

# **FANUC AC SPINDLE MOTOR αCi series**

## **DESCRIPTIONS**

- No part of this manual may be reproduced in any form.
- The appearance and specifications of this product are subject to change without notice.

The products in this manual are controlled based on Japan's "Foreign Exchange and Foreign Trade Law". The export from Japan may be subject to an export license by the government of Japan.

Further, re-export to another country may be subject to the license of the government of the country from where the product is re-exported. Furthermore, the product may also be controlled by re-export regulations of the United States government.

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

In this manual, we endeavor to include all pertinent matters.

There are, however, a very large number of operations that must not or cannot be performed, and if the manual contained them all, it would be enormous in volume.

It is, therefore, requested to assume that any operations that are not explicitly described as being possible are "not possible".

# SAFETY PRECAUTIONS

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This "Safety Precautions" section describes the precautions which must be observed to ensure safety when using FANUC spindle motors.

Users of any spindle motor model are requested to read this manual carefully before using the spindle motor.

The users are also requested to read this manual carefully and understand each function of the motor for correct use.

The users are basically forbidden to do any behavior or action not mentioned in this manual. They are invited to ask FANUC previously about what behavior or action is prohibited.

For matters that are not described in this manual, a machine must be designed and assembled in accordance with EN60204-1 to ensure the safety of the machine and compliance with European specifications. For details, refer to the specification.

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## 1.1 DEFINITION OF WARNING, CAUTION, AND NOTE

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

**WARNING**

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

**CAUTION**

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

**NOTE**

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

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

## 1.2 WARNING

### WARNING

**- Be safely dressed when handling a motor.**

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

**- Use a crane or lift to move a motor from one place to another.**

A motor is heavy. If you lift the motor by hand, you may get a backache, or you may be seriously injured when you drop the motor. A suitable crane or lift must be used to move the motor. (For the weight of motors, refer to Chapter II-2 "SPECIFICATIONS.")

When moving a motor using a crane or lift, use a hanging bolt if the motor has a corresponding tapped hole, or textile rope if it has no tapped hole. If a motor is attached with a machine or any other heavy stuff, do not use a hanging bolt to move the motor as the hanging bolt and/or motor may get broken.

**- Before starting to connect a motor to electric wires, make sure they are isolated from an electric power source.**

A failure to observe this caution is very dangerous because you may get electric shocks.

**- Be sure to secure power wires.**

If operation is performed with a terminal loose, the terminal block may become abnormally hot, possibly causing a fire. Also, the terminal may become disconnected, causing a ground fault or short-circuit, and possibly giving you electric shocks. See the section in this manual that gives the tightening torque for attaching power wires and short-bars to the terminal block.

**- Be sure to ground a motor frame.**

To avoid electric shocks, be sure to connect the grounding terminal in the terminal box to the grounding terminal of the machine.

**- Do not ground a motor power wire terminal or short-circuit it to another power wire terminal.**

A failure to observe this caution may cause electric shocks or a burned wiring.

\* Some motors require a special connection such as a winding switching. Refer to their respective motor specification manuals for details.

**- Do not supply the power to the motor while any terminal is exposed.**

A failure to observe this caution is very dangerous because you may get electric shocks if your body or any conductive stuff touches an exposed terminal.

**⚠ WARNING****- Do not bring any dangerous stuff near a motor.**

Motors are connected to a power line, and may get hot. If a flammable is placed near a motor, it may be ignited, catch fire, or explode.

**- Do not get close to a rotary section of a motor when it is rotating.**

You may get your clothes or fingers caught in a rotary section, and may be injured. Before starting a motor, ensure that there is no stuff that can fly away (such as a key) on the motor.

**- Do not touch a motor with a wet hand.**

A failure to observe this caution is very dangerous because you may get electric shocks.

**- Before touching a motor, shut off the power to it.**

Even if a motor is not rotating, there may be a voltage across the terminals of the motor.

Especially before touching a power supply connection, take sufficient precautions.

Otherwise you may get electric shocks.

**- Do not touch any terminal of a motor for a while (at least 5 minutes) after the power to the motor is shut off.**

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

**- To drive a motor, use a specified amplifier and parameters.**

An incorrect combination of a motor, amplifier, and parameters may cause the motor to behave unexpectedly. This is dangerous, and the motor may get damaged.

**- Before driving a motor, be sure to secure it.**

If a motor is drove without being secured, it may roll over during acceleration or deceleration, injuring the user.

## 1.3 CAUTION

### CAUTION

**- Do not touch a motor when it is running or immediately after it stops.**

A motor may get hot when it is running. Do not touch the motor before it gets cool enough. Otherwise, you may get burned.

**- Be careful not get your hair or cloths caught in a fan.**

Be careful especially for a fan used to generate an inward air flow. Be careful also for a fan even when the motor is stopped, because it continues to rotate while the amplifier is turned on.

**- FANUC motors are designed for use with machines. Do not use them for any other purpose.**

If a FANUC motor is used for an unintended purpose, it may cause an unexpected symptom or trouble. If you want to use a motor for an unintended purpose, previously consult with FANUC.

**- Ensure that a base or frame on which a motor is mounted is strong enough.**

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

**- Ensure that motors and related components are mounted securely.**

If a motor or its component slips out of place or comes off when the motor is running, it is very dangerous.

**- Be sure to connect motor cables correctly.**

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

**- Ensure that motors are cooled if they are those that require forcible cooling.**

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

**- When attaching a component having inertia, such as a pulley, to a motor, ensure that any imbalance between the motor and component is minimized.**

If there is a large imbalance, the motor may vibrates abnormally, resulting in the motor being broken.

**⚠ CAUTION**

- **Be sure to attach a key to a motor with a keyed shaft.**

If a motor with a keyed shaft runs with no key attached, it may impair torque transmission or cause imbalance, resulting in the motor being broken. With the *αi* series, a shaft with no key is used as standard.

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## 1.4 NOTE

### NOTE

**- Do not step or sit on a motor.**

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

**- When storing a motor, put it in a dry (non-condensing) place at room temperature (0 to 40 °C).**

If a motor is stored in a humid or hot place, its components may get damaged or deteriorated. In addition, keep a motor in such a position that its shaft is held horizontal and its terminal box is at the top.

**- Do not remove a nameplate from a motor.**

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

**- Do not apply shocks to a motor or cause scratches to it.**

If a motor is subjected to shocks or is scratched, its components may be adversely affected, resulting in normal operation being impaired. Be very careful when handling plastic portions, sensors, and windings, because they are very liable to break. Especially, avoid lifting a motor by pulling its plastic portion, winding, or power cable.

**- Do not conduct dielectric strength or insulation test for a sensor.**

Such a test can damage elements in the sensor.

**- When testing the winding or insulation resistance of a motor, satisfy the conditions stipulated in IEC34.**

Testing a motor under a condition severer than those specified in IEC34 may damage the motor.

**- Do not disassemble a motor.**

Disassembling a motor may cause a failure or trouble in it. If disassembly is in need because of maintenance or repair, please contact a service representative of FANUC.

**- Do not modify a motor.**

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

**- Use a motor under an appropriate environmental condition.**

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

**NOTE**

- **Do not apply a commercial power source voltage directly to a motor.**

Applying a commercial power source voltage directly to a motor may result in its windings being burned. Be sure to use a specified amplifier for supplying voltage to the motor.

- **For a motor with a terminal box, make a conduit hole for the terminal box in a specified position.**

When making a conduit hole, be careful not to break or damage unspecified portions. Refer to an applicable specification manual.

- **Before using a motor, measure its winding and insulation resistances, and make sure they are normal.**

Especially for a motor that has been stored for a prolonged period of time, conduct these checks. A motor may deteriorate depending on the condition under which it is stored or the time during which it is stored. For the winding resistances of motors, refer to their respective specification manuals, or ask FANUC. For insulation resistances, see the following table.

- **To use a motor as long as possible, perform periodic maintenance and inspection for it, and check its winding and insulation resistances.**

Note that extremely severe inspections (such as dielectric strength tests) of a motor may damage its windings. For the winding resistances of motors, refer to their respective specification manuals, or ask FANUC. For insulation resistances, see the following table.

**MOTOR INSULATION RESISTANCE MEASUREMENT**

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

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

## PREFACE

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The series covered by this manual, and their abbreviations are:

<b>Series</b>	<b>Model</b>
<i>αCi series</i>	<i>αC1/6000i, αC2/6000i, αC3/6000i, αC6/6000i, αC8/6000i, αC12/6000i, αC15/6000i</i>

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## **I. DESCRIPTIONS FOR THE $\alpha$ Ci SERIES**

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# 1

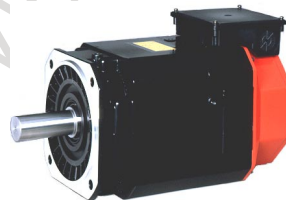
## GENERAL

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As motors for driving the spindle of a CNC machine tool, the FANUC AC Spindle Motor  $\alpha Ci$  series has incorporated accumulated technologies and employs the latest design and manufacturing techniques to provide the features listed below.

### Features

- The user can select an appropriate motor according to whether the spindle driving mechanism is belt driving or motor direct coupling.
- An up-to-date stator cooling method is employed for direct air-cooling of the electromagnetic steel plate. So, a high power and high torque are achieved with a compact size.
- By precision rotor aluminum casting and accurate rotor balance correction, vibration grade V5 is achieved even at high speed.
- The user can select a motor fan exhaust direction: forward direction or backward direction. An exhaust direction that subjects the machine to less heat deformation can be selected.
- This series employ waterproof and pressure-proof design conforming to the international standard (IEC).



$\alpha Ci$  series

# 2

## CONFIGURATION OF THE $\alpha Ci$ series

The FANUC AC Spindle Motor  $\alpha Ci$  series includes the following models.

### Feature

Series	Rated output kW	Feature	Example of applicable machine
$\alpha Ci$	1.1 to 15	Economical model based on sensor-less control	Lathe system (suited to belt driving)

### Lineup for $\alpha i$ series spindle motor

Continuous rated output kW	1.1	22	37	55	75	11	15
$\alpha Ci$	$\alpha C1/6000i$	$\alpha C2/6000i$	$\alpha C3/6000i$	$\alpha C6/6000i$	$\alpha C8/6000i$	$\alpha C12/6000i$	$\alpha C15/6000i$

# 3

## MOTOR TYPES

Each model includes the types of motors listed below, and the user can make an optimal choice according to the spindle driving structure.

Item	Type	Use	Remarks
Mounting types	Flange mounting type	Directly connected to a spindle Connected to spindle via a belt	The motor can be positioned accurately.
	Foot mounting type	Connected to spindle via a belt	
Shaft figure	With no key	Connected to a pulley	A shaft with no key is used as standard to facilitate pulley balance correction and acceleration/ deceleration operation. When a shaft with a key is needed, contact your FANUC sales representative.
Cooling air exhaust direction	Rearward exhaust (Exhaust from side opposite the output shaft)	When the machine is positioned at the output shaft side	Direct the exhaust out and away from the machine.
	Forward exhaust (Exhaust from the output shaft side)	When the machine is positioned at the side opposite the output shaft	
Output shaft seal	Oil seal	Direct connection, and belt driving	Used in flange mounting type models.
	No seal	Belt driving (Only when no lubricant splashes onto the flange surface of the motor)	Foot mounting type models have no output shaft seal, but can be changed to a model with an oil seal.

# 4

## NOTES ON INSTALLATION

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## 4.1 COMMON

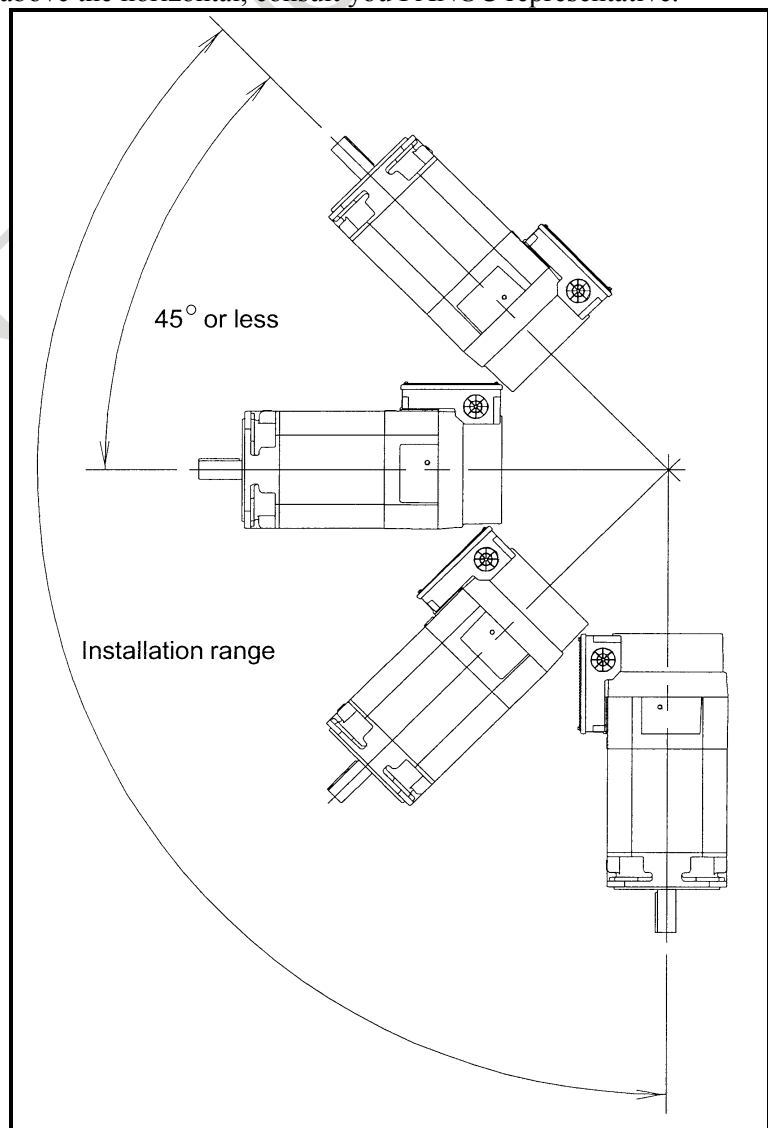
**⚠ WARNING**

Be sure to observe the following, regardless of the connection method of the motor:

When connecting a metallic conduit to a plastic terminal box, connect the conduit to ground on the power magnetics cabinet side.

**⚠ CAUTION**

- 1 Mount the motor so that the output shaft points in a direction ranging within  $45^\circ$  degrees above the horizontal to vertically downwards.
- 2 When the motor needs to be pointed to more than  $45^\circ$  degrees above the horizontal, consult you FANUC representative.

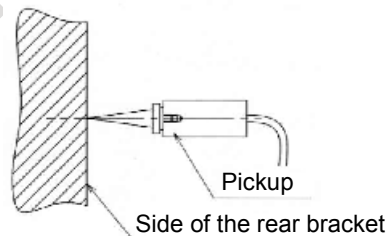


- 3 Use the eyebolt of the motor to lift only a single motor, (pulley may be attached).
- 4 Place a cover over an air-cooled motor to prevent the motor from being exposed to coolant or lubricant.
- 5 Limit the vibration acceleration at the rear bracket of the motor to 0.5 G ( $4.9 \text{ m/s}^2$ ) to ensure the long-term reliability of each part of the motor.  
In particular, to limit the acceleration in the case of direct connection to 0.5 G, carefully perform centering with the mating spindle and make the motor shaft parallel with the spindle.

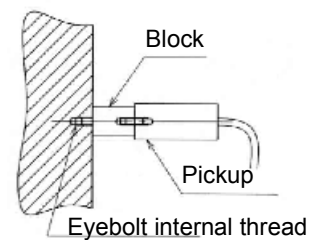
- Details of the measuring method  
Measuring instrument:  
Equivalent to the VM-3314A or VM-3304 manufactured by IMV CORPORATION.  
Condition:  
At the time of highest-speed rotation with no load  
Measurement frequency range with no load at the highest speed:  
10 to 1000 Hz  
Criteria:  
0.5 G ( $4.9 \text{ m/s}^2$ ) or less at the rear bracket

1. Using a pickup

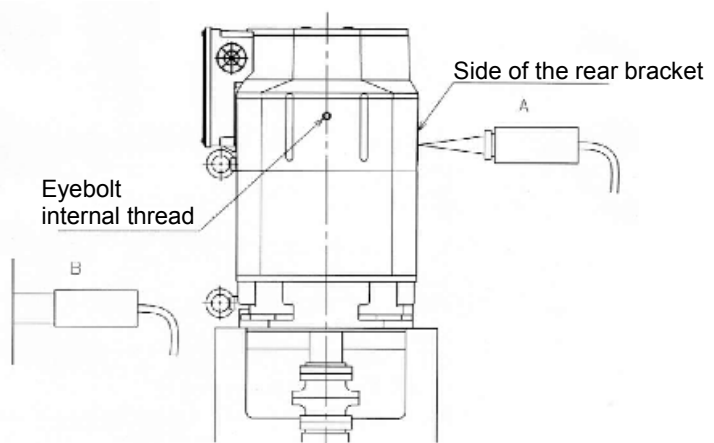
A. Pressing a pickup against the side of the rear bracket



B. Screwing a block into the eyebolt internal thread on the rear bracket, then screwing a pickup into the block.



2. Vibration measurement position (rear bracket)



#### 6 Dynamic balance

During high-speed operation, a small imbalance may cause a large vibration, resulting in an unusual sound, premature bearing damage, or some other abnormality.

Therefore, reduce the amount of the imbalance with the dynamic balance of the other rotation shafts, as well as the pulley mounted on the output shaft of the motor, as much as possible.

- Balance correction

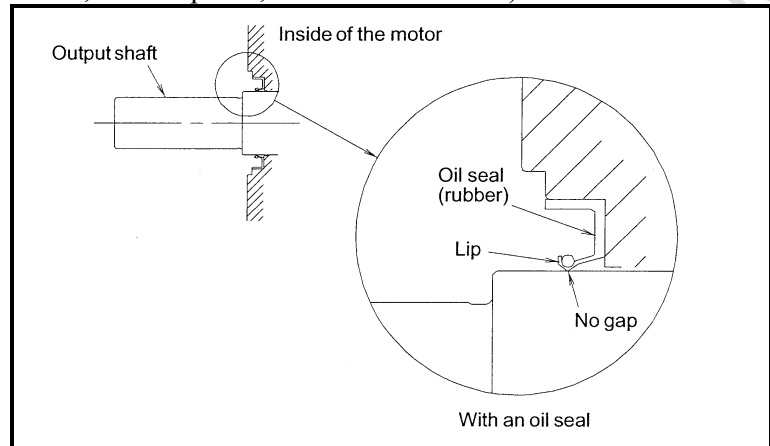
With the  $\alpha Ci$  series, a shaft with no key is used as standard to facilitate the balance correction of a pulley and coupling attached to the shaft. Use a completely symmetric pulley or coupling, and use a backlash-less tightening part such as a SPANN ELEMENTE to secure a pulley or coupling to the shaft. When attaching a pulley to a shaft, for example, adjust the periphery vibration to within 20  $\mu\text{m}$ . This basically eliminates the need for balance correction. To further reduce the vibration level, make a field balance correction, for example, by tightening a screw into the tapped hole for balance correction provided on a component such as a pulley.

**NOTE**

When a shaft with a key is required, contact your FANUC sales representative.

## 7 Output shaft seal

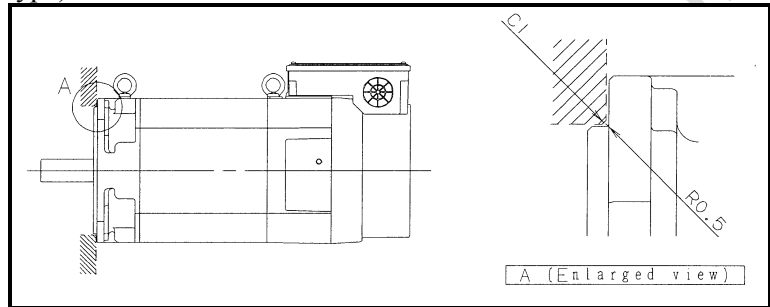
To prevent cutting lubricant or dust from penetrating inside the motor (flange mounting type), one of the following output shaft seals is provided on the output shaft. (For the use and applicable motors, see Chapter 3, "MOTOR TYPES.")



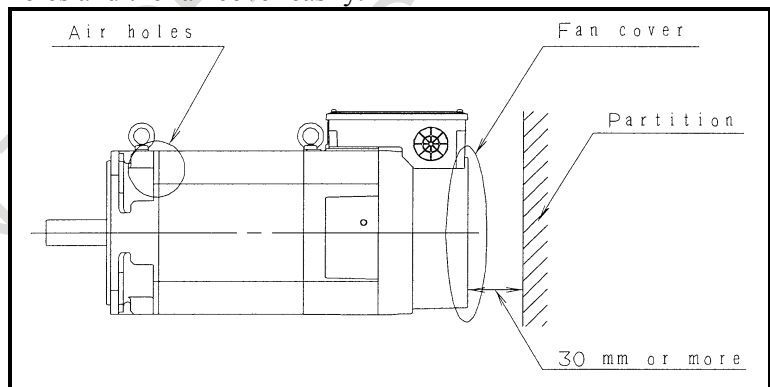
For those models with an oil seal, ensure that the surface of the lubricant is below the lip of the oil seal.

If no seal is provided (foot mounting type), ensure that lubricant does not splash onto the flange surface.

- 8 The lid of the terminal box is provided with rubber gasket to make it waterproof.  
Check that the lid has this gasket, then mount it on the terminal box.
- 9 The edge of the fauset joint to mount the motor (flange mounting type) should be chamfered about C1.



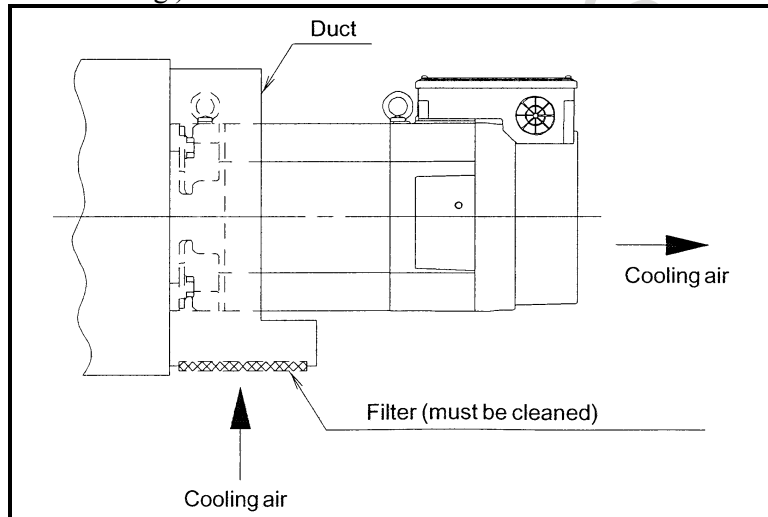
- 10 Please space 30 mm or more between the fan cover and the partition to keep the cooling ability well.  
We recommend to take a structure such as you can clean air holes and the fan cover easily.



- 11 If much oil mist, dust, or other foreign matter settles on the motor, the cooling performance is degraded, resulting in degraded performance of the motor. Design the machine such that only clean cooling air is drawn into the motor.

Example)

When a duct with a filter is installed on a flange mounting type motor with a rear exhaust (The filter requires periodic cleaning.)



**NOTE**

- 1 A foot mounting type motor has no oil seal. When an oil seal is required, add #0002 to the drawing number of the motor.

Example)

Model  $\alpha$ C12/6000i (foot mounting type, with no key, rearward exhaust)

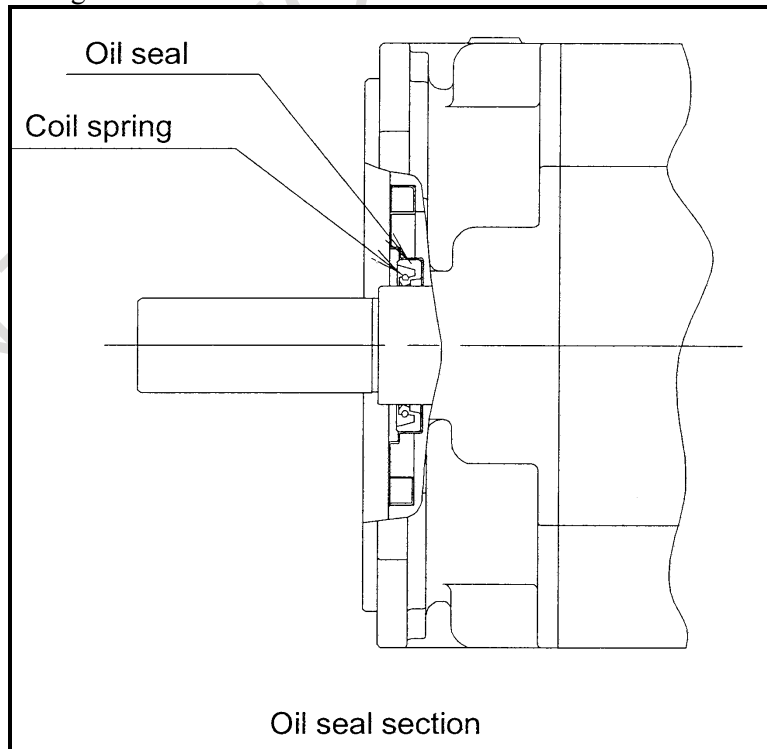
A06B-1438-B200

A06B-1438-B200#0002 (with oil seal)

- 2 When the oil seal is not exposed to lubricant, remove the coil spring of the oil seal to decrease the friction between the lip and shaft.

There is no problem with dry dust sealing.

If the motor is turned at high speed with the contact section between the oil seal and shaft being dry, the contact section can make an abnormal sound (interfering sound), or the lip can be damaged.



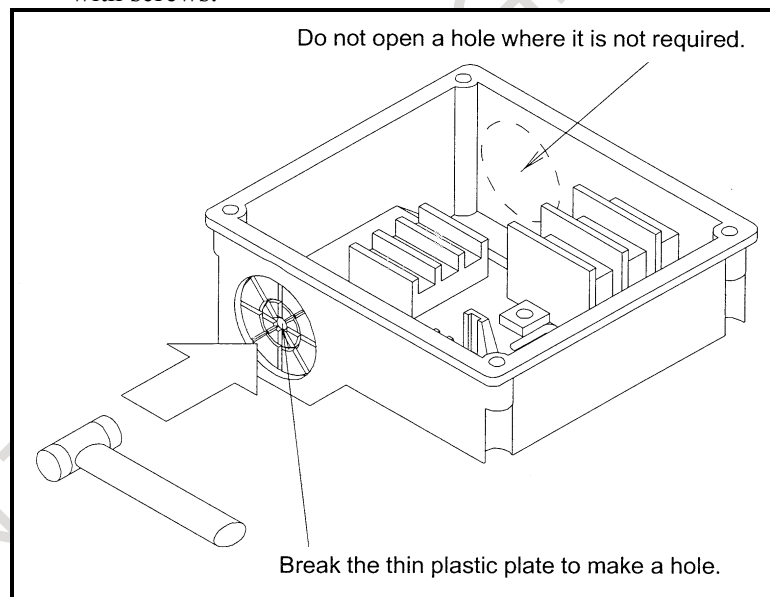
## 3 Cable wiring

Follow the procedure below to install the cable.

- (1) Use a hammer to strike the portion for the cable hole on the terminal box and open the hole.

This time, pay attention not to break the other place except hole. (In some models, it is not necessary to make a hole.)

- (2) Thread the cable through a conduit. Connect the conduit with the connector. (\*1)
- (3) Tighten the connector at the cable hole of the terminal box using a nut. (\*2, \*3)
- (4) Connect each terminal appropriately in the terminal box with screws.

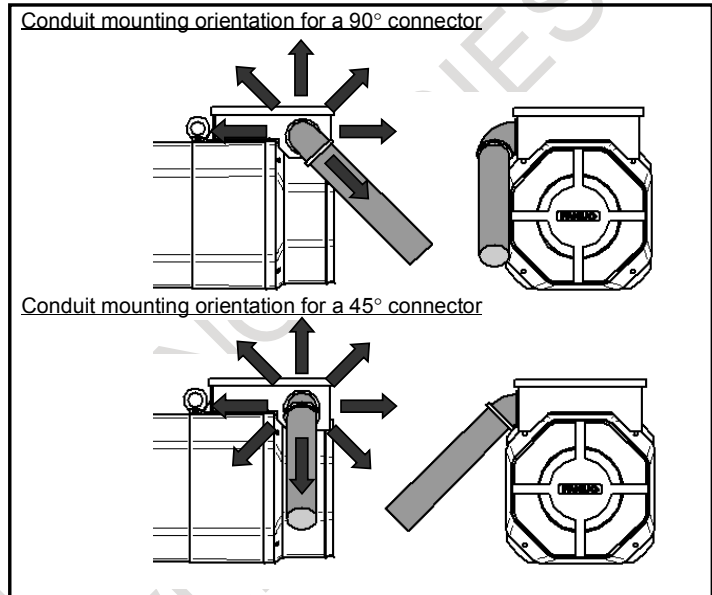


When a hole once made is not used, purchase the following rubber bushing and mount it at the hole.

Model	Ordering number
$\alpha$ C1i to $\alpha$ C15i	A06B-0754-K001

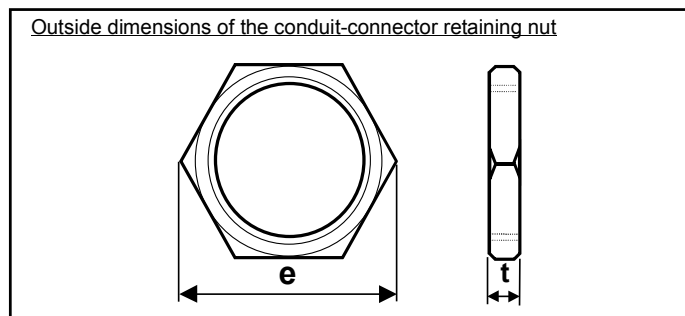
- \*1 If a 90° connector is used on any of the following models, the mounting orientation of its conduit is limited as shown below to avoid interference between the conduit and motor. If you want to mount the conduit in any orientation, use a 45° connector. (For any model other than listed below, the conduit for a 90° connector can be mounted in any orientation.)

Applicable models :  $\alpha C12i$  to  $\alpha C15i$

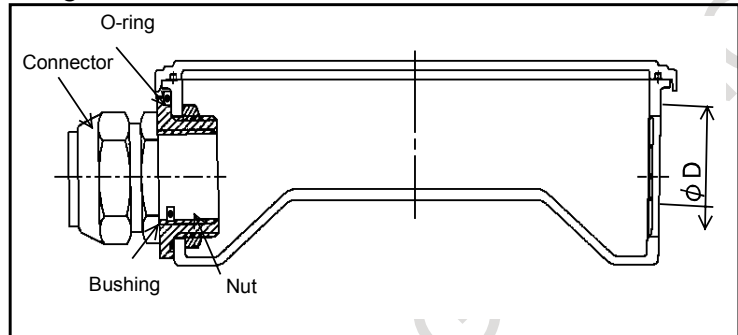


- \*2 The nut used to fasten the connector to the terminal box must be smaller than the size listed below. (Any larger nut interferes with the terminal box.) For the diameter of the cable hole in each model, refer to the outside dimension drawing of the respective models.

Cable hole diameter	Outside diameter e	Width t
$\phi 42.5$ mm	53 mm (maximum)	9 mm (maximum)
$\phi 61$ mm	80 mm (maximum)	15 mm (maximum)



- \*3 If the connector you want to use is smaller than the cable hole on the terminal box, prepare the bushing, nut, and O-ring shown below.



Cable hole diameter $\phi D$	O-ring code	
	JIS B 2401	ISO 3601-1
$\phi 42.5$ mm	P46	C0462G
$\phi 61$ mm	P65	C0650G

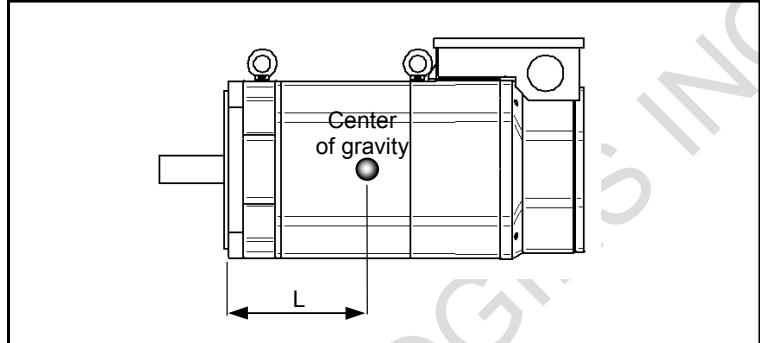
- \* For the diameter of the cable hole in each model, refer to the outside dimension drawing of the respective models.

- 4 Fan motor specification  
 Select a cable and circuit breaker for your machine tool by referencing the following lists.
- \*1 The term "surge current" represents a peak-to-peak current that flows when the power is turned on.
- \*2 The values listed below are a rough standard. They are not guaranteed.

$\alpha$ Ci series spindle motor models	50Hz				60Hz			
	Usable voltage [V]	Rated voltage [V]	Rated current [A]	Surge current [App]	Usable voltage [V]	Rated voltage [V]	Rated current [A]	Surge current [App]
$\alpha$ C1i	160-270	240	0.15	0.47	160-270	240	0.12	0.48
$\alpha$ C2i, $\alpha$ C3i	170-240	200	0.10	0.41	170-240	200	0.10	0.40
$\alpha$ C6i, $\alpha$ C8i	170-240	200	0.13	0.50	170-240	200	0.14	0.51
$\alpha$ C12i, $\alpha$ C15	170-240	200	0.22	1.15	170-240	200	0.32	1.10

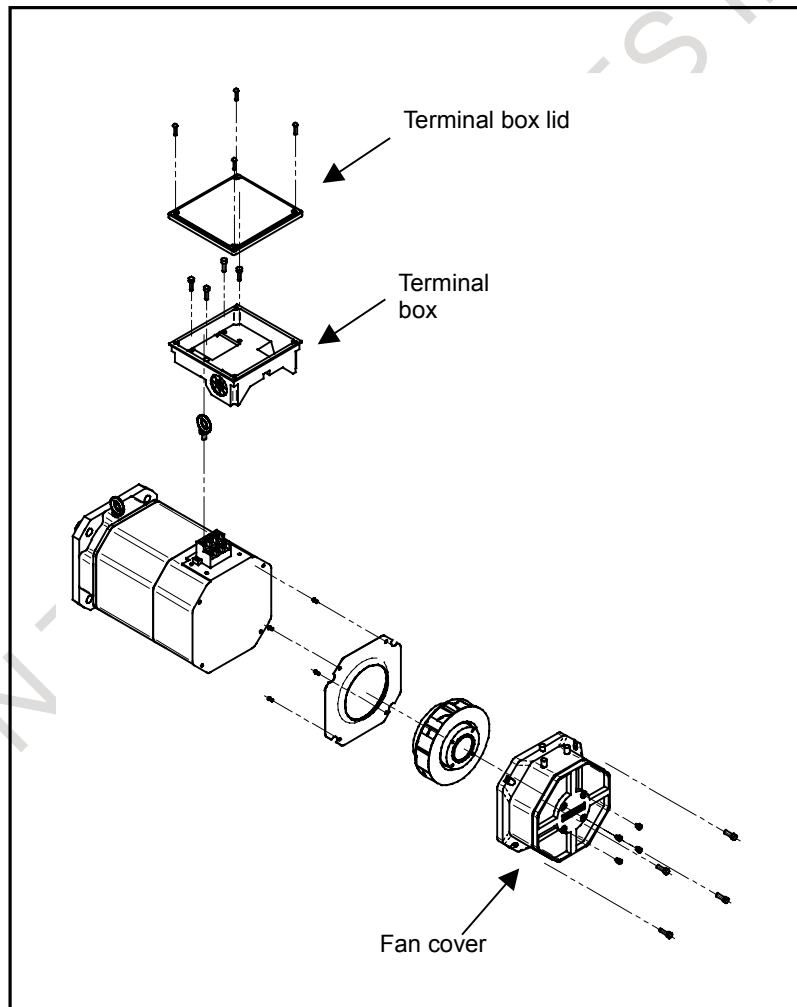
## 5 Center of gravity

The distance L from the flange end face to the center of gravity in each model is listed below.



$\alpha$ Ci series	Center of gravity [mm]
$\alpha$ C1/6000i	125±5
$\alpha$ C2/6000i	125±5
$\alpha$ C3/6000i	170±5
$\alpha$ C6/6000i	150±5
$\alpha$ C8/6000i	185±5
$\alpha$ C12/6000i	160±5
$\alpha$ C15/6000i	175±5

- 6 Segregated disposal of plastic and metal parts of motors  
Before disposing of motors, separate their plastic parts (such as terminal box, terminal box lid, and fan cover) from the other parts (metal parts) by disassembling the motors as shown below.  
All the plastic parts are made of the following materials:  
Plastic: >(PBT+PC)-GF(30)FR(17)<



## 4.2 POWER LEAD CONNECTION

---

**CAUTION**

1. To attach power leads to the motor terminal board, fasten them with the tightening torque listed below.

Terminal size	Tightening torque [N·m]
M4	1.1 to 1.5
M5	2.0 to 2.5
M6	3.5 to 4.5

2. To maintain the required isolation distance, observe the following:
  - When attaching a crimp terminal at the end of a power lead, cover the crimped portion of the crimp terminal with insulating tube.
  - If the terminal board is provided with an insulating cover, fasten the power leads with the screws, and then put back the insulating cover in place.

## 4.3 WHEN A MOTOR IS CONNECTED TO A SPINDLE VIA A BELT

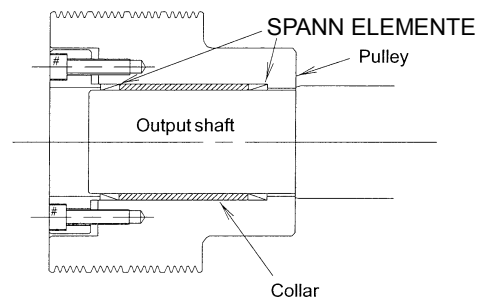
### CAUTION

- 1 Mounting the pulley
  - The gap between the inner surface of the motor pulley and output shaft should be  $10\mu\text{m}$  to  $15\mu\text{m}$ .
  - If the gap is large when the high-speed rotation ( $4500\text{ min}^{-1}$ ), fretting produced at the gap causes a large vibration, resulting in damage to the motor bearing.
  - As the vibration is intensified, fretting occurs in the gap mentioned above, and the pulley and shaft can stick to each other.
  - To secure a pulley, use a friction-tightening part such as a SPANN ELEMENTE or clamping sleeve.

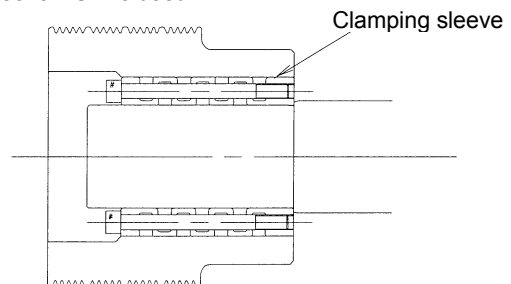
### NOTE

The SPANN ELEMENTE RfN8006 is manufactured by RINGFEDER.  
The clamping sleeve DSM is manufactured by SPIETH.

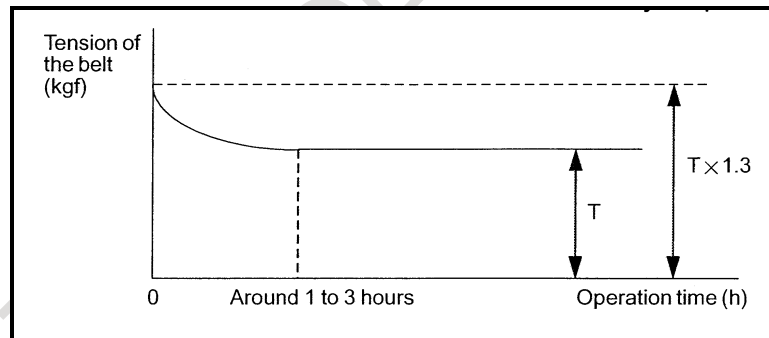
Example 1 Two sets of SPANN ELEMENTE RfN8006 are used.  
The collar is pinched at two points by the two sets.



Example 2 Clamping sleeve DSM is used.



- 2 After attaching a pulley to the motor, adjust the vibration of the belt groove to within  $20\ \mu\text{m}$  (T.I.R).
- 3 Before the belt is looped, FANUC recommends that the dynamic balance (field balance) be corrected.
- 4 Limit the radial load applied to the motor output shaft by the tension of the belt to the allowable value described in the manual for each series. If the allowable value is exceeded, the bearing or shaft may fail prematurely.
- 5 The tension of the belt is reduced as a result of abrasion during the initial several hours of operation. To transfer torque normally after this reduction in tension, the initial tension before operation should be set to a value 1.3 times the actually required tension  $T$ .



Recommended belts:

Ribace manufactured by BANDO.

Ribstar manufactured by MITSUBOSHI.

- Use an appropriate tension gage to tension the belt.

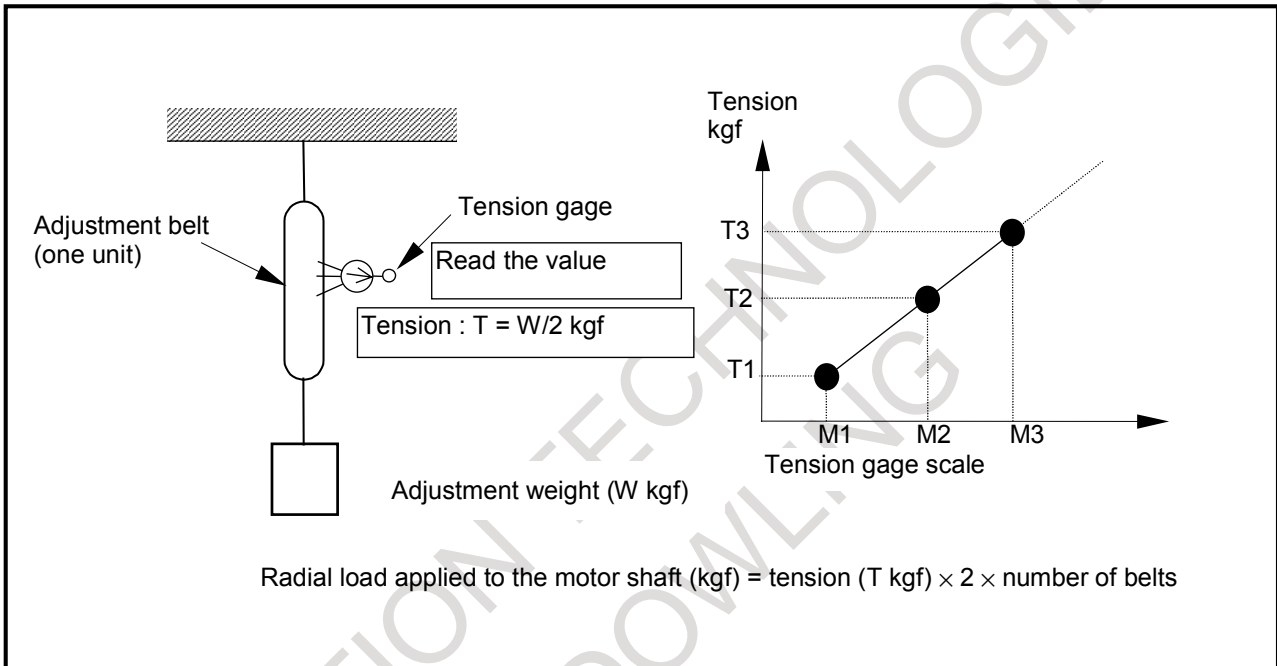
Examples Sonic type:

U-305 series manufactured by UNITTA.

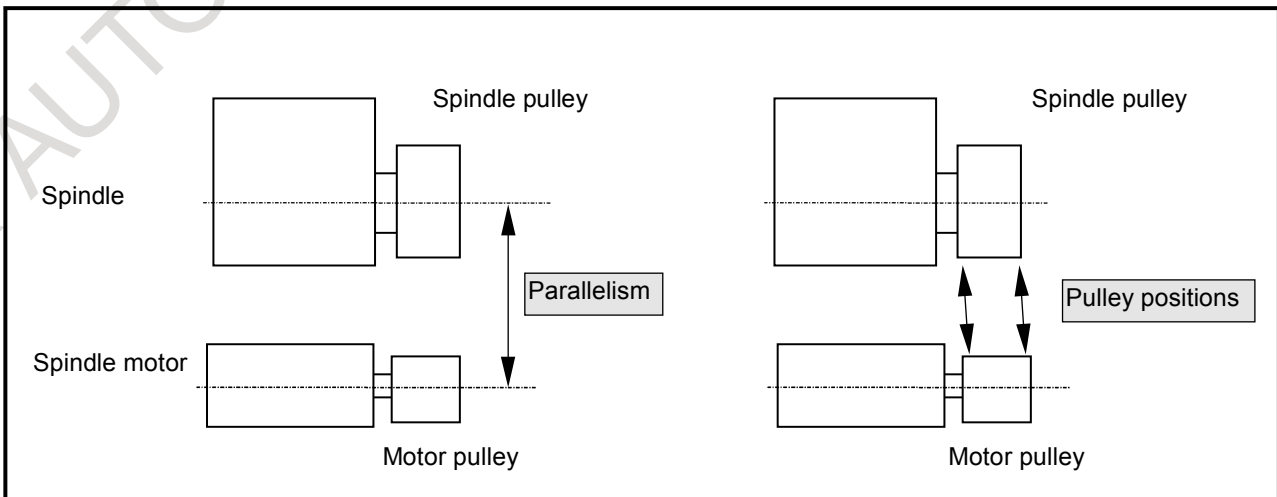
Mechanical type:

BT-33 series manufactured by Borroughs of the United States

A mechanical type tension gage may give a false reading depending on the belt's number of peaks and length. To overcome this problem, hang an object of a known weight on the belt, read the tension value, then adjust the tension gage.



- Reduce the deviation between the positions of the motor and machine pulleys in the shaft direction as much as possible and ensure that the center lines of the shafts are as parallel as possible.



## 4.4 WHEN A MOTOR IS DIRECTLY CONNECTED TO A SPINDLE VIA A COUPLING

---

 <b>CAUTION</b>
--

- 1 Use a coupling which can absorb thermal expansion in the axial direction of the motor mating shaft so that no load is applied in the motor axial direction.  
(Examples)
  - Diaphragm coupling (EAGLE INDUSTRY CO., LTD.)
  - Oldham's coupling
  - Leaf spring coupling
- 2 Set the torsional rigidity of the coupling to an appropriate high value. If the torsional rigidity is low, vibration may be produced during orientation.
- 3 It is important to perform centering and obtain parallelism to avoid having to recourse to the flexibility of the coupling.  
At high speeds, any eccentricity may cause the bearing to fail prematurely.
- 4 Check all machines before shipping to confirm that the vibration acceleration is 0.5 G or less when measured using the method described in CAUTION 5 of Section 4.1.

# 5

## NOTES ON OPERATION

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**⚠ WARNING**

- 1 When supplying voltage to the spindle motor or the fan motor, ensure that the earth cable is connected to the earth terminal and secure that the spindle motor is put to earth certainly.

**⚠ CAUTION**

- 1 Sound and vibration  
Check that there is no abnormal sound or vibration.
- 2 Cooling  
Clean off dust from the cooling air inlet and outlet of the stator every year, and check the flow of air carefully.

**NOTE**

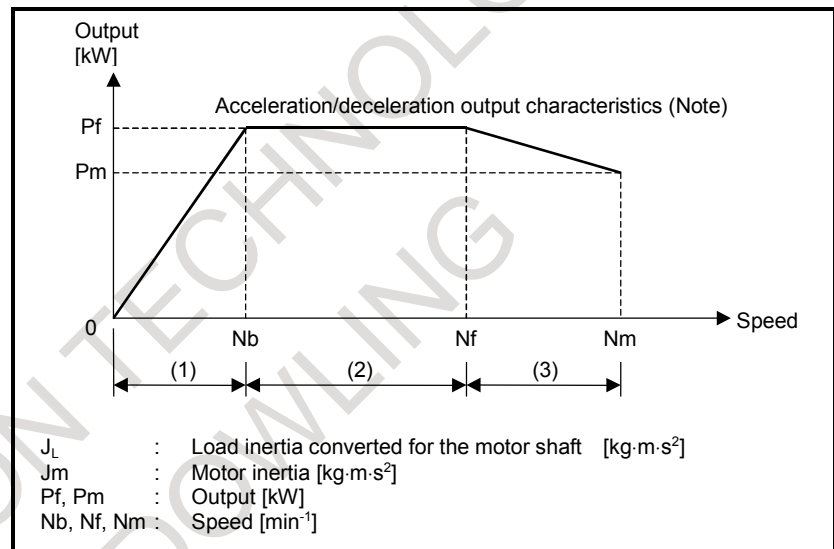
- 1 To increase the operating lifetime of a motor of these series, break in the motor. As a guideline, increase the speed of the motor from  $1000 \text{ min}^{-1}$  to its maximum speed in  $1000 \text{ min}^{-1}$  increments, and operate the motor at each speed for about 5 minutes.

# 6

## DETERMINING THE ACCELERATION TIME

The time required for each acceleration for the acceleration/deceleration output characteristics shown below can be obtained from the following equation.

Since machine load torque is not taken into consideration, the actual time is slightly longer than the calculated time.



### NOTE

The 30-minute rated output must be used as the acceleration output.

- Acceleration time (t1) in the constant-torque range (0 to Nb)

$$t1 = 0.10754 \times \frac{(JL + Jm) \times Nb^2}{Pf \times 1000} \text{ [sec]}$$

- Acceleration time (t2) in the constant-output range (Nb to Nf)

$$t2 = 0.10754 \times \frac{(JL + Jm) \times (Nf^2 - Nb^2)}{2 \times Pf \times 1000} \text{ [sec]}$$

- Acceleration time (t3) in the decreasing-output range (Nf to Nm)

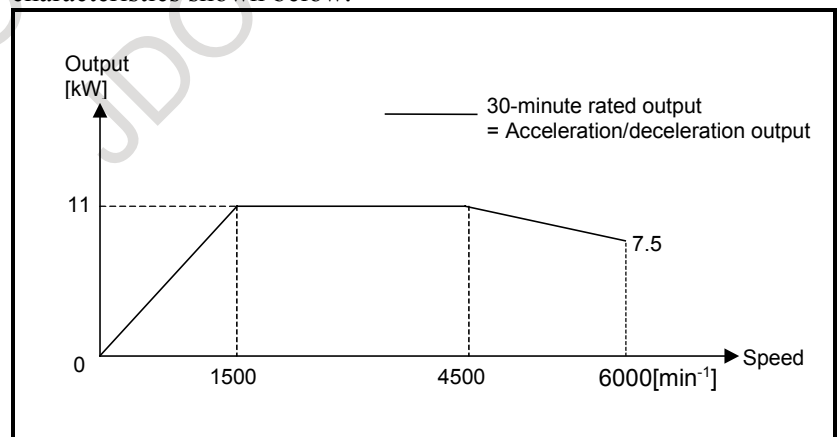
$$t3 = 0.10754 \times \frac{(JL + Jm) \times (Nm - Nf)}{(Pm - Pf) \times 1000} \times \left\{ (Nm - Nf) - \frac{Pf \times Nm - Pm \times Nf}{Pm - Pf} \times \ln(Pm / Pf) \right\} \text{ [sec]}$$

The total time (t) required for acceleration in the range from 0 to Nm is  $t1 + t2 + t3$  [s]

Deceleration can be controlled so that the time required for deceleration is nearly equal to that for acceleration. When the power voltage is high, or the impedance of the power is high, the time required for deceleration may not be made equal to that for acceleration.

**Calculation example**

Model  $\alpha C8/6000i$  has the acceleration/deceleration output characteristics shown below.



In this case, the variables have the following values.

$$Jm : 0.0028 \text{ [kgf} \cdot \text{m} \cdot \text{sec}^2]$$

**NOTE**

The rotor inertia is 0.28 [kgf·cm·sec<sup>2</sup>] in the  $\alpha C8/6000i$  specifications. When the unit is changed for calculation, the rotor inertia is  $0.28 \text{ [kgf} \cdot \text{cm} \cdot \text{sec}^2] / 100 = 0.0028 \text{ [kgf} \cdot \text{m} \cdot \text{sec}^2]$

6.DETERMINING THE ACCELERATION TIME SPECIFICATIONS FOR THE  $\alpha Ci$  SERIES B-65372EN/01

Pf : 11 [kW]  
 Pm : 7.5 [kW]  
 Nb : 1500 [min<sup>-1</sup>]  
 Nf : 4500 [min<sup>-1</sup>]  
 Nm : 6000 [min<sup>-1</sup>]

Suppose that JL is 0.0056 [kgf·m·sec<sup>2</sup>]. Then the acceleration times are as follows:

- Acceleration time (t1) in the constant-torque range (0 to Nb)

$$t_1 = 0.10754 \times \frac{(0.0056 + 0.0028) \times 1500^2}{11 \times 1000} = 0.185 \text{ [sec]}$$

- Acceleration time (t2) in the constant-output range (Nb to Nf)

$$t_2 = 0.10754 \times \frac{(0.0056 + 0.0028) \times (4500^2 - 1500^2)}{2 \times 11 \times 1000} = 0.739 \text{ [sec]}$$

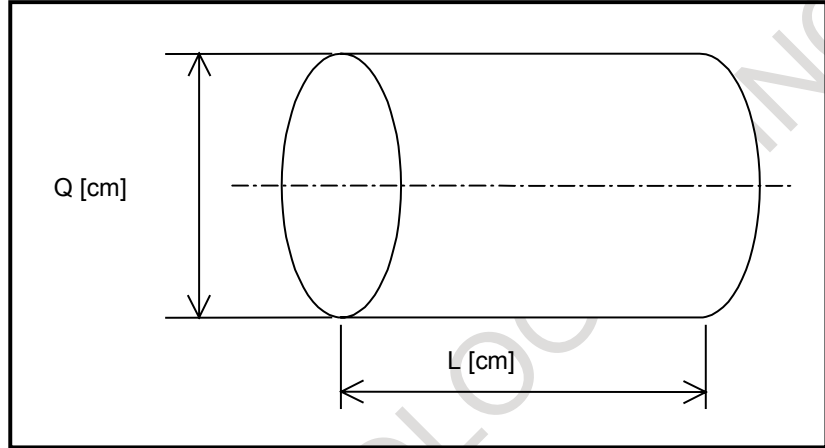
- Acceleration time (t3) in the decreasing-output range (Nf to Nm)

$$t_3 = 0.10754 \times \frac{(0.0056 + 0.0028) \times (6000 - 4500)}{(7.5 - 11) \times 1000} \times \left\{ (6000 - 4500) - \frac{11 \times 6000 - 7.5 \times 4500}{7.5 - 11} \times \ln(7.5/11) \right\} = 0.785 \text{ [sec]}$$

The total time required for acceleration in the range from 0 to 6000 min<sup>-1</sup> is t1+t2+t3=1.71 [s]

**Reference 1**

When a cylinder rotates about its center axis, its inertia can be obtained from the following equation.



$$J = \frac{\pi\gamma}{32 \times 980} Q^4 L \text{ [kgf} \cdot \text{cm} \cdot \text{sec}^2\text{]}$$

When steel ( $\gamma = 7.8 \times 10^{-3} \text{ kgf/cm}^3$ ) is used, the approximate inertia is obtained from the following equation.

$$J = 0.78 \times 10^{-6} Q^4 L \text{ [kgf} \cdot \text{cm} \cdot \text{sec}^2\text{]}$$

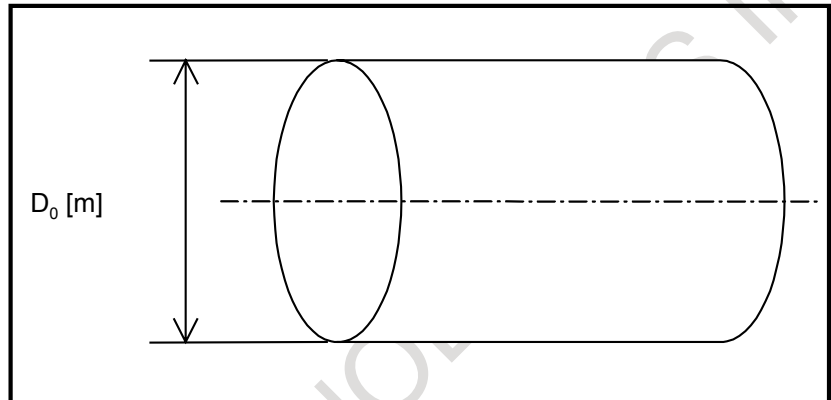
When the unit for J is changed.

$$J = 0.78 \times 10^{-8} Q^4 L \text{ [kgf} \cdot \text{m} \cdot \text{sec}^2\text{]}$$

**Reference 2**

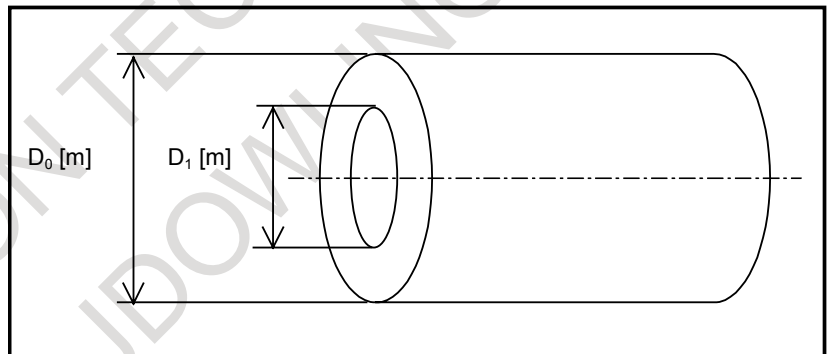
To obtain the value  $GD^2$  [kgf·m<sup>2</sup>] for cylinder, get the value of G from its weight in kilograms and use the following equation to get the value of  $D^2$ .

**- Solid cylinder**



$$D^2 = D_0^2 / 2$$

**- Hollow cylinder**



$$D^2 = (D_0^2 + D_1^2) / 2$$

Use the following equation to convert  $GD^2$  [kgf·m<sup>2</sup>] to J [kgf·cm·sec<sup>2</sup>]  
 $J$ [kgf·cm·sec<sup>2</sup>] =  $GD^2$  [kgf·m<sup>2</sup>]/4/g×100  
 =  $GD^2$  [kgf·m<sup>2</sup>]/4/9.8×100  
 =  $GD^2$  [kgf·m<sup>2</sup>] ×2.55

**NOTE**  
 g indicates the acceleration of gravity :  
 9.80 [m/sec<sup>2</sup>].

**Reference 3**

Note the following relationship between the value of inertia I [kg·m<sup>2</sup>] in SI units and the value of GD<sup>2</sup> [kgf·m<sup>2</sup>]:

$$I[\text{kg}\cdot\text{m}^2]=\text{GD}^2[\text{kgf}\cdot\text{m}^2]/4$$

Therefore, to convert I [kg·m<sup>2</sup>] to J [kgf·cm·sec<sup>2</sup>], use the following equation:

$$\begin{aligned} J[\text{kgf}\cdot\text{cm}\cdot\text{sec}^2] &= \text{GD}^2[\text{kgf}\cdot\text{m}^2]/4/g\times 100 \\ &= I[\text{kg}\cdot\text{m}^2]/g\times 100 \\ &= I[\text{kg}\cdot\text{m}^2]/9.80\times 100 \\ &= I[\text{kg}\cdot\text{m}^2]\times 10.2 \end{aligned}$$

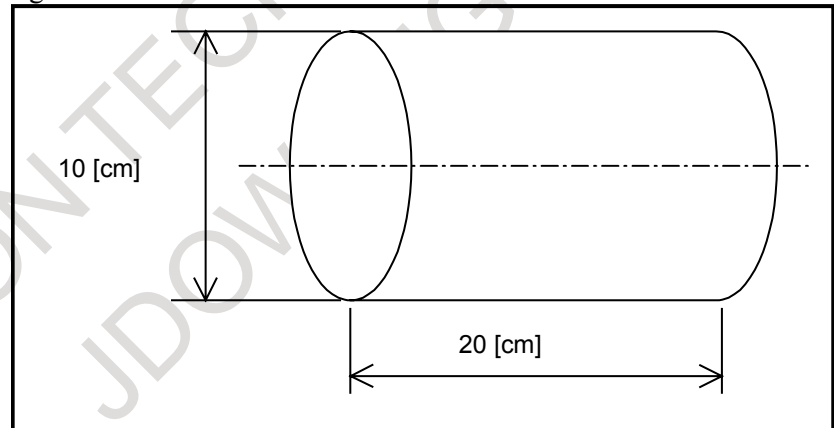
**NOTE**

g indicates the acceleration of gravity:  
9.80 [m/sec<sup>2</sup>].

**Reference 4**

**- Difference of inertia**

Calculate the inertia of the solid steel cylinder shown in the following figure.



(1) Calculating J [kgf·cm·sec<sup>2</sup>]

$$\begin{aligned} J &= \pi\gamma/(32\times 980)\times Q^4\times L \\ &= \pi\times 7.8\times 10^{-3}/(32\times 980)\times 10^4\times 20 \\ &= 0.156[\text{kgf}\cdot\text{cm}\cdot\text{sec}^2] \end{aligned}$$

(2) Calculating GD<sup>2</sup> [kgf·m<sup>2</sup>]

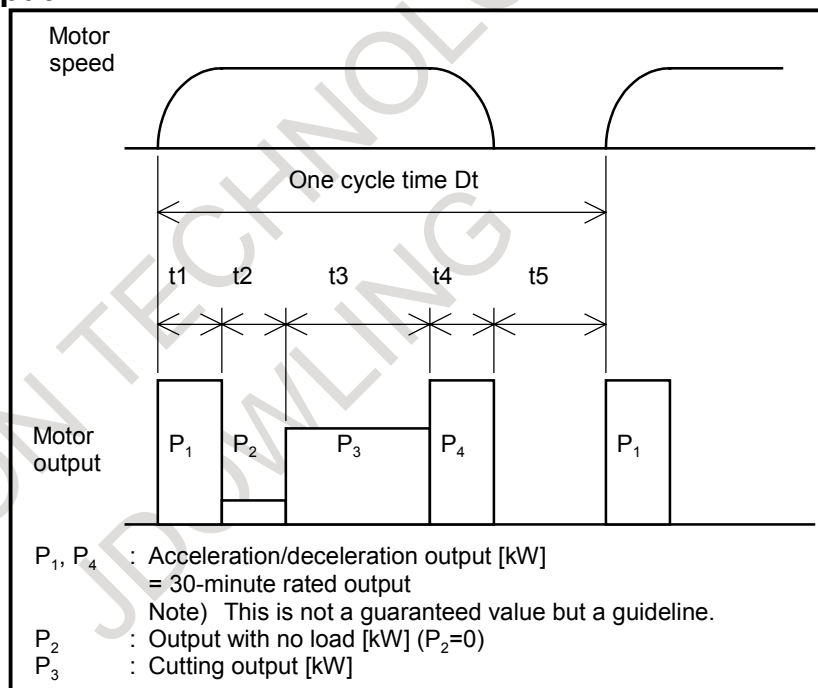
$$\begin{aligned} G &= \pi/4\times 10^2\times 20\times \gamma \\ &= \pi/4\times 10^2\times 20\times 7.8\times 10^{-3} \\ &= 12.25[\text{kgf}] \\ D^2 &= D_0^2/2 \\ &= 0.1^2/2 \\ &= 0.005[\text{m}^2] \\ \text{GD}^2 &= 12.25\times 0.005 \\ &= 0.0613[\text{kgf}\cdot\text{m}^2] \end{aligned}$$

# 7

## DETERMINING THE ALLOWABLE DUTY CYCLE

When machining requires the spindle to accelerate and decelerate frequently, the average output per cycle must not exceed the continuous rated output. The allowable duty cycle for a typical AC spindle motor can be obtained as shown below.

### Duty cycle and average output



$$\text{Average output } P_{av} = \sqrt{\frac{P_1^2 t_1 + P_2^2 t_2 + P_3^2 t_3 + P_4^2 t_4}{D_t}}$$

**NOTE** This is not a guaranteed value but a guideline.

#### NOTE

1 Cutting output  $P_3$  at motor speed  $N$  which is lower than base speed  $N_b$  shall be calculated by the following equation.

$$P_3 = P_C \times N_b / N \text{ [kW]} \quad (P_C: \text{Actual cutting output})$$

2 In case that  $P_3$  is calculated by the load indicator voltage, use the following equation.

$$P_3 = P_1 \times L_3 / 10 \text{ [kW]}$$

( $L_3$ : Load indicator voltage in cutting [V])

### Allowable duty cycle time Dt

From the equation for getting the value of Pav[kW].

$$Dt = \frac{1}{P_{av}^2} \times (P_1^2 t_1 + P_2^2 t_2 + P_3^2 t_3 + P_4^2 t_4)$$

Substitute the continuous rated output of the used AC spindle motor for Pav [kW] in the equation above.

Example)

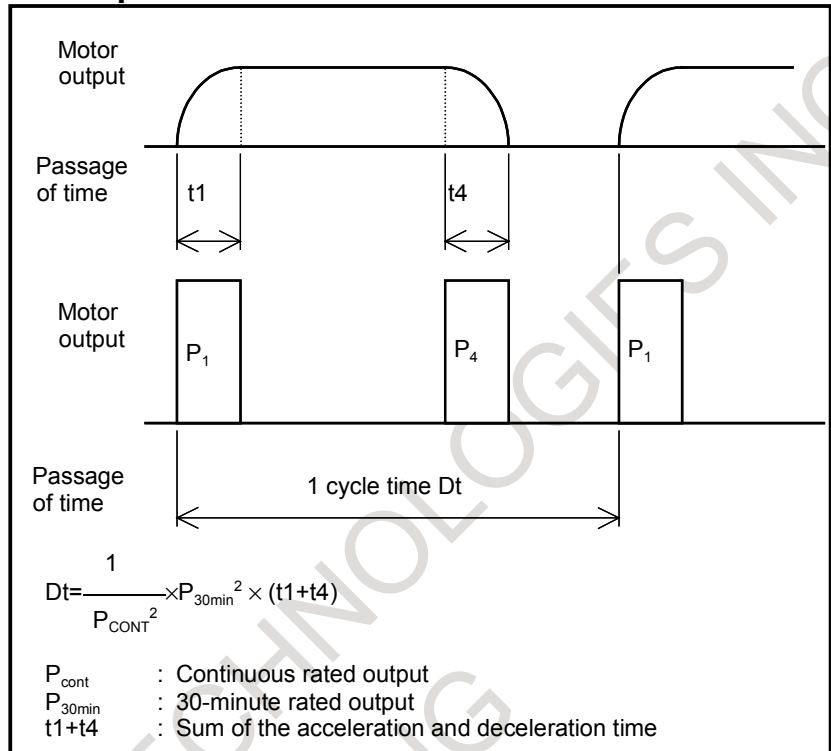
To obtain the allowable duty cycle when model  $\alpha C3i$  accelerates and decelerates repeatedly without load ( $P_2=P_3=0$ ).

- Continuous rated output  $P_{av}=P_{cont}=3.7kW$
- Acceleration/deceleration output  $P_1=P_4=5.5kW$
- Acceleration time  $t_1=3s$ , deceleration time  $t_4=3s$

$$Dt = \frac{1}{3.7^2} \times (5.5^2 \times 3 + 5.5^2 \times 3) = 13.3 \text{ seconds}$$

As shown above, when model  $\alpha C3i$  accelerates and decelerates repeatedly, the allowable duty cycle time is 13.3 seconds.

**Allowable duty cycle time Dt for repeated acceleration/deceleration**



## II. FANUC AC SPINDLE MOTOR $\alpha$ Ci SERIES

JR AUTOMATION TECHNOLOGIES INC\*  
JDOWLING

JR AUTOMATION TECHNOLOGIES INC\*  
JDOWLING

# 1

## GENERAL

---

The FANUC AC spindle motor  $\alpha$ Ci series is economical and ideal for small lathes.

### Features

- Economical configuration includes a servo amplifier.
- Waterproof and pressure-proof design conforming to the international standard (IEC) is employed to improve reliability and make it resistant to most environments.

# 2

## SPECIFICATIONS

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JR AUTOMATION TECHNOLOGIES INC\*  
JDOWLING

Series		$\alpha$ Ci series		
Item	Model	$\alpha$ C1/6000i	$\alpha$ C2/6000i	$\alpha$ C3/6000i
		Output (*1)	Cont. rated kW (HP)	1.5 (2.0)
30 min rated kW [15 min] (*2) (HP)	2.2 (3.0)		3.7 (5.0)	5.5 (7.4)
S3 40% kW [60%] (*3)(*4) (HP)	2.2 (3.0)		3.7 (5.0)	5.5 (7.4)
Rated current A (*5)	Cont. rated	11	20	22
	30 min rated (*2) S3 40% (*3)	14	28	28
Speed min <sup>-1</sup>	Base speed	3000	1500	1500
	Max. speed	6000	6000	6000
Output torque (Cont. rated torque at const. rated torque range) N·m (kgf·cm)		4.77 (48.7)	14.0 (143)	23.5 (240)
Rotor inertia	kg·m <sup>2</sup>	0.003	0.0078	0.0148
	kgf·cm·s <sup>2</sup>	0.03	0.08	0.15
Weight kgf		18	27	46
Vibration		V5		
Noise		75dB(A) or less		
Cooling system (*6)		Totally enclosed and fan cooled IC0A6		
Cooling fan W		17		
Installation (*7)		Mount the motor so that the output shaft points in a direction ranging within 45° degrees above the horizontal to vertically downwards. IMB5,IMV1,IMB3,IMB6,IMB7,IMB8,IMV5		
Insulation		Class H		
Ambient temperature		0 to 40°C		
Altitude		Height above sea level not exceeding 1000m		
Painting color		Munsell system N2.5		
Type of thermal protection (*8)		TP211		
Bearing lubrication		Grease		
Maximum output during acceleration(*9) kW		2.64	4.44	6.6
Applicable spindle amplifier module		SPMC-2.2i	SPMC-5.5i	
Model		$\alpha$ C1/6000i	$\alpha$ C2/6000i	$\alpha$ C3/6000i

Series		$\alpha$ Ci series			
Item	Model	$\alpha$ C6/6000i	$\alpha$ C8/6000i	$\alpha$ C12/6000i	$\alpha$ C15/6000i
	Output (*1)	Cont. rated kW (HP)	5.5 (7.4)	7.5 (10)	11 (14.7)
30 min rated kW [15 min] (*2) (HP)		7.5 (10)	11 (14.7)	15 (20.1)	18.5 (24.8)
S3 40% kW [60%] (*3)(*4) (HP)		7.5 (10)	11 (14.7)	15 (20.1)	18.5 (24.8)
Rated current A (*5)	Cont. rated	42	44	56	74
	30 min rated (*2) S3 40% (*3)	51	56	68	86
Speed min <sup>-1</sup>	Base speed	1500	1500	1500	1500
	Max. speed	6000	6000	6000	6000
Output torque (Cont. rated torque at const. rated torque range) N·m (kgf·cm)		35.0 (357)	47.7 (487)	70.0 (714)	95.4 (974)
Rotor inertia	kg·m <sup>2</sup>	0.0179	0.0275	0.07	0.09
	kgf·cm·s <sup>2</sup>	0.18	0.28	0.77	0.93
Weight kgf		51	80	95	110
Vibration		V5			
Noise		75dB(A) or less			
Cooling system (*6)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		20		56	
Installation (*7)		Mount the motor so that the output shaft points in a direction ranging within 45° degrees above the horizontal to vertically downwards. IMB5,IMV1,IMB3,IMB6,IMB7,IMB8,IMV5			
Insulation		Class H			
Ambient temperature		0 to 40°C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Type of thermal protection (*8)		TP211			
Bearing lubrication		Grease			
Maximum output during acceleration(*9) kW		9.0	13.2	18.0	22.2
Applicable spindle amplifier module		SPMC-11i		SPMC-15i	SPMC-22i
Model		$\alpha$ C6/6000i	$\alpha$ C8/6000i	$\alpha$ C12/6000i	$\alpha$ C15/6000i

- (\*1) The rated output is guaranteed at the rated voltage.  
(Amplifier input: 200/220/230VAC +10% -15%, 50/60 Hz  $\pm$ 1Hz)  
If the input voltage fluctuates, it is possible that the rated output cannot be obtained even when such fluctuations are within the allowable fluctuation range.
- (\*2) The output for  $\alpha$ C1/6000i or  $\alpha$ C2/6000i is 15 min rated.
- (\*3) S3 60% for  $\alpha$ C1/6000i or  $\alpha$ C2/6000i.
- (\*4) The cycle time is 10 minutes, S3 60%: ON 6 minutes, OFF 4 minutes and S3 40%: ON 4 minutes, OFF 6 minutes.
- (\*5) The rated current is not a guaranteed value but a guideline for the maximum current at rated output.
- (\*6) IC code conforms to IEC 34-6.
- (\*7) IM code conforms to IEC 34-7.
- (\*8) Type conforms to IEC 34-11.
- (\*9) These values are to be used only as guidance for selecting a power supply module and are not guaranteed.
- (\*10) Degree of protection:  
with oil seal: IP54,  
without oil seal: IP40.

# 3

## OUTPUT/TORQUE CHARACTERISTICS

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### Reference Calculation for torque

Torque T can be obtained by the following equation.

$$T[\text{N}\cdot\text{m}] = P[\text{kW}] \times 1000 / 0.1047 / N[\text{min}^{-1}]$$

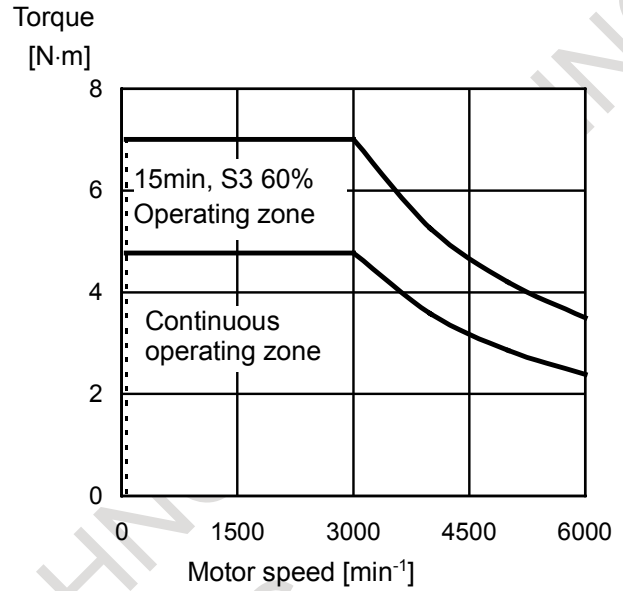
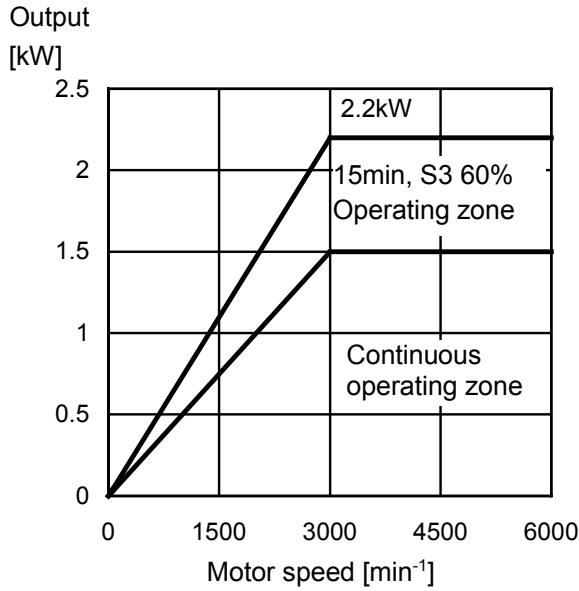
P[kW]: Motor output

N[ $\text{min}^{-1}$ ]: Motor speed

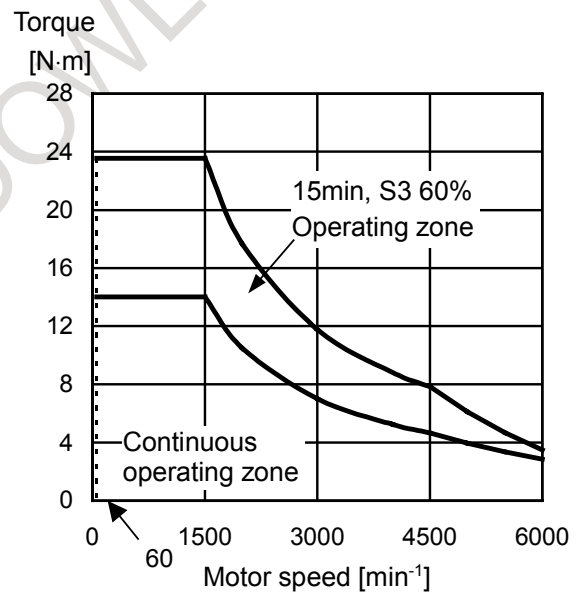
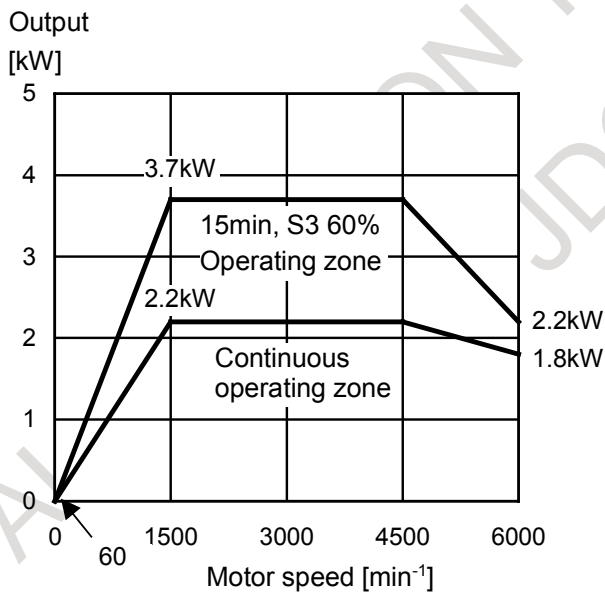
When the unit of T is [kgf·m],

$$T[\text{kgf}\cdot\text{m}] = P[\text{kW}] \times 1000 / 1.0269 / N[\text{min}^{-1}]$$

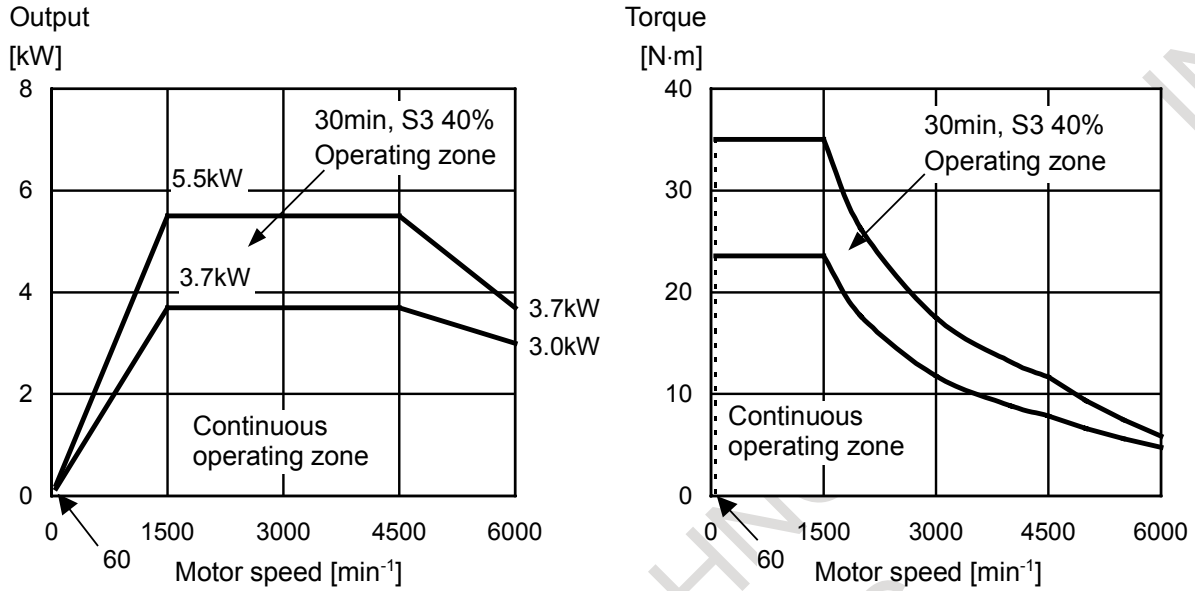
### 3.1 MODEL $\alpha$ C1/6000i



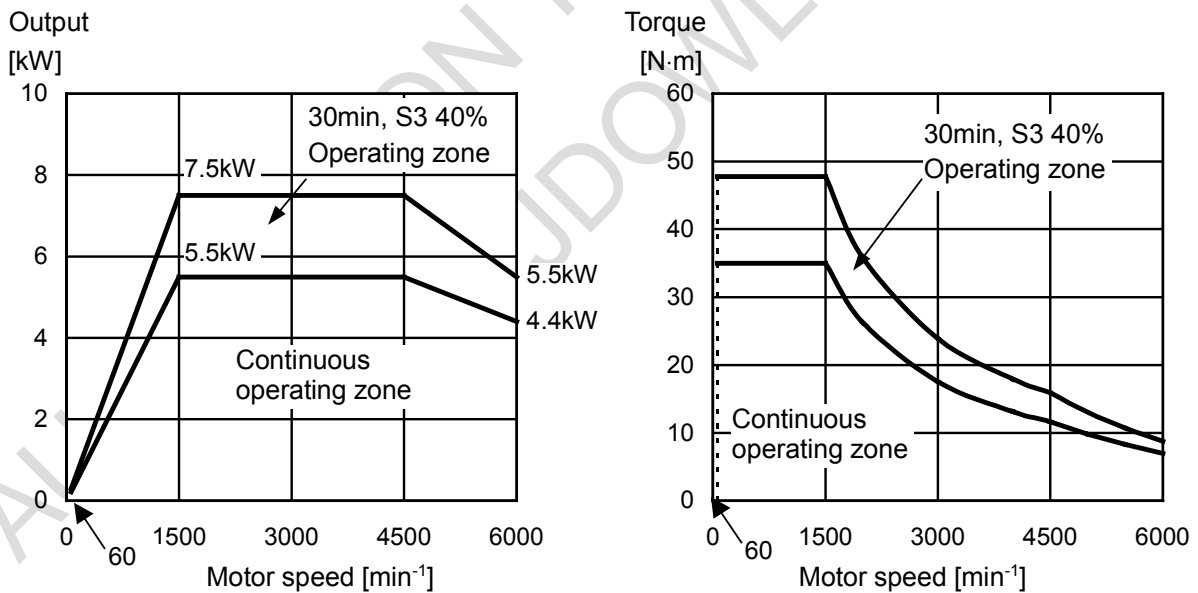
### 3.2 MODEL $\alpha$ C2/6000i



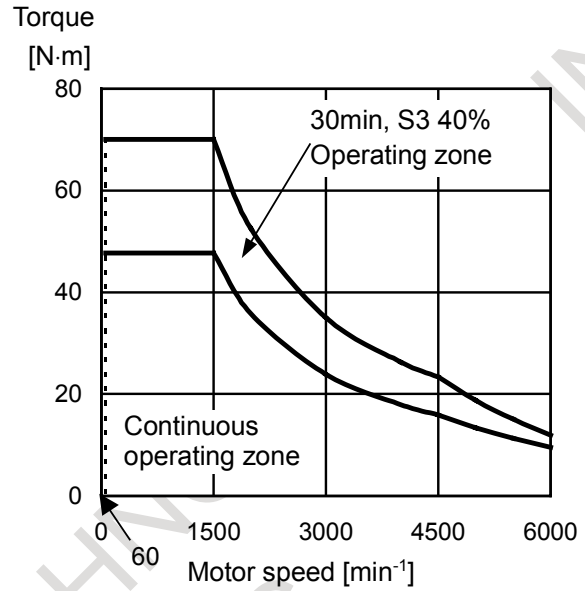
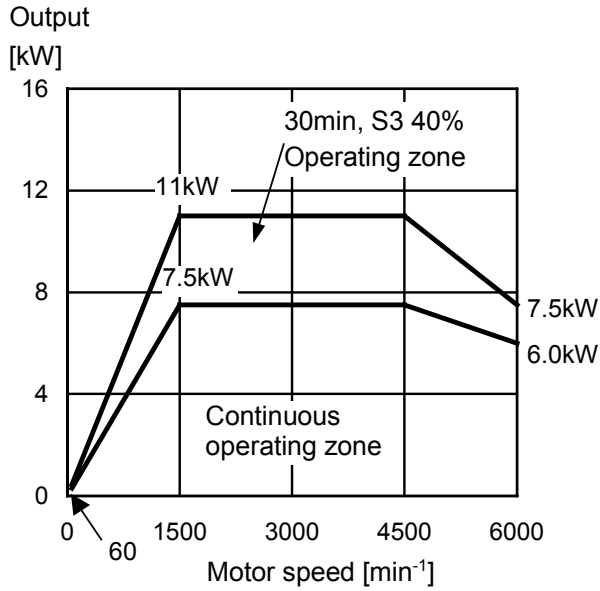
### 3.3 MODEL $\alpha$ C3/6000i



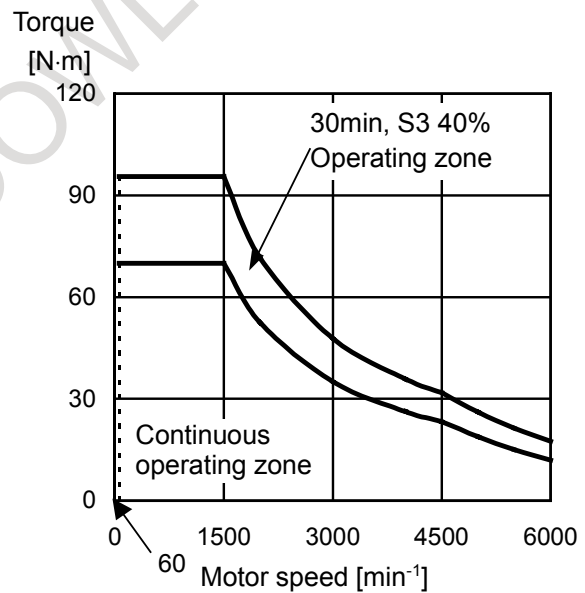
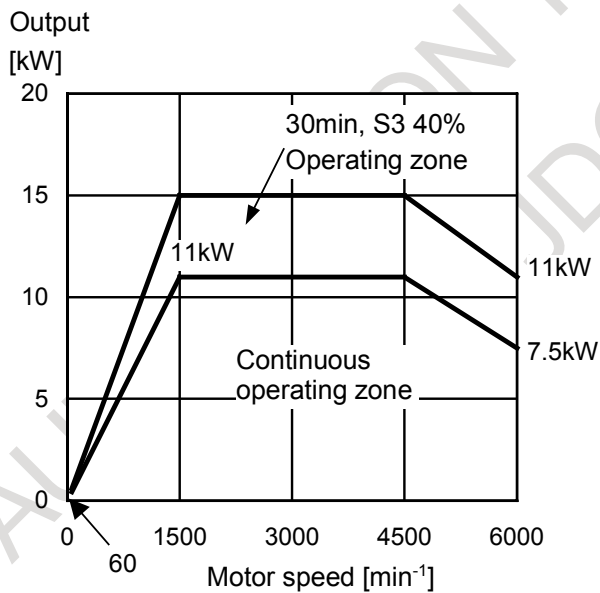
### 3.4 MODEL $\alpha$ C6/10000i



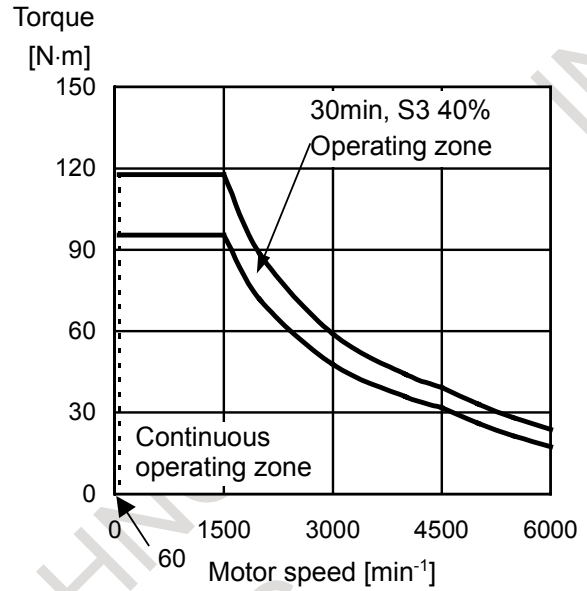
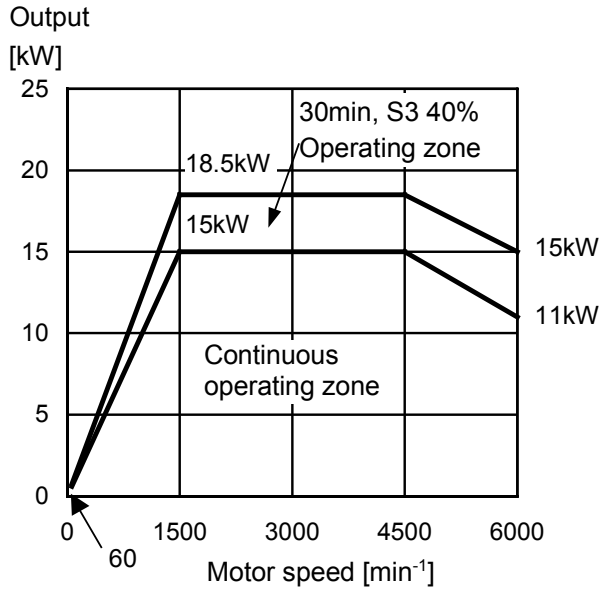
### 3.5 MODEL $\alpha$ C8/6000i



### 3.6 MODEL $\alpha$ C12/6000i



### 3.7 MODEL $\alpha$ C15/6000i



# 4 CONNECTIONS

## 4.1 MODELS $\alpha$ C1/6000*i* TO $\alpha$ C15/6000*i*

Cables of primary winding and fan motor are connected to the terminal block.

Thermistor signal use a connector manufactured by AMP.

The connector housing and the connector are attached to the motor.

Model	Size of screws used in the terminal block	Power lead U,V,W,G	Fan motor FMU,FMV,FMW
	$\alpha$ C1/6000 <i>i</i>		M5
$\alpha$ C2/6000 <i>i</i> to $\alpha$ C15/6000 <i>i</i>		M5	Screw-less terminal block

### Cable for the power lead

For the power lead cable specification, refer to "FANUC SERVO AMPLIFIER  $\alpha$ *i* series DESCRIPTIONS (B-65282EN)".

### Cable for the fan motor

The machine tool builder is to prepare the following cable for the fan motor:

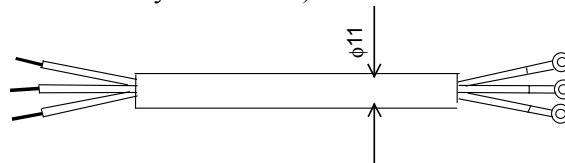
Vinyl heavy-duty power cord JIS C 3312 3-conductor

Conductor: 37/0.26 (2 mm<sup>2</sup>)

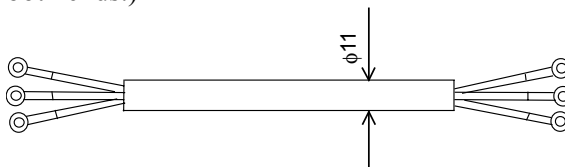
Sheath: PVC $\phi$ 11

Crimp terminal: T2-4S

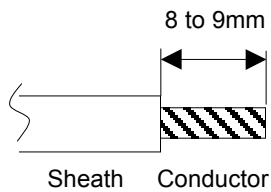
<1> For a non-screw terminal block (Peel off each wire sheath on the motor side by 8 to 9 mm.)



<2> For an M4 screw terminal block (Attach crimp terminals to the both ends.)



## Method of connection



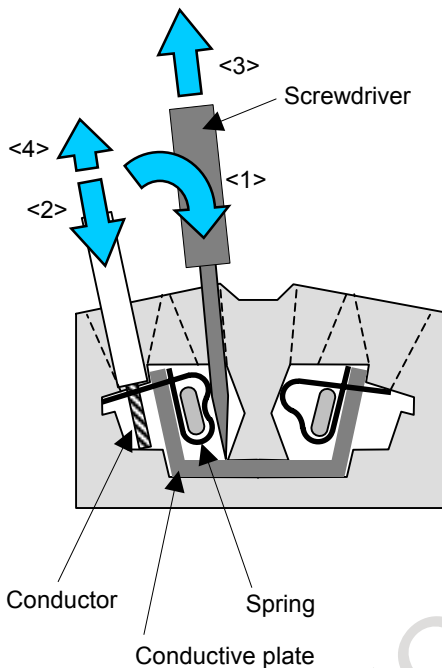
### Peel-off length of a wire sheath

By using an appropriate tool, peel off each wire sheath by 8 to 9 mm.

### Screwdriver

Use a flat-blade screwdriver with a blade size of  $3.5 \times 0.5$  mm. (210-120J (standard type), 210-350J (short type) manufactured by WAGO)

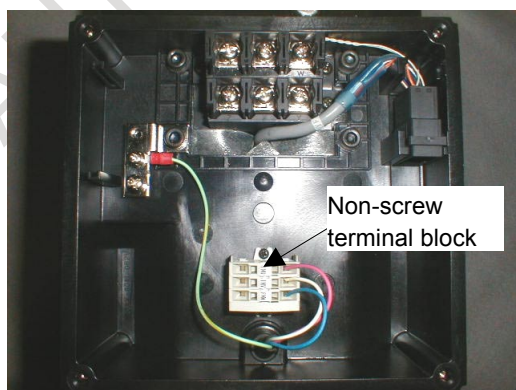
### Connection procedure



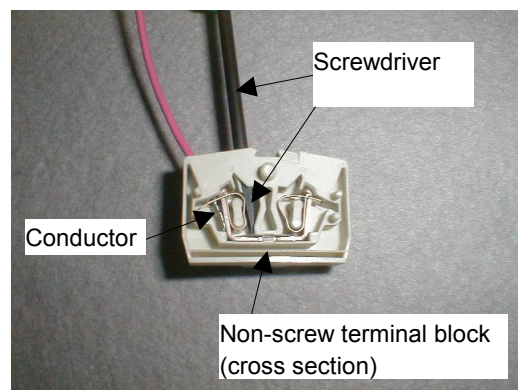
- <1> Insert the tip of the screwdriver into the screwdriver insertion slot (small rectangular hole) until the tip touches the spring. Next, while tilting the screwdriver toward the inside of the terminal block, push the screwdriver until it butts the conductive plate. In this state, the spring is opened completely, and the screwdriver is held in the terminal block. Ensure that the screwdriver is secured. Otherwise, the next step (wire insertion) cannot be conducted easily.
- <2> Check the peel-off length (8 to 9 mm), then insert the wire into the wire insertion slot (large rectangular hole) until it stops, by sliding the wire along the outer side of the hole slowly so that the conductor does not become loose. Be careful not to push a thin wire excessively.
- <3> While holding down the inserted wire by one hand, extract the screwdriver. The spring is closed to make a connection.
- <4> By slightly pulling the wire, check that the wire is connected firmly. The wire need not be pulled intensely.

### Cautions

- Only one wire must be connected to one spring.
- A wire, which may be a stranded wire or single conductor, can be directly connected without performing terminal processing if its sheath is peeled off. A wire after ferrule processing can also be connected.



Inside the terminal box



State of cable connection

### Connector attachment of thermistor signal



Connector pins arrangement

<b>Number</b>	B1	B2	B3	B4	B5	B6
<b>Color</b>						
<b>Signal</b>						THR2
<b>Number</b>	A1	A2	A3	A4	A5	A6
<b>Color</b>						
<b>Signal</b>						THR1

### - Connector housing and contact specifications

Connector and contact : tyco Electronics AMP specification D-3000 series

	Motor side		Cable side	
	FANUC specification	AMP specification	FANUC specification	AMP specification
Housing	A63L-0001-0535/121KDF	178964-6	A63L-0001-0460/121KD	178289-6
Contact	A63L-0001-0456/ASMT	175288-2	A63L-0001-0456/ASM	1-175217-2

Crimping tool : 91559-1 Extractor : 234168-1

### - Thermistor specification

Signal THR1 corresponds to one of the thermistor terminals, and signal THR2, to the other terminal. The resistance of the thermistor is about 30 to 90 k $\Omega$  as measured at room temperature (20°C to 30°C).

# 5

## ALLOWABLE RADIAL LOAD

Use the motor output shaft below the allowable radial loads shown in the table below.

Model	Allowable radial load (kgf)	
	At output shaft end	At output shaft center
$\alpha$ C1/6000 <i>i</i>	392N (40kgf)	441N (45kgf)
$\alpha$ C2/6000 <i>i</i>	882N (90kgf)	999N (102kgf)
$\alpha$ C3/6000 <i>i</i>	1470N (150kgf)	1607N (164kgf)
$\alpha$ C6/6000 <i>i</i>	1960N (200kgf)	2205N (225kgf)
$\alpha$ C8/6000 <i>i</i>	2940N (300kgf)	3371N (344kgf)
$\alpha$ C12/6000 <i>i</i> , $\alpha$ C15/6000 <i>i</i>	2940N (300kgf)	3410N (348kgf)

### NOTE

- 1 When using a belt, adjust the tension so the allowable loads indicated above are not exceeded. If an excessive load is applied, consider the use of a support bearing on the machine side to maintain the long-term reliability of the motor. (If an excessive load is applied, it is possible that an abnormal sound may occur.)
- 2 When the belt tension is maximized at a point outside the output shaft end, the allowable loads are less than those at the output shaft end.
- 3 Never apply a thrust load.

# 6

## ASSEMBLING ACCURACY

Item	Model	$\alpha$ C1i to $\alpha$ C15i	Measuring method
Run-out at the end of the output shaft		20 $\mu$ m or less	<p>1/2 the output shaft length</p>
Run-out of the faucet joint for mounting the flange against the core of the shaft (Only for flange type)		40 $\mu$ m or less	
Run-out of the flange mounting surface against the core of the shaft (Only for flange type)		80 $\mu$ m or less	

# 7

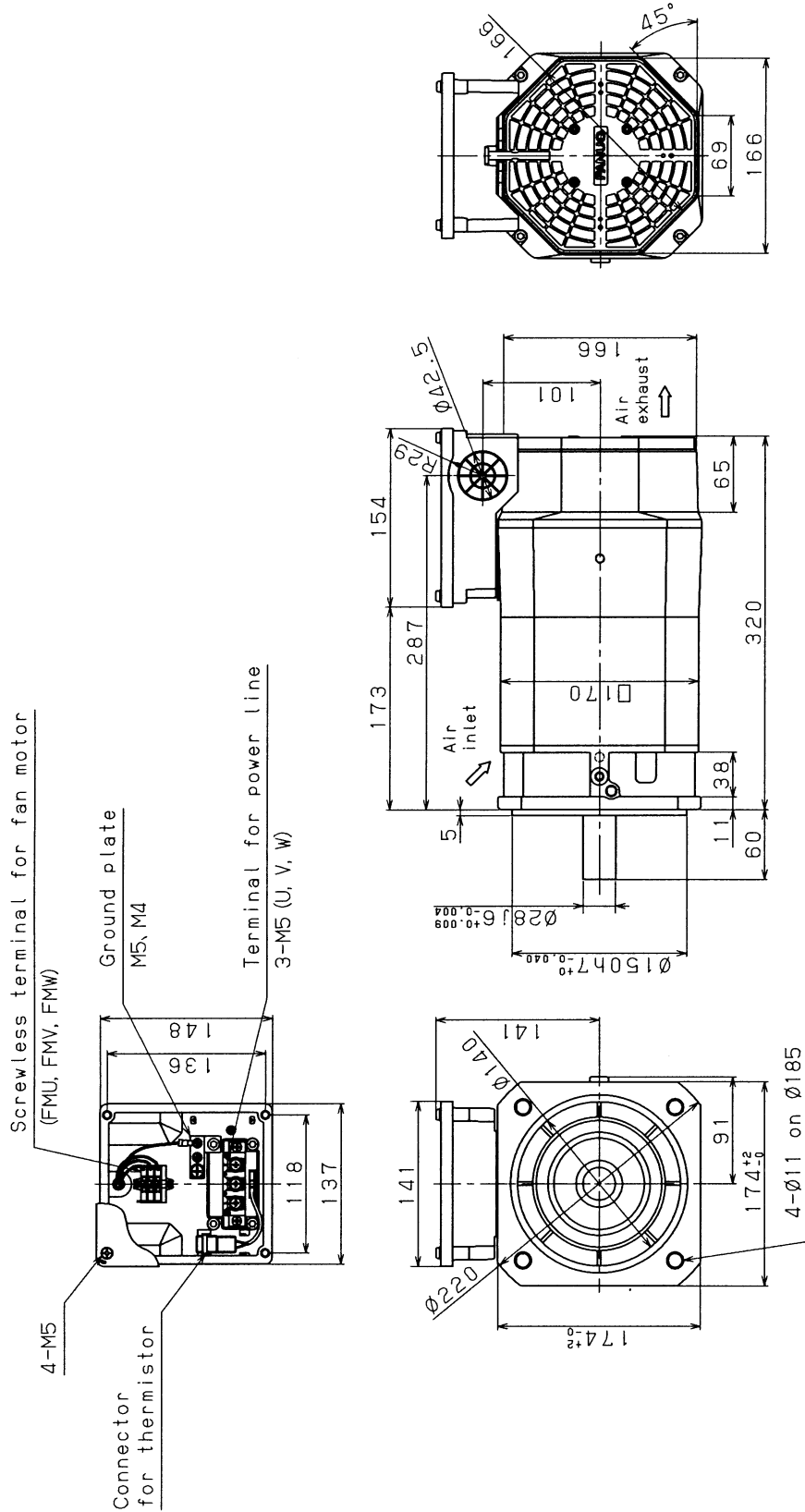
## EXTERNAL DIMENSIONS

Model name	Section
Model $\alpha$ C1/6000i (flange mounting type)	7.1
Model $\alpha$ C1/6000i (foot mounting type)	7.2
Model $\alpha$ C2/6000i (flange mounting type)	7.3
Model $\alpha$ C2/6000i (foot mounting type)	7.4
Model $\alpha$ C3/6000i (flange mounting type)	7.5
Model $\alpha$ C3/6000i (foot mounting type)	7.6
Model $\alpha$ C6/6000i (flange mounting type)	7.7
Model $\alpha$ C6/6000i (foot mounting type)	7.8
Model $\alpha$ C8/6000i (flange mounting type)	7.9
Model $\alpha$ C8/6000i (foot mounting type)	7.10
Model $\alpha$ C12/6000i (flange mounting type)	7.11
Model $\alpha$ C12/6000i (foot mounting type)	7.12
Model $\alpha$ C15/6000i (flange mounting type)	7.13
Model $\alpha$ C15/6000i (foot mounting type)	7.14



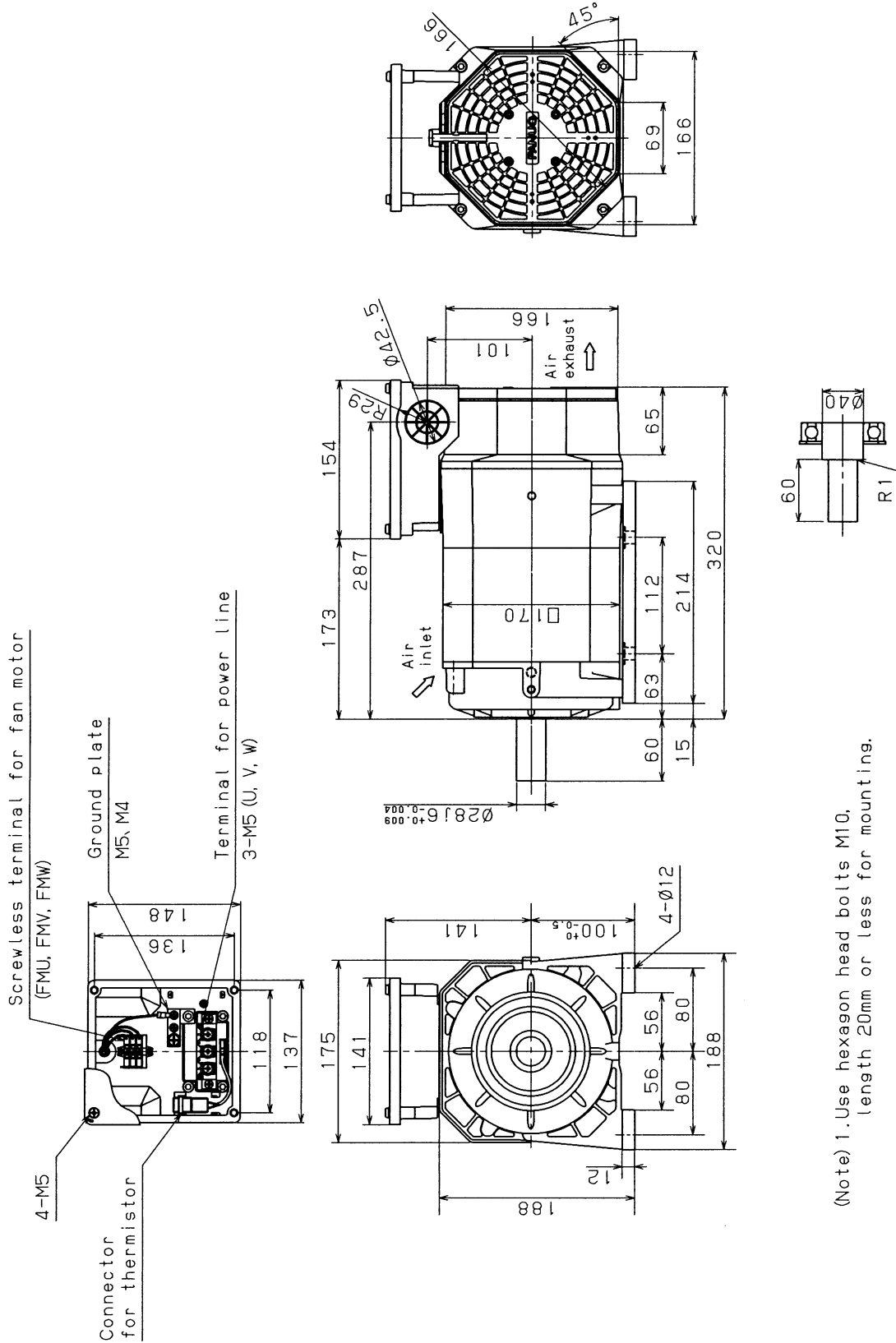


# 7.3 MODEL $\alpha$ C2/6000i (FLANGE MOUNTING TYPE)



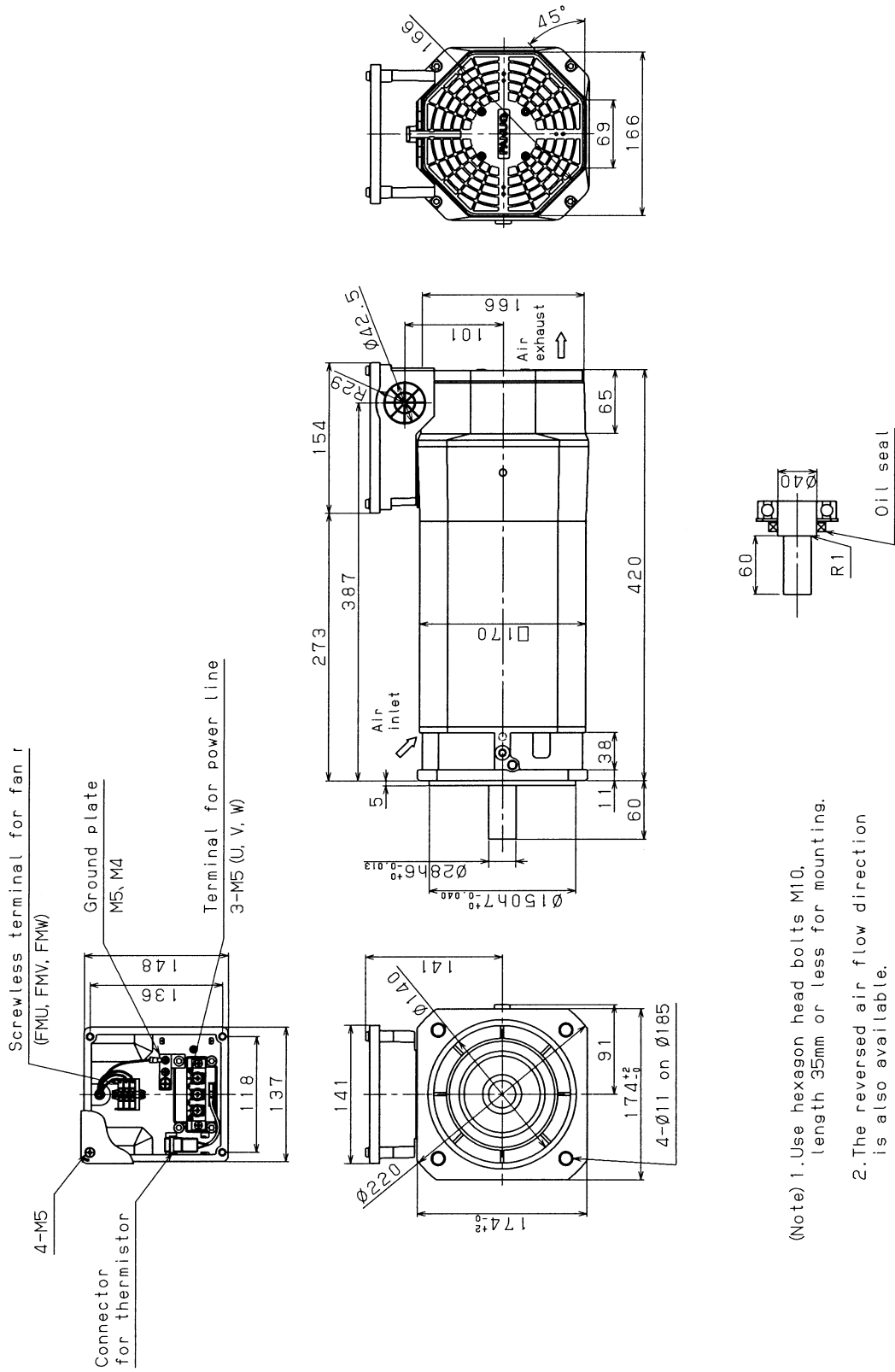
(Note) 1. Use hexagon head bolts M10, length 35mm or less for mounting.  
 2. The reversed air flow direction is also available.

## 7.4 MODEL $\alpha$ C2/6000i (FOOT MOUNTING TYPE)



- (Note) 1. Use hexagon head bolts M10, length 20mm or less for mounting.
2. The reversed air flow direction is also available.

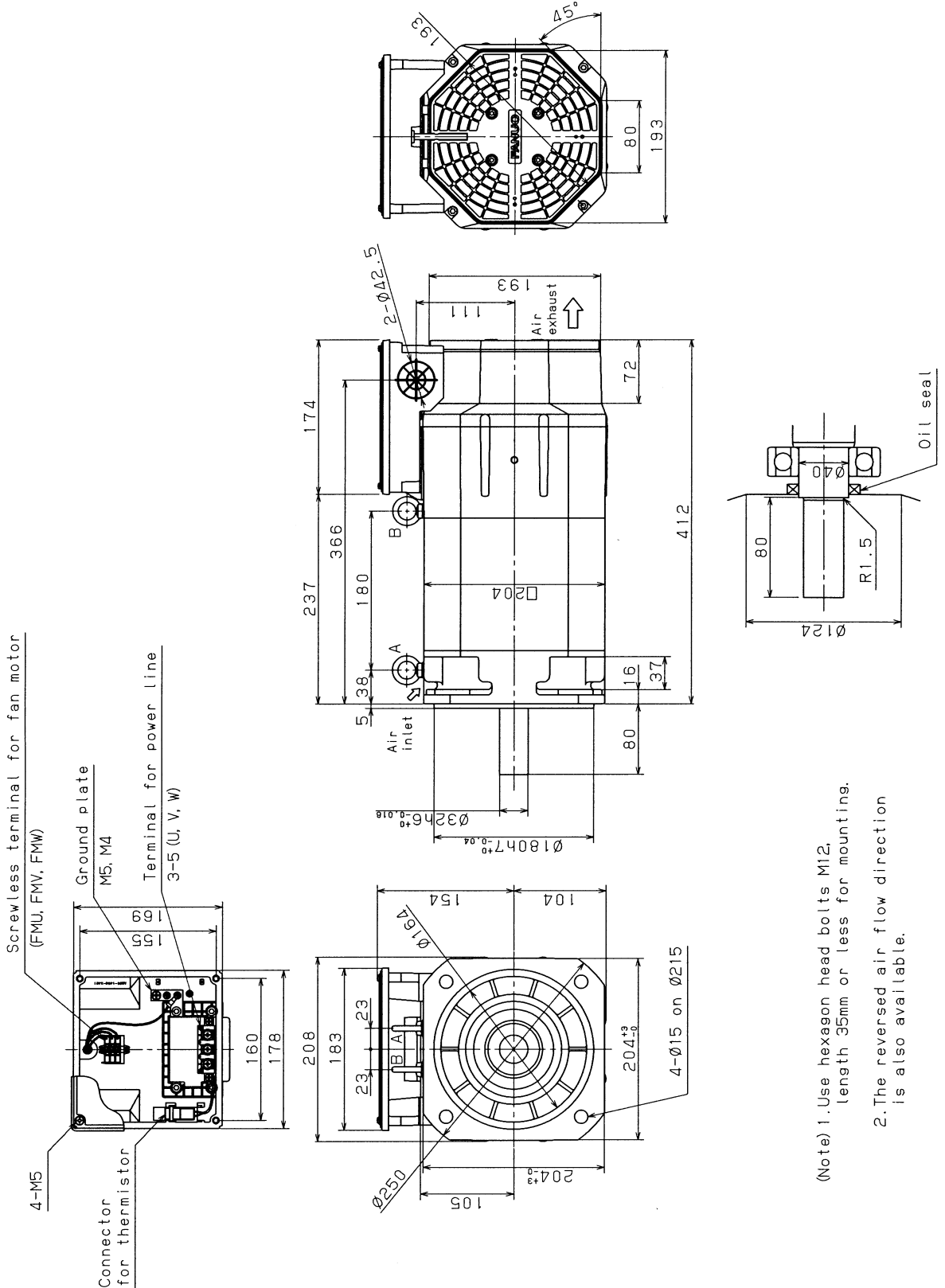
# 7.5 MODEL $\alpha$ C3/6000i (FLANGE MOUNTING TYPE)



(Note) 1. Use hexagon head bolts M10, length 35mm or less for mounting.  
 2. The reversed air flow direction is also available.



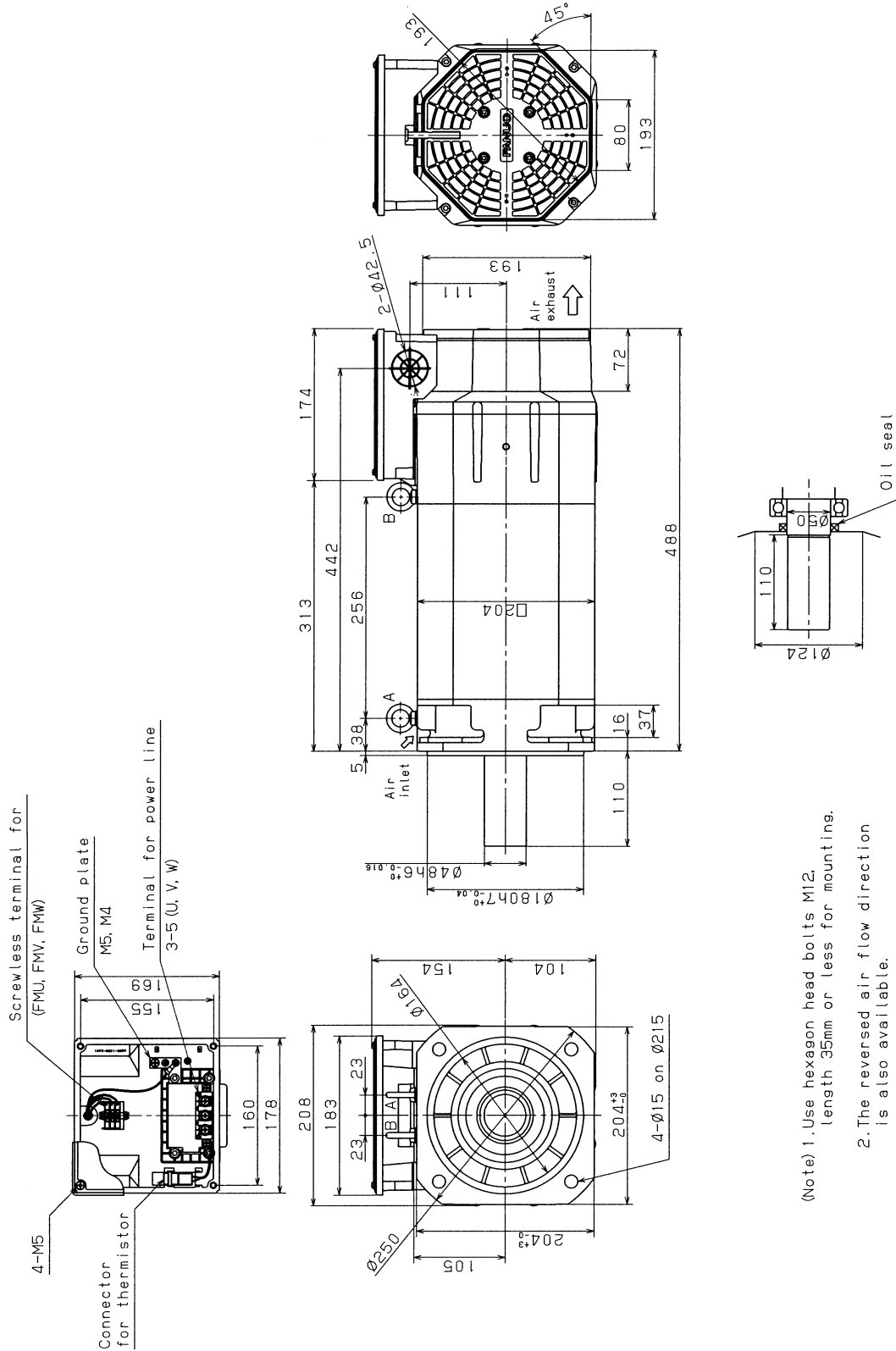
# 7.7 MODEL $\alpha$ C6/6000i (FLANGE MOUNTING TYPE)



- (Note) 1. Use hexagon head bolts M12, length 35mm or less for mounting.  
 2. The reversed air flow direction is also available.



# 7.9 MODEL $\alpha$ C8/6000i (FLANGE MOUNTING TYPE)

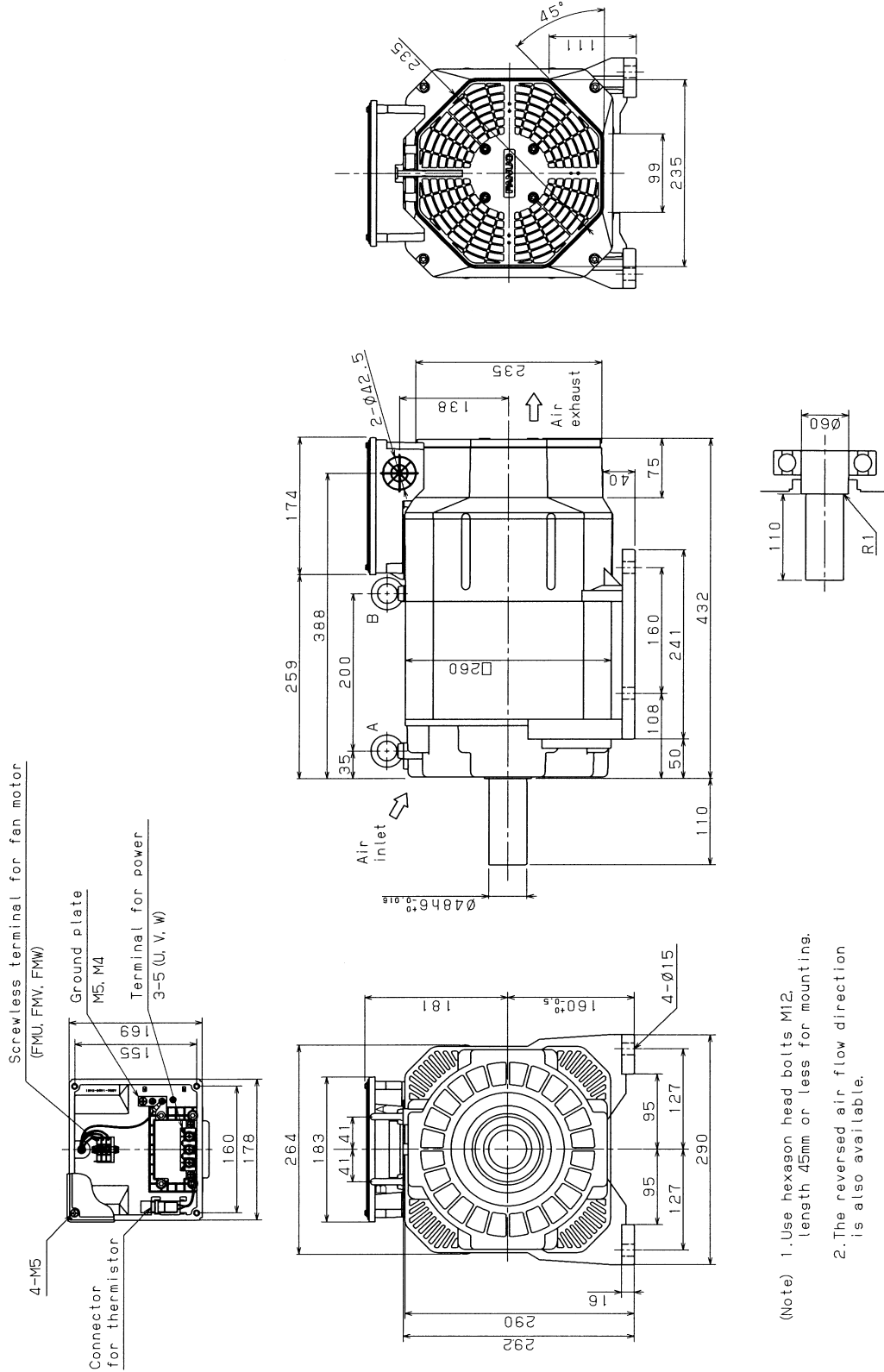


(Note) 1. Use hexagon head bolts M12, length 35mm or less for mounting.  
 2. The reversed air flow direction is also available.



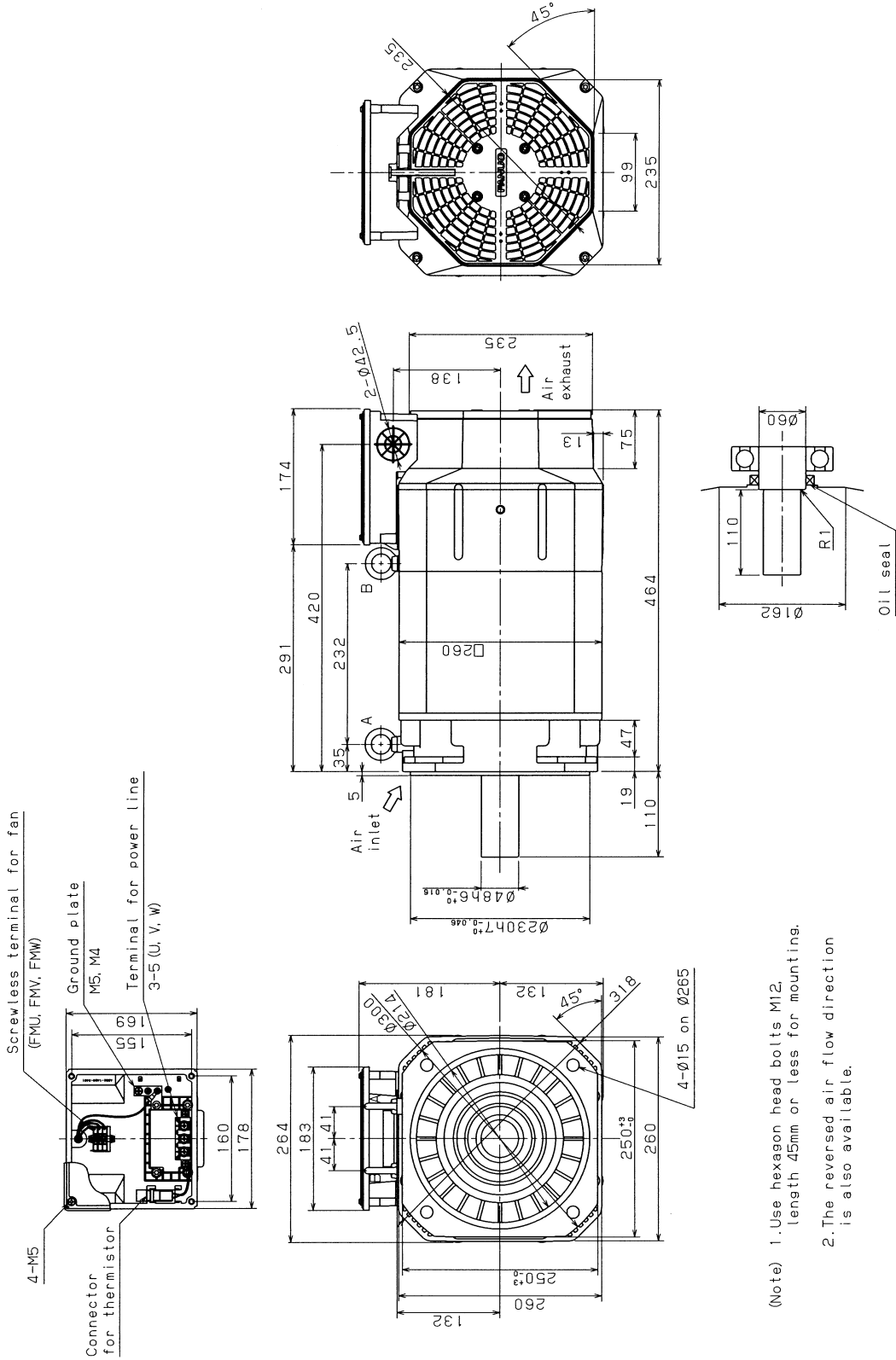


# 7.12 MODEL $\alpha$ C12/6000i (FOOT MOUNTING TYPE)

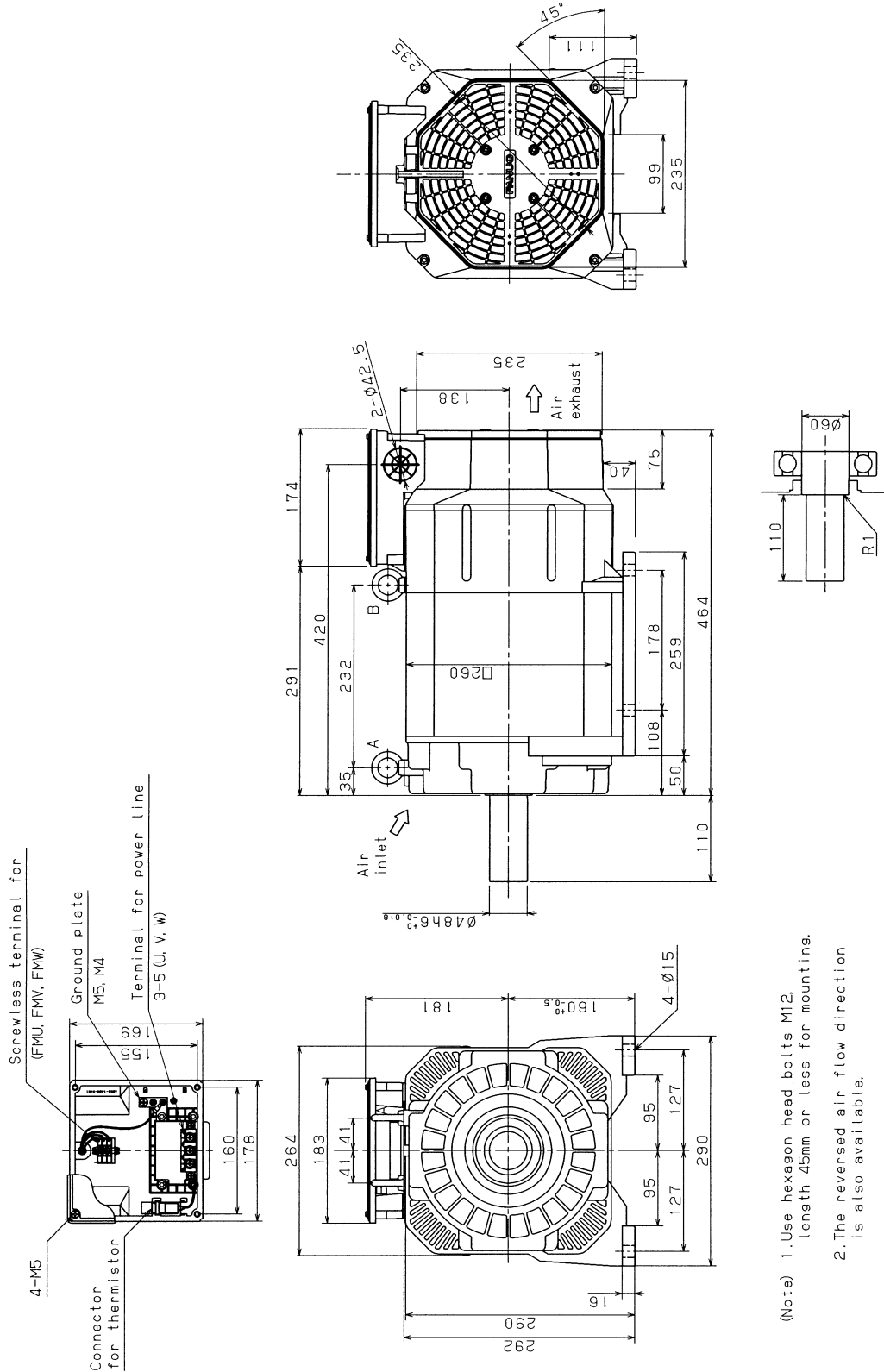


(Note) 1. Use hexagon head bolts M12, length 45mm or less for mounting.  
2. The reversed air flow direction is also available.

# 7.13 MODEL $\alpha$ C15/6000i (FLANGE MOUNTING TYPE)



# 7.14 MODEL $\alpha$ C15/6000i (FOOT MOUNTING TYPE)



(Note) 1. Use hexagon head bolts M12, length 45mm or less for mounting.  
2. The reversed air flow direction is also available.

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JR AUTOMATION TECHNOLOGIES INC\*  
JDOWLING

Revision Record

FANUC AC SPINDLE MOTOR  $\alpha$  Ci series DESCRIPTIONS (B-65372EN)

Edition	Date	Contents	Edition	Date	Contents
01	Aug., 2003	_____			

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**B-65372EN/01**

