FANUC AC SERVO MOTOR αE series

DESCRIPTIONS

B-65182EN/02

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I. DESCRIPTIONS FOR FANUC AC SERVO MOTOR αE series

1 OVERVIEW

The FANUC AC SERVO MOTOR αE series is a range of cost–effective AC servo motors that are ideally suited to the positioning of the peripheral equipment used with machine tools. The series is notable for the following features.

Compact

By employing a larger frame, the length of the motors has been reduced.

Detector

An absolute pulse coder (αA8B) or incremental pulse coder (αI8B) is built into each model of the series. (Resolution: 8192/rev)

Drip–proof structure

The series has a drip–proof structure complying with the IP55 standard.

Optional built–in brake

An optional built–in holding brake is available.

2 NOTES ON USE

2.1 COMPATIBLE AMPLIFIERS

The FANUC AC SERVO MOTOR αE series can be driven by the FANUC Power Mate–MODEL E, E series amplifier, or series amplifier.

Motor model	Names and specifications of compatible amplifiers and Power Mate			Connection axis
αE1/3000 αE2/3000	Power Mate–MODEL E		A02B–0168–B003 A02B–0168–B013	
	Power Mate–MODEL E (conforms to CE standard)		A02B–0168–B043 A02B–0168–B053	
	E series servo amplifier		A06B–6070–H005	
	α series servo amplifier module	SVM1–12	A06B–6079–H101	
		SVM2–12/12 SVM2–12/20 SVM2–12/40	A06B–6079–H201 A06B–6079–H202 A06B–6079–H204	L–axis and M–axis L–axis L–axis
		SVM3–12/12/12 SVM3–12/12/20 SVM3–12/20/20 SVM3–12/12/40 SVM3–12/20/40	A06B–6079–H301 A06B–6080–H301(*1) A06B–6079–H302 A06B–6080–H302(*1) A06B–6079–H303 A06B–6080–H303(*1) A06B–6079–H305 A06B–6080–H305(*1) A06B–6079–H306 A06B–6080–H306(*1)	L–axis, M–axis, and N–axis L–axis and M–axis L–axis L–axis and M–axis L–axis
	α series servo amplifier unit	SVU1–12	A06B–6089–H101	
		SVU2–12/12 SVU2–12/20 SVU2–12/40 SVU2–12/80	A06B–6089–H201 A06B–6089–H202 A06B–6089–H204 A06B–6089–H209	L–axis and M–axis L–axis L–axis L–axis

Motor model	Names and specifications of compatible amplifiers and Power Mate			Connection axis
αE3/2000 αE6/2000	Power Mate–MODEL E		A02B–0168–B002 A02B–0168–B012	
	Power Mate–MODEL E (conforms to CE standard)		A02B–0168–B042 A02B–0168–B052	
	E series servo amplifier		A06B–6070–H004	
	α series servo amplifier module	SVM1–12	A06B–6079–H102	
		SVM2–12/20 SVM2–20/20 SVM2–20/40	A06B–6079–H202 A06B–6079–H203 A06B–6079–H205	M–axis L–axis and M–axis L–axis
		SVM3–12/12/20 SVM3–12/20/20 SVM3–20/20/20 SVM3–12/20/40 SVM3–20/20/40	A06B–6079–H302 A06B–6080–H302(*1) A06B–6079–H303 A06B–6080–H303(*1) A06B–6079–H304 A06B–6080–H304(*1) A06B–6079–H306 A06B–6080–H306(*1) A06B–6079–H307 A06B–6080–H307(*1)	N–axis M–axis, N–axis L–axis, M–axis, and N–axis M–axis L–axis and M–axis
	α series servo amplifier unit	SVU1–20	A06B–6089–H102	
		SVU2–12/20 SVU2–20/20 SVU2–20/40 SVU2–20/80	A06B–6089–H202 A06B–6089–H203 A06B–6089–H205 A06B–6089–H210	M–axis L–axis and M–axis L–axis L–axis

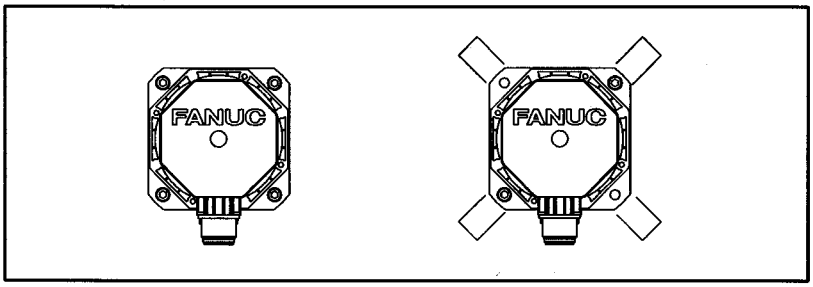
Notes

1 Using a combination other than those listed above is likely to result in motor damage.
2 For information about the Power Mate–MODEL E, refer to the descriptions of the Power Mate–MODEL E (B–62112E).
3 For information about the E series amplifier, refer to Chapter III of this manual.
4 For information about the α series servo amplifier modules, refer to the relevant Control Motor Amplifier α series Descriptions (B–65162E).
5 For information about the α series servo amplifier units, refer to the relevant Control Motor Amplifier α series (SVU) Descriptions (B–65162JAE).
6 *1 When a three–axis amplifier of the series is used with the FS20 or FS21 series, the amplifier specifications will differ from those of other NCs.

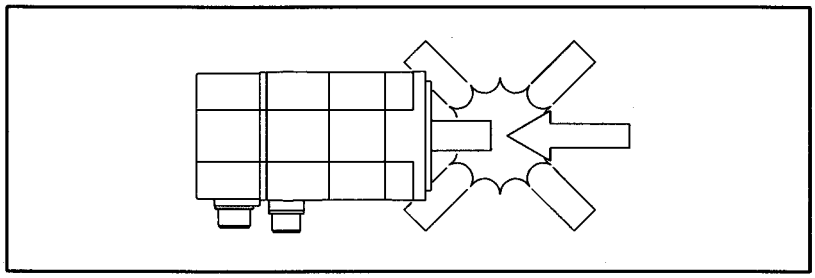
2.2 INSTALLATION

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

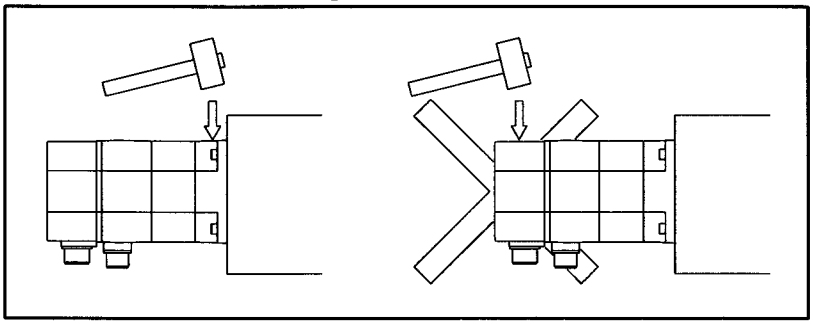
- Secure the servo motor uniformly using four bolt holes provided on the front flange.



- When mounting on the machine, take care not to apply a shock to the motor.



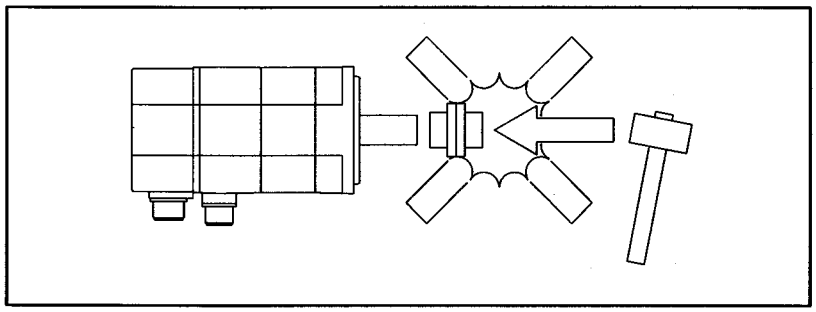
- When it is unavoidable to tap the motor for adjusting the position, etc., use a plastic hammer and tap only the front flange if possible.



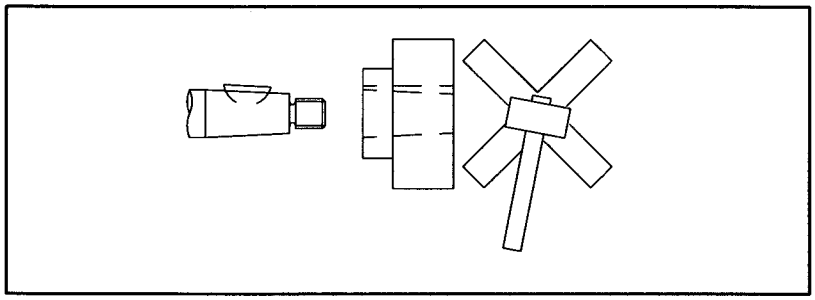
2.3 COUPLING

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

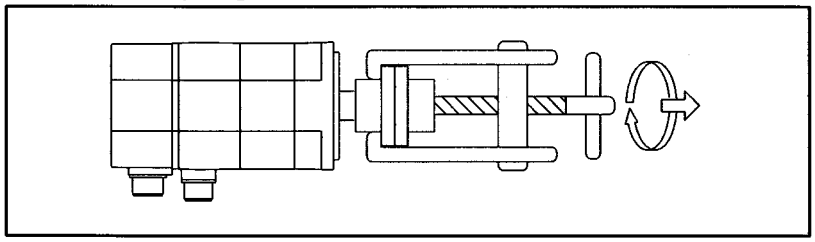
- When connecting the power transmission elements such as a gear, a pulley and a coupling to the shaft, take care not to apply a shock to the shaft.



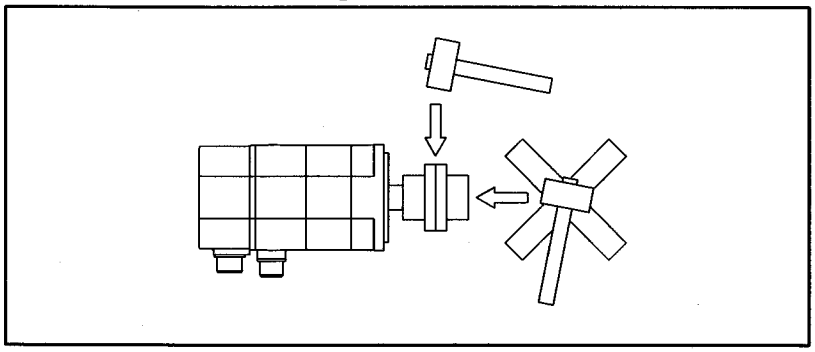
- Generally, in the case of straight shaft, use a span ring for connection with the shaft.
- In the case of tapered shaft, match the tapered surface with the power transmission element and fix by tightening the screw at the end. When the woodruff key is too tight, don't tap it with a hammer. Use the 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.



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



- When tapping slightly to remove the tightly contacted tapered surface, tap in the radial direction to prevent a shock in the axial direction.



- 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 αE3/2000 and αE6/2000.
The oil seal surface is made of steel plate. Take care not to apply a force to the oil seal when installing the motor or connecting the power transmission elements.

2.4 AXIS LOAD

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

Motor model	Radial load	Axial load	Front bearing (reference)
αE1/3000 αE2/3000	25kg	8kg	6003 (without brake)
			6202 (with brake)
αE3/2000 αE6/2000	70kg	20kg	6205

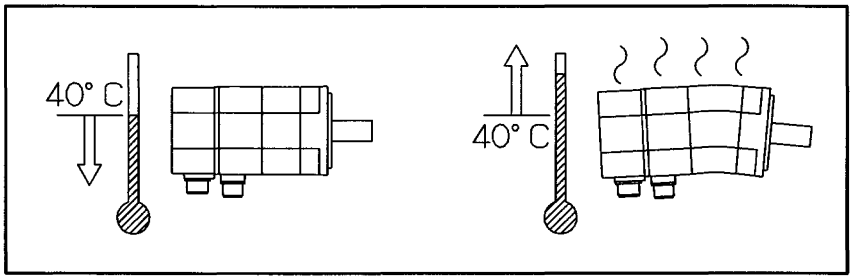
The above values are the reference assuming the use as a feed axis on the typical machine tool.

- 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).
- The belt tension is critical particularly when a timing belt is used. Too tight belt causes breakage of the shaft or other fault.
  Belt tension must be controlled so as not to exceed the limits calculated from the permissible radial load indicated above.
- In some operation conditions, the pulley diameter and the gear size need to be checked. For example, when using the model αE6 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 belt, as the belt tension is added to this value, it is thus necessary to support the shaft end.
  The timing belt is also subject to the belt tension restrictions. Therefore, some support is required; for example, the end of the motor shaft should be supported mechanically.
- 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.
- 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.
- 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.
- The motor bearing is generally fixed with a C-snap ring, and there is a small play in the axial direction. When this play influences the positioning in the case of using a worm gear and a helical gear, for example, it is necessary to fix it with another bearing.

2.5 ENVIRONMENT

Ambient temperature

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



Vibration

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

Installation height

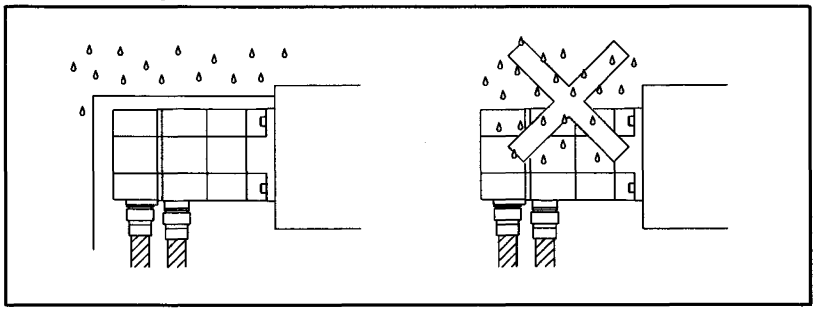
Up to 1,000 meters above the sea level requires, no particular provision for attitude. When operating the machine at a higher level, special care is unnecessary if the ambient temperature is lowered 1°C at every 100m higher than 1,000m. For example, when the machine is installed at a place of 1,500 meters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

If any one of the three environmental conditions specified above is not satisfied, the output must be restricted.

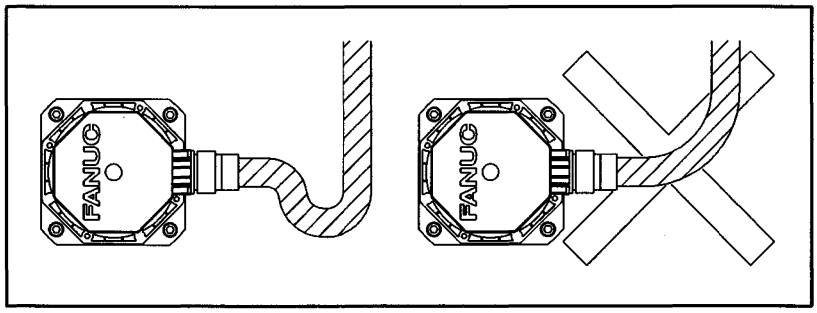
Drip–proof environment

The protection form for a single motor unit satisfies IP55 of the IEC standards (equivalent to JP55, dust–proof and jet–proof type, of JIS C4004–1980, code for revolving electric machines) These standards, however, refer only to short–term performance. In actual operation, note also the following:

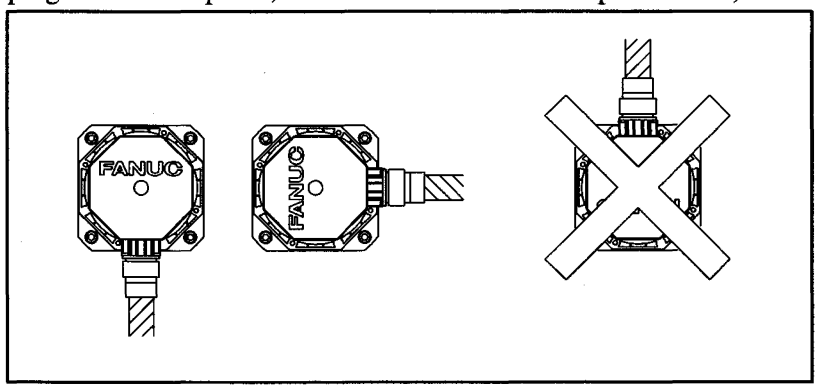
- Protect the motor surface from the cutting fluid or lubricant. Use a cover when there is a possibility of wetting the motor surface. Only the telescopic cover of the sliding part can not completely prevent leakage of the cutting fluid. Pay attention to the drop along the structure body, too.



- 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.



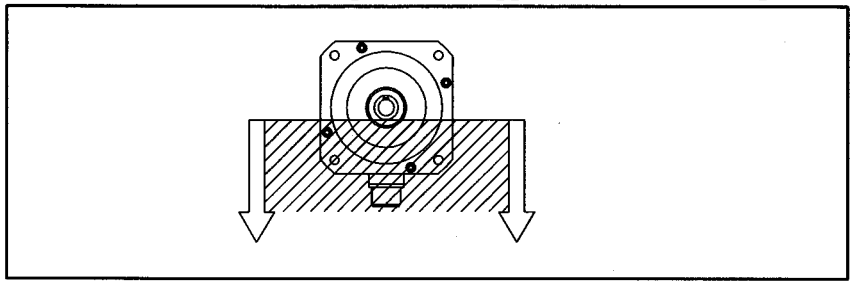
- When the motor connector is up, the cutting fluid is collected in the cable connector through the cable. Turn the motor connector sideways or downward as far as possible. Most of the defects caused by the cutting fluid have occurred in the cable connector.
  The standard receptacle on the motor side is waterproof. If the cable connector will be subjected to moisture, it is recommended that an R class or waterproof plug be used. Suitable plugs are listed in the cable plug combination recommendations in Chapter 7. (The standard MS plug is not waterproof; water is liable to enter the pin section.)



Shaft attachment section requirements

The shaft of the motor has an oil seal to prevent foreign matter such as oil from entering the motor. Given that motors tend to be used in a wide range of environments, however, protection against oil penetration cannot always be perfect. Therefore, always observe the following precautions when using these motors. Oil seals have a limited service life. To ensure reliable sealing over the long term, an oil seal must be replaced periodically. Note that the service life of an oil seal varies greatly with the environment and conditions to which it is subjected.

When oil bath lubrication is provided for the gear engagement, for example, the oil level must be below the lip of the shaft's oil seal. Set the oil level so that oil merely splashes the lip. Thus, as the shaft rotates, the oil seal can repel oil. If, however, pressure is applied continuously while the shaft is stopped, oil may penetrate the lip. When the shaft is always immersed in oil, for example, under the condition that the motor is to be used with the shaft oriented vertically a special design is required. For example, another oil seal could be installed on the machine side, and a drain provided so that oil penetrating that seal can drain off.
When grease is used for lubrication, the oil seal characteristics are usually lost.
In either case, ensure that no pressure is applied to the oil seal lip.



The motor shaft oil seal diameter is as shown below.

Motor mode	Oil seal diameter
αE1/3000, αE2/3000	ϕ 15mm
αE3/2000, αE6/2000	ϕ 24mm

2.6 ACCEPTANCE AND STORAGE

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

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

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

Direct connection using a flexible coupling

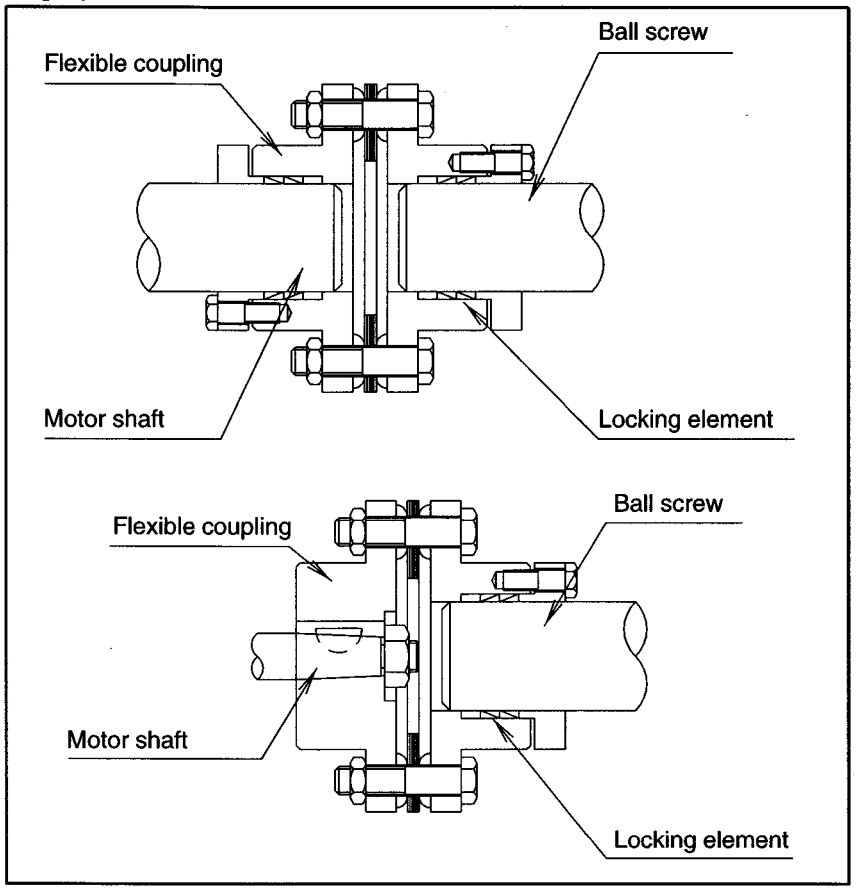
Direct connection by a flexible coupling has the following advantages over connection using gears:

- 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.



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.

Gears

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

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

Timing belt

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

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

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

Connection between the straight shaft and a connecting element

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

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

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

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

3.2 MACHINE MOVEMENT PER 1 REVOLUTION OF MOTOR SHAFT

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

- The machine movement per 1 revolution of motor shaft ("L") must be such that the desired rapid traverse speed can be obtained. For example, if the maximum motor speed is 1500 rpm and the rapid traverse speed must be 12 m/min., the amount of "L" must be 8 mm/rev. or higher.
- As the machine movement per 1 revolution of motor shaft is reduced, both the load torque and the load inertia reflected to motor shaft also decrease.
  Therefore, to obtain large thrust, the amount of "L" should be the lowest value at which the desired rapid traverse speed can be obtained.
- Assuming that the accuracy of the reduction gear is ideal, it is advantageous to make the machine movement per 1 rev. of motor shaft as low as possible to obtain the highest accuracy in mechanical servo operations. In addition, minimizing the machine movement per 1 rev. of motor shaft can increase the servo rigidity as seen from the machine's side, which can contribute to system accuracy and minimize the influence of external load changes.
- When the machine is operation is characterized by repeated acceleration/deceleration cycles, a heating problem may occur due to the current flow caused by the acceleration and deceleration. Should this occur, the machine travel distance per motor shaft revolution should be modified. Given optimum conditions, the machine travel distance per motor shaft revolution is set such that the motor's rotor inertia equals the load inertia based on motor shaft conversion. For machines such as punch presses and PCB drilling machines, the machine's travel distance per motor shaft revolution should be set so as to satisfy this optimum condition as far as possible, while also considering the rapid traverse rate and increment system.

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 load torque (percentage duty cycle and ON time) is within a desired range.

4.1 MOTOR SELECTION

Select a suitable motor according to the load to be applied, rapid traverse feedrate, and increment system. To ensure satisfactory motor selection, the user should determine the conditions of use according to the servo motor selection data table (models for positioning) given at the end of this section. Enter the necessary machine data (up to the external detector item) in the servo motor selection data table (models for positioning). FANUC will provide the remaining items, and check the user–provided data. For details of each item in the servo motor selection data table, see the descriptions below.

4.1.1 Blanks for Those Other than Data

Kind of machine tool

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

Type of machine tool

Fill in this blank with the type of machine tool decided by machine tool builder.

CNC equipment

Fill in this blank with the name of CNC (15T, 16M, 0MC, etc.) employed.

Names of axes

Fill in this blank with names of axes practically employed in CNC command. If the number of axes exceeds 2 axes, enter them in the second sheet.

Blanks of version number, date, name, and reference number.

These blanks are left blank by the FANUC.

4.1.2 Data Items to be Entered

The machine tool builder is to provide the following data: direction of movement, feed mechanism, mechanical specifications, and external position detector. Enter either determined or desired values for these items. Leave blank any items for which a value cannot be determined. FANUC will enter an appropriate value, considering the overall specification. Each item is described in detail below.

Specifications of moving object

Data in this blank are used for determining approximate values of motor load conditions (inertia, torque). Fill in blanks of all items.

- **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.

- **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.

- **Counter balance**

Enter the weight of the counter balance in the vertical axis, if provided. Write the force in case of hydraulic balance.

- **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.

Feed mechanism

Enter values for whichever items are pertinent.

- **Feed screw**

  Enter the diameter, pitch, and axial length of the lead screw in order.

- **Rack and pinion**

  Enter the pinion diameter and amount of travel for the machine tool, per revolution of the pinion.

- **Others**

  When using a feed mechanism other than the above, provide details of the mechanical section, and enter a travel amount for the machine tool.

Mechanical specifications

Data in this blank serve as the basis for selecting the motor. Enter these data correctly.

- **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 12 mm and the gear ratio is 2/3,
  $12 \times 2/3 = 8$ mm

  • When the gear ratio is 1/72 in rotary table ;
  $360 \times 1/72 = 5$ deg

- **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.

- **Inertia**

  Enter a load inertia value reflected to the motor shaft.
  It is not always necessary to enter this inertia value in detail.
  Enter it as a 2–digit or 1–digit value. (Example : 0.2865→0.29 or 0.3)
  Do not include any inertia of the motor proper in this value.

- **Least input increment CNC**

  Enter the least input increment of NC command. The standard value is 0.001 mm in αE series servo motor.

- **Maximum rapid traverse feedrate**

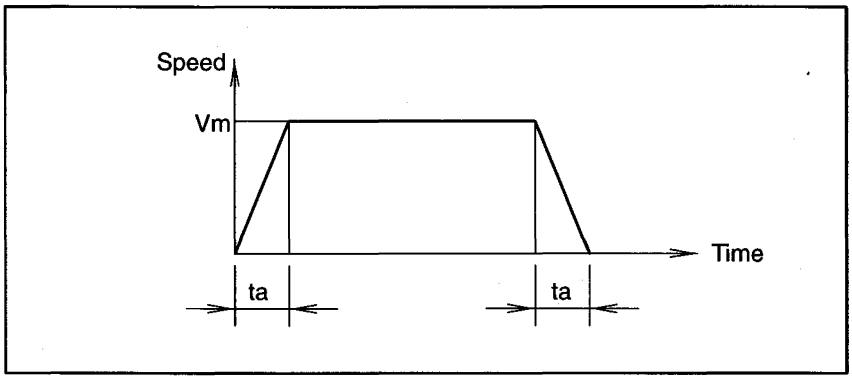
  Enter a maximum rapid traverse feedrate according to the mechanical specifications.

- **Motor speed during rapid traverse**

  FANUC will enter this value. The motor speed for the maximum rapid traverse feedrate is entered.

- **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.
  The acceleration/deceleration mode at rapid traverse is generally linear acceleration/deceleration in FANUC's CNC.



- **Distance covered when positioning during rapid traverse**

Enter the amount of travel when positioning during rapid traverse.

- **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.

- **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.

- **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.

External position detector

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

- **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
- Encoder
  Move amount per revolution of pulse coder
  Number of pulses of pulse coder

When using a rotary encoder, enter a gear diameter and reduction ratio.

Motor specifications

- **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.

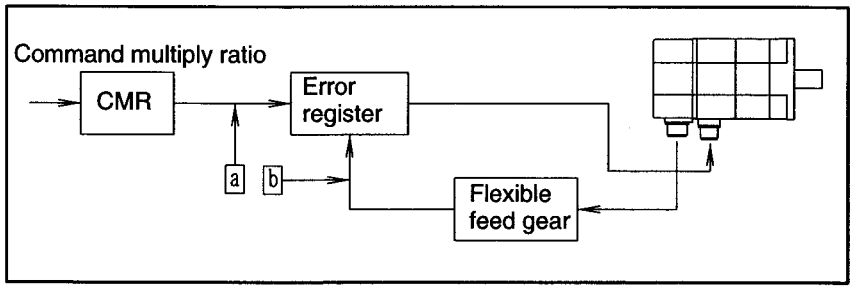
- **Option, special specifications**

Enter special specifications, if any, in this blank.

Data to be provided by FANUC

- **Input multiply ratio, command multiply ratio, and flexible feed gear ratio**

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



In the above figure, each ratio is set so that the units of the two inputs (a and b) of the error register are the same. The α pulse coder uses a flexible feed gear as standard. So, CMR is normally set to 1. When other than 1 is to be set for CMR, contact FANUC for details.
For the flexible feed gear (F.FG), the ratio of the number of position pulses required per motor shaft revolution to the number of feedback pulses is set. The set value is obtained as follows:

$$F.FG = \frac{\text{Number of position pulses required per motor shaft revolution}}{1{,}000{,}000}$$

Notes
For calculation, the number of feedback pulses for the α pulse coder must always be set to 1,000,000. The maximum permissible value for both the numerator and denominator is 32,767. So, the fraction should be reduced to its lowest terms, after which the resultant numerator and denominator should be set.

Example)
Suppose that the NC uses increments of 10μm, the machine travel distance per motor shaft revolution is 8 mm, and pulse coder αA8B is used.

$$F.FG = \frac{800}{1{,}000{,}000} = \frac{1}{1{,}250} \qquad CMR = 1$$

- **Position loop gain**

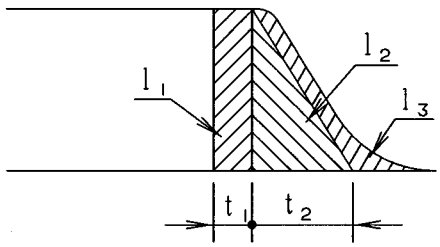
Fill in this blank with a value which is considered to be settable judging it from the inertia value based on experiences. Since this value is not always applicable due to rigidity, damping constant, and other factors of the machine tool, it is usually determined on the actual machine tool. If the position 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.

- **Deceleration stopping distance and dynamic brake stopping distance**

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

- **Deceleration stop distance**

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



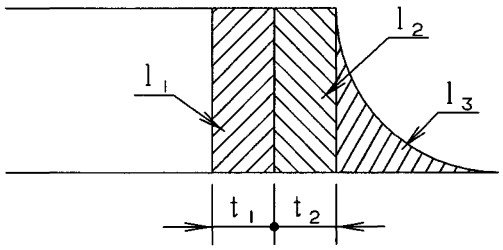
Vm : Rapid traverse rate, mm/min or deg /min
l_1 : Coasting distance due to delay time t_1 of receiver
l_2 : Coasting distance due to deceleration time t_2
l_3 : Servo deflection amount
t_1 : Usually about 0.02 seconds

$$\textit{Coasting distance} = \frac{Vm}{60} \times \left(t_1 + \frac{t_2}{2} + \frac{1}{k_s}\right)$$

k_s : Position loop gain (sec^{-1})

- **Dynamic brake stop distance**

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



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

l_1 : Coasting distance due to delay time t_1 of receiver

l_2 : Coasting distance due to deceleration time t_2 of magnetic contactor (MCC)

l_3 : Coasting distance by dynamic braking after magnetic contactor has been operated

(t_1+t_2) is usually about 0.05 seconds.

Coasting distance(mm or deg)

$$= \frac{Vm}{60} \times (t_1 + t_2) + (J_m + J_1) \times (ANo + BNo^3) \times L$$

Jm : Motor inertia (kg·cm·s^2)

J : Load inertia (kg·cm·s^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 constants that vary with the model of the motor being used. The values for each model are listed under "Coefficients for Calculating the Dynamic Brake Stopping Distance."

- **Specifications of amplifier and transformer**

For these items, the specifications of the servo amplifier and transformer to be used are entered. Enter a desired amplifier model, if any, as the remarks item.

Coefficients for calculating the dynamic brake stopping distance

Model	A	B	Jm (kgf·cm·s^2)
αE series			
αE1/3000	4.8×10^{-2}	5.7×10^{-8}	0.0034
αE2/3000	1.9×10^{-2}	3.1×10^{-8}	0.0067
αE3/2000	9.7×10^{-3}	2.4×10^{-8}	0.020
αE6/2000	3.9×10^{-3}	1.2×10^{-8}	0.040

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.

MTB Servo motor selection data table (models for positioning)

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.)				
	1 Ball screw: Diameter _ pitch _ length			
	2 Rack and pinion: Diameter of pinion (traveling distance of the machine tool per revolution of the pinion: mm)			
	3 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.")	kgf·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	m·sec		
	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	kgf·cm		
	Load torque: Rapid traverse	kgf·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		
	Flexible feed gear	FFG		
	Deceleration stop distance	mm		
	Dynamic brake stop distance	mm		
	Specifications of amplifier			
	Regenerative discharge unit			
	Specifications of transformer			

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

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4.2 CHARACTERISTIC CURVE AND DATA SHEET

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

4.2.1 Performance Curves

The typical characteristic curves consist of the following.

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)

Overload duty characteristic

These curves are known as duty cycle curves and provided 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.

4.2.2 Data Sheet

The data sheet gives the values of motor parameters relating to the performance.
The values of parameters are those under the following conditions.

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

Important parameters on the data sheet are defined as follows :

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).

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 :

$$Kt(kgf \cdot cm/Arms) = 30.6Kv(Volt \cdot \sec/rad)$$

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

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 :

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

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

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.

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

Jm : Rotor inertia (kgf·cm·s^2)

Ra ; Resistance of the armature

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.

Static friction : Tf (kg·cm)

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

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.

4.2.3 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 form 1.

3 Calculate t_F by formula (a)

$$t_F = t_R \times \left(\frac{100}{Duty\ percent} - 1\right) \quad \cdots\cdots\cdots \text{(a)}$$

$$TMD = \frac{Load\ torque}{Continuous\ rated\ torque} \quad \cdots\cdots\cdots \text{(b)}$$

t_F : "OFF" time
t_R : "ON" time

The values of t_R and t_F 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 t_R and t_F 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 IEC34 STANDARD

5.1 REQUIREMENTS FOR COMPLIANCE

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

5.1.1 Drive unit

The motor must be driven by the Power Mate–MODEL E, or α series control motor amplifier.

5.1.2 Connector

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

Motor model	Plug connector FANUC specification [Manufacturer's specification]		Cable clamp specification Connector manufacturer
αE1/3000, αE2/3000, αE3/2000, αE6/2000 Power cable	Straight type	H/MS3106A18–10S–D–T(10) [A63L–0001–0648/61810SH]	H/MS3057–10A(10) [A63L–0001–0592/10AK]
	L type	H/MS3108A18–10S–D–T(10) [A63L–0001–0648/81810SH]	HIROSE ELECTRIC
Brake unit connection	Straight type	JL04V–6A10SL–3SE–EB [A63L–0001–0648/610SL3SJ]	JL–04–1012CK–(07) [A63L–0001–0653/04A]
	L type	JL04V–8A10SL–3SE–EB [A63L–0001–0648/810SL3SJ]	Japan Aviation Electronics Industry

Notes
- The plug connectors do not feature a cable clamp.
- For grounding, a wire with a cross–sectional area equal to or greater than that of U, V, or W must be used.

5.2 APPROVAL SPECIFICATIONS

5.2.1 Output (IEC34–1)

The rated output is guaranteed as continuous output only at the rated output speed. Beyond the rated output speed, the rated output is defined based on the continuous operation torque. Output in an intermittent operating zone is not defined.

5.2.2 Protection Mode (IEC34–5)

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

Motor model	IP	Approval condition
αE1/3000, αE2/3000, αE3/2000, αE6/2000	55	Only when a specified connector and waterproof cover are used

IP5x:Dust–proof machine tool

Dust protection need not be perfect, but any dust caught must not prevent the smooth operation of the machine tool.

IPx5:Machine tool protected against water spray

Water, sprayed randomly onto the machine tool through a nozzle, must not adversely affect the operation of the machine tool.

The IPx5 mode test conditions are as follows:

Inner nozzle diameter: 6.3 mm
Volume of water: 12.5 l/minute
Water pressure at nozzle: 30 kPa
Injection time per unit surface area (1 m^2): 1 minute
Minimum test time: 3 minutes
Distance between nozzle and machine tool: About 3 m

Notes

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

5.2.3 Cooling Method (IEC34–6)

The following motor cooling method is to be used:

Motor model	IC code	Method
αE1/3000, αE2/3000, αE3/2000, αE6/2000	IC 410	Totally enclosed, natural air–cooling

5.2.4 Installation Method (IEC34–7)

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

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

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

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

5.2.5 Heat Protection (IEC34–11)

The heat protection mode defined in IEC–34 is as follows:

Motor model	Code	Method
αE6/2000	TP112	Indirect protection of windings by means of a thermal cut–out

TP112

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

Notes

1 Heat protection is not defined for αE1/3000, αE2/3000, and αE3/2000.

2 Models αE1/3000, αE2/3000, αE3/2000, and αE6/2000 are software–protected against an abrupt overload of 150% or more.

6 FEEDBACK DETECTOR

6.1 BUILT–IN DETECTOR

All AC servo motors feature a pulse coder (optical encoder).
The pulse coder outputs position information and an alarm signal.
The following lists the available pulse coders, together with their specifications and the motors with which they are compatible.

Pulse coder type	Resolution Division/rev	Absolute/ incremental	Applicable motor
Pulse coder αA8B	8,192	Absolute	αE1/3000, αE2/3000, αE3/2000, αE6/2000
Pulse coder αI8B	8,192	Incremental	

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

6.2 ABSOLUTE–TYPE PULSE CODER

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

6.3 EXTERNAL POSITION DETECTOR

For detecting a position by attaching directly to a ball screw or a machine, use an external (separate type) position detector. Pay attention to the following items when using the 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.The ratio of the resolution of the built–in pulse coder to that of the separate–type position detector is designed to be an integer. That is, when an optical scale of 1 μm is used on a machine tool moving through 8 mm per motor revolution, a pulse coder with 2000 or 10000 pulses rather than 2500 pulses is used.

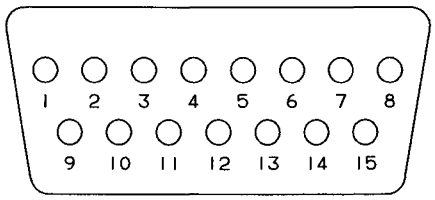
To connect the separate type position detector to the NC, connect only the signals described in the connecting manual. (A, B, Z, 0V, 5V and REQ if necessary)
When the other signal is connected, the unit may malfunction.
Do not connect the C1, C2, C4, and C8 signals output from the separate type pulse coder unit.

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

6.4 DETECTOR SIGNAL OUTPUT

Models αE1/3000, αE2/3000, αE3/2000, αE6/2000

The α–type pulse coders output signals as shown below. The pin assignments of the signals for the connector used for each model are also shown.



D–SUB 15P

Signal name	Pin No.	
	αA8B	αI8B
SD	12	12
*SD	13	13
REQ	5	5
*REQ	6	6
+5V	8, 15	8, 15
0V	1, 2, 3	1, 2, 3
Shield	–	–
+6V	14	–
0V	10	–

7 BUILT–IN BRAKE

Some of αE series servo motors 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.

7.1 BRAKE SPECIFICATIONS

The specifications of built–in brakes are listed below.

Motor model		Unit	αE1/3000 αE2/3000	αE3/2000 αE6/2000
Brake torque		Nm kgf·cm	2 20	8 82
Response time	Release	msec	60	80
	Brake	msec	10	40
Supply voltage Current		VDC(±10%) A	90 0.3 or less	90 0.4 or less
Weight increase		kg	Approx. 1.5kg	Approx. 2.3kg
Inertia increase		$kg \cdot m^2$ $kgf \cdot cm \cdot s^2$	0.00002 0.0002	0.00007 0.0007

Common notes to each series

Notes

Use the full-wave rectified 100VAC or 90VDC as a power supply. Don't use the half-wave rectified 200VAC. The surge suppressor may be damaged.

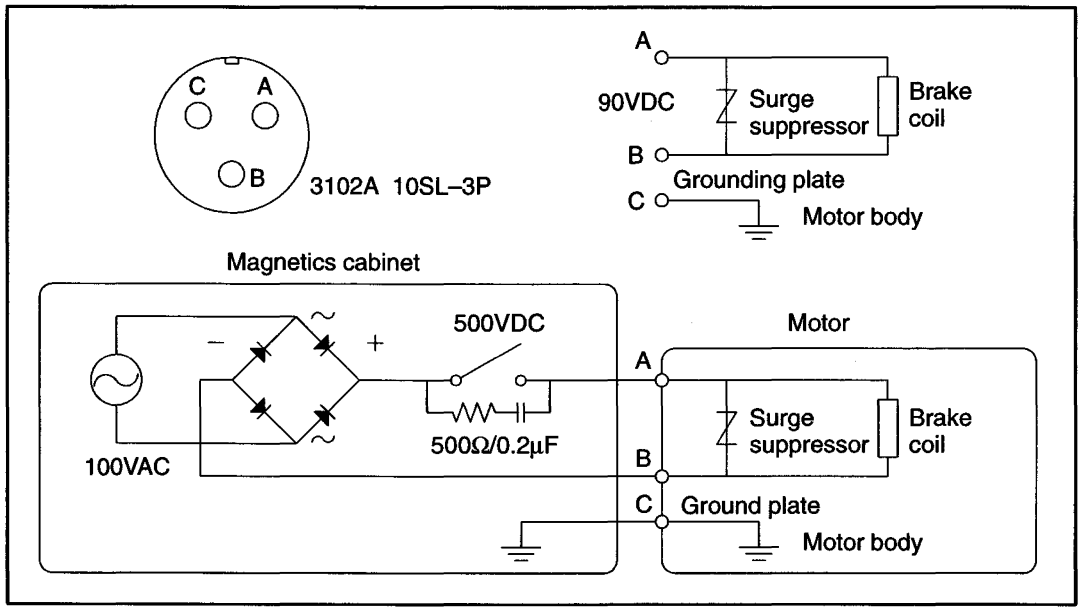
Use a rectifier with dielectric strength of 400V or higher. Connect CR as shown in the drawing, to protect the contact of the switch.

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.
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.

7.2 CONNECTION OF THE BRAKES

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

Models αE1/3000, αE2/3000, αE3/2000, αE6/2000



8 CONNECTORS

8.1 SPECIFICATIONS OF MOTOR CONNECTORS

With the FANUC AC SERVO MOTOR αE series, TUV–approved connectors are used for power lines and brakes to ensure conformity with the IEC34 standard. For power lines and brakes, receptacle connectors that are drip–proof when unmated (as single units) are used as standard.

+The standard receptacle connectors do not exactly satisfy the MS standard in that the connectors are waterproof as single units, and their exterior color is black. However, their sizes and shapes are compatible with the conventional round–type connectors conforming to the MS standard. Accordingly, in addition to the products recommended below, plug connectors conforming to the MS standard can also be used. (When the water–resistance of the system is of prime importance, the waterproof plug connectors recommended in Sections 8.2.1 and 8.2.2 should be used.)

8.1.1 Motor Connector Specifications

For power lines	For signals	For brakes
H/MS3102A18–10P–D–T(10) (HIROSE ELECTRIC)	SDAB–15P (HIROSE ELECTRIC)	JL04V–2A10SL–3P–B (Japan Aviation Electronics Industry)

Notes

1 Direct motor connectors downwards whenever possible. When a motor connector must be directed horizontally or upwards, provide sufficient cable slack to prevent, for example, the connector from being wetted by liquid such as coolant. In any case, if a motor connector is exposed to liquid, protection by means of a cover, for example, must be provided.

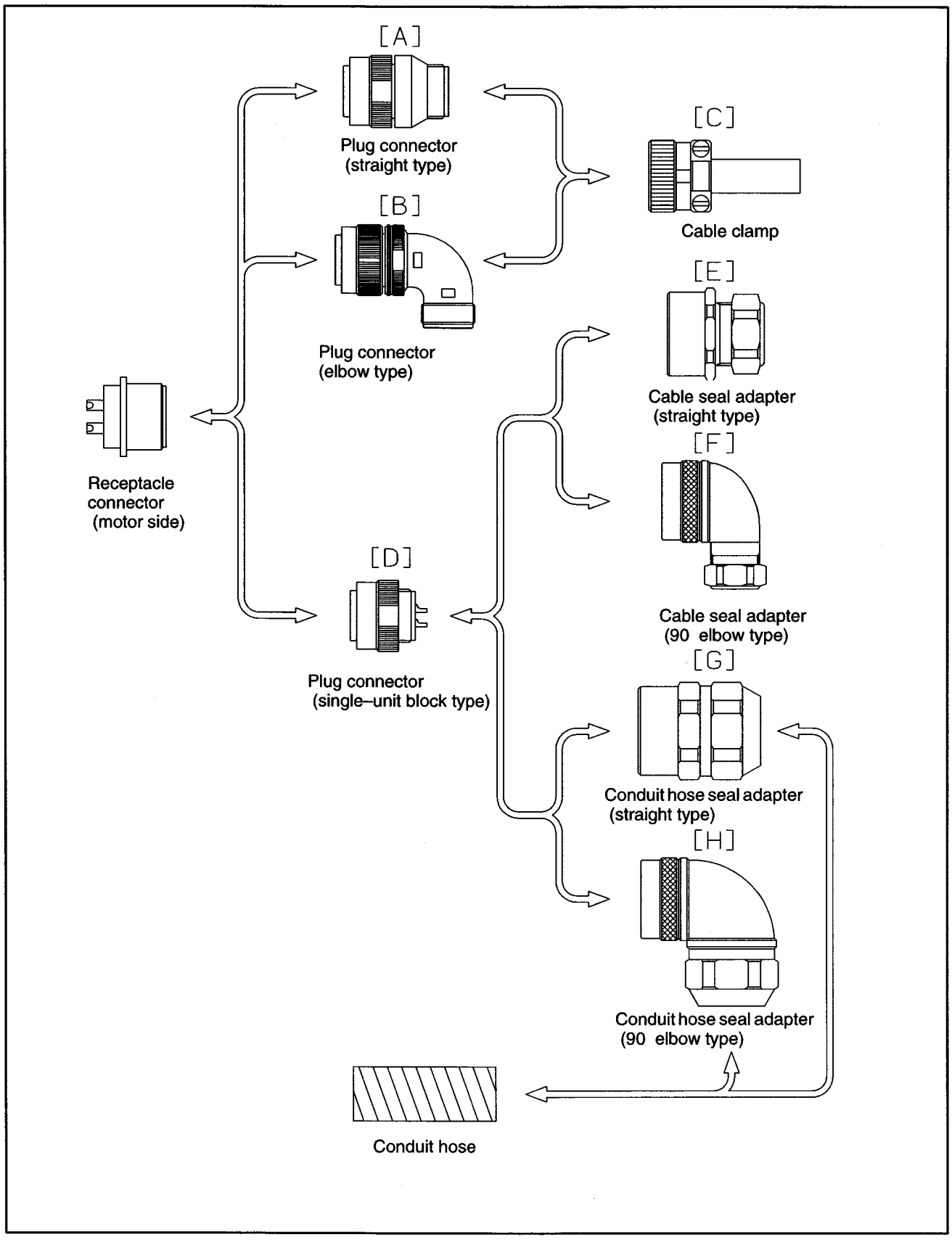
2 Mount the motor so the connector is downward in the gravity direction as far as possible. When it must be set to side or up, make drip loop to prevent the cutting fluid running along the cable to wet the connector plug. In any case, when there is a possibility of wetting the connector plug, use a cover or take the other suitable means to protect it.

8.2 SPECIFICATIONS OF CABLE–SIDE PLUG CONNECTORS FOR POWER LINES

To comply with the IEC34 standard, the plug connectors and cable clamp shown below must be used for the power line and brake unit connections. When the IEC34 standard can be satisfied only by using a cable seal adapter and conduit hose seal adapter, consult with the connector manufacturer. As the cable–side plug connectors for the FANUC AC SERVO MOTOR αE series, TUV–approved (waterproof), waterproof, and non–waterproof connectors are available (all in black). Because these connectors are compatible with the MS standard, conventional plug connectors can also be used.

An example of connector connections is shown below.
The corresponding, connector specifications for this example are also provided.

Example cable connections



8.2.1 Specifications of Cable Plug Connectors (TUV–approved Type)

Connector type	For power lines	For brakes
[A]	H/MS3106A18–10S–D–T(10) (HIROSE ELECTRIC)	JL04V–6A10SL–3SE–EB (Japan Aviation Electronics Industry)
[B]	H/MS3108A18–10S–D–T(10) (HIROSE ELECTRIC)	JL04V–8A10SL–3SE–EB (Japan Aviation Electronics Industry)
[C]	H/MS3057–10A(10) (HIROSE ELECTRIC)	JL04–1012CK–(07) (Japan Aviation Electronics Industry)

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

8.2.2 Specifications of Cable Plug Connectors (Waterproof Type)

Connector type	For power lines	For brakes
[A]	H/MS3106A18–10S(10) (HIROSE ELECTRIC)	H/MS3106A10SL–3S(10) (HIROSE ELECTRIC)
[B]	H/MS3108A18–10S(10) (HIROSE ELECTRIC)	H/MS3108A10SL–3S(10) (HIROSE ELECTRIC)
[C]	H/MS3057–10A(10) (HIROSE ELECTRIC)	H/MS3057–4A(10) (HIROSE ELECTRIC)
[D]	JL04–6A18–10S–(A72) (Japan Aviation Electronics Industry) H/MS3106A18–10S(13) (HIROSE ELECTRIC)	JL04–6A10SL–3S–(A72) (Japan Aviation Electronics Industry) H/MS3106A10SL–3S(13) (HIROSE ELECTRIC)
[E]	YSO 18–12–14 (Daiwa Dengyou) ACS–12RL–MS18F (Japan Flex)	YSO 10–5–8 (Daiwa Dengyou)
[F]	YLO 18–12–14 (Daiwa Dengyou) ACA–12RL–MS18F (Japan Flex)	YLO 10–5–8 (Daiwa Dengyou)
[G]	BOS 18–15 (Daiwa Dengyou) RCC–104RL–MS18F (Japan Flex)	BOS 9–10 (Daiwa Dengyou)
[H]	BOL 18–15 (Daiwa Dengyou) RCC304RL–MS18F (Japan Flex)	BOL 9–10 (Daiwa Dengyou)

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

As described above, a combination of a plug connector (single–unit block type) and an adapter (that is, a combination of [D] and one of [E] to [H] in the cable connection example) can enhance the water resistance around a cable/connector joint. Because these connectors are compatible with the MS standard, conventional waterproof plug connectors can also be used. Use the table above for reference only. For details, consult with the relevant manufacturer.

8.2.3 Specifications of Cable Plug Connectors (Non–waterproof Type)

Connector type	For power lines	For brakes
[A]	MS3106B18–10S–(A72) (Japan Aviation Electronics Industry) H?MSA3106A18–10S(10) (HIROSE ELECTRIC)	MS3106B10SL–3S(A72) (Japan Aviation Electronics Industry) H/MSA3106A10SL–3S(10) (HIROSE ELECTRIC)
[B]	MS3108B18–10S(A72) (Japan Aviation Electronics Industry) H/MSA3108B18–10S(10) (HIROSE ELECTRIC)	MS3108B10SL–3S–(A72) (Japan Aviation Electronics Industry) H/MSA3108B10SL–3S(10) (HIROSE ELECTRIC)
[C]	MS3057–10A–(A72) (Japan Aviation Electronics Industry) H/MSA3057–10A(10) (HIROSE ELECTRIC)	MS3057–4A–(A72) (Japan Aviation Electronics Industry) H/MSA3057–4A(10) (HIROSE ELECTRIC)

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

8.3 SIGNAL LINE CONNECTORS

D–subconnectors are used as standard for the signal lines of the FANUC AC SERVO MOTOR αE series. To maintain an airtight seal, special connector covers are required. The specifications of the cable–side special connectors are given below.

8.3.1 Connector Kit

Name	Applicable motor (pulse coder)	Specification
Connector kit for signal lines (straight type)	αE1/3000, αE2/3000, αE3/2000, αE6/2000 For α series pulse coders	A06B–6050–K115

Components in connector kit (signal line 15: A06B–6050–K115)

Name	Quantity	FANUC specification	Manufacturer	Manufacturer specification/ remarks
Contact	1	A63L–0001–0434#AB15SNO	HIROSE ELECTRIC	HDAB–15S, solder type
Waterproof cover	1	A63L–0001–0496	HIROSE ELECTRIC	HDAW–15CV

8.3.2 Cable Assembly (14m Standard)

Name	FANUC specification
Cable assembly for signal cables (straight type)	A06B–6050–K853

II. FANUC AC SERVO MOTOR

αE series

1 TYPES OF MOTORS AND DESIGNATION

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

Models αE1/3000 and αE2/3000

A06B–010□–B☆ ○○

□

1 : Model αE1/3000
2 : Model αE2/3000

☆

0 : Straight shaft (standard)
1 : Straight shaft with the key
2 Straight shaft with the break (2Nm)
3 Straight shaft with the key and the break (2Nm)
5 Taper shaft
7 Taper shaft with the break (2Nm)

○○

78 : With the pulse coder αA8B
80 : With the pulse coder αI8B

Models αE3/2000 and αE6/2000

A06B–010□–B☆ ○○

□

5 : Model αE3/2000
6 : Model αE6/2000

☆

0 : Straight shaft (standard)
1 : Straight shaft with the key
2 Straight shaft with the break (8Nm)
3 Straight shaft with the key and the break (8Nm)
5 Taper shaft
7 Taper shaft with the break (8Nm)

○○

78 : With the pulse coder αA8B
80 : With the pulse coder αI8B

The resolution of the αA8B and αI8B serial pulse coders is 8,192/rev.

The standard shafts used for αE series motor are straight shafts. Use a straight shaft as far as circumstances, such as the delivery time and maintenance, permit.

2 SPECIFICATIONS AND CHARACTERISTICS

2.1 TYPE OF MOTORS AND SPECIFICATIONS

Item	Unit	αE1/3000	αE2/3000	αE3/20000	αE6/20000
Output	kw	0.3	0.5	0.5	0.9
	HP	0.4	0.67	0.67	1.2
Rated torque at stall	Nm	1.0	2.0	3	6.0
	kgf·cm	10	20	30	60
Maximum speed	1/min	3000	3000	2000	2000
Maximum theoretical torque	Nm	5.6	11	17	32
	kgf·cm	58	112	171	321
Rotor inertia	$kg \cdot m^2$	0.00033	0.00065	0.0019	0.0039
	$kgf \cdot cm \cdot s^2$	0.0034	0.0067	0.020	0.040
Maximum theoretical acceleration	rad/s^2	17000	16500	8500	8000
Weight	kg	2.5	3.5	5.0	8.5

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

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

2.2 CHARACTERISTIC CURVE AND DATA SHEET

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 (200V).

Overload duty characteristic

The overload duty characteristic curves are determined based on the temperature restriction for the single motor unit (the temperature is restricted by means of a thermal trip built into the motor). The curves are determined by assuming that the temperature increases gradually under certain overload conditions. Therefore, the curves do not apply to the rapid temperature rise which occurs, for example, when the motor shaft is locked. (An overcurrent flows in the motor windings until the thermal trip operates. The temperature rises momentarily.)
To detect such an abrupt temperature rise, the FANUC digital servo system provides a software thermal function that uses servo software to observe the current. During operation that is characterized by frequent acceleration/deceleration cycles, control is imposed by the software thermal function.
Driving units (such as amplifiers) and built–in detectors contain their own overheating protection devices. Therefore, note that control may be imposed according to how the equipment is being used.

Data sheet

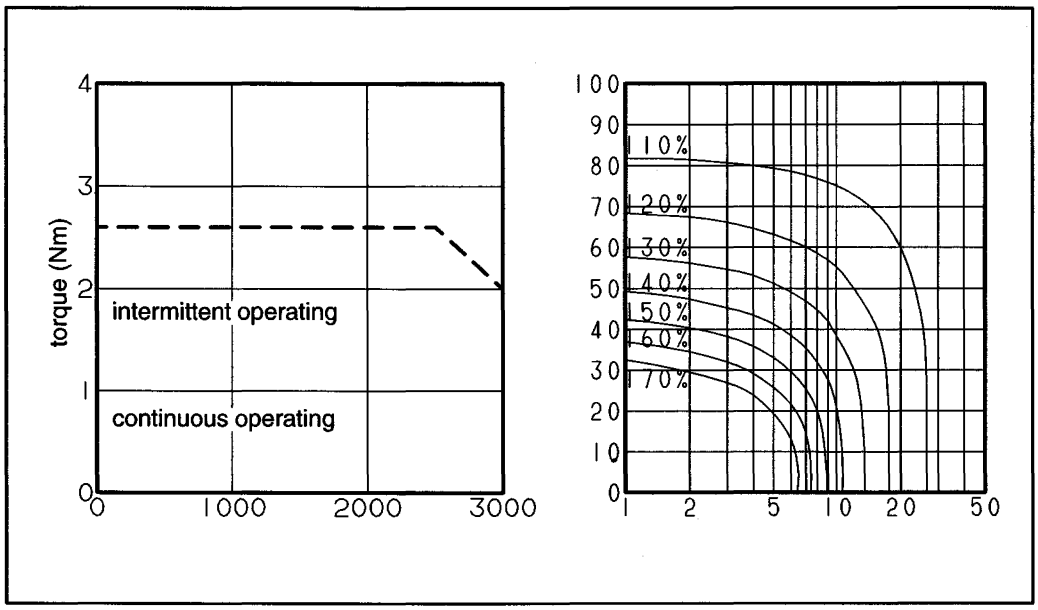
The parameters given in the data sheet are representative values for an ambient temperature of 20°C. They are subject to an error of +10%.
The indicated logical values are threshold values for the single motor unit (when the motor is not restricted by the control system).
The maximum torque that can be produced during acceleration or deceleration in actual use is calculated as the approximate product of the motor torque constant and the current limit value of the amplifier.

Example : αE1/3000

- Motor torque constant = 0.31 (Nm/Arms)
- Amplifier limit value = 12 Apeak
- Maximum torque value
  = $\underline{12 \times 0.707} \times 0.31$
  (Converted to an effective value)
  = 2.6 Nm (Converted to an effective value)

This value is for reference only. The actual value will vary depending on changes in the power supply, as well as variations in motor parameters and amplifier limit values.
In some models, if the maximum current flows in the motor, the actual maximum torque is affected by, for example, magnetic saturation. As a result, the actual maximum torque will be lower than the calculated value.
The intermittent operation area (maximum torque value) indicated in the torque–to–speed characteristics is the effective value, determined according to the combination with the amplifier.

• Model αE1/3000 Specification : A06B–0101–B□□□

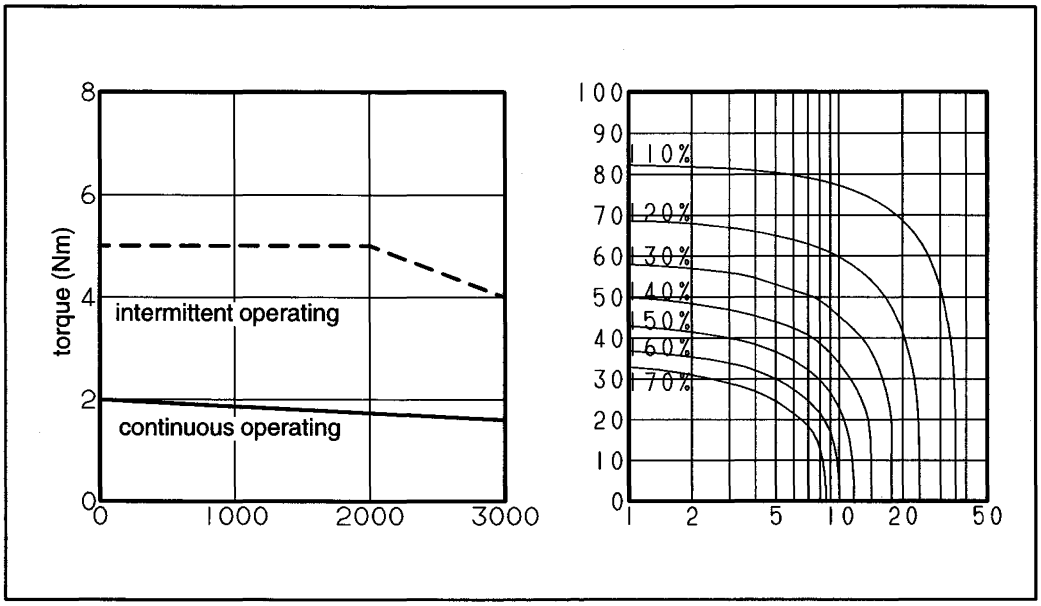


Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	3000			min $^{-1}$
Rated torque at stall (*)	Ts	1.0 10			Nm kgfcm
Rotor inertia	Jm	0. 00033 0. 0034			kgm^2 kgfcms^2
Continuous RMS current at stall	Is	3.2			A (rms)
Torque constant (*)	Kt	0. 31 3.2			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (*) (*)	Ke Kv	10.9 0. 10			V/1000min $^{-1}$ Vsec/rad
Armature resistance (*)	Ra	0.90			Ω
Mechanical time constant (*)	tm	0.011			s
Thermal time constant	tt	15			min
Static friction	Tf	0. 1 1			Nm kgfcm
Maximum allowable current	Im	18			A (peak)
Maximum theoretical torque	Tm	5.6 58			Nm kgfcm
Maximum theoretical acceleration		17000			rad/s^2
Weight		2. 5			kg

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

• Model αE2/3000 Specification : A06B–0102–B□□□



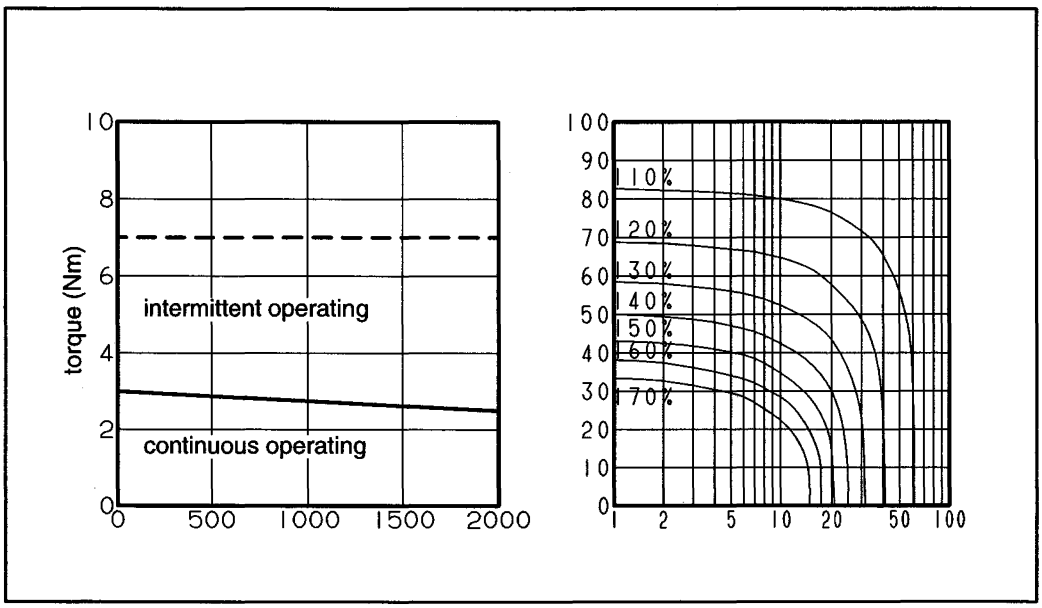
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	2.0 20			Nm kgfcm
Rotor inertia	Jm	0.00065 0.0067			kgm^2 $kgfcms^2$
Continuous RMS current at stall	Is	3.2			A (rms)
Torque constant (*)	Kt	0.61 6.2			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (*) (*)	Ke Kv	21.4 0.20			$V/1000min^{-1}$ Vsec/rad
Armature resistance (*)	Ra	1.4			Ω
Mechanical time constant (*)	tm	0.008			s
Thermal time constant	tt	20			min
Static friction	Tf	0.1 1.5			Nm kgfcm
Maximum allowable current	Im	18			A (peak)
Maximum theoretical torque	Tm	11 112			Nm kgfcm
Maximum theoretical acceleration		16500			rad/s^2
Weight		3.5			kg

(*) The values are the standard values at 20°C and the tolerance is ± 10%.

The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.) These values may be changed without prior notice.

• Model αE3/2000 Specification : A06B–0105–B□□□



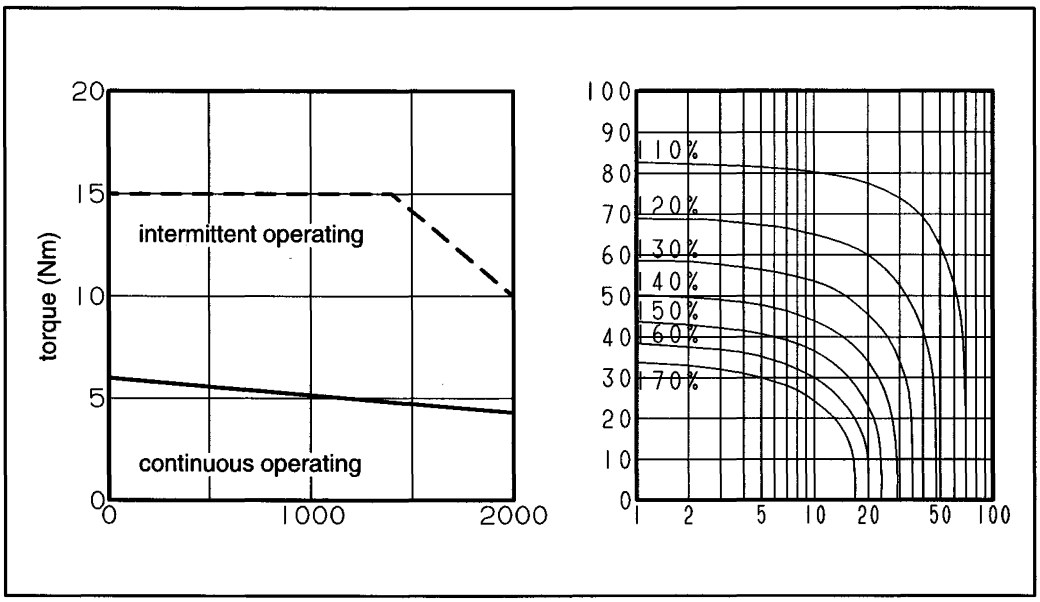
Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	2000			min $^{-1}$
Rated torque at stall (*)	Ts	3 30			Nm kgfcm
Rotor inertia	Jm	0.0019 0.020			kgm^2 kgfcms^2
Continuous RMS current at stall	Is	5.3			A (rms)
Torque constant (*)	Kt	0.56 5.7			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (*) (*)	Ke Kv	19.4 0.18			V/1000min $^{-1}$ Vsec/rad
Armature resistance (*)	Ra	0.57			Ω
Mechanical time constant (*)	tm	0.009			s
Thermal time constant	tt	40			min
Static friction	Tf	0.3 3			Nm kgfcm
Maximum allowable current	Im	30			A (peak)
Maximum theoretical torque	Tm	17 171			Nm kgfcm
Maximum theoretical acceleration		8500			rad/s^2
Weight		5.0			kg

(*) The values are the standard values at 20°C and the tolerance is ± 10%.

The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.) These values may be changed without prior notice.

• Model αE6/2000 Specification : A06B-0106-B□□□



Data sheet

Parameter	Symbol	Value			Unit
Maximum speed	Nmax	2000			min $^{-1}$
Rated torque at stall (*)	Ts	6.0 60			Nm kgfcm
Rotor inertia	Jm	0.0039 0.040			kgm^2 kgfcms^2
Continuous RMS current at stall	Is	5.6			A (rms)
Torque constant (*)	Kt	1.05 10.7			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (*) (*)	Ke Kv	37.0 0.35			V/1000min $^{-1}$ Vsec/rad
Armature resistance (*)	Ra	0.85			Ω
Mechanical time constant (*)	tm	0.009			s
Thermal time constant	tt	40			min
Static friction	Tf	0.3 3			Nm kgfcm
Maximum allowable current	Im	30			A (peak)
Maximum theoretical torque	Tm	32 321			Nm kgfcm
Maximum theoretical acceleration		8000			rad/s^2
Weight		8.5			kg

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

2.3 OUTLINE DRAWINGS

Model	Fig. No.
Models αE1 and αE2	Fig. 2.3(a)
Models αE1 and αE2 (with the brake)	Fig. 2.3(b)
Models αE1 and αE2 (shaft option)	Fig. 2.3(c)
Models αE3 and αE6	Fig. 2.3(d)
Models αE3 and αE6 (with the brake)	Fig. 2.3(e)
Models αE3 and αE6 (shaft option)	Fig. 2.3(f)

Fig. 2.3 (a) Models αE1 and αE2

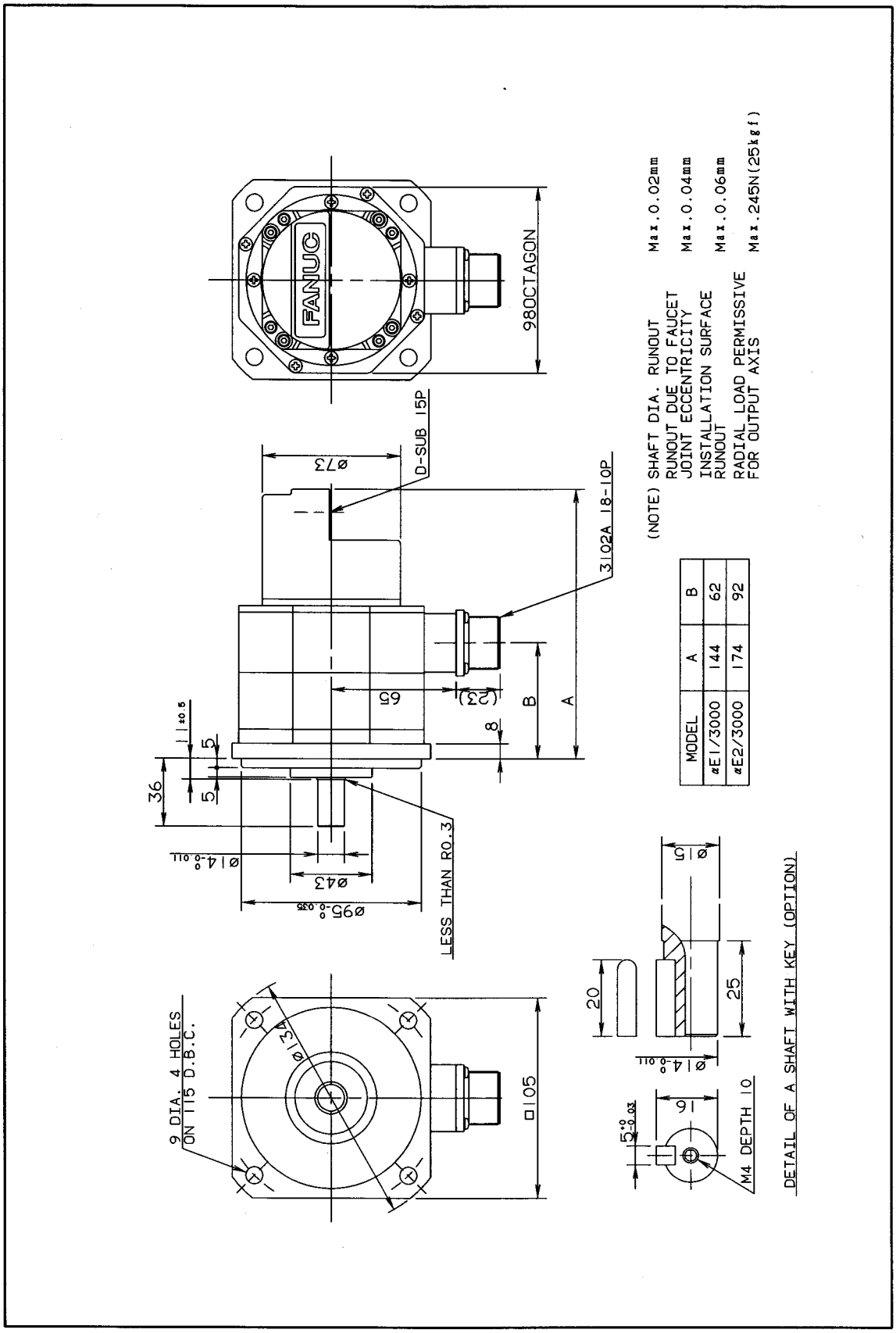


Fig. 2.3 (b) Models αE1 and αE2 (with the brake)

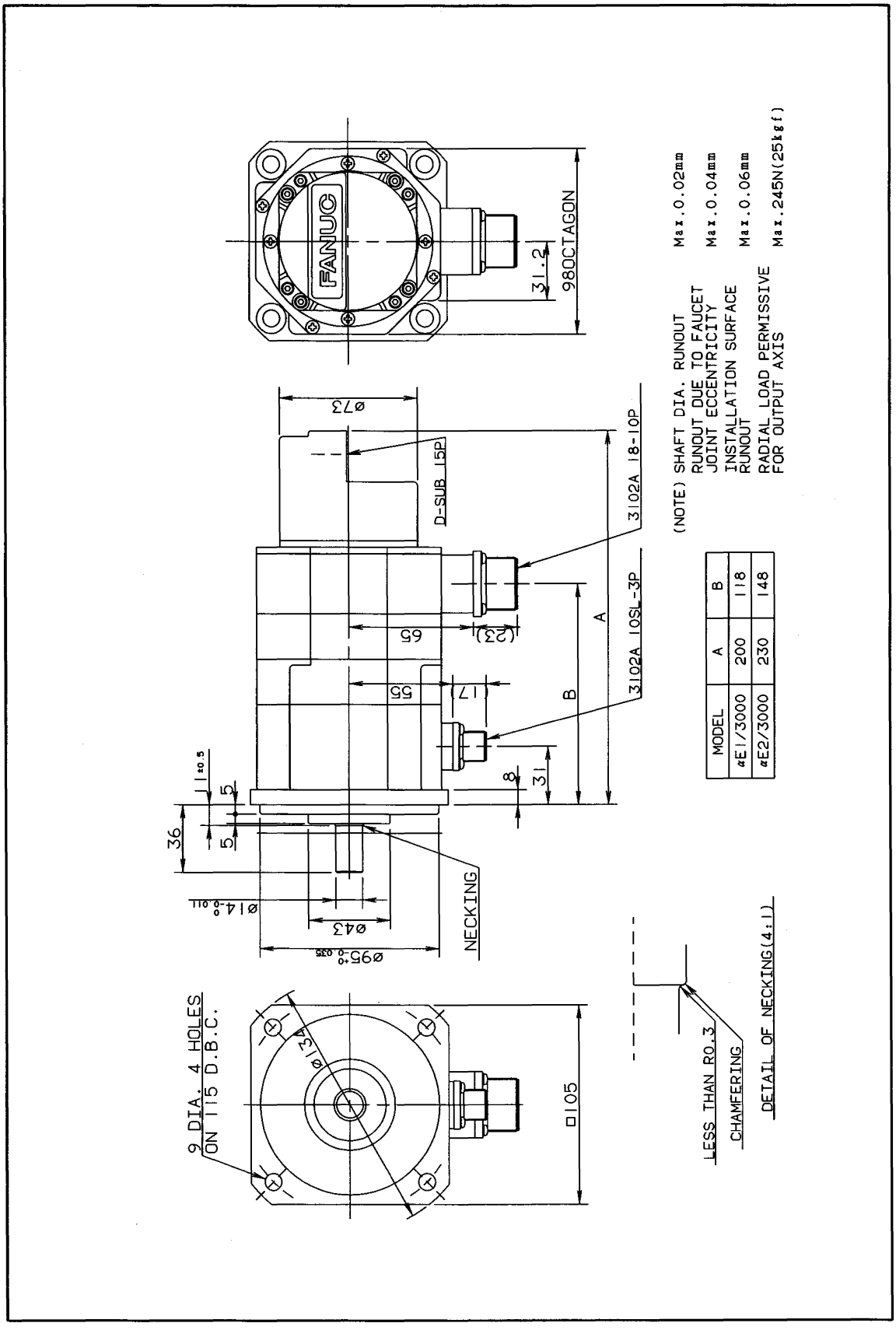


Fig. 2.3 (c) Models αE1 and αE2 (shaft option)

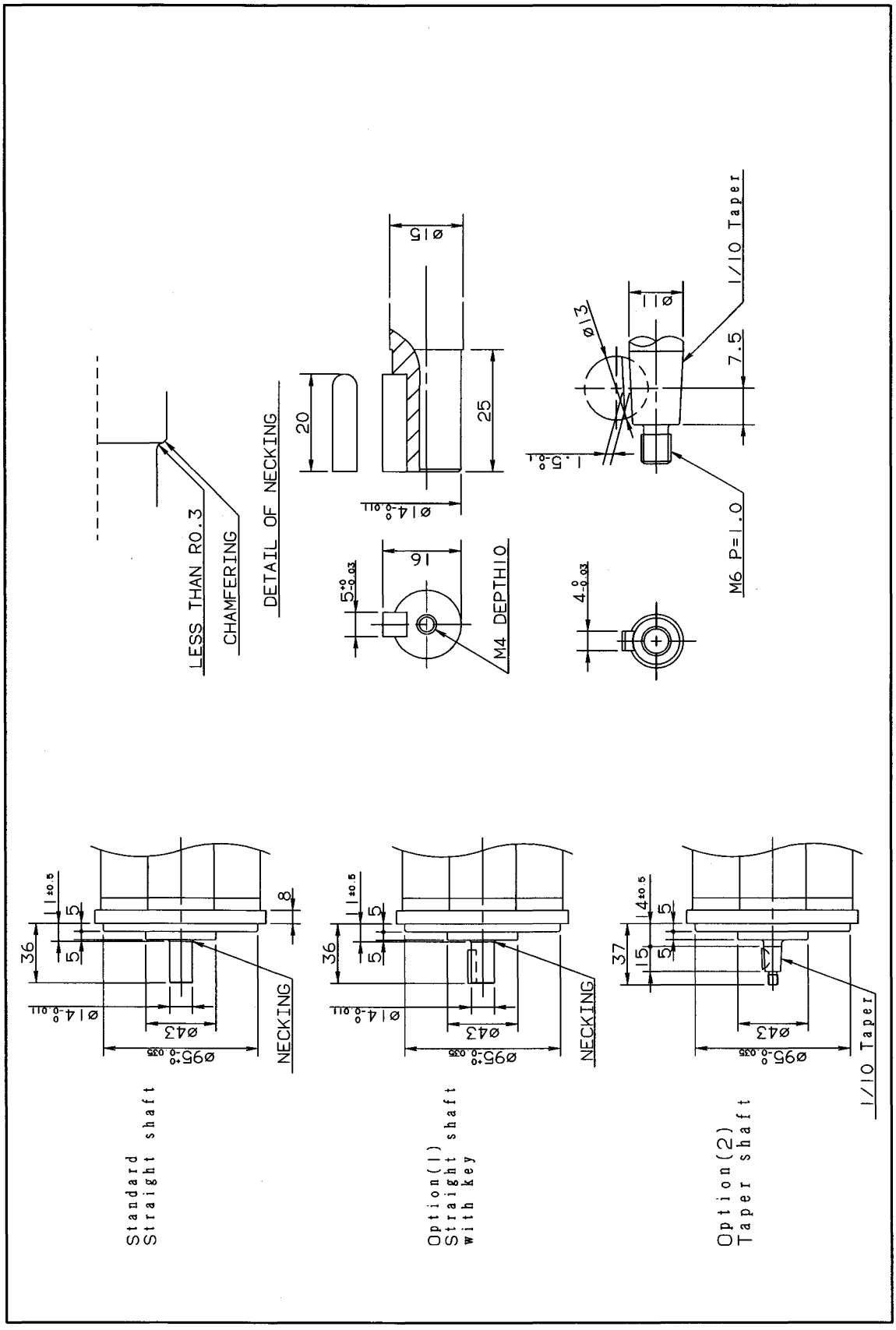


Fig. 2.3 (d) Models αE3 and αE6

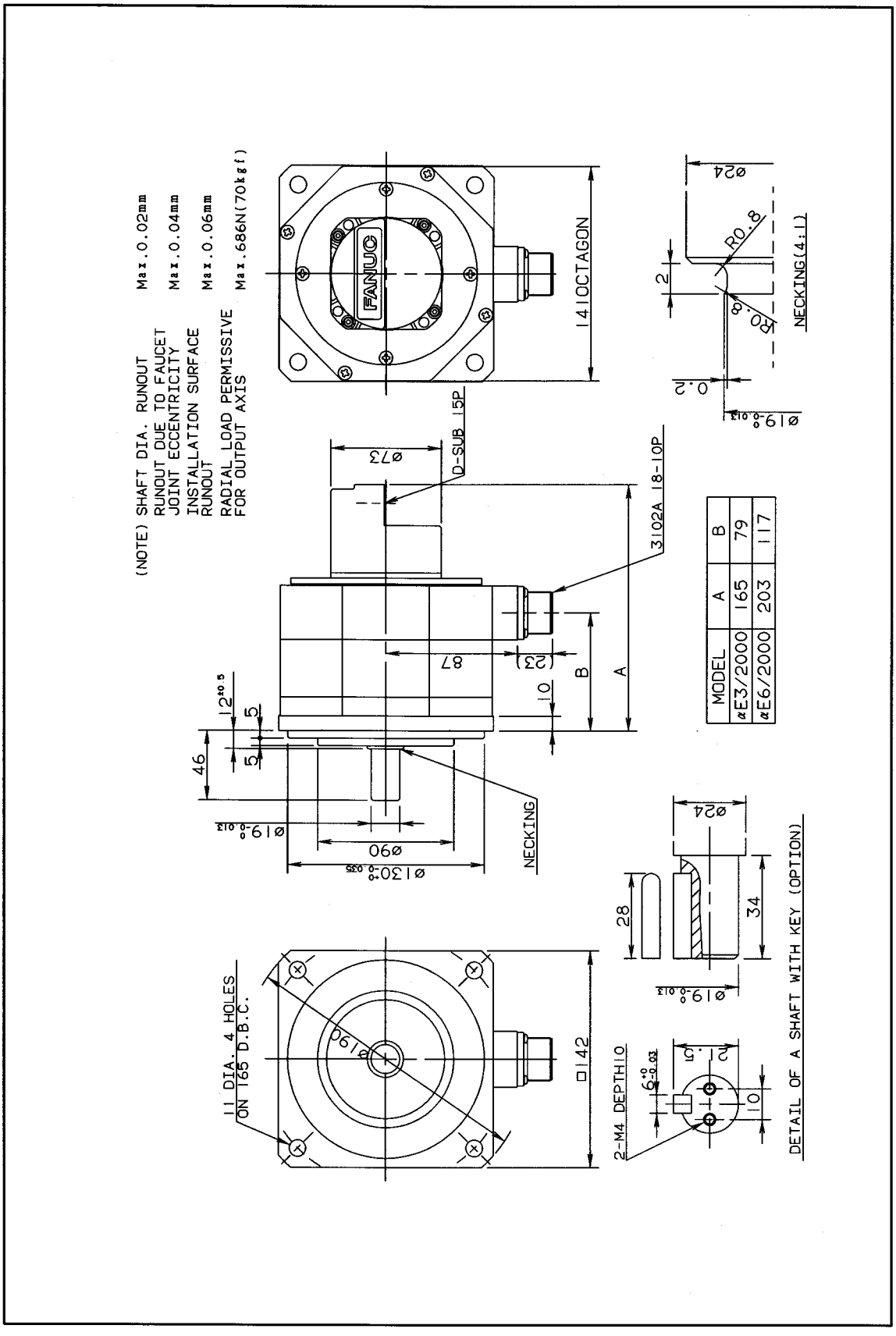


Fig. 2.3 (e) Models αE3 and αE6 (with the brake)

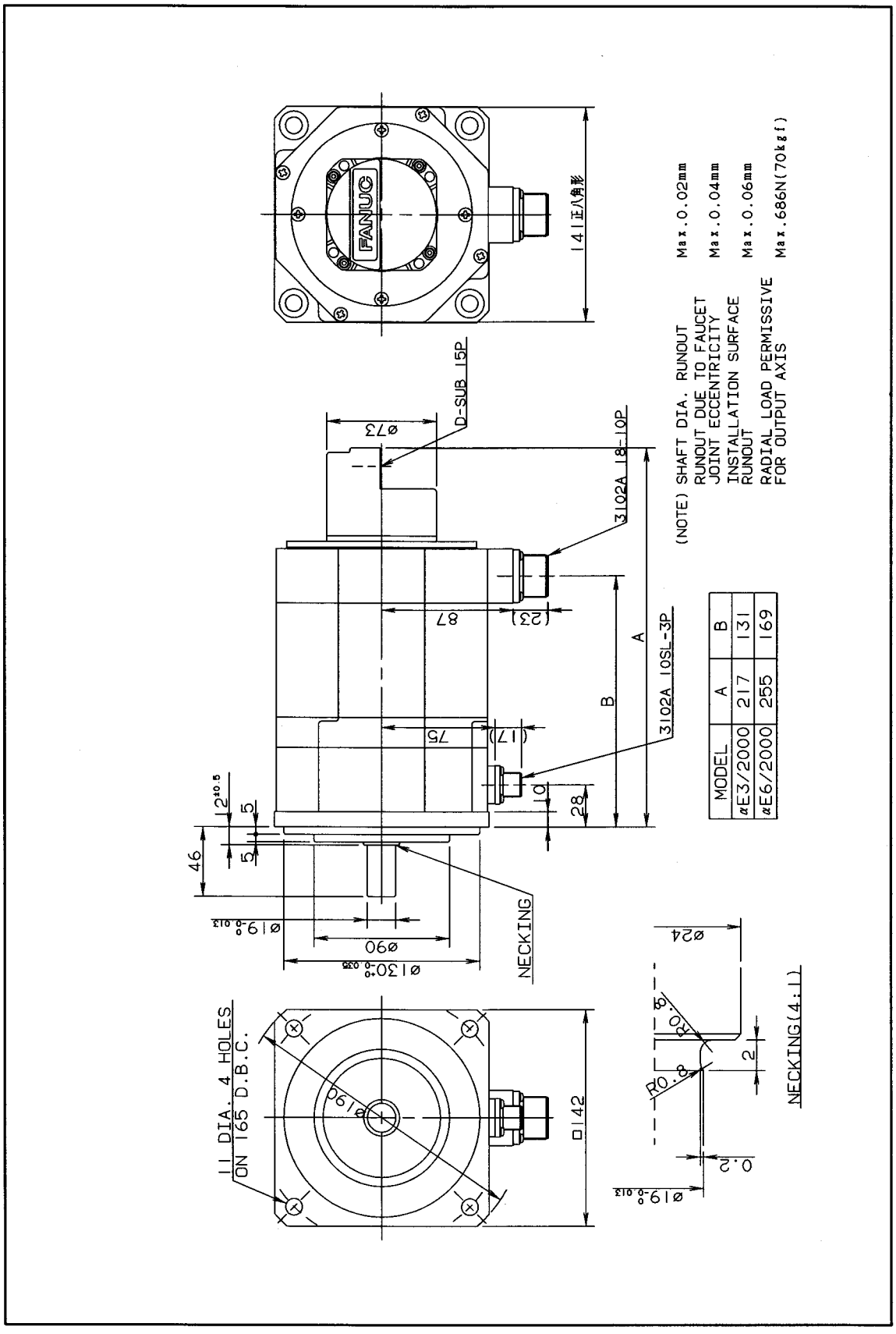
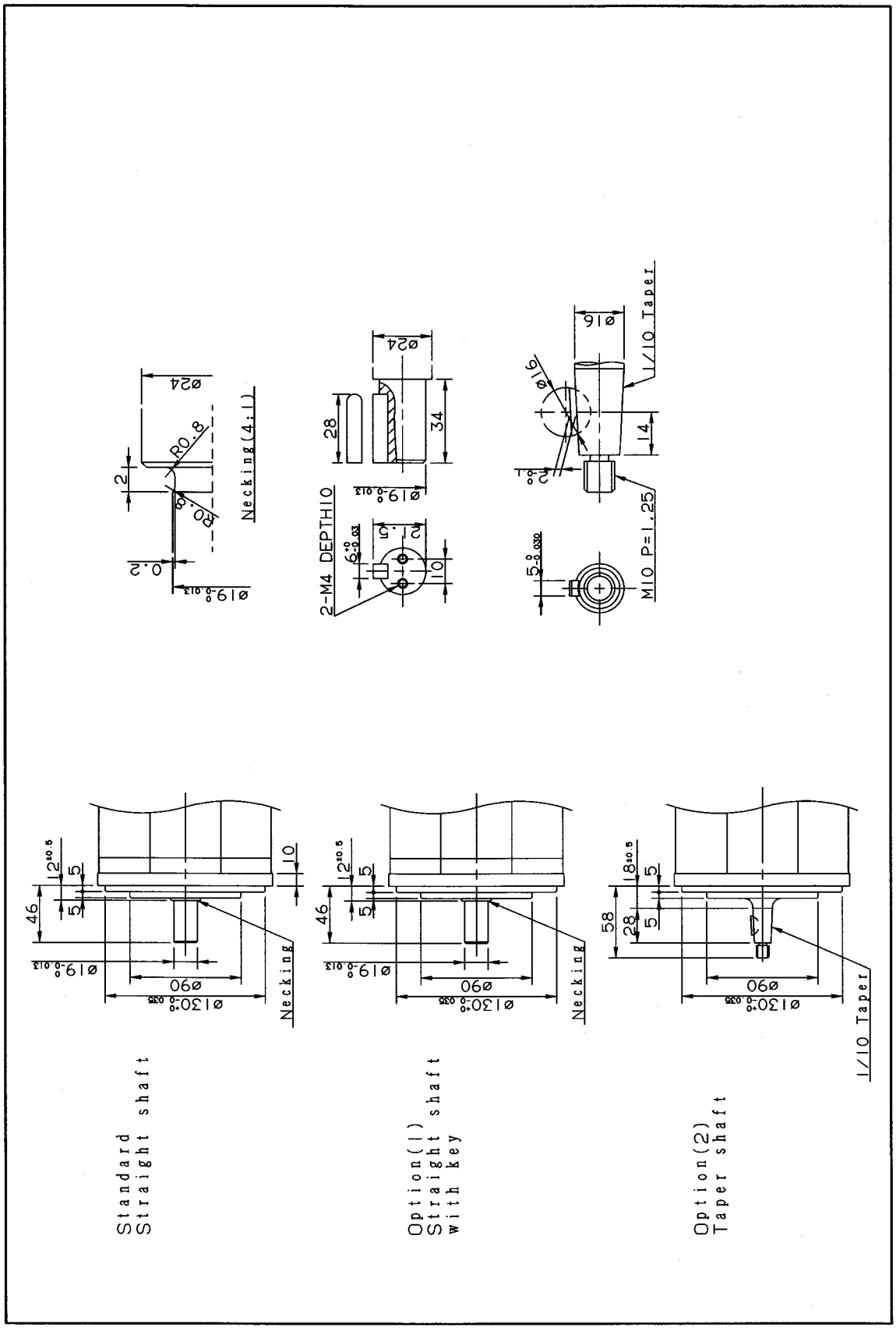
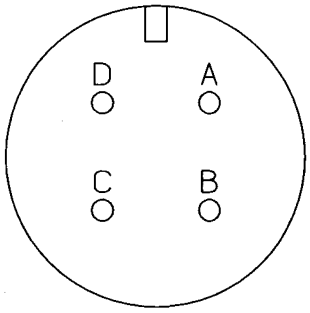


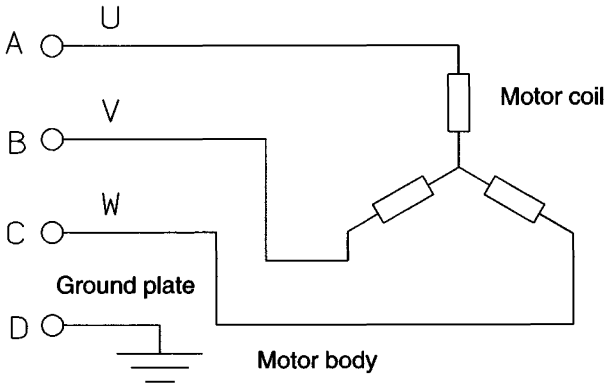
Fig. 2.3 (f) Models αE3 and αE6 (shaft option)



2.4 CONNECTION OF POWER LINE

- **Models αE1/3000, αE2/3000, αE3/2000, and αE6/2000**





Notes

If a motor is not connected to ground through the machine (housing) on which it is mounted, connect, for noise suppression, the ground plate of the motor, through a cable, to the point where the ground plate of the amplifier is connected.

In this case, do not use the GND wire of the power line. Instead, use a separate cable having a cross–sectional area of 1.25 mm^2 or more. Route the cable as far as possible from the power line.

III. E series SERVO AMPLIFIER (200 V, 1 AXIS)

1 GENERAL

The FANUC AC SERVO AMPLIFIER E series is a range of cost–effective servo amplifiers designed specifically for positioning when combined with the AC SERVO MOTOR αE series. The FANUC AC SERVO AMPLIFIER E series replaces conventional hydraulic and pneumatic systems with AC servo systems, thus allowing highly reliable, precision systems to be built.

The FANUC AC SERVO AMPLIFIER E series can be used with the FANUC Series 15–B, Series 16/18, and so forth, to control the peripheral equipment of machine tools.

The FANUC AC SERVO AMPLIFIER E series has the following features:

- Low cost
- Designed specifically for positioning
- Does not conform to European safety standards.

2 CONFIGURATION

Fig. 2.1 shows an example configuration having two controlled axes. Depending on the load and operating conditions, options such as a regenerative discharge unit, additional regenerative resistance, and dynamic braking may be required.

Example of αE series Motor Configuration Involving Two Controlled Axes

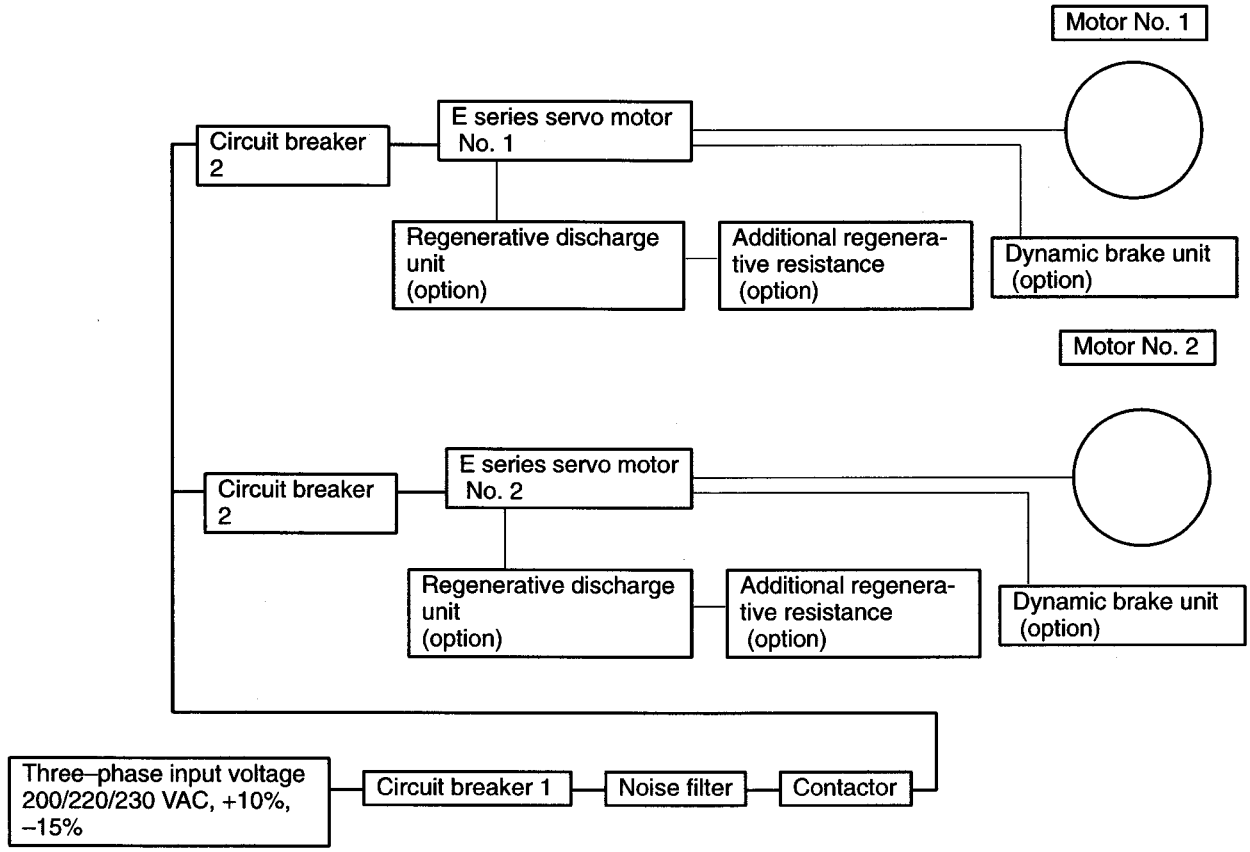


Fig2.1

Notes
1 Circuit breaker 1 is used for power line protection. Circuit breaker 2 is used for servo amplifier protection.
2 At the power inlet of the power magnetics cabinet, install a surge suppressor between the lines and between one line and ground. For an explanation of the installation method, see Section 5.6

2.1 TYPES OF UNITS AND SPECIFICATIONS

Types of Servo Amplifiers and Specifications (1)

Table 2.1.1

Name	Application	Specification
Servo amplifier (*1)	Motors αE1/3000, αE2/3000	A06B–6070–H005
	Motors αE3/2000, αE6/2000	A06B–6070–H004

Options and Specifications (2)

Table 2.1.2

Name	Application	Specification
Regenerative discharge unit(*2)	(10 ohms/20 W, natural air–cooling)	A06B–6070–H500
Additional regenerative resistance(*2)	(10 ohms/50 W, natural air–cooling)	A06B–6070–H550
Dynamic brake unit(*3)	Dynamic brake function	A06B–6070–H600
AC line filter(*4)	Type A: For use when the combined rated motor powers does not exceed 5.4 kW	A81L–0001–0083#3C
Power transformer for export(*5)	Type SAE: 2.2 kVA capacity	A80L–0022–0005
	Type SBE: 3.5 kVA capacity	A80L–0024–0006
Battery for absolute pulse coders	Specified when an absolute pulse coder is used	A06B–6070–J201
Dynamic brake unit dummy connector	Connected to CP1 when the dynamic brake unit is not used	A06B–6070–K001
Regenerative discharge unit dummy connector	Connected to CP2 when the regenerative discharge unit is not used	A06B–6070–K002
Battery (spare)	Used for absolute pulse coders	A02B–0168–K111
Fuse (spare)	Used for control power supply	A02B–0168–K101

Notes

1 The E series servo amplifiers do not conform to European safety standards.
2 *1 See Section 4.1 Regenerative Discharge Unit and Additional Regenerative Resistance
3 *2 See Section 4.2 Dynamic Brake Unit
4 *3 See Section 4.3 AC Line Filter
5 *4 See Section 4.4 Export–Specification Power Transformer

3 SPECIFICATIONS

3.1 SPECIFICATIONS

Specifications (Common)

Item		Specification
Power supply	Three–phase input for power	Voltage: 200/220/230 VAC, Allowable voltage fluctuation: +10%, –15%, Frequency: 50 Hz, 60 Hz, Allowable frequency fluctuation: +2 Hz
	Single–phase input for control power supply	Voltage: 200/220/230 VAC, Allowable voltage fluctuation: +10%, –15%, Frequency: 50 Hz, 60 Hz, Allowable frequency fluctuation: +2 Hz
Main circuit control method		Sinusoidal wave PWM control using a transistor (IGBT) bridge
Alarm/protection function		HC: DC link overcurrent alarm HV: DC link overvoltage alarm OHI: Internal overheat alarm (when a thermostat built into the amplifier is tripped) OHE: External overheat alarm (when a thermostat attached to the outer casing of the amplifier is tripped)
Relay contact output for external contactor control CP3(B)		Contact rating Upon the completion of preparation, the contact is closed. 220 VAC: 2 A (maximum rating), 500 mA (continuous rating) 30 VDC: 2 A (maximum rating), 500 mA (continuous rating)

Specifications (Individual)

Servo amplifier	Applicable motor model	Current at rated output(*1)	Nominal current limit value
A06B–6070–H005	αE1/3000	3.2 A_{rms}	12A_{peak}
	αE2/3000	3.2 A_{rms}	
A06B–6070–H004	αE3/2000	5.3 A_{rms}	20A_{peak}
	αE6/2000	5.6 A_{rms}	

Notes

*1 The rated output is guaranteed at the rated input voltage. Note, however, that if the input voltage fluctuates even within its allowable fluctuation range, the rated output may not be obtained.

3.2 PROTECTION AND ABNORMALITY DETECTION FUNCTIONS

The E series servo amplifiers feature the protection and abnormality detection functions listed below. An alarm is indicated using the LED on the front panel of the servo amplifier.

Protection and Abnormality Detection Functions

Type of alarm	LED display, : Turned on	Description
DC link overcurrent alarm (HC)	HC HV OHE OHI ● ○ ○ ○	This alarm is issued when an abnormally high current is detected in the main circuit.
DC link overvoltage alarm (HV)	HC HV OHE OHI ○ ● ○ ○	This alarm is issued when the DC voltage of the main circuit power supply is abnormally high.
Overheat alarm (OHI)	HC HV OHE OHI ○ ○ ○ ●	This alarm is issued when the thermostat is tripped by an abnormally high temperature inside the amplifier.
External overheat alarm (OHE)	HC HV OHE OH I ○ ○ ● ○	This alarm is issued when the thermostat for the regenerative discharge unit or additional regenerative resistance is tripped. The thermostat for the power transformer may be connected in series with this thermostat.

3.3 CONTROL POWER SUPPLY VOLTAGE DISPLAY

When the control power supply voltage (5 V) is applied, the LED (POW) is turned on.

3.4 SETTING PINS

The setting pins, S1 and S2, are used to select an NC interface. Change the setting according to the NC to be connected.

NC interface		Interface switching
Type A	FS15–B, FS–16, FS–18, etc.	Insert a plug into pin S1 on the front panel.
Type B	PM–H, PM–I, etc.	Insert a plug into pin S2 on the front panel.

3.5 DCP AND DCN ON TERMINAL BLOCK T2

Even after the L1, L2, and L3 inputs to the main circuit have been turned off, a dangerous voltage still exist between DCP and DCN on terminal block T2 because an internal capacitor is charged. This remaining voltage disappears in about 120 seconds as it is slowly discharged through a resistor. Accordingly, be careful when connecting a cable to DCP or DCN. Be careful also when using a regenerative discharge unit because DCP and DCN on T2 must be connected in such a case.

4 OPTIONS

4.1 REGENERATIVE DISCHARGE UNIT AND ADDITIONAL REGENERATIVE RESISTANCE

4.1.1 When Regenerative Discharge Unit and Additional Regenerative Resistance Options Are Not Required

When the amount of regenerative energy per occurrence does not exceed the amounts of energy [J] indicated in Table 4.1, the regenerative discharge unit and additional regenerative resistance options are not required.

αE1/3000, αE2/3000	15[J]
αE3/2000, αE6/2000	20[J]

Calculating amount of regenerative energy per occurrence

- **When operation is in the horizontal plane:**

$$P = 5.37 \times 10^{-4} JV_m^2 - 5.13 \times 10^{-3} t_a V_m T_L (J) \quad \text{....(Expression 1)}$$

where

$J = J_M + J_L$

J_M :Motor rotor inertia (kgf cm sec^2)

J_L : Additional inertia applied to the motor shaft (kgf cm sec^2)

V_m : Motor speed during rapid traverse (rpm)

t_a : Acceleration/deceleration time during rapid traverse (sec)

T_L : Machine tool friction torque (applied to the motor shaft) (kgf cm)

- **When operation is in the vertical plane:**

$$Q = 1.026 \times 10^{-2} ThV_m \times t_a (J) \quad \text{....(Expression 2)}$$

where, P is given by Expression 1, andQ is given by:

$$R = P + Q(J) \quad \text{....(Expression 3)}$$

Th :Torque supported upward by the motor during rapid traverse falling (kgf cm)

V_m : Motor speed during rapid traverse (rpm)

t'_a : Acceleration/deceleration time during rapid traverse (sec)

4.1.2 When the Regenerative Discharge Unit and Additional Regenerative Resistance Options Are Required

When the amount of regenerative energy per occurrence exceeds the amounts of energy [J] indicated in Table 4.1, the DC link overvoltage alarm is issued. In such a case, the regenerative discharge unit and additional regenerative resistance options are required. For details of the connection, see Chapter 9.

First, calculate the average regenerative energy.

- **When operation is in the horizontal plane:**

When the operation is in the horizontal plane:

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

Suppose that acceleration/deceleration during rapid traverse is performed once every F sec. In this case, the separate type regenerative discharge unit is required when P, obtained using the expression below, continuously exceeds the value specified for the regenerative discharge unit built into the servo amplifier.

where

F : Frequency of acceleration/deceleration during rapid traverse (sec/occurrence). (Acceleration/deceleration in rapid traverse is assumed to occur once every 5 seconds, unless otherwise specified.)

J = Jm+ JL

Jm :Motor rotor inertia (kgf cm sec^2)

JL : Additional inertia applied to the motor shaft (kgf cm sec^2)

Vm : Motor speed during rapid traverse (1/min)

ta : Acceleration/deceleration time during rapid traverse (sec)

TL : Machine tool friction torque (applied to the motor shaft) (kgf cm)

- **When the operation is in the vertical plane:**

Let D (%) be the duty cycle of the downward operation in rapid traverse. Then,

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

where

Th : Torque supported upward by the motor during rapid traverse falling (kgf cm)

Vm :Motor speed during rapid traverse (1/min)

D : Duty cycle of downward operation during rapid traverse (%) (The maximum value of D is 50%, with a smaller value usually being assumed.)

The sum (R) of Q (obtained from Expression 2) and P (obtained from Expression 1) is:

$$R = P + Q \quad ....(3)$$

When the calculated average regenerative energy does not exceed 20 W, connect a regenerative discharge unit. The ambient temperature must not exceed 55° C.

When the calculated average regenerative energy is greater than 20 W but does not exceed 50 W, use a regenerative discharge unit together with an additional regenerative resistance. The ambient temperature must not exceed 55° C.

By using a cooling fan, the additional regenerative resistance can be used even when the average regenerative energy exceeds 50 W.

If an installed regenerative discharge unit or additional regenerative resistance overheats, the built–in thermostat is tripped, thus issuing an external overheat alarm.

4.2 DYNAMIC BRAKE UNIT

If the emergency stop function is activated or an alarm is issued during motor rotation, the motor is deactivated and free–runs. By connecting a dynamic brake unit, the motor can be decelerated to a stop when the emergency stop function is activated or an alarm is issued. Note, however, that when a force is externally applied as in the case of vertical axes, the dynamic brake unit does not function. For details of making the necessary connections, see Chapter 9.

4.3 AC LINE FILTER

The AC line filter is used to reduce the influence of high–frequency noise on the power supply. When multiple amplifiers are connected to one line filter, the sum of the power supply capacities of the amplifiers must not exceed the capacity of the line filter. For an explanation of how to calculate the amplifier power supply capacity, see Chapter 5.

4.4 EXPORT–SPECIFICATION POWER TRANSFORMER

The export–specification power transformer is used to match a power supply voltage with the input power supply voltage range of each amplifier. For details of making the necessary connections, see Table 4.4.1 and Fig. 4.4.1 When multiple amplifiers are to be connected to a single power transformer, the combined power supply requirements of the amplifiers must not exceed the capacity of the power transformer.

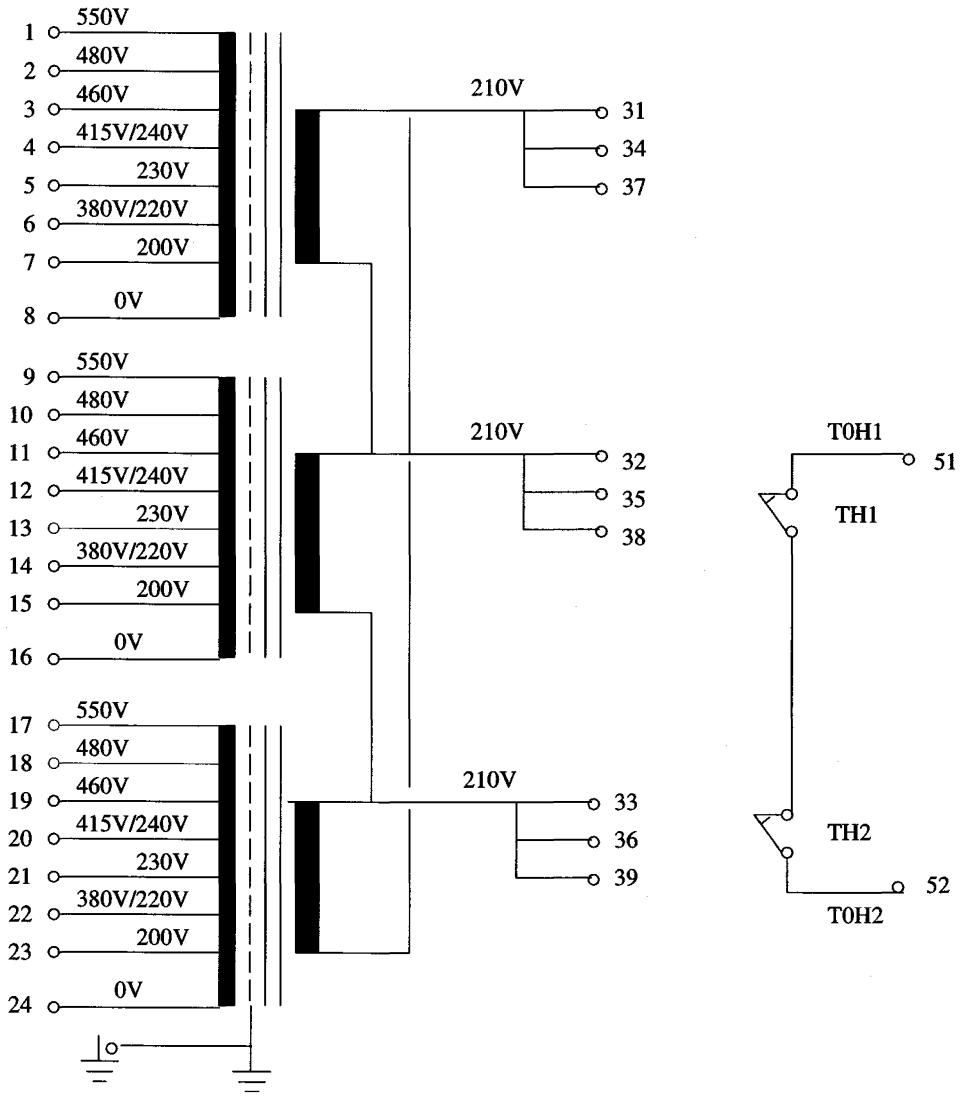
Connection of Power Cables for Transformer Input, and Connection between Primary–Side Pins

Table 4.4.1

Power supply voltage	Power cables for input (U, V, W)	Connection locations for wiring modification	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		

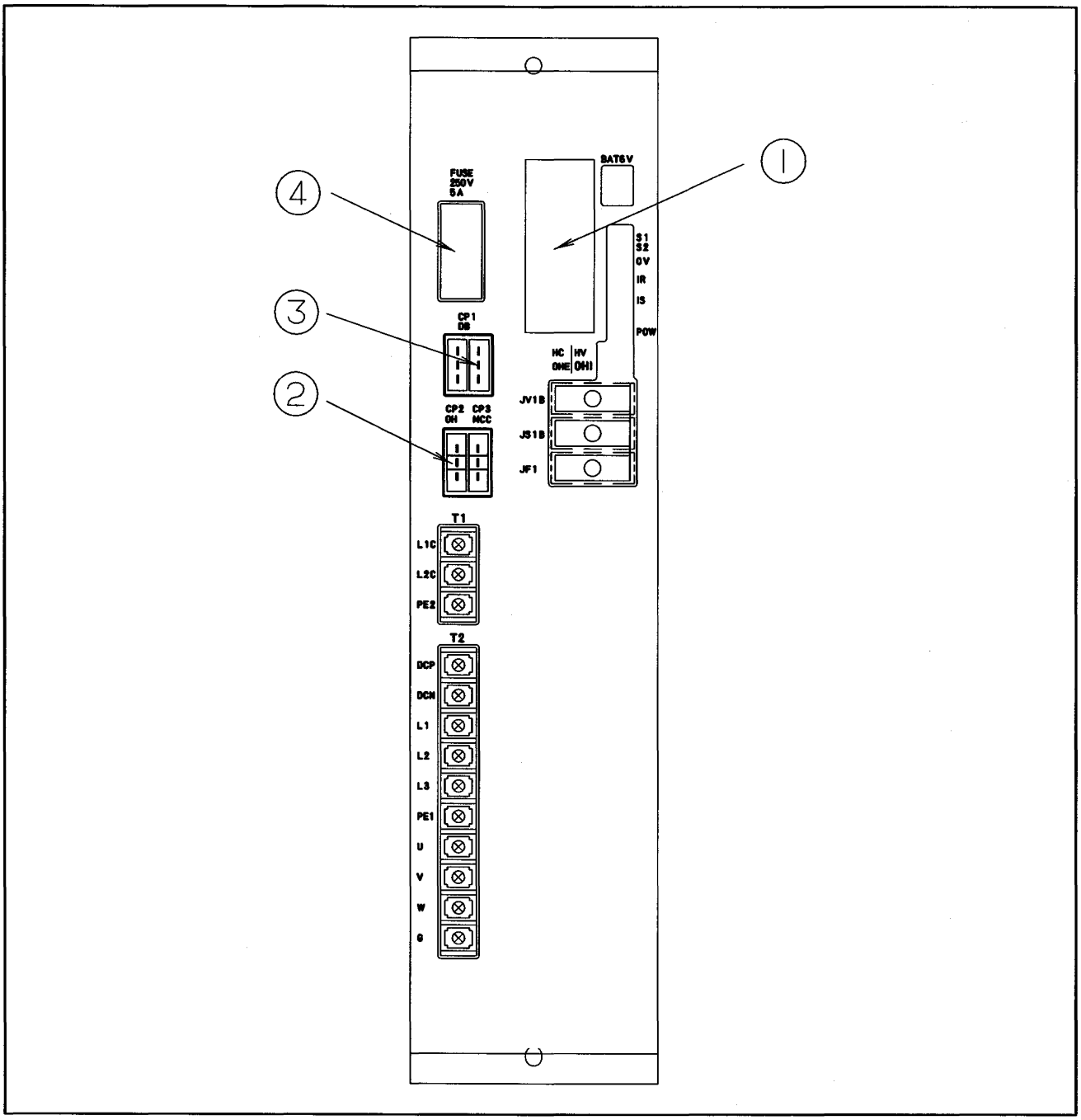
Connection Diagram

Fig. 4.4.1

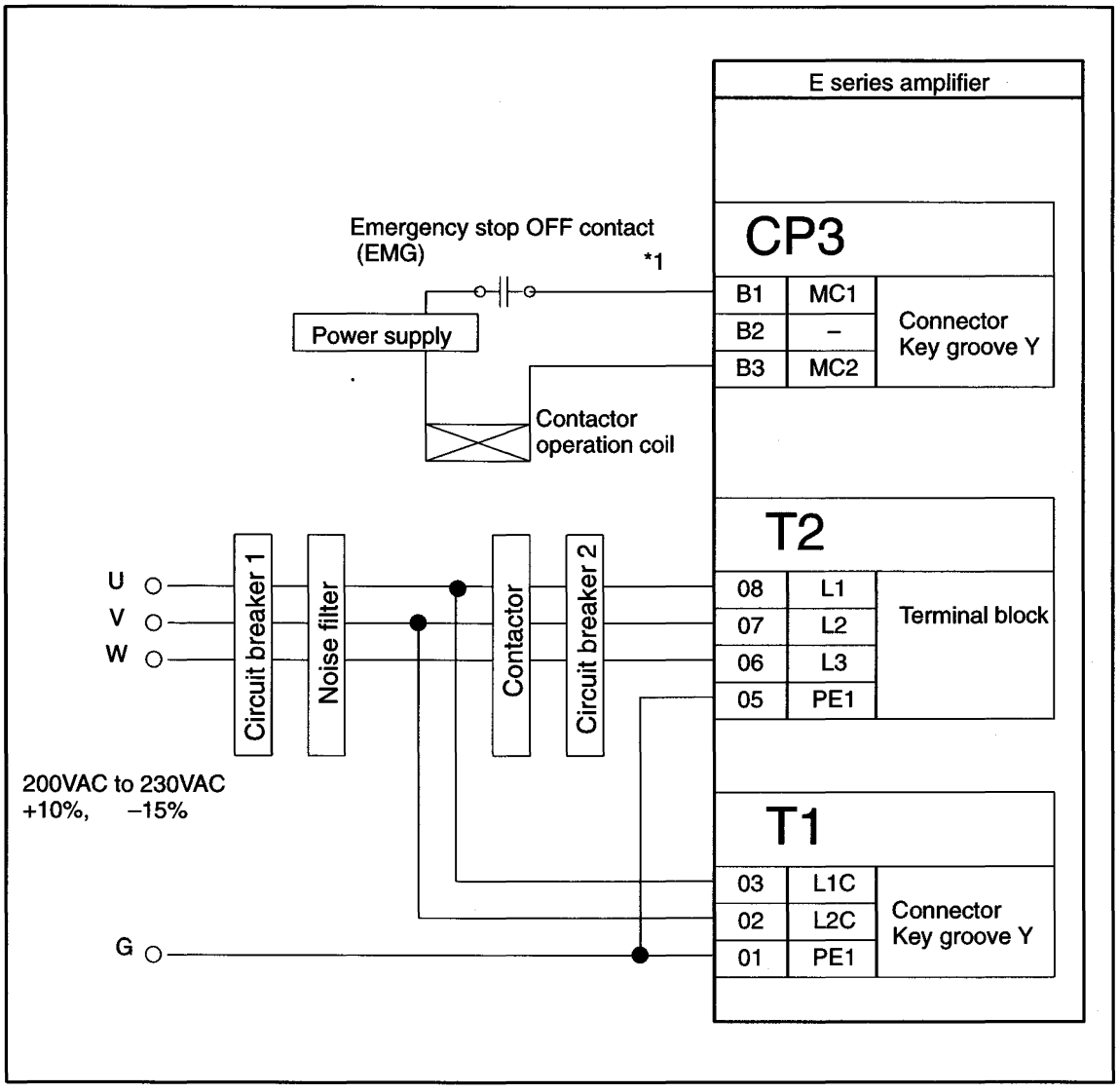


4.5 MOUNTING LOCATIONS OF OPTIONS AND ACCESSORIES

① Battery (option) for absolute pulse coders, battery (accessory)
② Regenerative discharge unit dummy connector (option)
③ Dynamic brake unit dummy connector (option)
④ Fuse (accessory)



5 POWER SUPPLY



Notes

*1 Connector CP3 is a relay contact. So, note that when only the power supply is directly connected, an internal relay may be damaged.

5.1 RATING OF THREE–PHASE POWER SUPPLY

Rating of Three–Phase Power Supply

Table5.1 indicates the rating of the three–phase power supply connected to terminal block T2 (L1, L2, L3).

Table5.1

Motor model	Power supply capacity per motor	Phase current (when the power supply voltage is 170 VAC)
αE1/3000	0.45 [KVA]	1.5 [Arms]
αE2/3000	0.83 [KVA]	2.8 [Arms]
αE3/2000	0.83 [KVA]	2.8 [Arms]
αE6/2000	1.5 [KVA]	5.1 [Arms]

Notes

1 The power supply capacity needed when using two or more motors can be determined by summing the power supply requirements of the individual motors.
2 The power supply capacities indicated in Table 5.1 serve as continuous ratings. However, a capacity about two times larger than the continuous rating may be required momentarily at the time of abrupt AC servo motor acceleration/deceleration.
3 When the power is turned on, a surge current of up to about 18 A (when 253 VAC is applied) flows for 30 msec.

5.2 CAPACITY OF SINGLE–PHASE POWER SUPPLY FOR CONTROL

Capacity of Single–Phase Power Supply for Control

Table 5.2 indicates the capacity of the single–phase power supply for control connected to terminal block T1 (L1C, L2C).

Table 5.2

Power supply capacity per amplifier	20VA

Notes
1 When the power is turned on, a surge current up to about 35 A (when 253 VAC is applied) flows for 5 msec.
2 An amplifier contains a 5–A fuse for the single–phase power supply used for control. An external fuse is not necessary. A fuse is mounted on the top of the front panel. (The location is marked FUSE.)

5.3 CIRCUIT BREAKERS

5.3.1 Circuit Breaker for Amplifier Input Power Supply (Circuit Breaker 2)

For safety, install a fuse (10 A or less) to protect the amplifier input. (The three-phase amplifier power supply contains no circuit breaker or fuse.) Determine the capacity of a circuit breaker from Table 5.1

5.3.2 Capacity of the Main Circuit Breaker (Circuit Breaker 1)

Determine the capacity of the main circuit breaker from Table 5.1 When multiple amplifiers are connected to a single circuit breaker, determine the required circuit breaker capacity by summing the capacities of the three-phase power supplies of the individual motors.
When one amplifier is connected to one main circuit breaker, circuit breaker 2 is not required.

5.3.3 Ground Fault Interrupter

When a ground fault interrupter is used for the main circuit breaker, use an inverter-compatible ground fault interrupter.

Reference information:

Manufacturer	Model	Application status
FUJI ELECTRIC	EG-A series SG-A series	Fully inverter-compatible, first used in July,1983
Hitachi, Ltd.	ES100C type ES225C type	Fully inverter-compatible, first used in July,1984
Matsushita Electric Works	Ground fault interrupter type C Ground fault interrupter type KC	Fully inverter-compatible, first used in November, 1984

5.4 NOISE FILTER

The noise filter is used to reduce the influence of high–frequency noise on the power supply. Determine the capacity of the noise filter by referring Table 5.1. When multiple amplifiers are connected to a single noise filter, determine the capacity of the noise filter by summing the three–phase power supply capacities of the individual motors.

5.4.1 AC Line Filter (Option)

An optional AC line filter is available. The AC line filter allows multiple E series amplifiers to be connected within the capacity indicated in Table 2.1.2.

5.4.2 Commercially Available Noise Filter

The user can use a commercially available noise filter.

5.5 CONTACTOR

Always install a contactor to disconnect an amplifier's power source when the emergency stop function is activated or an alarm is issued. FANUC recommends the use of a contactor of AC class 3, No. 1, type 0, as defined in JISC8325 (AC electromagnetic switch) of the Japanese Industrial Standards. Determine the rating of a contactor according to Table 5.1. When multiple amplifiers are connected to a single contactor, determine the capacity of the contactor by summing the capacities of the three–phase power supplies the individual motors.

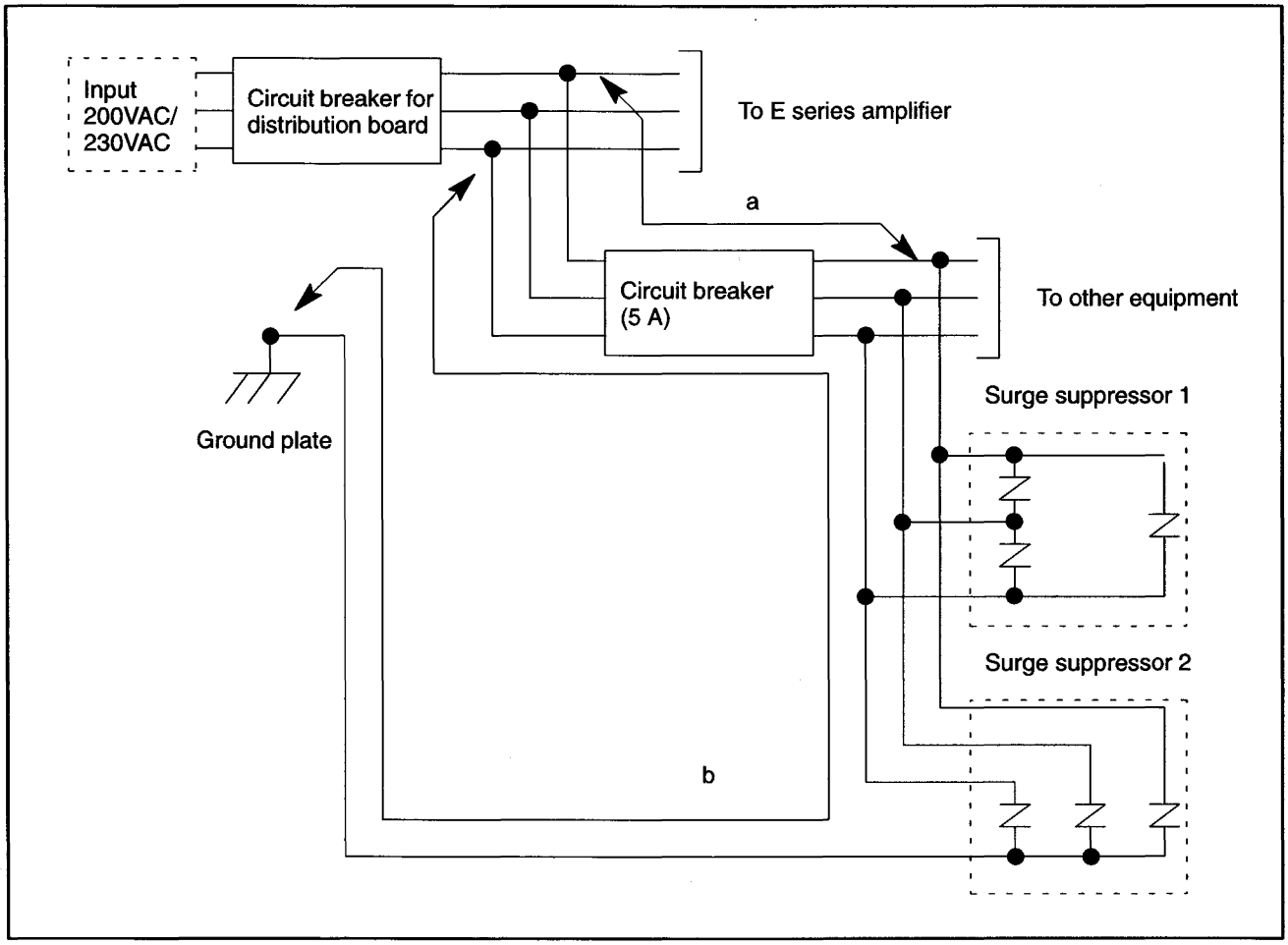
5.6 SURGE SUPPRESSOR

The user should install surge suppressors to protect the servo amplifier against the surge voltages that can be generated, for example, by lightning striking a power line.

Sample lightning surge suppressors

	Model	Clamp voltage (V) +10%	Tolerable surge current 8/20μs(A)	Tolerable surge voltage 1.2/50μs(V)	Maximum allowable circuit voltage (Vrms)
1	R.A.V–718BYZ–2	783	1000	12K	300
2	R.A.V–718BYZ–2A	783	1000	12K	300

5.6.1 Installing Surge Suppressors



Notes

1 For improved surge suppression, route the wires indicated by heavy lines along the shortest possible paths.
Wire: 2 mm^2 or more
The total length of a and b in the figure must not exceed 2 m.
2 When a dielectric breakdown test is to be performed by applying an overvoltage to the power line, the surge suppressors must be removed to enable operation at the applied voltage.
3 Usually, no current flows through surge suppressors 1 and 2, so that the circuit breaker (5 A) can be also be used to provide protection for other equipment.
4 The mode of connection should allow the user to see whether the circuit breaker is open.
1) Use a circuit breaker (5 A) having a contact for checking whether the circuit breaker is open.

6 HEAT DISSIPATION

Heat Dissipation of Servo Amplifiers

Table 6.1 (a)

Servo amplifier drawing number	Motor model	Heat dissipation
A06B–6070–H005	αE1/3000	80W
	αE2/3000	80W
A06B–6070–H004	αE3/2000	95W
	αE6/3000	95W

Heat Dissipation of Other Units

Table 6.2 (b)

Drawing number	Name	Heat dissipation
A06B–6070–H500	Regenerative discharge unit	25W
A06B–6070–H550	Additional regenerative resistance	50W

7 INSTALLATION CONDITIONS AND NOTES

7.1 INSTALLATION CONDITIONS

7.1.1 Ambient Temperature

Allowable ambient temperature: 0°C to 55°C (during operation)
–20°C to 60°C (during storage or operation)
Temperature variation rate: 1.1°C/min or less

7.1.2 Humidity

30% to 95% RM (no condensation)

7.1.3 Altitude

No more than 1000 m above sea level

7.1.4 Vibration

0.5 G or less during operation

7.1.5 Atmosphere

No corrosive or conductive vapor or droplets shall come into contact with the electronic circuits or radiator.

7.1.6 Notes on Installation

The αE series servo amplifiers have been designed to be installed in the power magnetics or other cabinet, with the radiator projecting from the rear of the cabinet. This configuration is intended to dissipate heat, generated by the semiconductors, away from the cabinet, thus preventing heat build–up within the cabinet. When installing an amplifier, therefore, the following conditions must be satisfied:

(1) No cutting fluid, oil mist, or chips shall come into contact with the radiator or fan. Otherwise, cooling performance is likely to degrade, preventing the specified amplifier characteristics from being attained. Also, the service life of the semiconductors may be reduced.
When the amplifier is installed in a power magnetics cabinet having an air intake, fit an air filter to the intake and completely seal all cable holes and doors.

(2) The amplifier unit shall be installed in the cabinet, such that the unit is not exposed to contaminants (such as dust, cutting fluid, organic solvent, acid, corrosive gas, or salt).
The unit shall be shielded if used in an environment subject to radiation (such as microwaves, ultraviolet rays, laser light, or X–rays).

(3) No dust or cutting fluid shall enter the cabinet through an exhaust port. The flow of cooling air shall not be interrupted.

(4) During maintenance, the inspection, removal, and replacement of the unit, if necessary, shall not be unduly difficult.

(5) Cables carrying power shall be kept separate from those carrying signals. Appropriate countermeasures shall be applied to minimize the effect of noise. For details, see Section 7.3 and Chapter 9, and refer to the connection manual for the CNC being used.

7.2 SELECTING A GROUND FAULT INTERRUPTER

E series servo amplifiers drive motors using the PWM inverter method, which requires the use of transistors. High–frequency leakage current therefore flows to ground, via stray capacitance between the ground and motor coils, power cables, and amplifier. Such leakage current may cause the ground fault interrupter or leakage prevention relay, on the power supply side, to operate. To prevent this, use an inverter–compatible ground fault interrupter.

Motor model	Commercial frequency component
αE1/3000, αE2/3000, αE3/2000, αE6/2000,	1.8 mA

7.3 COUNTERMEASURES AGAINST NOISE

7.3.1 Separation of Signal Lines

Signal lines shall be separated from the amplifier and motor power lines. Handle the cables as follows:

Group	Cable	Handling
A	Amplifier input power line	Shall be separated from group B cables by means of separate binding(*1) or electromagnetic shielding(*2). A noise prevention device, such as a spark killer, shall be connected to the MMC drive coils.
	Motor power line	
	MCC drive coil	
B	Cable between CNC and amplifier	Shall be separated from group A cables by means of separate binding or electromagnetic shielding. Noise shielding shall always be provided.
	Pulse coder feedback cable	

Notes
1 Separate binding involves separating a bundle of one group from that of another group by at least 10 cm.
2 Electromagnetic shielding involves shielding one group from another group, using a grounded metal plate (steel).

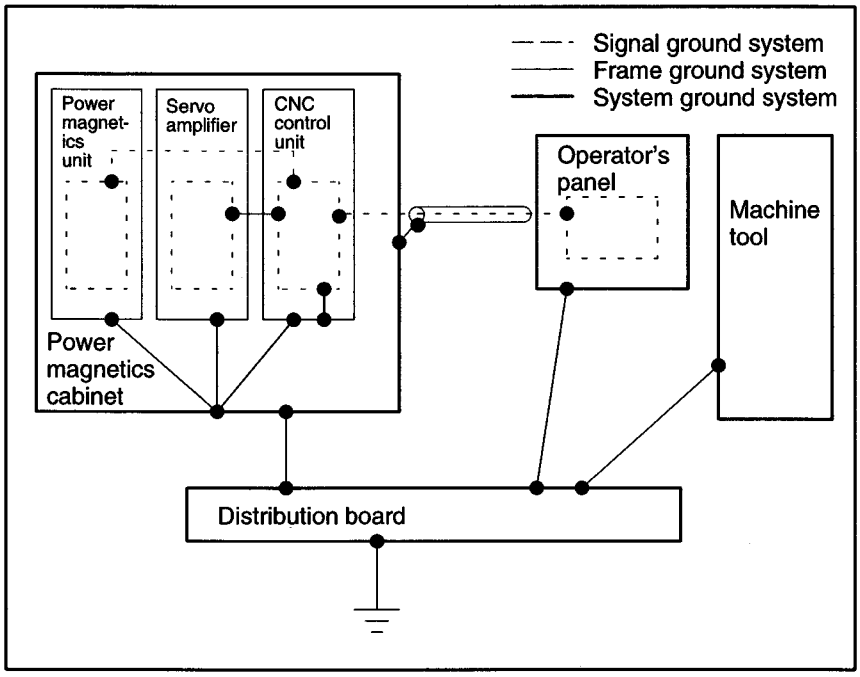
7.3.2 Grounding

CNC machine tools have the following three ground paths:

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

(b) Frame ground path (FG)
The frame ground path is provided as a safety measure, but also functions as shielding against external and internal noise. It includes the frame, case, and panels of a unit, and the shielding of the interface cables used to connect units.

(c) System ground path (SG)
The system ground path is a system–wide ground path, used to connect each frame ground path (FG) in the system to ground.

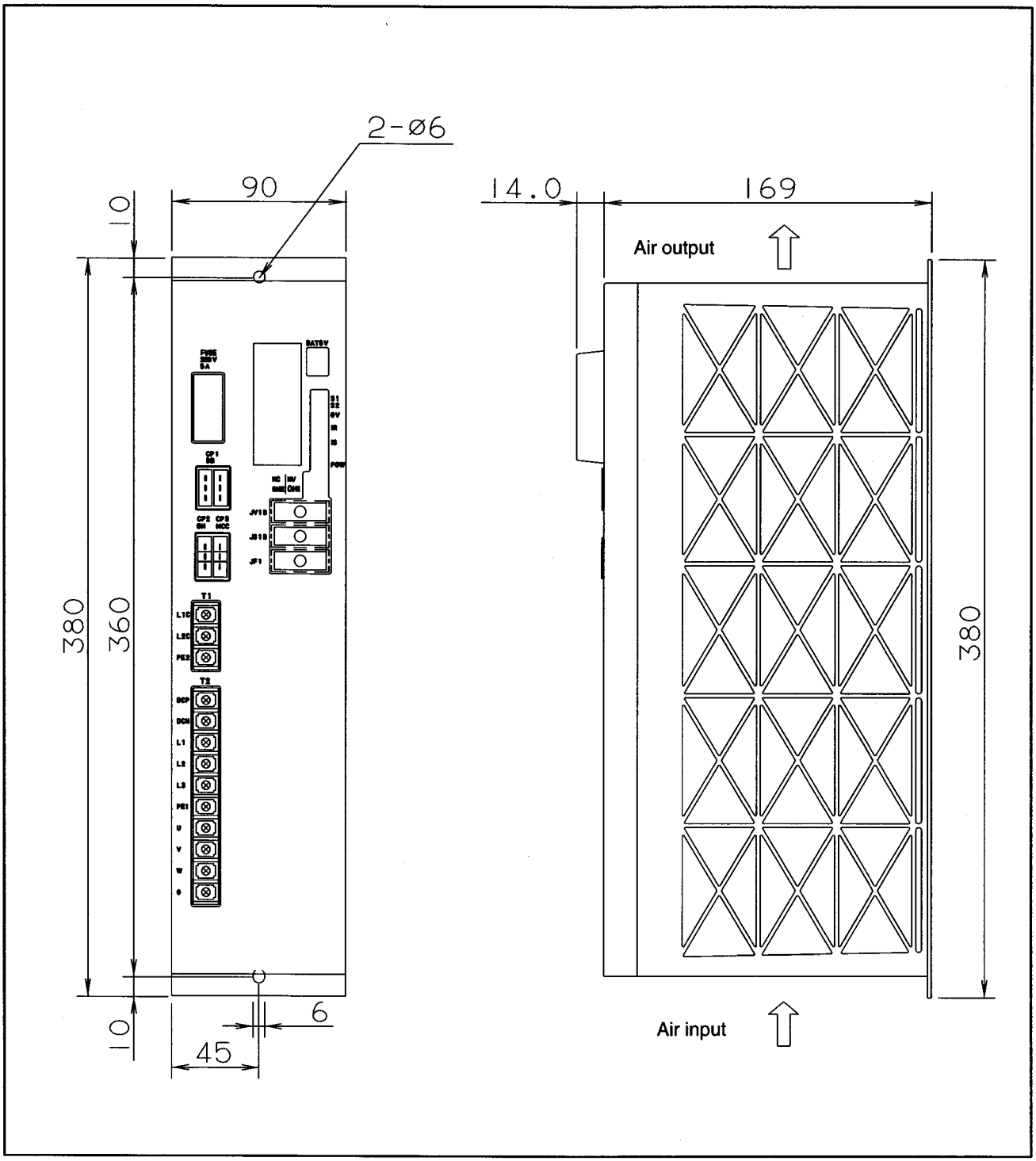


[Notes on ground wiring]

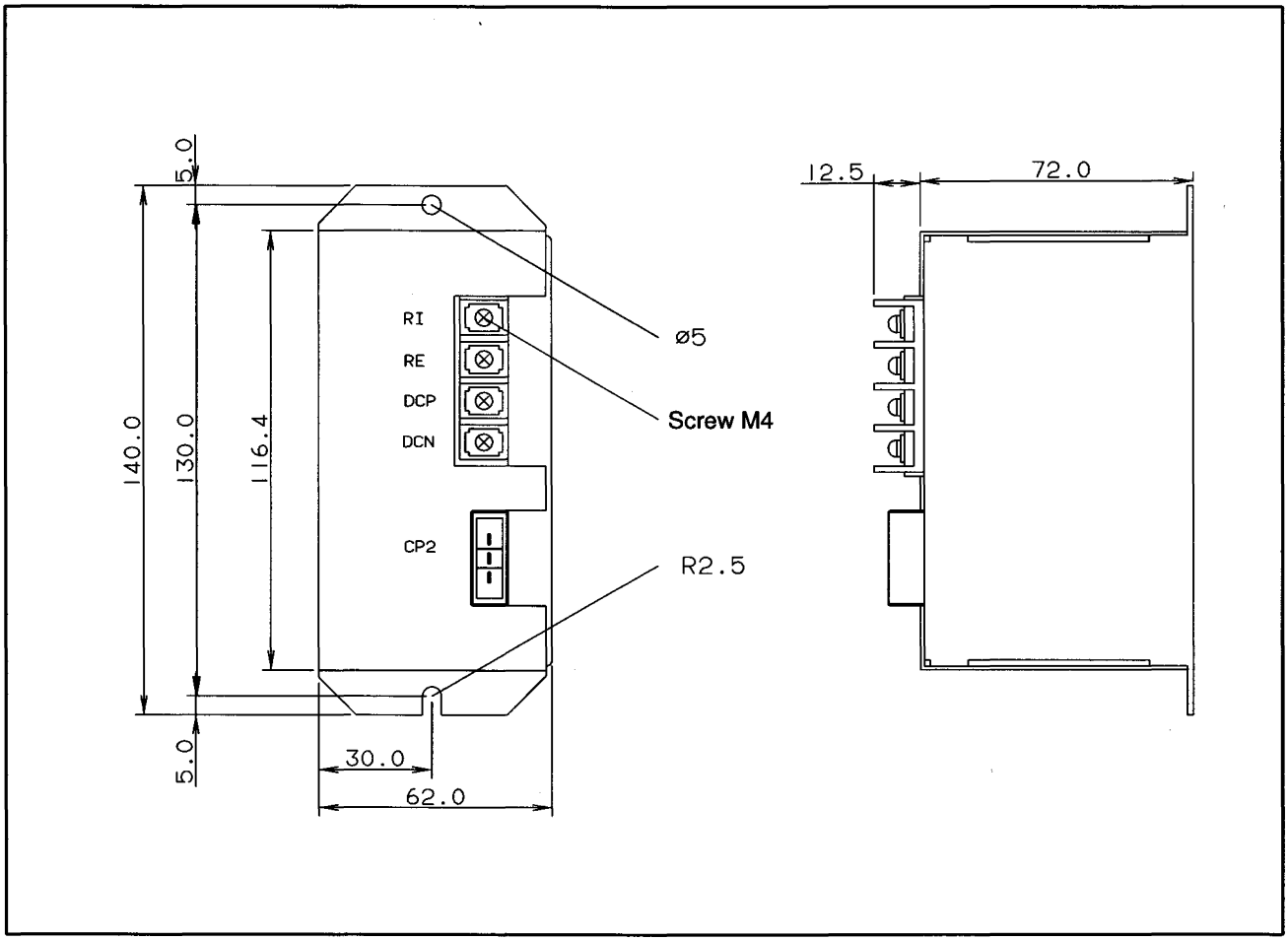
- The ground resistance for the system ground shall be no more than 100Ω (class 3 grounding).
- The cross–sectional area of the cable for the system ground shall be such that it can safely carry any fault current likely to flow into the system ground, for example, upon the occurrence of a short–circuit (in general, this shall be equal to or greater than the cross–sectional area of the AC power cable).
- The grounding cable for the system ground shall be combined with the AC power cable, to prevent power from being supplied without connecting the ground line.
  Section 2.1 details the specifications of the export–model power transformer.

8 OUTLINE DRAWINGS

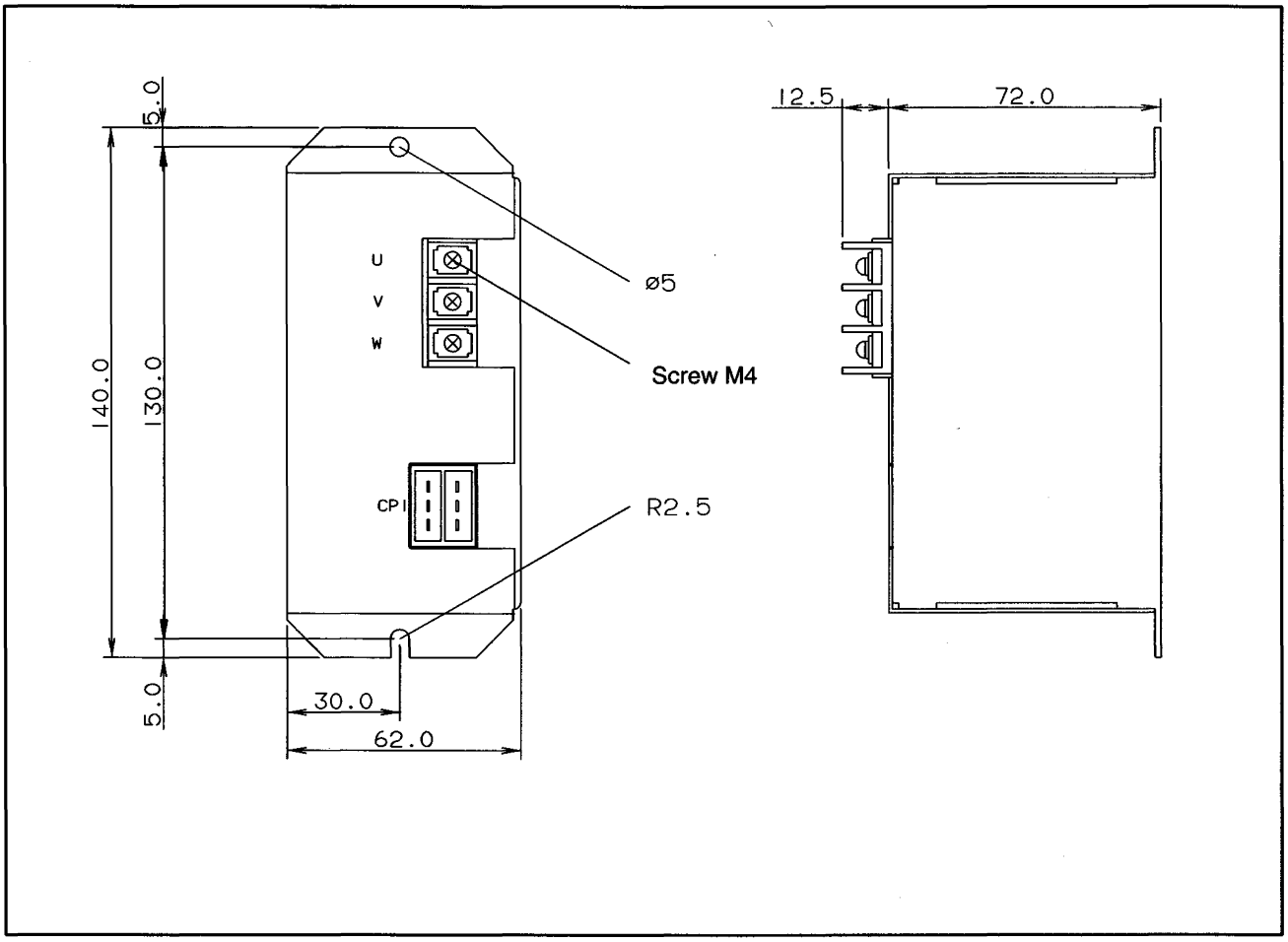
8.1 E SERIES AMPLIFIERS



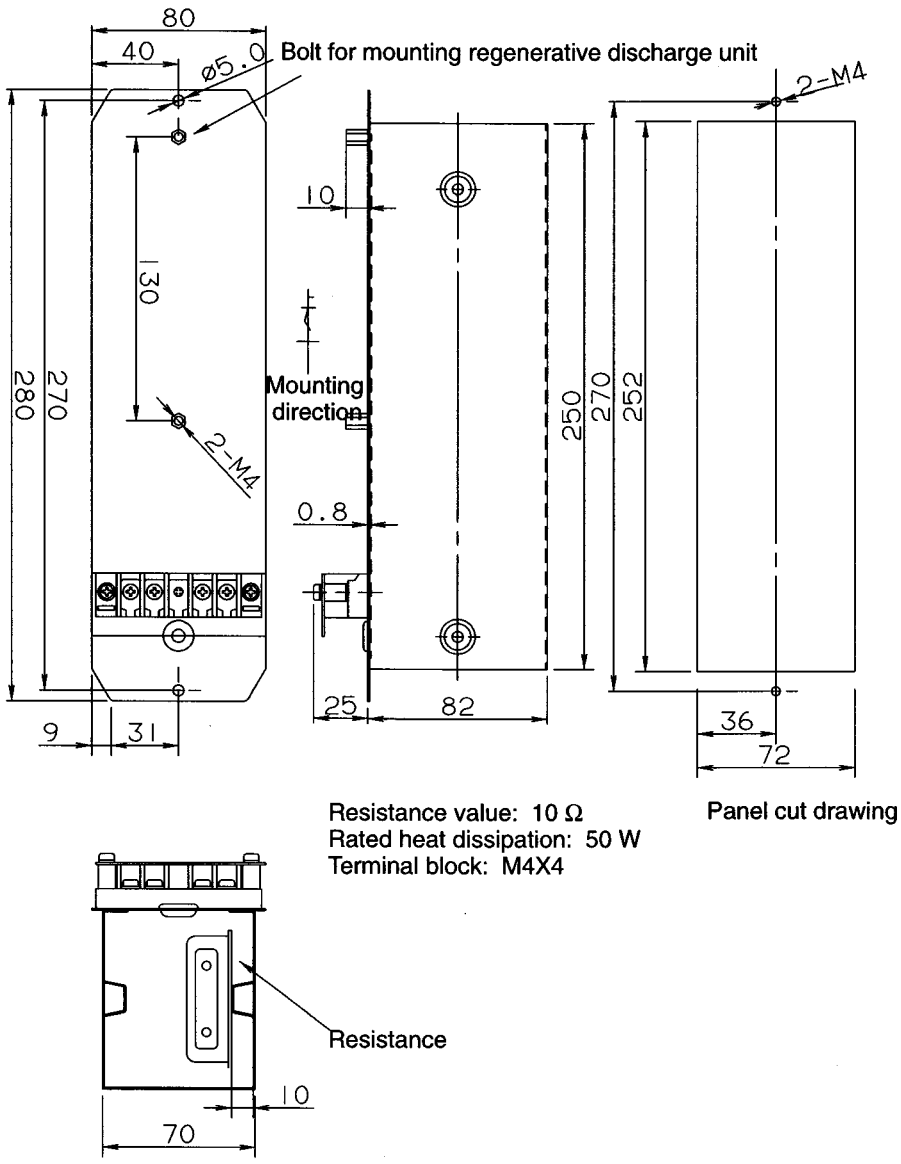
8.2 REGENERATIVE DISCHARGE UNIT (A06B–6070–H500)



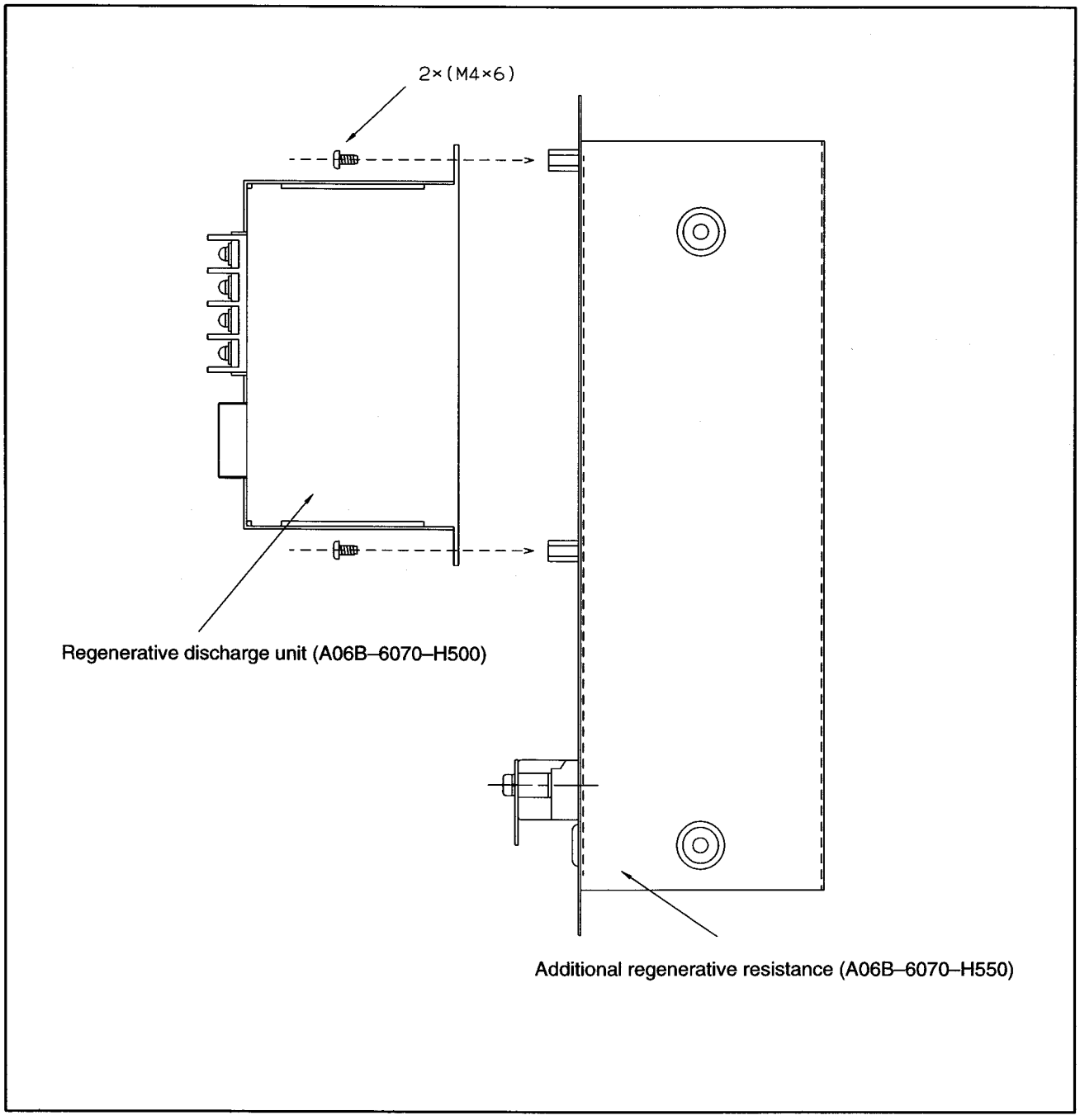
8.3 DYNAMIC BRAKE UNIT (A06B–6070–H600)



8.4 ADDITIONAL REGENERATIVE RESISTANCE (A06B–6070–H550)

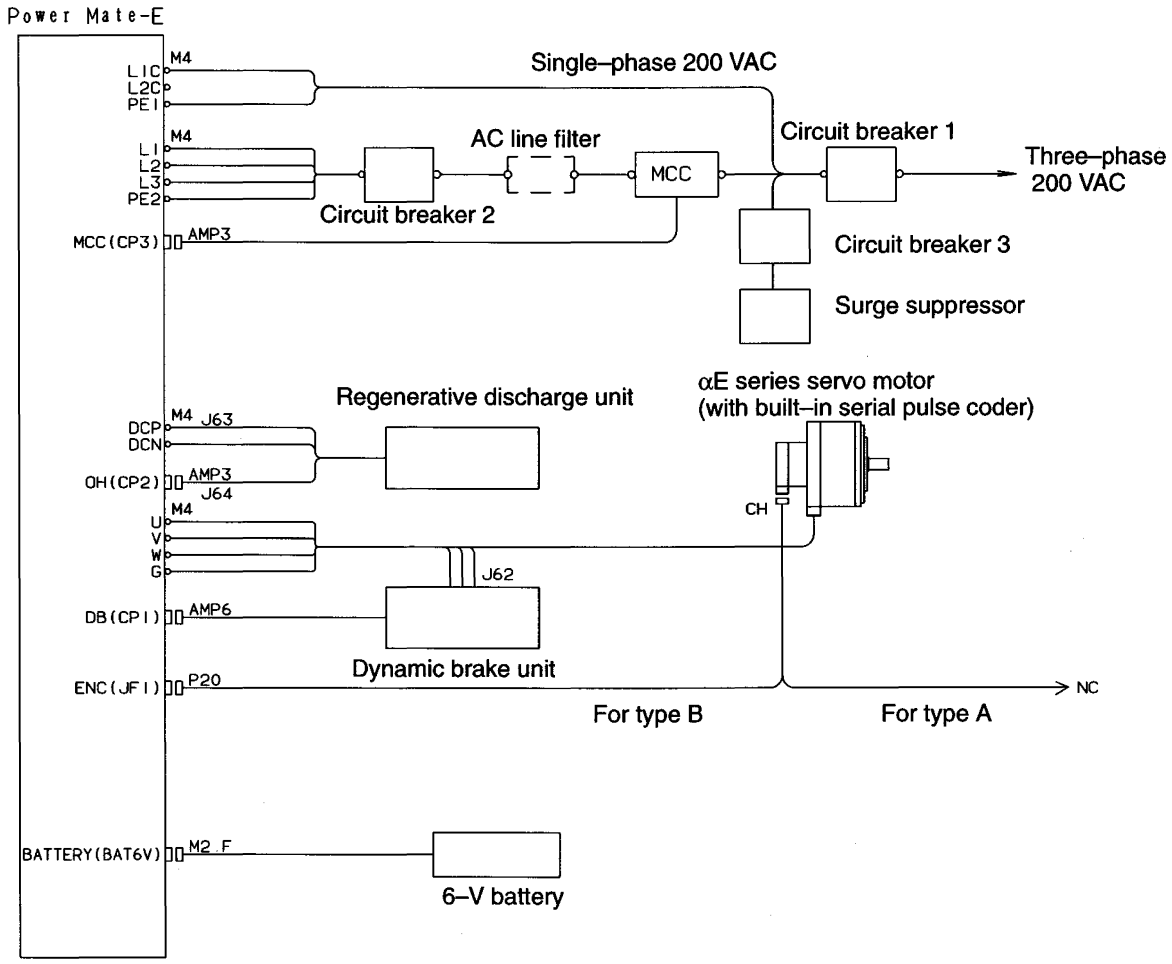


A regenerative discharge unit and additional regenerative resistance can also be mounted as shown below.

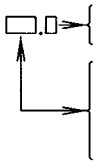


9 CONNECTIONS

9.1 OVERALL CONNECTION DIAGRAM FOR E SERIES AMPLIFIERS



Note 1) Connector and terminal symbols



M: Connector (male)
F: Connector (female)
H50: Honda Tsushin MR connector 50P
D15: D–subconnector 15P
D25: D–subconnector 25P
P20: Honda tsushin PCR connector
BN3: Burndy Brown
AMP3: AMP
AMP6: AMP
N2: Japan Aviation Electronics Industry
M2: MOLEX
M3: M3 screw terminal
M4: M4 screw terminal
CH: Varies depending on the AC motor being used

Note 2) For an explanation of surge suppressor installation, see Section 5.6.

9.2 CONNECTION TO NCS

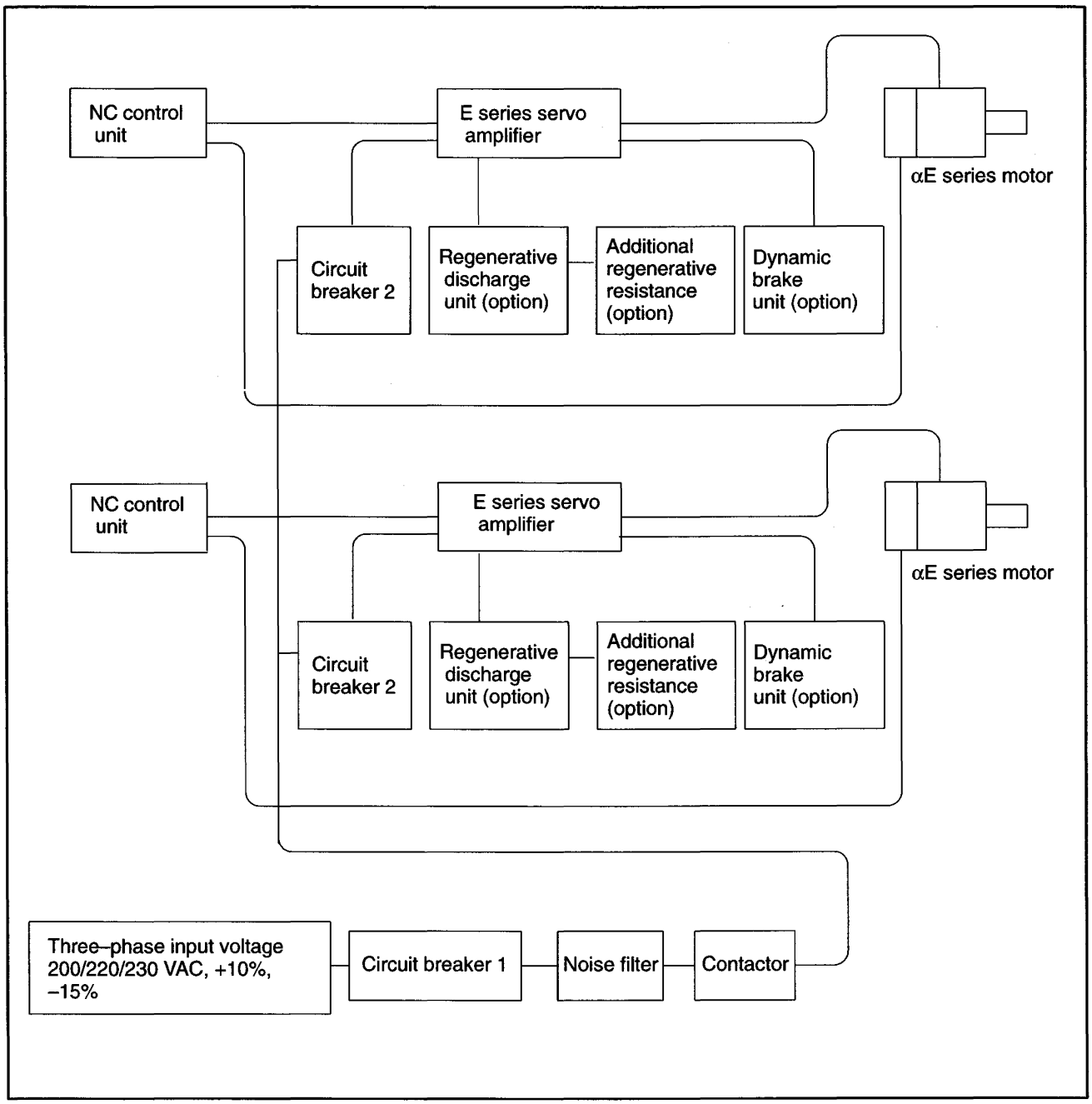
9.2.1 Interface

The E series servo amplifiers have two types of interfaces. Set the appropriate interface according to the table below.

NC interface		Interface switching
Type A	FS15–B, FS–16, FS–18, etc.	Insert the plug of the setting pin on the front panel into S1.
Type B	PM–H, PM–I, etc.	Insert the plug of the setting pin on the front panel into S2.

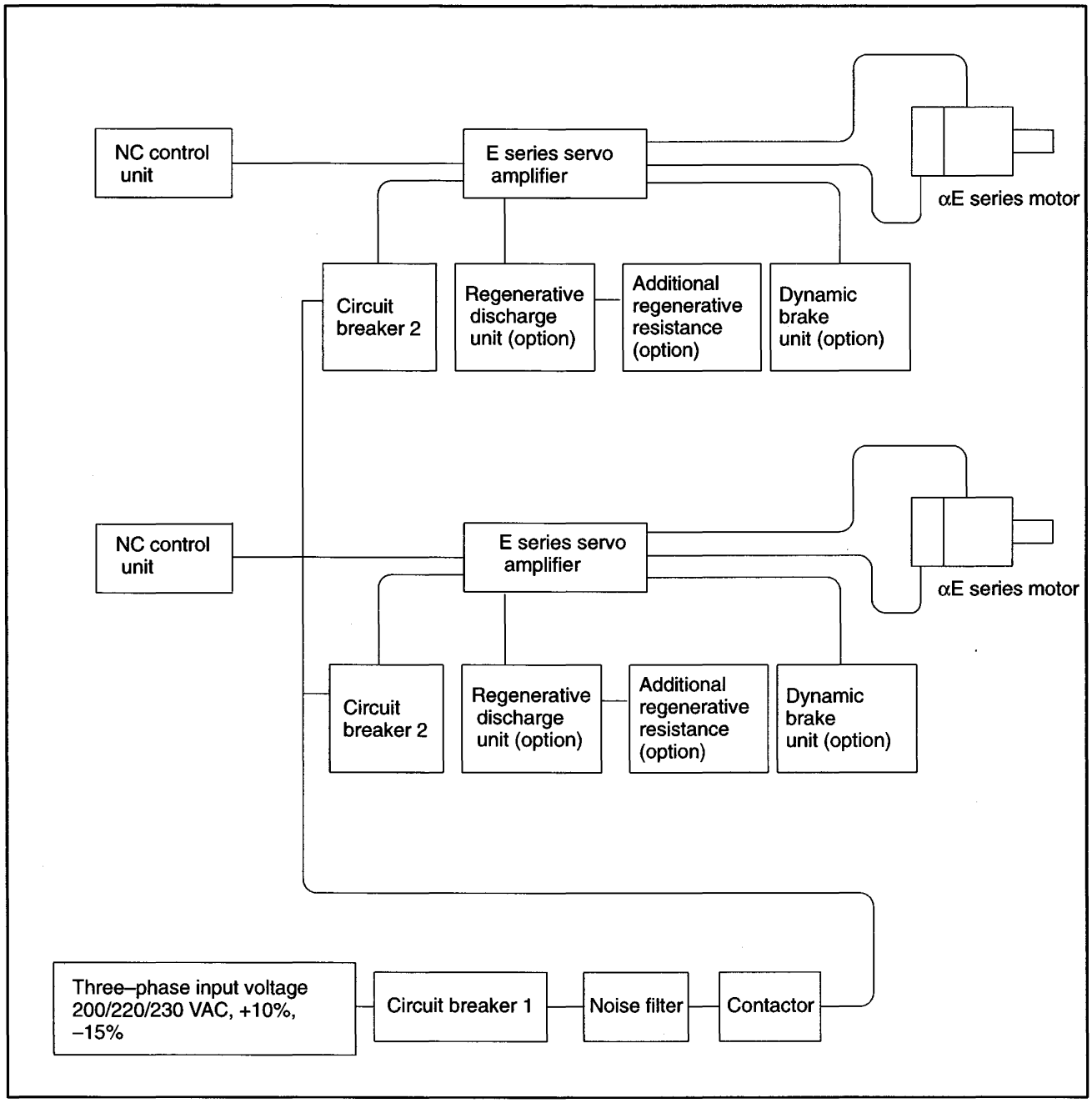
9.2.2 Connections for Type A

The figure below shows an example system configuration for two controlled axes. When type A is employed, the signal from the pulse coder of a motor is connected to the NC control unit. Depending on the load and operating conditions, options such as a regenerative discharge unit, additional regenerative resistance, and dynamic braking may be required.

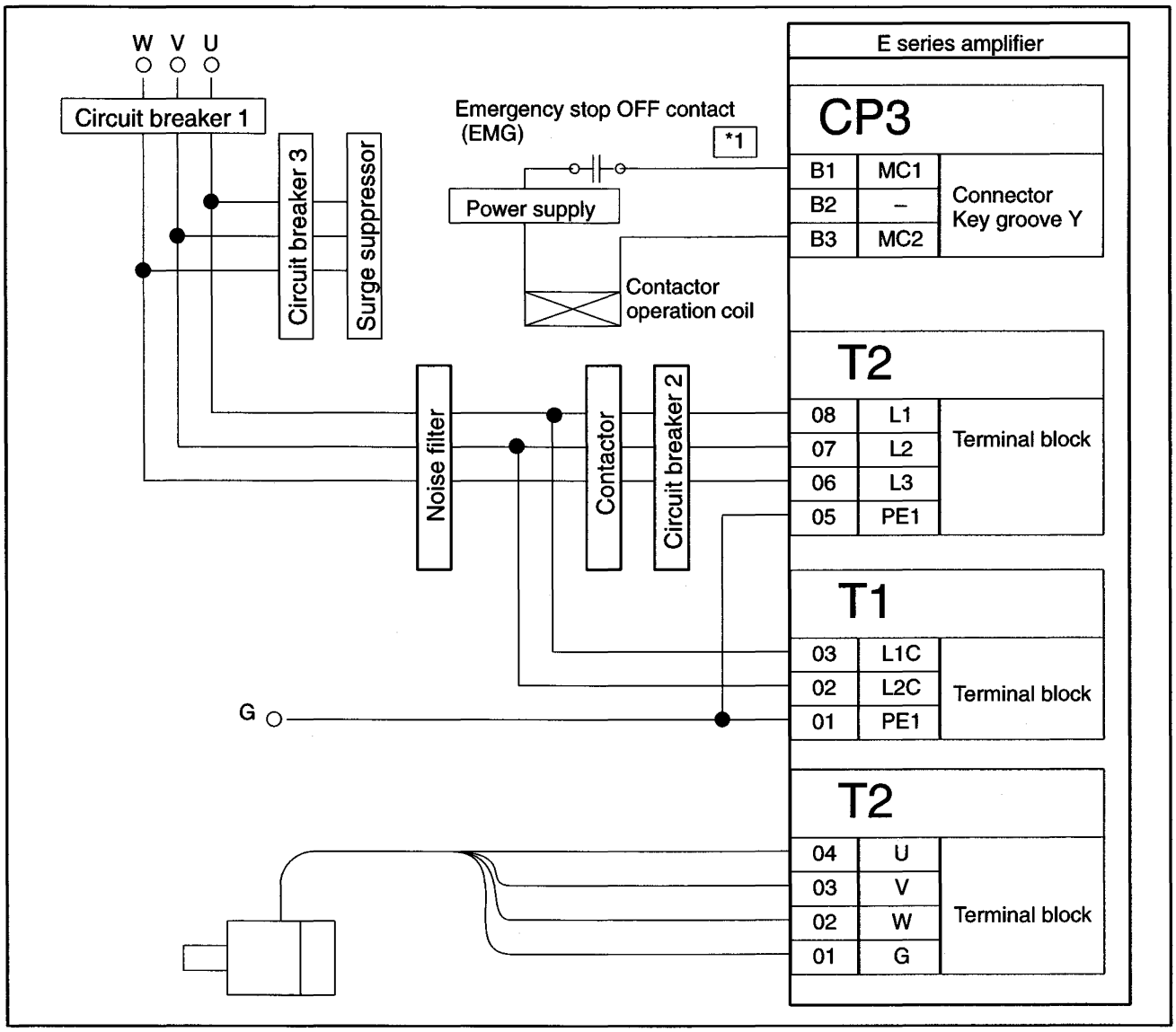


9.2.3 Connections for Type B

The figure below shows an example system configuration for two controlled axes. When type B is employed, the signal from the pulse coder of a motor is connected to the E series servo amplifier. Depending on the load and operating conditions, options such as a regenerative discharge unit, additional regenerative resistance, and dynamic braking may be required.



9.3 DETAILS OF E SERIES AMPLIFIER CONNECTION



Notes

1 *1 Connector CP3 is a relay contact. So, note that when only the power supply is directly connected, an internal relay may be damaged.
2 Circuit breaker 1 is used for power line protection. Circuit breaker 2 is used for servo amplifier protection.
3 Circuit breaker 3 protects against damage when the surge suppressor has been activated. For circuit breaker 3, the user should use a circuit breaker that has a contact for checking whether the circuit breaker is open. For information about surge suppressor installation, see Section 5.6

9.4 CABLES FOR CONNECTION TO THE E SERIES AMPLIFIER INPUT SECTION

<table>
<tr><th>Name</th><th>Application</th><th>Specification</th></tr>
<tr><td>J59</td><td>External contactor control</td><td>
<table>
<tr><td>Conductor structure/cross–sectional area</td><td>Amplifier terminal</td></tr>
<tr><td>30/0.18(0.75mm^2)</td><td>Housing (Y)
AMP 2–178128–3
Contact
AMP 1–175218–2</td></tr>
</table>
600–V heat–resistant vinyl wire or cabtyre cable
</td></tr>
<tr><td>J58</td><td>Cable for amplifier power input</td><td>
<table>
<tr><td>Motor model</td><td>Conductor structure/cross–sectional area</td><td>Amplifier terminal</td></tr>
<tr><td>αE1/3000, αE2/3000,
αE3/2000, αE6/2000</td><td>37/0.26(2.0mm^2)</td><td>T2–4</td></tr>
</table>
600–V heat–resistant vinyl wire or cabtyre cable
</td></tr>
<tr><td>J57</td><td>Cable for control power</td><td>
<table>
<tr><td>Conductor structure/cross–sectional area</td><td>Amplifier terminal</td></tr>
<tr><td>30/0.18(0.75mm^2)</td><td>T1.25–4</td></tr>
</table>
600–V heat–resistant vinyl wire or cabtyre cable
</td></tr>
<tr><td>J60</td><td>Amplifier/motor power cable</td><td>
<table>
<tr><td>Motor model</td><td>Conductor structure/cross–sectional area</td><td>Amplifier terminal</td></tr>
<tr><td>αE1/3000, αE2/3000</td><td>30/0.18(0.75mm^2)</td><td>T1.25–4S</td></tr>
<tr><td>αE3/2000, αE6/2000</td><td>37/0.26(2.0mm^2)</td><td>T2–4S</td></tr>
</table>
600–V heat–resistant vinyl wire or cabtyre cable
</td></tr>
</table>

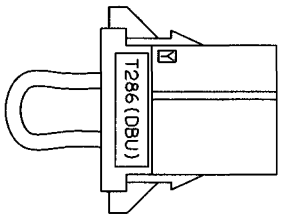
Dummy connectors

- **When the dynamic brake unit is not connected**

Insert a dummy connector (A06B–6070–K001) into CP1 (IL).

Component	Specification	Quantity
Cable	200–V heat–resistant vinyl wire 30/0.18 (0.75 mm^2)	About 50 mm
Housing (Y key)	AMP 2–178288–3	1
Contact	AMP 1–175218–2	2

Assembly drawing

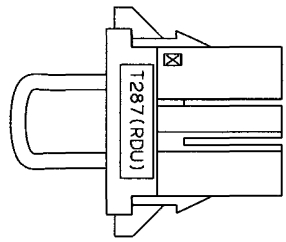


- **When the regenerative discharge unit is not used**

Insert a dummy connector (A06B–6070–K002) into CP2.

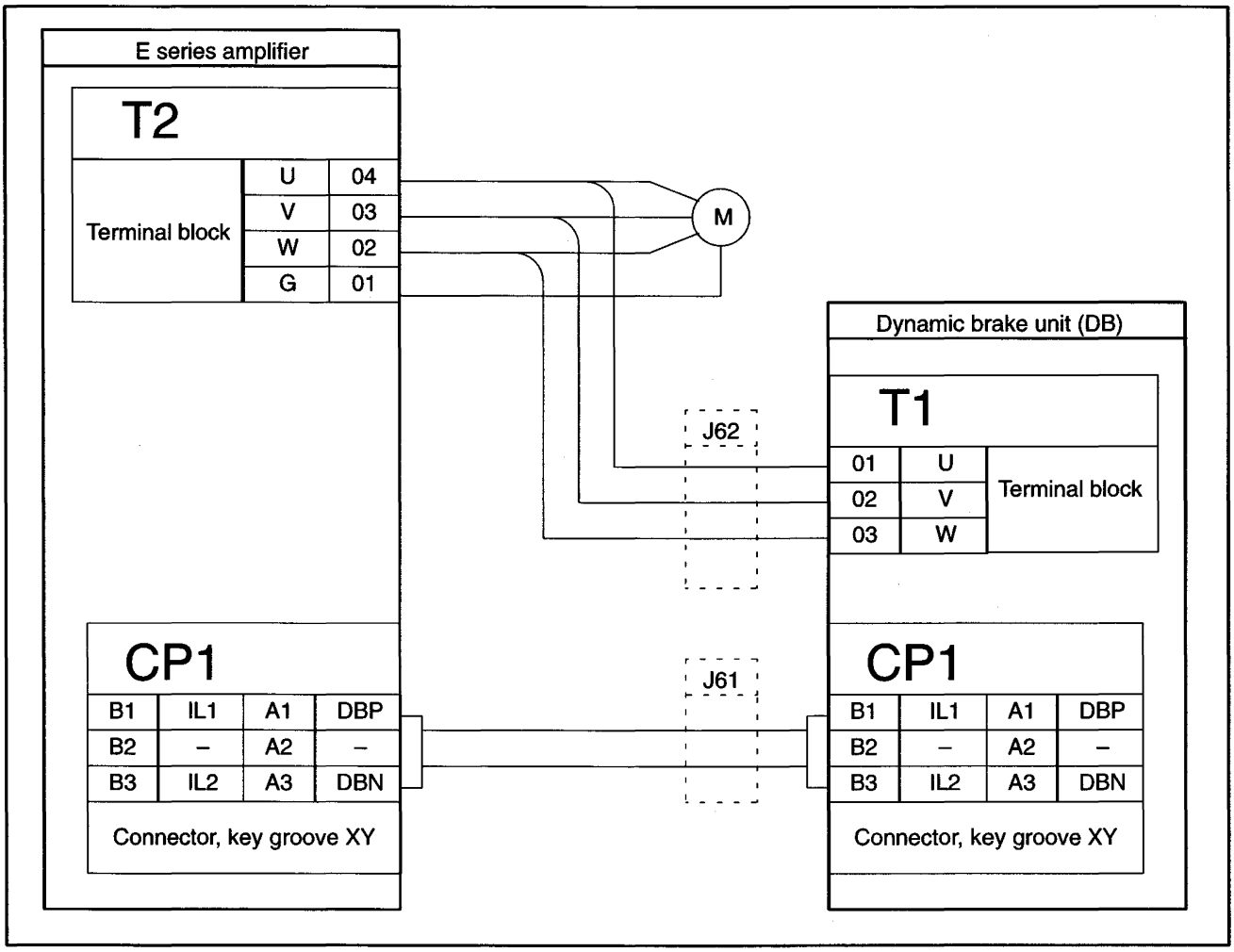
Component	Specification	Quantity
Cable	200–V heat–resistant vinyl wire 30/0.18 (0.75 mm^2)	About 50 mm
Housing (X key)	AMP 1–178128–3	1
Contact	AMP 1–175218–2	2

Assembly drawing



9.5 CONNECTION OF OPTIONS

9.5.1 Connection of Dynamic Brake Unit



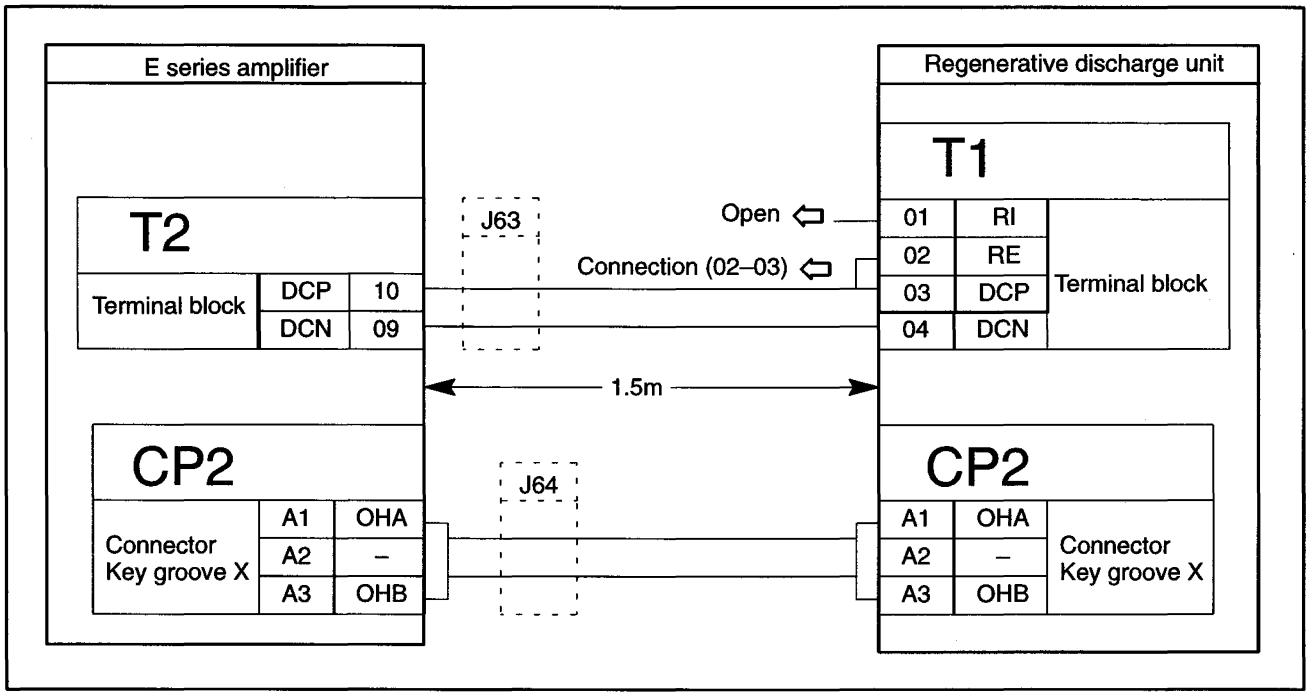
Cables for connection to the dynamic brake unit

<table>
<tr><th>Name</th><th>Application</th><th>Specification</th></tr>
<tr><td>J62</td><td>Amplifier/DB cable</td><td>
<table>
<tr><th>Motor model</th><th>Conductor structure/cross–sectional area</th><th>Amplifier terminal</th><th>DB terminal</th></tr>
<tr><td>αE1/3000, αE2/3000,</td><td>30/0.18(0.75mm^2)</td><td>T1.25–4S</td><td>T1.25–4S</td></tr>
<tr><td>αE3/2000, αE6/2000</td><td>37/0.26(2mm^2)</td><td>T2–4S</td><td>T2–4S</td></tr>
</table>
600–V heat–resistant vinyl wire or cabtyre cable
</td></tr>
<tr><td>J61</td><td>Amplifier/DB cable</td><td>
<table>
<tr><th>Conductor structure/ cross–sectional area</th><th>Amplifier terminal</th><th>DB terminal</th></tr>
<tr><td>30/0.18(0.75mm^2)</td><td>Housing (XY)
AMP 3–178127–6
Contact
AMP 1–175218–2</td><td>Housing (XY)
AMP
3–178127–6
Contact
AMP
1–175218–2</td></tr>
</table>
Note) Twisted pair cables are used for IL1 and IL2 connection.

200–V heat–resistant vinyl wire
</td></tr>
</table>

9.5.2 Connection of Regenerative Discharge Unit

When only a regenerative discharge unit is connected



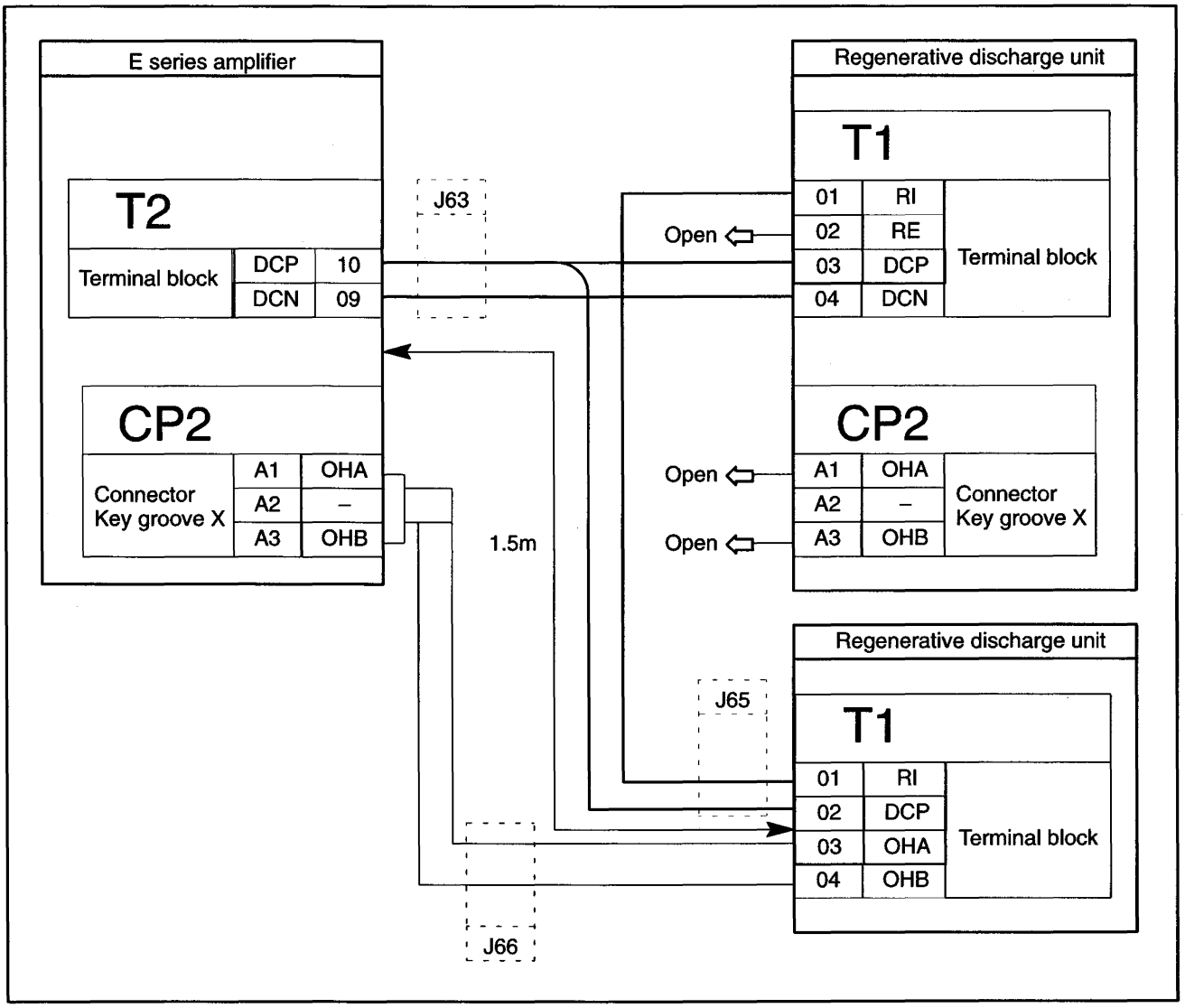
Notes

The cable between the E series amplifier and regenerative discharge unit must not be longer than 1.5 m.

Cables for connection to the regenerative discharge unit

<table>
<tr><th>Name</th><th>Application</th><th>Specification</th></tr>
<tr><td>J63</td><td>Amplifier/regenerative discharge unit cable</td><td>
<table>
<tr><td>Conductor structure/cross–sectional area</td><td>Amplifier terminal</td><td>Regenerative discharge unit</td></tr>
<tr><td>37/0.26(2.0mm^2)</td><td>T2–4S</td><td>T2–4S</td></tr>
</table>
600–V heat–resistant vinyl wire
</td></tr>
<tr><td>J64</td><td>Amplifier/regenerative discharge unit cable</td><td>
<table>
<tr><td>Conductor structure/cross–sectional area</td><td>Amplifier terminal</td><td>Regenerative discharge unit</td></tr>
<tr><td>30/0.18(0.75mm^2)</td><td>Housing (X)
AMP 1–178128–3
Contact
AMP 1–175218–2</td><td>Housing (X)
AMP
1–178128–3
Contact
AMP
1–175218–2</td></tr>
</table>
Note) Twisted pair cables are used for OHA and OHB connection.
200–V heat–resistant vinyl wire
</td></tr>
</table>

When a regenerative discharge unit and additional regenerative resistance are used



Notes

The cables between the E series amplifier and regenerative discharge unit, and between the E series amplifier and additional regenerative resistance must not be longer than 1.5 m. The cables should be routed in parallel where possible.

Cables for connection to the regenerative discharge unit and additional regenerative resistance

<table>
<tr><th>Name</th><th>Application</th><th>Specification</th></tr>
<tr><td>J63</td><td>Amplifier/regenerative discharge unit cable</td><td>
<table>
<tr><td>Conductor structure/cross–sectional area</td><td>Amplifier terminal</td><td>Regenerative discharge unit</td></tr>
<tr><td>37/0.26(2.0mm^2)</td><td>T2–4S</td><td>T2–4S</td></tr>
</table>
600–V heat–resistant vinyl wire
</td></tr>
<tr><td>J65</td><td>Amplifier/regenerative discharge unit/ additional regenerative resistance cable</td><td>
<table>
<tr><td>Conductor structure/cross–sectional area</td><td>Amplifier terminal</td><td>Regenerative discharge unit</td><td>Additional regenerative resistance</td></tr>
<tr><td>37/0.26(2.0mm^2)</td><td>T2–4S</td><td>T2–4S</td><td>T2–4S</td></tr>
</table>
600–V heat–resistant vinyl wire
</td></tr>
<tr><td>J66</td><td>Amplifier/additional regenerative resistance cable</td><td>
<table>
<tr><td>Conductor structure/cross–sectional area</td><td>Amplifier terminal</td><td>Additional regenerative resistance</td></tr>
<tr><td>30/0.18(0.75mm^2)</td><td>Housing (X)
AMP 1–178128–3
Contact
AMP 1–175218–2</td><td>T1.25–4</td></tr>
</table>
Note) Twisted pair cables are used for OHA and OHB connection.
</td></tr>
</table>

IV. SERVO PARAMETERS

1 OVERVIEW

To use E servo motor and αE series servo motor, you must first prepare the digital servo software of the corresponding series/edition listed in following table.
The series of the digital servo software varies with CNC models.

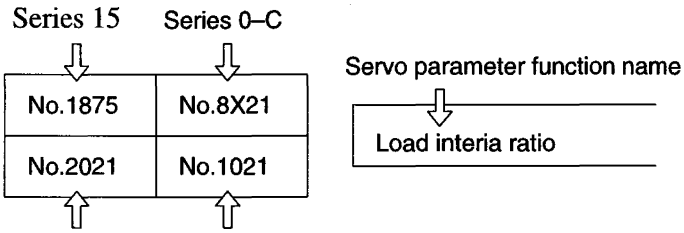
CNC model	Servo software series (E series)	Servo software series (αE series)	Module
Series 0–C Series 15–A	9046 Series / 001B~	9046 Series / 001G~	Axis board for a serial pulse coder
Series 15–B(68030) Series 16–A Series 18 Series 20 Power Mate–MODEL H Power Mate–MODE I	9060 Series / 001M~	9060 Series / 001W~	47 MHz servo module
Series 15–B(68040) Series 16–B	9070 Series / 001A~ 9080 Series / 001A~	9070 Series / 001H~ 9070 Series / 001H~	320C51 servo module 320C52 servo module
Series 21 Power Mate–MODEL D Power Mate–MODEL F	9060 Series / 001M~ (*1)	9060 Series / 001W~ (*1)	47 MHz servo module
Power Mate–MODEL E	9064 Series / 001E~	9064 Series / 001F~	

Notes
*1 For Series 21, Power Mate–MODEL D and F, the NC software editions listed below are applicable to the E series servo motors and αE series servo motor .

Series 21 Power Mate–MODEL D	8866 Series / 001C~ 8831 Series / 001C~ 8836 Series / 001A~
Power Mate–MODEL F	8870 Series / 001B~

In this manual, the servo parameters are explained using the following notation:

(Example)



Series 16, 18, 20, 21 Power Mate–MODEL E
Power Mate–MODEL D, F, H, I

2 INITIALIZING SERVO PARAMETERS

2.1 BEFORE SERVO PARAMETER INITIALIZATION

Before starting servo parameter initialization, confirm the following:

1. NC model (ex.: Series 15–B)
2. Servo motor model (ex.: αE 6/2000)
3. Pulse coder built in a motor (ex.: α pulse coder)
4. Is the separate position detector used? (ex.: Not used)
5. Distance the machine tool moves per revolution of the motor (ex.: 10mm per one revolution)
6. Machine detection unit (ex.: 0.01 mm)
7. NC command unit (ex.: 0.01 mm)

2.2 SERVO PARAMETER INITIALIZATION PROCEDURE

1. Switch on the NC in an emergency stop state.
   Enable parameter writing (PWE = 1).
2. Initialize servo parameters on the servo setting screen.
   For a Power Mate with no CRT, specify a value for an item number on the servo setting screen. See Fig. 2.2 (a).
   To display the servo setting screen, follow the procedure below, using the key on the NC.

Series 0–C

Press the PARAM key several times, and the servo setting screen will appear.

If no servo screen appears, set the following parameter as shown, and switch the NC off and on again.

	b7	b6	b5	b4	b3	b2	b1	b0
No.389								SVS

SVS (b0) = 0 (to display the servo screen)

Series 15

Press the SERVICE key several times, and the servo setting screen will appear.

Series 16,18,20,21

SYSTEM → [SYSTEM] → [▷] → [SV–PRM]

If no servo screen appears, set the following parameter as shown, and switch the NC off and on again.

	b7	b6	b5	b4	b3	b2	b1	b0
No.3111								SVS

SVS (b0) = 1 (to display the servo screen)

When the following screen appears, move the cursor to the item you want to specify, and enter the value directly.

Servo set			01000 N0000
		X axis	Z axis
INITIAL SET BITS		00011010	00001010
Motor ID No.		16	16
AMR		00000000	00000000
CMR		2	2
Feed gear	N	1	1
(N / M)	M	100	100
Direction Set		111	–111
Velocity Pulse No.		8192	8192
Position Pulse No.		12500	12500
Ref. counter		10000	10000
Value SETTING			

⇦

Power Mate MODEL F, G, H, I	Power Mate MODEL E
No. 2000	No. 1000
2020	1020
2001	1001
1820	100
2084	1084
2085	1085
2022	1022
2023	1023
2024	1024
1821	324

Fig.2.2(a) Servo setting menu

⇧ **Correspondence of Power Mate**

3. Start initialization.

INITIAL SET BITS

b7	b6	b5	b4	b3	b2	b1	b0
			1	1		DGPR	0

b4: Position gain setting range extension function bit(Set this bit to 1.)

b3: 0(FS0–C)

1(other than FS0–C)⇨ (This bit is automatically set to 1.)

DGPR (b1) =0 ⇦ Automatically set to 1 after initialization.

4. Specify the motor ID No.

Select the motor ID No. according to the model and specification (four digits in the middle segment of A06B–XXXX–BXXX) of your motor.

⇧

Motor model	E1/3000 αE1/3000	E2/3000 αE2/3000	αE3/2000	E6/2000 αE6/2000
Motor specification	0101	0102	0105	0106
Motor type No.	35	36	33	34

5. Set AMR as described below:

α pulse coder	00000000

6. Set CMR with the scale of a distance the NC instructs the machine to move.

   CMR = Command unit / Detection unit

CMR 1/2 ~ 48	Setting value = CMR×2

   Usually, CMR = 1, so specify 2.

7. Specify the flexible feed gear (F.FG). This function makes it easy to specify a detection unit for the leads and gear reduction ratios of various ball screws by changing the number of position feedback pulses from the pulse coder and separate detector.

Setting for the α pulse coder in the semi–closed mode

$$\frac{\text{F.FG numerator } (\leqq 32767)\ \text{⇩ (Note1)}}{\text{F.FG denominator } (\leqq 32767)} = \frac{\text{Necessary position feedback pulses per motor revolution}}{1{,}000{,}000} \quad \text{(as irreducible fraction)}$$

Notes

For both F.FG numerator and denominator, the maximum setting value (after reduced) is 32767.

(Example of setting)

For detection in 10 μ m units, specify as follows:

Ball screw lead	Number of necessary position pulses	F&FG
10 (mm/rev)	1000(pulses/rev)	1/1000
20	2000	2/1000 or 1/500
30	3000	3/1000

(Example of setting)

If the machine is set to detection in 100 degree units with a gear reduction ratio of 10:1 for the rotation axis, the table rotates by 360/10 degrees each time the motor makes one turn. 100 position pulses are necessary for the table to rotate through one degree. The number of position pulses necessary for the motor to make one turn is:

$$360/10 \times 100 = 3600$$

$$\frac{\text{F.FG numerator}}{\text{F.FG denominator}} = \frac{3600}{1{,}000{,}000} = \frac{36}{10000}$$

Setting for use of a separate detector (full–closed)

$$\frac{\text{F.FG numerator } (\leqq 32767)}{\text{F.FG denominator } (\leqq 32767)} = \frac{\text{Necessary position feedback pulses per motor revolution}}{\text{Actual position feedback pulses from separate detector per motor revolution}} \quad \text{(as irreducible fraction)}$$

Notes
DMR can also be used with the separate position detector, provided that F.FG = 0.

(Example of setting)
When a separate position detector detects 1 μm m with a 1 μm scale

Ball screw lead	Number Of Position Pulses From The Separate Position Detector	F . F G
1(mm / rev)	1000 (pulses/rev)	1/1
5	5000	1/1
10	10000	1/1

8. Specify the direction in which the motor rotates.

111	Clockwise as viewed from the pulse coder
–111	Counterclockwise as viewed from the pulse coder

9. Specify the number of velocity pulses and the number of position pulses.

	Semi–closed	Full–closed
Initialization bit	b0=0	b0=0
Number of velocity pulses	8192	8192
Number of position pulses	12500	Np

Np:Number of position pulses from the separate detector when the motor makes one turn

When using a separate detector (full–closed mode), also specify the following parameters:

Series 0–C

	b7	b6	b5	b4	b3	b2	b1	b0
No.37			STP8	STP7	STP4	STPZ	STPY	STPX

STPX to 8 The separate position detector is:

0 : Not used for the X–axis, Y–axis, Z–axis, fourth axis, seventh axis, or eighth axis

1 : Used for the X–axis, Y–axis, Z–axis, fourth axis, seventh axis, and eighth axis

Series 15, 16, 18, 20, 21, Power Mate–MODEL D, F, H, I

	b7	b6	b5	b4	b3	b2	b1	b0
No.1807 No.2002					PFSE			

⇧ Must be specified only for Series 15

PFSE (b3) The separate position detector is:

0 : Not used

1 : Used

Notes
This parameter is used only for Series 15.

	b7	b6	b5	b4	b3	b2	b1	b0
No.1815							OPTX	

⇧ Must be specified for all NCs.

OPTX (b1) The separate position detector is:

0 : Not used

1 : Used

Notes
For Series 16, 18, 20, and 21, setting this parameter causes bit 3 of parameter No. 2002 to be set to 1 automatically.

Power Mate–MODEL E

	b7	b6	b5	b4	b3	b2	b1	b0
No.1002	GRSL				PFSE			

GRSL (b7) PFSE (b3)

The separate position detector is:

0 : Not used

1 : Used

Specify the same value for both GRSL and PFSE.

10. Specify the reference counter. The reference counter is used in making a return to the reference position by a grid method. The value to be specified is the number of pulses necessary for the motor to make one turn, or a value obtained by dividing the number by an integer.

(Example of setting)

α pulse coder, semi–closed (detection in 1 μm units)

Ball screw lead	Number of necessary position pulses	Reference counter	Grid width
10 mm/rev	10000 pulses/rev	10000	10 mm
20	20000	20000	20
30	30000	30000	30

(Example of setting)

α pulse coder, semi–closed (detection in 10 μm units)

Ball screw lead	Number of necessary position pulses	Reference counter	Grid width
10 mm/rev	1000 pulses/rev	1000	10 mm
20	2000	2000	20
30	3000	3000	30

11. Switch the NC off and on again.

This completes servo parameter initialization. If an invalid servo parameter setting alarm occurs, go to Chapter 3.

If a servo alarm related to pulse coders occurs for an axis for which a servo motor or amplifier is not connected, specify the following parameter.

A feedback connector is used in conventional Series 0–C and 15–A models. However it does not need in a system designed for operation with an α pulse coder.

No.1953	No.8X09
No.2009	No.1009

b7	b6	b5	b4	b3	b2	b1	b0
							SERD

SERD (b0) The serial feedback dummy function is:

0 : Not used

1 : Used

12. When using an α pulse coder as an absolute pulse coder, use the procedure below. When absolute position communication is set using an pulse coder, the procedure is somewhat different from that for conventional pulse coders. (That is, steps 3 through 5 are added.)

1. Specify the following parameter, then switch the NC off.

Series 0–C

	b7	b6	b5	b4	b3	b2	b1	b0
No.21			APC8	APC7	APC4	APCZ	APCY	APCX

APCX to 8 The absolute position detector is:

0 : Not used for the X–axis, Y–axis, Z–axis, fourth axis, seventh axis, or eighth axis.

1 : Used for the X–axis, Y–axis, Z–axis, fourth axis, seventh axis, and eighth axis.

Series 15, 16, 18, 20, 21, Power Mate–MODEL D, F, H, I

	b7	b6	b5	b4	b3	b2	b1	b0
No.1815			APCX					

APCX (b5) The position detector to be used is:

0 : Other than an absolute position detector

1 : Absolute position detector

Power Mate–MODEL E

	b7	b6	b5	b4	b3	b2	b1	b0
No.21								APCX

STPX (b0) An absolute position detector is:

0 : Not used

1 : Used

2. After making sure that the battery for the pulse coder is connected, switch the NC on.

3. Absolute position communication is performed, and a request to return to the reference position is displayed.

4. Cause the motor to make one turn by jogging.

5. Turn off and on the CNC.

⇦ These steps were added.

6. You can see the message "NEED ZERO RETURN."

7. Do the zero return.

3 ACTIONS FOR INVALID SERVO PARAMETER SETTING ALARMS

The following table contains actions to be taken for invalid servo parameter setting alarms.
Find the relevant guideline under "Decision criterion," and proceed to the corresponding "Adjustment item."

Alarm	Decision criterion	Adjustment item
POA1 overflow	Try resetting POA1 to 0. Parameter: No. 8X47–1859–2047 = 0	Adjustment 1
N pulse suppression level overflow	Disable the N pulse suppression function. Function bit: No. 8X03–1808–2003 = 0	Adjustment 2
Feed–forward coefficient overflow	Reset the feed–forward coefficient to 0. Parameter: No. 8X68–1961–2068 = 0 No. 8X92–1985–2092 (advance) = 0	Adjustment 3
Position gain overflow	Reset the position gain to 0. Parameter: No. 517–1825–1825 = 0	Adjustment 4
Number of position pulses overflow	The number of position pulses is greater than 13100 (with initialization bit 0 = 1). Parameter: No. 8X00–1804–2000	Adjustment 5
Motor ID No.	Check whether the motor ID No. is correct. Parameter: No. 8X20–1874–2020	Adjustment 6
Invalid axis selection parameter setting	Check whether the setting is correct. Series 0–C: No. 269 to 274 Series 15, 16, 18, 20, 21: No. 1023	
Others	Number of position pulses ≦ 0 Number of velocity pulses ≦ 0 Direction of travel = 0 Flexible feed gear numerator < 0, denominator < 0 For semi–closed mode, numerator > denominator	

Notes
The parameter numbers in the table are in the following order:
No. (Series 0–C)–(Series 15)–(Series 16,18,20,21)

3.1 ADJUSTMENTS

Adjustment 1: POA1 overflow (No. 8X47–1859–2047)

Use the POA1 setting tenfold function

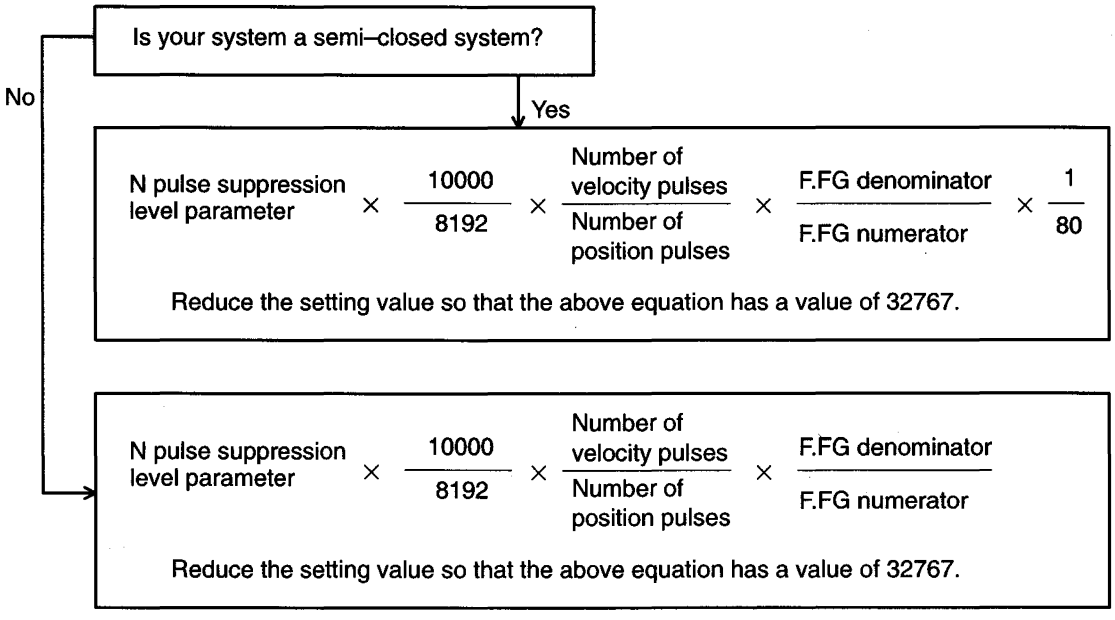
If a negative number is specified for POA1, the internal processing assumes a value 10 times the absolute value of the specified number.
If the current setting is a positive number, specify as follows:

(–1) × setting value/10

This function is supported for 9060/L, 9070/C, 9046/A, and later.

Adjustment 2: N pulse suppression (No. ——1992–2099)

Reduce the setting value according to the following flowchart. For Series 0–C, however, discontinue the use of this function if an overflow occurs, because the N pulse suppression level parameter is fixed at 400.



Number of velocity pulses	(No. 8X23–1876–2023)
Number of position pulses	(No. 8X24–1891–2024)
F.FG numerator	(No. 8X84–1977–2084)
F.FG denominator	(No. 8X85–1978–2085)

Adjustment 3: Feed forward coefficient

(No. 8X68–1961–2068, No. 8X92–1985–2092 (advance))

Series 15–B, 16, 18, 20, 21

Specify the position gain setting range expansion function.

Function bit: No. 2000–1804, B4 = 1

The function also expands the feed–forward coefficient range.

Series 0–C, 15–A

If a negative number is specified for the feed–forward coefficient, the internal processing assumes a value ten times the absolute number of the specified number.

If the calculation result obtained during parameter setting exceeds 32767, specify as follows:

(–1) × calculation result/10

Adjustment 4: Position gain

Use the position gain setting range expansion function.

Setting No.8X11–1955, B5 = 1 (Series 0–C,15–A)
Multiply 8X24–1891 by 8 and re–enter it.
No.2000–1804, B4 = 1 (Series 15–B,16,18, 20)

If an overflow still occurs:

(1) Multiply the value of the flexible feed gear (or DMR) by integer A.
(2) Multiply the following setting values by A.

Parameter	Series0–C	Series 15, 16, 18, 20
CMR	No. 100–103	No. 1820
Effective area	500–503	1826, 27
Limit to a position error during travel	504–507	1828
Limit to a position error at a halt	593–596	1829
Backlash	535–538	1851, 52
Reference counter	570–573	1896

Examples

α pulse coder
Reduction gear ratio: 1/20
Ball screw: 1 μm/rev
Position gain: 30 (with 1μ scale)

In this case, specify the position gain setting range expansion function. For Series 0–C and 15–A, multiply the number of position pulses by 8.

Number of position pulses (No. 8X24–1891) 50 $\xrightarrow{\times 8}$ 400

Adjustment 5: Number of position pulses

Make the changes listed below. Value E must satisfy the following:

Number of current position pulses/E < 13100

Current setting value/E		
Series 0–C	Series 15	Series 16, 18, 20, 21
No. 8X23	No. 1876	No. 2023
8X24	1891	2024
8X43	1855	2043
8X44	1856	2044
8X54	1866	2054
8X56	1868	2056
8X57	1869	2057
8X53	1865	2053
8X74	1967	2074
8X76	1969	2076

Adjustment 6: Motor ID No.

The motor ID numbers valid for each series of models are listed below. An invalid parameter setting alarm occurs if a specified number does not fall in any of the following corresponding ranges.

Servo software series/edition	Motor ID No.
9046 Series / Edition A	15–89
/ Edition B or later	3–89
9060 Series / Edition K	15–89
/ Edition L or later	3–89
9070 Series / Edition C or later	3–89
9064 Series / Edition E or later	3–89 *1

Notes

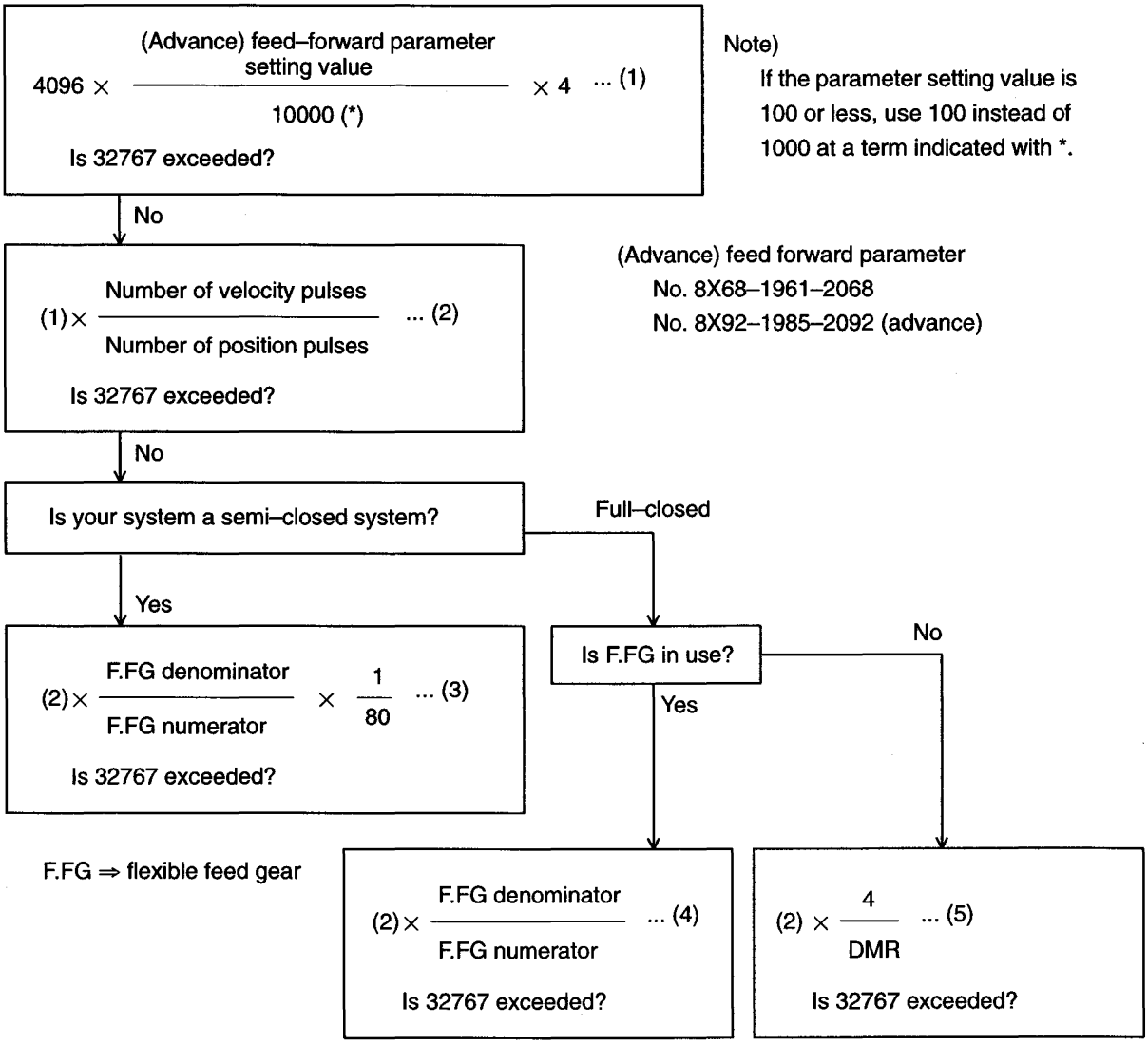
*1 The alarm is not issued in this range, but the 9064 Series can drive the E series servo motors and αE series servo motors only.

Reference

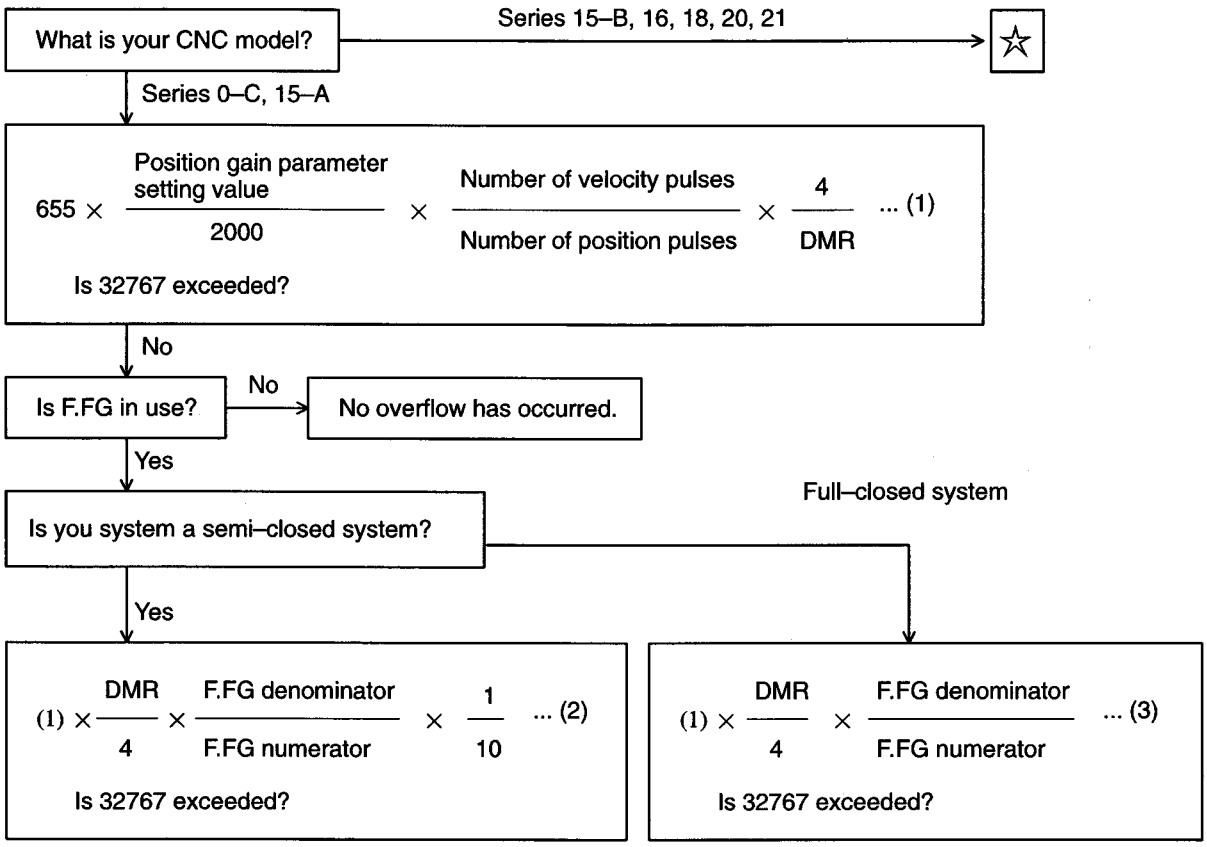
Feed–forward coefficient overflow check

(Series 15–B, 16, 18, 20, 21)

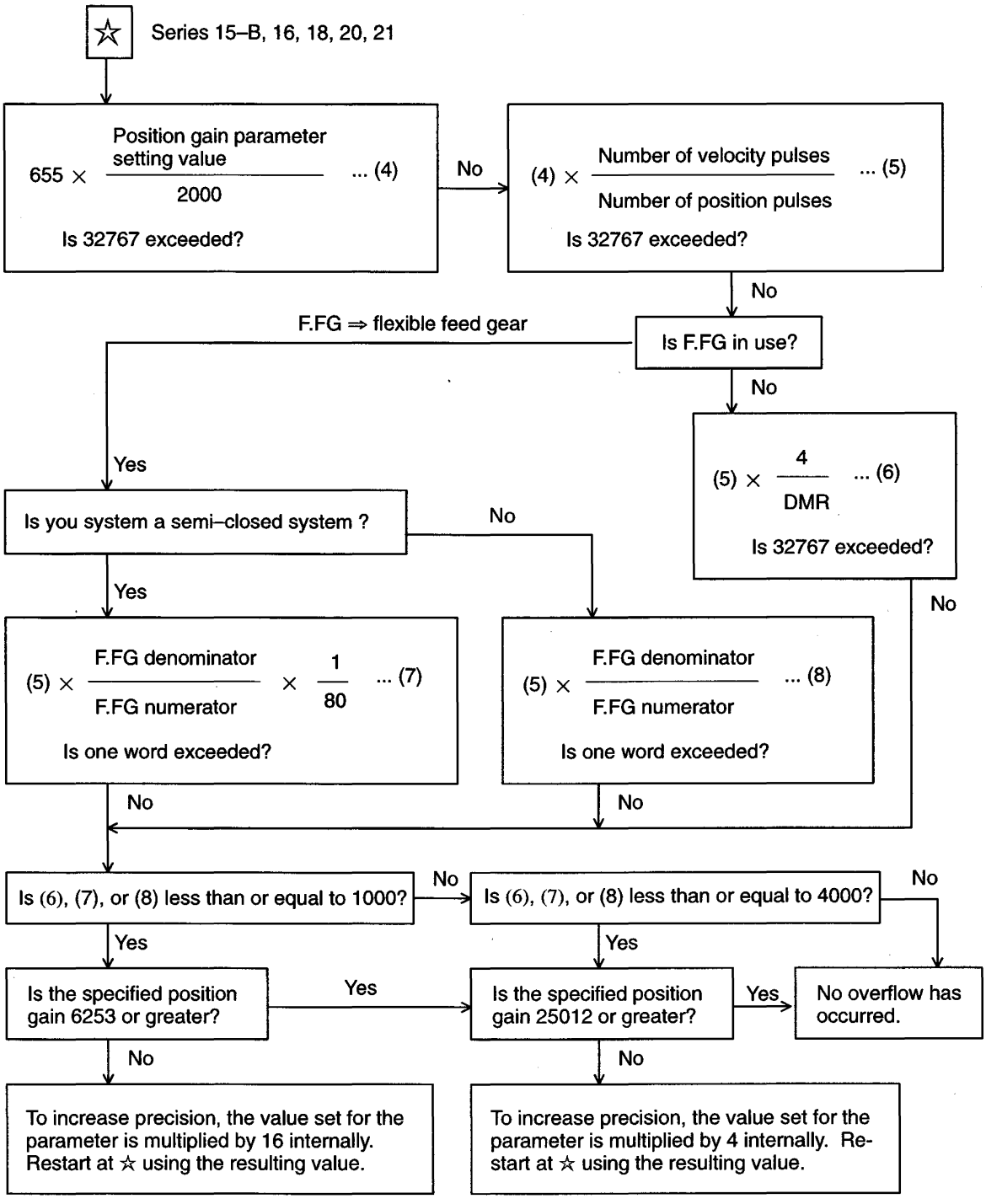
If the result of any of the following calculations exceed 32767, an invalid parameter setting alarm occurs.



Position gain overflow check



F.FG ⇒ flexible feed gear


☆ Series 15–B, 16, 18, 20, 21
655 × Position gain parameter setting value / 2000 ... (4)
Is 32767 exceeded?
No
(4) × Number of velocity pulses / Number of position pulses ... (5)
Is 32767 exceeded?
No
F.FG ⇒ flexible feed gear
Is F.FG in use?
No
Yes
(5) × 4 / DMR ... (6)
Is 32767 exceeded?
No
Is you system a semi–closed system ?
No
Yes
(5) × F.FG denominator / F.FG numerator × 1 / 80 ... (7)
Is one word exceeded?
(5) × F.FG denominator / F.FG numerator ... (8)
Is one word exceeded?
No
No
Is (6), (7), or (8) less than or equal to 1000?
No
Is (6), (7), or (8) less than or equal to 4000?
No
Yes
Yes
Is the specified position gain 6253 or greater?
Yes
Is the specified position gain 25012 or greater?
Yes
No overflow has occurred.
No
No
To increase precision, the value set for the parameter is multiplied by 16 internally. Restart at ☆ using the resulting value.
To increase precision, the value set for the parameter is multiplied by 4 internally. Re-start at ☆ using the resulting value.

4 PARAMETER LIST

4.1 FOR SERIES 0-C AND 15-A (9046 SERIES)

			αE3/2000	αE6/2000	αE1/3000	αE2/3000
Motor model			αE3/2000	αE6/2000	αE1/3000	αE2/3000
Drawing No. of motor			0105	0106	0101	0102
Motor model			E3/2000	E6/2000	E1/3000	E2/3000
Motor type			33	34	35	36
Symbol	Parameter No. F15-A	F0-C				
	1808	8□03	00001100	00001100	00001100	00001100
	1809	8□04	01000110	00100110	00000110	00000110
	1883	8□05	00000100	00000100	00000100	00000100
	1884	8□06	01000000	00100000	01000000	01000000
	1954	8□10	00000010	00000010	00000000	00000010
PK1	1852	8□40	275	990	359	704
PK2	1853	8□41	-1006	-3544	-1129	-2401
PK3	1854	8□42	-2622	-2632	-2564	-2596
PK1V	1855	8□43	144	144	102	62
PK2V	1856	8□44	-2587	-2587	-916	-1111
PK3V	1857	8□45	0	0	0	0
PK4V	1858	8□46	-8235	-8235	-8235	-8235
POA1	1859	8□47	1467	1467	4141	3415
BLCMP	1860	8□48	0	0	0	0
RESERV	1861	8□49	0	0	0	0
POK1	1862	8□50	956	956	956	956
POK2	1863	8□51	510	510	510	510
RESERV	1864	8□52	3840	3072	0	3072
PPMAX	1865	8□53	21	21	21	21
PDDP	1866	8□54	1894	3787	1894	1894
PHYST	1867	8□55	319	319	319	319
EMFCMP	1868	8□56	3000	3200	2500	3300
PVPA	1869	8□57	3200	2000	2100	2700
PALPH	1870	8□58	80	57	71	78
PPBAS	1871	8□59	5	5	5	5
TQLIM	1872	8□60	7282	7282	7282	7282
EMFLMT	1873	8□61	120	120	120	120
POVC1	1877	8□62	32456	32456	32617	32540
POVC2	1878	8□63	3897	3897	1884	2850
TGALMLV	1892	8□64	4	4	4	4
POVCLMT	1893	8□65	11600	11600	5594	8474
PK2VAUX	1894	8□66	0	0	0	0
FILTER	1895	8□67	0	0	0	0
FALPH	1961	8□68	0	0	0	0
VFFLT	1962	8□69	0	0	0	0
ERBLM	1963	8□70	0	0	0	0
PBLCT	1964	8□71	0	0	0	0
RESERV	1965	8□72	0	0	0	0
RESERV	1966	8□73	0	0	0	0
AALPH	1967	8□74	0	0	0	0
MODEL	1968	8□75	0	0	0	0
WKAC	1969	8□76	0	0	0	0
OSCTPL	1970	8□77	0	0	0	0
RESERV	1971	8□78	0	0	0	0
RESERV	1972	8□79	0	0	0	0
RESERV	1973	8□80	0	0	0	0
RESERV	1974	8□81	0	0	0	0
BLENDL	1975	8□82	0	0	0	0
MOFCTL	1976	8□83	0	0	0	0
RTCURR	1979	8□86	2506	2506	1740	2142
TDPLD	1980	8□87	0	0	0	0
MCNFB	1981	8□88	0	0	0	0
BLBSL	1982	8□89	0	0	0	0

ROBSTL	1983	8□90	0	0	0	0
ACCSPL	1984	8□91	0	0	0	0
ADFF1	1985	8□92	0	0	0	0
VMPK3V	1986	8□93	12923	12923	12923	14203
BLCMP2	1987	8□94	0	0	0	0
AHDRTL	1988	8□95	0	0	0	0
RADUSL	1989	8□96	0	0	0	0
RESERV	1990	8□97	0	0	0	0
DEPVPL	1991	8□98	–1476	30	80	–2786
ONEPSL	1992	8□99	400	400	400	400

4.2 FOR SERIES 15–B, 16, 18, 20, 21, POWER MATE D, E, F, H, AND I(9060, 9064, AND 9070 SERIES)

Motor model			αE3/2000	αE6/2000	αE1/3000	αE2/3000
Drawing No. of motor			0105	0106	0101	0102
Motor model				E6/2000	E1/3000	E2/3000
Motor type			33	34	35	36
Symbol	Parameter No.					
	F15–B	F16,18,20				
	1808	2003	00001100	00001100	00001100	00001100
	1809	2004	01000110	01000110	00000110	00000110
	1883	2005	00000100	00000100	00000100	00000100
	1884	2006	01000000	01000000	01000000	01000000
	1955	2011	00100000	00100000	00000000	00100000
PK1	1852	2040	275	990	359	704
PK2	1853	2041	–1006	–3544	–1129	–2401
PK3	1854	2042	–2622	–2632	–2564	–2596
PK1V	1855	2043	144	144	102	62
PK2V	1856	2044	–2587	–2587	–916	–1111
PK3V	1857	2045	0	0	0	0
PK4V	1858	2046	–8235	–8235	–8235	–8235
POA1	1859	2047	1467	1467	4141	3415
BLCMP	1860	2048	0	0	0	0
RESERV	1861	2049	0	0	0	0
POK1	1862	2050	956	956	956	956
POK2	1863	2051	510	510	510	510
RESERV	1864	2052	0	0	0	0
PPMAX	1865	2053	21	21	21	21
PDDP	1866	2054	1894	3787	1894	1894
PHYST	1867	2055	319	319	319	319
EMFCMP	1868	2056	3000	3200	2500	3300
PVPA	1869	2057	3200	2000	2100	2700
PALPH	1870	2058	80	57	71	78
PPBAS	1871	2059	5	5	5	5
TQLIM	1872	2060	7282	7282	7282	7282
EMFLMT	1873	2061	120	120	120	120
POVC1	1877	2062	32456	32456	32617	32540
POVC2	1878	2063	3897	3897	1884	2850
TGALMLV	1892	2064	4	4	4	4
POVCLMT	1893	2065	11600	11600	5594	8474
PK2VAUX	1894	2066	0	0	0	0
FILTER	1895	2067	0	0	0	0
FALPH	1961	2068	0	0	0	0
VFFLT	1962	2069	0	0	0	0
ERBLM	1963	2070	0	0	0	0
PBLCT	1964	2071	0	0	0	0
RESERV	1965	2072	0	0	0	0
RESERV	1966	2073	0	0	0	0
AALPH	1967	2074	0	0	0	0
MODEL	1968	2075	0	0	0	0
WKAC	1969	2076	0	0	0	0
OSCTPL	1970	2077	0	0	0	0
RESERV	1971	2078	0	0	0	0
RESERV	1972	2079	0	0	0	0
RESERV	1973	2080	0	0	0	0
RESERV	1974	2081	0	0	0	0
BLENDL	1975	2082	0	0	0	0

MOFCTL	1976	2083	0	0	0	0
RTCURR	1979	2086	2506	2506	1740	2142
TDPLD	1980	2087	0	0	0	0
MCNFB	1981	2088	0	0	0	0
BLBSL	1982	2089	0	0	0	0
ROBSTL	1983	2090	0	0	0	0
ACCSPL	1984	2091	0	0	0	0
ADFF1	1985	2092	0	0	0	0
VMPK3V	1986	2093	0	0	0	0
BLCMP2	1987	2094	0	0	0	0
AHDRTL	1988	2095	0	0	0	0
RADUSL	1989	2096	0	0	0	0
RESERV	1990	2097	0	0	0	0
DEPVPL	1991	2098	–1476	30	80	–2786
ONEPSL	1992	2099	400	400	400	400
INPA1	1993	2100	0	0	0	0
INPA2	1994	2101	0	0	0	0
DBLIM	1995	2102	15000	12000	0	12000
LP24PA	1999	2106	12923	12923	12923	14203

ADDITIONAL INFORMATION

The modification of the outline dimension
for FANUC AC SERVO MOTOR αE series

1. Type of applied technical documents

Name	FANUC AC SERVO MOTOR αE series DESCRIPTIONS
Spec. No./Version	B－65182EN／02

2. Summary of Change

Group	Name / Outline	New, Add, Correct, Delete	Applicable Date
Basic Function			
Optional Function			
Unit			
Maintenance Parts			
Notice			
Correction			
Another	Modify the outline dimensions of αE1/3000 and αE2/3000.		

				TITLE DESCRIPTIONS for FANUC AC SERVO MOTOR αE series	
				DRAW. NO. B-65182EN/02	CUST.
EDIT	DATE	DESIG.	DESCRIPTION	FANUC LTD	SHEET 1/4

Outline dimensions of αE1/3000 and αE2/3000 are changed as the follows.

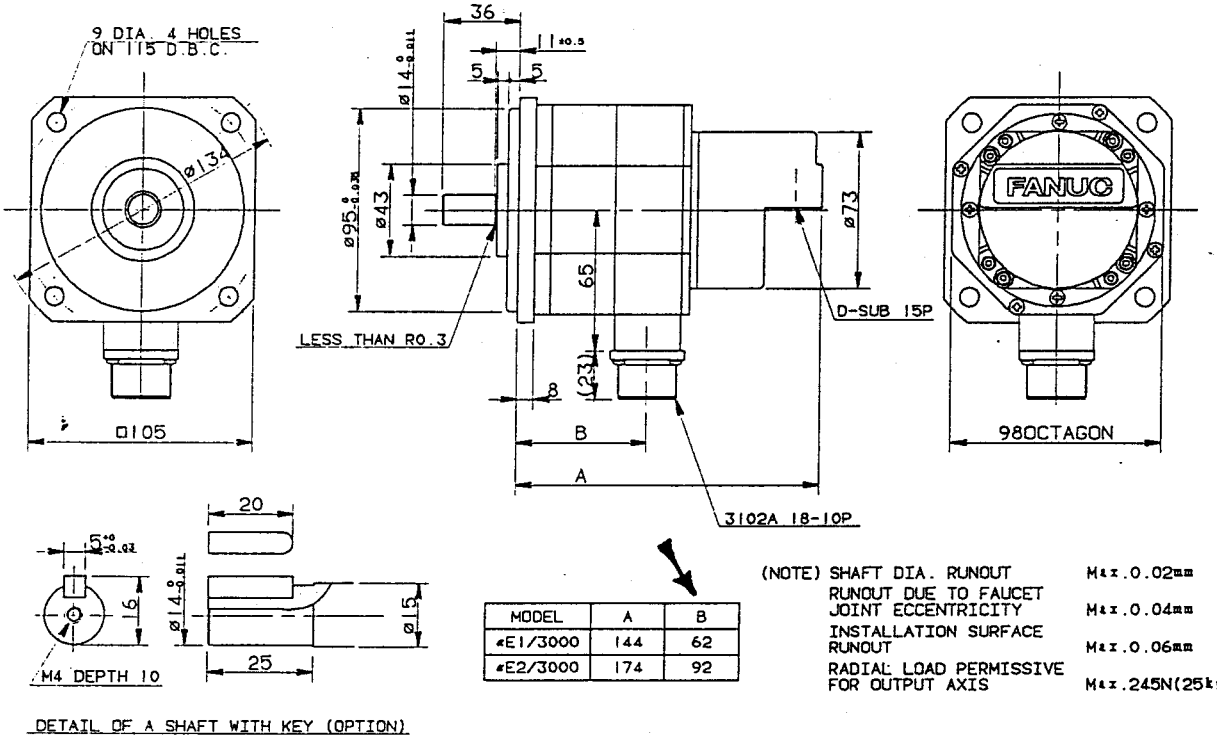
	Dimension of "B"
αE1/3000 standard type	: 62mm → 63mm
αE1/3000 with brake type	: 118mm → 119mm
αE2/3000 standard type	: 92mm → 93mm
αE2/3000 with brake type	: 148mm → 149mm

This modification is to change the sealing method between power line connector and rear housing.

αE3/2000 and αE6/2000 are not changed the outline dimensions.

				TITLE DESCRIPTIONS for FANUC AC SERVO MOTOR αE series	
				DRAW. NO. B-65182EN/02	CUST.
EDIT	DATE	DESIG.	DESCRIPTION	FANUC LTD	SHEET 2/4

Before Changing



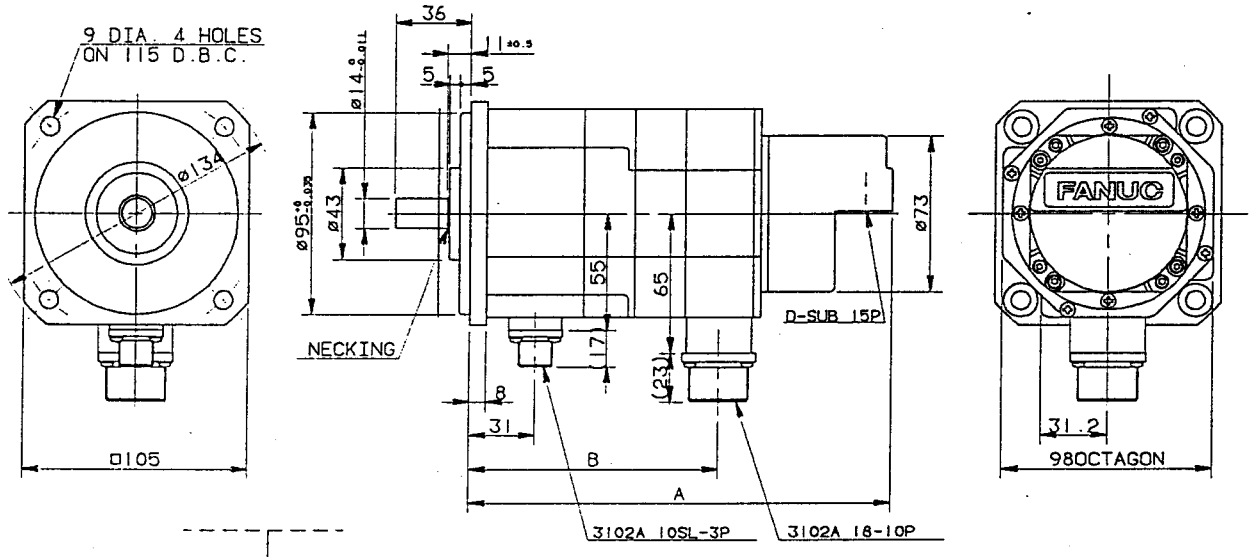
DETAIL OF A SHAFT WITH KEY (OPTION)

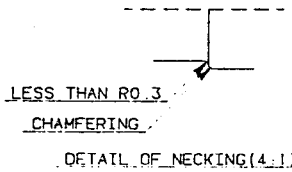
MODEL	A	B
αE1/3000	144	62
αE2/3000	174	92

(NOTE)

SHAFT DIA. RUNOUT	Max.0.02mm
RUNOUT DUE TO FAUCET JOINT ECCENTRICITY	Max.0.04mm
INSTALLATION SURFACE RUNOUT	Max.0.06mm
RADIAL LOAD PERMISSIVE FOR OUTPUT AXIS	Max.245N(25kgf)

Fig.2.3(a) Models αE1/3000 and αE2/3000





MODEL	A	B
αE1/3000	200	118
αE2/3000	230	148

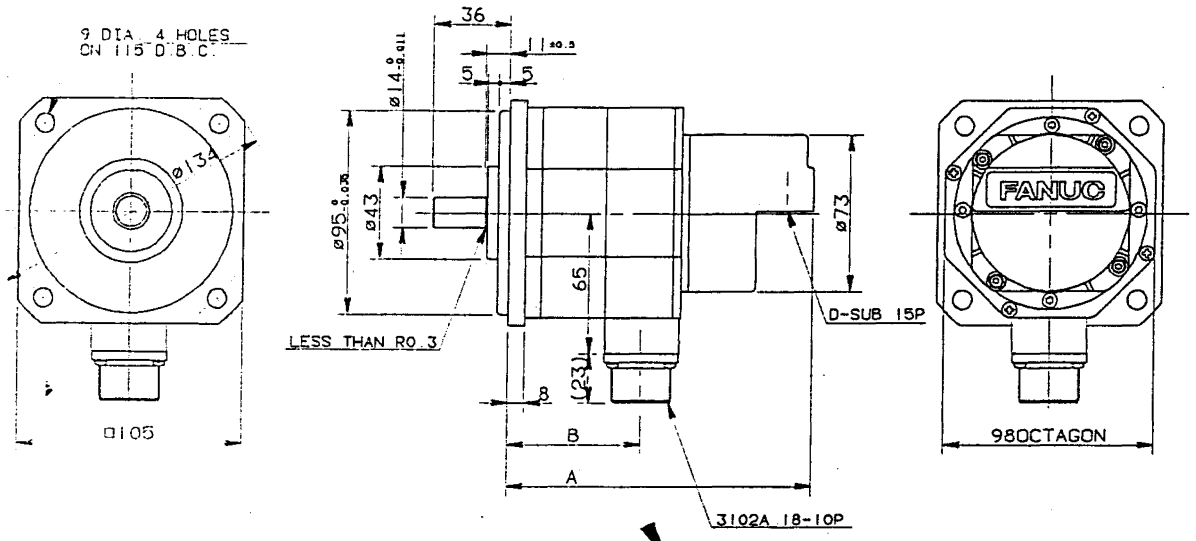
(NOTE)

SHAFT DIA. RUNOUT	Max.0.02mm
RUNOUT DUE TO FAUCET JOINT ECCENTRICITY	Max.0.04mm
INSTALLATION SURFACE RUNOUT	Max.0.06mm
RADIAL LOAD PERMISSIVE FOR OUTPUT AXIS	Max.245N(25kgf)

Fig.2.3(b) Models αE1/3000 and αE2/3000 (with the brake)

			TITLE	DESCRIPTIONS for FANUC AC SERVO MOTOR αE series	
			DRAW. NO.	B-65182EN/02	CUST.
EDIT	DATE	DESIG.	DESCRIPTION	FANUC LTD	SHEET 3/4

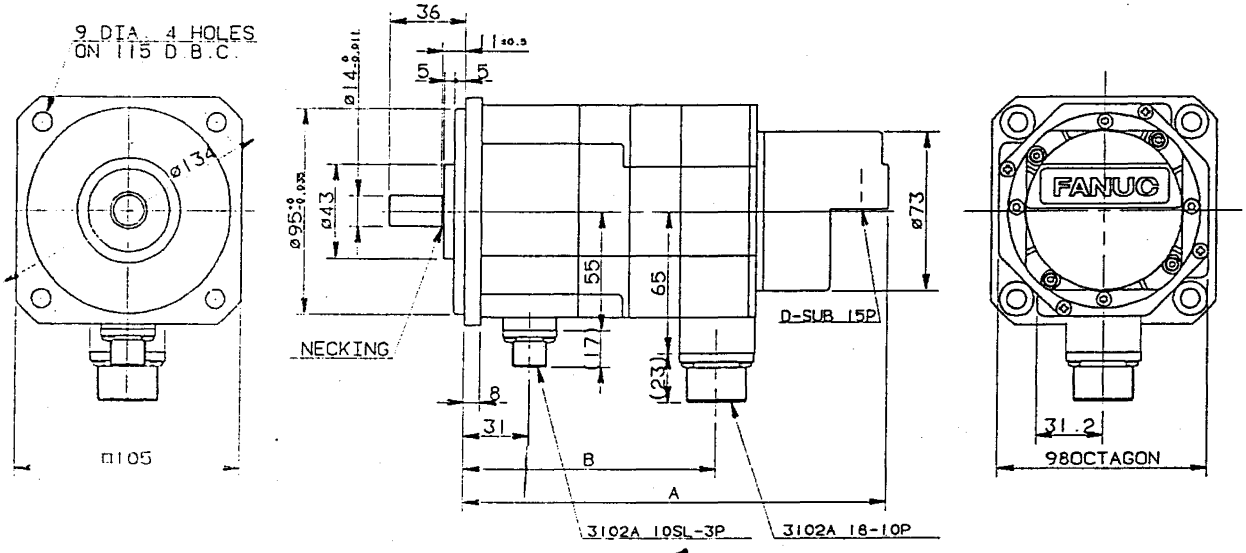
After Changing



MODEL	A	B
αE1/3000	144	63
αE2/3000	174	93

(NOTE) SHAFT DIA. RUNOUT Max.0.02mm
RUNOUT DUE TO FAUCET JOINT ECCENTRICITY Max.0.04mm
INSTALLATION SURFACE RUNOUT Max.0.06mm
RADIAL LOAD PERMISSIVE FOR OUTPUT AXIS Max.245N(25kgf)

Fig.2.3(a) Models αE1/3000 and αE2/3000



MODEL	A	B
αE1/3000	200	119
αE2/3000	230	149

(NOTE) SHAFT DIA. RUNOUT Max.0.02mm
RUNOUT DUE TO FAUCET JOINT ECCENTRICITY Max.0.04mm
INSTALLATION SURFACE RUNOUT Max.0.06mm
RADIAL LOAD PERMISSIVE FOR OUTPUT AXIS Max.245N(25kgf)

Fig.2.3(b) Models αE1/3000 and αE2/3000 (with the brake)

			TITLE	DESCRIPTIONS for FANUC AC SERVO MOTOR αE series	
			DRAW. NO.	B-65182EN/02	CUST.
EDIT	DATE	DESIG.	DESCRIPTION	FANUC LTD	SHEET 4/4

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Revision Record

FANUC AC SERVO MOTOR E series DESCRIPTIONS (B–65182EN)

Edition	Date	Contents	Edition	Date	Contents
02	Jun., '95	The AC servo motor αE series was formerly known as the AC servo motor E series.			
01	Jan., '95	———			

B-65182EN/02

* B - 6 5 1 8 2 E N / 0 2 *