FANUC SERVO AMPLIFIER βi series

DESCRIPTIONS MANUAL

MARDCBETA03071E REV. B

FANUC America Corporation
3900 W. Hamlin Road
Rochester Hills, Michigan 48309–3253

B-65322EN/03

If you have a controller labeled R-J3*i*C, you should read R-J3*i*C as R-30*i*A.

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WARNING

This equipment generates, uses, and can radiate radiofrequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. As temporarily permitted by regulation, it has not been tested for compliance with the limits for Class A computing devices pursuant to subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of the equipment in a residential area is likely to cause interference, in which case the user, at his own expense, will be required to take whatever measure may be required to correct the interference.

FANUC conducts courses on its systems and products on a regularly scheduled basis at the company's world headquarters in Rochester Hills, Michigan. For additional information contact

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Send your comments and suggestions about this manual to:
product.documentation@fanucrobotics.com

Patents

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Should you wish to export or re-export these products, please contact FANUC for advice.

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".

General Safety Precautions

- When an abnormality such as an alarm or a hardware failure occurs, the operations described in the specifications are not guaranteed unless otherwise specifically noted. When action corresponding to the abnormality is specifically described, take the action. When no action is described, please contact FANUC.
- The signals and functions described in the specifications cannot be used separately for safety functions unless otherwise described as being usable for the safety functions. Their specifications are not assumed to be used as the safety functions in this case, an unexpected danger may be caused. For information about the safety functions, please contact FANUC.
  Generally, the safety functions represent functions that protect the operators from machine danger.
- A wrong device connection or setting can lead to unpredictable operation. When starting to operate the machine for the first time after assembling the machine, replacing components, or modifying parameter settings, exercise the greater care by, for example, reducing the torque limit value, error detection level, or operating speed or by operating the machine in such a way that an emergency stop can be made quickly.

Safety

FANUC Robotics is not and does not represent itself as an expert in safety systems, safety equipment, or the specific safety aspects of your company and/or its work force. It is the responsibility of the owner, employer, or user to take all necessary steps to guarantee the safety of all personnel in the workplace.

The appropriate level of safety for your application and installation can be best determined by safety system professionals. FANUC Robotics therefore, recommends that each customer consult with such professionals in order to provide a workplace that allows for the safe application, use, and operation of FANUC Robotics systems.

According to the industry standard ANSI/RIA R15-06, the owner or user is advised to consult the standards to ensure compliance with its requests for Robotics System design, usability, operation, maintenance, and service. Additionally, as the owner, employer, or user of a robotic system, it is your responsibility to arrange for the training of the operator of a robot system to recognize and respond to known hazards associated with your robotic system and to be aware of the recommended operating procedures for your particular application and robot installation.

Ensure that the robot being used is appropriate for the application. Robots used in classified (hazardous) locations must be certified for this use.

FANUC Robotics therefore, recommends that all personnel who intend to operate, program, repair, or otherwise use the robotics system be trained in an approved FANUC Robotics training course and become familiar with the proper operation of the system. Persons responsible for programming the system–including the design, implementation, and debugging of application programs–must be familiar with the recommended programming procedures for your application and robot installation.

The following guidelines are provided to emphasize the importance of safety in the workplace.

CONSIDERING SAFETY FOR YOUR ROBOT INSTALLATION

Safety is essential whenever robots are used. Keep in mind the following factors with regard to safety:

- The safety of people and equipment
- Use of safety enhancing devices
- Techniques for safe teaching and manual operation of the robot(s)
- Techniques for safe automatic operation of the robot(s)
- Regular scheduled inspection of the robot and workcell
- Proper maintenance of the robot

Keeping People Safe

The safety of people is always of primary importance in any situation. When applying safety measures to your robotic system, consider the following:

- External devices
- Robot(s)
- Tooling
- Workpiece

Using Safety Enhancing Devices

Always give appropriate attention to the work area that surrounds the robot. The safety of the work area can be enhanced by the installation of some or all of the following devices:

- Safety fences, barriers, or chains
- Light curtains
- Interlocks
- Pressure mats
- Floor markings
- Warning lights
- Mechanical stops
- EMERGENCY STOP buttons
- DEADMAN switches

Setting Up a Safe Workcell

A safe workcell is essential to protect people and equipment. Observe the following guidelines to ensure that the workcell is set up safely. These suggestions are intended to supplement and not replace existing federal, state, and local laws, regulations, and guidelines that pertain to safety.

- Sponsor your personnel for training in approved FANUC Robotics training course(s) related to your application. Never permit untrained personnel to operate the robots.
- Install a lockout device that uses an access code to prevent unauthorized persons from operating the robot.
- Use anti–tie–down logic to prevent the operator from bypassing safety measures.
- Arrange the workcell so the operator faces the workcell and can see what is going on inside the cell.
- Clearly identify the work envelope of each robot in the system with floor markings, signs, and special barriers. The work envelope is the area defined by the maximum motion range of the robot, including any tooling attached to the wrist flange that extend this range.
- Position all controllers outside the robot work envelope.

- Never rely on software or firmware based controllers as the primary safety element unless they comply with applicable current robot safety standards.
- Mount an adequate number of EMERGENCY STOP buttons or switches within easy reach of the operator and at critical points inside and around the outside of the workcell.
- Install flashing lights and/or audible warning devices that activate whenever the robot is operating, that is, whenever power is applied to the servo drive system. Audible warning devices shall exceed the ambient noise level at the end–use application.
- Wherever possible, install safety fences to protect against unauthorized entry by personnel into the work envelope.
- Install special guarding that prevents the operator from reaching into restricted areas of the work envelope.
- Use interlocks.
- Use presence or proximity sensing devices such as light curtains, mats, and capacitance and vision systems to enhance safety.
- Periodically check the safety joints or safety clutches that can be optionally installed between the robot wrist flange and tooling. If the tooling strikes an object, these devices dislodge, remove power from the system, and help to minimize damage to the tooling and robot.
- Make sure all external devices are properly filtered, grounded, shielded, and suppressed to prevent hazardous motion due to the effects of electro–magnetic interference (EMI), radio frequency interference (RFI), and electro–static discharge (ESD).
- Make provisions for power lockout/tagout at the controller.
- Eliminate *pinch points*. Pinch points are areas where personnel could get trapped between a moving robot and other equipment.
- Provide enough room inside the workcell to permit personnel to teach the robot and perform maintenance safely.
- Program the robot to load and unload material safely.
- If high voltage electrostatics are present, be sure to provide appropriate interlocks, warning, and beacons.
- If materials are being applied at dangerously high pressure, provide electrical interlocks for lockout of material flow and pressure.

Staying Safe While Teaching or Manually Operating the Robot

Advise all personnel who must teach the robot or otherwise manually operate the robot to observe the following rules:

- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Know whether or not you are using an intrinsically safe teach pendant if you are working in a hazardous environment.

- Before teaching, visually inspect the robot and work envelope to make sure that no potentially hazardous conditions exist. The work envelope is the area defined by the maximum motion range of the robot. These include tooling attached to the wrist flange that extends this range.
- The area near the robot must be clean and free of oil, water, or debris. Immediately report unsafe working conditions to the supervisor or safety department.
- FANUC Robotics recommends that no one enter the work envelope of a robot that is on, except for robot teaching operations. However, if you must enter the work envelope, be sure all safeguards are in place, check the teach pendant DEADMAN switch for proper operation, and place the robot in teach mode. Take the teach pendant with you, turn it on, and be prepared to release the DEADMAN switch. Only the person with the teach pendant should be in the work envelope.

WARNING

Never bypass, strap, or otherwise deactivate a safety device, such as a limit switch, for any operational convenience. Deactivating a safety device is known to have resulted in serious injury and death.

- Know the path that can be used to escape from a moving robot; make sure the escape path is never blocked.
- Isolate the robot from all remote control signals that can cause motion while data is being taught.
- Test any program being run for the first time in the following manner:

WARNING

Stay outside the robot work envelope whenever a program is being run. Failure to do so can result in injury.

  - Using a low motion speed, single step the program for at least one full cycle.
  - Using a low motion speed, test run the program continuously for at least one full cycle.
  - Using the programmed speed, test run the program continuously for at least one full cycle.
- Make sure all personnel are outside the work envelope before running production.

Staying Safe During Automatic Operation

Advise all personnel who operate the robot during production to observe the following rules:

- Make sure all safety provisions are present and active.

- Know the entire workcell area. The workcell includes the robot and its work envelope, plus the area occupied by all external devices and other equipment with which the robot interacts.
- Understand the complete task the robot is programmed to perform before initiating automatic operation.
- Make sure all personnel are outside the work envelope before operating the robot.
- Never enter or allow others to enter the work envelope during automatic operation of the robot.
- Know the location and status of all switches, sensors, and control signals that could cause the robot to move.
- Know where the EMERGENCY STOP buttons are located on both the robot control and external control devices. Be prepared to press these buttons in an emergency.
- Never assume that a program is complete if the robot is not moving. The robot could be waiting for an input signal that will permit it to continue its activity.
- If the robot is running in a pattern, do not assume it will continue to run in the same pattern.
- Never try to stop the robot, or break its motion, with your body. The only way to stop robot motion immediately is to press an EMERGENCY STOP button located on the controller panel, teach pendant, or emergency stop stations around the workcell.

Staying Safe During Inspection

When inspecting the robot, be sure to

- Turn off power at the controller.
- Lock out and tag out the power source at the controller according to the policies of your plant.
- Turn off the compressed air source and relieve the air pressure.
- If robot motion is not needed for inspecting the electrical circuits, press the EMERGENCY STOP button on the operator panel.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- If power is needed to check the robot motion or electrical circuits, be prepared to press the EMERGENCY STOP button, in an emergency.
- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.

Staying Safe During Maintenance

When performing maintenance on your robot system, observe the following rules:

- Never enter the work envelope while the robot or a program is in operation.
- Before entering the work envelope, visually inspect the workcell to make sure no potentially hazardous conditions exist.

- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Consider all or any overlapping work envelopes of adjoining robots when standing in a work envelope.
- Test the teach pendant for proper operation before entering the work envelope.
- If it is necessary for you to enter the robot work envelope while power is turned on, you must be sure that you are in control of the robot. Be sure to take the teach pendant with you, press the DEADMAN switch, and turn the teach pendant on. Be prepared to release the DEADMAN switch to turn off servo power to the robot immediately.
- Whenever possible, perform maintenance with the power turned off. Before you open the controller front panel or enter the work envelope, turn off and lock out the 3–phase power source at the controller.
- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.

WARNING

Lethal voltage is present in the controller WHENEVER IT IS CONNECTED to a power source. Be extremely careful to avoid electrical shock. HIGH VOLTAGE IS PRESENT at the input side whenever the controller is connected to a power source. Turning the disconnect or circuit breaker to the OFF position removes power from the output side of the device only.

- Release or block all stored energy. Before working on the pneumatic system, shut off the system air supply and purge the air lines.
- Isolate the robot from all remote control signals. If maintenance must be done when the power is on, make sure the person inside the work envelope has sole control of the robot. The teach pendant must be held by this person.
- Make sure personnel cannot get trapped between the moving robot and other equipment. Know the path that can be used to escape from a moving robot. Make sure the escape route is never blocked.
- Use blocks, mechanical stops, and pins to prevent hazardous movement by the robot. Make sure that such devices do not create pinch points that could trap personnel.

WARNING

Do not try to remove any mechanical component from the robot before thoroughly reading and understanding the procedures in the appropriate manual. Doing so can result in serious personal injury and component destruction.

- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.
- When replacing or installing components, make sure dirt and debris do not enter the system.
- Use only specified parts for replacement. To avoid fires and damage to parts in the controller, never use nonspecified fuses.
- Before restarting a robot, make sure no one is inside the work envelope; be sure that the robot and all external devices are operating normally.

KEEPING MACHINE TOOLS AND EXTERNAL DEVICES SAFE

Certain programming and mechanical measures are useful in keeping the machine tools and other external devices safe. Some of these measures are outlined below. Make sure you know all associated measures for safe use of such devices.

Programming Safety Precautions

Implement the following programming safety measures to prevent damage to machine tools and other external devices.

- Back–check limit switches in the workcell to make sure they do not fail.
- Implement ‘‘failure routines” in programs that will provide appropriate robot actions if an external device or another robot in the workcell fails.
- Use *handshaking* protocol to synchronize robot and external device operations.
- Program the robot to check the condition of all external devices during an operating cycle.

Mechanical Safety Precautions

Implement the following mechanical safety measures to prevent damage to machine tools and other external devices.

- Make sure the workcell is clean and free of oil, water, and debris.
- Use DCS (Dual Check Safety), software limits, limit switches, and mechanical hardstops to prevent undesired movement of the robot into the work area of machine tools and external devices.

KEEPING THE ROBOT SAFE

Observe the following operating and programming guidelines to prevent damage to the robot.

Operating Safety Precautions

The following measures are designed to prevent damage to the robot during operation.

- Use a low override speed to increase your control over the robot when jogging the robot.
- Visualize the movement the robot will make before you press the jog keys on the teach pendant.
- Make sure the work envelope is clean and free of oil, water, or debris.
- Use circuit breakers to guard against electrical overload.

Programming Safety Precautions

The following safety measures are designed to prevent damage to the robot during programming:

- Establish *interference zones* to prevent collisions when two or more robots share a work area.
- Make sure that the program ends with the robot near or at the home position.
- Be aware of signals or other operations that could trigger operation of tooling resulting in personal injury or equipment damage.
- In dispensing applications, be aware of all safety guidelines with respect to the dispensing materials.

NOTE: Any deviation from the methods and safety practices described in this manual must conform to the approved standards of your company. If you have questions, see your supervisor.

ADDITIONAL SAFETY CONSIDERATIONS FOR PAINT ROBOT INSTALLATIONS

Process technicians are sometimes required to enter the paint booth, for example, during daily or routine calibration or while teaching new paths to a robot. Maintenance personnel also must work inside the paint booth periodically.

Whenever personnel are working inside the paint booth, ventilation equipment must be used. Instruction on the proper use of ventilating equipment usually is provided by the paint shop supervisor.

Although paint booth hazards have been minimized, potential dangers still exist. Therefore, today's highly automated paint booth requires that process and maintenance personnel have full awareness of the system and its capabilities. They must understand the interaction that occurs between the vehicle moving along the conveyor and the robot(s), hood/deck and door opening devices, and high–voltage electrostatic tools.

CAUTION

Ensure that all ground cables remain connected. Never operate the paint robot with ground provisions disconnected. Otherwise, you could injure personnel or damage equipment.

Paint robots are operated in three modes:

- Teach or manual mode
- Automatic mode, including automatic and exercise operation
- Diagnostic mode

During both teach and automatic modes, the robots in the paint booth will follow a predetermined pattern of movements. In teach mode, the process technician teaches (programs) paint paths using the teach pendant.

In automatic mode, robot operation is initiated at the System Operator Console (SOC) or Manual Control Panel (MCP), if available, and can be monitored from outside the paint booth. All personnel must remain outside of the booth or in a designated safe area within the booth whenever automatic mode is initiated at the SOC or MCP.

In automatic mode, the robots will execute the path movements they were taught during teach mode, but generally at production speeds.

When process and maintenance personnel run diagnostic routines that require them to remain in the paint booth, they must stay in a designated safe area.

Paint System Safety Features

Process technicians and maintenance personnel must become totally familiar with the equipment and its capabilities. To minimize the risk of injury when working near robots and related equipment, personnel must comply strictly with the procedures in the manuals.

This section provides information about the safety features that are included in the paint system and also explains the way the robot interacts with other equipment in the system.

The paint system includes the following safety features:

- Most paint booths have red warning beacons that illuminate when the robots are armed and ready to paint. Your booth might have other kinds of indicators. Learn what these are.

- Some paint booths have a blue beacon that, when illuminated, indicates that the electrostatic devices are enabled. Your booth might have other kinds of indicators. Learn what these are.
- EMERGENCY STOP buttons are located on the robot controller and teach pendant. Become familiar with the locations of all E–STOP buttons.
- An intrinsically safe teach pendant is used when teaching in hazardous paint atmospheres.
- A DEADMAN switch is located on each teach pendant. When this switch is held in, and the teach pendant is on, power is applied to the robot servo system. If the engaged DEADMAN switch is released or pressed harder during robot operation, power is removed from the servo system, all axis brakes are applied, and the robot comes to an EMERGENCY STOP. Safety interlocks within the system might also E–STOP other robots.

WARNING

An EMERGENCY STOP will occur if the DEADMAN switch is released on a bypassed robot.

- Overtravel by robot axes is prevented by software limits. All of the major and minor axes are governed by software limits. DCS (Dual Check Safety), limit switches and hardstops also limit travel by the major axes.
- EMERGENCY STOP limit switches and photoelectric eyes might be part of your system. Limit switches, located on the entrance/exit doors of each booth, will EMERGENCY STOP all equipment in the booth if a door is opened while the system is operating in automatic or manual mode. For some systems, signals to these switches are inactive when the switch on the SOC is in teach mode.
- When present, photoelectric eyes are sometimes used to monitor unauthorized intrusion through the entrance/exit silhouette openings.
- System status is monitored by computer. Severe conditions result in automatic system shutdown.

Staying Safe While Operating the Paint Robot

When you work in or near the paint booth, observe the following rules, in addition to all rules for safe operation that apply to all robot systems.

WARNING

Observe all safety rules and guidelines to avoid injury.

WARNING

Never bypass, strap, or otherwise deactivate a safety device, such as a limit switch, for any operational convenience. Deactivating a safety device is known to have resulted in serious injury and death.

WARNING

Enclosures shall not be opened unless the area is known to be nonhazardous or all power has been removed from devices within the enclosure. Power shall not be restored after the enclosure has been opened until all combustible dusts have been removed from the interior of the enclosure and the enclosure purged. Refer to the Purge chapter for the required purge time.

- Know the work area of the entire paint station (workcell).
- Know the work envelope of the robot and hood/deck and door opening devices.
- Be aware of overlapping work envelopes of adjacent robots.
- Know where all red, mushroom–shaped EMERGENCY STOP buttons are located.
- Know the location and status of all switches, sensors, and/or control signals that might cause the robot, conveyor, and opening devices to move.
- Make sure that the work area near the robot is clean and free of water, oil, and debris. Report unsafe conditions to your supervisor.
- Become familiar with the complete task the robot will perform BEFORE starting automatic mode.
- Make sure all personnel are outside the paint booth before you turn on power to the robot servo system.
- Never enter the work envelope or paint booth before you turn off power to the robot servo system.
- Never enter the work envelope during automatic operation unless a safe area has been designated.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Remove all metallic objects, such as rings, watches, and belts, before entering a booth when the electrostatic devices are enabled.
- Stay out of areas where you might get trapped between a moving robot, conveyor, or opening device and another object.
- Be aware of signals and/or operations that could result in the triggering of guns or bells.
- Be aware of all safety precautions when dispensing of paint is required.
- Follow the procedures described in this manual.

Special Precautions for Combustible Dusts (Powder Paint)

When the robot is used in a location where combustible dusts are found, such as the application of powder paint, the following special precautions are required to insure that there are no combustible dusts inside the robot.

- Purge maintenance air should be maintained at all times, even when the robot power is off. This will insure that dust can not enter the robot.
- A purge cycle will not remove accumulated dusts. Therefore, if the robot is exposed to dust when maintenance air is not present, it will be necessary to remove the covers and clean out any accumulated dust. Do not energize the robot until you have performed the following steps.

1. Before covers are removed, the exterior of the robot should be cleaned to remove accumulated dust.
2. When cleaning and removing accumulated dust, either on the outside or inside of the robot, be sure to use methods appropriate for the type of dust that exists. Usually lint free rags dampened with water are acceptable. Do not use a vacuum cleaner to remove dust as it can generate static electricity and cause an explosion unless special precautions are taken.
3. Thoroughly clean the interior of the robot with a lint free rag to remove any accumulated dust.
4. When the dust has been removed, the covers must be replaced immediately.
5. Immediately after the covers are replaced, run a complete purge cycle. The robot can now be energized.

Staying Safe While Operating Paint Application Equipment

When you work with paint application equipment, observe the following rules, in addition to all rules for safe operation that apply to all robot systems.

WARNING

When working with electrostatic paint equipment, follow all national and local codes as well as all safety guidelines within your organization. Also reference the following standards: NFPA 33 Standards for Spray Application Using Flammable or Combustible Materials, and NFPA 70 National Electrical Code.

- **Grounding**: All electrically conductive objects in the spray area must be grounded. This includes the spray booth, robots, conveyors, workstations, part carriers, hooks, paint pressure pots, as well as solvent containers. Grounding is defined as the object or objects shall be electrically connected to ground with a resistance of not more than 1 megohms.
- **High Voltage**: High voltage should only be on during actual spray operations. Voltage should be off when the painting process is completed. Never leave high voltage on during a cap cleaning process.
- Avoid any accumulation of combustible vapors or coating matter.
- Follow all manufacturer recommended cleaning procedures.
- Make sure all interlocks are operational.

- No smoking.
- Post all warning signs regarding the electrostatic equipment and operation of electrostatic equipment according to NFPA 33 Standard for Spray Application Using Flammable or Combustible Material.
- Disable all air and paint pressure to bell.
- Verify that the lines are not under pressure.

Staying Safe During Maintenance

When you perform maintenance on the painter system, observe the following rules, and all other maintenance safety rules that apply to all robot installations. Only qualified, trained service or maintenance personnel should perform repair work on a robot.

- Paint robots operate in a potentially explosive environment. Use caution when working with electric tools.
- When a maintenance technician is repairing or adjusting a robot, the work area is under the control of that technician. All personnel not participating in the maintenance must stay out of the area.
- For some maintenance procedures, station a second person at the control panel within reach of the EMERGENCY STOP button. This person must understand the robot and associated potential hazards.
- Be sure all covers and inspection plates are in good repair and in place.
- Always return the robot to the ‘‘home’’ position before you disarm it.
- Never use machine power to aid in removing any component from the robot.
- During robot operations, be aware of the robot’s movements. Excess vibration, unusual sounds, and so forth, can alert you to potential problems.
- Whenever possible, turn off the main electrical disconnect before you clean the robot.
- When using vinyl resin observe the following:
  - Wear eye protection and protective gloves during application and removal.
  - Adequate ventilation is required. Overexposure could cause drowsiness or skin and eye irritation.
  - If there is contact with the skin, wash with water.
  - Follow the Original Equipment Manufacturer’s Material Safety Data Sheets.
- When using paint remover observe the following:
  - Eye protection, protective rubber gloves, boots, and apron are required during booth cleaning.
  - Adequate ventilation is required. Overexposure could cause drowsiness.
  - If there is contact with the skin or eyes, rinse with water for at least 15 minutes. Then seek medical attention as soon as possible.
  - Follow the Original Equipment Manufacturer’s Material Safety Data Sheets.

SAFETY PRECAUTIONS

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

Contents

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.

WARNINGS AND CAUTIONS RELATING TO MOUNTING

Warning

⚠ WARNING

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

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

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

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

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

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

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

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

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

- **Confirm that the input voltage meets the specifications of the amplifier before making connection.**
  If the input voltage exceeds the specified value (for example, if the input voltage for a 200-V input amplifier is 400 V), an internal component may be damaged and burnt out.

- **Prevent conductive, flammable, or corrosive foreign matters, mists, or water droplets from entering the unit.**
  If conductive or flammable foreign matters enter the unit, explosion or corruption may be caused.
  If corrosive or conductive mists or water droplets are attached to an electric circuit, unexpected operation may be caused in the circuit.
  The electronic circuit portion must be installed in an environment of pollution level 2 specified by IEC60664-1. To achieve pollution level 2 in a severe machine tool environment, it is generally necessary to install the portion in a cabinet that satisfies IP54.

- **Do not disassemble the amplifier.**

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

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

Caution

⚠ CAUTION

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

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

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

- **Do not block the air inlet to the radiator.**

- **Take appropriate measures to prevent coolant, oil mist, or chips from being adhered to the radiator and fan motors that are exposed to the outside of the power magnetics cabinet.**
  A deposit of coolant, oil mist, or chips on the air inlet will result in a reduction in the cooling efficiency. In some cases, the required efficiency cannot be achieved. The deposit may also lead to a reduction in the useful life of the fan motors and semiconductors. Especially, when outside air is drawn in, mount filters on both the air inlet and outlet. These filters must be replaced regularly.
  So, an easy-to-replace type of filter should be used.

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

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

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

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

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

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

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

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

- **Notes relating to this product storage, transportation and environment**
  This servo amplifier uses electronic parts corroded by the halogen (fluorine, chlorine, bromine, iodine, etc.)
  Do not storage or transport or use this servo amplifier in the halogen (fluorine, chlorine, bromine, iodine, etc.) atmosphere.
  Fumigant and industrial cleaning solvent, and pesticide might contain the halogen.

Note

NOTE

- **Keep the nameplate clearly visible.**

- **Keep the legend on the nameplate clearly visible.**

- **After unpacking the amplifier, carefully check for any damage.**

- **Mount the amplifier in a location where it can be easily accessed periodic inspection and daily maintenance.**

- **Leave sufficient space around the machine to enable maintenance to be performed easily.**
  Do not place any heavy objects such that they would interfere with the opening of the doors.

- **Keep the parameter table and spare parts at hand.**
  Also, keep the specifications at hand. These items must be stored in a location where they can be retrieved immediately.

- **Provide adequate shielding.**
  A cable to be shielded must be securely connected to the ground plate, using a cable clamp or the like.

WARNINGS AND CAUTIONS RELATING TO A PILOT RUN

Warning

⚠ WARNING

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

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

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

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

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

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

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

Caution

⚠ CAUTION

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

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

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

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

Warnings and Cautions Relating to Maintenance

Warning

⚠ WARNING

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

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

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

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

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

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

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

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

Caution

⚠ CAUTION

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

- **Tighten all screws firmly.**

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

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

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

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

Note

NOTE

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

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

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

TABLE OF CONTENTS

APPENDIX

I. β*i*SV

1 OVERVIEW

The β*i*SV series amplifiers are used to drive a servo motor. Select an appropriate amplifier according to the servo motor connected.
There are two types of β*i*SV series, as follows:

(1) 200-V input series
This amplifier drives a servo motor of the 200-V input series.
Amplifiers for one axis and two axes are available.

(2) 400-V input series
This amplifier drives a servo motor of the 400-V input series.
Amplifiers for one axis are available.

β*i* SV ☐ / ☐ HV
(A) (B) (C) (D)

(A) Model name: SV = Servo amplifier
(B) L-axis maximum output current value [Apeak]
(C) M-axis maximum output current value [Apeak]
(D) For an amplifier supporting 400-V input, "HV" is added.

1.1 FEATURE

The one-axis servo amplifier β*i*SV series has the following features:

(1) Because a power supply is incorporated, a compact one-axis servo amplifier system can be built easily.
(2) One-axis servo amplifier with excellent cost performance
(3) The FSSB interface, which is the standard interface of FANUC, is supported.
(4) This amplifier has a small installation area and volume.
(5) This one-axis servo amplifier is suitable for the servo motor α*i*S, α*i*F, β*i*S, and β*i*F series, which is suitable for feed axes of machining tools and for applications of their peripheral equipment and industrial machines.
(6) The one-axis servo amplifier β*i*SV series for 30*i*-B series CNCs does not support Smart troubleshooting and Preventive maintenance the α*i* series for 30*i*-B series CNCs supports.

The two-axis servo amplifier β*i*SV series has the following features:

(1) Because a power supply is incorporated, a compact two-axis servo amplifier system can be built easily.
(2) Two-axis servo amplifier with excellent cost performance
(3) The FSSB interface, which is the standard interface of FANUC, is supported.
(4) This amplifier has a small installation area and volume.
(5) This two-axis servo amplifier is suitable for the servo motor α*i*S, α*i*F, β*i*S, and β*i*F series, which is suitable for feed axes of machining tools and for applications of their peripheral equipment and industrial machines.
(6) The two-axis servo amplifier β*i*SV series for 30*i*-B series CNCs does not support Smart troubleshooting and Preventive maintenance the α*i* series for 30*i*-B series CNCs supports.

1.2 NOTES

The CNC that can be connected to each model of the servo amplifier β*i*SV series are listed below.

CNC	One-axis β*i*SV series (200 V type) (A06B-6130-H***)	One-axis β*i*SV series for 30*i*-B series CNCs (200 V type) (A06B-6160-H***)	One-axis β*i*SV series (400 V type) (A06B-6131-H***)	One-axis β*i*SV series for 30*i*-B series CNCs (400 V type) (A06B-6161-H***)
30*i*-B series	-	○	-	○
30*i*-A series	○	○	○	○
0*i*-D series	○	○	○	○
0*i*-B,0*i*-C series	○	-	○	-
Power Mate *i* D/H series	○	-	○	-
16*i*/18*i*/21*i*-B series	○	-	○	-

CNC	Two-axis β*i*SV series (A06B-6136-H***)	Two-axis β*i*SV series for 30*i*-B series CNCs (A06B-6166-H***)
30*i*-B series	-	○
30*i*-A series	-	○
0*i*-D series	○(*)	○
0*i*-B, 0*i*-C series	○	-
Power Mate *i* D/H series	-	-
16*i*/18*i*/21*i*-B series	-	-

(*) Parameter setting
The 0*i*/0*i* Mate-MODEL C compatible mode must be set. To connect the 0*i*/0*i* Mate-MODEL D, input the following parameter:

14476#0=1

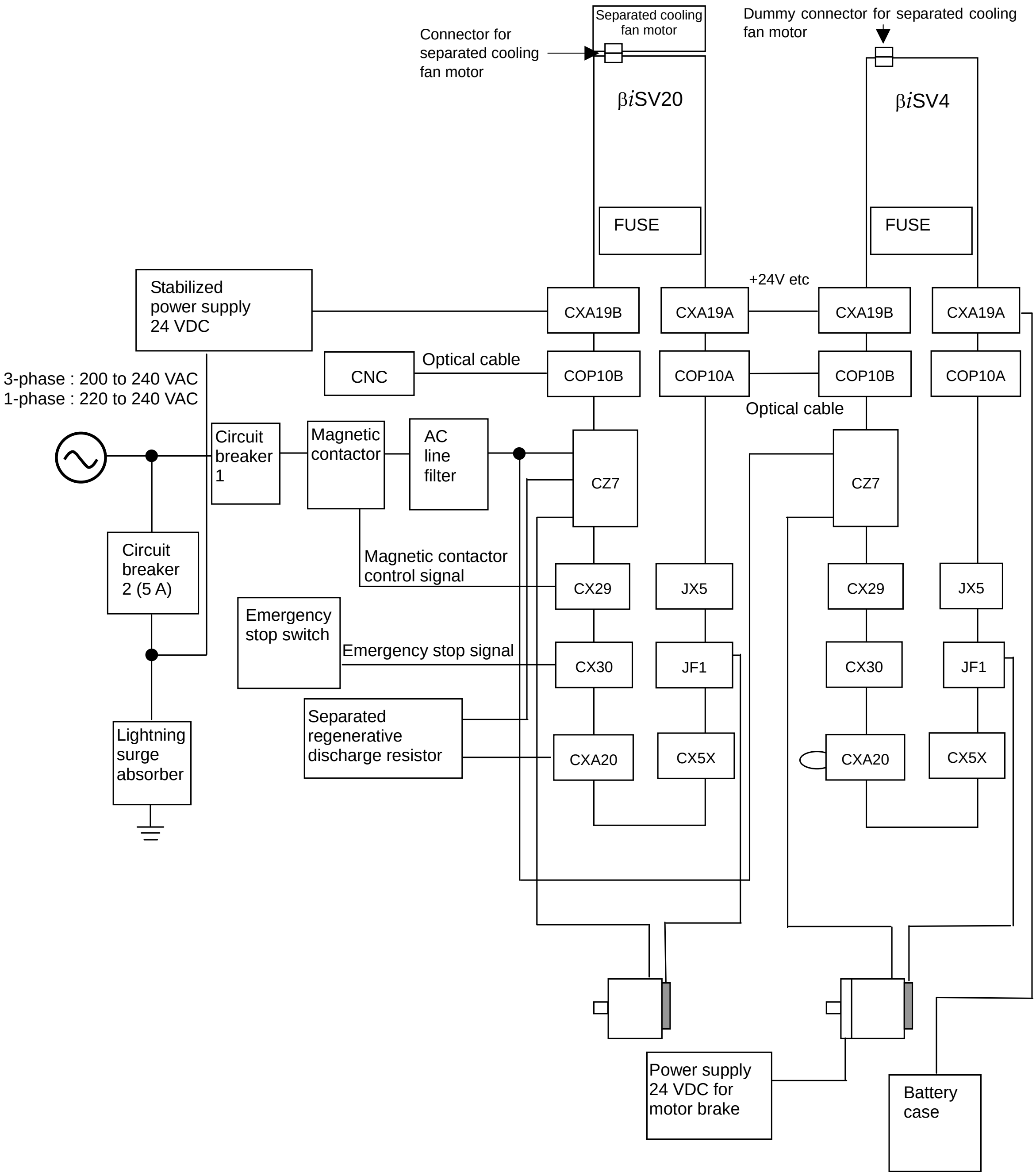
Turn the power off, then on again.

The maximum number of units that can be connected to one FSSB line is as follows:

In the servo control (HRV3) mode, up to four servo axes can be connected.
In the servo control (HRV2) mode, up to eight servo axes can be connected.

2 CONFIGURATION

2.1 β*i*SV4 AND β*i*SV20



NOTE

1. Use the stabilized power supply 24VDC for the amplifier. Power supply 24VDC for the amplifier and power supply 24VDC for the motor brake cannot be shared.
2. The cabling of CX29 and CX30 of the second and subsequent amplifiers may be omitted. For details, see Subsection 9.2.12, "Details of Cable K8" and Chapter 11, "COMBINATIONS OF DIFFERENT MODELS".

NOTE

3 A circuit breakers, magnetic contactor, and AC line filter are always required.

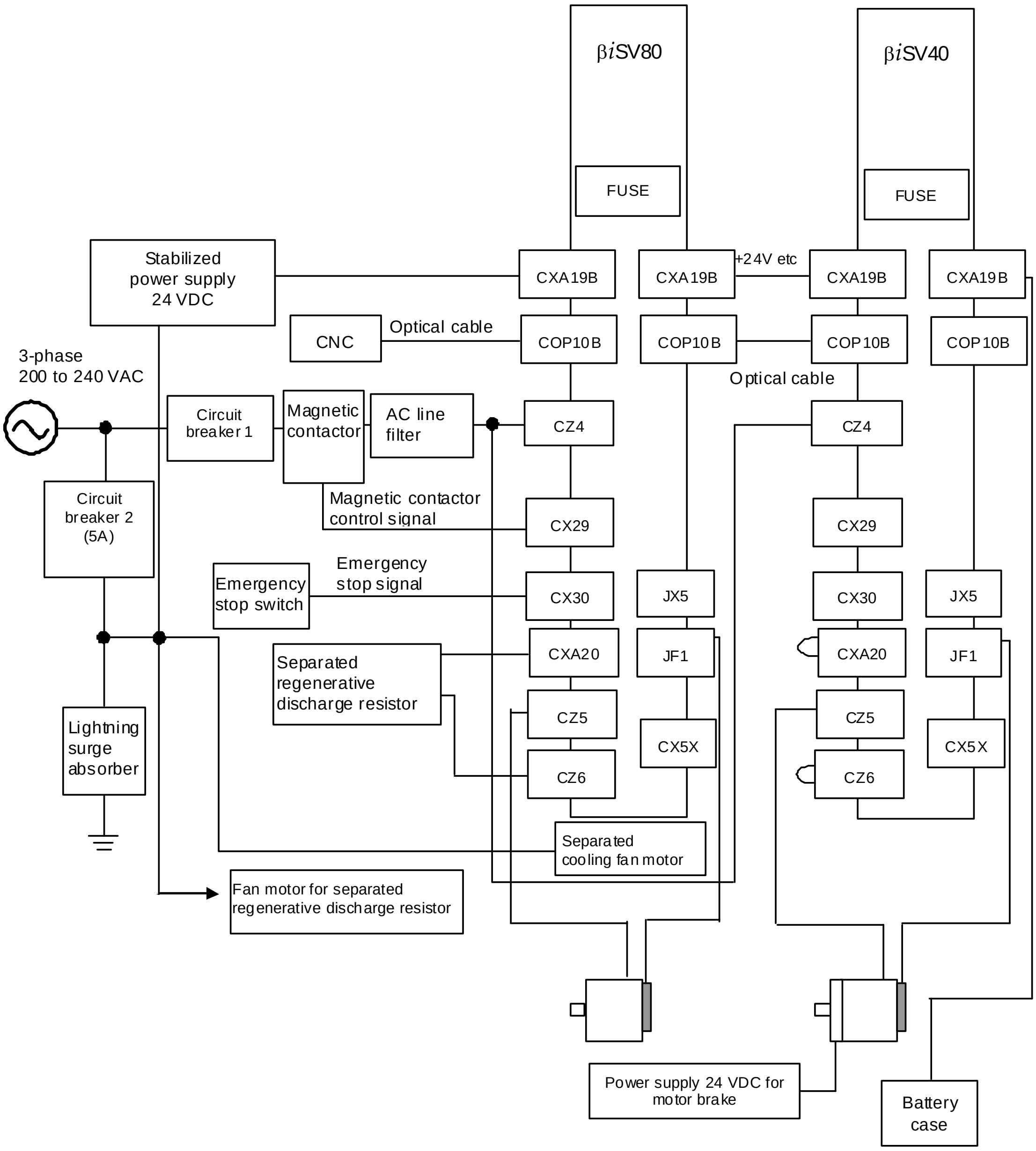
4 To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.

⚠ **WARNING**

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

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

2.2 βiSV40 AND βiSV80



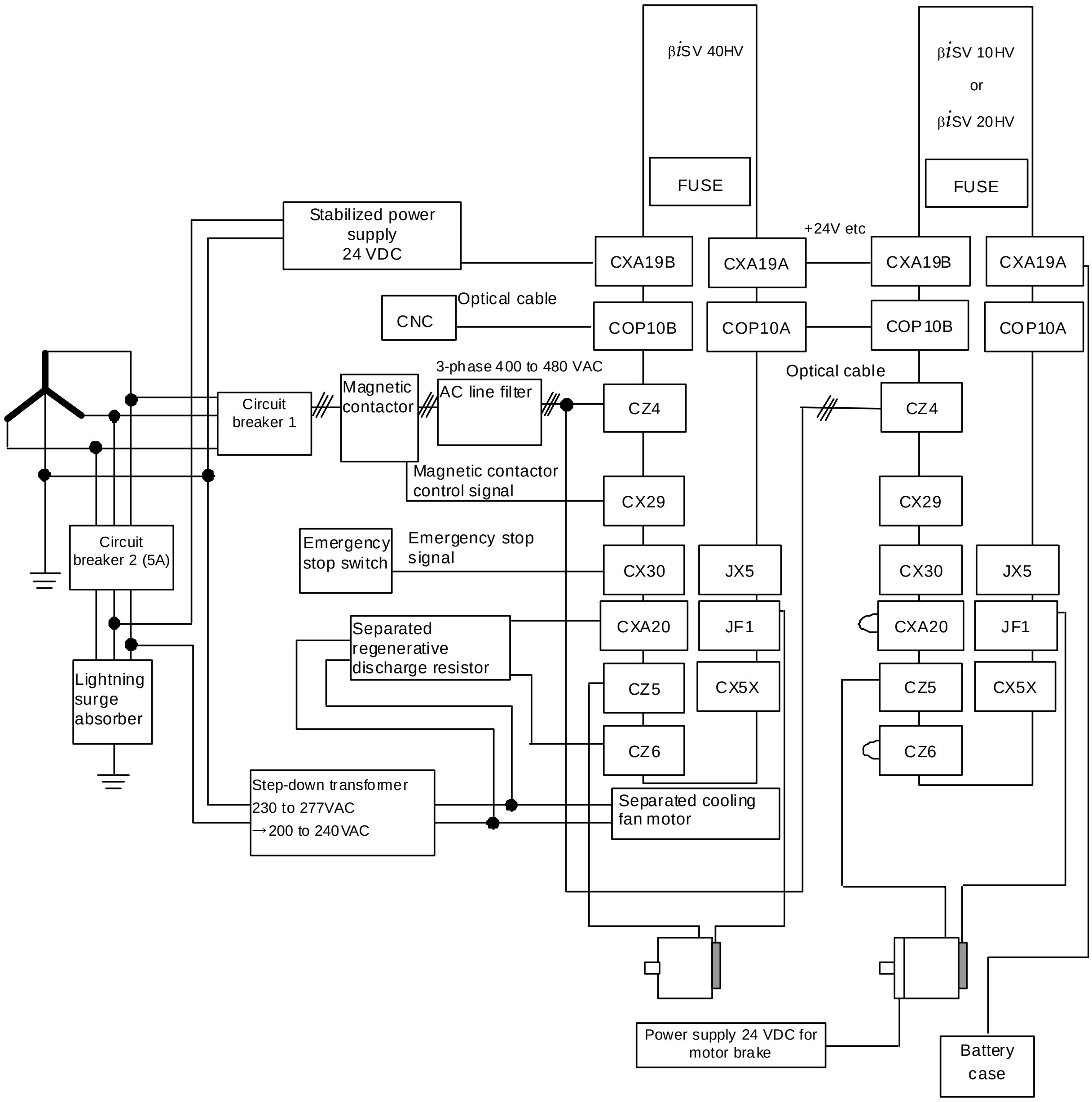
NOTE

1. Use the stabilized power supply 24VDC for the amplifier. Power supply 24VDC for the amplifier and power supply 24VDC for the motor brake cannot be shared.
2. The cabling of CX29 and CX30 of the second and subsequent amplifiers may be omitted. For details, see Subsection 9.2.12, “Details of Cable K8” and Chapter 11, “COMBINATIONS OF DIFFERENT MODELS”.
3. A circuit breakers, magnetic contactor, and AC line filter are always required.
4. To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.

⚠ **WARNING**

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

2.3 βiSV10HV, βiSV20HV, AND βiSV40HV



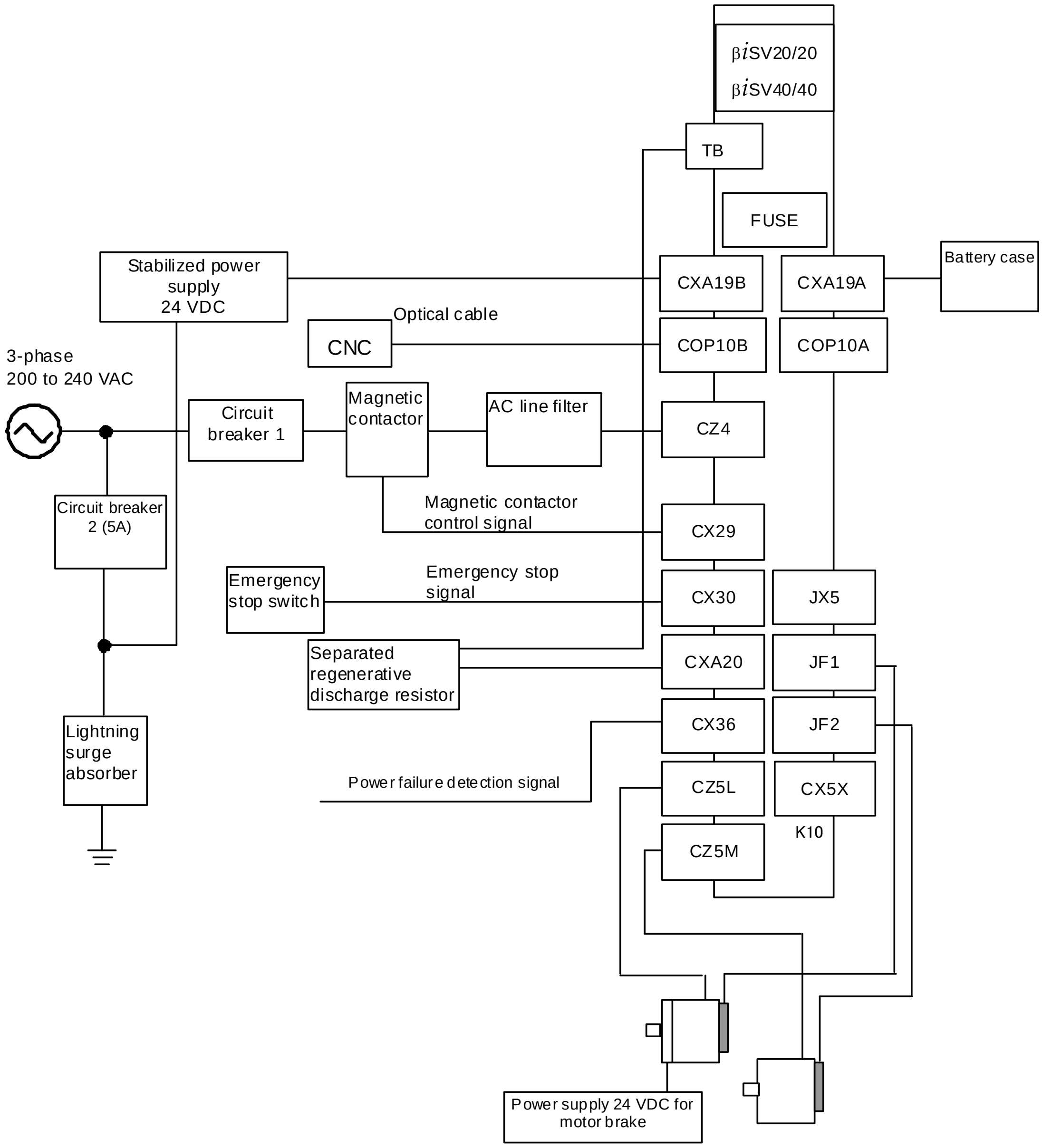
NOTE

1. Use the stabilized power supply 24VDC for the amplifier. Power supply 24VDC for the amplifier and power supply 24VDC for the motor brake cannot be shared.
2. The cabling of CX29 and CX30 of the second and subsequent amplifiers may be omitted. For details, see Subsection 9.2.12, “Details of Cable K8” and Chapter 11, “COMBINATIONS OF DIFFERENT MODELS”.
3. A circuit breakers, magnetic contactor, and AC line filter are always required.
4. To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.

⚠ **WARNING**

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

2.4 β*i*SV20/20 AND β*i*SV40/40



NOTE

1. Use the stabilized power supply 24VDC for the amplifier. Power supply 24VDC for the amplifier and power supply 24VDC for the motor brake cannot be shared.
2. The cabling of CX29 and CX30 of the second and subsequent amplifiers may be omitted. For details, see Subsection 9.2.12, "Details of Cable K8" and Chapter 11, "COMBINATIONS OF DIFFERENT MODELS".
3. A circuit breakers, magnetic contactor, and AC line filter are always required.
4. To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.

⚠ **WARNING**

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

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

3 SPECIFICATIONS

3.1 INPUT POWER

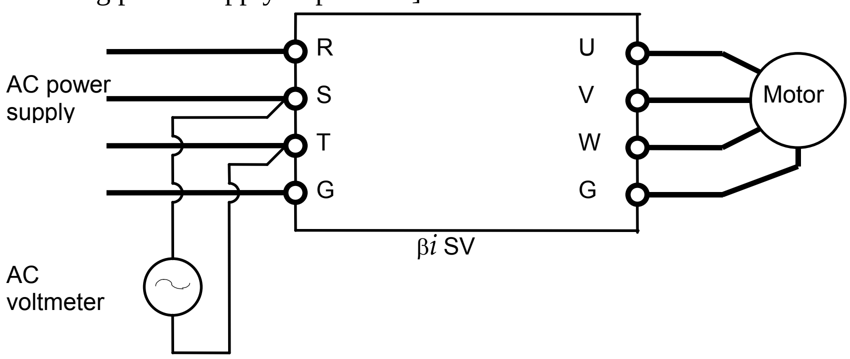
3.1.1 Power Supply of 200-V Input Series (Three-phase Input)

(1) Power specification

Item	Specification
Main power supply voltage	Three-phase 200 to 240 VAC
Allowable voltage deviation	-15% to +10% (including voltage variation due to load)
Instantaneous power failure guarantee time	3ms
Power frequency	50/60Hz, ±1Hz
Power supply unbalance	±5% of the rated voltage or less
Power supply impedance (Note)	The voltage variation must be within ±7% when a maximum output is produced for voltage at non-load time.

NOTE
When the power supply impedance is high, and the voltage variation exceeds the specified values, an alarm (DC link undervoltage alarm or DC link overvoltage alarm) can be issued in an amplifier, and the output of the motor can decrease.

[Method of checking power supply impedance]



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

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

(2) 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.

(3) Ground
The main circuit power supply must be grounded through the neutral point or one phase of the three-phase power supply.

(4) Noise filter
To satisfy the EMC regulation enforced in the EU countries, a noise filter must be installed in the power supply input section.

(5) Low-voltage command
Separate the signal cables from the main power supply and power cables including motor cables with double insulation.

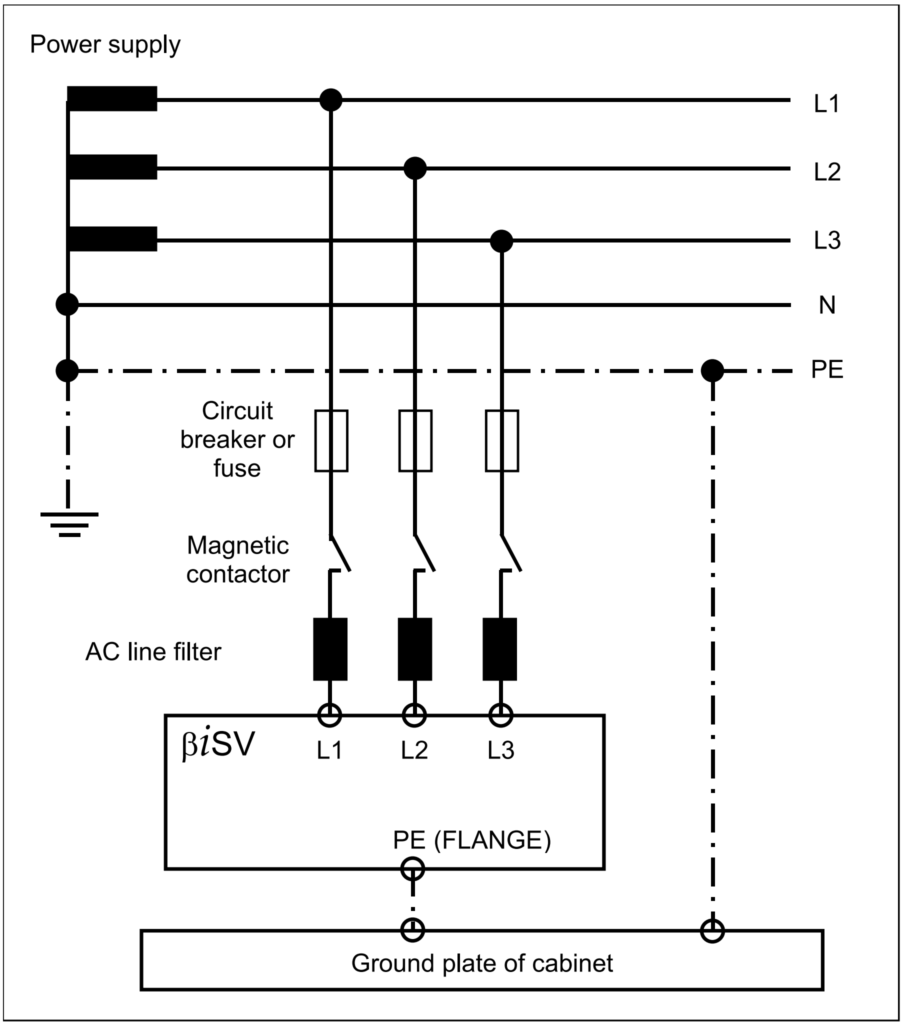
(6) Example of connecting the Power supply of the main circuit

No.	Power system	Power specification	Power supply of amplifier
1	TN-power system	• Star connection • Neutral grounding on the power supply side • PE provided on the power line • Power supply voltage specification 200 to 240 VAC (-15%,+10%)	• Directly connectable to the power supply (No transformer is required.)
2	TN-power system	• Star connection • Neutral grounding on the power supply side • PE provided on the power line • Power supply voltage specification Not within the range 200 to 240 VAC (-15%, +10%)	[When the power supply voltage is lower than the specified power supply voltage] The power supply voltage is increased with an auto-transformer. [When the power supply voltage is higher than the specified power supply voltage] The power supply voltage is decreased with an auto-transformer. Before starting to use the power supply, check that it conforms to the relevant safety standards.
3	TN-power system	• Delta connection • Single-phase grounding on the power supply side • PE provided on the power line • Power supply voltage specification 200 to 240 VAC (-15%,+10%)	• Directly connectable to the power supply (No transformer is required.)
4	TN-power system	• Delta connection • Single-phase grounding on the power supply side • PE provided on the power line • Power supply voltage specification Not within the range 200 to 240 VAC (-15%, +10%)	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.
5	TT-power system	• Star connection • Neutral grounding on the power supply side • No PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.
6	TT-power system	• Delta connection • Single-phase grounding on the power supply side • No PE provided on the power line	
7	IT-power system	• Star connection • No direct ground connection made on the power supply side • No PE provided on the power line	
8	IT-power system	• Delta connection • No direct ground connection made on the power supply side • No PE provided on the power line	

* The TN-power system, TT-power system, and IT-power system are based on the DC power distribution system standard IEC60364.

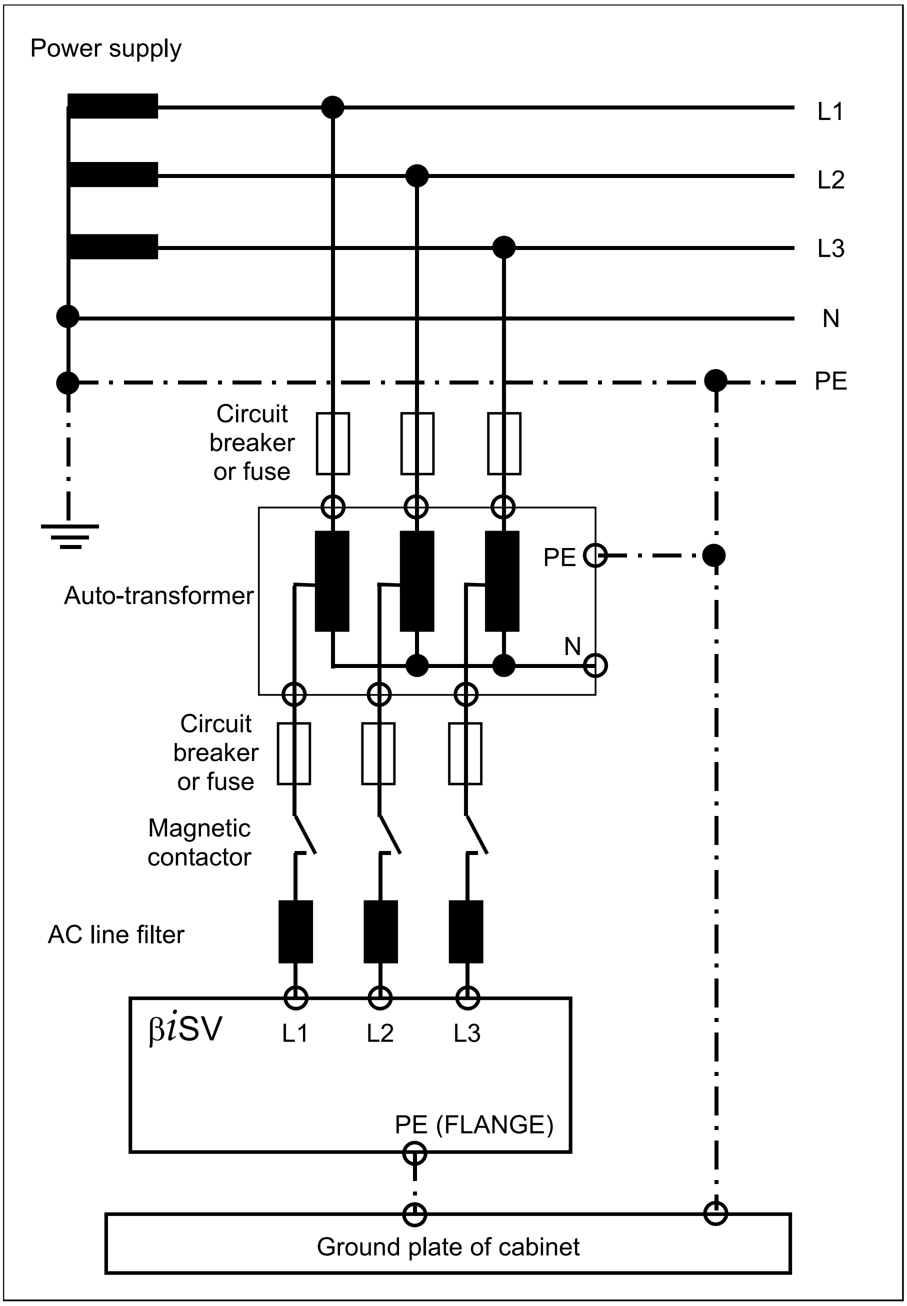
(a) TN-power system

No.	Power system	Power specification	Power supply of amplifier
1	TN-power system	• Star connection • Neutral grounding on the power supply side • PE provided on the power line • Power supply voltage specification 200 to 240 VAC (-15%,+10%)	• Directly connectable to the power supply (No transformer is required.)



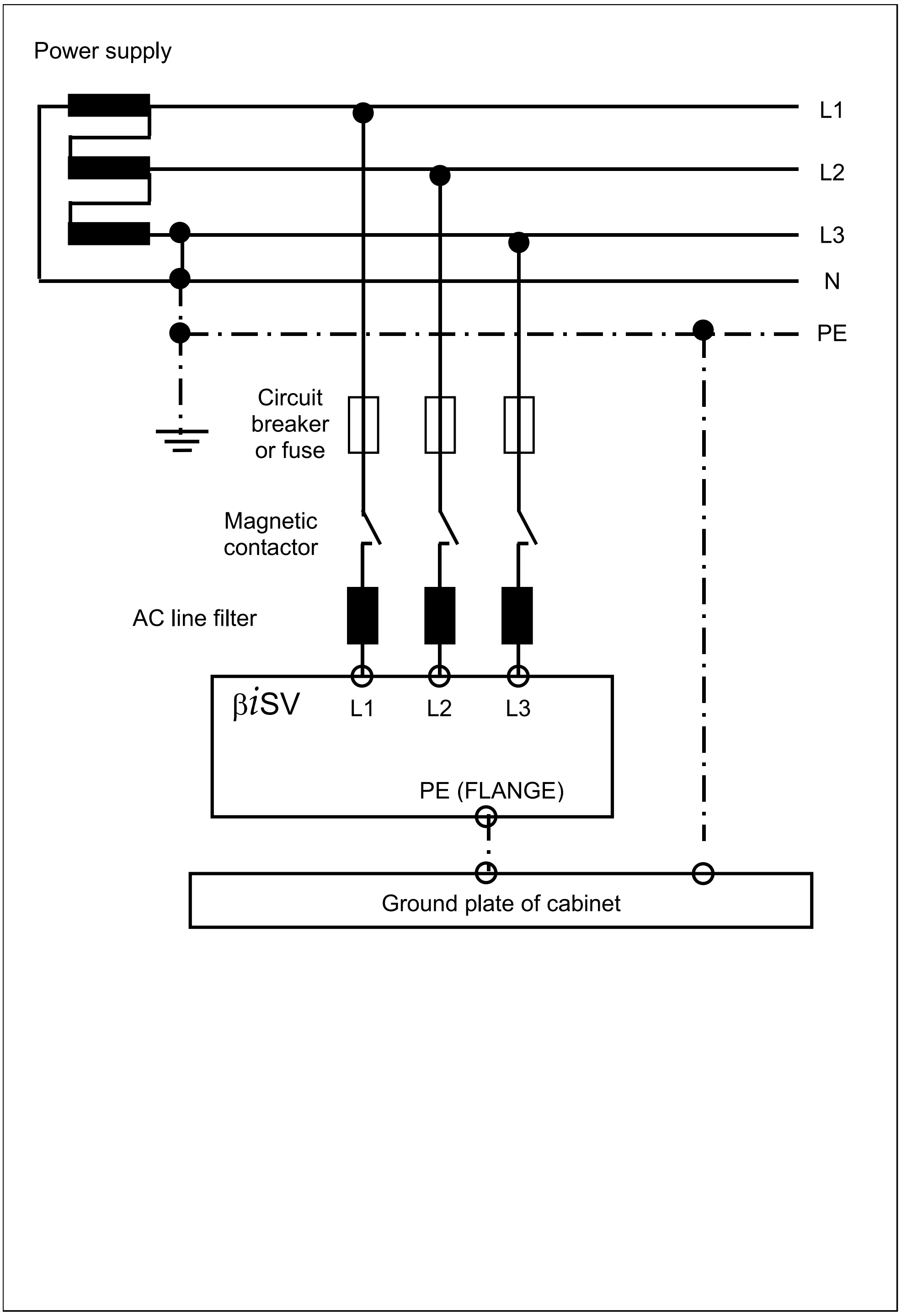
(b) TN-power system

No.	Power system	Power specification	Power supply of amplifier
2	TN-power system	• Star connection • Neutral grounding on the power supply side • PE provided on the power line • Power supply voltage specification Not within the range 200 to 240 VAC (-15%, +10%)	[When the power supply voltage is lower than the specified power supply voltage] The power supply voltage is increased with an auto-transformer. [When the power supply voltage is higher than the specified power supply voltage] The power supply voltage is decreased with an auto-transformer. Before starting to use the power supply, check that it conforms to the relevant safety standards.



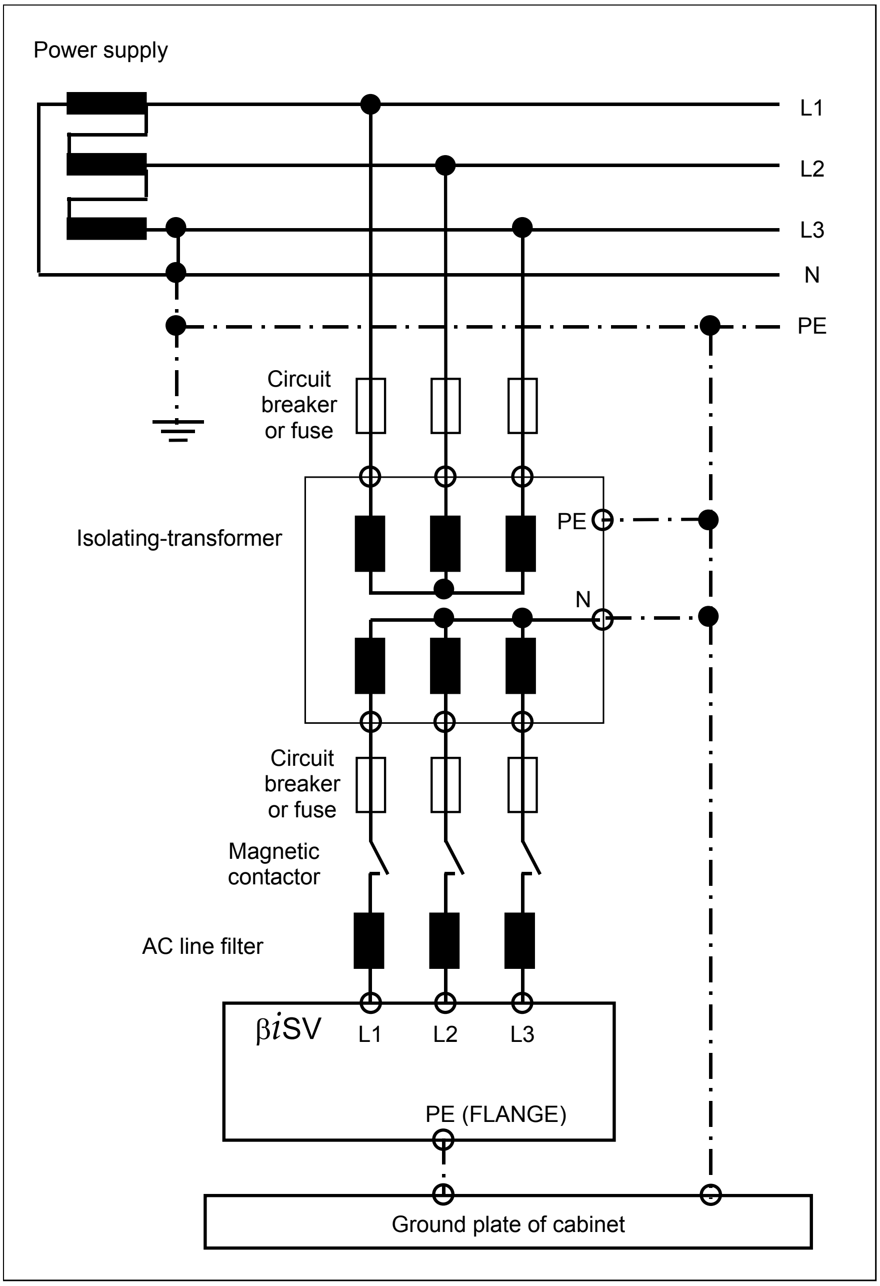
(c) TN-power system

No.	Power system	Power specification	Power supply of amplifier
3	TN-power system	• Delta connection • Single-phase grounding on the power supply side • PE provided on the power line • Power supply voltage specification 200 to 240 VAC (-15%,+10%)	• Directly connectable to the power supply (No transformer is required.)



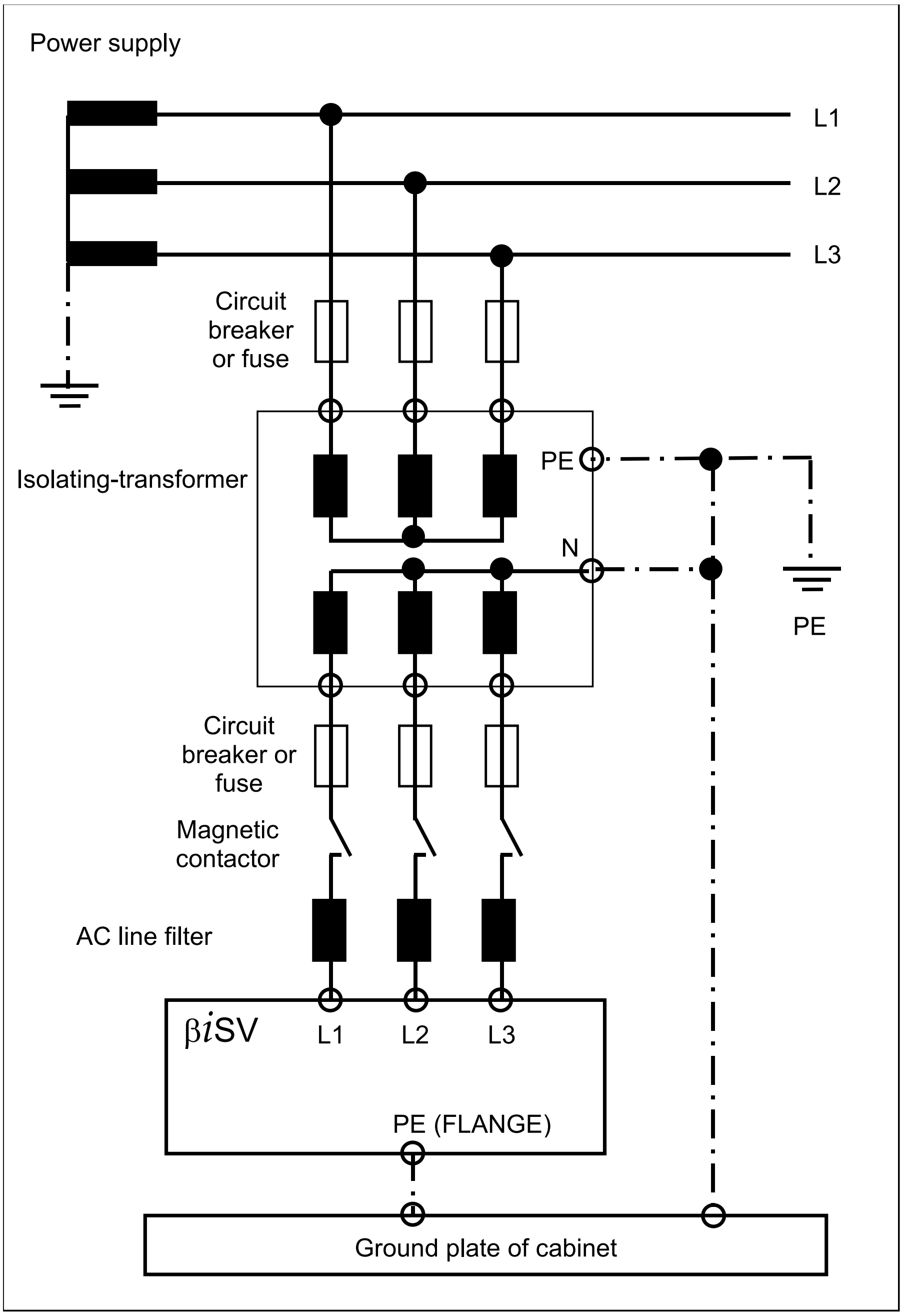
(d) TN-power system

No.	Power system	Power specification	Power supply of amplifier
4	TN-power system	• Delta connection • Single-phase grounding on the power supply side • PE provided on the power line • Power supply voltage specification Not within the range 200 to 240 VAC (-15%, +10%)	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.



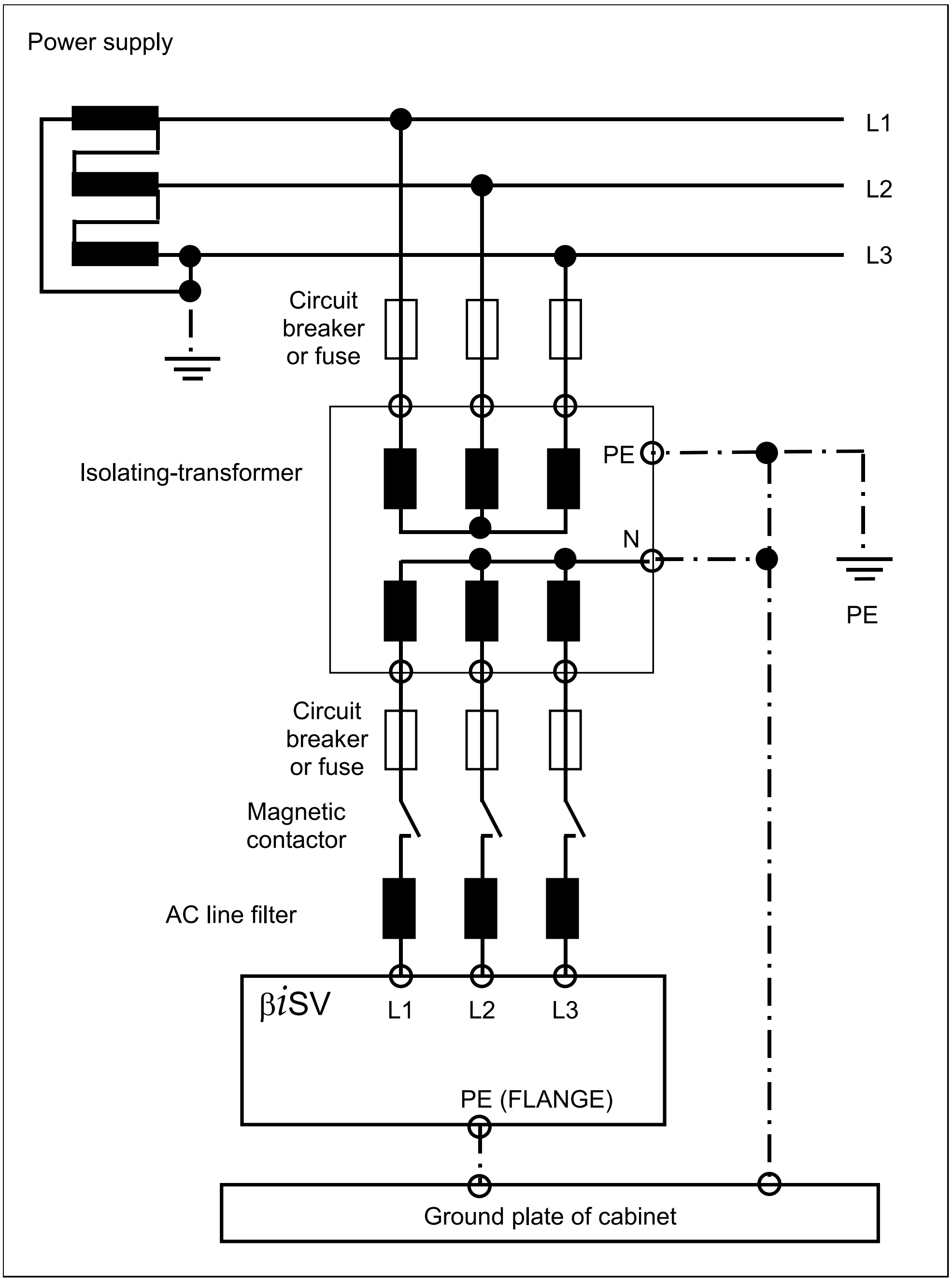
(e) TT-power system

No.	Power system	Power specification	Power supply of amplifier
5	TT-power system	• Star connection • Neutral grounding on the power supply side • No PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.



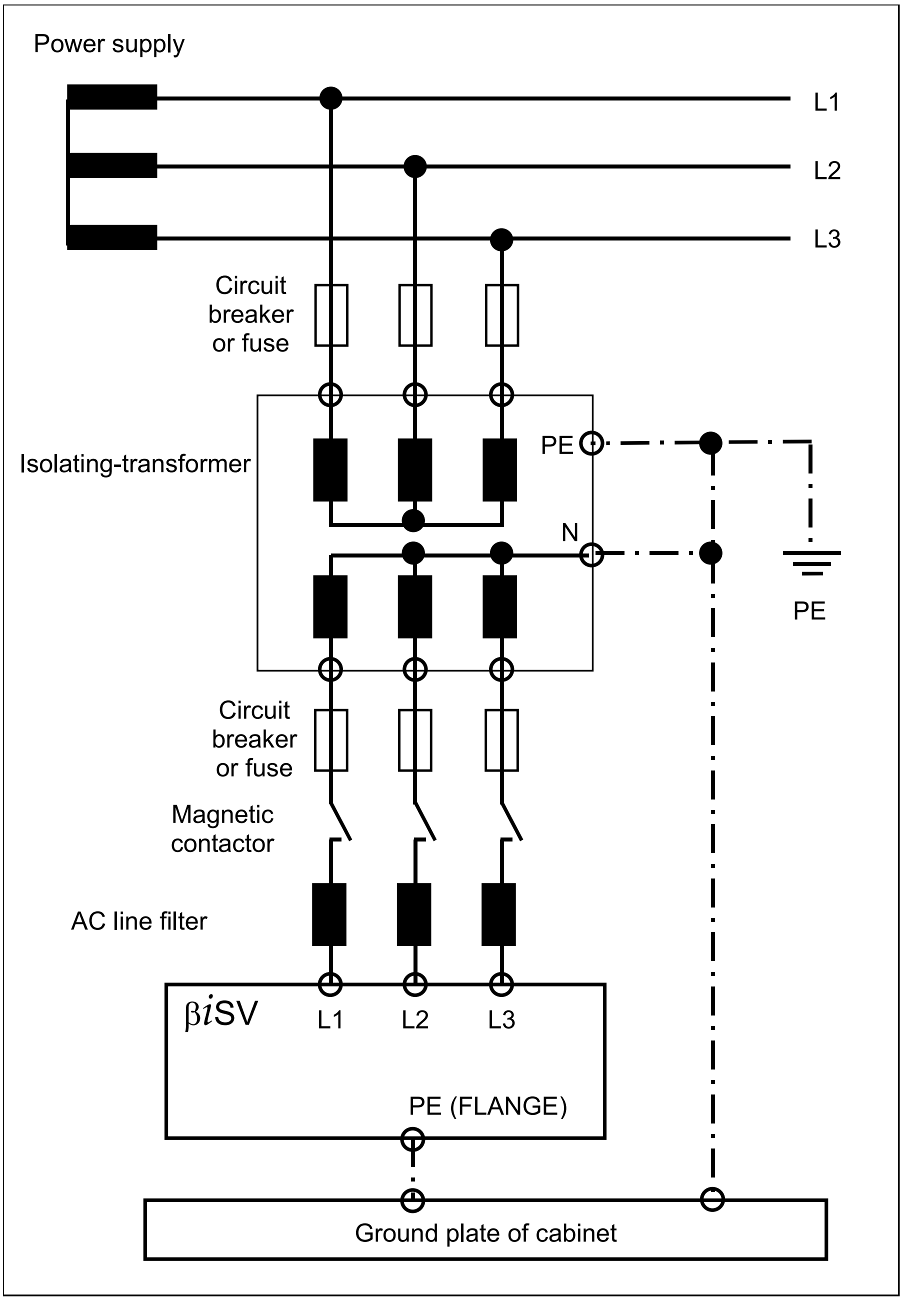
(f) TT-power system

No.	Power system	Power specification	Power supply of amplifier
6	TT-power system	• Delta connection • Single-phase grounding on the power supply side • No PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.



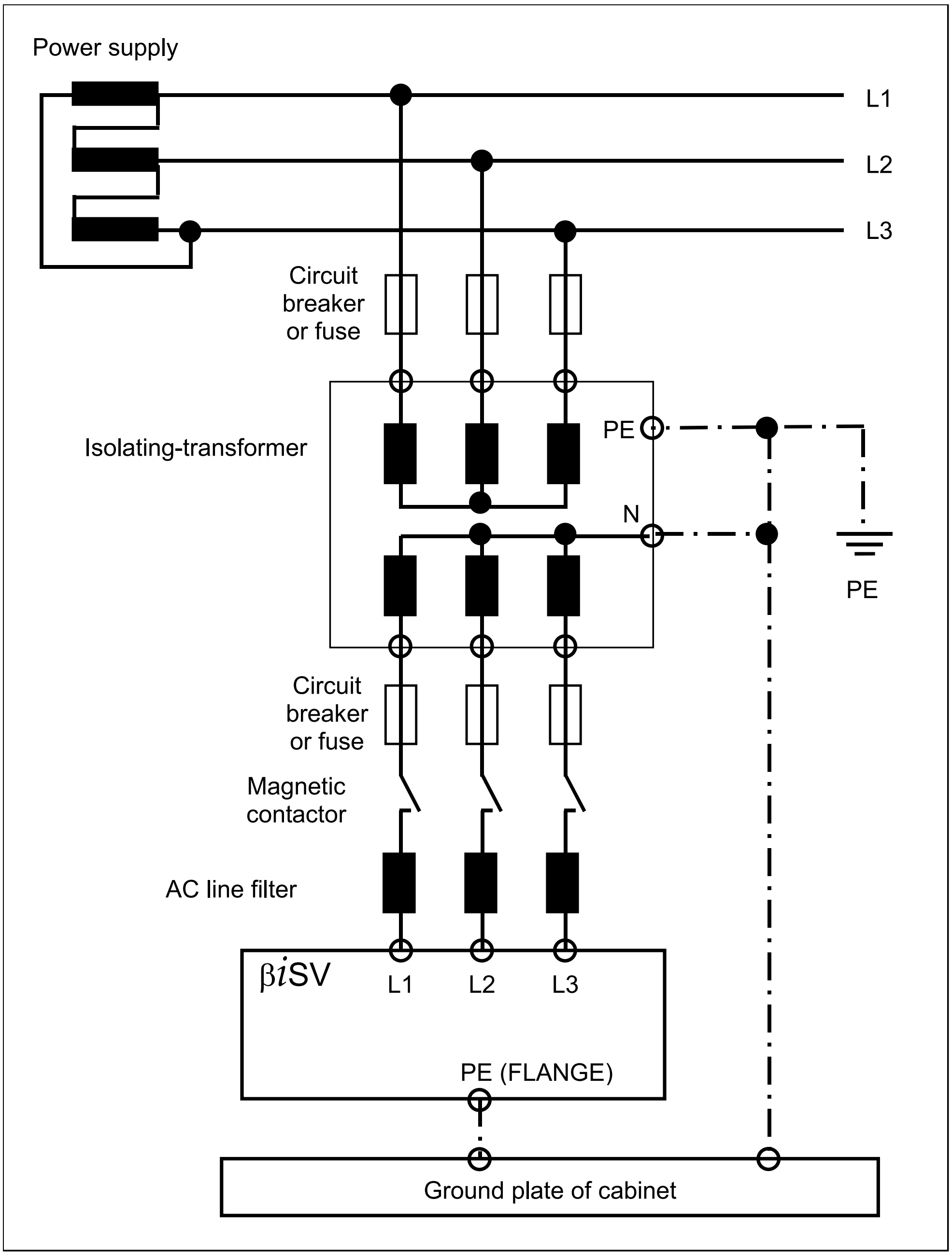
(g) IT-power system

No.	Power system	Power specification	Power supply of amplifier
7	IT-power system	• Star connection • No direct ground connection made on the power supply side • No PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.



(h) IT-power system

No.	Power system	Power specification	Power supply of amplifier
8	IT-power system	• Delta connection • No direct ground connection made on the power supply side • No PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.

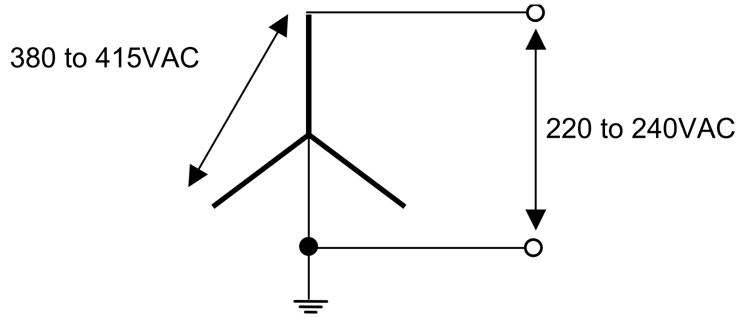


3.1.2 Power Supply of 200-V Input Series (Single-phase Input)

In European countries, power sources are 380 to 415 VAC and neutral-grounded. In these countries, the single-phase input specifications are available for using the servo amplifier β*i*SV series. To use the series with the single-phase input specifications, observe the following. Only servo amplifier models β*i*SV4 and β*i*SV20 support single-phase input.

(1) Power specification

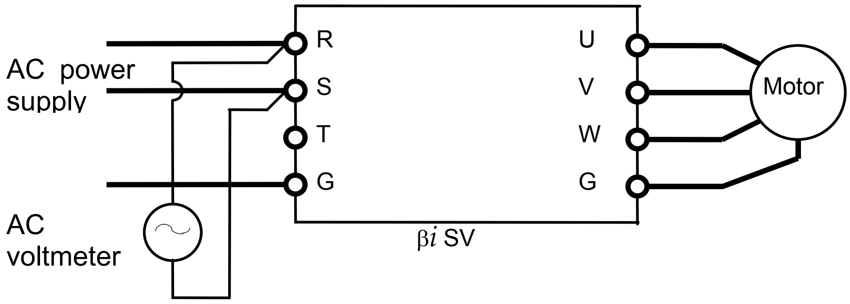
Item	Specification
Main power supply voltage	Single-phase 220 to 240VAC (neutral grounding of three-phase 380 to 415 VAC)
Allowable voltage deviation	-15% to +10% (including voltage variation due to load)
Instantaneous power failure guarantee time	3ms
Power frequency	50/60Hz, ±1Hz
Power supply unbalance	±5% of the rated voltage or less
Power supply impedance (Note)	The voltage variation must be within ±7% when a maximum output is produced for voltage at non-load time.



Power supply (star connection, neutral grounding)

NOTE
When the power supply impedance is high, and the voltage variation exceeds the specified values, an alarm (DC link undervoltage alarm or DC link overvoltage alarm) can be issued in an amplifier, and the output of the motor can decrease.

[Method of checking power supply impedance]



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

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

(2) 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.

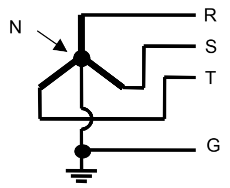
(3) Noise filter
To satisfy the EMC regulation enforced in the EU countries, a noise filter must be installed in the power supply input section.

(4) Low-voltage command
Separate the signal cables from the main power supply and power cables including motor cables with double insulation.

(5) Example of connecting the Power supply of the main circuit
See Subsection 3.1.1, "Power Supply of 200-V Input Series (Three-phase Input)".

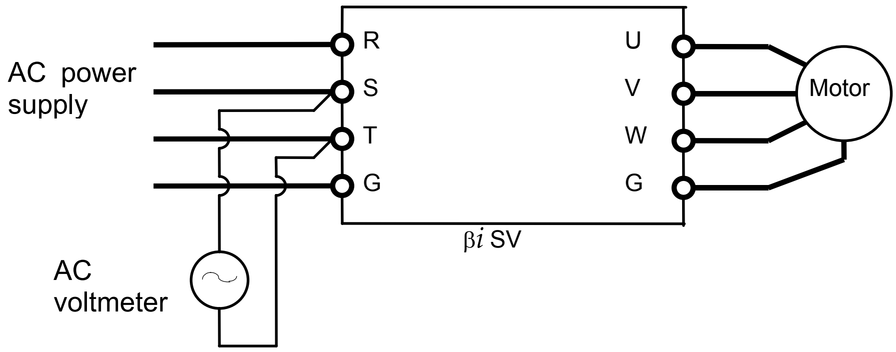
3.1.3 Power Supply of 400-V Input Series (Three-phase Input)

(1) Power specification

Item	Specification
Main power supply voltage	Three-phase 400 to 480V Star connection, neutral grounding (For details, see Items (6) and (7).) 
Allowable voltage deviation	-15% to +10% (including voltage variation due to load)
Instantaneous power failure guarantee time	3ms
Power frequency	50/60Hz, ±1Hz
Power supply unbalance	±5% of the rated voltage or less
Power supply impedance (Note)	The voltage variation must be within ±7% when a maximum output is produced for voltage at non-load time.

NOTE
When the power supply impedance is high, and the voltage variation exceeds the specified values, an alarm (DC link undervoltage alarm or DC link overvoltage alarm) can be issued in an amplifier, and the output of the motor can decrease.

[Method of checking power supply impedance]



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

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

(2) 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.

(3) Power supply voltage for the main circuit

- The power specification of the main circuit for the 400-V input series of the servo amplifier β*i*SV series is as follows:
  <1> Star connection
  <2> Neutral grounding on the power supply side
  <3> PE provided on the power line (The PE of the amplifier and motor is connected to the PE of the power line.)
  <4> The inter-phase voltage of the power supply is 400 to 480 VAC (-15%,+10%)
- If the power supply does not satisfy the conditions above, the power supply needs to be converted to a power supply for neutral grounding by using a star connection and an isolating-transformer.
- The 400-V input series of the servo amplifier β*i*SV series is designed in compliance with the safety standard EN50178 to implement insulation design of the pattern and components of the printed circuit board by ensuring that the phase voltage of the power supply and the voltage between grounds connected to the neutral point of the star connection are AC 300 Vrms or below.
  Accordingly, if the power supply does not satisfy the conditions above, the pattern and components of the printed circuit board are poorly insulated. This can cause very dangerous states including a failure in servo amplifier operation and the occurrence of a high voltage at exposed areas.

(4) Example of connecting the Power supply of the main circuit

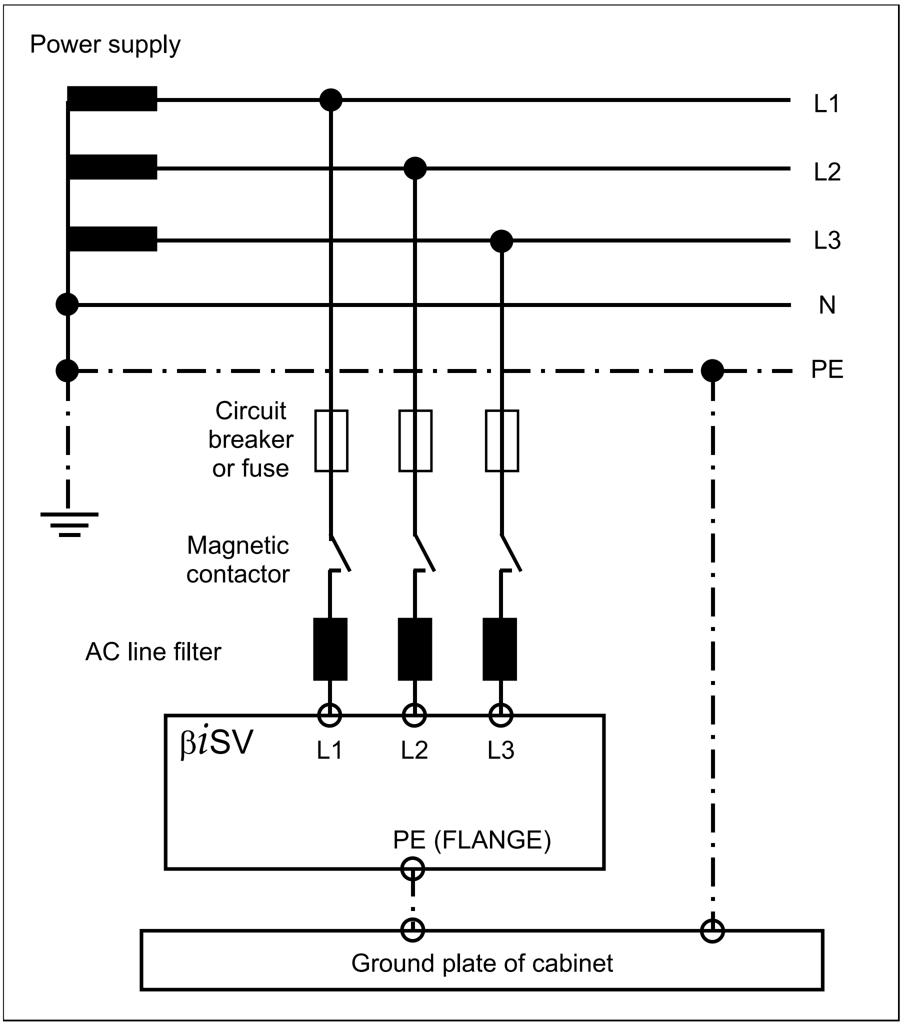
NO	Power system	Power specification	Power supply of amplifier
1	TN-power system	• Star connection • Neutral grounding on the power supply side • PE provided on the power line • Power supply voltage specification 400 to 480VAC(-15%,+10%)	• Directly connectable to the power supply (No transformer is required.)
2	TN-power system	• Star connection • Neutral grounding on the power supply side • PE provided on the power line • Power supply voltage specification Not within the range 400 to 480 VAC (-15%, +10%)	[When the power supply voltage is lower than the specified power supply voltage] The power supply voltage is increased with an auto-transformer. [When the power supply voltage is higher than the specified power supply voltage] The power supply voltage is decreased with an auto-transformer. Before starting to use the power supply, check that it conforms to the relevant safety standards.

NO	Power system	Power specification	Power supply of amplifier
3	TN-power system	• Delta connection • Single-phase grounding on the power supply side • PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.
4	TT-power system	• Star connection • Neutral grounding on the power supply side • No PE provided on the power line	
5	TT-power system	• Delta connection • Single-phase grounding on the power supply side • No PE provided on the power line	
6	IT-power system	• Star connection • No direct ground connection made on the power supply side • No PE provided on the power line	
7	IT-power system	• Delta connection • No direct ground connection made on the power supply side • No PE provided on the power line	

* The TN-power system, TT-power system, and IT-power system are based on the DC power distribution system standard IEC60364.

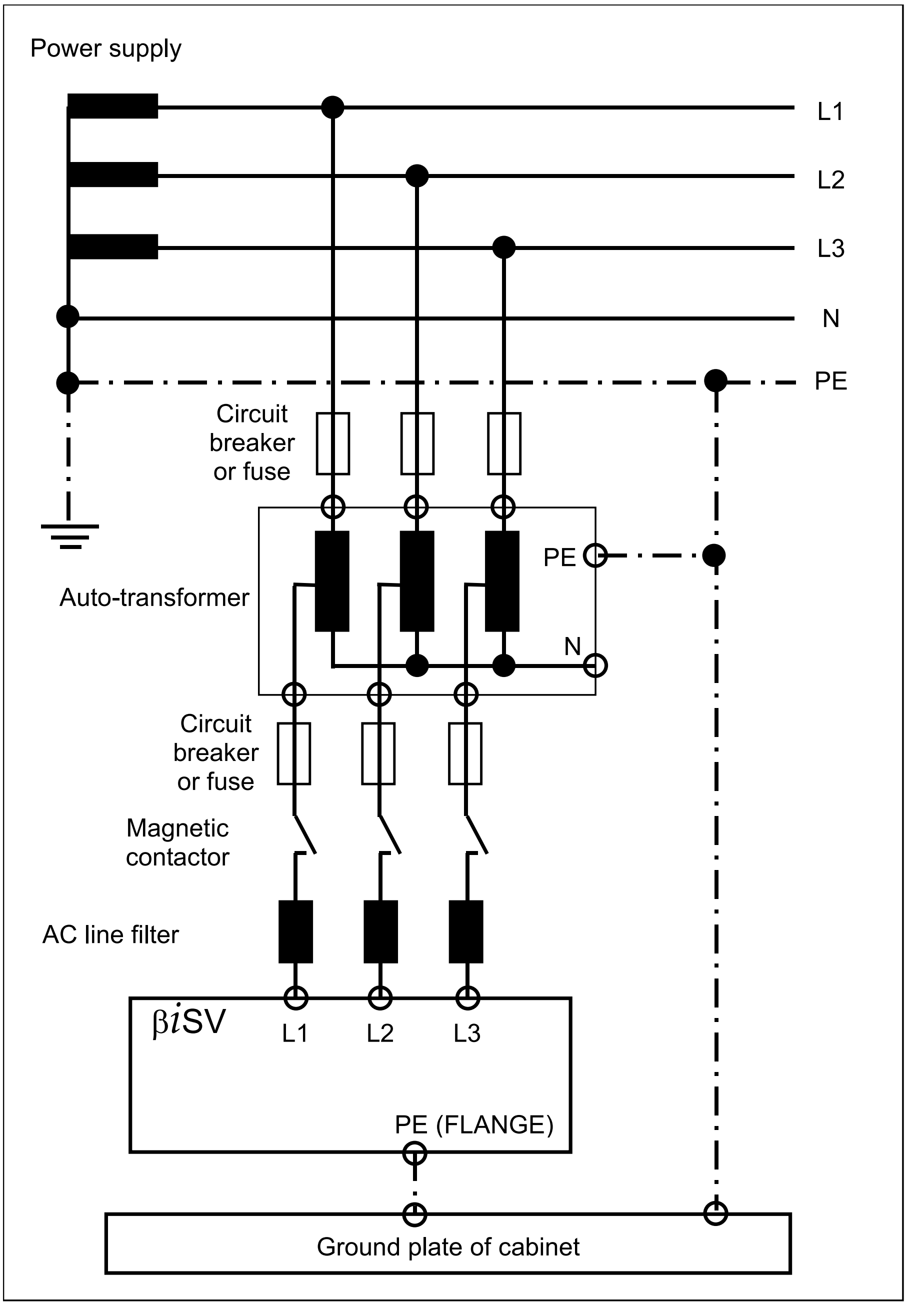
(a) TN-power system

No.	Power system	Power specification	Power supply of amplifier
1	TN-power system	• Star connection • Neutral grounding on the power supply side • PE provided on the power line • Power supply voltage specification 400 to 480VAC(-15%,+10%)	• Directly connectable to the power supply (No transformer is required.)



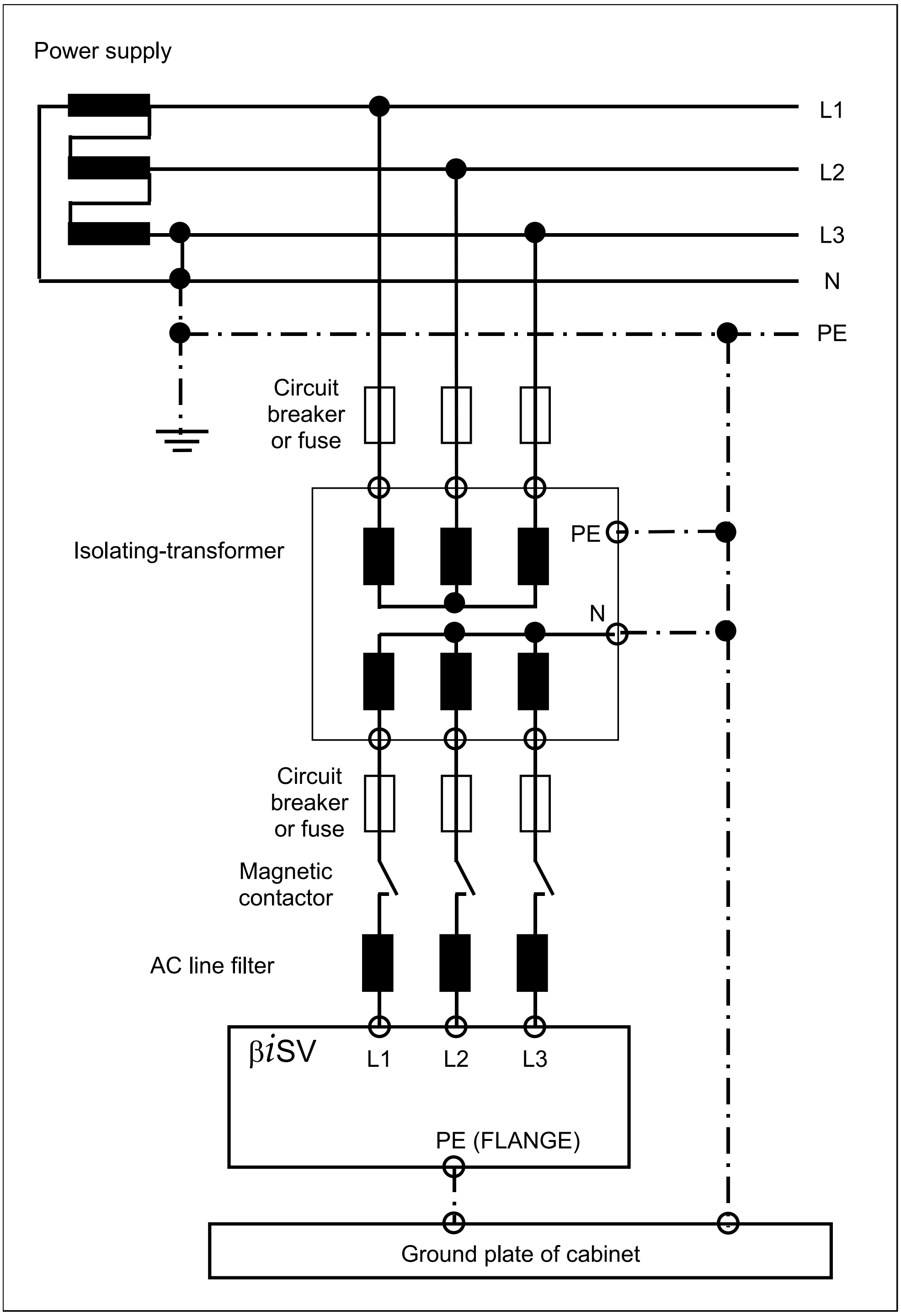
(b) TN-power system

No.	Power system	Power specification	Power supply of amplifier
2	TN-power system	• Star connection • Neutral grounding on the power supply side • PE provided on the power line • Power supply voltage specification Not within the range 400 to 480 VAC (-15%, +10%)	[When the power supply voltage is lower than the specified power supply voltage] The power supply voltage is increased with an auto-transformer. [When the power supply voltage is higher than the specified power supply voltage] The power supply voltage is decreased with an auto-transformer. Before starting to use the power supply, check that it conforms to the relevant safety standards.



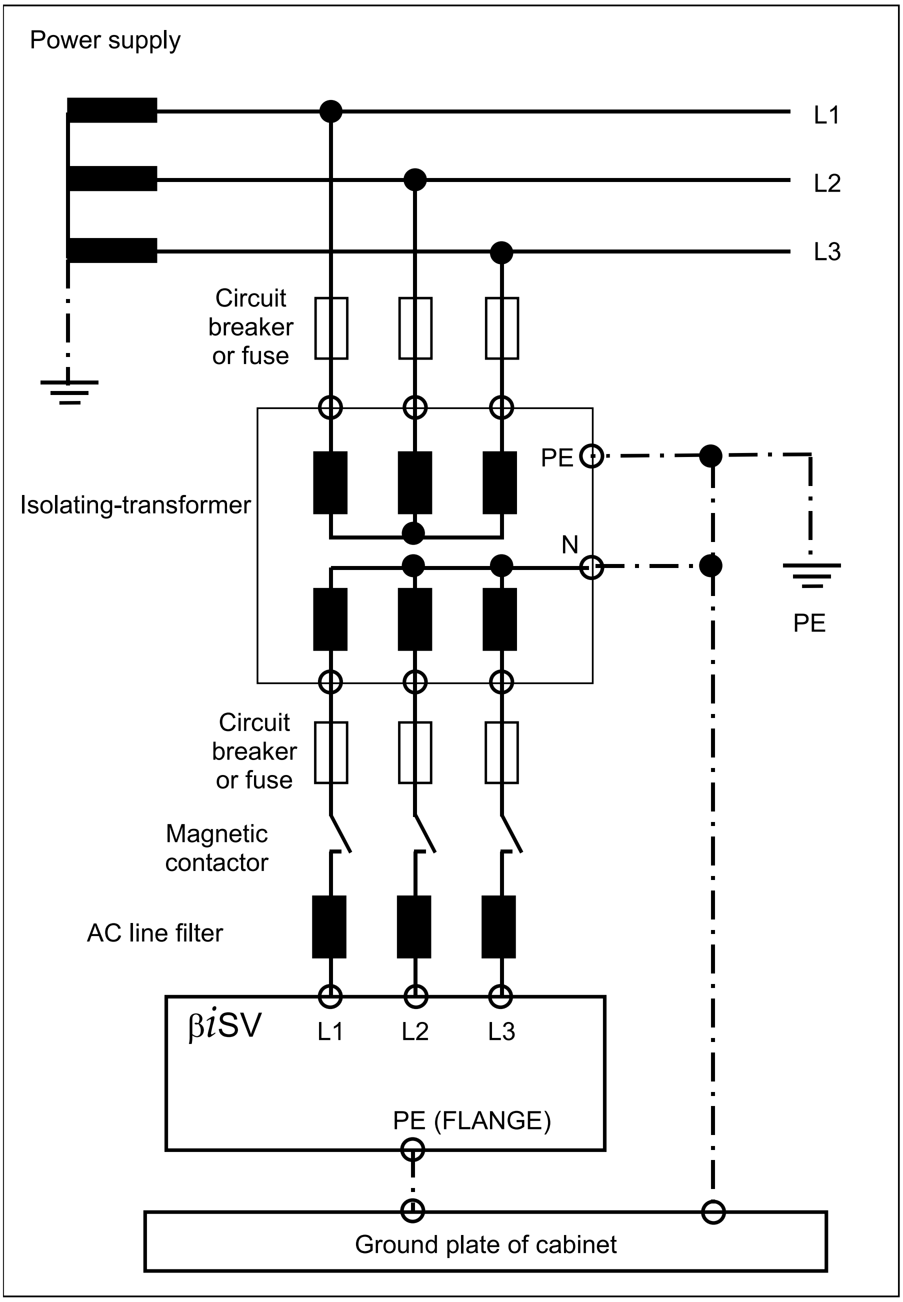
(c) TN-power system

No.	Power system	Power specification	Power supply of amplifier
3	TN-power system	• Delta connection • Single-phase grounding on the power supply side • PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.



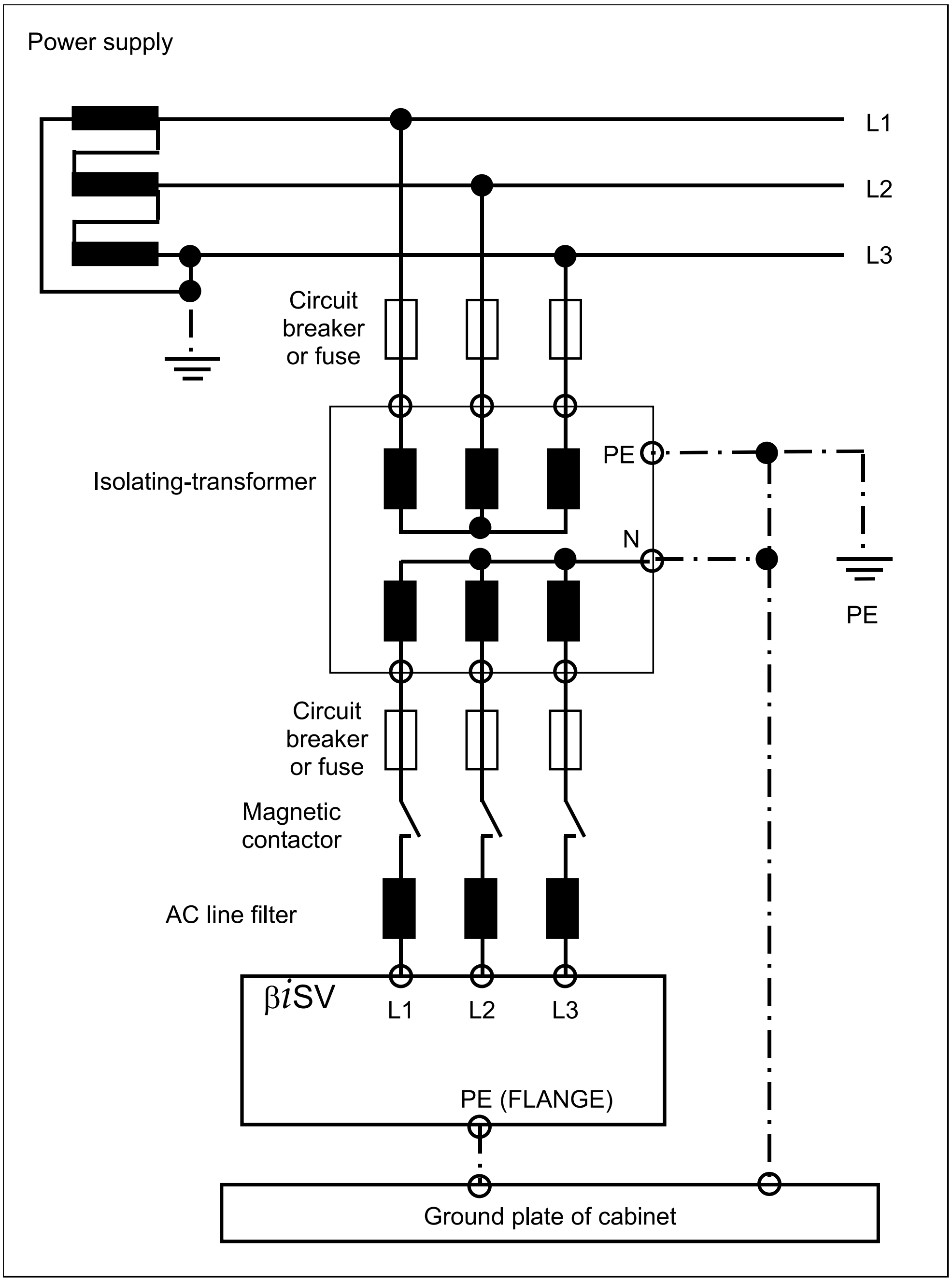
(d) TT-power system

No.	Power system	Power specification	Power supply of amplifier
4	TT-power system	• Star connection • Neutral grounding on the power supply side • No PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.



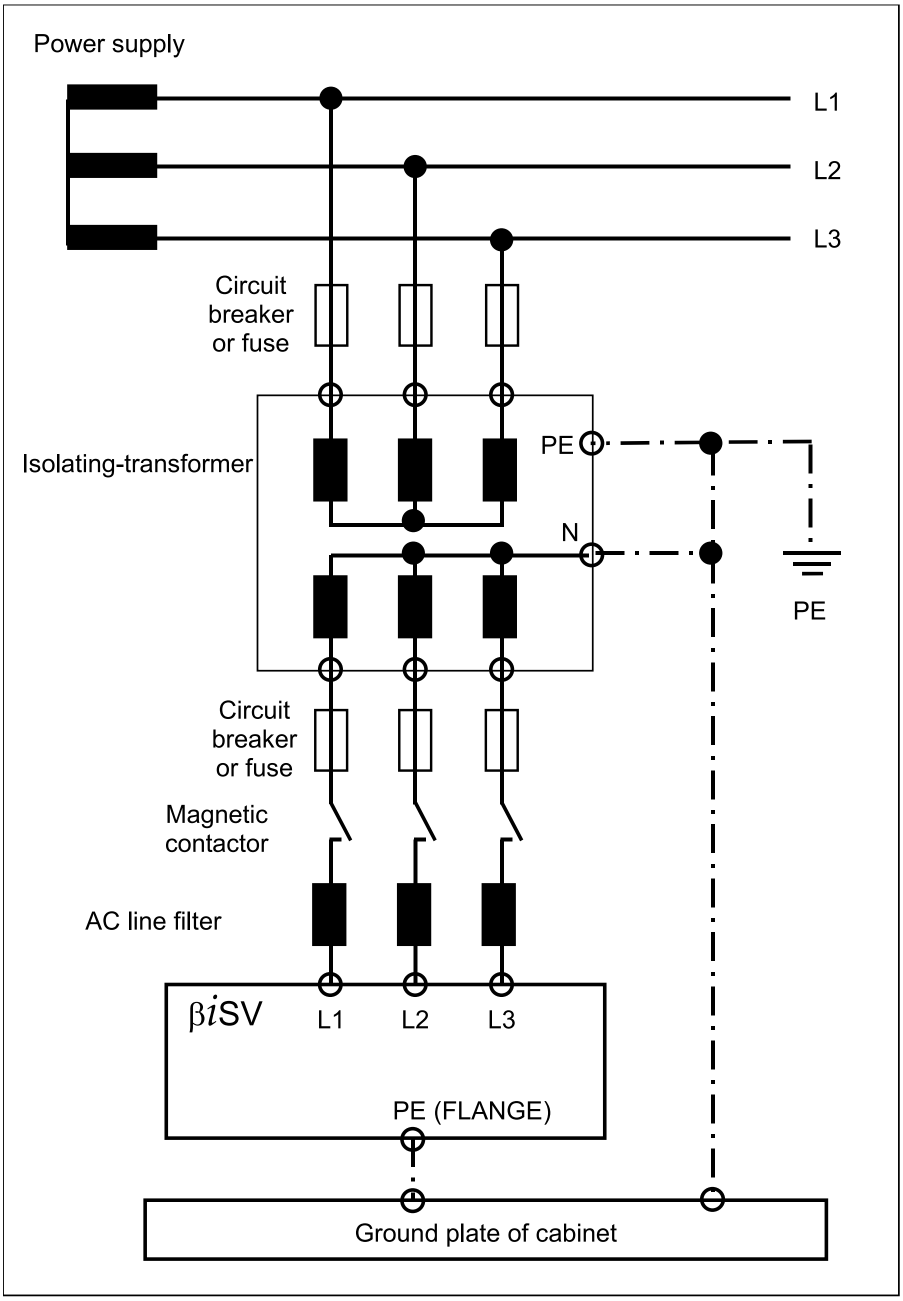
(e) TT-power system

No.	Power system	Power specification	Power supply of amplifier
5	TT-power system	• Delta connection • Single-phase grounding on the power supply side • No PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.



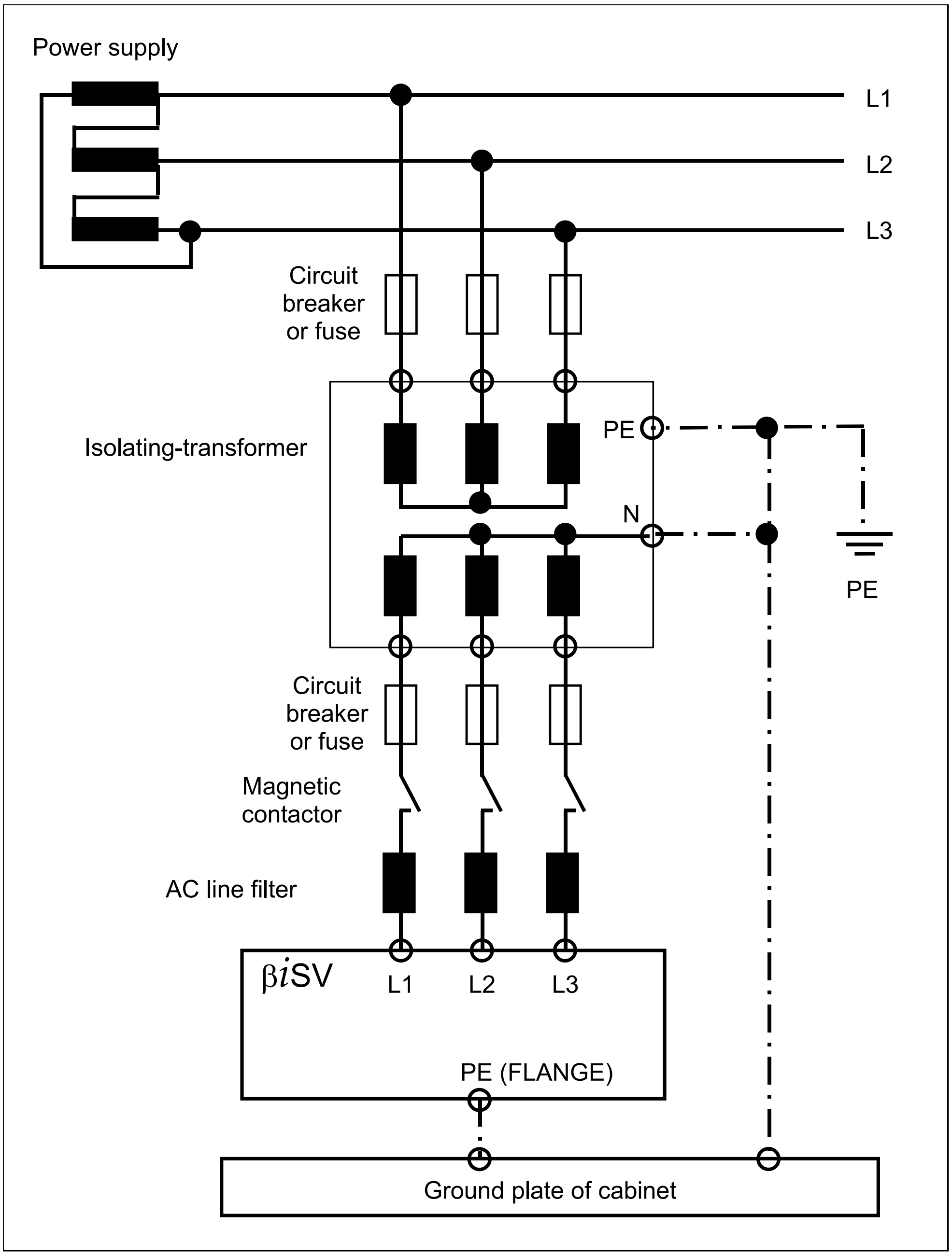
(f) IT-power system

No.	Power system	Power specification	Power supply of amplifier
6	IT-power system	• Star connection • No direct ground connection made on the power supply side • No PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.



(g) IT-power system

No.	Power system	Power specification	Power supply of amplifier
7	IT-power system	• Delta connection • No direct ground connection made on the power supply side • No PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.



3.1.4 Control Power Supply

Use a class 2 power supply (UL standard) as the power supply connected to the 24-VDC power supply.
Be sure to use a stabilized power supply as the 24-VDC power supply for the amplifier. The 24-VDC power supply for motor brakes cannot be shared.

- Nominal rated voltage : 24VDC
- Allowable voltage deviation : ±10%(including momentary variations)
- Power supply ratings

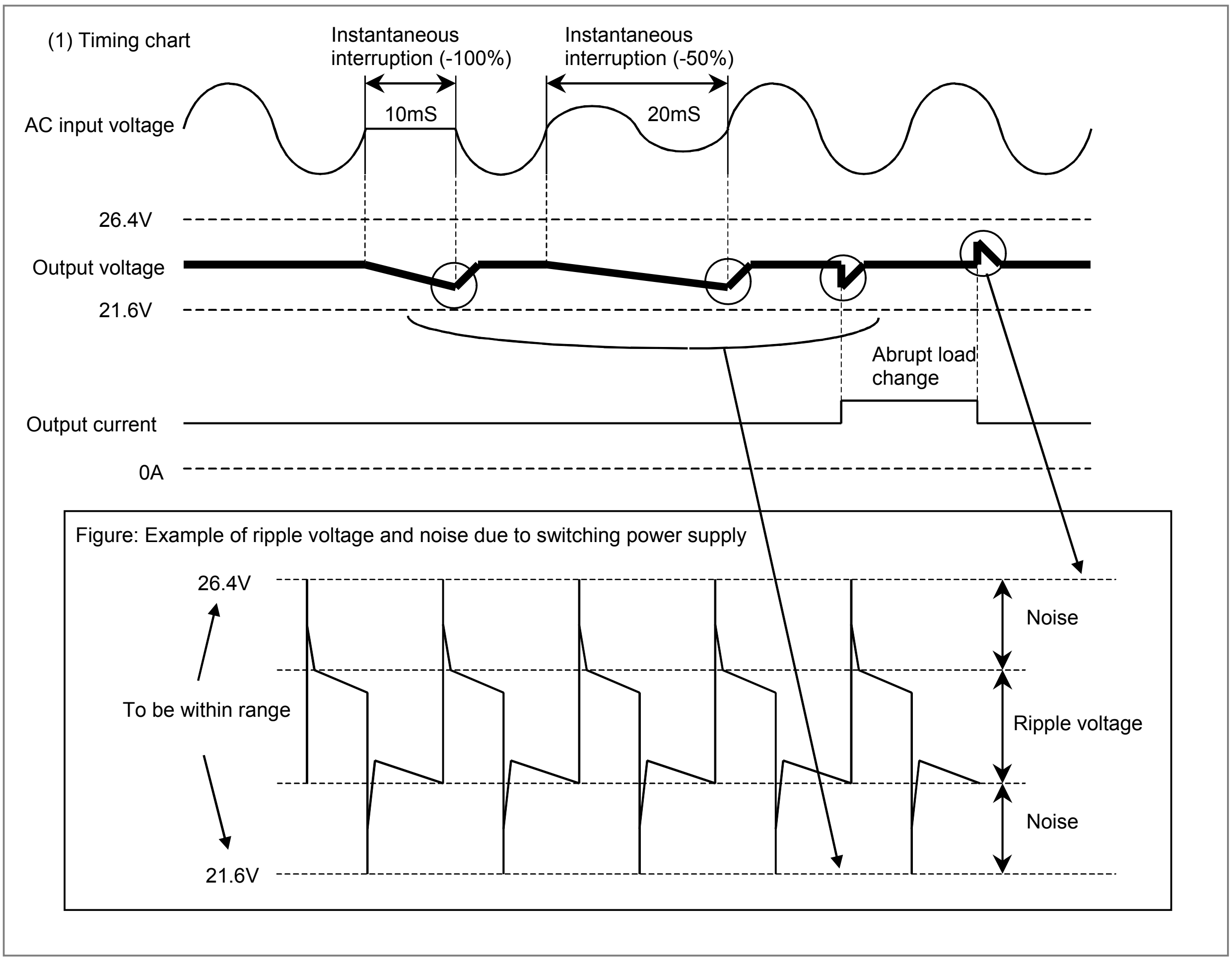
Power supply rating per amplifier	1-axis β*i*SV	0.9A
	2-axis β*i*SV	1.0A

Specifications of external 24 VDC power supply

Specifications of recommended external 24 VDC power supply (Stabilized power supply) (UL1950 must be satisfied.)

Output voltage +24V±10% (21.6 to 26.4V)
(Ripple voltage and noise are contained. See the figure below.)
Output current The continuous load current must be at least the current consumption of the CNC and other units.

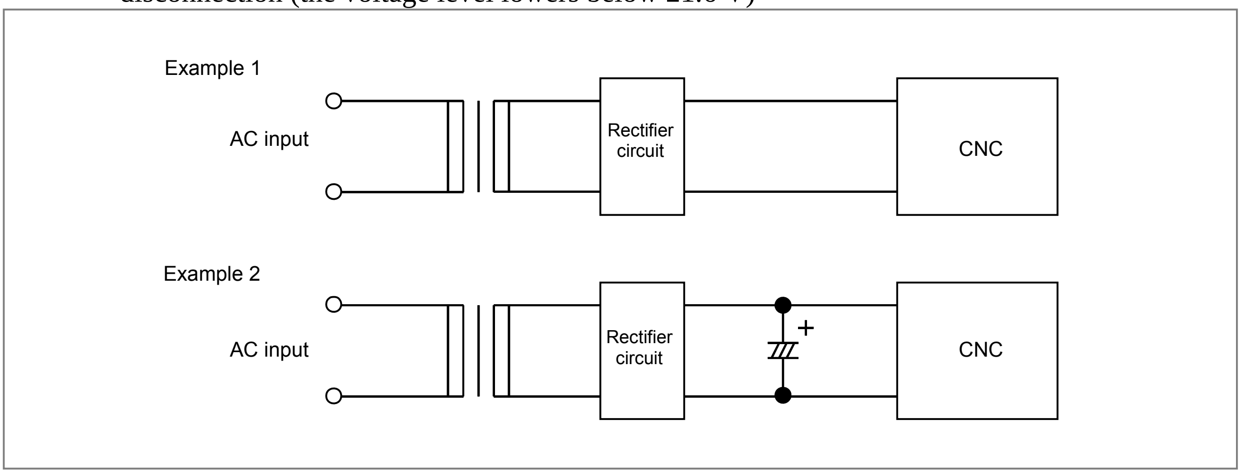
(At the maximum temperature inside the power magnetics cabinet in which the power supply is located.)
Load fluctuations (including rush current) The output voltage must not go out of the above range due to load fluctuations.
Instantaneous input interruption retention time 10mS (for -100%)
20mS (for -50%)



- Circuit configuration
  The circuit configurations shown in (1) and (2) below are not permitted.

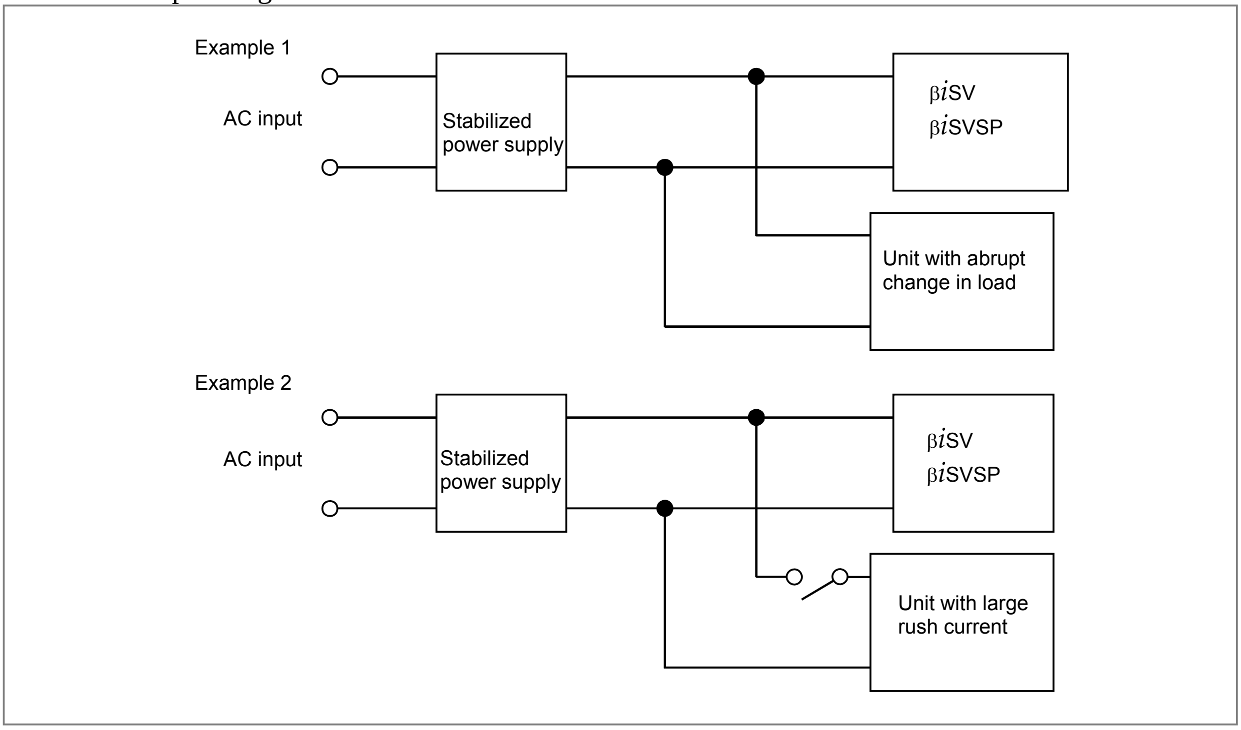
Prohibited

(1) Examples of circuits in which the output voltage cannot be held at the time of momentary disconnection (the voltage level lowers below 21.6 V)



NOTE
A rectifier circuit performs full-wave rectification by using diodes.

(2) Examples of circuits in which the output voltage specification (21.6 to 26.4 V) is exceeded by abrupt change in load



In case (2), prepare an additional stabilized power supply dedicated to a unit whose load changes abruptly, so that the βiSV and βiSVSP are not affected.

3.2 ENVIRONMENTAL CONDITIONS

The servo amplifier β*i* series must be installed in a sealed type cabinet to satisfy the following environmental requirements. For how to design such a cabinet, see Appendix G, "EXAMPLES OF RECOMMENDED POWER MAGNETICS CABINETS FOR SERVO AMPLIFIER INSTALLATION" in the FANUC SERVO AMPLIFIER α*i* series DESCRIPTIONS (B-65282EN).

(1) Ambient Temperature
Ambient temperature of the unit : 0 to 55°C (at operation)
-20 to 60°C (at keeping and transportation)

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

(3) Vibration
In operation : Below 0.5G

(4) Atmosphere
Prevent conductive, flammable, or corrosive foreign matters, mists, or water droplets from entering the unit

(5) Altitude
1,000m or less

⚠ **WARNING**

If conductive or flammable foreign matters enter the unit, explosion or corruption may be caused.
If corrosive or conductive mists or water droplets are attached to an electronic circuit, unexpected operation may be caused in the circuit.
The electronic circuit portion must be installed in an environment of pollution level 2 specified by IEC60664-1. To achieve pollution level 2 in a severe machine tool environment, it is generally necessary to install the portion in a cabinet that satisfies IP54.

NOTE

If the control unit is installed 1000 m or higher above sea level, the allowable upper ambient temperature of the control unit in the cabinet is changed as follows. Assume that the allowable upper ambient temperature of the servo amplifier in the cabinet installed 1000 m or higher above sea level decreases by 1.0°C for every 100 m rise in altitude.
If the altitude exceeds 2000 m, contact FANUC.

(6) Notes on Installation
The β*i* series 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 semiconductors, thus preventing heat from building up in the cabinet as much as possible. Therefore, note the following when installing the amplifier.

(a) Take appropriate measures to prevent coolant, oil mist, or chips from being adhered to the radiator and fan motors. A deposit of coolant, oil mist, or chips on the radiator or fan motors can lower the cooling efficiency. In some cases, the amplifier specifications cannot sometimes be satisfied. The deposit may also reduce the service life of the fan motors or semiconductors.

When outside air is drawn in to the radiator, mount an air filter on the air inlet. In addition, ensure to seal doors and parts where cables are drawn in and out.

(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 Chapter 6, "INSTALLATION" and the connection manual for each CNC for details.

(e) Each amplifier must be installed vertically.

(f) Servo amplifiers are to be arranged horizontally. When arranging servo amplifiers vertically from necessity, note the following:

   1) Ensure that cooling air from a lower amplifier does not blow directly against the upper amplifier. Otherwise, radiation performance can degrade and the rated output may not be satisfied.

   2) Ensure that the flow of cooling air of a lower amplifier is not impeded.

(g) Maintenance areas must be reserved for each servo amplifier.

(7) Notes relating to this product storage, transportation and environment

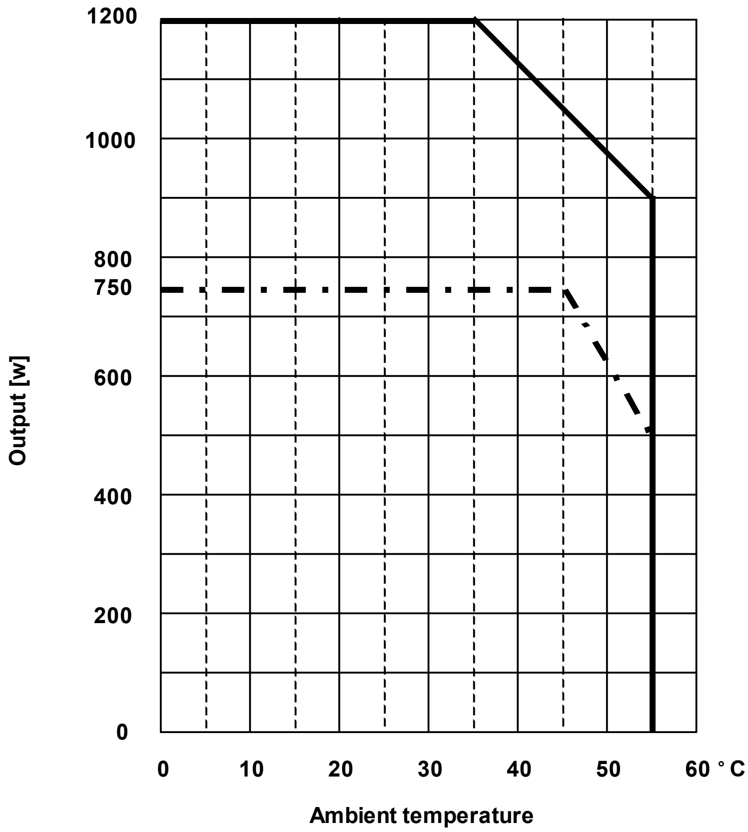
This servo amplifier uses electronic parts corroded by the halogen (fluorine, chlorine, bromine, iodine, etc.)

Do not storage or transport or use this servo amplifier in the halogen (fluorine, chlorine, bromine, iodine, etc.) atmosphere.

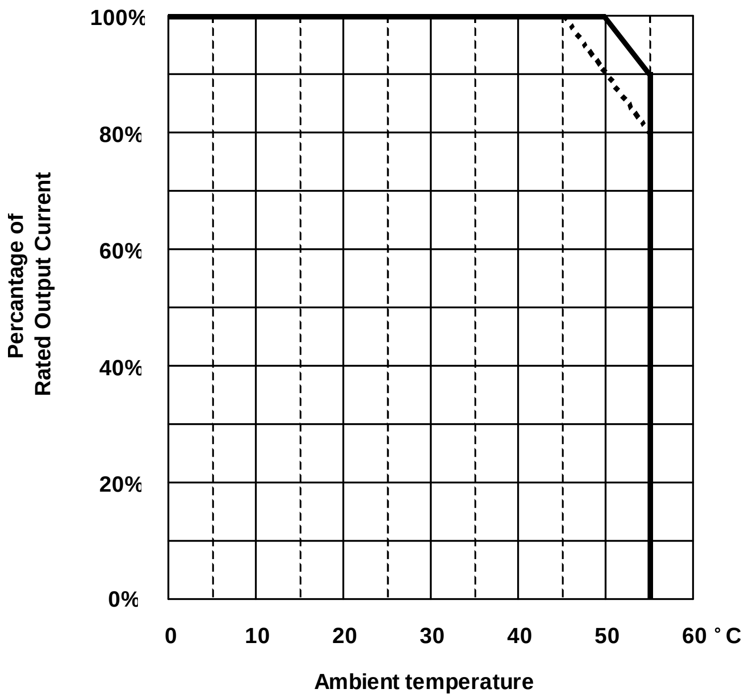
Fumigant and industrial cleaning solvent, and pesticide might contain the halogen.

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

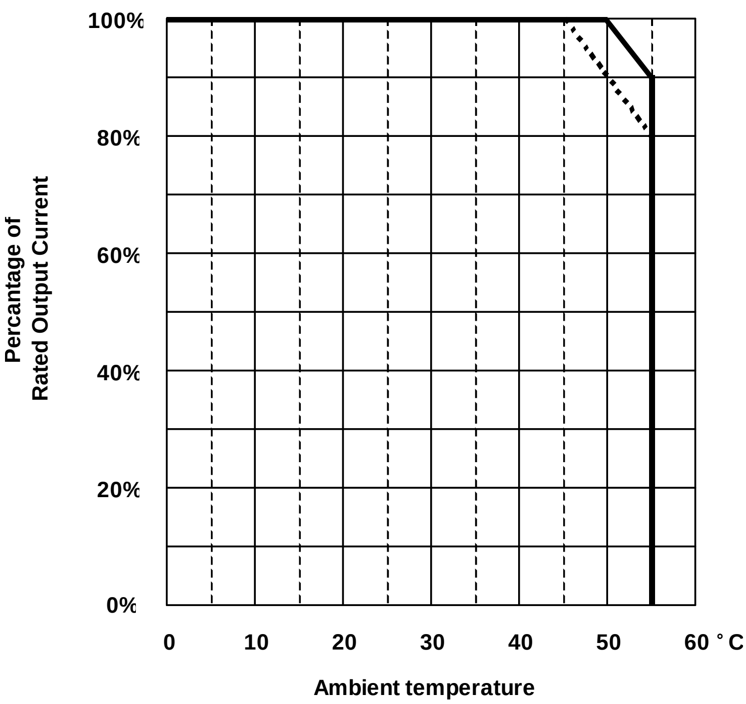
(a) β*i*SV20 Output derating for single-phase input
The solid line indicates derating when a separated cooling fan motor is provided; the dot-dash line indicates derating when no separated cooling fan motor is provided.



(b) β*i*SV40 Current derating
The solid line indicates derating when HRV2 is applied; the dotted line indicates derating HRV3 is applied.

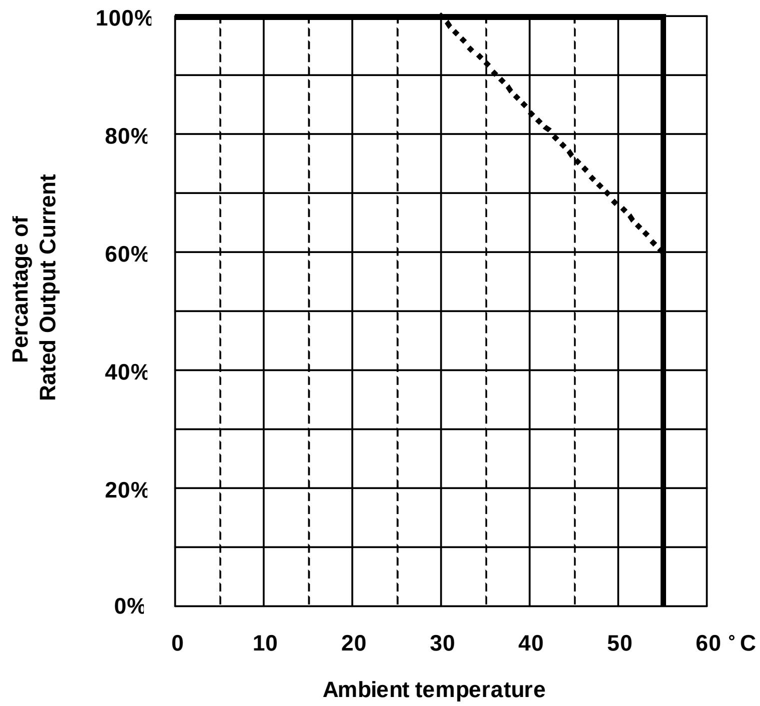


(c) β*i*SV80 Current derating
The solid line indicates derating when HRV2 is applied; the dotted line indicates derating HRV3 is applied.



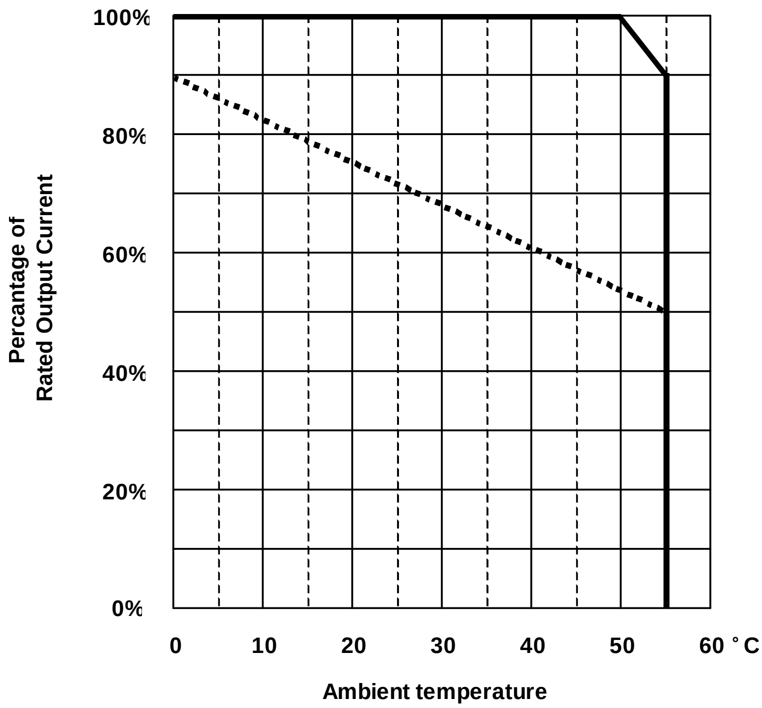
(d) β*i*SV20HV Current derating

The solid line indicates derating when HRV2 is applied; the dotted line indicates derating HRV3 is applied.

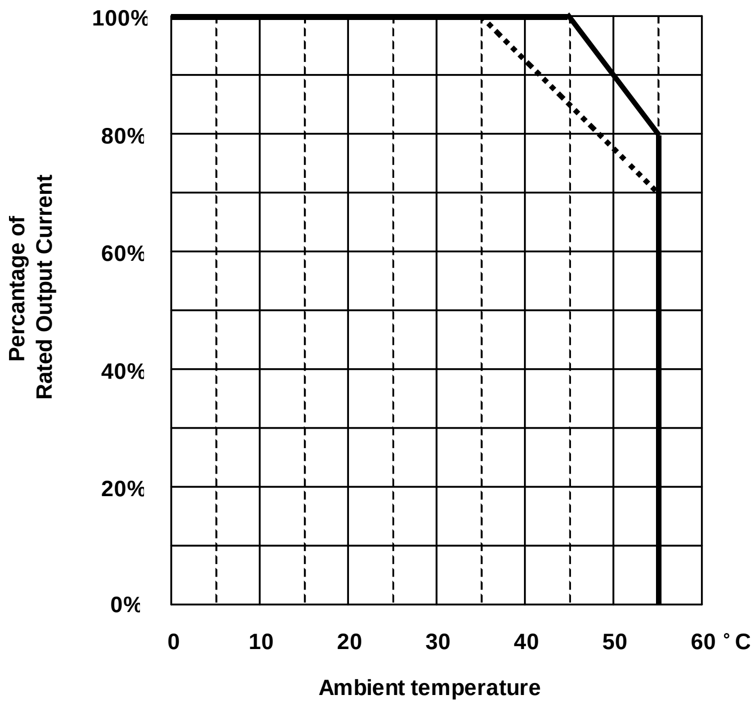


(e) β*i*SV40HV Current derating

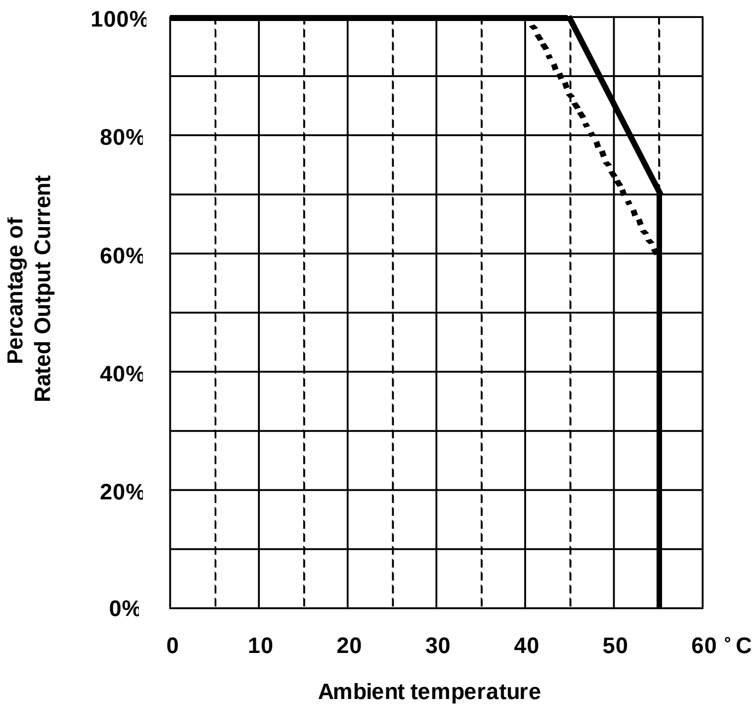
The solid line indicates derating when HRV2 is applied; the dotted line indicates derating HRV3 is applied.



(f) β*i*SV20/20 Current derating
The solid line indicates derating when HRV2 is applied; the dotted line indicates derating HRV3 is applied.



(g) β*i*SV40/40 Current derating
The solid line indicates derating when HRV2 is applied; the dotted line indicates derating HRV3 is applied.



3.3 SPECIFICATIONS

(a) 1-axis β*i*SV series (200-V type) : (A06B-6130-H***)

Item		β*i* SV4	β*i* SV20	β*i* SV40	β*i* SV80
Interface		FSSB			
Unit specification		A06B-6130-H001	A06B-6130-H002	A06B-6130-H003	A06B-6130-H004
Power PC board		A20B-2101-0090	A20B-2101-0091	A16B-3200-0512	A16B-3200-0513
Control PC board		A20B-2101-0050		A20B-2101-0051	
Main power supply 3-phase input	Input voltage	AC 200V～240V (-15%,+10%) 50 / 60 Hz			
	Input current(50Hz)	0.5 Arms	8.0 Arms	14.0 Arms	19.0 Arms
	Power supply rating	0.2 KVA	2.8 KVA	4.7 KVA	6.5 KVA
Main power supply Single-phase input	Input voltage	AC 220V～240V (-15%,+10%) 50/60 Hz		-	-
	Input current(50Hz)	1.1 Arms	8.0 Arms	-	-
	Power supply rating	0.3 KVA	1.9 KVA	-	-
Control power supply	Input voltage	DC 24 V (-10%, +10%)			
	Input current	0.9 Arms			
Rated output current		0.9 Arms	6.8 Arms	13 Arms	18.5 Arms
Maximum output current		4Ap	20 Ap	40 Ap	80 Ap
Servo HRV Control		HRV2, HRV3			
Control Method		Sine wave PWM control with Transistor Bridge			
Dynamic brake circuit		Included			
Output frequency range		0-550Hz			
Protection function		- High Current - IPM Abnormal - High Voltage of DC Link - Low Voltage of DC Link - Overheat of dischage resistor - Low Voltage of Control Power Supply - FSSB Communication Error - Locked fan motor			
Ambient temperature range		0℃～+55℃			
Weight		1.2kg		3.9kg	
Remarks		Separated regenerative resistor (30Ω, 20W/100W) Separate AC line filter Separate battery		Built-in regenetative resistor (16Ω, 50W no-wind condition) (16Ω, 130W wind velocity of 2m/s) Separated regenerative resistor (16Ω, 200W～1200W) Separate AC line filter Separate battery	
Demension in 'mm' (Including fin block)		75×150×172		60×380×272	
Demension in 'mm' (Fin block (only))		-		60×380×100(max.)	

(b) 1-axis β*i*SV series for 30*i*-B series CNC (200-V type) : (A06B-6160-H***)

Item		β*i* SV4	β*i* SV20	β*i* SV40	β*i* SV80
Interface		FSSB			
Unit specification		A06B-6160-H001	A06B-6160-H002	A06B-6160-H003	A06B-6160-H004
Power PC board		A20B-2101-0090	A20B-2101-0091	A16B-3200-0512	A16B-3200-0513
Control PC board		A20B-2102-0081			
Main power supply 3-phase input	Input voltage	AC 200V～240V (-15%,+10%) 50 / 60 Hz			
	Input current(50Hz)	0.5 Arms	8.0 Arms	14.0 Arms	19.0 Arms
	Power supply rating	0.2 KVA	2.8 KVA	4.7 KVA	6.5 KVA
Main power supply Single-phase input	Input voltage	AC 220V～240V (-15%,+10%) 50/60 Hz		-	-
	Input current(50Hz)	1.1 Arms	9.7 Arms	-	-
	Power supply rating	0.3 KVA	2.2 KVA	-	-
Control power supply	Input voltage	DC 24 V (-10%, +10%)			
	Input current	0.9 Arms			
Rated output current		0.9 Arms	6.8 Arms	13 Arms	18.5 Arms
Maximum output current		4Ap	20 Ap	40 Ap	80 Ap
Servo HRV Control		HRV2, HRV3			
Control Method		Sine wave PWM control with Transistor Bridge			
Dynamic brake circuit		Included			
Output frequency range		0-550Hz			
Protection function		- High Current - IPM Abnormal - High Voltage of DC Link - Low Voltage of DC Link - Overheat of dischage resistor - Low Voltage of Control Power Supply - FSSB Communication Error - Locked fan motor			
Ambient temperature range		0℃～+55℃			
Weight		1.2kg		3.9kg	
Remarks		Separated regenerative resistor (30Ω, 20W/100W) Separate AC line filter Separate battery		Built-in regenetative resistor (16Ω, 50W no-wind condition) (16Ω, 130W wind velocity of 2m/s) Separated regenerative resistor (16Ω, 200W～1200W) Separate AC line filter Separate battery	
Demension in 'mm' (Including fin block)		75×150×172		60×380×272	
Demension in 'mm' (Fin block (only))		-		60×380×100(max.)	

* Smart troubleshooting and Preventive maintenance the α*i* series for 30*i*-B series CNCs supports are not supported.

(c) 1-axis β*i*SV series (400-V type) : (A06B-6131-H***)

Item		βi SV10HV	βi SV20HV	βi SV40HV
Interface		FSSB		
Unit specification		A06B-6131-H001	A06B-6131-H002	A06B-6131-H003
Power PC board		A16B-3200-0515	A16B-3200-0516	A16B-3200-0517
Control PC board		A20B-2101-0051		
Main power supply 3-phase input	Input voltage	AC 400V～480V (-15%,+10%) 50 / 60 Hz		
	Input current(50Hz)	2.3 Arms	3.6 Arms	9.0 Arms
	Power supply rating	1.6 KVA	2.5 KVA	6.2 KVA
Control power supply	Input voltage	DC 24 V (-10%, +10%)		
	Input current	0.9 Arms		
Rated output current		3.1 Arms	5.6 Arms	9.2 Arms
Maximum output current		10Ap	20 Ap	40 Ap
Servo HRV Control		HRV2, HRV3		
Control Method		Sine wave PWM control with Transistor Bridge		
Dynamic brake circuit		Included		
Output frequency range		0-550Hz		
Protection function		- High Current - IPM Abnormal - High Voltage of DC Link - Low Voltage of DC Link - Overheat of dischage resistor - Low Voltage of Control Power Supply - FSSB Communication Error - Locked fan motor		
Ambient temperature range		0℃～+55℃		
Weight		3.9kg		
Remarks		Separated regenerative resistor (64Ω, 50W no-wind condition) (64Ω, 130W wind velocity of 2m/s) Separate AC line filter Separate battery		
Demension in 'mm' (Including fin block)		60×380×272		
Demension in 'mm' (Fin block (only))		60×380×100(max.)		

(d) 1-axis β*i*SV series for 30*i*-B series CNC (400-V type) : (A06B-6161-H***)

Item		β*i* SV10HV	β*i* SV20HV	β*i* SV40HV
Interface		FSSB		
Unit specification		A06B-6161-H001	A06B-6161-H002	A06B-6161-H003
Power PC board		A16B-3200-0515	A16B-3200-0516	A16B-3200-0517
Control PC board		A20B-2102-0081		
Main power supply 3-phase input	Input voltage	AC 380V～480V (-10%,+10%) 50 / 60 Hz AC 400V～480V (-15%,+10%) 50 / 60 Hz		
	Input current(50Hz)	2.8 Arms	5.9 Arms	9.4 Arms
	Power supply rating	1.9 KVA	3.9 KVA	6.2 KVA
Control power supply	Input voltage	DC 24 V (-10%, +10%)		
	Input current	0.9 Arms		
Rated output current		3.1 Arms	5.6 Arms	9.2 Arms
Maximum output current		10Ap	20 Ap	40 Ap
Servo HRV Control		HRV2, HRV3		
Control Method		Sine wave PWM control with Transistor Bridge		
Dynamic brake circuit		Included		
Output frequency range		0-550Hz		
Protection function		- High Current - IPM Abnormal - High Voltage of DC Link - Low Voltage of DC Link - Overheat of dischage resistor - Low Voltage of Control Power Supply - FSSB Communication Error - Locked fan motor		
Ambient temperature range		0℃～+55℃		
Weight		3.9kg		
Remarks		Separated regenerative resistor (64Ω, 50W no-wind condition) (64Ω, 130W wind velocity of 2m/s) Separate AC line filter Separate battery		
Demension in 'mm' (Including fin block)		60×380×272		
Demension in 'mm' (Fin block (only))		60×380×100(max.)		

* Smart troubleshooting and Preventive maintenance the α*i* series for 30*i*-B series CNCs supports are not supported.

(e) 2-axis βiSV series (200-V type) : (A06B-6136-H***)

Item		βi SV20/20	βi SV40/40
Interface		FSSB	
Unit specification		A06B-6136-H201	A06B-6136-H203
Power PC board		A16B-3200-0642	A16B-3200-0643
Control PC board		A20B-2101-0290	
Main power supply 3-phase input	Input voltage	AC 200V～240V (-15%,+10%) 50 / 60 Hz	
	Input current(50Hz)	7.6Arms	13Arms
	Power supply rating	2.7kVA	4.8kVA
Control power supply	Input voltage	DC 24 V (-10%, +10%)	
	Input current	0.8 Arms	
Rated output current	L-axis	6.5Arms	13Arms
	M-axis	6.5Arms	13Arms
Maximum output current	L-axis	20 Ap	40 Ap
	M-axis	20 Ap	40 Ap
Servo HRV Control		HRV2, HRV3	
Control Method		Sine wave PWM control with Transistor Bridge	
Dynamic brake circuit		Included	
Output frequency range		0-550Hz	
Protection function		- High Current - IPM Abnormal - High Voltage of DC Link - Low Voltage of DC Link - Overheat of dischage resistor - Low Voltage of Control Power Supply - FSSB Communication Error - Locked fan motor	
Ambient temperature range		0℃～+55℃	
Weight		2.2kg	3.0kg
Remarks		Separated regenerative resistor (16Ω, 100W no-wind condition) (16Ω, 200W no-wind condition) (16Ω, 400W wind velocity of 2m/s) Separate AC line filter Separate battery	
Demension in 'mm' (Including fin block)		60×380×172	90×380×172
Demension in 'mm' (Fin block (only))		-	

(f) 2-axis β*i*SV series for 30*i*-B series CNC (200-V type) : (A06B-6166-H***)

Item		β*i* SV20/20	β*i* SV40/40
Interface		FSSB	
Unit specification		A06B-6166-H201	A06B-6166-H203
Power PC board		A16B-3200-0642	A16B-3200-0643
Control PC board		A20B-2101-0881	
Main power supply 3-phase input	Input voltage	AC 200V～240V (-15%,+10%) 50 / 60 Hz	
	Input current(50Hz)	7.6Arms	13Arms
	Power supply rating	2.7kVA	4.8kVA
Control power supply	Input voltage	DC 24 V (-10%, +10%)	
	Input current	1.0 Arms	
Rated output current	L-axis	6.5Arms	13Arms
	M-axis	6.5Arms	13Arms
Maximum output current	L-axis	20 Ap	40 Ap
	M-axis	20 Ap	40 Ap
Servo HRV Control		HRV2, HRV3	
Control Method		Sine wave PWM control with Transistor Bridge	
Dynamic brake circuit		Included	
Output frequency range		0-550Hz	
Protection function		- High Current - IPM Abnormal - High Voltage of DC Link - Low Voltage of DC Link - Overheat of dischage resistor - Low Voltage of Control Power Supply - FSSB Communication Error - Locked fan motor	
Ambient temperature range		0℃～+55℃	
Weight		2.2kg	3.0kg
Remarks		Separated regenerative resistor (16Ω, 100W no-wind condition) (16Ω, 200W no-wind condition) (16Ω, 400W wind velocity of 2m/s) Separate AC line filter Separate battery	
Demension in 'mm' (Including fin block)		60×380×172	90×380×172
Demension in 'mm' (Fin block (only))		-	

* Smart troubleshooting and Preventive maintenance the α*i* series for 30*i*-B series CNCs supports are not supported.

3.4 APPLICABLE MOTORS

	βi S series													
	βi S 0.2 /5000	βi S 0.3 /5000	βi S 0.4 /5000	βi S 0.5 /6000	βi S 1 /6000	βi S 2 /4000 βi Sc 2 /4000	βi S 4 /4000 βi Sc 4 /4000	βi S 8 /3000 βi Sc 8 /3000	βi S 12 /2000 βi Sc 12 /2000	βi S 12 /3000	βi S 22 /2000	βi S 22 /3000	βi S 30 /2000	βi S 40 /2000
βi SV4 A06B-6130-H001 A06B-6160-H001	O	O												
βi SV20 A06B-6130-H002 A06B-6160-H002			O	O	O	O	O	O	O					
βi SV40 A06B-6130-H003 A06B-6160-H003										O	O			
βi SV80 A06B-6130-H004 A06B-6160-H004												O	O	O
βi SV20/20 A06B-6136-H201 A06B-6166-H201			O	O	O	O	O	O	O					
βi SV40/40 A06B-6136-H203 A06B-6166-H203										O	O			

	βi F series				
	βi F 4 /3000	βi F 8 /2000	βi F 12 /2000	βi F 22 /2000	βi F 30 /1500
βi SV4 A06B-6130-H001 A06B-6160-H001					
βi SV20 A06B-6130-H002 A06B-6160-H002	O	O	O		
βi SV40 A06B-6130-H003 A06B-6160-H003				O	
βi SV80 A06B-6130-H004 A06B-6160-H004					O
βi SV20/20 A06B-6136-H201 A06B-6166-H201	O	O	O		
βi SV40/40 A06B-6136-H203 A06B-6166-H203				O	

	αi F series							αi S series						
	αi F 1 /5000	αi F 2 /5000	αi F 4 /5000	αi F 8 /3000	αi F 8 /4000	αi F 12 /4000	αi F 22 /3000	αi S 2 /5000	αi S 2 /6000	αi S 4 /5000	αi S 4 /6000	αi S 8 /4000	αi S 8 /6000	αi S 12 /4000
βi SV4 A06B-6130-H001 A06B-6160-H001														
βi SV20 A06B-6130-H002 A06B-6160-H002	O	O						O	O	O	O			
βi SV40 A06B-6130-H003 A06B-6160-H003			O	O										
βi SV80 A06B-6130-H004 A06B-6160-H004					O	O	O					O	O	O
βi SV20/20 A06B-6136-H201 A06B-6166-H201	O	O						O	O	O	O			
βi SV40/40 A06B-6136-H203 A06B-6166-H203			O	O										

	βi S series							
	βi S 2 /4000HV	βi S 4 /4000HV	βi S 8 /3000HV	βi S 12 /3000HV	βi S 22 /2000HV	βi S 22 /3000HV	βi S 30 /2000HV	βi S 40 /2000HV
βi SV10HV A06B-6131-H001 A06B-6161-H001	O	O	O					
βi SV20HV A06B-6131-H002 A06B-6161-H002				O	O			
βi SV40HV A06B-6131-H003 A06B-6161-H003						O	O	O

	αi F series					αi S series						
	αi F 4 /5000HV	αi F 8 /3000HV	αi F 8 /4000HV	αi F 12 /4000HV	αi F 22 /3000HV	αi S 2 /5000HV	αi S 2 /6000HV	αi S 4 /5000HV	αi S 4 /6000HV	αi S 8 /4000HV	αi S 8 /6000HV	αi S 12 /4000HV
βi SV10HV A06B-6131-H001 A06B-6161-H001						O	O	O	O			
βi SV20HV A06B-6131-H002 A06B-6161-H002	O	O										
βi SV40HV A06B-6131-H003 A06B-6161-H003			O	O	O					O	O	O

⚠ **CAUTION**

1 When the β*i*SV40/40 servo amplifier is combined with any of the following servo motors, the dynamic brake stop distance is longer than it when the α*i*SV or one-axis β*i*SV servo amplifier is combined. Calculate and certainly confirm the dynamic brake stop distance by using coefficients for calculating the dynamic brake distance if it is within the assumption on the machine. For calculation and details of the dynamic brake stop distance, refer to "FANUC AC SERVO MOTOR β*i* series DESCRIPTIONS" (B-65262EN).
[Servo motor specifications]
β*i*S 12/3000, β*i*S 22/2000, β*i*F 22/2000, α*i*F 4/5000, α*i*F 8/3000
2 It is recommended to use the stop distance reduce function for not only the motors listed in 1 above, but also others to reduce the stop distance at emergency stop and power failure. For details, refer to the parameter manual (B-65270EN). To surely operate the stop distance reduces function at a power failure, use an uninterruptible power supply (UPS) or the like to be able to maintain the control power supply (24 VDC) of the CNC and servo amplifier.
3 If some alarms occur, the stop distance will not be short because the quick stop functions does not operate effectively.
4 It should be certainly confirmed at the actual machine that the stop distance is shortened at emergency stop or power failure when the quick stop functions are applied.

⚠ **WARNING**

1 If the dynamic brake is applied with a load inertia ratio larger than the allowable load inertia of the servo motor, an overheat may occur in the servo amplifier and the servo amplifier may be burnt out. Calculate the load inertia correctly. If you want to use the dynamic brake with a load inertia larger than the allowable load inertia, contact FANUC.
2 If the dynamic brake is used with a load inertia larger than the allowable load inertia of the servo motor and a power failure occurs (when the stop distance reduce function is disabled) or an alarm is issued during rapid traverse, wait for at least 30 minutes before restarting the system to protect the servo amplifier.
3 If the motor is stopped repeatedly by the dynamic brake without keeping intervals of at least 30 minutes, an overheat may occur in the servo amplifier and the servo amplifier may be burnt out.

4 ORDERING INFORMATION

4.1 SERVO AMPLIFIER

Input voltage	Name	Name	Ordering number
200-V input series	1-axis β*i*SV series	β*i*SV4	A06B-6130-H001
		β*i*SV20	A06B-6130-H002
		β*i*SV40	A06B-6130-H003
		β*i*SV80	A06B-6130-H004
	1-axis β*i*SV series for 30*i*-B series CNC	β*i*SV4	A06B-6160-H001
		β*i*SV20	A06B-6160-H002
		β*i*SV40	A06B-6160-H003
		β*i*SV80	A06B-6160-H004
	2-axis β*i*SV series	β*i*SV20/20	A06B-6136-H201
		β*i*SV40/40	A06B-6136-H203
	2-axis β*i*SV series for 30*i*-B series CNC	β*i*SV20/20	A06B-6166-H201
		β*i*SV40/40	A06B-6166-H203
400-V input series	1-axis β*i*SV series	β*i*SV10HV	A06B-6131-H001
		β*i*SV20HV	A06B-6131-H002
		β*i*SV40HV	A06B-6131-H003
	1-axis β*i*SV series for 30*i*-B series CNC	β*i*SV10HV	A06B-6161-H001
		β*i*SV20HV	A06B-6161-H002
		β*i*SV40HV	A06B-6161-H003

4.2 CIRCUIT BREAKER

Select a circuit breaker based on the continuous current ratings of the individual motors listed in the table, "Input current for continuous output ratings of motors", on the next page. When connecting more than one amplifier, determine the rating of the circuit breaker based on the sum of the continuous current ratings of the motors.

When the motor accelerates or decelerates rapidly, current about three times as high as the continuous current rating may flow for approximately three seconds. So, select a circuit breaker that does not trip under such current flow conditions.

⚠ **WARNING**

Select a circuit breaker having a rating of up to 30 A for the main power supply to protect amplifiers.

Because of a possibility of cable burning, consider protection coordination of the cables between the circuit breaker output and the input of each amplifier and the selected circuit breaker.

NOTE

1 For the installation positions of the circuit breakers and magnetic contactor, see Chapter 2, "CONFIGURATION".

2 Set the rated voltage of circuit breakers 1 and 2 according to the power supply voltage.

3 The current and voltage of the operation coil of the magnetic contactor must be within the rating of the internal contact [CX29(MCC)] of the β*i*SV. For details, see Chapter 9, "TOTAL CONNECTION DIAGRAM".

NOTE

4 When the circuit breaker trips, the contact of the magnetic contactor may be melted. Therefore, before turning on the circuit breaker again, check to make sure that the contact of the magnetic contactor is not melted.

Servo amplifier	Circuit breaker 1	Circuit breaker 2
βiSV4	30A or less	5A
βiSV20		
βiSV40		
βiSV80		
βiSV20/20		
βiSV40/40		
βiSV10HV		
βiSV20HV		
βiSV40HV		

Name	Specification	Remarks
Circuit breaker for main power supply (30A)	A06B-6077-K101	Fuji Electric EA53C/30 + cover BZ6TBH10C3
Circuit breaker for control power supply (5A)	A06B-6077-K106	Fuji Electric EA33AC/5 + cover BZ6TBH10C3

Input current for continuous output ratings of motors

Servo motor	Continuous current rating with 3-phase input [Arms] (Reference)	Power supply rating with 3-phase input [kVA] (Reference)	Continuous current rating with single-phase input [Arms] (Reference)	Power supply rating with single-phase input [kVA] (Reference)
βiS0.2/5000	0.2	0.08	0.5	0.12
βiS0.3/5000	0.5	0.15	1.1	0.25
βiS0.4/5000	0.6	0.20	1.4	0.32
βiS0.5/6000	1.6	0.54	3.8	0.86
βiS1/6000	2.2	0.77	5.4	1.2
βiS2/4000	2.2	0.77	5.4	1.2
βiS4/4000	3.3	1.2	8.1	1.9
βiS8/3000	5.4	1.9	9.7	2.2
βiS12/2000	6.2	2.2	10.0	2.2
βiS12/3000	8.0	2.8	-	-
βiS22/2000	11.1	3.9	-	-
βiS22/3000	13.4	4.63	-	-
βiS30/2000	13.4	4.63	-	-
βiS40/2000	13.4	4.63	-	-
βiSc2/4000	2.2	0.77	5.4	1.2
βiSc4/4000	3.3	1.2	8.1	1.9
βiSc8/3000	5.4	1.9	9.7	2.2
βiSc12/2000	6.2	2.2	9.7	2.2
βiF4/3000	3.3	1.2	8.1	1.9
βiF8/2000	5.4	1.9	10.0	2.2
βiF12/2000	6.2	2.2	10.0	2.2
βiF22/2000	11.1	3.9	-	-
βiF30/1500	13.4	4.63	-	-
αiF1/5000	2.2	0.77	5.4	1.2
αiF2/5000	3.3	1.2	8.1	1.9
αiF4/5000	6.2	2.2	-	-
αiF8/3000	7.1	2.5	-	-
αiF8/4000	9.8	3.4	-	-

Servo motor	Continuous current rating with 3-phase input [Arms] (Reference)	Power supply rating with 3-phase input [kVA] (Reference)	Continuous current rating with single-phase input [Arms] (Reference)	Power supply rating with single-phase input [kVA] (Reference)
α*i*F12/4000	13.4	4.6	-	-
α*i*F22/3000	17.8	6.2	-	-
α*i*S2/5000	3.3	1.2	8.1	1.9
α*i*S2/6000	4.5	1.5	9.7	2.2
α*i*S4/5000	4.5	1.5	9.7	2.2
α*i*S4/6000	4.5	1.5	9.7	2.2
α*i*S8/4000	11.1	3.9	-	-
α*i*S8/6000	9.8	3.4	-	-
α*i*S12/4000	12.0	4.2	-	-
β*i*S2/4000HV	1.2	0.8	-	-
β*i*S4/4000HV	1.7	1.2	-	-
β*i*S8/3000HV	2.7	1.9	-	-
β*i*S12/3000HV	4.0	2.8	-	-
β*i*S22/2000HV	5.6	3.9	-	-
β*i*S22/3000HV	6.7	4.6	-	-
β*i*S30/2000HV	6.7	4.6	-	-
β*i*S40/2000HV	6.7	4.6	-	-
α*i*F4/5000HV	3.2	2.2	-	-
α*i*F8/3000HV	3.6	2.5	-	-
α*i*F8/4000HV	4.9	3.4	-	-
α*i*F12/4000HV	6.7	4.6	-	-
α*i*F22/3000HV	8.9	6.2	-	-
α*i*S2/5000HV	1.7	1.2	-	-
α*i*S2/6000HV	2.3	1.5	-	-
α*i*S4/5000HV	2.3	1.5	-	-
α*i*S4/6000HV	2.3	1.5	-	-
α*i*S8/4000HV	5.2	3.6	-	-
α*i*S8/6000HV	4.9	3.4	-	-
α*i*S12/4000HV	5.6	3.9	-	-

4.3 MAGNETIC CONTACTOR

Select a magnetic contactor according to the table, "Input current for continuous output ratings", in the previous section. When connecting more than one amplifier, make a selection based on the sum of the continuous current ratings of the motors.

Ordering number	Magnetic contactor specification	Magnetic contactor cover specification
A06B-6077-K121	Fuji Electric SC-5-1 (30A)	Fuji Electric SZ-JC4

NOTE

The coil voltage specification of the magnetic contactor is 200 VAC.
For details, refer to the brochure supplied by Fuji Electric Co., Ltd.

4.4 AC LINE FILTER

Select an AC line filter according to the table, "Input current for continuous output ratings", in the previous section. When connecting more than one amplifier, make a selection based on the sum of the continuous current ratings of the motors.

Applicable amplifiers	AC line filter	Continuous current rating	Remarks
β*i*SV4 β*i*SV20 β*i*SV40 β*i*SV80 β*i*SV20/20 β*i*SV40/40	A81L-0001-0171	24A	For 200VAC amplifiers
	A81L-0001-0101#C	44A	
β*i*SV10HV β*i*SV20HV β*i*SV40HV	A81L-0001-0168	12A	For 400VAC amplifiers
	A81L-0001-0169	22A	

> ⚠ **WARNING**
> The AC line filter is different from the AC reactor. Neither substitution between them nor use of one of them for both purposes is allowed.

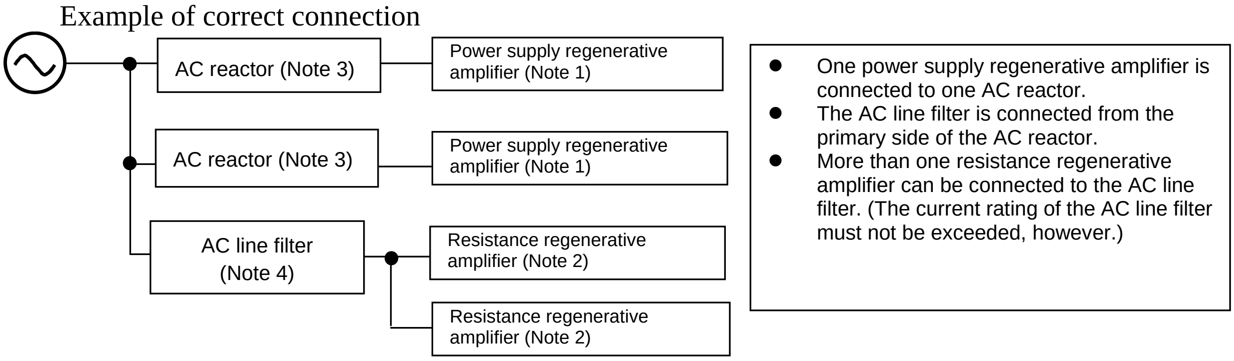
• Difference between the AC line filter and AC reactor

1. Overview

   For a power supply regenerative amplifier such as the α*i*PS or β*i*SVSP, use an AC reactor. For a resistance regenerative amplifier such as the β*i*SV, use an AC line filter.
   Incorrect connection may damage the amplifier or cause it to malfunction.
   An example of correct connection and examples of incorrect connection are shown below.

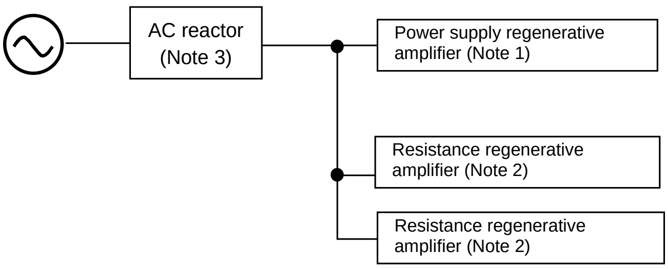
2. Connection

   Example of correct connection



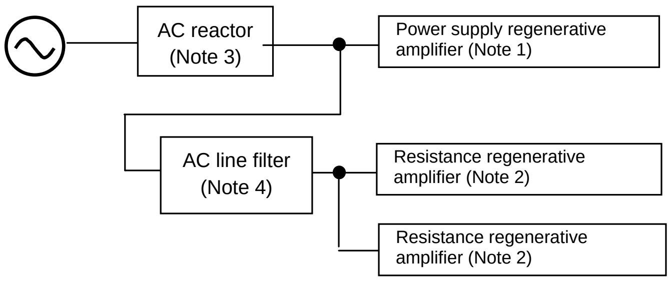
Examples of incorrect connection

Example 1 of incorrect connection)



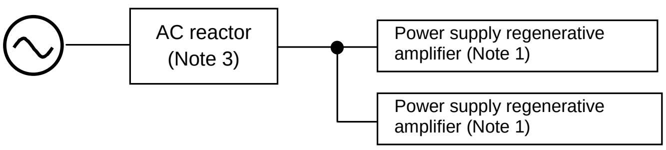
- The resistance regenerative amplifier is connected to the secondary side of the AC reactor.
  The resistance regenerative amplifier may be damaged.
  The power supply regenerative amplifier may malfunction.

Example 2 of incorrect connection)



- The AC line filter is connected from the secondary side of the AC reactor.
  The resistance regenerative amplifier may be damaged.
  The power supply regenerative amplifier may malfunction.

Example 3 of incorrect connection)



- More than one power supply regenerative amplifier is connected to one AC reactor.
  One power supply regenerative amplifier may be damaged.
  The other power supply regenerative amplifier may malfunction.

NOTE

Any devices must not be connected between the AC reactor and power supply regenerative amplifier.
Otherwise, the connected device may be damaged and the power supply regenerative amplifier may malfunction.

NOTE

1 Power supply regenerative amplifier
αPSM series, α*i*PS series, β*i*SVSP series and so on

2 Resistance regenerative amplifier
αPSMR series, α*i*PSMR series, αSVU series, αSVUC series, βSVU series, β*i*SV series

3 AC reactor
A81L-0001-0133, A81L-0001-0147, A81L-0001-0150, A81L-0001-0122, A81L-0001-0123, A81L-0001-0120, A81L-0001-0124, A81L-0001-0155, A81L-0001-0156, A81L-0001-0157, A81L-0001-0158, A81L-0001-0159, A81L-0001-0160, A81L-0001-0163, A81L-0001-0164, A81L-0001-0165, A81L-0001-0167, A81L-0001-0170 and so on

NOTE

4 AC line filter
A81L-0001-0171, A81L-0001-0101#C, A81L-0001-0168, A81L-0001-0169 and so on

4.5 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 Section 6.4, FITTING A LIGHTNING SURGE PROTECTION DEVICE (POWER SUPPLY OF 200-VAC INPUT SERIES)" and Section 6.5, "FITTING A LIGHTNING SURGE PROTECTION DEVICE (POWER SUPPLY OF 400-VAC INPUT SERIES)".

Category	Ordering number	Specification	Remarks
Optional	A06B-6077-K142	For line-to-line installation : RAV-781BYZ-2 For line-to-ground installation : RAV-781BXZ-4	Manufactured by Okaya Electric Industries Co., Ltd. For 200VAC line TÜV approved products
	A06B-6077-K143	For line-to-line installation : RAV-152BYZ-2A For line-to-ground installation : RAV-801BXZ-4	Manufactured by Okaya Electric Industries Co., Ltd. For 400VAC line TÜV approved products
	A06B-6077-K144	Integration type for line-to-line installation/line-to-ground installation: RCM-601BUZ-4	Manufactured by Okaya Electric Industries Co., Ltd. For 200VAC line TÜV approved products

The line-to-line or line-to-ground installation type (A06B-6077-K142) and the integration type (A06B-6077-K144) are equivalent in performance and specifications.

4.6 NOISE FILTER

A noise filter must be installed in the amplifier input section to satisfy the requirements of the EMC Directives which are now being enforced in the EU countries.

For single-phase grounding (200V to 240V)

Category	Applicable models	Ordering number	Rated output	Specification
Optional	βiSV	A06B-6077-K155	30A	3SUP-HL30-ER-6: Okaya Electric Industries Co., Ltd.

For neutral grounding (common to 400 to 480 V)

Category	Applicable models	Ordering number	Rated output	Specification
Optional	βiSVHV	A06B-6110-K160	50A	NF3050C-VQ: Soshin Electric Co., Ltd.

⚠ **WARNING**

Use the noise filter specified by ordering number A06B-6077-K155 only for a power supply of 200-V input series with single-phase grounding. Do not use the noise filter for any power supply of 400-V input series.
If the noise filter is used for a power supply of 400-V input series, it may overheat, emit smoke, or cause a short-circuit.

NOTE
1 The noise filter specified by ordering number A06B-6110-K160 cannot be used for any power supply with single-phase grounding.
2 The above applicable models are listed as guidelines for selection. Load currents of the CNC, amplifier, and other devices flow through the noise filter. Obtain these load currents, and select a noise filter so that the sum of the obtained load currents does not exceed the rated current of the noise filter.

4.7 BATTERY FOR ABSOLUTE PULSECODER

For connection of a battery for an absolute Pulsecoder, two methods are available. For each method, options are available.

NOTE
1 A battery needs to be maintained periodically. So, [connection type 1] is recommended because this type uses a battery (consisting of four size D alkaline cells) easily obtainable from the market.
2 A built-in battery used with [connection type 2] is not available on the market, but needs to be purchased from FANUC. So, it is recommended to purchase spare built-in batteries.

[Connection type 1]
Power is fed from one battery to multiple β*i*SV models.
See Subsection 9.2.13, "Details of Cable K9".

Category	Ordering number	Name	Remarks
Optional	A06B-6050-K061	Battery	Four pieces of size D battery
	A06B-6050-K060	Battery case	
	A06B-6130-K201	Battery connection connector	

[Connection type 2]
A battery is built into each β*i*SV.
See Subsection 9.2.14, "Details of Cable K10".

Category	Ordering number	Name	Remarks
Optional	A06B-6093-K001	Built-in battery	Lithium battery
Optional	A06B-6093-K002	Battery case	For 1-axis β*i*SV

[Connection type 3]
A battery is built into each 2-axis β*i*SV.

Category	Ordering number	Name	Remarks
Optional	A06B-6114-K504	Built-in battery	Lithium battery For 2-axis β*i*SV
Optional	A06B-6114-K505	Battery case	For 2-axis β*i*SV

4.8 SEPARATED COOLING FAN MOTOR

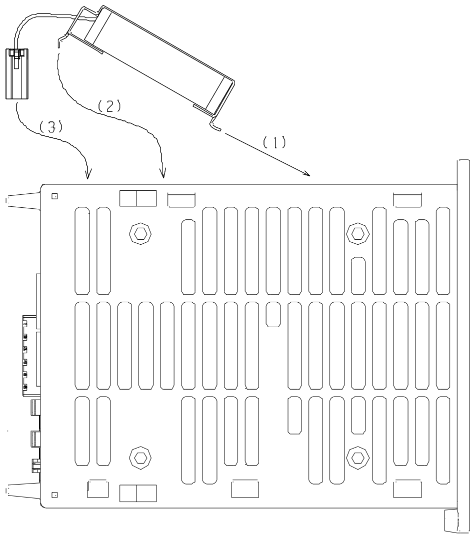
4.8.1 Models Requiring Separated Cooling Fan Motors

The combinations listed below require separated cooling fan motors.

Ordering number	Amplifier	Combined motor
A06B-6134-K002	β*i*SV80	General 80-A/200-V class motors
	β*i*SV40HV	General 40-A/400-V class motors
A06B-6134-K005	β*i*SV20 Running on 3-phase 200-240 VAC power	α*i*S4/5000,α*i*S4/6000 β*i*S8/3000, β*i*S12/2000 β*i*Sc8/3000,β*i*Sc12/2000 β*i*F8/2000,β*i*F12/2000
	β*i*SV20 Running on 1-phase 220-240VAC power	α*i*F2/5000 α*i*S2/5000,α*i*S2/6000 α*i*S4/5000,α*i*S4/6000 β*i*S4/4000,β*i*S8/3000,β*i*S12/2000 β*i*Sc4/4000,β*i*Sc8/3000,β*i*Sc12/2000 β*i*F4/3000,β*i*F8/2000,β*i*F12/2000

4.8.2 Installing a Separated Cooling Fan Motor

When using one of the above combinations that require a separated cooling fan motor, install an optional separated cooling fan motor in the order (1), (2), and (3) as illustrated below.



5 HOW TO SELECT THE AMPLIFIER

5.1 SELECTING A SEPARATED REGENERATIVE DISCHARGE RESISTOR

5.1.1 When Amplifier Models β*i*SV4 and β*i*SV20 Are Used

[When no separated regenerative discharge resistor is needed]

No separated regenerative discharge resistor is needed if the amount of energy regenerated per regeneration cycle is not higher than the value listed in the table, "Maximum regenerative energy permitted for individual amplifier models", below.
Note that an incorrect connection can damage the amplifier.

Maximum regenerative energy permitted for individual amplifier models

Amplifier model	Maximum regenerative energy permitted for individual amplifier models
β*i*SV4 β*i*SV20	16 [J]

How to calculate the amount of energy regenerated per regeneration cycle

- For horizontal movement
  (a) SI unit system

$$P = (5.48 \times 10^{-3} \cdot (Jm + JL) \cdot Vm^2 - 5.23 \times 10^{-2} \cdot ta \cdot Vm \cdot TL)\,[J] \qquad \text{(Equation 1)}$$

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

  (b) CGS unit system

$$P = (5.37 \times 10^{-4} \cdot (Jm + JL) \cdot Vm^2 - 5.13 \times 10^{-3} \cdot ta \cdot Vm \cdot TL)[\mathrm{J}] \qquad \text{(Equation 1)}$$

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

- For vertical movement
  (a) SI unit system

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

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

(b) CGS unit system

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

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

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

R＝P＋Q 〔J〕 (Equation 3)

[When a separated regenerative discharge resistor is needed]

If the amount of energy regenerated per regeneration cycle exceeds the value listed in the table, "Maximum regenerative energy permitted for individual amplifier models", on the previous page, a DC link overvoltage alarm is issued. In this case, a separated regenerative discharge resistor is needed.
Note that an incorrect connection can damage the amplifier.

Selecting a regenerative discharge resistor
First, obtain the amount of regenerative discharge (W).

- For horizontal movement

(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

$$w1 = \frac{1}{F} \times (5.48 \times 10^{-3} \cdot (Jm + JL) \cdot Vm^2 - 5.23 \times 10^{-2} \cdot ta \cdot Vm \cdot TL)[W] \quad \text{(Equation 4)}$$

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

(b) CGS unit system

$$w1 = \frac{1}{F} \times (5.37 \times 10^{-4} \cdot (Jm + JL) \cdot Vm^2 - 5.13 \times 10^{-3} \cdot ta \cdot Vm \cdot TL)[W] \quad \text{(Equation 4)}$$

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

From the table, "Regenerative discharge capacities of separated regenerative discharge resistors", below, select a separated regenerative discharge resistor having a greater regenerative discharge capacity than the value obtained from (Expression 4).

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

(a) SI unit system

$$w2 = 1.047 \times 10^{-1} \cdot Th \cdot Vm \times \frac{D}{100} \ [W] \qquad \text{(Equation 5)}$$

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

(b) CGS unit system

$$w2 = 1.026 \times 10^{-2} \cdot Th \cdot Vm \times \frac{D}{100} \ [W] \qquad \text{(Equation 5)}$$

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

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

w＝w1＋w2 ［W］ (Equation 6)

From the table, "Regenerative discharge capacities of separated regenerative discharge resistors", below, select a separated regenerative discharge resistor having a greater regenerative discharge capacity than the value obtained from (Expression 6).

Regenerative discharge capacities of separated regenerative discharge resistors

Amplifier	Separated regenerative discharge resistor	Regenerative discharge capacity	Condition
βiSV4 βiSV20	A06B-6130-H401(30Ω): For closed air system	20W	Wind speed 0m/sec
	A06B-6130-H402(30Ω): For closed air system (Caution)	100W	

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

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

5.1.2 When Amplifier Models β*i*SV40 and β*i*SV80 Are Used

If the amount of regenerative discharge from a servo motor exceeds the regenerative discharge capacity of the regenerative discharge resistor incorporated in the corresponding servo amplifier, a separated regenerative discharge resistor is needed.
If the motor regenerative discharge amount R obtained with expressions in the previous subsection exceeds the corresponding value listed in the table, "Regenerative discharge capacities of the regenerative discharge resistors incorporated in servo amplifiers", below, use a separated regenerative discharge resistor.

Regenerative discharge capacities of the regenerative discharge resistors incorporated in servo amplifiers

Servo amplifier	Capacity
β*i*SV40	50W
β*i*SV80	130W

The following table lists the separated regenerative discharge resistors that are available.
From the table, "Regenerative discharge capacities of regenerative discharge resistors installed separately from servo amplifiers", below, select a separated regenerative discharge resistor whose discharge capacity exceeds the motor regenerative discharge amount R obtained with expressions in the previous subsection.

Regenerative discharge capacities of regenerative discharge resistors installed separately from servo amplifiers

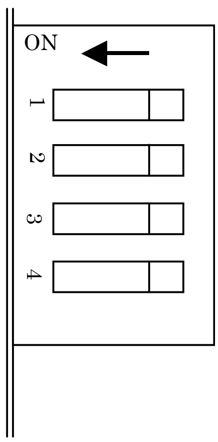
Separated regenerative discharge resistor	Wind speed 0 m/sec	Wind speed 2 m/sec	Wind speed 4 m/sec
A06B-6089-H500: For open air system	R＝200W	R＝400W	R＝ 600W
A06B-6089-H713: For open air system	Incorporates a cooling fan motor.		R＝ 800W
A06B-6089-H714: For open air system	Incorporates a cooling fan motor.		R＝ 1200W

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

Switch setting (when amplifier models β*i*SV40 and β*i*SV80 are used)
The β*i*SV40 and β*i*SV80 have four switches on their front side for protecting regenerative resistors. Be sure to set these switches to the positions that match the resistors used.

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

These switches are numbered 1 to 4. The one on top is switch 1, the one below it is switch 2, and so on. When the lever of a switch is at the left, the switch is on. When it is at the right, the switch is off.



(1) Setting of switches 3 and 4
The setting of switches 3 and 4 varies depending on what regenerative discharge resistor is used.
⇒ If a switch setting is incorrect, it is impossible to detect an excessive converter deceleration power alarm normally.

Switch 3	Switch 4	Regenerative discharge resistor
ON	ON	Incorporated
OFF	ON	Separated A06B-6089-H500
OFF	OFF	Separated A06B-6089-H713, A06B-6089-H714

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

5.1.3 When Amplifier Models β*i*SV10HV, β*i*SV20HV, and β*i*SV40HV Are Used

If the amount of regenerative discharge from a servo motor exceeds the regenerative discharge capacity of the regenerative discharge resistor incorporated in the corresponding servo amplifier, a separated regenerative discharge resistor is needed.
If the motor regenerative discharge amount R obtained with expressions in Subsection 5.1.1 exceeds the corresponding value listed in the table, "Regenerative discharge capacities of the regenerative discharge resistors incorporated in servo amplifiers", below, use a separated regenerative discharge resistor.

Regenerative discharge capacities of the regenerative discharge resistors incorporated in servo amplifiers

Servo amplifier	Capacity
β*i*SV10HV	50W No wind
β*i*SV20HV	
β*i*SV40HV	130W Wind speed of 2 m/s

The following table lists the separated regenerative discharge resistors that are available.
From the table, "Regenerative discharge capacities of regenerative discharge resistors installed separately from servo amplifiers", below, select a separated regenerative discharge resistor whose discharge capacity exceeds the motor regenerative discharge amount R obtained with expressions in Subsection 5.1.1.

Regenerative discharge capacities of regenerative discharge resistors installed separately from servo amplifiers

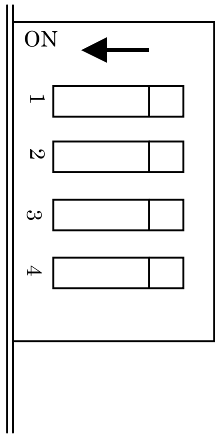
Separated regenerative discharge resistor	Capacity	
A06B-6130-H403: For open air system	Incorporates a cooling fan motor.	R＝800W

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

Switch setting (when amplifier models β*i*SV10HV, β*i*SV20HV, and β*i*SV40HV are used)
The β*i*SV10HV, β*i*SV 20HV, and β*i*SV 40HV have four switches on their front side for protecting regenerative resistors. Be sure to set these switches to the positions that match the resistors used.

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

These switches are numbered 1 to 4. The one on top is switch 1, the one below it is switch 2, and so on. When the lever of a switch is at the left, the switch is on. When it is at the right, the switch is off.



(1) Setting of switches 3 and 4
The setting of switches 3 and 4 varies depending on what regenerative discharge resistor is used.
⇒ If a switch setting is incorrect, it is impossible to detect an excessive converter deceleration power alarm normally.

Switch 3	Switch 4	Regenerative discharge resistor
ON	ON	Incorporated
OFF	OFF	Separated A06B-6130-H403

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

5.1.4 When Amplifier Models β*i*SV20/20 and β*i*SV40/40 Are Used

[When no separated regenerative discharge resistor is needed]
No separated regenerative discharge resistor is needed if the amount of energy regenerated per regeneration cycle is not higher than the amount [J] of energy listed below.
Note that an incorrect connection can damage the amplifier.

Maximum regenerative energy permitted for individual amplifier models

Amplifier model	Maximum regenerative energy permitted for individual amplifier models
β*i*SV20/20	25 [J]
β*i*SV40/40	35 [J]

For how to calculate the amount of energy regenerated per regeneration cycle, see Subsection 5.1.1.

[When a separated regenerative discharge resistor is needed]
If the amount of energy regenerated per regeneration cycle exceeds the value listed in the above table, "Maximum regenerative energy permitted for individual amplifier models", a DC link overvoltage alarm is issued. In this case, a separated regenerative discharge resistor is needed.
Note that an incorrect connection can damage the amplifier.

Selecting a regenerative discharge resistor
See Subsection 5.1.1.

Regenerative discharge capacities of separated regenerative discharge resistors

Amplifier	Separated regenerative discharge resistor	Regenerative discharge capacity	Condition
β*i*SV20/20 β*i*SV40/40	A06B-6130-H404 (for closed air system)	100W (wind speed 0m/s)	-
	A06B-6089-H500 (for open air system)	200W (wind speed 0m/s)	400W (wind speed 2m/s)

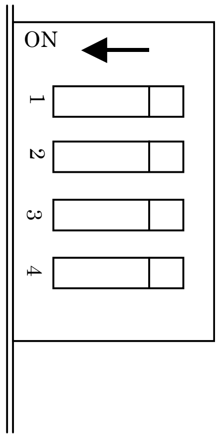
Set-up switch (for changing the DCSW alarm level)

Switch setting (when amplifier models β*i*SV20/20 and β*i*SV40/40 are used)

The β*i*SV20/20 and β*i*SV40/40 have four switches on their front side for protecting regenerative resistors. Be sure to set these switches to the positions that match the resistors used.

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

These switches are numbered 1 to 4. The one on top is switch 1, the one below it is switch 2, and so on. When the lever of a switch is at the left, the switch is on. When it is at the right, the switch is off.



(1) Setting of switches 3 and 4

The setting of switches 3 and 4 varies depending on what regenerative discharge resistor is used.

⇒ If a switch setting is incorrect, it is impossible to detect an excessive converter deceleration power alarm normally.

Switch 3	Switch 4	Regenerative discharge resistor
ON	ON	• Regenerative resistor not used • Separated A06B-6130-H404 (for closed air system)
OFF	ON	Separated A06B-6089-H500 (for open air system)

(2) Setting of switches 1 and 2

Neither switch 1 nor 2 is used. Leave them off.

5.1.5 Cautions for Installing a Separated Regenerative Discharge Resistor

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

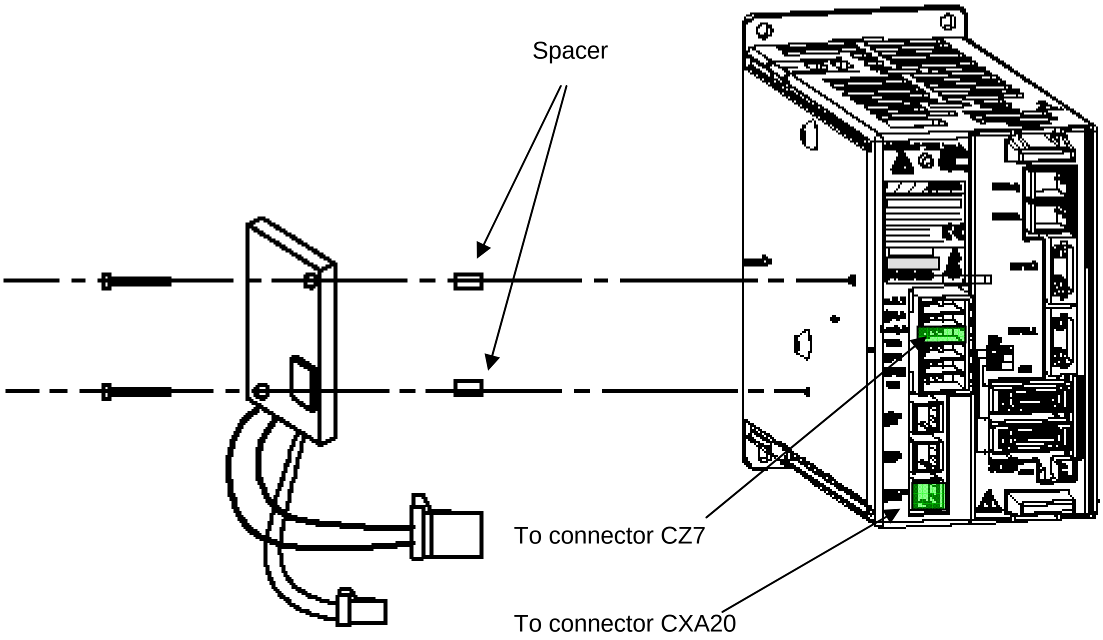
(1) Related ordering numbers

Ordering number of separated regenerative discharge resistor	Resistance	Capacity Wind speed 0m/sec	2m/sec	4m/sec	Remarks
A06B-6130-H401	30Ω	20W	-	-	For βiSV4, βiSV20
A06B-6130-H402	30Ω	100W	-	-	For βiSV4, βiSV20
A06B-6130-H403	64Ω	Incorporates a cooling fan motor.		800W	For βiSV10HV, βiSV20HV, βiSV40HV
A06B-6130-H404	16Ω	100W	-	-	For βiSV20/20, βiSV40/40
A06B-6089-H500	16Ω	200W	400W	600W	For βiSV40, βiSV80, βiSV20/20, βiSV40/40
A06B-6089-H713	16Ω	Incorporates a cooling fan motor.		800W	For βiSV40, βiSV80
A06B-6089-H714	16Ω	Incorporates a cooling fan motor.		1200W	For βiSV40, βiSV80

(2) Installation requirements

A06B-6130-H401 A06B-6130-H402 A06B-6130-H404	Install these models in a completely sealed cabinet.
A06B-6130-H403 A06B-6089-H500 A06B-6089-H713 A06B-6089-H714	Place the pin side in a completely sealed cabinet and the resistor side (heat generating section) in an exhaust air duct. (a) Use supplied gaskets. (b) Take measures so that the pin side and resistor side (heat generating section) can be kept from coolant, oil mist, and cuttings. (c) When taking in fresh air to the resistor (heat generating section), use an air filter at the air inlet. Also seal the cable inlets, cable outlets, and doors securely.

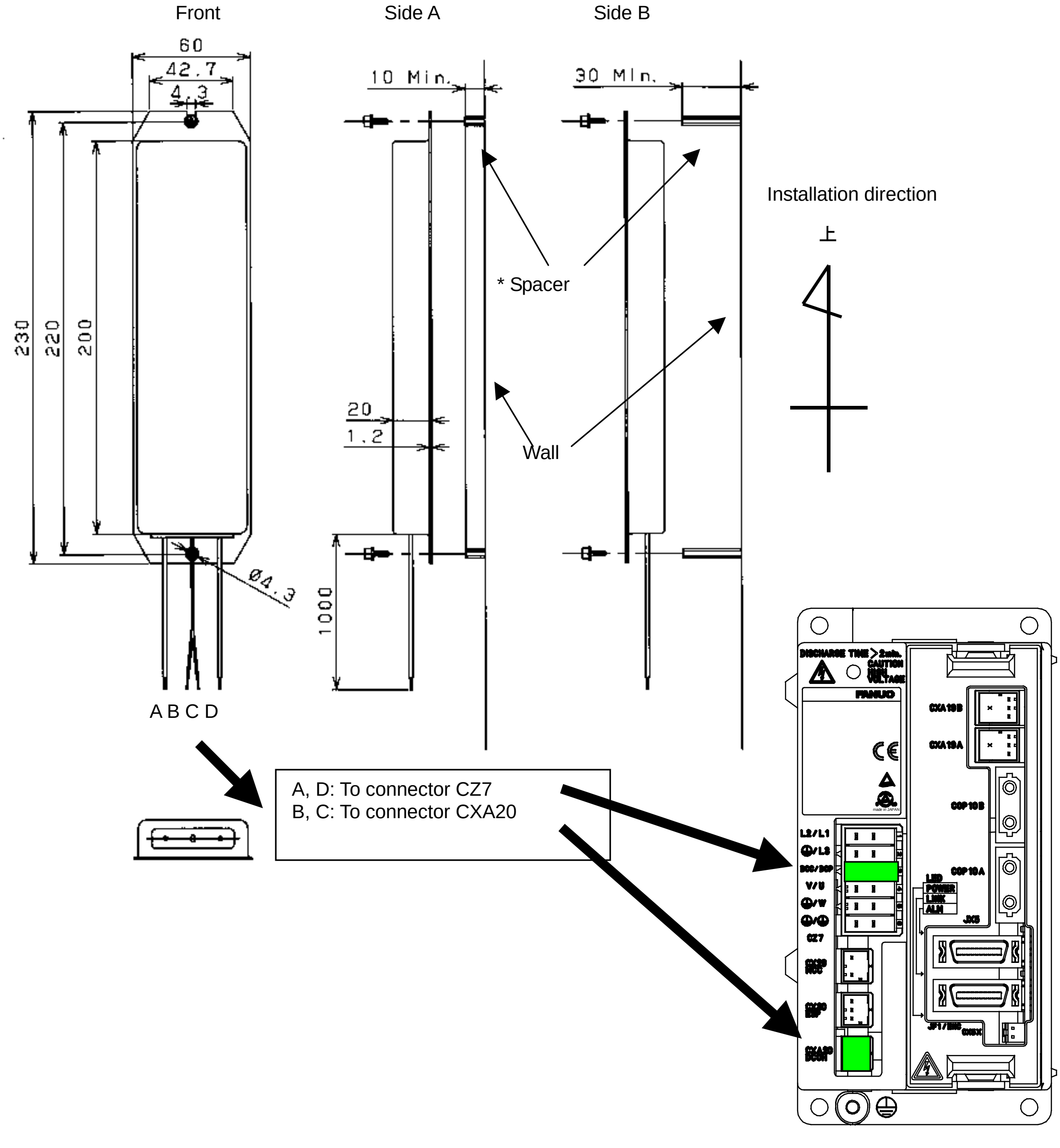
(a) Installing A06B-6130-H401



⚠ **WARNING**

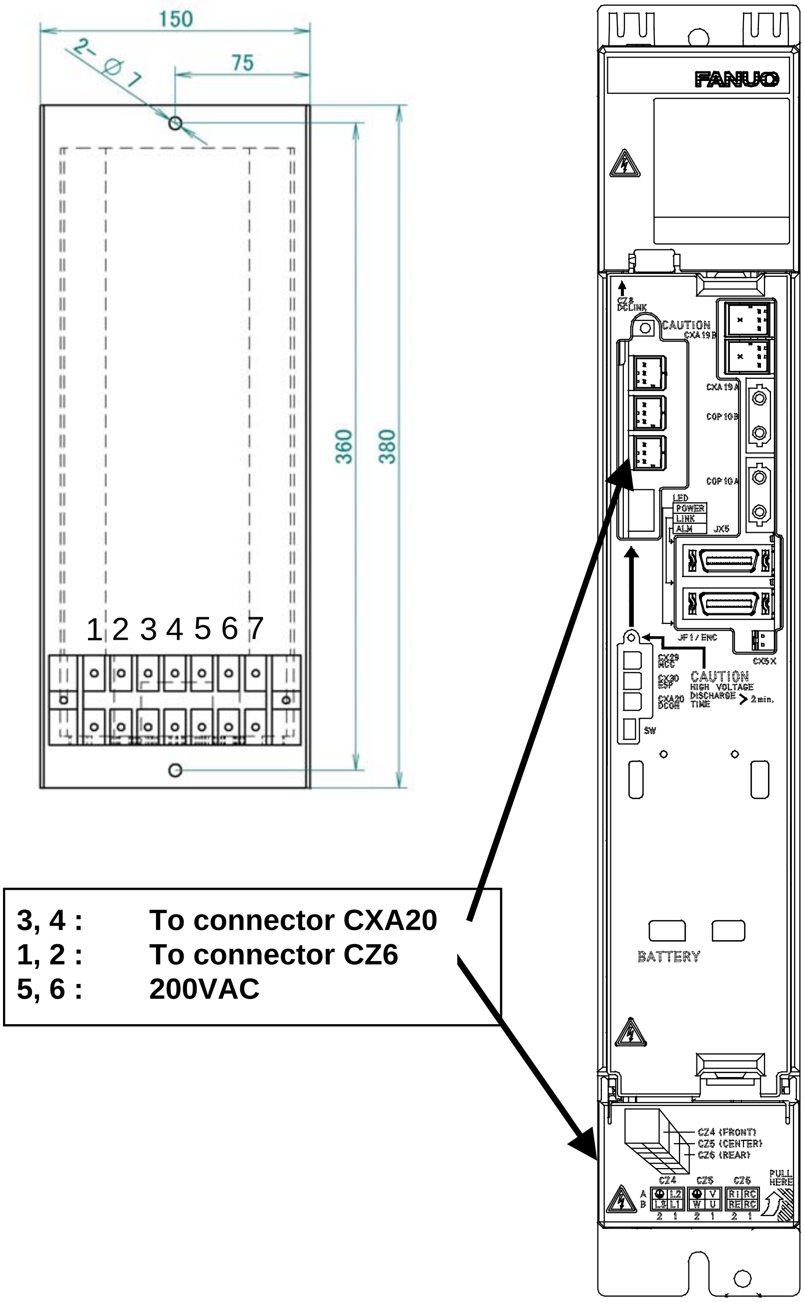
1. Separated regenerative discharge resistors may become very hot (100°C to 200°C). Be careful not to touch them.
2. Before touching a separated regenerative discharge resistor, for example, for maintenance purposes, turn all power to the amplifier off, wait for at least 30 minutes, and make sure that the DC link charge indicator LED (CAUTION CHARGE) is off and the separated regenerative discharge resistor is sufficiently cool.
3. When installing a separated regenerative discharge resistor, keep it sufficiently far from any flammable.
4. The minimum clearance between the separated regenerative discharge resistor and the wall should be 10 mm.

(b) Installing A06B-6130-H402



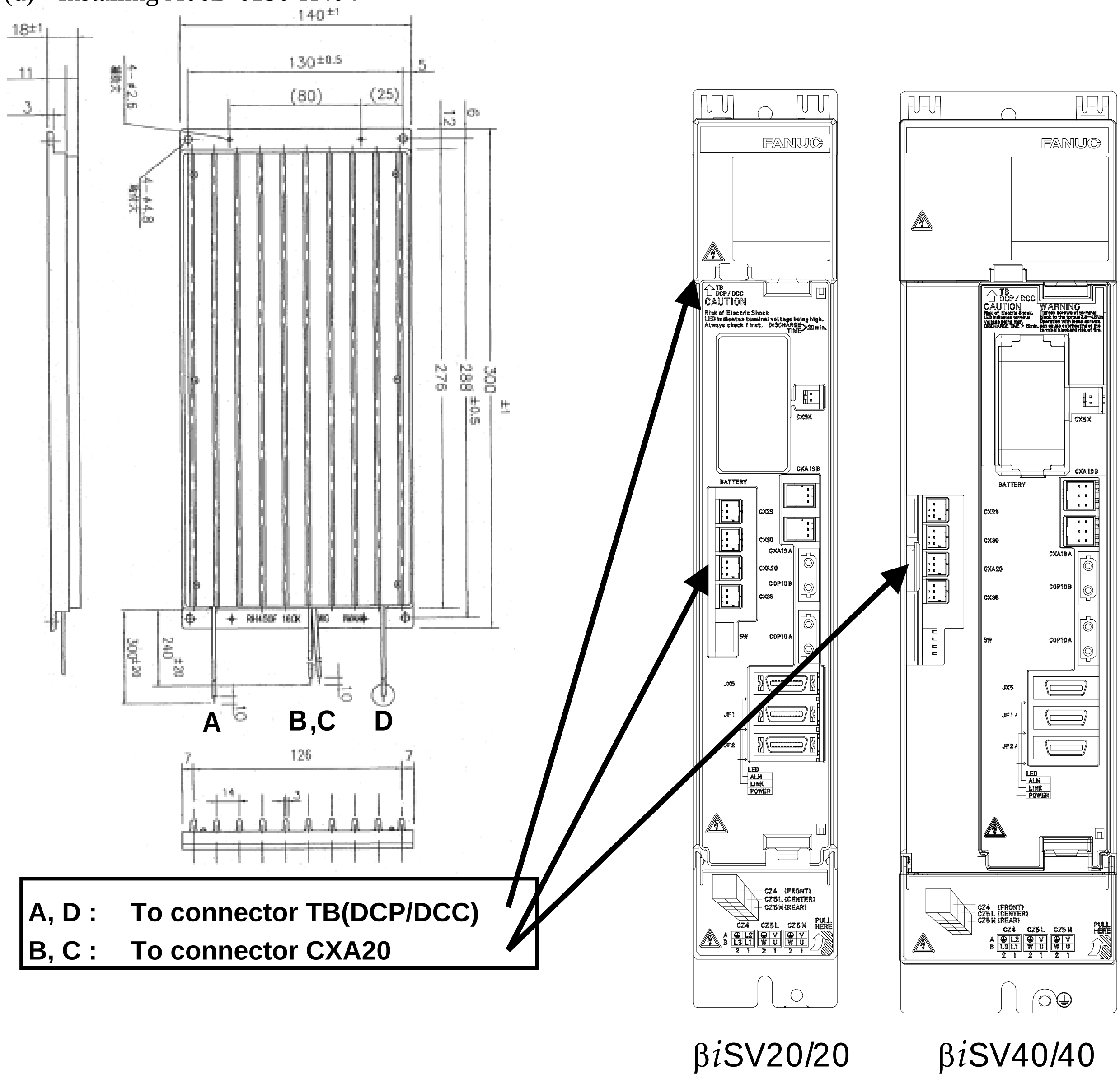
> ⚠ **WARNING**
> 1 Separated regenerative discharge resistors may become very hot (100°C to 200°C). Be careful not to touch them.
> 2 Before touching a separated regenerative discharge resistor, for example, for maintenance purposes, turn all power to the amplifier off, wait for at least 30 minutes, and make sure that the DC link charge indicator LED (CAUTION CHARGE) is off and the separated regenerative discharge resistor is sufficiently cool.
> 3 When installing a separated regenerative discharge resistor, keep it sufficiently far from any flammable.
> 4 The minimum clearance between the separated regenerative discharge resistor and the wall should be 10 mm.

(c) Installing A06B-6130-H403 and A06B-6089-H713 to -H714



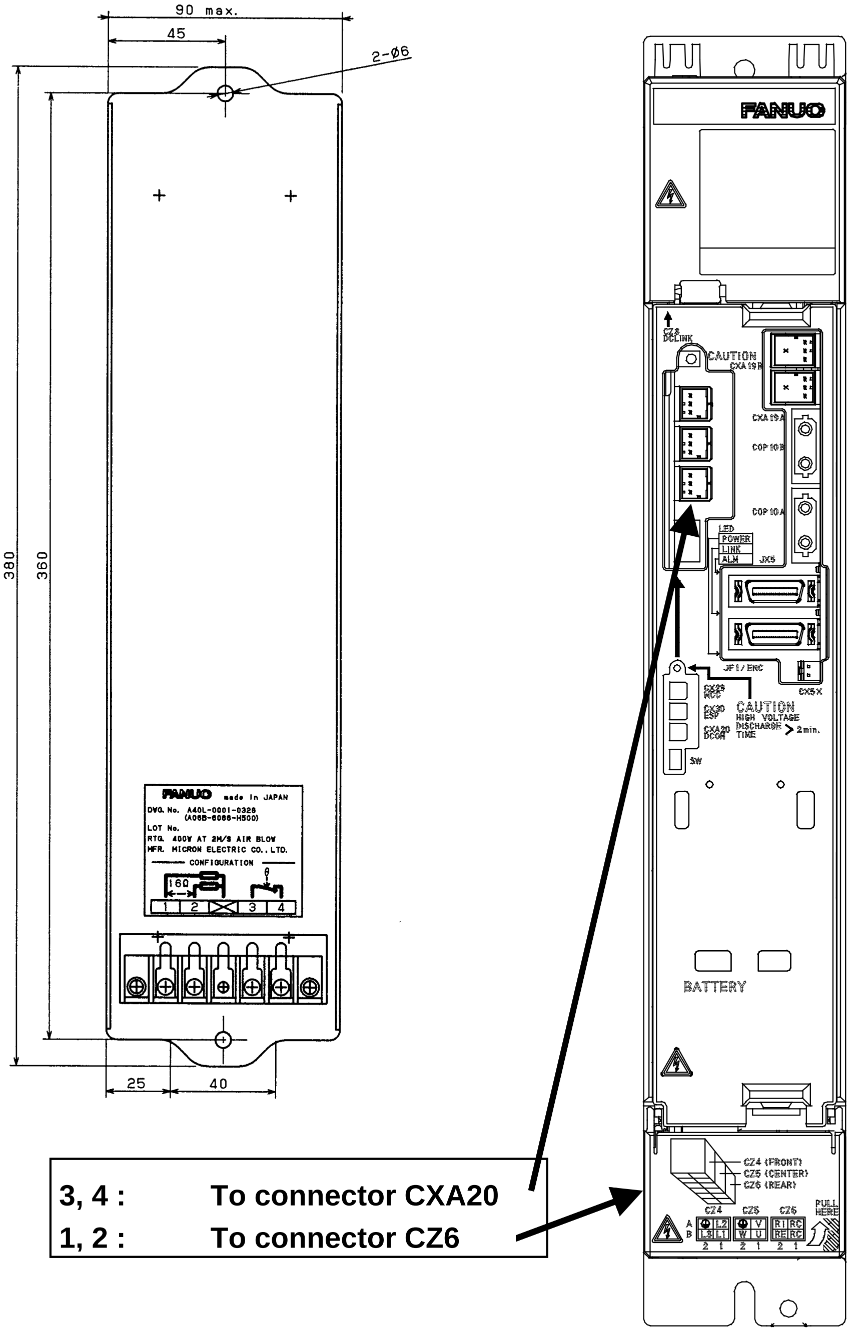
> ⚠ **WARNING**
>
> 1 Separated regenerative discharge resistors may become very hot (100°C to 200°C). Be careful not to touch them.
>
> 2 Before touching a separated regenerative discharge resistor, for example, for maintenance purposes, turn all power to the amplifier off, wait for at least 30 minutes,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

(d) Installing A06B-6130-H404



> ⚠ **WARNING**
> 1 Separated regenerative discharge resistors may become very hot (100°C to 200°C). Be careful not to touch them.
> 2 Before touching a separated regenerative discharge resistor, for example, for maintenance purposes, turn all power to the amplifier off, wait for at least 30 minutes, and make sure that the DC link charge indicator LED (CAUTION CHARGE) is off and the separated regenerative discharge resistor is sufficiently cool.
> 3 When installing a separated regenerative discharge resistor, keep it sufficiently far from any flammable.
> 4 The minimum clearance between the separated regenerative discharge resistor and the wall should be 10 mm.

(e) Installing A06B-6089-H500



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

6 INSTALLATION

6.1 LEAKAGE CURRENT

The servo amplifier β*i* 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 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
Criterion for selection: 2mA per amplifier (Note 1)
(b) Selection criterion per motor
Criterion for selection: 1mA per motor (Note 1)

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

Example) When the system consists of β*i*SV × 4
2mA×4 (for the amplifiers) + 1mA×4 (for the motors) = 12mA
→ Select a circuit breaker (Note 2) with a non-operating current of 12 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 These criteria are for selecting a circuit breaker with a ground fault interrupter; they do not indicate accurate leakage currents.
2 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.
3 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.

⚠ **WARNING**
Install a ground-fault circuit breaker.
To prevent fire and electric shock to a person, be sure to install a ground-fault circuit breaker (for inverter circuits).

6.2 GROUND

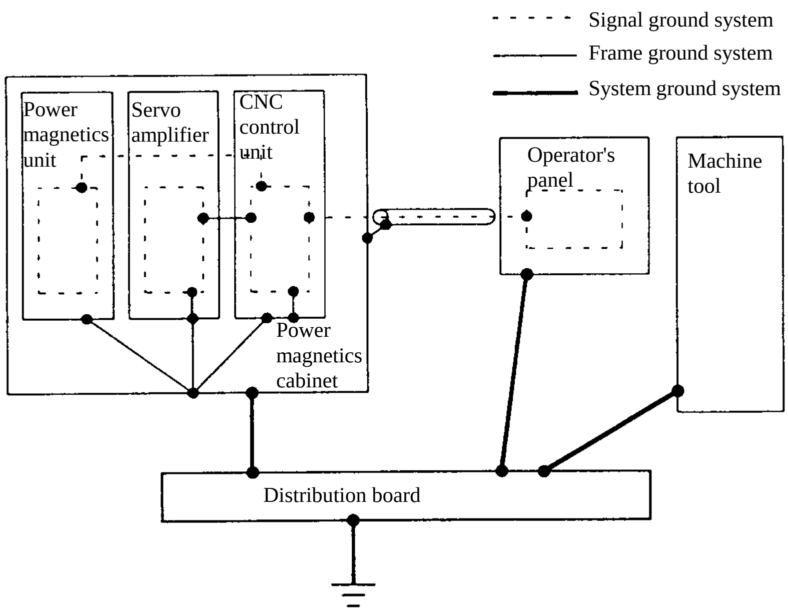
6.2.1 Ground Systems

There are three ground systems for CNC system grounding.

(1) Signal ground system (SG)
The signal ground (SG) supplies the reference voltage (0V) of the electrical signal system.

(2) 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, panels, and shields for the interface cables between the units are connected.

(3) System ground system (PE)
In the system ground system (PE), frame ground provided for each device or among units is connected systematically to ground at one place.



6.2.2 Grounding Method

Generally, noise that causes problems is high-frequency noise. Grounding each device with a low impedance(Note) is a key to suppression of high-frequency noise. Methods of grounding for this purpose are explained below.

> **NOTE**
> In addition to a resistance component, which converts current to heat, impedance contains a reactance component, which prevents the flow of AC current at a certain frequency.

(1) Multi-point grounding
If a metal plate of a cabinet is grounded with a sufficiently low impedance, the metal plate is used as a ground plate, and each device is grounded nearby. This method allows grounding to a low-impedance metal plate of the cabinet over a shortest distance, and can therefore effectively suppress high-frequency noise. On the other hand, because a metal plate of a cabinet is used as a ground plate, noise suppression efficiency depends on the structure of the cabinet. For cabinets, see Subsection 6.3.3, “Cabinet”. Fig. 1 shows a cabling schematic.
When the multi-point grounding method is used, units can be grounded with a low impedance, and the lengths of ground cables can also be reduced, so cabling can be simplified.

> ⚠ **CAUTION**
> If a metal plate of a cabinet does not show a low impedance, a noise problem may arise between the power ground line and signal ground line.

(2) Single-point grounding
Signal lines and power lines are grounded separately, and grounding is performed at a single point to suppress noise from a power line to signal line. With this method, the length of a cable for grounding a unit tends to be long. So, to suppress high-frequency noise sufficiently, the cable diameter must be increased, or more than one connection cable must be used. Fig. 2 shows a cabling schematic.

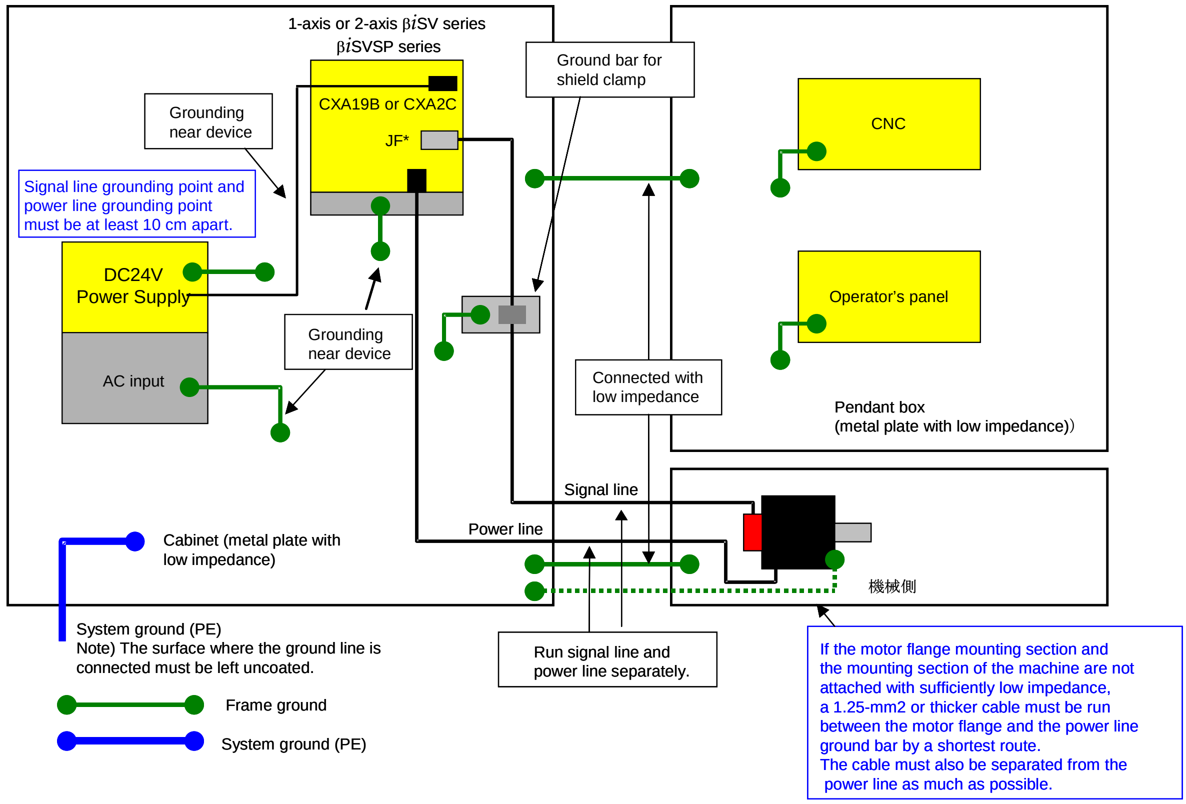


Figure1 Schematic of multi-point grounding

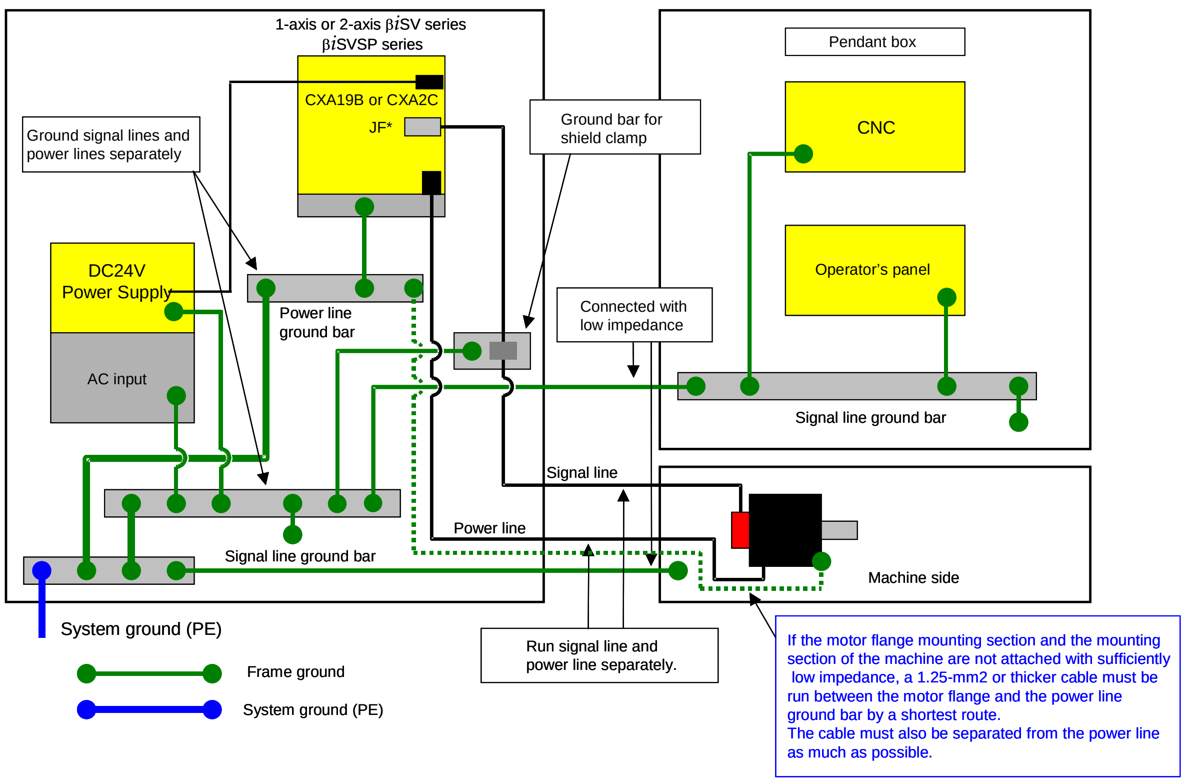


Figure2 Schematic of single-point grounding

6.2.3 Notes on Connecting

- Connect the signal ground (0V) with the frame ground (FG) at only one place in the servo amplifier β*i*SV series or servo amplifier β*i*SVSP series.
- The grounding resistance of the system ground shall be 100 ohms or less (class D 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.

NOTE
1 Securing the ground terminal and a cable together is not permitted.
2 The motor flange mounting section may not be able to be connected to the machine mounting section of the power magnetics cabinet via the mechanical unit at sufficiently low impedance in a machine. In this case, a cable of a minimum required length that is at least 1.25 mm^2 thick must be run from the motor flange to the frame ground of the power magnetics cabinet. The cable must also be separated from the motor power line as much as possible.

6.3 NOISE PREVENTION

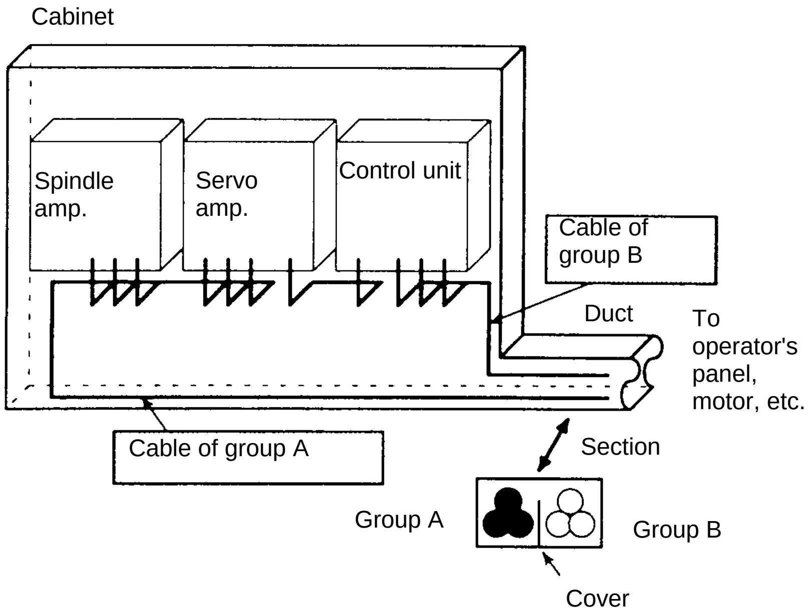
6.3.1 Separation of Signal Lines

If a signal cable is near a power cable, noise may be induced. The signal cables must be separated from the power cables when routed. When power and signal cables cannot possibly be separated from each other, the cables must be run in parallel in the minimum distance. When a conduit is used, it is recommended that the signal cables be separated from the power cables in it.

[Types of cables]

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 SP	Separate binding or electromagnetic shielding is necessary for group A cables. All cables must be shielded.
	Cable for position feedback or velocity feedback	
	Cable for Positioncoder	
	Other cable related to sensor	

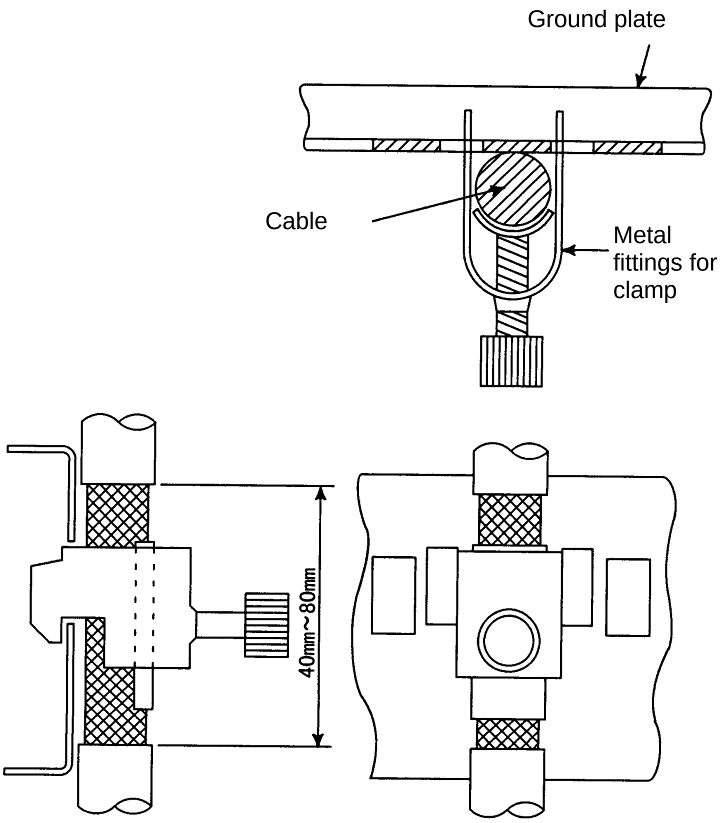
NOTE
1 The groups must be 10 cm or more apart from one another when binding the cables in each group.
2 The electromagnetic shield refers to shielding between groups with grounded steel plates.
3 Attach a noise suppressor such as a spark killer to the magnetic contactor driving coil.



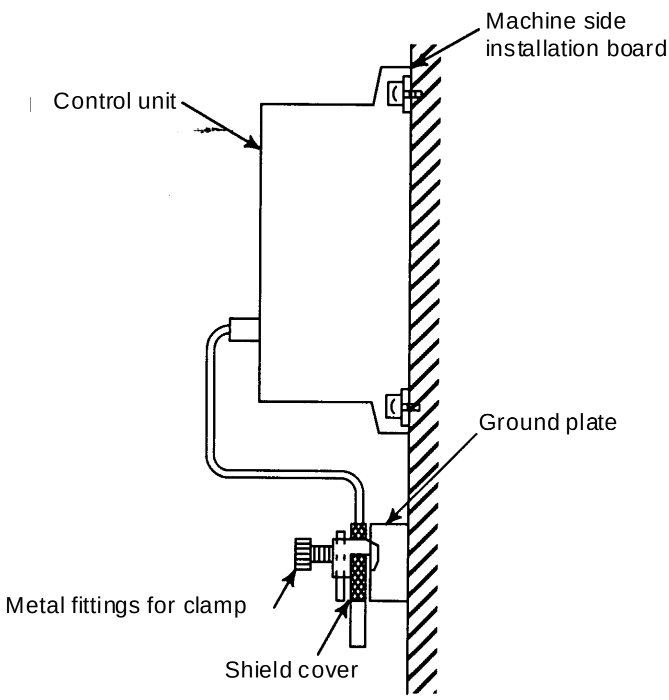
6.3.2 Cable Clamp and Shield Processing

Basically, signal lines require shield clamping. Correct shield clamping can suppress noise from the outside.
Strip part of the cable jacket to expose the shield sheath, and secure that part of the cable to the ground bar by using a clamp. At this time, the ground bar must be in contact with the surface of the shield so that the contact area becomes wide. (See the figure in next page.)
When using the multi-point grounding method, remove the coating of the part where the shield clamp ground bar is connected to the cabinet, to allow surface contact.

- Terminal processing of the shield sheaths
  Perform terminal processing of the shield sheaths of the signal cables according to the description in Chapter 9, “TOTAL CONNECTION DIAGRAM”.
- Cable clamp
  Clamp the cables connected to the amplifier that require shielding as shown in the figures on the next page.
  Clamping secures a cable and also provides shielding. Clamping must always be performed since it is very important for stable system operation.
  Connect the shield clamp of the signal cables of servo amplifiers β*i*SV and β*i*SVSP series to common the ground plate for signals.
- Grounding
  The user is to prepare a ground plate and install it as shown in the figures on the following pages.

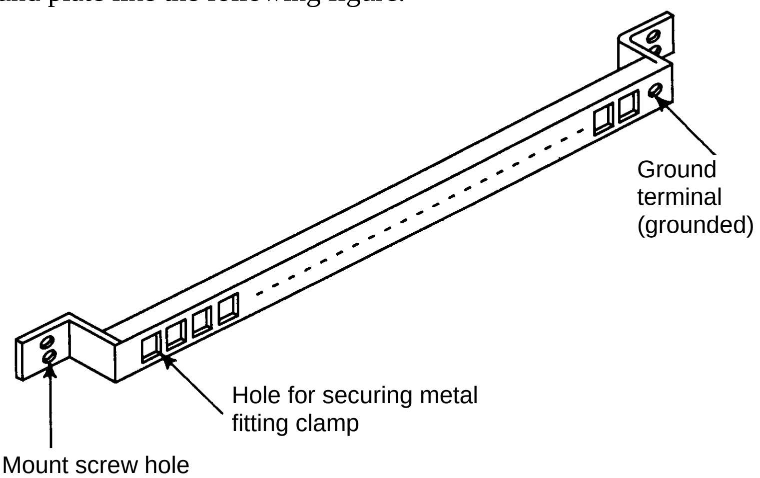


Cable clamp (1)



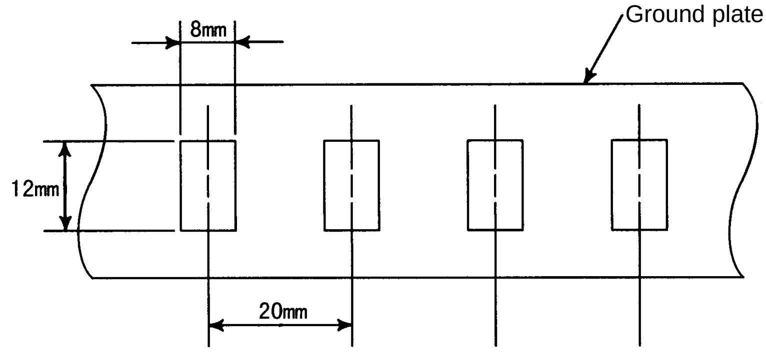
Cable clamp (2)

Prepare a ground plate like the following figure.



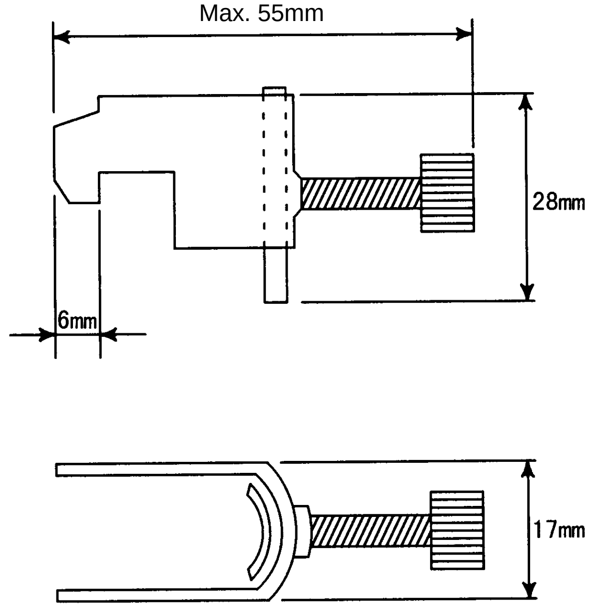
Ground plate

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



Ground plate holes

Reference) Outer drawings of metal fittings for clamp

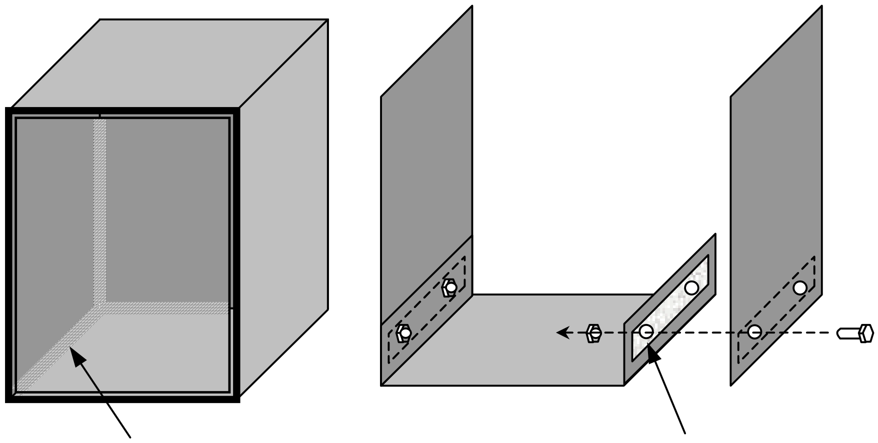


Outer drawings of metal fittings for clamp

6.3.3 Cabinet

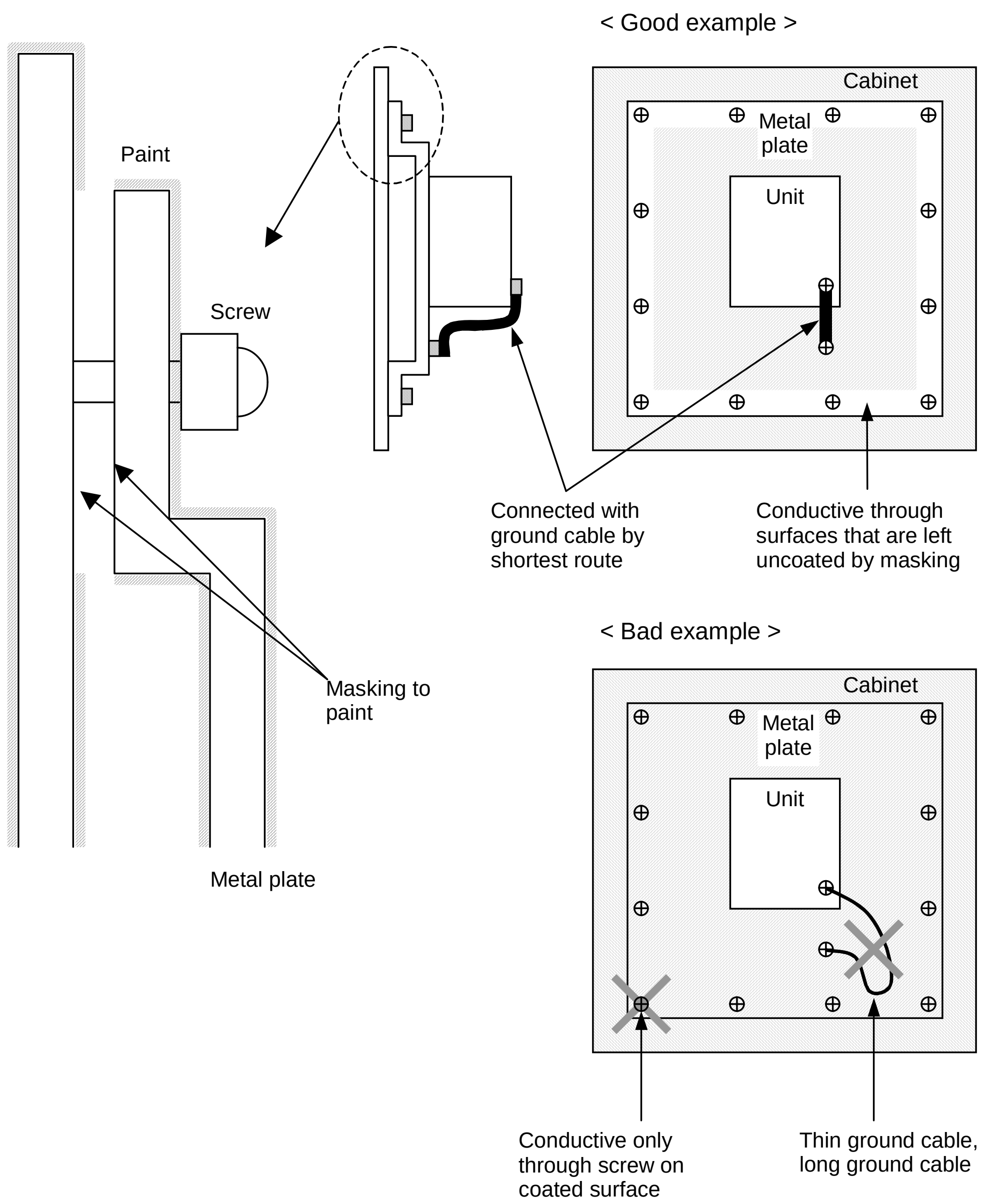
A cabinet is a key element for improving noise resistance and suppressing radiation noise.
One factor of noise resistance and radiation noise problems is insufficient electrical conductivity between metal plates of a cabinet. Generally, noise that causes problems is high-frequency noise. Therefore, a cabinet needs to be designed considering high-frequency noise.

(1) Basic structure of a cabinet
Basically, cabinets should be made of metal.
To improve noise resistance, the metal plates of the side walls, top plate, and bottom plate of a cabinet must be electrically low-impedance conductive. So, welding is recommended for the cabinet. Bead (continuous) welding, rather than spot welding, should be applied to the cabinet to enhance low-impedance electrical conductivity among the metal plates.
When the cabinet uses a built-up structure, joint part of each metal plate must be left uncoated, so that the plates come in direct contact with each other to provide electrical conductivity.
When metal plates are connected only via cables because of structural restrictions, it becomes more difficult to achieve low-impedance connection than when the metal plates are welded or are in direct contact. It is necessary to ensure large sectional areas of the cables used, sufficient conductivity of the connection parts, and large contact areas.



> **NOTE**
> The purpose of the description in this subsection is to provide a cabinet with low-impedance electric conductivity to improve noise resistance. To implement a protection circuit, a cable having an appropriate sectional area for the AC input power capacity of the unit mounted on each metal plate needs to be used to connect the metal plates to perform protective grounding.

(2) Installing a unit in a cabinet
Run the ground cable of the unit by a shortest route. If the conductive wire of the ground cable is thin, impedance to high-frequency noise in particular becomes high, so grounding becomes less effective. For the position of the ground terminal of each unit, see the relevant manual. When a metal plate is installed in the cabinet after a unit is attached to the metal plate, the following method should be used. Attach the metal plate to the cabinet so that their wide areas left uncoated by masking come in contact with each other. The method of using only screws to provide electric conductivity is not recommended because impedance to high frequencies cannot be decreased sufficiently.



6.3.4 Others

Cable length

If a cable is longer than required, a loss of power increases, and the signal line becomes likelier to be affected by noise. Use each cable of the minimum required length.

Use of shield cables

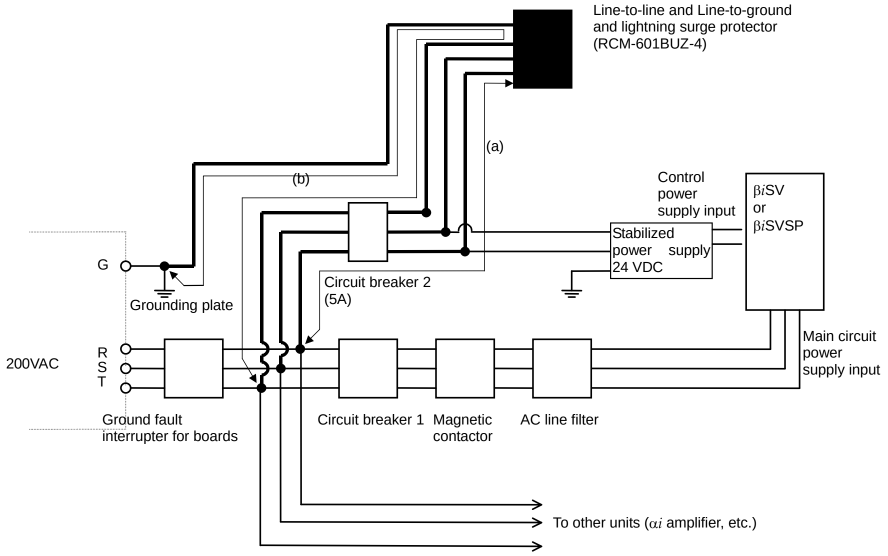
- Satisfying the requirements of the EMC Directives
  For details, refer to the FANUC technical report, "Satisfying the Requirements of the EMC Directive" (A-72937EN).
- Protection against noise
  Noise generated from the shielded wire of a power shield cable may affect signals via the shielded wire of a signal cable. For this reason, separate the ground of the shielded wire of a power cable from that of the shielded wire of a signal cable. Use different ground clamping plates (ground plates) for power cables and signal cables to improve safety.

6.4 FITTING A LIGHTNING SURGE PROTECTION DEVICE (POWER SUPPLY OF 200-VAC INPUT SERIES)

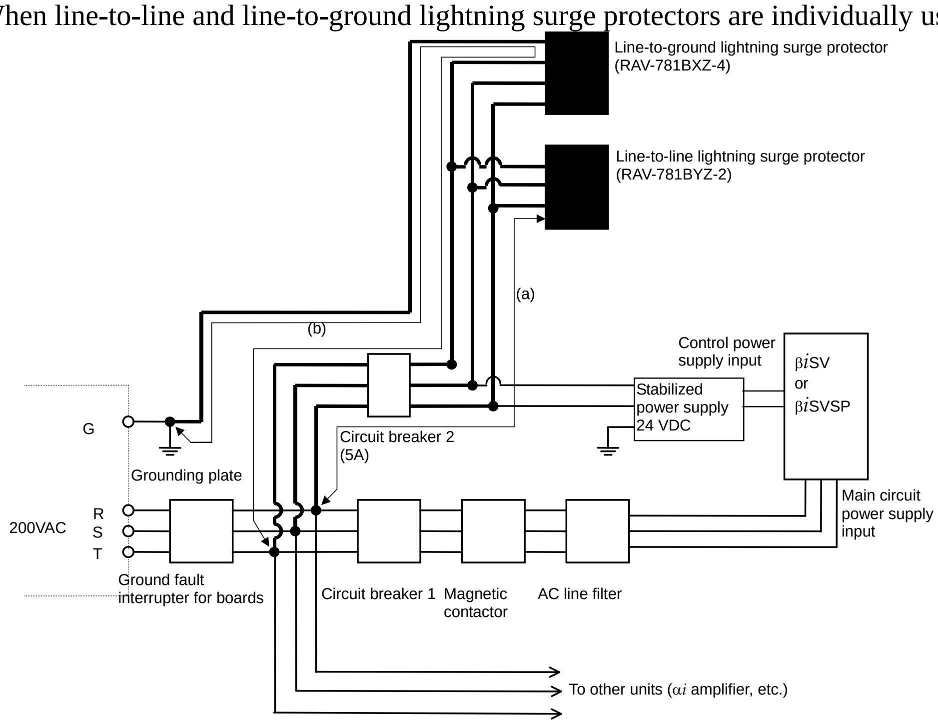
At the power input of the power magnetics cabinet, install a surge protection device between the power lines and between each power line and a ground to protect the unit from a voltage surge caused by lightning.
How to install the surge protection device is shown below.

(1) Surge protector for three-phase input

(a) When a line-to-line and line-to-ground lightning surge protector is used

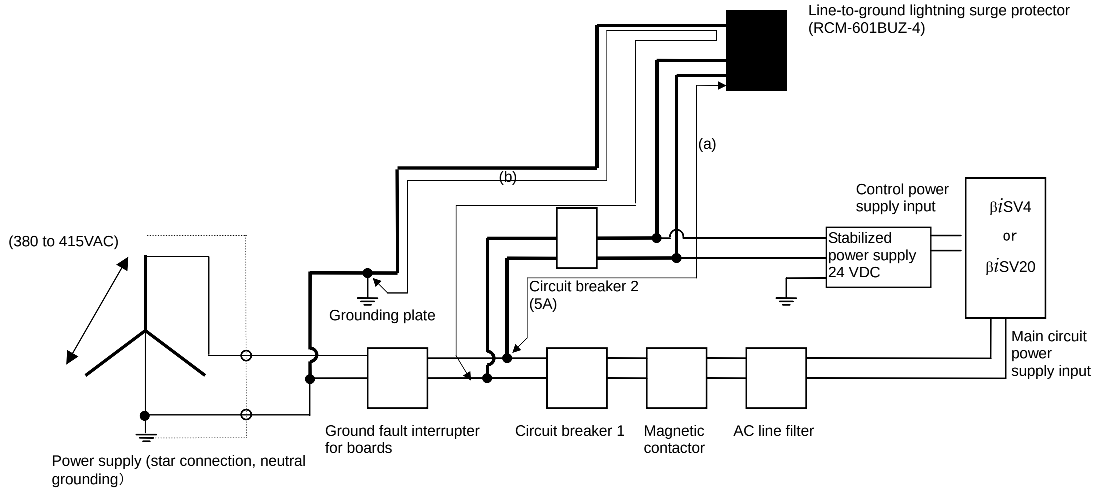


(b) When line-to-line and line-to-ground lightning surge protectors are individually used

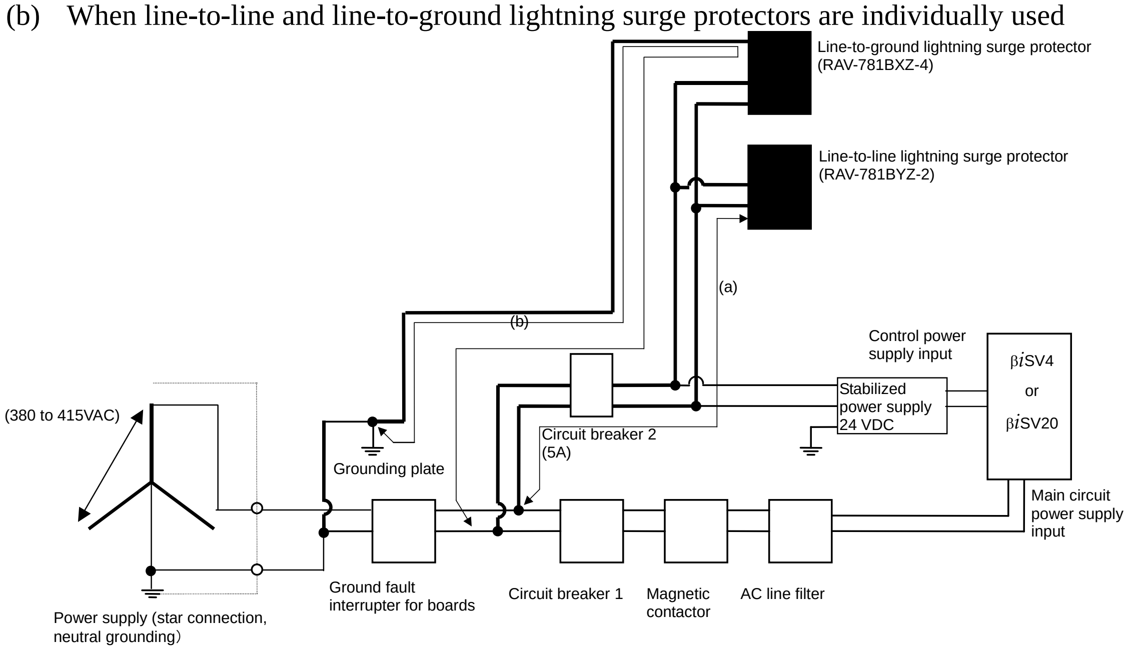


(2) Surge protector for single-phase input

(a) When a line-to-line and line-to-ground lightning surge protector is used



(b) When line-to-line and line-to-ground lightning surge protectors are individually used



⚠ CAUTION

1 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 line-to-line lightning surge protector (a) and that used for line-to-ground lightning surge protector (b) must not exceed 2 m.

2 When performing a dielectric strength test by applying an overvoltage to the power line, line-to-ground lightning surge protector must be removed to enable the applied voltage to be maintained.

3 The circuit breaker 2 (5A) works for line protection when the lightning surge absorber is short-circuited because of a surge higher than its rating being applied.

⚠ **CAUTION**

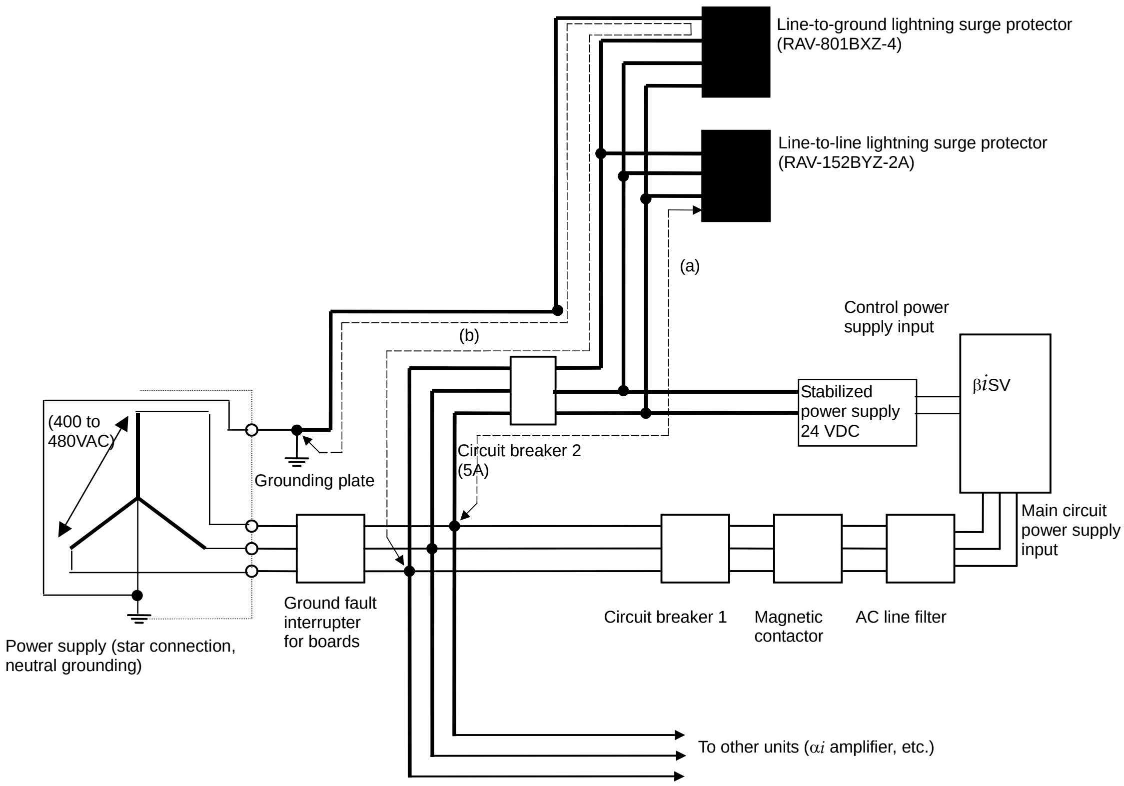
4 Because current does not flow through lightning surge protector in a normal state, the circuit breaker 2 (5A) can be used together with the surge absorbers as well as with other equipment.

Lightning surge protector specifications

Category	Ordering number	Specification	Remarks
Optional	A06B-6077-K142	For line-to-line installation : RAV-781BYZ-2 For line-to-ground installation : RAV-781BXZ-4	Manufactured by Okaya Electric Industries Co., Ltd. For 200VAC line TÜV approved products
	A06B-6077-K144	Integration type for line-to-line installation/line-to-ground installation: RCM-601BUZ-4	Manufactured by Okaya Electric Industries Co., Ltd. For 200VAC line TÜV approved products

* The line-to-line or line-to-ground installation type (A06B-6077-K142) and the integration type (A06B-6077-K144) are equivalent in performance and specifications.

6.5 FITTING A LIGHTNING SURGE PROTECTION DEVICE (POWER SUPPLY OF 400-VAC INPUT SERIES)



⚠ **CAUTION**

1 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 line-to-line lightning surge protector (a) and that used for line-to-ground lightning surge protector (b) must not exceed 2 m.
2 When performing a dielectric strength test by applying an overvoltage to the power line, line-to-ground lightning surge protector must be removed to enable the applied voltage to be maintained.
3 The circuit breaker 2 (5A) works for line protection when the lightning surge absorber is short-circuited because of a surge higher than its rating being applied.
4 Because current does not flow through lightning surge protector in a normal state, the circuit breaker 2 (5A) can be used together with the surge absorbers as well as with other equipment.

Lightning surge protector specifications

Category	Ordering number	Specification	Remarks
Optional	A06B-6077-K143	For line-to-line installation : RAV-152BYZ-2A For line-to-ground installation : RAV-801BXZ-4	Manufactured by Okaya Electric Industries Co., Ltd. For 400VAC line TÜV approved products

6.6 AMPLIFIER INSTALLATION NOTES RELATING TO SAFETY STANDARDS

The servo amplifier β*i*SV series or servo amplifier β*i*SVSP series is designed to meet the following safety standards:

(1) 200-V input series (1-axis β*i*SV, 2-axis β*i*SV, β*i*SVSP)
EN61800-5-1
UL508C Second Edition or Third Edition

(2) 400-V input series (1-axis β*i*SV HV)
EN50178 1997
UL508C Second Edition or Third Edition

To verify the conformity to these standards, the amplifiers are certified by TÜV Rheinland, a third certification organization, and UL.
When performing the CE Marking or UL Marking process, in design of the power magnetics cabinet, pay special attention to the installation conditions described in this section.

6.6.1 Requirements of EN and IEC Standards

6.6.1.1 Classification in standards on insulation design

(1) Insulation between circuits and between a circuit and protective ground
According to EN50178 5.2, insulation design of the amplifier conforms to the related standards in IEC60664 Part 1.
- The primary (the power supply and main circuit side) and the secondary (control circuit side) are separated by enforced insulation to ensure safety.
- Basic insulation is applied to the protective ground side.

Basic insulation is also applied between the main circuit of the power supply and the aluminum flanges (integrated with the heat sink), so connect a protective ground cable to the ground terminal of the lower aluminum flange.

(2) Installation category (overvoltage category)
In EN50178 5.2.16.2, power supply facilities are classified according to the impulse voltage to ground, included in the power supply to which the amplifier is connected.
This amplifier is designed to fall into installation category (overvoltage category) II.
Space distance is designed on the assumption that the rated impulse withstanding voltage (impulse voltage to ground) that appears in the power supply to which the amplifier is connected is 2.5 kV or less. If an impulse to ground that is higher than the assumed value appears in the power supply, it needs to be suppressed. In general, this condition is considered to be satisfied if an insulation transformer is used in the power supply input section of the machine. If an insulation transformer is not used, a surge protector (lightning surge absorber) must be inserted before ground to suppress impulse higher than 2.5 kV to ground.

(3) Pollution degree of the installation environment and protection class of the power magnetics cabinet
EN 50178 5.2.15.2 requires that when the machine is installed in the environment of ordinary plants, the class of protection against dust, coolant, chips, and so on be IP54 or higher.
If the power magnetics cabinet satisfies this requirement, the degree of pollution inside the power magnetics cabinet is considered to be class 2.
Insulation design of this amplifier assumes that the amplifier is installed in an environment with pollution degree 2.
When the amplifier is used in a general machine installation environment, install the amplifier in a power magnetics cabinet that satisfies protection class IP54 or higher.

The IP level, however, is determined by the environment (atmosphere) in which the machine is installed. So, the protection class of the power magnetics cabinet should be selected according to the environment.
When an external heat sink cooling type amplifier of which heat sink fin protrudes behind the mounting flange is used, the fin section must be in a cooling area (duct) conforming to around IP22 to IP33, and must be protected from being exposed to direct splashes of coolant, chips, and so forth.

6.6.1.2 Protection against electric shock

(1) Protection against direct contact with charged parts (EN50178 7.2.1)
The electric shock protection level of this amplifier after it is installed is equivalent to IP1X (hand protection), which requires protection against unintentional or careless contact.
This amplifier must be installed in a power magnetics cabinet. According to Section 6.2.1, "Electric shock protection by cabinets", in EN 60204-1, the power magnetics cabinet must be equipped with a lock so that when the power to the amplifier is on, the power magnetics cabinet cannot be opened by persons except special maintenance personnel or persons authorized to do maintenance work who have been sufficiently trained in prevention of electric shock.
If the operator of the machine needs to open the power magnetics cabinet for some operations, the operator must be given thorough safety training, or a protection cover must be provided to prevent the operator from touching the amplifier.

(2) Confirmation of discharge of the electrolytic capacitor (EN50178 7.2.1)
This amplifier includes a large-capacity electrolytic capacitor for the power smoothing circuit. Even after the power supply input circuit is shut off, this capacitor remains charged for a while.
When it becomes necessary to touch the amplifier to do maintenance work or for other purposes, wait until the discharge time indicated on the face plate of the amplifier is passed, or start work after ensuring safety by measuring the residual voltage of the DC link section with a volt-ohm meter and checking that the LED (red) indicating charging is turned off.

(3) Leakage current to the protective ground cable (EN50178 7.2.11)
The motor is controlled by changing the average amplitude and frequency of voltage by pulse duration modulation and applying the modulated voltage to the armature. To do this, chopper voltage at a frequency of several kilohertz, which is the carrier frequency for the pulse duration modulation, is applied to the power line of the motor.
Ground stray capacitance mainly between the motor winding and casing and between the power line and protective ground line of the motor power cable causes leakage current to flow through the protective ground line of the motor power cable and machine ground, part of which flows also to the protective ground line of the machine.
The resultant leakage current value is around 1 to 2 mA per motor axis at the commercial power frequency component (50/60Hz). However, with the measurement circuit defined by EN 50178 5.2.11, the sensitivity of high-frequency components cannot be reduced sufficiently, so a value greatly exceeding 3.5 mA is sometimes observed.
If the machine is not grounded, making contact with the machine can result in electric shock. Therefore, provide sufficient protection against electric shock by taking one of the following measures:
(a) Use a protective ground cable with a copper wire having a sectional area of 10 mm^2 or more.
(b) Install a ground-fault circuit interrupter to shut off power as soon as a ground fault occurs.
(c) Add a protective ground terminal to the cabinet to duplicate protective ground cable connection.
(d) When installing an RCD unit, use RCD type B.
When using a ground-fault circuit interrupter, select an electromagnetic type with low high-frequency component sensitivity or an electronic type supporting inverters to prevent troubles due to high-frequency components.
Measure (a) or (d), which can detect leakage current, is recommended.

6.6.1.3 Protective grounding

The amplifier has several protective ground terminals (marked according to 417-IEC-5019). These terminals are used not only for protection against electric shock due to dielectric breakdown but also for functional grounding to prevent noise.
Connect all the protective ground terminals to the protective ground (PE) terminal in the power magnetics cabinet.
For how to connect a protective ground cable and its cable diameter, refer to Section 6.2, "GROUND", and Subsection 9.2.7, "Details of Cable K2".
Note that connecting a cable terminal to a protective ground point is not permitted.

6.6.1.4 EMC

For CE Marking, the EMC Directive must be observed. FANUC's products have obtained certificates of conformance to EN61000 -6-2:200 and N55011:2009+A1 from a third certification organization.
In addition, EMC of the machine and system units must be evaluated according to the above EU and (or) other requirements.

6.6.1.5 Notes on the emergency stop circuit configuration

The power system in the amplifier is shut off by IGBT (transistor) and not by electro-mechanical means.
When configuring an emergency stop circuit, therefore, be sure to insert a line contactor to the power input line of amplifier for power feeding to allow electro-mechanical shut-off operation, so that voltage is applied to the control coil of the contactor via the contactor control output of amplifier.
If the amplifier fails, even when the emergency stop command input (*ESP) of the amplifier is driven low, the output relay of amplifier cannot sometimes be turned off, disabling the line contactor from being shut off.
To surely shut off power, besides the shut-off feature of the amplifier, the emergency stop circuit must have a redundant circuit structure that has an independent route for directly shutting off the line contactor when a command is issued from the emergency stop switch.
When a servo amplifier β*i*SVSP series is used, if the power line is shut off during spindle rotation, the power regeneration function may not be able to stop the spindle immediately, allowing the spindle to coast for a long time. So, the redundant circuit mentioned above must have a delay feature using an off-delay timer with a normal stop time taken into account.

6.6.1.6 Reduction of load ratio to ambient temperature

Some servo amplifier models have been approved as products conforming to standards with a load reduction ratio described below set.
If the load ratio is exceeded during use, the permissible temperature range of a part used may be exceeded, which can result in the issuance of an overheat alarm or decrease of the life of the part. So, the amplifier must be used so that the reduction characteristic is not exceeded.
For the load reduction ratio, refer to Section 3.2, “ENVIRONMENTAL CONDITIONS”.

6.6.1.7 Overload protection

An overload protection feature is provided as follows:

β*i*SVSP : The protection feature works when the maximum output continues for the spindle for at least 30 s or when the current level becomes 1.3 times as high as the rated current of the motor for a servo axis.

β*i*SV : The protection feature works when the current level becomes 1.3 times as high as the rated current of the motor for a servo axis.

6.6.1.8 External overload protection device

The servo amplifier is not equipped with a special protection device. To protect conductors, pay attention to the specifications of the power supply unit.

6.6.1.9 Over-speed protection

The servo amplifiers β*i*SV series and servo amplifiers β*i*SVSP series are not equipped with an over-speed protection device.

6.6.1.10 24-V power supply

Use a class 2 power supply as an external power supply. The class 2 power supply uses a transformer and other parts that are proven safety. For details, contact the power supply manufacturer.

6.6.1.11 Screw tightening torque

The screws of the servo amplifier are tightened with the following torque:

Screw size	Tightening torque (Nm)
M4	1.1 to 1.5
M5	2.0 to 2.5

6.6.2 Requirements of UL Standards

6.6.2.1 Classification in standards on insulation design

(1) Insulation between circuits and between a circuit and protective ground (UL508C 36)
According to requirements of UL508C, insulation design of the amplifier conforms to the requirements of UL840. Connect a protective ground cable to the ground terminal of the lower aluminum flange.

(2) Installation category (overvoltage category) (UL508C 36)
According to UL508C 36.9.4(c), this amplifier is designed to fall into installation category (overvoltage category) II, so an isolating-transformer must be installed in the power input section of the machine. Space distance is designed on the assumption that a power load applied when general equipment or a portable device, or equivalent is connected is applied to this amplifier.

(3) Pollution degree of the installation environment and protection class of the power magnetics cabinet (UL508C 36)
UL508C requires that when the machine is installed in the environment of ordinary plants, the power magnetics cabinet in which this amplifier is to be installed meet pollution degree class 2.
The servo amplifiers β*i*SV series and servo amplifiers β*i*SVSP series are open type devices that are not equipped with a complete enclosure.
If the power magnetics cabinet satisfies the above requirement, the degree of pollution inside the cabinet is considered to be class 2.
Insulation design of this amplifier assumes that the amplifier is installed in an environment with pollution degree 2.

When an external heat sink cooling type amplifier of which heat sink fin protrudes behind the mounting flange is used, the fin section must be in a cooling area (duct) conforming to around IP22 to IP33, and must be protected from being exposed to direct splashes of coolant, chips, and so forth.

6.6.2.2 Protection against electric shock

(1) Protection against direct contact with charged parts
This amplifier must be installed in a power magnetics cabinet.
The power magnetics cabinet must be equipped with a lock so that when the power to the amplifier is on, the power magnetics cabinet cannot be opened by persons except special maintenance personnel or persons authorized to do maintenance work who have been sufficiently trained in prevention of electric shock.
If the operator of the machine needs to open the power magnetics cabinet for some operations, the operator must be given thorough safety training, or a protection cover must be provided to prevent the operator from touching the amplifier.

(2) Confirmation of discharge of the electrolytic capacitor (UL508C 21)
This amplifier includes a large-capacity electrolytic capacitor for the power smoothing circuit. Even after the power supply input circuit is shut off, this capacitor remains charged for a while.
When it becomes necessary to touch the amplifier to do maintenance work or for other purposes, wait until the discharge time indicated on the face plate of the amplifier is passed, or start work after ensuring safety by measuring the residual voltage of the DC link section with a volt-ohm meter and checking that the LED (red) indicating charging is turned off.

6.6.2.3 Protective grounding

Connect all of the protective ground terminals to the protective ground (PE) terminal in the power magnetics cabinet.
For how to connect a protective ground cable and its cable diameter, refer to Section 6.2, "接地" and Subsection 9.2.7, “Details of Cable K2”.
Note that connecting a cable terminal to a protective ground point is not permitted.

6.6.2.4 Overload protection

An overload protection feature is provided as follows:

βiSVSP : The protection feature works when the maximum output continues for the spindle for at least 30 s or when the current level becomes 1.3 times as high as the rated current of the motor for a servo axis.

βiSV : The protection feature works when the current level becomes 1.3 times as high as the rated current of the motor for a servo axis.

6.6.2.5 External overload protection device

The servo amplifier is not equipped with a special protection device. To protect conductors, pay attention to the specifications of the power supply unit.

6.6.2.6 Short-circuit protection

The servo amplifiers βiSV series and servo amplifiers βiSVSP series of 200-V input are suitable for use with a power supply facility with 85000Arms or less/240V(max).
The servo amplifiers βiSV series of 400-V input are suitable for use with a power supply facility with 85000Arms or less/480V(max).

6.6.2.7 Over-speed protection

The ervo amplifiers βiSV series and servo amplifiers βiSVSP series are not equipped with an over-speed protection device.

6.6.2.8 24-V power supply

Use a class 2 power supply as an external power supply. The class 2 power supply uses a transformer and other parts that are proven safety. For details, contact the power supply manufacturer.

6.6.2.9 Screw tightening torque

The screws of the servo amplifier are tightened with the following torque:

Screw size	Tightening torque (Nm)
M4	1.1 to 1.5
M5	2.0 to 2.5

6.7 NOTES ON CUTTING FLUID (REFERENCE)

Cutting fluid containing highly active sulfur, oil-free cutting fluid called synthetic cutting fluid, or highly alkaline, water-soluble cutting fluid in particular significantly affect the CNC, motor or amplifier. Even when these components are protected from direct spraying of cutting fluid, problems as described below may arise. So special care should be taken.

- **Cutting fluid containing highly active sulfur**
  Some of cutting fluids containing sulfur include extremely highly active sulfur. If such a cutting fluid penetrates into the CNC, motor, or amplifier, it can corrode copper, silver, and other metallic materials of components, therefore resulting in component failures.

- **Synthetic cutting fluid with high permeability**
  Some synthetic type cutting fluids that use polyalkylene glycol (PAG) as a lubricant have extremely high permeability. Such cutting fluids easily penetrate into a motor even if it is well closed. When this type of cutting fluid penetrates into the CNC, motor, or amplifier, it can lead to insulation degrading and component failures.

- **Highly alkaline, water-soluble cutting fluid**
  Some cutting fluids that strengthen pH by alkanolamine show strong alkalinity of pH10 or higher when diluted to the standard level. If such a cutting fluid penetrates into the CNC, motor, or amplifier, it can cause a chemical reaction with plastic or other materials, therefore degrading the materials.

7 POWER FAILURE DETECTION FUNCTION

7.1 POWER FAILURE DETECTION FUNCTION

To the 2-axis servo amplifier β*i*SV series (β*i*SV20/20, β*i*SV40/40), a power failure detection function has been added to prevent a vertical axis from falling at a power failure. Add an uninterruptible power supply unit (UPS) and so on so that the control power supply (24 VDC) for the CNC and the amplifier can be maintained from the time a power failure occurs until the mechanical brake is operated.

[Specifications]

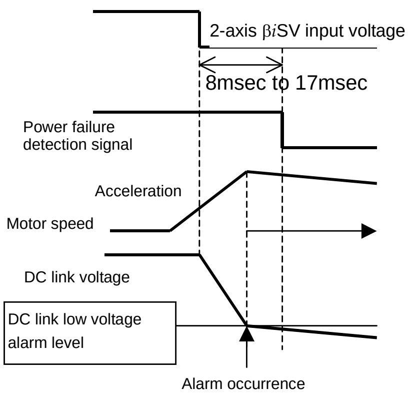
If a power failure is detected, a power failure detection signal is output from connector CX36.

A voltage drop of the three-phase 200 VAC input to connector CZ4 is detected.
CZ4 input voltage range: 0 to 240VAC +10%, 3ϕ, 50Hz/60Hz±2Hz

A detection delay time is provided so that the function is not overly sensitive to an instantaneous interruption.
Detection delay time: 8msec to 17msec

NOTE

The power failure detector detects simultaneous drops in three phases as a power failure. Under the following conditions, a power failure may not be detected properly.
There are cases in which a power failure in which a drop occurs in a single phase only (phase interruption) cannot be detected.
There are cases in which if a power failure occurs during motor acceleration, it cannot be detected. (See the figure below.)



The power failure detection signal is output from 2-axis β*i*SV 8 to 17 msec after the occurrence of a power failure. If the motor output is increasing due to acceleration, the DC link low voltage alarm may occur before the power failure is detected because the DC link voltage reduces abruptly after the occurrence of the power failure.

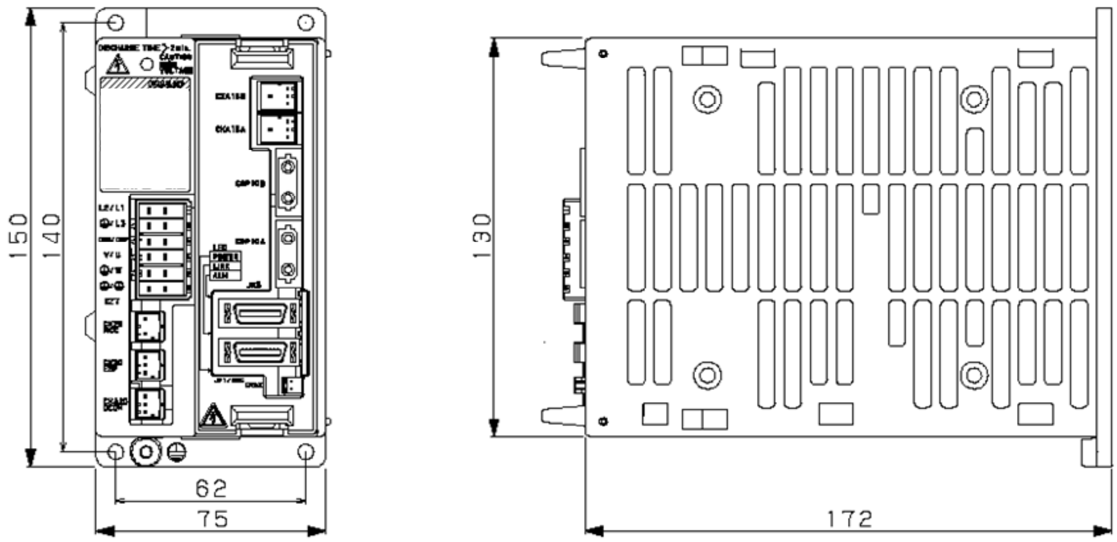
See Chapter 6, "POWER FAILURE DETECTION FUNCTION" in the Part II, "β*i*SVSP" for details.

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

8.1 EXTERNAL DIMENSIONS

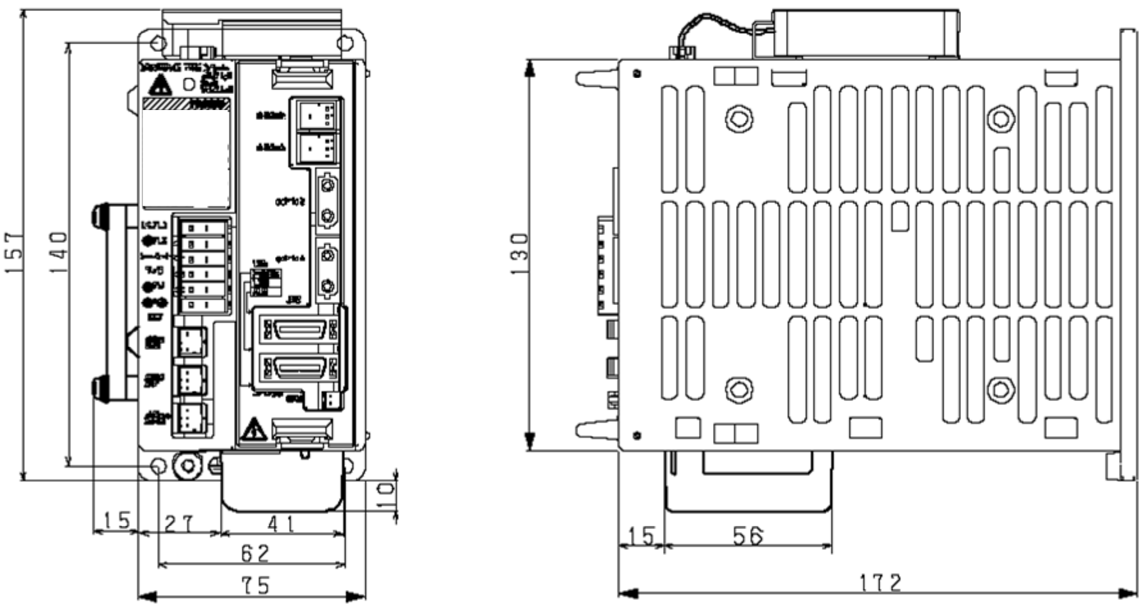
8.1.1 External Dimensions of β*i*SV4 and β*i*SV20

(1) Amplifier alone



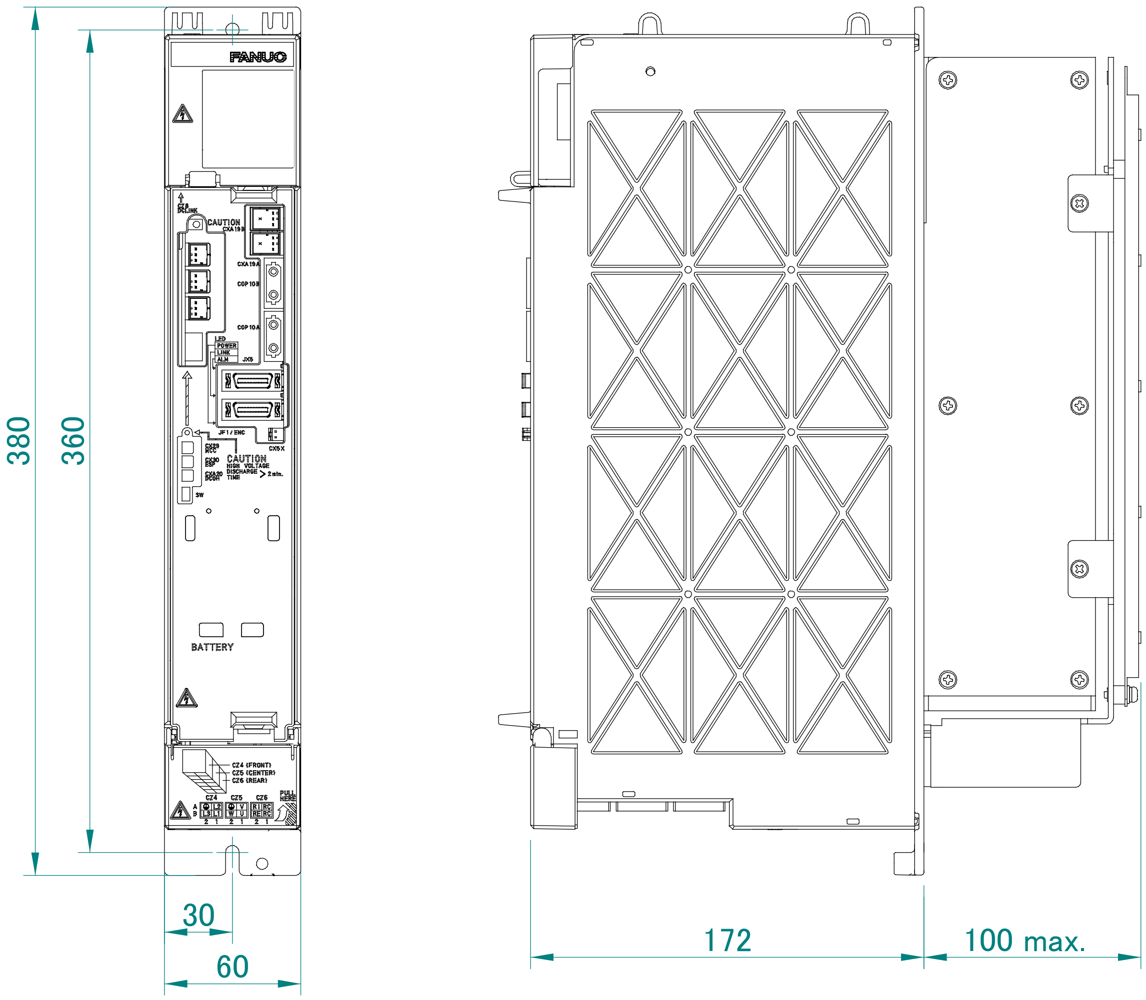
Weight : 1.2kg

(2) Amplifier with a separated regenerative discharge resistor, separated cooling fan motor, and battery attached



Weight : 1.3kg

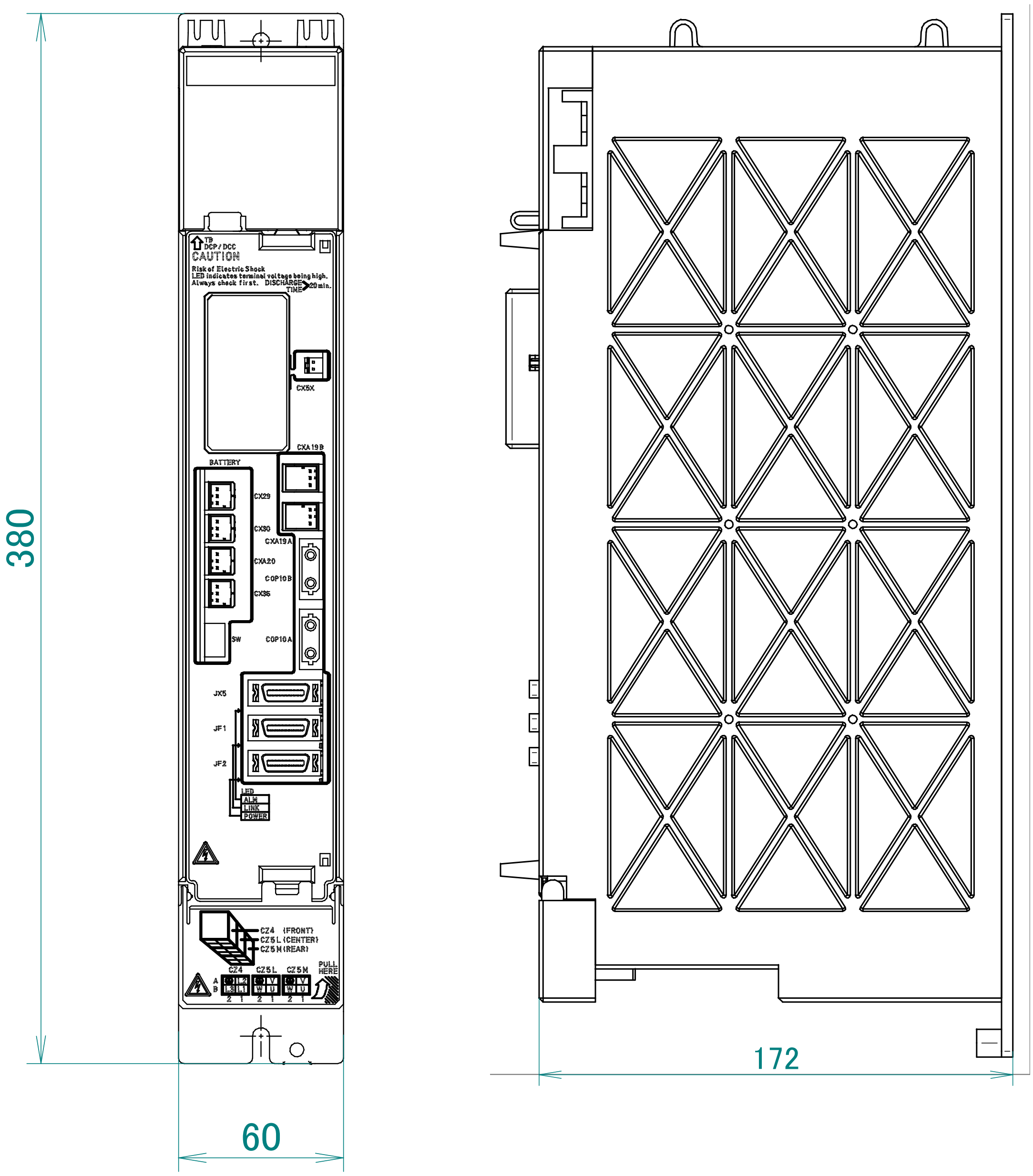
8.1.2 External Dimensions of βiSV40, βiSV80, βiSV10HV, βiSV20HV, and βiSV40HV



Weight : 3.9kg

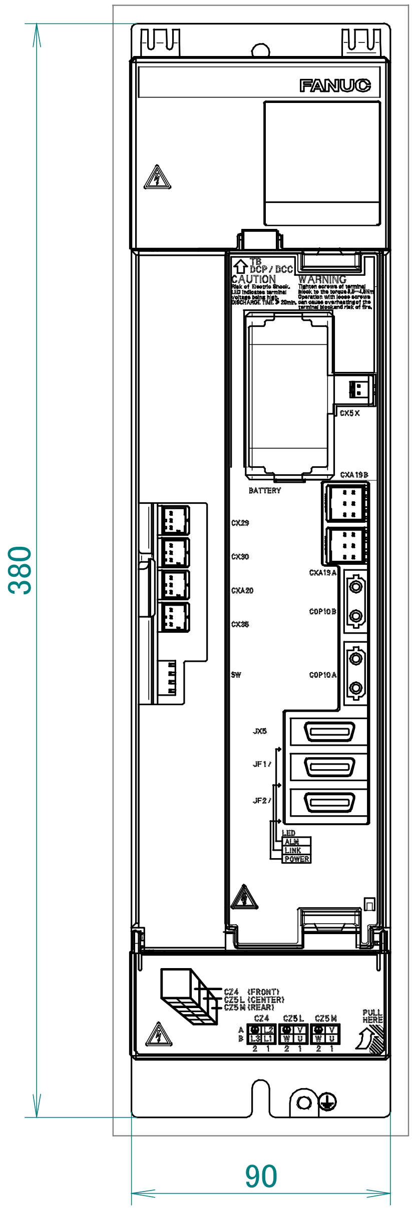
8.1.3 External Dimensions of β*i*SV20/20 and β*i*SV40/40

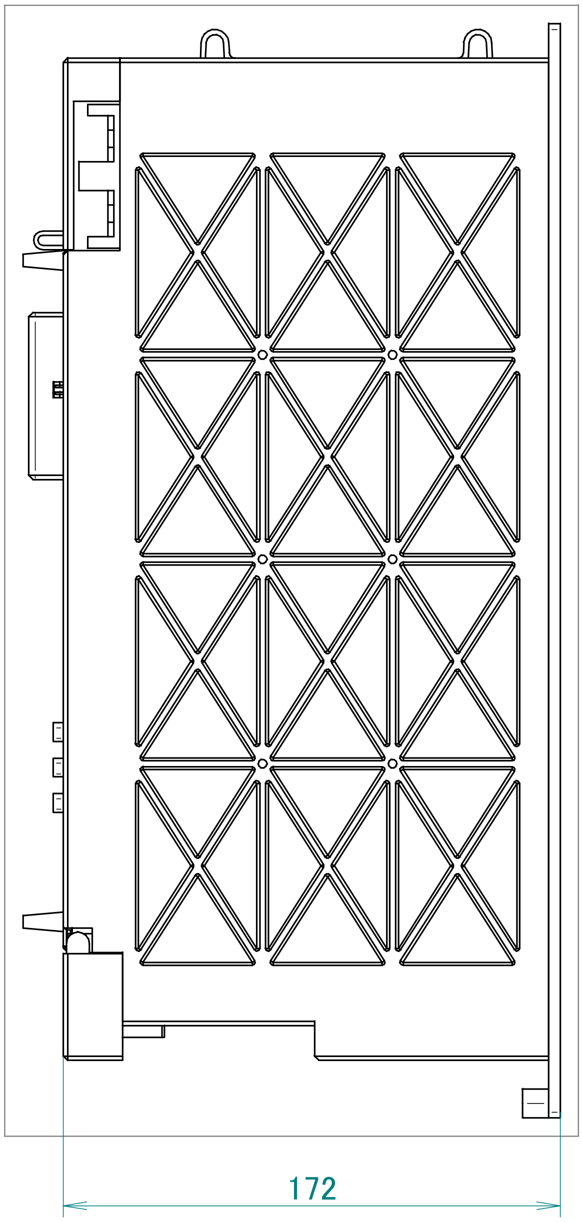
(a) β*i*SV20/20



Weight : 2.2kg

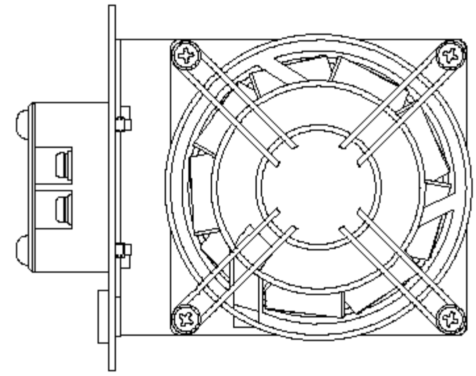
(b) β*i*SV40/40

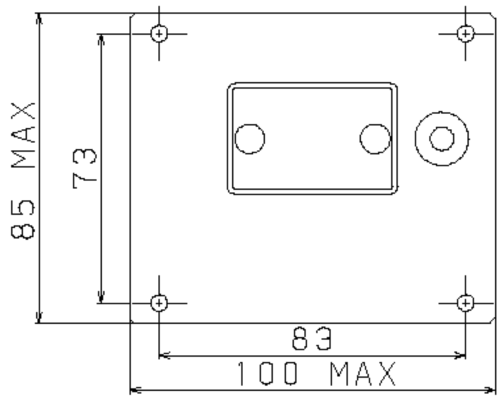


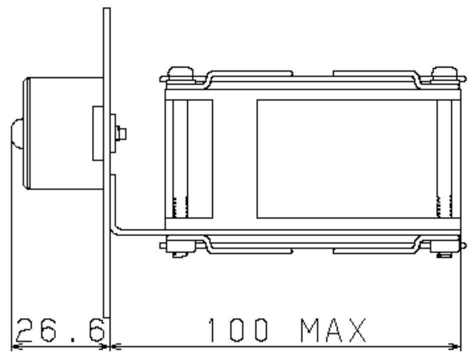


Weight : 3.0kg

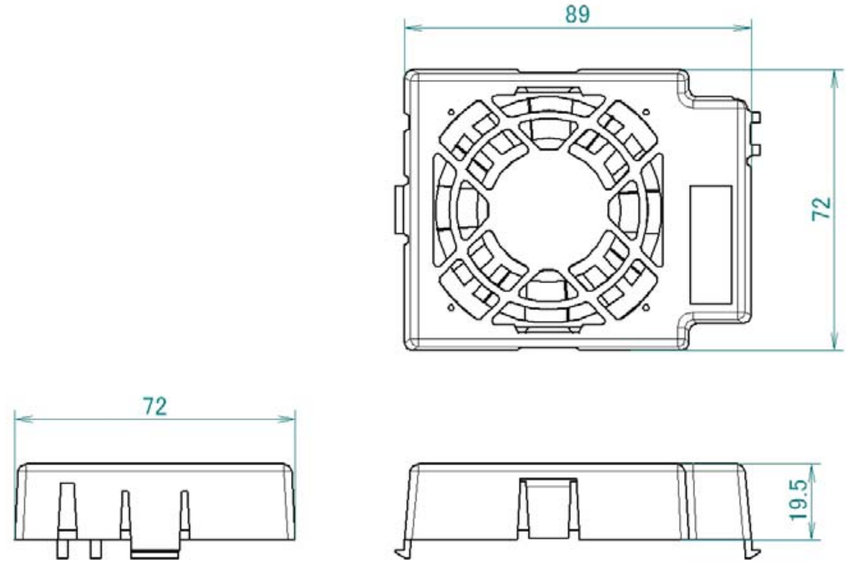
8.1.4 External Dimensions of Separated Cooling Fan Motor (A06B-6134-K002)

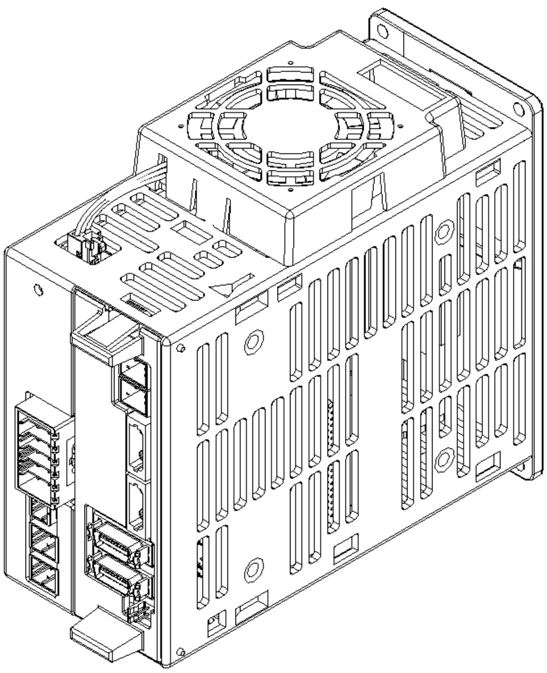






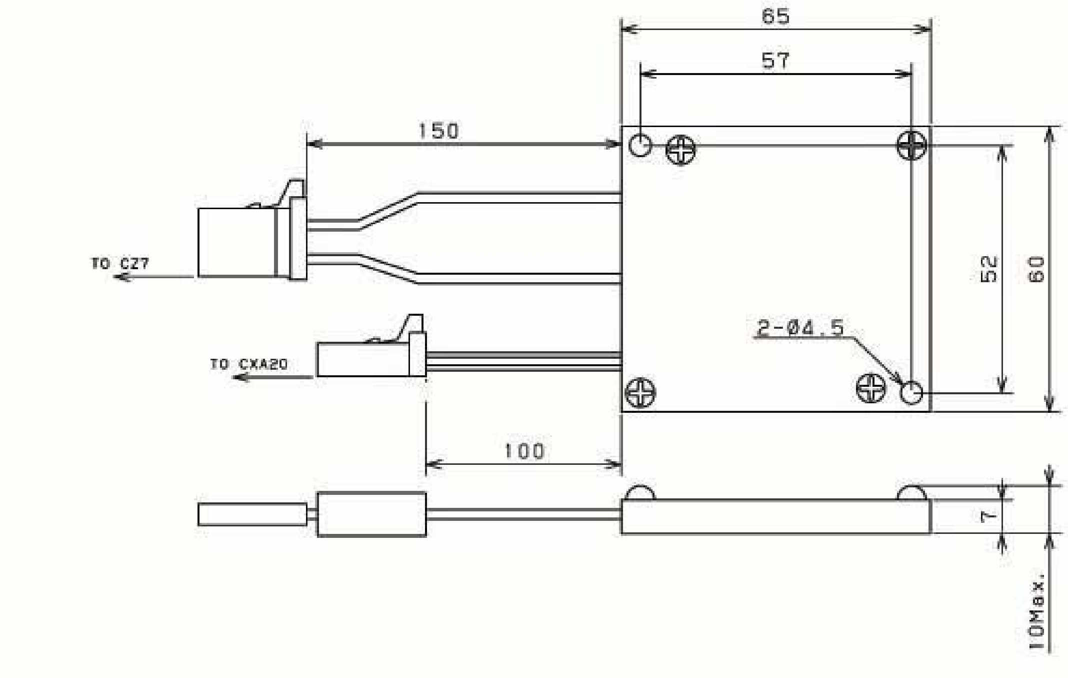
8.1.5 External Dimensions of Separated Cooling Fan Motor (A06B-6134-K005)





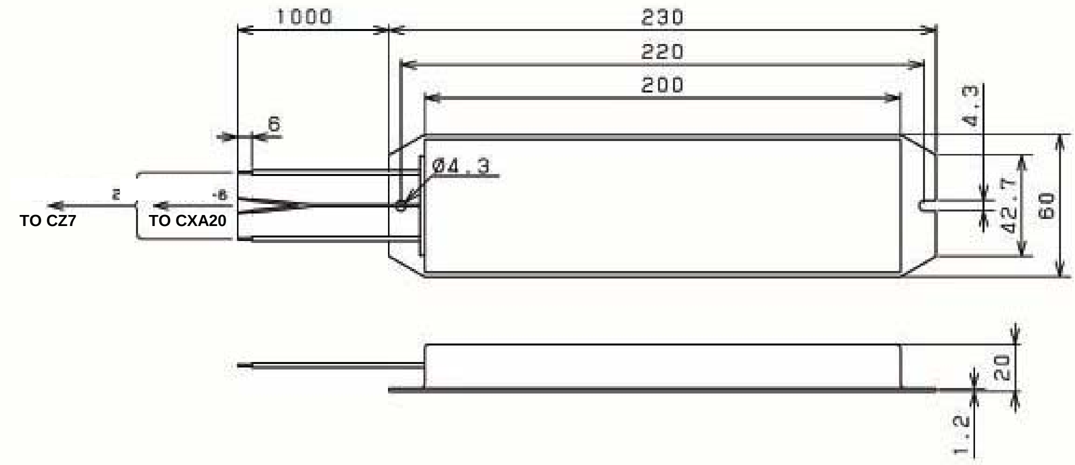
8.1.6 Separated Regenerative Discharge Resistor

(a) A06B-6130-H401



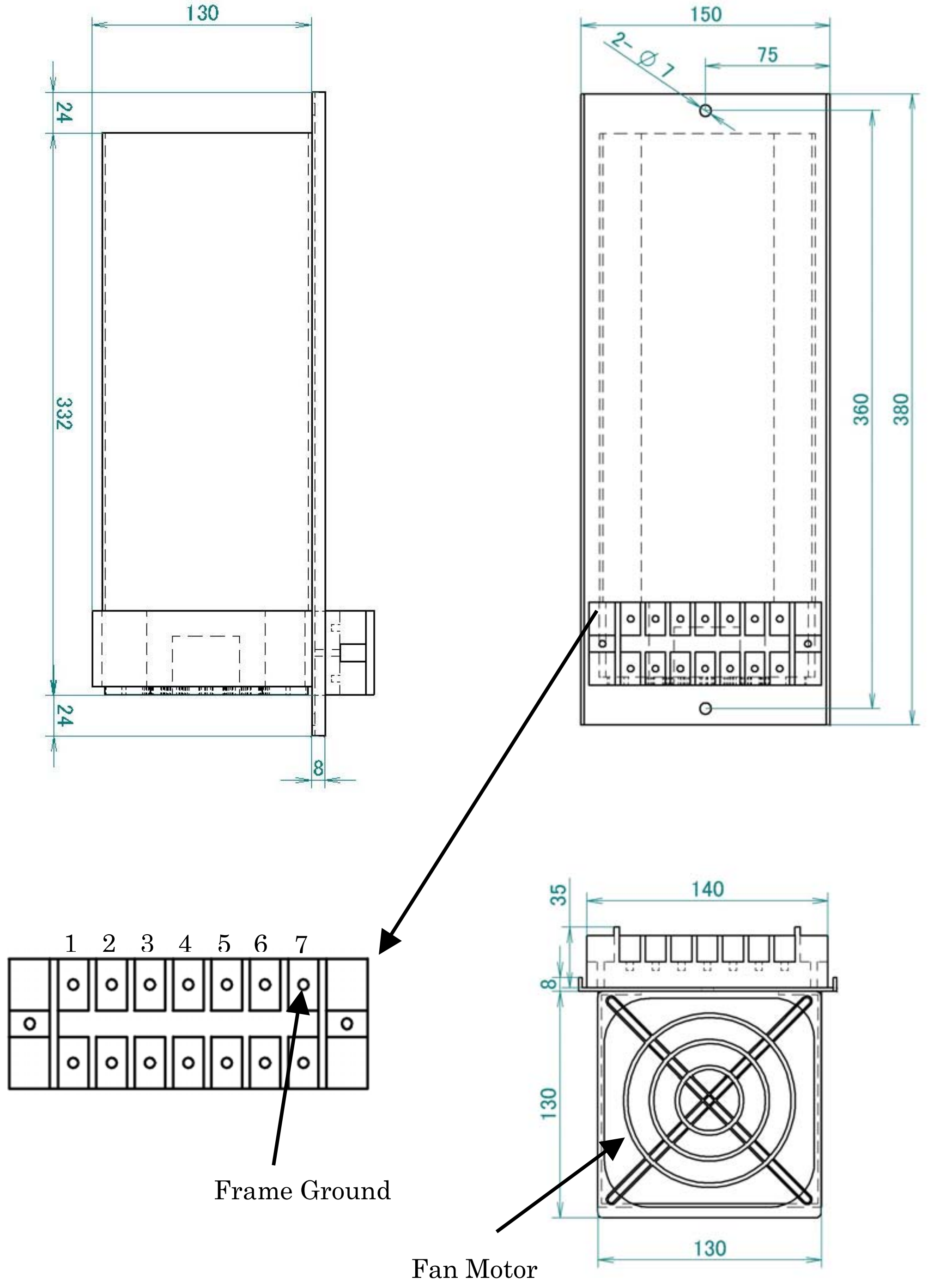
Weight : 0.07kg

(b) A06B-6130-H402

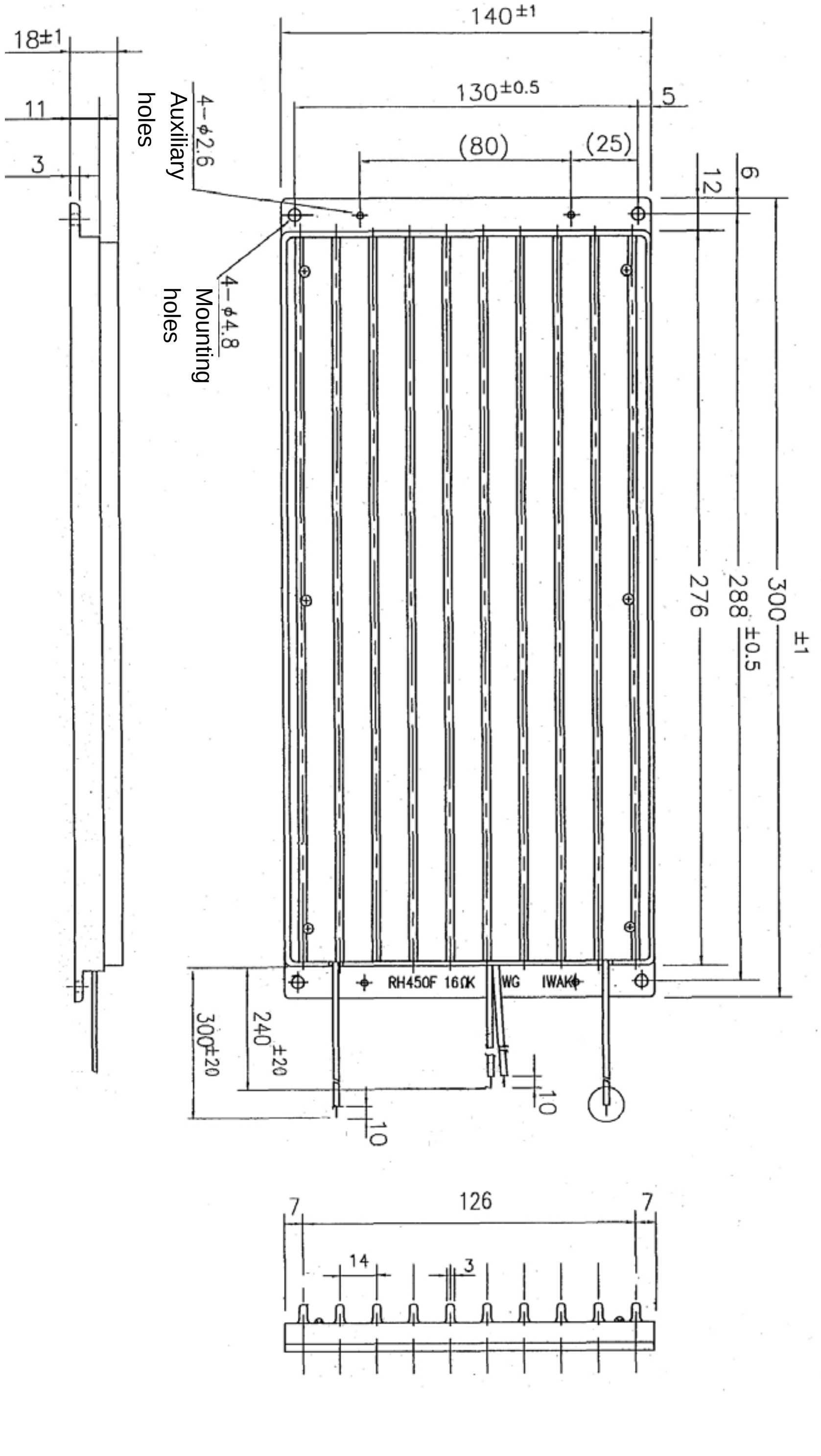


Weight : 0.5kg

(c) A06B-6130-H403, A06B-6089-H713 to H714

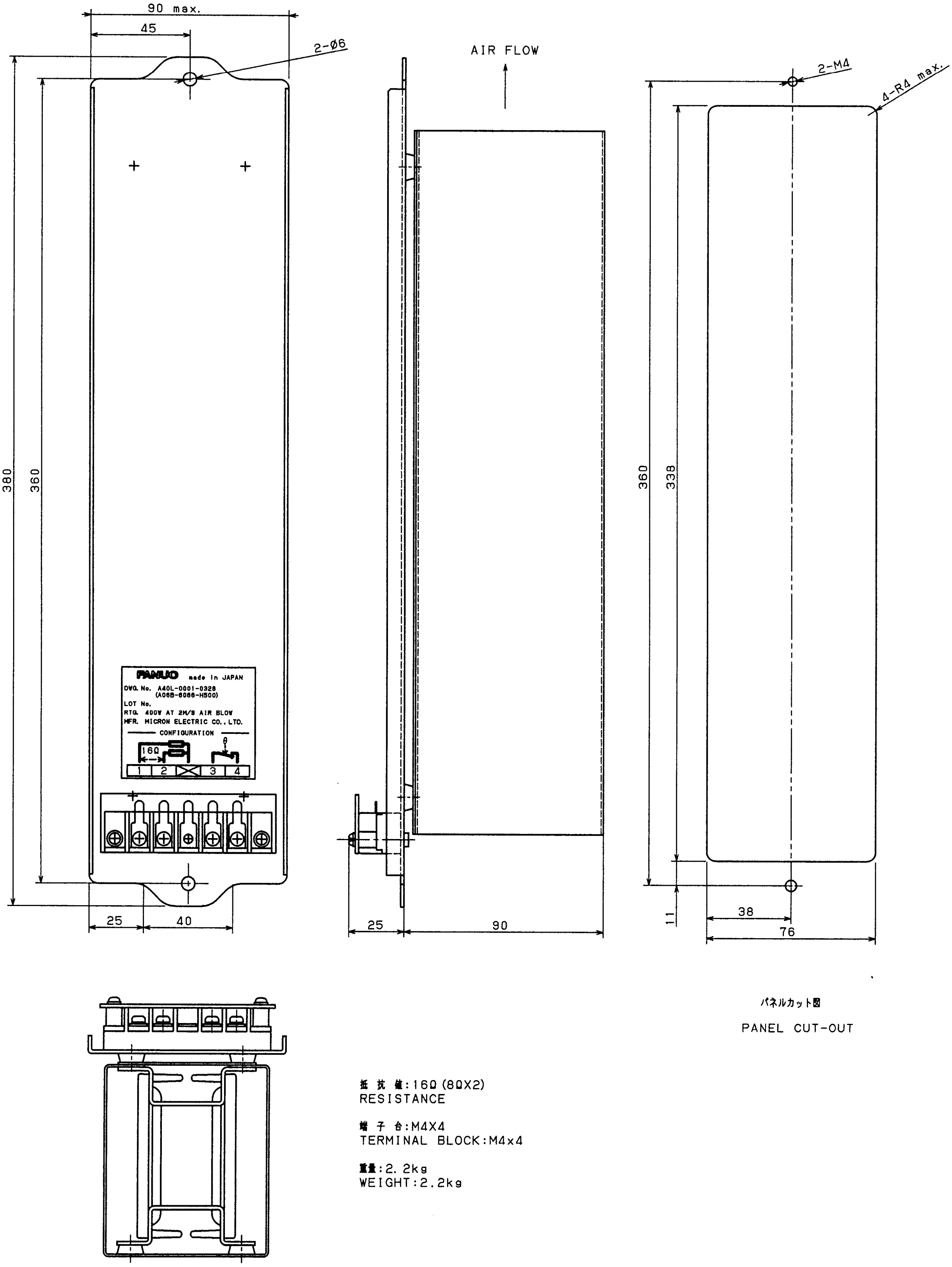


(d) A06B-6130-H404



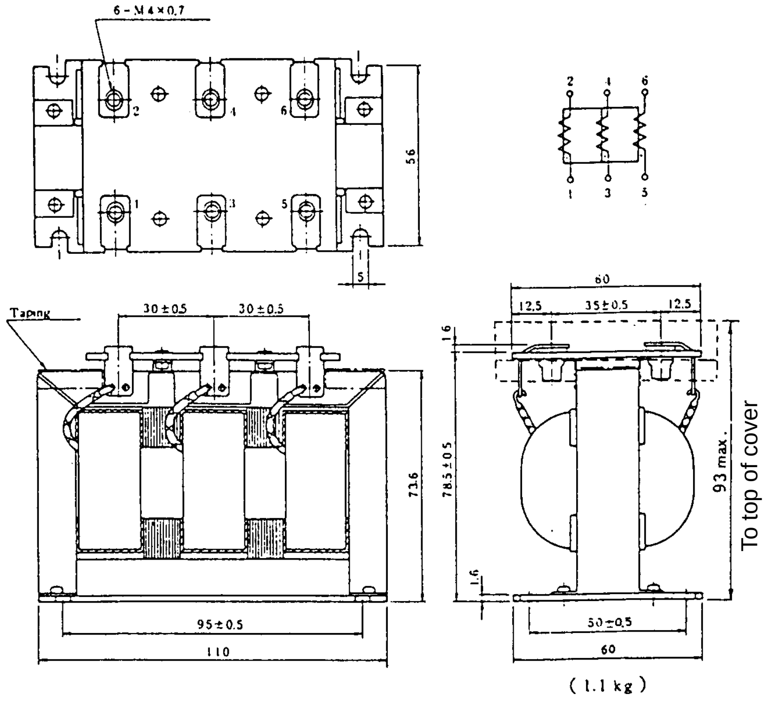
Weight : 1.2kg

(e) A06B-6089-H500

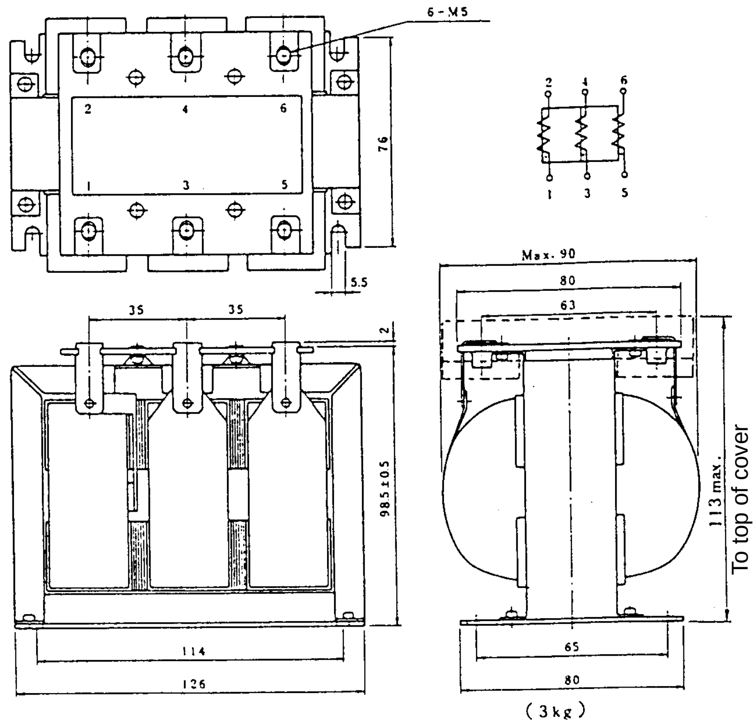


8.1.7 AC Line Filter

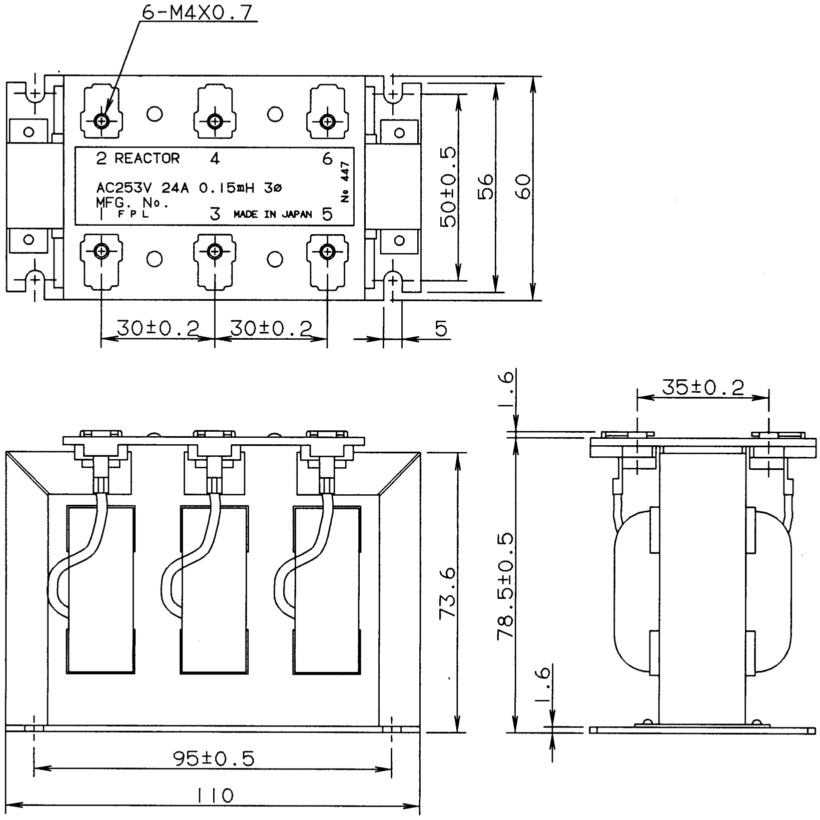
(a) A81L-0001-0171



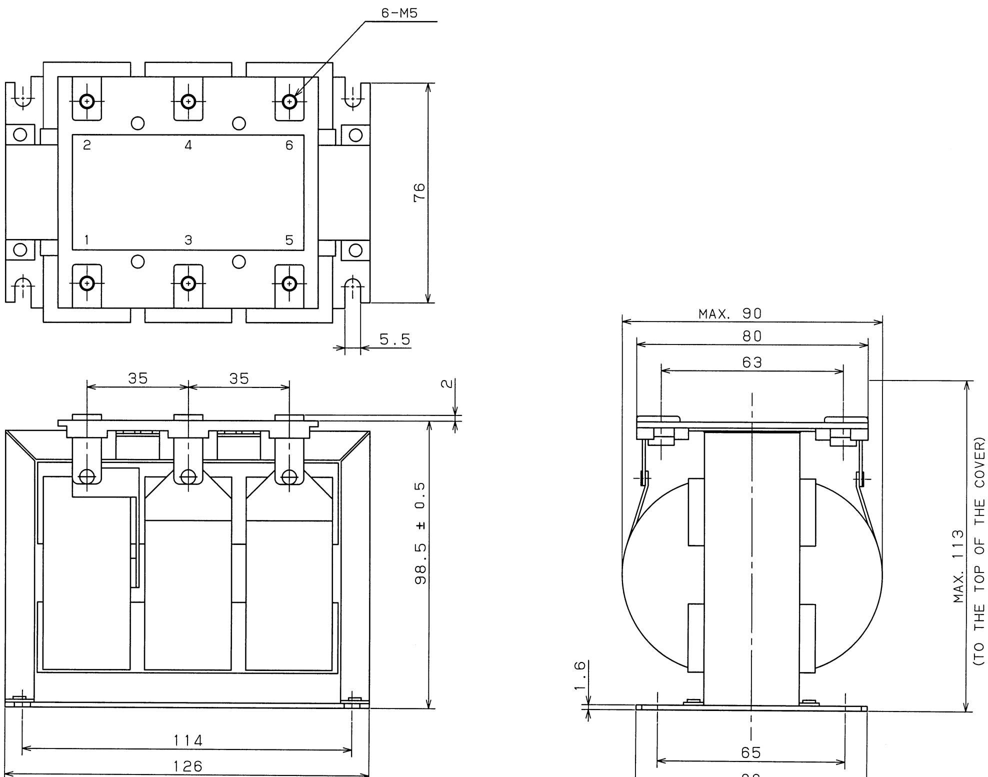
(b) A81L-0001-0101#C



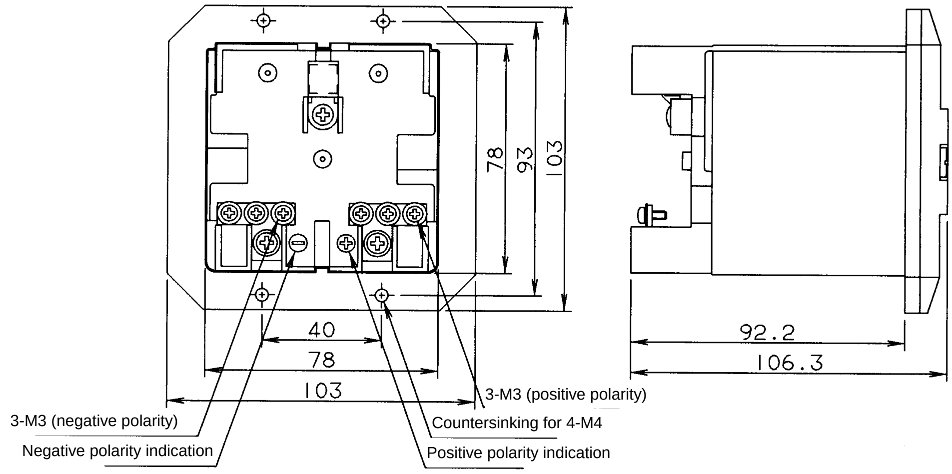
(c) A81L-0001-0168



(d) A81L-0001-0169

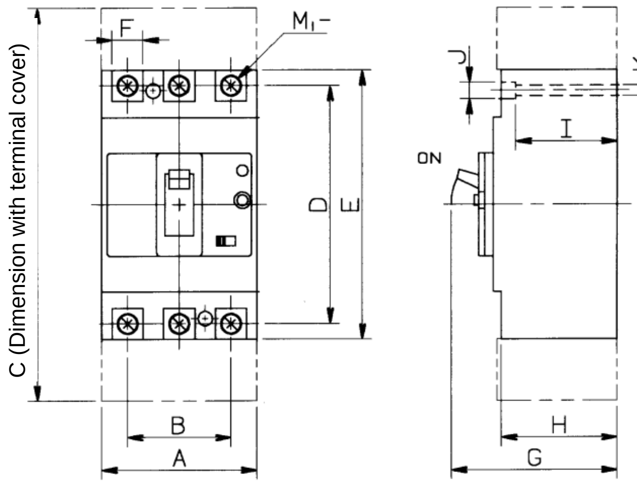


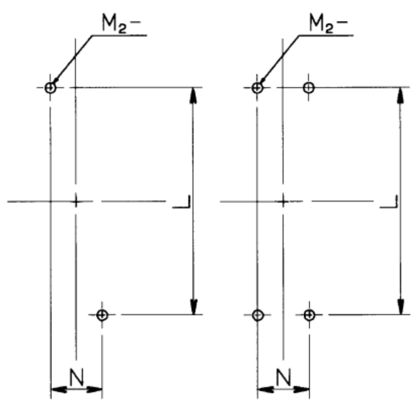
8.1.8 Battery Case



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	180	84	100	M5	17	84	60	43	ϕ7.8	ϕ4.9	84	M4	25	2 positions
(b)	A06B-6077-K106	75	50	180	84	100	M5	17	84	60	43	ϕ7.8	ϕ4.9	84	M4	25	2 positions



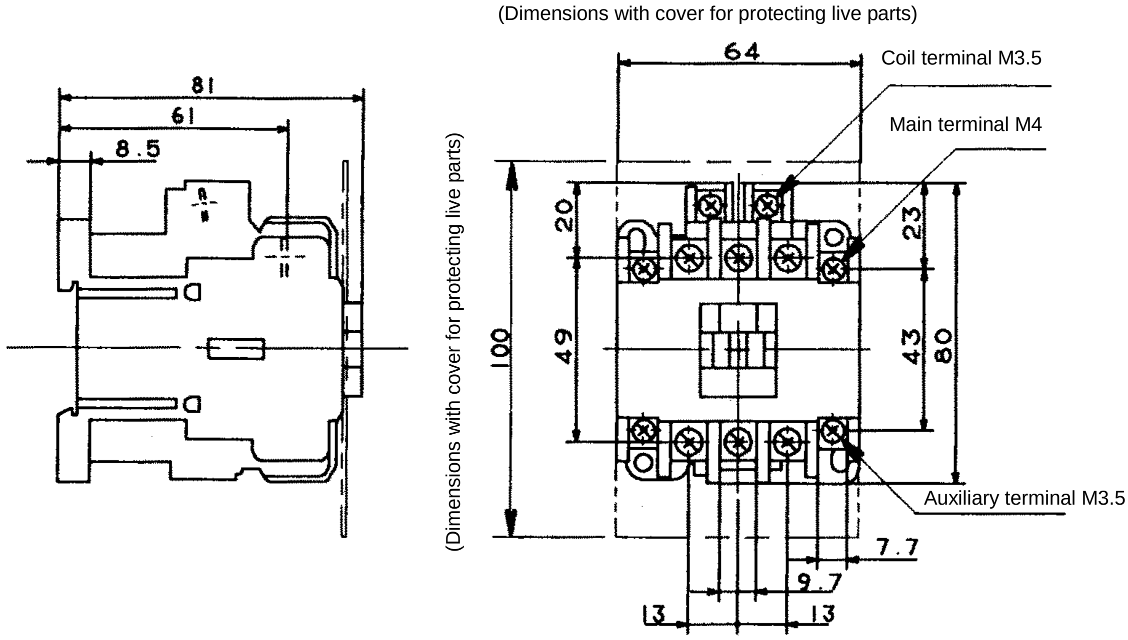


Two mounting holes Four mounting holes

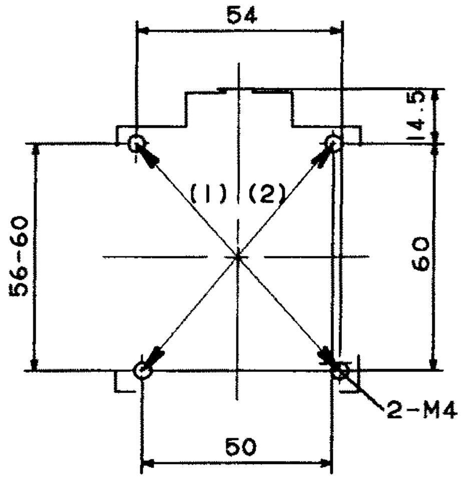
The circuit breakers have two or four mounting holes.

8.1.10 Magnetic Contactors

(a) A06B-6077-K121



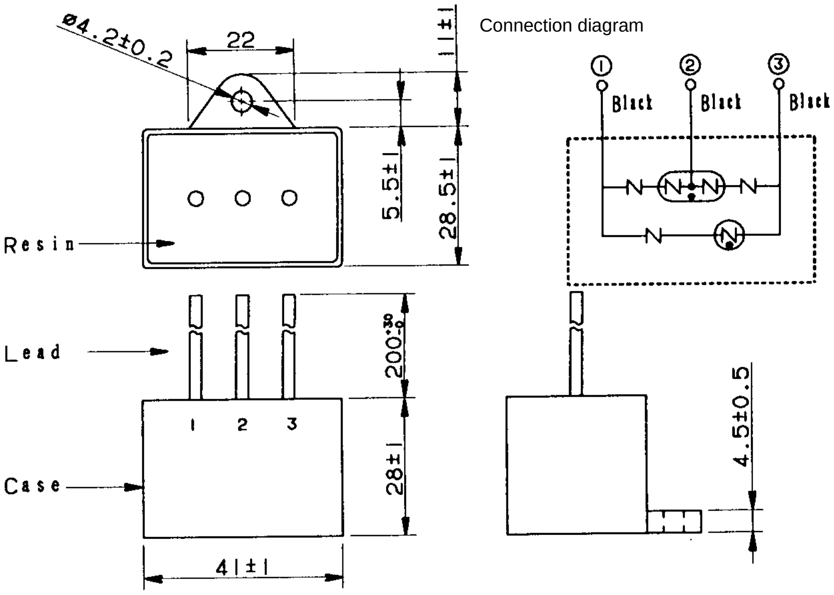
Dimensions for drilling mounting holes
Mounting (1) and (2) are possible.
(1) : 54X56-60
(2) : 50X60



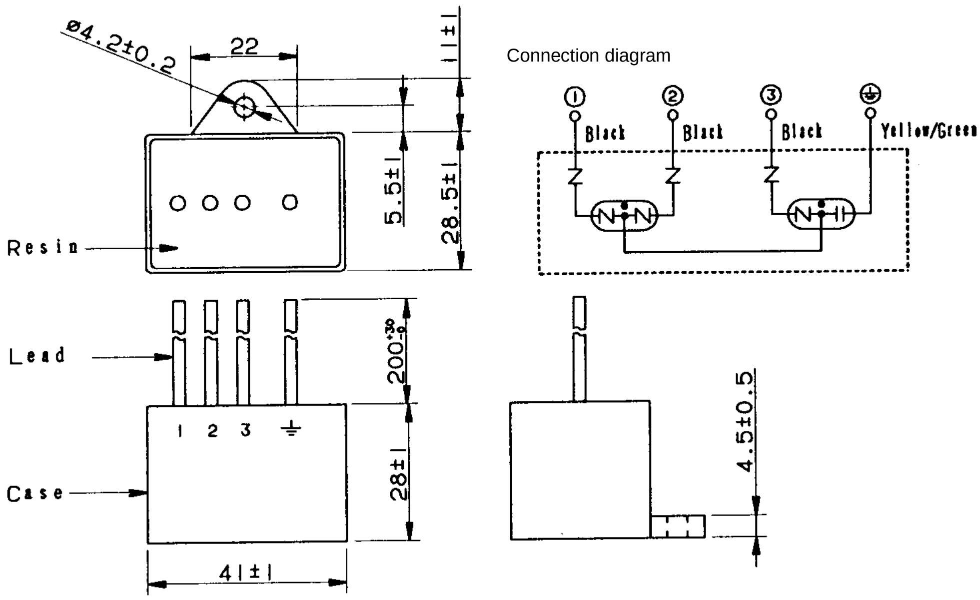
Ordering drawing number	Fuji Electric part number		Operation coil voltage	Auxiliary contact structure	Weight
	Body	Cover			
A06B-6077-K121	SC-5-1	SZ-JC4	200V/50Hz 200-220V/60Hz	1a1b	0.38Kg

8.1.11 Lightning Surge Protector

(a) A06B-6077-K142



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

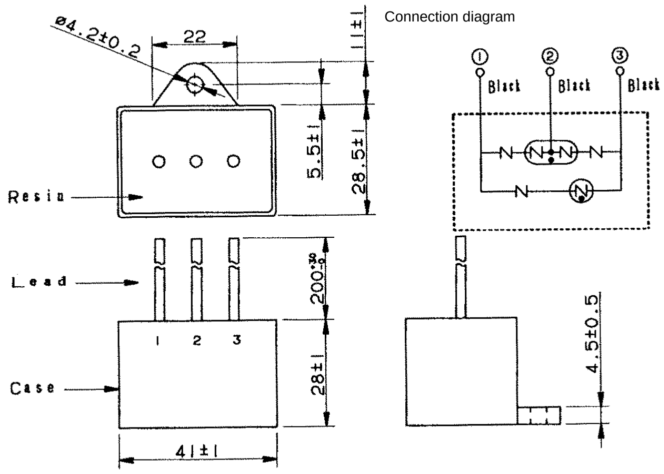


(2) For line-to-ground installation: RAV-781BXZ-4

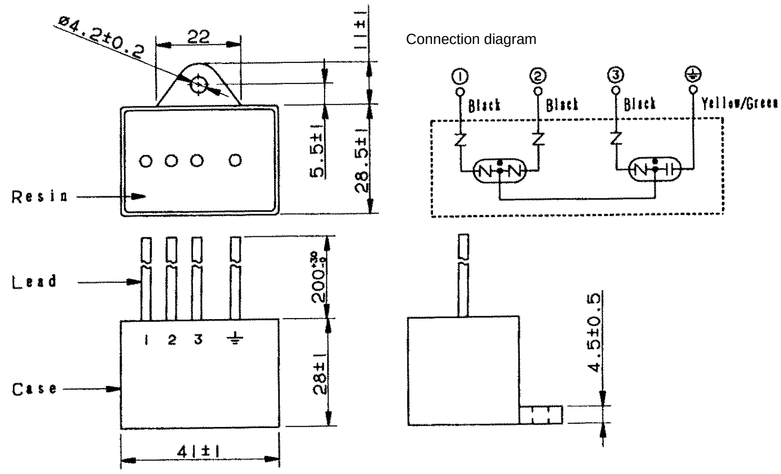
Specification	Rated voltage	Clamp voltage	Surge withstand current	Surge withstand voltage
RAV-781BYZ-2	250VAC	783VDC±10%(V1.0)	2500A(8/20µS)	20kV(1.2/50µS)

Specification	Rated voltage	AC discharge start voltage	Surge withstand current	Maximum surge discharge start voltage
RAV-781BXZ-4	line-to-line: 430VAC, line-to-ground: 250VAC	700VAC±20%(Ua)	2500A(8/20µS)	2.0kV(1.2/50µS)

(b) A06B-6077-K143



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

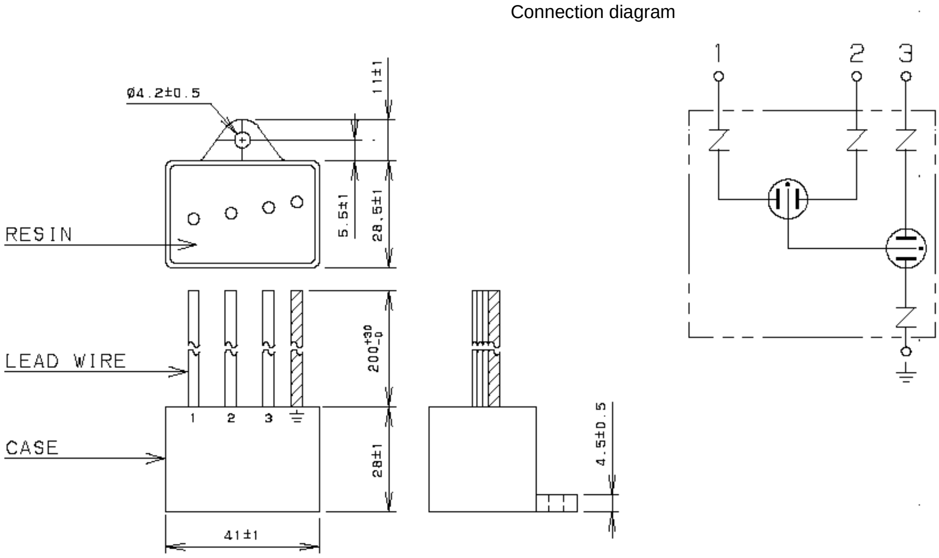


(2) For line-to-ground installation: RAV-801BXZ-4

Specification	Rated voltage	Clamp voltage	Surge withstand current	Surge withstand voltage
RAV-152BYZ-2A	460VAC+15%	1470V±10%(V1.0)	2500A(8/20μS)	20kV(1.2/50μS)

Specification	Rated voltage	AC discharge start voltage	Surge withstand current	Maximum surge discharge start voltage
RAV-801BXZ-4	line-to-line: 500VAC, line-to-ground: 290VAC	800VAC±20%(Ua)	2500A(8/20μS)	2.32kV(1.2/50μS)

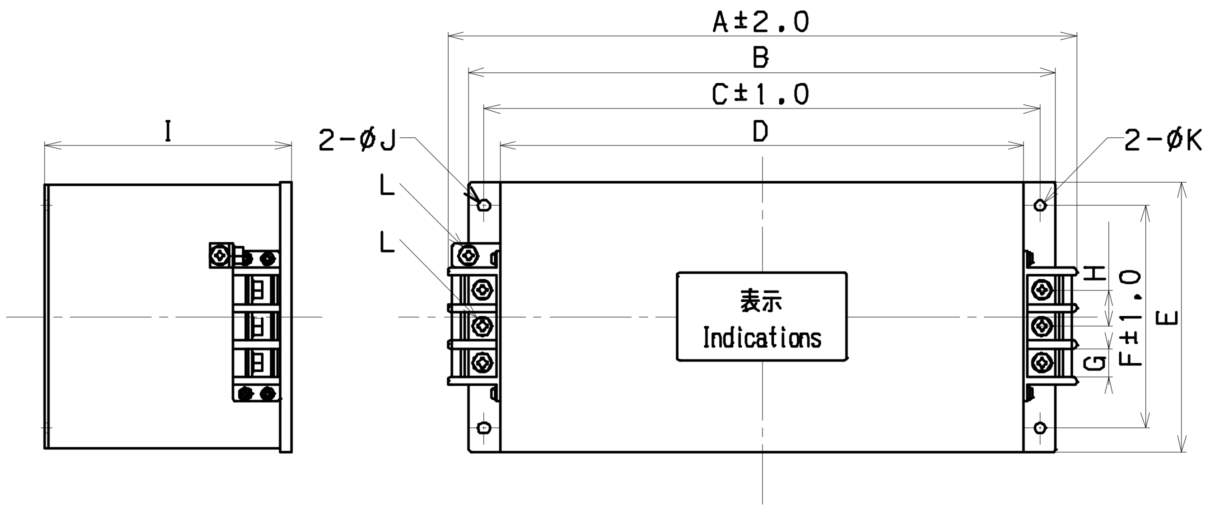
(c) A06B-6077-K144



Specification	Rated voltage	AC discharge start voltage	Clamp voltage	Surge withstand current	Surge withstand voltage	Maximum surge discharge start voltage
RCM-601BUZ-4	250VAC	560VAC ±20%(Ua)	2000V ±10%(V1.0)	2500A (8/20μS)	20kV (1.2/50μS)	2kV (1.2/50μS)

8.1.12 Noise Filter

(a) A06B-6077-K155



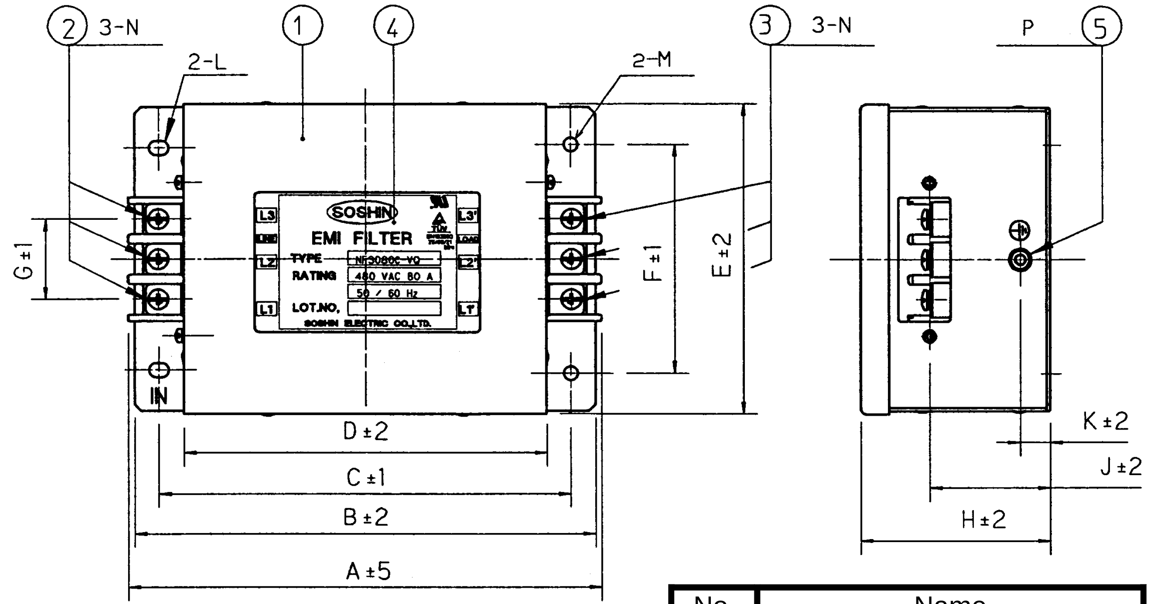
Unit : mm

General tolerance : ±1.5mm

Type	Dimensions (mm)											
	A	B	C	D	E	F	G	H	I	J	K	L
A06B-6077-K155 (3SUP-HL30-ER-6)	246	230	215	200	100	85	13	18	140	4.5×7	4.5	M4

3SUP-HL30-ER-6: External dimensions of noise filter

(b) A06B-6110-K160



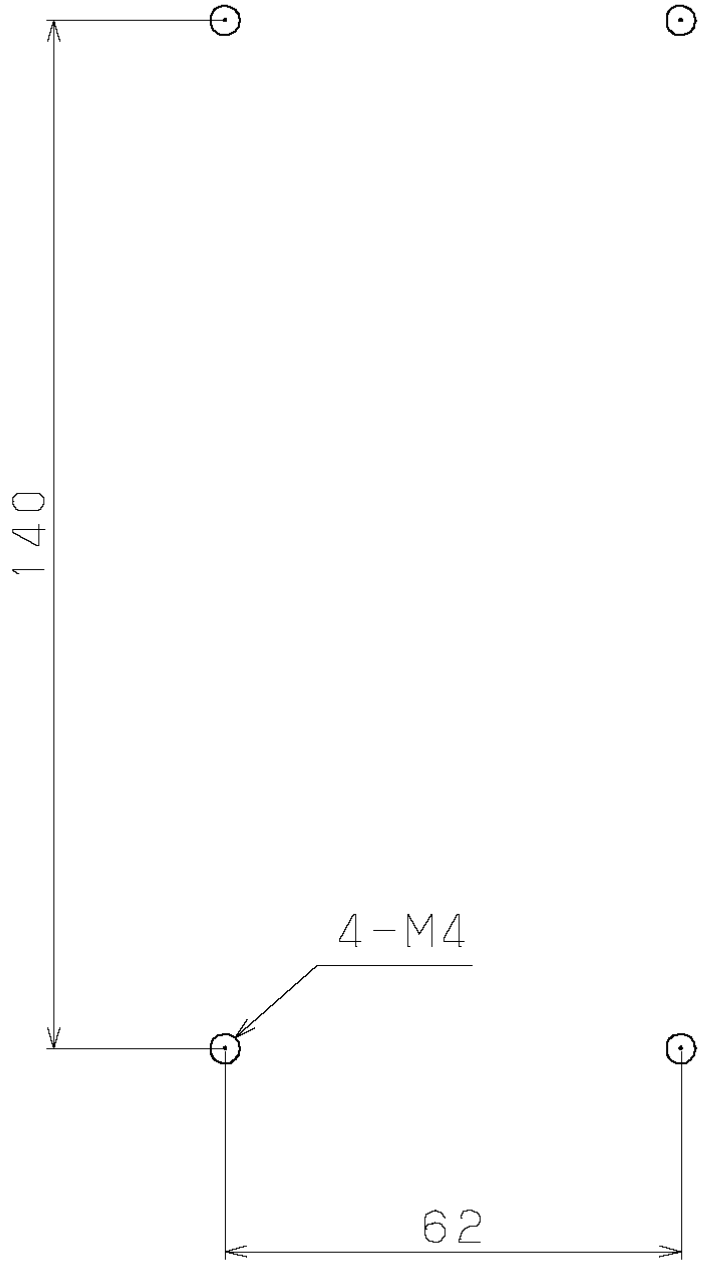
No.	Name
1	Case
2	Input terminal
3	Output terminal
4	Name plate
5	Earth terminal

Type	Dimensions (mm)													
	A	B	C	D	E	F	G	H	J	K	L	M	N	P
A06B-6110-K160 (NF3050C-VQ)	217	200	185	170	120	90	44	115	85	20	5.5×7	ϕ5.5	M6	M4

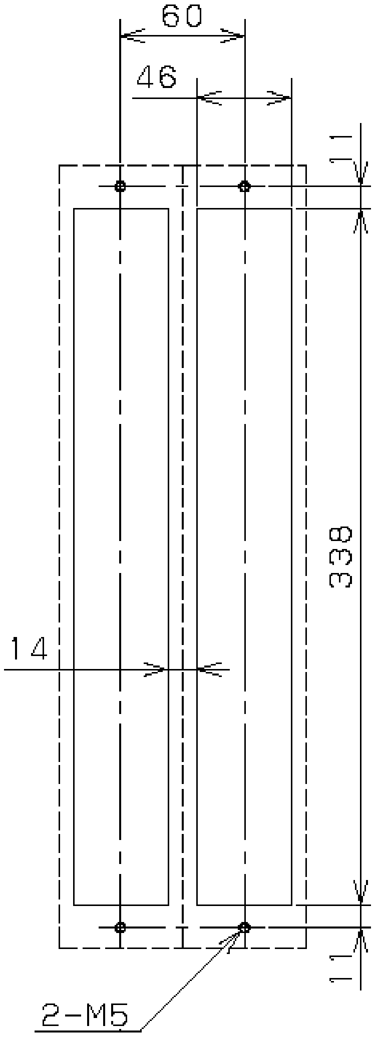
NF3050C-VQ: External dimensions of noise filter

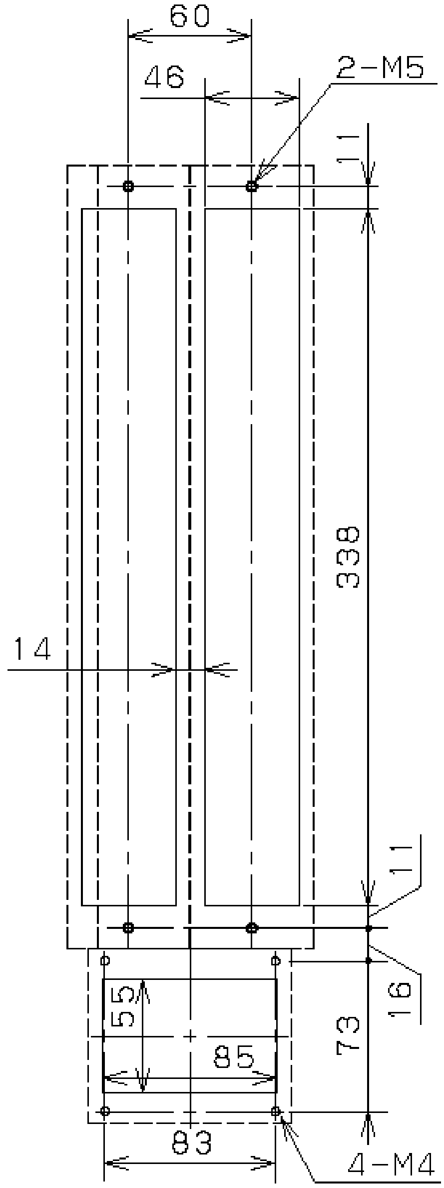
8.2 PANEL CUT-OUT

8.2.1 β*i*SV4 and β*i*SV20



8.2.2 β*i*SV40, β*i*SV80, β*i*SV10HV, β*i*SV20HV, and β*i*SV40HV

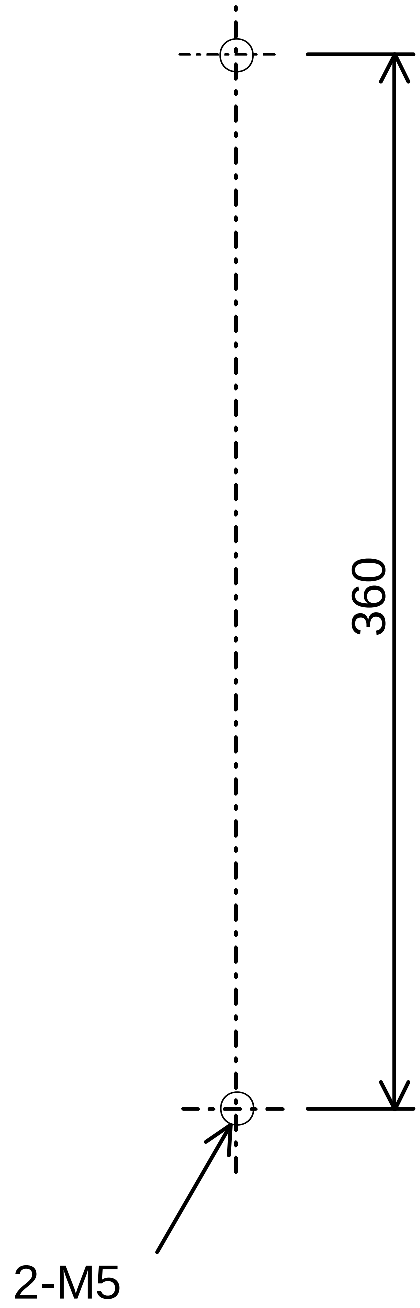




NOTE

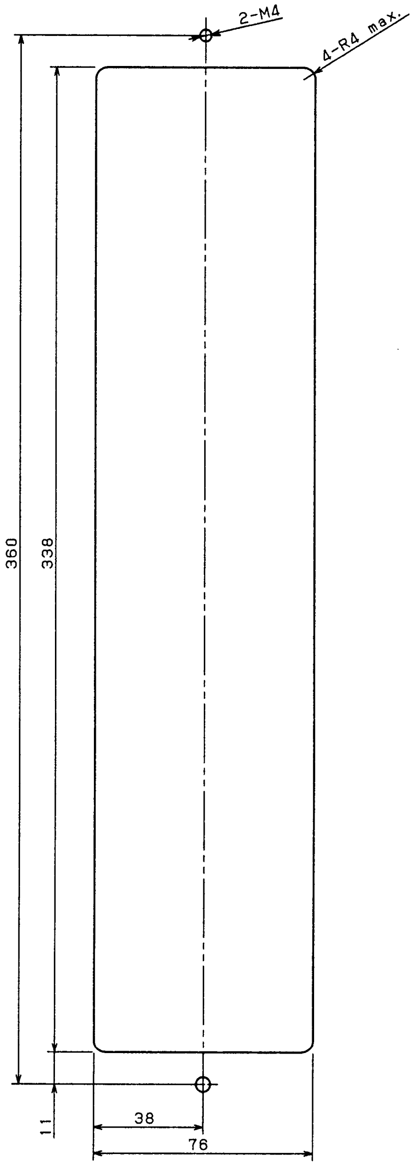
Attach the supplied gasket around the panel cut-out to prevent oil and dust from getting into it.
Reinforce the right and left sides of the panel cut-out in the power magnetics cabinet by using fittings such as angles to maintain satisfactory contact between the sheet metal of the power magnetics cabinet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

8.2.3 β*i*SV20/20 and β*i*SV40/40



8.2.4 Separated Regenerative Discharge Resistor

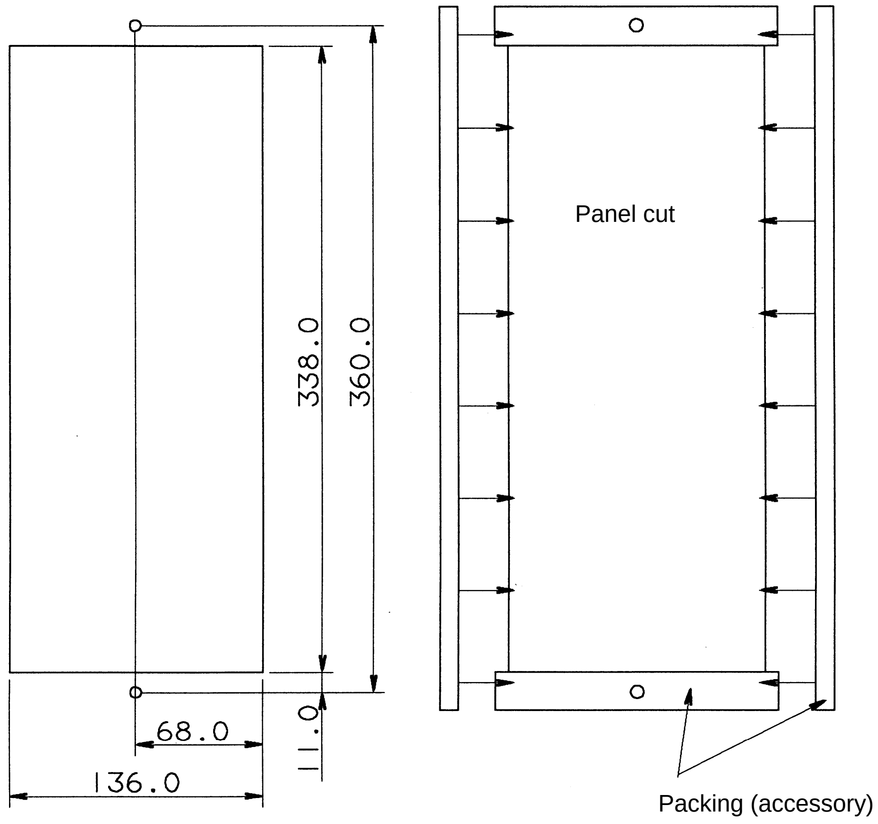
(a) A06B-6089-H500



パネルカット図
PANEL CUT-OUT

> **NOTE**
> Attach a packing (acrylonitrile-butadiene rubber, NBR (soft type)) for protection against oil and dust.

(b) A06B-6130-H403,A06B-6089-H713 to H714

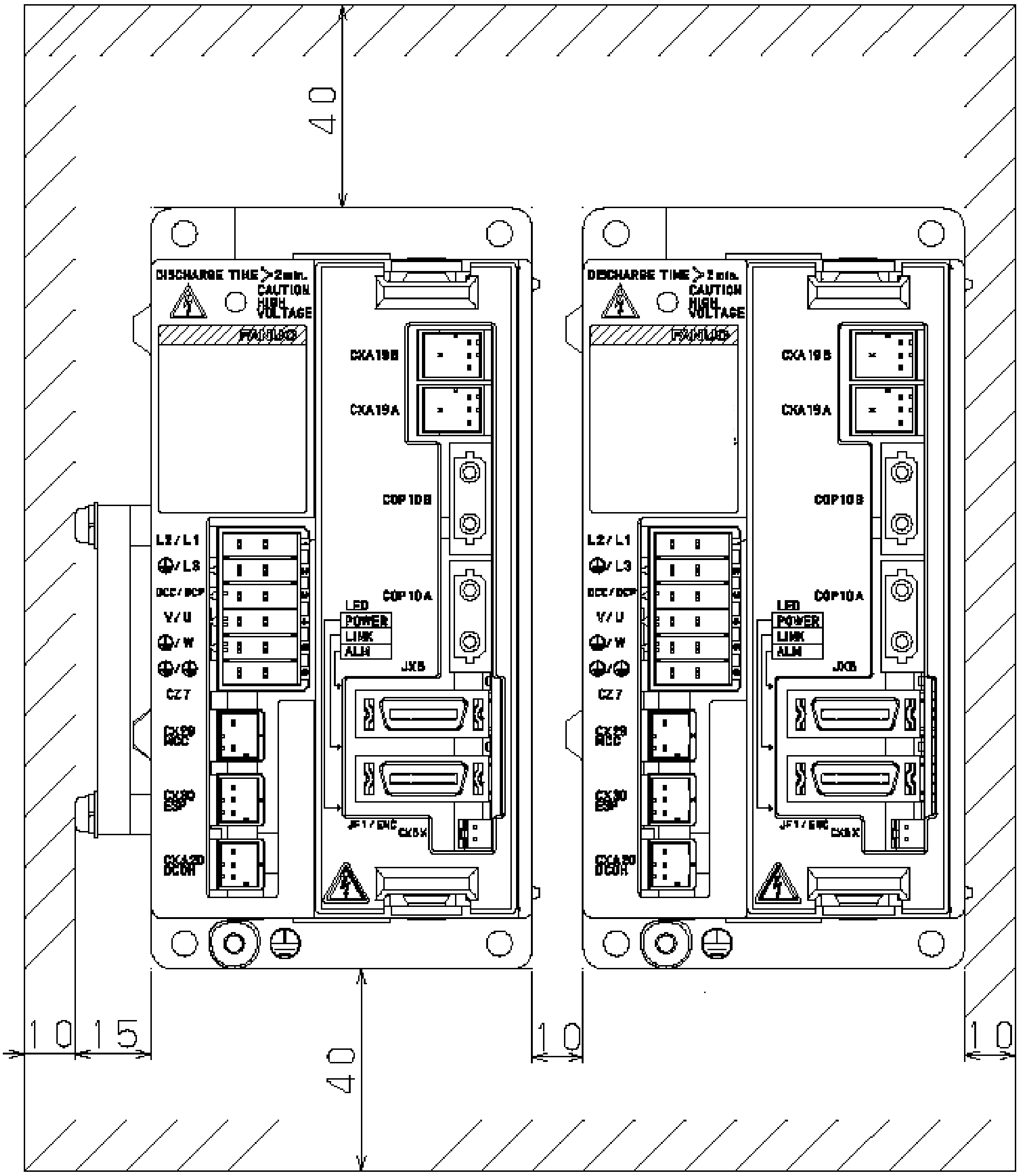


Panel cut

> **NOTE**
> Attach a packing (acrylonitrile-butadiene rubber, NBR (soft type)) for protection against oil and dust.

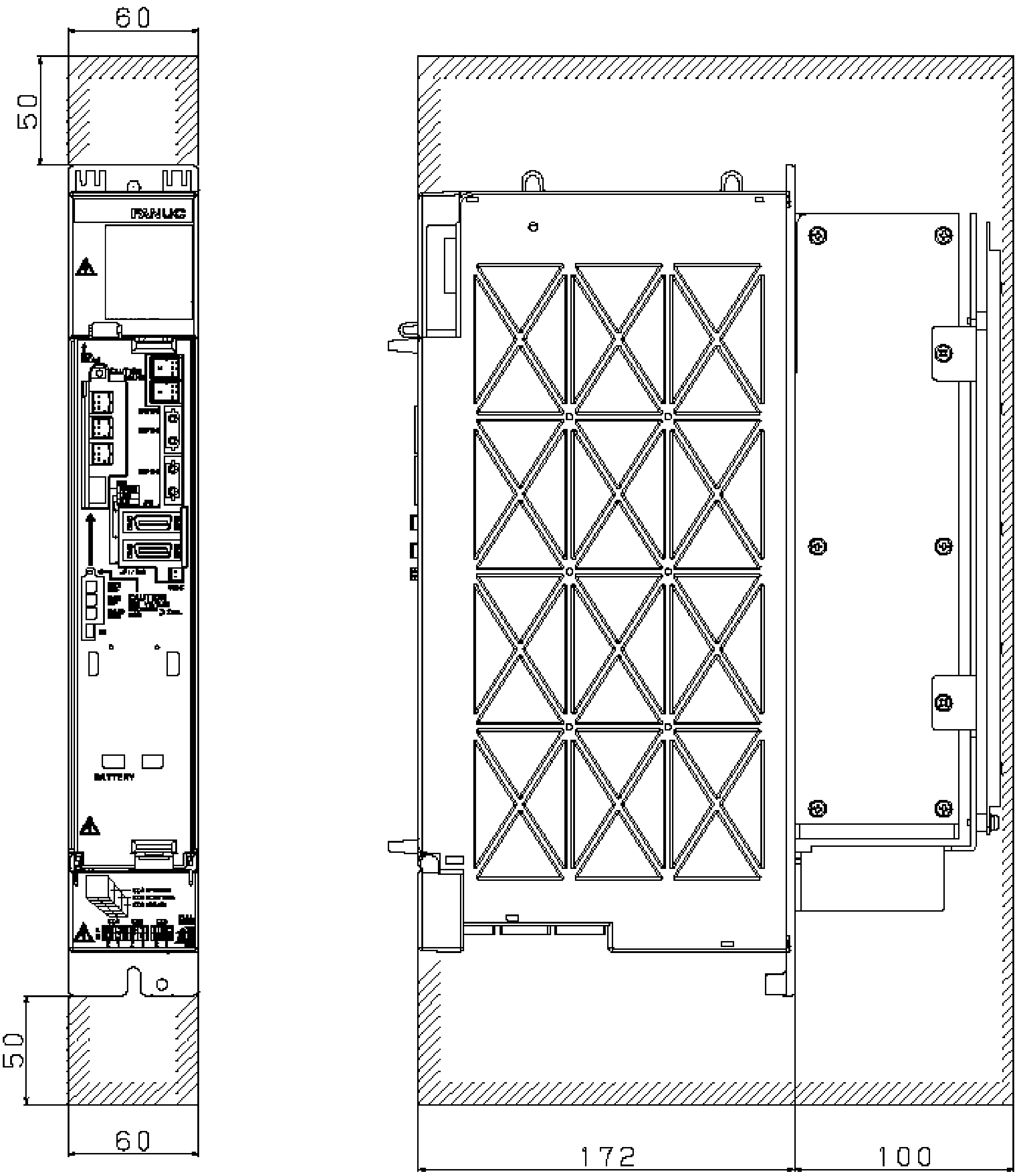
8.3 MAINTENANCE AREA

8.3.1 Maintenance Area for the β*i*SV4 and β*i*SV20

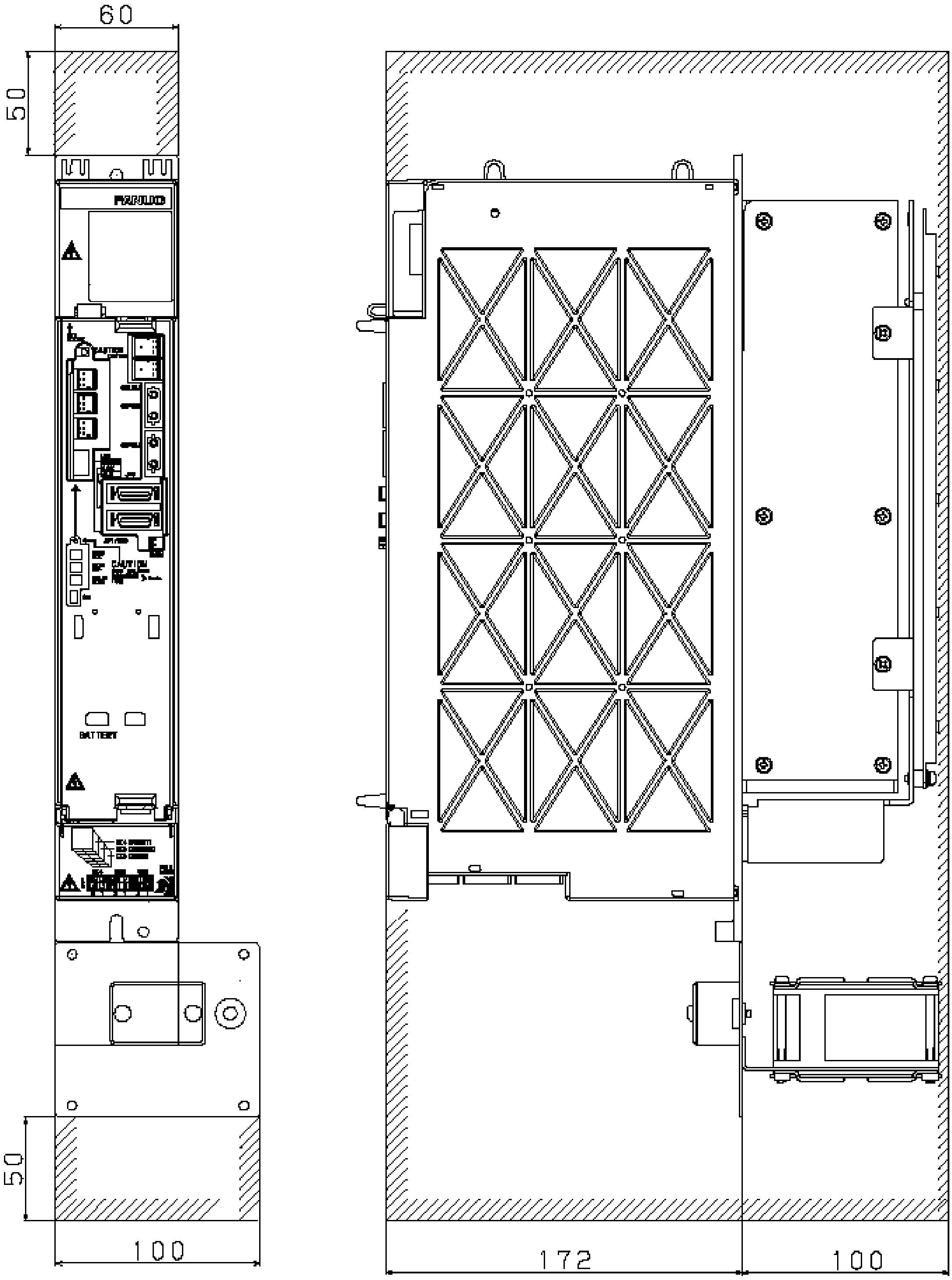


8.3.2 Maintenance Area for the β*i*SV40, β*i*SV80, β*i*SV10HV, β*i*SV20HV, and β*i*SV40HV

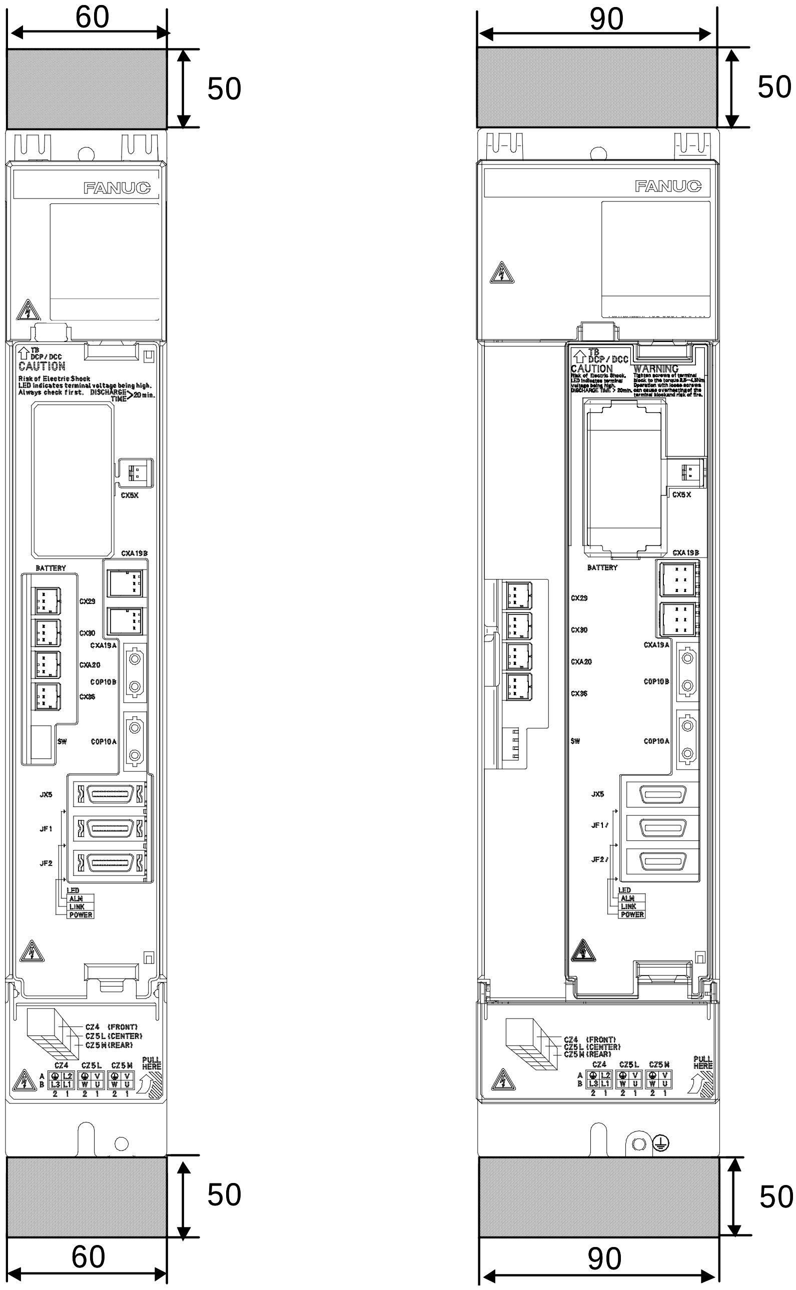
(a) When the separated cooling fan motor (A06B-6134-K002) is not used



(b) When the separated cooling fan motor (A06B-6134-K002) is used



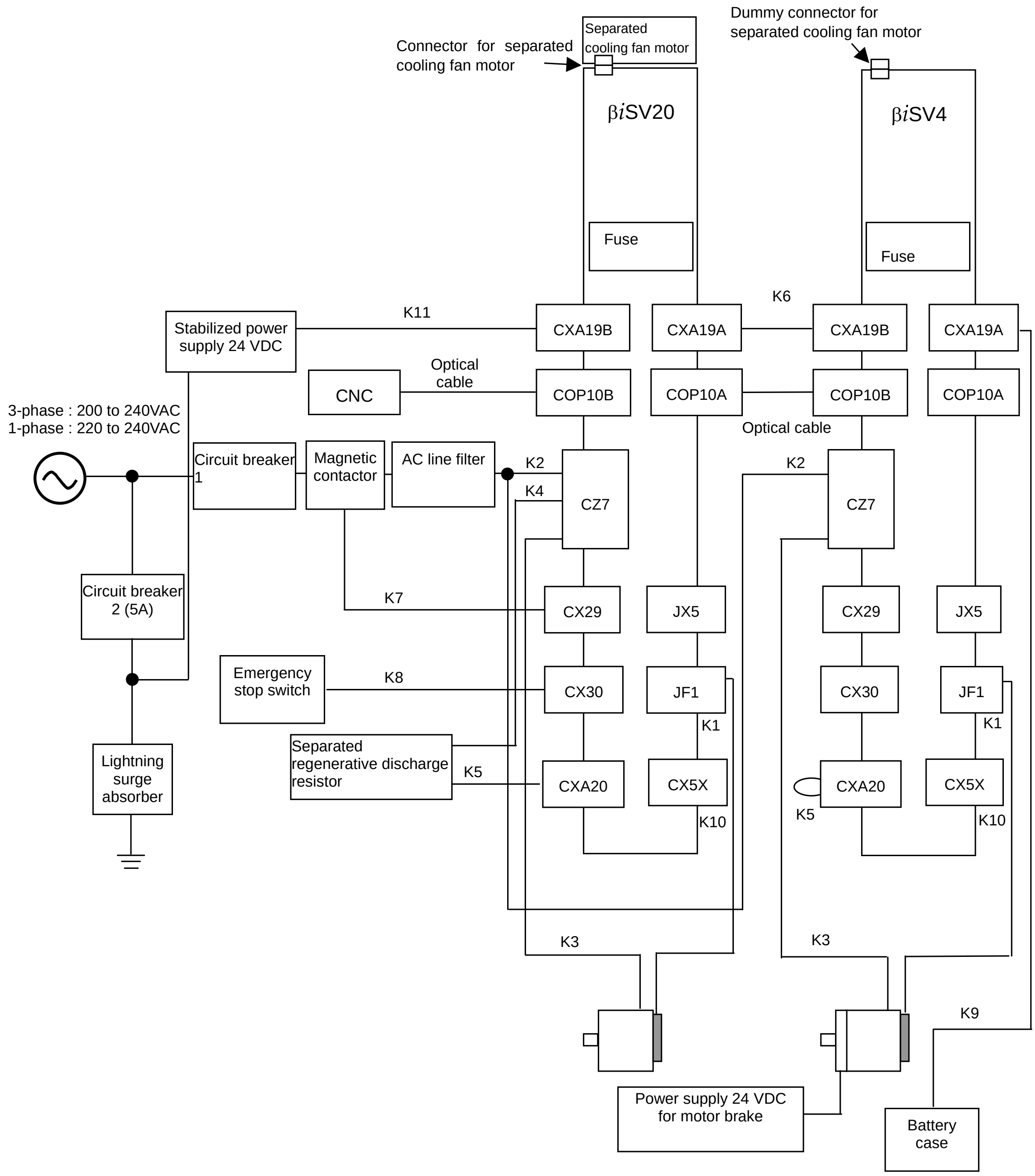
8.3.3 Maintenance Area for the β*i*SV20/20 and β*i*SV40/40



9 TOTAL CONNECTION DIAGRAM

9.1 CONNECTION DIAGRAM

9.1.1 β*i*SV4 and β*i*SV20



NOTE
1 Use the stabilized power supply 24VDC for the amplifier. Power supply 24VDC for the amplifier and power supply 24VDC for the motor brake cannot be shared.

NOTE

2 The cabling of CX29 and CX30 of the second and subsequent amplifiers may be omitted. For details, see Subsection, “Details of Cable K8” and Chapter, “COMBINATIONS OF DIFFERENT MODELS”.

3 Always install the circuit breakers, magnetic contactor, and AC line filter.

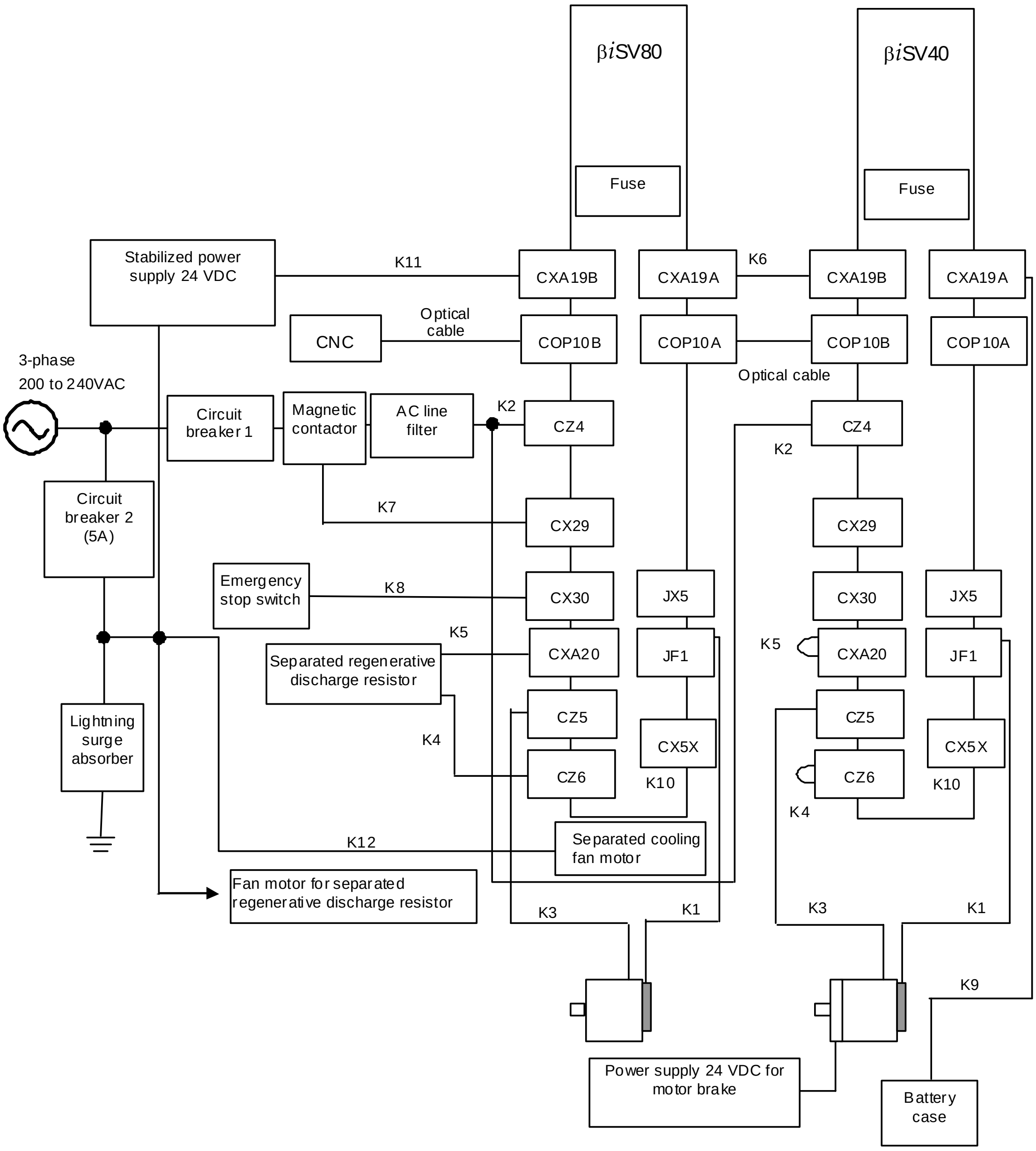
4 To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.

⚠ **WARNING**

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

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

9.1.2 β*i*SV40 and β*i*SV80



NOTE

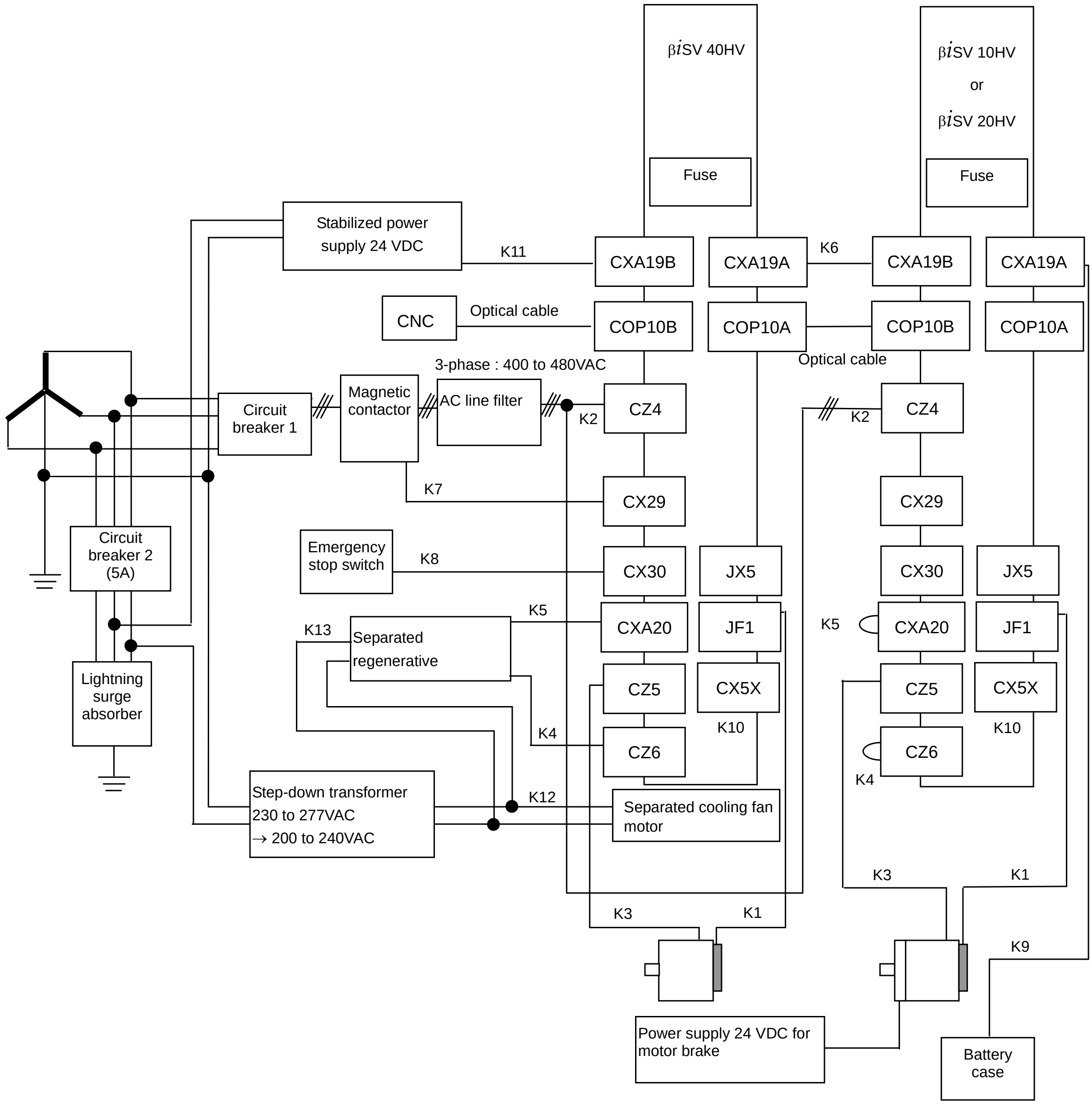
1 Use the stabilized power supply 24VDC for the amplifier. Power supply 24VDC for the amplifier and power supply 24VDC for the motor brake cannot be shared.
2 The cabling of CX29 and CX30 of the second and subsequent amplifiers may be omitted. For details, see Subsection, "Details of Cable K8" and Chapter, "COMBINATIONS OF DIFFERENT MODELS".
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 absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.

⚠ **WARNING**

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

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

9.1.3 β*i*SV10HV, β*i*SV20HV, and β*i*SV40HV



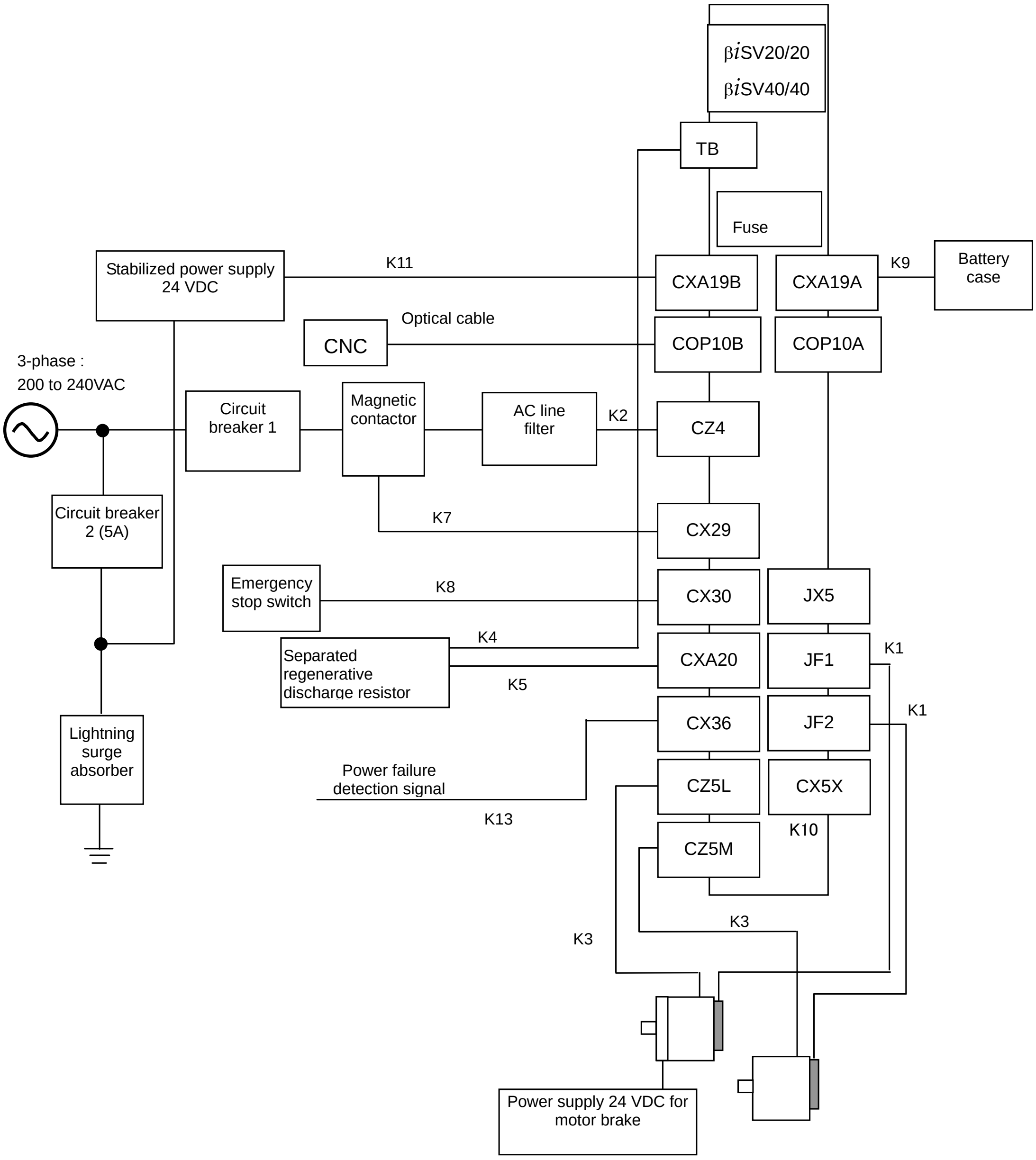
NOTE

1. Use the stabilized power supply 24VDC for the amplifier. Power supply 24VDC for the amplifier and power supply 24VDC for the motor brake cannot be shared.
2. The cabling of CX29 and CX30 of the second and subsequent amplifiers may be omitted. For details, see Subsection, "Details of Cable K8" and Chapter, "COMBINATIONS OF DIFFERENT MODELS".
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 absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.

⚠ **WARNING**

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

9.1.4 βiSV20/20 and βiSV40/40



NOTE

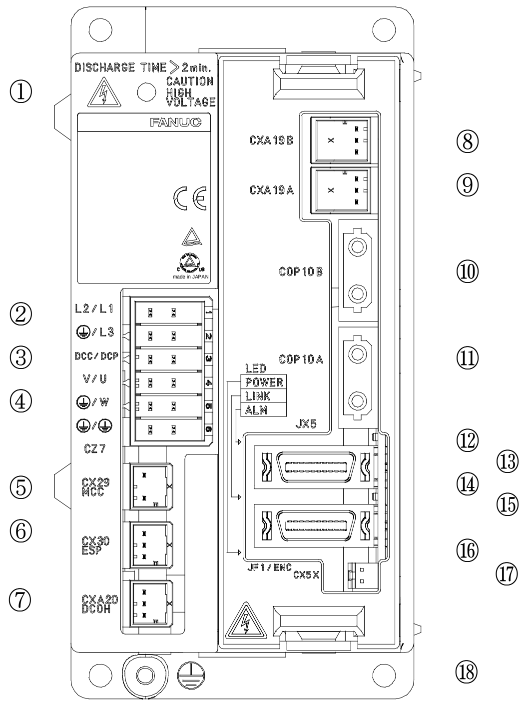
1 Use the stabilized power supply 24VDC for the amplifier. Power supply 24VDC for the amplifier and power supply 24VDC for the motor brake cannot be shared.
2 The cabling of CX29 and CX30 of the second and subsequent amplifiers may be omitted. For details, see Subsection, "Details of Cable K8" and Chapter, "COMBINATIONS OF DIFFERENT MODELS".
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 absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.

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

9.2 CONNECTOR LOCATION

9.2.1 β*i*SV4 and β*i*SV20

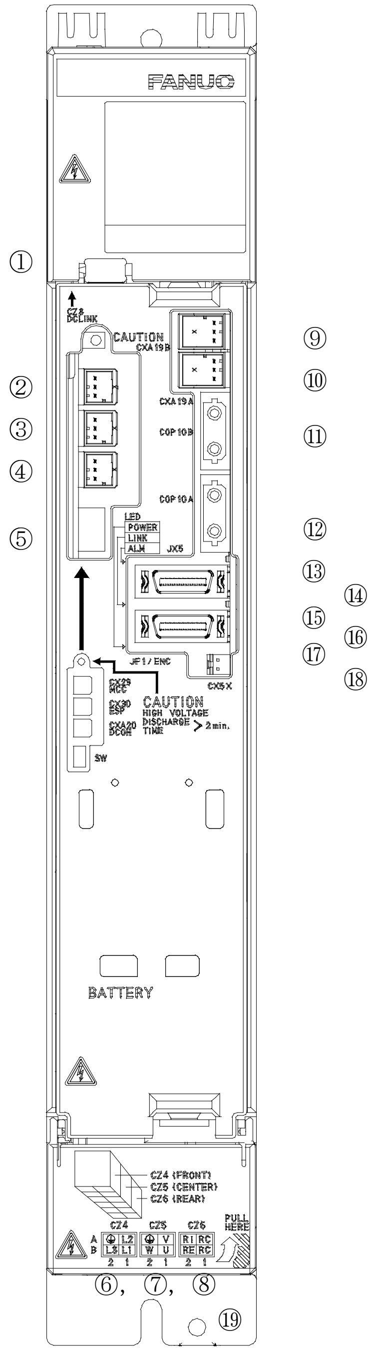
No.	Name	Remarks
1		DC link charge LED
2	CZ7-1 CZ7-2	Main power input connector
3	CZ7-3	Connector for separated regenerative discharge resistor (for discharge register)
4	CZ7-4 CZ7-5 CZ7-6	Motor power connector
5	CX29	Connector for main power MCC control signal
6	CX30	ESP signal connection connector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



> **NOTE**
> Connect nothing to JX5, and leave it open.

9.2.2 β*i*SV40, β*i*SV80, β*i*SV10HV, β*i*SV20HV, and β*i*SV40HV

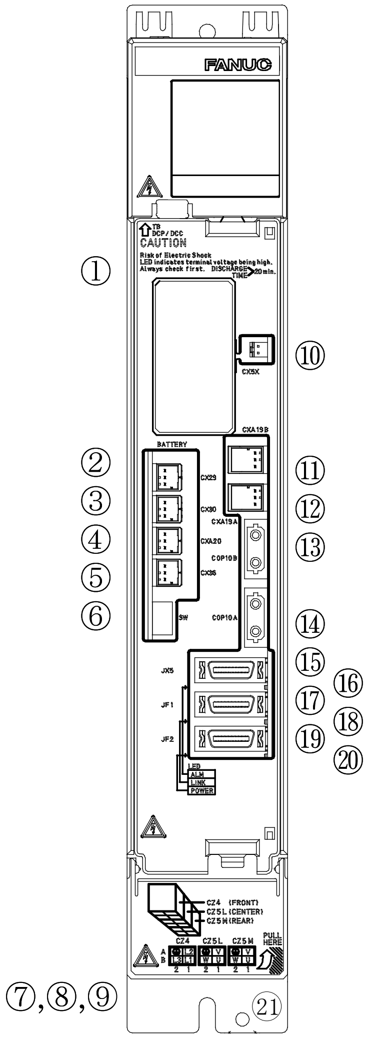
No.	Name	Remarks
1		DC link charge LED
2	CX29	Connector for main power MCC control signal
3	CX30	ESP signal connection connector
4	CXA20	Connector for separated regenerative discharge resistor (for alarms)
5	SW	Setting switch (DC alarm level)
6	CZ4	Main power input connector
7	CZ5	Motor power connector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



NOTE
Connect nothing to JX5, and leave it open.

9.2.3 βiSV20/20

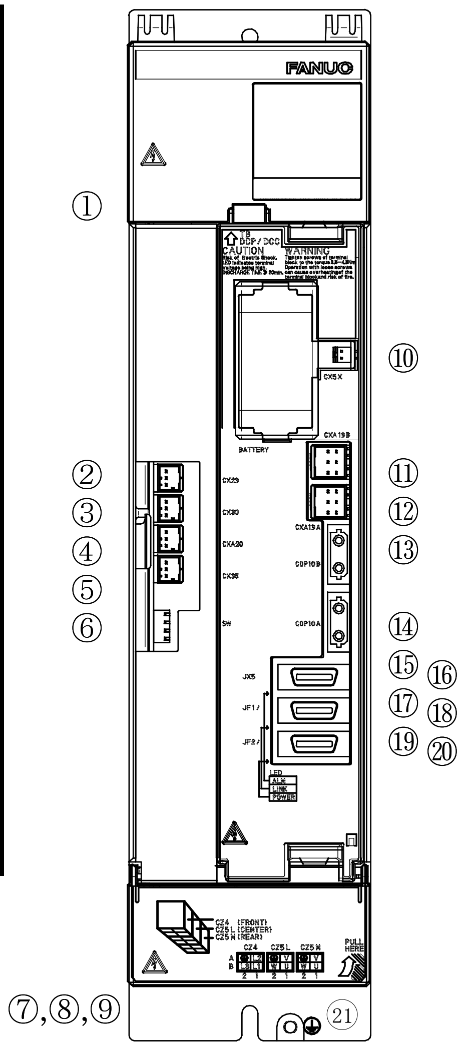
No.	Name	Remarks
1	TB	DC link charge LED/ Terminal block for separated regenerative discharge resistor (for discharge register)
2	CX29	Connector for main power MCC control signal
3	CX30	ESP signal connection connector
4	CXA20	Connector for separated regenerative discharge resistor (for alarms)
5	CX36	Power failure detection output
6	SW	Setting switch (DCSW alarm level)
7	CZ4	Main power input connector
8	CZ5L	Motor power connector: L-axis
9	CZ5M	Motor power connector: M-axis
10	CX5X	Absolute Pulsecoder battery
11	CXA19B	24VDC power input
12	CXA19A	24VDC power input
13	COP10B	Servo FSSB I/F
14	COP10A	Servo FSSB I/F
15	JX5	Connector for testing (Note)
16	ALM	Servo alarm status display LED
17	JF1	Pulsecoder: L-axis
18	LINK	FSSB communication status display LED
19	JF2	Pulsecoder: M-axis
20	POWER	Control power status display LED
21	⏚	Tapped hole for grounding the flange



NOTE
Connect nothing to JX5, and leave it open.

9.2.4 β*i*SV40/40

No.	Name	Remarks
1	TB	DC link charge LED/ Terminal block for separated regenerative discharge resistor (for discharge register)
2	CX29	Connector for main power MCC control signal
3	CX30	ESP signal connection connector
4	CXA20	Connector for separated regenerative discharge resistor (for alarms)
5	CX36	Power failure detection output
6	SW	Setting switch (DCSW alarm level)
7	CZ4	Main power input connector
8	CZ5L	Motor power connector: L-axis
9	CZ5M	Motor power connector: M-axis
10	CX5X	Absolute Pulsecoder battery
11	CXA19B	24VDC power input
12	CXA19A	24VDC power input
13	COP10B	Servo FSSB I/F
14	COP10A	Servo FSSB I/F
15	JX5	Connector for testing (Note)
16	ALM	Servo alarm status display LED
17	JF1	Pulsecoder: L-axis
18	LINK	FSSB communication status display LED
19	JF2	Pulsecoder: M-axis
20	POWER	Control power status display LED
21	⏚	Tapped hole for grounding the flange



NOTE
Connect nothing to JX5, and leave it open.

9.2.5 Connection Tools

The ordering specification drawing numbers of connection tools for connectors when the tools are purchased from FANUC are listed below. You may also purchase these tools directly from the manufacturer.

Connectors manufactured by Tyco Electronics AMP

D-2000 series

Type	Ordering specification drawing No.	Manufacturer part No.	Use
Option	A06B-6110-K220#D2M	91595-1	M size Contact crimping tool
Option	A06B-6110-K220#D2R	1276716-1	Contact extractor

D-3000 series

Type	Ordering specification drawing No.	Manufacturer part No.	Use
Option	A06B-6110-K220#D3L	91558-1	L size Contact crimping tool
Option	A06B-6110-K220#D3R	234168-1	Contact extractor

D-5000 series

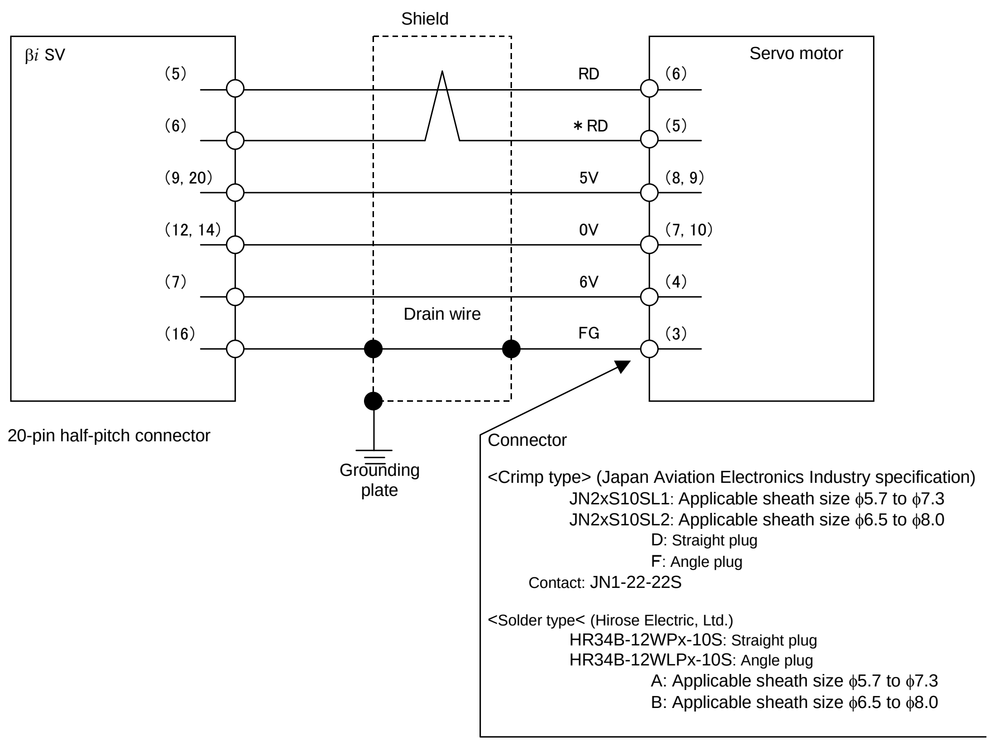
Type	Ordering specification drawing No.	Manufacturer part No.	Use
Option	A06B-6110-K220#D5SS	91596-1	SS size Contact crimping tool
Option	A06B-6110-K220#D5S	234170-1	S size Contact crimping tool
Option	A06B-6110-K220#D5M	234171-1	M size Contact crimping tool
Option	A06B-6110-K220#D5L	1366044-1	L size Contact crimping tool
Option	A06B-6110-K220#D5R	409158-1	Contact extractor

9.2.6 Details of Cable K1

9.2.6.1 α*i*S and α*i*F series servo motors, β*i*S (β*i*S0.4/5000 to β*i*S40/2000), β*i*Sc, and β*i*F series servo motors

Cable K1 is used to connect the β*i*SV and Pulsecoder.

> ⚠ **WARNING**
> If the connector (JF*) of the Pulsecoder is connected incorrectly, an unpredictable motor operation may occur.



Using cable conductor

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

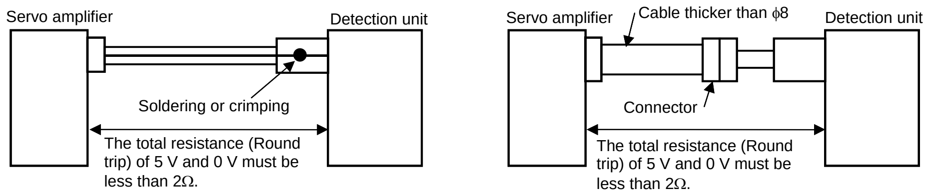
See Appendix A, "CABLES", for detailed explanations about the cable.

> **NOTE**
> 1 The ground plate to which the shield is connected must be placed as close as possible to the servo amplifier so that distance between the ground plate and the servo amplifier becomes shortest.
> 2 In case that the cable is prepared by MTB, total resistance of 5V and 0V must be less than 2Ω.

NOTE

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

[Case 1] Cable conductor exceeds 0.5mm^2. [Case 2] Sheath diameter of exceeds ϕ8.



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

- Crimp tool specification

FANUC specification	Japan Aviation Electronics Industry specification	Applicable cable thickness
A06B-6114-K201/JN1E	CT150-2-JN1-E	21AWG(0.5mm^2:20/0.18) 23AWG(0.3mm^2) 25AWG(0.18mm^2)
A06B-6114-K201/JN1D	CT150-2-JN1-D	20AWG(0.5mm^2:104/0.08) 21AWG(0.5mm^2:20/0.18) 25AWG(0.18mm^2)

- Recommended cable

Recommended cable specification	Description	Crimp tool specification
A66L-0001-0460	Flexible cable 28 m or less	A06B-6114-K201/JN1E (FANUC specification) CT150-2-JN1-E (Japan Aviation Electronics Industry specification)
A66L-0001-0481	Fixed cable 28 m or less	
A66L-0001-0462	Flexible cable 50 m or less	A06B-6114-K201/JN1D (FANUC specification) CT150-2-JN1-D (Japan Aviation Electronics Industry specification)
A66L-0001-0491	Fixed cable 50 m or less	

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

  <Solder type>
  - A06B-6114-K205/S: Straight plug
  - A06B-6114-K205/E: Elbow plug

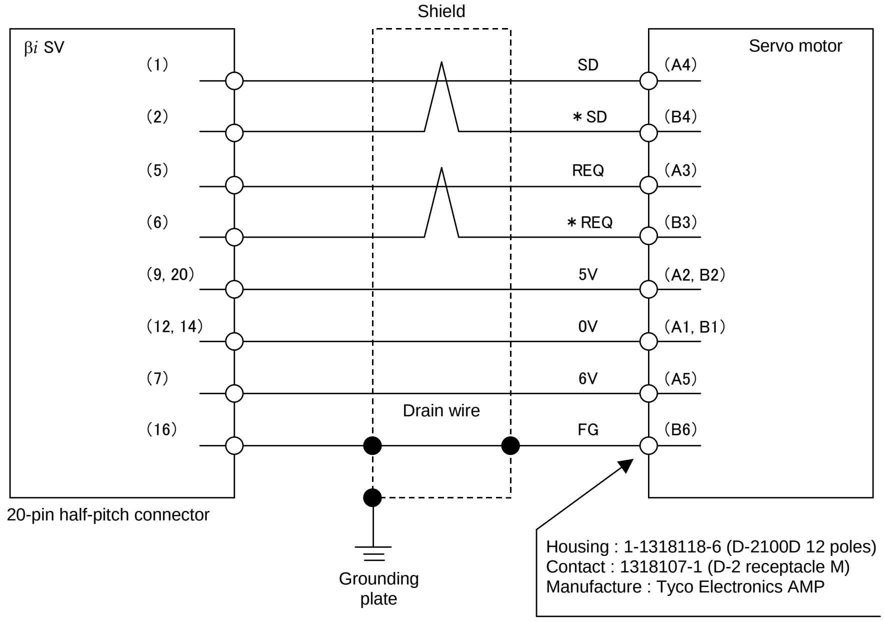
20-pin half-pitch connectors

Recommended cable specification	Applicable connector	Connector model number	Housing model number	Connector + housing
A66L-0001-0460 A66L-0001-0462 A66L-0001-0481 A66L-0001-0491	Soldering type Note that this connector does not have pin No. 11, 13, 15, 17, or 19.	Hirose Electric Co., Ltd. FI40B-2015S	Sideways cable slot type FI-2015-CVS	Sideways cable slot type FI40B-2015S-CVS

9.2.6.2 β*i*S series servo motors (β*i*S0.2/5000 and β*i*S0.3/5000)

Cable K1 is used to connect the β*i*SV and Pulsecoder.

> ⚠ **WARNING**
> If the connector (JF*) of the Pulsecoder is connected incorrectly, an unpredictable motor operation may occur.



Using cable conductor

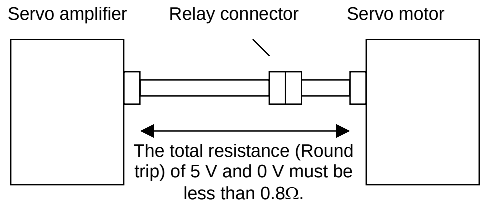
Signal name	Cable length: 28 m or less
5V, 0V,6V	0.5mm^2 (AWG21)× 5 (Note 4) Strand configuration: 20/0.18, Insulation outer diameter: ϕ0.88 to ϕ1.5
SD, *SD, REQ, *REQ	0.18mm^2(AWG25) or more Twisted-pair wire Strand configuration 7/0.18, Insulation outer diameter: ϕ0.88 to ϕ1.5
Drain wire	0.15mm^2 or more
Recommended wire	0.5mm^2 × 5 + 0.18mm^2 × two-pair (For a fixed cable) Hitachi Cable, Ltd. : UL20276-SB(0)5X21AWG+2PX25AWG (For a movable cable) Hitachi Cable, Ltd. : UL20276-SB(FLEX)5X20AWG+2PX25AWG

NOTE

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

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

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



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

20-pin half-pitch connectors

Recommended cable specification	Applicable connector	Connector model number	Housing model number	Connector + housing
A66L-0001-0461 A66L-0001-0488	Soldering type Note that this connector does not have pin No. 11, 13, 15, 17, or 19.	Hirose Electric Co., Ltd. FI40B-2015S	Sideways cable slot type FI-2015-CVS	Sideways cable slot type FI40B-2015S-CVS

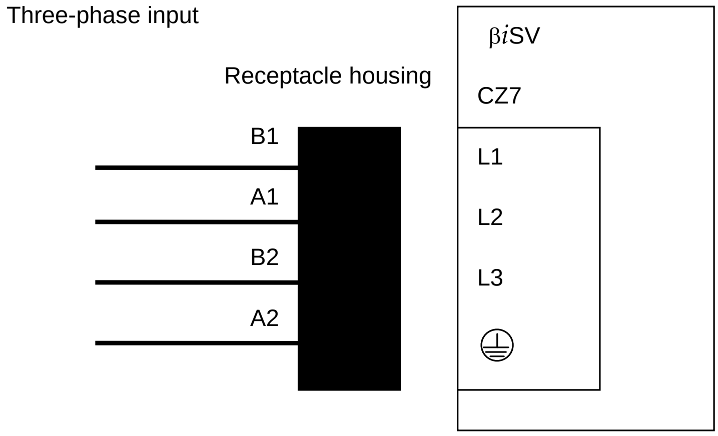
9.2.7 Details of Cable K2

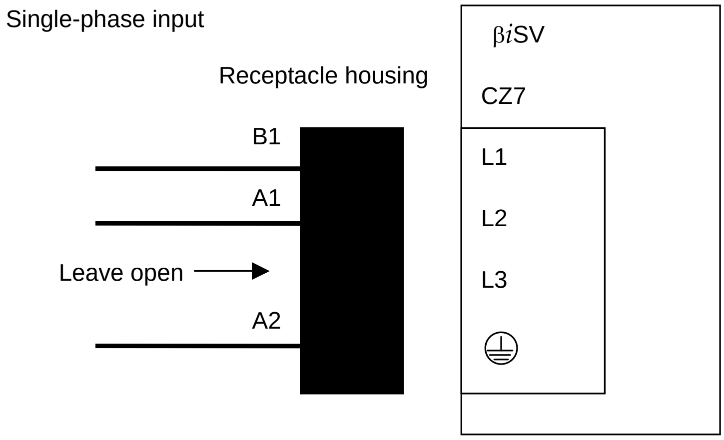
The following items related to servo amplifier input cables are explained below in the stated order.

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

9.2.7.1 Details of connectors

(a) β*i*SV4 and β*i*SV20





[Receptacle housing]
Use the following receptacle housing.

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

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

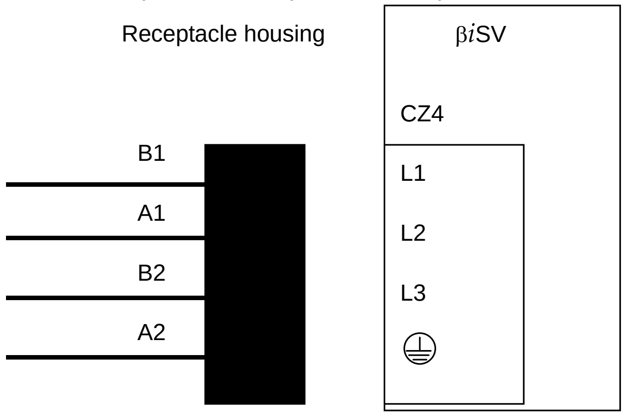
Rectangle contact model number		Conductor size (mm^2)	Conductor size AWG	Insulation outer diameter (mm)	Manual tool model number	Manufacture
L size	1-175218-2	0.5- 1.25	20/18/16	1.8-2.8	91558-1	Tyco Electronics AMP

[Ordering numbers of connectors and tools]

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

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

(b) βiSV40, βiSV80, βiSV10HV, βiSV20HV, βiSV40HV, βiSV20/20, and βiSV40/40



[Receptacle housing]

Use the following receptacle housing.

Manufacturer part No.	Specification of the key	Manufacture
1-917807-2	XX	Tyco Electronics AMP

[Receptacle contact]

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

[Ordering numbers of connectors and tools]

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

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

[Crimping tool]

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

9.2.7.2 Selecting cables (general)

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

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

[Selection example of power line (reference)]

[Selection example 1]
Heavy-duty power cable specification : Maximum allowable conductor temperature : 60°C

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

[Selection example 2]
Heavy-duty power cable specification : Maximum allowable conductor temperature : 80°C

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

Select cables based on the input current for the continuous output rating of each motor listed in the table below.

[Input current for continuous output ratings of servo motors (reference only)]

Input current for continuous output ratings of motors

Servo motor	Continuous current rating for three-phase input [Arms] (reference only)	Power supply rating for three-phase input [kVA] (reference only)	Continuous current rating for single-phase input [Arms] (reference only)	Power supply rating for single-phase input [kVA] (reference only)
β*i*S0.2/5000	0.2	0.08	0.5	0.12
β*i*S0.3/5000	0.5	0.15	1.1	0.25
β*i*S0.4/5000	0.6	0.20	1.4	0.32
β*i*S0.5/6000	1.6	0.54	3.8	0.86
β*i*S1/6000	2.2	0.77	5.4	1.2
β*i*S2/4000	2.2	0.77	5.4	1.2
β*i*S4/4000	3.3	1.2	8.1	1.9
β*i*S8/3000	5.4	1.9	9.7	2.2
β*i*S12/2000	6.2	2.2	10.0	2.2
β*i*S12/3000	8.0	2.8	-	-
β*i*S22/2000	11.1	3.9	-	-
β*i*S22/3000	13.4	4.63	-	-
β*i*S30/2000	13.4	4.63	-	-
β*i*S40/2000	13.4	4.63	-	-
β*i*Sc2/4000	2.2	0.77	5.4	1.2
β*i*Sc4/4000	3.3	1.2	8.1	1.9
β*i*Sc8/3000	5.4	1.9	9.7	2.2
β*i*Sc12/2000	6.2	2.2	9.7	2.2
β*i*F4/3000	3.3	1.2	8.1	1.9
β*i*F8/2000	5.4	1.9	10.0	2.2
β*i*F12/2000	6.2	2.2	10.0	2.2
β*i*F22/2000	11.1	3.9	-	-
β*i*F30/1500	13.4	4.63	-	-
α*i*F1/5000	2.2	0.77	5.4	1.2
α*i*F2/5000	3.3	1.2	8.1	1.9
α*i*F4/5000	6.2	2.2	-	-
α*i*F8/3000	7.1	2.5	-	-
α*i*F8/4000	9.8	3.4	-	-
α*i*F12/4000	13.4	4.6	-	-
α*i*F22/3000	17.8	6.2	-	-
α*i*S2/5000	3.3	1.2	8.1	1.9
α*i*S2/6000	4.5	1.5	9.7	2.2
α*i*S4/5000	4.5	1.5	9.7	2.2
α*i*S4/6000	4.5	1.5	9.7	2.2
α*i*S8/4000	11.1	3.9	-	-
α*i*S8/6000	9.8	3.4	-	-
α*i*S12/4000	12.0	4.2	-	-
β*i*S2/4000HV	1.2	0.8	-	-
β*i*S4/4000HV	1.7	1.2	-	-
β*i*S8/3000HV	2.7	1.9	-	-
β*i*S12/3000HV	4.0	2.8	-	-
β*i*S22/2000HV	5.6	3.9	-	-
β*i*S22/3000HV	6.7	4.6	-	-
β*i*S30/2000HV	6.7	4.6	-	-

Servo motor	Continuous current rating for three-phase input [Arms] (reference only)	Power supply rating for three-phase input [kVA] (reference only)	Continuous current rating for single-phase input [Arms] (reference only)	Power supply rating for single-phase input [kVA] (reference only)
β*i*S40/2000HV	6.7	4.6	-	-
α*i*F4/5000HV	3.2	2.2	-	-
α*i*F8/3000HV	3.6	2.5	-	-
α*i*F8/4000HV	4.9	3.4	-	-
α*i*F12/4000HV	6.7	4.6	-	-
α*i*F22/3000HV	8.9	6.2	-	-
α*i*S2/5000HV	1.7	1.2	-	-
α*i*S2/6000HV	2.3	1.5	-	-
α*i*S4/5000HV	2.3	1.5	-	-
α*i*S4/6000HV	2.3	1.5	-	-
α*i*S8/4000HV	5.2	3.6	-	-
α*i*S8/6000HV	4.9	3.4	-	-
α*i*S12/4000HV	5.6	3.9	-	-

9.2.8 Details of Cable K3

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

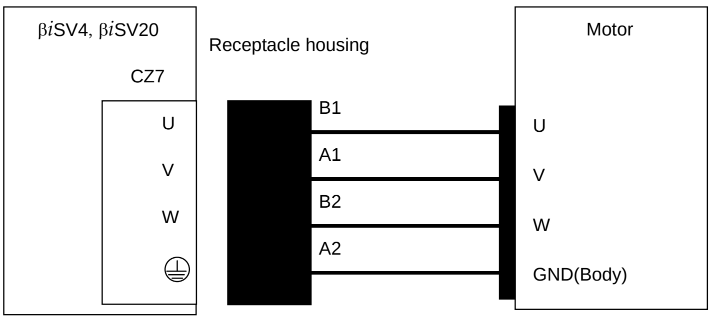
(1) Details of connectors
(2) Selecting cables (general)

> ⚠ **WARNING**
> If the phase order of the power lines is incorrect, an unpredictable motor operation may occur.

9.2.8.1 Details of connectors

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

(a) β*i*SV4 and β*i*SV20



[Receptacle housing]
Use the following receptacle housing.

Manufacturer part No.	Manufacture
1318095-2	Tyco Electronics AMP

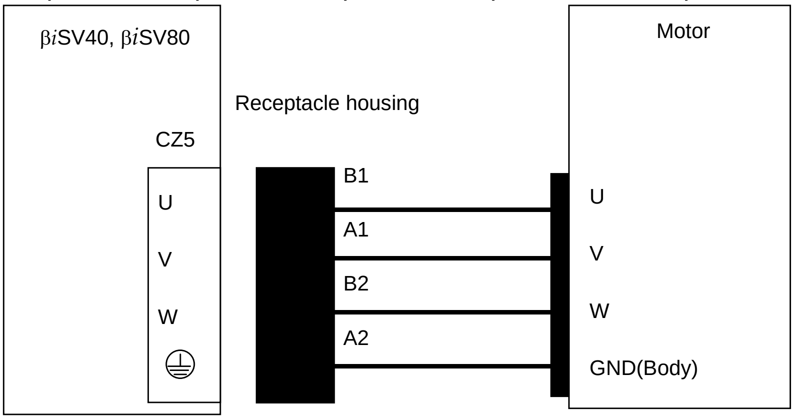
[Receptacle contact]

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

[Ordering numbers of connectors and tools]

Connectors (including housings and contacts) and tools can be purchased directly from Tyco Electronics AMP. They can be ordered as options also from FANUC as listed below. For details, see Subsection 9.2.7, "Details of Cable K2"

(b) β*i*SV40, β*i*SV80, β*i*SV10HV, β*i*SV20HV, β*i*SV40HV, β*i*SV20/20, and β*i*SV40/40



[Receptacle housing]

Use the following receptacle housing.

(1) β*i*SV40, β*i*SV80, β*i*SV10HV, β*i*SV20HV, and β*i*SV40HV

Connector name	Manufacturer part No.	Specification of the key	Manufacture
CZ5	2-917807-2	YY	Tyco Electronics AMP

(2) β*i*SV20/20 and β*i*SV40/40

Connector name	Manufacturer part No.	Specification of the key	Manufacture
CZ5L	2-917807-2	YY	Tyco Electronics AMP
CZ5M	3-917807-2	XY	

[Receptacle contact]

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

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

[Ordering numbers of connectors and tools]

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

Ordering number	Description
A06B-6110-K202#YYS	Housing: YY key 2-917807-2 (1pcs.) Contact: S size 316040-6 (4pcs.) Applicable wire diameter: 1.25-2.20mm2, AWG16/14 Applicable tool: 234170-1 (not included in this kit)
A06B-6110-K202#YYM	Housing: YY key 2-917807-2 (1pcs.) Contact: M size 316041-6 (4pcs.) Applicable wire diameter: 3.50-5.50mm2, AWG12/10 Applicable tool: 234171-1 (not included in this kit)
A06B-6110-K201#XYS	Housing: XY key 3-917807-2 (1pcs.) Contact: S size 316040-6 (4pcs.) Applicable wire diameter: 1.25-2.20mm2, AWG16/14 Applicable tool: 234170-1 (not included in this kit)
A06B-6110-K201#XYM	Housing: XY key 3-917807-2 (1pcs.) Contact: M size 316041-6 (4pcs.) Applicable wire diameter: 3.50-5.50mm2, AWG12/10 Applicable tool: 234171-1 (not included in this kit)

9.2.8.2 Details of cables (general)

Select cables based on the continuous current rating of each motor listed in the table below.
For details, see Subsection 9.2.7, "Details of Cable K2"

[Continuous current rating of motors (reference only)]

Servo motor	Continuous current rating [Arms] (reference only)
β*i*S0.2/5000	0.84
β*i*S0.3/5000	0.84
β*i*S0.4/5000	3.6
β*i*S0.5/6000	2.9
β*i*S1/6000	2.7
β*i*S2/4000	3.3
β*i*S4/4000	4.7
β*i*S8/3000	6.0
β*i*S12/2000	6.5
β*i*S12/3000	10.2
β*i*S22/2000	11.3
β*i*S22/3000	17.7
β*i*S30/2000	18.6
β*i*S40/2000	18.6
β*i*Sc2/4000	3.3
β*i*Sc4/4000	4.7
β*i*Sc8/3000	6.0
β*i*Sc12/2000	6.5
β*i*F4/3000	3.6
β*i*F8/2000	4.9
β*i*F12/2000	6.0
β*i*F22/2000	11.2
β*i*F30/1500	12.8
α*i*F1/5000	2.7
α*i*F2/5000	3.5
α*i*F4/5000	7.7
α*i*F8/3000	8.4
α*i*F8/4000	13.5
α*i*F12/4000	18.1
α*i*F22/3000	18.4

Servo motor	Continuous current rating [Arms] (reference only)
α*i*S2/5000	3.3
α*i*S2/6000	4.0
α*i*S4/5000	6.1
α*i*S4/6000	5.6
α*i*S8/4000	11.1
α*i*S8/6000	17.9
α*i*S12/4000	13.4
β*i*S2/4000HV	1.6
β*i*S4/4000HV	2.3
β*i*S8/3000HV	3.0
β*i*S12/3000HV	5.1
β*i*S22/2000HV	5.6
β*i*S22/3000HV	8.9
β*i*S30/2000HV	9.3
β*i*S40/2000HV	9.3
α*i*F4/5000HV	4.1
α*i*F8/3000HV	4.2
α*i*F8/4000HV	6.7
α*i*F12/4000HV	9.0
α*i*F22/3000HV	9.1
α*i*S2/5000HV	1.6
α*i*S2/6000HV	2.0
α*i*S4/5000HV	3.0
α*i*S4/6000HV	2.8
α*i*S8/4000HV	5.6
α*i*S8/6000HV	9.0
α*i*S12/4000HV	6.7

Motor-side connector

The specifications of a motor-side connector vary depending on the motor model for which it is used.

Refer to “FANUC AC SERVO MOTOR β*i* series Descriptions” (B-65302EN) for detailed descriptions about motor-side connectors for the β*i*s series servo motors.

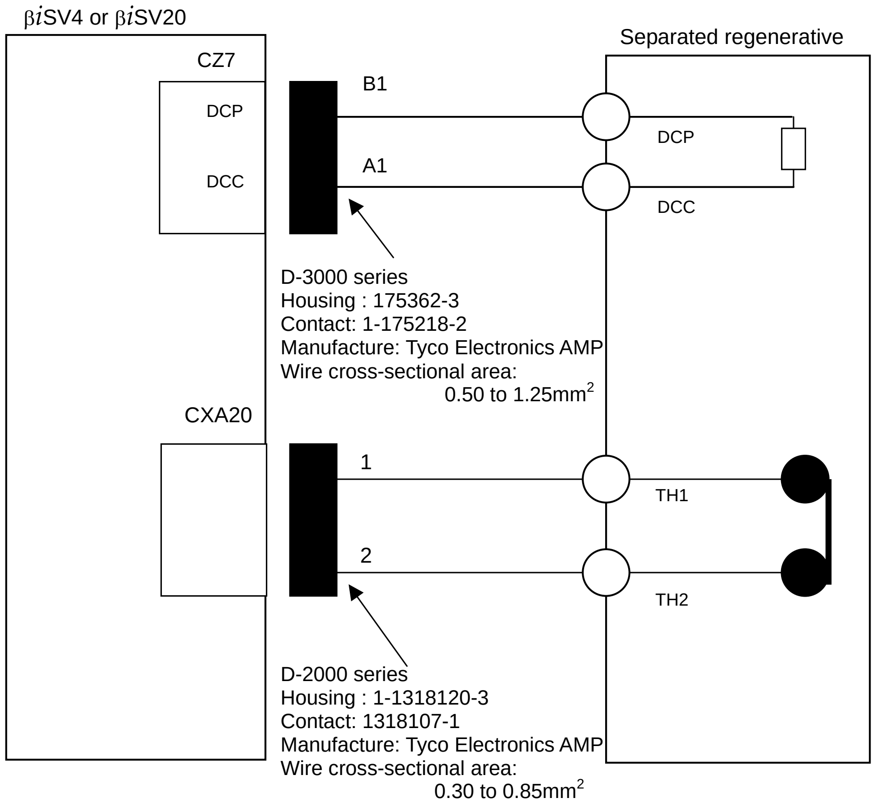
Refer to “FANUC AC SERVO MOTOR α*i* series Descriptions” (B-65262EN) for detailed descriptions about motor-side connectors for the α*i*s/α*i* series servo motors.

9.2.9 Details of Cables K4 and K5

9.2.9.1 β*i*SV4 and β*i*SV20

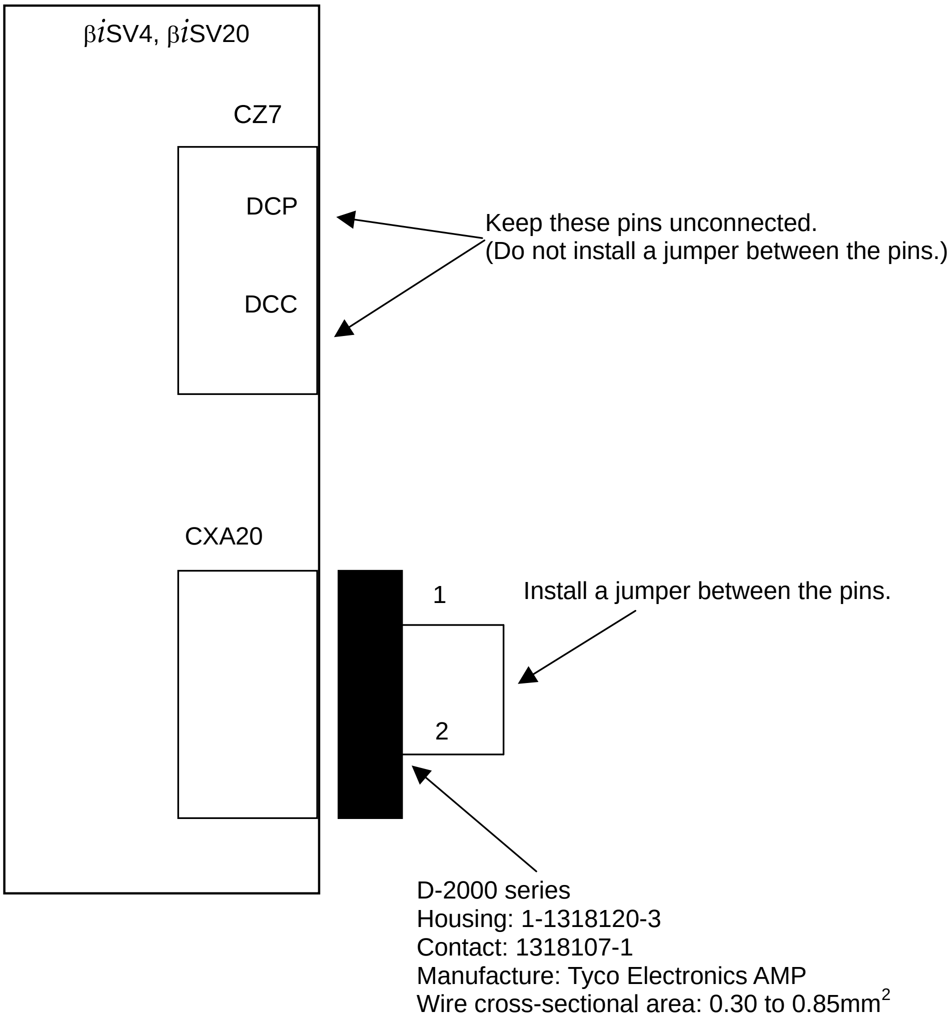
(a) When a separated regenerative discharge resistor is used
The following separated regenerative discharge resistor models are available.

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



For details of connection tools, see Subsection 9.2.5, “Connection Tools”.

(b) When no separated regenerative discharge resistor is used



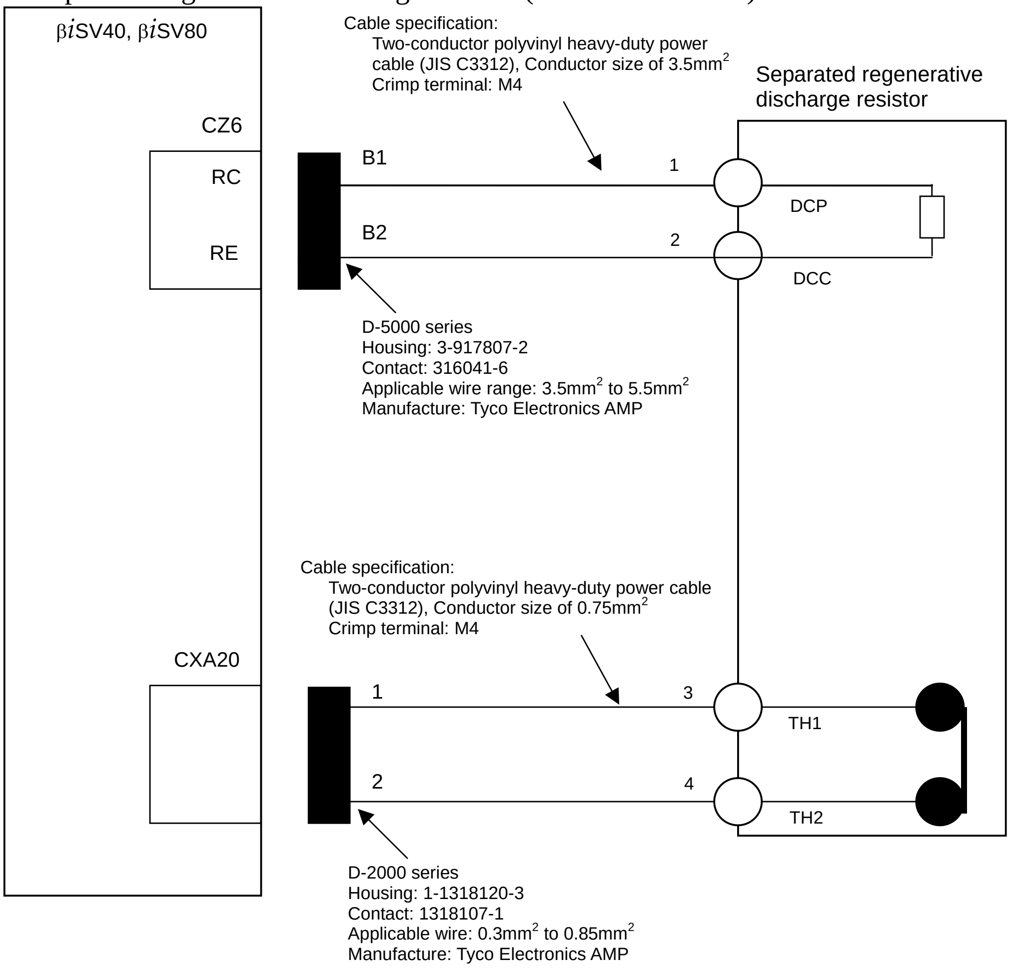
For details of connection tools, see Subsection 9.2.5, “Connection Tools”.

⚠ **CAUTION**

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

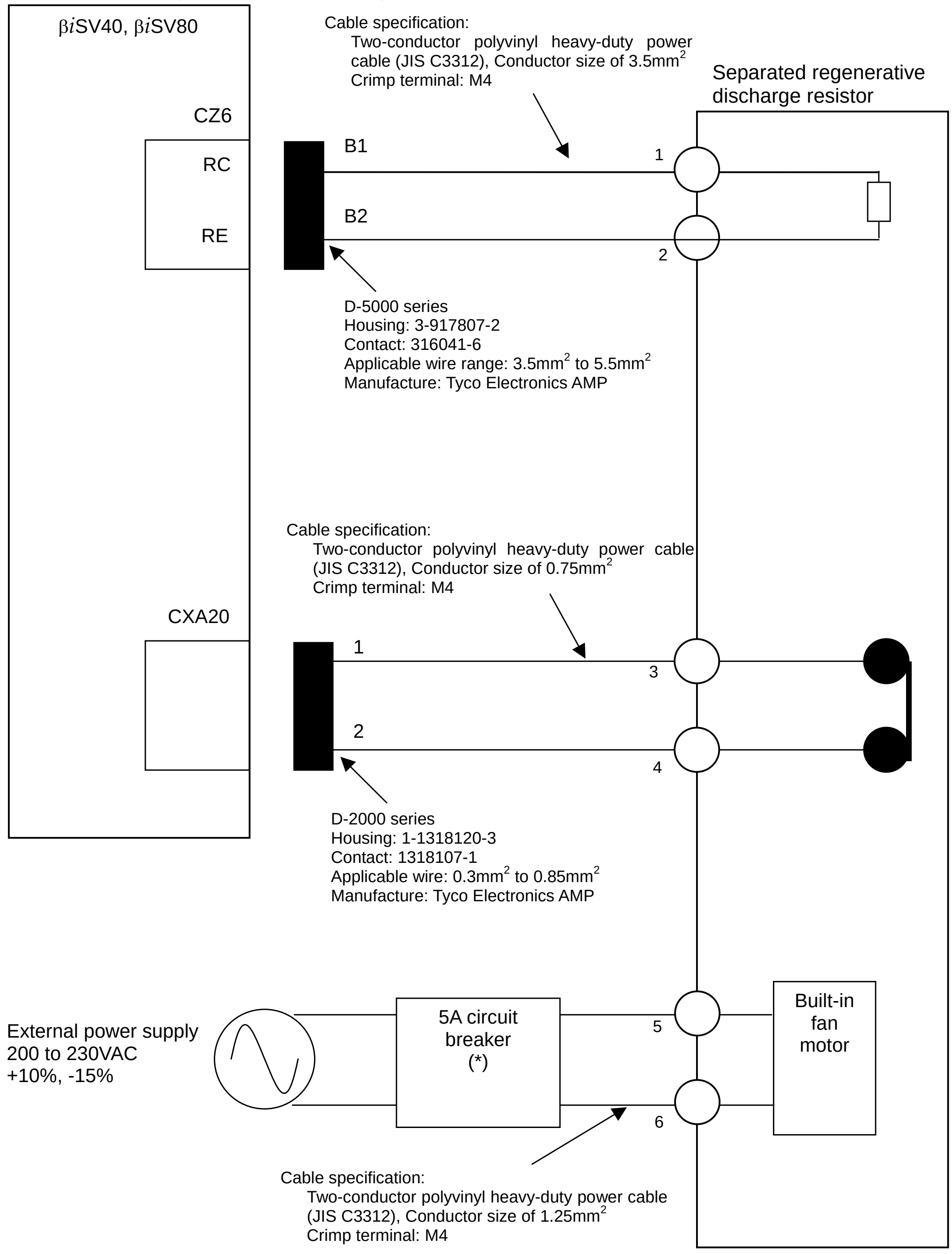
9.2.9.2 βiSV40 and βiSV80

(a) When a separated regenerative discharge resistor (A06B-6089-H500) is used



For details of connection tools, see Subsection 9.2.5, "Connection Tools".

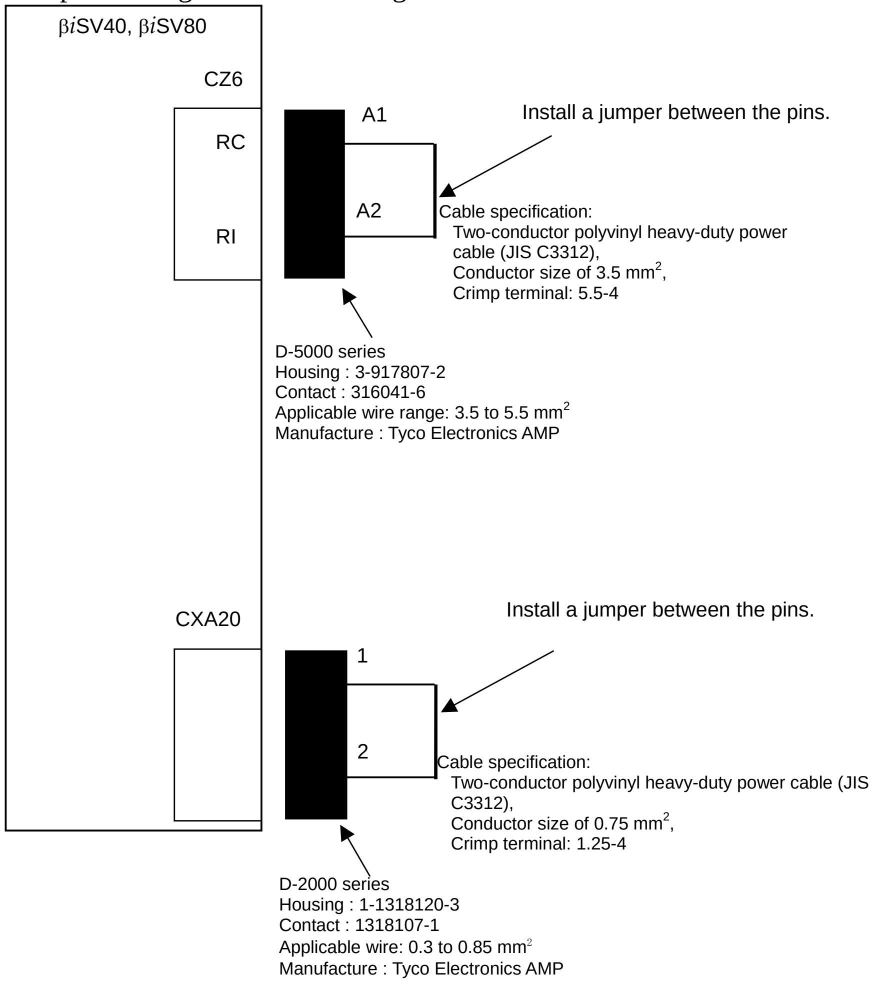
(b) When a separated regenerative discharge resistor (A06B-6089-H713 or -H714) is used



(*) See "TOTAL CONNECTION DIAGRAM".

For details of connection tools, see Subsection 9.2.5, “Connection Tools”.

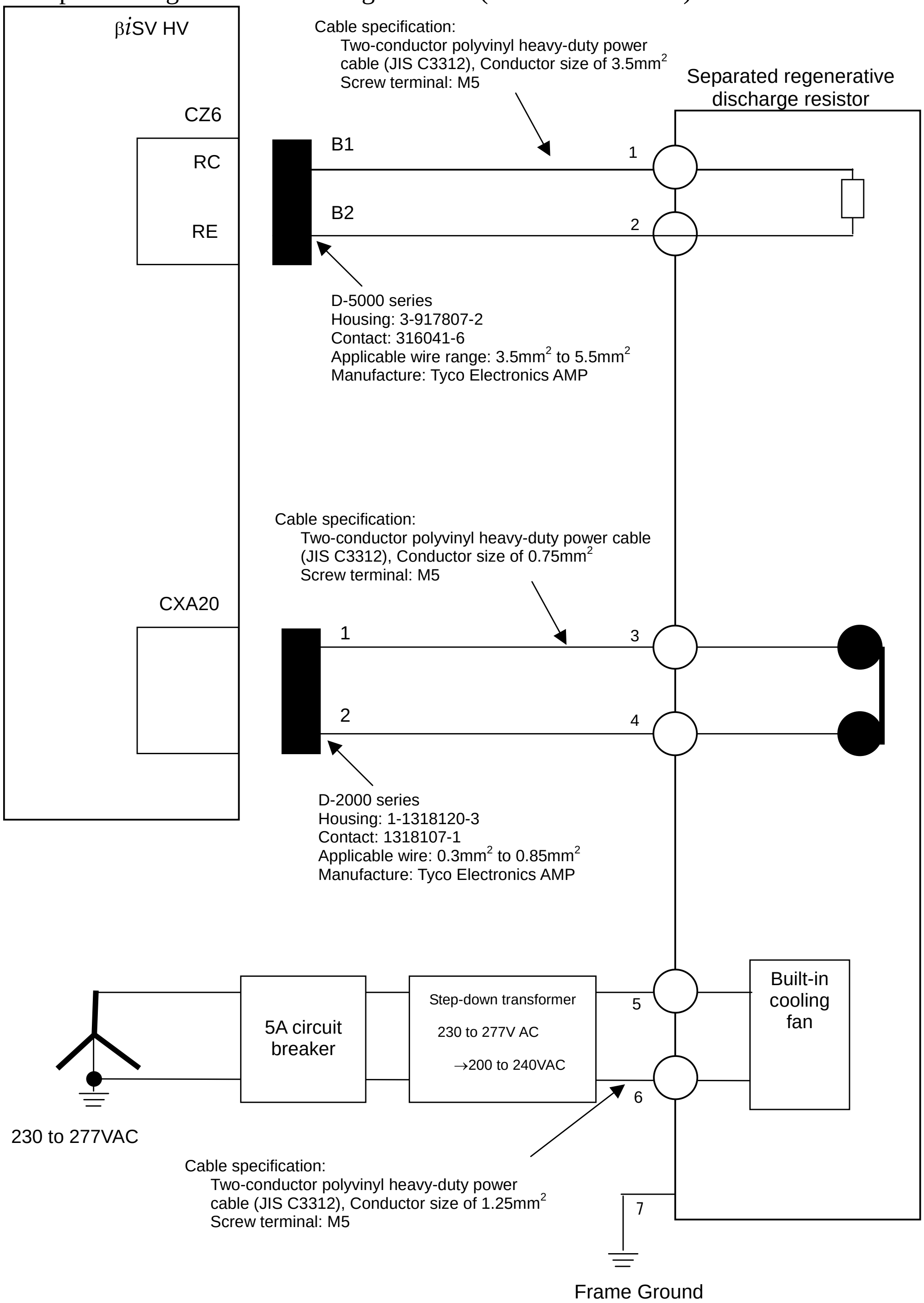
(c) When the incorporated regenerative discharge resistor is used



For details of connection tools, see Subsection 9.2.5, “Connection Tools”.

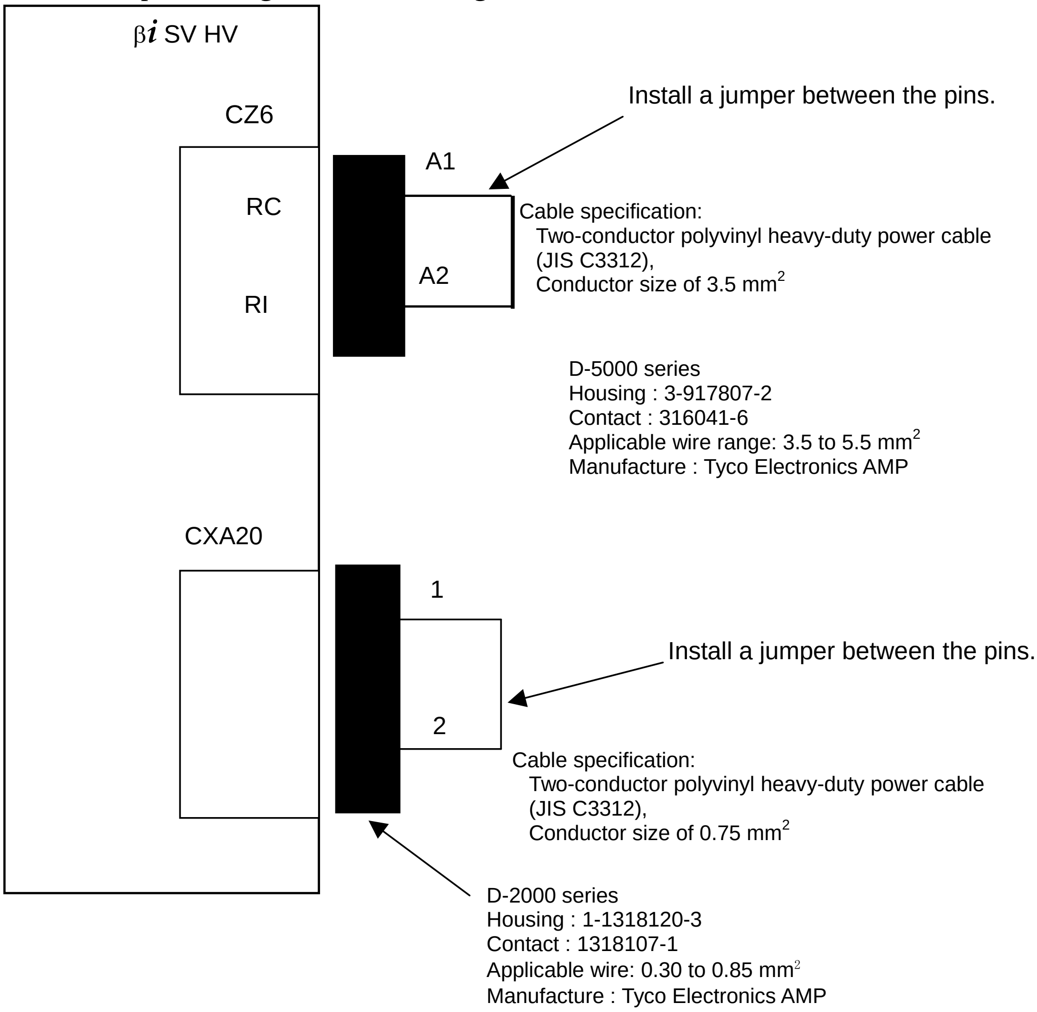
9.2.9.3 β*i*SV10HV, β*i*SV20HV, and β*i*SV40HV

(a) When a separated regenerative discharge resistor (A06B-6130-H403) is used



For details of connection tools, see Subsection 9.2.5, “Connection Tools”.

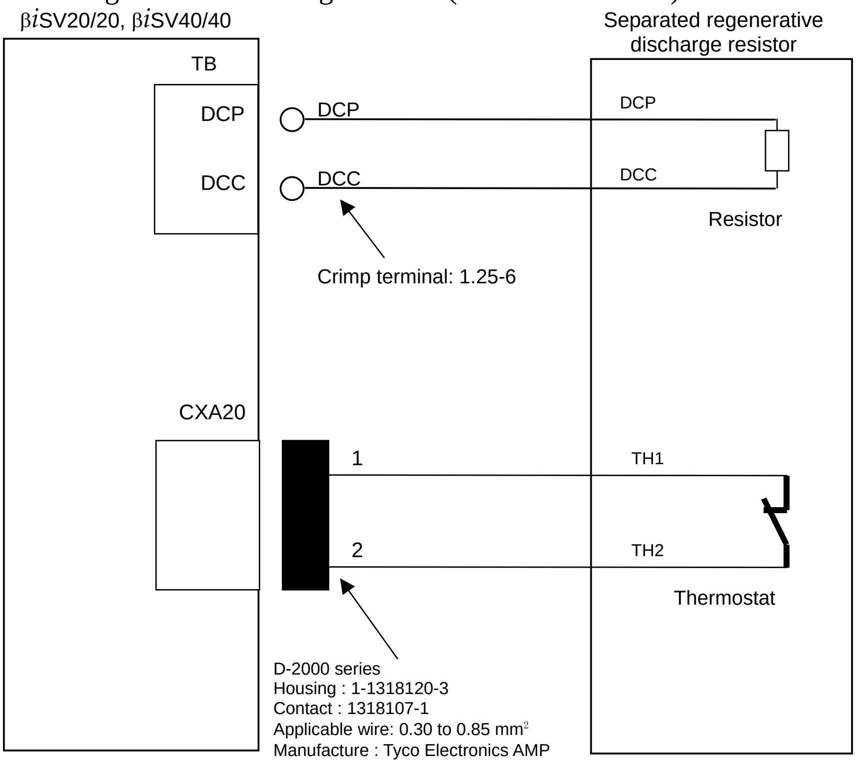
(b) When the incorporated regenerative discharge resistor is used



For details of connection tools, see Subsection 9.2.5, “Connection Tools”.

9.2.9.4 β*i*SV20/20 and β*i*SV40/40

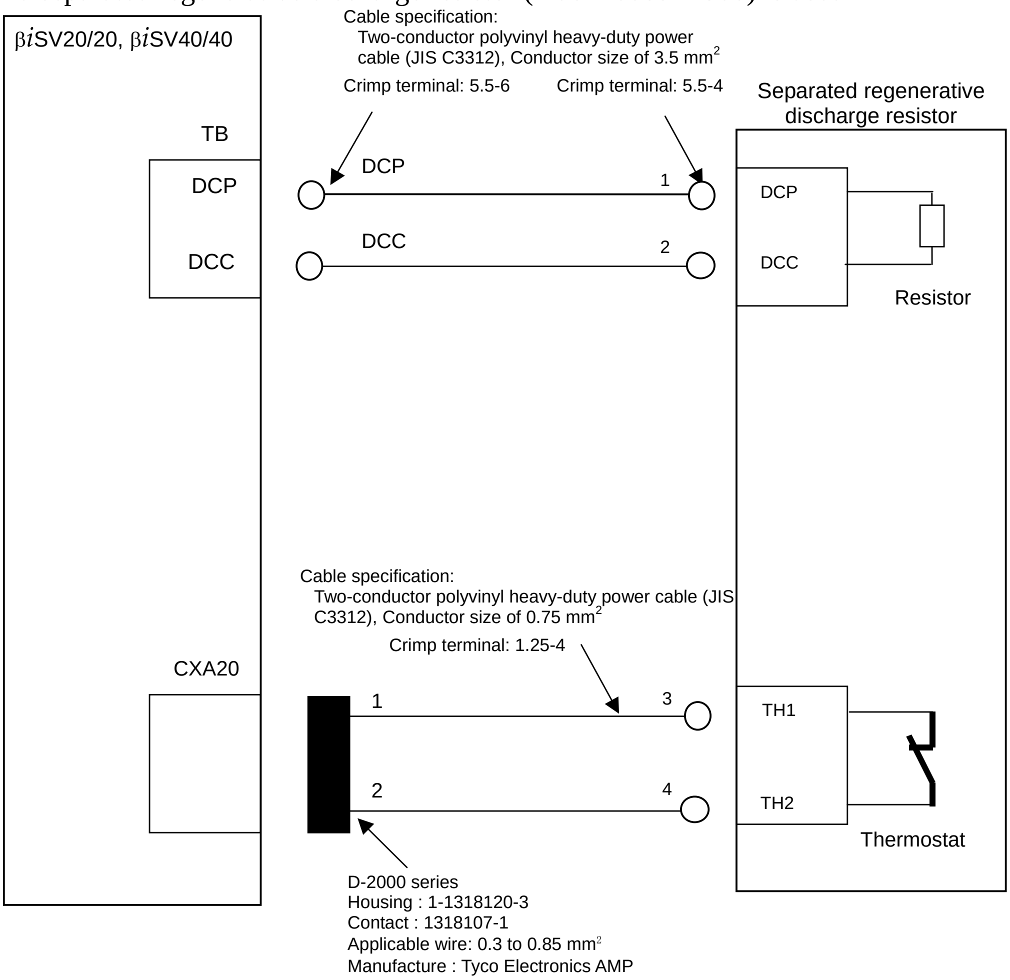
(a) When a separated regenerative discharge resistor (A06B-6130-H404) is used



For details of connection tools, see Subsection 9.2.5, "Connection Tools".

> ⚠ **CAUTION**
> Do not connect the DCP and DCC pins to each other.
> Do not connect TB to servo amplifier α*i* series terminal block TB1 (DCP/DCN).
> Otherwise, the servo amplifier may be damaged.

(b) When a separated regenerative discharge resistor (A06B-6089-H500) is used

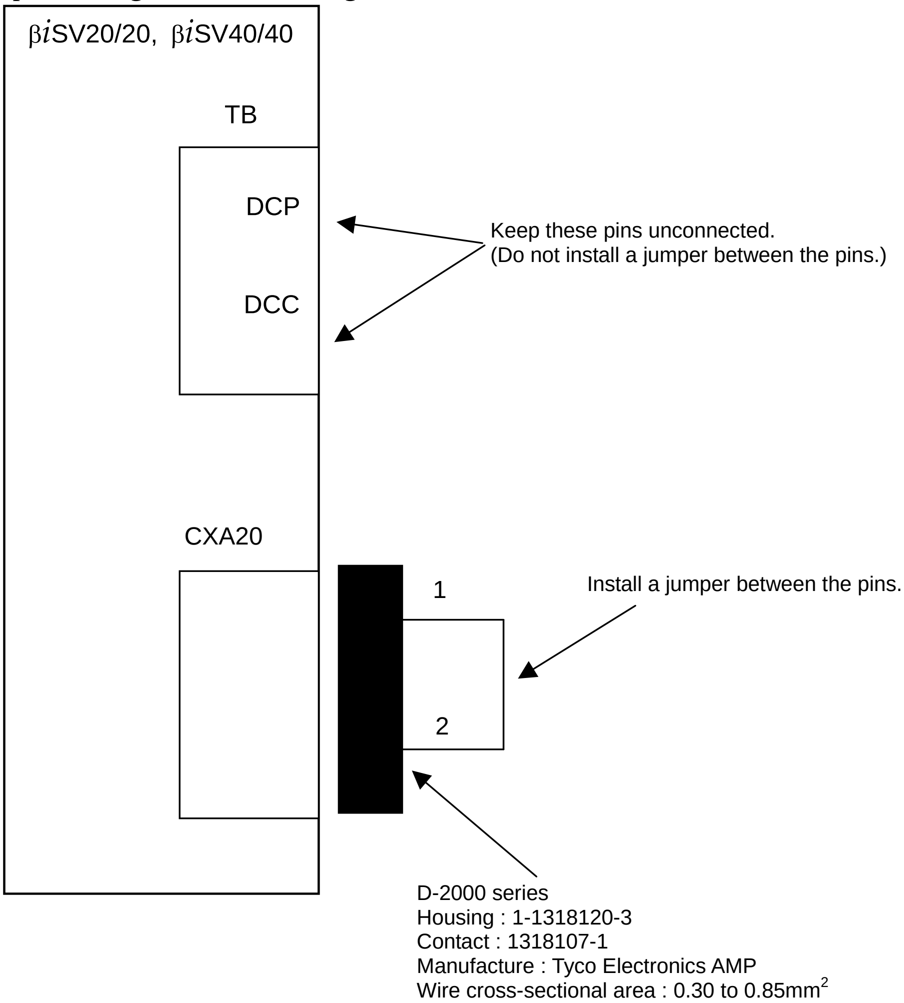


For details of connection tools, see Subsection 9.2.5, “Connection Tools”.

⚠ **CAUTION**

Do not connect the DCP and DCC pins to each other.
Do not connect TB to servo amplifier αi series terminal block TB1 (DCP/DCN).
Otherwise, the servo amplifier may be damaged.

(c) When a separated regenerative discharge resistor is not used

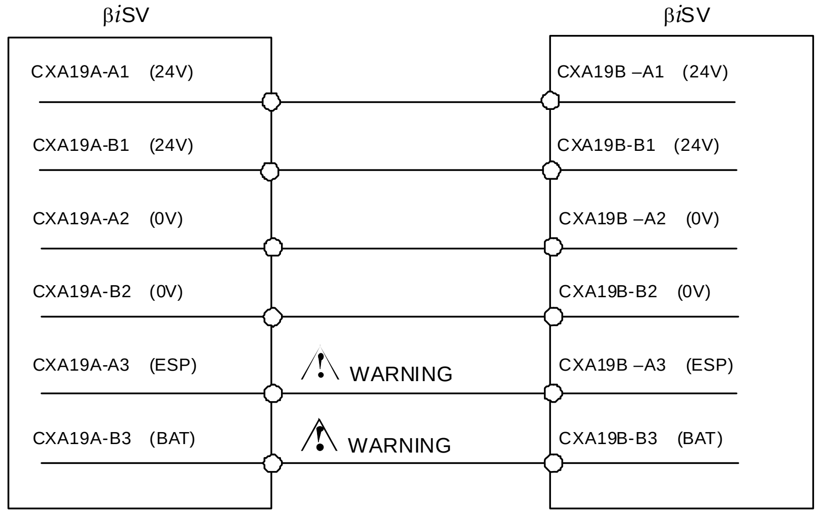


For details of connection tools, see Subsection 9.2.5, “Connection Tools”.

⚠ **CAUTION**

Do not connect the DCP and DCC pins to each other.
Do not connect TB to servo amplifier αi series terminal block TB1 (DCP/DCN).
Otherwise, the servo amplifier may be damaged.

9.2.10 Details of Cable K6



D-2000 series
Housing : 1-1318119-3
Contact : 1318107-1
Applicable wire: 0.3 to 0.85 mm^2
Manufacture : Tyco Electronics AMP

D-2000 series
Housing : 1-1318119-3
Contact : 1318107-1
Applicable wire: 0.3 to 0.85 mm^2
Manufacture : Tyco Electronics AMP

For details of connection tools, see Subsection 9.2.5, “Connection Tools”.

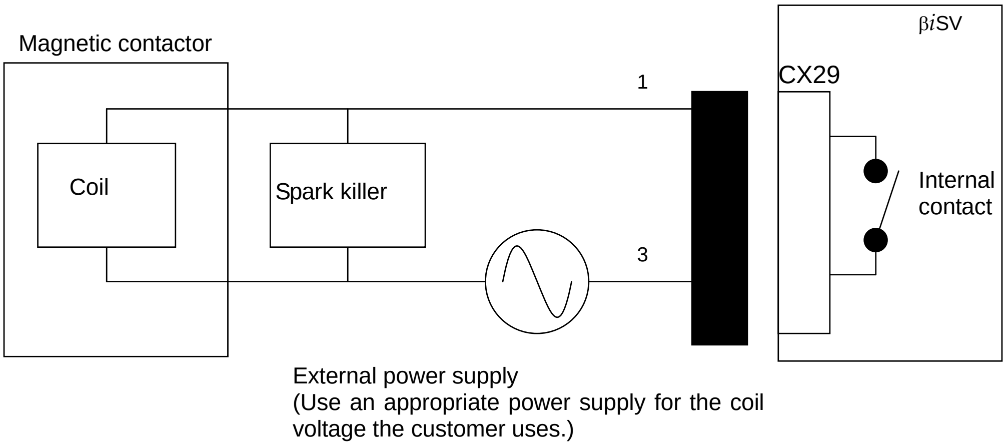
NOTE

The (B3)BAT is the interface used to connect the batteries for the absolute Pulsecoder. For details, see Subsections 9.2.13, “Details of Cable K9” and 9.2.14, “Details of Cable K10”.

⚠ **WARNING**

1 When connecting two or more servo amplifiers, be careful about the way the ESP (A3) is connected, because even when the emergency stop button is pressed, it may fail to stop the motor promptly. For details, see Subsection 9.2.12, "Details of Cable K8."
2 When using the built-in battery (A06B-6093-K001), never connect the BAT(B3) of the connector CXA19A/CXA19B.
Otherwise, a short-circuit will occur between the battery output voltages for different SVMs, possibly resulting in the batteries becoming very hot, which is dangerous.
3 Do not connect more than one battery to the same BAT(B3) line. Otherwise, a short-circuit will occur between the output voltages of different batteries, possibly resulting in the batteries becoming very hot, which is dangerous.

9.2.11 Details of Cable K7



D-2000 series
Housing : 3-1318130-3
Contact : 1318107-1
Applicable wire: 0.3 to 0.85 mm^2
Manufacture : Tyco Electronics AMP

For details of connection tools, see Subsection 9.2.5, “Connection Tools”.

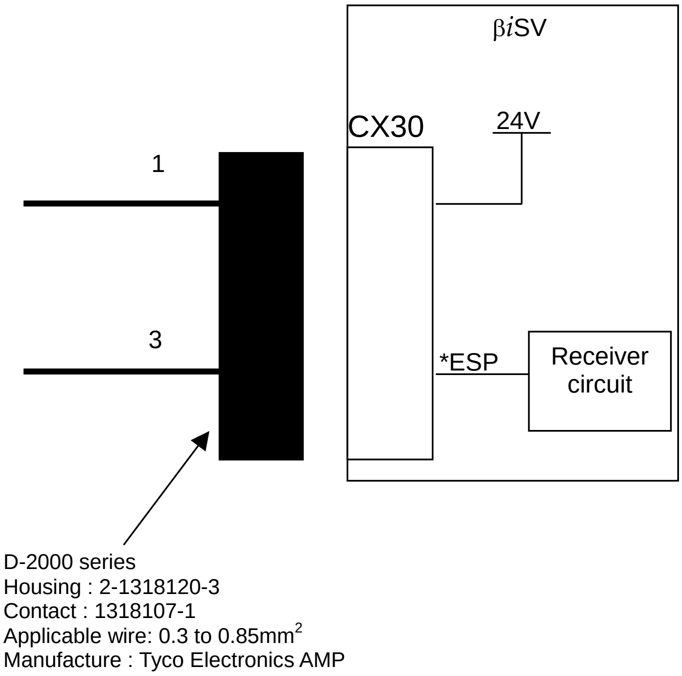
Internal contact capacity

	Resistance load (COSϕ=1)	Inductive load (COSϕ=0.4, L/R=15msec)
Rated load	250VAC, 3A / 24VDC, 5A	250VAC, 2A / 24VDC, 1A
Maximum contact capacity	5A	5A

NOTE

1. To protect the internal contact, be sure to insert a spark killer (CR) that matches the magnetic contactor used.
2. When more than one servo amplifier is connected, the cabling of cable K7 of the second and subsequent amplifiers may be omitted.

9.2.12 Details of Cable K8



For details of connection tools, see Subsection 9.2.5, “Connection Tools”.

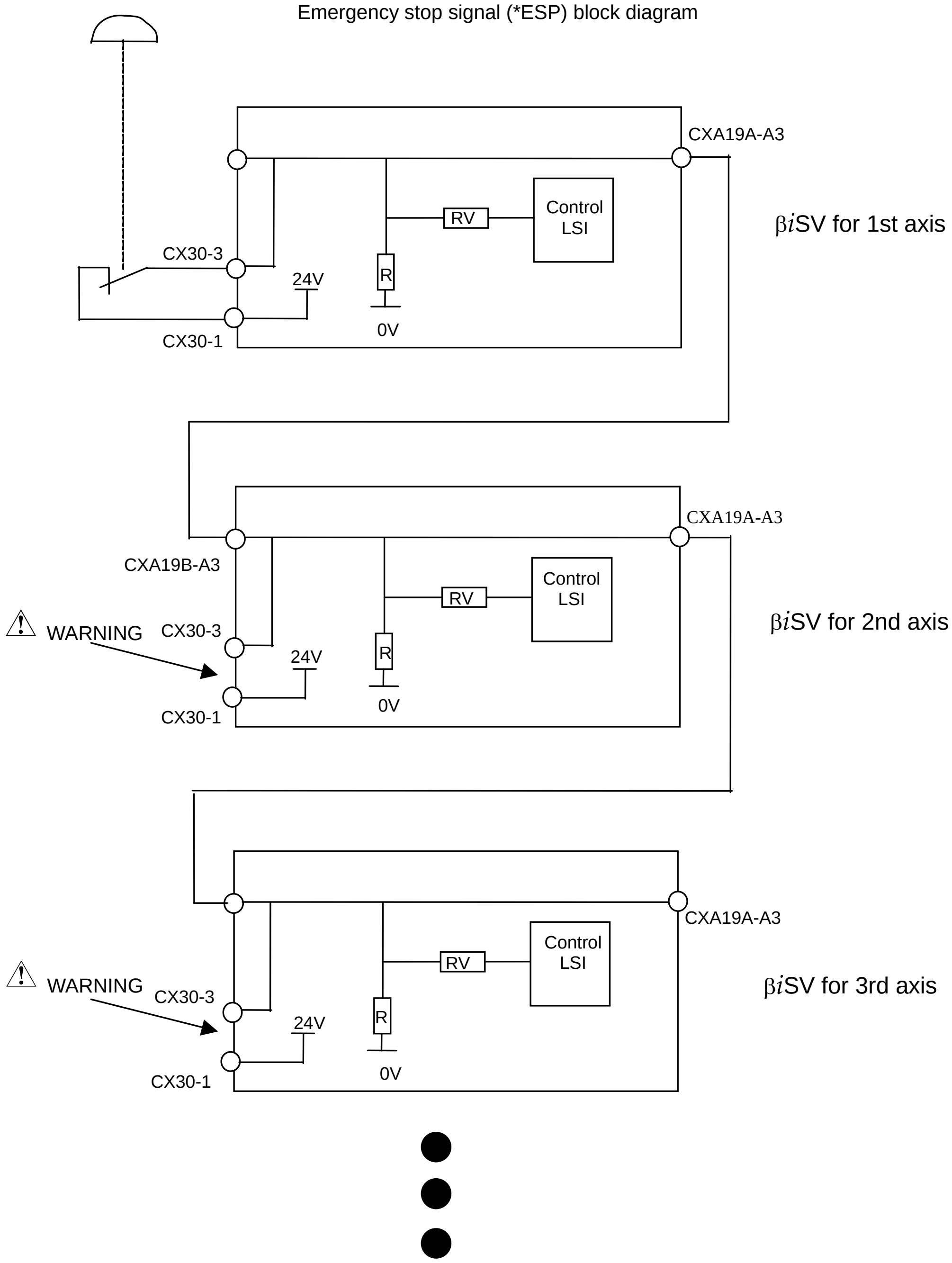
(1) When the contact is ON (closed), the servo motor is operational.
When the contact is OFF (open), the external magnetic contactor (MCC) is in the off state, and the servo motor does not operate.

(2) When the contact is set to OFF (open) while the motor is turning, the servo motor is stopped by the dynamic brake.

(3) The contact input signal is defined as follows:
<1> As the external contact capacity, a voltage of at least 30 VDC and a current of at least 100 mA are required.
<2> When contactless input is used, the significant levels (the voltage across the input pin) are as follows:
Low level "logic 0": 2 V or less
High level "logic 1": 20 V or more

> ⚠ **WARNING**
> The ESP signal receive circuit of the amplifier is implemented by an electronic circuit. This means that input of the ESP signal to the amplifier due to an electronic circuit failure may not stop the motor.

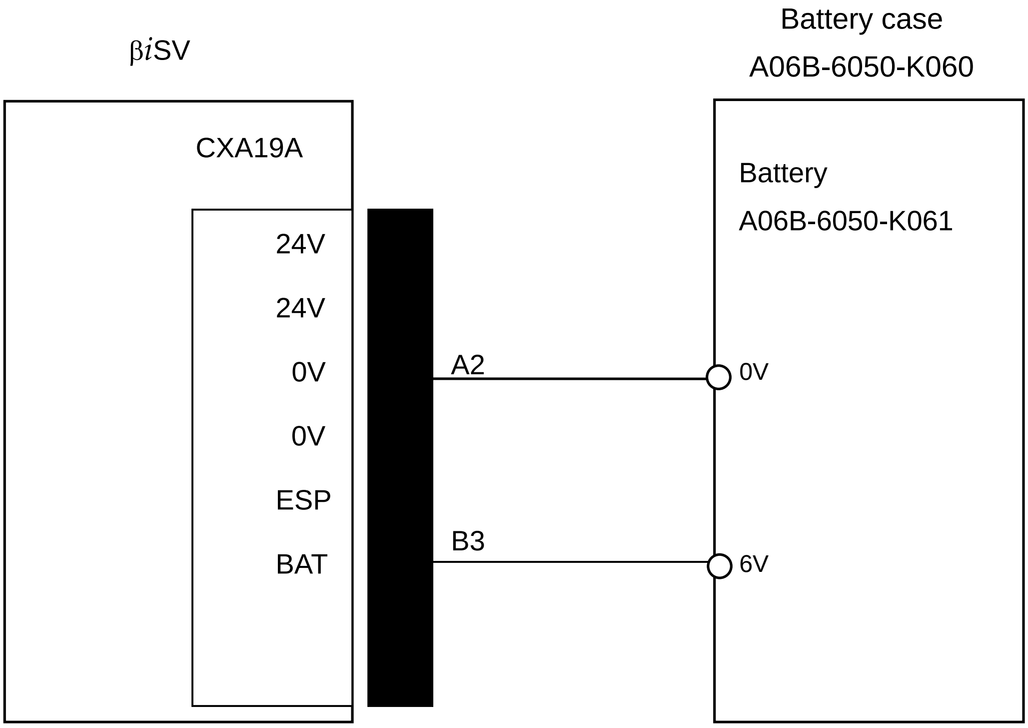
Emergency stop signal (*ESP) block diagram



⚠ WARNING

When connecting more than one amplifier, connect the ESP signal described in Subsection 9.2.10, "Details of Cable K6", and leave connector CX30 of every amplifier for the second and subsequent axes open.
(Never connect these connectors with a wire, a switch, or the like.)
Even when the emergency stop button is pressed, the motors may not stop immediately.

9.2.13 Details of Cable K9



D-2000 series
Housing : 1-1318119-3
Contact : 1318107-1
Applicable wire : 0.3 to 0.85mm^2
Manufacture : Tyco Electronics AMP

Crimp terminal : 1.25-2
Applicable wire : 0.3 to 0.85mm^2

For details of connection tools, see Subsection 9.2.5, “Connection Tools”.

NOTE

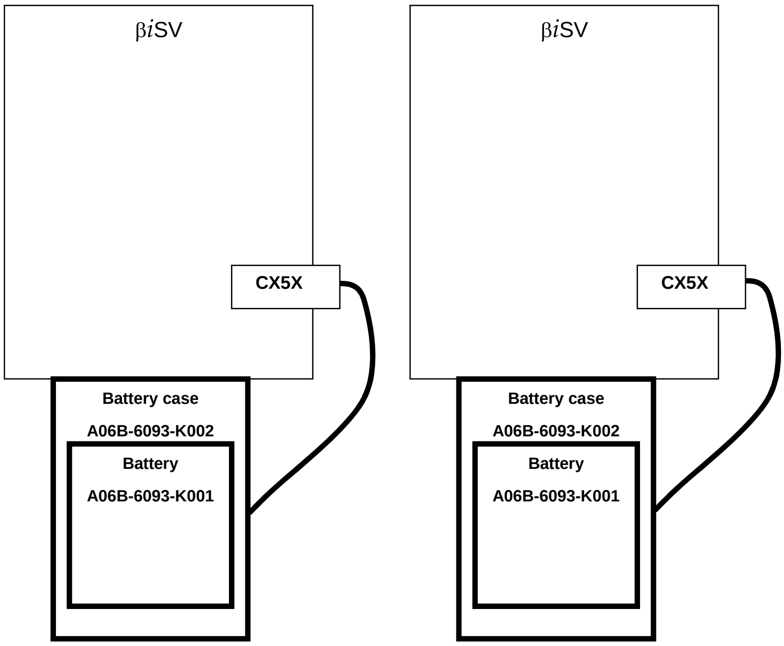
1. Because the battery requires periodic maintenance, the above connection method is recommended, where easily available commercial batteries (four size D alkaline batteries) can be used.
2. Servo motors for six axes can be connected to one battery unit.
3. If servo motors for six axes are connected to the battery unit, the service life of the battery unit is about two years for the β*i* series servo motors or about one year for the β series servo motors. The battery should be replaced periodically.

⚠ **WARNING**

Do not connect more than one battery to the same BATL(B3) line. Otherwise, a short-circuit will occur between the output voltages of different batteries, possibly resulting in the batteries becoming very hot, which is dangerous.

9.2.14 Details of Cable K10

(1) Incorporating built-in batteries in each β*i*SV (For β*i*SV4 or β*i*SV20)

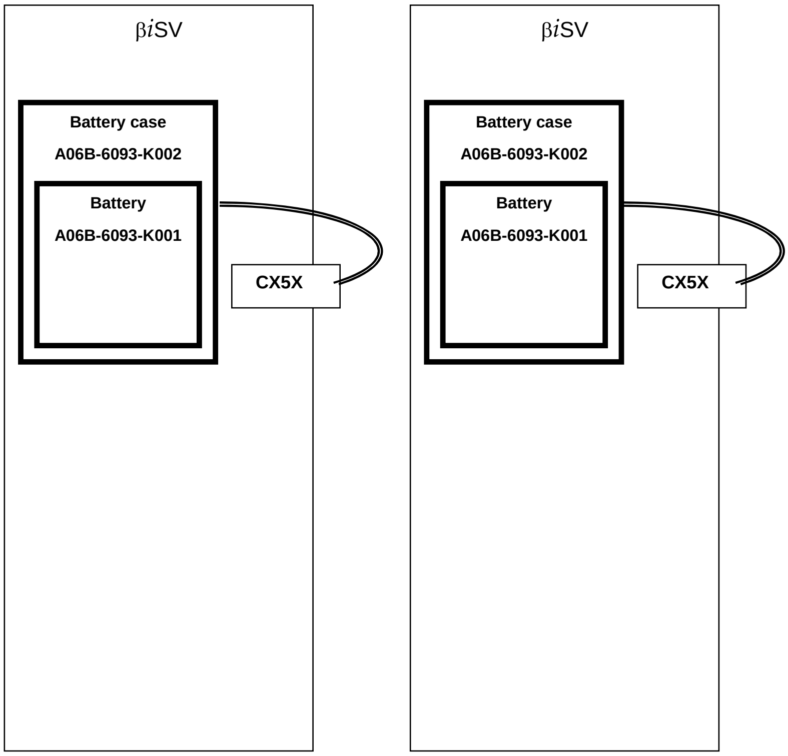


- Using the built-in battery (A06B-6093-K001) requires the battery case (A06B-6093-K002).

⚠ **WARNING**

1. When using the built-in battery (A06B-6093-K001), never connect the BAT(B3) of the connector CXA19A/CXA19B.
   Otherwise, a short-circuit will occur between the output voltages of different β*i*SV batteries, possibly resulting in the batteries becoming very hot, which is dangerous.
2. Do not connect more than one battery to the same BAT(B3) line. Otherwise, a short-circuit will occur between the output voltages of different batteries, possibly resulting in the batteries becoming very hot, which is dangerous.

(2) Incorporating built-in batteries in each βiSV (For βiSV40 or βiSV80)

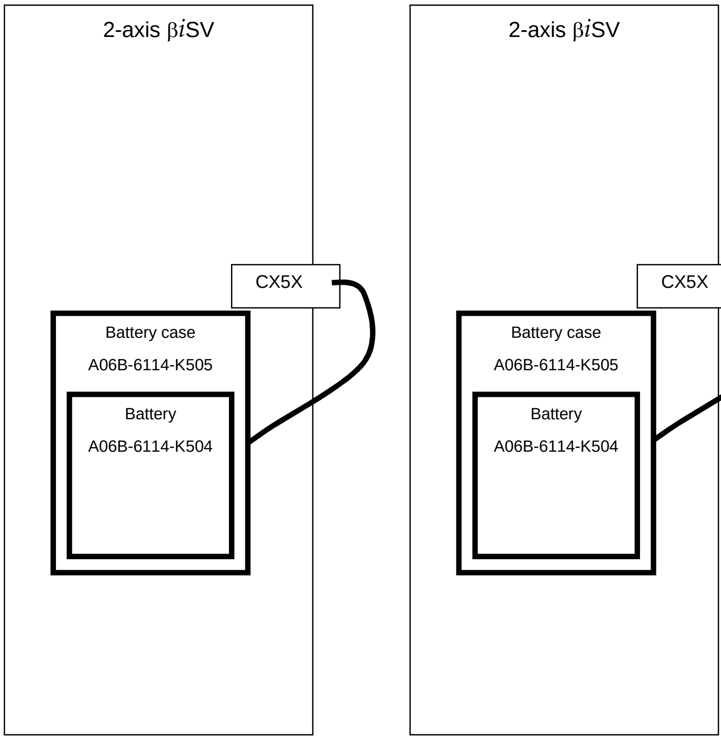


- Using the built-in battery (A06B-6093-K001) requires the battery case (A06B-6093-K002).

⚠ WARNING

1. When using the built-in battery (A06B-6093-K001), never connect the BAT(B3) of the connector CXA19A/CXA19B.
   Otherwise, a short-circuit will occur between the output voltages of different βiSV batteries, possibly resulting in the batteries becoming very hot, which is dangerous.
2. Do not connect more than one battery to the same BAT(B3) line. Otherwise, a short-circuit will occur between the output voltages of different batteries, possibly resulting in the batteries becoming very hot, which is dangerous.

(3) Incorporating built-in batteries in each 2-axis β*i*SV (For β*i*SV20/20 or β*i*SV40/40)

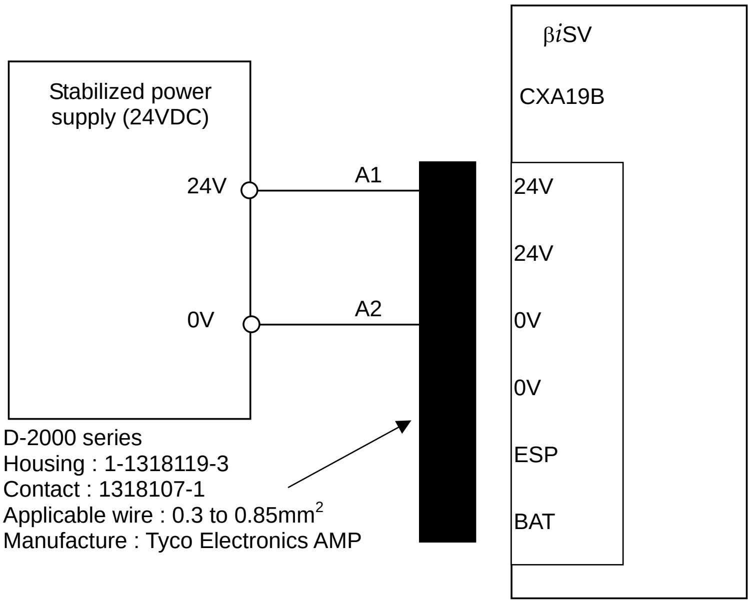


- Using the built-in battery (A06B-6114-K504) requires the battery case (A06B-6114-K505).

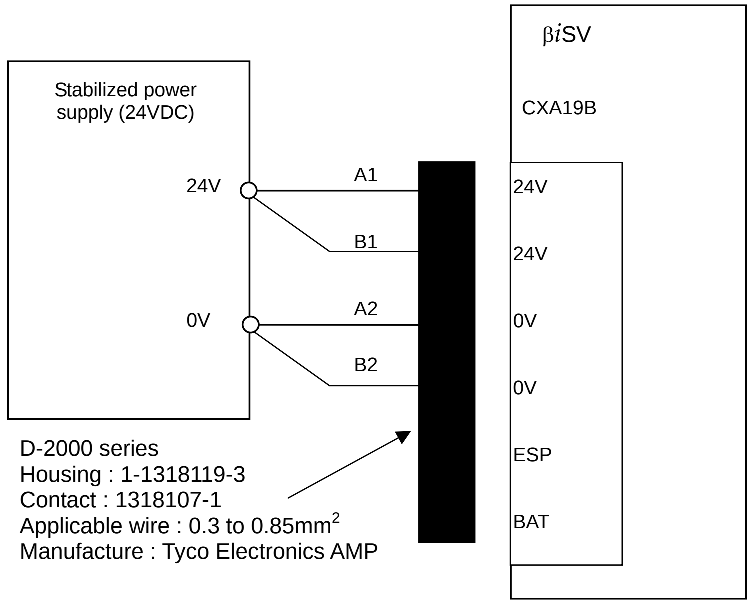
⚠ **WARNING**

1. When using the built-in battery (A06B-6093-K001), never connect the BAT(B3) of the connector CXA19A/CXA19B.
   Otherwise, a short-circuit will occur between the output voltages of different β*i*SV batteries, possibly resulting in the batteries becoming very hot, which is dangerous.
2. Do not connect more than one battery to the same BAT(B3) line. Otherwise, a short-circuit will occur between the output voltages of different batteries, possibly resulting in the batteries becoming very hot, which is dangerous.

9.2.15 Details of Cable K11



Up to four units can be connected (when AWG#18 cable is used).



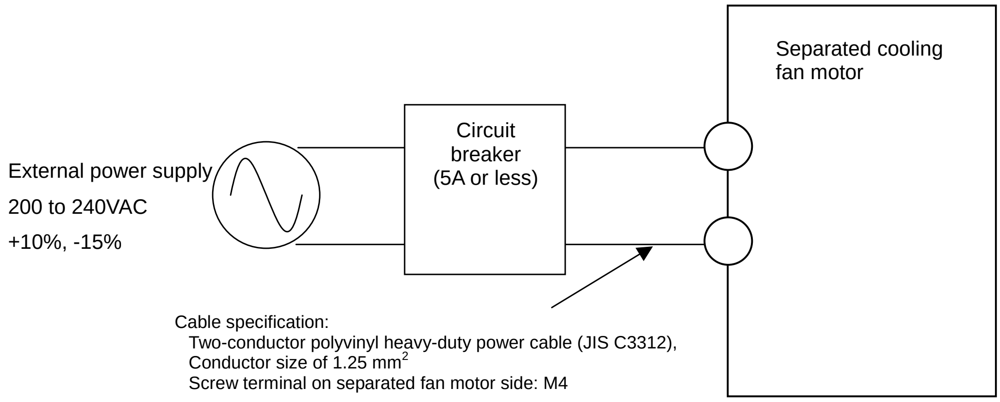
Up to eight units can be connected (when AWG#18 cable is used)

Maximum permissible current of the connector

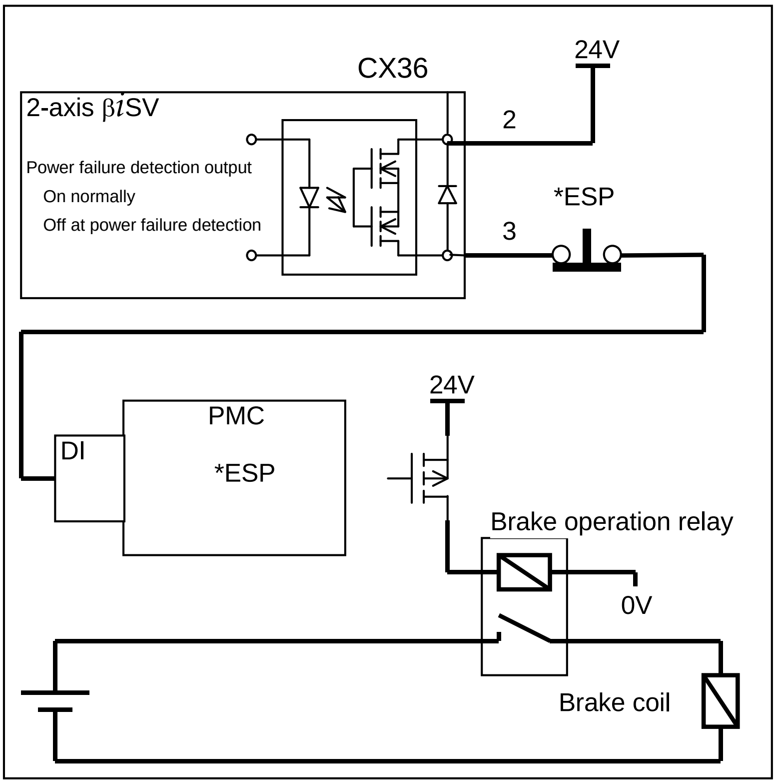
	When only one pin is connected
Maximum permissible current	4 A/pin (when AWG#18 cable is used)

For details of connection tools, see Subsection 9.2.5, “Connection Tools”.

9.2.16 Details of Cable K12



9.2.17 Details of Cable K13



CX36 requirements (output rating)
Load voltage 30V Max. / Load current 200mA Max.

Connector	Manufactured by Tyco Electronics AMP D-2100 series Housing (Y key): 2-1318120-3 (1 pcs.) Contact (M size): 1318107-1 (2 pcs.)
Cable	Conductor size : 0.5mm^2, AWG20 Insulation outer diameter: 1.11-1.87 mm
Applicable tool	: 91595-1

10 HEAT DISSIPATION

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

10.1 TOTAL AMOUNT OF HEAT DISSIPATION

10.1.1 β*i*SV and β*i*SV HV

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

Total amount of heat dissipation = a + Ka1 × b1 + Ka2 × b2

a : Amount of heat dissipation determined by the β*i*SV model [W]
Ka1, Ka2 : Coefficient determined by the β*i*SV [W/Arms]
b1, b2 : Current flowing through the servo motor [Arms]

Name	Ordering number	a[W]	Axis	Ka1 [W/Arms]	
				HRV2	HRV3
β*i*SV4	A06B-6130-H001 A06B-6160-H001	15	-	5.0	6.5
β*i*SV20	A06B-6130-H002 A06B-6160-H002	15	-	5.0	6.5
β*i*SV40	A06B-6130-H003 A06B-6160-H003	15	-	4.6	5.9
β*i*SV80	A06B-6130-H004 A06B-6160-H004	15	-	4.3	5.8
β*i*SV20/20	A06B-6136-H201 A06B-6166-H201	16	L	5.0	6.5
			M	5.0	6.5
β*i*SV40/40	A06B-6136-H203 A06B-6166-H203	16	L	4.5	5.7
			M	4.5	5.7
β*i*SV10HV	A06B-6131-H001 A06B-6161-H001	15	-	8.2	14.8
β*i*SV20HV	A06B-6131-H002 A06B-6161-H002	15	-	8.8	14.5
β*i*SV40HV	A06B-6131-H003 A06B-6161-H003	15	-	8.8	15.3

10.1.2 AC Line Filter

The total amount of heat dissipation of each AC line filter used for the servo amplifier βiSV series is listed below.

Applicable amplifier	AC line filter	Rated output	Total amount of heat dissipation	Remarks
βiSV4 βiSV20 βiSV40 βiSV80 βiSV20/20 βiSV40/40	A81L-0001-0171	5.4kW	20W	For 200 VAC amplifiers
	A81L-0001-0101#C	10.5kW	70W	
βiSV10HV βiSV20HV βiSV40HV	A81L-0001-0168	5.4kW	10W	For 400 VAC amplifiers
	A81L-0001-0169	10.5kW	70W	

10.2 RESIDUAL AMOUNT OF HEAT IN THE CABINET

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

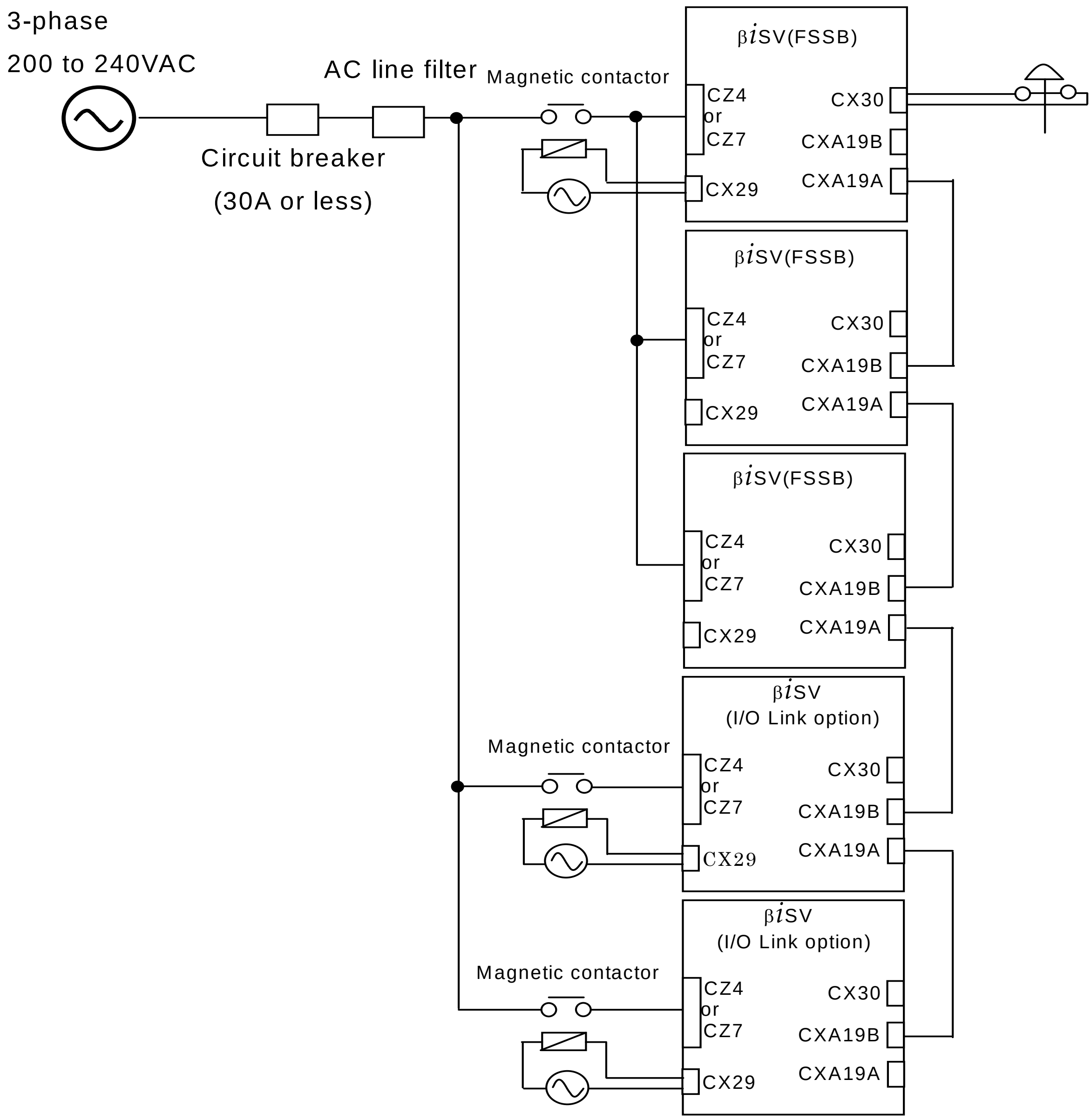
Total amount of heat dissipation = $a + Ka1 \times b1 + Ka2 \times b2$

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

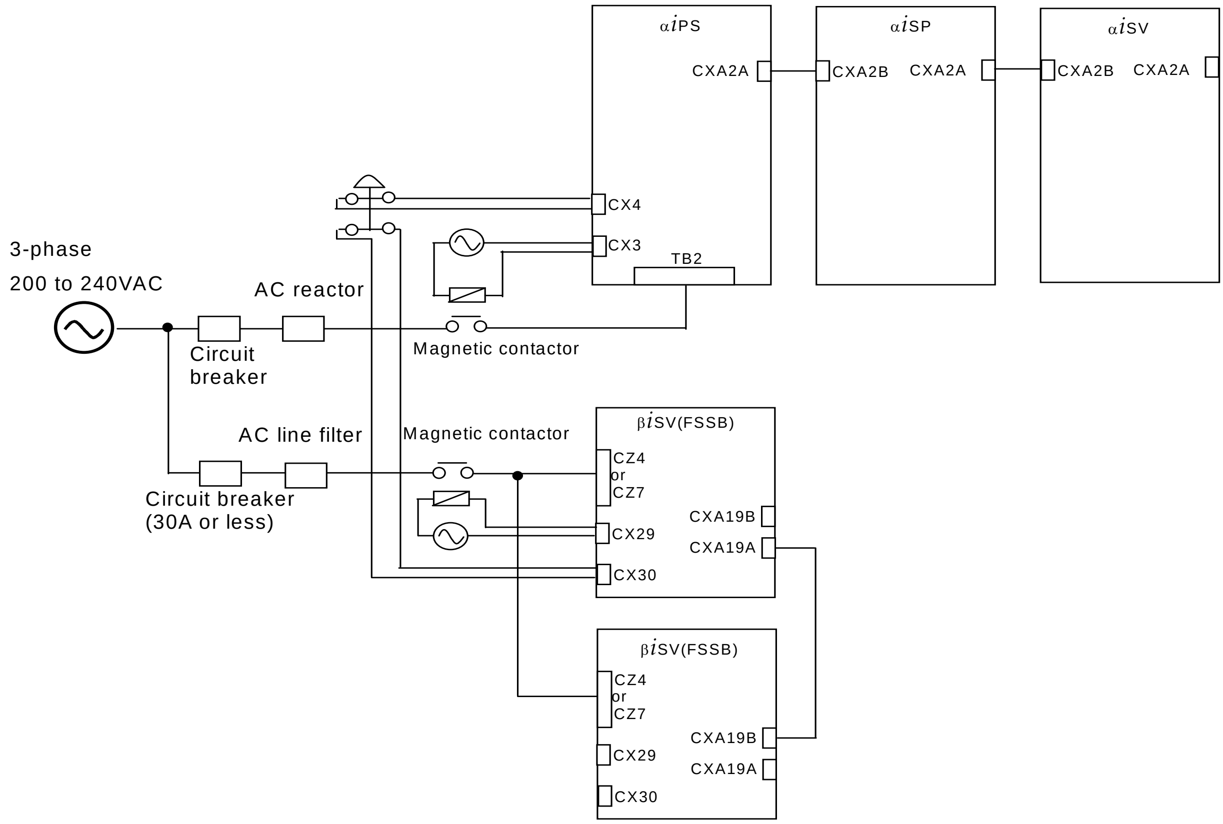
Name	Ordering number	a[W]	Axis	Ka1 [W/Arms]	
				HRV2	HRV3
βiSV4	A06B-6130-H001 A06B-6160-H001	15	-	5.0	6.5
βiSV20	A06B-6130-H002 A06B-6160-H002	15	-	5.0	6.5
βiSV40	A06B-6130-H003 A06B-6160-H003	15	-	0.92	1.18
βiSV80	A06B-6130-H004 A06B-6160-H004	15	-	0.86	1.16
βiSV20/20	A06B-6136-H201 A06B-6166-H201	16	L	5.0	6.5
			M	5.0	6.5
βiSV40/40	A06B-6136-H203 A06B-6166-H203	16	L	4.5	5.7
			M	4.5	5.7
βiSV10HV	A06B-6131-H001 A06B-6161-H001	15	-	1.64	2.96
βiSV20HV	A06B-6131-H002 A06B-6161-H002	15	-	1.76	2.9
βiSV40HV	A06B-6131-H003 A06B-6161-H003	15	-	1.76	2.9

11 COMBINATIONS OF DIFFERENT MODELS

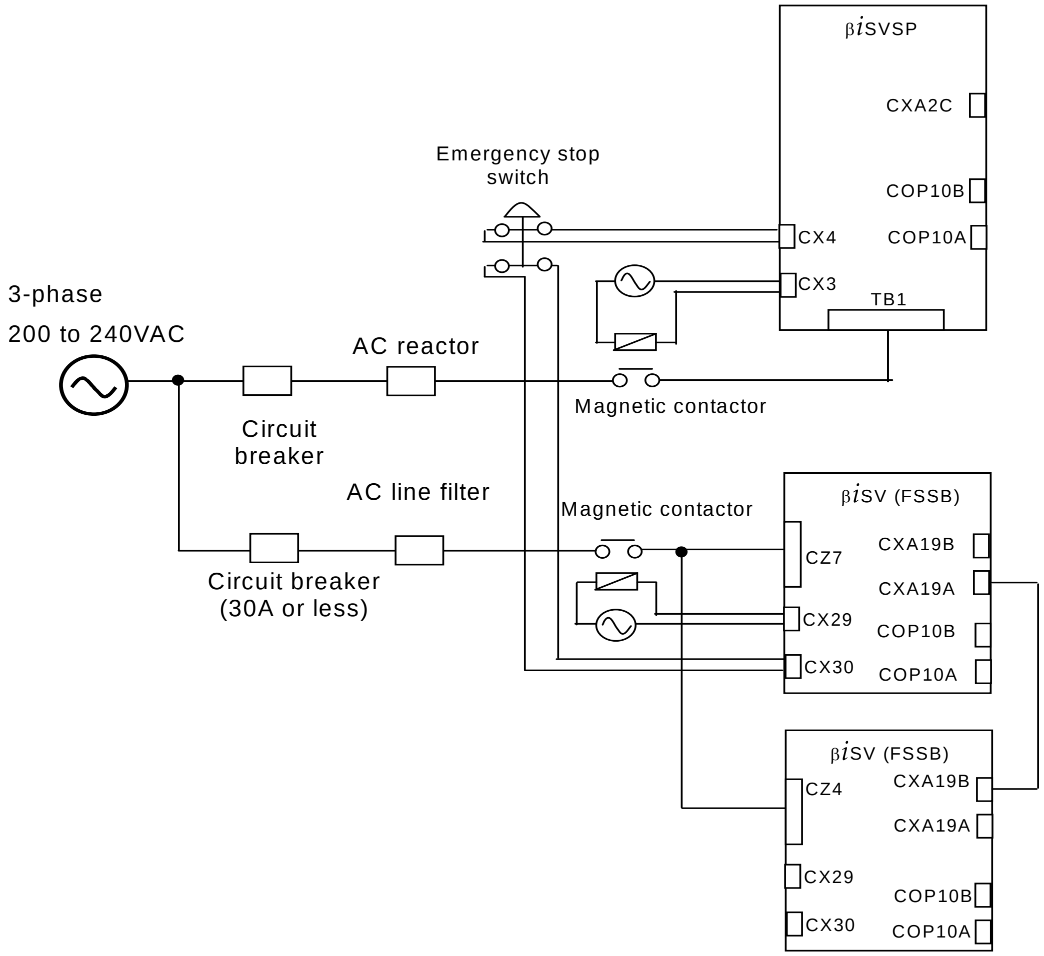
11.1 βiSV(FSSB) AND βiSV(I/O Link Option)



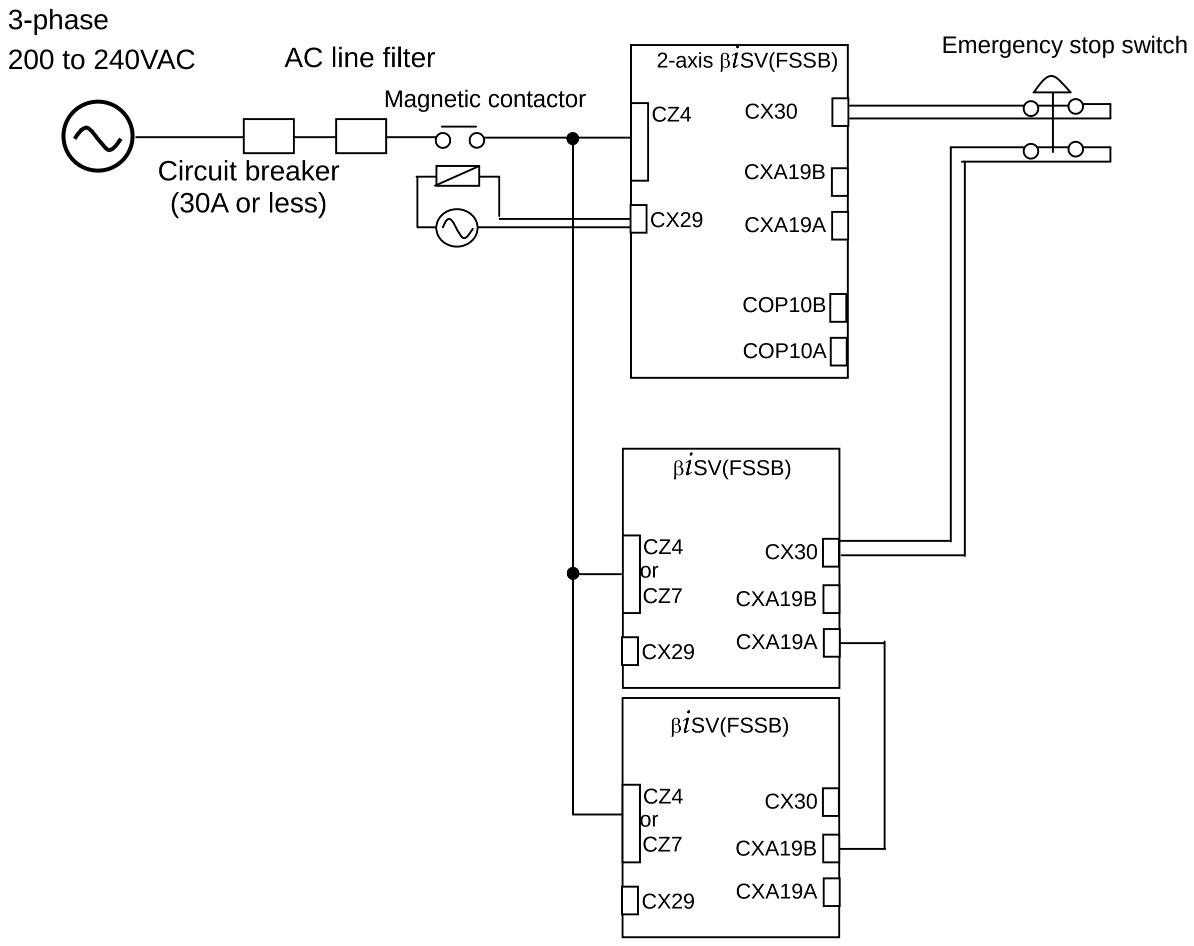
11.2 αi AMPLIFIER AND βiSV(FSSB)



11.3 β*i*SVSP AMD β*i*SV(FSSB)



11.4 2-AXIS β*i*SV(FSSB) AND β*i*SV(FSSB)



II. βiSVSP

1 OVERVIEW

1.1 FEATURE

The servo amplifier β*i*SVSP series has the following features:

[β*i*SVSP]

- Because a power supply is incorporated, a system with two or three servo axes and one spindle can be built easily.
- Multi-axis servo amplifier with excellent cost performance
- The FSSB interface, which is the standard interface of FANUC, is supported.
- This amplifier has a small installation area and volume.
- The β*i*SVSP is an amplifier for the Series 0*i*/0*i* Mate.
- Multi-axis servo amplifier suitable for the servo motor β*i*S and β*i*F series, which are suitable for feed axes of machining tools and for applications of their peripheral equipment, and for the spindle motor α*i*I and β*i*I series, which are suitable for a spindle.
- As a separated sensor for a spindle, the α*i* position coder, α*i*BZ sensor, or α*i*CZ sensor can be used.

[β*i*SVSPc]

- Because a power supply is incorporated, a system with two or three servo axes and one spindle can be built easily.
- Multi-axis servo amplifier with excellent cost performance
- The FSSB interface, which is the standard interface of FANUC, is supported.
- This amplifier has a small installation area and volume.
- The β*i*SVSPc is a servo amplifier with excellent cost performance as a lathe when combined with the Series 0*i*/0*i* Mate-TD.
- Servo amplifier for a sensor-less spindle motor.
- As a separated sensor for a spindle, the α*i* position coder or α*i*BZ sensor can be used. (The α*i*CZ sensor cannot be used.)
- Cs contour control is not supported.

1.2 COMPATIBILITY

The β*i*SVSP for the Series 0*i*/0*i* Mate-MODEL D differs from the conventional β*i*SVSP in ordering numbers.
Differences from the conventional models are:

(a) Differences between the β*i*SVSP for the Series 0*i*/0*i* Mate-MODEL D and the conventional β*i*SVSP (A06B-6134-H***#A, #C)

- The β*i*SVSP for the Series 0*i*/0*i* Mate-MODEL D has upgraded the spindle axis from 5.5 kW to 7.5 kW. (5.5 kW model does not exist.)
- An inter-CNC communication (FSSB) connector has been added.
- A power failure detection function has been incorporated.
- The sheet metal case has been replaced by a resin case and a terminal cover.
- New models (40/40/80-15, 40/40-18, 80/80-18, 40/40/80-18, and 80/80/80-18) have been added.
- With the spindle motor α*i*I and β*i*I series (α*i*M and α*i*MZ sensors attached), the α*i*BZ sensor or the α*i*CZ sensor can now be used as a separated sensor for a spindle.

(b) Differences between the β*i*SVSP for the Series 0*i*/0*i* Mate-MODEL D and the conventional β*i*SVSP (A06B-6134-H***#D)

- With the spindle motor α*i*I and β*i*I series (α*i*M and α*i*MZ sensors attached), the β*i*SVSP for Series 0*i*/0*i* Mate-MODEL D has made it possible to use the α*i*BZ sensor or the α*i*CZ sensor as a separated sensor for a spindle.
- New models (40/40-18, 80/80-18, 40/40/80-18, and 80/80/80-18) have been added.

(c) Differences between the β*i*SVSPc for the Series 0*i*/0*i* Mate-TD and the conventional β*i*SVSP (A06B-6134-H***#C and A06B-6165-H***#H560)

- The β*i*SVSPc is for the Series 0*i*/0*i* Mate-TD only.
- New models (β*i*SVSPc 20/20-7.5L and β*i*SVSPc 20/20/20-7.5L) have been added.
- The current value of the servo axis (Z-axis) of the servo 3-axis model differs.
  (β*i*SVSP 20/20/40-7.5,-11 → β*i*SVSPc 20/20/20-7.5, -7.5L,-11)
- As a separated sensor for a spindle, the α*i* position coder or α*i*BZ sensor can be used. (The α*i*CZ sensor cannot be used.)
- Cs contour control is not supported.

For a list of the β*i*SVSP for the Series 0*i*/0*i* Mate-MODEL D and their corresponding conventional β*i*SVSP, see the table below.

• Old and new β*i*SVSP correspondence table

Conventional β*i*SVSP amplifier	→	β*i*SVSP amplifier for the Series 0*i*/0*i* Mate-MODEL D
A06B-6134-H201#A A06B-6134-H201#D	→	A06B-6164-H201#H580
A06B-6134-H202#A A06B-6134-H202#D	→	A06B-6164-H202#H580
A06B-6134-H203#A A06B-6134-H203#D	→	A06B-6164-H223#H580
-	→	A06B-6164-H224#H580
-	→	A06B-6164-H244#H580
A06B-6134-H301#A A06B-6134-H301#D	→	A06B-6164-H311#H580
A06B-6134-H302#A A06B-6134-H302#D	→	A06B-6164-H312#H580
A06B-6134-H303#A A06B-6134-H303#D	→	A06B-6164-H333#H580
A06B-6134-H313#D	→	A06B-6164-H343#H580
-	→	A06B-6164-H344#H580
-	→	A06B-6164-H364#H580

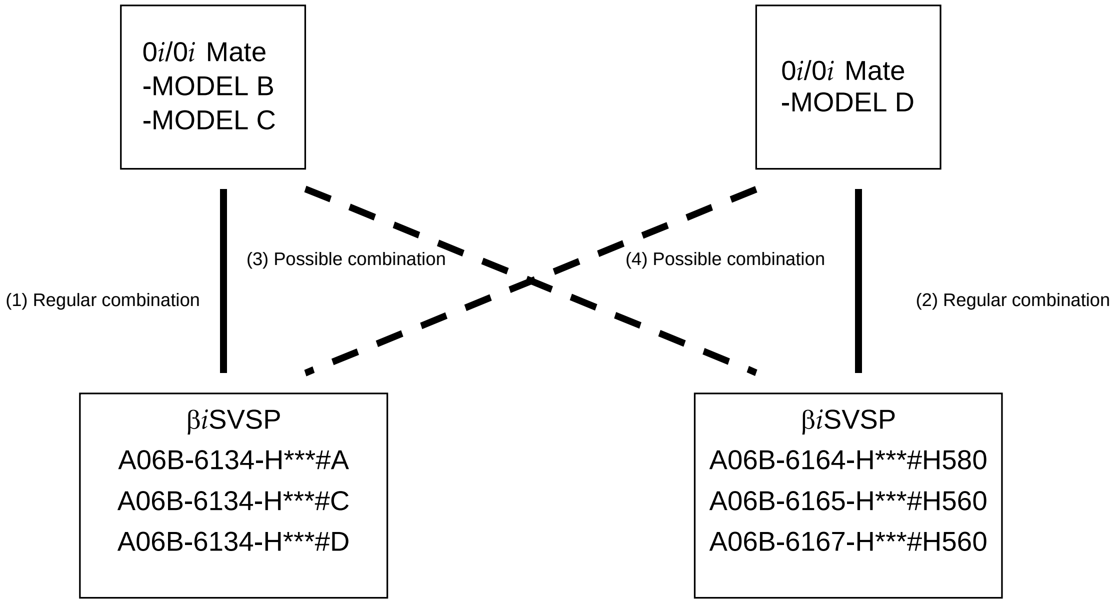
• Old and new β*i*SVSPc correspondence table

Conventional β*i*SVSP amplifier (Model for sensor-less spindle motors only)	→	β*i*SVSPc amplifier for the Series 0*i*/0*i* Mate-TD
A06B-6134-H201#C A06B-6165-H201#H560	→	A06B-6167-H201#H560
-	→	A06B-6167-H209#H560
A06B-6134-H202#C A06B-6165-H202#H560	→	A06B-6167-H202#H560
A06B-6134-H203#C A06B-6165-H223#H560	→	-
A06B-6134-H301#C A06B-6165-H311#H560	→	A06B-6167-H301#H560
-	→	A06B-6167-H309#H560

Conventional β*i*SVSP amplifier (Model for sensor-less spindle motors only)	→	β*i*SVSPc amplifier for the Series 0*i*/0*i* Mate-TD
A06B-6134-H302#C A06B-6165-H312#H560	→	A06B-6167-H302#H560
A06B-6134-H303#C A06B-6165-H333#H560	→	-
A06B-6165-H343#H560	→	-

* The current value of the servo axis (Z-axis) of the servo 3-axis model differs.
(β*i*SVSP 20/20/40-7.5,-11 → β*i*SVSPc 20/20/20-7.5, -7.5L,-11)

Compatibility between the CNC (0*i*/0*i* Mate) and the servo amplifier β*i*SVSP series



Combinations (1) and (2) are regular ones.
Combination (3) is possible.
Combination (4) is possible although this requires the setting of additional special parameters. Besides, there are restrictions.
For details, see item (1).

(1) Details of (4)

(a) Setting of the servo part of the β*i*SVSP and restrictions
The 0*i*/0*i* Mate-MODEL C compatible mode must be set. Enter the following parameter:

14476#0=1
Turn the power off, then on again.

The maximum number of units that can be connected to one FSSB line is as follows:
In the servo control (HRV3) mode, up to four servo axes can be connected.
In the servo control (HRV2) mode, up to eight servo axes can be connected.

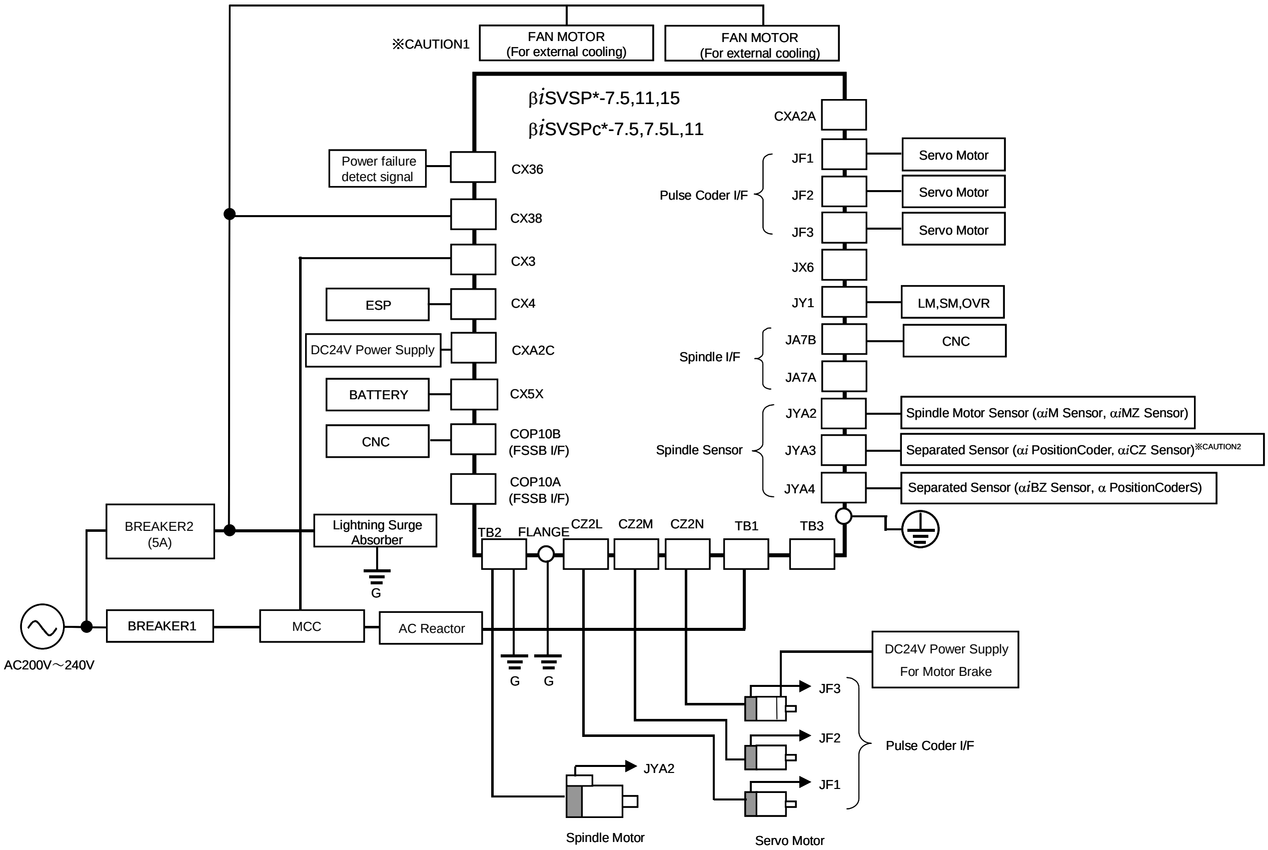
(b) Notes on the spindle part of the β*i*SVSP
To support the interface between the 0*i*/0*i* Mate-MODEL D and the β*i*SVSP during spindle position control (such as rigid tapping), spindle software of the series and edition 9D50/V (edition 22) to Y (edition 25) or 9D5A/A (edition 01) or later can be connected. (For other series and editions, combination (4) is not possible.)

The servo amplifier β*i*SVSP has upgraded the spindle axis from 5.5 kW to 7.5 kW depending on the series. See the table below.

β*i*SVSP drawing number	Continuous rated output of the spindle axis [KW]
A06B-6134-H201#A, #C A06B-6134-H301#A, #C	5.5KW
A06B-6134-H201#D A06B-6134-H301#D	7.5KW
A06B-6164-H201#H580, A06B-6164-H311#H580 A06B-6165-H201#H560, A06B-6165-H311#H560 A06B-6167-H201#H560, A06B-6167-H301#H560	7.5KW

2 CONFIGURATION

2.1 βiSVSP*-7.5/-11/-15 AND βiSVSPc*-7.5/-7.5L/-11



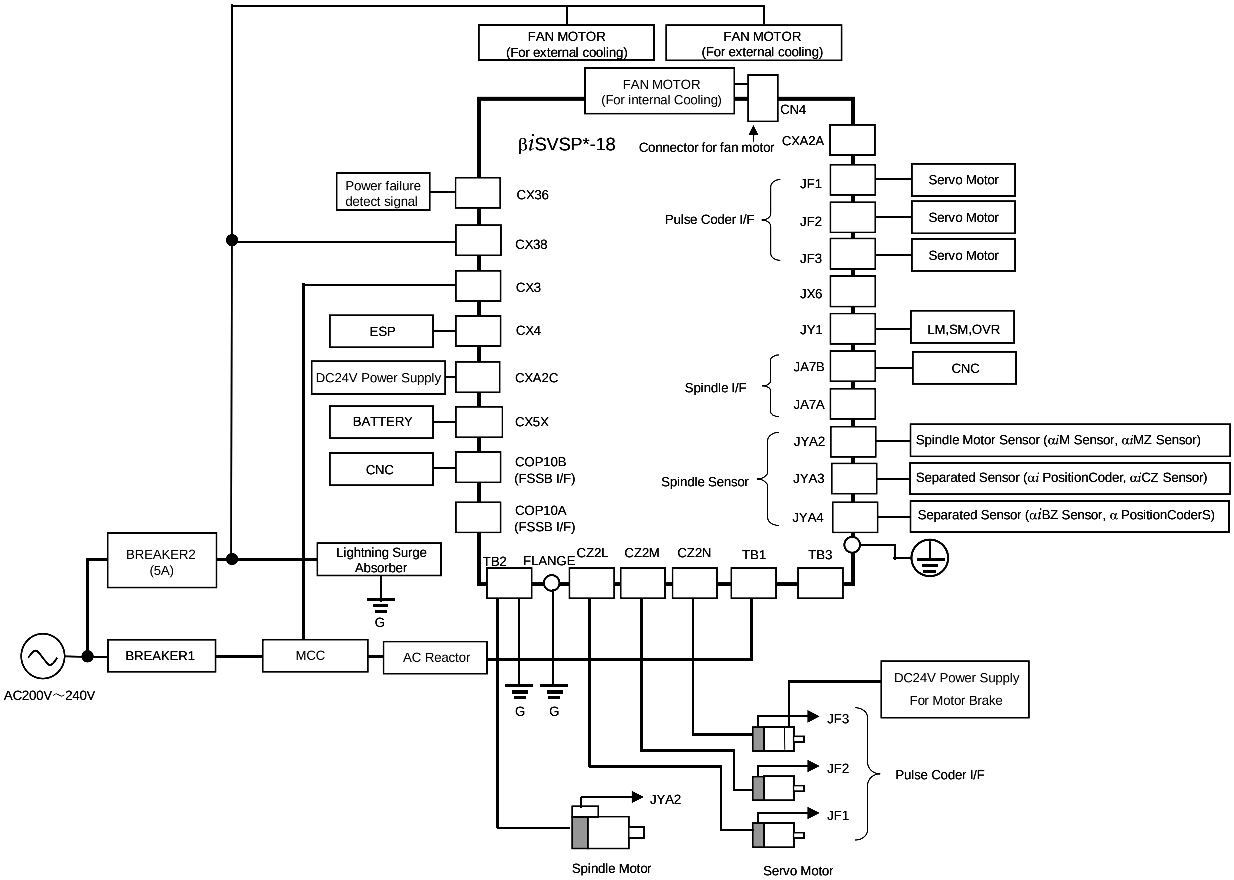
NOTE

1. Always install the circuit breakers, magnetic contactor, and AC reactor.
2. Use the stabilized power supply 24VDC for the servo amplifier. Power supply 24VDC for the servo amplifier and power supply 24VDC for the motor brake cannot be shared.
3. To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.
4. Always ground the grounding terminal (G) on TB2 and the tapped hole for grounding the flange.

⚠ CAUTION

1. In the βiSVSP*-7.5 and -11, as well as the βiSVSPc*-7.5L and -11, install only one separated cooling fan motor (for cooling the radiator fin). If installing only one, install it on this side.
2. The αiCZ sensor cannot be connected to the βiSVSPc.

2.2 βiSVSP*-18



> **NOTE**
> 1 Always install the circuit breakers, magnetic contactor, and AC reactor.
> 2 Use the stabilized power supply 24VDC for the servo amplifier. Power supply 24VDC for the servo amplifier and power supply 24VDC for the motor brake cannot be shared.
> 3 To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.
> 4 Always ground the grounding terminal (G) on TB2 and the tapped hole for grounding the flange.

3 SPECIFICATIONS

3.1 INPUT POWER

3.1.1 Power Supply of 200-V Input Series

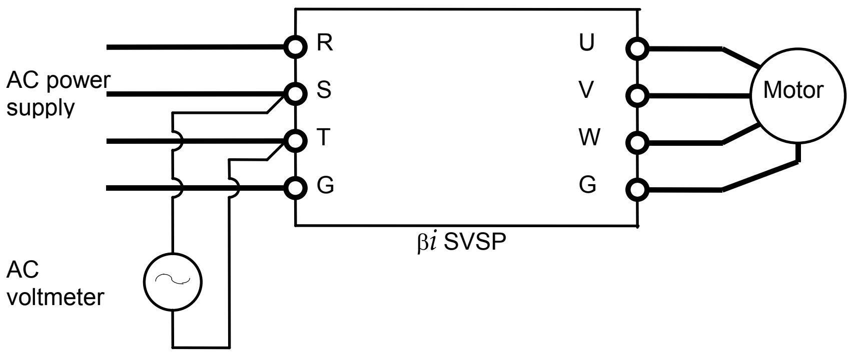
(1) Power specification

Item	Specification
Main power supply voltage	Three-phase 200 to 240 VAC
Allowable voltage deviation	-15% to +10% (including voltage variation due to load)
Instantaneous power failure guarantee time	3ms
Power frequency	50/60Hz, ±1Hz
Power supply unbalance	±5% of the rated voltage or less
Power supply impedance (Note)	The voltage variation must be within ±7% when a maximum output (power running and regeneration) is produced for voltage at non-load time.

NOTE

When the power supply impedance is high, and the voltage variation exceeds the specified values, an alarm (DC link undervoltage alarm or DC link overvoltage alarm) can be issued in an amplifier, and the output of the motor can decrease.

[Method of checking power supply impedance]



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

E0: Voltage at non-load time

E1: Voltage at maximum output time (power running and regeneration)

(2) It is recommended not to install a capacitor for power-factor improvement because it may affect power regeneration.

(3) 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.

(4) Ground

The main circuit and the 200-V control power supply must be grounded through the neutral point or one phase of the three-phase power supply.

(5) Noise filter

To satisfy the EMC regulation enforced in the EU countries, a noise filter must be installed in the power supply input section.

(6) Low-voltage command
Separate the signal cables from the main power supply and power cables including motor cables with double insulation.

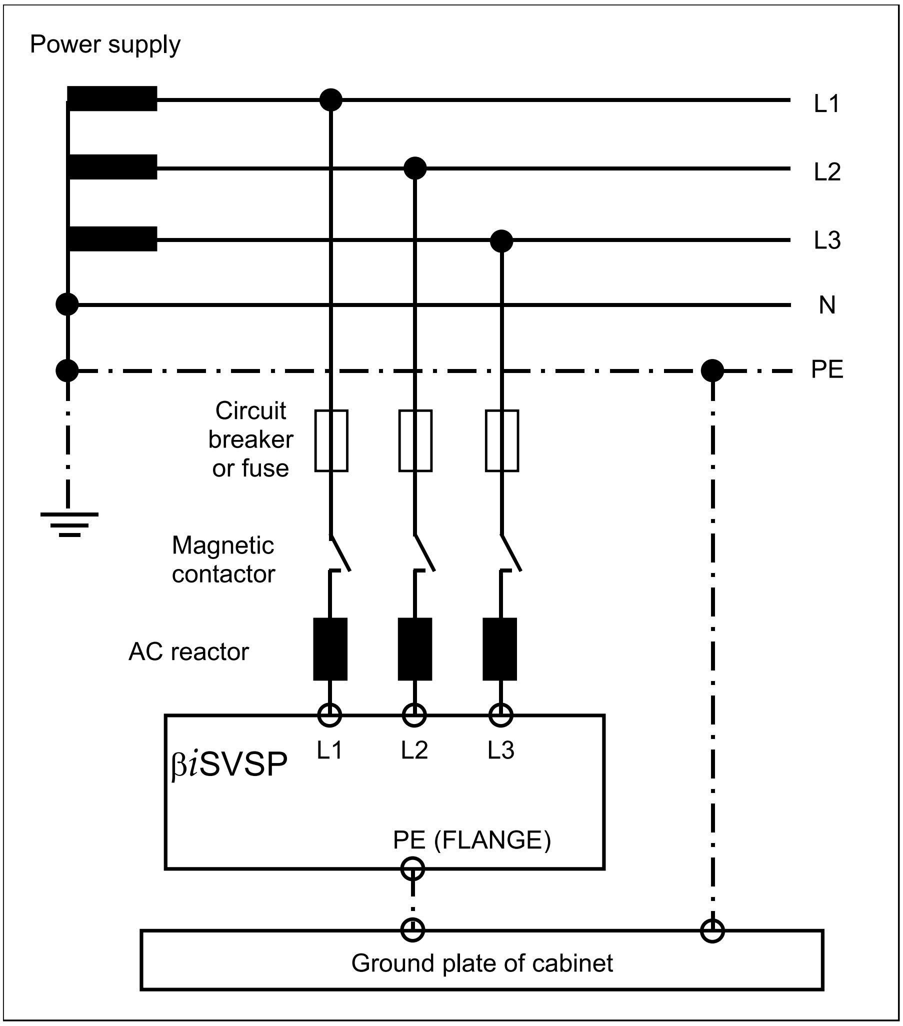
(7) Example of connecting the Power supply of the main circuit

No.	Power system	Power specification	Power supply of amplifier
1	TN-power system	• Star connection • Neutral grounding on the power supply side • PE provided on the power line • Power supply voltage specification 200 to 240 VAC (-15%,+10%)	• Directly connectable to the power supply (No transformer is required.)
2	TN-power system	• Star connection • Neutral grounding on the power supply side • PE provided on the power line • Power supply voltage specification Not within the range 200 to 240 VAC (-15%, +10%)	[When the power supply voltage is lower than the specified power supply voltage] The power supply voltage is increased with an auto-transformer. [When the power supply voltage is higher than the specified power supply voltage] The power supply voltage is decreased with an auto-transformer. Before starting to use the power supply, check that it conforms to the relevant safety standards.
3	TN-power system	• Delta connection • Single-phase grounding on the power supply side • PE provided on the power line • Power supply voltage specification 200 to 240 VAC (-15%,+10%)	• Directly connectable to the power supply (No transformer is required.)
4	TN-power system	• Delta connection • Single-phase grounding on the power supply side • PE provided on the power line • Power supply voltage specification Not within the range 200 to 240 VAC (-15%, +10%)	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.
5	TT-power system	• Star connection • Neutral grounding on the power supply side • No PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.
6	TT-power system	• Delta connection • Single-phase grounding on the power supply side • No PE provided on the power line	
7	IT-power system	• Star connection • No direct ground connection made on the power supply side • No PE provided on the power line	
8	IT-power system	• Delta connection • No direct ground connection made on the power supply side • No PE provided on the power line	

* The TN-power system, TT-power system, and IT-power system are based on the DC power distribution system standard IEC60364.

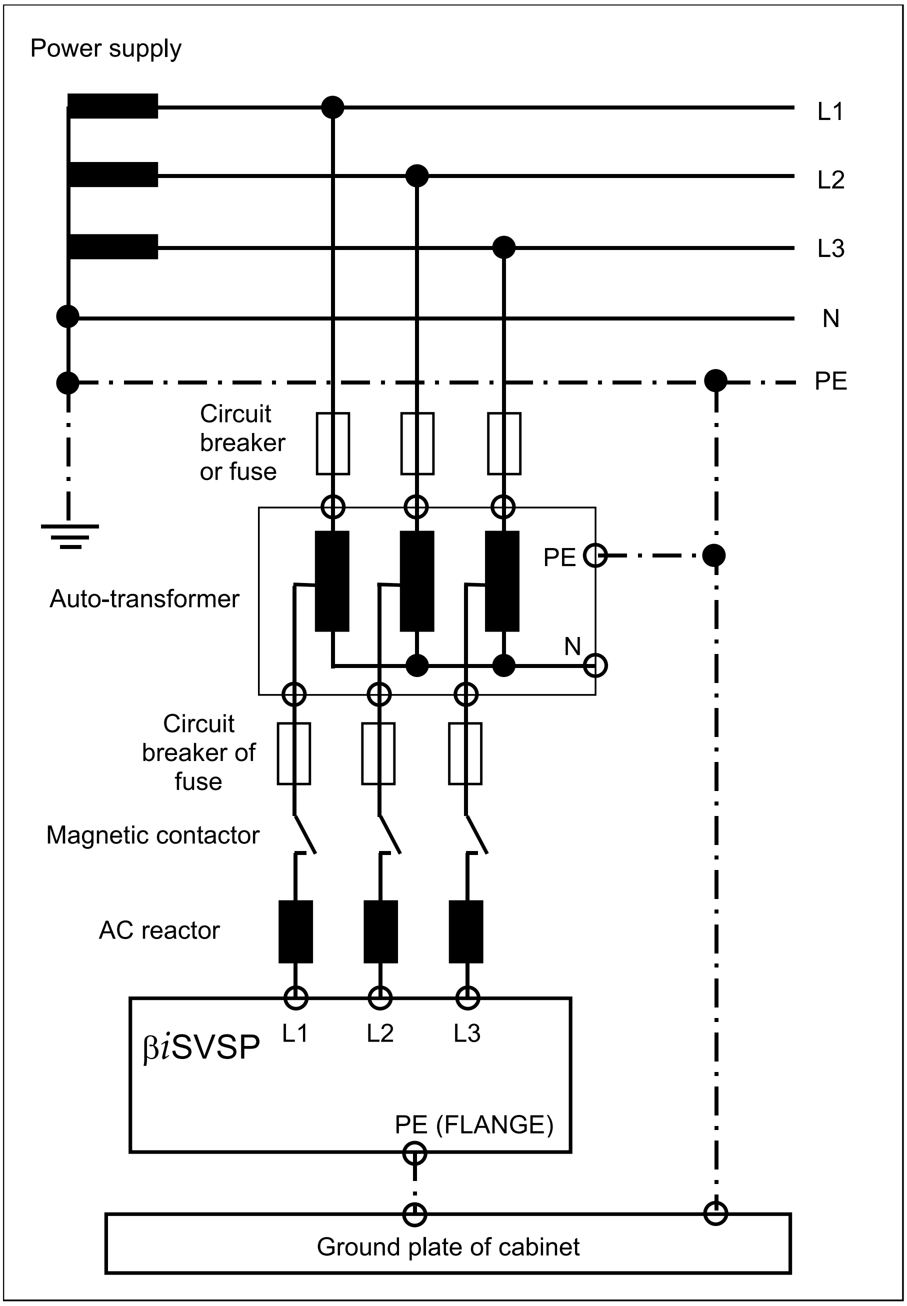
(a) TN-power system

No.	Power system	Power specification	Power supply of amplifier
1	TN-power system	• Star connection • Neutral grounding on the power supply side • PE provided on the power line • Power supply voltage specification 200 to 240 VAC (-15%,+10%)	• Directly connectable to the power supply (No transformer is required.)



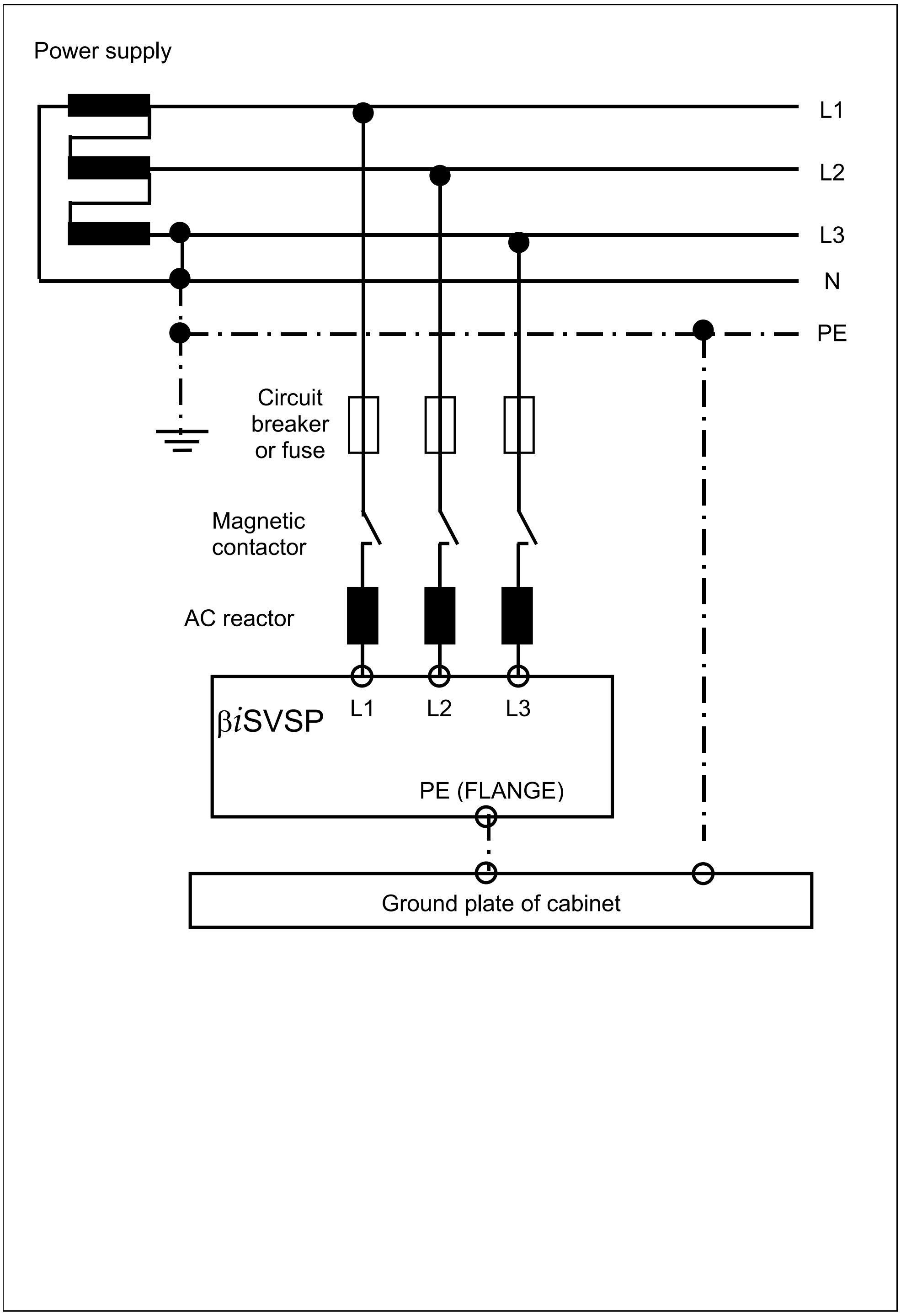
(b) TN-power system

No.	Power system	Power specification	Power supply of amplifier
2	TN-power system	• Star connection • Neutral grounding on the power supply side • PE provided on the power line • Power supply voltage specification Not within the range 200 to 240 VAC (-15%, +10%)	[When the power supply voltage is lower than the specified power supply voltage] The power supply voltage is increased with an auto-transformer. [When the power supply voltage is higher than the specified power supply voltage] The power supply voltage is decreased with an auto-transformer. Before starting to use the power supply, check that it conforms to the relevant safety standards.



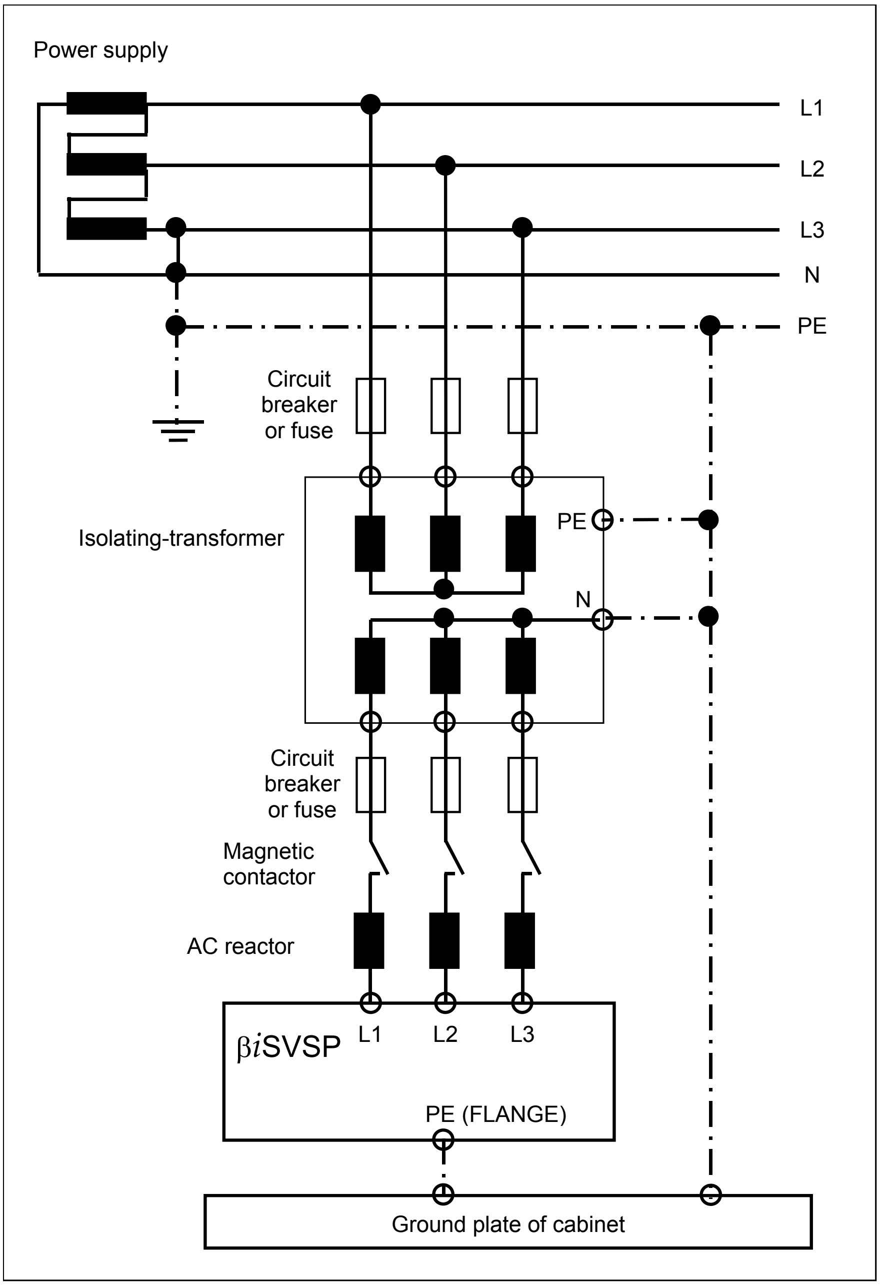
(c) TN-power system

No.	Power system	Power specification	Power supply of amplifier
3	TN-power system	• Delta connection • Single-phase grounding on the power supply side • PE provided on the power line • Power supply voltage specification 200 to 240 VAC (-15%,+10%)	• Directly connectable to the power supply (No transformer is required.)



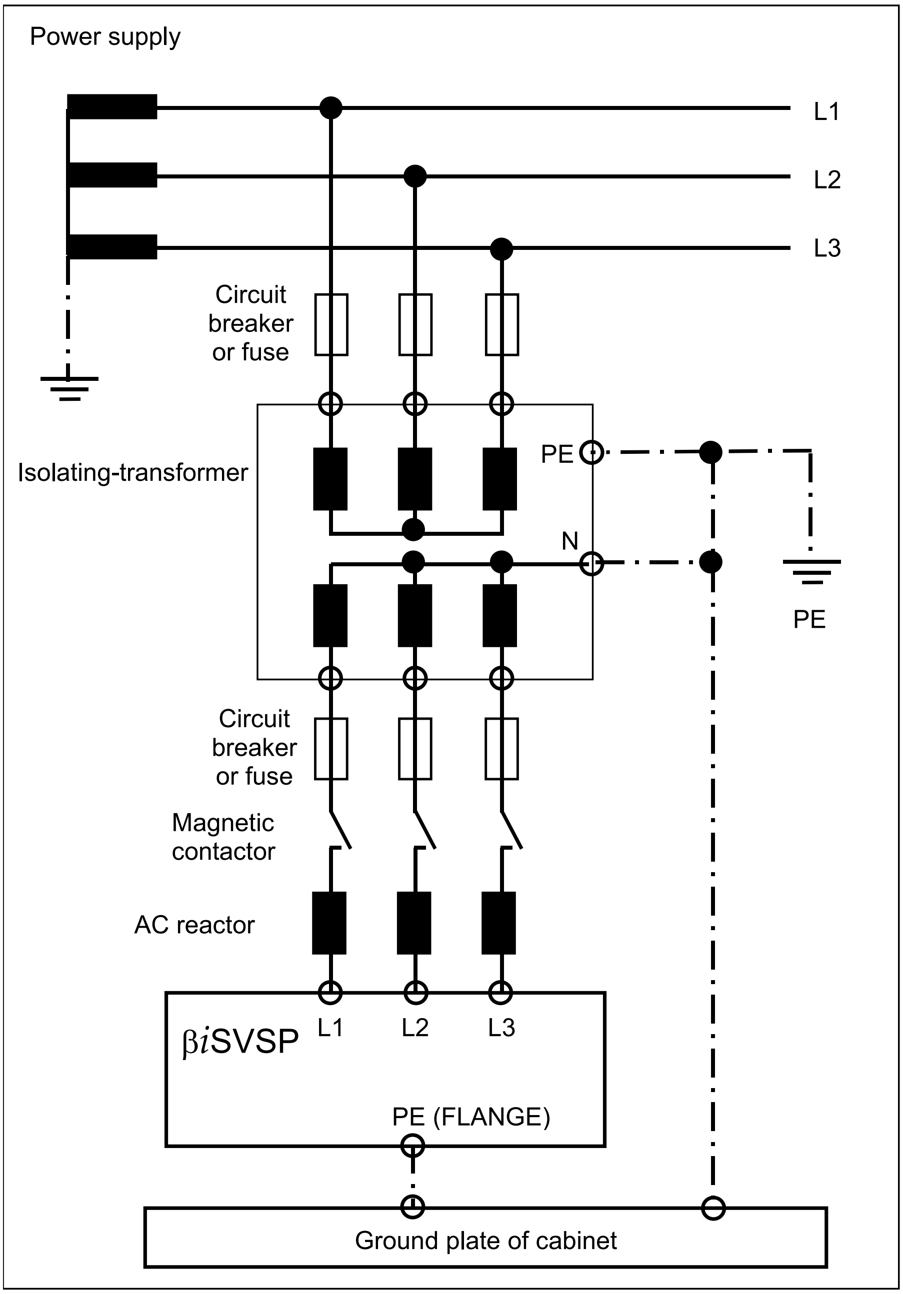
(d) TN-power system

No.	Power system	Power specification	Power supply of amplifier
4	TN-power system	• Delta connection • Single-phase grounding on the power supply side • PE provided on the power line • Power supply voltage specification Not within the range 200 to 240 VAC (-15%, +10%)	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.



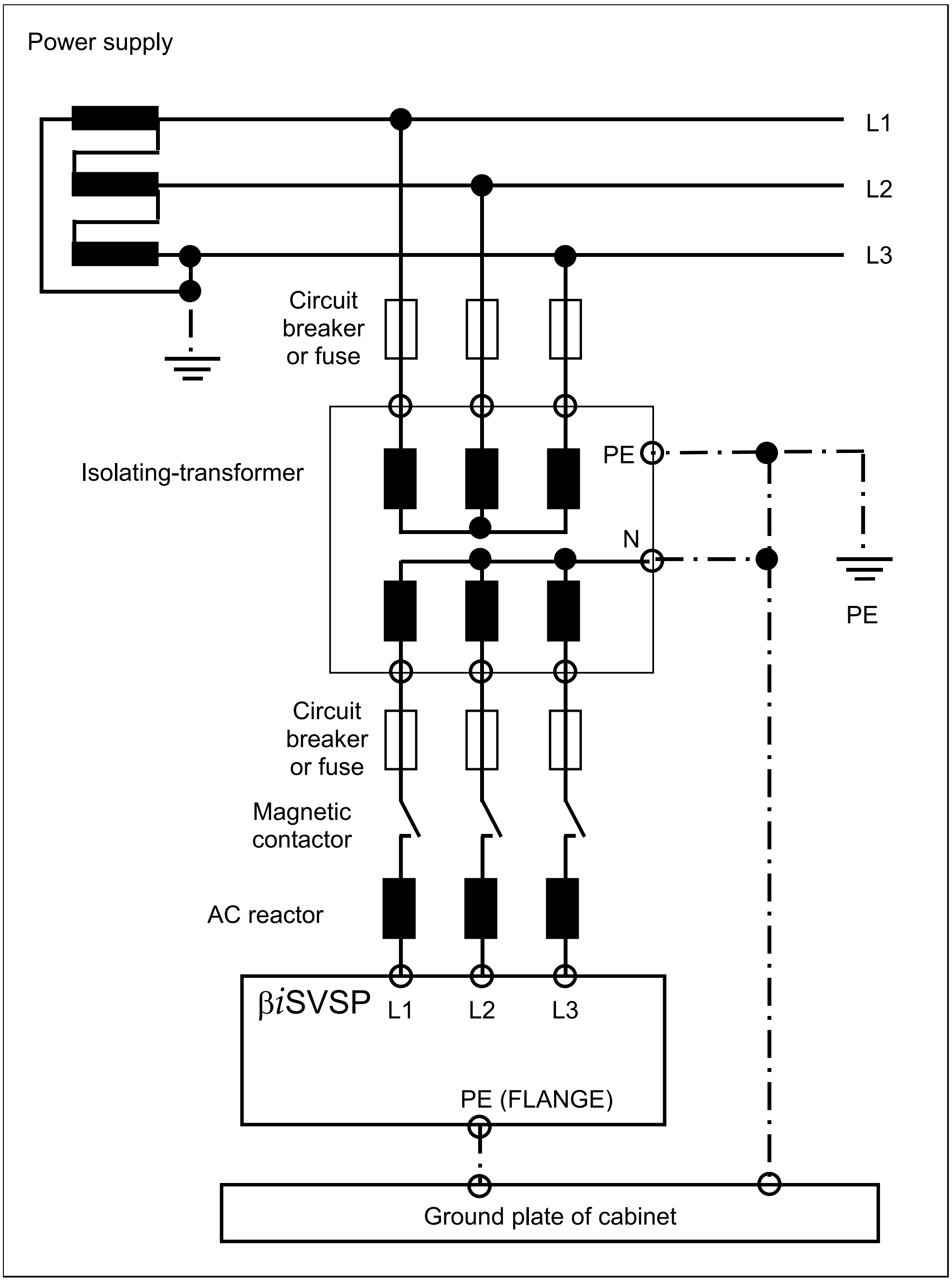
(e) TT-power system

No.	Power system	Power specification	Power supply of amplifier
5	TT-power system	• Star connection • Neutral grounding on the power supply side • No PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.



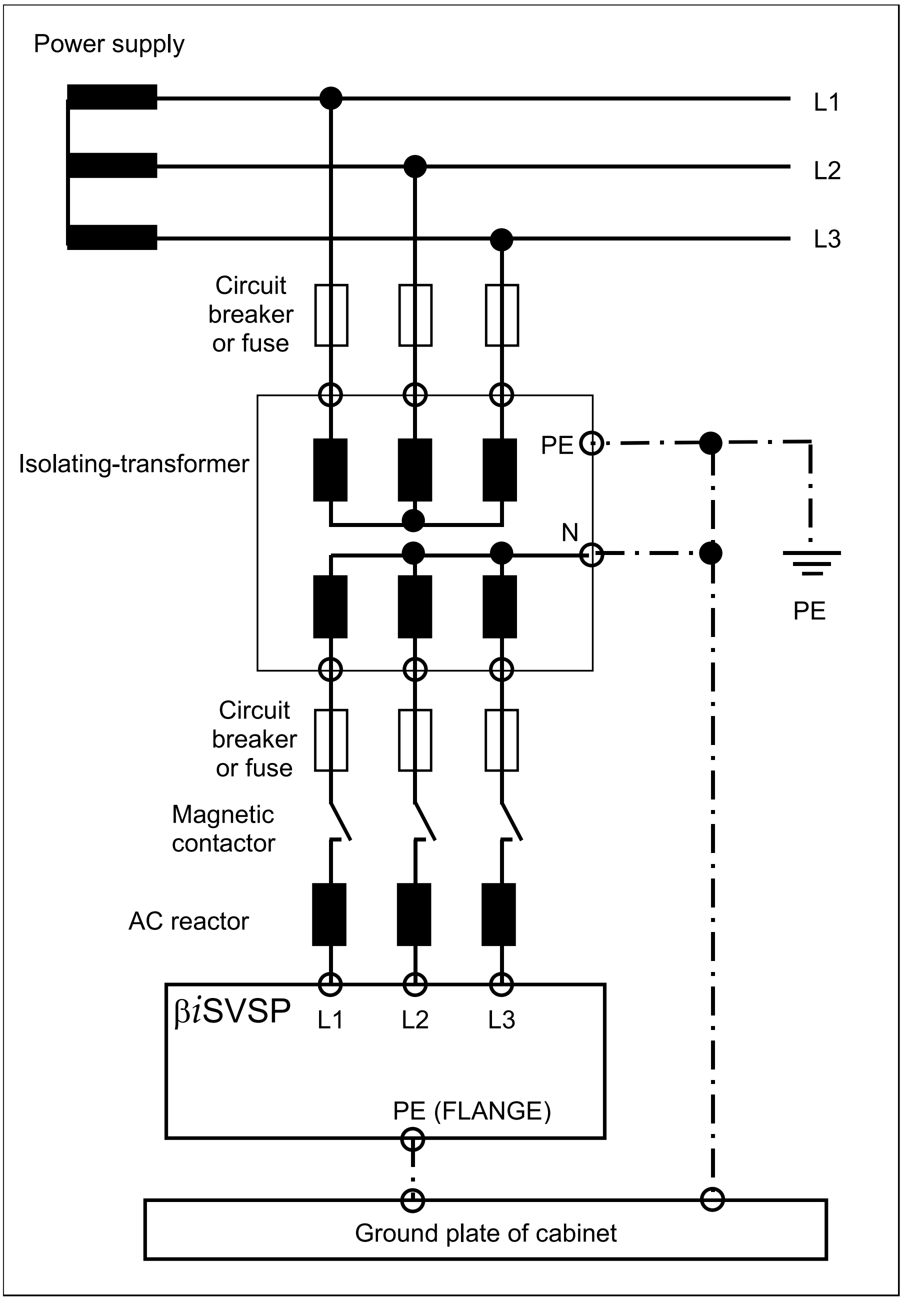
(f) TT-power system

No.	Power system	Power specification	Power supply of amplifier
6	TT-power system	• Delta connection • Single-phase grounding on the power supply side • No PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.



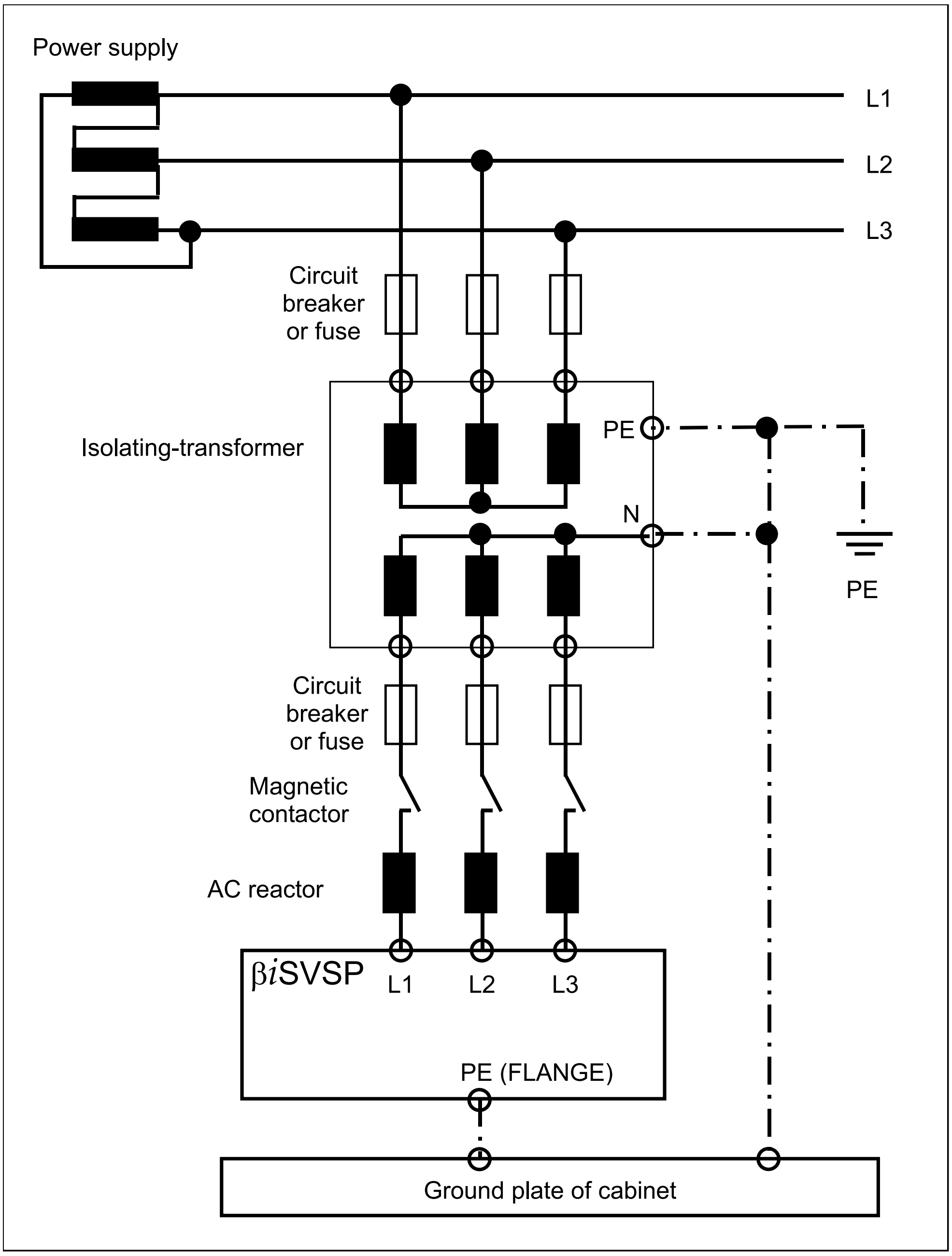
(g) IT-power system

No.	Power system	Power specification	Power supply of amplifier
7	IT-power system	• Star connection • No direct ground connection made on the power supply side • No PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.



(h) IT-power system

No.	Power system	Power specification	Power supply of amplifier
8	IT-power system	• Delta connection • No direct ground connection made on the power supply side • No PE provided on the power line	• An isolating-transformer is used. • A star connection is made on the secondary side of an isolating-transformer, and the neutral point is grounded.



3.1.2 Control Power Supply

Use a class 2 power supply (UL standard) as the power supply connected to the 24-VDC power supply.
Be sure to use a stabilized power supply as the 24-VDC power supply for the amplifier. The 24-VDC power supply for motor brakes cannot be shared.

- Nominal rated voltage : 24VDC
- Allowable voltage deviation : ±10% (including momentary variations)
- Power supply ratings

Power supply rating per amplifier
Up to 2.0 A

NOTE
For the specification of the external 24-VDC power supply, see Subsection 3.1.4, "Control Power Supply" in Part I, "β*i*SV".

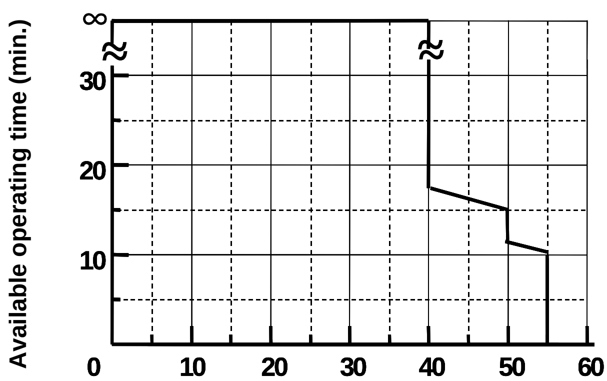
3.2 ENVIRONMENTAL CONDITIONS

For details, see Section 3.2, "ENVIRONMENTAL CONDITIONS" in the Part I, "β*i*SV".

Derating

Consider derating as shown below, according to ambient temperatures.

Target models: All β*i*SVSP and β*i*SVSPc



Ambient temparature (°C)

3.3 SPECIFICATIONS

Servo 2-axis type (spindle motor [αiM and αiMZ sensors attached])

Item		βi SVSP20/20-7.5	βi SVSP20/20-11	βi SVSP40/40-15
Unit specification		A06B-6164-H201#H580	A06B-6164-H202#H580	A06B-6164-H223#H580
Power PC board		A20B-2101-0440	A20B-2101-0441	A20B-2101-0022
Control PC board		A20B-2101-0710	A20B-2101-0710	A20B-2101-0710
Module PC board		A20B-2902-0671	A20B-2902-0671	A20B-2902-0671
Main power supply 3-phase input	Input voltage	AC200-240V (+10%,-15%) 50/60Hz		
	Input	31Arms	39Arms	60Arms
	Power supply rating	11KVA	14KVA	21KVA
Control power supply	Input voltage	DC24V ±10%		
	Input current	2.0Amax.		
Servo HRV Control		HRV2, HRV3		
Spindle HRV Control		HRV1		
Control Method		Sine wave PWM control with Transistor Bridge		
Spindle rated output current		31Arms	56Arms	64Arms
Spindle output frequency range		1Hz-667Hz		
Spindle speed control range		1:100		
Servo rated output current	L-axis	6.5Arms	6.5Arms	13Arms
	M-axis	6.5Arms	6.5Arms	13Arms
Servo maximum output current	L-axis	20A	20A	40A
	M-axis	20A	20A	40A
Servo output frequency range		0Hz-550Hz		
Protection function		- High Current - IPM Abnormal - High Voltage of DC Link - Low Voltage of DC Link - Overheat of dischage resistor - Low Voltage of Control Power Supply - FSSB Communication Error		
Ambient temperature range		0～+55 ℃		
Weight		10.2kg	14.8kg	14.8kg
Demension in 'mm'	Including fin block	260x380x272		
	Fin block (only)	260x380x100		
Associated products	AC Reactor	A81L-0001-0155		A81L-0001-0156

NOTE

These specifications are established under the condition that the servo axis operates intermittently in the intermittent operating zone. They are not established under the condition that the servo axis operates continuously in the continuous operating zone.

Servo 2-axis type (spindle motor [αiM and αiMZ sensors attached])

Item		βi SVSP40/40-18	βi SVSP 80/80-18
Unit specification		A06B-6164-H224#H580	A06B-6164-H244#H580
Power PC board		A20B-2102-0300	A20B-2102-0302
Control PC board		A20B-2102-0206	A20B-2102-0206
Module PC board		A20B-2902-0674	A20B-2902-0674
Main power supply 3-phase input	Input voltage	AC200-240V (+10%,-15%) 50/60Hz	
	Input	75Arms	77Arms
	Power supply rating	26KVA	27KVA
Control power supply	Input voltage	DC24V ±10%	
	Input current	2.0Amax.	
Servo HRV Control		HRV2, HRV3	
Spindle HRV Control		HRV1	
Control Method		Sine wave PWM control with Transistor Bridge	
Spindle rated output current		76 Arms	76Arms
Spindle output frequency range		1Hz-667Hz	
Spindle speed control range		1:100	
Servo rated output current	L-axis	13Arms	22.5Arms
	M-axis	13Arms	22.5Arms
Servo maximum output current	L-axis	40A	80A
	M-axis	40A	80A
Servo output frequency range		0Hz-550Hz	
Protection function		- High Current - IPM Abnormal - High Voltage of DC Link - Low Voltage of DC Link - Overheat of dischage resistor - Low Voltage of Control Power Supply - FSSB Communication Error	
Ambient temperature range		0～+55 ℃	
Weight		14.8kg	
Demension in 'mm'	Including fin block	260x380x272	
	Fin block (only)	260x380x100	
Associated products	AC Reactor	A81L-0001-0157	

NOTE

These specifications are established under the condition that the servo axis operates intermittently in the intermittent operating zone. They are not established under the condition that the servo axis operates continuously in the continuous operating zone.

Servo 3-axis type (spindle motor [αiM and αiMZ sensors attached])

Item		βi SVSP20/20/40-7.5	βi SVSP20/20/40-11	βi SVSP40/40/40-15
Unit specification		A06B-6164-H311#H580	A06B-6164-H312#H580	A06B-6164-H333#H580
Power PC board		A20B-2101-0581	A20B-2101-0582	A20B-2101-0025
Control PC board		A20B-2101-0711	A20B-2101-0711	A20B-2101-0711
Module PC board		A20B-2902-0671	A20B-2902-0671	A20B-2902-0671
Main power supply 3-phase input	Input voltage	AC200-240V (+10%,-15%) 50/60Hz		
	Input	36Arms	45Arms	65Arms
	Power supply rating	13KVA	16KVA	23KVA
Control power supply	Input voltage	DC24V ±10%		
	Input current	2.0Amax.		
Servo HRV Control		HRV2, HRV3		
Spindle HRV Control		HRV1		
Control Method		Sine wave PWM control with Transistor Bridge		
Spindle rated output current		31Arms	56Arms	64Arms
Spindle output frequency range		1Hz-667Hz		
Spindle speed control range		1:100		
Servo rated output current	L-axis	6.5Arms	6.5Arms	13Arms
	M-axis	6.5Arms	6.5Arms	13Arms
	N-axis	13Arms	13Arms	13Arms
Servo maximum output current	L-axis	20A	20A	40A
	M-axis	20A	20A	40A
	N-axis	40A	40A	40A
Servo output frequency range		0Hz-550Hz		
Protection function		- High Current - IPM Abnormal - High Voltage of DC Link - Low Voltage of DC Link - Overheat of dischage resistor - Low Voltage of Control Power Supply - FSSB Communication Error		
Ambient temperature range		0～+55 ℃		
Weight		14.8kg		
Demension in 'mm'	Including fin block	260x380x272		
	Fin block (only)	260x380x100		
Associated products	AC Reactor	A81L-0001-0155		A81L-0001-0156

NOTE

These specifications are established under the condition that the servo axis operates intermittently in the intermittent operating zone. They are not established under the condition that the servo axis operates continuously in the continuous operating zone.

Servo 3-axis type (spindle motor [αiM and αiMZ sensors attached])

Item		βi SVSP40/40/80-15	βi SVSP40/40/80-18	βi SVSP80/80/80-18
Unit specification		A06B-6164-H343#H580	A06B-6164-H344#H580	A06B-6164-H364#H580
Power PC board		A20B-2101-0029	A20B-2102-0301	A20B-2101-0028
Control PC board		A20B-2101-0711	A20B-2102-0207	A20B-2102-0207
Module PC board		A20B-2902-0671	A20B-2902-0674	A20B-2902-0674
Main power supply 3-phase input	Input voltage	AC200-240V (+10%,-15%) 50/60Hz		
	Input	69Arms	81Arms	83Arms
	Power supply rating	24KVA	28KVA	29KVA
Control power supply	Input voltage	DC24V ±10%		
	Input current	2.0Amax.		
Servo HRV Control		HRV2, HRV3		
Spindle HRV Control		HRV1		
Control Method		Sine wave PWM control with Transistor Bridge		
Spindle rated output current		64Arms	76Arms	76Arms
Spindle output frequency range		1Hz-667Hz		
Spindle speed control range		1:100		
Servo rated output current	L-axis	13Arms	13Arms	22.5Arms
	M-axis	13Arms	13Arms	22.5Arms
	N-axis	22.5Arms	22.5Arms	22.5Arms
Servo maximum output current	L-axis	40A	40A	80A
	M-axis	40A	40A	80A
	N-axis	80A	80A	80A
Servo output frequency range		0Hz-550Hz		
Protection function		- High Current - IPM Abnormal - High Voltage of DC Link - Low Voltage of DC Link - Overheat of dischage resistor - Low Voltage of Control Power Supply - FSSB Communication Error		
Ambient temperature range		0～+55 ℃		
Weight		14.8kg		
Demension in 'mm'	Including fin block	260x380x272		
	Fin block (only)	260x380x100		
Associated products	AC Reactor	A81L-0001-0156	A81L-0001-0157	

NOTE

These specifications are established under the condition that the servo axis operates intermittently in the intermittent operating zone. They are not established under the condition that the servo axis operates continuously in the continuous operating zone.

Servo 2-axis type (spindle motor βiIc series [αiM and αiMZ sensor-less])

Item		βi SVSPc20/20-7.5	βi SVSPc20/20-7.5L	βi SVSPc20/20-11
Unit specification		A06B-6167-H201#H560	A06B-6167-H209#H560	A06B-6167-H202#H560
Power PC board		A20B-2101-0440	A20B-2101-0440	A20B-2101-0441
Control PC board		A20B-2101-0710	A20B-2101-0710	A20B-2101-0710
Module PC board		A20B-2902-0673	A20B-2902-0673	A20B-2902-0673
Main power supply 3-phase input	Input voltage	AC200-240V (+10%,-15%) 50/60Hz		
	Input current(50Hz)	31Arms	31Arms	39Arms
	Power supply rating	11KVA	11KVA	14KVA
Control power supply	Input voltage	DC24V ±10%		
	Input current	2.0Amax.		
Servo HRV Control		HRV2, HRV3		
Spindle HRV Control		HRV1		
Control Method		Sine wave PWM control with Transistor Bridge		
Spindle rated output current		31Arms	35Arms	56Arms
Spindle output frequency range		4Hz-300Hz		
Spindle speed control range		1:100		
Servo rated output current	L-axis	6.5Arms	6.5Arms	6.5Arms
	M-axis	6.5Arms	6.5Arms	6.5Arms
Servo maximum output current	L-axis	20A	20A	20A
	M-axis	20A	20A	20A
Servo output frequency range		0Hz-550Hz		
Protection function		- High Current - IPM Abnormal - High Voltage of DC Link - Low Voltage of DC Link - Overheat of dischage resistor - Low Voltage of Control Power Supply - FSSB Communication Error		
Ambient temperature range		0～+55 ℃		
Weight		10.7kg		
Demension in 'mm'	Including fin block	260x380x272		
	Fin block (only)	260x380x100		
Associated products	AC Reactor	A81L-0001-0155		

NOTE

These specifications are established under the condition that the servo axis operates intermittently in the intermittent operating zone. They are not established under the condition that the servo axis operates continuously in the continuous operating zone.

Servo 3-axis type (spindle motor β*i*Ic series [α*i*M and α*i*MZ sensor-less])

Item		β*i* SVSPc20/20/20-7.5	β*i* SVSPc20/20/20-7.5L	β*i* SVSPc20/20/20-11
Unit specification		A06B-6167-H301#H560	A06B-6167-H309#H560	A06B-6167-H302#H560
Power PC board		A20B-2102-0104	A20B-2102-0104	A20B-2102-0105
Control PC board		A20B-2101-0711	A20B-2101-0711	A20B-2101-0711
Module PC board		A20B-2902-0673	A20B-2902-0673	A20B-2902-0673
Main power supply 3-phase input	Input voltage	AC200-240V (+10%,-15%) 50/60Hz		
	Input current(50Hz)	34Arms	34Arms	43Arms
	Power supply rating	12KVA	12KVA	15KVA
Control power supply	Input voltage	DC24V ±10%		
	Input current	2.0Amax.		
Servo HRV Control		HRV2, HRV3		
Spindle HRV Control		HRV1		
Control Method		Sine wave PWM control with Transistor Bridge		
Spindle rated output current		31Arms	35Arms	56Arms
Spindle output frequency range		4Hz-300Hz		
Spindle speed control range		1:100		
Servo rated output current	L-axis	6.5Arms	6.5Arms	6.5Arms
	M-axis	6.5Arms	6.5Arms	6.5Arms
	N-axis	6.5Arms	6.5Arms	6.5Arms
Servo maximum output current	L-axis	20A	20A	20A
	M-axis	20A	20A	20A
	N-axis	20A	20A	20A
Servo output frequency range		0Hz-550Hz		
Protection function		- High Current - IPM Abnormal - High Voltage of DC Link - Low Voltage of DC Link - Overheat of dischage resistor - Low Voltage of Control Power Supply - FSSB Communication Error		
Ambient temperature range		0～+55 ℃		
Weight		10.7kg		
Demension in 'mm'	Including fin block	260x380x272		
	Fin block (only)	260x380x100		
Associated products	AC Reactor	A81L-0001-0155		

NOTE

These specifications are established under the condition that the servo axis operates intermittently in the intermittent operating zone. They are not established under the condition that the servo axis operates continuously in the continuous operating zone.

3.4 APPLICABLE MOTORS

Applicable motors (spindle motor αiI series and βiI series [αiM and αiMZ sensors attached])

	αiI 0.5 /10000	αiI 1 /10000	αiI 1.5 /10000	αiI 2 /10000	αiI 3 /10000	αiI 6 /10000	αiI 8 /8000	αiI 12 /7000	αiI 1 /15000	αiI 1.5 /20000	αiI 2 /20000	αiI 3 /12000	αiI 6 /12000	αiI 8 /10000	αiI 8 /12000	αiI 12 /10000 αiI 12 /12000
βiSVSP 20/20-7.5 A06B-6164-H201#H580	○	○	○	○	○				○							
βiSVSP 20/20-11 A06B-6164-H202#H580	△	△	△	△	△	○			△			○	☆			
βiSVSP 40/40-15 A06B-6164-H223#H580	△	△	△	△	△	△	○		△	○		△	△	☆	☆	
βiSVSP 40/40-18 A06B-6164-H224#H580						△	△	○		△	○	△	△	△	△	☆
βiSVSP 80/80-18 A06B-6164-H244#H580						△	△	○		△	○	△	△	△	△	☆
βiSVSP 20/20/40-7.5 A06B-6164-H311#H580	○	○	○	○	○				○							
βiSVSP 20/20/40-11 A06B-6164-H312#H580	△	△	△	△	△	○			△			○	☆			
βiSVSP 40/40/40-15 A06B-6164-H333#H580	△	△	△	△	△	△	○		△	○		△	△	☆	☆	
βiSVSP 40/40/80-15 A06B-6164-H343#H580	△	△	△	△	△	△	○		△	○		△	△	☆	☆	
βiSVSP 40/40/80-18 A06B-6164-H344#H580						△	△	○		△	○	△	△	△	△	☆
βiSVSP 80/80/80-18 A06B-6164-H364#H580						△	△	○		△	○	△	△	△	△	☆

	αiIP 12 /6000 αiIP 12 /8000	αiIP 15 /6000 αiIP 15 /8000	αiIP 18 /6000 αiIP 18 /8000	αiIT 1.5 /20000	αiIT 2 /20000	αiIT 3 /12000	αiIT 6 /12000	αiIT 8 /12000	βiI 3 /10000	βiI 6 /10000	βiI 8 /10000	βiI 12 /8000	βiI 15 /7000	βiIP 12 /6000	βiIP 15 /6000	βiIP 18 /6000	βiIP 22 /6000	βiIP 30 /6000
βiSVSP 20/20-7.5 A06B-6164-H201#H580									○					○				
βiSVSP 20/20-11 A06B-6164-H202#H580	☆					○			**	○	○			**	○	○		
βiSVSP 40/40-15 A06B-6164-H223#H580	△	☆	☆	○		△	☆	☆	**	**	**	○		**	**	**	○	
βiSVSP 40/40-18 A06B-6164-H224#H580	△	△	△	△	○	△	△	△		**	**	**	○		**	**	**	○
βiSVSP 80/80-18 A06B-6164-H244#H580	△	△	△	△	○	△	△	△		**	**	**	○		**	**	**	○
βiSVSP 20/20/40-7.5 A06B-6164-H311#H580									○					○				
βiSVSP 20/20/40-11 A06B-6164-H312#H580	☆					○			**	○	○			**	○	○		
βiSVSP 40/40/40-15 A06B-6164-H333#H580	△	☆	☆	○		△	☆	☆	**	**	**	○		**	**	**	○	
βiSVSP 40/40/80-15 A06B-6164-H343#H580	△	☆	☆	○		△	☆	☆	**	**	**	○		**	**	**	○	
βiSVSP 40/40/80-18 A06B-6164-H344#H580	△	△	△	△	○	△	△	△		**	**	**	○		**	**	**	○
βiSVSP 80/80/80-18 A06B-6164-H364#H580	△	△	△	△	○	△	△	△		**	**	**	○		**	**	**	○

NOTE

○ : Standard combination.
☆ : The spindle output switching (Y-Δ switching) function is required.
** : Combining with this motor requires changing the motor control parameter. There is a dedicated motor number; select it if combining with this motor. An incorrect parameter setting may damage the motor.
△ : Combining with this motor requires changing the motor control parameter. For details, see FANUC AC SPINDLE MOTOR αi series PARAMETER MANUAL (B-65280EN).

Applicable motors (servoe motor β*i*S series and β*i*F series)

		β*i*S 2 /4000 β*i*Sc 2 /4000	β*i*S 4 /4000 β*i*Sc 4 /4000	β*i*S 8 /3000 β*i*Sc 8 /3000	β*i*S 12 /2000 β*i*Sc 12 /2000	β*i*S 12 /3000	β*i*S 22 /2000	β*i*S 22 /3000	β*i*S 30 /2000	β*i*S 40 /2000	β*i*F 4 /3000	β*i*F 8 /2000	β*i*F 12 /2000	β*i*F 22 /2000	β*i*F 30 /1500
β*i* SVSP 20/20-7.5 A06B-6164-H201#H580	L-axis	O	O	O	O						O	O	O		
	M-axis	O	O	O	O						O	O	O		
β*i* SVSP 20/20-11 A06B-6164-H202#H580	L-axis	O	O	O	O						O	O	O		
	M-axis	O	O	O	O						O	O	O		
β*i* SVSP 40/40-15 A06B-6164-H223#H580	L-axis	**	**	**	**	O	O				**	**	**	O	
	M-axis	**	**	**	**	O	O				**	**	**	O	
β*i* SVSP 40/40-18 A06B-6164-H224#H580	L-axis	**	**	**	**	O	O				**	**	**	O	
	M-axis	**	**	**	**	O	O				**	**	**	O	
β*i* SVSP 80/80-18 A06B-6164-H244#H580	L-axis					**	**	O	O	O				**	O
	M-axis					**	**	O	O	O				**	O
β*i* SVSP 20/20/40-7.5 A06B-6164-H311#H580	L-axis	O	O	O	O						O	O	O		
	M-axis	O	O	O	O						O	O	O		
	N-axis	**	**	**	**	O	O				**	**	**	O	
β*i* SVSP 20/20/40-11 A06B-6164-H312#H580	L-axis	O	O	O	O						O	O	O		
	M-axis	O	O	O	O						O	O	O		
	N-axis	**	**	**	**	O	O				**	**	**	O	
β*i* SVSP 40/40/40-15 A06B-6164-H333#H580	L-axis	**	**	**	**	O	O				**	**	**	O	
	M-axis	**	**	**	**	O	O				**	**	**	O	
	N-axis	**	**	**	**	O	O				**	**	**	O	
β*i* SVSP 40/40/80-15 A06B-6164-H343#H580	L-axis	**	**	**	**	O	O				**	**	**	O	
	M-axis	**	**	**	**	O	O				**	**	**	O	
	N-axis					**	**	O	O	O				**	O
β*i* SVSP 40/40/80-18 A06B-6164-H344#H580	L-axis	**	**	**	**	O	O				**	**	**	O	
	M-axis	**	**	**	**	O	O				**	**	**	O	
	N-axis					**	**	O	O	O				**	O
β*i* SVSP 80/80/80-18 A06B-6164-H364#H580	L-axis					**	**	O	O	O				**	O
	M-axis					**	**	O	O	O				**	O
	N-axis					**	**	O	O	O				**	O

NOTE

○ : Standard combination.

** : Combining with this motor requires changing the motor control parameter. There is a dedicated motor number; select it if combining with this motor. An incorrect parameter setting may damage the motor.

⚠ CAUTION

1. When the servo amplifier β*i*SVSP is combined with any of the following servo motors, the dynamic brake stop distance is longer than it when the α*i*SV or one-axis β*i*SV servo amplifier is combined. Calculate and certainly confirm the dynamic brake stop distance by using coefficients for calculating the dynamic brake distance if it is within the assumption on the machine. For calculation and details of the dynamic brake stop distance, refer to "FANUC AC SERVO MOTOR β*i* series DESCRIPTIONS" (B-65262EN).
   [Servo motor specifications]
   β*i*S 12/3000, β*i*S 22/2000, β*i*S 22/3000, β*i*S 30/2000, β*i*S 40/2000, β*i*F 22/2000, β*i*F 30/1500
2. It is recommended to use the stop distance reduce function for not only the motors listed in 1 above, but also others to reduce the stop distance at emergency stop and power failure. For details, refer to the parameter manual (B-65270EN). To surely operate the stop distance reduce function at a power failure, use an uninterruptible power supply (UPS) or the like to be able to maintain the control power supply (24 VDC) of the CNC and servo amplifier.
3. If some alarms occur, the stop distance will not be short because the quick stop functions does not operate effectively.

> ⚠ **CAUTION**
> 4 It should be certainly confirmed at the actual machine that the stop distance is shortened at emergency stop or power failure when the quick stop functions are applied.

> ⚠ **WARNING**
> 1 If the dynamic brake is applied with a load inertia ratio larger than the allowable load inertia of the servo motor, an overheat may occur in the servo amplifier and the servo amplifier may be burnt out. Calculate the load inertia correctly. If you want to use the dynamic brake with a load inertia larger than the allowable load inertia, contact FANUC.
> 2 If the dynamic brake is used with a load inertia larger than the allowable load inertia of the servo motor and a power failure occurs (when the stop distance reduce function is disabled) or an alarm is issued during rapid traverse, wait for at least 30 minutes before restarting the system to protect the servo amplifier.
> 3 If the motor is stopped repeatedly by the dynamic brake without keeping intervals of at least 30 minutes, an overheat may occur in the servo amplifier and the servo amplifier may be burnt out.

Applicable motors (spindle motor βiIc series [αiM and αiMZ sensor-less] and servo motor βiSc series)

		Spindle Motor			Servo Motor			
		βi Ic 3 /6000	βi Ic 6 /6000	βi Ic 8 /6000	βi Sc 2 /4000	βi Sc 4 /4000	βi Sc 8 /3000	βi Sc 12 /2000
βi SVSPc 20/20-7.5 A06B-6167-H201#H560	Spindle	O						
	Servo L-axis				O	O	O	O
	Servo M-axis				O	O	O	O
βi SVSPc 20/20-7.5L A06B-6167-H209#H560	Spindle		O					
	Servo L-axis				O	O	O	O
	Servo M-axis				O	O	O	O
βi SVSPc 20/20-11 A06B-6167-H202#H560	Spindle			O				
	Servo L-axis				O	O	O	O
	Servo M-axis				O	O	O	O
βi SVSPc 20/20/20-7.5 A06B-6167-H301#H560	Spindle	O						
	Servo L-axis				O	O	O	O
	Servo M-axis				O	O	O	O
	Servo N-axis				O	O	O	O
βi SVSPc 20/20/20-7.5L A06B-6167-H309#H560	Spindle		O					
	Servo L-axis				O	O	O	O
	Servo M-axis				O	O	O	O
	Servo N-axis				O	O	O	O
βi SVSPc 20/20/20-11 A06B-6167-H302#H560	Spindle			O				
	Servo L-axis				O	O	O	O
	Servo M-axis				O	O	O	O
	Servo N-axis				O	O	O	O

3.5 SPINDLE AXIS TYPES AND APPLICABLE SENSORS

The following table lists combinations of applicable sensors and functions.

		Configuration	Configuration number 1	2	3	4	5	6	7	8	9	Remarks
Spindle system configuration	βiSVSP	A06B-6164-H***#H580	○	○	○	○	○	○	○	×	×	
		A06B-6167-H***#H560	×	×	×	×	×	×	×	○	○	
	Sensor on the motor	αiM sensor	○	×	○	○	○	○	○	×	×	
		αiMZ sensor	×	○	×	×	×	×	×	×	×	
		Without sensor	×	×	×	×	×	×	×	○	○	
	Sensor on the spindle	αi position coder	×	×	○	×	×	×	×	○	×	*3
		External one-rotation (Proximity switch)	×	×	×	○	×	×	×	×	×	*3
		αiBZ sensor	×	×	×	×	○	×	×	×	○	*3
		αiCZ sensor	×	×	×	×	×	○	×	×	×	*3
		α position coder S	×	×	×	×	×	×	○	×	×	*3
Function	Rigid tapping		○ *1	○ *11	○	○ *2, *10	○	○	○	○	○	
	Orientation by a position coder		×	○ *6	○	×	○	○	○	○	○	
	Orientation by the external one-rotation signal		×	×	×	○ *2	×	×	×	×	×	*5
	Spindle synchronization	Velocity synchronization	○ *2	○ *2	○	○ *2	○	○	○	○	○	*4
		Phase synchronization	×	○ *6	○	○ *2,*7	○	○	○	○	○	*4
	Threading		×	○ *6	○	×	○	○	○	○	○	
	Cs contouring control		×	○ *6	○ *8	×	○ *9	○ *12	○ *9	×	×	

*1 The spindle and the motor must be interconnected directly or with a timing belt or gear. It is not possible to perform reference position return operation for adjusting the tapping start position.
*2 The spindle and the motor must be interconnected directly or with a timing belt or gear.
*3 The spindle and sensor must be interconnected in one-to-one connection mode.
*4 Two motors and two amplifiers are required.
*5 Note that the stop position moves by a backlash between the spindle and motor because of the theory of operation.
*6 The spindle and the motor must be interconnected directly or with a timing belt or gear in one-to-one connection mode.
*7 Before using spindle synchronization, perform orientation; after the detection of a one-rotation signal (PC1DT=1), specify spindle synchronization.
*8 The resolution of position detection is 4,096p/rev.
*9 The resolution of position detection is 360,000p/rev.
*10 To perform reference position return operation for adjusting the tapping start position, perform orientation before rigid tapping; after the detection of one-rotation signal (PC1DT=1), specify rigid tapping.
*11 The spindle and the motor must be interconnected directly or with a timing belt or gear. If, however, reference position return operation for adjusting the tapping start position is to be performed, they must be interconnected in one-to-one connection mode.
*12 The resolution of position detection is 3,600,000p/rev.

Other spindle axis functions

○ : Applicable

	A06B-6164-H***#H580	A06B-6167-H***#H560	Remarks
Analog output of load meter and speedometer	○	×	Connector JY1
Analog output of either load meter or speedometer	×	○	Connector JY1
Analog override input	○	○	Connector JY1
Excitation off monitor signal output	○	×	Connector JX6

NOTE

Position coder signal output and the spindle EGB function are not supported.

3.6 HOW TO OBTAIN A POWER SUPPLY CAPACITY

- Output capacity -

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

-Power supply capacity-

β*i*SVSP *-7.5

Power supply capacity (kVA) = output capacity (kW) × 1.73

β*i*SVSP *-11

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

β*i*SVSP *-15

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

β*i*SVSP *-18

Power supply capacity (kVA) = output capacity (kW) × 1.18

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

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

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

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

4 ORDERING INFORMATION

4.1 SERVO AMPLIFIER β*i*SVSP SERIES

Spindle sensor	Name	Ordering number
For spindle motor (with α*i*M or α*i*MZ sensor)	β*i*SVSP 20/20-7.5	A06B-6164-H201#H580
	β*i*SVSP 20/20-11	A06B-6164-H202#H580
	β*i*SVSP 40/40-15	A06B-6164-H223#H580
	β*i*SVSP 40/40-18	A06B-6164-H224#H580
	β*i*SVSP 80/80-18	A06B-6164-H244#H580
	β*i*SVSP 20/20/40-7.5	A06B-6164-H311#H580
	β*i*SVSP 20/20/40-11	A06B-6164-H312#H580
	β*i*SVSP 40/40/40-15	A06B-6164-H333#H580
	β*i*SVSP 40/40/80-15	A06B-6164-H343#H580
	β*i*SVSP 40/40/80-18	A06B-6164-H344#H580
	β*i*SVSP 80/80/80-18	A06B-6164-H364#H580
For spindle motor β*i*Ic series (with sensor-less)	β*i*SVSPc 20/20-7.5	A06B-6167-H201#H560
	β*i*SVSPc 20/20-7.5L	A06B-6167-H209#H560
	β*i*SVSPc 20/20-11	A06B-6167-H202#H560
	β*i*SVSPc 20/20/20-7.5	A06B-6167-H301#H560
	β*i*SVSPc 20/20/20-7.5L	A06B-6167-H309#H560
	β*i*SVSPc 20/20/20-11	A06B-6167-H302#H560

4.2 CIRCUIT BREAKER, MAGNETIC CONTACTOR

The circuit breaker and magnetic contactor capacities are determined by the specifications of the β*i*SVSP used. The ordering numbers and specifications of circuit breakers and magnetic contactors are shown below.
If they are to be prepared by the user, they must satisfy the circuit breaker and magnetic contactor specifications indicated below.

Circuit and magnetic contactor specifications

Applicable models	Circuit breaker 1	Circuit breaker 2	Magnetic contactor
β*i*SVSP 20/20-7.5 β*i*SVSP 20/20-11 β*i*SVSP 20/20/40-7.5 β*i*SVSP 20/20/40-11 β*i*SVSPc 20/20-7.5 β*i*SVSPc 20/20-7.5L β*i*SVSPc 20/20-11 β*i*SVSPc 20/20/20-7.5 β*i*SVSPc 20/20/20-7.5L β*i*SVSPc 20/20/20-11	55A to 75A	5A	55A
β*i*SVSP 40/40-15 β*i*SVSP 40/40/40-15 β*i*SVSP 40/40/80-15	70A to 100A		70A
β*i*SVSP 40/40-18 β*i*SVSP 80/80-18 β*i*SVSP 40/40/80-18 β*i*SVSP 80/80/80-18	120A to 150A		120A

NOTE

1. For the installation positions of the circuit breakers and magnetic contactor, see Chapter 2, “CONFIGURATION”.
2. Set the rated voltage of circuit breakers 1 and 2 according to the power supply voltage.
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 βiSVSP. For details, see Subsection 9.3.1.2, "Details of cable K6".
4. When the circuit breaker trips, the contact of the magnetic contactor may be melted. Therefore, before turning on the circuit breaker again, check to make sure that the contact of the magnetic contactor is not melted.

Ordering numbers of circuit breaker 1

Applicable models	Ordering number	Circuit breaker specifications	Circuit breaker cover specifications
βiSVSP 20/20-7.5 βiSVSP 20/20-11 βiSVSP 20/20/40-7.5 βiSVSP 20/20/40-11	A06B-6077-K103	Fuji Electric EA103C/60	Fuji Electric BZ6TBH10C3
βiSVSP 40/40-15 βiSVSP 40/40/40-15 βiSVSP 40/40/80-15	A06B-6077-K104	Fuji Electric EA103C/75	Fuji Electric BZ6TBH10C3
βiSVSP 40/40-18 βiSVSP 80/80-18 βiSVSP 40/40/80-18 βiSVSP 80/80/80-18	A06B-6077-K105	Fuji Electric EA203B/150	Fuji Electric BZ-TB40B

Applicable models	Ordering number	Circuit breaker specifications	Circuit breaker cover specifications
βiSVSPc 20/20-7.5 βiSVSPc 20/20-7.5L βiSVSPc 20/20-11 βiSVSPc 20/20/20-7.5 βiSVSPc 20/20/20-7.5L βiSVSPc 20/20/20-11	A06B-6077-K103	Fuji Electric EA103C/60	Fuji Electric BZ6TBH10C3

Ordering numbers of circuit breaker 2

Applicable models	Ordering number	Circuit breaker specifications	Circuit breaker cover specifications
For control power supply (common to all models)	A06B-6077-K106	Fuji Electric EA33AC/5	Fuji Electric BZ6TBH10C3

NOTE

1. For the installation positions of the circuit breakers and magnetic contactor, see Chapter 2, “CONFIGURATION”.
2. Set the rated voltage of circuit breaker according to the power supply voltage.

Ordering numbers of magnetic contactor

Applicable models	Ordering number	Magnetic contactor specification	Magnetic contactor cover specification
β*i*SVSP 20/20-7.5 β*i*SVSP 20/20-11 β*i*SVSP 20/20/40-7.5 β*i*SVSP 20/20/40-11	A06B-6077-K123	Fuji Electric SC-N2	Fuji Electric SZ-N1J
β*i*SVSP 40/40-15 β*i*SVSP 40/40/40-15 β*i*SVSP 40/40/80-15	A06B-6077-K124	Fuji Electric SC-N2S	Fuji Electric SZ-N2SJ
β*i*SVSP 40/40-18 β*i*SVSP 80/80-18 β*i*SVSP 40/40/80-18 β*i*SVSP 80/80/80-18	A06B-6077-K125	Fuji Electric SC-N4	Fuji Electric SZ-N4J

Applicable models	Ordering number	Magnetic contactor specification	Magnetic contactor cover specification
β*i*SVSPc 20/20-7.5 β*i*SVSPc 20/20-7.5L β*i*SVSPc 20/20-11 β*i*SVSPc 20/20/20-7.5 β*i*SVSPc 20/20/20-7.5L β*i*SVSPc 20/20/20-11	A06B-6077-K123	Fuji Electric SC-N2	Fuji Electric SZ-N1J

NOTE
For details, refer to the brochure supplied by Fuji Electric Co., Ltd.

4.3 AC REACTOR

Applicable models	Ordering number
β*i*SVSP 20/20-7.5 β*i*SVSP 20/20-11 β*i*SVSP 20/20/40-7.5 β*i*SVSP 20/20/40-11	A81L-0001-0155
β*i*SVSP 40/40-15 β*i*SVSP 40/40/40-15 β*i*SVSP 40/40/80-15	A81L-0001-0156
β*i*SVSP 40/40-18 β*i*SVSP 80/80-18 β*i*SVSP 40/40/80-18 β*i*SVSP 80/80/80-18	A81L-0001-0157

Applicable models	Ordering number
β*i*SVSPc 20/20-7.5 β*i*SVSPc 20/20-7.5L β*i*SVSPc 20/20-11 β*i*SVSPc 20/20/20-7.5 β*i*SVSPc 20/20/20-7.5L β*i*iSVSPc 20/20/20-11	A81L-0001-0155

⚠ **WARNING**
The AC line filter is different from the AC reactor. Neither substitution between them nor use of one of them for both purposes is allowed.

Difference between the AC line filter and AC reactor
For details, see Section 4.4, "AC LINE FILTER" in the Part I, "β*i*SV".

4.4 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, "FITTING A LIGHTNING SURGE PROTECTION DEVICE" in the FANUC SERVO AMPLIFIER α*i* series DESCRIPTIONS (B-65282EN).

Ordering number	Specification	Remarks
A06B-6077-K142	For line-to-line installation : RAV-781BYZ-2 For line-to-ground installation : RAV-781BXZ-4	Manufactured by Okaya Electric Industries Co., Ltd. For 200VAC line TÜV approved products
A06B-6077-K144	Integration type for line-to-line installation/line-to-ground installation: RCM-601BUZ-4	Manufactured by Okaya Electric Industries Co., Ltd. For 200VAC line TÜV approved products

* The line-to-line or line-to-ground installation type (A06B-6077-K142) and the integration type (A06B-6077-K144) are equivalent in performance and specifications.

4.5 NOISE FILTER

A noise filter must be installed in the 200 VAC power input section to satisfy the requirements of the EMC Directives which are now being enforced in the EU countries.

Applicable models	Ordering number	Rated output	Specification
β*i*SVSP 20/20-7.5 β*i*SVSP 20/20-11 β*i*SVSP 40/40-15 β*i*SVSP 20/20/40-7.5 β*i*SVSP 20/20/40-11 β*i*SVSP 40/40/40-15 β*i*SVSP 40/40/80-15	A06B-6077-K156	75A	Manufactured by Okaya Electric Industries Co., Ltd. 3SUP-HL75-ER-6 For single-phase grounding
	A06B-6110-K161	80A	Manufactured by Soshin Electric Co., Ltd. NF3080C-VQ For neutral point grounding
β*i*SVSP 40/40-18 β*i*SVSP 80/80-18 β*i*SVSP 40/40/80-18 β*i*SVSP 80/80/80-18	A06B-6077-K157	150A	Manufactured by Okaya Electric Industries Co., Ltd. 3SUP-HL150-ER-6 For single-phase grounding
	A06B-6110-K162	150A	Manufactured by Soshin Electric Co., Ltd. NF3150C-VQ For neutral point grounding

Applicable models	Ordering number	Rated output	Specification
β*i*SVSPc 20/20-7.5 β*i*SVSPc 20/20-7.5L β*i*SVSPc 20/20-11 β*i*SVSPc 20/20/20-7.5 β*i*SVSPc 20/20/20-7.5L β*i*SVSPc 20/20/20-11	A06B-6077-K156	75A	Manufactured by Okaya Electric Industries Co., Ltd. 3SUP-HL75-ER-6 For single-phase grounding
	A06B-6110-K161	80A	Manufactured by Soshin Electric Co., Ltd. NF3080C-VQ For neutral point grounding

> ⚠ **WARNING**
> Use the noise filter specified by ordering number A06B-6077-K156 or -K15 only for a power supply of 200-V input series with single-phase grounding. Do not use the noise filter for any power supply of 400-V input series.
> If the noise filter is used for a power supply of 400-V input series, it may overheat, emit smoke, or cause a short-circuit.

> **NOTE**
> 1 The noise filter specified by ordering number A06B-6110- K161 or -K162 cannot be used for any power supply with single-phase grounding.
> 2 The above applicable models are listed as guidelines for selection. Load currents of the CNC, amplifier, and other devices flow through the noise filter. Obtain these load currents, and select a noise filter so that the sum of the obtained load currents does not exceed the rated current of the noise filter.

4.6 BATTERY FOR ABSOLUTE PULSECODER

For connection of a battery for an absolute Pulsecoder, two methods are available. For each method, options are available.

> **NOTE**
> 1 A battery needs to be maintained periodically. So, [connection type 1] is recommended because this type uses a battery (consisting of four size D alkaline cells) easily obtainable from the market.
> 2 A built-in battery used with [connection type 2] is not available on the market, but needs to be purchased from FANUC. So, it is recommended to purchase spare built-in batteries.

[Connection type 1]

Power is fed from one battery to multiple β*i*SVSP models.
(For details, see Chapter 9, “TOTAL CONNECTION DIAGRAM”.)

Category	Ordering number	Name	Remarks
Optional	A06B-6050-K061	Battery	Four pieces of size D battery
	A06B-6050-K060	Battery case	
	A06B-6110-K211	Battery connection connector	

[Connection type 2]

A battery is built into each β*i*SVSP.
(For details, see Chapter 9, “TOTAL CONNECTION DIAGRAM”.)

Category	Ordering number	Name	Remarks
Optional	A06B-6114-K504	Built-in battery	Lithium battery
Optional	A06B-6114-K506	Battery case	For β*i*SVSP

4.7 SEPARATED COOLING FAN MOTOR

Depending on the amplifier specifications, a separated cooling fan motor (for cooling the external radiator fin or for cooling the inside of the amplifier) is required.
Be sure to install a FANUC separated cooling fan motor (for cooling the external radiator fin, A06B-6134-K001, or for cooling the inside of the amplifier, A06B-6134-K006).
If the fan motor does not meet the cooling conditions satisfactorily, the motor properties may reduce from the values in the specifications.
Confirm that there is a sufficient convection of air around the amplifier radiator fin.
Design the locker so that the ambient temperature of the amplifier radiator fin meets Section 3.2, "ENVIRONMENTAL CONDITIONS" (Derating).

Spindle motor	**Amplifier name**	**Ordering number**	**Separated cooling fan motor**	
			For cooling the external radiator fin (A06B-6134-K001)	**For cooling the inside of the amplifier (A06B-6134-K006)**
For spindle motor (with α*i*M or α*i*MZ sensor)	β*i*SVSP 20/20-7.5	A06B-6164-H201#H580	-	-
	β*i*SVSP 20/20-11	A06B-6164-H202#H580	1	-
	β*i*SVSP 40/40-15	A06B-6164-H223#H580	2	-
	β*i*SVSP 40/40-18	A06B-6164-H224#H580	2	1
	β*i*SVSP 80/80-18	A06B-6164-H244#H580	2	1
	β*i*SVSP 20/20/40-7.5	A06B-6164-H311#H580	1	-
	β*i*SVSP 20/20/40-11	A06B-6164-H312#H580	1	-
	β*i*SVSP 40/40/40-15	A06B-6164-H333#H580	2	-
	β*i*SVSP 40/40/80-15	A06B-6164-H343#H580	2	-
	β*i*SVSP 40/40/80-18	A06B-6164-H344#H580	2	1
	β*i*SVSP 80/80/80-18	A06B-6164-H364#H580	2	1

Spindle motor	**Amplifier name**	**Ordering number**	**Separated cooling fan motor**	
			For cooling the external radiator fin (A06B-6134-K001)	**for cooling the inside of the amplifier (A06B-6134-K006)**
For spindle motor β*i*Ic series (with sensor-less)	β*i*SVSPc 20/20-7.5	A06B-6167-H201#H560	-	-
	β*i*SVSPc 20/20-7.5L	A06B-6167-H209#H560	1	
	β*i*SVSPc 20/20-11	A06B-6167-H202#H560	1	-
	β*i*SVSPc 20/20/20-7.5	A06B-6167-H301#H560	-	-
	β*i*SVSPc 20/20/20-7.5L	A06B-6167-H309#H560	1	-
	β*i*SVSPc 20/20/20-11	A06B-6167-H302#H560	1	-

5 INSTALLATION

5.1 LEAKAGE CURRENT

For details, see Section 6.1, "LEAKAGE CURRENT" in the Part I, "β*i*SV".

(a) Selection criterion per amplifier
Criterion for selection : 2mA per amplifier (Note 1)

(b) Selection criterion per motor
Criterion for selection : 1mA per motor (Note 1)

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

Example) When the system consists of β*i*SVSP × 1, spindle motor × 1, and servo motor × 3
2mA×1(for the amplifiers)+1mA×1(for the spindle motors)+1mA×3(for the servo motors)=6mA

→ Select a circuit breaker (Note 2) with a non-operating current of 6 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 These criteria are for selecting a circuit breaker with a ground fault interrupter; they do not indicate accurate leakage currents.
2 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.
3 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.

⚠ **WARNING**
Install a ground-fault circuit breaker.
To prevent fire and electric shock to a person, be sure to install a ground-fault circuit breaker (for inverter circuits).

5.2 GROUND

For details, see Section 6.2, "GROUND" in the Part I, "β*i*SV".

5.3 NOISE PREVENTION

For details, see Section 6.3, "NOISE PREVENTION" in the Part I, "β*i*SV".

5.4 FITTING A LIGHTNING SURGE PROTECTION DEVICE (POWER SUPPLY OF 200-VAC INPUT SERIES)

For details, see Section 6.4, "FITTING A LIGHTNING SURGE PROTECTION DEVICE (POWER SUPPLY OF 200-VAC INPUT SERIES)" in the Part I, "β*i*SV".

5.5 AMPLIFIER INSTALLATION NOTES RELATING TO SAFETY STANDARDS

For details, see Section 6.6, "AMPLIFIER INSTALLATION NOTES RELATING TO SAFETY STANDARDS" in the Part I, "β*i*SV".

5.6 NOTES ON CUTTING FLUID (REFERENCE)

For details, see Section 6.7, "NOTES ON CUTTING FLUID (REFERENCE)" in the Part I, "β*i*SV".

6 POWER FAILURE DETECTION FUNCTION

6.1 POWER FAILURE DETECTION FUNCTION

The power failure detection function has been added for the purpose of preventing a vertical axis from falling at power failure. For connection, see Chapter 9, “TOTAL CONNECTION DIAGRAM”.
Add an uninterruptible power supply unit (UPS) and so on so that the control power supply (24 VDC) for the CNC and the amplifier can be maintained from the time a power failure occurs until the mechanical brake is operated.

[Specifications]

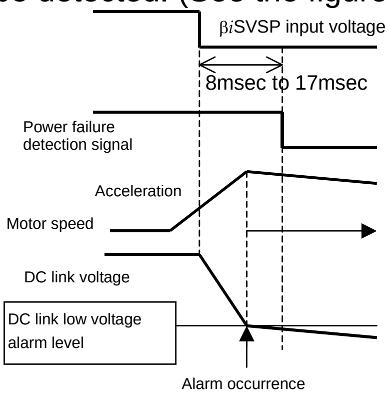
If a power failure is detected, a power failure detection signal is output from connector CX36.

A voltage drop of the three-phase 200 VAC input to connector CX38 is detected.
CX38 input voltage range: 0 to 240VAC +10%, 3ϕ, 50Hz/60Hz±2Hz

A detection delay time is provided so that the function is not overly sensitive to an instantaneous interruption.
Detection delay time: 8msec to 17msec

NOTE

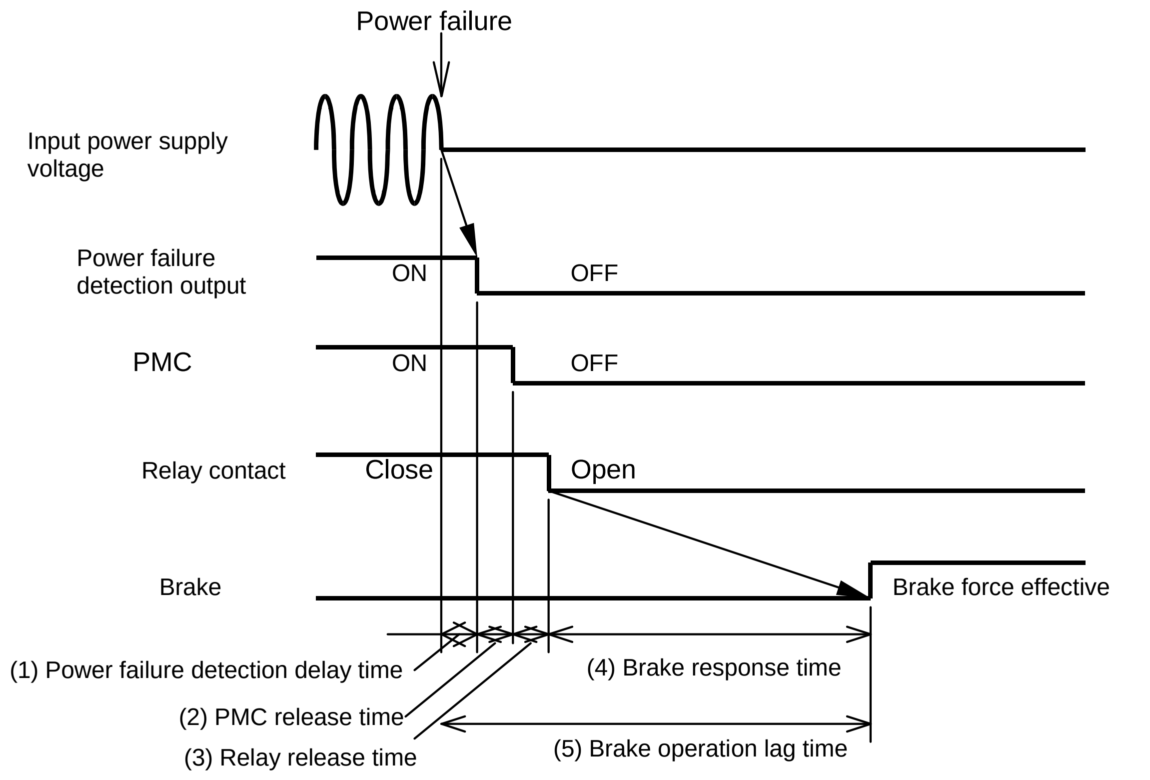
The power failure detector detects simultaneous drops in three phases as a power failure. Under the following conditions, a power failure may not be detected properly.
There are cases in which a power failure in which a drop occurs in a single phase only (phase interruption) cannot be detected.
There are cases in which if a power failure occurs during motor acceleration, it cannot be detected. (See the figure below.)



The power failure detection signal is output from βiSVSP 8 to 17 msec after the occurrence of a power failure. If the motor output is increasing due to acceleration, the DC link low voltage alarm may occur before the power failure is detected because the DC link voltage reduces abruptly after the occurrence of the power failure.

Time from the occurrence of a power failure until the brake operates

The "brake operation lag time" from the occurrence of a power failure is the sum of the "power failure detection delay time", "relay release time", and "brake response time".



(1) Power failure detection delay time	:	Time from a power failure until the power failure detection signal is output from β*i*SVSP (8 to 17msec)
(2) PMC delay time	:	Time from the time the DI of the PMC receives the signal until the contact operates at DO (15msec)
(3) Relay release time	:	Time from the time the rated voltage is removed from the relay coil until the relay contact is released (contact "a" becomes open)
(4) Brake response time	:	Time from the time the rated voltage is removed from the brake coil until the brake force becomes effective
(5) Brake operation lag time	:	Time from a power failure until the brake force becomes effective

Relay release time

Select a relay with a short contact release time.

Example)

Omron G2R (coil voltage of 24 VDC, with a built-in diode): Release time of 20 msec or less

Brake response time

Listed below are the specifications of the built-in brake of each motor model.

Motor model	β*i*S2, β*i*S4 β*i*Sc2, β*i*Sc4 β*i*F4, β*i*F8	β*i*S8, β*i*S12, β*i*S22, β*i*S30, β*i*S40 β*i*Sc8, β*i*Sc12, β*i*F12, β*i*F22, β*i*F30
Response time (max)	20msec	30msec

Brake operation lag time

Given below is an example of calculating the time that elapses from the occurrence of a power failure until the brake operates.

Conditions

(1) Power failure detection delay time → 10msec
(2) PMC delay time → 15msec
(3) Relay (Omron G2R) release time → 20msec
(4) Brake (built-in brake for β*i*S8) response time → 30msec

Result 10msec + 15msec + 20msec + 30msec = <u>75msec</u>

Confirmation at the actual machine

Be sure to confirm at the actual machine that the power failure detection function is operated and the motor stops at the designed value.

7 SENSOR

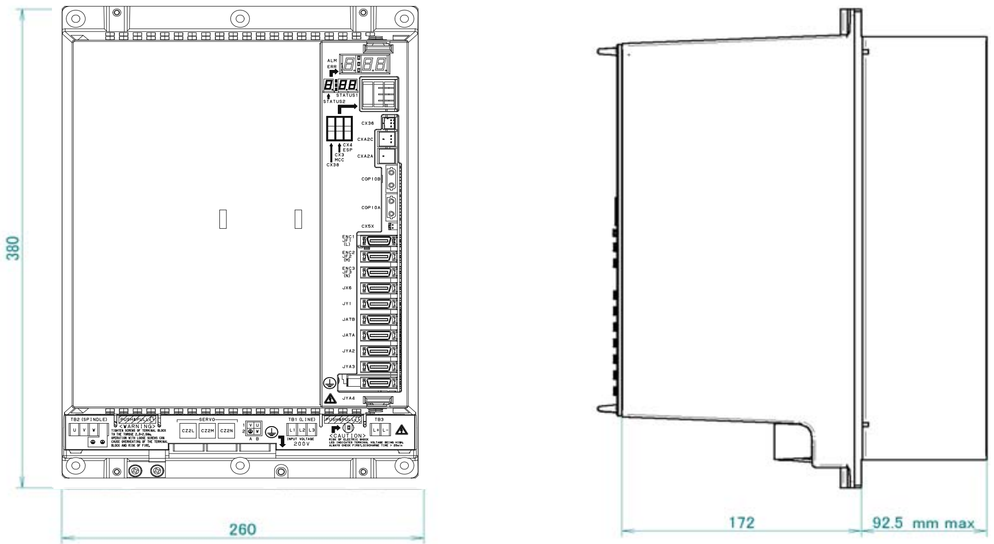
For details of the sensors, see Chapter 11, “SENSOR” in the FANUC SERVO AMPLIFIER α*i* series DESCRIPTIONS (B-65282EN)

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

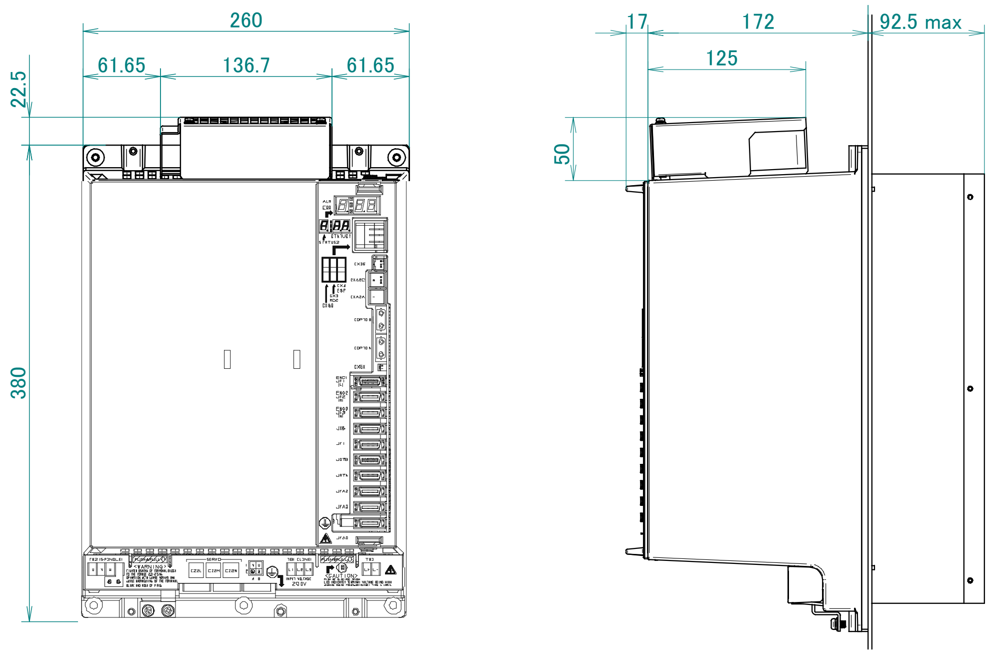
8.1 EXTERNAL DIMENSIONS

8.1.1 β*i*SVSP and β*i*SVSPc

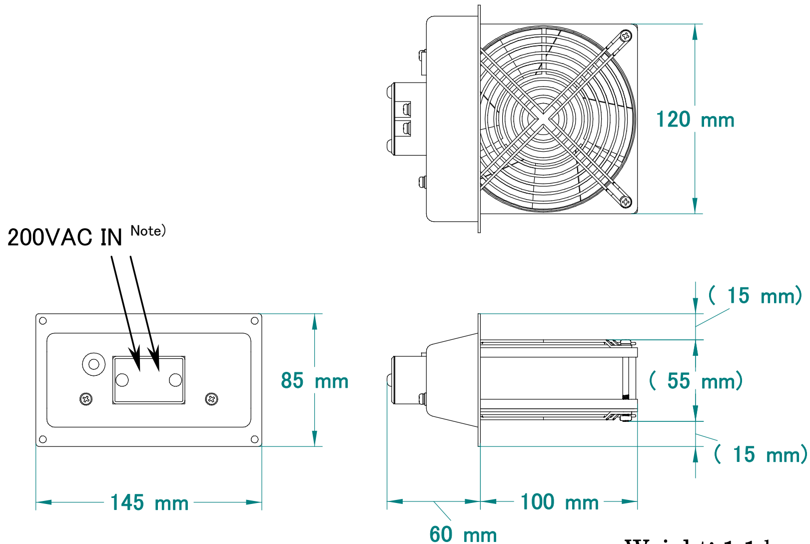
(a) External dimensions of β*i*SVSP and β*i*SVSPc series



(b) External dimensions after the mounting of the separated cooling fan motor (for cooling the inside of the amplifier, A06B-6134-K006) (for the β*i*SVSP*-18 model only)



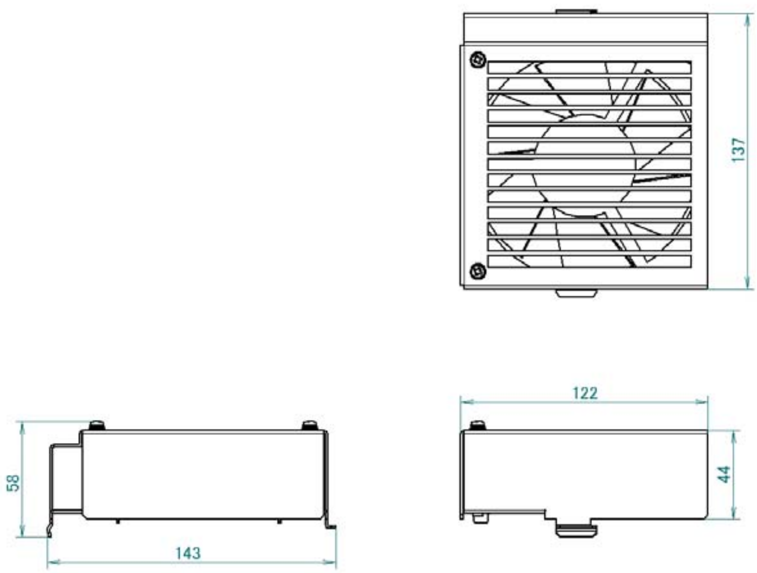
8.1.2 Separated Cooling Fan Motor (For Cooling The External Radiator Fin: A06B-6134-K001)



Weight: 1.1 kg

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

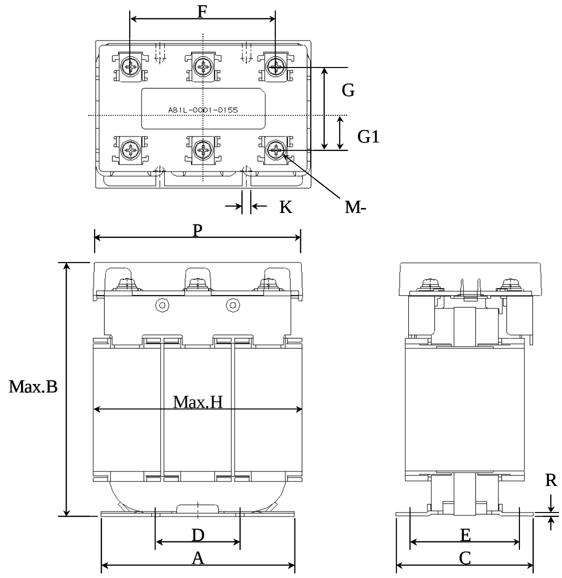
8.1.3 Separated Cooling Fan Motor (For Cooling The Inside Of The Amplifier: A06B-6134-K006)



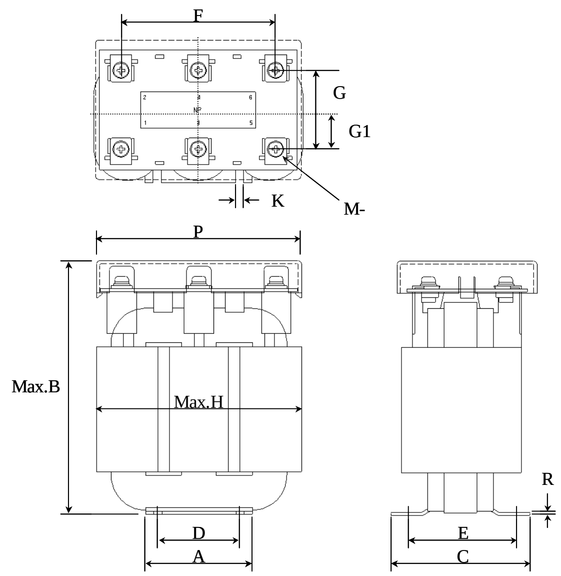
8.1.4 AC Reactor

(a) A81L-0001-0155
There are external dimensions for two models with the same specification drawing number. The mounting pitches and so on are the same.
External dimensions (1) and (2) cannot be specified.

External dimensions (1)



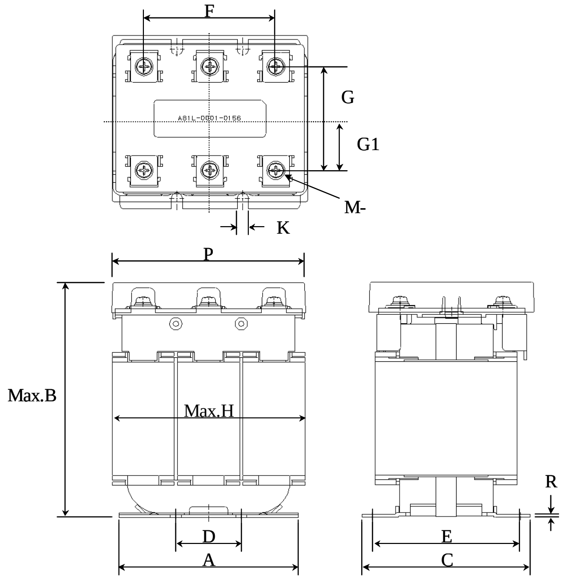
External dimensions (2)



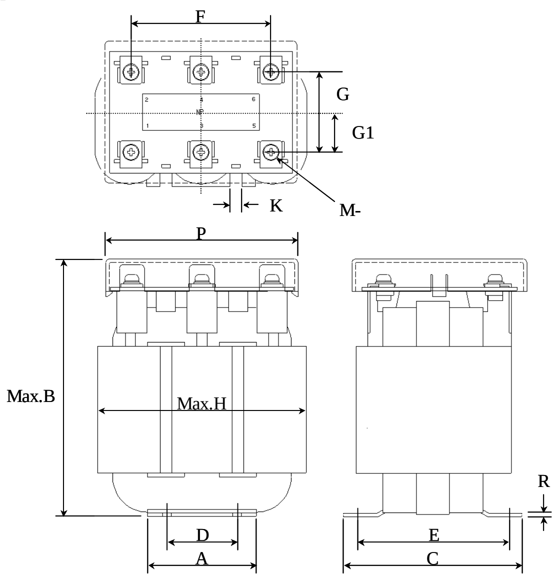
	A	B	C	D	E	F	G	G1	H	K	P	R	M
External dimensions (1)	115	155	82	50	65	84	48	20.5	135	5	135	2	M5
External dimensions (2)	65	155	85	50	65	94	48	20.5	127	5	125	2	M5

(b) A81L-0001-0156
There are external dimensions for two models with the same specification drawing number. The mounting pitches and so on are the same.
External dimensions (1) and (2) cannot be specified.

External dimensions (1)



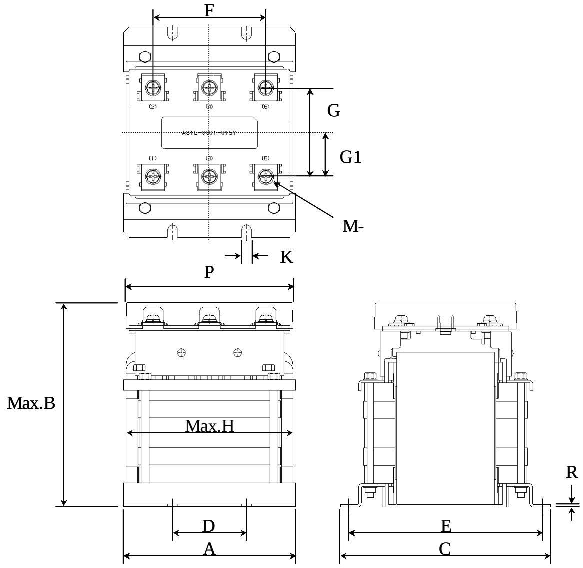
External dimensions (2)



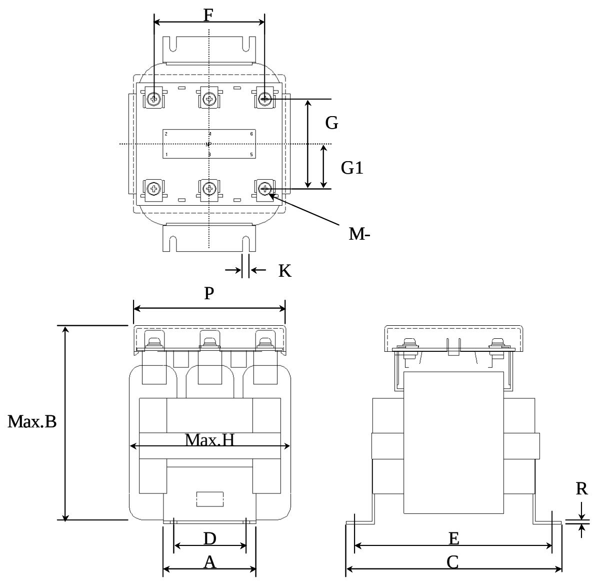
	A	B	C	D	E	F	G	G1	H	K	P	R	M
External dimensions (1)	115	155	108	42	95	84	66	29.5	135	7.2	135	2	M5
External dimensions (2)	65	155	107	42	95	84	66	29	131	7.2	115	2	M5

(c) A81L-0001-0157
There are external dimensions for two models with the same specification drawing number. The mounting pitches and so on are the same.
External dimensions (1) and (2) cannot be specified.

External dimensions (1)



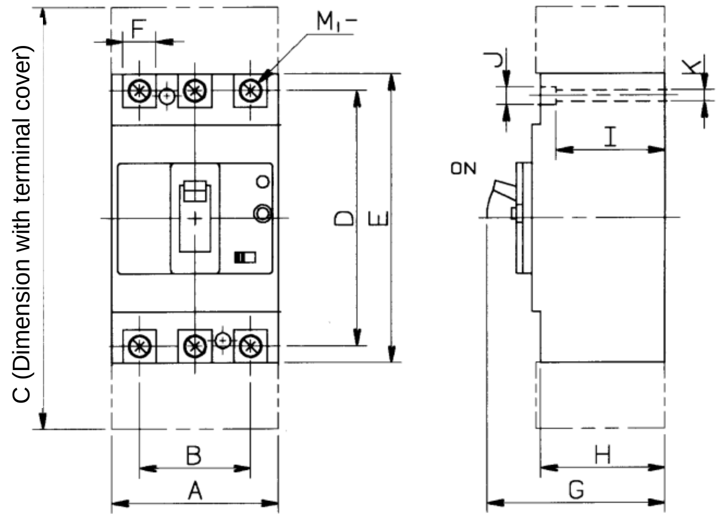
External dimensions (2)

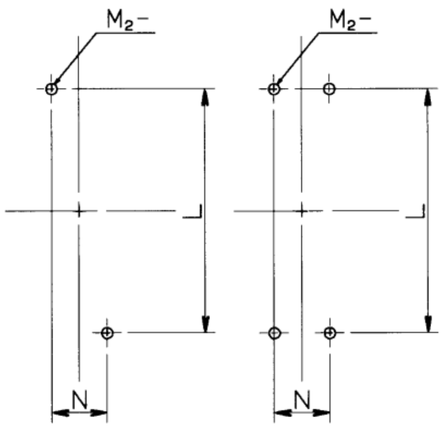


	A	B	C	D	E	F	G	G1	H	K	P	R	M
External dimensions (1)	128	155	165	55	145	84	66	33	135	7.2	135	2	M5
External dimensions (2)	70	155	165	55	145	84	66	33	135	7.2	115	2	M5

8.1.5 Circuit Breaker

Ordering drawing number	A	B	C	D	E	M_1-	F	G	H	I	J	K	L	M_2-	N	Mounting
A06B-6077-K103	75	50	180	84	100	M8	17	84	60	43	φ7.8	φ4.9	84	M4	25	2 positions
A06B-6077-K104																
A06B-6077-K105	105	70	265	144	165	M8	25.5	84	56	47	φ8.5	φ4.5	126	M4	35	4 positions



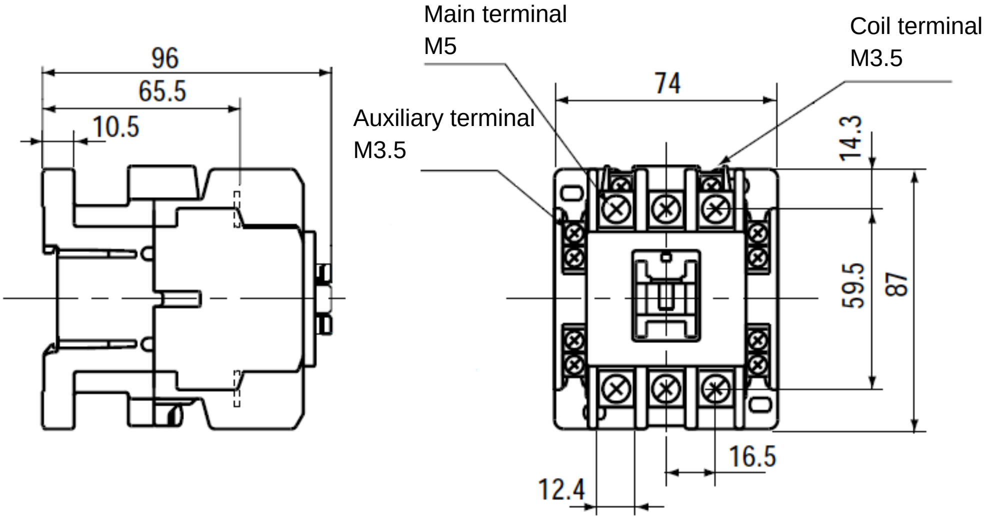


Two mounting holes   Four mounting holes

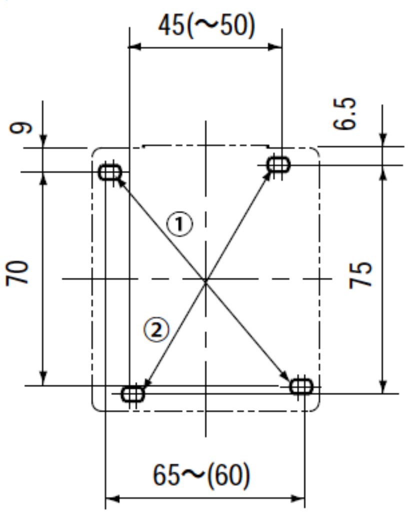
The circuit breakers have two or four mounting holes.

8.1.6 Magnetic Contactors

(a) A06B-6077-K123



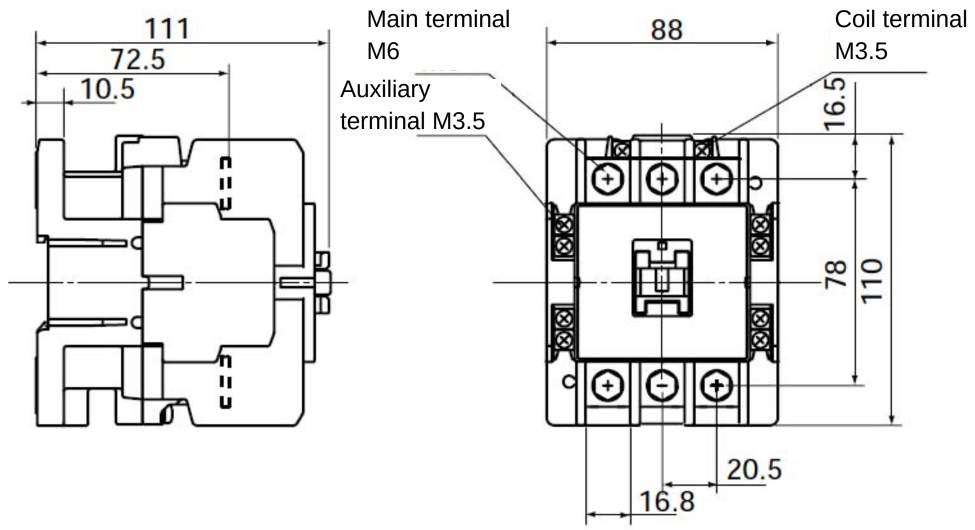
Dimensions for drilling mounting holes



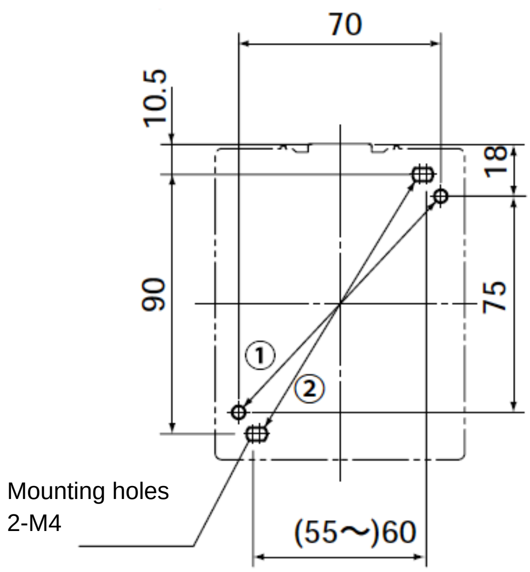
Mounting dimensions
Mounting (1) and (2) are possible.
(1) : (60 to) 65 × 70 (compatible with SC-1N and 2N)
(2) : 45 (to 50) × 75
Mounting screw: 2-M4
Mount at two diagonal mounting holes.

Ordering drawing number	Fuji Electric part number		Operation coil voltage	Auxiliary contact structure	Weight
	Body	Cover			
A06B-6077-K123	SC-N2	SZ-N1J	200V/50Hz 200-220V/60Hz	2a2b	0.59Kg

(b) A06B-6077-K124



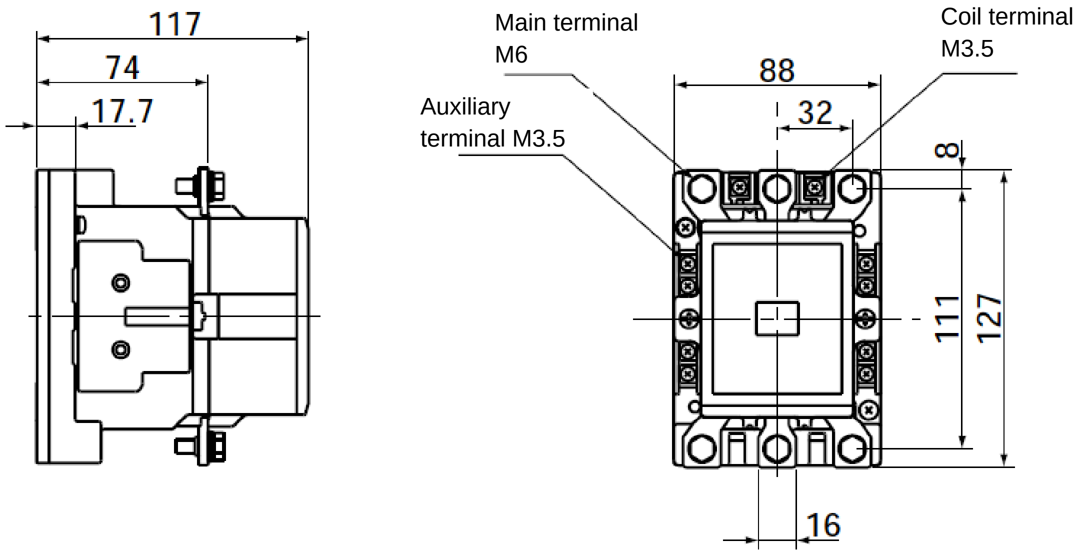
Dimensions for drilling mounting holes



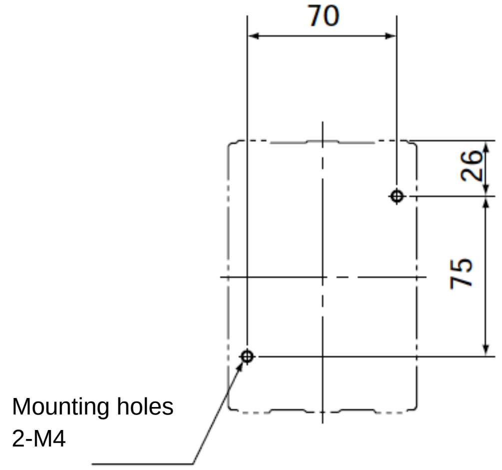
Mounting dimensions
Mounting (1) and (2) are possible.
(1) : 70 × 75 (compatible with SC-2SN and 3N)
(2) : (55 to) 60 × 90
Mounting screw: 2-M4
Mount at two diagonal mounting holes.

Ordering drawing number	Fuji Electric part number		Operation coil voltage	Auxiliary contact structure	Weight
	Body	Cover			
A06B-6077-K124	SC-N2S	SZ-N2SJ	200V/50Hz 200-220V/60Hz	2a2b	1.1Kg

(c) A06B-6077-K125



Dimensions for drilling mounting holes



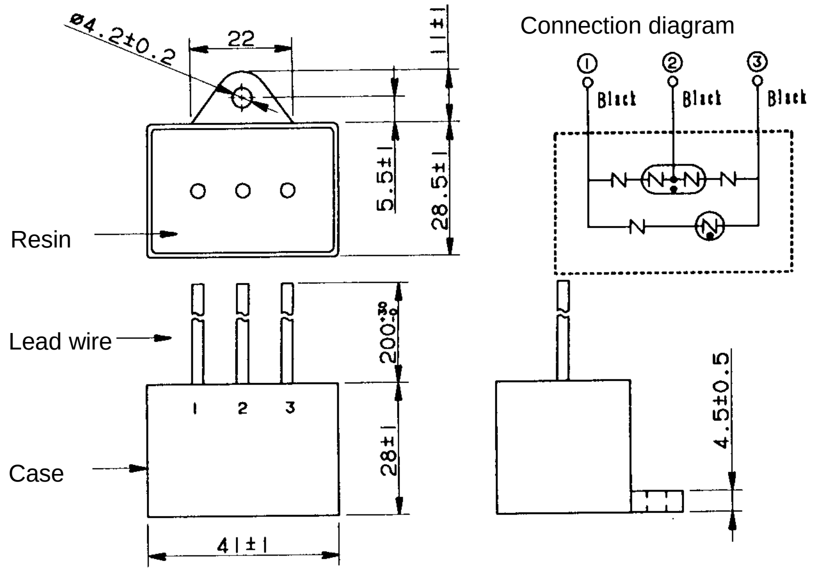
Ordering drawing number	Fuji Electric part number		Operation coil voltage	Auxiliary contact structure	Weight
	Body	Cover			
A06B-6077-K125	SC-N4	SZ-N4J	200V/50Hz 200-220V/60Hz	2a2b	1.5Kg

8.1.7 Battery Case

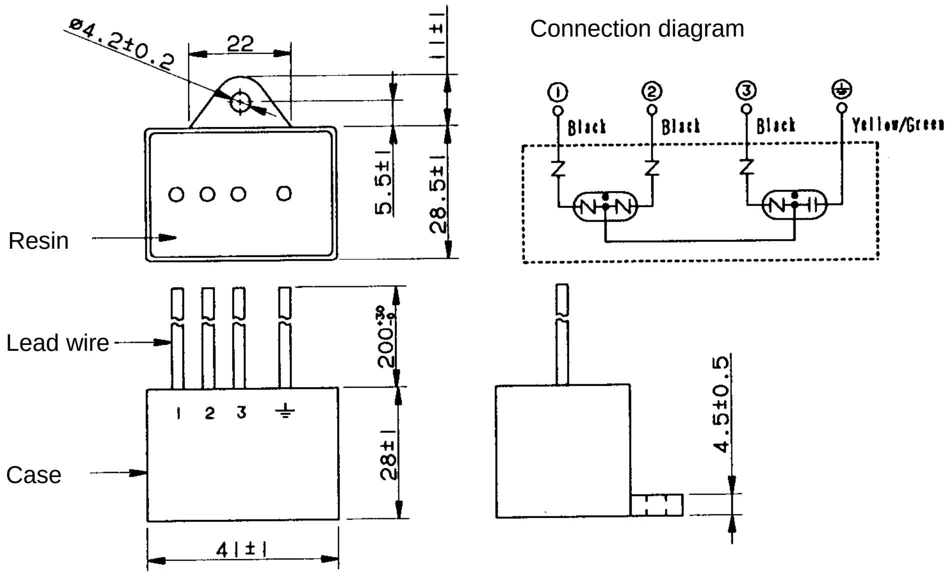
For details, see Subsection 8.1.8, "Battery Case" in the Part I, "β*i*SV".

8.1.8 Lightning Surge Protector

(a) A06B-6077-K142



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

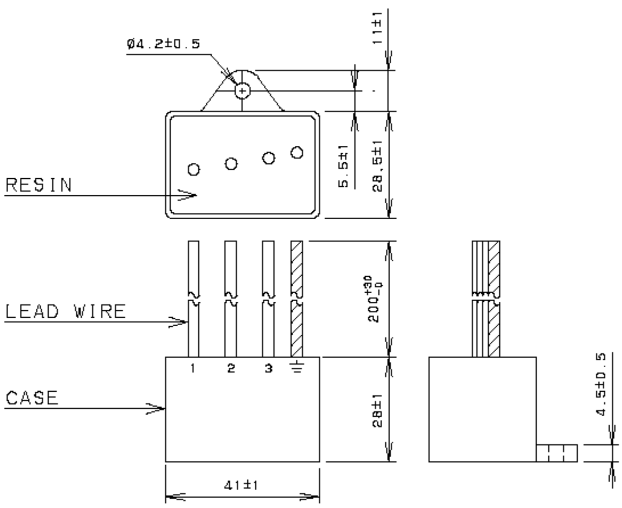


(2) For line-to-ground installation : RAV-781BXZ-4

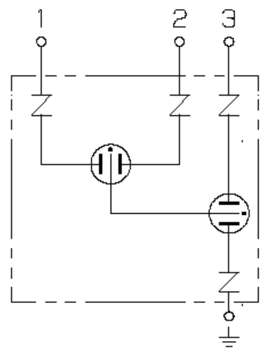
Specification	Rated voltage	Clamp voltage	Surge withstand current	Surge withstand voltage
RAV-781BYZ-2	250VAC	783VDC±10%(V1.0)	2500A(8/20μS)	20kV(1.2/50μS)

Specification	Rated voltage	AC discharge start voltage	Surge withstand current	Maximum surge discharge start voltage
RAV-781BXZ-4	Line-to-line: 430VAC, Line-to-ground: 250VAC	700VAC±20%(Ua)	2500A(8/20μS)	2.0kV(1.2/50μS)

(b) A06B-6077-K144



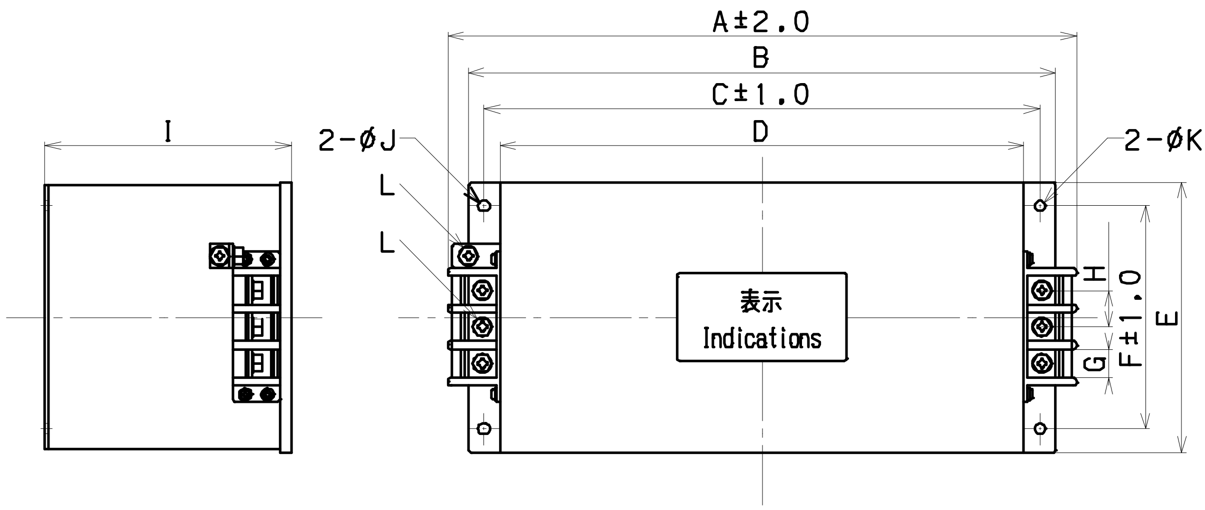
Connection diagram



Specification	Rated voltage	AC discharge start voltage	Clamp voltage	Surge withstand current	Surge withstand voltage	Maximum surge discharge start voltage
RCM-601BUZ-4	250VAC	560VAC ±20%(Ua)	2000V ±10%(V1.0)	2500A (8/20μS)	20kV (1.2/50μS)	2kV (1.2/50μS)

8.1.9 Noise Filter

(a) A06B-6077-K156, -K157



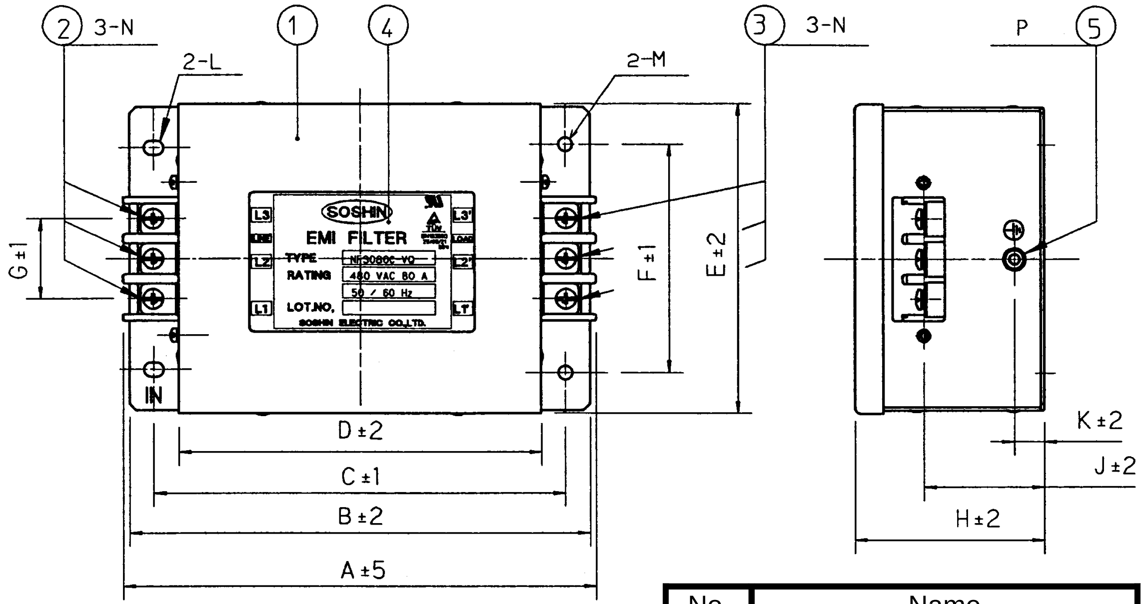
Unit : mm

General tolerance : ±1.5mm

Type	Dimensions (mm)											
	A	B	C	D	E	F	G	H	I	J	K	L
A06B-6077-K156 (3SUP-HL75-ER-6)	396	370	350	330	170	140	18	23	155	6.5×8	6.5	M6
A06B-6077-K157 (3SUP-HL150-ER-6)	484	440	420	400	200	170	30	25	200	6.5×8	6.5	M8

3SUP-HL□-ER-6: External dimensions of noise filter

(b) A06B-6110-K161, -K162



No.	Name
1	Case
2	Input terminal
3	Output terminal
4	Name plate
5	Earth terminal

Type	Dimensions (mm)												
	A	B	C	D	E	F	G	H	J	K	L	M	N	P
A06B-6110-K161 (NF3080C-VQ)	217	200	185	170	120	90	44	115	85	20	5.5×7	ϕ5.5	M6	M4
A06B-6110-K162 (NF3150C-VQ)	314	300	280	260	200	170	57	130	90	35	6.5×8	ϕ6.5	M8	M6

NF3080C/3150C-VQ: External dimensions of noise filter

8.2 PANEL CUT-OUT

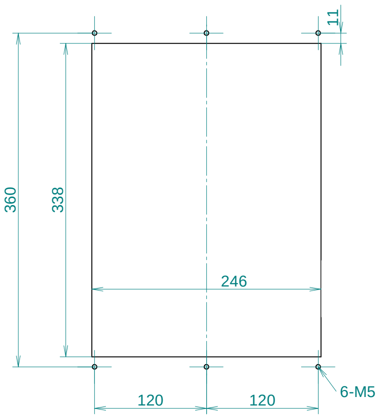
The panel cut-out of the separated cooling fan motor is shown below.
Install the FANUC separated cooling fan motor (A06B-6134-K001).

If the fan motor does not meet the cooling conditions satisfactorily, the motor properties will reduce from the values in the specifications.
Confirm that there is a sufficient convection of air around the amplifier radiator fin.
Design the locker so that the ambient temperature of the amplifier radiator fin meets Section 3.2, "ENVIRONMENTAL CONDITIONS" (Derating).

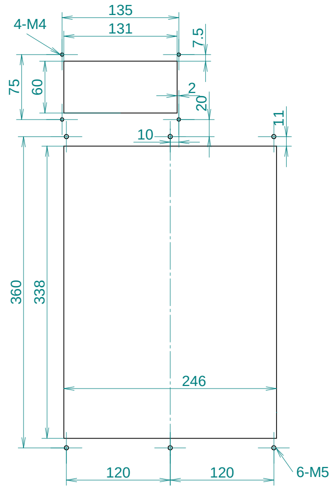
NOTE

1. Attach the supplied gasket around the panel cut-out to prevent oil and dust from getting into it.
2. Reinforce the right and left sides of the panel cut-out in the power magnetics cabinet by using fittings such as angles to maintain satisfactory contact between the sheet metal of the power magnetics cabinet and the flange of the amplifier.
3. Placing a FANUC fan unit on top of the servo amplifier requires installing a duct. See the “example duct structure where a FANUC separated cooling fan motor (A06B-6134-K001) is used” for descriptions about the structure of the duct.
4. Placing a FANUC separated cooling fan motor below the servo amplifier does not require installing a duct.

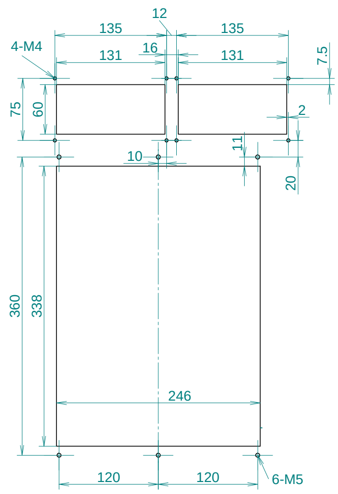
(1) Model that does not use a separated cooling fan motor



(2) If a separated cooling fan motor is placed on top of the servo amplifier

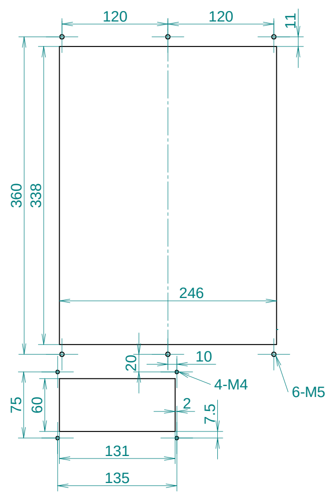


When one motor is used

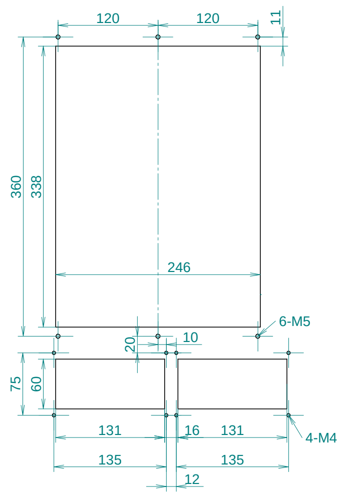


When two motors are used

(3) If a separated cooling fan motor is placed below the servo amplifier



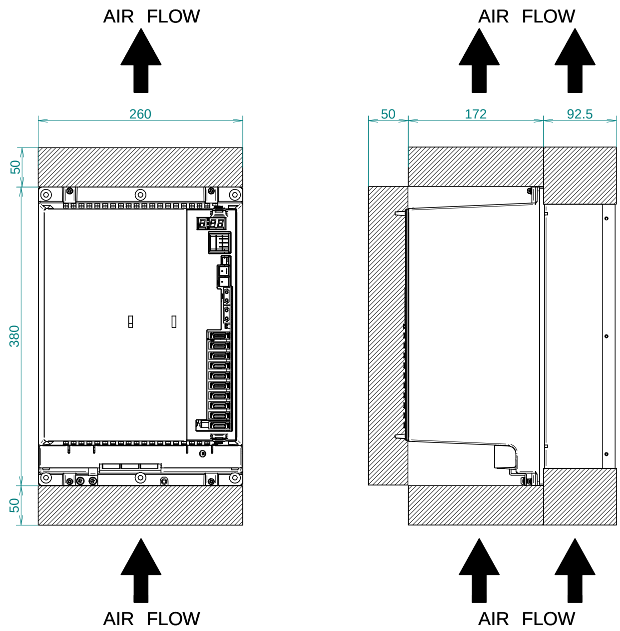
When one motor is used



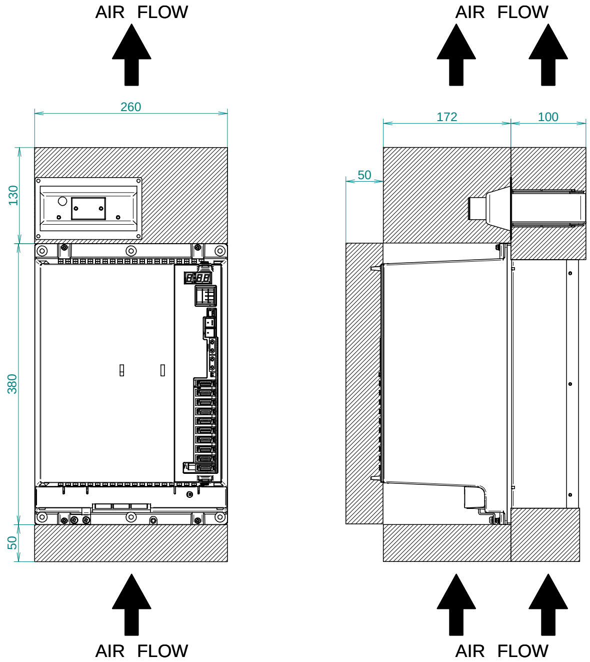
When two motors are used

8.3 MAINTENANCE AREA

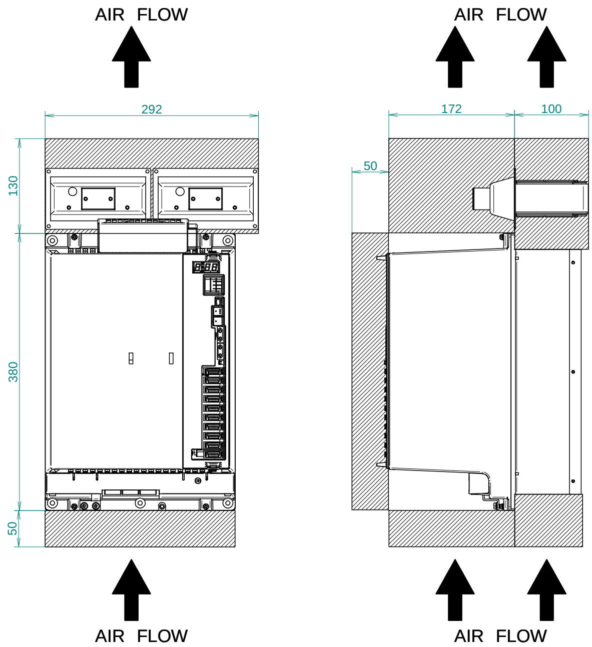
(1) Model that does not use a separated cooling fan motor



(2) Model that use a separated cooling fan motor (placed on top of the servo amplifier)

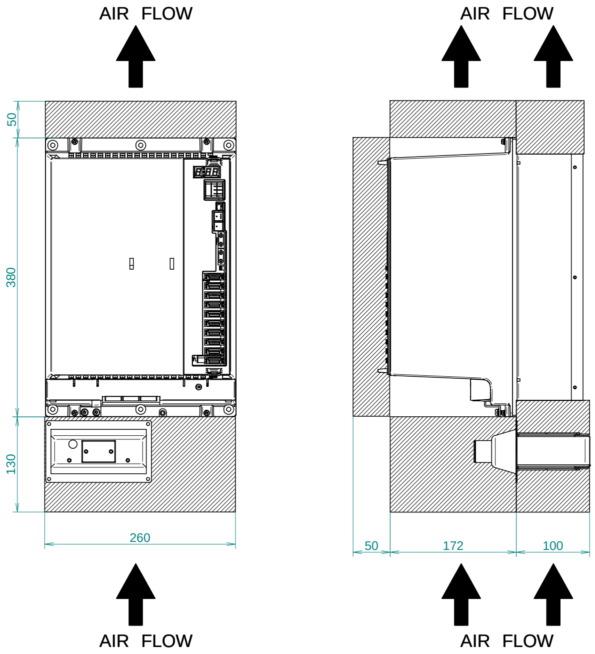


When one motor is used

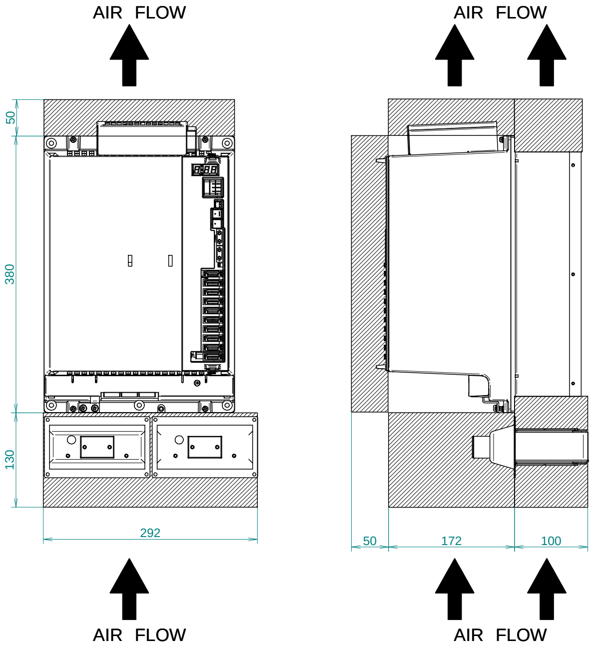


When two motors are used

(3) Model that use a separated cooling fan motor (placed below the servo amplifier)



When one motor is used



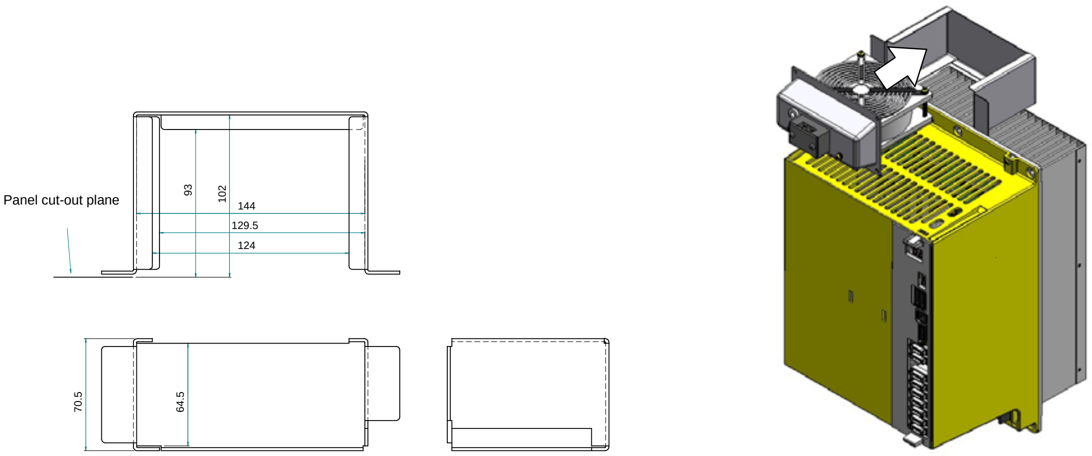
When two motors are used

8.4 DUCT

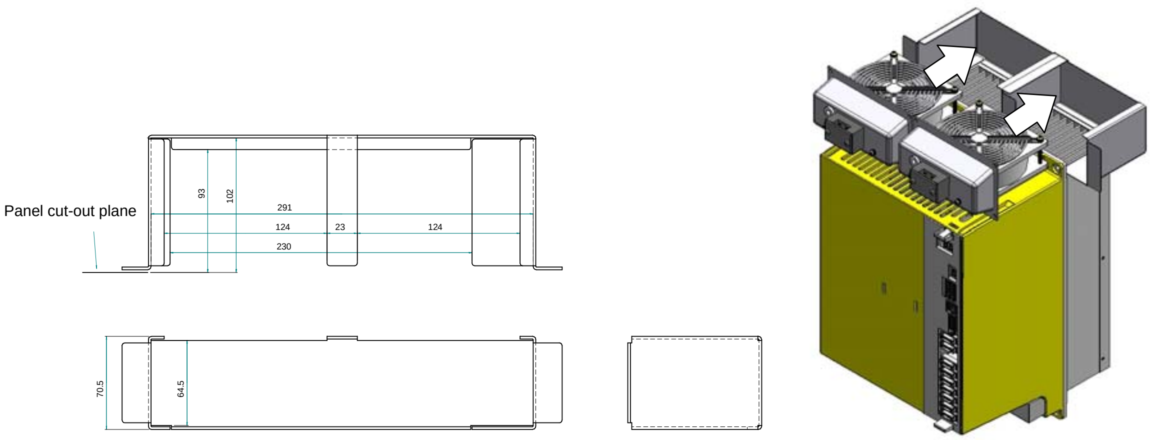
Shown below is an example duct structure where a separated cooling fan motor (A06B-6134-K001) is used.
If a duct is not installed, the motor properties may reduce from the values in the specifications.

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

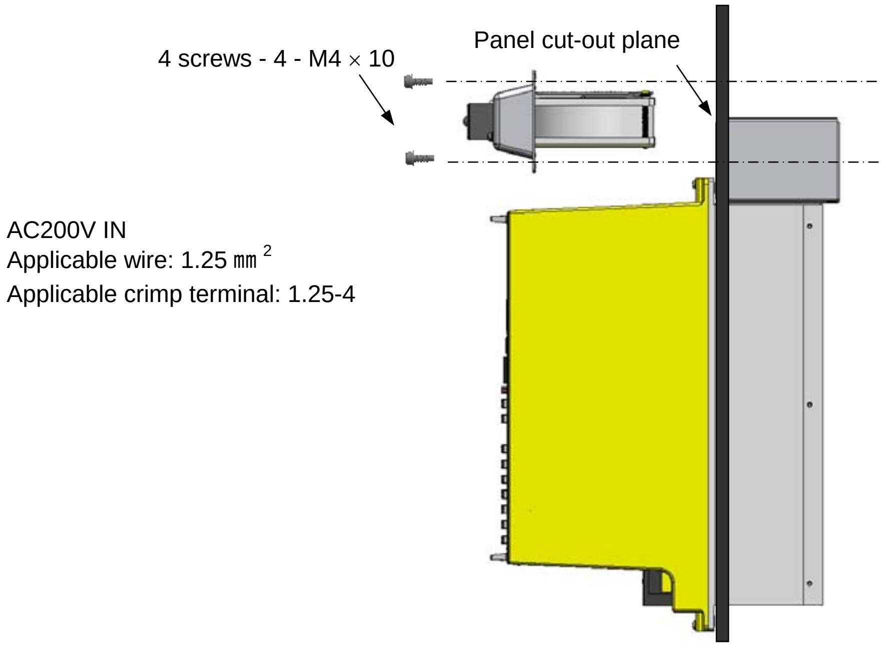
When one separated cooling fan motor (for cooling the external radiator fin) is used



When two separated cooling fan motors (for cooling the external radiator fin) are used



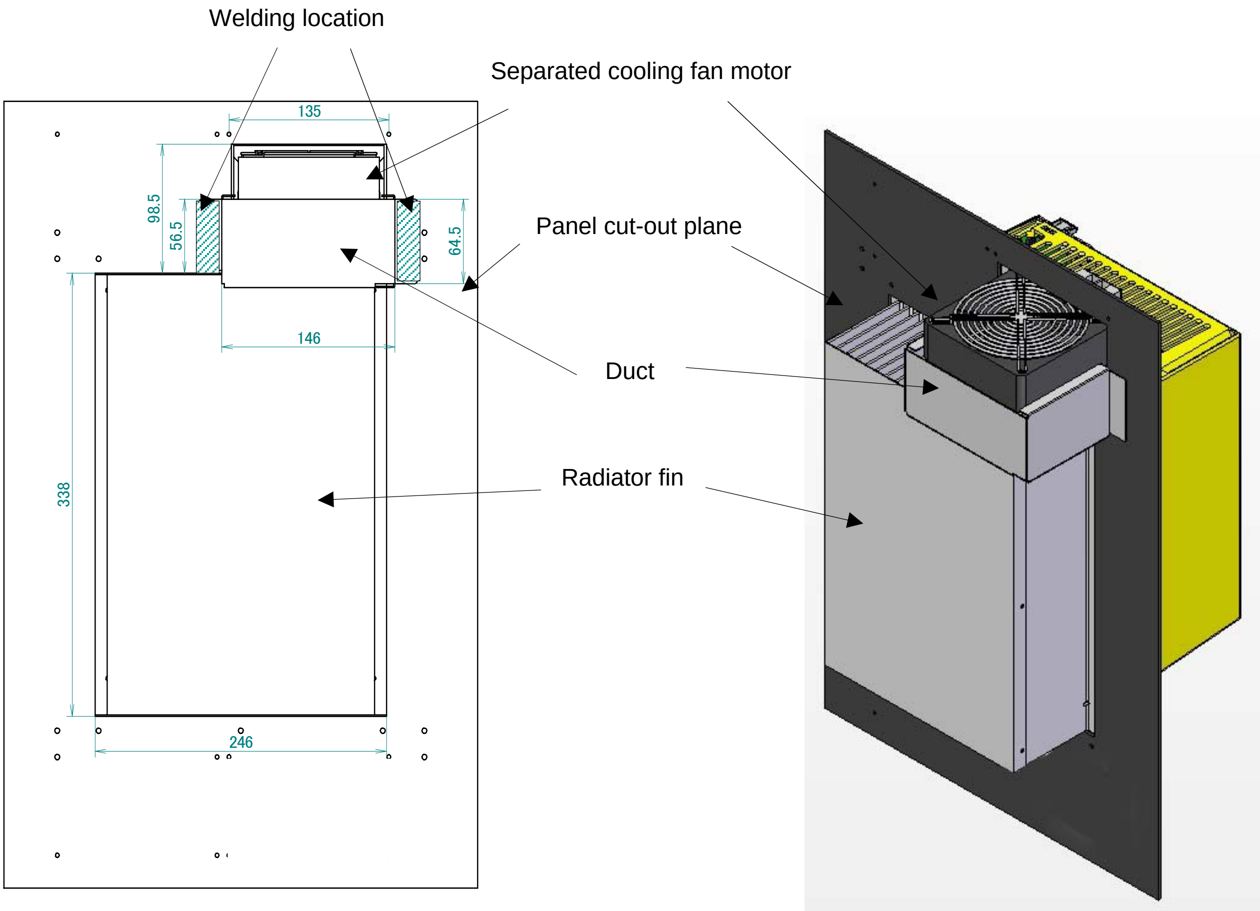
How to mount a separated cooling fan motor (A06B-6134-K001)



- Duct mounting diagram

  FANUC recommended example

  (1) When one separated cooling fan motor (for cooling the external radiator fin) is used

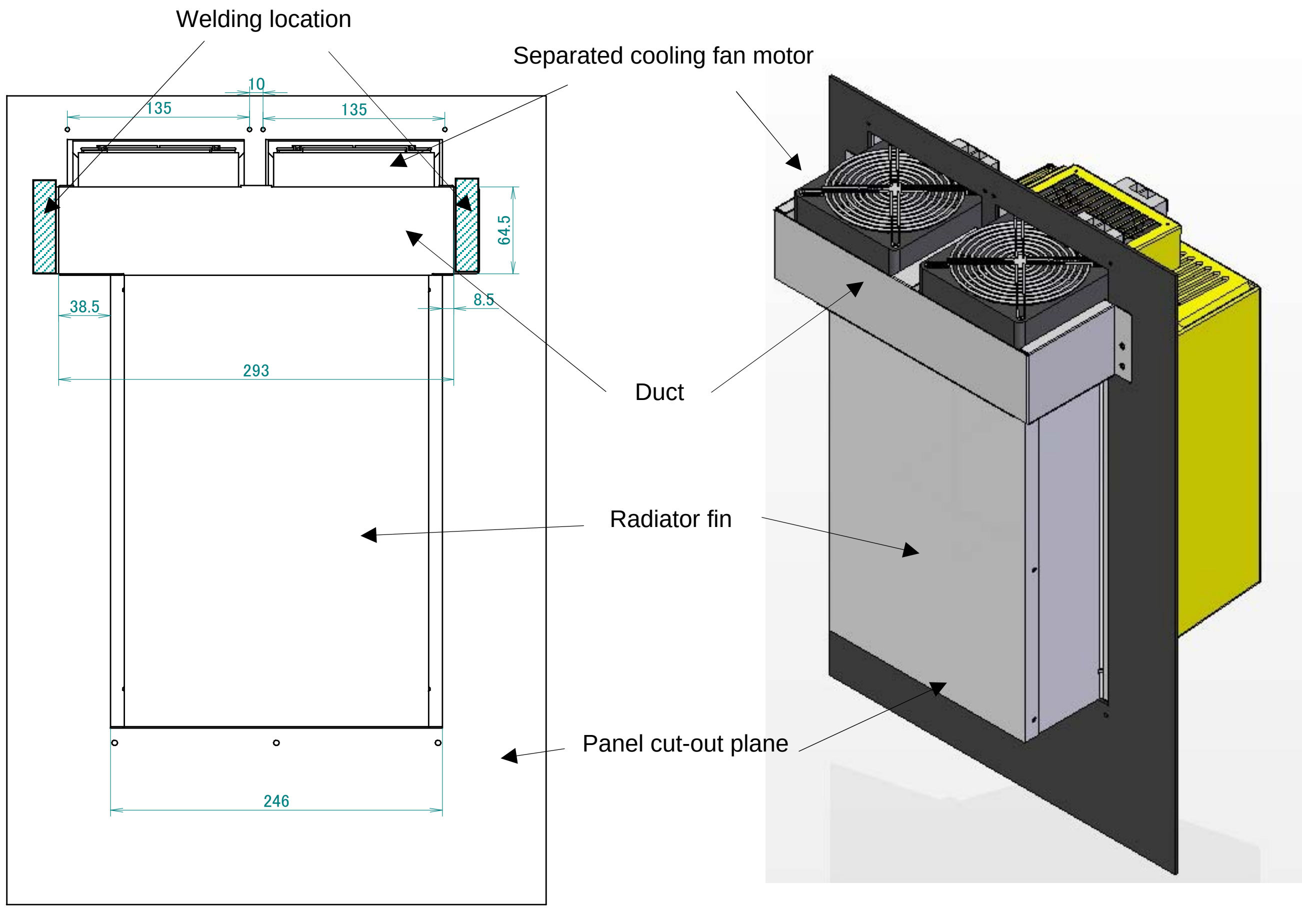


(a) Rear view (duct mounting position)

(b) Rear view（diagonally backward left）

> **NOTE**
> 1 Mount the duct by welding.
> 2 Install the duct in such a way that there is no gap between the duct and the radiator fin. Use caution to prevent the duct and the radiator fin from interfering.
> 3 Install the duct in such a way that there is no gap between the duct and the separated cooling fan motor.

(2) When two separated cooling fan motors (for cooling the external radiator fin) are used



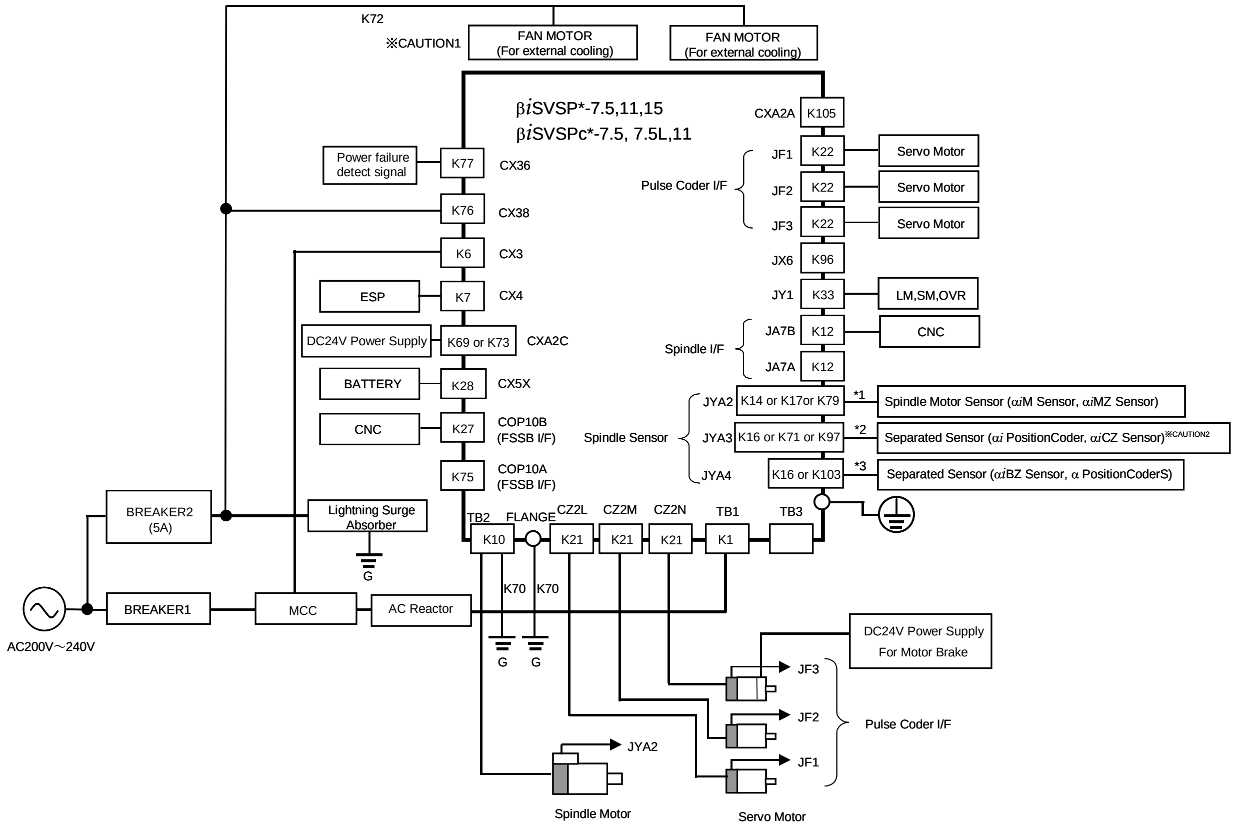
(a) Rear view (duct mounting position) **(b) Rear view（diagonally backward left）**

NOTE
1 Mount the duct by welding.
2 Install the duct in such a way that there is no gap between the duct and the radiator fin. Use caution to prevent the duct and the radiator fin from interfering.
3 Install the duct in such a way that there is no gap between the duct and the separated cooling fan motor.

9 TOTAL CONNECTION DIAGRAM

9.1 CONNECTION DIAGRAM

9.1.1 β*i*SVSP*-7.5/-11/-15 and β*i*SVSPc*-7.5/-7.5L/-11

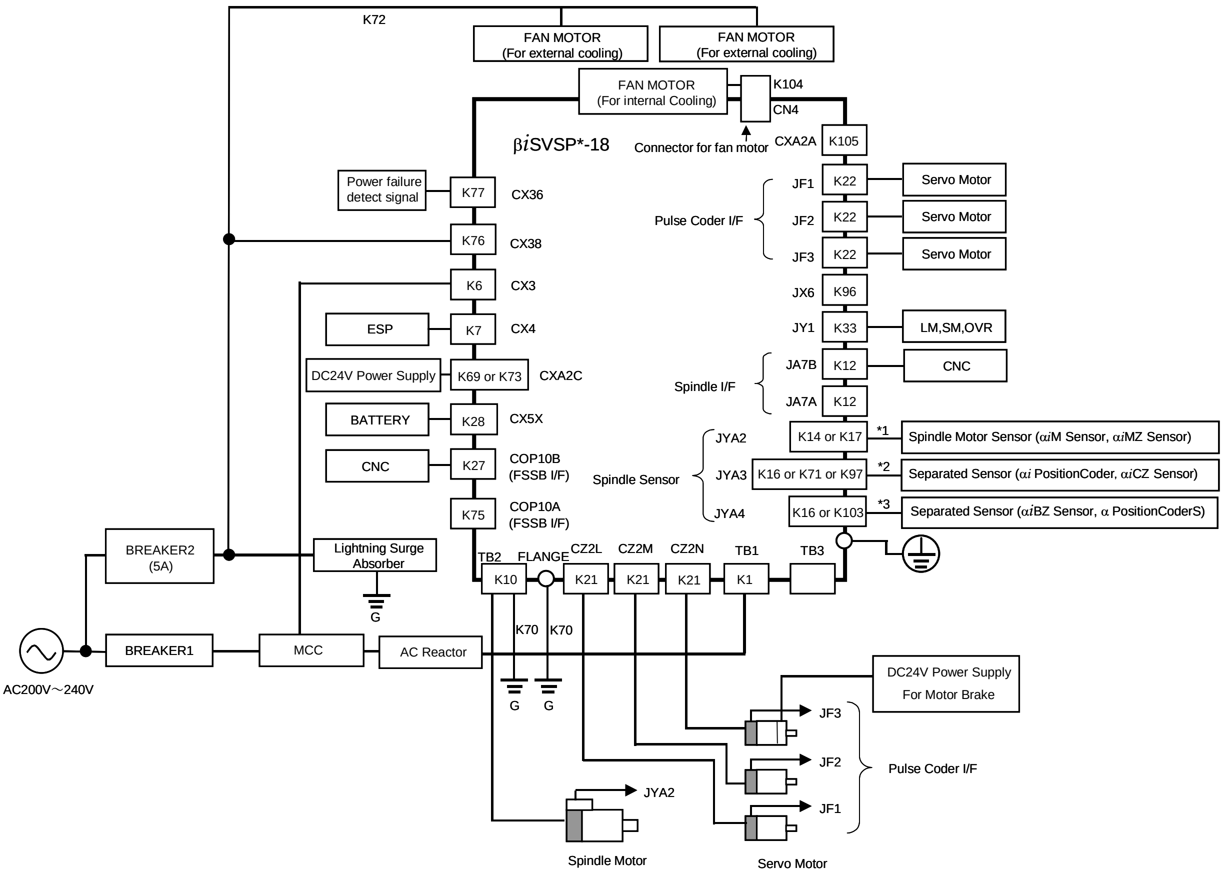


*1 K14 is for the α*i*M sensor only. For the α*i*MZ sensor, use K17. When the sensor-less spindle motor is used, use K79.
*2 K16 is for the α*i* position coder only. For the α*i*CZ sensor, use K97. If an external one-rotation switch is used, use K71.
*3 K103 is for the α*i*BZ sensor only. For the α position coder S, use K16.

> **NOTE**
> 1 Always install the circuit breakers, magnetic contactor, and AC reactor.
> 2 Use the stabilized power supply 24VDC for the servo amplifier. Power supply 24VDC for the servo amplifier and power supply 24VDC for the motor brake cannot be shared.
> 3 To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.
> 4 Always ground the grounding terminal (G) on TB2 and the tapped hole for grounding the flange.

> ⚠ **CAUTION**
> 1 In the βiSVSP*-7.5 and -11, as well as the βiSVSPc*-7.5L and -11, install only one separated cooling fan motor (for cooling the radiator fin). If installing only one, install it on this side.
> 2 The αiCZ sensor cannot be connected to the βiSVSPc.

9.1.2 βiSVSP*-18



*1 K14 is for the αiM sensor only. For the αiMZ sensor, use K17.

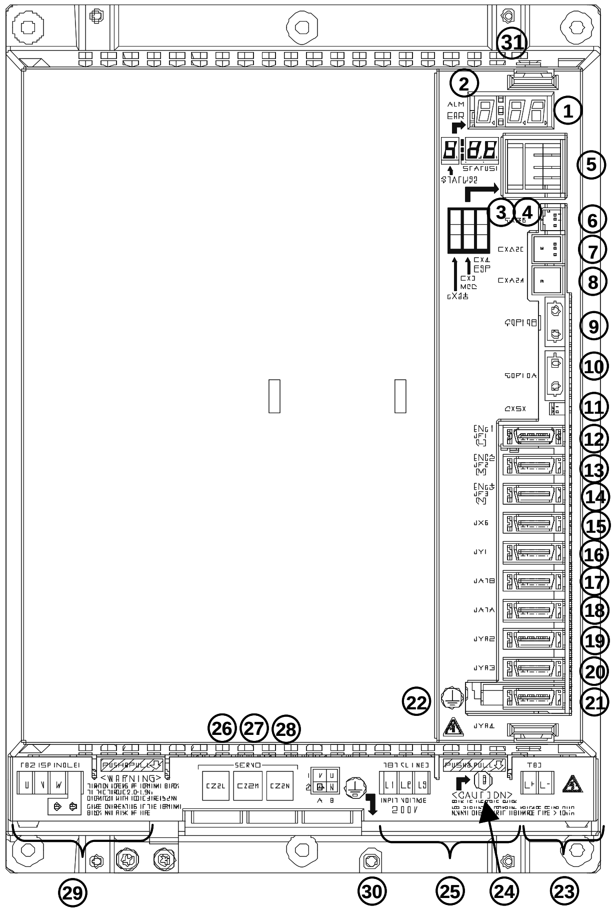
*2 K16 is for the αi position coder only. For the αiCZ sensor, use K97. If an external one-rotation switch is used, use K71.

*3 K103 is for the αiBZ sensor only. For the α position coder S, use K16.

> **NOTE**
> 1 Always install the circuit breakers, magnetic contactor, and AC reactor.
> 2 Use the stabilized power supply 24VDC for the servo amplifier. Power supply 24VDC for the servo amplifier and power supply 24VDC for the motor brake cannot be shared.
> 3 To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.
> 4 Always ground the grounding terminal (G) on TB2 and the tapped hole for grounding the flange.

9.2 CONNECTOR LOCATION

No.	Name	Remarks
1	STATUS1	Status LED : spindle
2	STATUS2	Status LED : servo
3	CX38	Input for power failure detection
4	CX3	Main power MCC control signal
5	CX4	Emergency stop signal (ESP)
6	CX36	Output for power failure detection
7	CXA2C	24VDC power input
8	CXA2A	24VDC power output
9	COP10B	Servo FSSB interface
10	COP10A	Servo FSSB interface
11	CX5X	Absolute Pulsecoder battery
12	JF1	Pulsecoder : L axis
13	JF2	Pulsecoder : M axis
14	JF3	Pulsecoder : N axis
15	JX6	Power outage backup module
16	JY1	Load meter, speedometer, analog override
17	JA7B	Spindle interface input
18	JA7A	Spindle interface output
19	JYA2	Spindle sensor αi M, αi MZ
20	JYA3	Separated sensor for a spindle (αi position coder, αiCZ sensor) External one-rotation signal
21	JYA 4	Separated sensor for a spindle (α position coder S, αiBZ sensor)
22	⏚	Ground terminal for signals
23	TB3	DC link terminal block
24	V4	DC link charge LED (Warning)
25	TB1	Main power supply connection terminal board
26	CZ2L	Servo motor power line : L axis
27	CZ2M	Servo motor power line : M axis
28	CZ2N	Servo motor power line : N axis
29	TB2	Spindle motor power line
30	⏚	Tapped hole for grounding the flange
31	CN4	Connector for an internal cooling fan



⚠ **WARNING**

Do not touch any component in the module or any connected cable when LED (24) is on, because it is dangerous.

9.3 DETAILED DESCRIPTONS OF CONNECTIONS

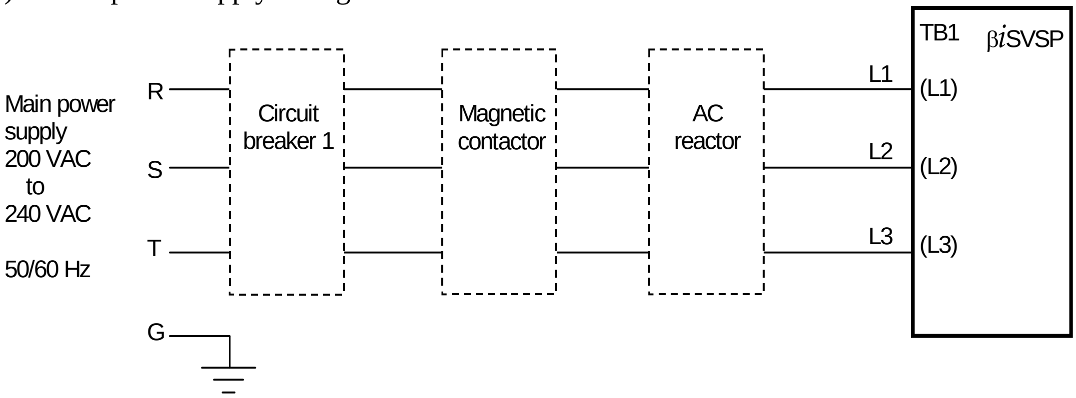
9.3.1 Common

9.3.1.1 Details of cable K1

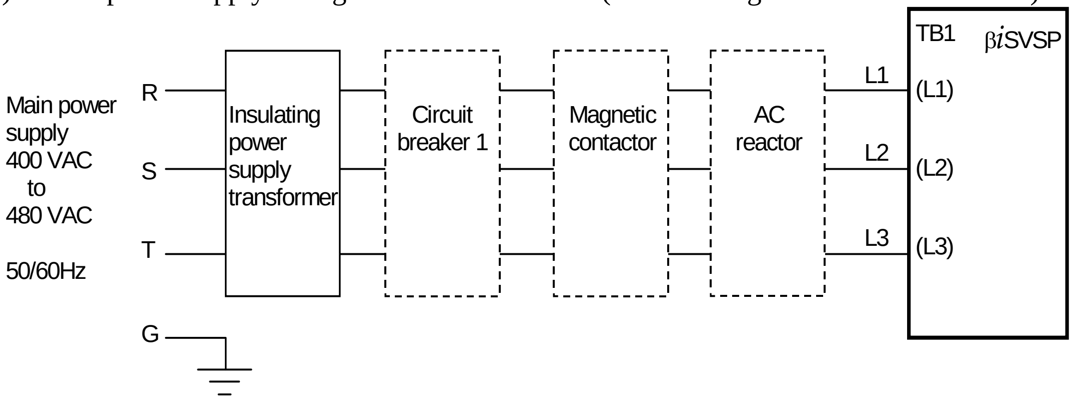
Cable K1 is used to supply main power to the βiSVSP.

(1) Configuration

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



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



(2) Cable specifications

Model	Applicable cable		Terminal screw	Tightening torque
	Heavy-duty power cable (Note 1)	Heat-resistant cable (Note 2)		
βiSVSP*-7.5	8mm^2 or more	5.5mm^2 or more	M5	2.0 to 2.5Nm
βiSVSP*-11	8mm^2 or more	8mm^2 or more	M5	2.0 to 2.5Nm
βiSVSP*-15	14 mm^2 or more	14mm^2 or more	M5	2.0 to 2.5Nm
βiSVSP*-18	-	22mm^2 or more	M5	2.0 to 2.5Nm

NOTE

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

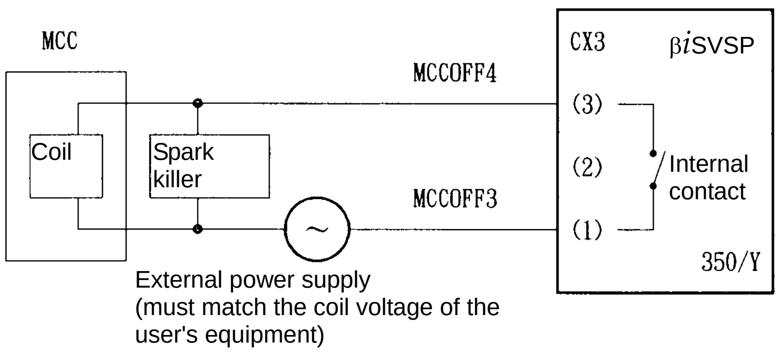
2 Fire-retardant polyflex wire (heat-resistant 105 °C) or equivalent to LMFC manufactured by The Furukawa Electric Co., Ltd.

NOTE

3 The cross-section area of each cable is determined under the following conditions:
(1) At βiSVSP rated output
(2) Environment temperature of cable : 30°C
(3) Number of harnesses: 3 (No current flows through the ground wire during normal operation.)
The necessary cable cross-section area must be selected according to a user's environment and requirements.

9.3.1.2 Details of cable K6

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



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

Internal-contact specification:

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

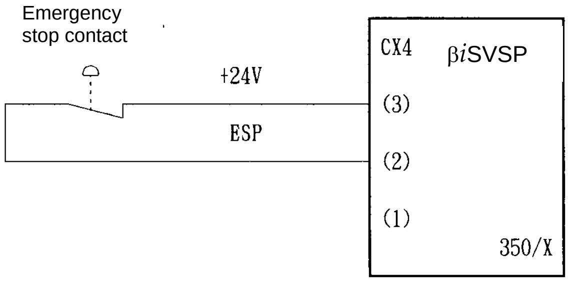
NOTE

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**
24VDC	0.22μF	22Ω
100 to 230VAC	0.1μF	220Ω

9.3.1.3 Details of cable K7

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



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

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

When the contact is set to OFF (open) during motor rotation, the spindle motor decelerates, then stops, and the servo motor is stopped by the dynamic brake.
The contact input signal is specified as follows:

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

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

⚠ **WARNING**

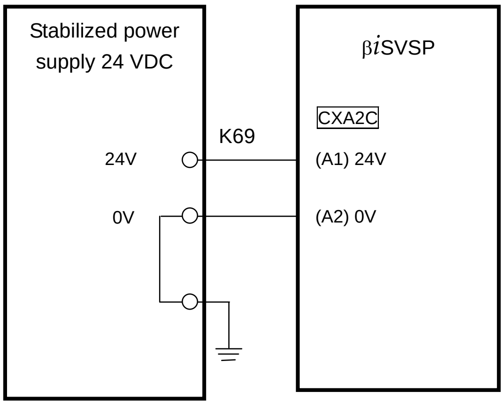
1 The spindle free-runs as a result of a power failure, an alarm, or a command from the ladder (MPOFA signal). During free running, the spindle does not stop even when an emergency stop is applied.
2 Note that even when the power is off, the spindle might be free-running.
3 When an amplifier requires an external dynamic brake module, but no dynamic brake module is connected to the amplifier, applying an emergency stop causes the servo axis to coast.

⚠ **WARNING**

4 The ESP signal receive circuit of the amplifier is implemented by an electronic circuit. This means that input of the ESP signal to the amplifier due to an electronic circuit failure may not stop the motor.

9.3.1.4 Details of cable K69

Cable K69 is used to supply the control power supply 24 VDC to the β*i*SVSP.



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

9.3.1.5 Details of cable K70

Cable K70 is used to ground the frame ground and the signal ground of the β*i*SVSP.

Grounding cable conductor diameter

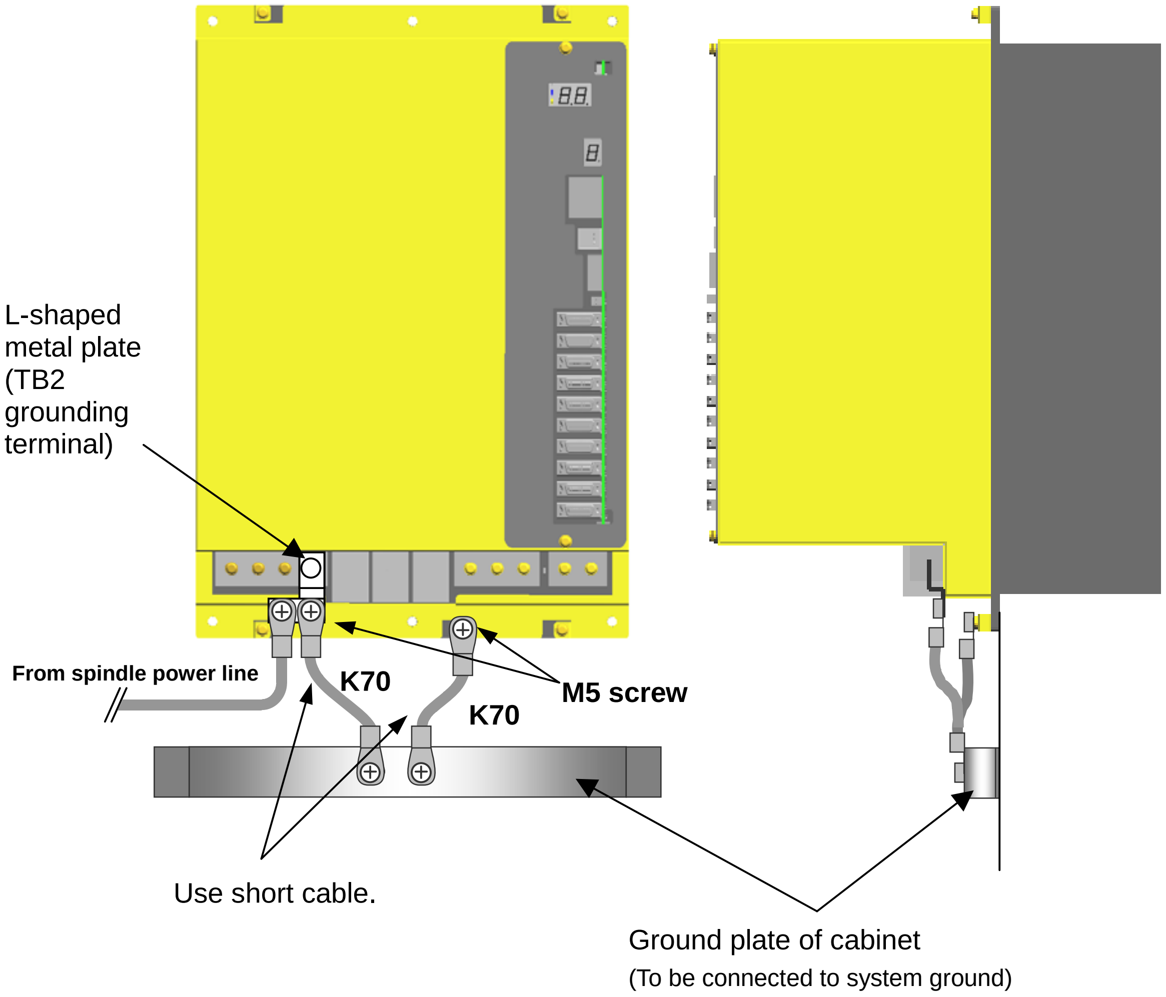
Motor power cable cross-section S (mm^2)	Grounding cable cross-section (mm^2)
S≤5.5	5.5 or greater
5.5<S≤16	S or greater
16<S≤35	16 or greater
35<S	S/2 or greater

NOTE

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

Model	Terminal screw	Tightening torque
β*i*SVSP*-7.5	M5	2.0 to 2.5Nm
β*i*SVSP*-11	M5	2.0 to 2.5Nm
β*i*SVSP*-15	M5	2.0 to 2.5Nm
β*i*SVSP*-18	M5	2.0 to 2.5Nm

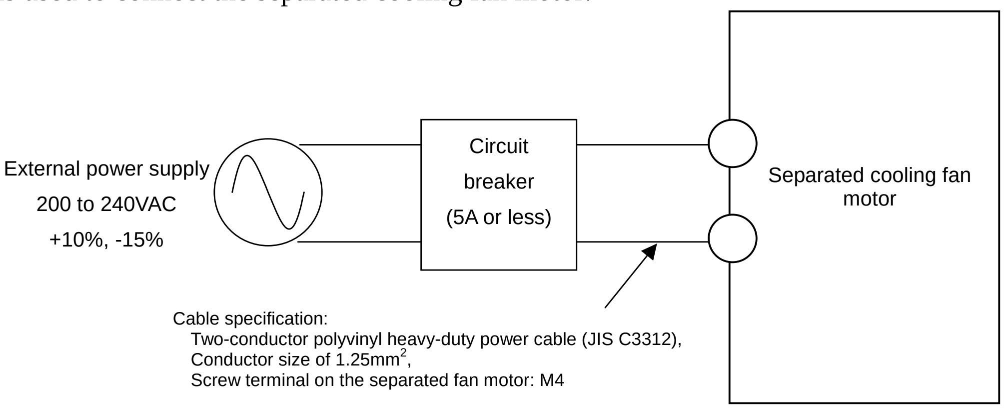
(Grounding example with K70)



> **NOTE**
> Securing cables (crimp terminals) to the ground terminal together is not permitted.
> As shown in the above figure, attach one cable (crimp terminal) to each screw.

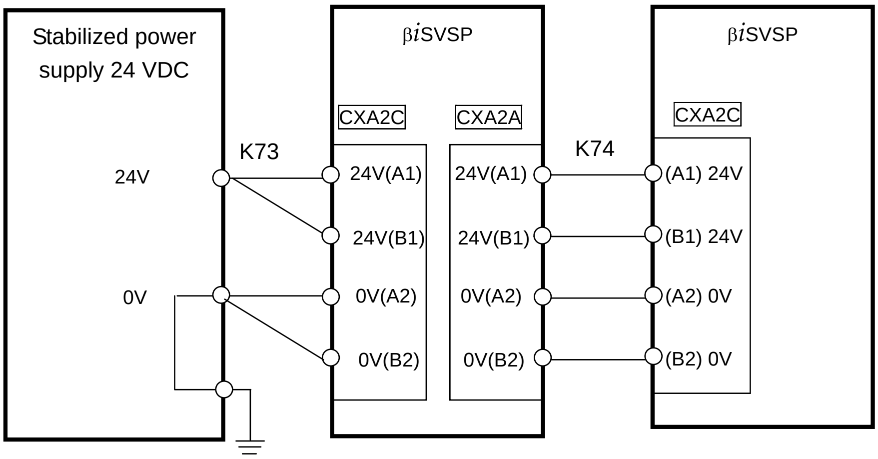
9.3.1.6 Details of cable K72

This cable is used to connect the separated cooling fan motor.



9.3.1.7 Details of cable K73,K74

When connecting only one βiSVSP unit, see Details of cable K69.
When connecting two βiSVSP units, connect two wires to both 24V and 0V.



K73	**Connector**	Manufactured by Tyco Electronics AMP D-2100 series Housing (X key) : 1-1318119-4 (1 pcs.) Contact (M size) : 1318107-1 (4 pcs.)
	Cable	Conductor size : 0.5mm^2, AWG20 Instruction outer diameter : 1.08-2.83 mm
	Applicable tool	91595-1
K74	**Connector**	Manufactured by Tyco Electronics AMP D-2100 series Housing (X key) : 1-1318119-4 (2 pcs.) Contact (M size) : 1318107-1 (8 pcs.)
	Cable	Conductor size : 0.5mm^2, AWG20 Instruction outer diameter : 1.08-2.83 mm
	Applicable tool	91595-1

[Ordering information for connectors and tools]

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

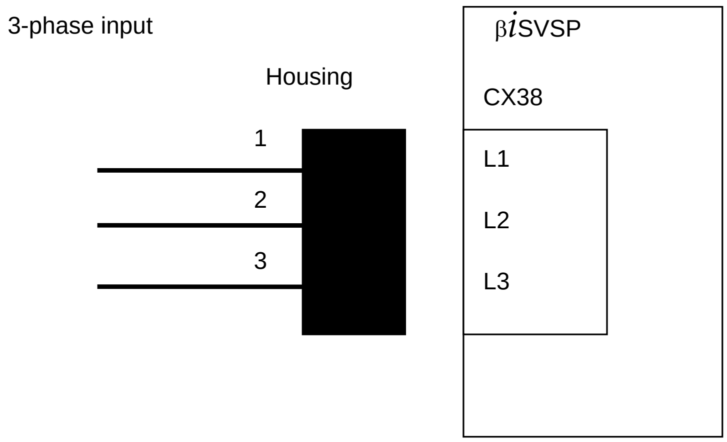
Ordering number	Description
A06B-6134-K202 (for K6,K7, and K73) (Note)	Manufactured by Tyco Electronics AMP D-3200 series Housing (Y key) : 2-178128-3 (1 pcs.) Contact (L size) : 1-175218-2 (2pcs.) Applicable tool: 91558-1 (not included in this kit) Manufactured by Tyco Electronics AMP D-3200 series Housing (X key) : 1-178128-3 (1 pcs.) Contact (L size) : 1-175218-2 (2pcs.) Applicable tool: 91558-1 (not included in this kit) Manufactured by Tyco Electronics AMP D-2100 series Housing (X key) : 1-1318119-4 (1 pcs.) Contact (M size) : 1318107-1 (4 pcs.) Applicable tool: 91595-1 (not included in this kit)

Ordering number	Description
A06B-6134-K203 (Two required for K74)	Manufactured by Tyco Electronics AMP D-2100 series Housing (X key) : 1-1318119-4 (1 pcs.) Contact (M size) : 1318107-1 (8 pcs.) Applicable tool: 91595-1 (not included in this kit)

NOTE
Information is valid if two β*i*SVSP units are to be connected.
If connecting one β*i*SVSP unit, specify A06B-6134-K201.

9.3.1.8 Details of cable K76

Cable K76 is used to input three-phase 200 VAC for the power failure detection function. If not using the power failure detection function, leave it unconnected.



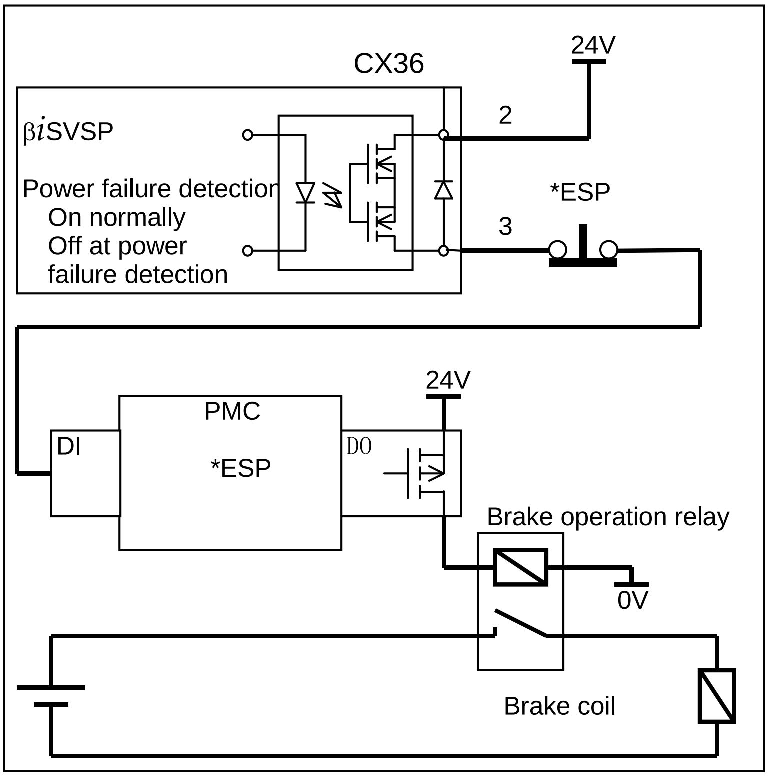
Connector	Manufactured by Tyco Electronics AMP D-3200 series Housing (Z key): 3-178128-3 (1 pcs.) Contact (L size): 1-175218-2 (3 pcs.)
Cable	Conductor size: 1.25mm^2,(50/0.18), PVC sheath 9.6 mm in diameter
Applicable tool	91558-1

[Ordering numbers of connectors and tools]
Connectors (including housings and contacts) and tools can be purchased directly from Tyco Electronics AMP. They can be ordered as options also from FANUC as listed below.

Ordering number	Description
A06B-6134-K204 (for K76 and K77)	Manufactured by Tyco Electronics AMP D-3200 series Housing (Z key): 3-178128-3 (1 pcs.) Contact (L size): 1-175218-2 (3pcs.) Applicable tool: 91558-1 (not included in this kit) Manufactured by Tyco Electronics AMP D-2100 series Housing (Y key): 2-1318120-3 (1pcs.) Contact (M size): 1318107-1 (2pcs.) Applicable tool: 91595-1 (not included in this kit)

9.3.1.9 Details of cable K77

Cable K77 is used for an output signal for the power failure detection function. If not using the power failure detection function, leave it unconnected.



CX36 requirements (output rating)

Load voltage 30V Max. / Load current 200mA Max.

Connector	Manufactured by Tyco Electronics AMP D-2100 series Housing (Y key): 2-1318120-3 (1 pcs.) Contact (M size): 1318107-1 (2 pcs.)
Cable	Conductor size: 0.5mm^2, AWG20 Instruction outer diameter: 1.11-1.87 mm
Applicable tool	91595-1

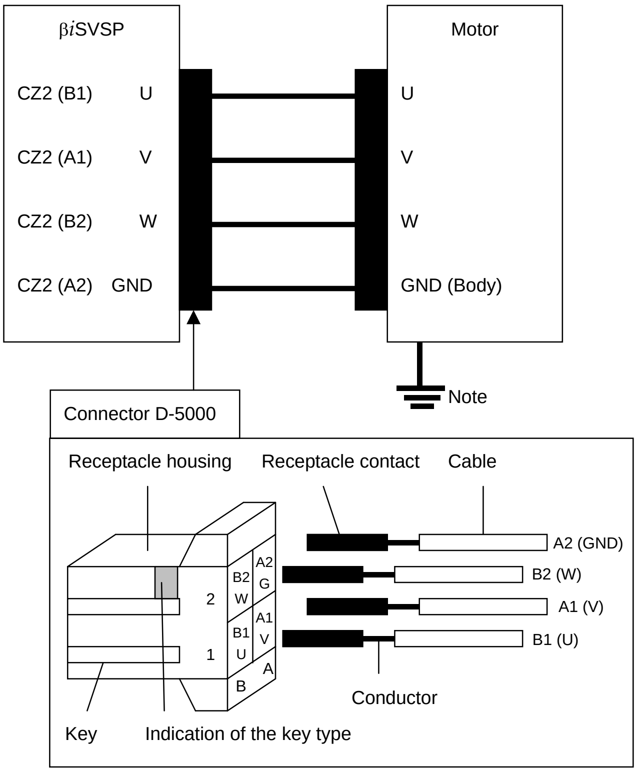
[Ordering numbers of connectors and tools]

Connectors (housings and contacts) and tools can be purchased directly from Tyco Electronics AMP, but FANUC can provide them as options. See Subsection 9.3.1.8, “Details of cable K76”.

9.3.2 Servo Motor

9.3.2.1 Details of cable K21

The cable K21 is a power cable used between the β*i*SVSP and motor. The cable is attached to the β*i*SVSP through the connector D-5000.



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

Specification of the key	Applicable β*i*SVSP
XX	CZ2L
XY	CZ2M
YY	CZ2N

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

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

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

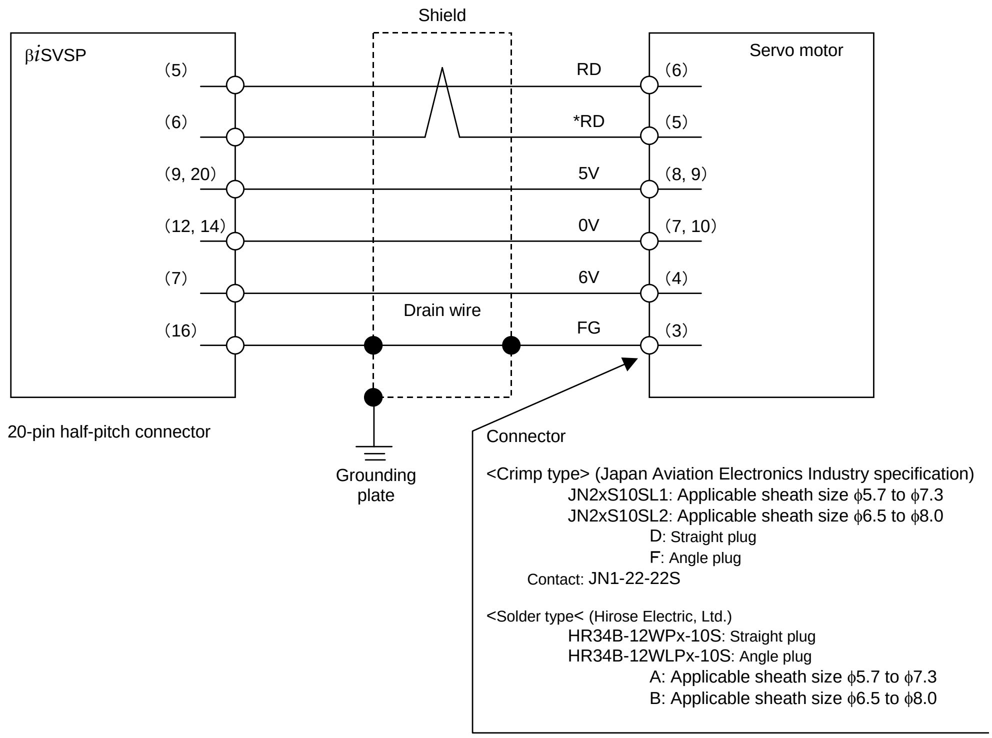
9.3.2.2 Details of cable K22

The cable K22 is used to connect the β*i*SVSP and Pulsecoder.

> ⚠ **WARNING**
> If the connector (JF*) of the Pulsecoder is connected incorrectly, an unpredictable motor operation may occur.

[When servo motor β*i*S or β*i*F series is used]

β*i*S series servo motor (β*i*S2/4000 to β*i*S 40/2000)
β*i*F series servo motor (β*i*F4/3000 to β*i*F 30/1500)



Using cable conductor

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

For information about the β*i*SVSP-side connectors suitable for recommended cables, see Subsection 9.4.1, "20-Pin Half-Pitch Connectors".

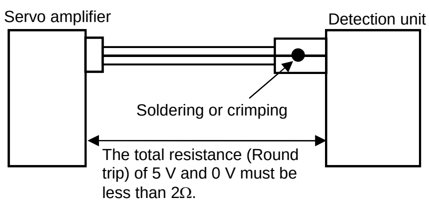
NOTE

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

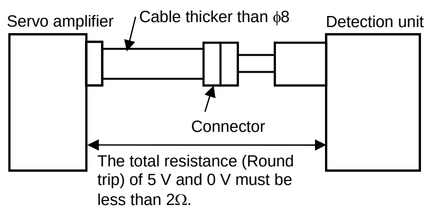
2 In case that the cable is prepared by MTB, total resistance of 5V and 0V must be less than 2Ω.

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

[Case 1] Cable conductor exceeds 0.5mm^2.



[Case 2] Sheath diameter of exceeds ϕ8.



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

- Crimp tool specification

FANUC specification	Japan Aviation Electronics Industry specification	Applicable cable thickness
A06B-6114-K201/JN1E	CT150-2-JN1-E	21AWG(0.5mm^2:20/0.18) 23AWG(0.3mm^2) 25AWG(0.18mm^2)
A06B-6114-K201/JN1D	CT150-2-JN1-D	20AWG(0.5mm^2:104/0.08) 21AWG(0.5mm^2:20/0.18) 25AWG(0.18mm^2)

- Recommended cable

Recommended cable specification	Description	Crimp tool specification
A66L-0001-0460	Flexible cable 28 m or less	A06B-6114-K201/JN1E (FANUC specification) CT150-2-JN1-E (Japan Aviation Electronics Industry specification)
A66L-0001-0481	Fixed cable 28 m or less	
A66L-0001-0462	Flexible cable 50 m or less	A06B-6114-K201/JN1D (FANUC specification) CT150-2-JN1-D (Japan Aviation Electronics Industry specification)
A66L-0001-0491	Fixed cable 50 m or less	

- Connector kit specification

<Crimp type>

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

<Solder type>

A06B-6114-K205/S: Straight plug
A06B-6114-K205/E: Elbow plug

See Appendix A, "CABLES", for detailed explanations about the cable.

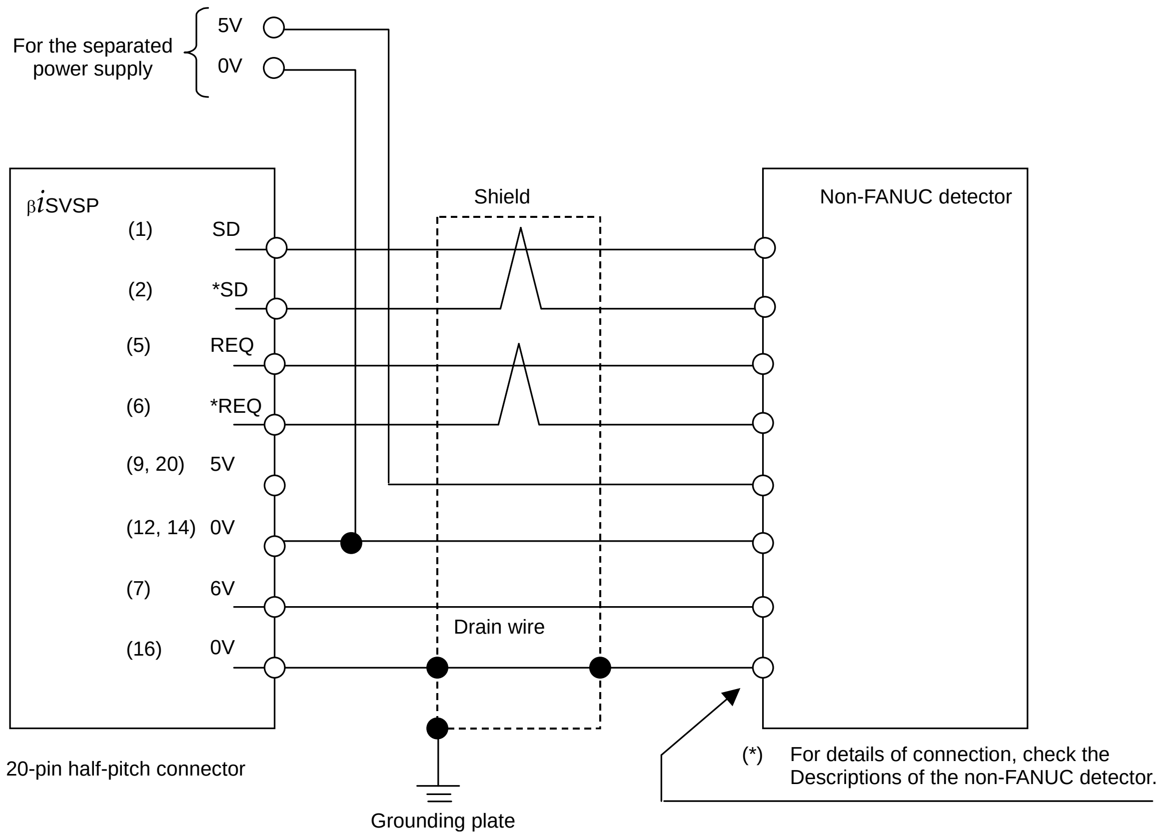
[For non-FANUC detector]

For a non-FANUC detector, power consumption of up to 0.35 A can be supplied from the servo amplifier β*i*SVSP. If power consumption of 0.35 A is exceeded, a separated power supply is required.

When using a separated power supply, note the following:

[Details of connection]

The separated power supply for the non-FANUC detector is required.



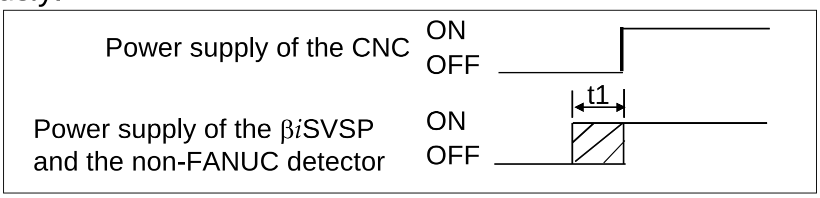
[Power on/off sequence]

(1) Power on sequence

Turn on the power to the CNC, β*i*SVSP, and non-FANUC detector at the same time or with the following sequence:

Turn on the power to the β*i*SVSP and the non-FANUC detector

Turn on the power to the CNC

> **NOTE**
>
> What it means to turn on the power simultaneously :
>
> If the power on timing below is met, the power is regarded to be turned on simultaneously.
>
> 
>
>
> t1: 200ms: Means that the power to the β*i*SVSP and the non-FANUC detector is turned on within 200 ms before the power to the CNC is turned on.

(2) Power off sequence

Turn on the power to the CNC, β*i*SVSP, and non-FANUC detector at the same time or with the following sequence:

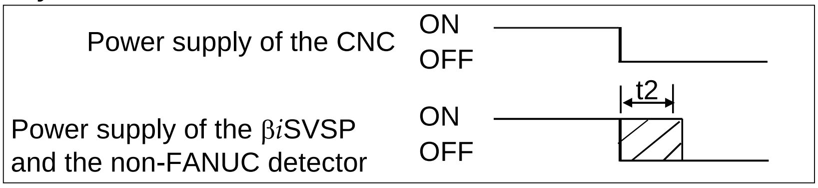
Turn off the power to the CNC

Turn off the power to the β*i*SVSP and the non-FANUC detector

NOTE

What it means to turn off the power simultaneously :

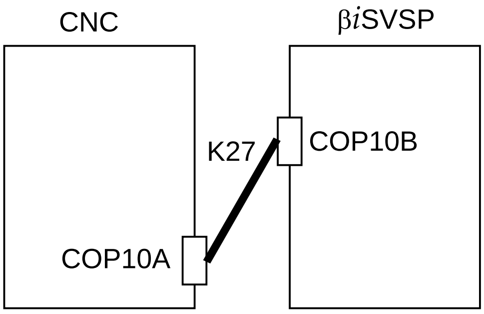
If the power off timing below is met, the power is regarded to be turned off simultaneously.



t2: 200ms: Means that the power to the β*i*SVSP and the non-FANUC detector is turned off within 200 ms after the power to the CNC is turned off.

9.3.2.3 Details of cable K27

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



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

9.3.2.4 Details of cable K28

The following two methods can be used to connect the batteries for the absolute Pulsecoder: [connection method 1] and [connection method 2]

NOTE

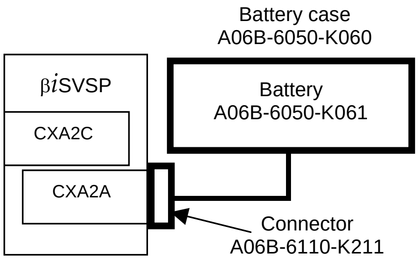
1 Since the battery is a part that is in need of periodic maintenance by nature, it is recommended to use [connection method 1]. In this case, commercial batteries (four R20 alkaline batteries), which are easy to purchase, can be used.

2 The built-in batteries used in [connection method 2] must be purchased directly from FANUC. It is recommended that spare built-in batteries is purchased. Do not use both [connection method 1] and [connection method 2] at the same time.

3 Otherwise, multiple batteries are connected to the same BATL(B3) line, and a short-circuit will occur between the output voltages of different batteries, possibly resulting in the batteries becoming very hot, which is dangerous.

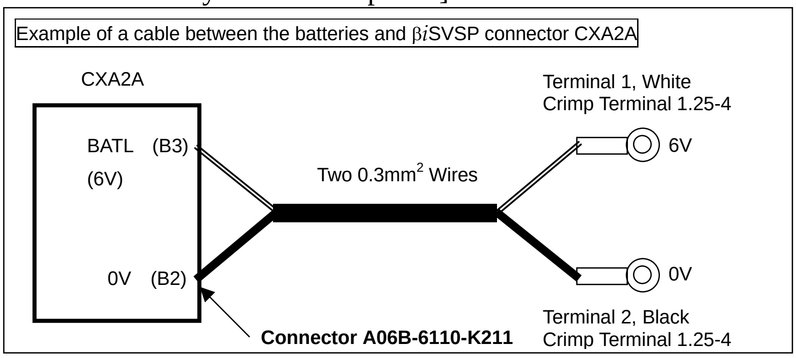
[Connection method 1]

(1) Supplying power from one battery unit to more than one βiSVSP (1)



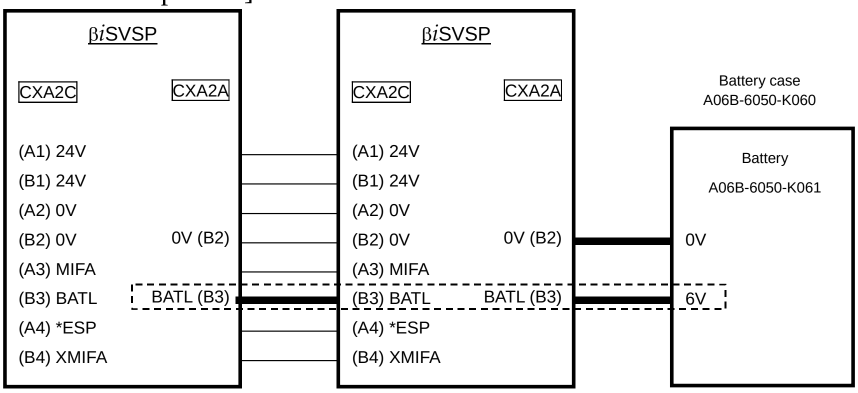
- A battery case (A06B-6050-K060) and four R20 alkaline batteries (A06B-6050-K061) are available as options. Commercial R20 alkaline batteries can also be used.

[Connection between the battery case and amplifier]



- A connector (A06B-6110-K211) for connecting batteries is available as an option.

[Connection between amplifiers]



- The BATL(B3) is an interface for supplying power from one absolute Pulsecoder battery unit to more than one βiSVSP.

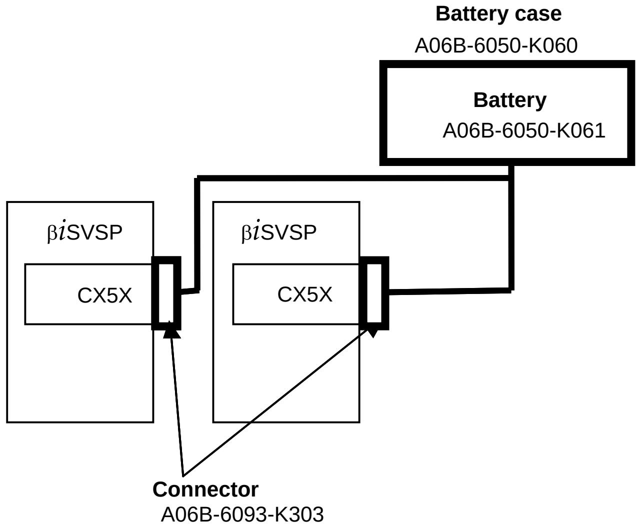
- Specification of the connector

Manufacturer	Tyco Electronics AMP
Connector specification	D-2100 series Housing : 1-1318119-4 (1 pcs.) Contact : 1318107-1 (4 pcs.) [Ordering information : A06B-6110-K210 connector only]
Conductor size	0.5mm^2, AWG20
Instruction outer diameter	1.08-2.83 mm

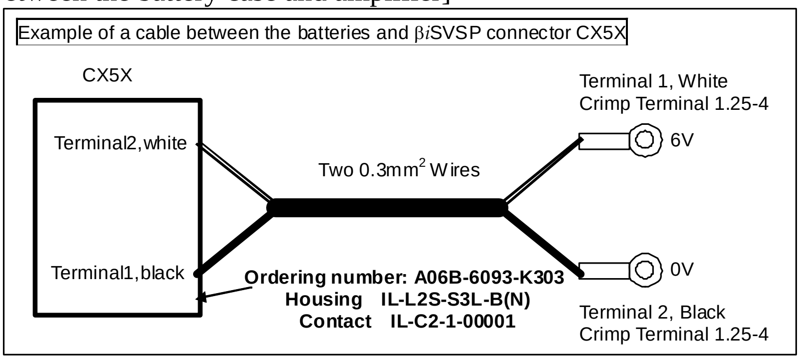
NOTE
1 Up to six servo motors can be connected to one battery.
2 The battery service life is about two years for the β*i* series servo motor or about one year for the β series servo motor.

⚠ **WARNING**
Do not connect more than one battery to the same BATL(B3) line. Otherwise, a short-circuit will occur between the output voltages of different batteries, possibly resulting in the batteries becoming very hot, which is dangerous.

(2) Supplying power from one battery unit to more than one β*i*SVSP (2)



[Connection between the battery case and amplifier]



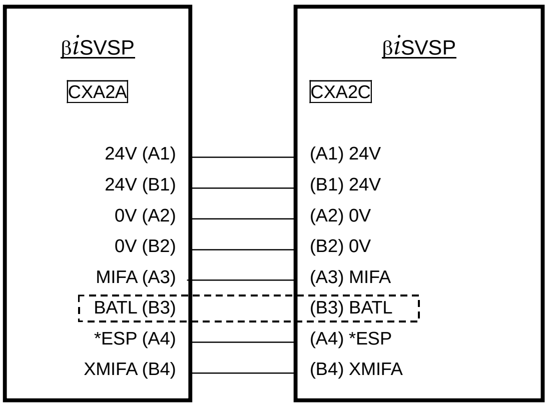
- Specification of the connector

Drawing No.	A06B-6093-K303
Manufacturer	Japan Aviation Electronics Industry
Manufacturer part number	Housing: IL-L2S-S3L-B(N), Quantity: 1 Contact: IL-C2-1-00001, Quantity: 2

To connect the contacts to the cable, a special crimping tool is required. Contact the manufacturer (Japan Aviation Electronics Industry Ltd.).

- A battery case (A06B-6050-K060) and four size-D alkaline dry cells (A06B-6050-K061) are available as options. Size-D alkaline dry cells are commercially available.

[Connection between amplifiers]

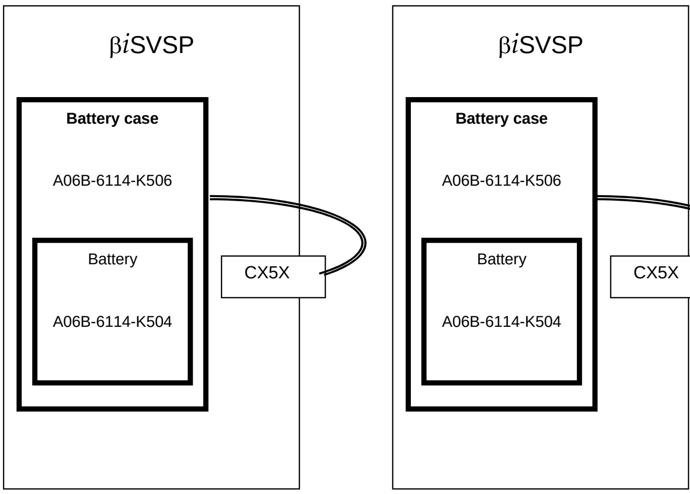


Leave BATL(B3) open.

NOTE
1 Up to six servo motors can be connected to one battery.
2 The battery service life is about two years for the β*i* series servo motor or about one year for the β series servo motor.

⚠ **WARNING**
Do not connect multiple batteries to the same BATL(B3) line.
Otherwise, a short-circuit will occur between the output voltages of different batteries, possibly resulting in the batteries becoming very hot, which is dangerous.

[Connection method 2]
(1) Incorporating built-in batteries in each β*i*SVSP



- Using the built-in battery (A06B-6114-K504) requires the battery case (A06B-6114-K505).

⚠ **WARNING**
1 When using the built-in battery, never connect the BATL(B3) of the connector CXA2A/CXA2C.
Otherwise, a short-circuit will occur between the output voltages of different β*i*SVSP batteries, possibly resulting in the batteries becoming very hot, which is dangerous.

⚠ **WARNING**

2 Do not connect more than one battery to the same BATL(B3) line. Otherwise, a short-circuit will occur between the output voltages of different batteries, possibly resulting in the batteries becoming very hot, which is dangerous.

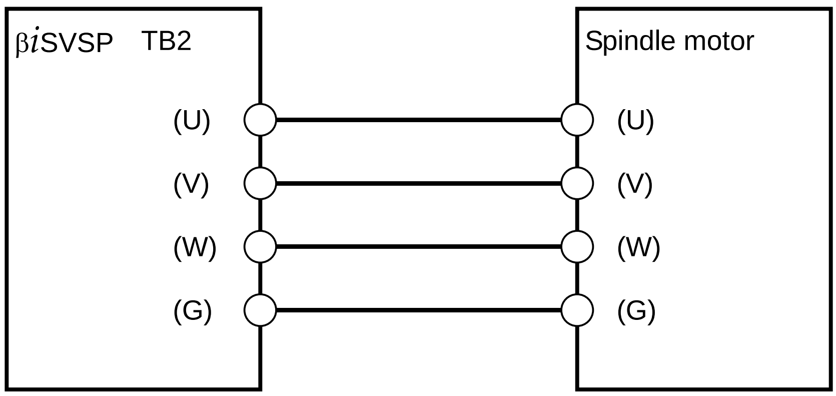
Battery life

When the β*i* series servo motor is used, the batteries need to be replaced periodically as follows:

Battery ordering specification	Standard backup life	Remark
A06B-6050-K061	2 years/6 axes	Size D alkaline dry cell × 4
A06B-6114-K504	1 year/3 axes	Lithium battery

9.3.3 Spindle Motor

9.3.3.1 Details of cable K10



Cables should be connected to the β*i*SVSP using crimp terminals as listed in the following table.

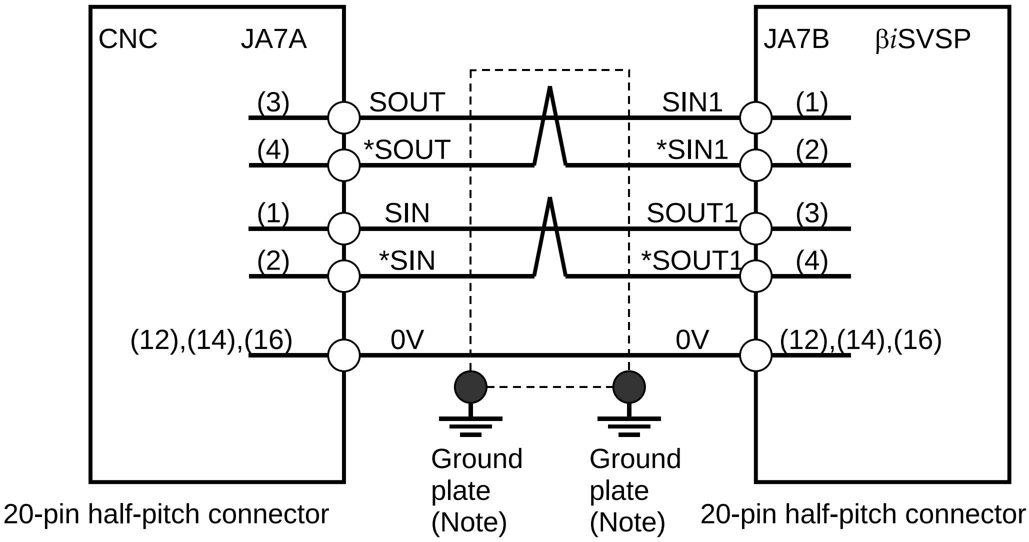
Terminal screw	Rigid torque
M5	2.0 to 2.5Nm

About the cable specification

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

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

9.3.3.2 Details of cable K12



Cable specification: 0.09mm^2 twisted pair with common shielded
Recommended cable (wire only) : A66L-0001-0284#10P
See Subsection 9.4.1, "20-Pin Half-Pitch Connectors" for details of connectors applied to recommended cable.

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

Connector pin assignment
JA7A and JA7B

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

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

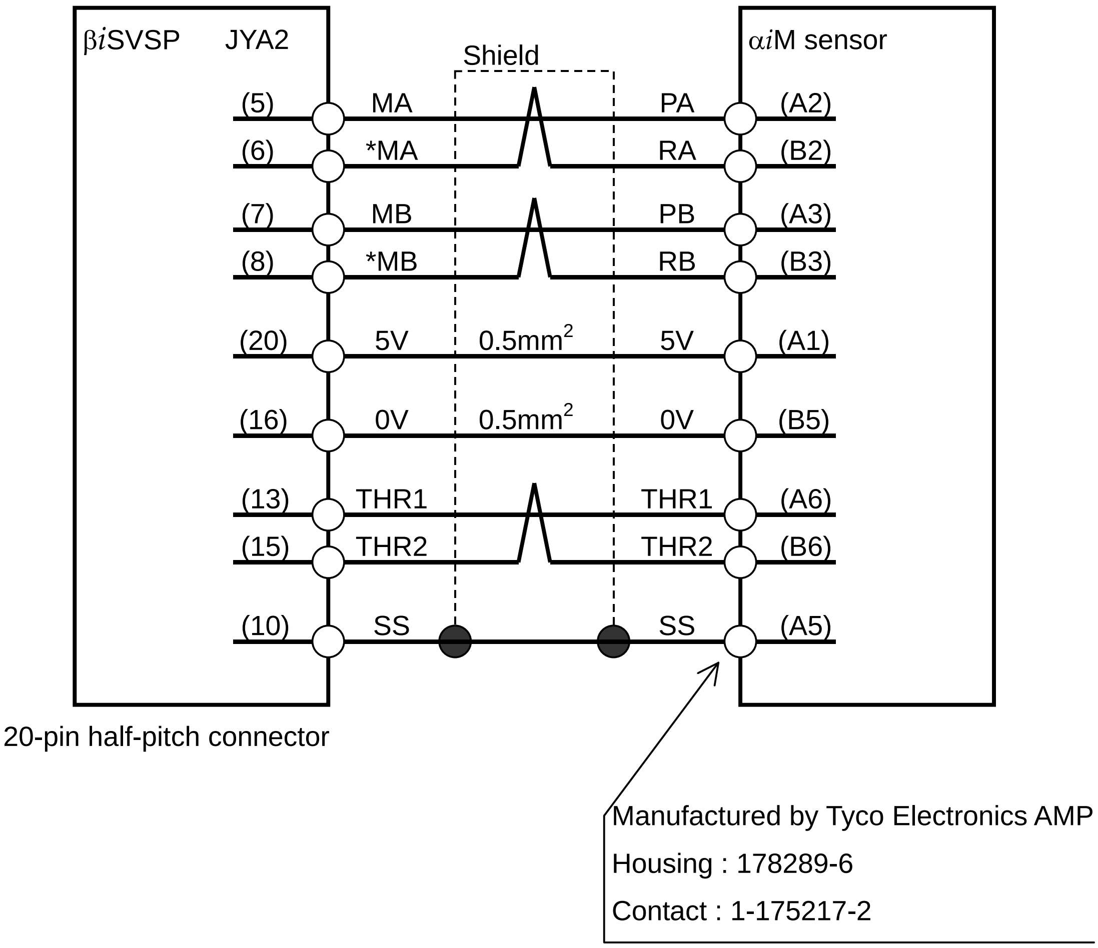
NOTE

2 β*i*SVSP serial interface connection using an optical fiber cable
The use of an optical I/O link adapter with the β*i*SVSP 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.

9.3.3.3 Details of cable K14

(1) For the motor with α*i*M sensor



Cable specification: 6 common shielded cable (Three 0.18mm^2 twisted pairs + 0.5mm^2 wires)
Recommended cable (wire only) : A66L-0001-0368
See Subsection 9.4.1, “20-Pin Half-Pitch Connectors” for explanations about the JYA2-side connector that matches the recommended cable.

NOTE

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

⚠ **WARNING**

If the feedback signal is connected incorrectly, an unpredictable motor operation may occur.

Connector pin assignment

JYA2

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

NOTE

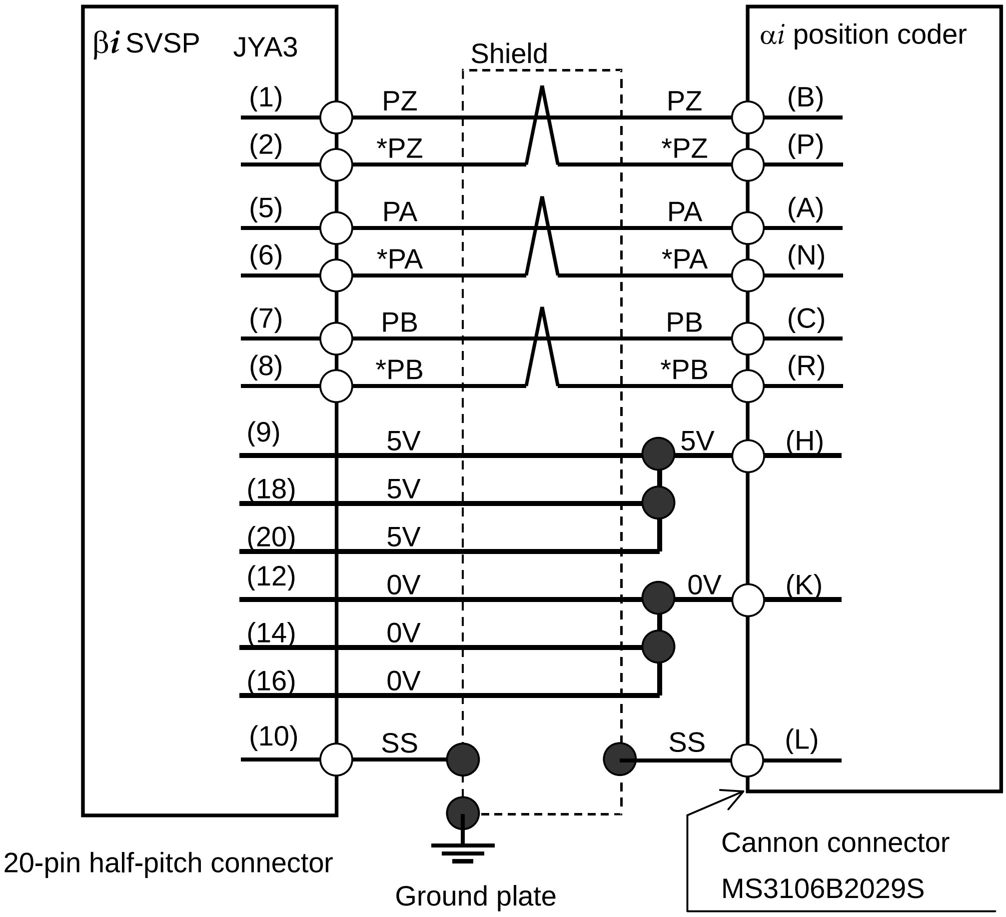
Do not use any pin that is marked #, because they may already be in use for input/output signals for an optional PCB.

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

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

9.3.3.4 Details of cable K16

[When an α*i* position coder is used]



Cable specification: 6 common shielded cable (Three 0.18mm^2 twisted pairs + 0.5mm^2 wires)
Recommended cable (wire only) : A66L-0001-0286
See Subsection 9.4.1, “20-Pin Half-Pitch Connectors” for explanations about the JYA3-side connector that matches the recommended cable.

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

Connector pin assignment

JYA3

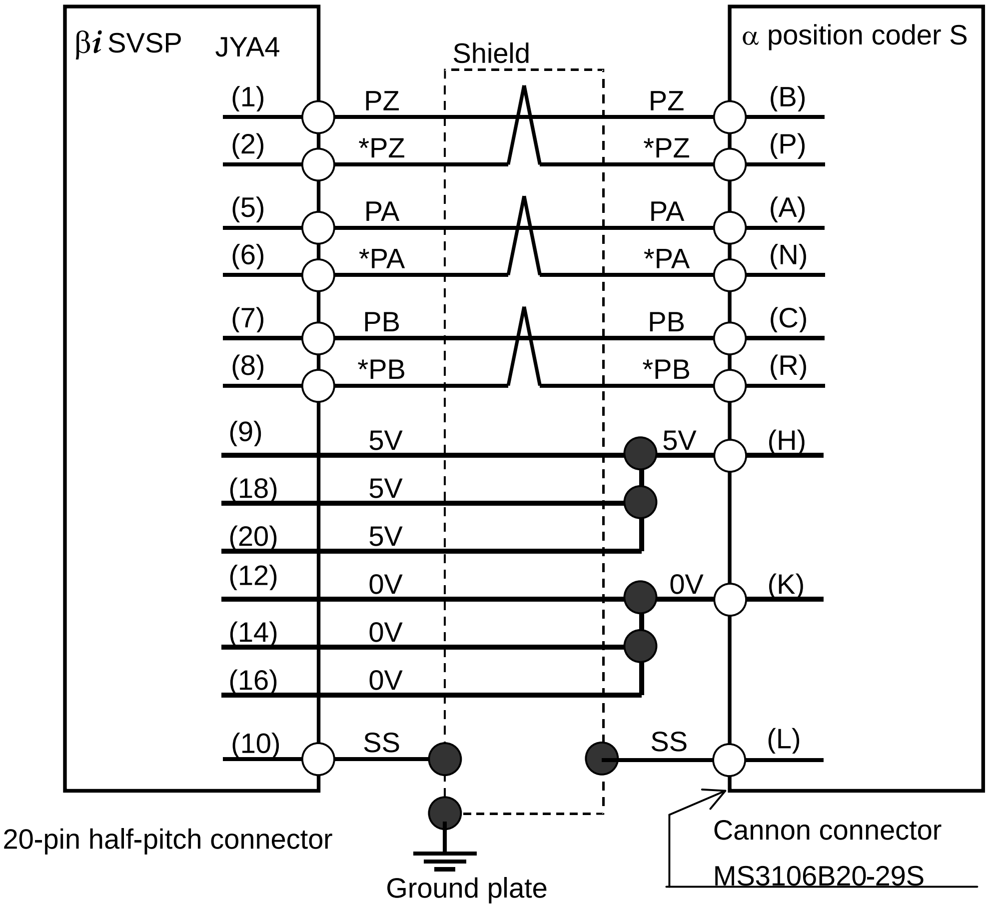
9	5V	10	#	19	#	20	5V
7	PB	8	*PB	17	#	18	5V
5	PA	6	*PA	15	EXTSC	16	0V
3	#	4	#	13	SCCOM	14	0V
1	PZ	2	*PZ	11	24V	12	0V

NOTE
Do not use any pin that is marked #.

Pin arrangement of the cannon connector on the position coder side

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

[When an α position coder S is used]



Cable specification: 6 common shielded cable (Three 0.18mm^2 twisted pairs + 0.5mm^2 wires)
Recommended cable (wire only) : A66L-0001-0286
Recommended connector : FI40B-2015S (Hirose Electric Co., Ltd.)

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

Connector pin assignment

JYA4

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

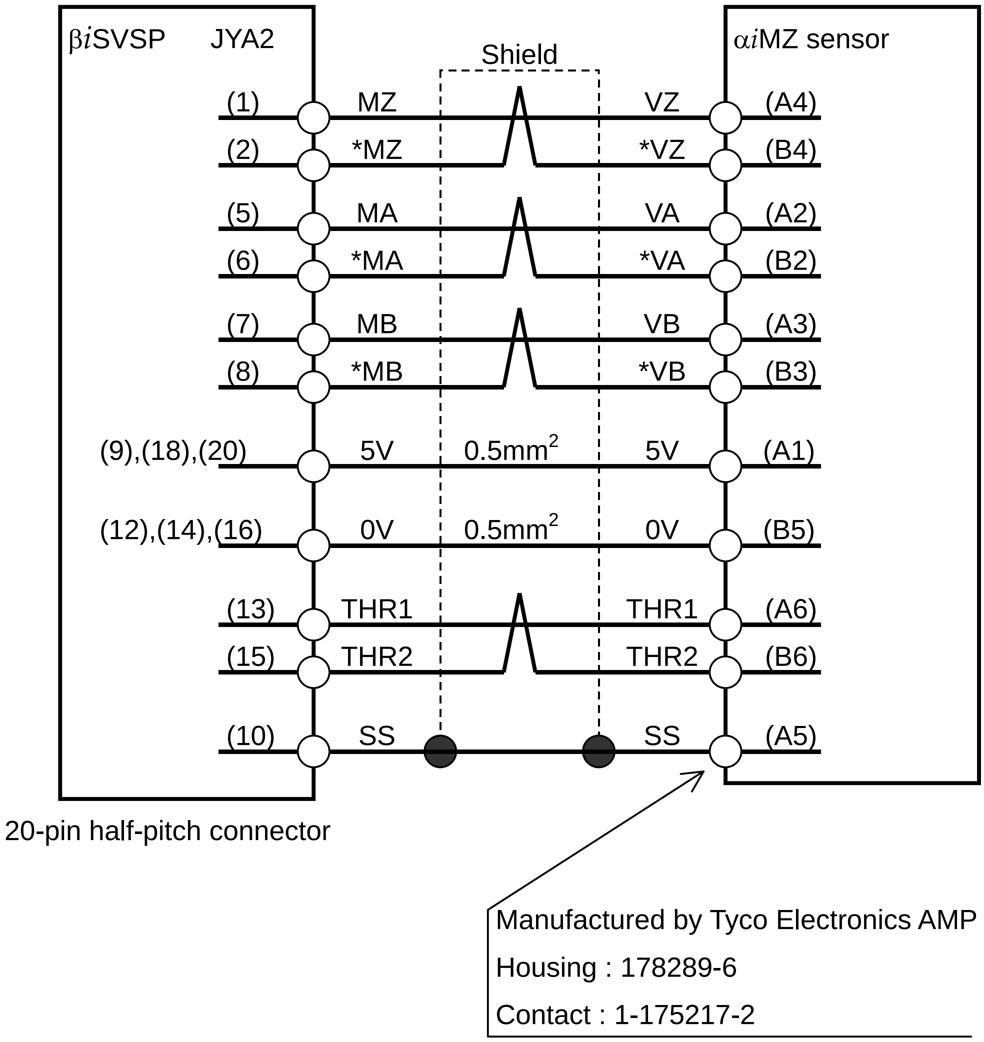
NOTE

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

9.3.3.5 Details of cable K17

It is unnecessary to wire THR1 and THR2 if the α*i* BZ sensor is used as a separate detector (connected to the connector JYA4).

(1) For the motor with α*i*MZ sensor



Cable specification: 6 common shielded cable (Four 0.18mm^2 twisted pairs + 0.5mm^2 wires)
Recommended cable (wire only) : A66L-0001-0368
See Subsection 9.4.1, "20-Pin Half-Pitch Connectors" for explanations about the JYA2-side connector that matches the recommended cable.

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

> ⚠ **WARNING**
> If the feedback signal is connected incorrectly, an unpredictable motor operation may occur.

Connector pin assignment

JYA2

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

JYA4

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

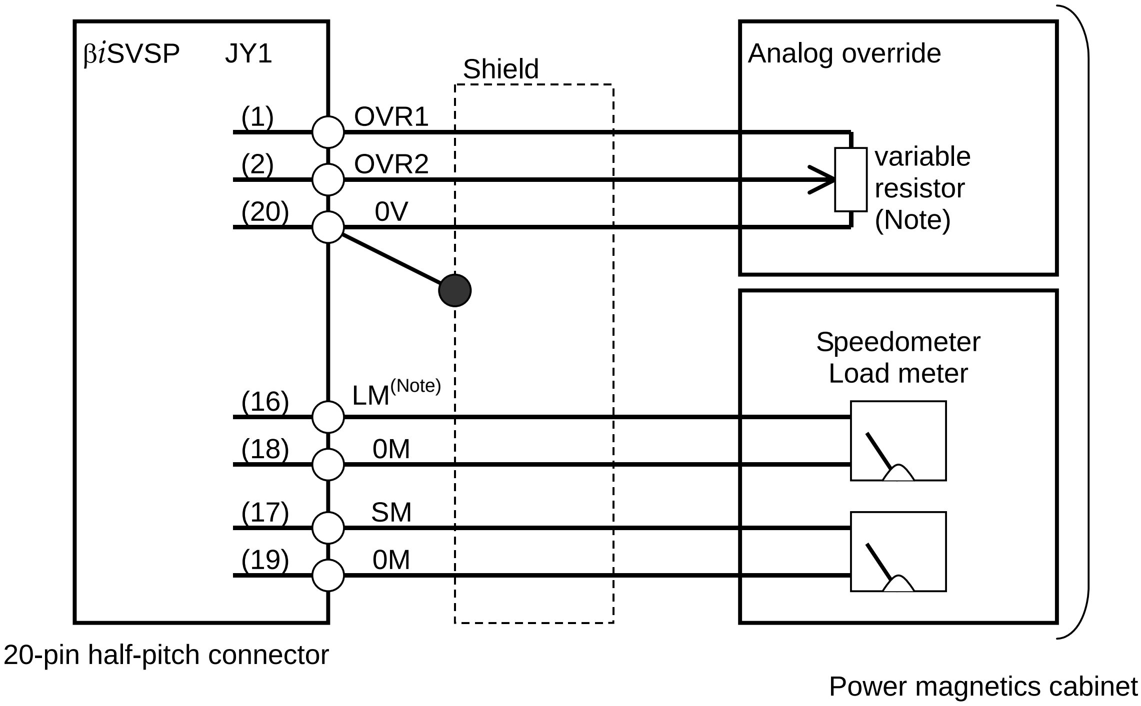
NOTE

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

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

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

9.3.3.6 Details of cable K33



Cable specification:0.09mm^2 common shielded cable
Recommended cable (wire only) : A66L-0001-0284#10P
See Subsection 9.4.1, “20-Pin Half-Pitch Connectors” for explanations about the JY1-side connector that matches the recommended cable.

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

Connector pin assignment
JY1

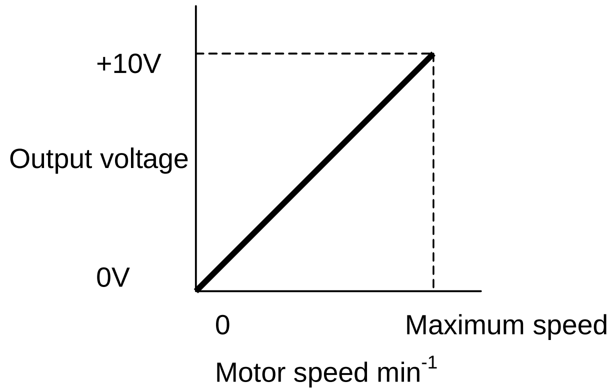
9	#	10	#	19	0M	20	0V
7	#	8	#	17	SM	18	0M
5	#	6	#	15	#	16	LM
3	#	4	#	13	#	14	#
1	OVR1	2	OVR2	11	#	12	#

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

Voltage signal for the speedometer (SM)

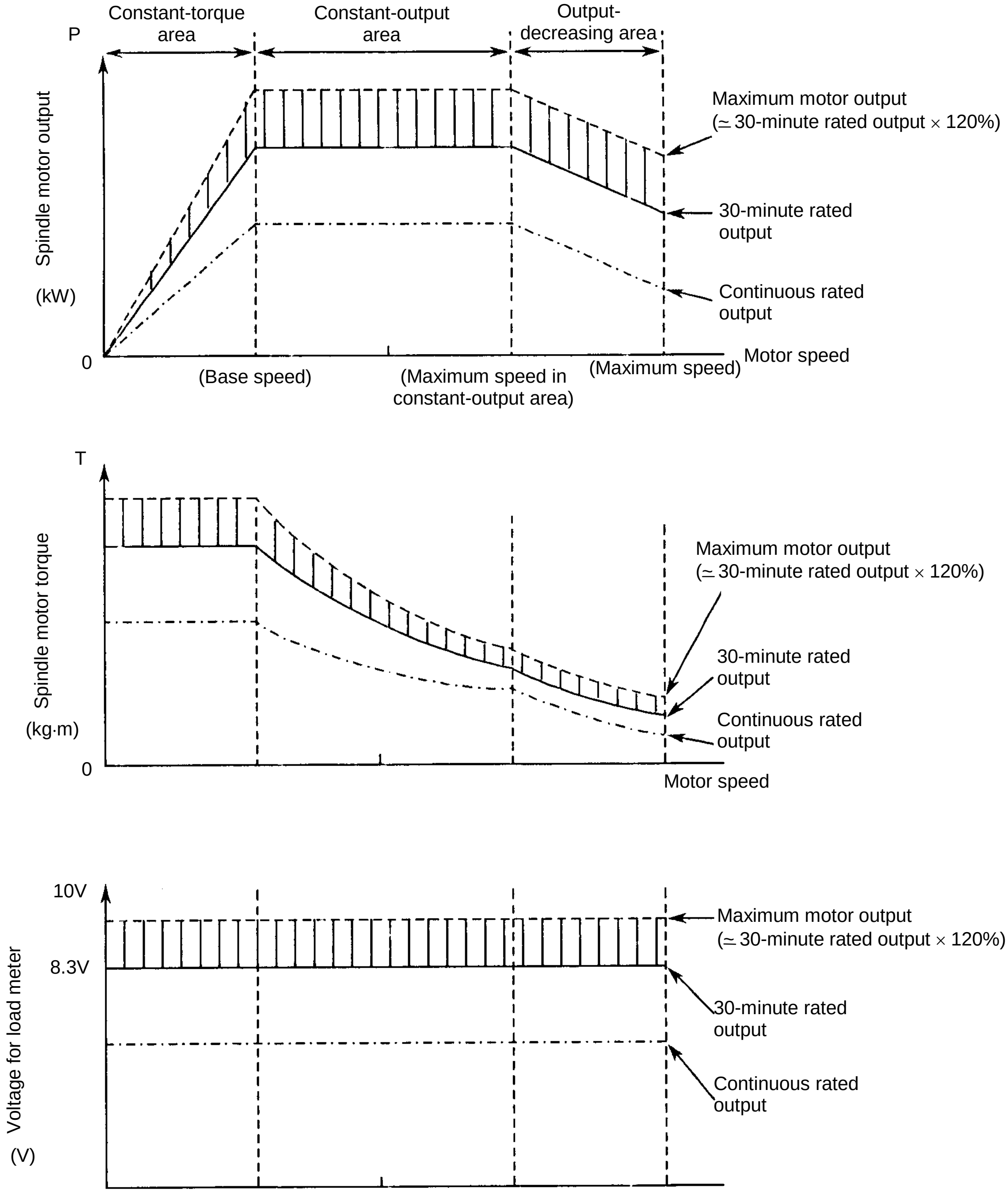
By externally connecting a tachometer, the speed of the spindle motor can be indicated. The voltage (DC) proportional to the speed (for the β*i*SVSPc model, an estimated speed) is output, regardless of the rotation direction of the motor. At the maximum motor speed, +10 V is output.

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



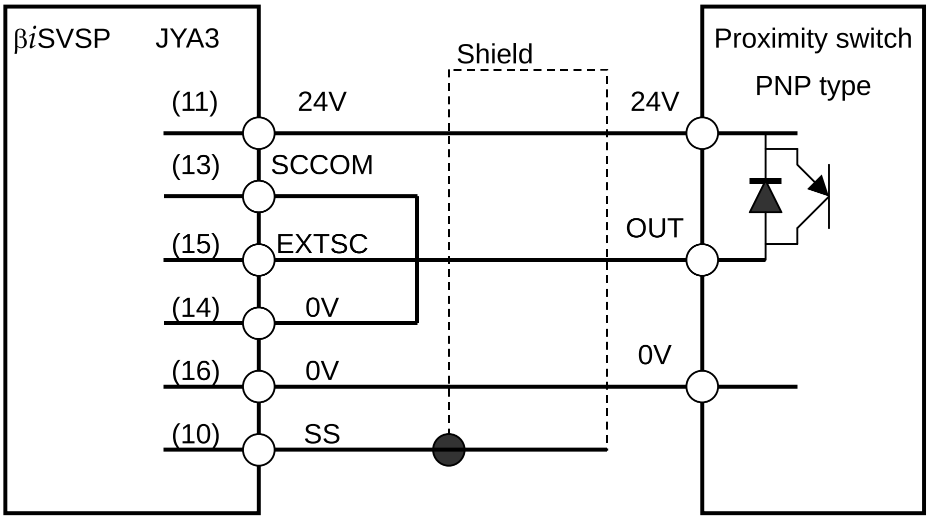
Voltage signal for the load meter (LM)

The load meter indicates a load ratio, that is, the ratio of load at the time of non-load rotation of the machine tool spindle or at the time of cutting to the maximum output of the spindle motor. At the rated input voltage, the relationships of spindle motor output, spindle motor torque, and voltage for the load meter with speed are as described in next page.

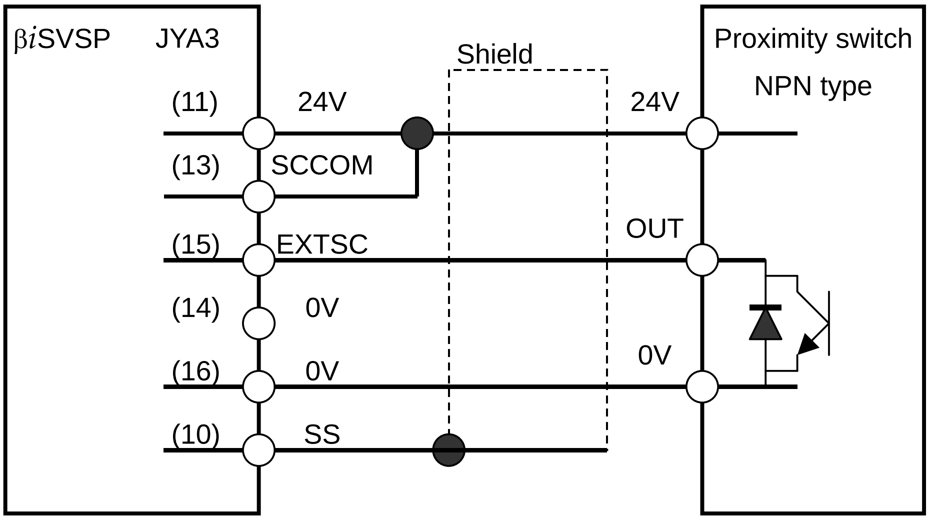


See FANUC AC SPINDLE MOTOR α*i* series DESCRIPTIONS (B-65272EN) and β*i*series DESCRIPTIONS (B-65312EN) for this item.

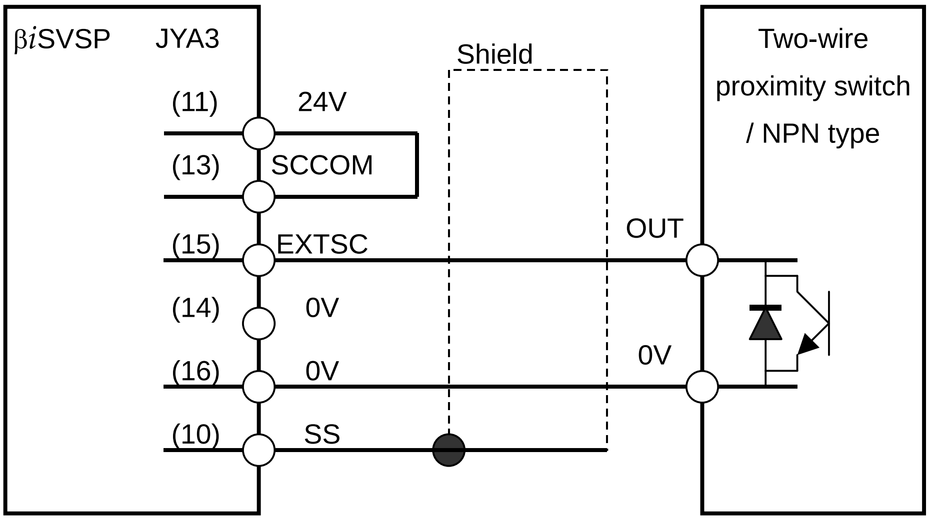
9.3.3.7 Details of cable K71



20-pin half-pitch connector



20-pin half-pitch connector



20-pin half-pitch connector

Cable specification:0.09mm^2 common shielded cable
Recommended cable (wire only) : A66L-0001-0284#10P
See Subsection 9.4.1, “20-Pin Half-Pitch Connectors” for explanations about the JYA3-side connector that matches the recommended cable.

Connector pin assignment
See Subsection 9.3.3.4, “Details of cable K16”.

External one-rotation signal switch (proximity switch)

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

(a) DC two-wire proximity switch

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

(b) DC three-wire proximity switch

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

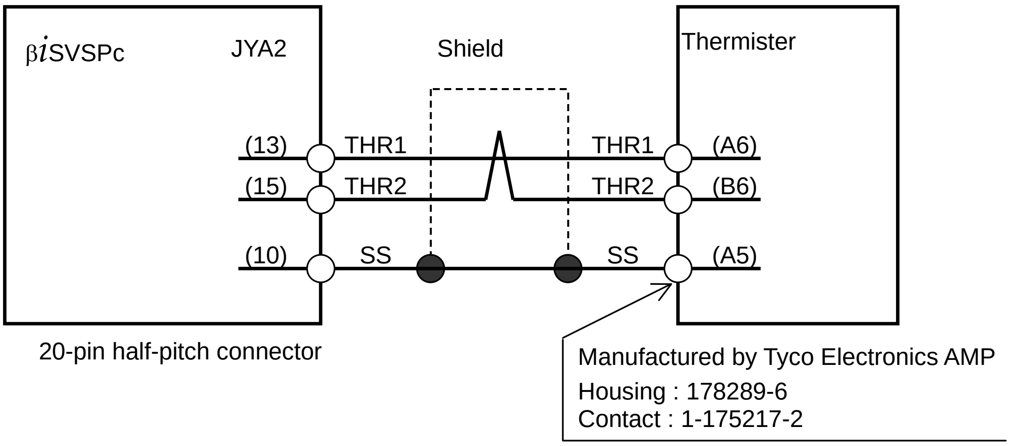
NOTE
The location where a proximity switch signal occurs depends on the temperature. So, consider the ambient temperature when selecting a proximity switch.

Input signal specification (EXTSC input section)

Item	Specification
High level	20V or higher
Low level	4V or lower
Minimum signal width	100 us

NOTE
In design, the width of the signal to be detected should have a sufficient margin by considering variations in proximity switch on/off time.

9.3.3.8 Details of cable K79

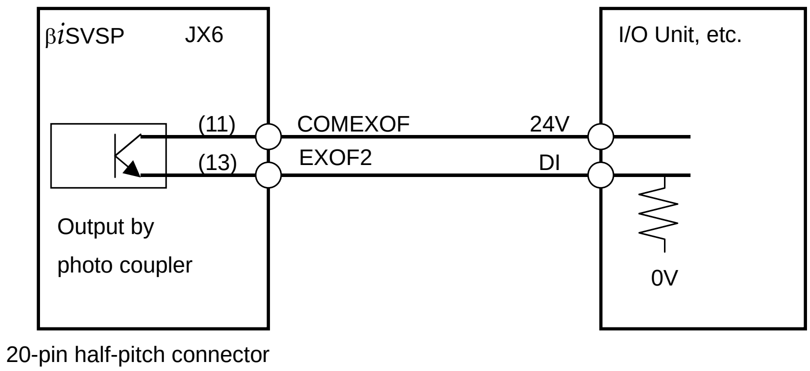


Cable specification: Common shielded cable (One $0.18mm^2$ twisted pairs + $0.5mm^2$ wires)
Recommended cable (wire only) : A66L-0001-0368

9.3.3.9 Details of cable K96

This signal is used to externally monitor the excitation status of the spindle amplifier and implement a safety circuit for the safety spindle stop function of dual check safety.

For how to configure a safety circuit with this signal, refer to the Series 0*i* -MODEL D Dual Check Safety CONNECTION MANUAL (B-64303EN-4).

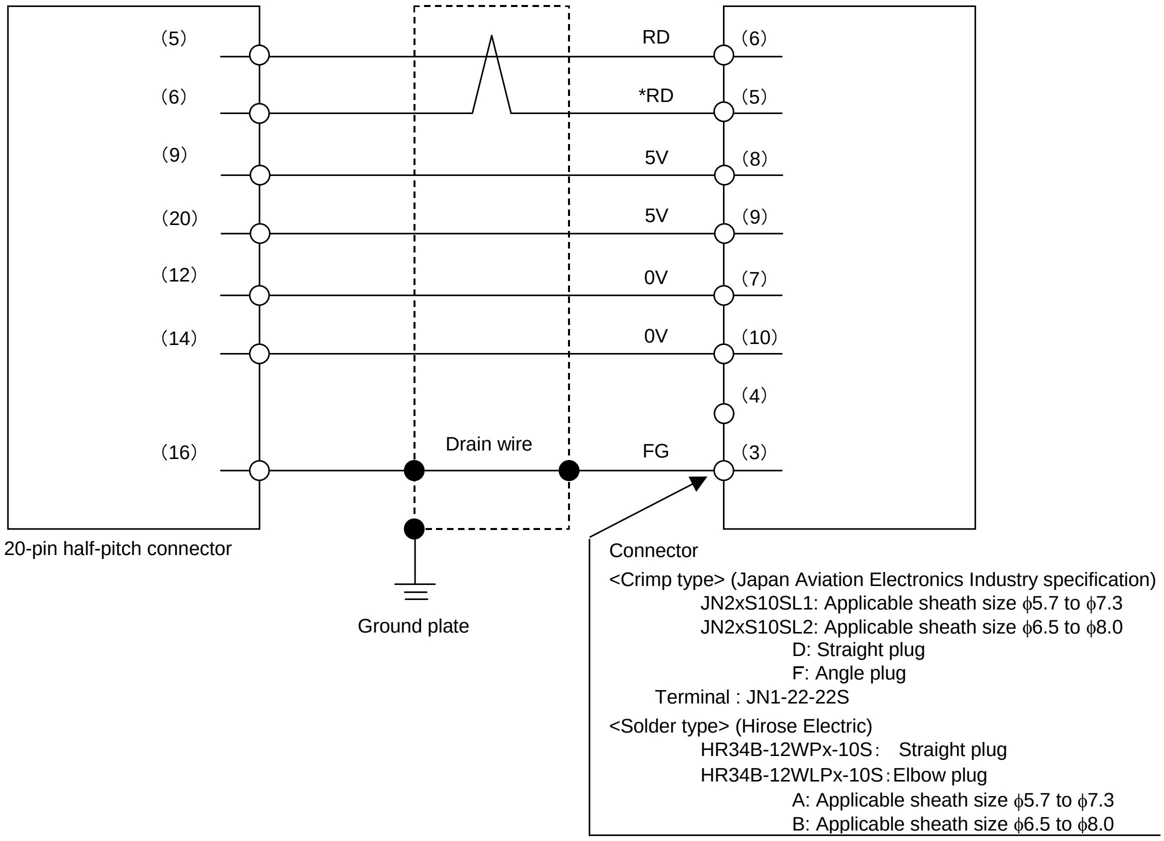


SP contact output specifications
- Circuit type: Polar photo coupler
- Rated voltage: 30 VDC or less
- Output current: DC 40 mA or less
- Saturation voltage: 1.5 V or less (at output current of 40 mA)

Open contact: Excitation on
Closed contact: Excitation off

> ⚠ **CAUTION**
> If the connector is connected incorrectly, externally supplied 24VDC can damage the internal circuit of the βiSVSP.
> This function is not provided in A06B-6167-H***＃H560.

9.3.3.10 Details of cable K97



Using cable conductor

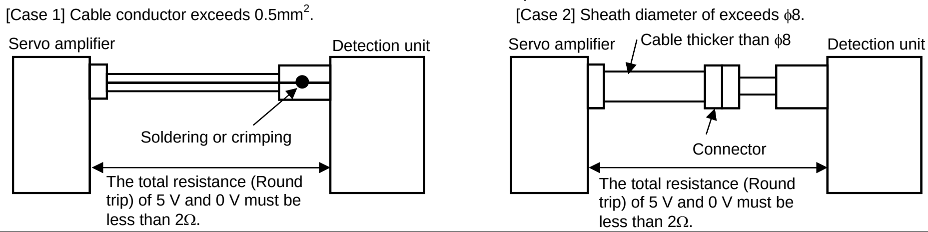
Signal name	Cable length: 28 m or less	Cable length: 50 m or less
5V, 0V, 6V	0.3mm^2 x 5 Strand configuration: 12/0.18 or 60/0.08 Insulation outer diameter: diameter 1.5 or less	0.5mm^2 x 5 Strand configuration: 20/0.18 or 104/0.08 Insulation outer diameter: diameter 1.5 or less
RD, *RD	0.18mm^2 or more Twisted-pair wire Insulation outer diameter: diameter 1.5 or less	0.18mm^2 or more Twisted-pair wire Insulation outer diameter: diameter 1.5 or less
Drain wire	0.15mm^2 or more	0.15mm^2 or more

NOTE

1. The ground plate to which the shield is connected must be placed near the βiSVSP to minimize the distance between the βiSVSP and the ground plate.
2. Run the power line and signal line so that they are not in parallel.
3. When the customer prepares the cable, the total wire resistance of 5 V and 0 V must be 2 Ω or less.

NOTE

4 The maximum wire thickness applicable to the connector on the detection circuit side is 0.5 mm^2 (strand configuration: 20/0.18 or 104/0.08, insulation outer diameter: 15 or less), and the sheath is 5.7 to 8.0 in diameter. When using a wire or cable thicker than the above size is used, take measures as shown below.



- Crimp tool specification

FANUC specification	Japan Aviation Electronics Industry specification	Applicable cable thickness
A06B-6114-K201#JN1E	CT150-2-JN1-E	21AWG(0.5mm^2:20/0.18) 23AWG(0.3mm^2) 25AWG(0.18mm^2)
A06B-6114-K201#JN1D	CT150-2-JN1-D	20AWG(0.5mm^2:104/0.08) 21AWG(0.5mm^2:20/0.18) 25AWG(0.18mm^2)

- Extractor specification
  A06B-6114-K201/JN1R

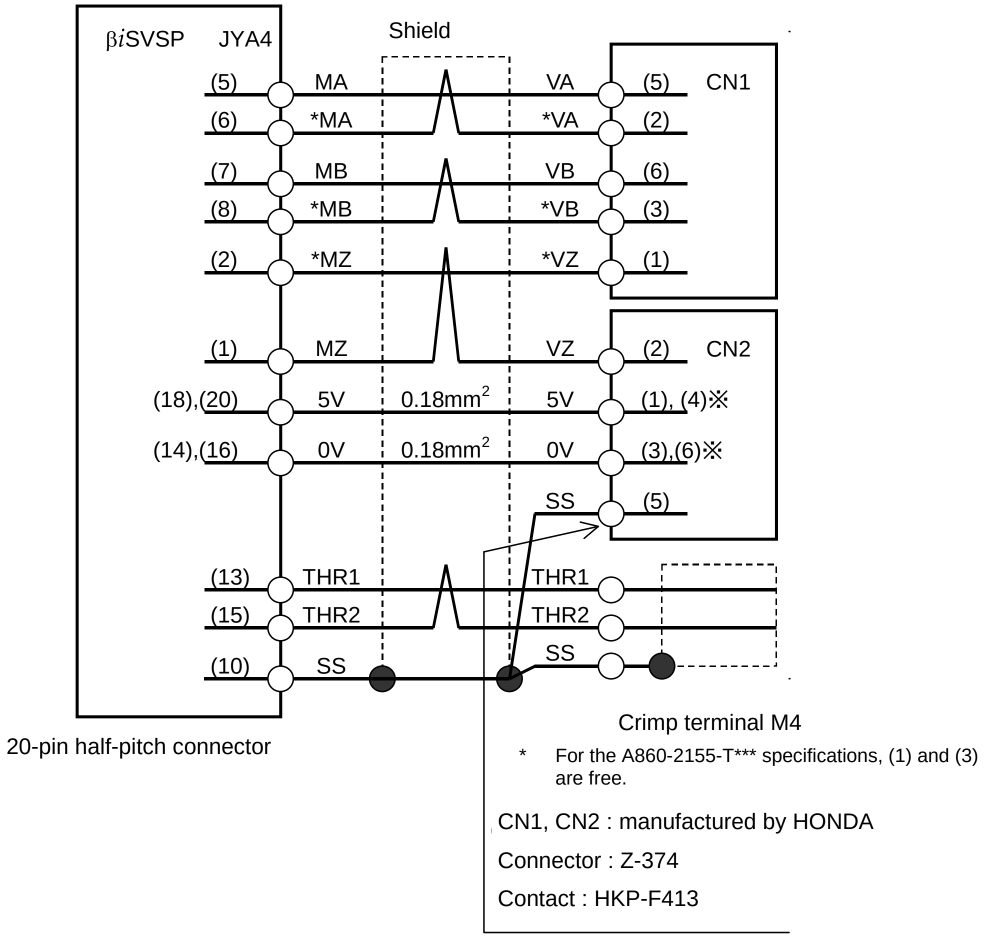
- Recommended cable

Recommended cable specification	Description	Crimp tool specification
A66L-0001-0460	Flexible cable 28 m or less	A06B-6114-K201#JN1E (FANUC specification) CT150-2-JN1-E (Japan Aviation Electronics Industry specification)
A66L-0001-0481	Fixed cable 28 m or less	
A66L-0001-0462	Flexible cable 50 m or less	A06B-6114-K201#JN1D (FANUC specification) CT150-2-JN1-D (Japan Aviation Electronics Industry specification)
A66L-0001-0491	Fixed cable 50 m or less	

- Connector kit specification
  <Crimp type>
  A06B-6114-K204#S: Straight plug (including a contact)
  A06B-6114-K204#E: Elbow plug (including a contact)
  <Solder type>
  A06B-6114-K205#S: Straight plug
  A06B-6114-K205#E: Elbow plug

9.3.3.11 Details of cable K103

(1) αiBZ Sensor (conventional shape, A860-2120-T***) and αiBZ sensor (compact type, A860-2155-T***)



Cable specification: 4 common shielded cable (Four 0.18mm^2 twisted pairs + 0.18mm^2 wires)
Recommended cable (wire only) : A66L-0001-0367

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

Pin arrangement of the connector CN1 (manufactured by Honda Tsushin Kogyo Co., Ltd.) on the motor side

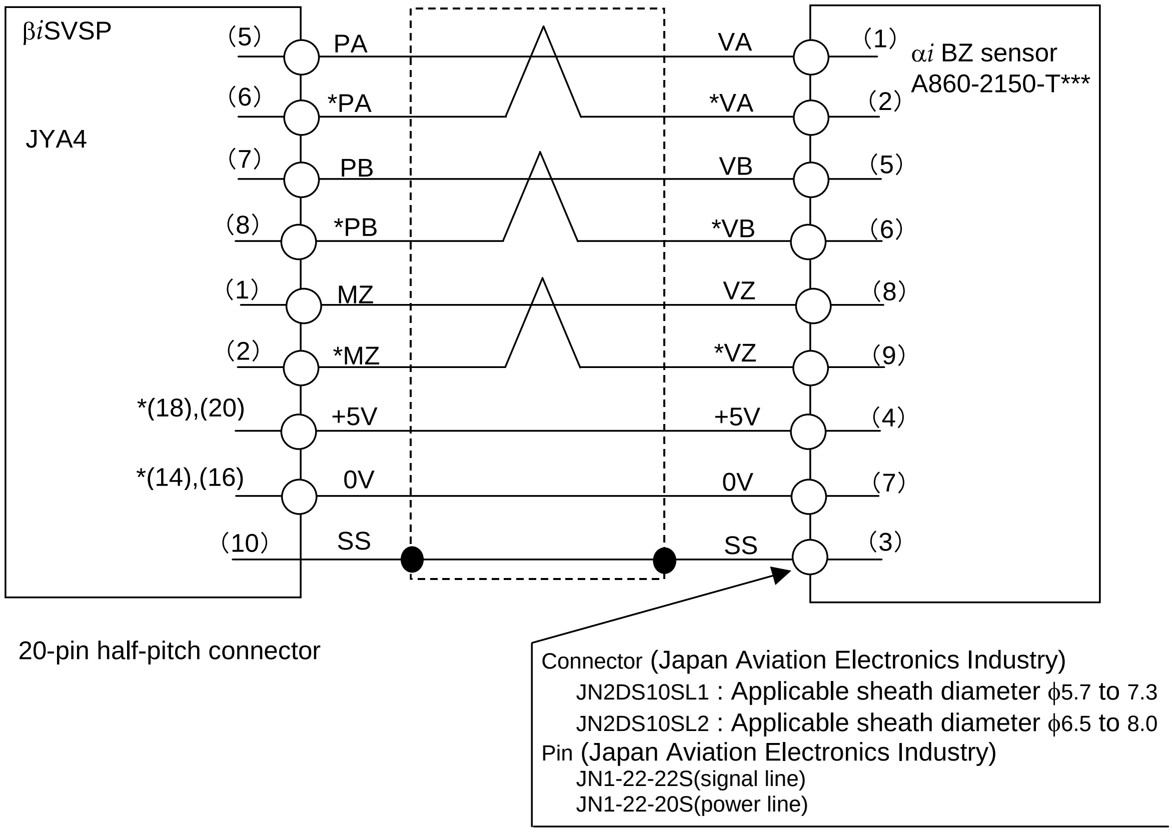
1	*VZ	4	
2	*VA	5	VA
3	*VB	6	VB

Pin arrangement of the connector CN2 (manufactured by Honda Tsushin Kogyo Co., Ltd.) on the motor side

1	5V	4	5V
2	VZ	5	SS
3	0V	6	0V

For A860-2155-T*** specification, pins 1 and 3 of CN2 are left open.

(2) α*i*BZ sensor (compact type, A860-2150-T***)



Recommended cable conductor: A66L-0001-0482

Cable length	28m max.
5V, 0V	0.3mm^2 (Connected to one of the pins marked *)
VA,*VA,VB,*VB,VZ,*VZ	0.2mm^2 twisted pair × 3

Crimp tool specification

A06B-6114-K201/JN1E : For 0.3mm^2

A06B-6114-K201/JN1D : For 0.18mm^2 and 0.5mm^2

Connector kit specification

A06B-6114-K204/S : Straight plug (including a contact)

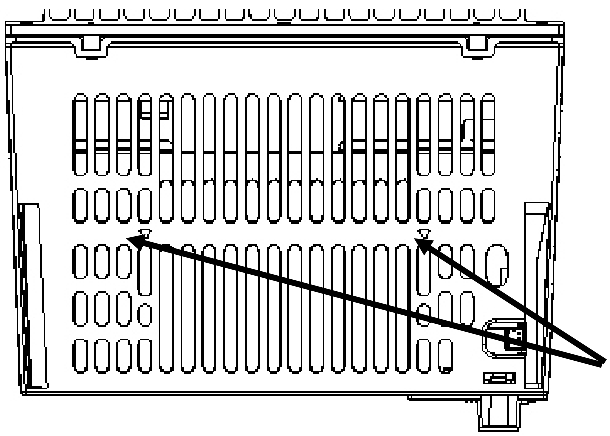
Connector pin assignment

Sensor head side: Connector manufactured by Japan Aviation Electronics Industry

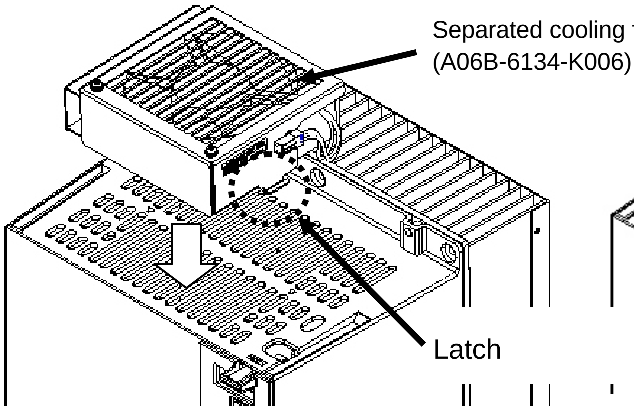
1	VA
2	*VA
3	SS
4	5V
5	VB
6	*VB
7	0V
8	VZ
9	*VZ
10	

9.3.3.12 Details of cable K104

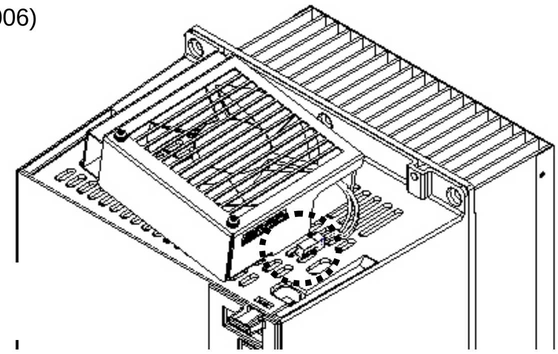
Cable K104 is used to connect the separated cooling fan motor to be installed with the βiSVSP*-18.



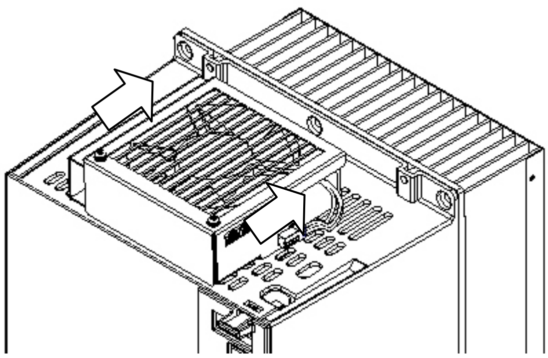
βiSVSP top view



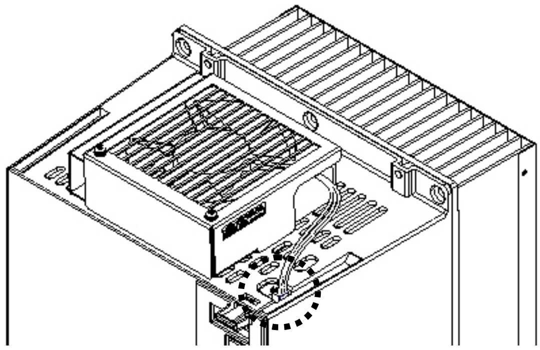
(a) Mount a separated cooling fan motor at the mounting position.



(b) First mount the latch of the separated cooling fan motor.



(c) Mount the opposite side, too, and fully insert the separated cooling fan motor.



(d) Connect the connector of the separated cooling fan motor to the connector of the amplifier.

Mounting a separated cooling fan motor (for cooling the inside of the amplifier)

9.4 DETAILS OF CONNECTORS

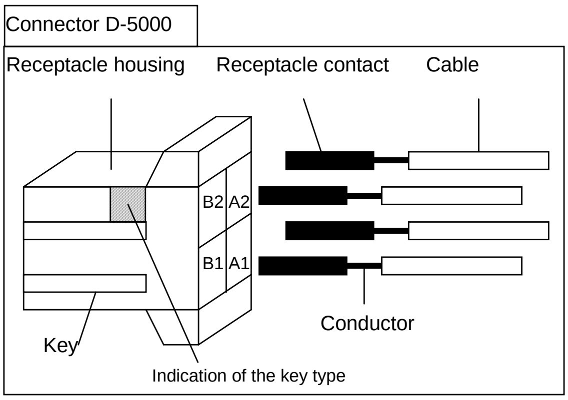
9.4.1 20-pin Half-pitch Connectors

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

Recommended cable specification	Applicable connector	Connector model number	Housing model number	Connector + housing
A66L-0001-0460 A66L-0001-0462 A66L-0001-0481 A66L-0001-0491	Soldering type Note that this connector does not have pin No. 11, 13, 15, 17, or 19.	Hirose Electric Co., Ltd. FI40B-2015S	Sideways cable slot type FI-2015-CVS	Sideways cable slot type FI40B-2015S-CVS

9.4.2 Tyco Electronics AMP D-5000 Series Connector

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



[Receptacle housing]

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

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

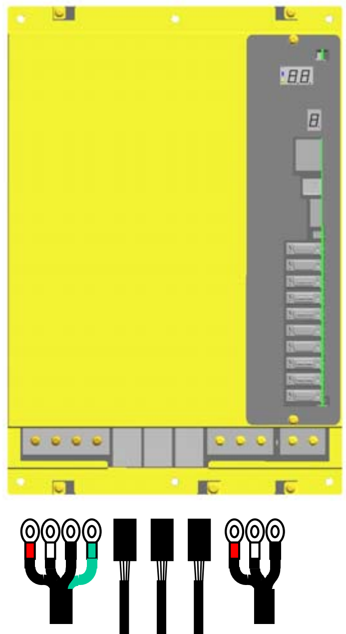
(Reference)

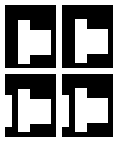
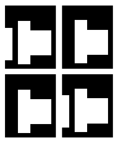
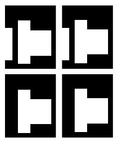
There is a cable-end connectors which are inserted no matter what key is used. Contact the connector manufacturer (Tyco Electronics AMP) for details.

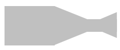
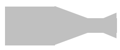
[Receptacle contact]

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

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



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

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

10 HEAT DISSIPATION

The amount of heat generated in a servo amplifier β*i*SVSP series varies depending on its model, the current flowing through the motor, and the motor output. (Refer to the respective motor description manuals for the current and output of each motor.)

10.1 TOTAL AMOUNT OF HEAT DISSIPATION

10.1.1 β*i*SVSP and β*i*SVSPc

The total amount of heat dissipation by the servo amplifier β*i*SVSP series is calculated according to the following expression:

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

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

Name	Specification	a [W]	Coefficient [W/Arms]		
			Ka*	Servo axis HRV2	Servo axis HRV3
β*i*SVSP 20/20-7.5	A06B-6164-H201#H580	31	Ka1	10.3	
			Ka2	4.2	
			Ka3	5.0	6.5
			Ka4	5.0	6.5
β*i*SVSP 20/20-11	A06B-6164-H202#H580	31	Ka1	10.3	
			Ka2	4.0	
			Ka3	5.0	6.5
			Ka4	5.0	6.5
β*i*SVSP 40/40-15	A06B-6164-H223#H580	31	Ka1	10.2	
			Ka2	4.2	
			Ka3	4.6	5.9
			Ka4	4.6	5.9
β*i*SVSP 40/40-18	A06B-6164-H224#H580	31	Ka1	10.2	
			Ka2	4.2	
			Ka3	4.6	5.9
			Ka4	4.6	5.9
β*i*SVSP 80/80-18	A06B-6164-H244#H580	31	Ka1	10.2	
			Ka2	4.2	
			Ka3	4.3	5.8
			Ka4	4.3	5.8
β*i*SVSP 20/20/40-7.5	A06B-6164-H311#H580	32	Ka1	10.3	
			Ka2	4.2	
			Ka3	5.0	6.5
			Ka4	5.0	6.5
			Ka5	4.6	5.9

Name	Specification	a [W]	Coefficient [W/Arms]		
			Ka*	Servo axis HRV2	Servo axis HRV3
βiSVSP 20/20/40-11	A06B-6164-H312#H580	32	Ka1	10.3	
			Ka2	4.0	
			Ka3	5.0	6.5
			Ka4	5.0	6.5
			Ka5	4.6	5.9
βiSVSP 40/40/40-15	A06B-6164-H333#H580	32	Ka1	10.2	
			Ka2	4.2	
			Ka3	4.6	5.9
			Ka4	4.6	5.9
			Ka5	4.6	5.9
βiSVSP 40/40/80-15	A06B-6164-H343#H580	32	Ka1	10.2	
			Ka2	4.2	
			Ka3	4.6	5.9
			Ka4	4.6	5.9
			Ka5	4.3	5.8
βiSVSP 40/40/80-18	A06B-6164-H344#H580	32	Ka1	10.2	
			Ka2	4.2	
			Ka3	4.6	5.9
			Ka4	4.6	5.9
			Ka5	4.3	5.8
βiSVSP 80/80/80-18	A06B-6164-H364#H580	32	Ka1	10.2	
			Ka2	4.2	
			Ka3	4.3	5.8
			Ka4	4.3	5.8
			Ka5	4.3	5.8
βiSVSPc 20/20-7.5	A06B-6167-H201#H560	31	Ka1	10.3	
			Ka2	4.2	
			Ka3	5.0	6.5
			Ka4	5.0	6.5
βiSVSPc 20/20-7.5L	A06B-6167-H209#H560	31	Ka1	10.3	
			Ka2	4.2	
			Ka3	5.0	6.5
			Ka4	5.0	6.5
βiSVSPc 20/20-11	A06B-6167-H202#H560	31	Ka1	10.3	
			Ka2	4.0	
			Ka3	5.0	6.5
			Ka4	5.0	6.5
βiSVSPc 20/20/20-7.5	A06B-6167-H301#H560	32	Ka1	10.3	
			Ka2	4.2	
			Ka3	5.0	6.5
			Ka4	5.0	6.5
			Ka5	5.0	6.5
βiSVSPc 20/20/20-7.5L	A06B-6167-H309#H560	32	Ka1	10.3	
			Ka2	4.2	
			Ka3	5.0	6.5
			Ka4	5.0	6.5
			Ka5	5.0	6.5
βiSVSPc 20/20/20-11	A06B-6167-H302#H560	32	Ka1	10.3	
			Ka2	4.0	
			Ka3	5.0	6.5
			Ka4	5.0	6.5
			Ka5	5.0	6.5

10.1.2 AC Reactor

The total amount of heat dissipation of each AC reactor used for the servo amplifier β*i*SVSP series is listed below.

Name	Ordering number	Rated output	Total amount of heat dissipation
β*i*SVSP 20/20-7.5 β*i*SVSP 20/20/40-7.5	A81L-0001-0155	7.5kW	26W
β*i*SVSP 20/20-11 β*i*SVSP 20/20/40-11		11kW	38W
β*i*SVSP 40/40-15 β*i*SVSP 40/40/40-15 β*i*SVSP 40/40/80-15	A81L-0001-0156	15kW	50W
β*i*SVSP 40/40-18 β*i*SVSP 80/80-18 β*i*SVSP 40/40/80-18 β*i*SVSP 80/80/80-18	A81L-0001-0157	24.5kW	70W

Name	Ordering number	Rated output	Total amount of heat dissipation
β*i*SVSPc 20/20-7.5 β*i*SVSPc 20/20-7.5L β*i*SVSPc 20/20/20-7.5 β*i*SVSPc 20/20/20-7.5L	A81L-0001-0155	7.5kW	26W
β*i*SVSPc 20/20-11 β*i*SVSPc 20/20/20-11		11kW	38W

10.2 RESIDUAL AMOUNT OF HEAT IN THE CABINET

By placing the heat sink section of servo amplifier β*i*SVSP series outside the cabinet, the residual amount of heat in the cabinet can be calculated according to the expression below.

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

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

Name	Ordering number	a [W]	Coefficient [W/Arms]		
			Ka*	Servo axis HRV2	Servo axis HRV3
β*i*SVSP 20/20-7.5	A06B-6164-H201#H580	31	Ka1	1.55	
			Ka2	0.63	
			Ka3	0.75	0.98
			Ka4	0.75	0.98
β*i*SVSP 20/20-11	A06B-6164-H202#H580	31	Ka1	1.03	
			Ka2	0.4	
			Ka3	0.5	0.65
			Ka4	0.5	0.65
β*i*SVSP 40/40-15	A06B-6164-H223#H580	31	Ka1	0.72	
			Ka2	0.3	
			Ka3	0.32	0.42
			Ka4	0.32	0.42
β*i*SVSP 40/40-18	A06B-6164-H224#H580	31	Ka1	1.02	
			Ka2	0.42	
			Ka3	0.46	0.59
			Ka4	0.46	0.59
β*i*SVSP 80/80-18	A06B-6164-H244#H580	31	Ka1	1.02	
			Ka2	0.42	
			Ka3	0.43	0.58
			Ka4	0.43	0.58
β*i*SVSP 20/20/40-7.5	A06B-6164-H311#H580	32	Ka1	1.03	
			Ka2	0.42	
			Ka3	0.5	0.65
			Ka4	0.5	0.65
			Ka5	0.46	0.59
β*i*SVSP 20/20/40-11	A06B-6164-H312#H580	32	Ka1	1.03	
			Ka2	0.4	
			Ka3	0.5	0.65
			Ka4	0.5	0.65
			Ka5	0.46	0.59
β*i*SVSP 40/40/40-15	A06B-6164-H333#H580	32	Ka1	0.72	
			Ka2	0.3	
			Ka3	0.32	0.42
			Ka4	0.32	0.42
			Ka5	0.32	0.42

Name	Ordering number	a [W]	Coefficient [W/Arms]		
			Ka*	Servo axis HRV2	Servo axis HRV3
β*i*SVSP 40/40/80-15	A06B-6164-H343#H580	32	Ka1	0.72	
			Ka2	0.3	
			Ka3	0.32	0.42
			Ka4	0.32	0.42
			Ka5	0.3	0.41
β*i*SVSP 40/40/80-18	A06B-6164-H344#H580	32	Ka1	1.02	
			Ka2	0.42	
			Ka3	0.46	0.59
			Ka4	0.46	0.59
			Ka5	0.43	0.58
β*i*SVSP 80/80/80-18	A06B-6164-H364#H580	32	Ka1	1.02	
			Ka2	0.42	
			Ka3	0.43	0.58
			Ka4	0.43	0.58
			Ka5	0.43	0.58
β*i*SVSPc 20/20-7.5	A06B-6167-H201#H560	31	Ka1	1.55	
			Ka2	0.63	
			Ka3	0.75	0.98
			Ka4	0.75	0.98
β*i*SVSPc 20/20-7.5L	A06B-6167-H209#H560	31	Ka1	1.03	
			Ka2	0.42	
			Ka3	0.5	0.65
			Ka4	0.5	0.65
β*i*SVSPc 20/20-11	A06B-6167-H202#H560	31	Ka1	1.03	
			Ka2	0.4	
			Ka3	0.5	0.65
			Ka4	0.5	0.65
β*i*SVSPc 20/20/20-7.5	A06B-6167-H301#H560	32	Ka1	1.55	
			Ka2	0.63	
			Ka3	0.75	0.98
			Ka4	0.75	0.98
			Ka5	0.75	0.98
β*i*SVSPc 20/20/20-7.5L	A06B-6167-H309#H560	32	Ka1	1.03	
			Ka2	0.42	
			Ka3	0.5	0.65
			Ka4	0.5	0.65
			Ka5	0.5	0.65
β*i*SVSPc 20/20/20-11	A06B-6167-H302#H560	32	Ka1	1.03	
			Ka2	0.4	
			Ka3	0.5	0.65
			Ka4	0.5	0.65
			Ka5	0.5	0.65

11 α*i* AMPLIFIER COMBINATIONS WHEN ADDITIONAL AXES ARE ADDED

11.1 Overview

With a lathe in which the servo amplifier β*i*SVSP is used for the basic axis, the servo amplifier α*i* series can be connected for use as a rotating tool axis.

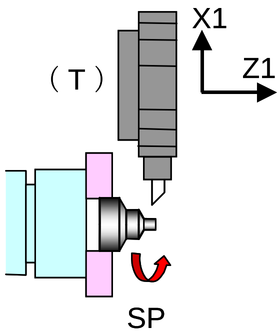
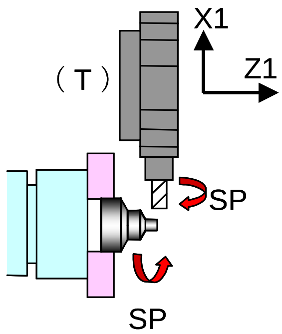
[Constraints on connection]

- The servo amplifier α*i* series can be connected only for use as a rotating tool axis in the lathe.
- The main spindle on the basic axis (built-in spindle of the β*i*SVSP) and the servo amplifier α*i* series (α*i*SP or α*i*SV) on the live tool axis do not perform cutting simultaneously.
- Connect the CNC and the servo amplifier in the order below.

CNC — β*i*SVSP — Servo amplifier α*i* series

[Application examples]

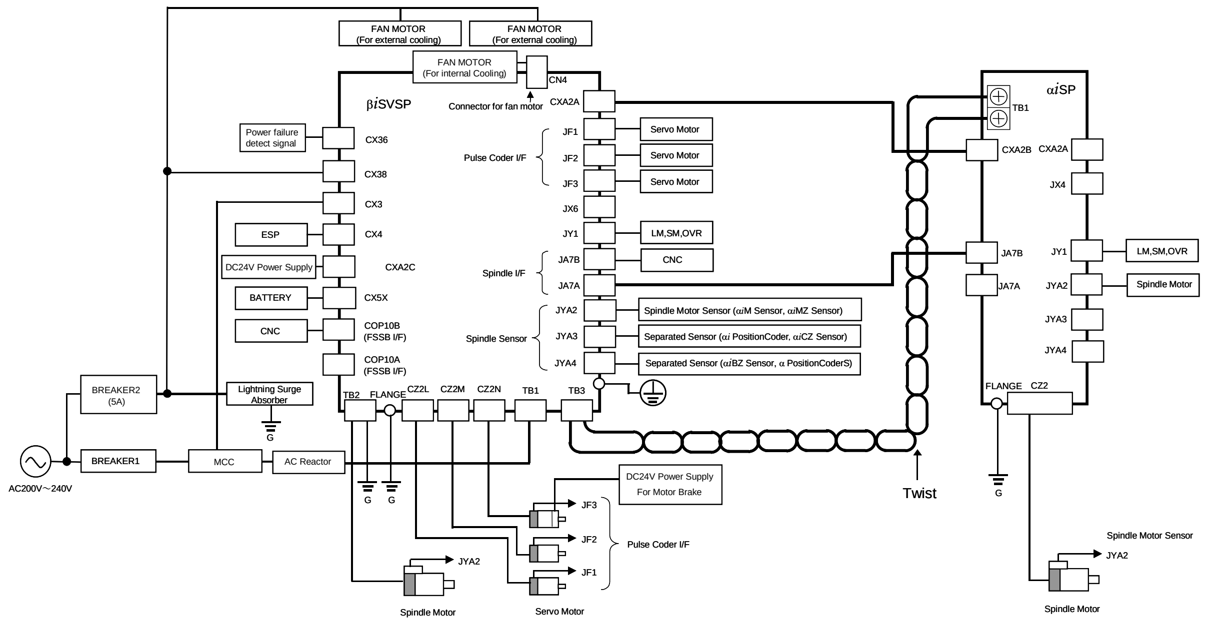
Optimum connections are possible in machine configuration examples such as shown below.

Basic configuration	Basic configuration + Rotating tool
	 + 
	
β*i*SVSP (1-axis SP + 2-axis SV or 3-axis SV)	β*i*SVSP (1-axis SP＋2-axis SV or 3-axis SV) + α*i*SP or α*i*SV (live tool axis)

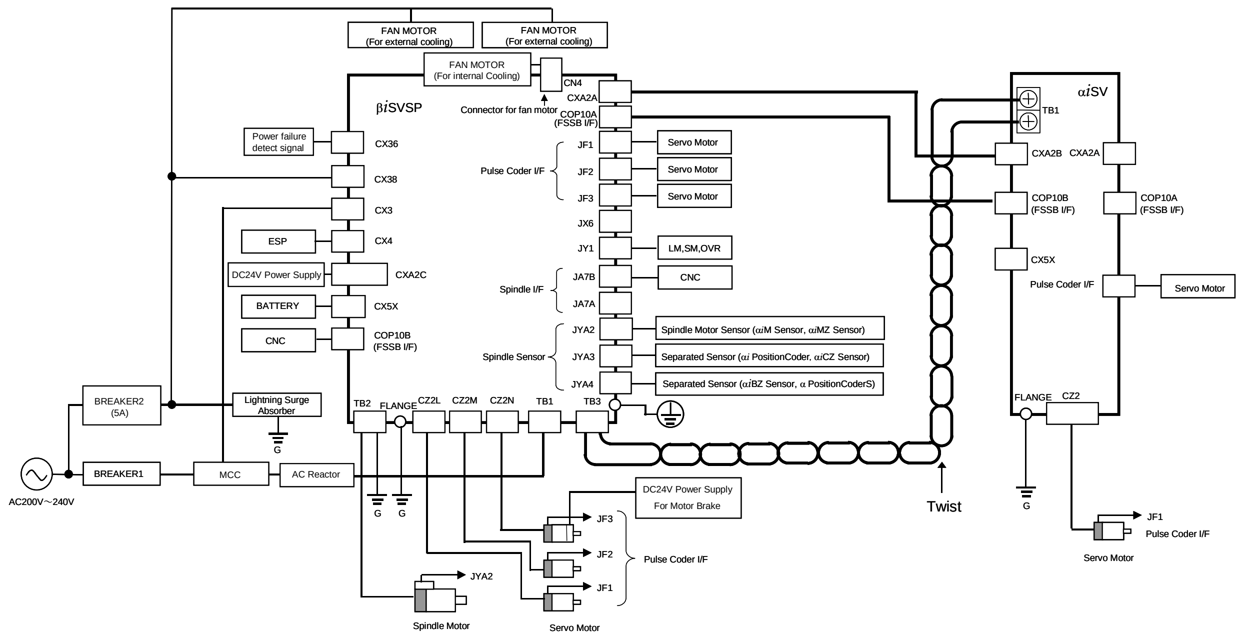
> ⚠ **CAUTION**
> If wishing to use the spindle amplifier α*i*SP series and the servo amplifier α*i*SV series for uses other than a live tool axis, contact FANUC.

11.2 CONFIGURATION

(a) For a configuration of the servo amplifier β*i*SVSP series and the α*i*SP series for use as a rotating tool axis only



(b) For a configuration of the servo amplifier β*i*SVSP series and the α*i*SV series for use as a rotating tool axis only



11.3 SPECIFICATIONS

11.3.1 Servo Amplifier α*i* Series That Can Be Connected to the β*i*SVSP Series

One α*i* series servo amplifier for use as a live tool axis can be connected to the servo amplifier β*i*SVSP series.
Listed below are the specifications of the servo amplifier α*i* series for use as a live tool axis that can be connected to the servo amplifier β*i*SVSP series.

Basic configuration β*i*SVSP specification drawing number	α*i*SP specification drawing number			
	α*i*SP 2.2 (A06B-614*-H002#H580) (A06B-6144-H002#H590) (A06B-6220-H002#H600)	α*i*SP 5.5 (A06B-614*-H006#H580) (A06B-6144-H006#H590) (A06B-6220-H006#H600)	α*i*SP 11 (A06B-614*-H011#H580) (A06B-6144-H011#H590) (A06B-6220-H011#H600)	α*i*SP 15 (A06B-614*-H015#H580) (A06B-6144-H015#H590) (A06B-6220-H015#H600)
β*i*SVSP 20/20-7.5 (A06B-6164-H201#H580)	○	○	×	×
β*i*SVSP 20/20-11 (A06B-6164-H202#H580)	○	○	○	×
β*i*SVSP 40/40-15 (A06B-6164-H223#H580)	○	○	○	○
β*i*SVSP 40/40-18 (A06B-6164-H224#H580)	○	○	○	○
β*i*SVSP 80/80-18 (A06B-6164-H244#H580)	○	○	○	○
β*i*SVSP 20/20/40-7.5 (A06B-6164-H311#H580)	○	○	×	×
β*i*SVSP 20/20/40-11 (A06B-6164-H312#H580)	○	○	○	×
β*i*SVSP 40/40/40-15 (A06B-6164-H333#H580)	○	○	○	○
β*i*SVSP 40/40/80-15 (A06B-6164-H343#H580)	○	○	○	○
β*i*SVSP 40/40/80-18 (A06B-6164-H344#H580)	○	○	○	○
β*i*SVSP 80/80/80-18 (A06B-6164-H364#H580)	○	○	○	○

Basic configuration β*i*SVSPc specification drawing number	α*i*SP specification drawing number			
	α*i*SP 2.2 (A06B-614*-H002#H580) (A06B-6144-H002#H590) (A06B-6220-H002#H600)	α*i*SP 5.5 (A06B-614*-H006#H580) (A06B-6144-H006#H590) (A06B-6220-H006#H600)	α*i*SP 11 (A06B-614*-H011#H580) (A06B-6144-H011#H590) (A06B-6220-H011#H600)	α*i*SP 15 (A06B-614*-H015#H580) (A06B-6144-H015#H590) (A06B-6220-H015#H600)
β*i*SVSPc 20/20-7.5 (A06B-6167-H201#H560)	○	○	×	×
β*i*SVSPc 20/20-7.5L (A06B-6167-H209#H560)	○	○	×	×
β*i*SVSPc 20/20-11 (A06B-6167-H202#H560)	○	○	○	×
β*i*SVSPc 20/20/20-7.5 (A06B-6167-H301#H560)	○	○	×	×
β*i*SVSPc 20/20/20-7.5L (A06B-6167-H309#H560)	○	○	×	×
β*i*SVSPc 20/20/20-11 (A06B-6167-H302#H560)	○	○	○	×

Basic configuration β*i*SVSP specification drawing number	α*i*SV specification drawing number				
	α*i*SV 4 (A06B-6117-H101) (A06B-6240-H101)	α*i*SV 20 (A06B-6117-H103) (A06B-6240-H103)	α*i*SV 40 (A06B-6117-H104) (A06B-6240-H104)	α*i*SV 80 (A06B-6117-H105) (A06B-6240-H105)	α*i*SV 160 (A06B-6117-H106) (A06B-6240-H106)
β*i*SVSP 20/20-7.5 (A06B-6164-H201#H580)	○	○	○	×	×
β*i*SVSP 20/20-11 (A06B-6164-H202#H580)	○	○	○	○	×
β*i*SVSP 40/40-15 (A06B-6164-H223#H580)	○	○	○	○	×
β*i*SVSP 40/40-18 (A06B-6164-H224#H580)	○	○	○	○	○
β*i*SVSP 80/80-18 (A06B-6164-H244#H580)	○	○	○	○	○
β*i*SVSP 20/20/40-7.5 (A06B-6164-H311#H580)	○	○	○	×	×
β*i*SVSP 20/20/40-11 (A06B-6164-H312#H580)	○	○	○	○	×
β*i*SVSP 40/40/40-15 (A06B-6164-H333#H580)	○	○	○	○	×
β*i*SVSP 40/40/80-15 (A06B-6164-H343#H580)	○	○	○	○	×
β*i*SVSP 40/40/80-18 (A06B-6164-H344#H580)	○	○	○	○	○
β*i*SVSP 80/80/80-18 (A06B-6164-H364#H580)	○	○	○	○	○

Basic configuration β*i*SVSPc specification drawing number	α*i*SV specification drawing number				
	α*i*SV 4 (A06B-6117-H101) (A06B-6240-H101)	α*i*SV 20 (A06B-6117-H103) (A06B-6240-H103)	α*i*SV 40 (A06B-6117-H104) (A06B-6240-H104)	α*i*SV 80 (A06B-6117-H105) (A06B-6240-H105)	α*i*SV 160 (A06B-6117-H106) (A06B-6240-H106)
β*i*SVSPc 20/20-7.5 (A06B-6167-H201#H560)	○	○	○	×	×
β*i*SVSPc 20/20-7.5L (A06B-6167-H209#H560)	○	○	○	×	×
β*i*SVSPc 20/20-11 (A06B-6167-H202#H560)	○	○	○	○	×
β*i*SVSPc 20/20/20-7.5 (A06B-6167-H301#H560)	○	○	○	×	×
β*i*SVSPc 20/20/20-7.5L (A06B-6167-H309#H560)	○	○	○	×	×
β*i*SVSPc 20/20/20-11 (A06B-6167-H302#H560)	○	○	○	○	×

⚠ **CAUTION**

If wishing to use the spindle amplifier α*i*SP series and the servo amplifier α*i*SV series for uses other than a live tool axis, contact FANUC.

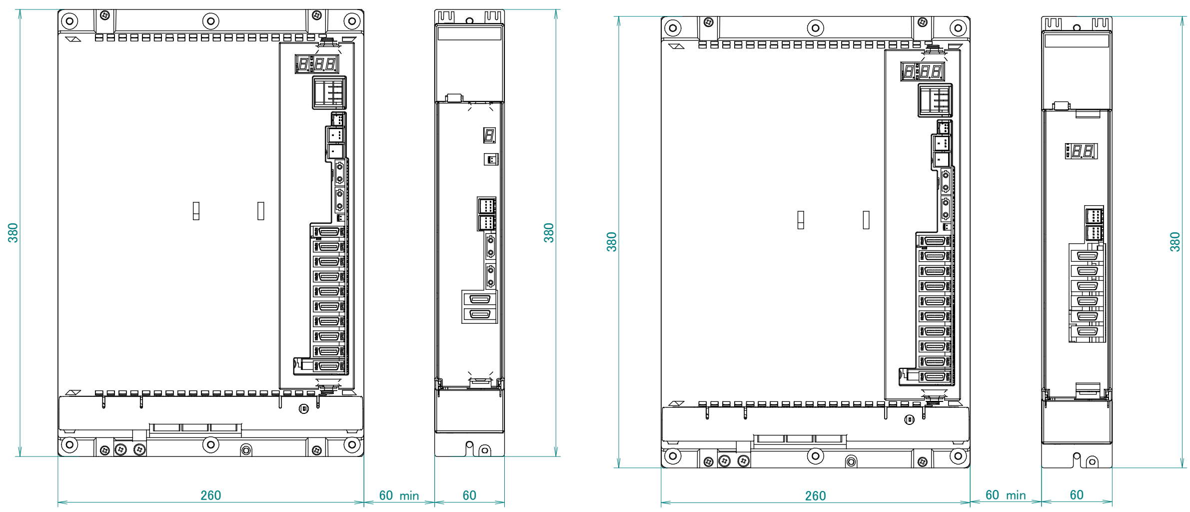
11.3.2 Specifications of Circuit Breakers, Magnetic Contactors, and AC Reactors

If the servo amplifier α*i* series (α*i*SP or α*i*SV) for use as a live tool axis is to be connected to the servo amplifier β*i*SVSP, the circuit breaker, magnetic contactor, and AC reactor capacities are determined by the specifications of the β*i*SVSP used for the basic axis. See Chapter 4, "ORDERING INFORMATION".

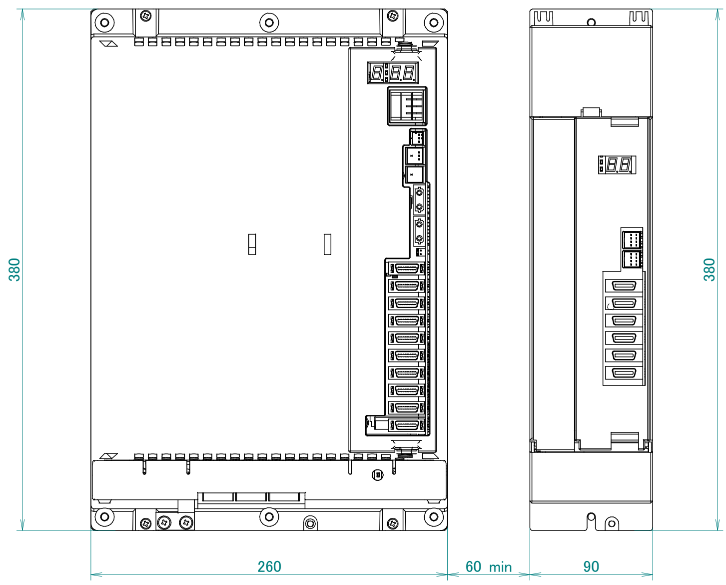
11.4 EXTERNAL DIMENSIONS

Shown below are the external dimensions assumed if the servo amplifier α*i* series (α*i*SP or α*i*SV) for use as a live tool axis is connected to the servo amplifier β*i*SVSP.

(a) If the servo amplifier α*i* series to be connected is 60mm wide



(b) If the servo amplifier α*i* series to be connected is 90mm wide

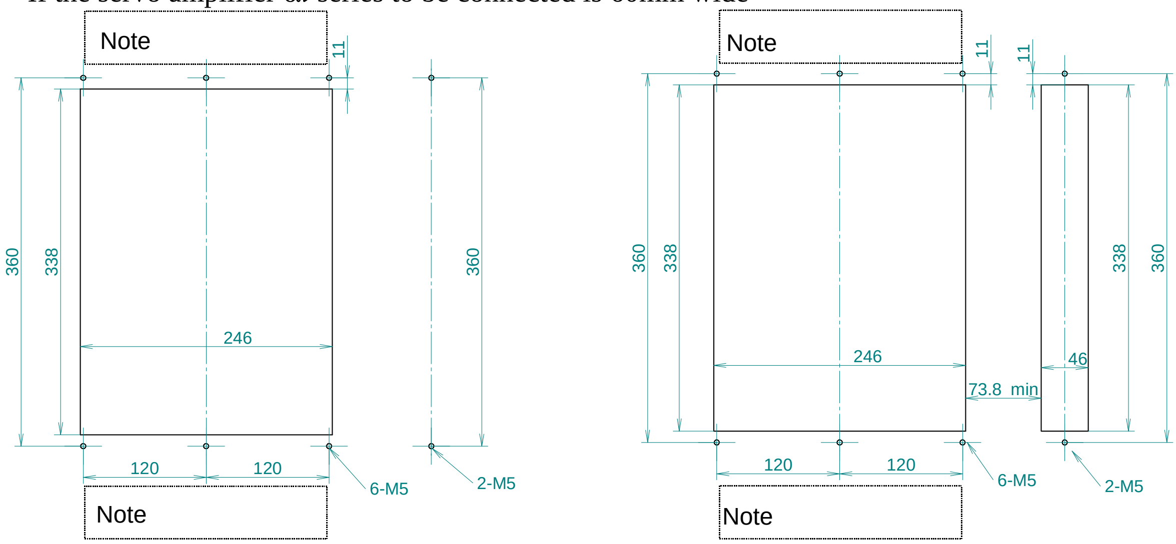


11.5 PANEL CUT-OUT

Shown below are the panel-cut-outs assumed if the servo amplifier αi series (αiSP or αiSV) for use as a live tool axis is connected to the servo amplifier βiSVSP.

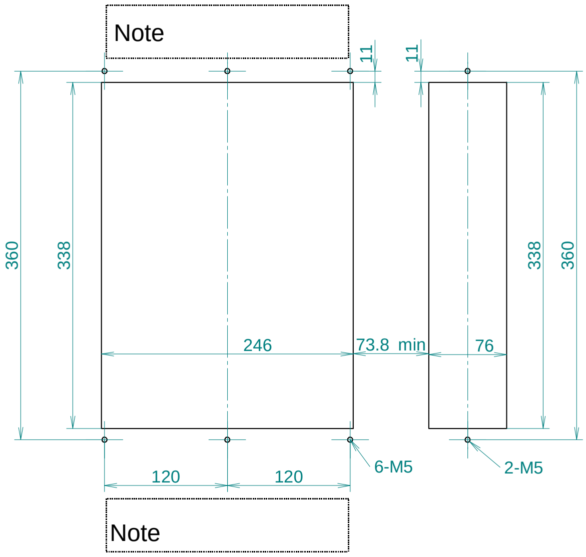
> **NOTE**
> 1. Attach the supplied gasket around the panel cut-out to prevent oil and dust from getting into it.
> 2. Reinforce the right and left sides of the panel cut-out in the power magnetics cabinet by using fittings such as angles to maintain satisfactory contact between the sheet metal of the power magnetics cabinet and the flange of the amplifier.
> 3. When βiSVSP is used, placing a FANUC fan unit on top of the servo amplifier requires installing a duct. See the "example duct structure where a FANUC separated cooling fan motor (A06B-6134-K001) is used" for descriptions about the structure of the duct.
> 4. Placing a FANUC separated cooling fan motor below the servo amplifier does not require installing a duct.

(a) If the servo amplifier αi series to be connected is 60mm wide



(i) A 60-mm wide external fin is not attached **(ii) A 60-mm wide external fin is attached**

(b) If the servo amplifier α*i* series to be connected is 90mm wide



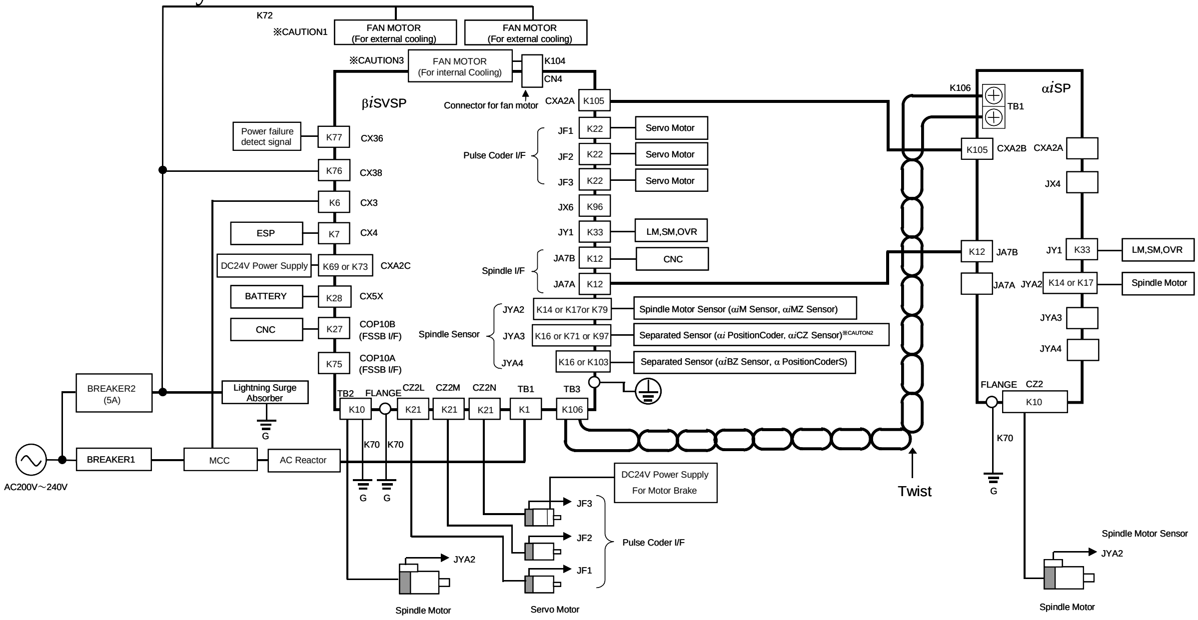
> **NOTE**
> 1 For the β*i*SVSP series, the number of separated cooling fan motors to mount differs with the model.
> 2 For the panel cut-out of β*i*SVSP series , see Section 8.2, "PANEL CUT-OUT".

11.6 MAINTENANCE AREA

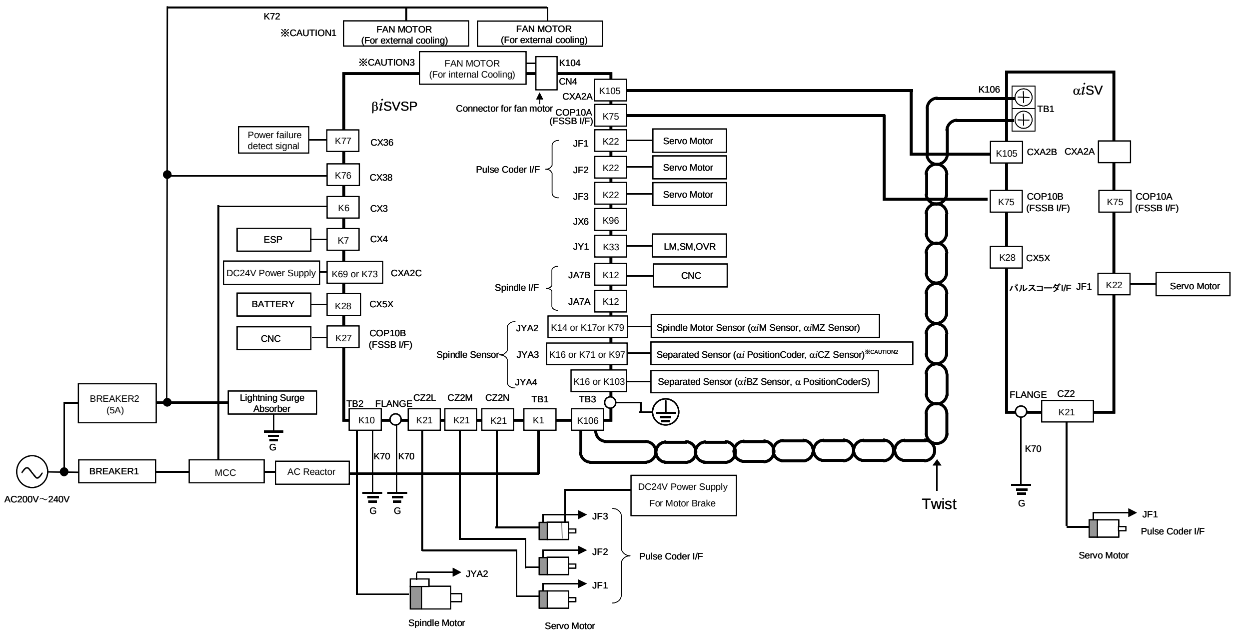
For information about the maintenance area of the servo amplifier α*i* series (α*i*SP or α*i*SV) for use as a live tool axis that is connected to the servo amplifier β*i*SVSP, refer to the item on "maintenance area" of the FANUC SERVO AMPLIFIER α*i* series DESCRIPTIONS (B-65282EN).

11.7 TOTAL CONNECTION DIAGRAM

(a) For a configuration of the servo amplifier β*i*SVSP series and the α*i*SP series for use as a rotating tool axis only



(b) For a configuration of the servo amplifier β*i*SVSP series and the α*i*SV series for use as a rotating tool axis only



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

NOTE

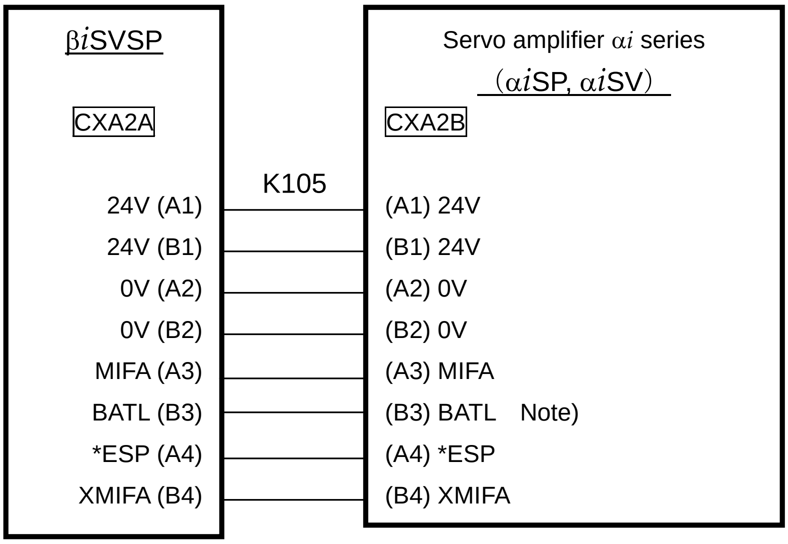
3 Always ground the grounding terminal (G) on TB2 and the tapped hole for grounding the flange.

⚠ **CAUTION**

1 In the βiSVSP*-7.5 and -11, as well as the βiSVSPc*-7.5L and -11, install only one separated cooling fan motor (for cooling the radiator fin). If installing only one, install it on this side.
2 The αiCZ sensor cannot be connected to the βiSVSPc.
3 Only the βiSVSP*-18 model requires the installation of a separated cooling fan motor (for cooling the inside of the amplifier).

11.8 DETAILED DESCRIPTONS OF CONNECTIONS

11.8.1 Details of Cable K105



Connector specifications

Manufacturer	Tyco Electronics AMP
Connector specification	D-2100 series Housing : 1-1318119-4 (1 pcs.) Contact : 1318107-1 (8 pcs.) [Ordering information : A06B-6110-K210 connector only]
Conductor size	0.5mm^2, AWG20
Instruction outer diameter	1.08-2.83 mm

NOTE

The (B3)BATL is the interface used to connect the batteries for the absolute Pulsecoder. For details, see Subsections 9.3.24, “Details of Cable K28”.

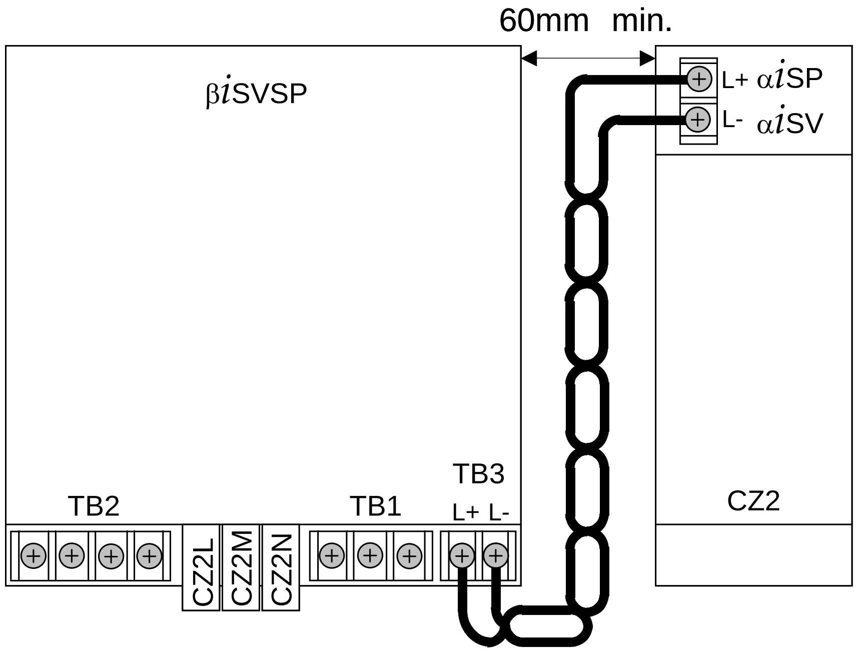
⚠ **WARNING**

1 When using the built-in battery (A06B-6114-K504), never connect the BATL(B3) of the connector CXA2A/CXA2B.
Otherwise, a short-circuit will occur between the output voltages for different batteries, possibly resulting in the batteries becoming very hot, which is dangerous.

2 Do not connect more than one battery to the same BATL(B3) line. Otherwise, a short-circuit will occur between the output voltages of different batteries, possibly resulting in the batteries becoming very hot, which is dangerous.

11.8.2 Details of Cable K106

Cable K106 is used to supply the DC link voltage from the β*i*SVSP to the servo amplifier α*i* series (α*i*SP or α*i*SV).



[Wire diameters]

Listed below are the wire diameters of the cables for supplying the DC link voltage if the α*i* series servo amplifiers below are connected for use as a rotating tool axis in a lathe in which the servo amplifier β*i*SVSP is used as the basic axis. Electric wire diameters are determined based on JCS No. 168 E, "Allowable Currents for Power Cables (1)."

[Selection example]

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

α*i* series amplifier for use as a rotating tool axis	Cable diameter [mm^2] when environment temperature 30°C	Cable diameter [mm^2] when environment temperature 55°C
α*i*SP 2.2	2.0mm^2 or larger	3.5mm^2 or larger
α*i*SP 5.5	2.0mm^2 or larger	3.5mm^2 or larger
α*i*SP 11	5.5mm^2 or larger	8.0mm^2 or larger
α*i*SP 15	14.0mm^2 or larger	14.0mm^2 or larger

α*i* series amplifier for use as a rotating tool axis	**Cable diameter [mm^2] when environment temperature 30°C**	**Cable diameter [mm^2] when environment temperature 55°C**
α*i*SV 4	2.0mm^2 or larger	3.5mm^2 or larger
α*i*SV 20	2.0mm^2 or larger	3.5mm^2 or larger
α*i*SV 40	2.0mm^2 or larger	3.5mm^2 or larger
α*i*SV 80	2.0mm^2 or larger	3.5mm^2 or larger
α*i*SV 160	5.5mm^2 or larger	8.0mm^2 or larger

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

For the wire diameter versus AWG number table (reference), see the item in Chapter 12, "POWER CABLE FOR SERVO MOTOR AND AMPLIFIER".

⚠ **WARNING**

1 Two cables (L+ and L-) must be a twisted pair.
2 Wire them separately from signal lines (such as K12 and K105).
3 Tighten the four screws securely. Loose screws will cause abnormal heating, and can cause fire.
4 The DC link cable length must be 1.5 m or less.
5 Connect the polarities (L+ and L-) properly. If the polarities are connected incorrectly, a fire may occur.

⚠ **CAUTION**

For information about the DC link cable diameters if using the spindle amplifier α*i*SP series and the servo amplifier α*i*SV series for other than a rotating tool axis, contact FANUC.

12 POWER CABLE FOR SERVO MOTOR AND AMPLIFIER

12.1 SELECTING A POWER CABLE

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

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

[Selection example of power line (reference)]

[Selection example 1]
- Heavy-duty power cable specification : Maximum allowable conductor temperature 60 °C

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

[Selection example 2]
- Heavy-duty power cable specification : Maximum allowable conductor temperature 80 °C

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

[Selection example 3]

- Fire-retardant polyflex wire or equivalent to LMFC manufactured by The Furukawa Electric Co., Ltd.:
  Number of wires bundled: 3
  Maximum allowable conductor temperature: 105℃

Cable diameter [mm^2]	Allowable current value [Arms] when environment temperature 30°C	Allowable current value [Arms] when environment temperature 55°C
0.75	Less than 12	Less than 10
1.25	Less than 16	Less than 13
2	Less than 21	Less than 17
3.5	Less than 32	Less than 26
5.5	Less than 43	Less than 35
8	Less than 55	Less than 44
14	Less than 79	Less than 64
22	Less than 113	Less than 92
30	Less than 137	Less than 112

- Wire diameter versus AWG number table (reference)

Cable diameter [mm2]	AWG number
0.8226	AWG18
1.307	AWG16
2.082	AWG14
3.309	AWG12
5.262	AWG10
8.368	AWG8
13.30	AWG6
21.15	AWG4
33.62	AWG2
42.41	AWG1
53.49	AWG1/0
67.42	AWG2/0
85.03	AWG3/0
107.2	AWG4/0

III. β*i*SV (I/O Link Option)

1 OVERVIEW

The servo amplifier β*i* series (I/O Link option) (called the β*i*SV hereinafter) has the following features:

(1) One-axis AC servo amplifier with excellent cost performance, suitable for a positioning axis
(2) This one-axis servo amplifier is suitable for the servo motor α*i*S, α*i*F, β*i*S, and β*i*F series, which is suitable for feed axes of machining tools and for applications of their peripheral equipment and industrial machines.
(3) A position control function is provided. In addition, a set for easily controlling peripheral equipment such as a turret and ATC is provided.
(4) The β*i* SV can be connected to the Series 0*i*/0*i* Mate, Series 16*i*/18*i*/21*i*, Series 30*i*/31*i*/32*i*/35*i*, and Power Motion *i* -MODEL A via the FANUC I/O Link (called the I/O Link hereinafter), therefore, easily expanding positioning axes.
(5) Parameters, current positions, and diagnostic information can be displayed and set from a CNC.
(6) Instructions for making a movement in synchronization with pulse trains externally input are provided, which can find various uses.

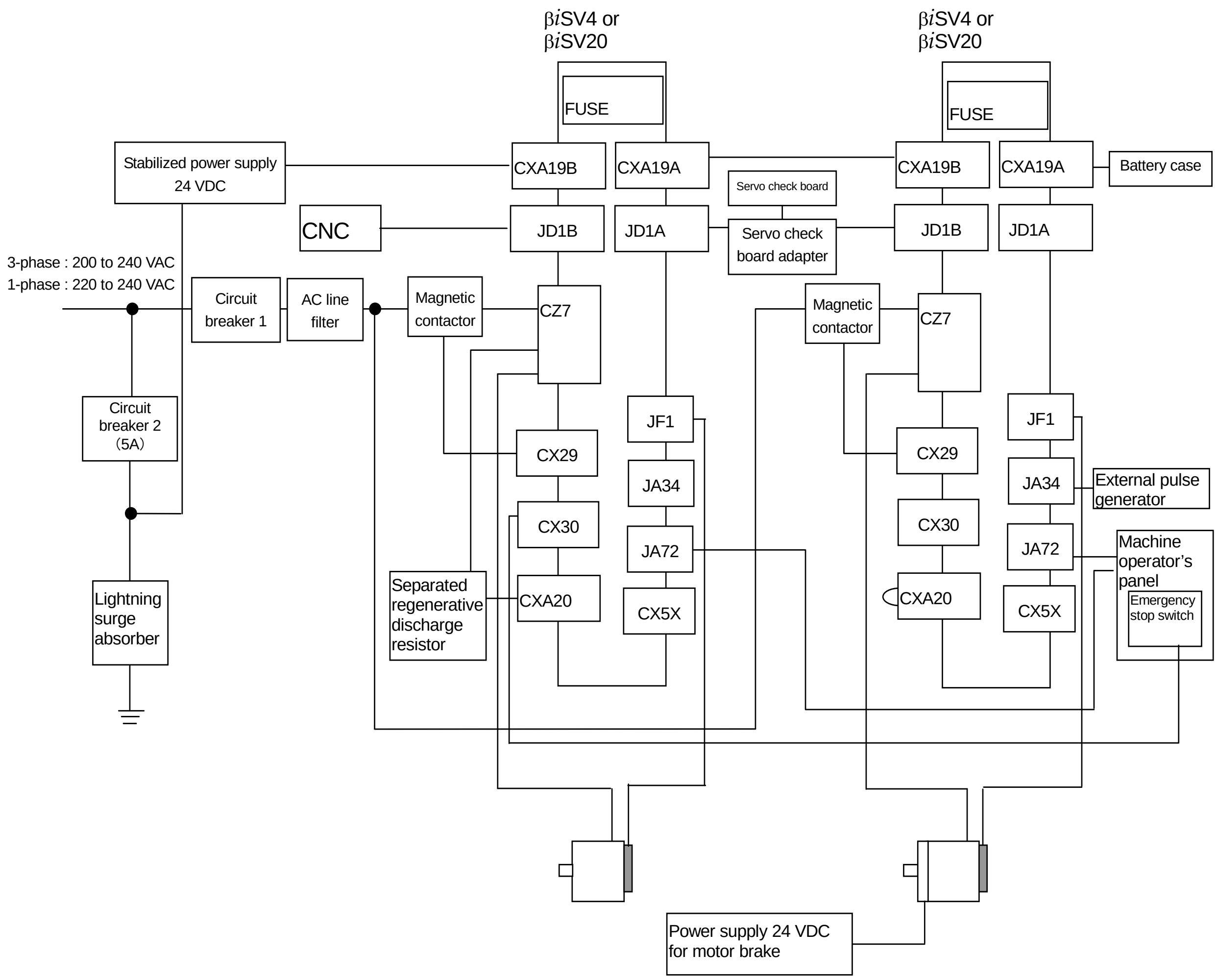
The following improvements have been made from servo amplifier β series I/O Link option:

(1) HRV2 is employed as the current control method. This improves the response characteristics of the motor and makes feed operations more smoothly.
(2) Improved maintainability
    - The new structure used allows you to remove the control PC board from the front of the β*i*SV without removing the case. So, you can replace fuses more easily than before.
    - You can replace the cooling fan without removing the case.
    - Use of the Power Mate CNC manager enables the CNC to identify the β*i*SV specifications and other information without opening the power magnetics cabinet. To use this function, the Power Mate CNC manager supporting this function is required.

2 CONFIGURATION

2.1 βiSV4 AND βiSV20

This section shows an example of a 2-axis system configuration using two βiSVs which are the βiSV 4 or βiSV 20.
In this example, a separated regenerative discharge resistor is connected but no external pulse generator is connected to the βiSV for the first axis (the unit nearer the CNC), while no separated regenerative discharge resistor is connected but an external pulse generator is connected to the βiSV for the second axis.
The servo check board adapter and servo check board in the configuration example are provided for the first axis.



NOTE
1. Use the stabilized power supply 24VDC for the amplifier. Power supply 24VDC for the amplifier and power supply 24VDC for the motor brake cannot be shared.
2. A circuit breakers, magnetic contactor, and AC line filter are always required.
3. The cabling of CX30 of the second and subsequent amplifiers may be omitted. For details, see Subsection 9.2.12, “Details of Cable K8” in the part I, “βiSV” and Chapter 11, “COMBINATIONS OF DIFFERENT MODELS” in the part I, “βiSV”.

NOTE

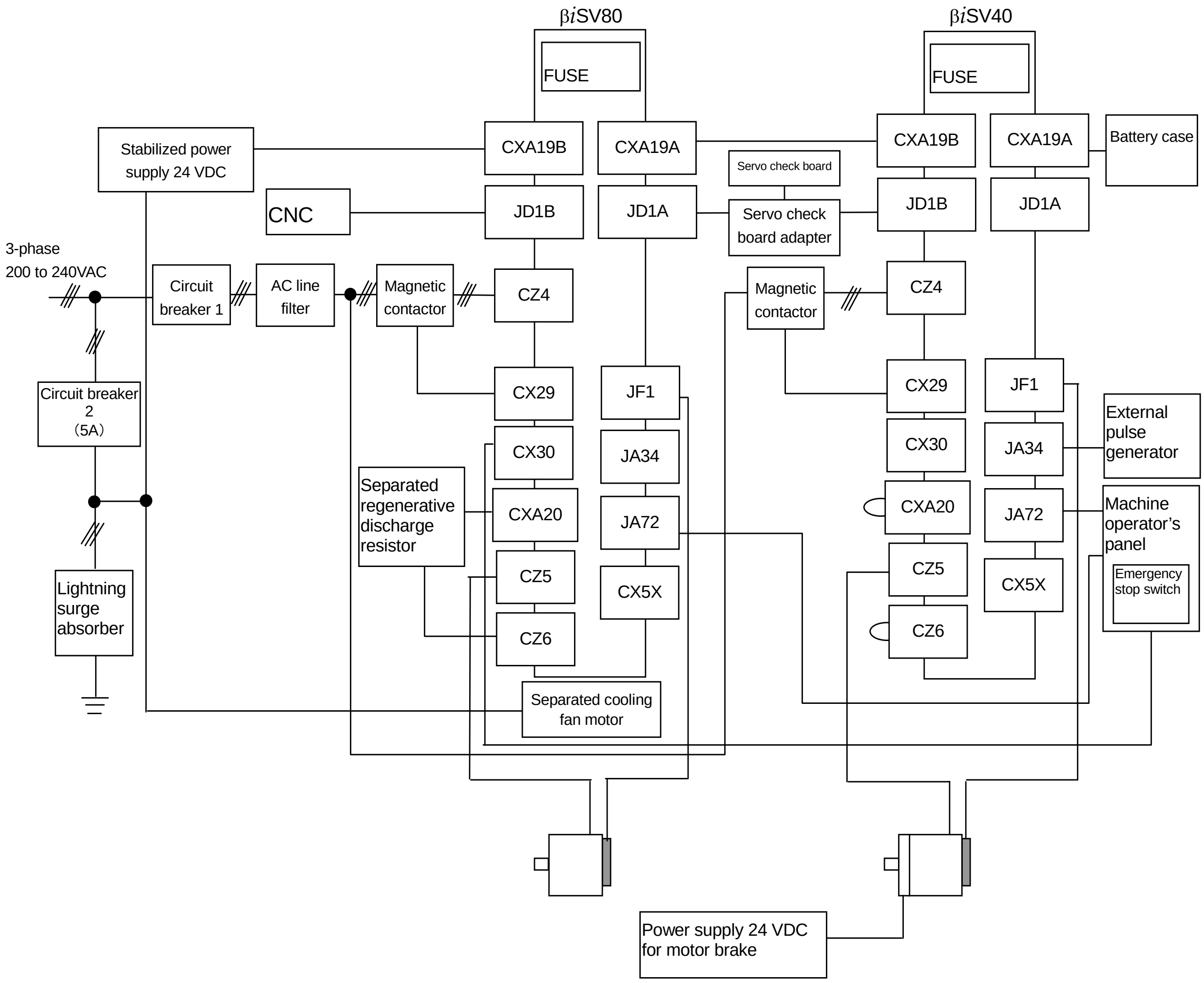
4 To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.

⚠ **WARNING**

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

2.2 β*i*SV40 AND β*i*SV80

This section shows an example of a 2-axis system configuration using the β*i*SV80 for the first axis (the unit nearer the CNC) and the β*i*SV40 for the second axis.
In this example, a separated regenerative discharge resistor is connected but no external pulse generator is connected for the first axis, while no separated regenerative discharge resistor is connected but an external pulse generator is attached for the second axis.
The servo check board adapter and servo check board in the configuration example are provided for the first axis.



NOTE
1. Use the stabilized power supply 24VDC for the amplifier. Power supply 24VDC for the amplifier and power supply 24VDC for the motor brake cannot be shared.
2. A circuit breakers, magnetic contactor, and AC line filter are always required.
3. The cabling of CX30 of the second and subsequent amplifiers may be omitted. For details, see Subsection 9.2.12, "Details of Cable K8" in the part I, "β*i*SV" and Chapter 11, "COMBINATIONS OF DIFFERENT MODELS" in the part I, "β*i*SV".
4. To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.

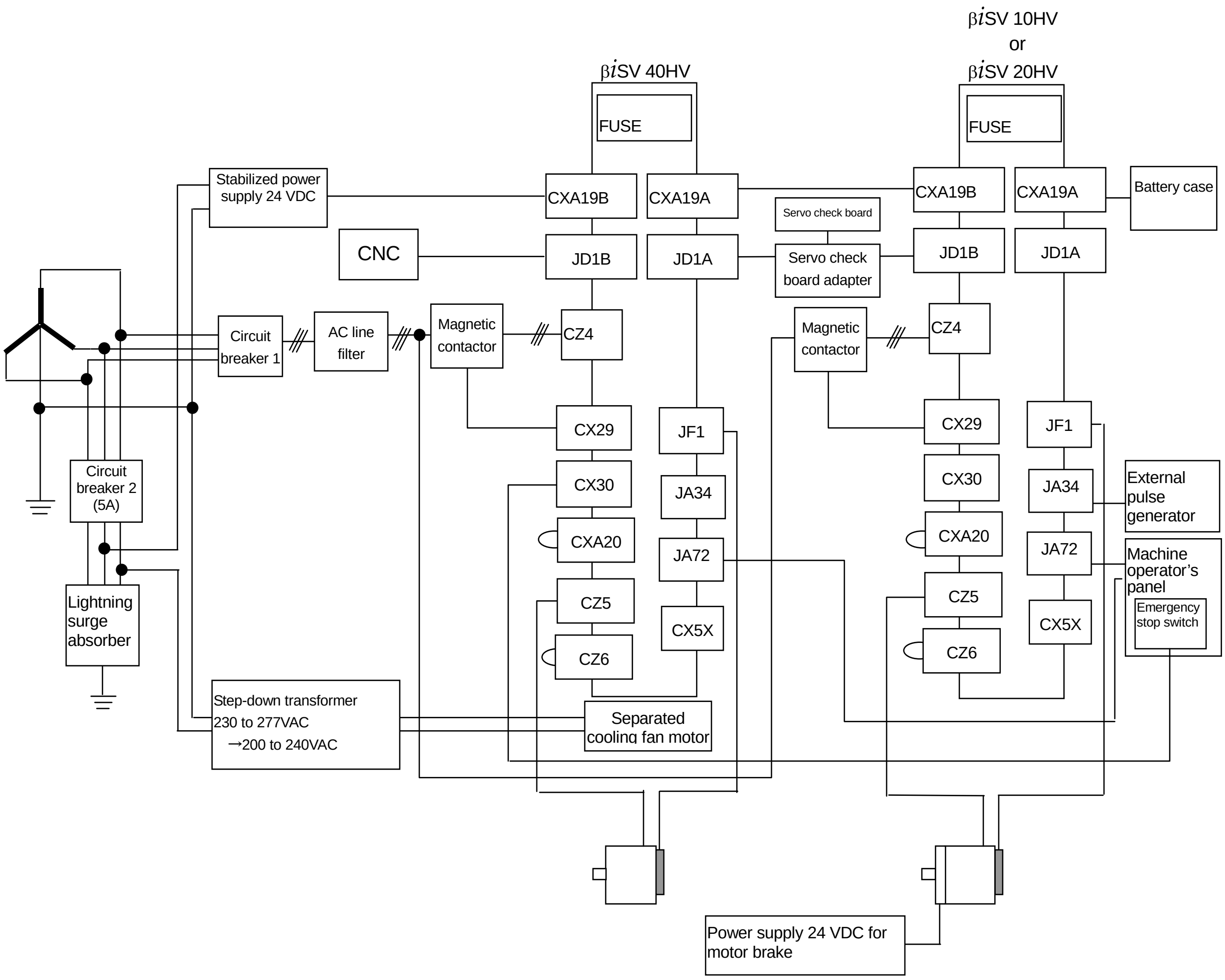
⚠ **CAUTION**

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

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

2.3 βiSV10HV, βiSV20HV, AND βiSV40HV

Shown below is an example of a 2-axis system configuration using the βiSV 40HV for the first axis (the unit nearer the CNC) and the βiSV 10HV or the 20HV for the second axis. The servo check board adapter and servo check board in the configuration example are provided for the first axis.



NOTE

1. Use the stabilized power supply 24VDC for the amplifier. Power supply 24VDC for the amplifier and power supply 24VDC for the motor brake cannot be shared.
2. A circuit breakers, magnetic contactor, and AC line filter are always required.
3. The cabling of CX30 of the second and subsequent amplifiers may be omitted. For details, see Subsection 9.2.12, "Details of Cable K8" in the part I, "βiSV" and Chapter 11, "COMBINATIONS OF DIFFERENT MODELS" in the part I, "βiSV".
4. To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.
5. The input voltage of the separated cooling fan motor is 200 to 240 VAC.

⚠ **CAUTION**

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

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

3 SPECIFICATIONS

3.1 INPUT POWER

3.1.1 Power Supply of 200-V or 400-V Input Series (Three-phase Input)

For details, see Subsections 3.1.1, "Power Supply of 200-V Input Series (Three-phase Input)" and 3.1.3, “Power Supply of 400-V Input Series (Three-phase Input)” in the Part I, "β*i*SV".

3.1.2 Power Supply of 200-V Input Series (Single-phase Input)

For details, see Subsections 3.1.2, "Power Supply of 200-V Input Series (Single-phase Input)” in the Part I, "β*i*SV".

3.1.3 Control Power Supply

Use a class 2 power supply (UL standard) as the power supply connected to the 24-VDC power supply.
Be sure to use a stabilized power supply as the 24-VDC power supply for the amplifier. The 24-VDC power supply for motor brakes cannot be shared.

- Nominal rated voltage : 24VDC
- Allowable voltage deviation : ±10%(including momentary variations)
- Power supply ratings

Power supply rating per amplifier	0.9A

Specifications of external 24 VDC power supply

Specifications of recommended external 24 VDC power supply (Stabilized power supply) (UL1950 must be satisfied.)

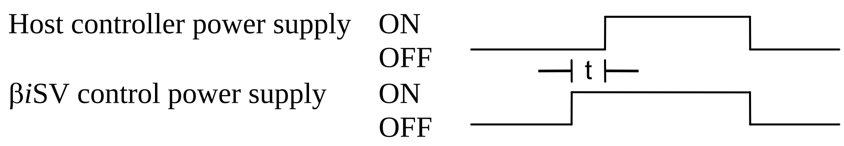
Output voltage +24V±10% (21.6V to 26.4V)
(Ripple voltage and noise are contained. See the figure below.)
Output current The continuous load current must be at least the current consumption of the CNC and other units.

(At the maximum temperature inside the power magnetics cabinet in which the power supply is located.)
Load fluctuations (including rush current) The output voltage must not go out of the above range due to load fluctuations.
Instantaneous input interruption retention time 10mS (for -100%)
20mS (for -50%)

* For information on the time chart in the specifications of the control power supply and the circuit configuration, see Subsection 3.1.4, "Control Power Supply", of Chapter 3 in Part I, "β*i*SV".

3.1.4 Sequence for Turning on Control Power Supply

Turn on the control power supply of the β*i*SV at the same time when the power to the host controller connected via the I/O Link is turned on or before the host controller is turned on. When turning off the power to the host controller, be sure to also turn off the control power supply of the β*i*SV.



t: 0 or more

3.2 ENVIRONMENTAL CONDITIONS

For details, see Section 3.2, "ENVIRONMENTAL CONDITIONS" in the Part I, "β*i*SV".

3.3 SPECIFICATIONS

(a) βiSV series (200-V type) : (A06B-6132-H***)

Item		βi SV4	βi SV20	βi SV40	βi SV80
No. of controlled axes		1-axis			
Interface		FANUC I/O Link			
Unit specification		A06B-6132-H001	A06B-6132-H002	A06B-6132-H003	A06B-6132-H004
Power PC board		A20B-2101-0090	A20B-2101-0091	A16B-3200-0512	A16B-3200-0513
Control PC board		A20B-8101-0200			
Main power supply 3-phase input	Input voltage	AC 200V～240V (-15%,+10%) 50 / 60 Hz			
	Input current(50Hz)	0.5 Arms	8.0 Arms	14.0 Arms	19.0 Arms
	Power supply rating	0.2 KVA	2.8 KVA	4.7 KVA	6.5 KVA
Main power supply Single-phase input	Input voltage	AC 220V～240V (-15%,+10%) 50/60 Hz		-	-
	Input current(50Hz)	1.1 Arms	8.0 Arms	-	-
	Power supply rating	0.3 KVA	1.9 KVA	-	-
Control power supply	Input voltage	DC 24 V (-10%, +10%)			
	Input current	0.9 Arms			
Rated output current		0.9 Arms	6.8 Arms	13 Arms	18.5 Arms
Maximum output current		4Ap	20 Ap	40 Ap	80 Ap
Servo HRV Control		HRV2			
Control Method		Sine wave PWM control with Transistor Bridge			
Dynamic brake circuit		Included			
Output frequency range		0-550Hz			
External pulse input		Differential phase A/B, 1ch			
Internal DI		5 points (ESP, interlock, +overtravel, -overtravel, skip)			
Setting display		Performed by master CNC via I/O Link			
LEDs for status display		8 LEDs			
Protection function		- High Current - IPM Abnormal - High Voltage of DC Link - Low Voltage of DC Link - Overheat of dischage resistor - Low Voltage of Control Power Supply - I/O Link communication Error - Locked fan motor - Disconnection of External Pulse Input - Program or Setting Error - Servo Motor Overheat - Exceeding Stroke Limit			
Ambient temperature range		0℃～+55℃			
Weight		1.3kg		3.9kg	
Remarks		Separated regenerative resistor (30Ω, 20W/100W) Separate AC line filter Separate battery		Built-in regenetative resistor (16Ω, 50W no-wind condition) (16Ω, 130W wind velocity of 2m/s) Separated regenerative resistor (16Ω, 200W～1200W) Separate AC line filter Separate battery	
Demension in 'mm' (Including fin block)		75×157×172		60×380×272	
Demension in 'mm' (Fin block (only))		-		60×380×100(max.)	

(b) β*i*SV series (400-V type) : (A06B-6133-H***)

Item		β*i* SV10HV	β*i* SV20HV	β*i* SV40HV
No. of controlled axes		1-axis		
Interface		FANUC I/O Link		
Unit specification		A06B-6133-H001	A06B-6133-H002	A06B-6133-H003
Power PC board		A16B-3200-0515	A16B-3200-0516	A16B-3200-0517
Control PC board		A20B-8101-0200		
Main power supply 3-phase input	Input voltage	AC 400V～480V (-15%,+10%) 50 / 60 Hz		
	Input current(50Hz)	2.3 Arms	3.6 Arms	9.0 Arms
	Power supply rating	1.6 KVA	2.5 KVA	6.2 KVA
Control power supply	Input voltage	DC 24 V (-10%, +10%)		
	Input current	0.9 Arms		
Rated output current		3.1 Arms	5.6 Arms	9.2 Arms
Maximum output current		10Ap	20 Ap	40 Ap
Servo HRV Control		HRV2		
Control Method		Sine wave PWM control with Transistor Bridge		
Dynamic brake circuit		Included		
Output frequency range		0-550Hz		
External pulse input		Differential phase A/B, 1ch		
Internal DI		5 points (ESP, interlock, +overtravel, -overtravel, skip)		
Setting display		Performed by master CNC via I/O Link		
LEDs for status display		8 LEDs		
Protection function		- High Current - IPM Abnormal - High Voltage of DC Link - Low Voltage of DC Link - Overheat of dischage resistor - Low Voltage of Control Power Supply - I/O Link communication Error - Locked fan motor - Disconnection of External Pulse Input - Program or Setting Error - Servo Motor Overheat - Exceeding Stroke Limit		
Ambient temperature range		0℃～+55℃		
Weight		3.9kg		
Remarks		Separated regenerative resistor (64Ω, 50W no-wind condition) (64Ω, 130W wind velocity of 2m/s) Separate AC line filter Separate battery		
Demension in 'mm' (Including fin block)		60×380×272		
Demension in 'mm' (Fin block (only))		60×380×100(max.)		

3.4 APPLICABLE MOTORS

For details, see Section 3.4, "APPLICABLE MOTORS" in the Part I, "β*i*SV".

4 ORDERING INFORMATION

4.1 SERVO AMPLIFIER

Input voltage	Name	Name	Ordering number
200-V input series	1-axis βiSV series	βiSV4	A06B-6132-H001
		βiSV20	A06B-6132-H002
		βiSV40	A06B-6132-H003
		βiSV80	A06B-6132-H004
400-V input series	1-axis βiSV series	βiSV10HV	A06B-6133-H001
		βiSV20HV	A06B-6133-H002
		βiSV40HV	A06B-6133-H003

4.2 CIRCUIT BREAKER

For details, see Section 4.2, "CIRCUIT BREAKER" in the Part I, "βiSV".

4.3 MAGNETIC CONTACTOR

For details, see Section 4.3, "MAGNETIC CONTACTOR in the Part I, "βiSV".

NOTE
It is recommended that one magnetic contactor be installed per βiSV unit.

4.4 AC LINE FILTER

For details, see Section 4.4, "AC LINE FILTER" in the Part I, "βiSV".

4.5 LIGHTNING SURGE PROTECTOR

For details, see Section 4.5, "LIGHTNING SURGE PROTECTOR" in the Part I, "βiSV".

4.6 NOISE FILTER

For details, see Section 4.6, "NOISE FILTER" in the Part I, "βiSV".

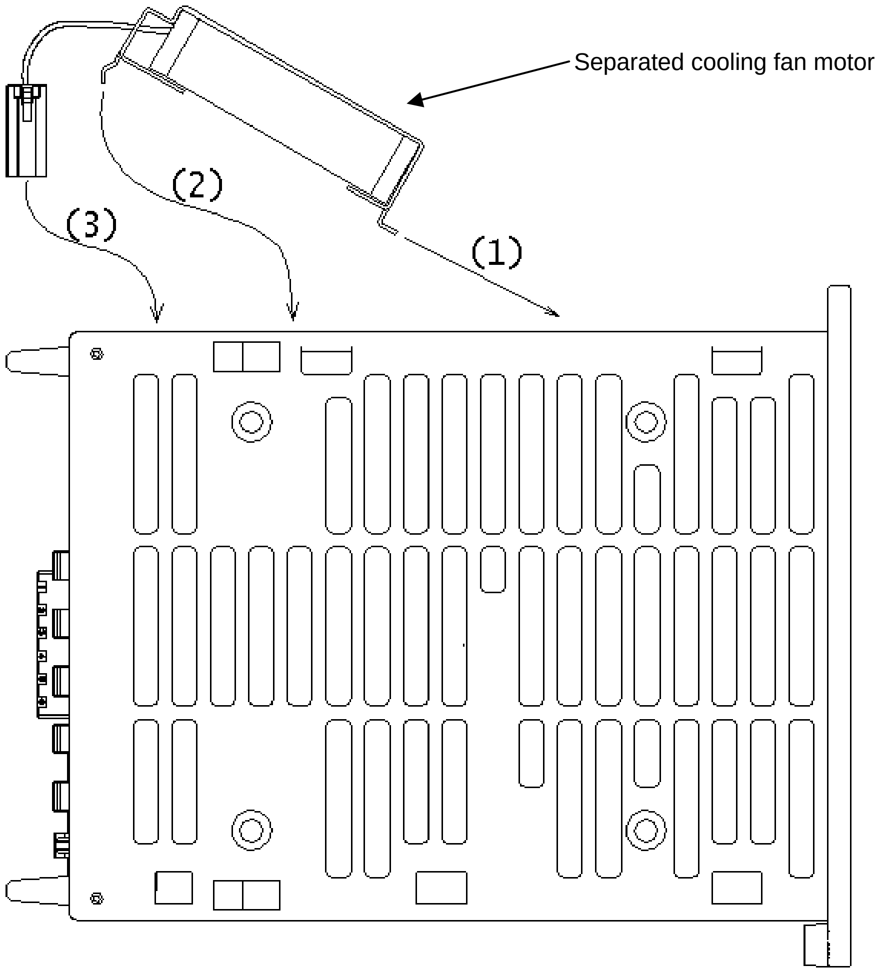
4.7 BATTERY FOR ABSOLUTE PULSECODER

For details, see Section 4.7, "BATTERY FOR ABSOLUTE PULSECODER" in the Part I, "βiSV".

4.8 SEPARATED COOLING FAN MOTOR

4.8.1 Installing a Separated Cooling Fan Motor in the β*i*SV4 and the β*i*SV20

The β*i*SV4 and the β*i*SV20 are attached with a separated cooling fan motor as standard.
Install it in the order (1), (2), and (3) as illustrated below. For an assembled diagram after the installation, see Subsection 8.1.1, "External Dimensions of β*i*SV4 and β*i*SV20", in Part I, "β*i*SV".



4.8.2 β*i*SV80

For the β*i*SV80, the following separated cooling fan motor is required:

	Ordering number
Separated cooling fan motor	A06B-6134-K002

5 HOW TO SELECT THE AMPLIFIER

5.1 SELECTING A SEPARATED REGENERATIVE DISCHARGE RESISTOR

For details, see Section 5.1, "SELECTING A SEPARATED REGENERATIVE DISCHARGE RESISTOR" in the Part I, "β*i*SV".

5.2 CAUTIONS FOR INSTALLING A SEPARATED REGENERATIVE DISCHARGE RESISTOR

For details, see Subsection 5.1.5, "Cautions for Installing a Separated Regenerative Discharge Resistor" in the Part I, "β*i*SV".

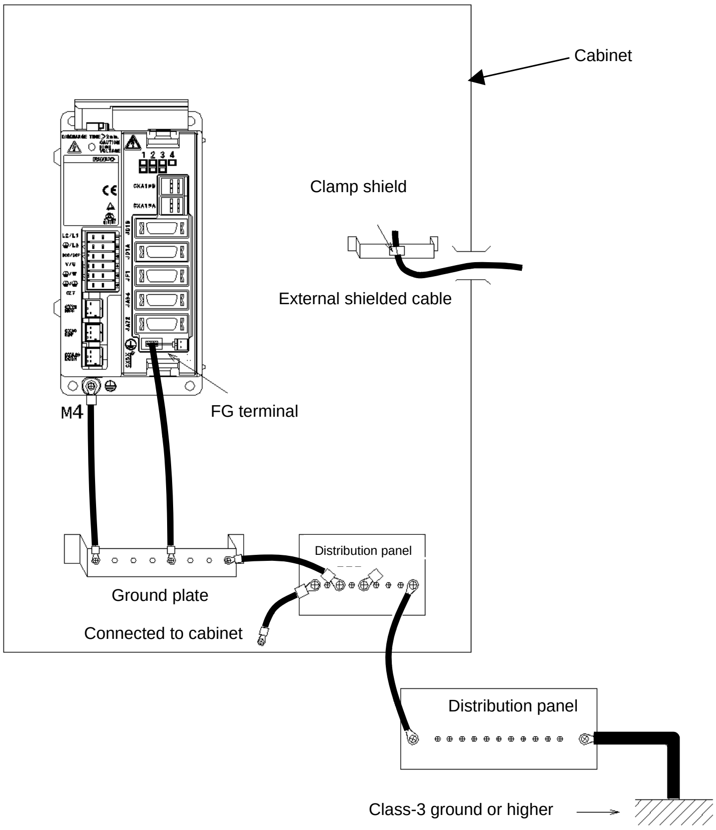
6 INSTALLATION

For details, see Chapter 6, "INSTALLATION" in the Part I, "β*i*SV".
In the drawings contained in Sections 6.4, "FITTING A LIGHTNING SURGE PROTECTION DEVICE (POWER SUPPLY OF 200-VAC INPUT SERIES)" and 6.5, "FITTING A LIGHTNING SURGE PROTECTION DEVICE (POWER SUPPLY OF 400-VAC INPUT SERIES)" in Part I, "β*i*SV", replace magnetic contactors and AC line filters with each other.

6.1 GROUND

For details, see Section 6.2, "GROUND" in the Part I, "β*i*SV".

6.2 βiSV4 AND βiSV20



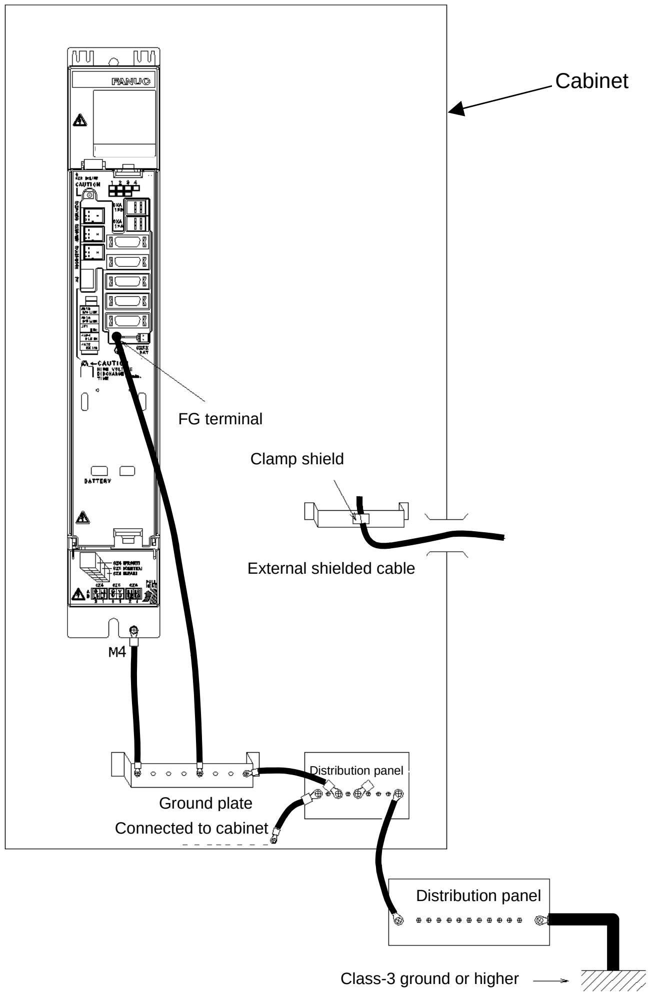
⚠ **CAUTION**

1 Ground the shield of the cable drawn from the outside of the cabinet to the ground plate provided near the cabinet inlet with a clamp. This is to prevent noise on the cable shield outside the cabinet from getting into the cabinet and also to prevent noise inside the cabinet from radiating outside.

2 Connect the FG terminal of the βiSV to a ground. Use a Faston terminal (A65L-0001-0148/2) as the terminal on the βiSV side. Use a 2-mm^2 or thicker twisted cable with a length of around 100 to 300 mm for installation. If the FG terminal is not grounded as mentioned here, the unit becomes more susceptible to noise.

3 The flange of the βiSV has an M4 threaded hole for grounding. Use this hole for grounding as shown in the above figure.

6.3 βiSV40, βiSV80, βiSV10HV, βiSV20HV, AND βiSV40HV



⚠ **CAUTION**

1 Ground the shield of the cable drawn from the outside of the cabinet to the ground plate provided near the cabinet inlet with a clamp. This is to prevent noise on the cable shield outside the cabinet from getting into the cabinet and also to prevent noise inside the cabinet from radiating outside.

2 Connect the FG terminal of the βiSV to a ground. Use a Faston terminal (A65L-0001-0148/2) as the terminal on the βiSV side. Use a 2-mm^2 or thicker twisted cable with a length of around 100 to 300 mm for installation. If the FG terminal is not grounded as mentioned here, the unit becomes more susceptible to noise.

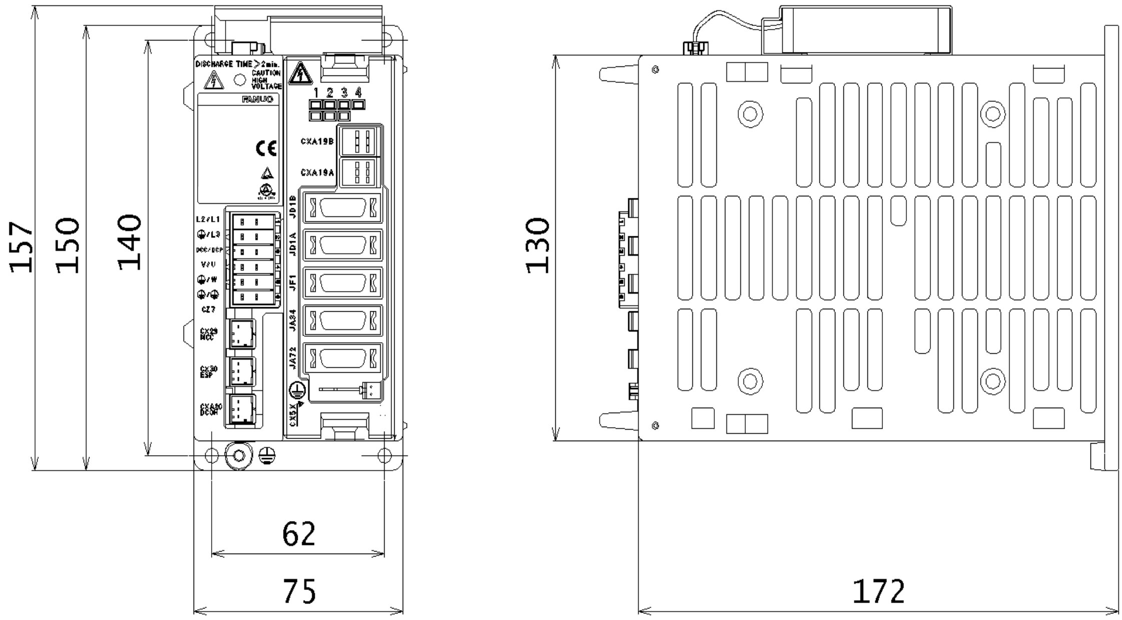
3 The flange of the βiSV has an M4 threaded hole for grounding. Use this hole for grounding as shown in the above figure.

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

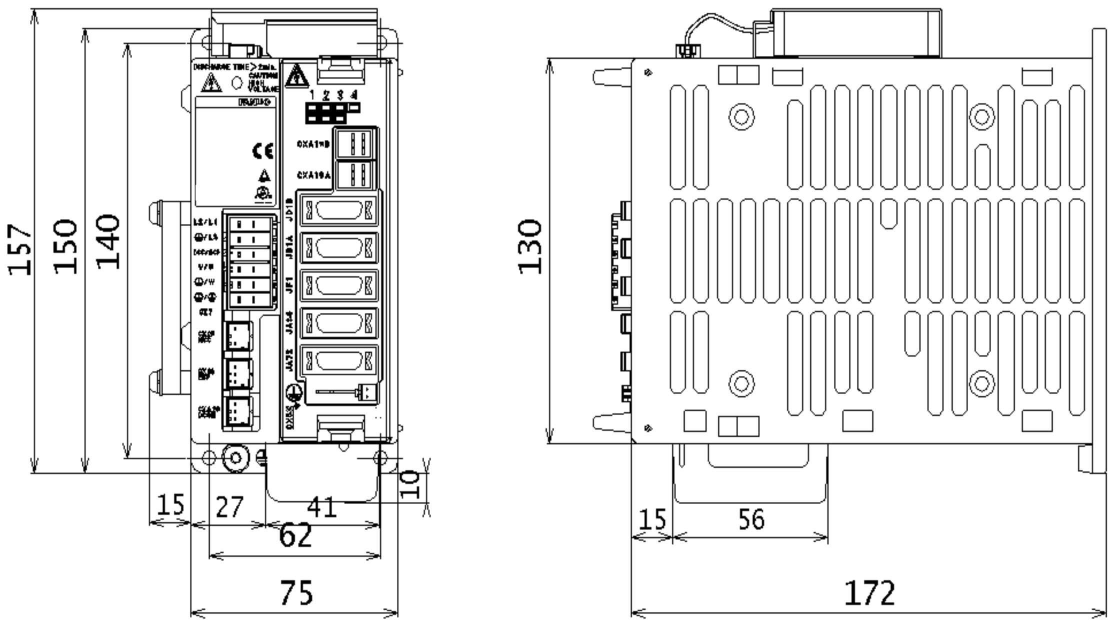
7.1 EXTERNAL DIMENSIONS

7.1.1 β*i*SV4 and β*i*SV20

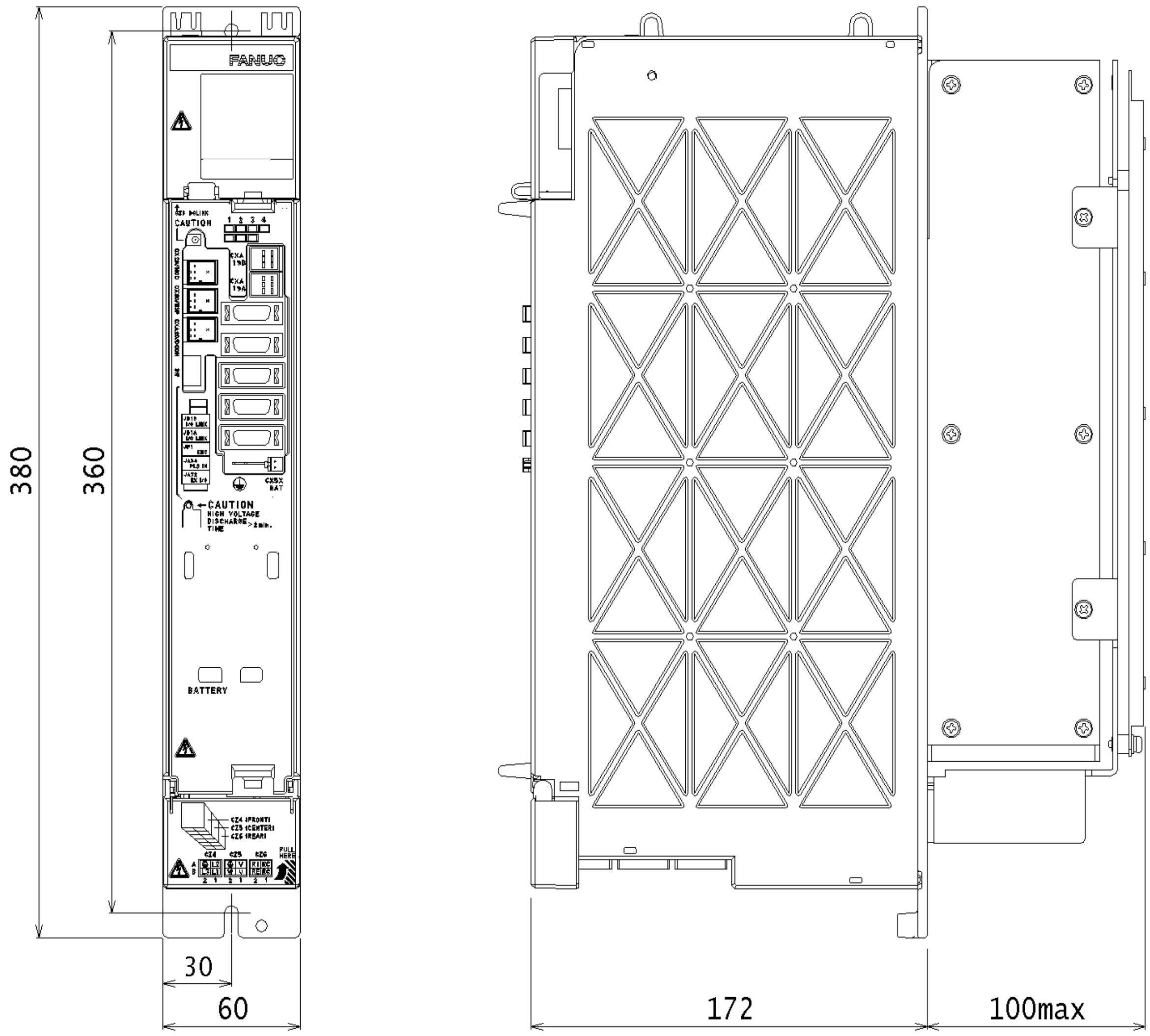
(a) Amplifier alone



(b) Amplifier with a separated regenerative discharge resistor and battery attached



7.1.2 β*i*SV40, β*i*SV80, β*i*SV10HV, β*i*SV20HV, and β*i*SV40HV



7.1.3 Separated Cooling Fan Motor (A06B-6134-K002)

For details, see Subsection 8.1.4, "External Dimensions of Separated Cooling Fan Motor (A06B-6134-K002)" in the Part I, "β*i*SV".

7.1.4 Separated Regenerative Discharge Resistor

For details, see Subsection 8.1.6, "Separated Regenerative Discharge Resistor" in the Part I, "β*i*SV".

7.1.5 AC Line Filter

For details, see Subsection 8.1.7, "AC Line Filter" in the Part I, "β*i*SV".

7.1.6 Battery Case (for Size D Alkaline Battery)

For details, see Subsection 8.1.8, "Battery Case" in the Part I, "β*i*SV".

7.1.7 Circuit Breaker

For details, see Subsection 8.1.9, "Circuit Breaker" in the Part I, "β*i*SV".

7.1.8 Magnetic Contactors

For details, see Subsection 8.1.10, "Magnetic Contactors" in the Part I, "β*i*SV".

7.1.9 Lightning Surge Protector

For details, see Subsection 8.1.11, "Lightning Surge Protector" in the Part I, "β*i*SV".

7.1.10 Noise Filter

For details, see Subsection 8.1.12, "Noise Filter" in the Part I, "β*i*SV".

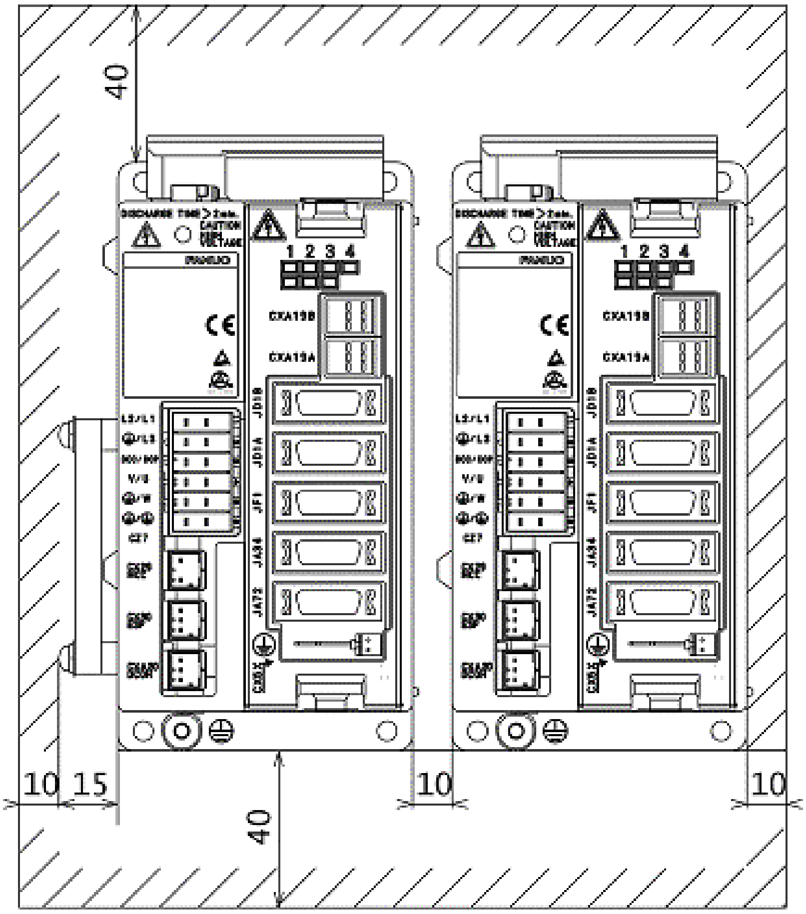
7.2 PANEL CUT-OUT

For details, see Section 8.2, "PANEL CUT-OUT" in the Part I, "β*i*SV".

7.3 MAINTENANCE AREA

7.3.1 Maintenance Area for the β*i*SV4 and β*i*SV20

The maintenance area varies depending on whether the separated regenerative discharge resistor (A06B-6130-H401) is used or not. For details, see the figure below. The maintenance area when the separated regenerative discharge resistor (A06B-6130-H401) is installed is shown on the left side of the figure, and the maintenance area when the separated regenerative discharge resistor (A06B-6130-H401) is not installed is shown on the right side. When the battery for the absolute pulse coder (dedicated lithium battery) is installed, the same maintenance area applies.



7.3.2 Maintenance Area for the β*i*SV40, β*i*SV80, β*i*SV10HV, β*i*SV20HV, and β*i*SV40HV

For details, see Subsection 8.3.2, "Maintenance Area for the β*i*SV40, β*i*SV80, β*i*SV10HV, β*i*SV20HV, and β*i*SV40HV" in the Part I, "β*i*SV".

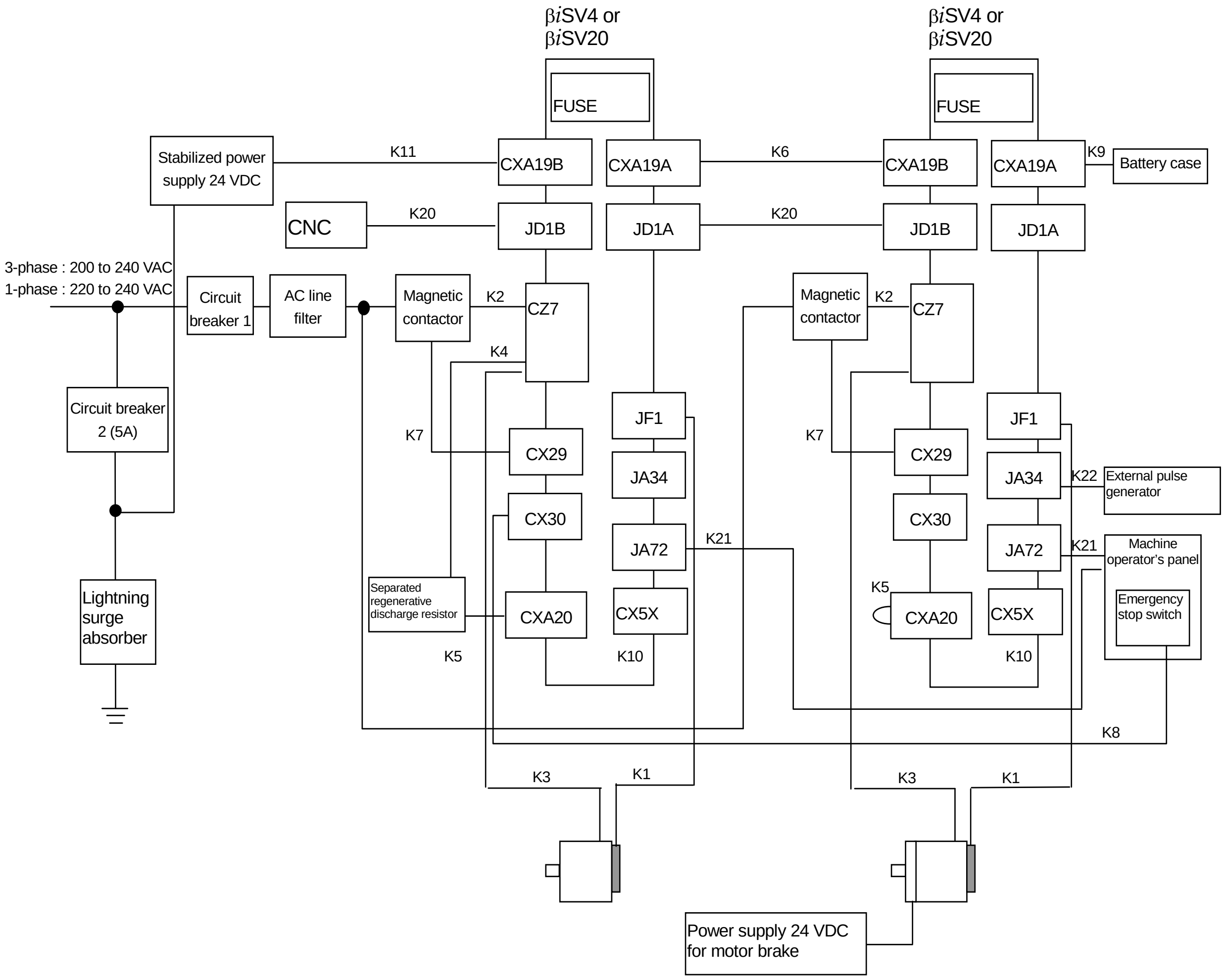
8 TOTAL CONNECTION DIAGRAM

8.1 CONNECTION DIAGRAM

8.1.1 β*i*SV4 and β*i*SV20

This subsection shows a connection example of a 2-axis system using two β*i*SVs which are the β*i*SV4 or β*i*SV20.

In this example, a separated regenerative discharge resistor is connected but no external pulse generator is connected to the β*i*SV for the first axis (the unit nearer the CNC), while no separated regenerative discharge resistor is connected but an external pulse generator is connected to the β*i*SV for the second axis.



NOTE

1 Use the stabilized power supply 24VDC for the amplifier. Power supply 24VDC for the amplifier and power supply 24VDC for the motor brake cannot be shared.

2 A circuit breakers, magnetic contactor, and AC line filter are always required.

NOTE

3 The cabling of CX30 of the second and subsequent amplifiers may be omitted. For details, see Subsection 9.2.12, “Details of Cable K8” in the part I, “βiSV” and Chapter 11, “COMBINATIONS OF DIFFERENT MODELS” in the part I, “βiSV”.

4 To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.

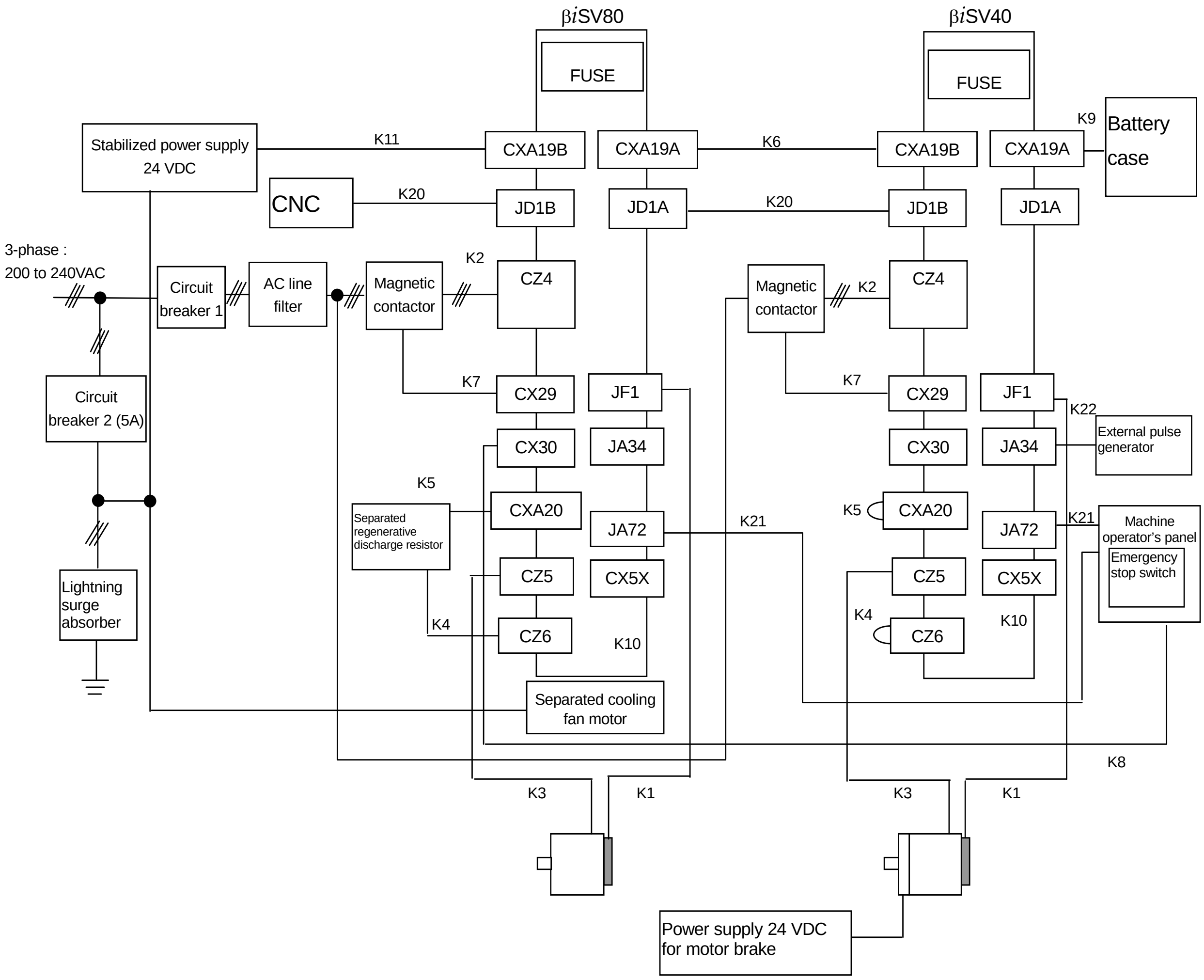
⚠ **WARNING**

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

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

8.1.2 β*i*SV40 and β*i*SV80

This subsection shows a connection example of a 2-axis system using the β*i*SV80 for the first axis (the unit nearer the CNC) and the β*i*SV40 for the second axis.
In this example, a Separated regenerative discharge resistor is connected but no external pulse generator is connected for the first axis, while no Separated regenerative discharge resistor is connected but an external pulse generator is connected for the second axis.



NOTE
1. Use the stabilized power supply 24VDC for the amplifier. Power supply 24VDC for the amplifier and power supply 24VDC for the motor brake cannot be shared.
2. A circuit breakers, magnetic contactor, and AC line filter are always required.
3. The cabling of CX30 of the second and subsequent amplifiers may be omitted. For details, see Subsection 9.2.12, “Details of Cable K8” in the part I, “β*i*SV” and Chapter 11, “COMBINATIONS OF DIFFERENT MODELS” in the part I, “β*i*SV”.
4. To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.

⚠ **WARNING**

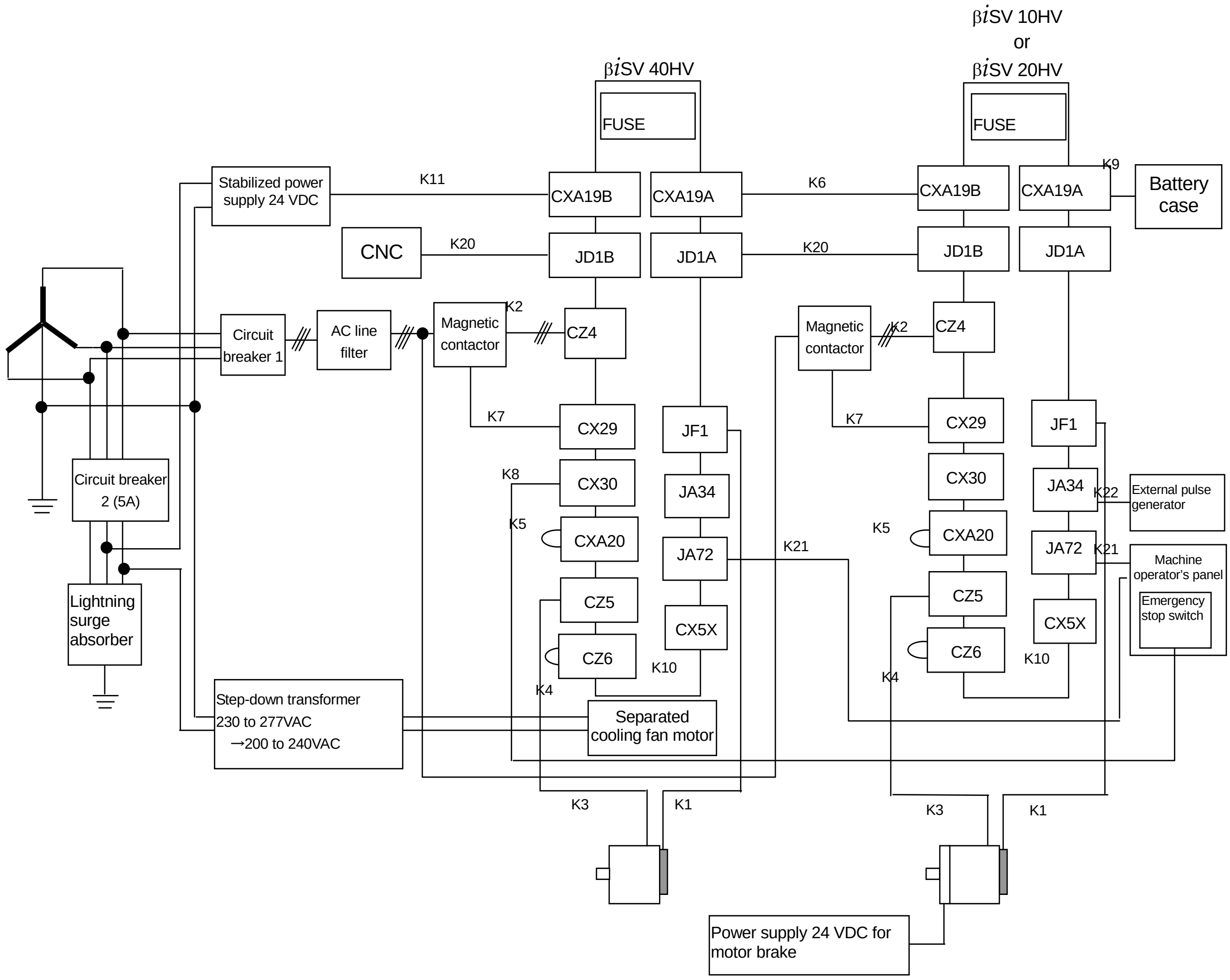
Defects, such as a loose screw and an incorrectly inserted connector, can lead to a motor malfunction, excessive heat generation, and a ground fault. Exercise adequate care in installing servo amplifiers.

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

8.1.3 β*i*SV10HV, β*i*SV20HV, and β*i*SV40HV

This subsection shows a connection example of a 2-axis system using the β*i*SV40HV for the first axis (the unit nearer the CNC) and the β*i*SV10HV or β*i*SV20HV for the second axis.
Connection of magnetic contactors includes a case in which one magnetic contactor is connected to one β*i*SV HV unit and a case in which a magnetic contactor is shared. The former case is recommended. If a magnetic contactor is shared, and an alarm that turns off the magnetic contactor is issued in one β*i*SV HV unit, the DC link low voltage alarm is issued in other β*i*SV HV units, possibly making troubleshooting difficult. If the β*i*SV HV units that share the magnetic contactor differ in the timing for releasing an emergency stop, the DC link low voltage alarm may also be issued.

(a) Example of installing one magnetic contactor for one β*i*SV HV unit (recommended)



> **NOTE**
> 1 Use the stabilized power supply 24VDC for the amplifier. Power supply 24VDC for the amplifier and power supply 24VDC for the motor brake cannot be shared.
> 2 A circuit breakers, magnetic contactor, and AC line filter are always required.
> 3 The cabling of CX30 of the second and subsequent amplifiers may be omitted. For details, see Subsection 9.2.12, “Details of Cable K8” in the part I, “β*i*SV” and Chapter 11, “COMBINATIONS OF DIFFERENT MODELS” in the part I, “β*i*SV”.

NOTE

4 To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.

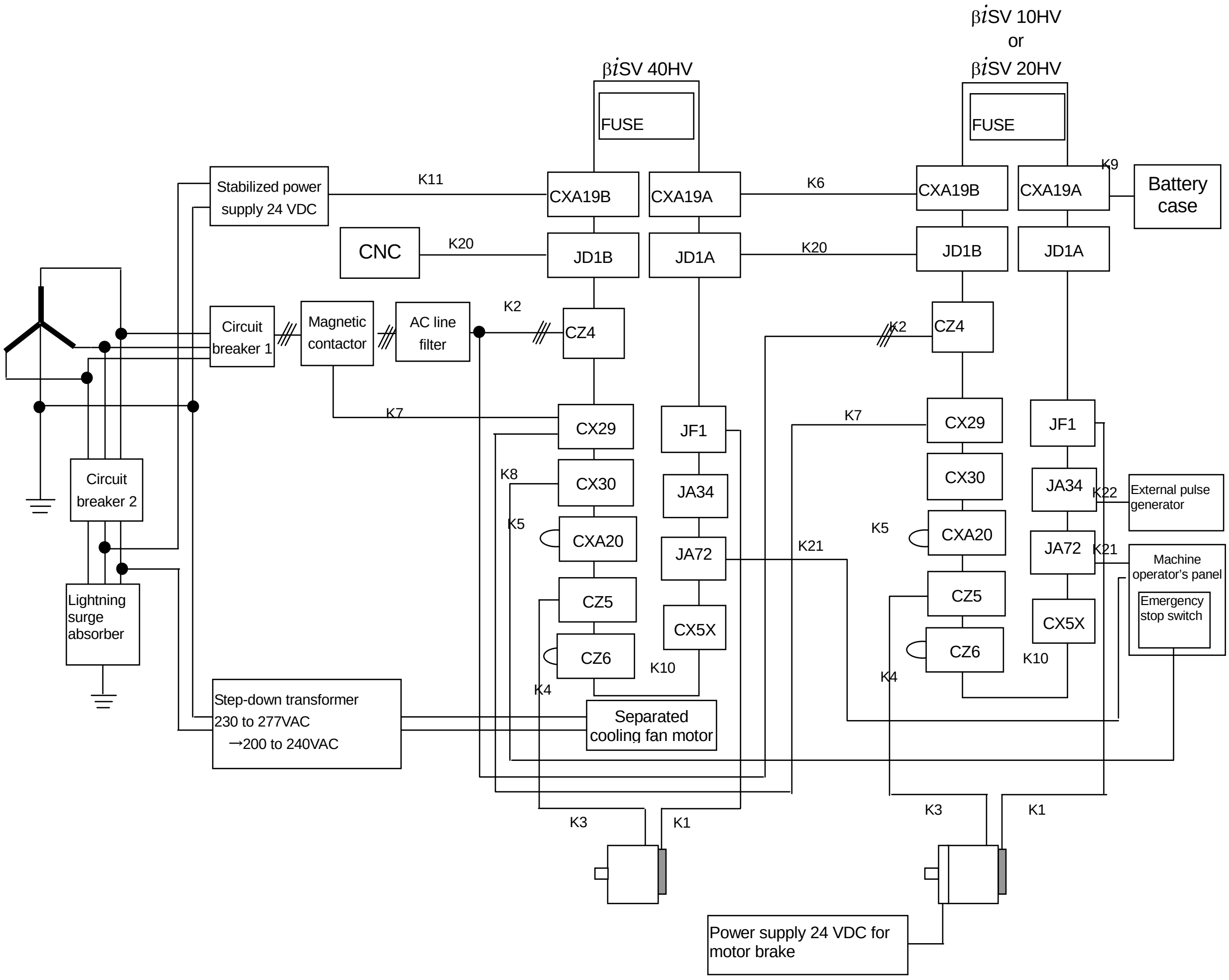
5 The input voltage of the fan unit is 200 to 240 VAC.

⚠ **WARNING**

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

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

(b) Example of sharing a magnetic contactor (reference)



NOTE

1 Use the stabilized power supply 24VDC for the amplifier. Power supply 24VDC for the amplifier and power supply 24VDC for the motor brake cannot be shared.
2 A circuit breakers, magnetic contactor, and AC line filter are always required.
3 The cabling of CX30 of the second and subsequent amplifiers may be omitted. For details, see Subsection 9.2.12, “Details of Cable K8” in the part I, “βiSV” and Chapter 11, “COMBINATIONS OF DIFFERENT MODELS” in the part I, “βiSV”.
4 To protect the equipment from lightning surge voltages, install a lightning surge absorber across each pair of power lines and across each power line and the grounding line at the power inlet of the power magnetics cabinet.
5 The input voltage of the separated cooling fan motor is 200 to 240 VAC.
6 If an alarm that turns off the magnetic contactor is issued in a βiSV HV unit, an alarm indicating DC link voltage shortage is issued in the other βiSV HV units. If the timing for releasing an emergency stop differs, an alarm indicating DC link voltage shortage may also be issued.

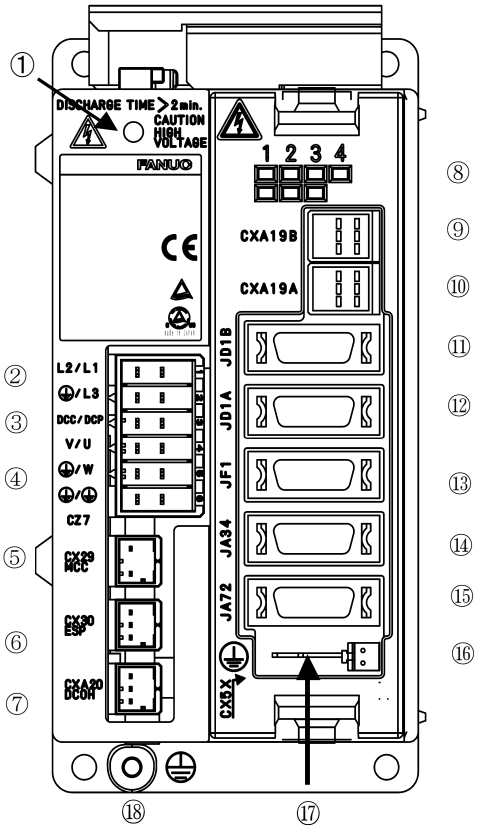
⚠ **WARNING**

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

8.2 CONNECTOR LOCATION

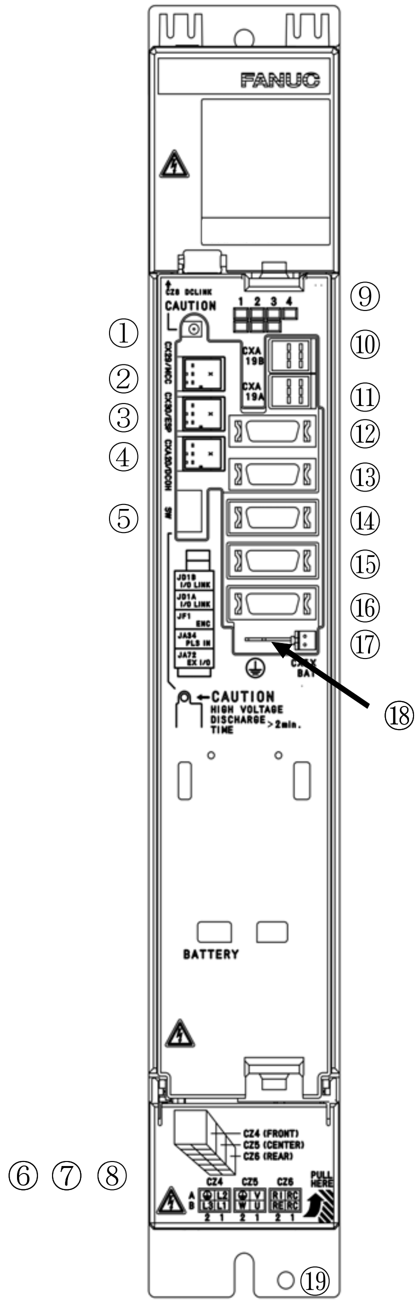
8.2.1 βiSV4 and βiSV20

No.	Name	Remarks
1		DC link charge LED
2	CZ7-1 CZ7-2	Main power input connector
3	CZ7-3	Connector for separated regenerative discharge resistor (for discharge register)
4	CZ7-4 CZ7-5 CZ7-6	Motor power connector
5	CX29	Connector for main power MCC control signal
6	CX30	ESP signal connection connector
7	CXA20	Connector for separated regenerative discharge resistor (for alarms)
8	LED	LED for status display
9	CXA19B	24VDC power input
10	CXA19A	24VDC power output
11	JD1B	Connector for I/O Link (to previous stage)
12	JD1A	Connector for I/O Link (to following stage)
13	JF1	Connector for Pulsecoder
14	JA34	Connector for external pulse input
15	JA72	Connector for built-in DI
16	CX5X	Absolute Pulsecoder battery
17	FG terminal	Grounding terminal of control section
18	⏚	Tapped hole for grounding the flange



8.2.2 β*i*SV40, β*i*SV80, β*i*SV10HV, β*i*SV20HV, and β*i*SV40HV

No.	Name	Remarks
1		DC link charge LED
2	CX29	Connector for main power MCC control signal
3	CX30	ESP signal connection connector
4	CXA20	Connector for separated regenerative discharge resistor (for alarms)
5	SW	Setting switch (DCSW alarm level)
6	CZ4	Main power input connector
7	CZ5	Motor power connector
8	CZ6	Connector for separated regenerative discharge resistor (for discharge register)
9	LED	LED for status display
10	CXA19B	24VDC power input
11	CXA19A	24VDC power output
12	JD1B	Connector for I/O Link (to previous stage)
13	JD1A	Connector for I/O Link (to following stage)
14	JF1	Connector for Pulsecoder
15	JA34	Connector for external pulse input
16	JA72	Connector for built-in DI
17	CX5X	Absolute Pulsecoder battery
18	FG terminal	Grounding terminal of control section
19	⏚	Tapped hole for grounding the flange



8.2.3 Connection Tools

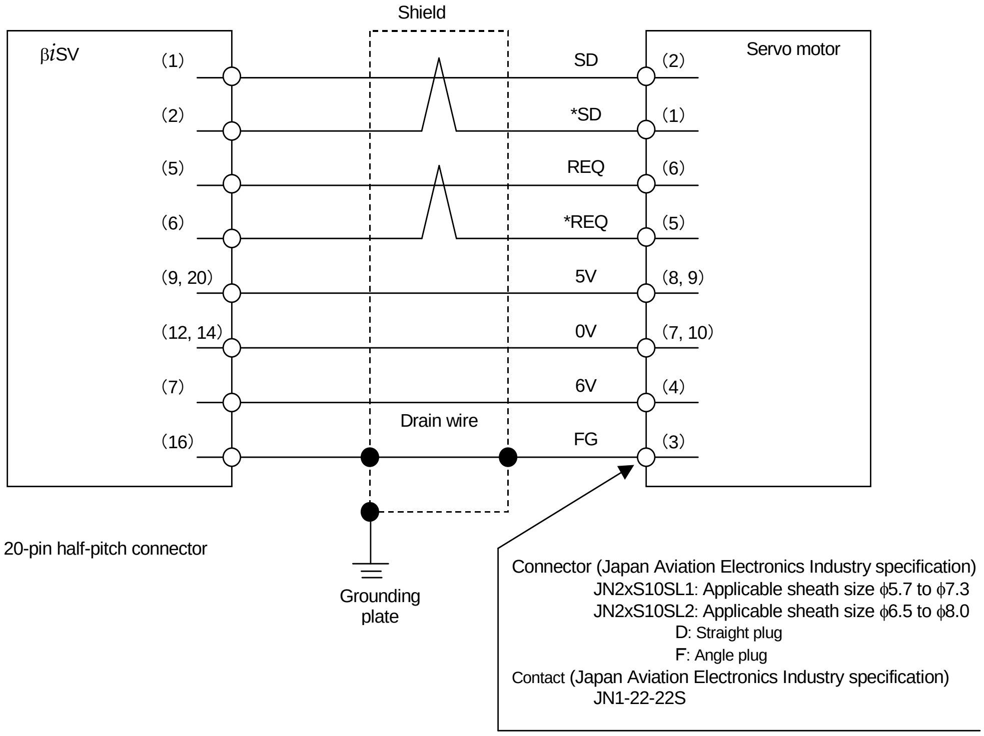
For details, see Subsection 9.2.5, "Connection Tools" in the Part I, "β*i*SV".

8.2.4 Details of Cable K1

8.2.4.1 α*i*S and α*i*F series servo motors, β*i*S (β*i*S0.4/5000 to β*i*S40/2000), β*i*Sc, and β*i*F series servo motors

Cable K1 is used to connect the β*i*SV and Pulsecoder.

> ⚠ **WARNING**
> If the connector (JF*) of the Pulsecoder is connected incorrectly, an unpredictable motor operation may occur.



Using cable conductor

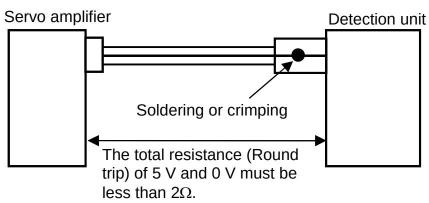
Signal name	Cable length: 28 m or less	Cable length: 50 m or less
5V, 0V,6V	$0.3mm^2$ ×5 (Note 4) Strand configuration: 12/0.18 or 60/0.08 Insulation outer diameter: ϕ0.8 to ϕ1.5	$0.5mm^2$ × 5 (Note 4) Strand configuration: 20/0.18 or 104/0.08 Insulation outer diameter: ϕ0.8 to ϕ1.5
SD,*SD,REQ,*REQ	$0.18mm^2$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

See Appendix A, "CABLES", for detailed explanations about the cable.

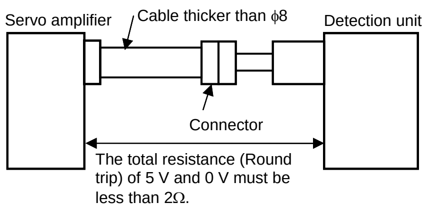
NOTE

1 The ground plate to which the shield is connected must be placed as close as possible to the servo amplifier so that distance between the ground plate and the servo amplifier becomes shortest.
2 In case that the cable is prepared by MTB, total resistance of 5V and 0V must be less than 2Ω.
3 Pulsecoder side connector can accept maximum 0.5mm^2 (wire construction 20/0.18 or 104/0.08, insulation outer diameter ϕ1.5 or less) wire and sheath diameter is ϕ5.7 to ϕ8.0. In case of using thicker wire or cable, take measures described below.

[Case 1] Cable conductor exceeds 0.5mm^2.



[Case 2] Sheath diameter of exceeds ϕ8.



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

- Crimp tool specification
  A06B-6114-K201/JN1E: For 0.18mm^2 and 0.3mm^2
  A06B-6114-K201/JN1D: For 0.18mm^2 and 0.5mm^2

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

- Recommended cable
  A66L-0001-0479: Flexible cable 28 m or less
  A66L-0001-0488: Flexible cable 50 m or less

8.2.4.2 β*i*S series servo motors (β*i*S0.2/5000 and β*i*S0.3/5000)

For details, see Subsection 9.2.6.2, "β*i*S series servo motors (β*i*S0.2/5000 and β*i*S0.3/5000)" in the Part I, "β*i*SV".

8.2.5 Details of Cable K2

For details, see Subsection 9.2.7, "Details of Cable K2" in the Part I, "β*i*SV".

8.2.6 Details of Cable K3

For details, see Subsection 9.2.8, "Details of Cable K3" in the Part I, "β*i*SV".

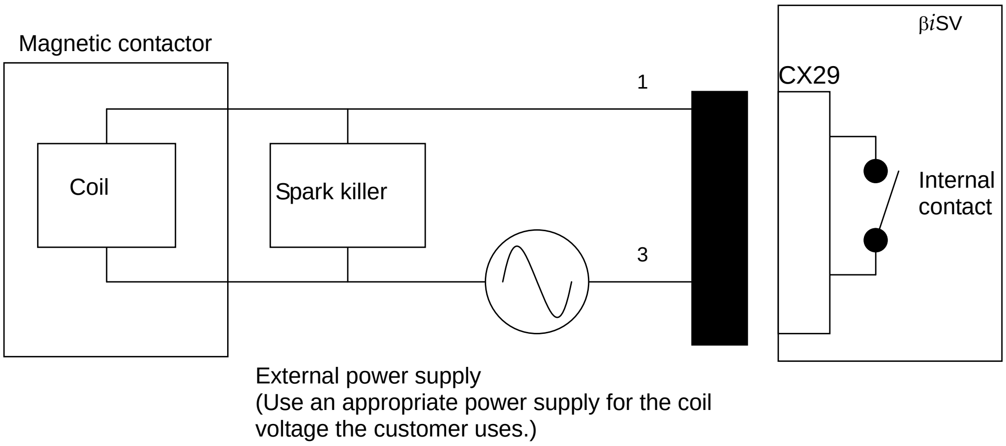
8.2.7 Details of Cables K4 and K5

For details, see Subsection 9.2.9, "Details of Cables K4 and K5" in the Part I, "β*i*SV".

8.2.8 Details of Cable K6

For details, see Subsection 9.2.10, "Details of Cable K6" in the Part I, "β*i*SV".

8.2.9 Details of Cable K7



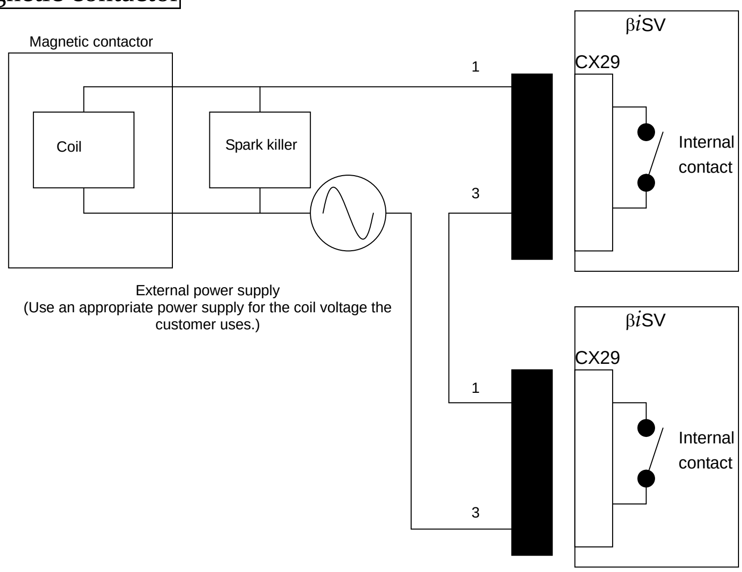
D-2000 series
Housing : 3-1318130-3
Contact : 1318107-1
Applicable wire: 0.3 to 0.85 mm^2
Manufacture : Tyco Electronics AMP

Internal contact capacity

	Resistance load (COSϕ=1)	Inductive load (COSϕ=0.4, L/R=15msec)
Rated load	250VAC, 3A / 24VDC, 5A	250VAC, 2A / 24VDC, 1A
Maximum contact capacity	5A	5A

NOTE
1. To protect the internal contact, be sure to insert a spark killer (CR) that matches the magnetic contactor used.
2. It is recommended that one MCC be installed per β*i*SV.

When sharing a magnetic contactor



8.2.9.1 Connection of external magnetic contactor when β*i*SV FSSB interface is used together

For details, see Section 11.1, "β*i*SV (FSSB)と β*i*SV (I/O Link Option)" in the Part I, "β*i*SV".

8.2.10 Details of Cable K8

For details, see Subsection 9.2.12, "Details of Cable K8" in the Part I, "β*i*SV".

8.2.11 Details of Cable K9

For details, see Subsection 9.2.13, "Details of Cable K9" in the Part I, "β*i*SV".

8.2.12 Details of Cable K10

For details, see Subsection 9.2.14, "Details of Cable K10" in the Part I, "β*i*SV".

8.2.13 Details of Cable K11

For details, see Subsection 9.2.15, "Details of Cable K11" in the Part I, "β*i*SV".

8.2.14 Details of Cable K20 (Connection of FANUC I/O Link)

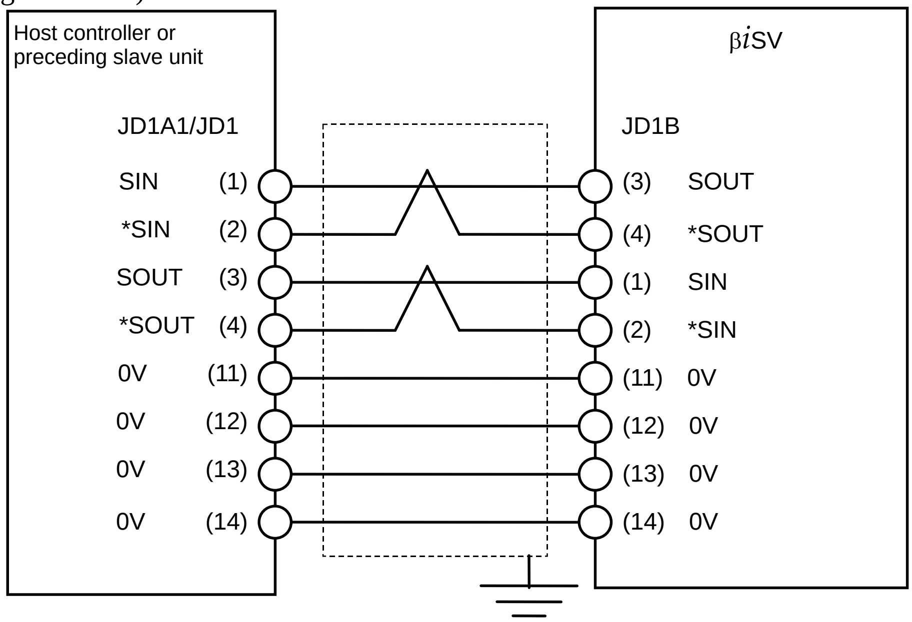
8.2.14.1 Overview

The FANUC I/O Link is a serial interface that connects a CNC, β*i*SV, I/O Unit MODEL A, and other units to transfer I/O signals (bit data) between these units at high speed. When units are connected by the FANUC I/O Link, one of the units serves as a master, and the other units serve as slaves. The status of input signals from the slaves is transferred to the master at regular intervals, and an output signal from the master is transferred to the slaves at regular intervals. The β*i*SV can function as a slave only. It has 128 input signals and 128 output signals.
The connectors of the I/O Link are named JD1A (or JD1A1) and JD1B, which are common to all units having the I/O Link function. Every cable must be connected from JD1A (or JD1A1) to JD1B. JD1A of the last unit is connected to nothing, so it is left open. It need not be connected to a terminator or the like.
Electric cables or optical fiber cables are used for I/O Link connection. In the following cases, use optical fiber cables:

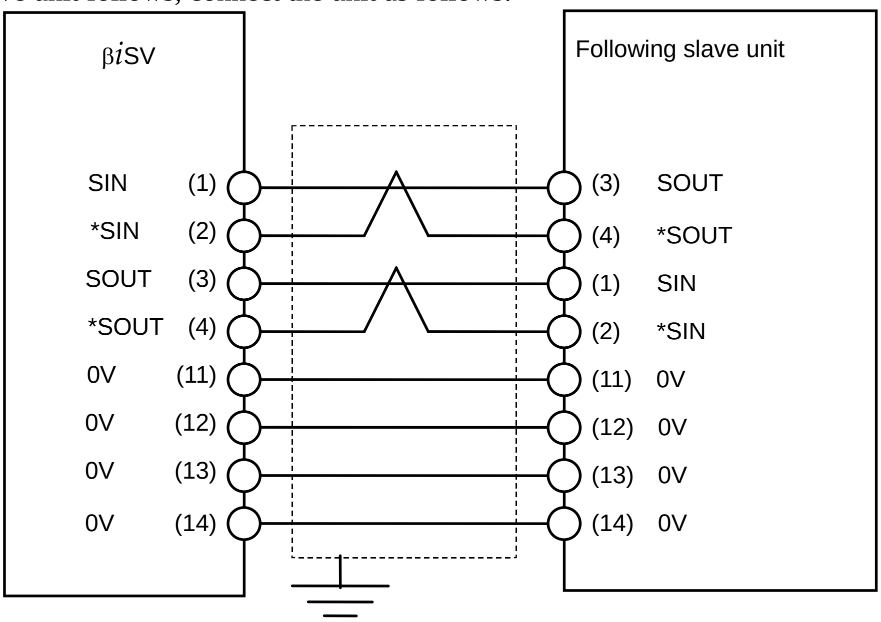
- The cable length is 10 m or longer. When units are located within the same cabinet, the cable length is 15 m or longer. When a cable is installed in a duct, the units connected at both ends of the cable should be assumed to be within the same cabinet. For example, suppose that a CNC serving as the host is placed on the operator's panel, the β*i*SV is placed in the power magnetics cabinet, and the I/O Link cable connecting these units is passed through a duct. In this case, the CNC and β*i*SV are assumed to be within the same cabinet.
- A cable is routed between different cabinets, and it is impossible to connect the cabinets with a 5.5-mm^2 or thicker ground cable.
- There is a possibility that a cable is affected by noise significantly. For example, there is a strong electromagnetic noise source such as a welding machine near the cable, or a cable generating noise such as a power cable or a power magnetics cable is laid in parallel to the cable over a long distance.

8.2.14.2 Connection of FANUC I/O Link by electric cable

(a) Details of connection by cable K20 (when the β*i*SV is connected to the host controller or the preceding slave unit)



(b) Details of connection by cable K20 (when connected to the following slave unit)
When a slave unit follows, connect the unit as follows:



Specifications of recommended connector and case of cable K20 on the β*i*SV side
Connector : PCR-E20FS (soldering type) (Honda Tsushin)
PCR-E20FA (crimp type)
Case : PCR-V20L

Recommended cable for cable K20
A66L-0001-0284#10P (10 twisted pairs, 28AWG, with common shield)

NOTE
1 Maximum cable length: 10m (when the above recommended cable is used)

NOTE

2 Be sure to use twisted pairs to connect the SIN and *SIN signals and the SOUT and *SOUT signals in pairs.
3 Except the pins indicated in the above figure, leave pins open. Never connect unused conductors of the cable to these pins.
4 Connect the shield of the cable to the ground plate of the cabinet by using a cable clamp. Regardless of whether the β*i*SV is connected to the host controller (or the preceding slave unit) or the following slave unit, clamp the cable and process the shield properly as soon as the cable is drawn into the cabinet. When the host controller and the β*i*SV are placed in different cabinets, shield processing must be performed in two places for one cable. Even when the cable is not drawn outside the cabinet, it must be clamped for shield processing in at least one place.

8.2.14.3 Connection of FANUC I/O Link by optical fiber cable

When an optical I/O Link adapter is used, FANUC I/O Link can be extended to up to 200 m by using optical fiber cables.
For details, refer to the manual on the host controller.

8.2.15 Details of Cable K21 (Internal DI Connection)

8.2.15.1 Signals

The β*i*SV has five DI signals. For the connection of the emergency stop signal, see Subsections 9.2.12, "Details of Cable K8" and 9.2.10, "Details of Cable K6" in the Part I, "β*i*SV". The other four DI signals are explained below.

(1) *+OT :
A + overtravel signal input.
When this signal is set to "logic 0", movement in the positive direction is disabled.
Use of this signal can be suppressed by parameter setting.

(2) *-OT :
A - overtravel signal input.
When this signal is set to "logic 0", movement in the negative direction is disabled.
Use of this signal can be suppressed by parameter setting.

(3) *RILK(*DEC) :
An interlock signal input (*RILK) or a reference position return deceleration signal input (*DEC). One of these functions is selected by parameter setting. When the interlock signal input (*RILK) is selected, setting this signal to "logic 0" decelerates then stops axis movement operation. Setting this signal to "logic 1" resumes the operation. When the reference position return deceleration signal input (*DEC) is selected, setting this signal to "logic 0" decelerates the feedrate, then feed operation continues at a constant low feedrate. If the signal is then set to "logic 1", the feed operation stops as an electrical grid position is encountered.

(4) HDI :
Skip signal input.
The currently executed block is skipped at the rising edge or falling edge of this signal. Whether to use the rising edge or falling edge of the signal is determined by parameter setting.

8.2.15.2 *+OT, *-OT, and *RILK(*DEC)

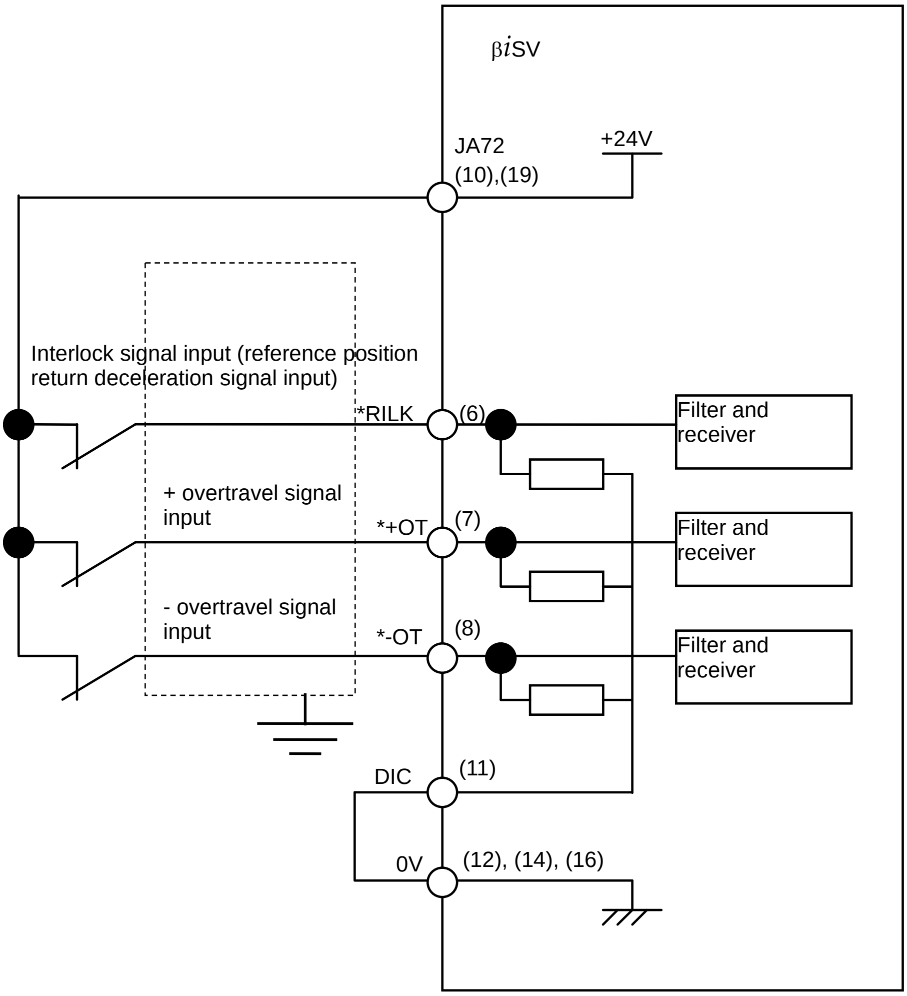
• Input signal specifications

The receiving circuit has a non-insulating interface that can switch between the sink type (24 V common) and the source type (0 V common). Safety standards require use of the sink type.

The contacts on the machine side must satisfy the following:

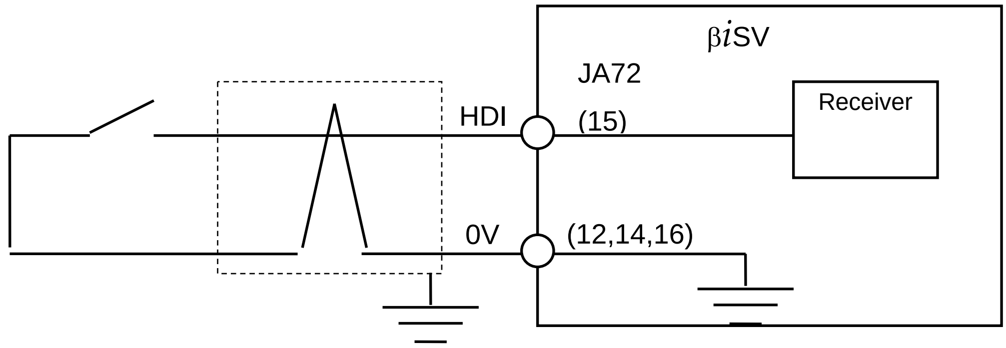
Contact capacity: 30 VDC, 16 mA or more
Leak current between contact points when a contact is closed: 1 mA or less (voltage: 26.4 V)
Voltage drop between contact points when a contact is closed:
  2 V or less (current: 8.5 mA, including voltage drop in cable)

• Signal connection to power magnetics cabinet



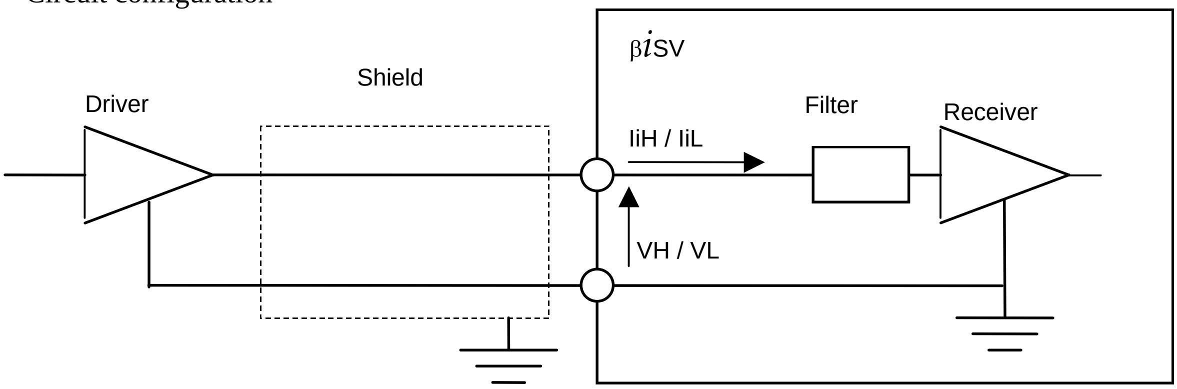
NOTE
1 Use a common shield cable as cable K21.
2 For 0V, +24V, and DIC, wires of at least 7/0.18 (0.18mm^2) must be used.
3 Except the pins indicated in the above figure, leave pins open. Never connect unused conductors of the cable to these pins.
4 The above shows an example of the 24 V common type.
  When the 0 V common type is used, connect DIC (JA72-11) to +24V (JA72-10, and 19), and the later stage of each switch to 0V (JA72-12, 14, and 16).

8.2.15.3 Skip signal interface



• Input signal specifications

- Circuit configuration



- Maximum absolute rating
  Input voltage range Vin: -3.6 V to +13.6 V

- Input characteristics

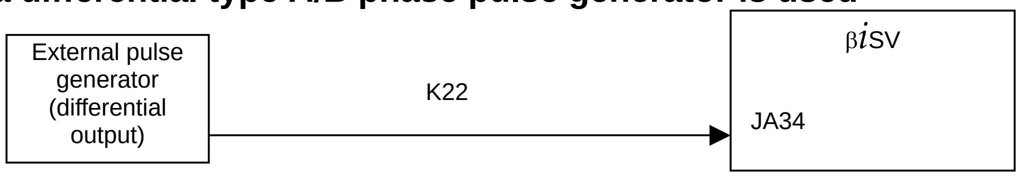
Item	Signal	Specification	Unit	Remarks
High level input voltage	VH	3.6 to 11.6	V	
Low level input voltage	VL	0 to 0.55	V	
High level input current	IiH	2 max	mA	Vin=5V
		11 max	mA	Vin=10V
Low level input current	IiL	-8.0 max	mA	Vin=0V
Input signal pulse width		20 min	μs	

NOTE
The positive sign (+) of IiH/IiL indicates the direction in which current flows into the receiver, and the negative sign (-) indicates the direction in which current flows out of the receiver.

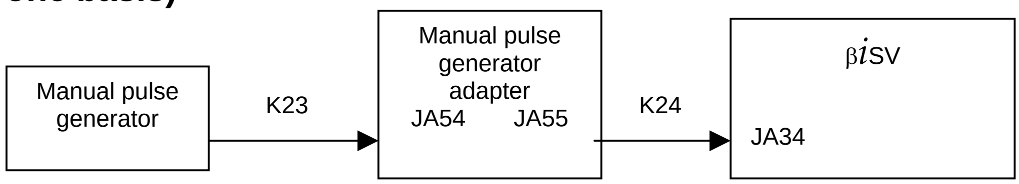
8.2.16 Connection to External Pulse Generator

The β*i*SV can operate according to the pulse input from the outside.
As the external pulse generator, a differential type A/B phase pulse generator that satisfies specifications or FANUC's manual pulse generator may be selected. When selecting the manual pulse generator, you need a manual pulse generator adapter (A06B-6093-D001).
One manual pulse generator can be connected to up to six β*i*SV units. In this case, one manual pulse generator adapter is required per β*i*SV unit.

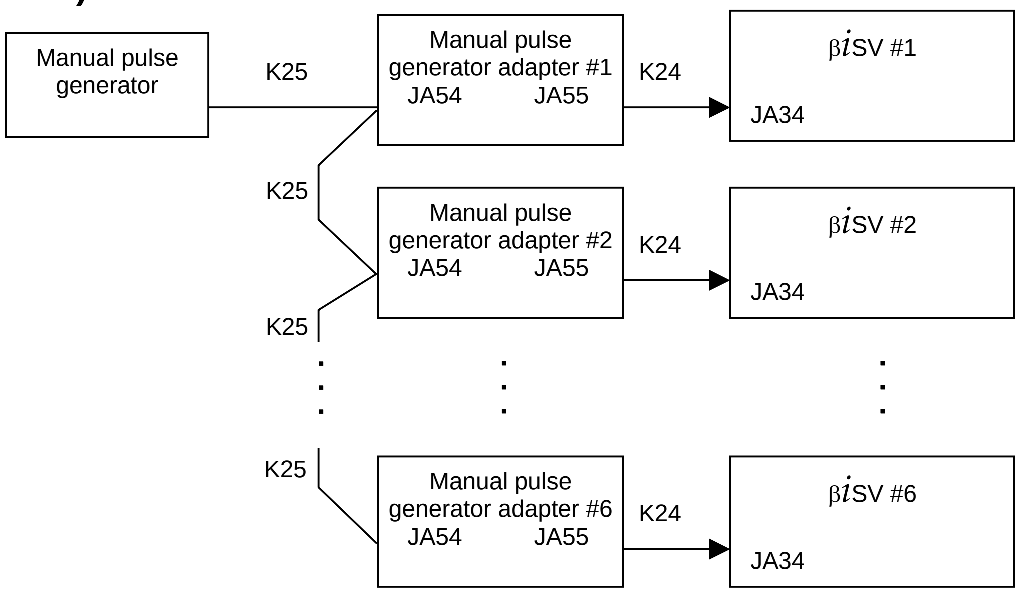
- **When a differential type A/B phase pulse generator is used**



- **When FANUC's manual pulse generator is used (connected to β*i*SV on a one-to-one basis)**

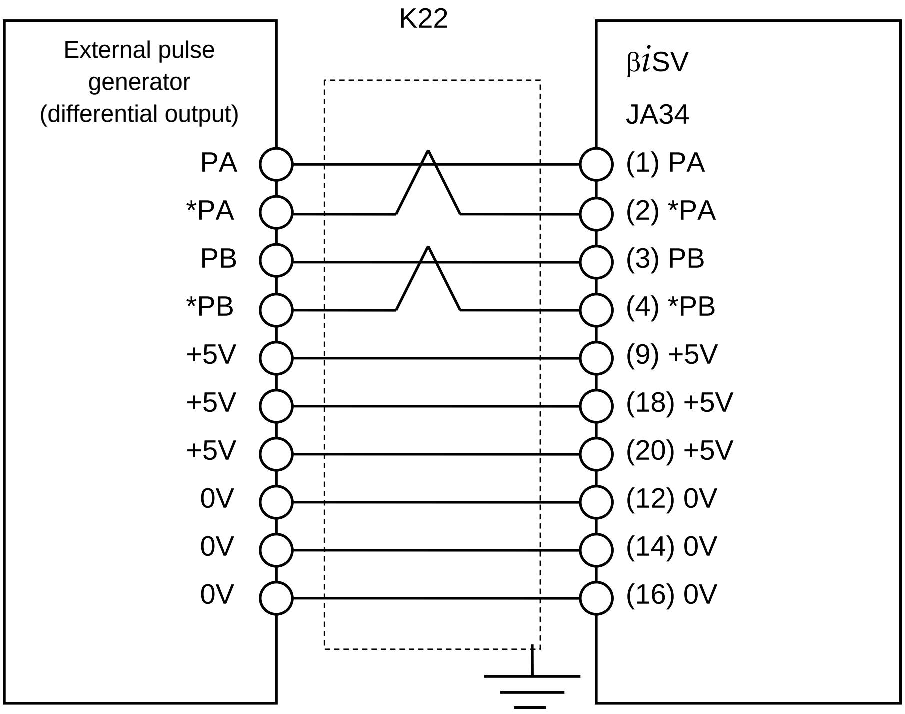


- **When FANUC's manual pulse generator is used (connected to more than one β*i* SVM)**



8.2.16.1 Connection when differential type A/B phase pulse generator is used

Details of cable K22



Connector: FI40-2015S (Hirose Electric Co., Ltd.)
Case: FI-20-CV (Hirose Electric Co., Ltd.)

Cable specification: Conductor 20/0.18 × 6, 7/0.18 × 3 pairs
Recommended cable: A66L-0001-0286 (#20AWG × 6 + #24AWG × 6 + #24AWG × 3 pairs)

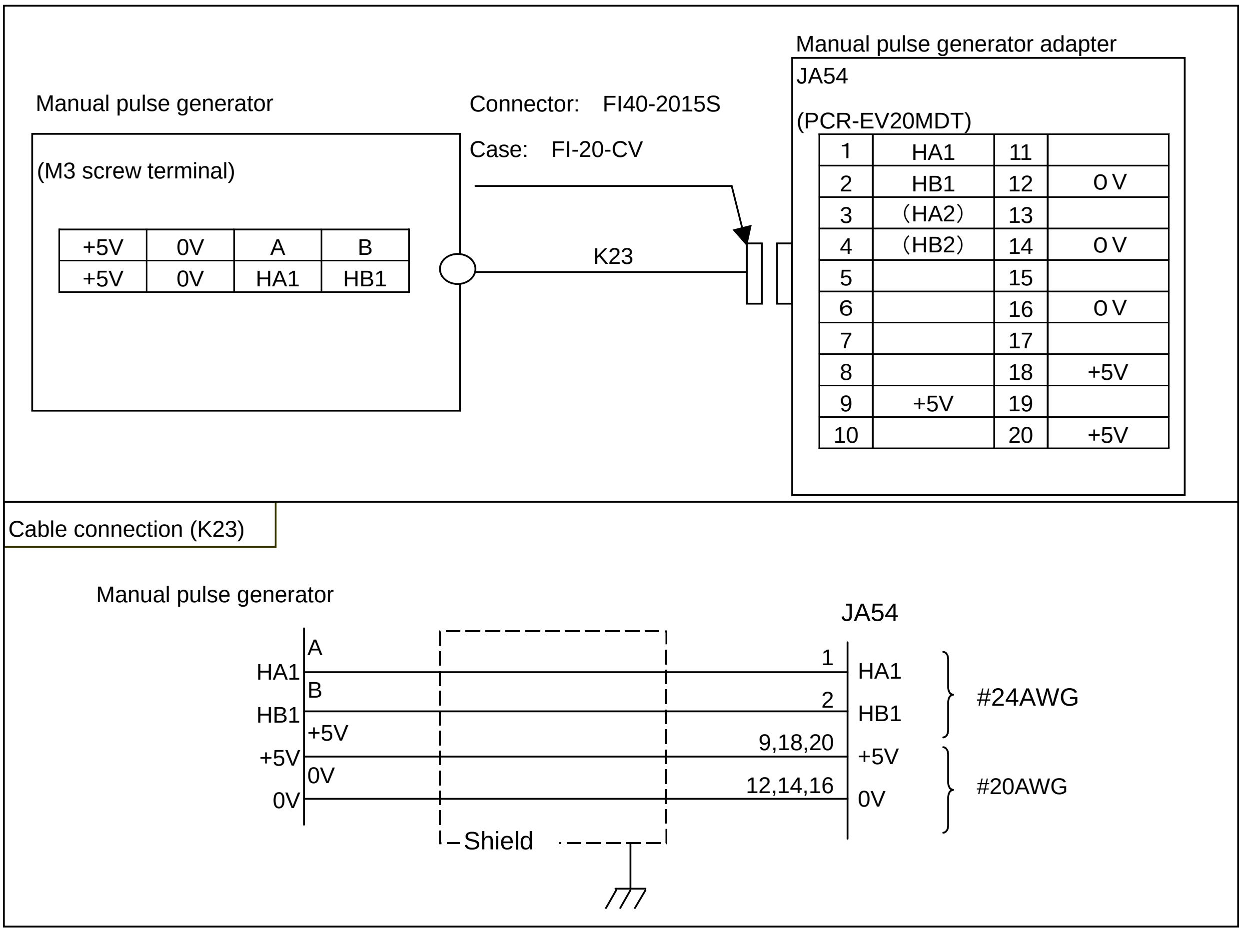
NOTE

1. Power can be supplied from the βiSV to the equipment if the equipment operates on +5 V and 0.35 A maximum. In this case, pay attention to the power supply voltage drop due to cable resistance.
2. Be sure to use twisted pairs to connect the PA and *PA signals and the PB and *PB signals in pairs.
3. Except the pins indicated in the above figure, leave pins open. Never connect unused conductors of the cable to these pins.
4. Maximum cable length: 50 m

8.2.16.2 Connection when FANUC's manual pulse generator is used

Details of cable K23

Cable K23 is a signal cable used to connect the manual pulse generator and adapter (JA54).



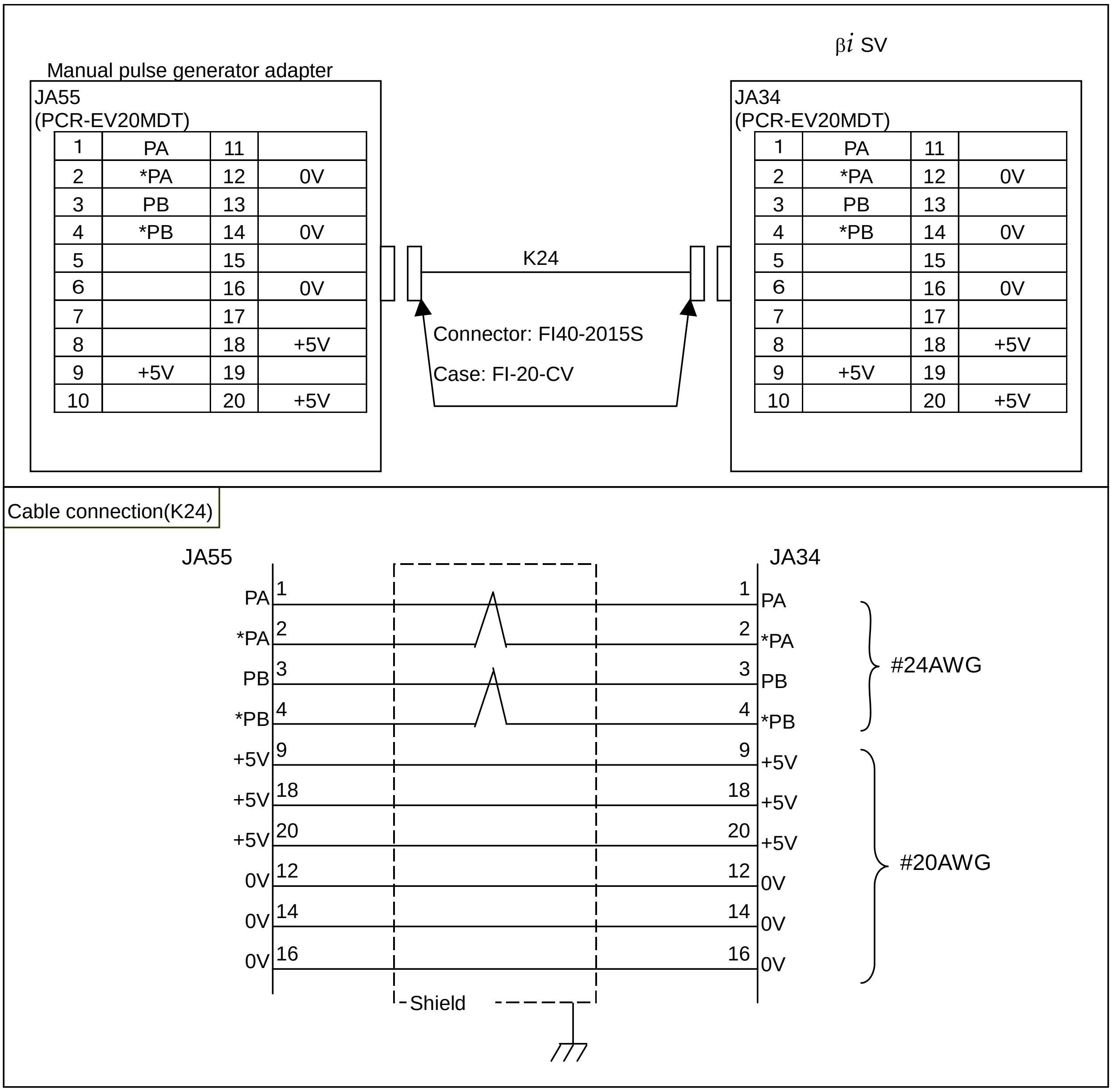
Recommended cable: A66L-0001-0286 (#20AWG × 6 + #24AWG × 3 pairs)
Recommended connector (JA54 side): A02B-0120-K303
Recommended cable: A02B-0259-K821(7m), Change the connector name before use.

Although the maximum cable length is 50 m, the length is further limited because of the power supply voltage drop as follows:

Limitation due to power supply voltage drop
Suppress the power supply voltage drop due to the cable resistance to 0.2 V or less (the sum of the voltage drop of both the 0V and 5V lines).
Perform calculation assuming that the power supply current of the manual pulse generator is 0.1 A.
In the calculations, the cable length must include the cable length of K24.

Details of cable K24

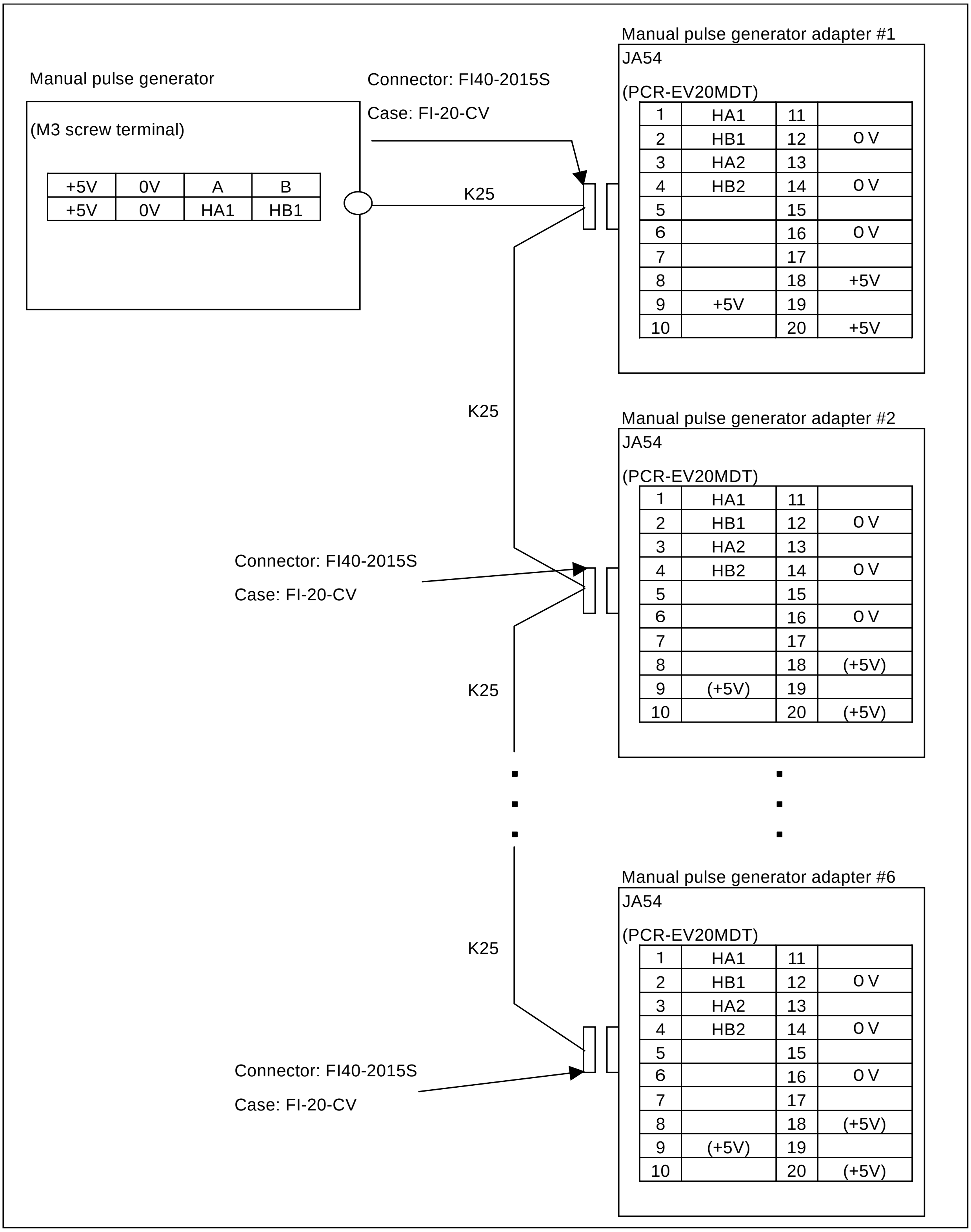
Cable K24 is a signal cable used to connect the manual pulse generator adapter (JA55) and the β*i*SV (JA34).



Recommended cable: A66L-0001-0286 (#20AWG × 6 + #24AWG × 3 pairs)
Recommended connector: A02B-0120-K303
The maximum cable length is 5 m.

Details of cable K25

Cable K25 is a signal cable used to connect the manual pulse generator and more than one manual pulse generator adapter (JA54).



Manual pulse generator (M3 screw terminal)

+5V	0V	A	B
+5V	0V	HA1	HB1

Manual pulse generator adapter #1, JA54 (PCR-EV20MDT)

1	HA1	11	
2	HB1	12	0 V
3	HA2	13	
4	HB2	14	0 V
5		15	
6		16	0 V
7		17	
8		18	+5V
9	+5V	19	
10		20	+5V

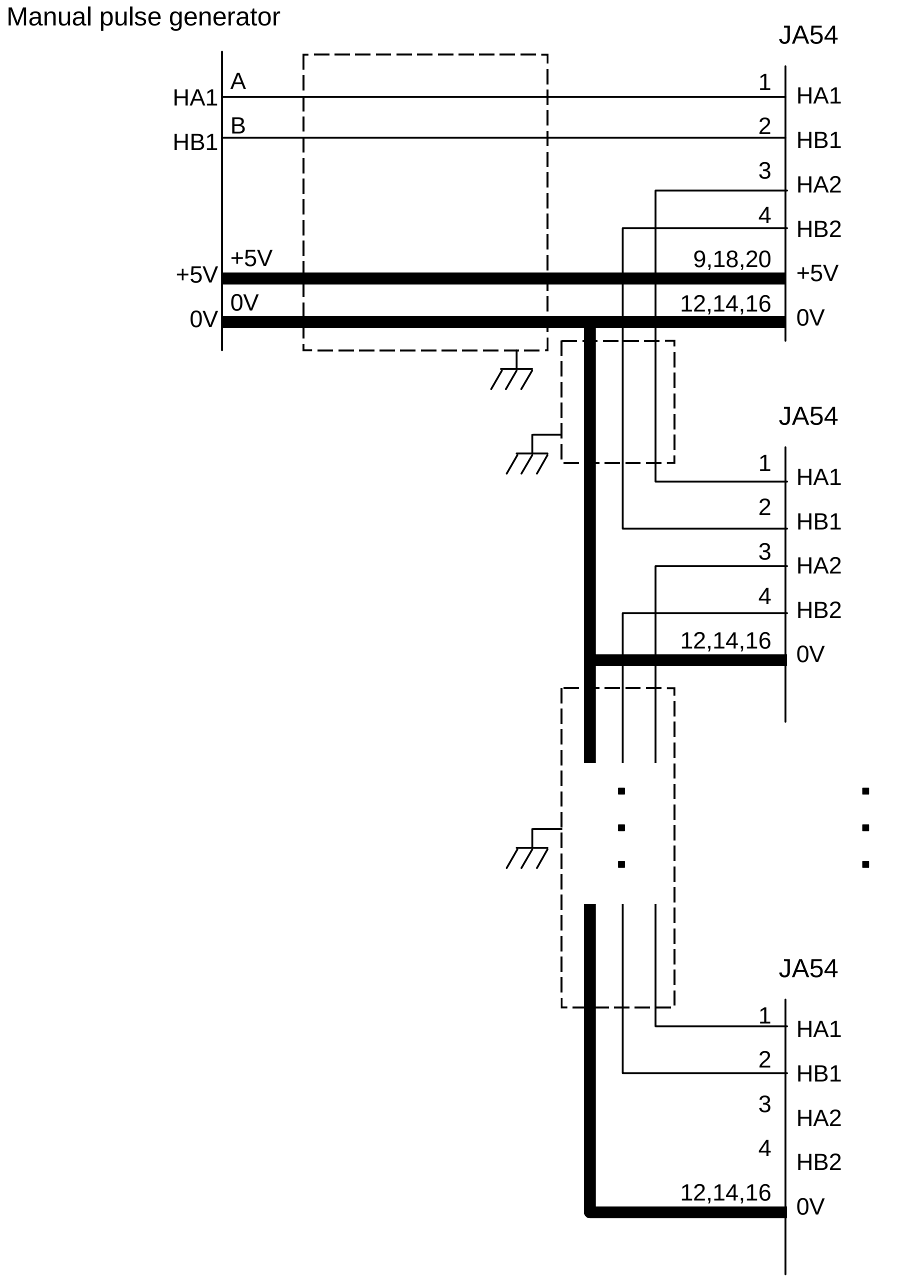
Manual pulse generator adapter #2, JA54 (PCR-EV20MDT)

1	HA1	11	
2	HB1	12	0 V
3	HA2	13	
4	HB2	14	0 V
5		15	
6		16	0 V
7		17	
8		18	(+5V)
9	(+5V)	19	
10		20	(+5V)

Manual pulse generator adapter #6, JA54 (PCR-EV20MDT)

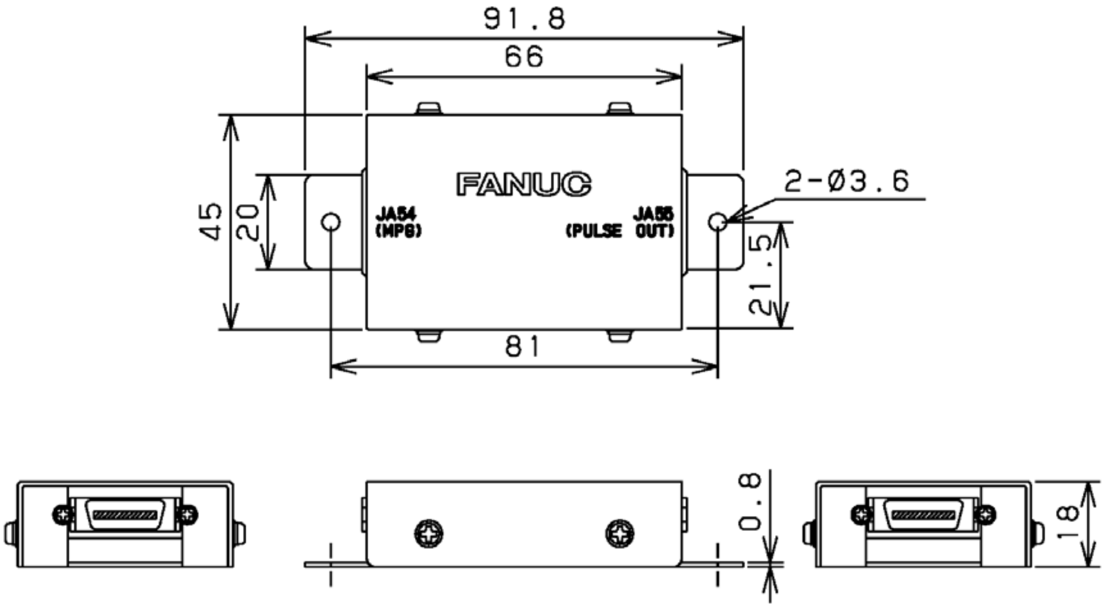
1	HA1	11	
2	HB1	12	0 V
3	HA2	13	
4	HB2	14	0 V
5		15	
6		16	0 V
7		17	
8		18	(+5V)
9	(+5V)	19	
10		20	(+5V)

Cable connection (K25)
The bold lines indicate that three conductors are used for connection.



Manual pulse generator adapter

• Dimensions



Weight: Approximately 100 g

• Installation condition

Because the manual pulse generator adapter does not have a sealed structure, it must be installed in a sealed cabinet similar to the cabinet of the β*i*SV.

The manual pulse generator adapter has two 3.6-diameter holes. Use these holes to secure the adapter.

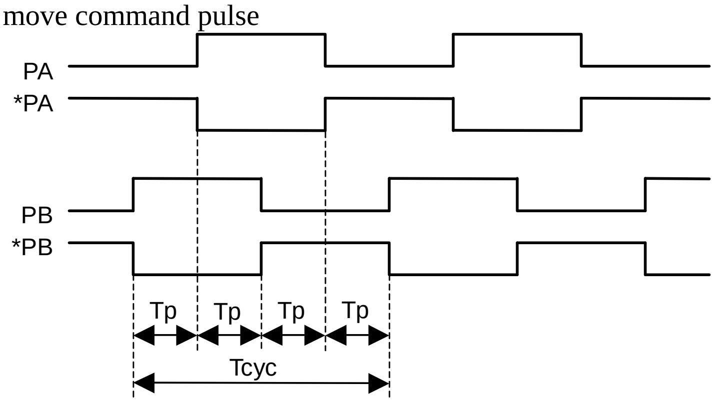
Because being lightweight, the manual pulse generator adapter need not secured with screws. However, be careful not to allow the adapter to touch other electrical circuits to cause short-circuit.

Ground the case by using the case mounting screw of the manual pulse generator adapter.

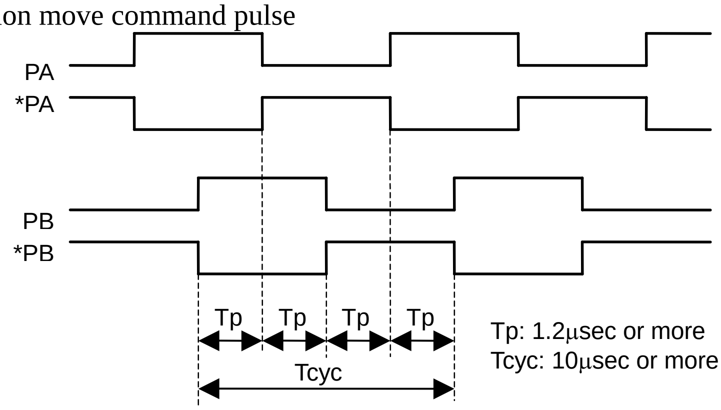
• Operation conditions

The maximum allowable frequency of the input signals is 100 kHz. The β*i*SV multiplies input pulses by four to obtain move commands. Therefore, up to 400 kpps is specified as a move command.

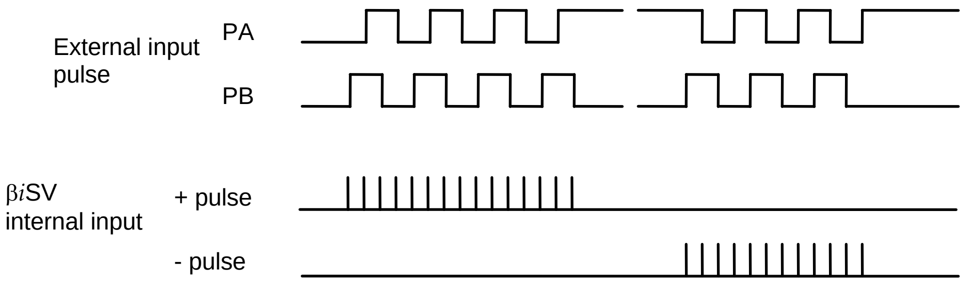
(a) Positive direction move command pulse



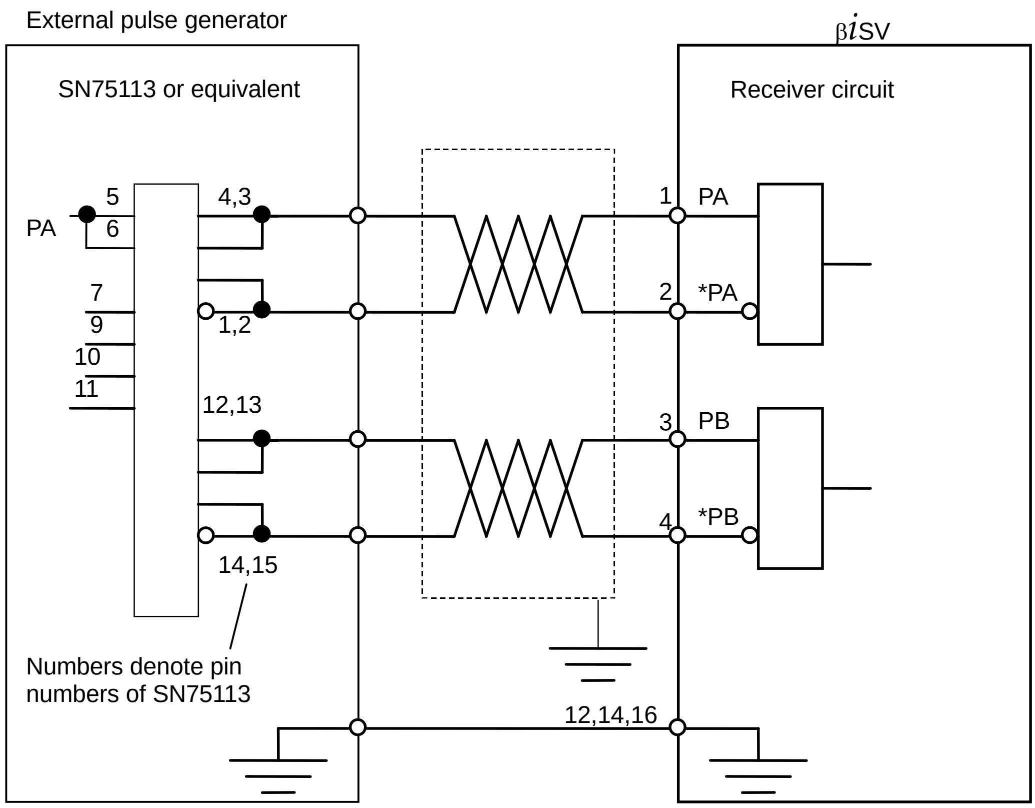
(b) Negative direction move command pulse



(c) Sequence



• Recommended circuit example



8.2.17 Connection to Servo Check Board

The servo check board converts digital values used for control in the digital servo system into analog voltages to allow observation with instruments such as an oscilloscope.

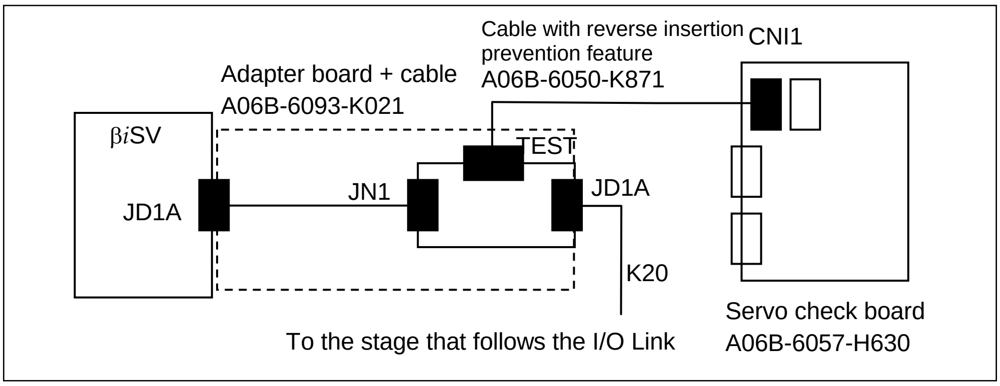
Ordering specification

A cable with a reverse connection prevention feature and a servo check board adapter are required to connect the servo check board to the β*i*SV.

Ordering specification	Name
A06B-6057-H630	Servo check board
A06B-6050-K871	Cable with reverse connection prevention feature
A06B-6093-K021	Servo check board adapter (adapter board and cable, both dedicated to β*i*SV)

Connection

Before installing and removing the servo check board, turn off the power to the β*i*SV.



> **NOTE**
> The servo check board adapter and the servo check board may be connected only when adjustments are made. Never start operation while they are left connected.

9 HEAT DISSIPATION

For details, see Chapter 10, "HEAT DISSIPATION" in the Part I, "βiSV".

APPENDIX

A 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.
The table below lists the cables we have developed for interface connectors.
Contact the manufacturers as required.

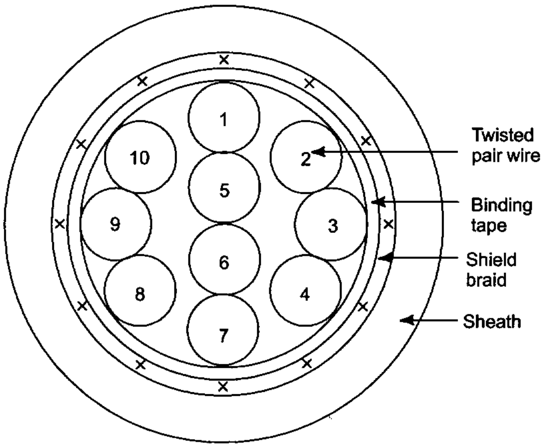
Cable name	Purpose		Configuration	FANUC specification	Manufacturer	Manufacturer specification
10-pair cable	For general use		0.09mm^2 10 pairs	A66L-0001-0284#10P	Hitachi Electric Cable Co., Ltd.	UL20276-SB(0) 10P×28AWG(7/0.127)
					Oki Electric Cable Co., Ltd.	7/0.127 10P VX10-SV
Composite 7-core cable	For Pulsecoder For α*i*CZ sensor (serial output)	28m or less Flexible	0.3mm^2 5 cables 0.20mm^2 1 pairs	A66L-0001-0460	Hitachi Electric Cable Co., Ltd.	UL20276-SB(FLEX) 5×23AWG+1P×25AWG
		50m or less Flexible	0.5mm^2 5 cables 0.20mm^2 1 pairs	A66L-0001-0462	Hitachi Electric Cable Co., Ltd.	UL20276-SB(FLEX) 5×20AWG＋1P×25AWG
		28m or less Fixed	0.3mm^2 5 cables 0.18mm^2 1 pairs	A66L-0001-0481	Hitachi Electric Cable Co., Ltd.	UL20276-SB(0) 5×23AWG+1P×25AWG
		50m or less Fixed	0.5mm^2 5 cables 0.18mm^2 1 pairs	A66L-0001-0491	Hitachi Electric Cable Co., Ltd.	UL20276-SB(0) 5×20AWG+1P×25AWG
Composite 9-core cable	For Pulsecoder	28m or less Flexible	0.3mm^2 5 cables 0.20mm^2 2 pairs	A66L-0001-0479	Hitachi Electric Cable Co., Ltd.	UL20276-SB(FLEX) 5×23AWG+2P×25AWG
		50m or less Flexible	0.5mm^2 5 cables 0.20mm^2 2 pairs	A66L-0001-0488	Hitachi Electric Cable Co., Ltd.	UL20276-SB(FLEX) 5×23AWG+2P×25AWG
Composite 10-core cable	For α*i*M sensor (for α*i*I 0.5) For α*i*MZ sensor (for α*i*I 0.5) For α*i*BZ sensor (small type)		0.3mm^2 2 cables 0.2mm^2 4 pairs	A66L-0001-0482	Hitachi Electric Cable Co., Ltd.	UL20276-SB(FLEX) 2×23AWG+4P×25AWG
Composite 12-core cable	For α*i* position coder For α position coder S		0.5mm^2 6 cables 0.18mm^2 3 pairs	A66L-0001-0286	Hitachi Electric Cable Co., Ltd.	F-CO-VV(0)-SB 6×0.5SQ+3P×O.18SQ
					Oki Electric Cable Co., Ltd.	MIX12C(7/0.18, 20/0.18) HRS-SV
10-pair cable	For α*i*BZ sensor (conventional type)		0.18mm^2 10 pairs	A66L-0001-0367	Shinko Electric Industries Co., Ltd.	FNC-019
Composite 16-core cable	For α*i* M sensor For α*i* MZ sensor		0.5mm^2 6 cables 0.18mm^2 5 pairs	A66L-0001-0368	Shinko Electric Industries Co., Ltd.	FNC-021

A.1 10-PAIR CABLE (FOR GENERAL USE)

(a) 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
Conductor	Size	AWG	28
	Structure	Conductors / mm	7/0.127
	Outside diameter	mm	0.38
Insulator	Thickness	mm	0.1 (Thinnest portion : 0.08(3. 1mils))
	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		Conductors / mm	Hitachi Cable : Not available Oki Electric Cable : Available, 10/0.12
Shield braid	Element wire diameter	mm	0.12
	Braid density	%	85 or more
Sheath	Color	–	Black
	Thickness	mm	1.0
	Outside diameter (approx.)	mm	6.2
Standard length		mm	200
Packing method		mm	Bundle
Electrical performance	Resistance of conductor (20°C)	Ω/km	233 or less
	Insulation resistance (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.

(b) Cable structure

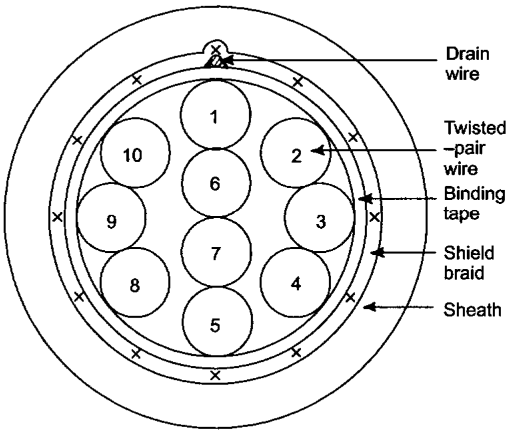


Wire identification table (Hitachi)

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.B.1(a) Cable made by Hitachi Electric 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.B.2(b) Cable made by Oki Electric Cable

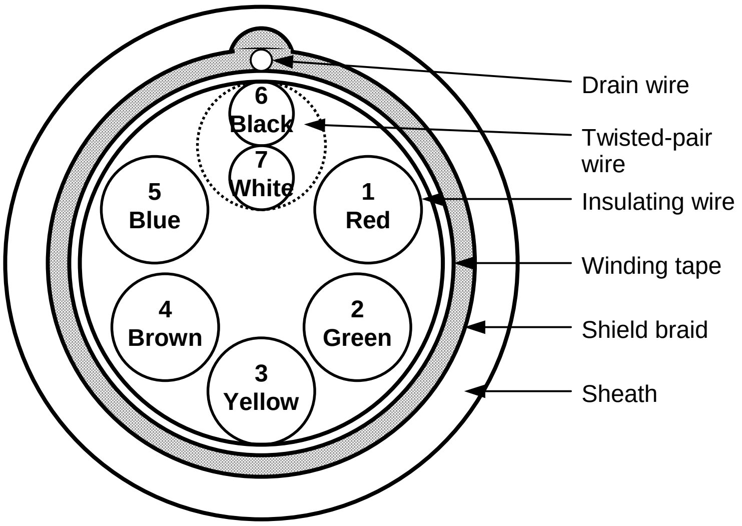
A.2 COMPOSITE 7-CORE CABLE

(a) Specifications of A66L-0001-0460

Item		Unit	Specifications	
Product No.		–	A66L-0001-0460	
Manufacturer		–	Hitachi Cable,Ltd.	
Rating		–	80°C, 30V	
Material	Conductor, braid-shielded wire, drain wire	–	Strand wire of tinned annealed copper (JIS C3152)	
	Insulator	–	Fluorine plastics (ETFE)	
	Sheath	–	Heat-resistant oilproof vinyl	
Number of wires (wire nos.)		Cores	5(1 to 5)	2(one pair)(6 to 7)
Conductor	Size	mm^2	0.3	0.20
	Structure	Conductors / mm	60/0.08	40/0.08
	Outside diameter	mm	0.72	0.58
Insulator	Standard thickness	mm	0.15	0.15
	Outside diameter	mm	1.02	0.88
Twisted pair	Outside diameter	mm	-	1.76
	Pitch (approx.)	mm	-	13
Lay diameter (approx.)		mm	3.4	
Drain wire	Size	mm^2	0.15	
	Structure	Conductors / mm	30/0.08	
	Outside diameter	mm	0.51	
Shield braid	Element wire diameter	mm	0.12	
	Thickness	mm	0.3	
	Braid density	%	85 or more	
	Outside diameter (approx.)	mm	4.2	
Sheath	Color	–	Black	
	Standard thickness	mm	1.0	
	Standard outside diameter (approx.)	mm	6.2	
	Outside diameter allowance	mm	5.7 to 7.3 (Note)	
Standard length		m	200	
Packing method		–	Bundle	
Electrical performance	Resistance of conductor (20°C)(wire nos.)	Ω/km	69.5 or less (1 to 5)	109 or less (6 to 7)
	Insulation resistance (20°C)	MΩ-km	100 or more	
	Dielectric strength (AC)	–	500VAC for 5 minutes	
Flame resistance		–	Shall pass flame resistance test VW-1 of UL standards.	

NOTE
The maximum outside diameter applies to portions other than the drain wire.

(b) Cable structure of A66L-0001-0460



The colors in the figure indicate the colors of insulators.

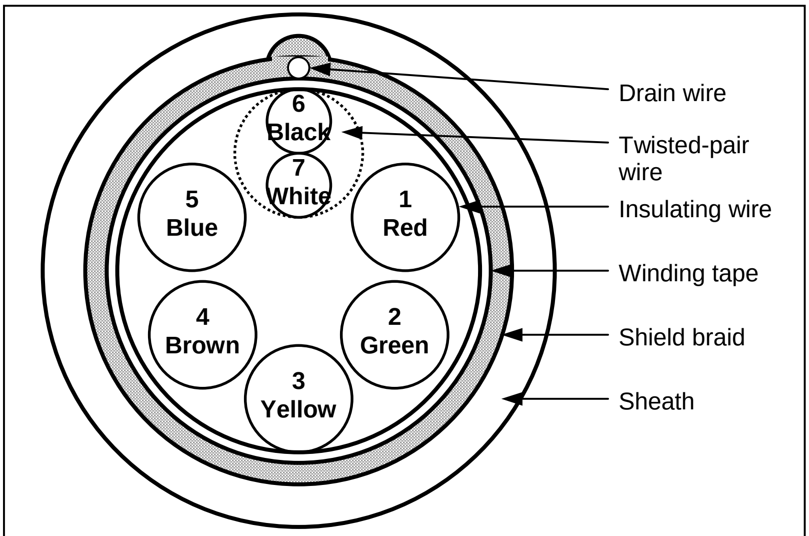
(c) Specifications of A66L-0001-0462

Item		Unit	Specifications	
Product No.		–	A66L-0001-0462	
Manufacturer		–	Hitachi Cable,Ltd.	
Rating		–	80°C, 30V	
Material	Conductor, braid-shielded wire, drain wire	–	Strand wire of tinned annealed copper (JIS C3152)	
	Insulator	–	Fluorine plastics (ETFE)	
	Sheath	–	Heat-resistant oilproof vinyl	
Number of wires (wire nos.)		Cores	5(1 to 5)	2(one pair)(6 to 7)
Conductor	Size	mm^2	0.5	0.20
	Structure	Conductors / mm	104/0.08	40/0.08
	Outside diameter	mm	0.94	0.58
Insulator	Standard thickness	mm	0.2	0.15
	Outside diameter	mm	1.34	0.88
Twisted pair	Outside diameter	mm	-	1.76
	Pitch (approx.)	mm	-	13
Lay diameter (approx.)		mm	4.2	
Drain wire	Size	mm^2	0.15	
	Structure	Conductors / mm	30/0.08	
	Outside diameter	mm	0.51	
Shield braid	Element wire diameter	mm	0.12	
	Thickness	mm	0.3	
	Braid density	%	85 or more	
	Outside diameter (approx.)	mm	5.0	
Sheath	Color	–	Black	
	Standard thickness	mm	1.0	
	Standard outside diameter (approx.)	mm	7.0	
	Outside diameter allowance	mm	6.5 to 8.0 (Note)	
Standard length		m	200	
Packing method		–	Bundle	

Item		Unit	Specifications	
Electrical performance	Resistance of conductor (20°C)(wire nos.)	Ω/km	40.1 or less (1 to 5)	109 or less (6 to 7)
	Insulation resistance (20°C)	MΩ-km	100 or more	
	Dielectric strength (AC)	–	500VAC for 5 minutes	
Flame resistance		–	Shall pass flame resistance test VW-1 of UL standards.	

NOTE
The maximum outside diameter applies to portions other than the drain wire.

(d) Cable structure of A66L-0001-0462



The colors in the figure indicate the colors of insulators.

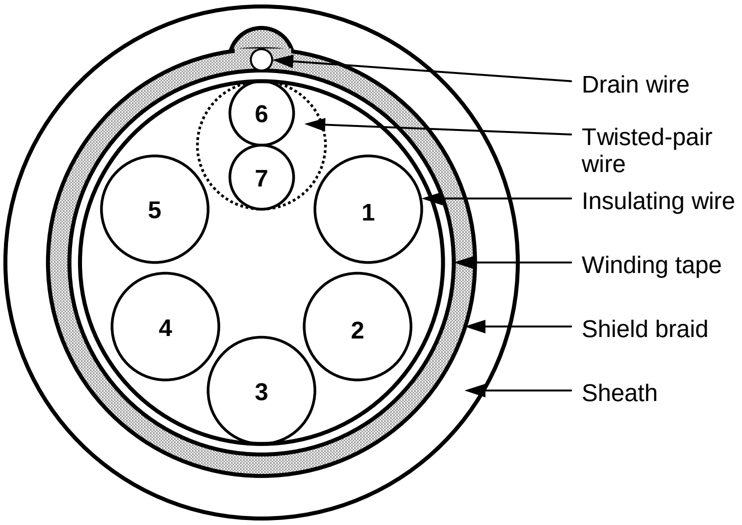
(e) Specifications of A66L-0001-0481

Item		Unit	Specifications	
Product No.		–	A66L-0001-0481	
Manufacturer		–	Hitachi Cable,Ltd.	
Rating		–	80°C, 30V	
Material	Conductor, braid-shielded wire, drain wire	–	Strand wire of tinned annealed copper (JIS C3152)	
	Insulator	–	Heat-resistant vinyl	
	Sheath	–	Heat-resistant oilproof vinyl	
Number of wires (wire nos.)		Cores	5(1 to 5)	2(one pair)(6 to 7)
Conductor	Size	mm^2	0.3	0.18
	Structure	Conductors / mm	12/0.18	7/0.18
	Outside diameter	mm	0.72	0.54
Insulator	Standard thickness	mm	0.25	0.25
	Outside diameter	mm	1.22	0.94
Twisted pair	Outside diameter	mm	-	1.88
	Pitch (approx.)	mm	-	20
Lay diameter (approx.)		mm	3.9	
Drain wire	Size	mm^2	0.18	
	Structure	Conductors / mm	7/0.18	
	Outside diameter	mm	0.54	

Item		Unit	Specifications	
Shield braid	Element wire diameter	mm	0.12	
	Thickness	mm	0.3	
	Braid density	%	85 or more	
	Outside diameter (approx.)	mm	4.6	
Sheath	Color	–	Black	
	Standard thickness	mm	0.8	
	Standard outside diameter (approx.)	mm	6.2	
	Outside diameter allowance	mm	5.7 to 7.3 (Note)	
Standard length		m	200	
Packing method		–	Bundle	
Electrical performance	Resistance of conductor (20°C)(wire nos.)	Ω/km	65.7 or less (1 to 5)	113 or less (6 to 7)
	Insulation resistance (20°C)	MΩ-km	15 or more	
	Dielectric strength (AC)	–	500VAC for 5 minutes	
Flame resistance		–	Shall pass flame resistance test VW-1 of UL standards.	

NOTE
The maximum outside diameter applies to portions other than the drain wire.

(f) Cable structure of A66L-0001-0481



The numbers assigned to the wires correspond to the numbers in the table below.

Wire No.	Insulator color	Dot mark color
1	Yellow	--
2	Yellow	Black
3	Yellow	Red
4	Bright green	Black
5	Bright green	Red
6	Light brown	Black
7	Light brown	Red

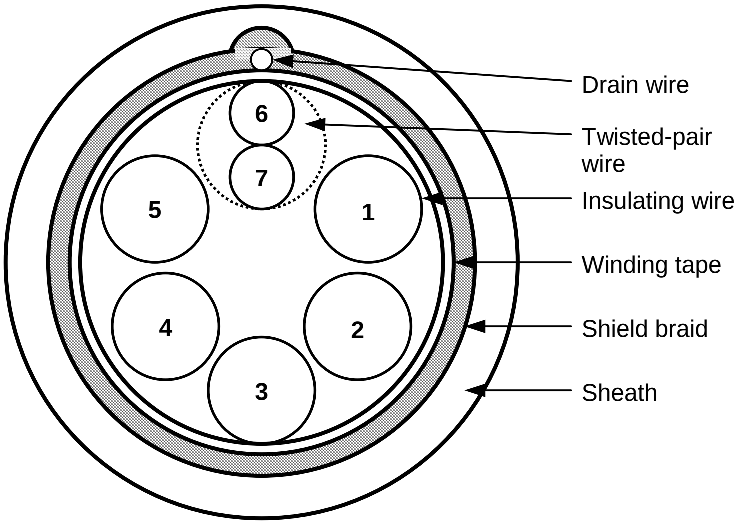
(g) Specifications of A66L-0001-0491

Item		Unit	Specifications	
Product No.		–	A66L-0001-0491	
Manufacturer		–	Hitachi Cable,Ltd.	
Rating		–	80°C, 30V	
Material	Conductor, braid-shielded wire, drain wire	–	Strand wire of tinned annealed copper (JIS C3152)	
	Insulator	–	Heat-resistant vinyl	
	Sheath	–	Heat-resistant oilproof vinyl	
Number of wires (wire nos.)		Cores	5(1 to 5)	2(one pair)(6 to 7)
Conductor	Size	mm^2	0.5	0.18
	Structure	Conductors / mm	20/0.18	7/0.18
	Outside diameter	mm	0.93	0.54
Insulator	Standard thickness	mm	0.25	0.25
	Outside diameter	mm	1.43	0.94
Twisted pair	Outside diameter	mm	-	1.88
	Pitch (approx.)	mm	-	23
Lay diameter (approx.)		mm	4.4	
Drain wire	Size	mm^2	0.18	
	Structure	Conductors / mm	7/0.18	
	Outside diameter	mm	0.54	
Shield braid	Element wire diameter	mm	0.12	
	Thickness	mm	0.3	
	Braid density	%	85 or more	
	Outside diameter (approx.)	mm	5.1	
Sheath	Color	–	Black	
	Standard thickness	mm	0.55	
	Standard outside diameter (approx.)	mm	6.2	
	Outside diameter allowance	mm	5.7 to 7.3 (Note)	
Standard length		m	200	
Packing method		–	Bundle	
Electrical performance	Resistance of conductor (20°C)(wire nos.)	Ω/km	39.4 or less (1 to 5)	113 or less (6 to 7)
	Insulation resistance (20°C)	MΩ-km	15 or more	
	Dielectric strength (AC)	–	500VAC for 5 minutes	
Flame resistance		–	Shall pass flame resistance test VW-1 of UL standards.	

NOTE

The maximum outside diameter applies to portions other than the drain wire.

(h) Cable structure of A66L-0001-0491



The numbers assigned to the wires correspond to the numbers in the table below.

Wire No.	**Insulator color**	**Dot mark color**
1	Light brown	--
2	Yellow	--
3	Yellow	Black
4	Yellow	Red
5	Bright green	--
6	Light brown	Black
7	Light brown	Red

A.3 COMPOSITE 9-CORE CABLE

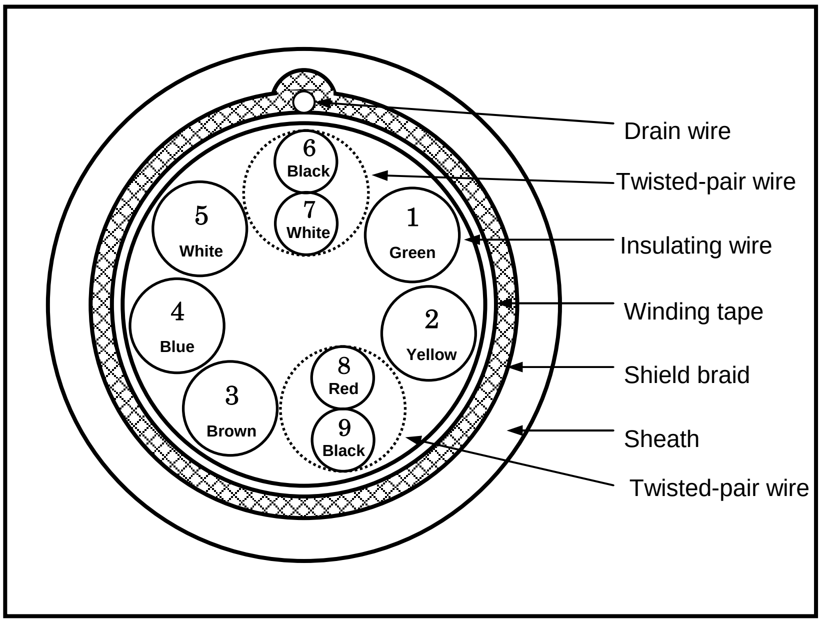
(a) Specifications of A66L-0001-0479

Item		Unit	Specifications	
Product No.		–	A66L-0001-0479	
Manufacturer		–	Hitachi Cable,Ltd.	
Rating		–	80°C, 30V	
Material	Conductor, braid-shielded wire, drain wire	–	Strand wire of tinned annealed copper (JIS C3152)	
	Insulator	–	Fluorine plastics (ETFE)	
	Sheath	–	Heat-resistant oilproof vinyl	
Number of wires (wire nos.)		Cores	5(1 to 5)	4(two pairs)(6 to 9)
Conductor	Size	mm^2	0.3	0.20
	Structure	Conductors / mm	60/0.08	40/0.08
	Outside diameter	mm	0.72	0.58
Insulator	Standard thickness	mm	0.15	0.15
	Outside diameter	mm	1.02	0.88
Twisted pair	Outside diameter	mm	-	1.76
	Pitch (approx.)	mm	-	13
Lay diameter (approx.)		mm	4.0	
Drain wire	Size	mm^2	0.15	
	Structure	Conductors / mm	30/0.08	
	Outside diameter	mm	0.51	
Shield braid	Element wire diameter	mm	0.12	
	Thickness	mm	0.3	
	Braid density	%	85 or more	
	Outside diameter (approx.)	mm	4.8	
Sheath	Color	–	Black	
	Standard thickness	mm	1.1	
	Standard outside diameter (approx.)	mm	7.0	
	Outside diameter allowance	mm	6.5 to 8.0 (Note)	
Standard length		m	200	
Packing method		–	Bundle	
Electrical performance	Resistance of conductor (20°C)(wire nos.)	Ω/km	69.5 or less (1 to 5)	109 or less (6 to 9)
	Insulation resistance (20°C)	MΩ-km	100 or more	
	Dielectric strength (AC)	–	500VAC for 5 minutes	
Flame resistance		–	Shall pass flame resistance test VW-1 of UL standards.	

NOTE

The maximum outside diameter applies to portions other than the drain wire.

(b) Cable structure of A66L-0001-0479



(c) Specifications of A66L-0001-0488

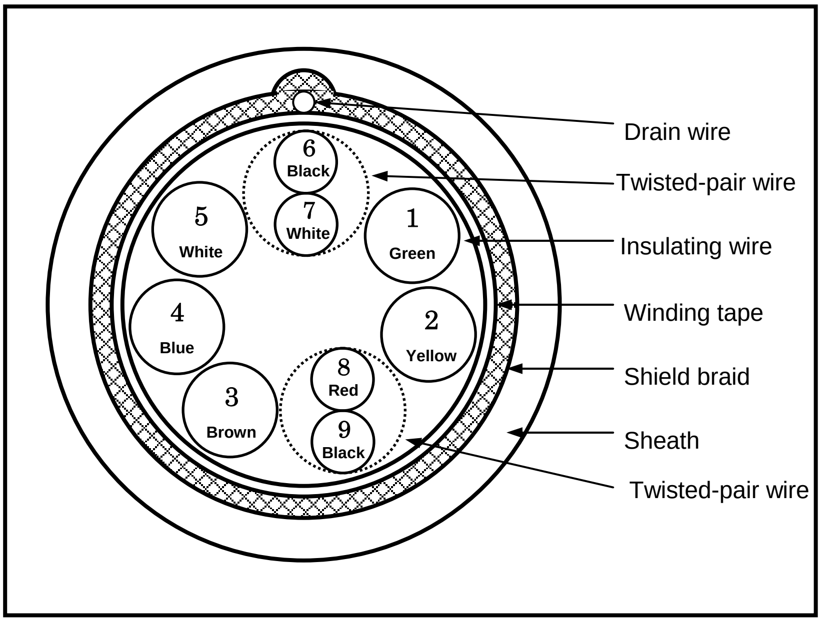
Item		Unit	Specifications	
Product No.		–	A66L-0001-0488	
Manufacturer		–	Hitachi Cable,Ltd.	
Rating		–	80°C, 30V	
Material	Conductor, braid-shielded wire, drain wire	–	Strand wire of tinned annealed copper (JIS C3152)	
	Insulator	–	Fluorine plastics (ETFE)	
	Sheath	–	Heat-resistant oilproof vinyl	
Number of wires (wire nos.)		Cores	5(1 to 5)	4(two pairs)(6 to 9)
Conductor	Size	mm^2	0.5	0.20
	Structure	Conductors / mm	104/0.08	40/0.08
	Outside diameter	mm	0.94	0.58
Insulator	Standard thickness	mm	0.2	0.15
	Outside diameter	mm	1.34	0.88
Twisted pair	Outside diameter	mm	-	1.76
	Pitch (approx.)	mm	-	13
Lay diameter (approx.)		mm	4.7	
Drain wire	Size	mm^2	0.15	
	Structure	Conductors / mm	30/0.08	
	Outside diameter	mm	0.51	
Shield braid	Element wire diameter	mm	0.12	
	Thickness	mm	0.3	
	Braid density	%	85 or more	
	Outside diameter (approx.)	mm	5.0	
Sheath	Color	–	Black	
	Standard thickness	mm	1.0	
	Standard outside diameter (approx.)	mm	7.5	
	Outside diameter allowance	mm	6.5 to 8.0 (Note)	
Standard length		m	200	
Packing method		–	Bundle	

Item		Unit	Specifications	
Electrical performance	Resistance of conductor (20°C)(wire nos.)	Ω/km	40.1 or less (1 to 5)	109 or less (6 to 9)
	Insulation resistance (20°C)	MΩ-km	100 or more	
	Dielectric strength (AC)	–	500VAC for 5 minutes	
Flame resistance		–	Shall pass flame resistance test VW-1 of UL standards.	

NOTE

The maximum outside diameter applies to portions other than the drain wire.

(d) Cable structure of A66L-0001-0488



A.4 COMPOSITE 10-CORE CABLE

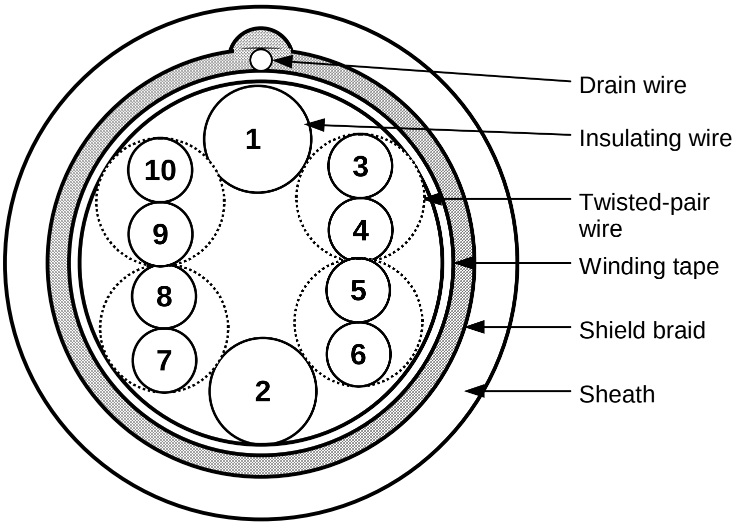
(a) Specifications of A66L-0001-0482

Item		Unit	Specifications	
Product No.		–	A66L-0001-0482	
Manufacturer		–	Hitachi Cable,Ltd.	
Rating		–	80°C, 30V	
Material	Conductor, braid-shielded wire, drain wire	–	Strand wire of tinned annealed copper (JIS C3152)	
	Insulator	–	Heat-resistant vinyl	
	Sheath	–	Heat-resistant oilproof vinyl	
Number of wires (wire nos.)		Cores	2	8(four pairs)
Conductor	Size	mm^2	0.3	0.2
	Structure	Conductors / mm	60/0.08	40/0.08
	Outside diameter	mm	0.72	0.58
Insulator	Standard thickness	mm	0.25	0.2
	Outside diameter	mm	1.22	0.98
Twisted pair	Outside diameter	mm	-	1.96
	Pitch (approx.)	mm	-	
Lay diameter (approx.)		mm	5.0	
Drain wire	Size	mm^2	0.15	
	Structure	Conductors / mm	30/0.08	
	Outside diameter	mm	0.51	
Shield braid	Element wire diameter	mm	0.12	
	Thickness	mm	0.3	
	Braid density	%	85 or more	
	Outside diameter (approx.)	mm	5.7	
Sheath	Color	–	Black	
	Standard thickness	mm	0.65	
	Standard outside diameter (approx.)	mm	7.0	
	Outside diameter allowance	mm	6.5 to 8.0 (Note)	
Standard length		m	200	
Packing method		–	Bundle	
Electrical performance	Resistance of conductor (20°C)(wire nos.)	Ω/km	69.5 or less	109 or less
	Insulation resistance (20°C)	MΩ-km	15 or more	
	Dielectric strength (AC)	–	500VAC for 5 minutes	
Flame resistance		–	Shall pass flame resistance test VW-1 of UL standards.	

NOTE

The maximum outside diameter applies to portions other than the drain wire.

(b) Cable structure of A66L-0001-0482



The numbers assigned to the wires correspond to the numbers in the table below.

Wire No.	Insulator color	Dot mark color
1	Light brown	--
2	Yellow	--
3	Light brown	Black
4	Light brown	Red
5	Yellow	Black
6	Yellow	Red
7	Bright green	Black
8	Bright green	Red
9	Gray	Black
10	Gray	Red

A.5 COMPOSITE 12-CORE CABLE

(a) Specifications

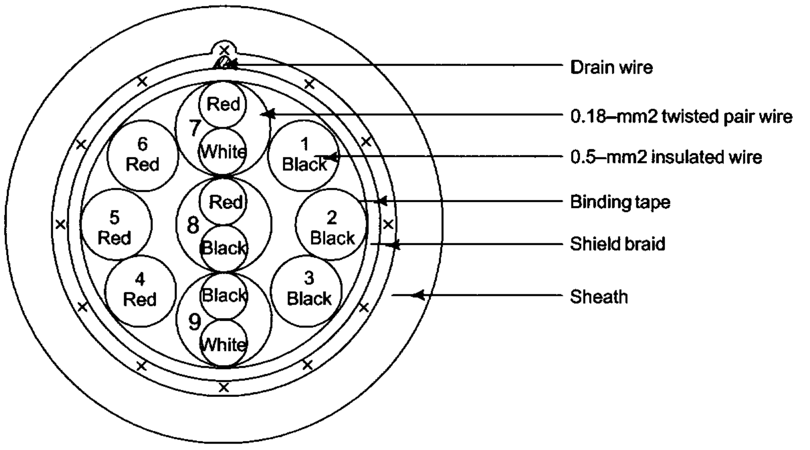
Item		Unit	Specifications	
Product No.		–	A66L-0001-0286	
Manufacturer		–	Hitachi Cable,Ltd. Oki Electric Cable, Co.,Ltd.	
Rating		–	80°C, 30V	
Material	Conductor, braid-shielded wire, drain wire	–	Strand wire of tinned annealed copper (JIS C3152)	
	Insulator	–	Heat-resistant flame-retardant vinyl	
	Sheath	–	Oilproof, heat-resistant, flame-retardant vinyl	
Number of wires (wire nos.)		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 (approx.)		mm	5.7	
Drain wire	Size	mm^2	0.3	
	Structure	Conductors / 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	
Sheath	Color	–	Black	
	Standard thickness (The minimum thickness is at least 85% of the standard thickness.)	mm	1.1	
Sheath	Outside diameter	mm	8.5Max.9.0(1)	
Standard length		m	100	
Packing method		–	Bundle	
Electrical performance	Resistance of conductor (20°C)(wire nos.)	Ω/km	39.4(1 to 6)	113(7 to 9)
	Insulation resistance (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.

(b) Markings on cable

(i) Name or symbol of the manufacturer
(ii) Manufacturing year

(c) Cable structure
The cable structure is shown below.



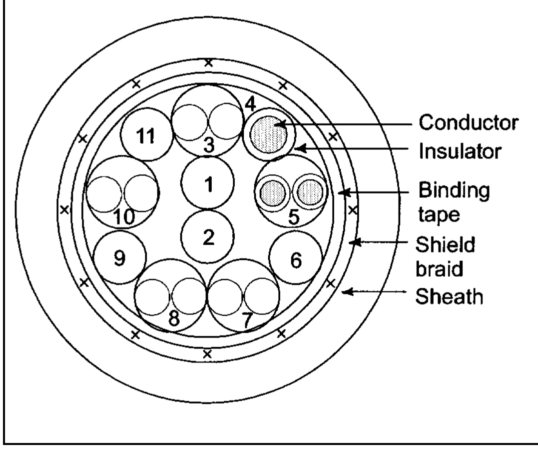
The colors in the figure indicate the colors of insulators.

A.6 COMPOSITE 16-CORE CABLE

(a) 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 wires		Cores	6	10(five pairs)
Conductor	Nominal cross-sectional area	mm^2	0.5	0.18
	Structure	Conductors / mm	20/0.18	7/0.18
	Outside diameter	mm	Approx. 0.9	Approx. 0.54
Insulator	Thickness	mm	0.25 (Average thickness : 90% or more)	0.2 (Average thickness : 90% or more)
	Outside diameter	mm	Approx. 1.5	Approx. 0.94
Twisted pair	Outside diameter	mm	–	Approx. 1.88 (pitch : 20 mm or less)
Lay	Outside diameter	mm	Approx. 6.5	
Tape-wound wire	Outside diameter	mm	Approx. 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	Electric resistance 0.18mm^2	Ω/km	113 or less (20°C JIS C 3005 6)	
	Electric resistance 0.5mm^2	Ω/km	39.4 or less (20°C JIS C 3005 6)	
	Dielectric strength	V/min	AC500(JIS C 3005 8 (2))	
	Insulation resistance	MΩ-km	15 or more (20°C JIS C 3005 9.1)	

(b) Cable structure



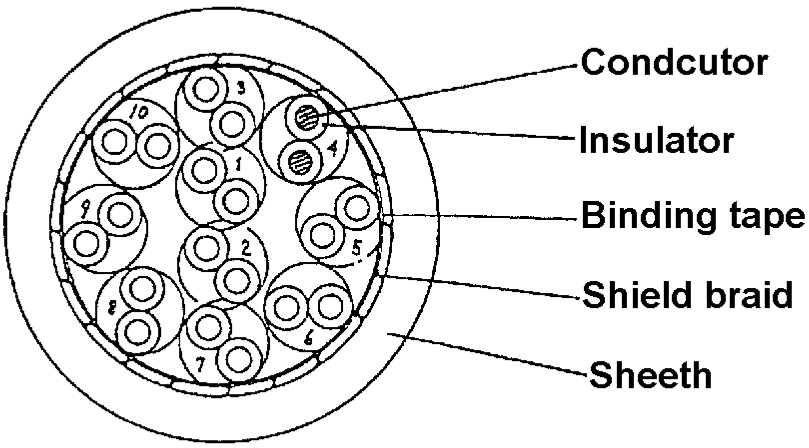
Pair No.	Dot mark color	Size mm^2
1	Red	0.5
2	Red	0.5
3	White/Yellow	0.18
4	Black	0.5
5	White/Green	0.18
6	Black	0.5
7	White/Gray	0.18
8	Black/Orange	0.18
9	Black	0.5
10	Black/Brown	0.18
11	Red	0.5

A.7 10-PAIR CABLE (FOR αiBZ SENSOR (CONVENTIONAL TYPE))

(a) Specifications

Item		Unit	Specifications
Product No.			A66L-0001-0367(FNC-019)
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 wires		Cores	20(ten pairs)
Conductor	Nominal cross-sectional area	mm^2	0.18
	Structure	Conductors / mm	7/0.18
	Outside diameter	mm	Approx. 0.54
Insulator	Thickness	mm	0.25(Average thickness : 90% or more)
	Outside diameter	mm	Approx. 1.04
Twisted pair	Outside diameter	mm	Approx. 2.08 (pitch : 25 mm or less)
Lay	Outside diameter	mm	Approx. 6.5
Tape-wound wire	Outside diameter	mm	Approx. 6.6
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	Electric resistance	Ω/km	110 or less (20°C JIS C 3005 6)
	Dielectric strength	V/min	AC500(JIS C 3005 8 (2))
	Insulation resistance	MΩ-km	15 or more (20°C JIS C 3005 9.1)

(b) Cable structure



Pair number	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

B FEEDBACK CABLE LENGTH

B.1 SPINDLE CABLE LENGTH (WHEN RECOMMENDED CABLES ARE USED)

Detector	Recommended cable	Cable structure	Maximum cable length
α*i*M sensor	A66L-0001-0368	0.5 mm^2, 2 conductors used out of 6 (for power supply) 0.18mm^2, 5 pairs (for signals)	72m (Note)
α*i*MZ sensor	A66L-0001-0368	0.5 mm^2, 2 conductors used out of 6 (for power supply) 0.18mm^2, 5 pairs (for signals)	50m (Note)
α*i*M sensor (for α*i*I 0.5)	A66L-0001-0482	0.3 mm^2, 2 conductors (for power supply) 0.2mm^2, 3 pairs (for signals)	41m
α*i*MZ sensor (for α*i*I 0.5) α*i*BZ sensor (small type)	A66L-0001-0482	0.3 mm^2, 2 conductors (for power supply) 0.2mm^2, 4 pairs (for signals)	28m
α*i*CZ sensor (serial output)	A66L-0001-0460 A66L-0001-0481	0.3mm^2, 5 conductors (for power supply) 0.2mm^2, 1 pair (for signals)	28m
	A66L-0001-0462 A66L-0001-0491	0.5mm^2, 5 conductors (for power supply) 0.2mm^2, 1 pair (for signals)	50m
α*i*BZ sensor (conventional type)	A66L-0001-0367	0.18 mm^2, 4 conductors (for power supply) 0.18mm^2, 5 pairs (for signals)	36m
α*i* positioncoder	A66L-0001-0286	0.5 mm^2, 6 conductors (for power supply) 0.18mm^2, 3 pairs (for signals)	50m
α positioncoder S	A66L-0001-0286	0.5 mm^2, 6 conductors (for power supply) 0.18mm^2, 3 pairs (for signals)	50m

If a cable other than recommended ones is to be used, the cable must be such that the sum of the resistances of the +5V and 0V electric wires does not exceed the values in the table below.

Detector	Sum of the 5V and 0V resistances
α*i* M sensor	5Ω
α*i* MZ sensor, α*i* BZ sensorr (conventional type, small type)	4Ω
α*i* CZ sensor (serial output)	2Ω
α*i* positioncoder	2Ω
α positioncoder S	2Ω

NOTE

If a cable exceeding the maximum cable length listed is to be used, the cable can be used if the maximum speed, which depends on the number of gear teeth on sensor, is not exceeded, as long as the length does not exceed 100 m. For a model that exceeds the maximum speed, the maximum speed must be restricted.

Number of gear teeth on sensor	Maximum speed if the maximum cable length is exceeded	Motor model example
128λ	12000 min^{-1}	α*i* I 1, α*i* I 1.5, α*i* I 2, α*i* I 3
256λ	6000 min^{-1}	α*i* I 6, α*i* I 8, α*i* I 12

B.2 PULSECODER CABLE LENGTH (WHEN RECOMMENDED CABLES ARE USED)

Recommended cable	Cable structure	Maximum cable length
A66L-0001-0460	0.3 mm^2, 5 conductors (for power supply) 0.20mm^2, 1 pair (for signals)	28m
A66L-0001-0462	0.5 mm^2, 5 conductors (for power supply) 0.20mm^2, 1 pair (for signals)	50m
A66L-0001-0481	0.3 mm^2, 5 conductors (for power supply) 0.18mm^2, 1 pair (for signals)	28m
A66L-0001-0491	0.5 mm^2, 5 conductors (for power supply) 0.18mm^2, 1 pair (for signals)	50m

When a cable other than recommended cable is used, ensure that the sum of the resistances of 0 V and 5 V is 2 ohms or less.

INDEX

REVISION RECORD

Edition	Date	Contents
03	Nov., 2012	• Total revision - Changing of models names - Reflection of the Technical reports of edition 02 to the main text - Addition of Appendix A, “CABLES” - Addition of Appendix B, “FEEDBACK CABLE LENGTH”
02	Aug., 2004	• Total revision
01	Aug., 2003	

ADDITIONAL INFORMATION

Change of order number for Surge Protective Device
used for αi series and βi series SERVO AMPLIFIER

1. Type of applied technical documents

Name	FANUC SERVO AMPLIFIER αi series DESCRIPTIONS FANUC SERVO AMPLIFIER αi series (for 30i-B) DESCRIPTIONS FANUC SERVO AMPLIFIER βi series DESCRIPTIONS
Spec. No./Version	B-65282EN/06 B-65322EN/03 B-65412EN/01

2. Summary of Change

Group	Name/Outline	New, Add Correct, Delete	Applicable Date
Basic Function			
Optional Function	Order number of Surge Protective Device changed by the update of UL standard	Add	Oct. 2012
Unit			
Maintenance Parts			
Notice			
Correction			
Another			

Edit	Date	Design	Description

Date	12.10.24	Desig.	Shirouzu	Apprv.	Harada

Title	Change of order number for Surge Protective Device used for αi series and βi series SERVO AMPLIFIER
Draw No.	B-65282EN/06-28, B-65322EN/03-03 B-65412EN/01-02

FANUC CORPORATION

1. Summary

Surge Protective Device (SPD) used in the main power input of α*i* series SERVO AMPLFIER or β*i* series SERVO AMPLIFIER is changed to new model which supports updated safety standards of UL. Conventionally there were two types of SPD, “Line-to-line and line-to-ground in one package” and “Line-to-line and line-to-ground separate package”. Due to the update of safety standards, they are unified to “Line-to-line and line-to-ground in one package”.

2. Changes in UL standards

UL standard which certifies SPD (UL1449) was updated from version 02 to version 03. By the update of standard, SPD used for the main power input of Servo Amplifier is required to use “SPD which is certified for Type1 or Type2 of UL1449 version 03”.
Thus, for a machine to ship newly, it is required that “SPD which is certified for Type1 or Type2 of UL1449 version 03” should be applied before expiration migration time (until June 30, 2013).

3. Specifications of the Surge Protective Device(SPD) corresponds to updated UL standard

SPD used in the main power input of α*i* series SERVO AMPLFIER or β*i* series SERVO AMPLIFIER is changed to new model (“Line-to-line and line-to-ground in one package” type) which supports Type2 of UL1449 version 03. The change is needed because conventional SPD can not be certified with Type1 or Type2 of UL1449 version 03. Order number of new SPD is as follows.

List of Surge Protective Device (SPD)

Order number	A06B-6200-K141	A06B-6200-K140
Manufacturer code	Okaya Electric Industries Co., Ltd. RSPD-250-U4	Okaya Electric Industries Co., Ltd. RSPD-500-U4
Rated voltage	AC250V	AC500V
Frequency	50/60Hz	
Configuration	Line-to-line and line-to-ground in one package type	
UL standard	UL1449 Version 03 Type2 certification	
Operating temperature	-5°C ~ +40°C	

Notes) New SPD has different manufacturer codes. If machine is applying for manufacturer codes of SPD to Certificate Authority when obtaining CE marking or UL mark, please note that Certificate Authority may request application documents about the change of SPD code.

Notes) Refer to following descriptions as for the wirings.
“FANUC SERVO AMPLIFIER α*i* series descriptions B-65282EN”
“FANUC SERVO AMPLIFIER α*i* series (for 30*i*-B) descriptions B-65412EN”
“FANUC SERVO AMPLIFIER β*i* series descriptions B-65322EN”

4. Correspondence table for exchanging new from the previous

200V input type

Previous model			New model	
Order number	Configuration (Manufacturer code)		Order number	Configuration (Manufacturer code)
A06B-6077-K142	Line-to-line and line-to-ground separated type (RAV-781BYZ-2, RAV-781BXZ-4)	→ (*1)	A06B-6200-K141	Line-to-line and line-to-ground in one package type(RSPD-250-U4)
A06B-6077-K144	Line-to-line and line-to-ground in one package type (RCM-601BUZ-4)	→		

400V input type

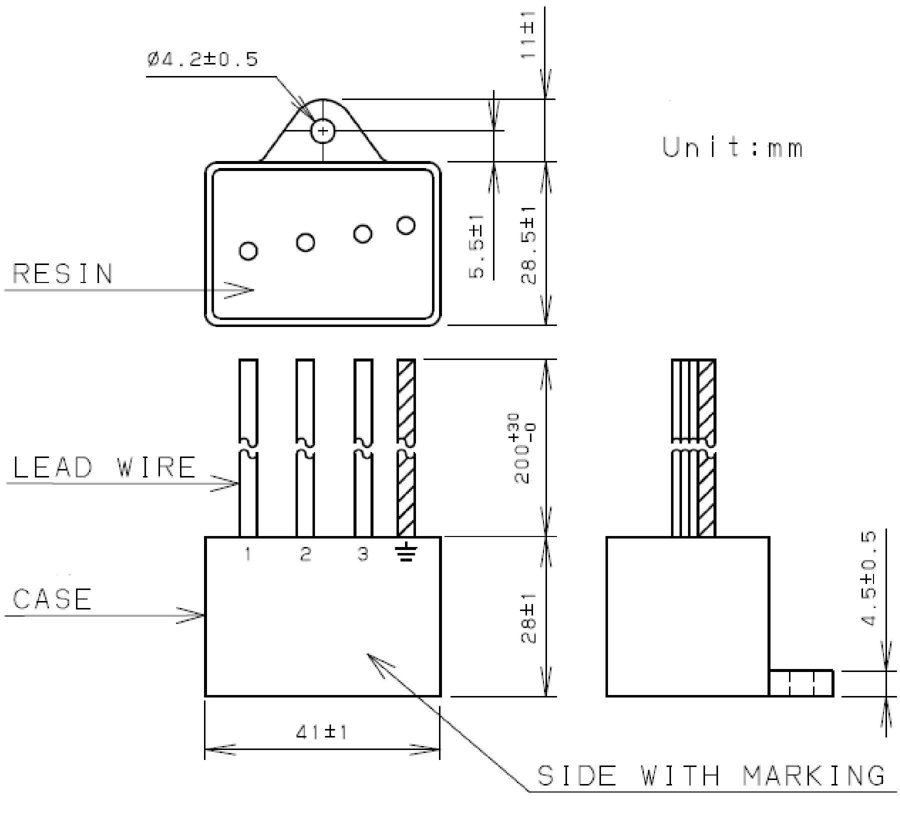
Previous model			New model	
Order number	Configuration (Manufacturer code)		Order number	Configuration (Manufacturer code)
A06B-6077-K143	Line-to-line and line-to-ground separated type (RAV-152BYZ-2A, RAV-801BXZ-4)	→ (*1)	A06B-6200-K140	Line-to-line and line-to-ground in one package type (RSPD-500-U4)

(*1) Please "Line-to-line and line-to-ground separated type" change to "Line-to-line and line-to-ground in one package type", because it can not be adapted to updated UL standard.

5. Outline

A06B-6200-K140, A06B-6200-K141

Notes) same outlines with conventional Line-to-line and line-to-ground in one package type.



Edit	Date	Design	Description		
Date		Desig.		Apprv.	

Title	Change of order number for Surge Protective Device used for αi series and βi series SERVO AMPLIFIER
Draw No.	B-65282EN/06-28, B-65322EN/03-03 B-65412EN/01-02
FANUC CORPORATION	3/3