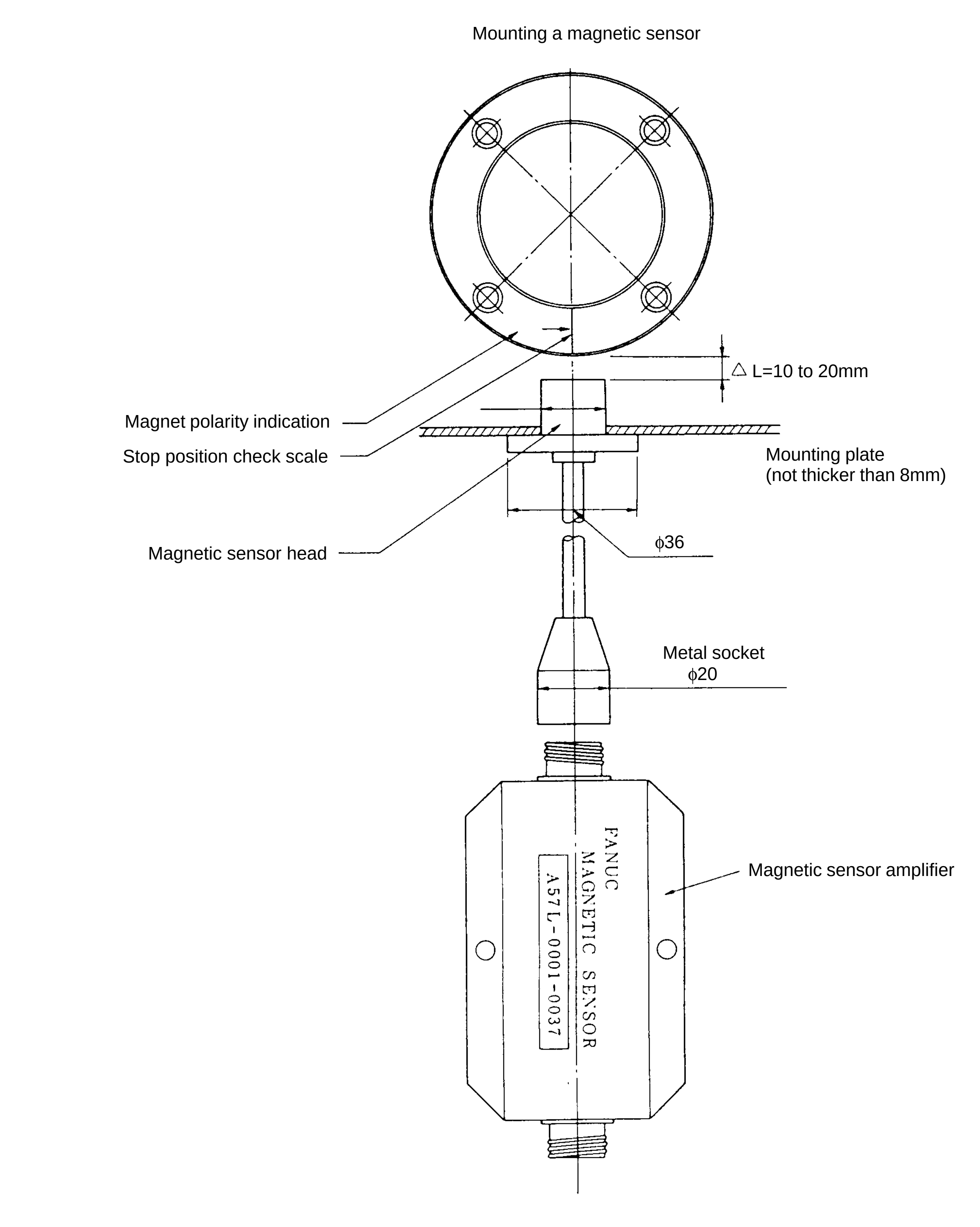
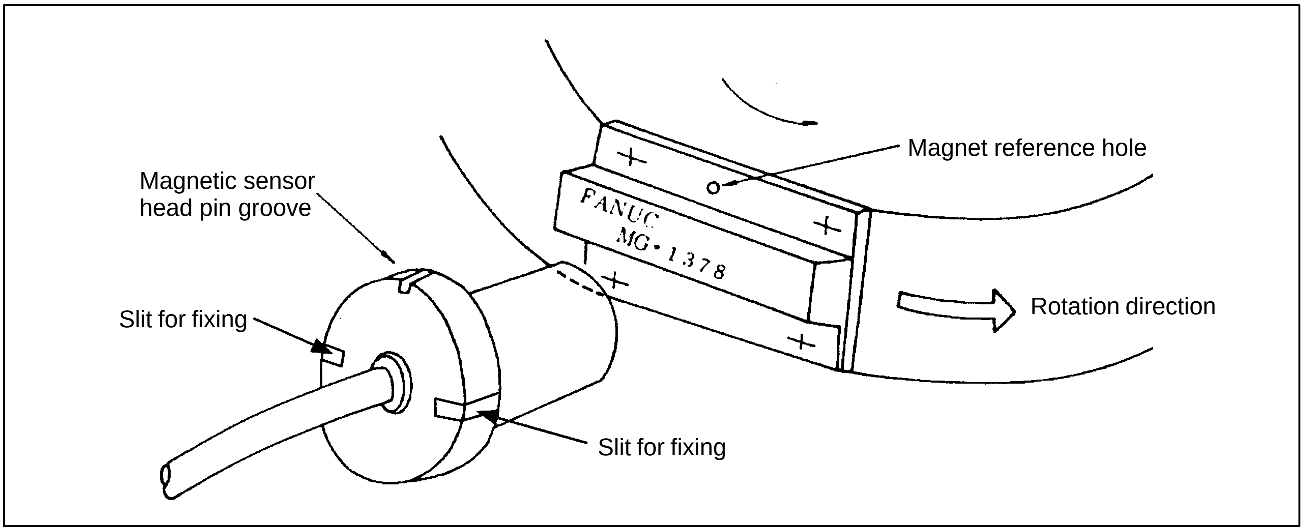


Fig.12.3.2 (d) Example of Mounting a Magnetic Sensor (4) (Mounting Magnetic Sensor Q, R, S, or T)

(9) Mounting Method

When a magnet is mounted on the spindle of a machine tool, the mounting direction depends on the spindle configuration (belt or gear connection) because of the polarity relationship with a magnetic sensor. When the connection shown in the magnetic sensor interface is used, the relative positions of the magnet reference hole and magnetic sensor pin groove must be as shown below. Otherwise, forward and reverse rotations may be repeated without stopping.



If SFRA (forward rotation command) = 1, all spindle motors rotate counterclockwise when viewed from the motor shaft. Align the magnet reference hole with the magnetic sensor pin groove so that the rotation direction shown above is achieved when the forward rotation command is on.

(10) Notes on Mounting a Magnetic Sensor

(a) A magnetic sensor is mounted on the rotation body of the spindle. So, ensure that a magnet is not dislodged by centrifugal force. The surface speed of a magnet should not exceed 3770 m/min. (N and P types)

(b) Mount a magnetic sensor amplifier as close to the sensor as possible.

(c) Never allow a magnetic substance to come close to the magnetic sensor. (Otherwise, the stop position may change.) In particular, never place a magnetic device such as a solenoid near the magnet.

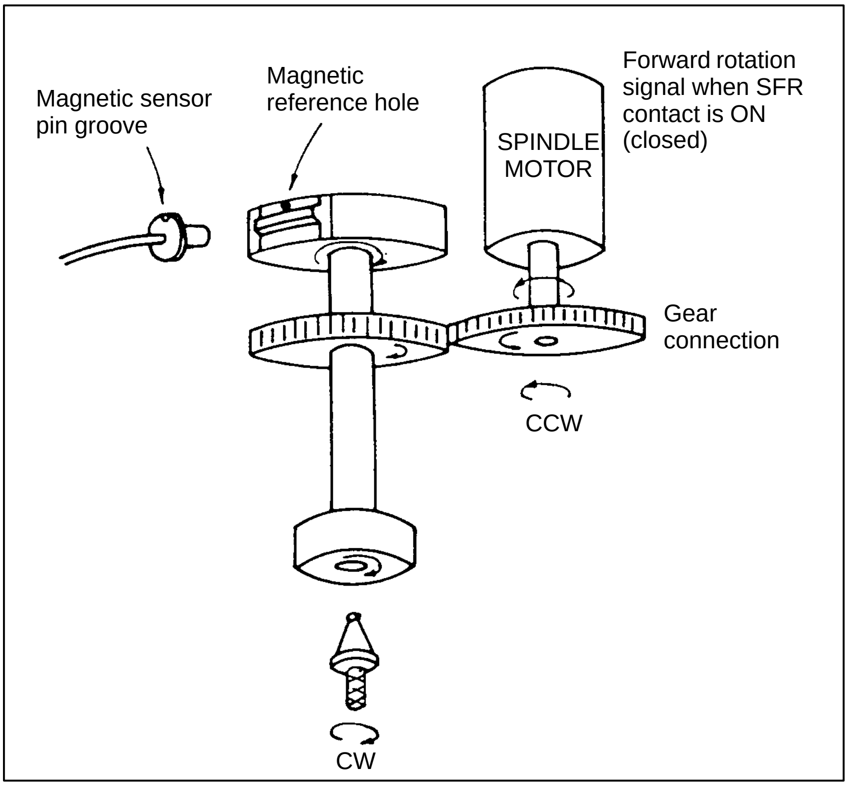
(d) Be careful not to allow iron chips or powder to adhere to the magnet.

(e) If the spindle contains a circuit such as a magnetic clutch for high/low switching that forms a magnetic loop, mount a magnet on a non–magnetic (such as aluminum) plate. The magnetic flux of the magnet at a stop position is zero. However, if the magnetic loop of a magnetic clutch has an influence, a magnetic flux is always applied when the magnetic clutch is on. Note that if the magnetic clutch is turned on and off at a stop position, the stable magnetic flux changes, thus causing the stop position to change.

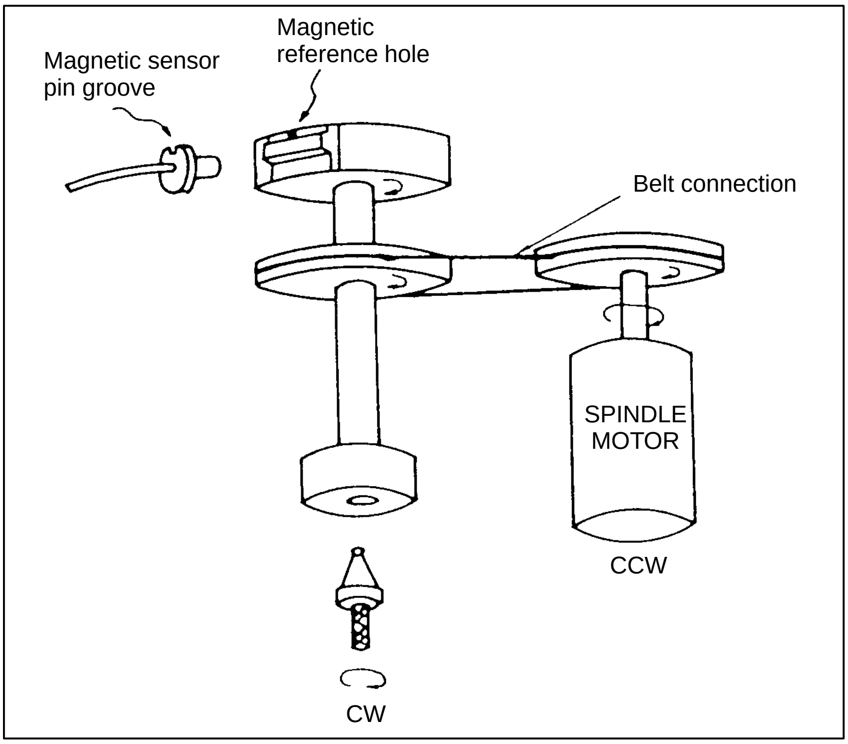
(f) Pay careful attention to the configuration so that the cable side of the magnetic sensor head, magnetic sensor amplifier, and connection cables are not exposed to lubricant or coolant.

(g) Mount the magnet of a magnetic sensor directly on the spindle. If a magnet is mounted by means of a gear connection or spline connection, the repeatability degrades, depending on the amount of backlash between the spindle and magnet. For improved repeatability, also consider deterioration with age (such as mechanical wear).

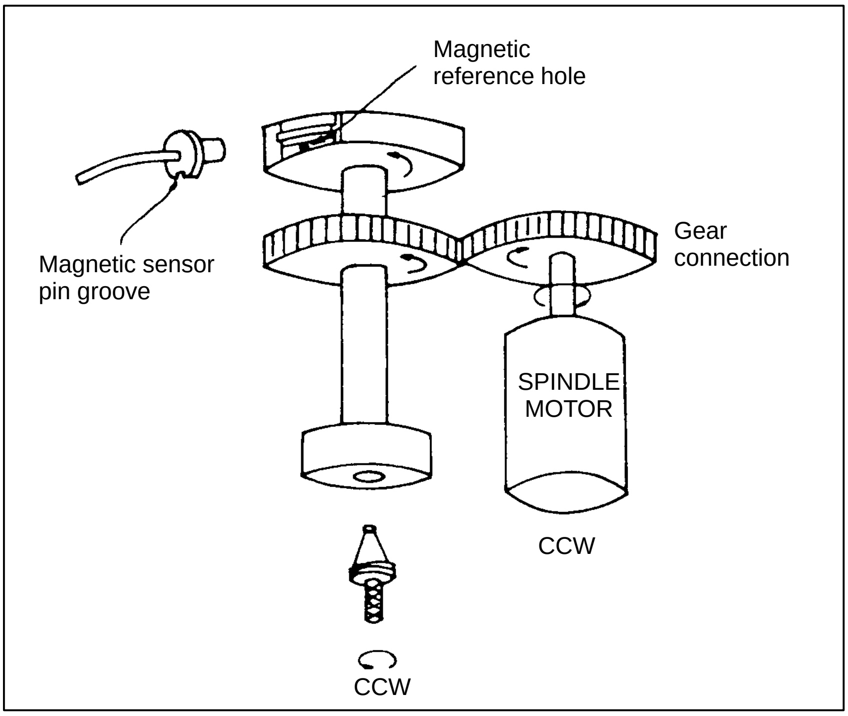
[Mounting example 1]



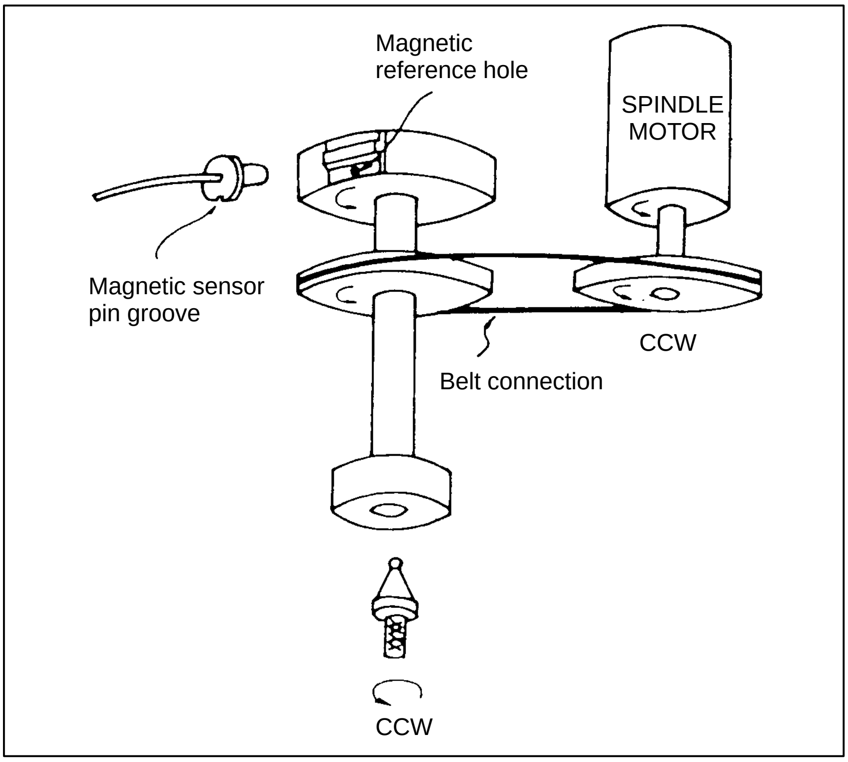
[Mounting example 2]



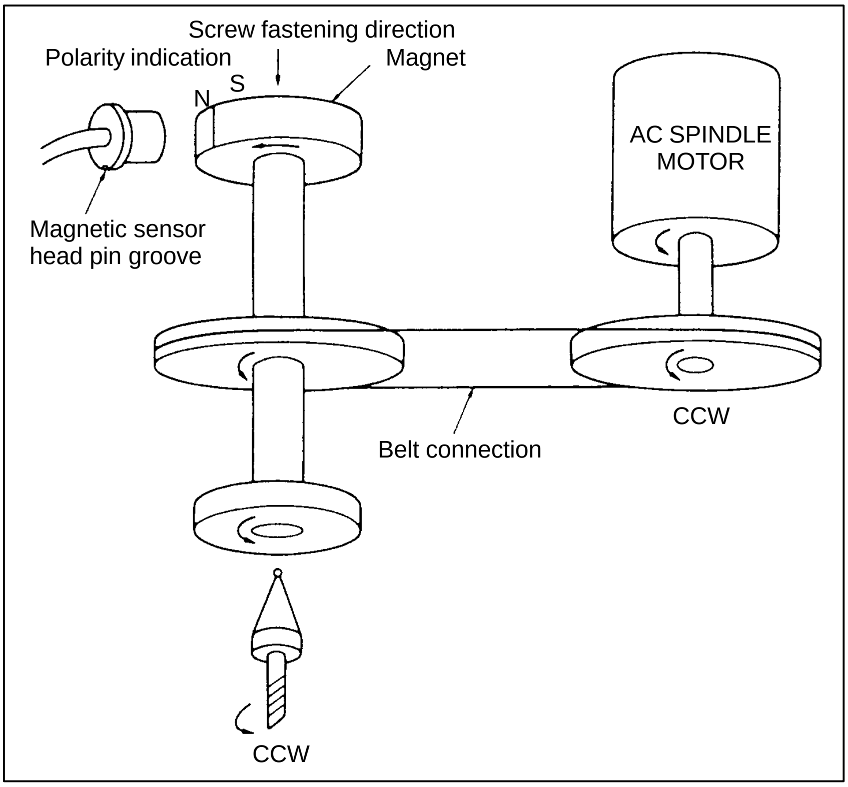
[Mounting example 3]



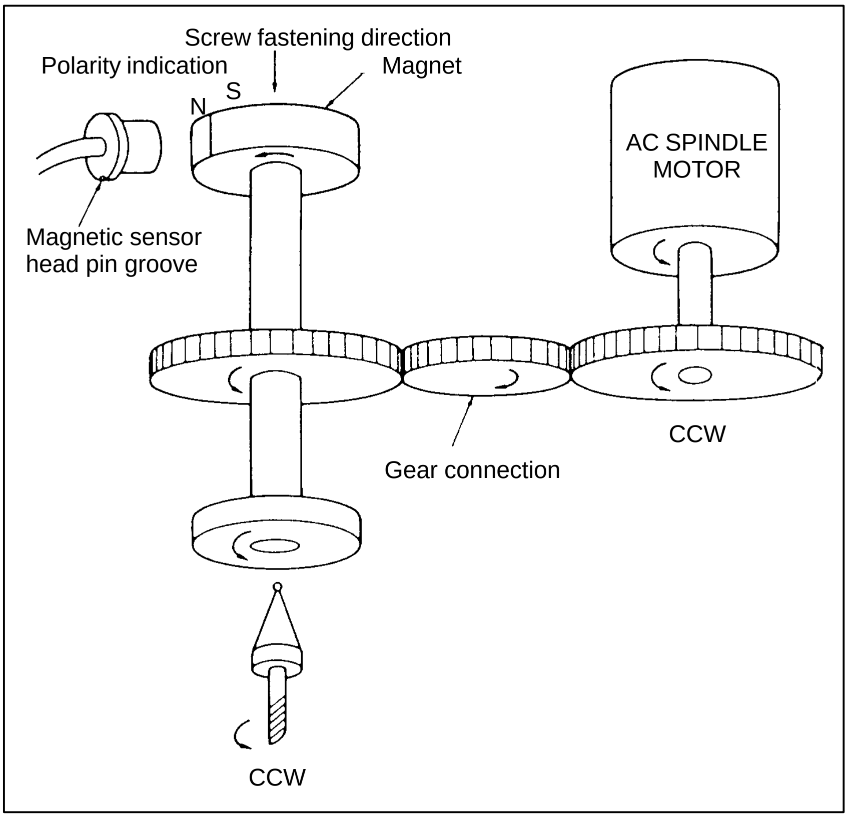
[Mounting example 4]



[Mounting example 5]



[Mounting example 6]



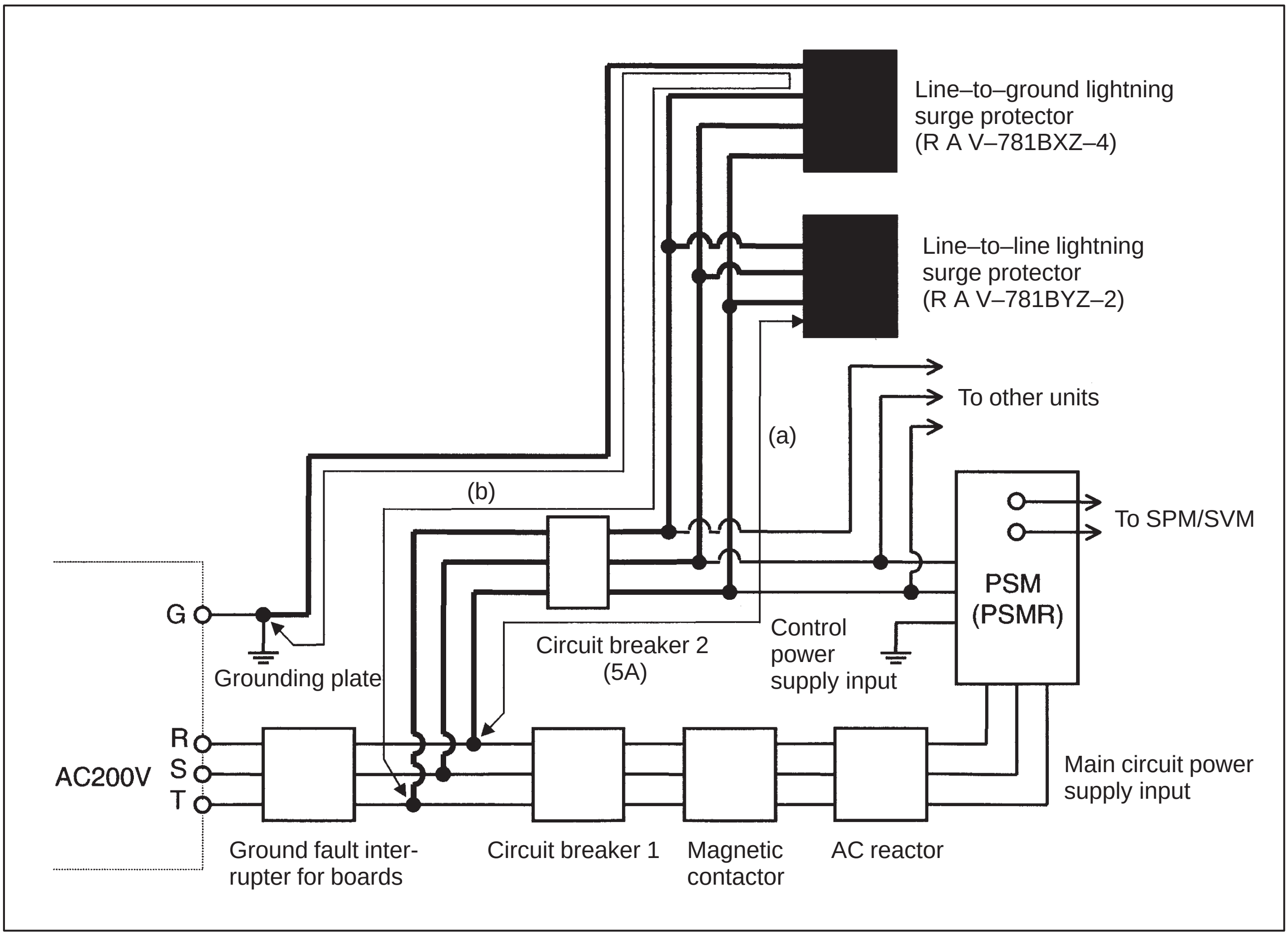
APPENDIX

A FITTING A LIGHTNING SURGE PROTECTION DEVICE

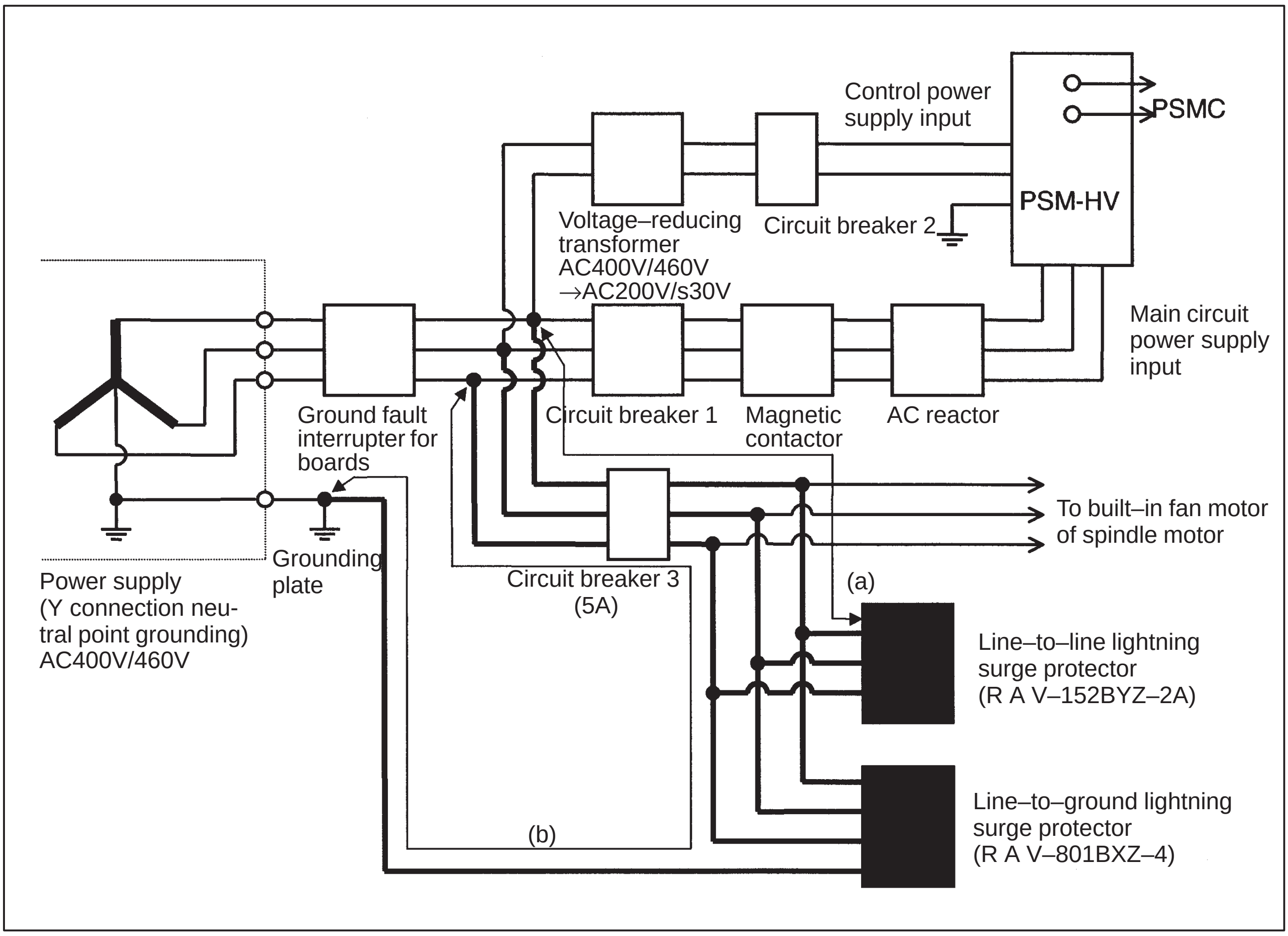
This appendix describes how to install a lightning surge protector and provides notes on installation. For information about the lightning surge protector recommended by FANUC, see Section 8.1.11.

A.1 INSTALLATION

A.1.1 200V Power Supply



A.1.2 400V Power Supply



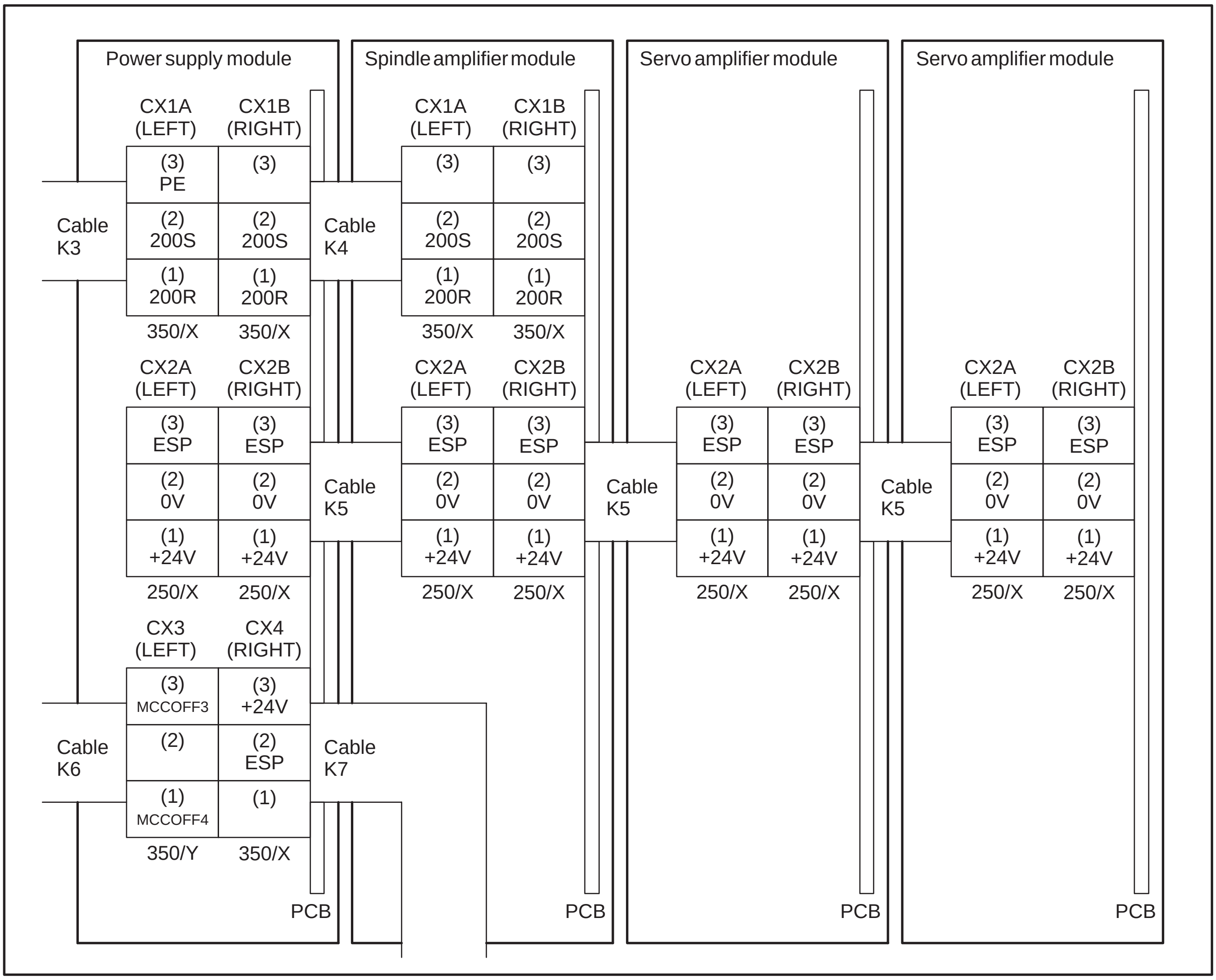
A.2 NOTES

- To increase the efficiency of lightning surge absorption, the wires indicated by bold lines should be as short as possible.

  Wire cross–sectional area:
  2 mm^2 or more

  Wire length:
  The total length of the cables used for lightning surge protection device 1 (a) and that used for lightning surge protection device 2 (b) must not exceed 2 m.
- When performing a dielectric strength test by applying an overvoltage to the power line, lightning surge protection device 2 must be removed to enable the applied voltage to be maintained.
- The circuit protector (5 A) works for line protection when the lightning surge absorber is short–circuited because of a surge higher than its rating being applied.
- Because current does not flow through the lightning surge absorber 1 nor 2 in a normal state, the circuit protector (5 A) can be used together with the surge absorbers as well as with other equipment. It can be connected to the power supply for power supply module control or spindle motor fans.
- Use Y connection neutral point grounding for the 400 V power supply. It cannot be used for the Δ connection 400/460 VAC line.

B SUMMARY OF AMP CONNECTORS



NOTE
Details such as connector locations may be changed without notice.

C CABLES

This appendix describes the cables used for the 20–pin interface connectors.
The cables are basically the same as those used for the FS16/18 (except those that have been newly developed).
The table below lists the cables we have developed for interface connectors. Contact the manufacturers as required.

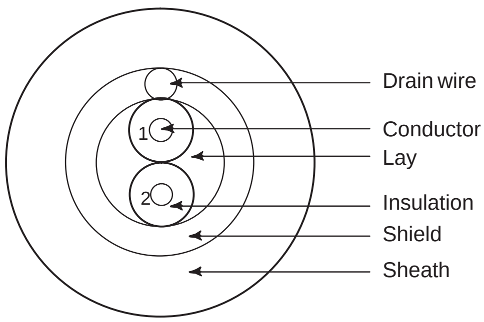
Cable name	Purpose	Configuration	FANUC specification	Manufacturer	Manufacturer specification
2–core cable	For motor thermostat of αC series	0.3mm^2 2 wires	A66L–0001–0275	Hitachi Cable, Ltd	CO–IREV (0)–SX 1P × 0.3SQ
10–pair cable	For general use	0.09 mm^2 10 pairs	A66L–0001–0284#10P	Hitachi Cable, Ltd.	UL20276–SB(0) 10PX28AWG(7/0.127)
				Oki Electric Cable Co., Ltd.	7/0.127 10P VX10–SV
Composite 12–core cable	For pulse coder For magnetic sensor For position coder	0.5 mm^2 6 cables 0.18 mm^2 3 pairs	A66L–0001–0286	Hitachi Cable, Ltd.	F–CO–VV(0)–SB 6X0.5SQ+3PX0.18SQ
				Oki Electric Cable Co., Ltd.	MIX12C(7/0.18, 20/0.18)HRS–SV
10–pair cable	For high–resolution magnetic pulse coder	0.18 mm^2 10 pairs	A66L–0001–0367	Shinko Electric Industries Co., Ltd.	FNC–019
Composite 16–core cable	For pulse generator, MZ sensor, BZ sensor For built–in sensor For high–resolution position coder	0.5 mm^2 6 cables 0.18 mm^2 5 pairs	A66L–0001–0368	Shinko Electric Industries Co., Ltd.	FNC–021

2–core cable

- **Specifications**

Item		Unit	Specifications
Product No.		–	A66L–0001–0275 (CO–IREV (0) –SX 1P×0.3SQ
Manufacturer		–	Hitachi Electric Cable Co., Ltd.
Rating		–	80°C, 30V
Material	Conductor	–	Stranded wire of tinned annealed copper
	Insulator	–	Irradiation Crosslinking Poliethylene
	Shield braid	–	Aluminum laminate poliestel tape is binded on both sides
	Sheath	–	Oilproof, heat–resistant vinyl
Number of wires (wire ons.)		Cores	2
Conductor	Size	mm^2	0.3
	Structure	Conductors /mm	7/0.26
	Outside diameter	mm	0.78
Insulator	Standard thickness	mm	0.3
	Outside diameter	mm	About 1.38
Twisted pair	Outside diameter	mm	About 2.8
Strand	Outside diameter	mm	–
Lay diameter		mm	About 3.5
Shield	Element wire diameter	mm	–
Sheath	Color	–	Black
	Thickness	mm	About 1.0
	Outside diameter	mm	About 5.0 (Max. 5.5)
Electrical performance	Resistance of conductor	Ω/km	Less than 54 (20°C)
	Dielectric strength (AC)	V/min.	AC1500
	Insulation resistance	MΩ–km	More than 1000 (20°C)

- **Specifications**



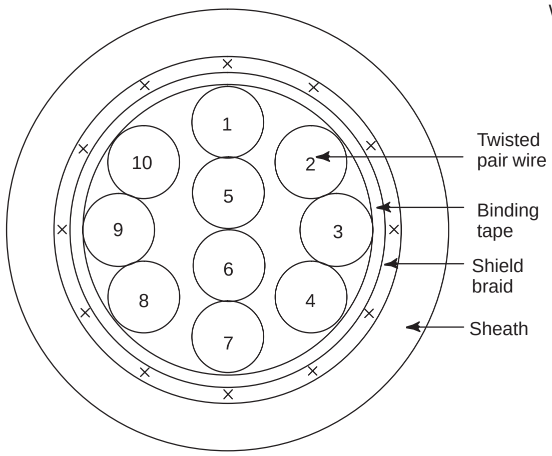
Wire No.	color
1	Red
2	Black

10–pair cable

- **Specifications**

Item		Unit	Specifications
Product No.		–	A66L–0001–0284#10P
Manufacturer			Hitachi Cable,Ltd. Oki Electric Cable, Co.,Ltd.
Rating		–	60°C 30V:UL2789 80°C 30V:UL80276
Material	Conductor	–	Stranded wire of tinned annealed copper (ASTM B–286)
	Insulator	–	Cross–linked vinyl
	Shield braid	–	Tinned annealed copper wire
	Sheath	–	Heat–resistant oilproof vinyl
Number of pairs		Pairs	10
Conduc-tor	Size	AWG	28
	Structure	Conduc-tors /mm	7/0.127
	Outside diameter	mm	0.38
Insulator	Thickness	mm	0.1 Thinnest portion : 0.08 (3.1mm)
	Outside diameter (approx.)	mm	0.58
	Core style (rating)	mm	UL15157(80°C, 30V)
Twisted pair	Outside diameter (approx.)	mm	1.16
	Pitch	mm	20 or less
Lay		–	Collect the required number of twisted pairs into a cable, then wrap binding tape around the cable. To make the cable round, apply a cable separator as required.
Lay diameter (approx.)		mm	3.5
Drain wire		Conduc-tors /mm	Hitachi Cable : Not available Oki Electric Cable : Available,10/0.12
Shield braid	Element wire diameter	mm	0.12
	Braid density	%	85 or less
Sheath	Color	–	Black
	Thickness	mm	1.0
	Outside diameter (approx.)	mm	6.2
Standard length		m	200
Packing method		–	Bundle
Electrical perfor-mance	Resistance of conductor (at 20°C)	Ω/km	233 or less
	Insulation resistance (at 20°C)	MΩ–km	10 or less
	Dielectric strength (AC)	V/min.	300
Flame resistance		–	Shall pass flame resistance test VW–1SC of UL standards.

• Cable structure

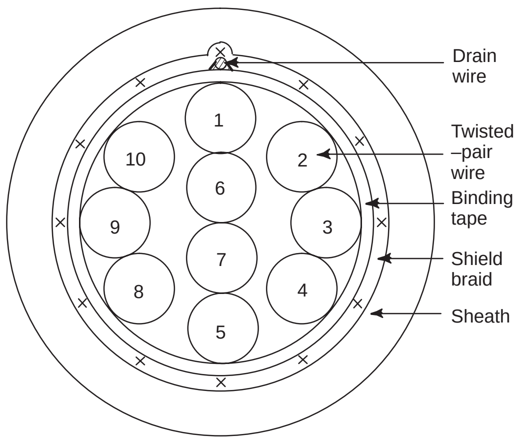


Wire identification table (Hitachi)

Wire No.	Insulator color	
	First wire	Second wire
1	Blue	White
2	Yellow	White
3	Green	White
4	Red	White
5	Purple	White
6	Blue	Brown
7	Yellow	Brown
8	Green	Brown
9	Red	Brown
10	Purple	Brown

The numbers assigned to the wires correspond to the numbers in the table at right.

Fig.C (a) Cable made by Hitachi Cable



Wire identification table (Oki)

Pair No.	Insulator color	Dot mark (1 pitch)	Dot mark color	
			First wire	Second wire
1	Orange	–	Red	Black
2	Gray	–	Red	Black
3	White	–	Red	Black
4	Yellow	–	Red	Black
5	Pink	–	Red	Black
6	Orange	– –	Red	Black
7	Gray	– –	Red	Black
8	White	– –	Red	Black
9	Yellow	– –	Red	Black
10	Pink	– –	Red	Black

The numbers assigned to the wires correspond to the numbers in the table at right.

Fig.C (b) Cable made by Oki Electric Cable

Composite 12–core cable

- **Specifications**

Item		Unit	Specifications	
Product No.		–	A66L–0001–0286	
Manufacturer		–	Oki Cable, Ltd. Hitachi Electric Cable Co., Ltd.	
Rating		–	80℃, 30V	
Material	Conductor,braid–shielded wire,drain wire	–	Strand wire of tinned annealed copper (JIS C3152)	
	Insulator	–	Heat–resistant flame–retardant vinyl	
	Sheath	–	Oilproof, heat–resistant, flame–retardant vinyl	
Number of wires (wire ons.)		Cores	6 (1 to 6)	6 (three pairs) (7 to 9)
Conductor	Size	mm^2	0.5	0.18
	Structure	Conductors /mm	20/0.18	7/0.18
	Outside diameter	mm	0.94	0.54
Insulator	Standard thickness (The minimum thickness is at least 80% of the standard thickness.)	mm	0.25	0.2
	Outside diameter	mm	1.50	0.94
Twisted pair	Outside diameter	mm		1.88
	Direction of lay	–		Left
	Pitch	mm		20 or less
Lay		–	Twist the wires at an appropriate pitch so the outermost layer is right–twisted, and wrap tape around the outermost layer. Apply a cable separator as required.	
Lay diameter		mm	5.7	
Drain wire	Size	mm^2	0.3	
	Structure	Wires/ mm	12/0.18	
	Outside diameter	mm	0.72	
Shield braid	Element wire diameter	mm	0.12	
	Thickness	mm	0.3	
	Braid density	%	70	
	Outside diameter	mm	6.3	

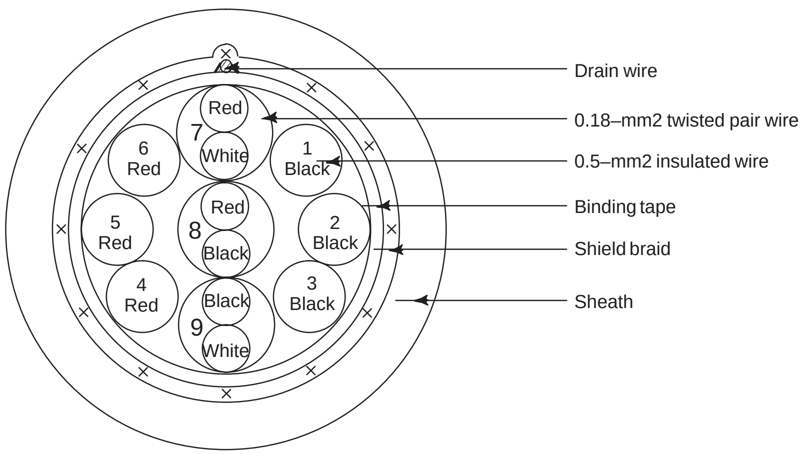
Item		Unit	Specifications	
Sheath	Color	–	Black	
	Standard thickness (The minimum thickness is at least 85% of the standard thickness.)	mm	1.1	
	Outside diameter	mm	8.5Max. 9.0(1)	
Standard length		m	100	
Packing method		–	Bundle	
Electrical perfor-mance	Resistance of conductor (at 20°C) (wire nos.)	Ω/km	39.4(1 to 6)	113(7 to 9)
	Insulation resistance (at 20°C)	MΩ–km	15	
	Dielectric strength (AC)	V/min.	500	
Flame resistance		–	Shall pass flame resistance test VW–1SC of UL standards,	

NOTE
The maximum outside diameter applies to portions other than the drain wire.

- **Markings on cable**
  - Name or symbol of the manufacturer
  - Manufacturing year

- **Cable structure**

The cable structure is shown below.

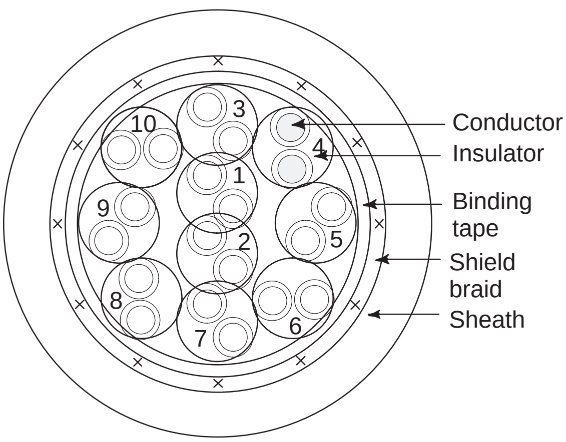


The colors in the figure indicate the colors of insulators.

10–pair cable

• Specifications

Item		Unit	Specifications
Product No.		–	A66L–0001–0367(FNC–019)
Manufacturer			Shinko Electric Industries Co., Ltd.
Rating		–	80℃ 60V
Material	Conductor	–	Strandedwire of tinned annealed copper (JIS C 3152)
	Insulator	–	Heat–resistant polivinyl chioride
	Shield braid	–	Tinned annealed copper wire
	Sheath	–	Heat–resistant, oil–resistance, flame–retardent polivinyl chioride (S–3)
Number of pairs		Pairs	10
Conductor	Nominal cross–sectional area	mm^2	0.18
	Structure	Conduc-tors /mm	7/0.18
	Outside diameter (approx.)	mm	0.54
Insulator	Thickness	mm	0.25 (Average thickness : 90% or more)
	Outside diameter (approx.)	mm	1.04
Twisted pair	Outside diameter (approx.)	mm	2.08 (pitch : 25 mm or less)
Lay	Diameter (approx.)	mm	6.5
Tape–wound wire	Diameter (approx.)	mm	6.6
Shield	Element wire diameter	mm	0.12 (Braid density : 75% or more)
Sheath	Color	–	Black
	Thickness	mm	1.0
	Outside diameter	mm	9.2 ±0.3
Electrical perfor-mance	Resistance of conductor	Ω/km	110 or less (20°C JIS C 3005 6)
	Dielectric strength	VAC/min.	500 (JISx C 3005 8 (2))
	Insulation resistance	MΩ–km	15 or more (20°C JIS C 3005 9.1)

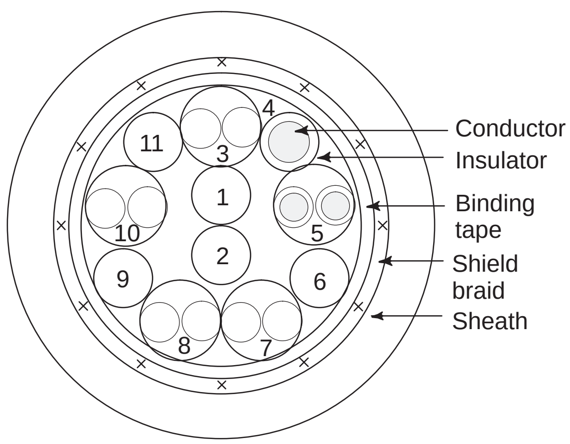


Pair No.	Dot mark color
1	Black/Orange
2	Black/Gray
3	White/Yellow
4	White/Green
5	White/Brown
6	White/Orange
7	White/Gray
8	Black/Yellow
9	Black/Green
10	Black/Brown

Composite 16–core cable

- **Specifications**

Item			Unit	Specifications	
Product No.			–	A66L–0001–0368(FNC–021)	
Manufacturer				Shinko Electric Industries Co., Ltd.	
Rating			–	80°C 60V	
Material	Conductor		–	Stranded wire of tinned annealed copper (JIS C 3152)	
	Insulator		–	Heat–resistant polivinyl chioride	
	Shield braid		–	Tinned annealed copper wire	
	Sheath		–	Heat–resistant, oil–resistance, flame–retardent polivinyl chioride (S–3)	
Number of pairs			Pairs	6	10 (5–pair)
Conductor	Nominal cross–sectional area		mm^2	0.5	0.18
	Structure		Conductors/mm	20/0.18	7/0.18
	Outside diameter (approx.)		mm	0.9	0.54
Insulator	Thickness		mm	0.25 (Average thickness : 90% or more)	0.2 (Average thickness : 90% or more)
	Outside diameter (approx.)		mm	1.5	0.94
Twisted pair	Outside diameter (approx.)		mm	–	1.88 (pitch : 20 mm or less)
Lay	Diameter (approx.)		mm	6.5	
Tape–wound wire	Diameter (approx.)		mm	6.6	
Drain wire	Structure		Conductors/mm	12/0.18	
Shield	Element wire diameter		mm	0.12 (Braid density : 70% or more)	
Sheath	Color		–	Black	
	Thickness		mm	1.0 (Average thickness : 90% or more)	
	Outside diameter		mm	9.2 ±0.3	
Electrical performance	Resistance of conductor	Electric resistance	Ω/km	113 or less (20°C JIS C 3005 6)	
		Electric resistance		39.4 or less (20°C JIS C 3005 6)	
	Dielectricstrength		VAC/min.	500 (JISx C 3005 8 (2))	
	Insulation resistance		MΩ–km	15 or more (20°C JIS C 3005 9.1)	



Pair No.	Dot mark color	Size mm^2
1	Red	0.5
2	Red	0.5
3	White/Yellow	0.18
4	Black	0.5
5	White/Green	0.18
6	Black	0.5
7	White/Gray	0.18
8	Black/Orange	0.18
9	Black	0.5
10	Black/Brown	0.18
11	Red	0.5

D EXTERNAL DIMENSIONS OF EACH CONNECTOR

Name	Number of Figure
AMP Connector (1)	Fig. 1
AMP Connector (2)	Fig. 2
AMP Connector (3)	Fig. 3
Contact for AMP Connector	Fig. 4
PCR Connector (Crimp Type)	Fig. 5
PCR Connector (Solder Type)	Fig. 6
FI40 Connector (Solder type)–(1)	Fig. 7
FI40 Connector (Solder type)–(2)	Fig. 8
Connector Case (HONDA PCR Type)	Fig. 9
Connector Case (HIROSE FI Type)–(1)	Fig. 10
Connector Case (HIROSE FI Type)–(2)	Fig. 11

Fig. 1 AMP Connector (1)

Manufacture	:	AMP JAPAN, LTD.
Type	:	(AMP) 1–178128–3
Usage	:	Control power 1 phase 200VAC (CX1A) Emergency stop signal input (CX4) For dynamic brake drive coil (CX9)

CX1A

3	PE	■
2	200S	■
1	200R	

CX4

3	+24V	■
2	ESP	■
1		

■ Key location

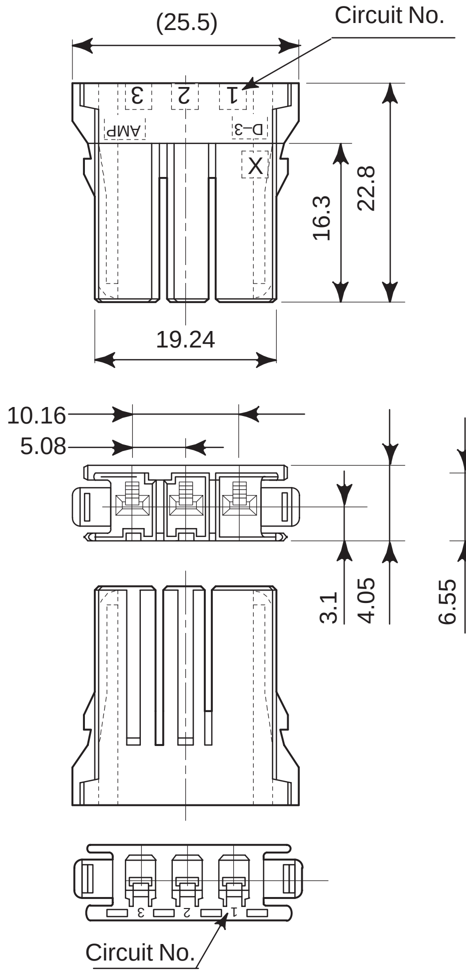


Fig. 2 AMP Connector (2)

Manufacture	:	AMP JAPAN, LTD.
Type	:	(AMP) 2–178128–3 (CX3)
Usage	:	For dynamic brake interlock signal (CX8)

CX3

3	MCCOFF3
2	■
1	MCCOFF4 ■

CX8

3	INTL ■
2	■
1	+24V

■ Key location

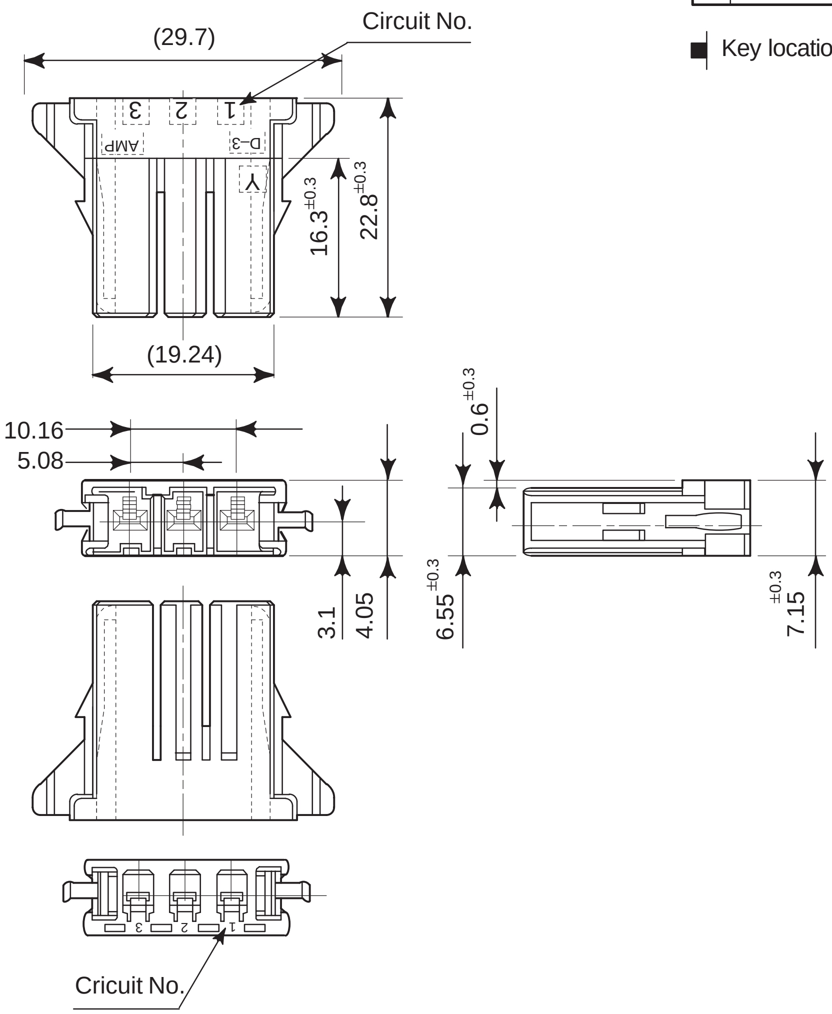


Fig. 3 AMP Connector (3)

Manufacture	:	AMP JAPAN, LTD.
Type	:	(AMP) 1–178288–3
Usage	:	Control power +24VDC input (CX2A/B)

CX2A
CX2B

3	ESP	■
2	0V	■
1	+24V	

■ Key location

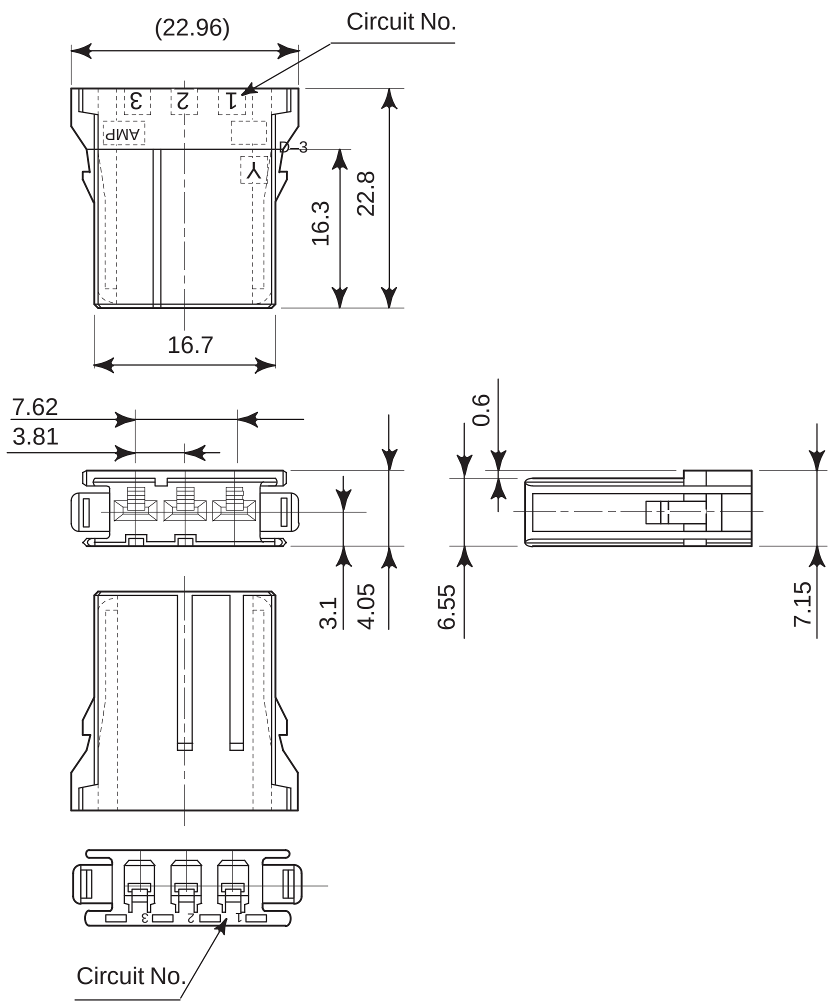


Fig. 4 AMP Connector (4)

Manufacture : AMP JAPAN, LTD.
Model : (AMP) 2–178129–6
Application : Used for phase detection signal (CX10)

CX10

	A	B
3		400T
2	400S	
1		400R

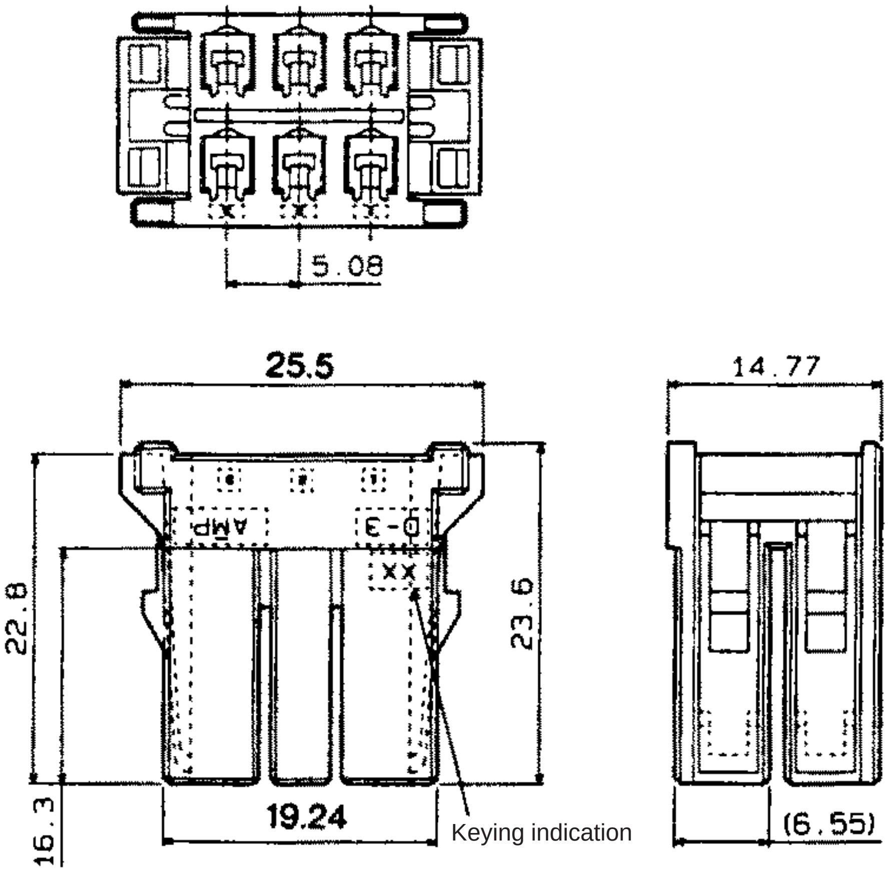


Fig. 5 Contact for AMP Connector

Manufacture	:	AMP JAPAN, LTD.
Type	:	(AMP) 1–175218–2
Cable	:	AWG16, 18, 20

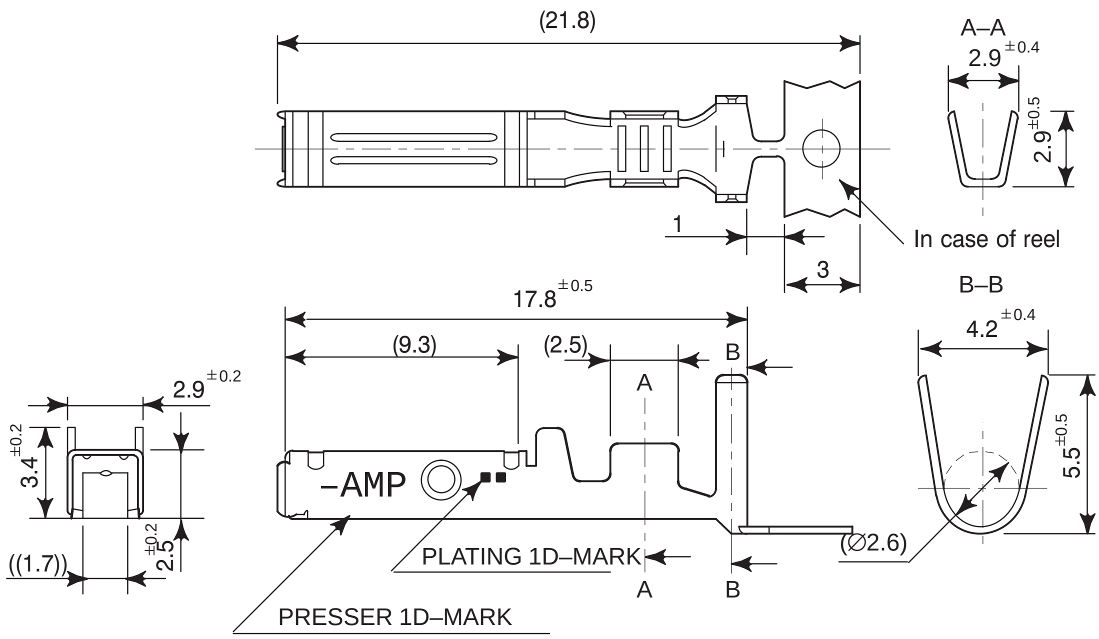
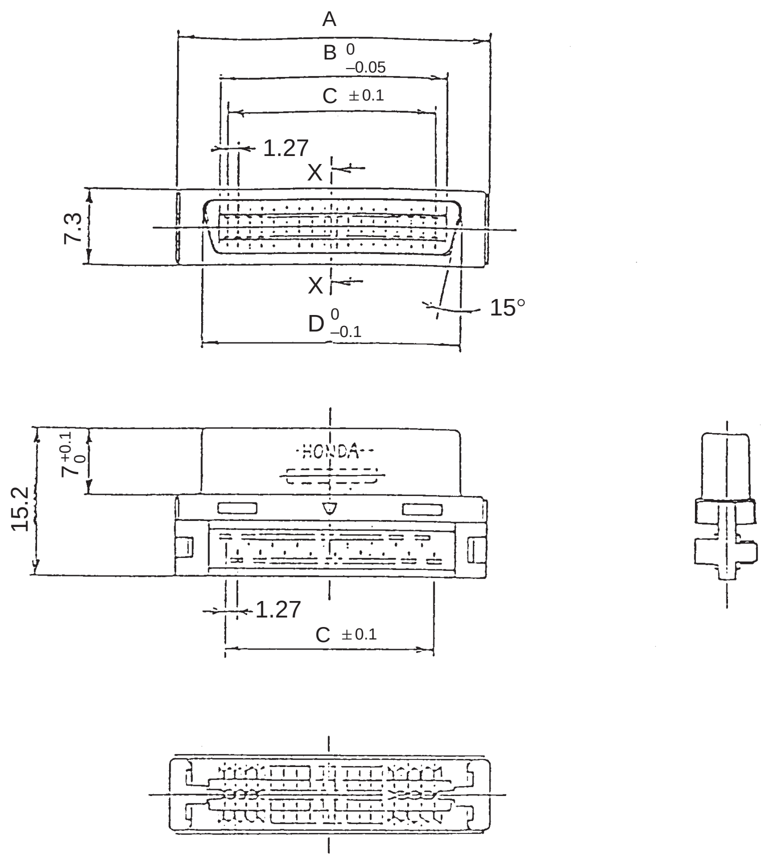


Fig. 6 PCR Connector (Crimp Type)

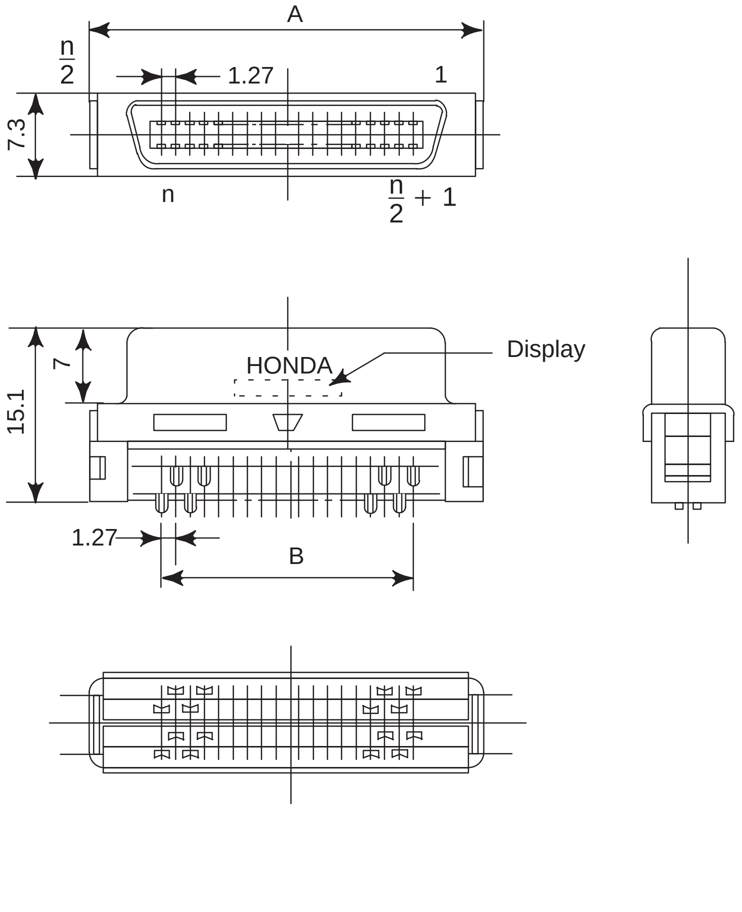
Manufacture	:	HONDA TSUSHIN KOGYO CO., LTD.
Type	:	PCR–E20FA (crimp type)
Usage	:	Interface
Housing	:	PCS–V20L (plastic) See to Fig. 10.



Cores	Type number	A	B	C	D
20	PCR–E20F( )	21.65	13.35	1.27×9=11.43	16.25

Fig. 7 PCR Connector (Solder Type)

Manufacture	:	HONDA TSUSHIN KOGYO CO., LTD.
Type	:	PCR–E20FS (solder type)
Usage	:	Interface
Housing	:	PCS–V20L (plastic) See to Fig. 10.



Type number	A	B
PCR–E20FS	21.65	11.43

Fig. 8 FI40 Connector (Solder Type) –(1)

Manufacture	:	HIROSE ELECTRIC CO., LTD.
Type	:	FI40–2015S (solder type)
Usage	:	Pulse coder Magnetic sensor Position coder
Housing	:	FI–20–CV (plastic) See to Fig. 11

NOTE
This connector does not contact locations 11, 13, 15, 17, and 19.

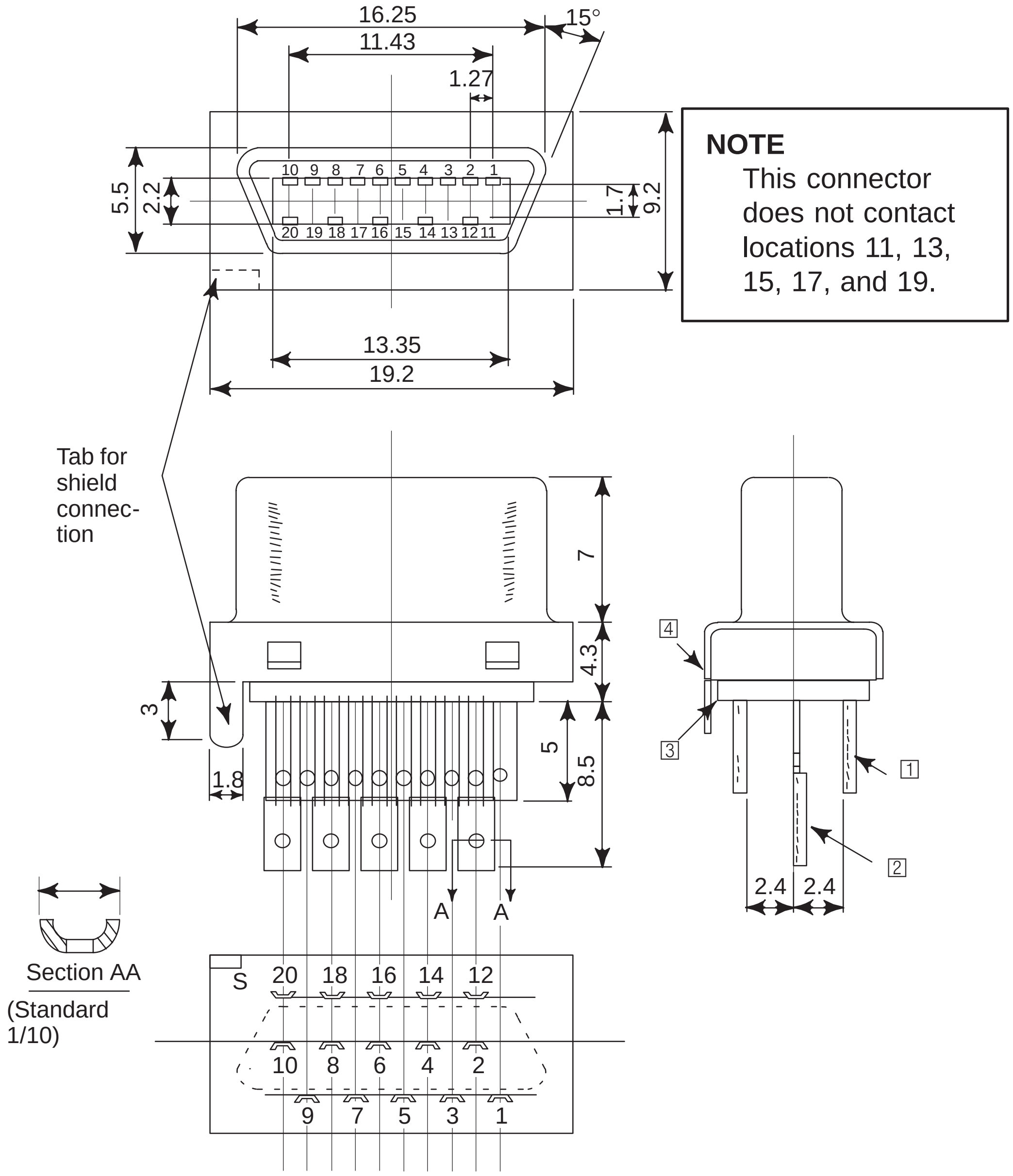


Fig. 9 FI40 Connector (Solder Type) –(2)

Manufacture	:	HIROSE ELECTRIC CO., LTD.
Type	:	FI40B–20S (solder type)
Usage	:	Pulse generator Built–in sensor High resolution pulse coder High resolution position coder
Housing	:	FI–20–CV5 (plastic) See to Fig. 12

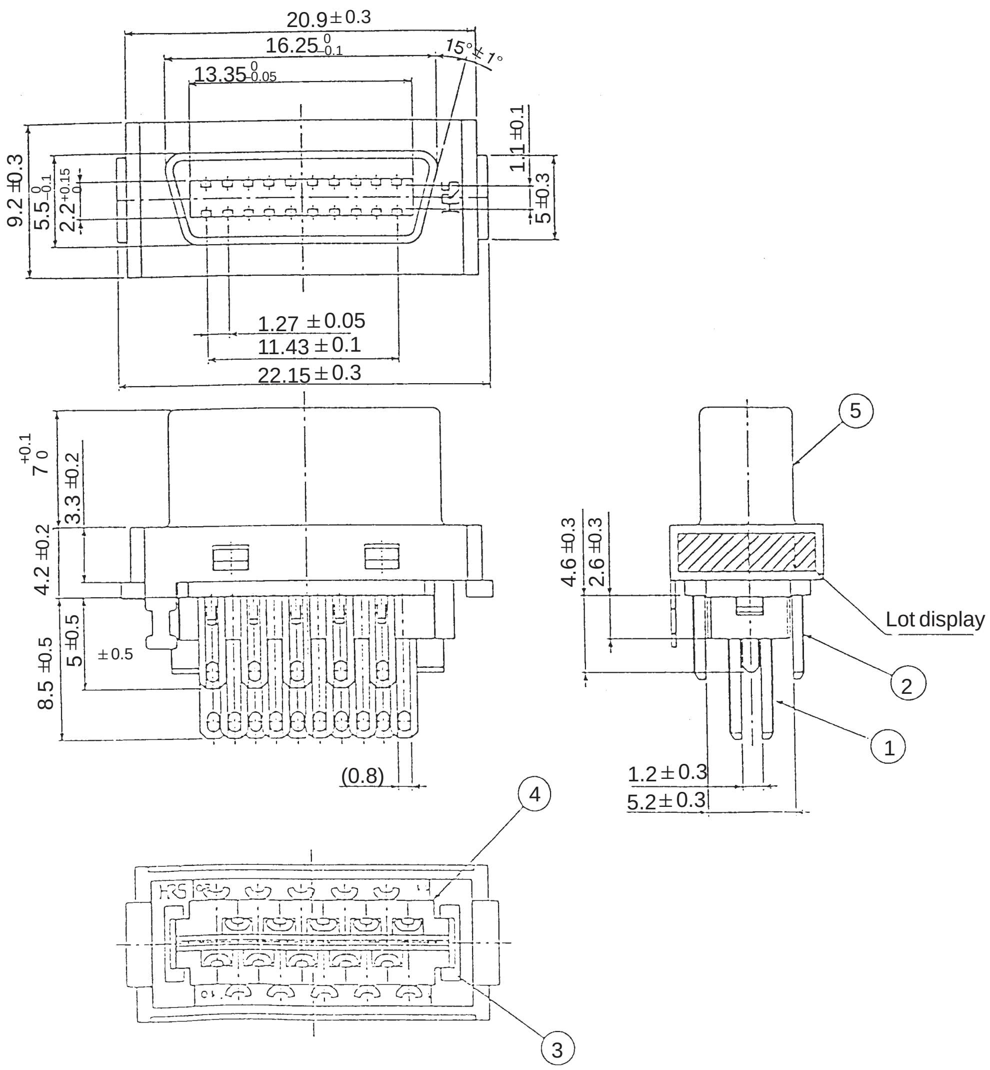
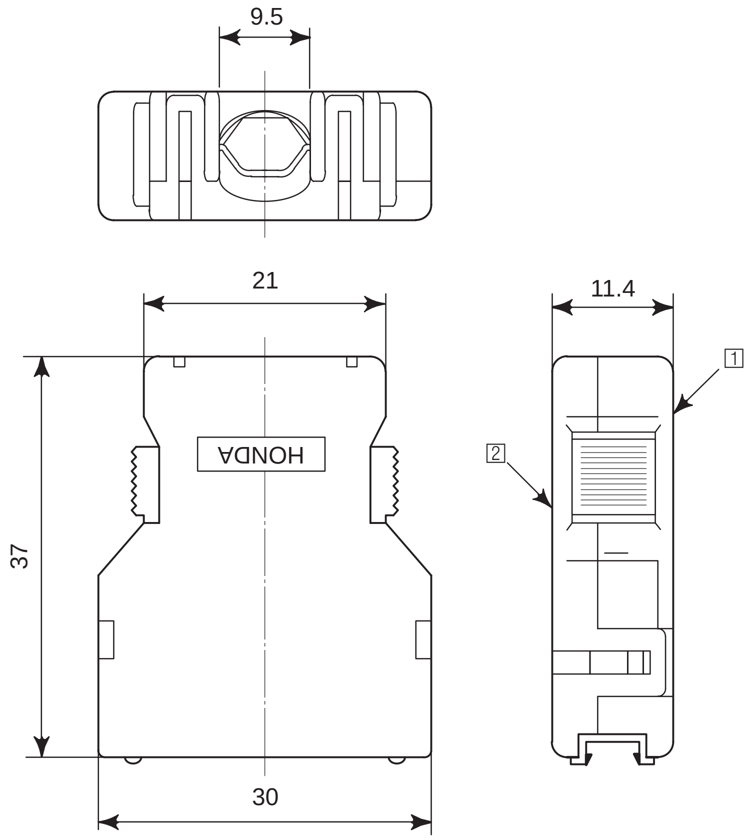
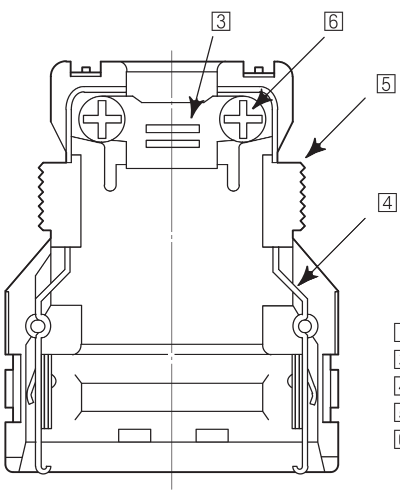


Fig. 10 Connector Case (HONDA PCR Type)

Manufacture	:	HONDA TSUSHIN KOGYO CO., LTD.
Type	:	PCR–V20LA (for 6 dia. cable)





1 2	Case
3	Cable clamp
4	Lock bracket
5	Lock lever
6	Set screw for cable clamp

Fig. 11 Connector Case (HIROSE FI Type) –(1)

Manufacture : HIROSE ELECTRIC CO., LTD.
Type : FI–20–CV

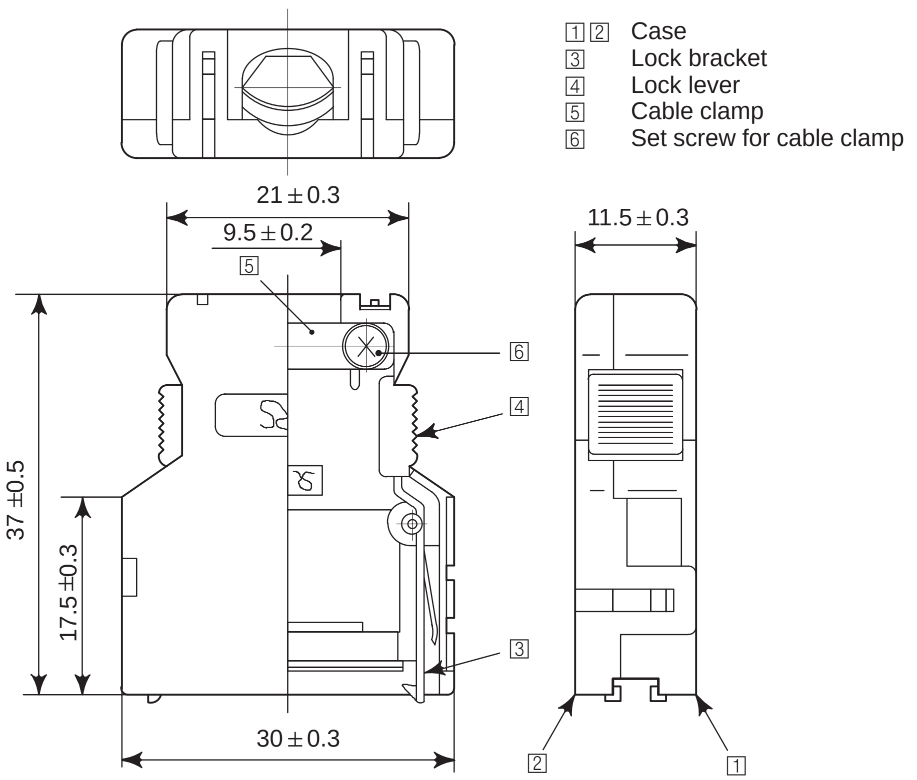
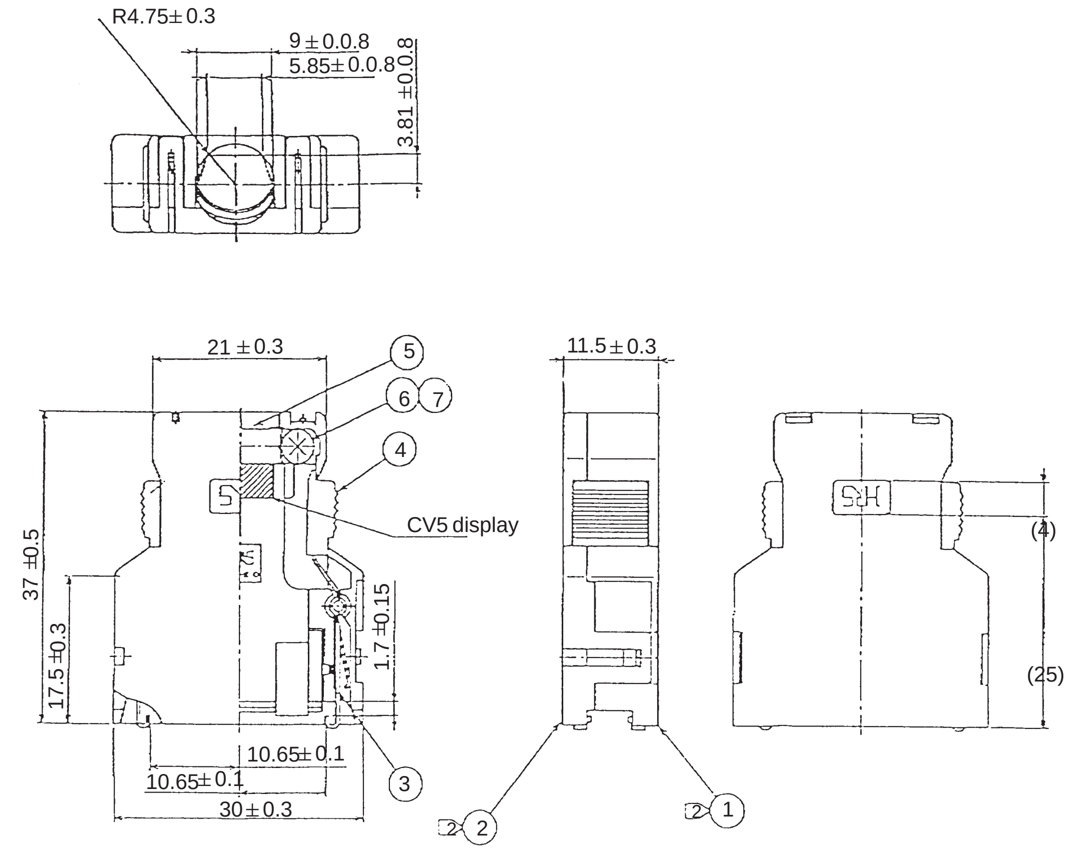


Fig. 12 Connector Case (HIROSE FI Type) –(2)

Manufacture : HIROSE ELECTRIC CO., LTD.
Type : FI–20–CV5



E FEEDBACK CABLE LENGTH

E.1 SPINDLE CABLE LENGTH (WHEN RECOMMENDED CABLES ARE USED)

Detector	Recommended cable	Cable structure	Maximum cable length
M sensor (pulse generator)	A66L–0001–0368	0.5mm^2, 6 conductors (for power supply) 0.18mm^2, 5 pairs (for signals)	72m When one power line is used
MZ sensor, BZ sensor (built–in sensor)	A66L–0001–0368	0.5mm^2, 6 conductors (for power supply) 0.18mm^2, 5 pairs (for signals)	50m When one power line is used
Magnetic sensor (for orientation)	A66L–0001–0286	0.5mm^2, 6 conductors (for power supply) 0.18mm^2, 3 pairs (for signals)	25m When one power line is used
Position coder	A66L–0001–0286	0.5mm^2, 6 conductors (for power supply) 0.18mm^2, 3 pairs (for signals)	7m When one power line is used
High–resolution magnetic pulse coder	A66L–0001–0367	0.18mm^2, 10 pairs (for power supply and signals)	18m When one power line is used
High–resolution position coder	A66L–0001–0367	0.18mm^2, 10 pairs (for power supply and signals)	7m When one power line is used

When a cable other than one of the recommended cables above is used, the voltage drop in the cable must be within 0.2 V for a +5 V power supply.

(Tip) Maximum cable length L can be found from the following formula:

$$L\ [m] \leqq 0.2\ [V] \times n[line] \div 2 \div I\ [A] \div R\ [\Omega / m]$$

n : Number of power lines (number of +5V or +15V lines)
I : Current consumption of the detector
R : Resistance of a wire used for a power line

Detector	Current consumption
M sensor (pulse generator)	0.035A
MZ sensor, BZ sensor (built–in sensor)	0.05A
Magnetic sensor (for orientation)	0.1A
Position coder	0.35A
High–resolution magnetic pulse coder	0.15A
High–resolution position coder	0.35A

Check the check board to confirm that the feedback signal waveform of each detector satisfies the specifications.

E.2 SERVO CABLE LENGTH (WHEN RECOMMENDED CABLES ARE USED)

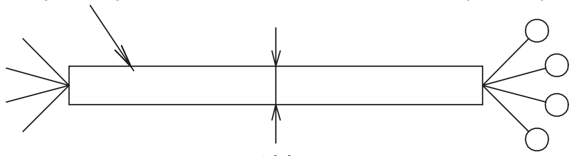
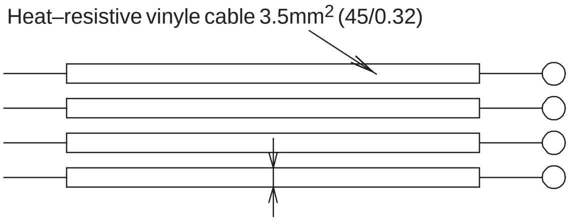
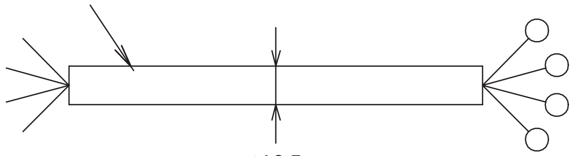
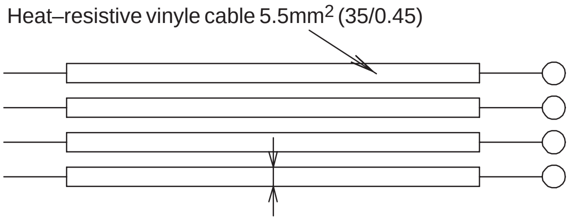
Recommended cable	Cable structure	Maximum cable length
A66L–0001–0286	0.5 mm^2, 6 conductors (for power supply) 0.18mm^2, 3 pairs (for signals)	14m When two power lines are used

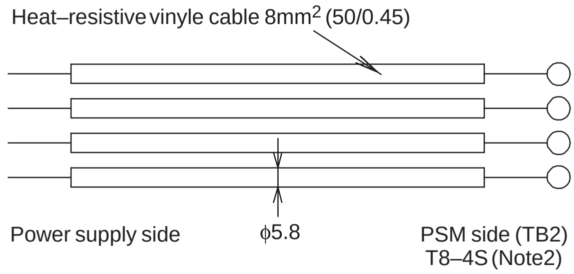
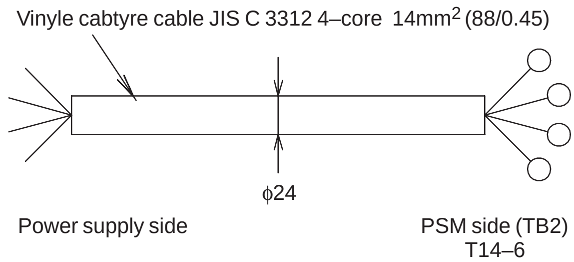
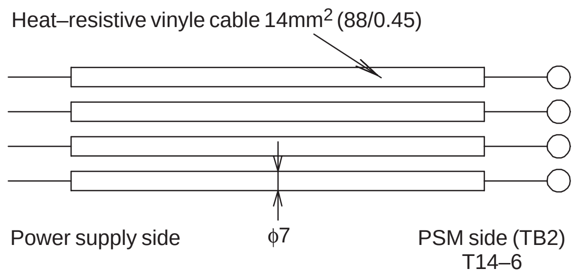
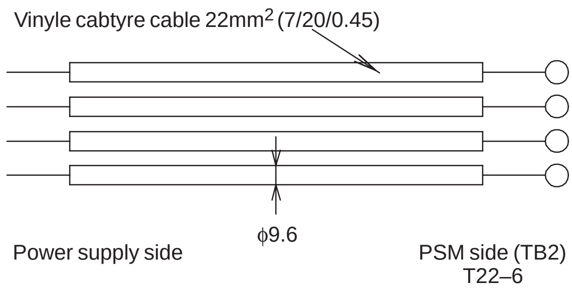
When a cable longer than 14 m is used, ensure that the sum of the resistances of 0 V and 5 V is 0.5 ohms or less.

F SPECIFICATIONS OF CABLES

The following table lists the specifications of cables.
The cables without FANUC's specification or the cables with different cable length shall be prepared by Machine Tool Builder.

(1) Power supply module

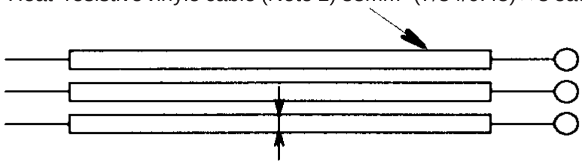
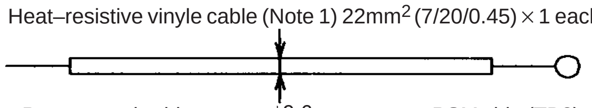
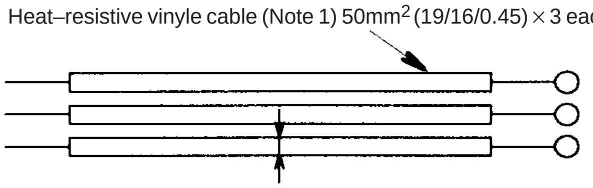
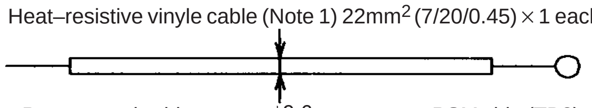
Use	Sym-bol	Specification	FANUC specification (complete cable)
PSMR–3 (Power line)	K1		
			
PSMR–5.5 PSM–5.5 (Power line)	K1		
			

Use	Sym-bol	Specification	FANUC specification (complete cable)
PSM–11 (Power line)	K1		
PSM–15 (Power line)	K1		
			
PSM–26 PSM–30 (Power line)	K1		

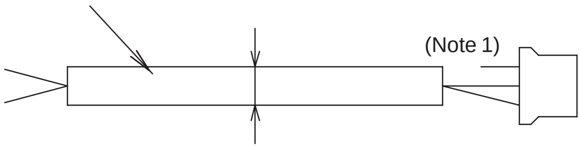
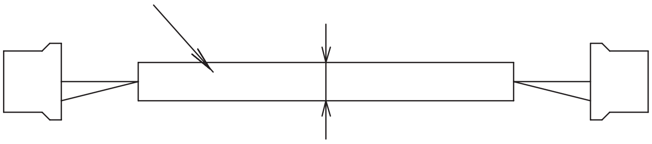
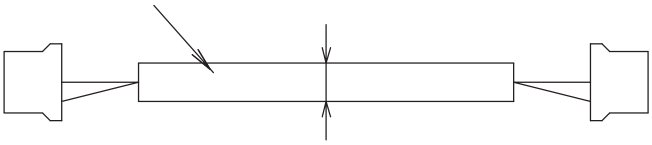
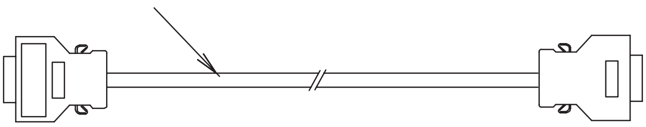
NOTE

1 Heat–resistant cable: Furukawa Electric Co., Ltd. Contact: 03(3286)3144
LMFC (Fire–retardant Polyflex electric cable, Maximum allowable conductor temperature: 105°C)

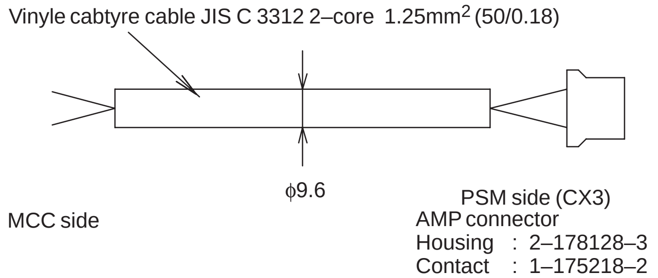
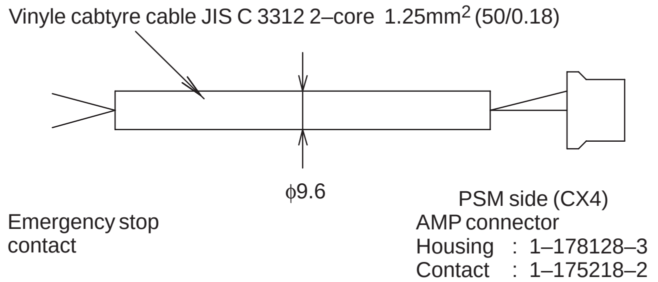
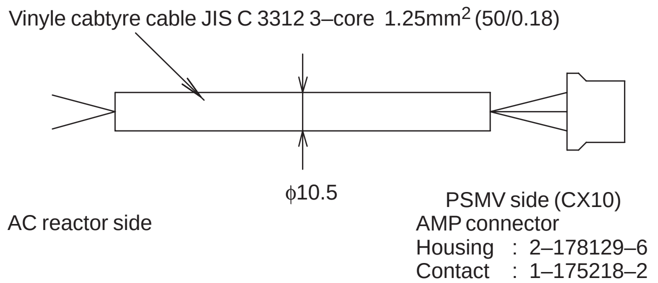
2 Crimp terminal: Nichifu Contact: 03(3452)7381
8–4S

Use	Sym- bol	Specification	FANUC specification (complete cable)
PSM–37 (Power line)	K1	Heat–resistive vinyle cable (Note 1) 38mm^2 (7/34/0.45) × 3 each  Power supply side φ11.7 PSM side (TB2) T38–6S (Note 2) Heat–resistive vinyle cable (Note 1) 22mm^2 (7/20/0.45) × 1 each  Power supply side φ9.6 PSM side (TB2) T22–6	
PSM–45 (Power line)	K1	Heat–resistive vinyle cable (Note 1) 50mm^2 (19/16/0.45) × 3 each  Power supply side φ13.6 PSM side (TB2) T60–10 Heat–resistive vinyle cable (Note 1) 22mm^2 (7/20/0.45) × 1 each  Power supply side φ9.6 PSM side (TB2) T22–6	

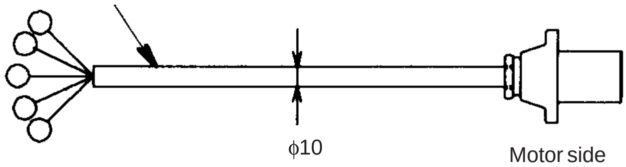
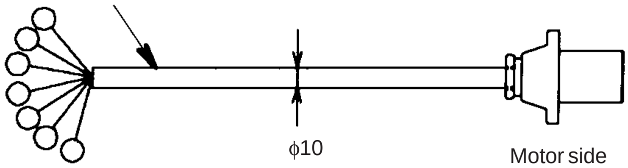
NOTE
1. Heat–resistant cable: Furukawa Electric Co., Ltd. Contact: 03(3286)3144
   LMFC (Fire–retardant Polyflex electric cable, Maximum allowable conductor temperature: 105°C)
2. Crimp terminal: Japan Crimp Terminal Production
   38–6S

Use	Sym-bol	Specification	FANUC specification (complete cable)
PSM (For control power 1ϕ, 200VAC)	K3	Vinyle cabtyre cable JIS C 3312 2–core 1.25mm^2 (50/0.18)  (Note 1) ϕ9.6 Power supply side PSM side (CX1A) AMP connector Housing : 1–178128–3 Contact : 1–175218–2	
PSM (For power between PSM and SPM, 1ϕ, 200VAC)	K4	Vinyle cabtyre cable JIS C 3312 2–core 1.25mm^2 (50/0.18)  ϕ9.6 PSM side (CX1B) AMP connector Housing : 1–178128–3 Contact : 1–175218–2 SPM side (CX1A) AMP connector Housing : 1–178128–3 Contact : 1–175218–2	A set of K4, K5, K8 A06B–6078–K808 (Cable length : 200m) A06B–6078–K809 (Cable length : 150mm) A06B–6078–K810 (Cable length : 100mm)
PSM (For power between PSM and SPM, 24VDC)	K5	Vinyle cabtyre cable JIS C 3312 3–core 1.25mm^2 (50/0.18)  ϕ10.5 PSM side (CX2B) AMP connector Housing : 1–178288–3 Contact : 1–175218–2 SPM side (CX2A) AMP connector Housing : 1–178288–3 Contact : 1–175218–2	
PSM (For interface between PSM and SPM)	K8	Twisted pair unified shield 10–pair 0.09mm^2 (7/0.127) (*2)  PSM side (JX1B) HONDA connector Connector : PCR–E20FA Housing : PCR–V20LA SPM side (JX1A) HONDA connector Connector : PCR–E20FA Housing : PCR–V20LA	

NOTE
1. Vinyle cabtyre cable for protective earth JIS C 3312 1–core 1.25mm^2 (50/0.18)
2. FANUC'S specification (Material only) : A66L–0001–0284#10P

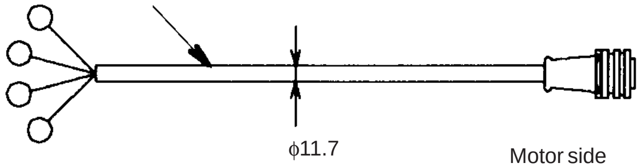
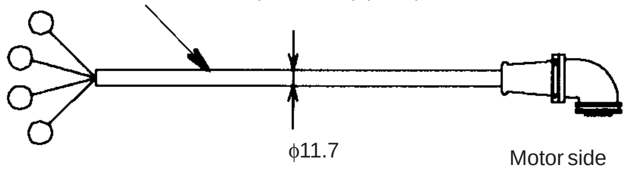
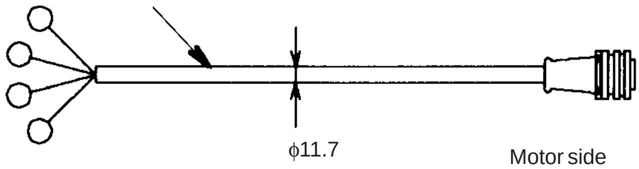
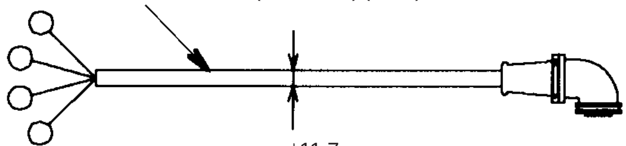
<table>
<tr><th>Use</th><th>Sym-
bol</th><th>Specification</th><th>FANUC specification
(complete cable)</th></tr>
<tr><td>PSM
(For external MCC control)</td><td>K6</td><td></td><td></td></tr>
<tr><td>PSM
(For Emergency stop signal input)</td><td>K7</td><td></td><td></td></tr>
<tr><td>Dedicated to PSMV–HV (For phase detection signal input)</td><td>K7</td><td></td><td></td></tr>
</table>

(2) Servo amplifier module

Use	Sym- bol	Specification	FANUC specification (complete cable)
α1, α2 αM2, αM2.5 (Motor power line)	K10	A66L–0001–0410#8× 0.75N (FNC–074) (Note)  φ10 SVM side (TB2) V1–4 × 3 V2–M4 × 2 Motor side AMP connector Connector kit : A06B–6050–K121	A06B–6050–K824 (Cable length : 14m)
α1, α2 αM2, αM2.5 (Motor power line) With a brake	K10	A66L–0001–0410#8× 0.75 (FNC–074) (Note)  φ10 SVM side (TB2) V1–4 × 5 V2–M4 × 2 Motor side AMP connector Connector kit : A06B–6050–K121	A06B–6050–K825 (Cable length : 14m)

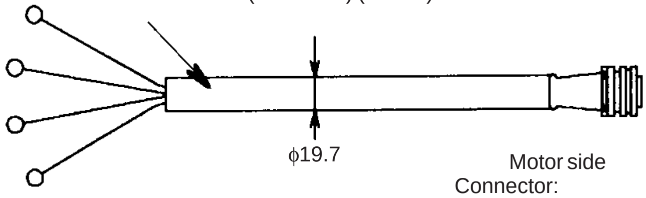
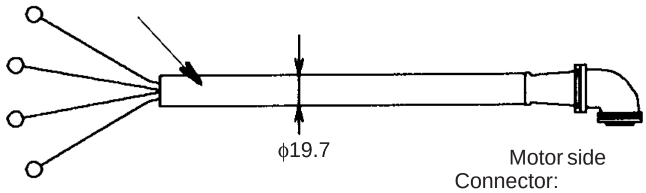
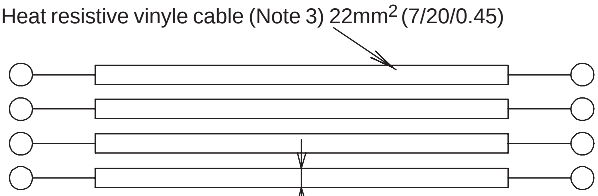
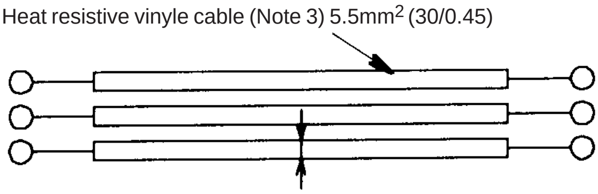
NOTE

Heat–resistant cable:
Shinko Electric Industries Co., Ltd.
Contact: 03(3492)0073 Tokyo Sales Office
06(363)2691 Osaka Headquarters
Cable conforming to IEC (oil–resistant PVC)

Use	Sym-bol	Specification	FANUC specification (complete cable)
α3, α6 , αM3, αM6, αM9, αC3, αC6, αL3, αL6, αL9, β1, β2, β3, and β6 (motor power line)	K21	A66L–0001–0410#4× 2.5 (FNC–065) (Note)  ϕ11.7 SVM side (TB2) V2–4×3 V3–4×1 Motor side Connector: H/MS3106A18–10S–D–T(10) Cable clamp: H/MS3057–10A(10)	A06B–6079–K800 (Cable length : 14m)
		A66L–0001–0410#4× 2.5 (FNC–065) (Note)  ϕ11.7 SVM side (TB2) V2–4×3 V3–4×1 Motor side Connector: H/MS3108B18–10S–D–T(10) Cable clamp: H/MS3057–10A(10)	A06B–6079–K801 (Cable length : 14m)
α12, α22/1500, α22/2000, α30/1200, αC12, αC22, (motor power line)	K21	A66L–0001–0410#4× 2.5 (FNC–065) (Note)  ϕ11.7 SVM side (TB2) V2–T4×3 V3–M4×1 Motor side Connector: JL04V–6A22–22SE–EB Cable clamp: JL04–2022CK(14)	A06B–6079–K802 (Cable length : 14m)
		A66L–0001–0410#4× 2.5 (FNC–065) (Note)  ϕ11.7 SVM side (TB2) V2–T4×3 V3–M4×1 Motor side Connector: JL04V–8A22–22SE–EB Cable clamp: JL04–2022CK(14)	A06B–6079–K803 (Cable length : 14m)

NOTE

Heat–resistant cable:
Shinko Electric Industries Co., Ltd.
Contact: 03(3492)0073 Tokyo Sales Office
06(363)2691 Osaka Headquarters
Cable conforming to IEC (oil–resistant PVC)

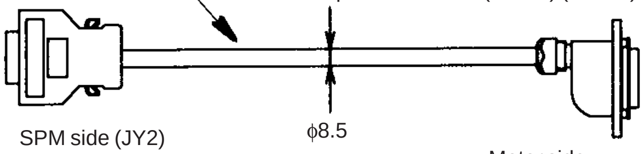
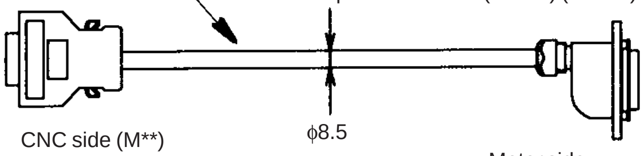
Use	Sym-bol	Specification	FANUC specification (complete cable)
α22/3000, α30/2000, α30/3000, α40, αC22, αL25, αL50, αM22, αM30 (motor power line)	K21		A06B–6079–K804 (Cable length : 14m)
			A06B–6079–K805 (Cable length : 14m)
α100/2000, α150/2000, α300/1200, α400/1200, α65/2000 (motor power line)	K21		
For SVM–DBM (power line)	K26		

NOTE

1 Heat–resistant cable:
Shinko Electric Industries Co., Ltd.
Contact: 03(3492)0073 Tokyo Sales Office
06(363)2691 Osaka Headquarters
Cable conforming to IEC (oil–resistant PVC)

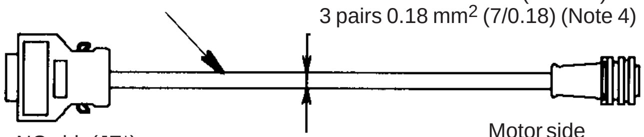
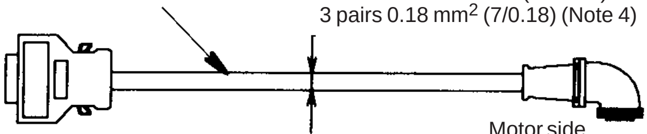
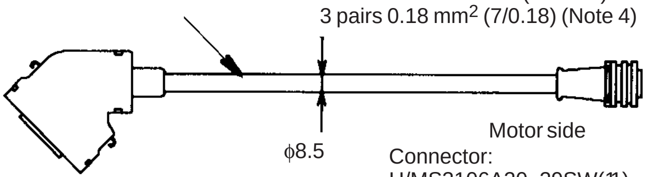
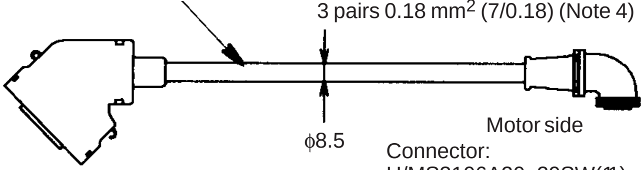
2 Crimp terminal: Nichifu Contact: 03(3452)7381
8–4S

3 Heat–resistant cable: Furukawa Electric Co., Ltd. Contact: 03(3286)3144
LMFC (Fire–retardant Polyflex electric cable, Maximum allowable conductor temperature: 105°C)

Use	Sym-bol	Specification	FANUC specification (complete cable)
α1, α2, αM2, αM2.5 (for FS15B, 16, 18, 20, SVM pulse coders)	K22	Composite 12–conductor group shielded cable, 6 conductors 0.5mm^2 (20/0.18) 3 pairs 0.18 mm^2 (7/0.18) (Note 4)  SPM side (JY2) ϕ8.5 Connector manufactured by Hirose Electric Connector: FI40A–20S Housing: FI–20–CV5 Motor side Connector kit: A06B–6050–K1 15	A06B–6050–K853 (Cable length : 14m)
α1, α2, αM2, αM2.5 (for FS0, FS15A, pulse cod- ers)	K22	Composite 12–conductor group shielded cable, 6 conductors 0.5mm^2 (20/0.18) 3 pairs 0.18 mm^2 (7/0.18) (Note 4)  CNC side (M**) ϕ8.5 Connector manufactured by Honda Tsushin Kogyo Connector: MR–20LMH Motor side Connector kit: A06B–6050–K1 15	A06B–6050–K854 (Cable length : 14m)

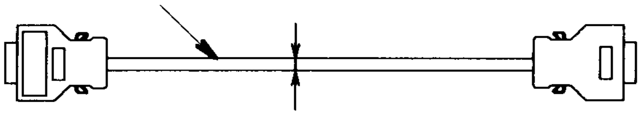
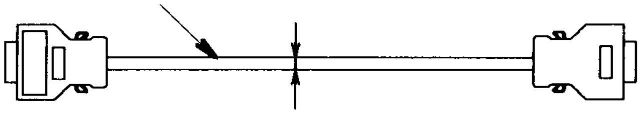
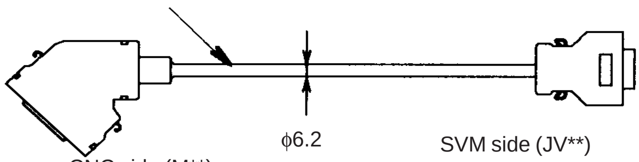
NOTE

4 FANUC drawing number (wire only): A66L–0001–0286
Contact:
Hitachi Cable Trading Company 03(3255)5415
Oki Electric Cable Co., Ltd. 044(766)3171

Use	Sym-bol	Specification	FANUC specification (complete cable)
α3, α6, α12, α22, α30, α40, α65, α100, α150, αM3, αM6, αM9, αM22, αM30, αC3, αC6, αC12, αC22, αL3, αL6, αL9, αL25, αL50 (for FS15B, 16, 18, 20, SVM pulse coders)	K22	Composite 12–conductor group shielded cable, 6 conductors 0.5mm^2 (20/0.18) 3 pairs 0.18 mm^2 (7/0.18) (Note 4)  ϕ8.5 NC side(JF*) SVM side (JF*) Connector manufactured by Hirose Electric Connector: FI40–2015S Housing: FI–20–CV Motor side Connector: H/MS3106A20–29SW(11) JA06A–20–29SW–JI–EB Cable clamp: H/MS3057–12A	A02B–0200–K800 (Cable length : 14m)
		Composite 12–conductor group shielded cable, 6 conductors 0.5mm^2 (20/0.18) 3 pairs 0.18 mm^2 (7/0.18) (Note 4)  ϕ8.5 NC side(JF*) SVM side (JF*) Connector manufactured by Hirose Electric Connector: FI40–2015S Housing: FI–20–CV Motor side Connector: H/MS3106A20–29SW(11) JA06A–20–29SW–JI–EB Cable clamp: H/MS3057–12A	A02B–0200–K801 (Cable length : 14m)
α3, α6, α12, α22, α30, α40, α65, α100, α150, αM3, αM6, αM9, αM22, αM30, αC3, αC6, αC12, αC22, αL3, αL6, αL9, αL25, αL50 (for FS0 and FS15A pulse cod-ers)	K22	Composite 12–conductor group shielded cable, 6 conductors 0.5mm^2 (20/0.18) 3 pairs 0.18 mm^2 (7/0.18) (Note 4)  ϕ8.5 NC side(JF*) Connector manufactured by Honda Tsushin Kogyo Connector: MR–20LMH Motor side Connector: H/MS3106A20–29SW(11) JA06A–20–29SW–JI–EB Cable clamp: H/MS3057–12A	A02B–0098–K860 (Cable length : 14m)
		Composite 12–conductor group shielded cable, 6 conductors 0.5mm^2 (20/0.18) 3 pairs 0.18 mm^2 (7/0.18) (Note 4)  ϕ8.5 NC side(M*) Connector manufactured by Honda Tsushin Kogyo Connector: MR–20LMH Motor side Connector: H/MS3106A20–29SW(11) JA06A–20–29SW–JI–EB Cable clamp: H/MS3057–12A	A02B–0098–K861 (Cable length : 14m)

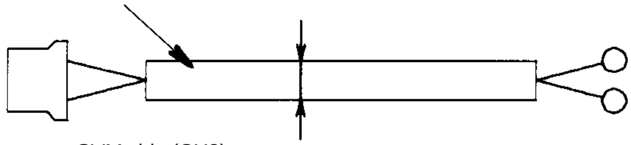
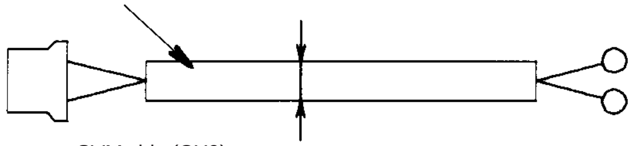
NOTE

4 FANUC drawing number (wire only): A66L–0001–0286
Contact:
Hitachi Cable Trading Company 03(3255)5415
Oki Electric Cable Co., Ltd. 044(766)3171

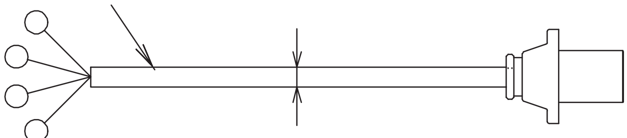
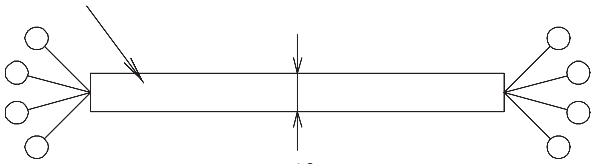
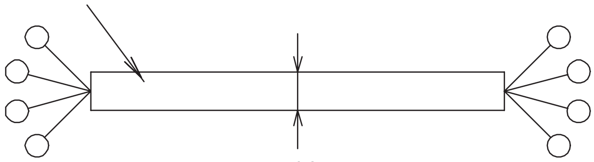
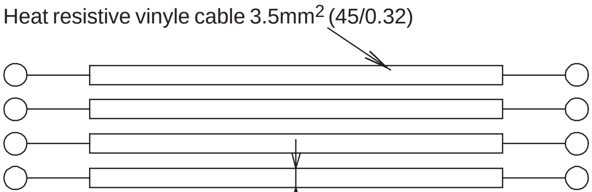
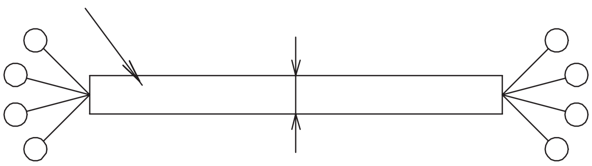
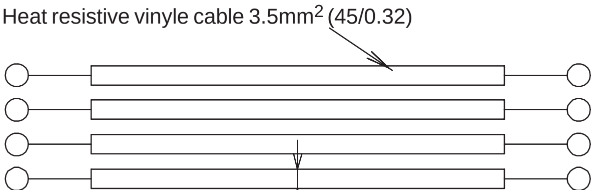
Use	Sym-bol	Specification	FANUC specification (complete cable)
CNC–AMP-TYPE A I/F	K23	Twisted pair unified shield 10–pair 0.09mm^2 (7/0.127) (Note 5)  ϕ6.2 CNC side (JV**) Connector manufactured by Honda Tsushin Kogyo Connector: PCR–E20FA Housing: PCR–V20LA SVM side (JV**) Connector manufactured by Honda Tsushin Kogyo Connector: PCR–E20FA Housing: PCR–V20LA	A02B–0120–K800 (Cable length : 5m)
CNC–AMP-TYPE B I/F	K23	Twisted pair unified shield 10–pair 0.09mm^2 (7/0.127) (Note 5)  ϕ6.2 CNC side (JV**) Connector manufactured by Honda Tsushin Kogyo Connector: PCR–E20FA Housing: PCR–V20LA SVM side (JV**) Connector manufactured by Honda Tsushin Kogyo Connector: PCR–E20FA Housing: PCR–V20LA	
CNC–AMP FS0, FS15A	K23	Twisted pair unified shield 10–pair 0.09mm^2 (7/0.127) (Note 5)  ϕ6.2 CNC side (M**) Connector manufactured by Honda Tsushin Kogyo Connector: MR–20LMH SVM side (JV**) Connector manufactured by Honda Tsushin Kogyo Connector: PCR–E20FA Housing: PCR–V20LA	A02B–0098–K841 (Cable length : 5m)

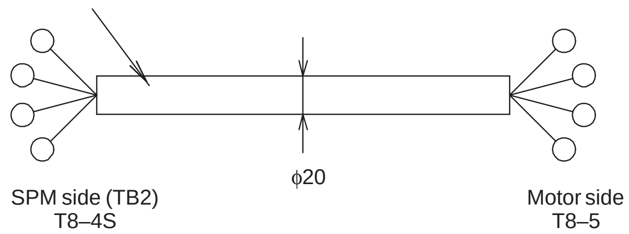
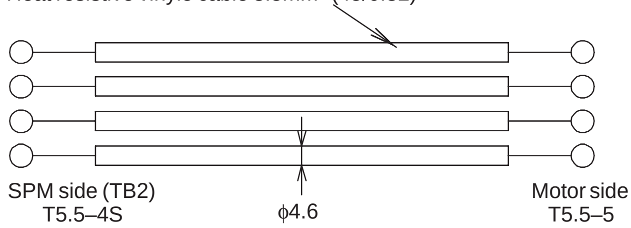
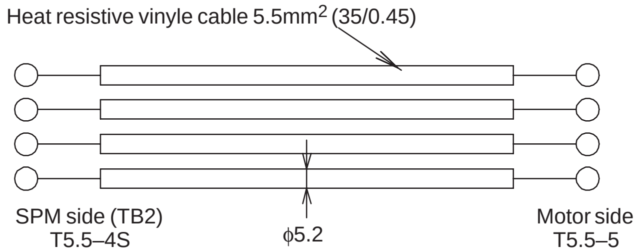
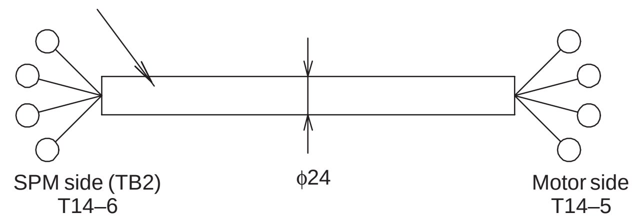
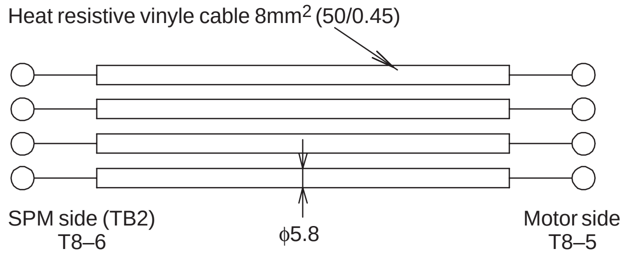
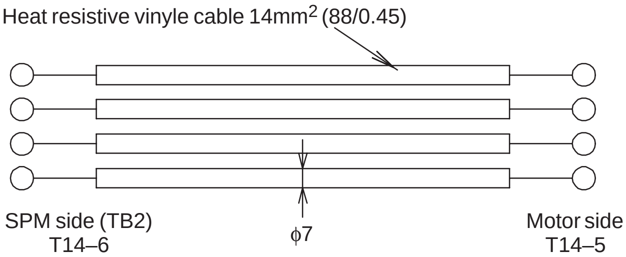
NOTE

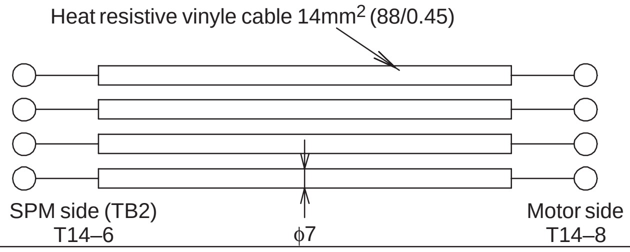
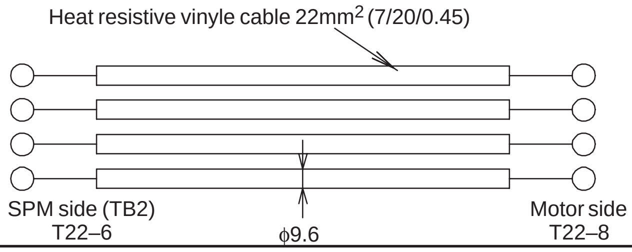
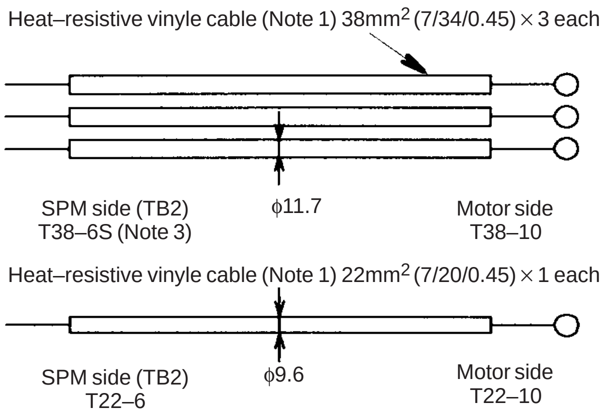
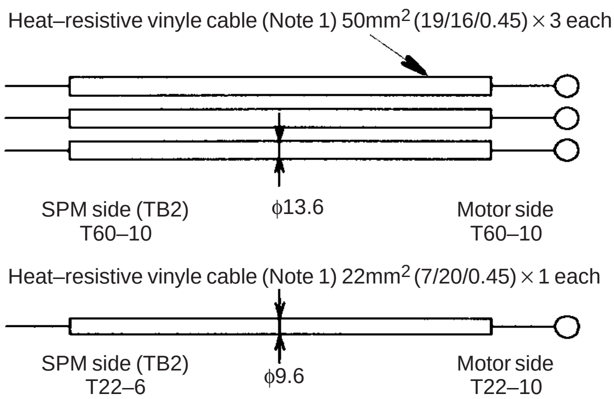
5 FANUC drawing number (wire only): A66L–0001–0286#10P
Contact:
Hitachi Cable Trading Company 03(3255)5415
Oki Electric Cable Co., Ltd. 044(766)3171

Use	Sym-bol	Specification	FANUC specification (complete cable)
SVM–DBM (for interlock signal)	K24	Vinyle cabtyre cable JIS C 3312 2–core 1.25mm^2 (50/0.18)  SVM side (CX8) ϕ9.6 Dynamic brake side T2–4 Connector manufactured by AMP Japan Receptacle housing: 2–178128–3 Receptacle contact: 1–175218–2	
SVM–DBM (for driving coil)	K25	Vinyle cabtyre cable JIS C 3312 2–core 1.25mm^2 (50/0.18)  SVM side (CX9) ϕ9.6 Dynamic brake side T2–4 Connector manufactured by AMP Japan Receptacle housing: 2–178128–3 Receptacle contact: 1–175218–2	

(3) Spindle amplifier module

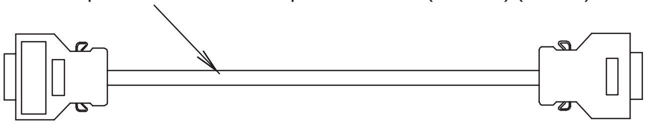
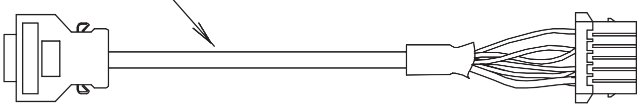
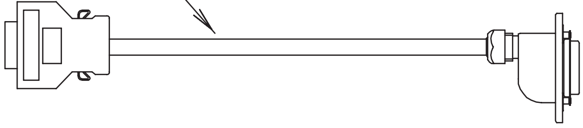
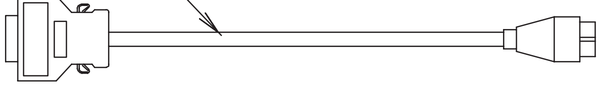
Use	Sym-bol	Specification	FANUC specification (complete cable)
α0.5 (Motor power line)	K10	Vinyle cabtyre cable JIS C 3312 4–core 0.75mm^2 (30/0.18) 	A06B–6050–K801 (Cable length : 14m) A06B–6050–K803 (Cable length : 7m)
α1 (Motor power line)	K10	Vinyle cabtyre cable JIS C 3312 4–core 2mm^2 (37/0.26) 	
α1.5, α2 (Motor power line)	K10	Vinyle cabtyre cable JIS C 3312 4–core 3.5mm^2 (45/0.32)  Heat resistive vinyle cable 3.5mm^2 (45/0.32) 	
α3 (Motor power line)	K10	Vinyle cabtyre cable JIS C 3312 4–core 5.5mm^2 (70/0.32)  Heat resistive vinyle cable 3.5mm^2 (45/0.32) 	

Use	Sym-bol	Specification	FANUC specification (complete cable)
α6 αP8, αP12 (Motor power line)	K10	Vinyle cabtyre cable JIS C 3312 4–core 8mm^2 (50/0.45)  Heat resistive vinyle cable 3.5mm^2 (45/0.32) 	
α8 αP15 (Motor power line)	K10	Heat resistive vinyle cable 5.5mm^2 (35/0.45) 	
α12 αP18 (Motor power line)	K10	Vinyle cabtyre cable JIS C 3312 4–core 14mm^2 (88/0.45)  Heat resistive vinyle cable 8mm^2 (50/0.45) 	
α15 αP22 (Motor power line)	K10	Heat resistive vinyle cable 14mm^2 (88/0.45) 	

Use	Sym-bol	Specification	FANUC specification (complete cable)
α18 αP30 (Motor power line)	K10		
α22 αP40 αP50 αP60 (Motor power line)	K10		
α30 (motor power line)	K10		
PSM–45 (Power line)	K10		

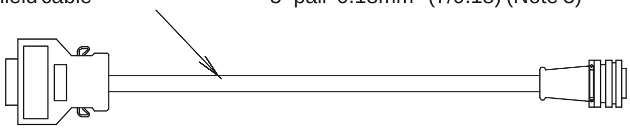
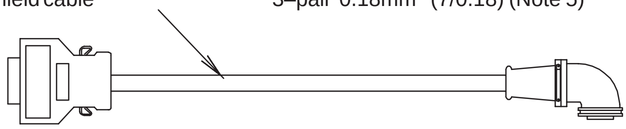
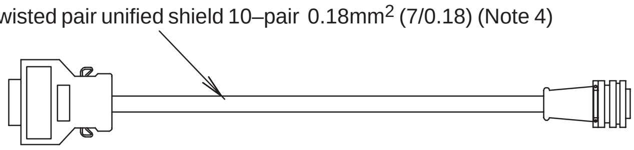
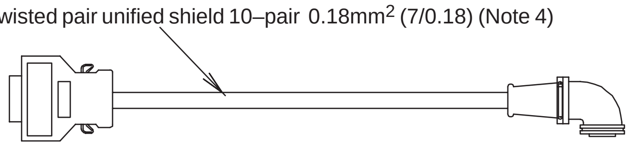
NOTE

1. Heat–resistant cable: Furukawa Electric Co., Ltd.
   Contact: 03(3286)3144
   LMFC (Fire–retardant Polyflex electric cable, Maximum allowable conductor temperature: 105°C)
2. Crimp terminal: Nichifu Contact: 03(3452)7381 8–4S
3. Crimp terminal: Japan Crimp Terminal Production 38–6S

Use	Sym-bol	Specification	FANUC specification (complete cable)
SPM (Interface between NC and SPM)	K12	Twisted pair unified shield 10–pair 0.09mm^2 (7/0.127) (Note 1)  NC side (JA7A) HONDA connector Connector : PCR–E20FA Housing : PCR–V20LA SPM side (JA7B) HONDA connector Connector : PCR–E20FA Housing : PCR–V20LA	
PSM (For pulse generator, Built–in sensor)	K14	Composite 16–core unified shield cable 6–core 0.5mm^2 (20/0.18) 5–pair 0.18mm^2 (7/0.18) (Note 2)  SPM side (JY2) HIROSE connector Connector : FI40B–20S Housing : FI–20–CV5 Motor side AMP connector Housing : 178289–6 Connector : 1–175217–2	A06B–6078–K811 (Cable length : 7m)
α0.5 (For pulse generator, Built–in sensor)	K14	Composite 16–core unified shield cable 6–core 0.5mm^2 (20/0.18) 5–pair 0.18mm^2 (7/0.18) (Note 2)  SPM side (JY2) HIROSE connector Connector : FI40B–20S Housing : FI–20–CV5 Motor side Connector kit : A06B–6050–K110	
SPM (For magnetic sensor)	K15	Composite 12–core unified shield cable 6–core 0.5mm^2 (20/0.18) 3–pair 0.18mm^2 (7/0.18) (Note 3)  SPM side (JY3) HIROSE connector Connector : FI40–2015S Housing : FI–20–CV Metal receptacle on megnetic sensor side	A06B–6078–K813 (Cable length : 7m)

NOTE

1 FANUC'S specification (Material only) : A66L–0001–0284#10P
2 FANUC'S specification (Material only) : A66L–0001–0368
3 FANUC'S specification (Material only) : A66L–0001–0286

Use	Sym-bol	Specification	FANUC specification (complete cable)
SPM (For Position coder)	K16	Composite 12–core unified shield cable 6–core 0.5mm^2 (20/0.18) 3–pair 0.18mm^2 (7/0.18) (Note 3)  SPM side (JY3) HIROSE connector Connector : FI40–2015S Housing : FI–20–CV Position coder side Connector : MS3106B 20–29S Cable clamp : MS3057–12A	A06B–6078–K814 (Cable length : 7m)
		Composite 12–core unified shield cable 6–core 0.5mm^2 (20/0.18) 3–pair 0.18mm^2 (7/0.18) (Note 5)  SPM side (JY3) HIROSE connector Connec-tor : FI40–2015S Housing : FI–20–CV Position coder side Connector : MS3108B 20–29S Cable clamp : MS3057–12A	A06B–6078–K815 (Cable length : 7m)
SPM (For high–resolution magnetic pulse coder)	K18	Twisted pair unified shield 10–pair 0.18mm^2 (7/0.18) (Note 4)  SPM side (JY5) HIROSE connector Connector : FI40B–20S Housing : FI–20–CV5 Pre–amplifier side HIROSE connector HR22–12WTPA–20S	A06B–6078–K816 (Cable length : 7m)
SPM (For High–resolution position coder)	K31	Twisted pair unified shield 10–pair 0.18mm^2 (7/0.18) (Note 4)  SPM side (JY4) HIROSE connector Connector : FI40B–20S Housing : FI–20–CV5 Position coder side Connector : MS3106B 20–29S Cable clamp : MS3057–12A	A06B–6078–K817 (Cable length : 7m)
		Twisted pair unified shield 10–pair 0.18mm^2 (7/0.18) (Note 4)  SPM side (JY4) HIROSE connector Connector : FI40B–20S Housing : FI–20–CV5 Position coder side Connector : MS3108B 20–29S Cable clamp : MS3057–12A	A06B–6078–K818 (Cable length : 7m)

NOTE

1 FANUC'S specification (Material only) :
A66L–0001–0284#10P
2 FANUC'S specification (Material only) : A66L–0001–0368
3 FANUC'S specification (Material only) : A66L–0001–0286
4 FANUC'S specification (Material only) : A66L–0001–0367

G SERVO AMPLIFIER NOISE PROTECTION

This appendix describes how noise is generated when a servo motor or spindle motor is driven by a servo amplifier, and also describes countermeasures required for devices affected by noise.
While referring to this appendix, the user should pay careful attention to noise protection when installing the machine.

G.1 SERVO AMPLIFIER NOISE GENERATION

Fig. G.1 is a schematic diagram of a servo amplifier.

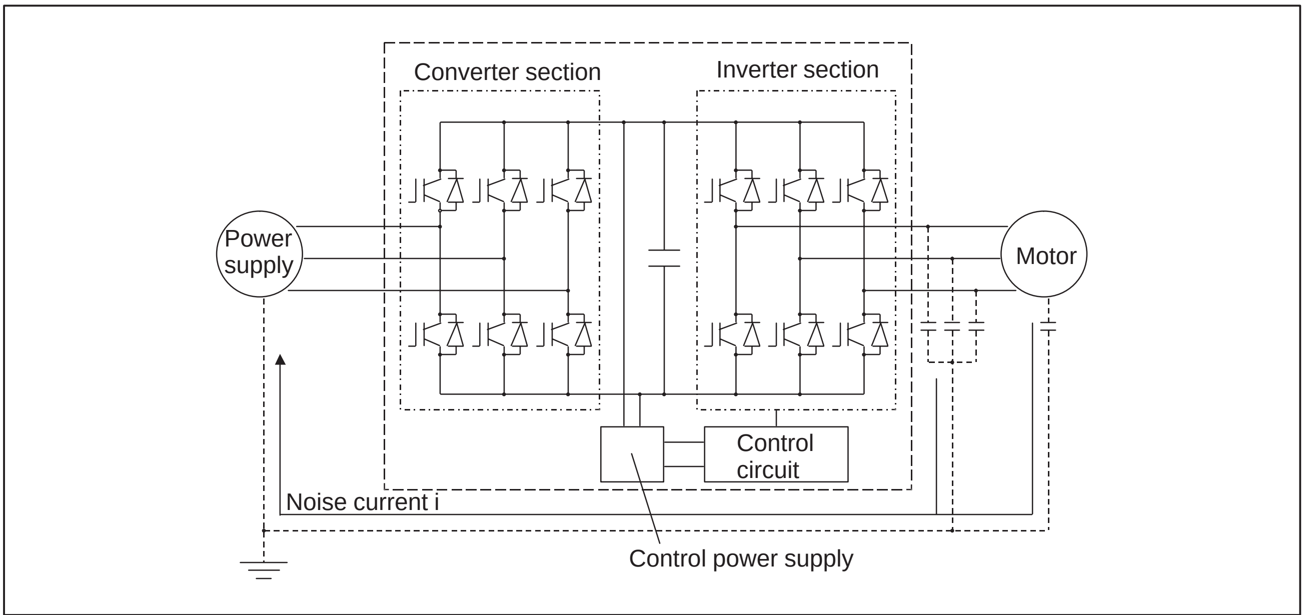


Fig.G.1 Schematic Diagram of Servo Amplifier

The servo amplifier converts alternating current to direct current in the converter section, and exercises variable motor speed control by PWM control based on switching by the six transistors in the inverter section. Switching noise is generated by the six transistors turning on and off at high speed. Each time a transistor is turned on or off, noise current (i) flows to ground through stray capacitance (C) between the cable or motor and ground. The value of this noise current (i) depends on stray capacitance (C) and transistor switching speed (dV/dt), as follows:

$i = C\, dV/dt$

The frequency band of this noise is about 30 to 40 MHz. So, a device using low frequencies (such as an AM radio) is affected by this noise. However, FM radios and TV sets, which use higher frequencies, are not normally affected by this noise.

As described above, noise is generated by the transistor switching that is performed when the motor is driven.

In addition, when a servo amplifier performs power regeneration when a motor decelerates (rotation energy is fed back to the power supply during deceleration), voltage variations caused by current phase commutation at regeneration can affect the operation of a device that shares that power supply.

G.2 TYPES OF NOISE

Noise generated by a servo amplifier are classified into the three major types described below.

(1) Conductive Noise

Noise generated by a servo amplifier travels through a conductor such as a run wire, and affects a device connected to the same power supply.

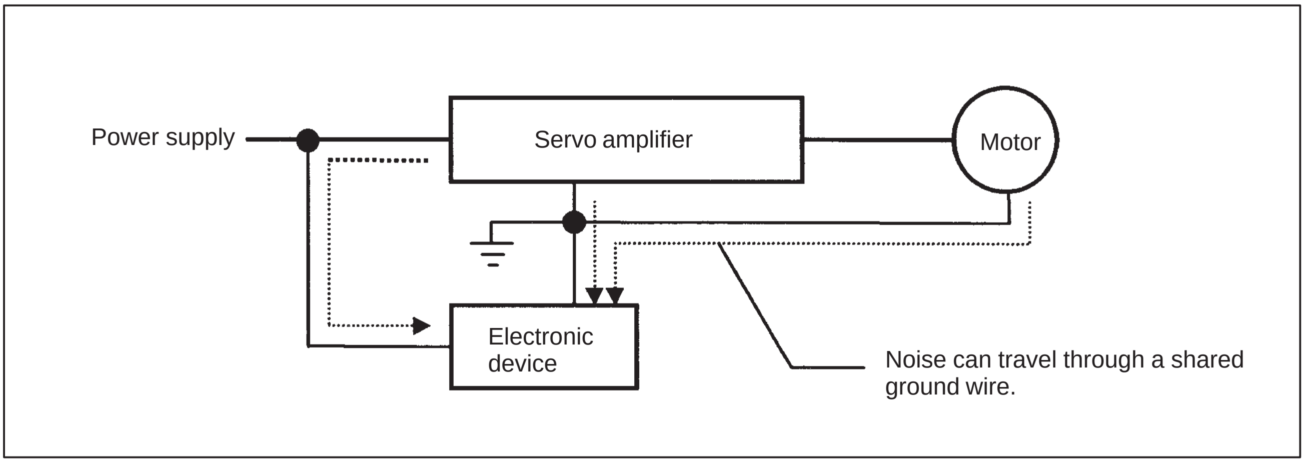


Fig.G.2 (a) Conductive Noise

(2) Induced Noise

Noise is induced when a signal line or a line from a nearby device runs near a line carrying a noise current.

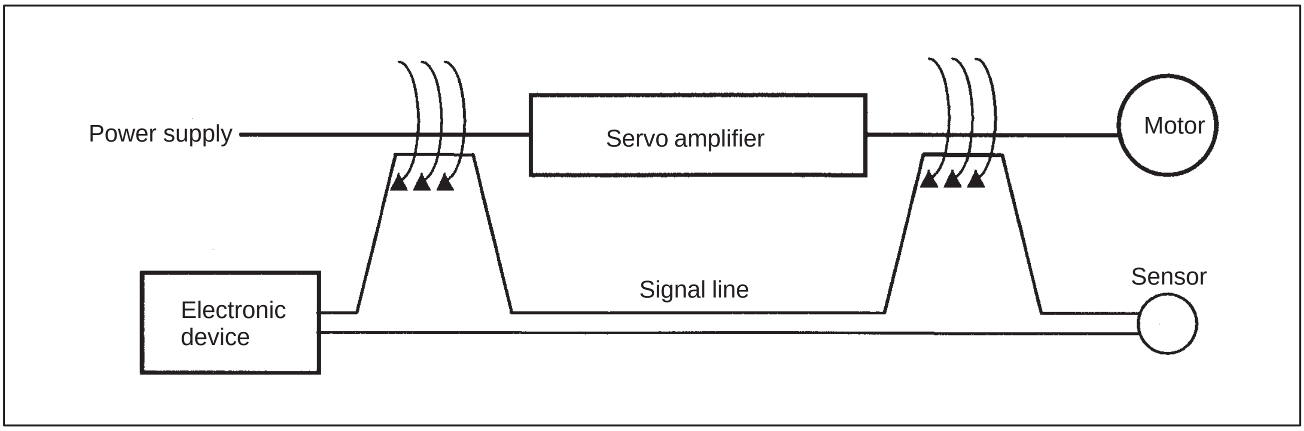


Fig.G.2 (b) Electromagnetically Induced Noise

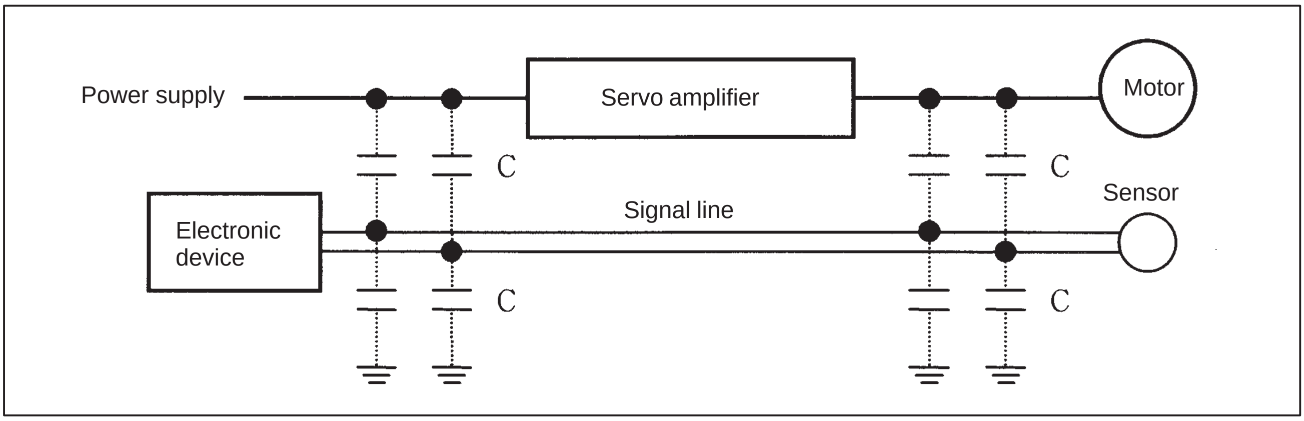


Fig.G.2 (c) Electrostatically Induced Noise

(3) Radiation Noise

Noise generated in a servo amplifier is radiated into the surroundings, with a power line acting as an antenna.

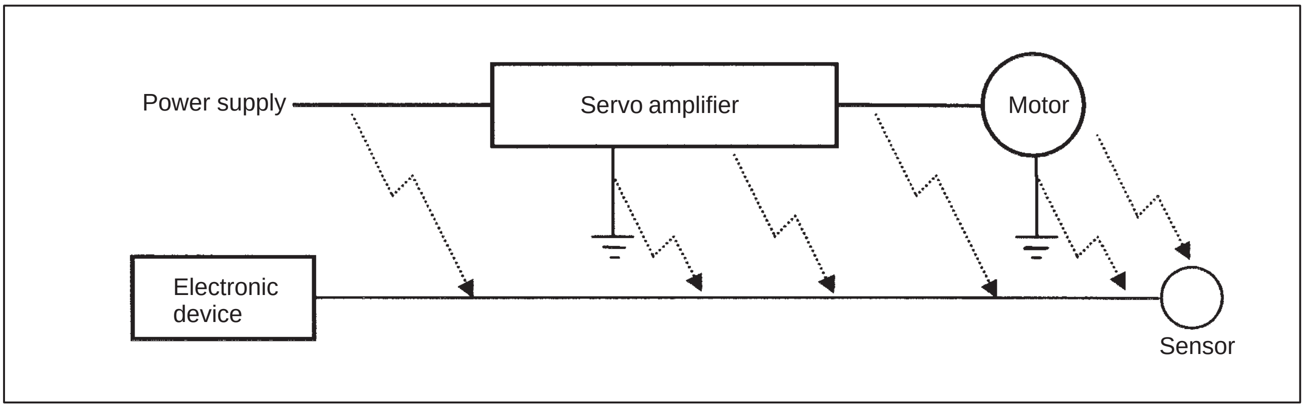


Fig.G.2 (d) Radiation Noise

Noise travels in many different ways, and affects the system to various extents, depending on the system configuration.

G.3 NOISE PROTECTION

Present–day technology cannot eliminate noise completely. So, cost–effective measures must be applied, depending on the level of the noise and the status of the installation.

G.3.1 Precautions to be Applied Prior to Installation

If a noise problem is detected after installation, more costs may be incurred to solve the problem. So, the following precautions must be applied:

1 Separate power lines and motor power lines from signal lines.

2 Contain power lines and motor power lines in a metallic conduit.

3 Perform appropriate grounding installation including grounding wire connections. (This also serves as a measure against electric shock due to leakage currents.)

4 Grounding wires should be as thick and short as possible.

The electric installation standard defines types of grounding as follows:

Type of grounding	Application	Ground resistance
Class–3 grounding	300VAC or less	100Ω or less
Special class–3 grounding	300VAC to 600VAC	10Ω or less

G.3.2 Measures

Noise–related measures including those for devices affected by noise, must be applied from the viewpoint of the entire system.

(1) Measures to be applied to a device affected by noise

1 Separate the power lines and motor power lines from the signal lines to minimize the influence of noise.

2 Separate the power supply system to eliminate any noise propagation path.

3 Run the signal lines through ferrite core beads to maximize the impedance against noise.

4 Employ line filters and shielding wires for the signal lines to protect against noise.

(2) Measures to be applied to a noise source

1 Reduce the level of noise by installing a noise protective device such as a noise filter.

2 Confine noise by running the lines in metallic conduits or by using shielding wires.

3 Eliminate any noise propagation path by using an insulating transformer.

(3) Measures specific to each type of noise

The types of noise are described in G.2 above. Different measures should be taken for each type of noise. The measures and their effects depend on the environment (power supply, electromagnetic wave strength), machine operating status, machine anti–noise properties, and so forth.

Apply the most efficient measures as described in Table G.3.2

Table.G.3.2 Measures Specific to Each Type of Noise

Measures	Type of noise	Conductive noise	Induced noise	Radiation noise
Wiring and grounding	Separation of power lines and motor power lines from signal lines	○	○	
	Use of metallic conduits		○	○
	Elimination of parallel wiring		○	
	Employing shielded wires for power lines and motor power lines			○
	Secure grounding		○	
Noise protective device (at noise source)	Line filter	○		○
	Insulating transformer	○		○
Noise protective device (on devices affected by noise)	Running signal lines through ferrite core beads		○	○
	Employing shielded wires for signal lines		○	○
Others	Power system separation	○		

G.3.3 Examples of Noise Protection

(1) AM Radio

<<Symptoms>>

When a motor is activated, radios in the plant pick up noise, such that the radio output becomes inaudible.

<<Possible causes>>

Radiation noise from the motor power line connected to a servo amplifier is being picked up by the radios.

<<Measures>>

1 Install a noise filter (LC filter) on the power supply.

2 Install a capacitor between each input phase and ground.

<<Notes>>

- The measures described above may prove ineffective in some areas, such as dense residential areas and mountain areas, where radio signals are weak.
- When installing a noise filter, minimize the length of the wiring between the filter and servo amplifier.

(2) FM Radio

<<Symptoms>>

When the machine is operated, radios in the neighborhood are affected by noise. A radio in a car parked outside the plant also picks up noise.

<<Possible causes>>

The transformer on a utility pole is shared by neighbors, and noise is being radiated from the power supply wiring. Noise may also be conducted through the power supply line.

<<Measures>>

1 Install a noise filter (LC filter) on the power supply.

2 Feed power to the neighbors from a separate utility pole.

<<Notes>>

- When installing a noise filter, minimize the length of the wiring between the filter and servo amplifier.

(3) Refrigerator

<<Symptoms>>

When the spindle rotation is decelerated, the motor of a refrigerator in the neighborhood makes an abnormal sound.

<<Possible causes>>

The transformer on a utility pole is shared by neighbors, and voltage distortion is caused by power regeneration at spindle deceleration.

<<Measures>>

1 Feed power to the neighbors from a separate utility pole.

2 Review the power supply capacity.

<<Notes>>

- A plant located in a dense residential area often takes its power from a utility pole that also supplies power to neighboring houses (light power sharing), such that the power supply capacity of the system may be insufficient. In such a case, a larger power distortion may result, thus affecting the power being fed to neighboring houses.

(4) Telephone

<<Symptoms>>

When the machine is operated, the telephone of a house across the street is affected by noise.

<<Possible causes>>

When a high–frequency current from the servo amplifier or motor returns through the ground of the transformer of the utility pole, it flows through the ground shield of the telephone line, generating noise by electrostatic induction.

<<Measures>>

1 Feed power to the neighbors from a separate utility pole.

2 Insert a capacitor on the grounding wire on the servo amplifier power supply side.

<<Notes>>

- Noise consists of voice frequency components, so that a noise filter (LC filter) may have no effect.
- Inserting a capacitor on a grounding wire increases the leakage current, so that the ground fault interrupter may function.

(5) FAX

<<Symptoms>>

When the machine is operated, e telephone within the plant picks up noise, or a facsimile machine of a neighboring firm is disabled. The telephone within the plant uses 100 V; when the 100–V supply is removed, normal telephone communications are resumed.

<<Possible causes>>

The transformer of a utility pole is shared, so that conductive noise is conveyed through the power line. Or, noise may be induced in the wiring as in the case of (4) above.

<<Measures>>

1 Feed power to the neighbors from a separate utility pole.

2 Install an insulating transformer (noise cut transformer) in the power supply.

<<Notes>>

- As with (4) above, a noise filter (LC filter) may have no effect on low–frequency noise.

G.3.4 Noise–preventive Devices

As mentioned above, the protective measures and devices depend on the types of noise, noise sources, and the level of the noise. Noise–preventive devices are outlined below. The user should apply measures that are appropriate for the situation. For details including the specifications of these devices, contact the corresponding manufacturer. The contact for each manufacturer is listed below.

Okaya Electric Industries : Sales Division 03(3424)8126
Soshin Electric : EMC Division 03(3775)9112
TDK : Electronic Device Division 03(5201)7229
Tokin : Sales Promotion Division 03(3475)6818
Fuji Electric : Sales Group, Device Division 03(3211)9288

(1) Noise Filter

A noise filter is installed between a power supply and servo amplifier to reduce high–frequency noise superimposed on supply voltage (noise terminal voltage). A noise filter is useful for the AM radio frequency band.

Example products:
Okaya Electric : 3SUP–H/3SUP–D series
Soshin Electric : NF3000/HF3000 series
TDK : ZRCT/ZRGT series
Tokin : LH–3/LH–4 series

(2) Capacitor

A capacitor is directly connected to a servo amplifier to reduce radiation noise from the power line. When compared with a noise filter, a capacitor offers poorer attenuation characteristics, but is often more effective, depending on the electromagnetic wave status. Considering the leakage current, select a ground fault interrupter.

Example products :
Okaya Electric : 3XYB–105 104
Soshin Electric : LW3/LY3 series

(3) Zero–phase reactor

A zero–phase reactor is installed between a power supply and servo amplifier to reduce the amount noise being radiated from the power line.

Example product:
Soshin Electric : RC series

(4) Noise Cut Transformer

A noise cut transformer is installed between a power supply and device. This transformer is used to reduce the amount of radiation noise (low frequency) being conveyed through a power line or ground wire.

Example product:
Fuji Electric : FFT series

G.4 OTHERS

Harmonics and noise

A harmonic has an integral multiple of a fundamental frequency (50/60 Hz), usually, up to several kHz; a higher frequency (several kHz or higher) is referred to as noise.

In many cases, noise is generated from an inverter section, while harmonics are generated from a converter section. Accordingly, these differ in the problems they incur and the corresponding countermeasures.

For harmonics, a harmonics suppression guideline has been established.

≪Numbers≫

≪A≫

≪B≫

≪C≫

≪D≫

≪E≫

≪F≫

≪P≫

≪R≫

≪S≫

≪*T*≫

≪*W*≫

≪*Z*≫

Revision Record

FANUC SERVO AMPLIFIER α series DESCRIPTIONS (B–65162E)

Edition	Date	Contents
01	Apr., ’94	———
02	Apr., ’95	• Addition of PSMR (Registance regenerative type power supply module). • Addition of 2C series spindle amplifier module • Addition of Appendix E and F • Other changes
03	Sep., ’98	• Addition of Large model and 400V input series • •

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