FANUC

GE Fanuc Automation

Computer Numerical Control Products

AC Servo Motor

Descriptions Manual

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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.

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PREFACE

This manual describes following products:

1) Motor

Series name	Model name
FANUC AC SERVO MOTOR S series (200V input)	MODEL 4-0S, MODEL 3-0S, MODEL 2-0S, MODEL 1-0S, MODEL 1-0S/3000, MODEL 0S, MODEL 5S, MODEL 5S/3000, MODEL 10S, MODEL 10S/3000, MODEL 20S/1500, MODEL 20S, MODEL 20S/3000, MODEL 30S, MODEL 30S/3000, MODEL 40S/2000, MODEL 50S, MODEL 60S, MODEL 70S,
FANUC AC SERVO MOTOR S series (185V input)	MODEL 5-0, MODEL 30/2000, MODEL 40
FANUC AC SERVO MOTOR SP series	MODEL 2-0SP, MODEL 1-0SP, MODEL 1-0SP/3000, MODEL 0-0SP
FANUC AC SERVO MOTOR L series (200V input)	MODEL 0L, MODEL 5L, MODEL 6L, MODEL 7L, MODEL 10L
FANUC AC SERVO MOTOR T series (200V input)	MODEL 0T/3000, MODEL 5T/2000, MODEL 5T/3000, MODEL 10T/2000, MODEL 10T/3000
FANUC AC SERVO MOTOR F series (200 - 230V input)	MODEL 5F/3000, MODEL 10F/2000, MODEL 20F/2000, MODEL 30F/2000

2) SERVO AMPLIFIER

Series name	Corresponding motor (Note)
FANUC AC SERVO AMPLIFIER C series	FANUC AC SERVO MOTOR S series, L series, SP series, T series, F series
FANUC AC SERVO AMPLIFIER S series	FANUC AC SERVO MOTOR S series, SP series, T series
FANUC AC SERVO AMPLIFIER L series (185V input)	FANUC AC SERVO MOTOR L series

Note) Please refer to the text for a concrete correspondence.

CONTENTS

APPENDIX

I. FANUC AC SERVO MOTOR series

1. GENERAL

The FANUC AC Servo Motor is specially designed for the feed axis of machine tool, and has the following features.

(1) Smooth rotation
The unique magnetic pole form designed to minimize torque ripple enables very smooth rotation by strict current control and precise pulse coder feedback.

(2) Fast acceleration.
The unique rotor form makes the motor compact and light weight, providing high torque and fast acceleration.

(3) High reliability
The totally enclosed brushless structure with no wearing part permits inspection/maintenance free operation.

(4) Built-in high precision detector
The optical encoder (pulse coder) with very small indexing error is built in, permitting high precision positioning.
The pulse coder of 2,000 to 30,000 pulse permits the indexing of 120,000 divisions maximum per motor rotation.
(This value may be limited in some types of NC/motor).
Serial pulse coder A, which features super-high resolution, enables indexing with a resolution of up to 1,000,000 divisions.
When combined with the flexible feed gear function, serial pulse coder A enables feeding in units of 0.1 μm or 0.01 μm for almost all feed screw pitches.

The FANUC AC Servo Motor S series is suitable for controlling general machine tools, the L series is suitable for high precision positioning control of punch press/PCB drilling machines, and also hollow shaft type T series is available.
The S series is available in the type requiring an input transformer, models 5-0, 30/2000 and 40 and the type connectable directly to 200 to 230V power supply, models 4-0S, 3-0S, 2-0S, 1-0S, 0S, 5S, 10S, 20S/1500, 20S, 30S, 40S, 50S, 60S and 70S.
The SP Series has the same characteristics as the S Series models 2-0S, 1-0S, and 1-0S/3000, but offers superior air-tightness thanks to the newly developed connector and pulse coder.
The L series is available in models 0L, 5L, 6L, 7L and 10L, that require an input transformer. The T series is available in models 0T/3000, 5T/2000, 5T/3000, 10T/2000, and 10T/3000. The F series is available in models 5F/3000, 10F/2000, 20F/2000 and 30F/2000.

2. PRECAUTIONS ON USE

2.1 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 mounting surface needs to be sufficiently flat.
(3) When mounting on the machine, take care not to apply a shock to the motor.
(4) When it is unavoidable to tap the motor for adjusting the position, etc., use a plastic hammer and tap only the front flange if possible.

2.2 Coupling

A precision detector is directly connected to the servo motor shaft. Pay atention 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. When the woodruff key is too tight, don't tap it with a hammer. Use the woodruff key mainly for positioning, and use the tapered surface for torque transmission. Machine the tapered surface of the power transmission element so that over 70% of the whole surface is contacted.

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

(5) When tapping slightly to remove the tightly contacted tapered surface, tap in the radial direction to prevent a shock 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.

An exclusive large oil seal is used in the front flange of the models 0/5 and 10/20/30/40.
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.

2.3 Axis Load

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

Motor mode	Radial load	Axial load	Front bering (reference)
5-0	4kg	-	605
4-0S/3-0S	8kg	-	609
2-0S/1-0S	25kg	8kg	6002
0-0SP/2-0SP	25kg	8kg	6003
0S/5S, 0L to 6L, 5F	70kg	20kg	6205
10S to 40, 7L/10L, 10F to 30F	450kg	135kg	6208
50S to 70S	900kg	250kg	6312

The above values are the reference assuming the use as a feed axis on the typical machine tool.

(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.
(3) In some operation conditons, the pulley diameter and the gear size need to be checked. For example, when using the model 0 with a pulley/gear with the radius of 2.5cm or less, the radial load at the occurrence of 180kg.cm torque will exceed 70kg. In the case of timing balt, as the belt tension is added to this value, it is thus necessary to support the shaft end.
(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.

2.4 Environment

(1) The ambient temperature should be 40°C or less. 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.
(2) Any vibration applied to the motor should be 5G or less.
(3) 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.

When mounted as recommended, the motor protection type meets the IEC Standard IP55 (equivalent to JIS C4004-1980 Rotary Electric Machine General Rule JP55-Dust/jet-proof type). Note that as this standard defines the short time performance, consider the following points:

(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 up 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. When there is a possibility of fluid on the cable connector, we recommend using a water proof connector such as the R-class one. (The standard MS connector plug can not prevent the entry of the liquid.)

When lubricating gears with an oil bath, keep the oil level height lower than the oil seal lip of the shaft so that the lip is not exposed to the oil splash.
The oil seal functions to exhaust the oil on the shaft during rotation. However, if oil pressure is applied for a long time on the motor, the oil will seep into the motor.
When the shaft is up and exposed to oil, provide another oil seal in the machine and provide a drain so that the oil passing through that oil seal flows outside.
The motor shaft oil seal diameter is as shown below.

Motor mode	Oil seal diameter
4-0S/3-0S	ϕ 9mm
2-0S/1-0S	ϕ 15mm
2-0SP/1-0SP	ϕ 15mm
0S/5S, 0L to 6L	ϕ 24mm
10S to 40, 7L/10L	ϕ 35mm
10F to 30F	ϕ 38mm
50S to 70S	ϕ 55mm

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

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:

- Even if the angle of the motor shaft to the ball screw changes, it can be compensated to a certain extent.
- Because a flexible coupling connects elements with less backlash, driving noise from joints can be significantly suppressed.

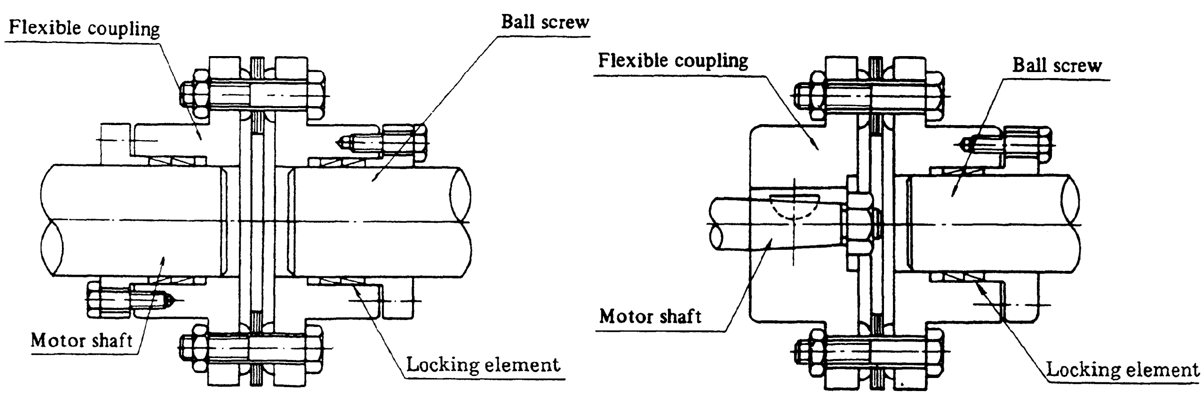
However, this method has the following disadvantages:

- The motor shaft and the ball screw must not slide from each other in the radial direction (for 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.

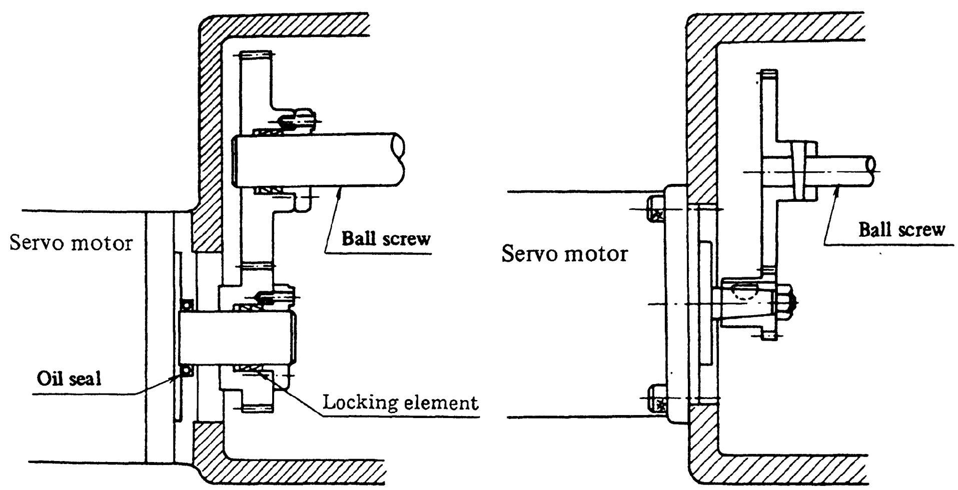
However, this method has the following disadvantages:

- The motor shaft and the ball screw must not slide from each other in the radial direction, and the angle of the motor shaft to the ball screw must be fixed.

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 certain extent by deflection. Note, however, that it is difficult to adjust or measure changes 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:

- o 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.
- o 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 corectly 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 snaft 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.

o 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.

o 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.

o 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.

o If the machine is to accelerate and decelerate frequently, and the heat generated must be minimized, the machine movement per 1 rev. of motor shaft should be such that the motor rotor inertia will be equal to the load inertia reflected to motor shaft. There may be some cases in punch press or printed circuit board drilling machine applications where this optimal condition can not be satisfied due to the limitation caused by the rapid traverse speed. Even then, the amount "L" should be as close to the optimal value as possible.

o If the motor shaft has a position sensor, the machine movement per 1 rev of motor shaft is limited by the sensor and NC specifications. For farther details, refer to the manuals of each NC.

When the flexible feed gear function of the NC is used, the machine travel per motor rotation can be selected from a wider range.
Because the flexible feed gear function rounds off fractions, a position detector whose resolution is sufficient to minimize the effect of fractions needs to be used.

4. SELECTING A MOTOR

When selecting an applicable motor, the load, rapid traverse feedrate, increment system, and other conditions must be considered. This section describes how to calculate the load and other conditions, showing an example of a table with a horizontal axis.
A motor is subjected to two types of load: load torque (including friction) and load inertia. Calculate the two loads accurately and select a motor that satisfies the following conditions:

Condition ① When the machine is operating without any load, the torque is lower than or equal to the continuous torque rating.
If the rated torque is exceeded because of an increase in the friction coefficient when the machine tool is stopped or operated at an extremely low speed, the motor may be overheated by the current flowing when the machine tool is stopped. If the rated torque is exceeded due to viscosity when the machine tool is operated at a high speed, a sufficient acceleration torque may not be obtained, resulting in need for a considerable increase in the acceleration time constant. (It would appear that no current flows through the motor when the machine tool stops. Actually, however, a current continuously flows to balance the torque with the friction produced at a low speed.)

Condition ② Acceleration can be made with a desired time constant.
Generally, the load torque helps deceleration. If acceleration can be executed with a desired time constant, deceleration can be made with the same time constant. Calculate the acceleration torque and check that the torque required for acceleration is within the intermittent operating zone of the motor.

Condition ③ The frequency of positioning in rapid traverse is set 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.

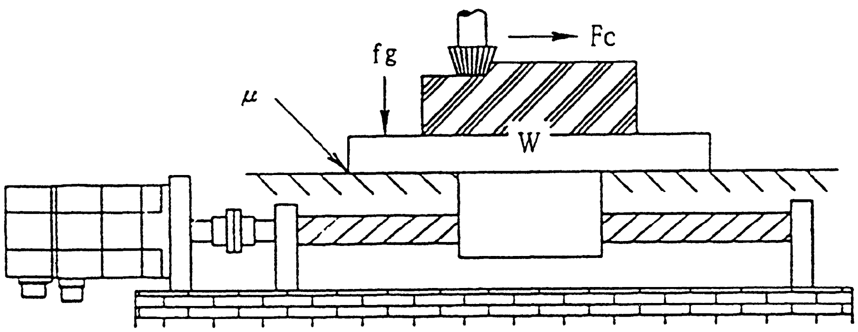
Condition ④ If the load condition varies during a single cycle, the root-mean-square value of the torques is smaller than or equal to the rated torque.

Condition ⑤ The time for which the table can be moved with the maximum cutting torque (percentage duty cycle and ON time) is within a desired range.

The procedure for selecting a motor is described below:

4.1 Calculating Conditions for Selecting a Motor

This section describes the procedure for selecting a servo motor best suited for a table with a horizontal axis (figure below).



Sample mechanical specifications of the table and workpiece

W: Weight of movable parts (table and workpiece) (kgf) = 1000 (kgf)

μ: Friction coefficient of the sliding surface = 0.05

η: Efficiency of the driving system (including a ball screw) = 0.9

fg: Gib fastening force (kgf) = 50 (kgf)

Fc: Thrust counterforce caused by the cutting force (kgf) = 100 (kgf)

Fcf: Force by which the table is pressed against the sliding surface, caused by the moment of cutting force (kgf) = 30 (kgf)

Z_1/Z_2: Gear reduction ratio = 1/1

Sample specifications of the feed screw (ball screw)

Db: Shaft diameter = 32 (mm)

Lb: Shaft length = 1000 (mm)

P: Pitch = 8 (mm)

Sample specifications of the operation of the motor shaft

Ta: Acceleration torque (kgf.cm)

Vm: Motor speed in rapid traverse (min^{-1})= 3000 (min^{-1})

ta: Acceleration time (s) = 0.10 (s)

J_M: Motor inertia ($kgf.cm.sec^2$)

J_L: Load inertia ($kgf.cm.sec^2$)

ks: Servo position loop gain (sec^{-1}) = 30 (sec^{-1})

4.1.1 Calculating the load torque and load inertia

1) Calculating the load torque

The load torque applied to the motor shaft is generally given by the following equation:

$$\boxed{Tm = \frac{F \times L}{2\pi\eta} + Tf}$$

Tm: Load torque applied to the motor shaft (Nm)

F: Force required to move a movable part (table or tool post) along the axis (kgf)

L: Traveling distance of the machine tool per revolution of the motor = P x (Z1/Z2) = 8 (mm)

Tf: Friction torque of the nut of the ball screw or bearing applied to the motor shaft = 2 (Nm)

F depends on the weight of the table, friction coefficient, whether cutting is in progress, and whether the axis is horizontal or vertical. If the axis is vertical, F also depends on the presence of a counterbalance. For a table with a horizontal axis, F is calculated as follows:

When cutting is not executed: $F = \mu (W + fg)$

Example) $F = 0.05 \times (1000 + 50) = 52.5$ (kgf)

$Tm = (52.5 \times 0.8)/(2 \times \pi \times 0.9) + 2 = 9.4$ (kgf.cm) $= 0.9$ (Nm)

When cutting is in progress: $F = Fc + \mu (W + fg + Fcf)$

Example) $F = 100 + 0.05 \times (1000 + 50 + 30) = 154$ (kgf)

$Tmc = (154 \times 0.8)/(2 \times \pi \times 0.9) + 2 = 21.8$ (kgf.cm) $= 2.1$ (Nm)

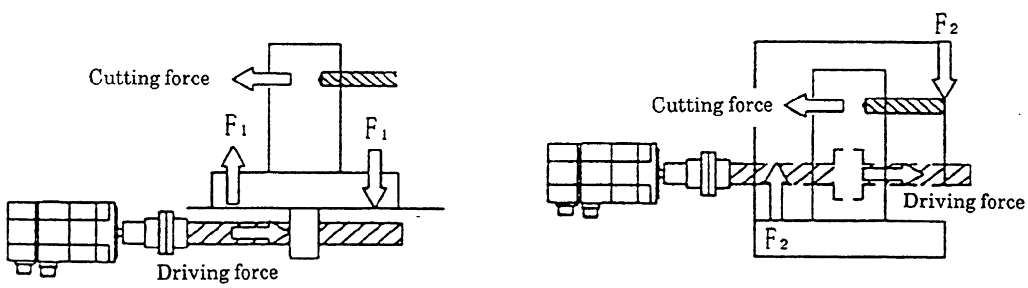
To satisfy condition ①, check the data sheet and select a motor whose load torque (rated torque at stall) when cutting is not executed is 0.9 (Nm) or higher and the maximum speed is 3000 (min^{-1}) or higher. Considering the acceleration/deceleration conditions, provisionally select 1-OSP/3000 (rated torque at stall is 2.0 (Nm)).

Note) When calculating the torque, take the following precautions:

① Allow for the friction torque caused by the gib fastening force (fg). The torque calculated only from the weight of a movable part and the friction coefficient is generally quite small. The gib fastening force and precision of the sliding surface may have a great effect on the torque.

② The pre-load of the bearing or nut of the ball screw, pre-tension of the screw, and other factors may make Fc of the rolling contact considerable. In a small, lightweight machine tool, the friction torque will greatly affect the entire torque.

③ Allow for an increase in friction on the sliding surface (Fcf) caused by the cutting resistance. The cutting resistance and the driving force generally do not act through a common point as illustrated below. When a large cutting resistance is applied, the moment increases the load on the sliding surface.
When calculating the torque during cutting, allow for the friction torque caused by the load.



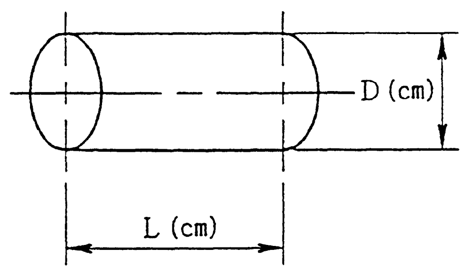
④ The feedrate may cause the friction torque to vary greatly. Obtain an accurate value by closely examining variations in friction depending on variations in speed, the mechanism for supporting the table (sliding contact, rolling contact, static pressure, etc.), material of the sliding surface, lubricating system, and other factors.

⑤ The friction torque of a single machine varies widely due to adjustment conditions, ambient temperature, and lubrication conditions. Collect a great amount of measurement data of identical models so that a correct load torque can be calculated. When adjusting the gib fastening force and backlash, monitor the friction torque. Avoid generating an unnecessarily great torque.

2) Calculating the load inertia

Unlike the load torque, an accurate load inertia can be obtained just by calculation. The inertia of all objects moved by the revolution of a driving motor forms the load inertia of the motor. It does not matter whether the object is rotated or moved along a straight line. Calculate the inertia values of individual moving objects separately, then add the values together, according to a rule, to obtain the load inertia. The inertia of almost all objects can be calculated according to the following basic rules:

① Inertia of a cylindrical object (ball screw, gear, coupling, etc.)



The inertia of a cylindrical object rotating about its central axis is calculated as follows:

$$J = \frac{\pi\gamma}{32\times980} D_b^4 L_b \ (\mathrm{kgf.cm.s^2})$$

J: Inertia ($\mathrm{kgf.cm.s^2}$)
γ: Weight of the object per unit volume ($\mathrm{kg/cm^3}$)
D_b: Diameter of the object (cm)
L_b: Length of the object (cm)

If the object is made of steel ($\gamma = 7.8\times10^{-3}$ $\mathrm{kg/cm^3}$), an approximation of the inertia is:

$$J = 0.78\times10^{-6}\ D_b^4 L_b \ (\mathrm{kgf.cm.s^2})$$

Example) When Db is 32 (mm) and Lb is 1000 (mm), inertia Jb of the shaft of a ball screw is calculated as follows:
$Jb = 0.78\times10^{-6}\times3.2^4\times100 = 0.0082$ ($\mathrm{kg.cm.s^2}$)

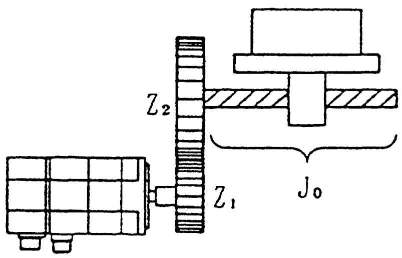
② Inertia of a heavy object moving along a straight line (table, workpiece, etc.)

$$J = \frac{W}{980} \times \left(\frac{L}{2\pi}\right)^2 \ (\mathrm{kgf.cm.s^2})$$

W: Weight of the object moving along a straight line (kg)
L: Traveling distance along a straight line per revolution of the motor (cm)

Example) When W is 1000(kg) and L is 8(mm), Jw of a table and workpiece is calculated as follows:
$Jw = 1000\div980\times(0.8\div2\div\pi)^2 = 0.0165$ ($\mathrm{kgf.cm.s^2}$)

③ Inertia of an object whose speed is increased above or decreased below the speed of the motor shaft

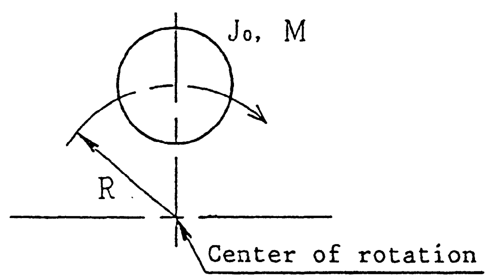


The inertia applied to the motor shaft by inertia Jo is calculated as follows:

$$J = \left(\frac{Z_1}{Z_2}\right)^2 \times J_0 \ (\text{kgf.cm.s}^2)$$

J_0: Inertia before the speed is changed (kgf.cm.s^2)

④ Inertia of a cylindrical object in which the center of rotation is displaced



$$J = J_0 + \frac{M}{980} \times R^2 \ (\text{kgf.cm.s}^2)$$

J_0: Inertia around the center of the object (kgf.cm.s^2)
M: Weight of the object (kg)
R: Radius of rotation (cm)

The above equation is used to calculate the inertia of, for example, a large gear which is hollowed out in order to reduce the inertia and weight.
The sum of the inertia values calculated above is J (load inertia) for accelerating the motor.
In this example, the sum of Jb and Jw obtained in ① and ② above is load inertia JL.

JL = 0.0082 + 0.0165 = 0.0247 (kgf.cm.s^2)

Note) Limitations on load inertia

The load inertia has a great effect on the controllability of the motor as well as the time for acceleration/deceleration in rapid traverse. When the load inertia is increased, the following two problems may occur: When a command is changed, it takes more time for the motor to reach the speed specified by the new command. When a machine tool is moved along two axes at a high speed to cut an arc or curve, a larger error occurs.

When the load inertia is smaller than or equal to the rotor inertia of the motor, those problems will not occur. When the load inertia is up to three times the rotor inertia, the controllability may have to be lowered a little. Actually, this will not adversely affect the operation of an ordinary metal cutting machine. If a router for woodworking or a machine to cut a curve at a high speed is used, it is recommended that the load inertia be smaller than or equal to the rotor inertia.

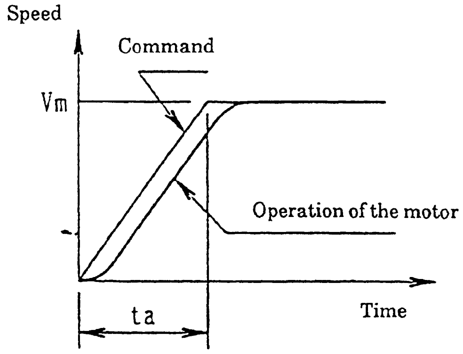
If the load inertia much larger than three times the rotor inertia, the controllability will be lowered significantly. If the load inertia much larger than three times the rotor inertia, an adjustment in the normal range may be insufficient. Avoid using a machine with such a great load inertia. If the machine design does not allow a smaller load inertia, contact a FANUC engineer.

4.1.2 Calculating the acceleration torque

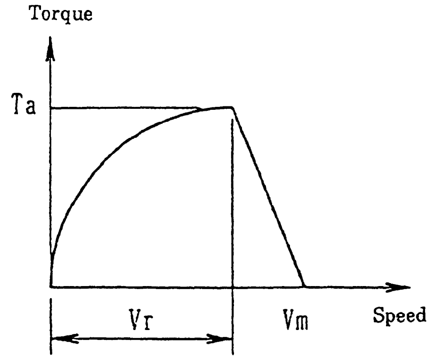
Following the procedure described below, calculate the torque required for acceleration:

1) Assuming that the motor shaft operates ideally in the acceleration/deceleration mode determined by the NC, calculate the acceleration. Multiply the acceleration by the entire inertia (motor inertia + load inertia). The product is the acceleration torque. The equation is given below.

   ① In linear acceleration/deceleration



Speed variation



Acceleration required to achieve the speed

$$T_a = \frac{V_m}{60} \times 2\pi \times \frac{1}{t_a} \times J_m \times (1 - e^{-ks \cdot ta})$$

$$+ \frac{V_m}{60} \times 2\pi \times \frac{1}{t_a} \times J_L \times (1 - e^{-ks \cdot ta}) \div \eta$$

$$V_r = V_m \times \left\{ 1 - \frac{1}{ta \cdot ks} (1 - e^{-ks \cdot ta}) \right\}$$

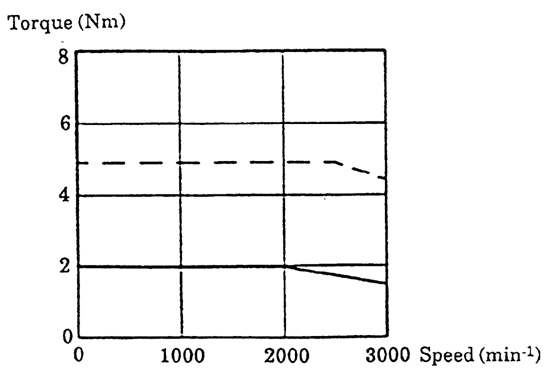
Ta: Acceleration torque (kgf.cm)
Vm: Motor speed in rapid traverse (min^{-1})
ta: Acceleration time (sec)
J_M: Motor inertia ($kgf.cm.sec^2$)
J_L: Load inertia ($kgf.cm.sec^2$)
Vr: Point from which the acceleration torque starts to decrease (difference from Vm) (min^{-1})
ks: Servo position loop gain (sec^{-1})
η: Machine tool efficiency

Example) When 1-OSP/3000 is used, the load inertia is calculated as follows. J_M motor inertia is 0.0061 ($kgf.cm.s^2$), Vm is 3000 (min^{-1}), ta is 0.1 (s), ks is 30 (sec^{-1}), and J_L = 0.0247 ($kgf.cm.s^2$).

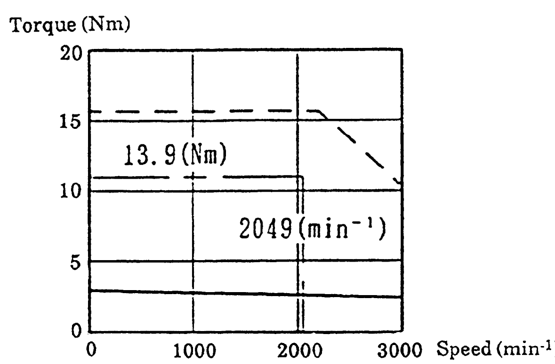
$$T_a = \frac{3000}{60} \times 2\pi \times \frac{1}{0.1} \times 0.0061 \times (1 - e^{-30*0.1})$$

$$+ \frac{3000}{60} \times 2\pi \times \frac{1}{0.1} \times 0.0247 \times (1 - e^{-30*0.1}) \div 0.9$$

$$= 100.1 \text{ (kgf.cm)} = 9.81 \text{ (Nm)}$$



Speed-torque characteristics of 1-OSP/3000



Speed-torque characteristics of OS

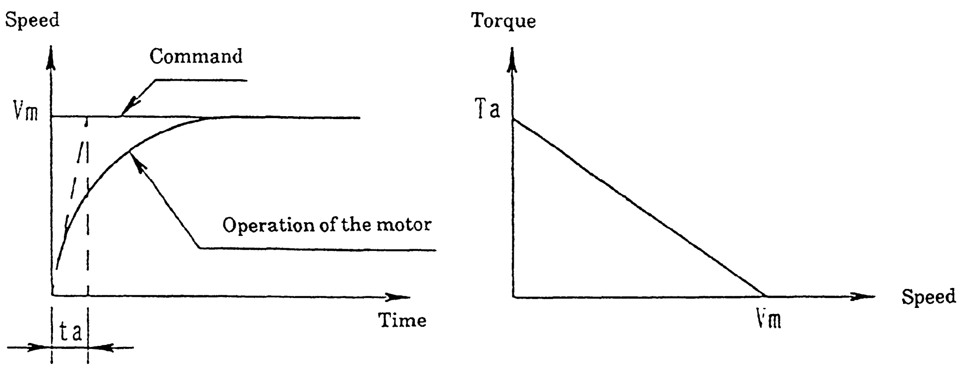
The speed-torque characteristics of 1-OSP/3000 show that the acceleration torque of 9.81 (Nm) is beyond the intermittent operating zone of 1-OSP/3000 (see the characteristic curve above and data sheet). (The torque is insufficient for 1-OSP/3000.)
If the operation specifications of the shaft (for instance, the acceleration time) cannot be changed, a larger motor must be selected. Select an OS (J_M is 0.02 (kgf.cm.s2)) and calculate the acceleration torque again.

Ta = 141.6 (kgcm) = 13.9 (Nm)
Vr = 2049 (min^{-1})

In acceleration, an acceleration torque of 13.9 (Nm) is required at 2049 (min^{-1}). The speed-torque characteristic curve shown above shows that the acceleration is possible with OS.

As 1-OSP/3000 is changed to OS, the size of the attachment flange is increased from 90 mm x 90 mm to 130 mm x 130 mm. If the machine tool does not allow a larger motor, the specifications must be changed. For example, the acceleration time must lengthen.

② When acceleration/deceleration is not controlled



Assume these equations.

$$Ta = \frac{Vm}{60} \times 2\pi \times \frac{1}{ts}(Jm + J_L),\ ts = \frac{1}{ks}$$

2) To obtain T (torque) required by the motor shaft, add Tm (friction torque) to Ta acceleration torque.

$$\boxed{Ta = Ta + Tm}$$

T = 13.9 (Nm) + 0.9 (Nm)
= 14.8 (Nm)

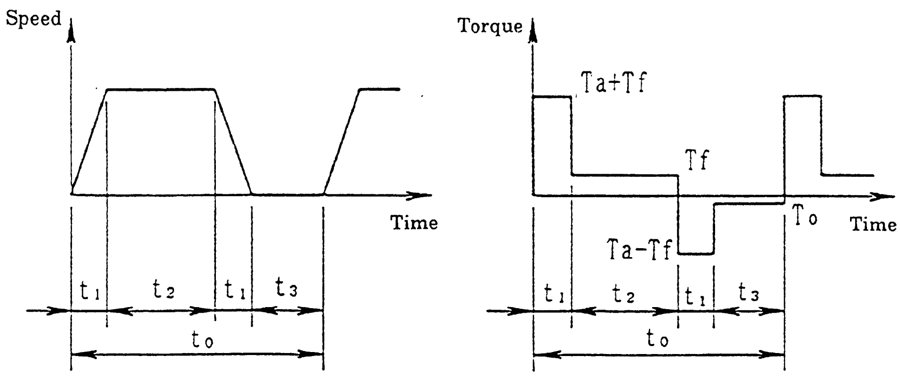
3) Check that T obtained in (2) above is smaller than or equal to the torque limit determined by the amplifier. Using the speed-torque characteristic curve on the data sheet of the corresponding motor, check that T obtained in (1) above is within the intermittent operating zone at Vr.
As Vr is 2049 (min^{-1}) and T is 14.8 (Nm), the acceleration is possible with the specified time constant (condition ②).

4.1.3 Calculating the root-mean-square value of the torques

(1) Calculating the frequency of positioning in rapid traverse

Generate an operation cycle which includes rapid traverse. Write the speed-time graph and torque-time graph as shown below.

In a common cutting machine, the frequency of positioning in rapid traverse will cause no problems. In a special machine tool which frequently executes rapid traverse, however, the motor must be checked to see whether it is overheated by the current required for acceleration or deceleration.



From the torque-time graph, obtain the root-mean-square value of torques applied to the motor during the single operation cycle. Check whether the value is smaller than or equal to the rated torque (condition ③).

$$Trms = \sqrt{\frac{(Ta+Tm)^2 t_1 + Tm^2 t_2 + (Ta-Tm)^2 + t_1 + To^2 t_3}{to}}$$

Ta : Acceleration torque
Tm : Friction torque
To : Torque when stopped

If Trms is smaller than or equal to the rated torque at stall (Ts), the motor can be used.

Example) When an OS (Ts = 30 (kgfcm) = 2.9 (Nm)) is used under the following conditions: Ta = 13.9 (Nm), Tm = To = 0.9 (Nm), t1 = 0.1 (s), t2 = 1.8 (s), t3 = 7.0 (s)

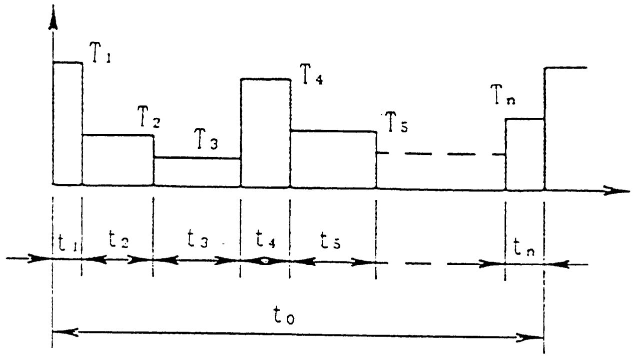
$$Trms = \sqrt{\frac{(13.9+0.9)^2 \times 0.1 + 0.9^2 \times 1.8 + (13.9-0.9)^2 \times 0.1 + 0.9^2 \times 7}{9}}$$

$$= 2.26(Nm) < Ts=2.9(Nm)$$

The OS can be used for operation. (Condition ③)

(2) Calculating the torque in a cycle in which the load varies

If the load conditions (cutting load, acceleration/deceleration conditions, etc.) vary widely in a single cycle, write a torque-time graph according to the operation cycle, as in (1) above. Obtain the root-mean-square value of the torques and check that the value is smaller than or equal to the rated torque (condition ④).



$to = t_1 + t_2 \cdots\cdots + t_n$

$$Trms = \sqrt{\frac{T^2{}_1t_1+T^2{}_2t_2+T^3{}_3t_3+ \cdots\cdots\cdots + T^2ntn}{to}}$$

$to=t_1+t_2 \cdots\cdots\cdots +tn$

4.1.4 Calculating the percentage duty cycle with the maximum cutting torque

Check that the time for which the table can be moved with the maximum cutting torque, Tmc, (percentage duty cycle and ON time) is within a desired range of cutting time. (Condition ⑤)

If Tmc (maximum load torque) applied to the motor shaft during cutting, which is obtained in 4.1.1, is smaller than the product of rated torque at stall of the motor (Tc) and α (thermal efficiency), the motor can be used in continuous cutting. If Tmc is greater than the product (Tmc > Tc $\times$ α), follow the procedure below to calculate the percentage ratio of time (t_{ON}) Tmc can be applied to the motor to total time (t) of a single cutting cycle. (α is assumed to be 0.9. Calculate the percentage considering the specifications of the machine.)

Tmc < Tc × α ···	Operation can be continued with the maximum cutting torque. (The percentage duty cycle with the maximum cutting torque is 100%.)
Tmc > Tc × α ···	Calculate the percentage duty cycle, according to the following figure and expressions.

Example) As calculated in Section 4.1.1,

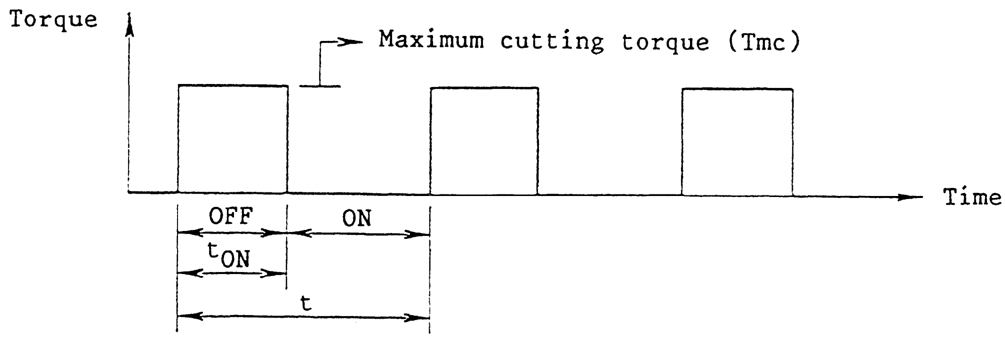
Tmc = 21.8 (kgfcm) = 2.1 (Nm)

OS: Tc = 30 (kgfcm) = 2.9 (Nm)

2.9 × 0.9 = 2.6 (Nm) > 2.1 (Nm) = Tmc

No problems will occur in continuous cutting.

Calculating the percentage duty cycle with the maximum cutting torque



t_{ON} : Time maximum cutting torque (Tmc) is applied
t_{OFF} : Time no cutting torque is applied
t : Maximum time of a single cutting cycle

Calculate the root-mean-square value of torques applied in a single cutting cycle as described in Section 4.1.3. Specify t_{ON} and t_{OFF} so that the value does not exceed the product of rated torque at stall of the motor (Tc) and thermal efficiency (α). Then, calculate the percentage duty cycle with the maximum cutting torque as shown below.

Percentage duty cycle with the maximum cutting torque (Tmc) = $\frac{t_{ON}}{T} \times 100$ (%)

Example) Assume that Tmc is 4.0(Nm) (Tm = 0.9(Nm)).

$$\sqrt{\frac{4.0^2 \times t_{ON} + 0.9^2 \times t_{OFF}}{t_{ON} + t_{OFF}}} < 2.6(\mathrm{Nm})$$

Therefore,

$$\frac{t_{ON}}{t_{OFF}} < \frac{1}{1.6}$$

The ratio of non-cutting time to cutting time must be 1.6 or greater. The percentage duty cycle is calculated as follows:

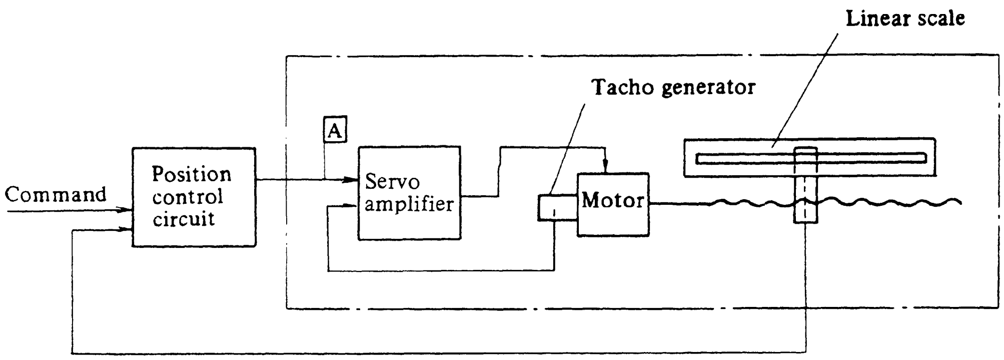
$$\frac{t_{ON}}{2.6t_{ON}} \times 100 = 38.5\%$$

Finally, the OS that satisfies conditions ① to ⑤ is selected.

4.2 Precautions for Using Linear Scale

In the case where the machine moves in a linear direction and movement is directly detected by linear scale such as inductosyn, magne-scale etc., special considerations are necessary in comparison with the method where feedback is produced by detecting the motor shaft rotation. This is because the machine movement now directly influences the characteristics of the control system.

1) Machine system natural frequency



This method is shown in the figure above by block diagram. The response of this control system is determined by the adjustment value (position loop gain) of the position control circuit. In other words, the position loop gain is determined by the specified response time of the control system. In the diagram above, the section enclosed by the broken line is called the velocity loop. Unless the response time of this section where position signal is detected is sufficiently shorter than the response time determined by the position loop gain, the system does not operate properly. In other words, when a command signal is put into point A, response time of the machine where position signals are detected must be sufficiently shorter than the response time defined by the position loop gain.
When the response of the detector section is slow, the position loop gain must be reduced to have the system operate normally, and as a result, the response of the whole system is slow. The same problem is caused when inertia is great (see section 3.3, item 5)).
The main causes for slow response are the mass of the machine and the elastic deformation of the machine system. The larger the volume, and the greater the elastic deformation, the slower the response becomes.
As an index for estimating the response of this machine system, the natural frequency of the machine is used, and this is briefly calculated by the following equation.

$$\omega = \frac{1}{2\pi} \sqrt{\frac{Km}{J\ell}} \quad \text{(Hz)}$$

ω : Natural frequency (Hz)

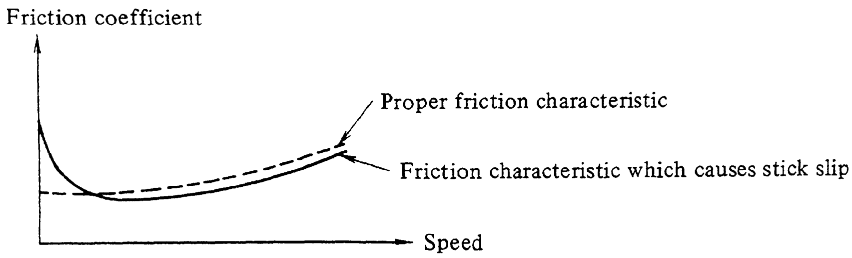
$J\ell$: Load inertia reflected to motor shaft ($kgf\text{-}cm\text{-}s^2$)

Km: Rigidity of machine system (kgf-cm/rad)
= Torque necessary to elastically deform 1 rad at the motor shaft when the machine table is clamped.

The above values can be obtained by calculating the elastic deformation for each section of the driving system. If the value of this natural frequency (Hz) is more than the value of position loop gain (see^{-1}), it operates normally in most cases. That is to say, when setting 20 sec^{-1} as the value of position loop gain, natural frequency of machine system must be more than 20 Hz. In this case, attention must be paid to the fact that response becomes a problem for extremely small amounts of movement.
Consequently, the natural frequency should be calculated from the rigidity at extremely small displacement such as less than 10 μm.

2) Stick slip

If machine movement causes a stick slip, the control system does not operate normally. That is, it does not stop where it is supposed to, but a phenomenon occurs where it goes beyond and then back within an extremely small range (hunting). To avoid stick slip, the machine rigidity should be increased, or friction characteristics of the sliding surface should be improved. When the sliding surface friction characteristic is as in the figure below, stick slip occurs easily.



3) Value of machine overrun (Damping coefficient of machine system)

When the machine is floated by static pressure, etc., there are cases where the machine keeps on moving within the range of backlash although the motor shaft has stopped. If this amount is large, hunting will also occur. To avoid this, backlash should be reduced (especially the backlash of the last mass where position detector is mounted) and the appropriate damping should be considered.

4.3 Motor Selection

Select a suitable motor according to the load condition, rapid traverse rate, increment system, and so on. To aid in selecting the correct motor, fill out the "servo motor selection data table" at the end of this section.
Fill in blanks of machine tool data items (No. 1, 2 and 3) of this table with necessary data, and send this table to our representative.
The representative will fill in blanks of item No. 4 to 8 with suitable data of motor and send this table back.
Details of each item in this selection data table are as described in paragraph 3.6.1.

4.3.1 Blanks for those other than data

1) Address blank
   Fill in this blank with machine tool builder's company name. However, this entry is not always needed.
2) Kind of machine tool
   Fill in this blank with a general name of machine tools, such as lathe, milling machine, machining center, and others.
3) Type of machine tool
   Fill in this blank with the type of machine tool decided by machine tool builder.
4) CNC equipment
   Fill in this blank with the name of CNC (15T, 16M, 10M, 0M, etc.) employed. Enter the cabinet type (self-standing type, separate type, etc.) in parentheses.
5) Spindle motor output
   Fill in this blank for reference when examining the servo motor output.
6) Names of axes
   Fill in this blank with names of axes practically employed in NC command. If the number of axes exceeds 4 axes, enter them in the second sheet.
   If names of axes other than entered X, Y, Z are used, delete these entered symbols with "//", and write correct names of axes aside.

7) Blanks of version number, date, name, and reference number.
   These blanks are left blank by the MTB.

4.3.2 Data

Machine tool builders are requested to fill in data blanks No. 1, 2, 3. Fill in No. 4 items and higher blanks with decided values or desired values, if any, from the viewpoints of specifications.
If these values are unknown or undecided, the representative will decide these values according to the contents in item No. 1, 2, and 3. So leave them blank.
For details of entry contents, refer to the following description.

1) No. 1 blank
   Data in this blank are used for determining approximate values of motor load conditions (inertia, torque). Fill in blanks of all items.
   a) Axis movement direction
      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 driven parts
      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.
   e) Feed screw
      Enter the diameter, pitch, and axial length of the lead screw in order.
      Example: ϕ40 x 10 x 1500 (when the diameter is 40 mm, pitch is 10 mm, and axial length is 1500 mm)
   f) 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.
2) No. 2 blank
   Data in this blank serve as the basis for selecting the motor. Enter these data correctly. For details of calculating methods of respective items, refer to para. 3.2 to 3.4.
   a) Movement per rotation of motor
      Enter the movement of the machine tool when the motor rotates one turn.
      Example: * When the pitch of ball screw is 12mm and the gear ratio is 2/3,
      12 x 2/3 = 8 mm
      * When the gear ratio is 1/72 in rotary table;
      360 x 1/72 = 5 deg
   b) Least input increment of CNC
      Enter the least input increment of NC command. The standard value is 0.001 mm in Series 0, 15, 16 and 18 CNCs.
   c) Rapid traverse rate and cutting feedrate
      Enter the rapid traverse rate and cutting feedrate required for machine tool specifications.

d) Inertia

Enter a load inertia value reflected to the motor shaft. For details of this calculation, see para. 3.4.

It is not always necessary to enter this inertia value in detail. Enter it as a 2-digit or 1-digit value.

(Example: 0.2865 → 0.29 or 0.3)

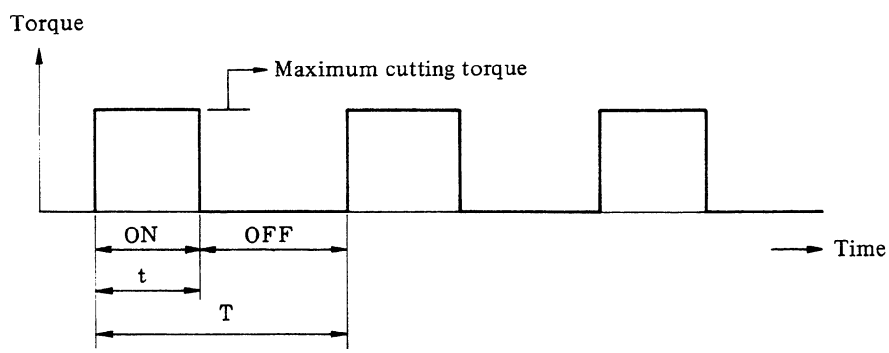
Do not include any inertia of the motor proper in this value.

e) Load torque

- Since the torque produced in low speed without cutting may be applied even during the stop of motor, a sufficient allowance is necessary as compared with the continuous rated torque of the motor. Suppress this load torque to be lower than 60% of the rated torque.
- For the torque during rapid traverse, enter the torque during traveling at rapid traverse steady-state speed. Keep this value within the continuous rating. Do not include any torque required for acceleration/deceleration in this item.
- For the cutting torque, enter the maximum value of the force being applied during cutting by the force in the feed axis direction.
- For the maximum cutting torque, enter the torque value on the motor shaft corresponding to the maximum value of the above cutting thrust. Since the torque transfer efficiency may substantially deteriorate to a large extent due to the reaction from the slide way, etc. produced by the cutting thrust, obtain an accurate value by taking measured values in similar machine tools and other data into due account.
- If the load torque values differ during lifting and lowering in the vertical axis, enter both values.

f) Maximum cutting duty/ON time

Enter the duty time and ON time with the maximum cutting torque in (e) applied. These values mean as follows.



ON : Time the maximum cutting torque is being applied

OFF: Time absent from the cutting torque

Duty = t/T x 100 (%)

ON time = t (min)

g) Rapid traverse positioning frequency

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.

3) No. 3 blank

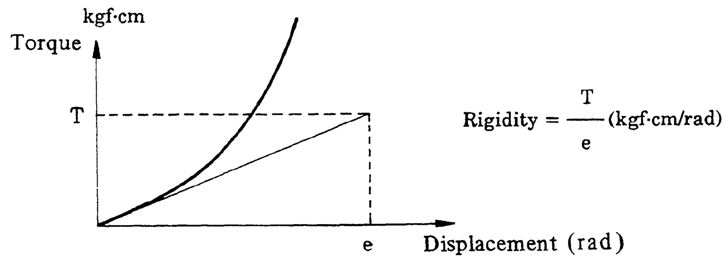
Data in this blank are necessary for examining the stability of the servo system when the position detector is attached outside the motor. Enter these data without fail when the servo system is constructed using a linear scale.

a) External position detector
   If the position detector is mounted outside the motor, enter the name of the detector. Enter the following items in the "remarks" column, if a rotary detector such as resolver, pulse coder, or the like is used.
   * Resolver : Move amount of machine tool per revolution of resolver
     Number of wave lengths per revolution of resolver
   * Pulse coder: Move amount per rotation of pulse coder
     Number of pulses of pulse coder

b) Rigidity of feed system machine tool
   Enter the relation between the torque and the displacement when the torque is applied to the motor shaft, assuming that the final driven part like the table has been fully locked. Fill in this value as a torque value required for the angular displacement of 1 radian.
   Example: If displacement of 5 deg. at 500 kgf-cm torque as a calculation results,

$$\text{Rigidity} = \frac{500}{5} \times \frac{180}{\pi} = 5730 \text{ kgf-cm/rad}$$

   If the relation between the displacement and the torque is nonlinear, calculate the rigidity by the gradient in the vicinity of origin.



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

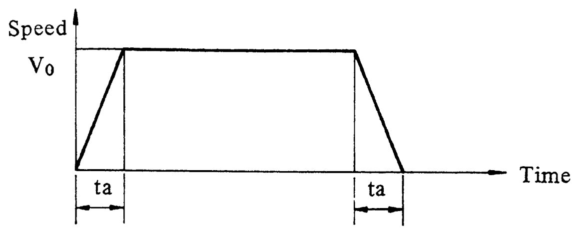
4) No. 4 blank: Motor specifications
   a) Motor model   Feedback (FB) type
      Enter the model name of the motor employed and the specifications of the built-in feedback unit by using symbols.
      (Example)

      Motor model — 10 ; Model 10
                    10B; Model 10 with brake

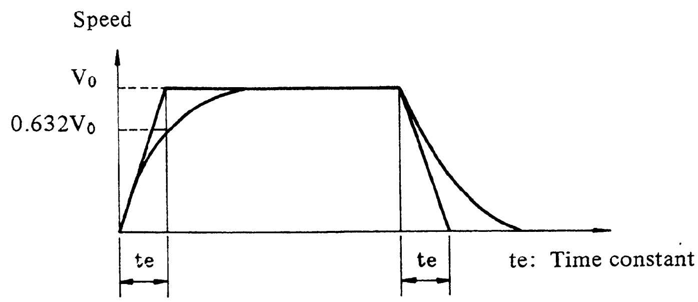
      Feedback — 2000; Pulse coder 2000 pulse/rev.

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

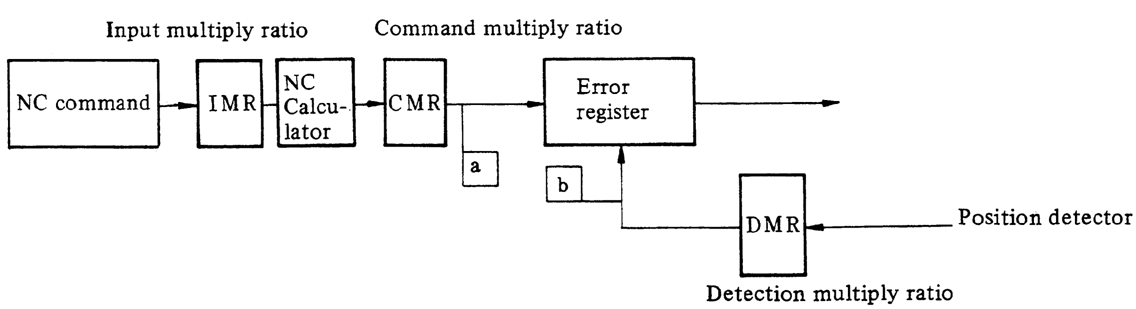
5) No. 5 blank
   (The acceleration/deceleration time in this item is a commanded value. It does not mean any actual completion time of positioning)
   a) Acceleration/deceleration time at rapid traverse
      The acceleration/deceleration time is determined according to the load inertia, load torque, motor output torque, and working speed. For details of calculations, refer to para. 3.3.
      The acceleration/deceleration mode at rapid traverse is generally linear acceleration/deceleration in FANUC's CNC.



b) Acceleration/deceleration time at cutting feed
The acceleration/deceleration at cutting feed is expotential acceleration/deceleration in general. This blank is filled in with its time constant.



6) No. 6 blank
a) Input multiply ratio, command multiply ratio, and detection multiply 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 is as illustrated below.



These multiply ratios are set so that the least input increments of two inputs (a, b) of the error register are equal to each other in the above figure.
(Example)
IMR = 1, CMR = 1, and DMR = 4, if the least input increment of NC is 1μm, the move amount of the machine tool per revolution of motor is 8 mm, and pulse coder 2000 P/rev is used.

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.

7) No. 7 blank

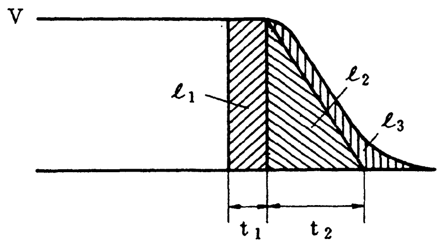
The coasting distance of the machine tool at the machine tool stroke end is entered in this blank. The stroke end is usually limited in 2 steps consisting of the deceleration stop in the first step and dynamic brake stop in the second step.

The position display accurately coincides with the stop position of the machine tool when the first step limit switch is depressed. However, this position is lost when the second step limit switch is depressed.

Mount this second limit switch without fail for preventing the machine tool from being damaged, because it is only one means of stopping the machine tool, if the machine tool should run away due to a control failure.

a) Deceleration stop distance

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



Vm: Rapid traverse rate, mm/min or deg/min

ℓ1: Coasting distance due to delay time t_1 of receiver

ℓ2: Coasting distance due to deceleration time t2

ℓ3: Servo deflection amount

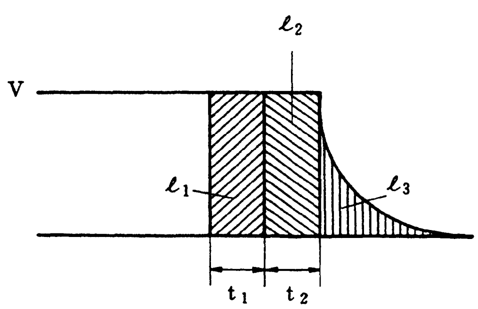
t1: usually about 0.02 seconds.

$$\text{Coasting distance} = \frac{Vm}{60} \times \left(t1 + \frac{t2}{2} + \frac{1}{ks}\right)$$

ks: Position loop gain sec^{-1}

b) Dynamic brake stop distance

This is the 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.



Vm: Rapid traverse rate, mm/min or deg/min

ℓ1: Coasting distance due to delay time t_1 of receiver

$\ell 2$: Coasting distance due to operation time t2 of magnetic contactor (MCC)

$\ell 3$: Coasting distance by dynamic braking after magnetic contactor has been operated

(t1 + t2) is usually about 0.05 seconds.

$$\text{Coasting distance (mm or deg)} = \frac{Vm}{60}(t1 + t2) + (Jm + JL) \times (ANo + BNo^3) \times L$$

Jm: Motor inertia (kg·cm·sec^2)

JL: Load inertia (kg·cm·sec^2)

No: Motor speed at rapid traverse (rpm)

L : Machine movement on one-rotation of motor (mm or deg)

NoL = Vm

A and B are the constants relative to the motor models as shown the table of (9).

8) No. 8 blank: Servo unit specification
   a) Type of amplifier
      Designate AC servo.
   b) Transformer
      Fill the transformer specification(input voltage specification).
   c) Specifications
      Fill the specifications of amplifier and regenerative discharge unit.

9) Coefficients for calculating the dynamic brake stopping distance

Model	A	B	Jm ($kgfcms^2$)
S Series			
5-0	1.9	1.4×10^{-8}	0.00003
4-0S	4.3×10^{-1}	2.7×10^{-8}	0.00038
3-0S	1.5×10^{-1}	1.7×10^{-8}	0.00074
2-0SP	4.5×10^{-2}	1.7×10^{-8}	0.0037
1-0SP	1.5×10^{-2}	6.5×10^{-9}	0.0061
1-0SP/3000	2.1×10^{-2}	4.6×10^{-9}	0.0061
0-0SP	3.7×10^{-2}	2.3×10^{-9}	0.0085
0S	8.4×10^{-3}	4.1×10^{-9}	0.020
5S	5.9×10^{-3}	2.0×10^{-9}	0.038
5S/3000	3.6×10^{-3}	1.8×10^{-9}	0.038
10S	2.8×10^{-3}	2.5×10^{-9}	0.10
10S/3000	6.9×10^{-3}	1.0×10^{-9}	0.10
20S	1.9×10^{-3}	6.3×10^{-10}	0.17
20S/1500	2.3×10^{-3}	5.2×10^{-10}	0.17
20S/3000	4.2×10^{-3}	2.8×10^{-10}	0.17
30S	6.0×10^{-4}	8.9×10^{-10}	0.24
30/2000	5.3×10^{-4}	1.0×10^{-9}	0.24
30S/3000	2.3×10^{-3}	2.3×10^{-10}	0.24
40	7.1×10^{-4}	4.1×10^{-10}	0.31
40S/2000	1.0×10^{-3}	2.9×10^{-10}	0.31
50S	1.5×10^{-3}	4.7×10^{-10}	0.24
60S	1.1×10^{-3}	2.8×10^{-10}	0.32
70S	9.0×10^{-4}	1.9×10^{-10}	0.39
L Series			
0L	2.3×10^{-2}	3.0×10^{-8}	0.0025
5L	9.3×10^{-3}	1.6×10^{-8}	0.0050
6L	6.7×10^{-3}	3.1×10^{-9}	0.0100
7L	5.8×10^{-3}	9.8×10^{-10}	0.055
10L	2.8×10^{-3}	6.7×10^{-10}	0.100
T Series			
0T/3000	14.0×10^{-3}	9.6×10^{-10}	0.034(0.045)
5T/2000	4.8×10^{-3}	5.0×10^{-10}	0.065(0.080)
5T/3000	7.5×10^{-3}	3.2×10^{-10}	0.065(0.080)
10T/2000	3.1×10^{-3}	3.1×10^{-10}	0.110(0.140)
10T/3000	5.9×10^{-3}	1.4×10^{-10}	0.110(0.140)
F Series			
5F/3000	7.8×10^{-3}	9.9×10^{-10}	0.038
10F/2000	4.0×10^{-3}	5.3×10^{-9}	0.10
20F/2000	1.7×10^{-3}	1.4×10^{-9}	0.17
30F/2000	1.3×10^{-3}	6.8×10^{-10}	0.265

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.
Coefficient will vary depending on the servo amplifiers. The machine may stop by a less distance movement by the coefficient.

AC servo motor selection data table

MTB ____________________

Machine	Kind	Type
NC, spindle motor	NC: FANUC ( )	Spindle motor kW

No.	Item / Axis		X	Y	Z	
1	Axis movement direction (horizontal, vertical rotation)					
	Weight of moving component parts (including workpiece, etc.) kg					
	Counter balance kg					
	Table support (sliding, rolling, static pressure)					
	Feed screw Diameter x pitch x axial length mm					
	Total gear ratio					
2	Movement of machine tool per revolution of motor mm					
	Least input increment of NC mm					
	Rapid traverse feedrate mm/min					
	Cutting traverse feedrate mm/min					
	Inertia $kg\text{-}cm\text{-}s^2$					
	Load torque	Low feed without cutting kg-cm				
		Rapid traverse kg-cm				
		Cutting thrust kg				
		Maximum cutting torque kg-cm				
	Maximum cutting duty/ON time %/min					
	Rapid traverse positioning frequency times/min					
3	External position detector					
	Feed system machine tool rigidity kg-cm/rad					
	Backlash amount mm					
4	Motor type, model - feedback type					
	FB type					
	Number of rotation at rapid traverse					
	Option/special specifications					
5	Acceleration/deceleration time at rapid traverse msec					
	Acceleration/deceleration time at cutting feed msec					
6	Input multiply ratio (IMR)					
	Command multiply ratio (CMR)					
	Detection multiply ratio (DMR)					
	Position loop gain sec^{-1}					
7	Deceleration stop distance mm					
	Dynamic brake stop distance mm					
8	Amplifier type					
	Transformer					
	Specifications	Amplifier				
		Regenerative unit				
Remarks						

Version	Date	Name
1		
2		
3		

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Servo motor selection data table (models for positioning)

MTB____________________

Machine		Model	
NC model	NC : FANUC	Name	

Item	Axis name		
Specifications of moving object	Direction of movement (horizontal, vertical, rotation)		
	Weight of the moving object (including the workpiece) kg		
	Counterbalance kg		
	Table support (sliding contact, rolling contact, static pressure)(*)		
Feed mechanism (Select one of the following and enter the corresponding data.)	Ball screw: Diameter × pitch × length		
	Rack and pinion: Diameter of pinion (traveling distance of the machine tool per revolution of the pinion: mm)		
	Others		
Mechanical specifications	Traveling distance of the machine tool per revolution of the motor mm		
	Total gear reduction ratio		
	Inertia (Note "before deceleration" or "applied to the motor shaft.") kg cm sec^2		
	Least input increment of NC (resolution) mm		
	Maximum rapid traverse feedrate mm/min		
	Motor speed in rapid traverse rpm		
	Acceleration/deceleration time in rapid traverse msec		
	Distance of positioning in rapid traverse mm		
	Frequency of positioning in rapid traverse times/min		
	In the remarks section, note the operation cycle (speed pattern) if it is determined.		
	Load torque: Low feed without cutting kg cm		
	Load torque: Rapid traverse kg cm		
	Backlash mm		
Fill in these blanks when an external position 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 type (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		
	Position loop gain sec^{-1}		
	Deceleration stop distance mm		
	Dynamic brake stop distance mm		
	Specifications of amplifier		
	Specifications of 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.		
Remarks			

Version	Date	Name
1		
2		
3		

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4.4 Characteristic Curve and Data Sheet

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

Performance Curves

The typical characteristic curves consist of the following.

1) Torque-speed characteristics

   These are known as operating curves and describe the relationship between the output torque and speed of the motor. The motor can be operated continuously at any combination of speed and torque within the prescribed continuous operating zone. Outside of this zone, the motor must be operated on an intermittent basis using the duty cycle curves.

   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 intermittent operating zone is determined by input voltage to the motor.

   Actual operation is limited by the current limit of servo unit.

   Due to the negative temperature coefficient of the magnetic material, continuous operating zone must be derated at the rate of 0.19% per degree centigrade rise of magnets. (i.e. for ambient temperature above 20° derate 0.19% for each degree over)

2) Overload duty characteristic

   These curves are known as duty cycle curves and provide very important information on how to determine the "ON" time for intermittent overload torque without overheating the motor. The curves shown in the following figures are ones determined by the limit of the temperature of the motors. When the motor is driven by some driving circuit having thermal protect devices such as thermal relay or fuse, the "ON" time may be limited by the characteristics of those elements.

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.

a) The ambient temperature for the motor is 20°C.

b) Drive current of the motor is pure sine wave.

Important parameters on the data sheet are defined as follows:

i) Continuous RMS current at stall TENV: Is (Arms)

   Up to 40°C ambient motor can be operated at this RMS current continuously at stall (or low speed) with TENV (Totally Enclosed Non Ventilation).

ii) Torque constant: Kt (kgf·cm/Arms)

   This is known as torque sensitivity and represents the torque developed per ampere of phase current. This value can usually be obtained by measuring the torque developed by rated current. The torque constant is a function of the total flux and the total number of conductors in the armature.

   The back EMF constant and the torque constant are inter-related as follows:

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

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

iii) Back EMF (electromotive force) constant: Kv (volt·sec/rad)

   The back EMF constant is the indication of the permanent magnet field strength. It is the value of the generated voltage at a specified speed when magnetic field is rotated mechanically, and is the function of total number of conductors in the armature and total flux of the field.

The back EMF constant has the dimensions of volt-second per radian or volts per rpm. The relationship can be given as:

$$\text{Volt}\cdot\text{sec/rad} = \frac{\text{volts}}{\text{rpm}} \times 9.55$$

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

iv) 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.

$$tm = \frac{Jm \cdot Ra}{Kt \cdot Kv}$$

, when Jm: rotor inertia ($\text{kgf}\cdot\text{cm}\cdot\text{sec}^2$)

v) Thermal time constant: t_t (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.

vi) Static friction: Tf (kg·cm)
This is the no-load torque required just to rotate the rotor.

vii) Max. current before demagnetization: Im (A)
This value of current is the instantaneous (peak) current which can be applied to the motor without demagnetizing the permanent magnet field. The magnet can be demagnetized even on only one pulse of high current. Care should therefore be taken to limit peak currents to the stated value. Repeated pulses at rated peak or less will not affect demagnetization.

How to Use Duty Cycle Curves

Servo motors can be operated in the range exceeding continuous rated torque depending on thermal time constant. Duty characteristics shows the Duty (%) and the "ON" time in which motor can be operated under the given overload conditions. Calculation procedure is as follows.

1. Calculate Torque percent by formula (b) below.
2. Motor can be operated at any point on and inside the curve corresponding to the given over load conditions obtained from 1 .
3. Calculate tF by formula (a)

$$tF = tR \times \left(\frac{100}{\text{Duty percent}} - 1 \right) \quad \text{.........................} \quad (a)$$

$$\text{Torque percent} = \frac{\text{Load torque}}{\text{Continuous rated torque}} \quad \text{...............} \quad (b)$$

tF: "OFF" time
tR: "ON" time

The values of tR and tF obtained form the above mentioned procedure shows the ones limited by motor thermal conditions. Other circuit protectors such a thermal relay or fuse also limit the operating zone of the motor. To determine tR and tF for actual use, characteristics of those protectors must be considered.

In the case of digital servo, the software protection is available to protect against a shorter time overload. This also limits the motor operating conditions.

5. FEEDBACK DETECTOR

5.1 Built-in Detector

A pulse coder (optical encoder) is built in every AC servo motor. The pulse coder generates an A quad B incremental signal, a Z-phase (1 rotation) signal, and a rotor phase signal necessary for motor control.
The pulse encoder is selectable to meet the machine requirements on motor models 2-0S to 40S.
The types of pulse coders that can be built into models 5-0, 4-0S, 3-0S, 2-0SP, and 1-0SP are limited.
Only three types of pulse coders can be built into models 50S, 60S, and 70S: The high-resolution pulse coder and serial pulse coders A and C.

5.1.1 Incremental pulse coder (standard)

This is the most compact standard pulse coder.
The incremental pulse coder is available in the types of 2,000, 2,500, 3,000, and 10,000 (A-phase) pulses per motor rotation.
When using with a digital servo, it can be used for up to 24m/min. at resolution of 1μm/pulse. For other resolutions, refer to the NC Specifications.
When the pulse coder that generates 10,000 pulses per motor rotation and the NC flexible feed gear function are used together, control can be performed based on 1 μm/pulse corresponding to various feed pitches.
However, an error is detected in some types of the feed pitches when the fractions are rounded off.

5.1.2 Absolute pulse coder

Even if the NC power is turned off, the pulse coder backed up with a battery tracks any position change eliminating the necessity of returning to the reference point at turning on the NC power.
Compared with the incremental pulse coder, the outside dimensions are larger.
The interface connector specifications are different from those of the incremental pulse coder.
The restrictions on the feed rate are the same as those of the incremental pulse coder. A battery unit must be installed between the NC and the motor.
After the display of NC "BATTERY LOW" appears, exchange the battery as much as possible early.
Do the battery exchange with the power supply of NC turned on.

5.1.3 High resolution pulse coder

This is available in the types of 10,000, 12,500, 15,000, 20,000, 25,000 and 30,000 (A/B-phase) pulses per motor rotation.
When the machine move distance per motor rotation is 4 to 12mm, 0.1μm/pulse can be detected.
The high resolution pulse coder can be used only in a digital servo NC. The high resolution pulse coder is available in two types. One is usable for up to 12m/min. (10,000, 12,500, 15,000, 20,000 and 25,000 pulses) at the resolution of 0.1μm/pulse.
The other is usable for up to 24m/min (20,000, 25,000 and 30,000 pulses). (High-speed high resolution pulse encoder)
(The high-speed high resolution pulse encoder needs a signal conversion circuit for the connection with NC.)
The high resolution pulse coder can also be used for ensuring high precision positioning even at the resolution of 1μm, and for enabling the setting of diameter 1μm in a lathe. However, in the case of 1μm setting, the rapid traverse speed and the positioning gain may be limited by the detection unit.
Generally, when the separate type position detector such as an optical scale is used, it is necessary to set the resolution of the detector built in the motor smaller than that of the position detector. When an optical scale of

$1\mu m$ is used in a machine of 16mm per motor rotation, the resolution is too low with the pulse coder of 3,000 pulses. A pulse coder of 10,000 or 20,000 pulses is necessary.

5.1.4 Serial pulse coder A

Serial pulse coder A is based on a totally different operating principle from that of the conventional pulse coders, and features a resolution of approximately 1,000,000 divisions per rotation.
When combined with the flexible feed gear function, serial pulse coder A can set detection units of 1 μm, 0.1 μm, and 0.01 μm irrespective of the machine travel, provided that the machine travel per motor rotation is not a fraction.
(The machine travel per motor rotation must be within the range selectable with both the flexible feed gear parameter and the parameter for the capacity of the reference counter.)
Even when the power to the NC is turned off, the pulse coder, which has a back-up battery, stores the current position. Therefore, the reference point return function need not be executed when the NC is turned on next time.
Serial pulse coder A has larger external dimensions than the increment pulse coder.
Serial pulse coders can be used only with the digital servo NC.
To use a serial pulse coder, the NC must be equipped with a serial pulse coder interface.

5.1.5 Serial pulse coders B and B2

These serial pulse coders are based on the same theory of operation as serial pulse coder A. However, serial pulse coder B features a resolution of approx. 250,000 pulses per rotation, and serial pulse coder B2 features a resolution of approx. 30,000 pulses per rotation.
Serial pulse coder B is used for T series servo motors. Serial pulse coder B2 is used for model 5-0.
Versatile feed systems can be specified with the flexible feed gear function.
Even when the power to the NC is cut, the pulse coder retains the position of the machine as it has a battery backup. Reference position return is not therefore required when the power to the NC is turned on.
Serial pulse coders can be used only for the digital servo NC.
To use the serial pulse coder, a serial pulse coder interface is required for the NC.

5.1.6 Serial pulse coder C

Serial pulse coder C has a resolution equivalent to that of the conventional 10,000 pulse per revolution high-resolution pulse coder.
Serial pulse coder C is connected to the NC through a serial interface.
The pulse coder is used in Series 16 and 18 when 0.1-μm resolution or the absolute functions are not required.
When combined with the flexible feed gear function, serial pulse coder C detects pulses in units of 1 μm for a machine that moves up to 12 mm per motor rotation.
(Note that a rounding error of up to 0.2 μm occurs when the machine travel is 12 mm.)
Serial pulse coder can be used only for the digital servo NC. To use the serial pulse coder, a serial pulse coder interface is required for the NC.

5.1.7 Built-in detectors for model 2-0SP/1-0SP/0-0SP

The incremental pulse coder with a resolution of 10,000 pulses per rotation, the absolute pulse coders with a resolution of 2000, 2500, and 3000 pulses per rotation, and serial pulse coders A and C can be used for model 2-0SP/1-0SP/0-0SP.
The features and restrictions are the same as above.
A pulse coder for model 2-0SP/1-0SP/0-0SP outputs data with the 15-pin or 25-

pin D-SUB connector.
Using a dedicated waterproof cover for the connector provides good protection extreme environments.
When the thickness of the housing does not exceed 17 mm, a commercially available connector cover can also be used.

5.1.8 Built-in detectors for model 4-0S/3-0S

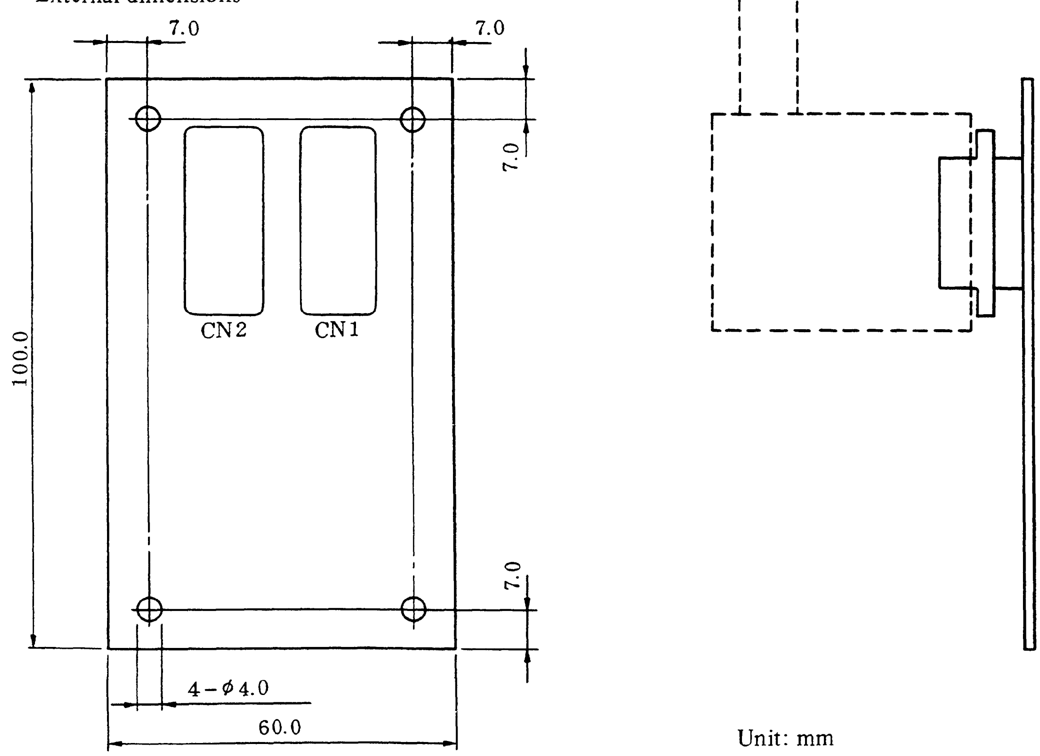
The incremental and absolute pulse coders with a resolution of 2,000 pulses per rotation (phase A) and serial pulse coders A and C can be used for model 4-0S/3-0S.
The features and restrictions are the same as above.
A pulse coder for model 4-0S/3-0S connections are by the lead or connector.
An absolute pulse coder for model 4-0S/3-0S connections are by connector.
Serial pulse coders A and C for model 4-0S/3-0S connections are by a 15-pin D-SUB connector. Since a dedicated waterproof cover cannot be used for the serial pulse coders for model 4-0S/3-0S, use a connector cover whose thickness does not exceed 17 mm when connecting the serial pulse coders.

5.1.9 Built-in detector of model 5-0

In the model 5-0, an incremental and an absolute pulse coder of 1,000 pulses or serial pulse coder B2 of 30,000 (A-phase) pulses is available.
The features and restrictions are the same as those described above.
The pulse coder of model 5-0 connections are through lead wires.
A signal conversion circuit is required when incremental and absolute pulse coders for model 5-0 are used for the digital servo.
Install the signal conversion circuit as close as possible to the motor.
The signal conversion circuit is not required when a serial pulse coder is used for the digital servo.

Signal conversion circuit for model 5-0
Order specification A16B-1700-0130
For the details, refer to the NC connecting manual.

External dimensions



Unit: mm

5.2 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 separate type position detector.

- 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.
- 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.
- It is necessary to use the built-in pulse coder with a resolution equal to or finer than that of the separate type position detector. Design the built-in pulse coder so that the ratio of resolution to that of the separate type is an integer value if possible. Namely, when an optical scale of $1\mu m$ is used in a machine of 8mm per motor rotation, use the pulse coder of 2,000 or 1,000 pulses, rather than that of 2,500 pulses.

To connect the separate type position detector to the NC, connect only the signals described in the connecting manual. (A, B, Z, 0V, 5V and REQ if necessary) When the other signal is connected, the unit may malfunction. FANUC provides the following external position (rotary) detector.

(1) Pulse coder unit

Available in the following specifications. The feature and restrictions on the feed rate, etc. are the same those of the built-in pulse coder.

A860-0301-T0□□ (Incremental pulse coder)

- 01 2000P/rev (up to 3000min^{-1})
- 02 2500P/rev (up to 2400min^{-1})
- 03 3000P/rev (up to 2000min^{-1})
- 04 4000P/rev (up to 1500min^{-1})

For the external dimensions, refer to item 4.2 (4).

(2) Absolute pulse coder unit

A860-0324-T1□□ (Absolute pulse coder)

- 01 2000P/rev (up to 3000min^{-1})
- 02 2500P/rev (up to 2400min^{-1})
- 03 3000P/rev (up to 2000min^{-1})
- 04 4000P/rev (up to 1500min^{-1})

For the external dimensions refer to item 4.2 (5).

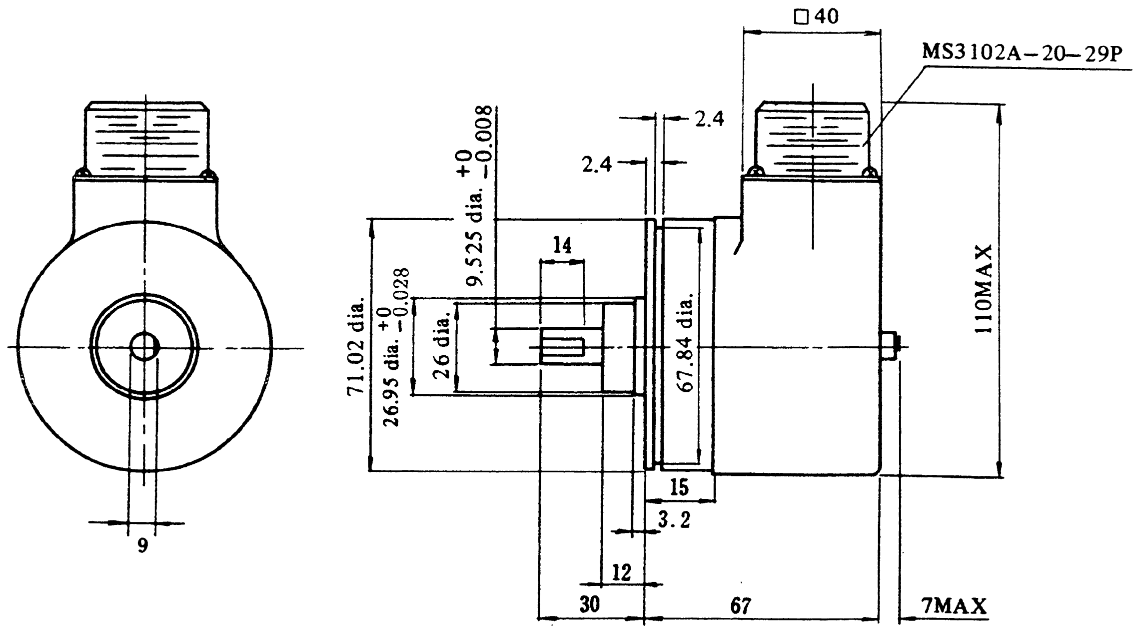
(3) High-speed high resolution pulse coder unit

A860-0314-T1□□ (High-speed high resolution pulse coder)

- 11 20000P/rev (up to 3000min^{-1})
- 12 25000P/rev (up to 2400min^{-1})
- 13 30000P/rev (up to 2000min^{-1})

A signal conversion circuit is required for the connection with NC. For the external dimensions, refer to item 4.2 (5).

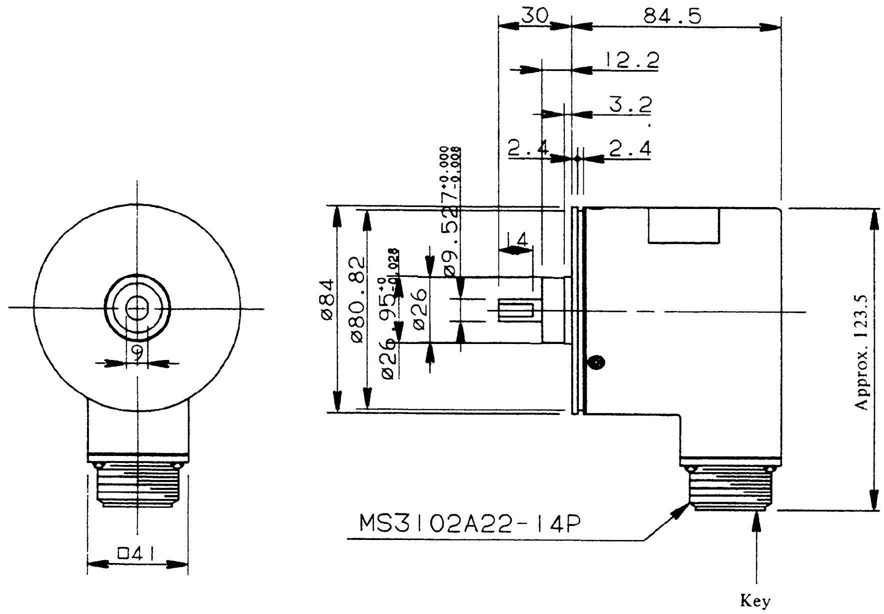
(4) Pulse coder unit



Note: Use flexible coupling.

Power supply	5V ±5% 0.35A or less
Output	A, $\overline{A}$, B, $\overline{B}$, Z, $\overline{Z}$
No. of pulses	2000, 2500, 3000 P/rev.
Maximum pulse rate	100kHz
Working temperature range	0°C -60°C
Rated loads	Radial 2.0 kg Axial 1.0 kg
Shaft diameter runout	0.02 mm
Weight	2.0 kg
Rotor inertia	Max. 0.057 g-cm-sec^2
Friction torque	Max. 0.8 kg-cm

(5) Absolute pulse coder unit
High speed/high resolution pulse coder unit



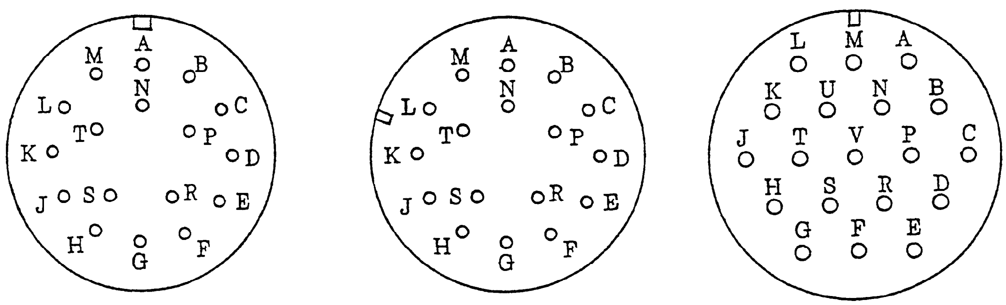
5.3 Detector Signal Output

The built-in and separate detector signals are output as follows.

(1) For S series and L series
Incremental, absolute, and high resolution pulse coder
Separate type incremental, absolute pulse coder unit

Signal names of the pulse coder	Pin names of the connector		
	Incremental MS310A20-29PW (Separate) (MS3102A2029P)	Absolute MS3102A22-14P (Separate) (MS3102A22-14P)	High-resolution MS3102A22-14P (NOT AVAILABLE SEPARATE)
A *A	A (A) D (D)	A (A) B (B)	A B
B *B	B (B) E (E)	C (C) D (D)	C D
Z *Z	F (F) G (G)	E (E) F (F)	E F
C1 C2 C4 C8	C (-) P (-) L (-) M (-)	G (G) H (H) J (J) K (K)	G H J K
+5V 0V Shield OH1 OH2 REQ +6VA 0VA	J, K (CJK) N, T (NPT) H (H) R (-) S (-) - - - - - -	L (L) M (M) N (N) P (-) R (-) S (S) T (T) U (U)	L, T M, U N P R - - -

MS3102A20-29P MS3102A20-29PW MS3102A22-14P



(2) For S series and L series
High-speed, high-resolution pulse coder separate type high-speed and high-resolution pulse coder unit

Signal names of the pulse coder	Pin names of the connector
	High-speed, high-resolution MS3102A22-14P (Separate) (MS3102A22-14P)
A AR	A (A) B (B)
B BR	C (C) D (D)
Z *Z	E (E) F (F)
C1 C2 C4 C8	G (G) H (H) J (J) K (K)
+5V 0V Shield OH1 OH2	L, T (L, T) M, U (M, U) N (N) P (-) R (-)

(3) • For S series, L series and F series
Serial pulse coder A and C
• For T series
Serial pulse coder B
• For S series model 5-0
Serial pulse coder B2

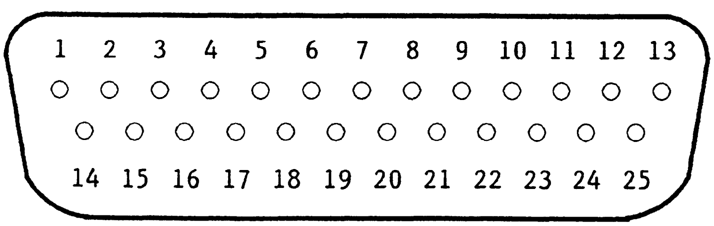
Signal names of the pulse coder	Pin names of the connector	Pin names of the connector	Signal pulse coder B2 colors of lead wires
	Serial pulse coder A MS3102A22-14P	Serial pulse coder C MS3102A20-29PW	
SD *SD	A B	A D	Black Black/White
REQ *REQ	E F	F G	Blue Blue/White
+5V 0V Shield +6VA 0VA	L M N T U	J, K N, T H — —	Red Gray — Orange Brown

For a serial pulse coder, the overheat signals, signals C1, C2, C4, C8, and Z, need not be connected because they are included in serial data.

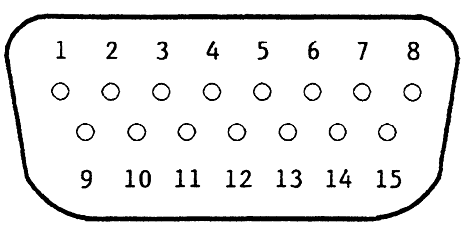
(4) Models 2-0SP, 1-0Sp, 0-0SP, 3-0S, 4-0S (Serial)
10000P incremental (2-0SP, 1-0SP and 0-0SP)
2000P, 2500P, 3000P absolute (2-0SP, 1-0SP and 0-0SP)
Serial A, Serial C

Signal name	Pin No. of D-SUB 25P	
	10000P Incremental	2000P, 2500P, 3000P Absolute
A *A	23 22	23 22
B *B	21 20	21 20
Z *Z	9 8	9 8
C1 C2 C4 C8	19 18 17 16	19 18 17 16
+5V 0V OHA OHB	12, 13, 25 1, 2, 14 5 6	12, 13, 25 1, 2, 14 5 6
REQ +6V	— —	7 4

Signal name	Pin No. of D-SUB 15P	
	Serial A	Serial C
SD *SD	12 13	12 13
REQ *REQ	5 6	5 6
+5V 0V Shield +6VA 0VA	8, 15 1, 2, 3 — 14 10	8, 15 1, 2, 3 — — —



D-SUB 25P (Convexity)
Pin arrangement



D-SUB 15P (Convexity)
Pin arrangement

(5) Model 4-0S/3-0S Incremental pulse coder
Model 5-0 Incremental and absolute pulse coder
(LEAD WIRES ONLY - COLOR CODED)

Signal name	4-0/3-0 Incremental	5-0 Incremental	5-0 Absolute
A *A	Black Black/White	Black -	Black -
B *B	Blue Blue/White	Blue -	Blue -
Z *Z	Green Green/White	Green -	Green -
C1 C2 C4 C8	Yellow/White Orange/White Brown/White Purple/White	- Yellow/White Orange/White Brown/White	- Orange/White Brown/White Purple/White
+5V 0V Shield REQ +6VA 0VA	Red, Red/White Gray, Gray/White Black - - -	Red Gray Black (thick line) - - -	Red Gray Black (thick line) Orange Red/Gray Gray/White

6. BUILT-IN BRAKE

Some of the S Series Models 2-0SP TO 40 and T Series Models use motors that contain a holding brake to prevent falling along a vertical axis.

Motors with a built-in brake have different outlines and weight from other types of motors. For their outlines, refer to appropriate outline drawings.

6.1 Brake Specifications

The specifications of built-in brakes are listed below:

S series, L series

Motor model		2-0 to 0-0s	0S, 5S, 0L to 6L	10S to 30S, 7L, 10L
Brake torque		20 kgf·cm	60 kgf·cm	180 kgf·cm
Response time	Release	60 ms	80 ms	100 ms
	Brake	10 ms	20 ms	60 ms
Supply voltage (±10%) Current		90 VDC 0.3 A or less	90 VDC 0.4 A or less	90 VDC 0.6 A or less
Weight increase		Approx. 1.5 kg	Approx. 3 kg	Approx. 6 kg
Inertia increase		0.0002	0.0007	0.006

Motor model		20S, 30S, 7L, 10L	40, 40S	50S - 70S
Brake torque		400 kgf·cm	400 kgf·cm	1000 kgf·cm
Response time	Release	130 ms	130 ms	160 ms
	Brake	60 ms	60 ms	70 ms
Supply voltage (±10%) Current		90 VDC 0.8 A or less	90 VDC 0.8 A or less	90 VDC 0.8 A or less
Weight increase		Approx. 7 kg	Approx. 10 kg	Approx. 15 kg
Inertia increase		0.006	0.006	0.010

Note) Motor model 10T with a built-in brake requires dedicated power to energize the brake. The supply voltage and current listed under "10T" apply where the dedicated power is used.

T Series

Motor model		0T, 5T	10T
Brake torque		100 kgf·cm	200 kgf·cm
Response time	Release	50 msec	50 msec
	Brake	20 msec	10 msec
Supply voltage (+10%) Current		90 VDC 0.3 A or less	90 VDC 0.6 A or less
Weight increase		About 3.8 kg	About 3.8 kg
Inertia increase		0.006	0.007

Note) Motor 10T with a built-in brake requires a special power supply which energizes the brake. The supply voltage and current in the 10T column are the values when this special power supply is used.

F Series

Motor model		5F/3000	10F~30F
Brake torque		80 kgf·cm	350 kgf·cm
Response time	Release	80 msec	150 msec
	Brake	40 msec	20 msec
Supply voltage (±10%) Current		90 VDC 0.4 A or less	90 VDC 0.6 A or less
Weight increase		About 3 kg	About 5 kg
Inertia increase		0.0007	0.006

Note) The power line and brake line are connected by an identical connector. For details, see the connection diagram of the power line of the F Series motor.

<u>Common notes to each series</u>

Use the full-wave rectified AC100V or DC90V as a power supply. Don't use the half-wave rectified AC200V. The surge suppressor may be damaged.
Use a rectifier with dielectric strength of 400V or higher. Connect CR as shown in the drawing, to protect the contact of the switch. The equivalent CR is the Fujitsu S2-A.

Note 1) This brake is used to hold the machine when the servo motor control is turned off. It is possible to brake the machine by turning off the brake power at emergency stop such as at the stroke end, but it is impossible to use this brake to reduce the stop distance in normal operation.

Note 2) Allow sufficient time to start the servo motor before releasing the brake. Don't use the brake as an aid for the axis to stop at the same position for a long time, such as an index table. Turn the servo off when holding the axis by the built-in brake or another holding means. At this time, allow sufficient time to set the brake before turning off the servo.

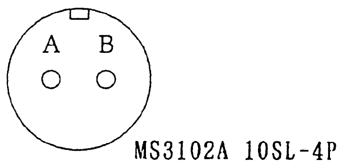
Note 3) Built-in brakes manufactured in 1989 or earlier use resin-molded asbestos in the friction plate.

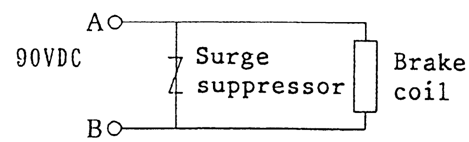
Note 4) Models 40 and 40S/2000 are longer because they contain a brake. If an excessive load is applied to the opposite side of the flange, the flange may be damaged. Do not apply any load to the opposite side of the flange, and do not subject the motor to excessive force.

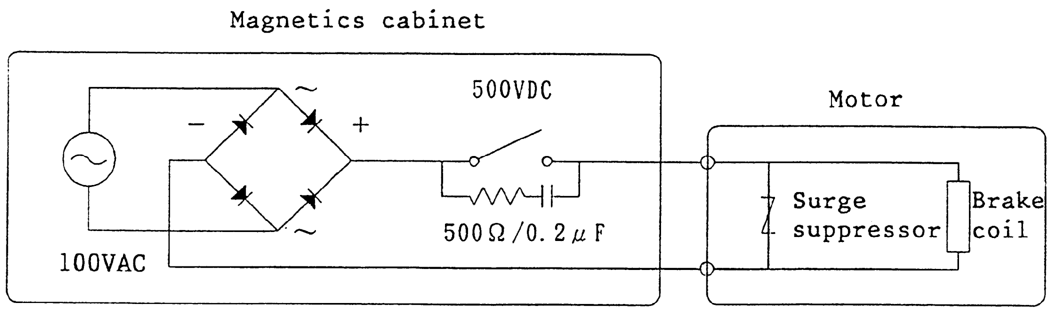
6.2 Connection of the brakes

The example of the connection of the brakes are as follows.

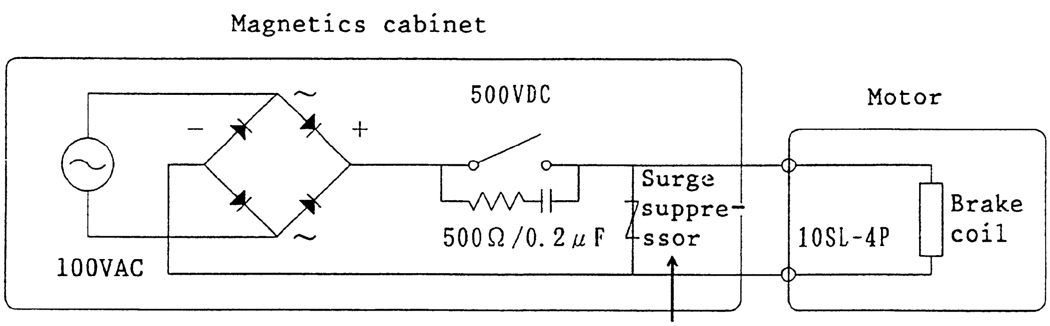
MODEL 0S, 5S, 10S, 20S, 30S



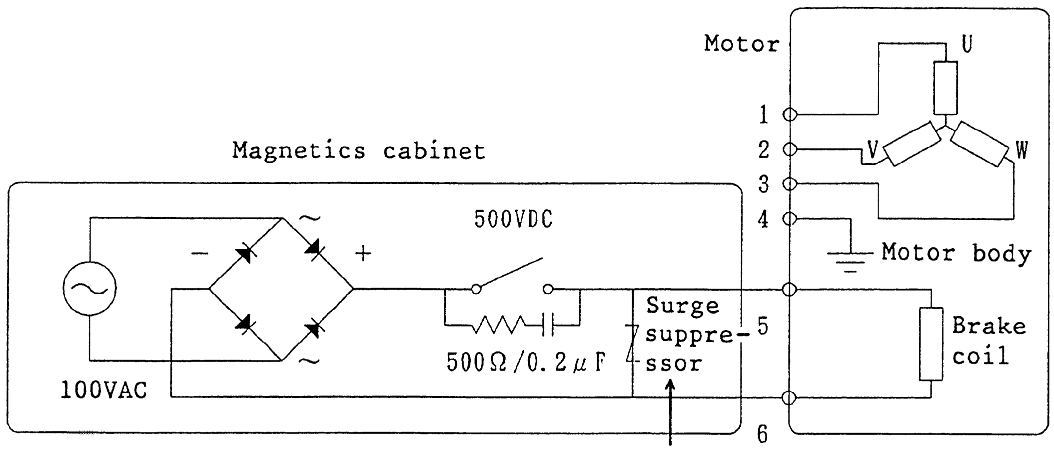




MODEL 2-0S, 1-0S

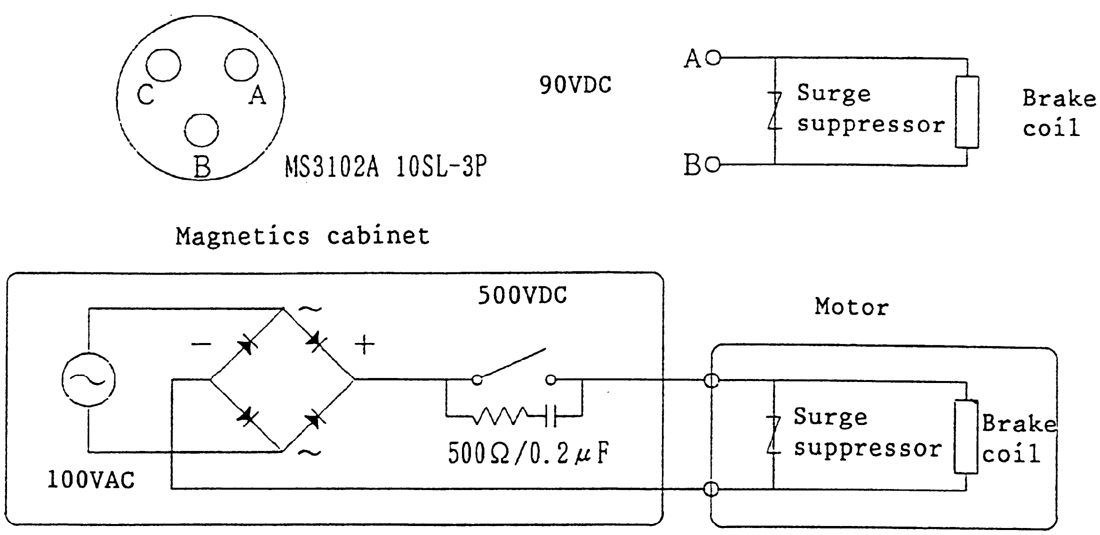


MODEL 2-0SP, 1-0SP



Manufactured by
Matsushita Denshi Buhin Co., Ltd.
ERZ-C20DK221, ERZ-C10DK221, or equivalent

MODELS 50S, 60S, 70S, 0L, 5L, 6L, 7L, 10L



7. CONNECTOR PLUG OF CONNECTION CABLE

7.1 Specifications for Connectors

The specifications for the connector plug of the cable corresponding to the specifications for the connector receptacle used in the FANUC AC servo motor are as follows.

No. of pins	Receptacle	Straight plug	Angle plug	Cable clamp
2	MS3102A 10SL-4P	MS3106B 10SL-4S	MS3108B 10SL-4S	MS3057-4A
3	MS3102A 10SL-3P	MS3106B 10SL-3S	MS3108B 10SL-3S	MS3057-4A
4	MS3102A 18-10P	MS3106B 18-10S	MS3108B 18-10S	MS3057-10A
4	MS3102A 22-22P	MS3106B 22-22S	MS3108B 22-22S	MS3057-12A
7	MS3102A 24-10P	MS3106B 24-10S	MS3108B 24-10S	MS3057-16A
7	MS3102A 20-15P	MS3106B 20-15S	MS3108B 20-15S	MS3057-12A
17	MS3102A 20-29PW	MS3106B 20-29SW	MS3108B 20-29SW	MS3057-12A
19	MS3102A 22-14P	MS3106B 22-14S	MS3108B 22-14S	MS3057-12A
4	RM15WTR-4P	RM15TP-4S		
4	RM12BRB-4P	RM12BPG-4S		

Note) Keep the connector plug away from the splash of cutting fluid or other liquid. When there is a possibility of wetting the connector plug, use a water-proof plug shown in 6.2 for the MS connector and the water-proof plug such as RM15WTP-4S for the RM15 connector. Mount the motor so the connector is downward in the gravity direction as far as possible. When it must be set to side or up, make drip loop to prevent the cutting fluid running along the cable to wet the connector plug. In any case, when there is a possibility of wetting the connector plug, use a cover or take the other suitable means to protect it.

7.2 Combination of Waterproof MS Plugs

Water proofing can be assured to some extent by adopting the following plugs and adapters:

(1) Use a waterproof MS plug manufactured by Japan Aviation Electronics Industry, Ltd., Daiichi Denshi Kogyo K. K., or Hirose Electric Co., Ltd.

(2) When a flexible conduit is used, connect a conduit connector manufactured by Nippon Flex Co., Ltd. or Daiwa Dengyo Co., Ltd to the conduit.

(3) For a power cord, clamp it using a connector manufactured by Nippon Flex or Daiwa Dengyo.
(Use the cable clamp manufactured by Hirose Electric Co., Ltd. for the plug manufactured by the company.)

The following table lists the plugs, conduit connectors, and flexible conduits corresponding to the receptacle used for each motor model.

Examples of how to connect the AC servo motor with waterproof MS plugs and flexible conduits

Motor model Pulse coder location Receptacle specifications (Outside diameter of the standard cable)	MS compatible plug specifications Japan Aviation Daiichi Densi Kogyo Hirose Electric	Conduit connector Daiwa Dengyo (straight) Daiwa Dengyo (L-shaped) Nippon Flex (straight) Nippon Flex (L-shaped)	Conduit	Inside diameter (mm)
0S, 5S, 0L, 5L, 6L Power line MS3102A18-10P (ϕ12)	JA06A-18-10S-J1 JL04-6A18-10S MS3106A18-10S(D190) H/MS3106A18-10S-D(03)	BOS 18-15 BOL 18-15	MPF15	14
		RCC-104RL-MS18F RCC-304RL-MS18F	VF-04 SR-04	14
10S, 20S, 30S Power line MS3102A22-22P (ϕ14)	JA06A-22-22S-J1 JL04-6A22-22S MS3106A22-22S(D190) H/MS3106A22-22S-D(03)	BOS 22-19 BOL 22-19	MPF19	17
		RCC-106RL-MS22F RCC-306RL-MS22F	VF-06 SR-06	19
20S/3000, 30/2000, 40, etc. 7L, 10L, etc. Power line MS3102A24-10P (ϕ17)	JA06A-24-10S-J1 JL04-6A24-10S MS3106A24-10S(D190) H/MS3106A24-10S-G(03)	BOS 24-19 BOL 24-19	MPF19 MPF15	19
		RCC-106RL-MS24F RCC-306RL-MS24F	VF-06 SR-06	17
Incremental Serial C pulse coder signal line MS3102A20-29PW (ϕ11)	JA06A-20-29SW-J1 MS3106A20-29SW(D190) H/MS3106A20-29SW(04)	BOS 20-15 BOL 20-15	MPF15	14
		RCC-104RL-MS20F RCC-304RL-MS20F	VF-04 SR-04	14
Absolute Serial A, B pulse coder signal line MS3102A22-14P (ϕ11)	JA06A-22-14S-J1 MS3106A22-14S(D190) H/MS3106A22-14S(03)	BOS 22-15 BOL 22-15	MPF15	14
		RCC-104RL-MS22F RCC-304RL-MS22F	VF-04 SR-04	14

This table is only for reference. For details, contact the manufacturer.
The specifications of a plug manufactured by Daiichi Denshi Kogyo, (190), must be specified.
The specifications of a plug manufactured by Hirose Electric Co., Ltd., (03) or (04), must be specified.
When JL04 series plugs manufactured by Japan Aviation Electronics Industry and plugs manufactured by Hirose Electric Co., Ltd. are used for power lines, they conform to JIS-B6015.
Do not connect the 0 V signal line of the pulse coder to the connector shell.

Examples of how to connect the AC servo motor with waterproof MS plugs and flexible conduits

Motor model Pulse coder location Receptacle specifications (Outside diameter of the standard cable)	MS compatible plug specifications Japan Aviation Daiichi Densi Kogyo Hirose Electric (straight) Hirose Electric (L-shaped)	Power cord connectors Daiwa Dengyo(straight) Daiwa Dengyo(L-shaped)	Outside diameters (mm) of applicable cables
		Nippon Flex(straight) Nippon Flex(L-shaped)	Except Hirose-made cables
0S, 5S, 0L, 5L, 6L Power line MS3102A18-10P (φ12)	JA06A-18-10S-J1 JL04-6A18-10S	YSO 18-12-14 YLO 18-12-14	φ11.3~φ14.5 φ11.3~φ14.5
φ11.3~φ14.5 φ11.3~φ14.5	MS3106A18-10S(D190) H/MS3106A18-10S-D H/MS3108B18-10S-D	ACS-12RL-MS18F ACS-16RL-MS18F ACA-12RL-MS18F ACA-16RL-MS18F	φ8~φ12 φ12~φ16 φ8~φ12 φ12~φ16
10S, 20S, 30S Power line MS3102A22-22P (φ14)	JA06A-22-22S-J1 JL04-6A22-22S	YSO 22-12-14 YLO 22-12-14	φ11.3~φ14.5 φ11.3~φ14.5
	MS3106A22-22S(D190) H/MS3106A22-22S-D H/MS3108B22-22S-D	ACS-16RL-MS22F ACA-16RL-MS22F	φ12~φ16 φ12~φ16
20S/3000, 30/2000, 40, etc. 7L, 10L, etc. Power line MS3102A24-10P (φ17)	JA06A-24-10S-J1 JL04-6A24-10S	YSO 24-15-17 YLO 24-15-17	φ14.5~φ17.5 φ14.5~φ17.5
	MS3106A24-10S(D190) H/MS3106A24-10S-G H/MS3108B24-10S-G	ACS-20RL-MS24F ACA-20RL-MS24F	φ16~φ20 φ16~φ20
Incremental Serial C pulse coder signal line MS3102A20-29W (φ11)	JA06A-20-29SW-J1 MS3106A20-29SW(D190)	YSO 20-9-11 YLO 20-9-11	φ8.3~φ11.3 φ8.3~φ11.3
	H/MS3106A20-29SW(01) H/MS3108B20-29SW(01)	ACS-12RL-MS20F ACA-12RL-MS20F	φ8~φ12 φ8~φ12
Absolute Serial A, B pulse coder signal line MS3102A22-14P (φ11)	JA06A-22-14S-J1 MS3106A22-14S(D190)	YSO 22-9-11 YLO 22-9-11	φ8.3~φ11.3 φ8.3~φ11.3
	H/MS3106A22-14S H/MS3108B22-14S	ACS-12RL-MS22F ACA-12RL-MS22F	φ8~φ12 φ8~φ12

This table is only for reference. For details, contact the manufacturer.
The specifications of a plug manufactured by Daiichi Denshi Kogyo, (190), must be specified.
The specifications of a plug manufactured by Hirose Electric Co., Ltd., (01), must be specified.
The cable clamp manufactured by Hirose Electric Co., Ltd. is used for the plug manufactured by the company. However, use the same plug for the connector for the cable covered with rubber manufactured by Nippon Flex or Daiwa Dengyo as for the conduit connector.
When JL04 series plugs manufactured by Japan Aviation Electronics Industry and plugs manufactured by Hirose Electric Co., Ltd. are used for power lines, they conform to JIS-B6015.
Do not connect the 0 V signal line of the pulse coder to the connector shell.

7.3 Connectors for Models 2-0SP, 1-0SP and 0-0SP

Models 2-0SP, 1-0SP and 0-0SP of the FANUC AC servo motors are equipped with special connectors to improve the water-tightness.
The specifications for the connectors used exclusively for cables are as follows.

Name	Applicable motor (pulse coder)	Specifications
Connector kit (power line)	Models 2-0SP, 1-0SP, 1-0SP/3000, and 0-0SP	A06B-6050-K111
Connector kit (signal line 25)	Models 2-0SP, 1-0SP, 1-0SP/3000, and 0-0SP Incremental pulse coder (10000P) Absolute pulse coders (2000P, 2500P, and 3000P)	A06B-6050-K110
Connector kit (signal line 15)	Models 2-0SP, 1-0SP, 1-0SP/3000, and 0-0SP Serial pulse coder A and C	A06B-6050-K115

Parts included in the connector kit (signal line 25)

Item	Quantity	FANUC specifications	Manufacturer	Manufacturer's specifications and remarks
Contact	1	A63L-0001-0434 #BB25SNO	Hirose Electric Co., Ltd.	HDBB-25S, soldering type
Waterproof cover	1	A63L-0001-0442	Hirose Electric Co., Ltd.	HDBW-25CV

Parts included in the connector kit (signal line 15)

Item	Quantity	FANUC specifications	Manufacturer	Manufacturer's specifications and remarks
Contact	1	A63L-0001-0434 #AB15SNO	Hirose Electric Co., Ltd.	HDAB-15S, soldering type
Waterproof cover	1	A63L-0001-0496	Hirose Electric Co., Ltd.	HDAW-15CV

Parts included in the connector kit (power line)

Item	Quantity	FANUC specifications	Manufacturer	Manufacturer's specifications and remarks
Connector	1	A63L-0001-0428/CJ	Nippon AMP Co., Ltd.	176346-4, crimp type(*) Outside diameter of an applicable cable: 9.9 to 10.9 mm

* Special crimping tool specifications: A97L-0200-0979 Nippon AMP Co., Ltd. 914596-3

* Special pulling tool specifications: A97L-0200-0980/D3 Nippon AMP Co., Ltd. 914677-1

Prepare the crimping and extracting tools if necessary.

8. COOLING FAN FOR MODELS 40 AND 40S/2000

Models 40 and 40S/2000 each have a cooling fan to which single-phase 200 VAC needs to be supplied.

The connections and the currents are as follows. Note that the magnetics cabinet needs to be equipped with a fuse or breaker because the fan motor does not have a protection circuit.

Connector for the fan motor MS3102A10SL-4P	
A	Single-phase 200 V
B	

Input voltage	Steady-state current	Surge current
200 V	Approx. 0.3 Arms	Approx. 0.4 Arms
230 V	Approx. 0.3 Arms	Approx. 0.5 Arms

II. FANUC AC SERVO MOTOR S series

1. GENERAL

The FANUC AC Servo Motor S series is optimum for the feed axis of most machine tools, and has the following features.

(1) Smooth rotation
The unique magnetic pole form designed to minimize torque ripple enables very smooth rotation by strict current control and precise pulse coder feedback.

(2) Fast acceleration performance
The unique rotor form makes the motor compact and light weight, providing high torque and fast acceleration.

(3) High reliability
The totally enclosed brushless structure with no wearing part permits inspection/maintenance free operation.

(4) Built-in high precision detector
An optical encoder (pulse coder) with low indexing error is built in, permitting high precision positioning. The pulse coder of 2,000 to 30,000 pulses permits the indexing of 120,000 divisions maximum per motor rotation. (This value may be limited in some types of NC/motor.)
Serial pulse coder A, which offers super-high resolution, enables indexing with a resolution of up to 1,000,000 increments.
When combined with the flexible feed gear function, serial pulse coder A enables feeding in units of 0.1 μm or 0.01 μm for almost all feed screw pitches.

(5) Sufficient stability
The motor constant permits stable control for a large machine tool.

(6) Abundant options
Other options that are available for machine design in addition to the many types of high precision detectors are:
- Built-in brake for holding (model 2-0S to 30S)
- Two types of shaft form (model 2-0S to 30S)

The S series motors are available in two types. One requires an input transformer (185 V specification): models 5-0, 30/2000 and 40. The other is operated from 200 to 230V power supply and does not require an input transformer (200V specification): models 4-0S, 3-0S, 2-0SP, 1-0SP, 1-0SP/3000, 0-0SP, 0S, 5S, 5S/3000, 10S, 10S/3000, 20S/1500, 20S, 20S/3000S, 30S, 30S/3000, 40S/2000, 50S, 60S and 70S.
The models with a subscript "S" are the motors optimized to the power supply voltage of 200 to 230V. The motor winding is different in 185V and 200V specifications, but the appearance and weight are the same.

Note 1) 100VAC is necessary for the driving unit of all motors.
Note 2) The driving unit of 185V specification needs 18VAC with a center tap.
Note 3) The driving unit of model 5-0 uses single-phase 100VAC.
Note 4) Single-phase 200VAC is required for the cooling fan of model 40 and 40S/2000.

2. TYPES OF MOTORS AND DESIGNATION

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

(1) Model 5-0

A06B-0531-B0□□

- 01 1000P incremental pulse coder
- 31 1000P absolute pulse coder
- 69 Serial pulse coder B2

(2) Models 4-0S, 3-0S

A06B-0□□□-B□□□

- 532 Model 4-0S
- 533 Model 3-0S

- 001 2000P incremental pulse coder (lead wires)
- 201 2000P incremental pulse coder (connector)
- 251 2000P absolute pulse coder (connector)
- 272 Serial pulse coder A (D-SUB connector)
- 274 Serial pulse coder C (D-SUB connector)

(3) Models 2-0SP, 1-0SP, 1-0SP/3000, 0-0SP

A06B-0□□□-B□ □□

- 371 Model 2-0SP
- 372 Model 1-0SP
- 373 Model 1-0SP/3000
- 374 Model 0-0SP

- 10 With the incremental pulse coder (1000P) (D-SUB connector)
- 41 With the 2000P absolute pulse coder (D-SUB connector)
- 42 With the 2500P absolute pulse coder (D-SUB connector)
- 43 With the 3000P absolute pulse coder (D-SUB connector)
- 69 With serial pulse coder A (D-SUB connector)
- 71 With serial pulse coder C (D-SUB connector)

- 0 Taper shaft (2-0SP, 1-0SP, 1-0SP/3000 standard)
- 1 With the taper shaft brake (20 kgf·cm)
- 5 Straight shaft
- 6 With the straight shaft brake (20 kgf·cm)

Previously, the motors with 2000P, 2500P and 3000P absolute pulse coders were designated as B□31, B□32, and B□33, respectively. Now, they are designated as B□41, B□42, and B□43, respectively.
Previously, a motor with a pulse coder whose resolution is 10,000 pulses/rotation was designated as B□61. Now, it is designated as B□10.
The installation and functions are completely compatible.
The standard shafts used for models 2-0SP, 1-0SP, and 1-0SP/3000 are taper shafts. Use a taper shaft as far as circumstances, such as the delivery time and maintenance, permit.
The standard shafts for model 0-0SP is a 14 mm dia. straight shaft. They is no taper shaft option.

(4) Models 0S, 5S, and 5S/3000

A06B-0□□□-B□ □□

- 313 Model 0S
- 314 Model 5S
- 514 Model 5S/3000

- 04 With the 2000P incremental pulse coder
- 05 With the 2500P incremental pulse coder
- 06 With the 3000P incremental pulse coder
- 10 With the 10000P incremental pulse coder (17P connector)
- 41 With the 2000P absolute pulse coder
- 42 With the 2500P absolute pulse coder
- 43 With the 3000P absolute pulse coder
- 81 With the 10000P high-resolution pulse coder (19P connector)
- 62~68 With the high-resolution pulse coder (See the attached table for the number of pulses)
- 72 With the serial pulse coder A
- 74 With the serial pulse coder C

- 0 Taper shaft (standard)
- 1 With the brake (60 kgf·cm)
- 5 Straight shaft
- 6 Straight shaft with the brake (60 kgf·cm)

For 1-μ detection in the NC having the flexible feed gear function, use the 10000P incremental pulse coder (17-pin connector) if possible.
The designations of the motors with the 2000P, 2500P, and 3000P incremental and absolute pulse coders and with the serial pulse coders has been changed.
The installation and functions are completely compatible.
See item (8) for the correspondence between the motors and the old designations.
The designations of the motors with the brake have been changed.
The position of the brake connectors and the shape of the oil seals have been changed. The installation dimensions of the new motors are the same as those of the old ones. However, thoroughly check whether the motors interfere with the machine tool. (See the outline drawings.)
The motors whose dimensions are old (whose designations are B2□□ and B7□□) can be supplied only for maintenance to eliminate the problem of interference between the motors and the machine tool.
Use the motors whose designations are B1□□ and B6□□ if possible, however.
The standard shafts used for models 0S, 5S, and 5S/3000 are taper shafts. Use a taper shaft as far as circumstances, such as the delivery time and maintenance, permit.

(5) Models 10S, 10S/3000, 20S/1500, 20S, 20S/3000, 30S, 30S/2000, 30S/3000, 40, and 40S/2000

A06B-0□□□-B□ □□

- 315 Model 10S
- 317 Model 10S/3000
- 505 Model 20S/1500
- 502 Model 20S
- 318 Model 20S/3000
- 590 Model 30S
- 506 Model 30/2000
- 319 Model 30S/3000
- 581 Model 40
- 583 Model 40S/2000

- 04 With the 2000P incremental pulse coder
- 05 With the 2500P incremental pulse coder
- 06 With the 3000P incremental pulse coder
- 10 With the 10000P incremental pulse coder (17P connector)
- 41 With the 2000P absolute pulse coder
- 42 With the 2500P absolute pulse coder
- 43 With the 3000P absolute pulse coder
- 81 With the 10000P high-resolution pulse coder (19P connector)
- 62~68 With the high-resolution pulse coder (See the attached table for the number of pulses)
- 72 With the serial pulse coder A
- 74 With the serial pulse coder C

- 0 Standard
- 2 With the brake (180 kgf·cm)
- 3 With the brake (400 kgf·cm)
- 5 Taper shaft
- 7 Taper shaft with the brake (180 kgf·cm)
- 8 Taper shaft with the brake (400 kgf·cm)

For 1-μ detection in the NC having the flexible feed gear function, use the 10000P incremental pulse coder (17-pin connector) if possible.
The designations of the motors with the 2000P, 2500P, and 3000P incremental and absolute pulse coders and the motors with the serial pulse coders have been changed.
The installation and functions are completely compatible.
See item (8) for the correspondence between the motors and the old designations.
The standard shafts for models 10S to 30S are straight. Use the straight shafts if possible, considering the appointed delivery date and the maintenance.
Only the straight shaft with a 400 kgf·cm brake can be provided for model 40.

(6) Models 50S, 60S, and 70S

A06B-033□-B0□□

- 1: Model 50S
- 2: Model 60S
- 3: Model 70S

- 61-68 With the high-resolution pulse coder (See the attached table for the number of pulses.)
- 69 With serial pulse coder A
- 71 With serial pulse coder C

- 0 Taper shaft (standard)
- 2 With the brake

(7) Motor with high resolution pulse coder.

```
A06B-0□□□-B□□□
              |  Pulse number   Max. speed
              |- 81 : 10000P    (3000 min-1)
              |- 61 : 10000P    (3000 min-1)
              |- 62 : 12500P    (2400 min-1)
              |- 63 : 15000P    (2000 min-1)
              |- 64 : 20000P    (1500 min-1)
              |- 65 : 25000P    (1200 min-1)
              |- 66 : 20000P    (3000 min-1) High-speed type
              |- 67 : 25000P    (2400 min-1) High-speed type
                 68 : 30000P    (2000 min-1) High-speed type
```

The high speed type needs a signal conversion circuit for the connection with NC. The maximum rotation speed is the restriction of the pulse coder. In addition, there are restrictions in the maximum rotation speed of the motor and the feed rate of NC.

(8) Detector compatibility table

The designations of the motors with the following pulse coders have been changed in models 0S to 40S/2000.
The installation and functions of the old and new motors are completely compatible.
The motor with the 10000P incremental pulse coder of B□10 has the same shape and the same connector as the motor with the old incremental pulse coder.
Use this new motor to enable the flexible feed gear function to be used by the 10000P pulse coder instead of the old incremental pulse coder during 1-μ detection.

Pulse coder	New designation	Old designation
2000P Incremental (17P)	B□04	B□01
2500P Incremental (17P)	B□05	B□02
3000P Incremental (17P)	B□06	B□03
10000P Incremental (17P)	B□10	
2000P Absolute (19P)	B□41	B□31
2500P Absolute (19P)	B□42	B□32
3000P Absolute (19P)	B□43	B□33
10000P High-resolution (19P)	B□81	B□61
Serial pulse coder A (19P)	B□72	B□69
Serial pulse coder C (17P)	B□74	B□71

3. SPECIFICATIONS AND CHARACTERISTICS

3.1 Types of Motors and Specifications

Item	Unit	5-0	4-0S	3-0S	2-0SP	1-0SP 1-0SP/ 3000	0-0SP	0S	5S 5S/3000
Output	kW	0.02	0.05	0.1	0.3	0.4 0.45	0.5	0.75	0.9 1.0
	HP	0.027	0.07	0.13	0.4	0.54 0.6	0.67	1.0	1.2 1.3
Rated torque at stall	Nm	0.10	0.25	0.49	1.0	2.0 2.0	2.9	2.9	5.9 5.9
	kgcm	1	2.5	5	10	20 20	30	30	60 60
Maximum speed	min^{-1}	3000	3000	3000	3000	2000 3000	3000	3000	2000 3000
Maximum theoret-ical torque	Nm	0.8	1.1	2.2	7.8	15.7 15.7	22	26	53
	kgcm	8	11.3	22.6	80	160 160	220	270	540
Rotor inertia	kgm^2	0.0000029	0.000037	0.000073	0.00036	0.00060	0.00083	0.0020	0.0037
	$kgcmS^2$	0.00003			0.0037	0.0061	0.0085	0.020	0.038
Maximum theoret-ical acceler-ation	rad/S^2	267000	29700	30500	21600	26200 26200	25900	13500	14200
Weight	kg	0.7	1.7	2.4	2.8	4.3	5.9	10	15

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

Note) The above values shown in the maximum theoretical torque are the theoretical values. The actual maximum torque is restricted by the current limit value of the drive amplifier.

Item	Unit	10S 10S/3000	20S/1500 20S 20S/3000	30S 30/2000 30S/3000	40 40S/2000	50S	60S	70S
Output	kW	1.8 2.3	2.8 3.5 3.5	3.3 4.0 4.4	3.6 7.0	8	10	13
	HP	2.4 3.1	3.8 4.7 4.7	4.4 5.4 6.0	4.8 9.4	11	13	17
Rated torque at stall	Nm	11.8 11.8	22.5 22.5 22.5	37.2 29.4 29.4	55.9 55.9	66	98	147
	kgcm	120 120	230 230 230	380 300 300	570 570	670	1000	1500
Maximum speed	min^{-1}	2000 3000	1500 2000 3000	1200 2000 3000	1200 2000	2000	2000	2000
Maximum theoret-ical torque	Nm	78	147	225	235	294	441	588
	kgcm	800	1500	2300	2400	3000	4500	6000
Rotor inertia	kgm^2	0.010	0.017	0.024	0.030	0.024	0.031	0.038
	$kgcmS^2$	0.10	0.17	0.24	0.31	0.24	0.32	0.39
Maximum theoret-ical acceler-ation	rad/S^2	8000	8800	9600	7700	12500	14100	15300
Weight	kg	23	34	45	60	80	100	120

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

Note) The above values shown in the maximum theoretical torque are the theoretical values. The actual maximum torque is restricted by the current limit value of the drive amplifier.

3.2 Characteristic Curve and Data Sheet

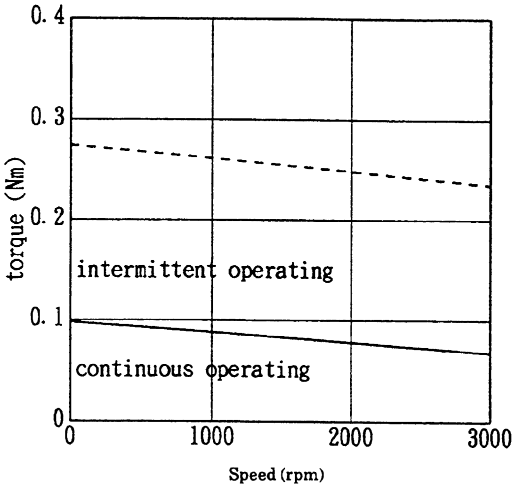
1) Torque-speed characteristics
   - The intermittent operation zone is determined by the input voltage applied to the drive amplifier. The curve shown is the value for the rated input voltage.
   - The maximum torque at acceleration/deceleration is restricted by the current limit value of the drive amplifier.
2) Overload duty curves
   - The curves shown obtained at the thermal limit of the motor. The overload duty is restricted by the drive amplifier or the characteristics of the protecter on the built-in detector in the motor.
3) Data sheet
   - Parameter of the motor for the data sheet is the value at 20°C and its tolerance is ±10%
   - The maximum torque at acceleration/deceleration under the actual operating condition is obtained by the intergration of the torque constant of the motor and the current limit value of the amplifier. Note that the current limit value of the amplifier is indicated as a maximum peak value.

   Ex) Model 20S
   - Torque constant of motor = 6.5 kgf·cm/Arms
   - Current limit value of amplifier = 40 Apeak
   - Max. torque = $\underbrace{40 \times 0.707}_{\text{(Convert into rated value)}} \times 6.5$ = 183 kgf·cm

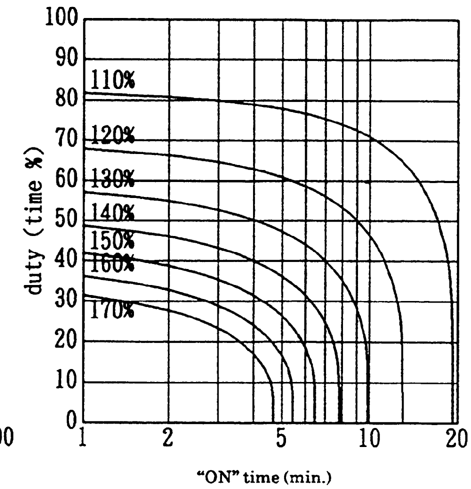
   The above value may deviate due to fluctuation of power source, motor parameter, or limit of amplifier.

Model 5-0 (A06B-0531-B□□□)

speed-torque characteristics (digital)



over load duty

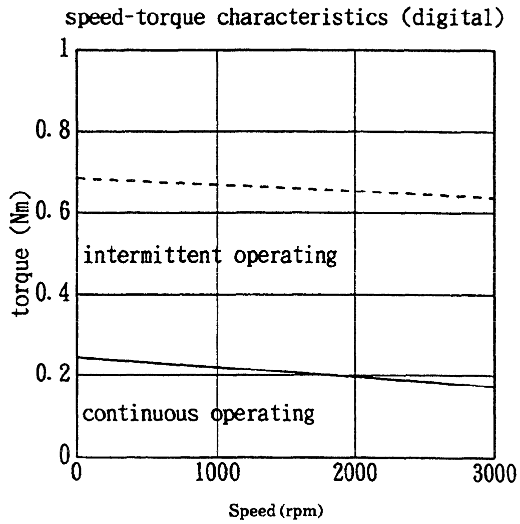


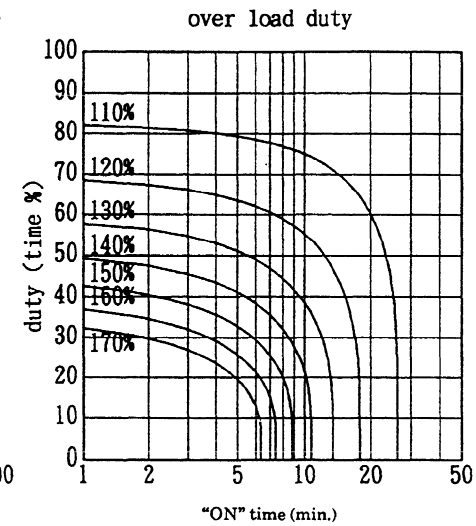
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	3000			min^{-1}
Rated torque at stall(*)	Ts	0.1 1			Nm kgfcm
Rotor inertia	Jm	0.0000029 0.00003			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	0.49			A(rms)
Torque constant(*)	Kt	0.20 2.0			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	7.0 0.07			$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	15			Ω
Mechanical time constant(*)	tm	0.003			s
Thermal time constant	tt	11			min
Static friction	Tf	0.01 0.1			Nm kgfcm
Maximum allowable current	Im	5.5			A(peak)
Max. torque	Tm	0.78 8			Nm kgfcm
Max. acceleration		267000			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		0.7			kg

Note) The values are the standard values at 20°C and the tolerance is ±10%. The speed-torque characteristics vary 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 4-0S (A06B-0532-B□□□)





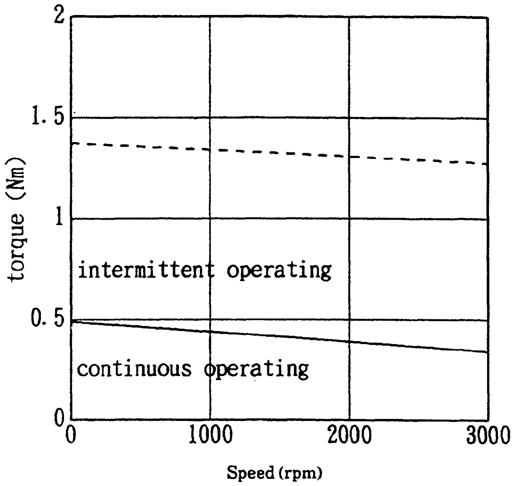
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	3000			min^{-1}
Rated torque at stall(*)	Ts	0.25 2.5			Nm kgfcm
Rotor inertia	Jm	0.000037 0.00038			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	0.93			A(rms)
Torque constant(*)	Kt	0.26 2.7			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	9.2 0.09			$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	6			Ω
Mechanical time constant(*)	tm	0.010			s
Thermal time constant	tt	15			min
Static friction	Tf	0.02 0.25			Nm kgfcm
Maximum allowable current	Im	6			A(peak)
Max. torque	Tm	1.1 11.3			Nm kgfcm
Max. acceleration		29700			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		1.7			kg

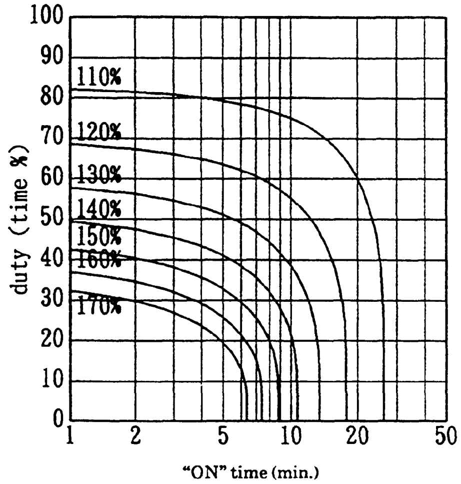
Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
These values may be changed without prior notice.

Model 3-0S (A06B-0533-B□□□)

speed-torque characteristics (digital)



over load duty

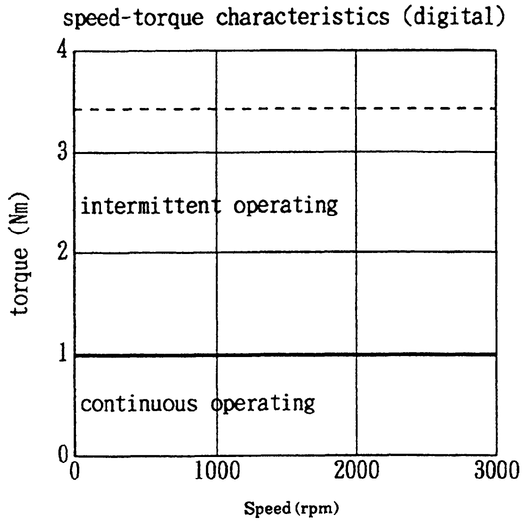


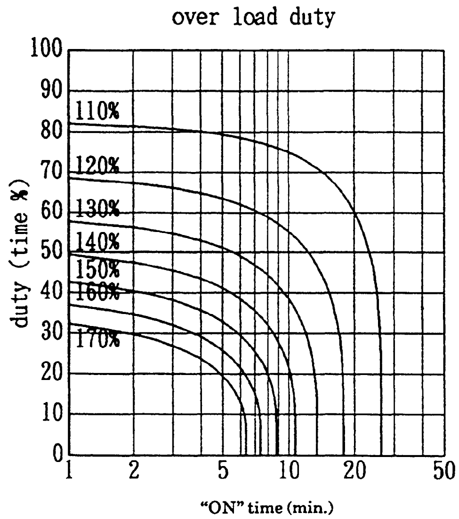
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	3000			min^{-1}
Rated torque at stall(*)	Ts	0.49 5			Nm kgfcm
Rotor inertia	Jm	0.000073 0.00074			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	0.93			A(rms)
Torque constant(*)	Kt	0.53 5.4			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	18.4 0.18			$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	8.7			Ω
Mechanical time constant(*)	tm	0.007			s
Thermal time constant	tt	15			min
Static friction	Tf	0.02 0.25			Nm kgfcm
Maximum allowable current	Im	6			A(peak)
Max. torque	Tm	2.2 22.6			Nm kgfcm
Max. acceleration		30500			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		2.4			kg

Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary 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 2-0SP (A06B-0371-B□□□)



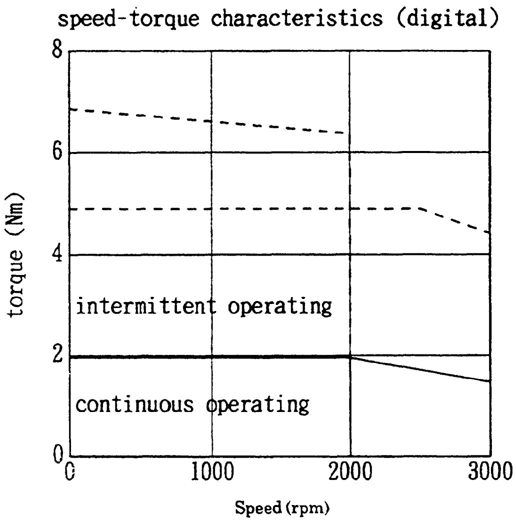


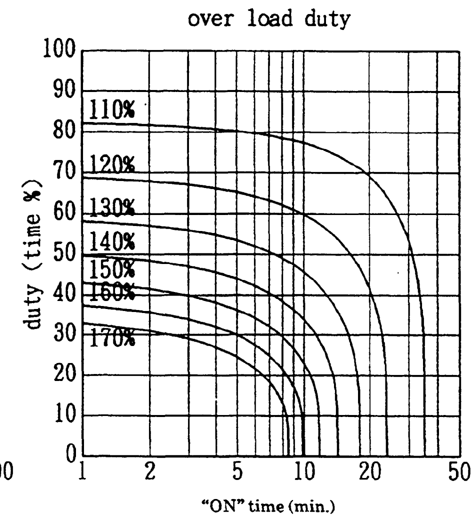
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	3000			min^{-1}
Rated torque at stall(*)	Ts	1.0 10			Nm kgfcm
Rotor inertia	Jm	0.00036 0.0037			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	2.2			A(rms)
Torque constant(*)	Kt	0.44 4.5			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	15.5 0.15			$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	1.733			Ω
Mechanical time constant(*)	tm	0.010			s
Thermal time constant	tt	15			min
Static friction	Tf	0.10 1			Nm kgfcm
Maximum allowable current	Im	24			A(peak)
Max. torque	Tm	7.8 80			Nm kgfcm
Max. acceleration		21600			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		2.8			kg

Note) The values are the standard values at 20°C and the tolerance is ±10%. The speed-torque characteristics vary 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 1-0SP (A06B-0372-B□□□)
Model 1-0SP/3000 (A06B-0373-B□□□)



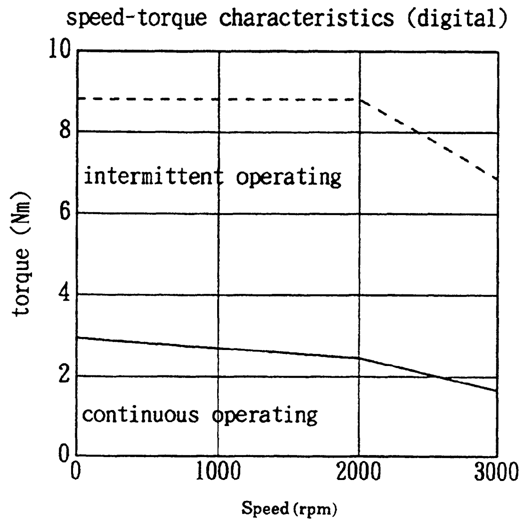


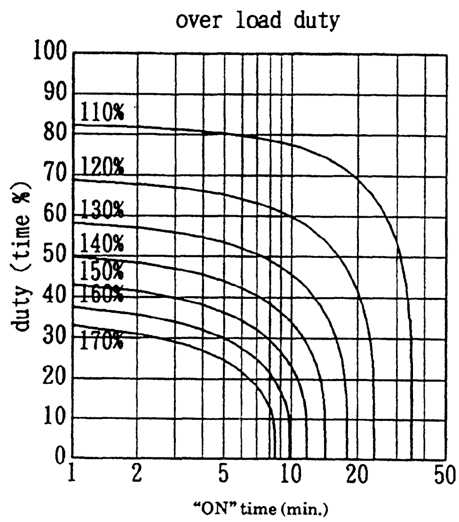
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	2000	3000		min^{-1}
Rated torque at stall(*)	Ts	2.0 20	2.0 20		Nm kgfcm
Rotor inertia	Jm	0.00060 0.0061	0.00060 0.0061		kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	2.2	2.9		A(rms)
Torque constant(*)	Kt	0.90 9.2	0.67 6.9		Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	31.3 0.30	23.5 0.22		$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	2.444	1.375		Ω
Mechanical time constant(*)	tm	0.005	0.005		s
Thermal time constant	tt	20	20		min
Static friction	Tf	0.15 1.5	0.15 1.5		Nm kgfcm
Maximum allowable current	Im	24	32		A(peak)
Max. torque	Tm	15.7 160	15.7 160		Nm kgfcm
Max. acceleration		26200	26200		rad/S^2
Maximum winding temperature rise	θ m	125	125		°C
Weight		4.3	4.3		kg

Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary 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 0-0SP (A06B-0374-B□□□)



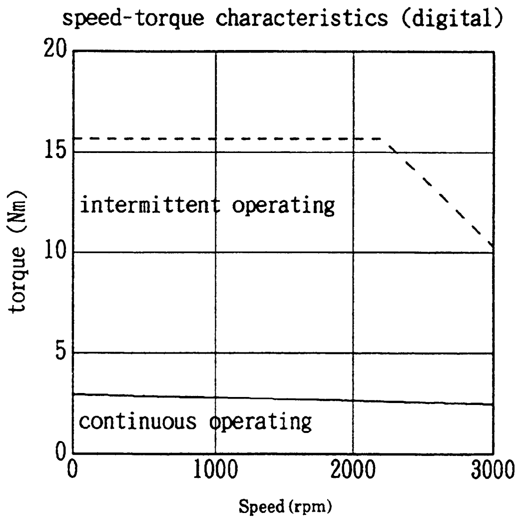


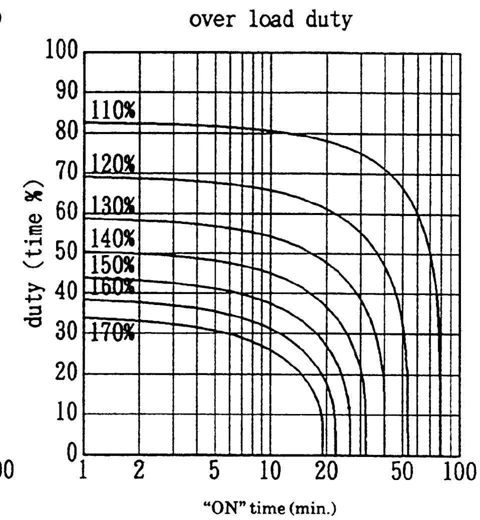
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	3000			min^{-1}
Rated torque at stall(*)	Ts	2.9 30			Nm kgfcm
Rotor inertia	Jm	0.00083 0.0085			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	8.7			A(rms)
Torque constant(*)	Kt	0.34 3.5			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	11.8 0.11			$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.275			Ω
Mechanical time constant(*)	tm	0.006			s
Thermal time constant	tt	20			min
Static friction	Tf	0.2 2			Nm kgfcm
Maximum allowable current	Im	83			A(peak)
Max. torque	Tm	22 220			Nm kgfcm
Max. acceleration		25900			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		5.9			kg

Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary 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 0S (A06B-0313-B□□□)



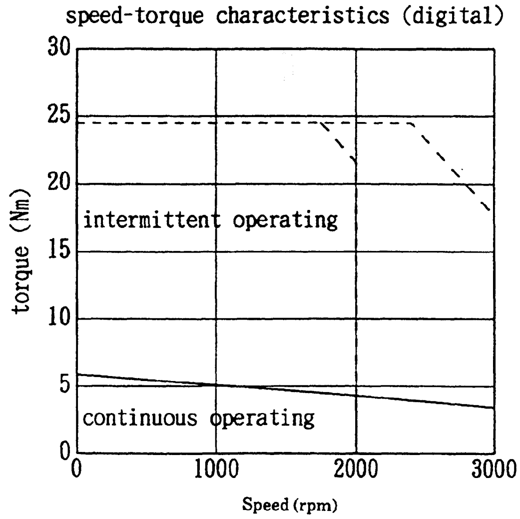


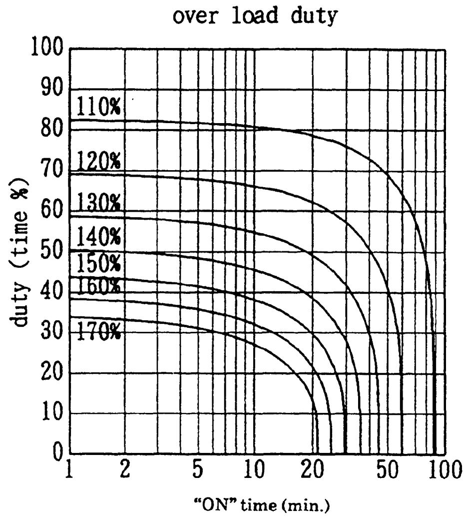
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	3000			min^{-1}
Rated torque at stall(*)	Ts	2.9 30			Nm kgfcm
Rotor inertia	Jm	0.0020 0.020			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	4.6			A(rms)
Torque constant(*)	Kt	0.64 6.5			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	22 0.21			$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.645			Ω
Mechanical time constant(*)	tm	0.009			s
Thermal time constant	tt	45			min
Static friction	Tf	0.3 3			Nm kgfcm
Maximum allowable current	Im	53			A(peak)
Max. torque	Tm	26.5 270			Nm kgfcm
Max. acceleration		13500			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		10			kg

Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary 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 5S (A06B-0314-B□□□)
Model 5S/3000(A06B-0514-B□□□)



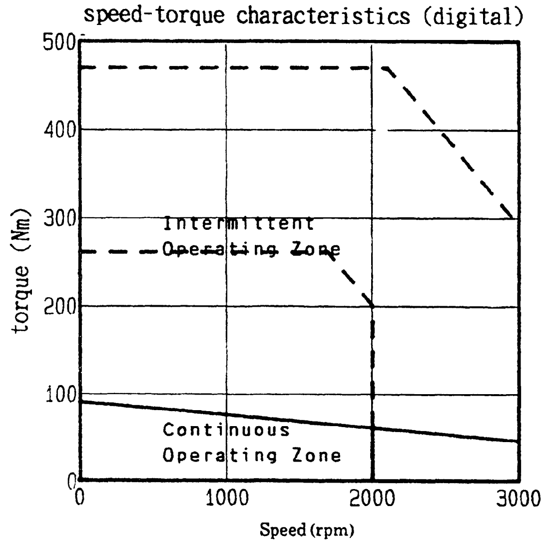


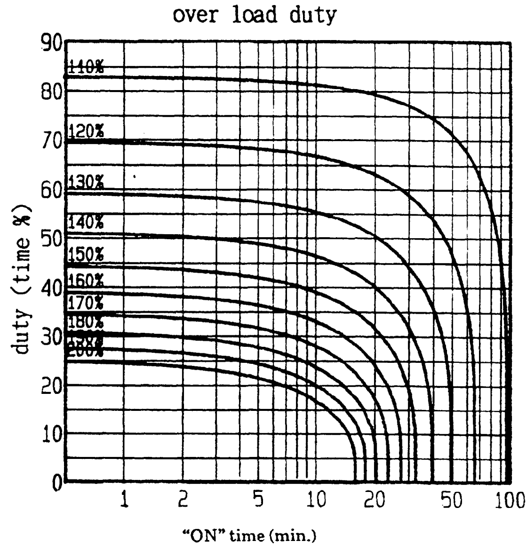
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	2000	3000		min^{-1}
Rated torque at stall(*)	Ts	5.9 60	5.9 60		Nm kgfcm
Rotor inertia	Jm	0.0037 0.038	0.0037 0.038		kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	5.8	10.2		A(rms)
Torque constant(*)	Kt	1.01 10.3	0.57 5.9		Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	35 0.34	20 0.19		$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.613	0.193		Ω
Mechanical time constant(*)	tm	0.007	0.007		s
Thermal time constant	tt	50	50		min
Static friction	Tf	0.3 3	0.3 3		Nm kgfcm
Maximum allowable current	Im	69	120		A(peak)
Max. torque	Tm	52.9 540	52.9 540		Nm kgfcm
Max. acceleration		14200	14200		rad/S^2
Maximum winding temperature rise	θ m	125	125		°C
Weight		15	14		kg

Note) The values are the standard values at 20°C and the tolerance is ±10%. The speed-torque characteristics vary 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 6S (A06B-0316-B□□□)
Model 6S/3000(A06B-0320-B□□□)





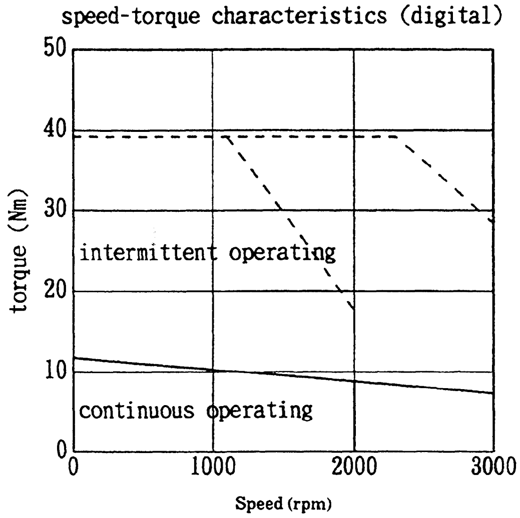
Data sheet

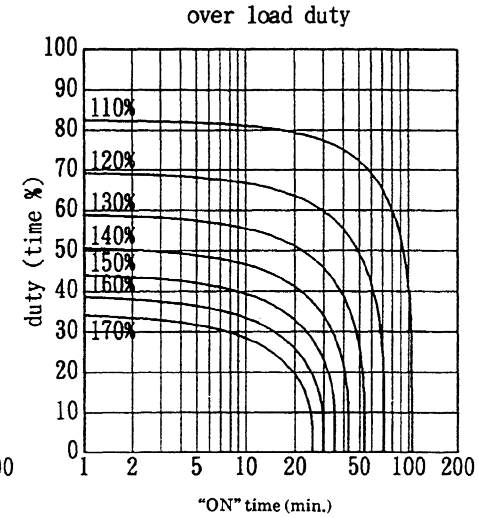
Parameter	Symbol	Value			Unit
Maximum speed	Nmax	2000	3000		rpm
Rated torque (**)	Ts	90	90		kgcm
Rotor inertia	Jm	0.056	0.056		$kgcmS^2$
Rated Current	Is	8.5	10.6		A(rms)
Torque constant(*)	Kt	10.6	8.5		kgcm/A(rms)
Back EMF constant(**)	Ke Kv	36 0.35	29 0.28		V/krpm Vsec/rad
Armature resistance(*)	Ra	0.320	0.205		Ω
Mechanical time constant(*)	tm	0.005	0.005		s
Thermal time constant	tt	55	55		min
Friction Torque	Tf	5	5		kgcm
Maximum current	Im	120	150		A(peak)
Max. torque	Tm	810	810		kgcm
Max. acceleration		14400	14400		rad/S^2
Maximum winding temperature rise	θ m	125	125		°C
Weight		20	20		kg

Note*) Values on 20°C. (±10%)
Speed-torque characteristics depends on digital servo software, parameters and line input voltage. (Typical characteristics is show above.)
All specifications are subject to change without notice.

Note**) Rated torque applicable to 400L ambient.

Model 10S (A06B-0315-B□□□)
Model 10S/3000 (A06B-0317-B□□□)



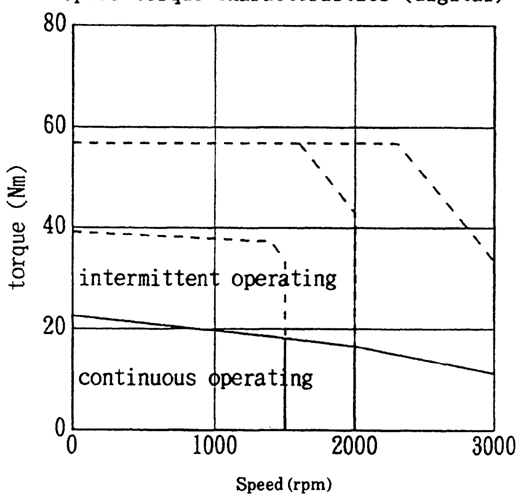


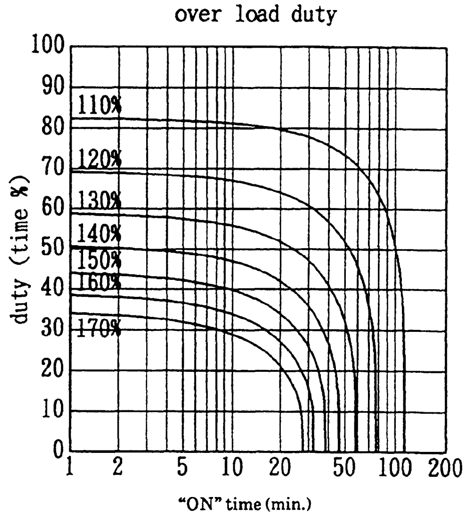
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	2000	3000		min^{-1}
Rated torque at stall(*)	Ts	11.8 120	11.8 120		Nm kgfcm
Rotor inertia	Jm	0.010 0.10	0.010 0.10		kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	7.6	15.3		A(rms)
Torque constant(*)	Kt	1.54 15.7	0.77 7.9		Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	54 0.51	27 0.26		$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.718	0.180		Ω
Mechanical time constant(*)	tm	0.009	0.009		s
Thermal time constant	tt	60	60		min
Static friction	Tf	0.8 8	0.8 8		Nm kgfcm
Maximum allowable current	Im	61	121		A(peak)
Max. torque	Tm	78 800	78 800		Nm kgfcm
Max. acceleration		8000	8000		rad/S^2
Maximum winding temperature rise	θ m	125	125		°C
Weight		23	23		kg

Note) The values are the standard values at 20°C and the tolerance is ±10%. The speed-torque characteristics vary 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 20S/1500 (A06B-0505-B□□□)
Model 20S (A06B-0502-B□□□)
Model 20S/3000 (A06B-0318-B□□□)



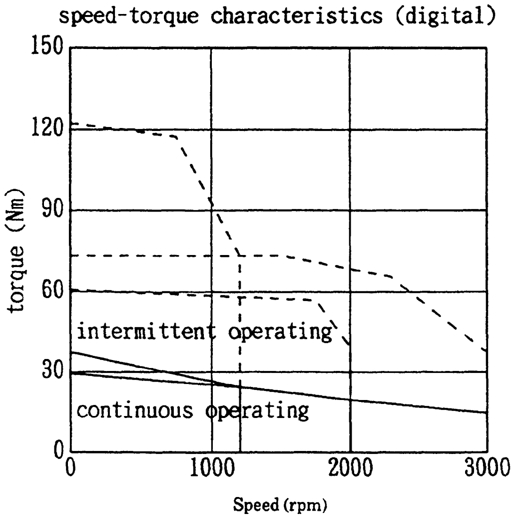


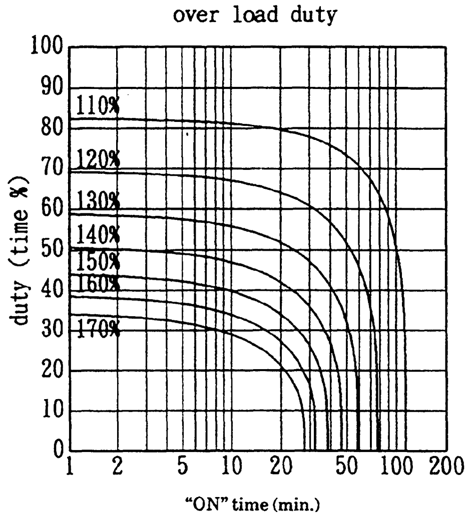
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	1500	2000	3000	min^{-1}
Rated torque at stall(*)	Ts	22.5 230	22.5 230	22.5 230	Nm kgfcm
Rotor inertia	Jm	0.017 0.17	0.017 0.17	0.017 0.17	kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	16.4	19.7	32.9	A(rms)
Torque constant(*)	Kt	1.37 14.0	1.14 11.7	0.69 7.0	Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	48 0.46	40 0.38	24 0.23	$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.220	0.150	0.050	Ω
Mechanical time constant(*)	tm	0.006	0.006	0.005	s
Thermal time constant	tt	65	65	65	min
Static friction	Tf	1.2 12	1.2 12	1.2 12	Nm kgfcm
Maximum allowable current	Im	142	170	283	A(peak)
Max. torque	Tm	147 1500	147 1500	147 1500	Nm kgfcm
Max. acceleration		8800	8800	8800	rad/S^2
Maximum winding temperature rise	θ m	125	125	125	°C
Weight		34	34	34	kg

Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary 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 30S (A06B-0590-B□□□)
Model 30/2000 (A06B-0506-B□□□)
Model 30S/3000 (A06B-0319-B□□□)



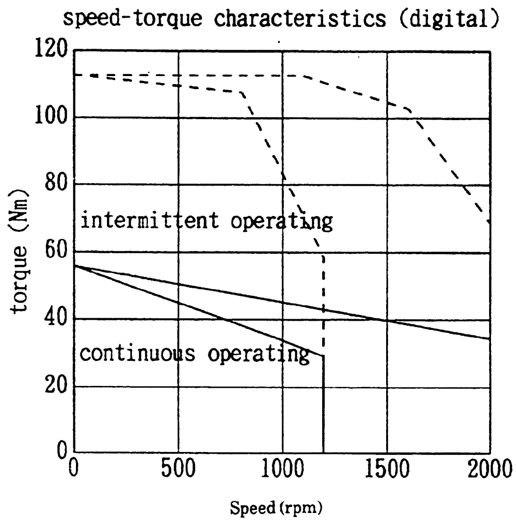


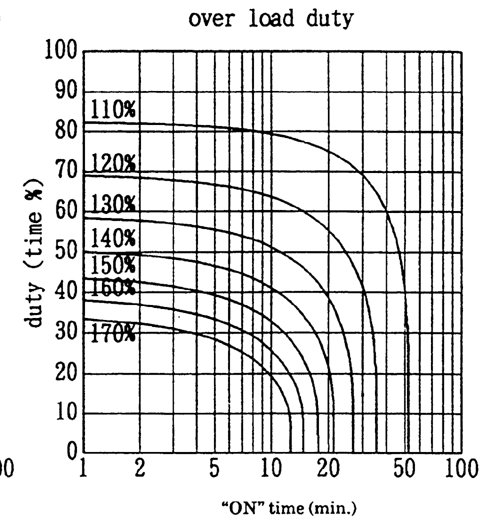
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	1200	2000	3000	min^{-1}
Rated torque at stall(*)	Ts	37.2 380	29.4 300	29.4 300	Nm kgfcm
Rotor inertia	Jm	0.0024 0.24	0.0024 0.24	0.0024 0.24	kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	15.6	28.6	34.4	A(rms)
Torque constant(*)	Kt	2.39 24.4	1.03 10.5	0.86 8.7	Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	84 0.80	36 0.34	30 0.29	$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.347	0.063	0.043	Ω
Mechanical time constant(*)	tm	0.004	0.004	0.004	s
Thermal time constant	tt	65	65	65	min
Static friction	Tf	1.8 18	1.8 18	1.8 18	Nm kgfcm
Maximum allowable current	Im	121	283	340	A(peak)
Max. torque	Tm	225 2300	225 2300	225 2300	Nm kgfcm
Max. acceleration		9600	9600	9600	rad/S^2
Maximum winding temperature rise	θ m	125	125	125	°C
Weight		45	45	45	kg

Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary 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 40 (A06B-0581-B0□□)
Model 40S/2000 (A06B-0583-B0□□)





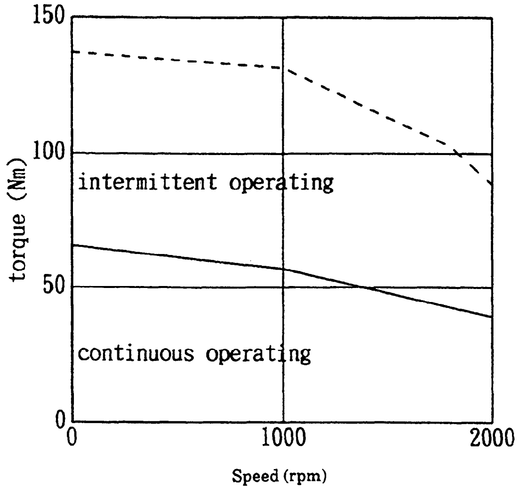
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	1200	2000		min^{-1}
Rated torque at stall(*)	Ts	55.9 570	55.9 570		Nm kgfcm
Rotor inertia	Jm	0.030 0.31	0.030 0.31		kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	30.7	40.9		A(rms)
Torque constant(*)	Kt	1.82 18.6	1.36 13.9		Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	64 0.61	48 0.45		$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.130	0.078		Ω
Mechanical time constant(*)	tm	0.004	0.004		s
Thermal time constant	tt	30	30		min
Static friction	Tf	1.8 18	1.8 18		Nm kgfcm
Maximum allowable current	Im	188	251		A(peak)
Max. torque	Tm	235 2400	235 2400		Nm kgfcm
Max. acceleration		7700	7700		rad/S^2
Maximum winding temperature rise	θ m	125	125		°C
Weight		60	60		kg

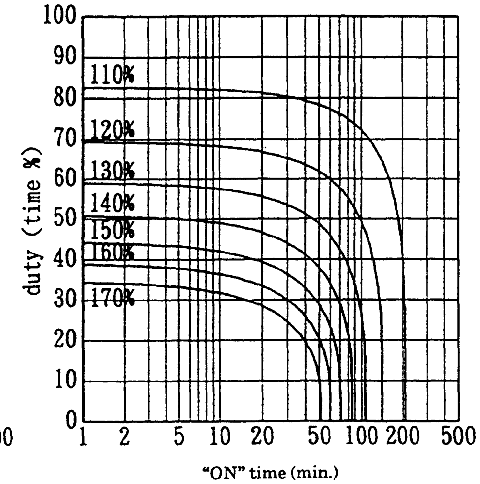
Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
These values may be changed without prior notice.

Model 50S (A06B-0331-B□□□)

speed-torque characteristics (digital)



over load duty

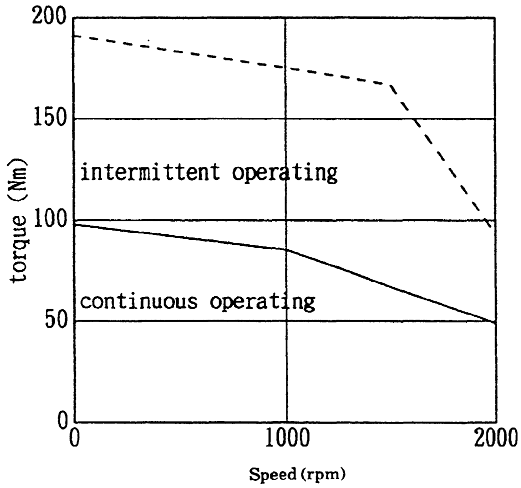


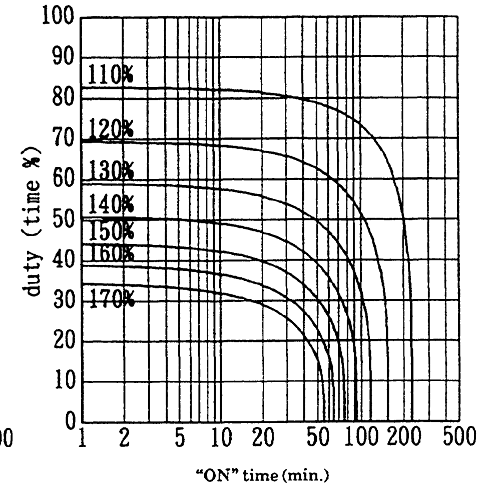
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	2000			min^{-1}
Rated torque at stall(*)	Ts	66 670			Nm kgfcm
Rotor inertia	Jm	0.024 0.24			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	63			A(rms)
Torque constant(*)	Kt	1.04 10.6			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	36 0.35			$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.020			Ω
Mechanical time constant(*)	tm	0.001			s
Thermal time constant	tt	120			min
Static friction	Tf	3.7 38			Nm kgfcm
Maximum allowable current	Im	420			A(peak)
Max. torque	Tm	294 3000			Nm kgfcm
Max. acceleration		12400			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		80			kg

Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary 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 60S (A06B-0332-B□□□)



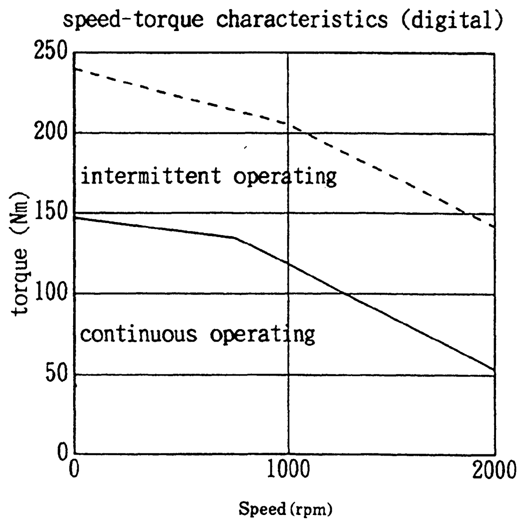


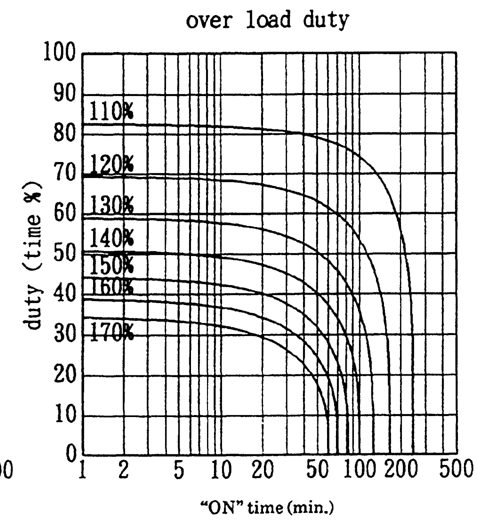
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	2000			min^{-1}
Rated torque at stall(*)	Ts	98 1000			Nm kgfcm
Rotor inertia	Jm	0.031 0.32			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	84			A(rms)
Torque constant(*)	Kt	1.17 12.0			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	41 0.39			$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.014			Ω
Mechanical time constant(*)	tm	0.001			s
Thermal time constant	tt	130			min
Static friction	Tf	5.5 56			Nm kgfcm
Maximum allowable current	Im	575			A(peak)
Max. torque	Tm	441 4500			Nm kgfcm
Max. acceleration		14100			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		100			kg

Note) The values are the standard values at 20°C and the tolerance is ±10%. The speed-torque characteristics vary 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 70S (A06B-0333-B□□□)



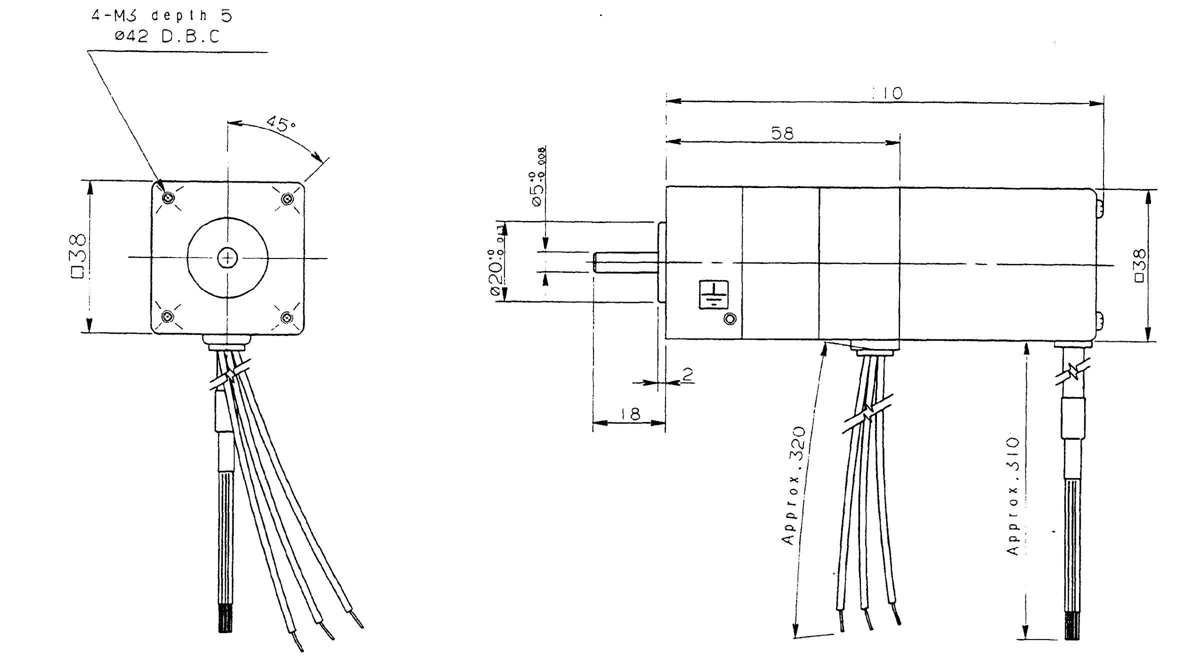


Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	2000			min^{-1}
Rated torque at stall(*)	Ts	147 1500			Nm kgfcm
Rotor inertia	Jm	0.038 0.39			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	113			A(rms)
Torque constant(*)	Kt	1.30 13.3			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	46 0.43			$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.011			Ω
Mechanical time constant(*)	tm	0.001			s
Thermal time constant	tt	140			min
Static friction	Tf	7.4 75			Nm kgfcm
Maximum allowable current	Im	688			A(peak)
Max. torque	Tm	588 6000			Nm kgfcm
Max. acceleration		15300			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		120			kg

Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary 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.

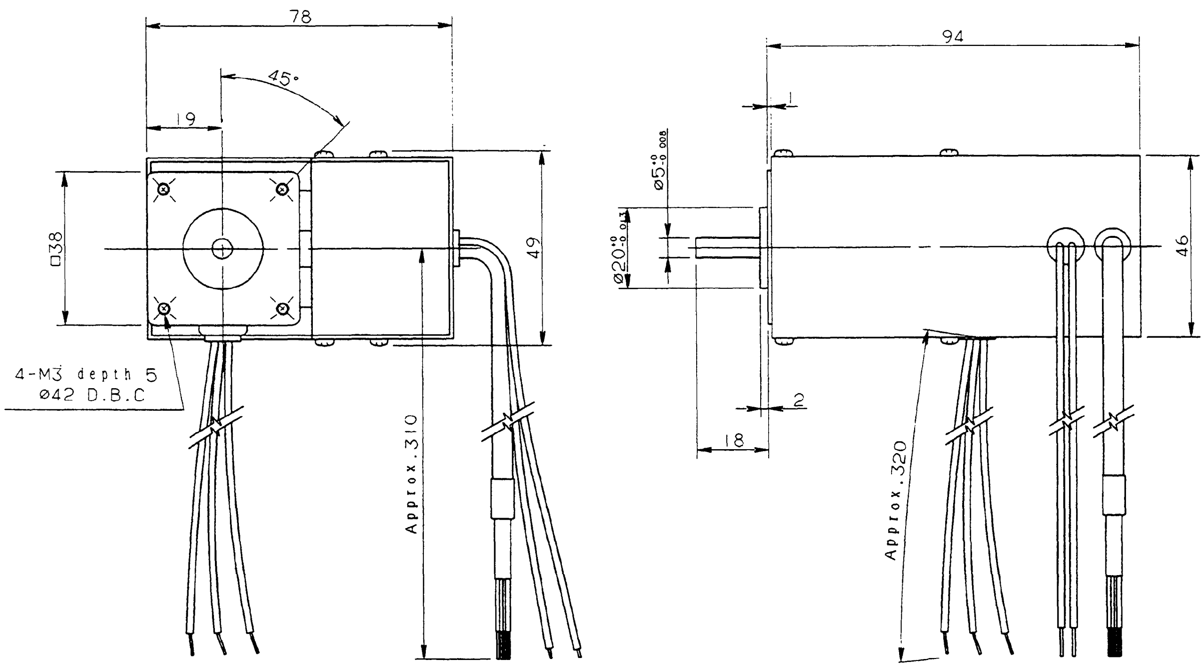
3.3 Outline Drawings



NOTE 1) Shaft dia.runout Max.0.02mm
Rabbet dia.eccentricity Max.0.04mm
Mounting face runout Max.0.05mm
Rated loads Radial 39N(4kgf)

NOTE 2) Use the M3 tap hole for connecting the earth wire. Use a screw less than 3mm in length. If the screw length is longer, the motor will be damaged. Avoid touching the screw by the tap.

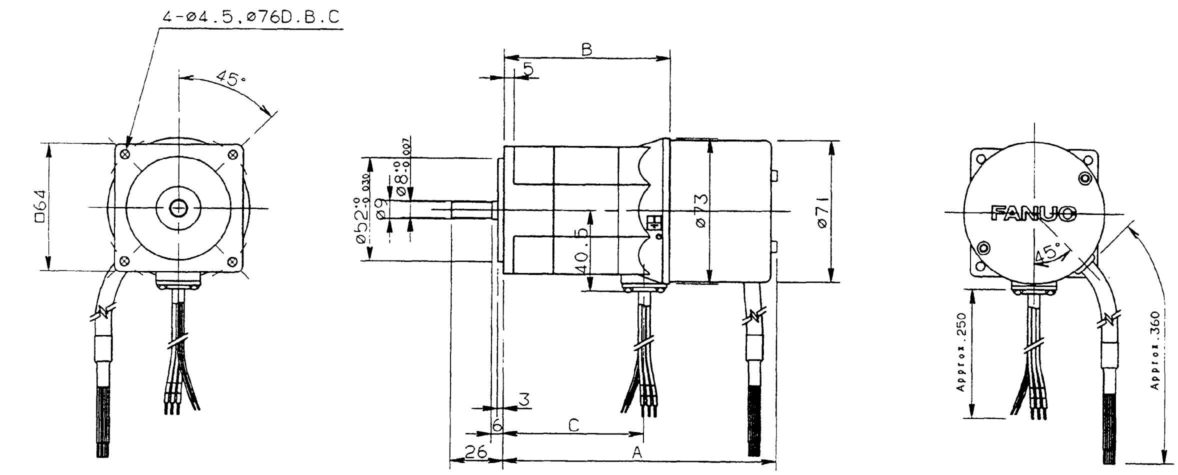
Fig. 3.3(a) Model 5-0 (with the incremental pulse coder)



NOTE 1) Shaft dia.runout Max.0.02mm
Rabbet dia.eccentricity Max.0.04mm
Mounting face runout Max.0.05mm
Rated loads Radial 39N(4kgf)

NOTE 2) Use the M3 tap hole for connecting the earth wire. Use a screw less than 3mm in length. If the screw length is longer, the motor will be damaged. Avoid touching the screw by the tap.

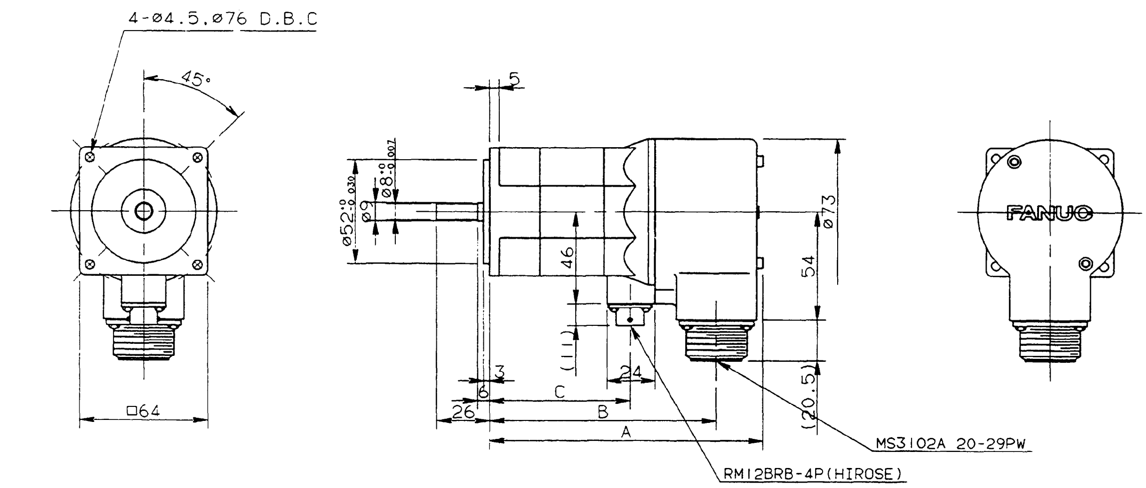
Fig. 3.3(b) Model 5-0 (with the absolute pulse coder)



NOTE 1) Shaft dia.runout Max.0.02mm
Rabbet dia.eccentricity Max.0.04mm
Mounting face runout Max.0.06mm
Rated loads Radial 78N(8kgf)

MOTOR	A	B	C
MODEL 4-0	136	84	70
MODEL 3-0	168	116	102

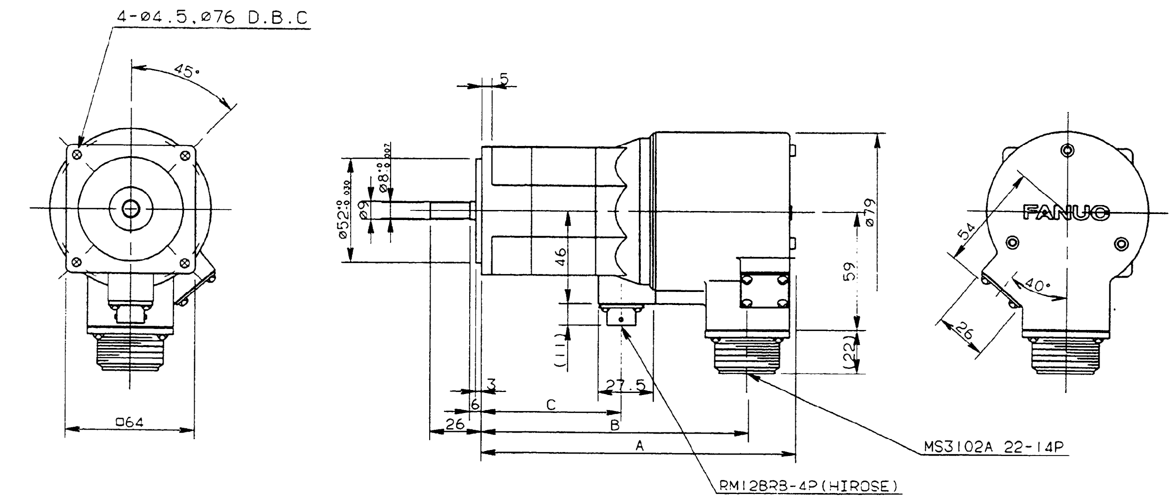
Fig. 3.3(c) Models 4-0S and 3-0S (with the incremental pulse coder, lead wire)



NOTE 1) Shaft dia.runout Max.0.02mm
Rabbet dia.eccentricity Max.0.04mm
Mounting face runout Max.0.06mm
Rated loads Radial 78N(8kgf)

MOTOR	A	B	C
MODEL 4-0	136	113	70
MODEL 3-0	168	145	102

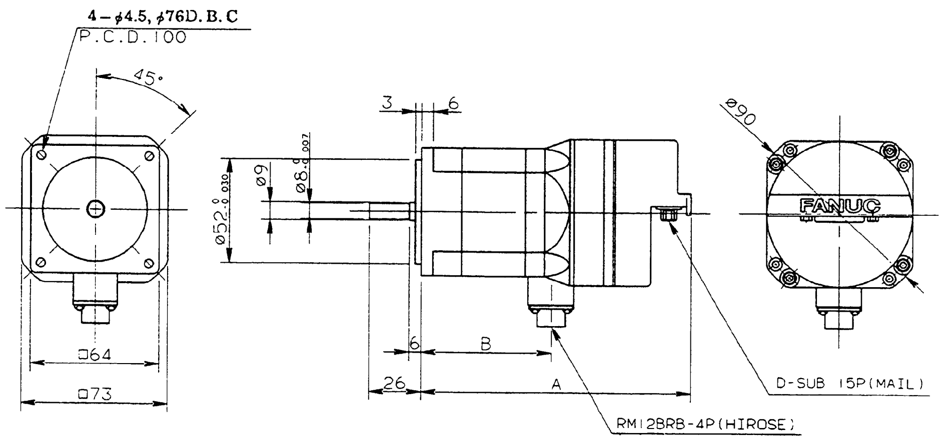
Fig. 3.3(d) Models 4-0S and 3-0S (with the incremental pulse coder, connector)



NOTE 1) Shaft dia. runout Max. 0.02mm
Rabbet dia. eccentricity Max. 0.04mm
Mounting face runout Max. 0.06mm
Rated loads Radial 78N (8kgf)

MOTOR	A	B	C
MODEL 4-0	158	134	70
MODEL 3-0	190	166	102

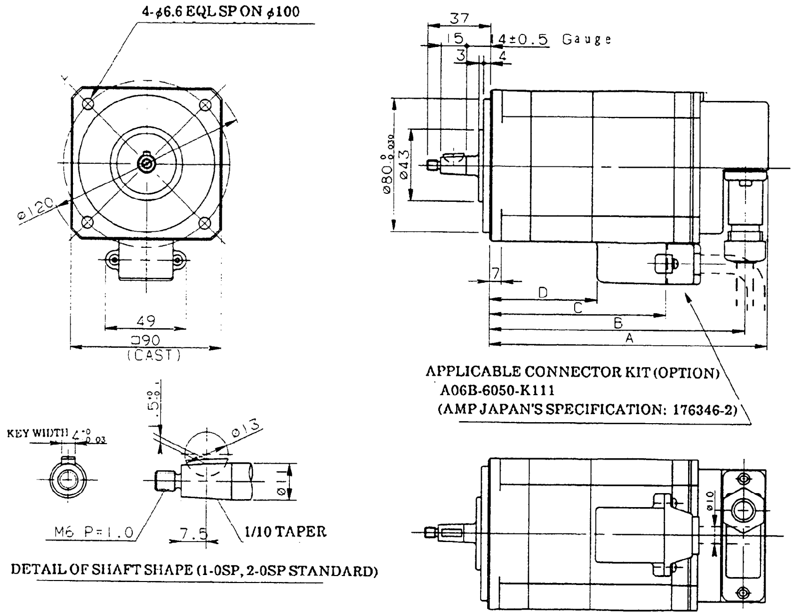
Fig. 3.3(e) Models 4-0S and 3-0S (with the absolute pulse coder)

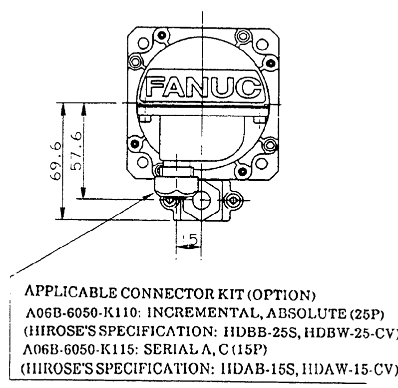


NOTE 1) Shaft dia. runout Max. 0.02mm
Rabbet dia. eccentricity Max. 0.04mm
Mounting face runout Max. 0.06mm
Rated loads Radial 78N (8kgf)

		PULSECODER SERIAL C	PULSECODER SERIAL A
MOTOR	B	A	A
MODEL 4-0S	65	136	149
MODEL 3-0S	97	168	181

Fig. 3.3(f) Models 4-0S and 3-0S (with the serial pulse coder)



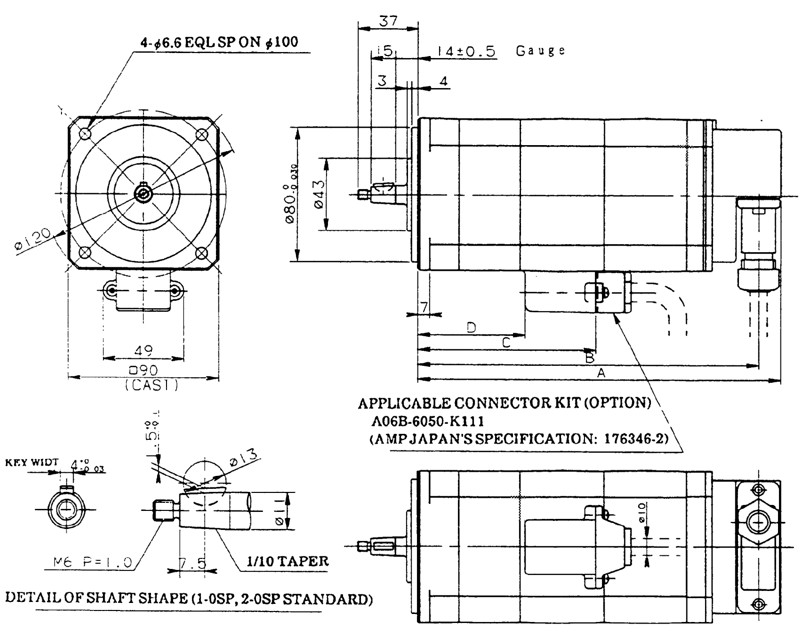


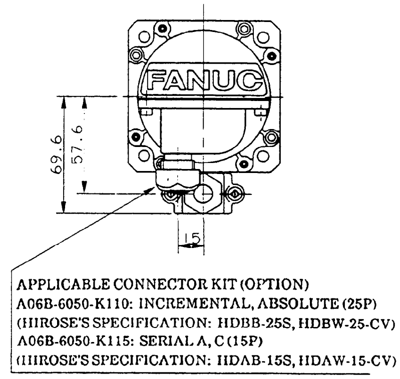
	WITH INCREMENTAL PULSE CODER AND SERIAL A, C			
MODEL	A	B	C	D
2-0SP	165	152	104	60
1-0SP	201	188	140	96
	WITH ABSOLUTE PULSE CODER			
MODEL	A	B	C	D
2-0SP	190	177	104	60
1-0SP	226	213	140	96

OUTLINE DIMENSIONS

NOTE 1) SHAFT ROTATION RUNOUT: 0.02 mm MAX
RUNOUT DUE TO FAUCET JOINT ECCENTRICITY: 0.04 mm MAX
INSTALLATION SURFACE RUNOUT: 0.06 mm MAX
PERMISSIBLE RADIAL LOAD ON OUTPUT SHAFT: 245 N (25 kgf)

Fig. 3.3(g) Models 2-0SP, 1-0SP, and 1-0SP/3000





	WITH INCREMENTAL PULSE CODER AND SERIAL A, C			
MODEL	A	B	C	D
2-0SP	215	202	104	60
1-0SP	251	238	140	96
	WITH ABSOLUTE PULSE CODER			
MODEL	A	B	C	D
2-0SP	240	227	104	60
1-0SP	276	263	140	96

OUTLINE DIMENSIONS

NOTE 1) SHAFT ROTATION RUNOUT: 0.02 mm MAX
RUNOUT DUE TO FAUCET JOINT ECCENTRICITY: 0.04 mm MAX
INSTALLATION SURFACE RUNOUT: 0.06 mm MAX
PERMISSIBLE RADIAL LOAD ON OUTPUT SHAFT: 245 N (25 kgf)

Fig. 3.3(h) Models 2-0SP, 1-0SP, and 1-0SP/3000 (with the brake)

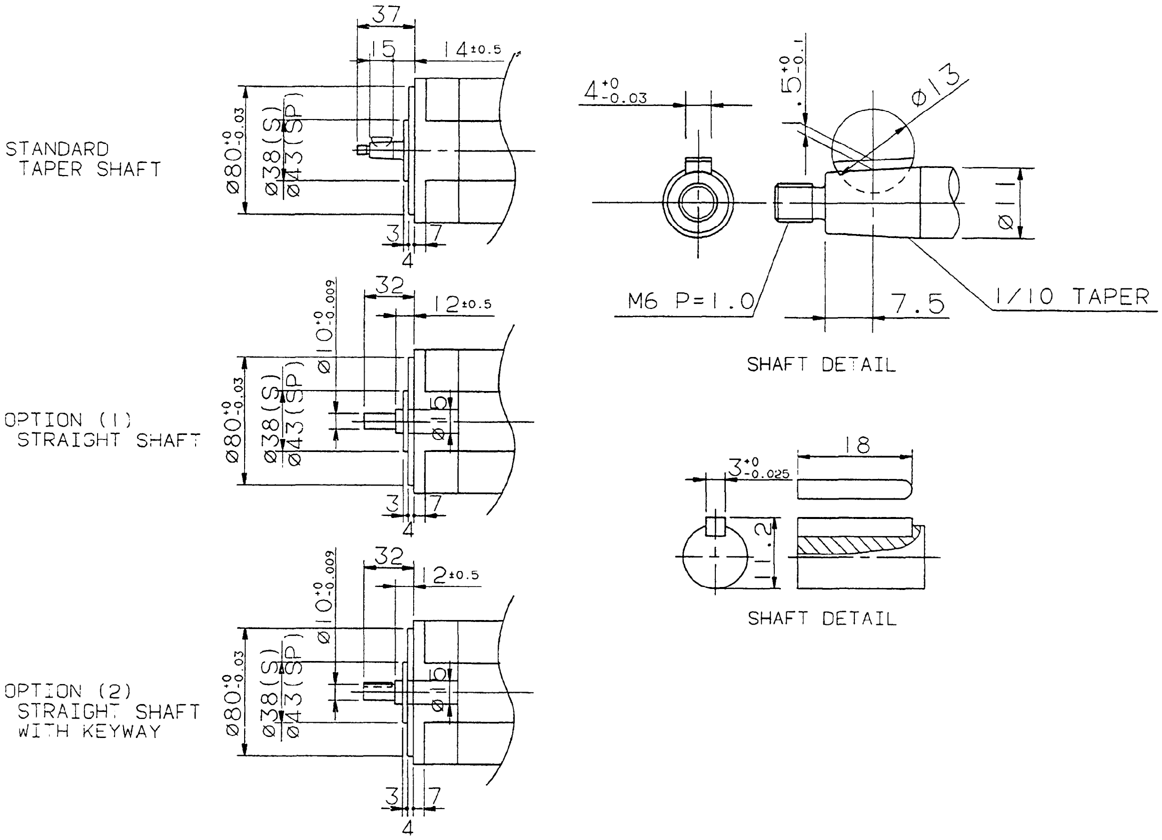
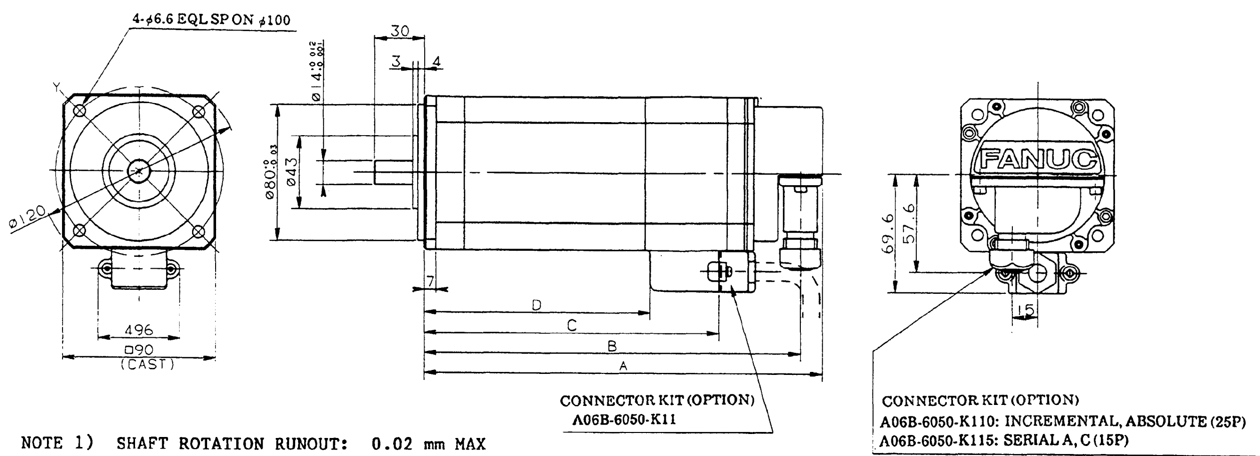


Fig. 3.3(i) Shaft option (models 2-0S, 1-0S, 1-0S/3000, 2-0SP, 1-0SP, and 1-0SP/3000)



NOTE 1) SHAFT ROTATION RUNOUT: 0.02 mm MAX
RUNOUT DUE TO FAUCET JOINT ECCENTRICITY: 0.04 mm MAX
INSTALLATION SURFACE RUNOUT: 0.06 mm MAX
PERMISSIBLE RADIAL LOAD ON OUTPUT SHAFT: 245 N (25 kgf)

	WITH INCREMENTAL PULSE CODER AND SERIAL A, C			
MODEL	A	B	C	D
0-0SP	237	224	176	132
	WITH ABSOLUTE PULSE CODER			
MODEL	A	B	C	D
0-0SP	262	249	176	132

OUTLINE DIMENSIONS

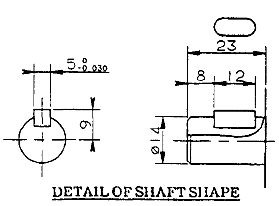
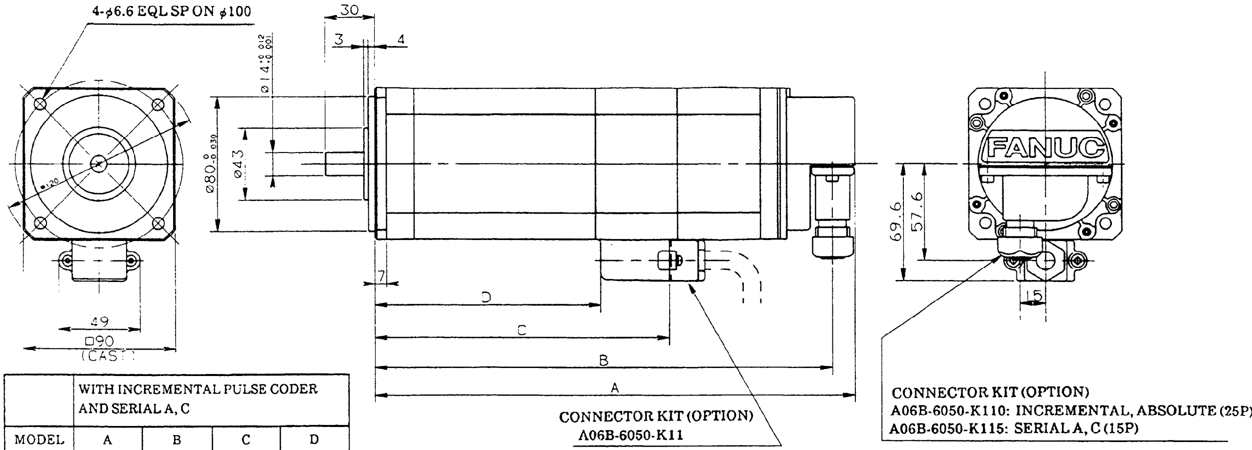


Fig. 3.3(j) Model 0-0SP



	WITH INCREMENTAL PULSE CODER AND SERIAL A, C			
MODEL	A	B	C	D
0-0SP	287	274	176	132
	WITH ABSOLUTE PULSE CODER			
MODEL	A	B	C	D
0-0SP	312	299	176	132

OUTLINE DIMENSIONS

NOTE 1) SHAFT ROTATION RUNOUT: 0.02 mm MAX
RUNOUT DUE TO FAUCET JOINT ECCENTRICITY: 0.04 mm MAX
INSTALLATION SURFACE RUNOUT: 0.06 mm MAX
PERMISSIBLE RADIAL LOAD ON OUTPUT SHAFT: 245 N (25 kgf)

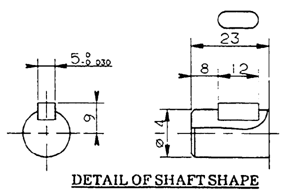
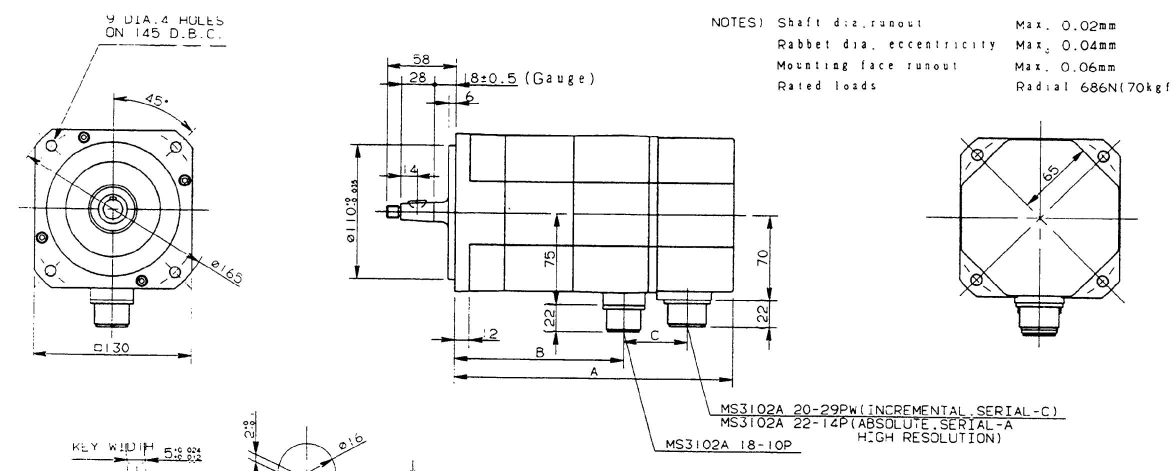
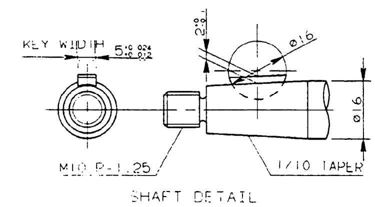


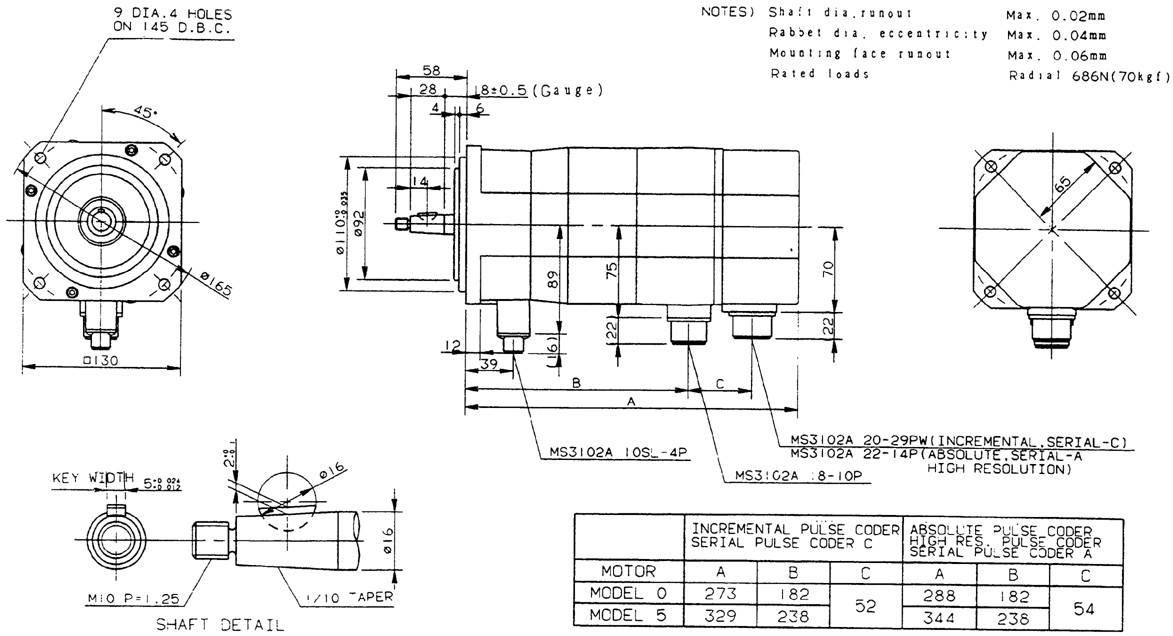
Fig. 3.3(k) Model 0-0SP (with the brake)





	INCREMENTAL PULSE CODER SERIAL PULSE CODER C			ABSOLUTE PULSE CODER HIGH RES. PULSE CODER SERIAL PULSE CODER A		
MOTOR	A	B	C	A	B	C
MODEL 0	230	139	52	245	139	54
MODEL 5	286	195		301	195	

Fig. 3.3(l) Models 0S, 5S, and 5S/3000



	INCREMENTAL PULSE CODER SERIAL PULSE CODER C			ABSOLUTE PULSE CODER HIGH RES. PULSE CODER SERIAL PULSE CODER A		
MOTOR	A	B	C	A	B	C
MODEL 0	273	182	52	288	182	54
MODEL 5	329	238		344	238	

Fig. 3.3(m) Models 0S, 5S, and 5S/3000 (with the brake)

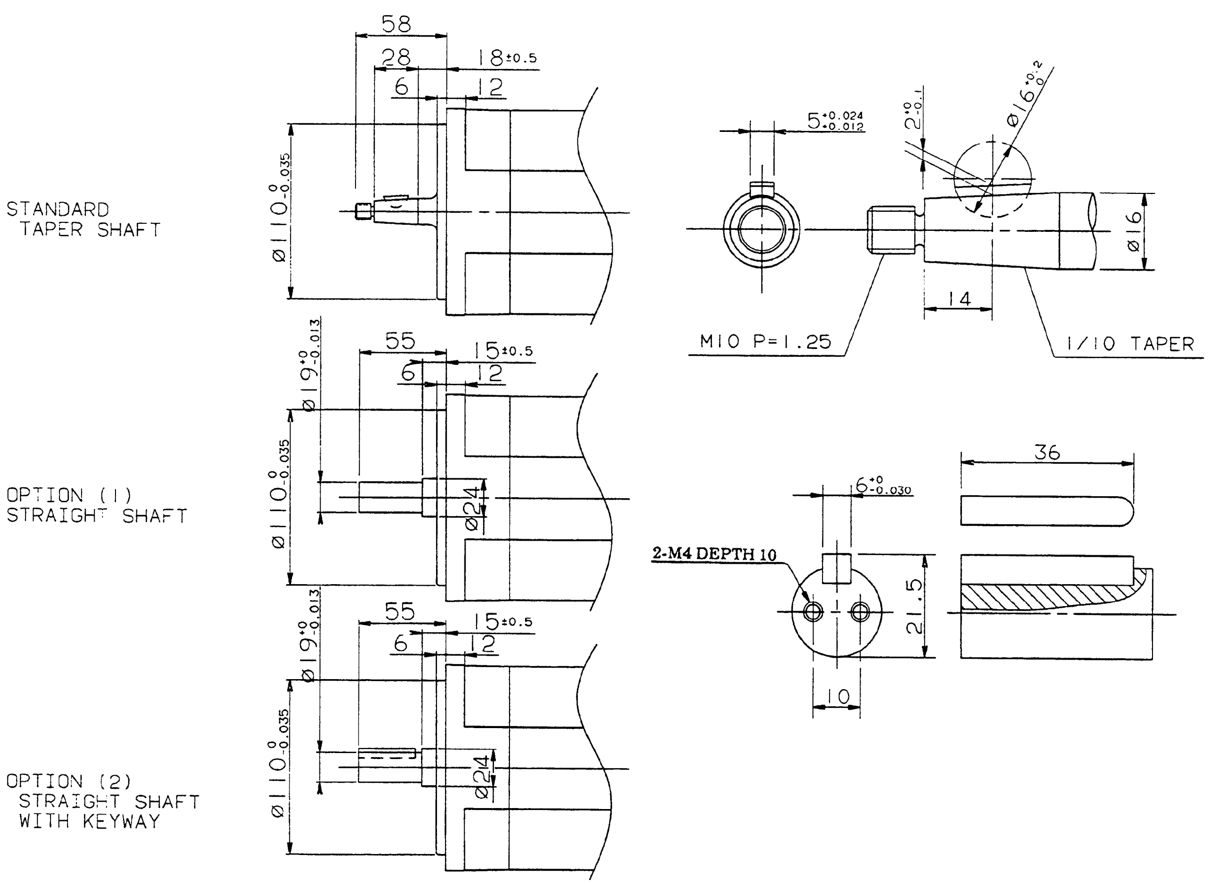
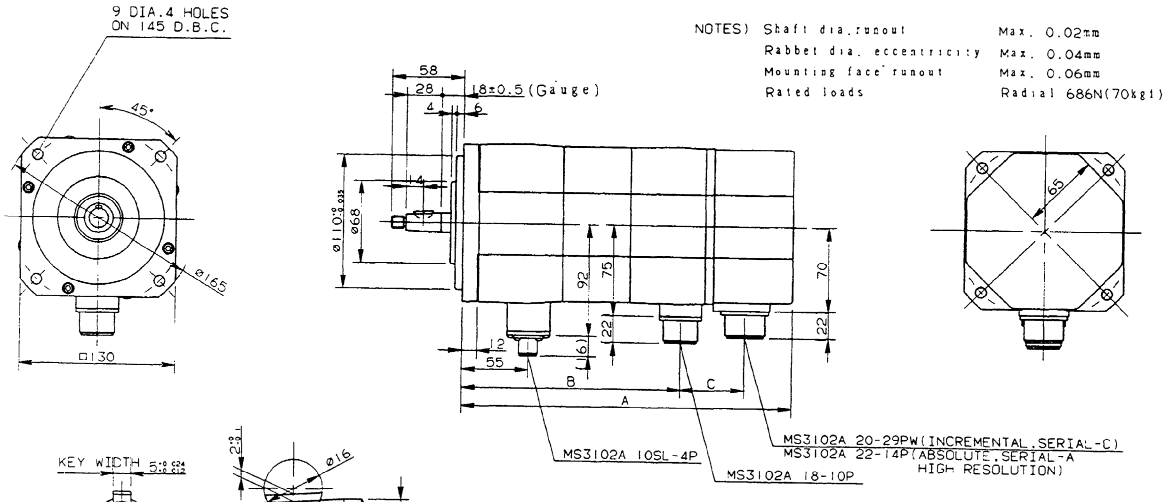
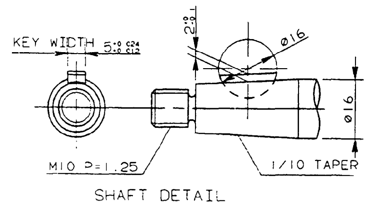


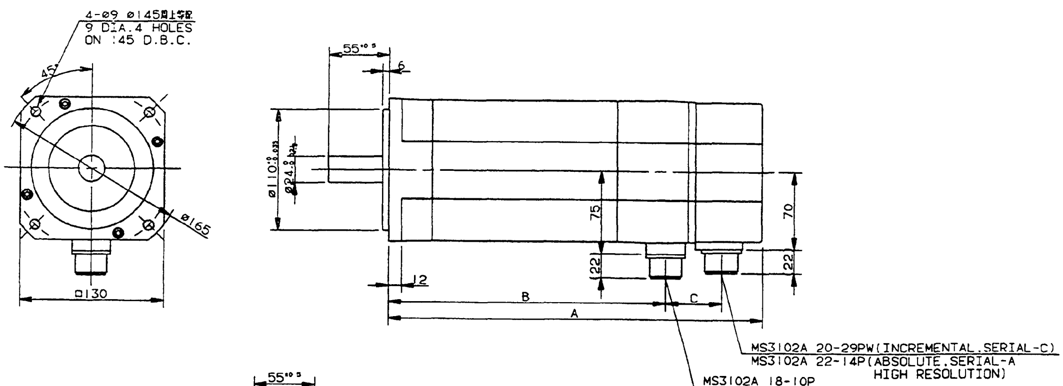
Fig. 3.3(n) Shaft option (models 0S, 5S, and 5S/3000)



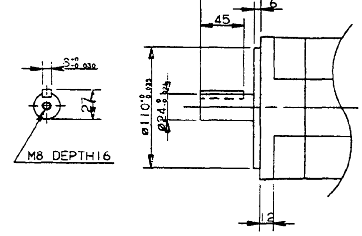


	INCREMENTAL PULSE CODER SERIAL PULSE CODER C			ABSOLUTE PULSE CODER HIGH RES. PULSE CODER SERIAL PULSE CODER A		
MOTOR	A	B	C	A	B	C
MODEL 0	273	182	52	288	182	54
MODEL 5	329	238		344	238	

Fig. 3.3(o) Models 0S, 5S, and 5S/3000 (with the brake)

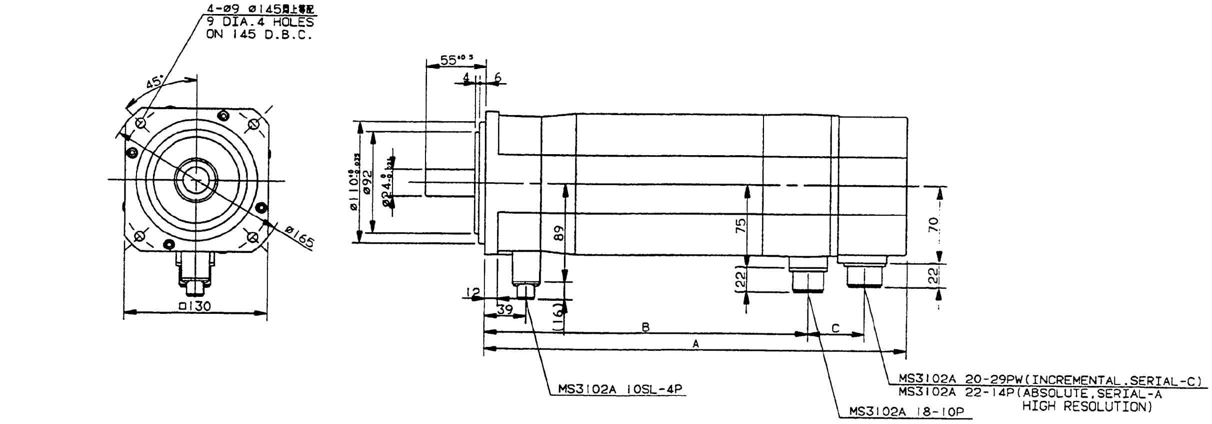


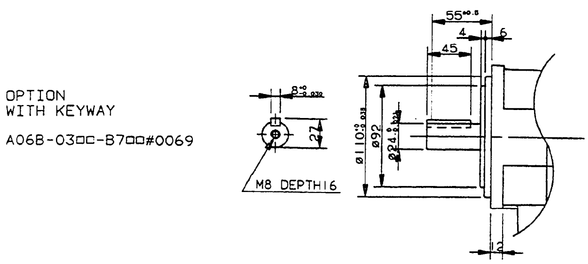
OPTION
WITH KEYWAY
A06B-03□□-B5□□#0069



	INCREMENTAL PULSE CODER SERIAL PULSE CODER C			ABSOLUTE PULSE CODER HIGH RES. PULSE CODER SERIAL PULSE CODER A		
MOTOR	A	B	C	A	B	C
MODEL 6S	344	253	52	359	253	54

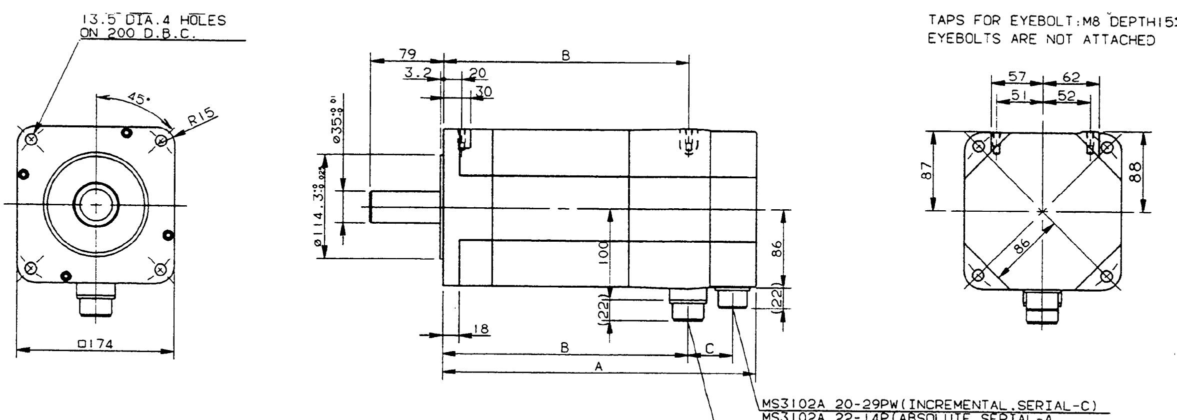
Fig. 3.3(p) Models 6S, and 6S/3000





	INCREMENTAL PULSE CODER SERIAL PULSE CODER C			ABSOLUTE PULSE CODER HIGH RES. PULSE CODER SERIAL PULSE CODER A		
MOTOR	A	B	C	A	B	C
MODEL 6S	387	296	52	402	296	54

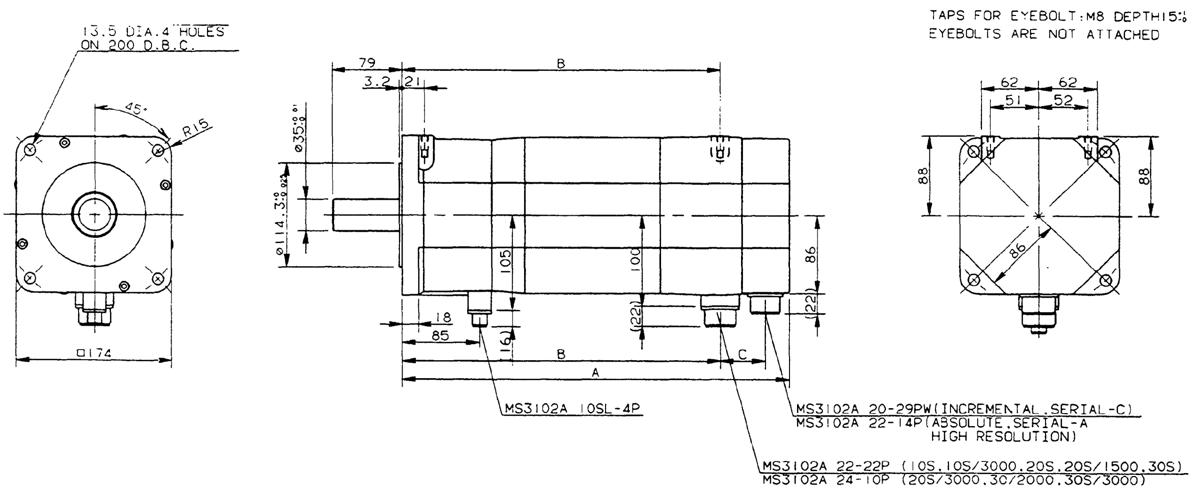
Fig. 3.3(q) Models 6S, and 6S/3000 (with Al Flange Brake)



NOTES) Shaft dia. runout Max. 0.05mm
Rabbet dia. eccentricity Max. 0.07mm
Mounting face runout Max. 0.10mm
Rated loads Radial 4410N(450kgf)

	INCREMENTAL PULSE CODER SERIAL PULSE CODER C			ABSOLUTE PULSE CODER HIGH RES. PULSE CODER SERIAL PULSE CODER A		
MOTOR	A	B	C	A	B	C
MODEL 10	271	196	49	286	196	54
MODEL 20	346	271		361	271	
MODEL 30	421	346		436	346	

Fig. 3.3(r) Models 10S, 10S/3000, 20S, 20S/1500, 20S/3000, 30S, 30/2000, and 30S/3000



NOTES) Shaft dia.runout: Max. 0.05mm
Rabbet dia. eccentricity Max. 0.07mm
Mounting face runout: Max 0.10mm
Rated loads Radial 4410N(450kgf)

	INCREMENTAL PULSE CODER SERIAL PULSE CODER C			ABSOLUTE PULSE CODER HIGH RES. PULSE CODER SERIAL PULSE CODER A		
MOTOR	A	B	C	A	B	C
MODEL 10	350	275	49	365	275	54
MODEL 20	425	350		440	350	
MODEL 30	500	425		515	425	

Fig. 3.3(s) Models 10S, 10S/3000, 20S, 20S/1500, 20S/3000, 30S, 30/2000, and 30S/3000 (with the brake)

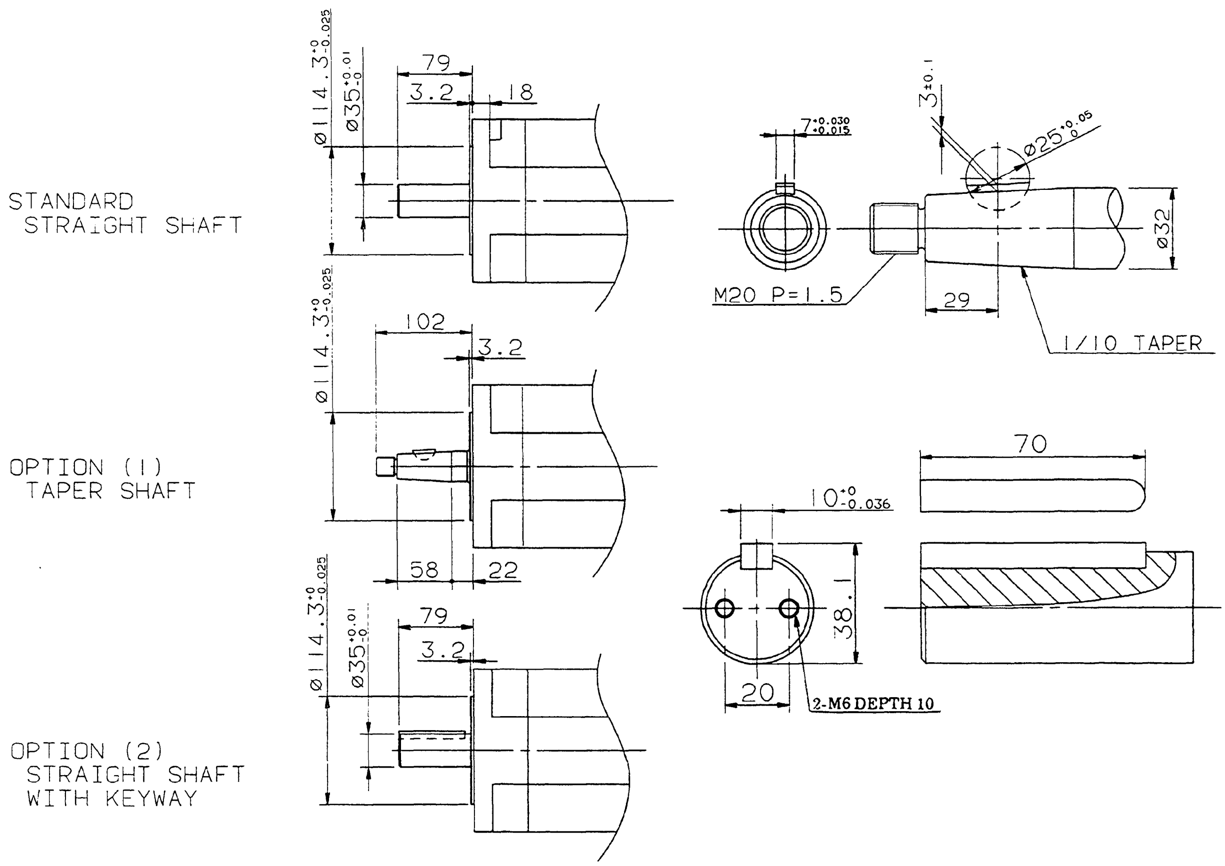
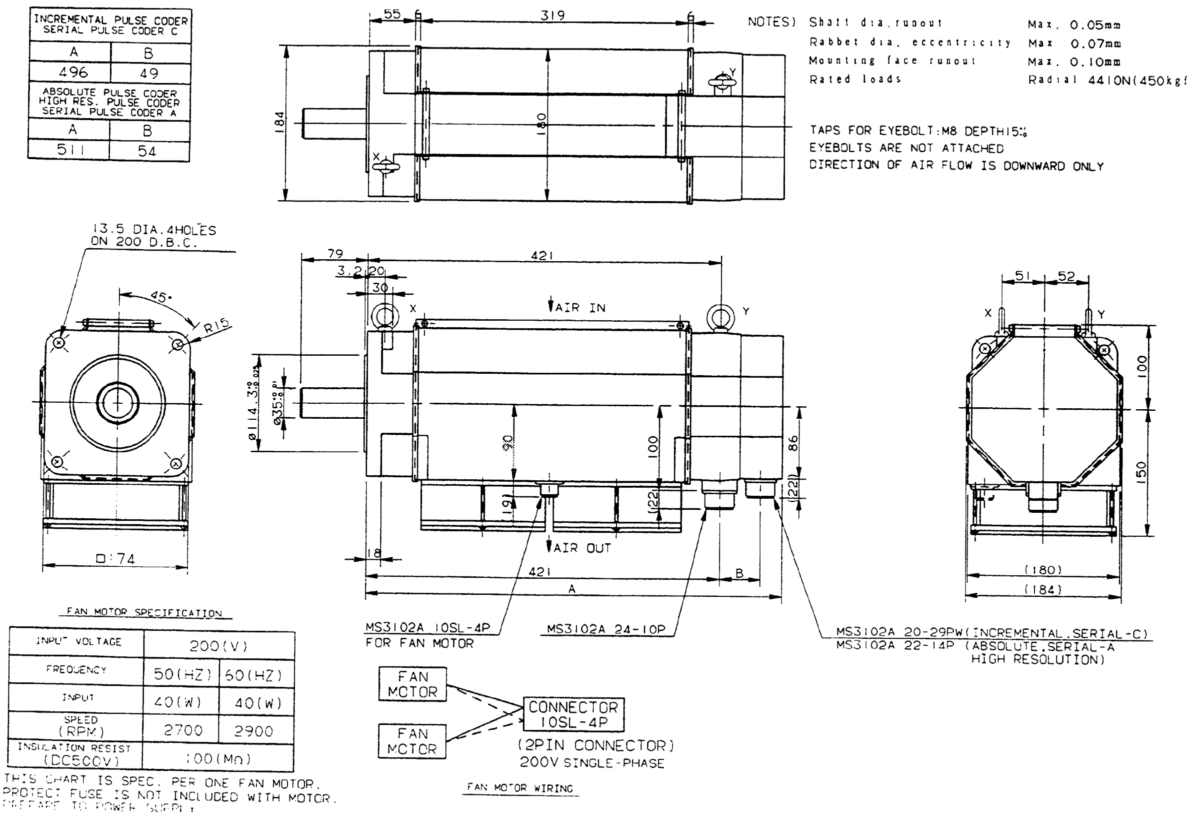


Fig. 3.3(t) Shaft option (models 10S, 10S/3000, 20S, 20S/1500, 20S/3000, 30S, 30/2000, 30S/3000)



INCREMENTAL PULSE CODER SERIAL PULSE CODER C	
A	B
496	49
ABSOLUTE PULSE CODER HIGH RES. PULSE CODER SERIAL PULSE CODER A	
A	B
511	54

NOTES)

Shaft dia. runout	Max. 0.05mm
Rabbet dia. eccentricity	Max 0.07mm
Mounting face runout	Max. 0.10mm
Rated loads	Radial 4410N(450kgf)

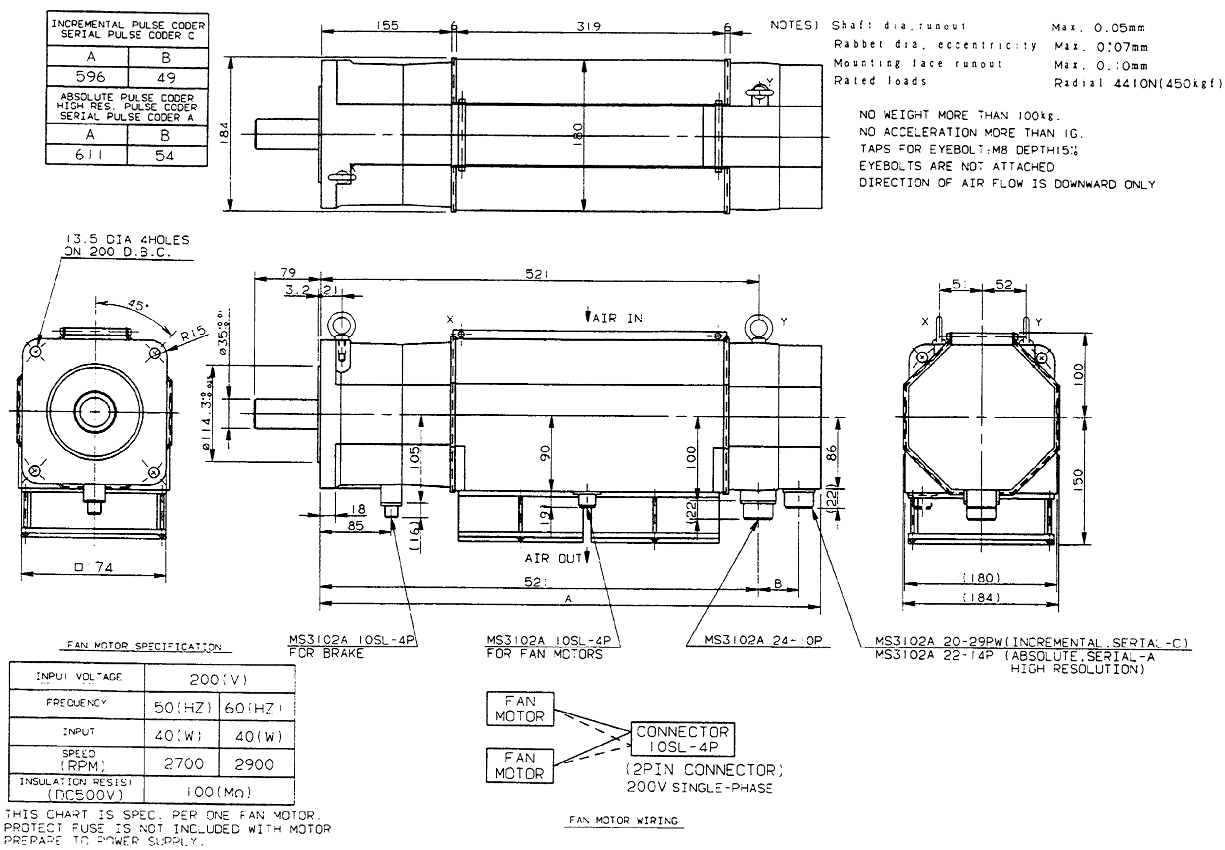
TAPS FOR EYEBOLT:M8 DEPTH15⅜
EYEBOLTS ARE NOT ATTACHED
DIRECTION OF AIR FLOW IS DOWNWARD ONLY

FAN MOTOR SPECIFICATION

INPUT VOLTAGE	200(V)	
FREQUENCY	50(HZ)	60(HZ)
INPUT	40(W)	40(W)
SPEED (RPM)	2700	2900
INSULATION RESIST (DC500V)	100(MΩ)	

THIS CHART IS SPEC. PER ONE FAN MOTOR.
PROTECT FUSE IS NOT INCLUDED WITH MOTOR.
PREPARE TO POWER SUPPLY.

Fig. 3.3(u) Models 40 and 40S/2000



INCREMENTAL PULSE CODER SERIAL PULSE CODER C	
A	B
596	49
ABSOLUTE PULSE CODER HIGH RES. PULSE CODER SERIAL PULSE CODER A	
A	B
611	54

NOTES)

Shaft dia. runout	Max. 0.05mm
Rabbet dia. eccentricity	Max. 0.07mm
Mounting face runout	Max. 0.10mm
Rated loads	Radial 4410N(450kgf)

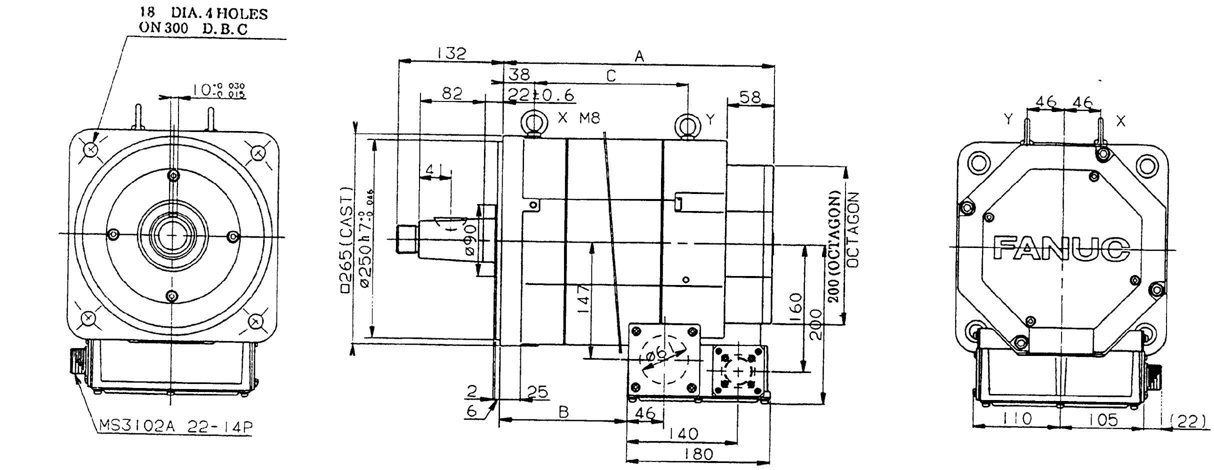
NO WEIGHT MORE THAN 100kg.
NO ACCELERATION MORE THAN 1G.
TAPS FOR EYEBOLT:M8 DEPTH15⅜
EYEBOLTS ARE NOT ATTACHED
DIRECTION OF AIR FLOW IS DOWNWARD ONLY

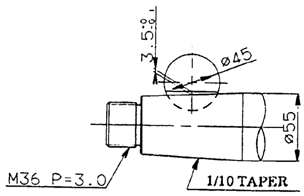
FAN MOTOR SPECIFICATION

INPUT VOLTAGE	200(V)	
FREQUENCY	50(HZ)	60(HZ)
INPUT	40(W)	40(W)
SPEED (RPM)	2700	2900
INSULATION RESIST (DC500V)	100(MΩ)	

THIS CHART IS SPEC. PER ONE FAN MOTOR.
PROTECT FUSE IS NOT INCLUDED WITH MOTOR
PREPARE TO POWER SUPPLY.

Fig. 3.3(v) Models 40 and 40S/2000 (with the brake)





SHAFT DETAIL

MODEL	A	B	C
50S	341	160	194
60S	401	220	254
70S	461	280	314

NOTES) Shaft dia. runout Max. 0.03mm
Rabbet dia. eccentricity Max. 0.06mm
Mounting face runout Max. 0.08mm
Rated loads Radial 8820N(900kgf)

Fig. 3.3(w) Models 50S, 60S, and 70S

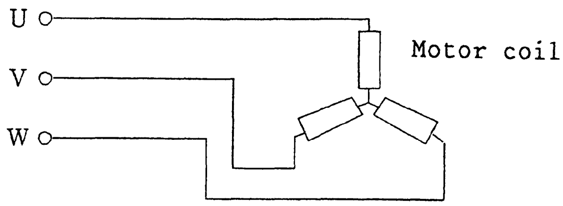
3.4 Connecting Power Lines

(a) Model 5-0S and models 4-0S and 3-0S of lead type

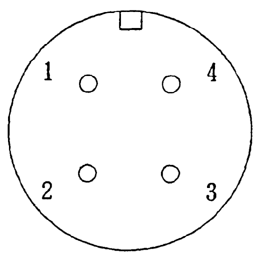
Color of leads

U: Red
V: White
W: Black

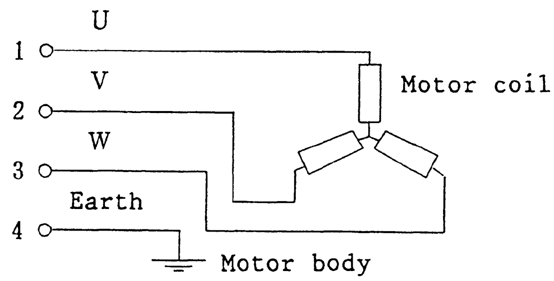
Or label indication: U, V, and W
Be sure to connect the protective circuit(ground) with the ground tap specified in the outline drawing.



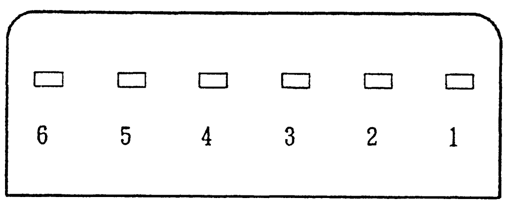
(b) Models 4-0S and 3-0S of connector type



RM-12BRB-4P
(manufactured by Hirose Electric Co., Ltd.)



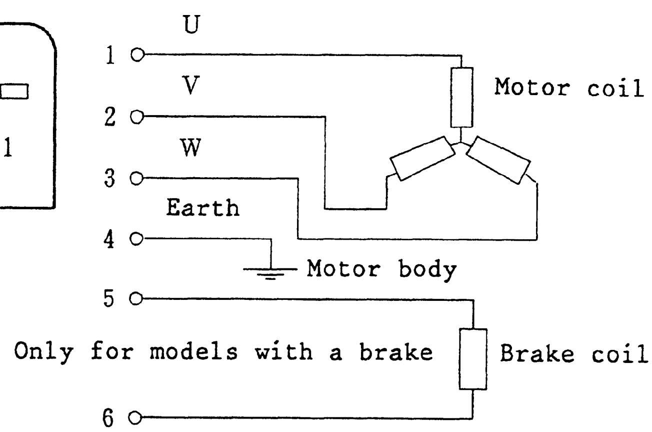
(c) Models 2-0SP, 1-0SP, 1-0SP/3000, and 0-0SP



SP series connector

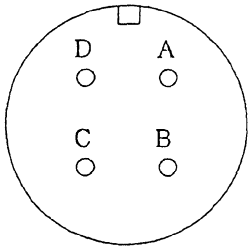
Applicable cable plug manufactured by Japan AMP

176346-2

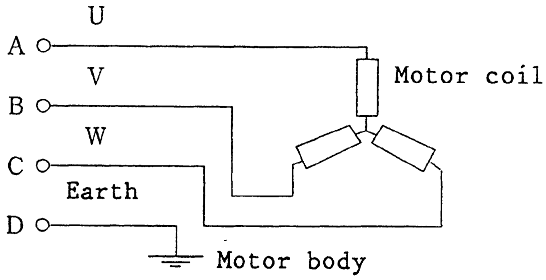


The surge absorber for the brake is not incorporated in the motor. Install it in the power magnetics cabinet.

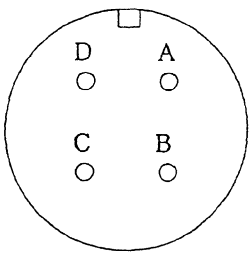
(d) Models 0S, 5S, and 5S/3000



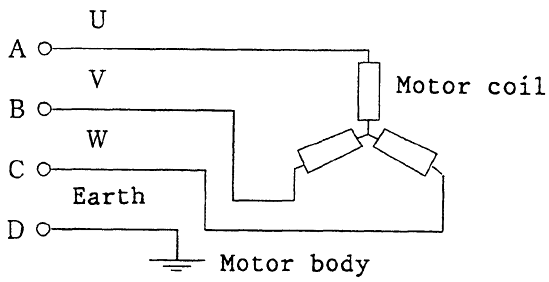
MS3102A18-10P



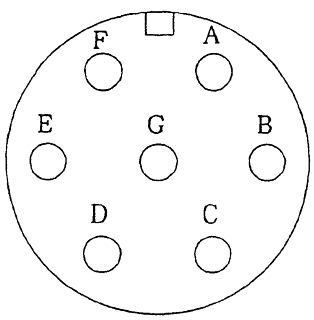
(e) Models 10S, 10S/3000, 20S, 20S/1500, and 30S



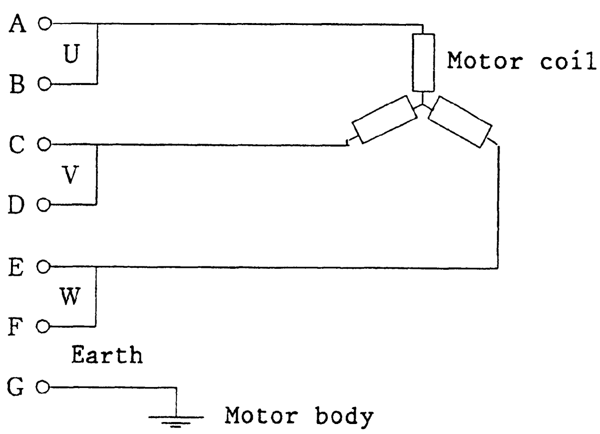
MS3102A22-22P



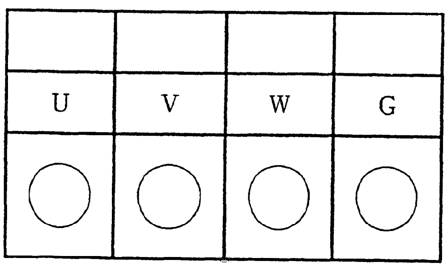
(f) Models 20S/3000, 30/2000, 30S/3000, 40 and 40S/2000



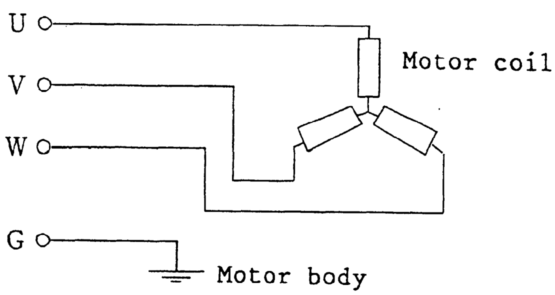
MS3102A24-10P



(g) Models 50S, 60S, and 70S



Terminal block
Thread dimension: M8



4. OLD MOTORS

4.1 Types and Specifications

Motors 2-0S, 1-0S, and 1-0S/3000 produce the same output as motors 2-0SP, 1-0SP, and 1-0SP/3000, respectively.
These motors are supplied only as replacement parts. Orders for these motors may not be accepted if they are going to be used in new machines. Please use SP models in your newly designed machines.
Models 2-0S, 1-0S, and 1-0S/3000 are further divided into the following types, each of which should be designated on the order sheet as listed below.

Models 2-0SP, 1-0SP, and 1-0SP/3000

A06B-0□□□-B□□□

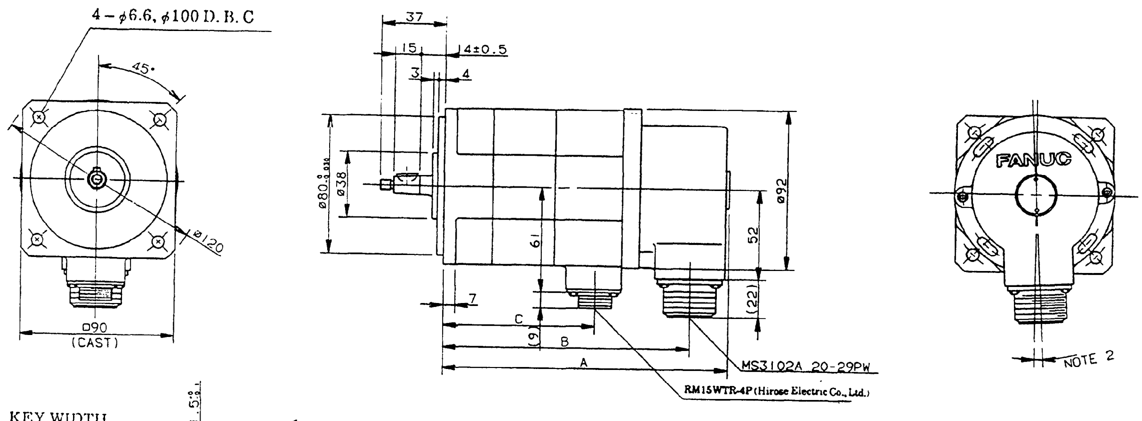
- 310 Model 2-0S
- 312 Model 1-0S
- 309 Model 1-0S/3000

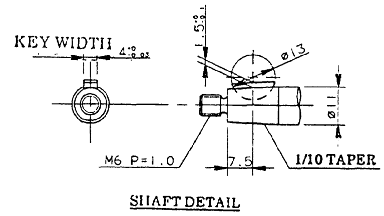
- 1 With the 2000P pulse coder (Except the high-resolution pulse coder)
- 2 With the 2500P pulse coder (Except the high-resolution pulse coder)
- 3 With the 3000P absolute pulse coder (Except the high-resolution pulse coder)

- 0 With the incremental pulse coder
- 3 With the absolute pulse coder
- 61~68 With the high-resolution pulse coder (See the attached table for the number of pulses)
- 69 With the serial pulse coder A
- 71 With the serial pulse coder C

- 0 Taper shaft (standard)
- 1 Taper shaft with the brake (20 kg•cm)
- 5 Straight shaft
- 6 Straight shaft with the brake (20 kg•cm)

4.2 Outline Drawings



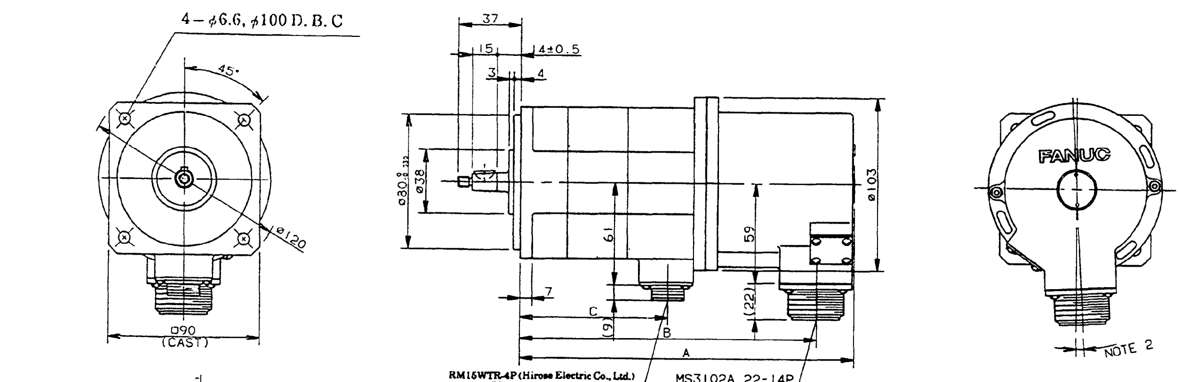


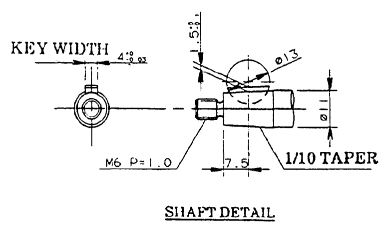
NOTE 1) Shaft dia.runout Max. 0.02mm
Rabbet dia. eccentricity Max. 0.04mm
Mounting face runout Max. 0.06mm
Rated loads Radial 245N(25kgf)

NOTE 2) THE POSITION OF SIGNAL CONNECTOR MAY DEVIATE WITHIN ±5°.

MOTOR	A	B	C
MODEL 2-0	164	142	88
MODEL 1-0	200	178	124

Fig. 4.2(a) Model 2-0S, 1-0S, 1-0S/3000



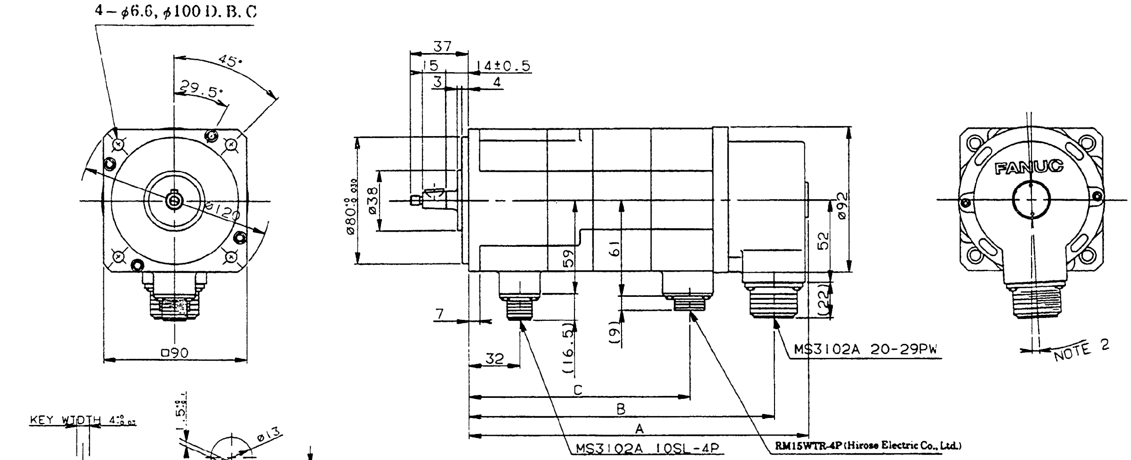


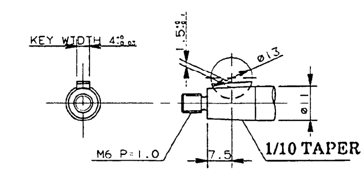
NOTE 1) Shaft dia runout Max. 0.02mm
Rabbet dia. eccentricity Max. 0.04mm
Mounting face runout Max. 0.06mm
Rated loads Radial 245N(25kgf)

NOTE 2) THE POSITION OF SIGNAL CONNECTOR MAY DEVIATE WITHIN ±5°.

MOTOR	A	B	C
MODEL 2-0	191	169	88
MODEL 1-0	227	205	124

Fig. 4.2(b) Models 2-0S, 1-0S, 1-0S/3000
(with the absolute pulse coder or high-resolution pulse coder)





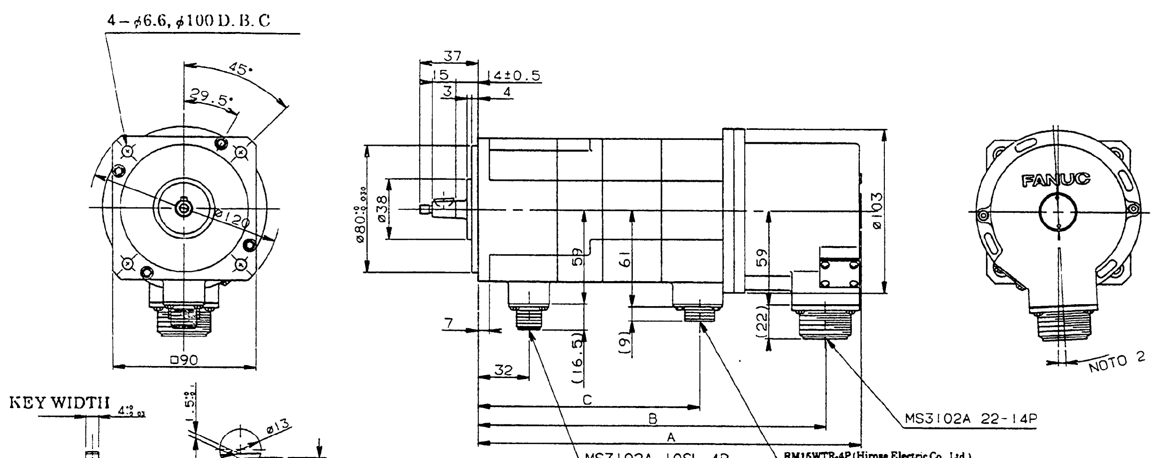
SHAFT DETAIL

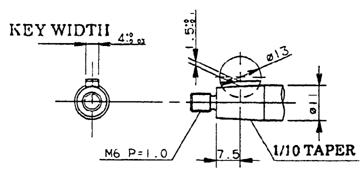
NOTE 1) Shaft dia runout — Max. 0.02mm
Rabbet dia. eccentricity — Max. 0.04mm
Mounting face runout — Max. 0.06mm
Rated loads — Radial 245N(25kgf)

NOTE 2) THE POSITION OF SIGNAL CONNECTOR MAY DEVIATE WITHIN ±5°.

MOTOR	A	B	C
MODEL 2-0	215	193	139
MODEL 1-0	251	229	175

Fig. 4.2(c) Models 2-0S, 1-0S, and 1-0S/3000 (with the brake)





SHAFT DETAIL

MOTOR	A	B	C
MODEL 2-0	242	220	139
MODEL 1-0	278	256	175

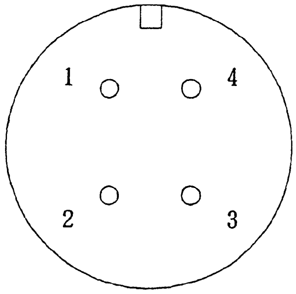
NOTE 1) Shaft dia. runout — Max. 0.02mm
Rabbet dia. eccentricity — Max. 0.04mm
Mounting face runout — Max. 0.06mm
Rated loads — Radial 245N(25kgf)

NOTE 2) THE POSITION OF SIGNAL CONNECTOR MAY DEVIATE WITHIN ±5°.

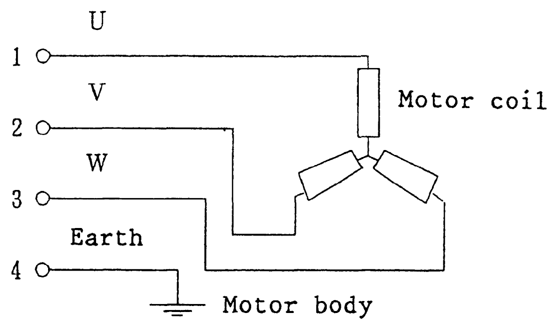
Fig. 4.2(d) Models 2-0S, 1-0S, 1-0S/3000 (with the brake and the absolute pulse coder or high-resolution pulse coder)

4.3 Connection of Power Line

(a) Models 2-0S, 1-0S, and 1-0S/3000



RM15WTR-4P
Hirose Electric made



III. FANUC AC SERVO MOTOR L series

1. GENERAL

The FANUC AC Servo Motor L series is optimum for high-speed positioning, and has the following features.

(1) Excellent acceleration performance
The unique rotor form and high-performance magnet provides high torque with minimum inertia, realizing excellent acceleration performance.

(2) Smooth rotation
The unique magnetic pole form designed to minimize torque ripple enables very smooth rotation by strict current control and precise pulse coder feedback.

(3) High reliability
The totally enclosed brushless structure with no wearing parts permits inspection/maintenance free operation.

(4) Built-in high precision detector
The optical encoder (pulse coder) with low indexing error is built in, permitting high precision positioning. The pulse coder of 2,000 to 30,000 pulse permits the indexing of 1,000 to 120,000 divisions per motor rotation.
Serial pulse coder A, which features super-high resolution, enables indexing with a resolution of up to 1000000 increments.
When combined with the flexible feed gear function, serial pulse coder A enables feeding in units of 0.1 μm or 0.01 μm for almost all feed screw pitches.

The L series is available in two types: the models 0L, 5L and 6L that are compatible in mounting dimensions with the models 0 and 5 of S series, and the models 7L and 10L that are compatible in mounting dimensions with the models 10 to 40 of S series. These models are compatible in mounting dimensions with the conventional FANUC DC motor L series. (The motor length is different.)

2. TYPES OF MOTORS AND DESIGNATION

The types and specification of L series servo motors are described as follows.

(1) Models 0L, 5L, and 6L

A06B-0□□□-B0□□□

- 561 Model 0L
- 562 Model 5L
- 564 Model 6L

- 1 With 2000P pulse coder (except high-resolution pulse coder)
- 2 With 2500P pulse coder (except high-resolution pulse coder)
- 3 With 3000P pulse coder (except high-resolution pulse coder)

- 0 With incremental pulse coder
- 3 With absolute pulse coder
- 6 With high-resolution pulse coder (For the number of pulses, see an attached table.)
- 69 With serial pulse coder A
- 71 With serial pulse coder C

- 0 Taper shaft (standard)
- 1 With brake (60 kgf.cm)

(2) Models 7L and 10L

A06B-0□□□-B0 □□

- 571 Model 7L
- 572 Model 10L

- 1 With 2000P pulse coder (except high-resolution pulse coder)
- 2 With 2500P pulse coder (except high-resolution pulse coder)
- 3 With 3000P pulse coder (except high-resolution pulse coder)

- 0 With incremental pulse coder
- 3 With absolute pulse coder
- 6 With high-resolution pulse coder (For the number of pulses, see an attached table.)
- 69 With serial pulse coder A
- 71 With serial pulse coder C

- 0 Straight shaft (standard)
- 2 With brake (180 kgf.cm)
- 3 With brake (400 kgf.cm)

(3) Motors with high resolution pulse coder

A06B-0□□□-B□6□

	Pulse number	Max. speed	
1	10000P	(3000 min^{-1})	
2	12500P	(2400 min^{-1})	
3	15000P	(2000 min^{-1})	
4	20000P	(1500 min^{-1})	
5	25000P	(1200 min^{-1})	
6	20000P	(3000 min^{-1})	High speed type
7	25000P	(2400 min^{-1})	High speed type
8	30000P	(2000 min^{-1})	High speed type

The high speed type needs a signal conversion circuit for the connection with NC. The maximum rotation speed is the restriction of the pulse coder. In addition, there are restrictions in the maximum rotation speed of the motor and the feed rate of NC.
To use a serial pulse coder, the NC must be equipped with a serial pulse coder interface.

3. SPECIFICATIONS AND CHARACTERISTICS

3.1 Types of Motors and Specifications

Item	Unit	0L	5L	6L	7L	10L
Output	kW	0.8	1.5	2.2	3.1	6.2
	HP	1.0	1.6	2.5	4.1	8.2
Stall torque	Nm	2.9	5.9	8.8	24.5	49.0
	kgcm	30	60	90	250	500
Maximum speed	rpm	3000	3000	3000	3000	2000
Maximum theoretical torque	Nm	12	24	47	74	147
	kgcm	120	240	480	750	1500
Rotor inertia	kgm^2	0.00025	0.00049	0.00098	0.0054	0.0098
	$kgcmS^2$	0.0025	0.0050	0.0100	0.055	0.100
Maximum theoretical acceleration	rad/S^2	48000	48000	48000	13600	15000
Weight	kg	9	12	18	28	45

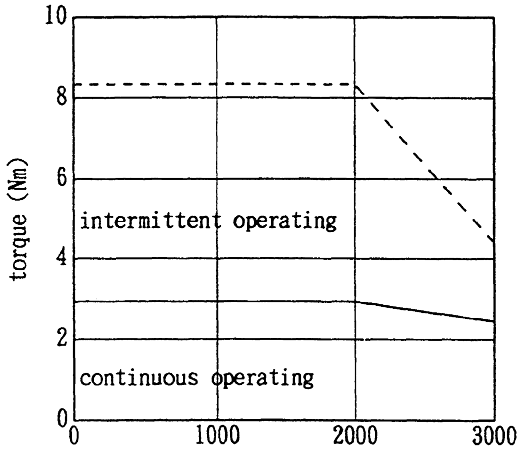
3.2 Characteristic Curve and Data Sheet

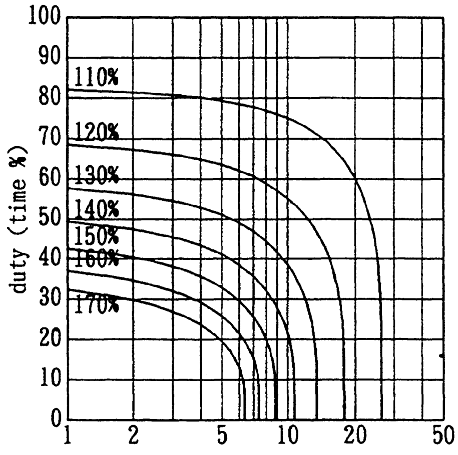
1) Torque-speed characteristics
   - The intermittent operation zone is determined by the input voltage applied to the drive amplifier. The curve shown below is the value against the rated input voltage.
   - The maximum torque at acceleration/deceleration is restricted by the current limit value of the drive amplifier.
2) Overload duty curve
   - The curve shown below is obtained by the thermal limit of the motor. The overload duty is restricted by the drive amplifier or the characteristics of the protecter on the built-in detector.
3) Data sheet
   - Parameter of the motor for the data sheet is the value at 20°C and its error is ±10%
   - The maximum torque at acceleration/deceleration under the actual operating condition is obtained by the integration of the torque constant of the motor and the current limit value of the amplifier. Note that the current limit value of the amplifier is indicated as a maximum peak value.

     Ex) Model 10L
     - Torque constant of motor = 10kgf·cm/Arms
     - Current limit value of amplifier = 130 Apeak
     - Max. torque = $\underbrace{130 \times 0.707}_{\text{(Convert into rated value)}} \times 10$ = 919 kgf·cm

     The above value may deviate due to fluctuation of power source, motor parameter, or limit of amplifier.

Model 0L (A06B-0561-B□□□)



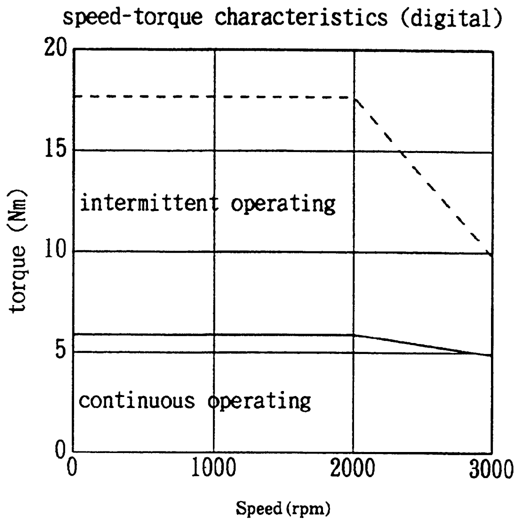


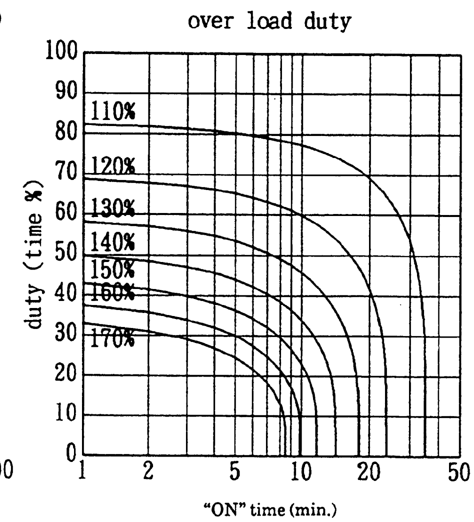
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	3000			min^{-1}
Rated torque at stall(*)	Ts	2.9 30			Nm kgfcm
Rotor inertia	Jm	0.00025 0.0025			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	5.8			A(rms)
Torque constant(*)	Kt	0.51 5.2			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	18 0.17			$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.810			Ω
Mechanical time constant(*)	tm	0.002			s
Thermal time constant	tt	15			min
Static friction	Tf	0.3 3			Nm kgfcm
Maximum allowable current	Im	55			A(peak)
Maximum torque	Tm	11.8 120			Nm kgfcm
Maximum acceleration		48000			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		9			kg

Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary 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 5L (A06B-0562-B□□□)



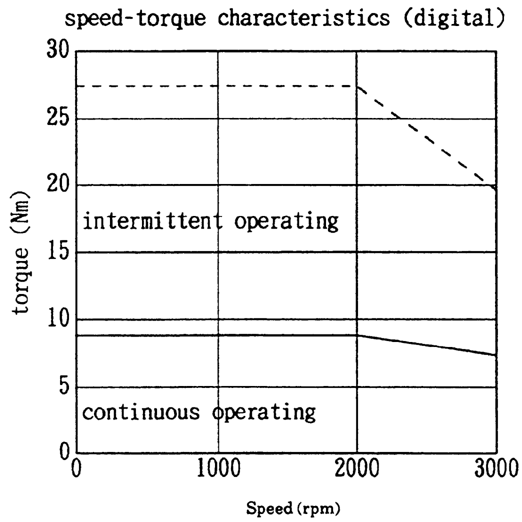


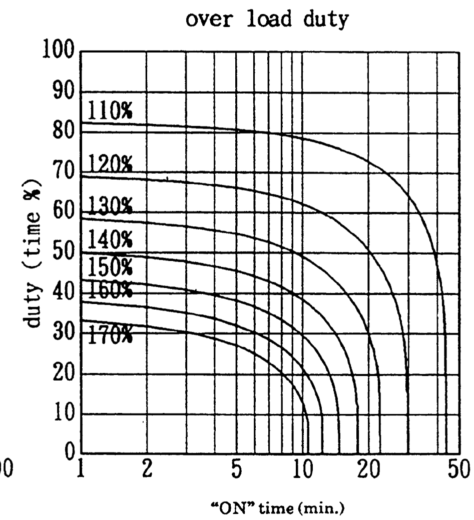
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	3000			min^{-1}
Rated torque at stall(*)	Ts	5.9 60			Nm kgfcm
Rotor inertia	Jm	0.00049 0.0050			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	11.4			A(rms)
Torque constant(*)	Kt	0.52 5.3			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	18 0.17			$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.275			Ω
Mechanical time constant(*)	tm	0.001			s
Thermal time constant	tt	20			min
Static friction	Tf	0.5 5			Nm kgfcm
Maximum allowable current	Im	80			A(peak)
Maximum torque	Tm	23.5 240			Nm kgfcm
Maximum acceleration		48000			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		12			kg

Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary 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 6L (A06B-0564-B□□□)





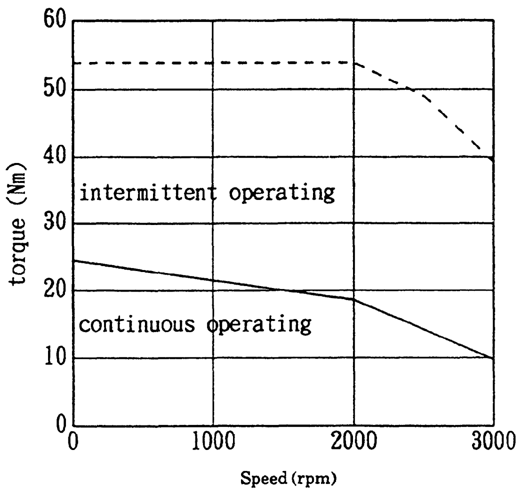
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	3000			min^{-1}
Rated torque at stall(*)	Ts	8.8 90			Nm kgfcm
Rotor inertia	Jm	0.00098 0.010			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	16.9			A(rms)
Torque constant(*)	Kt	0.52 5.3			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	18 0.17			$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.110			Ω
Mechanical time constant(*)	tm	0.001			s
Thermal time constant	tt	25			min
Static friction	Tf	0.9 9			Nm kgfcm
Maximum allowable current	Im	140			A(peak)
Maximum torque	Tm	47.0 480			Nm kgfcm
Maximum acceleration		48000			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		18			kg

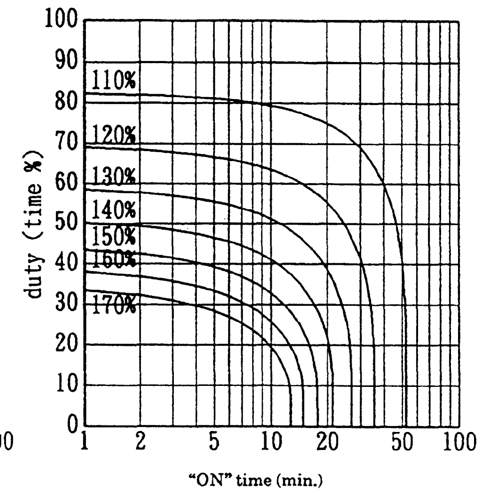
Note) The values are the standard values at 20°C and the tolerance is ±10%. The speed-torque characteristics vary depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
These values may be changed without prior notice.

Model 7L (A06B-0571-B□□□)

speed-torque characteristics (digital)



over load duty



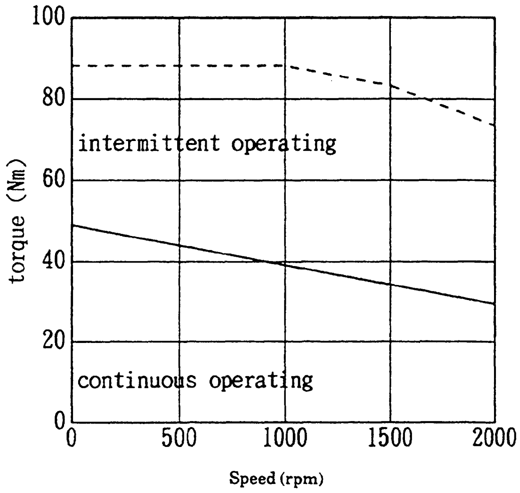
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	3000			min^{-1}
Rated torque at stall(*)	Ts	24.5 250			Nm kgfcm
Rotor inertia	Jm	0.0054 0.055			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	37			A(rms)
Torque constant(*)	Kt	0.66 6.8			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	23 0.22			$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.049			Ω
Mechanical time constant(*)	tm	0.001			s
Thermal time constant	tt	30			min
Static friction	Tf	1.2 12			Nm kgfcm
Maximum allowable current	Im	200			A(peak)
Maximum torque	Tm	74 750			Nm kgfcm
Maximum acceleration		13600			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		28			kg

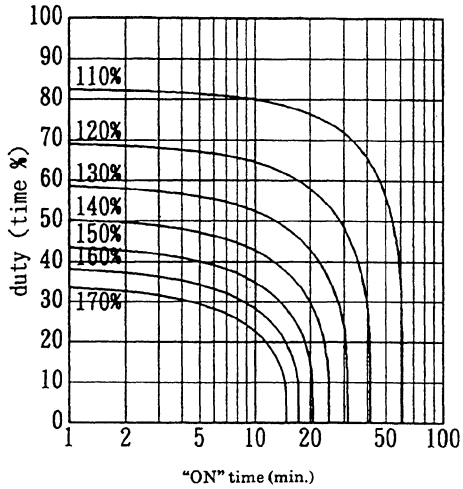
Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
These values may be changed without prior notice.

Model 10L (A06B-0572-B□□□)

speed-torque characteristics (digital)



over load duty

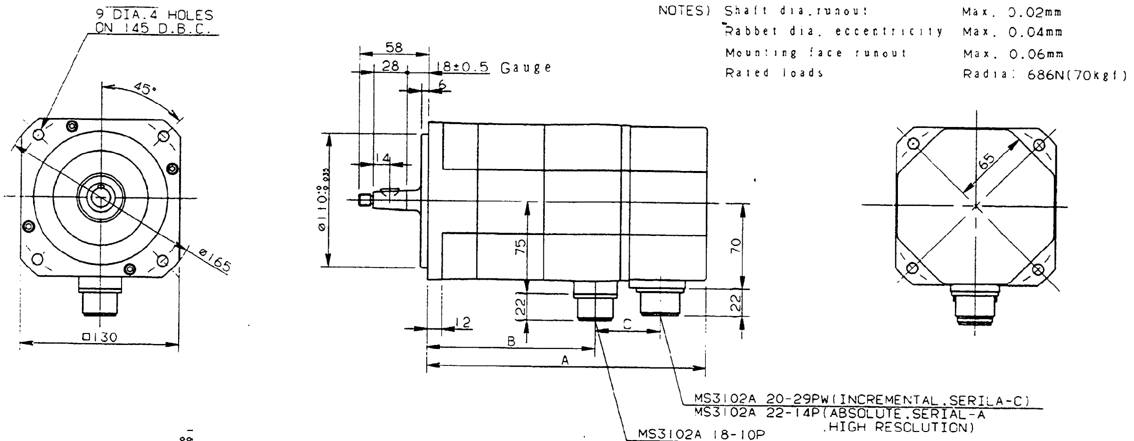


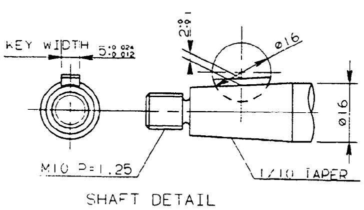
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	2000			min^{-1}
Rated torque at stall(*)	Ts	49 500			Nm kgfcm
Rotor inertia	Jm	0.0098 0.10			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	51			A(rms)
Torque constant(*)	Kt	0.96 9.8			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	33 0.32			$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.038			Ω
Mechanical time constant(*)	tm	0.001			s
Thermal time constant	tt	35			min
Static friction	Tf	1.8 18			Nm kgfcm
Maximum allowable current	Im	280			A(peak)
Maximum torque	Tm	147 1500			Nm kgfcm
Maximum acceleration		15000			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		45			kg

Note) The values are the standard values at 20°C and the tolerance is ±10%. The speed-torque characteristics vary 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.

3.3 External Dimensions



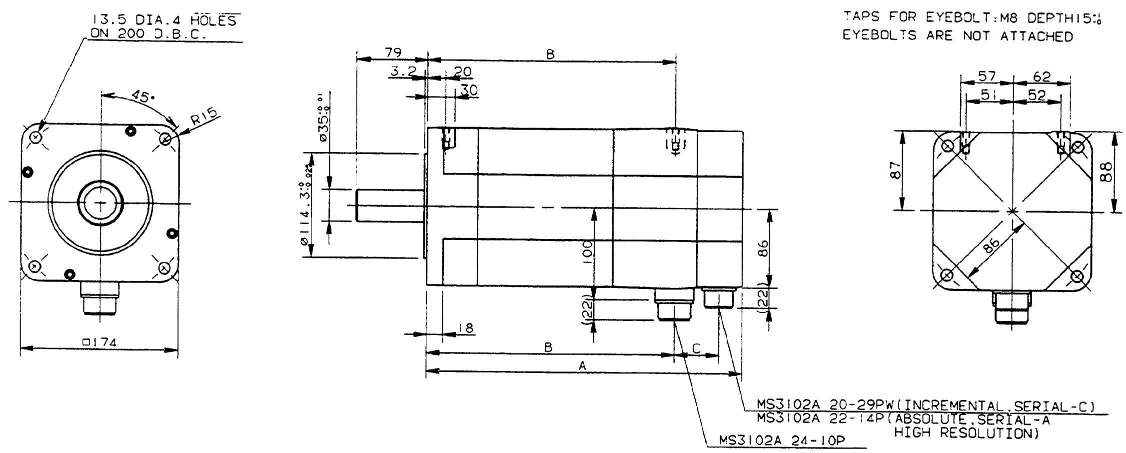


	INCREMENTAL PULSE CODER SERIAL PULSE CCDER C			ABSOLUIE PULSE CODER HIGH RES. PULSE CODER SERIAL PULSE CODER A		
MOTOR	A	B	C	A	B	C
MODEL 0L	211	120	52	226	120	54
MODEL 5L	248	157		263	157	
MODEL 6L	322	231		337	231	

(NOTE)

MOTOR	A	B	C	A	B	C
MODEL 6L(0563)	285	194	52	300	194	54

Fig. 3.3 (a) Outline drawing of model 0L, 5L, or 6L



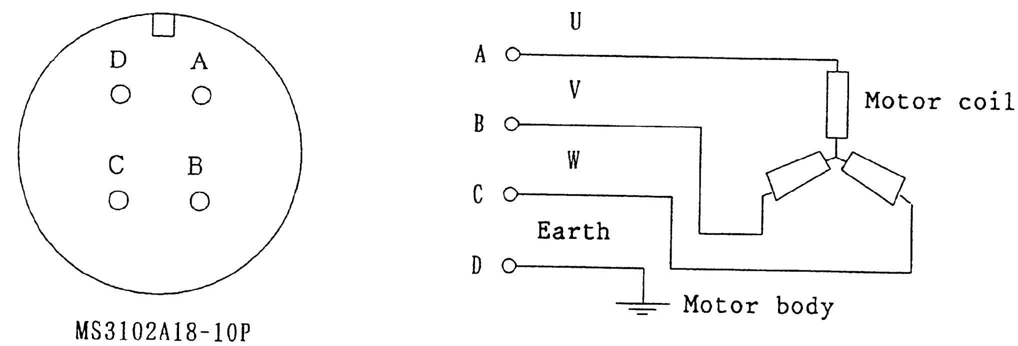
NOTES) Shaft dia. runout Max. 0.05mm
Rabbet dia. eccentricity Max. 0.07mm
Mounting face runout Max. 0.10mm
Rated loads Radial 4410N(450kgf)

	INCREMENTAL PULSE CODER SERIAL PULSE CODER C			ABSOLUTE PULSE CODER HIGH RES. PULSE CODER SERIAL PULSE CODER A		
MOTOR	A	B	C	A	B	C
MODEL 7L	297	222	49	312	222	54
MODEL 10L	398	323		413	323	

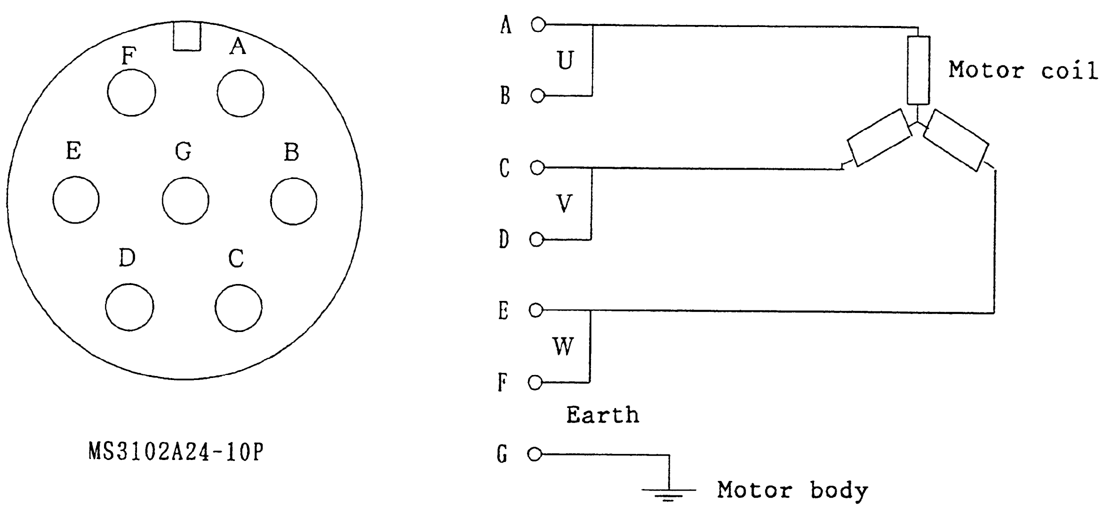
Fig. 3.3 (b) Outline drawing of model 7L or 10L

3.4 Connection of Power Line

a) Models 0L, 5L and 6L



b) Models 7L and 10L



IV. FANUC AC SERVO MOTOR T series

1. GENERAL

The FANUC AC Servo Motor T series has been developed to improve the efficiency of linear movement such as the axis feeding of machine tools.
The T-series motors have a hollow output shaft so the ball screw can go through the motor. The output shaft can hold and rotate the nut of the ball screw directly. This structure converts rotation of the motor to a linear movement of the screw.
The FANUC AC Servo Motor T series has the following features:

(1) Simple structure
No coupling or support mechanism is required between the output shaft of the motor and the ball screw. A slide mechanism can be configured simply by fixing the ball screw in the motor and mounting the motor to the table.

(2) Compactness
In addition to the simple structure, no space is required for the ball screw to pass through the table.

(3) Efficient configuration
Because the ball screw transmits the thrust by moving linearly, the line of thrust can be easily aligned with the table's center of gravity. This structure is also effective in making the system rigid, because no coupling or screw support mechanism is required. Moreover, the ball screw does not rotate faster then the speed limit.

(4) Low inertia
A larger ball screw can be driven thanks to the efficient design of the rotor, and the inertia of the motor is not substantially more that of the standard series motors.

(5) High axial rigidity
To enable the motor to withstand the full thrust of the machine, a highly rigid bearing has been employed. Furthermore, the other motor components including the mounting flange have been designed to improve the rigidity.

(6) Brake for holding
To prevent the vertical axis from falling, some of the T-series motors can be equipped with a holding brake. This brake does not cause a leakage flux, and therefore the ball screw is not magnetized.

(7) Absolute value detector
A high-speed, high-resolution absolute value detector is used. In all T-series motors, making them suitable to a wide variety of applications. applications.

(8) Low heat generation
By reducing the transfer of heat to the machine and ball screw, low heat generation has been enabled without sacrificing low inertia.

(9) High reliability
By adopting the fully closed brushless structure that contains no parts subject to wear, the motor can be operated under extreme conditions without inspection or maintenance.

The T series motors have been designed to operate at a power supply voltage of 200 to 230 V without a transformer.

Note) 100 VAC needs to be supplied to a motor drive unit.

2. TYPES OF MOTORS AND DESIGNATION

The T-series FANUC AC servo motors are available in the following types, each of which can be designated as follows.

Models 0T, 5T, and 10T

```
        A06B-038□-B□□□
┌──────────────────┘    │ │ └─ 2  High-speed high-resolution absolute pulse coder
├─1 Model 0T/3000       │ ├─── 0  Standard
├─2 Model 5T/2000       │ └─── 1  Compressed air cooling
├─3 Model 5T/3000       │
├─4 Model 10T/2000      │
└─5 Model 10T/3000      ├───── 0  For small-diameter screws
                        ├───── 1  For large-diameter screws
                        ├───── 5  With the brake for small-diameter screws
                        └───── 6  With the brake for large-diameter screws
```

3. SPECIFICATIONS AND CHARACTERISTICS

3.1 Types of Motors and Specifications

Item	Unit	0T/3000	5T/2000	5T/3000	10T/2000	10T/3000
Output	kW	0.9	1.1	1.2	1.8	1.8
	HP	1.2	1.5	1.7	2.4	2.4
Torque at stall	Nm	3.4	6.9	6.9	11.8	11.8
	kgfcm	35	70	70	120	120
Maximum speed	min^{-1}	3000	2000	3000	2000	3000
Maximum theoretical torque	Nm	29	58	60	62	62
	kgfcm	300	590	610	630	630
Rotor inertia	kgm^2	0.0033 / 0.0044	0.0064 / 0.0078	0.0064 / 0.0078	0.0108 / 0.0137	0.0108 / 0.0137
	$kgfcms^2$	0.034 / 0.045	0.065 / 0.080	0.065 / 0.080	0.110 / 0.140	0.110 / 0.140
Maximum theoretical acceleration	rad/s^2	8800 / 6600	9000 / 7300	9300 / 7600	5700 / 4500	5700 / 4500
Weight	kg	17 / 19	22 / 24	22 / 24	28 / 31	28 / 31

The above values are measured at a temperature of 20°C.

*1 The maximum torque is a theoretical value for the motor. The actual maximum torque is affected by the current limit value of the driving amplifier.

*2 Two values are provided for both the rotor inertia and the mechanical time constant: the upper value applies to the motor for small-diameter screws, and the lower value applies to the motor for large-diameter screws.

*3 The values in the field of the applicable amplifier indicate the current limit value for the corresponding amplifier.

*4 The values in the field of the weight apply to motors for small-diameter screws with no brake. When a brake is provided, 4 kg is added to each of the values.

3.2 Characteristic Curve and Data Sheet

(1) Torque-speed characteristic

The torque-speed characteristic in the intermittent operating zone is determined according to the input voltage to the drive unit. This curve is typical of the rated input voltage.

The maximum torque during acceleration/deceleration is also limited by the current limit value of the driver amplifier.

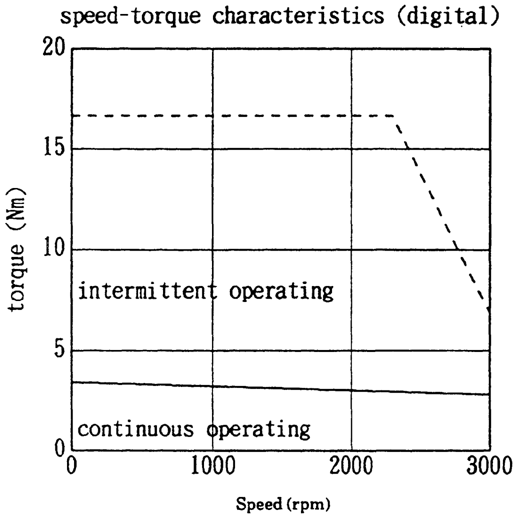
(2) Overload duty characteristic curve

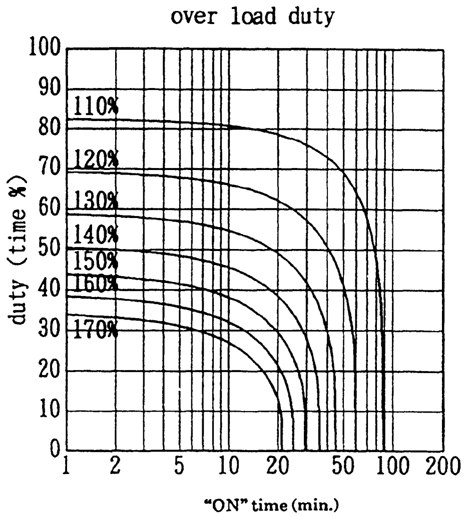
This curve is determined according to the temperature limit of the motor. This characteristic may be limited also by the characteristics of the drive unit and a protector unit such as a built-in detector.

(3) Data sheet

The motor parameters in this data sheet represent those measured at 20°C. Their errors are within ±10%.

Model 0T/3000 (A06B-0381-B□□□)



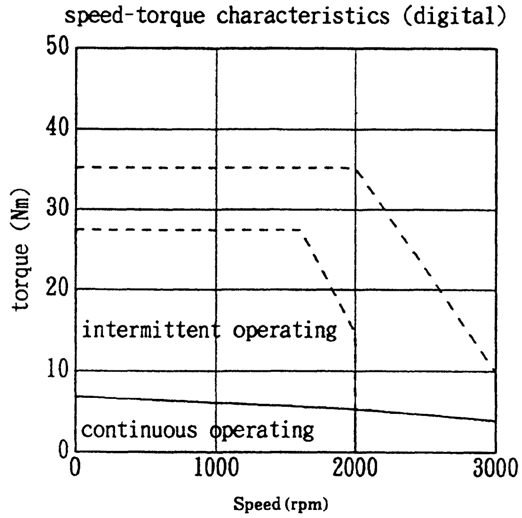


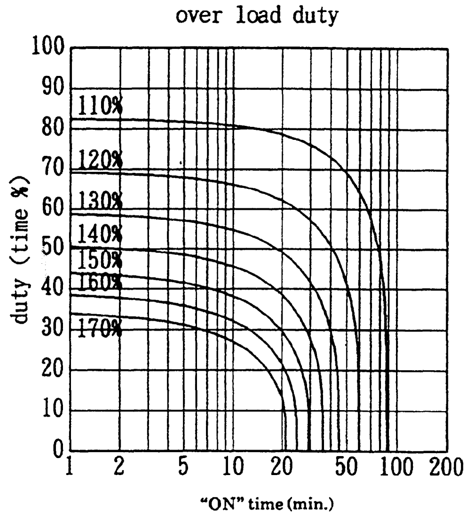
Data sheet

Parameter	Symbol	Value		Unit
Maximum speed	Nmax	2000		min^{-1}
Rated torque at stall(*)	Ts	3.4 35		Nm kgfcm
Rotor inertia	Jm	0.0033(0.0044) 0.034 (0.045)		kgm^2 $kgfcm^2$
Continuous RMS current at stall	Is	4.9		A(rms)
Torque constant(*)	Kt	0.70 7.1		Nm/A(rms) kgfcm/A(rms)
Back EMF constant(*) (RMS voltage per phase)(*)	Ke Kv	25.4 0.24		$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.83		Ω
Mechanical time constant(*)	tm	0.017 (0.022)		s
Thermal time constant	tt	50		min
Static friction	Tf	0.25(0.3) 2.5(3.0)		Nm kgfcm
Maximum allowed current	Im	62		A(peak)
Maximum theoretical torque	Tm	29.4 300		Nm kgfcm
Maximum theoretical acceleration		8800 (6600)		rad/s^2
Maximum winding temperature rise	θ m	125		°C
Weight		17 (19)		kg

* The values represent those measured at 20°C with a tolerance of ±10%.
The torque-speed characteristic varies with digital servo software, parameters, and input voltage. (The chart represents typical values.)
The values listed above are subject to change without prior notice.
The values enclosed in parentheses apply to the motor for large screws.

Model 5T/2000 (A06B-0382-B□□□)
Model 5T/3000 (A06B-0383-B□□□)



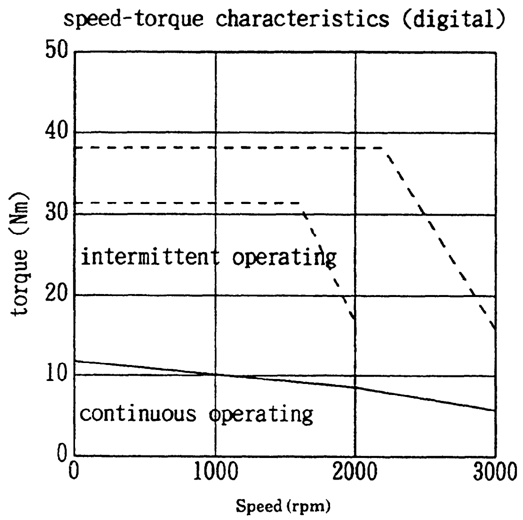


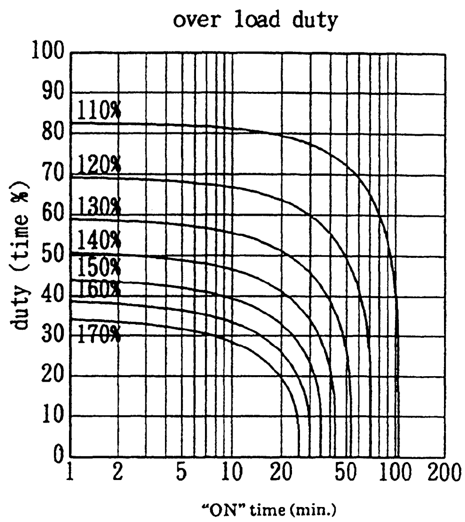
Data sheet

Parameter	Symbol	Value		Unit
Maximum speed	Nmax	2000	3000	min^{-1}
Rated torque at stall(*)	Ts	6.9 70	6.9 70	Nm kgfcm
Rotor inertia	Jm	0.0064(0.0078) 0.065 (0.080)	0.0064(0.0078) 0.065 (0.080)	kgm^2 $kgfcm^2$
Continuous RMS current at stall	Is	6.1	9.0	A(rms)
Torque constant(*)	Kt	1.12 11.4	0.76 7.8	Nm/A(rms) kgfcm/A(rms)
Back EMF constant(*) (RMS voltage per phase)(*)	Ke Kv	41 0.39	27 0.26	$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.700	0.280	Ω
Mechanical time constant(*)	tm	0.010 (0.013)	0.009 (0.011)	s
Thermal time constant	tt	50	50	min
Static friction	Tf	0.4(0.5) 4 (5)	0.4(0.5) 4 (5)	Nm kgfcm
Maximum allowed current	Im	77	116	A(peak)
Maximum theoretical torque	Tm	57.8 590	59.8 610	Nm kgfcm
Maximum theoretical acceleration		9000 (7300)	9300 (7600)	rad/s^2
Maximum winding temperature rise	θ m	125	125	°C
Weight		22 (24)	22 (24)	kg

* The values represent those measured at 20°C with a tolerance of ±10%.
The torque-speed characteristic varies with digital servo software, parameters, and input voltage. (The chart represents typical values.)
The values listed above are subject to change without prior notice.
The values enclosed in parentheses apply to the motor for large screws.

Model 10T/2000 (A06B-0384-B□□□)
Model 10T/3000 (A06B-0385-B□□□)





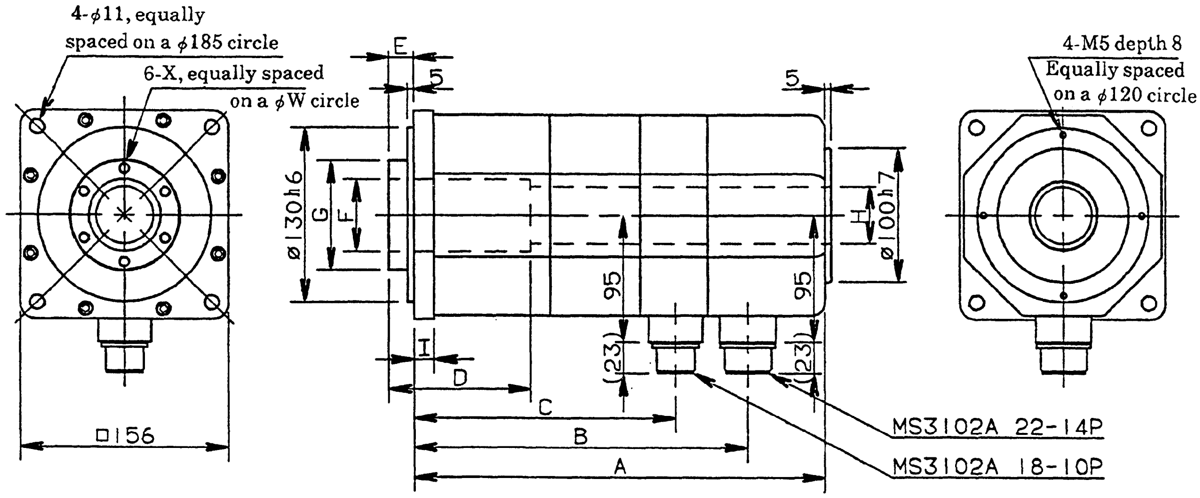
Data sheet

Parameter	Symbol	Value		Unit
Maximum speed	Nmax	2000	3000	min^{-1}
Rated torque at stall(*)	Ts	11.8 120	11.8 120	Nm kgfcm
Rotor inertia	Jm	0.0108(0.0137) 0.110 (0.140)	0.0108(0.0137) 0.110 (0.140)	kgm^2 $kgfcm^2$
Continuous RMS current at stall	Is	9.4	14.6	A(rms)
Torque constant(*)	Kt	1.24 12.7	0.80 8.2	Nm/A(rms) kgfcm/A(rms)
Back EMF constant(*) (RMS voltage per phase)(*)	Ke Kv	45 0.42	28 0.27	$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	0.350	0.140	Ω
Mechanical time constant(*)	tm	0.007 (0.009)	0.007 (0.009)	s
Thermal time constant	tt	60	60	min
Static friction	Tf	0.6(0.7) 6 (7)	0.6(0.7) 6 (7)	Nm kgfcm
Maximum allowed current	Im	74	120	A(peak)
Maximum theoretical torque	Tm	61.7 630	61.7 630	Nm kgfcm
Maximum theoretical acceleration		5700 (4500)	5700 (4500)	rad/s^2
Maximum winding temperature rise	θ m	125	125	°C
Weight		28 (31)	28 (31)	kg

* The values are those measured at 20°C with a tolerance of ±10%.
The torque-speed characteristic varies with digital servo software, parameters, and input voltage. (The chart represents typical values.)
The values listed above are subject to change without prior notice.
The values enclosed in parentheses apply to the motor for large screws.

3.3 Drawings

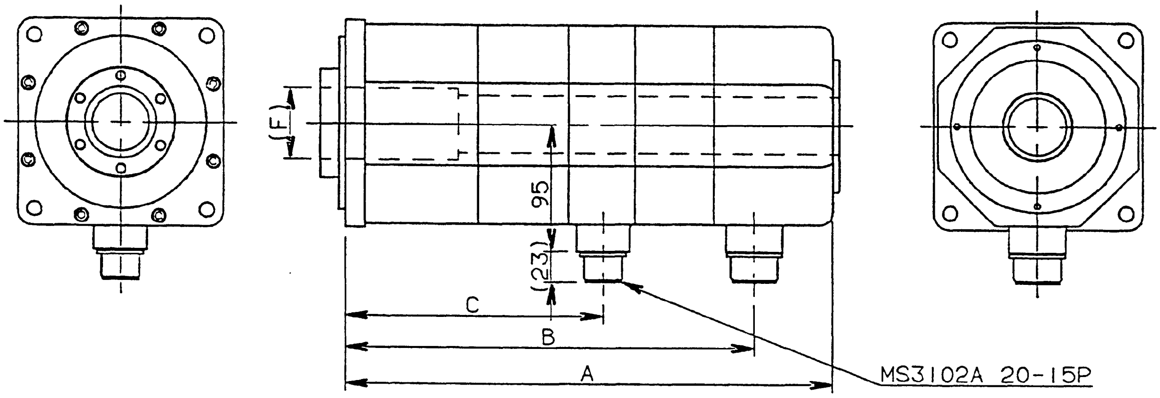
(1) Models 0T, 5T, and 10T



	A	B	C	D	E	F	G	H	I	X	W
Model 0T	262	164	110	66	13 ± 0.5	φ35H6	φ55	φ30	14	M5	φ46
	277	179	125	75	13 ± 0.5	φ42H6	φ66	φ30	15	M6	φ55
Model 5T	296	198	144	75	13 ± 0.5	φ42H6	φ66	φ30	15	M6	φ55
	306	208	154	106	29 ± 0.5	φ54H6	φ82	φ43	15	M8	φ70
Model 10T	333	235	181	106	29 ± 0.5	φ54H6	φ82	φ43	15	M8	φ70
	351	253	199	126	33 ± 0.5	φ62H6	φ96	φ43	15	M10	φ82

Note) Runout of shaft rotation: 0.01 mm or less
Runout of the shaft edge: 0.01 mm or less
Runout caused by eccentricity of the faucet joint: 0.01 mm or less
Runout of the clamp face: 0.01 mm or less

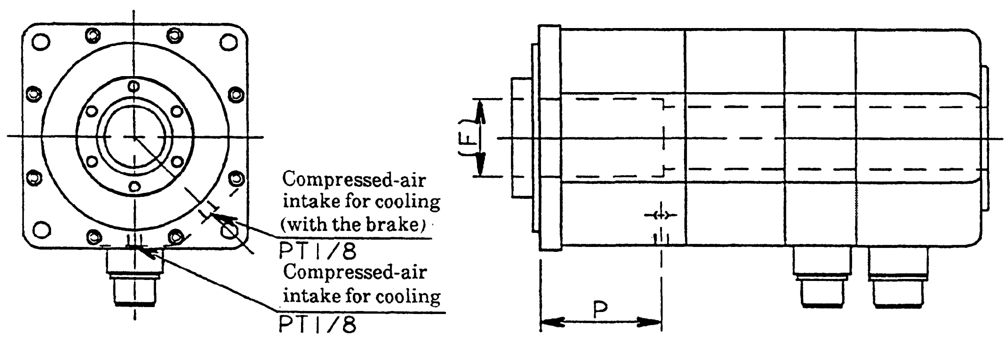
(2) Models 0T, 5T, and 10T with the brake



	A	B	C	F
Model 0T	322	224	110	(ϕ35)
	337	239	125	(ϕ42)
Model 5T	356	258	144	(ϕ42)
	366	268	154	(ϕ54)
Model 10T	393	295	181	(ϕ54)
	411	313	199	(ϕ62)

Note) Dimensions other than the above conform to the specifications of the motor with no brake.

(3) Models 0T, 5T, and 10T with the compressed-air cooling mechanism



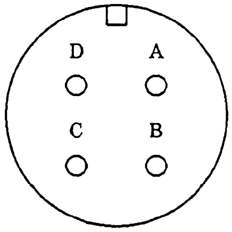
	P	F
Model 0T	40	(ϕ35)
	55	(ϕ42)
Model 5T	55	(ϕ42)
	65	(ϕ54)
Model 10T	65	(ϕ54)
	90	(ϕ62)

Note) Dimensions other than the above conform to the specifications of the motor with no air cooling mechanism.

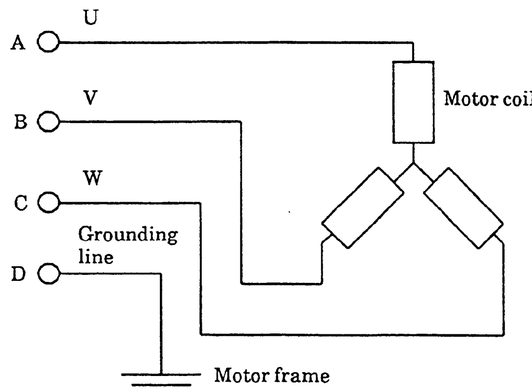
3.4 Connecting Power and Brake Lines

For motors with a built-in brake, the brake lines are connected through the same connector as the power lines.

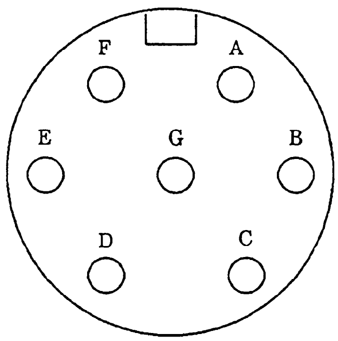
(a) Motor with no built-in brake



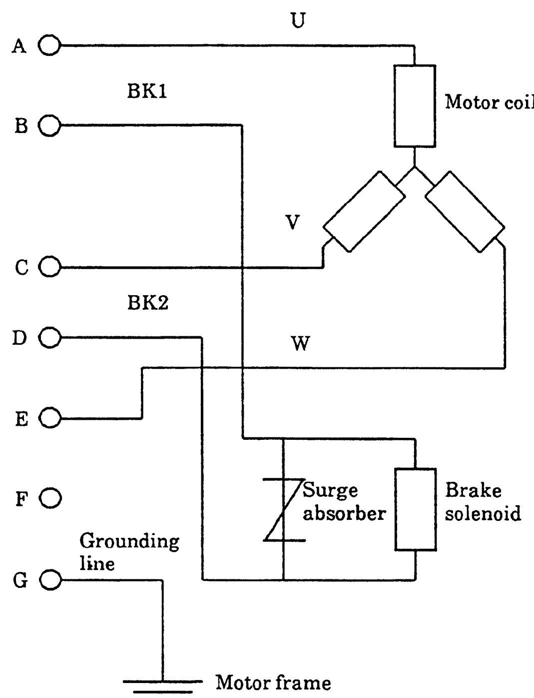
MS3102A 18-10P



(b) Motor with a built-in brake



MS3102A 20-15P

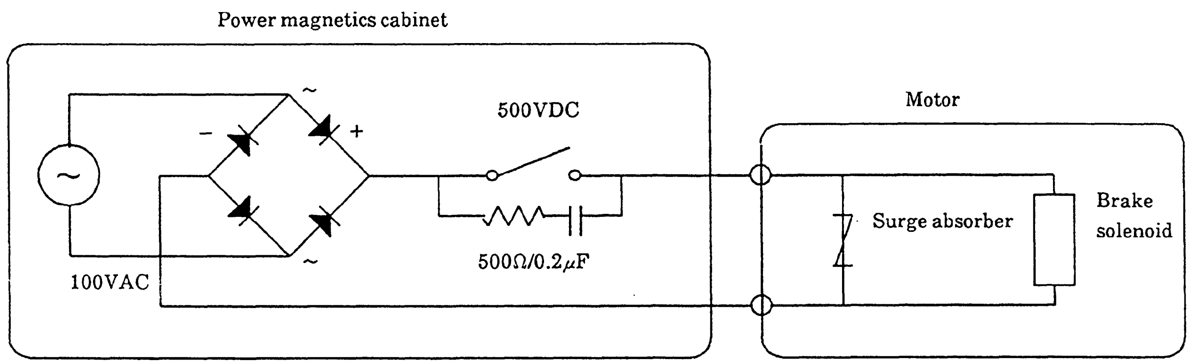


4. BUILT-IN BRAKE

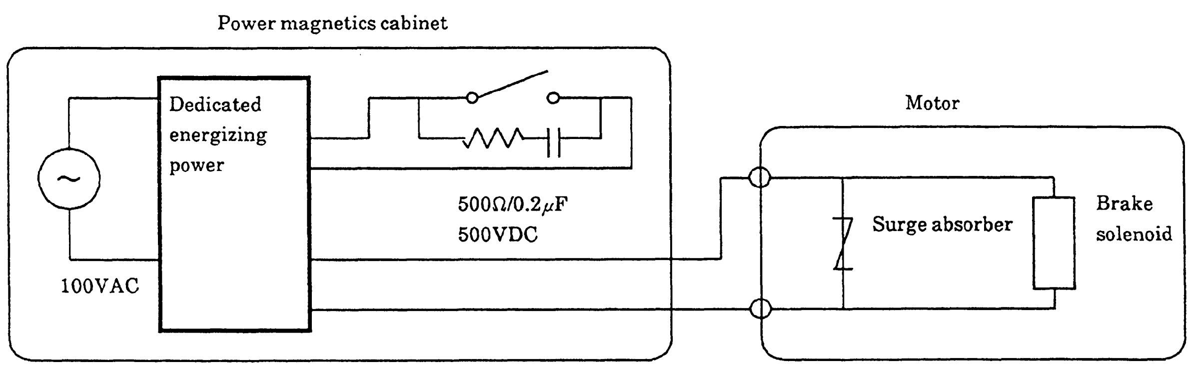
The holding brake in T Series AC servo motors has been specially designed to eliminate a harmful leakage flux that magnetizes a ball screw as they pass through the motor.
Motor model 10T with a built-in brake requires dedicated power to energize the brake solenoid.

4.1 Brake Connection Diagram

Models 0T and 5T



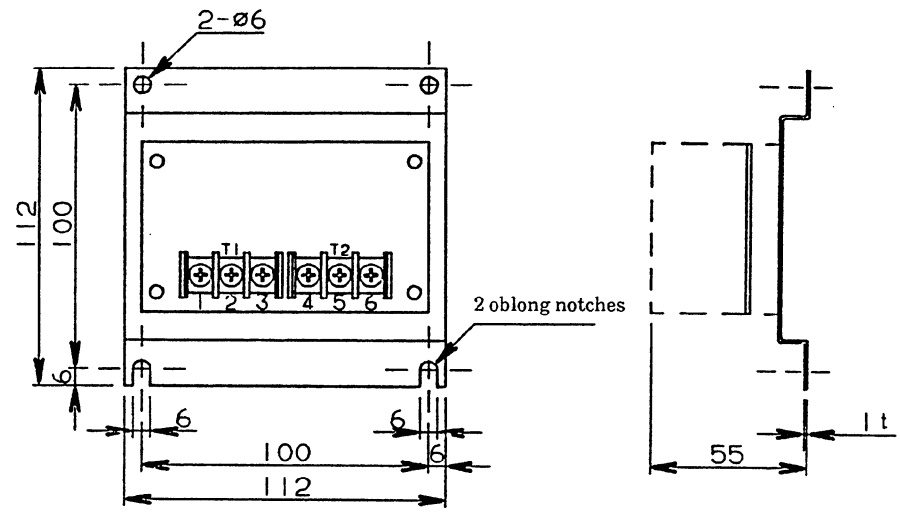
Models 10T



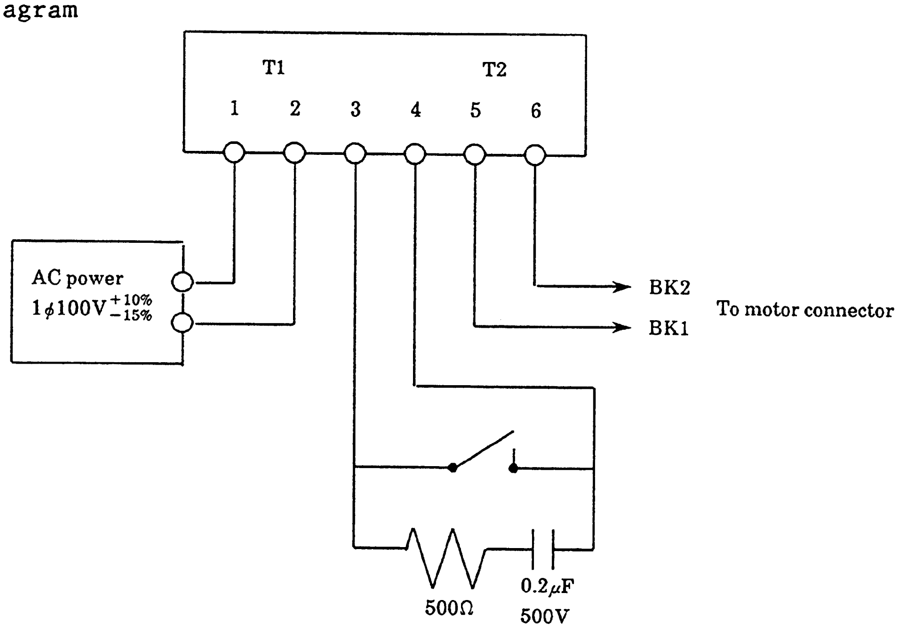
4.2 Dedicated Power for the Brake Solenoid

This power supply is dedicated to the brake incorporated in motor model 10T. Its specification drawing number is A16B-1700-0290.

Outline drawing



Connecting diagram



5. SPECIFICATIONS FOR AIR COOLING

The T Series AC servo motors are used in such a configuration that their output shaft is coupled directly to the nut of a ball screw. This configuration allows heat from the motor to conduct to the ball screw, possibly resulting in the expansion of the ball screw. In a semi-closed servo system, deformation of the ball screw affects directly the accuracy of feeding. To prevent this, heat transfer to the ball screw must be minimized. In addition to the low heat output design, the T Series motors are equipped with the following air-cooling mechanisms to reduce heat transfer to the ball screw.

5.1 Compressed-Air Cooling

The compressed-air cooling mechanism takes air from the compressed-air intake on the housing of the motor, guides it directly to the inside of the motor, and releases it from the gap between the rear housing and the output shaft. By this method, the heat generated in the motor is dissipated into the exhaust air and released from the rear of the motor, instead of being transferred to the ball screw.

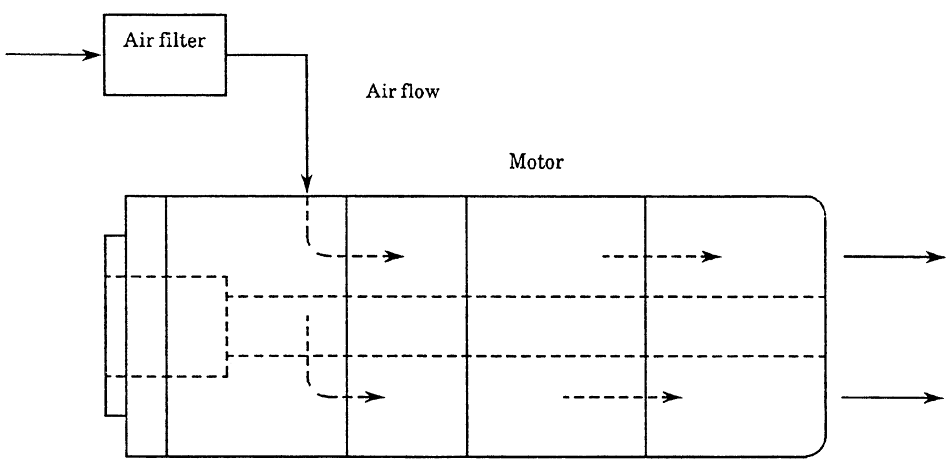
(1) The cooling effect is higher than with other methods. The heat transfer rate to the ball screw can be reduced to approximately one third of that with no air cooling mechanism.

(2) The internal pressure applied to the inside of the motor casing improves the waterproofing of the motor as a side effect.

(3) Because the cooling system is as compact as required for supplying compressed air, the space required to install the motor is almost the same as that for a motor with no cooling system.

(4) Because being guided directly to the inside of the motor, the compressed air must be dry and clean. It is absolutely necessary to filter out the compressed air.

(5) The air pressure to be supplied should be 1 kg/cm^2 or higher. The flow rate under 1 kg/cm2 is 130 liters a minute.



6. PRECAUTIONS ON USE

For the T Series AC servo motors, note the following points in addition to precautions for general servo motors described in Chapter 2 of Part I.

6.1 Installation

(1) The detector shaft passes through the motor body and comes out on the rear cover side of the motor. Do not apply excess force to this shaft; for example, do not lift the motor by holding the shaft with the hand.

(2) The output shaft passes through the motor making a very small gap at the front flange and detector cover for waterproofing and dustproofing. If these parts are deformed even slightly, the waterproofing and dust-proofing are adversely affected. So do not apply a large force to the motor, especially on the cover; be very careful not to step on it.

6.2 Coupling the Output Shaft

(1) When coupling the nut of the ball screw with the motor output shaft, do not apply shocks to the motor. Similarly, when removing the nut, be careful not to apply shocks.

(2) Use a nut with as small rotational imbalance as possible. Vibration due to rotational imbalance may damage the motor bearings or detector even if it is as small as 0.5 G. It is recommended to use a ball deflector with a circular flange.

6.3 Axis Load

The following table lists the allowable loads for the motor shaft, which should be used as a guideline.

Motor model	Radial load	Thrust load	Equivalent radial load (for reference)	Front bearing (reference)
0T	70kg	210kg	310kg	7009 DF
	190kg	580kg	650kg	7211 BDF
5T	190kg	580kg	650kg	7211 BDF
	260kg	790kg	890kg	7213 BDF
10T	260kg	790kg	890kg	7213 BDF
	300kg	890kg	1000kg	7215 BDF

In the above table, the values in the upper rows are the loads for motors with low inertia, and the values in the lower rows are the loads for motors with large ball screws.
The allowable loads are determined based on the life of the bearing assuming that the average motor speed is 500 rpm. In general, the life of a bearing is inversely proportional to the cube root of the speed. When the average speed is higher than 500 rpm, the allowable loads should be smaller than those listed above.
The listed allowable loads assume that the ratio of the radial load to the thrust load is 1:3. The motors can also be operated at ratios other than the stated ratio, in which case the radial load and the thrust load should be calculated by using the formula for the allowable load of the bearing.
If the allowable loads are determined according to the life of the shaft till the fatigue failure, they exceed the values listed above.

6.4 Environment

When the T Series AC servo motor is wired properly, its protection mechanism meets IP54 of the IEC Standards (equivalent to JP54 of JIS C4004-1980, General Rules for Rotating Electrical Machines - Dustproof/splash-proof type).

6.5 Lubricating the Ball Screw

Because the motor rotates the nut of the ball screw, lubricating oil cannot be supplied directly to the nut. The nut needs to be greased or lubricating oil needs to be applied directly to the ball screw. Because the nut is coupled directly to the motor, a proper lubrication method must be selected which does not affect the waterproofing of the motor.

6.6 Maintaining the Motor

The T Series AC servo motor tends to be configured in such a structure that it is difficult to remove it because of its nature. When designing a machine tool in which the motor is used, place priority on ease of maintenance.

FANUC recommends the machine tool builder that the motor and a ball screw be mounted on the machine tool in such a way that they can be removed together from the machine.

V. FANUC AC SERVO MOTOR F series

1. GENERAL

FANUC has developed a compact, lightweight AC servo motor Series - the F Series. The motor features the following:

(1) Small and lightweight: The motor is compact and lightweight because a state-of-the-art ferroneodymium magnet is used.

(2) Reduced length: A large housing is used to reduce the motor's length. (The motor is long and thin.)

(3) Built-in holding brake: A holding brake can be built into the motor.

(4) Built-in absolute position detector: The motor contains serial pulse coder A or C.

(5) High reliability: The motor is fully sealed and has no brushes or other consumable parts. It requires no inspection or maintenance even if it is operated in a severe environment.

The F Series motor is designed to be driven by a supply voltage of 200 to 230 V (without a transformer).

Note) Each motor driving unit requires its own supply voltage of 100 VAC.

2. TYPES OF MOTORS AND DESIGNATION

The FANUC AC servo motor F Series is available in the following models. Each model is designated as shown below.

(1) Model 5F/3000

A06B-034□-B□□□

- 6 Model 5F/3000
- 72 With the serial pulse coder A
- 74 With the serial pulse coder C
- 0 Taper shaft (standard)
- 2 Taper shaft with the brake (80kgfcm)

(2) Model 10F/2000, 20f/2000, and 30F/2000

A06B-035□-B□□□

- 5 Model 10F/2000
- 6 Model 20F/2000
- 7 Model 30F/2000
- 72 With the serial pulse coder A
- 74 With the serial pulse coder C
- 0 Straight shaft (standard)
- 2 Straight shaft with the brake (350kgfcm)
- 5 Taper shaft
- 7 Taper shaft with the brake (350kgfcm)

3 SPECIFICATIONS AND CHARACTERISTICS

3.1 Types of Motors and Specifications

Item	Unit	5F/3000	10F/2000	20F/2000	30F/2000
Output	kW	1.2	1.8	3.5	4.0
	HP	1.6	2.5	4.7	5.5
Rated torque of stall	Nm	6	12	22	30
	kgfcm	61	122	224	306
Maximum speed	min^{-1}	3000	2000	2000	2000
Maximum theoretical torque	Nm	49	45	96	135
	kgfcm	500	460	980	1370
Rotor inertia	$kgcm^2$	0.0037	0.010	0.017	0.026
	$kgfcms^2$	0.038	0.10	0.17	0.265
Maximum theoretical acceleration	rad/s^2	13200	4500	5700	5180
Weight	kg	9	17	21	28

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

Note) The above values shown in the maximum theoretical torque are the theoretical values. The actual maximum torque is restricted by the current limit value of the drive amplifier.

3.2 Characteristic Curve and Data Sheet

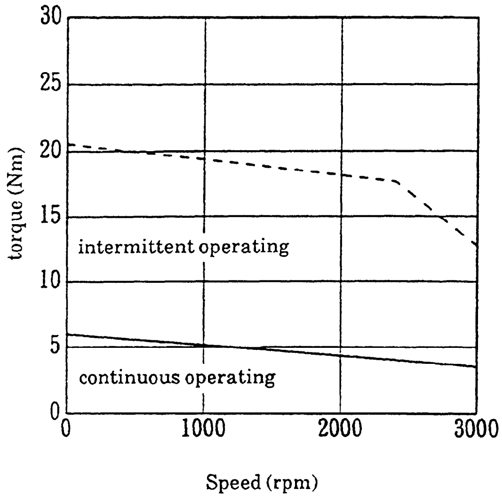
The following characteristic curves and parameters are obtained under the following conditions:

- The temperature of the motor is 20°C.
- The current for driving the motor is an ideal sine wave.
- Under the above conditions, measured values will be within ±10% of the typical values given in the tables and graphs on the following pages.

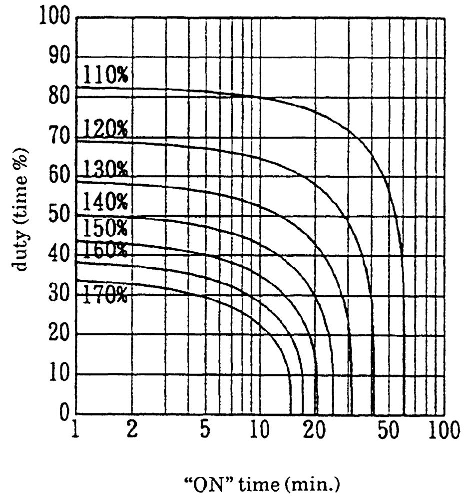
The torque-speed characteristics in the intermittent operating zone are determined by the voltage supplied to the driving amplifier. The characteristic curve represents typical values with a rated input voltage. The maximum torque is limited also by the current limit of the driving amplifier. For the parameters in the data sheet, refer to the descriptions of the S Series.

Model 5-0 (A06B-0531-B□□□)

speed-torque characteristics (digital)



over load duty



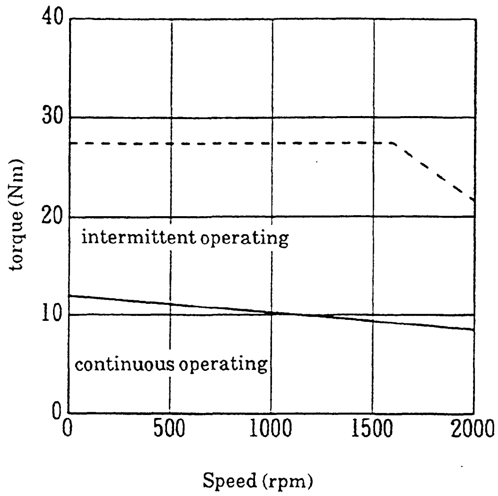
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	3000			min^{-1}
Rated torque at stall(*)	Ts	0.1 1			Nm kgfcm
Rotor inertia	Jm	0.0000029 0.00003			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	0.49			A(rms)
Torque constant(*)	Kt	0.20 2.0			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	7.0 0.07			$V/1000min^{-1}$ Vsec/rad
Armature resistance(*)	Ra	15			Ω
Mechanical time constant(*)	tm	0.003			s
Thermal time constant	tt	11			min
Static friction	Tf	0.01 0.1			Nm kgfcm
Maximum allowable current	Im	5.5			A(peak)
Max. torque	Tm	0.78 8			Nm kgfcm
Max. acceleration		267000			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		0.7			kg

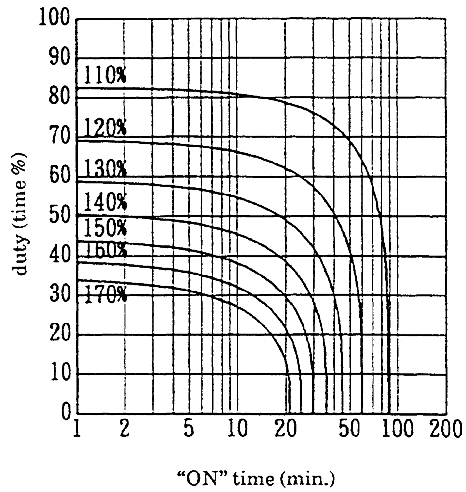
Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
These values may be changed without prior notice.

Model 10F/2000 (A06B-0355-B□□□)

speed-torque characteristics (digital)



over load duty

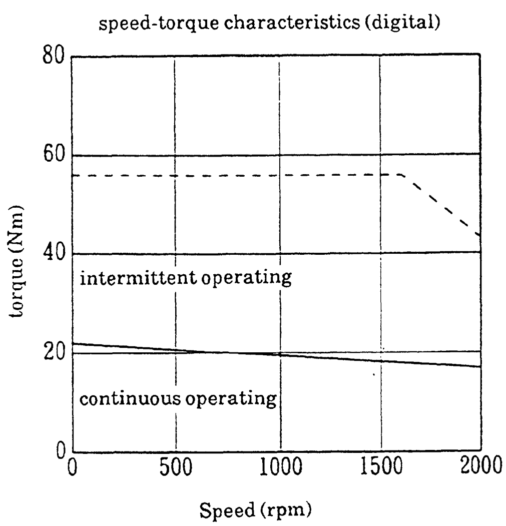


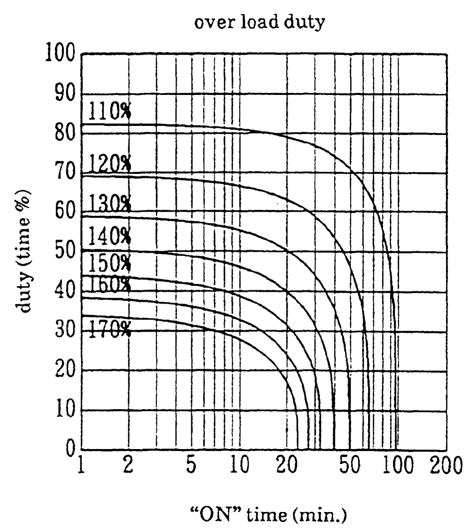
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	2000			min^{-1}
Rated torque at stall(*)	Ts	12 122			Nm kgfcm
Rotor inertia	Jm	0.01 0.1			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	10.9			A(rms)
Torque constant(*)	Kt	1.08 11.0			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	38 0.36			V(rms)/1000min^{-1} V(rms)sec/rad
Armature resistance(*)	Ra	0.37			Ω
Mechanical time constant(*)	tm	0.009			sec.
Thermal time constant	tt	50			min.
Static friction	Tf	0.8 8			Nm kgfcm
Maximum allowable current	Im	60			A(peak)
Max. torque	Tm	45 460			Nm kgfcm
Max. acceleration		4500			rad/S^2
Maximum winding temperature rise	θ m	125			°C
Weight		17			kg

Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary 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 20F/2000 (A06B-0356-B□□□)





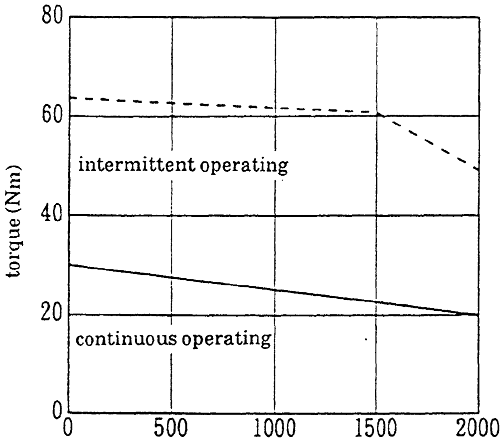
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	2000			min^{-1}
Rated torque at stall(*)	Ts	22 224			Nm kgfcm
Rotor inertia	Jm	0.017 0.17			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	19.3			A(rms)
Torque constant(*)	Kt	1.14 11.6			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	39 0.37			V(rms)/1000min^{-1} V(rms)sec/rad
Armature resistance(*)	Ra	0.14			Ω
Mechanical time constant(*)	tm	0.0055			sec.
Thermal time constant	tt	55			min.
Static friction	Tf	1.2 12			Nm kgfcm
Maximum allowable current	Im	120			A(peak)
Max. torque	Tm	96 980			Nm kgfcm
Max. acceleration		5700			rad/sec^2
Maximum winding temperature rise	θ m	125			°C
Weight		21			kg

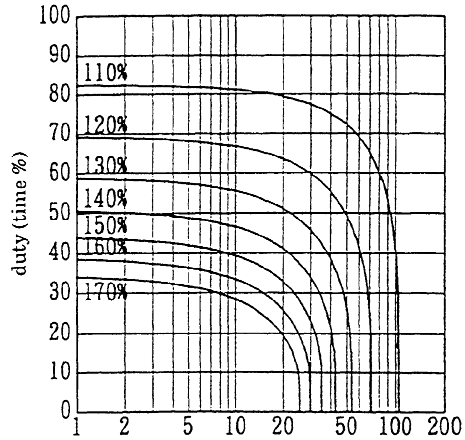
Note) The values are the standard values at 20°C and the tolerance is ±10%. The speed-torque characteristics vary depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
These values may be changed without prior notice.

Model 30F/2000 (A06B-0357-B□□□)

speed-torque characteristics (digital)



over load duty



Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	2000			min^{-1}
Rated torque at stall(*)	Ts	30 306			Nm kgfcm
Rotor inertia	Jm	0.026 0.265			kgm^2 $kgfcmS^2$
Continuous RMS current at stall	Is	24.4			A(rms)
Torque constant(*)	Kt	1.21 12.3			Nm/A(rms) kgfcm/A(rms)
Back EMF constant (RMS voltage per phase)(*)	Ke Kv	42 0.4			V(rms)/$1000min^{-1}$ V(rms)sec/rad
Armature resistance(*)	Ra	0.071			Ω
Mechanical time constant(*)	tm	0.004			sec.
Thermal time constant	tt	60			min.
Static friction	Tf	1.8 18			Nm kgfcm
Maximum allowable current	Im	160			A(peak)
Max. torque	Tm	135 1370			Nm kgfcm
Max. acceleration		5180			rad/sec^2
Maximum winding temperature rise	θm	125			°C
Weight		28			kg

Note) The values are the standard values at 20°C and the tolerance is ±10%.
The speed-torque characteristics vary 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.

3.3 Outline Drawings

(1) Model 5F/3000	Fig. 3.3 (a)
(2) Model 5F/3000 (with the brake)	Fig. 3.3 (b)
(3) Models 10F/2000, 20F/2000, and 30F/2000	Fig. 3.3 (c)
(4) Models 10F/2000, 20F/2000, and 30F/2000 (with the brake)	Fig. 3.3 (d)
(5) Shaft option (models 10F/2000, 20F/2000, and 30F/2000)	Fig. 3.3 (e)

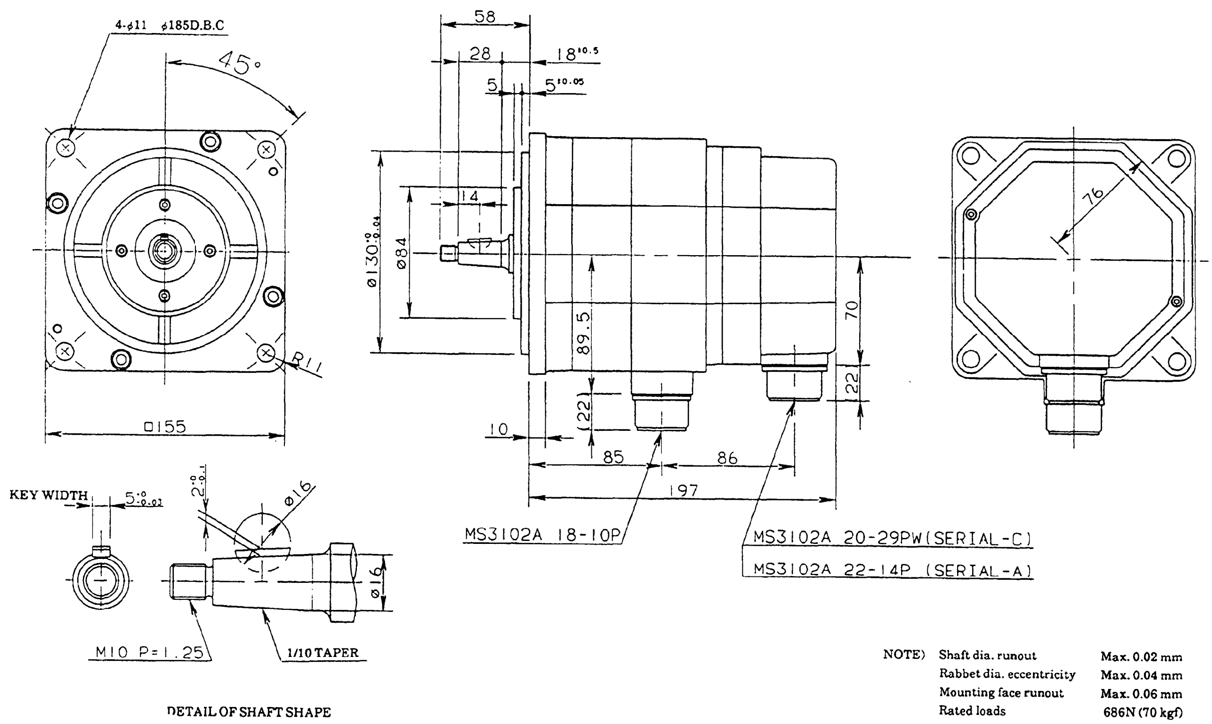
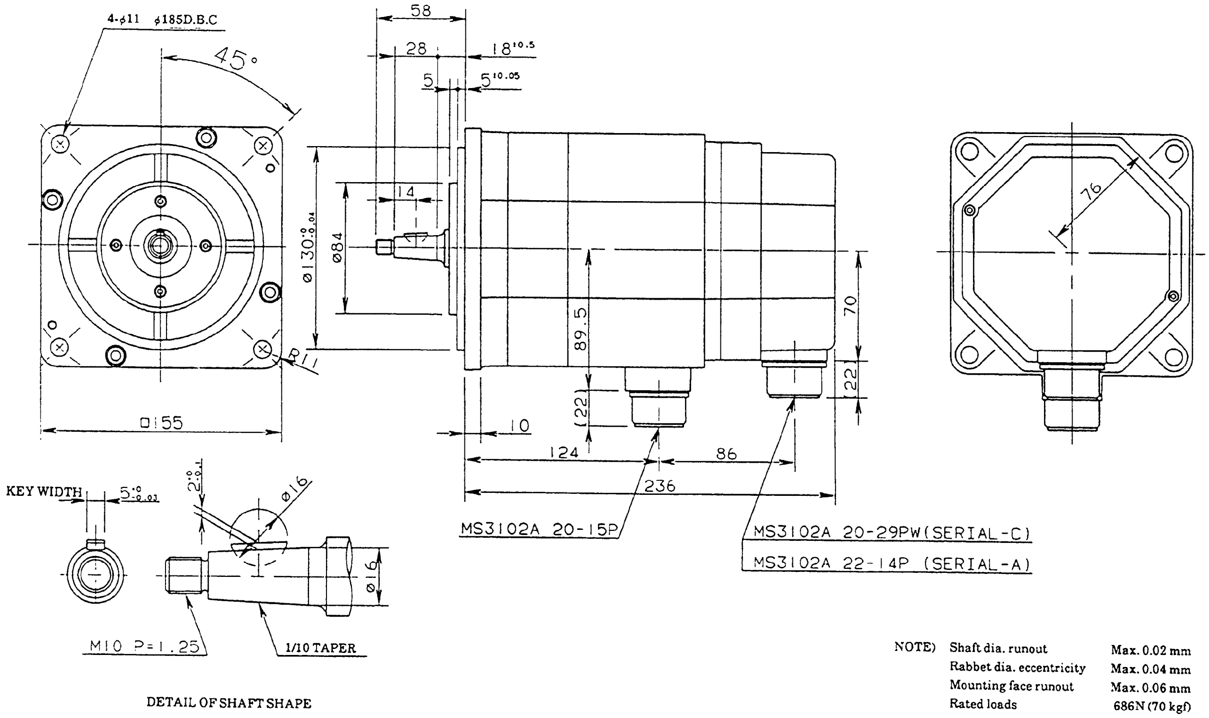


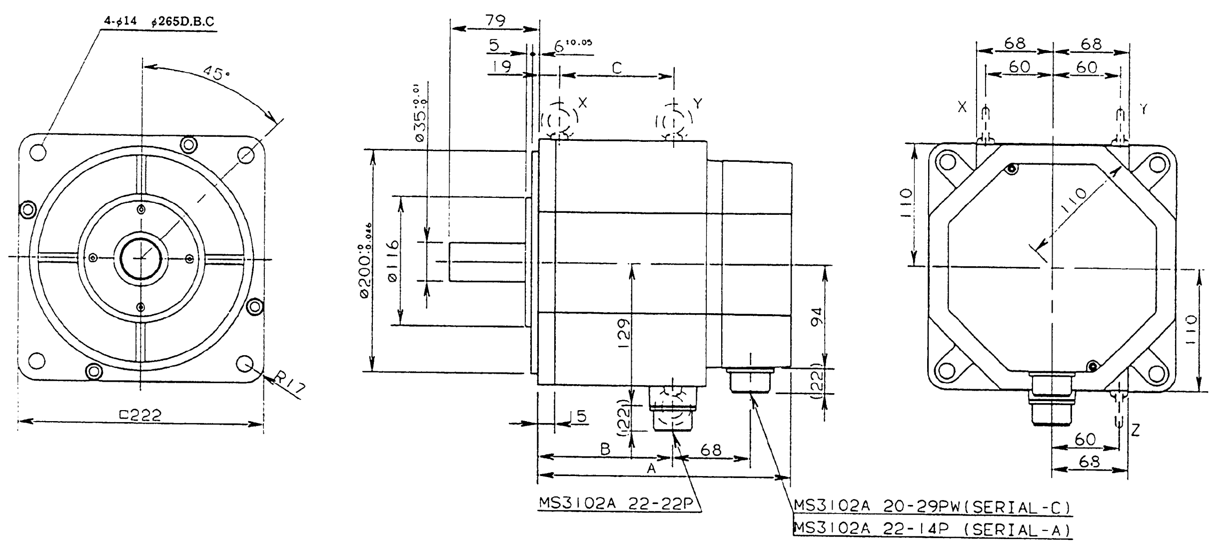
Fig. 3.3 (a) Model 5F/3000



NOTE)

Shaft dia. runout	Max. 0.02 mm
Rabbet dia. eccentricity	Max. 0.04 mm
Mounting face runout	Max. 0.06 mm
Rated loads	686N (70 kgf)

Fig. 3.3 (b) Model 5F/3000 (with the brake)



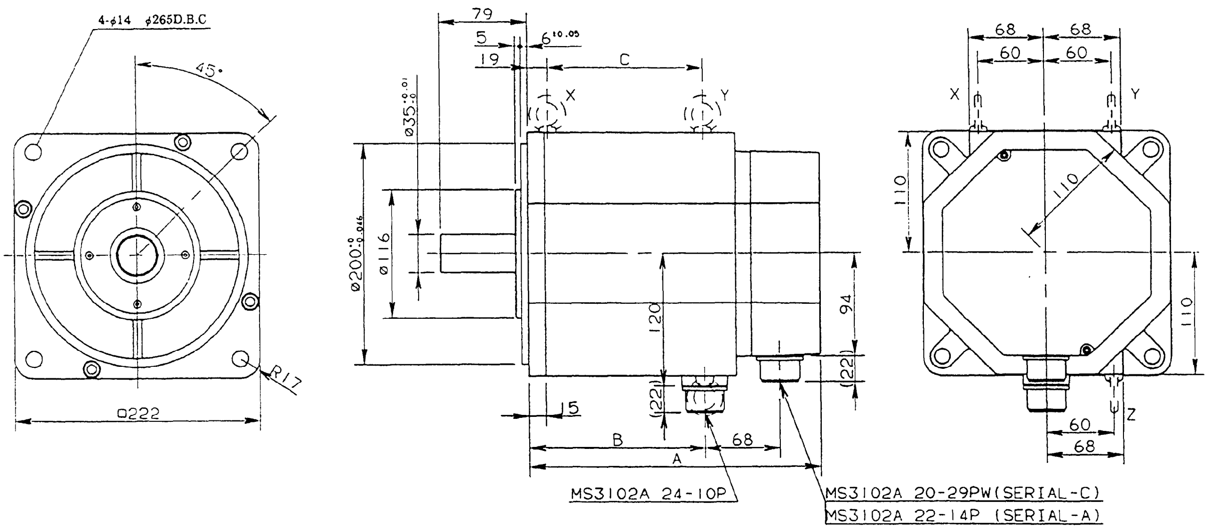
NOTE)

Shaft dia. runout	Max. 0.5 mm
Rabbet dia. eccentricity	Max. 0.7 mm
Mounting face runout	Max. 0.10 mm
Rated loads	4110N (450 kgf)

X, Y, and Z indicate the positions of M8 holes for eyebolts.
The eyebolts are not included.

MODEL	A	B	C
MODEL 10F	192	88	70
MODEL 20F	210	106	88
MODEL 30F	234	130	112

Fig. 3.3 (c) Models 10F/2000, 20F/2000, and 30F/2000



NOTE) Shaft dia. runout Max. 0.5 mm
Rabbet dia. eccentricity Max. 0.7 mm
Mounting face runout Max. 0.10 mm
Rated loads 4110N (450 kgf)
X, Y, and Z indicate the positions of M8 holes for eyebolts.
The eyebolts are not included.

MODEL	A	B	C
MODEL 10F	227	123	105
MODEL 20F	245	141	123
MODEL 30F	269	165	147

Fig. 3.3 (d) Models 10F/2000, 20F/2000, and 30F/2000 (with the brake)

Standard
Straight shaft

Option
Taper shaft

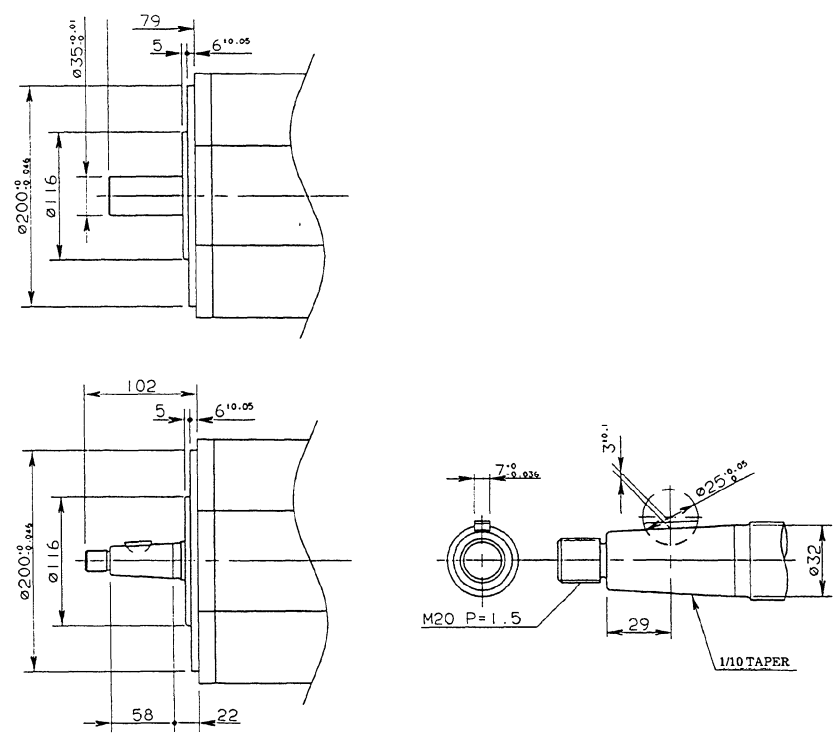
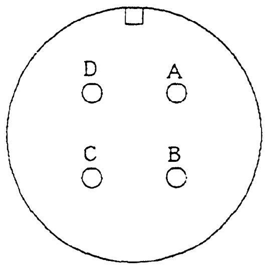


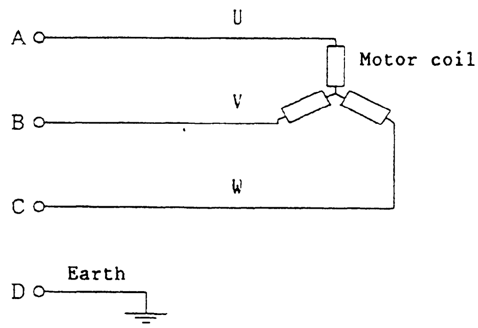
Fig. 3.3 (e) Shaft option (models 10F/2000, 20F/2000, and 30F/2000)

3.4 Connecting Power Lines (without the brake)

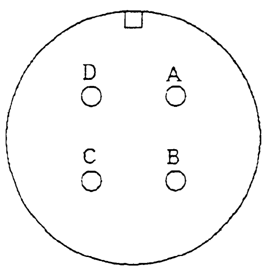
(a) Model 5F/3000



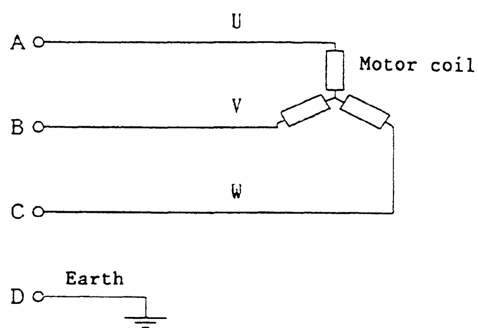
MS3102A 18-10P



(b) Models 10F/2000, 20F/2000, and 30F/2000

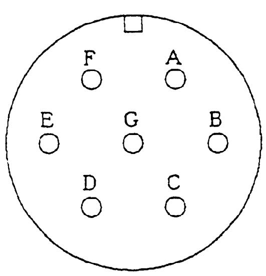


MS3102A 22-22P

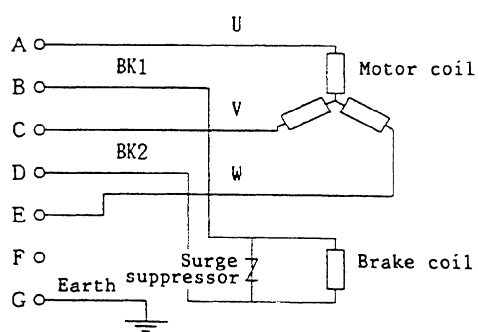


3.5 Connecting Power Lines (with the brake)

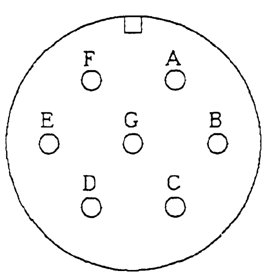
(a) Model 5F/3000



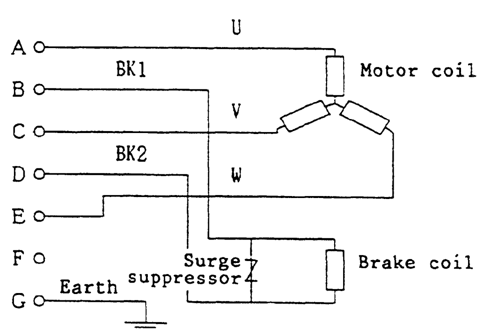
MS3102A 20-15P



(b) Models 10F/2000, 20F/2000, and 30F/2000



MS3102A 24-10P



VI. FANUC AC SERVO AMPLIFIER C series (FOR A SINGLE MOTOR AND TWO MOTORS)

1. OUTLINE

The FANUC C series AC servo amplifier is a totally new amplifier that has been designed to drive digital AC servo motors. The C series amplifier is compact and has less heating value. This amplifier has the following features:

1) Function-compatible with conventional amplifiers
(For users who are using conventional S series amplifiers, see the end of this manual for the differences between the C series servo amplifier and the S series servo amplifier.)

2) Requires only half the area required by conventional FANUC servo amplifiers for installation.

3) Generates only 70% of the heating value generated by conventional FANUC servo amplifiers.

4) Unique structure that minimizes temperature rise in the cabinet.

5) High reliability based on fully automated assembly without harnesses.

2. CONFIGURATION

Fig. 2 is an example of how the 2-axis NC system is configured. A separate regenerative discharge unit may also be required when regenerating energy becomes large by the load condition.

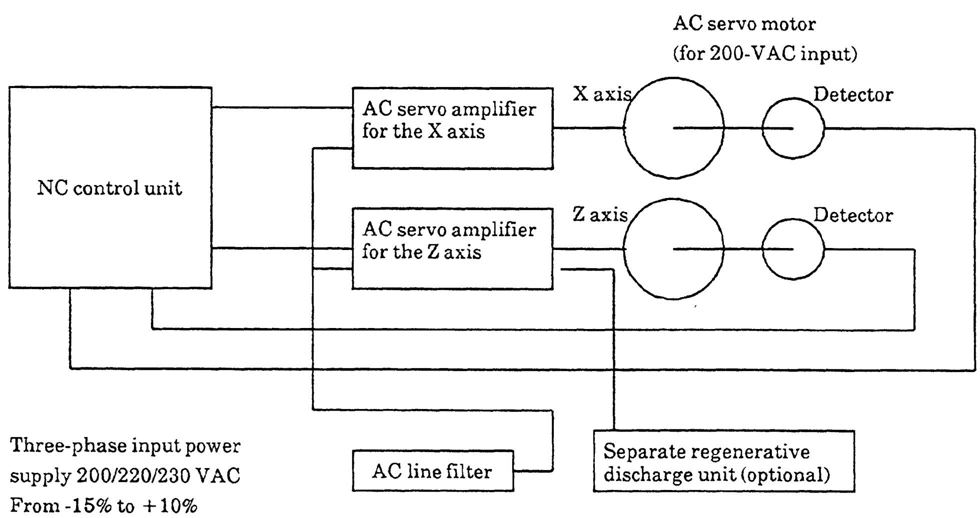


Fig. 2 Example of Configuration

2.1 Unit Types and Specifications

Table 2.1 Unit Types and Specifications (1/2)

<table>
<tr><th rowspan="2" colspan="2">Name</th><th colspan="2">Application</th><th rowspan="2">Specifications</th></tr>
<tr><th>L axis of Servo amplifier for two motors</th><th>M axis of Servo amplifier for two motors</th></tr>
<tr><td rowspan="14">Servo ampli-fier (Note 1) (Note 2)</td><td rowspan="4">For a single motor</td><td colspan="2">Motors 4-0S and 3-0S</td><td>A06B-6066-H002</td></tr>
<tr><td colspan="2">Motors 2-0S(Note 3), 1-0SP, and 1-0SP/3000</td><td>A06B-6066-H003</td></tr>
<tr><td colspan="2">Motors 0S(Note 3), 5S, 10S, 20S/1500, 0L, 5F/3000, and 10F/2000</td><td>A06B-6066-H004</td></tr>
<tr><td colspan="2">Motors 5S/3000, 10S/3000, 20S, 30S, 5L, 6L, 20F/2000, and 30F/2000 (Note 9)</td><td>A06B-6066-H006</td></tr>
<tr><td rowspan="10">For two motors</td><td>Motors 3-0S and 4-0S</td><td>Motors 3-0S and 4-0S</td><td>A06B-6066-H222</td></tr>
<tr><td colspan="2">Motors 20S/3000, 30S/3000, 40S/2000, 7L, and 10L.</td><td>A06B-6066-H008 (Built-in cooling fun)</td></tr>
<tr><td>Motors 3-0S and 4-0S</td><td>Motors 2-0SP, 1-0SP, and 1-0SP/3000</td><td>A06B-6066-H223</td></tr>
<tr><td>Motors 3-0S and 4-0S</td><td>Motors 0S, 5S, and 10S, 5F/3000, 10F/2000</td><td>A06B-6066-H224</td></tr>
<tr><td>Motors 2-0SP, 1-0SP, and 1-0SP/3000</td><td>Motors 2-0SP, 1-0SP, and 1-0SP/3000</td><td>A06B-6066-H233</td></tr>
<tr><td>Motors 2-0SP, 1-0SP, and 1-0SP/3000</td><td>Motors 0-0SP, 0S, 5S, 10S, 5F/3000, 10F/2000</td><td>A06B-6066-H234</td></tr>
<tr><td>Motors 2-0SP, 1-0SP, and 1-0SP/3000</td><td>Motors 5S/3000</td><td>A06B-6066-H236</td></tr>
<tr><td>Motors 0-0SP, 0S, 5S, 10S</td><td>Motors 0-0SP, 0S, 5S, 10S, 5F/3000</td><td>A06B-6066-H244</td></tr>
<tr><td>Motors 0-0SP, 0S, 5S, 10S, 5F/3000</td><td>Motors 5S/3000</td><td>A06B-6066-H246</td></tr>
<tr><td>Motors 5S/3000</td><td>Motors 5S/3000</td><td>A06B-6066-H266</td></tr>
<tr><td rowspan="3" colspan="2">AC line filter (Note 4)</td><td colspan="2">Type A (for motors with a total rated output of 5.4 kW or less)</td><td>A81L-0001-0083#3C</td></tr>
<tr><td colspan="2">Type B (for motors with a total rated output of 10.5 kW or less)</td><td>A81L-0001-0101#C</td></tr>
<tr><td colspan="2">Type C (for motors with a total rated output of 23 kW or less)</td><td>A81L-0001-0102</td></tr>
<tr><td rowspan="4" colspan="2">Power transformer for export</td><td colspan="2">Type SAE (with apparent power of 2.2 kVA)</td><td>A80L-0022-0005</td></tr>
<tr><td colspan="2">Type SBE (with apparent power of 3.5 kVA)</td><td>A80L-0024-0006</td></tr>
<tr><td colspan="2">Type SCE (with apparent power of 5 kVA)</td><td>A80L-0026-0003</td></tr>
<tr><td colspan="2">Type SDE (with apparent power of 7.5 kVA)</td><td>A80L-0028-0001</td></tr>
</table>

Table 2.1 Unit Types and Specifications (2/2)

Name	Application		Specifications
	L axis of Servo amplifier for two motors	M axis of Servo amplifier for two motors	
Separate regenerative discharge unit (Note 5)	Option for motors 10S to 30S (16Ω/400 W, when air-cooled at a wind speed of 2 m/s)		A06B-6066-H500
	Option for A06B-6066-H008 (8Ω/800 W, with a built-in cooling fan)		A06B-6066-H711
	Option for A06B-6066-H008 (8Ω/1200 W, with a built-in cooling fan)		A06B-6066-H712
	Option for motors 10S to 30S (16Ω/800 W, with a built-in cooling fan)		A06B-6066-H713
	Option for motors 10S to 30S (16Ω/1200 W, with a built-in cooling fan)		A06B-6066-H714
Input connector (Note 6)	Solder type		A06B-6066-K205
	Crimp type		A06B-6066-K206
Spare fuse (Note 7)	Control power supply fuse (HM32)		A06B-6066-K207
	Fuse (P405H) for the fan motor in the separate regenerative discharge unit (for H008)		A06B-6066-K208
Spare fan motor (Note 8)	Option for A06B-6066-H008		A06B-6066-K209
	For the separate regenerative discharge unit		A06B-6066-K210

Note 1) Use an AC servo motor that conforms to the specifications of the C series amplifier (200/220/230 VAC input).

Note 2) Select the appropriate servo amplifiers for the T series motors (hollow-type motors) by considering the following correspondence between the S and T series motors: 0S for 0T/3000, 5S for 5T/2000, 5S/3000 for 5T/3000, 10S for 10T/2000, and 10S/3000 for 10T/3000.

Note 3) For conventional S series servo amplifiers, two different servo amplifiers need to be used: one drives motor 2-0SP or 0S at 2000 rpm maximum, and another drives the motor at 3000 rpm maximum.
For the C series servo amplifier, on the other hand, only one amplifier needs to drive motor 2-0SP or 0S irrespective of the maximum motor speed specified. However, servo parameters (motor Nos.) are set in the same way as usual.

Note 4) The AC line filter needs to be used to minimize the effect of high-frequency noise on the power supply.
Up to three 10S amplifiers can be connected to one line filter, A81L-0001-0083#3C. (Rated output of model 10S: 1.8 kW)
Up to three 20S amplifiers can be connected to one line filter, A81L-0001-0101#C. (Rated output of model 20S: 3.5 kW)
If an insulating power transformer is used because the input power supply voltage is out of the specified range, this line filter may be omitted.

Note 5) When the load inertia is too large or the frequency in acceleration/deceleration is high, if regenerating energy from the motor exceeds the specified value, a separate regenerative discharge unit needs to be added.
If the calculated heat value exceeds the capacity of the regenerative discharge unit, contact FANUC for selection of the servo motor.
See section 4 for how to calculate the regeneration energy.

Note 6) This connector (CN1) is used in the cable which connect the servo amplifier with NC via a cable. Each axis requires one connector.

Note 7) There are two types of spare fuses, one for the control power supply and one for the fan motor. All servo amplifiers are equipped with a fuse for the control power supply. Only servo amplifier A06B-6606-H008 is equipped with a fuse for the fan motor.

Note 8) Servo amplifier A06B-6066-H008 and the separate regenerative discharge units with a built-in cooling fan (A06B-6066-H711 to -H714) contain a fan motor, for which a spare may have to be ordered as required.

Note 9) The amplifier in model 30F/2000, it should be compulsorily air cooled.

3. SPECIFICATIONS

3.1 Specifications

Table 3.1 (a) Specifications (common)

Item		Specifications
Power supply	Three-phase input for power(*1)	Voltage:200/220/230 VAC Allowable voltage fluctuation: -15% to +10% Frequency: 50 Hz or 60 Hz Allowable frequency fluctuation: ±2 Hz
	Single-phase input for control power(*1)	Voltage: 200/220/230 VAC Allowable voltage fluctuation: -15 % to +10% Frequency: 50 Hz or 60 Hz Allowable frequency fluctuation: ±2 Hz
	Single-phase input for emergency stop	Voltage: 100 VAC Allowable voltage fluctuation: -15 % to +10% Frequency: 50 Hz Allowable frequency fluctuation:±2 Hz or Allowable voltage fluctuation: -15 % to +10% Voltage: 100/110 VAC Frequency: 60 Hz Allowable frequency fluctuation:±2 Hz
Control of the main circuit		Sine-wave PWM control by transistor (IGBT) bridge
Alarm and protection functions		Overvoltage alarm, control power low-voltage alarm, DC link low-voltage alarm, regenerative control circuit failure alarm,regeneration over-discharge alarm, servoamplifier overheat alarm, overcurrent alarm, and circuit breaker
Contact of the magnetic contactor for confirmation of a circuit break(*2)		Auxiliary contact of the magnetic contactor for a circuit break (The main circuit is cut off when contact b is closed.) Rated current: 10 mA or more and 0.3 A or less at 24 VDC

*1 Two wires of the three-phase input for power are factory-set to be connected with the single-phase input for control power via jumper bars.

*2 This contact point can be used as a monitor when the user designs circuits such as a safety circuit.

Table 3.1 (b) Specifications for Each Model

Servo amplifier	Applicable motor	Peak current at rated output(*1)	Nominal current limit
A06B-6066-H222/L and M axes A06B-6066-H223/L axis A06B-6066-H224/L axis A06B-6066-H002	4-0S, 3-0S	1.4 Ap	4 Ap
A06B-6066-H223/M axis A06B-6066-H233/L and M axes A06B-6066-H234/L axis A06B-6066-H236/L axis A06B-6066-H003	2-0SP, 1-0SP, 1-0SP/3000	5 Ap	12 Ap
A06B-6066-H224/M axis A06B-6066-H234/M axis A06B-6066-H244/L and M axes A06B-6066-H246/L axis	0-0SP, 0S, 5S, 10S	13 Ap	40 Ap
A06B-6066-H004	0-0SP, 0S, 5S, 10S, 20S/1500, 0L	20 Ap	40 Ap
A06B-6066-H236/M axis A06B-6066-H246/M axis A06B-6066-H266/L and M axes	5S/3000	15 Ap	80 Ap
A06B-6066-H006	5S/3000, 10S/3000, 20S, 30S, 5L, 6L	30 Ap	80 Ap
A06B-6066-H008	20S/3000, 30S/3000, 40S/2000, 7L, 10L	65 Ap	130 Ap

*1 The rated output is guaranteed only at the rated input voltage. When the input voltage fluctuates, the rated output may not be maintained even if the fluctuation is within the allowable range.

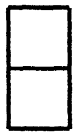
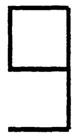
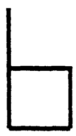
3.2 Protection and Error Detection Functions

The AC servo amplifier provides the following protection and error detection functions.
Alarm statuses are displayed on the seven-segment LED on the front panel of the servo amplifier.

Table 3.2 (a) Protection and Error Detection Functions (1/2)

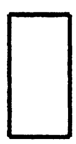
Type	Display	Description
Overvoltage alarm (HV)	LED indication 1	Activated when the DC voltage of power to the main circuit is abnormally high.
Control power low voltage alarm (LV5V)	LED indication 2.	Activated when the voltage for control power (+5 V) is abnormally low.
DC link low voltage alarm (LVDC)	LED indication 3	Activated when the DC voltage of power to the main circuit is abnormally low.
Regenerative control circuit failure alarm (DCSW)	LED indication 4	Activated when short-time regenerative discharge energy is too large. This is caused by failure of the regenerative discharge circuit.
Regenerative over-discharge alarm (DCOH)	LED indication 5.	Activated when the average regenerative discharge energy is too large, or when the frequency in acceleration/deceleration is too high. Also activated by an overheating transformer if a transformer overheat detector is connected (see Section 9.3) or a blown fuse for the servo amplifier fan motor (H008 only).
Servo amplifier overheat (OH)	LED indication 6.	Activated when the thermostat in the amplifier starts operating.
Magnetic contactor welding alarm (MCC)	LED indication 7	Activated when the contacts of the magnetic contactor are welded.

Table 3.2 (a) Protection and Error Detection Functions (2/2)

Type	Display	Description
Overcurrent alarm (HCL)	LED indication 	Occurs when the current passing through the main circuit of the 1-axis amplifier or the main L-axis circuit of the 2-axis amplifier is excessive.
Overcurrent alarm (HCM)	LED indication 	Occurs when the current passing through the main M-axis circuit of the 2-axis amplifier is excessive.
Overcurrent alarm (HCLM)	LED indication 	Occurs when the current passing through the main L- and M-axis circuits of the 2-axis amplifier is excessive.
Circuit breaker	The lever of the circuit breaker is set to off.	Activated when a current exceeding the operating current of the circuit breaker flows. The DC link low voltage alarm (LVDC) may come on concurrently.

Note 1) The motor is stopped by the dynamic brake when an alarm is activated.
Note 2) The following indications mean normal operation modes, not alarm statuses:

Table 3.2 (b) Normal operation mode

Type	Display	Description
Amplifier not ready	LED indication	The amplifier is not ready for driving the motor because the magnetic contactor in the amplifier is set to off.
Amplifier ready	LED indication 	The magnetic contactor in the amplifier is set to on, and the amplifier is ready for driving the motor.

4. AC LINE FILTER AND REGENERATIVE DISCHARGE UNIT

4.1 AC Line Filter (optional)

Use the AC line filter to reduce the effect of high-frequency noise on the power supply. Within the current capacity of the AC line filter, multiple servo amplifiers can be connected to one AC line filter. Table 4.1 indicates the upper sum of rated outputs for motors that can be connected to one AC line filter via an amplifier.

Table 4.1 Selection Standard of the AC Line Filter

Line filter	Continuous rated current	Heat loss	Sum of motor rated outputs
Type A	24 A	20 W	5.4 kW (Reference: Model 10S×3) (8.7 KVA)
Type B	44 A	70 W	10.5 kW (Reference: Model 20S×3) (16.0 KVA)
Type C	100 A	50 W	23 kW (35 KVA)

4.2 Separate Regenerative Discharge Unit

When energy regenerated from the motor exceeds the limit for the discharge unit in the servo amplifier, a separate regenerative discharge unit needs to be connected.

Find value P in 4.2.1 and value Q in 4.2.2 for each axis. If the sum of P and Q exceeds the specified value, and the NC system is operated continuously, use the separate regenerative discharge unit.

If the sum also exceeds the specified value for the separate regenerative discharge unit, contact FANUC.

4.2.1 For horizontal operation

When acceleration/deceleration for rapid traverse is performed every F seconds, value P is calculated as follows.

$$P = \frac{1}{F} \times (5.37 \times 10^{-4} JVm^2 - 5.13 \times 10^{-3} taVmTL) \quad \cdots\cdots\cdots\cdots \quad (1)$$

If P exceeds the specified value for the regenerative discharge unit built into the servo amplifier, and the NC system is operated continuously, the separate regenerative discharge unit is required.

Terms used in formula (1)

F : Frequency in acceleration/deceleration for rapid traverse (F seconds per cycle)
(Note: the frequency is approximately once per five seconds unless otherwise specified.)

J = Jm + JL

Jm : Rotor inertia of the motor ($kgf \cdot cm \cdot s^2$)

JL : Load inertia in terms of the motor axis ($kgf \cdot cm \cdot s^2$)

Vm : Motor speed for rapid traverse (rpm)

ta : Acceleration/deceleration time for rapid traverse (s)

TL : Friction torque of the machine (in terms of the motor axis) ($kg \cdot cm$)

4.2.2 For vertical operation

When the operating duty for rapid downward traverse is D(%), value Q is calculated as follows.

$$Q = 1.026 \times 10^{-2} ThVm \times \frac{D}{100} \quad \cdots\cdots\cdots\cdots \quad (2)$$

Terms used in formula (2)

Th : Upward torque of the motor during rapid downward traverse (kg/cm)

Vm : Motor speed for rapid traverse (rpm)

D : Operating duty (%) for rapid downward traverse (*1)

*1 D must be 50% or less.

The sum of P obtained by formula (1) and Q obtained by formula (2) is represented as R below.

$R = P + Q$ ·································· (3)

When R exceeds the specified value for the discharge unit in the servo amplifier, and the NC system is operated continuously, the separate regenerative discharge unit needs to be used.

If R in formula (3) also exceeds the specified value for the separate regenerative discharge unit, contact FANUC.

4.2.3 Capacity of the regenerative discharge resistance units (built-in and separate)

Table 4.2.3 (a) Specified values for the regenerative discharge unit in the servo amplifier

Servo amplifier	Wind speed: 0 m/sec	Wind speed: 2 m/sec	Wind speed: 4 m/sec
A06B-6066-H002 A06B-6066-H003	R=20W	-	-
A06B-6066-H004 (Note 2) A06B-6066-H006 A06B-6066-H222 to H226	R=100W	R=200W	R=300W
A06B-6066-H008	With a built-in cooling fan motor		R=400W

Table 4.2.3 (b) Specified values for the separate regenerative discharge unit

Separate regenerative discharge unit	Wind speed: 0 m/sec	Wind speed: 2 m/sec	Wind speed: 4 m/sec
A06B-6066-H500 (Note 2)	R=200W	R=400W	R=600W
A06B-6066-H711 (8 Ω)	With a built-in cooling fan motor		R=800W
A06B-6066-H712 (8 Ω)	With a built-in cooling fan motor		R=1200W
A06B-6066-H713 (16 Ω)	With a built-in cooling fan motor		R=800W
A06B-6066-H714 (16 Ω)	With a built-in cooling fan motor		R=1200W
Reference: For S Series (A06B-6050-H050)	R=400W	-	-

Note 1) For machines that have a large retention torque, such as those with no counterbalance for the gravity axis, the regeneration rate during downward operation is increased. Especially, for rapid downward traverse with a machine having a long stroke, the regeneration rate may exceed the capacity of the regenerative discharge unit. Contact FANUC for selection of the motor.

Note 2) For the separate or built-in regenerative discharge unit for the C series that has external fins, the regeneration capacity can be increased by forcibly air-cooling the discharge unit through the fan. The relationship between the wind speed for forced cooling and the specified value is indicated.

Note 3) The separate regenerative discharge unit (A06B-6050-H050) for the conventional S series servo amplifier can also be connected to the C series servo amplifier.
In this case, the following points must be noted:

(Caution) When separate regenerative discharge unit A06B-6050-H050 is used for the C series amplifier, do not forcibly air-cool the unit, and do not install the unit in a windy place.

(Reason) To fully utilize the capabilities of regenerative discharge units, the C series servo amplifier has a thermostat in the regenerative discharge resistor to monitor the resistance temperature thoroughly. In addition, the characteristics of the alarm circuit have been changed from that of the S series.
Because the separate regenerative discharge unit for the S series has a thermostat adjacent to the regenerative discharge resistor, the resistance temperature may not be monitored correctly in a windy place or under forced air-cooled conditions.

5. POWER SUPPLY

5.1 Input Power

AC servo amplifiers require three-phase power for the main circuit and single-phase power for the winding of the dynamic brake magnetic contactor. See Table 5.2.1 for the specifications of the power supplies.

5.2 Capacity

5.2.1 Three-phase power

Table 5.2.1 Capacity of the three-phase power supply

Motor model	Capacity per motor	Motor model	Capacity per motor	Motor model	Capacity per motor
4-0S	0.1 kVA	10S	3 kVA	0T/3000	1.2 kVA
3-0S	0.2 kVA	10S/3000	3.5 kVA	5T/2000	1.5 kVA
2-0SP	0.4 kVA	20S/1500	4.2 kVA	5T/3000	1.8 kVA
1-0SP	0.8 kVA	20S	5.3 kVA	10T/2000	3 kVA
2-0SP/3000	0.5 kVA	20S/3000	5.6 kVA	10T/3000	3.5 kVA
1-0SP/3000	0.8 kVA	30S	5 kVA	0L	1 kVA
0-0SP	1 kVA	30S/3000	7 kVA	5L	1.5 kVA
0S	1 kVA	40S/2000	10 kVA	6L	2.4 kVA
0S/3000	1.2 kVA			7L	5 kVA
5S	1.5 kVA			10L	10 kVA
5S/3000	1.8 kVA				

Note 1) If the power supply is to be used for more than one motor, its capacity can be obtained by summing up the capacities for the individual motors.

Note 2) The capacities listed above suffice as a continuous rating. When AC servo motors accelerate steeply, however, they require twice the continuous rating momentarily.

5.2.2 Single-phase 100 V power

Table 5.2.2 Capacity of the single-phase 100 V power supply

Amplifier specification drawing number	Moment the magnetic contactor is switched on	During continuous supply of power
A06B-6066-H002-H006	120 VA	30 VA
A06B-6066-H008	180 VA	36 VA
A06B-6066-H222-H266	130 VA	30 VA

5.2.3 Capacity of the single-phase power supply for control purposes

Power used for control purposes is usually supplied from the three-phase power supply for the motors using jumper bars. So its capacity is included in the capacity of the three-phase power supply.
If the control power is to be supplied separately, consult the table below.

Table 5.2.3 Capacity of the single-phase power supply for control purposes

Amplifier specification drawing number	Capacity
A06B-6066-H002-H006	30 VA
A06B-6066-H008	50 VA
A06B-6066-H222-H266	40 VA

5.3 Power Transformer

For the required power transformers, see Section 5.3 in Part VII.

6. HEAT DISSIPATION

The table below lists the heat generated in the C Series servo amplifier when it operates with the rated continuous load. When designing cabinets, consider the average heat typically generated to be half the listed value.
The listed values do not include the heat generated by the regenerative discharge resistance. They have to be modified as described in the Notes.

Table 6 Heat generated in the servo amplifiers (1/3)

Servo amplifier drawing number	Motor model		Heat generated in the servo amplifier	Heat released within the cabinet when the heat sink is installed outside the cabinet	
	L-axis	M-axis		Natural air cooling	Forced air cooling
A06B-6066-H002	4-0S, 3-0S		31 W	—	—
A06B-6066-H003	2-0S, 1-0S		41 W	—	—
	1-0S/3000		47 W	—	—
A06B-6066-H004	0-0SP		74 W	45W	31W
	0S		50 W	34W	26W
	5S		58 W	38W	28W
	10S		71 W	44W	31W
	20S/1500		140W	80W	50W
	0L		59 W	38W	28W
A06B-6066-H006	5S/3000		82 W	48W	31W
	10S/3000		114W	63W	38W
	20S		149W	80W	46W
	30S		117W	65W	39W
	5L		82 W	49W	32W
	6L		122W	67W	40W
A06B-6066-H008	20S/3000		229W	—	49W
	30S/3000		269W	—	53W
	40S/2000		335W	—	60W
	7L		276W	—	54W
	10L		381W	—	65W

Table 6 Heat generated in the servo amplifiers (2/3)

Servo amplifier drawing number	Motor model		Heat in generated the servo amplifier	Heat released within the cabinet when the heat sink is installed outside the cabinet	
	L-axis	M-axis		Natural air cooling	Forced air cooling
A06B-6066-H222	3-0S, 4-0S	3-0S, 4-0S	41 W	34W	30W
A06B-6066-H223	3-0S, 4-0S	1-0S, 2-0S	50 W	38W	32W
	3-0S, 4-0S	1-0S/3000	55 W	40W	33W
A06B-6066-H224	3-0S, 4-0S	0S	62 W	43W	34W
	3-0S, 4-0S	5S	70 W	47W	35W
	3-0S, 4-0S	10S	82 W	52W	37W
A06B-6066-H233	1-0S, 2-0S	1-0S, 2-0S	59 W	42W	34W
	1-0S, 2-0S	1-0S/3000	64 W	44W	34W
	1-0S/3000	1-0S/3000	69 W	46W	35W
A06B-6066-H234	1-0S, 2-0S	0S	71 W	47 W	35 W
	1-0S, 2-0S	5S	79 W	51 W	37 W
	1-0S, 2-0S	10S	91 W	56 W	39 W
	1-0S/3000	0S	76 W	49 W	36 W
	1-0S/3000	5S	84 W	53 W	37 W
	1-0S/3000	10S	96 W	58 W	39 W
A06B-6066-H236	1-0S, 2-0S	5S/3000	103W	61 W	40 W
	1-0S/3000	5S/3000	108W	63 W	41 W
A06B-6066-H244	0S	0S	83 W	52 W	36 W
	0S	5S	91 W	56 W	38 W
	0S	10S	103W	61 W	40 W
	5S	5S	99 W	59 W	40 W
	5S	10S	111W	65 W	42 W
	10S	10S	123W	70 W	44 W

Table 6 Heat generated in the servo amplifiers (3/3)

Servo amplifier drawing number	Motor model		Heat in generated the servo amplifier	Heat released within the cabinet when the heat sink is installed outside the cabinet	
	L-axis	M-axis		Natural air cooling	Forced air cooling
A06B-6066-H246	0S	5S/3000	115W	66 W	41 W
	5S	5S/3000	123W	70 W	43 W
	10S	5S/3000	135W	75 W	45 W
A06B-6066-H266	5S/3000	5S/3000	147W	80 W	46 W

Note 1) For servo amplifiers A06B-6066-H002 and -H003, the heat sink cannot be placed outside the cabinet. So, the heat generated in the regenerative discharge resistor must be added as the total generated heat. See Section 4.2 for the heat generated by regenerative discharge.

Note 2) The servo amplifiers other than A06B-6066-H002 and -H003 are so structured that the built-in regenerative discharge resistor and the heat sink can be placed outside the cabinet. If the heat sink is placed outside the cabinet, it is not necessary to add the heat from the regenerative discharge resistor as the heat released in the cabinet. The same holds true if the separate regenerative discharge resistance unit is used outside the cabinet. If the servo amplifier or the separate regenerative discharge resistance unit is placed outside the cabinet, the heat generated by the regenerative discharge resistance must be added as the total generated heat. See Section 4.2 for the heat generated by regenerative discharge.

Note 3) The term forced air cooling refers to a situation that the heat sink is exposed to air flow with a speed of 2 m/s. Servo amplifier A06B-6066-H008 and separate regenerative discharge resistance units A06B-6066-H711 and -H714 have a built-in cooling fan motor.

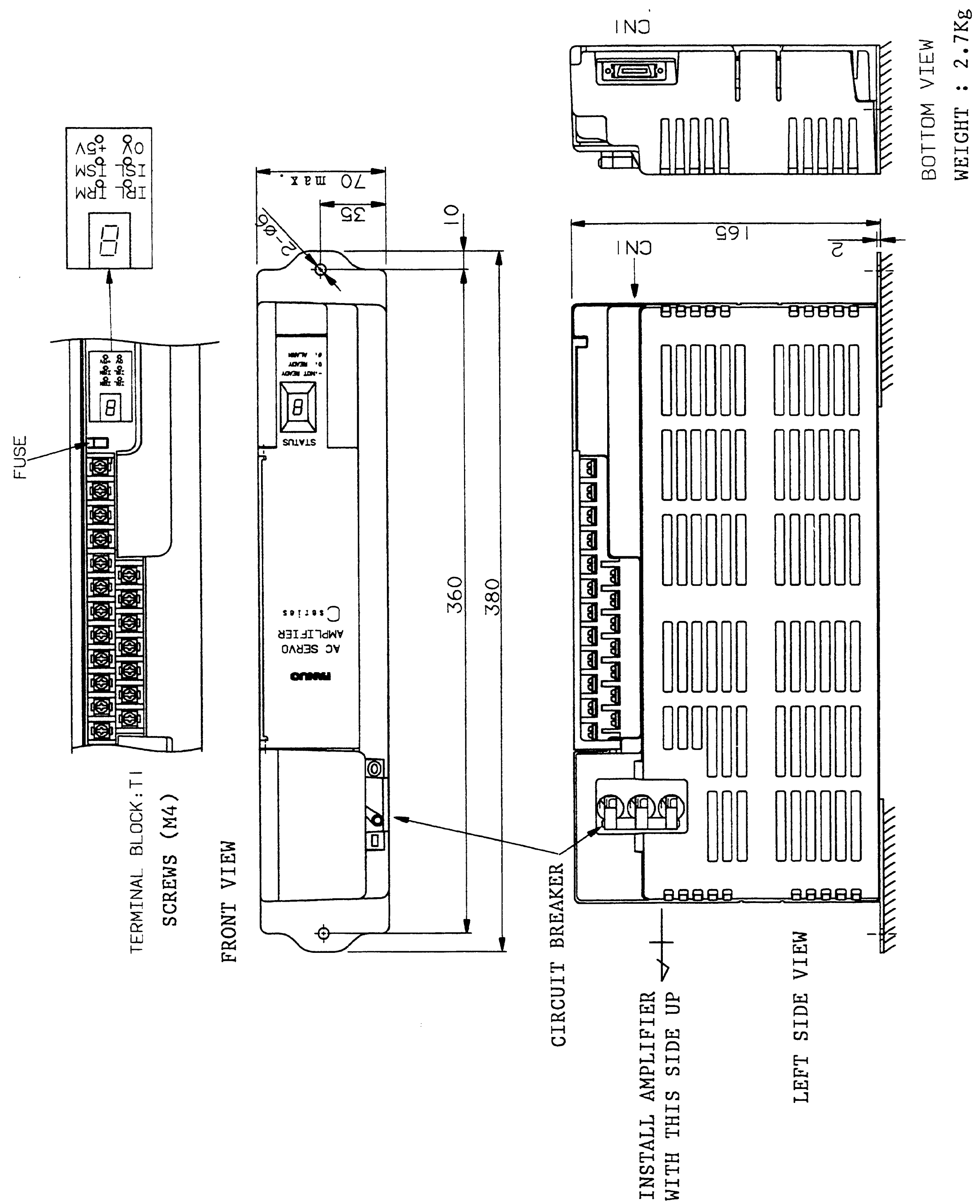
7. INSTALLATION CONDITIONS AND NOTES

See Chapter 7 of Part VII.

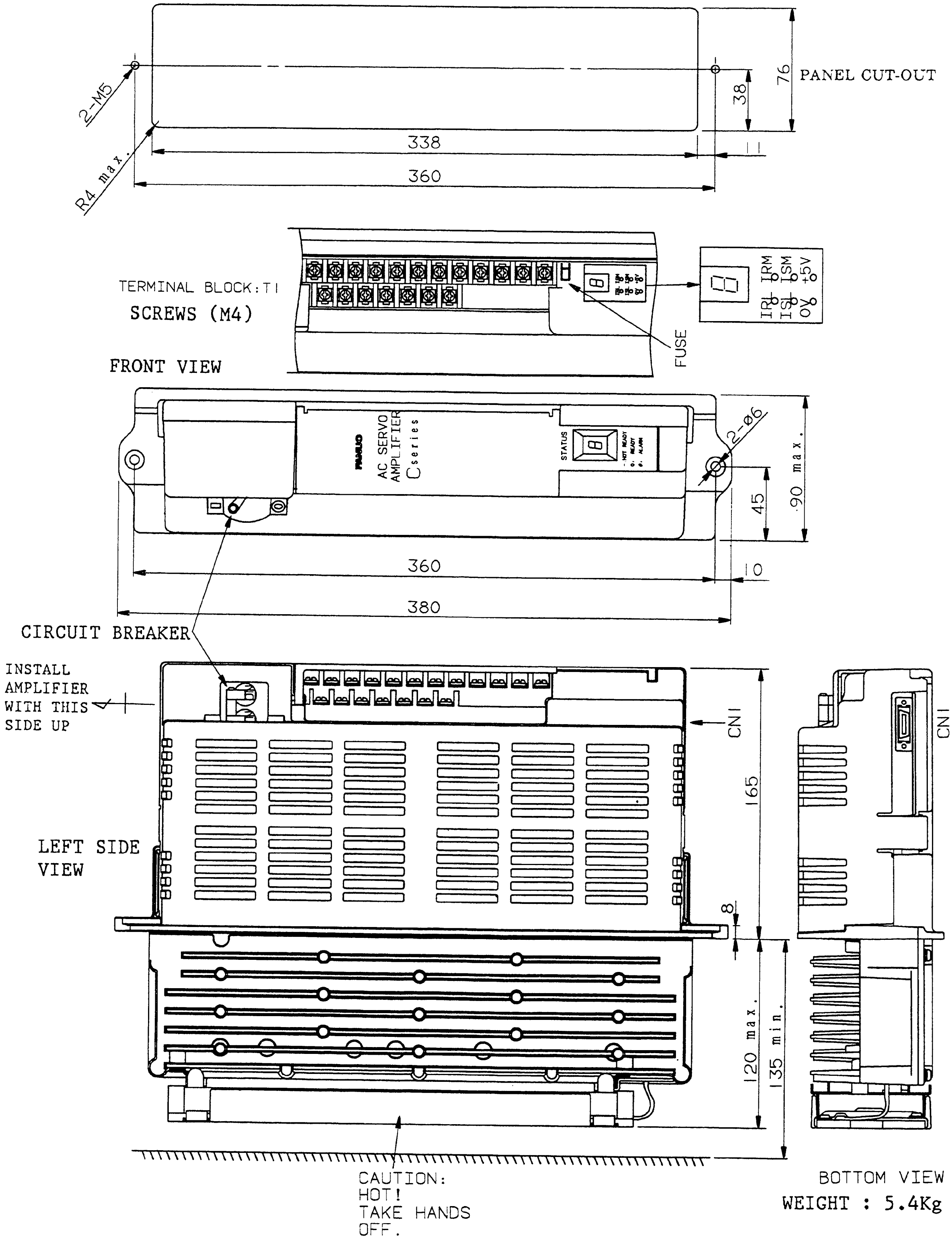
Note) The C Series servo amplifiers are more suitable to high-density packaging than conventional amplifiers. Note however that high-density packaging tends to result in a temperature rise around the amplifier, in which case the air surrounding the amplifier should be circulated as described in Section 7.2.1 in Part VI. Especially, a servo amplifier mounted in the upper section in the cabinet may be damaged because of the ambient air becoming hot unless it is circulated.

8. OUTLINE DRAWINGS

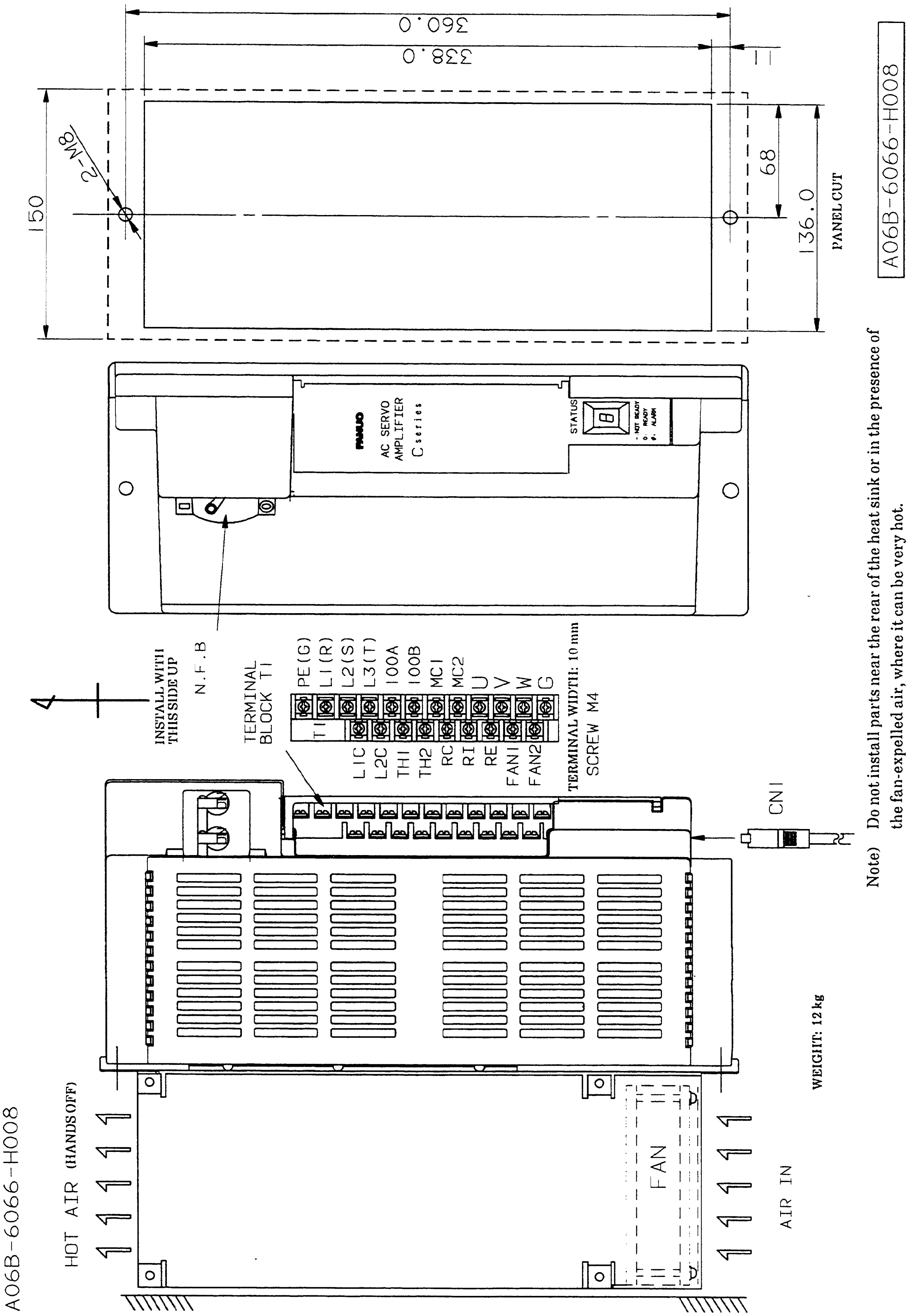
1) Outline drawing A06B-6066-H002 (amplifier for 4-0S and 3-0S)
A06B-6066-H003 (amplifier for 2-0SP, 1-0SP, and 1-0SP/3000)



2) Outline drawing A06B-6066-H004 (amplifier for 0S, 5S, 10S, and 20S/1500)
A06B-6066-H006 (amplifier for 5S/3000, 10S/3000, 20S, and 30S)

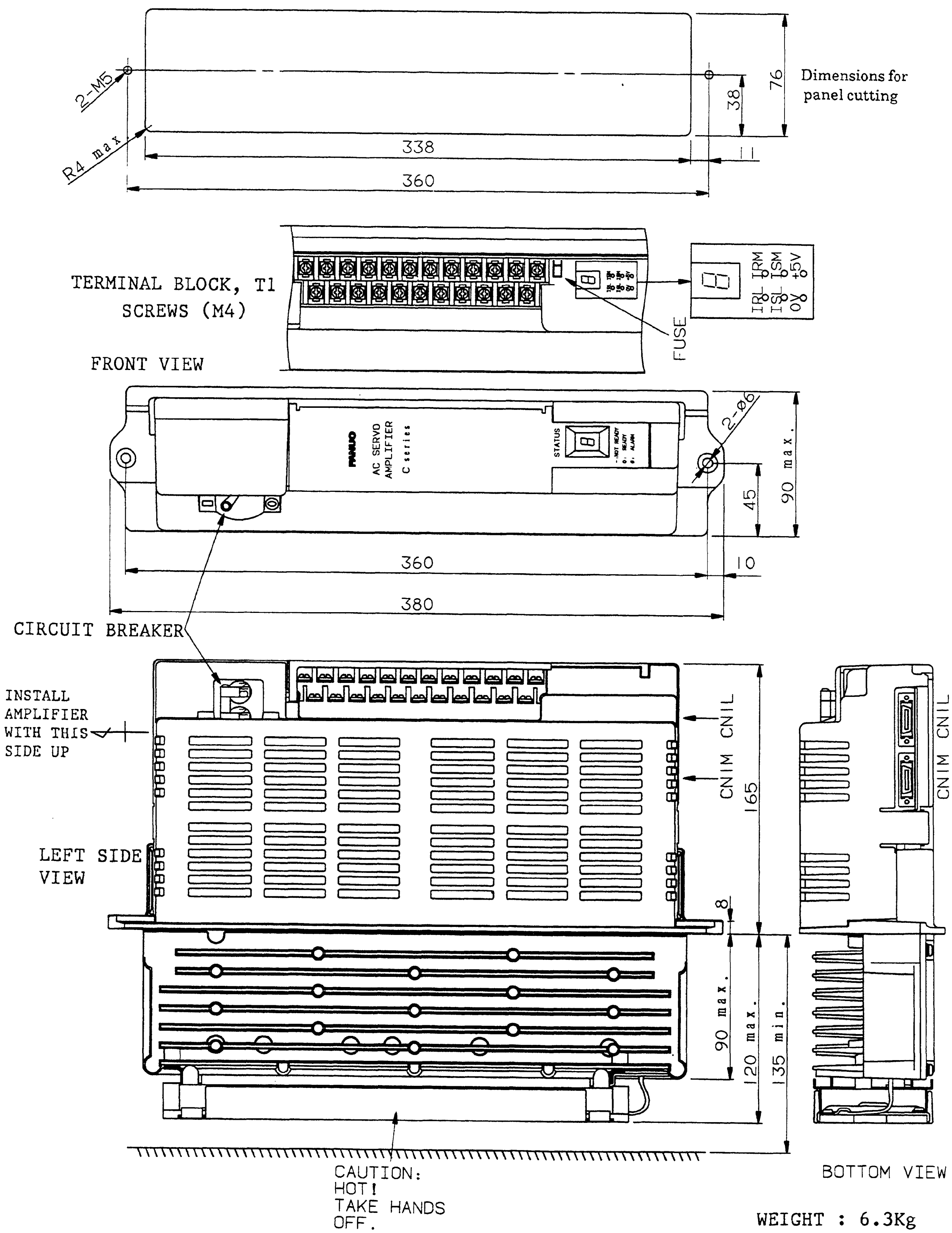


3) Outline drawing A06B-6066-H008 (amplifier for 20S/3000, 30S/3000, 40S/2000, 7L, and 10L)



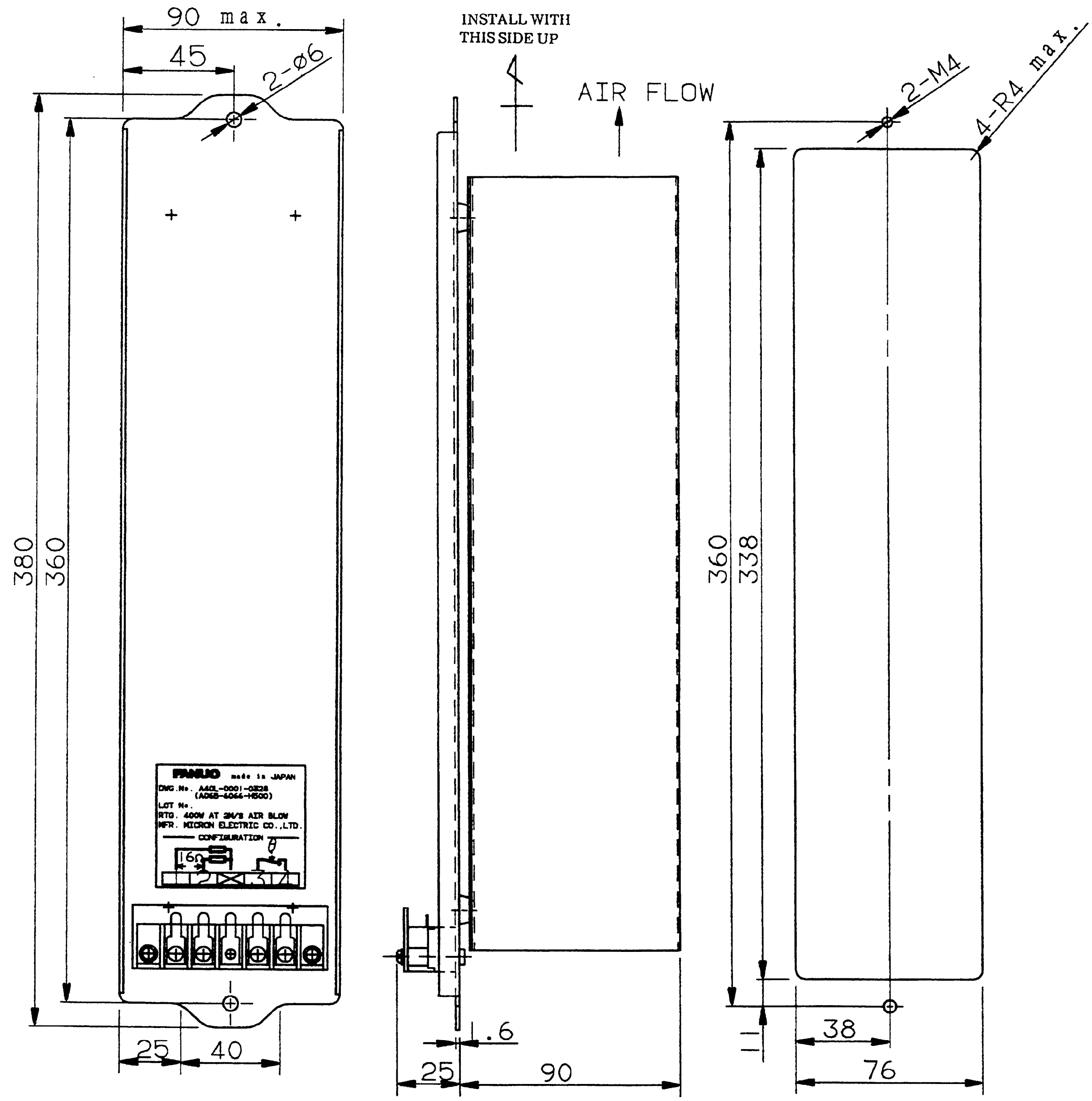
Note) Do not install parts near the rear of the heat sink or in the presence of the fan-expelled air, where it can be very hot.

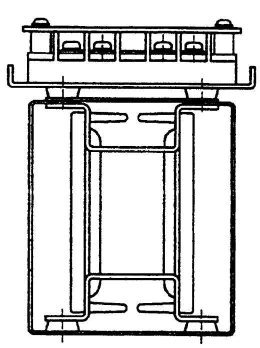
4) Outline drawing A06B-6066-H222, -H223, -H224, -H233, -H234, -H236, -H244, -H246 and -H266 (amplifier for two motors)



WEIGHT : 6.3Kg

5) Outline drawing A06B-6066-H500 (separate regenerative discharge unit)

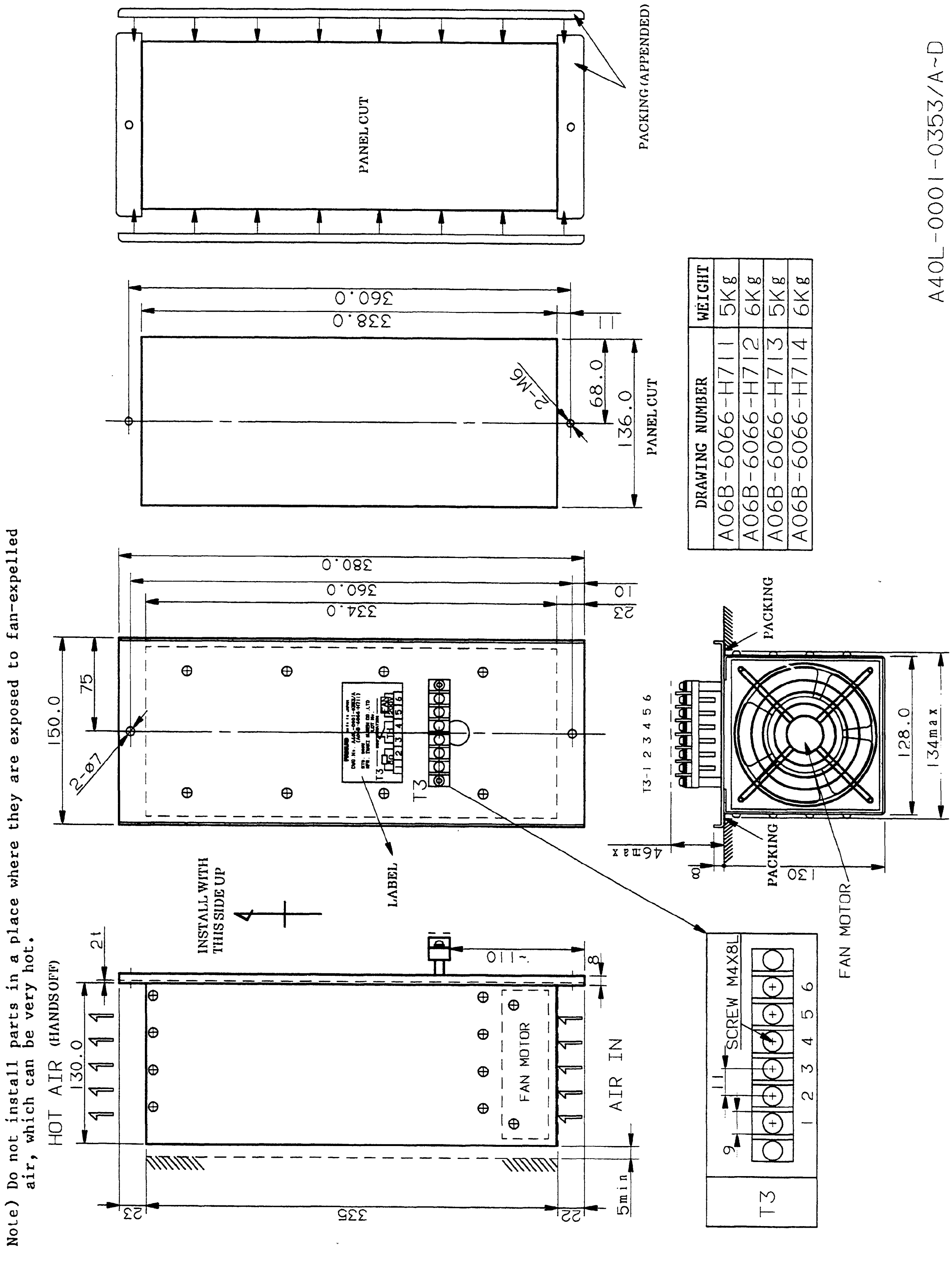




Resistance	:	16Ω (8Ω×2)
Rated heating value	:	400W (2m/s during ventilation)
Terminal block	:	M4×4 (between 1 and 2: resistance, between 3 and 4: thermostat)

WEIGHT : 2.2Kg

6) Outline drawings A06B-6066-H711 and -H714 (separate regenerative discharge unit)



7) Outline drawing of AC line filter

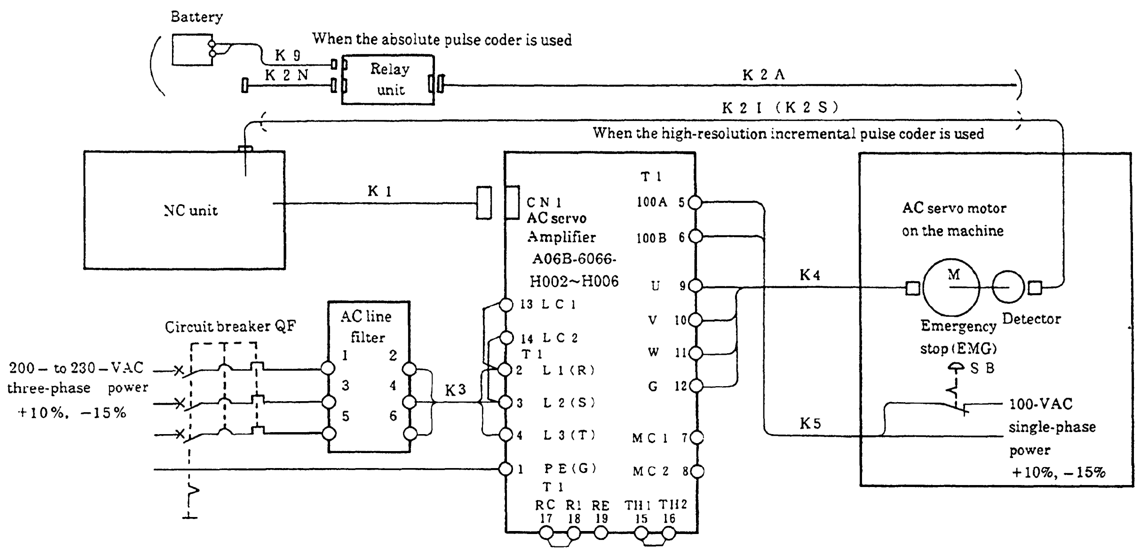
Note 1) See Chapter 8-6) in Section X for the outline drawing of the AC line filter (A81L-0001-0102).

Note 2) See Chapter 8-10) in Section VII for the outline drawings of other AC line filters and the power transformer for transportation.

9. CONNECTION

9.1 Connection Diagram

1) Standard connection (for a single motor A06B-6066-H002 to -H006)



Note 1) The cables for a conventional S series servo amplifier can be used as cables K2 to K9. Refer to section VII-9. Cable K1 uses different connectors and wires to a conventional cable. See item 9.2 for details.

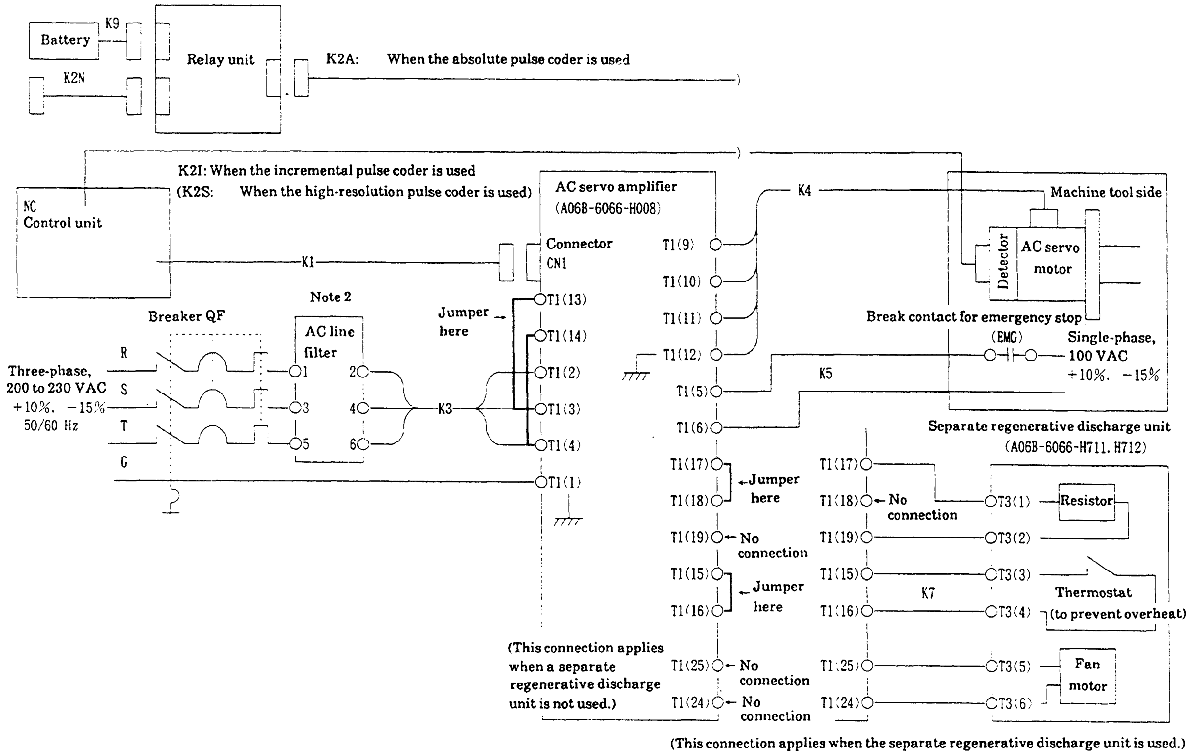
Note 2) Be sure to use an optional AC line filter to reduce the effect of high-frequency noise on the power.
Multiple servo amplifiers can be connected to one AC line filter provided they do not exceed the power that can be supplied to the AC line filter.

Note 3) Turning on circuit breaker QF for the power applies power to the servo amplifier.
Be sure to turn off the circuit breaker before touching the parts connecting the servo amplifier and the motor.

Note 4) The symbols ⊏ , ⊔ indicate the locations of the terminals that connected with jumper bars in the factory before shipping.

Note 5) Some NC units do not require a relay unit. For details, refer to the appropriate NC connection manual.

2) Standard connection (for 1-axis amplifier A06B-6066-H008)



Note 1) The cables for a conventional S series servo amplifier can be used as cables K2 to K9. Refer to section VII-9. Cable K1 uses different connectors and wires to a conventional cable. See item 9.2 for details.

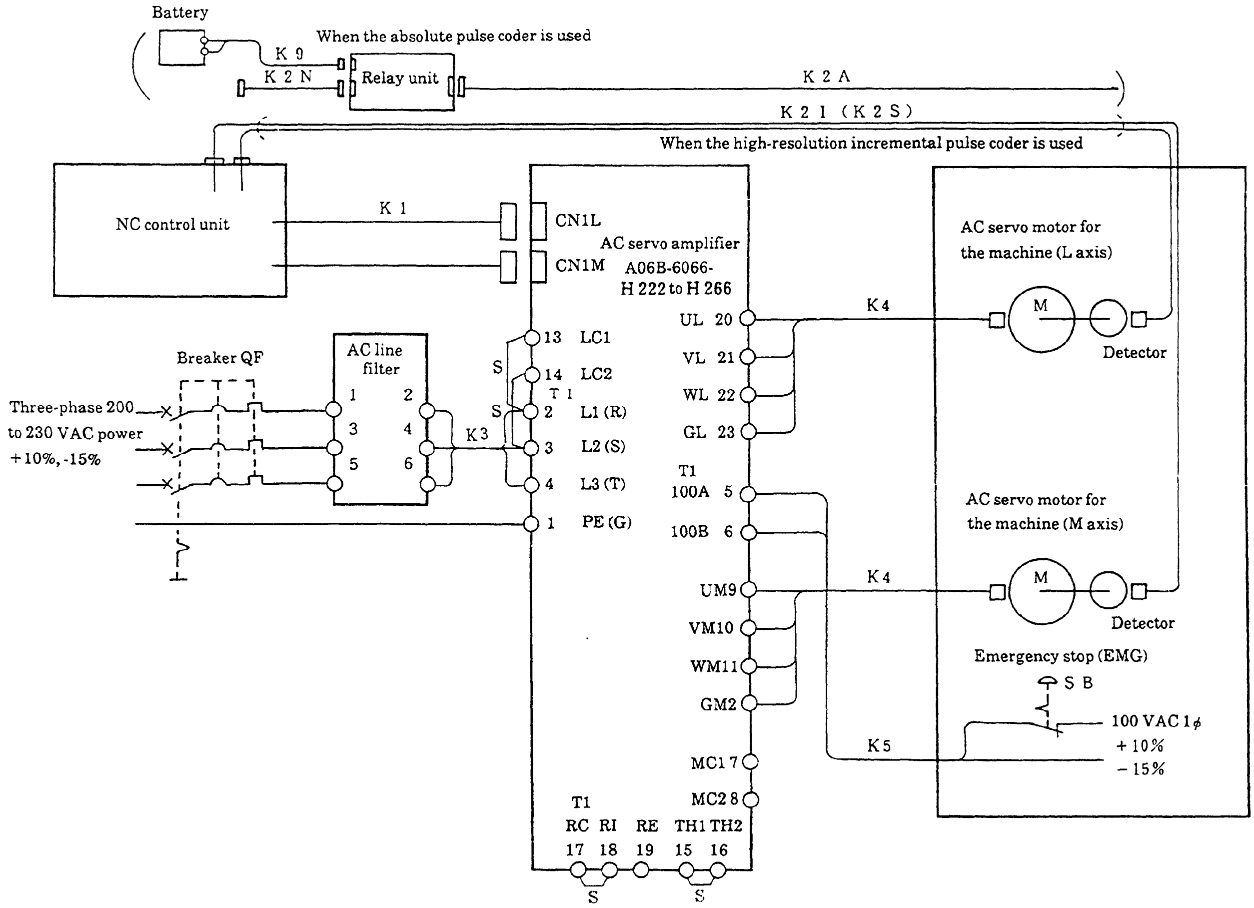
Note 2) Be sure to use an optional AC line filter to reduce the effect of high-frequency noise on the power.
Multiple servo amplifiers can be connected to one AC line filter provided they do not exceed the power that can be supplied to the AC line filter.

Note 3) Turning on circuit breaker QF for the power applies power to the servo amplifier.
Be sure to turn off the circuit breaker before touching the parts connecting the servo amplifier and the motor.

Note 4) The symbols (, _/ indicate the locations of the terminals that connected with jumper bars in the factory before shipping.

Note 5) Some NC units do not require a relay unit. For details, refer to the appropriate NC connection manual.

3) Standard connection (for 2-axis amplifier)



Note 1) The cables for a conventional S series servo amplifier can be used as cables K2 to K9. Refer to section VII-9. Cable K1 uses different connectors and wires to a conventional cable. See item 9.2 for details.

Note 2) Be sure to use an optional AC line filter to reduce the effect of high-frequency noise on the power.
Multiple servo amplifiers can be connected to one AC line filter provided they do not exceed the power that can be supplied to the AC line filter.

Note 3) Turning on circuit breaker QF for the power applies power to the servo amplifier.
Be sure to turn off the circuit breaker before touching the parts connecting the servo amplifier and the motor.

Note 4) The symbols (, ◡ indicate the locations of the terminals that connected with jumper bars in the factory before shipping.

Note 5) Some NC units do not require a relay unit. For details, refer to the appropriate NC connection manual.

Note 6) For the 2-axis amplifier motor power lines, the M-axis is connected to a smaller-numbered terminal than the L-axis.

9.2 Cable K1

The signals transmitted by cable K1 are the same as those transmitted by a conventional cable. Small connectors have been used for a new NC and C series servo amplifier.

Conventional connector	MR-20RF or equivalent	20 pins	
New connector	PCR-E20FA or equivalent	20 pins	Small connector (See Note 4.)

(1) Connect the C series servo amplifier with the new series NC as follows:

(NC: Such as FS16)

1	IRn	11	ISn
2	GDRn	12	GDSn
3	*PWMAn	13	*PWMDn
4	COMAn	14	COMDn
5	*PWMBn	15	*PWMEn
6	COMBn	16	COMEn
7	*PWMCn	17	*PWMFn
8	COMCn	18	COMFn
9		19	
10	*MCONn	20	*DRDYn

(Connector:
PCR-E20FA or equivalent)

Cable K1

(Amplifier: C series amplifier)

1	IRn	11	ISn
2	GDRn	12	GDSn
3	*PWMAn	13	*PWMDn
4	COMAn	14	COMDn
5	*PWMBn	15	*PWMEn
6	COMBn	16	COMEn
7	*PWMCn	17	*PWMFn
8	COMCn	18	COMFn
9		19	
10	*MCONn	20	*DRDYn

(Connector:
PCR-E20FA or equivalent)

Note 1) The letter n stands for an axis number. For the second axis, for example, read IRn as IR2.

(2) Connect the C series servo amplifier to the conventional NC as follows:

(NC: Such as FS0, FS15, or Power Mate)

1	*PWMAn	8	IRn	14	*PWMDn
2	COMAn	9	GDRn	15	COMDn
3	*PWMBn	10	ISn	16	*PWMEn
4	COMBn	11	GDSn	17	COMEn
5	*PWMCn	12	*MCONn	18	*PWMFn
6	COMCn	13	GNDn	19	COMFn
7	*DRDYn			20	

(See Note 2.)

(Connector: MR-20RF or equivalent)
(Refer to each NC connecting manual for the details of connectors on the NC.)

Cable K1

(Amplifier: C series amplifier)

1	IRn	11	ISn
2	GDRn	12	GDSn
3	*PWMAn	13	*PWMDn
4	COMAn	14	COMDn
5	*PWMBn	15	*PWMEn
6	COMBn	16	COMEn
7	*PWMCn	17	*PWMFn
8	COMCn	18	COMFn
9		19	
10	*MCONn	20	*DRDYn

(Connector: PCR-E20FA or equivalent)

Note 1) The letter n indicates an axis number. The IRn signal for the second axis is represented as IR2, for example.

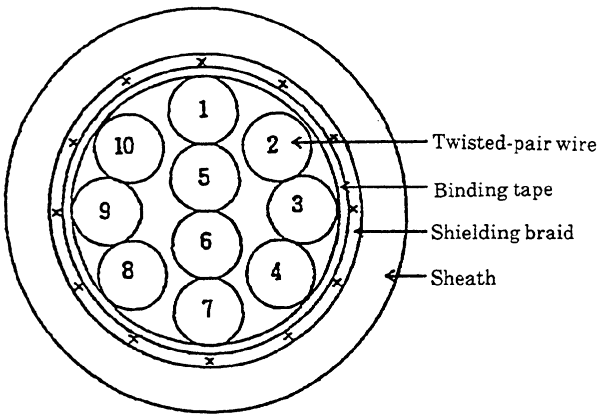
Note 2) Pin 13 (GNDn) of a conventional connector such as MR-20RF is not connected to the C series amplifier. There is, however, no problem with the amplifier because the common signal (0 V) is connected to the pin through terminals COMAn and COMFn. Do not connect wiring to the pin.

9.2.1 Wire for cable K1

This section describes wires that suit the new connector in conjunction with Section 9.2.2.

FANUC specification number: A66L-001-0284#10P
Name: 10-pair cable
Wire: #28AWG ×10 pair cable (20 conductors), standard length of 200 m
Manufacturer: Hitachi Cable, Ltd. and Oki Electric Cable Co., Ltd.

Structural drawing

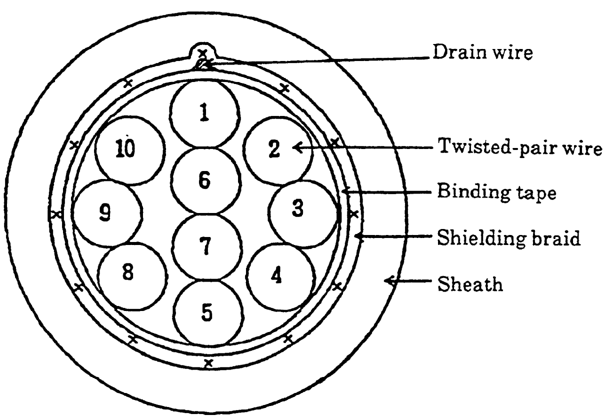


* The numbers in the above figure correspond to the twisted-pair wire numbers in the right table.

Conductor identification table (Hitachi)

Wire No.	Color of insulator	
	Conductor 1	Conductor 2
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

Fig. 1 Cable Manufactured by Hitachi Cable, Ltd.



* The numbers in the above figure correspond to the twisted-pair wire numbers in the right table.

Conductor identification table (Oki)

Wire No.	Color of insulator	Dot (1 pitch)	Color of dot	
			Class-1 conductor	Class-2 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

Fig. 2 Cable Manufactured by Oki Electric Cable Co., Ltd.

(1) Associate ten twisted-pair wires with pairs of pins 1 and 2, 3 and 4, ..., and 19 and 20 of a new connector such as PCR-E20FA when connecting the pins with the pairs.

(2) Use the central twisted-pair wires of the cable for pairs of pins 1 and 2 and pins 11 and 12 for current feedback signals IRn and ISn to minimize the external influence as much as possible. (Use twisted-pair wires 5 and 6 for IRn and ISn when the Hitachi cable is used. Use twisted-pair wires 6 and 7 for IRn and ISn when the Oki cable is used.)

(3) All the conductors of the cable have been covered with one shielding cable.
Ground the shielding to a grounding plate on the NC.

Specifications

Item		Unit	Specifications
Specifications (product No.)		—	A66L-0001-0284#10P
Manufacturer		—	Hitachi Cable, Ltd. Oki Electric Cable Co., Ltd.
Rating		—	60℃ 30V:UL2789 80℃ 30V:UL80276
Material	Conductor	—	Twisted tin-plated annealed copper wires (ASTM B-286)
	Insulator	—	Crosslinked vinyl
	Shielding braid	—	Tin-plated annealed copper wire
	Sheath	—	Heat- and oil-resistant vinyl
Number of pairs		Pair	10
Conductor	Size	AWG	28
	Configuration	Conductors/mm	7/0.127
	Outside diameter	mm	0.38
Insulator	Thickness	mm	0.1 Minimum partial thickness: 0.08 (3.1 mils)
	Outside diameter (approx.)	mm	0.58
	Core type (rating)	—	UL1571 (80℃, 30V)
Twisted-pair wire	Outside diameter (approx.)	mm	1.16
	Twisting pitch	mm	20 max.

Specifications

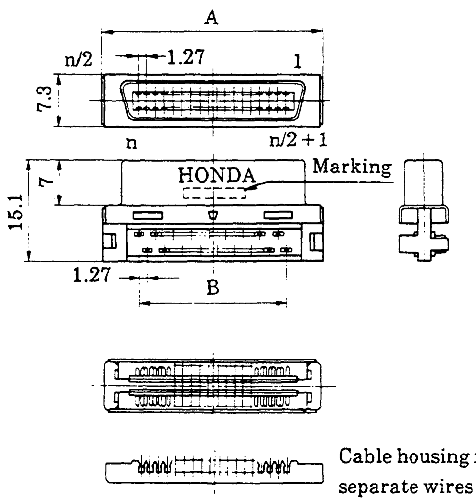
Item		Unit	Specifications
Bound wire		—	All the required twisted-pair wires shall be bundled into one group and bound with binding tape. Insent padding between the wires to finish them into one round cable if necessary.
Outside diameter (approx.) of the bound wire		—	3.5
Drain wire		Wires /mm	Not contained in Hitachi cable Contained in Oki cable: 10/0.12
Shielding braid	Diameter of a Single wire	mm	0.12
	Braid density	%	85 min.
Sheath	Color	—	Black
	Thickness	mm	1.0
	Outside diameter (approx.)	mm	6.2
Standard length		m	200
Packing		—	Bundle
Electrical characteristics	Electrical resistance (at 20℃)	Ω/km	233 max
	Insulation resistance (at 20℃)	MΩ-km	10 max.
	Dielectric strength (AC)	V/min.	300
Nonflammability		—	The cable must pass the nonflammability test, VW-1SC, in the UL standard.

9.2.2 Small type connector for cable K1

Item		Ordering information	Configuration
Input connector	Solder type	A06B-6066-K205	PCR-E20FS (body) and PCS-E20LA (cover)
	Crimp type	A06B-6066-K206	PCR-E20FA (body) and PCS-E20LA (cover)

Outline drawing

(1) Crimp type

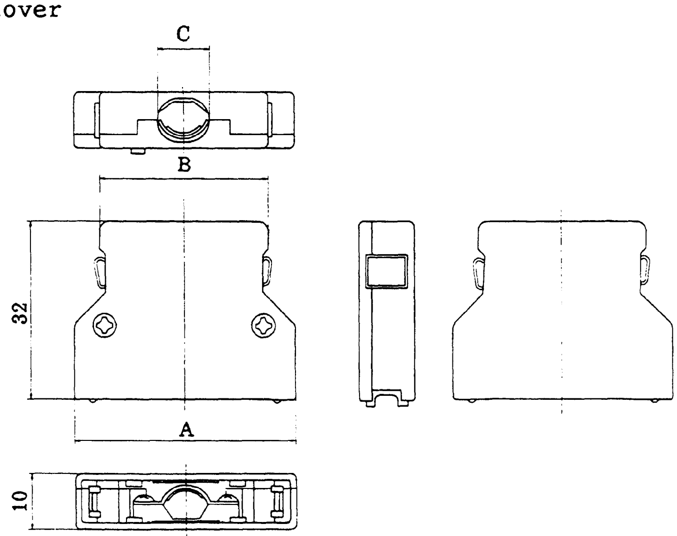


A special tool is required for crimping.
For the crimping tool, contact the manufacturer, Honda Communication Industrial Co., Ltd.

Wire layout cassette: JGPS-015-1/1-20
Wire layout cassette fixture: JGPS-014
Crimp locator: PCS-K1
Handpress: MFC-K1
(These are manufactured by Honda Communication Industrial Co., Ltd.)

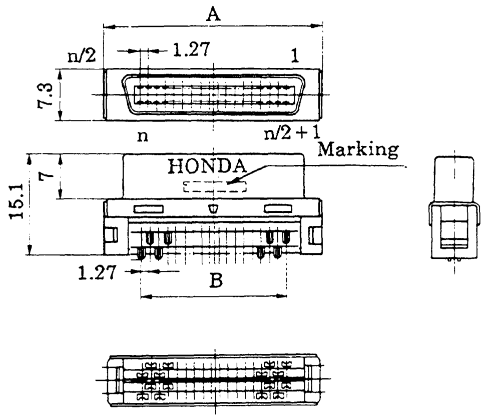
Number of conductors	Model	A	B
20	PCR-E20FA	21.65	11.43

(2) Connector cover



Number of conductors	Model	A	B	C
20	PCS-E20LA	30.0	20.3	6×5

(3) Solder type



Number of conductors	Model	A	B
20	PCR-E20FS	21.65	11.43

(Notes on soldering)
Since the new connector is very small, care must be taken when using the connector because the strength required to fasten the new connector contacts (pins) is less than that of conventional ones.
If the contacts are heated, the strength required is still less. Note the following when doing the soldering:

(1) The time for soldering the terminal section shall conform to the table below.
(2) Do not press the terminal section strongly using the soldering iron.
(3) Do not pull the wires immediately after soldering. Be sure to conform to the table below. (If it takes a long time for soldering, much care must be taken.)
(4) Do not expose the side engaged to the connector to hot air or pull the wires when applying heat-shrink tube.

Temperature of tip of soldering iron	Wire	Soldering time	No-load time after soldering
280℃	AWG#28(presoldered)	1.5 s	2 s min.
280℃	AWG#24(presoldered)	2.0 s	3 s min.
350℃	AWG#28(presoldered)	1.0 s	2 s min.
350℃	AWG#24(presoldered)	1.5 s	3 s min.

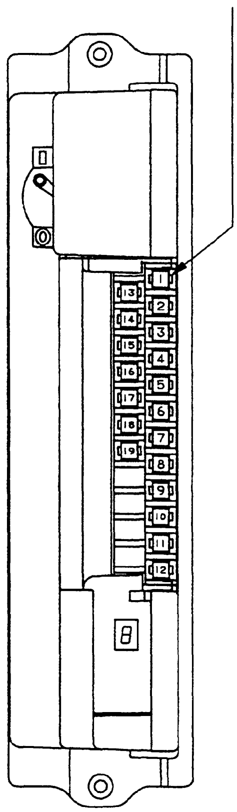
9.3 Terminal Block Connection

Connection to the terminal block and wire specification are basically the same as those for the S series. For details, refer to APPENDIX 1. Subsec. 9.3.1 below gives a table of correspondences.

If the wiring of the C series differs from that of the S series or if the connecting options are not clear, see Subsec. 9.3.2 and subsequent descriptions.

(For a single motor)

TERMINAL BLOCK :T1



Terminal block
(A06B-6066-H002 to A06B-6066-H006)

T1

13	L1C
14	L2C
15	TH1
16	TH2
17	RC
18	RI
19	RE

*1 *2 *3 *4

1	PE(G)
2	L1(R)
3	L2(S)
4	L3(T)
5	100A
6	100B
7	MC1
8	MC2
9	U
10	V
11	W
12	G

Note 1) Jumper bars (represented in bold) have been connected at the locations indicated by *1 to *4 in the factory before shipping.

Jumper bars indicated by *1 and *2 (for control power input)

The control power has been connected in the factory before shipping so that it has the same input as the motor power.
If the motor power is connected to terminals L1 (R), L2 (S), and L3 (T) under this condition, the C series servo amplifier can be used when the same power is connected to it as for the S series servo amplifier.

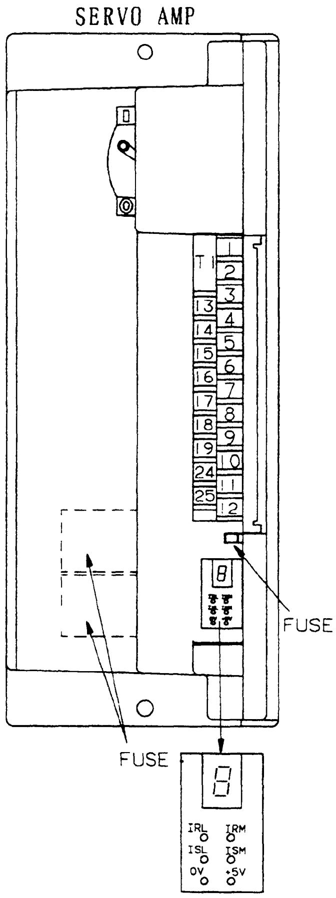
Jumper bar indicated by *3 (for thermostat input)

The separate regenerative discharge unit or the power transformer is assumed to be unused in the factory before shipping. Terminals TH1 and TH2 (external thermostat input) have been connected with this bar to prevent the alarms from being activated.

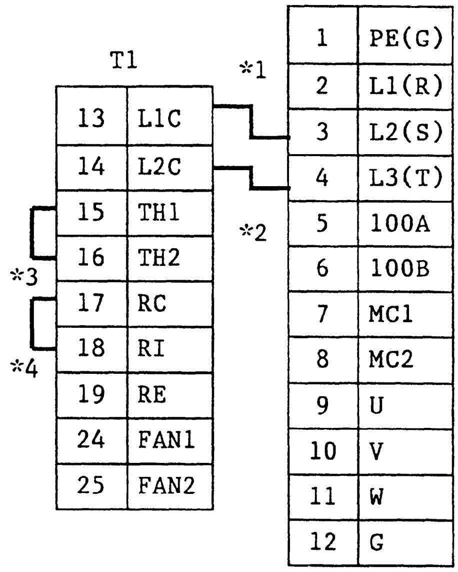
Jumper bar indicated by *4 (for built-in regenerative discharge unit)

The separate regenerative discharge unit is assumed to be unused in the factory before shipping. Connecting between terminals RC (regenerative register common) and RI (built-in resistor) enables the use of the regenerative discharge unit in the servo amplifier with this jumper bar removed.

Location of terminal block T1



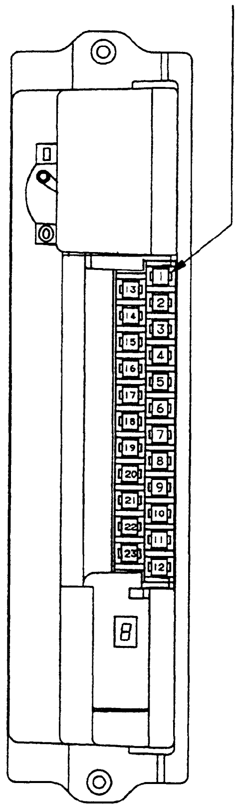
Terminal block (A06B-6066-H008)



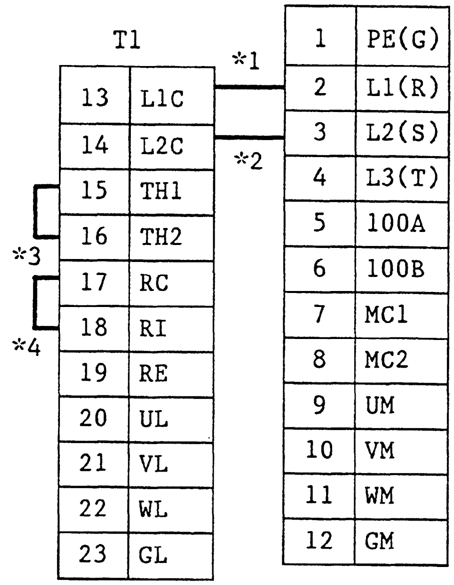
(for 2-axis amplifier)

Location of terminal block T1

TERMINAL BLOCK T1



Terminal block (A06B-6066-H222 to A06B-6066-H266)



Note that pin numbers are assigned to the M-axis power lines of the 2-axis amplifier prior to the L-axis ones when connecting the power lines.

9.3.1 Signal comparison between the S and C Series amplifiers

C Series 1-axis amplifier (A06B-6066-H002 to -H006)

Cable	Application	C series		S series	
		Name	Terminal	Name	Terminal
K3	Protective ground for amplifier	PE(G)	T1(1)	G	T1(G)
	AC power input 200/220/230 VAC +10%,-15% 3 phases	L1(R)	T1(2)	U,R	T1(A)
		L2(S)	T1(3)	V,S	T1(1)
		L3(T)	T1(4)	W,T	T1(2)
K5	Input for emergency stop 100 VAC, single phase +10%,-15%	100A	T1(5)	100A	T1(3)
		100B	T1(6)	100B	T1(4)
New	Signal for checking whether the magnetic contactor is turned of Contact-b output	MC1	T1(7)	No corresponding terminal	
		MC2	T1(8)	No corresponding terminal	
K4	AC motor output (motor line)	U	T1(9)	U	T1(5)
		V	T1(10)	V	T1(6)
		W	T1(11)	W	T1(7)
	Motor ground line	G	T1(12)	G	T1(8)
New	Control power input 200/220/230 VAC +10%,-15%	L1C	T1(13)	No corresponding terminal	
		L2C	T1(14)	No corresponding terminal	
K6	Thermostat input signal	TH1	T1(15)	TOH1	T4(1)
		TH2	T1(16)	TOH2	T4(2)
K7	Regenerative resistor (Built-in resistor) (Separate resistor)	RC	T1(17)		T2(4)
		RI	T1(18)		T2(5)
		RE	T1(19)		T2(6)

C Series 1-axis amplifier (A06B-6066-H008)

Cable	Application	C series		S series		L series	
		Name	Terminal	Name	Terminal	Name	Terminal
K3	Protective ground for amplifier	PE(G)	T1(1)	G	(G)	G	(G)
	3 phases AC power input 200/220/230 VAC +10%,-15%	L1(R)	T1(2)	R	NFB(R)	R	T1(A)
		L2(S)	T1(3)	S	NFB(S)	S	T1(1)
		L3(T)	T1(4)	T	NFB(T)	T	T1(2)
K5	Single-phase Emergency stop input 100 VAC +10%, -15%	100A	T1(5)	100A	FMA	100A	T1(3)
		100B	T1(6)	100B	FMB	100B	T1(4)
New	Break contact output to indicate the magnetic contactor is open.	MC1	T1(7)	No corresponding terminal			
		MC2	T1(8)	No corresponding terminal			
K4	AC motor output (power line) Motor grounding line	U	T1(9)	U	T1(U)	U	T1(5)
		V	T1(10)	V	T1(V)	V	T1(6)
		W	T1(11)	W	T1(W)	W	T1(7)
		G	T1(12)	G	T1(G)	G	(G)
New	Control power supply input 200/230/230 VAC +10%, -15%	L1C	T1(13)	No corresponding terminal			
		L2C	T1(14)	No corresponding terminal			
K6	Thermostat input signal	TH1	T1(15)	TOH1	T4(1)	TOH1	CN2(4)
		TH2	T1(16)	TOH2	T4(2)	TOH2	CN2(5)
K7	For regenerative discharge resistors (Built-in resistor) (Separate resistor)	RC	T1(17)		T2(4)		T2(4)
		RI	T1(18)		T2(5)		T2(5)
		RE	T1(19)		T2(6)		T2(6)
K10	Power for cooling fan for separate regenerative discharge resistor	FAN1	T1(24)	No corresponding terminal			
		FAN2	T1(25)	No corresponding terminal			

K10: Heavy-duty power cord or wire 37/0.26 (2 mm^2) × 2, sheathed in heat-resistant PVC

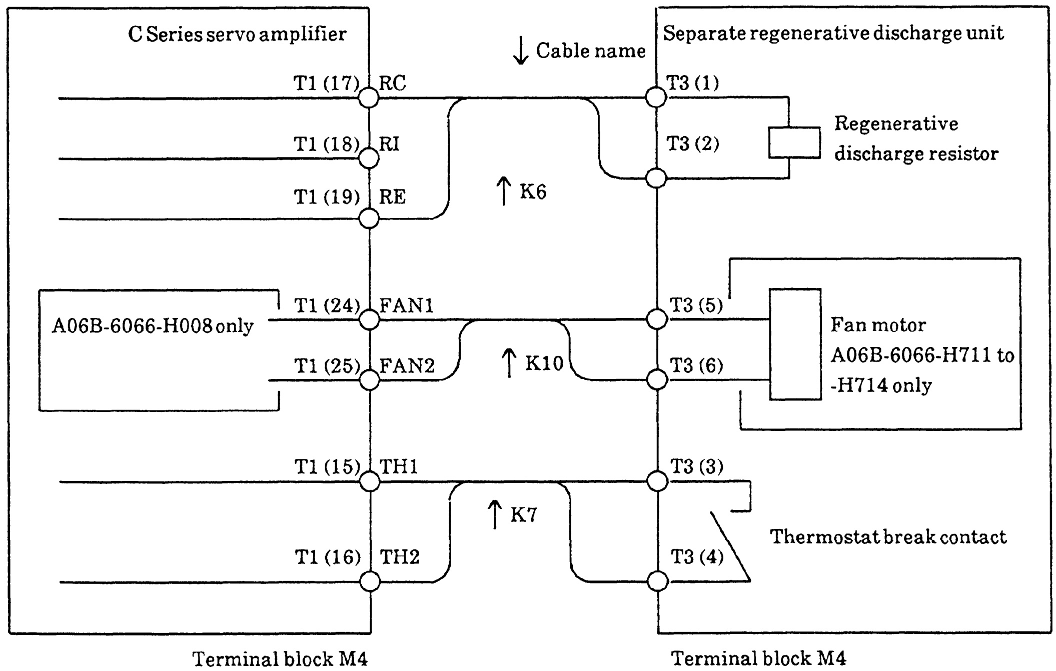
C Series 2-axis amplifier (A06B-6066-H222 to H266)

Cable	Application	C series		S series	
		Name	Terminal	Name	Terminal
K4	AC motor output (motor line)	UL	T1(20)	UL	T1(5L)
		VL	T1(21)	VL	T1(6L)
		WL	T1(22)	WL	T1(7L)
	Motor ground line	GL	T1(23)	GL	T1(G)
K4	AC motor output (motor line)	UM	T1(9)	UM	T1(5M)
		VM	T1(10)	VM	T1(6M)
		WM	T1(11)	WM	T1(7M)
	Motor ground line	GM	T1(12)	GM	T1(G)

9.3.2 Connecting the separate regenerative discharge unit

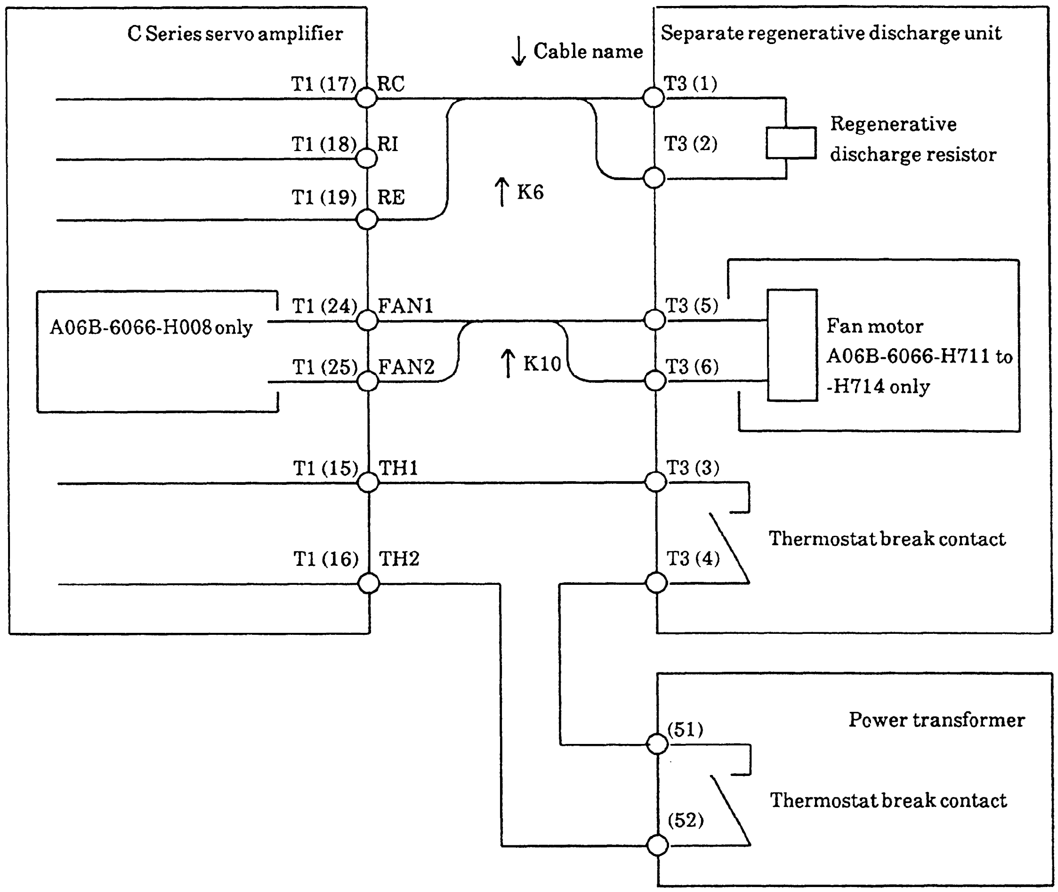
Before using the separate regenerative discharge unit, remove jumpers from between RC and RI and between TH1 and TH2, connect the resistor terminals of the separate regenerative discharge unit between RC and RE, and supply the thermostat signal between TH1 and TH2.

(1) Example of connecting the separate regenerative discharge unit



Wire in cable K10:	Heavy-duty power cord or wire 37/0.26 (2 mm^2) x 2, sheathed in heat-resistant PVC
Wire in cable K6:	AWG#14 (2 mm^2 min), 600 V, insulated with heat-resistant PVC
Wire in cable K7:	AWG#18 (0.75 mm^2 min), 200 V, insulated with heat-resistant PVC

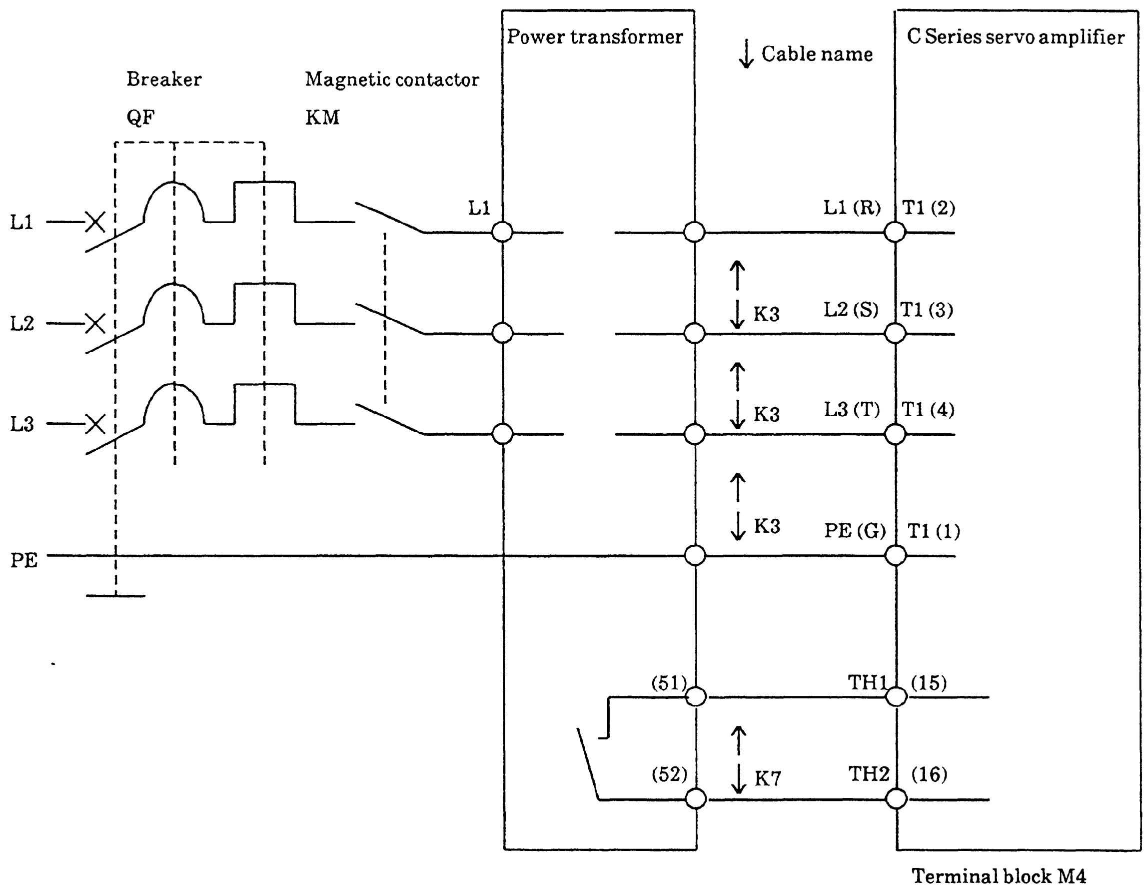
(2) Connecting the separate regenerative discharge unit and the power transformer
(Only the TH1 and TH2 are have to be wired. See Section 9.3.3 for the wiring for the entire transformer.)



9.3.3 Connecting the power transformer

The thermostat signal from the power transformer should be used in a sequence to shut off the line contactor at the input of the transformer in order to prevent it from burning because of a possible layer-to-layer short circuit.
To supply the thermostat signal from the transformer to the servo amplifier to reset an alarm, connect the transformer thermostat in series with the thermostat for the separate regenerative discharge unit between TH1 and TH2. In this case, the thermostat provides a DC alarm when it operates.
When the transformer is used in connection with the separate regenerative discharge unit, the TH1-TH2 wiring should be installed as shown below. See Section 9.3.2 also.

(1) Example of connecting the power transformer

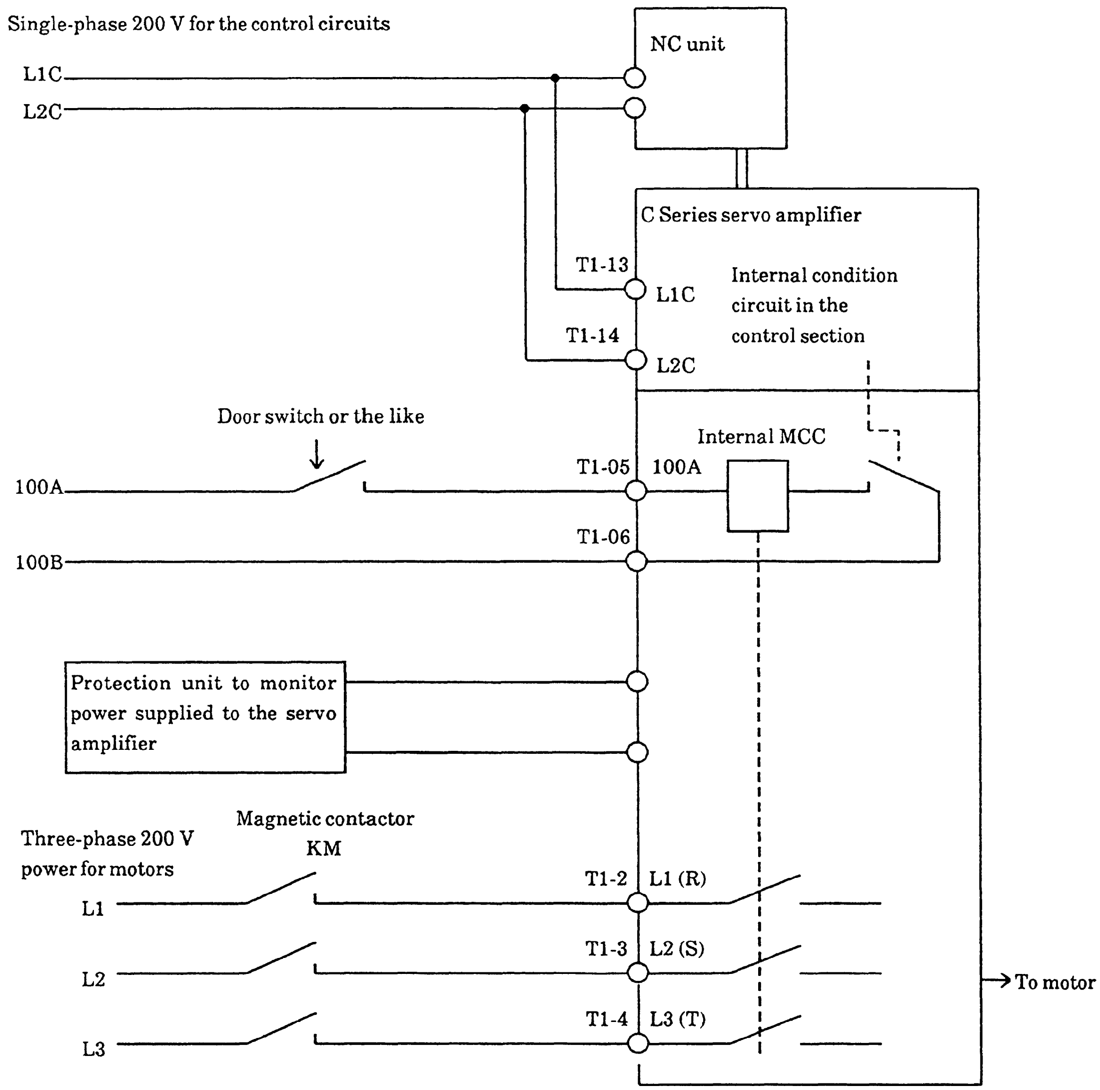


Wire in cable K7: AWG#18 (0.75 mm^2 min), 200 V, insulated with PVC
Wire in cable K3: See Chapter 9 of Part VII, in which how to tap the transformer is also explained.

Do not forget to remove the jumper between servo amplifier terminals TH1 ant TH2.

9.3.4 Using terminals L1C and L2C

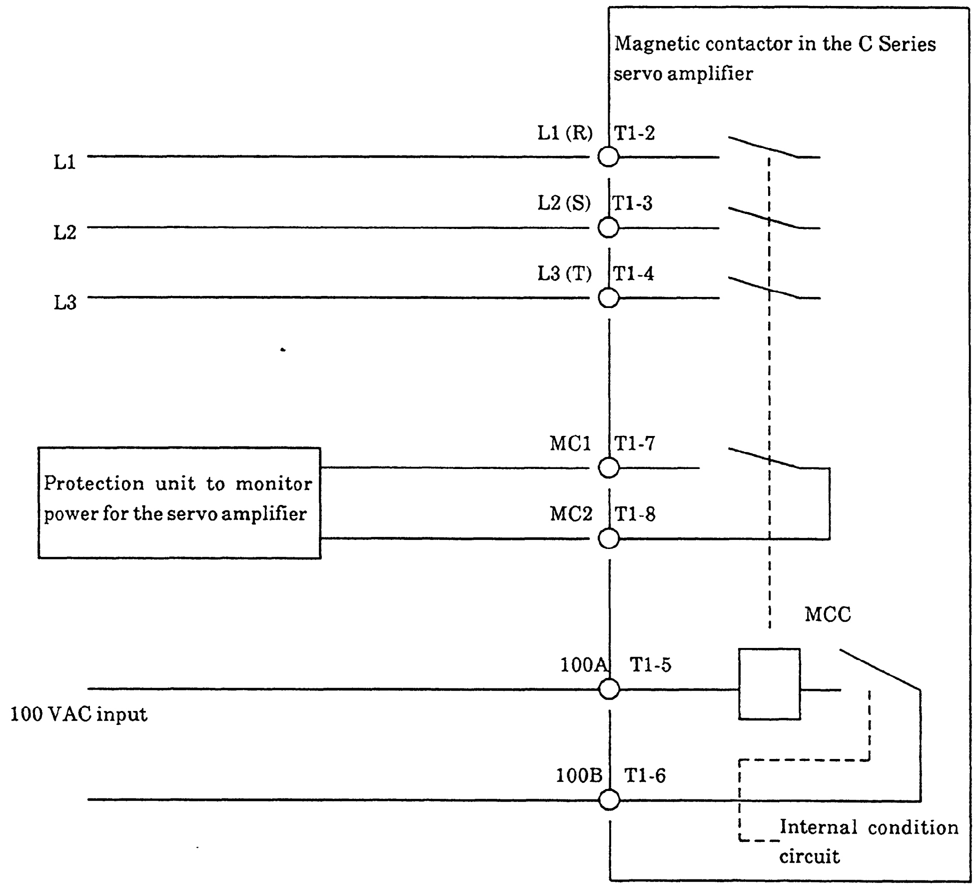
Terminals L1C and L2C are a newly added interface for the C Series servo amplifier. When the power for the control circuits is supplied separately from the main power supply, terminals L1C and L2C can be used to receive power (200 to 230 VAC +10%, -15%) for the control circuits, in which case the two jumper bars should previously be removed.



Usually, disconnecting 100A and 100A at the door switch switches off the internal MCC which in turn shuts off the motor power completely. If a safety standard requires that the power line be disconnected externally, design a configuration that power to LC1 and LC2 is supplied separately from the motor power and that after the 100A-100B loop is opened, the motor power is shut off. To supply power again with no alarm developing, the 100A-100B loop should be closed after the motor power is supplied.

9.3.5 Using terminals MC1 and MC2

Terminals MC1 and MC2 are a newly added interface for the C Series servo amplifier. These terminals are connected directly to the break contact of the magnetic contactor for the main circuit. They are closed when the main circuit is shut off.



As shown above, the user can design a special protection unit by monitoring a contact of the magnetic contactor incorporated in the amplifier to see whether the servo amplifier can supply power. (See Chapter 3 for the ratings of the contact.)

10. CHANGES FROM S SERIES SERVO AMPLIFIER

The functions and interface of the C series servo amplifier are basically the same as those of the S series servo amplifier. The C series amplifier, however, has some functions which differ from those of the S series servo amplifier. These changes are described below:

[Changes required when changing from the S series servo amplifier to the C series servo amplifier]

(1) The outer and installation dimensions of the amplifier have been changed. See section 8.
The panel cutting dimensions are changed if the radiating fin is installed outside the cabinet.
(2) The connector CN1 for interfacing with the CNC has been changed to a small connector. With this change, the servo-side connector and applied wires of cable K1 have also been changed. Conventional cables can be used for all cables except cable K1. See section 9.2.
(3) A new separate regenerative discharge unit for the panel mount has been added to prevent excessive amounts of heat from being generated in the cabinet. See Sections 4.2.1, 4.2.2, 5 to 8, and 9.3.
The discharge power during natural air-cooling is 200 W. The unit can be used at 600 W max. (wind velocity: 4 m/s) by forced air-cooling.
Care must be taken when using a conventional separate regenerative discharge unit.
See Note 3 in section 4.2.3.
The power transformer and AC line filter of the C series are the same as those of the S series.

[Added functions]

(1) The magnetic contactor for the main circuit in the amplifier is designed to break all the three phases of the motor power without fail. The auxiliary contact of the magnetic contactor can be used for checking whether the magnetic contactor is turned off. See Note 6 in section 9.3.
(2) The control power input can be separated from the three-phase motor power. The control power input is connected to the motor power with jumper bars in the factory before shipping.
If the power to the servo amplifier must be turned off to satisfy the safety requirements, the monitor state of the amplifier can be held by separating the control power from the motor power. See Note 5 in section 9.3.
(3) The power to the regenerative discharge resistor which is built in an amplifier is 100 W during natural air-cooling for motor models 0S to 30S. The discharge power can be increased to 300 W (wind velocity: 4 m/s) by forced air-cooling.
The separate regenerative discharge resistor rarely needs to be used.
Since the temperature of the regenerative discharge resistor may rise to approx. 200℃, the cabinet must be designed so that it is impossible to put parts near the resistor or to touch the resistor.
(4) The terminal block has been designed so that multiple C series amplifiers placed side by side can be connected with bus bars. This applies to the three-phase power and the 100-V power to the coil operating the magnetic contactor. (Refer to Fig. (10))
(5) Use of a fully covered structure has improved safety so that nobody can inadvertently get a electric shock.

(6) The alarm function has been improved by the added magnetic contactor welding alarm. Indicating an alarm number on the front panel has improved visibility.
(7) The sealed packing for installing the amplifier on the panel cutting surface is attached.

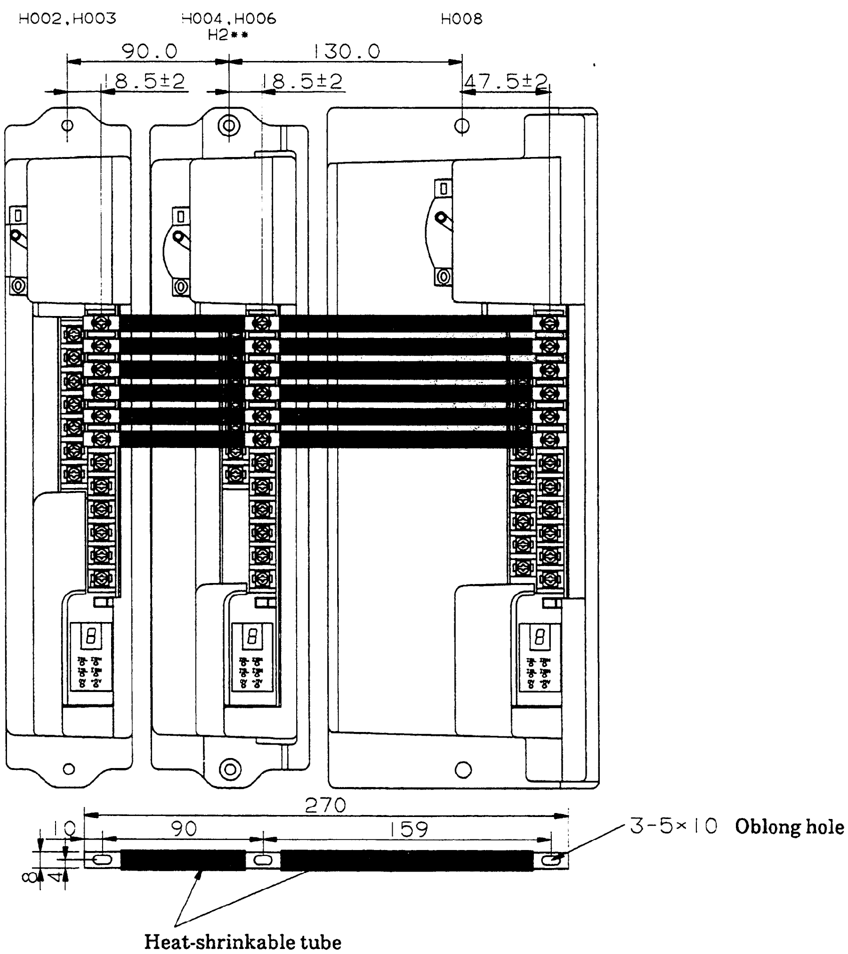


Fig. 10 Example of connecting the bus bars

The thickness of the bus bar should be determined according to the power to be supplied to the motor. When the bus bar is made of copper and 8 mm wide, the minimum required thickness of it is calculated by:

t [mm] = sum of three-phase power (kVA) for the motors x 0.1

Note) The bus bar in this example may not always meet every safety standard. The user is requested to prepare the bus bar on his/her own.

VII. FANUC AC SERVO AMPLIFIER S series (200 V INPUT FOR 1 AXIS)

1. GENERAL

The 1-axis digital AC servo amplifiers (200 V input type) are developed especially for machine tools and industrial robots. A motor for 200 V input is used. The main features are:

1) The input power voltage is 200/220/230 VAC +10%/-15%, permitting direct connection without a transformer in the main regions of the U.S.A. and all regions in Japan.
2) Compact structure realizes light weight and high reliability.
3) Externally cooled heat sink is employed. This keeps heat out of the enclosure, and permits construction of a more reliable system.
4) Circuit protection and fault detection are ensured by the no-fuse circuit breaker (or a fuse) and the overvoltage/low voltage detection function, the overcurrent detection function and the regenertive discharge circuit fault detection function.
5) A servo amplifier designed exclusively for a digital AC servo. Comblined with the latest FANUC NC, if utilizes the full performance capability of the servo motor.

Note) When selecting the servo amplifier for a T series servo motor (hollow-shaft type motor), select the same servo amplifier as for the corresponding S series servo motor.
The correspondence between the T series motors and S series motors regarding the servo amplifiers is as follows.

Model 0T/3000:	Model 0S/3000
Model 5T/2000:	Model 5S
Model 5T/3000:	Model 5S/3000
Model 10T/2000:	Model 10S
Model 10T/3000:	Model 10S/3000

2. CONFIGURATION

Fig. 2 shows an example of an NC system configuration for 2-axis control. When the regenerative energy is too large under certain load conditions, and a separate type regenerative discharge unit may be necessary.

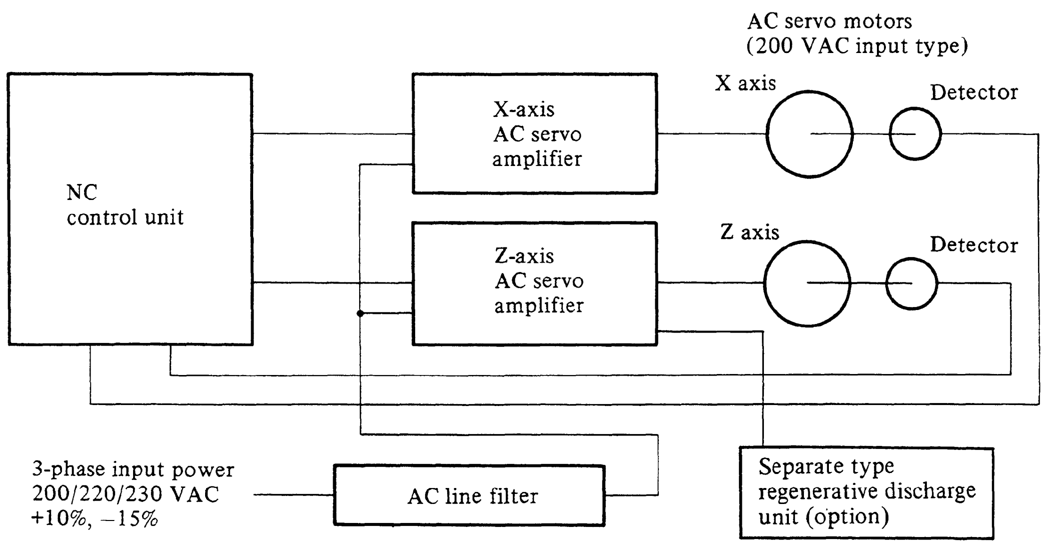


Fig. 2 Example of configuration

2.1 Types of Unit and Specifications

Table 2.1 Types of unit and specifications

Name	Application	Specification
Servo amplifier Note 1, 2, 3 and 4)	Models 4-0S and 3-0S	A06B-6058-H002
	Models 2-0SP and 1-0SP	A06B-6058-H003
	Models 2-0SP/3000 and 1-0SP/3000	A06B-6058-H023
	Models 0-0SP, 0S and 5S	A06B-6058-H004
	Models 0S/3000, 10S, and 20S/1500	A06B-6058-H005
	Models 5S/3000 and 10S/3000	A06B-6058-H025
	Models 20S and 30S	A06B-6058-H006
	Models 20S/3000, 30S/3000, and 40S/2000	A06B-6058-H007
AC line filter Note 5)	Type A: Sum of rated motor output 5.4 kW max.	A81L-0001-0083 #3C
	Type B: Sum of rated motor output 10.5 kW max.	A81L-0001-0101 #C
	Type C: Sum of rated motor output 23 kW max.	A81L-0001-0102
Power transformer for export	Type SAE: Capacity 2.2 kVA	A80L-0022-0005
	Type SBE: Capacity 3.5 kVA	A80L-0024-0006
	Type SCE: Capacity 5 kVA	A80L-0026-0003
	Type SDE: Capacity 7.5 kVA	A80L-0028-0001
Separate type regenerative discharge unit	Option for models 10S to 30S (Note 6), 16 Ω/400 W	A06B-6050-H050
	Models 20S/3000, 30S/3000, and 40S/2000 (Note 6), 8 Ω/800 W	A06B-6058-H192
Input connector Note 7)	Soldering type	A06B-6058-K205
	Crimp type	A06B-6058-K206
Spare fuse	Model 4-0S and 3-0S	A06B-6058-K101
	Model 2-0SP and 1-0SP	A06B-6058-K102
	Models 20S/3000, 30S/3000, and 40S/2000	A06B-6058-K301
Mounting adaptor Note 8)	Option for models 0S to 30S For 1-axis amplifiers except H007	A06B-6058-K103

Note 1) Use the AC servo motor corresponding to this series (200/220/230 VAC input).

Note 2) Because model 0S operates at both 3000 rpm and 2000 rpm, there is no distinction between a 3000rpm motor and a 2000rpm motor. However, the nominal capacity of the amplifier varies depening on the operating speed of the motor. In this manual, model 0S rated at 2000 rpm is designated as 0S, and model 0S rated at 3000 rpm is designated as 0S/3000. This also applies to model 2-0S.

Note 3) When selecting the servo amplifier for a T series servo motor (hollow-shaft type motor), select the same servo amplifier as for the corresponding S series servo motor.
The correspondence between the T series motors and S series motors regarding the servo amplifiers is as follows.

Model 0T/3000:	Model 0S/3000
Model 5T/2000:	Model 5S
Model 5T/3000:	Model 5S/3000
Model 10T/2000:	Model 10S
Model 10T/3000:	Model 10S/3000

Note 4) The amplifier for model 2-0S is the same as that for model 2-0SP, and the amplifier for model 1-0S is the same as that for model 1-0SP.
The descriptions for the amplifier for model 2-0SP and 1-0SP are also applicable to the amplifier for model 2-0S and 1-0S.

Note 5) Use this filter to minimize the high frequency noise on the power supply. With A81L-0001-0083 #3C, one line filter permits connection with three amplifiers of model 10S. (Model 10S: Rated output 1.8 kW)
With A81L-0001-0101 #C, a one line filter permits connection with three amplifiers of model 20S. (Model 20S: Rated output 3.5 kW)
This line filter can be deleted when a power transformer (insulated type) is used.

Note 6) When the load inertia is too large or the frequency of acceleration/deceleration is too high, if regenerative energy from the motor exceeds 100 W (for models 0S/3000 to 10S/3000), the separate regenerative discharge unit needs to be employed. If the heat loss is much larger than 100 W, refer to the servo motor selection manual, and contact FANUC. For the A06B-6058-H007 amplifier, the separate regenerative discharge unit is always required.

Note 7) A connector for the cable connected to the input terminal CN1 of the servo amplifier. One set is used per axis.

Note 8) The S series servo amplifier can be mounted on the front of a panel on a locker without needing to cut the panel.

3. SPECIFICATIONS

3.1 Specifications

Table 3.1 (a) Specifications (common)

Item		Specifications
Power source	Three-phase input for power	Voltage: 200/220/230 VAC Allowable voltage fluctuation: +10, -15% Frequency: 50/60 Hz Allowable frequency fluctuation: ±2 Hz
	Single-phase input for emergency stop	Voltage: 100 VAC, Frequency: 50 Hz Allowable voltage fluctuation: +10%, -15% Allowable frequency fluctuation: ±2 Hz or Voltage: 100/110 VAC, Frequency: 60 Hz Allowable voltage fluctuation: +10%, -15% Allowable voltage fluctuation: ±2 Hz
Main circuit control method		Sine wave PWM control with transistor bridge
Warning and protection function		. No-fuse circuit breaker (Models 0S to 30S) . Fuse (models 1-0S to 4-0S) . Overvoltage . Low voltage . Over-regeneration . Circuit faulty detection (Abnormal current)

Table 3.1 (b) Specifications (currents output by the servo amplifiers)

Model of the corresponding motor	Peak current at rated output of the servo amplifier (Note 1)	Servo amplifier current limit (Note 2)
4-0S, 3-0S	1.4 Ap	4 Ap
2-0SP, 1-0SP	3 Ap	12 Ap
2-0SP/3000, 1-0SP/3000	5 Ap	12 Ap
0-0SP, 0S, 5S	10 Ap	40 Ap
0S/3000, 10S, 20S/1500	20 Ap	40 Ap
5S/3000, 10S/3000	22 Ap	80 Ap
20S, 30S	30 Ap	80 Ap
20S/3000, 30S/3000, 40S/2000	58 Ap	130 Ap

Note 1) The rated output is guaranteed at the rated input voltage. If the input voltage fluctuates, the rated output may not be assured even when it falls within the allowable fluctuation range.

Note 2) The current limit value (peak value) is the standard setting value. Variations in operation due to a circuit constant is about ±10%.

Note 3) When selecting the servo amplifier for a T series servo motor (hollow-shaft type motor), select the same servo amplifier as for the corresponding S series servo motor. The correspondence between the T series motors and S series motors regarding the servo amplifiers are as follows.

Model 0T/3000:	Model 0S/3000
Model 5T/2000:	Model 5S
Model 5T/3000:	Model 5S/3000
Model 10T/2000:	Model 10S
Model 10T/3000:	Model 10S/3000

3.2 Protection and Error Detection Function

There are protection and error detection functions in AC servo amplifier.

Table 3.2 Protection and error detection function

No.	Item	Display	Content
1	Circuit breaker Note 1)	The lever of the circuit breaker turns off	If abnormal current exceeding the circuit breaker operating current flows, the circuit breaker operates, and the motor is stopped by dynamic brake action.
2	Overvoltage alarm	LED HV lights	If DC voltage of main circuit power supply is abnormally high, an overvoltage alarm is produced, and HV lamp lights, then the motor is stopped by dynamic brake action.
3	Low voltage alarm	LED LV lights	If the control supply voltage is abnormally low, LV lamp lights, and the motor is stopped by dynamic brake action.
4	Overheat	LED OH lights	If the contact point connected to the thermostat with the amplifier or terminal plate T4 is open, OH lamp lights, and the motor is stopped by dynamic brake action.
5	Over regenera-tion	LED DC lights	If the regenerative discharge time is abnormally long, DC lamp lights, and the motor is stopped by dynamic brake action. Also if acceleration/deceleration occurs often.
6	Circuit abnormality detection alarm	LED HC Lights	If an abnormally large current flows in the main circuit, HC lamp lights, and the motor is stopped by dynamic brake action.

In addition to the above, the unit detects the following abnormalities and displays them on the NC and initiating an alarm stop. (The following relate only to the velocity control system.)

1) Motor over load : Action of thermostat of motor
2) Feedback disconnection alarm : Abnormality of feedback signal
3) Over current alarm (OVC alarm): Excessive motor current

Note 1) An alarm fuse is used in models 1-0S to 4-0S. When the fuse is blown out, a metallic piece appears in the indicator window located on the front and upperside of the fuse.

4. AC LINE FILTER AND SEPARATE TYPE REGENERATIVE DISCHARGE UNIT

4.1 AC Line Filter (Option)

AC line filter (option) is used to reduc the effect of high-frequency noise on power supply is required.
A number of servo amplifiers can be connected to a single AC line filter within the range of AC line filter current capacity. Table 4.1 shows the sum of rated output of the motors that can be connected to one AC line filter via an amplifier.

Table 4.1 Selecting AC line filters

Line filter	Continuous rated current	Heat loss	Sum of rated outputs of the motors
Type A	24 A	20 W	5.4 kW (e.g. Model 10S x 3) (8.7 kVA)
Type B	44 A	70 W	10.5 kW (e.g. Model 20S x 3) (16.0 kVA)
Type C	100 A	50 W	23 kW, common mode type (35 kVA)

4.2 Separate Type Regenerative Discharge Unit

When the energy regenerated from the motor is so large as to exceed the discharge unit capacity (approx. 100 W) in the servo amplifier, it is necessary to use a separate type regenerative discharge unit.
Obtain the value or P or Q calculated in 4.2.1 or 4.2.2 for each axis. If the sum of these values is continuously for each axis. If the sum of these values is continuously used at 100 through 400 W, use a separate type regenerative discharge unit. If the sum if greater than 400 W, contact with the representative.

4.2.1 Horizontal move axis

The regenerative discharge unit is required when a motor is used continuously at P = 100 to P = 400.

$$P = \frac{1}{F} \times (5.37 \times 10^{-4}\ JVm^2 - 5.13 \times 10^{-3}\ taVmTL) \cdots\cdots (1)$$

In the equation (1),

F: Rapid traverse acceleration/deceleration cycle time (sec/time)
(Note: When not designated specially, the frequency is approx. 5 sec/time.)

$J = Jm + JL$

Jm: Rotor inertia of motor (kg·cm·sec^2)
JL: Motor axis conerison inertia of load (kg·cm·sec^2)
Vm: Number of motor revolutions at rapid traverse (rpm)
ta: Rapid traverse acceleration/deceleration time (sec)
TL: Machine friction torque (Motor-axis conversion) (kg·cm)

4.2.2 Vertical move axis

The regenerative discharge unit is required when a motor is used continuously at R = 100 to R = 400.

R = P + Q

P: Given in 4.2.1, (1)

$$Q = 1.026 \times 10^{-2}\ ThVm \times \frac{D}{100} \quad \cdots\cdots (2)$$

In the equation (2),

Th: Torque which is supported upward by motor at lowering in rapid traverse (kg•cm)

Vm: Number of motor revolutions at rapid traverse (rpm)

D : Operation duty of rapid traverse lowering direction (%)
(Note: $D \leqq 50\%$)

5. POWER SOURCE

5.1 Input Power Source

The AC servo amplifier uses a three-phase power source for the main circuit and a single-phase power source for the coil of the electromagnetic contactor for the dynamic brake. For the specifications of the power source, for each motor model see Tables 5.2.1 ane 5.2.2.

5.2 Capacity of Power Source

5.2.1 Capacity of three-phase power source

Table 5.2.1 Capacity of three-phase power source

Motor model	Power source capacity per motor
4-0S	0.1 kVA
3-0S	0.2 kVA
2-0SP	0.4 kVA
1-0SP	0.8 kVA
2-0SP/ 3000	0.5 kVA
1-0SP/ 3000	0.8 kVA
0-0SP	1 kVA
0S	1 kVA
0S/3000	1.2 kVA
5S	1.5 kVA
5S/3000	1.8 kVA

Motor model	Power source capacity per motor
10S	3 kVA
10S/3000	3.5 kVA
20S/1500	4.2 kVA
20S	5.3 kVA
20S/3000	5.6 kVA
30S	5 kVA
30S/3000	7 kVA
40S/2000	10 kVA

Motor model	Power source capacity per motor
0T/3000	1.2 kVA
5T/2000	1.5 kVA
5T/3000	1.8 kVA
10T/2000	3 kVA
10T/3000	3.5 kVA

Note 1) The power source capacity when 2 or more motors are used can be found by adding the power source capacity per motor.

Note 2) The power source capacity shown in Table 5.2.1 above is sufficient as continuous rating; during excessive acceleration of AC servo motor, however, the capacity of double the continuous rated value may be required momentarily.

5.2.2 Capacity of single-phase 100 VAC power source

Table 5.2.2 Power source capacity for single-phase 100 VAC

Amplifier specification drawing No.	When the magnetic contactor is turned on	During normal operation
A06B-6058-H002, H003, H023, H004	40 VA	10 VA
A06B-6058-H005, H025, H006	80 VA	20 VA
A06B-6058-H007	160 VA	16 VA

5.3 Power Transformer

The power transformer for S series servo amplifier is used when the servo amplifier is required in the usage of input voltage other than AC 200/220/230V.

5.3.1 Specification

Table 5.3.1 (a) Specification of power transformer

Items	Specification			
Specification No.	A80L-0022-0005	A80L-0024-0006	A80L-0026-0003	A80L-0028-0001
Item name	SAE	SBE	SCE	SDE
Capacity (30-Minute rating)	2.2 kVA	3.5 kVA	5.0 kVA	7.5 kVA
Heat loss	140 W	180 W	210 W	28 W
Frequency	50/60 Hz ± 1 Hz			
Primary voltage	AC 200/220/230/240 V (Δ) AC 380/415/460/480/550 V (Y)			
Secondary voltage	AC 210 V			
Secondary current	6.1 A	9.6 A	13.7 A	20.6 A
Voltage deviation	± 2 % Max.			
Voltage regulation (200% - LOAD)	11.7 % Typ.	7.8 % Typ.	6.6 % Typ.	8.2 % Typ.
Dielectric strength	AC2300V r.m.s One Minute			
Insulation resistance	Min. 100 Megohm by 1000 Vdc Megger			
Insulation	Class "B"			
Weight	21 kg	27 kg	36 kg	42 kg
Thermal protector	Normal Close Contact (Threshold Temperature 135 °C)			
Outline dimensions	Refer to section 8 (8)			
Connection diagram	Refer to Fig.9.2			

Note) If a AC420, 440V or 575V input power supply is employed, set the primary voltage of the transformers as shown below.

Table 5.3.1 (b) Setting when other input voltage employed

Input voltage	420V	440V	575V
Primary voltage setting	415V	460V	550V

5.3.2 Selecting method of power transformer

The power transformer must be selected according to the models and load conditions of AC servo motors employed. The power transformer is provided with secondary output terminals so that 2 axes or 3 axes can share each power transformer within the output rating.
The combinations of motor models which share the tranfsormer listed below are selected by considering actual usages.

Table 5.3.2 Motors sharing power transformer

Name	Capacity of transformer	Motor model applicable		
		AXIS 1	AXIS 2	AXIS 3
SAE	2.2 kVA	2-0S	2-0S	5S
		1-0S	0S	0S
		0S	5S	
		10S		
SBE	3.5 kVA	5S	5S	5S
		5S	10S	
		20S		
SCE	5.0 kVA	5S	5S	20S/1500
		10S	20S/1500	
		5S	20S	
SDE	7.5 kVA	10S	10S	20S/1500
		20S	20S	

Note 1) Listed motor models are representative ones of same or lower output models.

Note 2) In case that the sum of in-put power capacity of each motor unit exceeds the capacity of the transformer, it might be needed to reduce acceleration ratio (to lengthen acceleration time) to avoid excessive momentary voltage drop.

For power capacity per motor, refer to section 5.2.1.

Note 3) When selecting the transformer for a T series servo motor, the specifications for the corresponding S series servo motor apply. The correspondence between the T series models and the S series models are as follows.

Model 0S/3000:	Model 0T/3000
Model 5S:	Model 5T/2000
Model 5S/3000:	Model 5T/3000
Model 10S:	Model 10T/2000
Model 10S/3000:	Model 10T/3000

5.3.3 Accessories

Following parts are attached to each transformer as accessories.

Name	Specification No.	Q'ty
Jumper wire	A660-8001-T532	2
Jumper wire	A660-8004-T926	2
Bolt	A30L-0001-0021	4

Note 1) The above cables are used to connect pins when the export power transformer needs to be connected by delta connection or star connection (see Section 9.2).

6. HEAT LOSS

The heat loss in the S series servo amplifier at continuous rated load is shown in the table below. Assume that the average value used for designing a cabinet is generally 1/2 of the table value.

The values in the table do not include the heating value of a regenerative discharge resistor, and supplementary notes are necessary.

Table 6 Calorific values of S series servo amplifier

Motor model	Heat loss servo amp	Heat loss in cabinet with heat sink set outside		Remarks
		Natural air cooling	Forced air cooling	
4-0S	40 W	40 W	40 W	(Note 1, 2)
3-0S	40 W	40 W	40 W	(Note 1, 2)
2-0SP	60 W	60 W	60 W	(Note 1, 2)
2-0SP/3000	60 W	40 W	40 W	(Note 2)
1-0SP	60 W	60 W	60 W	(Note 1, 2)
1-0SP/3000	60 W	40 W	25 W	(Note 2)
0-0SP	80 W	50 W	30 W	(Note 2)
0S	80 W	50 W	30 W	(Note 2)
0S/3000	80 W	50 W	30 W	(Note 2)
5S	80 W	50 W	30 W	(Note 2)
5S/3000	120 W	60 W	35 W	(Note 3)
10S	120 W	60 W	35 W	(Note 3)
10S/3000	180 W	85 W	55 W	(Note 3)
20S/1500	150 W	70 W	45 W	(Note 3)
20S	180 W	85 W	55 W	(Note 3)
20S/3000	350 W	120 W	(Note 4)	(Note 3)
30S	200 W	100 W	60 W	(Note 3)
30S/3000	450 W	150 W	(Note 4)	(Note 3)
40S/2000	550 W	180 W	(Note 4)	(Note 3)
0T/3000	80 W	50 W	30 W	(Note 2)
5T/2000	80 W	50 W	30 W	(Note 2)
5T/3000	120 W	60 W	35 W	(Note 3)
10T/2000	120 W	60 W	35 W	(Note 3)
10T/3000	180 W	85 W	55 W	(Note 3)

Note 1) The heat sink can not be set outside in the amplifier for the model 4-0S to 1-0S.

Note 2) In the amplifier for the models after 5S, the heating of regenerative discharge resistor needs to be included in the calorific value in parenthesis. For the heating value of the regenerative discharge resistor, refer to section 4.2. For the application with relatively frequent acceleration/deceleration, take the following values as a reference.

4-0S/3-0S.....5W
2-0S/1-0S....10W
0S/5S.......40W

Note 3) In the amplifier for the models 10S to 30S, the built-in regenerative discharge resistor is set outside, and it is unnecessary to include the heating of the regenerative discharge resistor in the heat loss in the cabinet when the heat sink is set outside. When the separate type regenerative discharge unit is set in the cabinet or the heat sink is not set outside, add the average heat loss of the regenerative discharge resistor to the heat loss of the amplifier. For the heating value of the regenerative discharge resistor, refer to section 4.2 "Separate type regenerative discharge unit".

Note 4) "At forced air cooling" means the case where the heat sink is air cooled at the air flow of 2m/s.
The servo amplifiers for models 20S/3000, 30S/3000, and 40S/3000 each contain a fan for forced air-cooling.

7. INSTALLATION CONDITION AND NOTES

7.1 Installation Condition

Ambient temperature: 0°C to +55°C (during operation)-20°C to +60°C (during storage and transportation)
Humidity : 95% RH or less (no condensation)
Vibration : 0.5 G or less
Atmosphere: The unit shall not be exposed direct to cutting oil, lubricant or cutting chips.

7.2 Caution on Installation

The servo amplifier is designed so that it is mounted within a cabinet, such as power magnetics cabinet. No particular sealing is applied around the heat sink to the chassis; therefore, even when cooling the heat sink outside, take care not to expose the heat sink directly to the splash of cutting oil, lubricant or cutting chips.

7.2.1 When amplifiers are housed in a closed type cabinet

For the closed type cabinet, its internal air temperature generally increases. Ventilate the internal air so that the ambient temperature uniform. The ventilation air speed should be about 1 - 2 m/sec. Do not directly blow the fan or blower air on these units, otherwise dust may cling to the surfaces of these units and trouble may result.

7.2.2 When amplifiers are housed in an open-air ventilation type cabinet

1) Use an air filter at the open air inlet.
2) Do not directly blow the ventilation fan air or blower air to these units, otherwise dust may cling to the surfaces of these units, and a trouble may result.
3) Ingress of mist of the cutting oil or dust from the air inlet may cause trouble.
4) Securely seal the cable inlet/outlet, door, and other clearances.

7.2.3 Mounting position and other cautions

1) Mount the units for easy access to check, remove, and mount during maintenance.
2) Keep a space of more than 50 mm on both upper and lower sides of the amplifier respectively, so that the air from the heat sink smoothly flows on the upper side and wiring can be done to the terminal boards on the lower side.
3) Precaution should be taken to separate cables for power line and signal line, frame grounding of the amplifier and transformer, and countermeasures against noises.

7.2.4 Selection of ground fault detector

When the S series servo amplifier is used without a transformer, as the motor is driven by the PWM inverter system using a power transistor bridge, a high frequency leakage current flows through the motor winding, and the power cable. There is stray capacitance between the amplifier and ground which provides a path for leakage current. This may cause a malfunction of the ground fault detector.
Therefore, use the inverter applicable leak breaker that is devised to prevent such a malfunction.

1) Leakage current of AC servo amplifier and motor

The motors are largely divided into three groups according to the leakage potential, and the reference value for selecting the inverter applicable ground fault detector is shown in the table below. Considering the case of using a 14m cabtyre cable as a power cable, the high frequency leakage current value is compensate by the frequency characteristic (attenuation factor) of the inverter applicable ground fault detector and the value is shown as a reference of indicating the sensitivity. Therefore, it is not the measurement value with an ordinary leakage checker.

Motor model	Reference value for selection	Commercial frequency component (reference value)
4-0S to 5S	3.0 mA max.	1.8 mA max.
10S to 20S	3.6 mA max.	2.0 mA max.
30S and 40S/2000	6.3 mA max.	2.5 mA max.

The method of using the reference value for selection is shown by the following example.

. When a high-sensitive high-speed ground fault detector of rated sensitivity current of 30mA is used, the non-operating current is 15mA according to the catalogue.

. Assume that two sets of model 10S and 0S are used.

$$\frac{3.6\text{mA}}{10\text{S}} \times 2 + \frac{3.0\text{mA}}{0\text{S}} \times 2 = 13.2\text{mA} < \frac{15\text{mA}}{\text{Non-operating current}}$$

Therefore, the inverter applicable ground fault detector does not work in this case.

(Note 1) The above reference value for selectin and the commercial frequency component include the influences of the floating capacity of the motor and the power cable. Therefore, in the system with the shorter cable length, the reference value for selection may be estimated lower. Even in this case, consider 2/3 of the table value is the limit. Contrarily, when the cable is longer, note that the leak current is increased.

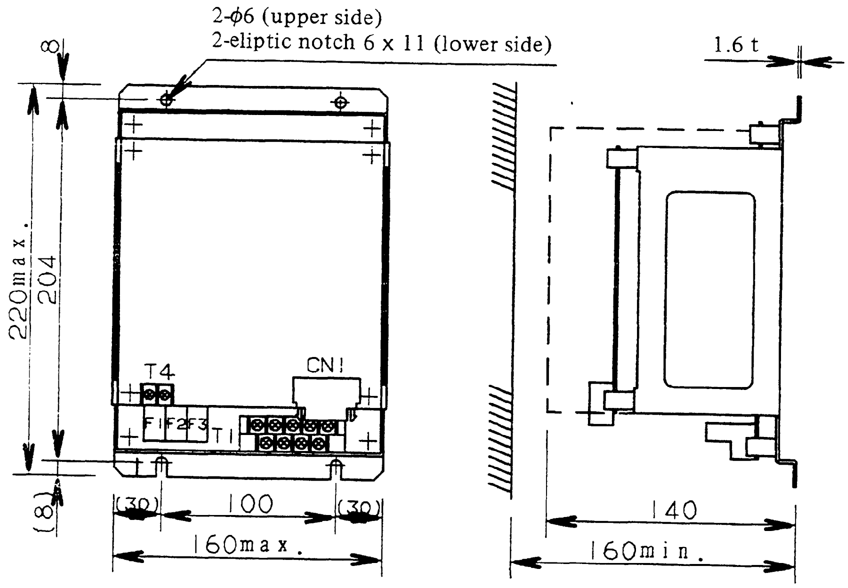
(Note 2) Generally, select the ground fault detector having the proper sensitivity rating according to the table. Be sure ground the machine (class 3) not to generate dangerous voltage in the machine body, the control panel, etc. in the event of leakage.

2) Example of inverter applicable leak breaker

Manufacturer	Model	Application status
Fuji Electric	EG-A series SG-A series	Modified totally to meet the inverter from July, 1983.
Hitachi Seisakusyo	ES100C type ES225C type	Modified totally to meet the inverter from July, 1984.
Matsushita	Leak breaker type C Leak breaker type KC	Modified totally to meet the inverter from November, 1984.

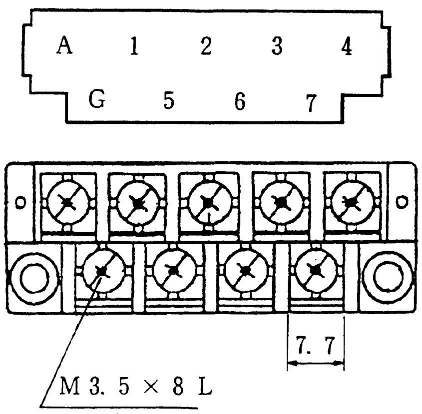
8. EXTERNAL DIMENSIONS

1) External dimensions of amplifier A06B-6058-H002 for models 4-0S and 3-0S.

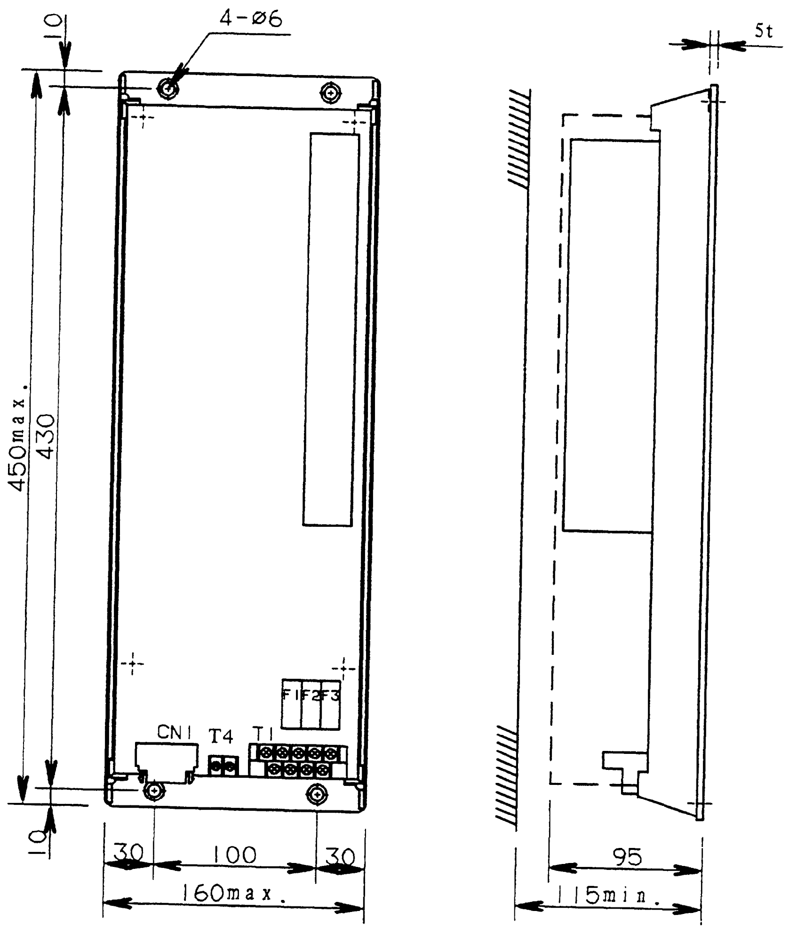


Weight 1.5 kg

T1 pin arrangement



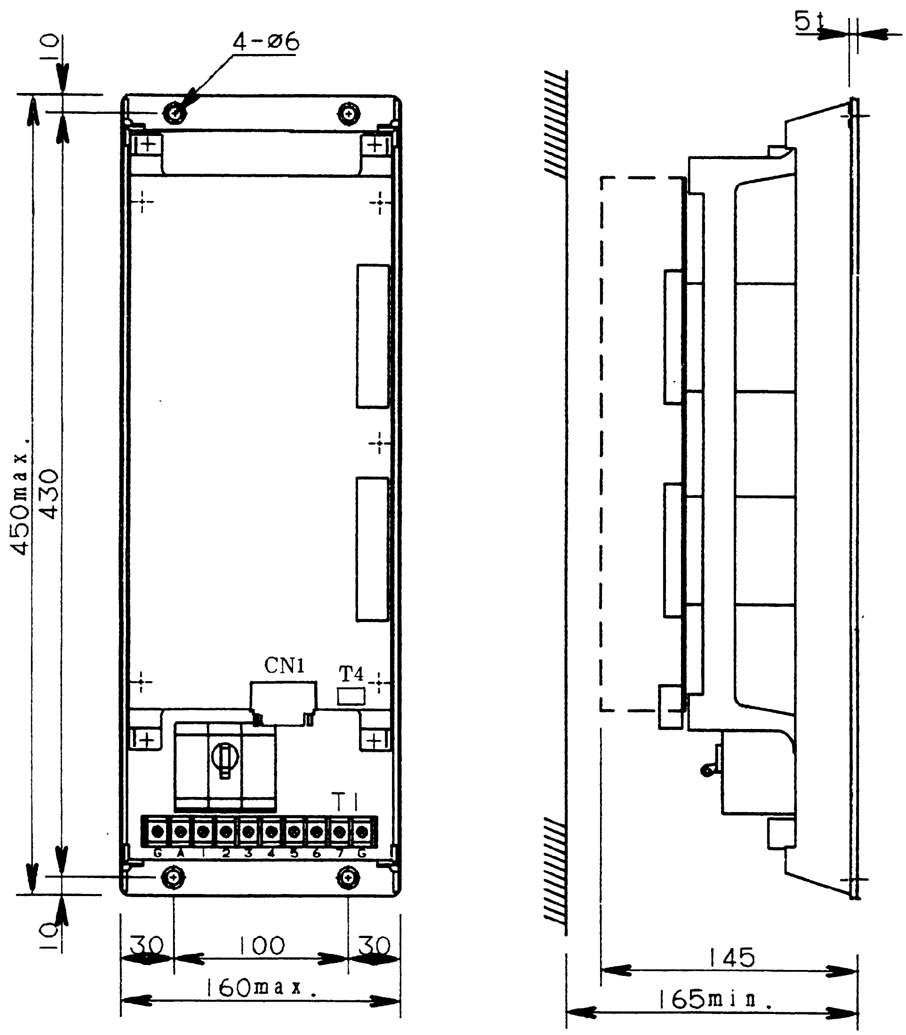
2) External dimensions of amplifier A06B-6058-H003 for models 2-0S and 1-0S



Weight 1.5 kg

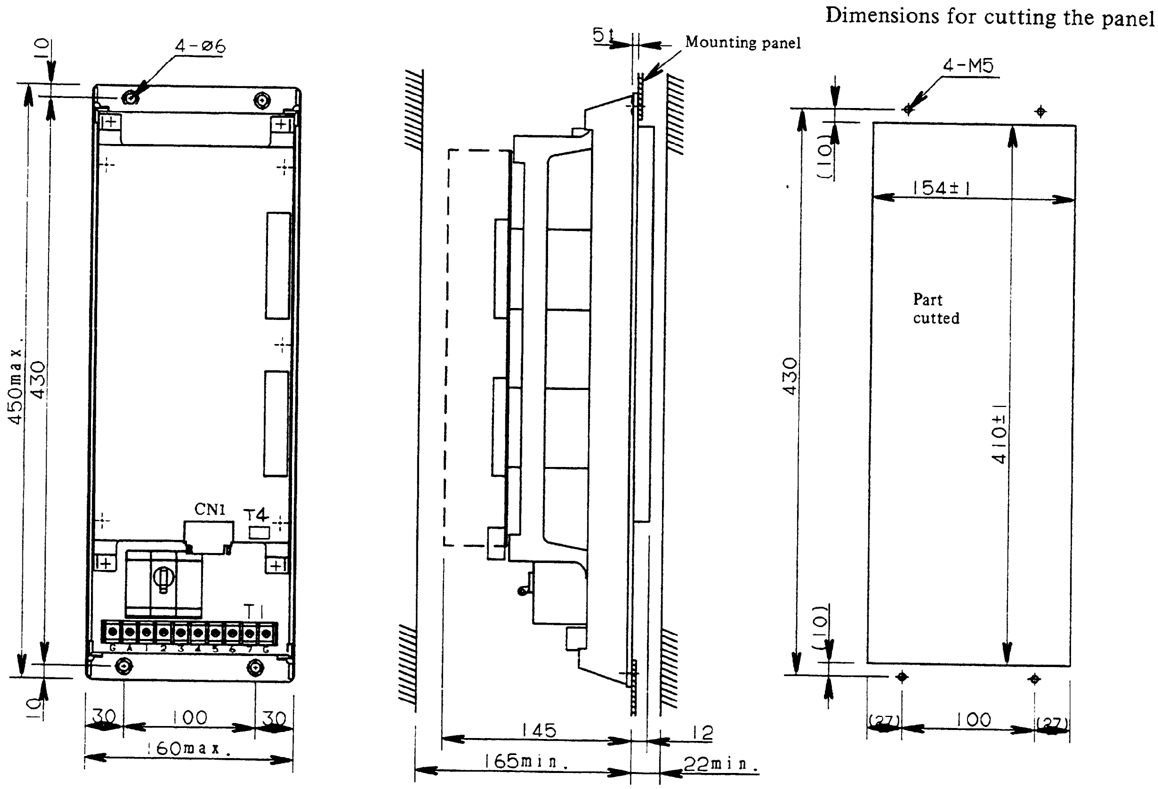
Note) See the description of H002 for the pin arrangement of terminal block T1.

3) External dimensions of amplifier A06B-6058-H023 for models 2-0SP/3000 and 1-0SP/3000



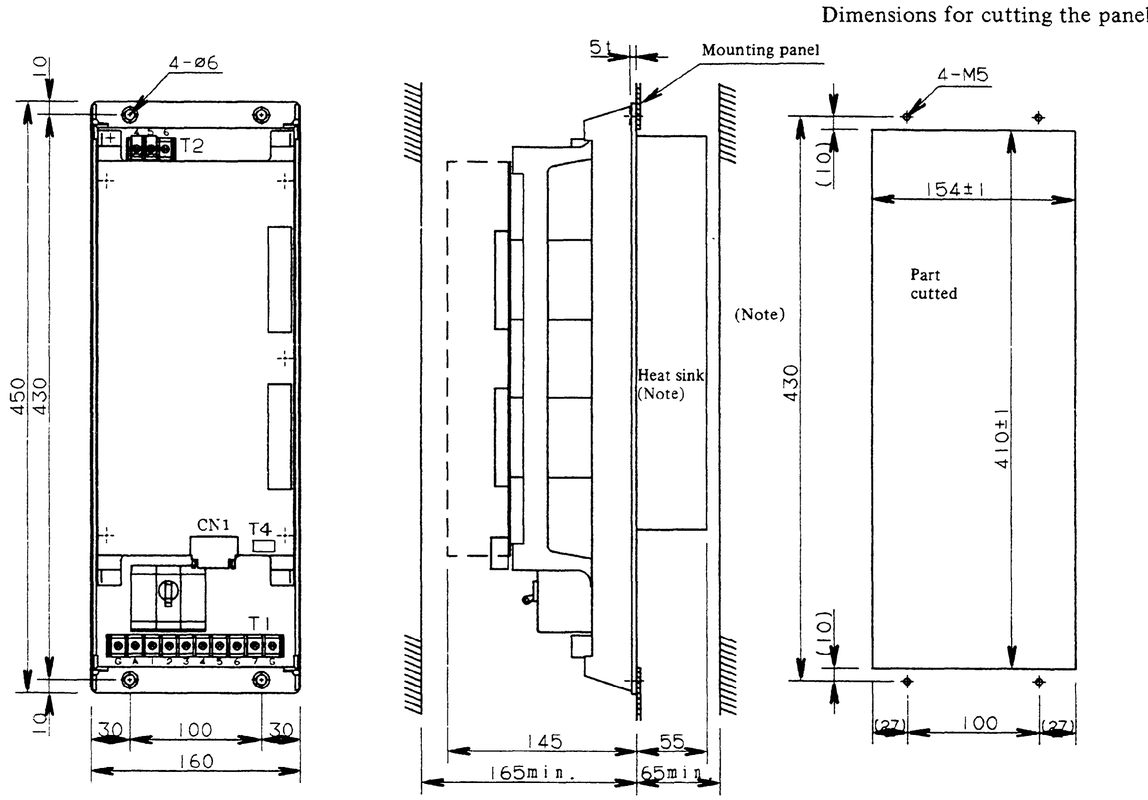
Weight 4.0 kg

4) External dimensions of amplifier A06B-6058-H004 for models 0-0SP, 0S and 5S



Weight 4.0 kg

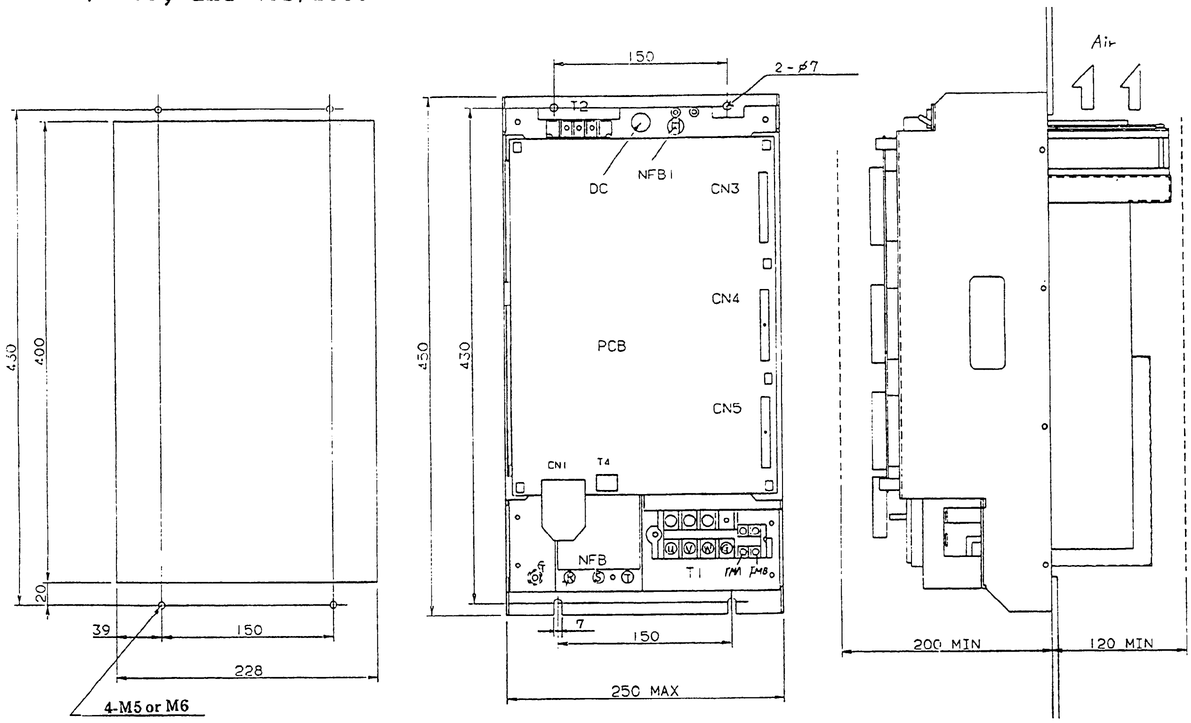
5) External dimensions of amplifiers A06B-6058-H005, H006, and H025 for models 10S to 30S



Weight 5.5 kg

Note) Temperature is raised very high behind the heat sink. Avoid mounting parts in this place.

6) External dimensions of amplifier A06B-6058-H007 for models 20S/3000, 30S/3000, and 40S/2000

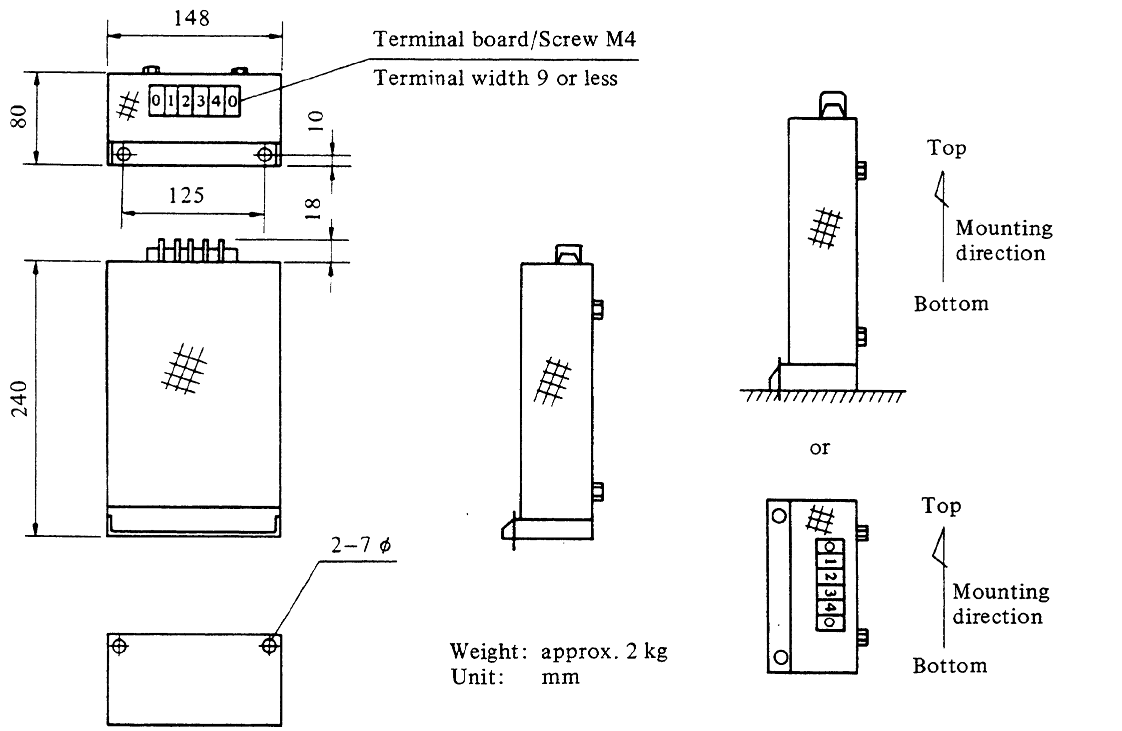


Dimensions for cutting the panel

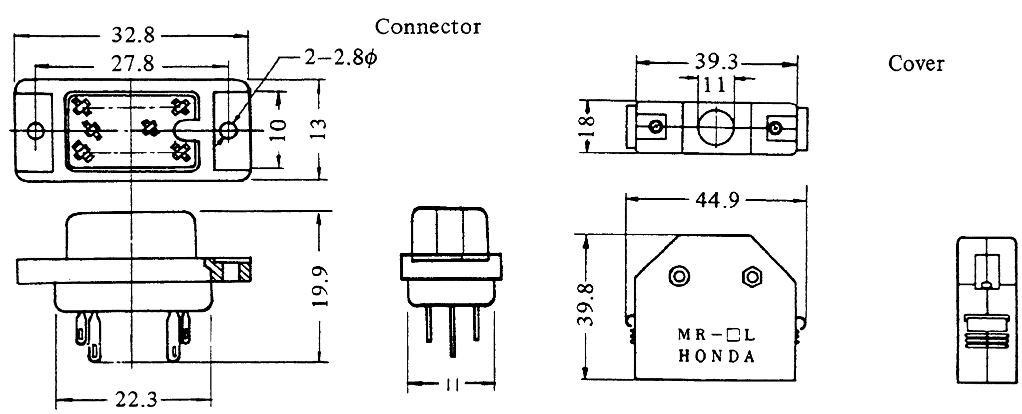
Weight 15kg

7) External dimensions of regenerative discharge unit
A06B-6050-H050, H052 (A06B-6050-C050, C052)
A06B-6047-H050 (A06B-6047-C050)

Note) See Section VIII-8-7) for the external dimensions of regenerative discharge unit A06B-6058-H192.



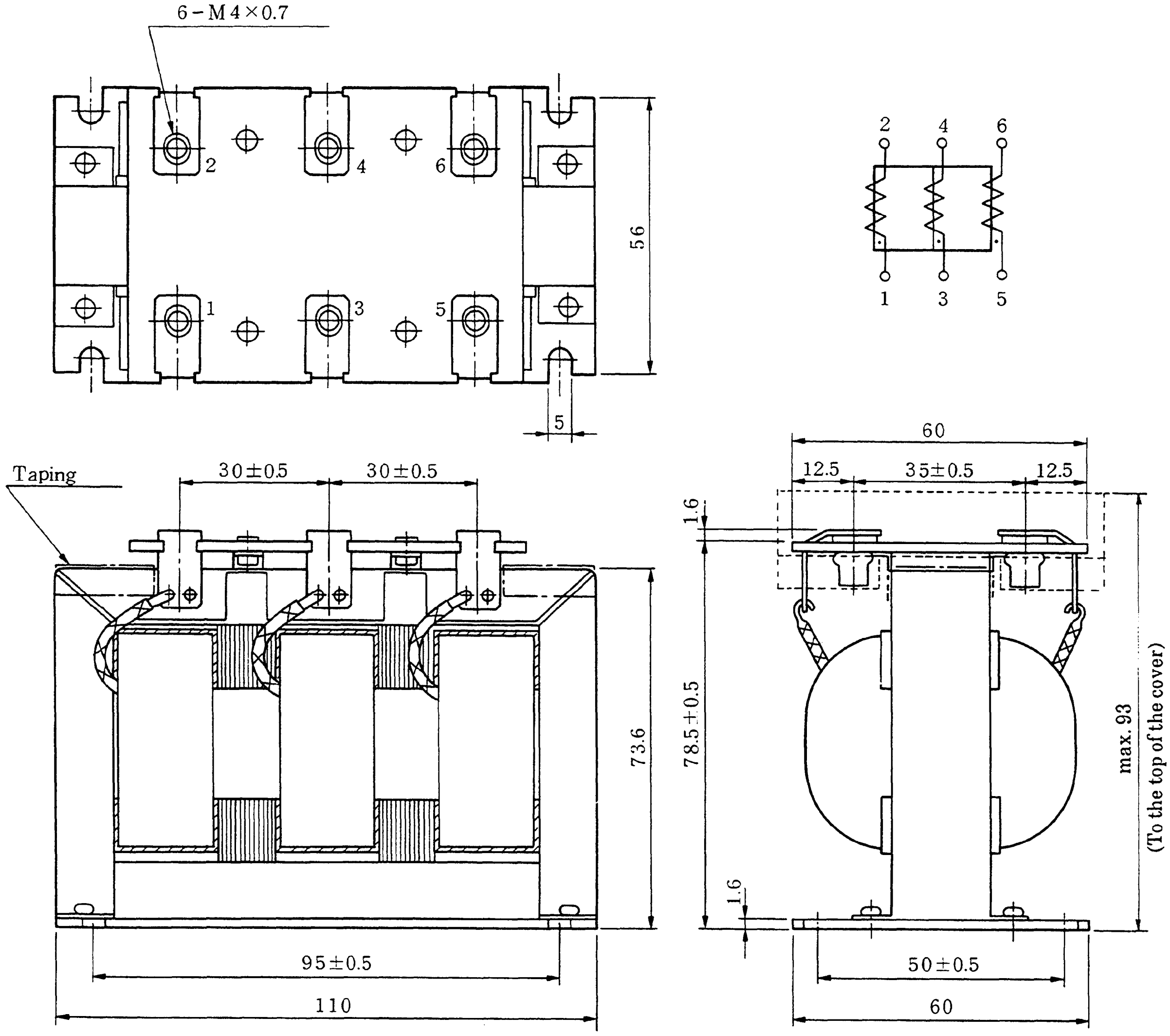
8) External dimensions of input connector



9) External dimensions of AC line filters

(a) External dimensions of AC line filter A81L-0001-0083#3C

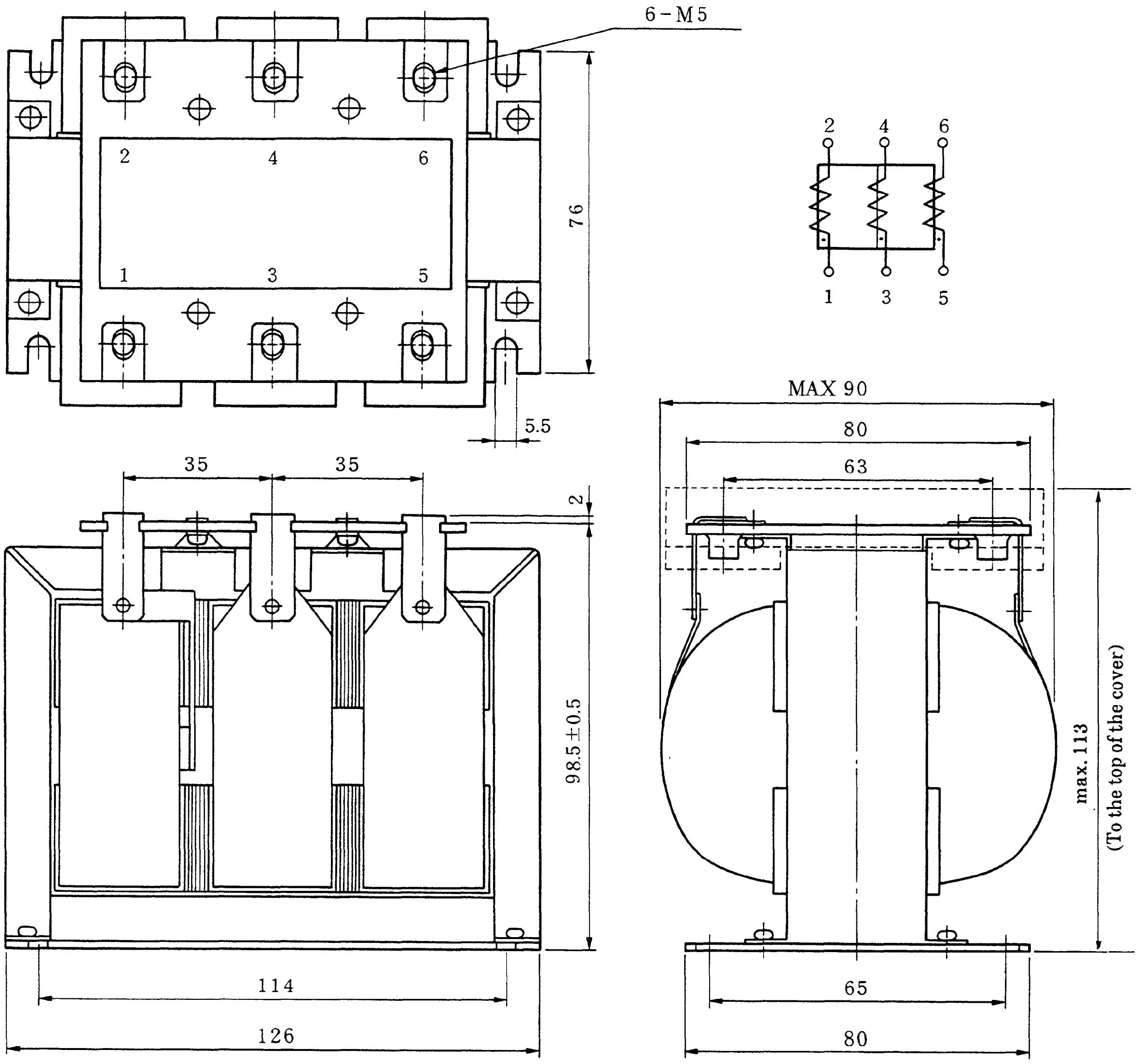
Type A



Weight: 1.1 kg

(b) External dimensions of AC line filter A81L-0001-0101#C

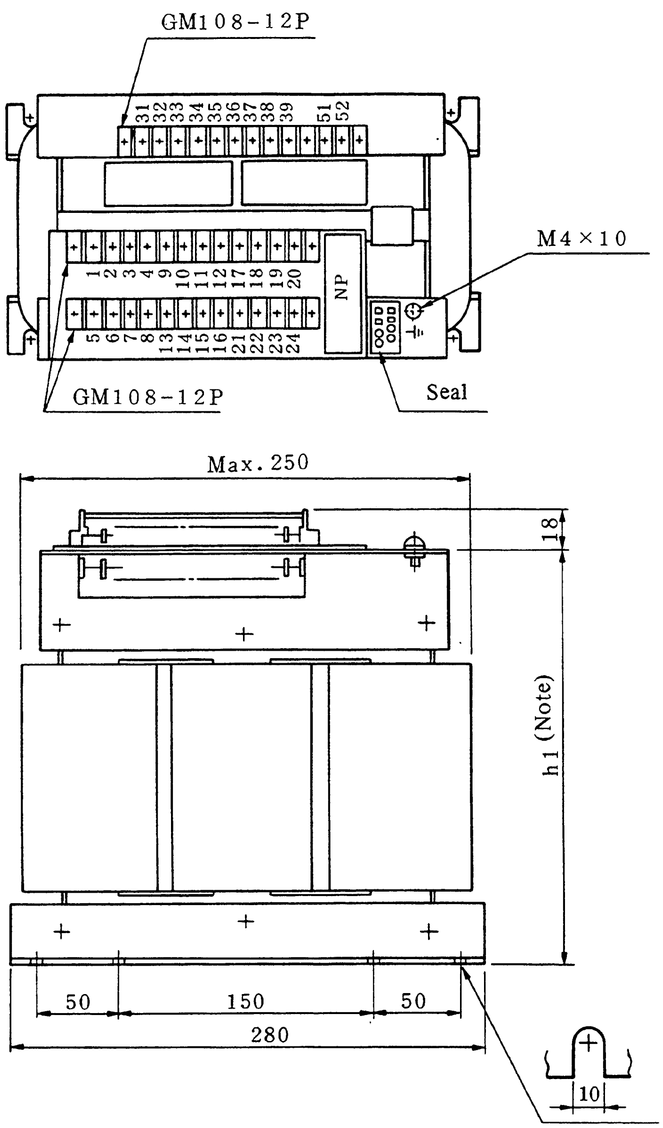
Type B



Weight: 3 kg

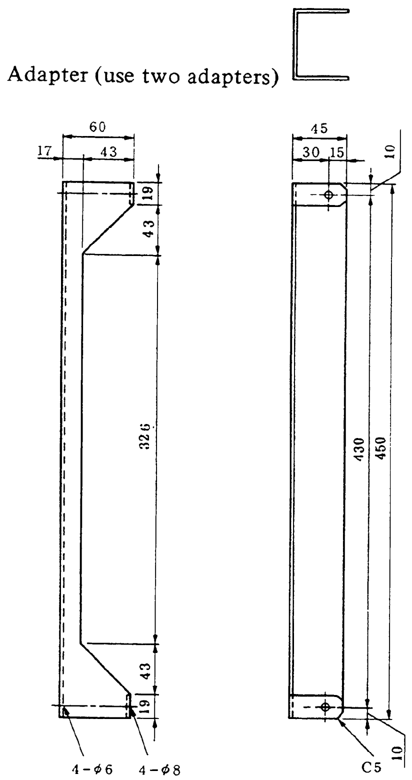
Note) See X-8-6) for the external dimensions of the type-C AC line filter, A81L-0001-0102.

10) External dimensions of power transformer for export



Drawing No.	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 the transformer)	217 cm or less	217 cm or less	247 cm or less	247 cm or less

11) External dimensions of adapter A06B-6058-K103



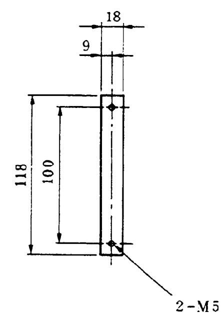
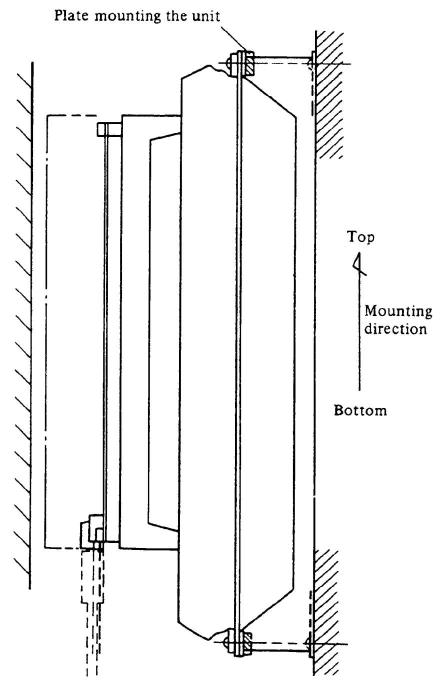


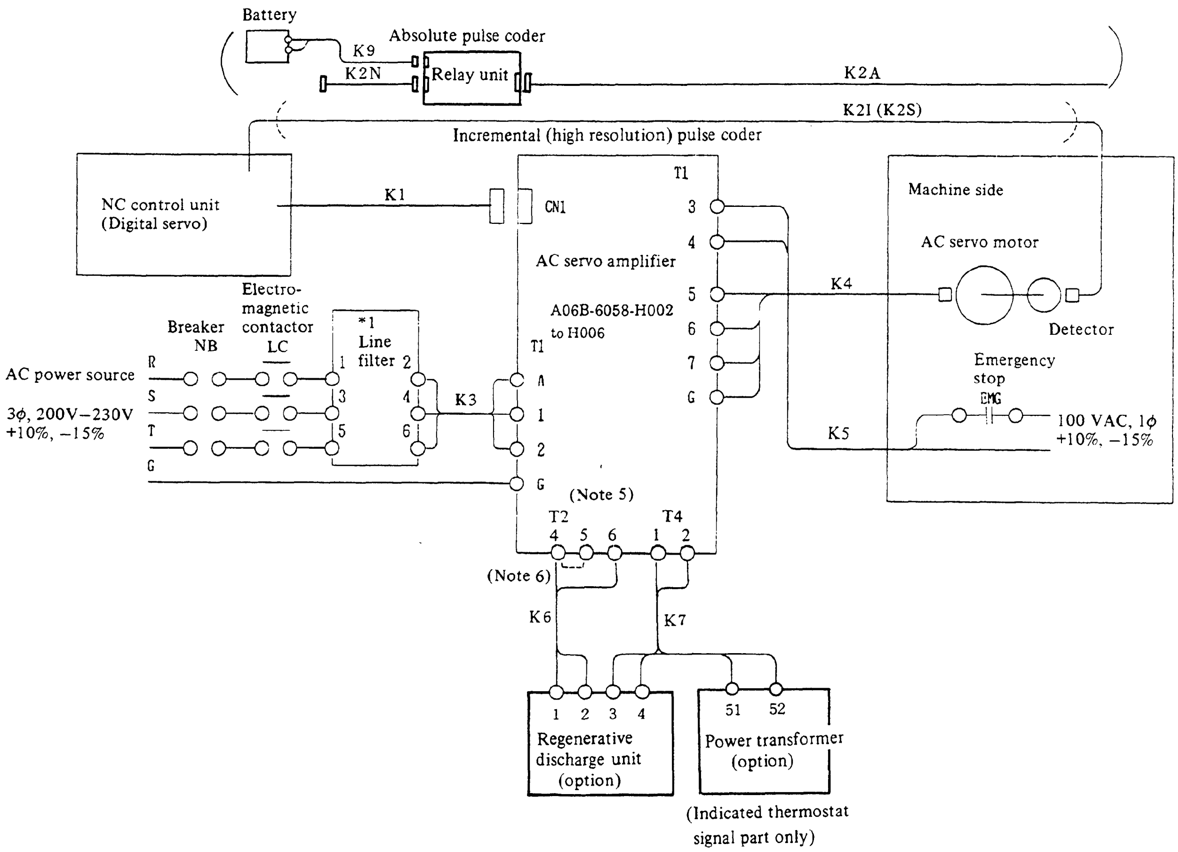
Plate mounting the unit
(use two plates)



A06B-6058-H004 to H006
Example of mounting adapters

9. CONNECTION

9.1.1 Connection diagram (for A06B-6058-H00x, x = 2 to 6)



Note 1) For cable K1 and K2 connection at NC side, refer to each NC CONNECTING MANUAL.

Note 2) For cable connection, refer to Appendix 1, 2.

Note 3) Use AC line filter (optional) *1 when the effect of high-frequency noise on the power supply should be reduced. Several of servo amplifiers can be connected for a single AC line filter within the AC line filter capacity.

Note 4) When the power breaker NB and electromagnetic contactor LC are turned ON, the servo amplifier is placed in Power-ON conditions. To prevent possible accidents, such as electric shocks, when touching the connections of servo amplifier and motor, etc., be sure to turn the NB or LC OFF in advance.

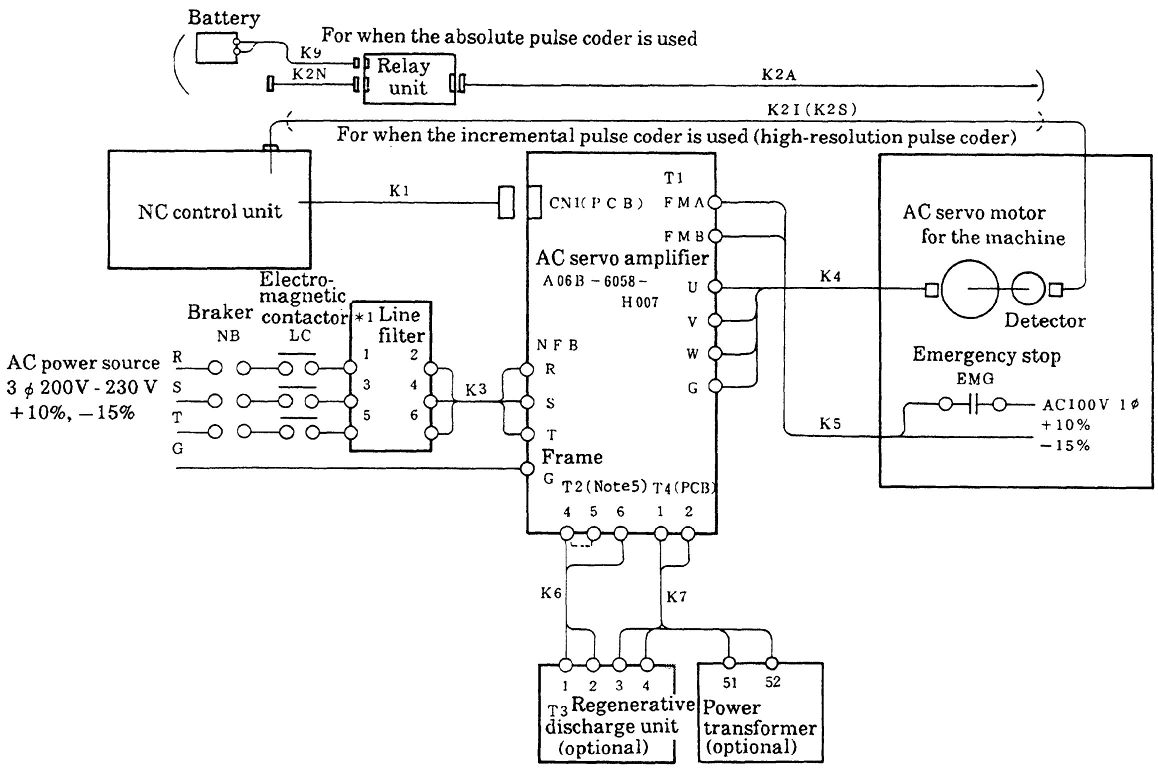
Note 5) The terminal block T2 is not provided in the model 4-0S to 5S.

Note 6) A short bar is connected between the terminals T2-4 and T2-5 before shipment.

Note 7) When using a separate type regenerative discharge unit or power transformer, connect the thermostat signals (usually on and turned off at detection) in series and to T4-1 and T4-2 terminals, and change the jumper S1 to L.

Note 8) When using the separate type regenerative discharging unit, set the terminal S2 to the "H" position on the PCB. Remove the short bar between the terminals T2-4 and T2-5.

9.1.2 Connection diagram for AC servo amplifier A06B-6058-H007



Note 1) For how to connect cables K1 and K2 to the NC, refer to the Connecting Manual of the NC used.

Note 2) For cable connection, see Section 10.

Note 3) Use the AC line filter marked with 1* to reduce the effect of high-frequency noise on the power source, except when an insulating power transformer is used.

Note 4) Turning on the power breaker NB and electromagnetic contactor LC turns on the power to the servo amplifier.
Before touching a conducting part of the servo amplifier or motor such as a cable joint, be sure to turn off the NB or LC.

Note 5) Pins T2-4 and T2-5 are connected with a short bar at the factory. Remove it when the regenerative discharge unit is connected.
To use the regenerative discharge unit, set pin S2 on the PC board to H.
When the regenerative discharge unit is not used, be sure to set pin S2 to L before operation.

Note 6) To use a transformer with a thermostat, connect the thermostat signals of the transformer with the thermostat signals of the regenerative discharge unit in series via a cable. Then connect T4-1 to T4-2 with the same cable. The thermostat signals are normally on, and turned off only when overheating is detected.
To connect a cable to T4, be sure to set pin S1 on the PC board to L.

9.2 Connection of Power Transformer for Export

(1) Connection of primary tap

Connections for input power and connections between the primary terminals of these transformers are as follows.

Table 9.2 Connection of power cable and jaumper

Power voltage	Input power cable U, V, W	Jumper between terminals	Remarks
200V	U-7, V-15, W-23	8-15, 16-23, 24-7	Delta connection
220V	U-6, V-14, W-22	8-14, 16-22, 24-6	
230V	U-5, V-13, W-21	8-13, 16-21, 24-5	
240V	U-4, V-12, W-20	8-12, 16-20, 24-4	
380V	U-6, V-14, W-22	8-16, 16-24 or (8-16-24)	Star connection
415V	U-4, V-12, W-20		
460V	U-3, V-11, W-19		
480V	U-2, V-10, W-18		
550V	U-1, V-9, W-17		

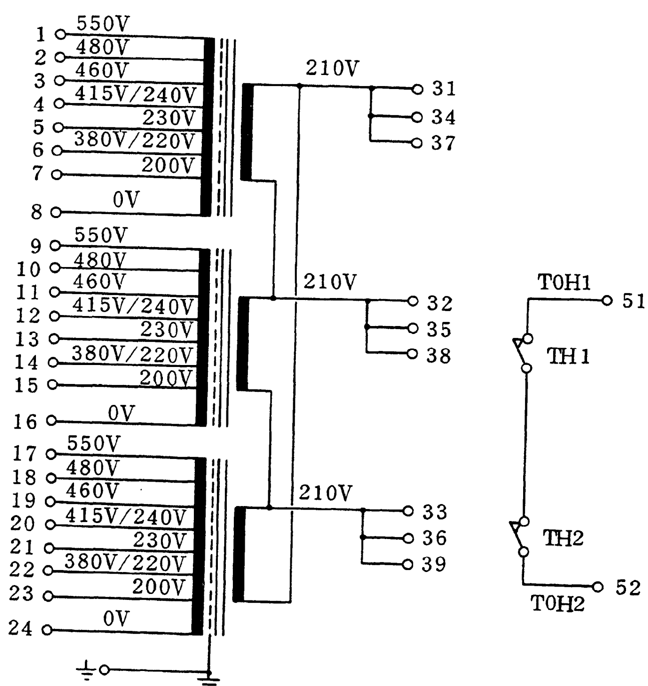


Fig. 9.2 Connection diagram

VIII. FANUC AC SERVO AMPLIFIER S series (200 V INPUT FOR 2 AXES)

1. GENERAL

AC servo amplifier for 2 axes (200 V input) is used exclusively for driving AC servo motors. This servo amplifier has been developed so that a cabinet can be compactly designed when a relatively small servo motor is used for a small machine tool. (The motors used are the 200 V input type.)
AC servo amplifier (200 V input type for 2 axes) has the following features.

1) When 3-phase power supply for power is 200 to 230 VAC, the unit can be connected directly without using any transformer.
2) The unit for 2 axes is compactly designed (same mounting dimensions as the single axis).
   Special custom IC and the latest power module technology are fully employed, thus producing a high reliability with fewer parts and compact external profile.
   The circuit breaker, dynamic brake circuit, rectified power circuit and transistor for regenerative discharge circuit are all assembled into one unit, thereby facilitating the mounting and maintenance.
3) The unit is constructed so that the heat sink can be externally cooled: The fin side of heat sink for power module can be cooled outside the storage cabinet.
4) The unit is also designed with due consideration given to unit protection and detection of abnormalities, such as circuit breaker, overvoltage, low voltage, overcurrent and abnormal regenerative discharge circuit.
5) This amplifier is only for a digital AC servo.
   The unit receives PWM signals obtained from a high-performance signal processor within NC to amplify and drive AC servo motors. The unit is used in connection with NC for the latest FANUC digital AC servo, thereby assuring a high speed, high-precision servo performance.

Note) When selecting the servo amplifier for a T series servo motor (hollow-shaft type motor), select the same servo amplifier as for the corresponding S series servo motor. The correspondence between the T series motors and S series motors regarding the servo amplifiers are as follows.

Model 0T/3000:	Model 0S/3000
Model 5T/2000:	Model 5S
Model 5T/3000:	Model 5S/3000
Model 10T/2000:	Model 10S
Model 10T/3000:	Model 10S/3000

2. CONFIGURATION

Fig. 2 shows a sample configuration of NC system using AC servo amplifier (200 V input type for 2 axes). The separate type regenerative discharge unit must be occasionally used when the regenerative energy is large from the load.

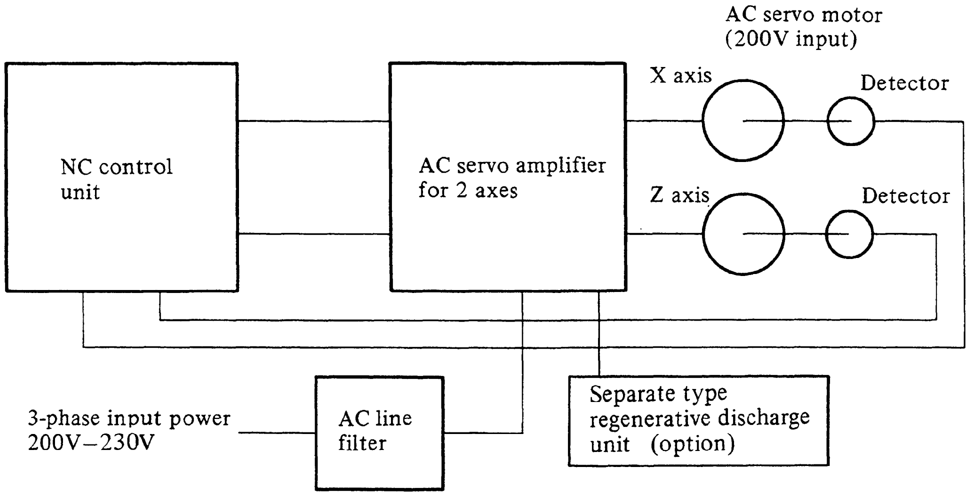


Fig. 2 Example of configuration

2.1 Types of Units and Specifications

Table 2.1 Types of units and specifications

Name	Applicable motor (Notes 1 and 2)		Specifications	Remarks
	L axis	M axis		
Servo amplifier	2-0SP, 1-0SP	2-0SP, 1-0SP	A06B-6058-H221	
	2-0SP, 1-0SP	0-0SP, 0S, 5S	A06B-6058-H222	
	0-0SP, 0S, 5S	0-0SP, 0S, 5S	A06B-6058-H223	
	0-0SP, 0S, 5S	0-0SP, 0S, 5S, 10S, 0S/3000	A06B-6058-H224	(Note 3)
	4-0S, 3-0S	2-0SP/3000, 1-0SP 1-0SP/3000	A06B-6058-H225	
	2-0SP/3000, 1-0SP 1-0SP/3000	10S, 0S/3000	A06B-6058-H227	
	10S, 0S/3000	10S, 0S/3000	A06B-6058-H229	(Note 10)
	5S/3000	5S/3000	A06B-6058-H230	(Note 10)
	5S, 10S, 0S/3000	5S/3000	A06B-6058-H231	(Note 10)
	10S/3000 20S, 30S, 5S/3000	10S/3000 20S, 30S, 5S/3000	A06B-6058-H251	(Notes 4 and 8)
	0-0SP, 0S, 5S, 10S, 20S/1500	5S/3000, 10S/3000, 20S, 30S	A06B-6058-H252	(Notes 4 and 8)
	0-0SP, 0S, 5S, 10S, 20S/1500	20S/1500	A06B-6058-H253	(Note 4)
Separate regenerative discharge unit (Note 4)	For A06B-6058-H221 to A06B-6058-H224		A06B-6047-H050	24Ω 400W
	For A06B-6058-H229 to A06B-6058-H231		A06B-6050-H050	16Ω 400W
	For A06B-6058-H251 to A06B-6058-H253		A06B-6058-H192	8Ω 800W
Export power transformer	Capacity of type SAE: 2.2 kVA		A80L-0022-0005	
	Capacity of type SBE: 3.5 kVA		A80L-0024-0006	
	Capacity of type SCE: 5 kVA		A80L-0026-0003	
	Capacity of type SDE: 7.5 kVA		A80L-0028-0001	
AC line filter (Note 5)	Sum of rated outputs of the motors: 5.4 kW or less		A81L-0001-0083 #3C	Type A
	Sum of rated outputs of the motors: 10.5 kW or less		A81L-0001-0101 #C	Type B
	Sum of rated outputs of the motors: 23 kW or less		A81L-0001-0102	Type C
Adapter for 2-axis amplifiers			A06B-6058-K103	(Note 6)
Input connector	Solder type		A06B-6058-K201	(Note 7)
	Crimp type		A06B-6058-K202	(Note 7)

Note 1) For AC servo motor, use models 4-0S to 30S (S Series) recently designed to be compatible with a 200 V input type amplifier.

Note 2) When selecting the servo amplifier for a T series servo motor (hollow-shaft type motor), select the same servo amplifier as for the corresponding S series servo motor. The correspondences between the T series motors and S series motors regarding the servo amplifiers are as follows.

Model 0T/3000:	Model 0S/3000
Model 5T/2000:	Model 5S
Model 5T/3000:	Model 5S/3000
Model 10T/2000:	Model 10S
Model 10T/3000:	Model 10S/3000

Note 3) For the load torque during 2-axis simultaneous load, use the load within the range of continuous rated torque of each axis.

Note 4) If the regenerative energy from the motor is more than 100 W and less than 400 W when servo amplifier A06B-6058-H223/H224 are used, the use of one separate type regenerative discharge unit DCU is required. If the regenerative energy from the motor exceeds 400 W, contact our factory. Because amplifiers A06B-6058-H25x, x = 1 to 3 do not contain regenerative discharge resistors, separate regenerative discharge units need to be connected to these amplifiers. Also, these amplifiers need to be forcibly air-cooled at an air speed of 2 m/s or more.

Note 5) Be sure to use the AC line filter to reduce the effect of high-frequency noise on the power source, except when an insulating power transformer is used. Line filter A80L-0001-0101#C must be used when two model-20S motors are connected to servo amplifier A06B-6058-H251.

Note 6) This adapter should be used when the unit is mounted on the wall surface.(This adapter is for A06B-6058-H22x, x = 1 to 7, and is not applicable to A06B-6058-H2xx, x = 29 to 53.)

Note 7) These input connectors are used for a cable connected to the connector CN1 on the servo amplifier.

Note 8) Limits on the motor torque output
When motor 20S is used with another motor 20S or motor 20S/15000, the rated output torque is limited as follows.

Amplifier drawing No.	Combination of motors		Upper limit of the output torque
A06B-6058-H251	20S	20S	80% of the rated torque
A06B-6058-H252	20S/1500	20S	90% of the rated torque

For combinations of motors other than the above, up to 100% of the rated load can be used.

Note 9) For the group to which motors 10S and 0S/3000 are applicable, motors 0S and 5S are also available. For the group to which motor 20S/1500 is applicable, motors 0S, 0S/3000, 5S, and 10S are also available.

Note 10) Using servo amplifiers H229 to H231 requires separate regenerative discharge unit A06B-6050-H050.

3. SPECIFICATIONS

3.1 Specifications

Refer to section VII-3.1.

3.2 Protection and Error Detection Function

Refer to section VII-3.2.

4. AC LINE FILTER AND SEPARATE TYPE REGENERATIVE DISCHARGE UNIT

4.1 AC Line Filter (Option)

The AC line filter (optional) is used to reduce the effect of high-frequency noise on the power source. For details of the AC line filter, see VII-4.1.

4.2 Separate Type Regenerative Discharge Unit

The average energy regenerated from the motor may become large, for example, when no counter balance is used on a vertical axis having a high rapid traverse acceleration/deceleration frequency. If the average regenerative energy (W) from the motor exceeds the capacity (approx. 70 W) of discharge unit built in the servo amplifier, it is necessary to use a separate type regenerative discharge unit DCU (capacity approx. 400 W). Find P (W) or Q (W) calculated in sections VII-4.2.1 and 4.2.2 for each axis; if the unit is used continuously at 70 W to 400 W total, use a separate type regenerative discharge unit DCU. If the total of P or Q exceeds 400 W, contact with our factory.

For details refer to section VII-4.2.

Each of the separate regenerative discharge units A06B-6058-H192 in A06B-6058-H251 to -H253, x = 1 to 3, can handle up to 800 W. If P or Q exceeds 800 W, contact FANUC.

5. POWER SOURCE

5.1 Input Power Source

AC servo amplifier (200 V input type for 2 axes) employs 3-phase power source for main circuit and single-phase power source for coil of electromagnetic contactor for dynamic brake. For the specifications of each power source, see Table 3.1 of VII-3.1.

5.2 Capacity of Power Source

5.2.1 Capacity of three-phase power source

Refer to section VII-5.2.1.

5.2.2 Capacity of single-phase 100 VAC power source

Table 5.2.2 Capacity of single-phase 100 VAC power source

Condition / Model	Continuous	When the electromagnetic contactor is turned on
Capacity of the single-phase 100-VAC power source for other than A06B-6058-H25x, x = 1 to 3	20 VA	80 VA
Capacity of the single-phase 100-VAC power source for A06B-6058-H25x, x = 1 to 3	30 VA	120 VA

5.3 Power Transformer

Refer to section VII-5.3.

6. HEAT LOSS

Refer to section VII-6.

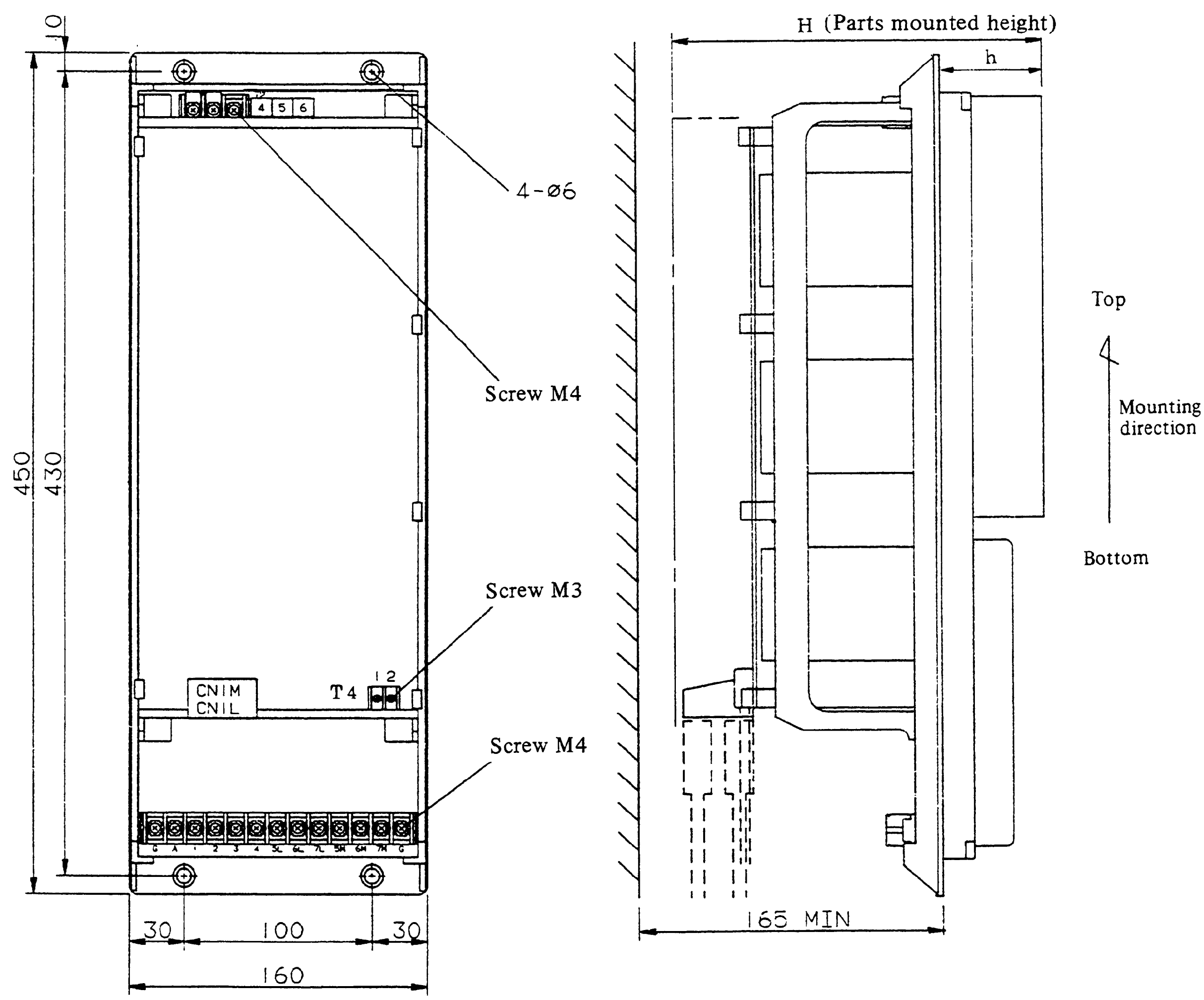
7. INSTALLATION CONDITION AND NOTES

Refer to section VII-7.

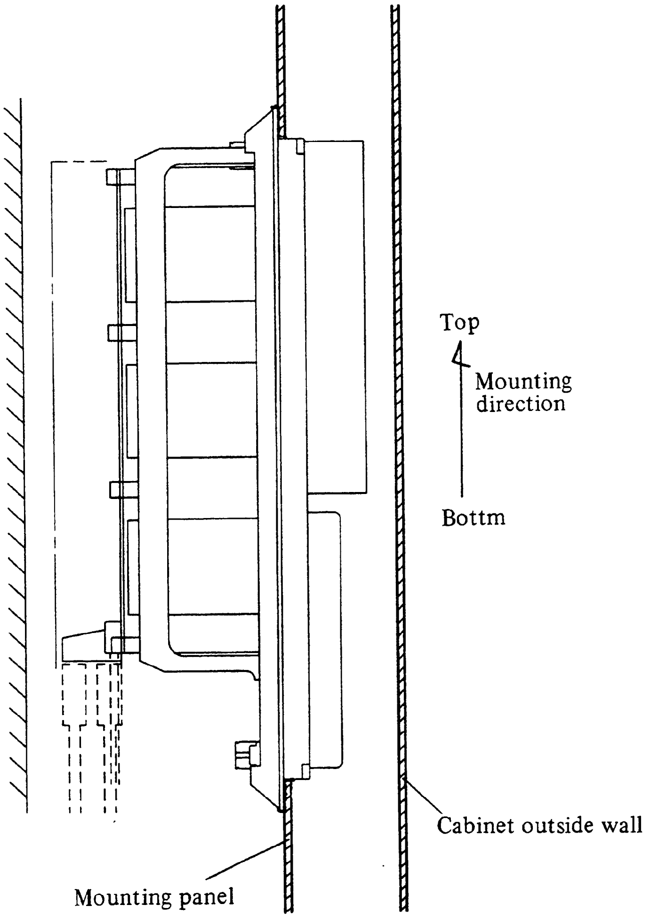
8. EXTERNAL DIMENSIONS

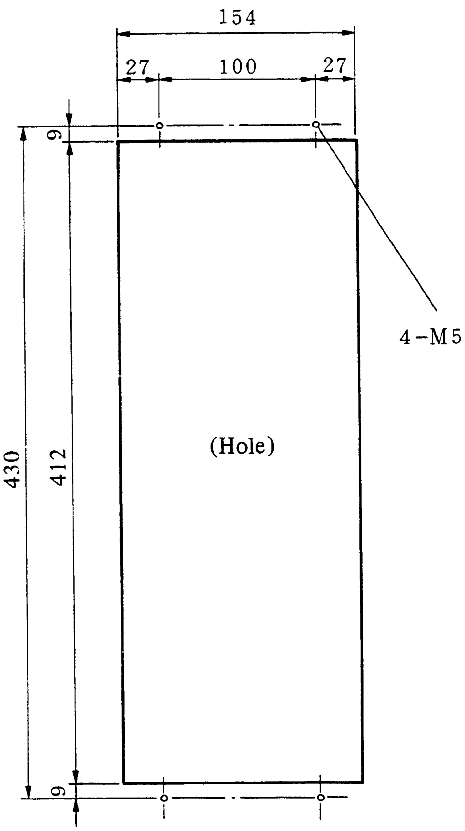
(1) External dimension of servo amplifier A06B-6058-H2xx (xx = 21 to 27 and 29 to 31)

	A06B-6058-H221 to H227	A06B-6058-H229 to H231
H	205	225
h	55	75
Weight	6.6 kg	7.5 kg



A06B-6058-H2xx (x = 21 to 27, 29 to 31, and 51 to 53)
Example of panel mounting



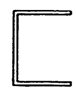


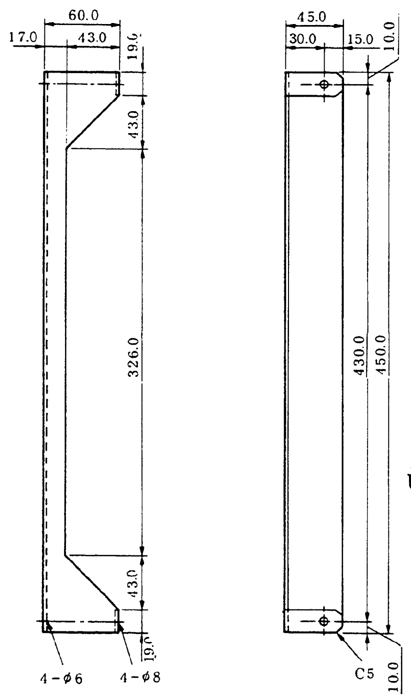
Dimensions for cutting the panel for A06B-6058-H2xx (xx = 21 to 27, 29 to 31, and 51 to 53)

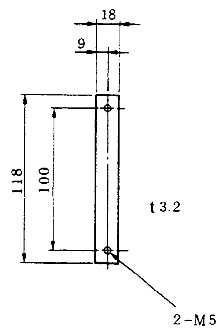
2) External dimensions of regenerative discharge unit A06B-6047-H050
   Refer to section VII-8-7).
3) External dimensions of input connector
   Refer to section VII-8-8).
4) External dimensions of AC line filter A81L-0001-0083#3C
   Refer to section VII-8-9)(a).

5) External dimensions of adapter for 2-axis amplifier A06B-6058-K103 (applicable only to H221 to H227)

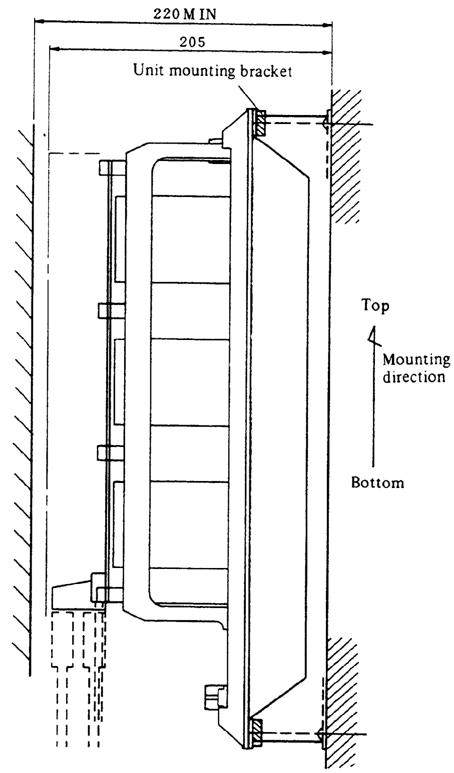
Adapter bracket (x 2)





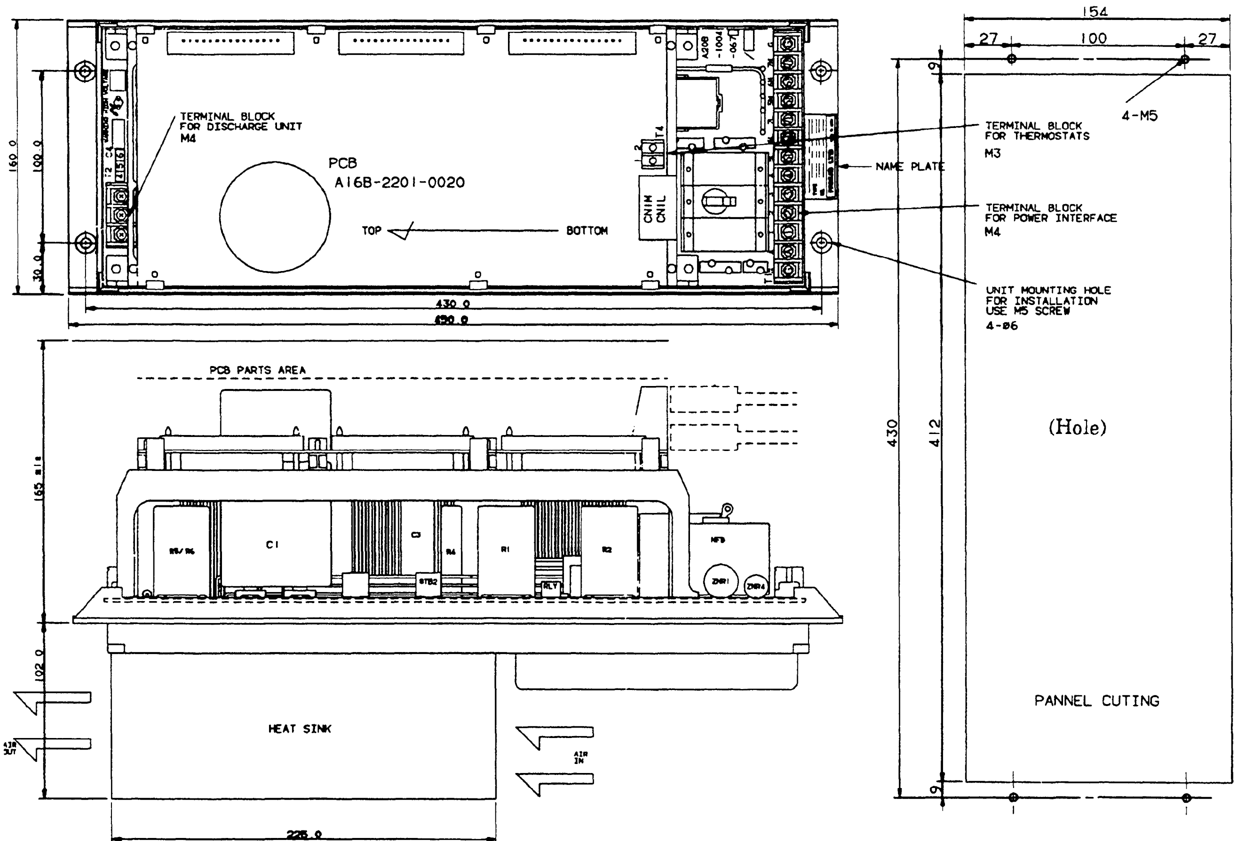


Unit mounting bracket (2 pcs)



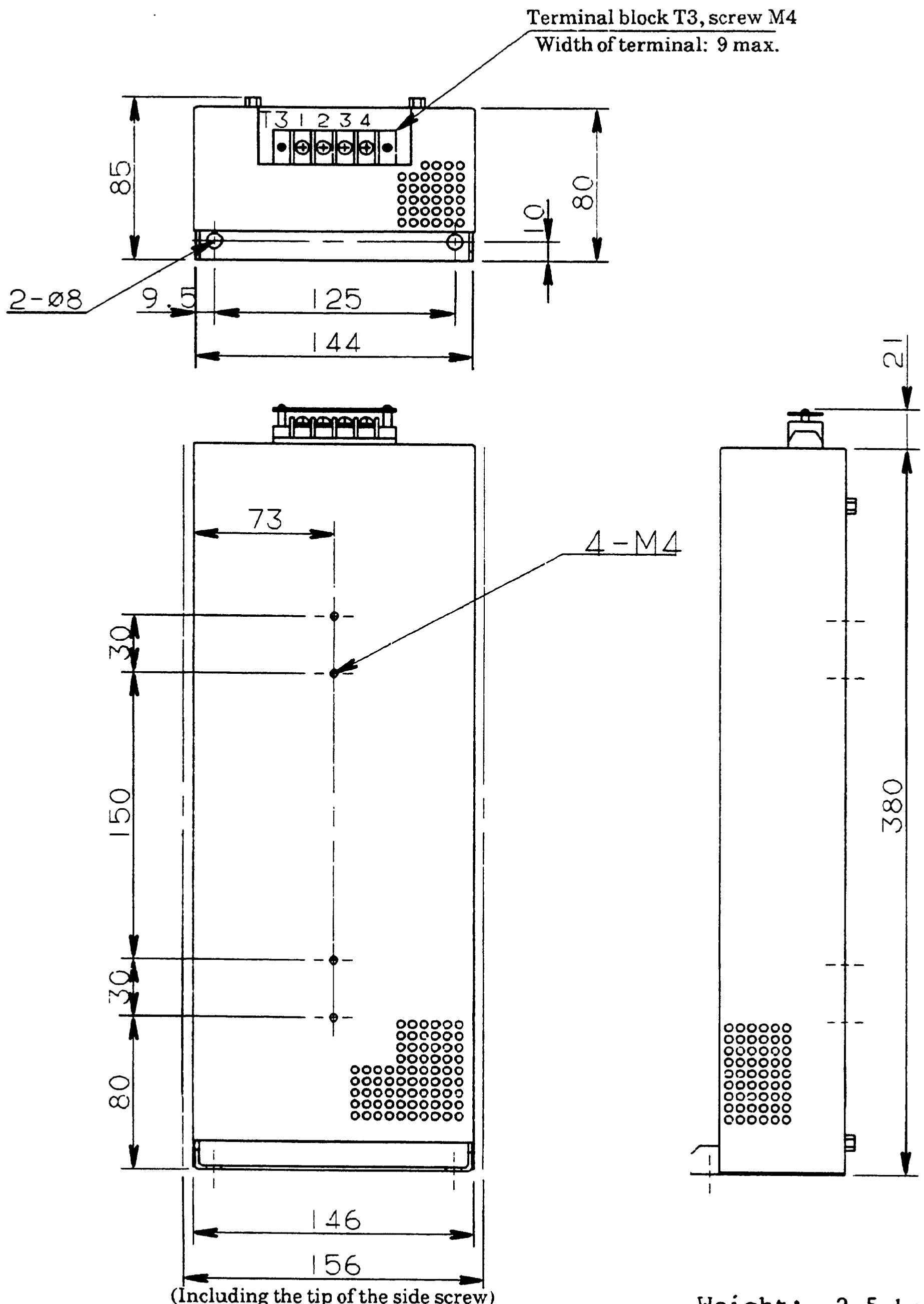
A06B-6058-H221 to H227
Example of mounting adapter

6) External dimensions of servo amplifier A06B-6058-H25x (x = 1 to 3)



Weight: 7.5 kg

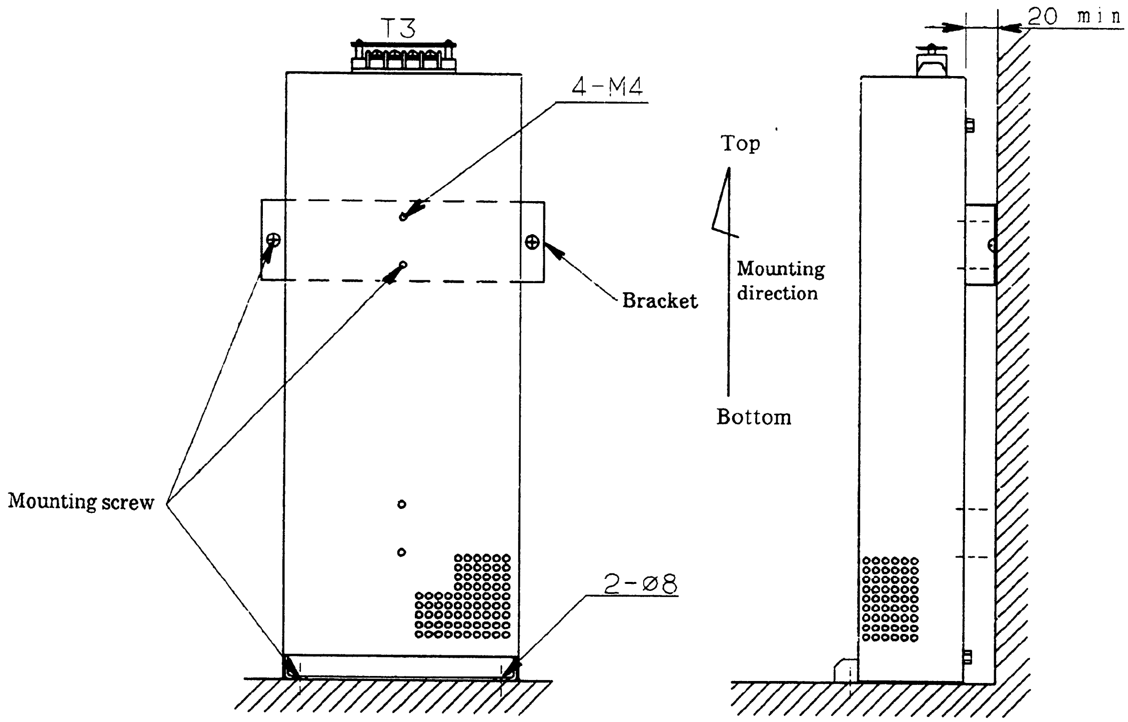
7) External dimensions of regenerative discharge unit A06B-6058-H192



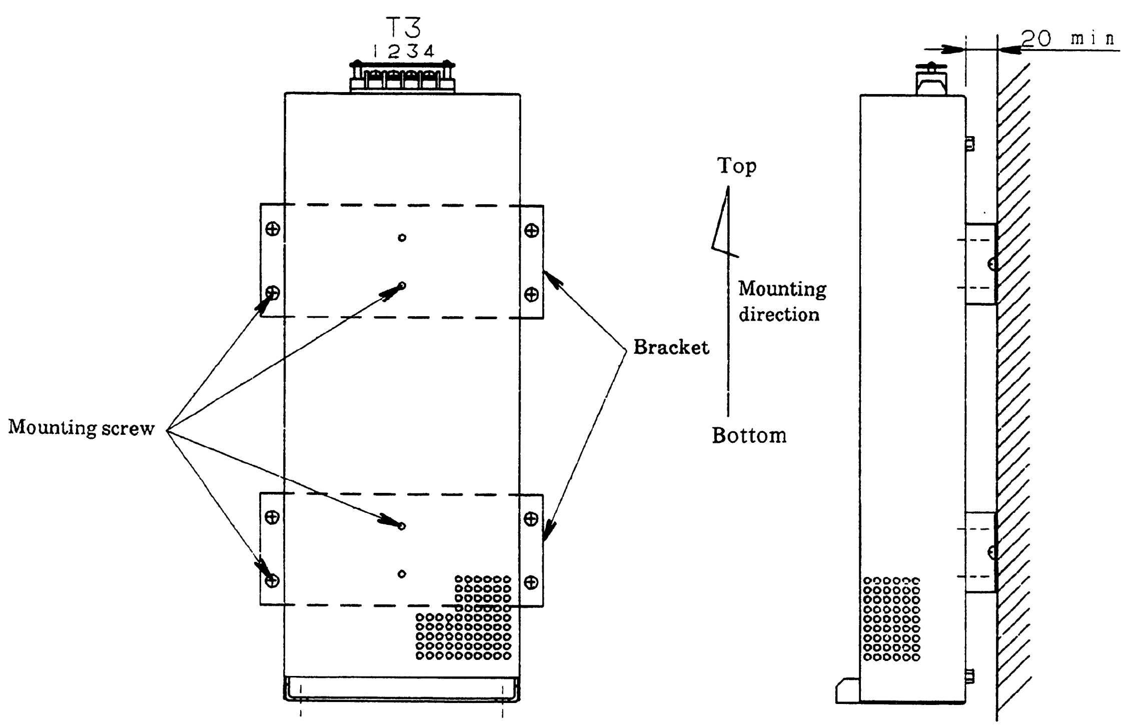
Weight: 2.5 kg

How to mount regenerative discharge unit A06B-6058-H192

Method 1



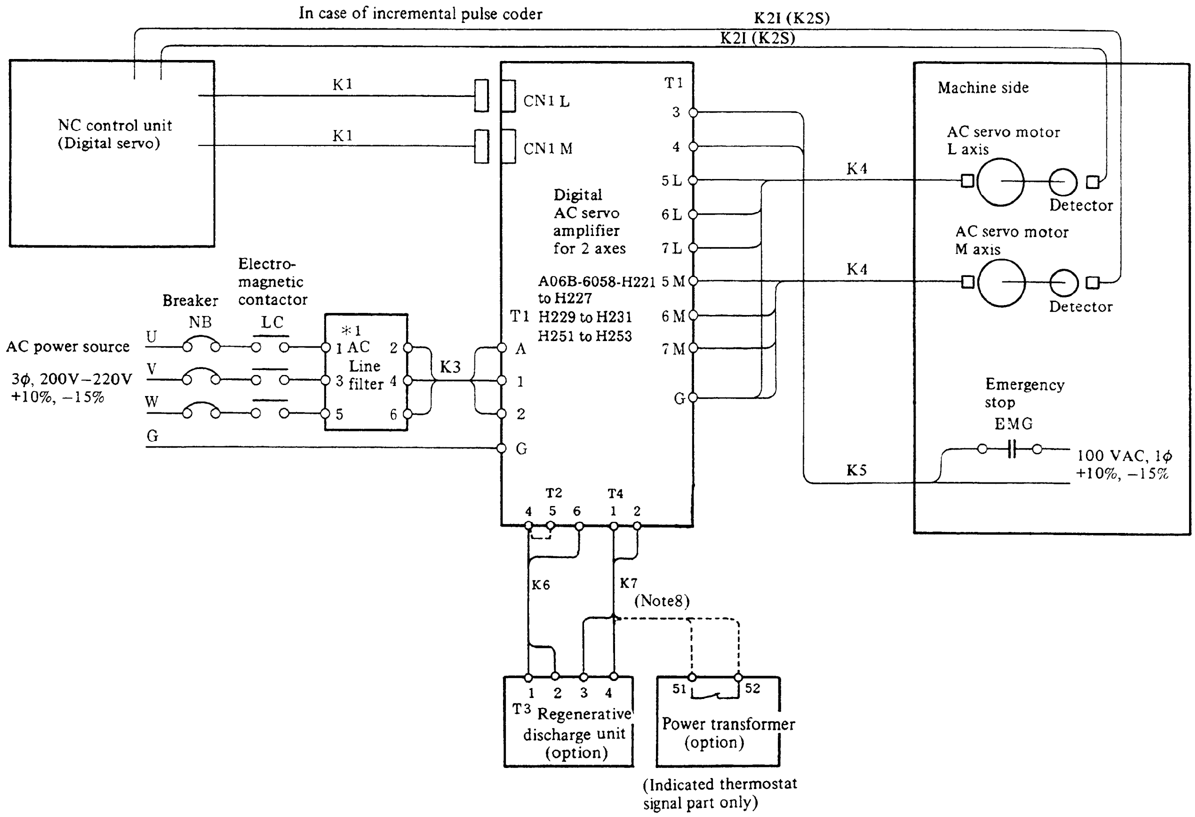
Method 2



Note 1) The bracket is not supplied with the regenerative discharge unit.

9. CONNECTION

9.1 Connection Diagram (for A06B-6058-H00x, x = 2 to 6)



Note 1) For cable K1-K7 connection details, refer to Appendix 1 and 2.

Note 2) Use AC line filter (optional) *1 when the effect of high-frequency noise on the power supply should be reduced. Several servo amplifiers can be connected for a single AC line filter within the AC line filter capacity.

Note 3) When the power breaker NB and electromagnetic contactor LC are turned ON, the servo amplifier is placed in Power-ON conditions. To prevent possible accidents, such as electric shocks, when touching the connections of servo amplifier and motor, etc., be sure to turn the NB or LC OFF in advance.

Note 4) A short bar is connected between the terminals T2-4 and T2-5 before shipment. This setting is to use the internal type regenerative discharge unit.

Note 5) When connecting the thermostat signal (Normally ON; OFF during detection) of a separate type regenerative discharge unit, or power transformer to T4, change the setting terminal S1 on the PCB to "L".

Note 6) When using the separate type regenerative discharge unit, set the terminal S2 to the "H" position on the PCB. Remove the short bar between the terminals T2-4 and T2-5.

Note 7) For the connection of the cable K2 when using the absolute pulse coder, refer to section VII-9.

Note 8) For cable K7 connection details, refer to section 7.1 of Appendix 2.

IX. FANUC AC SERVO AMPLIFIER S series (200 V INPUT FOR 3 AXES)

1. GENERAL

The AC servo amplifier for 3 axes (200 V input type) is used exclusively for driving AC servo motors. This servo amplifier has been developed so that a cabinet can be compactly designed when relatively small servo motors are used for a small machine tool.
The AC servo amplifier (200 V input type for 3 axes) has the following features.

1) When 3-phase power supply for power is 200 V to 230 VAC, the unit can be connected directly without using any transformer.
2) The unit for 3 axes is compactly designed.
   Special custom IC and the latest power module technology are fully employed, thus producing a high reliability with fewer parts and compact external profile.
   The circuit breaker, dynamic brake circuit, rectified power circuit and transistor for regenerative discharge circuit are all assembled into one unit, thereby facilitating the mounting and maintenance.
3) The unit is constructed so that the heat sink can be externally cooled: the fin side of heat sink for power module can be cooled outside the cabinet.
4) The unit is also designed with due consideration given to unit protection and detection of abnormalities, such as circuit breaker trip, overvoltage, low voltage, overcurrent and abnormal regenerative discharge circuit.
5) This amplifier is only for a digital AC servo.
   The unit receives PWM signals obtained by a high-performance signal processor within NC, and drives an AC servo motor. Used in connection with the latest FANUC CNC, it assures high speed, high-precision servo performance.

Note) When selecting the servo amplifier for a T series servo motor (hollow-shaft type motor), select the same servo amplifier as for the corresponding S series servo motor. The correspondence between the T series motors and S series motors regarding the servo amplifiers are as follows.

Model 0T/3000:	Model 0S/3000
Model 5T/2000:	Model 5S
Model 5T/3000:	Model 5S/3000
Model 10T/2000:	Model 10S
Model 10T/3000:	Model 10S/3000

2. CONFIGURATION

Fig. 2 shows a sample configuration of NC system for 3-axis control.

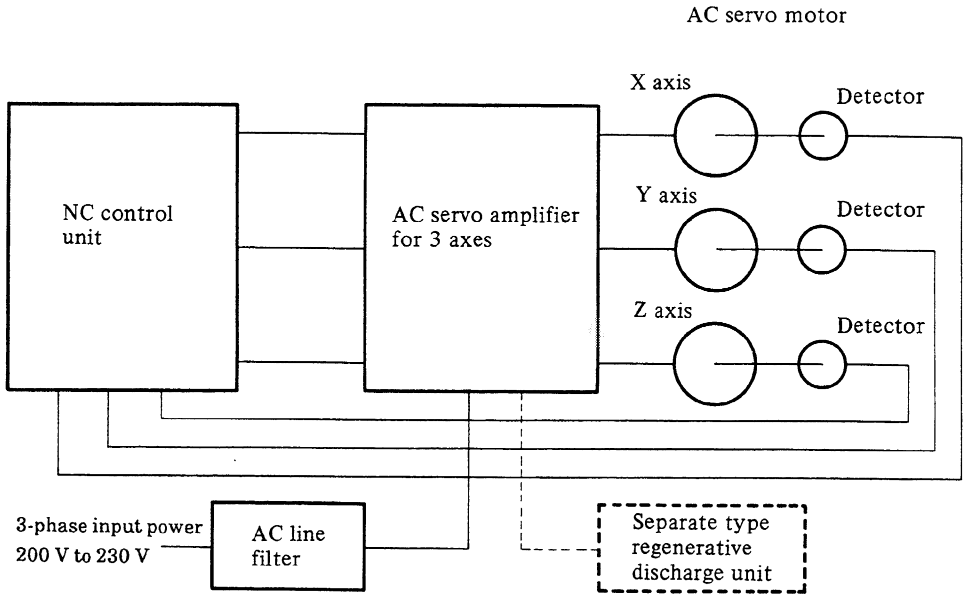


Fig. 2 Example of configuration

2.1 Types of Units and Specifications

Table 2.1 Types of units and specifications

Name	Applicable motor (Notes 1, 2, and 3)			Specifications	Remark
	L axis	M axis	N axis		
Servo amplifier (Notes 8 and 9)	2-0SP 1-0SP 1-0SP/3000	2-0SP 1-0SP 1-0SP/3000	2-0SP 1-0SP 1-0SP/3000	A06B-6058-H331	
	2-0SP 1-0SP 1-0SP/3000	2-0SP 1-0SP 1-0SP/3000	0S 5S 10S 0S(/3000)	A06B-6058-H332	
	2-0SP 1-0SP 1-0SP/3000	0S 5S 10S 0S(/3000)	0S 5S 10S 0S(/3000)	A06B-6058-H333	
	0S 5S 10S 0S(/3000)	0S 5S 10S 0S(/3000)	0S 5S 10S 0S(/3000)	A06B-6058-H334	
Separate regenerative discharge unit (See 4.2.) (10Ω/400W)				A06B-6050-H052	
AC line filter (Note 5)	Type A: The sum of the rated outputs of the motors is 5.4 kW or less.			A81L-0001-0083#3C	
	Type B: The sum of the rated outputs of the motors is 10.5 kW or less.			A81L-0001-0101#C	
	Type C: The sum of the rated outputs of the motors is 23 kW or less.			A81L-0001-0102	
Export power transformer	Capacity of type SAE: 2.2 kVA			A80L-0022-0005	
	Capacity of type SBE: 3.5 kVA			A80L-0024-0006	
	Capacity of type SCE: 5 kVA			A80L-0026-0003	
	Capacity of type SDE: 7.5 kVA			A80L-0028-0001	
Adapter for 3-axis amplifiers (Note 6)				A06B-6058-K104	
Input connector (Note 7)	Solder type			A06B-6058-K203	
	Crimp type			A06B-6058-K204	

Note 1) For the AC servo motor, apply the new models 2-0SP, 1-0SP, 1-0SP/3000, 0S, 5S, and 10S (A06B-0313-BXXX to A06B-0315-BXXX) that have been designed to fit the 200-V input type amplifier.

Note 2) The amplifier for model 2-0S is the same as that for model 2-0SP, and the amplifier for model 1-0S is the same as that for model 1-0SP.
The descriptions of the amplifiers for models 2-0SP and 1-0SP are also applicable to the amplifiers for models 2-0S and 1-0S, respectively.

Note 3) When selecting the servo amplifier for a T series servo motor (hollow-shaft type motor), select the same servo amplifier as for the corresponding S series servo motor. The correspondence between the T series motors and S series motors regarding the servo amplifiers are as follows.

Model 0T/3000:	Model 0S/3000
Model 5T/2000:	Model 5S
Model 5T/3000:	Model 5S/3000
Model 10T/2000:	Model 10S
Model 10T/3000:	Model 10S/3000

Note 4) The maximum continuous load which can be used with a single amplifier for 3 axes corresponds to continuous rating of Model 10S x 3.

Note 5) It is used when the effect of the high frequency noise to the power source must be decreased.

Note 6) This adapter is used when the unit is mounted on wall of the cabinet.

Note 7) This input connector is used for the signal cable from the CNC to the servo amplifier.

Note 8) Model 2-0SP is rated to operate at up to 3000 rpm, although it is not specifically designated as 2-0SP/3000.

Note 9) Of the applicable motors, models 0S, 5S, and 10S form a group, and model 0S(/3000) is added to that group.
Because model 0S operates at both 3000 rpm and 2000 rpm, there is no distinction between a 3000-rpm motor and a 2000-rpm motor. However, the driving capacity of the amplifier varies depending on the operating speed of the motor. In the above table, model 0S rated at 3000 rpm is designated as 0S(/3000) for the sake of convenience.

3. SPECIFICATIONS

3.1 Specifications

Refer to section VII-3.1.

3.2 Protection and Error Detection Function

Refer to section VII-3.2.

4. AC LINE FILTER AND SEPARATE TYPE REGENERATIVE DISCHARGE UNIT

4.1 AC Line Filter (Option)

Use the optional AC line filter to reduce the effect of high-frequency noise on the power source. For details of the AC line filter, see VII-4.1.

4.2 Separate Type Regenerative Discharge Unit

When servo amplifier A06B-6058-H331 - H334 are used, if the energy regenerated form the motor is large and exceeds the capacity of the servo amplifier built-in discharge unit, use a separate type regenerative discharge unit A06B-6050-H052. When P or Q calculated in sections VII-4.2.1 and 4.2.2 is found for each axis and the unit is continuously used at 70 to 400 W total, use a separate type regenerative discharge unit.
For details refer to section VII-4.2.

5. POWER SOURCE

5.1 Input Power Source

The AC servo amplifier (200 V input type for 3 axes) employs 3-phase power supply for main circuit and single-phase power source for coil of electro-magnetic contactor for dynamic brake. For the specifications of each power source, see Table 3.1 of VII-3.1.

5.2 Capacity of Power Source

Refer to section VII-5.2.1.

5.2.1 Capacity of three-phase power source

Refer to section VII-5.2.1.

5.2.2 Capacity of single-phase 100 VAC power source

Table 5.2.2 Power source capacity for single-phase 100 V

Condition	Power source capacity of single-phase 100 VAC
At continuously supplying power	50 VA
At turning on the electro-magnetic contactor	200 VA

5.3 Power Transformer

Refer to section VII-5.3.

6. HEAT LOSS

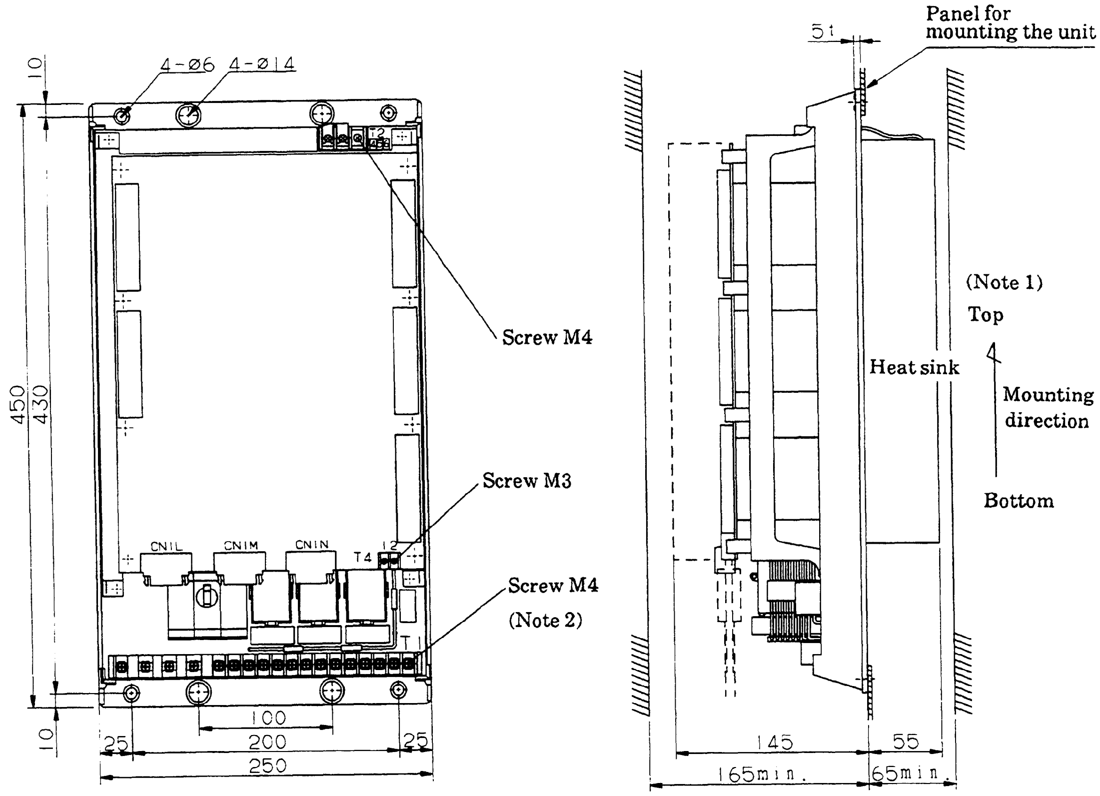
Refer to section VII-6.

7. INSTALLATION CONDITION AND NOTES

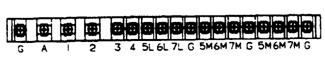
Refer to section VII-7.

8. EXTERNAL DIMENSIONS

(1) External dimensions of servo amplifier A06B-6058-H33x (x = 1 to 4)

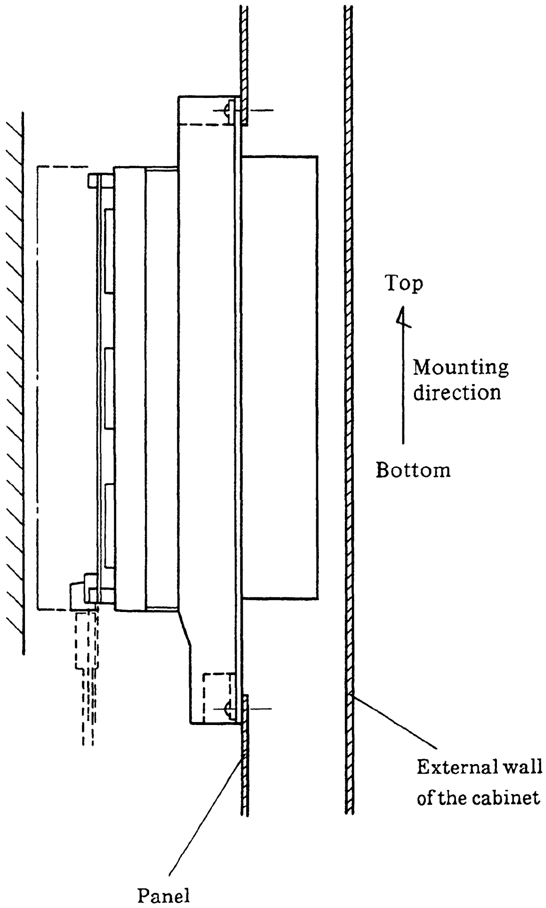


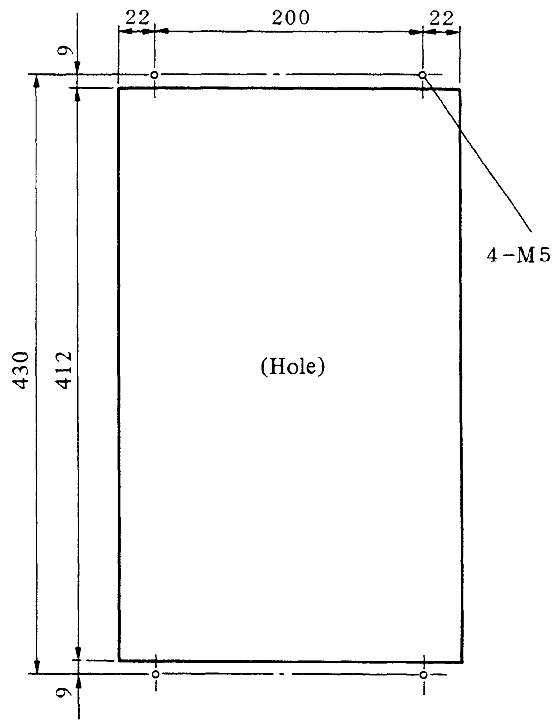
Note 1) The rear of the heat sink gets hot. Do not mount parts on it.
Note 2) Connection of T1 is as follows.



Weight: 10 kg

Example of how to mount A06B-6058-H33x (x = 1 to 4) on the panel





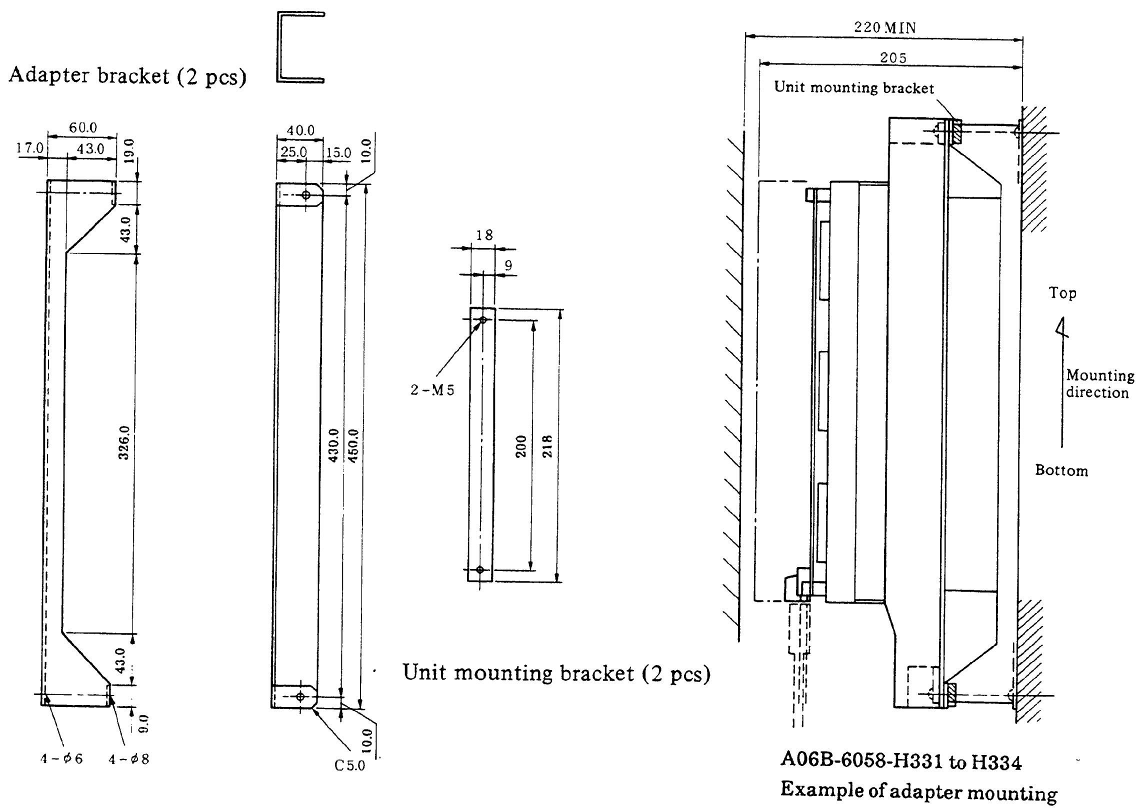
Dimensions for cutting the panel to mount A06B-6058-H33x (x = 1 to 4)

(2) External dimensions of regenerative discharge unit A06B-6058-H052
Refer to section VII-8-7).

(3) External dimensions of input connector
Refer to section VII-8-8).

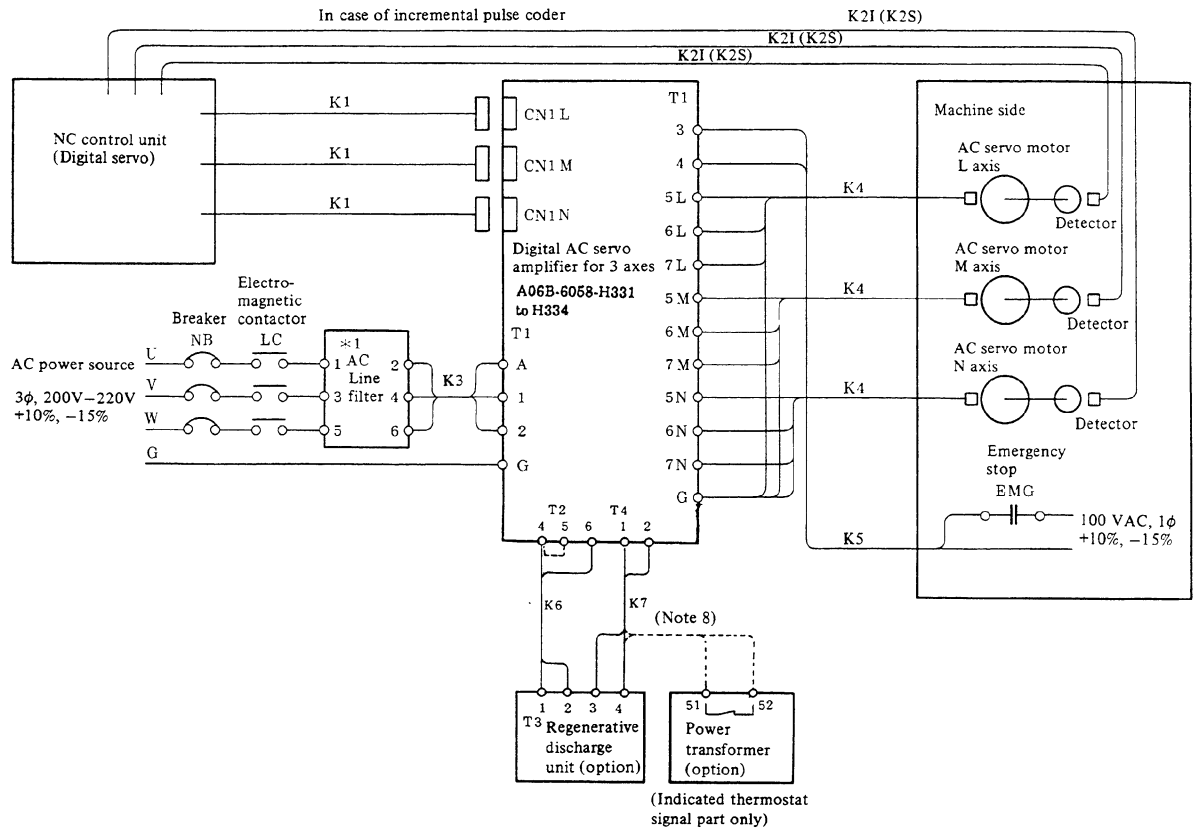
(4) External dimensions of the AC line filter
Refer to section VII-8 and VII-8-9)(a).

(5) External dimensions of adapter for 3-axes amplifier A06B-6058-K104



9. CONNECTION

9.1 Connection Diagram



Note 1) For cable K1-K7 connection details, refer to Appendix 1 and 2.

Note 2) Use AC line filter (optional) *1 when the effect of high-frequency noise on the power supply should be reduced. Several of servo amplifiers can be connected for a single AC line filter within the range of AC line filter capacity.

Note 3) When the power breaker NB and electromagnetic contactor LC are turned ON, the servo amplifier is placed in Power-ON conditions. To prevent possible accidents, such as electric shocks, when touching the connections of servo amplifier and motor, etc., be sure to turn the NB or LC OFF in advance.

Note 4) A short bar is connected between the terminals T2-4 and T2-5 before shipment. This setting is to use the internal type regenerative discharge unit.

Note 5) When connecting the thermostat signal (Normally ON; OFF during detection) of a separate type regenerative discharge unit or power transformer to T4, change the setting terminal S1 on the PCB to "L".

Note 6) When using the separate type regenerative discharge unit, set the terminal S2 to the "H" position on the PCB. Remove the short bar between the terminals T2-4 and T2-5.

Note 7) For the connection of the cable K2 when using the absolute pulse coder, refer to section VII-9.

Note 8) For cable K7 connection details, refer to section 7.1 of Appendix 2.

X. LARGE-SCALE SERVO AMPLIFIER

1. GENERAL

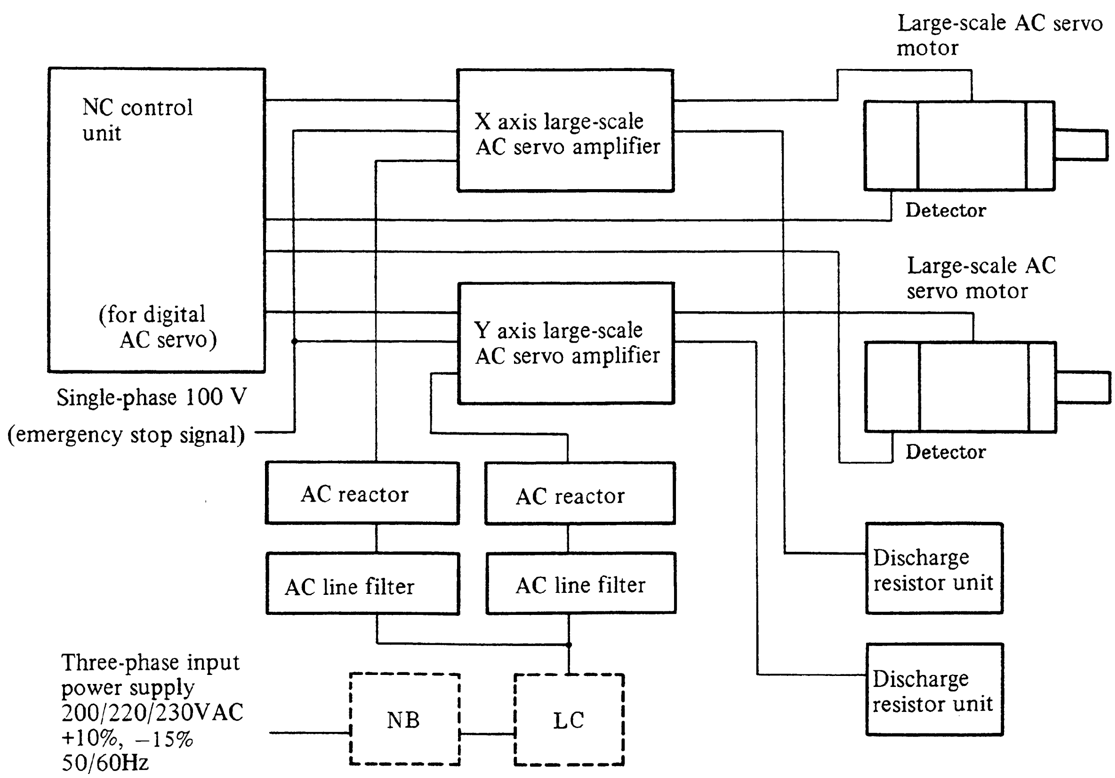
The FANUC large-scale AC servo amplifier is exclusively for digital AC servo, developed mainly for large-scale machine tool and used to drive the large scale AC motors models 50S, 60S, and 20S.

2. CONFIGURATION

The following parts are required to perform axis-control of machine tool using the FANUC large-scale AC servo motor and amplifier.

(1) NC control unit (for FANUC digital AC servo)
(2) FANUC large-scale AC servo motor
(3) FANUC large-scale AC servo amplifier
(4) Discharge resistor unit (for regenerative power discharge)
(5) AC line filter (for reducing high-frequency noise from servo amplifier)
(6) AC reactor (for improving power factor of servo amplifier)

The NC system configuration diagram for 2 control axes is shown in Fig. 2.1.



Note 1) NB: Breaker, fuse, etc.
Note 2) LC: Electromagnetic contactor

Fig. 2.1 NC system configuration example for 2 control axes

2.1 Types of Units and Specifications

Name	Applications	Specified specifications
Servo amplifier	For model 50S	A06B-6058-H101
	For models 60S/70S	A06B-6058-H102
Discharge resistor unit (Note 1) 2kW or less	1 unit/axis	A06B-6058-H191
AC line filter (Note 2)	1 piece/axis	A81L-0001-0102
AC reactor (Note 3)	1 piece/axis	A81L-0001-0063
Input connector (for one axis) (Note 4)	Soldering type	A06B-6058-K205
	Crimp type	A06B-6058-K206
Spare fuse	For PC boards	A06B-6058-K301
	For units	A06B-6058-K302
Power supply transformer for export (Note 5)	For models 50S/60S	A80L-0001-0127
	For model 70S	A80L-0001-0128

(Note 1) It is used to discharge regenerative power from the motor.
(Note 2) Use it to reduce high-frequency noise influence to power supply.
(Note 3) Use it to improve power factor.
(Note 4) It is a connector used for the signal cable from CNC connection to the input connector CN1 of servo amplifier.
(Note 5) The transformer should be installed outside the cabinet etc.

3. SPECIFICATIONS

3.1 Specifications

Table 3.1 Specifications

Item			Specifications		
Servo amplifier			For model 50S	For model 60S	For model 70S
Applied motor model			50S	60S	70S
Rated output current (Note 1)			67 Arms	77 Arms	118 Arms
Power supply	Three-phase power supply for power		Voltage 200/220/230VAC Allowable voltage fluctuation +10%, -15% Frequency 50/60Hz Allowable frequency fluctuation ±2Hz Number of phases 3		
		Power supply capacity	16 KVA	22 KVA	32 kVA
	Single-phase power supply for emergency stop signal		Voltage 100VAC Allowable voltage fluctuation +10%, -15% Frequency 50Hz Allowable frequency fluctuation ±2Hz OR Voltage AC100/110V AC Allowable voltage fluctuation +10%, -15% Frequency 60Hz Allowable frequency fluctuation ±2Hz		
		Power supply capacity	Inrush power 800 VA Rating 100 Va		
Main circuit/control system			Sinusoidal wave PWM control by transistor bridge		
Current control value			200 Ap	300 Ap	300 Ap
Alarm/protection function			*No fuse breaker (main circuit) *Excessive voltage *Shortage voltage *Excessive regenerative *Overheat *Abnormal current		
Ambient temperature range			0°C to 55°C		

(Note 1) The current limit value (peak value) of output current is the current control value. The tolerance of rated value due to circuit time constant is approximately ±5%.

4. AC LINE FILTER, AC REACTOR/DISCHARGE RESISTOR UNIT

Use the AC line filter, AC reactor, and discharge resistor unit for each axis. Consult us separately if the power consumption of discharge resistor unit exceeds 2 kW. Refer to section VII-4.1.
For selecting method of discharge resistor unit capacity, refer to section VII-4.2.

5. POWER SOURCE

See Table 3.1.

6. HEAT LOSS

In general, the heat build-up of servo amplifier depends on the use conditions and is greatly affected by the acceleration/deceleration frequency, acceleration/deceleration time constant, load inertia, cutting torque, and friction torque.

<table>
<tr><th colspan="3">Product name</th><th>Maximum heat loss (W)</th></tr>
<tr><td rowspan="3">Large-scale servo amplifier (Note 1)</td><td colspan="2">Control circuit side</td><td>200</td></tr>
<tr><td rowspan="2">Discharge side</td><td>50S</td><td>600</td></tr>
<tr><td>60S, 70S</td><td>1000</td></tr>
<tr><td colspan="3">Discharge resistor unit (Note 2)</td><td>2000</td></tr>
<tr><td colspan="3">AC line filter</td><td>Maximum 100</td></tr>
<tr><td colspan="3">AC reactor</td><td>Maximum 100</td></tr>
</table>

(Note 1) Maximum heat loss for rated output.
(Note 2) It depends on the maximum power rating of discharge resistor unit.

7. INSTALLATION CONDITION AND NOTES

7.1 Installation Conditions

Ambient temperature	0 - 55 degrees
Humidity	95 % RT or less (no dew forming)
Vibration	0.5 G or less
Environment	Not directly subject to cutting liquid, lubrication oil, or cutting dust

7.2 Cautions

1) The servo amplifier should be installed in the cabinet such as a power magnetic cabinet. No sealing is provided between the chassis and the heat sink. Thus, keep cutting liquid, lubrication oil, and cutting dust away from the heat sink with the air.

2) Install the servo amplifier so that the printed board is protected from accidental contact and allocate sufficient space for maintenance.

3) Do not allow wiring to approach the upper part and surrounding of discharge resistor unit. In addition, never install any object which may block evacuation of air from the discharge port.
Provide approximately 100 mm space near the air intake port of fan motor of discharge resistor unit and never install any object which may block intake.
If the cooling is not sufficient, the discharge resistor unit may be excessively overheated, thus resulting in a failure.

4) It should be easily inspected, removed or installed on maintenance.

5) Provide approximately 50 mm space above and below the servo amplifier for proper air flow form the heat build-up part and to ease wiring to the terminal block.

6) The large-scale AC servo amplifier weights approximately 45 kg. Adequate support must be provided for installation.

7) Separate the power line such as three-phase input power supply cable and motor power cable form the weak current signal cables such as motor detector cable for installation. Otherwise, malfunction may result due to noise, and could lead to intermittent failures.

7.2.1 When amplifiers are housed in a closed type cabinet

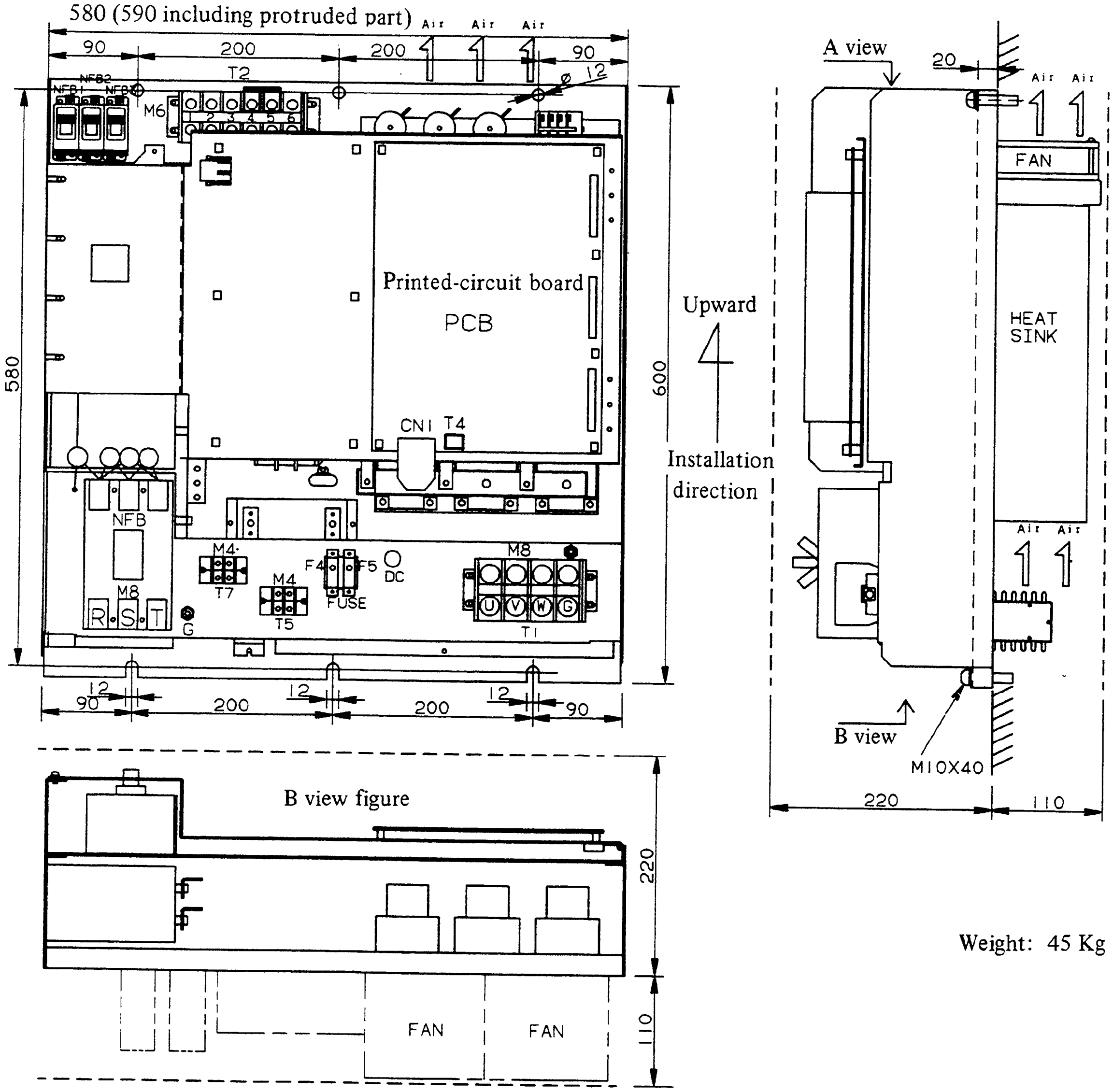
In the case of the closed type cabinet, the internal air temperature increases. Circulate the internal air so the ambient temperature of cabinet is uniform. Air speed should be approximately 1 to 2 m/sec. Install by keeping the fan or blower air away from the unit. Otherwise, dust may be adhered on the unit surface, causing failure.

7.2.2 When amplifiers are housed in an open-air ventilation cabinet

1) Use an air filter for air intake port.
2) Install the fan so that the amplifier is not directly subject to blower air. Otherwise, dust may be blown into the amp surface, leading to failure.
3) Cutting liquid mist or dust/dirt may enter from the air intake port, causing a failure. Also, be sure the air flow form the exhaust port is not blocked.
4) Securely seal the cable entrance and door.

8. EXTERNAL DIMENSIONS

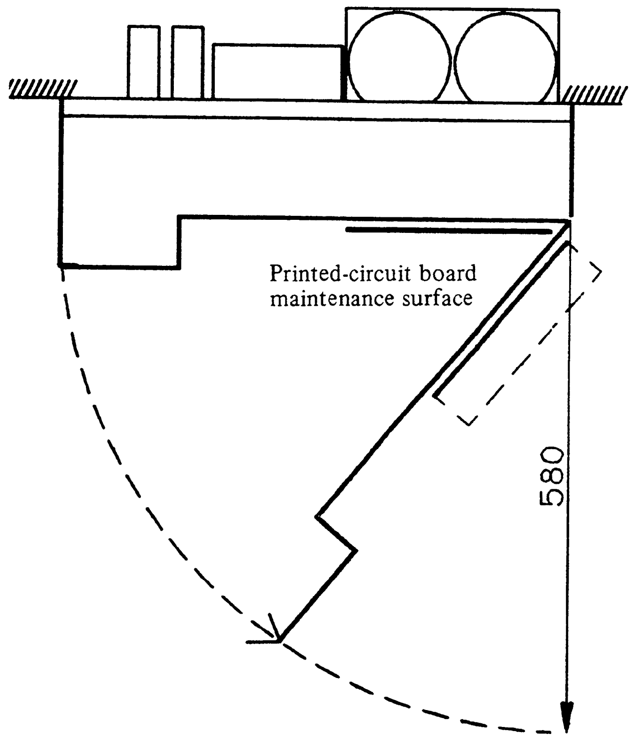
1) External dimensions for servo amplifier models 50S, 60S, and 70S



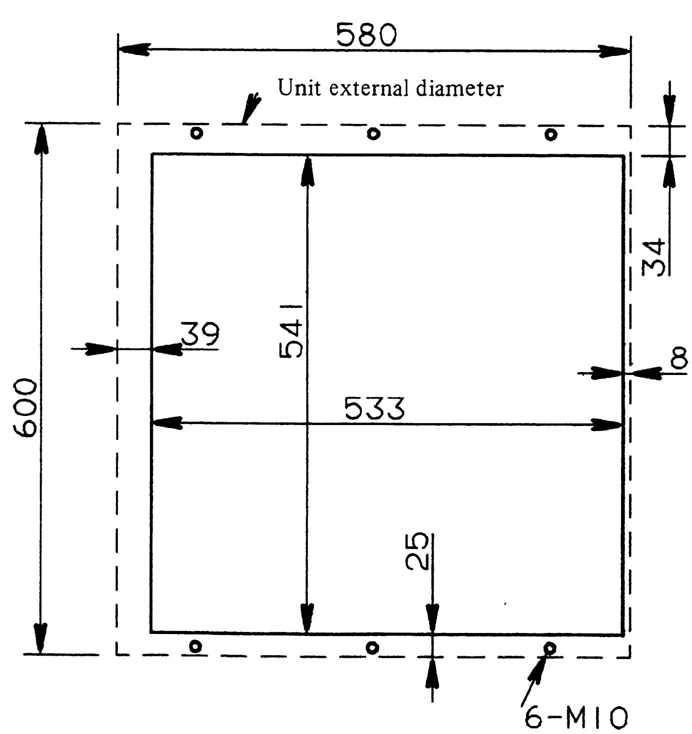
Weight: 45 Kg

2) Servo amplifier maintenance surface and area

A view figure

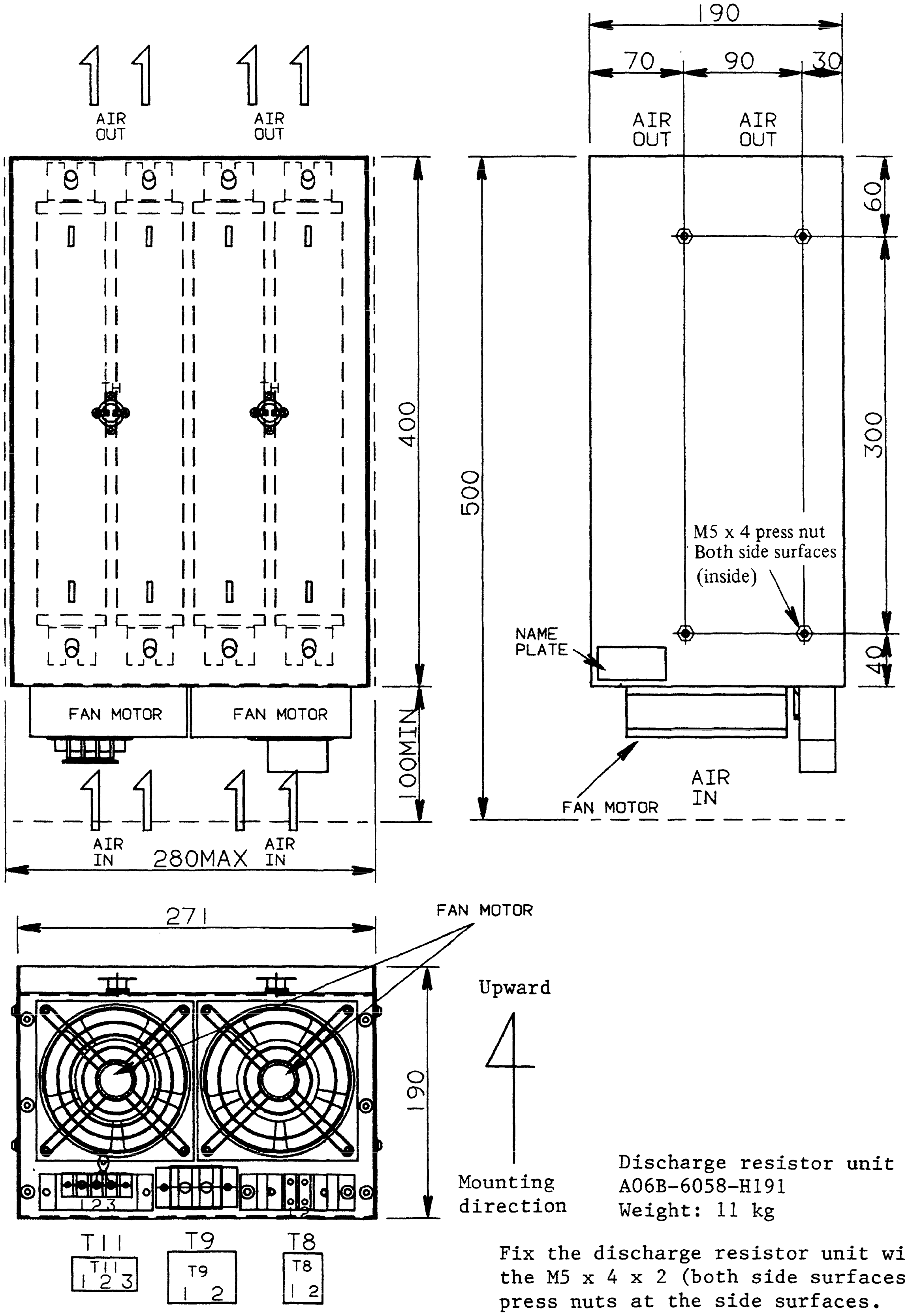


3) Panel cut out for mounting servo amplifier



Panel cut out

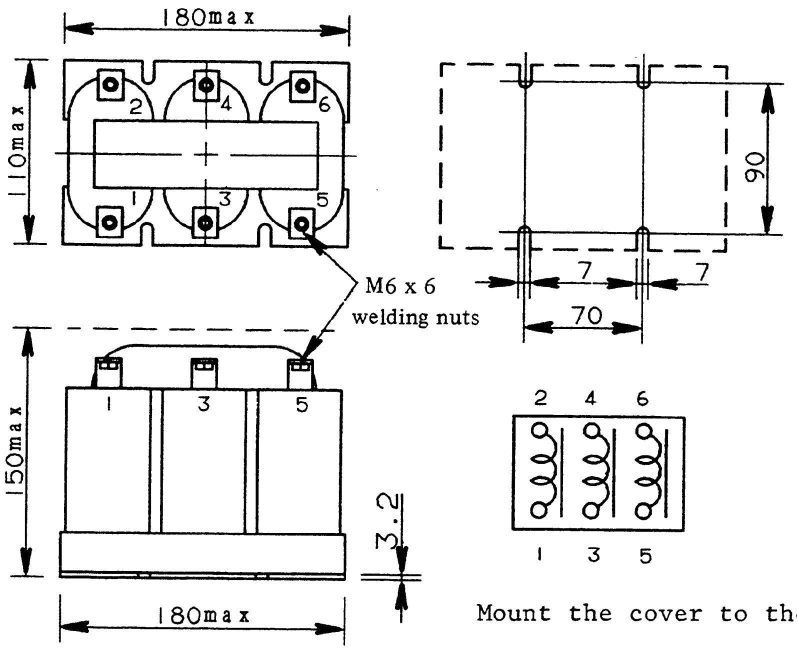
4) External dimension for discharge resistor unit 2kW (including screw hole dimensions diagram for mounting)



Discharge resistor unit
A06B-6058-H191
Weight: 11 kg

Fix the discharge resistor unit with the M5 x 4 x 2 (both side surfaces) press nuts at the side surfaces.

5) AC reactor external figure

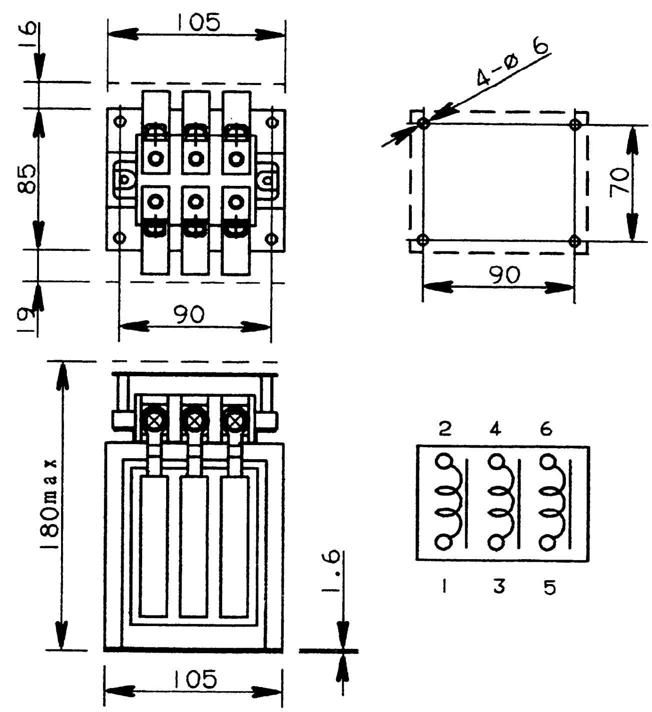


Mount the cover to the AC reactor.

AC reactor A81L-0001-0063

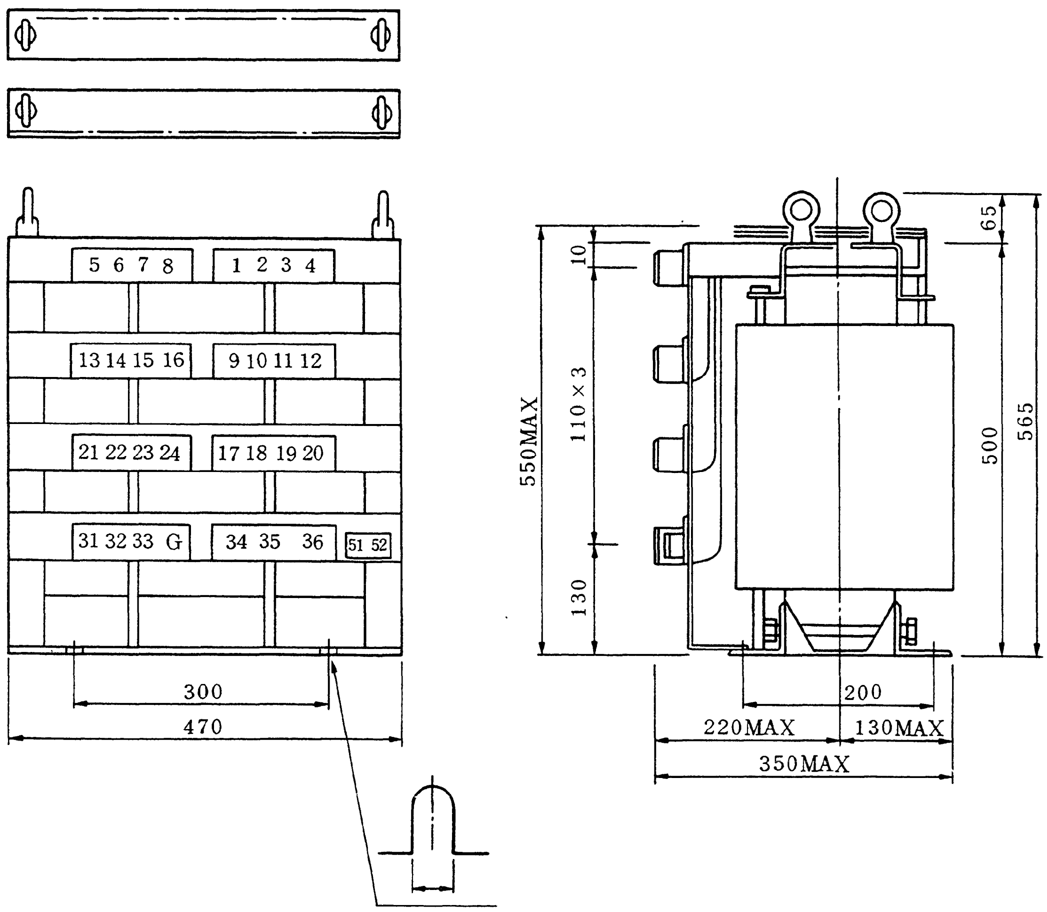
Weight: 8kg

6) AC line filter external figure



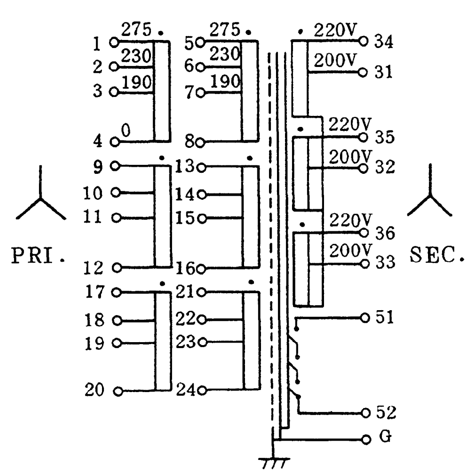
AC line filter (with terminal cover)
A81L-0001-0102 Weight: 3kg

7) External figure of export power supply transformer
a) For models 50S and 60S (A80L-0001-0127)

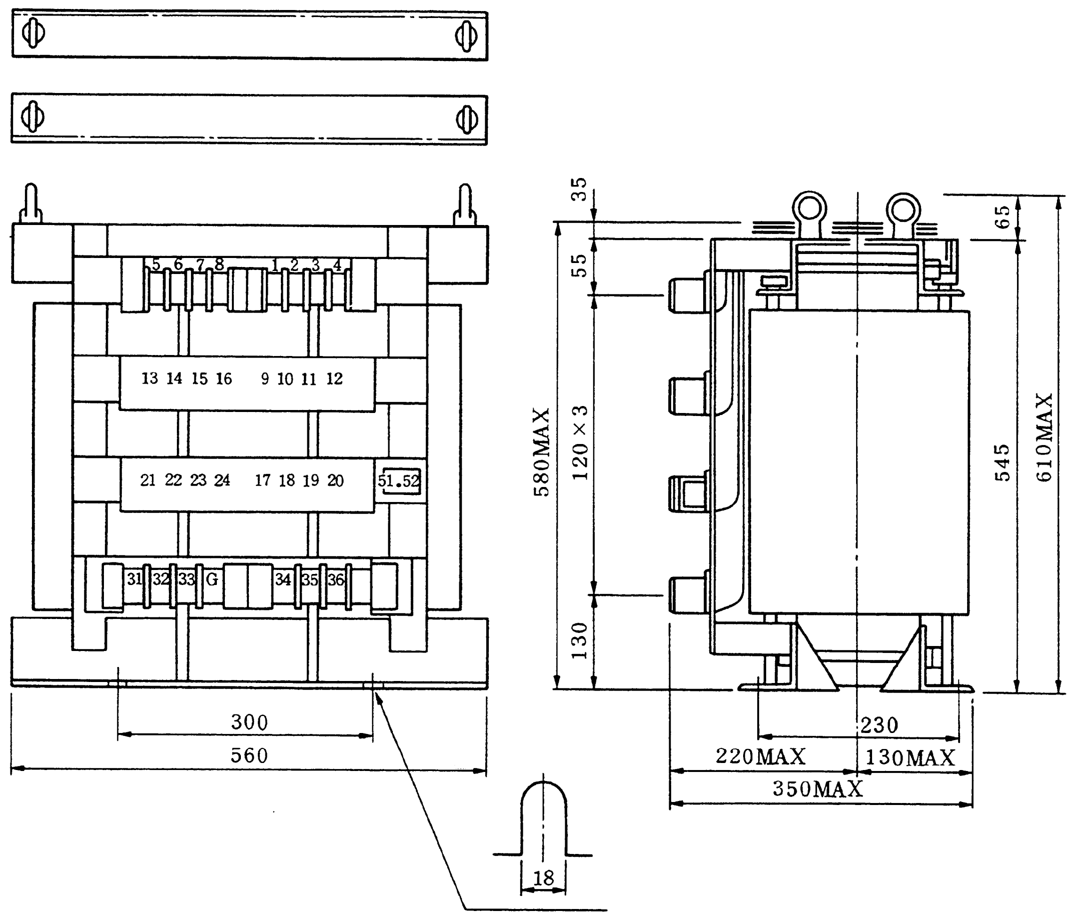


Note) See item (c) to (e) for terminal external figure.
A terminal: Terminal numbers 1-24, 31-36, G
C terminal: Terminal numbers 51, 52

Capacity	30 KVA
Insulation	H type
Thermostat operating point	160°C
Weight	Max. 220 kg



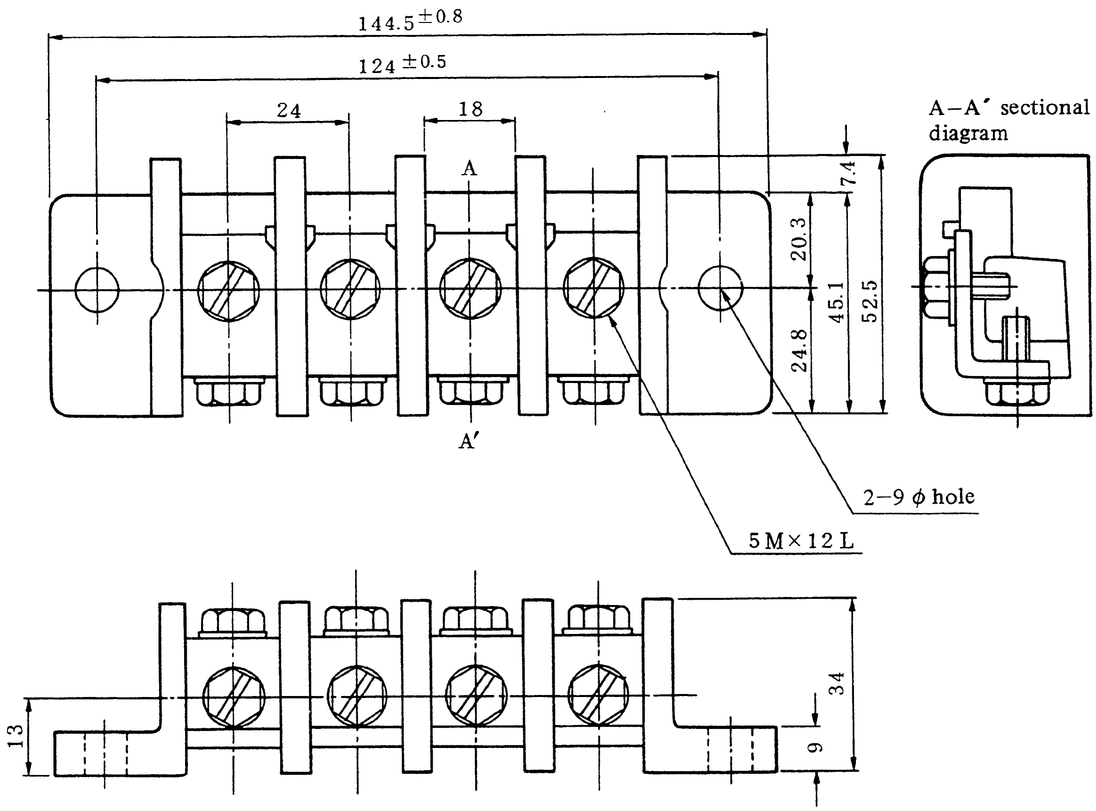
b) For model 70S (A80L-0001-0128)



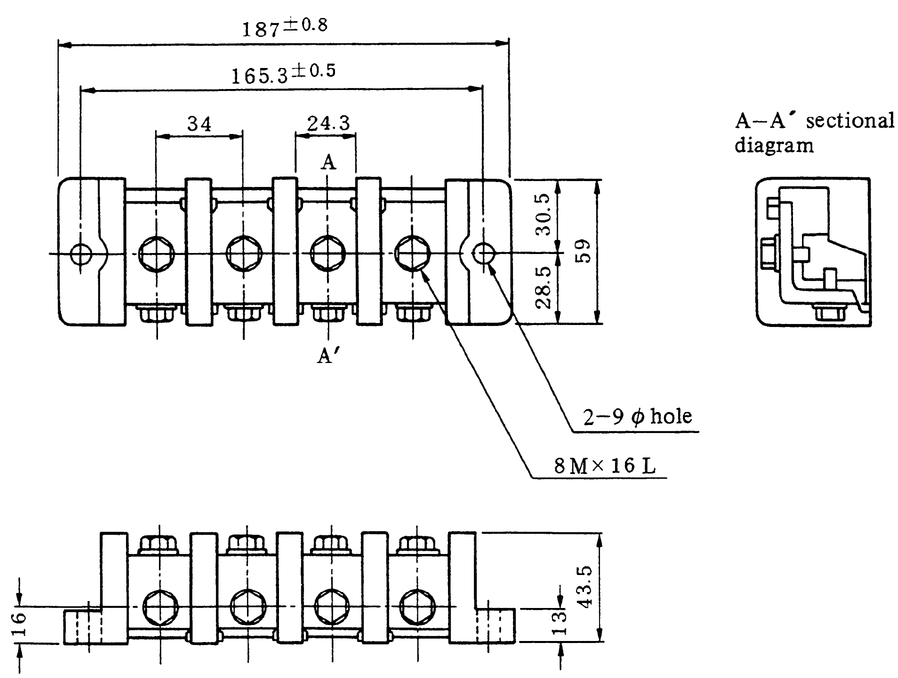
Note 1) See items (e) to (e) for terminal external figure.
A terminal: Terminal numbers 1-24
B terminal: Terminal numbers 31-36, G
C terminal: Terminal numbers 51, 52
Note 2) Wiring diagram is the same as that of A80L-0001-0127.

Capacity	40 KVA
Insulation	H type
Thermostat operating point	160°C
Weight	Max. 340 kg

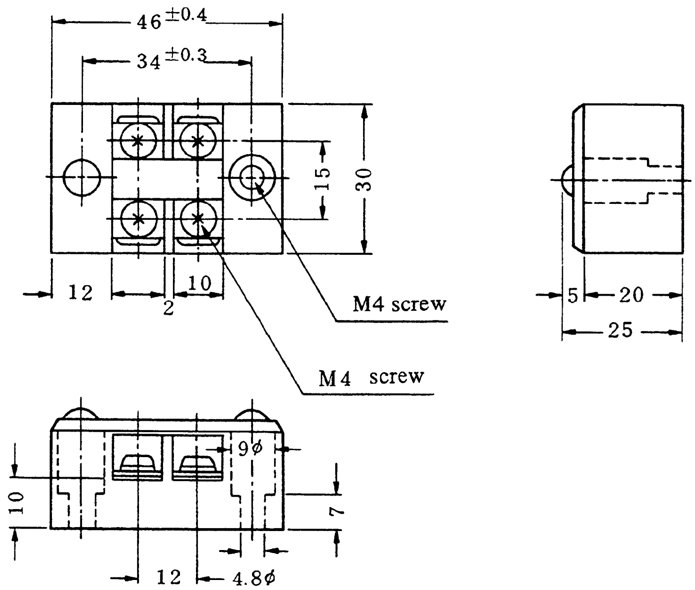
c) A terminal (rating 660V-100A)



d) B terminal (rating 660V - 200A)

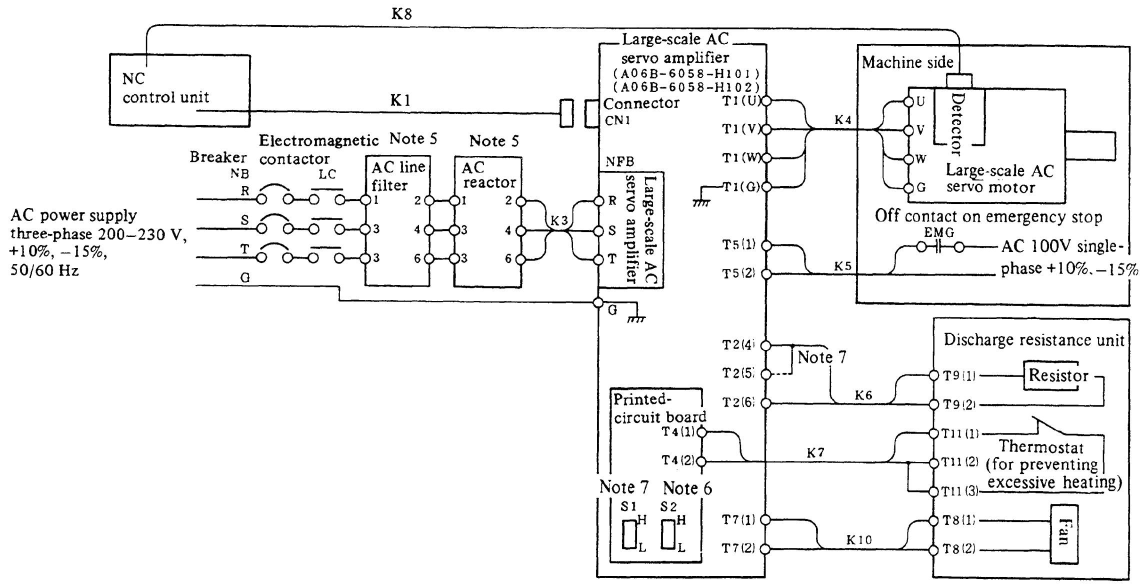


e) C terminal (rating 660V - 20A)



9. CONNECTION

9.1 Connection Diagram



Note 1) See each NC connecting manual for details on cable K1 connection.

Note 2) See Appendix 1 and 2 for details on connection of cables K2 - K8.

Note 3) Connect the power supply transformer between the electromagnetic contactor LC and AC servo amplifier in the case of AC power supply voltage other than 200 - 230 V. The AC line filter can be removed when the isolation transformer is used. However, use the AC line filter if the isolation transformer is an auto transformer.

Note 4) The AC line filter is used to reduce influence of high-frequency noise to the power supply. The AC reactor is used for improving power factor. Always use both of them.

Note 5) When the power supply breaker NB and electromagnetic contactor LC are turned on, the servo amplifier is turned on. At this time, the LED (DC) in the servo amplifier lights up. Also, the LED +5V on the printed-circuit board also lights up. Always turn off the NB and LC and then the LED (DC) before starting operation when touching the servo amplifier and motor connection parts. The LED (DC) indicates the voltage (remaining voltage) of electrolytic capacitor at the DC link part. Also, a high voltage is applied to one part of printed-circuit board.

Note 6) Always remove the short-circuit bar between the servo amplifier terminal bases T2(4) - T2(5) when connecting the discharge resistance unit. At the same time, set the setting terminal S2 of printed-circuit board to the 2 position.

Note 7) Always set the setting terminal S1 of printed-circuit board to the L position when wiring to the terminal bases T4(1) - T4(2) of servo amplifier printed-circuit board.

XI. FANUC AC SERVO AMPLIFIER L series

1. GENERAL

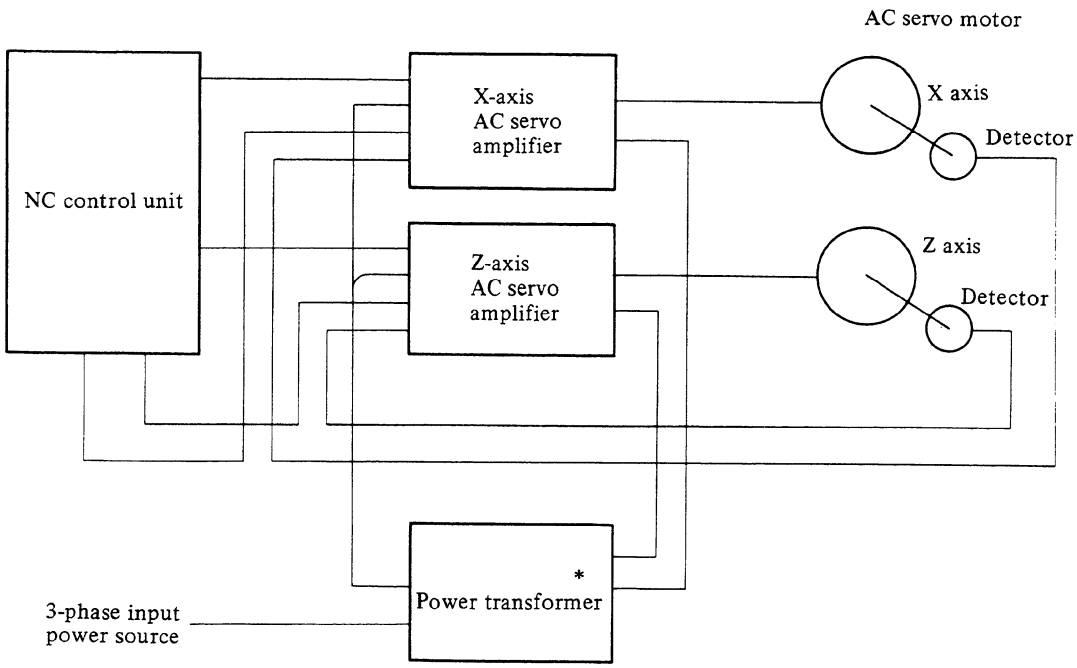
The L series AC servo amplifier has been specially designed and developed for high speed positioning driving the L series AC servo motor. The features are as follows.

1) Transistor PWM system assures smooth drive and excellent response.
2) Excellent acceleration/deceleration characteristic is obtained by adequate maximum control current.
3) Exclusive custom IC and the latest power module technique have realized high reliability with reduced number of parts.
4) The machine tools and AC servo motors are fully protected with fault detection of trip of no-fuse breaker, overcurrent alarm, abnormal velocity feedback, unusual high voltage, unusual circuit operation, etc.
5) The rectifier power circuit, dynamic brake circuit, regenerative discharge circuit (Note 1), and no-fuse breaker are assembled with the PWM amplifier circuit to realize a compact one-side maintenance structure featuring easy installation and maintenance.

Note 1) For applications having large regenerative discharge energy, separate regenerative discharge unit must be used. For details refer to section 4.3.

2. CONFIGURATION

Fig. 2 shows are example of the configuration of the AC servo amplifier in a 2-axis control NC system.



* This figure indicates an example when two axes employ one power transformer in common.

Fig. 2 Example of configuration

2.1 Types of Units and Specifications

Table 2.1(a) Types of units and specifications

<table>
<tr><th>Name</th><th colspan="2">Applicable motor</th><th>Specifications</th></tr>
<tr><td rowspan="3">Servo amplifier</td><td colspan="2">Model 0L</td><td>A06B-6057-H401</td></tr>
<tr><td colspan="2">Model 5L, 6L</td><td>A06B-6057-H402</td></tr>
<tr><td colspan="2">Model 7L, 10L</td><td>A06B-6057-H403</td></tr>
<tr><td rowspan="4">Power transformer</td><td rowspan="4">Common to 200 - 550V</td><td>Transformer AAE (1.5 kVA)</td><td>A80L-0001-0453</td></tr>
<tr><td>Transformer ABE (3.5 kVA)</td><td>A80L-0001-0454</td></tr>
<tr><td>Transformer ACE (5 kVA)</td><td>A80L-0001-0455</td></tr>
<tr><td>Transformer MH (6.5 kVA)</td><td>A80L-0001-0421</td></tr>
<tr><td rowspan="4">Separate type regenerative discharge unit</td><td colspan="2">Option for 5L, 6L (Note 1)</td><td>A06B-6050-H050</td></tr>
<tr><td colspan="2">For 7L, specify one unit per amplifier</td><td>A06B-6050-H053</td></tr>
<tr><td colspan="2">For 10L, specify one unit per amplifier</td><td>A06B-6050-H054</td></tr>
<tr><td colspan="2">For 7L, 10L (one unit for 2 axes)
(Note 2)</td><td>A06B-6042-H053</td></tr>
<tr><td rowspan="2">Input connector
(Note 3)</td><td colspan="2">Soldering type</td><td>A06B-6057-K100</td></tr>
<tr><td colspan="2">Crimp type</td><td>A06B-6057-K103</td></tr>
<tr><td>Spare part A</td><td colspan="2">Fuse for PCB</td><td>A06B-6057-K101</td></tr>
</table>

Note 1) This unit is used when the regenerated energy is 100 to 400 W for A06B-6057-H402.

Note 2) This unit can be used instead of two units (H053 or H054) when two motors (model 7L or 10L).

Note 3) The input connector is used for the signal cable from CNC connection connected to the velocity control unit, and it comprises the following parts.
One set of the input connector is required for each axis.

Table 2.1(b) shows parts included input connector (soldering type).
Table 2.1(c) shows parts included input connector (crimp type).

Table 2.1(b) Parts included input connector (soldering type)

Name	Qty	Use	Model	Specifications
Connector and cover	1	CN1	MR-20LFH *	A63L-0001-0134/02
Housing	1	CN2	SMS6PW-5 **	A63L-0001-0202/6W
Pin	5	CN2	RC16M-SCT3**	A63L-0001-0226

* Manufacturer: HONDA Tsushin Co., Ltd.
** Manufacturer: Nihon Burndy Co., Ltd.

Table 2.1(c) Parts included input connector (crimp type)

Name	Qty	Use	Model	Specifications
Connector and cover	1	CN1	MR-20L, MRP-20F01 *	A63L-0001-0134/22
Contact	20	CN1	MRP-F112 *	A63L-0001-0135/F112
Housing	1	CN2	SMS6PW-5 **	A63L-0001-0202/6W
Pin	5	CN2	RC16M-S23A **	A63L-0001-0127/S23A

* Manufacturer: HONDA Tsushin Co., Ltd.
** Manufacturer: Nihon Burndy Co., Ltd.

3. SPECIFICATIONS

3.1 Specifications

Table 3.1 Specifications

Item			Specifications		
Applicable motor model			0L	5L, 6L	7L, 10L
Rated output current (peak value) (Note 1)			11A	26A	42A
Input power supply	Transformer input	Common to all use	3-phase 200/220/230/240/380/415/460/480/550 VAC		
		Allowable voltage fluctuation	+10%, -15%		
		Allowable frequency	±2 Hz		
	100 VAC		50 Hz ± 2 Hz, 100 VAC +10/-15%, 60 Hz ± 2 Hz, 100 to 110 VAC +10/-15%		
Main circuit system			Transistor bridge		
Control system			Since wave PWM control		
Current limit value (Note 2)			40 A	80 A	100 A
Alarm, protective function			. Circuit breaker . Overvoltage . Low voltage . Over regeneration . Circuit abnormality detection		
Ambient temperature range			0°C to +55°C		

Note 1) The rated output is guaranteed at rated input voltage. If the input voltage fluctuates, the rated current is not always guaranteed, even if the input voltage fluctuation is within the allowable fluctuation range.

Note 2) The current limit value is the preset standard value. The deviation of the operating value due to the circuit constants is about ±10%.

3.2 Protection and Error Detection Function

Refer to section VII-3.2.

4. POWER TRANSFORMER AND SEPARATE TYPE REGENERATIVE DISCHARGE UNIT

The power transformer should be selected according to the models and load conditions of the AC servo motors employed. The power transformer is provided with secondary output terminals so that 2 axes or 3 axes can share each power transformer within the continuous output rating.
For connections, refer to section 9.

4.1 Number of Axes and Power Transformer

No. of axes	No. of power transformers
2 axes	1 - 2 units
3 axes	1 - 3 units
4 axes	2 - 4 units

4.2 Motors and Power Transformer

1st axes	2nd axis	3rd axis	Name of transformer	Remarks
0L	0L, 5L		AAE (1.5 kVA)	Use output terminals 31, 32 and 33
0L, 5L	0L, 5L	0L, 5L	ABE (3.5 kVA)	
0L, 5L	0L, 5L	6L		
6L	6L			
7L				
6L	6L	6L	ACE (5 kVA)	
0L, 5L, 6L	7L			
0L, 5L, 6L, 7L	7L		MH (6.5 kVA)	
10L				

Select the transformer according to the motor used, load condition, usage condition, etc. Refer to the servo motor selection data sheet described in section I-4 and section III-2.

4.3 Separate Type Discharge Unit

When the energy being regenerated from motor is large, separate discharge unit is required. To use the servo amplifier for model 7L or 10L the separate type regenerative discharge unit is required.

4.3.1 Horizontal move axis

The regenerative discharge unit is required when a motor is used continuously at P equals 100 to 400.

$$P = \frac{1}{4} \times (5.37 \times 10^{-4} JVm^2 - 5.13 \times 10^{-3} taVmTL) \qquad (1)$$

In the equation (1),

F : Rapid traverse acceleration/deceleration frequency (sec/time)
(Note: When not designated specially, the frequency is approx. 5 sec/time.)

J = Jm + JL

Jm: Rotor inertia of motor ($kg \cdot cm \cdot sec^2$)
JL: Motor axis conversion inertia of load ($kg \cdot cm \cdot sec^2$)
Vm: Number of motor revolutions at rapid traverse (rpm)
ta: Rapid traverse acceleration/deceleration time (sec)
TL: Machine friction torque (Motor-axis conversion) ($kg \cdot cm$)

4.3.2 Vertical move axis

The regenerative discharge unit is required when a motor is used continuously at R equals 100 to 400.

R = P + Q

P : Given in equation (1)

$$Q = 1.026 \times 10^{-2} ThVm \times \frac{D}{100} \qquad (2)$$

In the equation (2),

Th: Torque which is supported upward by motor at lowering in rapid traverse ($kg \cdot cm$)
Vm: Number of motor revolutions at rapid traverse (rpm)
D : Operation duty of rapid traverse lowering direction (%)
(Note: $D \leqq 50$)

Note) If value P of equation (1) or value Q of equation (2) exceeds 400 (W), contact FANUC.

5. POWER SOURCE

5.1 Input Power Source

The AC servo amplifier employs a 3-phase power source for main circuit and a single-phase 100 V power source for coils of the dynamic brake electromagnetic contactor (electromagnetic contactor and radiator cooling fan for models 7L and 10L).

5.1.1 Three-phase power source

a) Primary side tap voltage of power transformer

Power transformer	No. of phases	Voltage	Frequency
For all the countries	3 phases	200, 220, 230, 240, 380, 415, 460, 480, 550 VAC +10%, -15%	50/60 Hz ± 2 Hz

Note) If a 200, 220, 415, 440, or 480 V input power source is employed by using a transformer HM, select the primary voltage of the transformer as shown below.

Input voltage	415 V	440 V	480 V
Transformer primary voltage setting	420 V	420 V	460 V

b) Power transformer and fuses on primary side

Power voltage	Fuse type / Transformer capacity (kVA)	Utsunomiya Electric Co., Ltd. PC type (A)	Fuji Electric Co., Ltd. FCF type (A)
200 V to 220 V	1.5	15	20
	3.5	30	30
	5	30	30
	10	40	40
	15	50	50
380 V to 440 V	1.5	10	10
	2.5	10	15
	5	15	15
	10	25	30
	15	30	30

Power voltage	Fuse type / Transformer capacity (kVA)	Utsunomiya Electric Co., Ltd. JG type (A)	Fuji Electric Co., Ltd. Plug type (A)
480 V to 550 V	1.5	10	10
	2.5	10	15
	5	15	20
	10	20	30
	15	25	30

5.1.2 Single-phase 100 VAC power source

Nominal voltage		100 VAC	
No. of phases		Single-phase	
Frequency		50 Hz ± 2 Hz	60 Hz ± 2 Hz
Voltage		100 VAC +10%, -15%	100 - 110 VAC +10%, -15%
Capacity	0L, 5L, 6L	20 VA: Continuous 90 VA: At turning on the contactor	
	7L, 10L	50 VA: Continuous 110 VA: At turning on the contactor	

5.2 Capacity of Three-phase Power Source

The capacity of the power source should be as specified in table below as the continuous rated output of motor. When the AC servo motor is rapidly accelerated, power of about twice the continuous rated value may be needed momentarily. Accordingly, use the power source suitable for acceleration.

Motor	Power capacity per motor
0L	1 kVA
5L	1.5 kVA
6L	2.4 kVA
7L	5 kVA
10L	10 kVA

Calculation method of power source capacity

The power capacity for using two or more motors can be obtained by adding the power capacity per motor, respectively.

6. HEAT LOSS

Motor model	Maximum power dissipation of servo amplifier	Maximum power dissipation of power transformer
0L	90 W	60 W
5L	110 W	90 W
6L	180 W	120 W
7L	360 W	150 W
10 L	500 W	250 W

For thermal design of cabinets which accommodate the servo amplifier and servo transformer, it may be a general rule that the power dissipation quantity is about 50% of the maximum power dissipation value taking the servo motor load into consideration.

7. INSTALLATION CONDITION AND NOTES

7.1 Installation Condition

Ambient temperature: 0°C - +55°C
Humidity : 95% RH or less (no dew condensation)
Vibration : 0.5 G or less
Atmosphere: The unit should not be exposed directly to the splash of cutting oil, lubricant or cutting chips.

Note) When the servo amplifier A06B-6057-H403 is used for model 10L. The rated output current decreases by a ratio of 2%/°C in the ambient temperature of 45°C or more.

7.2 Cautions on Installation and Housing

The servo amplifier is designed to be mounted in a cabinet. Be careful with the following items when designing the cabinet.

7.2.1 Housed in closed type cabinet

In the closed type cabinet, the internal air temperature generally increases. Circulate the internal air so that the ambient temperature of these unit becomes even. The air speed should be about 1 to 2 m/sec. Do not blow the fan or blower air directly on these units, otherwise dust may cling to the surfaces of these units and trouble may result.

7.2.2 Housed in open air ventilation type cabinet

1) Use an air filter at the open air inlet.
2) Do not blow the fan or blower air directly on these units, otherwise dust may cling to the surfaces of these units, and trouble may result.
3) Ingress of mist of the cutting oil or dust form the air inlet, if any, may cause trouble. Be careful with the air flow at outlet side so it is not blocked.
4) Securely seal the cable entrance, door, and other openings.

7.2.3 Mounting position and other cautions

1) Mount the units so they are easy to check, remove, and mount during maintenance.
2) Keep a space of more than 50 mm above and below the velocity control unit, so that the air for the heat sink smoothly flows to the upper side and wiring can be done to the terminal boards on the lower side.

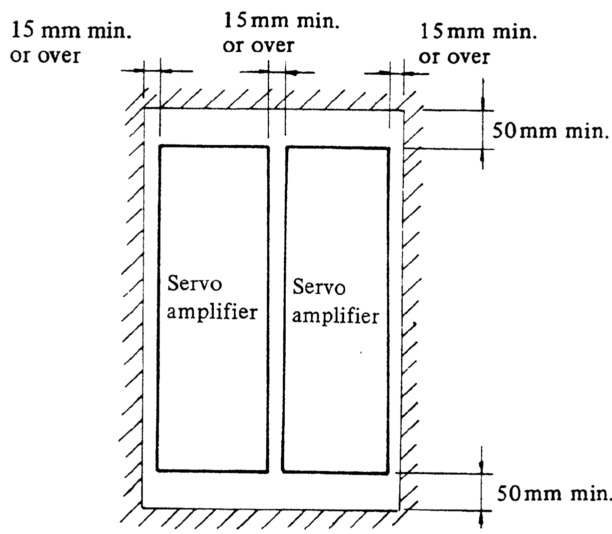
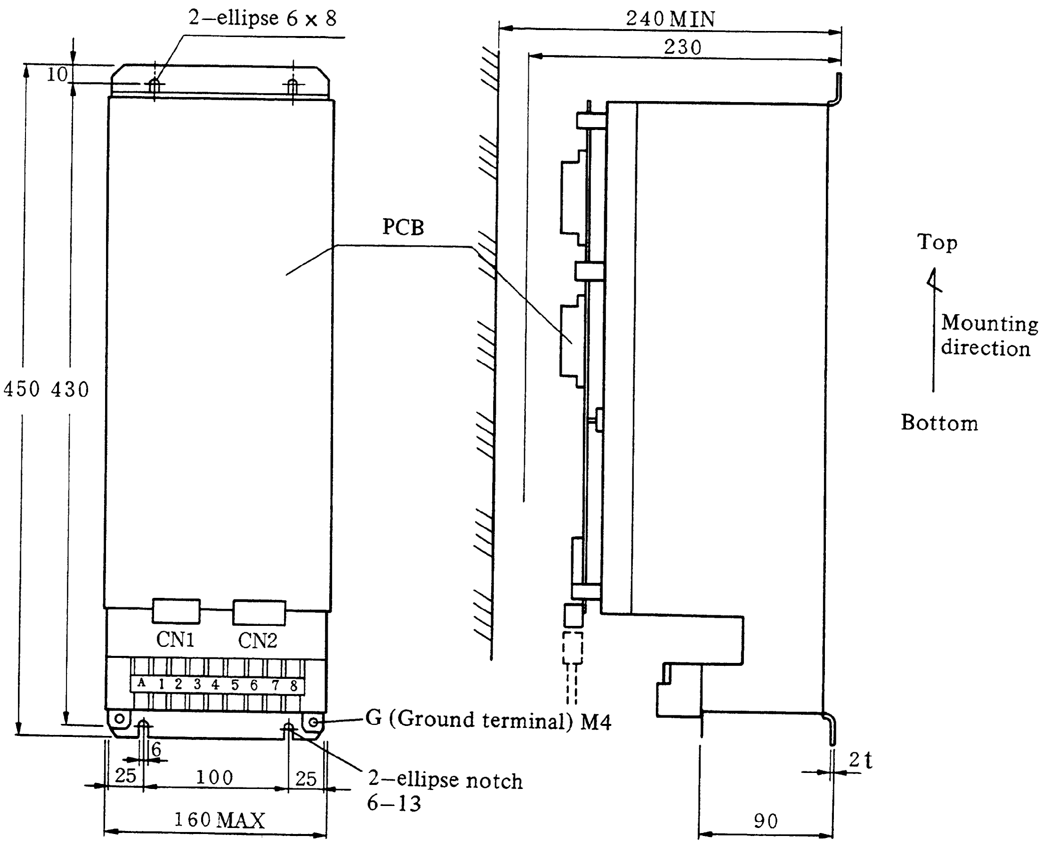


Fig. 7.2.3 Mounting space of servo amplifier

3) Precaution should be taken to separate of cables for power line and signal line, ground frame of the servo amplifier and transformer, and a protect against noises.

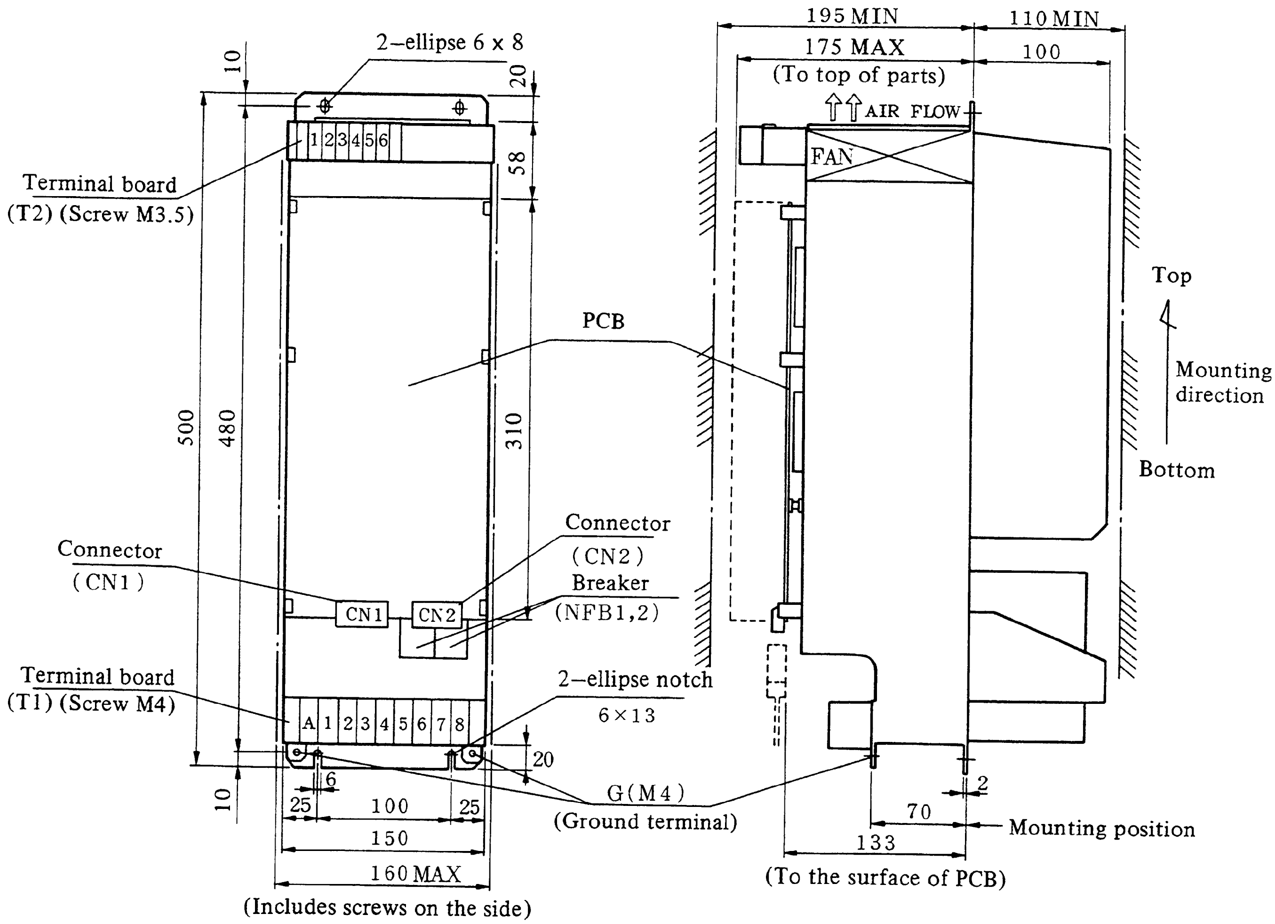
8. EXTERNAL DIMENSIONS

1) External dimensions of servo amplifier A06B-6057-H401, H402 for models 0L, 5L and 6L



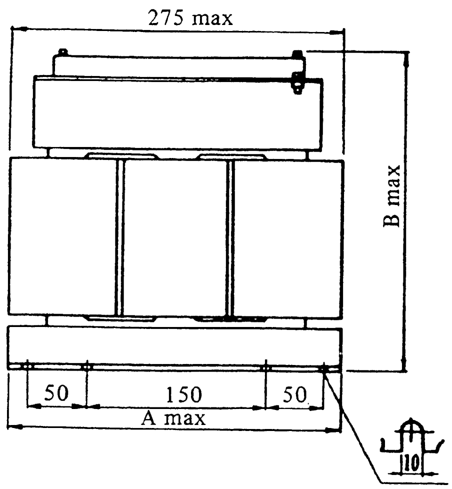
Weight: About 10kg

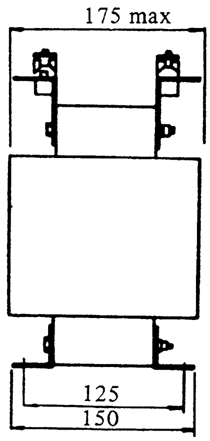
2) External dimensions of servo amplifier (A06B-6057-H403) for models 7L and 10L



Weight: About 16kg

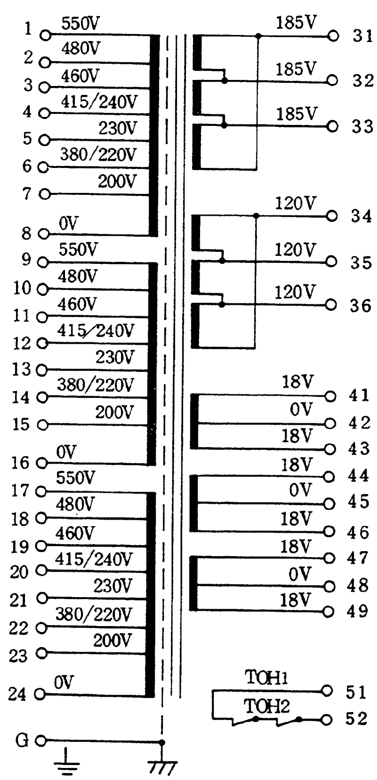
3) Power transformer



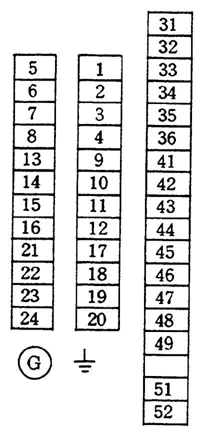


Power transformer	Weight	A	B
AAE	About 20 kg	280	265
ABE	About 30 kg		
ACE	About 36 kg		
MH	About 49 kg	310	315

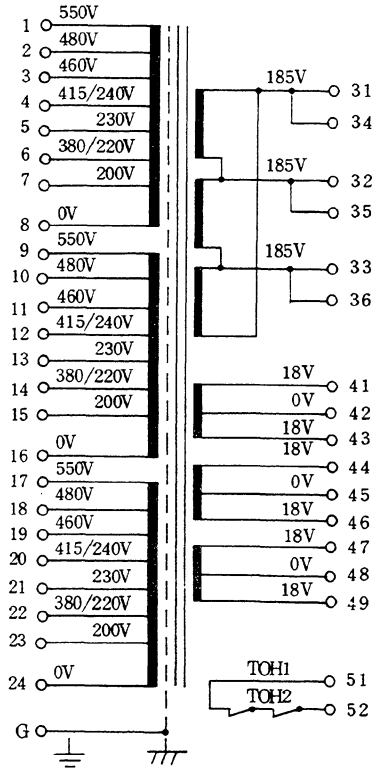
Connection diagram of power transformer AAE



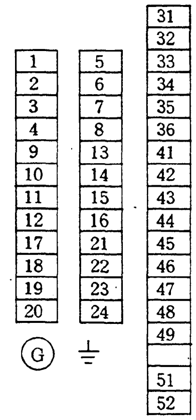
Te po Terminal layout of power transformer AAE



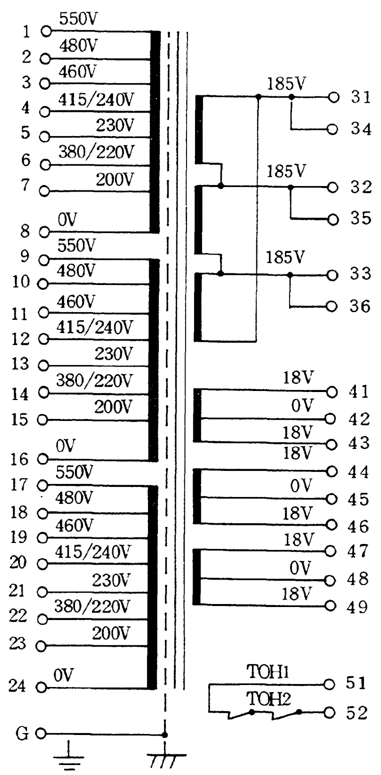
Connection diagram of power transformer ABE or ACE



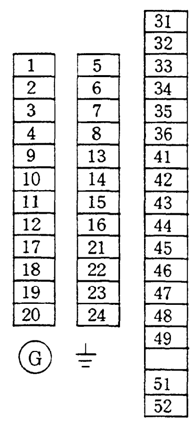
Terminal layout of power transformer ABE or ACE



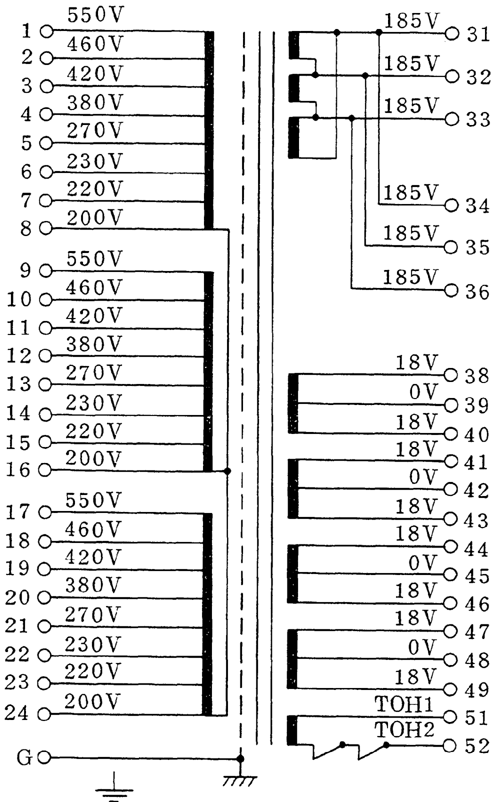
Power transformer ABE, ACE connection



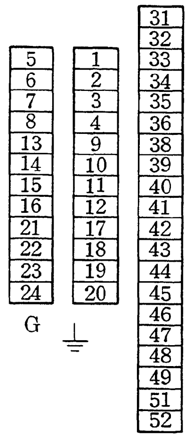
Terminal of power transformer ABE, ACE



Power transformer MH connection

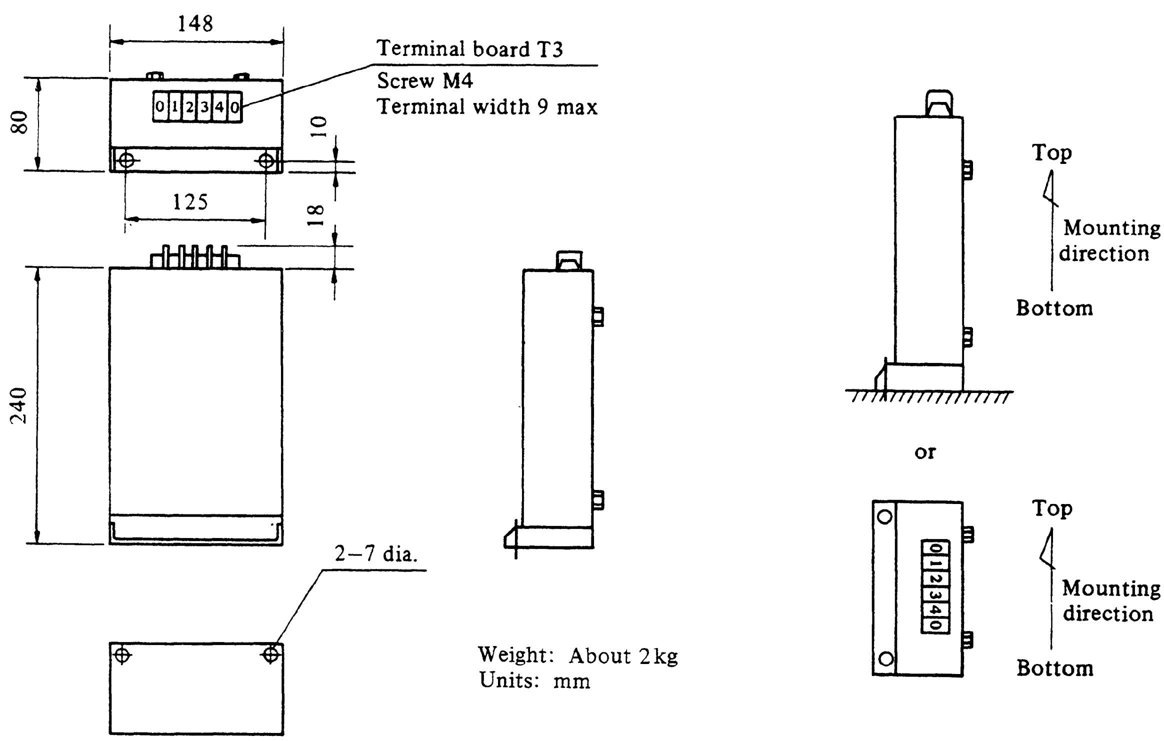


Terminal of power transformer MH



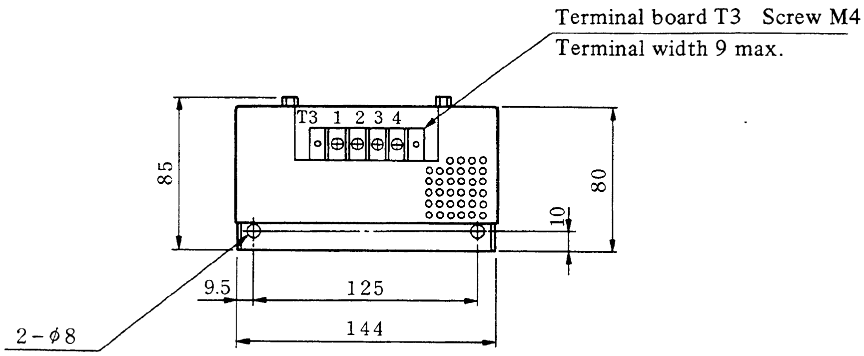
4) Separate type regenerative discharge unit

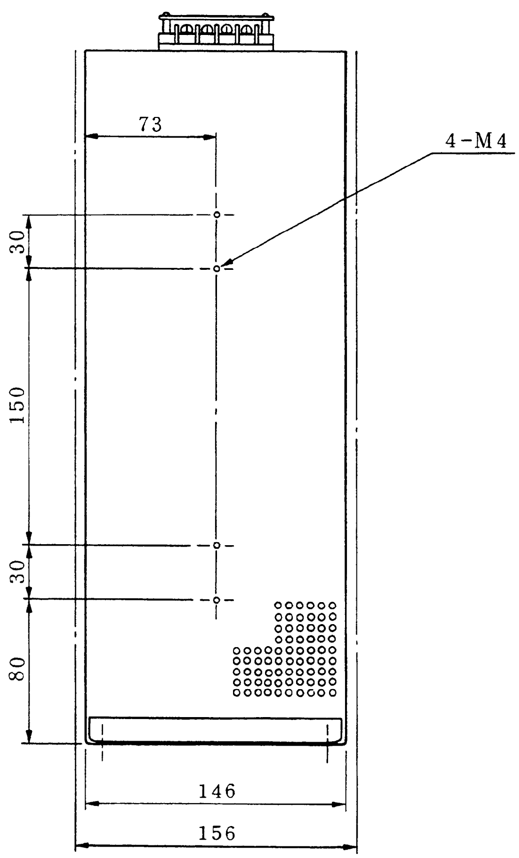
a) Regenerative discharge unit A06B-6050-H050 (A06B-6050-C050)



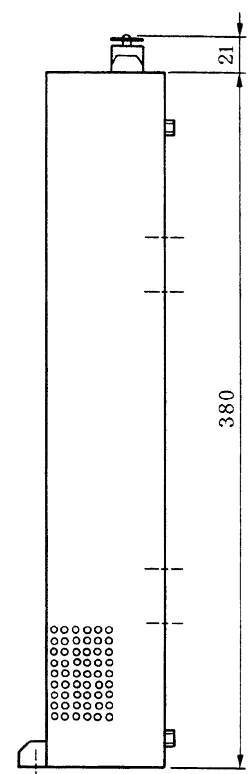
Weight: About 2kg
Units: mm

b) Regenerative discharge unit A06B-6050-H053 (A06B-6050-C053)



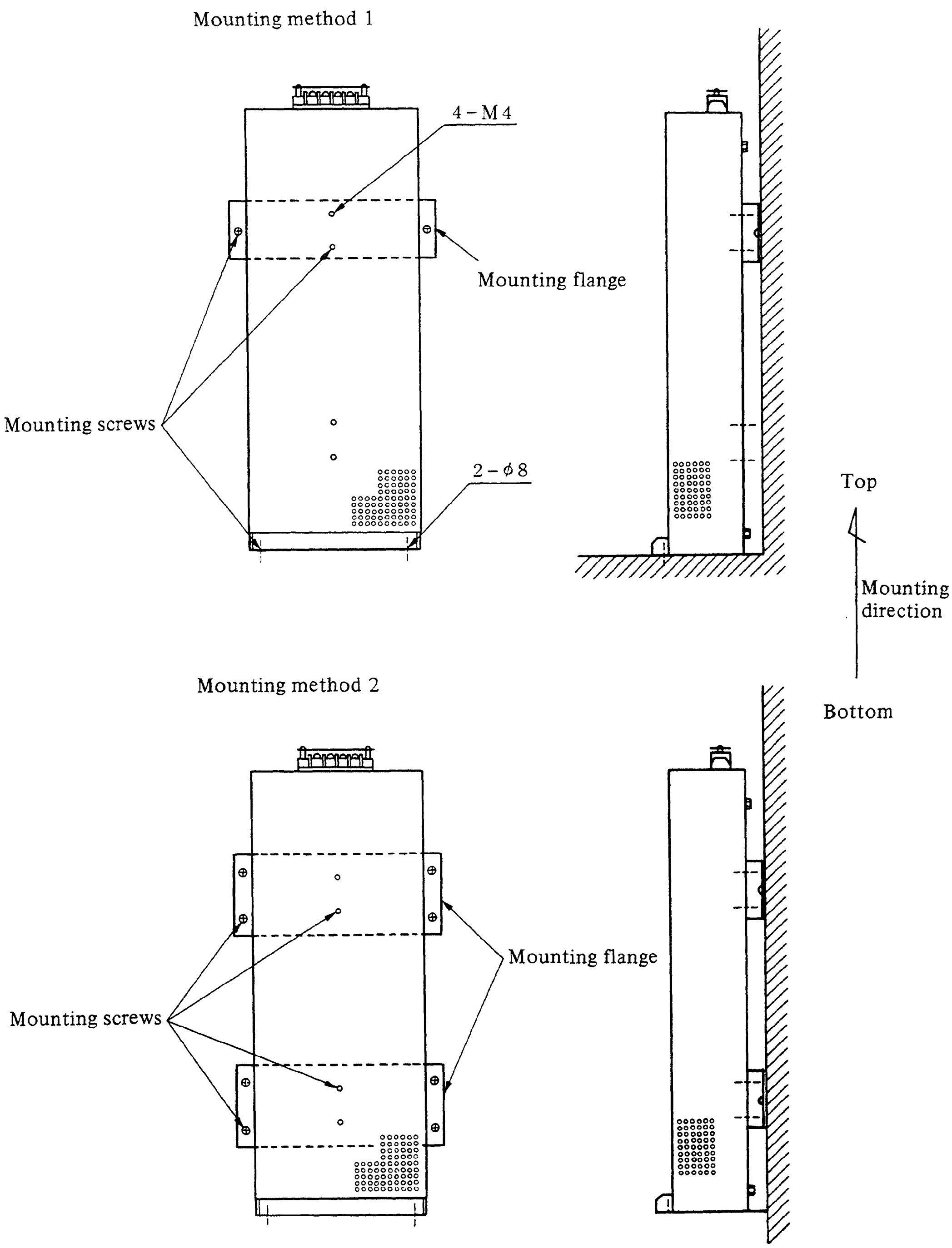


(Includes screws on the side)



Weight: 2.5kg

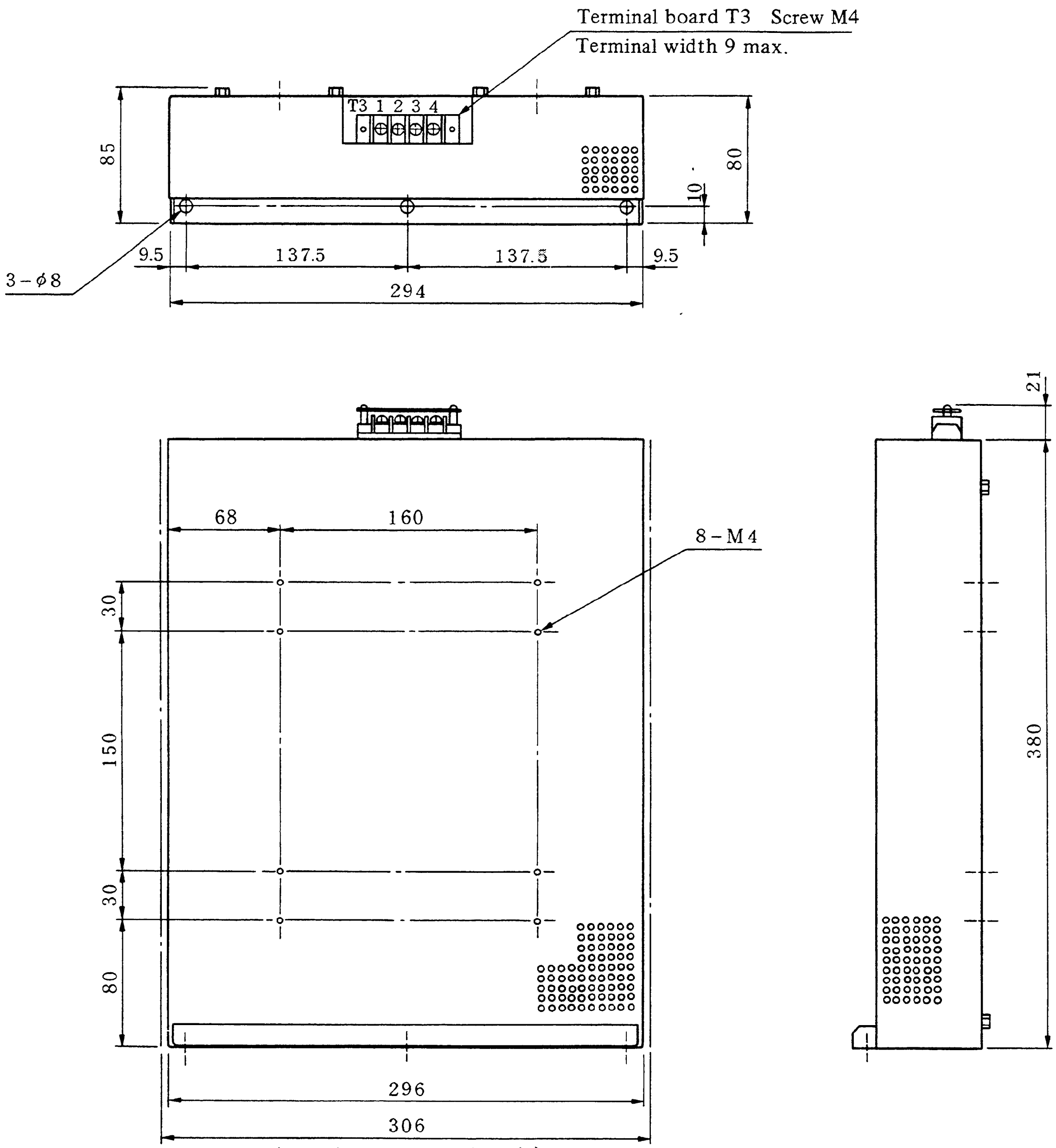
c) Mounting regenerative discharge unit A06B-6050-H053 (A06B-6050-C053)



Note) The mounting flange is not provided.

Weight: 2.5kg

d) Regenerative discharge unit A06B-6050-H054 (A06B-6050-C054)

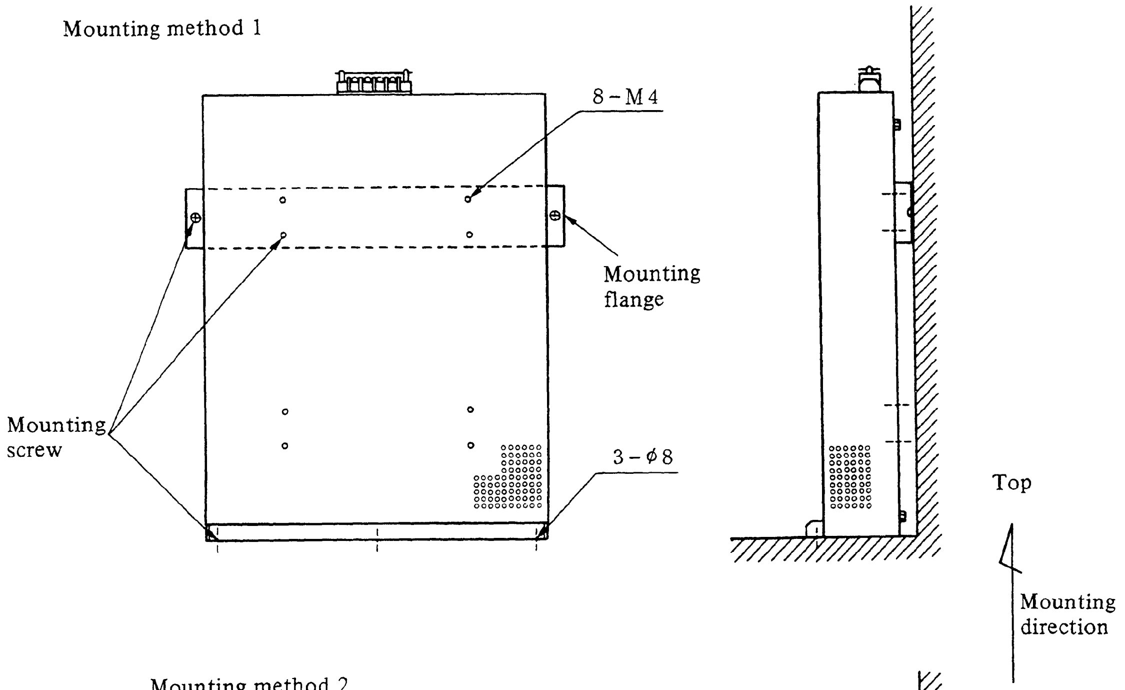


(Includes screws on the side)

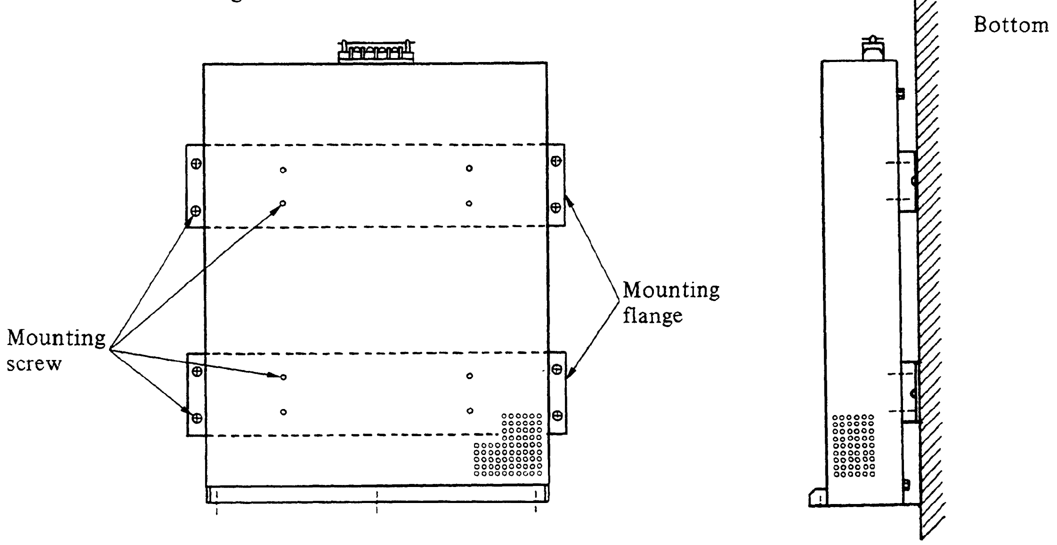
Weight: 5kg

e) Mounting regenerative discharge unit A06B-6050-H054 (A06B-6050-C054)

Mounting method 1



Mounting method 2



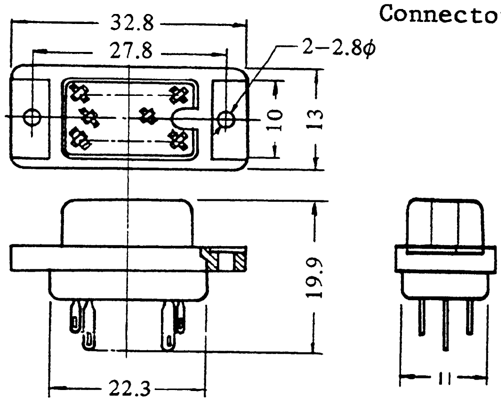
Note) The mounting flange is not provided.

Weight: 5kg

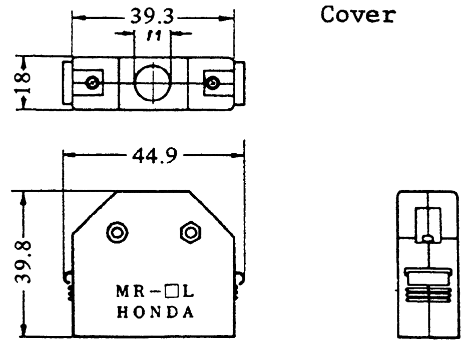
5) Input connector

a) Connector CN1

Connector



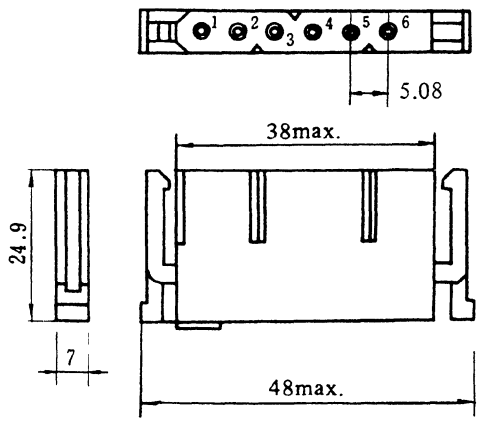
Cover



Name	Specifications (Connector maker's model)	Name of maker	No. of connectors employed per axis	Applicable cable mm^2	Remarks
Connector (with cover)	MR-20LFH	Honda Tsushin Kogyo Co.	1	0.18 - 0.3	CN1

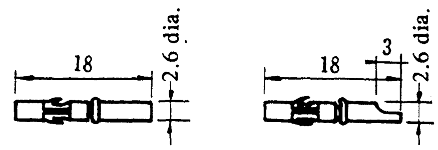
b) Connector CN2

Cable plug



Cable contact

Crimp style type   Soldering type

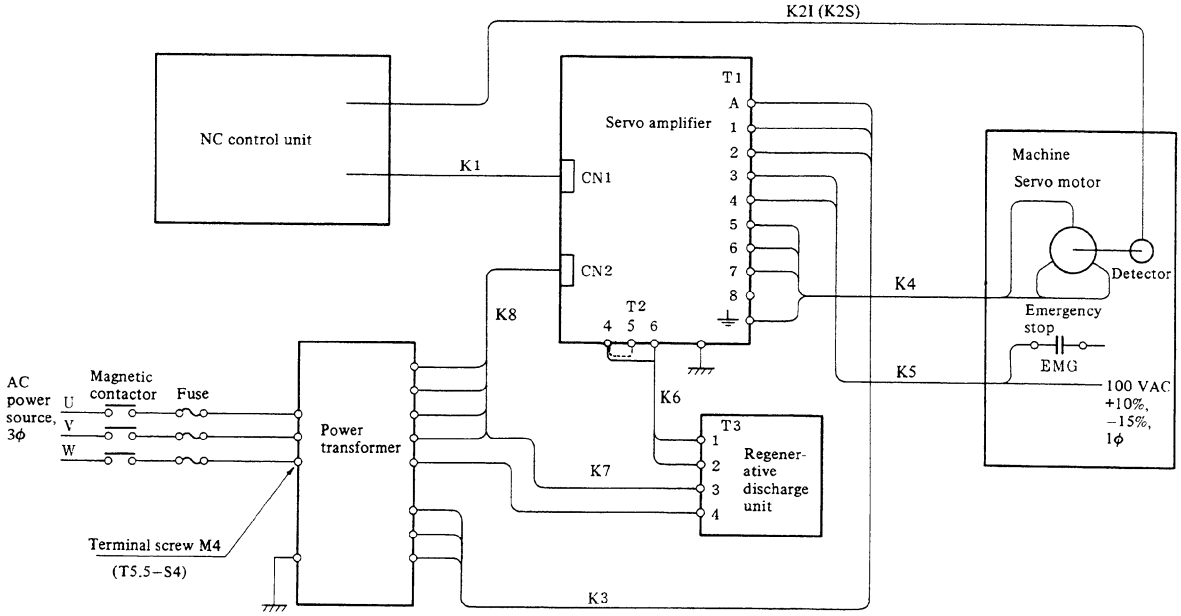


Applicable cable mm^2	Outer diameter of sheathing mm	Peel-off length of sheathing mm
0.75 (30/0.18)	2.80 max	7.2

Name		Specifications (Connector maker's model)	Name of maker	No. of connectors employed per axis	Remarks
Cable plug		SMS6PW-5	Nihon Burndy Co.	1	For crimping tool, etc., contact the connector maker.
Contact	Crimp style type	RC16M-23		5	
	Soldering type	RC16M-SCT3			

9. CONNECTION

9.1 Connection Diagram



Note 1) For cable connection details, refer to Appendix 1 and 2.

Note 2) When using the separate type regenerative discharge unit for models 5L and 6L remove the jumper between terminals of T2(4) and T2(5).

Note 3) For models 7L and 10L the separate type regenerative discharge unit is used.

9.2 Power Transformer Connections

a) Primary connections

For the connecting positions of power cable U, V, W and connection between terminals, refer to Tables 9.2(a) or (b) according to the input voltage.

Table 9.2(a) Power transformers AAE, ABE, ACE (Common to all use)

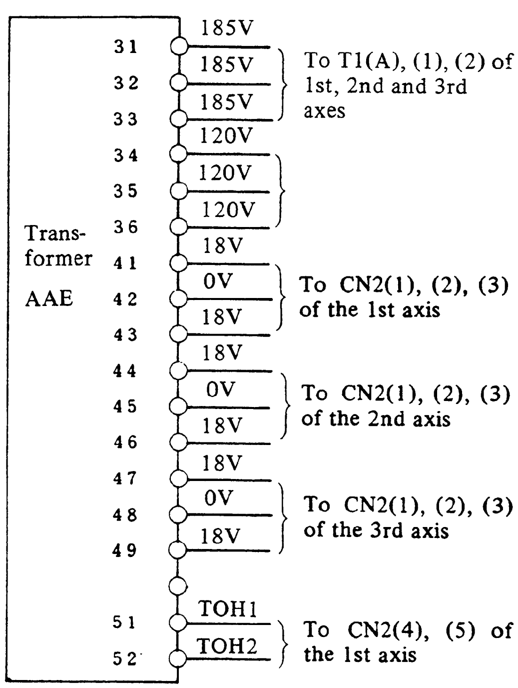
Power voltage	Connection of transformer primary terminal		Connection type
	Connection of power cable U, V, W	Jumper between transformer terminals	
200 V	U-7, V-15, W-23	8-15, 16-23, 24-7	Delta connection
220 V	U-6, V-14, W-22	8-14, 16-22, 24-6	
230 V	U-5, V-13, W-21	8-13, 16-21, 24-5	
240 V	U-4, V-12, W-20	8-12, 16-20, 24-4	
Delta connection			
380 V	U-6, V-14, W-22	8-16, 16-24 or (8-16-24)	Star connection
415 V	U-4, V-12, W-20		
460 V	U-3, V-11, W-19		
480 V	U-2, V-10, W-18		
550 V	U-1, V-9, W-17		
Star connection			

Table 9.2(b) Power transformer MH (Common to all use)

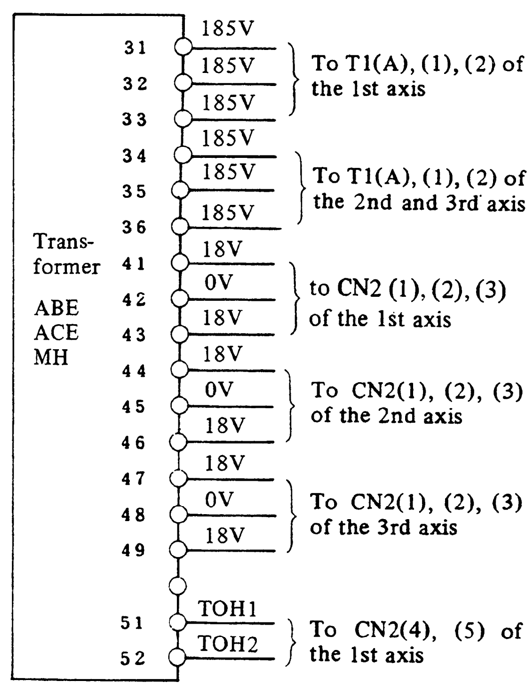
Power voltage	Connection of transformer primary terminal		Connection type
	Connection of power cable U, V, W	Jumper between transformer terminals	
200 V	U-8, V-16, W-24	Not connected	Star connection
220 V	U-7, V-15, W-23		
230 V	U-6, V-14, W-22		
240 V			
380 V	U-4, V-12, W-20		
420 V	U-3, V-11, W-19		
460 V	U-2, V-10, W-18		
480 V			
550 V	U-1, V- 9, W-17		
Star connection			

b) Secondary connections

For power transformers, AAE



For power transformers ABE, ACE, MH



XII. FANUC AC SERVO AMPLIFIER S series (185 V INPUT)

1. GENERAL

The S series servo amplifier (185 V input type) has been specially designed and developed for machine tools and industrial robots as the drive unit for S series (185 V input) AC servo motor. The features are as follows.

1) Transistor PWM system assures smooth drive and excellent response.
2) Excellent acceleration/deceleration characteristic is obtained by adequate maximum control current.
3) Exclusive custom IC and the latest power module technique have realized high reliability with reduced number of parts.
4) The machine tools and AC servo motors are fully protected with fault detection type of no-fuse breaker, overcurrent alarm, abnormal velocity feedback, unusual high voltage, unusual circuit operation, etc.
5) The rectifier power circuit, dynamic brake circuit, regenerative discharge circuit (Note 1), and no-fuse breaker are assembled with the PWM amplifier circuit to realize a compact one-side maintenance structure featuring easy installation and maintenance.

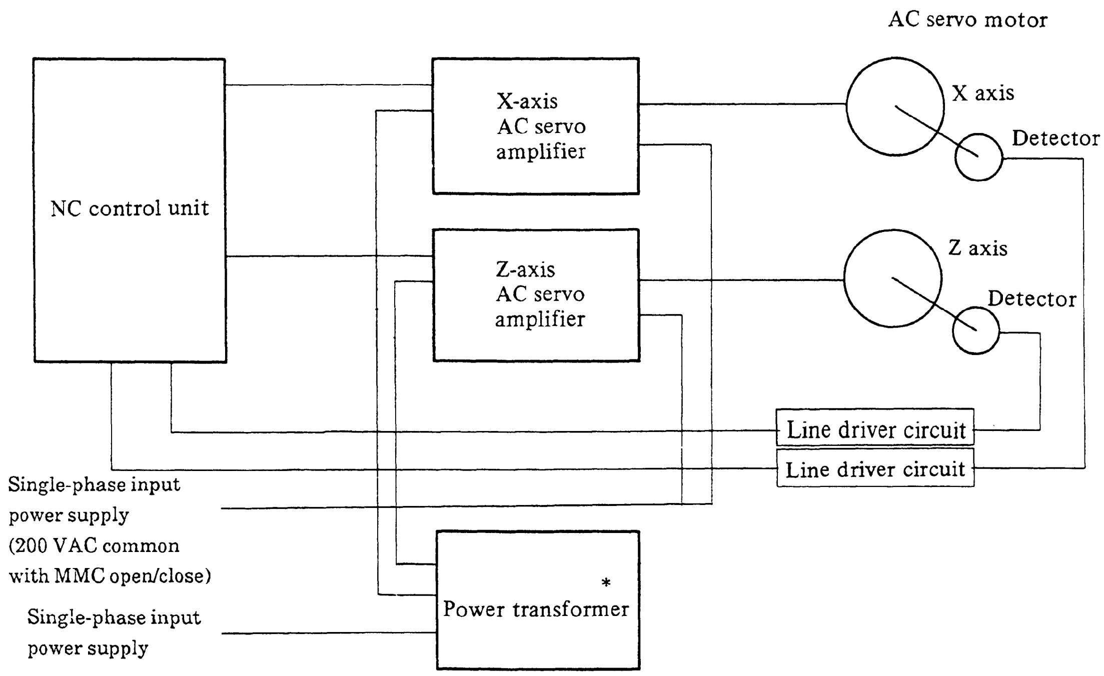
Note 1) For applications having large regenerative discharge energy, separate regenerative discharge unit is available. For details refer to section 4.3.

2. CONFIGURATION

2.1 Configuration Example

1) In case of model 5-0

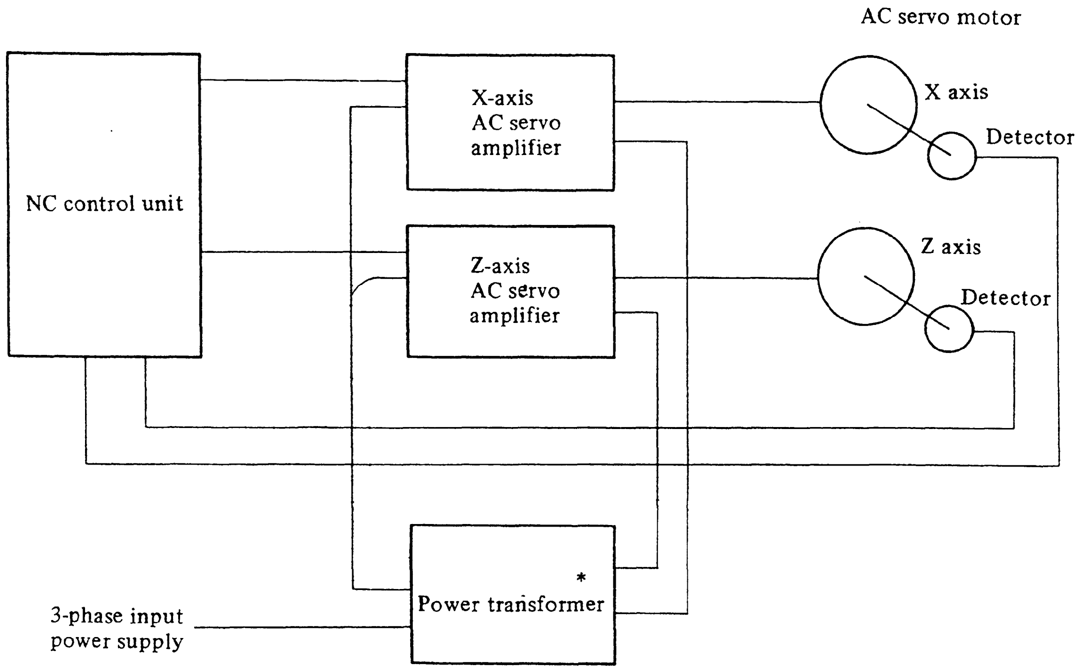
Fig. 2.1(a) and (b) show example of the structure of the AC servo unit in a two-controlled axes NC system.



* This figure indicates an example when two axes employ one power transformer in common.

Fig. 2.1(a) Example of configuration (model 5-0)

2) In case of models 30/2000 and 40
When the regenerative energy is large due to the load condition the separate type regenerative discharge unit is required.



* This figure indicates an example when two axes employ one power transformer in common.

Fig. 2.1(b) Example of configuration (models 30/2000 and 40)

2.2 Types of Units and Specifications

Table 2.2(a) Type of units and specifications

Name	Applicable motor		Specifications
Servo amplifier	Model 5-0		A06B-6057-H001
	Model 30/2000		A06B-6057-H007
	Model 40		A06B-6057-H008
Power transformer	Common to 200 - 550 V	Transformer for 5-0	A80L-0010-0041
		Transformer ACE (5 kVA)	A06B-6050-H023
		Transformer MH (6.5 kVA)	A06B-6047-H224
Line driver circuit	Model 5-0		A16B-1700-0130
Separate regenerative discharge unit (Note 1)			A06B-6050-H050
Input connector for servo amplifier (Note 2)	Soldering type		A06B-6057-K100
	Crimp type		A06B-6057-K103
Input connector for line driver circuit (Note 3)	Soldering type		A06B-6057-K105
	Crimp type		A06B-6057-K106
Spare part A	Fuse for PCB (for models 30/2000 and 40)		A06B-6057-K101
	Fuse for PCB (for model 5-0)		A06B-6057-K102

Note 1) The unit (A06B-6057-H007) for model 30/2000 normally needs the separate regenerative discharge unit.

Note 2) The input connector for servo amplifier is used for the cable connected to the servo amplifier, and it comprises the following parts.
One set of the input connector is required for each axis.

Note 3) The input connector for line driver circuit is used for the cable connected to the line driver circuit for model 5-0. One set of the input connector is required for each axis.

Table 2.2(b) shows parts included input connector for servo amplifier (soldering type).
Table 2.2(c) shows parts included input connector for servo amplifier (crimp type).

Table 2.2(b) Parts included input connector for servo amplifier (soldering type)

Name	Qty	Use	Model	FANUC specifications
Connector and cover	1	CN1	MR-20LFH *	A63L-0001-0134/02
Housing	1	CN2	SMS6PW-5 **	A63L-0001-0202/6W
Pin	5	CN2	RC16M-SCT3**	A63L-0001-0226

* Manufacturer: HONDA Tsushin Co., Ltd.
** Manufacturer: Nihon Burndy Co., Ltd.

Table 2.2(c) Parts included input connector for servo amplifier (crimp type)

Name	Qty	Use	Model	FANUC specifications
Connector and cover	1	CN1	MR-20L, MRP-20F01 *	A63L-0001-0134/22
Contact	20	CN1	MRP-F112 *	A63L-0001-0135/F112
Housing	1	CN2	SMS6PW-5 **	A63L-0001-0202/6W
Pin	5	CN2	RC16M-S23A **	A63L-0001-0127/S23A

* Manufacturer: HONDA Tsushin Co., Ltd.
** Manufacturer: Nihon Burndy Co., Ltd.

Table 2.2(d) shows parts included input connector for line dirver circuit (soldering type)
Table 2.2(e) shows parts included input connector for line driver circuit (crimp type).

Table 2.2(d) Parts included input connector for line driver circuit (soldering type)

Name	Qty	Use	Model	FANUC specifications
Connector and cover	1	CN2	MR-20 LWMH *	A63L-0001-0134/15
Connector and cover	1	CN1	MR-20 LWFH *	A63L-0001-0134/05

Table 2.2(e) Parts included input connector for line driver circuit (crimp type)

Name	Qty	Use	Model	FANUC specifications
Connector and cover	1	CN2	MR-20L, MRP-20M01 *	A63L-0001-0134/35
Connector and cover	1	CN1	MR-20L, MRP-20F01 *	A63L-0001-0134/25
Contact	20	CN2	MRP-M112 *	A63L-0001-0135/M112
Contact	20	CN1	MRP-F112 *	A63L-0001-0135/F112

* Manufacturer: HONDA Tsushin Co., Ltd.

3. SPECIFICATIONS

3.1 Specifications

Table 3.1 Specifications

<table>
<tr><td colspan="3">Item</td><td colspan="3">Specification</td></tr>
<tr><td colspan="3">Applicable motor model</td><td>5-0</td><td>30/2000</td><td>40</td></tr>
<tr><td colspan="3">Rated output current (peak value) (Note 1)</td><td>0.7 A</td><td>40 A</td><td>44 A</td></tr>
<tr><td rowspan="4">Input power supply (Note 3)</td><td rowspan="3">Transformer input</td><td>For Japan</td><td>-</td><td colspan="2">3-phase, 220/220/380/415/460/480/550 VAC</td></tr>
<tr><td>Allowable voltage fluctuation</td><td>-</td><td colspan="2">+10%, -15%</td></tr>
<tr><td>Allowable frequency</td><td>-</td><td colspan="2">±2 Hz</td></tr>
<tr><td colspan="2">100 VAC</td><td colspan="3">50 Hz ± 2 Hz, 100 VAC +10/-15%,
60 Hz ± 2 Hz, 100 - 110 VAC +10/-15%</td></tr>
<tr><td colspan="3">Main circuit system</td><td colspan="3">Transistor bridge</td></tr>
<tr><td colspan="3">Control system</td><td colspan="3">Sine wave PWM control</td></tr>
<tr><td colspan="3">Current limit value (Note 2)</td><td>2 A</td><td>90 A
(Note 2)</td><td>100 A
(Note 2)</td></tr>
<tr><td colspan="3">Alarm, protective function</td><td colspan="3">. Circuit breaker . Fuse (5-0)
. Overvoltage . Low voltage
. Over regeneration (30/2000, 40)
. Circuit abnormality detection (over current)</td></tr>
<tr><td colspan="3">Ambient temperature range</td><td colspan="3">0°C to +55°C</td></tr>
</table>

Note 1) The rated output is guaranteed at rated input voltage. If the input voltage fluctuates, the rated current is not always guaranteed, even if the input voltage fluctuation is within the allowable fluctuation range.

Note 2) The current limit value is the preset standard value. The deviation of the operating value due to the circuit constants is about ±10%.

Note 3) The servo amplifier for model 5-0 employs single-phase 100 VAC only as an input power.

3.2 Protection and Error Detection Function

Refer to section VII-3.2.

4. POWER TRANSFORMER AND SEPARATE TYPE REGENERATIVE DISCHARGE UNIT

The power transformer should be selected according to the models and load conditions of the AC servo motors employed. The power transformer is provided with secondary output terminals so that 2 axes or 3 axes can share each power transformer within the continuous output rating.
For connections, refer to section 9.

4.1 Number of Axes and Power Transformer

No. of axes	No. of power transformers
2 axes	1 - 2 units
3 axes	1 - 3 units
4 axes	2 - 4 units

4.2 Motors and Power Transformer

Model	Name of power transformer
30/2000	ACE (5 kVA)
40	MH (6.5 kVA)

Note) Select the transformer according to the motor used, load condition, usage condition, etc. Refer to the servo motor selection data sheet described in section I-4 and section II-2.

4.3 Separate Type Discharge Unit

When the energy being regenerated from motor is large, separate discharge unit is required. To use the servo amplifier for model 30/2000 the separate type regenerative discharge unit is required.
For how to calculate the regenerative capacity, see VII-4.2.1 or 4.2.2.

5. LINE DRIVER CIRCUIT FOR AC5-0

5.1 General

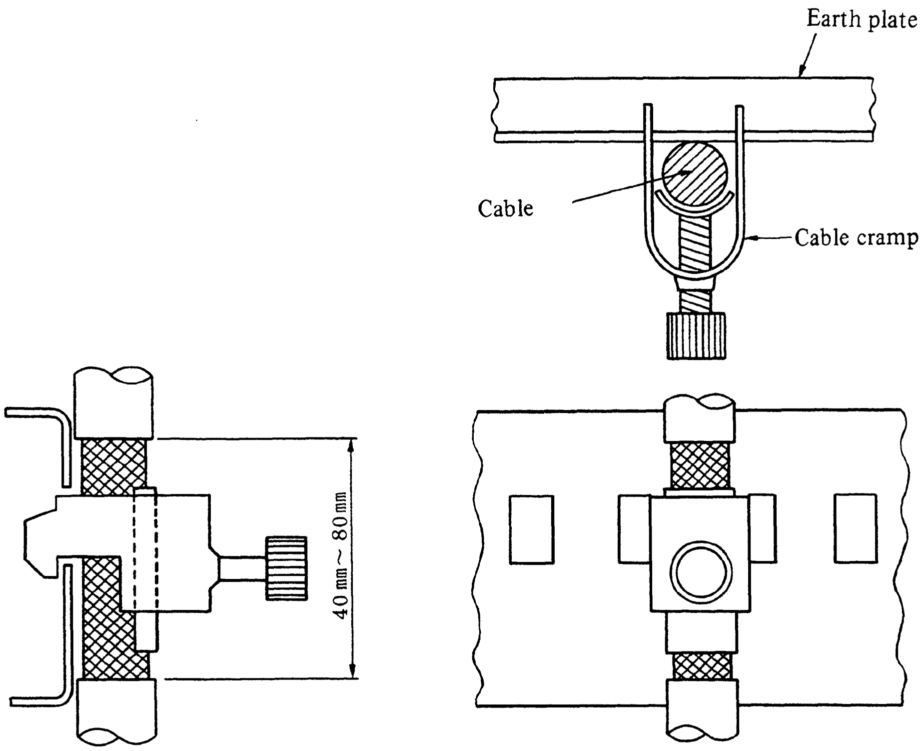
When the AC servo motor model 5-0 is driven by a digital servo, the pulse coder output signal must be matched to the digital servo interface and the line driver circuit for AC5-0 is required. One line driver circuit is necessary for one motor.

5.2 Installation Place

Mount the line driver circuit in an enclosed cabinet.

5.3 Noise Preventive Measure

To prevent a malfunction by a noise, mount the line driver circuit at least 100mm away from the cable and parts to which 50 VDC or higher voltage or AC power is applied. Treat the shielding wire of the signal cable as shown below, and connect it to the cabinet.



6. POWER SOURCE

6.1 Input Power Source

The AC servo amplifier employs a 3-phase power source for main circuit and a single-phase 100 V power source for coils of the dynamic brake electromagnetic contactor (electromagnetic contactor and radiator cooling fan for models 7L and 10L).

Note) A single-phase 100 VAC is used for the main circuit and for magnetic contactor of the dynamic brake in model 5-0.

6.1.1 Three-phase power source

Refer to section VII-5.2.1

6.1.2 Single-phase 100 VAC power source

Nominal voltage		100 VAC	
No. of phases		Single-phase	
Frequency		50 Hz ± 2 Hz	60 Hz ± 2 Hz
Voltage		100 VAC +10%, -15%	100-110 VAC +10%, -15%
Capacity	5-0	30 VA: Continuous 50 VA: At turning on the contactor	
	30/2000, 40	50 VA: Continuous 110 VA: At turning on the contactor	

6.2 Capacity of Three-phase Power Source

The capacity of the power source should be as specified in table below as the continuous rated output of motor. When the AC servo motor is rapidly accelerated, power of about twice the continuous rated value may be needed momentarily. Accordingly, use the power source enough for acceleration.

Motor	Power capacity per motor*
30/2000	6 kVA
40	6.3 kVA

* Calculation method of power source capacity
The power capacity for using two or more motors can be obtained by adding the power capacity per motor, respectively.

7. HEAT LOSS

Motor model employed	Maximum heat loss of servo amplifier	Maximum heat loss of power transformer
5 - 0	15 W	-
30/2000	300 W	150 W
40	420 W	180 W

The maximum heat loss of servo amplifier shows the value at the maximum continuous rated current of motor. It decreases according to the reduction of motor load.

(Reference)
For thermal design of cabinets which accommodate the servo amplifier and servo transformer, it may be a general rule that the power dissipation quantity is about 50% of the maximum heat loss with taking the servo motor load into consideration.

8. INSTALLATION CONDITION AND NOTES

8.1 Installation Condition

Ambient temperature: 0°C - +55°C
Humidity : 95% RH or less (no dew condensation)
Vibration : 0.5 G or less
Atmosphere: The unit should not be exposed direct to the splash of cutting oil, lubricant or cutting chips.

8.2 Cautions on Installation and Housing

The servo amplifier is designed to be mounted in a cabinet. Be careful with the following items when designing the cabinet.

8.2.1 Housed in closed type cabinet

In the closed type cabinet, the internal air temperature generally increases. Circulate the internal air so that the ambient temperature of these unit becomes even. The air speed should be about 1 to 2 m/sec. Do not blow the fan or blower air directly on these units, otherwise dust may cling to the surfaces of these units and a trouble may result.

8.2.2 Housed in open air ventilation type cabinet

1) Use an air filter at the open air inlet.
2) Do not blow the fan or blower air directly on these units, otherwise dust may cling to the surfaces of these units, and trouble may result.
3) Ingress of mist of the cutting oil or dust form the air inlet, if any, may cause trouble. Be careful with the air flow at outlet side so it is not blocked.
4) Securely seal the cable entrance, door, and other openings.

8.2.3 Mounting position and other cautions

1) Mount the units to make easy check, dismounting, and mounting during maintenance.
2) Keep a space of more than 50 mm above and below the velocity control unit respectively, so that the air from the heat sink smoothly flows to the upper side and wiring can be done to the terminal boards on the lower side.

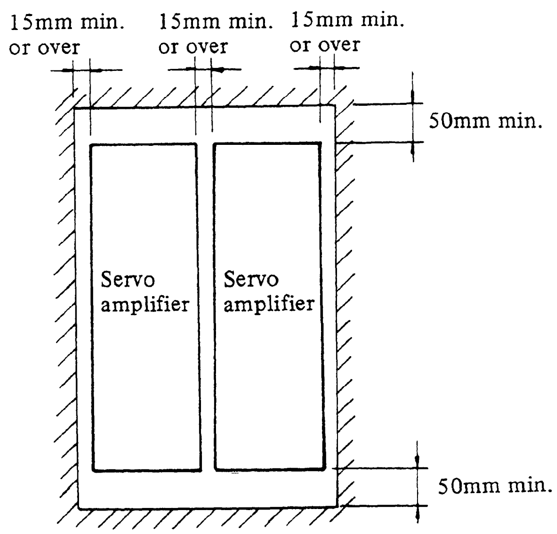
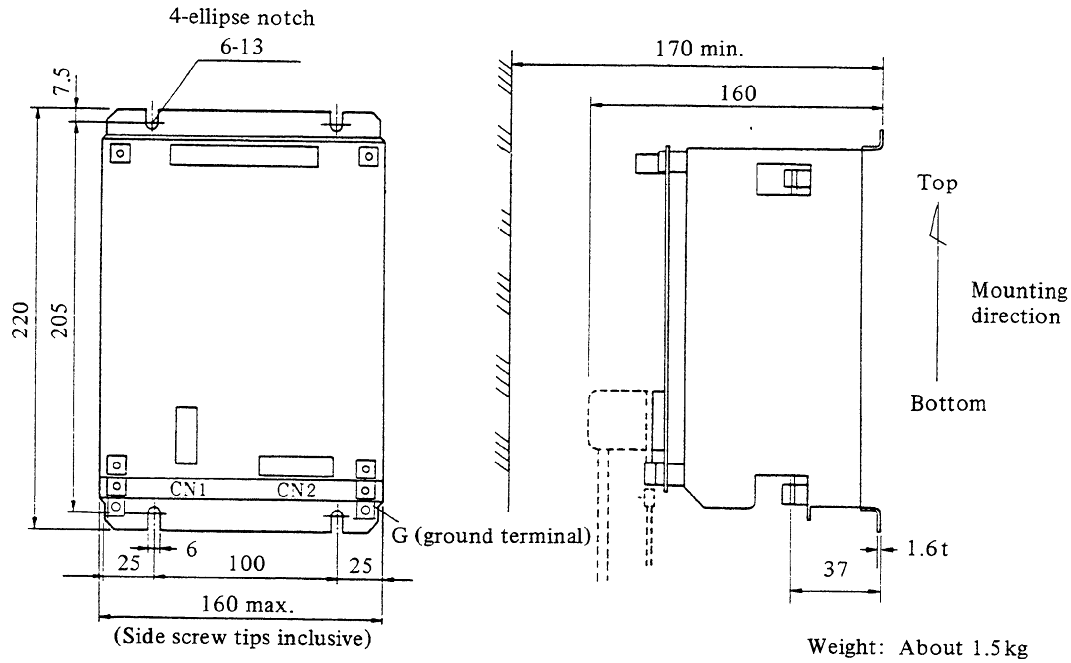


Fig. 8.2.3 Mounting space of servo amplifier

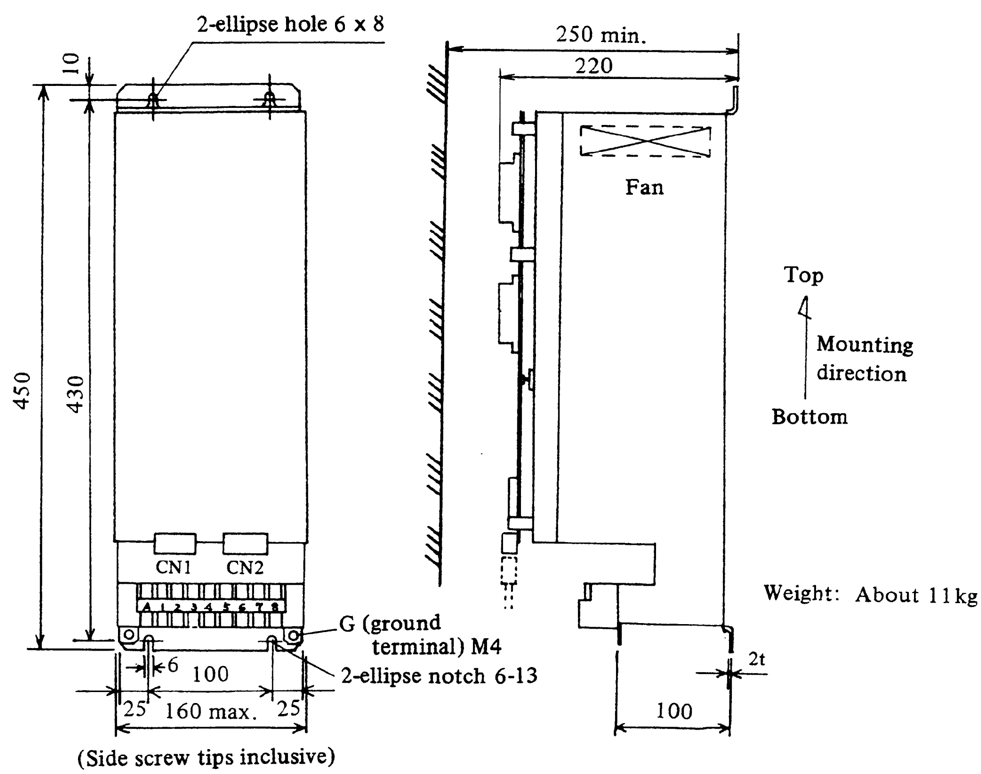
3) Precaution should be taken to separate of cables for power line and signal line, to ground frame of the servo amplifier and transformer, and to protect against noise.

9. EXTERNAL DIMENSIONS

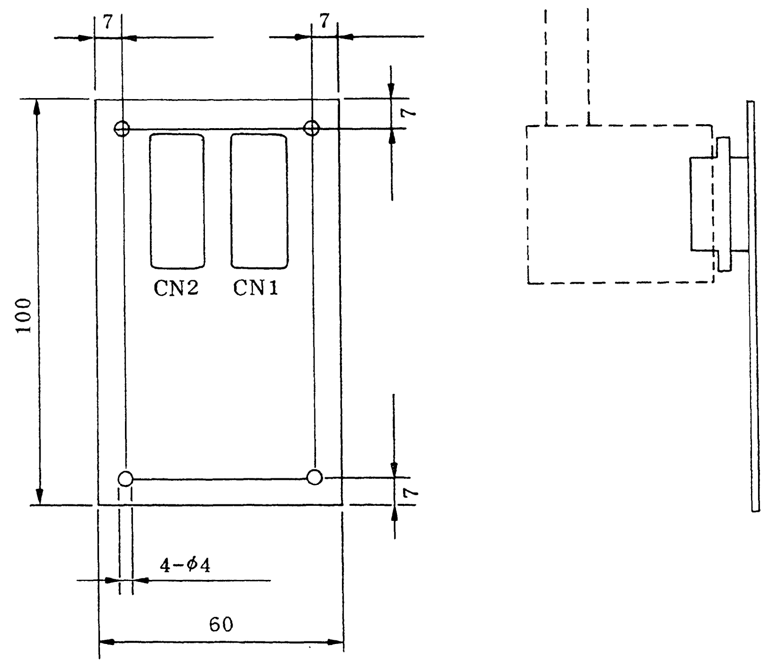
1) Model 5-0 (A06B-6057-H001)



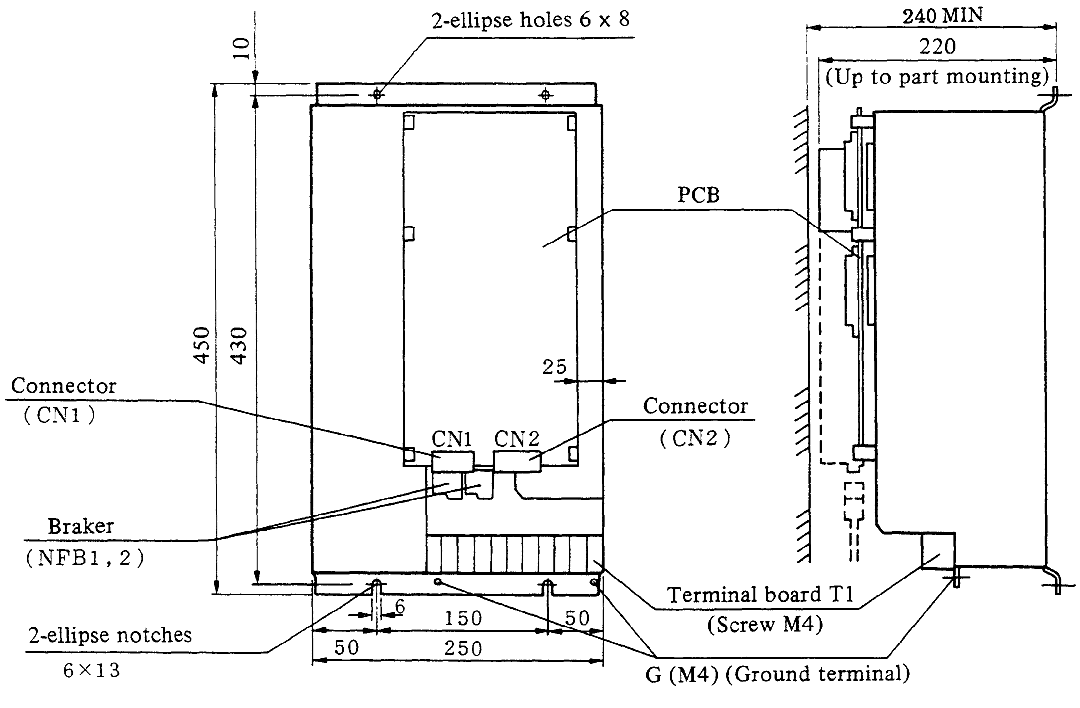
2) For Model 30/2000 (A06B-6057-H007)



3) Line driver circuit for AC5-0



4) Model 40 (A06B-6057-H008)



Weight: About 13.5kg

5) Power transformer
For detail of transformers ACE and MH, refer to section XI-8-3).

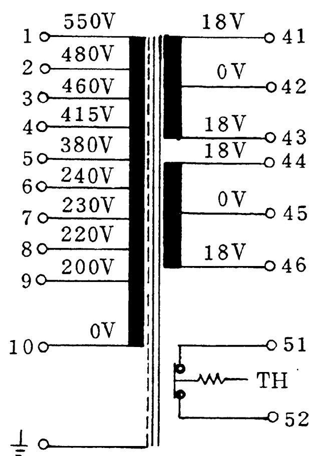
6) Separate type regenerative discharge unit A06B-6050-H050 (A06B-6050-C050)
Refer to section XI-8-4).

7) Input connector
Refer to section XI-8-5).

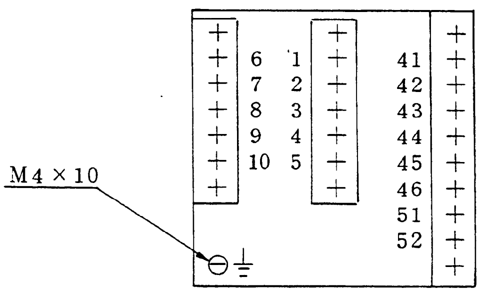
8) Power transformer for AC5-0

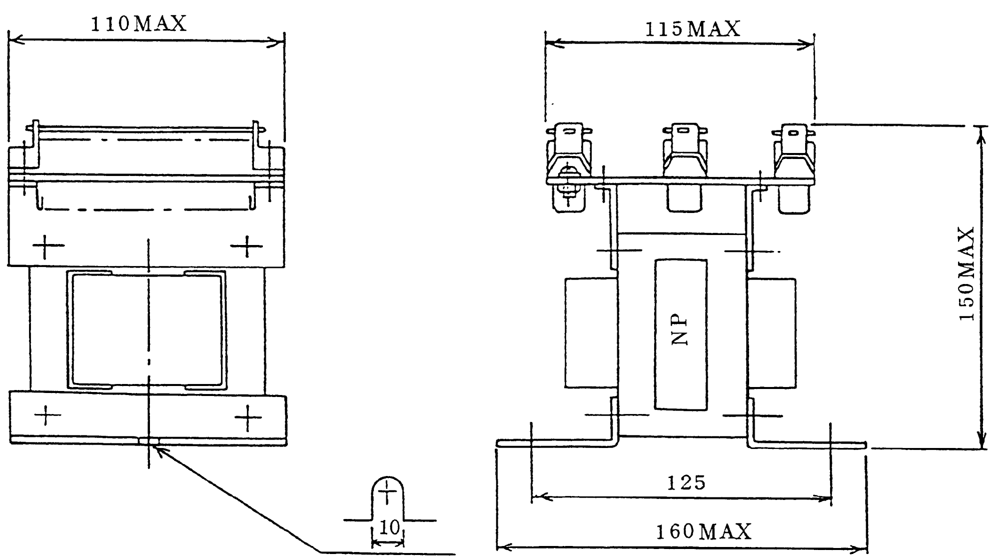
Continuous rating: 50 VA
Weight: 3.7 kg

Connection diagram



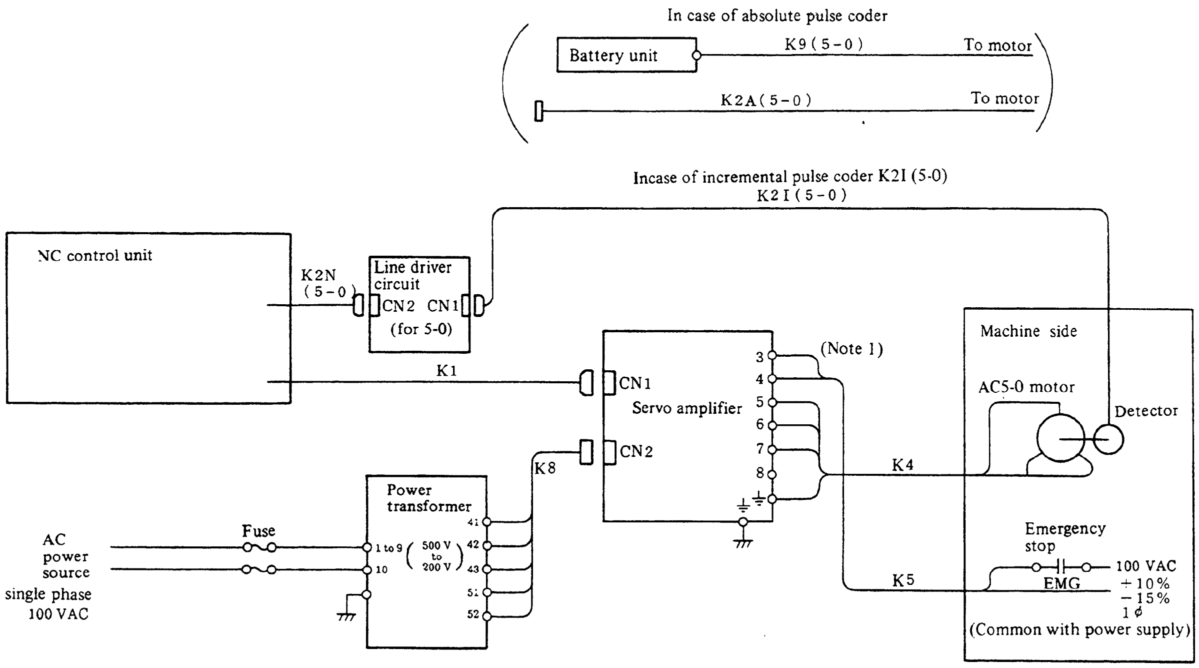
External dimensions and pin arrangement





10. CONNECTIONS

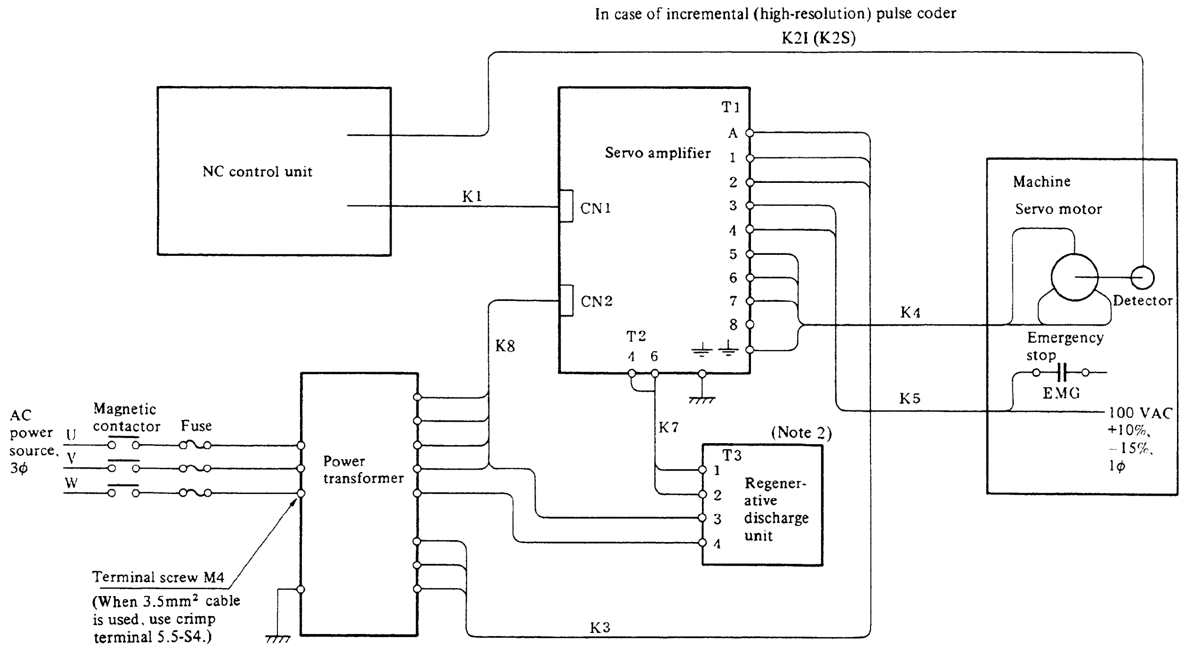
10.1 Standard connection diagram for AC5-0



Note 1) For the details of cable connection, refer Appendix 1 and 2.

Note 2) In the servo amplifier for 5-0, the 100 VAC input for emergency stop is used as a power supply for driving.

10.2 Standard connection diagram for 30/2000 and 40 (When separate type regenerative discharge unit is employed)



(Note 1) For the details of cable connection, refer to the Appendix 1 and 2.
(Note 2) The model 30/2000 needs the regenerative discharge unit in the stndard specification.
(Note 3) For the connection of the cable K2 in the case of absolute pulse coder, refer to section VII-9.

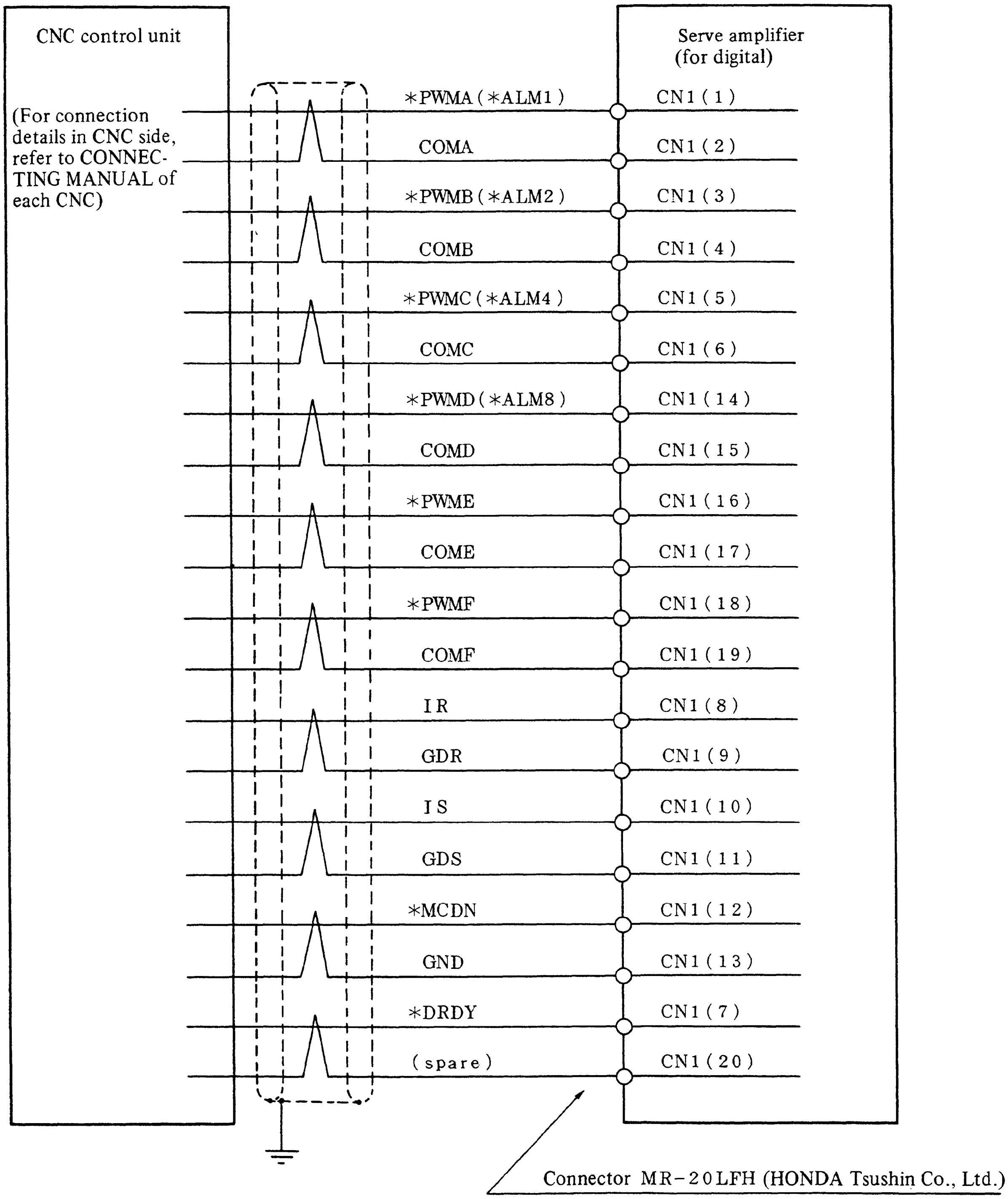
10.3 Power transformer connection

For details of power transformers ACE and MH, refer to section XI-8-3).
For details of transformer primary fuse, refer to section XI-8-5).

APPENDIX

APPENDIX 1 CONNECTION DETAILS OF CABLE

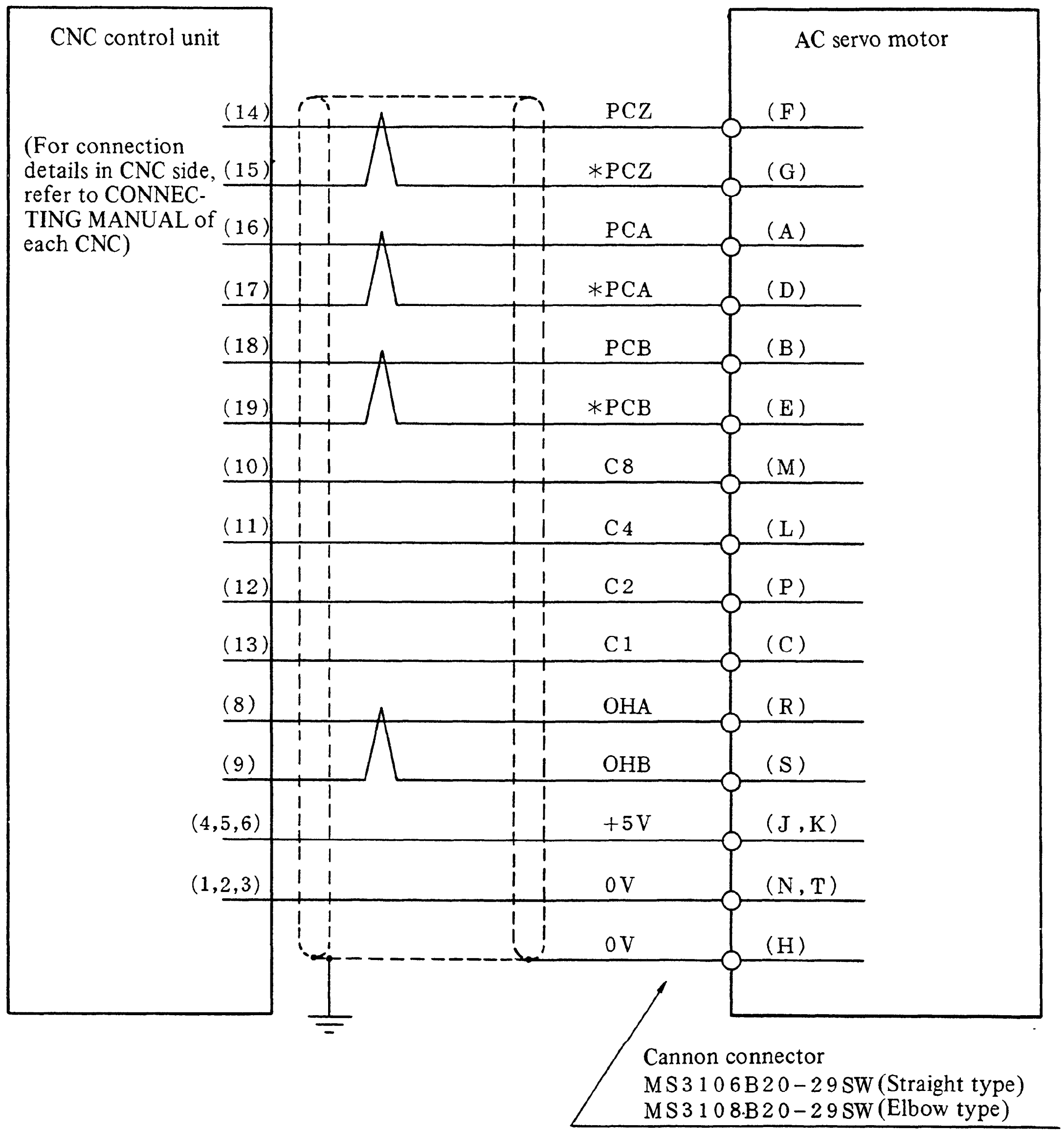
1. CABLE K1 (AMPLIFIER COMMAND SIGNAL LINE)



Wire material : 0.2mm² twisted pair totally
                shielded cable (10 pairs)

2. CABLE K2 (MOTOR FEEDBACK SIGNAL LINE)

2.1 Cable K2I (incremental standard pulse coder)

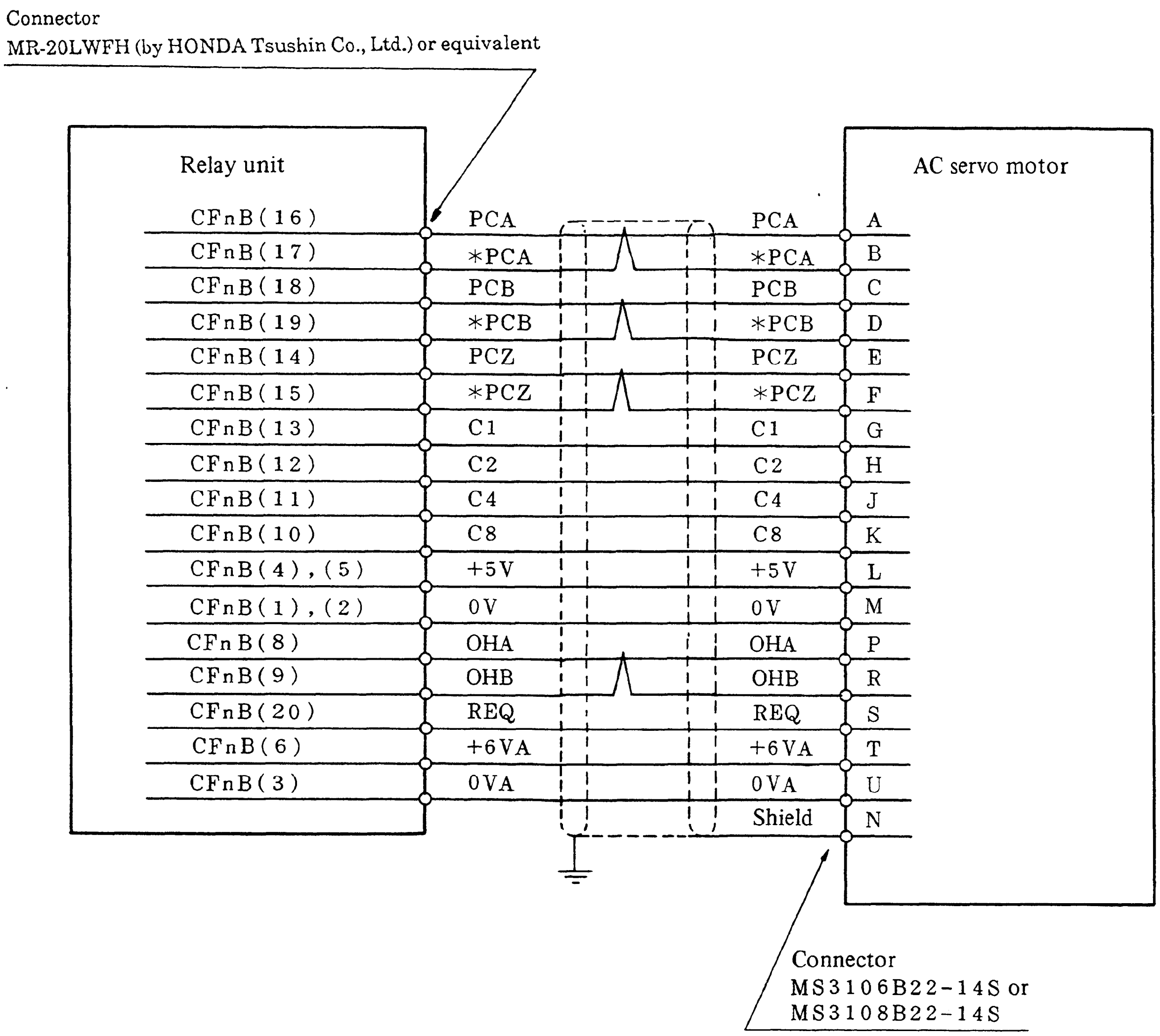


Wire material : +5V, 0V... Six or more 0.2mm² vinyl wires are connected in parallel (length 14m or less).
C8, C4, C2, C1... 0.2mm² vinyl wire is used.
Others... 0.1mm² or thicker twisted pair totally shielded wire.

Note) When the wire is longer than 14m, provide wire sized to limit the voltage drop of +5V to -0.02V or less.

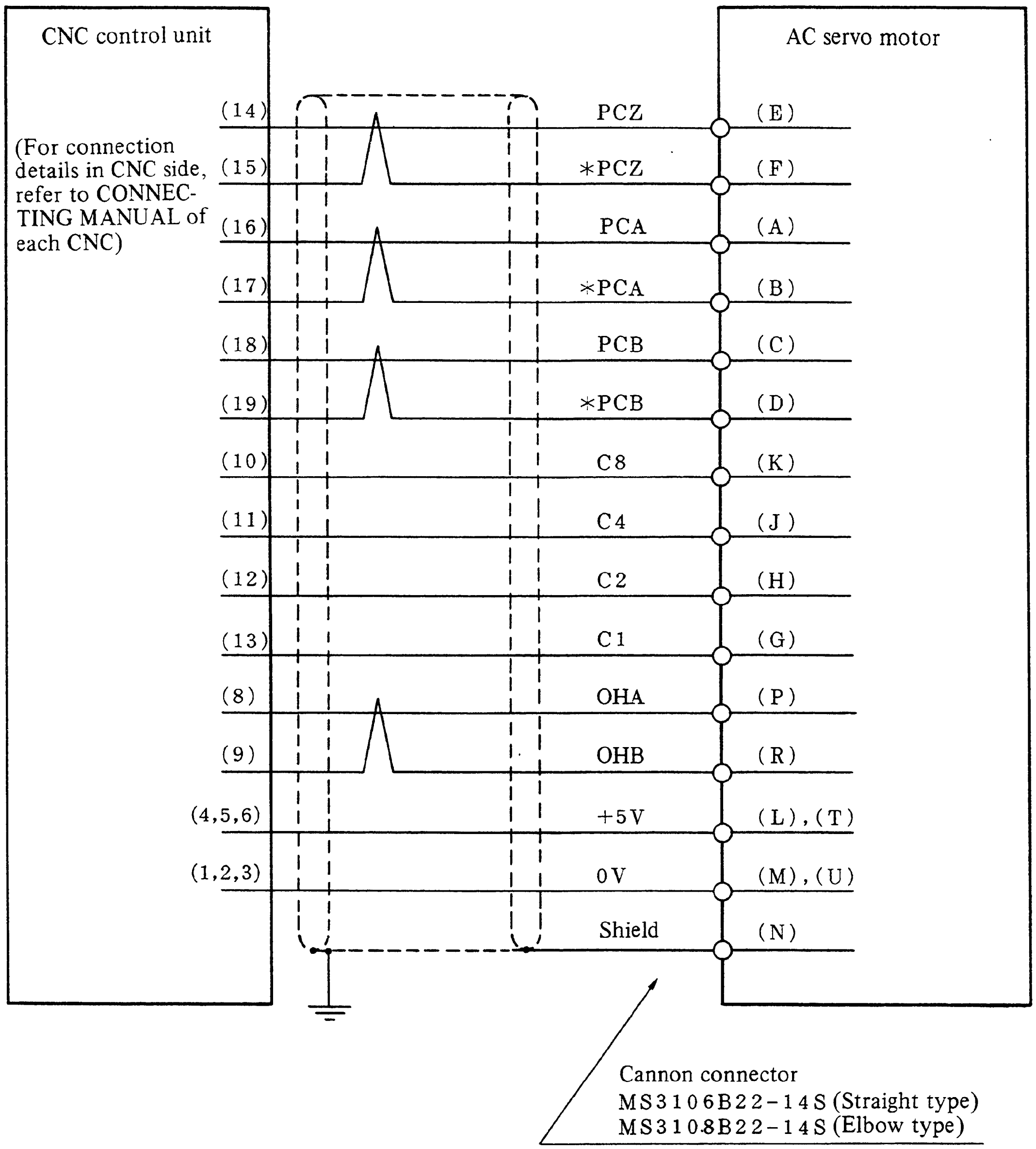
[Reference] Specified specification when purchasing the cable from FANUC:
Cable wire material only : A66L-0001-0199 (wire length 14m max.)
Cable with connector (14m long) :
With straight Cannon connector A02B-0074-K802
With elbow Cannon connector A02B-0074-K803

2.2 Cable K2A (absolute pulse coder)




```
Cable material
(when the sum of cable length K2A and K2N is 14m or less)
PCA, *PCA, PCB, *PCB, PCZ, *PCZ, OHA, OHB
        : 0.18mm2 twisted pair wire
-5V, 0V : 0.5mm2 x 2
Others  : 0.18mm2
```

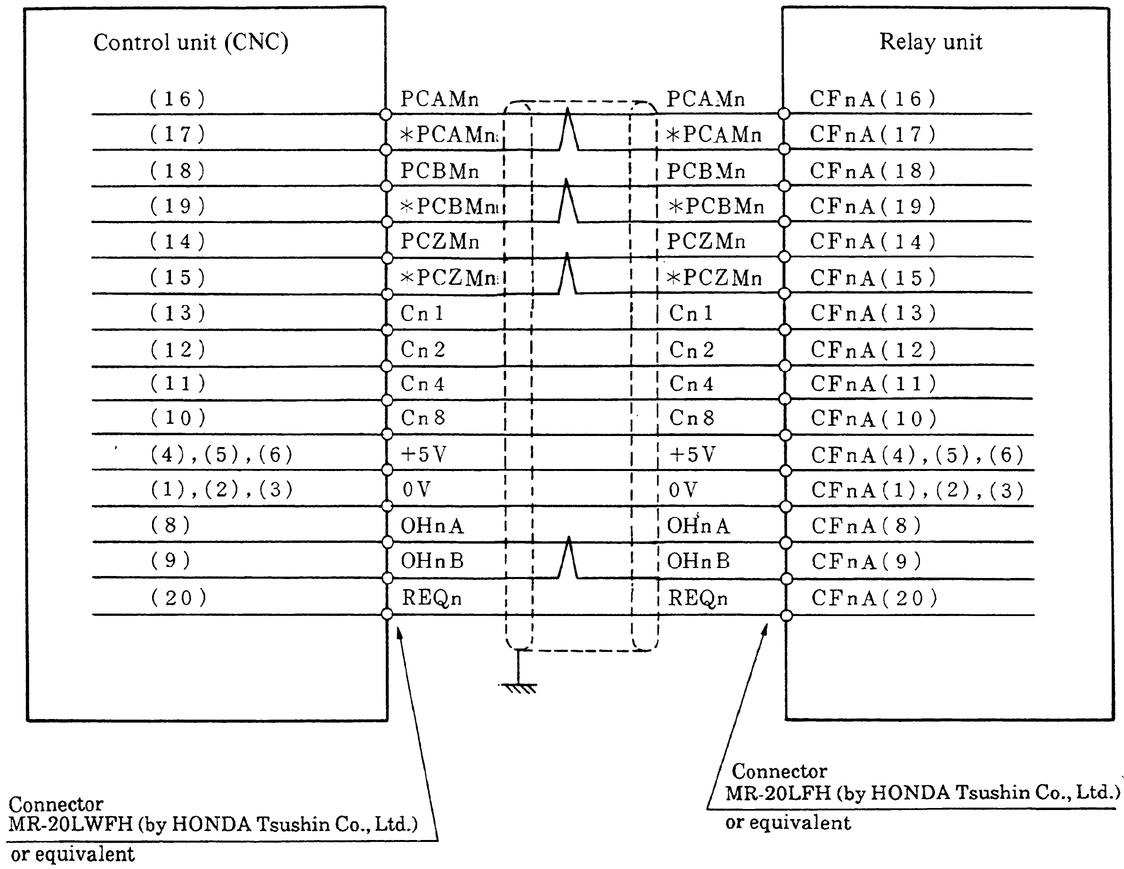
2.3 Cable K2S (high resolution pulse coder)



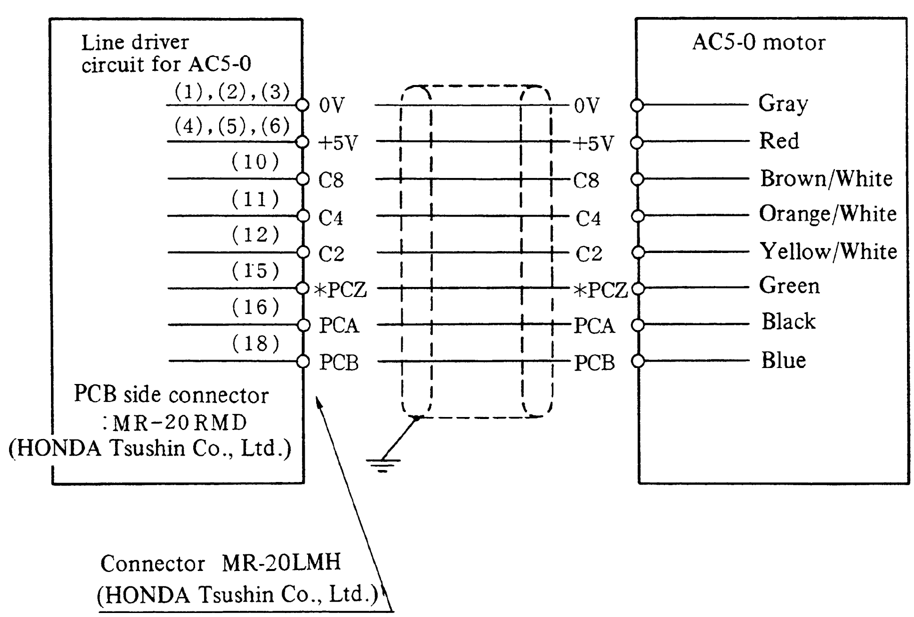
Wire material : Six or more 0.2mm² vinyl wires are connected in parallel (length 14m or less).
C8, C4, C2, C1... 0.2mm² vinyl wire is used.
Others... 0.1mm² or thicker twisted pair totally shielded wire.

Note) The wire is longer than 14m.

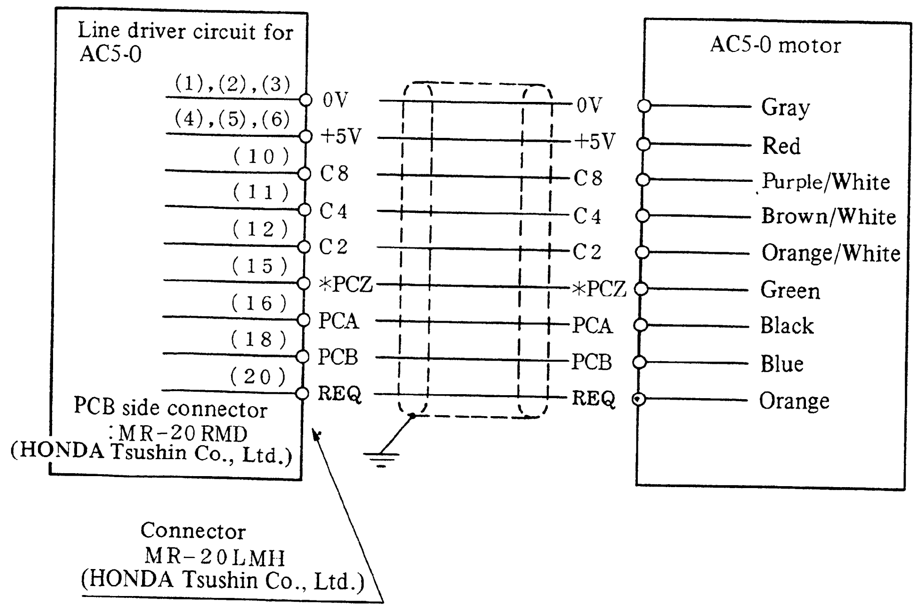
2.4 Cable K2N (absolute pulse coder)



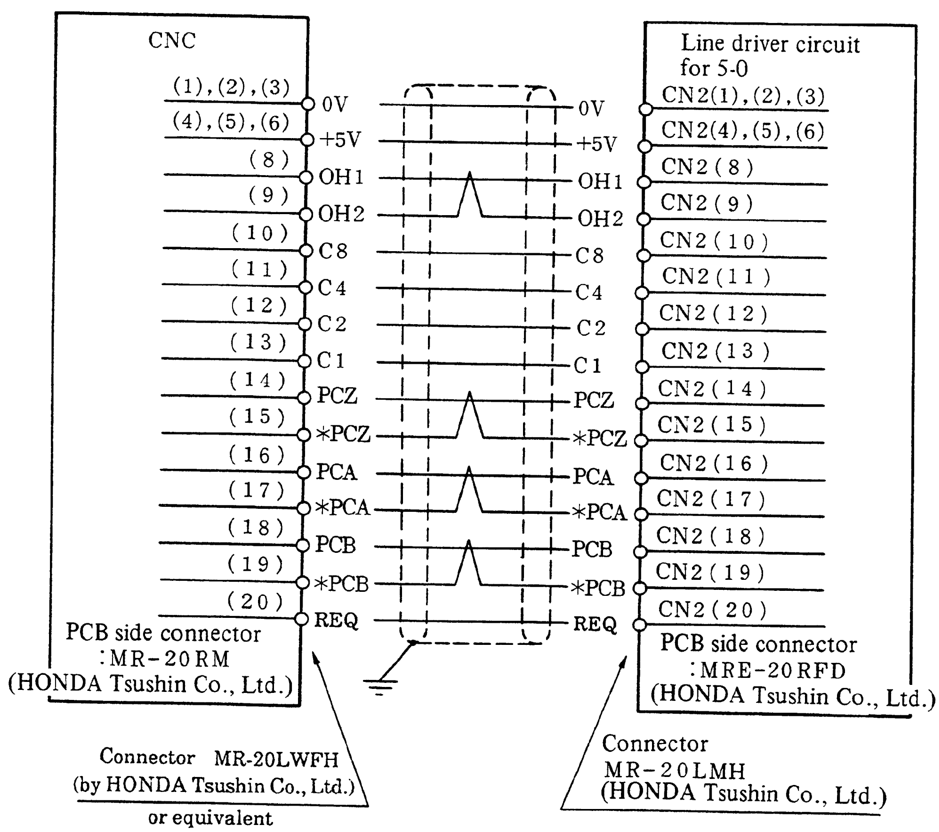
2.5 Cable K2I (5-0) (incremental pulse coder for 5-0)



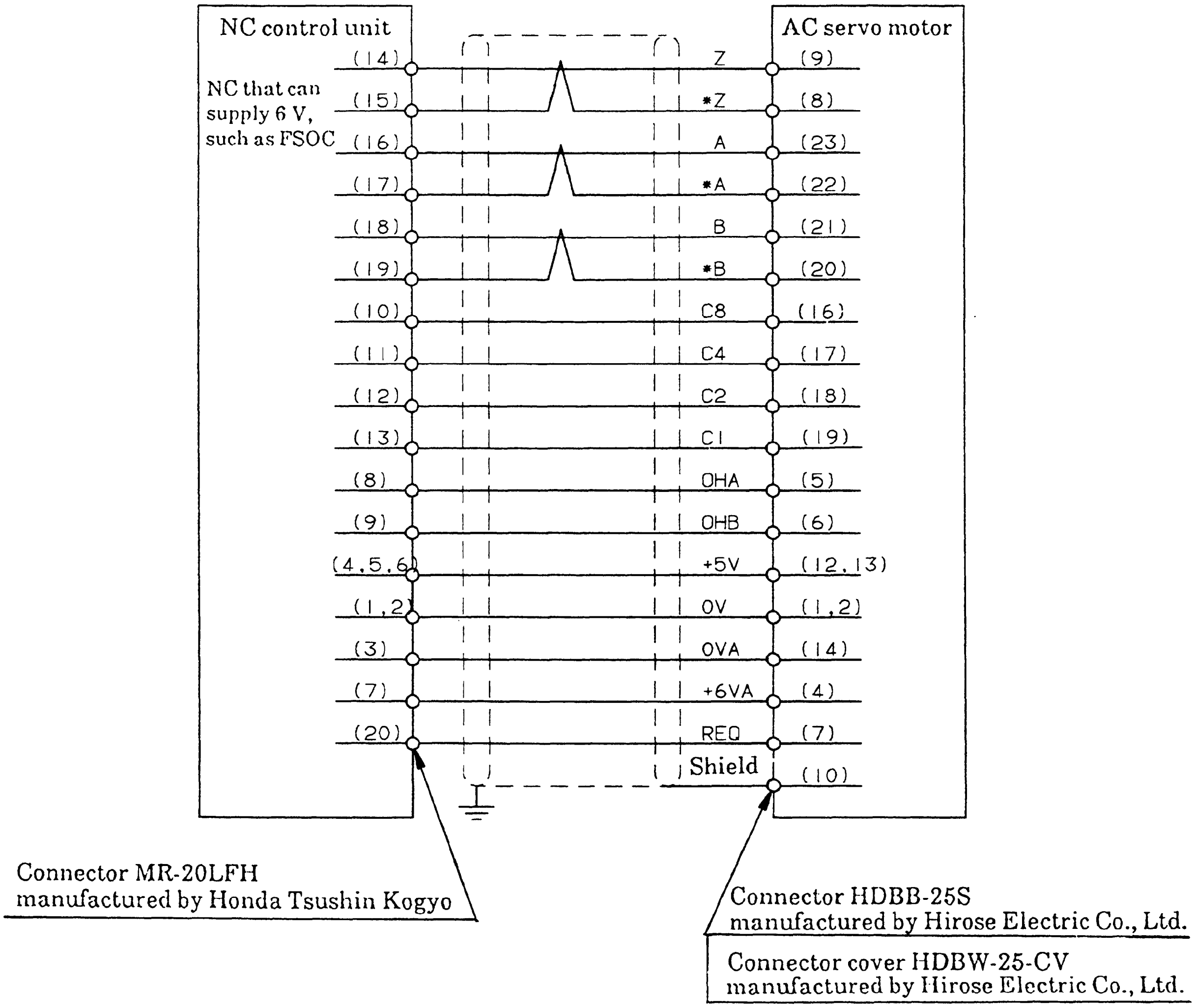
2.6 Cable K2A (5-0) (absolute pulse coder for 5-0)



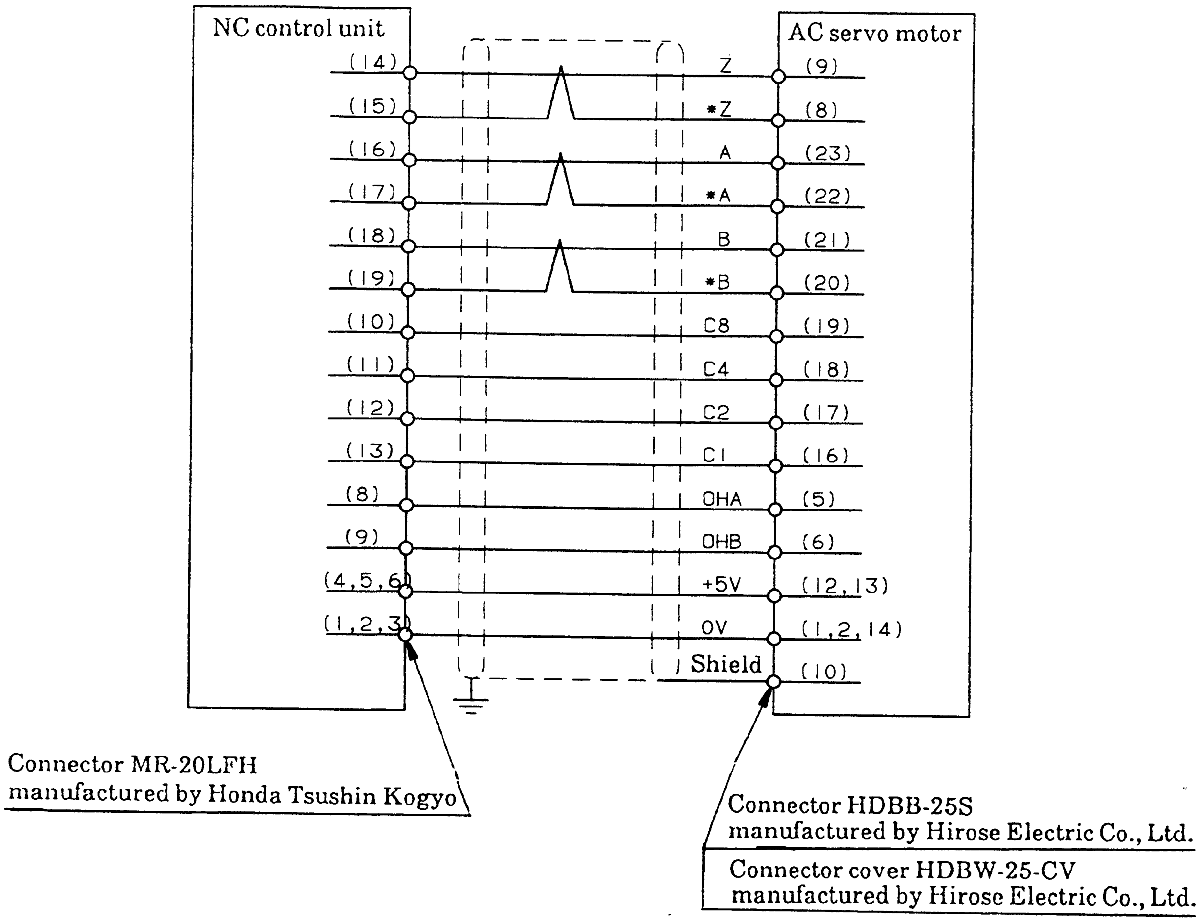
2.7 Cable K2N (5-0) (absolute pulse coder for 5-0)



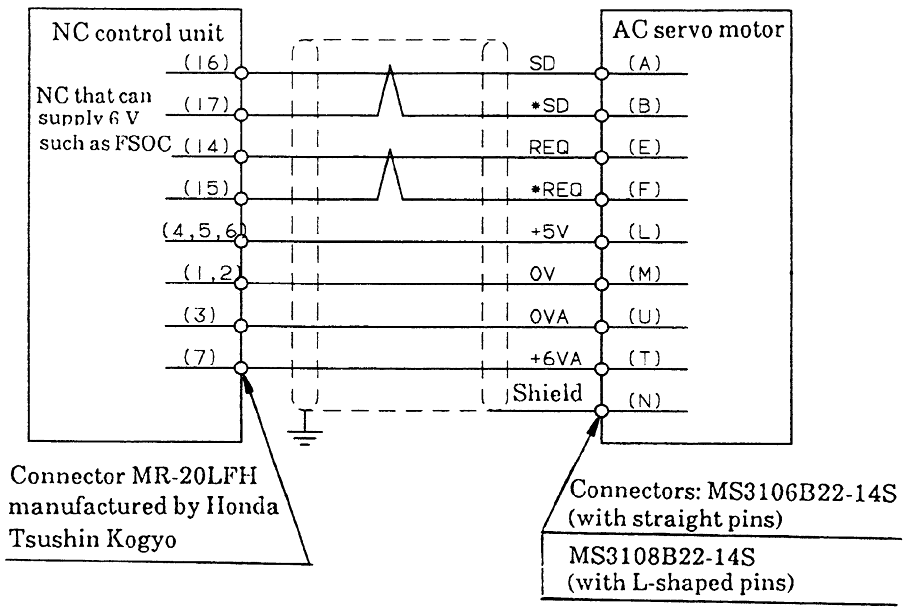
2.8 Absolute Pulse Coder for Models 2-0SP to 0-0SP

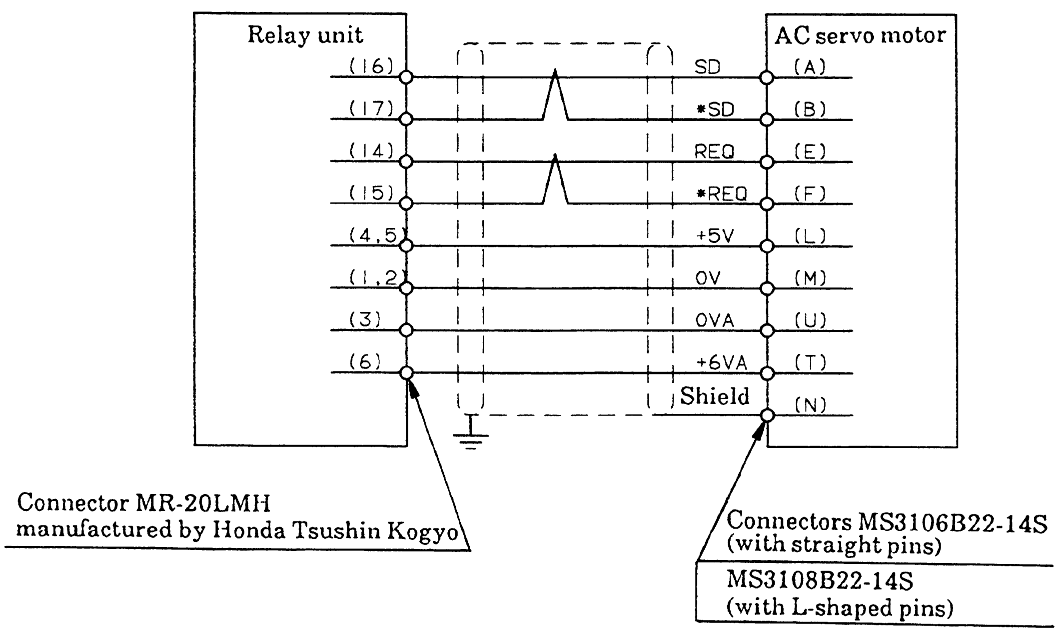


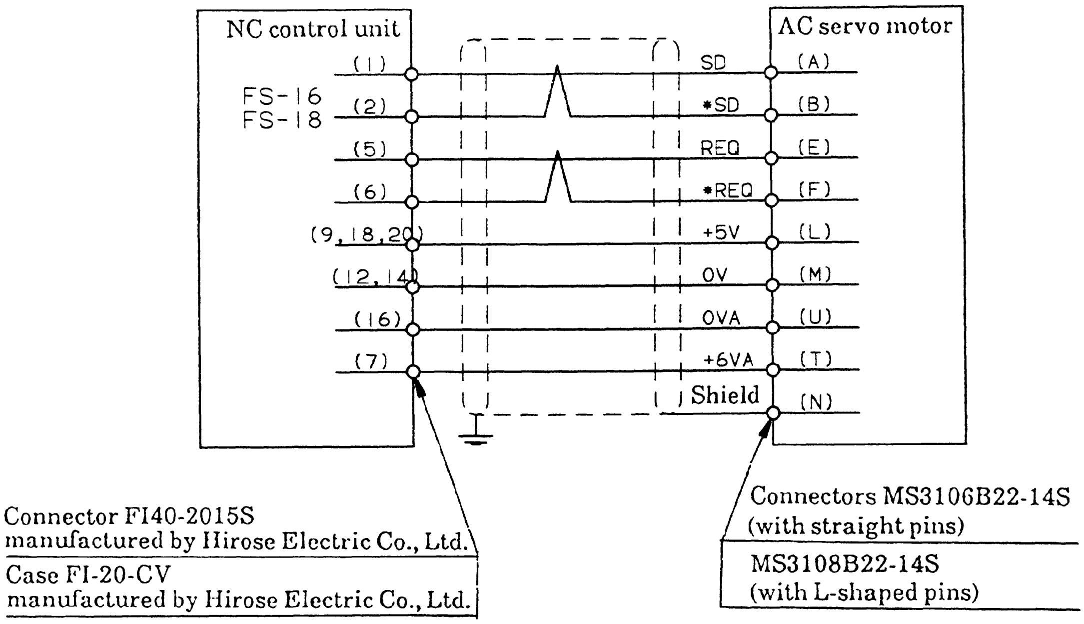
2.9 Incremental Pulse Coder for Models 2-0SP to 0-0SP



2.10 Serial Pulse Coder A for Model 0S or Subsequent Models







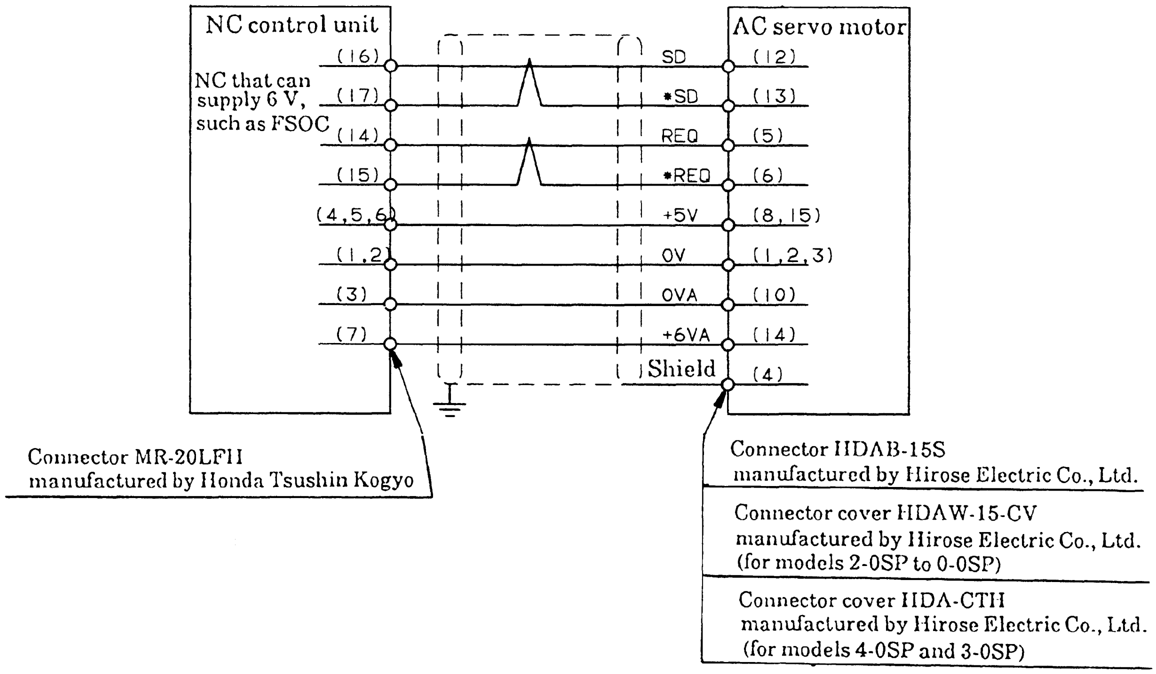
Wires: +5 V and 0 V: Wire of 0.5 mm^2 min. × 2 (when the wire does not exceed 14 m)

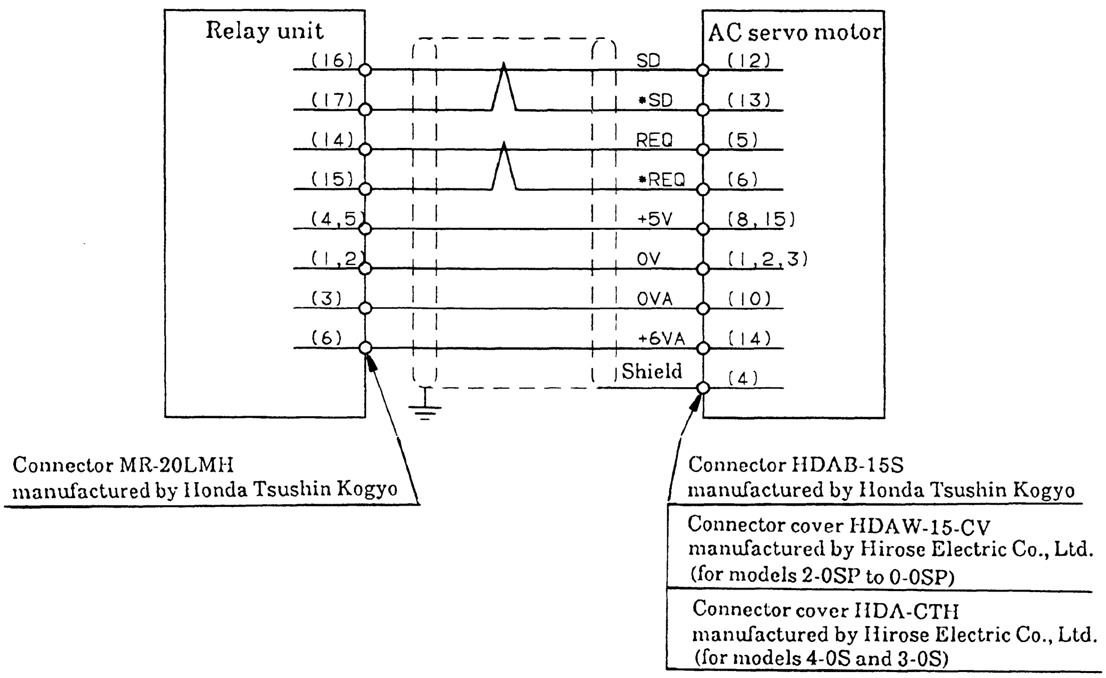
6 VA and 0 VA: Wire of 0.5 mm^2 min.

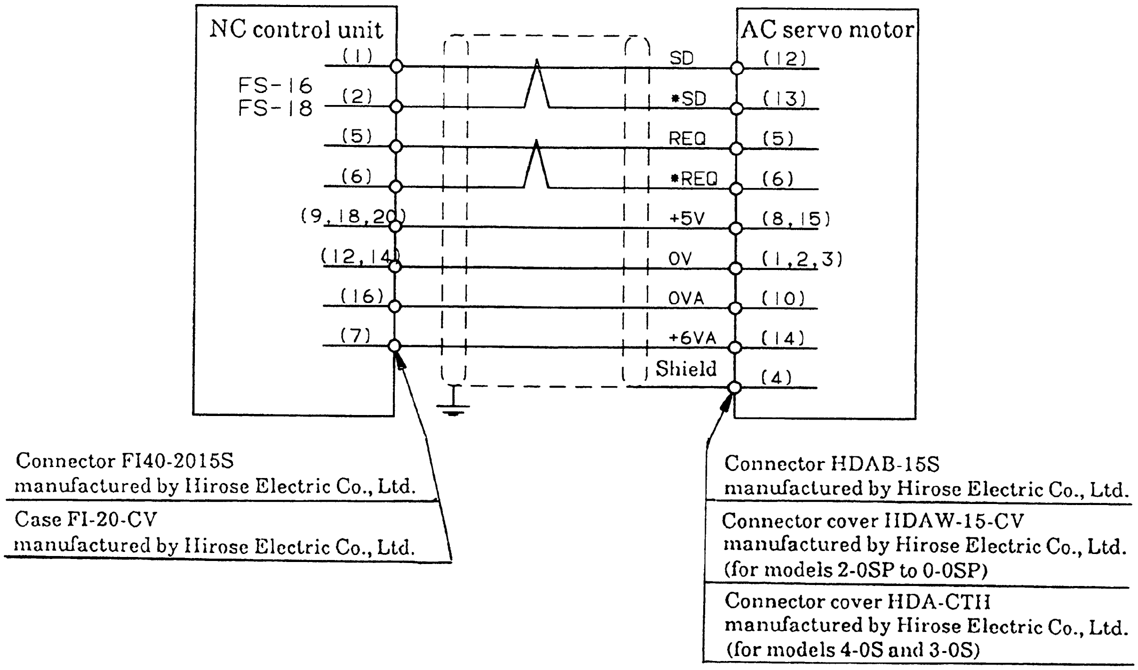
SD, *SD, REQ, and *REQ: Twisted pair of 0.18 mm^2 min.

Note) If the wire is 14 m long or more, the total resistance of the 0 V and +5 V wires must not exceed 0.5 ohms.

2.11 Serial Pulse Coder A for Models 4-0S to 0-0SP







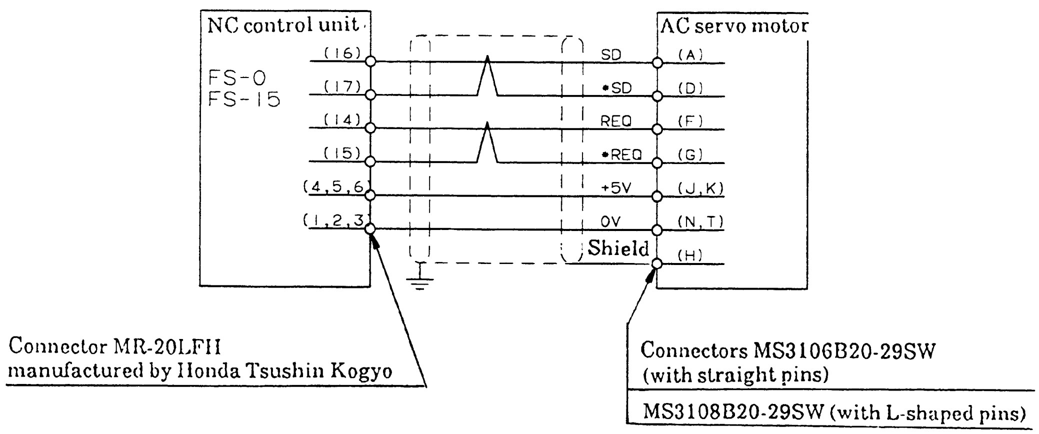
Wires: +5 V and 0 V: Wire of 0.5 mm^2 × 2 (when the wire does not exceed 14 m)

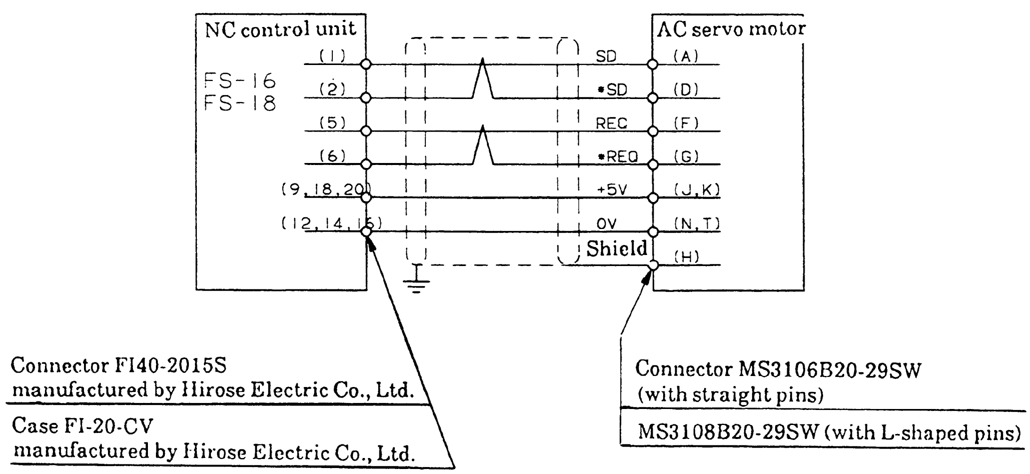
6 VA and 0 VA: Wire of 0.5 mm^2 min.

SD, *SD, REQ, and *REQ: Twisted pair of 0.18 mm^2 min.

Note) If the wire is 14 m long or more, the total resistance of the 0 V and +5 V wires must not exceed 0.5 ohms.

2.12 Serial Pulse Coder C for Model 0S or Ensuing Models

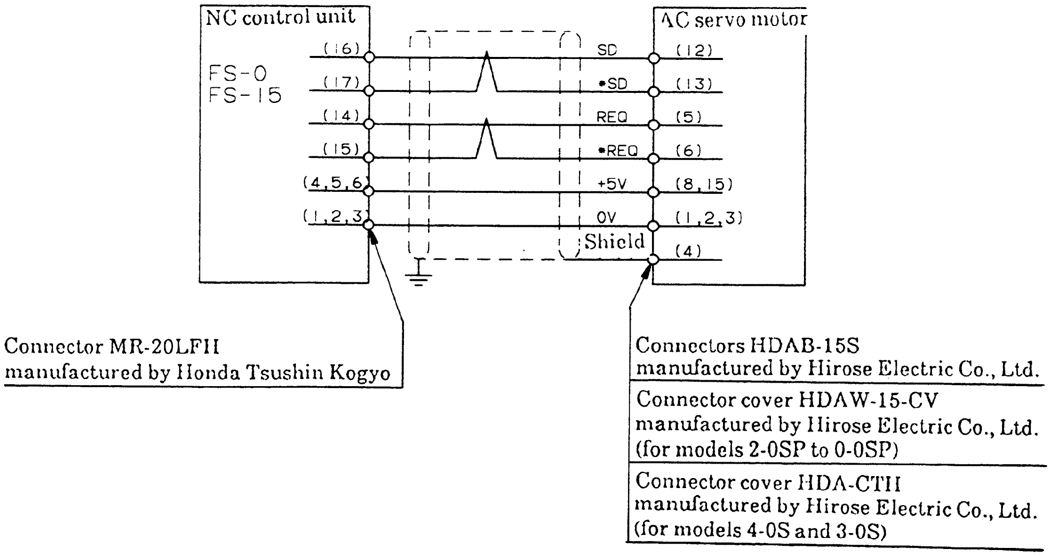


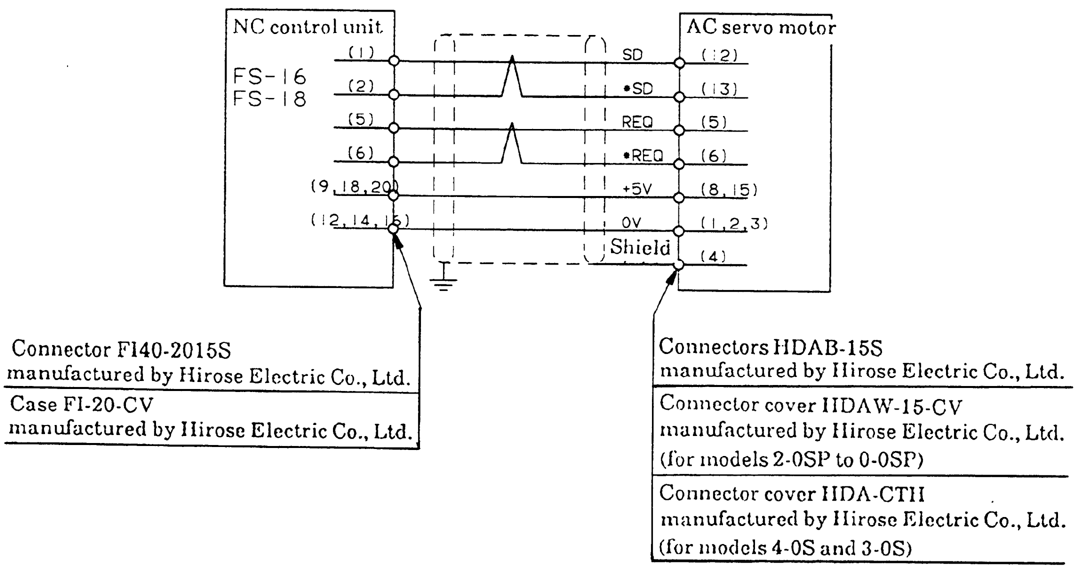


Wires: +5 V and 0 V: Wire of 0.5 mm^2 min. × 2 (when the wire does not exceed 14 m)
6 VA and 0 VA: Wire of 0.5 mm^2 min.
SD, *SD, REQ, and *REQ: Twisted pair of 0.18 mm^2 min.

Note) If the wire is 14 m long or more, the total resistance of the 0 V and +5 V wires must not exceed 0.5 ohms.

2.13 Serial Pulse Coder C for Model 4-0S to 0-0SP



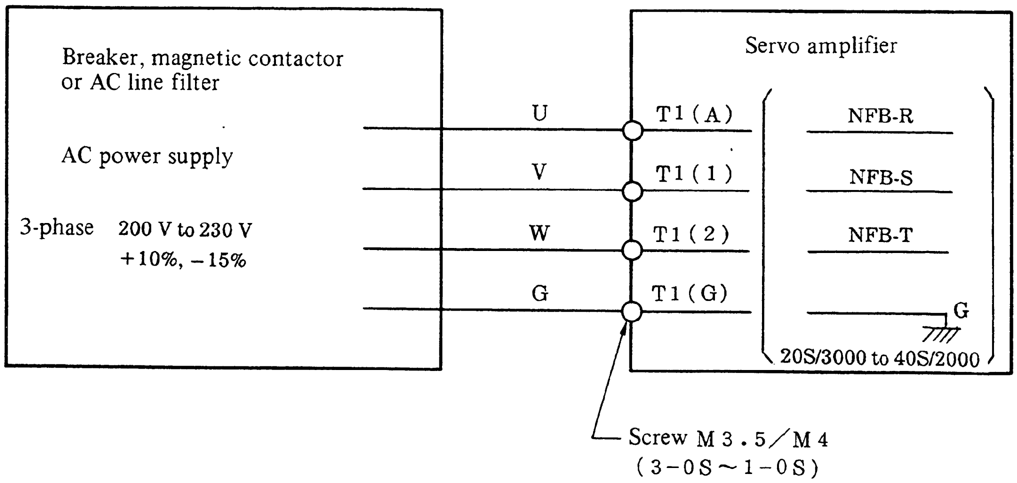


Wires: +5 V and 0 V: Wire of 0.5 mm^2 min. × 2 (when the wire does not exceed 14 m)
6 VA and 0 VA: Wire of 0.5 mm^2 min.
SD, *SD, REQ, and *REQ: Twisted pair of 0.18 mm^2 min.

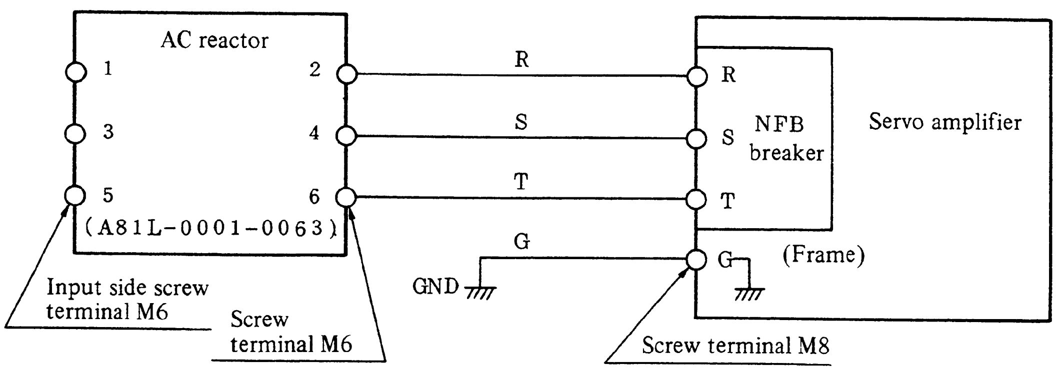
Note) If the wire is 14 m long or more, the total resistance of the 0 V and +5 V wires must not exceed 0.5 ohms.

3. CABLE K3 (AMPLIFIER POWRE LINE)

3.1 4-0S to 40S/2000



3.2 50S to 70S

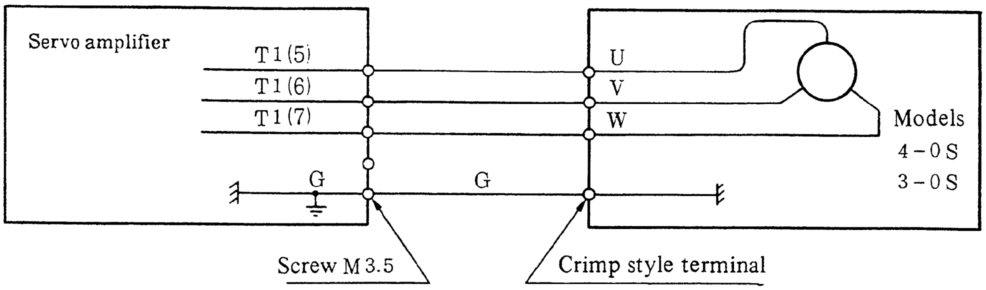


		Cable length	Cable specifications
K2		10m Max.	Crosslinked polyethylene electric cable 600 V (FURUKAWA Electric Co., Ltd. Bemex ER400 equivalent)
Cable materials (sectional area) Note 2)	AC50S	14mm^2 Min.	
	AC60S/70S	22mm^2 Min.	

Note 1) Separately consult FANUC if the cable length becomes extremely long.
Note 2) The number indicates the sectional area per cable used.

4. CABLE K4 (MOTOR POWER LINE)

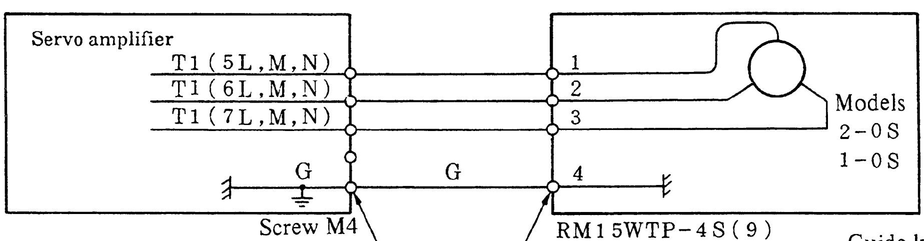
1) Models 4-0S and 3-0S



Wire material used:
30/0.18 (0.75 mm^2) 4-conductor
vinyl cabtyre cable

Color of lead wires
U – Red
V – White
W – Black
Ground: connected
to the motor body.

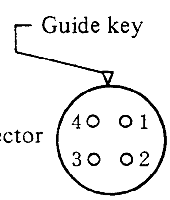
2) Models 2-0S and 1-0S



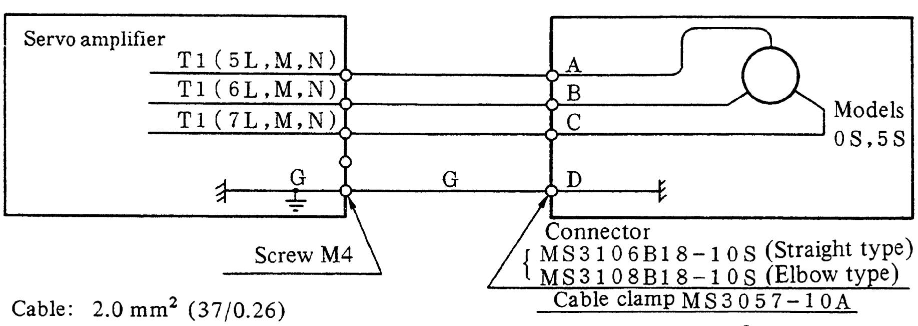
*Wire of Hirose Electric Co.

Wire material used:
30/0.18 (0.75 mm^2) 4-conductor
vinyl cabtyre cable

Cannon connector

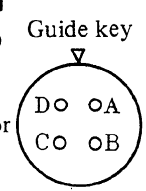


3) Models 0S, 5S, and 5S/3000

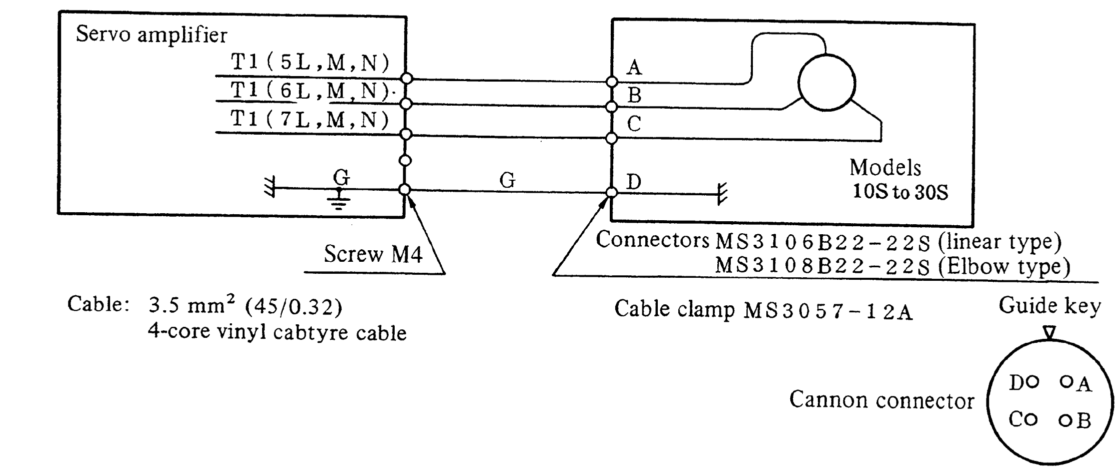


Cable: 2.0 mm^2 (37/0.26)
4-conductor vinyl
cabtyre cable

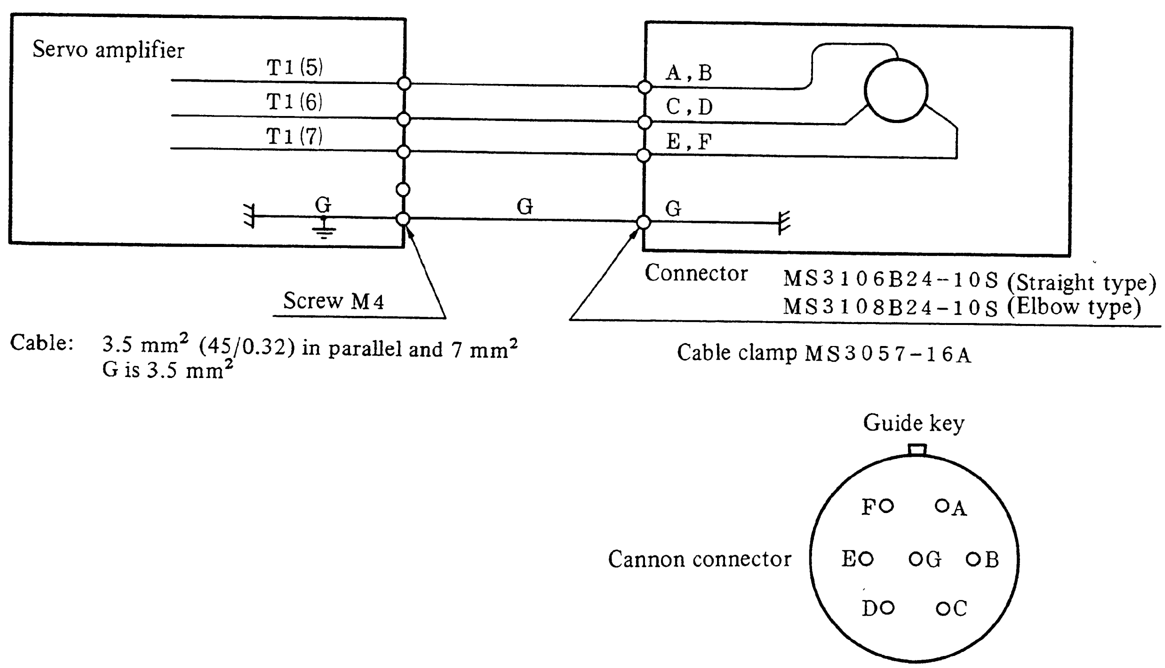
Cannon connector



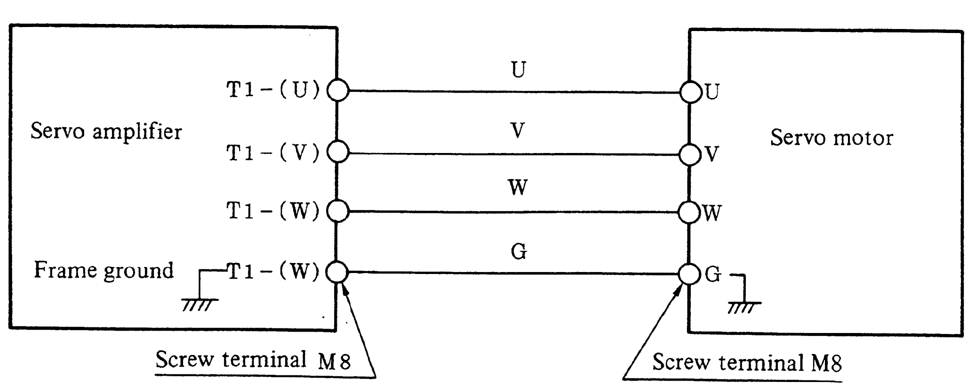
4) Models 10S, 10S/3000, 20S/1500, 20S, and 30S



5) Models 20S/3000, 30/2000, 30S/3000, 40, 40S/2000, 7L, and 10L

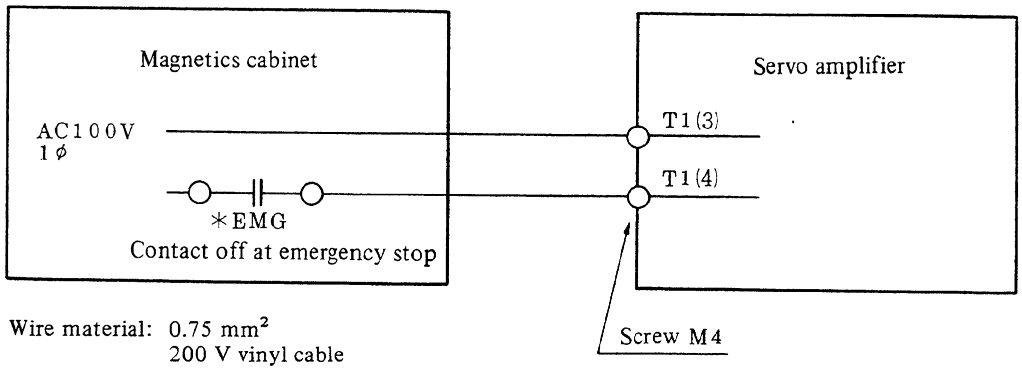


6) Models 50S to 70S



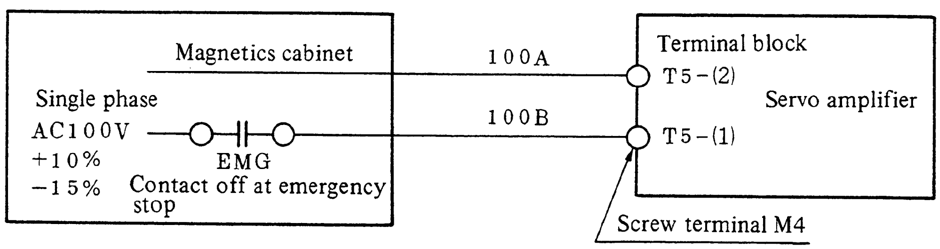
5. CABLE K5 (MAGNETIC CONTACTOR LINE)

5.1 Other than Models 50S to 70S



Wire material: 0.75 mm²
200 V vinyl cable

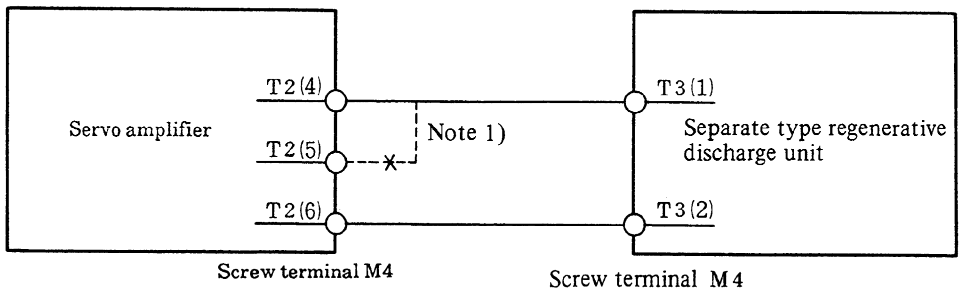
5.2 Models 50S to 70S



Wire material: 0.75 mm²
200 V vinyl cable

6. CABLE K6 (REGENERATIVE DISCHARGE RESISTOR LINE)

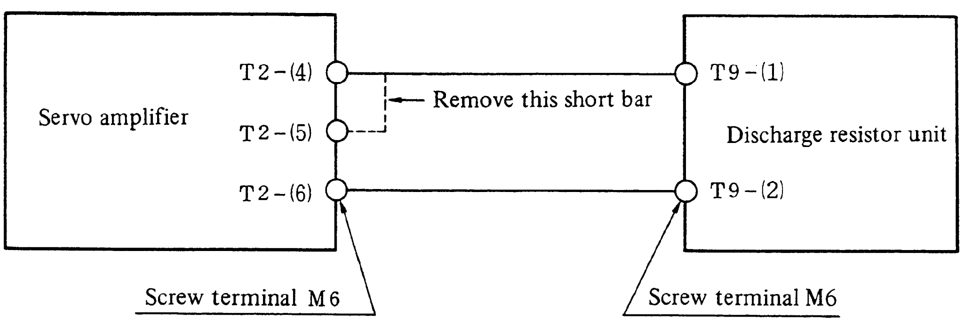
6.1 Other than Models 50S to 70S



Wire material: 2 mm^2 600 V heat-resistive vinyl cable

Note 1) When using the separate type regenerative discharge unit, remove the short bar between T2(4) and T2 (5).

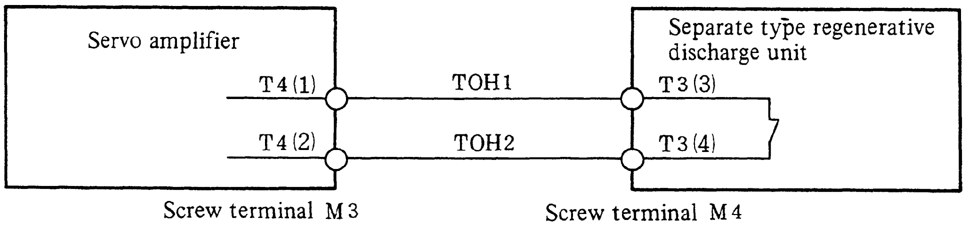
6.2 Models 50S to 70S



7. CABLE K7 (THERMOSTAT LINE)

7.1 Other than Models 50S to 70S

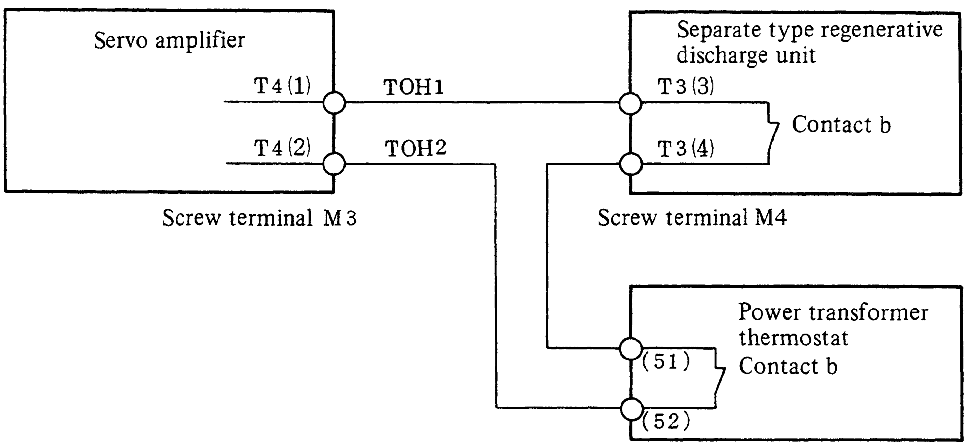
1) Without transformer



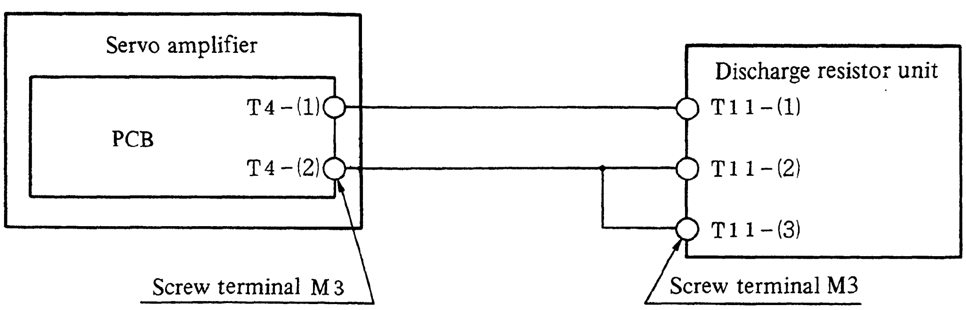
Wire material: 0.75 mm^2 200 V heat-resistive vinyl cable

when connecting the cable K6, it is necessary to change the setting of the servo amplifier PCB.

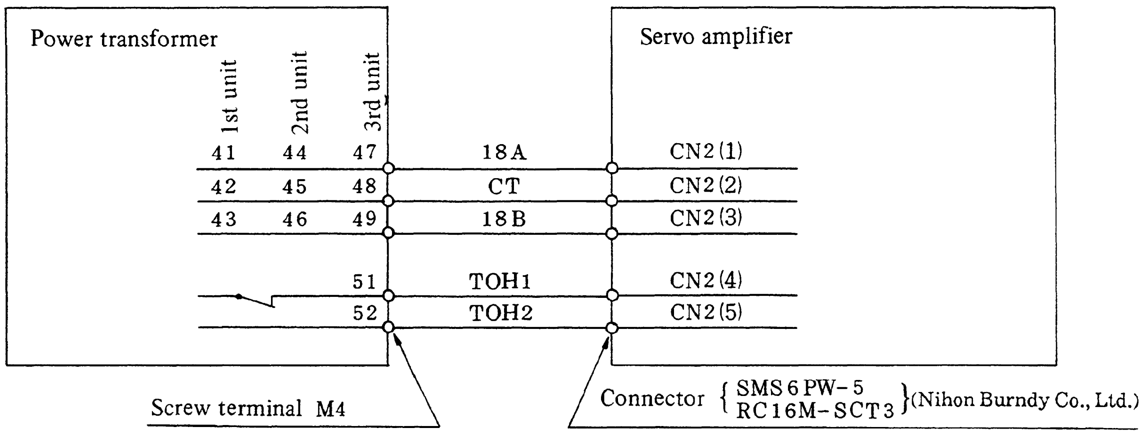
2) With transformer
When a transformer is used, bury a thermostat into the transformer and connect the contact b as shown below.



7.2 Models 50S to 70S



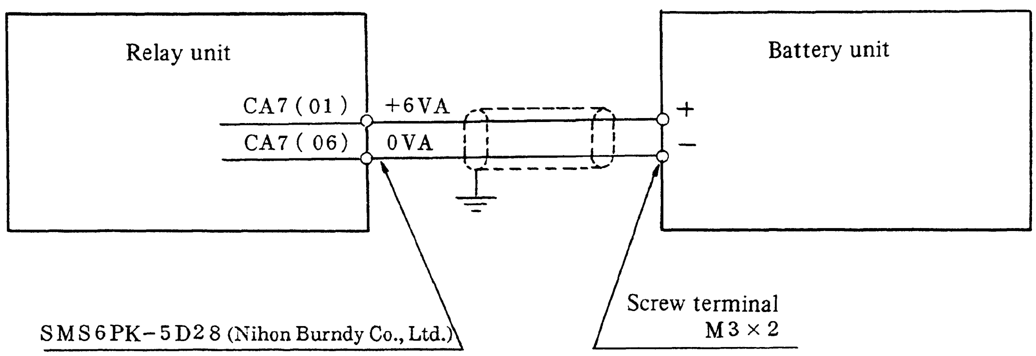
8. CABLE K8 (CONTROL POWER LINE)



Wire material: 0.75 mm^2 (30/0.18)
200 V heat-resistive vinyl cable

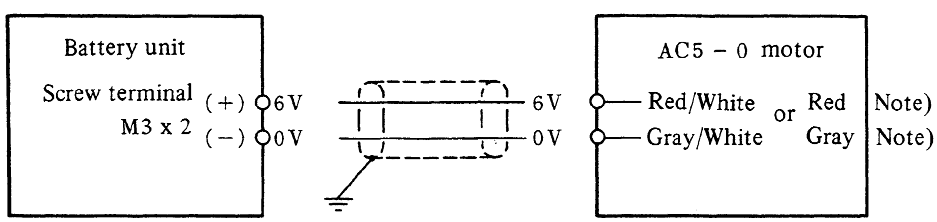
9. CABLE K9 (BATTERY LINE)

9.1 Connection between Relay Unit and Battery Unit



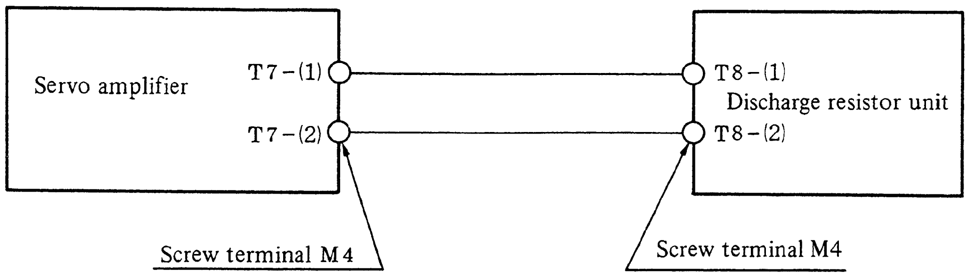
Wire material: Shielded wire (0.18 mm^2 or more)

9.2 Connection between Battery Unit and AC5-0 Motor



Note) Thick wire with red crimp terminal

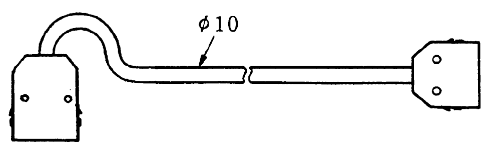
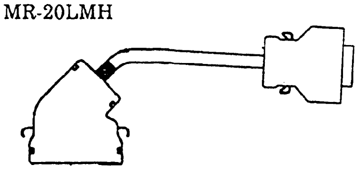
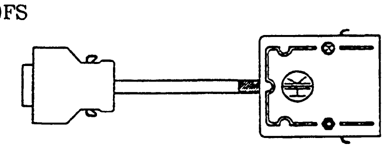
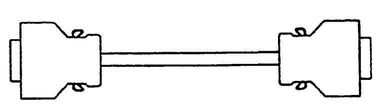
10. CABLE K10 (DISCHARGE RESISTOR UNIT COOLING FAN LINE FOR 50S TO 70S)



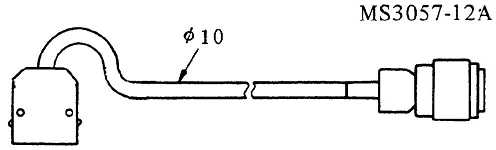
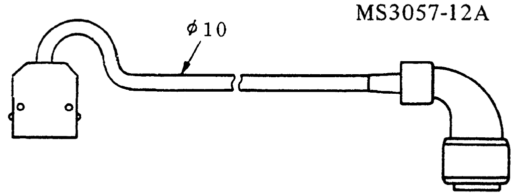
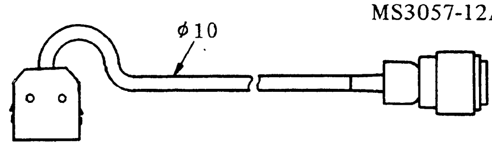
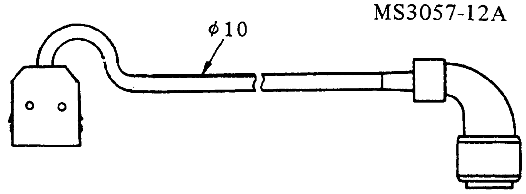
APPENDIX 2 CABLE ASSEMBLY

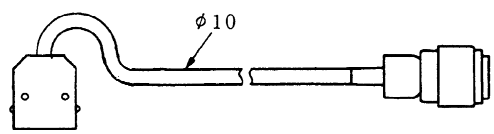
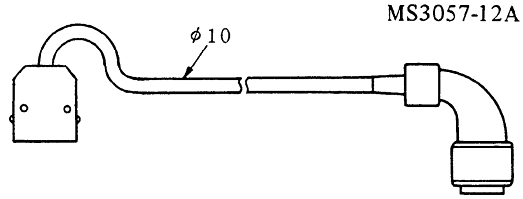
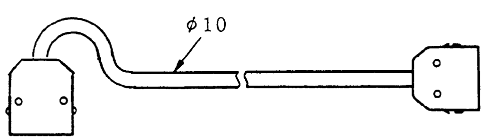
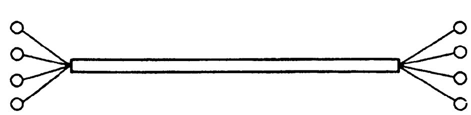
The type of the connector on the NC may vary depending on the type of the NC. Refer to the ordering information in the Description of the NC used.

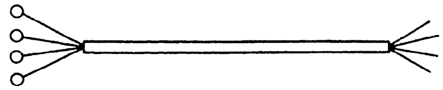
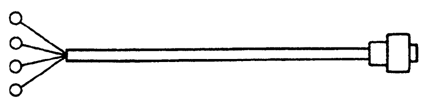
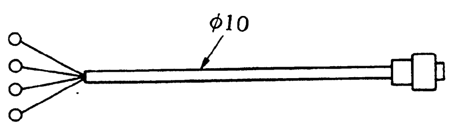
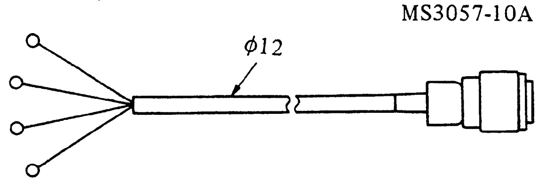
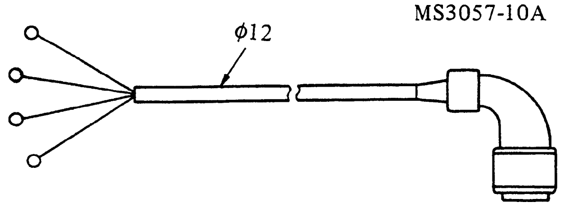
Cable List for AC Servo Amplifier (Digital)

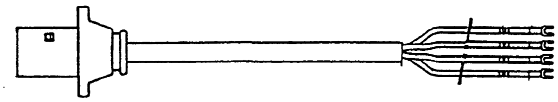
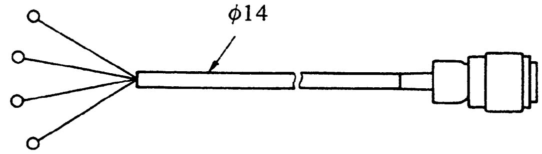
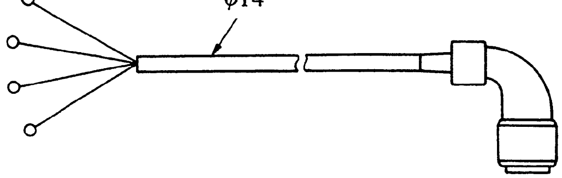
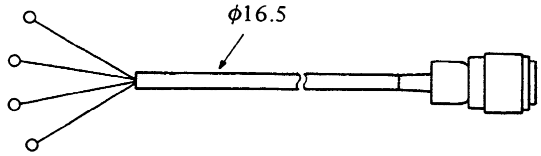
Name	Use	Specification	Designation (Length)
K1	NC/amp. signal cable NC : F0, F15, etc. AMP : S series AMP : L series	NC: MR-20LMH AMP: MR-20LFH  0.2 mm^2 twisted pair totally shielded cabtyre (cable A) Connector: HONDA Tsushin Co., Ltd.	A02B-0074-K801 (5 m) only cable material A66L-0001-0041
	NC/amp. signal cable NC: F0, F15, etc. AMP : C Series	NC : MR-20LMH AMP: PCR-E20FA PCR-E20FS  Cable with 10 pairs of AWG#28 wires (product of Hitachi Cable, Ltd. or Oki Electric Cable Co., Ltd.) (Cable A) Connector: Honda Tsushin Co., Ltd	A02B-0098-K841 (5m) A66L-0001-0284 (for cable wire only) #10
	NC/amp. signal cable NC : F16, F18, etc. AMP : S series	NC: PCR-E20FA PCR-E20FS AMP: MR-20LFH  Cable with 10 pairs of AWG#28 wires (product of Hitachi Cable, Ltd. or Oki Electric Cable Co., Ltd.) (Cable A) Connector: Honda Tsushin Co., Ltd	A02B-0120-K801 (5m) A66L-0001-0284 (for cable wire only) #10
	NC/amp. signal cable NC : F16, F18, etc. AMP : C Series	NC: PCR-E20FA PCR-E20FS AMP: PCR-E20FA PCR-E20FS  Cable with 10 pairs of AWG#28 wires (product of Hitachi Cable, Ltd. or Oki Electric Cable Co., Ltd.) (Cable A) Connector: Honda Tsushin Co., Ltd	A02B-0120-K800 (5m) A66L-0001-0284 (for cable wire only) #10

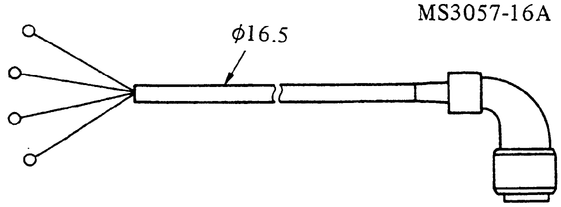
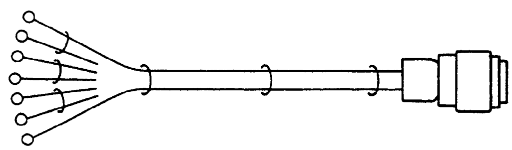
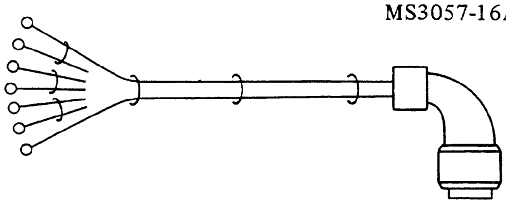
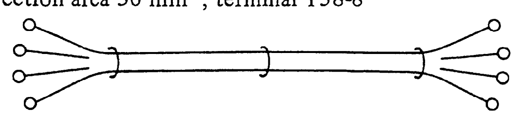
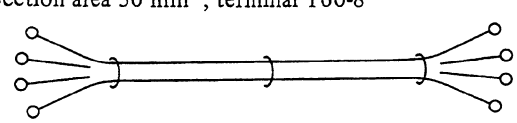
Note) Abbreviation in the above table
NC: NC TM: Relay unit TRF: Transformer MOT: Motor THM: Thermostat BAT: Battery
AMP: Servo amplifier DCR: Regenerative discharg unit

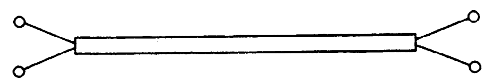
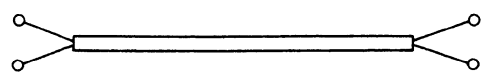
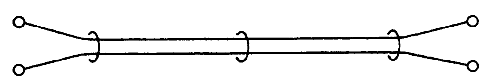
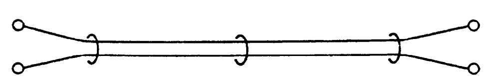
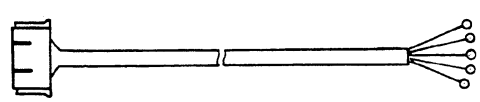
Name	Use	Specification	Designation (Length)
K21	NC/pulse coder signal cable, Straight type, for incremental pulse coder	NC: MR-20LWFH MOT: MS3106B20-29SW MS3057-12A  0.2 mm^2 twisted pair totally shielded cabtyre (cable B) Cannon connector: Japan Aviation Electronics Industry, Ltd.	A02B-0074-K802 (14 m)
	NC/pulse coder signal cable, elbow type, for incremental pulse coder	NC: MR-20LWFH MOT: MS3108B20-29SW MS3057-12A  0.2 mm^2 twisted pair totally shielded cabtyre (cable B)	A02B-0074-K803 (14 m)
K2A	Relay unit/pulse coder signal cable, straight type, for absolute pulse coder	TM: MR-20LMH MOT: MS3106B22-14S MS3057-12A  0.2 mm^2 twisted pair totally shielded cabtyre (cable C)	A06B-6050-K055 (14 m)
	Relay unit/pulse coder signal cable, elbow type, for absolute pulse coder	TM: MR-20LMH MOT: MS3108B22-14S MS3057-12A  0.2 mm^2 twisted pair totally shielded cabtyre (cable C)	A06B-6050-K056 (14 m)

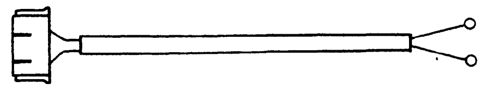
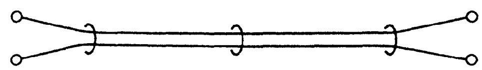
<table>
<tr><th>Name</th><th>Use</th><th colspan="3">Specification</th><th>Designation
(Length)</th></tr>
<tr><td rowspan="2">K2S</td><td>NC signal cable,
straight type,
for high resolution
pulse coder</td><td colspan="3">TM: MR-20LWFH MOT: MS3106B22-14S
MS3057-12A

0.2 mm^2 twisted pair totally shielded cabtyre (cable C)</td><td>A02B-0074-K807
(14 m)</td></tr>
<tr><td>NC signal cable,
elbow type,
for high resolution
pulse coder</td><td colspan="3">TM: MR-20LWFH MOT: MS3108B22-14S
MS3057-12A

0.2 mm^2 twisted pair totally shielded cabtyre (cable C)</td><td>A02B-0074-K808
(14 m)</td></tr>
<tr><td>K2N</td><td>NC/relay unit
signal cable,
for absolute pulse
coder</td><td colspan="3">NC: MR-20LW TM: MR-20LW

0.2 mm^2 twisted pair totally shielded cabtyre (cable B)</td><td>A02B-0074-K804
(2 m)</td></tr>
<tr><td rowspan="6">K3</td><td rowspan="6">Cable for amplifier
input</td><td>Motor model</td><td>Conductor
construction,
section area</td><td>Amplifier
terminal</td><td rowspan="6"></td></tr>
<tr><td>4-0S, 3-0S</td><td>30/.18 (.75 mm^2)</td><td>T1.25-4</td></tr>
<tr><td>2-0S, 1-0S, 0S, 5S</td><td>37/.26 (2 mm^2)</td><td>T2-4</td></tr>
<tr><td>10S, 20S/1500, 20S
30S, 0S, 5S, 6S</td><td>45/.32 (3.5 mm^2)</td><td>T5.5-4</td></tr>
<tr><td>30/2000, 40</td><td>70/.32 (5.5 mm^2)</td><td>T5.5-4</td></tr>
<tr><td colspan="3">AMP: refer to above table

600 V heat-resistive vinyle wire or cabtyre cable</td></tr>
</table>

Name	Use	Specification	Designation (Length)
K4	Amplifier/motor power cable, for 4-0S/3-0S	AMP: T1.25-4S  Cabtyre cable, or 600 V heat-resistive vinyl wire 30/0.18 (0.75 mm^2) x 4	
	Amplifier/motor power cable, for 4-0S/3-0S	AMP: T1.25-4S MOT: RM12BPG-4S  Cabtyre cable, or 600 V heat-resistive vinyl wire 30/0.18 (0.75 mm^2) x 4	A06B-6050-K809 (14m)
	Amplifier/motor power cable, for 2-0S/1-0S	AMP: T1.25-4S MOT: RM15WTP-4S-(9)  4-conductor vinyl cabtyre cable 30/0.18 (.75 mm^2)	A06B-6050-K003 (14 m)
	Amplifier/motor power cable, straight type, for 0S, 5S, 0L, 5L, and 6L	AMP: T2-4S MOT: MS3106B18-10S MS3057-10A  4-conductor vinyl cabtyre cable 37/0.26 (2 mm^2)	A06B-6050-K005 (14 m)
	Amplifier/motor power cable, elbow type, for 0S, 5S, 0L, 5L, and 6L	AMP: T2-4 MOT: MS3108B18-10S MS3057-10A  4-conductor vinyl cabtyre cable 37/0.26 (2 mm^2)	A06B-6050-K006 (14 m)

Name	Use	Specification	Designation (Length)
K4	Amplifier/motor power cable, with no brake for 1-0SP and 2-0SP	AMP: V1.25-4  Cable: 4-conductor vinyl power cord JISC 3312 30/0.18	A06B-6050-K807 (14m)
	Amplifier/motor power cable, with a brake for 1-0SP and 2-0SP	AMP: V1.25-4  Cable: PVC cable A66L-0001-0288	A06B-6050-K808 (14m)
	Amplifier/motor power cable, straight type, for 10S, 20S/1500, 20S, and 30S	AMP: T5.5-4 MOT: MS3106B22-22S MS3057-12A $\phi 14$  4-conductor vinyl cabtyre cable 45/0.32 (3.5 mm^2)	A06B-6050-K007 (14 m)
	Amplifier/motor power cable, elbow type, for 10S, 20S/1500, 20S, and 30S	AMP: T5.5-4 MOT: MS3108B22-22S MS3057-12A $\phi 14$  4-conductor vinyl cabtyre cable 45/0.32 (3.5 mm^2)	A06B-6050-K008 (14 m)
	Amplifier/motor power cable, straight type, for 30/2000	AMP: T5.5-4 MOT: MS3106B24-10S MS3057-16A $\phi 16.5$  4-conductor vinyl cabtyre cable 70/0.32 (5.5 mm^2)	A06B-6050-K009 (14 m)

Name	Use	Specification	Designation (Length)
K 4	Amplifier/motor power cable, elbow type, for 30/2000	AMP: T5.5-4 MOT: MS3108B24-10S MS3057-16A  4-conductor vinyl cabtyre cable 70/0.32 (5.5 m^2)	A06B-6050-K010 (14 m)
	Amplifier/motor power cable, straight type, for 40, 7L, and 10L	AMP: T5.5-4 MOT: MS3106B24-10S MS3057-16A  600 V heat-resistive vinyl wire 45/0.32 (3.5 mm^2) x 7	
	Amplifier/motor power cable, elbow type, for 40, 7L, and 10L	AMP: T5.5-4 MOT: MS3108B24-10S MS3057-16A  600 V heat-resistive vinyl wire 45/0.32 (3.5 mm^2) x 7	
	Amplifier/motor power cable, for 50S	Cable length 14 m or less: Section area 14 mm^2, terminal T14-8 Cable length 50 m or less: Section area 30 mm^2, terminal T38-8  Crosslinked polyethylene cable (FURUKAWA Electric Co., Ltd. BEMEX ER400 equivalent) withstand voltage 600 V 14 mm^2 or 30 mm^2 x 4	
	Amplifier/motor power cable, for 60S/70S	Cable length 14 m or less: Section area 30 mm^2, terminal T38-8 Cable length 50 m or less: Section area 50 mm^2, terminal T60-8  Crosslinked polyethylen cable (FURUKAWA Electric Co., Ltd. BEMEX ER400 equivalent) withstand voltage 600 V 30 mm^2 ro 50 mm^2 x 4	

Name	Use	Specification	Designation (Length)
K5	Amplifier/machine side power magnetics cabinet, cable for magnetic contactor	AMP: T1.25-4  Cabtyre cable or 200 V heat-resistive vinyl wire 30/0.18 (0.75 mm^2) x 2	
K6	Amplifier/regenerative discharge unit, power line, for 10S to 40	AMP: T2-4 DCR: T2-4  Cabtyre cable or 200 V heat-resistive vinyl wire 37/0.26 (2.0 mm^2) x 2	
	Amplifier/regenerative discharge unit, power line, for 50S to 70S	AMP: T8-6 DCR: T8-6  600 V heat-resistive vinyl wire 8 mm^2 x 2	
K7	Amplifier/thermostat (regenerative discharge unit or transformer)	AMP: T1.25-4 THM: T1.25-4  200 V heat-resistive vinyl wire 80/0.18 (.75 mm^2) x 2 In case of series connection, pay attention to connecting method.	
K8	Amplifier (CN2)/ transformer, cable for control power supply (transformer, thermostat), for 5-0, 30/2000, and 40	AMP: SMS6PW-5 RC16M-SCT3 TRF: T1.25-4  200 V heat-resistive vinyl wire 30/0.18 (.75 mm^2) × 5	

Name	Use	Specification	Designation (Length)
K9	Battery/relay unit, power cable, for absolute pulse coder	TM: SMS6PK-5D28 BAT: T1.25-3 Nihon Burndy Co., Ltd.  200 V heat-resistive vinyl wire 30/0.18 (.75 mm^2) x 2	
K10	Amplifier/regenerative discharge unit, cable for fan, for 50S to 70S	AMP: T1.25-4 DCR: T1.25-4  200 V heat-resistive vinyl wire 30/0.18 (.75 mm^2) x 2	

APPENDIX 3 SOFTWARE SERIES AND CORRESPONDING MOTORS

1. OUTLINE

Some software series cannot drive some motors. When determining motors to be used, check the software series for the digital servo according to the table below.

2. SOFTWARE SERIES AND CORRESPONDING MOTORS

Software series	High-speed motor	Large motor	S and T Series motor with serial pulse coder A, B	S Series motor with a serial pulse coder C
9000	Not available	Not available	Not available	Not available
9002	Not available	Not available	Not available	Not available
9010	Not available	Not available	Not available	Not available
9020	Version F or later	Version E or later	Not available	Not available
9022	Version D or later	Version B or later	Not available	Not available
9030	Version B or later	Version A or later	Not available	Not available
9031	Version A or later	Version A or later	Not available	Not available
9032	Version A or later	Version A or later	Not available	Not available
9034	Version A or later	Version A or later	Not available	Not available
9040	Version A or later	Version A or later	Version A or later	Version D or later
9044	Version A or later	Version A or later	Not available	Not available
9050	Version A or later	Version A or later	Version A or later	Version B or later
9054	Version A or later	Version A or later	Version A or later	Not available

Note) The C Series servo amplifier can drive the L Series high-speed motors (AC0L to AC10L) using the following servo software series:

9050 Series version 1 and on

INDEX

<A>

<B>

<C>

<T>

<U>

<V>

<W>

Revision Record

FANUC AC SERVO MOTOR series DESCRIPTIONS (B-65002E)

Edition	Date	Contents		Edition	Date	Contents
04	Dec., '91	Addition of AC servo amplifier for two motors.				
03	June, '91	(1) Models 1-0S/3000, 5S/3000, 10S/3000, 20S/3000, 30S/3000, 40S/2000, 2-0SP, 1-0SP, and 1-0SP/3000 have been added to the S series motors. (2) Models 0T/3000, 5T/2000, 5T/3000, 10T/2000, and 10T/3000 have been added to the T series motors. (3) Descriptions of the C series servo amplifiers have been added.				
02	July, '88	(1) Correction of motor models (Chapt. I to III) (2) Correction of models and addition of transformer (Chapt. IV to VI) (3) Addition of large-scale servo amplifier (Chapt. VII) (4) Correction of chapter number (Chapt. IX) (5) Addition of Appendix 1 and 2		06	Apr., '93	(1) Addition of AC servo motor F series (2) Correction of errors
01	July, '87	———		05	Aug., '92	Addition of AC servo amp. A06B-6066-M008 Correction of errors