FANUC

GE Fanuc Automation

Computer Numerical Control Products

Servo Motor β Series

Descriptions Manual

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Warnings, Cautions, and Notes as Used in this Publication

Warning

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

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

Caution

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

Note

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

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".

SAFETY PRECAUTIONS

This "Safety Precautions" section describes the precautions which must be observed to ensure safety when using FANUC servo motors and servo amplifiers. Users of any servo motor or amplifier model are requested to read the "Safety Precautions" carefully before using the servo motor or amplifier.
The users are also requested to read an applicable specification manual carefully and understand each function of the motor or amplifier for correct use.
The users are basically forbidden to do any behavior or action not mentioned in the "Safety Precautions." They are invited to ask FANUC previously about what behavior or action is prohibited.

Contents

1.1 DEFINITION OF WARNING, CAUTION, AND NOTE

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

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

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

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

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

1.2 FANUC SERVO MOTOR β SERIES

1.2.1 Warning

⚠ **WARNING**

- **Be safely dressed when handling a motor.**
  Wear safety shoes or gloves when handling a motor as you may get hurt on any edge or protrusion on it or electric shocks.

- **Use a crane or lift to move a motor from one place to another.**
  Motors are heavy. When moving them, use a crane or lift as required. (For the weight of motors, refer to their respective specification manuals.)
  When moving a motor using a crane or lift, use a hanging bolt if the motor has a corresponding tapped hole, or textile rope if it has no tapped hole.
  If a motor is attached with a machine or any other heavy stuff, do not use a hanging bolt to move the motor as the hanging bolt and/or motor may get broken.
  When moving a motor, be careful not to apply excessive force to its windings as the windings may break and/or their insulation may deteriorate.

- **Do not touch a motor with a wet hand.**
  A failure to observe this caution is very dangerous because you may get electric shocks.

- **Before starting to connect a motor to electric wires, make sure they are isolated from an electric power source.**
  A failure to observe this caution is very dangerous because you may get electric shocks.

- **Do not bring any dangerous stuff near a motor.**
  Motors are connected to a power line, and may get hot. If a flammable is placed near a motor, it may be ignited, catch fire, or explode.

- **Be sure to ground a motor frame.**
  To avoid electric shocks, be sure to connect the grounding terminal in the terminal box to the grounding terminal of the machine.

- **Do not ground a motor power wire terminal or short-circuit it to another power wire terminal.**
  A failure to observe this caution may cause electric shocks or a burned wiring.
  (*) Some motors require a special connection such as a winding changeover. Refer to their respective motor specification manuals for details.

⚠ WARNING

- **Connect power wires securely so that they will not get loose.**
  A failure to observe this caution may cause a wire to be disconnected, resulting in a ground fault, short circuit, or electric shock.

- **Do not supply the power to the motor while any terminal is exposed.**
  A failure to observe this caution is very dangerous because you may get electric shocks if your body or any conductive stuff touches an exposed terminal.

- **Do not get close to a rotary section of a motor when it is rotating.**
  A rotating part may catch your cloths or fingers. Before starting a motor, ensure that there is no stuff that can fly away (such as a key) on the motor.

- **Before touching a motor, shut off the power to it.**
  Even if a motor is not rotating, there may be a voltage across the terminals of the motor.
  Especially before touching a power supply connection, take sufficient precautions.
  Otherwise you may get electric shocks.

- **Do not touch any terminal of a motor for a while (at least 5 minutes) after the power to the motor is shut off.**
  High voltage remains across power line terminals of a motor for a while after the power to the motor is shut off. So, do not touch any terminal or connect it to any other equipment. Otherwise, you may get electric shocks or the motor and/or equipment may get damaged.

- **To drive a motor, use a specified amplifier and parameters.**
  An incorrect combination of a motor, amplifier, and parameters may cause the motor to behave unexpectedly. This is dangerous, and the motor may get damaged.

- **Do not touch a regenerative discharge unit for a while (at least 30 minutes) after the power to the motor is shut off.**
  A regenerative discharge unit may get hot when the motor is running.
  Do not touch the regenerative discharge unit before it gets cool enough. Otherwise, you may get burned.

- **Do not touch a motor when it is running or immediately after it stops.**
  A motor may get hot when it is running. Do not touch the motor before it gets cool enough. Otherwise, you may get burned.

- **Ensure that motors and related components are mounted securely.**
  If a motor or its component slips out of place or comes off when the motor is running, it is very dangerous.

- **Be careful not get your hair or cloths caught in a fan.**
  Be careful especially for a fan used to generate an inward air flow. Be careful also for a fan even when the motor is stopped, because it continues to rotate while the amplifier is turned on.

- **When designing and assembling a machine tool, make it compliant with EN60204-1.**
  To ensure the safety of the machine tool and satisfy European standards, when designing and assembling a machine tool, make it compliant with EN60204-1. For details of the machine tool, refer to its specification manual.

1.2.2 Caution

⚠ CAUTION

- **FANUC motors are designed for use with machines. Do not use them for any other purpose.**
  If a FANUC motor is used for an unintended purpose, it may cause an unexpected symptom or trouble. If you want to use a motor for an unintended purpose, previously consult with FANUC.

- **Ensure that a base or frame on which a motor is mounted is strong enough.**
  Motors are heavy. If a base or frame on which a motor is mounted is not strong enough, it is impossible to achieve the required precision.

- **Be sure to connect motor cables correctly.**
  An incorrect connection of a cable cause abnormal heat generation, equipment malfunction, or failure. Always use a cable with an appropriate current carrying capacity (or thickness). For how to connect cables to motors, refer to their respective specification manuals.

- **Ensure that motors are cooled if they are those that require forcible cooling.**
  If a motor that requires forcible cooling is not cooled normally, it may cause a failure or trouble. For a fan-cooled motor, ensure that it is not clogged or blocked with dust and dirt. For a liquid-cooled motor, ensure that the amount of the liquid is appropriate and that the liquid piping is not clogged.
  For both types, perform regular cleaning and inspection.

- **When attaching a component having inertia, such as a pulley, to a motor, ensure that any imbalance between the motor and component is minimized.**
  If there is a large imbalance, the motor may vibrates abnormally, resulting in the motor being broken.

- **Be sure to attach a key to a motor with a keyed shaft.**
  If a motor with a keyed shaft runs with no key attached, it may impair torque transmission or cause imbalance, resulting in the motor being broken.

1.2.3 Note

NOTE

- **Do not step or sit on a motor.**
  If you step or sit on a motor, it may get deformed or broken. Do not put a motor on another unless they are in packages.

- **When storing a motor, put it in a dry (non-condensing) place at room temperature (0 to 40°C).**
  If a motor is stored in a humid or hot place, its components may get damaged or deteriorated. In addition, keep a motor in such a position that its shaft is held horizontal and its terminal box is at the top.

- **Do not remove a nameplate from a motor.**
  If a nameplate comes off, be careful not to lose it. If the nameplate is lost, the motor becomes unidentifiable, resulting in maintenance becoming impossible.
  For a nameplate for a built-in spindle motor, keep the nameplate with the spindle.

- **Do not apply shocks to a motor or cause scratches to it.**
  If a motor is subjected to shocks or is scratched, its components may be adversely affected, resulting in normal operation being impaired. Be very careful when handling plastic portions, sensors, and windings, because they are very liable to break. Especially, avoid lifting a motor by pulling its plastic portion, winding, or power cable.

- **Do not conduct dielectric strength or insulation test for a sensor.**
  Such a test can damage elements in the sensor.

- **When testing the winding or insulation resistance of a motor, satisfy the conditions stipulated in IEC60034.**
  Testing a motor under a condition severer than those specified in IEC34 may damage the motor.

- **Do not disassemble a motor.**
  Disassembling a motor may cause a failure or trouble in it.
  If disassembly is in need because of maintenance or repair, please contact a service representative of FANUC.

- **Do not modify a motor.**
  Do not modify a motor unless directed by FANUC. Modifying a motor may cause a failure or trouble in it.

NOTE

- **Use a motor under an appropriate environmental condition.**
  Using a motor in an adverse environment may cause a failure or trouble in it.
  Refer to their respective specification manuals for details of the operating and environmental conditions for motors.

- **Do not apply a commercial power source voltage directly to a motor.**
  Applying a commercial power source voltage directly to a motor may result in its windings being burned. Be sure to use a specified amplifier for supplying voltage to the motor.

- **For a motor with a terminal box, make a conduit hole for the terminal box in a specified position.**
  When making a conduit hole, be careful not to break or damage unspecified portions.
  Refer to an applicable specification manual.

- **Before using a motor, measure its winding and insulation resistances, and make sure they are normal.**
  Especially for a motor that has been stored for a prolonged period of time, conduct these checks. A motor may deteriorate depending on the condition under which it is stored or the time during which it is stored. For the winding resistances of motors, refer to their respective specification manuals, or ask FANUC. For insulation resistances, see the following table.

- **To use a motor as long as possible, perform periodic maintenance and inspection for it, and check its winding and insulation resistances.**
  Note that extremely severe inspections (such as dielectric strength tests) of a motor may damage its windings. For the winding resistances of motors, refer to their respective specification manuals, or ask FANUC. For insulation resistances, see the following table.

MOTOR INSULATION RESISTANCE MEASUREMENT

Measure an insulation resistance between each winding and motor frame using an insulation resistance meter (500 VDC). Judge the measurements according to the following table.

Insulation resistance	Judgment
100MΩ or higher	Acceptable
10 to 100 MΩ	The winding has begun deteriorating. There is no problem with the performance at present. Be sure to perform periodic inspection.
1 to 10 MΩ	The winding has considerably deteriorated. Special care is in need. Be sure to perform periodic inspection.
Lower than 1 MΩ	Unacceptable. Replace the motor.

1.3 FANUC SERVO AMPLIFIER β SERIES

1.3.1 Warnings and Cautions Relating to Mounting

1.3.1.1 Warning

⚠ **WARNING**

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

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

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

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

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

- **Ensure that the power supply lines, power lines, and signal lines are securely connected.**
  A loose screw, loose connection, or the like will cause a motor malfunction or overheating, or a ground fault.

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

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

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

⚠ WARNING

- **Do not disassemble the amplifier.**

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

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

1.3.1.2 Caution

⚠ CAUTION

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

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

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

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

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

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

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

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

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

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

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

⚠ CAUTION

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

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

1.3.1.3 Note

NOTE

- **Keep the nameplate clearly visible.**

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

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

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

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

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

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

1.3.2 Warnings and Cautions Relating to a Pilot Run

1.3.2.1 Warning

⚠ **WARNING**

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

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

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

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

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

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

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

1.3.2.2 Caution

⚠ **CAUTION**

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

- **Before operating the motor for the first time, mount and adjust the position and speed 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.

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

1.3.3 Warnings and Cautions Relating to Maintenance

1.3.3.1 Warning

⚠ **WARNING**

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

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

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

⚠ WARNING

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

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

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

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

- **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 magnetics cabinet and amplifier.

1.3.3.2 Caution

⚠ **CAUTION**

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

- **Tighten all screws firmly.**

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

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

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

1.3.3.3 Note

NOTE

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

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

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

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V. CONNECTION

I. DESCRIPTIONS FOR FANUC AC SERVO MOTOR β series

1 OVERVIEW

The FANUC AC SERVO MOTOR β series is an economical AC servo motor series most suitable for positioning peripheral devices of industrial machines and machine tools, and has the features listed below.

SERVO MOTOR βM series

- Compactness

By employing a most advanced high-performance magnet and optimized structure, the SERVO MOTOR βM series is made shorter and compact in overall size.

- Superior acceleration performance

With a high maximum output torque and low inertia, high acceleration performance and highly frequent positioning are made possible.

- High-resolution detector

High-precision positioning is enabled by mounting a highly reliable, high-resolution β pulse coder (optical encoder). (Resolution: 65,536/rev.)

- High environmental resistance

The SERVO MOTOR βM series has high environmental resistance satisfying IP65 as standard.

- Brake option

An optional built-in holding brake is available.

SERVO MOTOR β series

- Compactness

By employing a most advanced high-performance magnet and larger frame, the SERVO MOTOR β series is made compact and thin in overall size.

- High-resolution detector

High-precision positioning is enabled by mounting a highly reliable, high-resolution β pulse coder (optical encoder). (Resolution: 32,768/rev.)

- High environmental resistance

The SERVO MOTOR β series has high environmental resistance satisfying IP65 as standard.

- Brake option

An optional built-in holding brake is available.

2 NOTES ON USE

2.1 COMPATIBLE AMPLIFIERS

2.1.1 Amplifiers Suitable for the βM series Servo Motors

The FANUC AC SERVO MOTOR βM series can be driven by the FANUC SERVO AMPLIFIER β series or α*i* series.

<table>
<tr><th>Motor model</th><th>Series</th><th></th><th>Model</th><th>Interface</th><th>Specification</th><th>Connection axis</th></tr>
<tr><td rowspan="4">βM0.2/4000
βM0.3/4000</td><td rowspan="2">β series servo amplifier unit</td><td rowspan="2">1-axis</td><td rowspan="2">SVU-4</td><td>FSSB</td><td>A06B-6093-H119</td><td rowspan="2"></td></tr>
<tr><td>I/O Link</td><td>A06B-6093-H159</td></tr>
<tr><td rowspan="2">αi series servo amplifier module</td><td>2-axis</td><td>SVM2-4/4i</td><td>FSSB</td><td>A06B-6114-H201</td><td>L, M</td></tr>
<tr><td>3-axis</td><td>SVM3-4/4/4i</td><td>FSSB</td><td>A06B-6114-H301</td><td>L, M, N</td></tr>
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<table>
<tr><th>Motor model</th><th>Series</th><th></th><th>Model</th><th>Interface</th><th>Specification</th><th>Connection axis</th></tr>
<tr><td rowspan="7">βM0.4/4000</td><td rowspan="2">β series servo amplifier unit</td><td rowspan="2">1-axis</td><td rowspan="2">SVU-20</td><td>FSSB</td><td>A06B-6093-H112</td><td rowspan="2"></td></tr>
<tr><td>TYPE B</td><td>A06B-6093-H102</td></tr>
<tr><td rowspan="5">αi series servo amplifier module</td><td>1-axis</td><td>SVM1-20i</td><td>FSSB</td><td>A06B-6114-H103</td><td></td></tr>
<tr><td rowspan="2">2-axis</td><td>SVM2-20/20i</td><td>FSSB</td><td>A06B-6114-H205</td><td>L, M</td></tr>
<tr><td>SVM2-20/40i</td><td>FSSB</td><td>A06B-6114-H206</td><td>L</td></tr>
<tr><td rowspan="2">3-axis</td><td>SVM3-20/20/20i</td><td>FSSB</td><td>A06B-6114-H303</td><td>L, M, N</td></tr>
<tr><td>SVM3-20/20/40i</td><td>FSSB</td><td>A06B-6114-H304</td><td>L, M</td></tr>
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<tr><td>I/O Link</td><td>A06B-6093-H152</td></tr>
<tr><td>TYPE B</td><td>A06B-6093-H102</td></tr>
<tr><td rowspan="5">αi series servo amplifier module</td><td>1-axis</td><td>SVM1-20i</td><td>FSSB</td><td>A06B-6114-H103</td><td></td></tr>
<tr><td rowspan="2">2-axis</td><td>SVM2-20/20i</td><td>FSSB</td><td>A06B-6114-H205</td><td>L, M</td></tr>
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<tr><td rowspan="2">3-axis</td><td>SVM3-20/20/20i</td><td>FSSB</td><td>A06B-6114-H303</td><td>L, M, N</td></tr>
<tr><td>SVM3-20/20/40i</td><td>FSSB</td><td>A06B-6114-H304</td><td>L, M</td></tr>
</table>

> ⚠ **WARNING**
> Using a combination other than those listed above is likely to result in motor damage.

NOTE

1 For information about the β series servo amplifier unit, refer to Part IV of this manual.
  For information about the α*i* series servo amplifier module, refer to FANUC AC SERVO AMPLIFIER α*i* series DESCRIPTIONS (B-65282EN).
2 The β series servo amplifier unit uses two types of interfaces with a CNC, namely, FSSB and TYPE B.
  The α*i* series servo amplifier module uses only one interface with a CNC, namely, FSSB. Before selecting a servo amplifier, check the interface of a CNC to be used. A β series servo amplifier unit with the I/O Link option for providing a position control feature is also available for choice.
3 βM0.4/4000 cannot be used with a β series servo amplifier unit with the I/O Link option.
4 When using the βM series servo motor with the α series servo amplifier module, consult with FANUC.

2.1.2 Amplifiers Suitable for the β series Servo Motors

The FANUC AC SERVO MOTOR β series can be driven by the FANUC SERVO AMPLIFIER β series or α series.

Motor model	Series		Model	Interface	Specification	Connection axis
β1/3000 β2/3000	β series servo amplifier unit	1-axis	SVU-12	FSSB	A06B-6093-H111	
				I/O Link	A06B-6093-H151	
				TYPE B	A06B-6093-H101	
	α series servo amplifier module	1-axis	SVM1-12	FSSB	A06B-6096-H101	
				TYPE A, B	A06B-6079-H101	
		2-axis	SVM2-12/12	FSSB	A06B-6096-H201	L, M
				TYPE A, B	A06B-6079-H201	
			SVM2-12/20	FSSB	A06B-6096-H202	L
				TYPE A, B	A06B-6079-H202	
			SVM2-12/40	FSSB	A06B-6096-H204	L
				TYPE A, B	A06B-6079-H204	
		3-axis	SVM3-12/12/12	FSSB	A06B-6096-H301	L, M, N
				TYPE A	A06B-6079-H301	
				TYPE B	A06B-6080-H301	
			SVM3-12/12/20	FSSB	A06B-6096-H302	L, M
				TYPE A	A06B-6079-H302	
				TYPE B	A06B-6080-H302	
			SVM3-12/20/20	FSSB	A06B-6096-H303	L
				TYPE A	A06B-6079-H303	
				TYPE B	A06B-6080-H303	
			SVM3-12/12/40	FSSB	A06B-6096-H305	L, M
				TYPE A	A06B-6079-H305	
				TYPE B	A06B-6080-H305	
			SVM3-12/20/40	FSSB	A06B-6096-H306	L
				TYPE A	A06B-6079-H306	
				TYPE B	A06B-6080-H306	

Motor model	Series		Model	Interface	Specification	Connection axis
β3/3000 β6/2000	β series servo amplifier unit	1-axis	SVU-20	FSSB	A06B-6093-H112	
				I/O Link	A06B-6093-H152	
				TYPE B	A06B-6093-H102	
	α series servo amplifier module	1-axis	SVM1-20	FSSB	A06B-6096-H102	
				TYPE A, B	A06B-6079-H102	
		2-axis	SVM2-12/20	FSSB	A06B-6096-H202	M
				TYPE A, B	A06B-6079-H202	
			SVM2-20/20	FSSB	A06B-6096-H203	L, M
				TYPE A, B	A06B-6079-H203	
			SVM2-20/40	FSSB	A06B-6096-H205	L
				TYPE A, B	A06B-6079-H205	
		3-axis	SVM3-12/12/20	FSSB	A06B-6096-H302	N
				TYPE A	A06B-6079-H302	
				TYPE B	A06B-6080-H302	
			SVM3-12/20/20	FSSB	A06B-6096-H303	M, N
				TYPE A	A06B-6079-H303	
				TYPE B	A06B-6080-H303	
			SVM3-20/20/20	FSSB	A06B-6096-H304	L, M, N
				TYPE A	A06B-6079-H304	
				TYPE B	A06B-6080-H304	
			SVM3-12/20/40	FSSB	A06B-6096-H306	M
				TYPE A	A06B-6079-H306	
				TYPE B	A06B-6080-H306	
			SVM3-20/20/40	FSSB	A06B-6096-H307	L, M
				TYPE A	A06B-6079-H307	
				TYPE B	A06B-6080-H307	

⚠ **WARNING**

Driving a motor according to a combination other than those listed above can damage the motor.

NOTE

1 For information about the β series servo amplifier unit, refer to Part IV of this manual.
For information about the α*i* series servo amplifier module, refer to FANUC AC SERVO AMPLIFIER α*i* series DESCRIPTIONS (B-65282EN).

2 The β series servo amplifier unit uses two types of interfaces with a CNC, namely, FSSB and TYPE B.
The α series servo amplifier module uses three types of interfaces with a CNC, namely, FSSB, TYPE A, and TYPE B. Before selecting a servo amplifier, check the interface of a CNC to be used.
A β series servo amplifier unit with the I/O Link option for providing a position control feature is also available for choice.

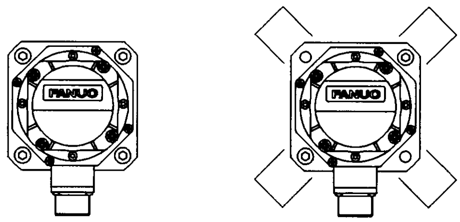
3 An α series servo amplifier module marked with TYPE A, B allows switching between TYPE A and TYPE B

4 When using the β series servo motor with the α*i* series servo amplifier module, consult with FANUC.

2.2 INSTALLATION

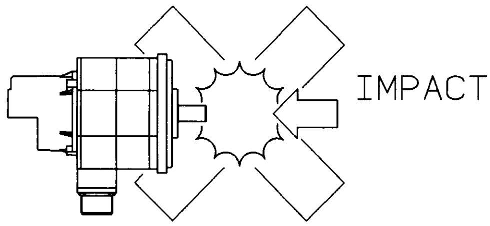
The servo motor contains a precision detector, and is carefully machined and assembled to provide the required precision. Pay attention to the following items to maintain the precision and prevent damage to the detector.

(1) Secure the servo motor uniformly using four bolt holes provided on the front flange.

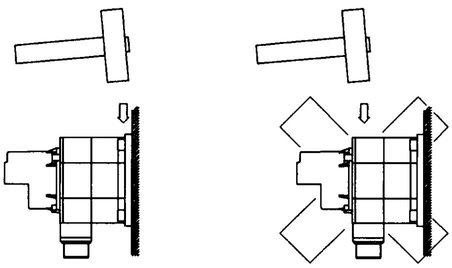


(2) The machine surface on which the motor is mounted must be flat.

(3) When mounting on the machine, take care not to apply a shock to the motor.



(4) When striking the motor is unavoidable for fine position adjustment, strike only the flange on the front side with a plastic hammer softly so that impact is not applied to any portions other than the flange on the front side.

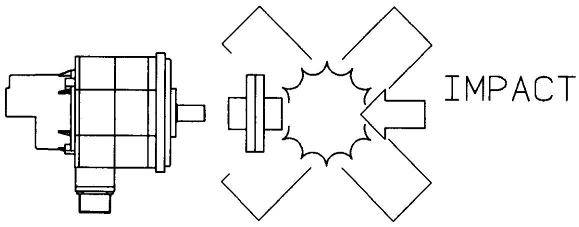


(5) When handling model βM0.2/4000 or βM0.3/4000, be sure to hold the main body of the motor. Do not carry the motor by holding the lead wire only.

2.3 COUPLING

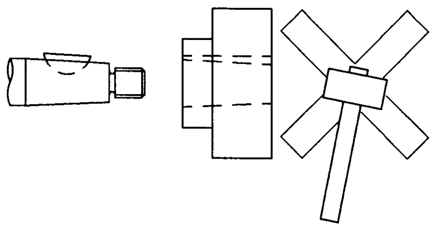
A precision detector is directly attached to the shaft end of the servo motor. Pay attention to the following items to prevent damage to the detector.

(1) When connecting the power transmission elements such as a gear, a pulley and a coupling to the shaft, take care not to apply a shock to the shaft.

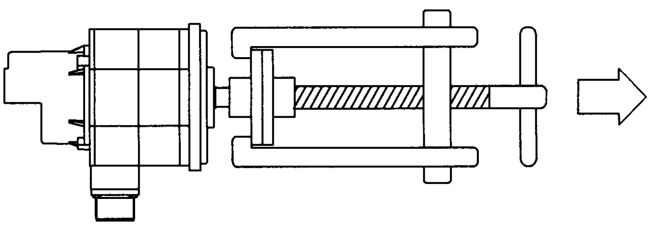


(2) Generally, in the case of straight shaft, use a span ring for connection with the shaft.

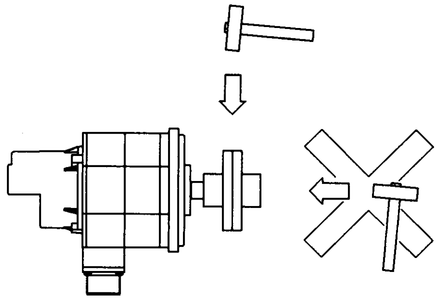
(3) In the case of tapered shaft, match the tapered surface with the power transmission element and fix by tightening the screw at the end. Even if the power transmission element cannot be mounted securely, for example, because of the woodruff key being tight, do not strike the shaft with a hammer or the like. The woodruff key mounted on the taper shaft is used mainly for positioning, while the tapered surface of the shaft is used for torque transmission. The tapered surface of the transmission element should be ground so that at least 70% of the papered surface meets the shaft surface for efficient torque transmission.



(4) To remove the connected power transmission element, be sure to use a jig such as a gear puller.



(5) Even when a light impact needs to be applied to remove the jointed taper surface, for example, just strike it softly in the radial direction. Do not apply impact in the axial direction.



(6) Suppress the rotary unbalance of the connected power transmission element to the level as low as possible. It is usually believed that there is no problem in the symmetrical form. Be careful when rotating continuously the asymmetrical different form power transmission element. Even if the vibration caused by the unbalance is as small as 0.5G, it may damage the motor bearing or the detector.

(7) An exclusive large oil seal is used in the front flange of the models β3/3000 and β6/2000.
The oil seal surface is made of steel plate. Take care not to apply a force to the oil seal when installing the motor or connecting the power transmission elements.

2.4 AXIS LOAD

The allowable axis load of the motor shaft is as follows.

Motor model	Radial load	Axial load	Front bearing (reference)
βM0.2/4000 βM0.3/4000	6.4kgf	4kgf	699
βM0.4/4000 βM0.5/4000 βM1/4000	20kgf	5kgf	6902
β1/3000 β2/3000	25kgf	8kgf	6003 (standard) 6202 (with brake)
β3/3000 β6/2000	70kgf	20kgf	6205

(1) The allowable radial load is the value when a load is applied to the shaft end. It indicates the total continuous force applied to the shaft in some methods of mounting (e.g, belt tension) and the force by load torque (e.g., moment/pulley radius).

(2) The belt tension is critical particularly when a timing belt is used. Too tight belt causes breakage of the shaft or other fault.
Belt tension must be controlled so as not to exceed the limits calculated from the permissible radial load indicated above.

(3) In some operation conditions, the pulley diameter and the gear size need to be checked. For example, when using the model β6 with a pulley/gear with the radius of 2.5cm or less, the radial load at the occurrence of 180kgf·cm torque will exceed 70kgf. In the case of timing belt, as the belt tension is added to this value, it is thus necessary to support the shaft end.
The timing belt is also subject to the belt tension restrictions. Therefore, some support is required; for example, the end of the motor shaft should be supported mechanically.

(4) Actually, when using a timing belt, a possible fault like a broken shaft can be prevented by positioning the pulley as close to the bearing as possible.

(5) When there is a possibility of a large load, the machine tool builder needs to examine the life by referring to the shaft diameter, bearing, etc.

(6) Since the standard single row deep groove ball bearing is used for the motor bearing, a very large axial load can not be used. Particularly, when using a worm gear and a helical gear, it is necessary to provide another bearing.

(7) The motor bearing is generally fixed with a C-snap ring, and there is a small play in the axial direction. When this play influences the positioning in the case of using a worm gear and a helical gear, for example, it is necessary to fix it with another bearing.

2.5 ENVIRONMENT

(1) Ambient temperature

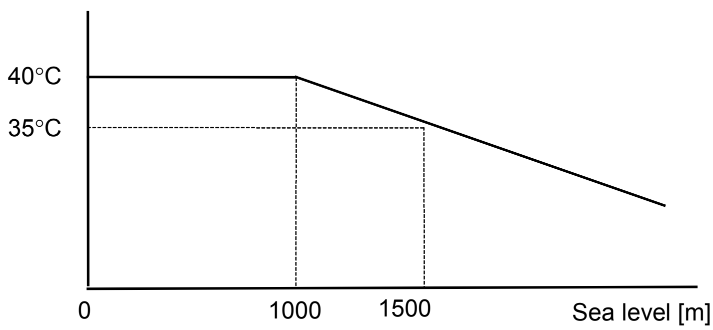
The ambient temperature should be -10 to 40°C. When operating the machine at a higher temperature, it is necessary to lower the output power so that the motor temperature does not exceed the specified constant value. (The values in the data sheet are determined for an ambient temperature of 20°C.)

(2) Vibration

When installed in a machine, the vibration applied to the motor must not exceed 5G.

(3) Installation height

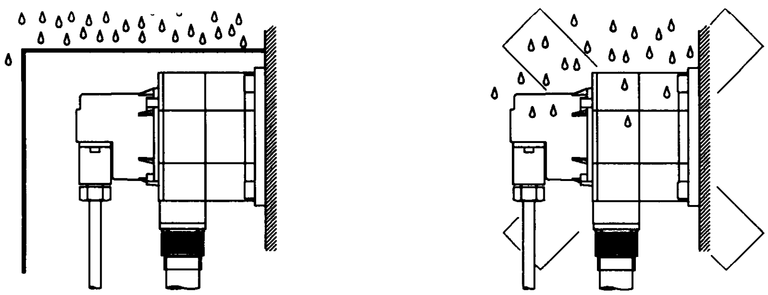
Up to 1,000 meters above the sea level requires, no particular provision for attitude. When operating the machine at a higher level, special care is unnecessary if the ambient temperature is lowered 1°C at every 100m higher than 1,000m. For example, when the machine is installed at a place of 1,500 meters above sea level, there is no problem if the ambient temperature is 35°C or less. For higher temperatures, it is necessary to limit the output power.



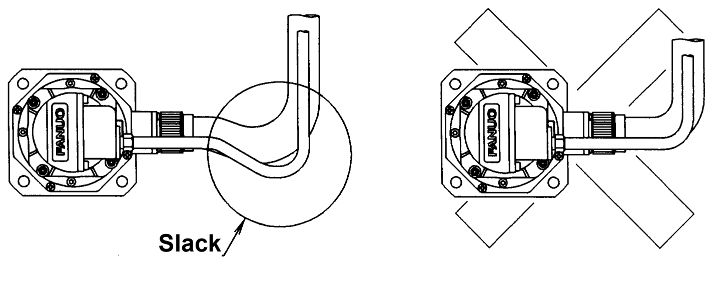
(4) Drip-proof environment

The protection form for a single motor unit satisfies IP65 of the IEC standards (equivalent to JP65, dust-proof and jet-proof type, of JIS C4004-1980, code for revolving electric machines) These standards, however, refer only to short-term performance. In actual operation, note also the following:

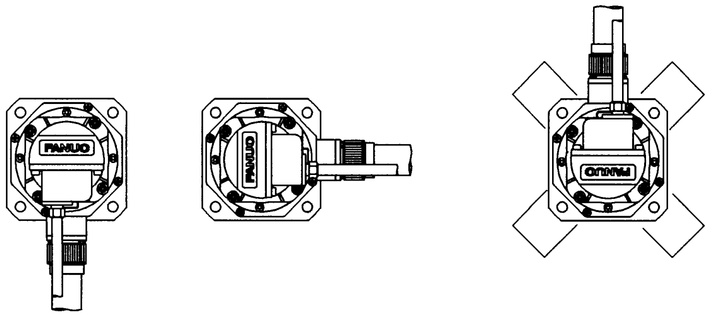
(a) Protect the motor surface from the cutting fluid or lubricant. Use a cover when there is a possibility of wetting the motor surface. Only the telescopic cover of the sliding part can not completely prevent leakage of the cutting fluid. Pay attention to the drop along the structure body, too.



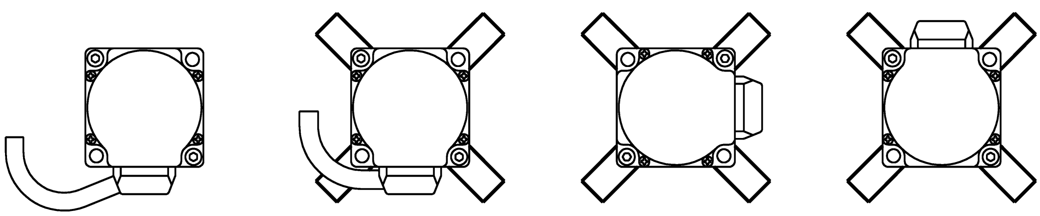
(b) Prevent the cutting fluid from being led to the motor through the cable. When the motor connector is used in the sideways position, put a drip loop in the cable.



(c) When the motor connector is up, the cutting fluid is collected in the cable connector through the cable. Turn the motor connector sideways or downward as far as possible. Most of the defects caused by the cutting fluid have occurred in the cable connector.
The standard receptacle on the motor side is waterproof. If the cable connector will be subjected to moisture, it is recommended that an R class or waterproof plug be used. Suitable plugs are listed in the cable plug combination recommendations in Chapter 9. (The standard MS plug is not waterproof; water is liable to enter the pin section.)



(d) The connectors and lead wires of power and signal lines of models βM0.2/4000 and βM0.3/4000 are not drip-proof. When a connector or lead wire must be drip-proof, the machine tool builder needs to provide drip protection.
If model βM0.2/4000 or βM0.3/4000 is exposed to coolant, for example, direct the lead wire outlet downward whenever possible. Moreover, do not install the shaft in the upward direction.
To prevent coolant from running to the motor through the cable, slack a part of the cable, for example, as a countermeasure.

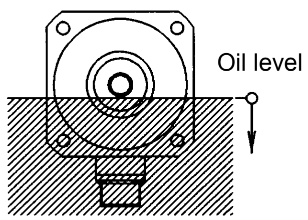


(5) Shaft attachment section requirements

The shaft of the motor has an oil seal to prevent foreign matter such as oil from entering the motor. Given that motors tend to be used in a wide range of environments, however, protection against oil penetration cannot always be perfect. Therefore, always observe the following precautions when using these motors.

- When oil bath lubrication is provided for the gear engagement, for example, the oil level must be below the lip of the oil seal (where the shaft sticks to the oil seal). Set the oil level so that oil merely splashes the lip.
- Thus, as the shaft rotates, the oil seal can repel oil. If, however, pressure is applied continuously while the shaft is stopped, oil may penetrate the lip.
- When the shaft is always immersed in oil, for example, under the condition that the motor is to be used with the shaft oriented vertically a special design is required. For example, another oil seal could be installed on the machine side, and a drain provided so that oil penetrating that seal can drain off.
- When grease is used for lubrication, the oil seal characteristics are usually lost.

In either case, ensure that no pressure is applied to the oil seal lip.



The motor shaft oil seal diameter is as shown below.

Motor model	Oil seal diameter
βM0.2/4000, βM0.3/4000	φ8mm
βM0.4/4000, βM0.5/4000, βM1/4000	φ14.9mm
β1/3000, β2/3000	φ15mm
β3/3000, β6/2000	φ24mm

2.6 ACCEPTANCE AND STORAGE

When the servo motor is delivered, check the following items.

- The motor meets the specifications.
  (Specifications of the model/shaft/detector)
- Damage caused by the transportation.
- The shaft is normal when rotated by hand.
- The brake works.
- Looseness or play in screws.

FANUC servo motors are completely checked before shipment, and the inspection at acceptance is normally unnecessary. When an inspection is required, check the specifications (wiring, current, voltage, etc.) of the motor and detector.

Store the motor indoors. However avoid storing in the following places.

- Place with high humidity so condensation will form.
- Place with extreme temperature changes.
- Place always exposed to vibration.
  (The bearing may be damaged.)
- Place with much dust.

The storage temperature is -20°C to +60°C.

3 INSTRUCTIONS

3.1 DRIVE SHAFT COUPLING

There are four methods for connecting the motor shaft to the ball screw:

- Direct connection through a flexible coupling
- Direct connection through a rigid coupling
- Connection through gears
- Connection through timing belts

It is important to understand the advantages and disadvantages of each method,
and select one that is most suitable for the machine.

(1) Direct connection using a flexible coupling

Direct connection by a flexible coupling has the following advantages over connection using gears:

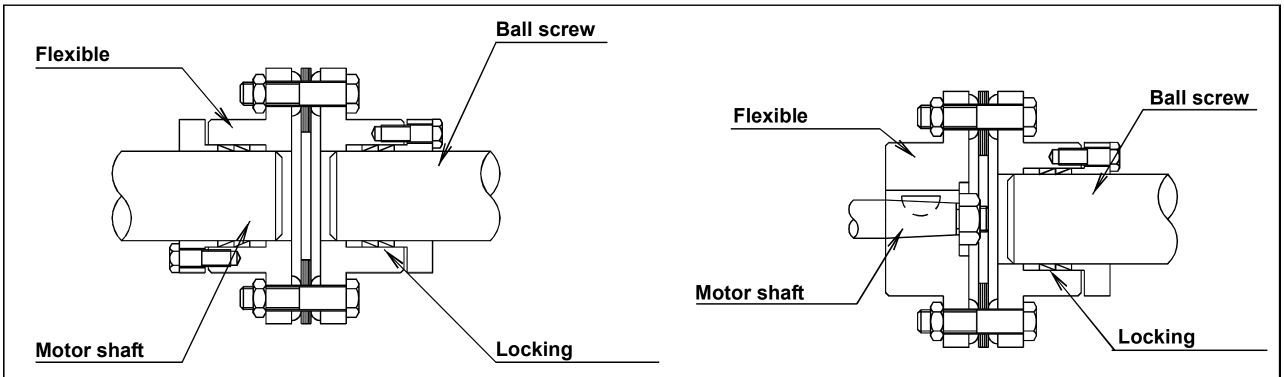
- A certain misalignment of the angle between the motor shaft and the ball screw can be compensated.
- Because a flexible coupling connects elements with less backlash, driving noise from joints can be significantly suppressed.

However, this method has the following disadvantages:

- The misalignment of the center between the motor shaft and the ball screw is not permitted (in the case of single coupling).
- Loose assembly may result in lower rigidity.

When the motor shaft needs to be connected directly to the ball screw, connecting them using a flexible coupling facilitates adjustment and installation of the motor.

To use a single coupling, the machine needs to be designed so that the centers of the motor shaft and the ball screw are aligned. If it is difficult to align the centers, a double coupling needs to be employed.



(2) Direct connection using a rigid coupling

Direct connection using a rigid coupling has the following advantages over direct connection using a flexible coupling:

- More economical
- The coupling rigidity can be increased.
- If the rigidity is the same as with a flexible coupling, the inertia can be reduced.

However, this method has the following disadvantages:

- The misalignment of the center and the angle between the motor shaft and the ball screw are not permitted strictly.

For this reason, a rigid coupling needs to be mounted very carefully.

It is desirable that the run-out of the ball screw is 0.01 mm or less. When a rigid coupling is used on the motor shaft, the run-out of the hole for the ball screw must be set to 0.01 mm or less by adjusting the tightness of the span ring.

The run-out of the motor shaft and the ball screw in the radial direction can be adjusted or compensated to a little certain extent by deflection. Note, however, that it is difficult to adjust or measure misalignment in the angle. Therefore, the structure of the machine should be such that precision can be fully guaranteed.

(3) Gears

This method is used when the motor cannot be put in line with the ball screw because of the mechanical interference problem or when the reduction gear is required in order to obtain large torque. The following attention should be paid to the gear coupling method:

- Grinding finish should be given to the gear, and eccentricity, pitch error, tooth-shape deviations etc. should be reduced as much as possible. Please use the JIS, First Class as a reference of precision.
- Adjustment of backlash should be carefully performed. Generally, if there is too little backlash, a high-pitched noise will occur during high-speed operation, and if the backlash is too big, a drumming sound of the tooth surfaces will occur during acceleration/deceleration. Since these noises are sensitive to the amount of backlash, the structure should be so that adjustment of backlash is possible at construction time.

(4) Timing belt

A timing belt is used in the same cases as gear connection, but in comparison, it has advantages such as low cost and reduced noise during operation, etc. However, it is necessary to correctly understand the characteristics of timing belts and use them appropriately to maintain high precision.

Generally, the rigidity of timing belt is sufficiently higher than that of other mechanical parts such as ball screw or bearing, so there is no danger of inferiority of performance of control caused by reduction of rigidity by using timing belt. When using a timing belt with a position detector on the motor shaft, there are cases where poor precision caused by backlash of the belt tooth and pulley tooth, or elongation of belt after a long time becomes problem, so consideration should be given to whether these errors significantly affect precision. In case the position detector is mounted behind the timing belt (for example, on the ball screw axis), a problem of precision does not occur.

Life of the timing belt largely varies according to mounting precision and tension adjustment. Please refer to the manufacturer's Instruction Manual for correct use.

(5) Connection between the straight shaft and a connecting element

To use a straight shaft that has no key groove, connect the shaft with a coupling using a span ring.

Because the span ring connects elements by the friction generated when the screw is tightened, it is free from backlash and the concentration of stress. For this reason, the span ring is highly reliable for connecting elements.

To assure sufficient transmission with the span ring, factors such as the tightening torque of the screw, the size of the screw, the number of screws, the clamping flange, and the rigidity of connecting elements are important. Refer to the manufacturer's specifications before using the span ring.

When a coupling or gear is mounted using the span ring, tighten the screws to remove a run-out of the coupling or gear including the shaft.

3.2 MACHINE MOVEMENT PER 1 REVOLUTION OF MOTOR SHAFT

The machine movement per 1 revolution of motor shaft must be determined at the first stage of machine design referring the load torque, load inertia, rapid traverse speed, and relation between minimum increment and resolution of the position sensor mounted on the motor shaft. To determine this amount, the following conditions should be taken into consideration.

- The machine movement per 1 revolution of motor shaft ("L") must be such that the desired rapid traverse speed can be obtained. For example, if the maximum motor speed is 1500 rpm and the rapid traverse speed must be 12 m/min., the amount of "L" must be 8 mm/rev. or higher.
- As the machine movement per 1 revolution of motor shaft is reduced, both the load torque and the load inertia reflected to motor shaft also decrease.
  Therefore, to obtain large thrust, the amount of "L" should be the lowest value at which the desired rapid traverse speed can be obtained.
- Assuming that the accuracy of the reduction gear is ideal, it is advantageous to make the machine movement per 1 rev. of motor shaft as low as possible to obtain the highest accuracy in mechanical servo operations. In addition, minimizing the machine movement per 1 rev. of motor shaft can increase the servo rigidity as seen from the machine's side, which can contribute to system accuracy and minimize the influence of external load changes.
- An optimum condition for the servo system is attained when the motor rotor inertia is equal to the load inertia reflected to the motor shaft. If the machine operation is characterized by repeated acceleration/ deceleration (for example, in a machine such as a punch press or print board drill), a heating problem may occur due to the current caused by acceleration and deceleration. Should this occur, specify the amount of machine movement per motor rotation so as to satisfy the optimum condition as much as possible.

4 SELECTING A MOTOR

When making a motor selection, select an optimal motor from the viewpoints of load conditions, feedrate, increment system, and so forth. This section describes how to calculate the load and other conditions, showing an example of a table with a horizontal axis.

Two types of loads are imposed on a motor: steady-state load torque such as friction, and load inertia (acceleration/deceleration torque). When selecting a motor, calculate these loads accurately, and check that the calculated values satisfy the selection conditions described below.

Condition 1

Check that the steady-state load torque at the time of idle machine feed is within 70% of the continuous rated torque of the motor.

Ensure that the steady-state load torque at rest time or very low speed operation time does not exceed 70% of the continuous rated torque. Even with the horizontal axis, the motor at rest time still generates a torque that matches the friction load, and the motor can overheat for a friction load at rest time.

Moreover, an influence such as viscosity can increase the steady-state load torque in the case of high-speed feed. So, check the steady-state load torque also at high-speed feed time.

Condition 2

Acceleration can be made with a desired time constant.

At the time of deceleration, in general, the steady-state load torque works to advance deceleration. So, if acceleration is possible, deceleration with the same time constant becomes possible. Calculate the acceleration torque and check that the torque required for acceleration is within the intermittent operating zone of the motor.

If the steady-state load torque is increased at high-speed feed time by an influence such as viscosity, the required acceleration torque should be increased in the same amount.

Condition 3

The frequency of positioning in rapid traverse satisfy to a desired value.

The greater the frequency of positioning in rapid traverse, the greater the ratio of acceleration time to the entire operation time. This may overheat the motor. When the acceleration time constant is increased according to the rapid traverse feedrate and positioning frequency constant, the amount of produced heat decreases in inverse proportion to the acceleration time constant.

Condition 4

If the load condition varies during a single cycle, the root-mean-square value of the torques is smaller than or equal to the rated torque.

Condition 5

The time for which the table can be moved (duty percentage and ON time) is within a desired range.

4.1 MOTOR SELECTION

When making a motor selection, select an optimal motor from the viewpoints of load conditions, rapid traverse rate, increment system, and so forth. To ensure satisfactory motor selection, the user should determine the conditions of use according to the servo motor selection data table given at the end of this section. Enter the necessary machine data (up to the external detector item) in the servo motor selection data table. If the customer sends it to FANUC, we will provide the remaining items, and check the customer-provided data. For details of each item in the servo motor selection data table, see the descriptions below.

4.1.1 Blanks for Those Other than Data

(1) Machine type
Fill in this blank with a general name of machine tools, such as lathe, milling machine, machining center, and others.

(2) Machine model
Fill in this blank with the model name of machine tool decided by machine tool builder.

(3) CNC model
Fill in this blank with the name of CNC (16*i*-MB, 21*i*-TB, PM*i*-H, etc.) employed.

(4) Axis name
Fill in this blank with axis name practically employed in CNC command. If the number of axes exceeds 2 axes, enter them in the second sheet.

(5) Blanks of version number, date, name, and reference number.
These blanks are left blank by the FANUC.

4.1.2 Data Items to be Entered

The machine tool builder is to provide the following data: direction of movement, feed mechanism, mechanical specifications, and external position detector. If a particular specification value is desired, specify the value. FANUC will enter an appropriate value, considering the overall specification. Each item is described in detail below.

(1) Specifications of moving object
Data in this blank are used for determining the values of motor load conditions (inertia, torque). Fill in blanks of all items.
   (a) Direction of movement
   Enter the movement directions of driven parts such as table, tool post, etc.
   Write the angle from the horizontal level, if their movement directions are slant (Example : Slant 60°)
   Whether their movement directions are horizontal or vertical (or slant) is necessary for calculating the regenerative energy. Fill in this blank without fail.
   (b) Weight of the moving object
   Enter the weight of driven parts, such as table , tool post, etc. by the maximum value including the weight of workpiece, jig, and so on. Do not include the weight of the counter balance in the next item in this item.
   (c) Counter balance
   Enter the weight of the counter balance in the vertical axis, if provided.
   Write the force in case of hydraulic balance.
   (d) Table support
   Enter the type of table slide as to rolling, sliding, or static pressure type. If a special slide way material like Turcite is used, note it.

(2) Feed mechanism
Enter values for whichever items are pertinent.
   (a) Ball screw
   Enter the diameter, pitch, and length of the ball screw in order.
   (b) Rack and pinion
   Enter the pinion diameter and amount of travel for the machine tool, per revolution of the pinion.
   (c) Others
   When using a feed mechanism other than the above, provide details of the mechanical section, and enter a travel amount for the machine tool.

(3) Mechanical specifications
Data in this blank serve as the basis for selecting the motor. Enter these data correctly.

(a) Travelling distance of machine per revolution of the motor
Enter the travelling of the machine when the motor rotates one turn.
Example 1)
When the pitch of ball screw is 12 mm and the gear ratio is 2/3,
12(mm)×2/3=8(mm)
Example 2)
When the gear ratio is 1/72 in rotary table ;
360(deg) ×1/72=5(deg)

(b) Total gear ratio
Enter the gear ratio between the ball screw and the servo motor, gear ratio between the final stage pinion and the servo motor in case of the rack pinion drive, or gear ratio between the table and the motor in case of rotary table.

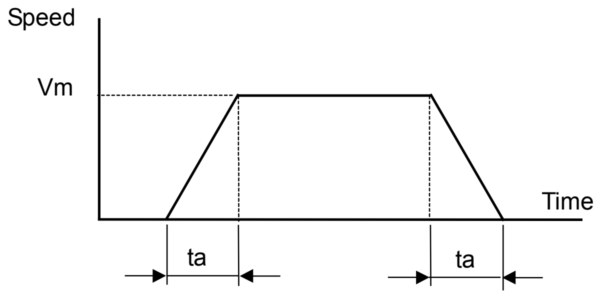
(c) Inertia
Enter a load inertia value reflected to the motor shaft.
It is not always necessary to enter this inertia value in detail. Enter it as a 2-digit value.
Example) 0.2865 → 0.29
Do not include any inertia of the motor proper in this value.

(d) Least input increment of CNC
Enter the least input increment of CNC command.

(e) Maximum rapid traverse feedrate
Enter a maximum rapid traverse feedrate according to the mechanical specifications.

(f) Motor speed in rapid traverse
The motor speed in the maximum rapid traverse feedrate is entered.

(g) Acceleration/deceleration time in rapid traverse
The acceleration/deceleration time is determined according to the load inertia, load torque, motor output torque, and working speed.
The acceleration/deceleration mode at rapid traverse is generally linear acceleration/deceleration in FANUC's CNC.



(h) Distance of positioning in rapid traverse
Enter the amount of travel when positioning during rapid traverse.

(i) Frequency of positioning in rapid traverse
Enter the rapid traverse positioning frequency by the number of times per minute.
This value is used to check if the motor is overheated or not by a flowing current during acceleration / deceleration or to check the regenerative capacity of the amplifier.

(j) Steady-state load torque
- At low speed
  The steady-state load torque at low-speed feed time may be applied even while the motor is at rest. So, the steady-state load torque needs to have a sufficient margin relative to the continuous rated torque of the motor.
  Set a steady-state load torque so that it is within 70% of the continuous rated torque.
- At rapid traverse
  As the steady-state load torque at rapid traverse time, enter the torque applied when a movement is made at steady-state rapid traverse rate. Do not include any torque required for acceleration/deceleration in this item.

(k) Backlash
Enter the backlash amount between the motor and the final driven part like table by converting it into the move amount of the table.

(4) External detector
This item is required to determine the servo system stability under the influence of an external position detector, mounted on the motor. When configuring a servo system using a linear scale, always enter this data.

(a) External position detector
If you want to mount an external position detector outside the motor, specify the name of the detector and its detection unit. If you want to use a rotary detector such as a resolver or rotary encoder, enter the following items in the "remarks" column.
- Resolver :
  Move amount of machine tool per revolution of resolver
  Number of wave lengths per revolution of resolver
- Rotary encoder :
  Move amount per revolution of pulse coder
  Number of pulses (per revolution)
  Gear diameter and reduction ratio

(5) Motor specifications

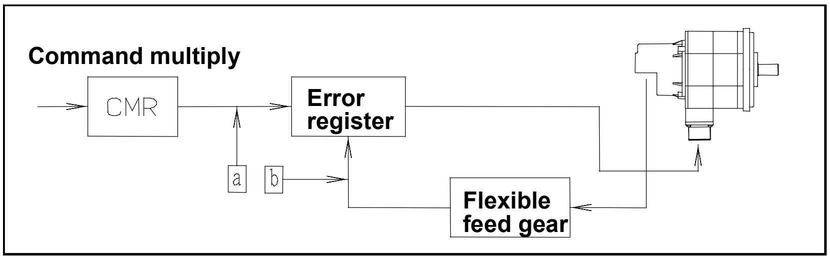
(a) Motor model, Feedback (FB) type
Enter the model name of the motor employed and the specifications of the built-in feedback unit by using symbols.

(b) Option
Enter optional specifications, if any, in this blank.

(6) Data to be provided by FANUC

(a) Input multiply ratio, command multiply ratio, and flexible feed gear ratio

The NC set values required for moving the machine tool at the least input increment values are entered in these blanks. The relation among these values as illustrated below.



In the above figure, each ratio is set so that the units of the two inputs (a and b) of the error register are the same. The β pulse coder uses a flexible feed gear as standard. So, CMR is normally set to 1. When other than 1 is to be set for CMR, contact FANUC for details.

For the flexible feed gear (F.FG), the ratio of the number of position pulses required per motor shaft revolution to the number of feedback pulses is set.

The set value is obtained as follows:

F.FG=(Number of position pulses requiredper motor shaft revolution)/1,000,000

NOTE

The maximum permissible value for both the numerator and denominator is 32,767. So, the fraction should be reduced to its lowest terms, after which the resultant numerator and denominator should be set.

Example)

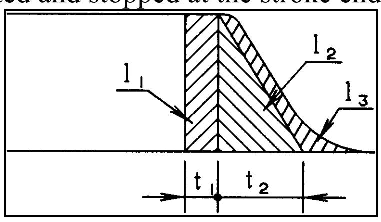
Suppose that the NC uses increments of 0.01mm, the machine travel distance per motor shaft revolution is 8 mm, and pulse coder βA32B is used.

F.FG=(8/0.01)/1,000,000=800/1,000,000=1/1250, CMR=1

(b) Position loop gain
Fill in this blank with a value which is considered to be settable judging it from the inertia value based on experiences. Since this value is not always applicable due to rigidity, damping constant, and other factors of the machine tool, it is usually determined on the actual machine tool. If the position detector is mounted outside the motor, this value is affected by the machine tool rigidity, backlash amount, and friction torque value. Enter these values without fail.

(c) Deceleration stop distance and dynamic brake stop distance
In these items, the coasting distance of the machine tool at the machine tool stroke end is entered. Usually, a stroke end consists of two limit stages. The stage-1 limit triggers a deceleration stop, while the stage-2 limit triggers a dynamic brake stop. When the stage-1 limit is tripped, the displayed position exactly matches the stop position of the machine tool. When the stage-2 limit is tripped, the position data is lost. The stage-2 limit is designed to stop the machine tool if the machine tool becomes uncontrollable and runs away. Therefore, always install a stage-2 limit to protect the machine tool from damage.

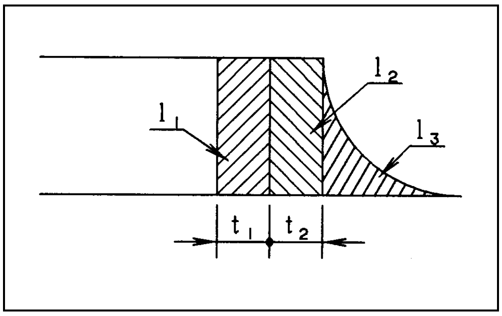
- Deceleration stop distance
  Enter the coasting distance when the machine tool is decelerated and stopped at the stroke end.



V_m : Rapid traverse rate, mm/min or rev/min
l_1 : Coasting distance due to delay time t_1 of receiver
l_2 : Coasting distance due to deceleration time t_2
l_3 : Servo deflection amount
t_1 : Usually about 0.02 seconds

Coasting distance = $Vm/60 \times (t_1+t_2/2+1/ks)$(mm or deg)
ks : Position loop gain (sec^{-1})

- Dynamic brake stop distance
  This is coasting distance when the machine tool is stopped by dynamic braking with both ends of the motor power line shorted, if the machine tool is in trouble.



V_m : Rapid traverse rate, mm/min or rev/min
l_1 : Coasting distance due to delay time t_1 of receiver
l_2 : Coasting distance due to deceleration time t_2 of magnetic contactor (MCC)
l_3 : Coasting distance by dynamic braking after magnetic contactor has been operated
(t1+t2) is usually about 0.05 seconds.

Coasting distance =
$Vm/60\times(t_1+t_2)+(J_m+J_L)\times(AN_0+BN_0^3)\times L$(mm or deg)
J_m : Motor inertia ($kg\cdot cm\cdot s^2$)
J_L : Load inertia ($kg\cdot cm\cdot s^2$)
N_0 : Motor speed at rapid traverse (min^{-1})
L : Machine movement on one-rotation of motor (mm or deg)
$N_0 = V_m$
A and B are constants that vary with the model of the motor being used. The values for each model are listed under "Coefficients for Calculating the Dynamic Brake Stopping Distance."

(d) Specifications of amplifier, regenerative discharge unit, and transformer
For these items, the specifications of the servo amplifier and transformer to be used are entered. Enter a desired amplifier model, if any, as the remarks item.

(7) Coefficients for calculating the dynamic brake stop distance

Motor model	A	B	J_m (kgfcms^2)
βM0.2/4000	8.1×10^{-1}	5.7×10^{-8}	1.9×10^{-5}
βM0.3/4000	3.4×10^{-1}	4.5×10^{-8}	3.5×10^{-5}
βM0.4/4000	2.2×10^{-1}	4.5×10^{-8}	1.0×10^{-4}
βM0.5/4000	8.8×10^{-2}	2.0×10^{-8}	1.8×10^{-4}
βM1/4000	3.7×10^{-2}	8.7×10^{-9}	3.5×10^{-4}
β1/3000	4.8×10^{-2}	5.7×10^{-8}	3.4×10^{-3}
β2/3000	1.9×10^{-2}	3.1×10^{-8}	6.7×10^{-3}
β3/3000	9.7×10^{-3}	2.4×10^{-8}	2.0×10^{-2}
β6/2000	3.9×10^{-3}	1.2×10^{-8}	4.0×10^{-2}

The values of A and B are calculated by assuming that the resistance of the power line is 0.05 Ω per phase. The values will vary slightly according to the resistance value of the power line.
These values are coefficients applicable when α and α*i* series servo amplifiers are combined. Depending on the servo amplifier used, each value slightly varies.

MTB ____________

Servo motor selection data table (models for positioning)

Machine type		Machine model	
CNC model	FANUC	Name	

Item		Axis name		
Specifications of moving object				
	Direction of movement (horizontal, vertical, slant__degrees, rotation)			
	Weight of the moving object (including the workpiece)	kg		
	Counterbalance	kg		
	Table support (sliding contact, rolling contact, static pressure), Frictional coefficient	(*)		
Feed mechanism (Select one of the following and enter the corresponding data.)				
	1 Ball screw: Diameter × pitch × length	mm		
	2 Rack and pinion: Diameter of pinion, traveling distance per revolution	mm		
	3 Others			
Mechanical specifications (Enter a typical operation pattern, if already determined, in the remarks field.)				
	Traveling distance of the machine per revolution of the motor	mm		
	Total gear ratio			
	Inertia (Note "before deceleration" or "applied to the motor shaft.")	$kgfcms^2$		
	Least input increment of CNC (resolution)	mm		
	Maximum rapid traverse feedrate	mm/min		
	Motor speed in rapid traverse	min^{-1}		
	Acceleration/deceleration time in rapid traverse	msec		
	Distance of positioning in rapid traverse	mm		
	Frequency of positioning in rapid traverse	frequency/min		
	Steady-state load torque: At low speed time	kgfcm		
	Steady-state load torque: At rapid traverse time	kgfcm		
	Backlash	mm		
Fill in these blanks when an external detector is used.		(**)		
	Type of external position detector (detection unit, number of pulses, etc.)			
	Gear diameter and reduction ratio when a rotary encoder is used			
Motor specifications				
	Motor model (desired size and output, if any)			
	FB type (when an absolute position detector is required)			
	Option (when a brake, non-standard shaft, etc. is required)			
FANUC will fill in these blanks.				
	Command multiplier	CMR		
	Detection multiplier	DMR		
	Flexible feed gear	FFG		
	Position loop gain	sec^{-1}		
	Deceleration stop distance	mm		
	Dynamic brake stop distance	mm		
	Specifications of amplifier			
	Regenerative discharge unit			
	Specifications of transformer			

Note:
(*) Note the friction coefficient of the sliding surface if it is determined.
(**) An external position detector is required when:
- The positions of the motor and machine may be mechanically displaced, for example, by slippage of a driving tire or an elongated driving chain. (Example: Expansion of chain when chain is driver, etc.)

Remarks	Version	Date	Name
	3		
	2		
	1		

FANUC LTD A.Ar-1870-

4.2 CHARACTERISTIC CURVE AND DATA SHEET

Performance of each motor model is represented by characteristic curves and data sheet shown below.

4.2.1 Characteristic Curves

The typical characteristic curves consist of the following.

(1) Speed-torque characteristics
These are known as operating curves and describe the relationship between the output torque and rotation speed of the motor. The motor can be operated continuously at any combination of speed and torque within the prescribed continuous operating zone. To use the motor outside this zone, obtain an operating condition from an overload duty curve, and use the motor intermittently. The limit of continuous operating zone is determined under the following conditions.
- The ambient temperature for the motor is 20°C.
- The drive current of the motor is pure sine wave.

The limit of the intermittent operating zone is determined by the rated input voltage (200 V) applied to the drive unit. So, the limit may change, depending on the voltage applied to the drive unit.
The torque in the continuous operating zone and intermittent operating zone decreases by 0.19% with the β series or by 0.11% with the βM series for each temperature increase of 1°C beyond 20°C due to the negative temperature coefficient of the magnet material.

(2) Overload duty characteristic
This is known as a duty cycle curve and used to calculate the ON time (during which the motor can be powered) and OFF time (during which the motor must be kept at a rest to get cooled) for the motor to run intermittently without becoming overheated.
This curve is determined by the limit of motor temperature. However, the curve may also depend on the thermal protection function of the drive unit and control unit.
See Section 4.2.3 for how to calculate the ON and OFF times.

4.2.2 Data Sheet

The data sheet gives the values of motor parameters relating to the performance.

The values of parameters are those under the following conditions.

- The ambient temperature for the motor is 20°C.
- The drive current of the motor is pure sine wave.

Important parameters on the data sheet are defined as follows :

(a) Continuous RMS current at stall : Is (Arms)

This current represents a maximum effective current that can continuously run the motor at low speed.

(b) Torque constant : Kt (kgf·cm/Arms)

This constant represents a torque value generated by the motor for a phase current of 1 ampere.

The torque constant decreases by 0.19% with the β series or by 0.11% with the βM series for each temperature increase of 1°C beyond 20°C due to the negative temperature coefficient of the magnet material.

The torque constant is a function of the total flux and the total number of conductors in the armature.

The back EMF constant (Kv) and the torque constant are interrelated as follows :

Kt (kgf·cm/Arms)=30.6 Kv (Volt·sec/rad)

Thus if Kv is reduced due to demagnetization of the magnet, Kt is also reduced in the same proportion.

(c) Back EMF (electromotive force) constant : Kv (Volt·sec/rad)

A back EMF is a voltage that is generated by rotating a servo motor with external mechanical force. The back EMF constant of a motor represents the relationship between the number of conductors in the armature of the motor and the amount of flux in the field magnet. The back EMF constant is also a parameter representing the intensity of a permanent magnet. The relationship can be given as.

(Volt·sec/rad)=(volt/min^{-1}) ×9.55

Back EMF constant is indicated as the RMS voltage per phase, so multiply $\sqrt{3}$ to get actual terminal voltage.

(d) Mechanical time constant : tm (sec)

This is a function of the initial rate of rise in velocity when a step voltage is applied. It is calculated from the following relationship.

tm=(Jm×Ra)/(Kt×Kv)

Jm : Rotor inertia (kgf·cm·sec^2)

Ra : Resistance of the armature (Ω)

(e) Thermal time constant : tt (min)

This is a function of the initial rate of rise of winding temperature at rated current. It is defined as the time required to attain 63.2 percent of the final temperature rise.

(f) Static friction : Tf (kgf·cm)

This is the no-load torque required just to rotate the rotor.

4.2.3 How to Use Overload Duty Curves

The servo motor can be driven out of the continuous operating zone, but intermittently. Duty characteristics shows the Duty (%) and the "ON" time in which motor can be operated under the given overload conditions. The ON and OFF times of a motor are conditioned using the following procedure.

<1> Calculate Torque percent by formula below.
TMD=Load torque/Continuous rated torque
The ON time for a motor can be specified within the torque percent.

<2> Calculate "OFF" time by formula.
$t_F = t_R \times (100/\text{Duty percent}-1)$
t_F : "OFF" time
t_R : "ON" time

> Example)
> If it is necessary to run the β2/3000 under a load of 30 kgf·cm at very low speed:
> Because the rated torque of the β2/3000 is 20 kgf·cm:
> Torque percent: TMD = 30/20 = 1.5 (150%)
> From the overload duty curve of the β2/3000:
> Duty percent of the motor when it runs with TMD = 150% for five minutes is: About 37%
> OFF time: $t_F = 5 \times (100/37 - 1) \fallingdotseq 8.5$ min
> After the motor runs under the above conditions, therefore, it must be kept at a stop for at least 8.5 minutes.

The drive amplifier also incorporates a thermal protection device such as a circuit breaker or thermal circuit. The thermal protection device may additionally limit the operation of the motor. In addition, a software function protects the motor and amplifier from short-term overload. The function may limit the operation of the motor.

5 IEC34 STANDARD

5.1 REQUIREMENTS FOR COMPLIANCE

This section describes the conformity of the FANUC AC SERVO MOTOR β series and βM series to the IEC34 standard. The IEC34 standard can be satisfied by using a motor having a nameplate bearing a TÜV mark and satisfying the conditions below.

5.1.1 Drive Unit

The motor must be driven by the FANUC AC SERVO AMPLIFIER β series, α*i* series, or α series.

5.1.2 Connector

Motor power lines and brake units must be connected using the connectors listed below.

[βM series]

<table>
<tr><th colspan="2">Motor model</th><th colspan="2">Connector specification
[FANUC specification]</th><th>Special tool specification
[FANUC specification]</th><th>Manufacturer</th></tr>
<tr><td rowspan="4">βM0.4/4000
βM0.5/4000
βM1/4000</td><td rowspan="2">Power</td><td>Straight type</td><td>Connector body : 54983-0000
Contact : 56052-8100
[A06B-6114-K230#S] (FANUC specification)
(The connector body and contact are contained in the same pack.)</td><td rowspan="4">Crimping tool
57406-5000
[A06B-6114-K234#C]
Pull-out tool
57406-6000
[A06B-6114-K234#R]</td><td rowspan="4">MOLEX JAPAN Co., Ltd.</td></tr>
<tr><td>Elbow type</td><td>Connector body : 55765-0000
Contact : 56052-8100
[A06B-6114-K230#E] (FANUC specification)
(The connector body and contact are contained in the same pack.)</td></tr>
<tr><td rowspan="2">Brake</td><td>Straight type</td><td>Connector body : 54982-0000
Contact : 56052-8100
[A06B-6114-K232#S] (FANUC specification)
(The connector body and contact are contained in the same pack.)</td></tr>
<tr><td>Elbow type</td><td>Connector body : 55766-0000
Contact : 56052-8100
[A06B-6114-K232#E] (FANUC specification)
(The connector body and contact are contained in the same pack.)</td></tr>
</table>

⚠ **WARNING**

For grounding, a wire with a cross-sectional area equal to or greater than that of U, V, or W must be used.

[β series]

Motor model			Plug connector specification [FANUC specification]	Cable clamp specification [FANUC specification]	Manufacturer
β1/3000 β2/3000 β3/3000 β6/2000	Power	Straight type	H/MS3106A18-10S-D-T(10) [A63L-0001-0648/61810SH]	H/MS3057-10A(10) [A63L-0001-0592/10AK]	HIROSE ELECTRIC
		L type	H/MS3108A18-10S-D-T(10) [A63L-0001-0648/81810SH]		
	Brake	Straight type	JL04V-6A10SL-3SE-EB [A63L-0001-0648/610SL3SJ]	JL-04-1012CK-(07) [A63L-0001-0653/04A]	Japan Aviation Electronics Industry
		L type	JL04V-8A10SL-3SE-EB [A63L-0001-0648/810SL3SJ]		

⚠ **WARNING**

For grounding, a wire with a cross-sectional area equal to or greater than that of U, V, or W must be used.

NOTE

The plug connectors do not feature a cable clamp.

TÜV has certified that the plug connectors and cable clamps above, when combined with the FANUC AC SERVO MOTOR β series, satisfy the VDE0627 safety standard.

In addition to the plug connectors above, connector manufacturers offer TÜV-compliant connectors. For compliance of these connectors with the safety standard when combined with the FANUC AC SERVO MOTOR β series, check with each connector manufacturer. Moreover, contact each connector manufacturer for details of each series.

Manufacturer	Product series name
HIROSE ELECTRIC	H/MS310 TÜV-compliant series
Japan Aviation Electronics Industry	JL04V series
DDK Ltd.	CE05 series

5.2 APPROVAL SPECIFICATIONS

5.2.1 Rotational Speed (IEC34-1)

Each model's maximum allowable speed is as shown below.
The maximum allowable speeds are determined from the viewpoint of speed alone within the range in which the certification condition for satisfying the IEC34 standard is observed. The characteristics at a maximum allowable speed are not guaranteed.

Motor model	Rated speed (min^{-1})	Maximum allowable speed (min^{-1})
βM0.4/4000	4000	5000
βM0.5/4000	4000	5000
βM1/4000	4000	5000
β1/3000	3000	4000
β2/3000	3000	4000
β3/3000	3000	4000
β6/2000	2000	3000

(*) The maximum allowable speeds are applicable only when HRV control is used for driving.

5.2.2 Output (IEC34-1)

The rated output is guaranteed as continuous output only at the rated output speed.
Output in the intermittent operating zone is not specified. The certified output value of each model is indicated below.

Motor model	Rated output (W)
βM0.4/4000	125
βM0.5/4000	200
βM1/4000	400
β1/3000	300
β2/3000	500
β3/3000	500
β6/2000	900

5.2.3 Protection Mode (IEC34-5)

The protection mode defined by IEC34-5 is as follows:

Motor model	IP	Approval condition
βM0.4/4000 βM0.5/4000 βM1/4000	65	A specified connector needs to be used.
β1/3000 β2/3000 β3/3000 β6/2000	65	A specified connector and waterproof cover (signal lines) need to be used.

IP6x : Complete dust-proof machine
Structure that completely prevents dust from penetrating

IPx5 : Machine tool protected against water spray
Water, sprayed randomly onto the machine tool through a nozzle, must not adversely affect the operation of the machine tool.

The IPx5 mode test conditions are as follows:

- Inner nozzle diameter 6.3mm
- Volume of water 12.51/min
- Water pressure at nozzle 30kPa
- Injection time per unit surface area (1 m^2) 1 minute
- Minimum test time 3 minutes or more
- Distance between nozzle and machine tool About 3 m

⚠ **WARNING**

As described above, IPx5 evaluates a machine tool by means of a short-term test using water, assuming that the machine tool is dried after being sprayed with water. Note that the use of a liquid other than water or the continuous application of water, such that the machine tool is not allowed to dry, can adversely affect the machine tool even if the other aspects of the test are less severe.

5.2.4 Cooling Method (IEC34-6)

The following motor cooling method is to be used:

Motor model	IC code	Method
βM0.4/4000 βM0.5/4000 βM1/4000	IC410	Totally enclosed, natural air-cooling
β1/3000 β2/3000 β3/3000 β6/2000		

5.2.5 Installation Method (IEC34-7)

A motor can be installed using any of the following methods:

IMB5	:	The motor is installed by using a flange, with the shaft oriented horizontally (from the back).
IMV1	:	The motor is installed by using a flange, with the shaft oriented upwards (from the back).
IMV3	:	The motor is installed by using a flange, with the shaft oriented downwards (from the back).

5.2.6 Heat Protection (IEC34-11)

The heat protection mode defined in IEC34-11 is as follows:

Motor model	Code	Method
β6/2000	TP112	Indirect protection of windings by means of a thermal cut-out

T P 1 1 2

2 : Temperature rise limit class 2 for heat protection
1 : One-stage stop only
(with no alarm information output)
1 : Protection against less abrupt overload only

NOTE
1. Heat protection is not defined for models other than the model indicated above.
2. Each model is software-protected against an abrupt overload.

6 EMC DIRECTIVE

The β series servo motors comply with the EMC directive.

To make the entire machine compliant to the EMC directive, the necessary measures must be taken according to the guideline published by FANUC (document No.: A-72937E).

7 FEEDBACK DETECTOR

7.1 BUILT-IN DETECTOR

All servo motors feature a pulse coder (optical rotary encoder).
The pulse coder outputs position information and an alarm signal.

The βM series motors incorporate pulse coders designed to the specifications listed below.

Pulse coder type	Resolution (Division/rev)	Absolute/ incremental	Applicable motor
Pulse coder βA64B	65,536	Absolute	All models in βM series motor
Pulse coder βI64B	65,536	Incremental	All models except βM0.2/4000 and βM0.3/4000

The β series motors incorporate pulse coders designed to the specifications listed below.

Pulse coder type	Resolution (Division/rev)	Absolute/ incremental	Applicable motor
Pulse coder βA32B	32,768	Absolute	All models in β series motor
Pulse coder βI32B	32,768	Incremental	

NOTE

The β series pulse coders can be connected to an NC if the NC is fitted with the serial interface, and the digital servo software for the α pulse coders is installed.

7.2 ABSOLUTE-TYPE PULSE CODER

When the CNC is turned off, the pulse coder position detection function is backed up by battery. So, when the CNC is next turned on, the operator does not have to perform reference position return.
For backup, a battery unit for back-up must be installed in the NC or servo amplifier.
If a low-battery indication appears on the CNC, renew the battery as soon as possible.
Replace the battery while the CNC is turned on.

7.3 EXTERNAL POSITION DETECTOR

For detecting a position by attaching directly to a ball screw or a machine, use an external (separate type) position detector. Pay attention to the following items when using the external position detector.

(1) Increase the machine rigidity between the servo motor and the position detector to minimize mechanical vibration. If the machine rigidity is low or the structure vibrates, poor performance is likely to occur.

(2) Generally, when the separate type detector is used, the influence of gear, ball screw pitch error or table inclination is decreased and the positioning accuracy and geometrical accuracy (roundness, etc.) are increased, but the smoothness may deteriorate due to the elasticity in the machine between the servo motor and the position detector.

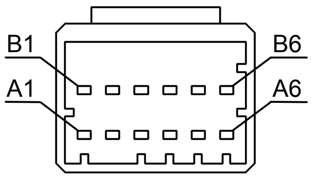
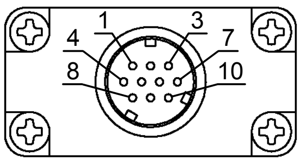
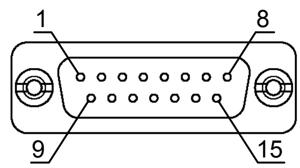
(3) Positioning precision is equivalent to the resolution of the built-in pulse coder, even if the resolution of the external position detector is higher than that of the built-in pulse coder.

(4) To connect the external position detector to the CNC, connect only the signals described in the connecting manual. (Phase A, Phase B, Phase Z, 0V, 5V and REQ if necessary)

(5) The specifications of the FANUC external position detector are given in the descriptions (B-65142E) of the α series servo motors.

7.4 DETECTOR SIGNAL OUTPUT

The following table lists the pin assignment of the β series servo motor output signals and the signals on each model's connectors.

Motor model	βM0.2/4000 βM0.3/4000	βM0.4/4000 βM0.5/4000 βM1/4000		β1/3000 β2/3000 β3/3000 β6/2000	
Pulse coder type	βA64B	βA64B	βI64B	βA32B	βI32B
Signal name	Pin number				
SD ***SD**	A4 B4	2 1	2 1	12 13	12 13
REQ ***REQ**	A3 B3	6 5	6 5	5 6	5 6
+5V **0V**	A2,B2 A1,B1	8,9 7,10	8,9 7,10	8,15 1,2,3	8,15 1,2,3
+6V **0VA**	A5 -	4 -	- -	14 10	- -
Connector pin assignment					

8 BUILT-IN BRAKE

β series servo motors have models that contain a holding brake to prevent falling of a vertical axis.
Motors with a built-in brake have different outlines and weight from other types of motors. For their outlines, refer to Part II or Part III.

The servo motor incorporates a brake which is applied to lock the shaft while the power is turned off, and which is released while the power is turned on.

8.1 BRAKE SPECIFICATIONS

The specifications of built-in brakes for βM series servo motors are listed below.

Item		Unit	βM0.2/4000 βM0.3/4000	βM0.4/4000 βM0.5/4000	βM1/4000
Brake torque		Nm kgf·cm	0.32 3.3	0.65 6.6	1.2 12
Response time	Release	msec	40	40	40
	Brake	msec	20	20	20
Supply voltage Current		V (±10%)	24 VDC		
		A	0.3 or lower	0.5 or lower	0.5 or lower
Weight increase		kgf	Approx. 0.22	Approx. 0.4	Approx. 0.4
Inertia increase		kgm^2 $kgfcms^2$	2×10^{-6} 2×10^{-5}	9×10^{-6} 9×10^{-5}	9×10^{-6} 9×10^{-5}

The values specified above are standard values at 20°C.

The specifications of built-in brakes for β series servo motors are listed below.

Item		Unit	β1/3000 β2/3000	β3/3000 β6/2000
Brake torque		Nm kgf·cm	2 20	8 82
Response time	Release	msec	60	70
	Brake	msec	20	30
Supply voltage Current		V (±10%)	90 VDC	
		A	0.3 or lower	0.4 or lower
Weight increase		kgf	Approx. 1.5	Approx. 2.3
Inertia increase		kgm^2 $kgfcms^2$	2×10^{-5} 2×10^{-4}	7×10^{-5} 7×10^{-4}

The values specified above are standard values at 20°C.

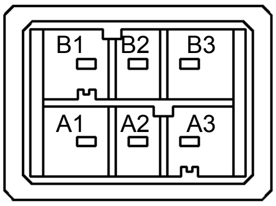
⚠ **CAUTION**

The built-in brake is used as a holding brake to prevent axis dropping at servo-off time. Though the built-in brake functions as braking in the case of an emergency stop or power outage, however, the built-in brake cannot be used to brake and shorten the stop distance at ordinary deceleration time. Moreover, while the motor is excited, the built-in brake cannot be used as an auxiliary mechanism for holding the motor.

8.2 FIGURES OF CONNECTORS

The figures and pin arrangements of brake connectors are shown below.

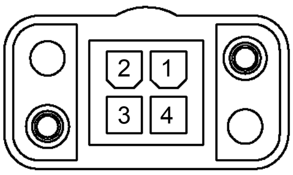
[Models βM0.2 and βM0.3]



Connection : B2=BK, B3=BK
(Connected to the power connector)
(A1=U, A2=V, A3=W, B1=GND)

Connect the brake power to BK.
No polarity is applied to brakes.

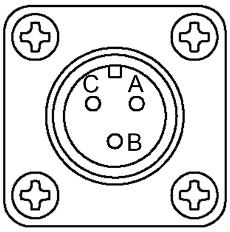
[Models βM0.4, βM0.5, and βM1]



Connection : 1=BK, 2=BK, 4=GND

Connect the brake power to BK.
No polarity is applied to brakes.

[Models β1 to β6]



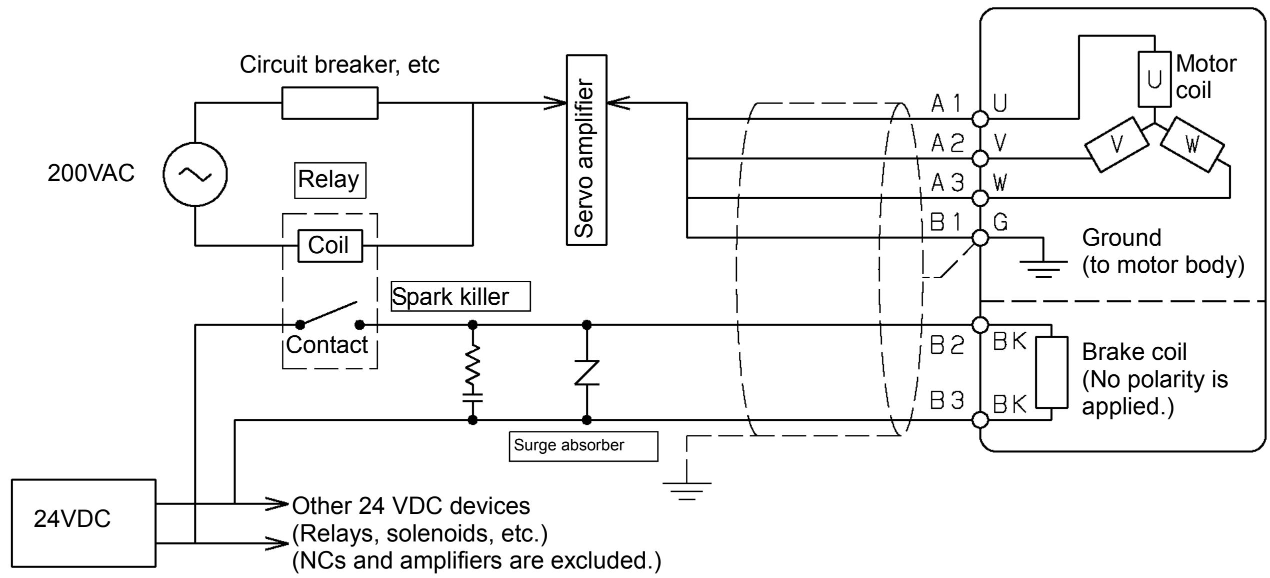
Connection : A=BK, B=BK, C=GND

Connect the brake power to BK.
No polarity is applied to brakes.

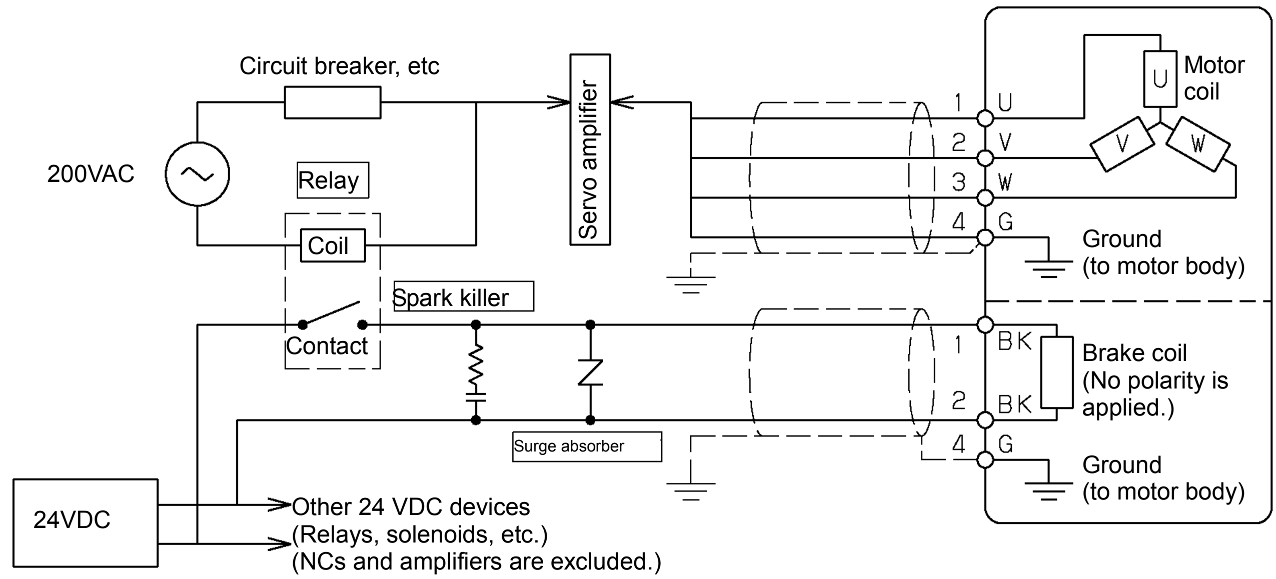
8.3 CONNECTION OF THE BRAKES

Configure a brake circuit by referencing the brake connection diagram, notes, and recommended components described below.

[Models βM0.2 and βM0.3]



[Models βM0.4, βM0.5, and βM1]



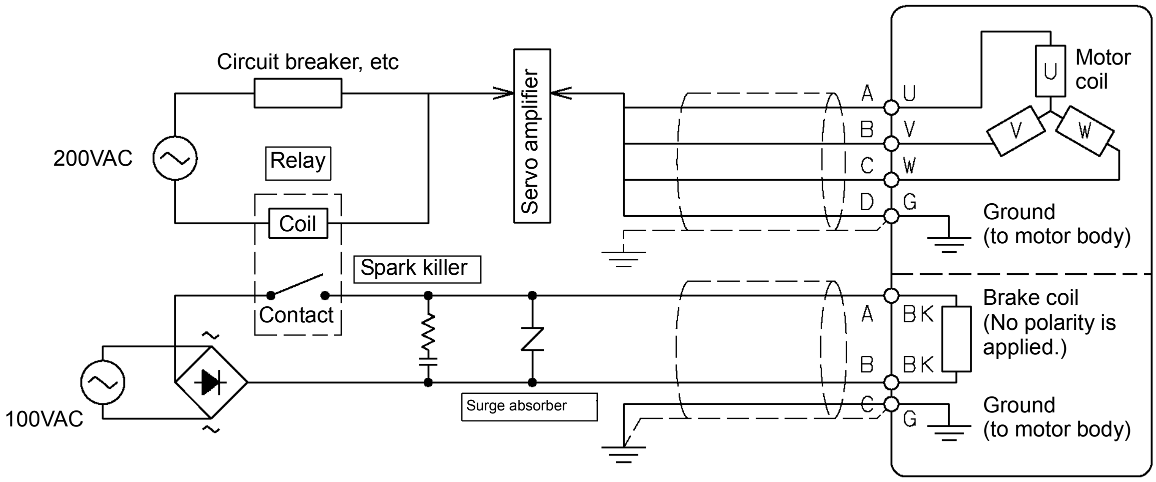
Notes

(1) Use 24 VDC as the brake power for the βM series servo motor. AC power decreased by a transformer and full-wave rectified to 24 Vrms can also be used.
(2) For the brake power, use a power system different from the 24 V power for CNC and amplifier control. If the power for CNC and amplifier control is shared as the brake power, the CNC and amplifier can malfunction. The power for peripheral devices such as relays and solenoids may be shared. In this case, however, pay attention to the power supply capacity and voltage variation due to load variation.
(3) When full-wave rectification is used, perform transformation to generate a secondary voltage of 29 VAC at the time of brake conduction, considering a voltage drop in the rectifier and cable. In this case, carefully check the power supply capacity and supply voltage variation and ensure that the variation in voltage applied to the brake at conduction time is within 24 Vrms ±10%. Be sure to prepare and select the suitable input taps on the primary side of the transformer according to the power supply voltage, such as 100-110-120 VAC or 200-220-240 VAC.
(4) When the contact is set on the DC side (position shown in the figure), the life of the contact is generally reduced due to a surge voltage generated at brake-off time. Ensure that the contact has a sufficient capacity. Moreover, use a surge absorber and spark killer to protect the contact.
(5) The brake coil has no polarity. When making a brake coil connection, the user need not be concerned with the positive and negative poles of the power.
(6) Use a shielded cable as required.

The table below indicates the recommended components and specifications of the brake circuit for the βM series servo motor.

Item	Stock number	Manufacture	Specification	FANUC specification
Switch	-	-	Rated capacity 250 VAC, 10 A or more	-
Surge absorber	ERZV10D820	Matsushita Electric Industrial Co., Ltd.	Varistor voltage 82 V Maximum allowable voltage 50 VAC	-
Spark killer	XEB0471	Okaya Electric Industries Co., Ltd.	47Ω/0.1μF Breakdown voltage 400 V or more	-
Rectifier	D3SB60	Shindengen Electric Manufacturing Co., Ltd.	Breakdown voltage 400 V or more Maximum output current 2.3 A (with no fin)	A06B-6050-K112

[Models β1 to β6]



Notes

(1) Use a full-wave rectified power of 100 VAC or use 90 VDC as the brake power for the β series servo motor. Do not use a half-wave rectified power of 200 VAC, because brake components such as a surge absorber can be damaged.

(2) When full-wave rectification is used, carefully check the power supply capacity and supply voltage variation and ensure that the variation in voltage applied to the brake at conduction time is within 90 Vrms ±10%.
Be sure to prepare and select the suitable input taps on the primary side of the transformer according to the power supply voltage, such as 100-110-120 VAC or 200-220-240 VAC.

(4) When the contact is set on the DC side (position shown in the figure), the life of the contact is generally reduced due to a surge voltage generated at brake-off time. Ensure that the contact has a sufficient capacity. Moreover, use a surge absorber and spark killer to protect the contact.

(5) The brake coil has no polarity. When making a brake coil connection, the user need not be concerned with the positive and negative poles of the power.

(6) Use a shielded cable as required.

The table below indicates the recommended components and specifications of the brake circuit for the β series servo motor.

Item	Stock number	Manufacture	Specification	FANUC specification
Switch	-	-	Rated capacity 500 VAC, 5 A or more	-
Surge absorber	ERZV20D221	Matsushita Electric Industrial Co., Ltd.	Varistor voltage 220 V Maximum allowable voltage 140 VAC	A06B-6050-K113
Spark killer	S2-A-0	Okaya Electric Industries Co., Ltd.	500Ω/0.2μF Breakdown voltage 400 V or more	-
Rectifier	D3SB60	Shindengen Electric Manufacturing Co., Ltd.	Breakdown voltage 400 V or more Maximum output current 2.3 A (with no fin)	A06B-6050-K112

9 CONNECTORS

9.1 SPECIFICATIONS OF MOTOR CONNECTORS

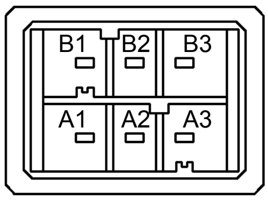
With the FANUC AC SERVO MOTOR β series, TÜV-approved connectors are used for power and brake to ensure conformity with the IEC34 standard.

The table below indicates the specifications of the connectors on the motor side.

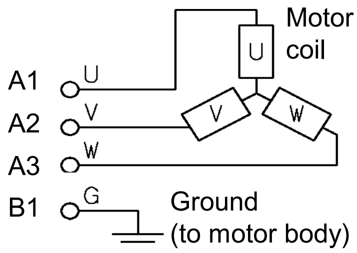
Motor model	For power	For signal	For brake
βM0.2/4000 βM0.3/4000	3-179554-3 (tyco Electronics AMP)	1-1318115-6 (tyco Electronics AMP)	Shared in power line connector
βM0.4/4000 βM0.5/4000 βM1/4000	55618-0401 (MOLEX JAPAN Co., Ltd.)	JN1AS10UL1 (Japan Aviation Electronics Industry)	55619-0401 (MOLEX JAPAN Co., Ltd.)
β1/3000 β2/3000 β3/3000 β6/2000	H/MS3102A18-10P-D-T(10) (HIROSE ELECTRIC)	SDAB-15P (HIROSE ELECTRIC)	JL04V-2A10SL-3P-B (Japan Aviation Electronics Industry)

The figures and pin arrangements of power connectors are shown below.

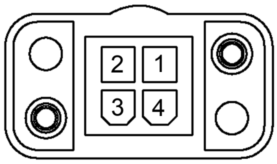
[Models βM0.2, βM0.3]



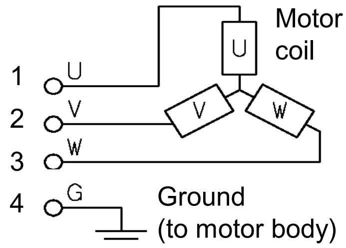
3-179554-3



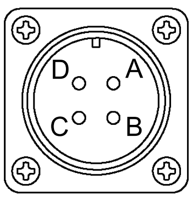
[Models βM0.4, βM0.5, βM1]



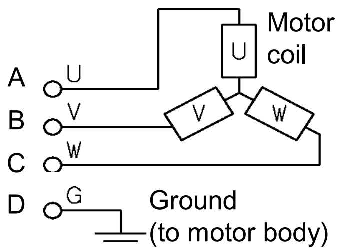
55618-0401



[Models β1 to β6]



3102A 18-10P



The standard receptacle connectors for models β1 to β6 do not exactly satisfy the MS standard in that the connectors are waterproof as single units, and their exterior color is black. However, their sizes and shapes are compatible with the conventional round-type connectors conforming to the MS standard.
Accordingly, in addition to the products recommended below, plug connectors conforming to the MS standard can also be used. (When the water-resistance of the system is of prime importance, the waterproof plug connectors recommended.

> ⚠ **WARNING**
> Direct motor connectors downwards whenever possible. When a motor connector must be directed horizontally, provide sufficient cable slack to prevent, for example, the connector from being wetted by liquid such as coolant. The connectors on the βM0.2 to βM0.3 motors are not water-proof. The machine tool builder is requested to make some provision to protect the connectors from water and moisture. In any case, if a motor connector is exposed to liquid, protection by means of a cover, for example, must be provided.

> ⚠ **CAUTION**
> If the motor in not grounded via the machine (cabinet) on which it is mounted, connect a wire between the terminal to which the motor ground cable is connected and that to which the amplifier ground cable is connected, to suppress noise. In such a case, use a wire of at least 1.25mm^2, independently of the ground wire within the power cable, and route it as far away from the power cable as possible.

9.2 βM0.2 AND βM0.3 CONNECTORS ON CABLE SIDE

9.2.1 Specifications of βM0.2 and βM0.3 Connectors for Power and Brake

The specifications of the power connector (cable side) for βM0.2 and βM0.3 are indicated below.
The connector is certified by TÜV.
The connector is not drip-proof.

		For both power and brake
Housing specification (tyco Electronics AMP)		3-178129-6 (D-3200M Receptacle housing 6 poles XY)
Contact specification (tyco Electronics AMP)		1-175218-2 (D-3 Receptacle contact L)
	Applicable wire size	0.5 to 1.25 mm^2
	Wire insulator outside diameter	ϕ1.8 to 2.8 mm

The connector kit for power and brake indicated below is available.

	For both power and brake
Connector kit specification (FANUC specification)	A06B-6114-K240
Connector kit components	Receptacle housing (3-178129-6) × 1 Receptacle contact D-3 L (1-175218-2) × 6

The table below indicates the tools dedicated to the connector.

	Applicable contact	**tyco Electronics AMP specification**	**FANUC specification**
Crimping tool	For D-3 contact of L size	914596-3	A06B-6110-K220#D3L
Pull-out tool	For D-3 contact	234168-1	A06B-6110-K220#D3R

NOTE

The contacts of the connectors are so structured that the wire and insulator are crimped together. So, be sure to observe the specified insulator diameter. Other types of wires may be usable, depending on wire and tool. For details, consult with the connector manufacturer.

9.2.2 Specifications of βM0.2 and βM0.3 Connectors for Signal

The specifications of the signal connector (cable side) for βM0.2 and βM0.3 are indicated below.
The connector is not drip-proof.

		For signal		
Housing specification (tyco Electronics AMP)		1-1318118-6 (D-2100D Receptacle housing 12 poles)		
Contact specification (tyco Electronics AMP)		1318107-1 (D-2 Receptacle contact M)		1318108-1 (D-2 Receptacle contact S)
	Applicable wire size	0.18 to 0.5 mm^2	0.3 to 0.85 mm^2	0.08 to 0.2 mm^2
	Wire insulator outside diameter	ϕ0.88 to 1.5 mm	ϕ1.1 to 1.87 mm	ϕ0.88 to 1.5 mm
	Applicable crimping tool	1463475-1 (Dedicated crimping tool)	1276654-1 (D-2 M Standard crimping tool))	1276653-1 (D-2 S Standard crimping tool)

The connector kit for signal indicated below is available.

	For signal
Connector kit specification (FANUC specification)	A06B-6114-K241
Connector kit components	Receptacle housing(1-1318118-6)×1 Receptacle contact D-2 M (1318107-1)×12

The table below indicates the tools dedicated to the connector.

	Applicable contact	**tyco Electronics AMP specification**	**FANUC specification**
Crimping tool	For D-2 contact of M size (Dedicated crimping tool suitable for wire size from 0.18 to 0.5 mm^2)	1463475-1	A06B-6114-K242
	For D-2 contact of M size	1276654-1	A06B-6110-K220#D2M
	For D-2 contact of S size	1276653-1	-
Pull-out tool	For D-2 contact	1276716-1	A06B-6110-K220#D2R

NOTE

1. When the recommended wire (wire size from 0.18 to 0.5 mm^2) is used only with D-2 contact of M size, the dedicated crimping tool indicated above is necessary.
   When the standard crimping tool for the D-2 contact is used, check the wire size and type of contact used, and the specifications of the crimping tool, and use the crimping tool within the allowable range.
2. The contacts of the connectors are so structured that the wire and insulator are crimped together. So, be sure to observe the specified insulator diameter. Other types of wires may be usable, depending on wire and tool. For details, consult with the connector manufacturer.

9.3 βM0.4 TO βM1 CONNECTORS ON CABLE SIDE

9.3.1 Specifications of βM0.4 to βM1 Connectors for Power and Brake

The specifications of the power and brake connectors (cable side) for βM0.4 to βM1 are indicated below.
The connector is certified by TÜV.
The connector is drip-proof when fitted.

		For power	For brake
Connector body specification (MOLEX JAPAN Co., Ltd.)	**Straight**	54983-0000	54982-0000
	Elbow	55765-0000	55766-0000
Contact specification (MOLEX JAPAN Co., Ltd.)		56052-8100	
	Applicable wire size	0.75 to 1.05 mm^2 (AWG18 to AWG17)	
	Wire insulator outside diameter	ϕ2.5 mm or lower	
	Applicable cable outside diameter	ϕ9.1 to ϕ9.8 mm	ϕ6.2 to ϕ6.7 mm

The connector kit for power and brake indicated below is available.

		For power	For brake
Connector kit specification (FANUC specification)	**Straight**	A06B-6114-K230#S	A06B-6114-K232#S
	Elbow	A06B-6114-K230#E	A06B-6114-K232#E
Connector kit components		Connector body × 1 Contact × 4	Connector body × 1 Contact × 3

The table below indicates the tools dedicated to the connector.

	MOLEX JAPAN specification	**FANUC specification**
Crimping tool	57406-5000	A06B-6114-K234#C
Pull-out tool	57406-6000	A06B-6114-K234#R

NOTE

The contacts of the connectors are so structured that the wire and insulator are crimped together. So, be sure to observe the specified insulator diameter. Other types of wires may be usable, depending on wire and tool. For details, consult with the connector manufacturer.

9.3.2 Specifications of βM0.4 to βM1 Connectors for Signal

The specifications of the signal connector (cable side) for βM0.4 and βM1 are indicated below.
The connector is drip-proof when fitted.

		For signal	
Connector body specification (Japan Aviation Electronics Industry)	**Straight**	JN1DS10SL2	JN1DS10SL1
	Elbow	JN1FS10SL2	JN1FS10SL1
Contact specification (Japan Aviation Electronics Industry)		JN1-22-22S	
	Applicable wire size	AWG21 (0.5mm^2, Strand structure 20/0.18) AWG25 (0.18mm^2, Strand structure 7/0.18)	
	Wire insulator outside diameter	ϕ1.5 mm or lower	
	Applicable cable outside diameter	ϕ6.5 to 8.0 mm	ϕ5.7 to 7.3 mm

The connector kit for signals indicated below is available.

		For signal
Connector kit specification (FANUC specification)	**Straight**	A06B-6114-K200#S
	Elbow	A06B-6114-K200#E
Connector kit components		Connector body × 1 (Two types of bushing, one for ϕ6.5 to 8.0 and the other for ϕ5.7 to 7.3, are included.) Contact × 10

The table below indicates the tools dedicated to the connector.

	Japan Aviation Electronics Industry specification	**FANUC specification**
Crimping tool	CT150-2-JN1-F	A06B-6114-K201#JN1L
Pull-out tool	ET-JN1	A06B-6114-K201#JN1R

> **NOTE**
> The contacts of the connectors are so structured that the wire and insulator are crimped together. So, be sure to observe the specified insulator diameter. Other types of wires may be usable, depending on wire and tool. For details, consult with the connector manufacturer.

9.4 β1 TO β6 CONNECTORS ON CABLE SIDE

9.4.1 Specifications of β1 to β6 Connectors for Power and Brake (TÜV-certified and Waterproof Type)

To satisfy the IEC34 standard, the TÜV-certified waterproof plug connectors and cable clamps indicated below need to be used for power line and brake unit connection.
If the IEC34 standard needs to be satisfied when a cable seal adapter or conduit hose seal adapter is used, consult with the connector manufacturers.

Connector type	For power	For brake
[A] Plug connector (Straight type)	H/MS3106A18-10S-D-T(10) (HIROSE ELECTRIC)	JL04V-6A10SL-3SE-EB (Japan Aviation Electronics Industry)
[B] Plug connector (Elbow type)	H/MS3108A18-10S-D-T(10) (HIROSE ELECTRIC)	JL04V-8A10SL-3SE-EB (Japan Aviation Electronics Industry)
[C] Cable clamp	H/MS3057-10A(10) (HIROSE ELECTRIC)	JL04-1012CK-(07) (Japan Aviation Electronics Industry)

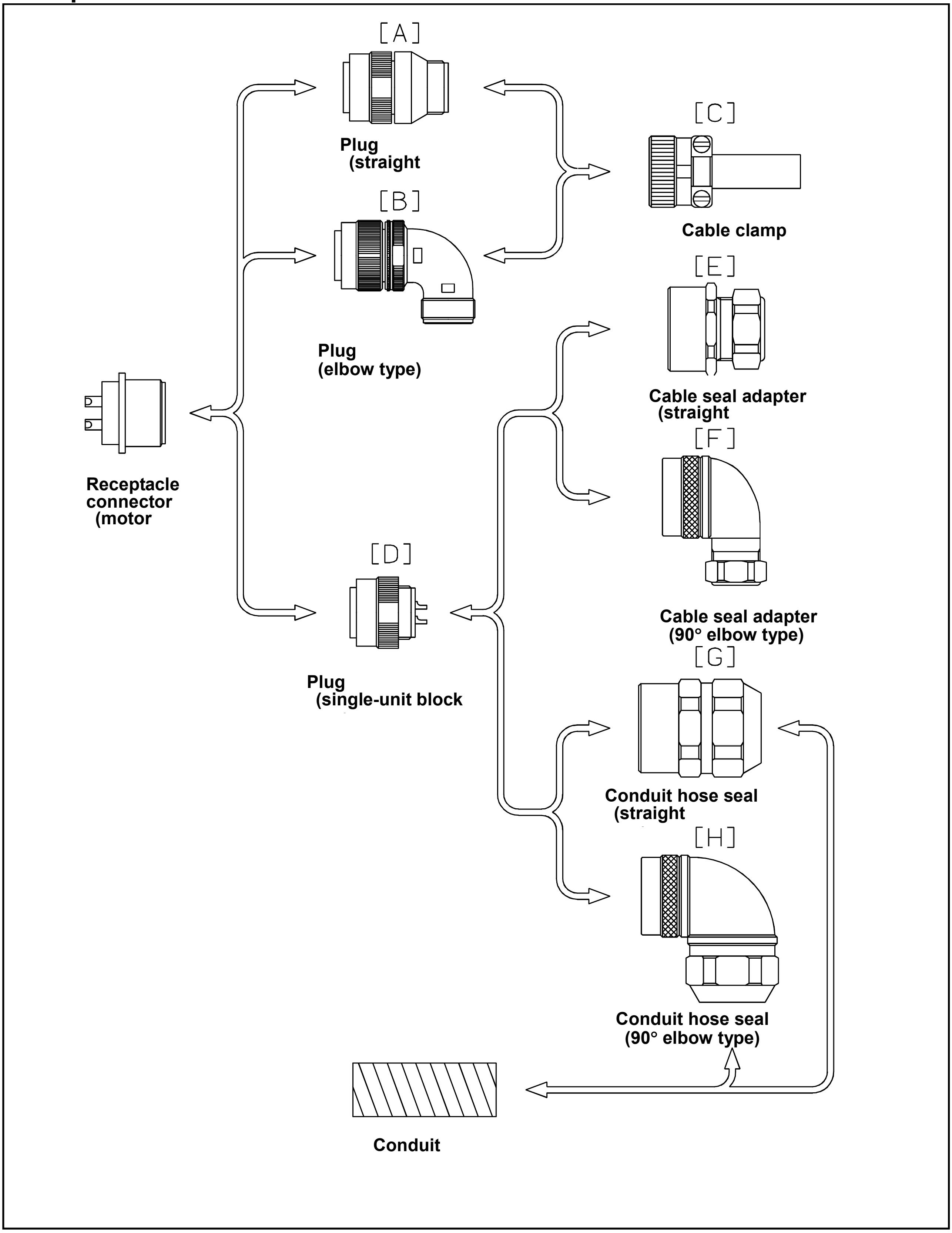
For [A] to [C], see "Example of cable connections" below.

NOTE

TUV has certified that the plug connectors and cable clamps above, when combined with the FANUC AC SERVO MOTOR β series, satisfy the VDE0627 safety standard.
In addition to the plug connectors above, connector manufacturers offer TÜV-compliant connectors.
For compliance of these connectors with the safety standard when combined with the FANUC AC SERVO MOTOR β series, check with each connector manufacturer. Moreover, contact each connector manufacturer for details of each series.

- HIROSE ELECTRIC (HRS) :
  H/MS310 TUV-compliant series
- Japan Aviation Electronics Industry (JAE) :
  JL04V series
- DDK Ltd. (DDK) : CE05 series

Example cable connections



9.4.2 Specifications of β1 to β6 Connectors for Power and Brake (Not TÜV-compliant and Waterproof Type)

When the IEC34 standard need not be satisfied, the waterproof plug connectors and cable clamps (not TÜV-compliant) indicated below can be used for power line and brake unit connection.

Connector type	For power	For brake
[A] Plug connector (Straight type)	H/MS3106A18-10S(10) (HIROSE ELECTRIC) JA06A-18-10S-J1-EB (Japan Aviation Electronics Industry) MS3106A18-10S-B-BSS (DDK Ltd.)	H/MS3106A10SL-3S(10) (HIROSE ELECTRIC) JA06A-10SL-3S-J1-EB (Japan Aviation Electronics Industry) MS3106A10SL-3S-B-BSS (DDK Ltd.)
[B] Plug connector (Elbow type)	H/MS3108B18-10S(10) (HIROSE ELECTRIC) JA08A-18-10S-J1-EB (Japan Aviation Electronics Industry) MS3108A18-10S-B-BAS (DDK Ltd.)	H/MS3108B10SL-3S(10) (HIROSE ELECTRIC) JA08A-10SL-3S-J1-EB (Japan Aviation Electronics Industry) MS3108A10SL-3S-B-BAS (DDK Ltd.)
[C] Cable clamp	H/MS3057-10A(10) (HIROSE ELECTRIC) JL04-18CK(13) (Japan Aviation Electronics Industry) CE3057-10A-1(D265) (DDK Ltd.)	H/MS3057-4A(10) (HIROSE ELECTRIC) JL04-1012CK-(05) (Japan Aviation Electronics Industry) CE3057-4A-1(D265) (DDK Ltd.)
[D] Plug connector (Single-unit block type)	H/MS3106A18-10S(13) (HIROSE ELECTRIC) JA06A-18-10S-J1-(A72) (Japan Aviation Electronics Industry) MS3106A18-10S-B(D190) (DDK Ltd.)	H/MS3106A10SL-3S(13) (HIROSE ELECTRIC) JA06A-10SL-3S-J1-(A72) (Japan Aviation Electronics Industry) MS3106A10SL-3S-B(D190) (DDK Ltd.)
[E]	YSO 18-12-14 (Daiwa Dengyou) ACS-12RL-MS18F (Japan Flex)	YSO 10-5-8 (Daiwa Dengyou)
[F]	YLO 18-12-14 (Daiwa Dengyou) ACA-12RL-MS18F (Japan Flex)	YLO 10-5-8 (Daiwa Dengyou)
[G]	BOS 18-15 (Daiwa Dengyou) RCC-104RL-MS18F (Japan Flex)	BOS 9-10 (Daiwa Dengyou)
[H]	BOL 18-15 (Daiwa Dengyou) RCC-304RL-MS18F (Japan Flex)	BOL 9-10 (Daiwa Dengyou)

For [A] to [H], see the cable connection examples.

By combining a plug connector (single-unit block type) with an adapter ([D]+([E] to [H]) in "Example cable connection"), cable and connector waterproofness can be enhanced.
The connector and seal adapters indicated above are compatible with products based on the MS standard. So, those products compatible with the MS standard that are not listed above are also usable.
For details of each of the connectors above, check with each connector manufacturer.

9.4.3 Specifications of β1 to β6 Connectors for Power and Brake (Not TÜV-compliant and Non-waterproof Type)

When the IEC34 standard need not be satisfied, and waterproofness is not required, the non-waterproof plug connectors and cable clamps (not TÜV-compliant) indicated below can be used for power and brake.

Connector type	For power	For brake
[A] Plug connector (Straight type)	H/MSA3106A18-10S(10) (HIROSE ELECTRIC) MS3106B18-10S-(A72) (Japan Aviation Electronics Industry) MS3106B18-10S-B (DDK Ltd.)	H/MSA3106A10SL-3S(10) (HIROSE ELECTRIC) MS3106B10SL-3S-(A72) (Japan Aviation Electronics Industry) MS3106A10SL-3S-B (DDK Ltd.)
[B] Plug connector (Elbow type)	H/MSA3108B18-10S(10) (HIROSE ELECTRIC) MS3108B18-10S-(A72) (Japan Aviation Electronics Industry) MS3108B-18-10S-B (DDK Ltd.)	H/MSA3108B10SL-3S(10) (HIROSE ELECTRIC) MS3108B10SL-3S-(A72) (Japan Aviation Electronics Industry) MS3108A10SL-3S-B (DDK Ltd.)
[C] Cable clamp °	H/MSA3057-10A(10) (HIROSE ELECTRIC) MS3057-10A-(A72) (Japan Aviation Electronics Industry) MS3057-16A(D265) (DDK Ltd.)	H/MSA3057-4A(10) (HIROSE ELECTRIC) MS3057-4A-(A72) (Japan Aviation Electronics Industry) MS3057-4A(D265) (DDK Ltd.)

For [A] to [C], see the cable connection examples.

NOTE
Be sure to use a waterproof connector where waterproofness is required.

9.4.4 Specifications of β1 to β6 Connectors for Signal

D-sub connectors are used as standard for the signal lines of the models β1 to β6. The D-Sub connectors are not water-proof.
To ensure waterproofness, a special connector cover is required.
The specifications of the cable-side special connectors are given below.

Item	Manufacturer	FANUC specification
Connector kit (The D-Sub connector and water-proof cover are packaged together.)	-	A06B-6050-K115
D-Sub connector (female)	HDAB-15S (Soldering type) (HIROSE ELECTRIC)	A63L-0001-0434/AB15SNO
Waterproof cover	HDAW-15CV (HIROSE ELECTRIC)	A63L-0001-0496

II. FANUC AC SERVO MOTOR βM series

1 TYPES OF MOTORS AND DESIGNATION

The types and specifications of βM series servo motors are described as follows.

Models βM0.2/4000 and βM0.3/4000

A06B-011x-Byzz

x
- 1 : Model βM0.2/4000
- 2 : Model βM0.3/4000

y
- 0 : Straight shaft
- 1 : Straight shaft with a 24VDC brake

zz
- 75 : With the pulse coder βA64B

Models βM0.4/4000, βM0.5/4000, and βM1/4000

A06B-011x-Byzz

x
- 4 : Model βM0.4/4000
- 5 : Model βM0.5/4000
- 6 : Model βM1/4000

y
- 0 : Straight shaft
- 1 : Straight shaft with a 24VDC brake

zz
- 75 : With the pulse coder βA64B
- 77 : With the pulse coder βI64B

NOTE

1. The resolution of the βA64B and βI64B pulse coders is 65,536/rev.
2. The standard shafts used for βM series motor are straight shafts. Use a straight shaft as far as circumstances, such as the delivery time and maintenance, permit.
3. To specify a straight shaft with a key, suffix the motor specification with #0008.

2 SPECIFICATIONS AND CHARACTERISTICS

2.1 TYPE OF MOTORS AND SPECIFICATIONS

Item	Unit	βM0.2/4000	βM0.3/4000	βM0.4/4000	βM0.5/4000	βM1/4000
Output	W	50	100	125	200	400
	HP	0.07	0.13	0.17	0.3	0.5
Rated torque at stall	Nm	0.16	0.32	0.4	0.65	1.2
	kgfcm	1.6	3.2	4.0	6.6	12
Rated rotation speed	min^{-1}	4000	4000	4000	4000	4000
Maximum rotation speed	min^{-1}	5000	5000	5000	5000	5000
Rotor inertia	kgm^2	0.0000019	0.0000034	0.00001	0.000018	0.000034
	$kgfcms^2$	0.000019	0.000035	0.0001	0.00018	0.00035
Weight	kg	0.33	0.44	0.8	1.0	1.5

NOTE
The above values are under the condition at 20°C.

2.2 CHARACTERISTIC CURVE AND DATA SHEET

See Section 4.2 of Part I of this manual for details of each item.

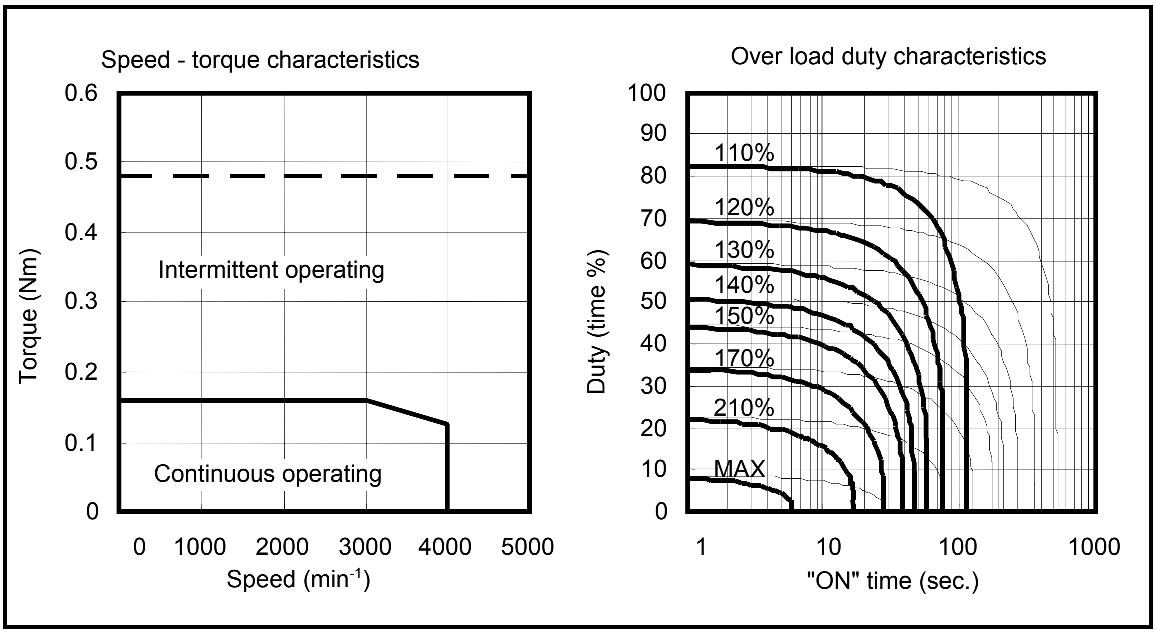
(1) Speed - torque characteristics
Typical characteristics of speed and output torque are indicated. The data curve shown in this specification is for the rated input voltage (200V). Note, however, that the intermittent operating zone varies with the input voltage of the driving unit.

(2) Overload duty characteristic
The overload duty characteristic curves are determined based on the temperature restriction for the single motor unit (such as protection based on a thermal protector). The curves are determined by assuming that the temperature increases gradually under certain overload conditions. Therefore, the curves do not apply to the rapid temperature rise which occurs, for example, when an overcurrent flows in the motor windings until the thermal trip operates.
A thermal software function is provided to prevent an abrupt temperature rise in the motor by monitoring for abnormal current in the motor. This function may put a thermal limit to the operation of the motor when it is frequently accelerated and decelerated.
Driving units (such as amplifiers) contain their own overheating protection devices. Therefore, note that the operation of motor may be limited according to thermal limit of driver.

(3) Data sheet
The parameters given in the data sheet are representative values for an ambient temperature of 20°C. They are subject to an error of ±10%.
The indicated logical values are threshold values for the single motor unit (when the motor is not restricted by the control system).
The maximum torque that can be produced during acceleration or deceleration is temporarily calculated as the approximate product of the motor torque constant and the current limit value of the amplifier.
Example : βM0.5/4000
Motor torque constant = 0.22(Nm/Arms)
Amplifier limit value = 20Apeak
Maximum torque value = $\underline{20 \times 0.707} \times 0.22 = 3.1$(Nm)
↑ (Converted to an effective value)
However, this value is a theoretical value. So, the actual maximum torque depends on the motor, amplifier, servo software, and power supply used. Particularly when a maximum current flows through the motor, the actual maximum torque can be far less than a calculated value due to an influence such as magnetic saturation.
The data curve of speed-torque characteristics indicates typical data obtained by combining a motor with an amplifier actually. It is requested to make a study based on the data curve.

Model βM0.2/4000

Specification : A06B-0111-Bxxx



Data sheet

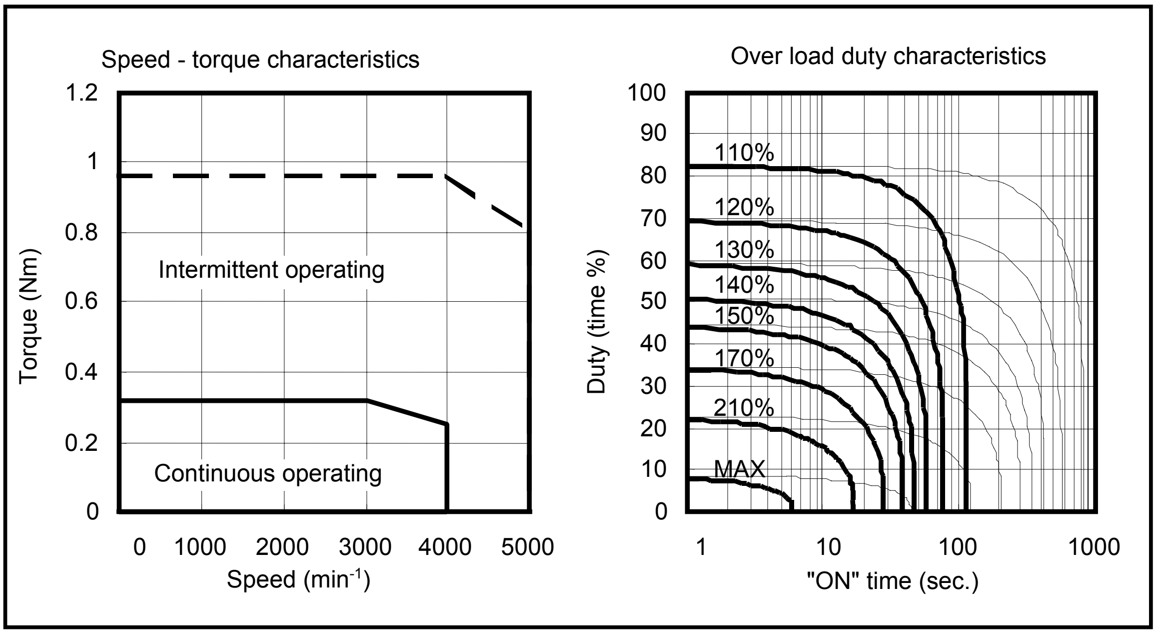
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	4000			min^{-1}
Rated torque at stall (*)	Ts	0.16 1.6			Nm kgfcm
Rotor inertia	Jm	0.0000019 0.000019			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	0.84			A(rms)
Torque constant (*)	Kt	0.19 1.9			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (1-phase) (*)	Ke Kv	6.7 0.064			$V(rms)/1000min^{-1}$ V(rms)sec/rad
Armature resistance (1-phase) (*)	Ra	6.0			Ω
Mechanical time constant	tm	0.0009			s
Thermal time constant	tt	5			min
Static friction	Tf	0.02 0.2			Nm kgfcm
Mass		0.33			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
These values may be changed without prior notice.

> **NOTE**
> The data above indicates torque characteristics obtained when HRV2 control is used for driving. When HRV1 control and an I/O link β amplifier are used for driving, the intermittent operating zone is limited.

Model βM0.3/4000

Specification : A06B-0112-Bxxx



Data sheet

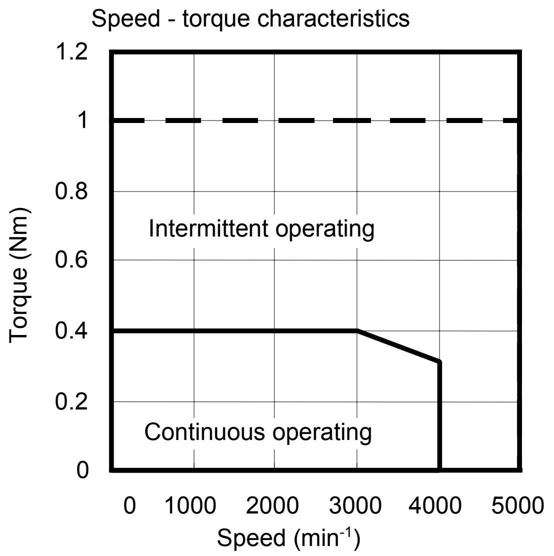
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	4000			min^{-1}
Rated torque at stall (*)	Ts	0.32 3.3			Nm kgfcm
Rotor inertia	Jm	0.0000034 0.000035			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	0.84			A(rms)
Torque constant (*)	Kt	0.38 3.9			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (1-phase) (*)	Ke Kv	13 0.13			$V(rms)/1000min^{-1}$ V(rms)sec/rad
Armature resistance (1-phase) (*)	Ra	10			Ω
Mechanical time constant	tm	0.0007			s
Thermal time constant	tt	8			min
Static friction	Tf	0.02 0.2			Nm kgfcm
Mass		0.44			kg

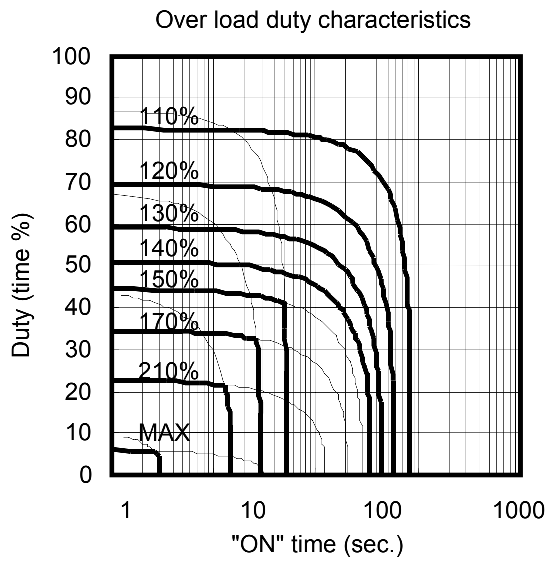
(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
These values may be changed without prior notice.

> **NOTE**
> The data above indicates torque characteristics obtained when HRV2 control is used for driving. When HRV1 control and an I/O link β amplifier are used for driving, the intermittent operating zone is limited.

Model βM0.4/4000

Specification : A06B-0114-Bxxx





Data sheet

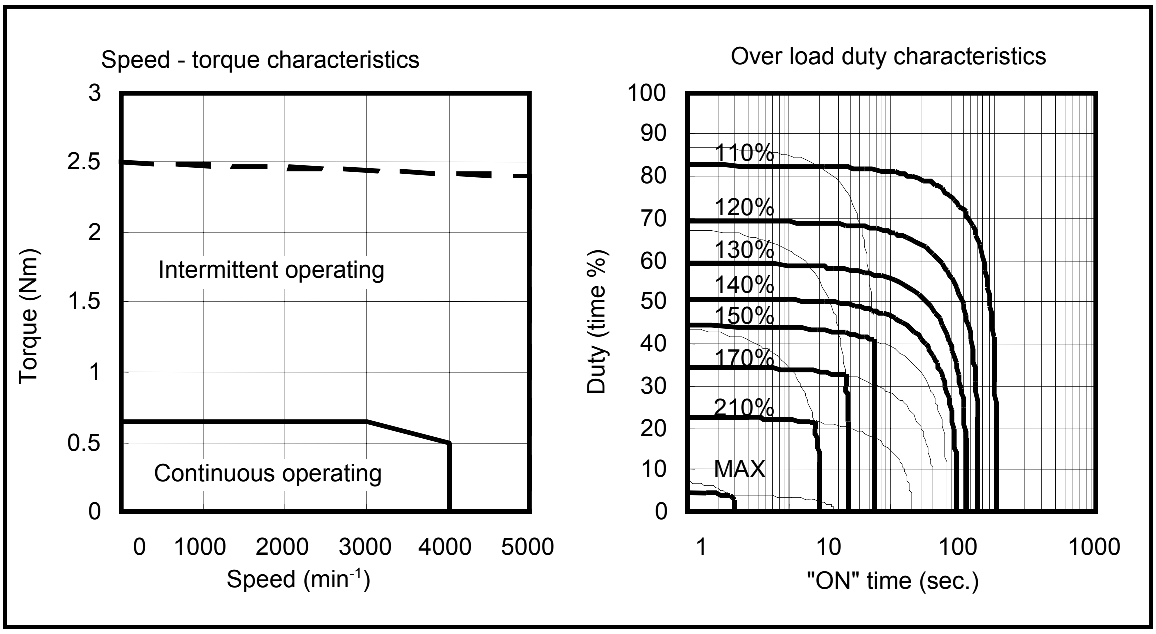
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	4000			min^{-1}
Rated torque at stall (*)	Ts	0.4 4.1			Nm kgfcm
Rotor inertia	Jm	0.00001 0.0001			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	3.5			A(rms)
Torque constant (*)	Kt	0.12 1.2			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (1-phase) (*)	Ke Kv	4.0 0.038			V(rms)/1000min^{-1} V(rms)sec/rad
Armature resistance (1-phase) (*)	Ra	0.5			Ω
Mechanical time constant	tm	0.001			s
Thermal time constant	tt	8			min
Static friction	Tf	0.04 0.4			Nm kgfcm
Mass		0.8			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
These values may be changed without prior notice.

> **NOTE**
> The data above indicates torque characteristics obtained when HRV2 control is used for driving. This motor cannot be driven by HRV control and I/O Link β amplifier.

Model βM0.5/4000

Specification : A06B-0115-Bxxx



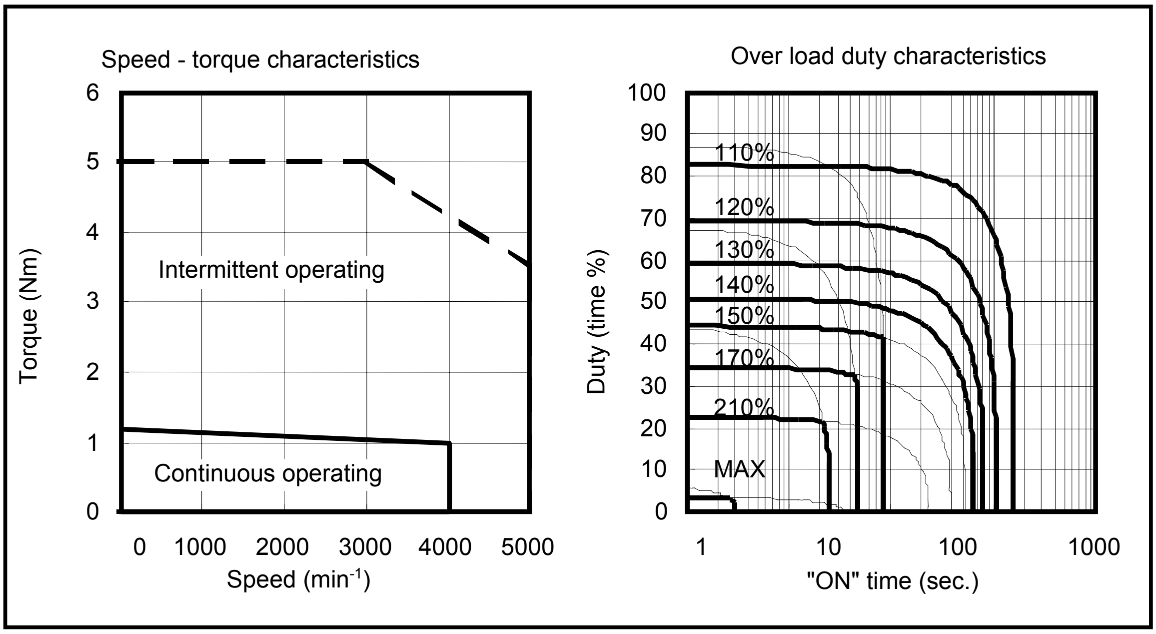
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	4000			min^{-1}
Rated torque at stall (*)	Ts	0.65 6.6			Nm kgfcm
Rotor inertia	Jm	0.000018 0.00018			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	3.0			A(rms)
Torque constant (*)	Kt	0.22 2.3			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (1-phase) (*)	Ke Kv	7.7 0.074			V(rms)/1000min^{-1} V(rms)sec/rad
Armature resistance (1-phase) (*)	Ra	0.9			Ω
Mechanical time constant	tm	0.0009			s
Thermal time constant	tt	10			min
Static friction	Tf	0.04 0.4			Nm kgfcm
Mass		1.0			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
These values may be changed without prior notice.

Model βM1/4000

Specification : A06B-0116-Bxxx



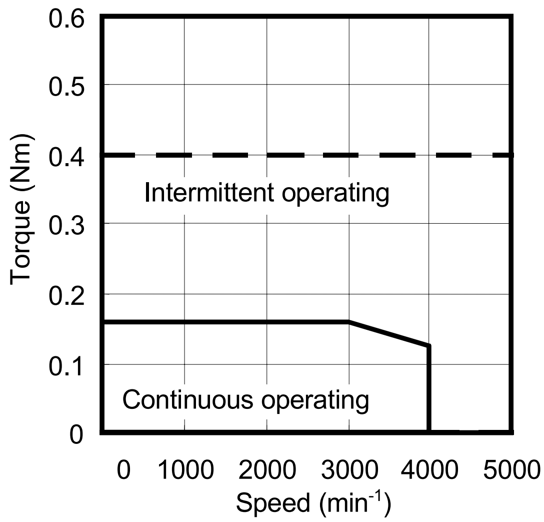
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	4000			min^{-1}
Rated torque at stall (*)	Ts	1.2 12			Nm kgfcm
Rotor inertia	Jm	0.000034 0.00035			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	2.7			A(rms)
Torque constant (*)	Kt	0.44 4.5			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (1-phase) (*)	Ke Kv	15.4 0.14			$V(rms)/1000min^{-1}$ V(rms)sec/rad
Armature resistance (1-phase) (*)	Ra	1.6			Ω
Mechanical time constant	tm	0.0007			s
Thermal time constant	tt	15			min
Static friction	Tf	0.04 0.4			Nm kgfcm
Mass		1.5			kg

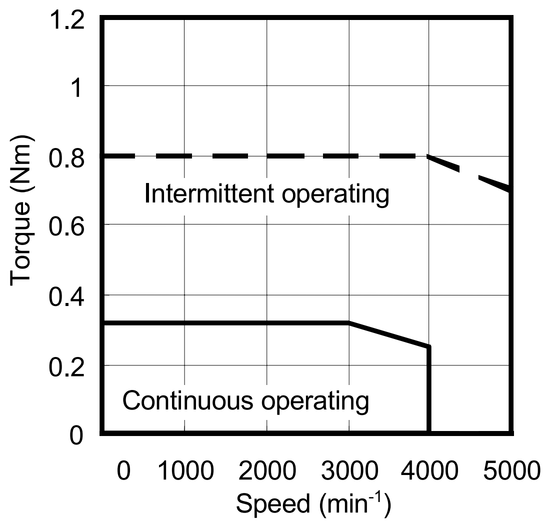
(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
These values may be changed without prior notice.

2.3 SPEED-TORQUE CHARACTERISTICS WHEN HRV1 CONTROL AND AN I/O Link β AMPLIFIER ARE USED

[Model βM0.2/4000]



[Model βM0.3/4000]



NOTE

HRV2 control may not be usable with some CNC systems.

When HRV1 control and an I/O link β amplifier are used, the intermittent operating zone is limited. The continuous operating zone is equivalent to that applicable when HRV2 control is used.

2.4 OUTLINE DRAWINGS

Model	Fig. No.
Models βM0.2 and βM0.3 : Outline drawing (standard)	Fig.2.4(a)
Models βM0.2 and βM0.3 : Outline drawing (with a brake)	Fig.2.4(b)
Models βM0.2 and βM0.3 : Shaft option	Fig.2.4(c)
Models βM0.4, βM0.5, and βM1 : Outline drawing (standard)	Fig.2.4(d)
Models βM0.4, βM0.5, and βM1 : Outline drawing (with a brake)	Fig.2.4(e)
Models βM0.4 and βM0.5: Shaft option	Fig.2.4(f)
Models βM1: Shaft option	Fig.2.4(g)
Models βM0.4, βM0.5, and βM1 : Connector mating diagram (elbow)	Fig.2.4(h)
Models βM0.4, βM0.5, and βM1 : Connector mating diagram (straight)	Fig.2.4(i)

Fig.2.4(a) Models βM0.2 and βM0.3 : Outline drawing (standard)

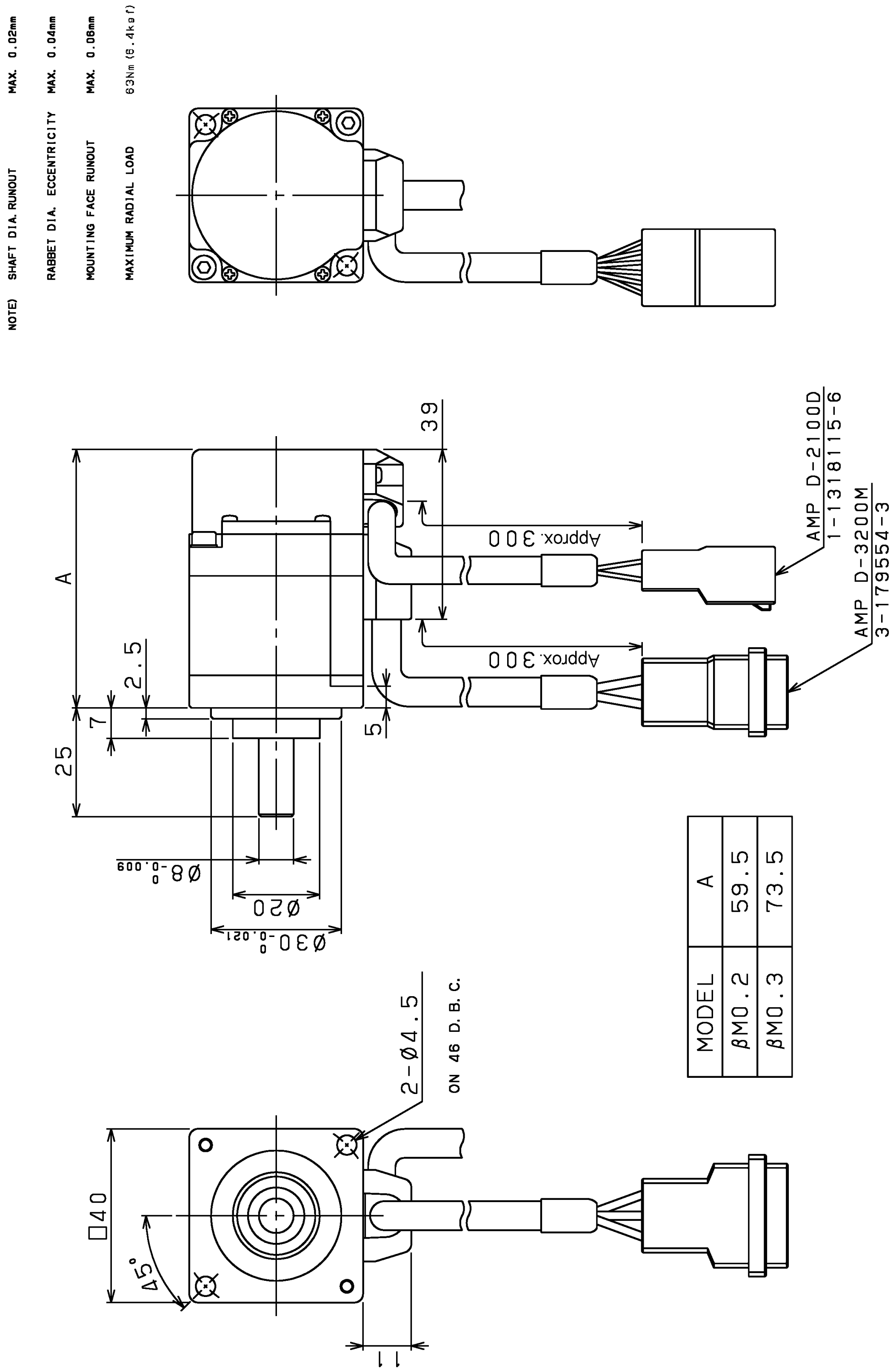
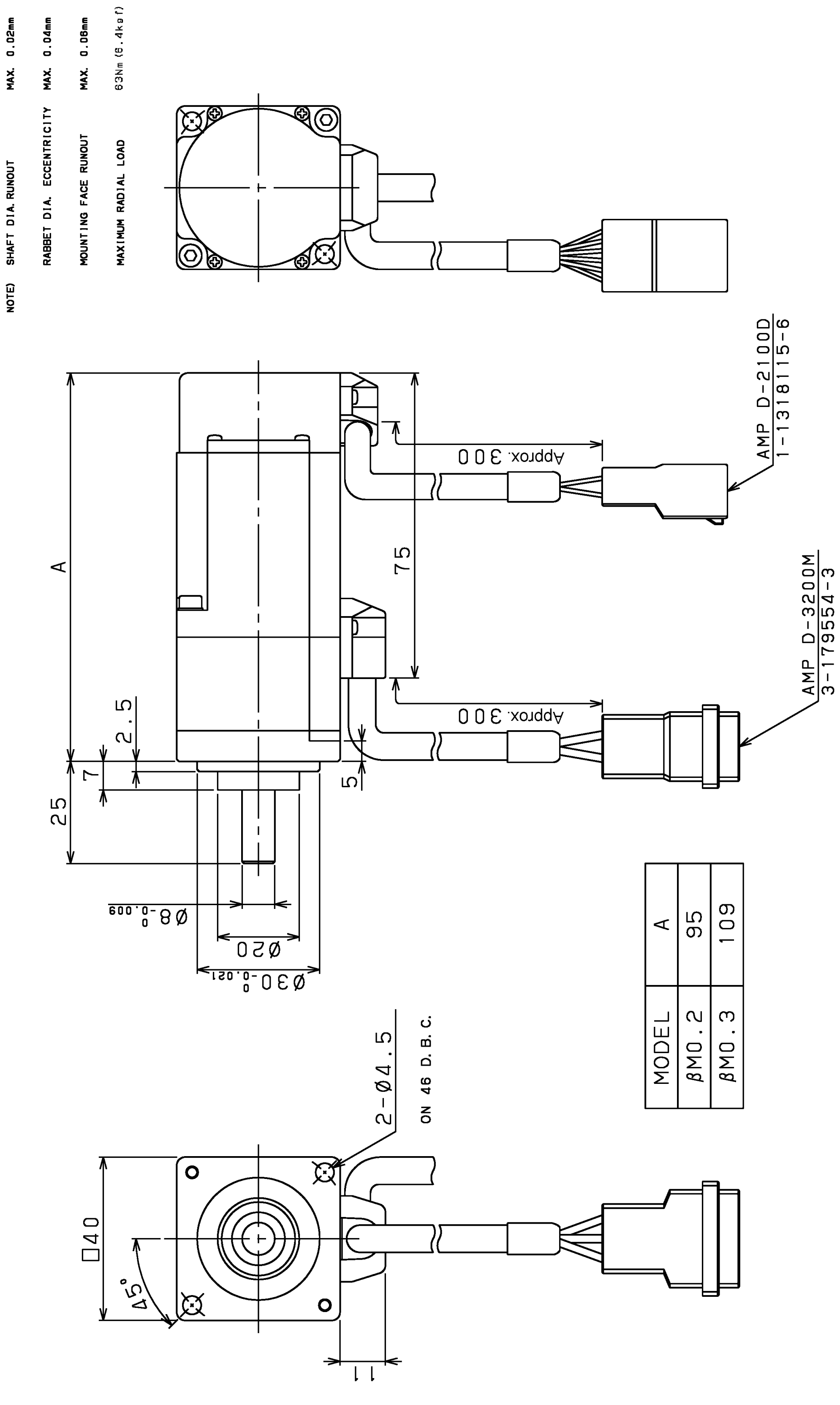


Fig.2.4(b) Models βM0.2 and βM0.3 : Outline drawing (with a brake)

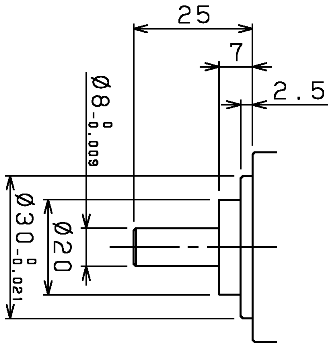


MODEL	A
βM0.2	95
βM0.3	109

Fig.2.4(c) Models βM0.2 and βM0.3 : Shaft option

Standard :
Straight shaft

A06B-011□-B□75



Option :
Straight shaft with a key

A06B-011□-B□75#0008

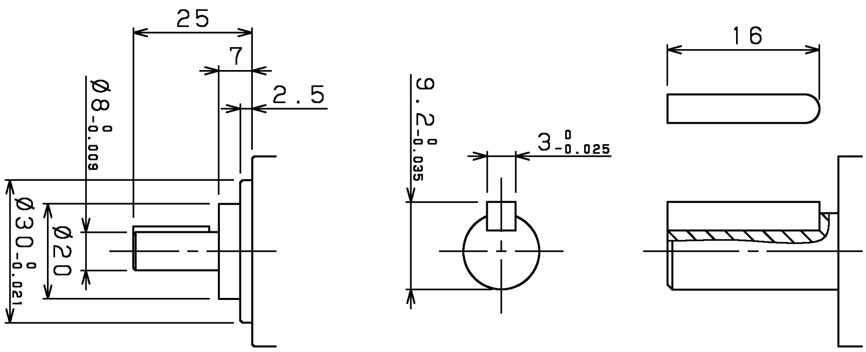
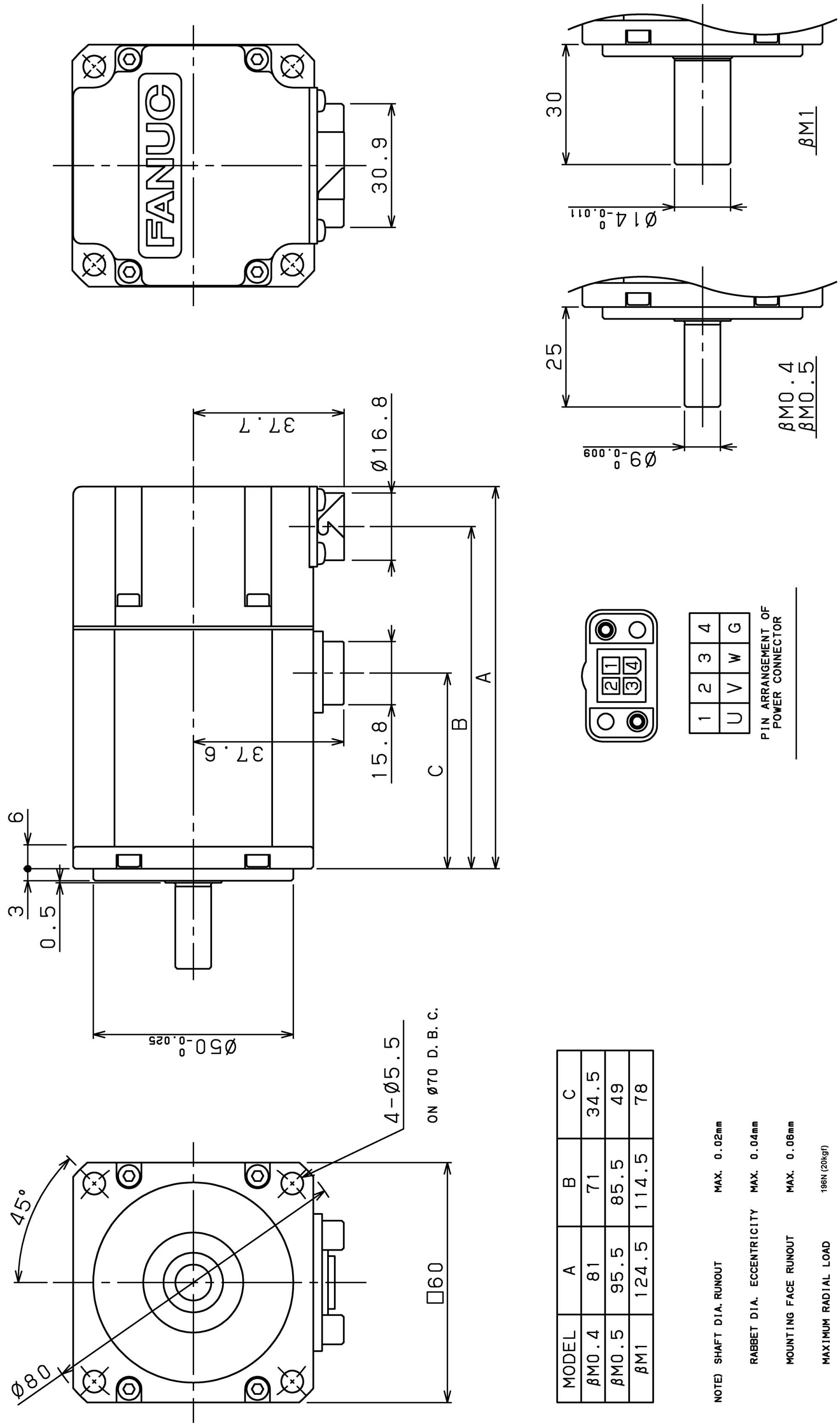


Fig.2.4(d) Models βM0.4, βM0.5, and βM1 : Outline drawing (standard)



MODEL	A	B	C
βM0.4	81	71	34.5
βM0.5	95.5	85.5	49
βM1	124.5	114.5	78

Fig.2.4(e) Models βM0.4, βM0.5, and βM1 : Outline drawing (with a brake)

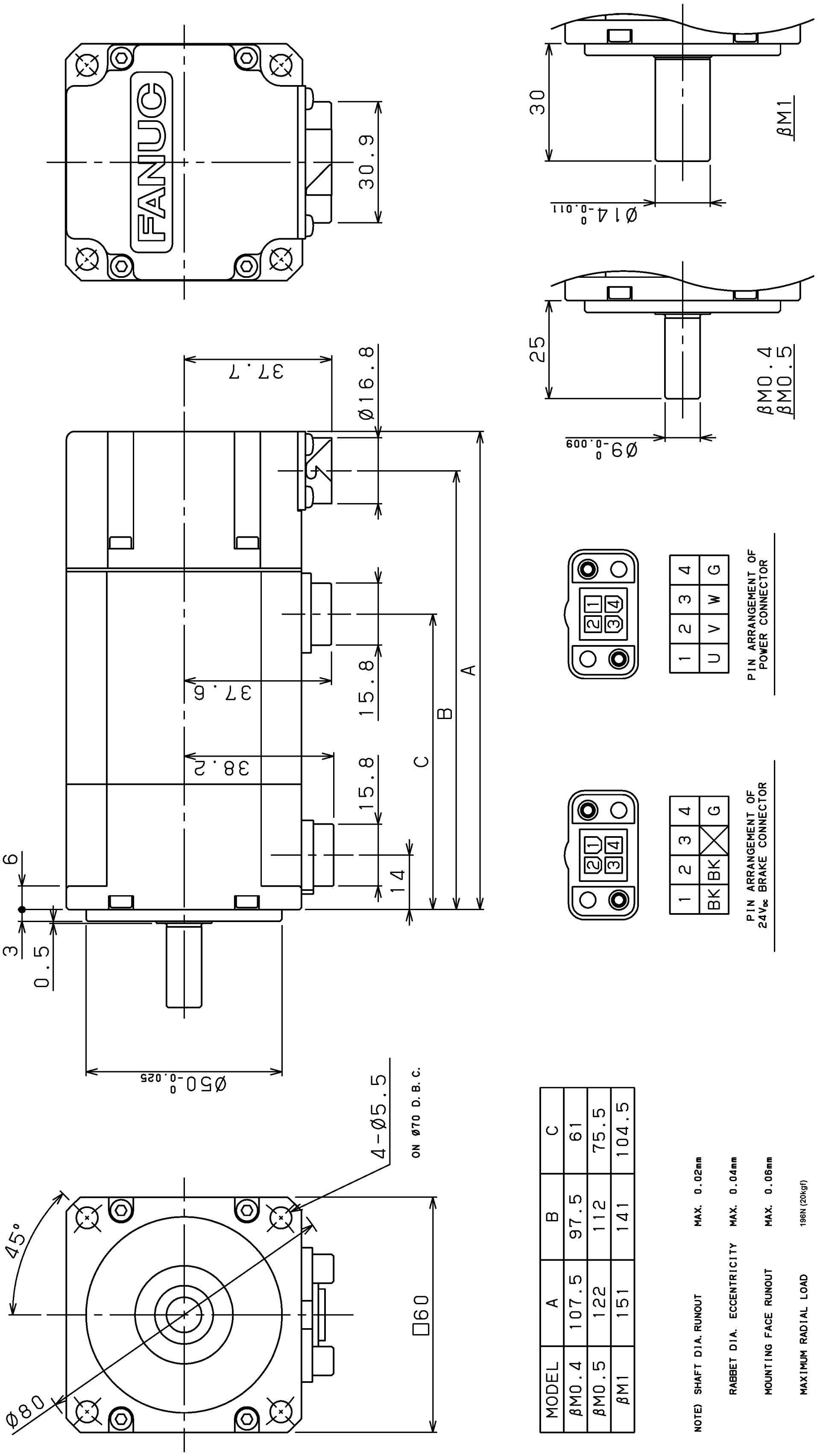
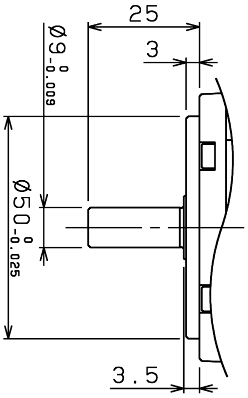


Fig.2.4(f) Models βM0.4 and βM0.5: Shaft option

Standard :
Straight shaft
A06B-011□-B□□□



Option :
Straight shaft with a key
A06B-011□-B□□□#0008

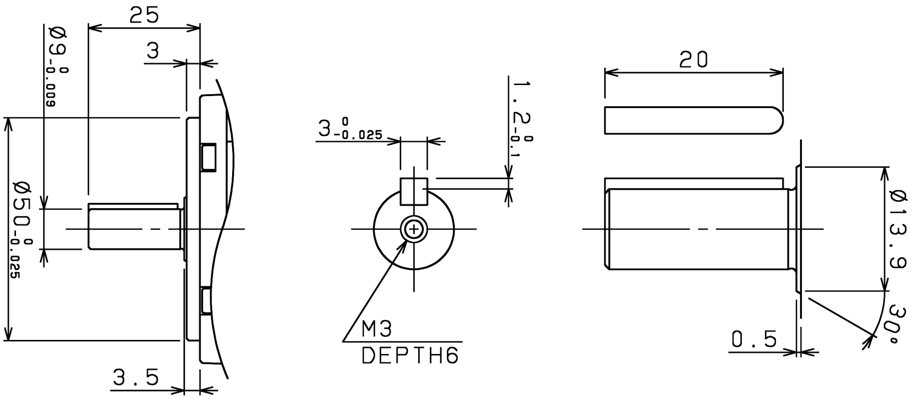
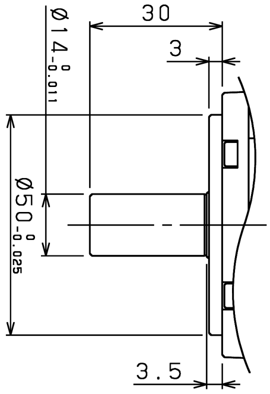


Fig.2.4(g) Model βM1: Shaft option

Standard :
Straight shaft
A06B-0116-B□□□



Option :
Straight shaft with a key
A06B-0116-B□□□#0008

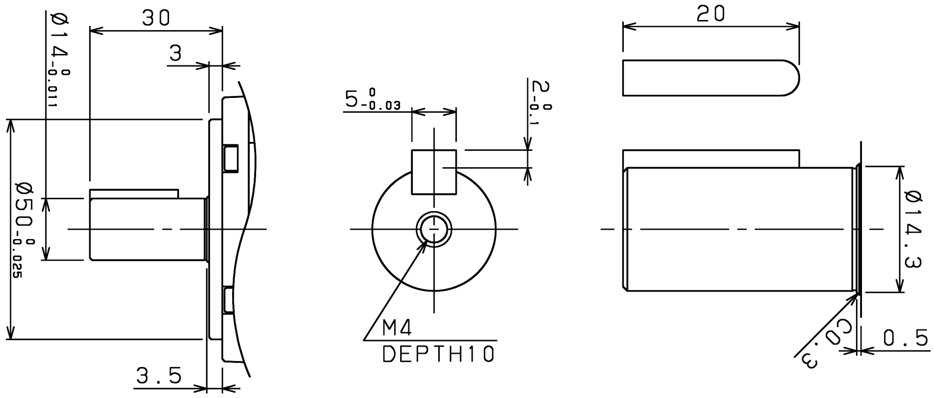
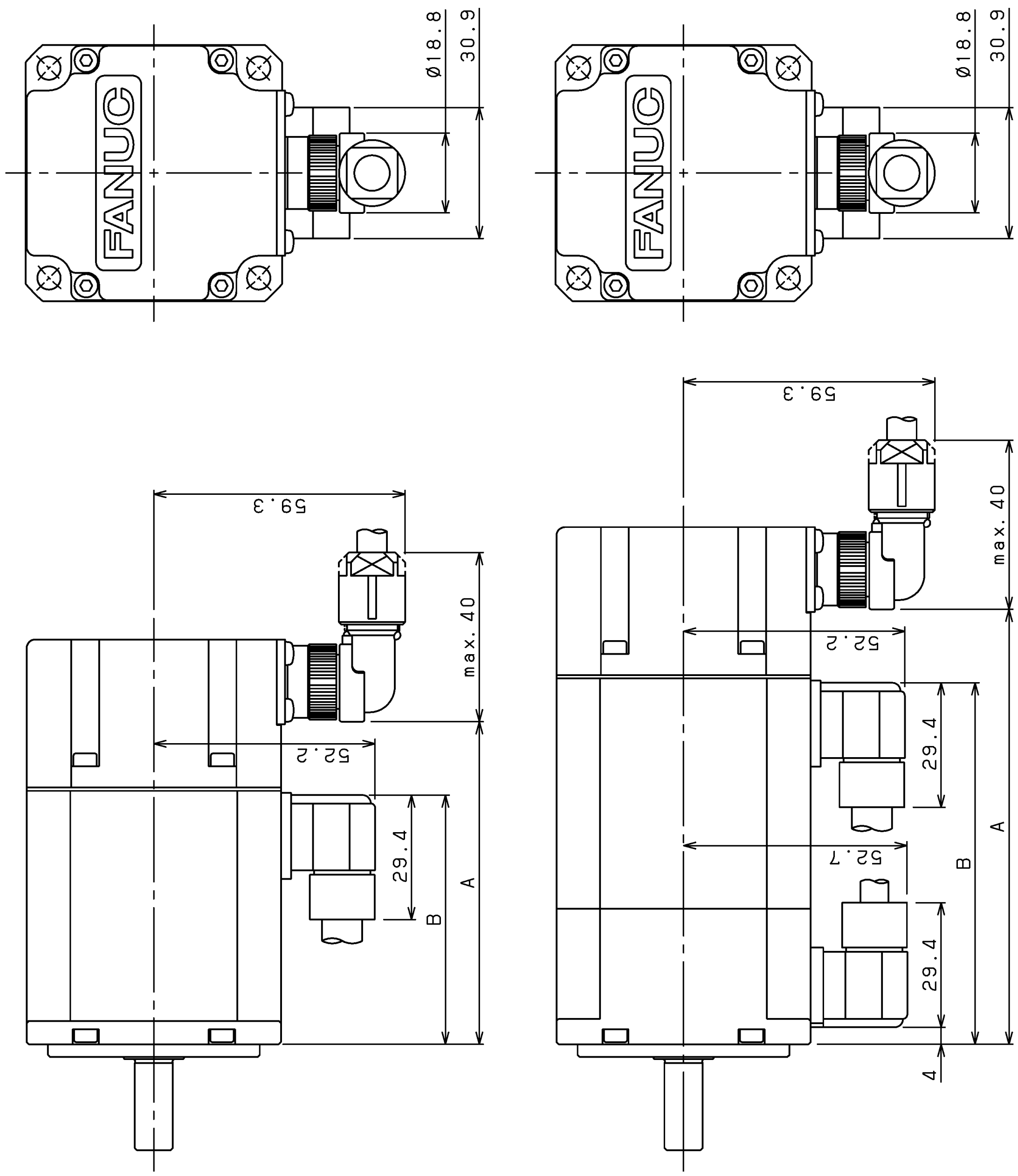


Fig.2.4(h) Models βM0.4, βM0.5, and βM1 : Connector mating diagram (elbow)



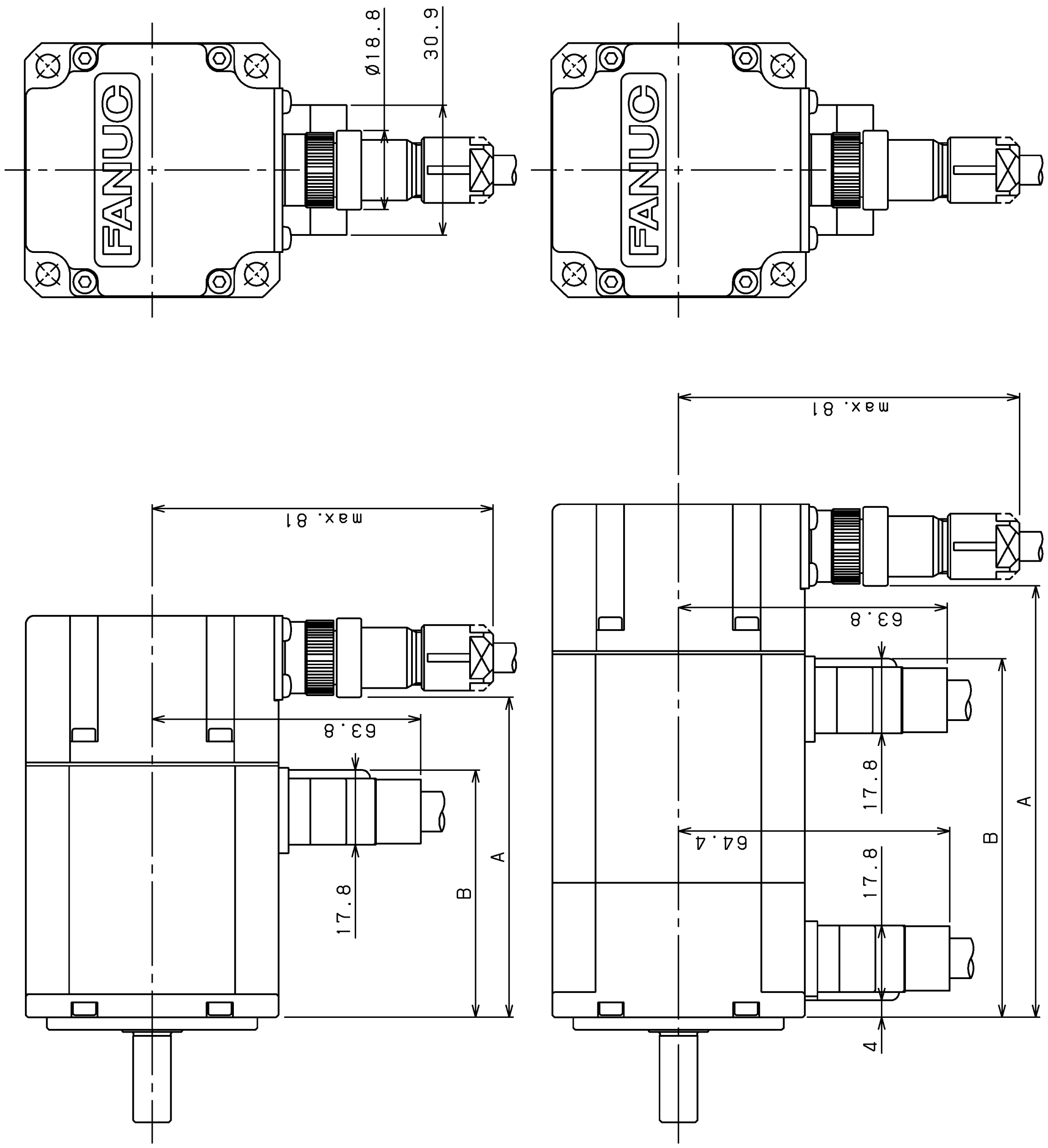
STANDARD

MODEL	A	B
βM0.4	61.6	44.3
βM0.5	76.1	58.8
βM1	105.1	87.8

WITH BRAKE

MODEL	A	B
βM0.4	88.1	70.8
βM0.5	102.6	85.3
βM1	131.6	114.3

Fig.2.4(i) Models βM0.4, βM0.5, and βM1 : Connector mating diagram (straight)



STANDARD

MODEL	A	B
βM0.4	61.6	44.3
βM0.5	76.1	58.8
βM1	105.1	87.8

WITH BRAKE

MODEL	A	B
βM0.4	88.1	70.8
βM0.5	102.6	85.3
βM1	131.6	114.3

III. FANUC AC SERVO MOTOR β series

1 TYPES OF MOTORS AND DESIGNATION

The types and specifications of β series servo motors are described as follows.

Models
β1/3000, β2/3000, β3/3000, and β6/2000

A06B-00xx-Byzz

xx

31	:	Model β1/3000
32	:	Model β2/3000
33	:	Model β3/3000
34	:	Model β6/2000

y

0	:	Straight shaft
1	:	Straight shaft with a 90VDC brake
5	:	Taper shaft
6	:	Taper shaft with a 90VDC brake

zz

75	:	With the pulse coder βA32B
77	:	With the pulse coder βI32B

NOTE

1 The resolution of the βA32B and βI32B serial pulse coders is 32,768/rev.
2 The standard shafts used for β series motor are straight shafts. Use a straight shaft as far as circumstances, such as the delivery time and maintenance, permit.
3 To specify a straight shaft with a key, suffix the motor specification with #0008.
4 A woodruff key is attached to the tapered shaft as a standard.

2 SPECIFICATIONS AND CHARACTERISTICS

2.1 TYPE OF MOTORS AND SPECIFICATIONS

Item	Unit	β1/3000	β2/3000	β3/3000	β6/2000
Output	kW	0.3	0.5	0.5	0.9
	HP	0.4	0.67	0.67	1.2
Rated torque at stall	Nm	1	2	3	6
	kgfcm	10	20	30	60
Rated rotation speed	min^{-1}	3000	3000	3000	2000
Maximum rotation speed	min^{-1}	4000 (3000)	4000 (3000)	4000 (3000)	3000 (2000)
Rotor inertia	kgm^2	0.00033	0.00065	0.0019	0.0039
	$kgfcms^2$	0.0034	0.0067	0.020	0.040
Weight	kg	2.5	3.5	5.0	8.5

(*) Maximum speed when HRV control is applied. When conventional control is applied, the maximum speed will be as indicated in the parentheses.

NOTE
The above values are under the condition at 20°C.

2.2 CHARACTERISTIC CURVE AND DATA SHEET

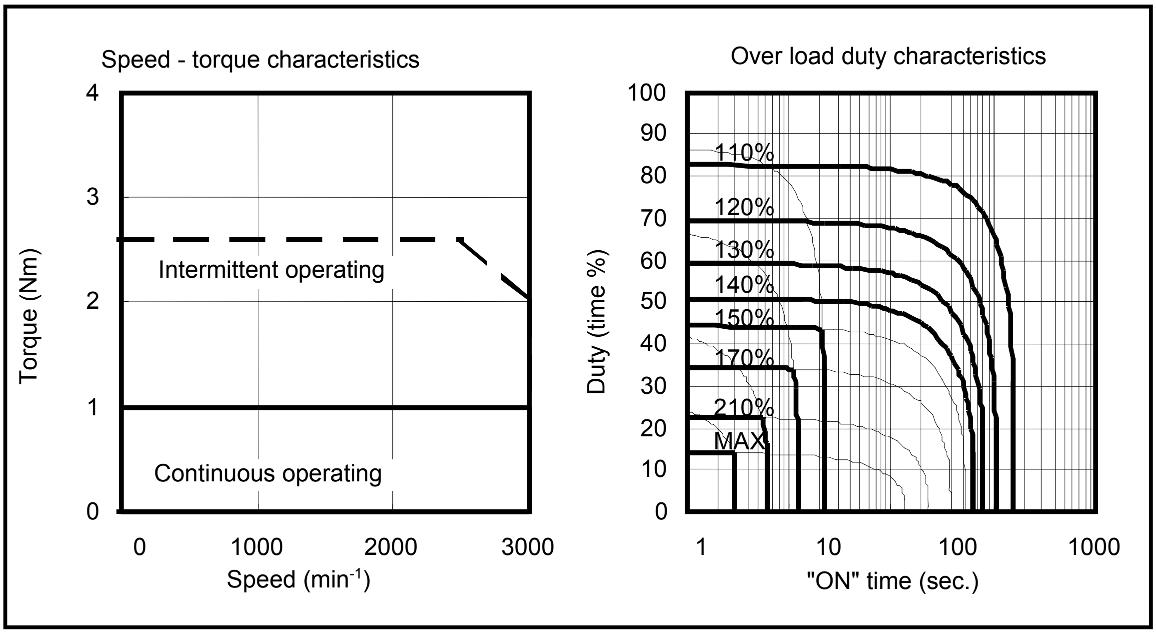
See Section 4.2 of Part I of this manual for details of each item.

(1) Speed - torque characteristics
Typical characteristics of speed and output torque are indicated. The data curve shown in this specification is for the rated input voltage (200V). Note, however, that the intermittent operating zone varies with the input voltage of the driving unit.

(2) Overload duty characteristic
The overload duty characteristic curves are determined based on the temperature restriction for the single motor unit (such as protection based on a thermal protector). The curves are determined by assuming that the temperature increases gradually under certain overload conditions. Therefore, the curves do not apply to the rapid temperature rise which occurs, for example, when an overcurrent flows in the motor windings until the thermal trip operates.
A thermal software function is provided to prevent an abrupt temperature rise in the motor by monitoring for abnormal current in the motor. This function may put a thermal limit to the operation of the motor when it is frequently accelerated and decelerated.
Driving units (such as amplifiers) contain their own overheating protection devices. Therefore, note that the operation of motor may be limited according to thermal limit of driver
The parameters given in the data sheet are representative values for an ambient temperature of 20°C. They are subject to an error of ±10%.
The indicated logical values are threshold values for the single motor unit (when the motor is not restricted by the control system).
The maximum torque that can be produced during acceleration or deceleration is temporarily calculated as the approximate product of the motor torque constant and the current limit value of the amplifier.
Example : β1/3000
Motor torque constant = 0.31(Nm/Arms)
Amplifier limit value = 12Apeak
Maximum torque value = $\underbrace{12 \times 0.707}_{\uparrow\text{ (Converted to an effective value)}} \times 0.31 = 2.6$(Nm)
However, this value is a theoretical value. So, the actual maximum torque depends on the motor, amplifier, servo software, and power supply used. Particularly when a maximum current flows through the motor, the actual maximum torque can be far less than a calculated value due to an influence such as magnetic saturation.
The data curve of speed-torque characteristics indicates typical data obtained by combining a motor with an amplifier actually. It is requested to make a study based on the data curve.

Model β1/3000

Specification : A06B-0031-Bxxx



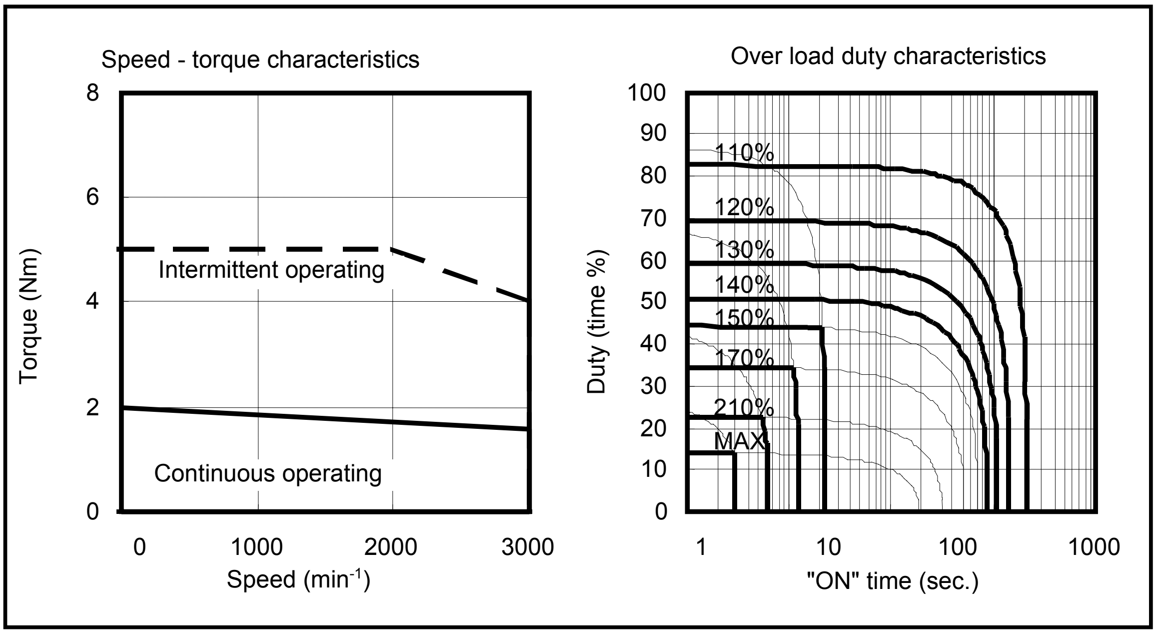
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	1 10			Nm kgfcm
Rotor inertia	Jm	0.00033 0.0034			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	3.2			A(rms)
Torque constant (*)	Kt	0.31 3.2			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (1-phase) (*)	Ke Kv	10.9 0.10			$V(rms)/1000min^{-1}$ V(rms)sec/rad
Armature resistance (1-phase) (*)	Ra	0.96			Ω
Mechanical time constant	tm	0.0011			s
Thermal time constant	tt	15			min
Static friction	Tf	0.1 1			Nm kgfcm
Mass		2.5			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
These values may be changed without prior notice.

Model β2/3000

Specification : A06B-0032-Bxxx



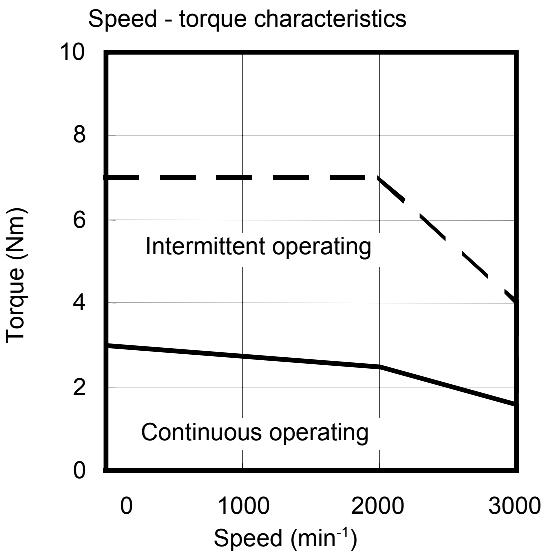
Data sheet

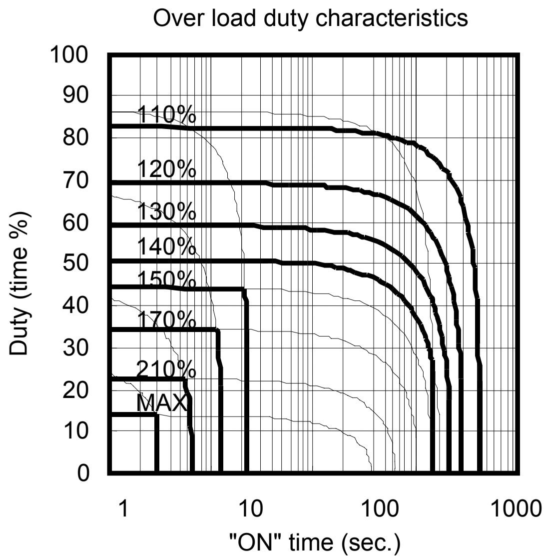
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	2 20			Nm kgfcm
Rotor inertia	Jm	0.00065 0.0067			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	3.2			A(rms)
Torque constant (*)	Kt	0.61 6.2			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (1-phase) (*)	Ke Kv	21.4 0.20			$V(rms)/1000min^{-1}$ V(rms)sec/rad
Armature resistance (1-phase) (*)	Ra	1.45			Ω
Mechanical time constant	tm	0.008			s
Thermal time constant	tt	20			min
Static friction	Tf	0.1 1			Nm kgfcm
Mass		3.5			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
These values may be changed without prior notice.

Model β3/3000

Specification : A06B-0033-Bxxx





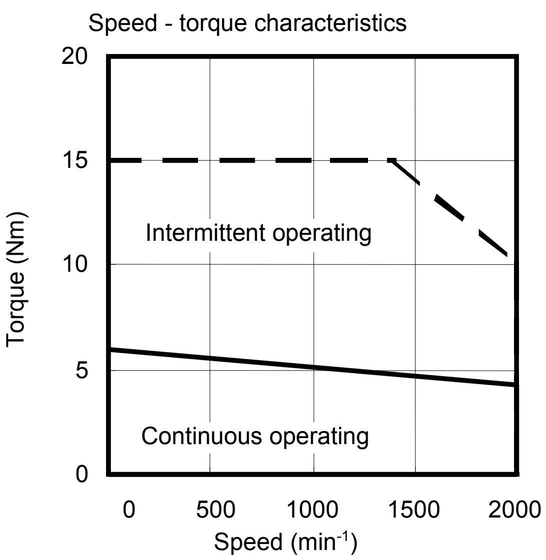
Data sheet

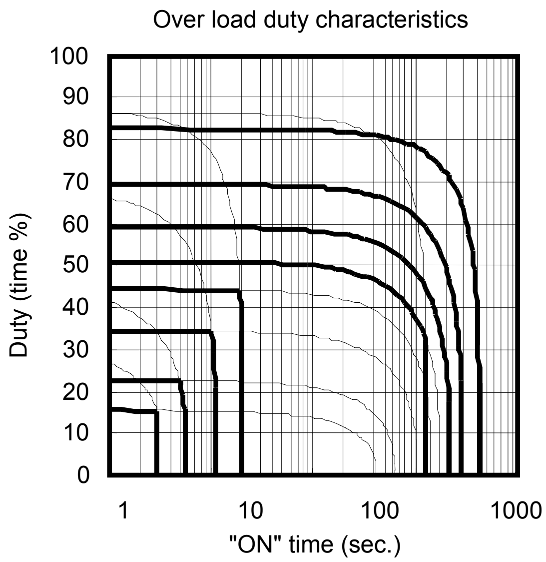
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	3 30			Nm kgfcm
Rotor inertia	Jm	0.0019 0.020			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	5.3			A(rms)
Torque constant (*)	Kt	0.56 5.7			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (1-phase) (*)	Ke Kv	19.4 0.18			V(rms)/1000min^{-1} V(rms)sec/rad
Armature resistance (1-phase) (*)	Ra	0.57			Ω
Mechanical time constant	tm	0.009			s
Thermal time constant	tt	40			min
Static friction	Tf	0.3 3			Nm kgfcm
Mass		5.0			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
These values may be changed without prior notice.

Model β6/2000

Specification : A06B-0034-Bxxx





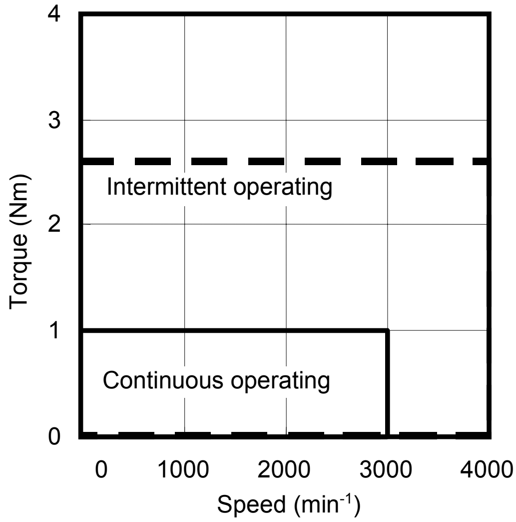
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000			min^{-1}
Rated torque at stall (*)	Ts	6 60			Nm kgfcm
Rotor inertia	Jm	0.0039 0.040			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	5.6			A(rms)
Torque constant (*)	Kt	1.05 10.7			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (1-phase) (*)	Ke Kv	37.0 0.35			$V(rms)/1000min^{-1}$ V(rms)sec/rad
Armature resistance (1-phase) (*)	Ra	0.87			Ω
Mechanical time constant	tm	0.009			s
Thermal time constant	tt	40			min
Static friction	Tf	0.3 3			Nm kgfcm
Mass		8.5			kg

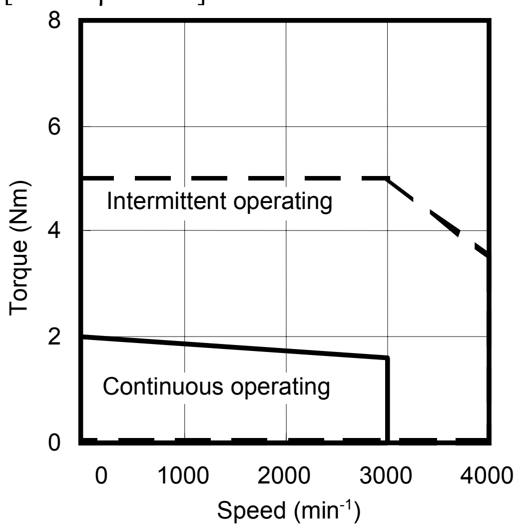
(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
These values may be changed without prior notice.

2.3 SPEED-TORQUE CHARACTERISTICS FOR HRV CONTROL

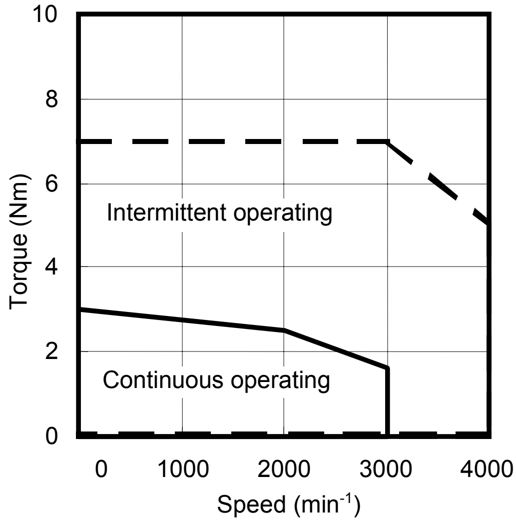
[Model β1/3000]



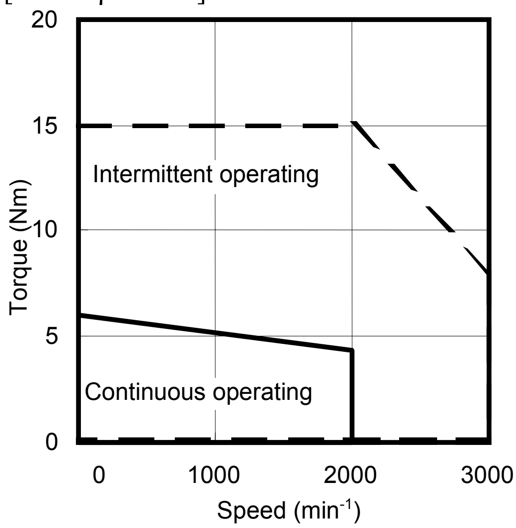
[Model β2/3000]



[Model β3/3000]



[Model β6/2000]

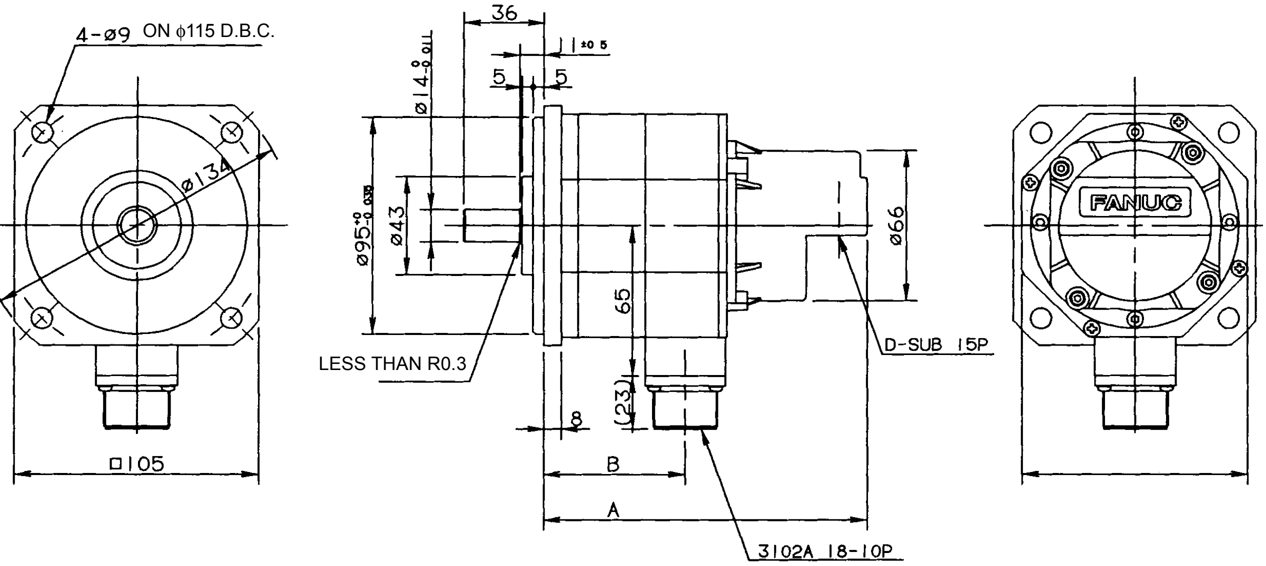


NOTE
Some CNC systems do not support HRV control. Applying HRV control causes the intermittent operating area to be expanded, at high speed. The continuous operating area is the same as that conventional control.

2.4 OUTLINE DRAWINGS

Model	Fig. No.
Models β1 and β2 : Outline drawing (standard)	Fig.2.4(a)
Models β1 and β2 : Outline drawing (with a brake)	Fig.2.4(b)
Models β1 and β2 : Shaft option	Fig.2.4(c)
Models β3 and β6 : Outline drawing (standard)	Fig.2.4(d)
Models β3 and β6 : Outline drawing (with a brake)	Fig.2.4(e)
Models β3 and β6 : Shaft option	Fig.2.4(f)

Fig.2.4(a) Models β1 and β2 : Outline drawing (standard)

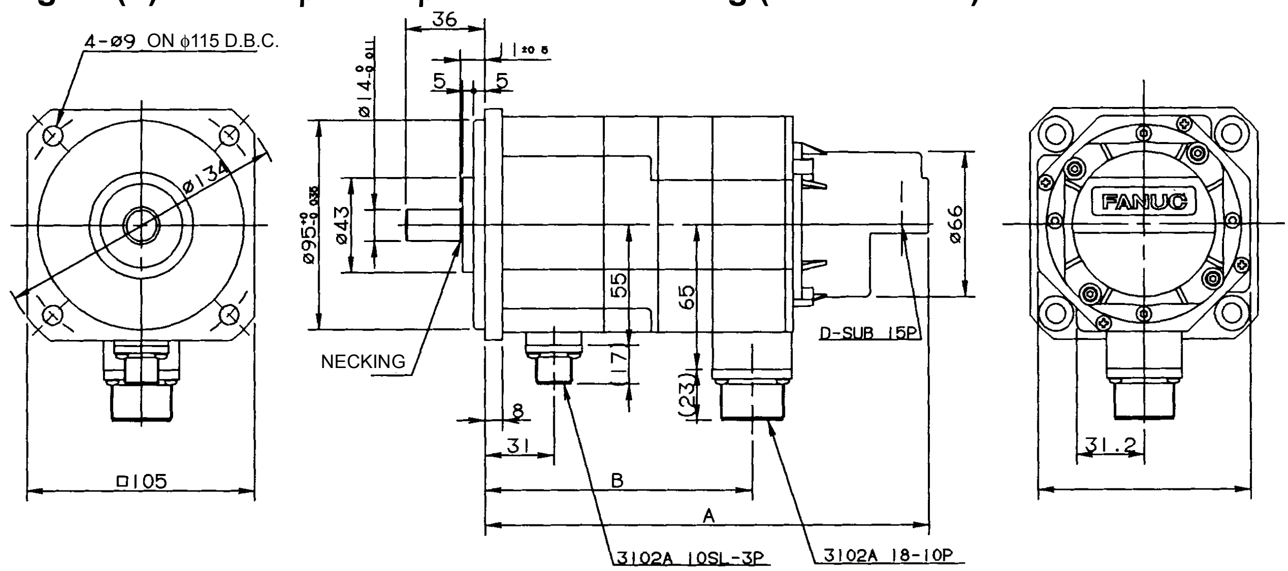


Motor model	A	B
β1/3000	144	63
β2/3000	174	93

Note

SHAFT DIA. RUNOUT	MAX 0.02 mm
RABBET DIA. ECCENTRICITY	MAX 0.04 mm
MOUNTING FACE RUNOUT	MAX 0.06 mm
MAXIMUM RADIAL LOAD	245N (25kgf)

Fig.2.4(b) Models β1 and β2 : Outline drawing (with a brake)



Motor model	A	B
β1/3000	200	119
β2/3000	230	149

Note

SHAFT DIA. RUNOUT	MAX 0.02 mm
RABBET DIA. ECCENTRICITY	MAX 0.04 mm
MOUNTING FACE RUNOUT	MAX 0.06 mm
MAXIMUM RADIAL LOAD	245 N (25kgf)

Fig.2.4(c) Models β1 and β2 : Shaft option

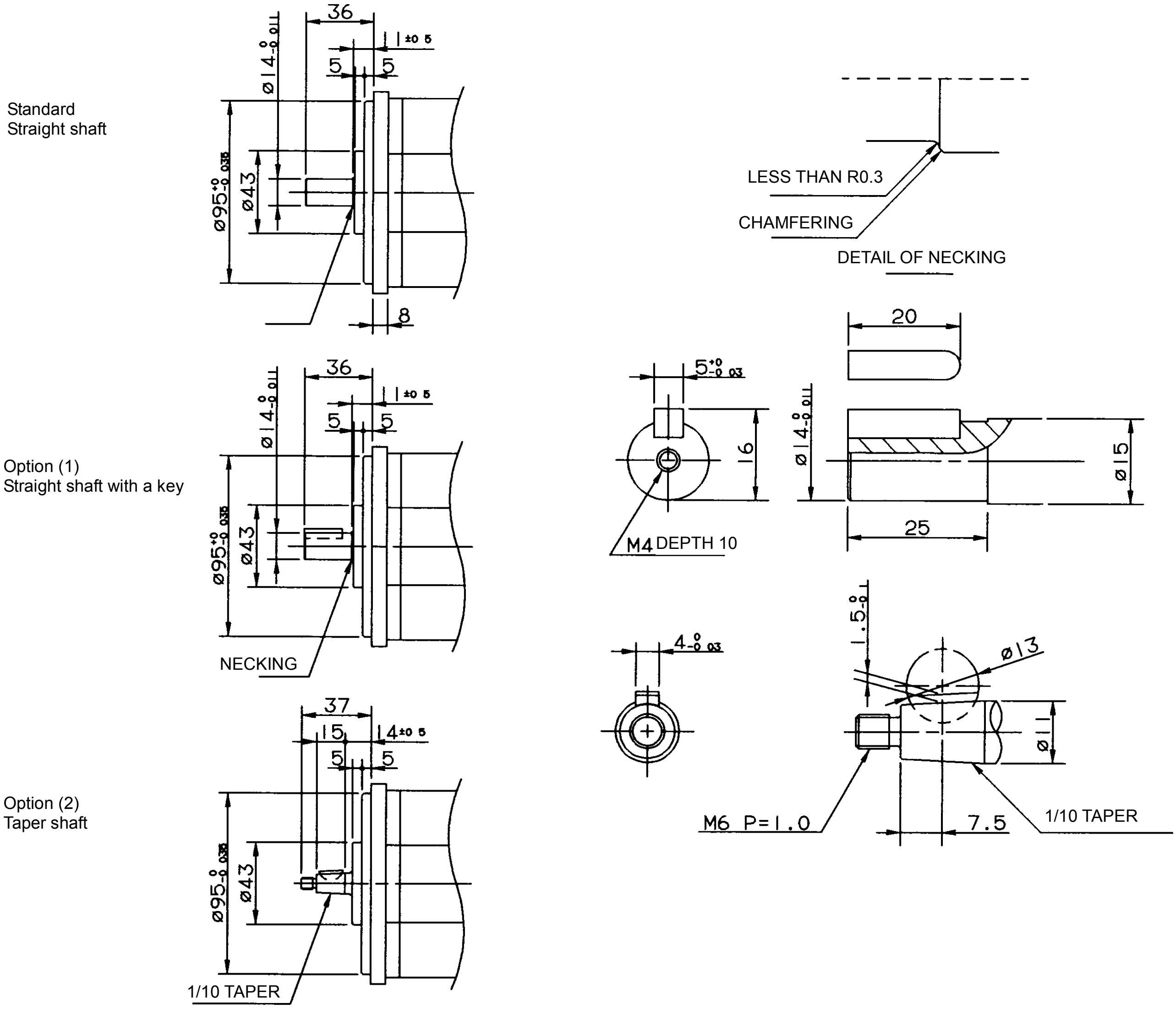
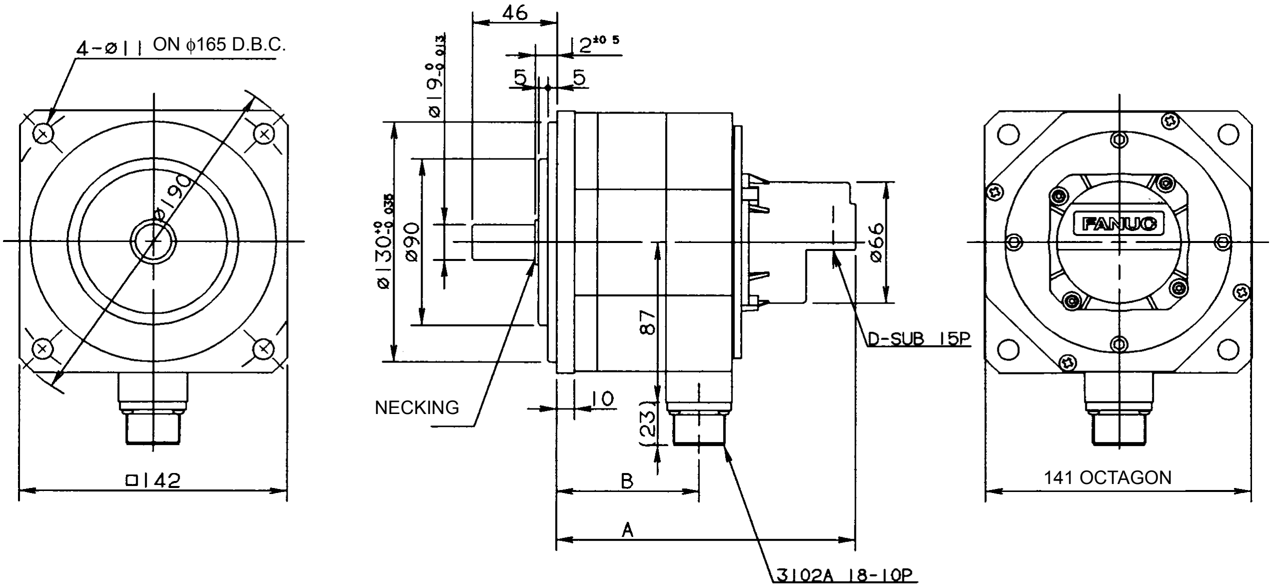


Fig.2.4(d) Models β3 and β6 : Outline drawing (standard)

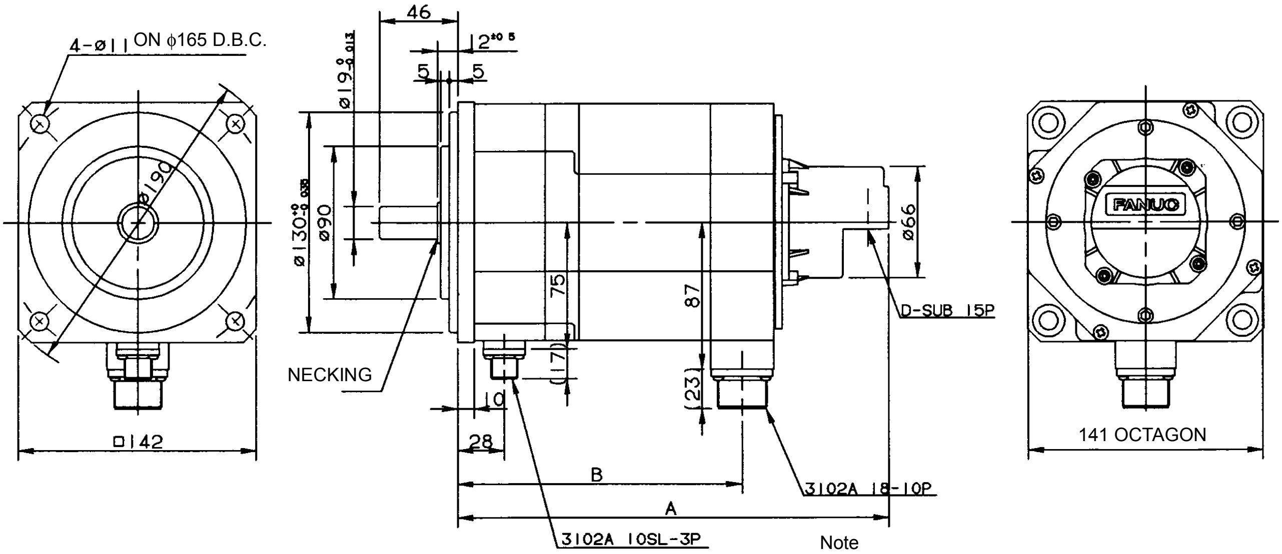


Motor model	A	B
β3/3000	165	79
β6/2000	203	117

Note

SHAFT DIA. RUNOUT	MAX 0.02 mm
RABBET DIA. ECCENTRICITY	MAX 0.04 mm
MOUNTING FACE RUNOUT	MAX 0.06 mm
MAXIMUM RADIAL LOAD	686 N (70kgf)

Fig.2.4(e) Models β3 and β6 : Outline drawing (with a brake)



Motor model	A	B
β3/3000	217	131
β6/2000	255	169

Note

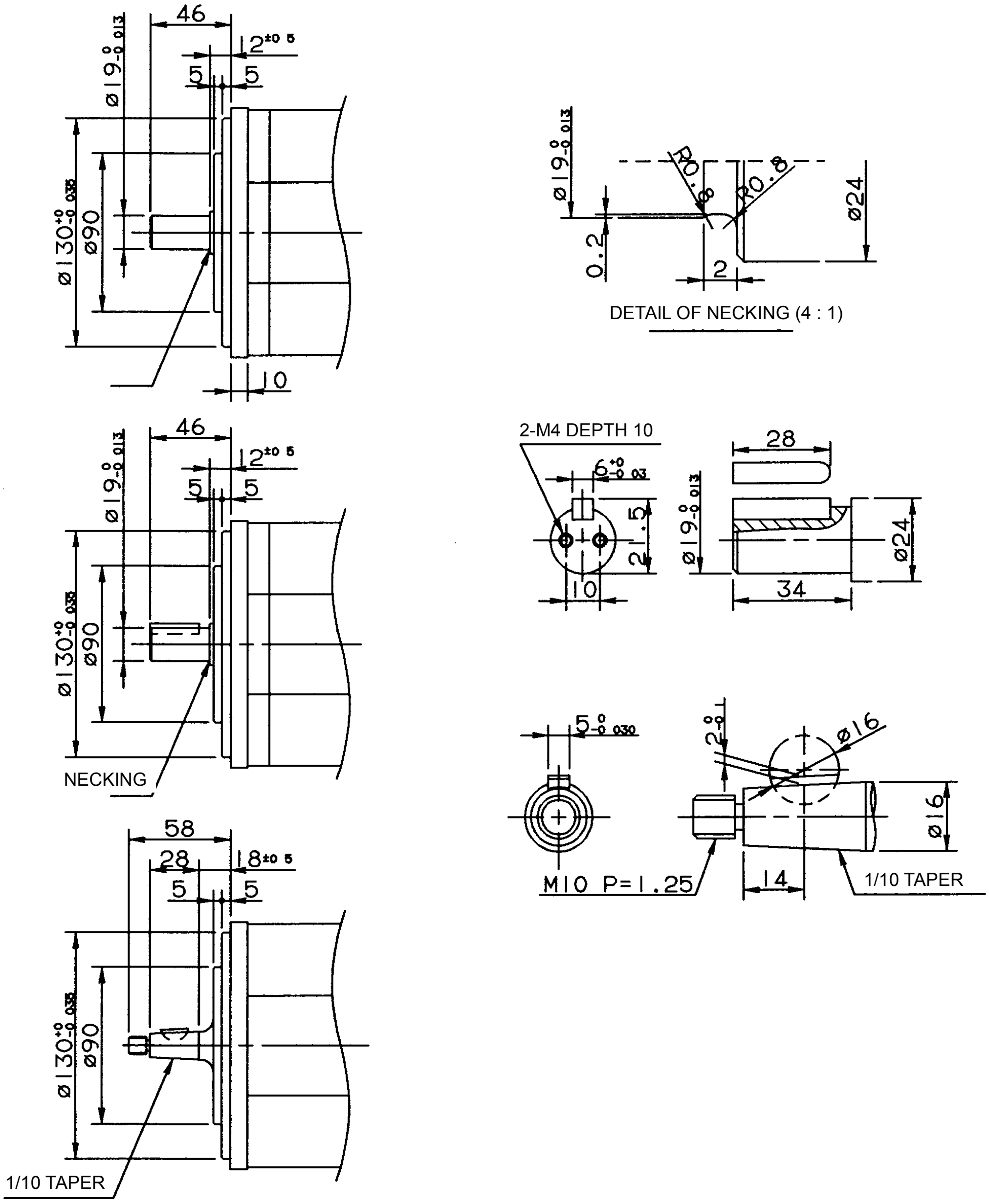
SHAFT DIA. RUNOUT	MAX 0.02 mm
RABBET DIA. ECCENTRICITY	MAX 0.04 mm
MOUNTING FACE RUNOUT	MAX 0.06 mm
MAXIMUM RADIAL LOAD	686 N (70kgf)

Fig.2.4(f) Models β3 and β6 : Shaft option

Standard
Straight shaft

Option (1)
Straight shaft with a key

Option (2)
Taper shaft



IV. FANUC AC SERVO AMPLIFIER β series

1 OVERVIEW

The main features of servo amplifier β series are as follows:

<u>Features not dependent on the interface</u>

(1) The servo amplifier β series is integrated with a power supply unit, so that a compact system can be implemented for one or two axes.
(2) The servo amplifier β series offers low-cost one-axis AC servo amplifiers.
(3) The servo amplifier β series offers models that support not only the FANUC standard interface, namely, the FSSB interface, but also the I/O Link interface available with the CNC, Power Mate, and PLC, and the conventional interface, namely, the PWM interface (type B).
(4) The dimensions of each amplifier are the same even if a different interface is employed.
(5) The servo amplifier β series offers a compact unit with its amounting space and cubic volume reduced by about 50% when compared with α SVU.
(6) The amplifier unit has been designed to conform to the European VDE0160 safety standard, American UL standards, and Canadian CSA standards.

<u>The servo amplifier β series with the FSSB interface has the following features:</u>

(1) The servo amplifier β series with the FSSB interface offers one-axis AC servo amplifiers that are designed for feed axes and are used to drive the servo motor β series suitable for positioning and the servo motor α*i* series suitable for use with feed axes.

<u>The servo amplifier β series with the I/O Link interface has the following features in addition to "Features not dependent on the interface":</u>

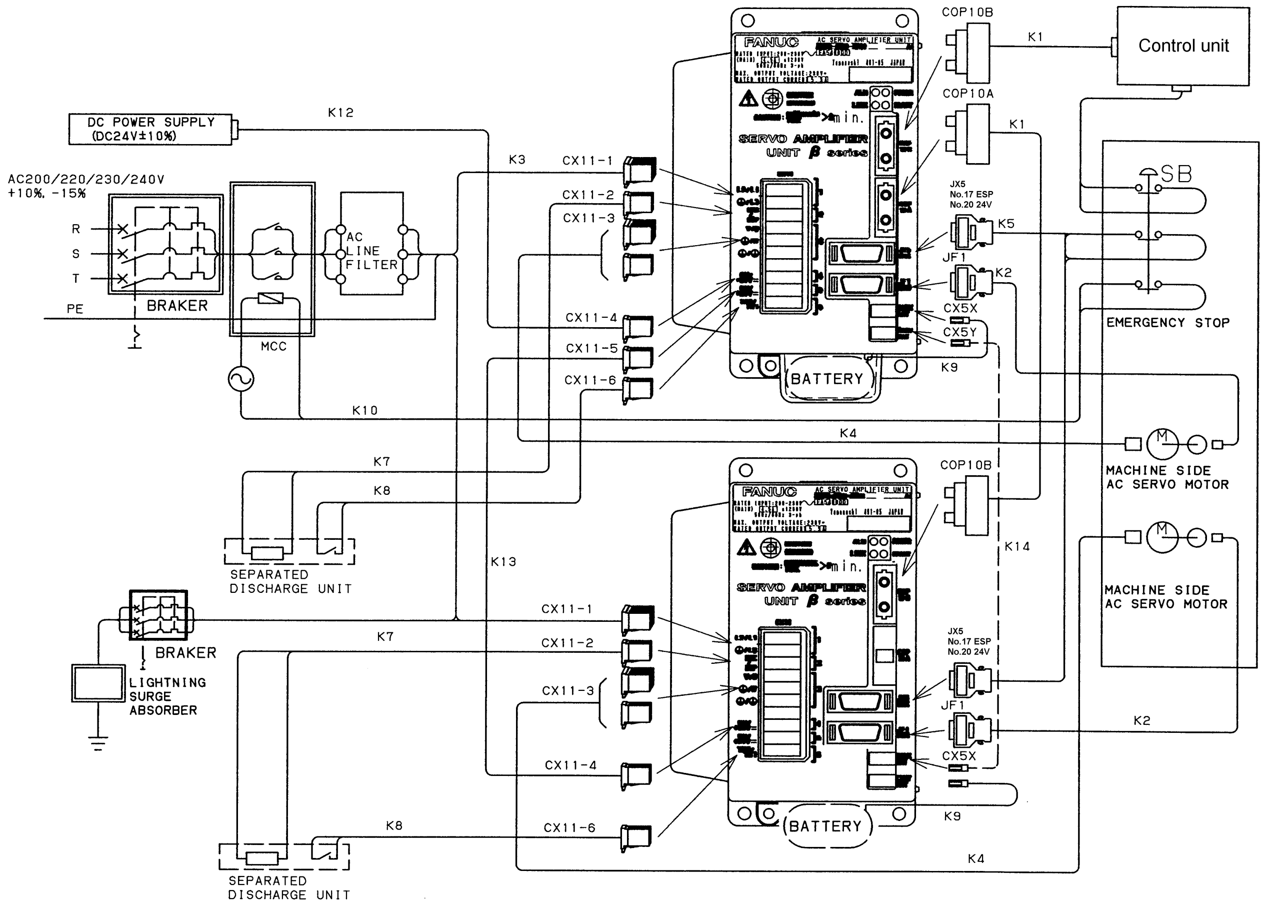
(1) Offer one-axis AC servo amplifiers suitable for use with positioning axes, and used to drive the servo motor β series and servo motor α*i* series.
(2) Have a position control function as well as a set to facilitate control over peripheral devices such as turrets and ATCs.
(3) Can be connected to the Series 16/18/21/15*i*/16*i*/18*i*/20*i*/21*i*, Power Mate, Power Mate *i* PMC, and PLC via the I/O Link, thereby facilitating positioning axis expansion.
(4) Enable the master CNC to set and display parameters, the current position, and diagnosis data.
(5) Support move commands that make movement synchronize with a train of external pulses, thereby enabling diverse use.

2 CONFIGURATION

Following contents shows an example system configuration having two controlled axes. A separated regenerative discharge unit nay be required to handle large amounts of regenerative energy if the load is particularly heavy.

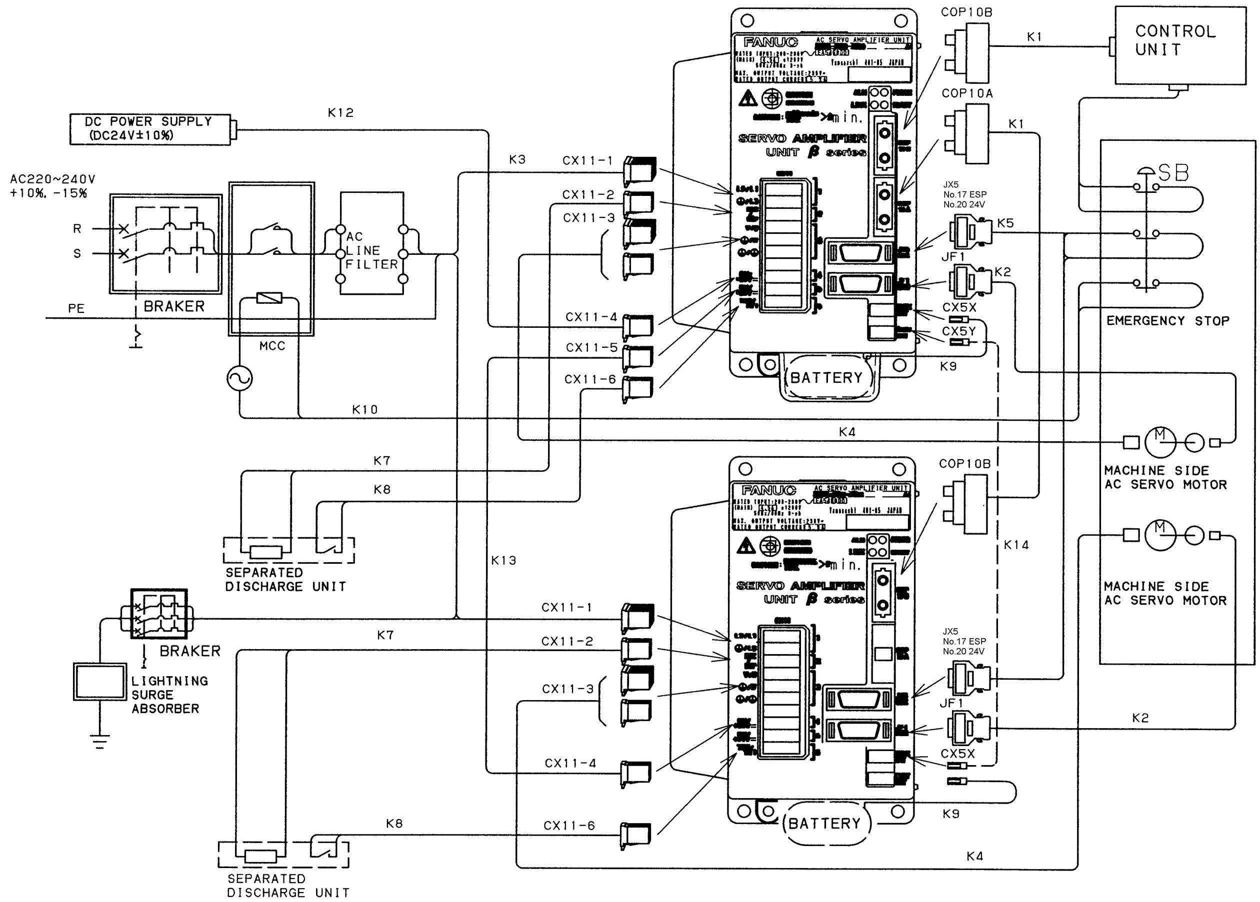
2.1 FSSB INTERFACE

2.1.1 SVU-4, SVU-12, SVU-20 (Three-phase Power Input)



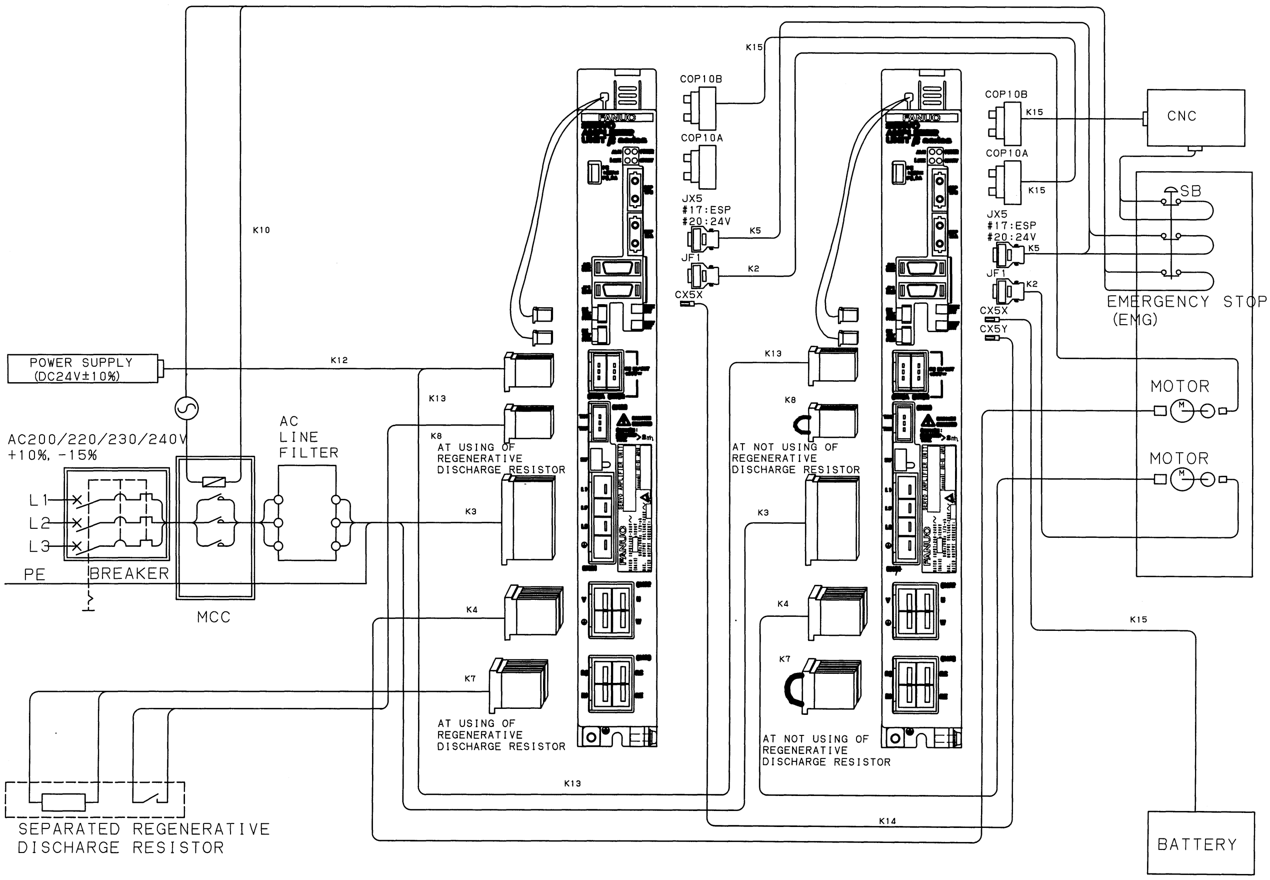
> ⚠ **WARNING**
> A circuit breaker, electromagnetic contactor, and AC line filter must be installed.

2.1.2 SVU-4, SVU-12, SVU-20 (Single-phase Power Input)



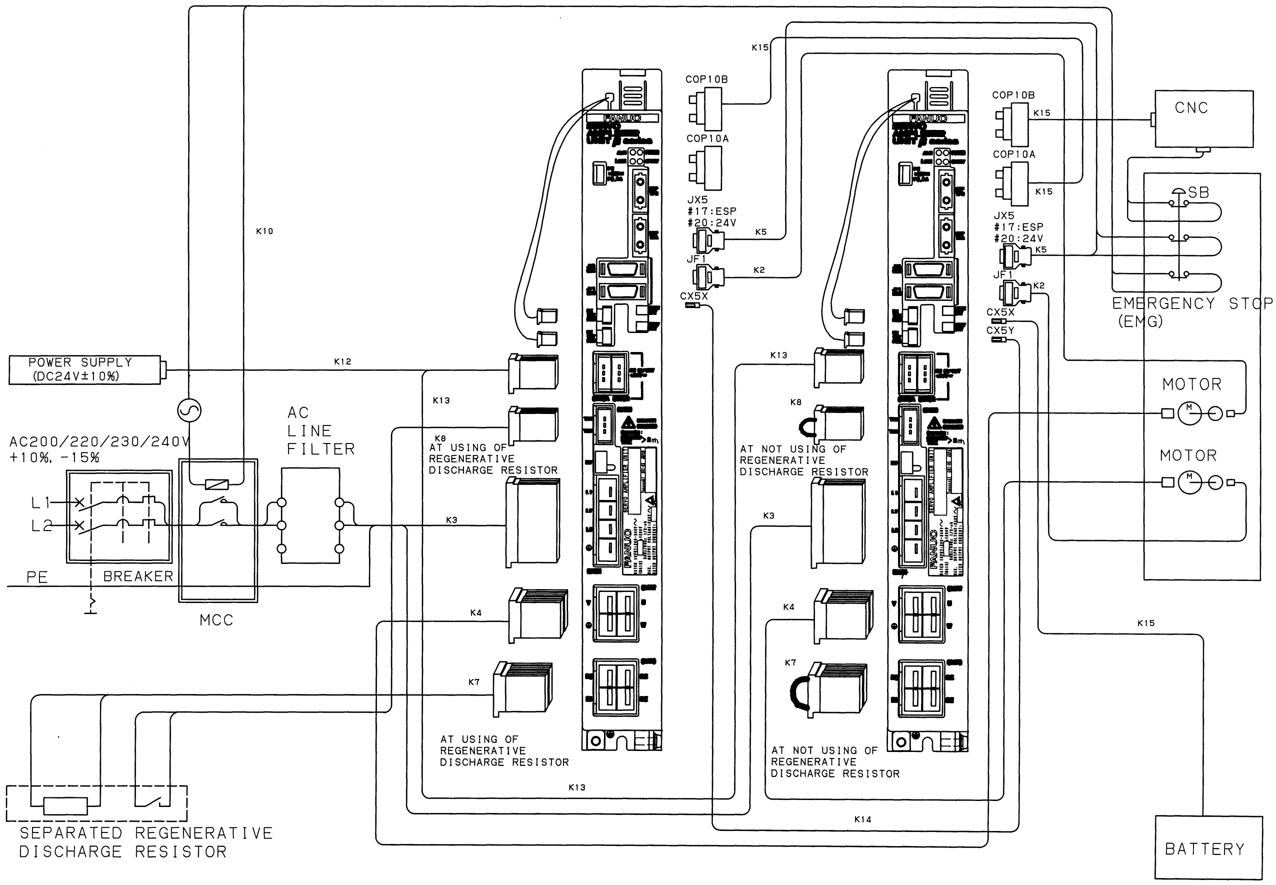
> ⚠ **WARNING**
> A circuit breaker, electromagnetic contactor, and AC line filter must be installed.

2.1.3 SVU-40, SVU-80 (Three-phase Power Input)



> ⚠ **WARNING**
> A circuit breaker, electromagnetic contactor, and AC line filter must be installed.

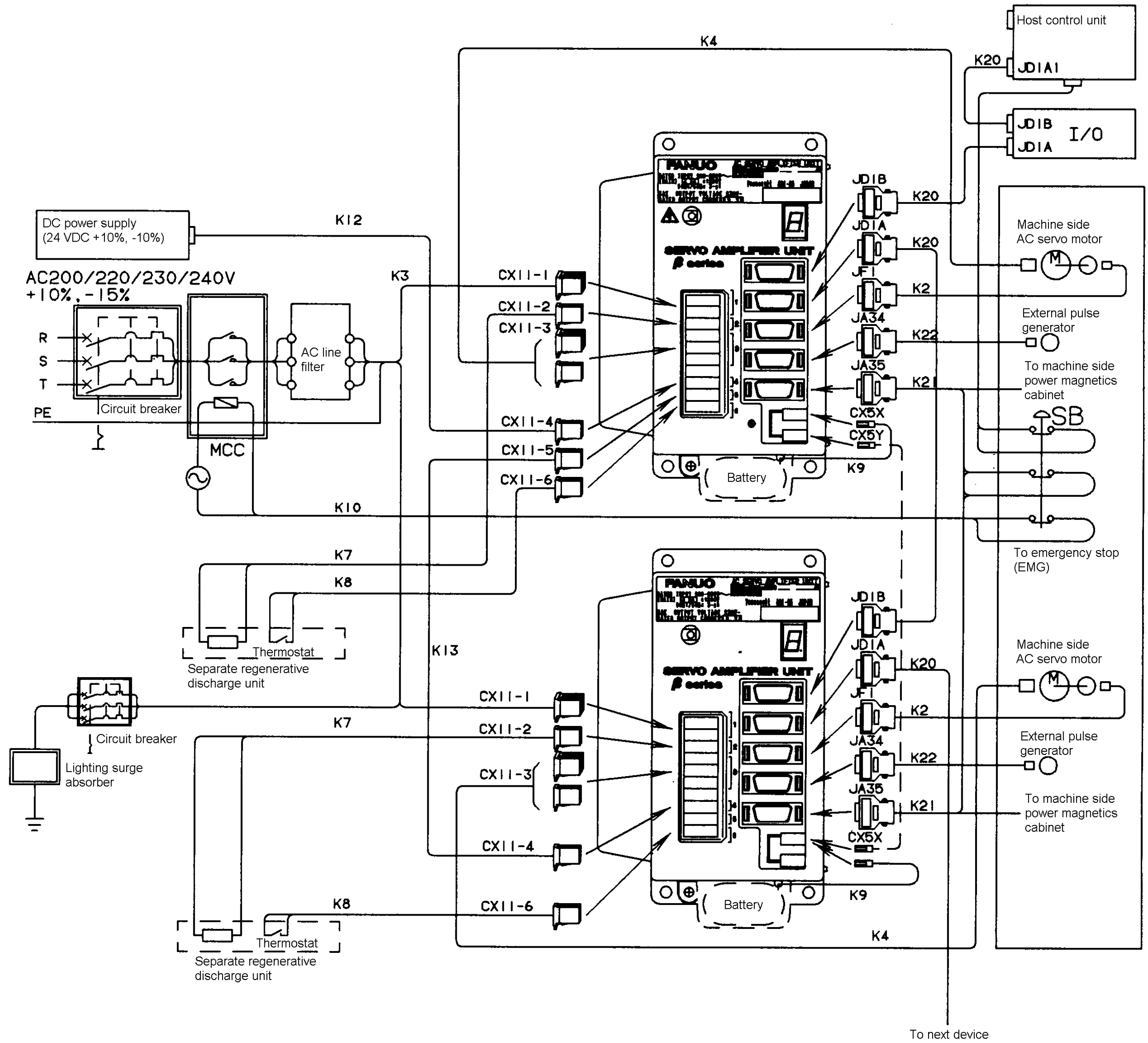
2.1.4 SVU-40, SVU-80 (Single-phase Power Input)



> ⚠ **WARNING**
> A circuit breaker, electromagnetic contactor, and AC line filter must be installed.

2.2 I/O Link INTERFACE

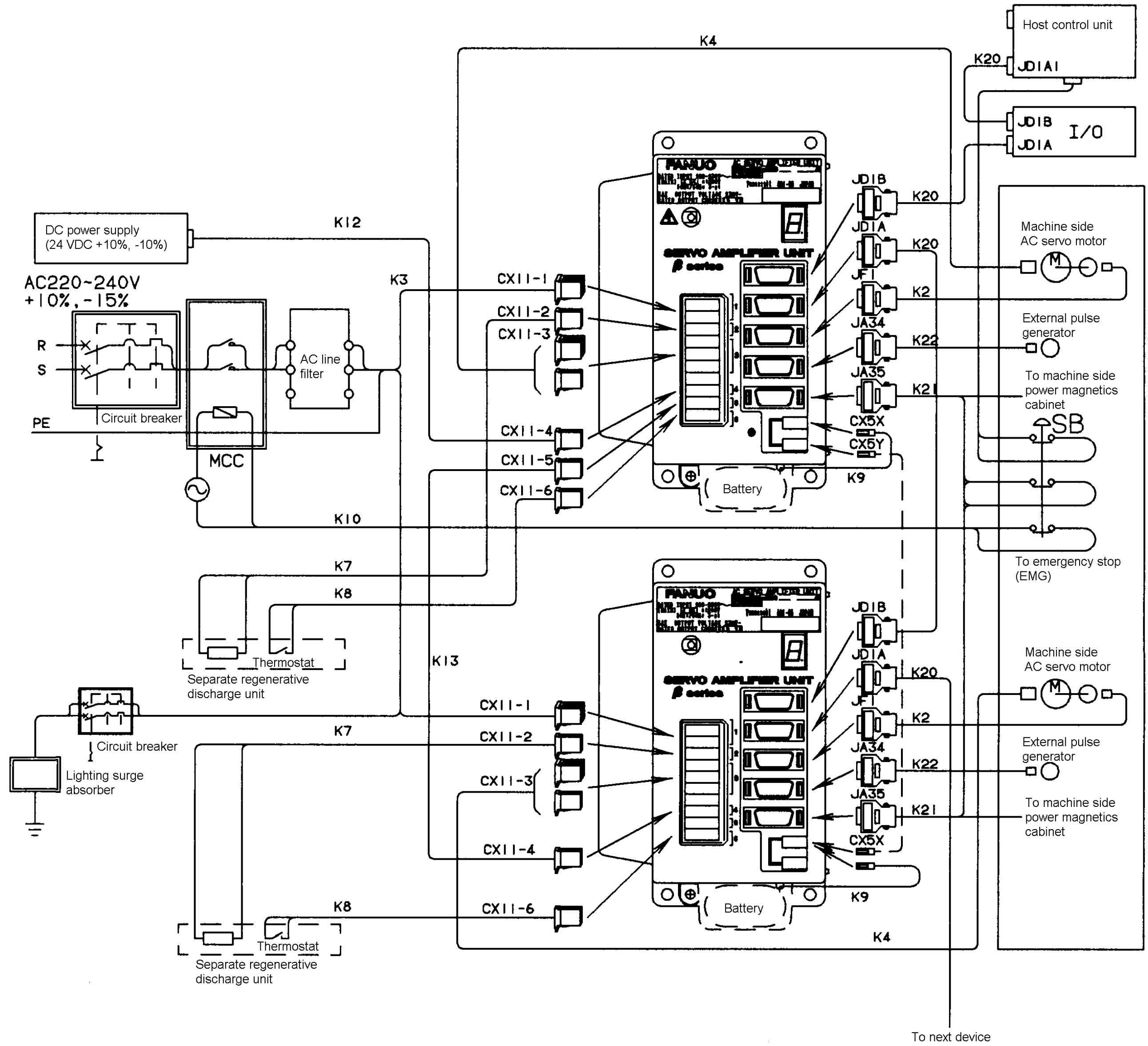
2.2.1 SVU-4, SVU-12, SVU-20 (Three-phase Power Input)



Example of configuration

> ⚠ **WARNING**
> A circuit breaker, electromagnetic contactor, and AC line filter must be installed.

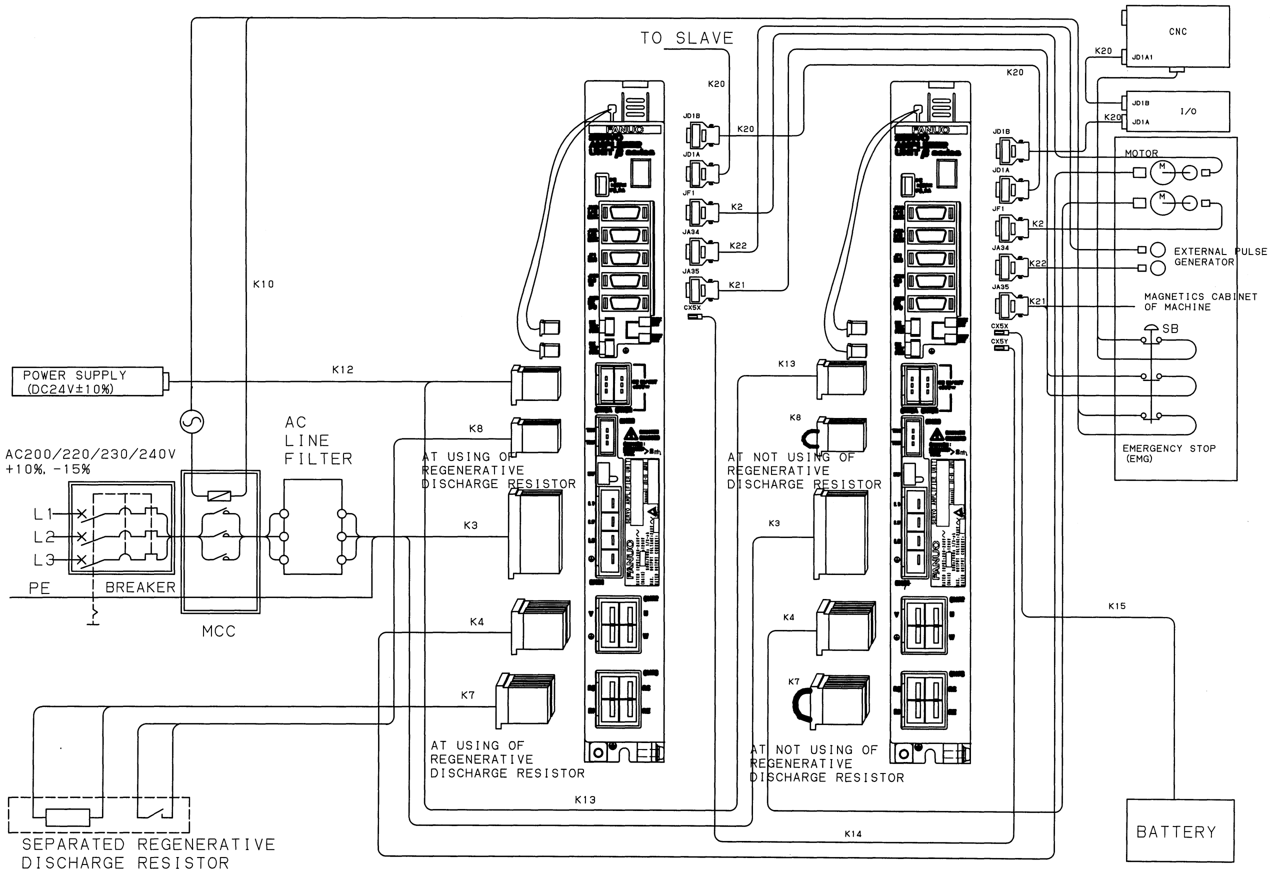
2.2.2 SVU-4, SVU-12, SVU-20 (Single-phase Power Input)



Example of configuration

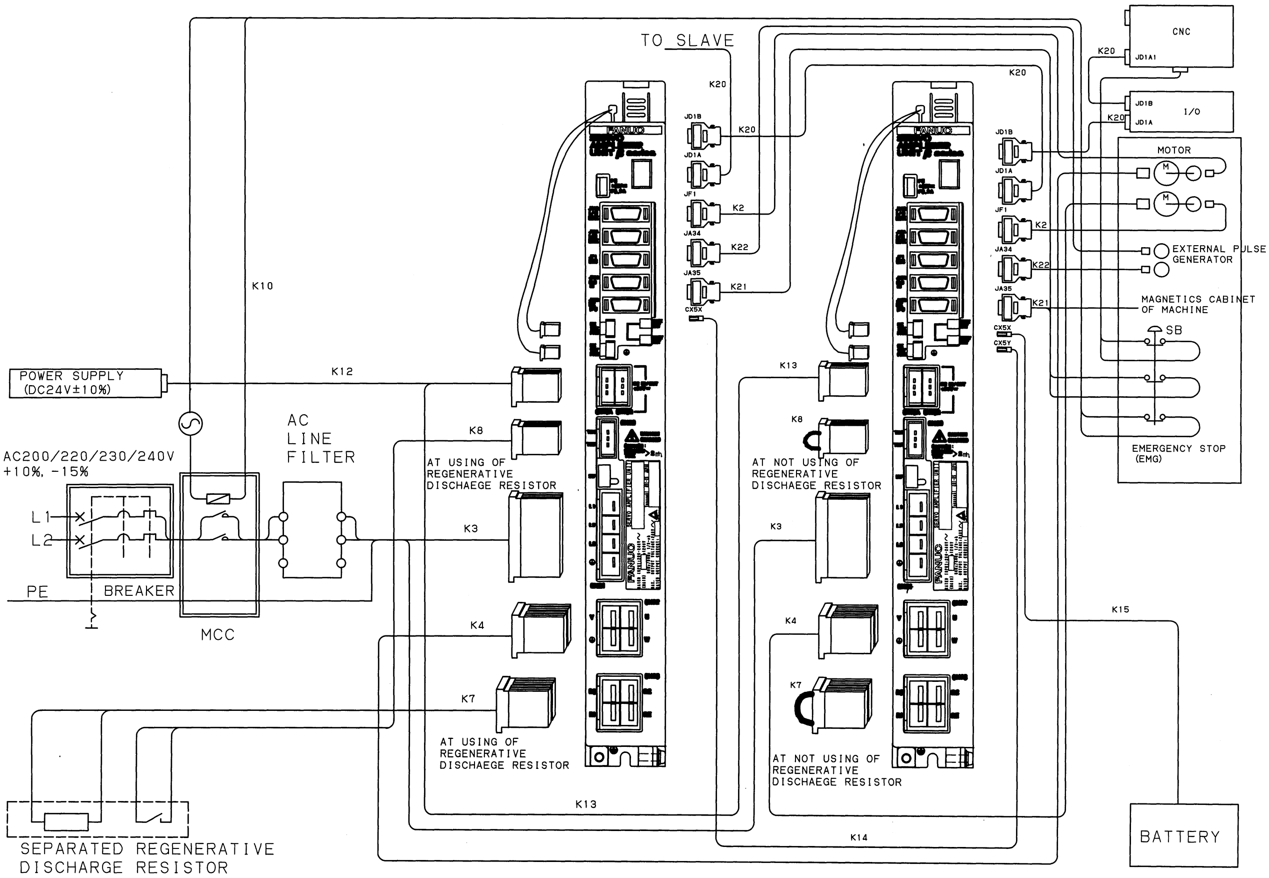
> ⚠ **WARNING**
> A circuit breaker, electromagnetic contactor, and AC line filter must be installed.

2.2.3 SVU-40, SVU-80 (Three-phase Power Input)



⚠ WARNING
A circuit breaker, electromagnetic contactor, and AC line filter must be installed.

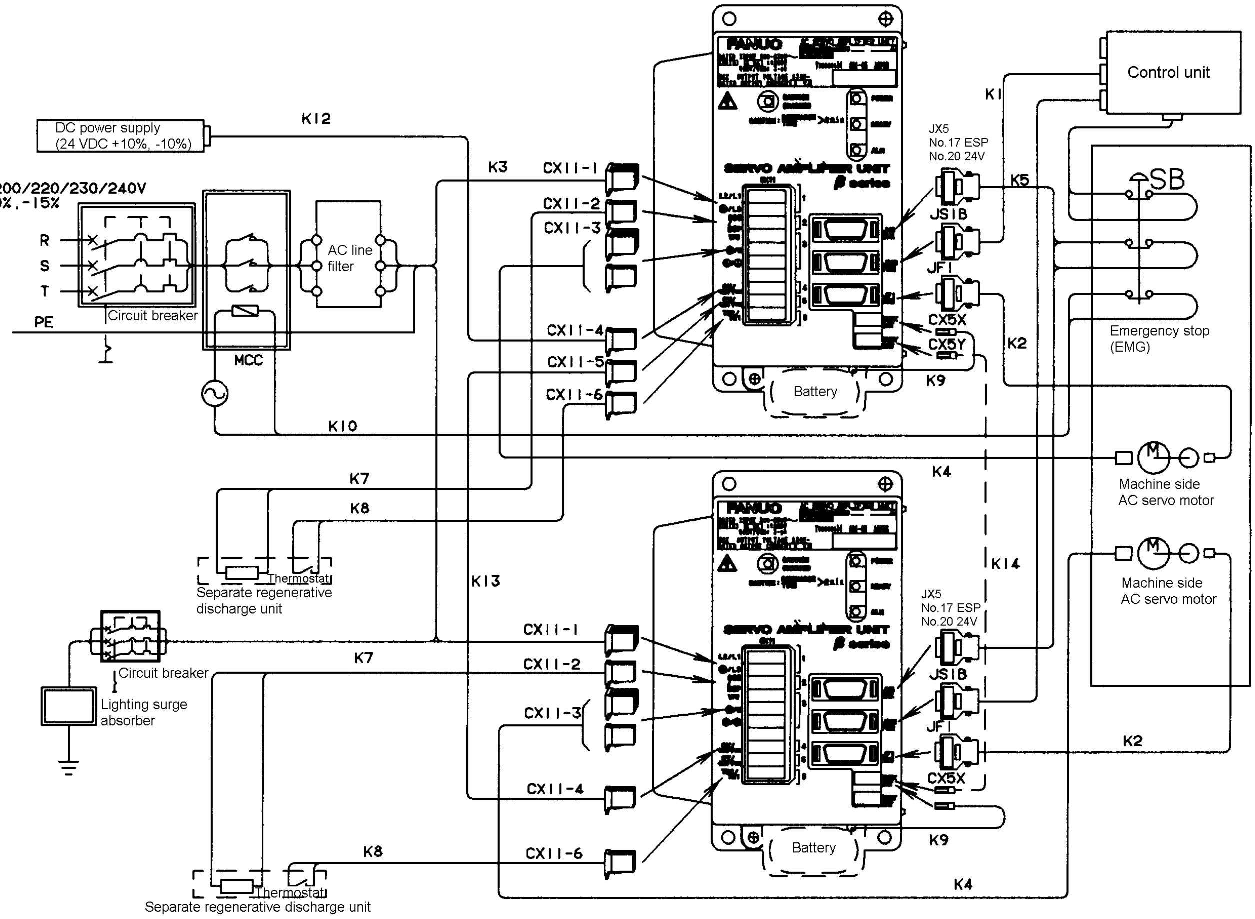
2.2.4 SVU-40, SVU-80 (Single-phase Power Input)



> ⚠ **WARNING**
> A circuit breaker, electromagnetic contactor, and AC line filter must be installed.

2.3 PWM INTERFACE

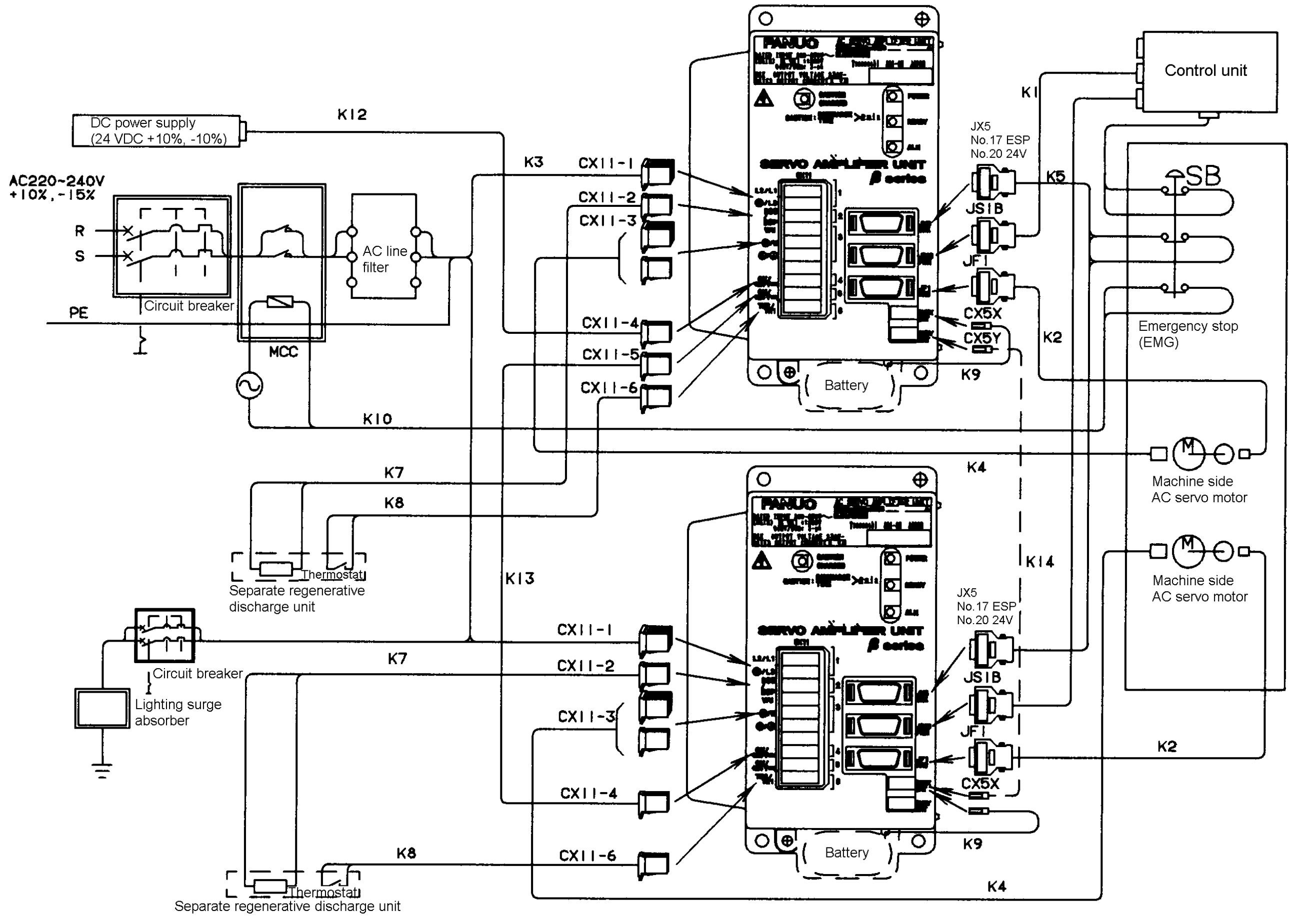
2.3.1 SVU-4, SVU-12, SVU-20 (Three-phase Power Input)



Example of configuration

> ⚠ **WARNING**
> A circuit breaker, electromagnetic contactor, and AC line filter must be installed.

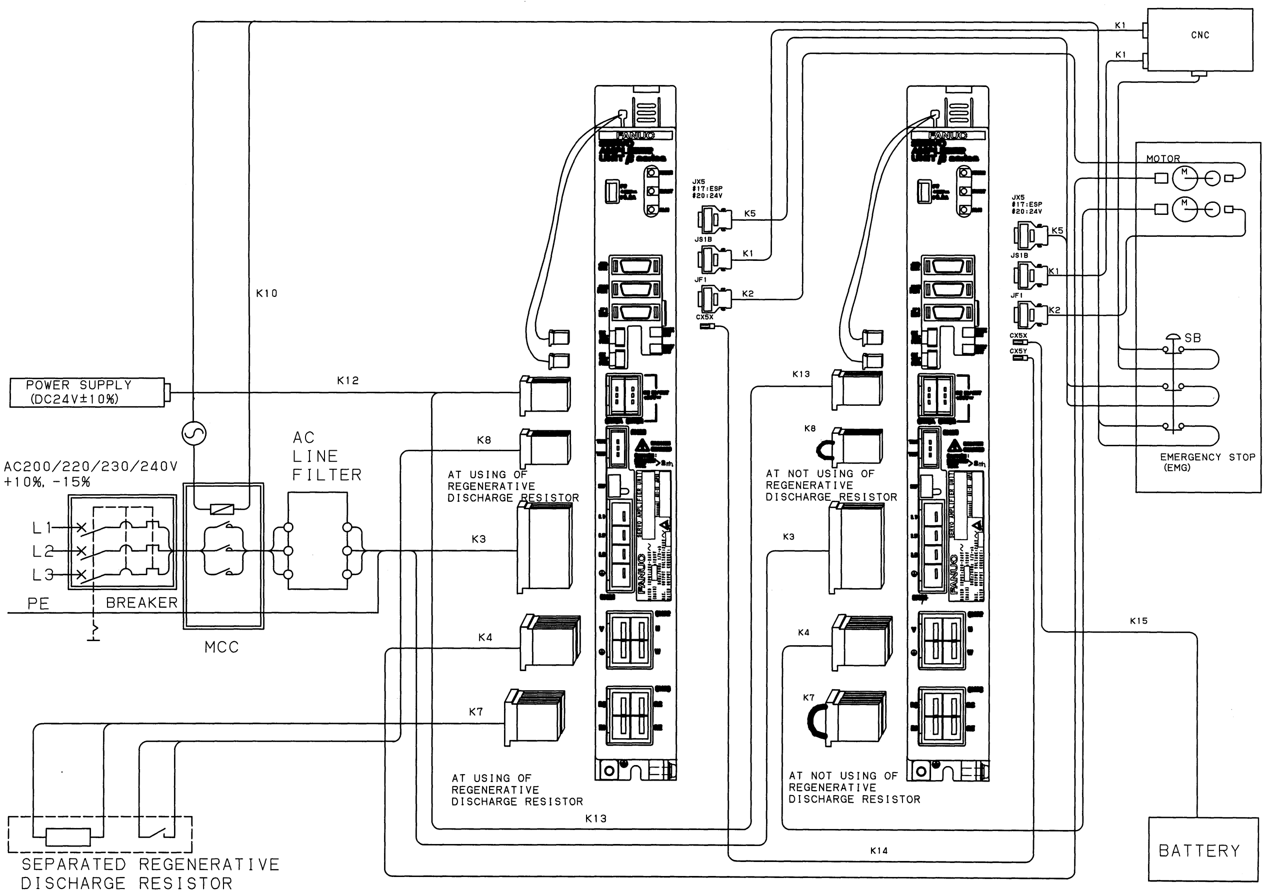
2.3.2 SVU-4, SVU-12, SVU-20 (Single-phase Power Input)



Example of configuration

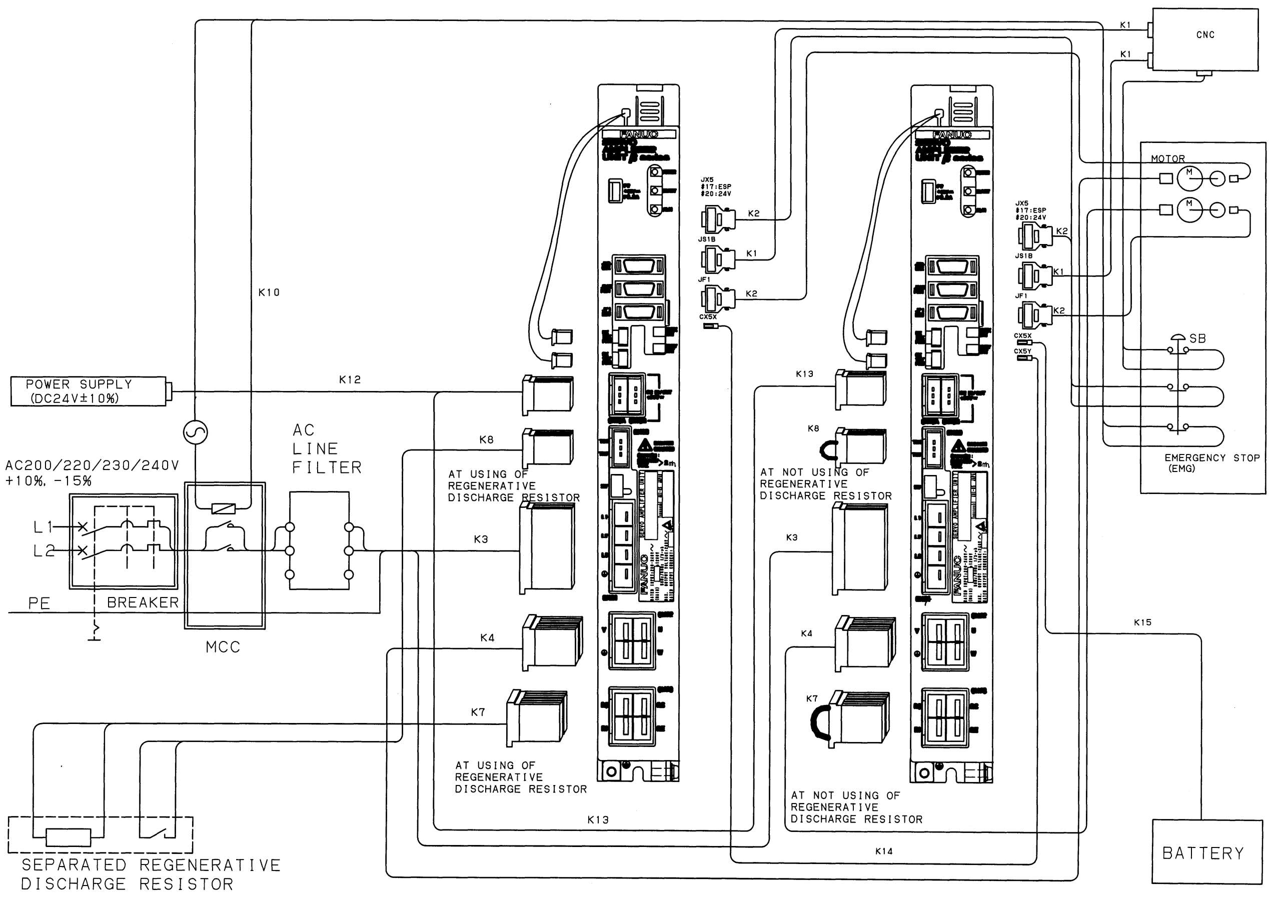
> ⚠ **WARNING**
> A circuit breaker, electromagnetic contactor, and AC line filter must be installed.

2.3.3 SVU-40, SVU-80 (Three-phase Power Input)



> ⚠ **WARNING**
> A circuit breaker, electromagnetic contactor, and AC line filter must be installed.

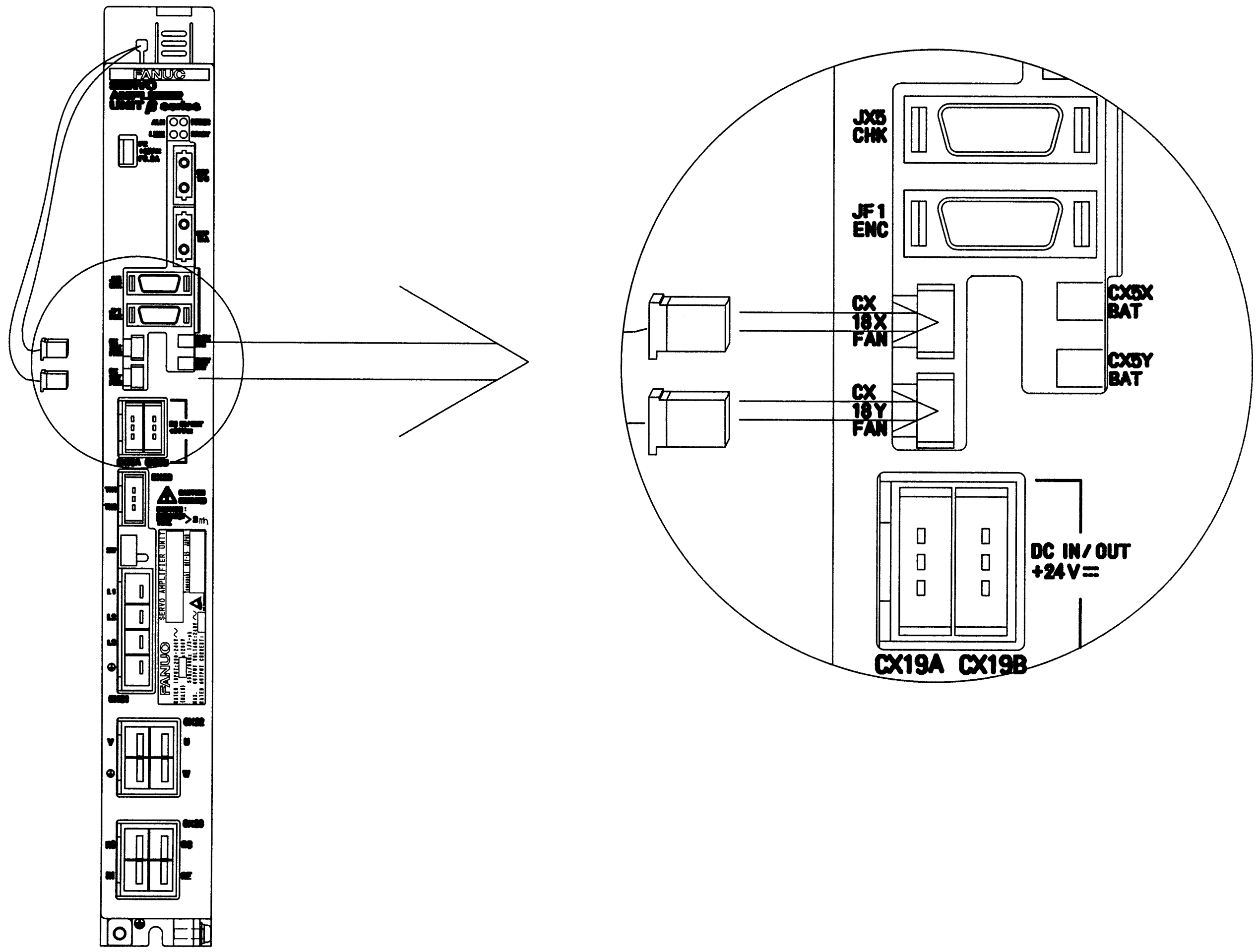
2.3.4 SVU-40, SVU-80 (Single-phase Power Input)



> ⚠ **WARNING**
> A circuit breaker, electromagnetic contactor, and AC line filter must be installed.

2.4 METHOD OF CONNECTING THE FAN MOTOR

Connect cables of two fan motors to the connector (CX18X, CX18Y) of servo amplifier unit. There is no distinction in CX18X and CX18Y. When the cable is attached or detached to the connector, keep cables loose and not stress to the connector.
Be careful because poor contact may be caused when the fan motor is connected under the condition that the cable spreads.



2.5 UNIT TYPES AND SPECIFICATIONS

Table 2.5(a) Unit types and specifications (1)

Model	Specification	Interface	Application
SVU-4	A06B-6093-H119	FSSB	For a feed axis that requires high precision
	A06B-6093-H159	I/O Link	For positioning that does not require high precision
SVU-12	A06B-6093-H111	FSSB	For a feed axis that requires high precision
	A06B-6093-H151	I/O Link	For positioning that does not require high precision
	A06B-6093-H101	PWM	For a feed axis that requires high precision
SVU-20	A06B-6093-H112	FSSB	For a feed axis that requires high precision
	A06B-6093-H152	I/O Link	For positioning that does not require high precision
	A06B-6093-H102	PWM	For a feed axis that requires high precision
SVU-40	A06B-6093-H113	FSSB	For a feed axis that requires high precision
	A06B-6093-H153	I/O Link	For positioning that does not require high precision
	A06B-6093-H103	PWM	For a feed axis that requires high precision
SVU-80	A06B-6093-H114	FSSB	For a feed axis that requires high precision
	A06B-6093-H154	I/O Link	For positioning that does not require high precision
	A06B-6093-H104	PWM	For a feed axis that requires high precision

Table 2.5(b) Applicable motor (α*i* series servo motor)

Amplifier model	Motor model	1	2	3	4		8			12		22		
	α*i*	α1 /5000*i* (20A)	α2 /5000*i* (20A)			α4 /4000*i* (40A)		α8 /3000*i* (40A)			α12 /3000*i* (80A)		α22 /3000*i* (80A)	
	αM*i*		αM2 /5000*i* (20A)	αM3 /5000*i* (20A)					αM8 /4000*i* (80A)		αM12 /4000*i* (80A)			
	αC*i*				αC4 /3000*i* (20A)		αC8 /2000*i* (20A)			αC12 /2000*i* (20A)		αC22 /2000*i* (40A)		αC30 /1500*i* (80A)
SVU-20	H112 H152 H102	O	O	O	O		O			O				
SVU-40	H113 H153 H103					O		O				O		
SVU-80	H114 H154 H104								O		O		O	O

Table 2.5(c) Applicable motor (βM, β series servo motor)

<table>
<tr><td rowspan="3">Amplifier model</td><td>Motor model</td><td>0.2</td><td>0.3</td><td>0.4</td><td>0.5</td><td colspan="2">1</td><td>2</td><td>3</td><td>6</td></tr>
<tr><td>βM</td><td>βM0.2
/4000
(4A)</td><td>βM0.3
/4000
(4A)</td><td>βM0.4
/4000
(20A)</td><td>βM0.5
/4000
(20A)</td><td>βM1
/4000
(20A)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>β</td><td></td><td></td><td></td><td></td><td></td><td>β1
/3000</td><td>β2
/3000</td><td>β3
/3000</td><td>β6
/2000</td></tr>
<tr><td rowspan="2">SVU-4</td><td>H119</td><td rowspan="2">O</td><td rowspan="2">O</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>H159</td></tr>
<tr><td rowspan="3">SVU-12</td><td>H111</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3">O</td><td rowspan="3">O</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>H151</td></tr>
<tr><td>H101</td></tr>
<tr><td rowspan="3">SVU-20</td><td>H112</td><td rowspan="3"></td><td rowspan="3"></td><td>O</td><td rowspan="3">O</td><td rowspan="3">O</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3">O</td><td rowspan="3">O</td></tr>
<tr><td>H152</td><td></td></tr>
<tr><td>H102</td><td>O</td></tr>
</table>

Table 2.5(d) Unit types and specifications (2)

<table>
<tr><th>Classification</th><th>Name</th><th colspan="2">Application</th><th>Specification</th></tr>
<tr><td rowspan="3">Basic</td><td rowspan="3">AC line filter (Note 1)</td><td colspan="2">Type A: For applications where the sum of the rated motor powers does not exceed 5.4 kW</td><td>A81L-0001-0083#3C</td></tr>
<tr><td colspan="2">Type B: For applications where the sum of the rated motor powers does not exceed 10.5 kW</td><td>A81L-0001-0101#C</td></tr>
<tr><td colspan="2">Type C: For applications where the sum of the rated motor powers does not exceed 23 kW</td><td>A81L-0001-0102</td></tr>
<tr><td rowspan="10">Option</td><td rowspan="4">Power transformer for export (Note 2)</td><td colspan="2">Type SAE : Capacity 2.2kVA</td><td>A80L-0022-0005</td></tr>
<tr><td colspan="2">Type SBE : Capacity 3.5kVA</td><td>A80L-0024-0006</td></tr>
<tr><td colspan="2">Type SCE : Capacity 5.0kVA</td><td>A80L-0026-0003</td></tr>
<tr><td colspan="2">Type SDE : Capacity 7.5kVA</td><td>A80L-0028-0001</td></tr>
<tr><td rowspan="5">Separated regenerative discharge unit (Caution)</td><td>30Ω/20W at natural cooling</td><td>For SVU-4, SVU-12, SVU-20</td><td>A06B-6093-H401</td></tr>
<tr><td>30Ω/100W at natural cooling</td><td>For SVU-4, SVU-12, SVU-20</td><td>A06B-6093-H402 (Note 3)</td></tr>
<tr><td>16Ω/200W at natural cooling</td><td>For SVU-40, SVU-80</td><td>A06B-6089-H500</td></tr>
<tr><td>16Ω/800W with cooling fan motor</td><td>For SVU-40, SVU-80</td><td>A06B-6089-H713</td></tr>
<tr><td>16Ω/1200W with cooling fan motor</td><td>For SVU-40, SVU-80</td><td>A06B-6089-H714</td></tr>
<tr><td>Fan adapter</td><td>With forced air cooling (Note 4)</td><td>For SVU-40, SVU-80</td><td>A06B-6078-K002</td></tr>
</table>

⚠ CAUTION

A separated regenerative discharge unit must be used when the amount of regenerative energy produced by the motor exceeds a specified value because of a high load inertia of frequent acceleration/deceleration.
Refer to Chapter 4 "Separated regenerative discharge unit" for details of regenerative discharge unit. For information about connections, see Part V, "CONNECTION". An incorrect connection can damage the amplifier. Care must be taken.

NOTE

1 An AC line filter must be used to suppress the influences of high-frequency noise on the power supply.
When a power transformer (insulation type) is used because a power supply voltage within the specified range is not available, this AC line filter is not necessary. If the use of this AC line filter fails to fully satisfy EMC requirements the use of a commercially available noise filter is recommended.
2 At single-phase power input, it is not necessary.
If the line voltage is higher than 200/220/230 VAC, use a power transformer. When a transformer is used, as AC line filter usually becomes unnecessary, however in case that requirements of EMC standard are still not satisfied, AC line filter will be needed.
3 A06B-6093-H402 contains a connector kit for connection with a β series amplifier as a standard accessory.

Table 2.5(e) Unit types and specifications (for SVU-4, SVU-12, SVU-20)

<table>
<tr><th>Classification</th><th>Name</th><th colspan="2">Application</th><th>Specification</th></tr>
<tr><td rowspan="16">Basic</td><td rowspan="2">Connector (PWM)</td><td rowspan="2">JX5 : For ESP signal</td><td>Solder type</td><td>A06B-6073-K212</td></tr>
<tr><td>Crimp type</td><td>A06B-6073-K213</td></tr>
<tr><td rowspan="2">Connector (PWM)</td><td rowspan="2">JS1B : NC-SVU command cable</td><td>Solder type</td><td>A06B-6073-K212</td></tr>
<tr><td>Crimp type</td><td>A06B-6073-K213</td></tr>
<tr><td rowspan="2">Connector (I/O Link)</td><td rowspan="2">JD1A : For I/O Link</td><td>Solder type</td><td>A06B-6073-K212</td></tr>
<tr><td>Crimp type</td><td>A06B-6073-K213</td></tr>
<tr><td rowspan="2">Connector (I/O Link)</td><td rowspan="2">JD1B : For I/O Link</td><td>Solder type</td><td>A06B-6073-K212</td></tr>
<tr><td>Crimp type</td><td>A06B-6073-K213</td></tr>
<tr><td rowspan="2">Connector (I/O Link)</td><td rowspan="2">JA35 : For built-in DI input cable</td><td>Solder type</td><td>A06B-6073-K212</td></tr>
<tr><td>Crimp type</td><td>A06B-6073-K213</td></tr>
<tr><td>Connector (common)</td><td colspan="2">JF1 : For pulse coder F/B cables</td><td>A06B-6073-K214</td></tr>
<tr><td>Connector (common)</td><td colspan="2">JA34 : For external pulse input cable</td><td>A06B-6073-K214</td></tr>
<tr><td>Connector (common)</td><td colspan="2">CX11-1, 3, 4, 5 and dummy plug for 6: When a regenerative discharge unit is not used</td><td>(Caution)
A06B-6093-K305</td></tr>
<tr><td>Connector (common)</td><td colspan="2">CX11-1, 3, 4, 5: When a regenerative discharge unit is used</td><td>(Caution)
A06B-6093-K306</td></tr>
<tr><td>Connector (common) (Note 1)</td><td colspan="2">CX11-4, 5: When the cross-sectional area of wire exceeds 0.5 mm^2</td><td>A06B-6093-K304</td></tr>
<tr><td>Fuse (common)</td><td colspan="2">For protecting control power 24 VDC from a short-circuit</td><td>A06B-6073-K250</td></tr>
<tr><td rowspan="8">Option</td><td>Connector</td><td colspan="2">CX5X, Y: For battery cable</td><td>A06B-6093-K303</td></tr>
<tr><td>Battery case</td><td colspan="2">For absolute pulse coders. Connection method 1 (Note 2)</td><td>A06B-6093-K002</td></tr>
<tr><td>Battery</td><td colspan="2">For absolute pulse coders. Connection method 1 (Note 2)</td><td>A06B-6093-K001</td></tr>
<tr><td>Battery case</td><td colspan="2">For absolute pulse coders. Connection method 2 (Note 2)</td><td>A06B-6050-K060</td></tr>
<tr><td>Battery</td><td colspan="2">For absolute pulse coders. Connection method 2 (Note 2)</td><td>A06B-6050-K061</td></tr>
<tr><td>Battery case</td><td colspan="2">For absolute pulse coders (Cable length: 5m). Connection method 2 (Note 2)</td><td>A06B-6093-K810</td></tr>
<tr><td rowspan="2">Lightning surge absorber</td><td colspan="2">Not complying with the standard (Warning)</td><td>A06B-6077-K141</td></tr>
<tr><td colspan="2">Complying with the standard (Warning)</td><td>A06B-6077-K142</td></tr>
</table>

The terms "PWM," " I/O Link," and "common" used in the Name column indicate what interface to be used.
PWM : The PWM interface is used.
I/O Link : The I/O Link interface is used.
Common : Both PWM and I/O Link interfaces can be used.

⚠ WARNING

At the power input of the power magnetics cabinet, install a surge absorber between the power lines and between each power line and a ground to protect the unit from a voltage surge caused by lightning.
See Section 7.5 for details of the lightning surge absorber.

⚠ CAUTION

Refer to Chapter 4 "Separated regenerative discharge unit" for details of regenerative discharge unit. For information about connections, see Part V, "CONNECTION". An incorrect connection can damage the amplifier. Care must be taken.

NOTE

1 When multiple β series amplifiers are connected, and a wire with a diameter of 0.53 mm^2 or more needs to be used, select this connector. The supply current of the control power supply per β series amplifier is 0.6 A for the FSSB interface, 0.9 A for the I/O Link interface, or 0.4 A for the PWM interface. So, select an appropriate wire according to the number of β series amplifiers to be connected.
2 There are two methods of connecting the batteries for the absolute pulse coder. Specify an appropriate battery case and battery according to the connection method selected.

Up to six units

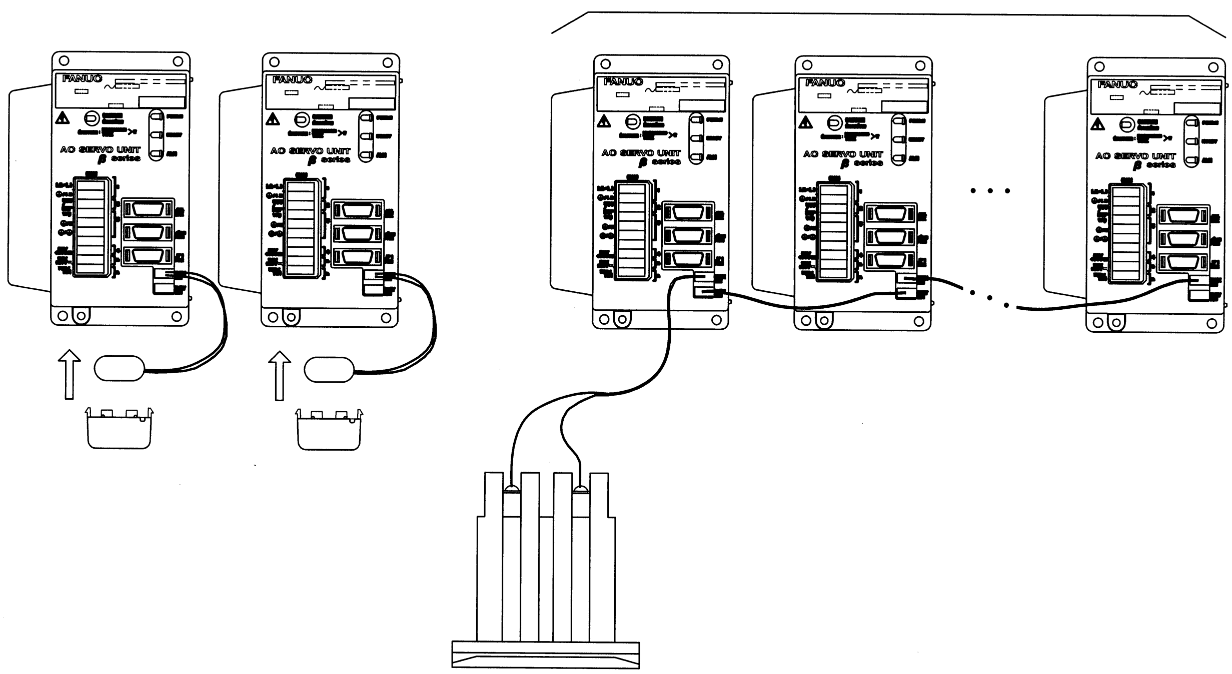


Table 2.5(f) Unit types and specifications (for SVU-40, SVU-80)

Classification	Name	Application		Specification
Basic	Connector (common)	CX21: For input power line	Crimp type	A06B-6093-K311
	Connector (common)	CX22: For motor power line (cross-sectional area of wire is under 3.5 mm^2)	Crimp type	A06B-6093-K312
	Connector (common)	CX22: For motor power line (cross-sectional area of wire is under 3.5 mm^2)	Crimp type	A06B-6093-K313
	Connector (common)	CX20, CX23:For regenerative discharge resistor (When separate regenerative discharge resistor is not used.)	Crimp type	A06B-6093-K314 (Note 1)
	Connector (common)	CX20, CX23: For regenerative discharge resistor (When separate regenerative discharge resistor is used.)	Crimp type	A06B-6093-K315 (Note 1)
	Connector (common)	CX19A/B: For 24 VDC input/output connector	Crimp type	A06B-6093-K316
	Connector (common)	CX19A/B: For 24 VDC input/output connector	Crimp type	A06B-6093-K317 (Note 2)
	Connector (common)	JF1 : For pulse coder F/B cables	Solder type	A06B-6073-K214
	Fuse (common)	For protecting control power 24 VDC from a short-circuit		A06B-6073-K250
	Connector (PWM, FSSB)	JX5 : For ESP signal	Solder type	A06B-6073-K212
			Crimp type	A06B-6073-K213
	Connector (PWM)	JS1B : NC-SVU command cable	Solder type	A06B-6073-K212
			Crimp type	A06B-6073-K213
	Connector (I/O Link)	JD1A : For I/O Link	Solder type	A06B-6073-K212
			Crimp type	A06B-6073-K213
	Connector (I/O Link)	JD1B : For I/O Link	Solder type	A06B-6073-K212
			Crimp type	A06B-6073-K213
	Connector (I/O Link)	JA35 : For built-in DI input cable	Solder type	A06B-6073-K212
			Crimp type	A06B-6073-K213
	Connector (I/O Link)	JA34 : For external pulse input cable		A06B-6073-K214
Option	Connector (common)	CX5X, Y : For battery		A06B-6093-K303
	Battery case (common)	For absolute pulse coders. Connection method 1 (Note 3)		A06B-6093-K002
	Battery (common)	For absolute pulse coders. Connection method 1 (Note 3)		A06B-6093-K001
	Battery case (common)	For absolute pulse coders. Connection method 2 (Note 3)		A06B-6050-K060
	Battery (common)	For absolute pulse coders. Connection method 2 (Note 3)		A06B-6050-K061
	Lightning surge absorber (common)	Not complying with the standard (Note 4)		A06B-6077-K141
		Complying with the standard (Note 4)		A06B-6077-K142

The terms "PWM," " I/O Link," and "common" used in the Name column indicate what interface to be used.
PWM : The PWM interface is used.
I/O Link : The I/O Link interface is used.
Common : The FSSB interface, I/O Link interface, and PWM interface can be used.

⚠ **WARNING**

At the power input of the power magnetics cabinet, install a surge absorber between the power lines and between each power line and a ground to protect the unit from a voltage surge caused by lightning.
See Section 7.5 for details of the lightning surge absorber.

NOTE

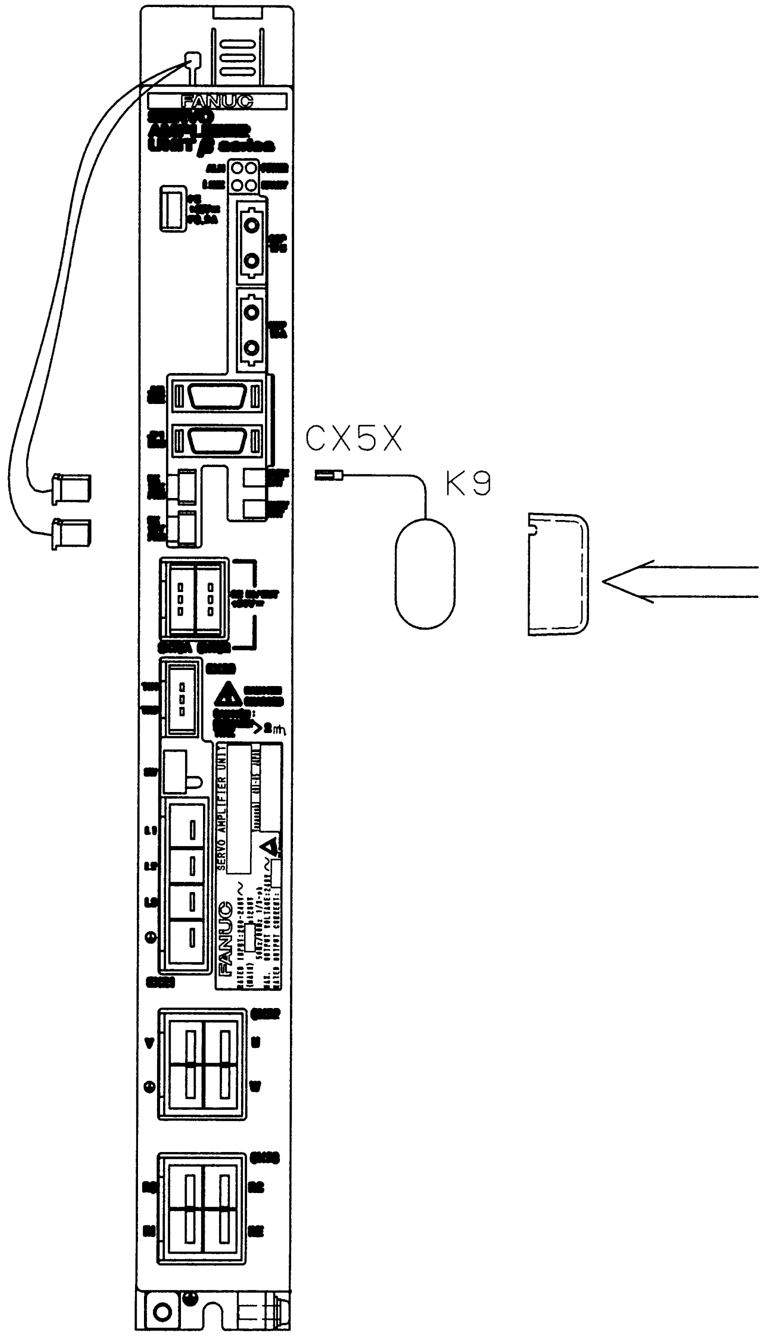
1 When no separate regenerative resistor is used, a dummy connector for connecting the overheat alarm (OH alarm) for separate regenerative resistors and a dummy connector for connecting a resistance wire are required.
Specify the ordering drawing number A06B-6093-K314 when ordering dummy connectors for connecting the OH alarm and resistance wire.
Specify the ordering drawing number A06B-6093-K315 when ordering a housing and contact for connecting a separate regenerative resistor with a β series amplifier.

2 When multiple β series amplifiers are connected, and a wire with a diameter of 0.5 mm^2 or more needs to be used, select this connector. The supply current of the control power supply per β series amplifier is 0.6 A for the FSSB interface, 0.9 A for the I/O Link interface, or 0.4 A for the PWM interface. So, select an appropriate wire according to the number of β series amplifiers to be connected.

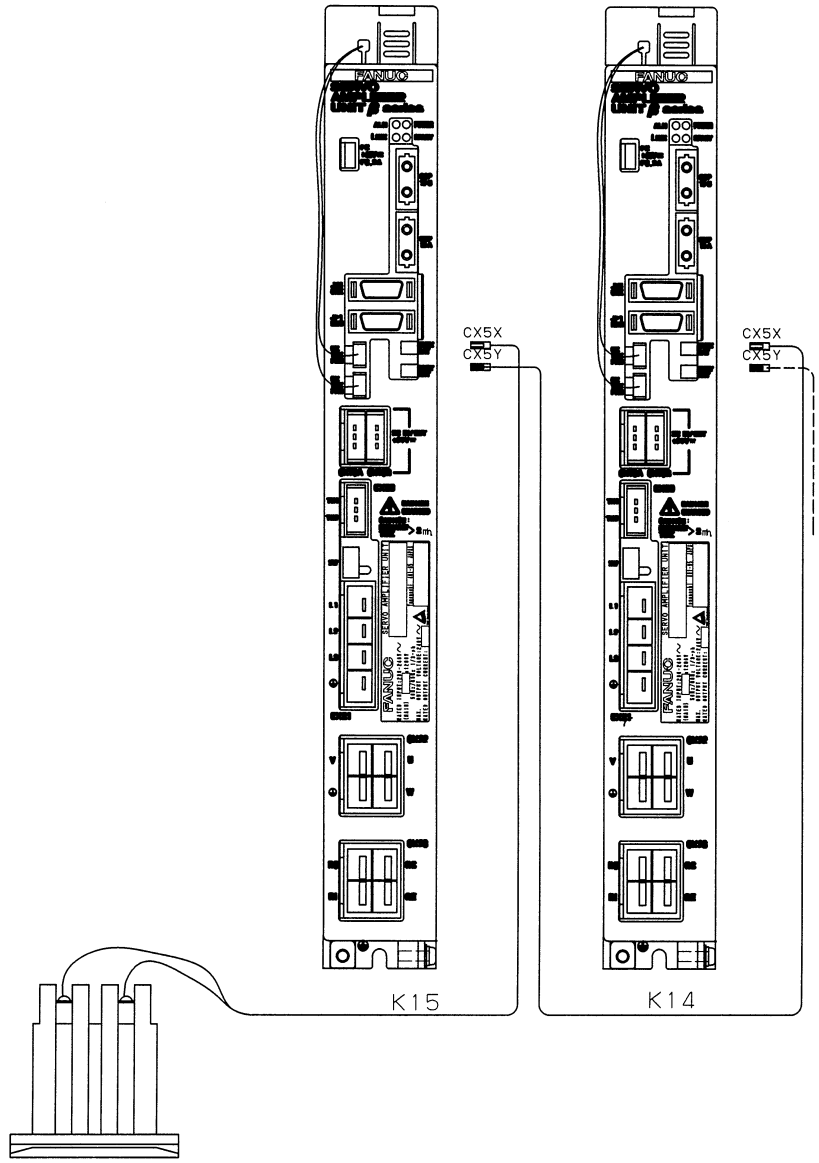
3 There are two methods of connecting the batteries for the absolute pulse coder. Specify an appropriate connection method according to the use environment.

4 See Section 3.2, "DERATING", to choose whether to cool the β series amplifier by natural air cooling or by forced air cooling.
For forced air cooling, a fan motor with a wind speed of 2 m/sec is required.
A desired cooling capability can be obtained by using a fan adapter.
For the attachment of a fan adapter, see Section 9.2, "PANEL CUT-OUT DRAWING" for forced air cooling.
When using forced air cooling, design a power magnetics cabinet so that cooling air from the fan motor does not leak. The fan motor may need to be maintained and replaced, depending on the use environment. So, give a consideration to the installation and structure of a fan motor so that maintenance and replacement work can be performed easily.

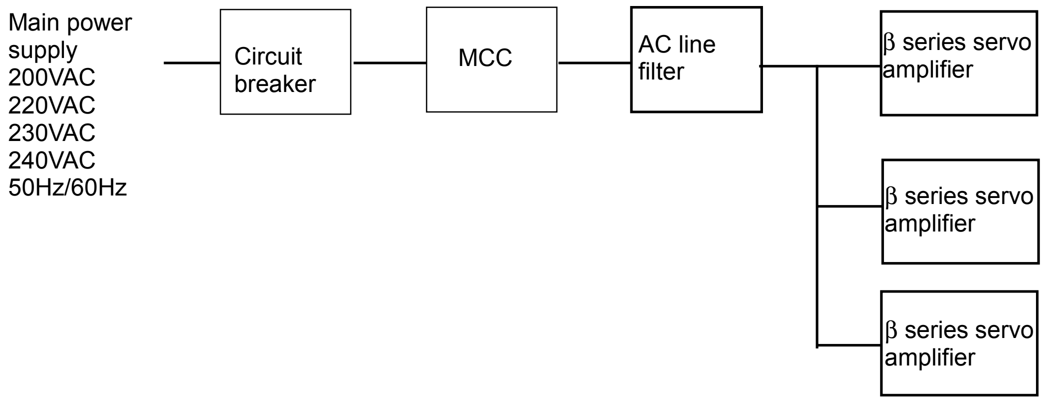
Connection method 1



Connection method 2



2.6 CIRCUIT BREAKER, ELECTROMAGNETIC CONTACTOR, AND AC LINE FILTER



2.6.1 Circuit Breaker Rating

Select an appropriate circuit breaker based on Table 2.6.1. When connecting multiple amplifiers to one circuit breaker, select a circuit breaker according to the sum of the input currents of the individual motors at continuous rated output based on Table 2.6.1.
Note that, during rapid motor acceleration, a current that is roughly triple the continuous rating flows. Therefore, select a circuit breaker that does not trip when a current that is triple the continuous rating flows for 3 seconds.
When certification of the European standard (VDE0160) is to be obtained, the capacity of a circuit breaker needs to be limited for protection of cables such as power input cables.
When connecting multiple amplifiers to one circuit breaker, select a circuit breaker so that the value obtained by multiplying the sum of the input currents of the individual motors at continuous rated output based on Table 2.6.1 by 0.6 does not exceed the rated current of the circuit breaker.

> ⚠ **WARNING**
> For servo amplifier protection, use a correct circuit breaker.
> SVU-4, SVU-20: Circuit breaker of 10 A or less
> SVU-40, SVU-80: Circuit breaker of 20 A or less

Example selection:
EA33 Series manufactured by Fuji Electric Co., Ltd.

Table 2.6.1 Currents drawn by motors operating at continuous rated output

Motor model	Input current (three-phase input) (Arms)	Input current (single-phase input) (Arms)
βM0.2/4000	0.2	0.4
βM0.3/4000	0.4	0.9
βM0.4/4000	0.6	1.1
βM0.5/4000	0.9	1.7
βM1/4000	1.8	3.5
β1/3000	1.3	2.6
β2/3000	2.2	4.3
β3/3000	2.2	4.3
β6/2000	4.0	7.8
α1/5000*i*	2.2	4.3
α2/5000*i*	3.3	6.5
α4/4000*i*	6.2	12.1
α8/3000*i*	7.1	13.8
α12/3000*i*	13.4	19.0 (*1)
α22/3000*i*	17.8	19.0 (*1)
αM2/5000*i*	3.3	10.4
αM3/5000*i*	4.5	8.6
αM8/4000*i*	11.1	19.0 (*1)
αM12/4000*i*	12.0	19.0 (*1)
αC4/3000*i*	4.5	8.6
αC8/2000*i*	5.3	8.6 (*1)
αC12/2000*i*	8.0	8.6 (*1)
αC22/2000*i*	13.4	19.0 (*1)
αC30/1500*i*	18.7	19.0 (*1)

(*1) Depends on the output limit applicable when single-phase input is used.

Example)

Connecting two β6/2000 units operating on three-phase power

Because one β6/2000 unit requires an input current of 4.0 Arms:

$(4.0+4.0) \times 0.6 \fallingdotseq 4.8$ Arms

So, a 10A circuit breaker can be used.

2.6.2 Electromagnetic Contactor Rating

Select an appropriate electromagnetic contactor based on Table 2.6.2. When multiple amplifiers are to be connected to a single electromagnetic contactor (MCC), select an MCC based on the currents on Table 2.4.1.

Table 2.6.2 Recommendation example of electromagnetic contactor

Manufactured by Fuji Electric Co., Ltd.	Rated current
SC-03	11Apeak
SC-4-1	18Apeak
SC-1N	26Apeak

2.6.3 AC Line Filter

When multiple amplifiers are connected to a single AC line filter, select a line filter based on the sum of the currents on Table 2.6.3.
An AC line filter or an EMC noise filter must be used to suppress the influence of high-frequency noise on the power supply unit.
The EMC noise filters of the LF series are available from Tokin Corporation.

Table 2.6.3 AC line filter specifications

AC line filter	Continuous rated current	Continuous rated power	Heat dissipation
Type A:A81L-0001-0083#3C	24A	5.4kW or less	20W
Type B:A81L-0001-0101#C	44A	10.5kW or less	70W
Type C:A81L-0001-0102	100A	23.0kW or less	50W

2.7 CONNECTOR

Specification : A06B-6093-K311

Connector name	Part number	Manufacturer	Use	Quantity	Remarks
CX21	1-179958-4 (housing)	AMP Japan, Ltd.	For input power line (200 VAC input)	1	Crimp type
	316041-2 (contact)			4	

Specification : A06B-6093-K312

Connector name	Part number	Manufacturer	Use	Quantity	Remarks
CX22	1-917807-2 (housing)	AMP Japan, Ltd.	For motor power line	1	Crimp type
	316040-2 (contact)			4	

Specification : A06B-6093-K313

Connector name	Part number	Manufacturer	Use	Quantity	Remarks
CX22	1-917807-2 (housing)	AMP Japan, Ltd.	For motor power line	1	Crimp type
	316041-2 (contact)			4	

Specification : A06B-6093-K315

Connector name	Part number	Manufacturer	Use	Quantity	Remarks
CX20	2-178288-3 (housing)	AMP Japan, Ltd.	For separate regenerative discharge resistor (for OH alarm)	1	Crimp type
	1-175218-5 (contact)			2	
CX23	2-917807-2 (housing)	AMP Japan, Ltd.	For separate regenerative discharge resistor (for resistor)	1	Crimp type
	316041-2 (contact)			2	

Specification : A06B-6093-K316

Connector name	Part number	Manufacturer	Use	Quantity	Remarks
CX19A	1-178288-3 (housing)	AMP Japan, Ltd.	For control unit 24VDC (IN)	1	Crimp type
	1-175217-5 (contact)			2	
CX19B	1-178288-3 (housing)	AMP Japan, Ltd.	For control unit 24VDC (OUT)	1	Crimp type
	1-175217-5 (contact)			2	

Specification : A06B-6093-K317

Connector name	Part number	Manufacturer	Use	Quantity	Remarks
CX19A	1-178288-3 (housing)	AMP Japan, Ltd.	For control unit 24VDC (IN)	1	Crimp type
	1-175218-5 (contact)			2	
CX19B	1-178288-3 (housing)	AMP Japan, Ltd.	For control unit 24VDC (OUT)	1	Crimp type
	1-175218-5 (contact)			2	

3 SPECIFICATIONS

3.1 SPECIFICATIONS

Table 3.1 (a) Specifications (common)

Item		Specifications
Power supply	Three-phase input power supply for motor power	Voltage: 200 VAC to 240 VAC Allowable voltage fluctuation: +10%, -15% (Note) Frequency: 50 Hz, 60 Hz Allowable frequency fluctuation: ±2 Hz Voltage fluctuation during acceleration/deceleration: 7% or less
	Single-phase power supply for motor power (Note)	Voltage: 220 VAC to 240 VAC Allowable voltage fluctuation: +10%, -15% (Note) Frequency: 50 Hz, 60 Hz Allowable frequency fluctuation: ±2 Hz Voltage fluctuation during acceleration/deceleration: 7% or less
	Single-phase input power supply for control power	Voltage: 24 VDC Allowable voltage fluctuation: ±10%
Main circuit control system		Sinusoidal PWM control based on transistor (IGBT) bridge
Alarm protection function		Converter: main circuit overload alarm Converter: control power supply undervoltage alarm Converter: DC link undervoltage alarm Inverter: Abnormal current alarm Converter: DC link undervoltage alarm Converter: excessive deceleration power alarm Converter: cooling fan stopped alarm FSSB disconnection alarm

Table 3.1 (b) Specifications (individual)

Name		Specification	Rated output current (RMS value)	Nominal current limiting (peak value)
SVU-4	FSSB interface	A06B-6093-H119	0.9 Arms	4 Apeak
	I/O Link interface	A06B-6093-H159		
SVU-12	FSSB interface	A06B-6093-H111	3.2 Arms	12 Apeak
	I/O Link interface	A06B-6093-H151		
	PWM interface	A06B-6093-H101		
SVU-20	FSSB interface	A06B-6093-H112	5.9 Arms	20 Apeak
	I/O Link interface	A06B-6093-H152		
	PWM interface	A06B-6093-H102		
SVU-40	FSSB interface	A06B-6093-H113	12 Arms	40 Apeak
	I/O Link interface	A06B-6093-H153		
	PWM interface	A06B-6093-H103		
SVU-80	FSSB interface	A06B-6093-H114	18.9 Arms	80 Apeak
	I/O Link interface	A06B-6093-H154		
	PWM interface	A06B-6093-H104		

NOTE

The allowable voltage fluctuation is a change observed for several minutes. It is not a continuous change.
The rated output is guaranteed provided the rated input voltage is applied. If the input voltage fluctuates, however, the rated output may not be obtained even if the fluctuation falls within the allowable fluctuation range.

3.2 DERATING

Motor current derating or output derating is required, depending on the motor used.

3.2.1 For SVU-20

Output derating is required to drive β6/2000, α2/5000*i*, αM2/5000*i*, αM3/5000*i*, αC4/3000*i*, αC8/2000*i*, and αC12/2000*i* with single-phase input.

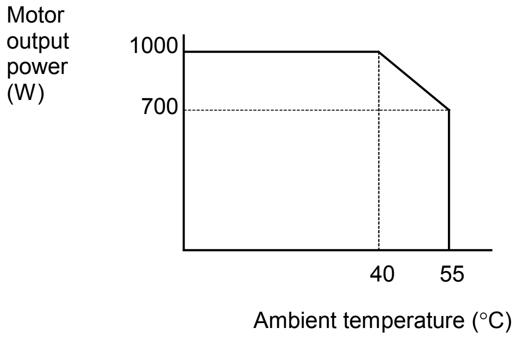


Fig. 3.2.1 Single-phase input time

3.2.2 For SVU-40 and SVU-80

Table 3.2.2(a) Three-phase input time

Motor specifications				Specifications of β series amplifiers SVU-40 and SVU-80		
Motor	**Peak current (Ap)**	**Rated current (Arms)**	**Rated output (kW)**	**Peak current (Ap)**	**Natural air cooling**	**Forced air cooling**
α4/4000*i*	40	7.7	1.4	40	A	A
α8/3000*i*		8.4	1.6		Not usable.	A
αM8/4000*i*		11.1	2.5		Not usable.	A
αC22/2000*i*		12.3	3.0		Not usable.	A
αM8/4000*i*	80	11.1	2.0	80	Not usable.	A
αM12/4000*i*		13.4	2.7		Not usable.	A
α12/3000*i*		18.1	3.0		Not usable.	B (15Arms at 55°C)
α22/3000*i*		18.4	4.0		Not usable.	B (15Arms at 55°C)
αC30/1500*i*		14.2	4.2		Not usable.	A

A : Usable without circuit derating at an ambient temperature of up to 55°C for the amplifier.

B : Requires the current derating shown in the following figure.
Motor output current derating curve

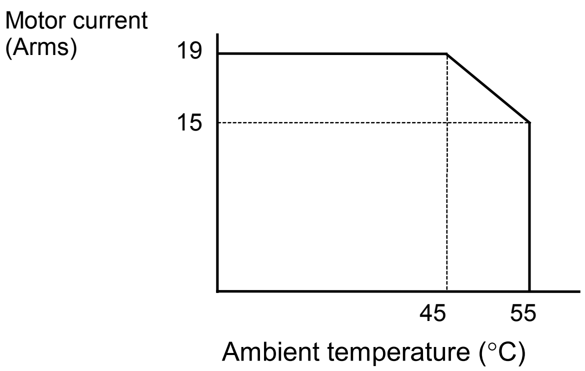
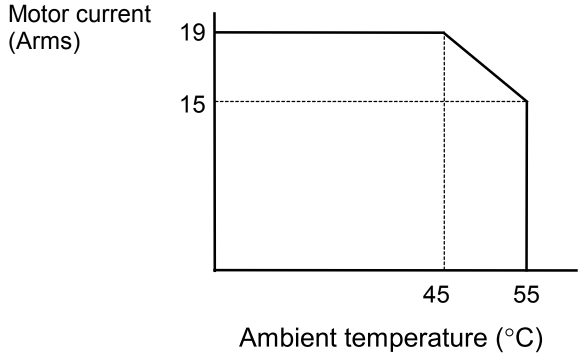


Table 3.2.2(b) Single-phase input time

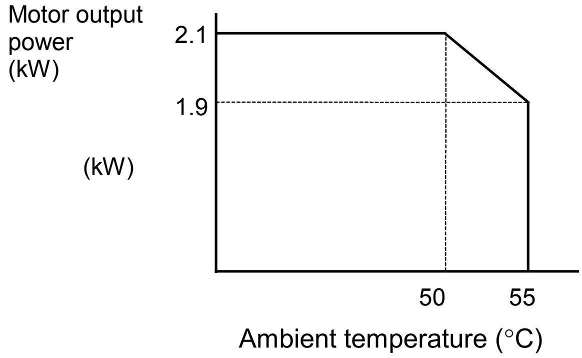
Motor specifications				Specifications of β series amplifiers SVU-40 and SVU-80		
Motor	**Peak current (Ap)**	**Rated current (Arms)**	**Rated output (kW)**	**Peak current (Ap)**	**Natural air cooling**	**Forced air cooling**
α4/4000*i*	40	7.7	1.4	40	A	A
α8/3000*i*		8.4	1.6		Not usable.	A
αM8/4000*i*		11.1	2.5		Not usable.	C (1.9kW at 55°C)
αM8/4000*i*	80	11.1	2.0	80	Not usable.	C (1.9kW at 55°C)
αM12/4000*i*		13.4	2.7		Not usable.	C (1.9kW at 55°C)

A : Usable without circuit derating at an ambient temperature of up to 55°C for the amplifier.
C : Requires the current derating shown in the following figure.

The α12/3000*i*, α22/3000*i*, αC22/2000*i*, and αC30/1500*i* motors cannot be used with the single phase.



Derating curve of motor output current



Derating curve of motor output

3.3 PROTECTION AND ABNORMALITY DETECTION FUNCTIONS

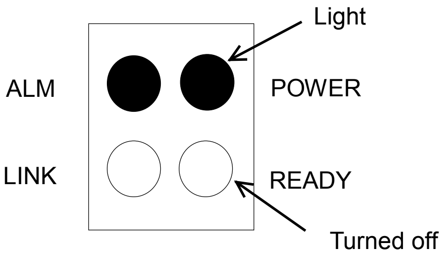
The servo amplifier is provided with the protection and abnormality detection functions indicated below.
Determine any alarm status from the diagnostic data displayed by the controller.

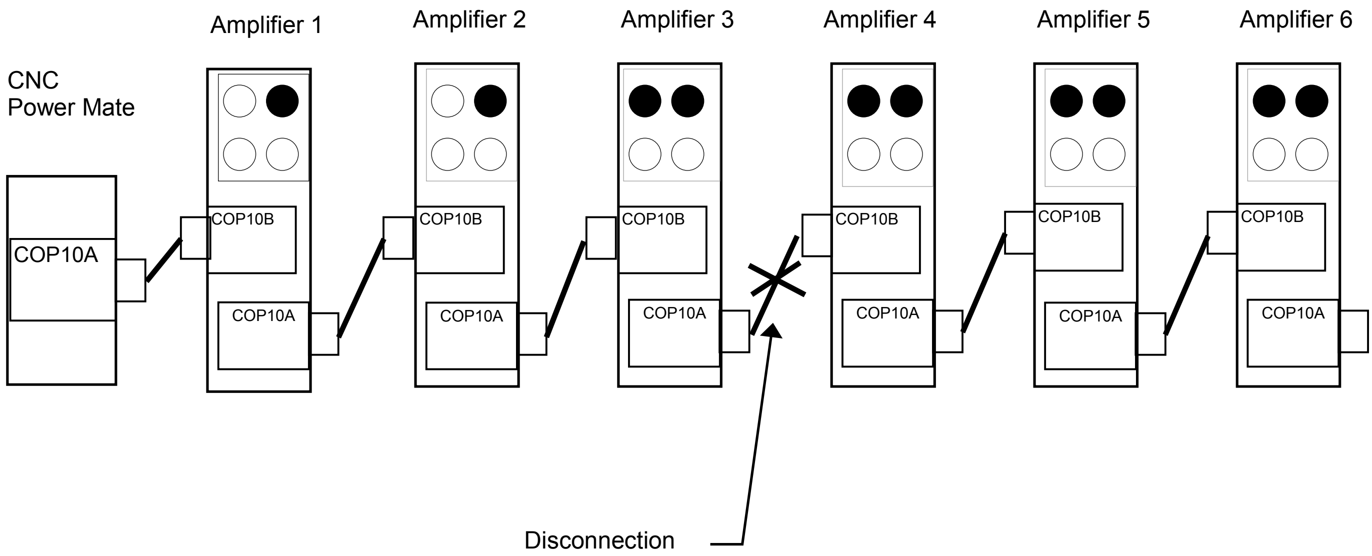
- Converter: main circuit overload
- Converter: control power supply undervoltage alarm
- Converter: DC link undervoltage alarm
- Inverter: Abnormal current alarm
- Converter: DC link undervoltage alarm
- Converter: excessive deceleration power alarm
- Converter: cooling fan stopped alarm
- FSSB disconnection alarm

When an alarm is issued, the LED "ALM" is turned on with the FSSB interface and PWM interface, and a 7-segment indicator is turned on with the I/O Link interface. For details of the 7-segment interface, refer to "FANUC SERVO MOTOR β series I/O Link Option Maintenance Manual".

FSSB interface	PWM interface	State	Description
● Light ALM ● ● POWER LINK ● ○ READY	● Light ● POWER ○ READY ● ALM	Alarm	Check the details of the alarm with diagnostic data on the controller.

When an FSSB disconnection alarm is issued, the faulty location can be identified using the check method described below.
When an FSSB disconnection alarm is issued, the "LINK" and "READY" LEDs are turned off, and the "ALM" LED is turned on.



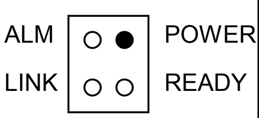
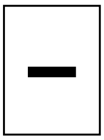
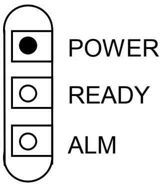
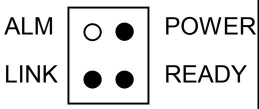
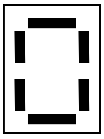
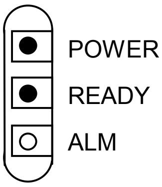


When the optical cable connecting the third β amplifier with the fourth β amplifier, the "ALM" LEDs on the third and subsequent amplifiers are turned on, and the "LINK" LEDs and the "READY" LEDs are turned off.

3.4 NORMAL OPERATING MODE

In normal operating mode, the LEDs located on the front of the servo amplifier light as indicated below.

Table 3.4 Normal Operating Mode

FSSB interface	I/O Link interface LED display	PWM interface	State	Description
● Light 		● Light 	Amplifier NOT READY	Indicates that the control power supply voltage (+24 VDC) is applied.
			Amplifier READY	Indicates that the motor has been activated, and that the servo amplifier is ready to accept commands.

4 SEPARATED REGENERATIVE DISCHARGE UNIT

4.1 FOR SVU-4, SVU-12, AND SVU-20

4.1.1 Cases Where a Separated Regenerative Discharge Unit Is Not Required

When the amount of regenerative energy produced [J] never exceeds the amounts indicated in Table 4.1, a separated regenerative discharge unit is not required.
For an external connection to be made when a regenerative discharge unit is not used, see Part V, "CONNECTION", of this manual.
An incorrect connection can damage the amplifier. Care must be taken.

Table 4.1 Maximum allowable regenerative energy for amplifiers

Name	Maximum allowable regenerative energy
SVU-12	13 [J]
SVU-20	16 [J]

Calculating the amount of regenerative energy produced
- For horizontal operation

(a) When the SI unit system is used

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

Jm: Motor rotor inertia [kg·m²]
JL: Load inertia converted to motor shaft inertia [kg·m²]
Vm: Motor speed during rapid traverse [min^{-1}]
ta: Acceleration/deceleration duration during rapid traverse [sec]
TL: Machine tool friction torque (in terms of motor) [N·m]

(b) When the CGS unit system is used

$$P = (5.37\times10^{-4}\cdot(Jm+JL)\cdot Vm^2 - 5.13\times10^{-3}\cdot ta\cdot Vm\cdot TL)\ [J] \quad \text{(Expression1)}$$

Jm: Motor rotor inertia [kgf·cm·sec²]
JL: Load inertia converted to motor shaft inertia [kgf·cm·sec²]
Vm: Motor speed during rapid traverse [min^{-1}]
ta: Acceleration/deceleration duration during rapid traverse [sec]
TL: Machine tool friction torque (in terms of motor) [kg·cm]

- For vertical operation

(a) When the SI unit system is used

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

Th: Upward supporting torque applied by the motor during downward rapid traverse [N·m]
Vm: Motor speed during rapid traverse [min^{-1}]
ta: Acceleration/deceleration duration during rapid traverse [sec]

(b) When the CGS unit system is used

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

Th: Upward supporting torque applied by the motor during downward rapid traverse [kg·cm]
Vm: Motor speed during rapid traverse [min^{-1}]
ta: Acceleration/deceleration duration during rapid traverse [sec]

If the operation is vertical, the regenerative energy per operation is a sum of the values of Expressions 1 and 2.

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

4.1.2 Cases Where a Separated Regenerative Discharge Unit Is Required

When the amount of regenerative energy produced [J] exceeds the amounts indicated in Table 4.1, the DC link overvoltage alarm is issued. To prevent this, a separated regenerative discharge unit is required.

For an external connection to be made when a regenerative discharge unit is not used, see Part V, "CONNECTION", of this manual.

An incorrect connection can damage the amplifier. Care must be taken.

Selecting regenerative discharge unit

First, calculate the regenerative energy.

- Servo motor : For horizontal operation

Amount of regenerative discharge (power [W]) when one acceleration/deceleration operation occurs in every F sec during rapid traverse.

(a) When the SI unit system is used

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

F : Frequency of acceleration/deceleration during rapid traverse [sec/occurrence]
Unless otherwise specified, it is assumed that about one acceleration/deceleration operation occurs in every 5 sec during rapid traverse.

Jm: Motor rotor inertia [kg·m^2]

JL: Load inertia converted to motor shaft inertia [kg·m^2]

Vm: Motor speed during rapid traverse [min^{-1}]

ta: Acceleration/deceleration duration during rapid traverse [sec]

TL: Machine tool friction torque (in terms of motor) [N·m]

(b) When the CGS unit system is used

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

F : Frequency of acceleration/deceleration during rapid traverse [sec/occurrence]
Unless otherwise specified, it is assumed that about one acceleration/deceleration operation occurs in every 5 sec during rapid traverse.

Jm: Motor rotor inertia [kgf·cm·sec^2]

JL: Load inertia converted to motor shaft inertia [kgf·cm·sec^2]

Vm: Motor speed during rapid traverse [min^{-1}]

ta: Acceleration/deceleration duration during rapid traverse [sec]

TL: Machine tool friction torque (in terms of motor) [kg·cm]

- For vertical operation

Amount of regenerative discharge (power [W]) when the duty cycle of downward vertical operation during rapid traverse is D(%)

(a) When the SI unit system is used

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

Th: Upward supporting torque applied by the motor during downward rapid traverse [N·m]

Vm: Motor speed during rapid traverse [min^{-1}]

D : Duty cycle of downward vertical operation during rapid traverse [%]
The maximum value of D is 50%, and D is usually less than 50%.

(b) When the CGS unit system is used

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

Th: Upward supporting torque applied by the motor during downward rapid traverse [kg·cm]

Vm: Motor speed during rapid traverse [min^{-1}]

D : Duty cycle of downward vertical operation during rapid traverse [%]
The maximum value of D is 50%, and D is usually less than 50%.

If the operation is vertical, the regenerative energy per operation is a sum of the values of Expressions 4 and 5.

R’ = P’ + Q’ [W] (Expression 6)

From Table 4.2, select a separated regenerative discharge unit having a regenerative discharge rating greater than the value determined in (1).

Table 4.2 Regenerative discharge ratings of separated regenerative discharge unit

Separated regenerative discharge unit	Regenerative discharge rating	Condition
A06B-6093-H401(30Ω)	20W	Air flow = 0m/sec
(Caution) A06B-6093-H402(30Ω)	100W	

> ⚠ **CAUTION**
> Use a regenerative resistance cable not longer than 1 m. If a cable longer than 1 m is used, the regenerative circuit in the amplifier can malfunction, or the amplifier can be damaged.

> **NOTE**
> If a separated regenerative discharge unit is used at a value exceeding the allowable limit, an overheat can occur and activate the built-in thermostat, resulting in an overheat alarm.

4.1.3 For SVU-40 and SVU-80

If the amount of regenerative discharge from a servo motor is so large that it exceeds the regenerative discharge capacity of the regenerative discharge resistor built into the servo amplifier, a separated regenerative discharge unit needs to be used.
When the amount of motor regenerative discharge (R) calculated in Subsection 4.1.2 exceeds the value indicated in Table 4.1.3(a) "Regenerative discharge capacity of the regenerative discharge unit built into a servo amplifier", use a separated regenerative discharge unit.

Table 4.1.3(a) Regenerative discharge capacity of the regenerative discharge unit built into a servo amplifier

Servo amplifier	Capacity
A06B-6093-H103	70W
A06B-6093-H113	
A06B-6093-H153	
A06B-6093-H104	
A06B-6093-H114	
A06B-6093-H154	

NOTE

The capacity is fixed at 70 W, regardless of whether natural air cooling or forced air cooling is used. The user should assume a severer use condition to ensure that the amount of regenerative discharge is less than 70 W.
If 70 W is exceeded, the long-term reliability can degrade.

The separated regenerative discharge units indicated below are available.
Specify a separated regenerative discharge unit to ensure that the amount of regenerative discharge is less than the discharge capacity.

Table 4.1.3(b) Regenerative discharge capacity of a separated regenerative discharge unit for a servo amplifier

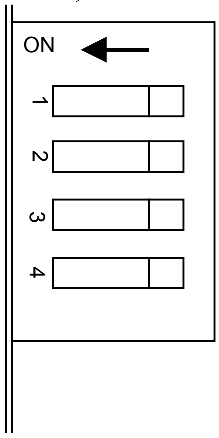
Separated regenerative discharge unit	Wind speed 0 m/sec	Wind speed 2 m/sec	Wind speed 4 m/sec
A06B-6089-H500	R=200W	R=400W	R= 600W
A06B-6089-H713	With a built-in fan motor for forced air cooling		R= 800W
A06B-6089-H714	With a built-in fan motor for forced air cooling		R=1200W

Switch setting (for SVU-40, SVU-80)

With SVU-40 and SVU-80, four switches are provided on the front of the servo amplifier. Be sure to set the switches to match the resistor used.

<u>If the switches are set incorrectly, the regenerative resistor can be damaged.</u>

From top to bottom, switch 1, switch 2, switch 3, and switch 4 are installed in this order. Each switch is turned on when the lever is at the left, and is turned off when the lever is at the right.



(1) Setting of switch 1 and switch 2
The switches need to be set according to the regenerative discharge resistor used.
⇒ If the switches are not set correctly, the regenerative overheat alarm is not detected correctly.

Switch 1	Switch 2	Regenerative discharge resistor
ON	ON	Built-in
ON	OFF	Separate : A06B-6089-H500
OFF	OFF	Separate : A06B-6089-H713, A06B-6089-H714

(2) Setting of switch 3 and switch 4
Switch 3 and switch 4 are not used. Set these switches off.

4.1.4 Notes on Regenerative Discharge Unit Installation

> ⚠ **WARNING**
> 1 A regenerative discharge resistor may be heated to a temperature from 100°C to 200°C. Be careful not to touch the regenerative discharge resistor.
> 2 If a regenerative resistor needs to be touched for a purpose such as maintenance, turn off all the power to the amplifier, wait 30 minutes or more, and check that DC link charge indicator LED (CAUTION CHARGE) is turned off and that the regenerative resistor is sufficiently cooled.
> 3 Install a regenerative resistor sufficiently away from a combustible material.

(1) Drawing numbers

Drawing number of regenerative discharge unit	Resistance value	Capacity			Remark
		Wind speed			
		0m/sec	2m/sec	4m/sec	
A06B-6093-H401	30Ω	20W	-	-	For 12/20A
A06B-6093-H402	30Ω	100W	-	-	For 12/20A
A06B-6089-H500	16Ω	200W	400W	600W	For 40/80A
A06B-6089-H713	16Ω	With cooling fan motor		800W	For 40/80A
A06B-6089-H714	16Ω	With cooling fan motor		1200W	For 40/80A

(2) Installation condition

<1> Cautions on installation

A06B-6093-H401	Install a regenerative discharge unit in a completely closed cabinet.
A06B-6093-H402	
A06B-6089-H500	Install the pin side in a completely closed cabinet, and install the resistor side (heat dissipation portion) in an exhaust duct. (a) Use the delivered packings. (b) Ensure that the pin side and resistor side (heat dissipation portion) are not exposed to coolant, oil mist, cuttings, and so forth. (c) To introduce the open air for the resistor (heat dissipation portion), use an air filter at the inlet. Ensure that the cable inlet and outlet, door, and so forth are sealed.
A06B-6089-H713	
A06B-6089-H714	

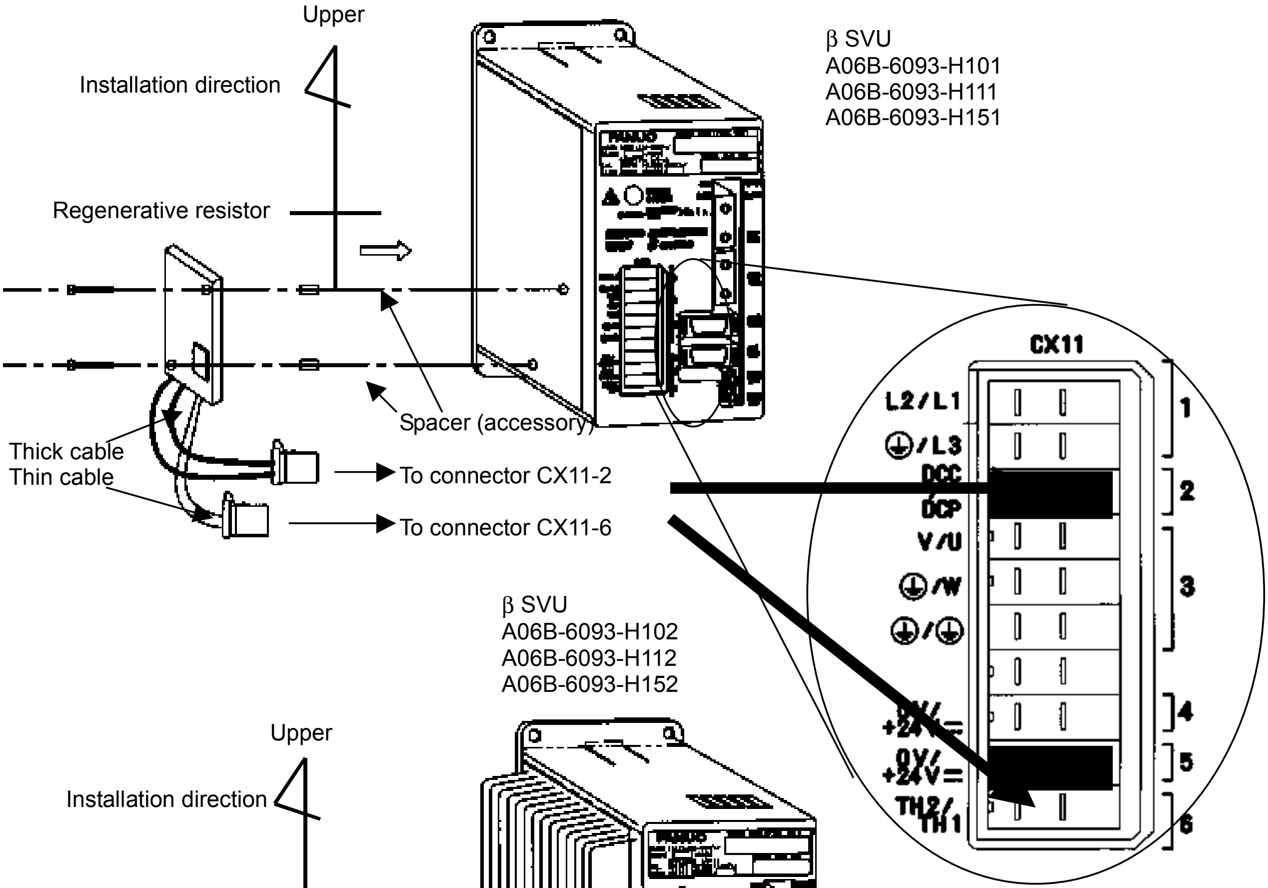
<2> Ambient Temperature
0 to 55 °C (operating)
-20 to 60 °C (storage and transportation)

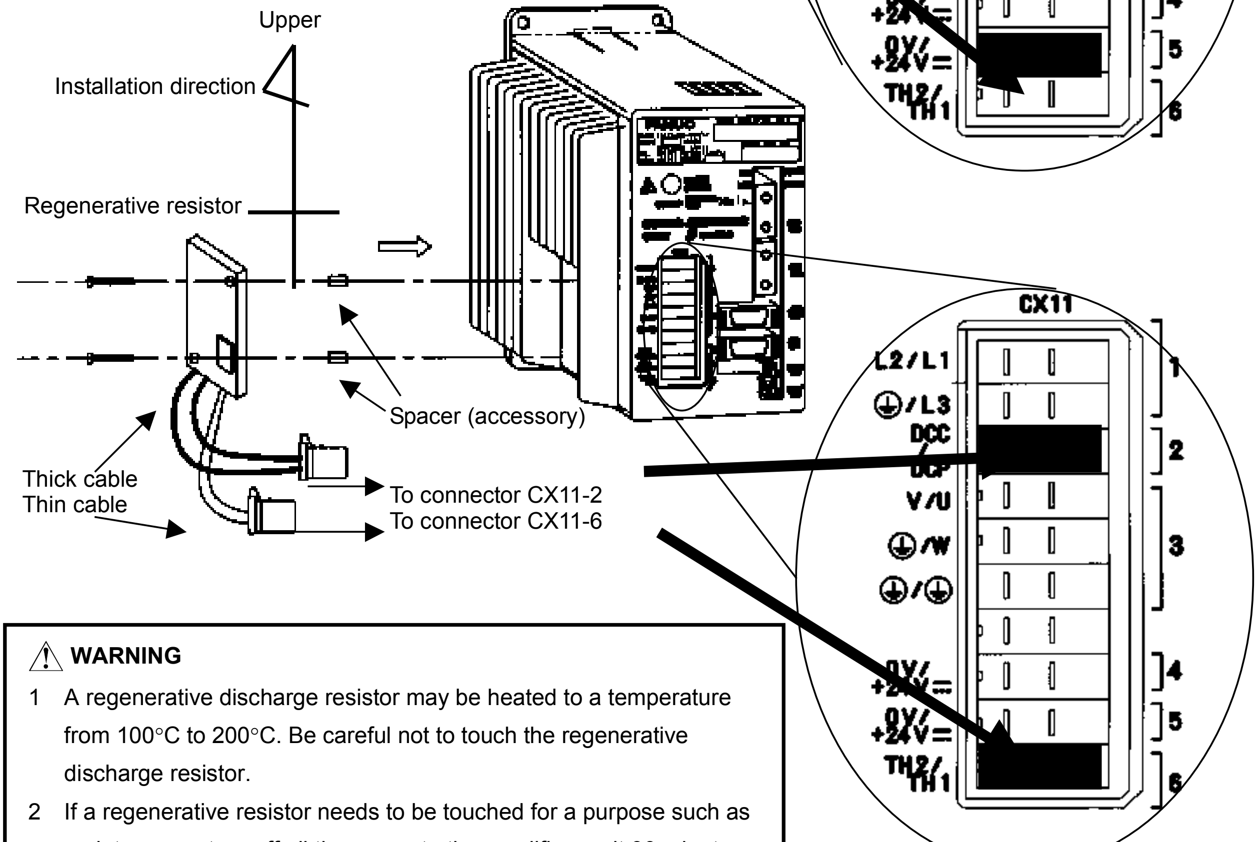
<3> Humidity
Usually, 95% RH or lower (no condensation)

<4> Vibration
No more than 0.5G during operation

<5> Installation direction
Install a regenerative discharge unit correctly according to the installation drawings that follow.

A06B-6093-H401

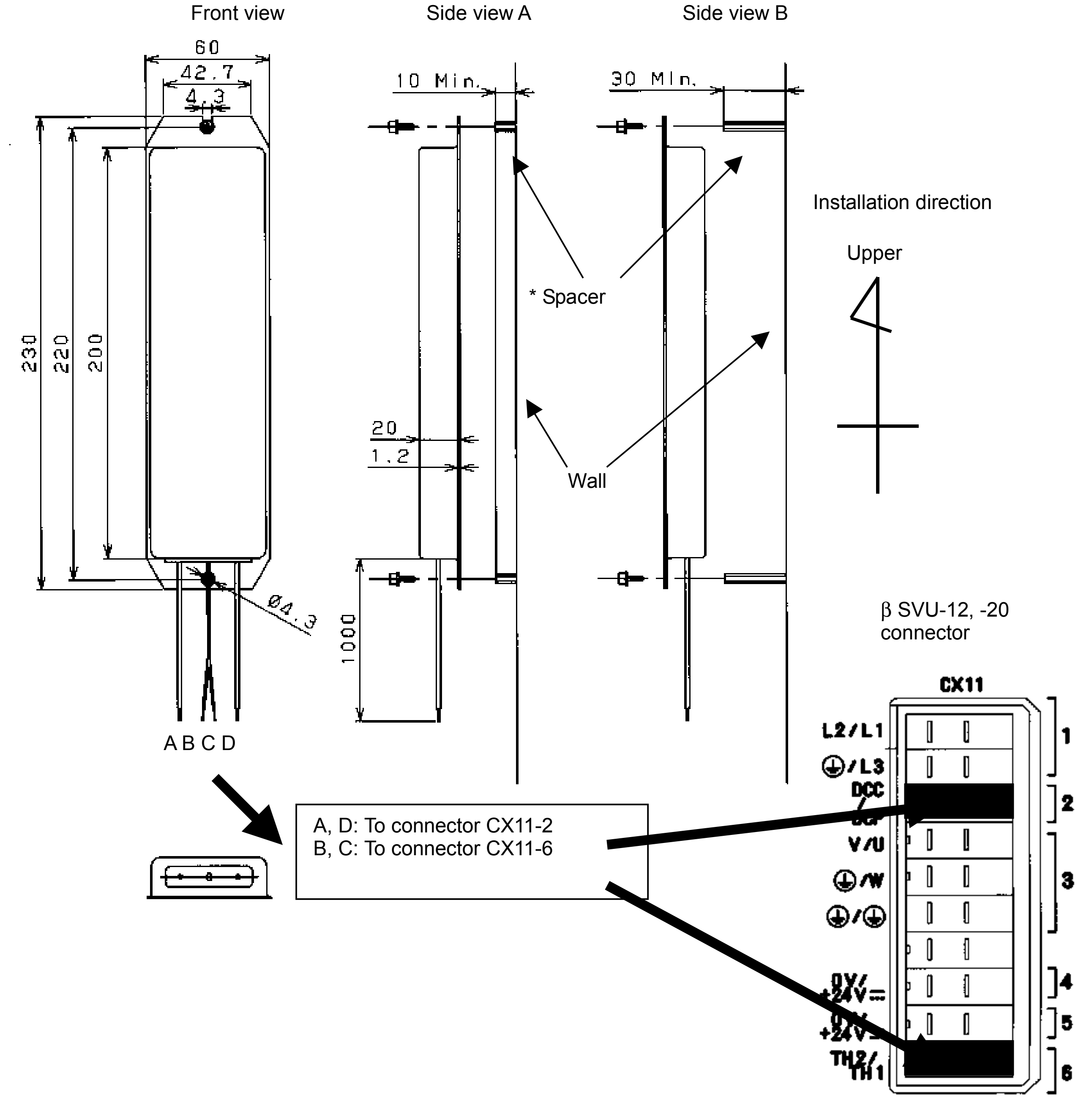




⚠ WARNING

1. A regenerative discharge resistor may be heated to a temperature from 100°C to 200°C. Be careful not to touch the regenerative discharge resistor.
2. If a regenerative resistor needs to be touched for a purpose such as maintenance, turn off all the power to the amplifier, wait 30 minutes or more, and check that DC link charge indicator LED (CAUTION CHARGE) is turned off and that the regenerative resistor is sufficiently cooled.

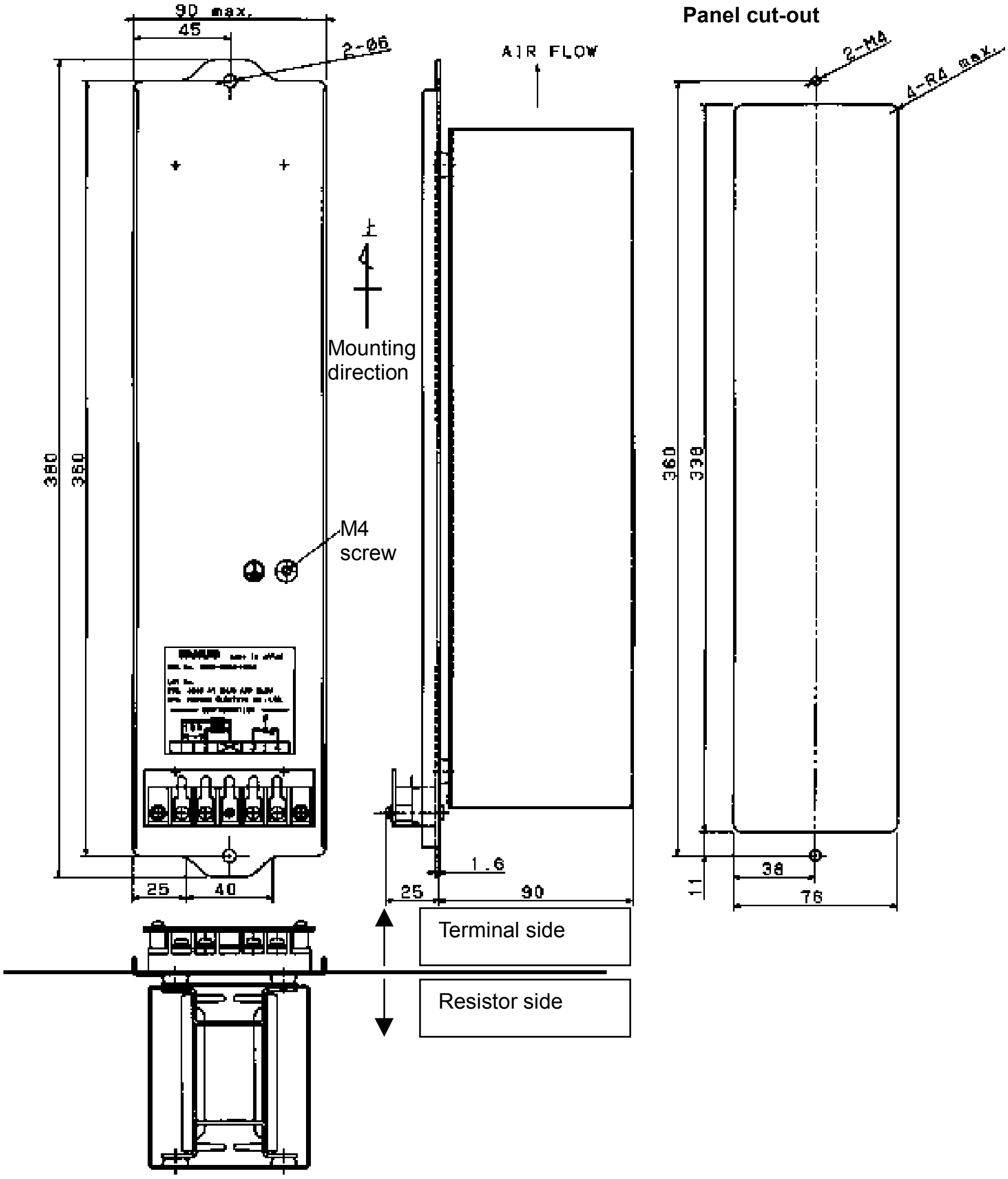
A06B-6093-H402



⚠ **WARNING**

1. A regenerative discharge resistor may be heated to a temperature from 100°C to 200°C. Be careful not to touch the regenerative discharge resistor.
2. If a regenerative resistor needs to be touched for a purpose such as maintenance, turn off all the power to the amplifier, wait 30 minutes or more, and check that DC link charge indicator LED (CAUTION CHARGE) is turned off and that the regenerative resistor is sufficiently cooled.
3. Install a regenerative resistor sufficiently away from a combustible material.
4. Provide a space of 10 mm or more between a regenerative resistor and the wall.

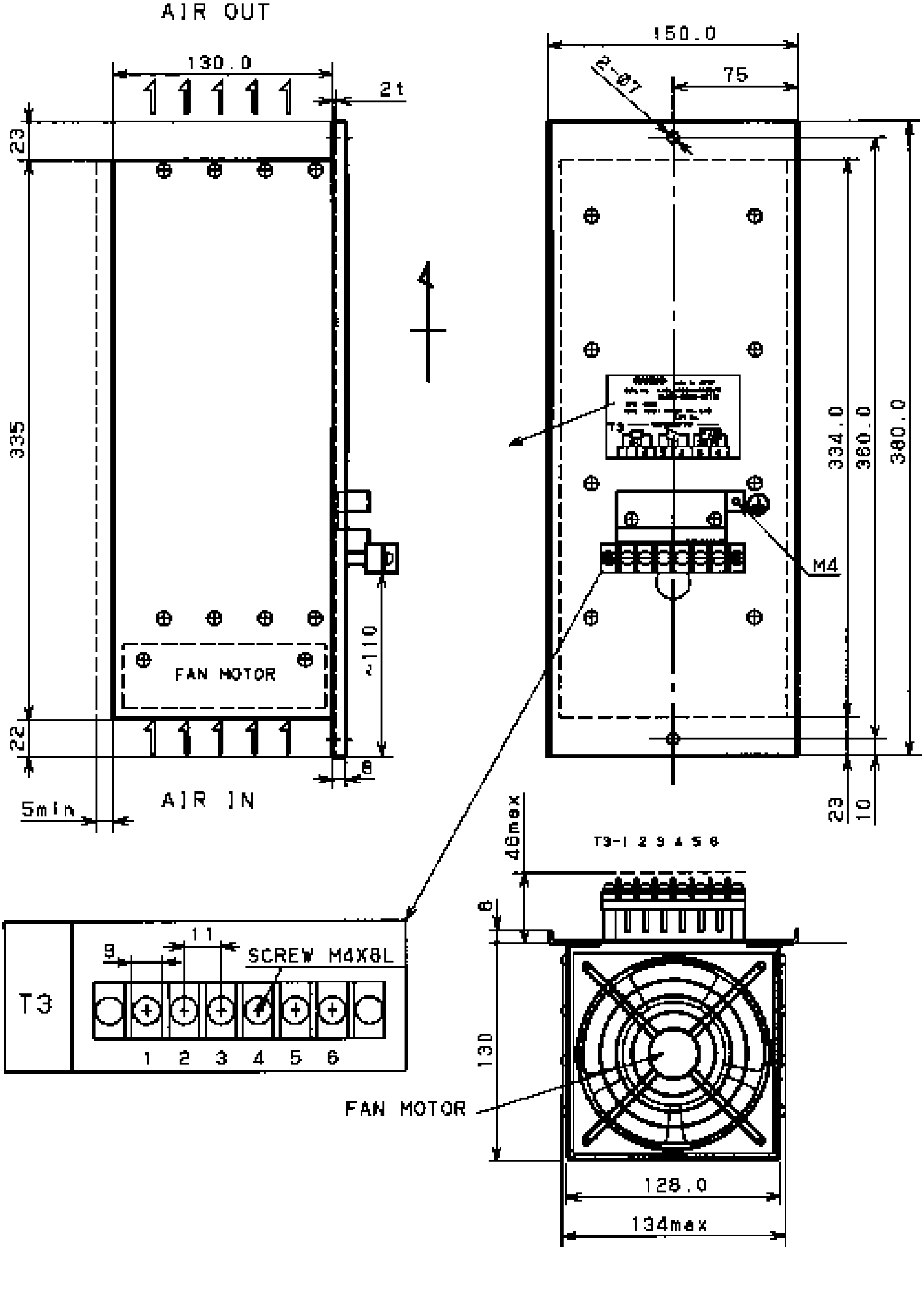
A06B-6089-H500



> ⚠ **WARNING**
> 1 A regenerative discharge resistor may be heated to a temperature from 100°C to 200°C. Be careful not to touch the regenerative discharge resistor.
> 2 If a regenerative resistor needs to be touched for a purpose such as maintenance, turn off all the power to the amplifier, wait 30 minutes or more, and check that DC link charge indicator LED (CAUTION CHARGE) is turned off and that the regenerative resistor is sufficiently cooled.
> 3 Install a regenerative resistor sufficiently away from a combustible material.

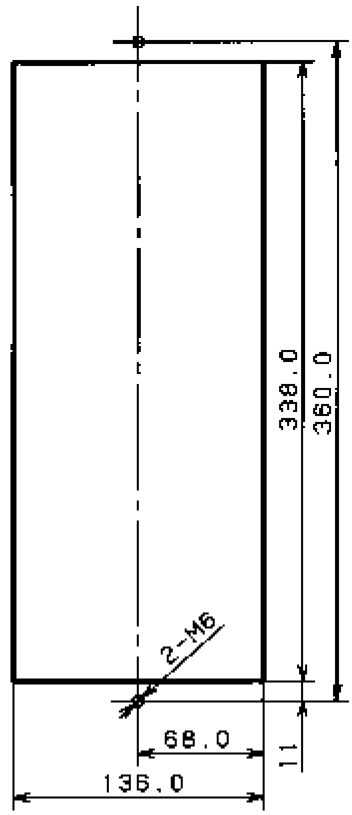
> **NOTE**
> For oil and dust protection, use the delivered packings.

A06B-6089-H713 to -H714



A06B-6089-H713 to -H714

Panel cut-out



> ⚠ **WARNING**
> 1 A regenerative discharge resistor may be heated to a temperature from 100°C to 200°C. Be careful not to touch the regenerative discharge resistor.
> 2 If a regenerative resistor needs to be touched for a purpose such as maintenance, turn off all the power to the amplifier, wait 30 minutes or more, and check that DC link charge indicator LED (CAUTION CHARGE) is turned off and that the regenerative resistor is sufficiently cooled.
> 3 Install a regenerative resistor sufficiently away from a combustible material.

> **NOTE**
> For oil and dust protection, use the delivered packings.

5 POWER SUPPLY

5.1 INPUT POWER SUPPLY

5.1.1 Three-phase Input Power Supply for Motor Power

- Nominal rated voltage: 200 to 240 VAC
- Allowable voltage fluctuation: -15% to +10%
- Frequency: 50/60 Hz
- Allowable frequency fluctuation: ±2 Hz
- Power supply impedance: Voltage fluctuation cased by load (at maximum output) not to exceed 7%
- Power supply unbalance: Within ±5% of the rated voltage

NOTE
The allowable voltage fluctuation is a change observed for several minutes. It is not a continuous change.

5.1.2 Single-phase Input Power Supply for Motor Power

In European countries, power sources are 380 to 415 VAC and neutral-grounded. To use the β series amplifiers in these European countries, it is necessary to install a power transformer at the input or supply single-phase power.
To use the motors with single-phase power, observe the following:

(1) Power supply specification
- Nominal voltage rating: 220 to 240 VAC
- Allowable voltage fluctuation: -15% to +10%
- Frequency: 50/60 Hz
- Allowable frequency fluctuation: ±2 Hz
- Voltage fluctuation at acceleration/deceleration: 7% or less

NOTE
The allowable voltage fluctuation is a change observed for several minutes. It is not a continuous change.

5.1.3 Single-phase Input for Control Power

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

	Power supply rating per amplifier
FSSB interface	0.6A
I/O Link interface	0.9A
PWM interface	0.4A

5.2 POWER SUPPLY RATINGS

5.2.1 Three-phase Input Power Supply Ratings for Motor Power

(1) The power supply rating necessary when using multiple servo motors can be determined by summing the rating of the power supplies required by the individual motors.

(2) The power supply ratings listed in Table 5.2.1 are sufficient as continuous ratings. Note, however, that servo motor acceleration causes a current that is roughly triple the continuous rating to flow momentarily.

(3) When the power is turned on, a surge current of about 37 A (when 264 VAC is applied) flows the 20 msec.

Table 5.2.1 Three-phase power supply ratings

Motor model	Power supply rating per motor (three-phase power input) (kVA)	Power supply rating per motor (single-phase power input) (kVA)
βM0.2/4000	0.08	0.10
βM0.3/4000	0.15	0.19
β1/3000	0.46	0.57
β2/3000	0.77	0.95
βM0.4/4000	0.20	0.25
βM0.5/4000	0.31	0.38
βM1/4000	0.62	0.76
β3/3000	0.77	0.95
β6/2000	1.4	1.7
α1/5000*i*	0.77	0.95
α2/5000*i*	1.2	1.4
α4/4000*i*	2.2	2.7
α8/3000*i*	2.5	3.0
α12/3000*i*	4.6	4.2 (*1)
α22/3000*i*	6.2	4.2 (*1)
αM2/5000*i*	1.2	2.3
αM3/5000*i*	1.5	1.9
αM8/4000*i*	3.9	4.2 (*1)
αM12/4000*i*	4.2	4.2 (*1)
αC4/3000*i*	1.5	1.9
αC8/2000*i*	1.9	1.9
αC12/2000*i*	2.8	1.9
αC22/2000*i*	4.6	4.2 (*1)
αC30/1500*i*	6.5	4.2 (*1)

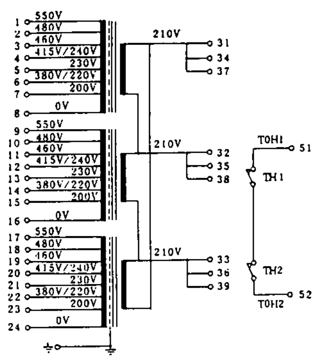
(*1) Depends on the output limit applicable when single-phase input is used.

5.3 POWER TRANSFORMER FOR EXPORTS

Use power transformer for an export when this servo amplifier unit is used at a site where the line voltage is other than 200 to 240 VAC.

5.3.1 Specification

Table 5.3.1 Specification of power transformer

Ordering drawing number	A80L-0022-0005	A80L-0024-0006	A80L-0026-0003	A80L-0028-0001
FANUC drawing number	A80L-0022-0005	A80L-0024-0006	A80L-0026-0003	A80L-0028-0001
Rated capacity	2.2kVA	3.5kVA	5kVA	7.5kVA
Rated primary voltage	200/220/230/240VAC (Δ connection) 380/415/460/480/550VAC (Y connection) ±15%, 50/60Hz±2Hz; 3φ			
Rated secondary voltage	210VAC			
Rated secondary current	6.1A	9.6A	13.7A	20.6A
Voltage regulation at the secondary	2%			
Voltage deviation at the secondary	±3%			
Connection	Δ-Δ connection or Y-Δ connection			
Insulation	Class B (maximum allowable temperature : 130°C)			
Ambient temperature	-20 to 55°C			
Allowable temperature rise	135deg			
Relative humidity	Max. 95%RH			
Type	Dry type, natural air cooling type			
Dielectric withstand voltage	2300VAC, for 1 minute			
Weight	Max. 21kg	Max. 27kg	Max.36kg	Max. 42kg
Outline drawing	Fig. 8.1.3			
Connection diagram				

5.3.2 How to Select a Transformer

Select a transformer according to the load condition and the model of the motor for which the transformer is used. Each transformer has secondary winding taps for three amplifiers so that it can be connected to two or three amplifiers.
For a machine with typical operating conditions, select a transformer according to the following guideline.

$$\underbrace{\text{(Sum of three-phase power requirements}}_{\text{Table 5.2.1}}\text{ of all models)} \times 0.6 \leq \underbrace{\text{transformer rating}}_{\text{Table 5.3.1}}$$

> ⚠ **CAUTION**
> When two or more motors are used, the transformer rating obtained using the above expression may be less than the actual power requirements of any one of those motors. Should this occur, use the motors' maximum power requirements as the transformer rating.
> (Example)
> The power requirements of the α22/3000*i* and α2/5000*i* are indicated in Table 5.2.1, as shown below :
> α22/3000*i* : 6.2 kVA
> α2/5000*i* : 1.2 kVA
> Using the expression given above, the transformer rating is calculated as follows :
> (6.2 + 1.2) × 0.6 = 4.4 kVA
> The power requirement of the α22/3000*i* is 6.2 kVA, this being greater than the calculated transformer rating of 4.4 kVA. So, the transformer rating should be 6.2 kVA.

6 HEAT DISSIPATION

Heat dissipation of β series amplifier is as follows :

Table 6.1 Total heat dissipation of each servo amplifier β series

Ordering number	Interface	Total amount of heat dissipation (W)	Residual amount of heat in the cabinet (W)	
			Without forced air cooling	With forced air cooling
A06B-6093-H119	SVU-4 (FSSB interface)	11	11	-
A06B-6093-H159	SVU-4 (I/O Link interface)	12	12	-
A06B-6093-H111	SVU-12 (FSSB interface)	19	19	-
A06B-6093-H151	SVU-12 (I/O Link interface)	20	20	-
A06B-6093-H101	SVU-12 (PWM interface)	18	18	-
A06B-6093-H112	SVU-20 (FSSB interface)	34	34	-
A06B-6093-H152	SVU-20 (I/O Link interface)	35	35	-
A06B-6093-H102	SVU-20 (PWM interface)	33	33	-
A06B-6093-H113	SVU-40 (FSSB interface)	53	20	15
A06B-6093-H153	SVU-40 (I/O Link interface)	53	20	15
A06B-6093-H103	SVU-40 (PWM interface)	53	20	15
A06B-6093-H114	SVU-80 (FSSB interface)	78	27	17
A06B-6093-H154	SVU-80 (I/O Link interface)	78	27	17
A06B-6093-H104	SVU-80 (PWM interface)	78	27	17

7 INSTALLATION CONDITIONS AND NOTES

7.1 ENVIRONMENTAL CONDITIONS

Install a β setting servo amplifier in a completely closed cabinet so that the environment conditions indicated below can be satisfied.

(1) Ambient Temperature
Ambient temperature
0 to 55°C (operating)
-20 to 60°C (storage and transportation)
Ambient temperature of the accommodation cabinet 0 to 45°C

(2) Humidity
Usually, 95% RH or lower (no condensation)

(3) Vibration
No more than 0.5G during operation

(4) Atmosphere
Ensure that the electronic circuits are not exposed to corrosive and conductive mist and waterdrops. (Note)

(5) Notes on installation
When installing an amplifier, consider the following:
(a) Ensure that the heat sink is not exposed to coolant, oil mist, cuttings, and so forth. Otherwise, the cooling efficiency can degrade, resulting in a failure to satisfy the characteristics of the amplifier. Moreover, the life of semiconductors can be adversely affected.
To introduce the open air for the heat sink, use an air filter at the inlet.
Ensure that the cable inlet and outlet, door, and so forth are sealed.

> **NOTE**
> The electronic circuits must be installed in an environment of contamination level 2 defined in IEC60664-1.
> In order to satisfy contamination level 2 in a severe environment for using machine tools, the servo amplifier β series must be installed in a cabinet that satisfy IP54.

(b) Ensure that dust, coolant, and so forth do not penetrate through the exhaust vent. Moreover, ensure that the flow of cooling wind is not interrupted.
(c) Ensure that the servo amplifier β series can be inspected, removed, and reinstalled easily in maintenance.

7.2 SELECTING A GROUND FAULT INTERRUPTER

To protect against electric shocks, be sure to install a ground fault interrupter at the input section of the machine. The β series servo amplifier drives a motor by means of the transistor-based PWM inverter method, in which a high-frequency leakage current flows to ground through the stray capacitance of the motor widings, power cable and amplifier.
The ground fault interrupter or leakage-protection relay, installed on the power supply side, can malfunction if such a leakage current should flow. So, select an inverter-compatible ground fault interrupter to protect against the occurrence of this malfunction. For the leakage current of each motor, use the values indicated in the table below as a guideline.

Motor model	Commercial frequency component (mA)
βM0.2 to βM1 α1*i* to α8*i* αM2*i* to αM8*i* αC4*i* to αC8*i*	1.8
α12*i* to α22*i* αM12 *i* αC12*i* to αC22*i*	2.0
αC30*i*	2.5

7.3 NOISE PROTECTION

7.3.1 Separation of Signal Lines

If a power cable and signal cable run close to each other, noise can be induced. So, ensure that a power cable is separated from a signal cable. When a power cable and signal line cannot be separated from each other for a reason, minimize the distance by which the two cables run in parallel. When conduits are used, run a power cable through one conduit, and run a signal cable through another conduit.

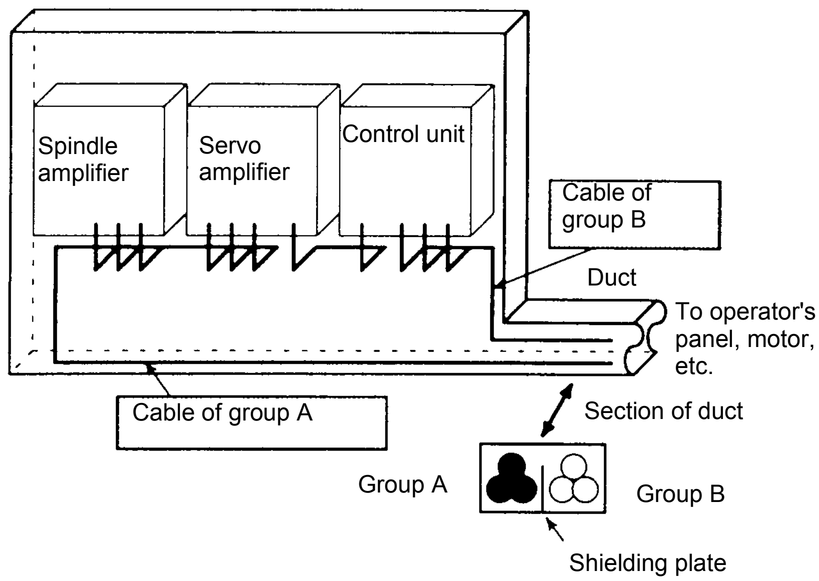
Cable type

Group	Signal	Action
A	Amplifier input power line	Separate these cables from those of group B by bundling them separately (Note 1) or by means of electromagnetic shielding (Note 2).
	Motor power line	
	Magnetic contactor drive coil (Note 3)	
B	Cable connecting the control unit and servo amplifier	Separate these cables from those of group A by bundling them separately (Note 1) or by means of electromagnetic shielding(Note 2). In addition, shielding must be provided.
	Sensor cable	
	Position coder cable	

NOTE

1. The bundle of group A cables must be separated from the bundle of group B cables by at least 10 cm.
2. Electromagnetic shielding involves shielding groups from each other by means of a grounded metal (steel) plate.
3. Attach a noise suppressor such as a spark killer to the magnetic contactor drive coil.

Cabinet


Spindle amplifier
Servo amplifier
Control unit
Cable of group B
Duct
To operator's panel, motor, etc.
Section of duct
Cable of group A
Group A
Group B
Shielding plate

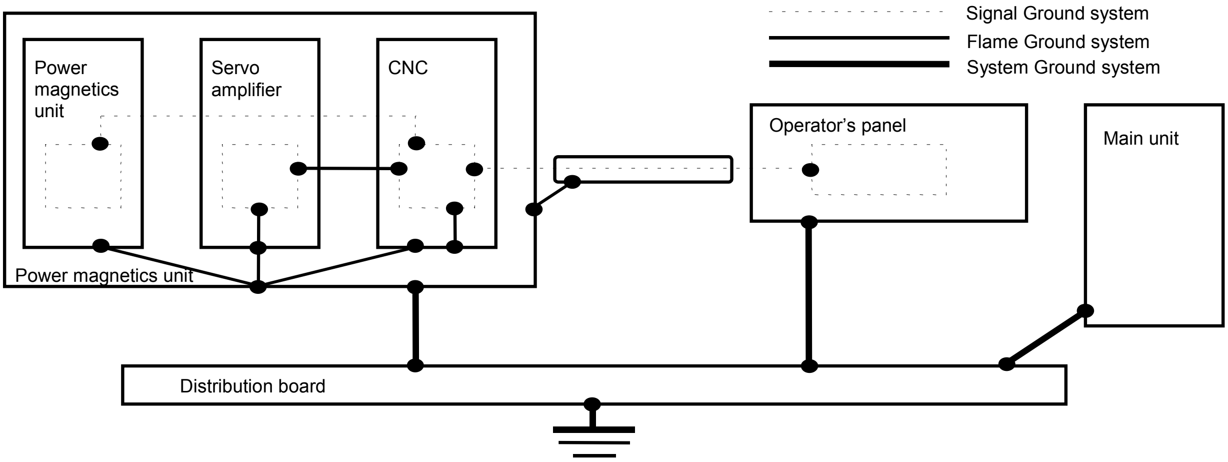
7.3.2 Grounding

A CNC machine tool has three separate ground systems:

(1) Signal ground (SG) system
The signal ground (SG) system provides the reference potential (0V) for the electrical signal system.

(2) Frame ground (FG) system
The frame ground (FG) system is provided to ensure safety and to shield external and internal noise. For example, the equipment frames, unit cases, panels, and interface cables connecting devices are all shielded.

(3) System ground system
The system ground system is designed to connect each unit and the inter-unit frame ground system to ground.



⚠ WARNING

[Warning on ground system wiring]

1 The ground resistance of the system ground must not exceed 100 Ω (class-3 ground).
2 System ground connection cables must have a sufficiently large cross-sectional area to enable them to safely carry the current that will arise in the event of a mishap such as a short-circuit. (In general, a cross-sectional area no less than that of the AC power line must be provided.)
3 The system ground connection cable shall be integrated with the AC power line, such that power cannot be supplied if the ground wire is disconnected.

7.3.3 Noise Suppressor

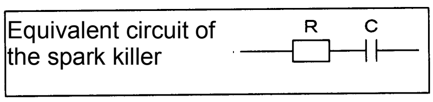
The AC/DC solenoid and relay are used in the power magnetics cabinet.
A high pulse voltage is caused by coil inductance when these devices are turned on or off.
This pulse voltage induced through the cable causes the electronic circuits to be disturbed. In general, to reduce this pulse voltage, a spark killer is used in AC circuits, while a diode is used in DC circuits.

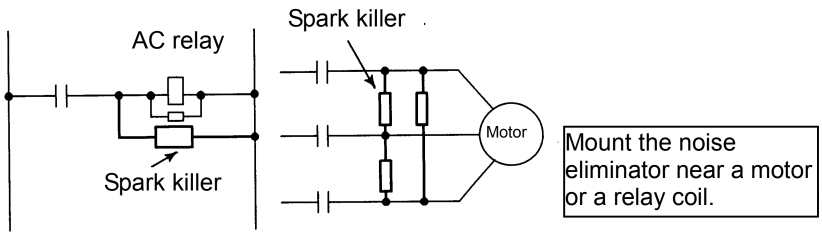
Spark killer

- Use a spark killer consisting of a resistor and capacitor in series. This type of spark killer is called a CR spark killer. (Use it under AC)
  (A varistor is useful in clamping the peak voltage of the pulse voltage, but cannot suppress the sudden rise of the pulse voltage. FANUC therefore recommends a CR spark killer.)

- The reference capacitance and resistance of the spark killer shall conform to the following based on the current (I(A)) and DC resistance of the stationary coil:

  ❑ Resistance (R) : Equivalent DC resistance of the coil
  ❑ Capacitance (C) : $I^2/10$ to $I^2/20$ (μF)
  I : Current at stationary state of the coil (A)

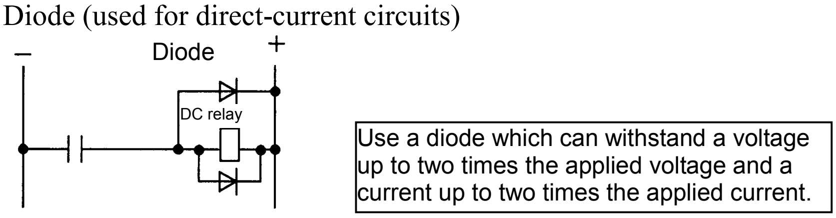




⚠ CAUTION
Use a CR-type noise eliminator. Varistor-type noise eliminators clamp the peak pulse voltage but cannot suppress a sharp rising edge.

Diode

Diode (used for direct-current circuits)



7.3.4 Cable Clamp and Shield Processing

- Shield terminal processing
  Process the terminal of the shield cover of a signal line according to Chapter 10, "DETAILS OF CABLE CONNECTION".
- Shield clamping
  The amplifier cables that require shielding should be clamped by the method shown below. This cable clamp treatment is for both cable support and proper grounding of the shield. To insure stable CNC system operation, follow this cable clamp method.
  Partially peel out the sheath and expose the shield. Push and clamp by the plate metal fittings for clamp at the part.
- Installation of a ground plate
  The user is to prepare a ground plate and install it according to Fig. 5.3.2(b) to (e).

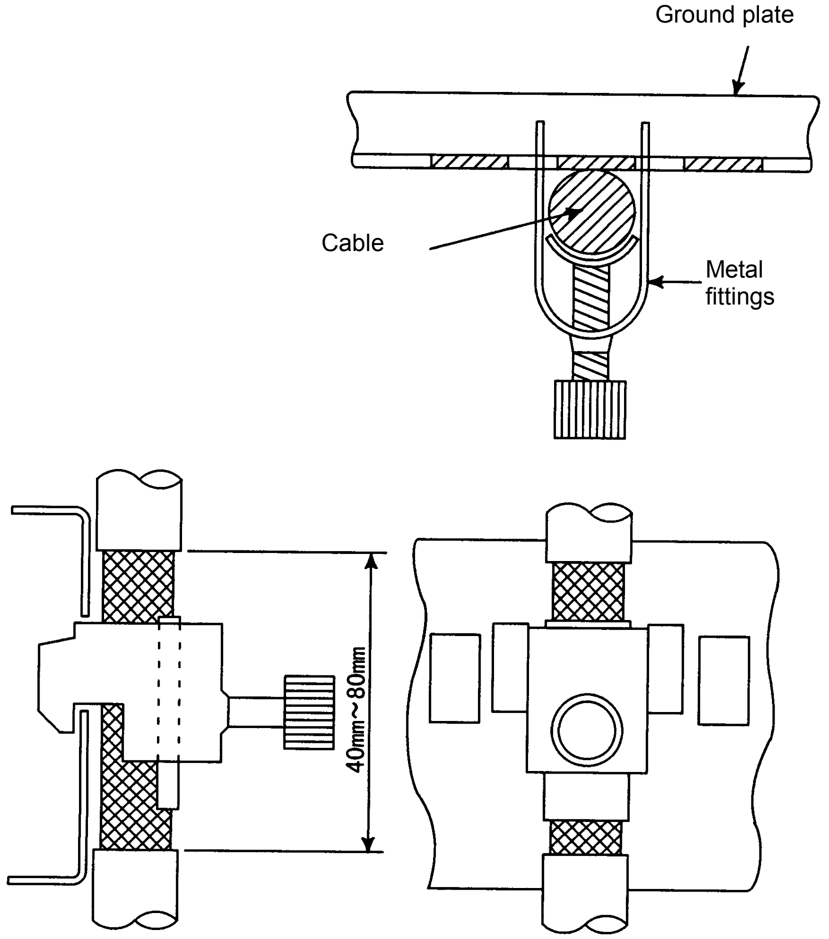


Fig.7.3.4(a) Cable clamp (1)

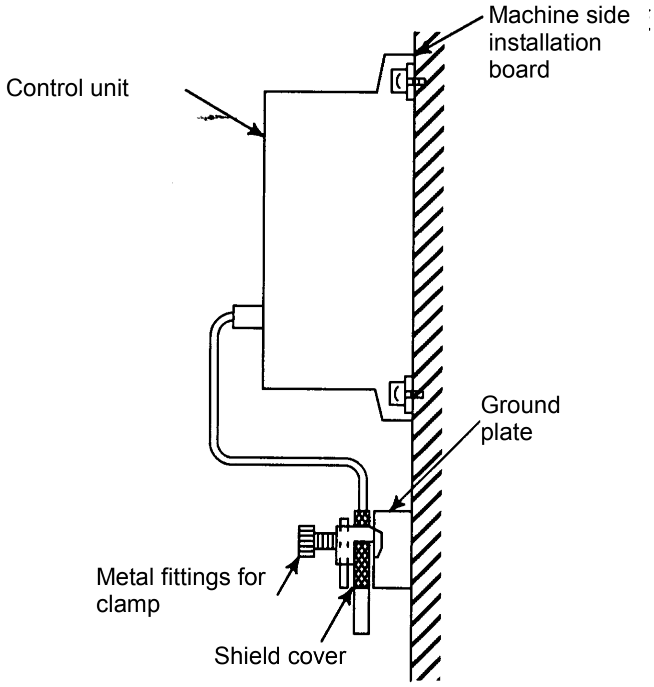


Fig.7.3.4(b) Cable clamp (2)

Prepare ground plate like the following figure.

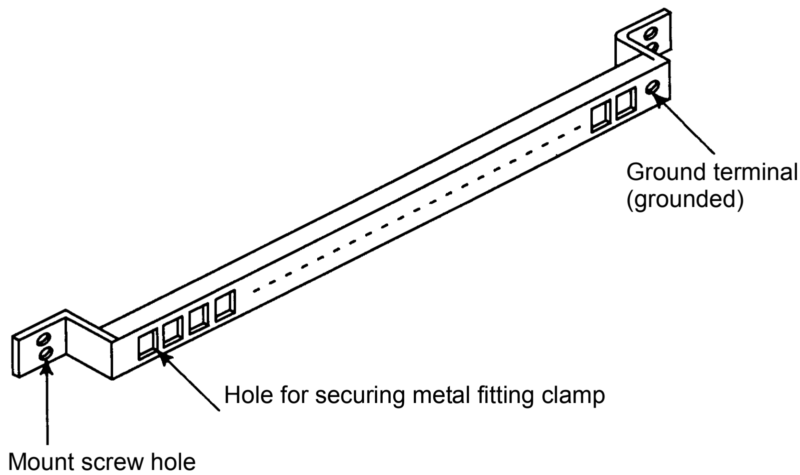


Fig.7.3.4(c) Ground plate

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

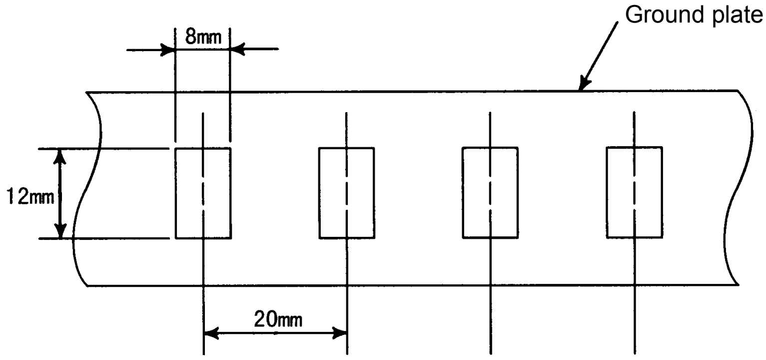


Fig.7.3.4(d) Ground plate holes

(Reference) Outer drawings of metal fittings for clamp.

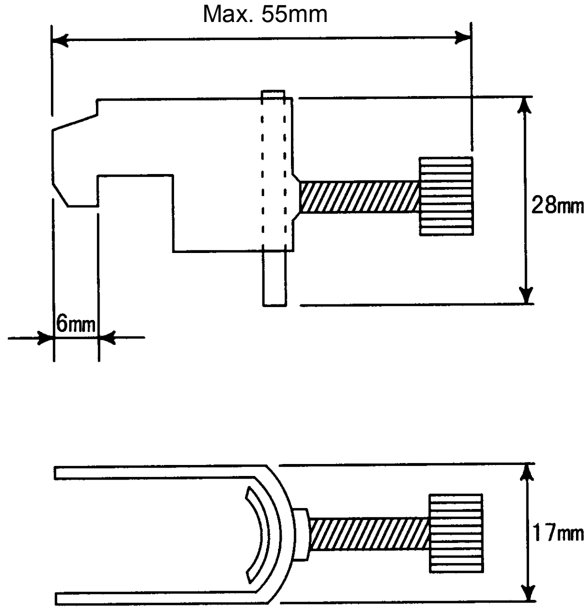


Fig.7.3.4(e) Outer drawings of metal fittings for clamp

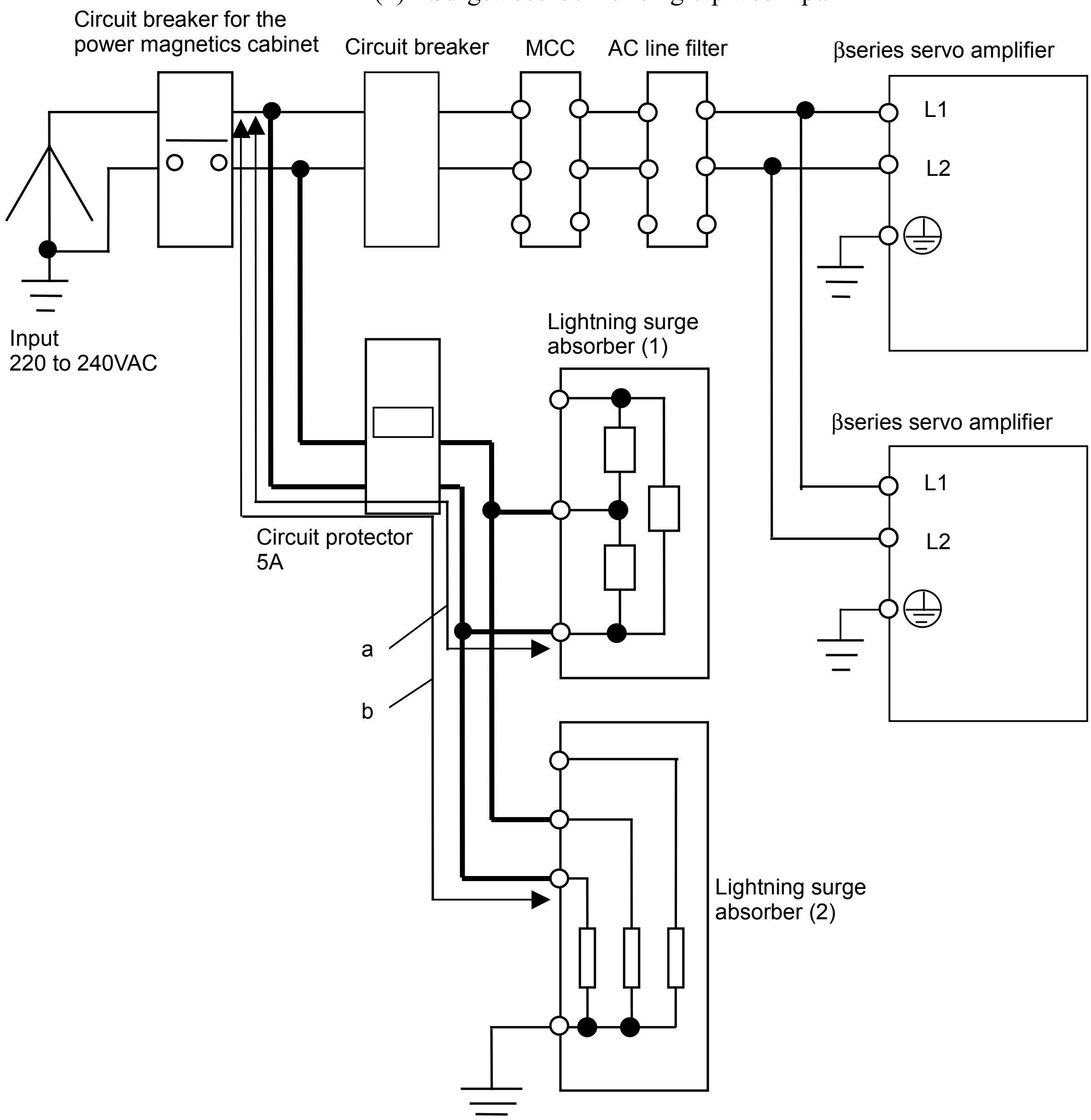
Ordering specification for metal fittings for clamp

A02B-0214-K001 (2 pieces)

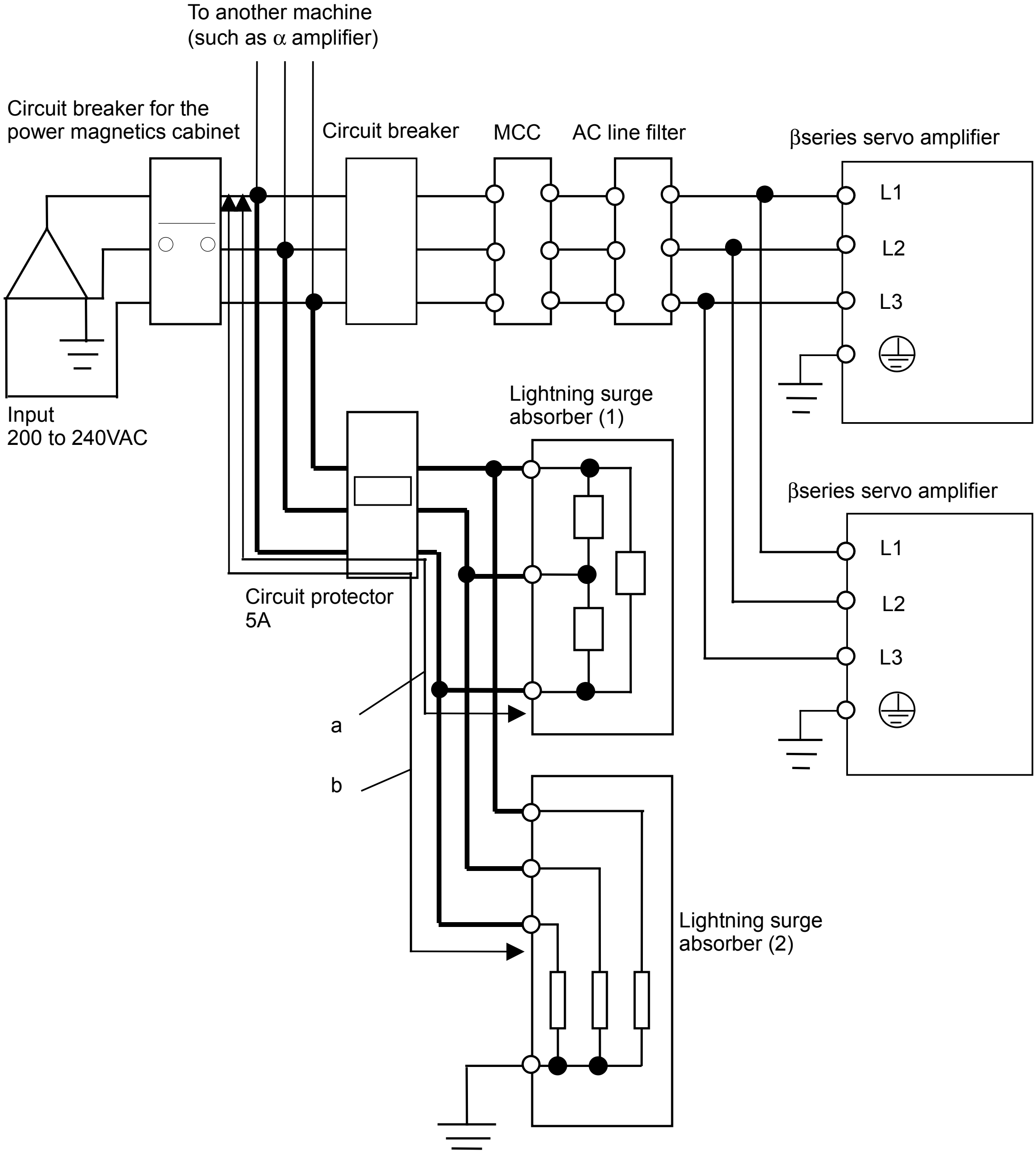
7.4 INSTALLING LIGHTNING SURGE ABSORBERS

At the power input of the power magnetics cabinet, install a surge absorber 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 absorber is shown below.

(1) Surge absorber for single-phase input



(2) Surge absorber for three-phase input



⚠ **WARNING**

1 Make the wires shown with thick line in the above diagram as short as possible in order to increase the effect of the lightning surge absorber.
Wire Cross section : At least $2mm^2$
Length : Keep the total wire length (a+b) to within 2m,where a = length of wire used to connect lightning surge absorber (1) b = length of wire used to connect lightning surge absorber (2)

2 When performing a dielectric strength test by applying an overvoltage (such as 1000 or 1500 VAC) to a power line, remove lightning surge absorber (2) so that it will not operate.

3 The circuit protector (5A) is intended to protect the lines if a lightning surge absorber is damaged due to a surge that is higher than the maximum allowable voltage of the surge absorber.

4 Usually, no current flows through the lightning surge absorbers. So the circuit protector (5A) may be used also for other sections (such as power supply module control power and spindle motor fan power).

The following table lists commercially available lightning surge absorbers.

Table 7.5.1(a) Lightning surge absorbers (not complying with the relevant standards)

Lightning surge absorber	Manufacturer's specification Okaya Electric Industries	Clamp voltage [V]±10%	Maximum allowable surge current 8/20μsec [A]	Maximum allowable surge voltage 1.2/50μsec [V]	Maximum allowable circuit voltage [Vrms]
<1>	R·A·V-781BYZ-2	783	1000	12000	300
<2>	R·A·V-781BXZ-2A	783	1000	12000	300

Table 7.5(b) Lightning surge absorbers (complying with the relevant standards)

Lightning surge absorber	Manufacturer's specification Okaya Electric Industries	Clamp voltage [V]±10%	Maximum allowable surge current 8/20μsec [A]	Maximum allowable surge voltage 1.2/50μsec [V]	Maximum allowable circuit voltage [Vrms]
<1>	R·A·V-781BYZ-2	783	1000	12000	300
<2>	R·A·V-781BXZ-4	783	1000	12000	300

8 CAUTIONS FOR SAFETY STANDARDS RELATED TO AMPLIFIER INSTALLATION

8.1 OVERVIEW

The β series servo amplifiers are designed to the following European safety standard.
DIN VDE 0160 : 1988/A1 : 1989
(Electronics devices to be used in power equipment and their installation in it)

This chapter supplements conditions for installation of the β series servo amplifiers, focusing on safety standard-related topics. If you want to acquire a CE mark for your power magnetics cabinet based on the EC machine commands (based on 89/392/EEC), be sure to satisfy this requirement in designing the power magnetics cabinet.

Remark
To acquire a CE mark for equipment, it is necessary to make the equipment comply with the related EN standard, EN60204-1 (general requirements for electric equipment for industrial machines).

If there is an EN standard (or IEC standard if there is no EN standard) that applies to machine components, the components used in your machine must conform to the standard.
Because there is no EN standard (IEC standard) for amplifiers at present, FANUC is using amplifiers that comply with the VDE standard according to the result of investigation made by TÜV Rheinland, which is a qualified certifying agency.

Therefore, the β series servo amplifiers satisfy the requirements to acquire a CE mark. So you can use them without anxiety.

8.2 STANDARD CATEGORIES RELATED TO INSULATION DESIGN

(1) Insulation between circuits and protective grounding
The amplifiers are designed to the DIN VDE 0160 standard, so they conform to Part 1 of DIN VDE 0110 and related standards.
- The primary side (power source and main circuit side) is separated from the secondary side (control circuit side) for safety with reinforced insulation.
- The circuits are isolated from the protective grounding with fundamental insulation.

The power supply main circuit and heat sinks are isolated from one another with fundamental insulation. So, the grounding terminal of a heat sink should be connected to the protective grounding line as shown in Section 8.7.

(2) Installation category (overvoltage category)
DIN VDE 0110 (electric device insulation harmony) classifies power supply equipment by the amplitude of an impulse voltage contained in the power supply for the amplifier in reference to a ground potential. The β series servo amplifiers are classified in installation category (overvoltage category) II.
This category requires that the rated impulse dielectric strength (measured in reference to a ground potential) in a power supply connected to the amplifiers be not higher than 2.5 kV. Any impulse voltage higher than 2.5 kV in reference to a ground potential must be eliminated from the power supply.
Generally, an isolation transformer at the input section of the power supply of a machine would make the machine satisfy that requirement. If the power supply does not use an isolation transformer, a lightning surge absorber should be installed between the power and ground lines to suppress an impulse voltage higher than 2.5 kV in reference to a ground potential.

(3) Installation environment contamination level and power magnetics cabinet protection grade
EN60204-1 (Chapter 13/Section 13.3) states that machines to be installed in an ordinary factory environment satisfy protection grade IP54 or higher against dust debris, cutting fluid, and cutting chips. The β series servo amplifiers do not satisfy IP54 unless an additional measure is taken. So they should be installed within a power magnetics cabinet that satisfies IP54.
The IP grade to be satisfied varies with the environment (atmosphere) in which the machine is installed. So, it is necessary to select the protection grade for the power magnetics cabinet according to the environment in which it is installed.
The β series amplifiers are designed on the assumption that they are installed in an environment with a contamination level of 2. So, the contamination level for the power magnetics cabinet must be 2 or below.

8.3 PROTECTION AGAINST SHOCK HAZARDS

(1) Preventing direct contact with live parts
The β series servo amplifiers, after installed, satisfy a protection grade of IP1X (hand protection), which prevents unconscious or inadvertent contact.
The β series servo amplifiers shall be installed within a power magnetics cabinet. When they are powered, the power magnetics cabinet shall be locked according to EN60204-1 so that any person other than specialist service personnel (including those sufficiently trained in avoiding shock hazards and qualified for maintenance) cannot open it.
Should if a machine operator must open the power magnetics cabinet and act on it, the operator shall be sufficiently trained for safety beforehand, or a provision, such as a protection cover, to keep the operator from touching the amplifiers shall be installed in advance.

(2) Confirming electrolytic capacitor discharge
The β series amplifiers contain electrolytic capacitors with a high capacitance in their smoothing circuits. These capacitors remain charged for a while after the power input is shut off. If you need to touch an amplifier, for example, for maintenance purposes, wait for at least two minutes after the power is switched off, or confirm safety by measuring the remaining voltage in the DC link section and making sure that the red LED to indicate "charge" is off.
DC voltages higher than 60V are assumed to be dangerous, according to the relevant standards.

(3) Current leakage to a protective grounding wire
Servo motors are controlled by changing the average amplitude and frequency of a voltage applied to their armature (winding) using pulse width modulation.
A chopper voltage with a carrier frequency of several kHz is applied to the motor power lines for pulse width modulation.
The motor current partly leaks to the protective grounding wire of the motor power cord and a ground through stray capacitances mainly between the motor armature winding and casing and between the motor power line and a protective ground. Part of the leakage current flows through the protective grounding wire of the machine. This leakage current is about 0.4 to 0.5mA per motor, measured at the commercial frequency (50/60Hz). It is increased to 2.0mA when measured with an EN60950 compliant measurement circuit, because the measurement circuit has a relatively high sensitivity to higher frequency components.
If the machine is not grounded to a substantial earth ground, you may get shocked when touching the machine. To avoid shock hazards:

- Use wire whose cross section is 10mm^2 or larger for protective grounding.
- Install a ground-fault circuit interrupter to shut off the power instantly on a ground fault.
- Install an additional protective grounding terminal to the cabinet for duplicated protective grounding connection.

The ground-fault circuit interrupter used for the machine should be an electromagnetic type with a low sensitivity to high frequency components or an electronics type usable together with an inverter, so that a malfunction will not occur.

8.4 PROTECTIVE GROUNDING

The β series servo amplifiers have more than one protective grounding terminal (marked according to 417-IEC-5019). These terminals are used to prevent shock hazards should a dielectric breakdown occur, and to prevent a malfunction due to noise.
All protective grounding terminals shall be connected to the protective grounding connection terminal (PE) in the power magnetics cabinet.
The protective grounding connections you installed should be checked according to the indicated connection instruction (shown in Section 8.7). Moreover, it is necessary to make sure that the cross section of the protective grounding wires is larger than that of the power wire.
Do not attach more than one wire to a single protective grounding terminal. So prepare protective grounding terminals for the number of protective grounding wires to be attached.

8.5 CAUTIONS FOR CONFIGURING AN EMERGENCY STOP CIRCUIT

The power shut-off method used in the β series servo amplifiers is based on an IGBT (transistor) rather than an electromechanical device. The emergency stop circuit must be so configured that operating the emergency stop switch can turn off directly a line connector installed on the power input line of the servo amplifiers.

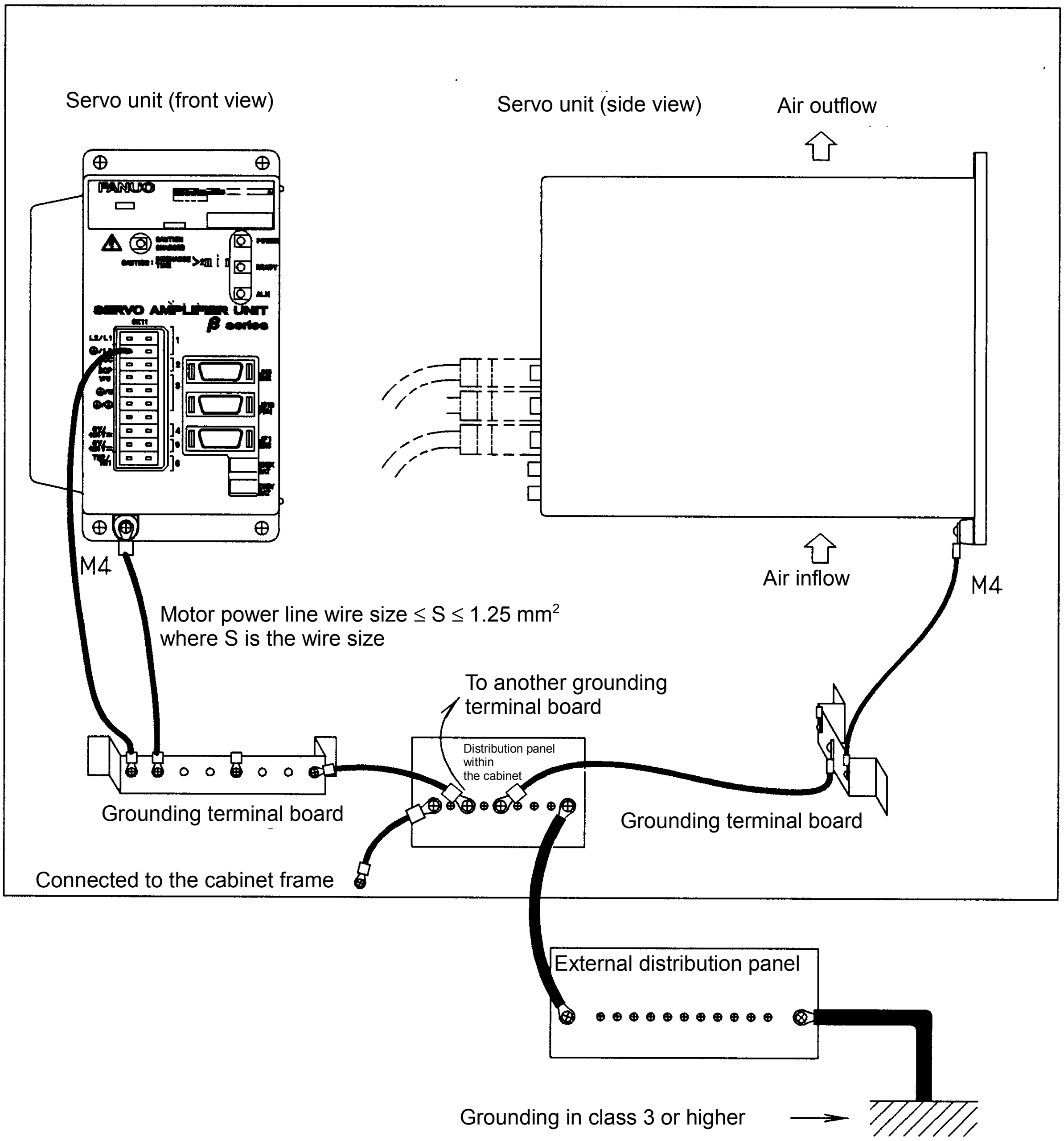
8.6 SUPPRESSING ELECTROMAGNETIC INTERFERENCE

The β series amplifiers conform to EN55011 group 1/class A for interference noise due to radiation or conduction.
To make a machine using the β series amplifiers conform to the EMC command, take necessary measures according to the guideline published by FANUC (document No.: A-72937E).

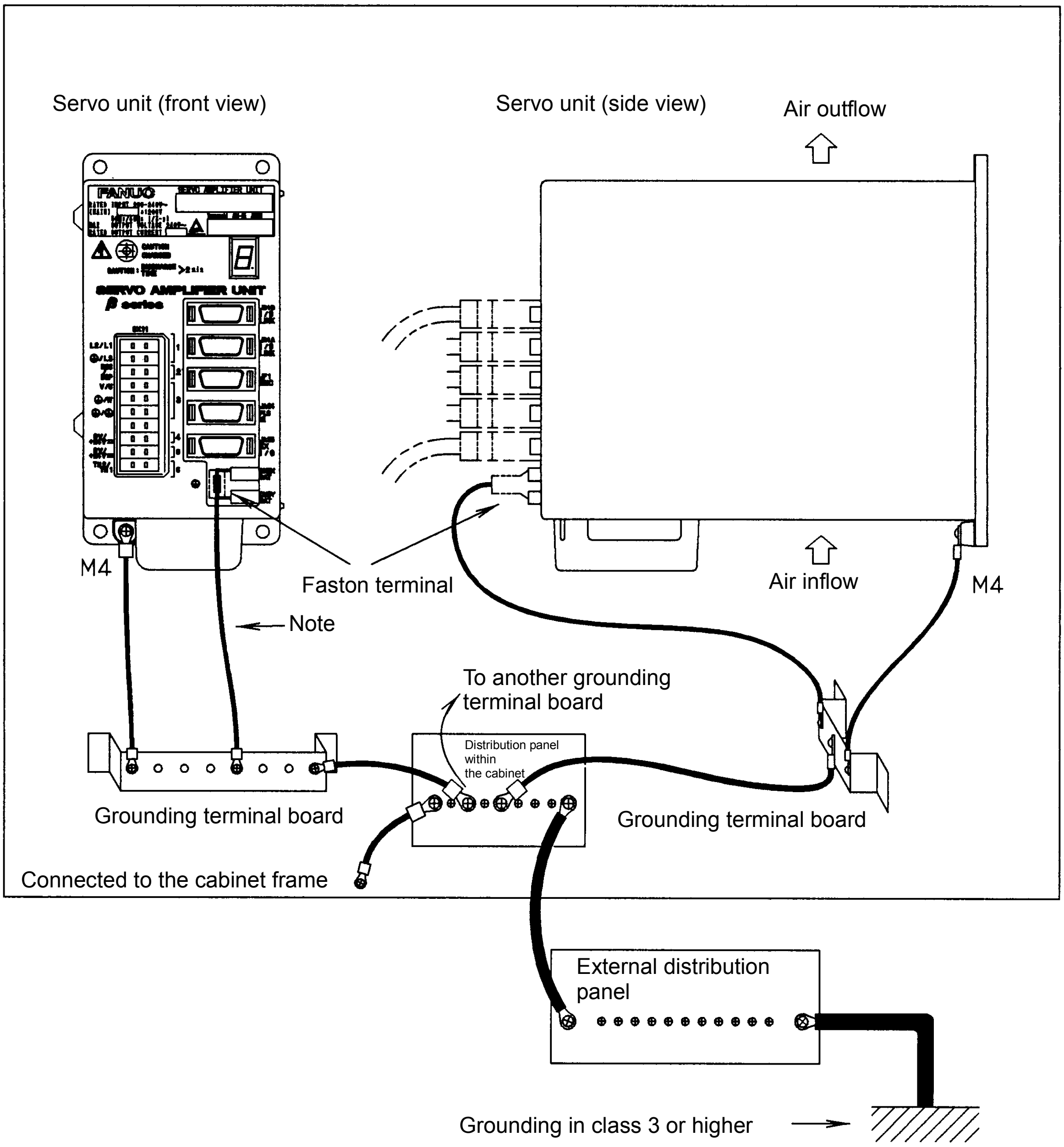
8.7 PROTECTIVE GROUND WIRE CONNECTION

8.7.1 SVU-4/12/20 (PWM Interface)

> ⚠ **CAUTION**
> The connection below also applies to the FSSB interface.



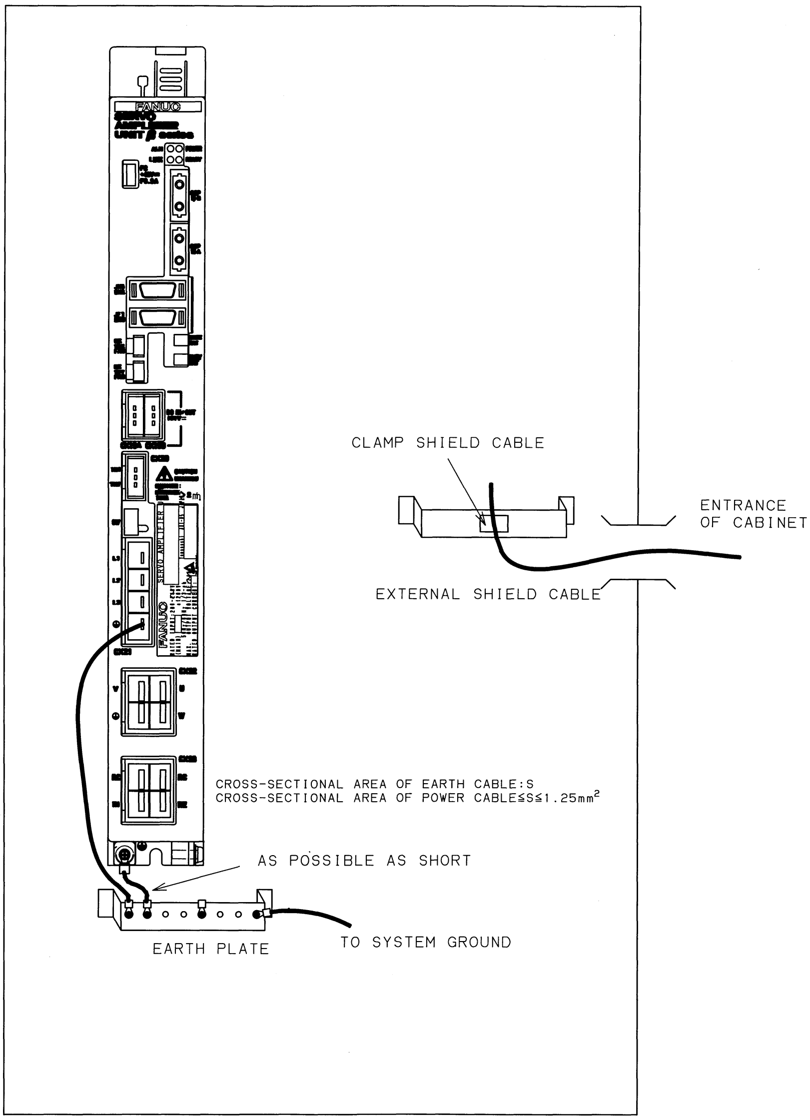
8.7.2 SVU-4/12/20 (I/O Link Interface)



> ⚠ **CAUTION**
> Ground the servo unit, using Faston terminals (A65L-0001-0148/2) in the servo unit and 2mm^2 or larger twisted wires 100 to 300 mm long. Otherwise, the servo unit becomes less immune to noise.
> Be sure to connect the frame ground terminal of the servo unit to a grounding terminal in the cabinet.

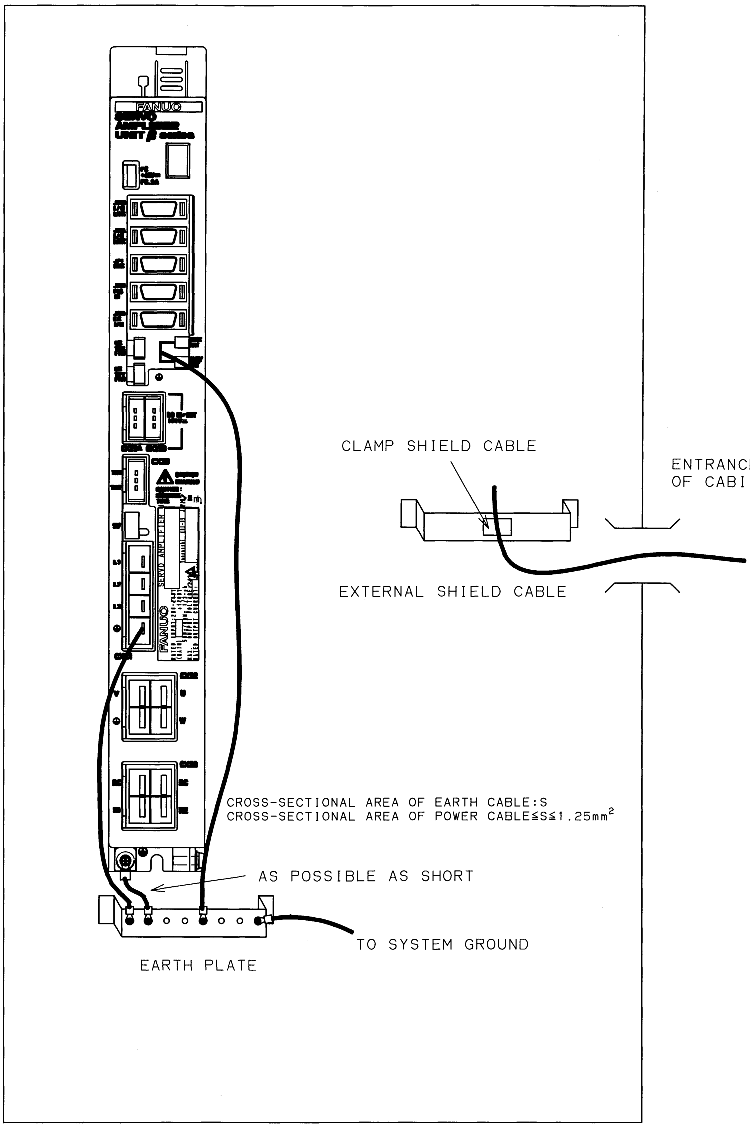
8.7.3 SVU-40/80 (FSSB Interface)

⚠ **CAUTION**
The connection below also applies to the PWM interface.



⚠ **CAUTION**
A shield cable from the outside of the power magnetics cabinet must be connected using a grounding clamp to the ground plate located very close to the inlet of the cabinet. The purpose of this processing is to prevent inter-cabinet noise from being radiated to the outside.

8.7.4 SVU-40/80 (I/O Link Interface)



⚠ **CAUTION**

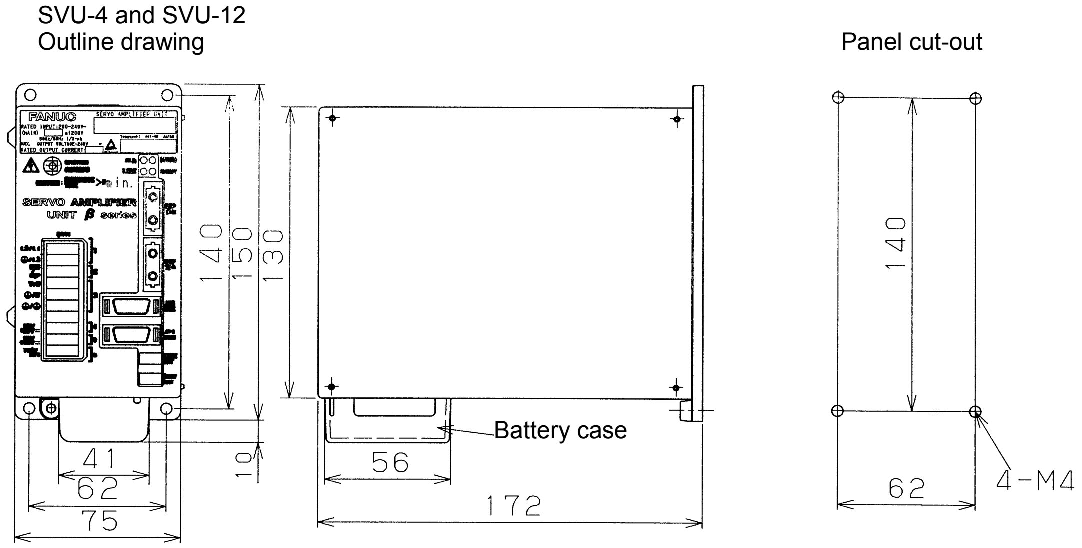
1 A shield cable from the outside of the power magnetics cabinet must be connected using a grounding clamp to the ground plate located very close to the inlet of the cabinet. The purpose of this processing is to prevent inter-cabinet noise from being radiated to the outside.

2 Ground the servo unit, using Faston terminals (A65L-0001-0148/2) in the servo unit and $2mm^2$ or larger twisted wires 100 to 300 mm long. Otherwise, the servo unit becomes less immune to noise.
Be sure to connect the frame ground terminal of the servo unit to a grounding terminal in the cabinet.

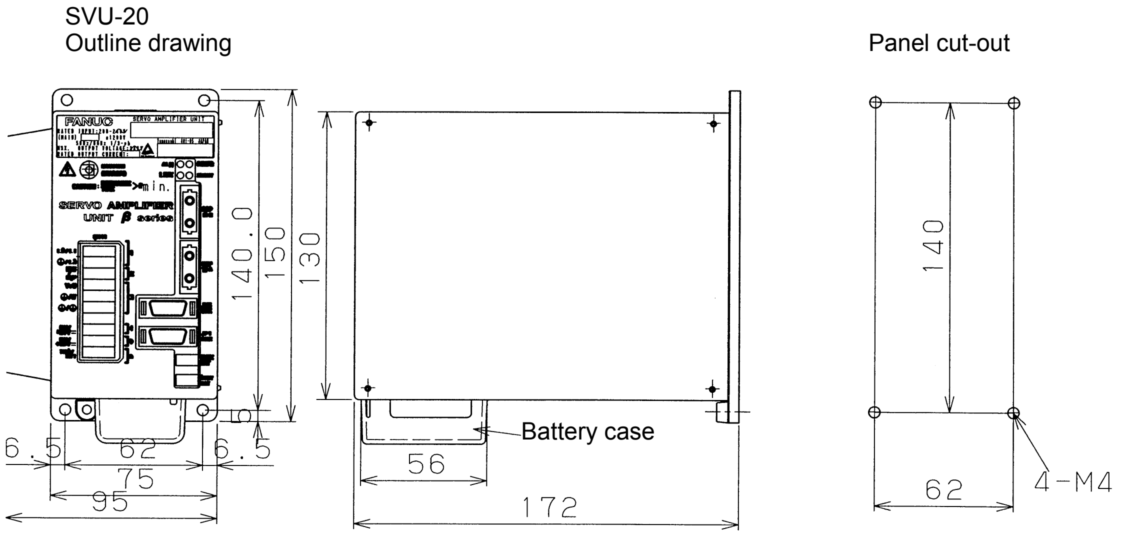
9 OUTLINE DRAWINGS AND MAINTENANCE CLEARANCES

9.1 OUTLINE DRAWINGS AND PANEL CUT-OUT DRAWINGS

9.1.1 Servo Amplifier Unit SVU-4,SVU-12,SVU-20 (FSSB Interface)



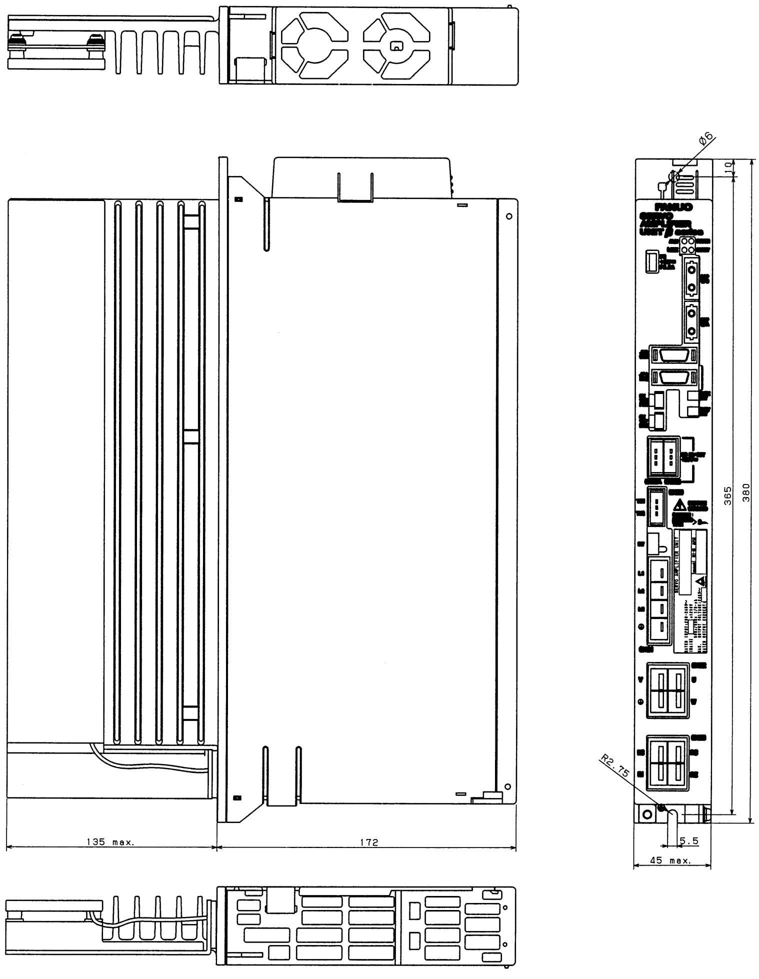
Weight : 1.1 kg



Weight : 1.2 kg

NOTE
1 The outside dimensions of the FSSB interface, I/O Link interface, and PWM interface are the same. Shown above are the FSSB interface versions.
2 The battery case is required only when an absolute pulse coder is used.

9.1.2 Servo Amplifier Unit SVU-40,SVU-80 (FSSB Interface)

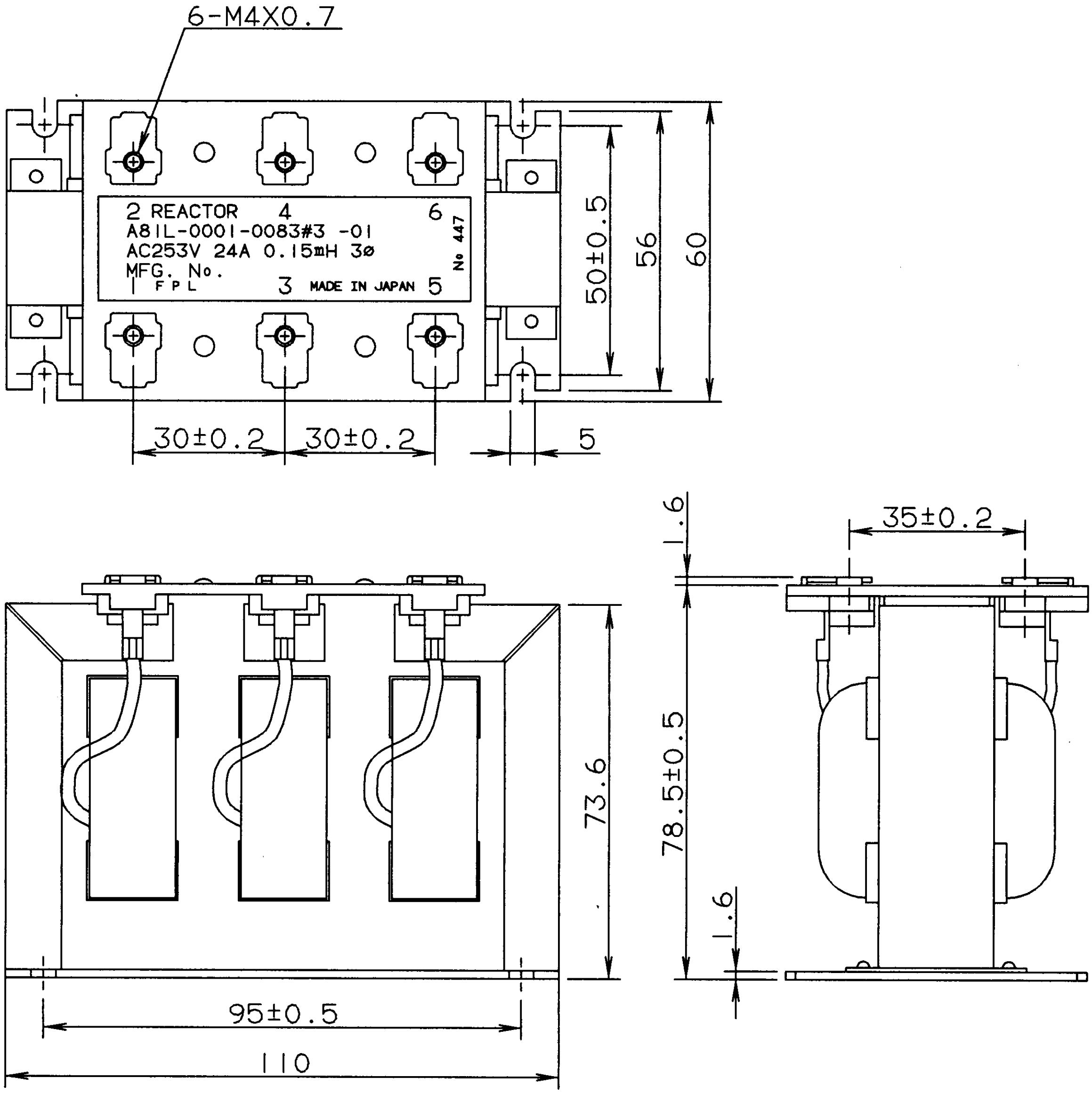


Weight : 3.9kg (applicable to all interfaces)

> **NOTE**
> The outside dimensions of the FSSB interface, I/O Link interface, and PWM interface are the same. Shown above are the FSSB interface versions.

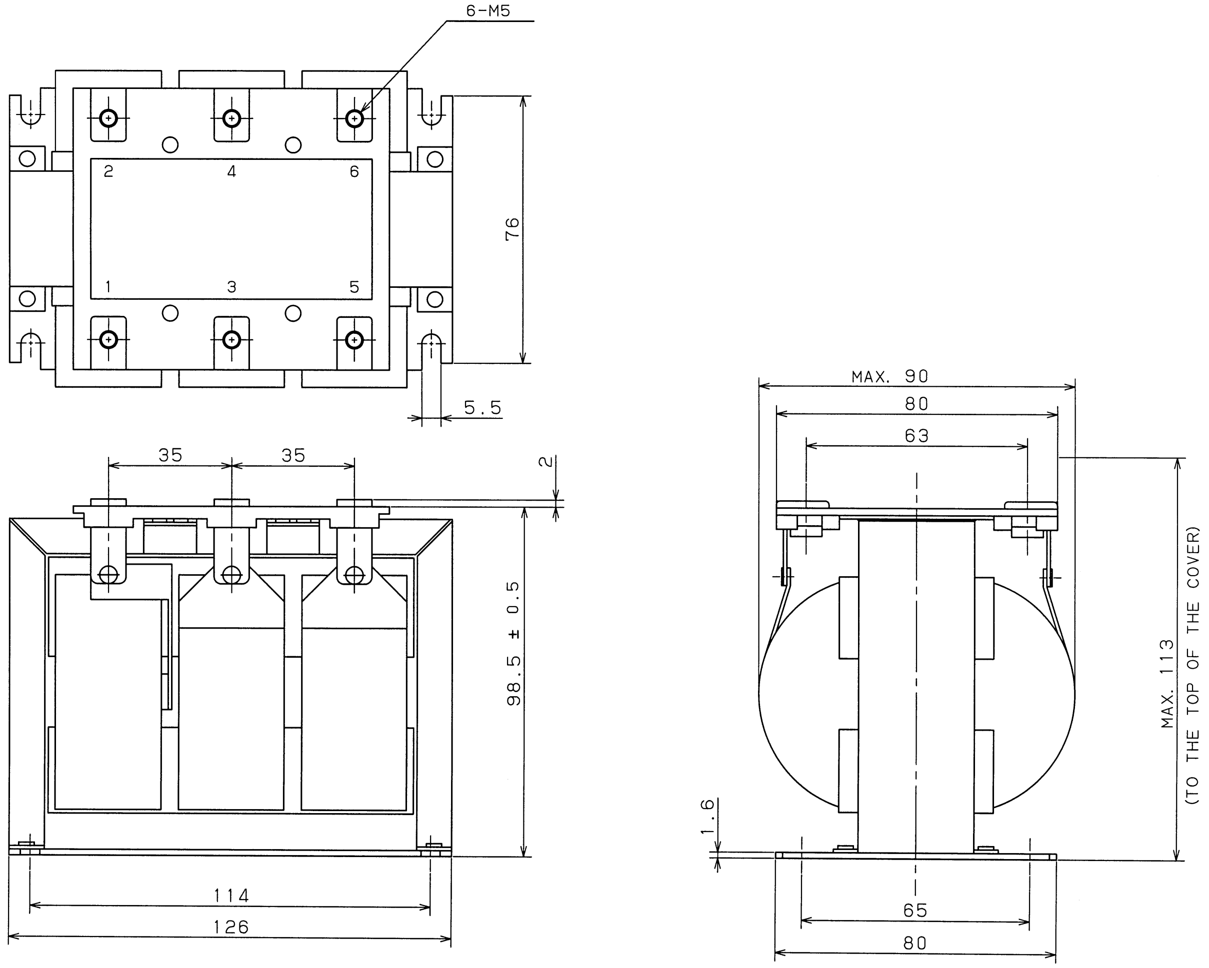
9.1.3 AC Line Filter

A81L-0001-0083#3C



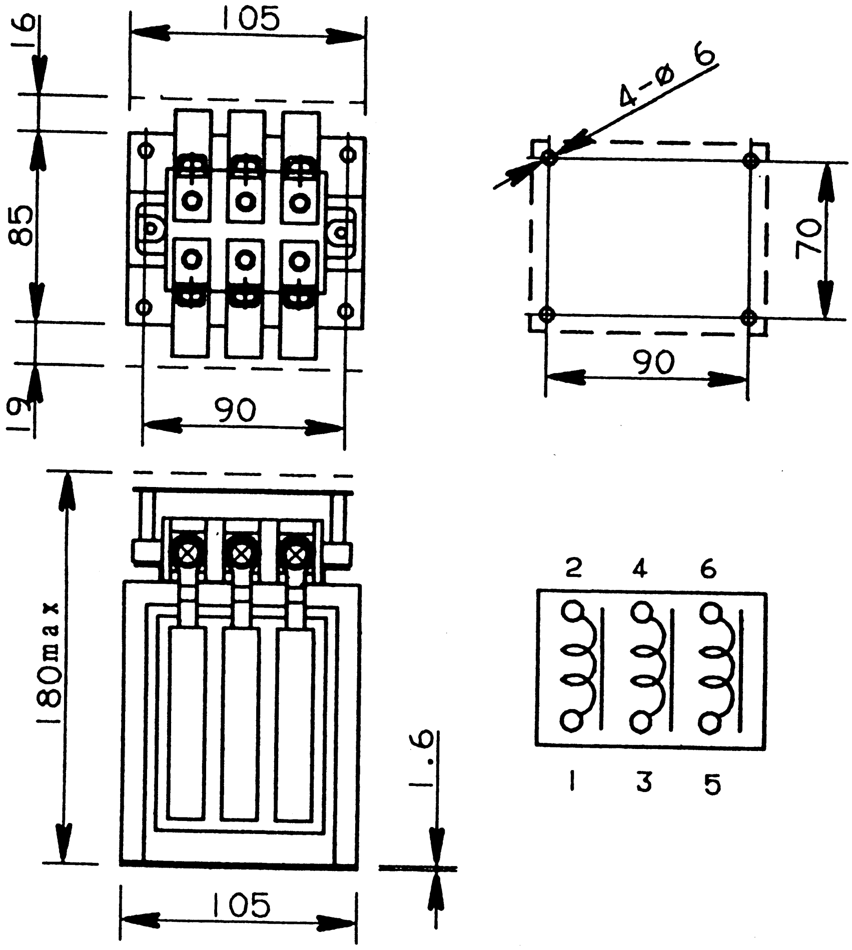
Weight : 1.1kg

A81L-0001-0101#C



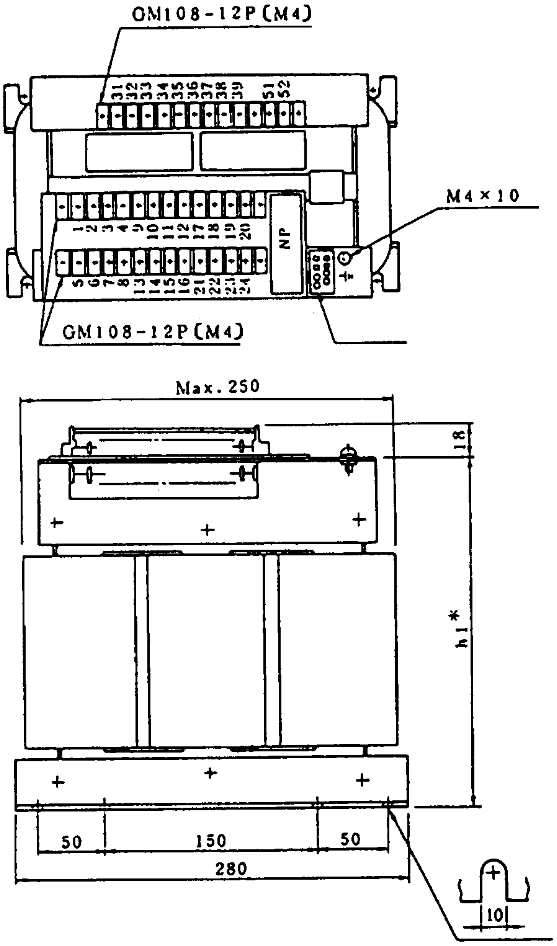
Weight : 3kg

A81L-0001-0102



Weight : 3kg

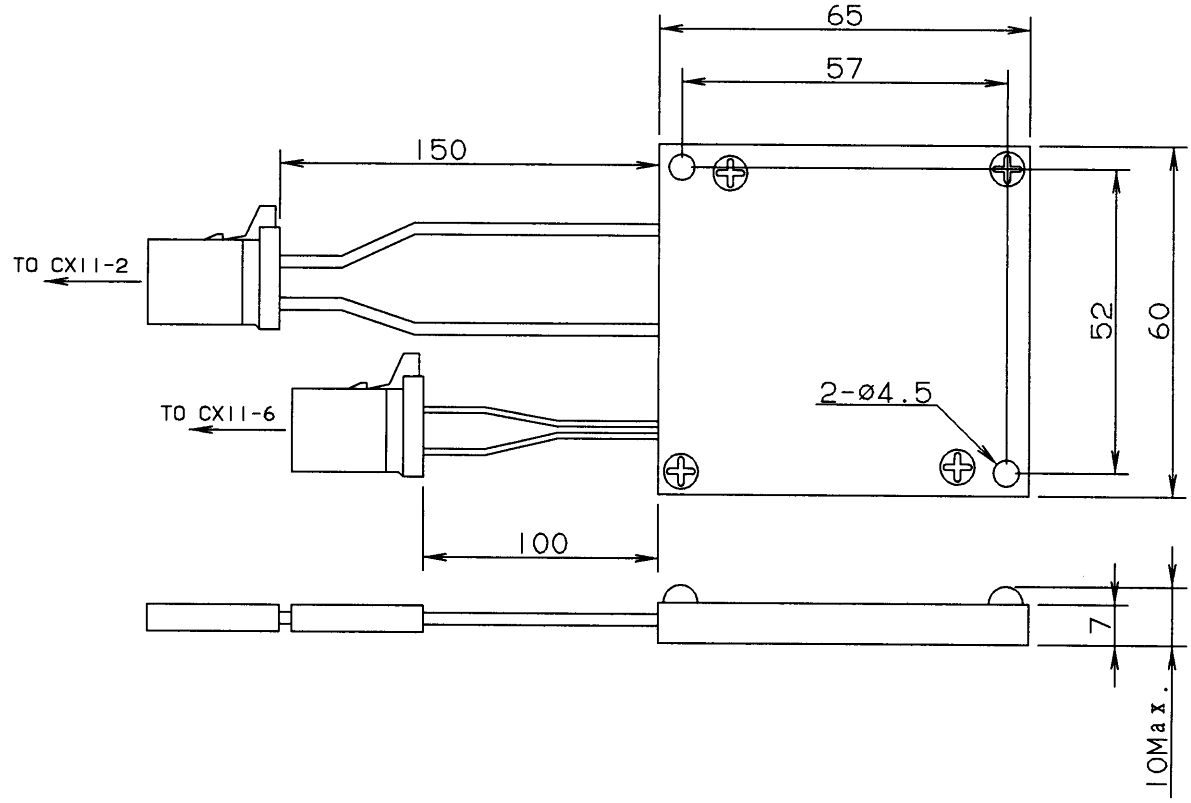
9.1.4 Power Transformer for Export



Specification	A80L-0022-0005	A80L-0024-0006	A80L-0026-0003	A80L-0028-0001
Type (name)	SAE	SBE	SCE	SDE
Weight	21 kg	27 kg	36 kg	42 kg
hl* (height of trans)	Max. 217mm	Max. 217mm	Max. 247mm	Max. 247mm

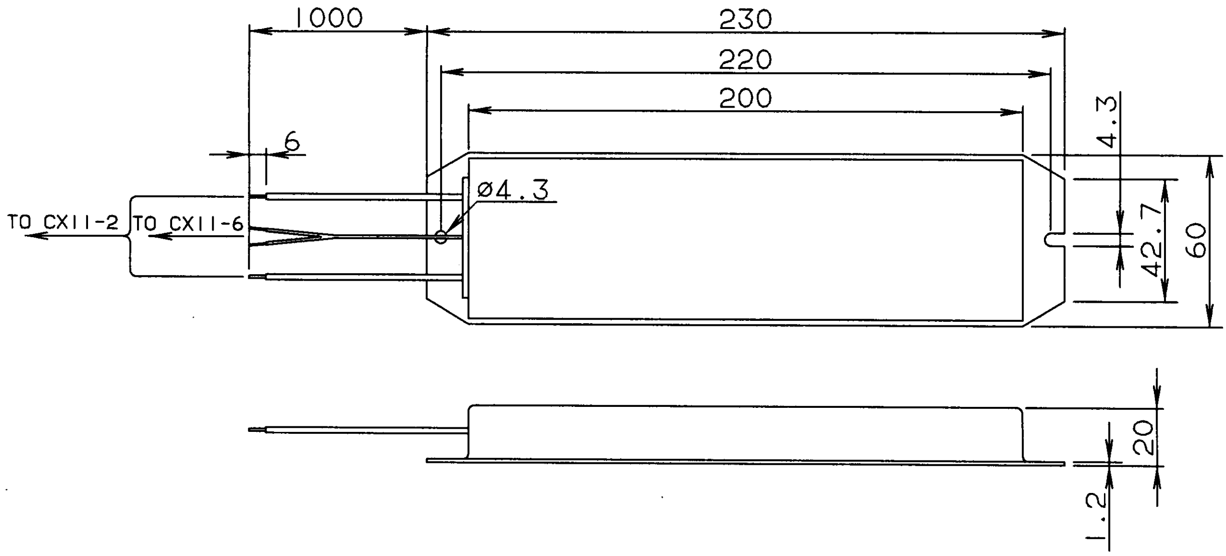
9.1.5 Separated Regenerative Discharge Unit

A06B-6093-H401



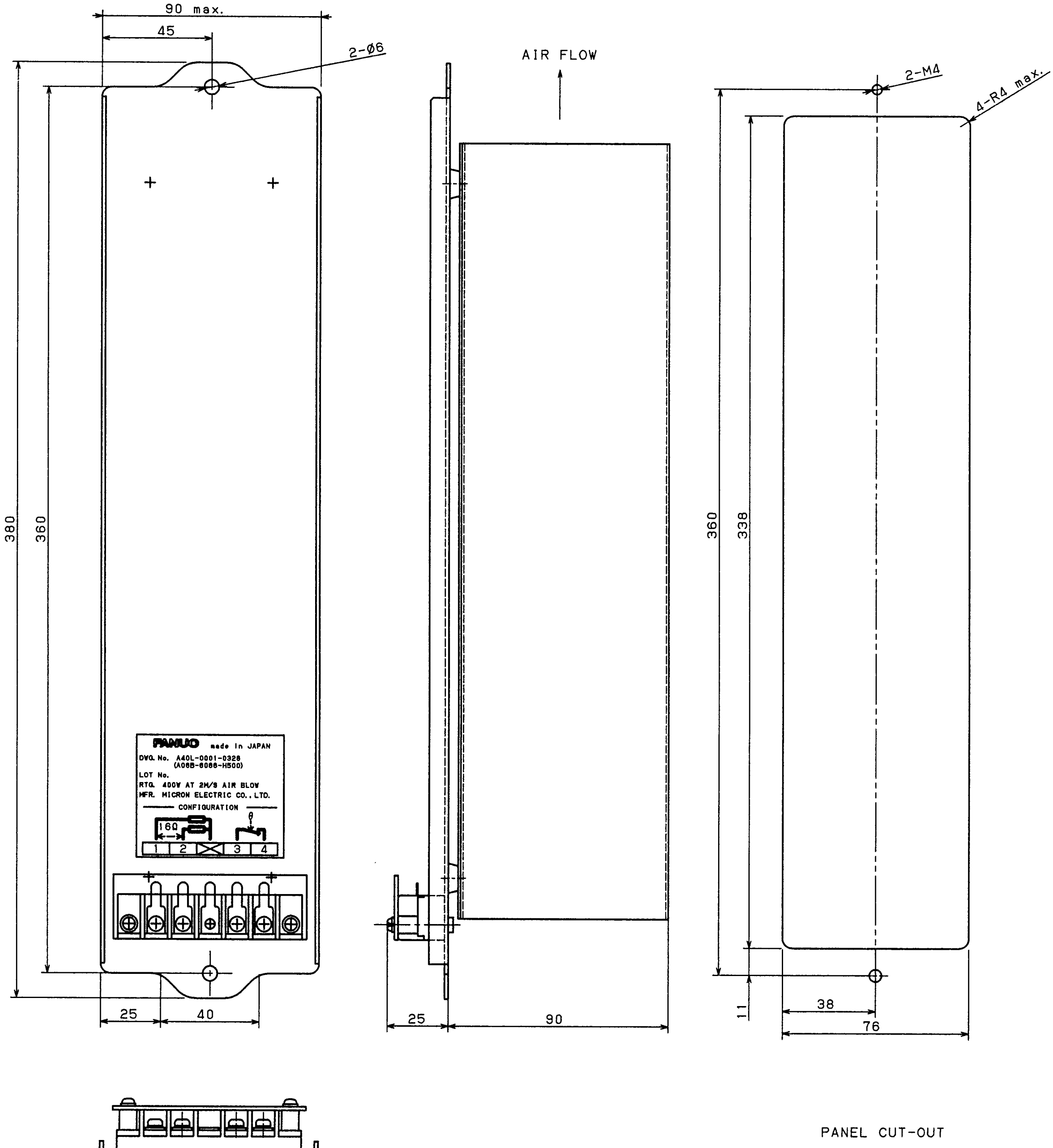
Weight : 0.07 kg

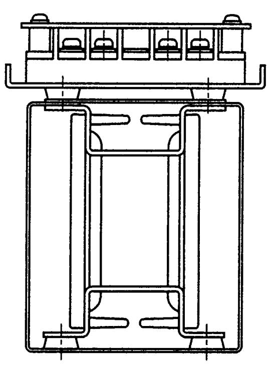
A06B-6093-H402



Weight : 0.5 kg

A06B-6089-H500



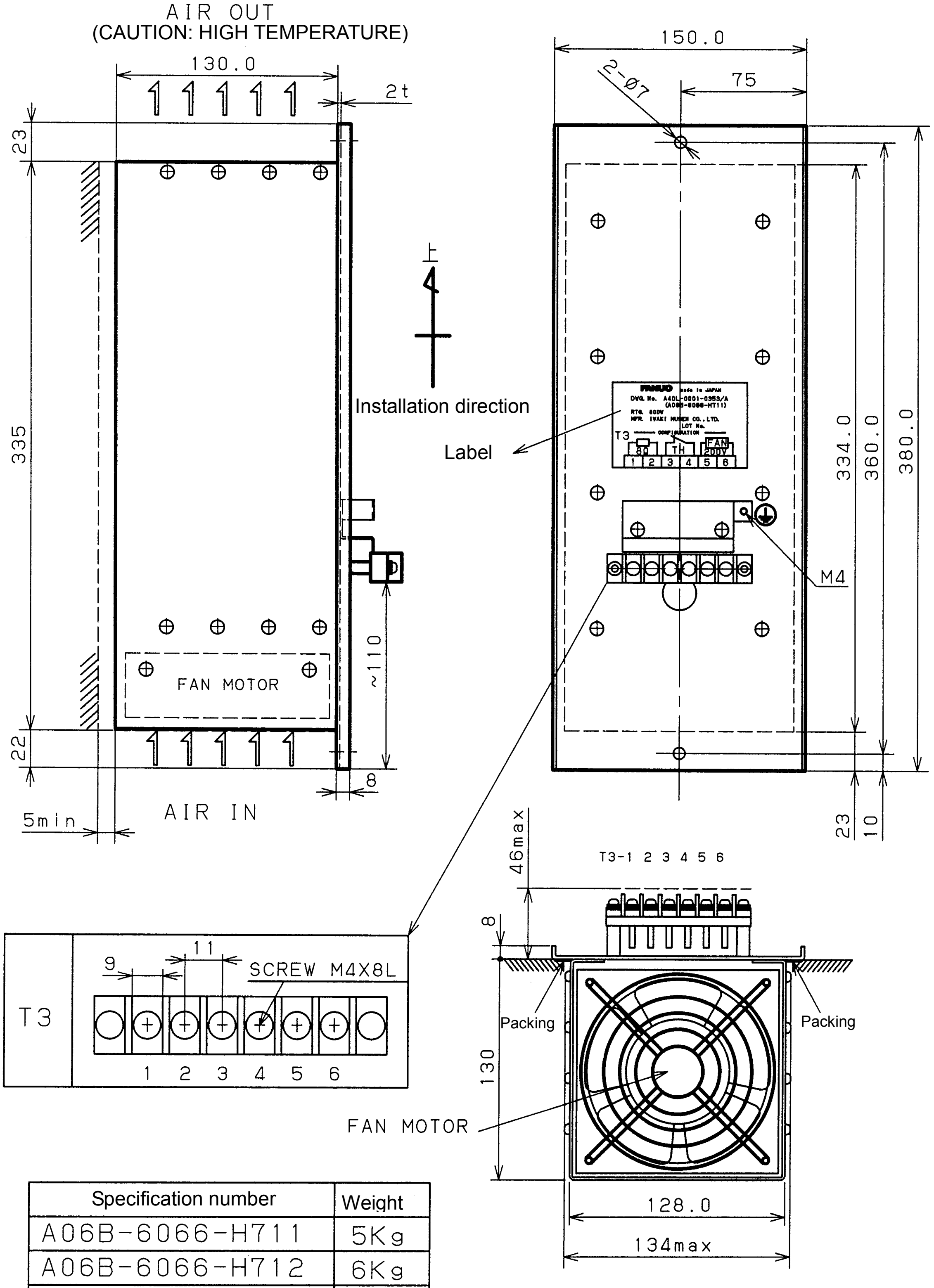


RESISTANCE:16Ω (8ΩX2)

TERMINAL BLOCK:M4x4

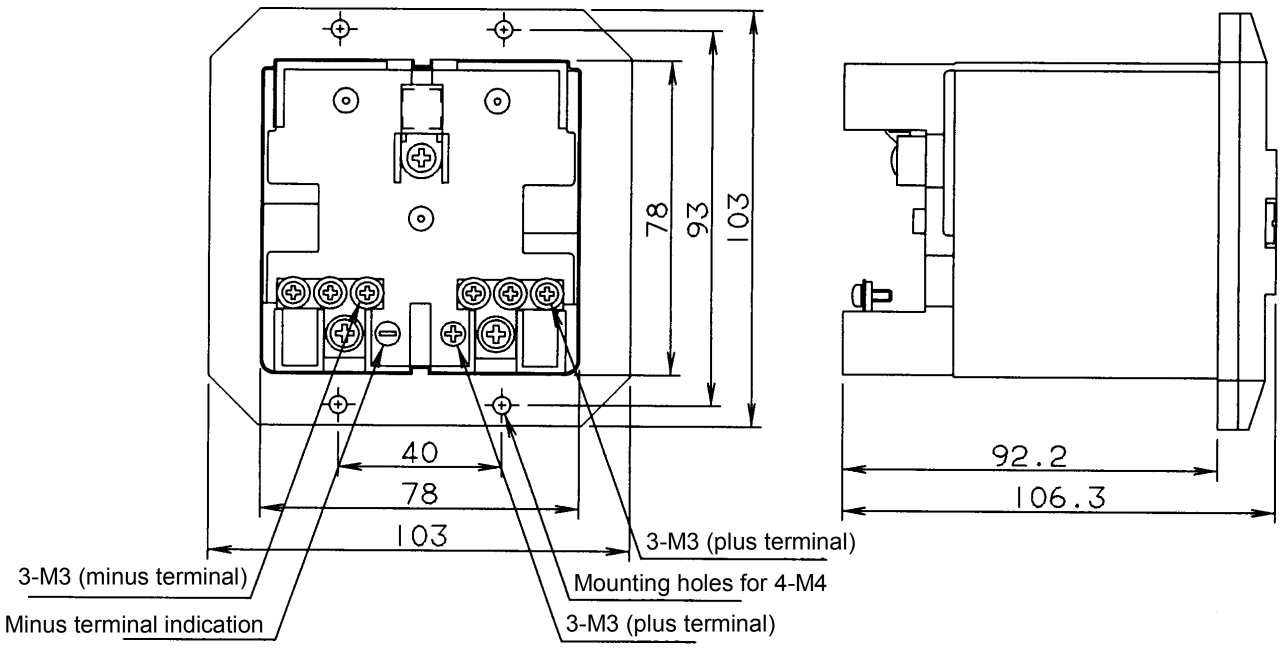
WEIGHT:2.2kg

A06B-6089-H713 to H714



Specification number	Weight
A06B-6066-H711	5Kg
A06B-6066-H712	6Kg
A06B-6066-H713	5Kg
A06B-6066-H714	6Kg

9.1.6 Battery Case

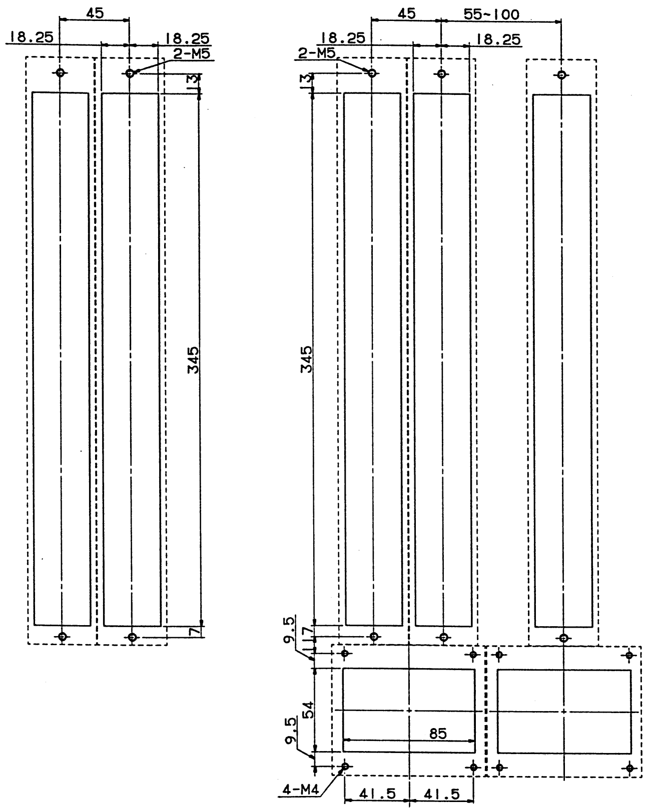


9.2 Panel Cut-out Drawings

9.2.1 SVU40, SVU-80

The descriptions of this subsection apply to all of the FSSB interface, I/O Link interface, and PWM interface.

Natural air cooling type **Forced air cooling type**



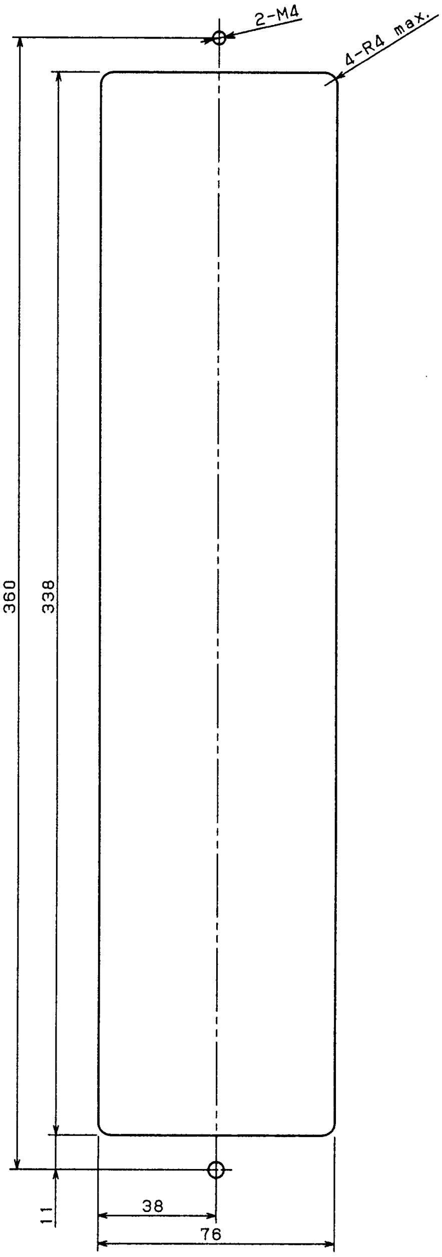
When two units of natural air cooling type are installed in parallel

When three units of forced air cooling type are installed in parallel (The fan adapter (A06B-6078-K002) is used.)

> **NOTE**
> 1 The width of the module (A06B-6078-K002) is 100mm. If two modules are used, the distance between modules is 100mm or more.
> 2 Attach packings (acrylonitrile-butadiene rubber, or soft NBR) to prevent the ingress of oil and dust.
> 3 Reinforce the right and left and of each panel cut-out in the power magnetics cabinet, for example with L-angle steel, to ensure reliable contact with the amplifier modules.
> 4 When installing a battery (by connection method 2), provide a space of 40 mm horizontally as a maintenance area for battery replacement. See Section 9.3.

9.2.2 Separated Regenerative Discharge Unit

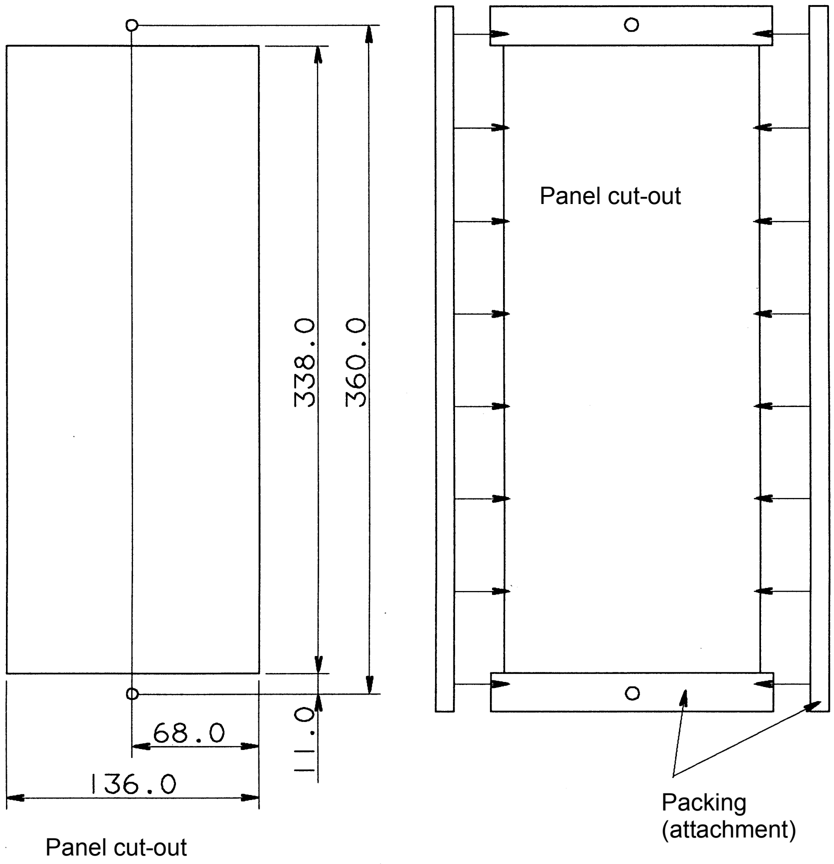
A06B-6089-H500



PANEL CUT-OUT

> ⚠ **CAUTION**
> Attach packings (acrylonitrile-butadiene rubber, or soft NBR) to prevent the ingress of oil and dust.

A06B-6089-H713 to H714



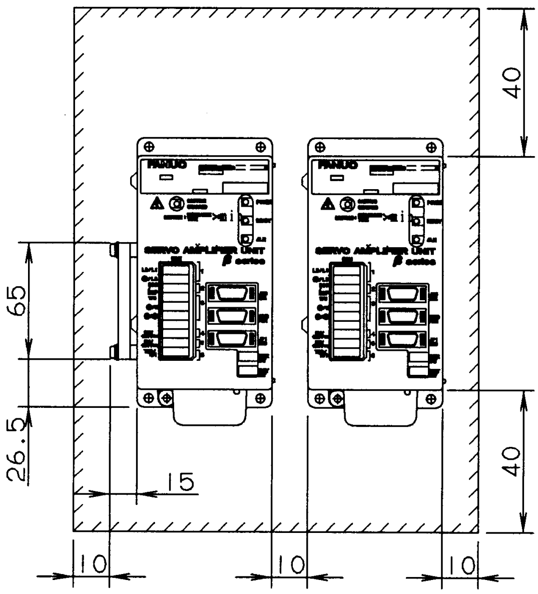
> ⚠ **CAUTION**
> Attach packings (acrylonitrile-butadiene rubber, or soft NBR) to prevent the ingress of oil and dust.

9.3 MAINTENANCE AREA

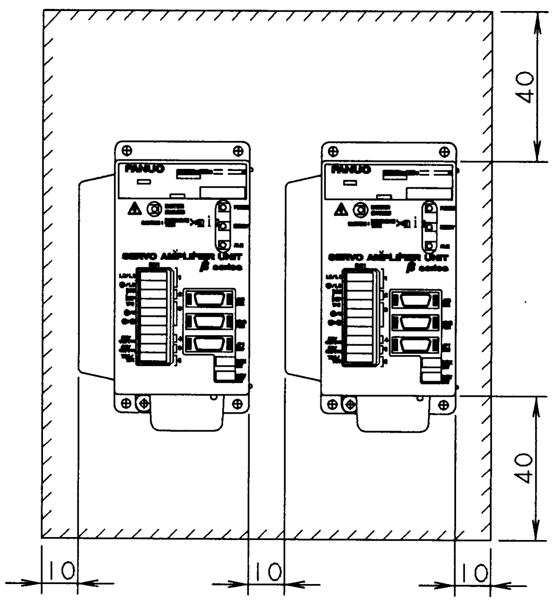
SVU-4, SVU-12, SVU-20

> ⚠ **CAUTION**
> The descriptions of this section apply to all of the FSSB interface, I/O Link interface, and PWM interface.

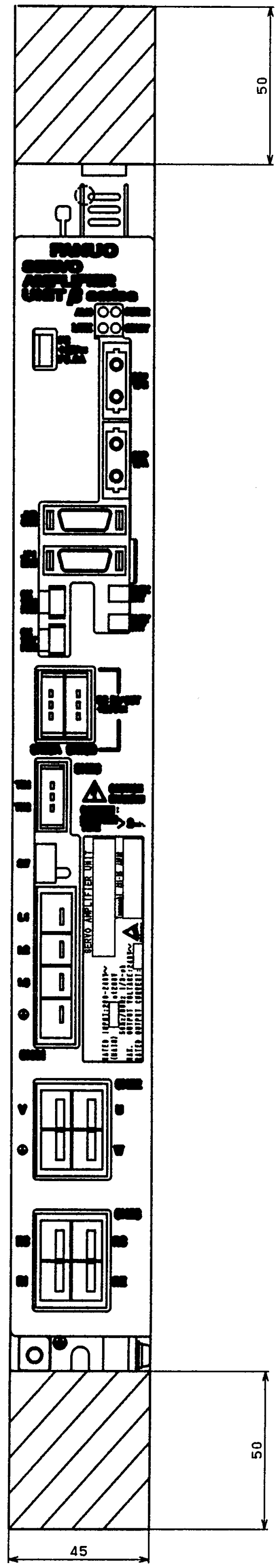
(a) SVU-12



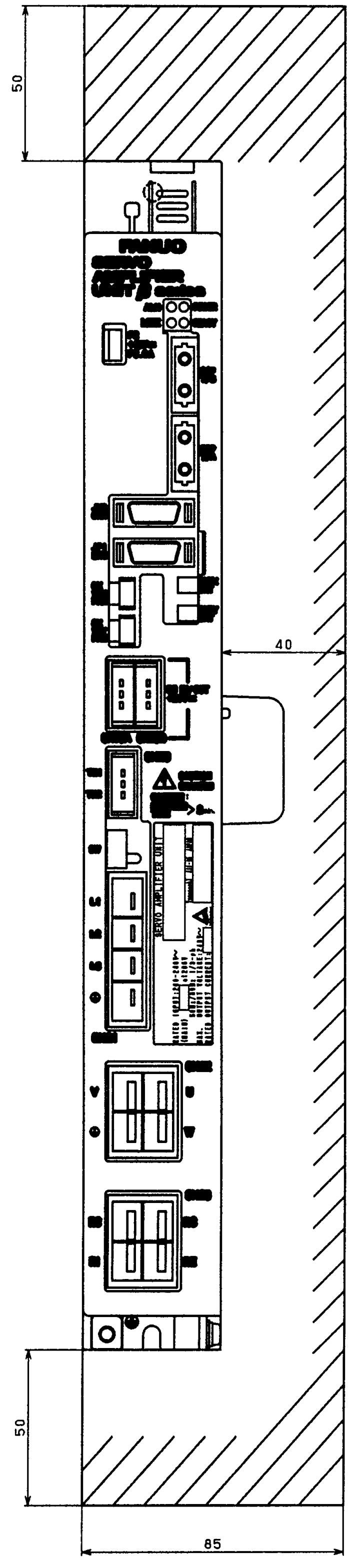
(b) SVU-20



SVU-40, SVU-80 (when the battery(A06B-6093-K001) is not used)



SVU-40, SVU-80 (when the battery(A06B-6093-K001) is used)

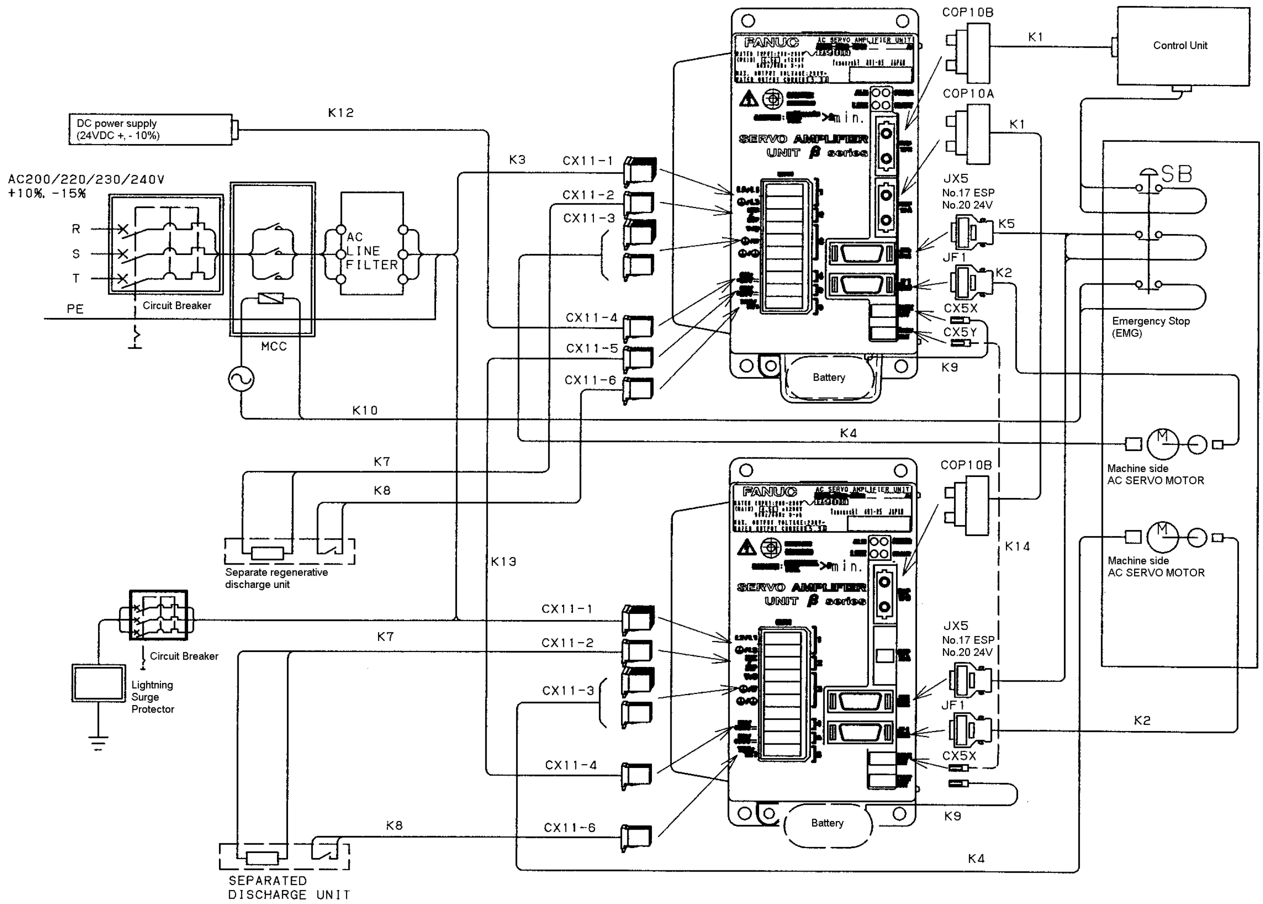


V. CONNECTION

1 TOTAL CONNECTION DIAGRAM

1.1 FSSB INTERFACE (SVU4, SVU-12, SVU-20)

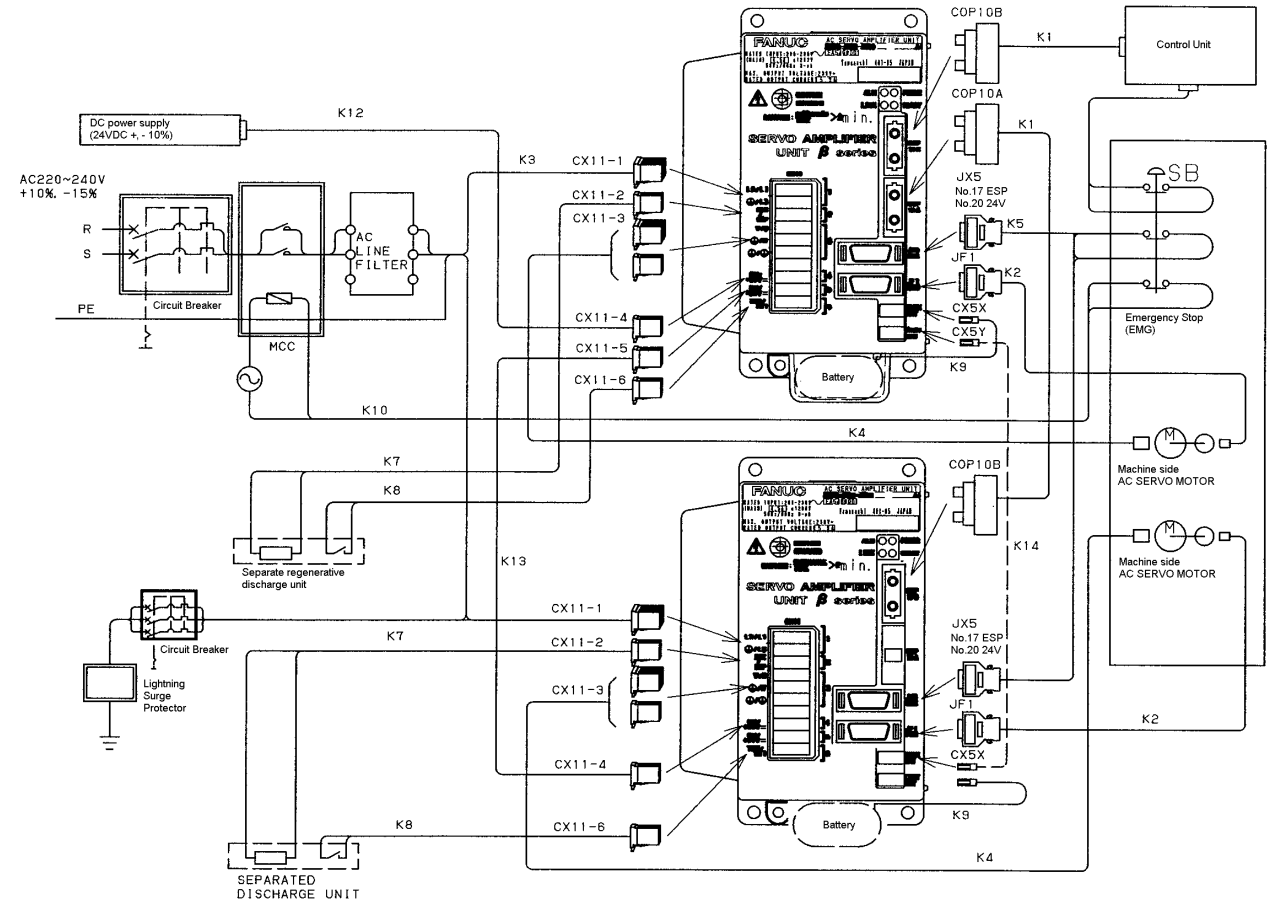
1.1.1 Three-phase Input



⚠ **WARNING**

Be sure to install circuit breakers, magnetic contactors, and AC line filters.

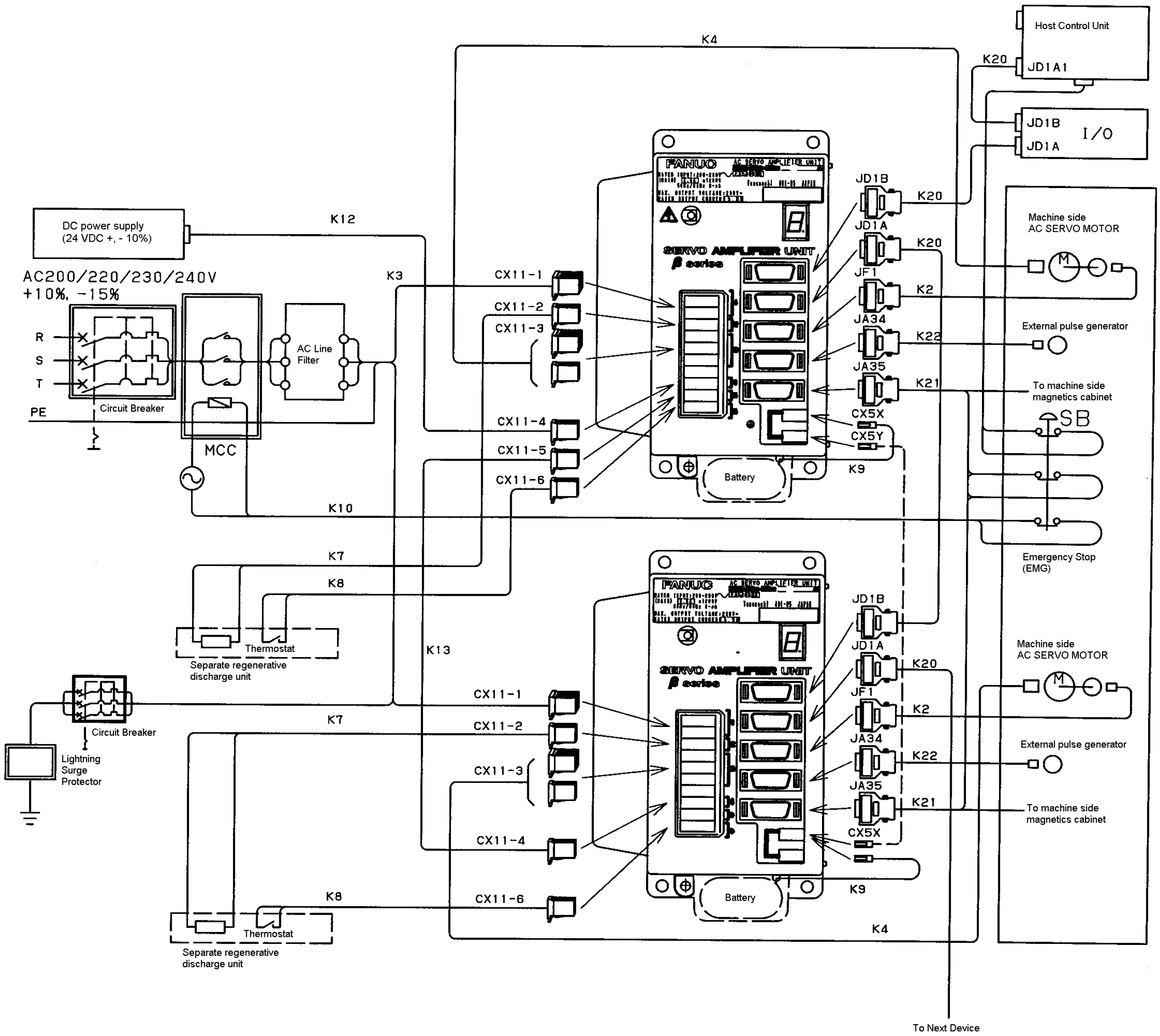
1.1.2 Single-phase Input (SVU4, SVU-12, SVU-20)



> ⚠ **WARNING**
> Be sure to install circuit breakers, magnetic contactors, and AC line filters.

1.2 I/O Link INTERFACE (SVU4, SVU-12, SVU-20)

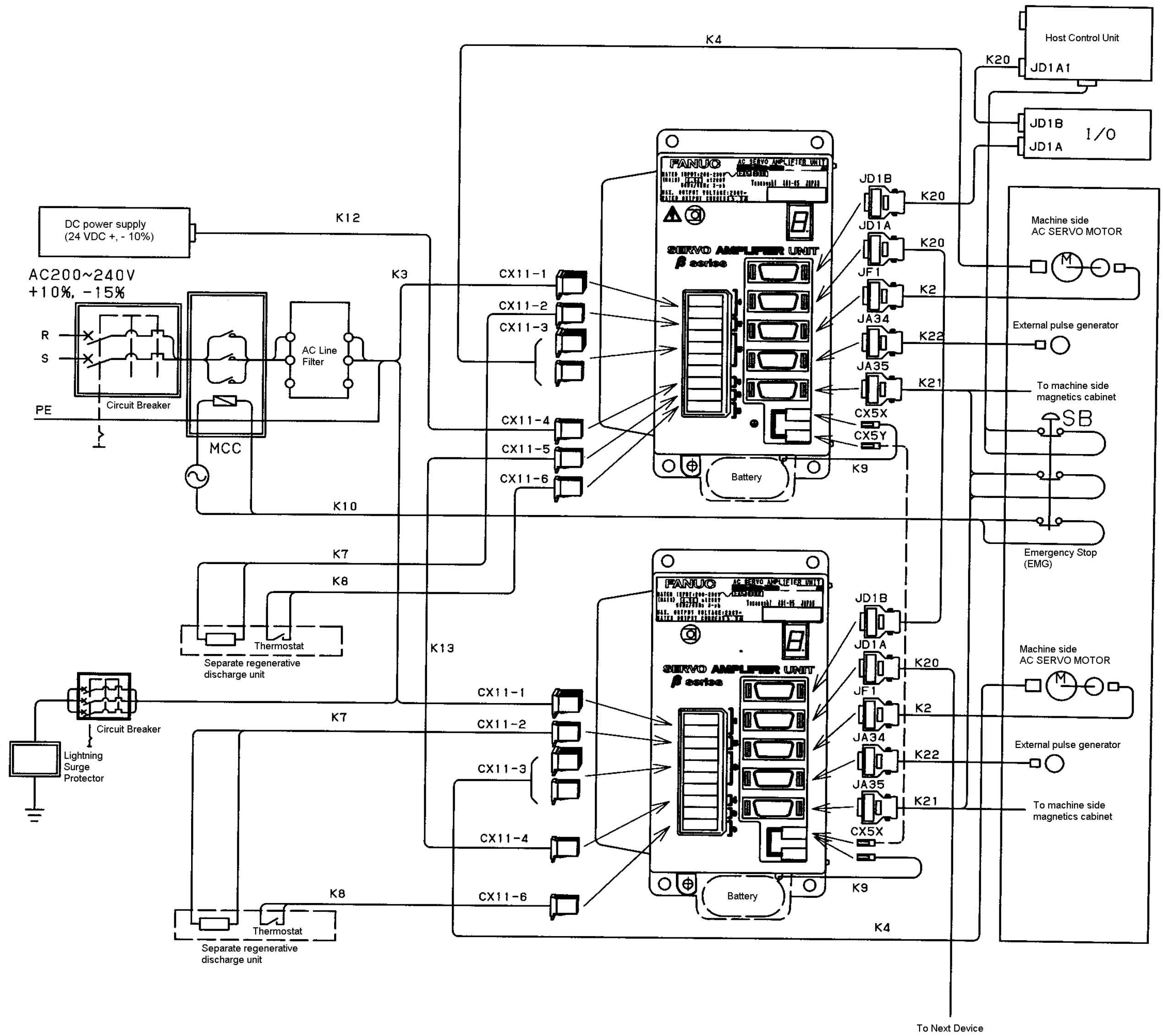
1.2.1 Three-phase Input



> ⚠ **WARNING**
> Be sure to install circuit breakers, magnetic contactors, and AC line filters.

> **NOTE**
> As shown above, make a configuration so that the external magnetic contactor inserted into the power input of the β series servo motor amplifier (with the I/O Link option) is turned on immediately upon emergency stop cancellation. The period of time allowed until the external magnetic contactor is turned on after emergency stop cancellation is 100 ms.

1.2.2 Single-phase Input (SVU4, SVU-12, SVU-20)

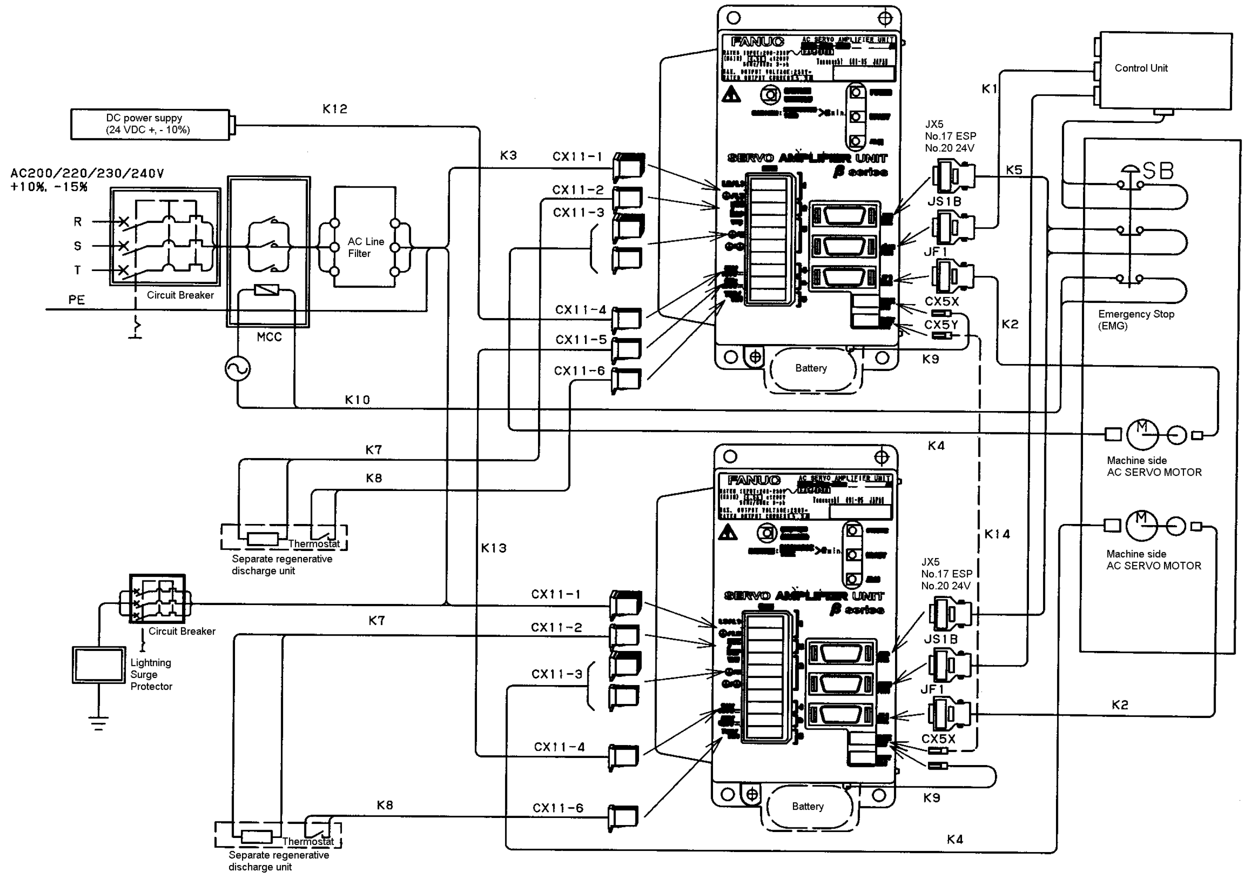


> ⚠ **WARNING**
> Be sure to install circuit breakers, magnetic contactors, and AC line filters.

> **NOTE**
> As shown above, make a configuration so that the external magnetic contactor inserted into the power input of the β series servo motor amplifier (with the I/O Link option) is turned on immediately upon emergency stop cancellation. The period of time allowed until the external magnetic contactor is turned on after emergency stop cancellation is 100 ms.

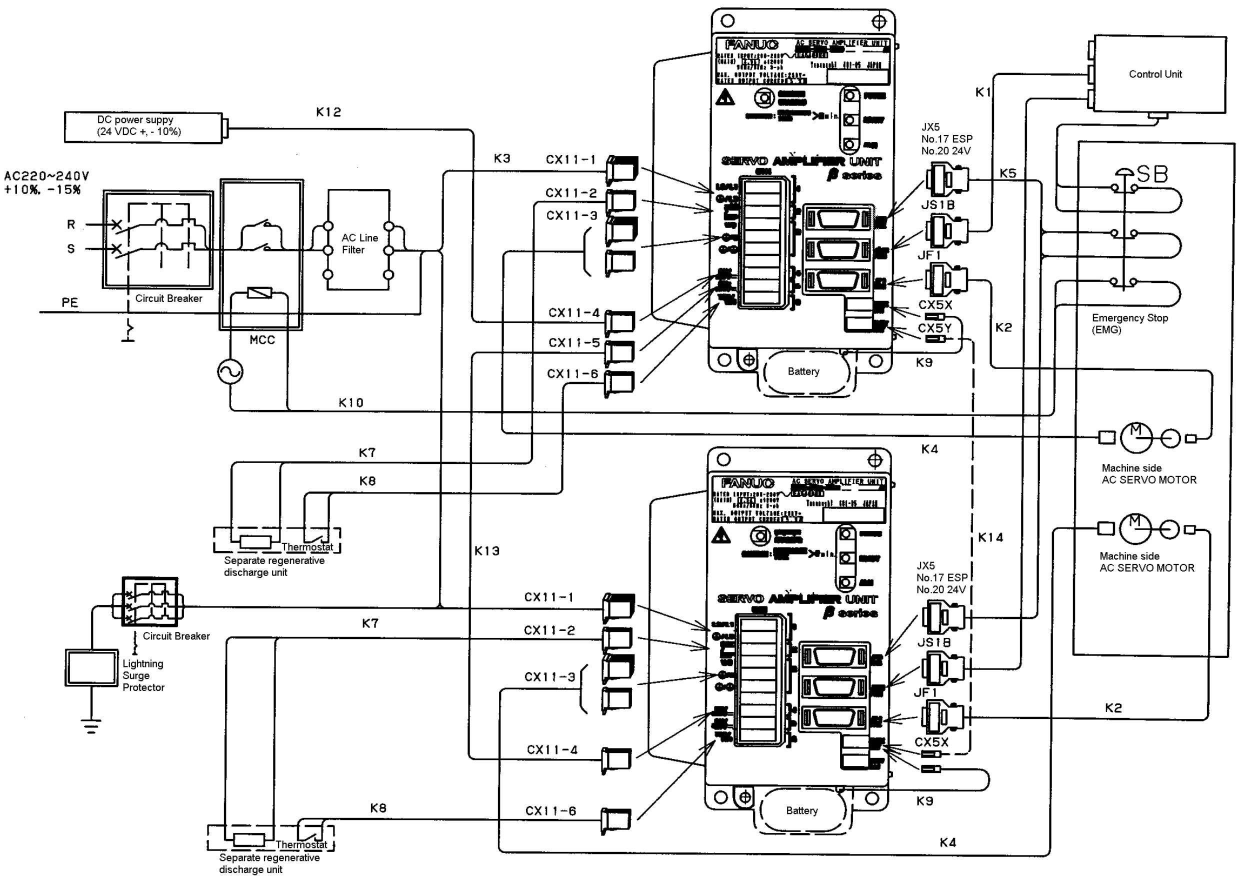
1.3 PWM INTERFACE (SVU4, SVU-12, SVU-20)

1.3.1 Three-phase Input



> ⚠ **WARNING**
> Be sure to install circuit breakers, magnetic contactors, and AC line filters.

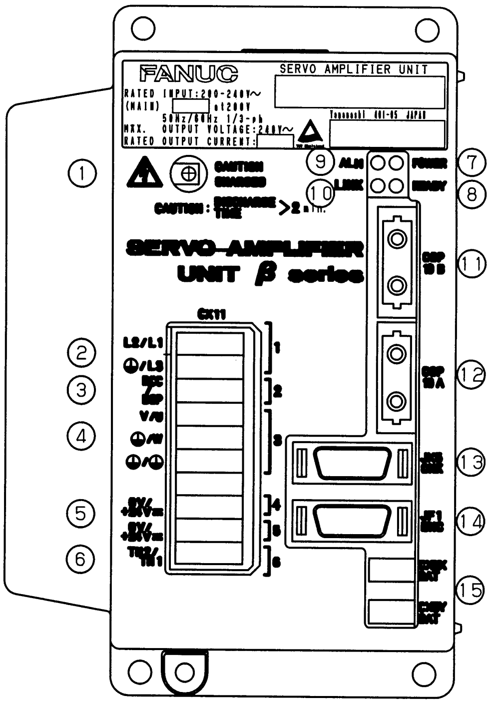
1.3.2 Single-phase Input (SVU4, SVU-12, SVU-20)



> ⚠ **WARNING**
> Be sure to install circuit breakers, magnetic contactors, and AC line filters.

2 CONNECTOR LOCATIONS FOR β SERIES AMPLIFIER

2.1 FSSB INTERFACE (SVU4, SVU-12, SVU-20)



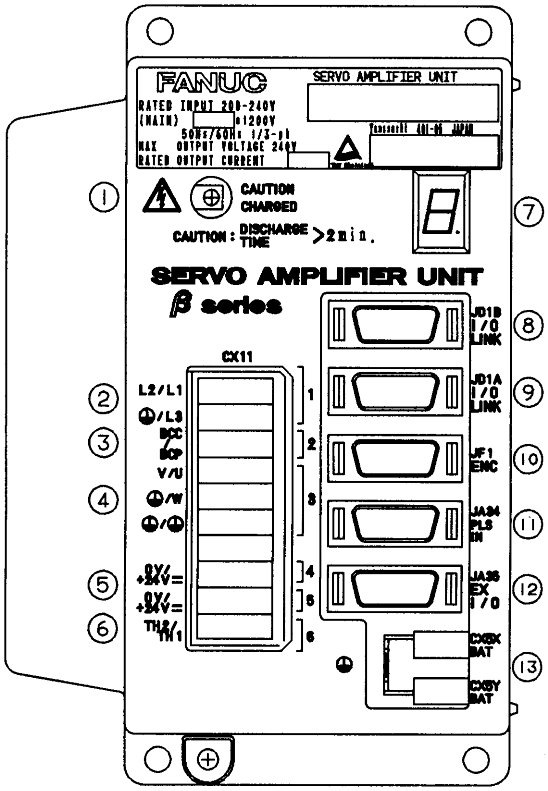
	Name	Description	Remarks
<1>		DC link charge indicator LED	(Warning 1)
<2>	CX11-1	Main power input connector	
<3>	CX11-2	Connector for regenerative resistor (DC link)	
<4>	CX11-3	Motor power line connector	
<5>	CX11-4,5	24V power input/output connector	
<6>	CX11-6	Connector for regenerative resistor (for overheat)	(Warning 2)
<7>	POWER	Control power status indicator LED	
<8>	READY	Activation status indicator LED	
<9>	ALM	Alarm status indicator LED	
<10>	LINK	FSSB communication status indicator LED	
<11>	COP10B	FSSB communication input connector	
<12>	COP10A	FSSB communication output connector	
<13>	JX5	Connector for the ESP signal and signal checking	
<14>	JF1	Connector for PULSECODER	
<15>	CX5X,CX5Y	Connector for ABS Pulsecoder battery	

⚠ WARNING

1 It is dangerous to touch any cables and components inside the module while this LED is lit. Never touch components or cables while this LED is lit.

2 Refer to Section 4.7 for details.

2.2 I/O Link INTERFACE (SVU4, SVU-12, SVU-20)

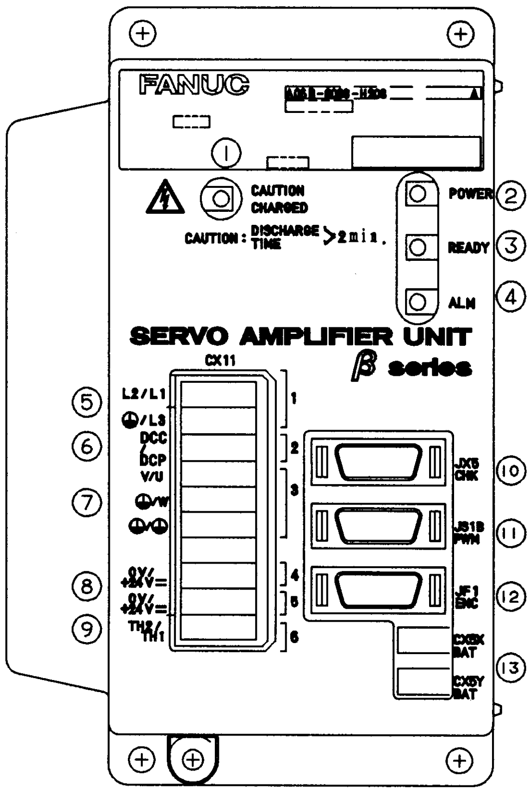


	Name	Description	Remarks
<1>		DC link charge indicator LED	(Warning 1)
<2>	CX11-1	Main power input connector	
<3>	CX11-2	Connector for regenerative resistor (DC link)	
<4>	CX11-3	Motor power line connector	
<5>	CX11-4,5	24V power input/output connector	Both connectors have the same function.
<6>	CX11-6	Connector for regenerative resistor (for overheat)	(Warning 2)
<7>		Status indicator LED	
<8>	JD1B/I/O LINK	FANUC I/O Link connector	From a unit at the previous stage
<9>	JD1A/I/O LINK	FANUC I/O Link connector	To a unit at the next stage
<10>	JF1/ENC	Connector for Pulsecoder connection	
<11>	JA34/Pulse In	External pulse input connector	
<12>	JA35/EX I/O	Built-in DI connector	
<13>	CX5X,CX5Y	Connector for ABS Pulsecoder battery	Both connectors have the same function.

⚠ **WARNING**

1. It is dangerous to touch any cables and components inside the module while this LED is lit. Never touch components or cables while this LED is lit.
2. Refer to Section 4.7 for details.

2.3 PWM INTERFACE (SVU4, SVU-12, SVU-20)



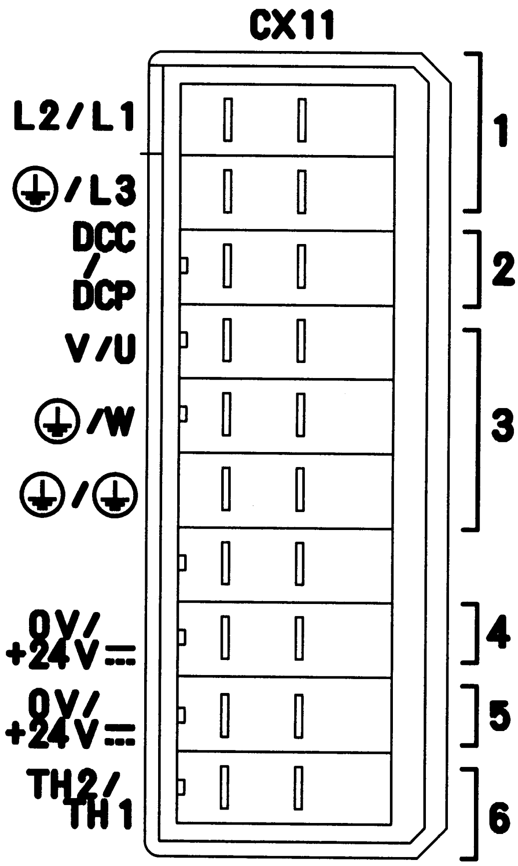
	Name	Description	Remarks
<1>		DC link charge indicator LED	(Warning 1)
<2>	POWER	Control power status indicator LED	
<3>	READY	Activation status indicator LED	
<4>	ALM	Alarm status indicator LED	
<5>	CX11-1	Main power input connector	
<6>	CX11-2	Connector for regenerative resistor (DC link)	
<7>	CX11-3	Motor power line connector	
<8>	CX11-4,5	24V power input/output connector	Both connectors have the same function.
<9>	CX11-6	Connector for regenerative resistor (for overheat)	(Warning 2)
<10>	JX5/CHK	ESP connector & Signal check connector	For the servo check pin board
<11>	JS1B/PWM	NC interface connector Type B interface	
<12>	JF1/ENC	Connector for Pulsecoder connection	
<13>	CX5X,CX5Y	Connector for ABS Pulsecoder battery	

⚠ WARNING

1. It is dangerous to touch any cables and components inside the module while this LED is lit. Never touch components or cables while this LED is lit.
2. Refer to Section 4.7 for details.

2.4 PIN ASSIGNMENT OF CONNECTOR CX11 (SVU4, SVU-12, SVU-20)

The following tables list the pin assignment of connectors CX11-1 to CX11-6.



2.4.1 When No Regenerative Resistor Is Used

Silk CX11	Signal	Housing pin No.	Signal	Housing pin No.	Connector kit A06B-6093-K305 Model number of housing	Specification
-1	L2	A1	L1	B1	175363-3	3φ 200VAC input 1φ 220VAC input
	⏚	A2	L3	B2		
-2	DCC	A	DCP	B	(Caution) 1318182-2	Regenerative resistor
-3	V	A1	U	B1	1318095-2	Motor output
	⏚	A2	W	B2		
	⏚	A3	⏚	B3		Connected when α1 or α2 is used
-4	0V	A	+24V	B	175362-1	Input of 24 VDC control power
-5	0V	A	+24V	B	175362-1	Input of 24 VDC control power
-6	TH2	A	TH1	B	A660-8011-T604	Thermostat for regenerative resistor

Housing manufacturer : tyco Electronics AMP

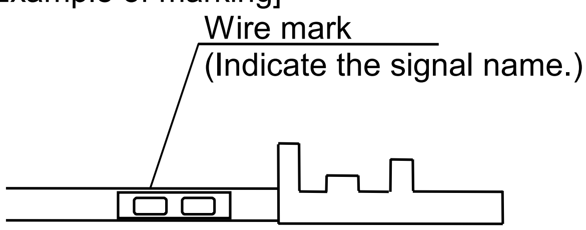
> ⚠ **CAUTION**
> When no regenerative discharge resistor is used, it is recommended to install a dummy housing (1318182-2) for preventing wrong insertion. Do not make a connection between the pins (A and B) of CX11-2. Otherwise, the amplifier can be damaged. For details, see Section 4.6.

2.4.2 When a Regenerative Resistor Is Used

Silk CX11	Signal	Housing pin No.	Signal	Housing pin No.	Improved connector kit A06B-6093-K306 Model number of housing	Specification
-1	L2	A1	L1	B1	175363-3	3φ 200VAC input
	⏚	A2	L3	B2		1φ 220VAC input
-2	DCC	A	DCP	B	---	(Caution) Regenerative resistor
-3	V	A1	U	B1	1318095-2	Motor output
	⏚	A2	W	B2		
	⏚	A3	⏚	B3		Connected when α1 or α2 is used
-4	0V	A	+24V	B	175362-1	Input of 24 VDC control power
-5	0V	A	+24V	B	175362-1	Input of 24 VDC control power
-6	TH2	A	TH1	B	---	(Caution) Thermostat for regenerative resistor

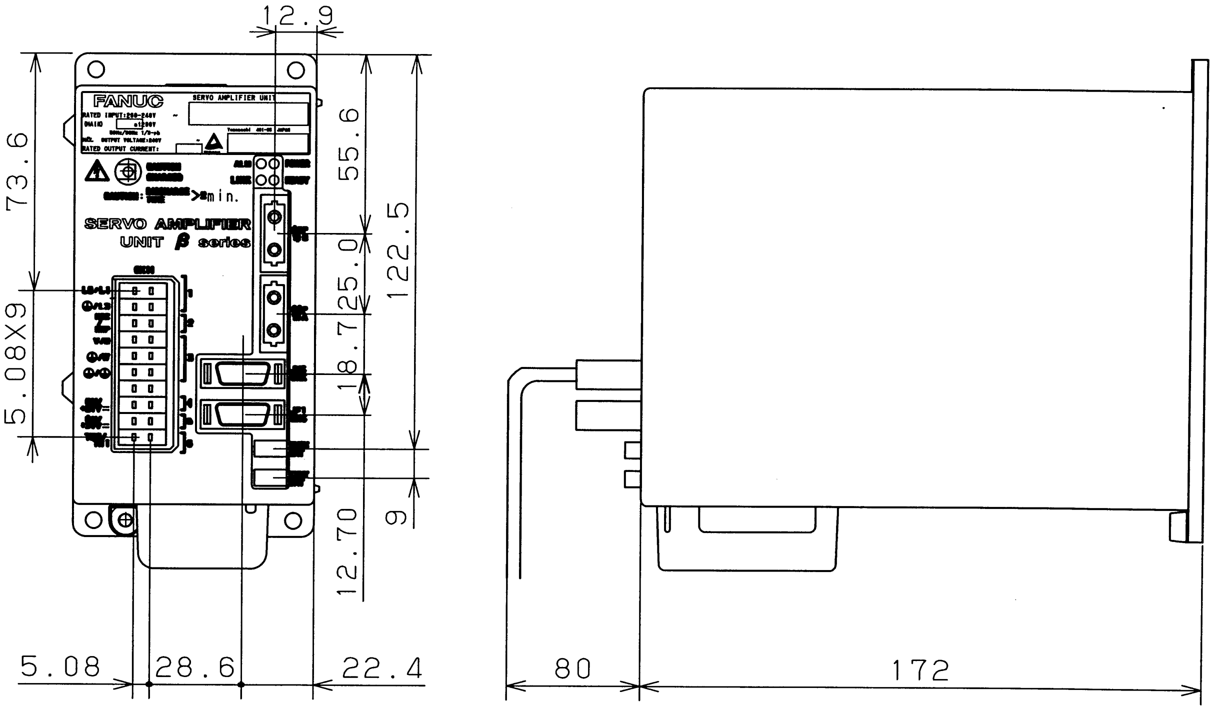
Housing manufacturer : tyco Electronics AMP

> ⚠ **CAUTION**
> Connect the regenerative resistor cables (resistor line and alarm signal line). If a wrong connection is made, the amplifier can be damaged. Refer to Section 4.7 for details.

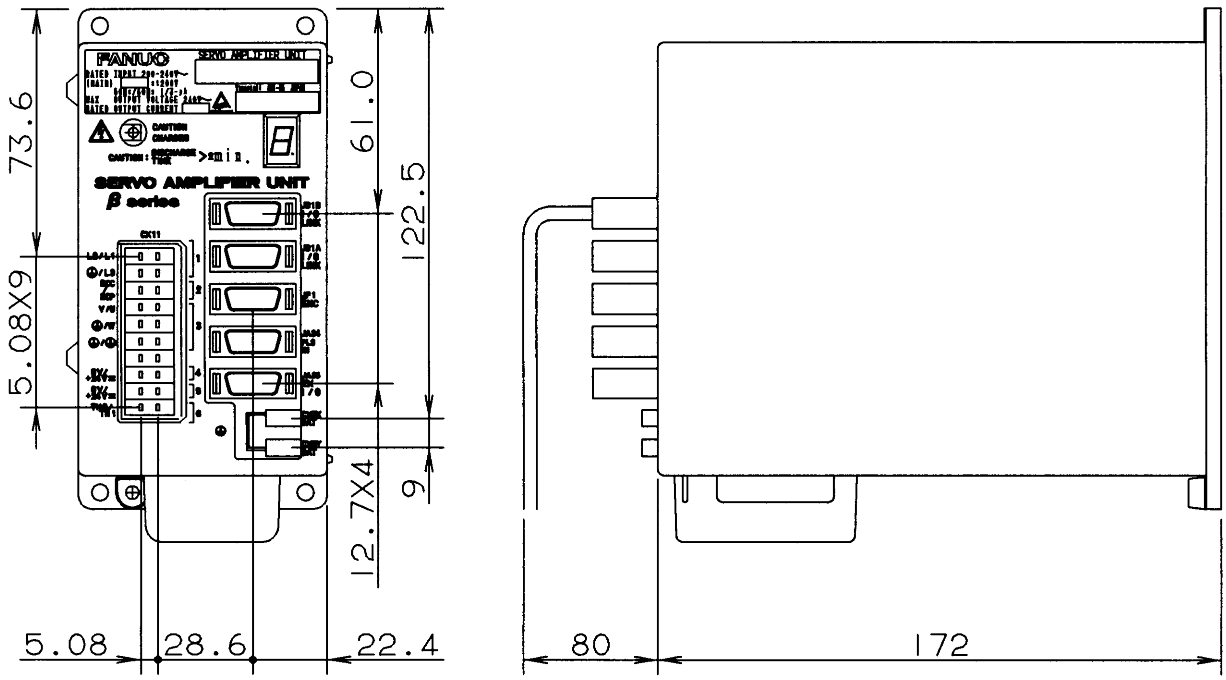
> **NOTE**
> Mark cables with signal names using wire labels or the like to prevent incorrect insertion.
> [Example of marking]
>
> 
>
>
> DCP and DCC can be in either polarity.
> TH1 and TH2 can be in either polarity.

3 DIMENSIONS INCLUDING CABLES

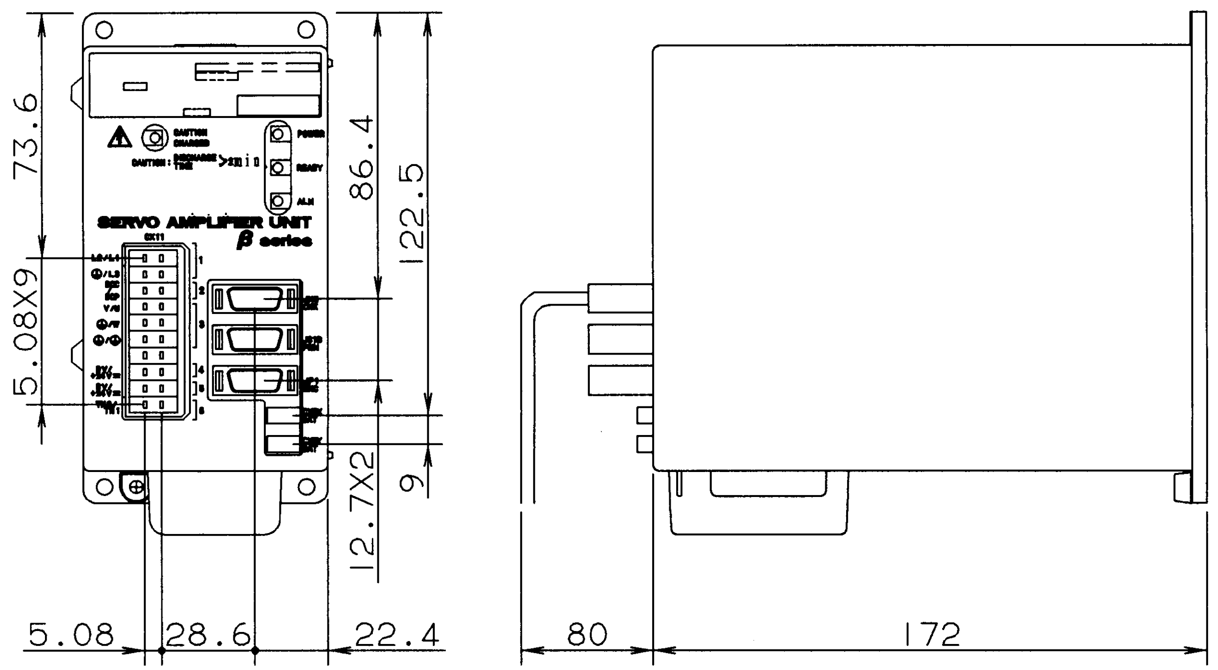
3.1 FSSB INTERFACE (SVU-4, SVU-12, SVU-20)



3.2 I/O Link INTERFACE (SVU-4, SVU-12, SVU-20)

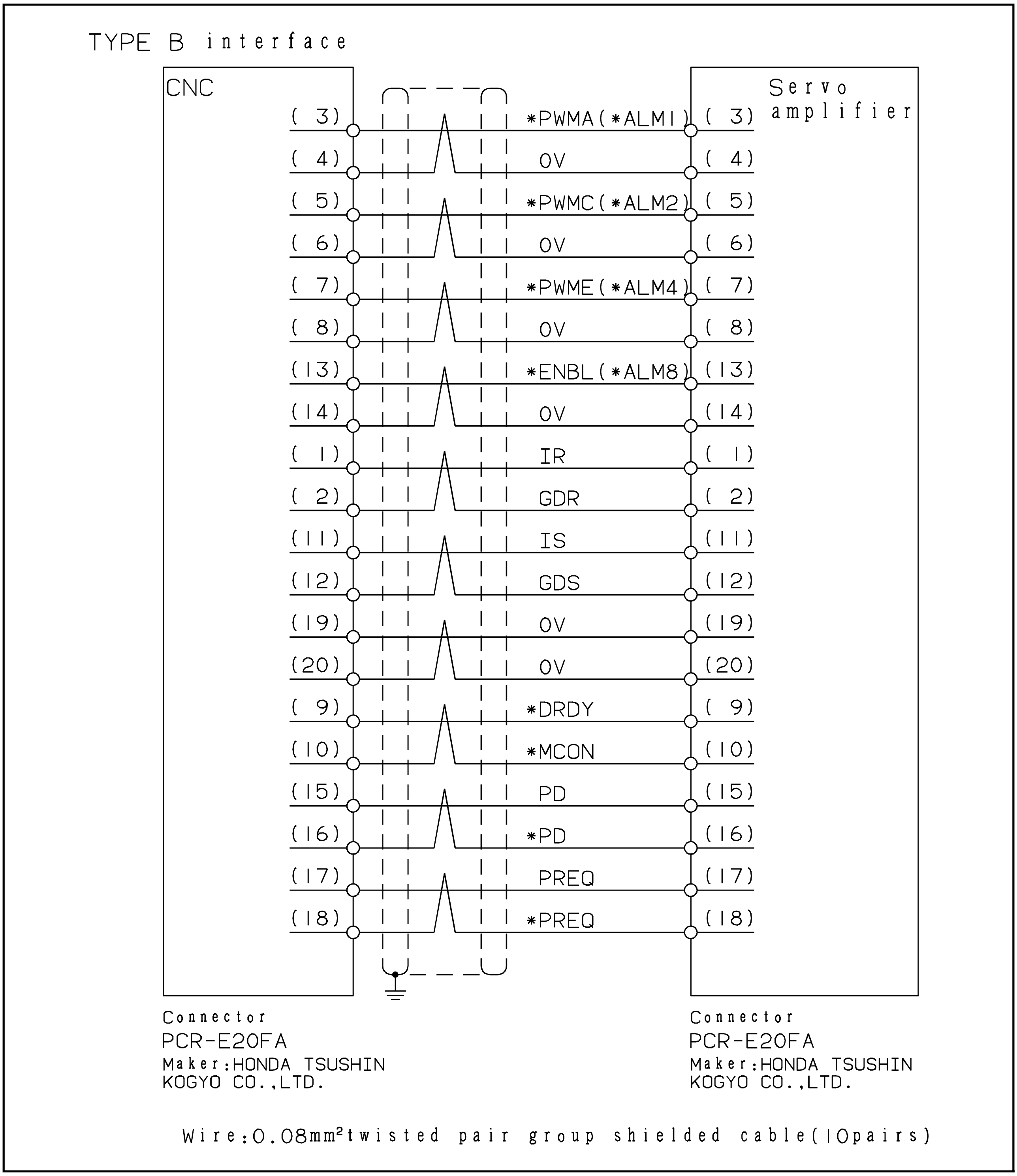


3.3 PWM INTERFACE (SVU-4, SVU-12, SVU-20)



4 DETAILS OF CABLE CONNECTIONS

4.1 K1 CABLE CONNECTION (ONLY FOR PWM INTERFACE)

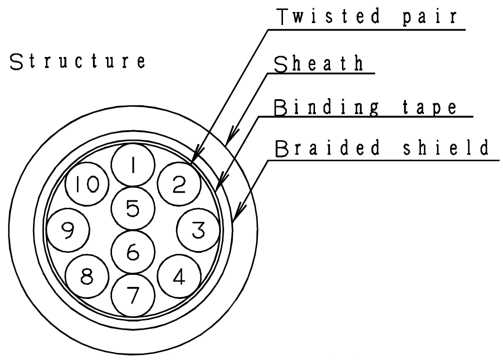


Reference

- Wire for K1 cable

The following wire is recommended for the K1 cable:
FANUC specification : A66L-0001-0284/10P
Name : 10-pair cable
Wire : #28AWG 10 pairs (20 conductors), standard length 200 m
Manufacturer : Hitachi Cable, Ltd., Oki Electric Cable Co., Ltd.

(a) Cable manufactured by HITACHI CABLE,LTD.

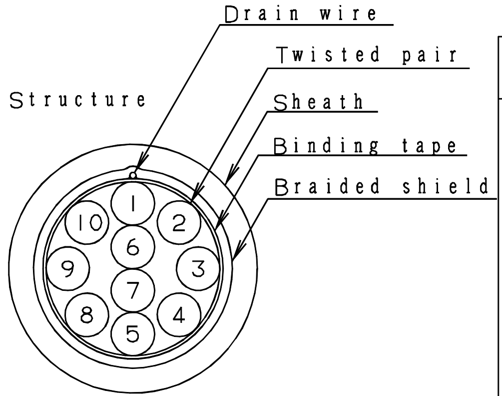


*The circled numbers correponded to the twisted pair numbers in the table shown on the right.

Twisted pair conductor identification(HITACHI)

Twisted pair number	Insulator color	
	First conductor	Second conductor
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

(b) Cable manufactured by OKIELECTRIC CABLE CO.,LTD.



*The circled numbers correponded to the twisted pair numbers in the table shown on the right.

Twisted pair conductor indentification (OKI)

Twisted pair number	Insulator color	Dot mark (1 pitch)	Dot mark color	
			First conductor	Second conductor
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

⚠ WARNING

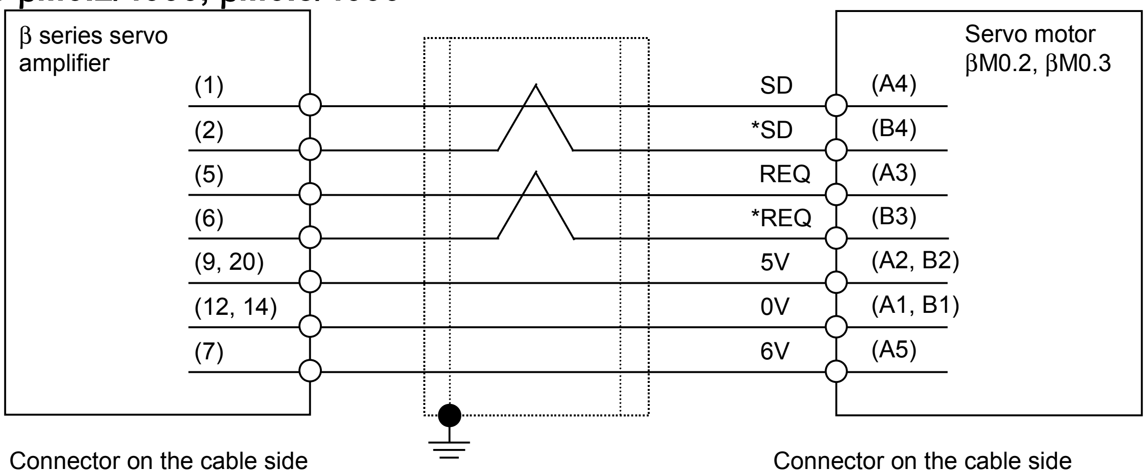
1 For the pairs (1-2, 11-12) used for the current feedback signals (IR, IS), use the central pairs of the cable to minimize the effect of external influences. (For IR and IS, use pairs 5 and 6 when using the Hitachi cable. Use pairs 6 and 7 when using the Oki cable.) The use of other cables may cause uneven feed or abnormal noise.
2 These cables feature group shielding. Connect the shielding to ground on the NC side.

Specifications

Item		Unit	Specifications
Specifications			A66L-0001-0284/10P
Manufacturer			Hitachi Cable, Ltd. Oki Electric Cable Co., Ltd.
Rating			60°C 30V : UL2789 80°C 30V : UL80276
Material	Conductor		Tinned soft steel wire (ASIM B-286)
	Insulator		Cross-linked vinyl
	Braided shield		Tinned soft steel wire
	Sheath		Heat-resistant, oil-resistant vinyl
Number of pairs		Pair	10
Conductor	Size	AWG	28
	Structure	Conductors/mm	7/0.127
	Outside diameter	mm	0.38
Insulator	Thickness	mm	0.1 Minimum thickness: 0.38 (3.1 mils)
	Outside diameter (approximate value)	mm	0.58
	Core style (rating)		UL1571(80°C 30V)
Twisted pair	Outside diameter (approximate value)	mm	1.16
	Twisting pitch	mm	20 or less
Twisted pair binding			A required number of twisted pairs are bundled using binding tape. To form a round cable, an interstitial wire can be used as required.
Outside diameter of bundled twisted pairs		mm	3.5
Drain wire		Wires/mm	Hitachi Cable, Ltd.: No drain wire is provided. Oki Electric Cable Co., Ltd.: A drain wire is provided. 10/0.12
Braided shield	Strand diameter	mm	0.12
	Braiding density	%	85 or more
Sheath	Color		Black
	Thickness	mm	1.0
	Outside diameter (approximate value)	mm	6.2
Standard length		m	200
Packing			Bundle
Electrical characteristics	Electric resistance (20_C)	Ω/km	233 or less
	Insulation resistance (20_C)	MΩ-km	10 or less
	Dielectric strength (A.C.)	V/min.	300
Flame resistance			The UL standard flame resistance test (VW-ISC) must be satisfied.

4.2 K2 CABLE CONNECTION

For βM0.2/4000, βM0.3/4000



Connector on the cable side
Connector
FI40-2015S
Connector cover
FI-20-CV
Manufacture : HIROSE ELECTRIC CO., LTD

Connector on the cable side
Housing
1-1318118-6 (D-2100D 12 poles)
Contact
1318107-1 (D-2 receptacle M)
Manufacture : tyco Electronics AMP

The specifications of a recommended wire are indicated below.

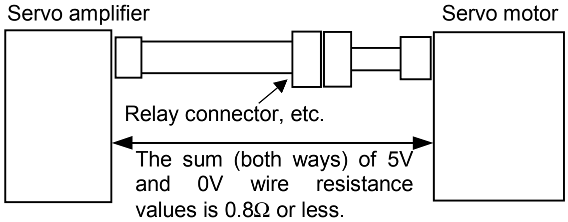
Cable length	20m or lower
5V, 0V	0.5 mm^2(AWG21) × 2 (strand structure 20/0.18, coating outer diameter φ0.88 to φ1.5)
6V	0.5 mm^2(AWG21) (strand structure 20/0.18, coating outer diameter φ0.88 to φ1.5)
SD, *SD, REQ, *REQ	0.18 mm^2 (AWG25) or more. Twisted pair wire (strand structure 7/0.18, coating outer diameter φ0.88 to φ1.5)
Recommended wire	0.5 mm^2 × 5 + 0.18 mm^2 × 2 pairs Hitachi Cable, Ltd. UL20276-SB(0) 5X21AWG+2PX25AWG (A66L-0001-0461) (For a fixed cable)

NOTE

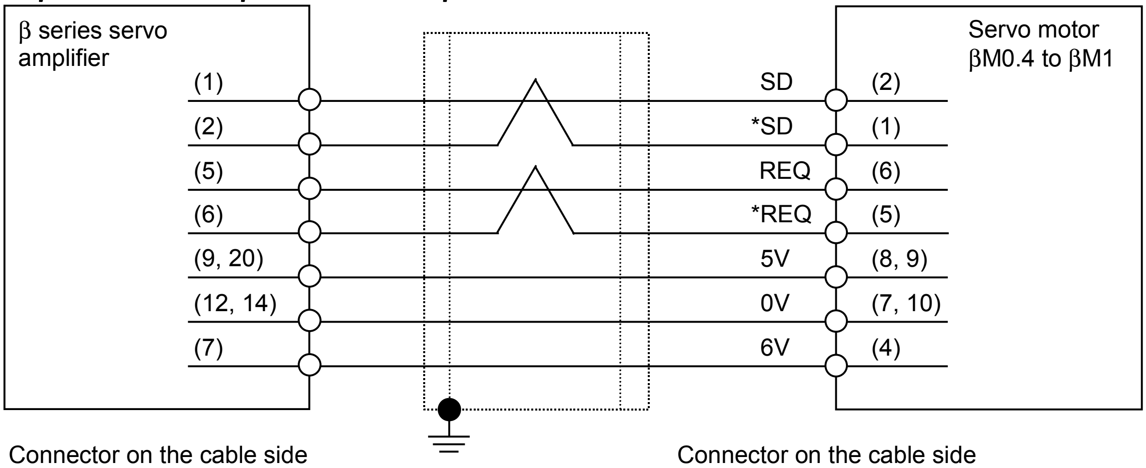
1 When the user prepares a cable, the user needs to ensure that the sum (both ways) of 5V and 0V wire resistance values is 0.8Ω or less.

2 The maximum applicable wire diameter for the motor-side cable connector is 0.5 mm^2 (when the crimping tool (1463475-1) is used) or 0.85 mm^2 (when the crimping tool (1276654-1) is used). When a thicker wire or cable needs to be used, make a relay connection as shown below.

Example: When a maximum applicable wire diameter is exceeded



For βM0.4/4000, βM0.5/4000, βM1/4000



Connector on the cable side
Connector
FI40-2015S
Connector cover
FI-20-CV
Manufacture : HIROSE ELECTRIC CO., LTD

Connector on the cable side
Connector
JN1xS10SL1 : for ϕ5.7 to 7.3 sheath diameter
JN1xS10SL2 : for ϕ6.5 to 8.0 sheath diameter
x→D : Straight plug
F : Angle plug
Contact
JN1-22-22S
Manufacture : Japan Aviation Electronics Industry

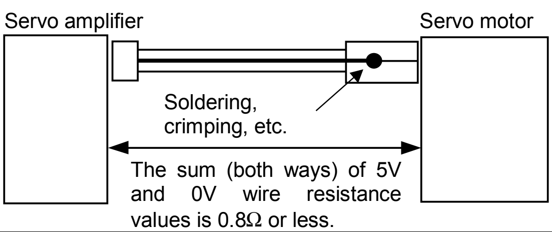
The specifications of a recommended wire are indicated below.

Cable length	20m or more
5V, 0V	0.5 mm^2(AWG21) × 2 (strand structure 20/0.18, coating outer diameter ϕ1.5 or lower)
6V	0.5 mm^2(AWG21) (strand structure 20/0.18, coating outer diameter ϕ1.5 or lower)
SD, *SD, REQ, *REQ	0.18 mm^2 (AWG25) or more. Twisted pair wire (strand structure 7/0.18, coating outer diameter ϕ1.5 or lower)
Recommended wire	0.5 mm^2 × 5 + 0.18 mm^2 × 2 pairs Hitachi Cable, Ltd. UL20276-SB(0) 5X21AWG+2PX25AWG (A66L-0001-0461) (For a fixed cable)

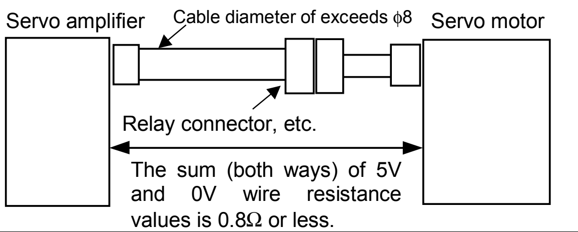
NOTE

1. When the user prepares a cable, the user needs to ensure that the sum (both ways) of 5V and 0V wire resistance values is 0.8Ω or less.
2. The maximum applicable wire diameter for the motor-side cable connector is 0.5 mm^2 (strand structure 20/0.18 or 104/0.08, coating outer diameter ϕ1.5 or less), and the sheath diameter is ϕ5.7 to ϕ8.0. When a thicker wire or cable needs to be used, perform the processing shown below.
3. For an incremental pulse coder, no 6V connection is required.

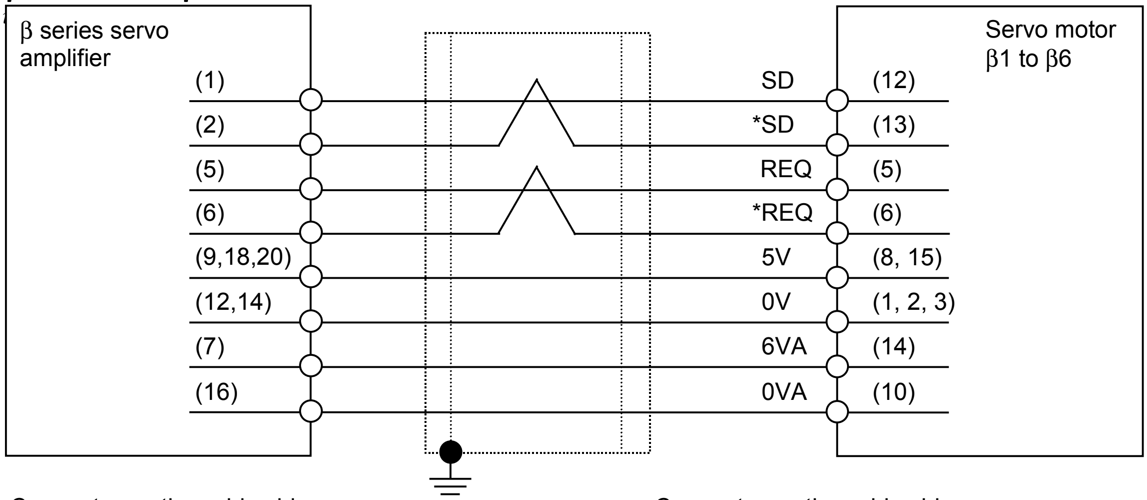
Example 1: When the wire diameter exceeds 0.5 mm^2



Example 2: When the sheath diameter of the cable exceeds ϕ8



For β1/3000 to β6/2000



Connector on the cable side
Connector
FI40-2015S
Connector cover
FI-20-CV
Manufacture : HIROSE ELECTRIC CO., LTD

Connector on the cable side
Connector
HDAB-15S (D-sub 15 pins)
Connector cover
HDAW-15-CV (waterproof)
HDA-CTH (non-waterproof)
Manufacture : HIROSE ELECTRIC CO., LTD

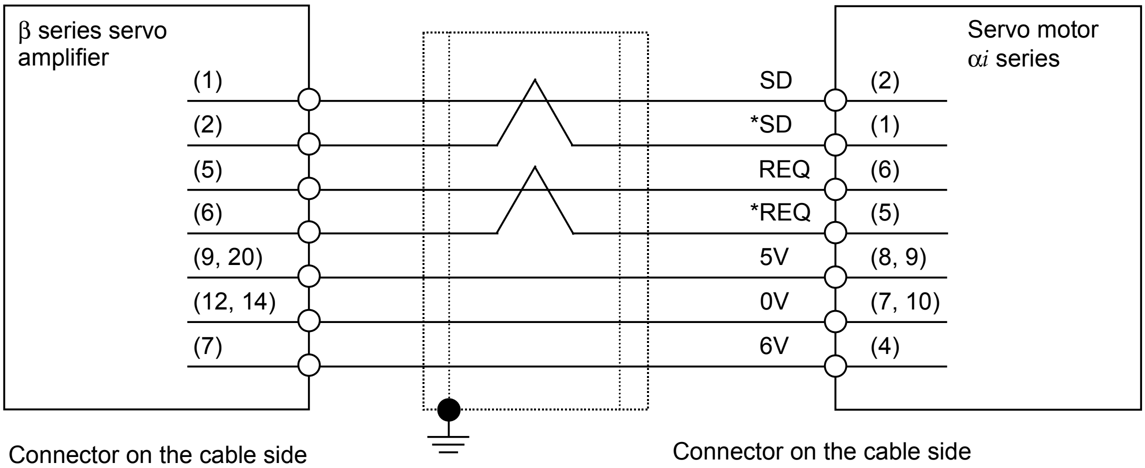
The specifications of a recommended wire are indicated below.

Cable length	14m or lower
5V, 0V	0.5 $mm^2 \times 2$
6VA, 0VA	0.5 mm^2
SD, *SD, REQ, *REQ	0.18 mm^2 (AWG25) or more. Twisted pair wire

NOTE

1 When the user prepares a cable, the user needs to ensure that the sum (both ways) of 5V and 0V wire resistance values is 0.5Ω or less.
2 For an incremental pulse coder, no 6VA and 0VA connections are required.

For αi series servo motor



Connector on the cable side
Connector
FI40-2015S
Connector cover
FI-20-CV
Manufacture : HIROSE ELECTRIC CO., LTD

Connector on the cable side
Connector
JN1xS10SL1 : for ϕ5.7 to 7.3 sheath diameter
JN1xS10SL2 : for ϕ6.5 to 8.0 sheath diameter
x→D : Straight plug
F : Angle plug
Contact
JN1-22-22S
Manufacture : Japan Aviation Electronics Industry

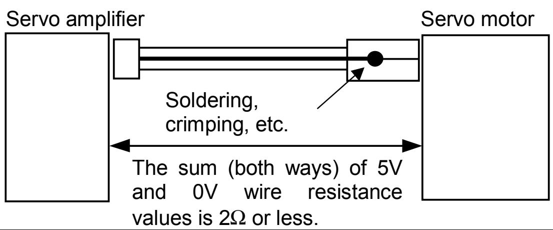
The specifications of a recommended wire are indicated below.

Cable length	50m or lower
5V, 0V	0.5 mm^2(AWG21) $\times$ 2 (strand structure 20/0.18, coating outer diameter ϕ1.5 or lower)
6V	0.5 mm^2(AWG21) (strand structure 20/0.18, coating outer diameter ϕ1.5 or lower)
SD, *SD, REQ, *REQ	0.18 mm^2 (AWG25) or more. Twisted pair wire (strand structure 7/0.18, coating outer diameter ϕ1.5 or lower)
Recommended wire	0.5 mm^2 $\times$ 5 + 0.18 mm^2 $\times$ 2 pairs Hitachi Cable, Ltd. UL20276-SB(0) 5X21AWG+2PX25AWG (A66L-0001-0461) (For a fixed cable)

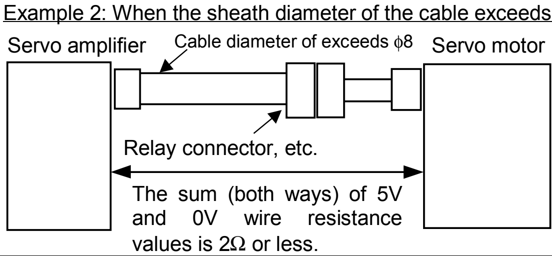
NOTE

1. When the user prepares a cable, the user needs to ensure that the sum (both ways) of 5V and 0V wire resistance values is 2Ω or less.
2. The maximum applicable wire diameter for the motor-side cable connector is 0.5 mm^2 (strand structure 20/0.18 or 104/0.08, coating outer diameter ϕ1.5 or less), and the sheath diameter is ϕ5.7 to ϕ8.0. When a thicker wire or cable needs to be used, perform the processing shown below.
3. For an incremental pulse coder, no 6V connection is required.

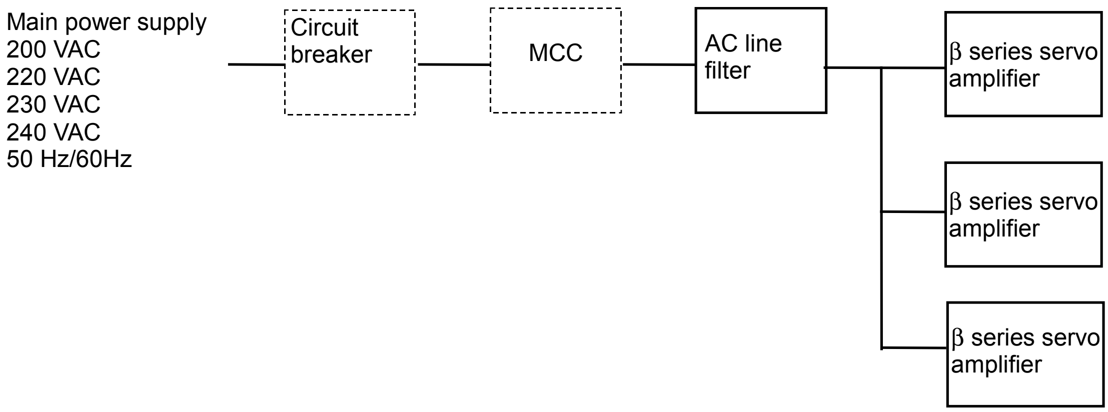
Example 1: When the wire diameter exceeds 0.5 mm^2



Example 2: When the sheath diameter of the cable exceeds ϕ8



4.3 K3 CABLE CONNECTION



Housing : 175363-3
Contact : 1-175218-2
Manufacturer : tyco Electronics AMP

Model	Applicable cable	
	Cabtyre cable (Warning 1)	Heat-resistant vinyl cable (Warning 2)
SVU-12	$0.5mm^2$ or more	$0.5mm^2$ or more
SVU-20	$1.0mm^2$ or more	$1.0mm^2$ or more

⚠ WARNING

1. 600V vinyl cabtyre cable, JIS C 3312, 4 conductors
2. Heat-resistive vinyl cable
   (maximum conductor temperature: 105°C)
   (equivalent to the LMFC, manufactured by FURUKAWA ELECTRIC CO., LTD.)

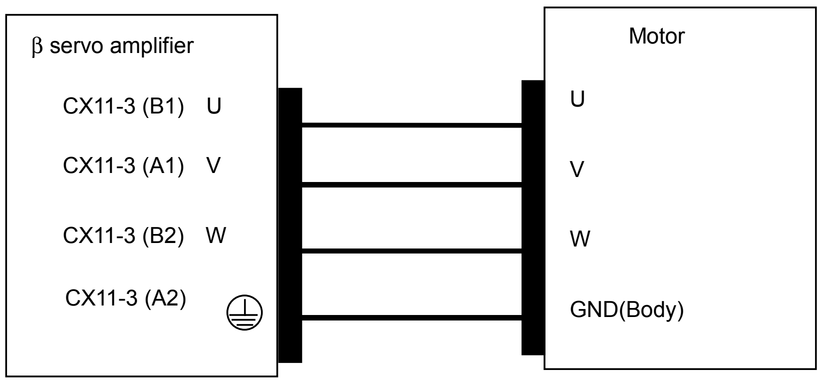
4.4 K4 CABLE CONNECTION

This section describes the servo motor/amplifier power cable in the following order:
1. Connector
2. Power cable selection (general)
3. Servo motor power cable

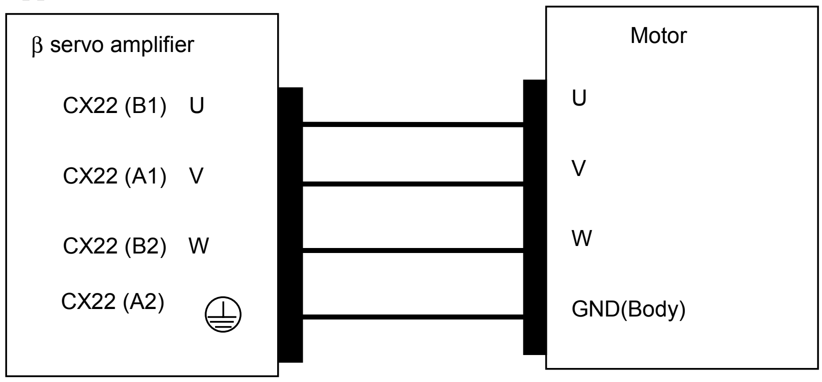
1. Connector

With the β series, the D-3000 or D-5000 series connector (manufactured by tyco Electronics AMP) is employed for power cable connection. For each model, the specifications of receptacle housings and receptacle contacts are provided below.

Applicable models : SVU-4, SVU-20



Applicable models : SVU-40, SVU-80



[Receptacle housing]
Receptacle housings with two key types are available. Use a receptacle housing with the key type suitable for the servo amplifier.

Model number of receptacle housing	Key specification	Applicable models	Remarks
1318095-2	Wrong insertion protection key	SVU-4, SVU-20	(*1)
1-917807-2	XX	SVU-40, SVU-80	

(*1) The key-less receptacle housings (175362-1, 175363-1) are also usable. However, the use of the receptacle housings with the specifications above is recommended.

[Receptacle contact]
Receptacle contacts are available for two wire diameter ranges of a cable. Use a receptacle contact suitable for the wire diameter of the cable used.

Applicable models : SVU-4, SVU-20

Model number of receptacle contact		Wire size (mm^2)	Wire size AWG	Insulation coating outer diameter (mm)	Model number of manual tool
M size	1-175217-2	0.2- 0.5	24/22/20	1.2-2.6	91559-1
L size	1-175218-2	0.5- 1.25	20/18/16	1.8-2.8	91558-1

Applicable models : SVU-40, SVU-80

Model number of receptacle contact		Wire size (mm^2)	Wire size AWG	Insulation coating outer diameter (mm)	Model number of manual tool
S size	316040-2	1.23 – 2.27	16/14	3.0-3.8	0-234170-1
M size	316041-2	3.08 – 5.50	12/10	4.0-5.2	0-234171-1

[Connector and tool ordering information]
The connectors (housings, contacts) and tools can be purchased directly from tyco Electronics AMP. They are also available as options from FANUC as indicated below.

Applicable models : SVU-4, SVU-20

Specifications	Contents	
A06B-6093-K305 (When no regenerative resistor is used)	Housing	Wrong insertion protection key 175363-3 (1pcs.) Wrong insertion protection key 1318182-2 (1pcs.) Wrong insertion protection key 1318095-2 (1pcs.) Key-less 175362-1 (2pcs.) Dummy connector A660-8011-T604 (1pcs.)
	Contact	M size 1-175217-2 (4pcs.) Applicable wire diameter: 0.2-0.5mm^2, AWG24/22/20 Applicable tool: 91559-1 (not included in the kit)
	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 the kit)
A06B-6093-K306 (When a regenerative resistor is used)	Housing	Wrong insertion protection key 175363-3 (1pcs.) Wrong insertion protection key 1318095-2 (1pcs.) Key-less 175362-1 (2pcs.)
	Contact	M size 1-175217-2 (4pcs.) Applicable wire diameter: 0.2-0.5mm^2, AWG24/22/20 Applicable tool: 91559-1 (not included in the kit)
	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 the kit)

Applicable models : SVU-40, SVU-80

Specifications	Contents
A06B-6093-K312	Housing: XX key 1-917807-2 (1pcs.) Contact: S size 316040-2 (4pcs.) Applicable wire diameter: 1.23-2.27mm^2, AWG16/14 Applicable tool: 0-234170-1 (not included in the kit)
A06B-6093-K313	Housing: XX key 1-917807-2 (1pcs.) Contact: M size 316041-2 (4pcs.) Applicable wire diameter: 3.08-5.50mm^2, AWG12/10 Applicable tool: 0-234171-1(not included in the kit)

Crimping tool

Specifications	Contents
A06B-6110-K220#D5S	Applicable tool: 0-234170-1 Contact: S size 316040-2 Applicable wire diameter: 1.23-2.27mm^2, AWG16/14
A06B-6110-K220#D5M	Tool: 0-234171-1 Contact: M size 316041-2 Applicable wire diameter: 3.08-5.50mm^2, AWG12/10
A06B-6110-K220#D5R	Extractor: 409158-1

2. Power cable selection (general)

When selecting cable specifications, consider the following use conditions:

<1> Motor rated current or actual current on the machine
<2> Power cable type (heat resistance, etc)
<3> Cable installation environment (ambient temperature, etc.)
<4> Requirement for waterproofness (Pay attention to the matching diameter with a cable clamp)
<5> Compliance with CE marking (compliance with various safety standards and EMC standard)

Examples of heavy-duty power cord selection are provided below. Before applying an example of selection to an actual case, the user needs to carefully check the use conditions. Note that data such as power line diameter information is calculated based on JCS No. 168 D (1980) "Allowable Current of Power Cable (No. 1)".

[Examples of power cable selection (reference information)]

[Selection example 1]

Heavy-duty power cord specifications

Maximum allowable conductor temperature: 60°C

Ambient temperature: 30°C

Cable wire diameter [mm^2]	Allowable current value [Arms]	Model number of receptacle contact
0.75	Up to 11	L size 1-175218-2
1.25	Up to 15	L size 1-175218-2 S size 316040-2
2	Up to 19	S size 316040-2
3.5	Up to 27	M size 316041-2
5.5	Up to 35	M size 316041-2

[Selection example 2]

Heavy-duty power cord specifications:

Maximum allowable conductor temperature: 80°C

Ambient temperature: 55°C

Cable wire diameter [mm^2]	Allowable current value [Arms]	Model number of receptacle contact
0.75	Up to 9.2	L size 1-175218-2
1.25	Up to 12.7	L size 1-175218-2 S size 316040-2
2	Up to 16.3	S size 316040-2
3.5	Up to 23.4	M size 316041-2
5.5	Up to 31.2	M size 316041-2

3. Servo motor power cable

A servo motor power cable consists of the following components:
<1> Power cable
<2> Amplifier-side connector
<3> Motor-side connector

<1> Power cable
Based on "2. Power cable selection (general)" above, an example of combinations of servo motors with power cables is described below.

[Example of combinations of servo motors with power cables (reference information)]

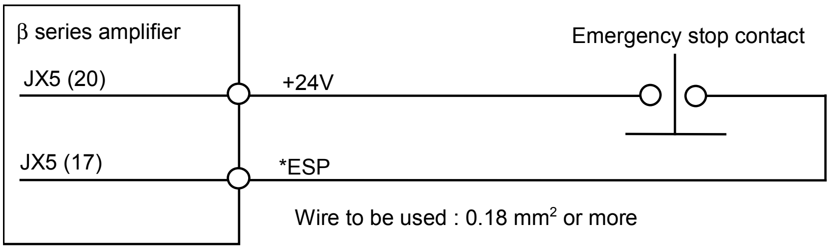
Servo motor	Continuous rated current [Arms] (reference value)	[Selection example 1] Cable wire diameter [mm^2]	[Selection example 2] Cable wire diameter [mm^2]
α1/5000*i*	2.7	0.75	0.75
αM2/5000*i*	3.3	0.75	0.75
α2/5000*i*	3.5	0.75	0.75
αC4/3000*i*	4.1	0.75	0.75
αM3/5000*i*	4.6	0.75	0.75
αC8/2000*i*	5.6	0.75	0.75
αC12/2000*i*	6.5	0.75	0.75
α4/4000*i*	7.7	0.75	0.75
α8/3000*i*	8.4	0.75	0.75
αM8/4000*i*	11.1	0.75	1.25
αC22/2000*i*	12.3	1.25	1.25
αM12/4000*i*	13.4	1.25	2
αC30/1500*i*	14.2	1.25	2
α12/3000*i*	18.1	2	3.5
α22/3000*i*	18.4	2	3.5
βM0.2/4000	0.9	0.75	0.75
βM0.3/4000	0.9	0.75	0.75
βM0.4/4000	3.5	0.75	0.75
βM0.5/4000	3.0	0.75	0.75
βM1/4000	2.7	0.75	0.75

<2> Amplifier-side connector
Select a connector according to "1. Connector" above.

<3> Motor-side connector
The specifications of a motor-side connector depend on the motor model.
For details of motor-side connectors for the β series servo motors and βM series servo motors, see Chapter 9, "CONNECTOR", in Part I of this manual.
For details of motor-side connectors for the α*i* series servo motors, refer to "FANUC AC SERVO MOTOR α*i* series DESCRIPTIONS (B-65262EN)".

4.5 K5 CABLE CONNECTION

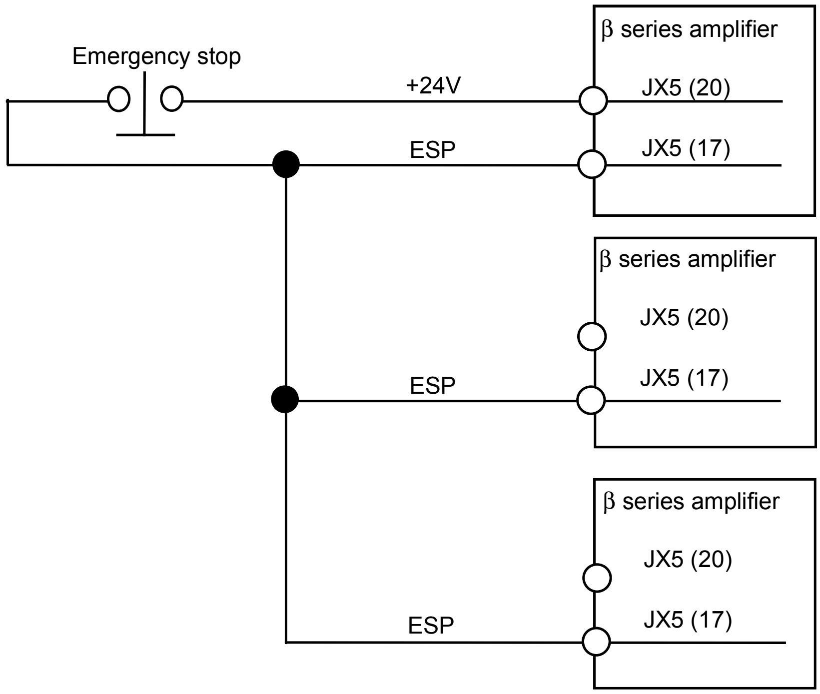
4.5.1 FOR FSSB Interface or PWM Interface



Housing : PCR-V20LA
Connector : PCR-E20FA
Manufacturer : Honda Tsushin Kogyo

> **NOTE**
> When the contact is on (closed), the servo motor is ready for operation. When the contact is off (open), the external magnetic contactor (MCC) is off, disabling the servo motor.
> If the contact is turned off (open) during motor rotation, the servo motor stops with a dynamic brake.
> Contact input signals must satisfy the following requirements:
> The external contact is rated at 30VDC, 100mA or higher.
> The significant levels for no-contact inputs (if used) are:
> Low level (logic 0) = not higher than 2V
> High level (logic 1) = not lower than 20V

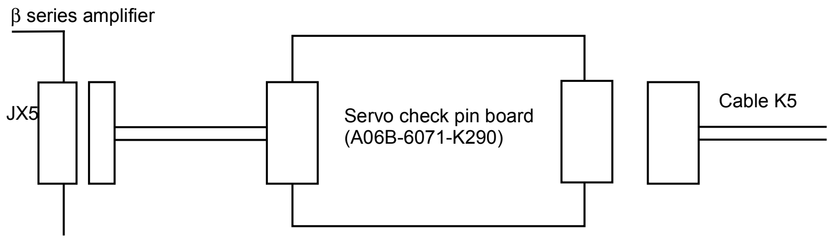
4.5.2 ESP Signal Using More than One β Amplifier



> ⚠ **WARNING**
> Up to six β series amplifiers can be connected to the emergency stop switch.

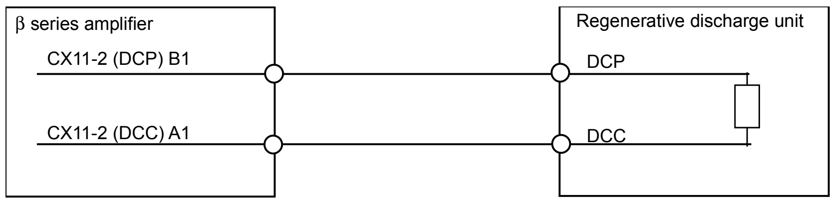
4.5.3 ESP Signal in Using a Servo Check Pin Board

To use a servo check pin board (A06B-6071-K290), remove cable K5 from connector JX5 and attach the servo check pin board. The pin board has two connectors that are arranged back-to-back with their pins connected on a one-to-one basis. Attach the cable K5 to the remaining connector.
For details, refer to the maintenance manual (B-65235EN) for the β series amplifiers.



4.6 K7 CABLE CONNECTION

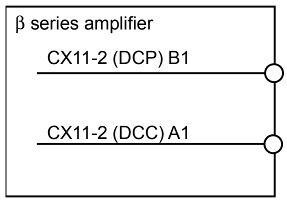
4.6.1 When Regenerative Discharge Unit is Used



Housing
175362-1
Contact
1-175218-2
Manufacturer : tyco Electronics AMP

A06B-6093-H401
or
A06B-6093-H402

4.6.2 When Regenerative Discharge Unit is not Used

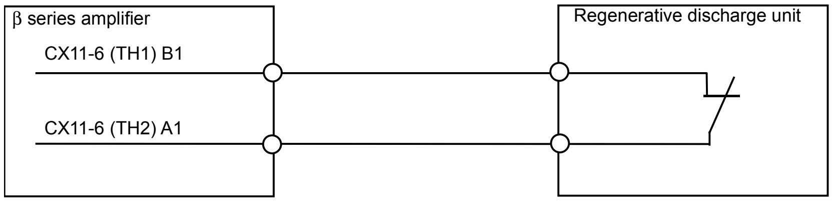


Housing
1318182-2
Contact
None
Manufacturer : tyco Electronics AMP

> ⚠ **CAUTION**
> Do not make a connection between the DCP pin and DCC pin.
> It is recommended to protect against wrong insertion by inserting a housing (1313182-2).

4.7 K8 CABLE CONNECTION

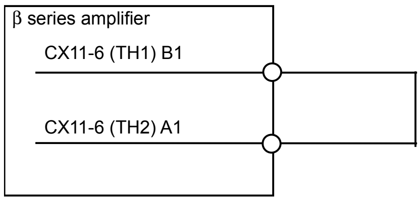
4.7.1 When Regenerative Discharge Unit is Used



Housing
175362-1
Contact
1-175218-2
Manufacturer : tyco Electronics AMP

4.7.2 When Regenerative Discharge Unit is not Used

If no regenerative discharge unit is used, jumper the CX11-6 pins.
The connector kit (A06B-6093-K301) comes with a standard dummy connector that jumpers the CX11-6 pins.

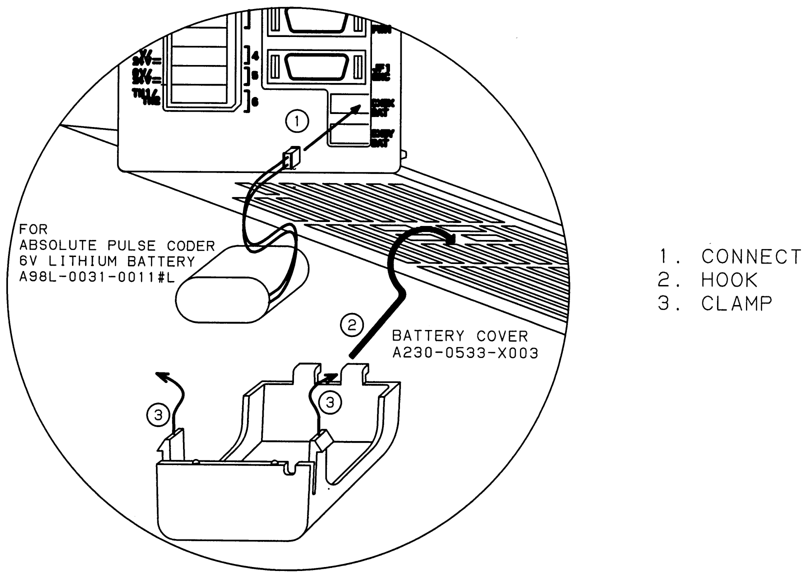


Housing
175362-1
Contact
1-175218-2
Manufacturer : tyco Electronics AMP

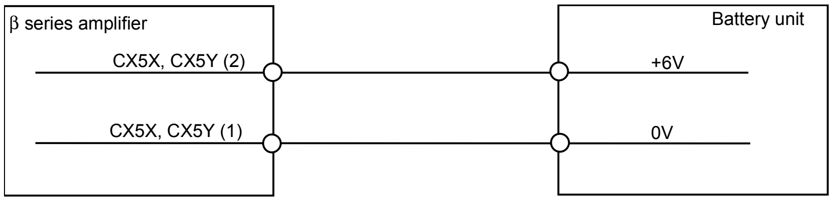
4.8 K9 CABLE CONNECTION

Connection method 1

The lithium battery has its own connecting cables. Mount the lithium battery in the amplifier, as shown below.

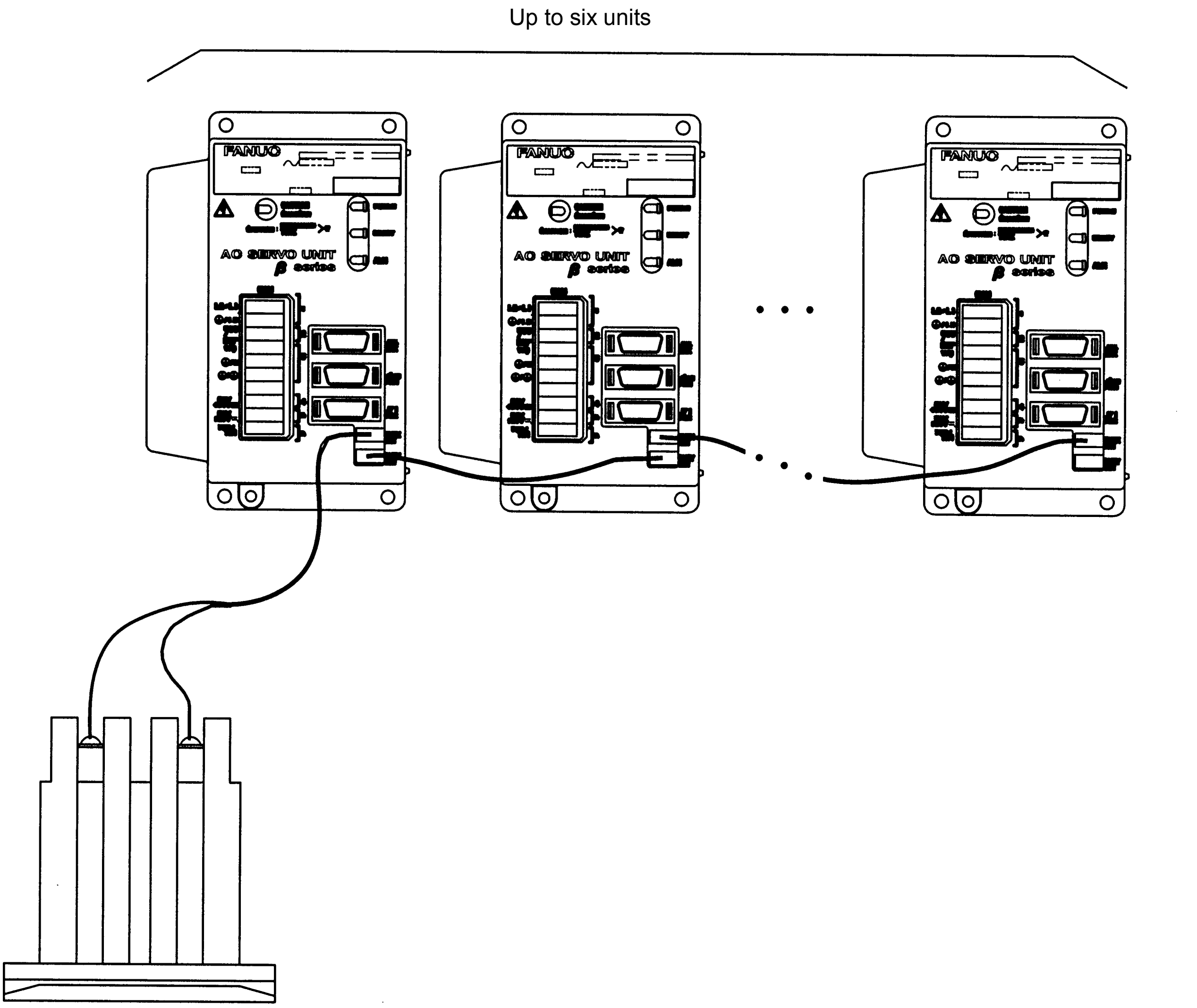


Connection method 2



Housing	Wire to be used	Screw terminal : M3
IL-L2S-S3L-B(N)	Nominal sectional area	Crimp terminal : 1.25-4
Contact	0.32mm^2 or less	
IL-C2-1-00001		

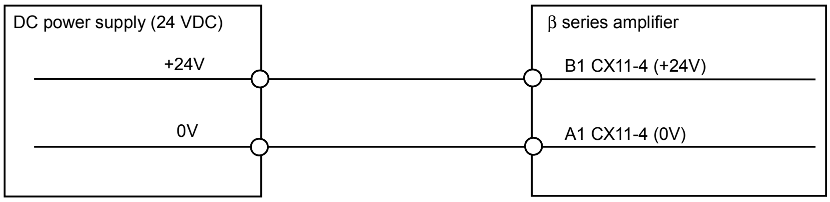
Manufacturer : Japan Aviation Electronics Industry



4.9 K10 CABLE CONNECTION

Use a wire that satisfies the specifications of the electromagnetic contactor.
Install a device such as a spark killer in order to suppress noise that can arise from an abrupt change in current when the circuit operates.

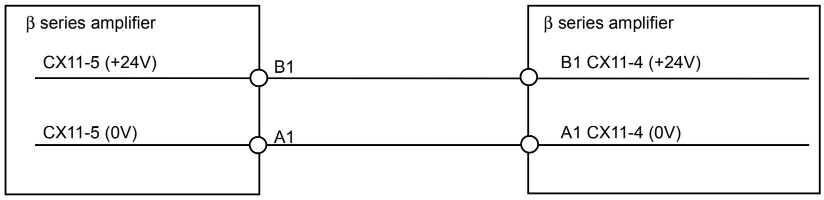
4.10 K12 CABLE CONNECTION



Wire to be used
Nominal sectional area :
0.22 to 1.42 mm^2 or less

Housing
175362-1
Contact
1-175217-2 (0.22 to 0.5mm^2)
1-175218-2 (0.51 to 1.42mm^2)
Manufacturer :
tyco Electronics AMP

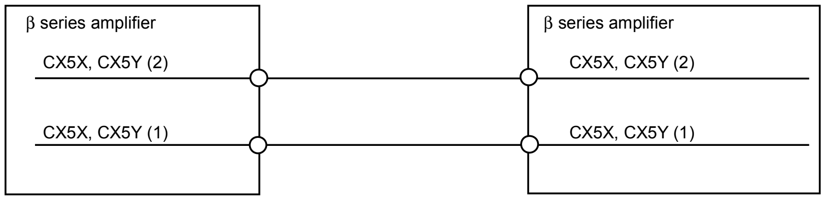
4.11 K13 CABLE CONNECTION



Wire to be used
Nominal sectional area : 0.22 to 1.42 mm^2

Housing	Housing
175362-1	175362-1
Contact	Contact
1-175217-2	1-175217-2 (0.22 to 0.5mm^2)
1-175218-2	1-175218-2 (0.51 to 1.42mm^2)
Manufacturer : tyco Electronics AMP	Manufacturer : tyco Electronics AMP

4.12 K14 CABLE CONNECTION



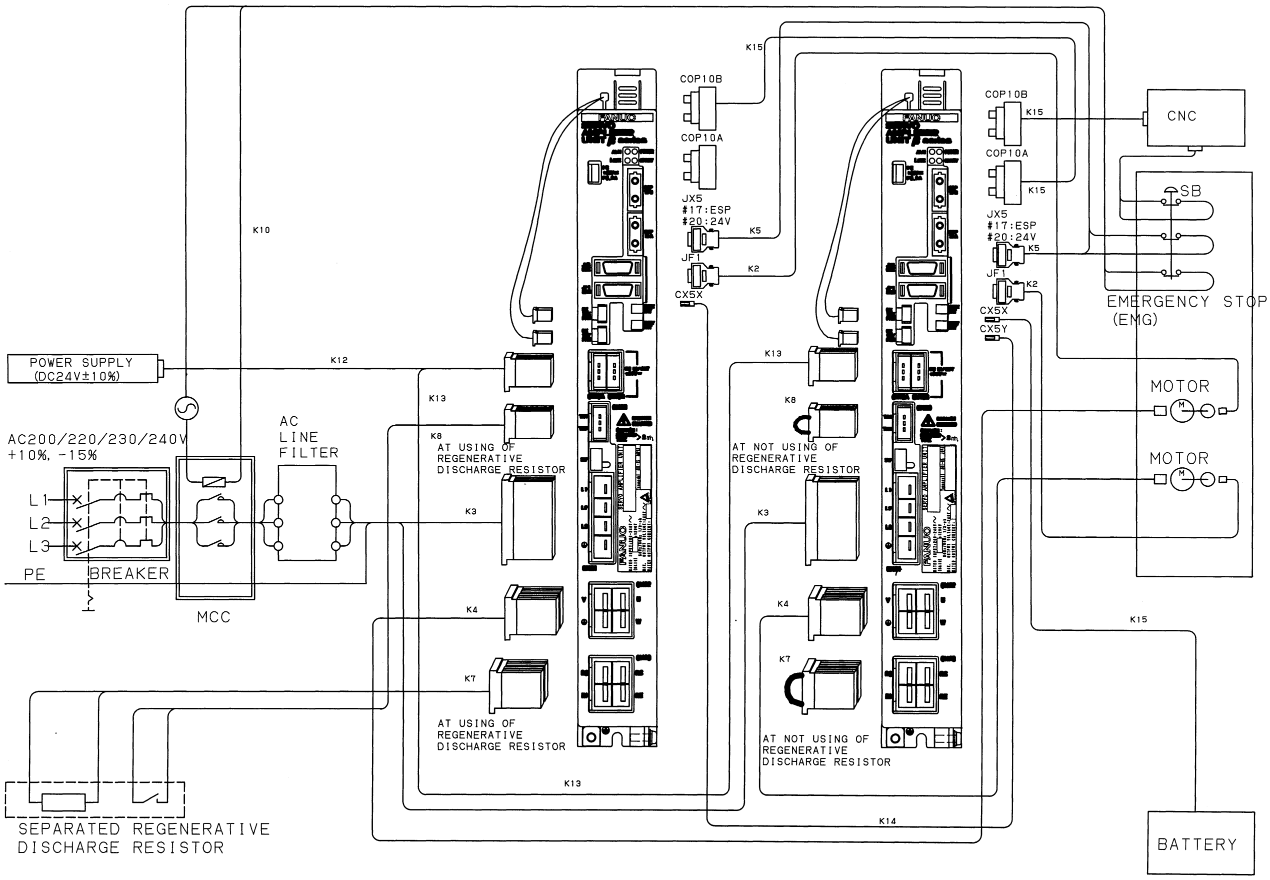
Wire to be used
Nominal sectional area : 0.32 mm^2 or less

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

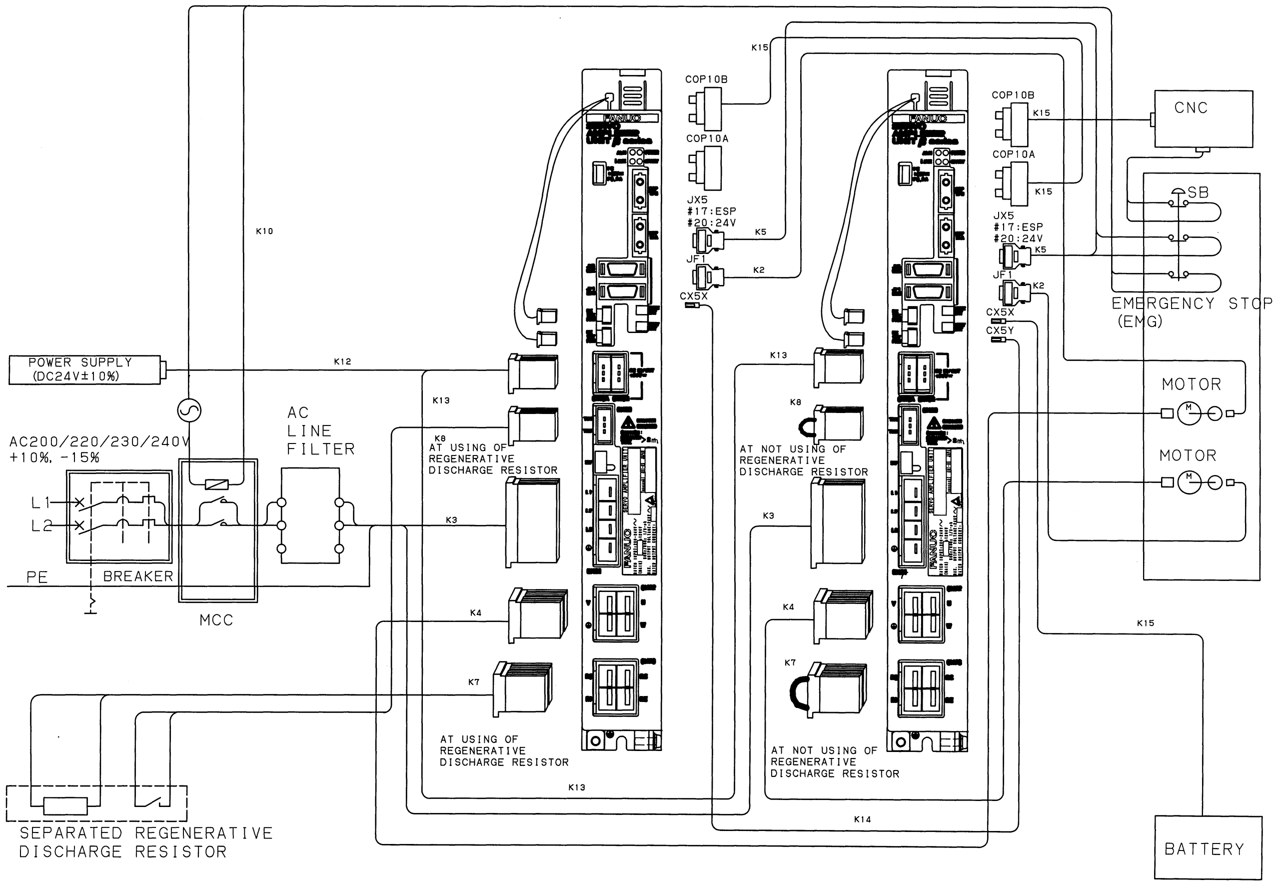
5 TOTAL CONNECTION DIAGRAM

5.1 FSSB INTERFACE (SVU40, SVU-80)

5.1.1 Three-phase Power Input

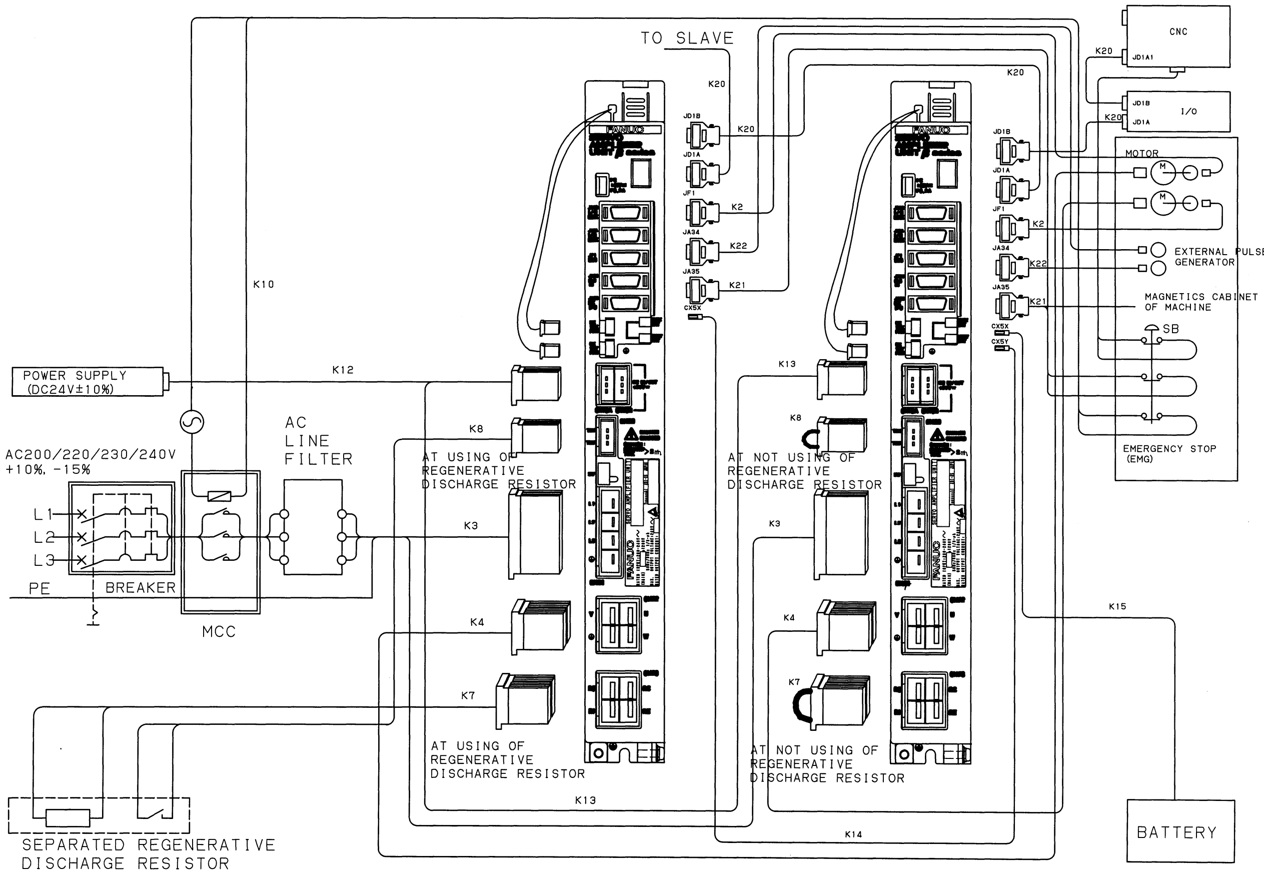


5.1.2 Single-phase Power Input

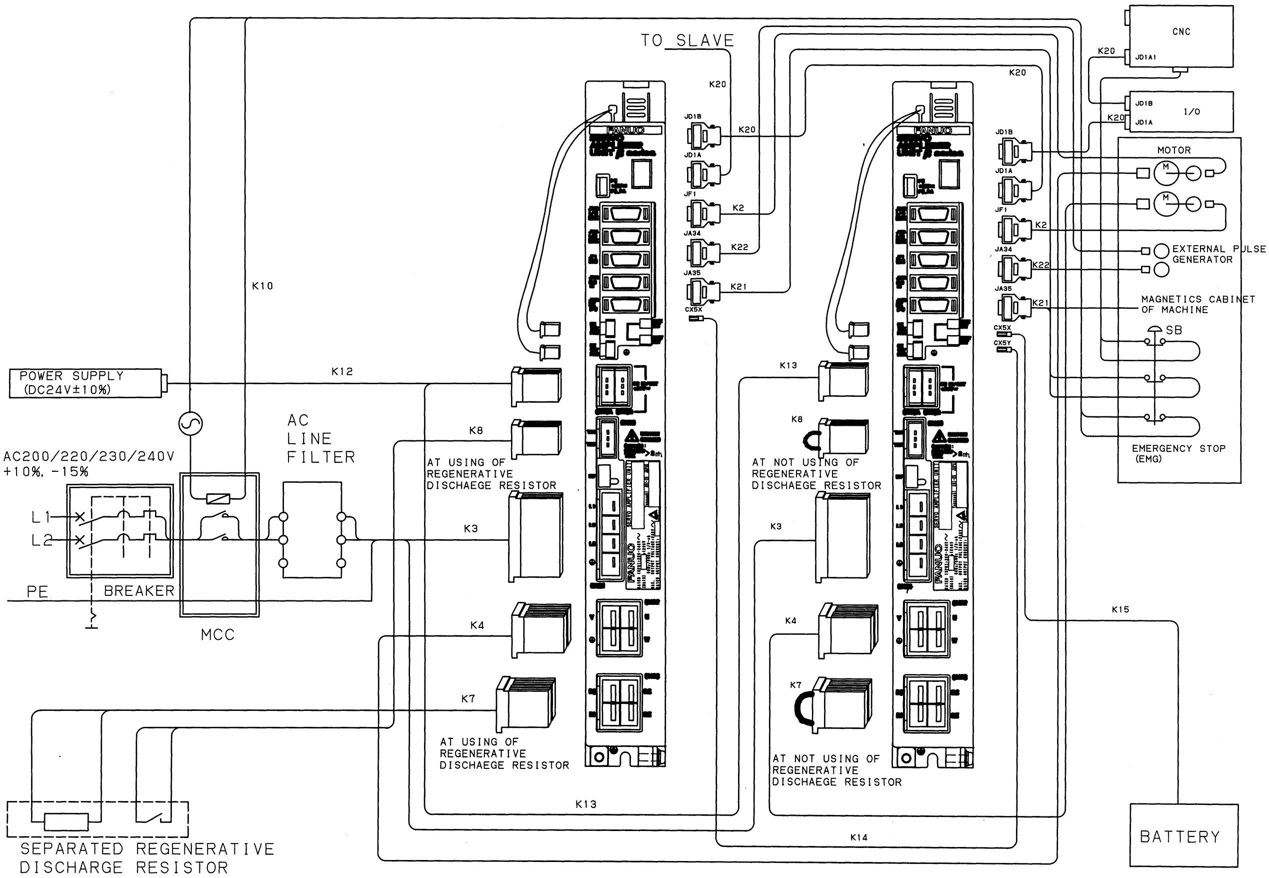


5.2 I/O Link INTERFACE(SVU40, SVU-80)

5.2.1 Three-phase Power Input

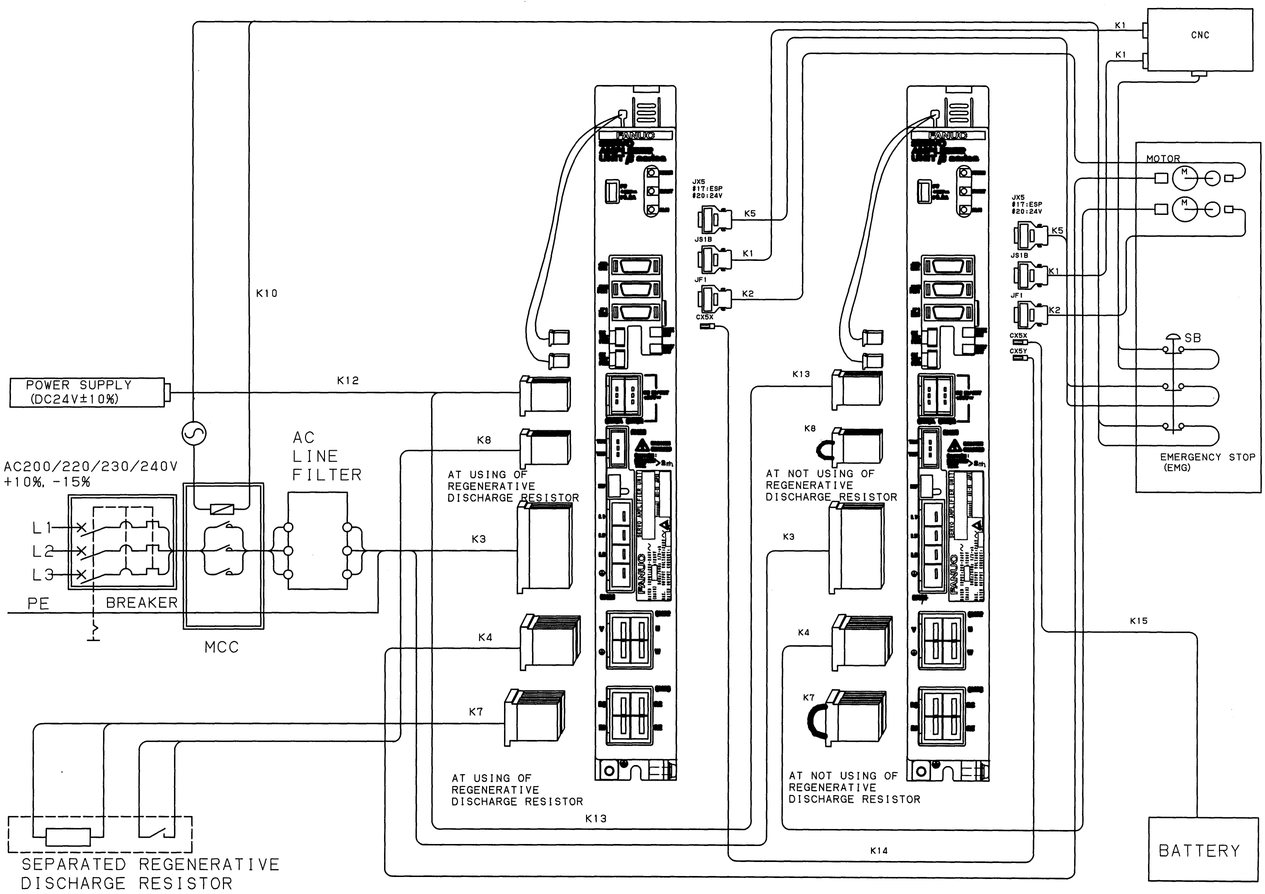


5.2.2 Single-phase Power Input

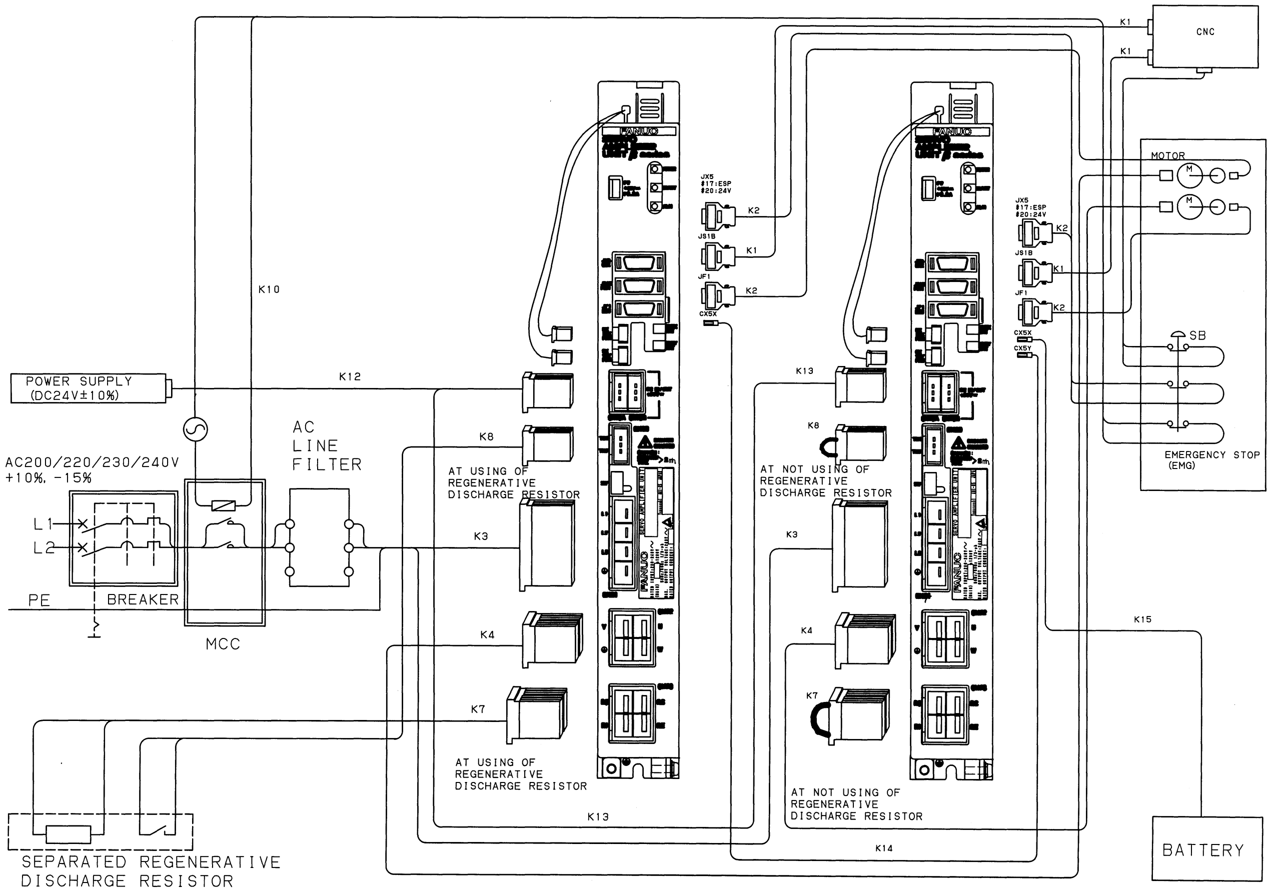


5.3 PWM INTERFACE (SVU40, SVU-80)

5.3.1 Three-phase Power Input

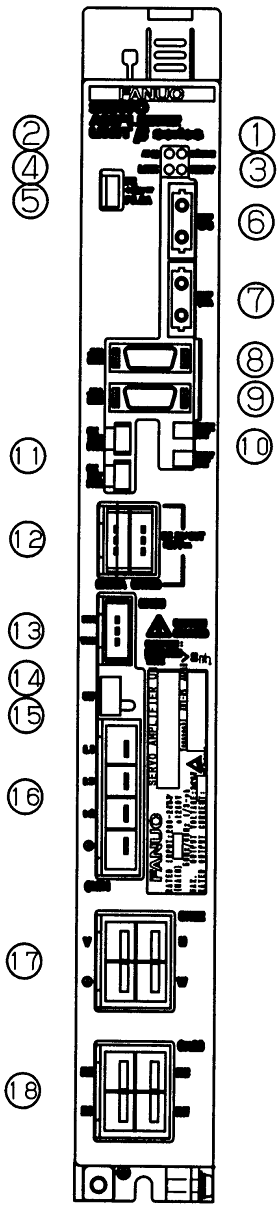


5.3.2 Single-phase Power Input



6 CONNECTOR ALLOCATION DIAGRAM OF β AMPLIFIERS (SVU40, SVU-80)

6.1 FSSB INTERFACE



	Name	Description	Remarks
<1>	POWER	Control power status indicator LED	
<2>	ALM	Alarm status indicator LED	
<3>	DRDY	Activation status indicator LED	
<4>	LINK	Communication status indicator LED	
<5>	FUSE	Fuse for 24V power supply	
<6>	COP10B	Connection for FSSB (to master)	
<7>	COP10A	Connection for FSSB (to slave)	
<8>	JX5/CHK	Connector for ESP and signal checking	
<9>	JF1/ENC	Connection for Pulsecoder	
<10>	CX5X/5Y	Battery connector for ABS Pulsecoder	For servo check pin board
<11>	CX18X/18Y	Connection for fan motor	
<12>	CX19A/19B	24V power input/output connector	
<13>	CX20	Connector for separated regenerative resistor (OH alarm)	(Note)
<14>		DC link charge indicator LED	(Warning)
<15>	SW	Switch for regeneration error detection circuit changeover	
<16>	CX21	Connector for primary power input	
<17>	CX22	Connector for motor power	
<18>	CX23	Connector for separated regenerative resistor (resistor line)	(Note)

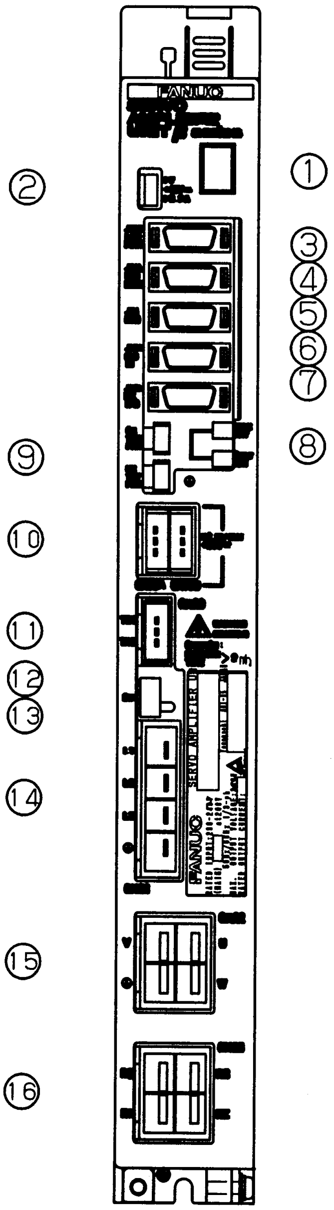
⚠ WARNING

It is dangerous to touch any cables and components inside the module while this LED is lit. Never touch components or cables while this LED is lit.

NOTE

Refer to Section 8.5 for details.

6.2 I/O Link INTERFACE (SVU-40, SVU-80)

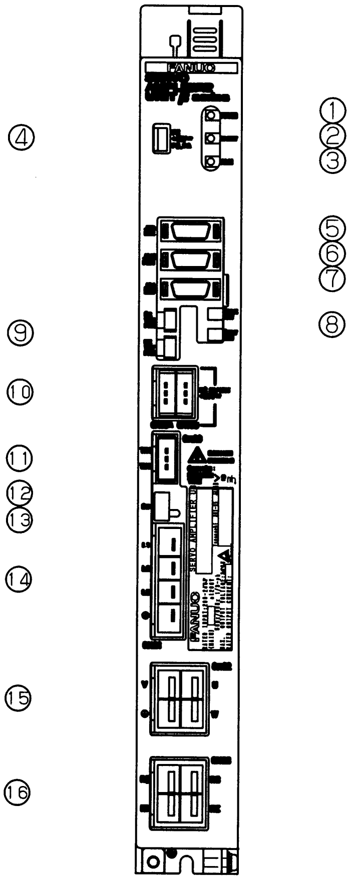


	Name	Description	Remarks
<1>	STATUS	Status indicator LED	
<2>	FUSE	Fuse for 24V power supply	
<3>	JD1B	Connector for I/O Link (to master)	
<4>	JD1A	Connector for I/O Link (to slave)	
<5>	JF1/ENC	Connector for Pulsecoder	
<6>	JA34/ Pulse In	Connector for external pulse input	
<7>	JA35/ EX I/O	Connector for built-in DI	
<8>	CX5X/5Y	Battery connector for ABS Pulsecoder	For servo check pin board
<9>	CX18X/18Y	Connector for fan motor	
<10>	CX19A/19B	24V power input/output connector	
<11>	CX20	Connector for separated regenerative resistor (OH alarm)	(Note)
<12>		DC link charge indicator LED	(Warning)
<13>	SW	Switch for regeneration error detection circuit changeover	
<14>	CX21	Connector for primary power input	
<15>	CX22	Connector for motor power	
<16>	CX23	Connector for separated regenerative resistor (resistor line)	(Note)

> ⚠ **WARNING**
> It is dangerous to touch any cables and components inside the module while this LED is lit. Never touch components or cables while this LED is lit.

> **NOTE**
> Refer to Section 8.5 for details.

6.3 PWM INTERFACE (SVU-40, SVU-80)



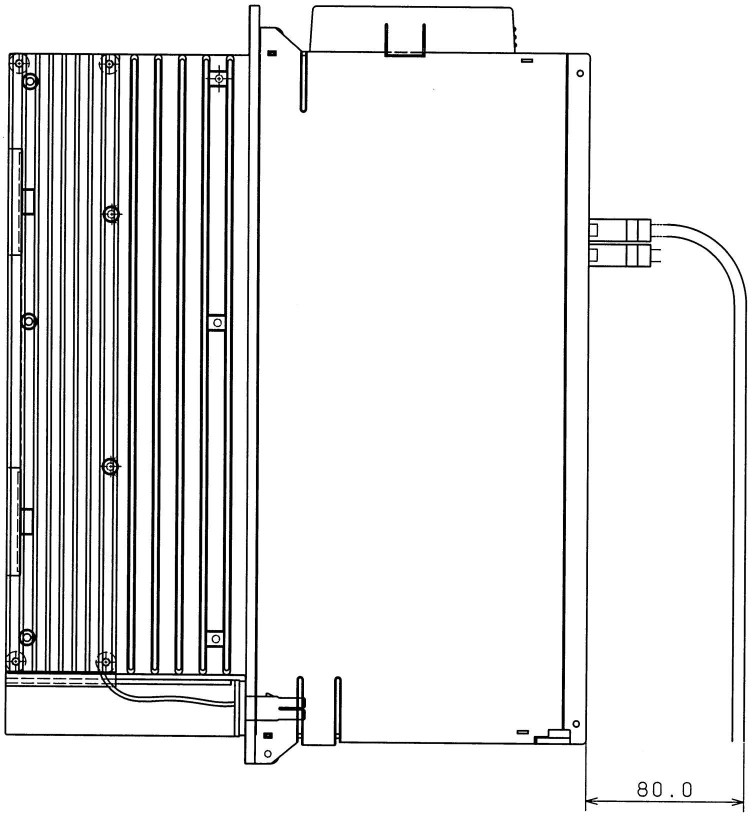
	Name	Description	Remarks
<1>	POWER	Control power status indicator LED	
<2>	DRDY	Activation status indicator LED	
<3>	ALM	Alarm status indicator LED	
<4>	FUSE	Fuse for 24V power supply	
<5>	JX5/CHK	Connector for ESP and signal checking	
<6>	JS1B	Connector for NC interface	
<7>	JF1/ENC	Connector for Pulsecoder	
<8>	CX5X/5Y	Battery connector for ABS Pulsecoder	For servo check pin board
<9>	CX18X/18Y	Connector for fan motor	
<10>	CX19A/19B	24V power input/output connector	
<11>	CX20	Connector for separated regenerative resistor (OH alarm)	(Note)
<12>		DC link charge indicator LED	(Warning)
<13>	SW	Switch for regeneration error detection circuit changeover	
<14>	CX21	Connector for primary power input	
<15>	CX22	Connector for motor power	
<16>	CX23	Connector for separated regenerative resistor (resistor line)	(Note)

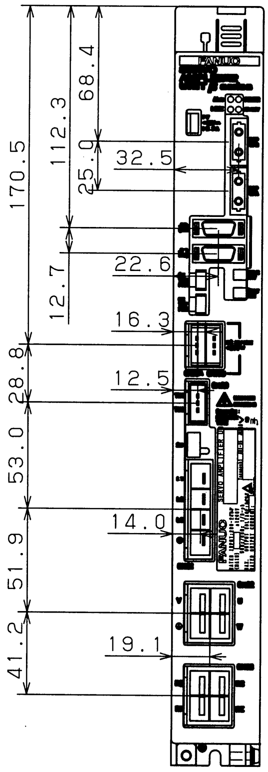
> ⚠ **WARNING**
> It is dangerous to touch any cables and components inside the module while this LED is lit. Never touch components or cables while this LED is lit.

> **NOTE**
> Refer to Section 8.5 for details.

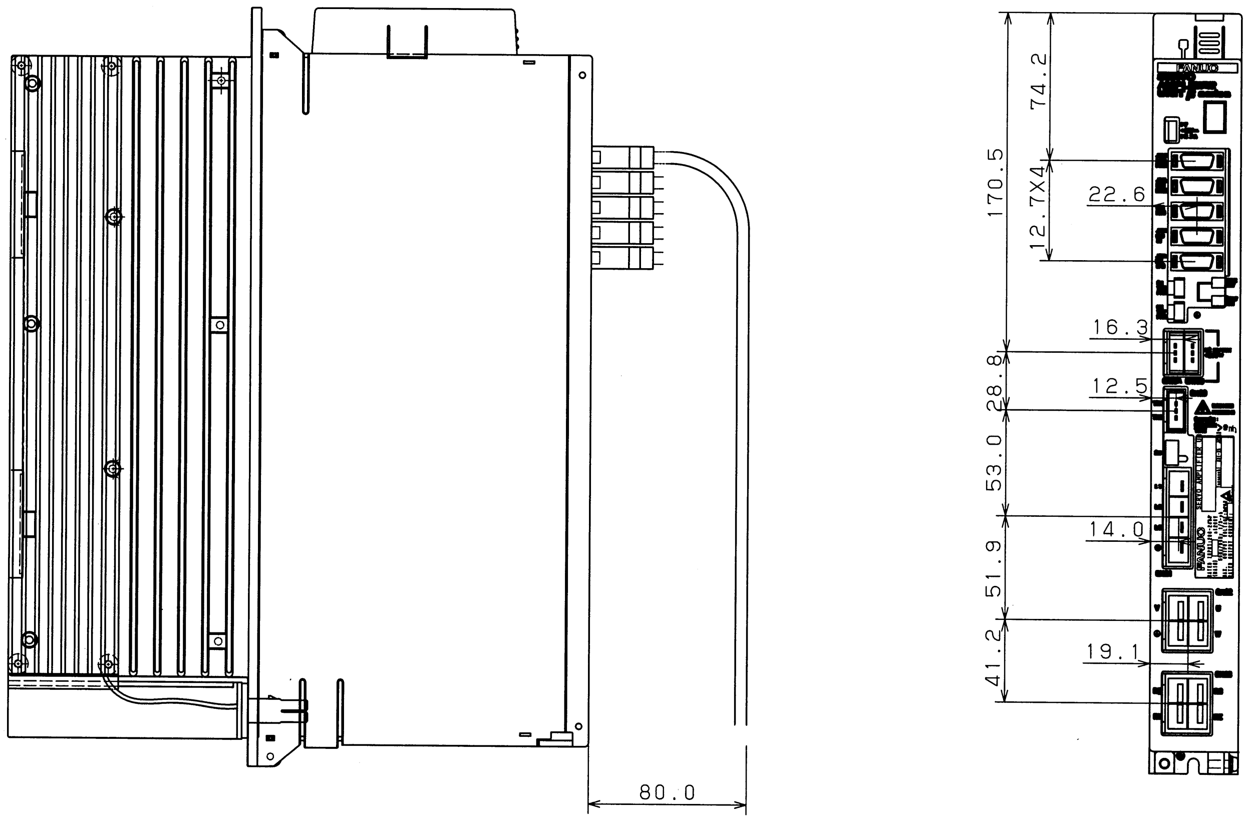
7 DIMENSIONS INCLUDING CABLES

7.1 FSSB INTERFACE (SVU-40, SVU-80)

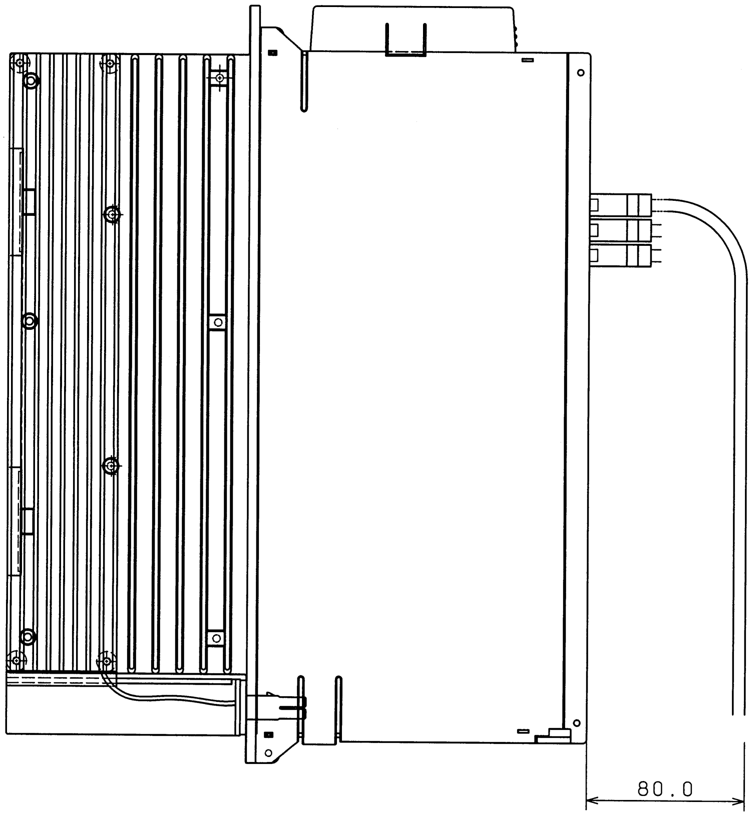


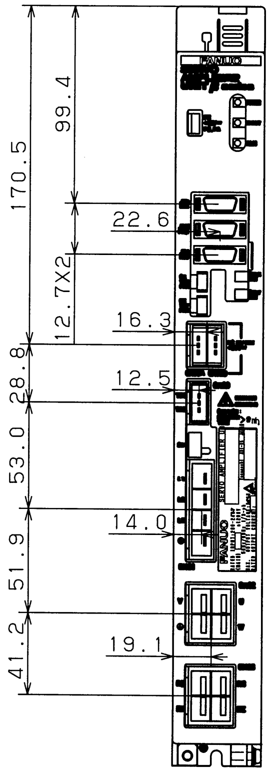


7.2 I/O Link INTERFACE (SVU-40, SVU-80)



7.3 PWM INTERFACE (SVU-40, SVU-80)





8 DETAILS OF CABLE CONNECTIONS

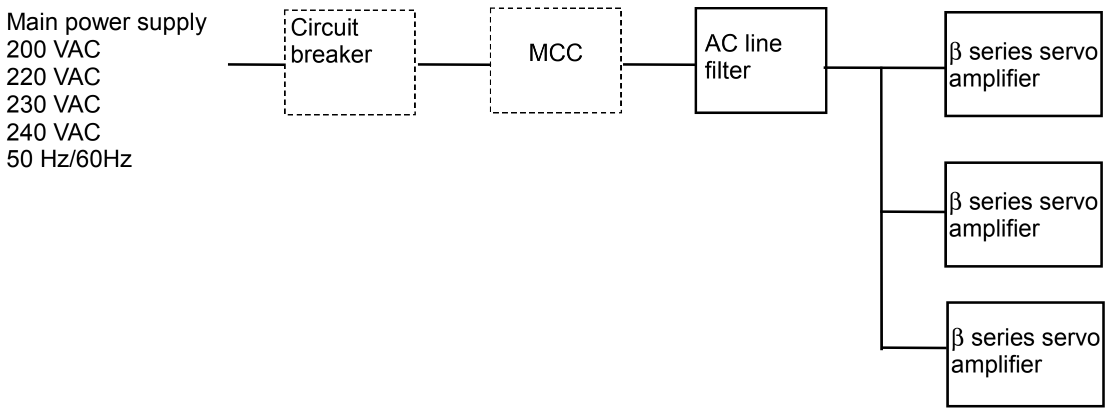
8.1 K1 CABLE CONNECTION (ONLY FOR PWM INTERFACE)

Refer to Section 4.1 “K1 CABLE CONNECTION (ONLY FOR PWM INTERFACE).”

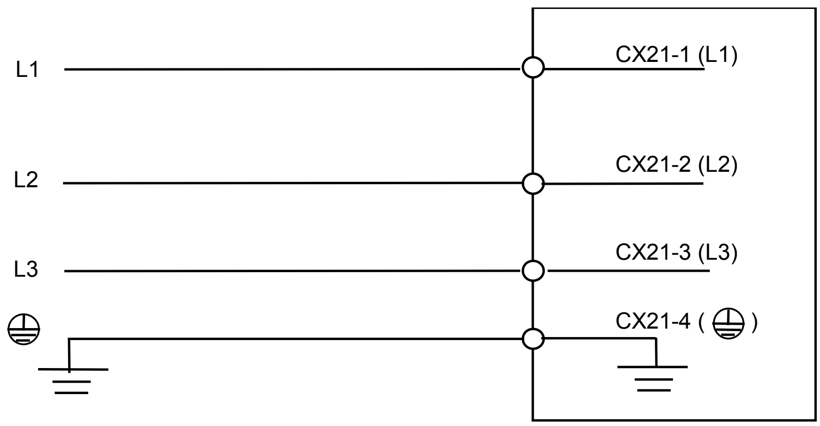
8.2 K2 CABLE CONNECTION (ONLY FOR PWM INTERFACE)

Refer to Section 4.2 “K2 CABLE CONNECTION (ONLY FOR PWM INTERFACE).”

8.3 K3 CABLE CONNECTION



Model	Applicable cable	
	Cabtyre cable (Warning 1)	Heat-resistant vinyl cable (Warning 2)
SVU-40	3.5 mm^2 or more	3.5 mm^2 or more
SVU-80	3.5 mm^2 or more	3.5 mm^2 or more



Housing : 1-179958-4
Contact : 316041.2
Applicable power line range :
3.50mm^2 to 5.50mm^2
Manufacturer :
tyco Electronics AMP

Wire to be used
600V vinyl cabtyre cable, 4 conductors
(Nominal sectional area : 3.5 mm^2)

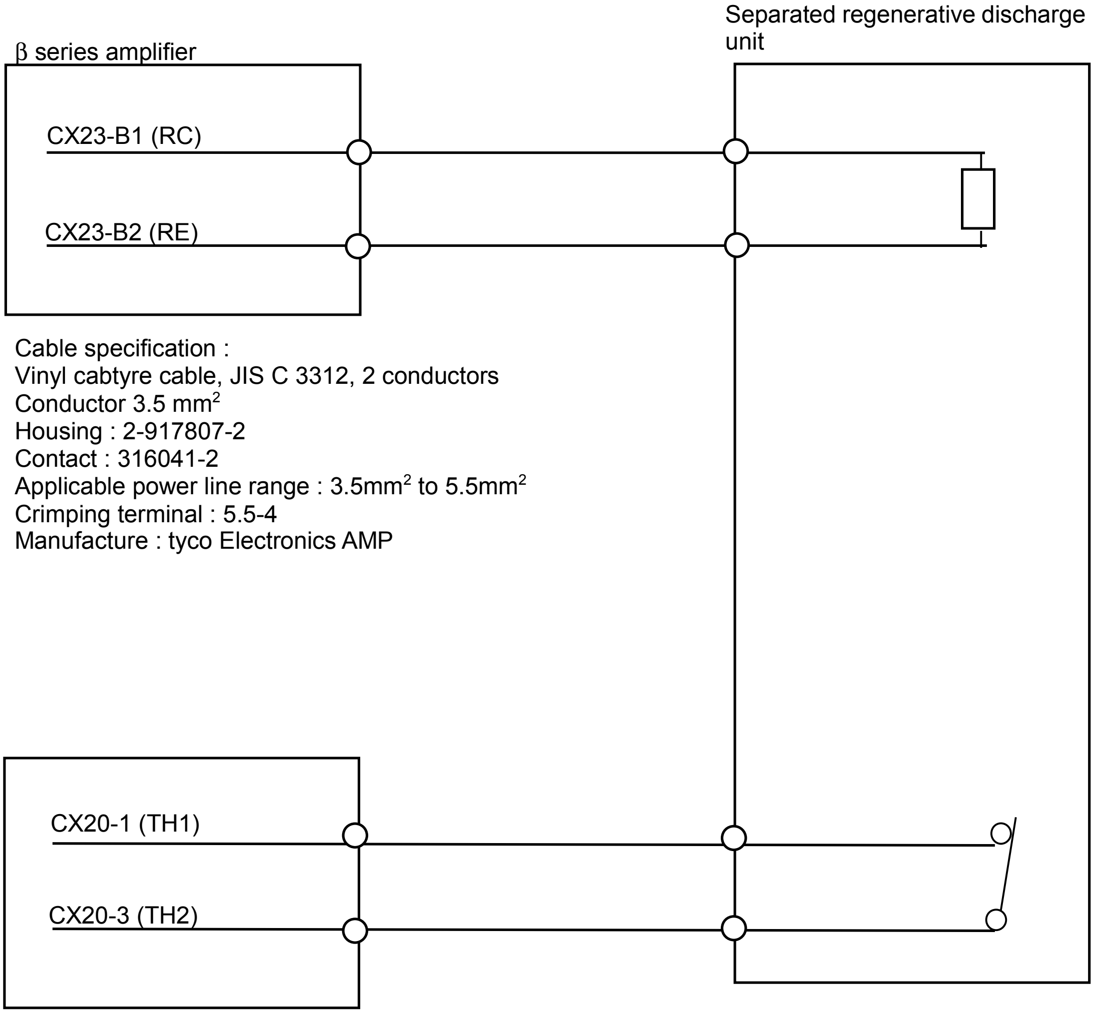
> **⚠ WARNING**
> 1 600V vinyl cabtyre cable, JIS C 3312, 4 conductors
> 2 Heat-resistive vinyl cable
> (maximum conductor temperature: 105°C)
> (equivalent to the LMFC, manufactured by FURUKAWA ELECTRIC CO., LTD.)

8.4 K4 CABLE CONNECTION

Refer to Section 4.4 “K4 CABLE CONNECTION.”

8.5 K7 AND K8 CABLES CONNECTION

When separated regenerative discharge unit is used

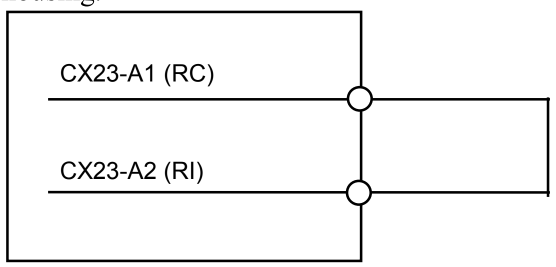


Cable specification :
Vinyl cabtyre cable, JIS C 3312, 2 conductors
Conductor 3.5 mm^2
Housing : 2-917807-2
Contact : 316041-2
Applicable power line range : 3.5mm^2 to 5.5mm^2
Crimping terminal : 5.5-4
Manufacture : tyco Electronics AMP

Cable specification :
Vinyl cabtyre cable, JIS C 3312, 2 conductors
Conductor 0.75 mm^2
Housing : 2-178288-3
Contact : 1-175218-5
Applicable power line range : 0.5mm^2 to 1.25mm^2
Crimping terminal : 1.25-4
Manufacture : tyco Electronics AMP

When separated regenerative discharge unit is not used

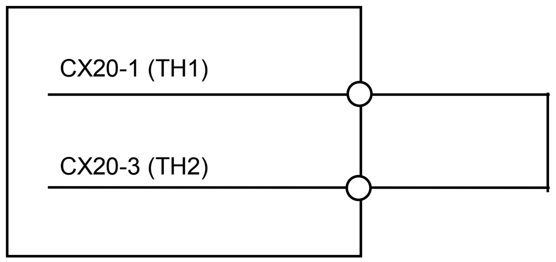
Make a connection within connector CX23 by using a dummy housing.



Cable specification :
Vinyl cabtyre cable, JIS C 3312, 2 conductors
Conductor 3.5 mm^2
Housing : 2-917807-2
Contact : 316041-2
Applicable power line range : 3.5mm^2 to 5.5mm^2
Manufacture : tyco Electronics AMP

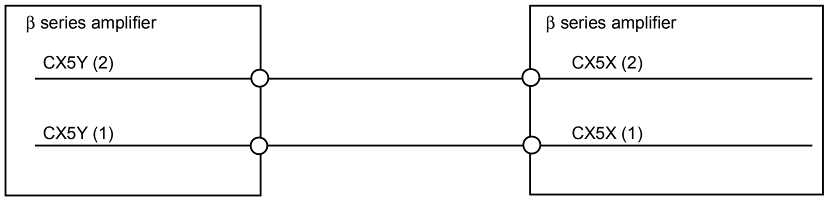
Make a connection within connector CX20 by using a dummy housing.

β series amplifier



Cable specification :
Vinyl cabtyre cable, JIS C 3312, 2 conductors
Conductor 0.75 mm^2
Housing : 2-178288-3
Contact : 1-175218-5
Applicable power line range : 0.5mm^2 to 1.25mm^2
Manufacture : tyco Electronics AMP

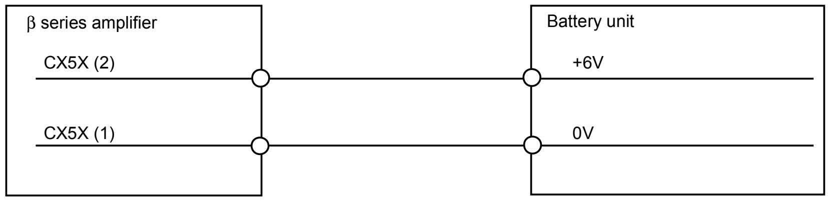
8.6 K14 CABLE CONNECTION



Wire to be used
Nominal sectional area : 0.32 mm^2 or less

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

8.7 K15 CABLE CONNECTION

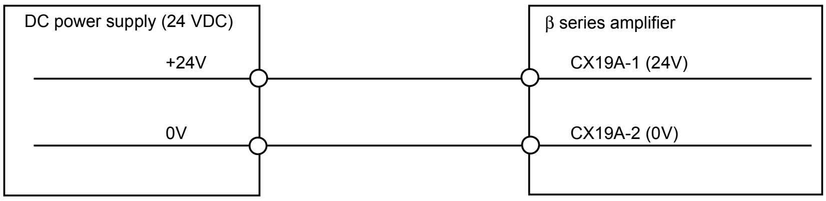


Wire to be used
Nominal sectional area : 0.32 mm^2 or less

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

Screw terminal : M3
Crimping terminal : 1.25-4

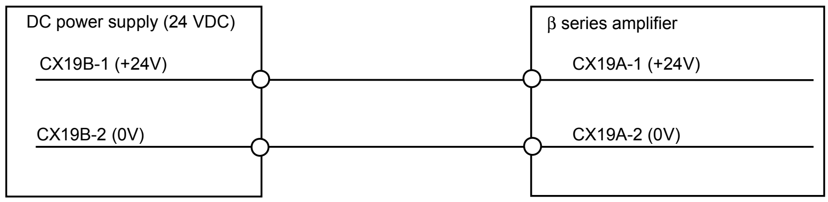
8.8 K12 CABLE CONNECTION



Wire to be used
Nominal sectional area : 0.22 to 1.25 mm^2 or less

Housing
1-178288-3
Contact
1-175217-5 (0.2 to 0.5mm^2)
1-175218-5 (0.5 to 1.25mm^2)
Manufacturer : Japan AMP

8.9 K12 CABLE CONNECTION



Wire to be used
Nominal sectional area : 0.22 to 1.25 mm^2 or less

Housing	Housing
1-178288-3	1-178288-3
Contact	Contact
1-175217-5 (0.2 to 0.5mm^2)	1-175217-5 (0.2 to 0.5mm^2)
1-175218-5 (0.5 to 1.25mm^2)	1-175218-5 (0.5 to 1.25mm^2)
Manufacturer : Japan AMP	Manufacturer : Japan AMP

8.10 OTHER CABLE CONNECTIONS

The descriptions for the β amplifiers SVU-4, SVU-12, and SVU-20 apply. See Chapter 4, "DETAILS OF CABLE CONNECTIONS".

9 FANUC I/O Link CONNECTION (FOR I/O Link INTERFACE ONLY)

9.1 OVERVIEW

The FANUC I/O Link is a serial interface for connecting a CNC, β series servo amplifier (with the I/O Link option), I/O Unit-A, Power Mate, and so forth to transfer I/O signals (bit data) at high-speed among those units. When multiple units are connected by using the FANUC I/O Link, one unit functions as a master, and the other units function as slaves. The states of input signals from the slaves are transferred to the master at regular intervals, and an output signal from the master is transferred to the slaves at regular intervals. The β series servo amplifier (with the I/O Link option) can function only as a slave. The number of input points is 128, and the number of output points is also 128.

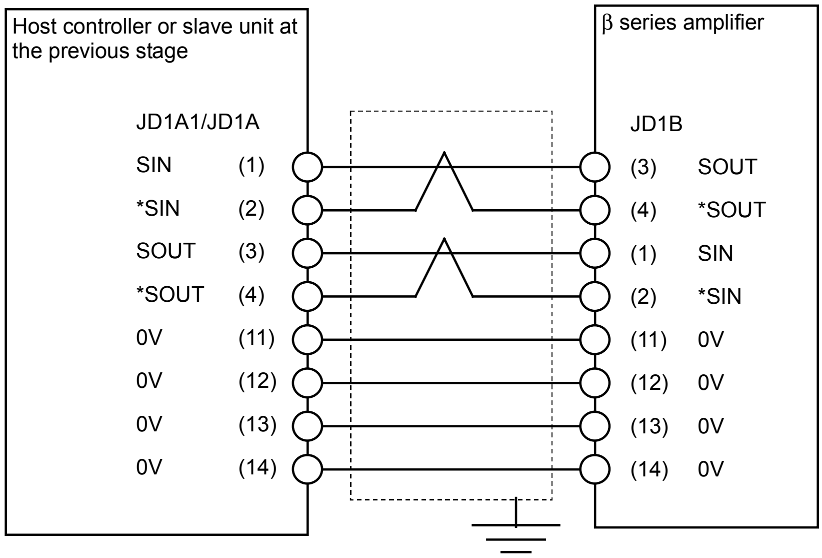
The connector names of the I/O Link are JD1A (or JD1A1) and JD1B, which are common to all units with the I/O Link function. A cable must always be connected from JD1A (or JD1A1) to JD1B. No cable is connected to JD1A of the last unit, so that JD1A of the last unit is left open, and need not have a component such as a terminator connected.

An I/O Link connection may be made via an electric cable or optical cable. Use an optical cable in the following cases:

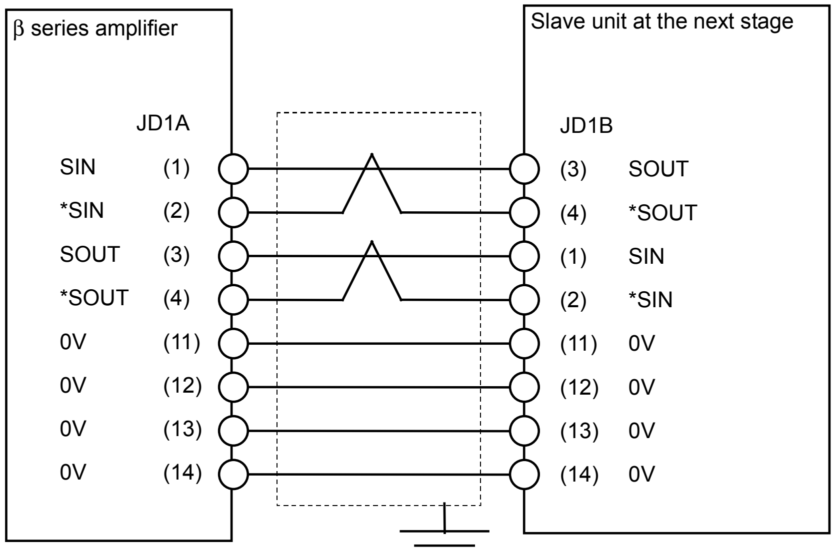
- When the cable is longer than 10 m, or when the cable within the same cabinet is longer than 15 m. If the cable is installed in a duct, the units connected to both ends of the cable must be regarded as being installed within the same cabinet. Suppose, for example, that a CNC functioning as the host is installed in the operator's panel, a β series servo amplifier (with the I/O Link option) is installed in the power magnetics cabinet, and an I/O Link cable for connecting the CNC with the β series servo amplifier is run through a duct. In this case, the CNC and the β series servo amplifier (with the I/O Link option) are regarded as being installed within the same cabinet.
- When the cable is run from one cabinet to another, and the cabinets cannot be connected with each other via a ground wire of 5.5 mm^2 or more
- When the cable is affected significantly by noise. For example, when a powerful electromagnetic noise source such as a welding machine is placed near the cable, or when the cable is routed for a long distance in parallel with a power line or cable related to power magnetics that generates noise

9.2 FANUC I/O Link CONNECTION VIA ELECTRIC CABLE

Details of connection of cable K20 (when a connection is made with the host controller or the slave unit at the previous stage)



Details of connection of cable K20 (when a connection is made with the slave unit at the next stage)
When there is a slave unit at the next stage, make the following connection:



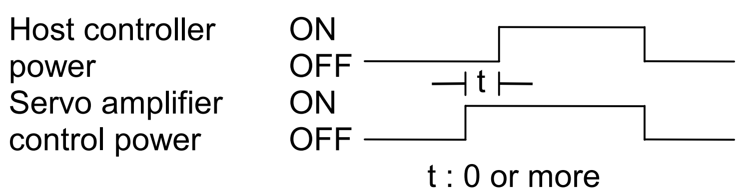
Specifications of a recommended connector and case for cable K20 on the β series amplifier side
Connector : PCR-E20FS (Soldering type) (Honda Communications)
PCR-E20FA (Crimping type)
Case : PCR-V20L

Recommended cable for K20 cable

A66L-0001-0284#10P (10 twisted pair cable with a shield on the outside)

NOTE

1 Maximum cable length: 10 m (when the above recommended wire is used)
2 Use the same twisted wire pair for the SIN and *SIN signals. Also use the same twisted wire pair for the SOUT and *SOUT signals.
3 Do not make any connection to the pins other than those shown above. Do not connect an unused conductor of the cable.
4 Connect the shield of the cable to the ground plate of the cabinet by using a cable clamp. Regardless of whether a β series servo amplifier is connected with the host controller (or the slave unit at the previous stage) or the slave unit at the next stage, clamp and shield the cable immediately when the cable is run into the cabinet. If the host controller is installed in one cabinet, and a β series servo amplifier is installed in another cabinet, shield processing is required twice for one cable. Even if the cable is not routed outside the cabinet, be sure to clamp and shield the cable at least one location.
5 Switch on the control power for the servo amplifier at the same time with or before the host controller connected to the servo amplifier through the I/O Link. When switching off the host controller power, also switch off the servo amplifier control power.



9.3 FANUC I/O Link CONNECTION VIA OPTICAL CABLE

By using an optical cable with an optical I/O Link adapter, the FANUC I/O Link can be extended up to 200 m. For details, refer to the manual of the host controller.

10 CONNECTION OF BUILT-IN DI (FOR I/O Link INTERFACE ONLY)

10.1 INPUT SIGNAL SPECIFICATION

The DC input signals are those sent from the machine to the servo unit.
They are transferred via a non-insulated interface that can be switched between sink type (24V common) and source type (0V common) except for an emergency stop input, which is fixed at a sink type (24 V common).
The relevant safety standards require that the interface be used as sink type.

The contacts on the machine side must satisfy the following requirements:

Contact capacity :
30VDC, 16mA or higher
Closed-state contact-to-contact leakage current :
1 mA or lower (at 26.4V) :
Closed-state contact-to-contact voltage drop :
2V or lower (including voltage drop across cable, with 8.5mA)

For information about the specifications of the skip signal, see Section 10.4.

10.2 LIST OF SIGNALS

(1) *ESP :

Opening the contact for the emergency stop signal input (*ESP) resets the servo unit and brings it to an emergency stop. Generally, this signal is issued using the B contact of a pushbutton switch.

(2) *+OT :

Setting the positive overtravel signal input (*+OT) to logical 0 disables forward movement. This signal can be made unusable by parameter setting.

(3) *-OT :

Setting the negative overtravel signal input (*-OT) to logical 0 disables reverse movement. This signal can be made unusable by parameter setting.

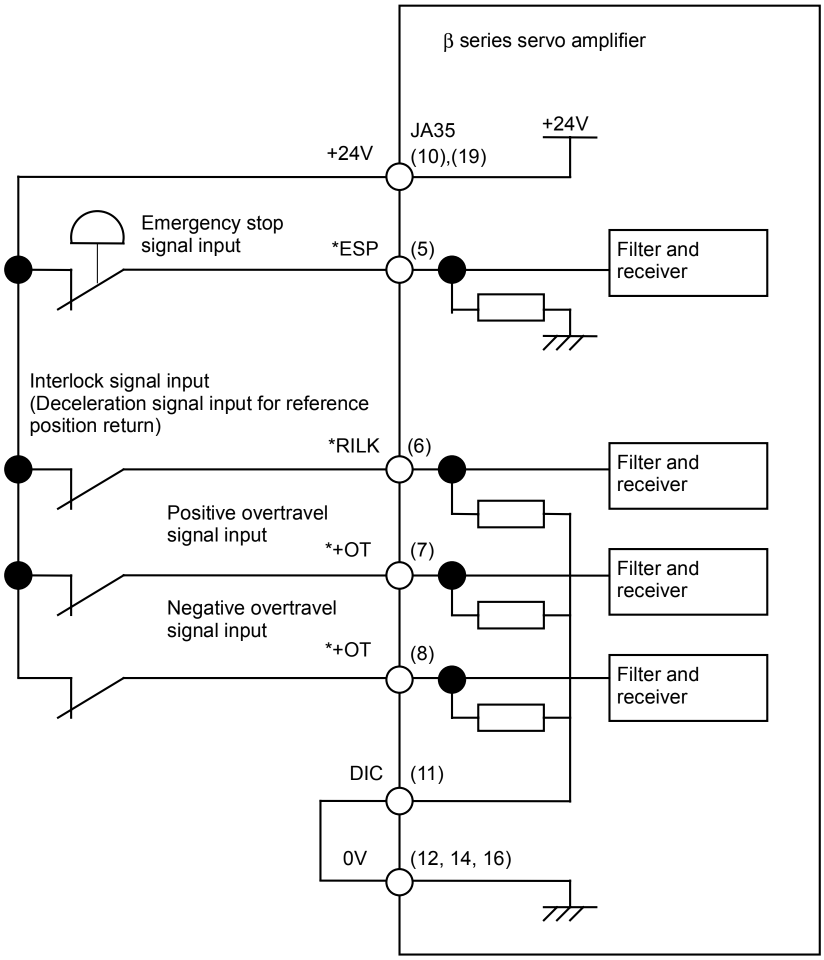
(4) *RILK(*DEC) :

Interlock signal input (*RILK) or deceleration signal input for reference position return (*DEC). One of the two functions is selected according to parameter setting. If the interlock signal input (*RILK) is selected, axis motion is decelerated to a stop when this signal is set to logic 0. When this signal is set to logic 1, axis motion is resumed. If the deceleration signal input for reference position return (*DEC) is selected, the feedrate decreases to a certain value then remains at the decreased value for continued movement when this signal is set to logic 0. When this signal is set to logic 1, feed operation stops at an electric grid position.

(5)HDI :

The rising or falling edge of the skip signal input (HDI) can be used to cause the current block to be skipped. Whether the rising edge or falling edge is used depends on the parameter setting.

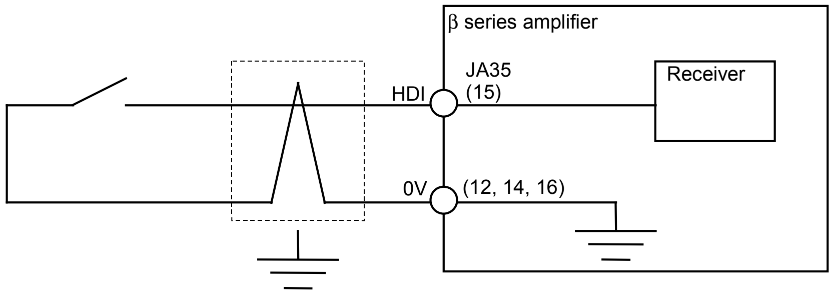
10.3 SIGNAL CONNECTION WITH THE POWER MAGNETICS CABINET



NOTE

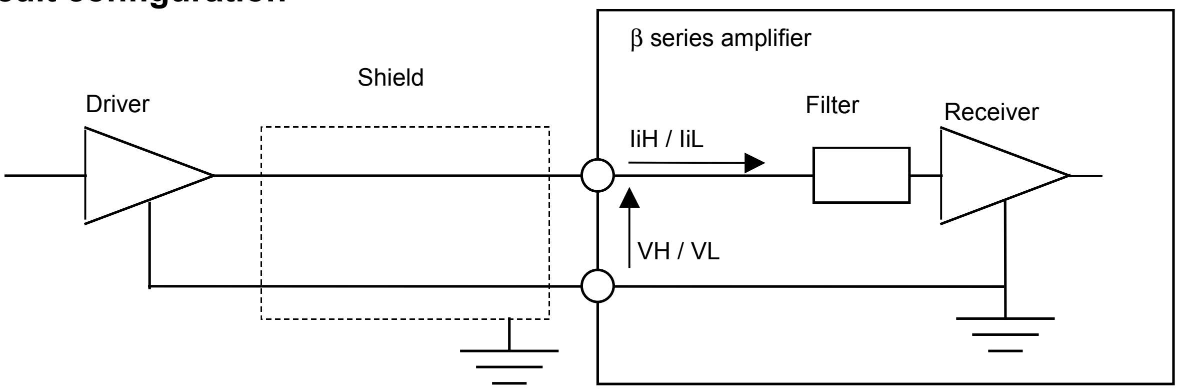
1 Use cable (with a shield on the outside) for Cable K21.
2 Use wire having a size of 7/0.18 (0.18mm^2) for 0V, +24V, and DIC.
3 Do not make any connection to the pins other than those shown above. Do not connect an unused conductor of the cable.
4 The above diagram is an example of a configuration with 24V common. For a configuration with 0V common, connect DIC (JA35-11) to +24V (JA35-10, 19), and the stage ahead of each switch to 0V (JA35-12, 14, 16). Note that only the 0V common configuration can be used for the emergency stop signal (JA35-5, *ESP).
5 Within 100 ms after emergency stop cancellation, turn on the external magnetic contactor inserted into the power input of the β series servo motor amplifier (with the I/O Link option).

10.4 SKIP SIGNAL INTERFACE



10.4.1 High-Speed Skip Signal Input Specification

Circuit configuration



Absolute maximum rating

Input voltage range Vin: -3.6V to +13.6V

Input characteristics

Item	Symbol	Rating	Unit	Remarks
High-level input voltage	VH	3.6 to 11.6	V	
Low-level input voltage	VL	0 to 1.0	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
Pulse width of input signal		20 min	µs	

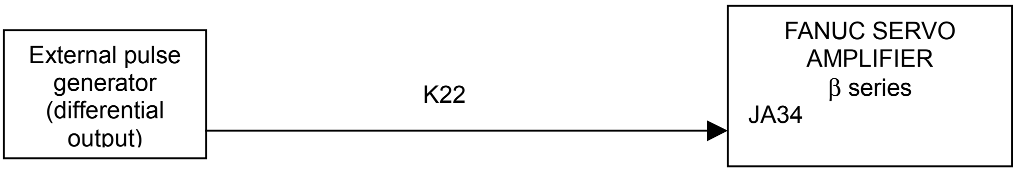
NOTE

For IiH and IiL, the plus algebraic sign indicates the current that flows into the receiver, while the minus algebraic sign indicates the current that flows out from the receiver.

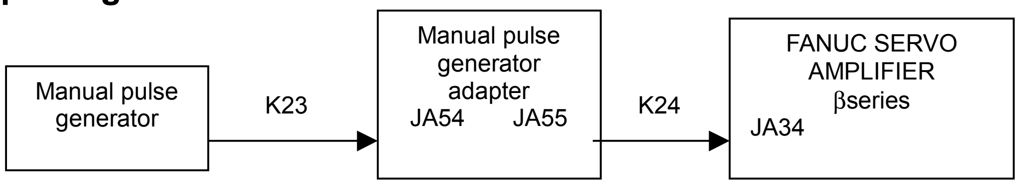
11 EXTERNAL PULSE INPUT (ONLY FOR I/O Link INTERFACE)

The FANUC servo amplifier unit β series (I/O Link option) enables operation according to externally applied pulses.
As an external pulse generator, an A/B-phase pulse generator of differential type satisfying the specification or a manual pulse generator available from FANUC can be selected. When a manual pulse generator is selected, a manual pulse generator adapter (A06B-6093-D001) is required.

When an A/B-phase pulse generator of differential type is used

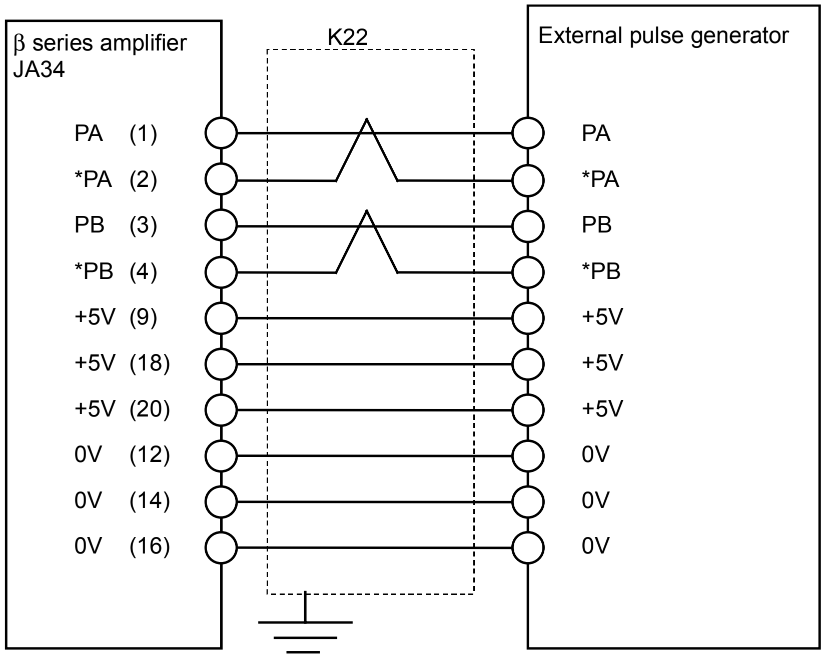


When a manual pulse generator available from FANUC is used



11.1 CONNECTION WHEN AN A/B-PHASE PULSE GENERATOR OF DIFFERENTIAL TYPE IS USED

11.1.1 K22 Cable Connection



Connector : FI40-2015S (Hirose Electric)
Case : FI-20-CV (Hirose Electric)

Cable specification : Conductor 20/0.18×6, 7/0.18×3 pairs
Recommended cable : A66L-0001-0286(#20AWG×6 + #24AWG×6 + #24AWG×3 pairs)

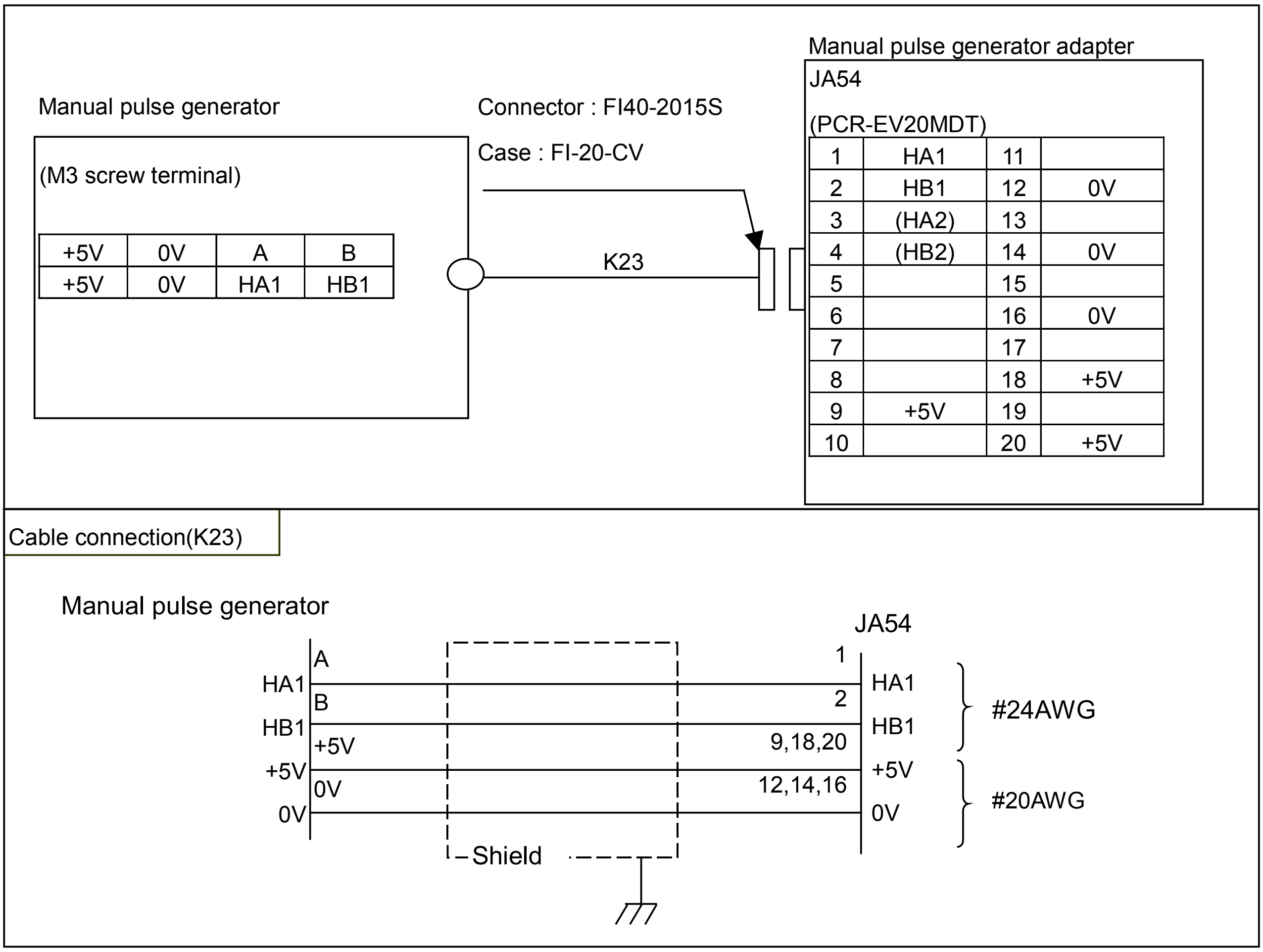
NOTE

1. The servo unit can supply power to a unit requiring up to +5V, 0.35A. In this case, consider the power supply voltage drop across the cable resistance.
2. Use the same twisted wire pair for the PA and *PA signals. Also use the same twisted wire pair for the PB and *PB signals.
3. Do not make any connection to the pins other than those shown above. Do not connect an unused conductor of the cable.
4. Maximum wire length: 50m

11.2 CONNECTION WHEN A MANUAL PULSE GENERATOR AVAILABLE FROM FANUC IS USED

11.2.1 K23 Cable Connection

The K23 cable is a signal cable for connecting a manual pulse generator with a manual pulse generator adapter (JA54).



+5V	0V	A	B
+5V	0V	HA1	HB1

1	HA1	11	
2	HB1	12	0V
3	(HA2)	13	
4	(HB2)	14	0V
5		15	
6		16	0V
7		17	
8		18	+5V
9	+5V	19	
10		20	+5V

Recommended wire : A66L-0001-0286 (#20AWG × 6 + #24AWG × 3 pairs)
Recommended connector (on the JA54 side): A02B-0120-K303
Recommended cable : A02B-0259-K821 (7 m). When using the cable, rewrite the connector name.

The maximum allowable length is 50 m. However, another limitation based on a power supply voltage drop is imposed as described below.

Limitation based on a power supply voltage drop

Suppress the power supply voltage drop due to cable resistance to 0.2 V or less (sum of the 0V and 5V lines).

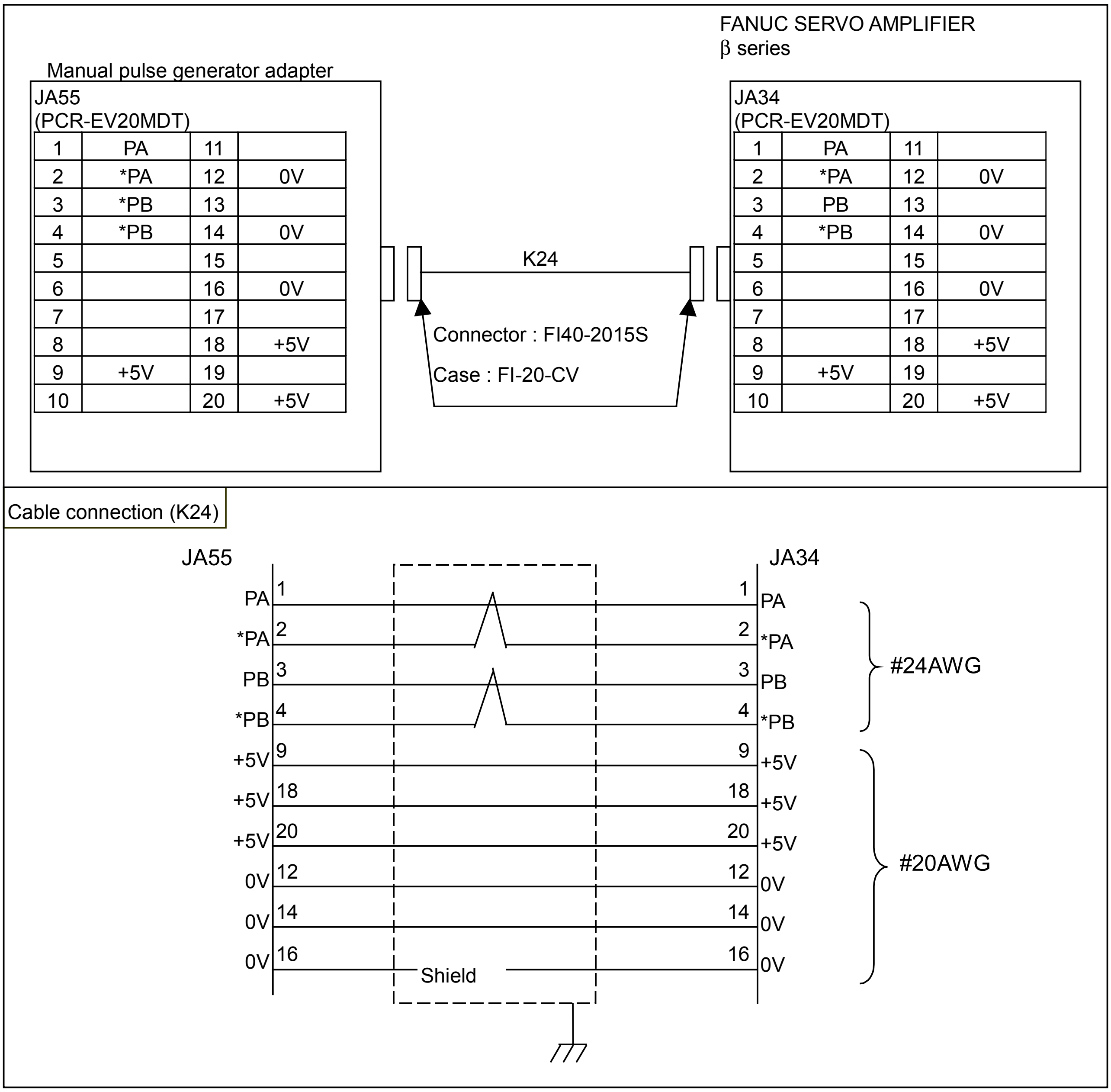
For calculation, assume that the power supply current of the manual pulse generator is 0.1 A.

When making a calculation, include the length of the K24 cable in the cable length.

To one manual pulse generator, multiple (up to six) units of the FANUC servo amplifier unit β series can be connected. In this case, prepare one manual pulse generator adapter for each unit of the FANUC servo amplifier unit β series. A unit of the FANUC servo amplifier unit β series can be connected with a manual pulse generator adapter in the same way as described in Subsection 8.2.2, "K24 Cable Connection ". JA54(3) and JA54(4) are signals used to connect multiple units of the FANUC servo amplifier unit β series. For details, refer to Subsection 8.1.3, "Connection with Multiple Power Mate Units" in "FANUC Power Mate-MODEL E Connection and Maintenance Manual (B-62115E)". One unit of the FANUC servo amplifier unit β series connected with a manual pulse generator adapter via cable K24 corresponds to one Power Mate unit.

11.2.2 K24 Cable Connection

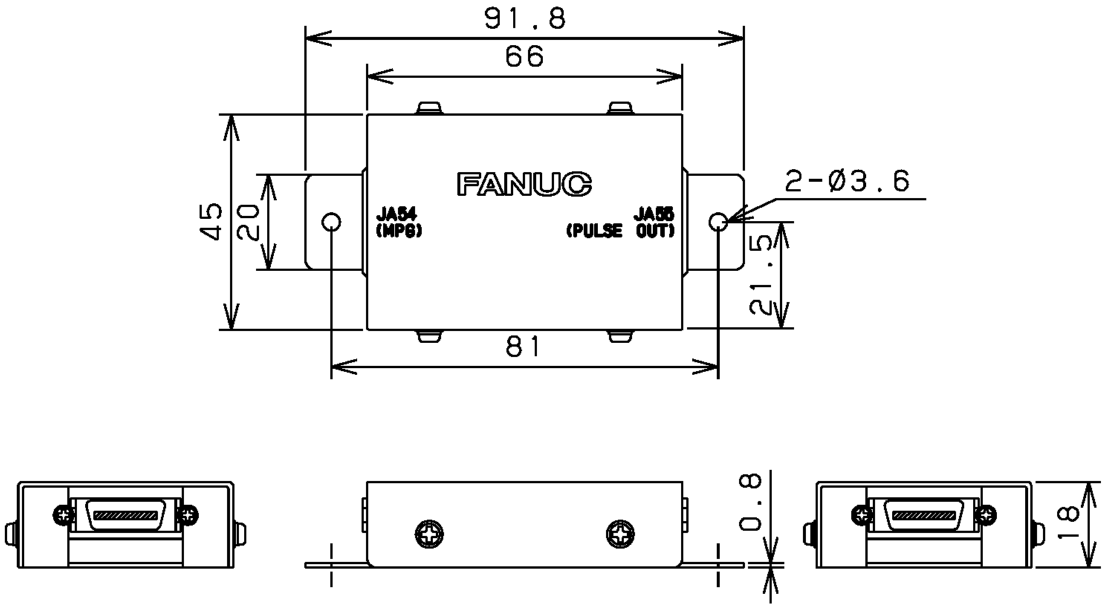
The K24 cable is a signal cable for connecting a manual pulse generator adapter (JA55) with the FANUC servo amplifier unit β series (JA34).



Recommended wire : A66L-0001-0286(#20AWG × 6 + #24AWG × ×3 pairs)
Recommended connector : A02B-0120-K303
Maximum wire length : Up to 5 m

11.2.3 Manual Pulse Generator Adapter

External view



Weight : Approx. 100g

Installation condition

The manual pulse generator adapter does not have a closed structure. So, install a manual pulse generator adapter in a closed cabinet similar to a one used for the FANUC servo amplifier β series (I/O Link option).

The manual pulse generator adapter has two ϕ3.6 holes. When securing a manual pulse generator adapter, use these holes.

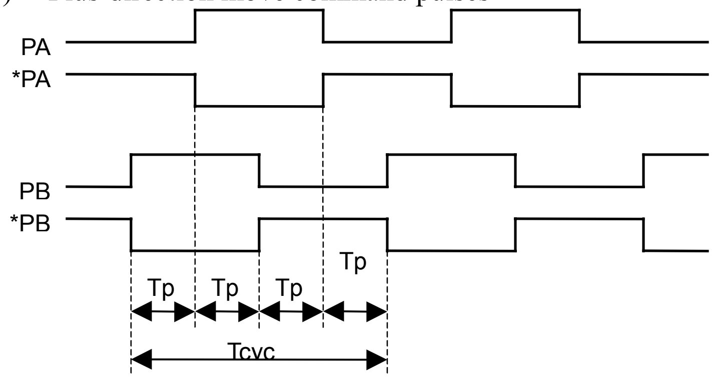
The manual pulse generator adapter is light. So, when securing a manual pulse generator adapter, it need not always be screwed. However, ensure that a manual pulse generator adapter is not short-circuited to another electric circuit.

Connect the case to ground by using a case mounting screw of the manual pulse generator adapter.

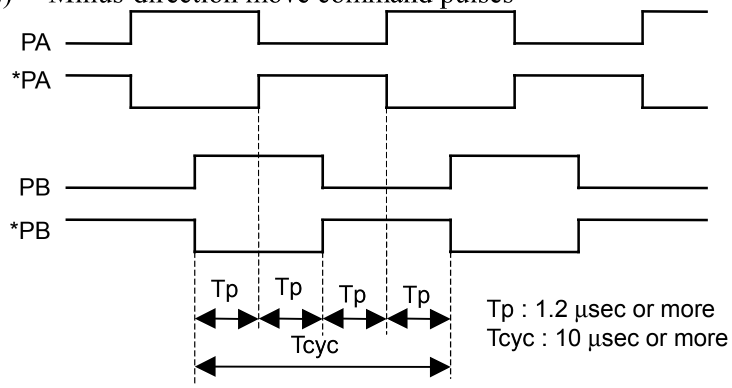
- Operating condition

The maximum allowable frequency of an input signal is 100 kHz.

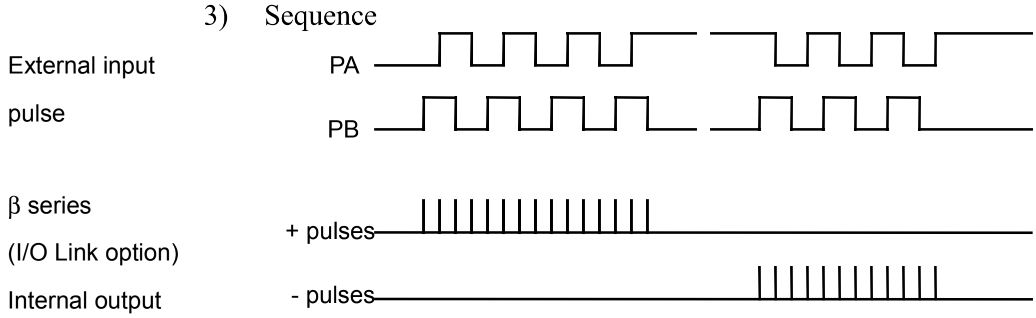
1) Plus-direction move command pulses



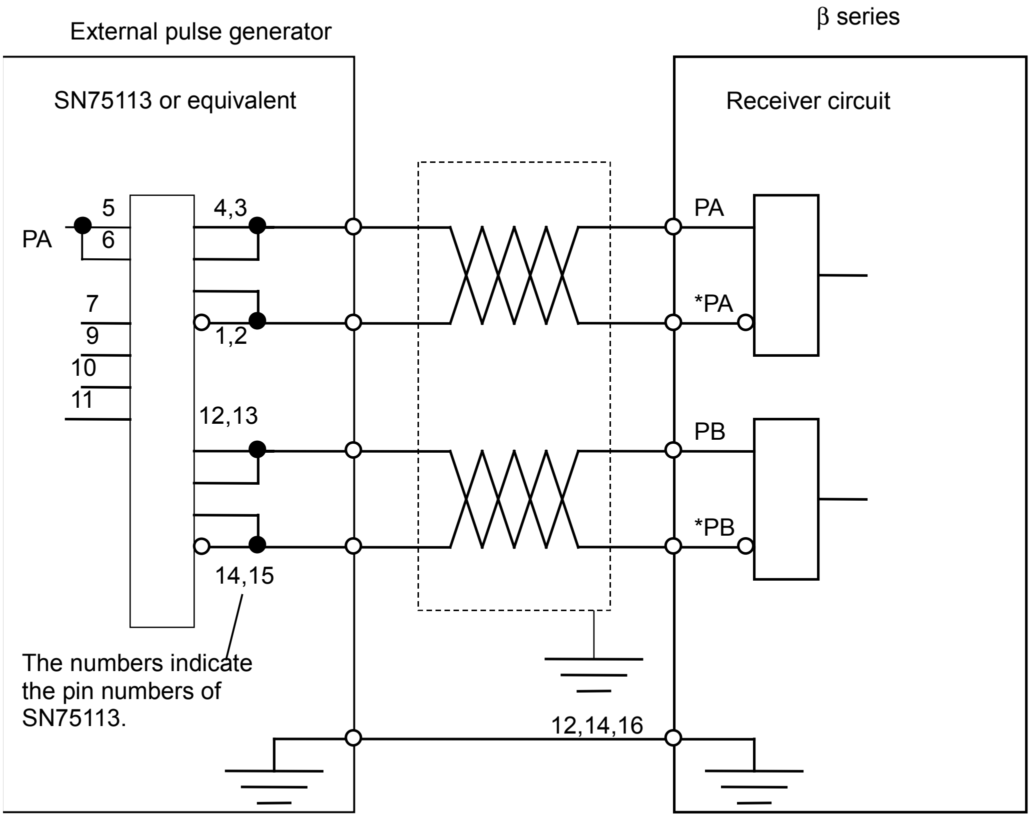
2) Minus-direction move command pulses



3) Sequence



- Example of recommended circuit



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Revision Record

FANUC SERVO MOTOR β series DESCRIPTIONS (B-65232EN)

Edition	Date	Contents	Edition	Date	Contents
03	Oct., 2002	- Total revision			
02	Aug., 1997	- Addition of model β0.5 - Addition of β series amplifier for I/O Link option			
01	Mar., 1996	———			