FANUC AC SPINDLE MOTOR αi series

DESCRIPTIONS

B-65272EN/05

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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 have tried as much as possible to describe all the various matters.
However, we cannot describe all the matters which must not be done, or which cannot be done, because there are so many possibilities.
Therefore, matters which are not especially described as possible in this manual should be regarded as "impossible".

SAFETY PRECAUTIONS

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

Contents

DEFINITION OF WARNING, CAUTION, AND NOTE

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

> ⚠ **WARNING**
> Applied when there is a danger of the user being injured or when there is a 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.

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 this manual.)
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 vary dangerous because you may get electric shocks.

- Be sure to secure power wires and short-bars.

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 vary 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.

If a motor is driven with a wrong combination of an amplifier and parameters, the motor may exhibit abnormal behavior, such as runaway or excessive torque output, possibly causing damage to the motor and machine. There also is a danger that workpieces, tools, or other objects may fly away due to excessive rotation, possibly injuring the user.

- 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.

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 spindle motors are designed for use with machine tool spindles. 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 α*i* series, a shaft with no key is used as standard.

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.

- 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 this manual 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 this manual, or ask FANUC. For insulation resistances, see the following table.

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

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

MOTOR INSULATION RESISTANCE MEASUREMENT

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

Insulation resistance	Judgment
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

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

Series	Model
α*i*I series 200V type	α*i*I 0.5/10000, α*i*I 1/10000, α*i*I 1.5/10000, α*i*I 2/10000, α*i*I 3/10000, α*i*I 6/10000, α*i*I 8/8000, α*i*I 12/7000, α*i*I 15/7000, α*i*I 18/7000, α*i*I 22/7000, α*i*I 30/6000, α*i*I 40/6000, α*i*I 50/4500, α*i*I 1/15000, α*i*I 1.5/20000, α*i*I 2/20000, α*i*I 3/12000, α*i*I 6/12000, α*i*I 8/10000, α*i*I 12/10000, α*i*I 12/12000, α*i*I 15/10000, α*i*I 15/12000, α*i*I 18/10000, α*i*I 18/12000, α*i*I 22/10000, α*i*I 22/12000
α*i*I series 400V type	α*i*I 0.5/10000HV, α*i*I 1/10000HV, α*i*I 1.5/10000HV, α*i*I 2/10000HV, α*i*I 3/10000HV, α*i*I 6/10000HV, α*i*I 8/8000HV, α*i*I 12/7000HV, α*i*I 15/7000HV, α*i*I 22/7000HV, α*i*I 30/6000HV, α*i*I 40/6000HV, α*i*I 60/4500HV, α*i*I 100/4000HV
α*i*IP series 200V type	α*i*IP 12/6000, α*i*IP 15/6000, α*i*IP 18/6000, α*i*IP 22/6000, α*i*IP 30/6000, α*i*IP 40/6000, α*i*IP 50/6000, α*i*IP 60/4500, α*i*IP 12/8000, α*i*IP 15/8000, α*i*IP 18/8000, α*i*IP 22/8000
α*i*IP series 400V type	α*i*IP 15/6000HV, α*i*IP 22/6000HV, α*i*IP 40/6000HV, α*i*IP 50/6000HV, α*i*IP 60/4500HV
α*i*IT series 200V type	α*i*IT 1.5/20000, α*i*IT 2/20000, α*i*IT 3/12000, α*i*IT 6/12000, α*i*IT 8/12000, α*i*IT 8/15000, α*i*IT 15/10000, α*i*IT 15/15000, α*i*IT 22/10000
α*i*IT series 400V type	α*i*IT 1.5/20000HV, α*i*IT 2/20000HV, α*i*IT 3/12000HV, α*i*IT 6/12000HV, α*i*IT 8/12000HV, α*i*IT 8/15000HV, α*i*IT 15/10000HV, α*i*IT 15/15000HV, α*i*IT 22/10000HV
α*i*IL series 200V type	α*i*IL 8/20000, α*i*IL 15/15000, α*i*IL 26/15000
α*i*IL series 400V type	α*i*IL 8/20000HV, α*i*IL 15/15000HV, α*i*IL 26/15000HV

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VIII. FANUC AC SPINDLE MOTOR αiIL series 200V type

IX. FANUC AC SPINDLE MOTOR αiIL series 400V type

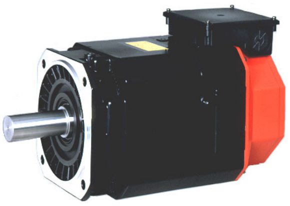
I. FANUC AC SPINDLE MOTOR αi SERIES

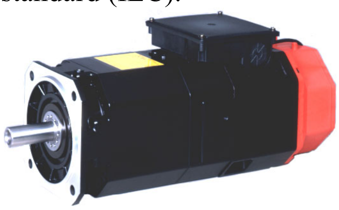
1 GENERAL

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

Features

- The series provides a lineup of motors that satisfy various spindle driving structures such as gear driving, belt driving, and direct motor connection. So, the user can choose an optimal motor that meets the spindle driving structure of the user.
- By employing winding switching, a wider rated output range required for the spindle driving motor of a machine tool is achieved. With the αiI series and αiIT series, a high-speed winding is used to remarkably increase the output level in the high-speed area, thus reducing acceleration/deceleration time. With the αiIP series, a low-speed winding is used to increase the torque by a factor of 1.5.
- 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 V3 (option) 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. With the αi series, the cooling air path is optimized to further improve cooling performance.
- Two types of speed sensors built into the motor are available: αiM sensor based on the A/B-phase signal and αiMZ sensor based on the A/B-phase signal and one-rotation signal. The user can choose between the two types according to the spindle configuration and spindle function.
- This series employ waterproof and pressure-proof design conforming to the international standard (IEC).

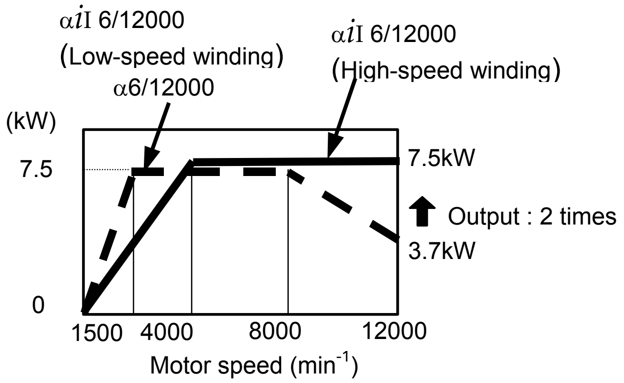

αiI series


αiIT series

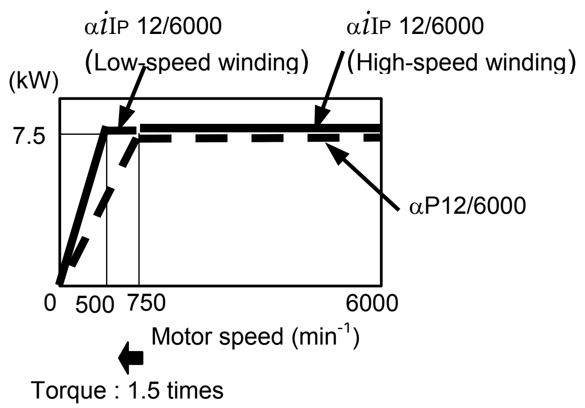
Features of αiI

- **Higher speed**
- **Increased rated output range by employing winding switching**

αiI, αiIT : Remarkable output increase in the high-speed area by employing a high-speed winding.



αiIP: Remarkable torque increase in the low-speed area by employing a low-speed winding
→ Enables optimal spindle speed selection and motor model downsizing



- **Low vibration: Vibration grade V3 (optional specification with the non-key type only)**

2 CONFIGURATION OF THE αi series

The FANUC AC Spindle Motor αi series consists of the series listed below with their features.

Series	Rated output [kW]	Feature	Example of applicable machine
αiI 200V type	0.55 to 45	Standard motors for machine-tool spindles	For Lathe and Machining center
αiI 400V type	0.55 to 100	αiI series directly connectable to a 400 V power supply	
αiIP	5.5 to 30	Motors with constant output over a wide range, which require no reduction units	
αiIT	1.5 to 22	Model for direct spindle connection used with machining centers	For Machining center
αiIL	7.5 to 30	Liquid-cooled model for direct spindle connection used with high precision machining centers	

Lineup for Spindle Motor αi series

- 200V type

Rated output [kW]	0.55	1.1	1.5	2.2	3.7	5.5	7.5	9	11	15	18.5	22	30	37	45	60	100
αiI	αiI 0.5/ 10000	αiI 1/ 10000	αiI 1.5/ 10000	αiI 2/ 10000	αiI 3/ 10000	αiI 6/ 10000	αiI 8/ 8000		αiI 12/ 7000	αiI 15/ 7000	αiI 18/ 7000	αiI 22/ 7000	αiI 30/ 6000	αiI 40/ 6000	αiI 50/ 4500		
		αiI 1/ 15000	αiI 1.5/ 20000	αiI 2/ 20000	αiI 3/ 12000	αiI 6/ 12000	αiI 8/ 10000		αiI 12/ 12000	αiI 15/ 12000	αiI 18/ 12000	αiI 22/ 12000					
αiIP						αiIP 12/ 6000	αiIP 15/ 6000	αiIP 18/ 6000	αiIP 22/ 6000	αiIP 30/ 6000	αiIP 40/ 6000	αiIP 50/ 6000	αiIP 60/ 4500				
αiIT			αiIT 1.5/ 20000	αiIT 2/ 20000	αiIT 3/ 12000	αiIT 6/ 12000	αiIT 8/ 12000			αiIT 15/ 15000		αiIT 22/ 10000					
αiIL							αiIL 8/ 20000			αiIL 15/ 15000			αiIL 26/ 15000				

- 400V type

αiI	αiI 0.5/ 10000 HV	αiI 1/ 10000 HV	αiI 1.5/ 10000 HV	αiI 2/ 10000 HV	αiI 3/ 10000 HV	αiI 6/ 10000 HV	αiI 8/ 8000 HV		αiI 12/ 7000 HV	αiI 15/ 7000 HV		αiI 22/ 7000 HV	αiI 30/ 6000 HV	αiI 40/ 6000 HV		αiI 60/ 4500 HV	<u>αiI 100/ 4000 HV</u>
αiIP							αiIP 15/ 6000 HV		αiIP 22/ 6000 HV		αiIP 40/ 6000 HV	αiIP 50/ 6000 HV	αiIP 60/ 4500 HV				
αiIT			αiIT 1.5/ 20000 HV	αiIT 2/ 20000 HV	αiIT 3/ 12000 HV	αiIT 6/ 12000 HV	αiIT 8/ 12000 HV			αiIT 15/ 15000 HV		αiIT 22/ 10000 HV					
αiIL							αiIL 8/ 20000 HV			αiIL 15/ 15000 HV			αiIL 26/ 15000 HV				

(Shaded cells) Model supporting winding switching

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.
See the ordering list (B-65271EN) for available motors.

Item	Type	Use	Remarks
Mounting types	Flange mounting type	Connected to spindle via a gear 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	
Built-in sensor	αiM sensor	When connected to the spindle via a belt or gear at a deceleration ratio other than 1:1 (When the spindle has a sensor)	For a detailed explanation, refer to the following descriptions: Subsection, “Spindle Amplifier (αiSP)” in the FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN)
	αiMZ sensor	When connected to the spindle via a belt, gear, or coupling on a 1:1 basis (When the spindle has no sensor)	
Shaft figure	With no key	Connected to a pulley	A shaft with no key is used as standard to facilitate pulley and gear 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	Gear connection, direct connection, and belt driving	Used in flange mounting type standard-speed models.
	Labyrinth	Belt driving and direct connection (Only when no lubricant or coolant splashes onto the flange surface of the motor)	Used in flange mounting type high-speed models. (Some high-speed models have an oil seal.)
	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 or labyrinth. For the models that can be changed, refer to "Order List" (B-65271EN).
Maximum speed	Standard-speed model	-	Consider the maximum speed of each model and select a model accordingly.
	High-speed model	-	

4 NOTES ON INSTALLATION

4.1 COMMON

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

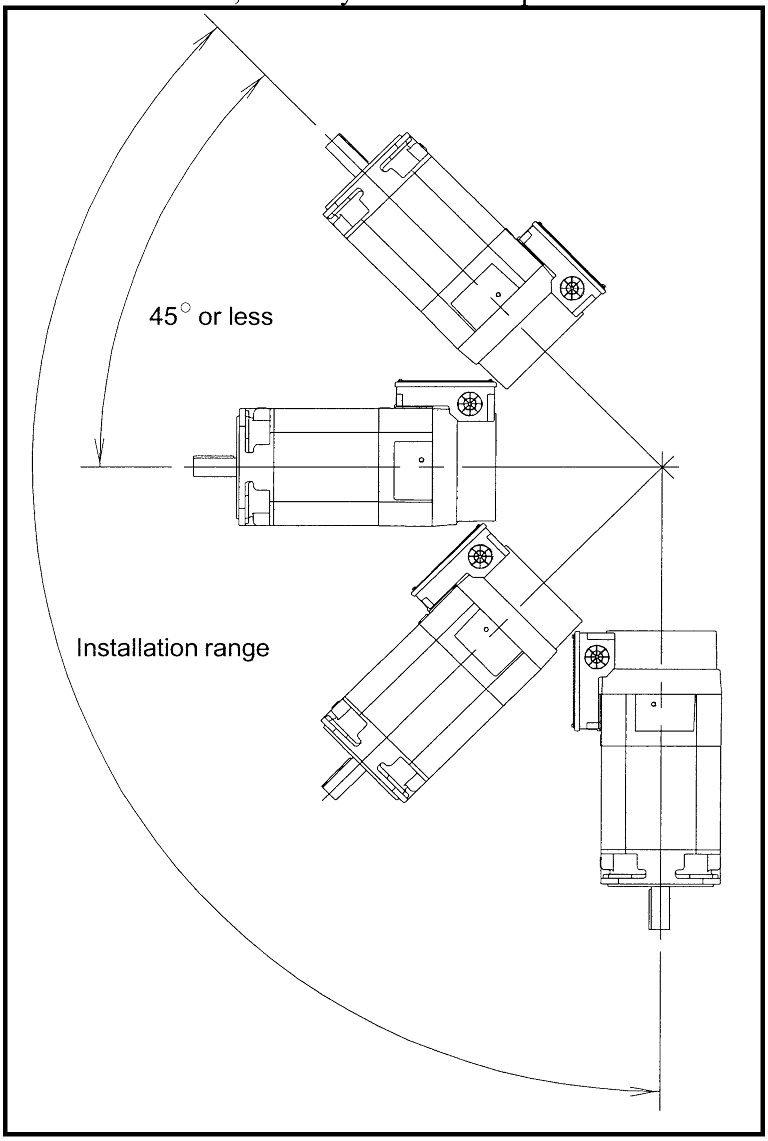
⚠ WARNING

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° degrees above the horizontal to vertically downwards.

2 When the motor needs to be pointed to more than 45° degrees above the horizontal, consult you FANUC representative.



3 Use the eyebolt of the motor to lift only a motor alone, (gear and pulley may be attached).

4 Place a cover over an air-cooled motor to prevent the motor from being exposed to cutting fluid or lubricant.

5 Limit the vibration acceleration at the rear bracket of the motor to 0.5 G (4.9 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:

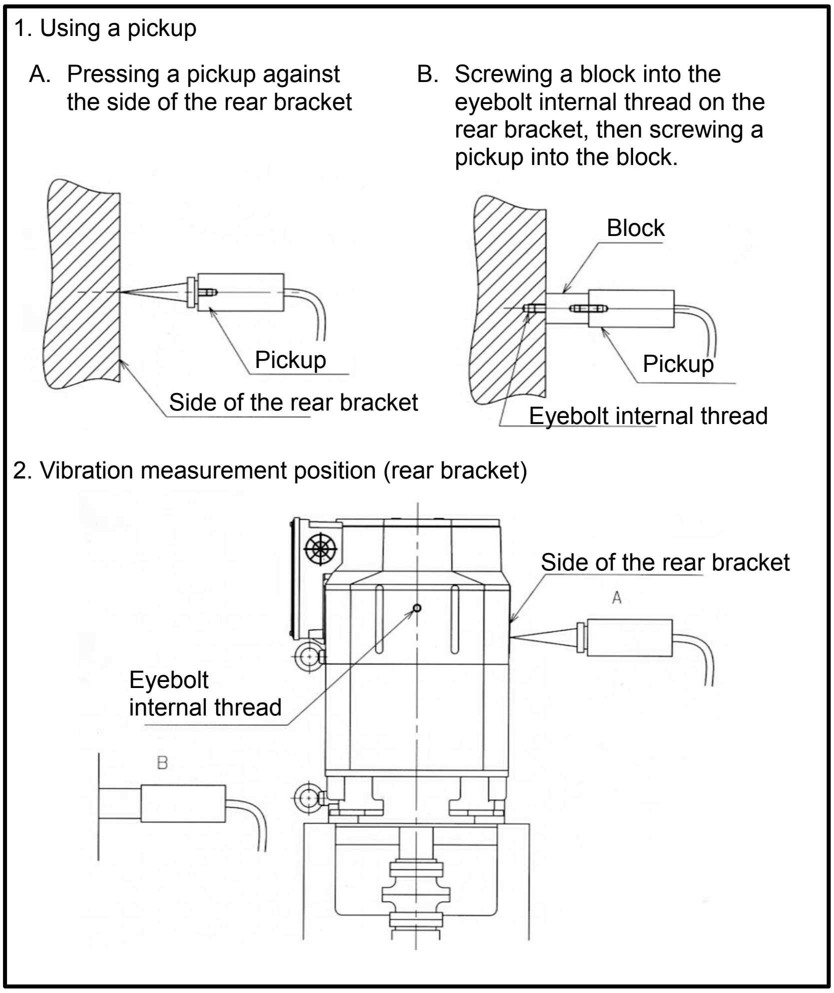
Equivalent to the VM-3314A or VM-3304 manufactured by IMV CORPORATION.

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 m/s^2) or less at the rear bracket



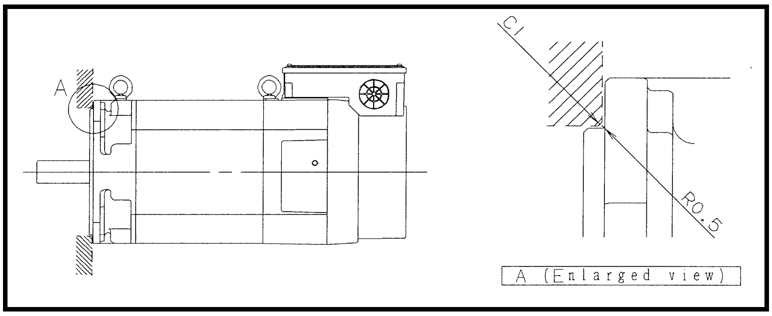
6 Dynamic balance
During high-speed operation, a small imbalance may cause a large vibration, resulting in an unusual sound, premature bearing damage, or some other abnormality.
Therefore, reduce the amount of the imbalance with the dynamic balance of the other rotation shafts, as well as the gear and pulley mounted on the output shaft of the motor, as much as possible.

- Balance correction

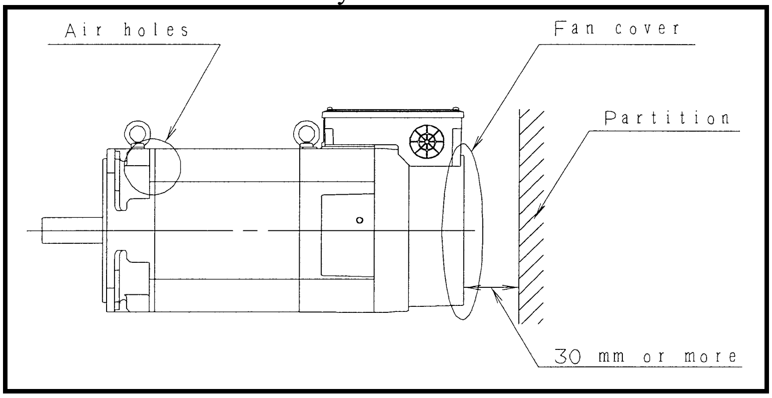
With the αi series, a shaft with no key is used as standard to facilitate the balance correction of a pulley, gear, and coupling attached to the shaft. Use a completely symmetric pulley, gear, or coupling, and use a backlash-less tightening part such as a SPANN ELEMENTE to secure a pulley, gear, or coupling to the shaft. When attaching a pulley to a shaft, for example, adjust the periphery vibration to within 20 μm. 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 The edge of the fauset joint to mount the flange mounting type motor should be chamfered about C1.

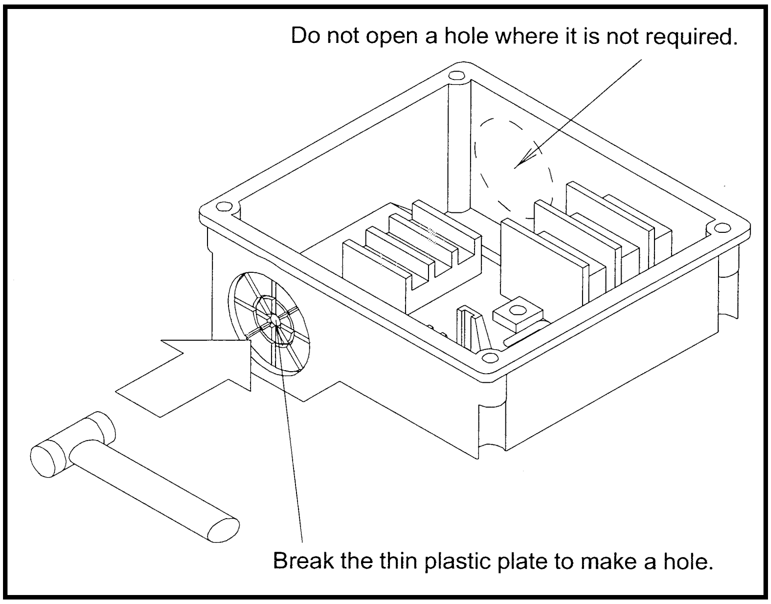


8 Please space 30 mm or more between the fan cover and the partition to keep the cooling ability well.
We recommend to take a structure such as you can clean air holes and the fan cover easily.



NOTE

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
αiI 1 to αiI 15 , αiI$_P$ 12 to αiI$_P$ 22 αiI$_T$ 1.5/20000 to αiI$_T$ 15/10000 αiI 6HV to αiI 22HV αiI$_P$ 15HV, αiI$_P$ 22HV αiI$_T$ 1.5/20000HV to αiI$_T$ 22/10000HV αiI$_L$ 8/20000, αiI$_L$ 8/20000HV	A06B-0754-K001
αiI 18, αiI 22, αiI$_P$ 30, αiI$_P$ 40, αiI$_P$ 50 αiI$_P$ 40HV, αiI$_P$ 50HV αiI$_T$ 15/15000, αiI$_T$ 22/10000 αiI$_L$ 15/15000, αiI$_L$ 26/15000 αiI$_L$ 15/15000HV, αiI$_L$ 26/15000HV	A06B-0731-K001

High-speed models are same as above.

*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 :

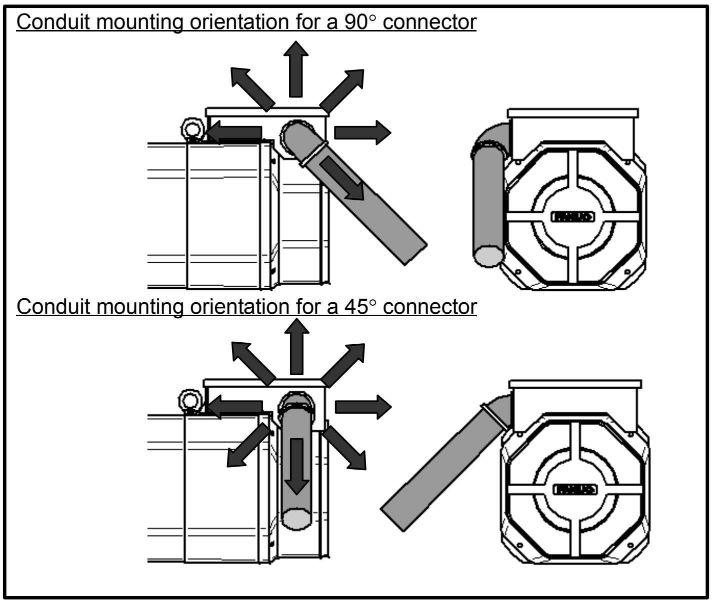
α*i*I 12 to α*i*I 15, α*i*IP 12 to α*i*IP 22, α*i*IT 15/10000,

α*i*I 12HV to α*i*I 22HV,

α*i*IP 15/6000HV to α*i*IP 22/6000HV,

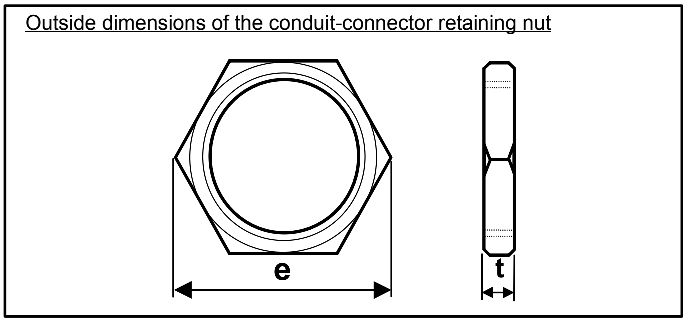
α*i*IT 15/10000HV, α*i*IT 15/15000HV,

α*i*IT 22/10000HV

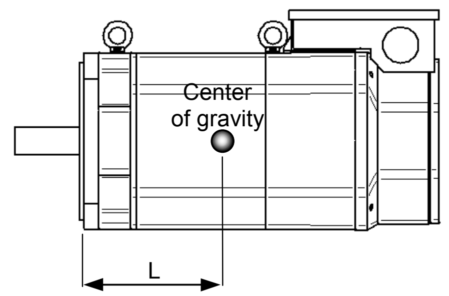


*2 The nut used to fasten the connector to the terminal box must be smaller than the size listed below. (Any larger nut interferes with the terminal box.) For the diameter of the cable hole in each model, refer to the outside dimension drawing of the respective models.

Cable hole diameter	Outside diameter e	Width t
ϕ42.5 mm	53 mm (maximum)	9 mm (maximum)
ϕ61 mm	80 mm (maximum)	15 mm (maximum)



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



αiI series 200V type	αiI series 400V type	αiIP series 200V type	αiIP series 400V type	Center of gravity [mm]
αiI 0.5/10000	αiI 0.5/10000HV	-	-	95±5
αiI 1/10000 αiI 1/15000	αiI 1/10000HV	-	-	125±5
αiI 1.5/10000 αiI 1.5/20000	αiI 1.5/10000HV	-	-	145±5
αiI 2/10000 αiI 2/20000	αiI 2/10000HV	-	-	125±5
αiI 3/10000 αiI 3/12000	αiI 3/10000HV	-	-	170±5
αiI 6/10000 αiI 6/12000	αiI 6/10000HV	-	-	150±5
αiI 8/8000 αiI 8/10000	αiI 8/8000HV	-	-	185±5
αiI 12/7000 αiI 12/10000	αiI 12/7000HV	αiIP 12/6000 αiIP 12/8000	-	160±5
αiI 15/7000 αiI 15/10000	αiI 15/7000HV	αiIP 15/6000 αiIP 15/8000	αiIP 15/6000HV	
αiI 18/7000 αiI 18/10000	-	αiIP 18/6000 αiIP 18/6000	-	
αiI 22/7000 αiI 22/10000	αiI 22/7000HV	αiIP 22/6000 αiIP 22/8000	αiIP 22/6000HV	
αiI 30/6000	αiI 30/6000HV	αiIP 30/6000 αiIP 40/6000	αiIP 40/6000HV	
αiI 40/6000	αiI 40/6000HV	αiIP 50/4500	αiIP 50/6000HV	
αiI 50/4500	-	-	-	
-	αiI 60/4500HV	αiIP 60/4500	αiIP 60/4500HV	
-	αiI 100/4000HV	-	-	

4.2 METHOD OF USING THE MOTOR WITH CONSIDERATION GIVEN TO ITS ENVIRONMENTAL RESISTANCE

⚠ CAUTION

The motor is an electric part, and if the lubricant or cutting fluid falls on the motor, it will enter the inside of the motor, possibly adversely affecting the motor. In particular, if the cutting fluid adheres to the motor, it will deteriorate the resin or rubber sealing members, causing a large amount of cutting fluid to enter the inside of the motor and possibly damaging the motor. When using the motor, note the points described below.

1. Level of motor protection

According to IEC 60034-5, the models equipped with an oil seal comply with the degree of protection IP54, and the other models comply with IP40. Even for the models complying with IP40, their motor main body excluding the output shaft end (with a simple labyrinth for the high-speed models or with no seal for the foot mounting type models) complies with IP54.

IP5□: Machine protected from dust
- Ingress of dust is not totally prevented, but dust does not enter in sufficient quantity to interfere with satisfactory operation of the motor.

IP4□: Machine protected from introduction of solid foreign matter over 1.0 mm
- Electric cables and wires with a diameter or thickness greater than 1.0 mm do not enter.

IP□4: Machine protected form water spray
- Water sprayed on the motor from any direction will have no harmful effect.

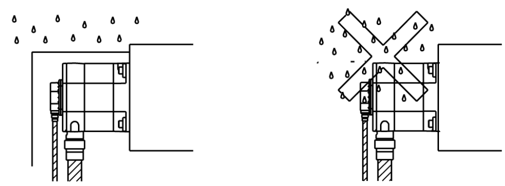
IP□0: Machine not protected
- No special protection is provided to prevent ingress of water.

Note that these models satisfy the provisions for short-time water immersion, and do not guarantee their water-proof performance in an atmosphere in which cutting fluid is applied directly to the motor. Before actual use, note the points described below.

2. Motor periphery

If the cutting fluid or lubricant falls on the motor, it will adversely affect the sealing properties of the motor surface, entering the inside of the motor and possibly damaging the motor.

- Make sure that the motor surface is never wet with the cutting fluid or lubricant, and also make sure that no fluid builds up around the motor. If there is a possibility of the surface being wet, a cover is required.



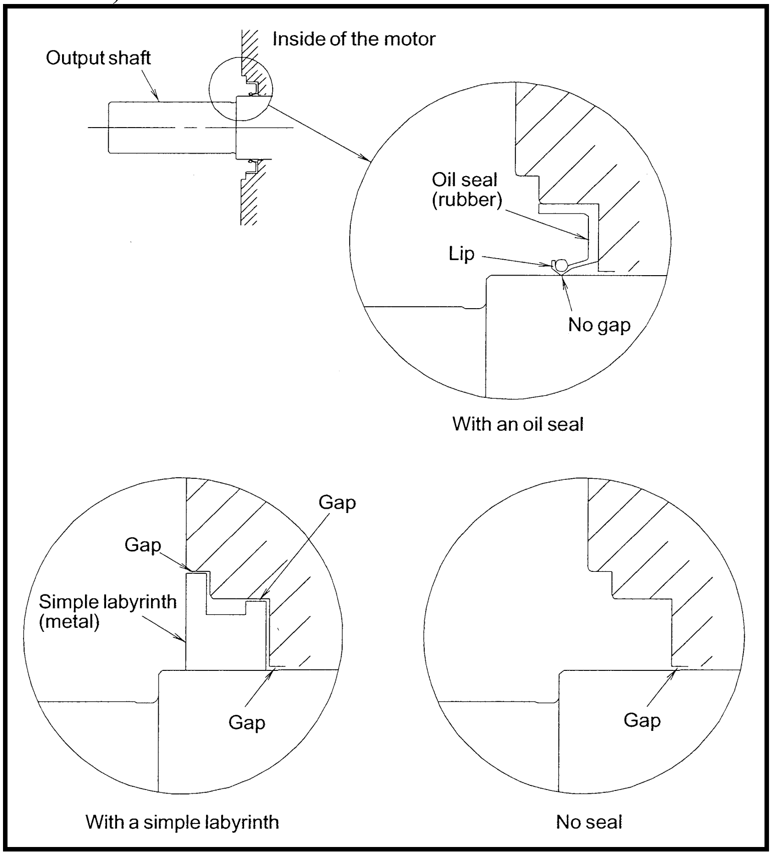
- If the cutting fluid is misted, the cutting fluid may be condensed on the inside of the cover and fall on the motor. Make sure that no condensed droplets fall on the motor.

- If the inside of the machine is full of misted cutting fluid, the cutting fluid adhered to the motor can enter the inside of the motor and damage the motor. Install a mist collector with an appropriate capacity to prevent the inside of the machine from becoming full of mist.

- Completely separate the machining area from the motor area, using a telescopic cover, accordion curtain, and so on. Note that partitions such as accordion curtains are consumable and require periodic inspection for damage.

3. Output shaft seal

To prevent cutting lubricant or dust from penetrating inside the motor, 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.

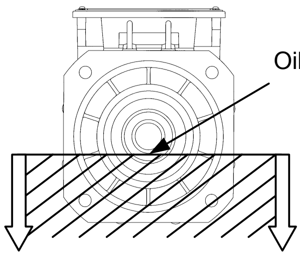
If a simple labyrinth is used as the output shaft seal (high-speed model) or if no seal is provided (foot mounting type), ensure that lubricant does not splash onto the flange surface. If such a motor is directly mounted on a gear box, the lubricant may gradually penetrate inside the motor even when no lubricant splashes on flange surface, thus resulting in motor failure. Therefore, do not mount such a motor on a gear box directly.

When the motor is used in an environment in which lubricant does not splash onto the motor, the simple labyrinth type instead of the oil seal type may be selected. Generally in a dry environment, the motor temperature of the simple labyrinth type will increase more moderately than that of the oil seal type.

3.1 oil seal

The shaft of the motor is provided with an oil seal to prevent entry of lubricant and other fluids into the motor. (The high-speed model and the foot mounting type are excluded.) It does not, however, completely prevent the entry of lubricant and other fluids depending on the working conditions.

- When the motor is rotating, the oil seal has an effect of discharging any oil that enters, but if it is pressurized for a long time when the motor is stopped, it may allow oil to enter through the lip. When lubrication with an oil bath is conducted for gear engagement, for example, the oil level must be below the lip of the oil seal of the shaft, and the oil level must be adjusted so that the oil does nothing but splash on the lip.



Diameters of the oil seal lips of motor shafts

Motor model	Oil seal diameter [mm]
αiI 0.5, αiI 0.5HV	φ 20
αiI 1, αiI 1.5, αiI 1HV, αiI 1.5HV	φ 30
αiI 2, αiI 3, αiI 6, αiI 2HV, αiI 3HV, αiI 6HV	φ 40
αiI 8, αiI 8HV	φ 50
αiI 12, αiI 15, αiI 18, αiI 22, αiI 12HV, αiI 15HV, αiI 22HV, αiIP 12, αiIP 15, αiIP 18, αiIP 22, αiIP 15HV, αiIP 22HV	φ 60
αiI 30, αiI 40, αiI 30HV, αiI 40HV, αiIP 30, αiIP 40, αiIP 50, αiIP 40HV, αiIP 50HV	φ 70
αiI 50, αiI 60HV, αiI 100HV, αiIP 60, αiIP 60HV	φ 85

- If foreign matter such as cutting chips is caught by the oil seal lip, it will be easily worn, losing its sealing properties. When the motor is used within a splash guard, and so cutting chips may fall on the motor, for example, take measures to prevent cutting chips from entering near the lip.

- In an environment in which dry and wet states alternate, if cutting fluid splashes onto the lip after it has worn in a dry state, the cutting fluid may easily enter the inside of the motor. In this case, provide a cover to prevent cutting fluid from splashing onto the oil seal of the motor.

- Ensure that no pressure is applied to the lip of the oil seal.

- The oil seal shows its sealing effect when a part such as the gear coupling is lubricated by oil bath. Cutting fluid does not provide lubrication for the oil seal lip, so the cutting fluid may easily penetrate the seal. Therefore, provide a cover to prevent cutting fluid from splashing onto the oil seal.

3.2 When the oil seal is not used

When a simple labyrinth is used as the output shaft seal (high-speed models) or when no seal is provided (foot mounting type), ensure that lubricant does not splash onto the flange surface directly. If such a motor is directly mounted on a gear box, lubricant may gradually enter the inside of the motor even when the flange surface is protected against lubricant splash, therefore resulting in motor failure. So, do not mount such a motor on a gear box directly.

NOTE

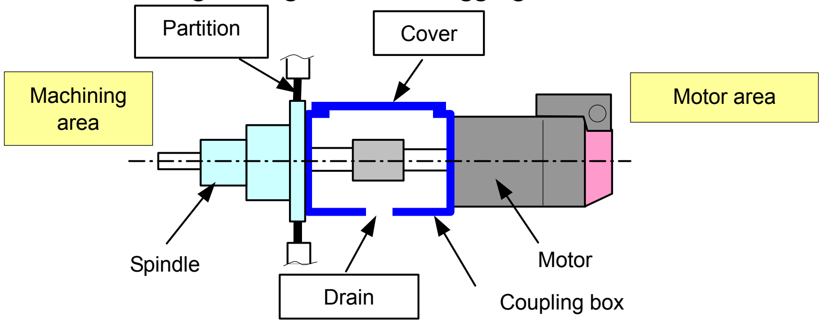
1 The foot mounting type motors are not equipped with an oil seal. When an oil seal is necessary, add #0002 to a motor drawing number when ordering the motor. The oil seal, however, cannot be added to the high-speed models. For details, refer to the order list (B-65271EN).
Example)
Model αiI 12/7000 (foot mounting type, with no key, rear exhaust)
To add an oil seal to A06B-1408-B200, order A06B-1408-B200#0002.

2 When lubricant does not splash onto the oil seal, remove the coil spring of the oil seal to reduce friction between the lip and shaft.
This does not affect sealing from dry dust.
When the area in which the shaft touches the oil seal is dry, turning the shaft at a high speed may generate contact sound (abnormal sound) from that area or may damage the lip.

4. Motor coupling

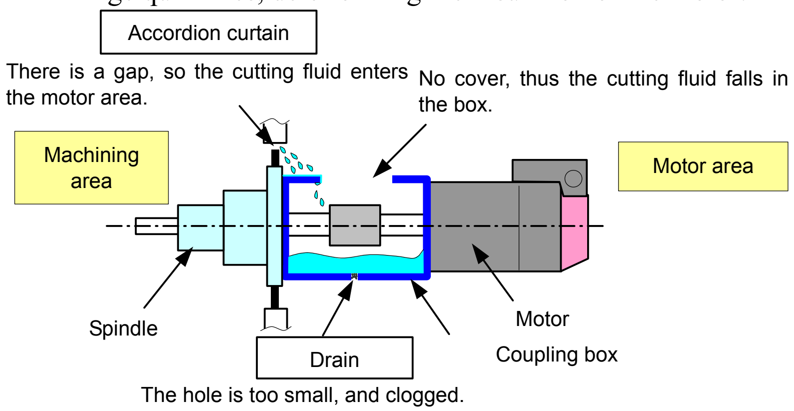
When a coupling box is used to connect the motor to the machine, take measures as follows not to allow leaked cutting fluid to build up in the coupling box.

- Provide a cover for the top and sides of the coupling box.
- Provide a drain hole at the bottom of the coupling box. The hole must be large enough to avoid clogging.



<Fault example>

The cutting fluid leaks from a gap in the accordion curtain to the motor area, and builds up in the coupling box. While the spindle is moving, the cutting fluid ripples, splashing onto the oil seal of the motor. The cutting fluid enters the inside of the motor there in large quantities, deteriorating the insulation of the motor.

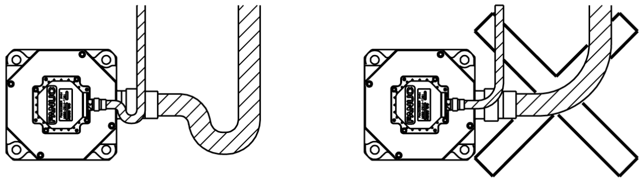


5. Connectors, terminal box, and their surroundings

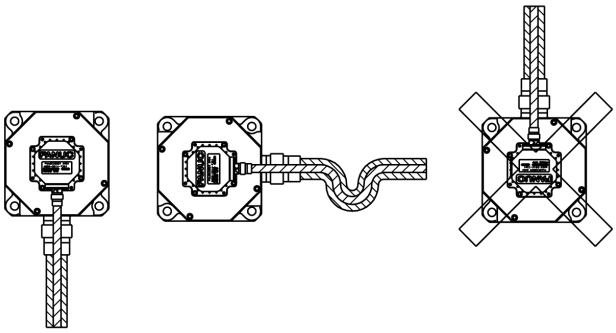
5.1 Connectors

The αiI 0.5/10000 and αiI 0.5/10000HV use connectors to connect the power and signal cables.

- Make sure that no cutting fluid is introduced to the motor via cables. If the motor connector is used horizontally, this can be accomplished by forming a slack in the cable.



- If the motor connector is directed upward, the cutting fluid collects into the cable connector. Whenever possible, direct the motor connector sideways or downward.

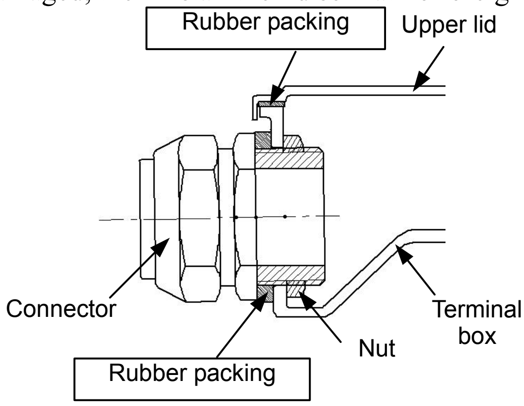


5.2 terminal box

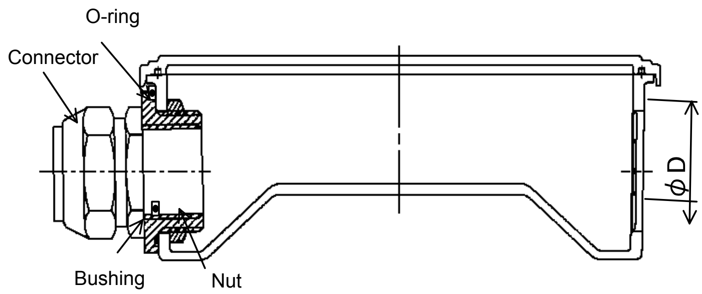
Models other than the αiI 0.5/10000 and αiI 0.5/10000HV use a terminal box to connect the power and signal cables.

- When a conduit is attached to the terminal box, use a water-proof connector with rubber packings to prevent lubricant and cutting fluid from entering the inside of the terminal box through its cable holes.

- On the inner side of the upper lid of the terminal box, a rubber water-proof packing is installed. Ensure that the packings are not damaged, then install the lid so that no foreign matter is caught.



- 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 ϕD	O-ring code	
	JIS B 2401	**ISO 3601-1**
ϕ42.5 mm	P46	C0462G
ϕ61 mm	P65	C0650G

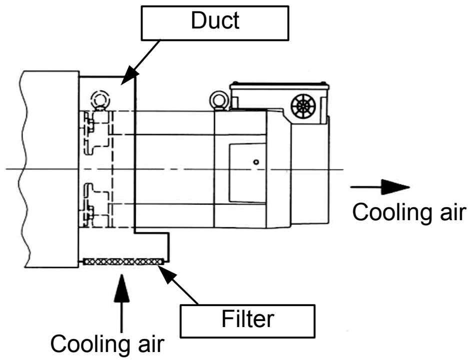
> **NOTE**
> For the diameter of the cable hole in each model, refer to the outside dimension drawing of the respective models.

6. Fan motor and its surroundings

If lubricant or cutting fluid mist, particles, or cutting chips are drawn into the fan motor, the air holes in the motor and the blades of the fan motor will clog, causing the cooling capacity to reduce. Employ a machine structure that allows clean, cooling air to be fed 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.)



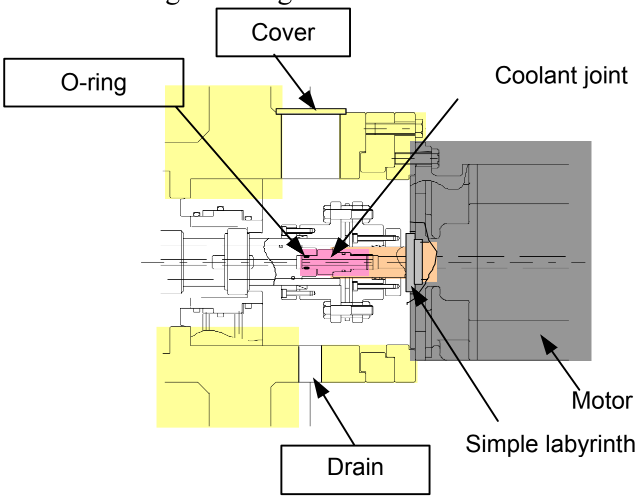
7. Motor with a through hole

The αiIT series and αiIL series motors with a through hole comply with the degree of protection IP40. The motor main body excluding the simple labyrinth at the end of the output shaft and the flinger at the rear end of the shaft complies with IP54. When center through coolant machining is performed, employ such a structure that cutting fluid leaked from the coolant joint or rotation joint does not enter the inside of the motor.

7.1 Front side of the motor

A simple labyrinth is mounted on the shaft on the front side of the motor. Therefore, a splash of cutting fluid or cutting fluid leaked from the coolant joint can enter the inside of the motor.

- Employ such a structure that the O-ring of the coolant joint is not damaged by sliding.
- Provide a drain not to allow leaked cutting fluid to build up in case the O-ring is damaged.



7.2 Rear side of the motor

When a separate external support type rotation joint is installed at the rear end of the shaft, cutting fluid leaks from the seal (where the stationary side and the rotation side come in contact); therefore, employ such a structure that the leaked cutting fluid does not enter the inside of the motor.

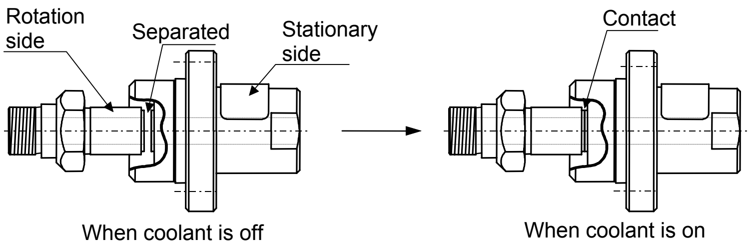
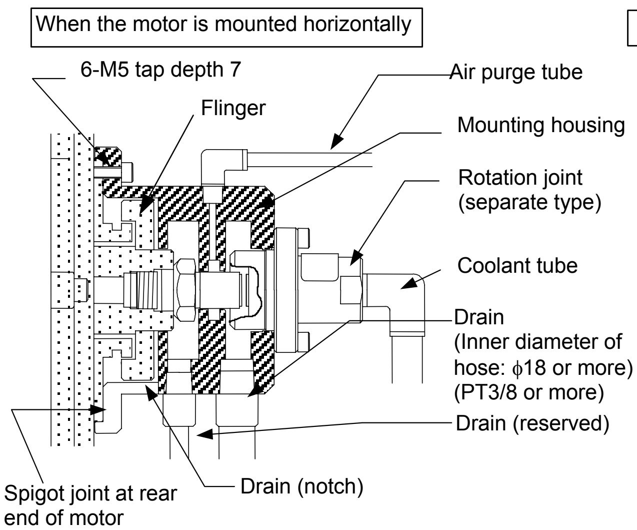
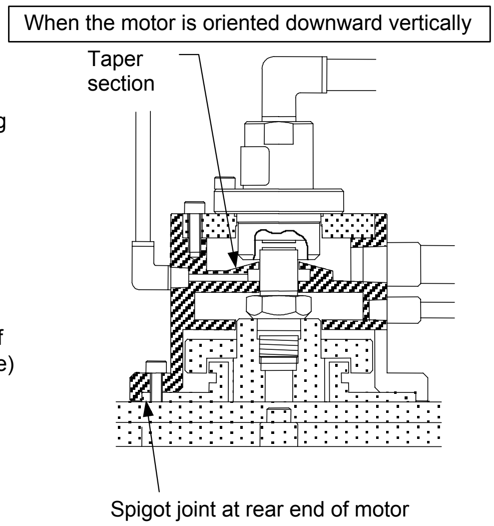
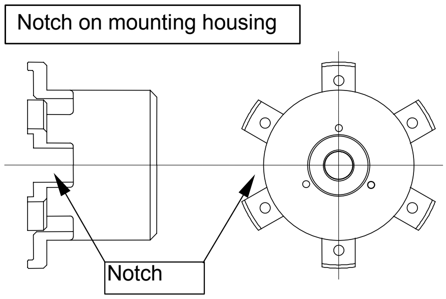


Fig. Example of a separate external support type rotation joint

- Provide the rotation joint mounting housing with notches and drains not to allow leaked cutting fluid to build up in the housing.
- The rotation joint is a consumable part. It requires periodic inspection and replacement.
- If the rotation joint is damaged, a large amount of cutting fluid can leak out. So, provide the mounting housing with many notches.
- When the motor is oriented downward vertically, enhance drainage by means such as air purging.







8. Notes on cutting fluid

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

- Cutting fluid containing highly active sulfur
  Some cutting fluids containing sulfur show extremely high activity of sulfur. Ingress of such cutting fluid into the CNC, motor, or amplifier can cause corrosion of copper, silver, and so on used as parts' materials, therefore resulting in parts' failures.

- Synthetic cutting fluid with high permeability
  Some synthetic type cutting fluids that use polyalkylene glycol (PAG) as a lubricant have extremely high permeability. Such cutting fluid can easily penetrate into the motor even if the motor is sealed well. Ingress of such cutting fluid into the CNC, motor, or amplifier can degrade insulation or lead to parts' failures.

- Highly alkaline, water-soluble cutting fluid
  Some cutting fluids that strengthen pH by alkanolamine show strong alkalinity of pH10 or higher when diluted to the standard level. Ingress of such cutting fluid into the CNC, motor, or amplifier can cause chemical reaction with plastic and so on and deteriorate them.

4.3 POWER LEAD CONNECTION

⚠ WARNING

To attach the power leads and jumpers, follow the procedure described in this section to make connections with specified torque. Driving a motor with terminals loosened could result in the terminal board overheating and causing a fire. In addition, it may remove terminal to cause a ground fault, short circuit, or electric shock.

⚠ CAUTION

1. When attaching the power leads and jumpers to the terminal board of a motor, tighten the screws with torque specified in the table. For the terminal size of a terminal board, refer to Chapter 4, "CONNECTIONS" in the manual of the corresponding series.

Terminal size	Tightening torque [N·m]
M4	1.1 to 1.5
M5	2.0 to 2.5
M6	3.5 to 4.5
M8	8 to 10
M10	15 to 16

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.

3. If you want to energize an output switching type motor only with the low- or high-speed winding rather than switching its output, jumper the low- or high-speed winding, whichever is applicable, and then connect three power leads (the U-, V-, and W-phase wires) to the motor (except for the αiIT 15/12000 and αiIL series motors).

   For the following motors, a jumper is provided as standard in the terminal block.

Model name	Type of supplied jumper
αiI 6/12000, αiI 8/10000 αiI 12/10000, αiI 12/12000 αiI 15/10000, αiI 15/12000 αiI 18/10000, αiI 18/12000 αiI 22/10000, αiI 22/12000	For low-speed winding (Y connection)
αiIP 12/6000, αiIP 12/8000 αiIP 15/6000, αiIP 15/8000 αiIP 18/6000, αiIP 18/8000 αiIP 22/6000, αiIP 22/8000 αiIP 30/6000, αiIP 40/6000 αiIP 15/6000HV αiIP 22/6000HV αiIP 40/6000HV	For High-speed winding (Δ connection)

   If you want to any other output switching type motor, place an order for jumpers according to the following list.

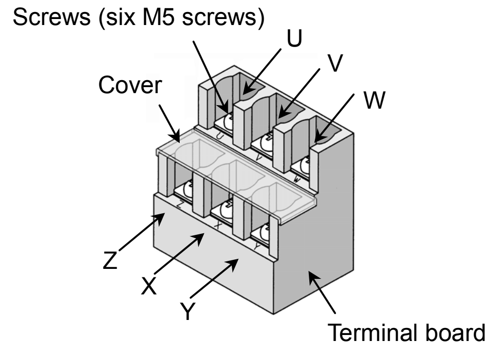
Terminal size	Specification of the winding to be used	Ordering number	Required quantity
M5	Low-speed winding	A65L-0001-0630/SS	1
M5	High-speed winding	A65L-0001-0630/SD	3
M6	Low-speed winding	A290-1410-X416	1
M6	High-speed winding	A290-1410-X417	3

4. How to connect power leads to output switching type motors

For output switching type motors, six power leads (the U-, V-, W-, X-, Y-, and Z-phase wires) can be connected on the terminal board.

- **Detailed descriptions of an M5 type terminal board**

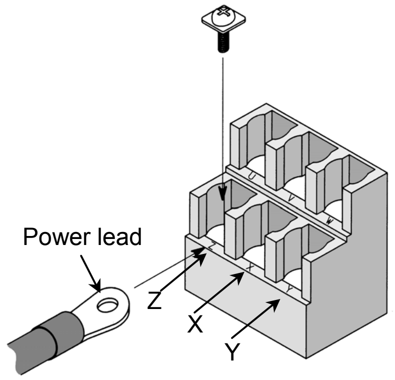
The terminal board has two rows. The U-, V-, and W-phase leads can be connected to the upper row, while the Z-, X-, and Y-phase wires can be connected to the lower row.



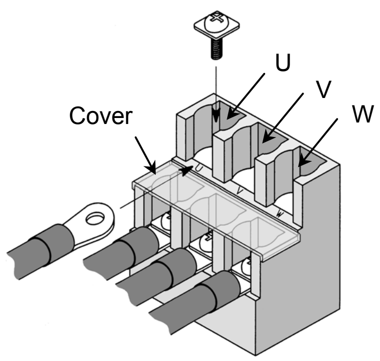
1) Using the motor by switching its output
To use the motor by switching its output, connect the six power leads (the U-, V-, W-, X-, Y-, and Z-phase wires) respectively to the terminal board screws marked U, V, W, X, Y, and Z.
(For the αiIT 15/12000 and αiIL series motors, the terminal board screws are marked U_1, V_1, W_1, U_2, V_2, and W_2.)

- **Connecting power wires to an M5 type terminal board**

<1> Connecting power leads to the lower row
Attach the Z-, X-, and Y-phase power leads to the lower row and fasten them with the screws.



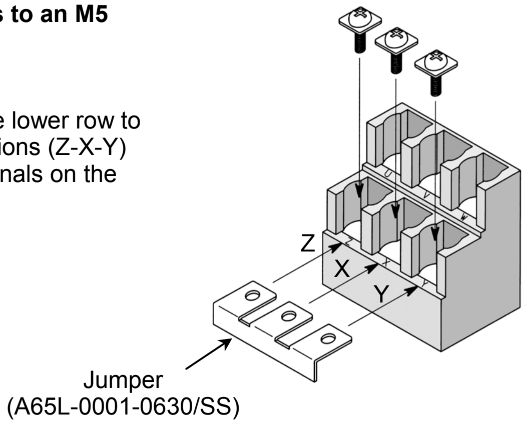
<2> Attaching power leads to the upper row
After putting the cover on the lower row, attach the U-, V-, and W-phase power leads to the upper row and fasten them with the screws.



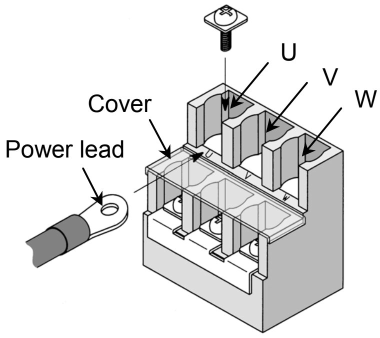
2) Using the motor by energizing it only with the low-speed winding (Y connection) rather than switching its output

- **Connecting power leads to an M5 type terminal board**

<1> Mounting a jumper
Mount a jumper on the lower row to make electric connections (Z-X-Y) among the three terminals on the lower row.

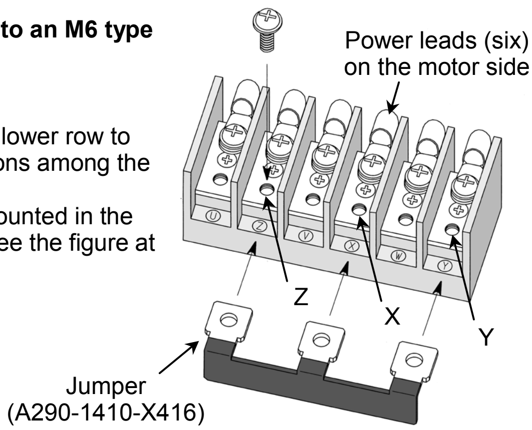


<2> Attaching power leads
After putting the cover on the lower row, attach the U-, V-, and W-phase power leads to the upper row and fasten them with the screws.

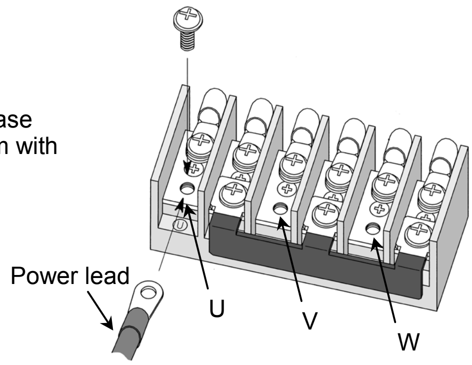


- **Connecting power leads to an M6 type terminal board**

<1> Mounting a jumper
Mount a jumper on the lower row to make electric connections among the Z, X, and Y terminals.
The jumper must be mounted in the specified orientation. See the figure at the right.



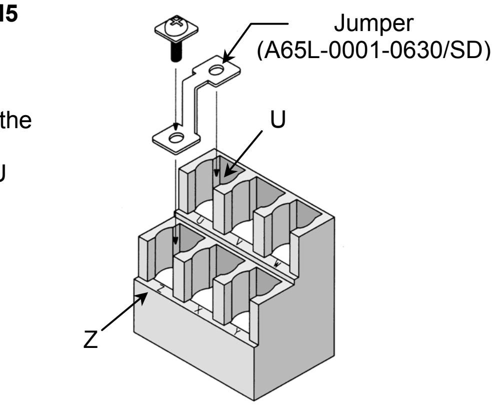
<2> Attaching power leads
Attach the U-, V-, and W-phase power leads and fasten them with the screws.



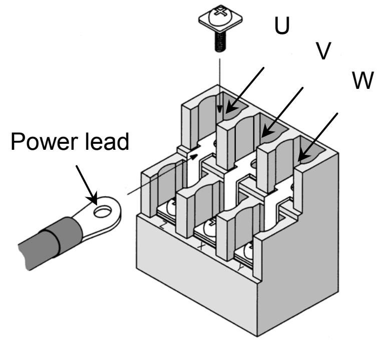
3) Using the motor by energizing it only with the high-speed winding (Δ connection) rather than switching its output

- **Connecting power leads to an M5 type terminal board**

<1> Mounting jumpers
Mount three jumpers between the upper and lower rows to make electric connections between U and Z, between V and X, and between W and Y.

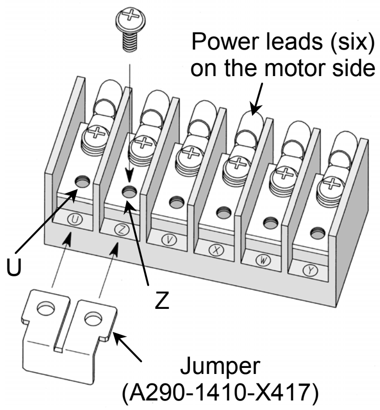


<2> Attaching power leads
Attach the U-, V-, and W-phase power leads to the upper row and fasten them with the screws.
No cover need be put on the lower row.

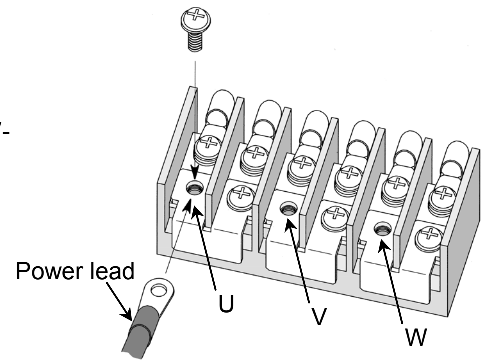


- **Connecting power leads to an M6 type terminal board**

<1> Mounting jumpers
Mount three jumpers to make an electric connection in each pair of adjacent terminals (between U and Z, between V and X, and between W and Y).
The jumper must be mounted in the specified orientation. See the figure at the right.



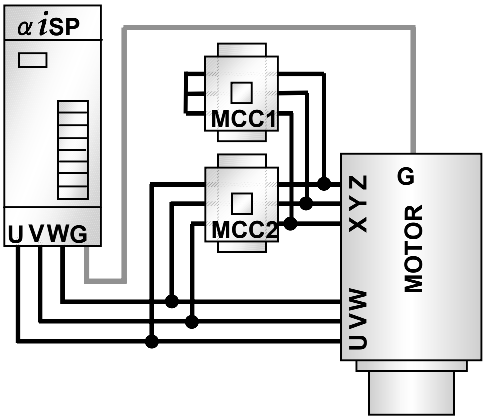
<2> Attaching power leads
Attach the U-, V-, and W-phase power leads and fasten them with the screws.



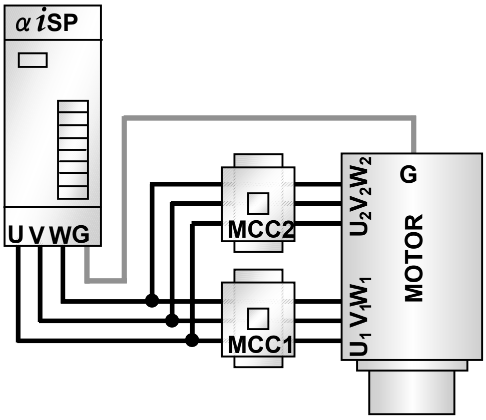
5. Connecting the motor and amplifier when output switching is used

To use output switching, connect the motor and amplifier as shown in the figure below. The switching method varies depending on the model used. Confirm the switching method by referring to Chapter 2, "SPECIFICATIONS", in each series.

1) Y-Δ switching



2) Y-Y switching



Relationship between the magnetic contactors (MCC) and the low- and high-speed windings

	Low-speed winding	High-speed winding
MCC1	ON	OFF
MCC2	OFF	ON

4.4 FAN MOTOR CONNECTION

Fan motor current values

αiI, αiIP, αiIT series 200V type spindle motor models	50Hz				60Hz			
	Usable voltage [V]	Rated voltage [V]	Rated current [A]	Surge current [Ap-p]	Usable voltage [V]	Rated voltage [V]	Rated current [A]	Surge current [Ap-p]
αiI 1, αiI 1.5, αiIT 1.5	160-270	240	0.15	0.47	160-270	240	0.12	0.48
αiI 2, αiI 3, αiIT 2, αiIT 3	170-240	200	0.10	0.41	170-240	200	0.10	0.40
αiI 6, αiI 8, αiIT 6, αiIT 8	170-240	200	0.13	0.50	170-240	200	0.14	0.51
αiI 12 to αiI 22, αiIP 12 to αiIP 22, αiIT 15, αiIT 22	170-240	200	0.22	1.15	170-240	200	0.32	1.10
αiI 30, αiI 40, αiIP 30, αiIP 40, αiIP 50	170-253	200	0.65	3.12	170-253	200	0.8	3.06
αiI 50, αiI 60, αiIP 60	170-253	200	0.75	3.96	170-253	200	0.75	3.68

αiI, αiIP, αiIT series 400V type spindle motor models	50Hz				60Hz			
	Usable voltage [V]	Rated voltage [V]	Rated current [A]	Surge current [Ap-p]	Usable voltage [V]	Rated voltage [V]	Rated current [A]	Surge current [Ap-p]
αiI 1HV, αiI 1.5HV, αiIT 1.5HV	170-220	200	0.09		195-253	230	0.11	
αiI 2HV, αiI 3HV, αiIT 2HV, αiIT 3HV	170-220	200	0.11		195-253	230	0.13	
αiI 6HV, αiI 8HV, αiIT 6HV, αiIT 8HV	323-440	400	0.07	0.31	391-528	480	0.08	0.37
αiI 12HV to αiI 22HV, αiIP 15HV, αiIP 22HV, αiIT 15HV, αiIT 22HV	323-440	400	0.20	0.97	391-528	480	0.24	1.22
αiI 30HV, αiI 40HV, αiI 100HV (circumference fan), αiIP 40HV, αiIP 50HV	320-460	380	0.30	1.86	320-460	380	0.35	1.82
αiI 60HV, αiIP 60HV	320-460	380	0.30	2.18	320-460	380	0.30	1.98
αiI 100HV (back fan)	320-528	400	0.30		320528	400	0.36	

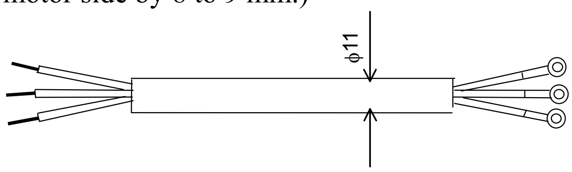
NOTE
1 The term "surge current" represents a peak-to-peak current that flows when the power is turned on.
2 The values listed below are a rough standard. They are not guaranteed.

Cable for the fan motor

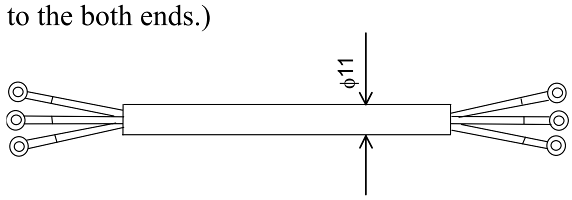
The machine tool builder is to prepare the following cable for the fan motor:

Vinyl heavy-duty power cord JIS C 3312 3-conductor
Conductor: 37/0.26 (2 mm^2)
Sheath: PVCϕ11
Crimp terminal: T2-4S

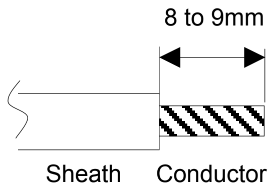
<1> For a non-screw terminal block (Peel off each wire sheath on the motor side by 8 to 9 mm.)

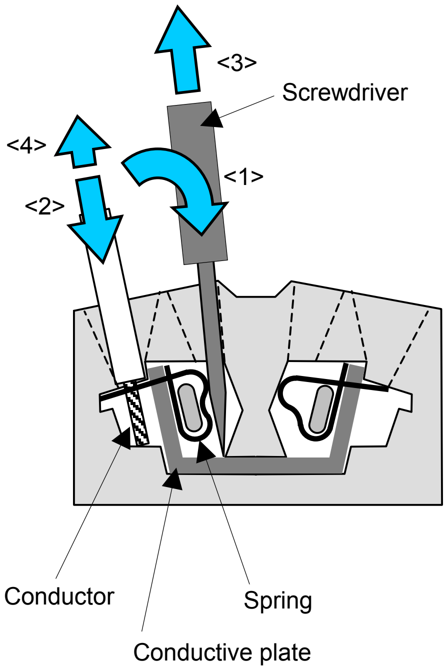


<2> For an M4 or M3.5 screw terminal block (Attach crimp terminals to the both ends.)



Method of connection to a non-screw terminal for the fan motor





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 × 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.

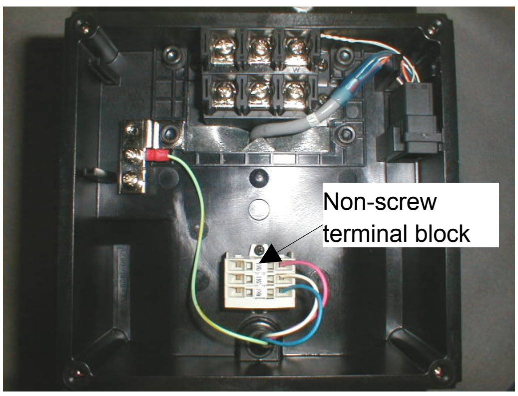
<2> Check the peel-off length (8 to 9 mm), then insert the wire into the wire insertion slot (large rectangular hole) until it stops, by sliding the wire along the outer side of the hole slowly so that the conductor does not become loose. Be careful not to push a thin wire excessively.

<3> While holding down the inserted wire by one hand, extract the screwdriver. The spring is closed to make a connection.

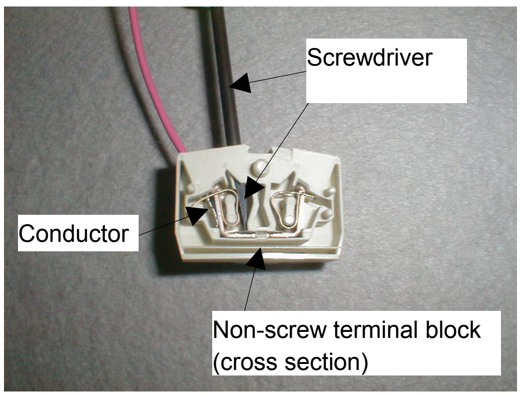
<4> By slightly pulling the wire, check that the wire is connected firmly. The wire need not be pulled intensely.

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

4.5 WHEN A MOTOR IS CONNECTED TO A SPINDLE VIA A BELT

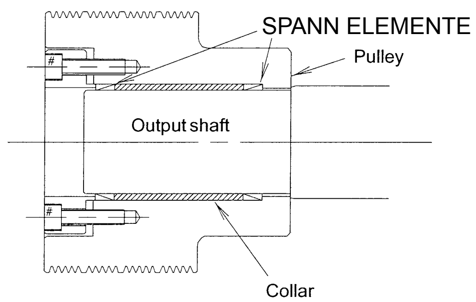
⚠ CAUTION

1 Mounting the pulley
- The gap between the inner surface of the motor pulley and output shaft should be 10μm to 15μm.
- If the gap is large when the high-speed rotation (4500 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.

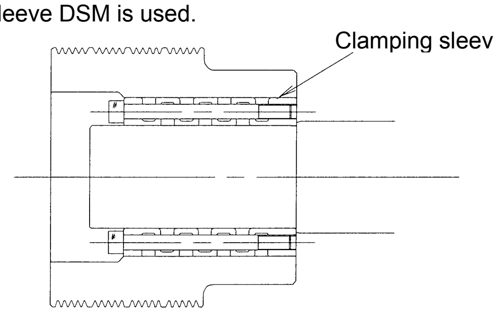
NOTE

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.

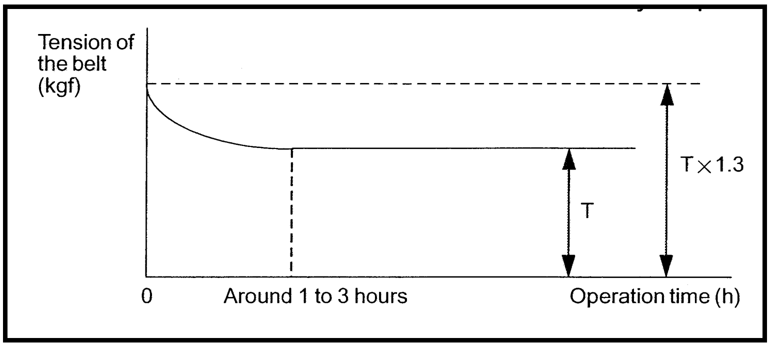


2 After attaching a pulley to the motor, adjust the vibration of the belt groove to within 20 μm (T.I.R).

5 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.

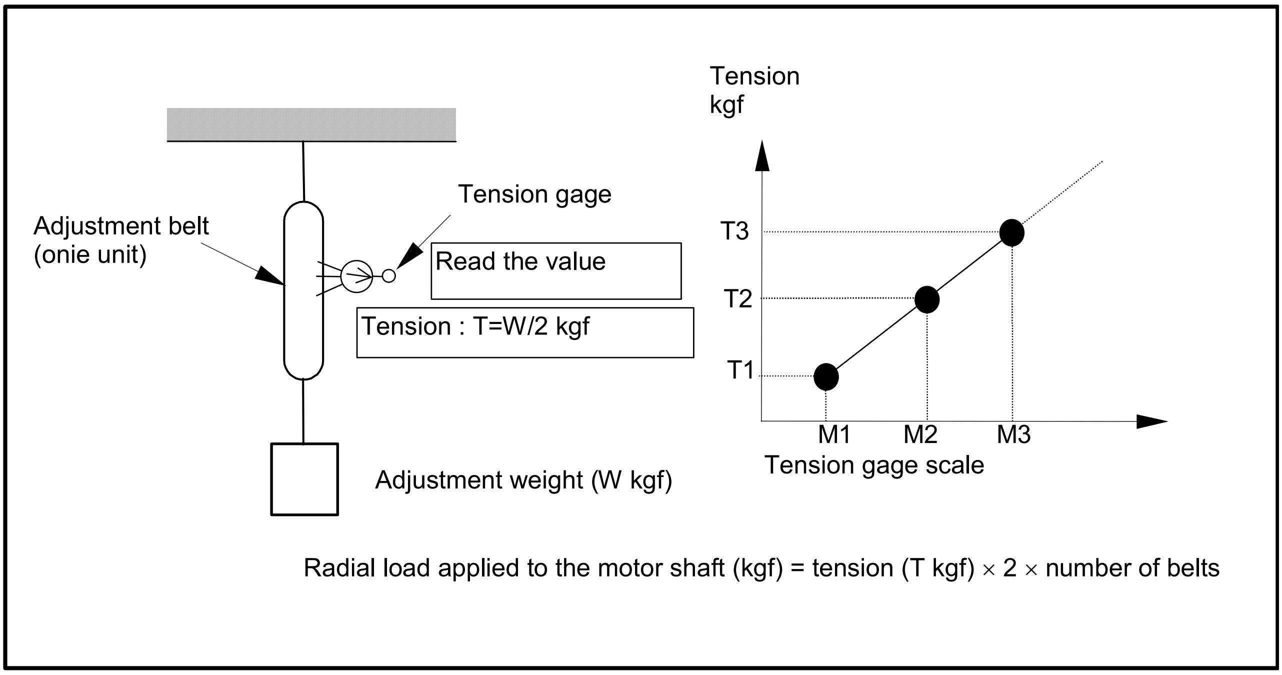


Recommended belts:

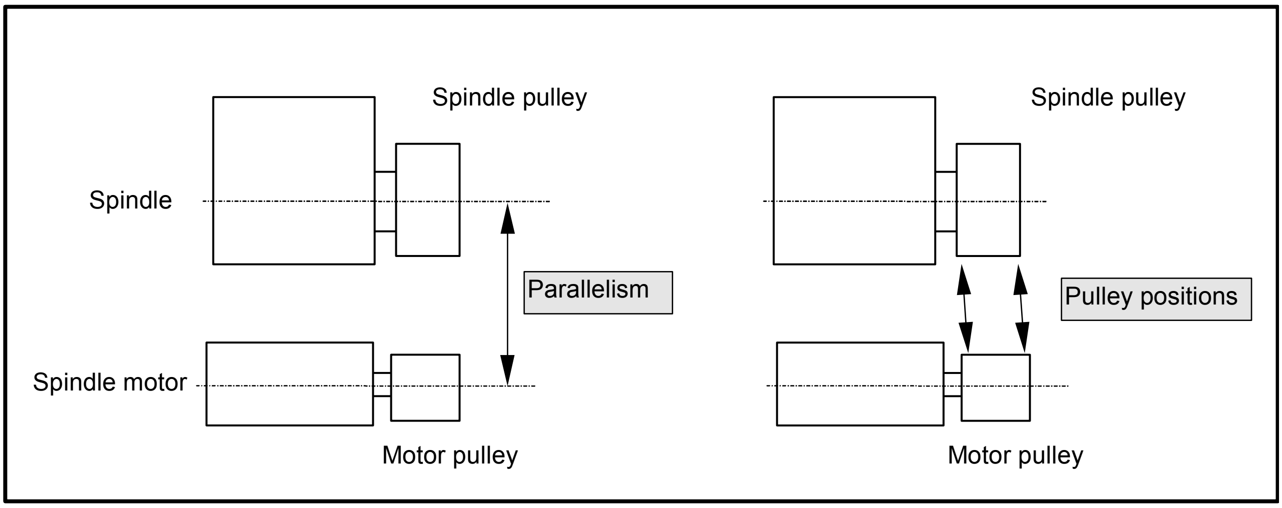
Ribace manufactured by BANDO.

Ribstar manufactured by MITSUBOSHI.

6 Use an appropriate tension gage to tension the belt.
Examples
Sonic type:
U-305 series manufactured by UNITTA.
Mechanical type:
BT-33-73F manufactured by KENT-MOORE 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.



7 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.



4.6 WHEN A MOTOR IS CONNECTED TO A SPINDLE VIA A GEAR

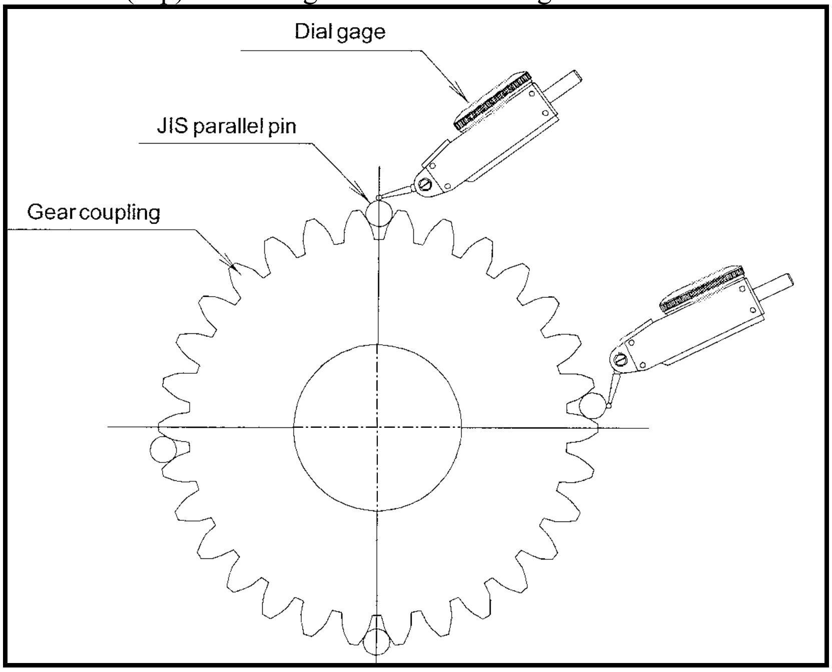
⚠ CAUTION

1 Do not use a helical gear which applies a load in the motor axial direction.

2 To prevent unusual gear sounds, apply the following precautions:

(1) The deviation of the gear tooth surface should indicate the proper value.

(Tip) Measuring the deviation of a gear tooth surface



(2) The correct backlash should be provided.

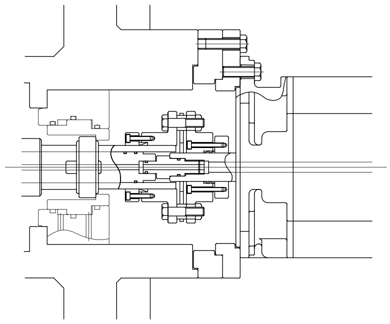
(3) The perpendicularity of the motor flange mounting surface to the machine shaft should indicate the proper value.

3 Mount the motor on the machine so that the vibration acceleration is 0.5 G or less when it is measured using the method described in CAUTION 4 of Section 4.1.

4.7 WHEN A MOTOR IS DIRECTLY CONNECTED TO A SPINDLE VIA A COUPLING

⚠ CAUTION

1 When connecting the spindle and motor shaft, be sure to use a flexible coupling.
(Flexible coupling examples)
- Diaphragm coupling (EAGLE INDUSTRY CO., LTD.)
- Oldham's coupling
- Gear coupling (MIKI PULLEY)



Example of disk coupling

Flexible coupling has three tolerances of degree of freedom: eccentricity, declination, and axial displacement. This enables coupling with less vibration and less noise to achieve high-speed rotation.

- Tolerances of eccentricity and declination: Slight eccentricity and declination that could not be absorbed by centering are absorbed.
- Tolerance of axial displacement: Extension of the spindle and motor shaft due to temperature increase is absorbed.

(Caution)

- These tolerances are criteria for preventing the coupling from being damaged, not criteria for preventing load from being applied to the spindle and motor bearings. Therefore, to peform rotation with low vibration and low noise before high-speed rotation is achieved, the spindle and motor shaft must be centered.
- FANUC has confirmed that with a coupling (disk coupling) that permits only the degrees of freedom of declination and axial displacement, rotation can take place properly if centering has been pereformed with a concentricity of 5 μm.

2 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.

3 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.

4 Set the torsional rigidity of the coupling to an appropriate high value. If the torsional rigidity is low, vibration may be produced during orientation.

5 When attaching the coupling to the motor shaft, never use a hammer or the like; otherwise, impact load is applied to the bearing.

5 NOTES ON OPERATION

⚠ 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. In addition, be sure to check that the power cable and jumper are secured to the terminal block.

⚠ CAUTION

1 After a continuous and long operation, the temperature of model αiI 0.5 may rise higher than other motors because they have no fan motor. So please treat them carefully.

2 Sound and vibration
Check that there is no abnormal sound or vibration.

3 Cooling
Clean off dust from the cooling air inlet and outlet of the stator every year, and check the flow of air carefully. The table given below indicates the direction of the rotation of the cooling fan when viewed from the rear side of the motor. Check that the actual rotating direction is correct.

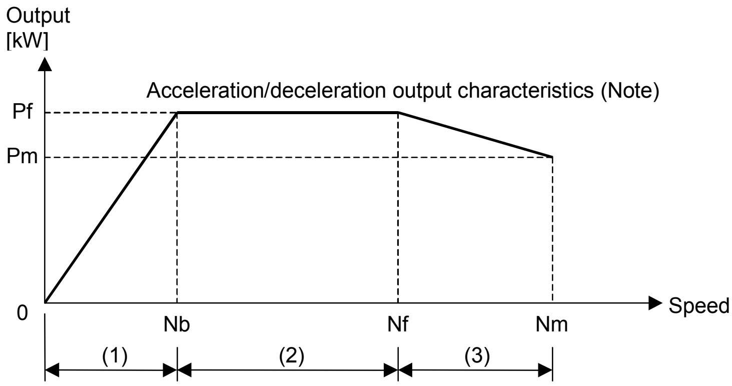
Model names	Rear exhaust (Exhaust on side opposite to load axis)	Front exhaust (Exhaust on load axis side)
αiI 2 to αiI 22, αiI 50 αiI 6HV to αiI 22HV, αiI 60HV αiIP 12 to αiIP 22, αiIP 60, αiIP 60HV αiIT 2 to αiIT 22	Counterclockwise (CCW)	Clockwise (CW)
Models other than the above	Clockwise (CW)	Clockwise (CW)

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 min^{-1} to its maximum speed in 1000 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.



J_L : Load inertia converted for the motor shaft [kgf·m·s^2]
Jm : Motor inertia [kgf·m·s^2]
Pf, Pm : Output [kW]
Nb, Nf, Nm : Speed [min^{-1}]

NOTE

Obtain an output value at acceleration time according to the following methods:

- When a maximum output value at acceleration time is shown in the output characteristics diagram, use the value.
- In other cases
  The target output during acceleration/deceleration is 1.2 times the 30-minute rated output of each model (10- or 15-minute rated output for some models).

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

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

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

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

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

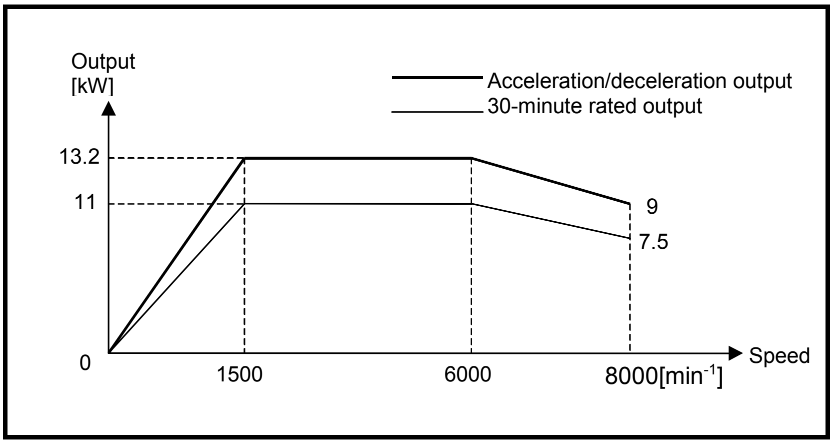
$$t3 = 0.10754 \times \frac{(JL+Jm) \times (Nm-Nf)}{(Pm-Pf) \times 1000} \times \{(Nm-Nf) - \frac{Pf\ Nm - Pm\ Nf}{Pm-Pf} \times Ln(Pm/Pf)\} [sec]$$

The total time (t) required for acceleration in the range from 0 to N m is t1+t2+t3 [sec]

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 αiI 8/8000 has the acceleration/deceleration output characteristics shown below.



In this case, the variables have the following values.

Jm : 0.0028 [kgf·m·sec^2]

NOTE

The rotor inertia is 0.28 [kgf·cm·sec^2] in the αiI 8/8000 specifications. When the unit is changed for calculation, the rotor inertia is 0.28 [kgf·cm·sec^2]/100 = 0.0028[kgf·m·sec^2]

Pf : 11×1.2=13.2 [kW]
Pm : 7.5×1.2=9 [kW]
Nb : 1500 [min^{-1}]
Nf : 6000 [min^{-1}]
Nm : 8000 [min^{-1}]

> **NOTE**
> A value obtained by "30-minute rated output × 1.2" is a rough standard, not a guaranteed value. And, setting of the parameter related to acceleration/deceleration time constant is also necessary. (Refer to Parameter Manual (B-65280EN).)

Suppose that JL is 0.0056 [$kgf \cdot m \cdot sec^2$]. Then the acceleration times are as follows:

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

$$t1=0.10754\times\frac{(0.0056+0.0028)\times1500^2}{13.2\times1000}=0.154[sec]$$

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

$$t2=0.10754\times\frac{(0.0056+0.0028)\times(6000^2-1500^2)}{2\times13.2\times1000}$$
$$=1.155[sec]$$

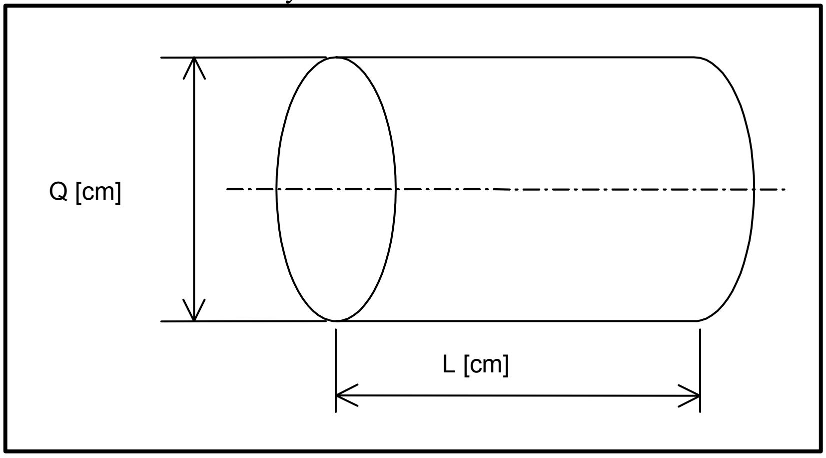
- Acceleration time (t3) in the decreasing-output range (Nf to Nm)

$$t3=0.10754\times\frac{(0.0056+0.0028)\times(8000-6000)}{(9-13.2)\times1000}$$
$$\times\{(8000-6000)-\frac{13.2\times8000-9\times6000}{9-13.2}\times Ln(9/13.2)\}$$
$$=1.164[sec]$$

The total time required for acceleration in the range from 0 to 8000 min^{-1} is t1+t2+t3=2.47 [s]

Reference 1

When a cylinder rotates about its center axis, its inertia can be obtained from the following equation. The inertia of a gear can be obtained in a similar way.



$$J=\frac{\pi\gamma}{32\times980}Q^4L \text{ [kgf}\cdot\text{cm}\cdot\text{sec}^2\text{]}$$

When steel ($\gamma=7.8\times10^{-3}$ kgf/cm^3) is used, the approximate inertia is obtained from the following equation.

$$J=0.78\times10^{-6}Q^4L \text{ [kgf}\cdot\text{cm}\cdot\text{sec}^2\text{]}$$

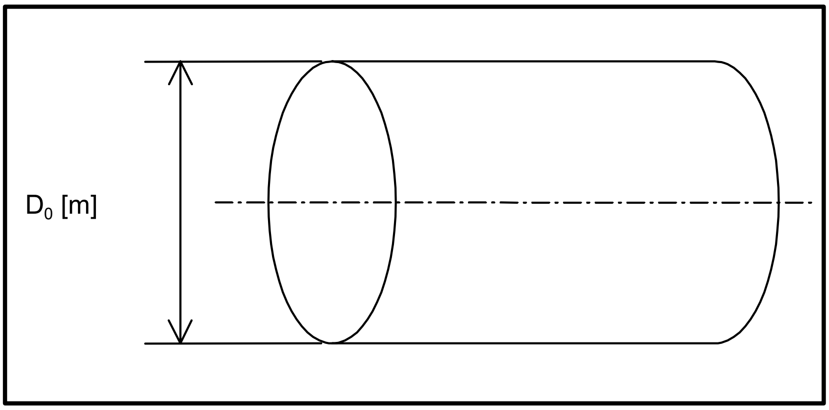
When the unit for J is changed.

$$J=0.78\times10^{-8}Q^4L \text{ [kgf}\cdot\text{m}\cdot\text{sec}^2\text{]}$$

Reference 2

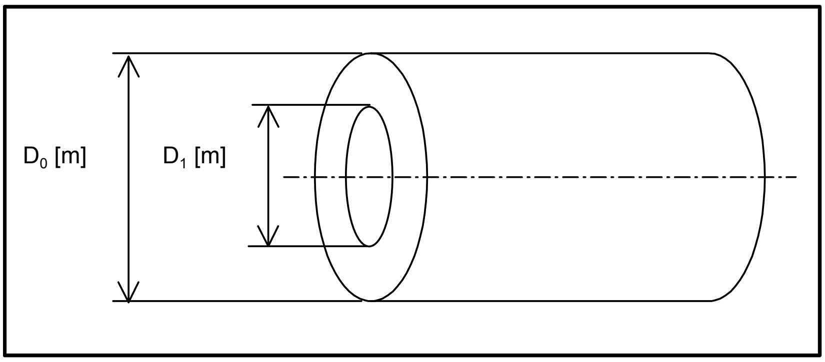
To obtain the value GD^2 [kgf·m^2] for cylinder, get the value of G from its weight in kilograms and use the following equation to get the value of D^2.

- Solid cylinder



$D^2=D_0^2/2$

- Hollow cylinder



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

Use the following equiation to convert GD^2 [kgf·m^2] to J [kgf·cm·sec^2]

J[kgf·cm·sec^2] $= GD^2$ [kgf·m^2]$/4/g\times100$

$= GD^2$ [kgf·m^2]$/4/9.8\times100$

$= GD^2$ [kgf·m^2] $\times2.55$

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

Reference 3

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

I[kg·m^2]=GD^2 [kgf·m^2]/4

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

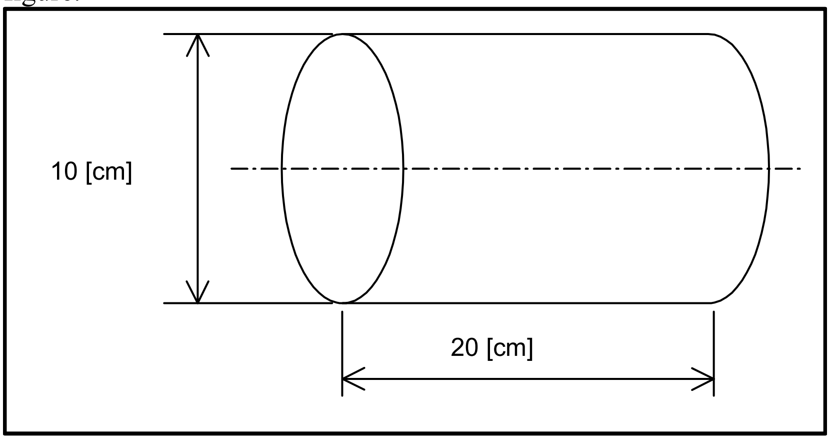
J[kgf·cm·sec^2] = GD^2 [kgf·m^2]/4/g×100
= I [kg·m^2]/g×100
= I [kg·m^2]/9.80×100
= I [kg·m^2] ×10.2

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

Reference 4

- Difference of inertia

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



(1) Calculating J [kgf·cm·sec^2]

J = πγ /(32×980) ×Q^4×L
= π×7.8×10^{-3}/(32×980) ×10^4×20
= 0.156[kgf·cm·sec^2]

(2) Calculating GD^2 [kgf·m^2]

G = π/4×10^2×20×γ
= π/4×10^2×20×7.8×10^{-3}
= 12.25[kgf]

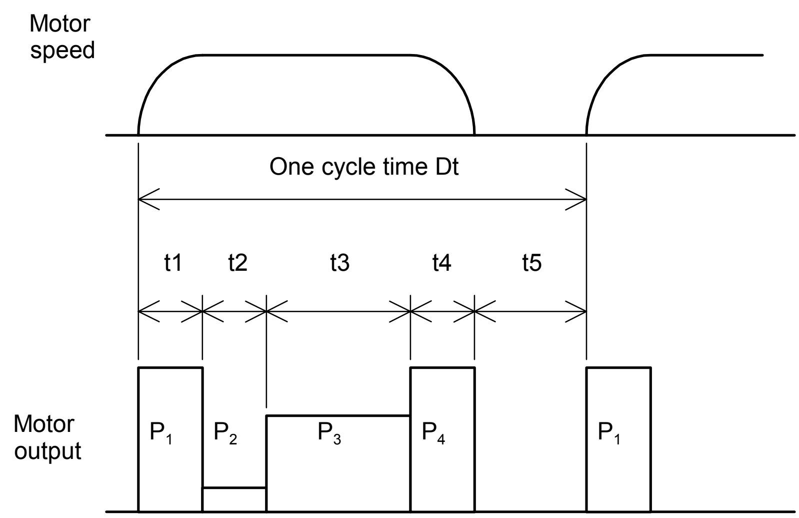
D^2 = D$_0^2$/2
= 0.1^2/2
= 0.005[m^2]

GD^2 = 12.25×0.005
= 0.0613[kgf·m^2]

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



P_1, P_4 : Acceleration/deceleration output [kW]
= 30 min rated output at const. output power range × 1.2
Note 1) 10 min rated output at const. output power range × 1.2 or 15 min rated output at const. output power range × 1.2 apply for some models.
Note 2) This is not a guaranteed value but a guideline.

P_2 : Output with no load [kW] (P_2=0)

P_3 : Cutting output [kW]

$$\text{Average output } \mathrm{Pav} = \sqrt{\frac{\mathrm{P_1}^2 t1 + \mathrm{P_2}^2 t2 + \mathrm{P_3}^2 t3 + \mathrm{P_4}^2 t4}{D_t}}$$

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 Nb shall be calculated by the following equation.
> $P_3=P_C \times Nb/N$ [kW] (P_C: Actual cutting output)
> 2 In case that P_3 is calculated by the load indicator voltage, use the following equation.
> $P_3=P_1 \times L_3/10$ [kW]
> (L_3: Load indicator voltage in cutting [V])

Allowable duty cycle time Dt

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

$$Dt=\frac{1}{Pav^2} \times (P_1^2t1+P_2^2t2+P_3^2t3+P_4^2t4)$$

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

Example)

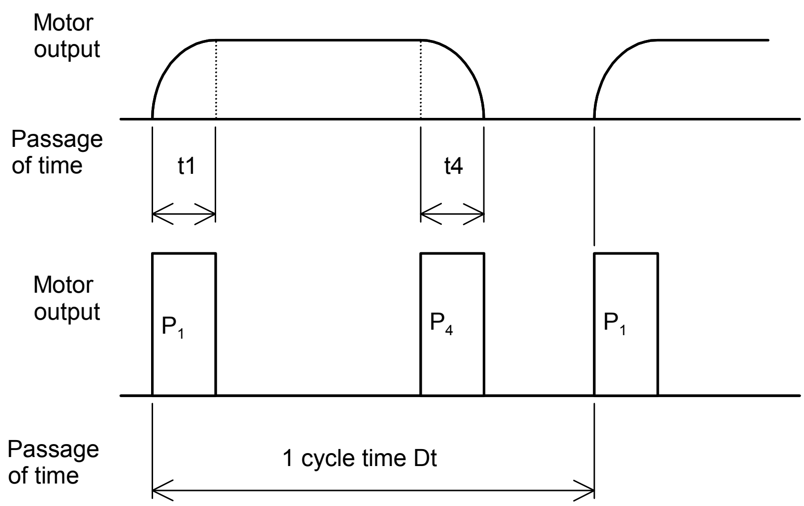
To obtain the allowable duty cycle when model αiI 3 accelerates and decelerates repeatedly without load ($P_2=P_3=0$).

- Continuous rated output Pav=Pcont=3.7kW
- Acceleration/deceleration output $P_1=P_4=5.5kW\times1.2=6.6kW$
- Acceleration time t1=3s, deceleration time t4=3s

$$Dt=\frac{1}{3.7^2}\times(6.6^2\times3+6.6^2\times3)=19.1 \text{ seconds}$$

As shown above, when model αiI 3 accelerates and decelerates repeatedly, the allowable duty cycle time is 19 seconds.

Allowable duty cycle time Dt for repeated acceleration/deceleration



$$Dt=\frac{1}{P_{CONT}{}^2}\times(P_{30min}{}^2\times1.2^2)\times(t1+t4)$$

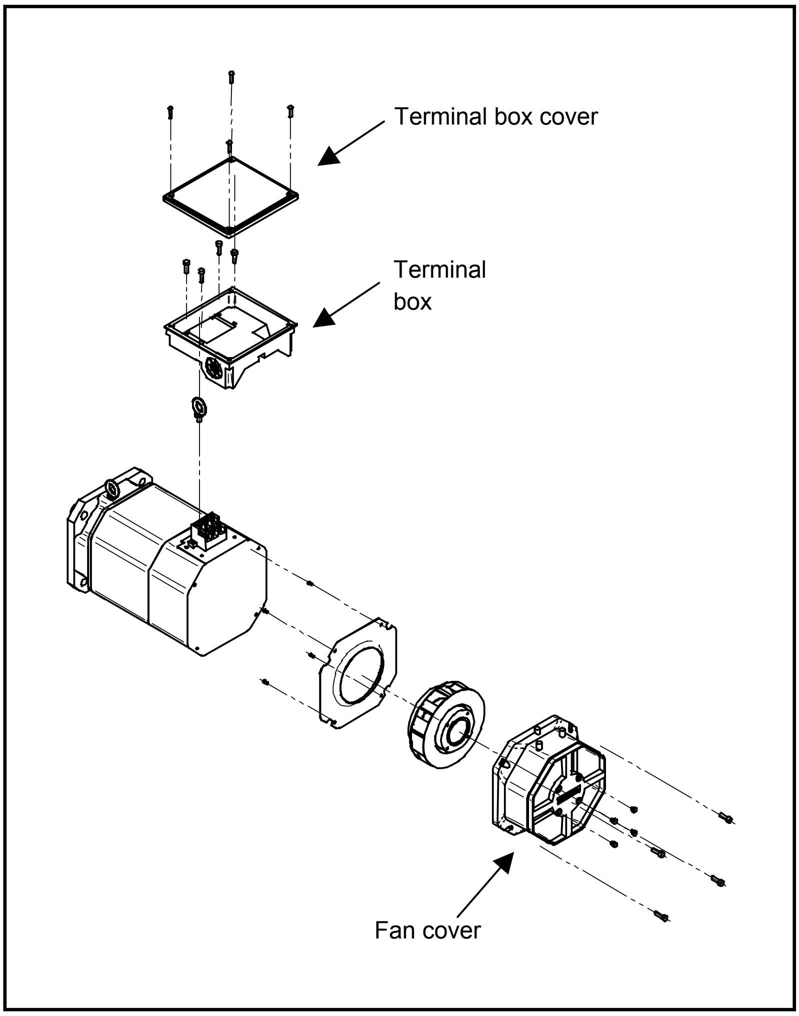
P_{cont}	: Continuous rated output
P_{30min}	: 30-minute rated output
t1+t4	: Sum of the acceleration and deceleration time

8 DISPOSAL OF SPINDLE MOTORS BY MATERIAL TYPE

Disposal of motors by separating plastic parts from metal parts

After a motor is dismantled, the plastic parts (terminal box, terminal box cover, fan cover) must be separated for disposal. The plastic parts are made of the following material.

Plastic material : >(PBT+PC)-GF(30)FR(17)<



II. FANUC AC SPINDLE MOTOR αiI series 200V type

1 GENERAL

The FANUC AC spindle motor α*i*I series 200V type is ideal for CNC machine tool spindles.

Features

- The motor is compact, light-weight and furnished with digital control for much higher performance.
- The motor inertia of the AC spindle motor is made smaller to shorten the acceleration/deceleration speed. Further, optimum control enables highly efficient cutting.
- The built-in α*i*M sensor or α*i*MZ sensor enables synchronous spindle and Z-axis feed and rigid tapping.
- Improvement in machining of the motor housing enhances the accuracy of the mounting part.
- 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

Series		α*i*I series 200V type		
Item	Model	**α*i*I 0.5/10000**	**α*i*I 1/10000**	**α*i*I 1.5/10000**
Output (*2)	Cont. rated kW (HP)	0.55 (0.74)	1.5 (2.0)	1.1 (1.5)
	30 min rated kW [15 min, 10min] (*3) (HP)	1.1 (1.5)	2.2 (3.0)	3.7 (5.0)
	S3 60% kW [40%,25%,15%] (*4)(*5) (HP)	1.1 (1.5)	2.2 (3.0)	3.7 (5.0)
Rated current A (*6)	Cont. rated	7	11	14
	30 min rated, S3 60% (*3) (*4)	11	13	28
	S3 25%	13		32
Speed min^{-1}	Base speed (*7)	3000 (2400)	3000 (2400)	1500 (1300)
	Max. speed	10000	10000	10000
Output torque (Cont. rated torque at const. rated torque range) N·m (kgf·cm)		1.75 (17.9)	4.77 (48.7)	7.00 (71.4)
Rotor inertia	kg·m^2	0.00048	0.003	0.0043
	kgf·cm·s^2	0.0048	0.03	0.04
Weight kgf		7	18	24
Vibration		V5 (option V3)		
Noise		75dB(A) or less		
Cooling system (*8)		Totally enclosed and non-ventilated IC0A0	Totally enclosed and fan cooled IC0A6	
Cooling fan W		None	17	
Installation (*9)		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		
Allowable overload capacity (1 min) (*10)		120 % of 30 min rated output		
Insulation		Class H		
Ambient temperature		0 to 40°C		
Altitude		Height above sea level not exceeding 1000m		
Painting color		Munsell system N2.5		
Sensor		α*i*M sensor or α*i*MZ sensor		
Type of thermal protection (*11)		TP211		
Resolution of the α*i*MZ sensor /rev.		2048		
Number of detected gear teeth per rotation λ/rev.		64	128	
Bearing lubrication		Grease		
Maximum output during acceleration (*12) kW		1.32	2.64	4.44
Applicable spindle amplifier		α*i*SP 2.2		α*i*SP 5.5
Model		α*i*I 0.5/10000	α*i*I 1/10000	α*i*I 1.5/10000

Series / Item	Model	αiI 2/10000	αiI 3/10000	αiI 6/10000	αiI 8/8000
Series		αiI series 200V type			
Output (*2)	Cont. rated kW (HP)	2.2 (3.0)	3.7 (5.0)	5.5 (7.4)	7.5 (10)
	30 min rated kW [15 min, 10min] (*3) (HP)	3.7 (5.0)	5.5 (7.4)	7.5 (10)	11 (14.7)
	S3 60% kW [40%,25%] (*4)(*5) (HP)	3.7 (5.0)	5.5 (7.4)	7.5 (10)	11 (14.7)
Rated current A (*6)	Cont. rated	19	23	43	43
	30 min rated, S3 60% (*3)(*4)	27	29	49	53
	S3 25%	32		53	
Speed min^{-1}	Base speed (*7)	1500 (1350)	1500 (1400)	1500 (1200)	1500 (1400)
	Max. speed	10000	10000	10000	8000
Output torque (Cont. rated torque at const. rated torque range) N·m (kgf·cm)		14.0 (143)	23.5 (240)	35.0 (357)	47.7 (487)
Rotor inertia	$kg \cdot m^2$	0.0078	0.0148	0.0179	0.0275
	$kgf \cdot cm \cdot s^2$	0.08	0.15	0.18	0.28
Weight kgf		27	46	51	80
Vibration		V5 (option V3)			
Noise		75dB(A) or less			
Cooling system (*8)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		17		20	
Installation (*9)		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			
Allowable overload capacity (1 min) (*10)		120 % of 30 min rated output			
Insulation		Class H			
Ambient temperature		0 to 40°C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Sensor		αiM sensor or αiMZ sensor			
Type of thermal protection (*11)		TP211			
Resolution of the αiMZ sensor /rev.		2048		4096	
Number of detected gear teeth per rotation λ/rev.		128		256	
Bearing lubrication		Grease			
Maximum output during acceleration (*12) kW		4.44	6.6	9.0	13.2
Applicable spindle amplifier		αiSP 5.5		αiSP 11	
Model		αiI 2/10000	αiI 3/10000	αiI 6/10000	αiI 8/8000

Series		αiI series 200V type			
Item \ Model		**αiI 12/7000**	**αiI 15/7000**	**αiI 18/7000**	**αiI 22/7000**
Output (*2)	Cont. rated kW (HP)	11 (14.7)	15 (20.1)	18.5 (24.8)	22 (29.5)
	30 min rated kW [15 min, 10min] (*3) (HP)	15 (20.1)	18.5 (24.8)	22 (29.5)	26 (34.9)
	S3 60% kW [40%,25%] (*4)(*5) (HP)	15 (20.1)	18.5 (24.8)	22 (29.5)	26 (34.9)
Rated current A (*6)	Cont. rated	54	70	82	98
	30 min rated, S3 60% (*3)(*4)	64	82	95	111
	S3 25%	72	96		
Speed min^{-1}	Base speed (*7)	1500 (1250)	1500 (1200)	1500 (1200)	1500 (1250)
	Max. speed	7000	7000	7000	7000
Output torque (Cont. rated torque at const. rated torque range) N·m (kgf·cm)		70.0 (714)	95.4 (974)	117.7 (1201)	140.0 (1428)
Rotor inertia	$kg\cdot m^2$	0.07	0.09	0.105	0.128
	$kgf\cdot cm\cdot s^2$	0.77	0.93	1.08	1.29
Weight kgf		95	110	125	143
Vibration		V5 (option V3)			
Noise		75dB(A) or less			
Cooling system (*8)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		56			
Installation (*9)		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			
Allowable overload capacity (1 min) (*10)		120 % of 30 min rated output			
Insulation		Class H			
Ambient temperature		0 to 40°C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Sensor		αiM sensor or αiMZ sensor			
Type of thermal protection (*11)		TP211			
Resolution of the αiMZ sensor /rev.		4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Maximum output during acceleration (*12) kW		18.0	22.2	26.4	31.2
Applicable spindle amplifier		αiSP 15	αiSP 22		αiSP 26
Model		αiI 12/7000	αiI 15/7000	αiI 18/7000	αiI 22/7000

Series		αiI series 200V type		
Item / Model		αiI 30/6000	αiI 40/6000	αiI 50/4500
Output (*2)	Cont. rated kW (HP)	30 (40.2)	37 (49.6)	45 (60.3)
	30 min rated kW [15 min, 10min] (*3) (HP)	37 (49.6)	45 (60.3)	55 (73.7)
	S3 60% kW [40%,25%] (*4)(*5) (HP)	37 (49.6)	45 (60.3)	55 (73.7)
Rated current A (*6)	Cont. rated	131	160	193
	30 min rated,S3 60% (*3)(*4)	155	185	236
	S3 25%			
Speed min^{-1}	Base speed (*7)	1150 (950)	1500 (1200)	1150 (950)
	Max. speed	6000	6000	4500
Output torque (Cont. rated torque at const. rated torque range) N·m (kgf·cm)		249.1 (2540)	235.5 (2402)	373.6 (3810)
Rotor inertia	$kg\cdot m^2$	0.295	0.355	0.49
	$kgf\cdot cm\cdot s^2$	3.0	3.6	5.0
Weight kgf		250	290	460
Vibration		V5 (option V3)		V10 (option V5)
Noise		75dB(A) or less		80dB(A) or less
Cooling system (*8)		Totally enclosed and fan cooled IC0A6		
Cooling fan W		84		185
Installation (*9)		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		
Allowable overload capacity (1 min) (*10)		120 % of 30 min rated output		
Insulation		Class H		
Ambient temperature		0 to 40°C		
Altitude		Height above sea level not exceeding 1000m		
Painting color		Munsell system N2.5		
Sensor		αiM sensor or αiMZ sensor		
Type of thermal protection (*11)		TP211		
Resolution of the αiMZ sensor /rev.		4096		
Number of detected gear teeth per rotation λ/rev.		256		
Bearing lubrication		Grease		
Maximum output during acceleration (*12) kW		44.4	54.0	66.0
Applicable spindle amplifier		αiSP 45		αiSP 55
Model		αiI 30/6000	αiI 40/6000	αiI 50/4500

Series		α*i*I series 200V type			
Item	Model	α*i*I 1/15000	α*i*I 1.5/20000	α*i*I 2/20000	α*i*I 3/12000
Output (*2)	Cont. rated kW (HP)	1.5 (2.0)	1.5 (2.0)	2.2 (3.0)	3.7 (5.0)
	30 min rated kW [15 min, 10min] (*3) (HP)	2.2 (3.0)	2.2 (3.0)	3.7 (5.0)	5.5 (7.4)
	S3 60% kW [40%,25%] (*4)(*5) (HP)	2.2 (3.0)	2.2 (3.0)	3.7 (5.0)	5.5 (7.4)
Rated current A (*6)	Cont. rated	24	28	41	36
	30 min rated (*3) S3 60% (*4)	27	33	53	46
Speed min^{-1}	Base speed	3000	3000	3000	1500
	Max. speed	15000	20000	20000	12000
Output torque (Cont. rated torque at const. rated torque range) N·m (kgf·cm)		4.77 (48.7)	4.77 (48.7)	7.0 (71.5)	23.5 (240)
Rotor inertia	$kg \cdot m^2$	0.003	0.0043	0.0078	0.0148
	$kgf \cdot cm \cdot s^2$	0.03	0.04	0.08	0.15
Weight kgf		18	24	27	46
Vibration		V3			V5 (option V3)
Noise		75dB(A) or less			
Cooling system (*8)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		17			
Installation (*9)		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			
Allowable overload capacity (1 min) (*10)		120 % of 30 min rated output			
Insulation		Class H			
Ambient temperature		0 to 40°C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Sensor		α*i*MZ sensor (*13)			
Type of thermal protection (*11)		TP211			
Resolution of the α*i*MZ sensor /rev.		2048			
Number of detected gear teeth per rotation λ/rev.		128			
Bearing lubrication		Grease			
Maximum output during acceleration (*12) kW		5.6	13	20	13
Applicable spindle amplifier		α*i*SP 5.5	α*i*SP 15	α*i*SP 22	α*i*SP 11
Model		α*i*I 1/15000	α*i*I 1.5/20000	α*i*I 2/20000	α*i*I 3/12000

Series		αiI series 200V type			
Item \ Model		αiI 6/12000(*1)		αiI 8/10000(*1)	
		Low-speed winding (Y connection)	High-speed winding (Δ connection)	Low-speed winding (Y connection)	High-speed winding (Δ connection)
Output (*2)	Cont. rated kW (HP)	5.5 (7.4)	5.5 (7.4)	7.5 (10)	7.5 (10)
	30 min rated kW [15 min, 10min] (*3) (HP)	7.5 (10)	7.5 (10)	11 (14.7)	11 (14.7)
	S3 60% kW [40%,25%] (*4)(*5) (HP)	7.5 (10)	7.5 (10)	11 (14.7)	11 (14.7)
Rated current A (*6)	Cont. rated	38	38	43	46
	30 min rated (*3) S3 60% (*4)	48	45	53	56
Speed min^{-1}	Base speed	1500	4000	1500	4000
	Max. speed	12000	12000	10000	10000
Output torque (Cont. rated torque at const. rated torque range) N·m (kgf·cm)		35.0 (357)	13.1 (133)	47.7 (487)	17.9 (183)
Rotor inertia	$kg \cdot m^2$	0.0179		0.0275	
	$kgf \cdot cm \cdot s^2$	0.18		0.28	
Weight kgf		51		80	
Vibration		V5 (option V3)			
Noise		75dB(A) or less			
Cooling system (*8)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		20			
Installation (*9)		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			
Allowable overload capacity (1 min) (*10)		120 % of 30 min rated output			
Insulation		Class H			
Ambient temperature		0 to 40°C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Sensor		αiM sensor or αiMZ sensor			
Type of thermal protection (*11)		TP211			
Resolution of the αiMZ sensor /rev.		4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Maximum output during acceleration (*12) kW		9		13.2	
Applicable spindle amplifier		αiSP 11			
Model		αiI 6/12000		αiI 8/10000	

Series		**αiI series 200V type**			
Item / **Model**		**αiI 12/10000(*1)** **αiI 12/12000**		**αiI 15/10000(*1)** **αiI 15/12000**	
		Low-speed winding (Y connection)	**High-speed winding (Δ connection)**	**Low-speed winding (Y connection)**	**High-speed winding (Δ connection)**
Output (*2)	Cont. rated kW (HP)	11 (14.7)	11 (14.7)	15 (20.1)	15 (20.1)
	30 min rated kW [15 min, 10min] (*3) (HP)	15 (20.1)	15 (20.1)	18.5 (24.8)	18.5 (24.8)
	S3 60% kW [40%,25%] (*4)(*5) (HP)	15 (20.1)	15 (20.1)	18.5 (24.8)	18.5 (24.8)
Rated current A (*6)	Cont. rated	54	52	70	71
	30 min rated (*3) S3 60% (*4)	64	63	82	81
Speed min^{-1}	Base speed	1500	4000	1500	4000
	Max. speed	10000,12000	10000,12000	10000,12000	10000,12000
Output torque (Cont. rated torque at const. rated torque range) N·m (kgf·cm)		70.0 (714)	26.3 (268)	95.4 (974)	35.8 (365)
Rotor inertia	$kg \cdot m^2$	0.07		0.09	
	$kgf \cdot cm \cdot s^2$	0.77		0.93	
Weight kgf		95		110	
Vibration		10000 : V5 12000 : V3			
Noise		75dB(A) or less			
Cooling system (*8)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		56			
Installation (*9)		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			
Allowable overload capacity (1 min) (*10)		120 % of 30 min rated output			
Insulation		Class H			
Ambient temperature		0 to 40°C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Sensor		αiM sensor or αiMZ sensor			
Type of thermal protection (*11)		TP211			
Resolution of the αiMZ sensor /rev.		4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Maximum output during acceleration (*12) kW		18.0		22.2	
Applicable spindle amplifier		αiSP 15		αiSP 22	
Model		αiI 12/10000 αiI 12/12000		αiI 15/10000 αiI 15/12000	

Series		αiI series 200V type			
Item / Model		αiI 18/10000(*1) αiI 18/12000		αiI 22/10000(*1) αiI 22/12000	
		Low-speed winding (Y connection)	**High-speed winding (Δ connection)**	**Low-speed winding (Y connection)**	**High-speed winding (Δ connection)**
Output (*2)	Cont. rated kW (HP)	18.5 (24.8)	18.5 (24.8)	22 (29.5)	22 (29.5)
	30 min rated kW [15 min, 10min] (*3) (HP)	22 (29.5)	22 (29.5)	26 (34.9)	26 (34.9)
	S3 60% kW [40%,25%] (*4)(*5) (HP)	22 (29.5)	22 (29.5)	26 (34.9)	26 (34.9)
Rated current A (*6)	Cont. rated	82	83	100	101
	30 min rated (*3) S3 60% (*4)	95	94	111	112
Speed min^{-1}	Base speed	1500	4000	1500	4000
	Max. speed	10000,12000	10000,12000	10000,12000	10000,12000
Output torque (Cont. rated torque at const. rated torque range) N·m (kgf·cm)		117.7 (1201)	44.2 (451)	140.0 (1428)	52.5 (536)
Rotor inertia	$kg{\cdot}m^2$	0.105		0.128	
	$kgf{\cdot}cm{\cdot}s^2$	1.08		1.29	
Weight kgf		125		143	
Vibration		10000 : V5 12000 : V3			
Noise		75dB(A) or less			
Cooling system (*8)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		56			
Installation (*9)		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			
Allowable overload capacity (1 min) (*10)		120 % of 30 min rated output			
Insulation		Class H			
Ambient temperature		0 to 40°C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Sensor		αiM sensor or αiMZ sensor			
Type of thermal protection (*11)		TP211			
Resolution of the αiMZ sensor /rev.		4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Maximum output during acceleration (*12) kW		26.4		31.2	
Applicable spindle amplifier		αiSP 22		αiSP 26	
Model		αiI 18/10000 αiI 18/12000		αiI 22/10000 αiI 22/12000	

(*1) For α*i*I 6/12000, α*i*I 8/10000, α*i*I 12/10000, α*i*I 12/12000, α*i*I 15/10000, α*i*I 15/12000, α*i*I 18/10000, α*i*I 18/12000, α*i*I 22/10000, and α*i*I 22/12000, the CNC soft option and switching magnetic contactor unit associated with the output switch function (Y-Δ switch) are required. See FANUC SERVO AMPLIFIER α*i* series DESCRIPTIONS (B-65282EN) for details of the output switch control.

(*2) The rated output is guaranteed at the rated voltage.
(Amplifier input: 200/220/230V AC +10% -15%, 50/60 Hz ±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.

(*3) The output for α*i*I 0.5/10000, α*i*I 1/10000, α*i*I 2/10000, α*i*I 1/15000, α*i*I 1.5/20000, or α*i*I 2/20000 is 15 min rated. That for α*i*I 1.5/10000is 10 min rated.

(*4) S3 40% for α*i*I 0.5/10000, α*i*I 30/6000, α*i*I 50/4500, α*i*I 1/15000, α*i*I 1.5/20000, or α*i*I 2/20000, S3 15% for α*i*I 1.5/10000.

(*5) The cycle time is 10 minutes, S3 60%: ON 6 minutes, OFF 4 minutes, S3 40%: ON 4 minutes, OFF 6 minutes and S3 25%: ON 2.5 minutes, OFF 7.5 minutes.

(*6) The rated current is not a guaranteed value but a guideline for the maximum current at rated output.

(*7) Values in parentheses represent the base speeds for S3 25% rated output. (For the α*i*I 1.5/10000, the base speed is S3 15%.) To output S3 25% rating (S3 15% rating for the α*i*I 1.5/10000), the α*i*SP amplifier (A06B-6141-Hxxx) and dedicated parameters are required.

(*8) IC code conforms to IEC 34-6.

(*9) IM code conforms to IEC 34-7. When using α*i*I 1/15000, α*i*I 1.5/20000, or α*i*I 2/20000, the output shaft must be placed horizontally or vertically downward (IMB5, IMV1).

(*10) This is not a guaranteed value but a guideline for the maximum motor output at a rated supply voltage. 120 % of 15 min rated for α*i*I 0.5/10000, α*i*I 1/10000, α*i*I 2/10000, α*i*I 1/15000, α*i*I 1.5/20000, or α*i*I 2/20000 and 120% of 10 min rated for α*i*I 1.5/10000.

(*11) Type conforms to IEC 34-11.

(*12) These values are to be used only as guidance for selecting a power supply (α*i*PS) and are not guaranteed.

(*13) There is another type of α*i*I 3/12000 that has a built-in α*i*M sensor.

(*14) Degree of protection:
with oil seal: IP54, without oil seal: IP40.

3 OUTPUT/TORQUE CHARACTERISTICS

Reference
Calculation for torque

Torque T can be obtained by the following equation.

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

P[kW]: Motor output

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

When the unit of T is [kgf·m],

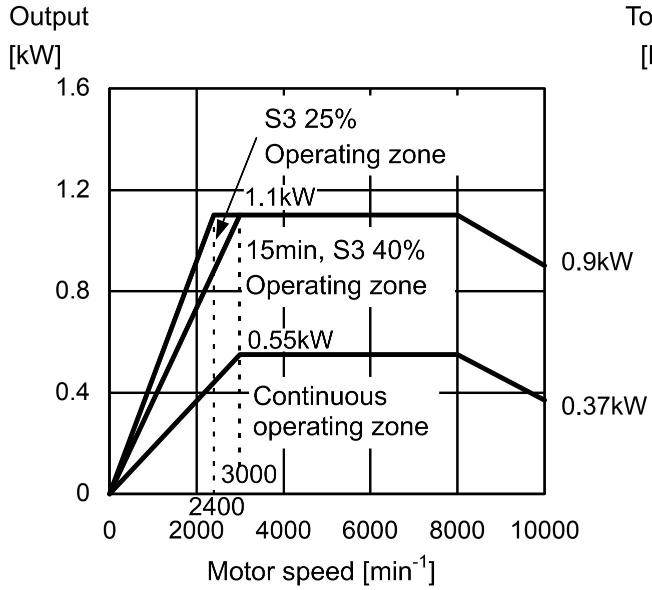
$T[kgf \cdot m] = P[kW] \times 1000 / 1.0269 / N[min^{-1}]$

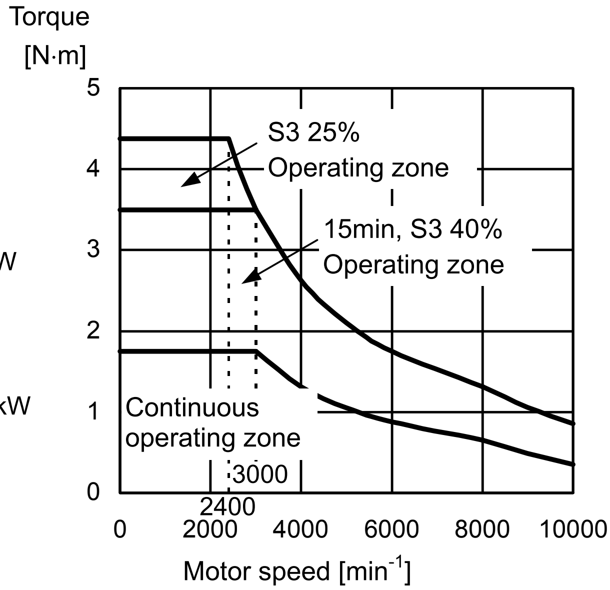
⚠ CAUTION

To output S3 25% rating (S3 15% rating for the α*i*I 1.5/1000), the α*i*SP amplifier (A06B-6141-Hxxx) and dedicated parameters are required.

3.1 MODEL αiI 0.5/10000

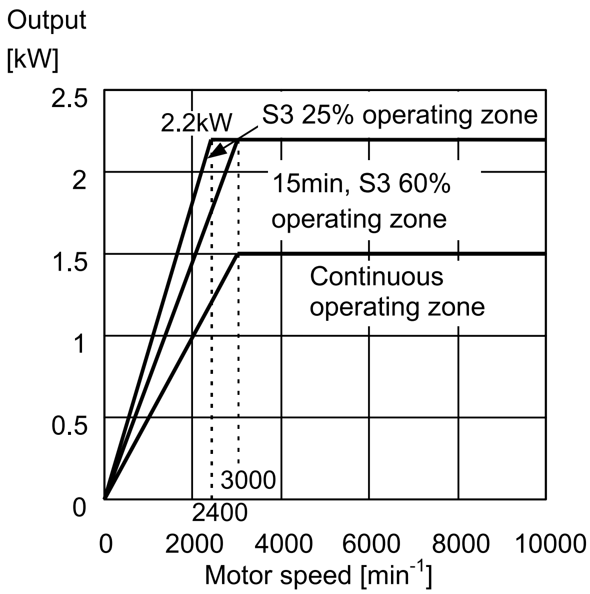
Applicable amplifier αiSP 2.2

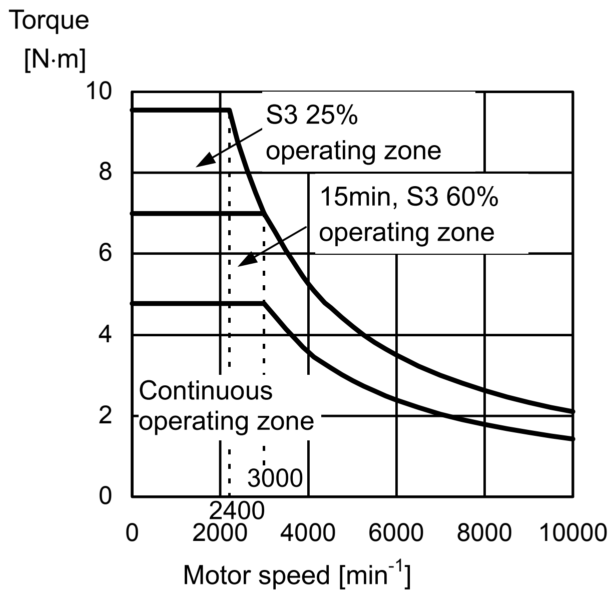




3.2 MODEL αiI 1/10000

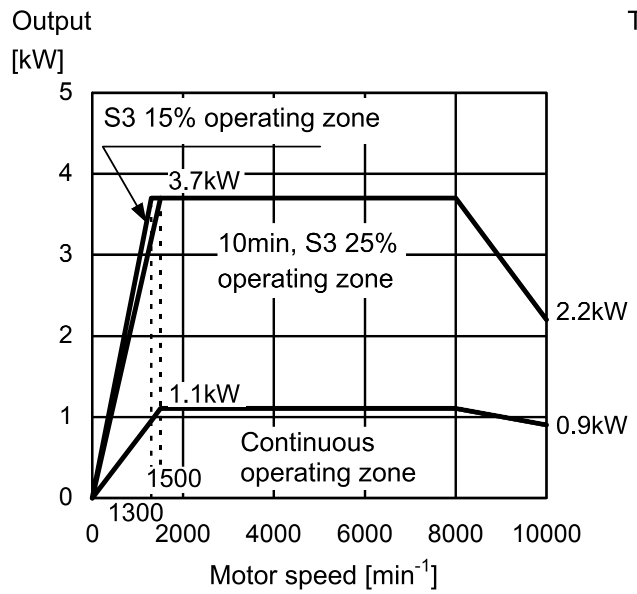
Applicable amplifier αiSP 2.2

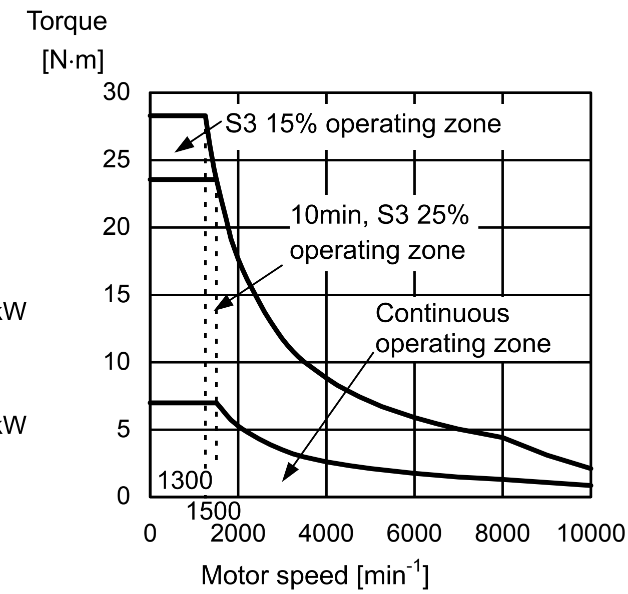




3.3 MODEL αiI 1.5/10000

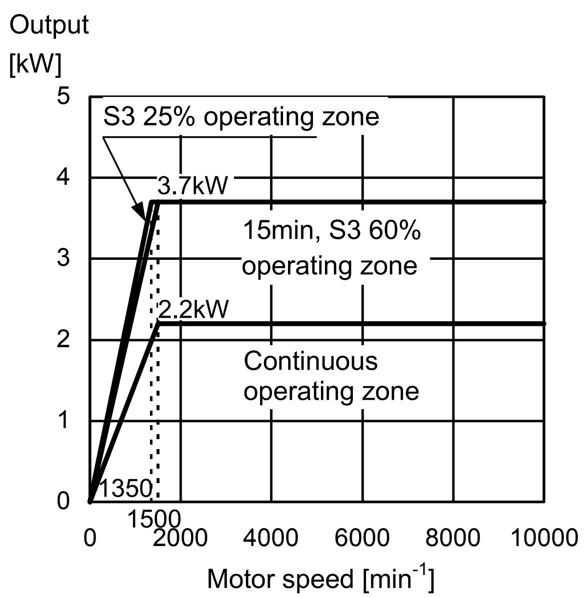
Applicable amplifier αiSP 5.5

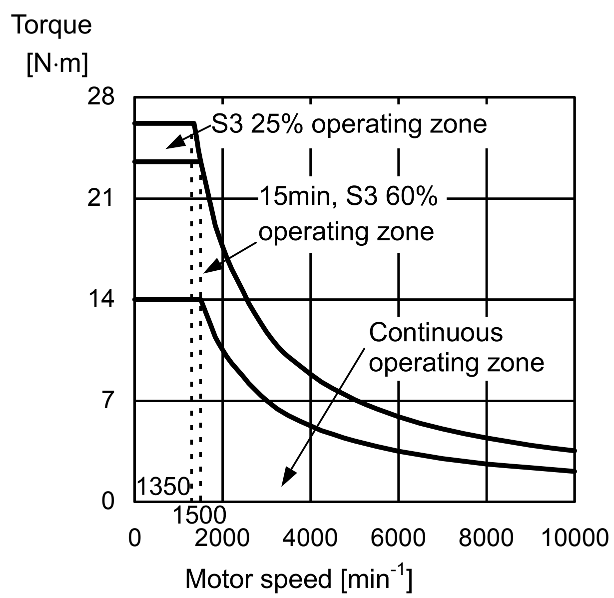




3.4 MODEL αiI 2/10000

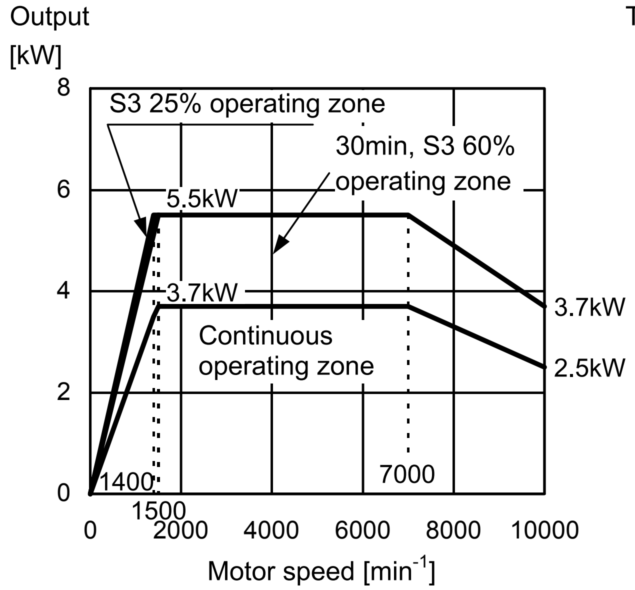
Applicable amplifier αiSP 5.5

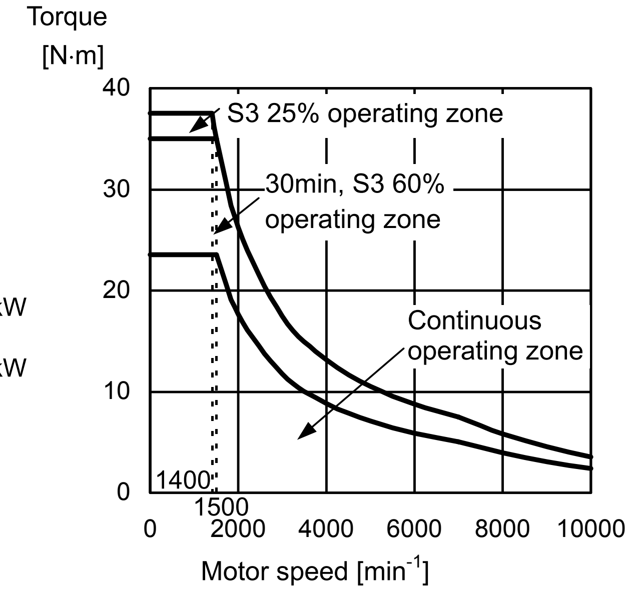




3.5 MODEL αiI 3/10000

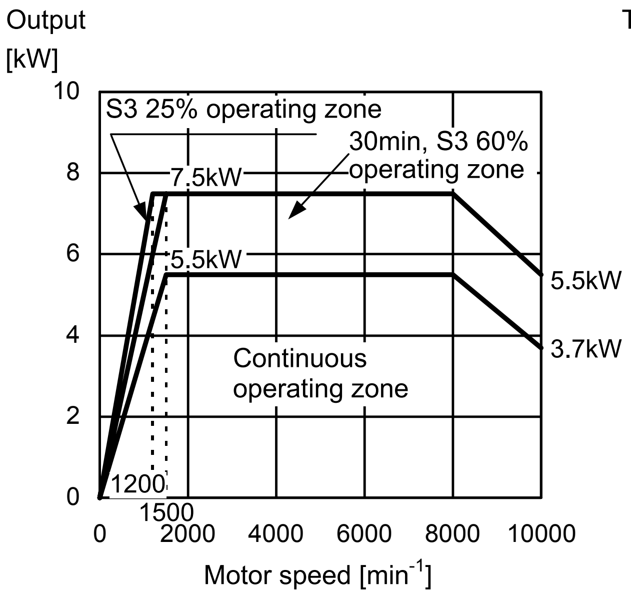
Applicable amplifier αiSP 5.5

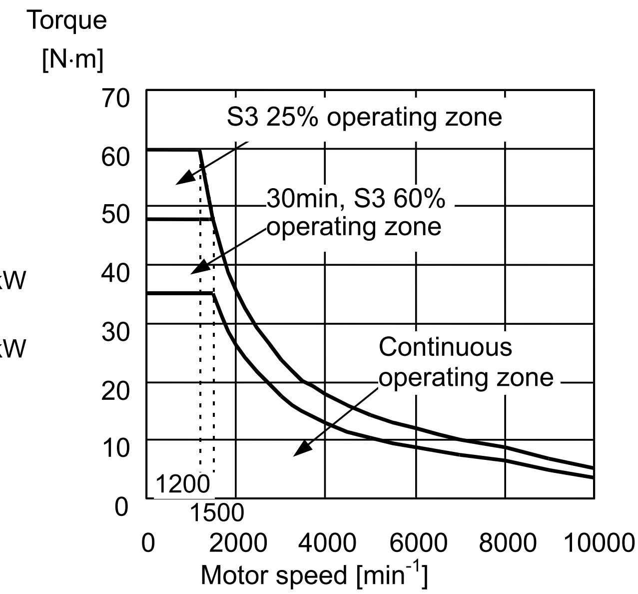




3.6 MODEL αiI 6/10000

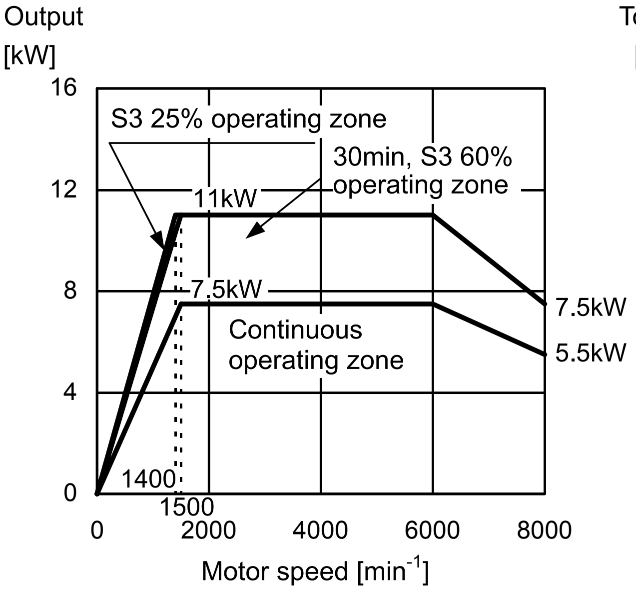
Applicable amplifier αiSP 11

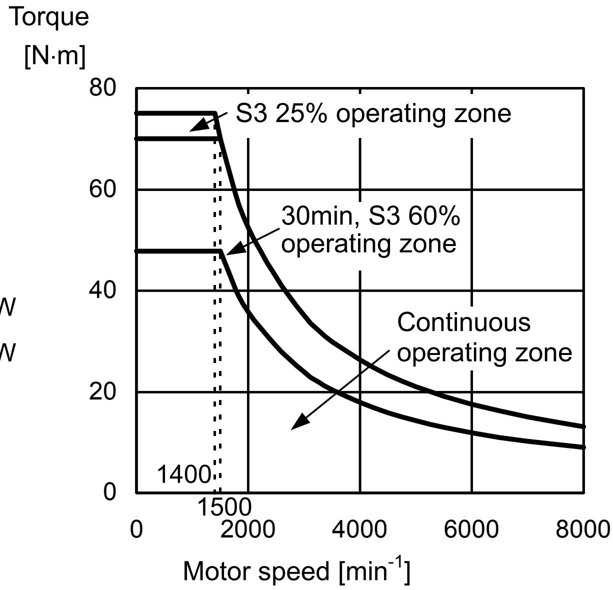




3.7 MODEL αiI 8/8000

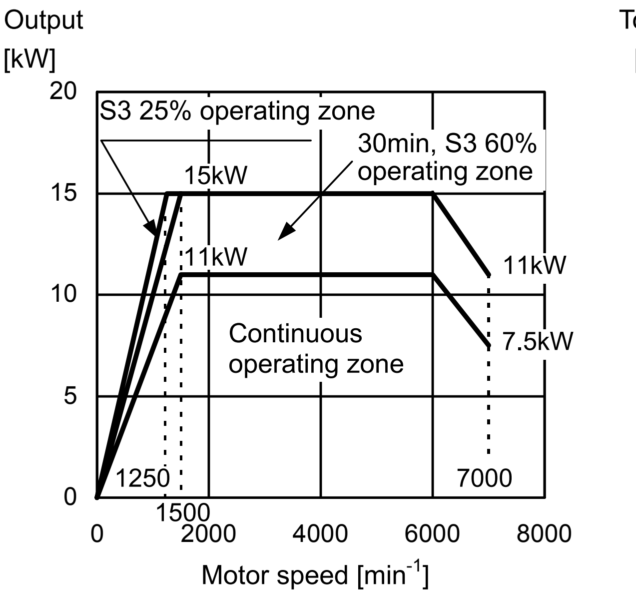
Applicable amplifier αiSP 11

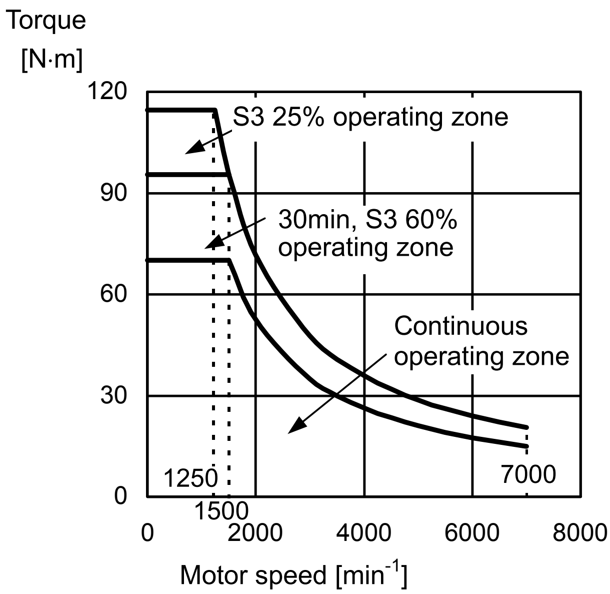




3.8 MODEL αiI 12/7000

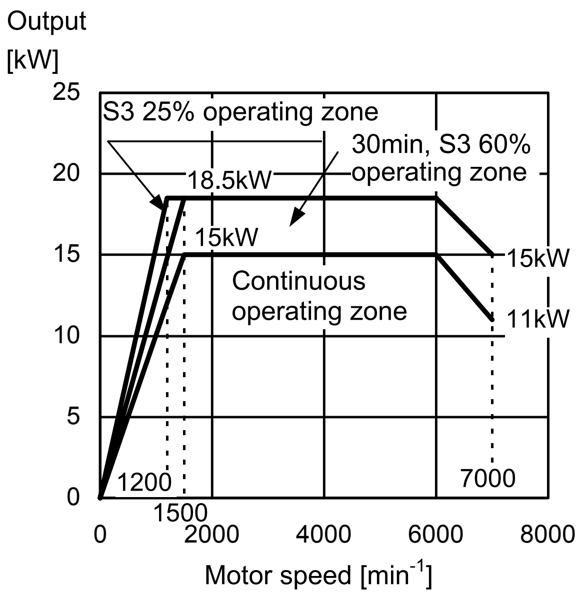
Applicable amplifier αiSP 15

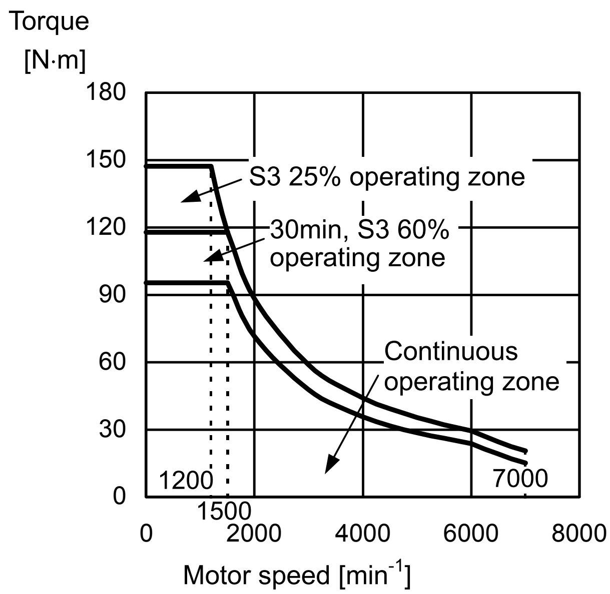




3.9 MODEL αiI 15/7000

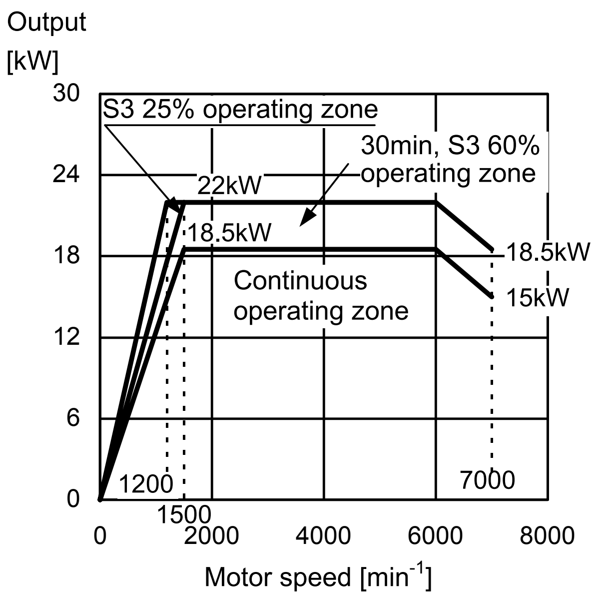
Applicable amplifier αiSP 22

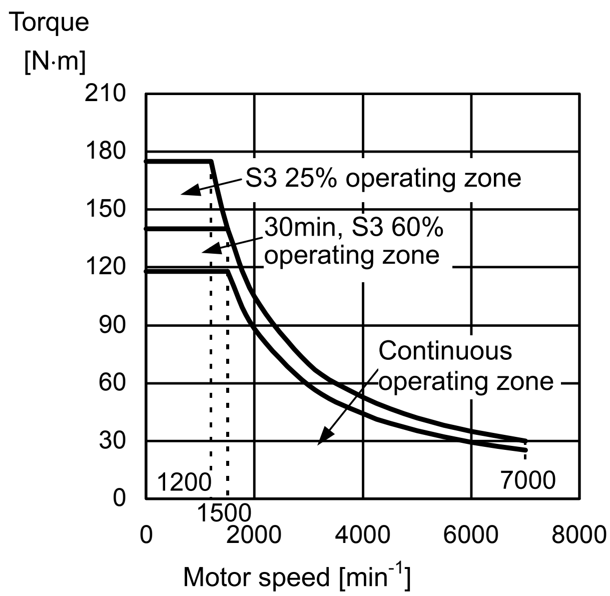




3.10 MODEL αiI 18/7000

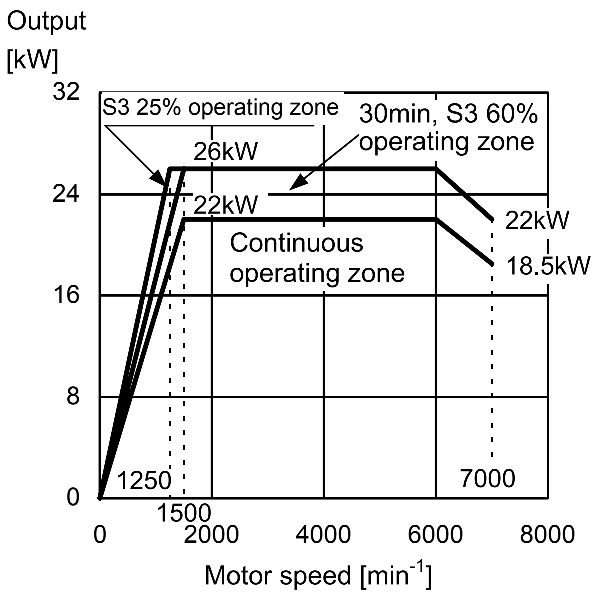
Applicable amplifier αiSP 22

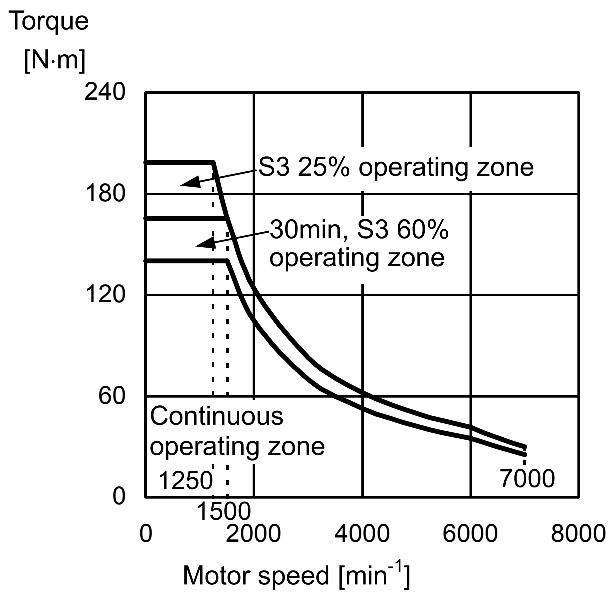




3.11 MODEL αiI 22/7000

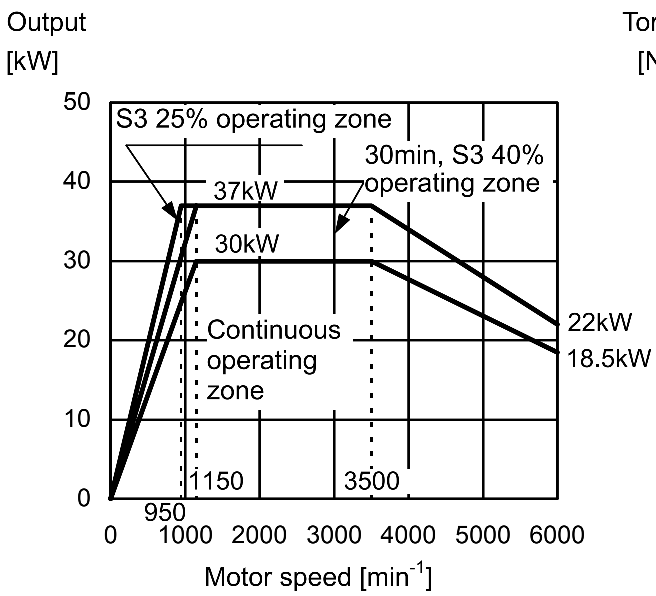
Applicable amplifier αiSP 26

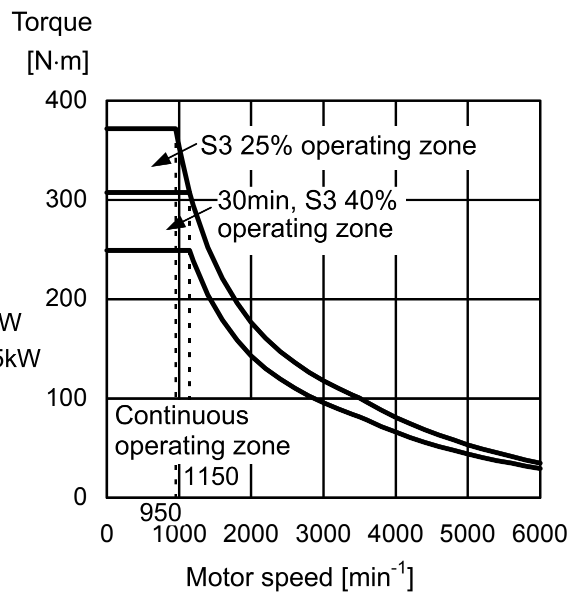




3.12 MODEL αiI 30/6000

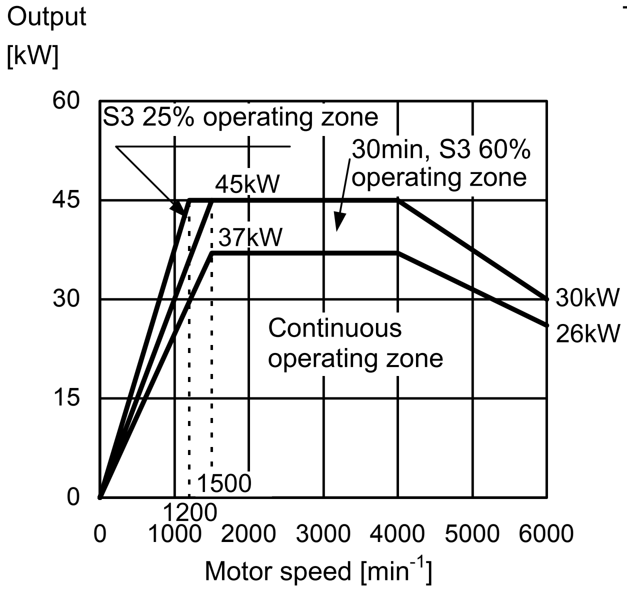
Applicable amplifier αiSP 45

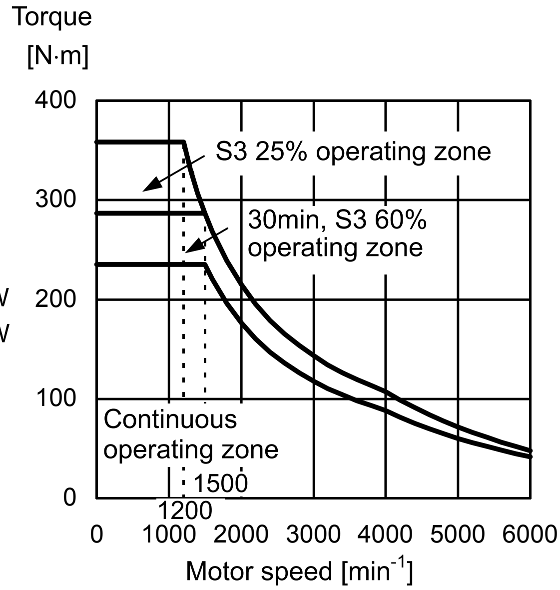




3.13 MODEL αiI 40/6000

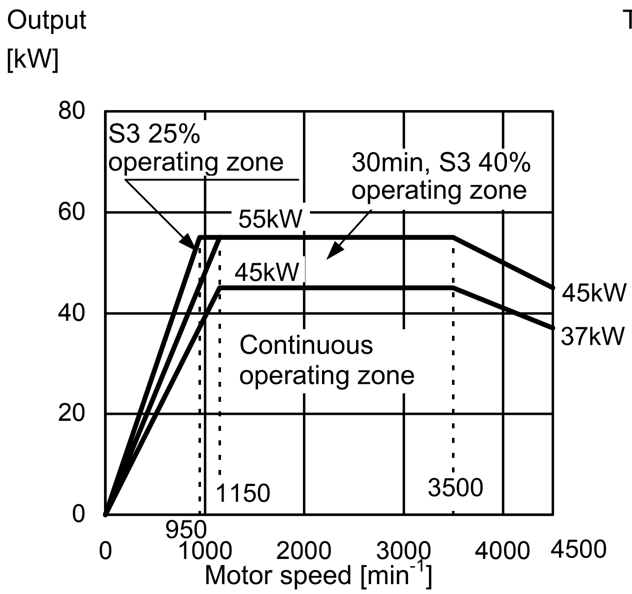
Applicable amplifier αiSP 45

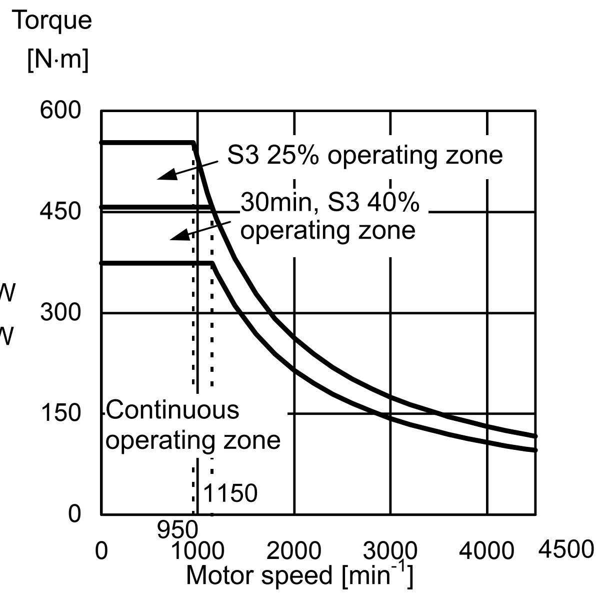




3.14 MODEL αiI 50/4500

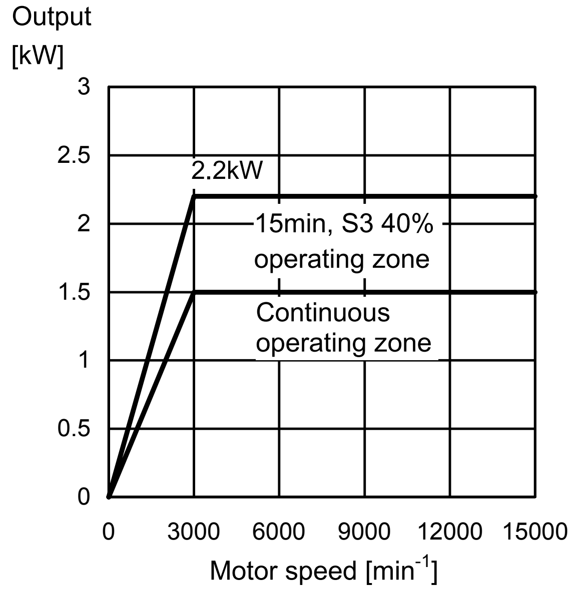
Applicable amplifier αiSP 55

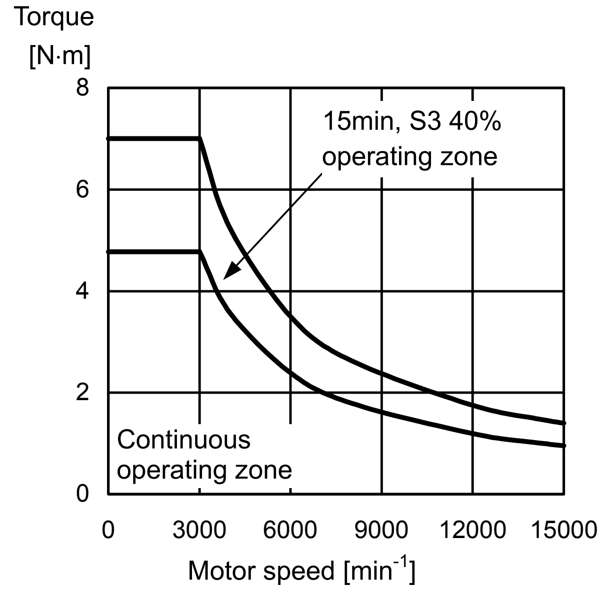


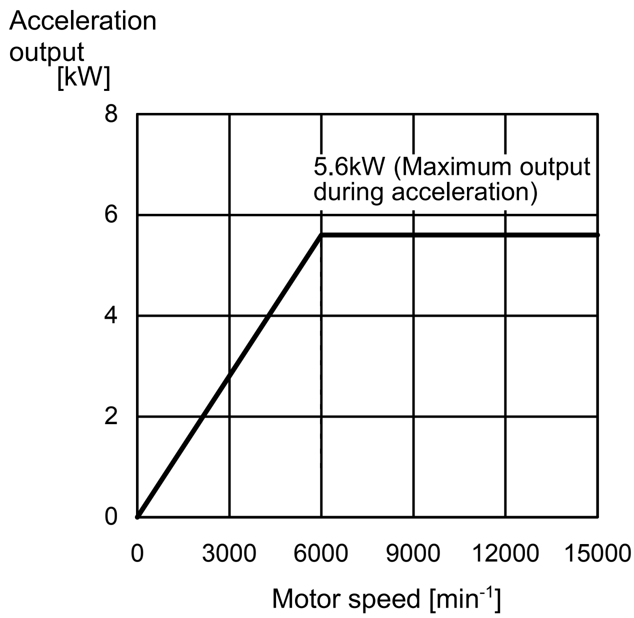


3.15 MODEL αiI 1/15000

Applicable amplifier αiSP 5.5



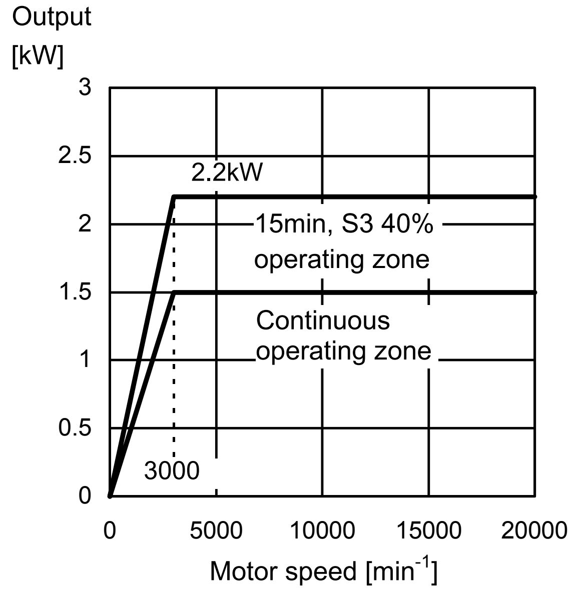


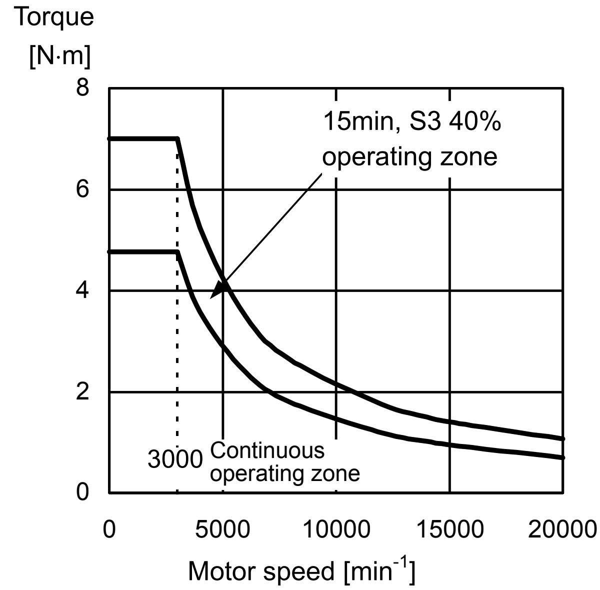


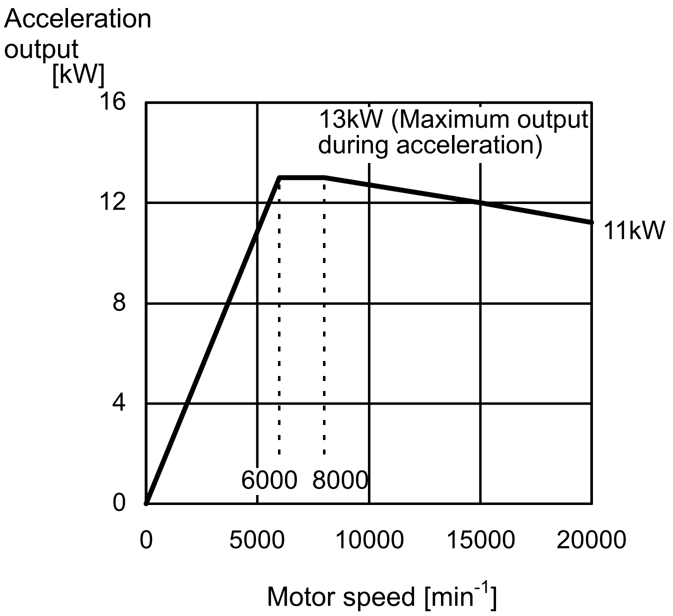
> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

3.16 MODEL αiI 1.5/20000

Applicable amplifier αiSP 15





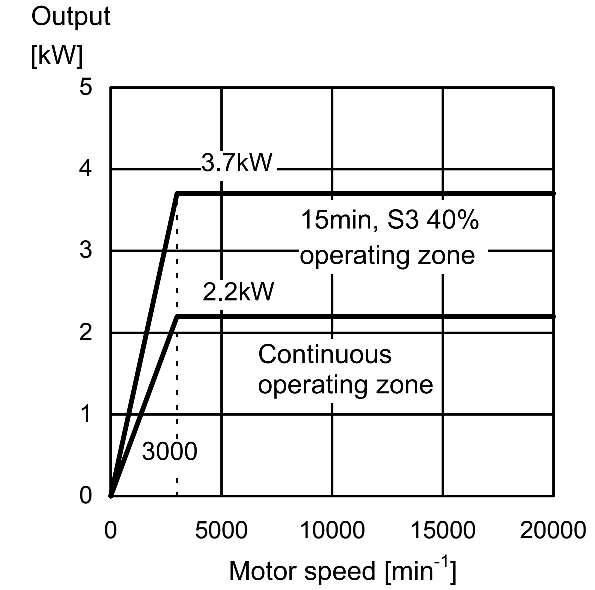


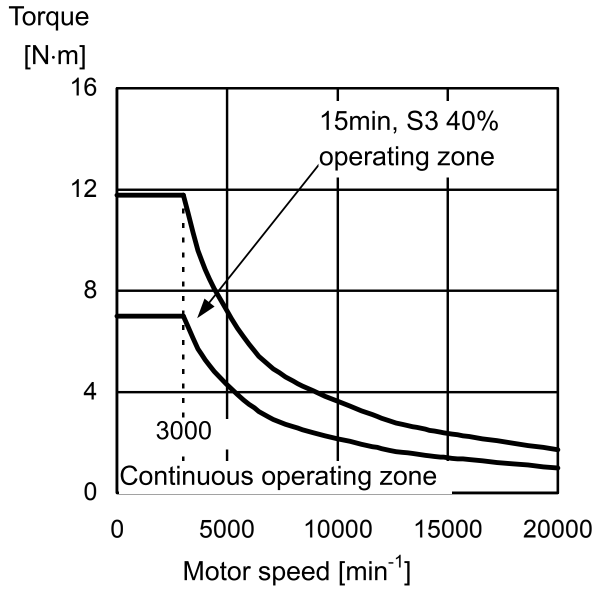
NOTE

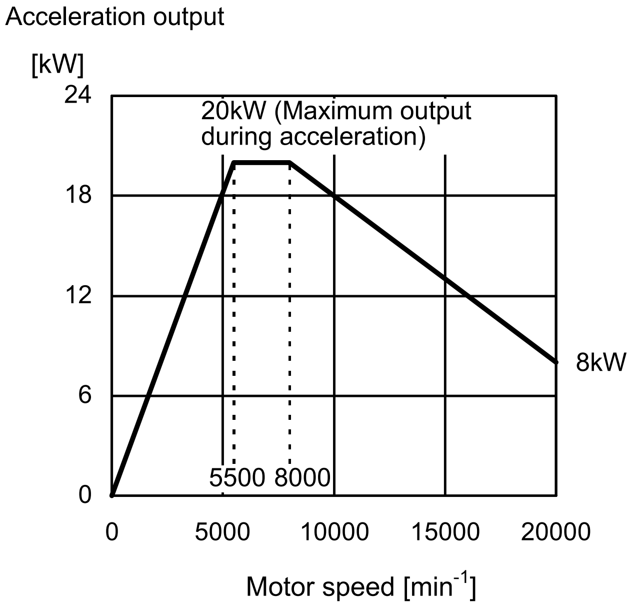
Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

3.17 MODEL αiI 2/20000

Applicable amplifier αiSP 22





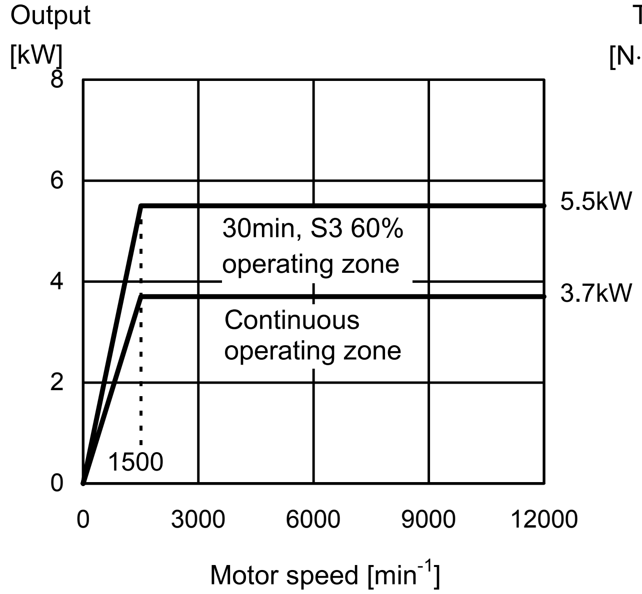


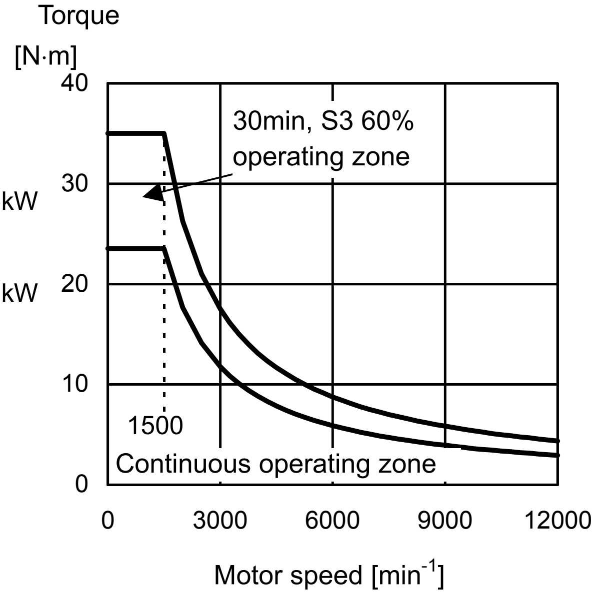
NOTE

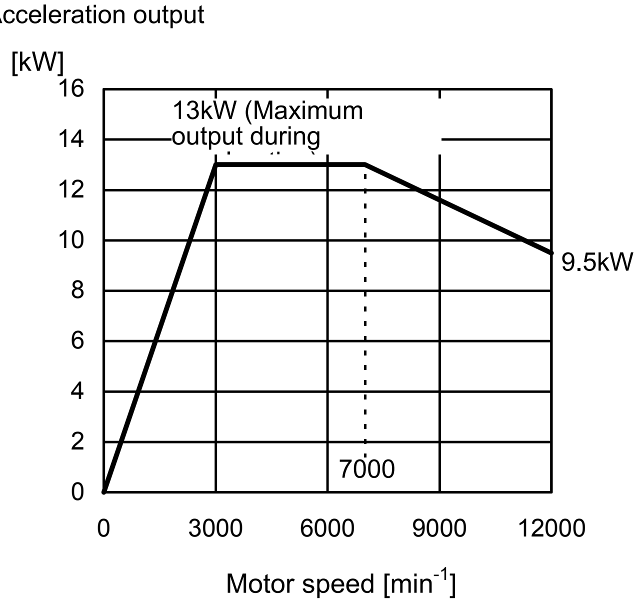
Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

3.18 MODEL αiI 3/12000

Applicable amplifier αiSP 11





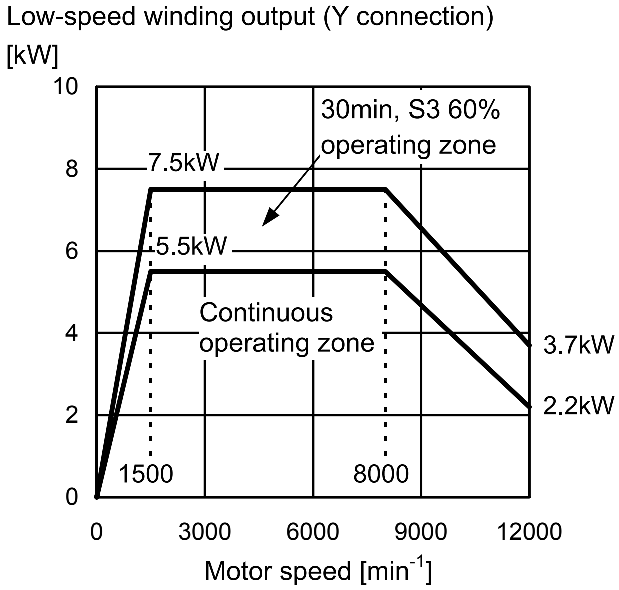


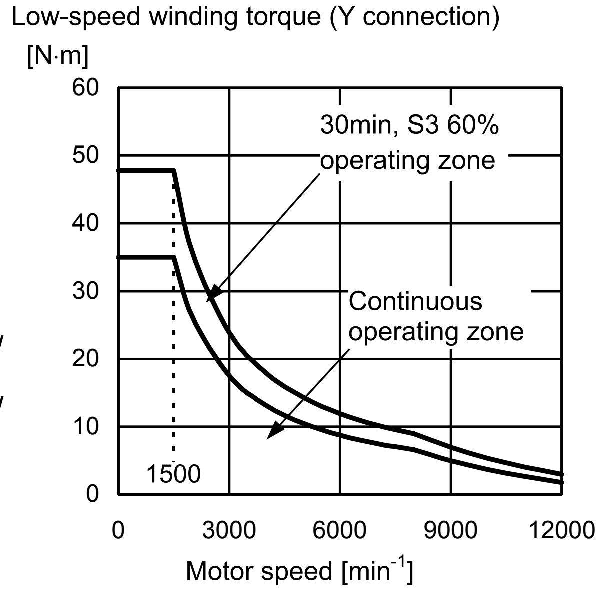
NOTE

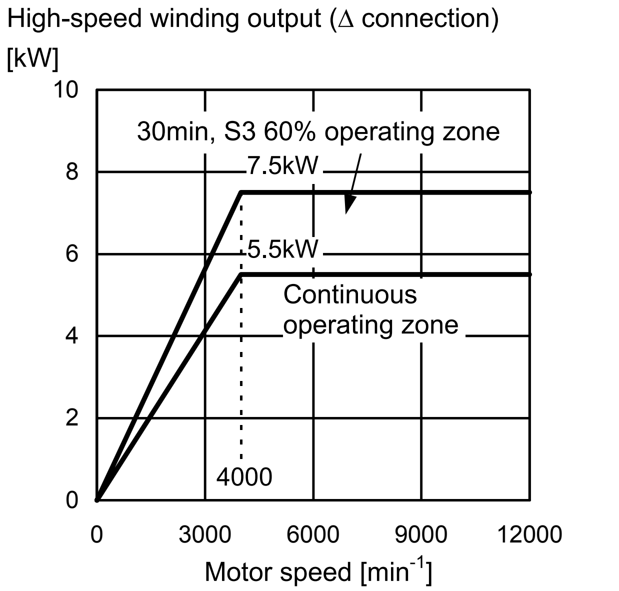
Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

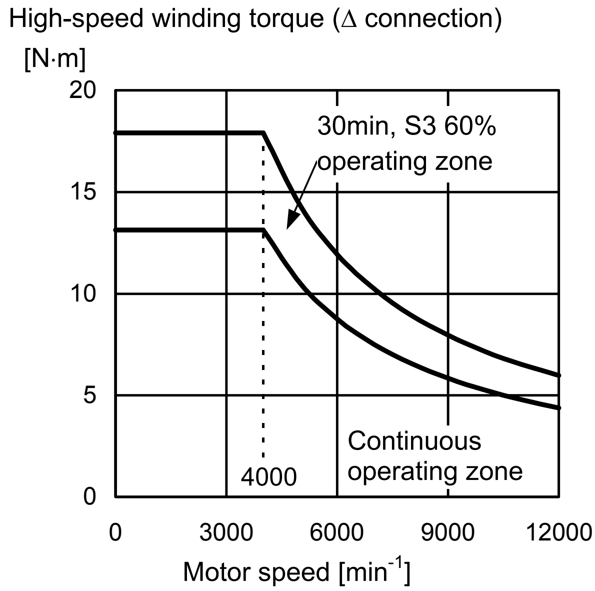
3.19 MODEL αiI 6/12000

Applicable amplifier αiSP 11



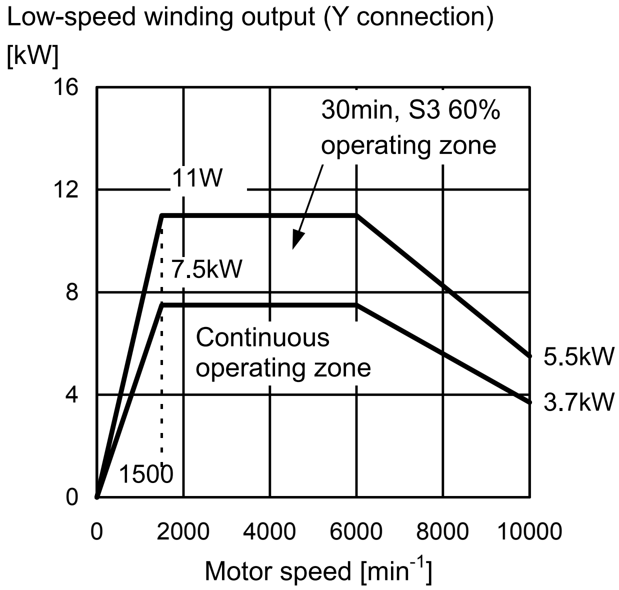


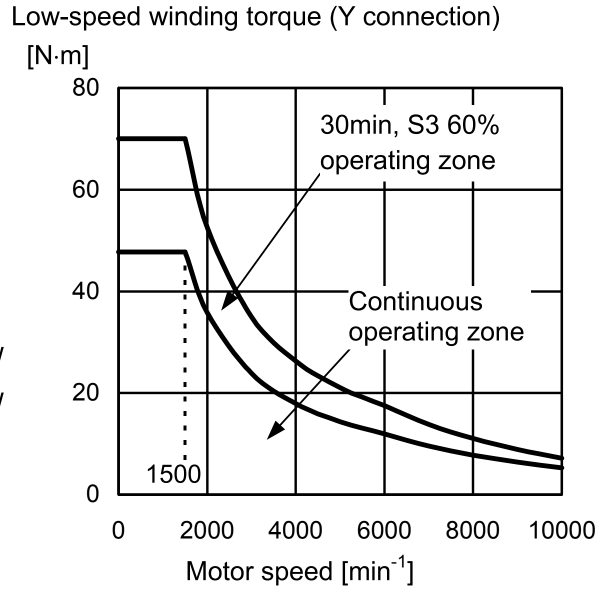


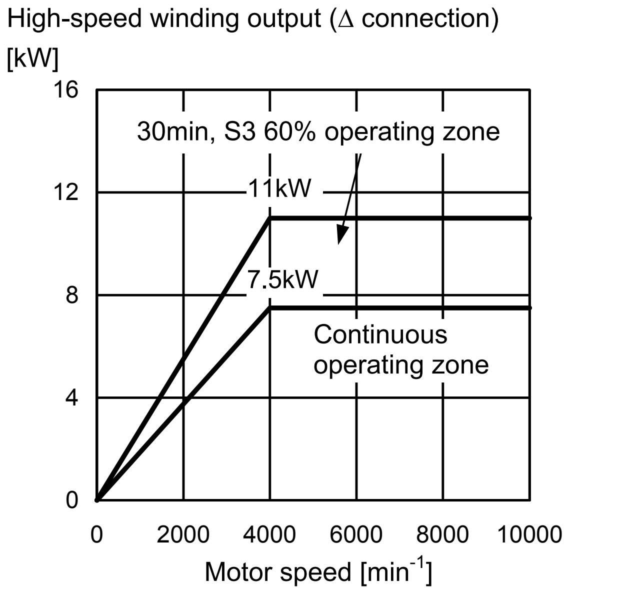


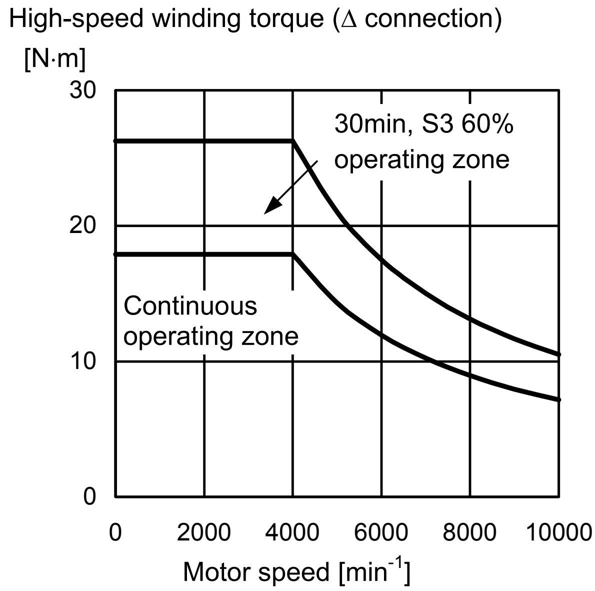
3.20 MODEL αiI 8/10000

Applicable amplifier αiSP 11





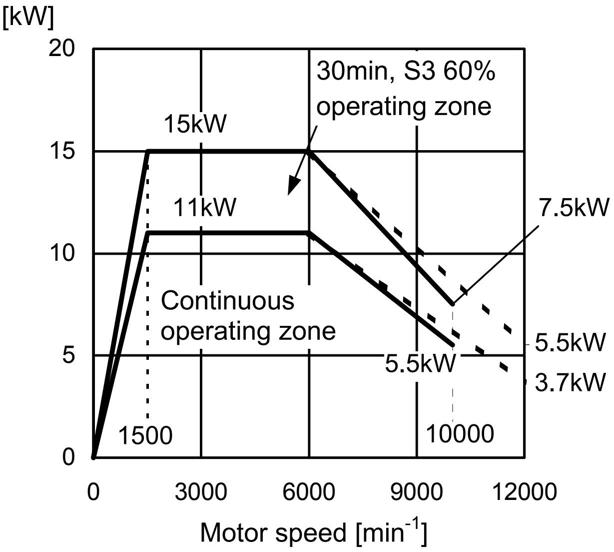




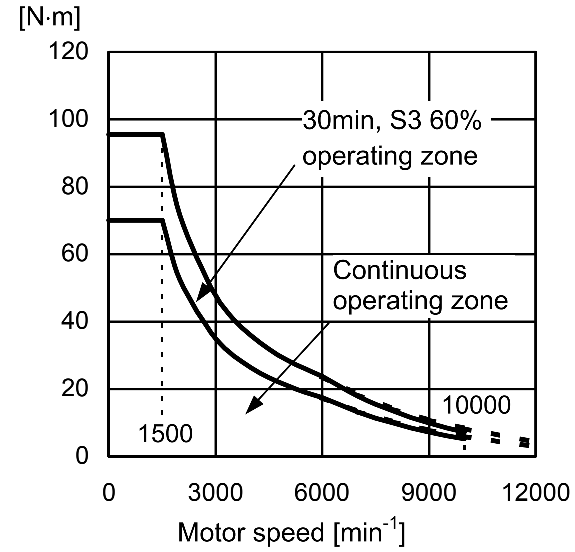
3.21 MODELS αiI 12/10000 AND αiI 12/12000

Applicable amplifier αiSP 15

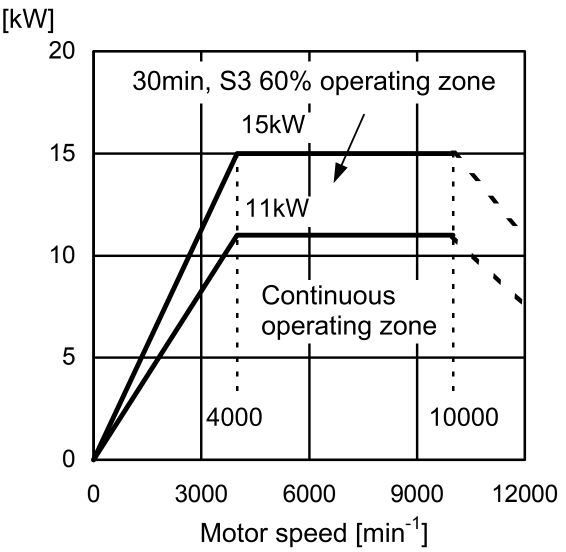
Low-speed winding output (Y connection)



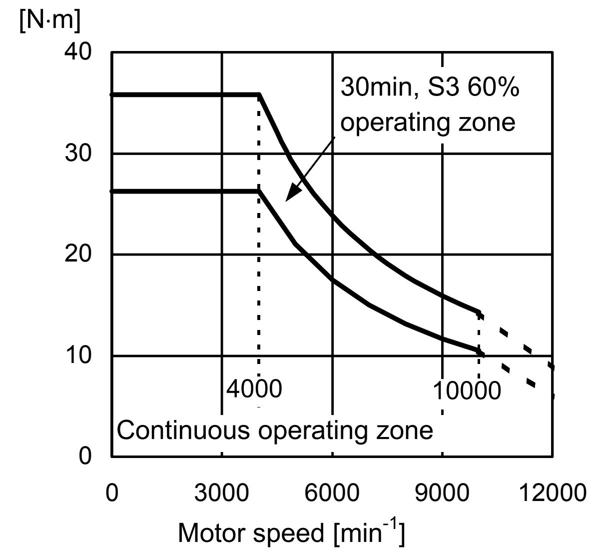
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



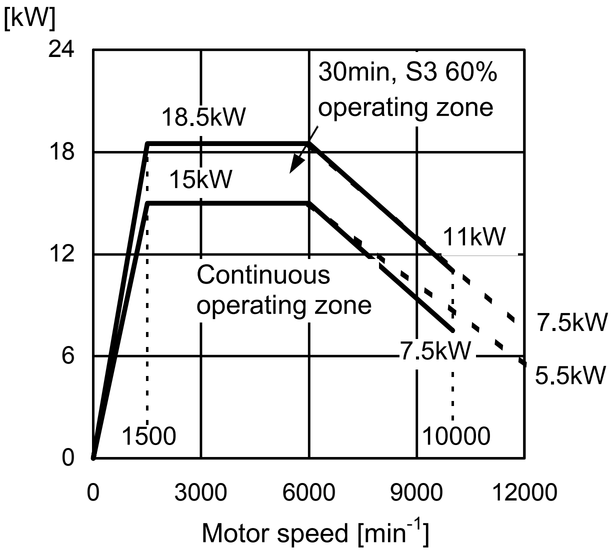
High-speed winding torque (Δ connection)



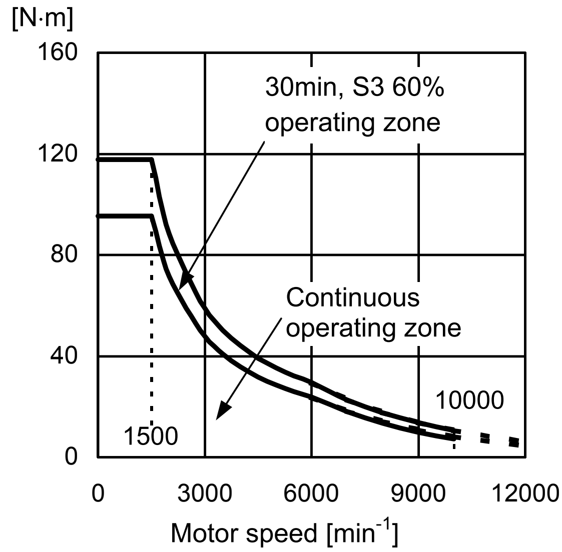
3.22 MODELS αiI 15/10000 AND αiI 15/12000

Applicable amplifier αiSP 22

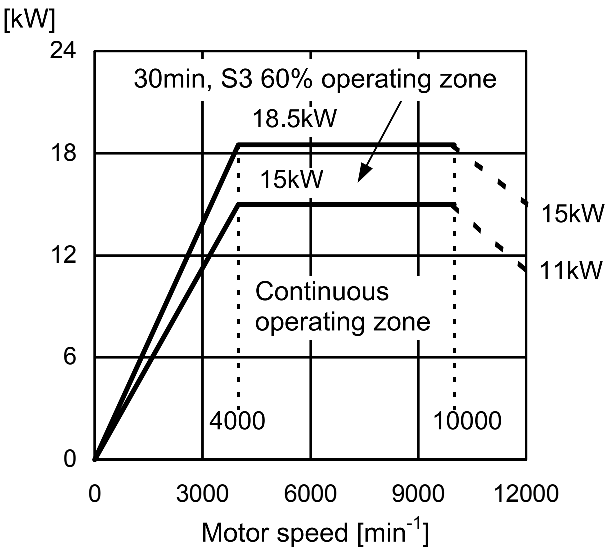
Low-speed winding output (Y connection)



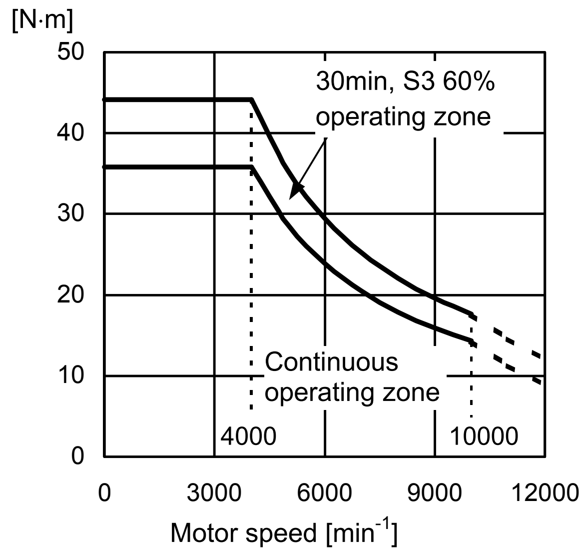
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

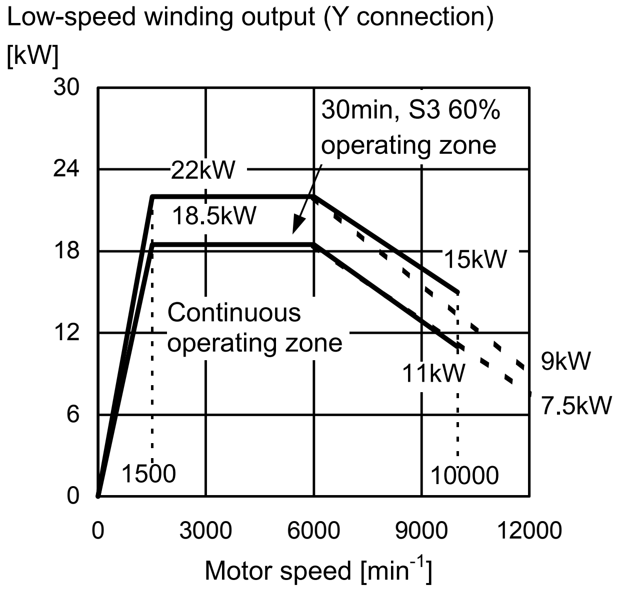


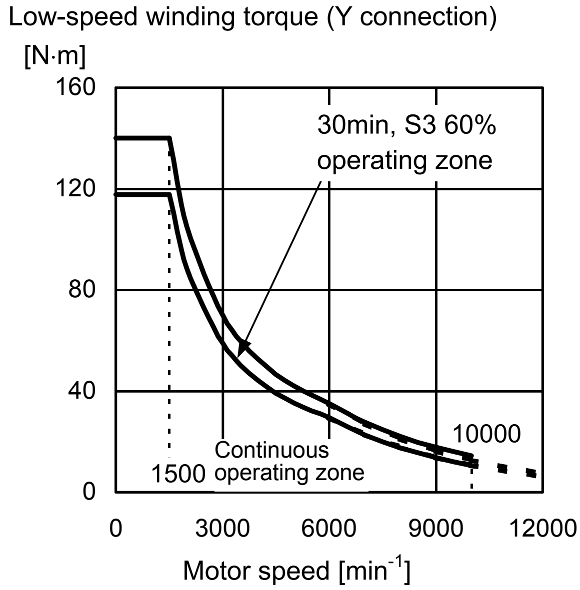
High-speed winding torque (Δ connection)

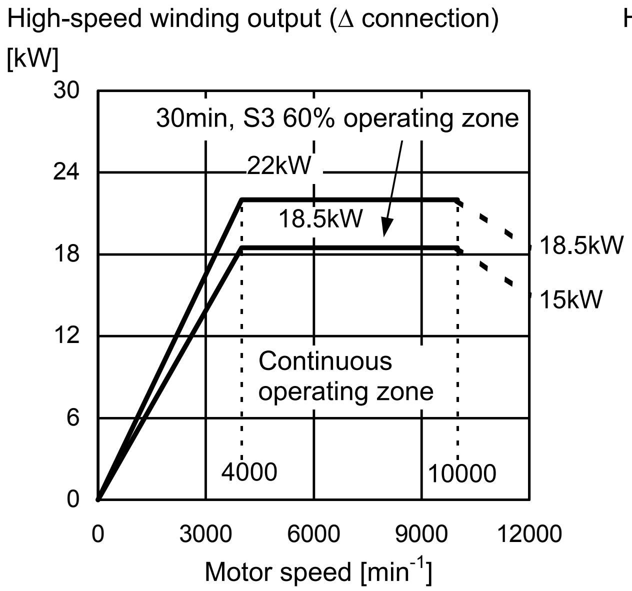


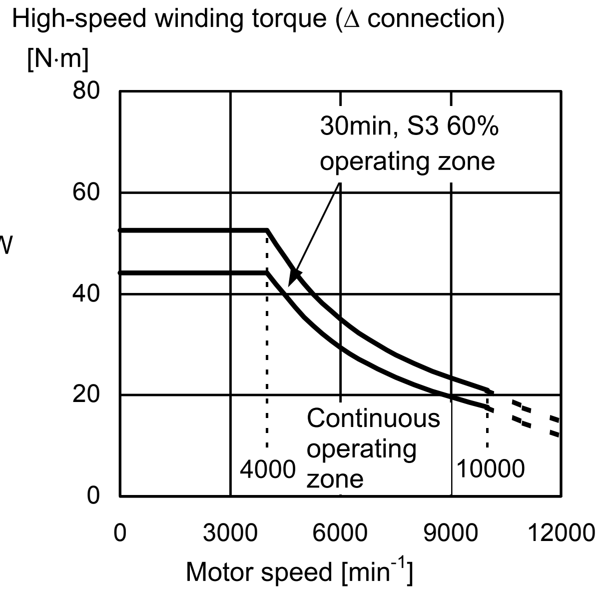
3.23 MODELS αiI 18/10000 AND αiI 18/12000

Applicable amplifier αiSP 22





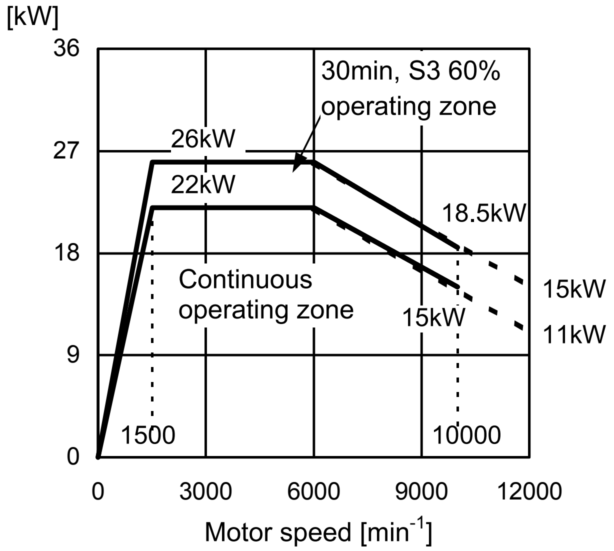




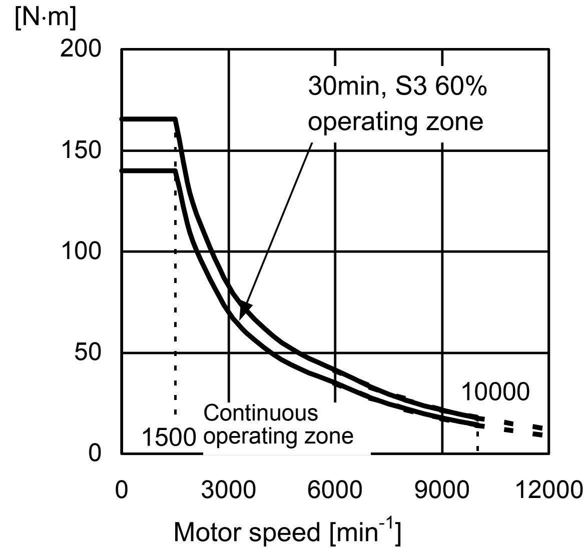
3.24 MODELS αiI 22/10000 AND αiI 22/12000

Applicable amplifier αiSP 26

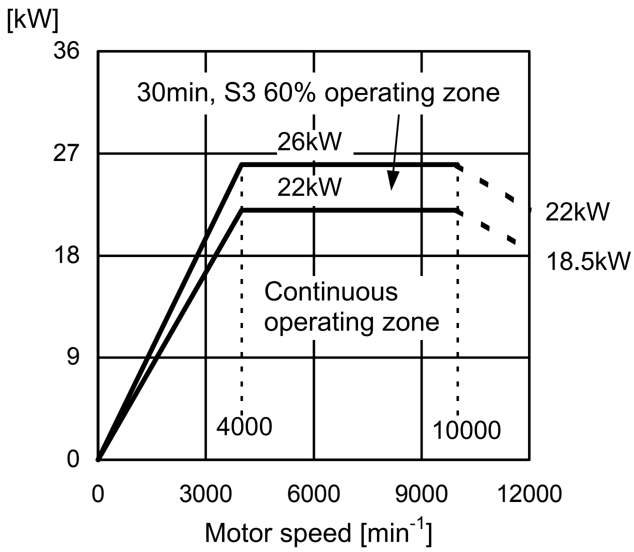
Low-speed winding output (Y connection)



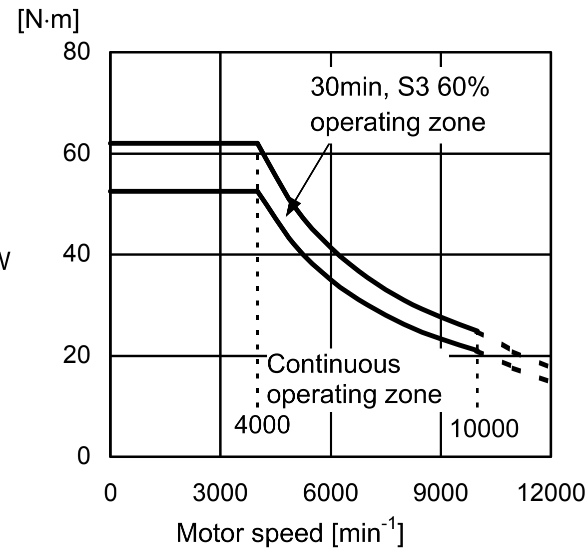
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



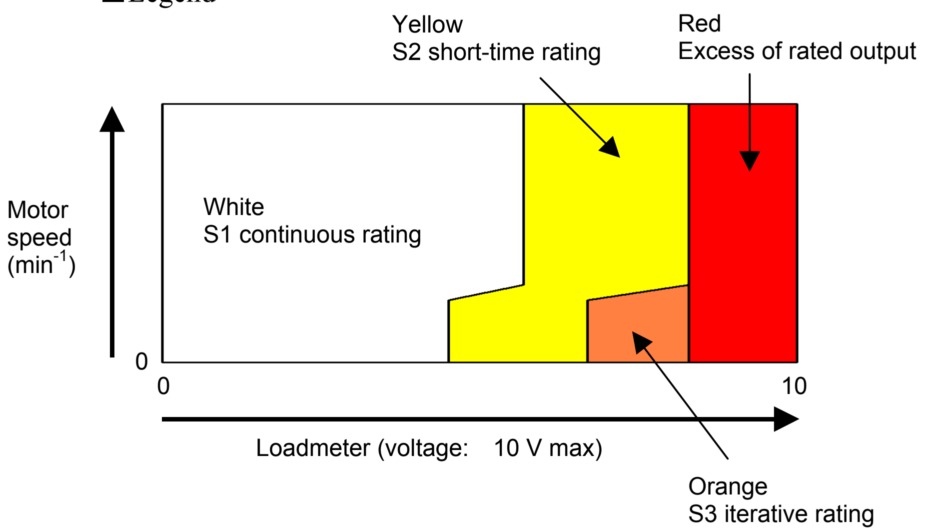
High-speed winding torque (Δ connection)



4 LOADMETER (DYNAMOMETER)

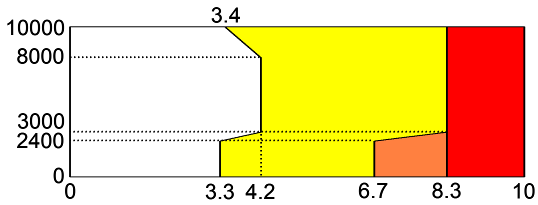
The loadmeter (dynamometer) shows the percentage of the load (load factor) to the maximum output that the motor can produce. At the maximum output, 10 V is output. It is output on pin 16 of the JY1 connector of the spindle amplifier (αiSP). (For details, refer to "FANUC SERVO AMPLIFIER αi series Descriptions" (B-65282EN).)

■Legend

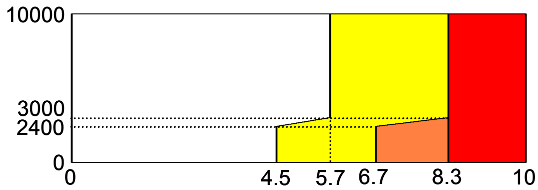


4.1 STANDARD TYPE

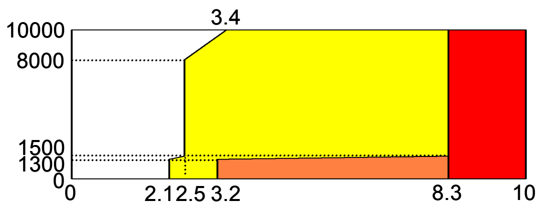
α*i*I 0.5/10000



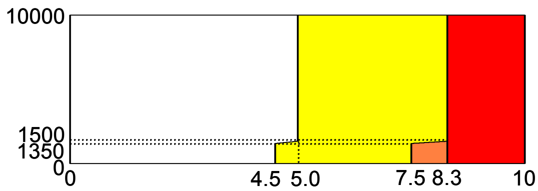
α*i*I 1/10000



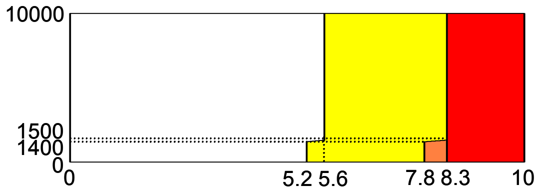
α*i*I 1.5/10000



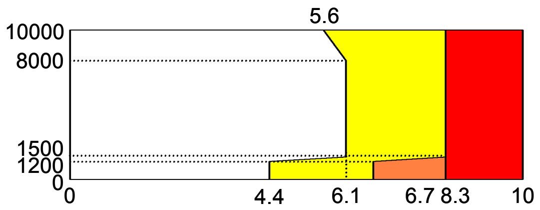
α*i*I 2/10000



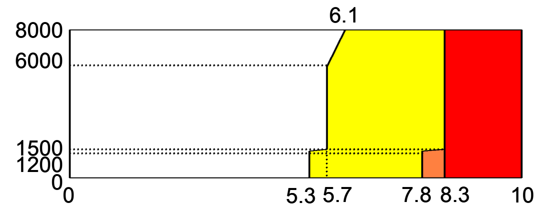
α*i*I 3/10000



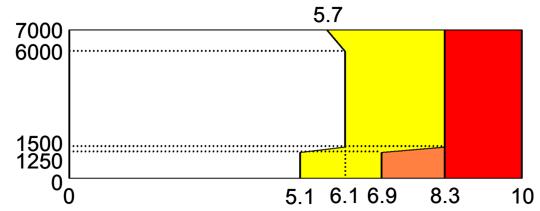
α*i*I 6/10000



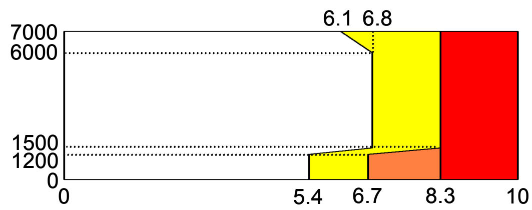
α*i*I 8/8000



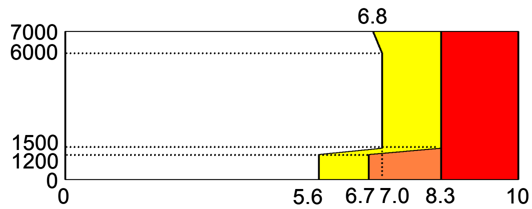
α*i*I 12/7000



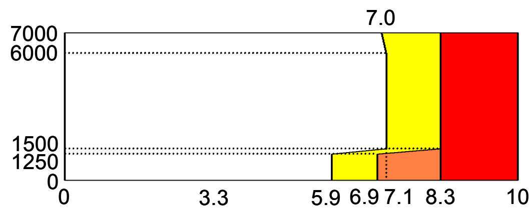
αiI 15/7000



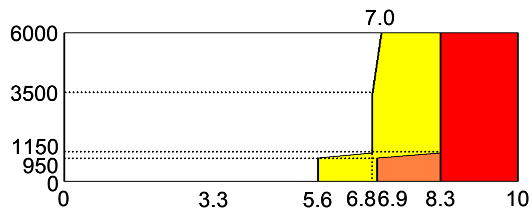
αiI 18/7000



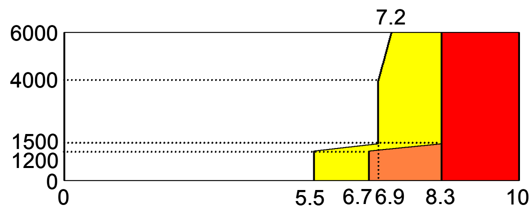
αiI 22/7000



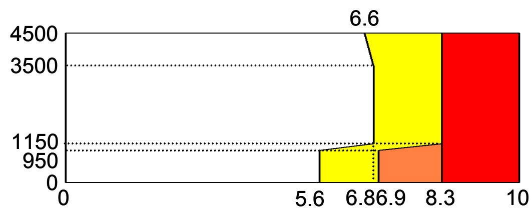
αiI 30/6000



α*i*I 40/6000



α*i*I 50/4500

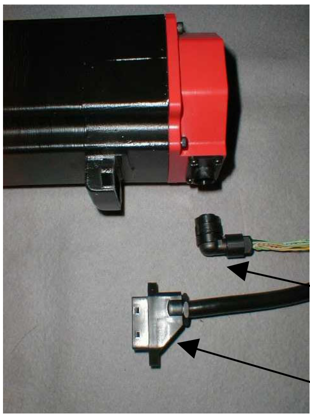


5 CONNECTIONS

5.1 MODEL α*i*I 0.5/10000

The power lead and signal lead are connected with the connector. Use the shield cable for the connection.

Refer to FANUC SERVO AMPLIFIER α*i* series DESCRIPTIONS (B-65282EN) for other respects in the connection.



Connection of power lead

Connector parts related to cable side

	Ordering number	Tyco Electronics AMP specification
Connector kit of power lead	A06B-6114-K220/S (FANUC specification : A63L-0001-0875/SC)	1473063-2

Power lead specification

Number of core	Conductor size	Grounding cable cross-section	Sheath diameter (Note)
4 or more	AWG16 to 18	ϕ1.8 to 2.8mm	ϕ10.4 to 11.4mm

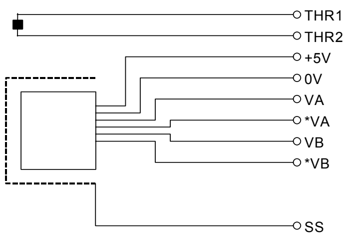
> **NOTE**
> If the outer sheath diameter is inadequate, the waterproofness can degrade.

Connector pins arrangement

1	2	3	4	5	6
U	V	W	G	-	-

Connection of signal lead

- For type with α*i*M sensor



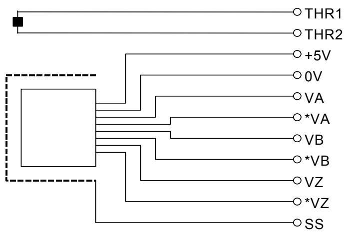
Connector parts related to cable side

	Japan Aviation Electronics Industry specification
Connector	JN2xS10SL1-R: Applicable sheath diameter φ5.7 to 7.3 JN2xS10SL2-R: Applicable sheath diameter φ6.5 to 8.0 ↑ D: Straight plug F: Elbow plug
Terminal	JN1-22-22S

Connector pins arrangement

1	2	3	
*VA	*VB	-	
4	5	6	7
VA	VB	-	0V
8	9	10	
+5V	THR1	THR2	

- For type with α*i*MZ sensor



Connector parts related to cable side

	Japan Aviation Electronics Industry specification
Connector	JN2xS10SL1-R: Applicable sheath diameter φ5.7 to 7.3 JN2xS10SL2-R:Applicable sheath diameter φ6.5 to 8.0 ↑ D: Straight plug F: Elbow plug
Terminal	JN1-22-22S

Connector pins arrangement

1	2	3	
*VA	*VB	*VZ	
4	5	6	7
VA	VB	VZ	0V
8	9	10	
+5V	THR1	THR2	

- 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 kΩ as measured at room temperature (20°C to 30°C).

5.2 MODELS αiI 1/10000 TO αiI 50/4500

Cables for power lead and fan motor are connected to the terminal block.

αiM sensor or αiMZ sensor signal or thermistor signal use a connector manufactured by Tyco Electronics AMP.

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

Size of screws used in the terminal block / Model	Power lead		Fan motor
	U,V,W,G	X,Y,Z	FMU,FMV,FMW
αiI 1/10000, αiI 1.5/10000	M5	-	M4
αiI 2/10000 to αiI 15/7000	M5	-	Screw-less terminal block
αiI 18/7000 to αiI 22/7000	M6	-	Screw-less terminal block
αiI 30/6000 to αiI 40/6000	M10	-	Screw-less terminal block
αiI 50/4500	M8	-	Screw-less terminal block
αiI 1/15000, αiI 1.5/20000	M5	-	M4
αiI 2/20000, αiI 3/12000	M5	-	Screw-less terminal block
αiI 6/12000 to αiI 15/10000	M5	M5	Screw-less terminal block
αiI 18/10000 to αiI 22/10000	M6	M6	Screw-less terminal block

Cable for the power lead

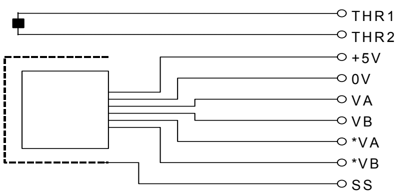
For the power lead cable specification, refer to "FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN)".

Cable for the fan motor

For the fan motor current value and cable specifications, refer to Section I.4.3, "FAN MOTOR CONNECTION" in this manual.

5.3 CONNECTION OF SIGNAL LEAD

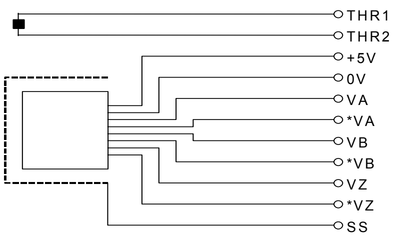
Connector attachment for a motor with a built-in αiM sensor



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		*VA	*VB		0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	VA	VB		SS	THR1

Connector attachment for a motor with a built-in αiMZ sensor



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		*VA	*VB	*VZ	0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	VA	VB	VZ	SS	THR1

- Connector housing and contact specifications

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

	Motor side		Cable side	
	FANUC specification	Manufacture specification	FANUC specification	Manufacture 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 kΩ as measured at room temperature (20°C to 30°C).

6 ALLOWABLE RADIAL LOAD

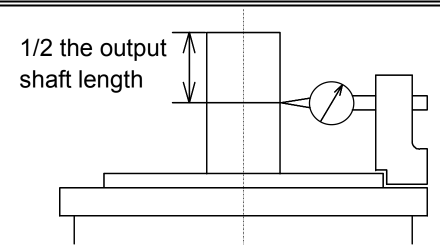
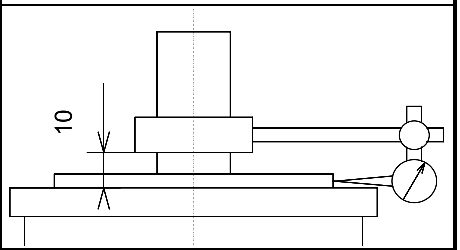
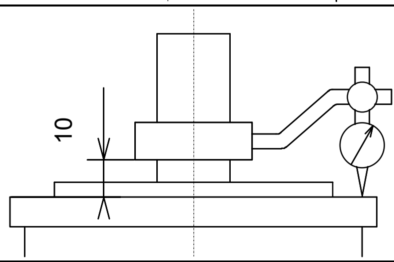
Use the motor output shaft below the allowable radial loads shown in the table below.

Model	Allowable radial load (kgf)	
	At output shaft end	At output shaft center
αiI 0.5/10000	294N (30kgf)	323N (33kgf)
αiI 1/10000	392N (40kgf)	441N (45kgf)
αiI 1.5/10000	882N (90kgf)	980N (100kgf)
αiI 2/10000	882N (90kgf)	999N (102kgf)
αiI 3/10000	1470N (150kgf)	1607N (164kgf)
αiI 6/10000	1960N (200kgf)	2205N (225kgf)
αiI 8/8000	2940N (300kgf)	3371N (344kgf)
αiI 12/7000, αiI 15/7000	2940N (300kgf)	3410N (348kgf)
αiI 18/7000, αiI 22/7000	4410N (450kgf)	4988N (509kgf)
αiI 30/6000, αiI 40/6000	5390N (550kgf)	6134N (626kgf)
αiI 50/4500	1078N (1100 kgf)	1230N (1255 kgf)
αiI 1/15000, αiI 1.5/20000	Direct connection to the spindle	
αiI 2/20000		
αiI 3/12000	980N (100kgf)	1068N (109kgf)
αiI 6/12000	1470N (150kgf)	1656N (169kgf)
αiI 8/10000	1960N (200kgf)	2244N (229kgf)
αiI 12/10000, αiI 12/12000 αiI 15/10000, αiI 15/12000	2450N (250kgf)	2842N (290kgf)
αiI 18/10000, αiI 18/12000 αiI 22/10000, αiI 22/12000	2940N (300kgf)	3332N (340kgf)

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. If a thrust load is applied when a helical gear is used, the shaft moves in the direction of the thrust. So, as a general rule, never apply a thrust load.

7 ASSEMBLING ACCURACY

Item \ Model	**αiI 0.5 to αiI 22**	**αiI 30 to αiI 50**	**αiI 1/15000 to αiI 2/20000, αiI 12/12000 to αiI 22/12000**	**Measuring method**
Run-out at the end of the output shaft	20μm or less	20μm or less	10μm or less	
Run-out of the faucet joint for mounting the flange against the core of the shaft (only for flange type)	40μm or less	60μm or less	30μm or less	
Run-out of the flange mounting surface against the core of the shaft (only for flange type)	80μm or less	100μm or less	40μm or less	

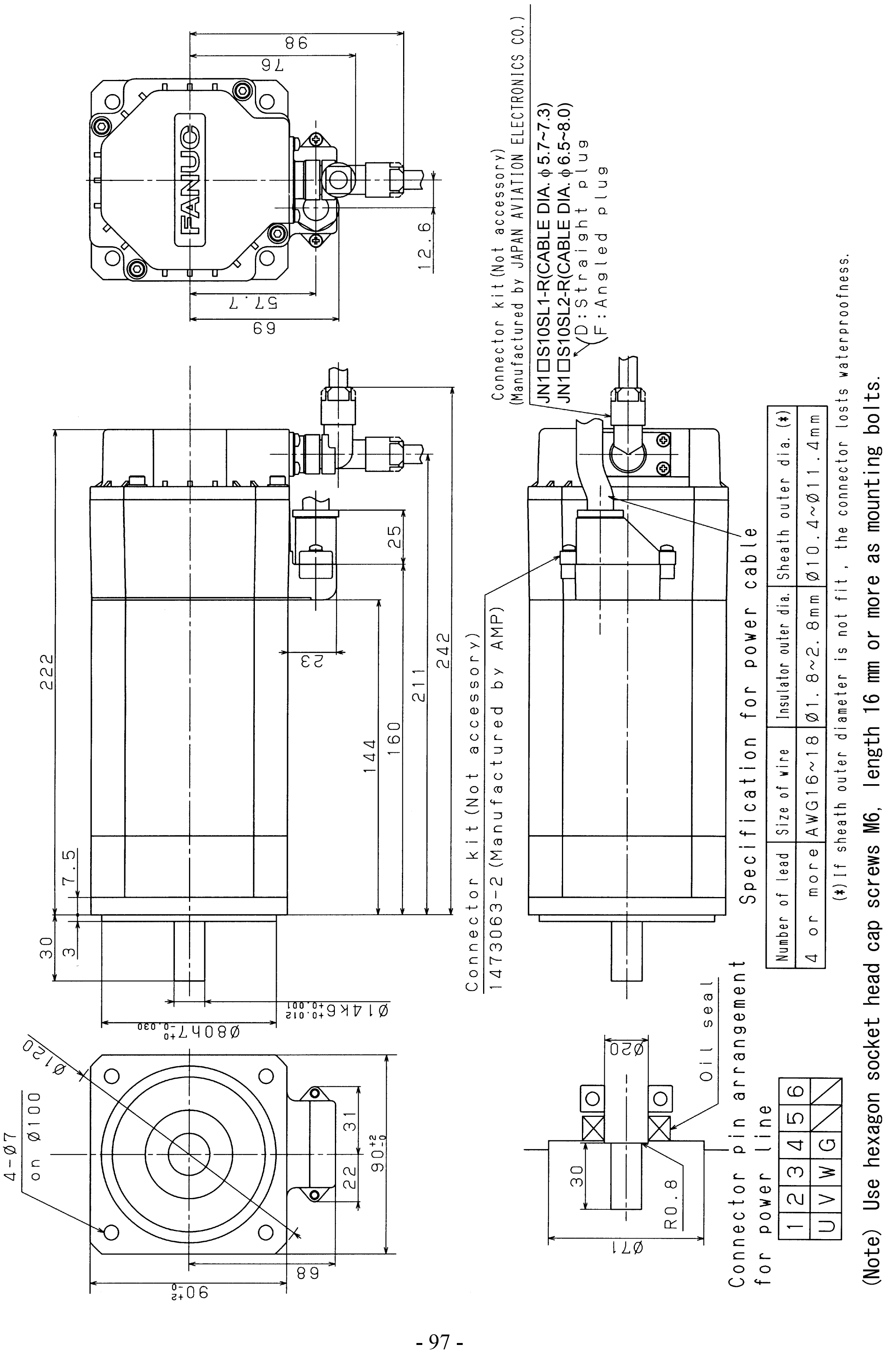
⚠ CAUTION

Except for αiI 1/15000 to αiI 2/15000, the assembling accuracies of high-speed models are the same as those of the standard models shown above.

8 EXTERNAL DIMENSIONS

Model name	Section
Model α*i*I 0.5/10000 (flange mounting type)	8.1
Models α*i*I 1/10000 and α*i*I 1/15000 (flange mounting type)	8.2
Model α*i*I 1/10000 (foot mounting type)	8.3
Model α*i*I 1.5/10000 (flange mounting type)	8.4
Model α*i*I 1.5/20000 (flange mounting type)	8.5
Model α*i*I 1.5/10000 (foot mounting type)	8.6
Model α*i*I 2/10000 (flange mounting type)	8.7
Model α*i*I 2/20000 (flange mounting type)	8.8
Model α*i*I 2/10000 (foot mounting type)	8.9
Models α*i*I 3/10000 and α*i*I 3/12000 (flange mounting type)	8.10
Model α*i*I 3/10000 (foot mounting type)	8.11
Models α*i*I 6/10000 and α*i*I 6/12000 (flange mounting type)	8.12
Model α*i*I 6/10000 (foot mounting type)	8.13
Models α*i*I 8/8000 and α*i*I 8/10000 (flange mounting type)	8.14
Model α*i*I 8/8000 (foot mounting type)	8.15
Models α*i*I 12/7000, α*i*I 12/10000, and α*i*I 12/12000 (flange mounting type)	8.16
Model α*i*I 12/7000 (foot mounting type)	8.17
Models α*i*I 15/7000, α*i*I 15/10000, and α*i*I 15/12000 (flange mounting type)	8.18
Model α*i*I 15/7000 (foot mounting type)	8.19
Models α*i*I 18/7000, α*i*I 18/10000, and α*i*I 18/12000 (flange mounting type)	8.20
Model α*i*I 18/7000 (foot mounting type)	8.21
Models α*i*I 22/7000, α*i*I 22/10000, and α*i*I 22/12000 (flange mounting type)	8.22
Model α*i*I 22/7000 (foot mounting type)	8.23
Model α*i*I 30/6000 (flange mounting type)	8.24
Model α*i*I 30/6000 (foot mounting type)	8.25
Model α*i*I 40/6000 (flange mounting type)	8.26
Model α*i*I 40/6000 (foot mounting type)	8.27
Model α*i*I 50/4500 (flange mounting type)	8.28
Model α*i*I 50/4500 (foot mounting type)	8.29

8.1 MODEL αiI 0.5/10000 (FLANGE MOUNTING TYPE)

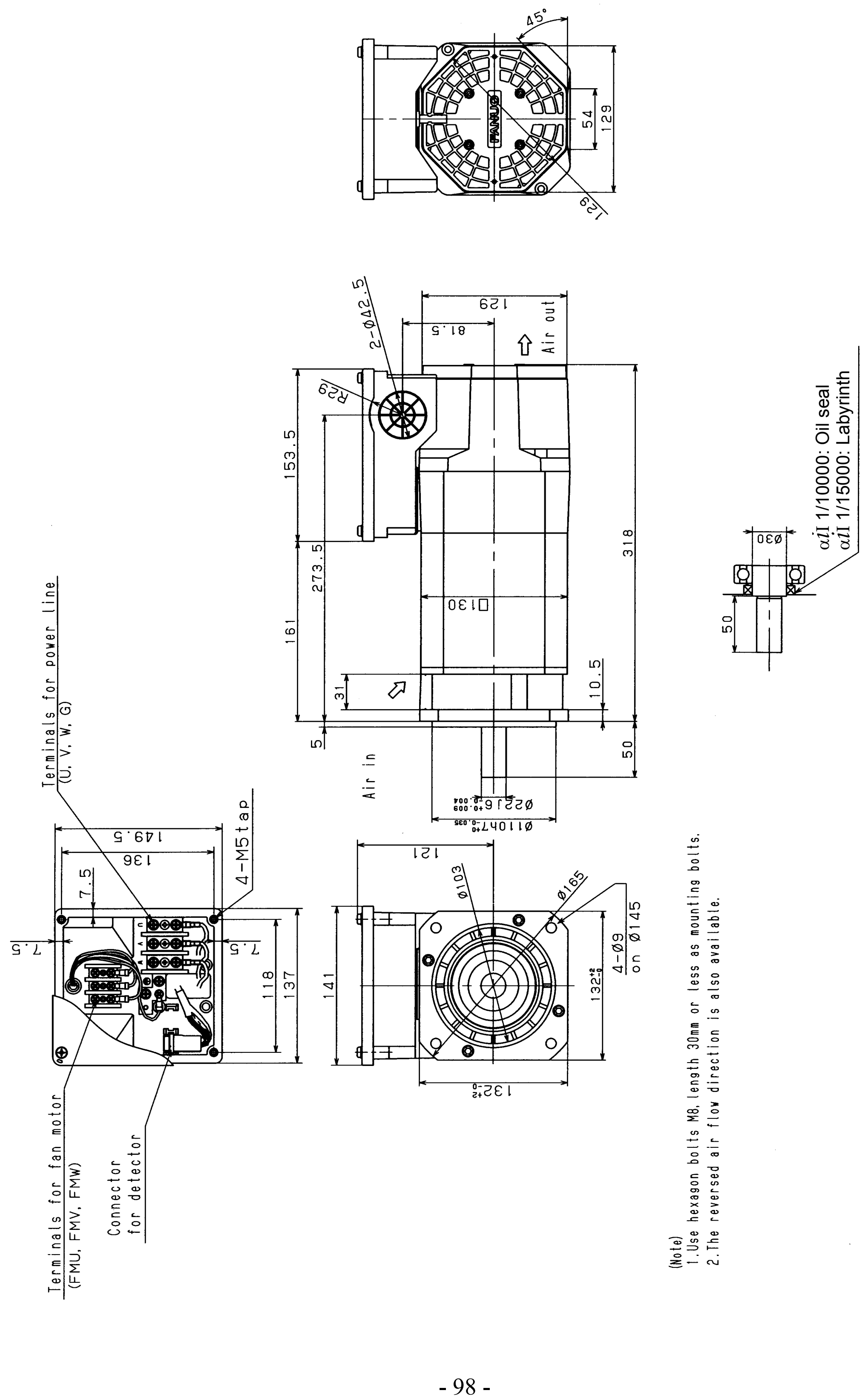


Number of lead	Size of wire	Insulator outer dia.	Sheath outer dia. (*)
4 or more	AWG16~18	Ø1.8~2.8mm	Ø10.4~Ø11.4mm

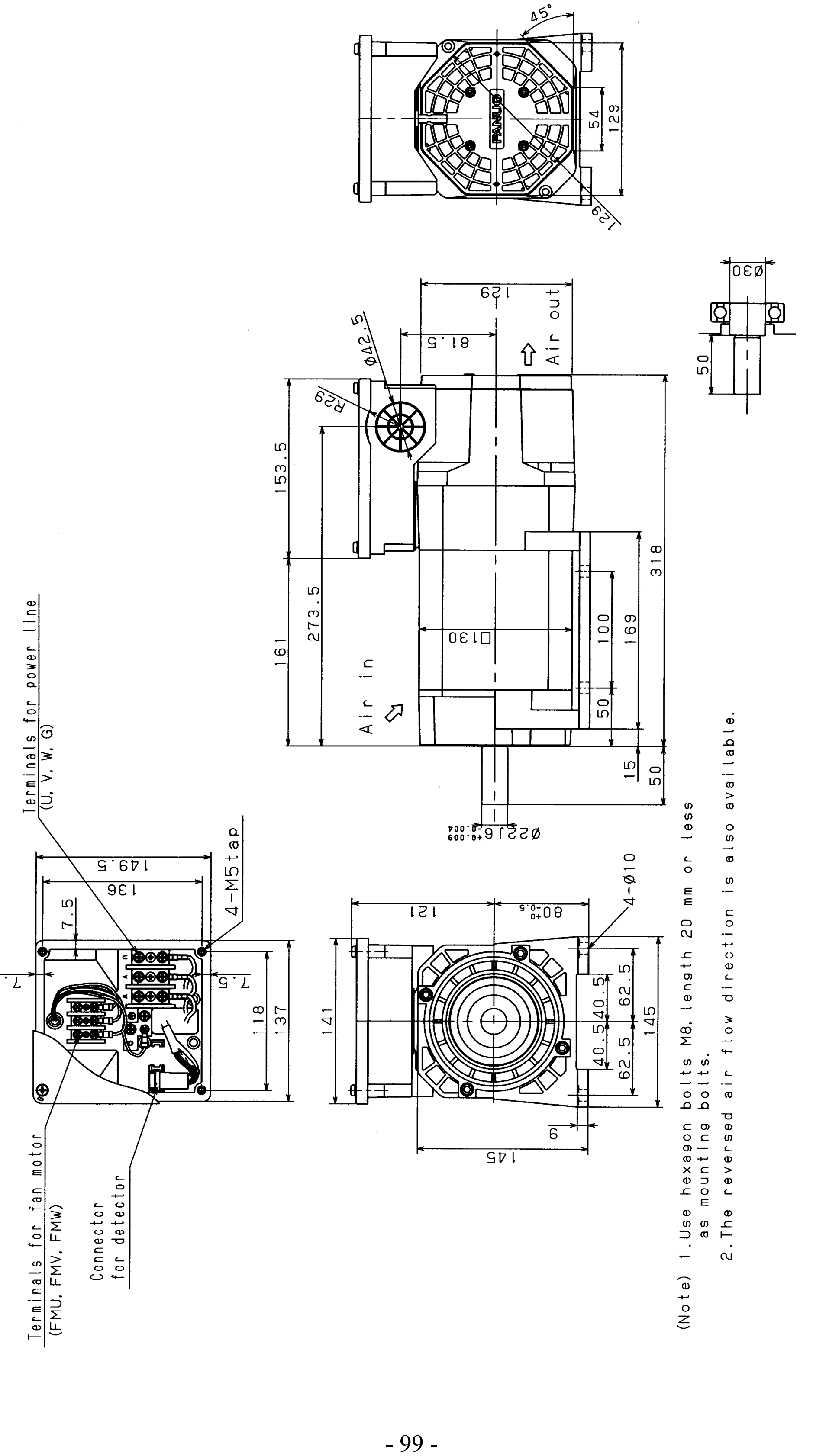
(*) If sheath outer diameter is not fit, the connector losts waterproofness.

(Note) Use hexagon socket head cap screws M6, length 16 mm or more as mounting bolts.

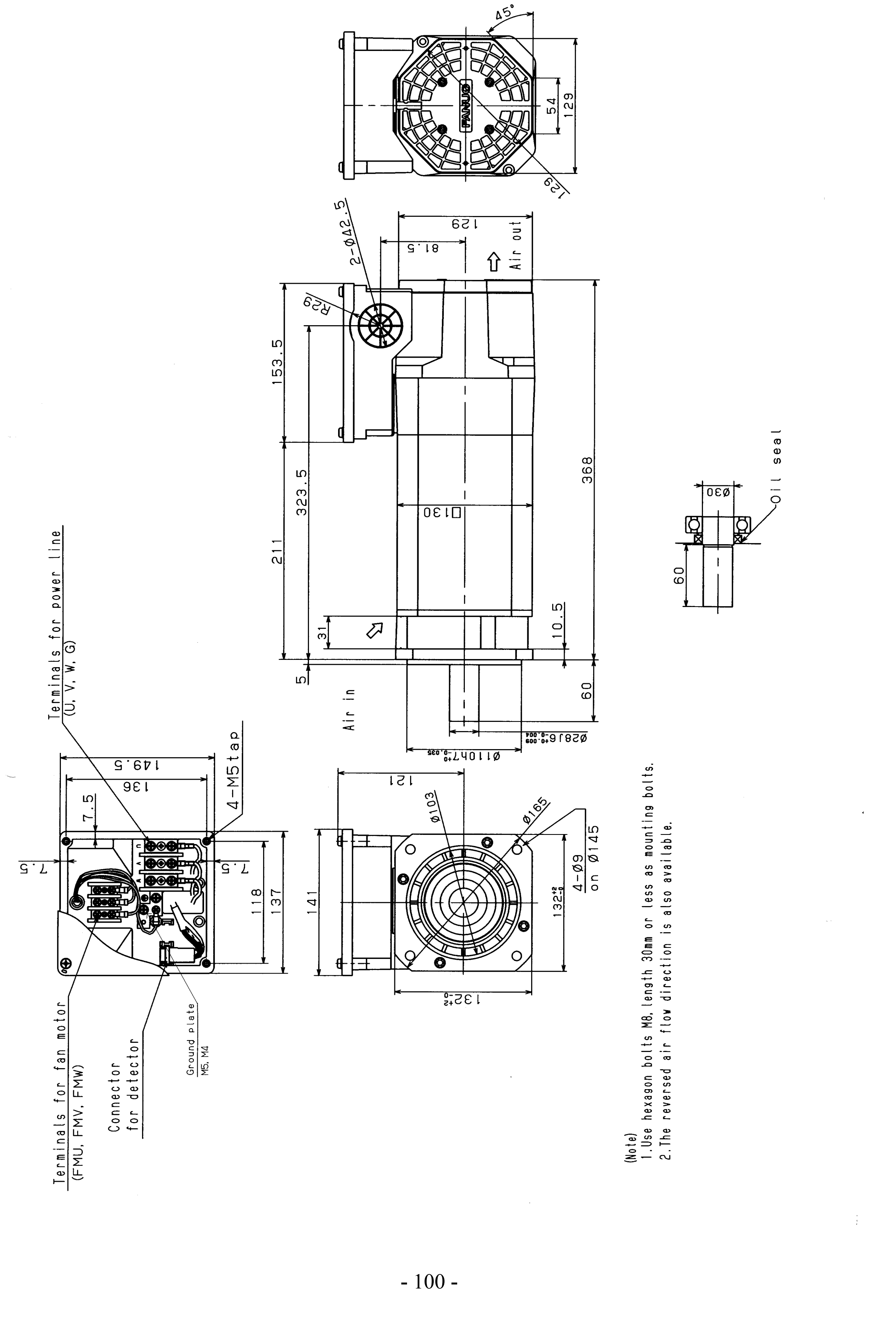
8.2 MODELS αiI 1/10000 AND αiI 1/15000 (FLANGE MOUNTING TYPE)



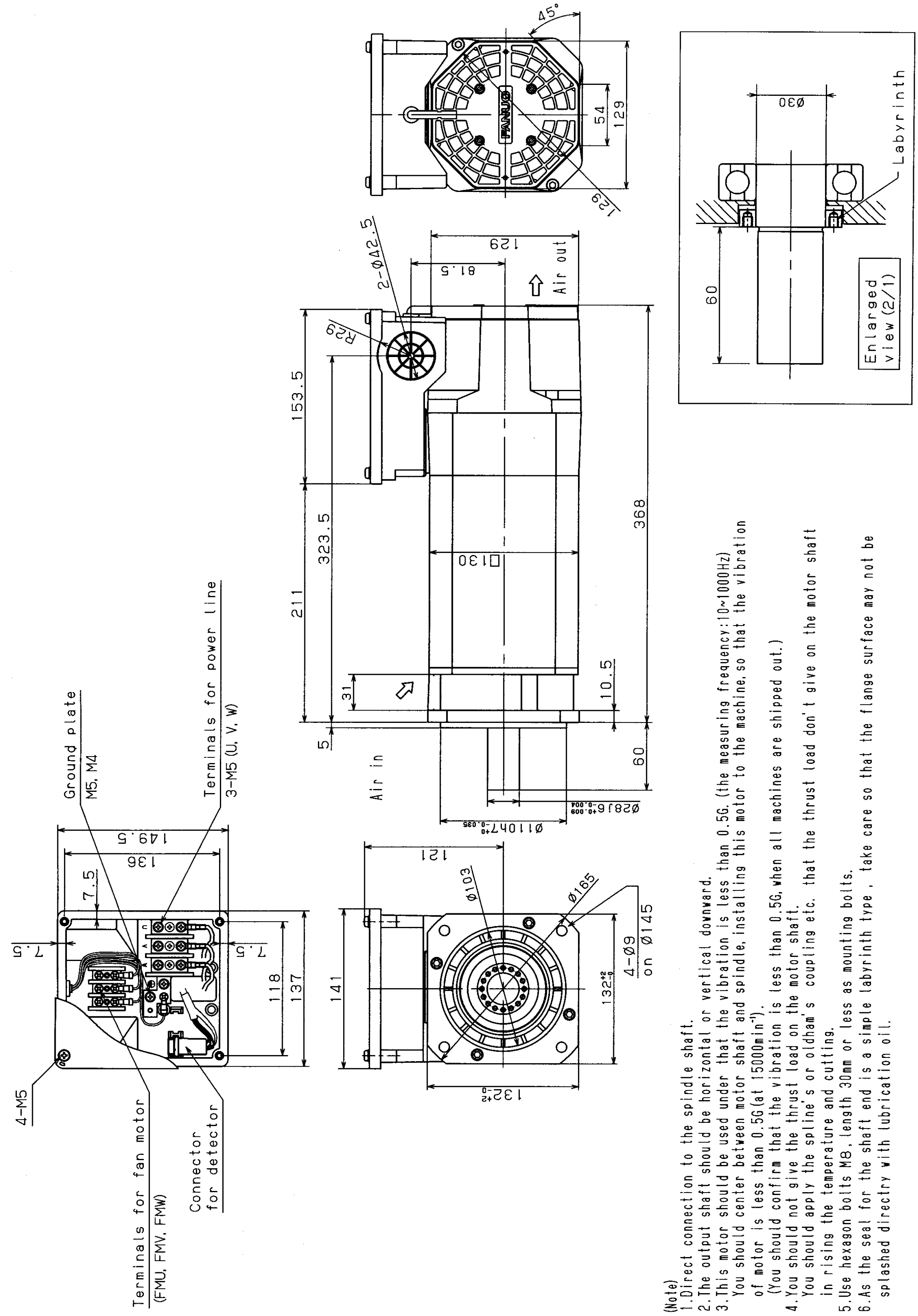
8.3 MODEL αiI 1/10000 (FOOT MOUNTING TYPE)



8.4 MODEL αiI 1.5/10000 (FLANGE MOUNTING TYPE)

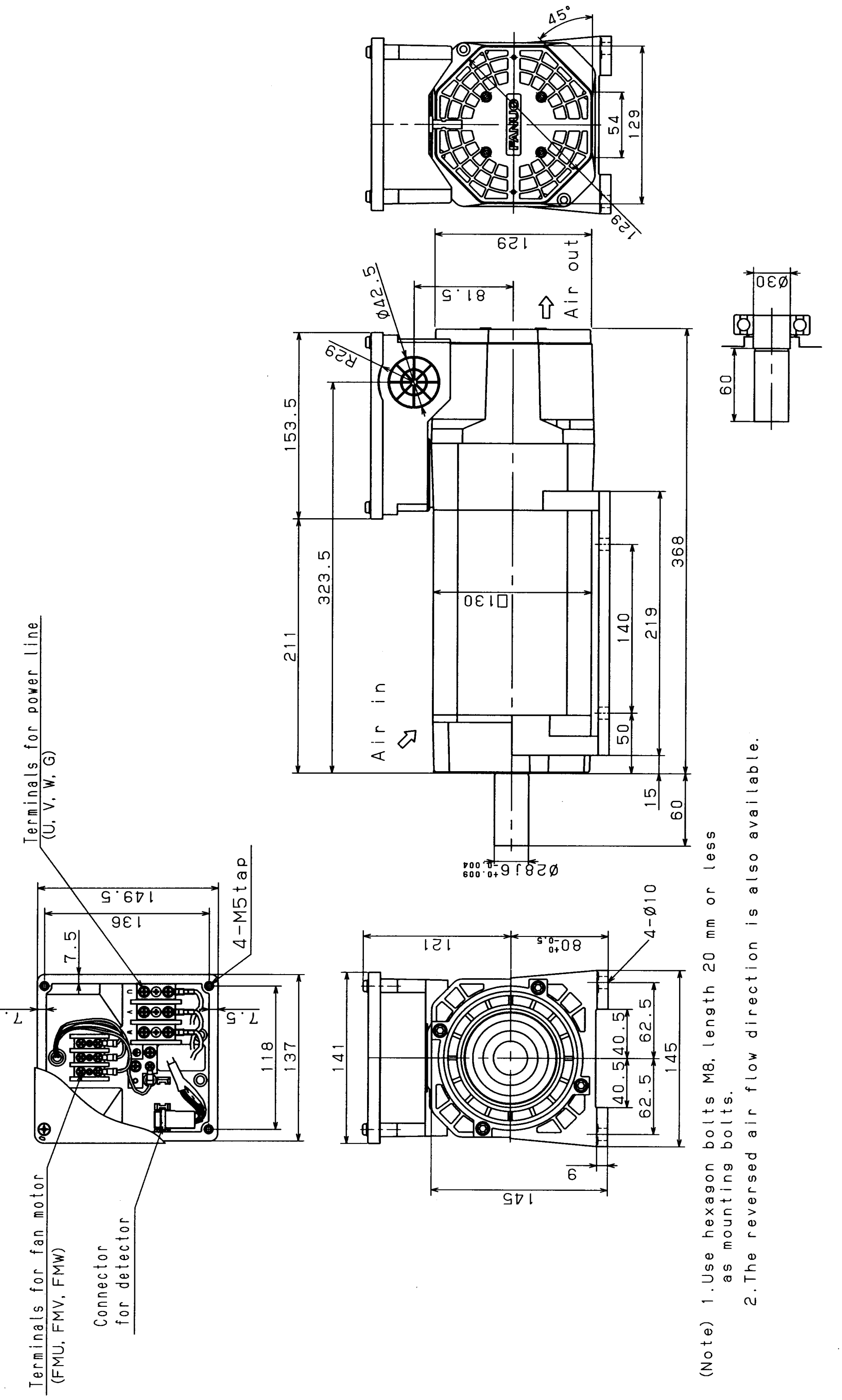


8.5 MODEL αiI 1.5/20000 (FLANGE MOUNTING TYPE)

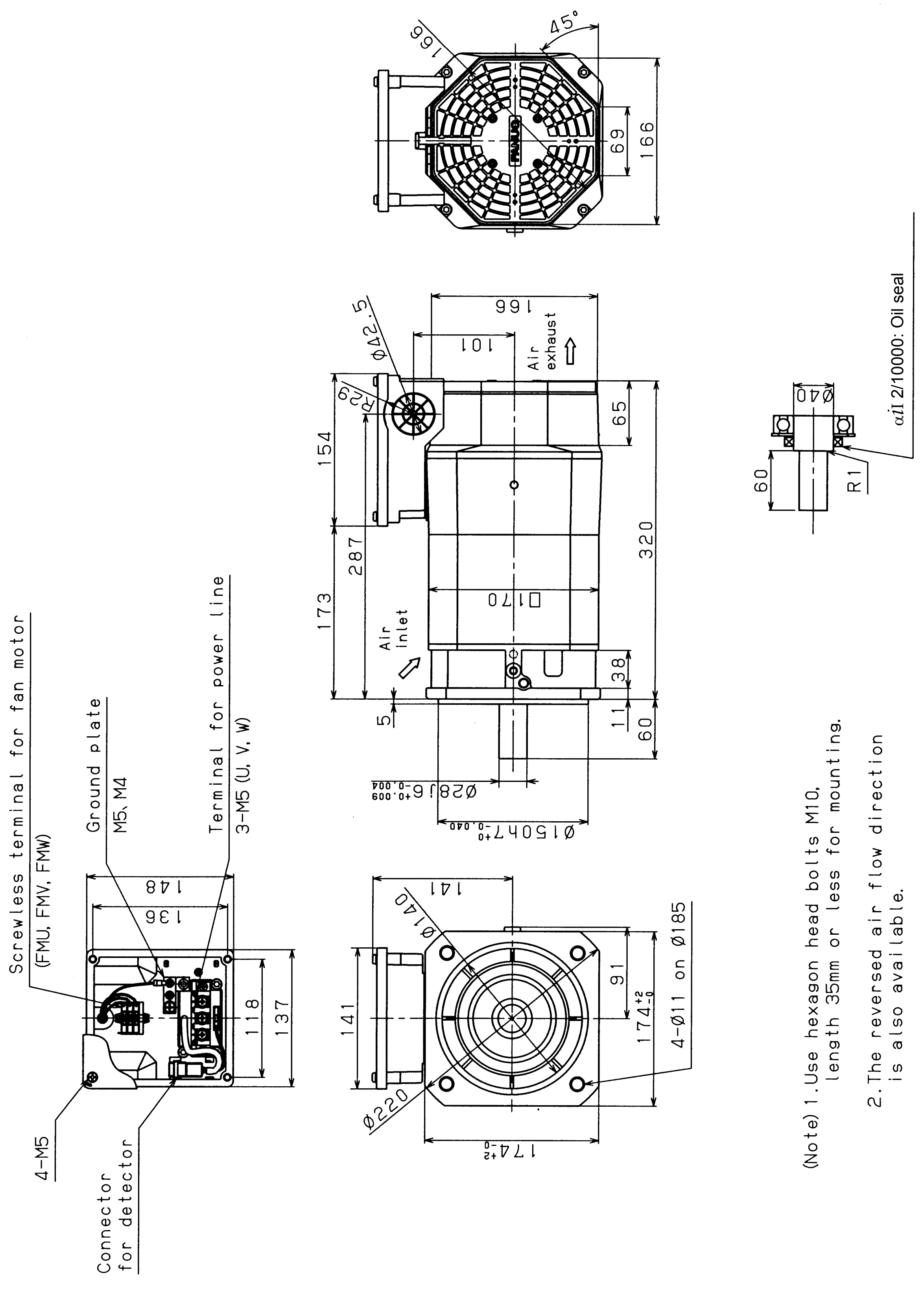


(Note)
1.Direct connection to the spindle shaft.
2.The output shaft should be horizontal or vertical downward.
3.This motor should be used under that the vibration is less than 0.5G. (the measuring frequency:10~1000Hz)
You should center between motor shaft and spindle, installing this motor to the machine, so that the vibration of motor is less than 0.5G (at 15000min^{-1}).
(You should confirm that the vibration is less than 0.5G, when all machines are shipped out.)
4.You should not give the thrust load on the motor shaft.
You should apply the spline's or oldham's coupling etc. that the thrust load don't give on the motor shaft in rising the temperature and cutting.
5.Use hexagon bolts M8, length 30mm or less as mounting bolts.
6.As the seal for the shaft end is a simple labyrinth type, take care so that the flange surface may not be splashed directry with lubrication oil.

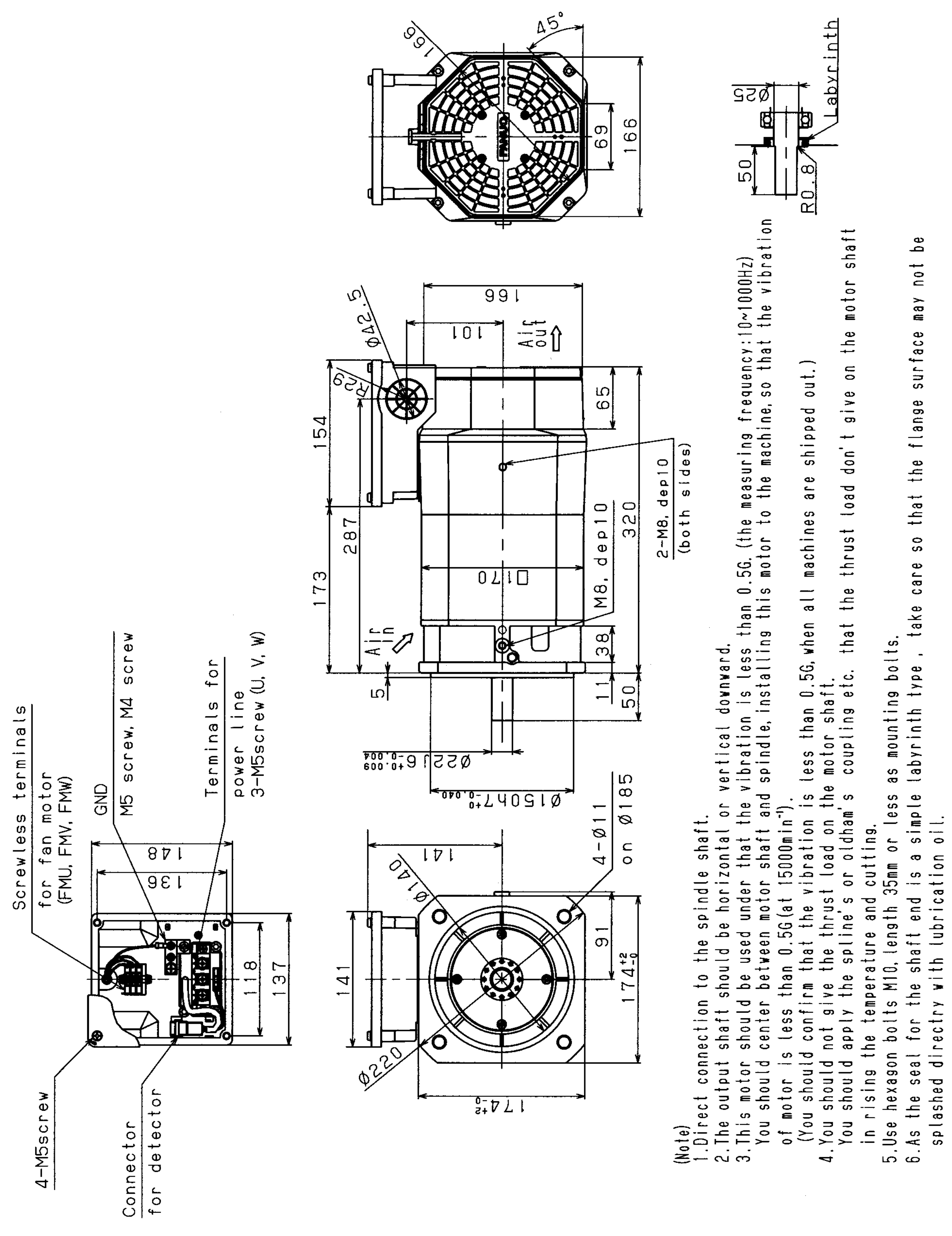
8.6 MODEL αiI 1.5/10000 (FOOT MOUNTING TYPE)



8.7 MODEL αiI 2/10000 (FLANGE MOUNTING TYPE)

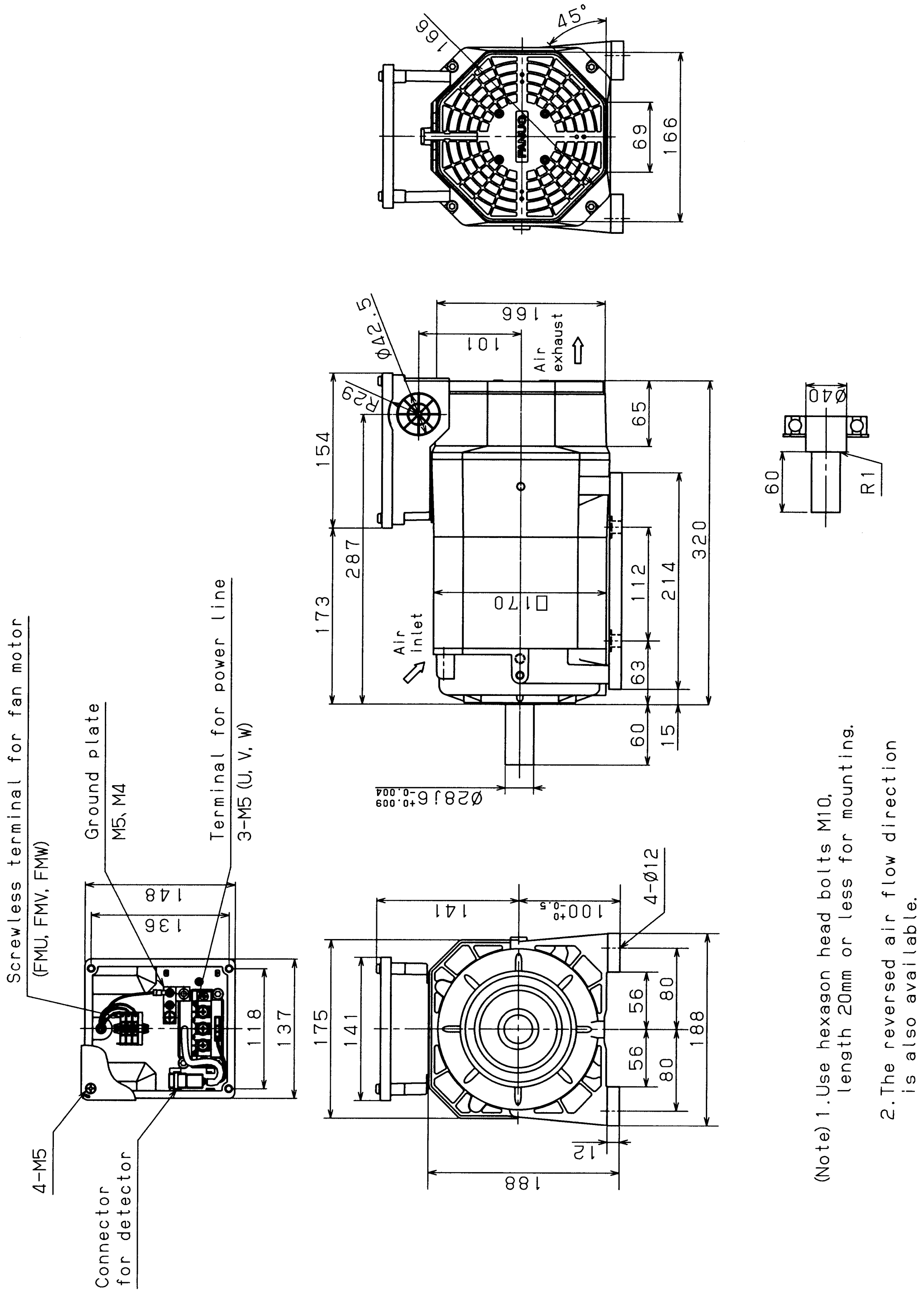


8.8 MODEL αiI 2/20000 (FLANGE MOUNTING TYPE)

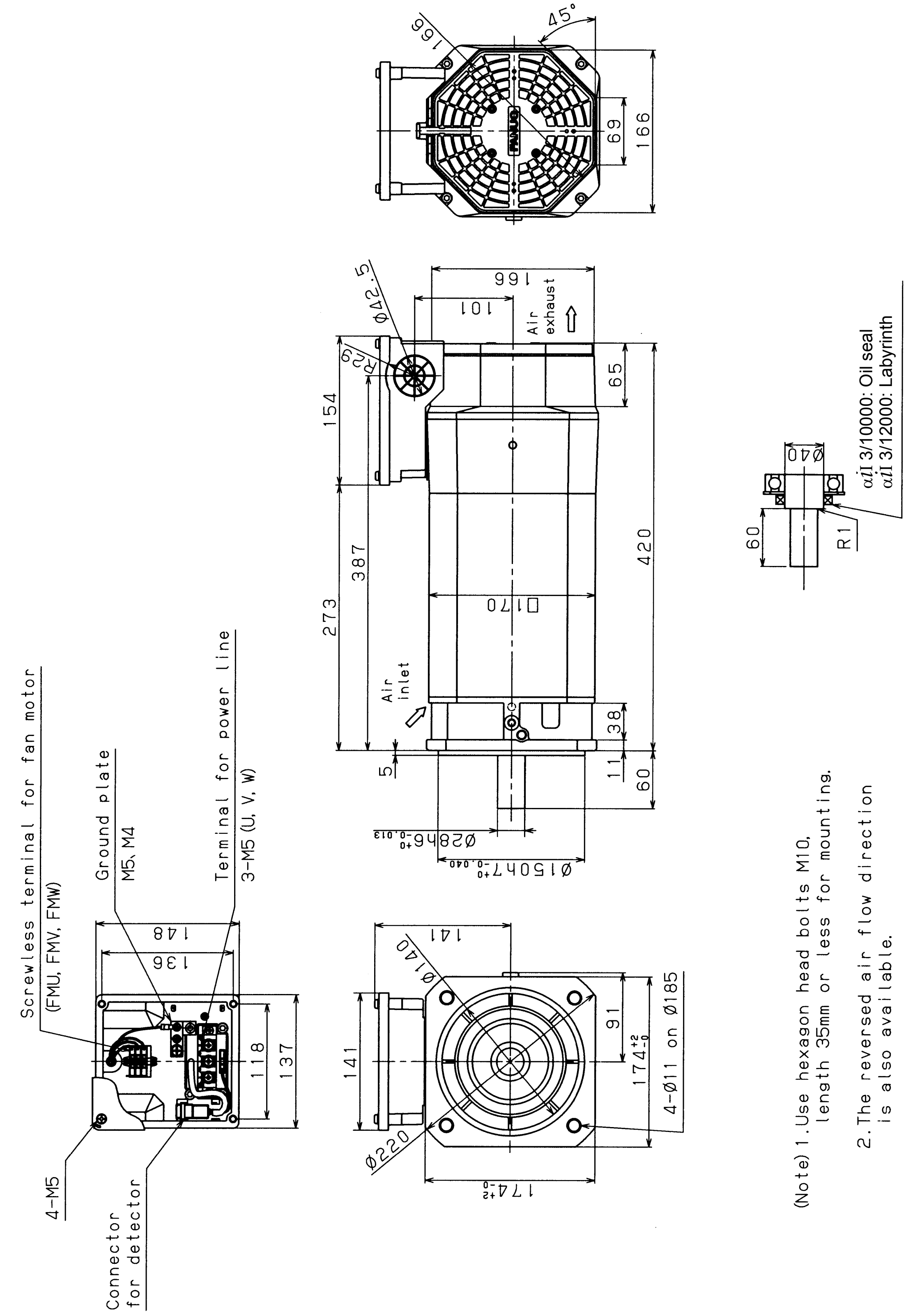


(Note)
1.Direct connection to the spindle shaft.
2.The output shaft should be horizontal or vertical downward.
3.This motor should be used under that the vibration is less than 0.5G.(the measuring frequency:10~1000Hz)
You should center between motor shaft and spindle, installing this motor to the machine, so that the vibration of motor is less than 0.5G(at 15000min-1).
(You should confirm that the vibration is less than 0.5G, when all machines are shipped out.)
4.You should not give the thrust load on the motor shaft.
You should apply the spline's or oldham's coupling etc. that the thrust load don't give on the motor shaft in rising the temperature and cutting.
5.Use hexagon bolts M10, length 35mm or less as mounting bolts.
6.As the seal for the shaft end is a simple labyrinth type, take care so that the flange surface may not be splashed directry with lubrication oil.

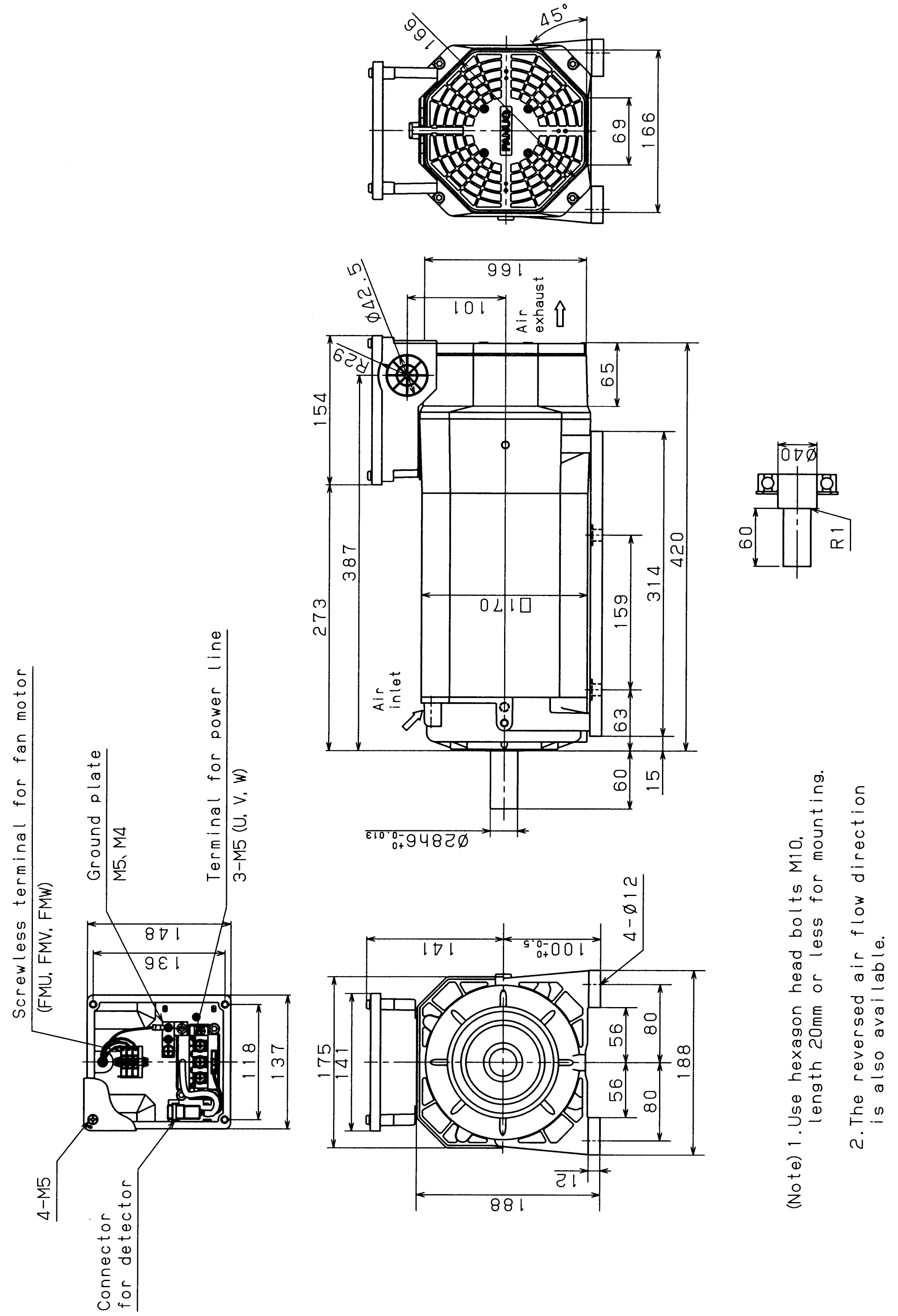
8.9 MODEL αiI 2/10000 (FOOT MOUNTING TYPE)



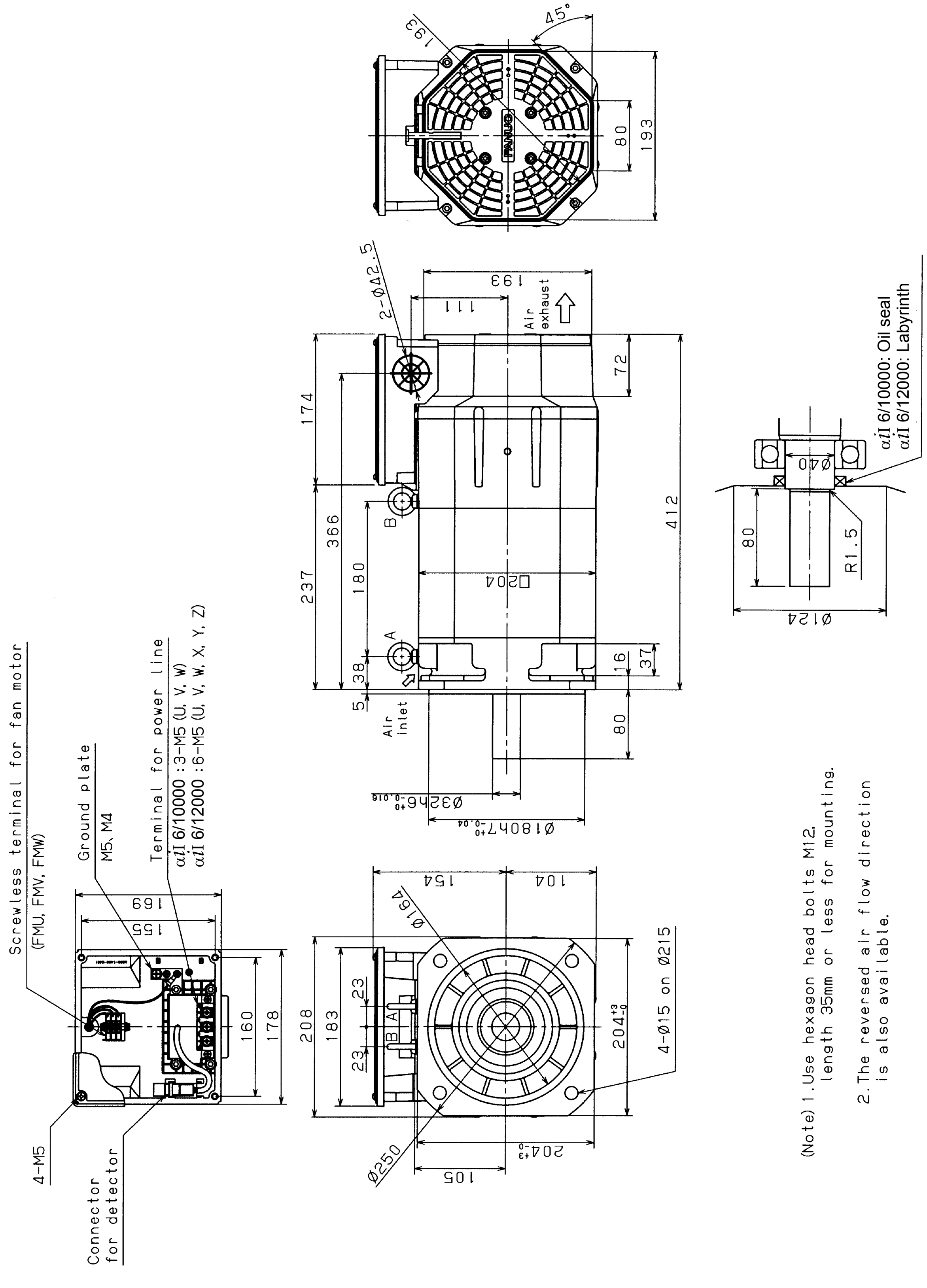
8.10 MODELS αiI 3/10000 AND αiI 3/12000 (FLANGE MOUNTING TYPE)



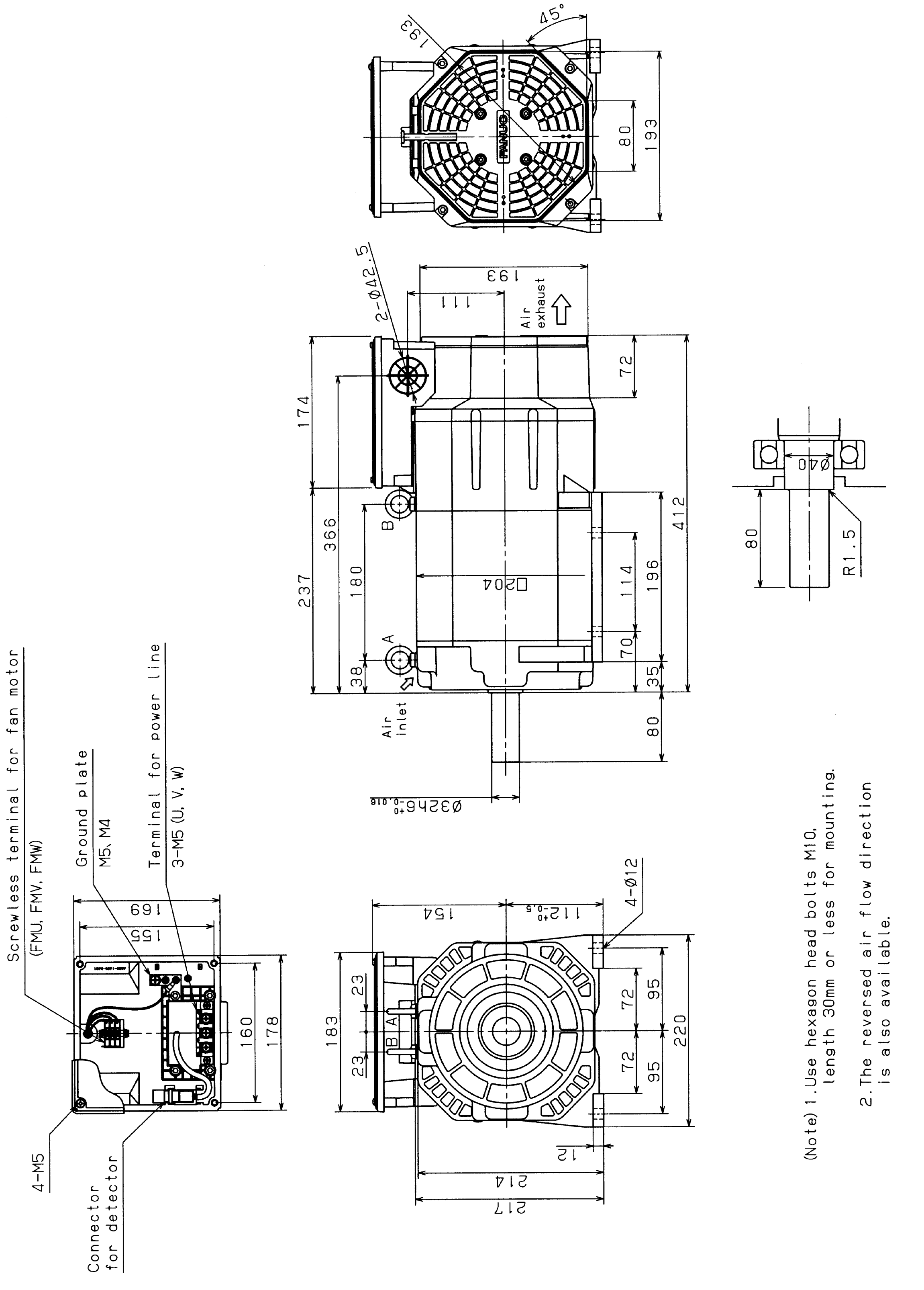
8.11 MODEL αiI 3/10000 (FOOT MOUNTING TYPE)



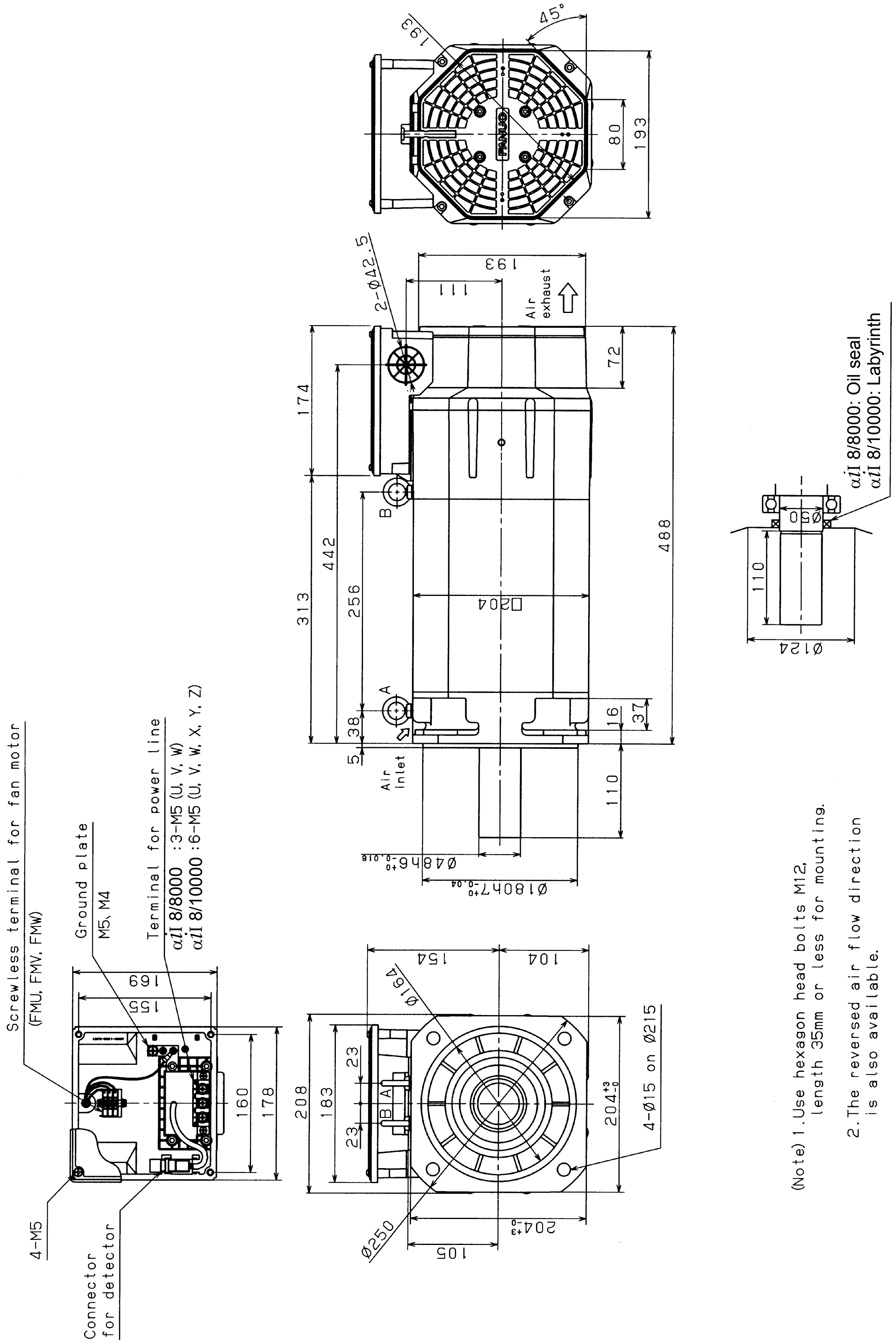
8.12 MODELS αiI 6/10000 AND αiI 6/12000 (FLANGE MOUNTING TYPE)



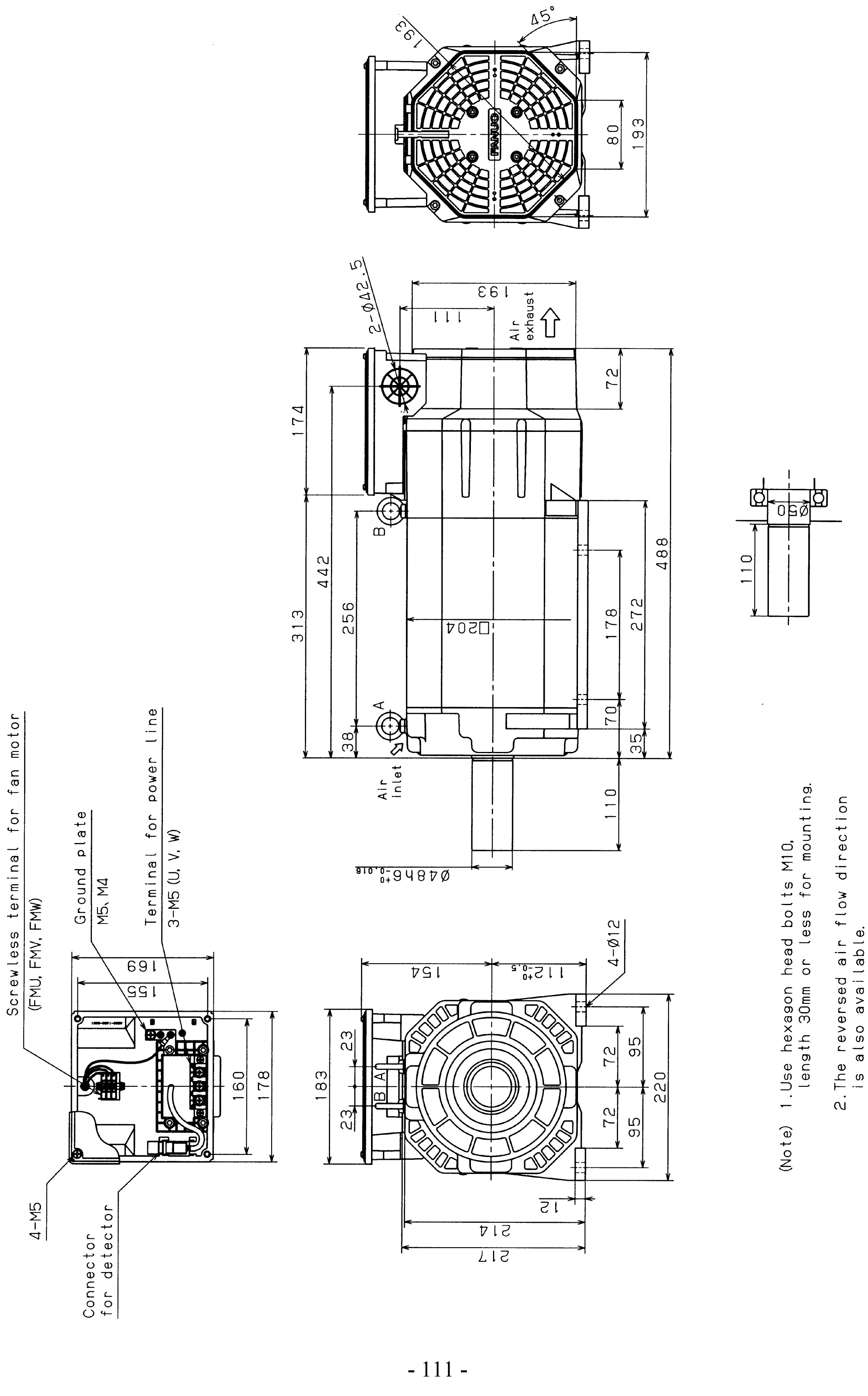
8.13 MODEL αiI 6/10000 (FOOT MOUNTING TYPE)



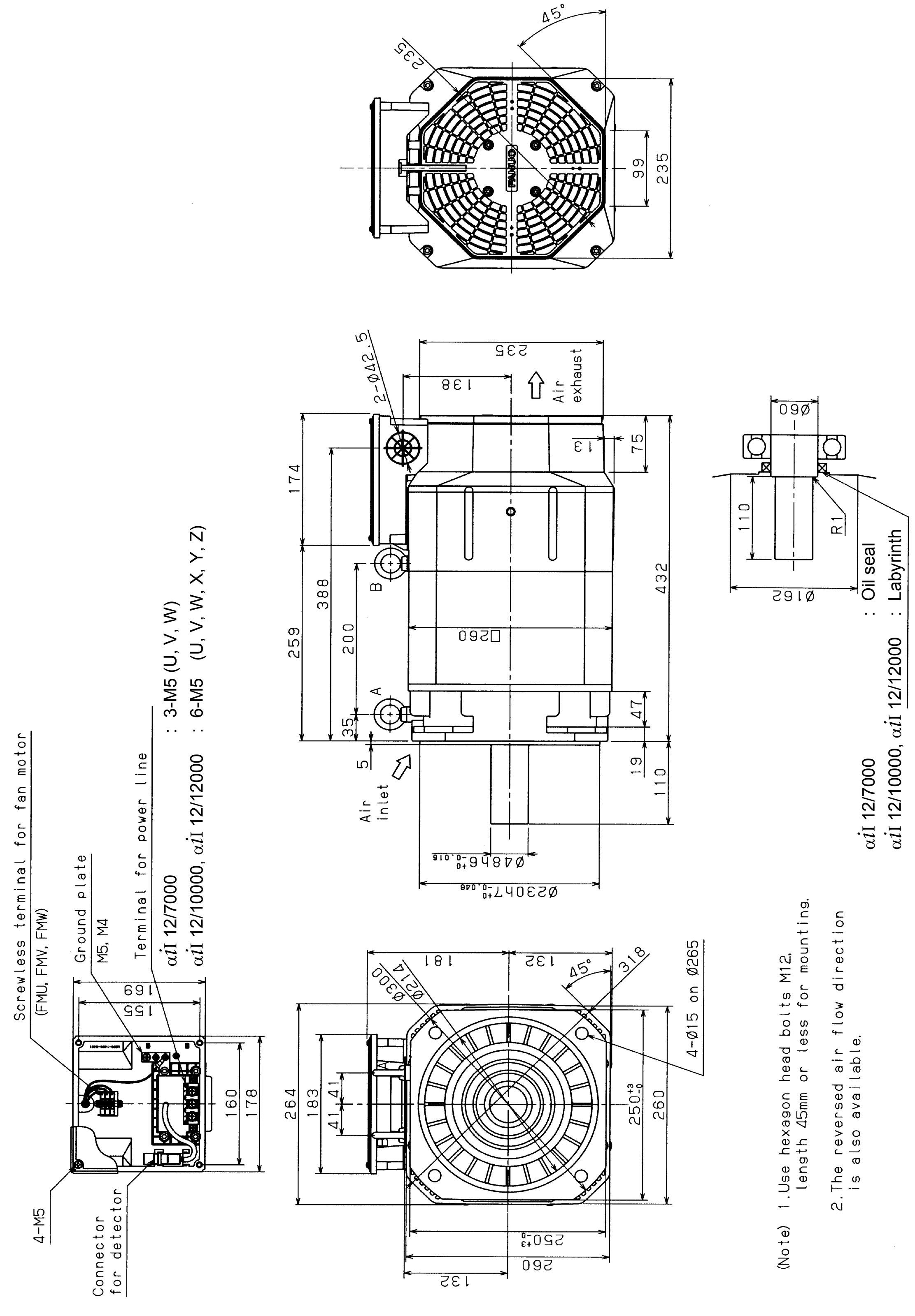
8.14 MODELS αiI 8/8000 AND αiI 8/10000 (FLANGE MOUNTING TYPE)



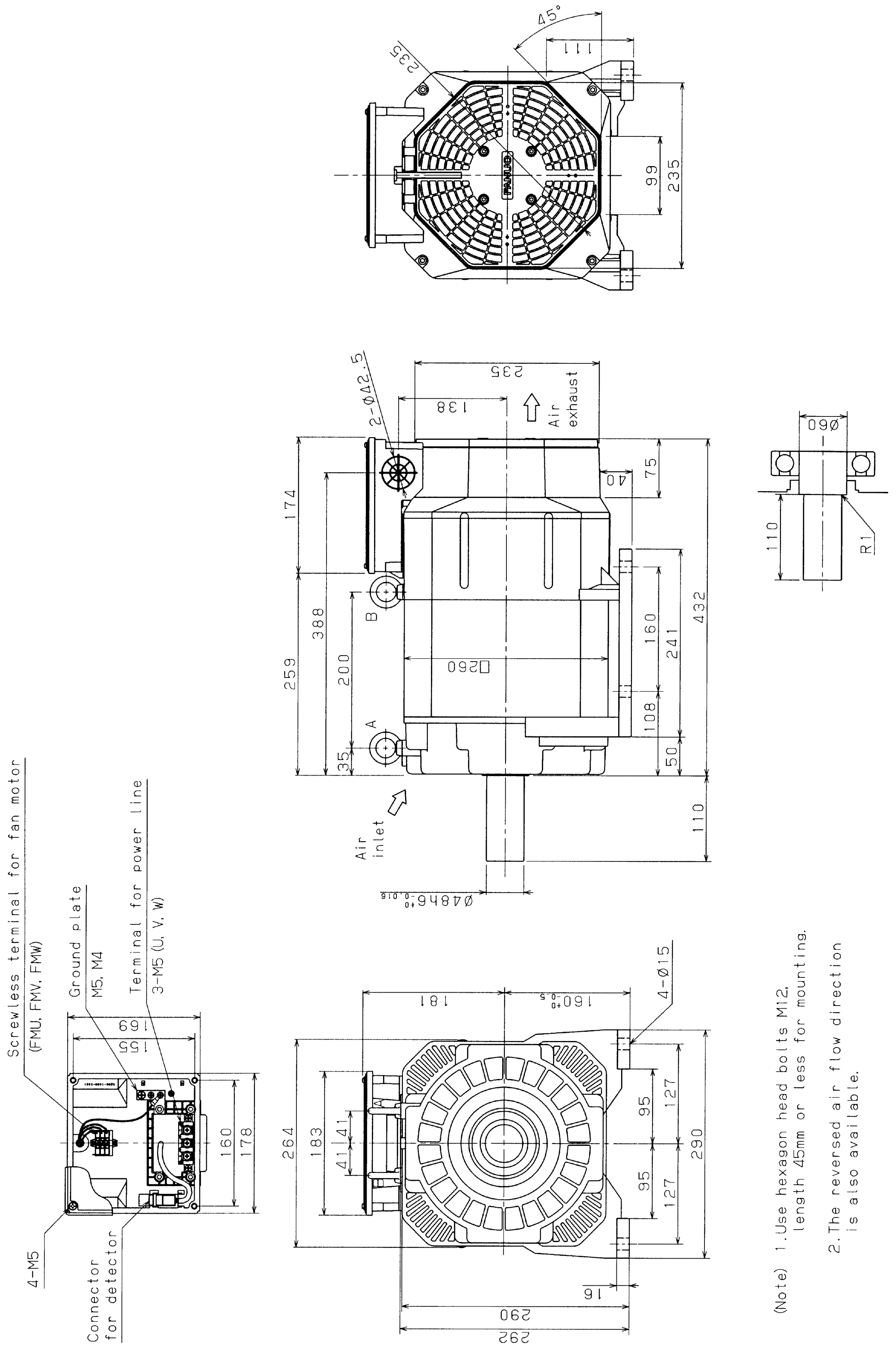
8.15 MODEL αiI 8/8000 (FOOT MOUNTING TYPE)



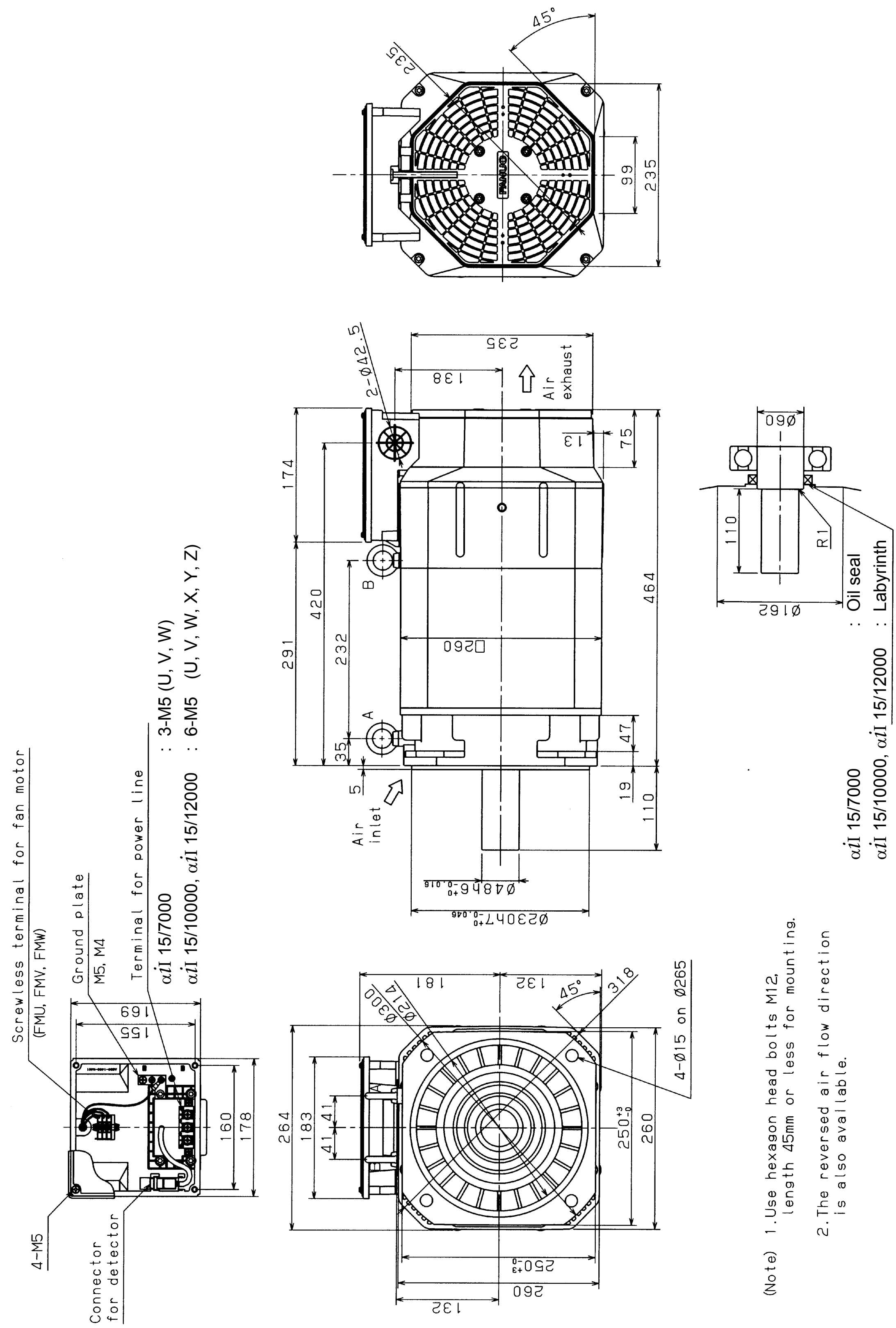
8.16 MODELS αiI 12/7000, αiI 12/10000, AND αiI 12/12000 (FLANGE MOUNTING TYPE)



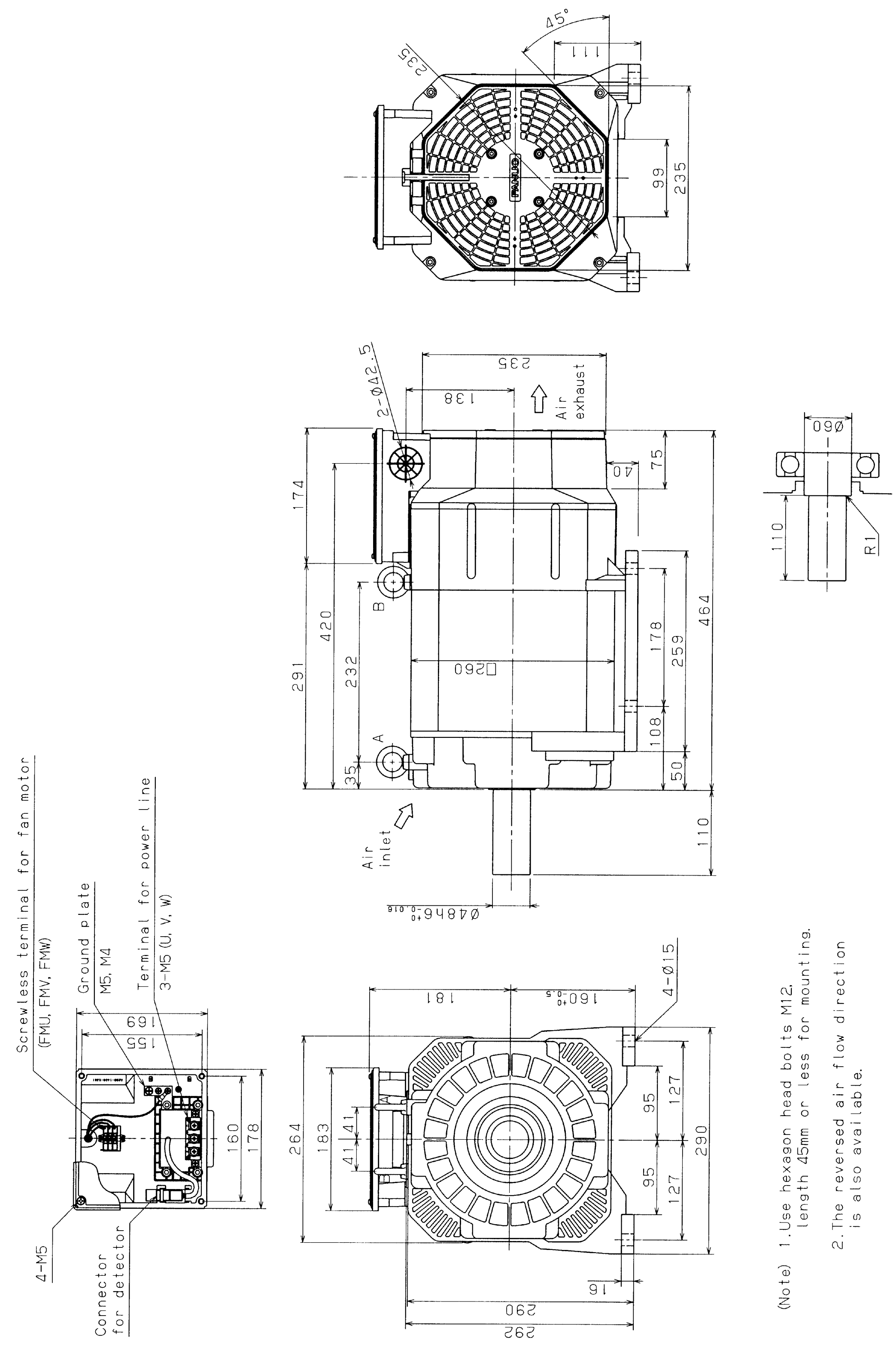
8.17 MODEL αiI 12/7000 (FOOT MOUNTING TYPE)



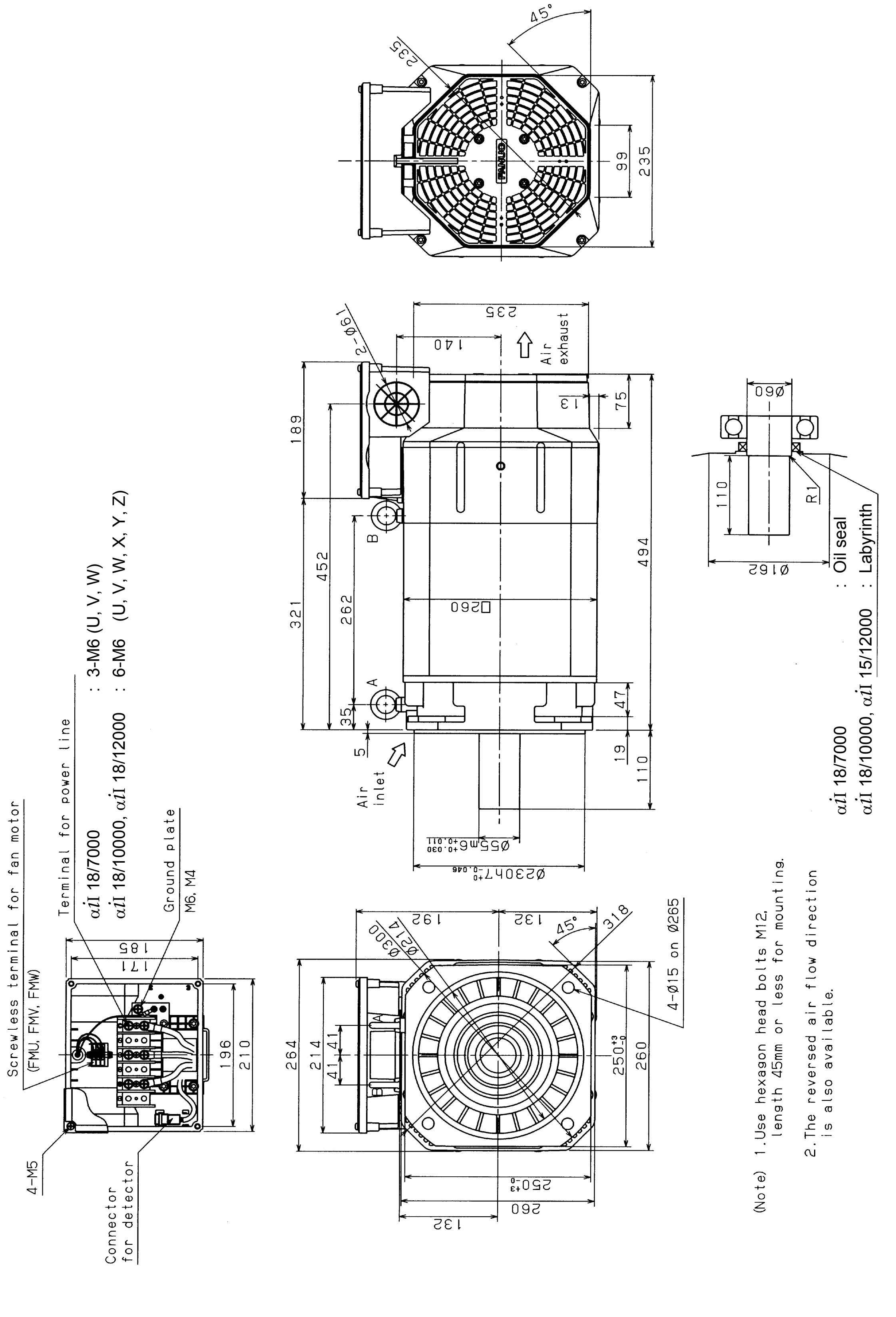
8.18 MODELS αiI 15/7000, αiI 15/10000, AND αiI 15/12000 (FLANGE MOUNTING TYPE)



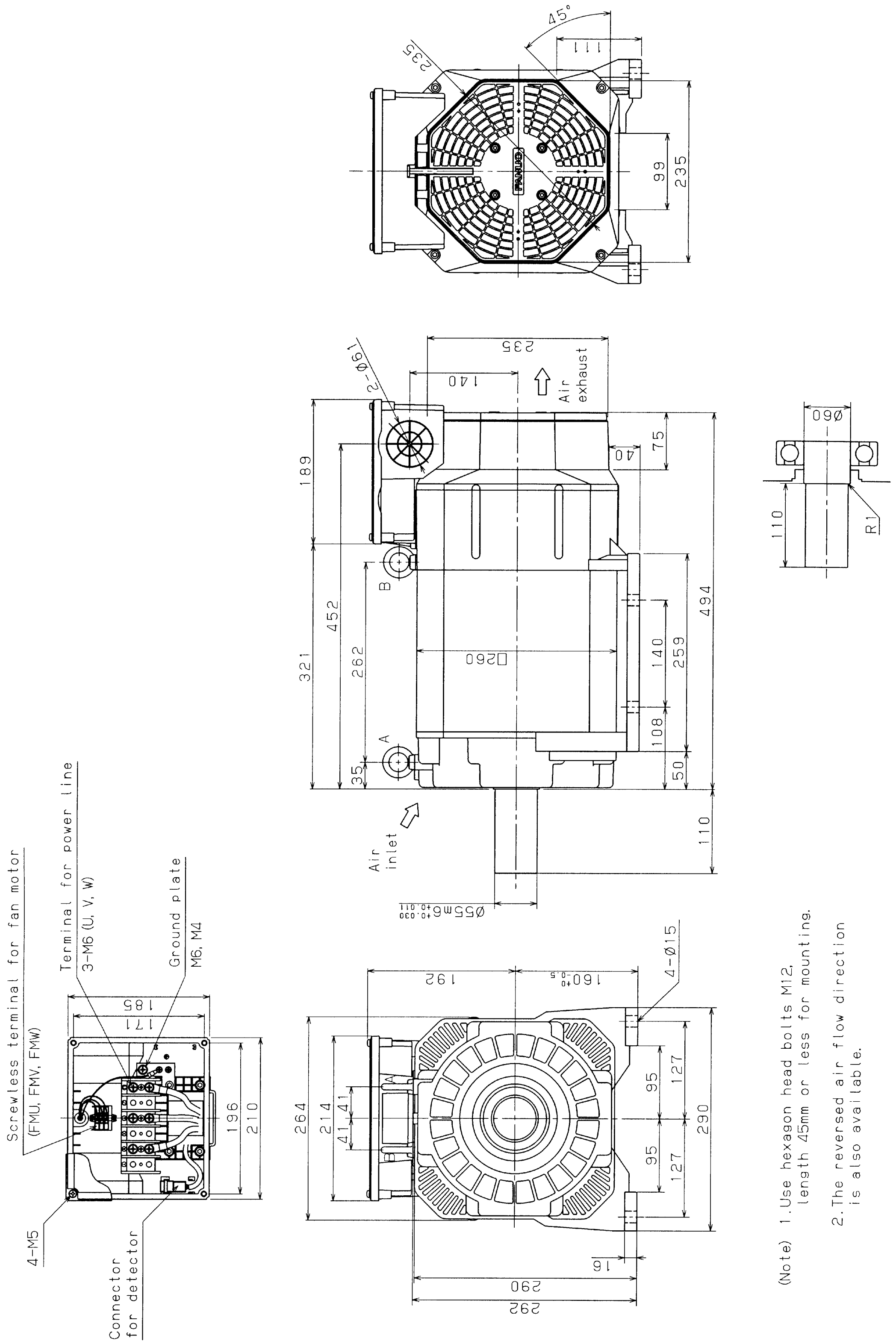
8.19 MODEL αiI 15/7000 (FOOT MOUNTING TYPE)



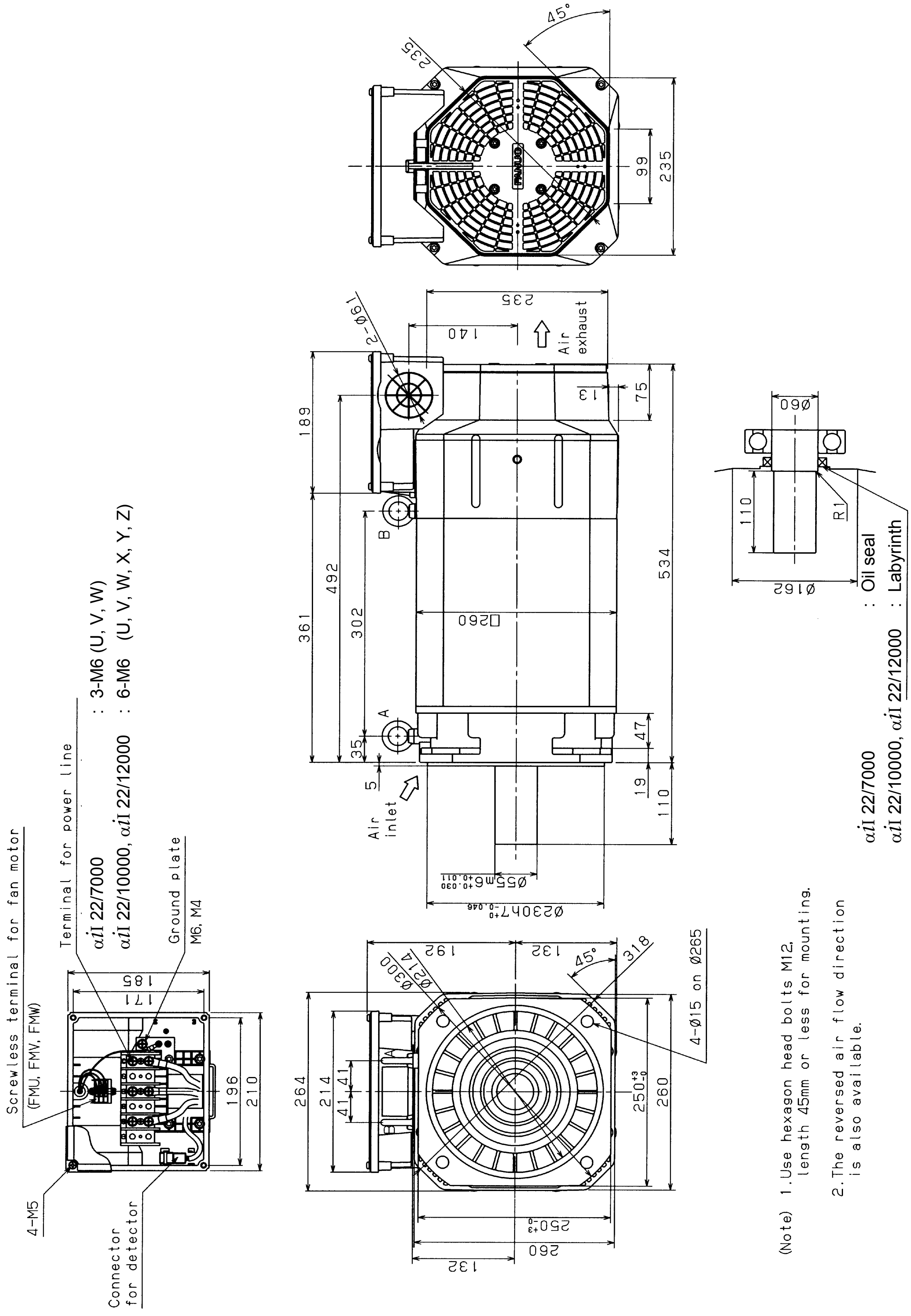
8.20 MODELS αiI 18/7000, αiI 18/10000, AND αiI 18/12000 (FLANGE MOUNTING TYPE)



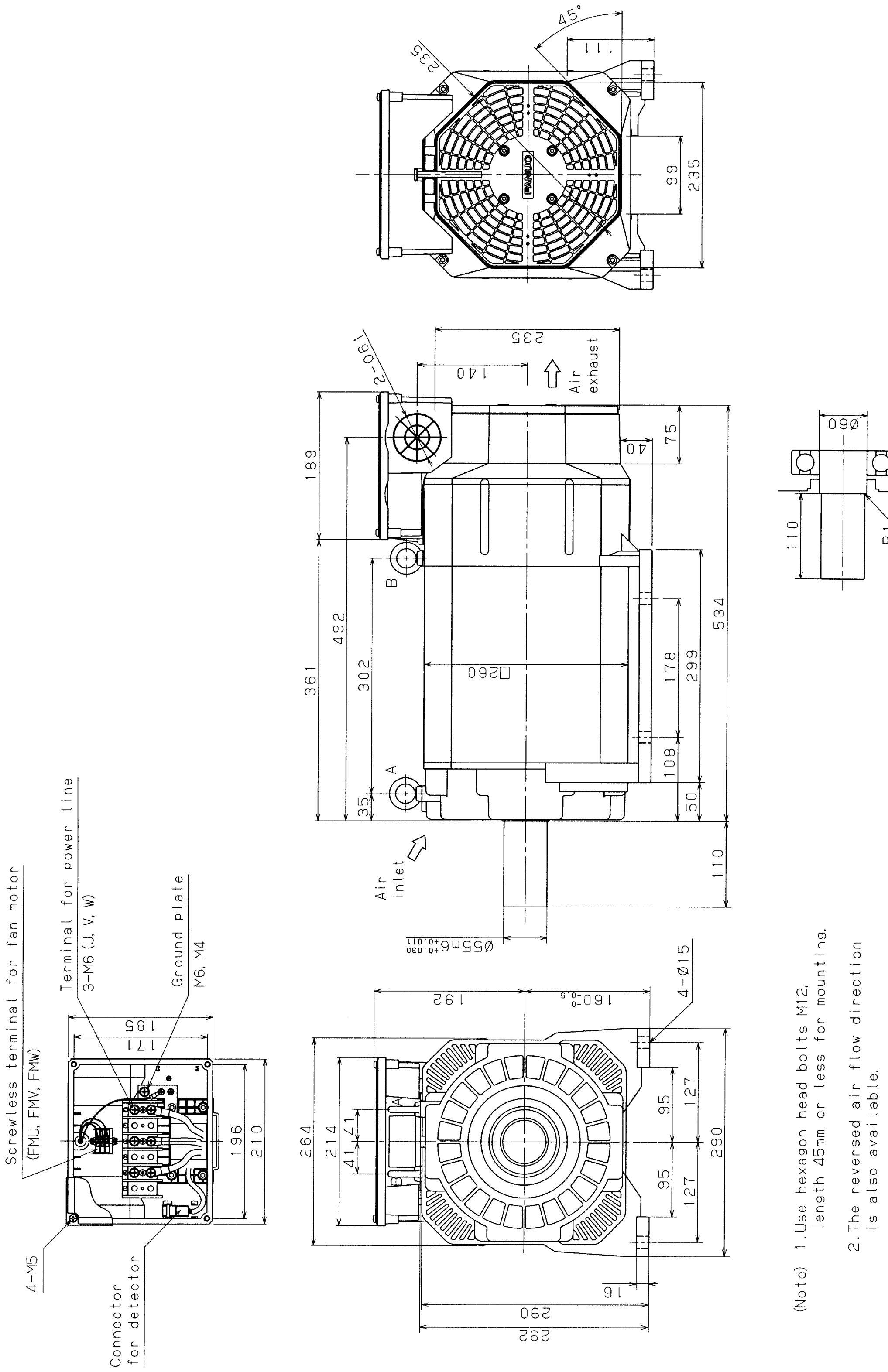
8.21 MODEL αiI 18/7000 (FOOT MOUNTING TYPE)



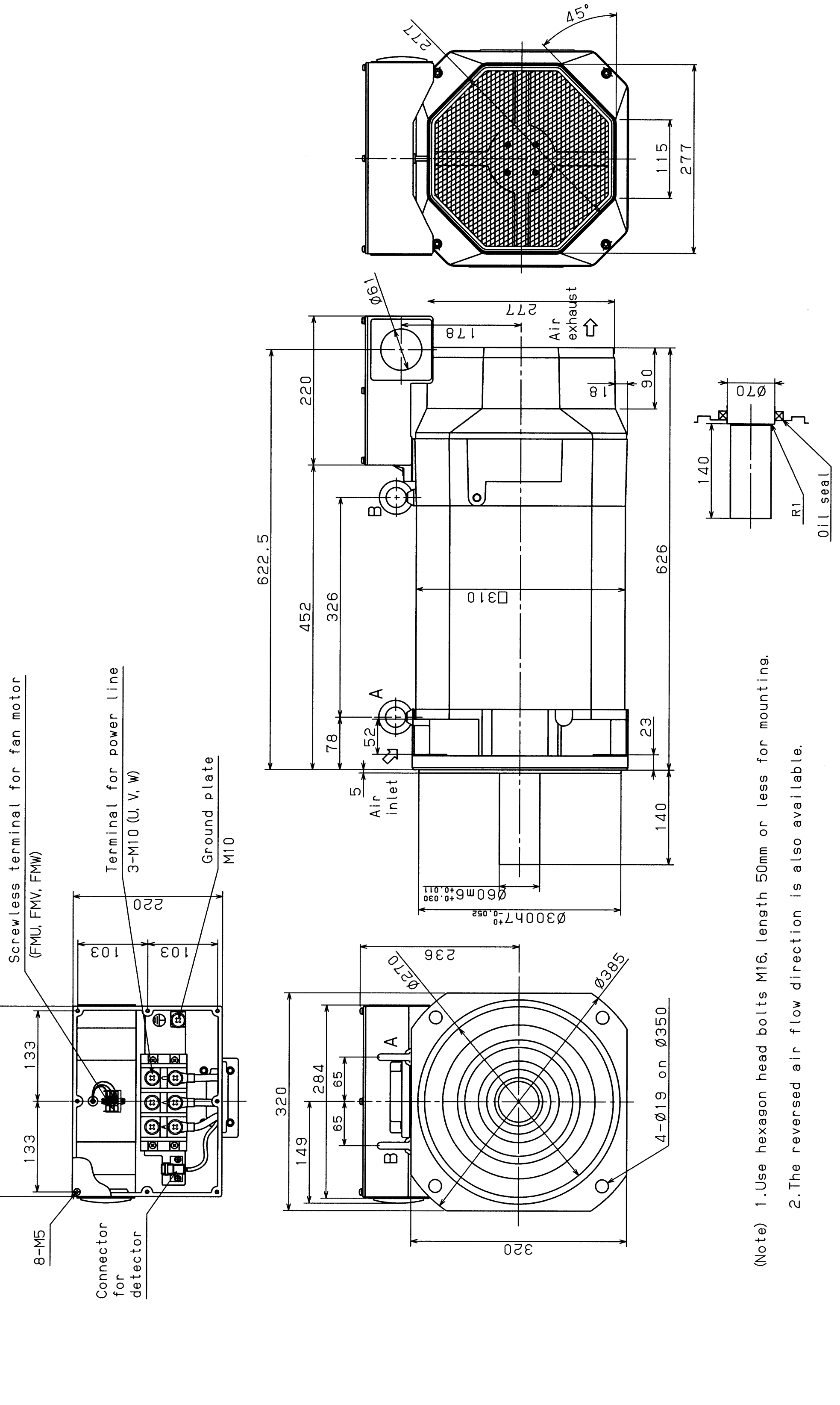
8.22 MODELS αiI 22/7000, αiI 22/10000, AND αiI 22/12000 (FLANGE MOUNTING TYPE)



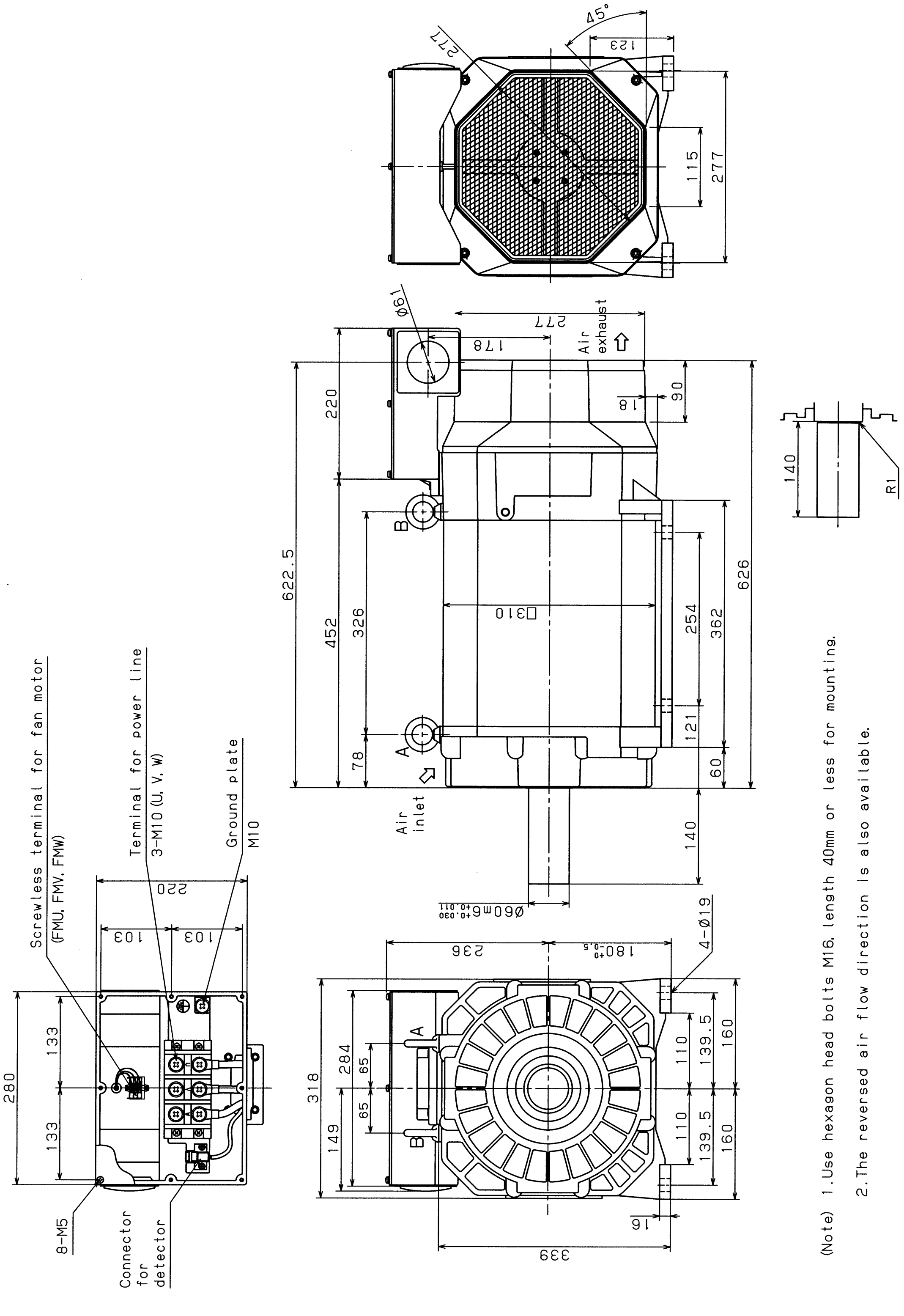
8.23 MODEL αiI 22/7000 (FOOT MOUNTING TYPE)



8.24 MODEL αiI 30/6000 (FLANGE MOUNTING TYPE)

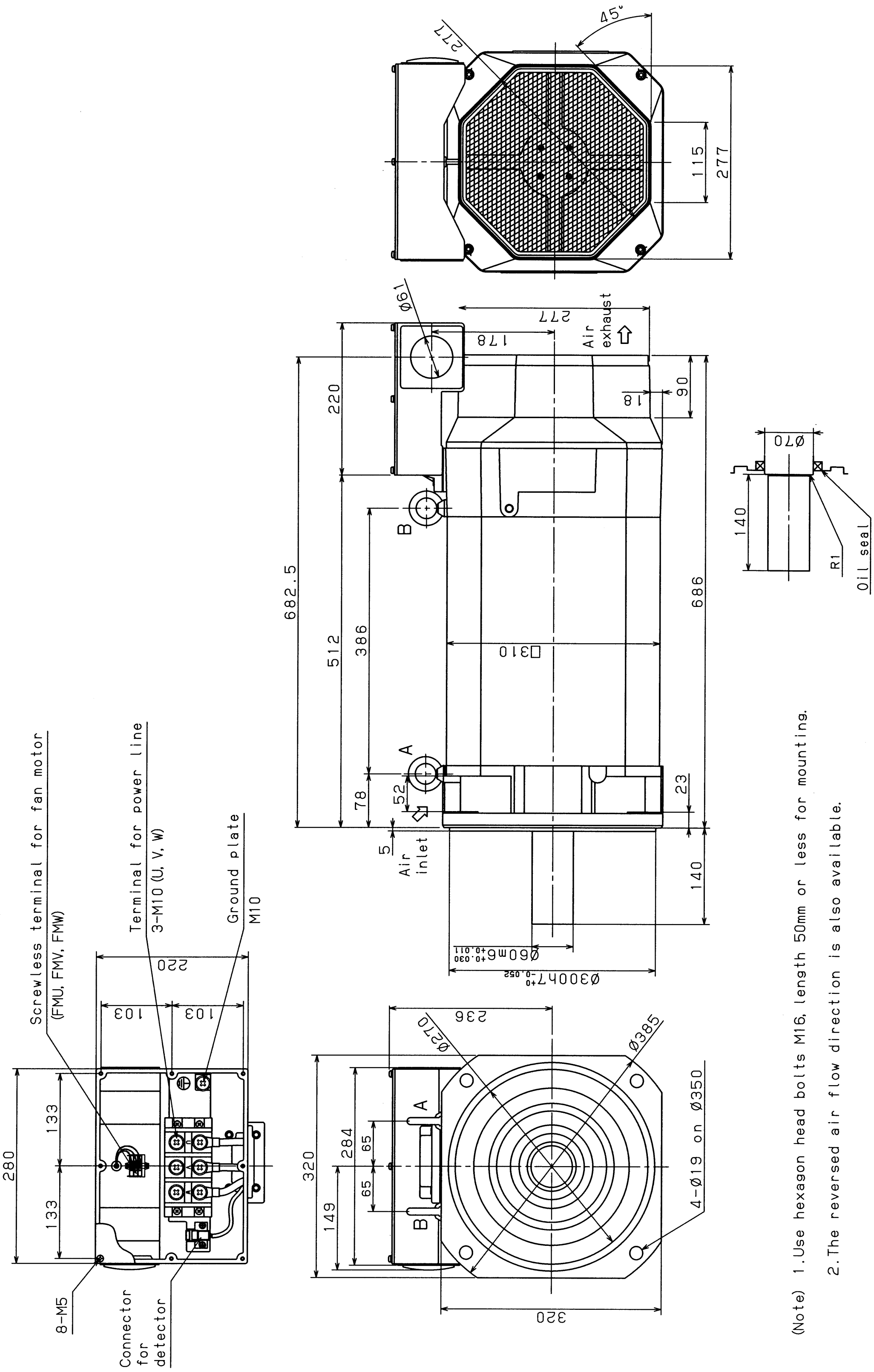


8.25 MODEL αiI 30/6000 (FOOT MOUNTING TYPE)

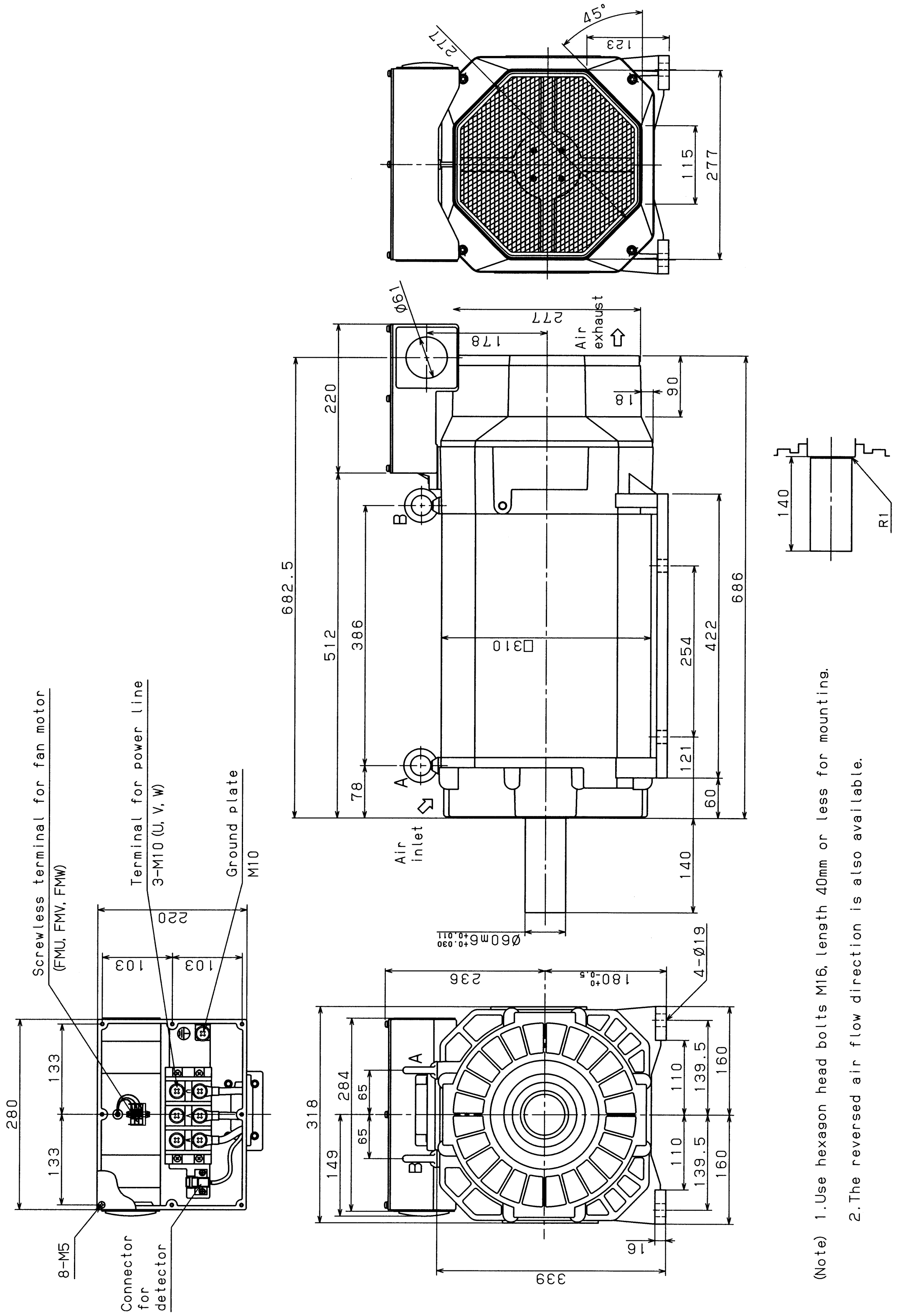


(Note) 1. Use hexagon head bolts M16, length 40mm or less for mounting.
2. The reversed air flow direction is also available.

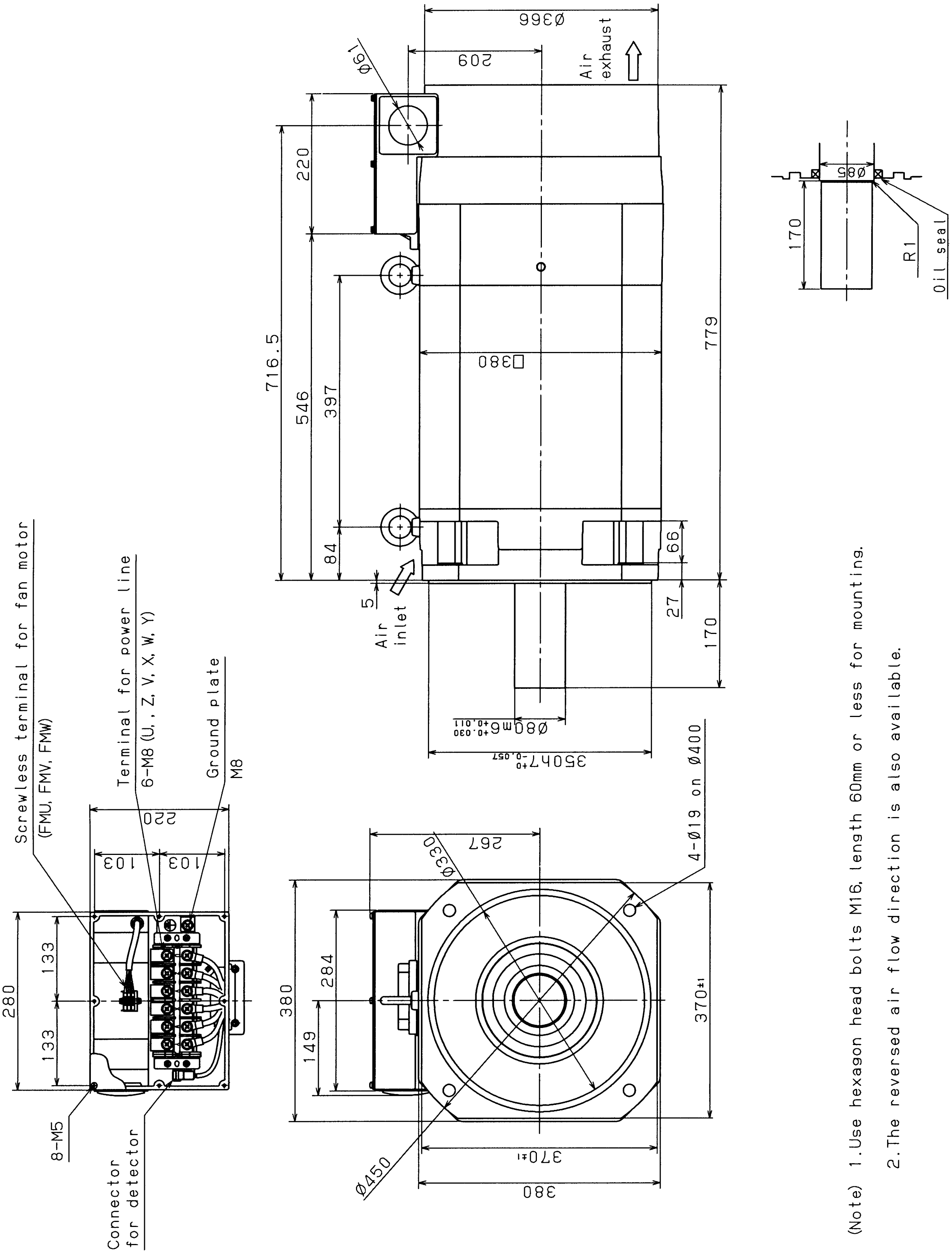
8.26 MODEL αiI 40/6000 (FLANGE MOUNTING TYPE)



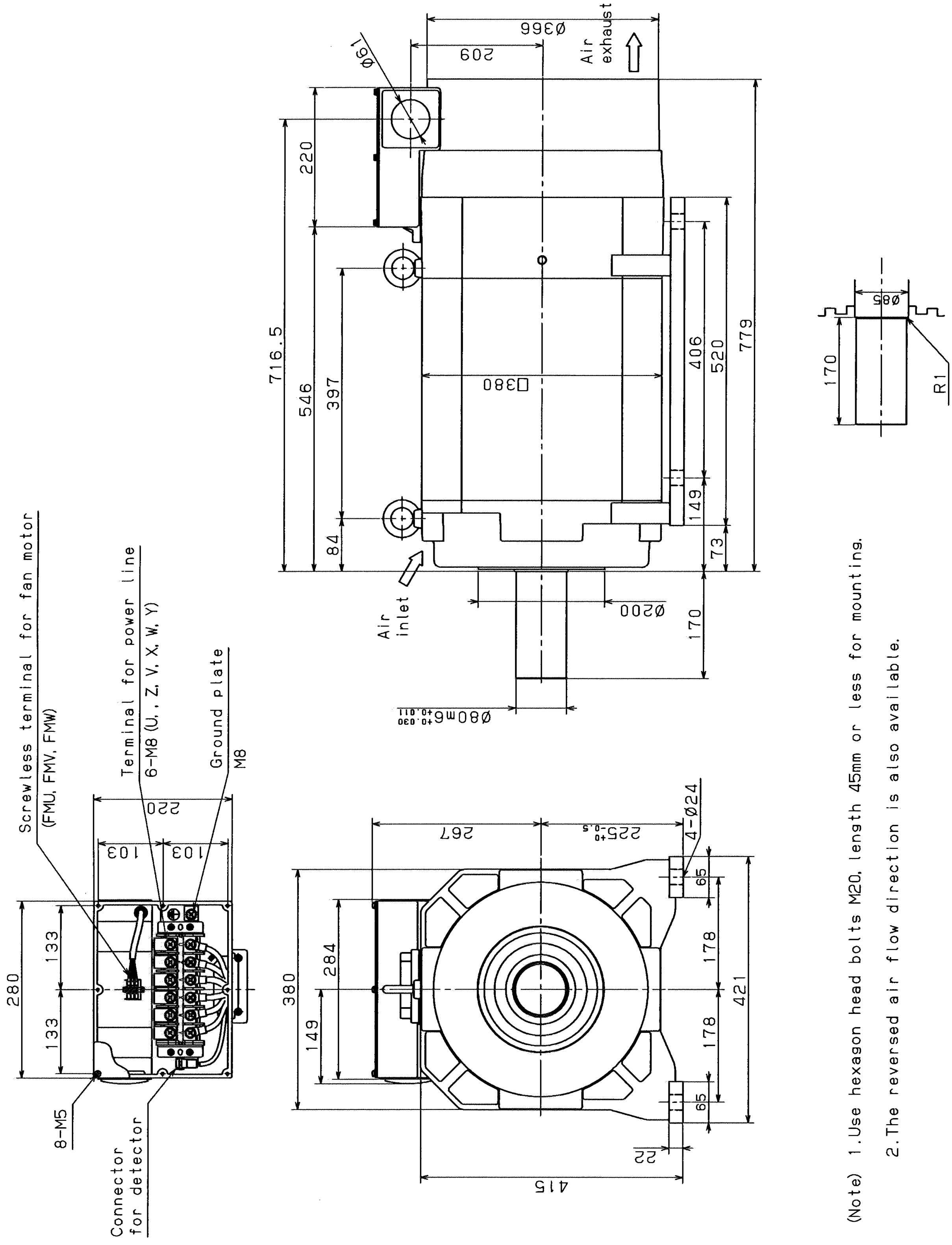
8.27 MODEL αiI 40/6000 (FOOT MOUNTING TYPE)



8.28 MODEL αiI 50/4500 (FLANGE MOUNTING TYPE)



8.29 MODEL αiI 50/4500 (FOOT MOUNTING TYPE)



III. FANUC AC SPINDLE MOTOR αiI series 400V type

1 GENERAL

The FANUC AC spindle motor αiI series 400V type includes standard spindle motors for CNC machine tool spindles, which can be driven by 400 to 480VAC without a step-down transformer(*1).

(*1) For models αiI 1HV, αiI 1.5HV, αiI 2HV, and αiI 3HV, however, a single-phase step-down transformer for fan motors is required when 480VAC is applied.

Features

- The motor is compact, light-weight and furnished with digital control for much higher performance.
- The motor inertia of the AC spindle motor is made smaller to shorten the acceleration/deceleration speed. Further, optimum control enables highly efficient cutting.
- The built-in αiM sensor or αiMZ sensor enables synchronous spindle and Z-axis feed and rigid tapping.
- Improvement in machining of the motor housing enhances the accuracy of the mounting part.
- 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

Series		αiI series 400V type		
Item / Model		**αiI 0.5/10000HV**	**αiI 1/10000HV**	**αiI 1.5/10000HV**
Output (*2)	Cont. rated kW (HP)	0.55 (0.74)	1.5 (2.0)	1.1 (1.5)
	30 min rated kW [15 min, 10min] (*3) (HP)	1.1 (1.5)	2.2 (3.0)	3.7 (5.0)
	S3 60% kW [40%,25%] (*4)(*5) (HP)	1.1 (1.5)	2.2 (3.0)	3.7 (5.0)
Rated current A (*6)	Cont. rated	4	5	7
	30 min rated (*3) S3 60% (*4)	5	7	14
Speed min^{-1}	Base speed	3000	3000	1500
	Max. speed	10000	10000	10000
Output torque (Cont. rated torque at const. rated torque range) N·m (kgf·cm)		1.75 (17.9)	4.77 (48.7)	7.00 (71.4)
Rotor inertia	$kg \cdot m^2$	0.00048	0.003	0.0043
	$kgf \cdot cm \cdot s^2$	0.0048	0.03	0.04
Weight kgf		7	18	24
Vibration		V5 (option V3)		
Noise		75dB(A) or less		
Cooling system (*7)		Totally enclosed and non-ventilated IC0A0	Totally enclosed and fan cooled IC0A6	
Cooling fan W		None	(*13)	
Installation (*8)		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		
Allowable overload capacity (1 min) (*9)		120 % of 30 min rated output		
Insulation		Class H		
Ambient temperature		0 to 40°C		
Altitude		Height above sea level not exceeding 1000m		
Painting color		Munsell system N2.5		
Sensor		αiM sensor or αiMZ sensor		
Type of thermal protection (*10)		TP211		
Resolution of the αiMZ sensor /rev.		2048		
Number of detected gear teeth per rotation λ/rev.		64	128	
Bearing lubrication		Grease		
Maximum output during acceleration(*11) kW		1.32	2.64	4.44
Applicable spindle amplifier		αiSP 5.5HV		
Model		αiI 0.5/10000HV	αiI 1/10000HV	αiI 1.5/10000HV

Series		αiI series 400V type			
Item \ Model		αiI 2/10000HV	αiI 3/10000HV	αiI 6/10000HV	αiI 8/8000HV
Output (*2)	Cont. rated kW (HP)	2.2 (3.0)	3.7 (5.0)	5.5 (7.4)	7.5 (10)
	30 min rated kW [15 min, 10min] (*3) (HP)	3.7 (5.0)	5.5 (7.4)	7.5 (10)	11 (14.7)
	S3 60% kW [40%,25%] (*4)(*5) (HP)	3.7 (5.0)	5.5 (7.4)	7.5 (10)	11 (14.7)
Rated current A (*6)	Cont. rated	10	11	20	21
	30 min rated (*3) S3 60% (*4)	15	14	26	28
Speed min^{-1}	Base speed	1500	1500	1500	1500
	Max. speed	10000	10000	10000	8000
Output torque (Cont. rated torque at const. rated torque range) N·m (kgf·cm)		14.0 (143)	23.5 (240)	35.0 (357)	47.7 (487)
Rotor inertia	$kg \cdot m^2$	0.0078	0.0148	0.0179	0.0275
	$kgf \cdot cm \cdot s^2$	0.08	0.15	0.18	0.28
Weight kgf		27	46	51	80
Vibration		V5 (option V3)			
Noise		75dB(A) or less			
Cooling system (*7)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		(*13)			
Installation (*8)		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			
Allowable overload capacity (1 min) (*9)		120 % of 30 min rated output			
Insulation		Class H			
Ambient temperature		0 to 40°C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Sensor		αiM sensor or αiMZ sensor			
Type of thermal protection (*10)		TP211			
Resolution of the αiMZ sensor /rev.		2048		4096	
Number of detected gear teeth per rotation λ/rev.		128		256	
Bearing lubrication		Grease			
Maximum output during acceleration(*11) kW		4.44	6.6	9.0	13.2
Applicable spindle amplifier		αiSP 5.5HV		αiSP 11HV	
Model		αiI 2/10000HV	αiI 3/10000HV	αiI 6/10000HV	αiI 8/8000HV

Series		αiI series 400V type			
Item / Model		**αiI 12/7000HV**	**αiI 15/7000HV**	**αiI 22/7000HV**	**αiI 30/6000HV**
Output (*2)	Cont. rated kW (HP)	11 (14.7)	15 (20.1)	22 (29.5)	30 (40.2)
	30 min rated kW [15 min, 10min] (*3) (HP)	15 (20.1)	18.5 (24.8)	26 (34.9)	37 (49.6)
	S3 60% kW [40%,25%] (*4)(*5) (HP)	15 (20.1)	18.5 (24.8)	26 (34.9)	37 (49.6)
Rated current A (*6)	Cont. rated	27	37	50	68
	30 min rated (*3) S3 60% (*4)	33	45	57	81
Speed min^{-1}	Base speed	1500	1500	1500	1150
	Max. speed	7000	7000	7000	6000
Output torque (Cont. rated torque at const. rated torque range) N·m (kgf·cm)		70.0 (714)	95.4 (974)	140.0 (1428)	249.1 (2540)
Rotor inertia	$kg{\cdot}m^2$	0.07	0.09	0.128	0.295
	$kgf{\cdot}cm{\cdot}s^2$	0.77	0.93	1.29	3.0
Weight kgf		95	110	143	250
Vibration		V5 (option V3)			
Noise		75dB(A) or less			
Cooling system (*7)		Totally enclosed and fan cooled IC0A6			
Cooling fan W					
Installation (*8)		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			
Allowable overload capacity (1 min) (*9)		120 % of 30 min rated output			
Insulation		Class H			
Ambient temperature		0 to 40°C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Sensor		αiM sensor or αiMZ sensor			
Type of thermal protection (*10)		TP211			
Resolution of the αiMZ sensor /rev.		4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Maximum output during acceleration(*11) kW		18.0	22.2	31.2	44.4
Applicable spindle amplifier		αiSP 15HV	αiSP 30HV		αiSP 45HV
Model		αiI 12/7000HV	αiI 15/7000HV	αiI 22/7000HV	αiI 30/6000HV

Series			αiI series 400V type			
Item \ Model			αiI 40/6000HV	αiI 60/4500HV	αiI 100/4000HV (*1) Low-speed winding (Y connection)	αiI 100/4000HV (*1) High-speed winding (Δ connection)
Output (*2)	Cont. rated kW (HP)		37 (49.6)	60 (80.4)	100 (134.0)	100 (134.0)
	30 min rated kW (*3) (HP)		45 (60.3)	75 (100.5)	-	-
	S3 60% [40%] kW (*4)(*5) (HP)		45 (60.3)	75 (100.5)	-	-
Rated current A (*6)	Cont. rated		84	138	159	170
	30 min rated S3 60%		97	163	-	-
Speed min^{-1}	Base speed	Cont. rated	1500	1380	1000	2000
		30 min rated	1500	1150	-	-
		120 min rated	-	1150	-	-
	Max. speed		6000	4500	3000	4000
Output torque (Cont. rated torque at const. rated torque range) N·m (kgf·cm)			235.5 (2402)	415.1 (4234)	955 (9738)	477 (4869)
Rotor inertia	$kg·m^2$		0.355	0.49	0.98	
	$kgf·cm·s^2$		3.6	5.0	10	
Weight kgf			290	468	820	
Vibration			V5 (option V3)	V10 (option V5)	V10	
Noise			75dB(A) or less	80dB(A) or less		
Cooling system (*7)			Totally enclosed and fan cooled IC0A6			
Cooling fan W				180	Circumference fan motor : 84×2 Rear fan motor : 84	
Installation (*8)			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			
Allowable overload capacity (1 min) (*9)			120 % of 30 min rated output		120 % of continuous rated output	
Insulation			Class H			
Ambient temperature			0 to 40°C			
Altitude			Height above sea level not exceeding 1000m			
Painting color			Munsell system N2.5			
Sensor			αiM sensor or αiMZ sensor		αiMZ sensor	
Type of thermal protection (*10)			TP211			
Resolution of the αiMZ sensor /rev.			4096			
Number of detected gear teeth per rotation λ/rev.			256			
Bearing lubrication			Grease			
Maximum output during acceleration(*11) kW			54	90	117	
Applicable spindle amplifier			αiSP 45HV	αiSP 75HV	αiSP 75HV	
Model			αiI 40/6000HV	αiI 60/4500HV	αiI 100/4000HV	

(*1) For αiI 100/4000HV, the CNC soft option and switching magnetic contactor unit associated with the output switch function (Y-Δ switch) are required.
See FANUC SERVO AMPLIFIER α*i* series DESCRIPTIONS (B-65282EN) for details of the output switch control.
(*2) The rated output is guaranteed at the rated voltage.
(Amplifier input:
α*i*I 100/4000HV : 460/480VAC +10% -0%, 50/60 Hz ±1Hz
Models except α*i*I 100/4000HV : 400/480VAC +10% -15%, 50/60 Hz ±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.
(*3) The output for α*i*I 0.5/10000HV, α*i*I 1/10000HV, or α*i*I 2/10000HV is 15 min rated. That for α*i*I 1.5/10000HV is 10 min rated.
(*4) S3 40% for α*i*I 0.5/10000HV, α*i*I 30/6000HV, or α*i*I 60/4500HV, S3 25% for α*i*I 1.5/10000HV.
(*5) The cycle time is 10 minutes, S3 60%: ON 6 minutes, OFF 4 minutes, S3 40%: ON 4 minutes, OFF 6 minutes and S3 25%: ON 2.5 minutes, OFF 7.5 minutes.
(*6) The rated current is not a guaranteed value but a guideline for the maximum current at rated output.
(*7) IC code conforms to IEC 34-6.
(*8) IM code conforms to IEC 34-7.
(*9) This is not a guaranteed value but a guideline for the maximum motor output at a rated supply voltage. 120% of 15 min rated for α*i*I 0.5/10000HV, α*i*I 1/10000HV, or α*i*I 2/10000HV, 120% of 10 min rated for α*i*I 1.5/10000HV, and 120% of continuous rated for α*i*I 100/40000HV.
(*10) Type conforms to IEC 34-11.
(*11) These values are to be used only as guidance for selecting a power supply (α*i*PS) and are not guaranteed.
(*12) Degree of protection: with oil seal:IP54, without oil seal:IP40.
Degree of protection (α*i*I 100/4000HV): with oil seal:IP40.
(*13) Input power supply voltage of a fan motor for α*i*I 1/10000HV, α*i*I 1.5/10000HV, α*i*I 2/10000HV, or α*i*I 3/10000HV is 200/230VAC +10% -15%, 50/60 Hz ±1Hz.

3 OUTPUT/TORQUE CHARACTERISTICS

Reference
Calculation for torque

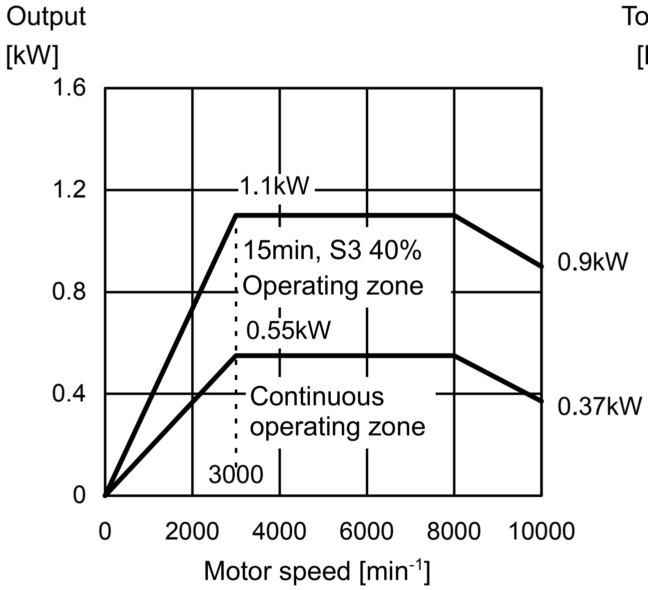
Torque T can be obtained by the following equation.

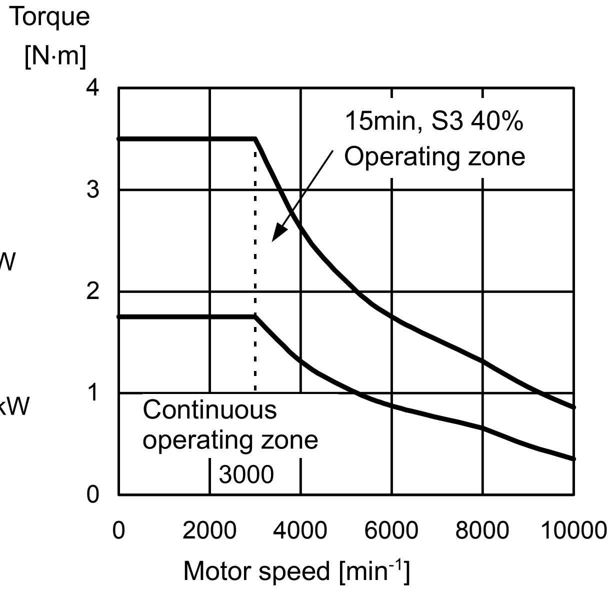
$T[N\cdot m]=P[kW]\times 1000/0.1047/N[min^{-1}]$
P[kW]: Motor output
$N[min^{-1}]$: Motor speed

When the unit of T is [kgf·m],
$T[kgf\cdot m]=P[kW]\times 1000/1.0269/N[min^{-1}]$

3.1 MODEL αiI 0.5/10000HV

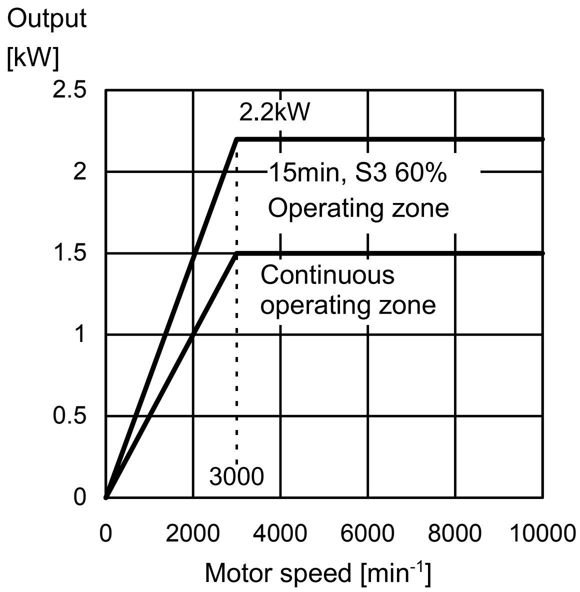
Applicable amplifier αiSP 5.5HV

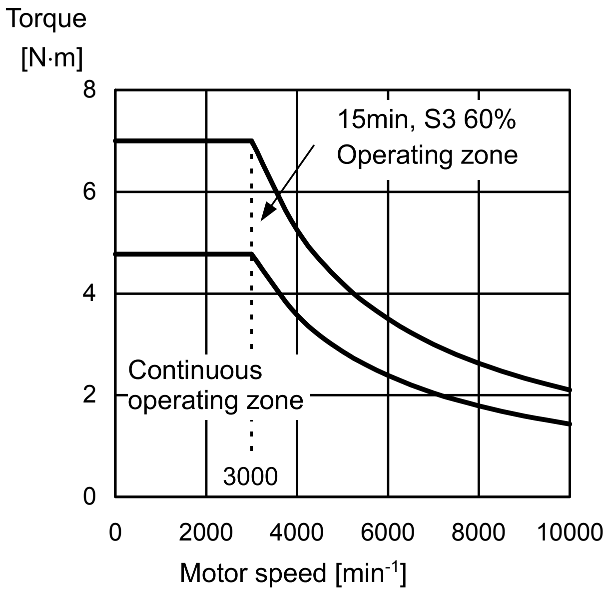




3.2 MODEL αiI 1/10000HV

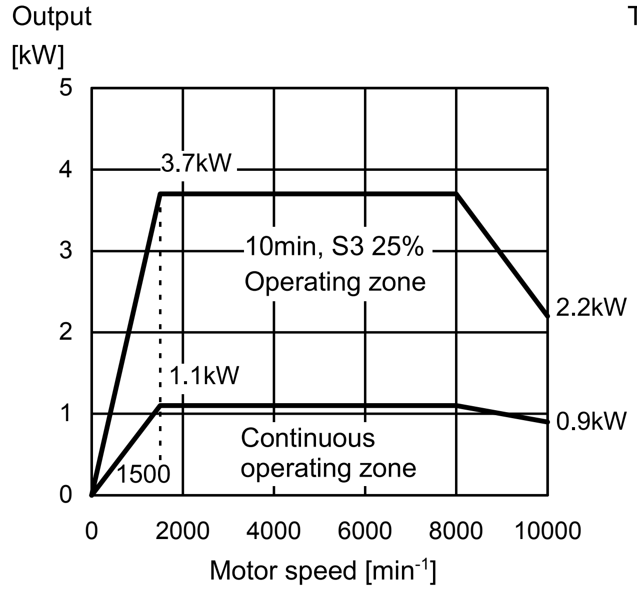
Applicable amplifier αiSP 5.5HV

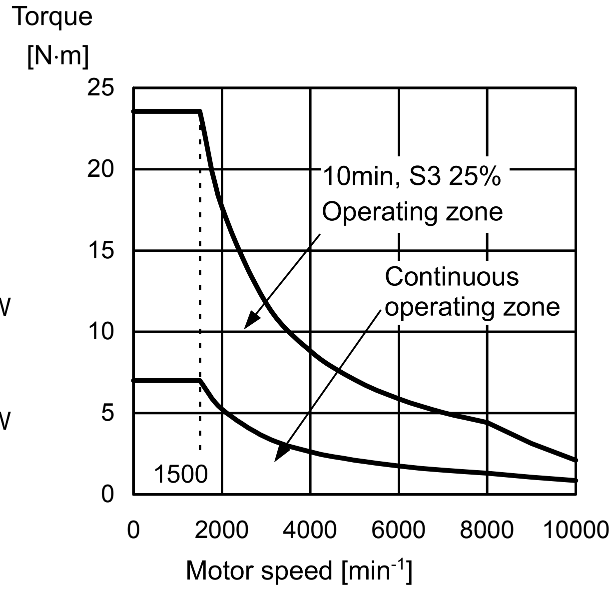




3.3 MODEL αiI 1.5/10000HV

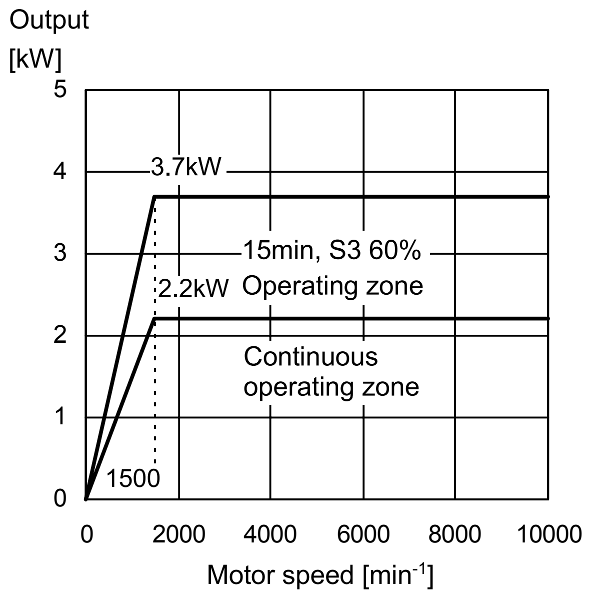
Applicable amplifier αiSP 5.5HV

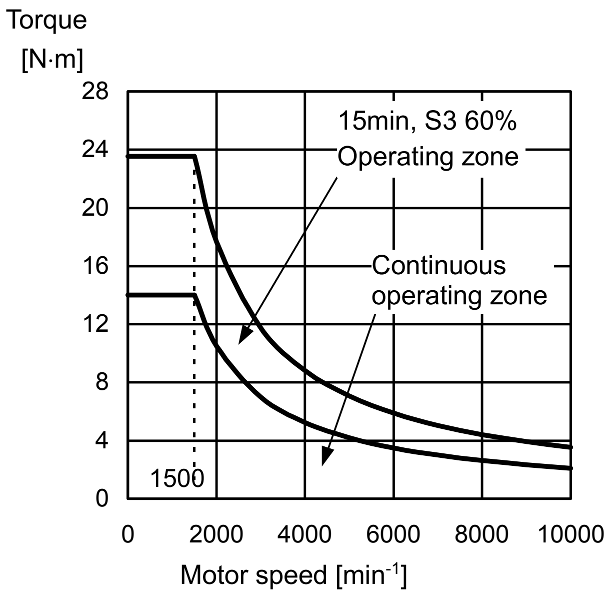




3.4 MODEL αiI 2/10000HV

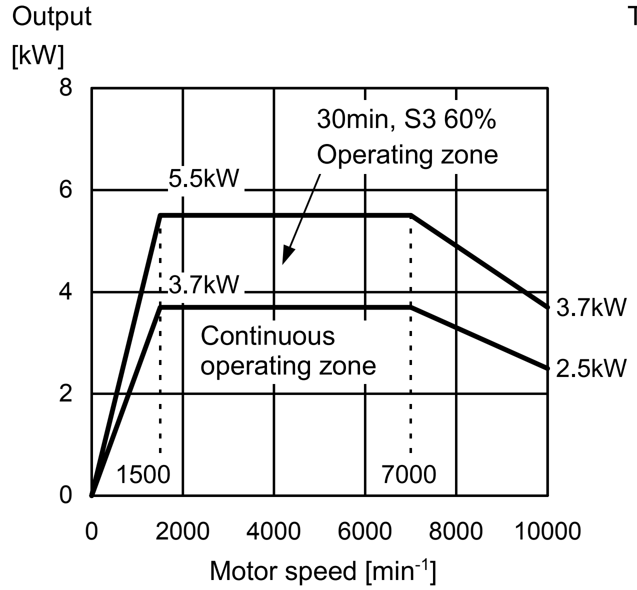
Applicable amplifier αiSP 5.5HV

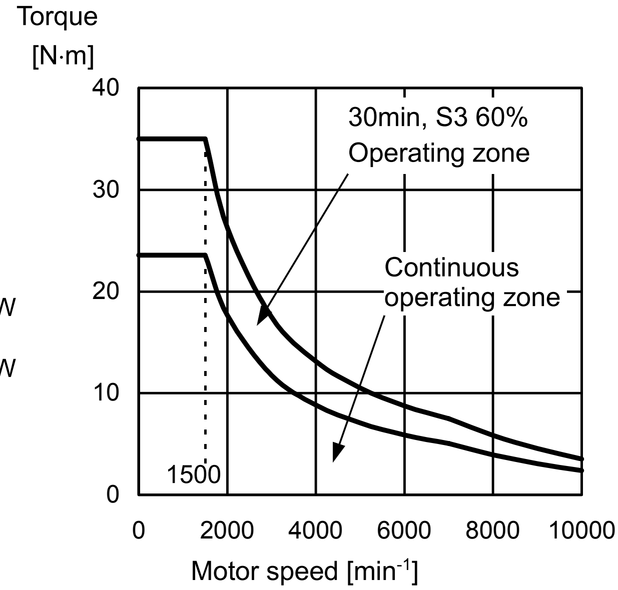




3.5 MODEL αiI 3/10000HV

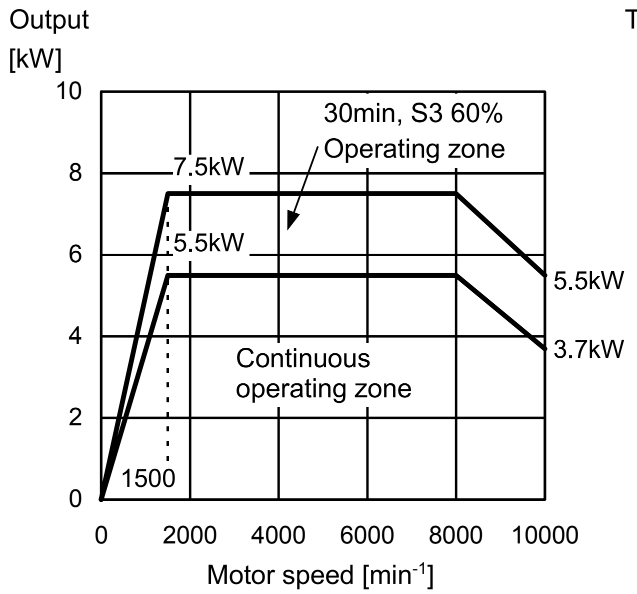
Applicable amplifier αiSP 5.5HV

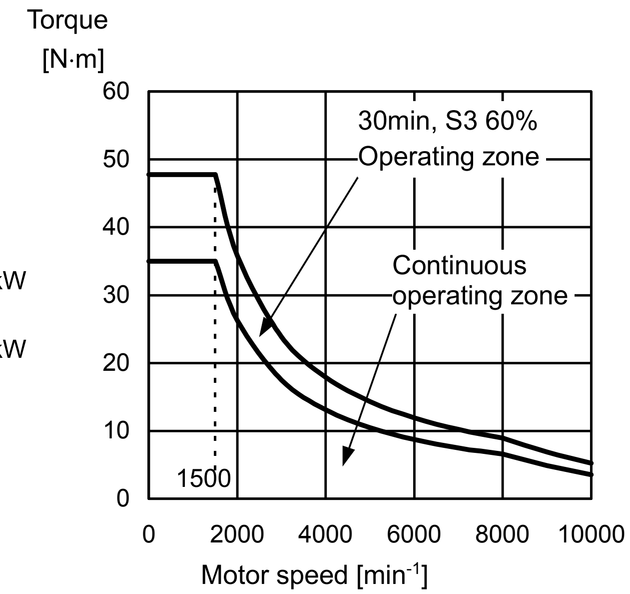




3.6 MODEL αiI 6/10000HV

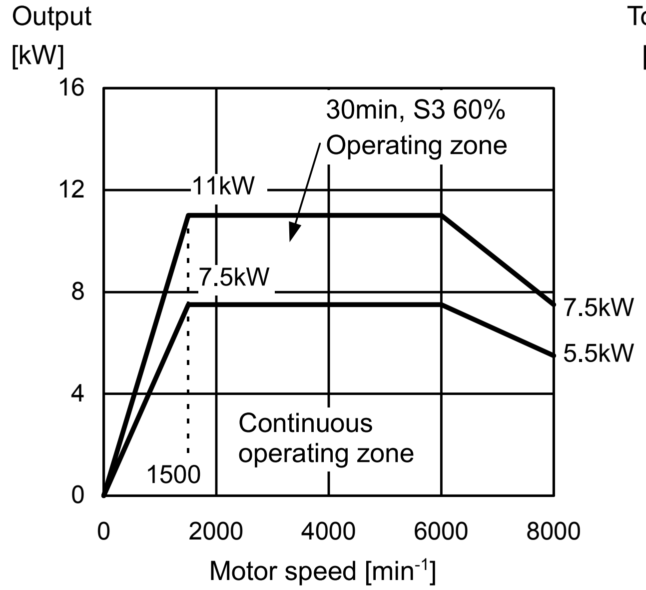
Applicable amplifier αiSP 11HV

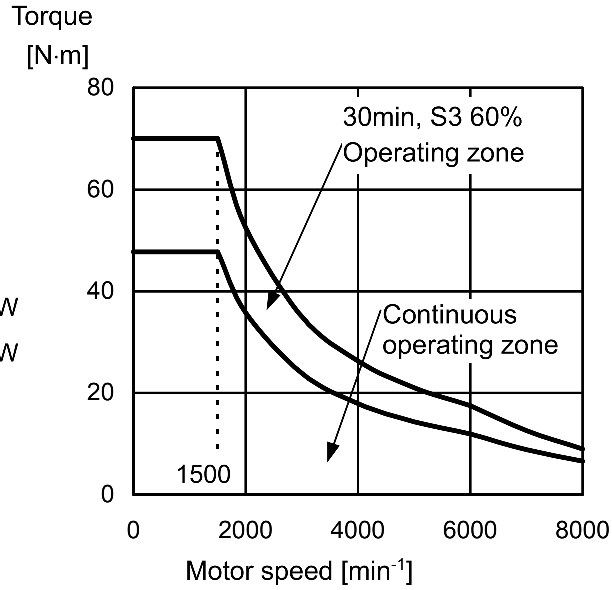




3.7 MODEL αiI 8/8000HV

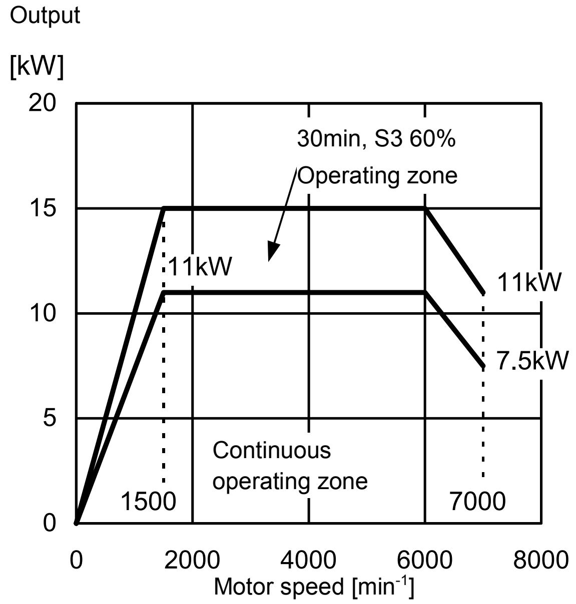
Applicable amplifier αiSP 11HV

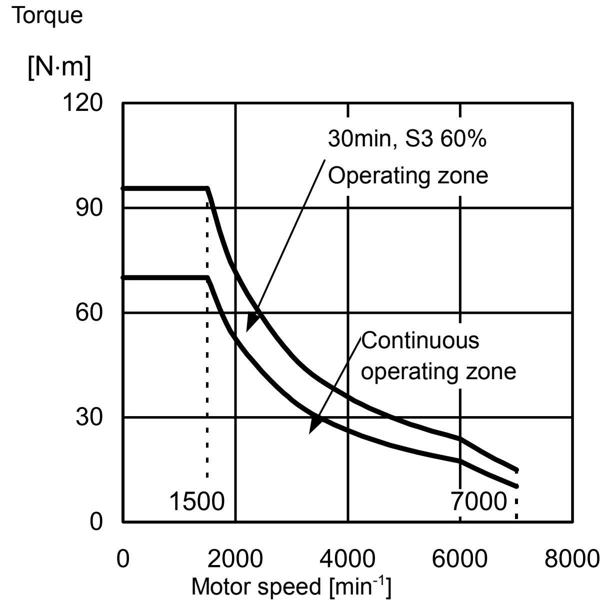




3.8 MODEL αiI 12/7000HV

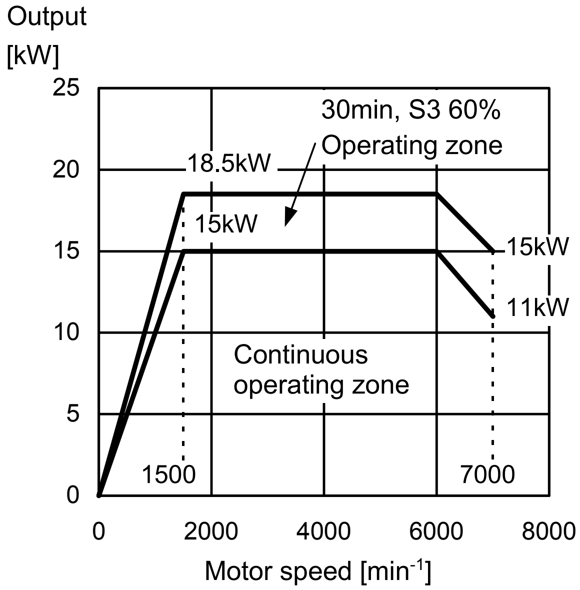
Applicable amplifier αiSP 15HV

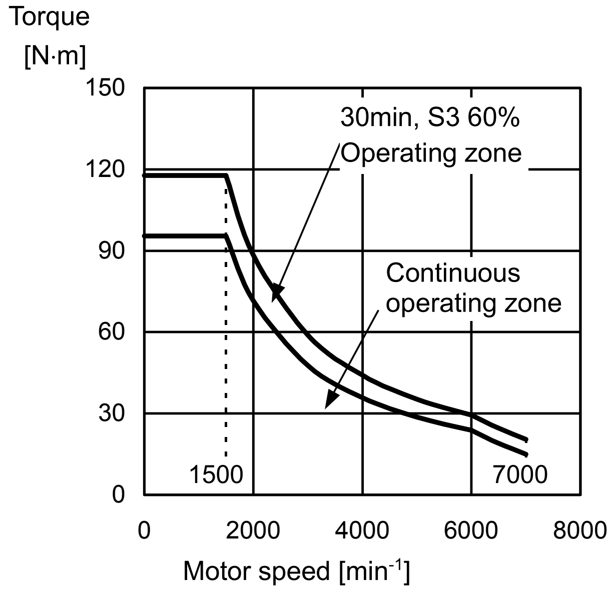




3.9 MODEL αiI 15/7000HV

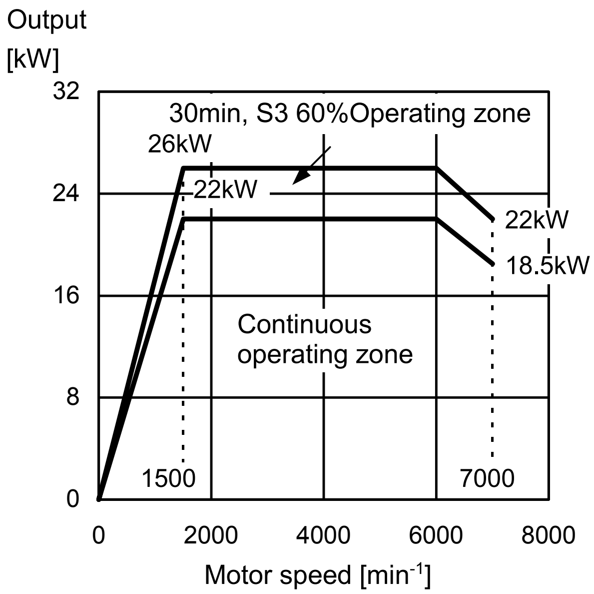
Applicable amplifier αiSP 30HV

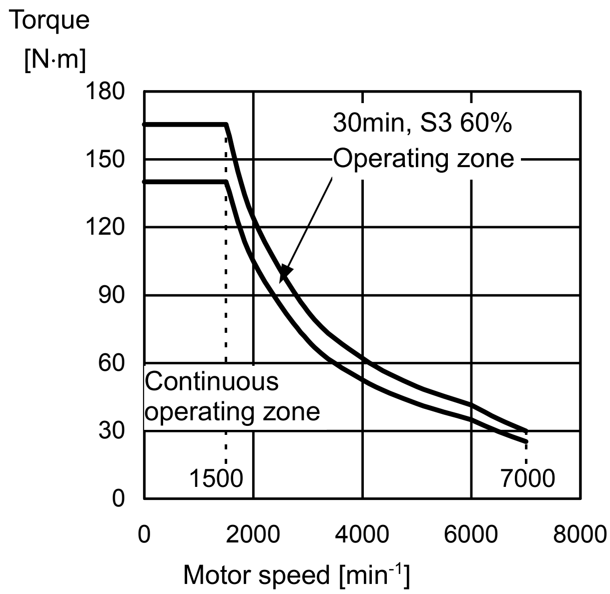




3.10 MODEL αiI 22/7000HV

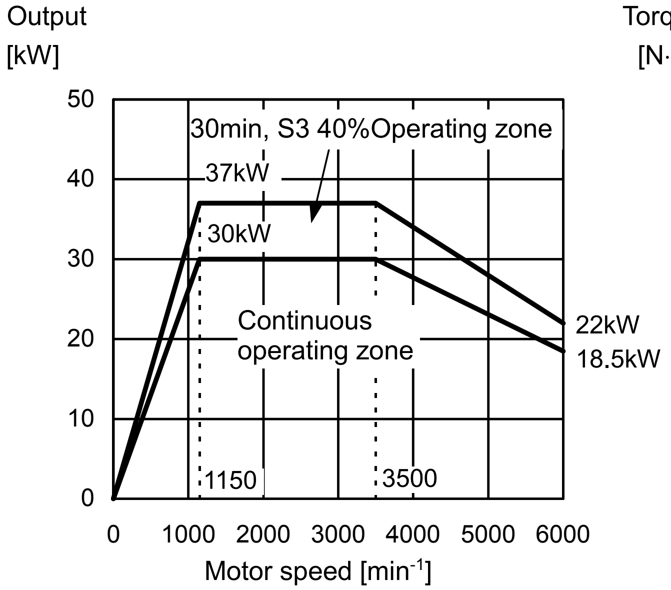
Applicable amplifier αiSP 30HV

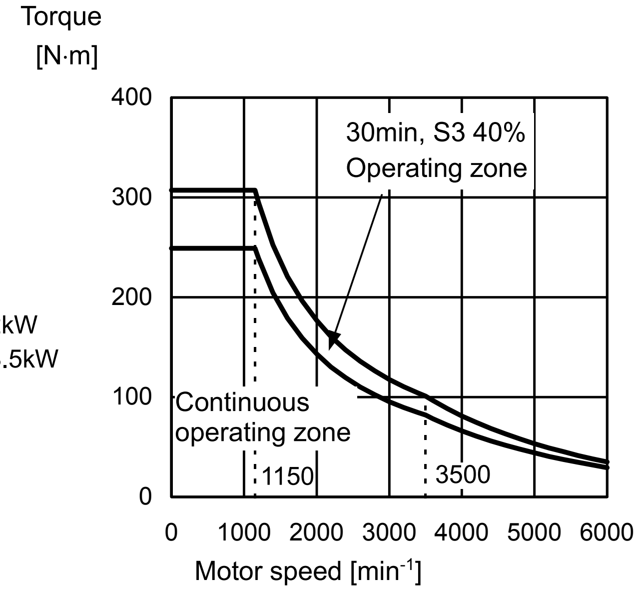




3.11 MODEL αiI 30/6000HV

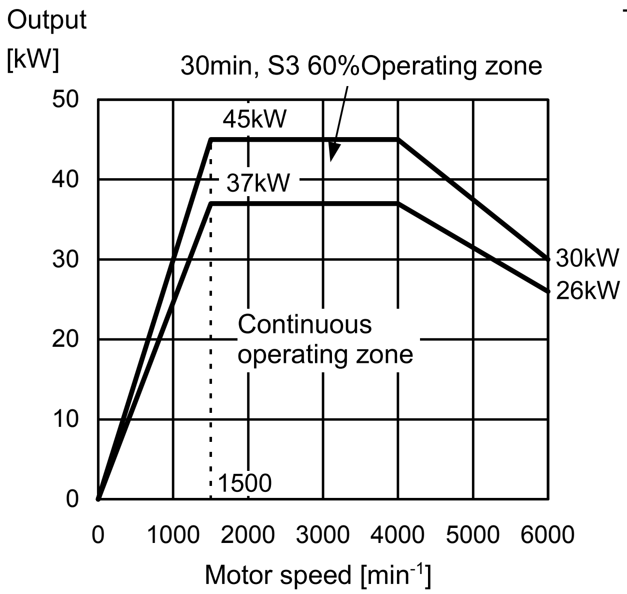
Applicable amplifier αiSP 45HV

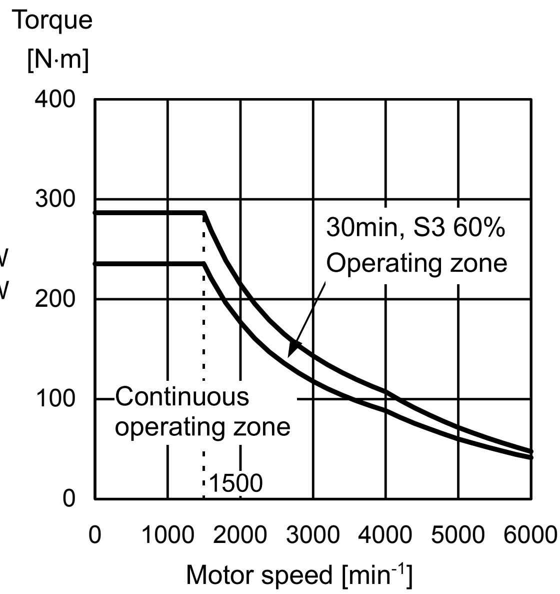




3.12 MODEL αiI 40/6000HV

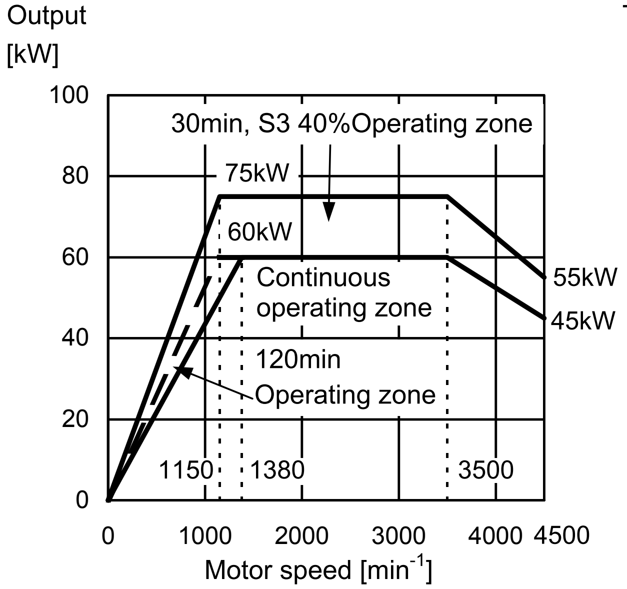
Applicable amplifier αiSP 45HV

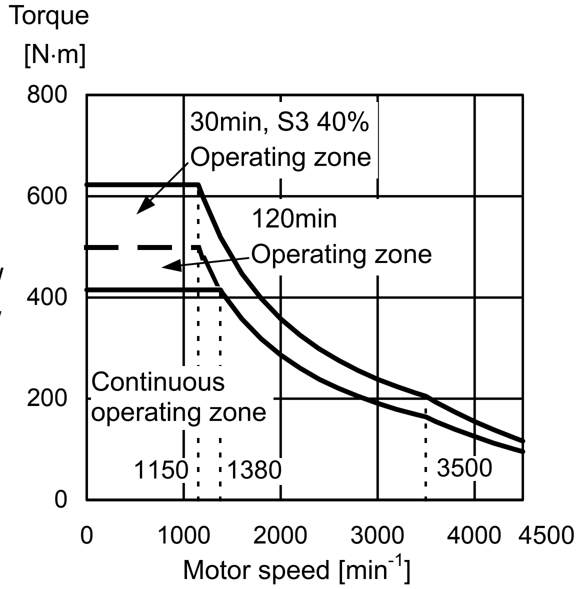




3.13 MODEL αiI 60/4500HV

Applicable amplifier αiSP 75HV

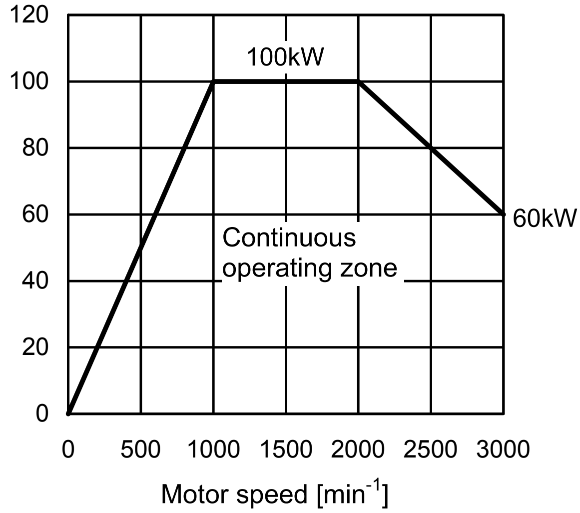




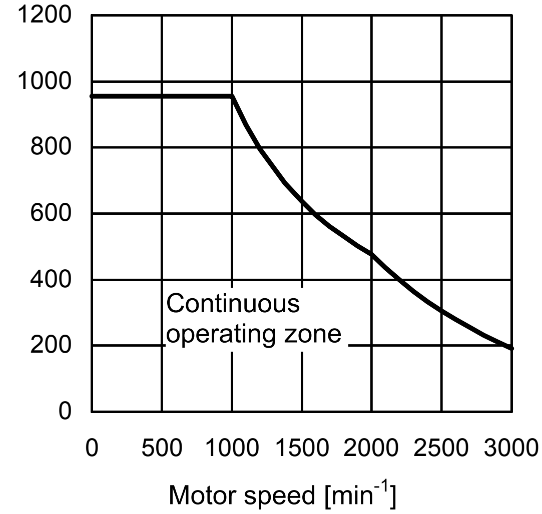
3.14 MODEL αiI 100/4000HV

Applicable amplifier αiSP 75HV

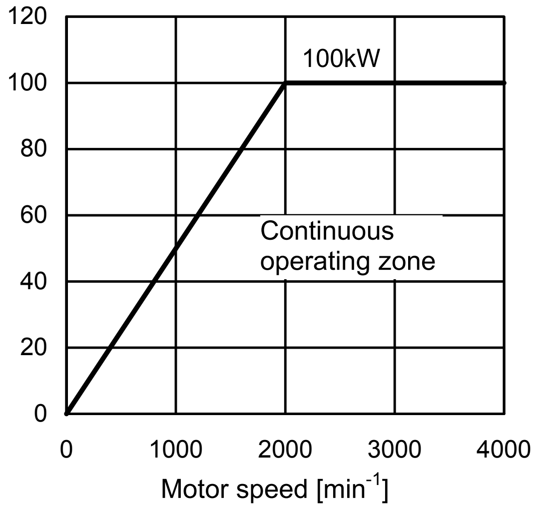
Low-speed winding output (Y connection)
[kW]



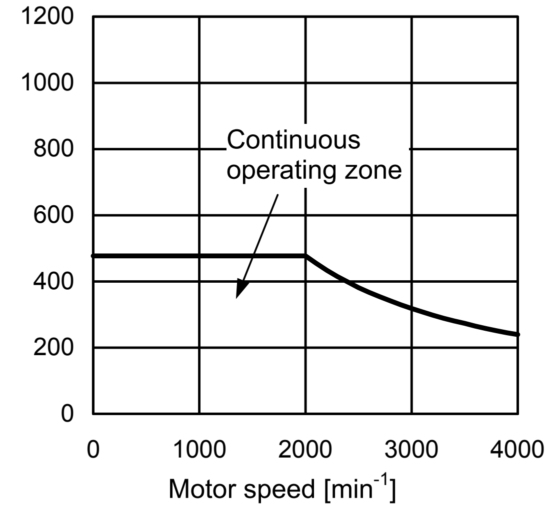
Low-speed winding torque (Y connection)
[N·m]



High-speed winding output (Δ connection)
[kW]



High-speed winding torque (Δ connection)
[N·m]

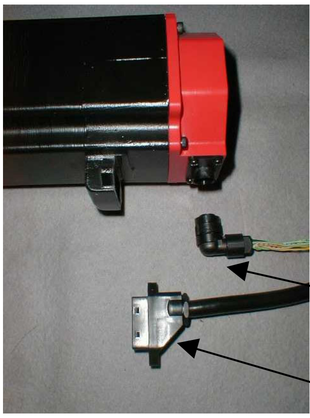


4 CONNECTIONS

4.1 MODEL αiI 0.5/10000HV

The power lead and signal lead are connected with the connector. Use the shield cable for the connection.

Refer to FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN) for other respects in the connection.



Connection of power lead

Connector parts related to cable side

	Ordering number	Tyco Electronics AMP specification
Connector kit of power lead	A06B-6114-K220/S (FANUC specification : A63L-0001-0875/SC)	1473063-2

Power lead specification

Number of core	Conductor size	Grounding cable cross-section	Sheath diameter (Note)
4 or more	AWG16 to 18	φ1.8 to 2.8mm	φ10.4 to 11.4mm

NOTE

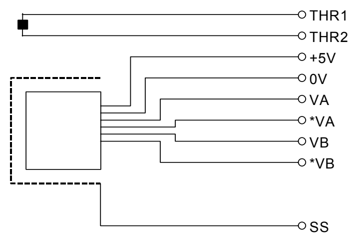
If the outer sheath diameter is inadequate, the waterproofness can degrade.

Connector pins arrangement

1	2	3	4	5	6
U	V	W	G	-	-

Connection of signal lead

- For type with αiM sensor



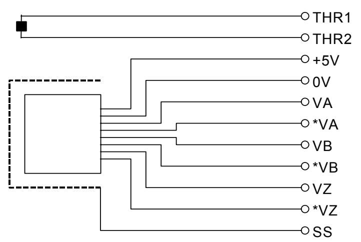
Connector parts related to cable side

	Japan Aviation Electronics Industry specification
Connector	JN2xS10SL1-R: Applicable sheath diameter ϕ5.7 to 7.3 JN2xS10SL2-R: Applicable sheath diameter ϕ6.5 to 8.0 ↑ D:Straight plug F:Elbow plug
Terminal	JN1-22-22S

Connector pins arrangement

	1	2	3
	*VA	*VB	-
4	5	6	7
VA	VB	-	0V
	8	9	10
	+5V	THR1	THR2

- For type with αiMZ sensor



Connector parts related to cable side

	Japan Aviation Electronics Industry specification
Connector	JN2xS10SL1-R: Applicable sheath diameter ϕ5.7 to 7.3 JN2xS10SL2-R: Applicable sheath diameter ϕ6.5 to 8.0 ↑ D:Straight plug F:Elbow plug
Terminal	JN1-22-22S

Connector pins arrangement

	1	2	3
	*VA	*VB	*VZ
4	5	6	7
VA	VB	VZ	0V
	8	9	10
	+5V	THR1	THR2

- 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 kΩ as measured at room temperature (20°C to 30°C).

4.2 MODELS αiI 1/10000HV TO αiI 100/4000HV

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

αiM sensor or αiMZ sensor signal or thermistor signal use a connector manufactured by Tyco Electronics AMP.
The connector housing and the connector are attached to the motor.

Size of screws used in the terminal block / Model	Power lead		Fan motor	
	U,V,W,G	X,Y,Z	FMU,FMV,FMW	FMU,FMV
αiI 1/10000HV to αiI 1.5/10000HV	M5	-	-	M4
αiI 2/10000HV to αiI 3/10000HV	M5	-	-	Screw-less terminal block
αiI 6/10000HV to αiI 22/7000HV	M5	-	Screw-less terminal block	-
αiI 30/6000HV, αiI 40/6000HV	M10	-	Screw-less terminal block	-
αiI 60/4500HV	M10	-	M3.5	-
αiI 100/4000HV	M8	M8	M3.5	-

Cable for the power lead

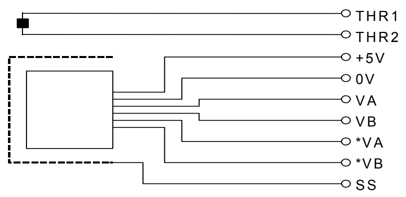
For the power lead cable specification, refer to "FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN)".

Cable for the fan motor

For the fan motor current value and cable specifications, refer to Section I.4.3, "FAN MOTOR CONNECTION" in this manual.

4.3 CONNECTION OF SIGNAL LEAD

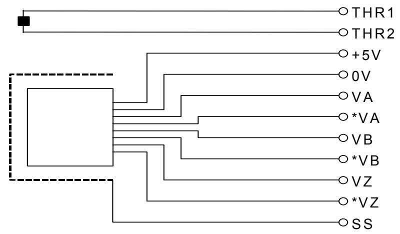
Connector attachment for a motor with a built-in αiM sensor



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		*VA	*VB		0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	VA	VB		SS	THR1

Connector attachment for a motor with a built-in αiMZ sensor



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		*VA	*VB	*VZ	0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	VA	VB	VZ	SS	THR1

- Connector housing and contact specifications

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

	Motor side		Cable side	
	FANUC specification	Manufacture specification	FANUC specification	Manufacture 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 kΩ as measured at room temperature (20°C to 30°C).

5 ALLOWABLE RADIAL LOAD

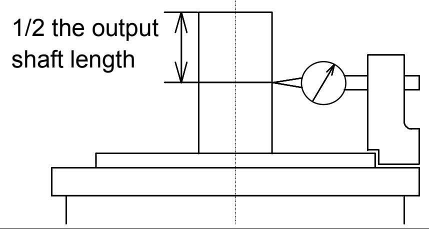
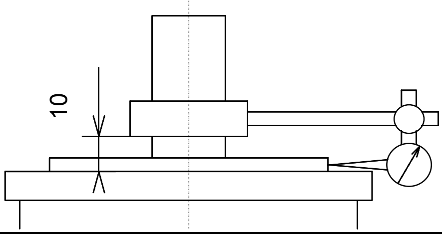
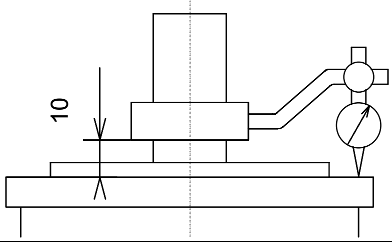
Use the motor output shaft below the allowable radial loads shown in the table below.

Model	Allowable radial load (kgf)	
	At output shaft end	At output shaft center
αiI 0.5/10000HV	294N (30kgf)	323N (33kgf)
αiI 1/10000HV	392N (40kgf)	441N (45kgf)
αiI 1.5/10000HV	882N (90kgf)	980N (100kgf)
αiI 2/10000HV	882N (90kgf)	999N (102kgf)
αiI 3/10000HV	1470N (150kgf)	1607N (164kgf)
αiI 6/10000HV	1960N (200kgf)	2205N (225kgf)
αiI 8/8000HV	2940N (300kgf)	3371N (344kgf)
αiI 12/7000HV, αiI 15/7000HV	2940N (300kgf)	3410N (348kgf)
αiI 22/7000HV	4410N (450kgf)	4988N (509kgf)
αiI 30/6000HV, αiI 40/6000HV	5390N (550kgf)	6134N (626kgf)
αiI 60/4500HV	-	19600N (2000kgf)
αiI 100/4000HV	Direct connection to the spindle	

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. If a thrust load is applied when a helical gear is used, the shaft moves in the direction of the thrust. So, as a general rule, never apply a thrust load.

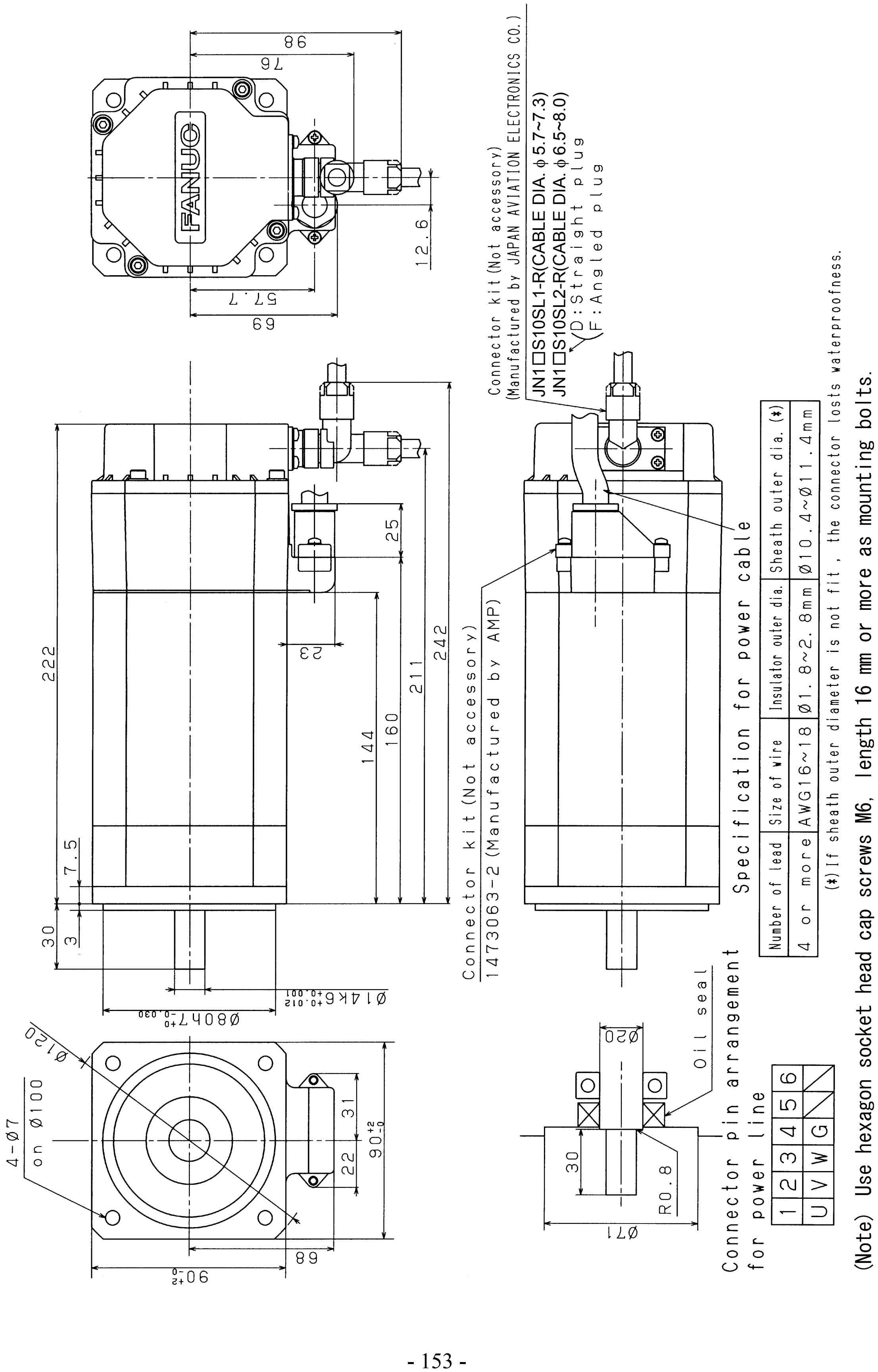
6 ASSEMBLING ACCURACY

Model / Item	αiI 0.5HV to αiI 22HV	αiI 30HV to αiI 60HV	αiI 100HV	Measuring method
Run-out at the end of the output shaft	20μm or less	20μm or less	40μm or less	
Run-out of the faucet joint for mounting the flange against the core of the shaft (for flange type or foot flange type)	40μm or less	60μm or less	200μm or less	
Run-out of the flange mounting surface against the core of the shaft (for flange type or foot flange type)	80μm or less	100μm or less	200μm or less	

7 EXTERNAL DIMENSIONS

Model name	Section
Model αiI 0.5/10000HV (flange mounting type)	7.1
Model αiI 1/10000HV (flange mounting type)	7.2
Model αiI 1/10000HV (foot mounting type)	7.3
Model αiI 1.5/10000HV (flange mounting type)	7.4
Model αiI 1.5/10000HV (foot mounting type)	7.5
Model αiI 2/10000HV (flange mounting type)	7.6
Model αiI 2/10000HV (foot mounting type)	7.7
Model αiI 3/10000HV (flange mounting type)	7.8
Model αiI 3/10000HV (foot mounting type)	7.9
Model αiI 6/10000HV (flange mounting type)	7.10
Model αiI 6/10000HV (foot mounting type)	7.11
Model αiI 8/8000HV (flange mounting type)	7.12
Model αiI 8/8000HV (foot mounting type)	7.13
Model αiI 12/7000HV (flange mounting type)	7.14
Model αiI 12/7000HV (foot mounting type)	7.15
Model αiI 15/7000HV (flange mounting type)	7.16
Model αiI 15/7000HV (foot mounting type)	7.17
Model αiI 22/7000HV (flange mounting type)	7.18
Model αiI 22/7000HV (foot mounting type)	7.19
Model αiI 30/6000HV (flange mounting type)	7.20
Model αiI 30/6000HV (foot mounting type)	7.21
Model αiI 40/6000HV (flange mounting type)	7.22
Model αiI 40/6000HV (foot mounting type)	7.23
Model αiI 60/4500HV (flange mounting type)	7.24
Model αiI 60/4500HV (foot mounting type)	7.25
Model αiI 100/4000HV (foot flange mounting type)	7.26

7.1 MODEL αiI 0.5/10000HV (FLANGE MOUNTING TYPE)



Specification for power cable

Number of lead	Size of wire	Insulator outer dia.	Sheath outer dia. (*)
4 or more	AWG16~18	Ø1.8~2.8mm	Ø10.4~Ø11.4mm

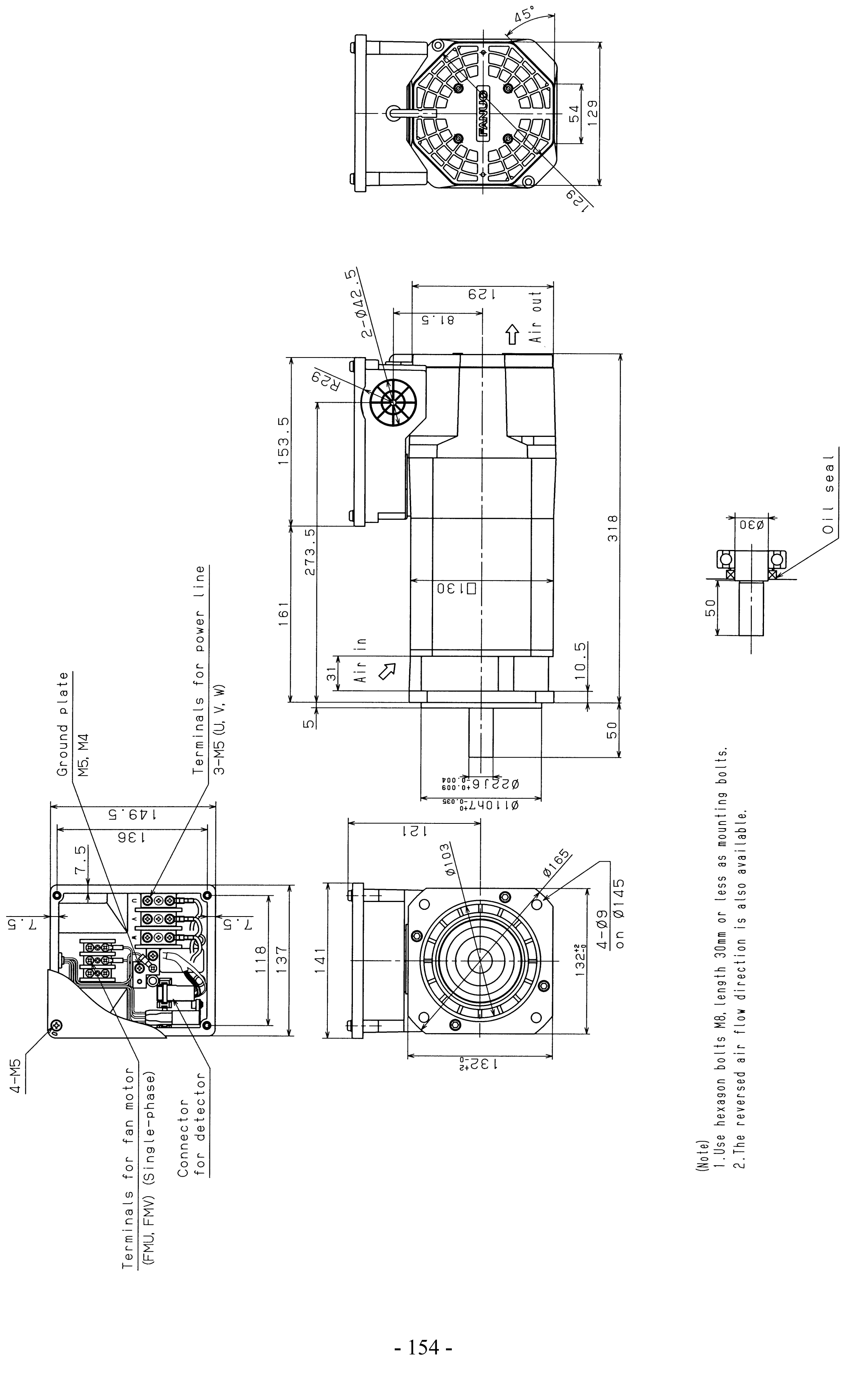
(*) If sheath outer diameter is not fit, the connector losts waterproofness.

Connector pin arrangement for power line

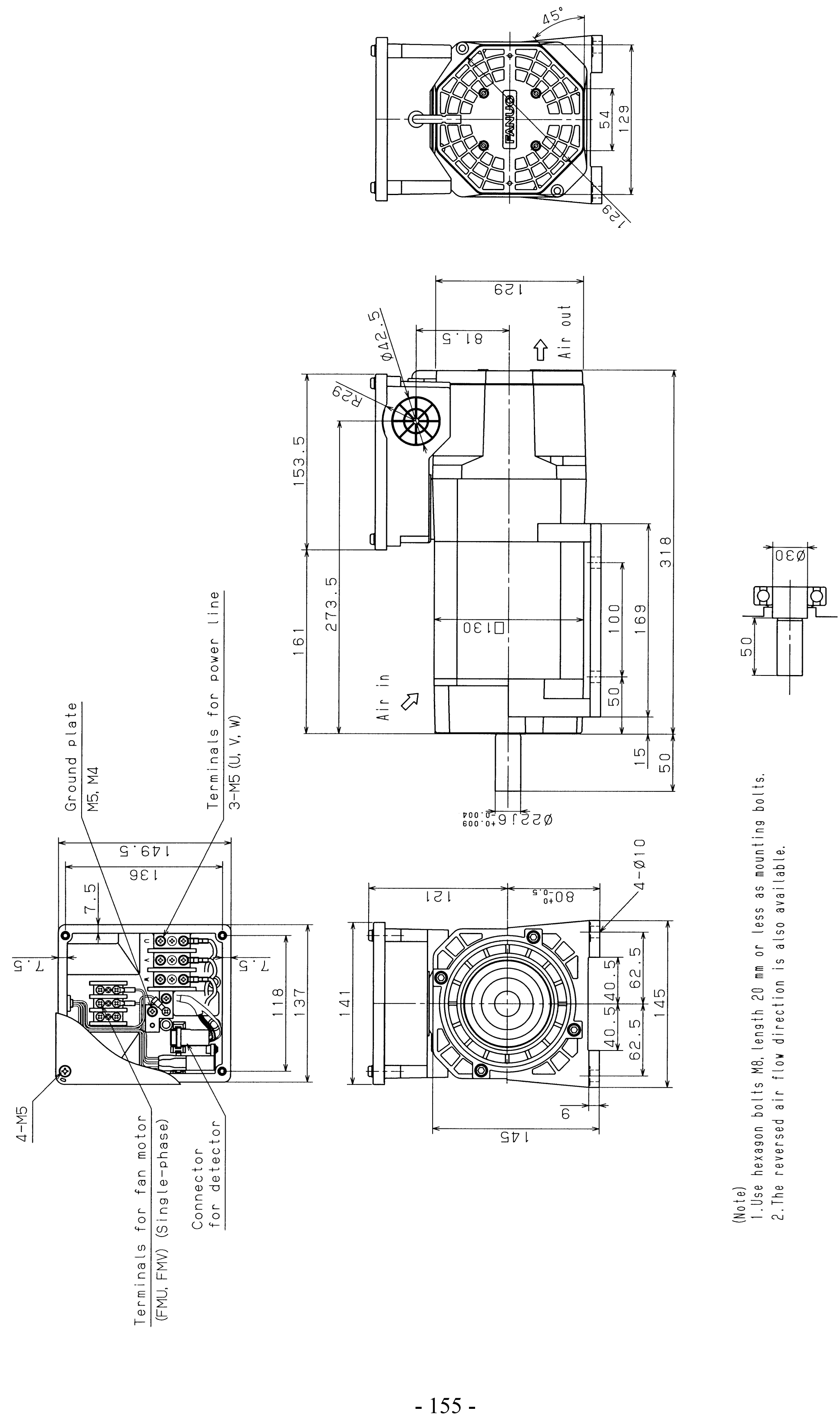
1	2	3	4	5	6
U	V	W	G		

(Note) Use hexagon socket head cap screws M6, length 16 mm or more as mounting bolts.

7.2 MODEL αiI 1/10000HV (FLANGE MOUNTING TYPE)

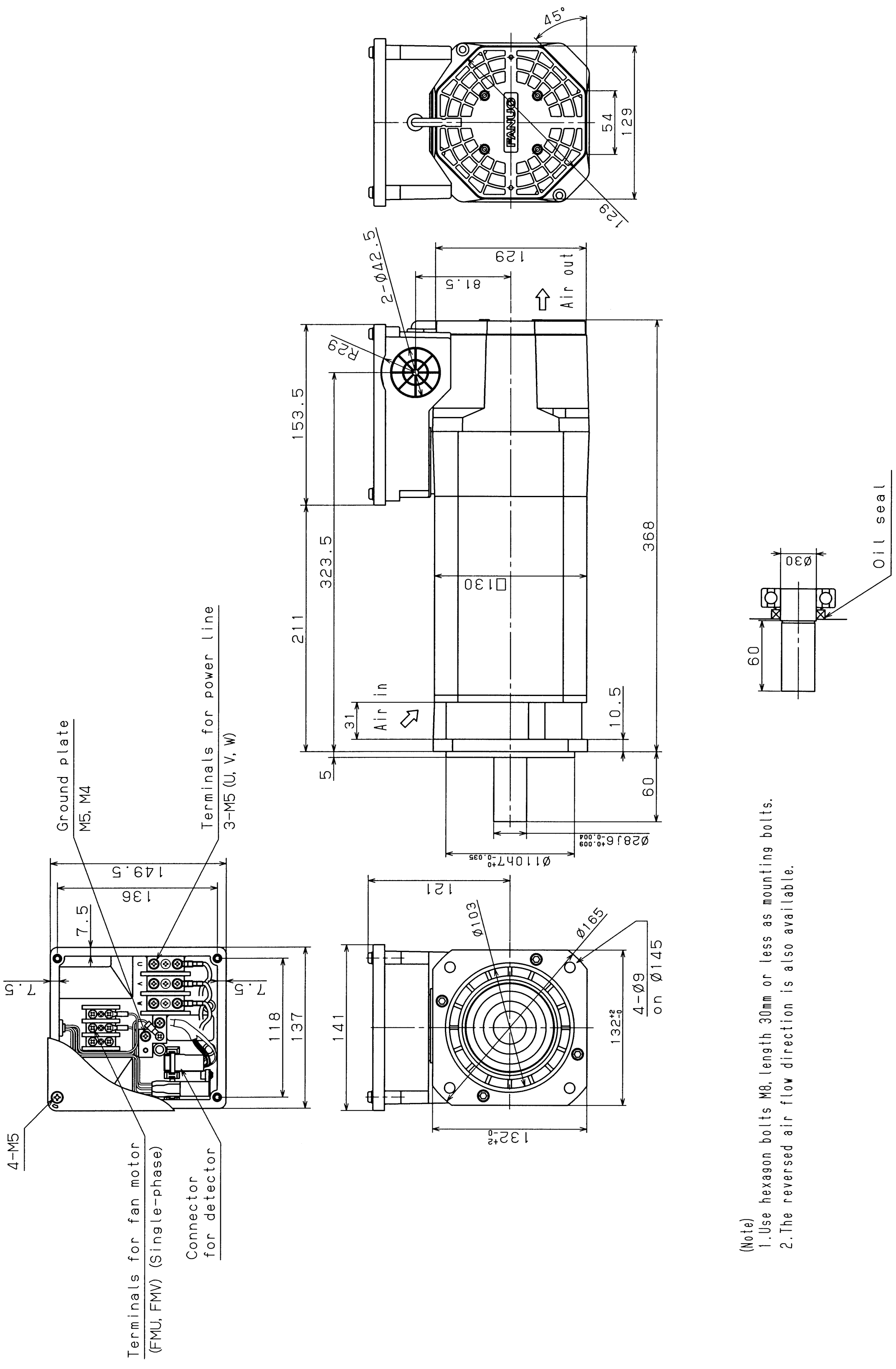


7.3 MODEL αiI 1/10000HV (FOOT MOUNTING TYPE)

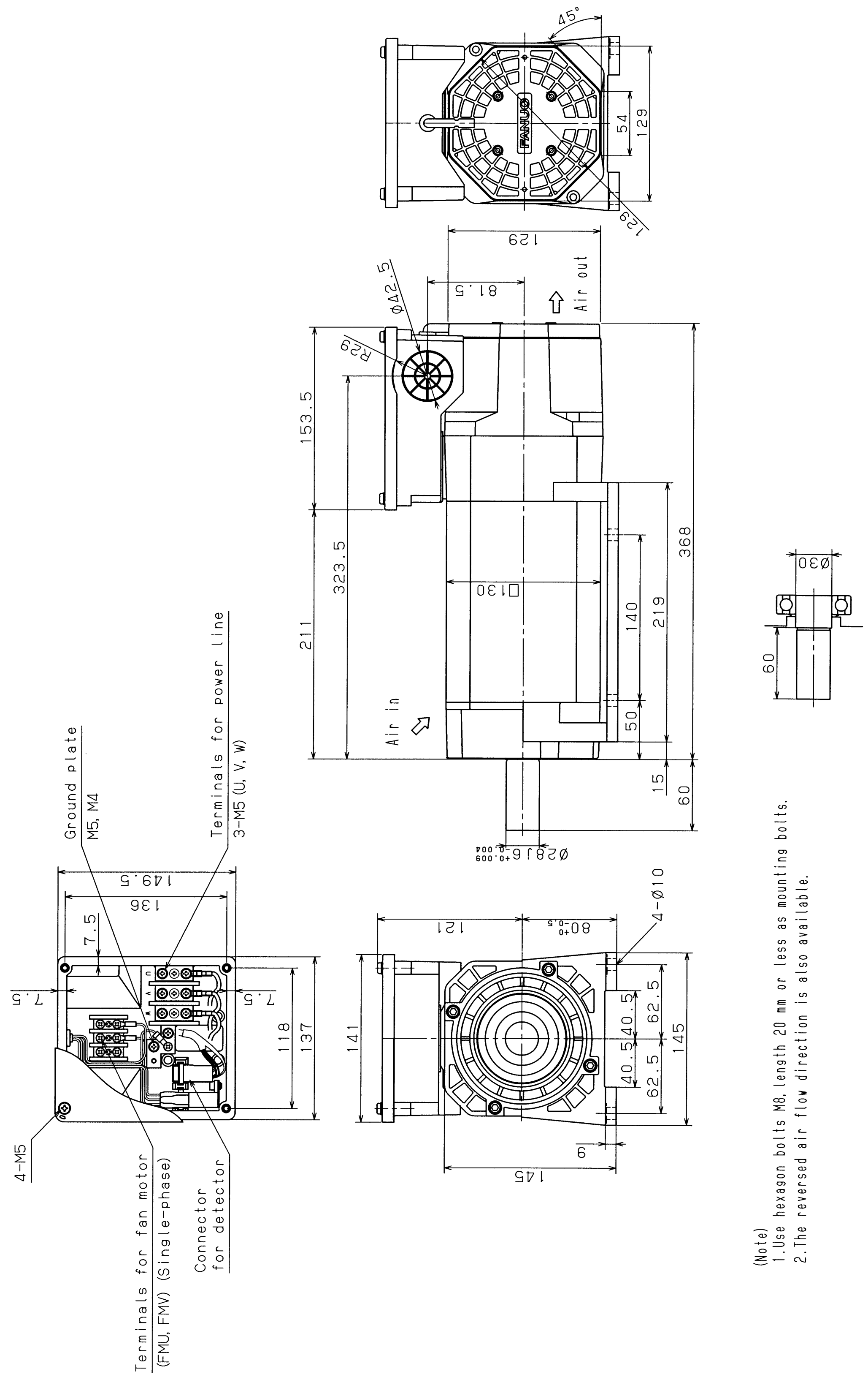


(Note)
1. Use hexagon bolts M8, length 20 mm or less as mounting bolts.
2. The reversed air flow direction is also available.

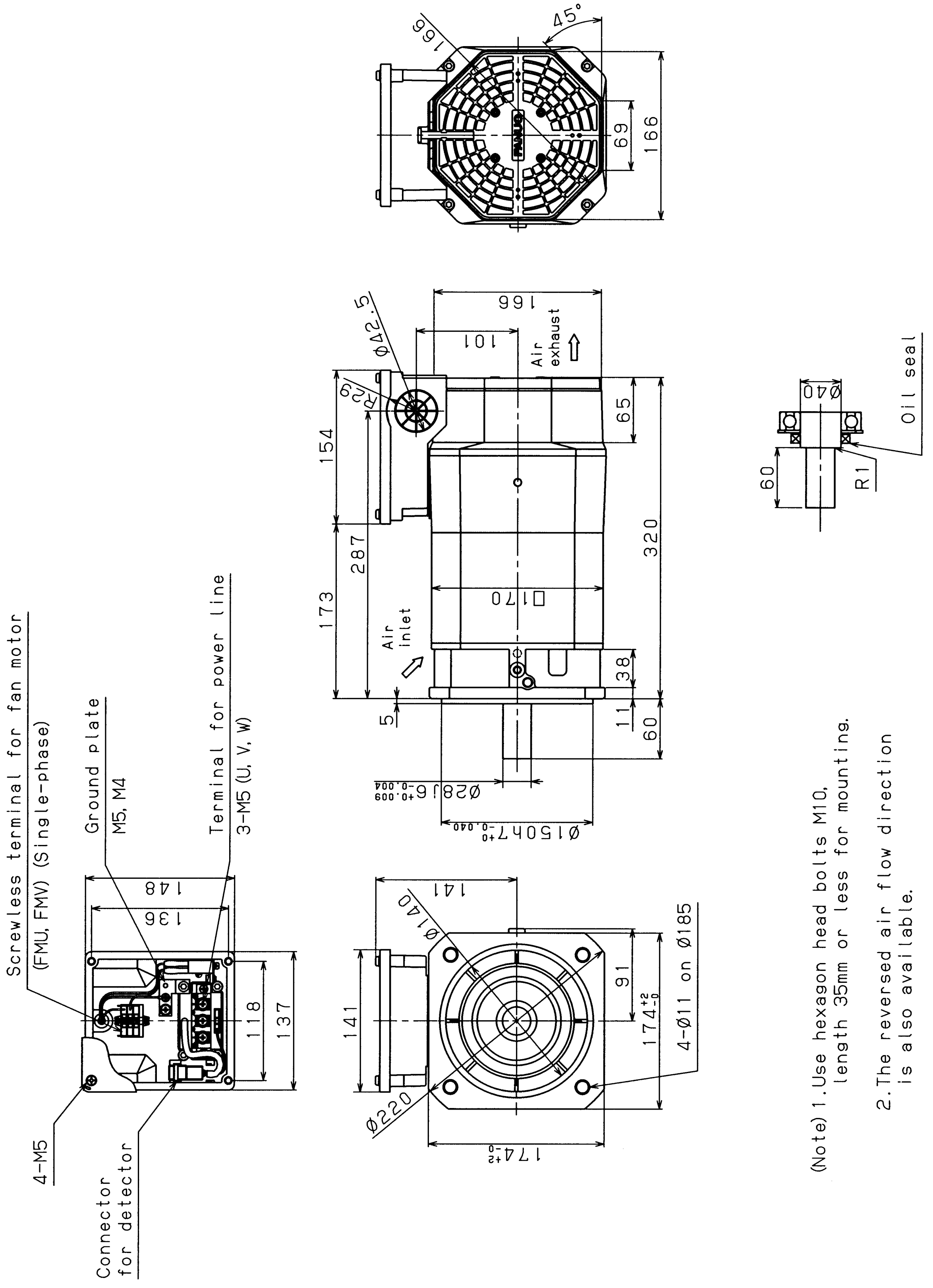
7.4 MODEL αiI 1.5/10000HV (FLANGE MOUNTING TYPE)



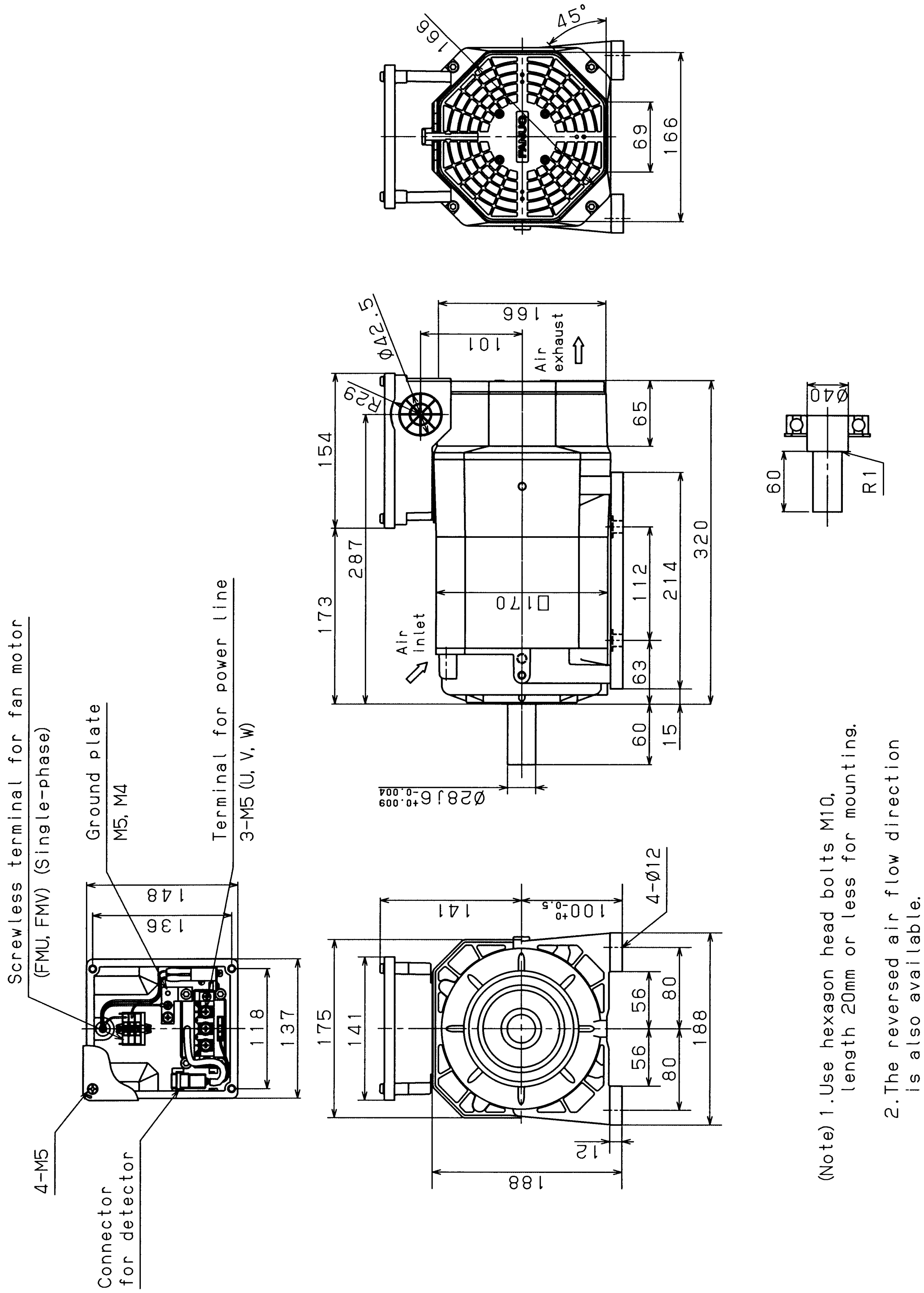
7.5 MODEL αiI 1.5/10000HV (FOOT MOUNTING TYPE)



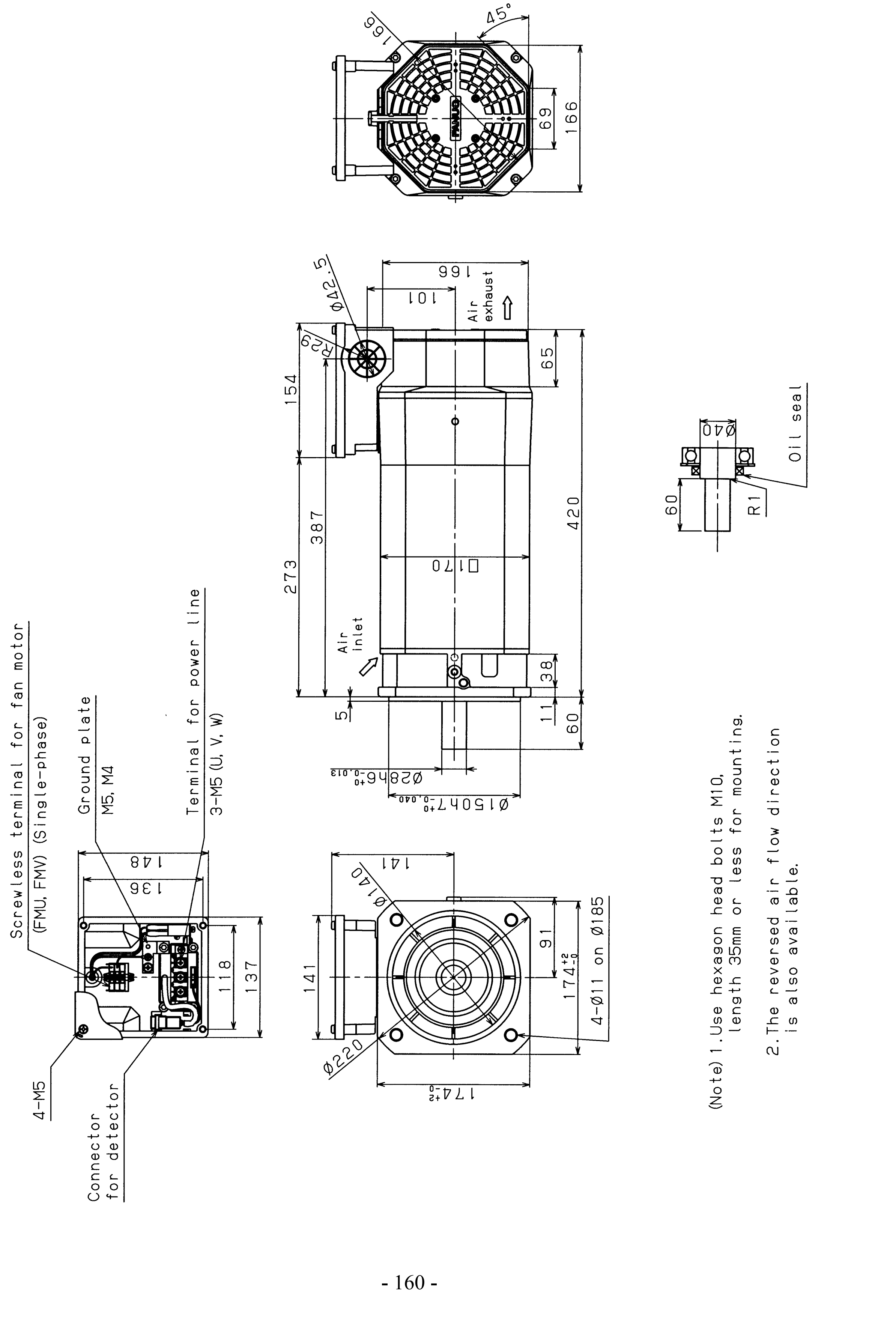
7.6 MODEL αiI 2/10000HV (FLANGE MOUNTING TYPE)



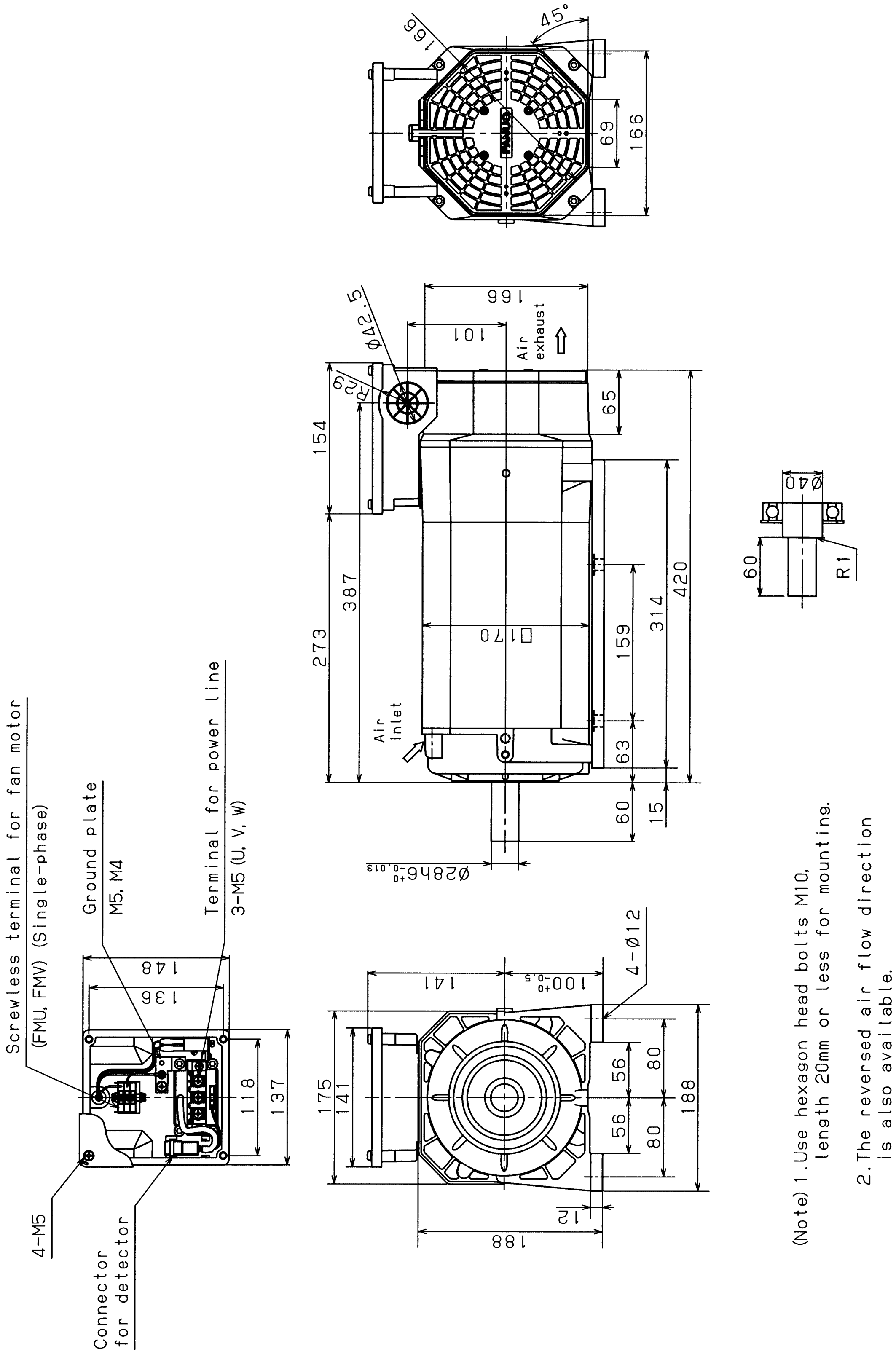
7.7 MODEL αiI 2/10000HV (FOOT MOUNTING TYPE)



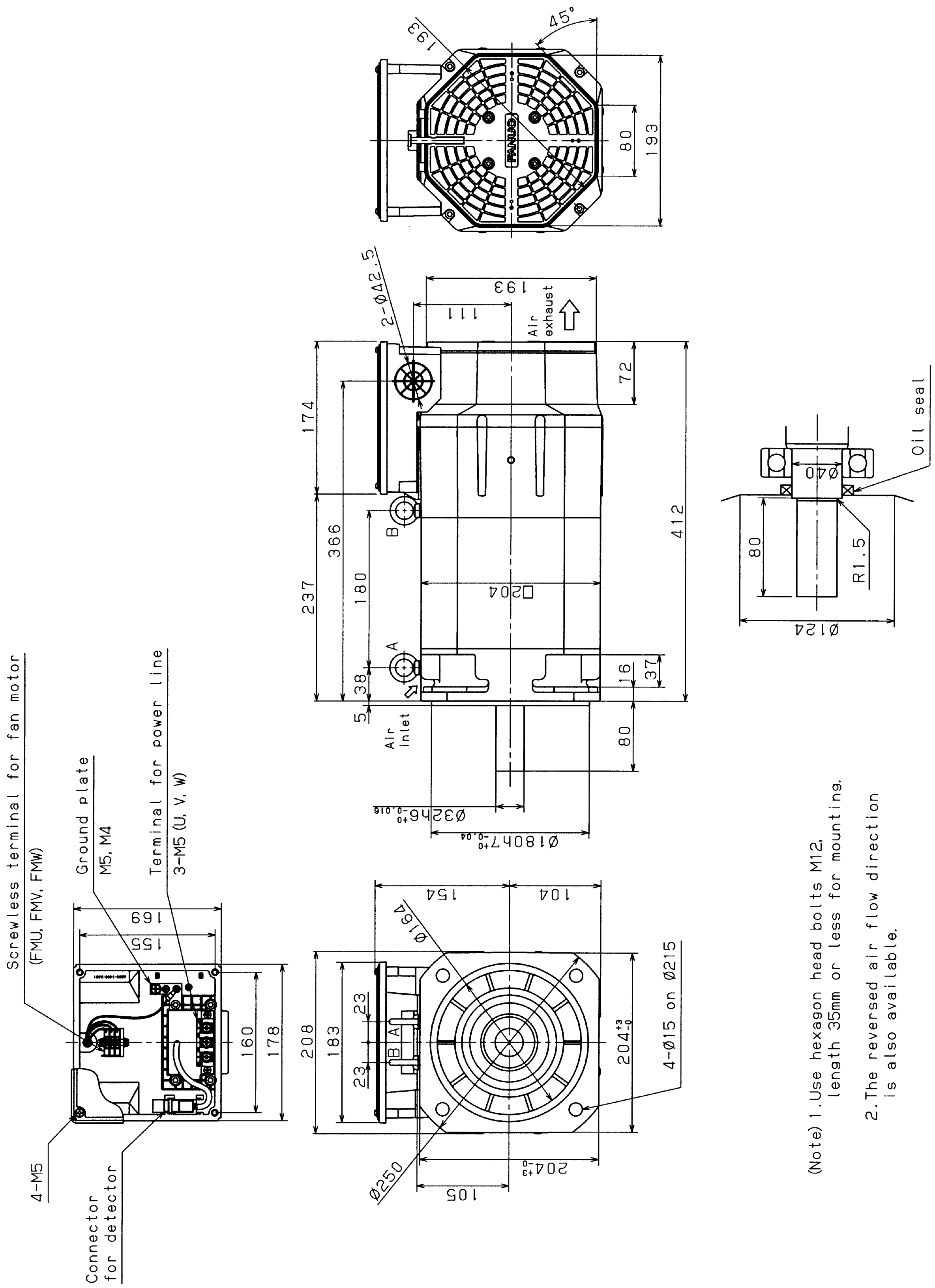
7.8 MODEL αiI 3/10000HV (FLANGE MOUNTING TYPE)



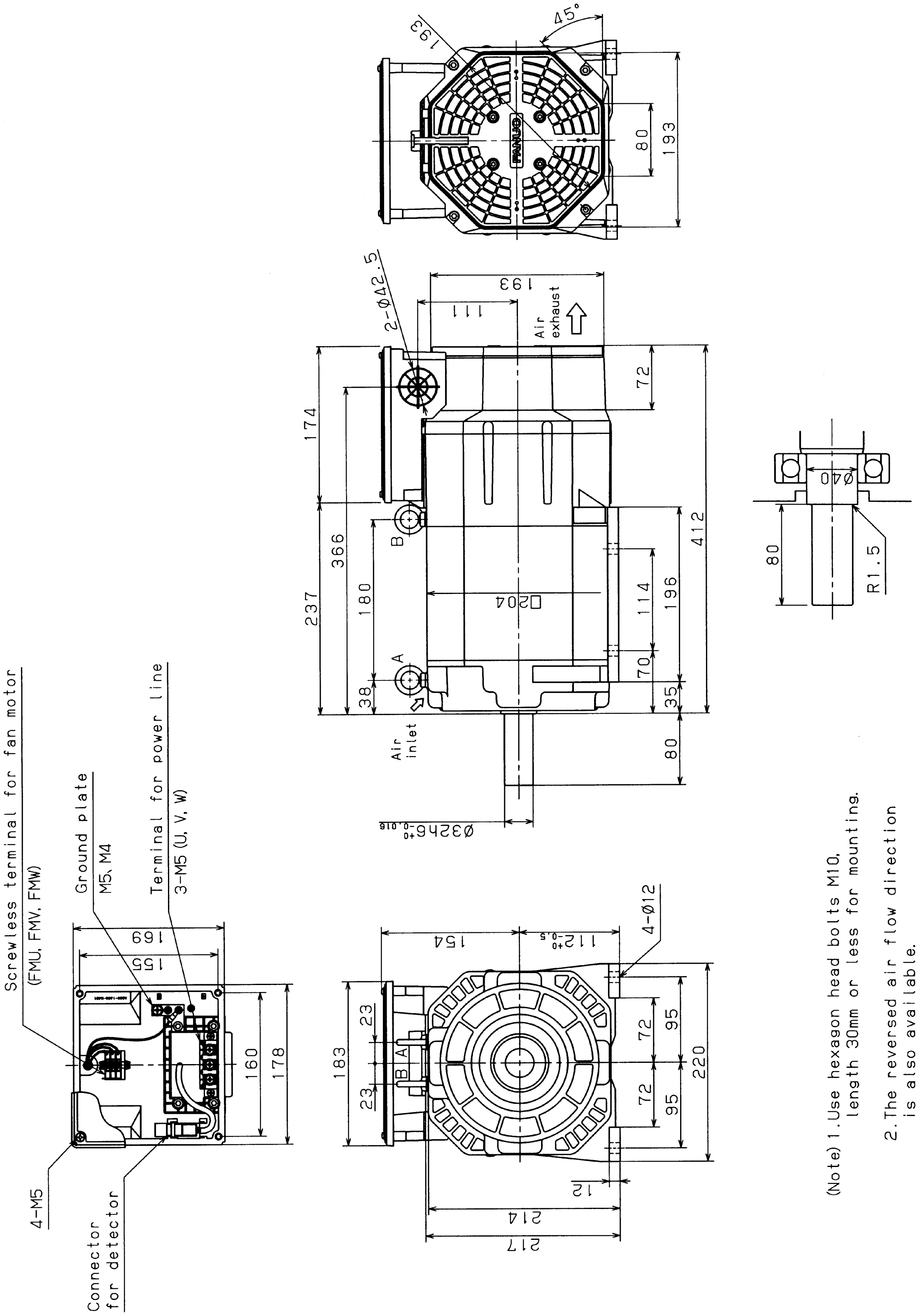
7.9 MODEL αiI 3/10000HV (FOOT MOUNTING TYPE)



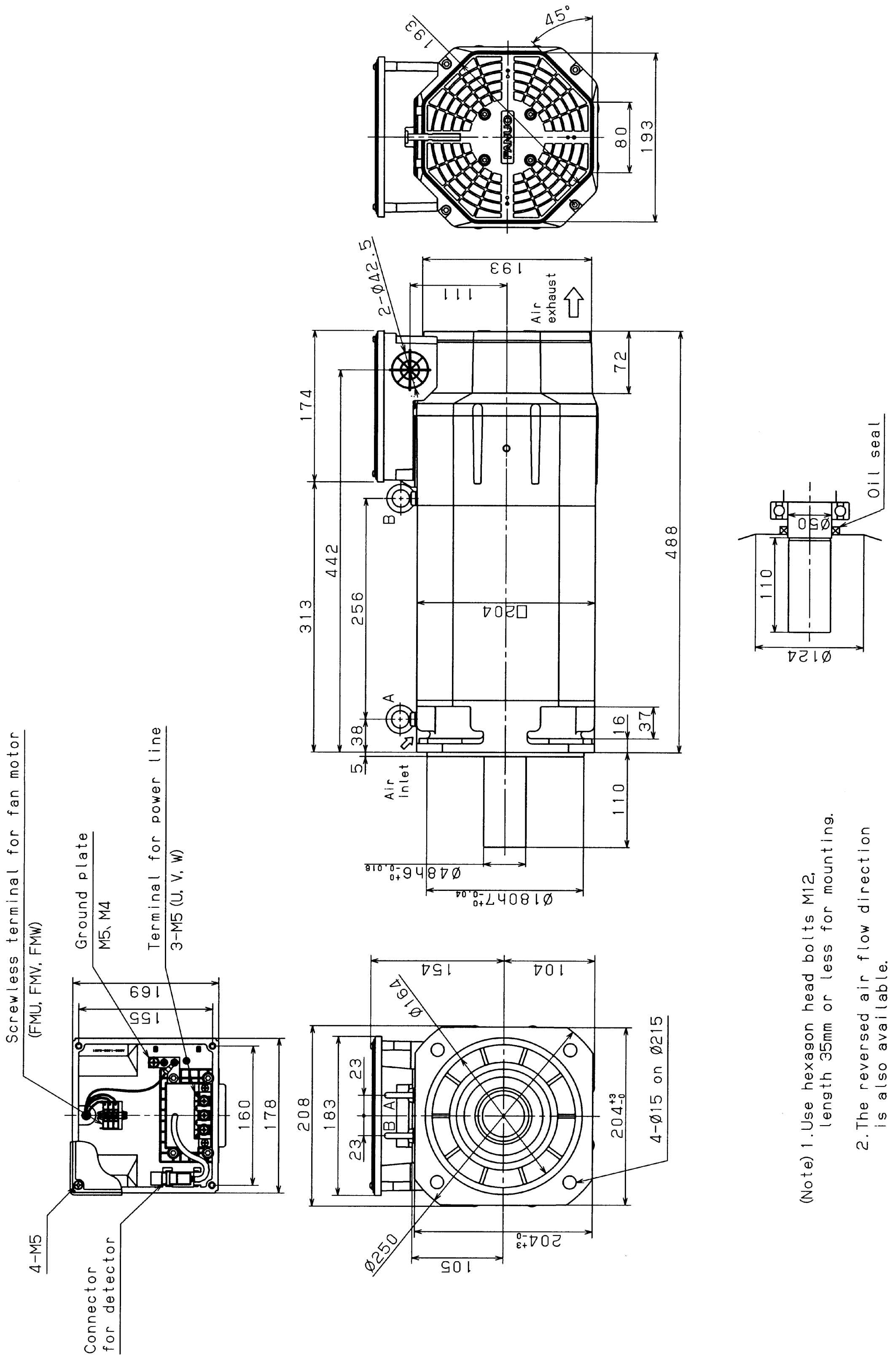
7.10 MODEL αiI 6/10000HV (FLANGE MOUNTING TYPE)



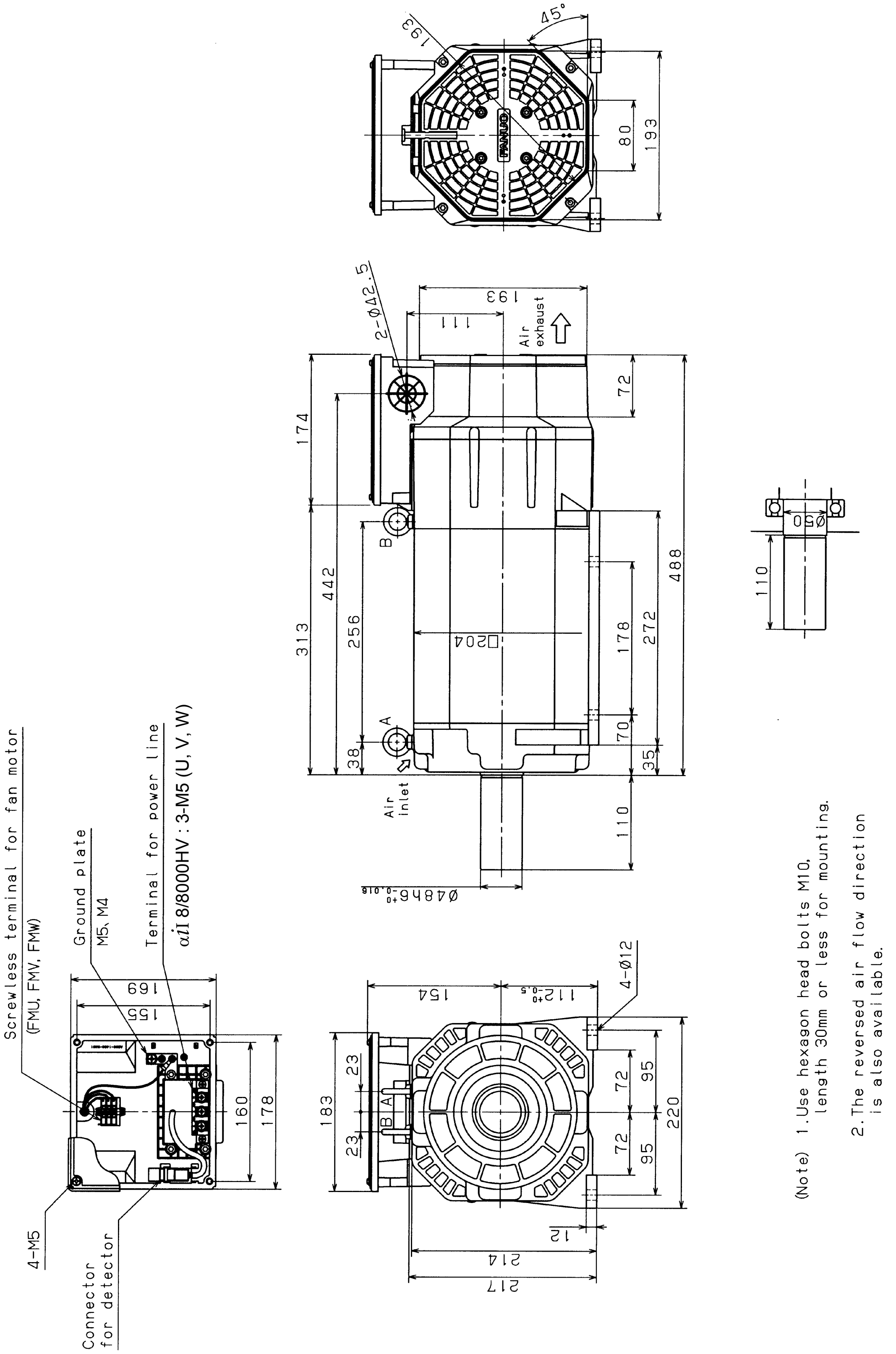
7.11 MODEL αiI 6/10000HV (FOOT MOUNTING TYPE)



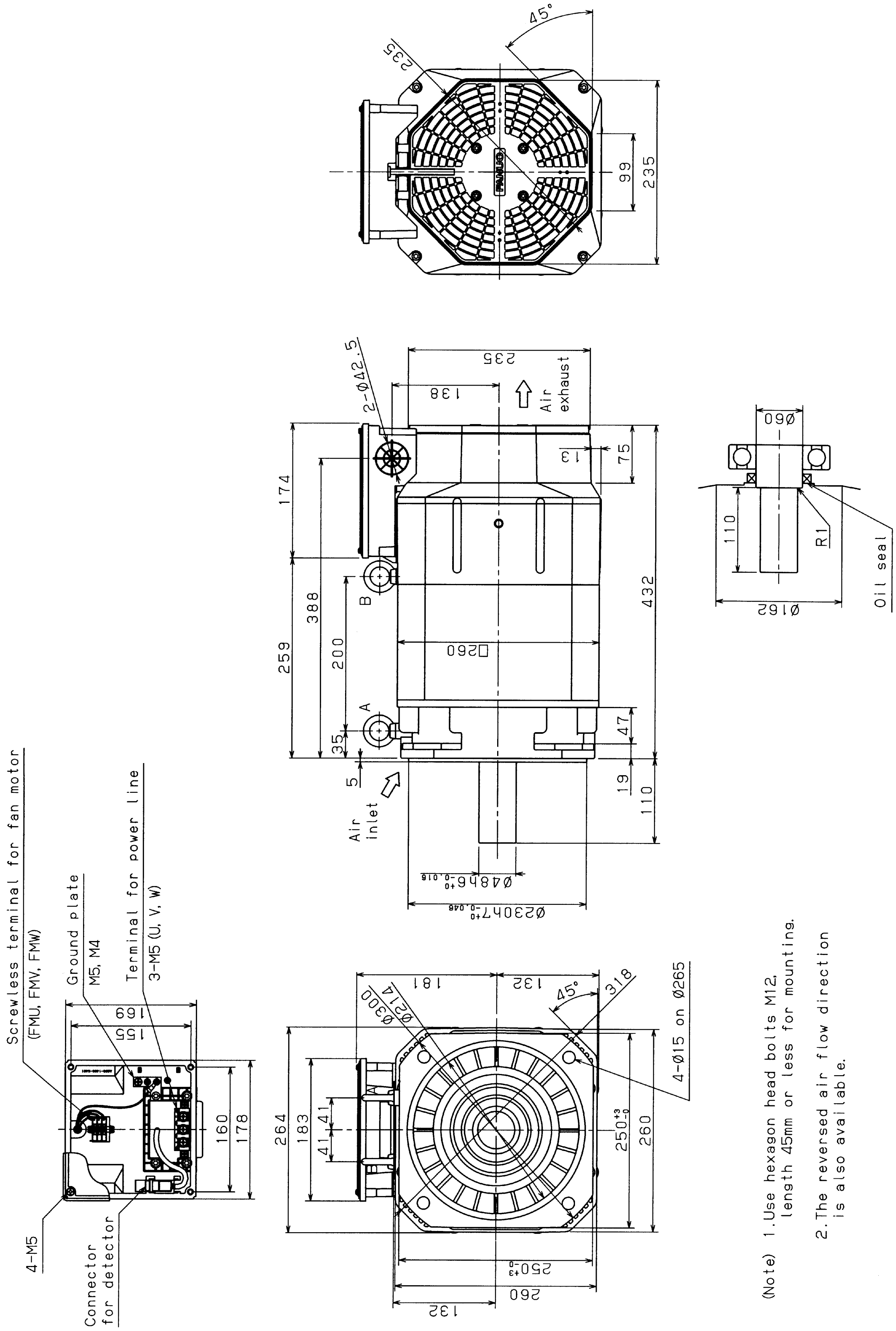
7.12 MODEL αiI 8/8000HV (FLANGE MOUNTING TYPE)



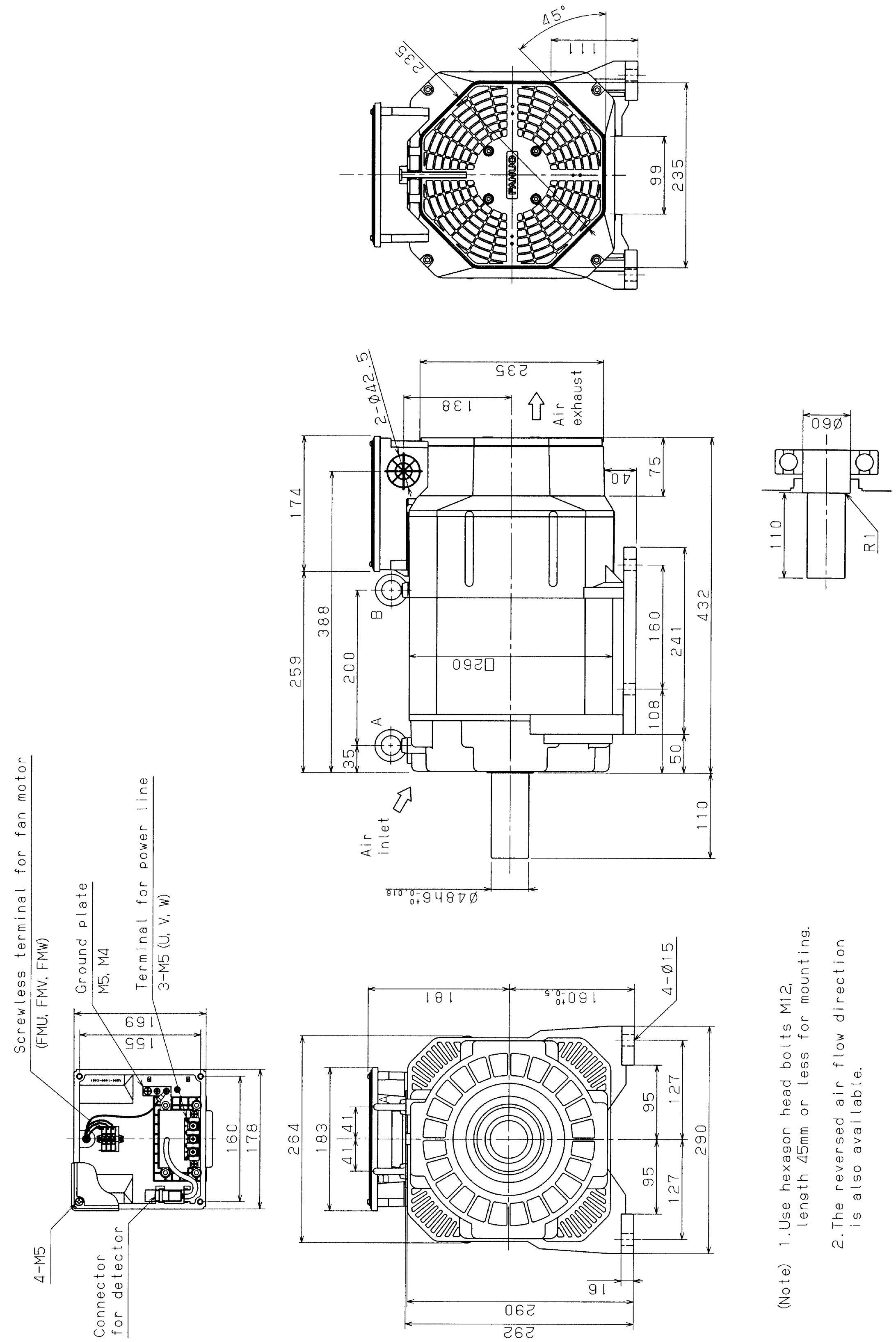
7.13 MODEL αiI 8/8000HV (FOOT MOUNTING TYPE)



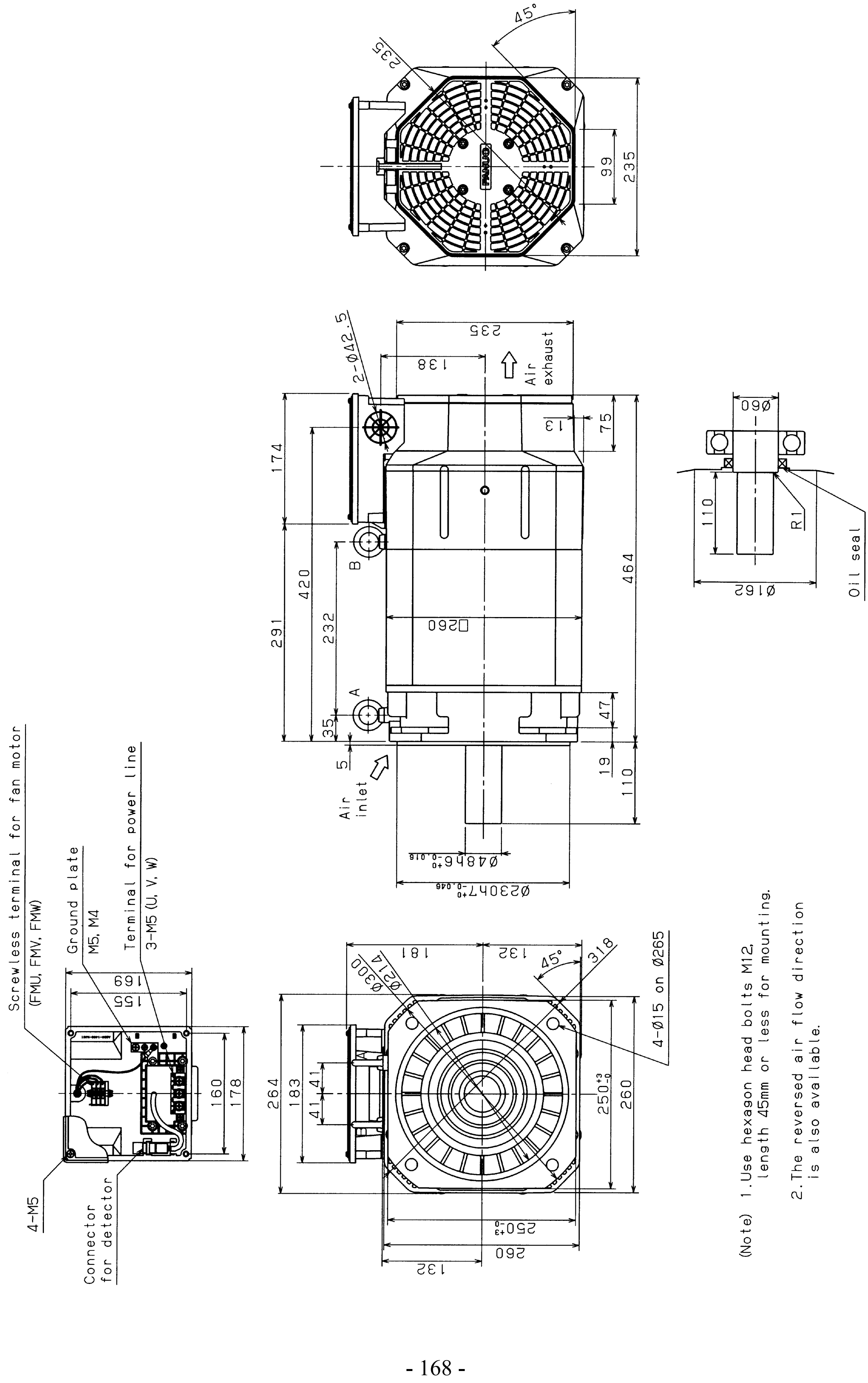
7.14 MODEL αiI 12/7000HV (FLANGE MOUNTING TYPE)



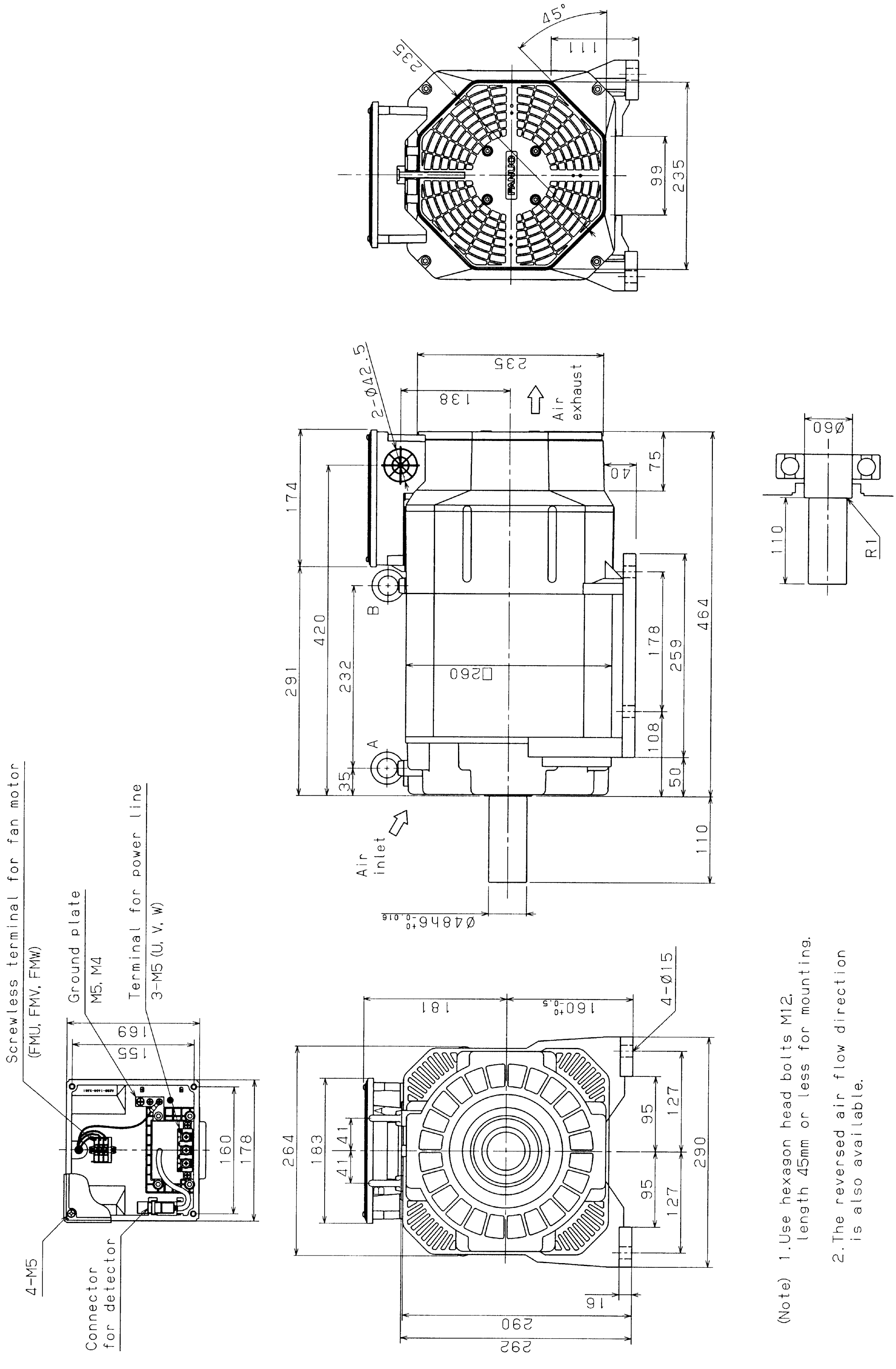
7.15 MODEL αiI 12/7000HV (FOOT MOUNTING TYPE)



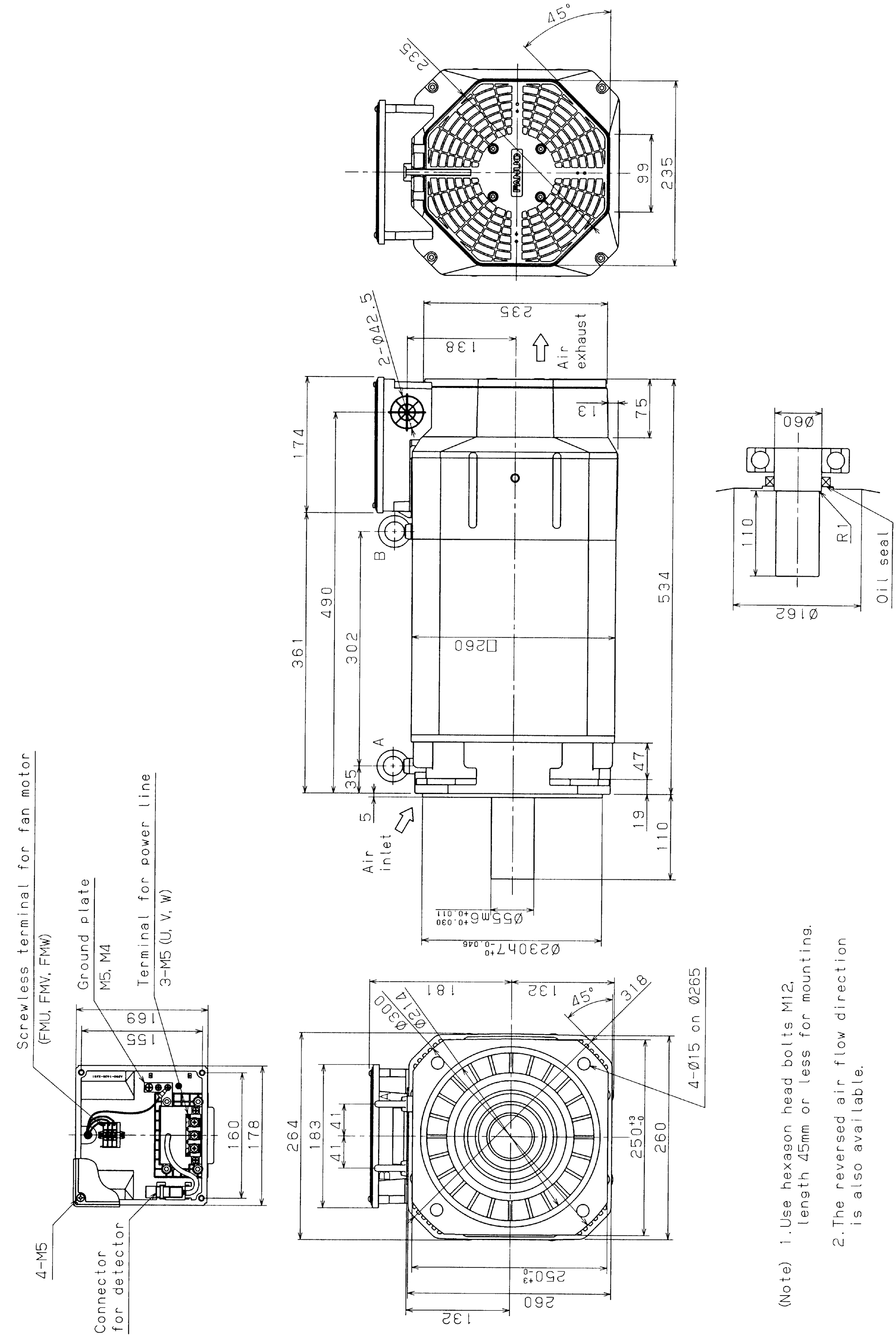
7.16 MODEL αiI 15/7000HV (FLANGE MOUNTING TYPE)



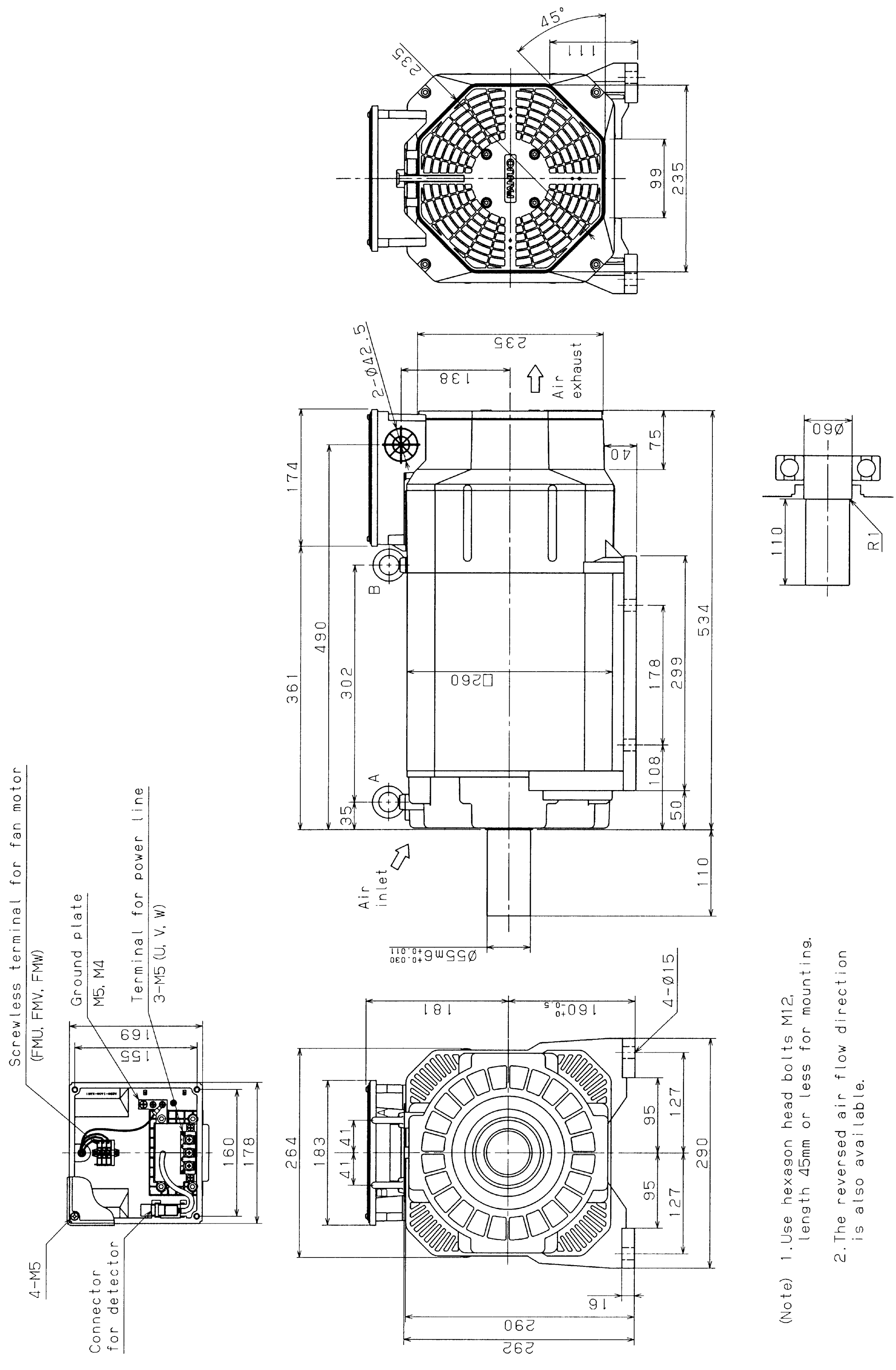
7.17 MODEL αiI 15/7000HV (FOOT MOUNTING TYPE)



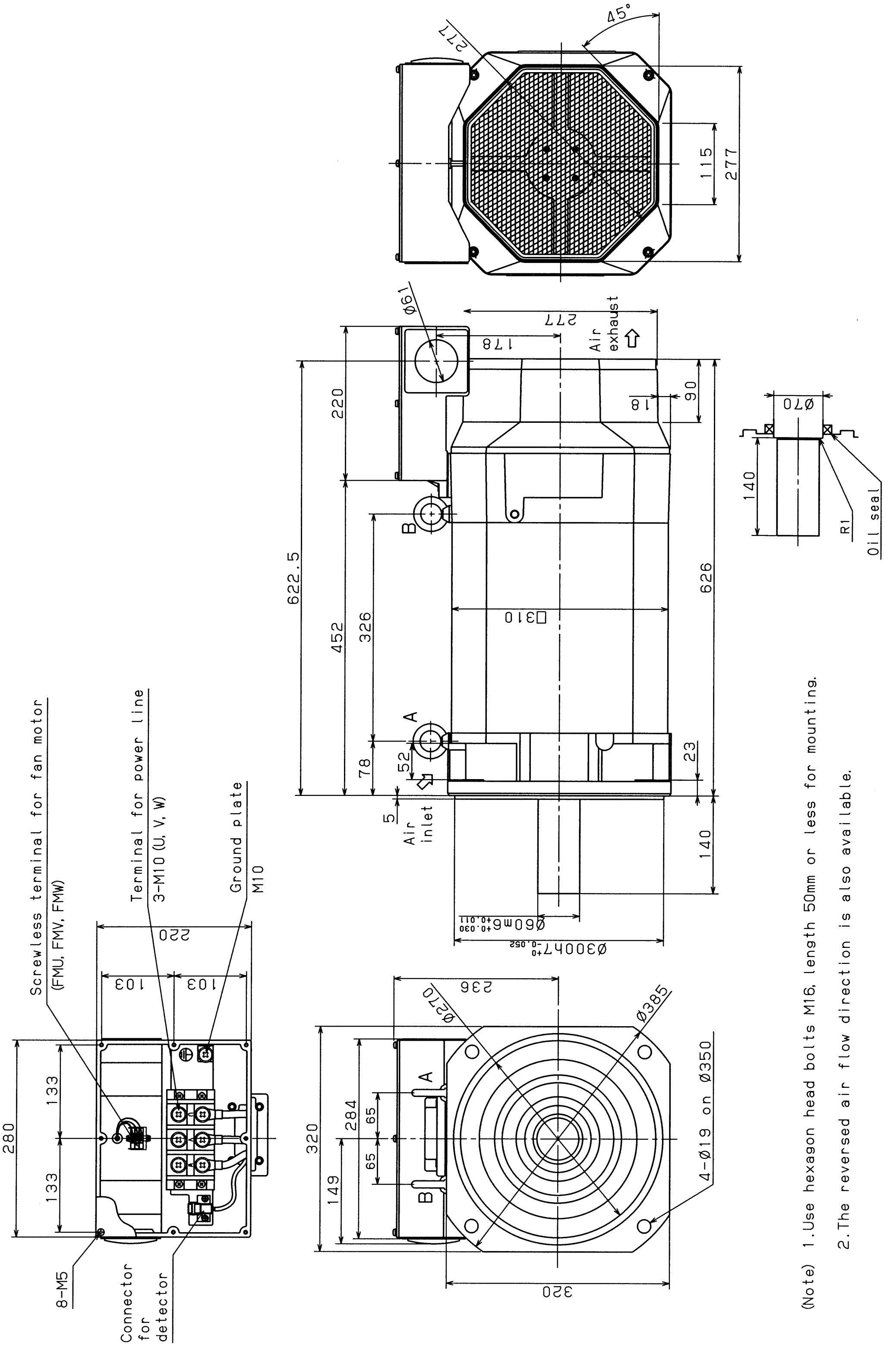
7.18 MODEL αiI 22/7000HV (FLANGE MOUNTING TYPE)



7.19 MODEL αiI 22/7000HV (FOOT MOUNTING TYPE)



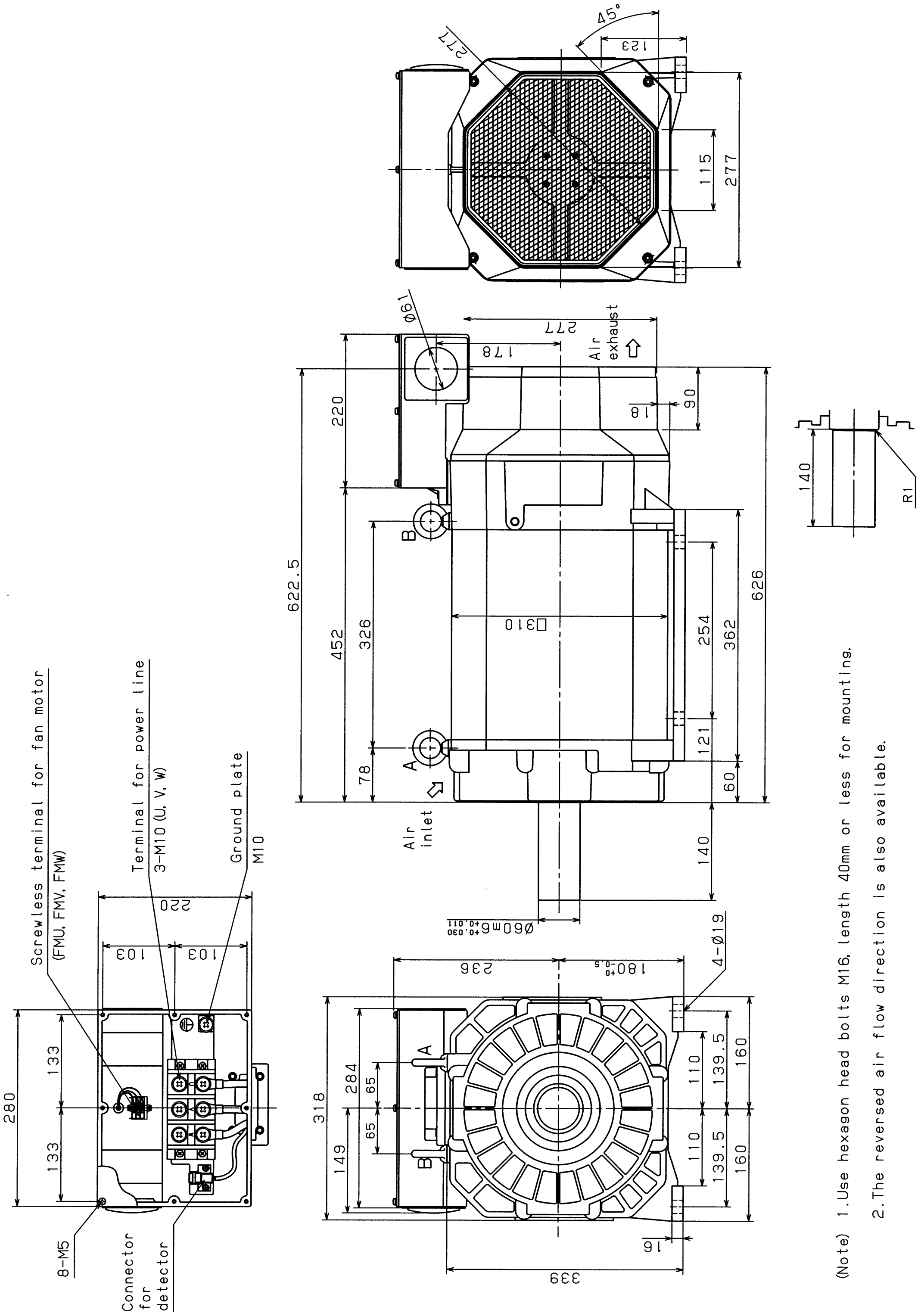
7.20 MODEL αiI 30/6000HV (FLANGE MOUNTING TYPE)



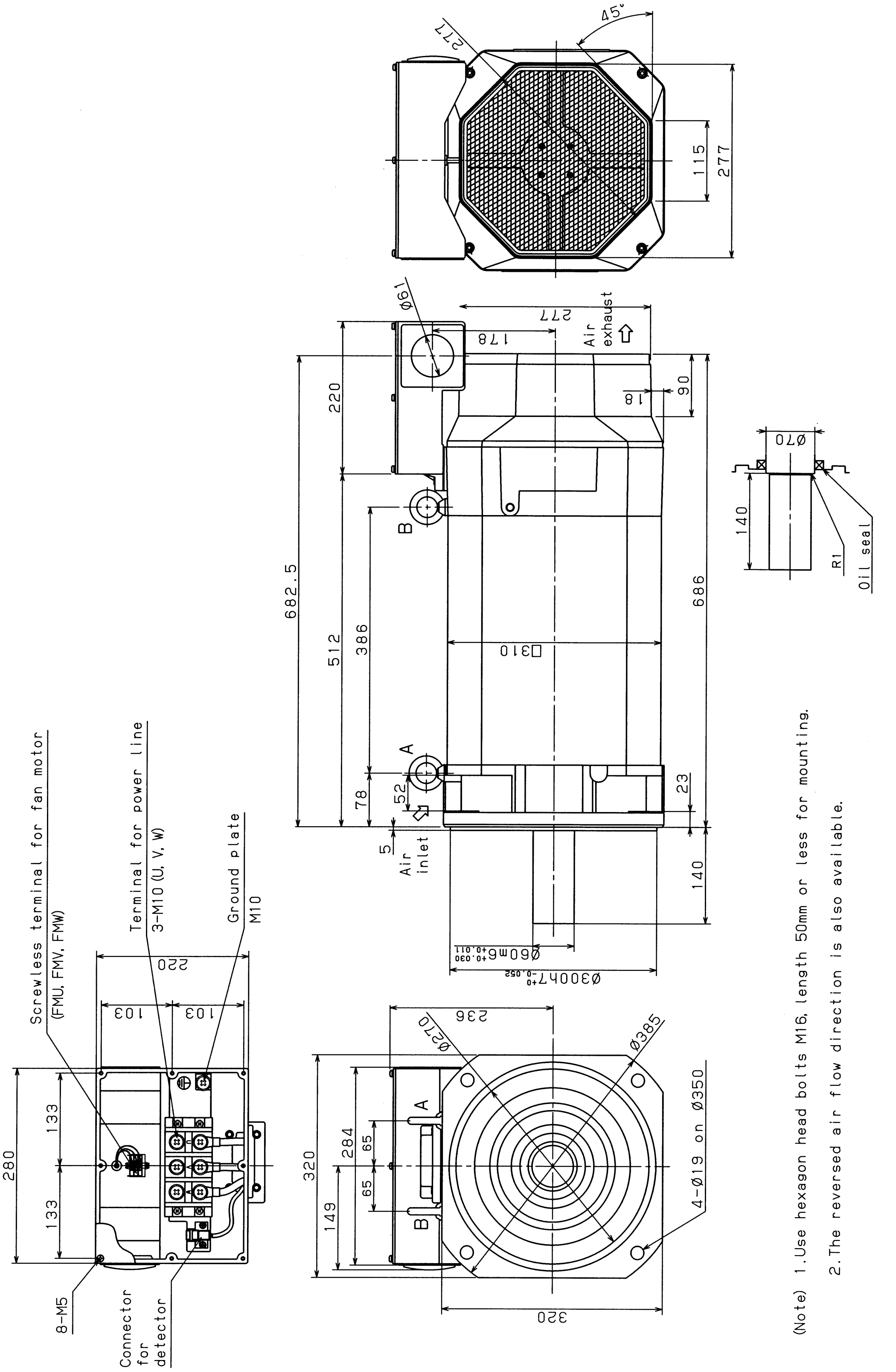
(Note) 1.Use hexagon head bolts M16, length 50mm or less for mounting.

2.The reversed air flow direction is also available.

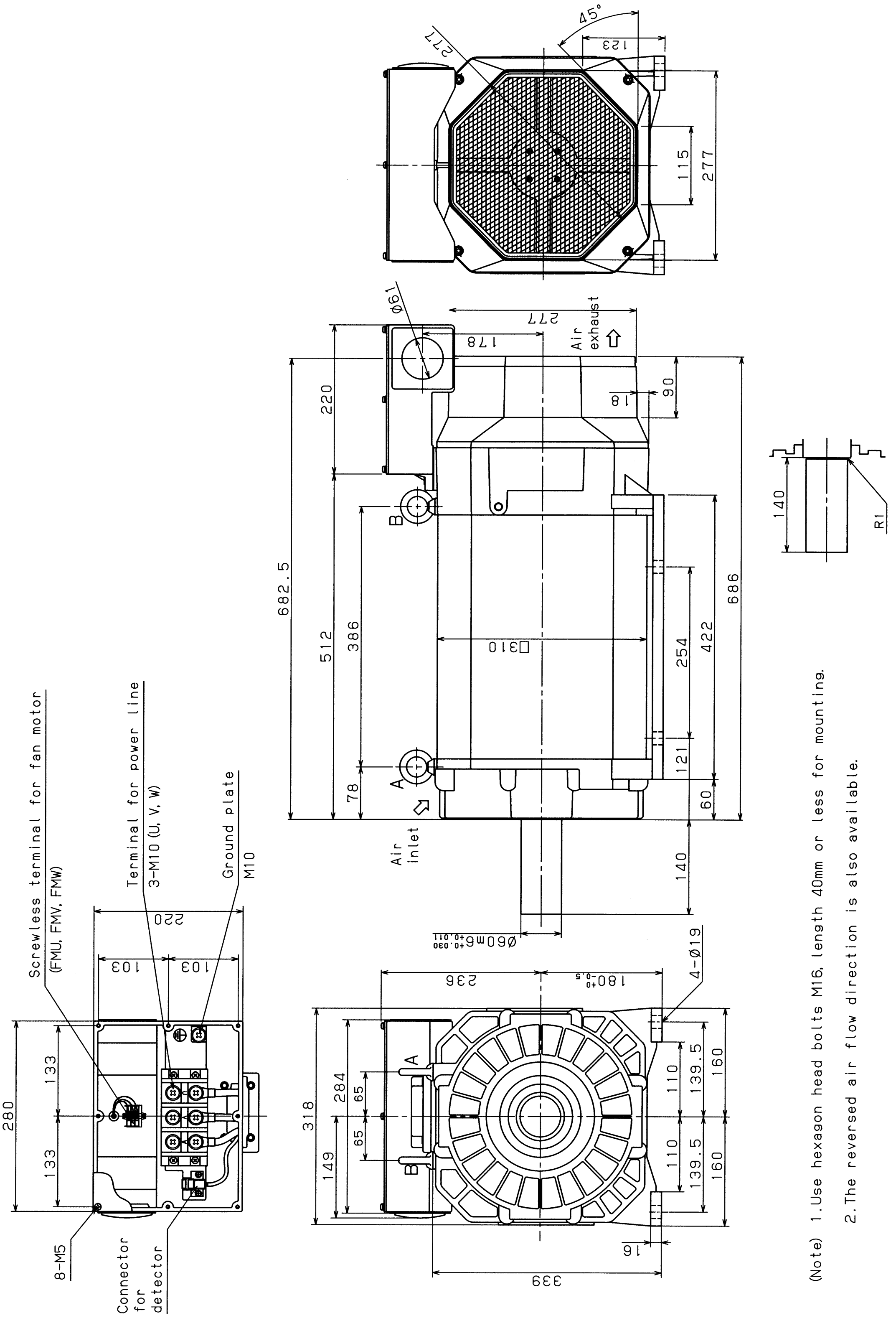
7.21 MODEL αiI 30/6000HV (FOOT MOUNTING TYPE)



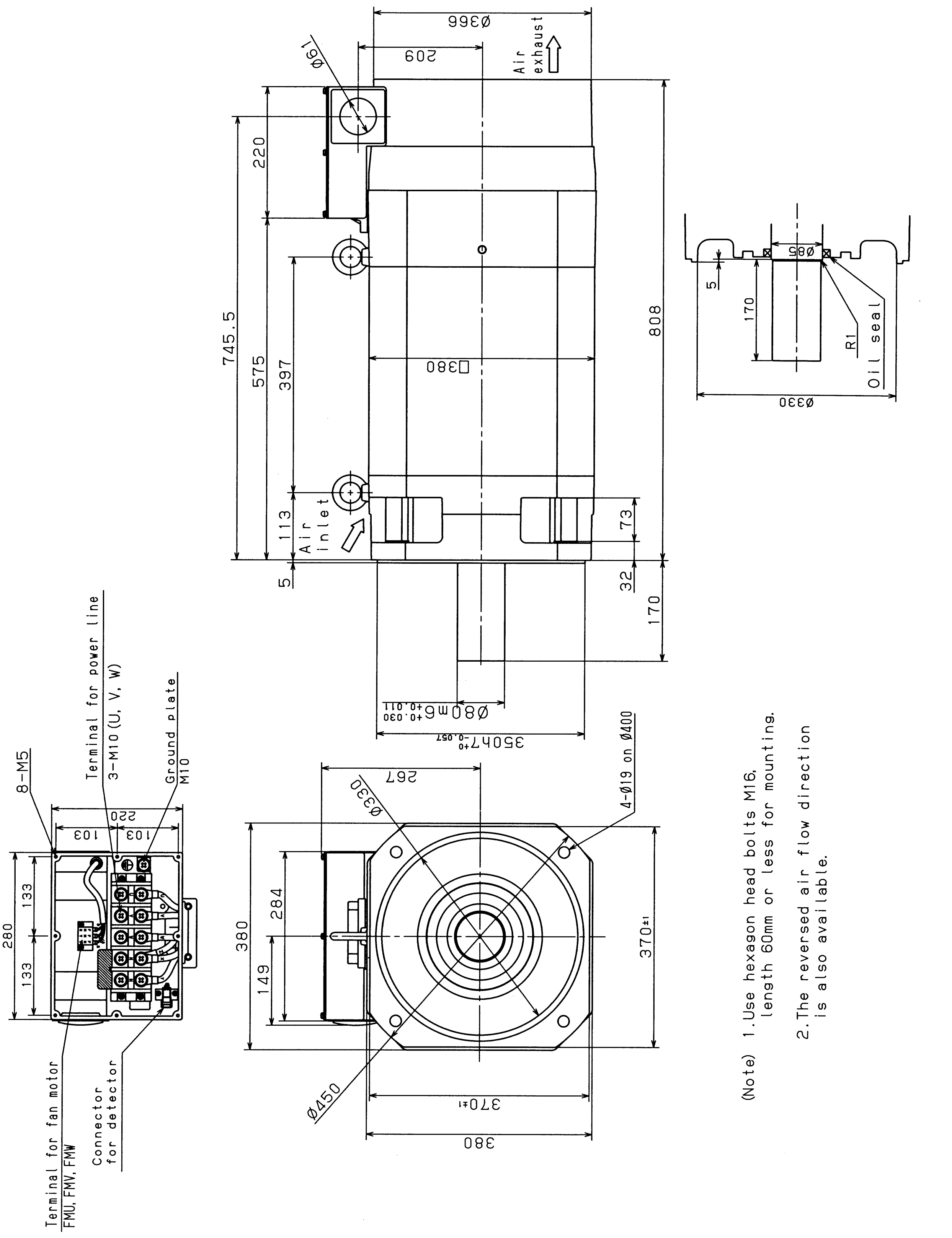
7.22 MODEL αiI 40/6000HV (FLANGE MOUNTING TYPE)



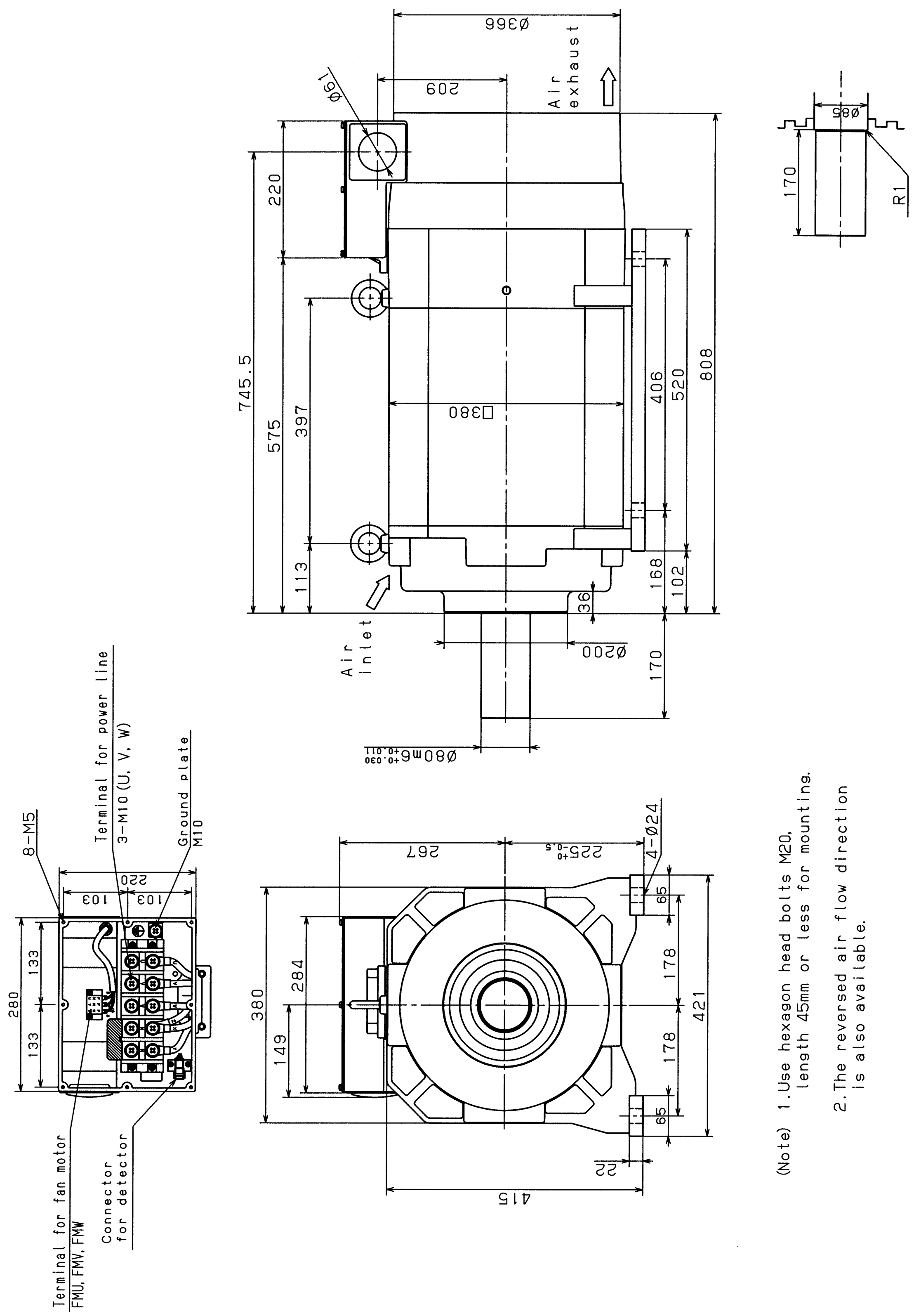
7.23 MODEL αiI 40/6000HV (FOOT MOUNTING TYPE)



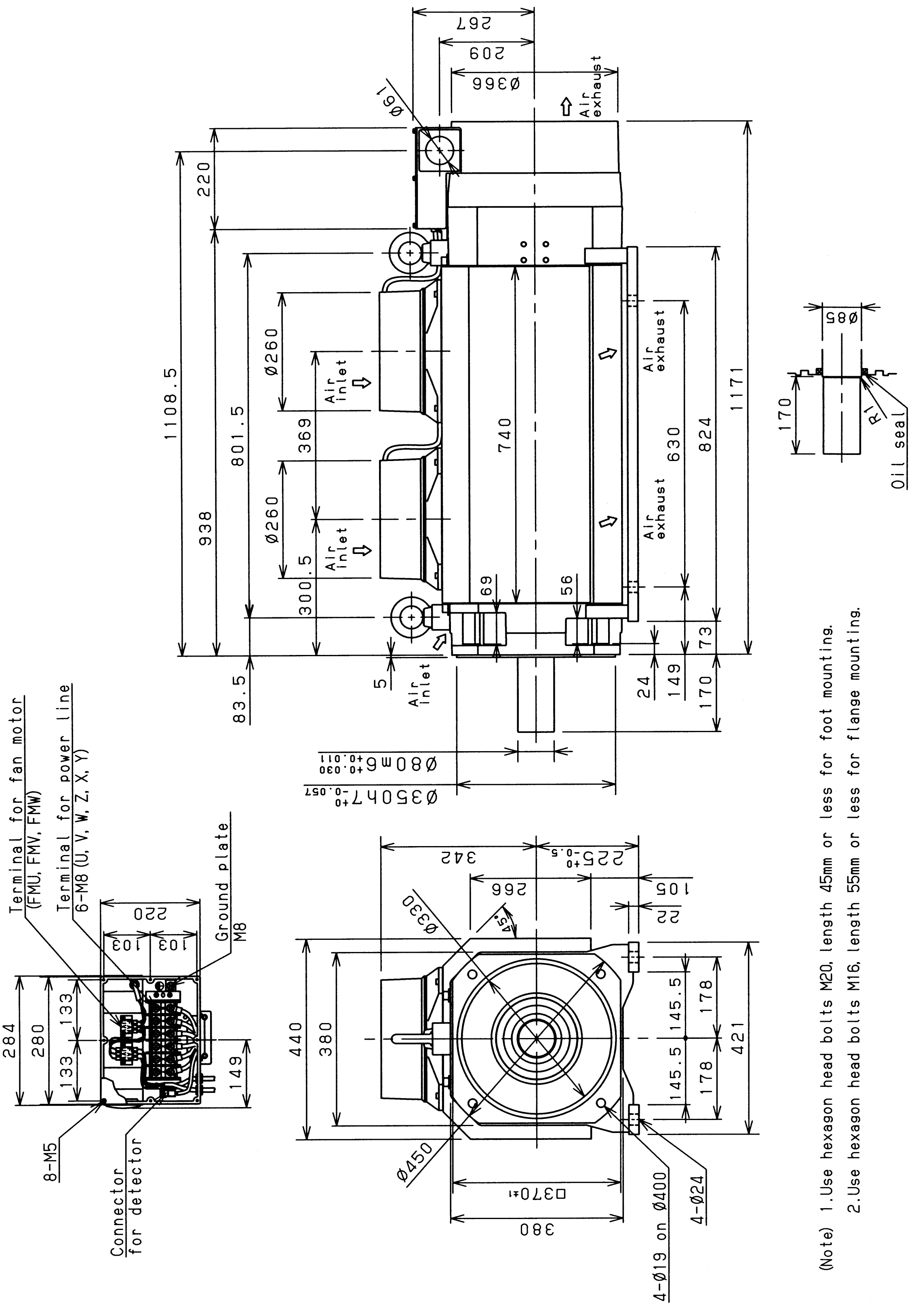
7.24 MODEL αiI 60/4500HV (FLANGE MOUNTING TYPE)



7.25 MODEL αiI 60/4500HV (FOOT MOUNTING TYPE)



7.26 MODEL αiI 100/4000HV (FOOT FLANGE MOUNTING TYPE)



IV. FANUC AC SPINDLE MOTOR αiIP series 200V type

1 GENERAL

FANUC AC spindle motor αiIP series 200V type is suitable for structural simplification by eliminating the machine spindle gear box.

Features

- As the rated output range is wide from 1:10 to 1:16 , a gear box structure for speed change is not required, thereby allowing the structure of the machine to be simplified.
  Accordingly, vibration and noise caused by the gear box structure is also eliminated.
- Improvement in efficiency of construction equipment
  Unnecessary use of time is reduced because it is not necessary to stop the spindle when switching the gear.
- Despite a compact configuration, a large low-speed torque can be obtained.
- The method of fan exhaust can be selected from either a exhaust front type or exhaust rear type, thus preventing heat deformation of the machine.
- 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

Series		αiIP series			
Item \ Model		αiIP 12/6000 αiIP 12/8000		αiIP 15/6000 αiIP 15/8000	
		Low-speed winding (Y connection)	High-speed winding (Δ connection)	Low-speed winding (Y connection)	High-speed winding (Δ connection)
Output (*2)	Cont. rated kW (HP)	3.7 (4.9)	5.5 (7.4)	5 (6.6)	7.5 (10)
	30 min rated [15 min] (*3) kW (HP)	7.5 (10)	7.5 (10)	9 (12)	9 (12)
	S3 60% [15%] (*4)(*5) kW (HP)	7.5 (10)	7.5 (10)	9 (12)	9 (12)
Rated current A (*6)	Cont. rated	23	39	40	50
	30 min rated (*3) S3 60%, 15% (*4)	42	49	61	58
Speed min^{-1}	Base speed	500	750	500	750
	Max. speed	1500	6000, 8000	1500	6000, 8000
Cont. rated torque at const. rated torque range N·m (kgf·cm)		70.7 (721)	70 (714)	95.5 (974)	95.5 (974)
Rotor inertia	$kg \cdot m^2$	0.07		0.09	
	$kgf \cdot cm \cdot s^2$	0.77		0.93	
Weight kgf		95		110	
Vibration		V5 (option V3)			
Noise		75dB(A) or less			
Cooling system (*7)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		56			
Installation (*8)		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			
Allowable overload capacity (1 min) (*9)		120 % of 30 min rated output			
Insulation		Class H			
Ambient temperature		0 to 40 °C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Sensor		αiM sensor or αiMZ sensor			
Type of thermal protection (*10)		TP211			
Resolution of the αiMZ sensor /rev.		4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Maximum output during acceleration (*11) kW		12.3		13.5	
Applicable spindle amplifier		αiSP 11		αiSP 15	
Model		αiIP 12/6000		αiIP 15/6000	

<table>
<tr><th colspan="2">Series</th><th colspan="4">αiIP series</th></tr>
<tr><th colspan="2" rowspan="2">Item / Model</th><th colspan="2">αiIP 18/6000
αiIP 18/8000</th><th colspan="2">αiIP 22/6000
αiIP 22/8000</th></tr>
<tr><th>Low-speed winding (Y connection)</th><th>High-speed winding (Δ connection)</th><th>Low-speed winding (Y connection)</th><th>High-speed winding (Δ connection)</th></tr>
<tr><td rowspan="3">Output (*2)</td><td>Cont. rated kW (HP)</td><td>6
(8)</td><td>9
(12)</td><td>7.5
(10)</td><td>11
(14.7)</td></tr>
<tr><td>30 min rated kW [15 min] (*3) (HP)</td><td>11
(14.7)</td><td>11
(14.7)</td><td>15
(20.1)</td><td>15
(20.1)</td></tr>
<tr><td>S3 60% kW [15%] (*4)(*5) (HP)</td><td>11
(14.7)</td><td>11
(14.7)</td><td>15
(20.1)</td><td>15
(20.1)</td></tr>
<tr><td rowspan="2">Rated current A (*6)</td><td>Cont. rated</td><td>32</td><td>55</td><td>43</td><td>69</td></tr>
<tr><td>30 min rated (*3)
S3 60%, 15% (*4)</td><td>53</td><td>63</td><td>80</td><td>88</td></tr>
<tr><td rowspan="2">Speed min^{-1}</td><td>Base speed</td><td>500</td><td>750</td><td>500</td><td>750</td></tr>
<tr><td>Max. speed</td><td>1500</td><td>6000, 8000</td><td>1500</td><td>6000, 8000</td></tr>
<tr><td colspan="2">Cont. rated torque at const. rated torque range N·m (kgf·cm)</td><td>114.6
(1169)</td><td>114.6
(1169)</td><td>143.2
(1461)</td><td>140
(1428)</td></tr>
<tr><td rowspan="2">Rotor inertia</td><td>kg·m^2</td><td colspan="2">0.105</td><td colspan="2">0.128</td></tr>
<tr><td>kgf·cm·s^2</td><td colspan="2">1.08</td><td colspan="2">1.29</td></tr>
<tr><td colspan="2">Weight kgf</td><td colspan="2">125</td><td colspan="2">143</td></tr>
<tr><td colspan="2">Vibration</td><td colspan="4">V5 (option V3)</td></tr>
<tr><td colspan="2">Noise</td><td colspan="4">75dB(A) or less</td></tr>
<tr><td colspan="2">Cooling system (*7)</td><td colspan="4">Totally enclosed and fan cooled IC0A6</td></tr>
<tr><td colspan="2">Cooling fan W</td><td colspan="4">56</td></tr>
<tr><td colspan="2">Installation (*8)</td><td colspan="4">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</td></tr>
<tr><td colspan="2">Allowable overload capacity (1 min) (*9)</td><td colspan="4">120 % of 30 min rated output</td></tr>
<tr><td colspan="2">Insulation</td><td colspan="4">Class H</td></tr>
<tr><td colspan="2">Ambient temperature</td><td colspan="4">0 to 40 °C</td></tr>
<tr><td colspan="2">Altitude</td><td colspan="4">Height above sea level not exceeding 1000m</td></tr>
<tr><td colspan="2">Painting color</td><td colspan="4">Munsell system N2.5</td></tr>
<tr><td colspan="2">Sensor</td><td colspan="4">αiM sensor or αiMZ sensor</td></tr>
<tr><td colspan="2">Type of thermal protection (*10)</td><td colspan="4">TP211</td></tr>
<tr><td colspan="2">Resolution of the αiMZ sensor /rev.</td><td colspan="4">4096</td></tr>
<tr><td colspan="2">Number of detected gear teeth per rotation λ/rev.</td><td colspan="4">256</td></tr>
<tr><td colspan="2">Bearing lubrication</td><td colspan="4">Grease</td></tr>
<tr><td colspan="2">Maximum output during acceleration (*11) kW</td><td colspan="2">15.1</td><td colspan="2">20.0</td></tr>
<tr><td colspan="2">Applicable spindle amplifier</td><td colspan="2">αiSP 15</td><td colspan="2">αiSP 22</td></tr>
<tr><td colspan="2">Model</td><td colspan="2">αiIP 18/6000</td><td colspan="2">αiIP 22/6000</td></tr>
</table>

Series		αiIP series			
Item \ Model		αiIP 30/6000		αiIP 40/6000	
		Low-speed winding (Y connection)	**High-speed winding (Δ connection)**	**Low-speed winding (Y connection)**	**High-speed winding (Δ connection)**
Output (*2)	Cont. rated kW (HP)	11 (14.7)	15 (20.1)	13 (17.3)	18.5 (24.8)
	30 min rated kW [15 min] (*3) (HP)	18.5 (24.8)	18.5 (24.8)	22 (29.5)	22 (29.5)
	S3 60% kW [15%] (*4)(*5) (HP)	18.5 (24.8)	18.5 (24.8)	22 (29.5)	22 (29.5)
Rated current A (*6)	Cont. rated	54	86	70	108
	30 min rated (*3) S3 60%, 15% (*4)	87	101	115	123
Speed min^{-1}	Base speed	400	575	400	575
	Max. speed	1500	6000	1500	6000
Cont. rated torque at const. rated torque range N·m (kgf·cm)		263 (2678)	249 (2540)	310 (3165)	307 (3133)
Rotor inertia	$kg \cdot m^2$	0.295		0.295	
	$kgf \cdot cm \cdot s^2$	3.0		3.0	
Weight kgf		250		250	
Vibration		V5 (option V3)			
Noise		75dB(A) or less			
Cooling system (*7)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		84			
Installation (*8)		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			
Allowable overload capacity (1 min) (*9)		120 % of 30 min rated output			
Insulation		Class H			
Ambient temperature		0 to 40 °C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Sensor		αiM sensor or αiMZ sensor			
Type of thermal protection (*10)		TP211			
Resolution of the αiMZ sensor /rev.		4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Maximum output during acceleration (*11) kW		25.0		29.0	
Applicable spindle amplifier		αiSP 22		αiSP 26	
Model		αiIP 30/6000		αiIP 40/6000	

Series		αiP series			
Item	Model	αiP 50/6000		αiP 60/4500	
		Low-speed winding (Y connection)	High-speed winding (Δ connection)	Low-speed winding (Y connection)	High-speed winding (Δ connection)
Output (*2)	Cont. rated kW (HP)	22 (29.5)	22 (29.5)	18.5 (24.8)	22 (29.5)
	30 min rated kW [15 min] (*3) (HP)	30 (40.2)	30 (40.2)	30 (40.2)	30 (40.2)
	S3 60% kW [15%] (*4)(*5) (HP)	30 (40.2)	30 (40.2)	30 (40.2)	30 (40.2)
Rated current A (*6)	Cont. rated	95	94	87	106
	30 min rated (*3) S3 60%, 15% (*4)	118	117	132	139
Speed min^{-1}	Base speed	575	1200	400	750
	Max. speed	1500	6000	1500	4500
Cont. rated torque at const. rated torque range N·m (kgf·cm)		365 (3726)	175 (1785)	442 (4504)	280 (2850)
Rotor inertia	$kg \cdot m^2$	0.355		0.49	
	$kgf \cdot cm \cdot s^2$	3.6		5.0	
Weight kgf		290		468	
Vibration		V5 (option V3)		V10 (option V5)	
Noise		75dB(A) or less		80dB(A) or less	
Cooling system (*7)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		84		185	
Installation (*8)		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			
Allowable overload capacity (1 min) (*9)		120 % of 30 min rated output			
Insulation		Class H			
Ambient temperature		0 to 40 °C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Sensor		αiM sensor or αiMZ sensor			
Type of thermal protection (*10)		TP211			
Resolution of the αiMZ sensor /rev.		4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Maximum output during acceleration (*11) kW		35.4		36	
Applicable spindle amplifier		αiSP 26		αiSP 30	
Model		αiP 50/6000		αiP 60/4500	

(*1) When the output switch function is used, the CNC soft option and switching magnetic contactor unit associated with the output switch function (Y-Δ switch) are required.
See FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN) for details of the output switch control.
(*2) The rated output is guaranteed at the rated voltage.
(Amplifier input: 200/220/230V AC +10% -15%, 50/60 Hz ±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.
(*3) The output for low-speed winding models other than αiIP 50/6000 and αiIP 60/4500 is 15 min rated.
(*4) S3 15% for low-speed winding models other than αiIP 50/6000 and αiIP 60/4500
S3 25% for low-speed winding of αiIP 50/6000 and αiIP 60/4500
(*5) The cycle time is 10 minutes, S3 60%: ON 6 minutes, OFF 4 minutes, S3 25%: ON 2.5 minutes, OFF 7.5 minutes and S3 15%: ON 1.5 minutes, OFF 8.5 minutes.
(*6) The rated current is not a guaranteed value but a guideline for the maximum current at rated output.
(*7) IC code conforms to IEC 34-6.
(*8) IM code conforms to IEC 34-7.
(*9) This is not a guaranteed value but a guideline for the maximum motor output at a rated supply voltage.
(*10) Type conforms to IEC 34-11.
(*11) These values are to be used only as guidance for selecting a power supply (αiPS) and are not guaranteed.
(*12) Degree of protection:
with oil seal: IP54, without oil seal: IP40.

3 OUTPUT/TORQUE CHARACTERISTICS

Reference
Calculation for torque

Torque T can be obtained by the following equation.

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

P[kW]: Motor output

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

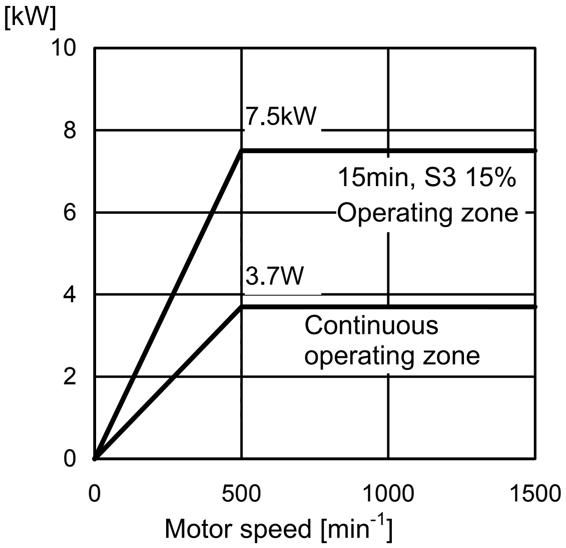
When the unit of T is [kgf·m],

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

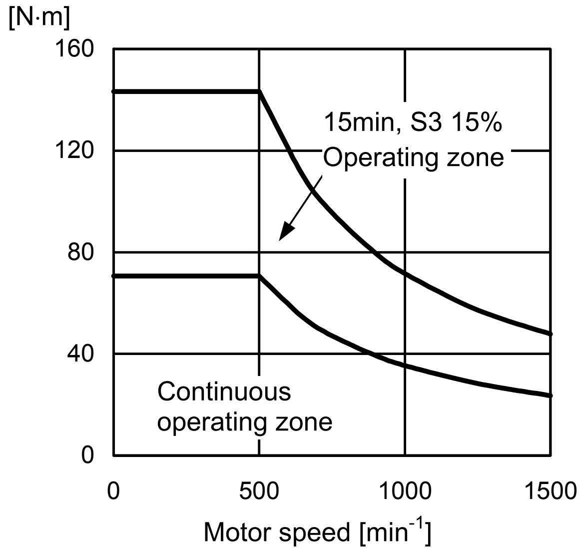
3.1 MODEL αiIP 12/6000

Applicable amplifier αiSP 11

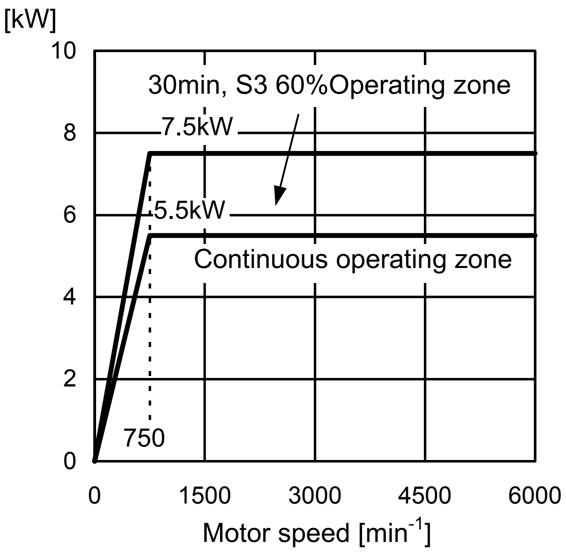
Low-speed winding output (Y connection)



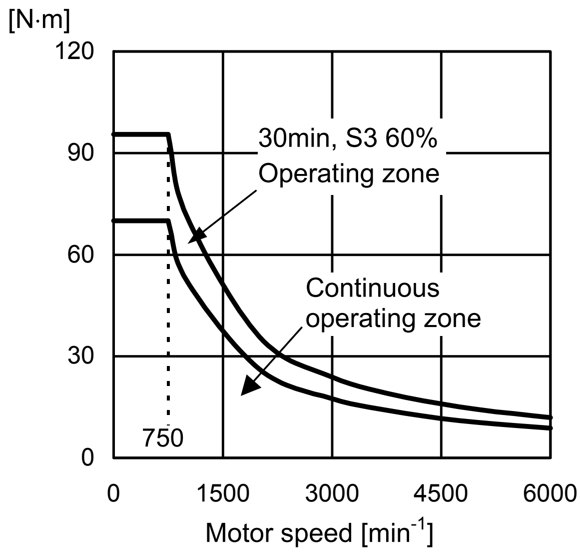
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

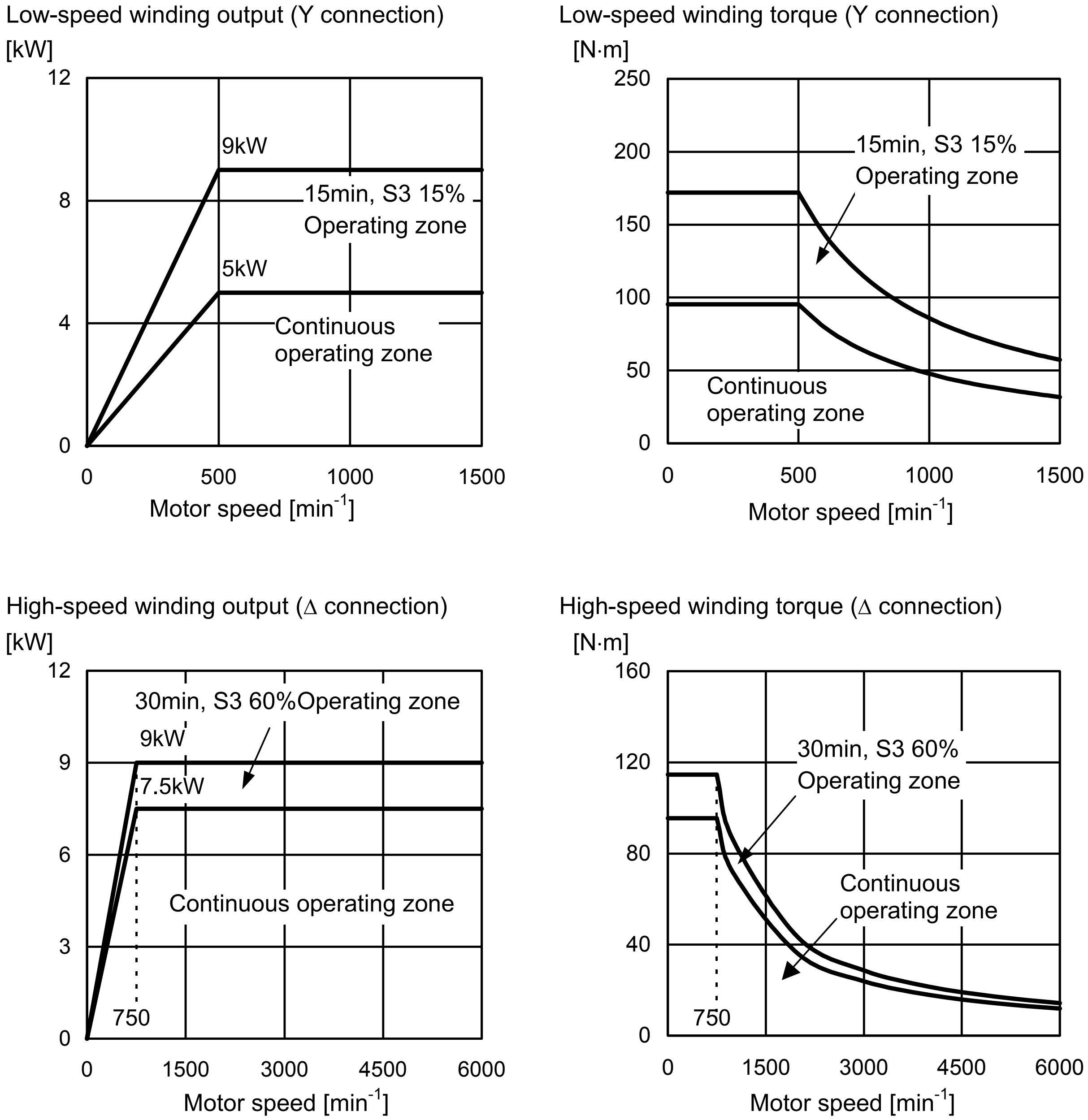


High-speed winding torque (Δ connection)



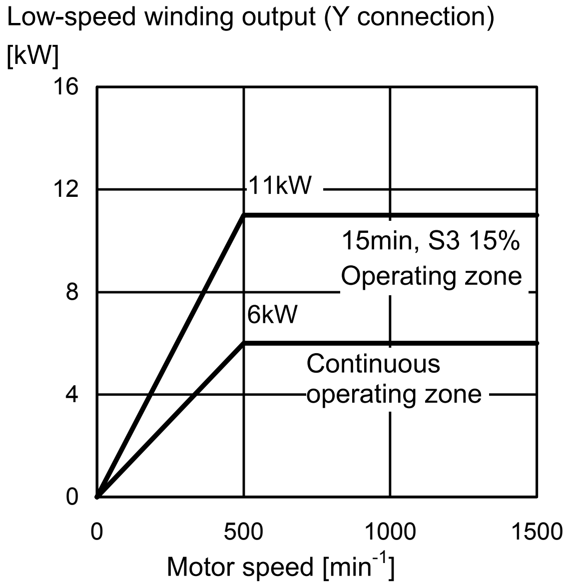
3.2 MODEL αiIP 15/6000

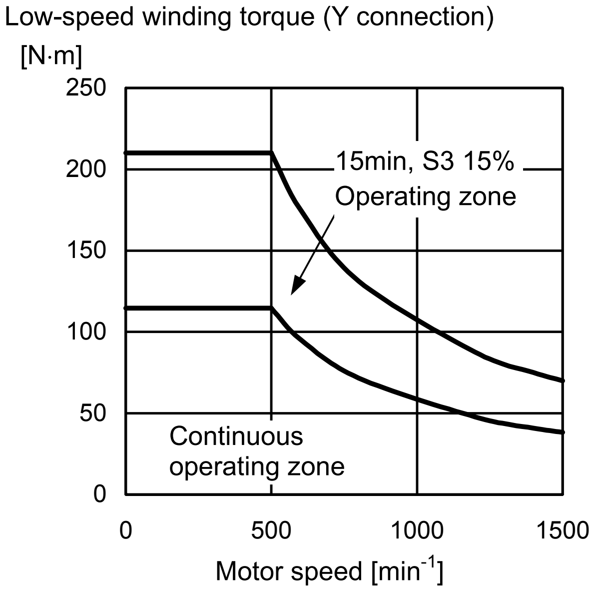
Applicable amplifier αiSP 15

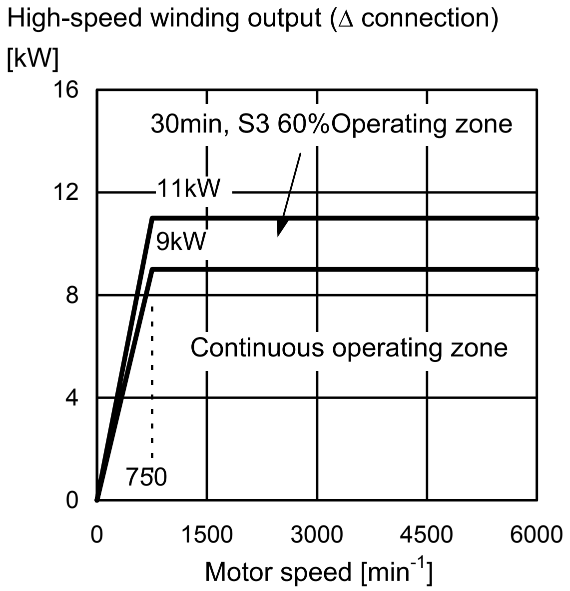


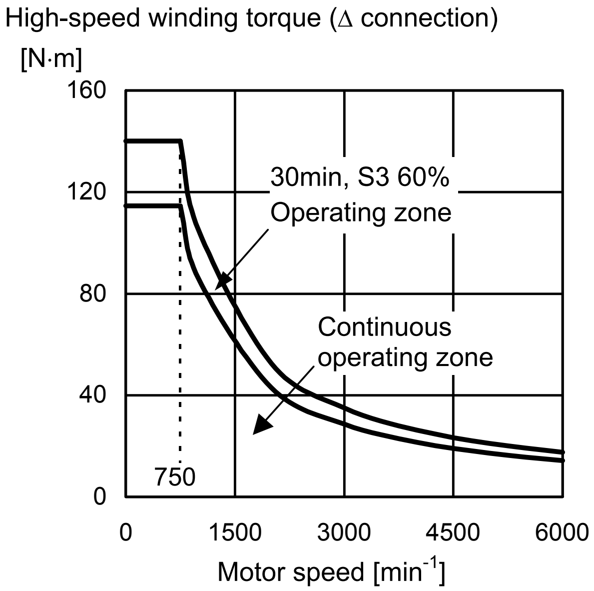
3.3 MODEL αiIP 18/6000

Applicable amplifier αiSP 15



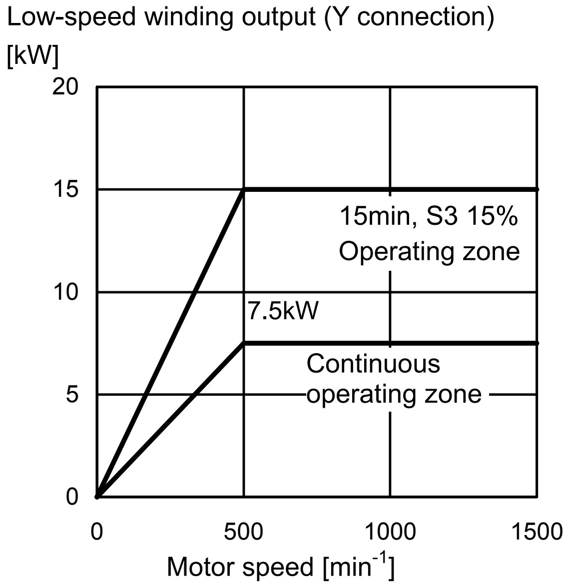


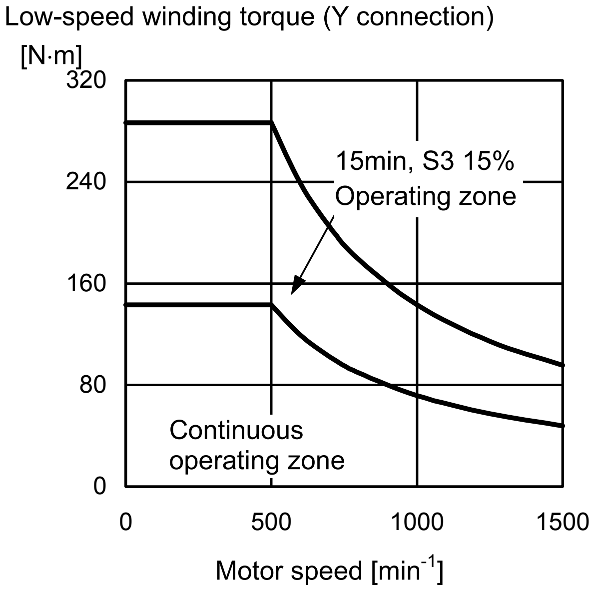


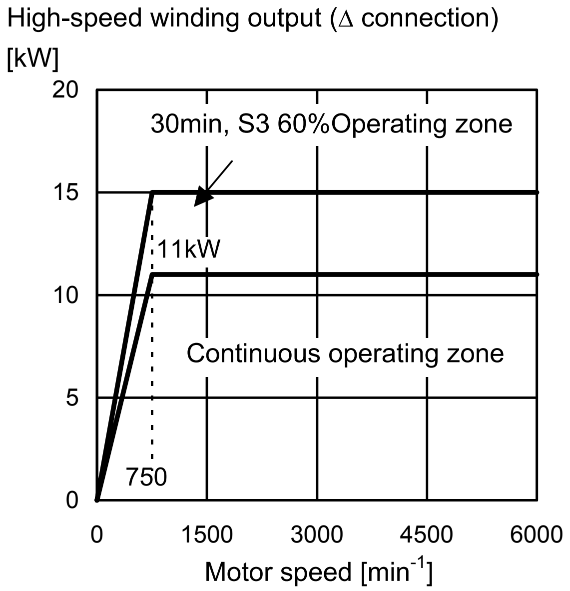


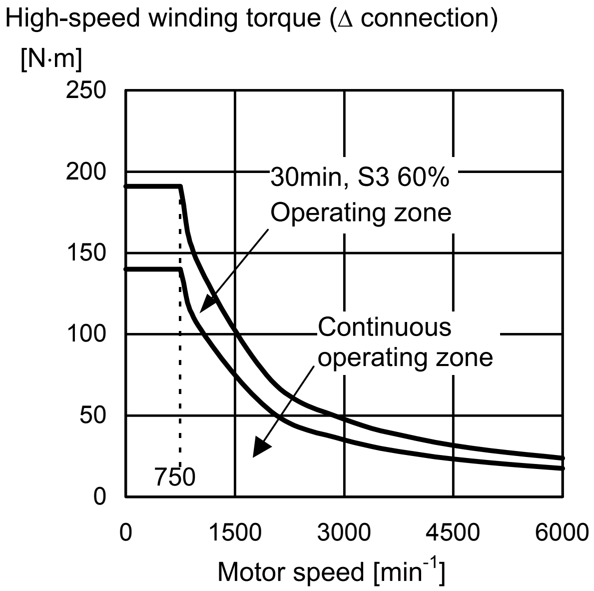
3.4 MODEL αiIP 22/6000

Applicable amplifier αiSP 22





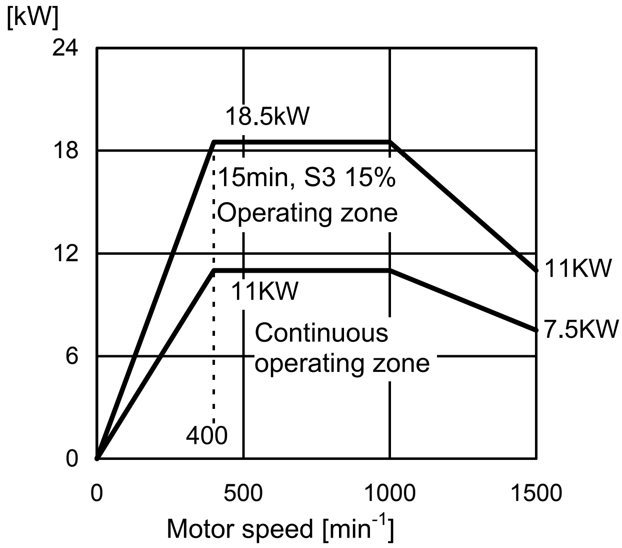




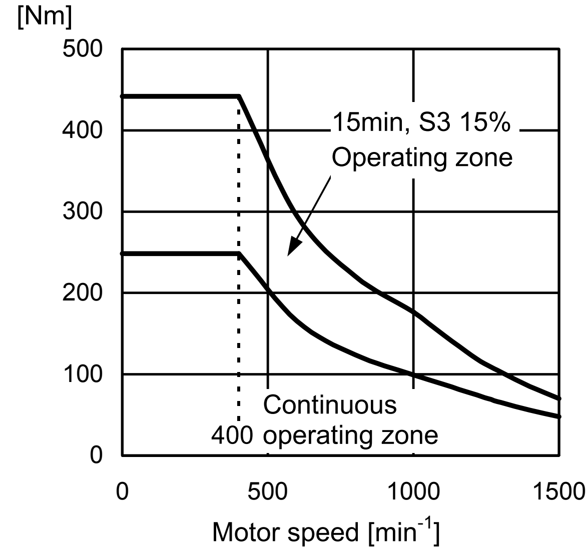
3.5 MODEL αiIP 30/6000

Applicable amplifier αiSP 22

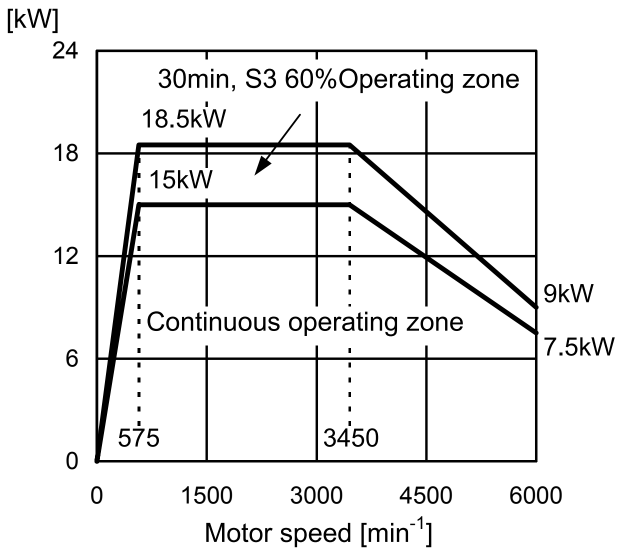
Low-speed winding output (Y connection)



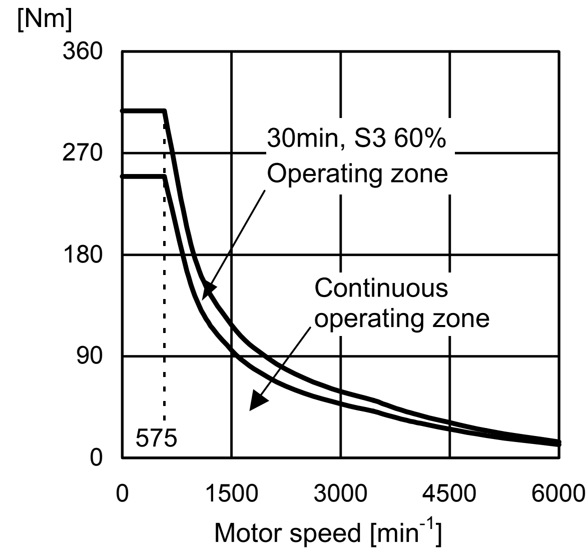
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



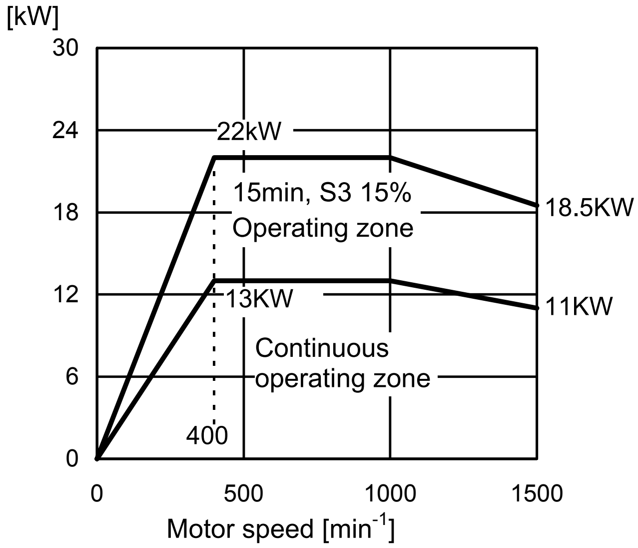
High-speed winding torque (Δ connection)



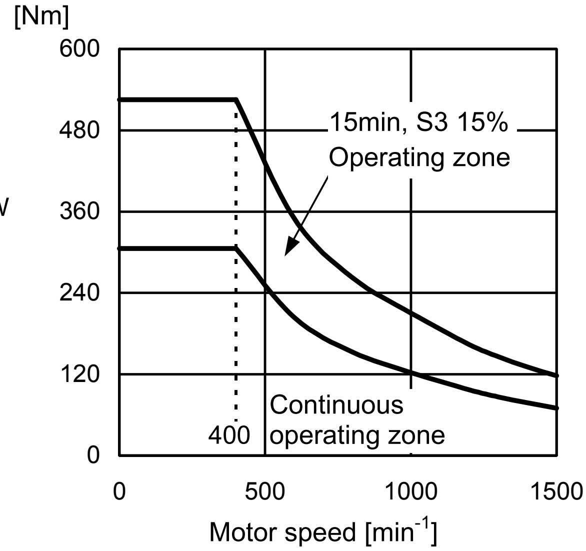
3.6 MODEL αiIP 40/6000

Applicable amplifier αiSP 26

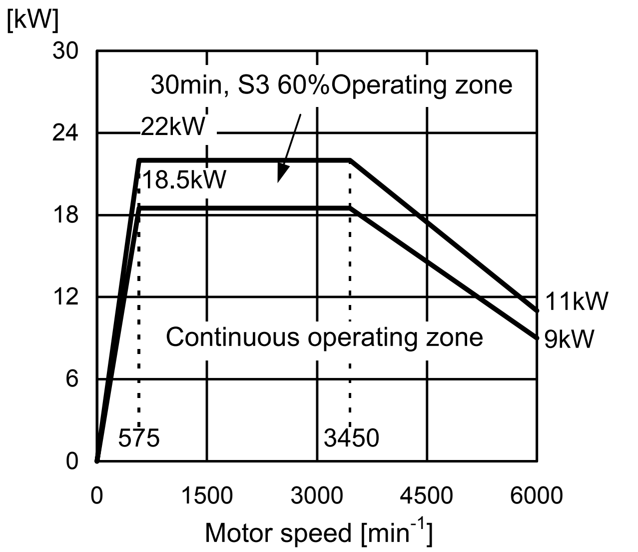
Low-speed winding output (Y connection)



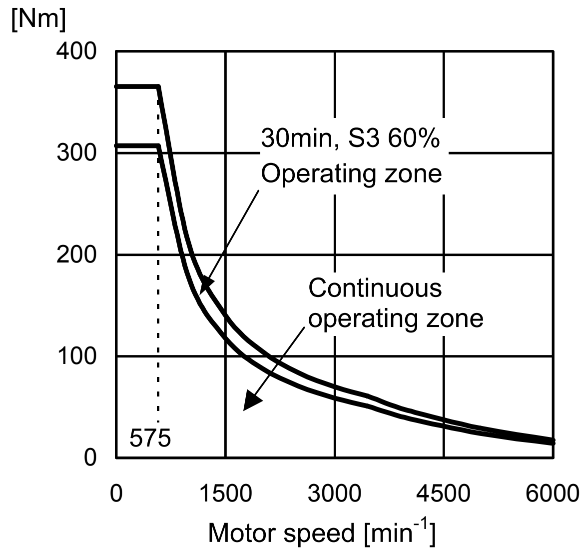
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



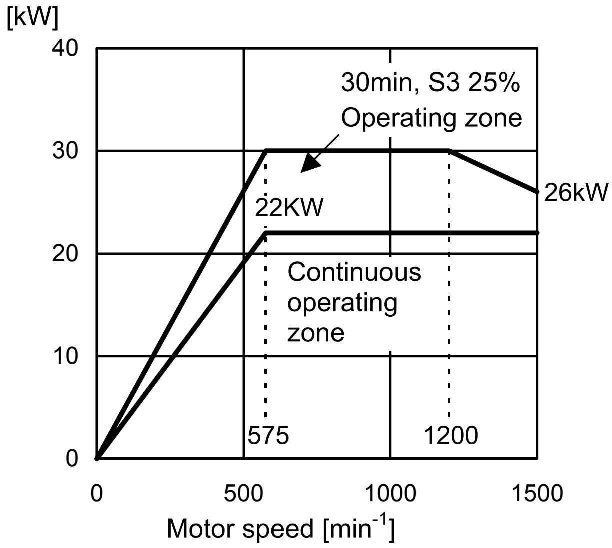
High-speed winding torque (Δ connection)



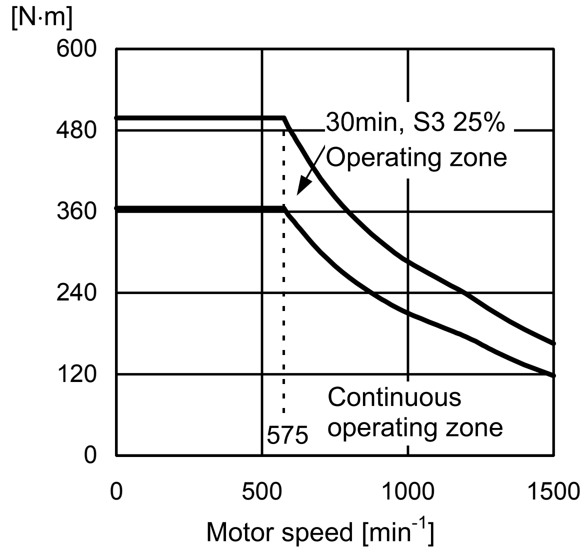
3.7 MODEL αiIP 50/6000

Applicable amplifier αiSP 26

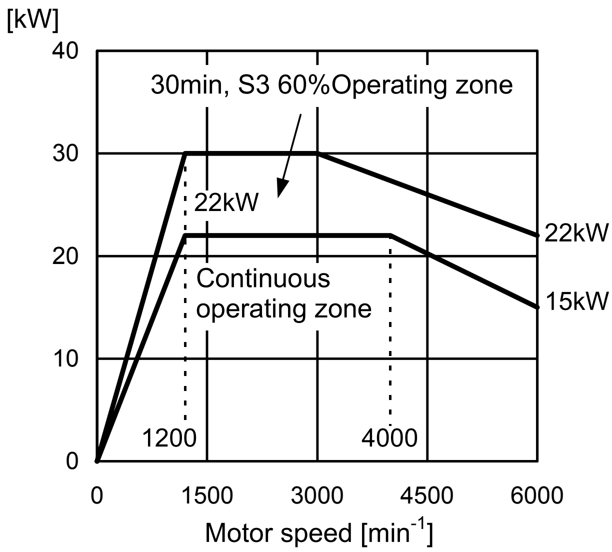
Low-speed winding output (Y connection)



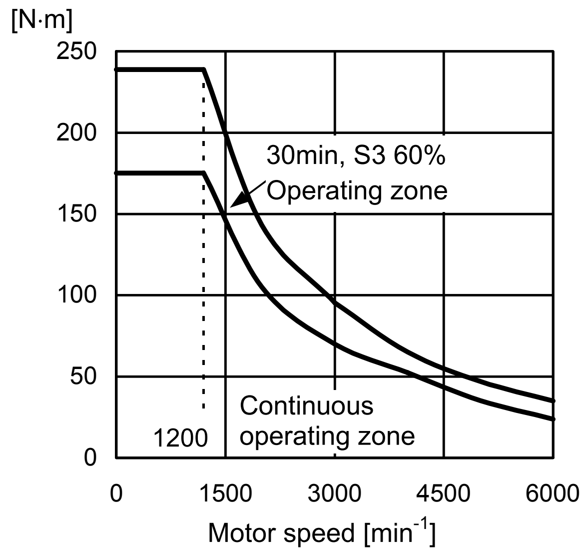
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



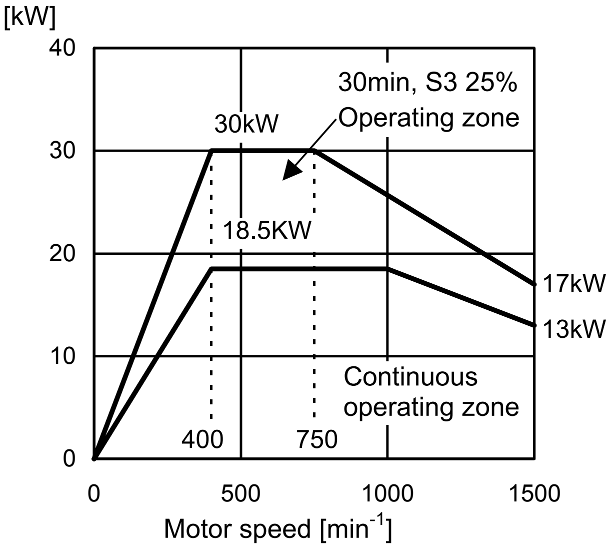
High-speed winding torque (Δ connection)



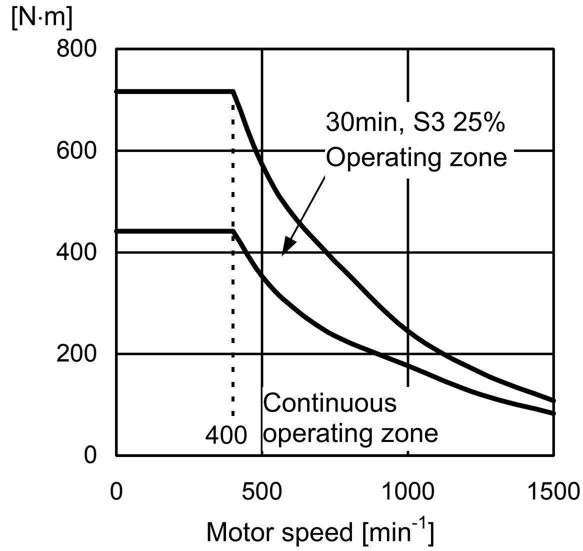
3.8 MODEL αiIP 60/4500

Applicable amplifier αiSP 30

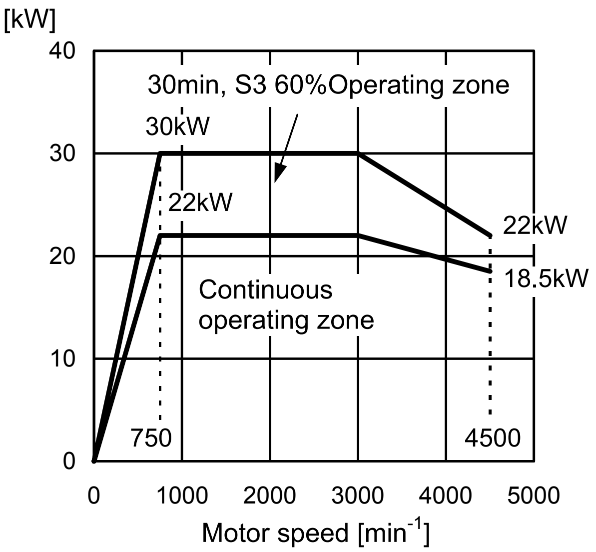
Low-speed winding output (Y connection)



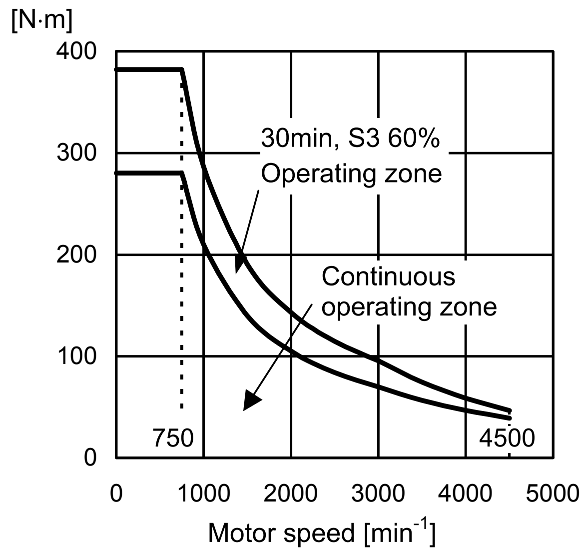
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

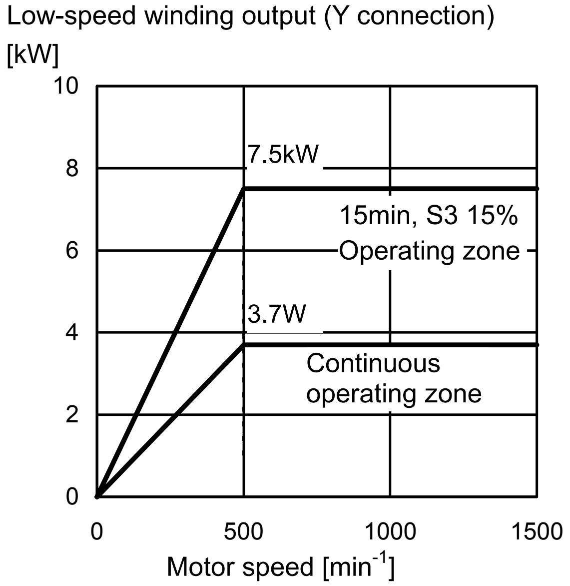


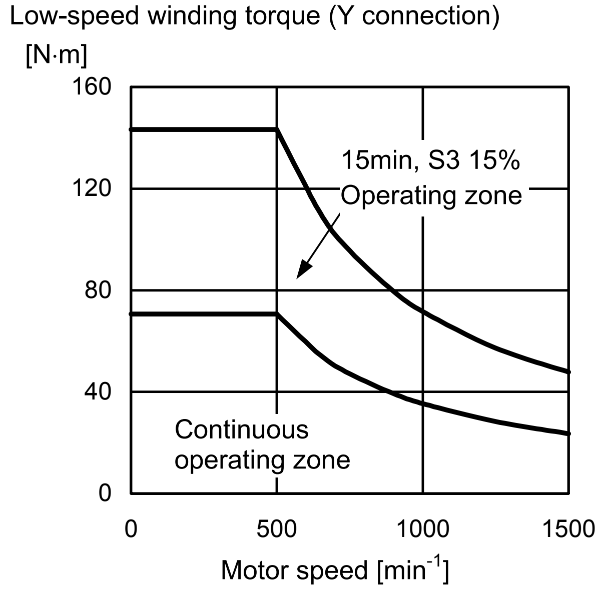
High-speed winding torque (Δ connection)

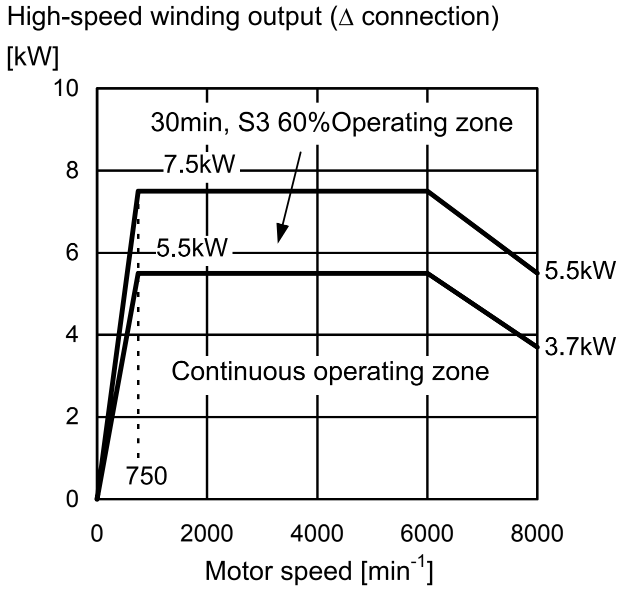


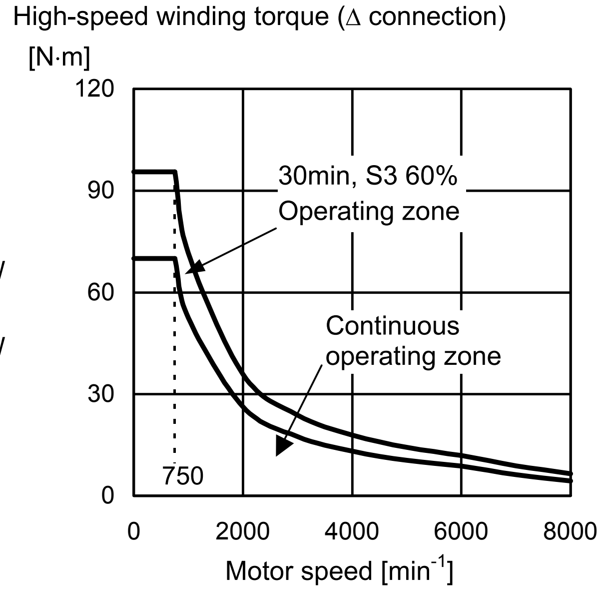
3.9 MODEL αiIP 12/8000

Applicable amplifier αiSP 11





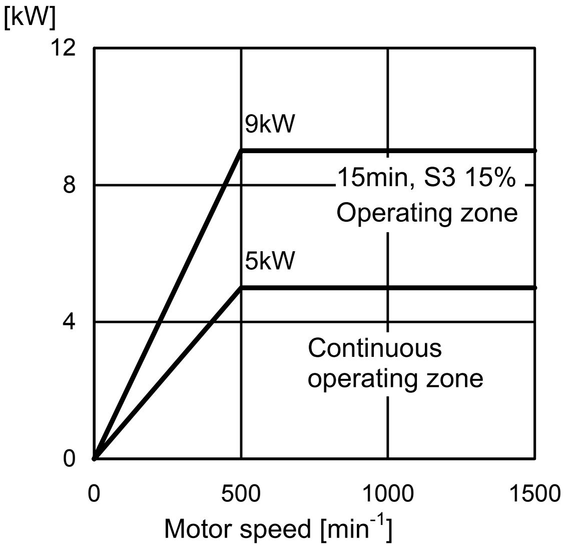




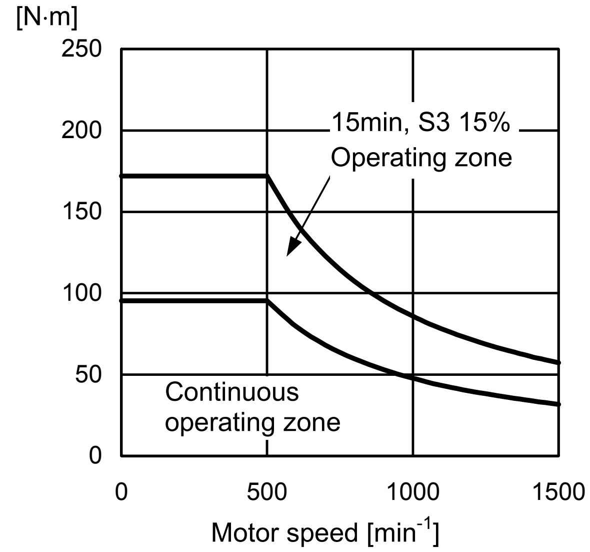
3.10 MODEL αiIP 15/8000

Applicable amplifier αiSP 15

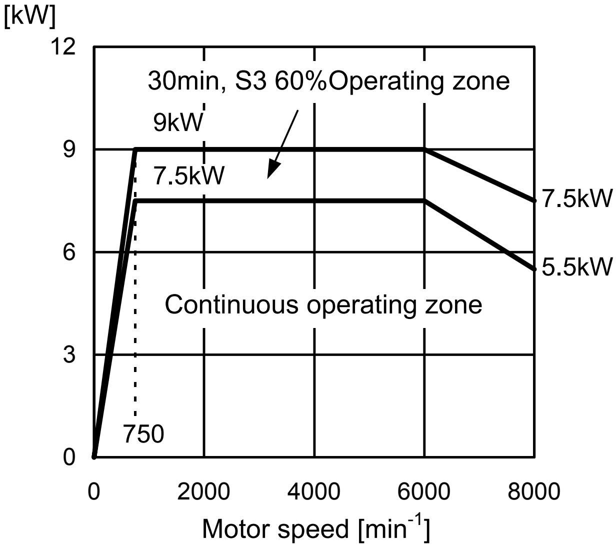
Low-speed winding output (Y connection)



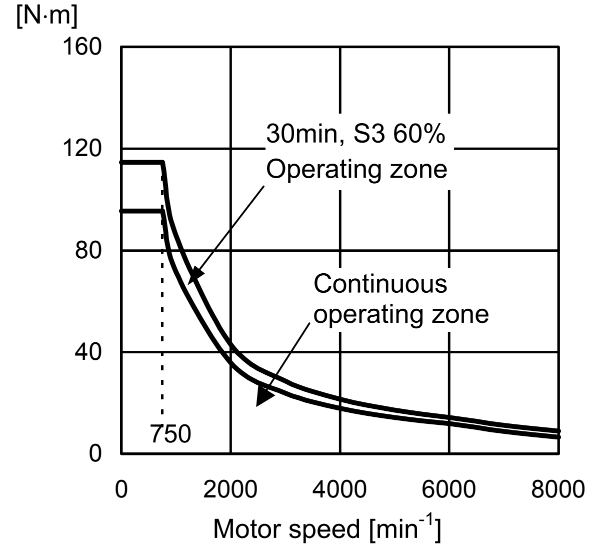
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

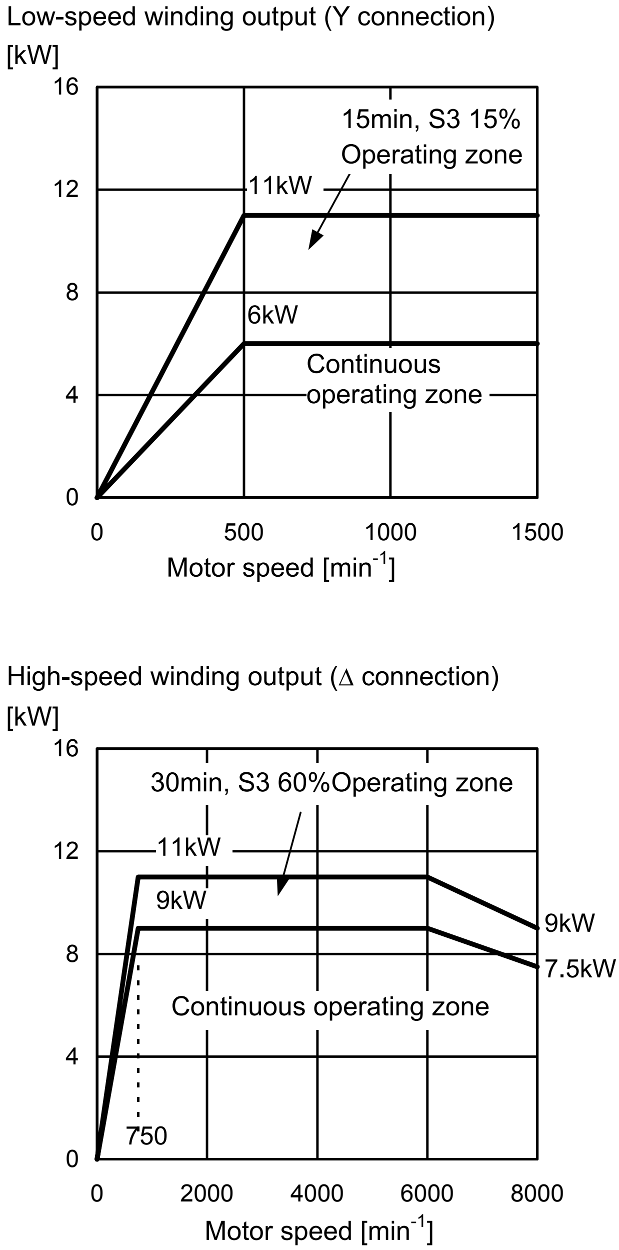


High-speed winding torque (Δ connection)



3.11 MODEL αiIP 18/8000

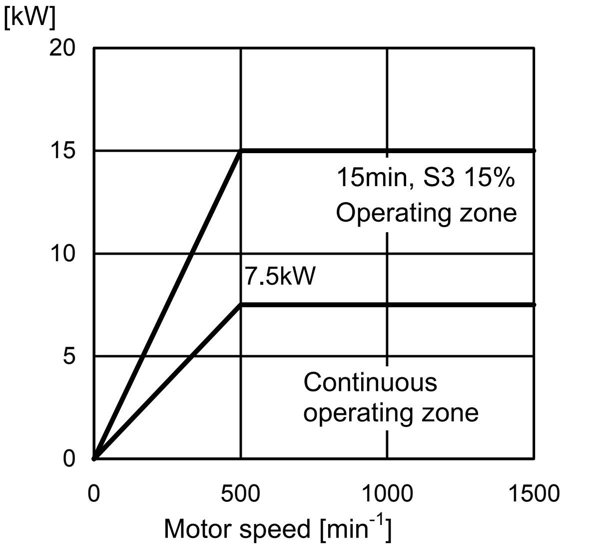
Applicable amplifier αiSP 15



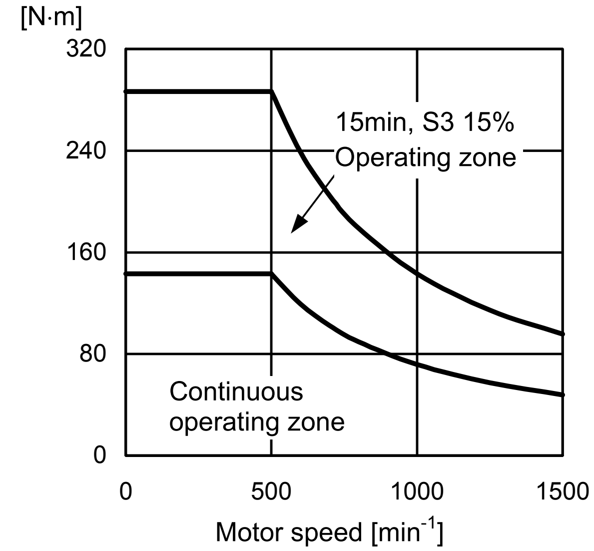
3.12 MODEL αiIP 22/8000

Applicable amplifier αiSP 22

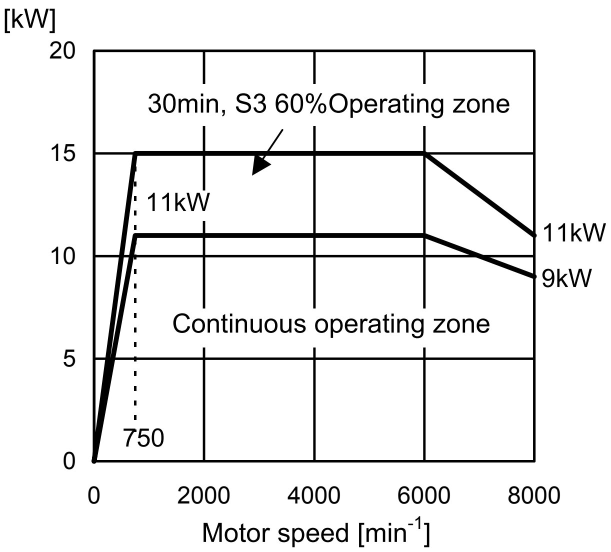
Low-speed winding output (Y connection)



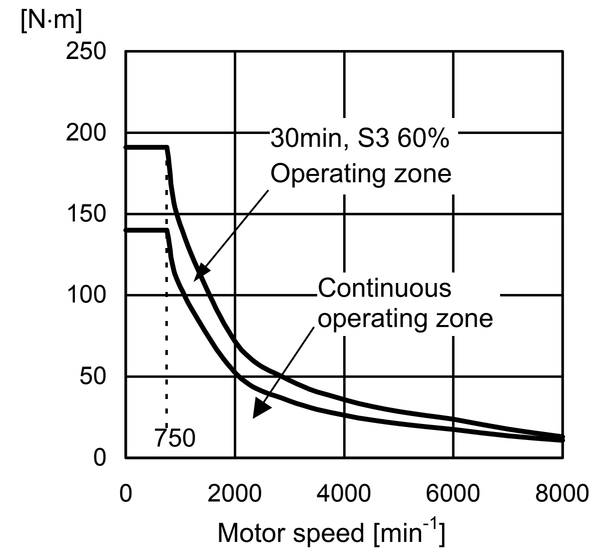
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



High-speed winding torque (Δ connection)



4 CONNECTIONS

4.1 MODELS αiIP 12/6000 TO αiIP 60/4500

Cables for power lead and fan motor are connected to the terminal block.

αiM sensor or αiMZ sensor signal or thermo stat signal use a connector manufactured by Tyco Electronics AMP.

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

Size of screws used in the terminal block / Model	Power lead		Fan motor
	U,V,W,G	X,Y,Z	FMU,FMV,FMW
αiIP 12/6000 to αiIP 22/6000	M5	M5	Screw-less terminal block
αiIP 30/6000 to αiIP 50/6000	M6	M6	Screw-less terminal block
αiIP 60/4500	M8	M8	M3.5

Cable for the power lead

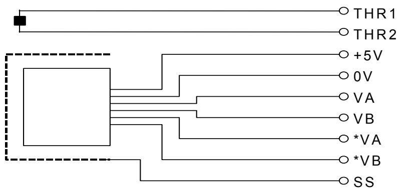
For the power lead cable specification, refer to "FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN)".

Cable for the fan motor

For the fan motor current value and cable specifications, refer to Section I.4.3, “FAN MOTOR CONNECTION” in this manual.

4.2 CONNECTION OF SIGNAL LEAD

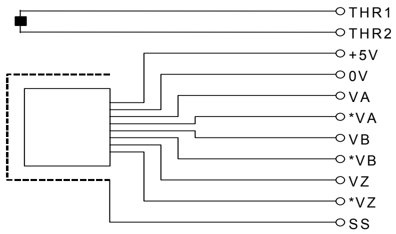
Connector attachment for a motor with a built-in αiM sensor



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		*VA	*VB		0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	VA	VB		SS	THR1

Connector attachment for a motor with a built-in αiMZ sensor



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		*VA	*VB	*VZ	0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	VA	VB	VZ	SS	THR1

- Connector housing and contact specifications

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

	Motor side		Cable side	
	FANUC specification	Manufacture specifica-tion	FANUC specification	Manufacture 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 kΩ as measured at room temperature (20°C to 30°C).

5 ALLOWABLE RADIAL LOAD

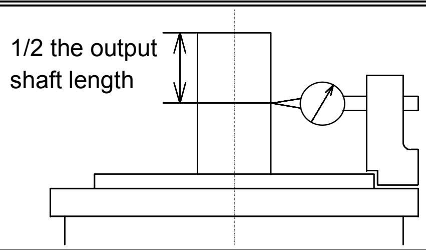
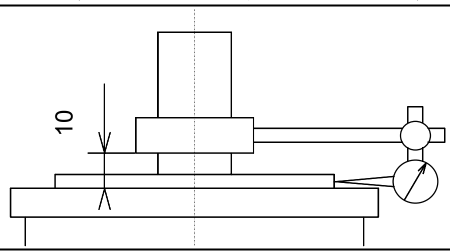
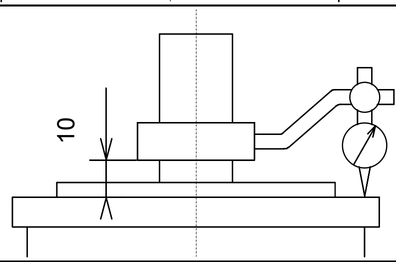
Use the motor output shaft below the allowable radial loads shown in the table below.

Model	Allowable radial load (kgf)	
	At output shaft end	At output shaft center
α*i*IP 12/6000, α*i*IP 15/6000	2940N (300kgf)	3410N (348kgf)
α*i*IP 18/6000, α*i*IP 22/6000	4410N (450kgf)	4988N (509kgf)
α*i*IP 30/6000, α*i*IP 40/6000, α*i*IP 50/6000	5390N (550kgf)	6134N (626kgf)
α*i*IP 60/4500	-	19600N (2000kgf)
α*i*IP 12/8000, α*i*IP 15/8000	2450N (250kgf)	2842N (290kgf)
α*i*IP 18/8000, α*i*IP 22/8000	2940N (300kgf)	3332N (340kgf)

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. If a thrust load is applied when a helical gear is used, the shaft moves in the direction of the thrust. So, as a general rule, never apply a thrust load.

6 ASSEMBLING ACCURACY

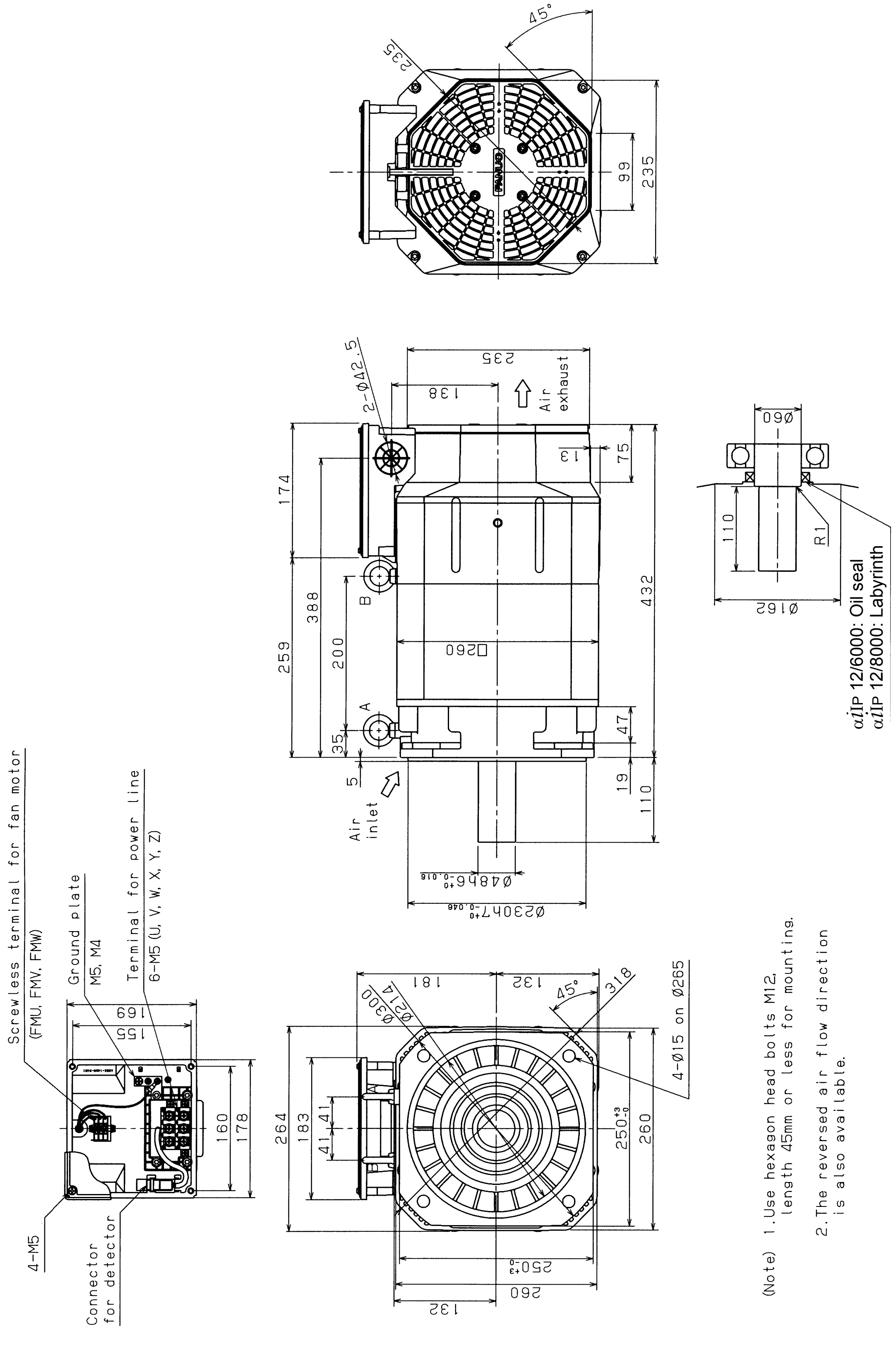
Item \ Model	αiIP 12 to αiIP 22	αiIP 30 to αiIP 60	Measuring method
Run-out at the end of the output shaft	20μm or less	20μm or less	
Run-out of the faucet joint for mounting the flange against the core of the shaft (only for flange type)	40μm or less	60μm or less	
Run-out of the flange mounting surface against the core of the shaft (only for flange type)	80μm or less	100μm or less	

⚠ **CAUTION**
Assembling accuracy of high speed models are same as above.

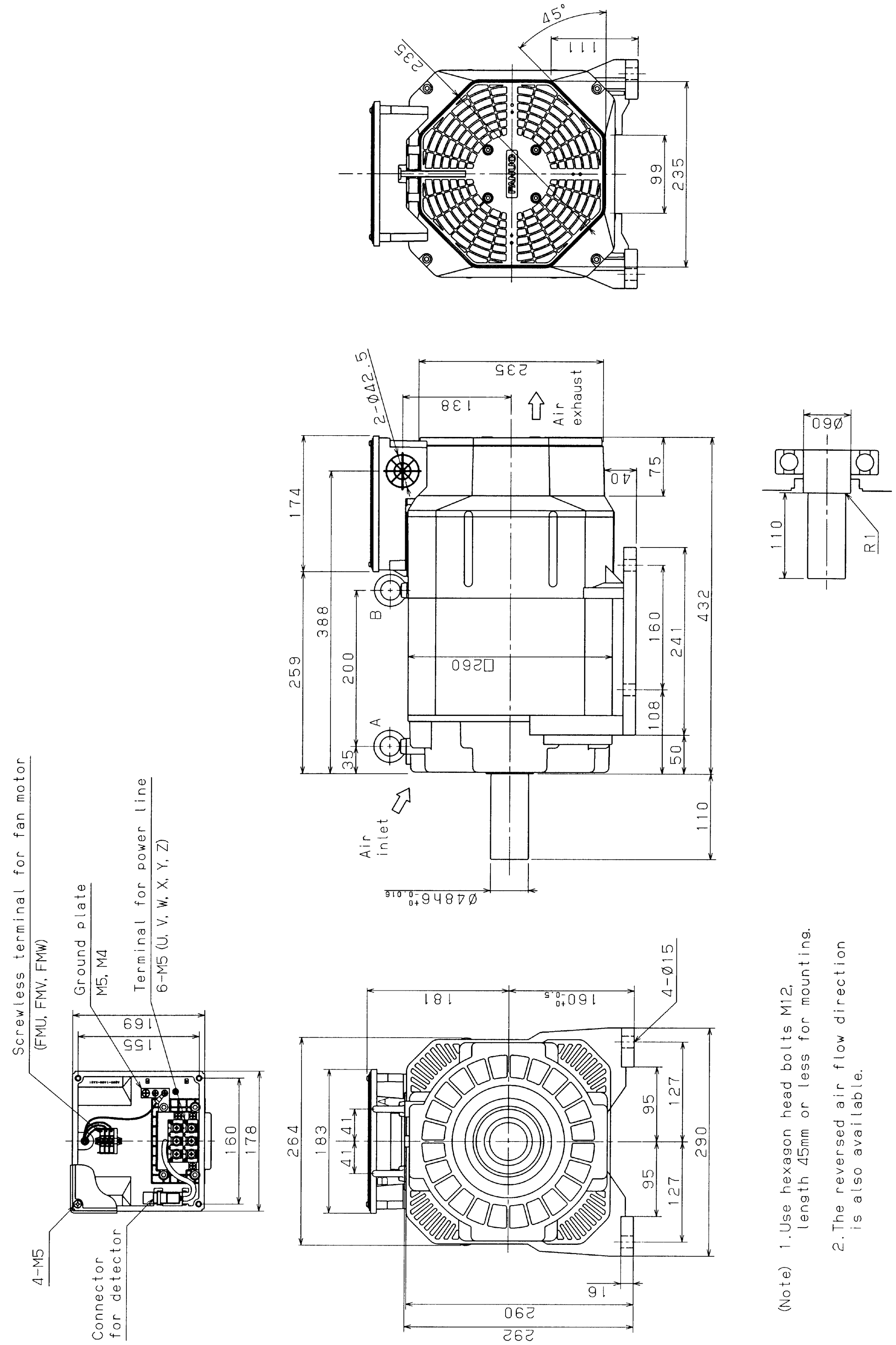
7 EXTERNAL DIMENSIONS

Model name	Section
Models αiIP 12/6000 and αiIP 12/8000 (flange mounting type)	7.1
Model αiIP 12/6000 (foot mounting type)	7.2
Models αiIP 15/6000 and αiIP 15/8000 (flange mounting type)	7.3
Model αiIP 15/6000 (foot mounting type)	7.4
Models αiIP 18/6000 and αiIP 18/8000 (flange mounting type)	7.5
Model αiIP 18/6000 (foot mounting type)	7.6
Models αiIP 22/6000 and αiIP 22/8000 (flange mounting type)	7.7
Model αiIP 22/6000 (foot mounting type)	7.8
Models αiIP 30/6000 and αiIP 40/6000 (flange mounting type)	7.9
Models αiIP 30/6000 and αiIP 40/6000 (foot mounting type)	7.10
Model αiIP 50/6000 (flange mounting type)	7.11
Model αiIP 50/6000 (foot mounting type)	7.12
Model αiIP 60/4500 (flange mounting type)	7.13
Model αiIP 60/4500 (foot mounting type)	7.14

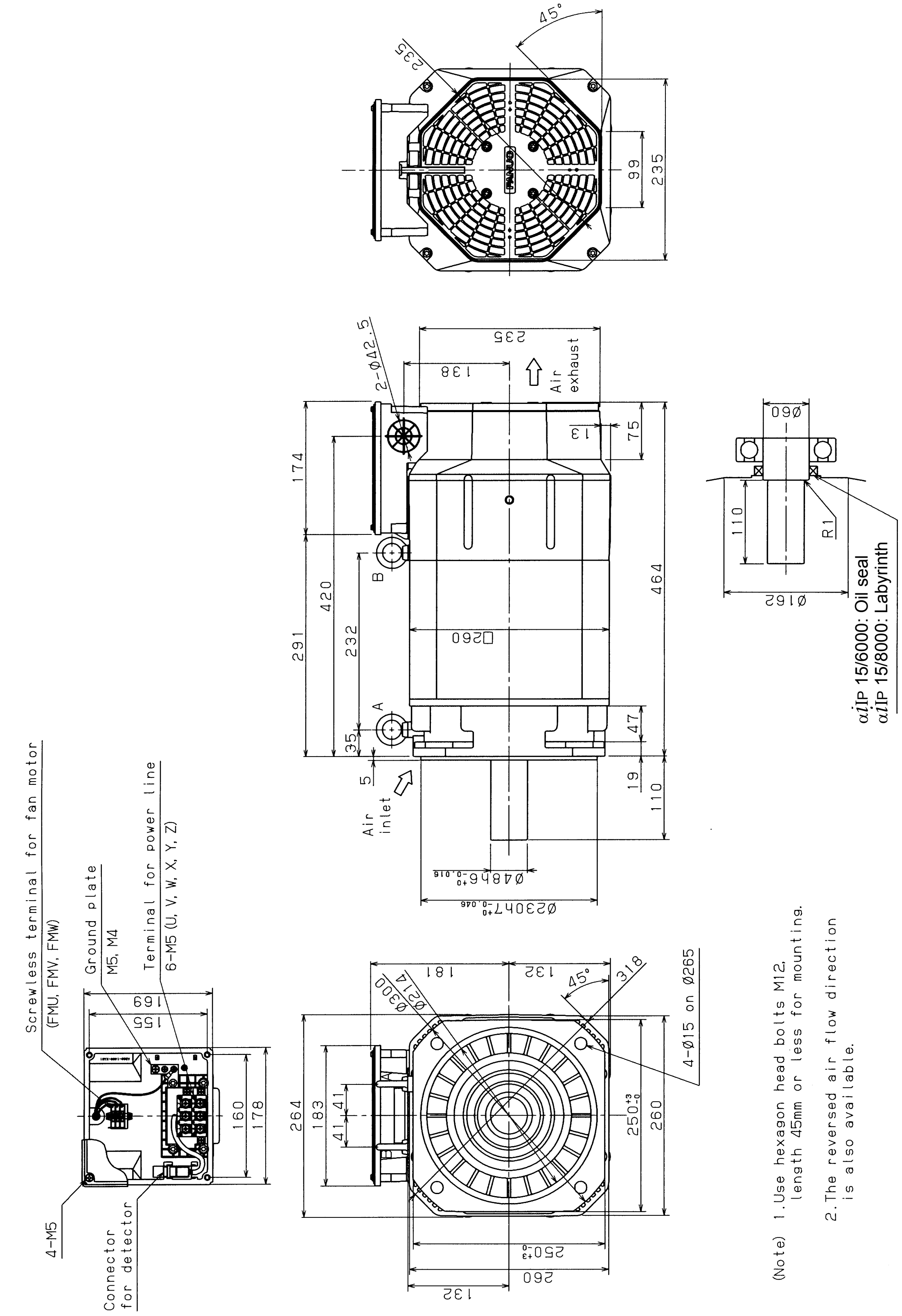
7.1 MODELS αiIP 12/6000 AND αiIP 12/8000 (FLANGE MOUNTING TYPE)



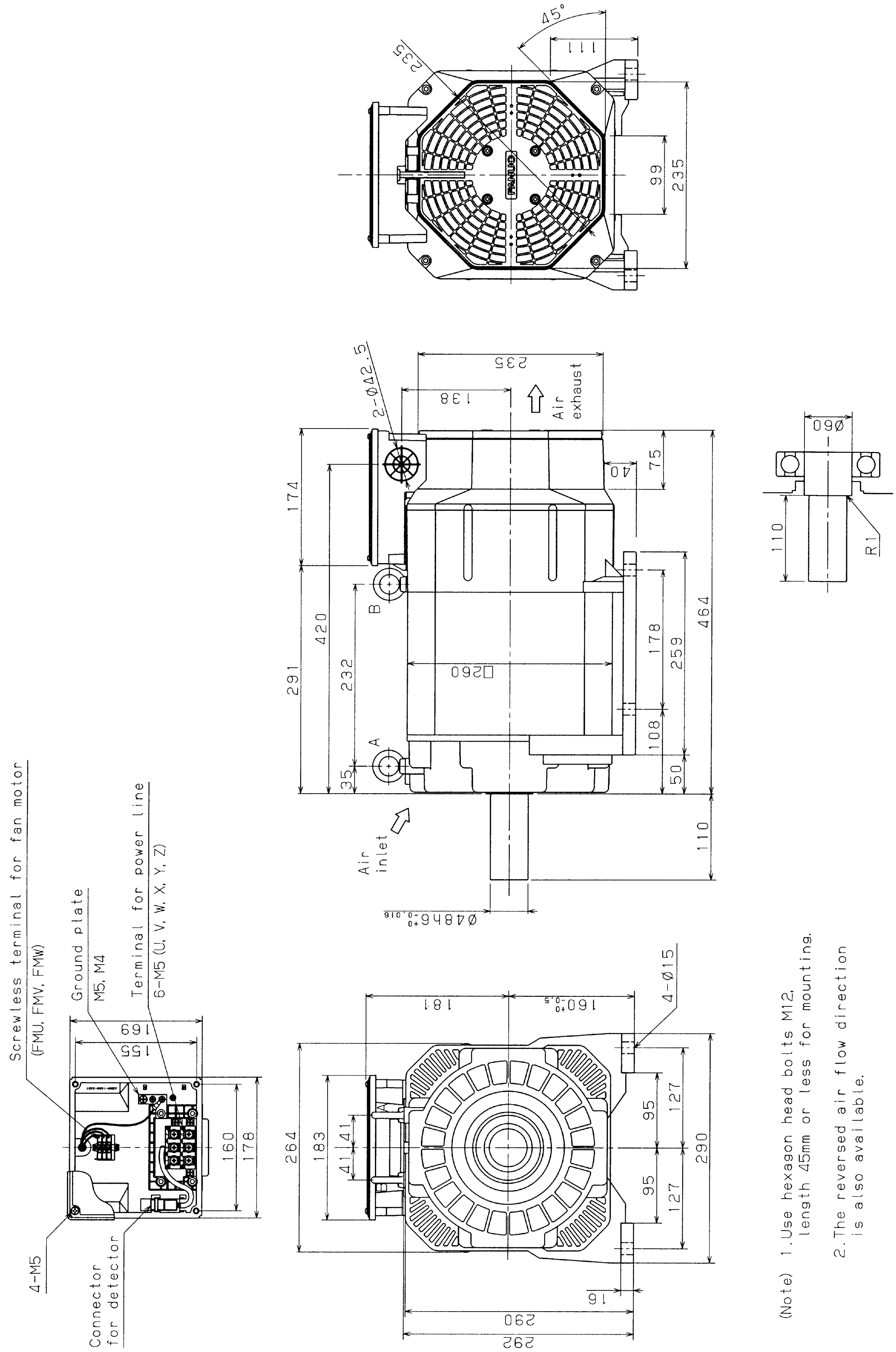
7.2 MODEL αiIP 12/6000 (FOOT MOUNTING TYPE)



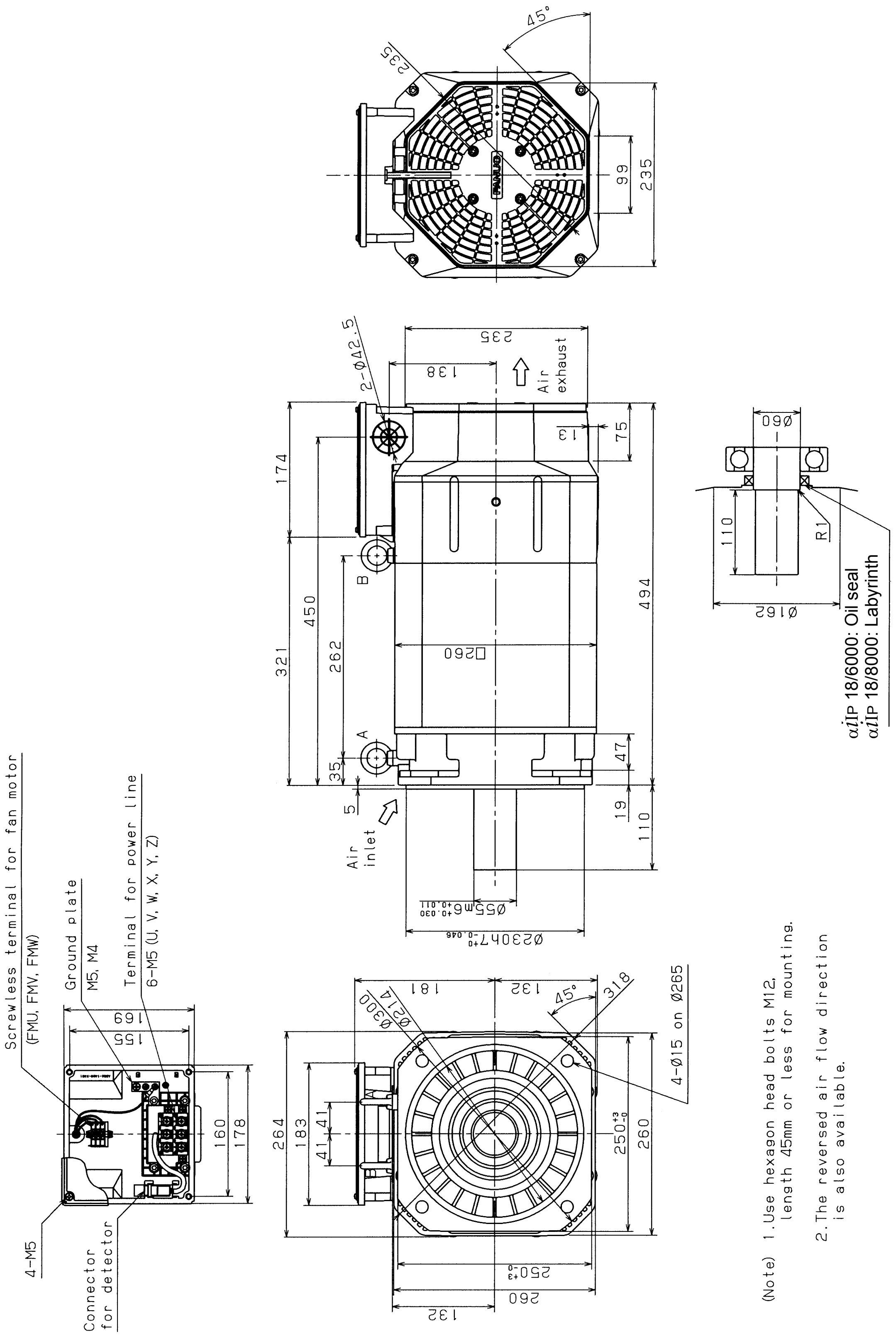
7.3 MODELS αiIP 15/6000 AND αiIP 15/8000 (FLANGE MOUNTING TYPE)



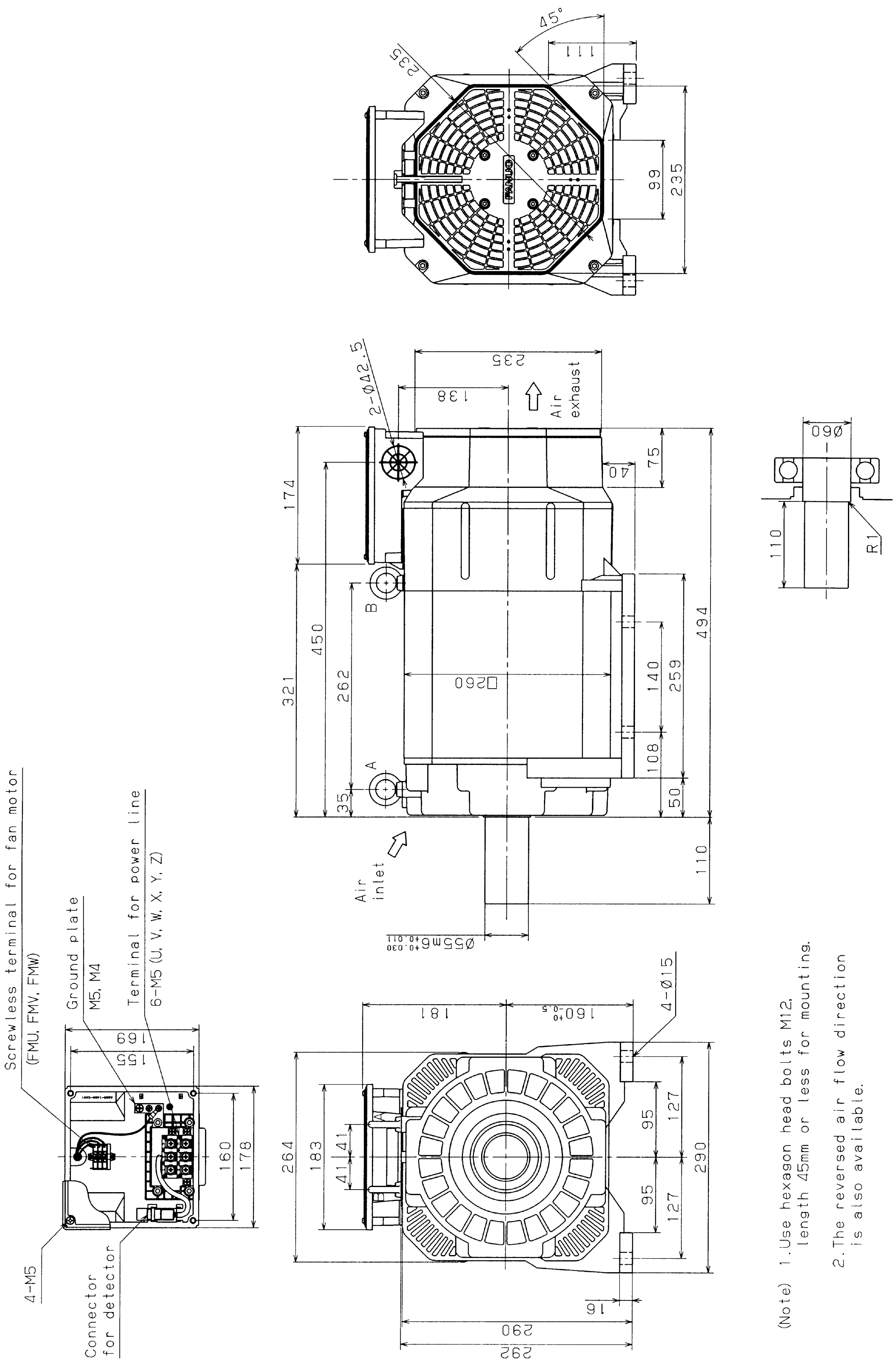
7.4 MODEL αiIP 15/6000 (FOOT MOUNTING TYPE)



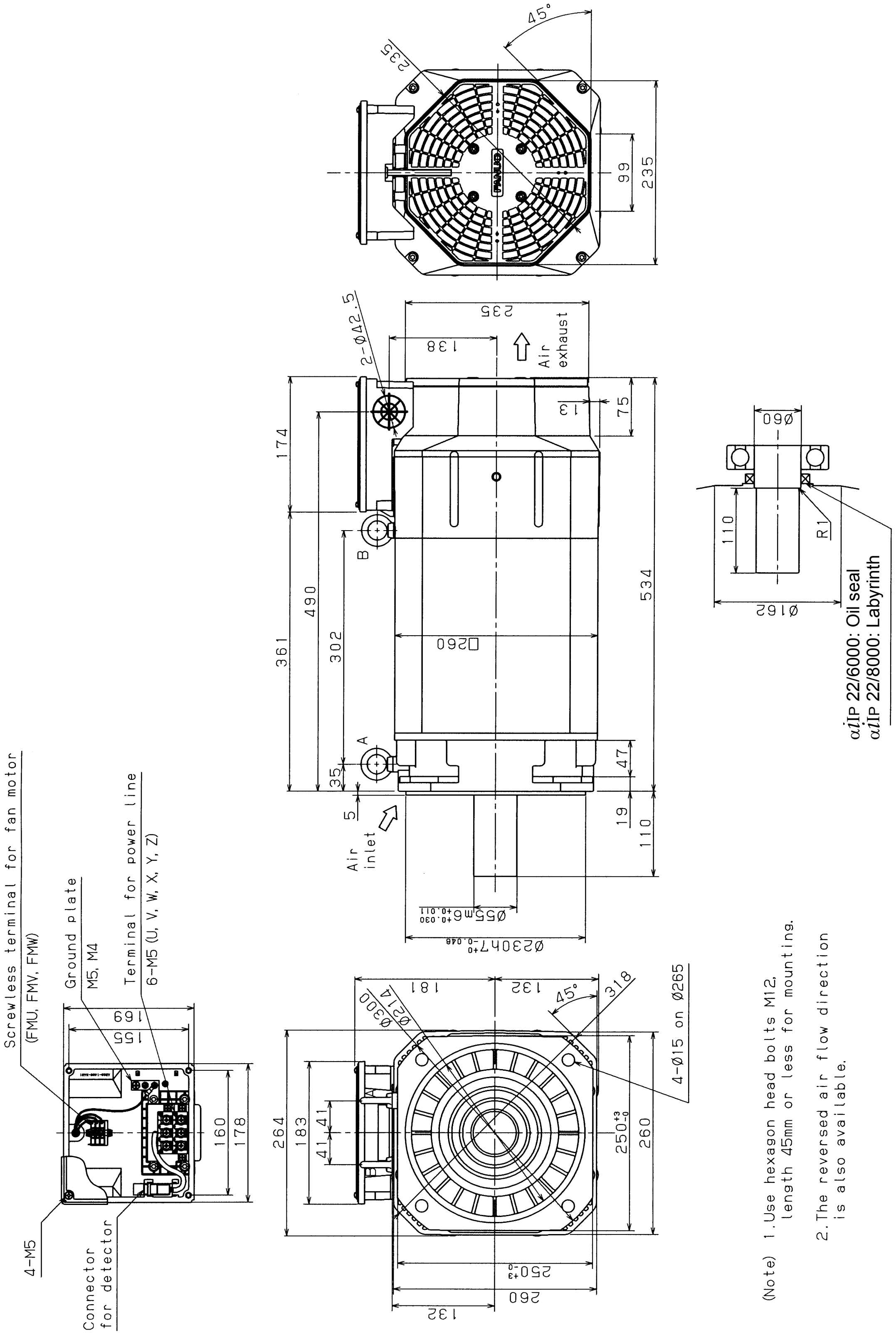
7.5 MODELS αiIP 18/6000 AND αiIP 18/8000 (FLANGE MOUNTING TYPE)



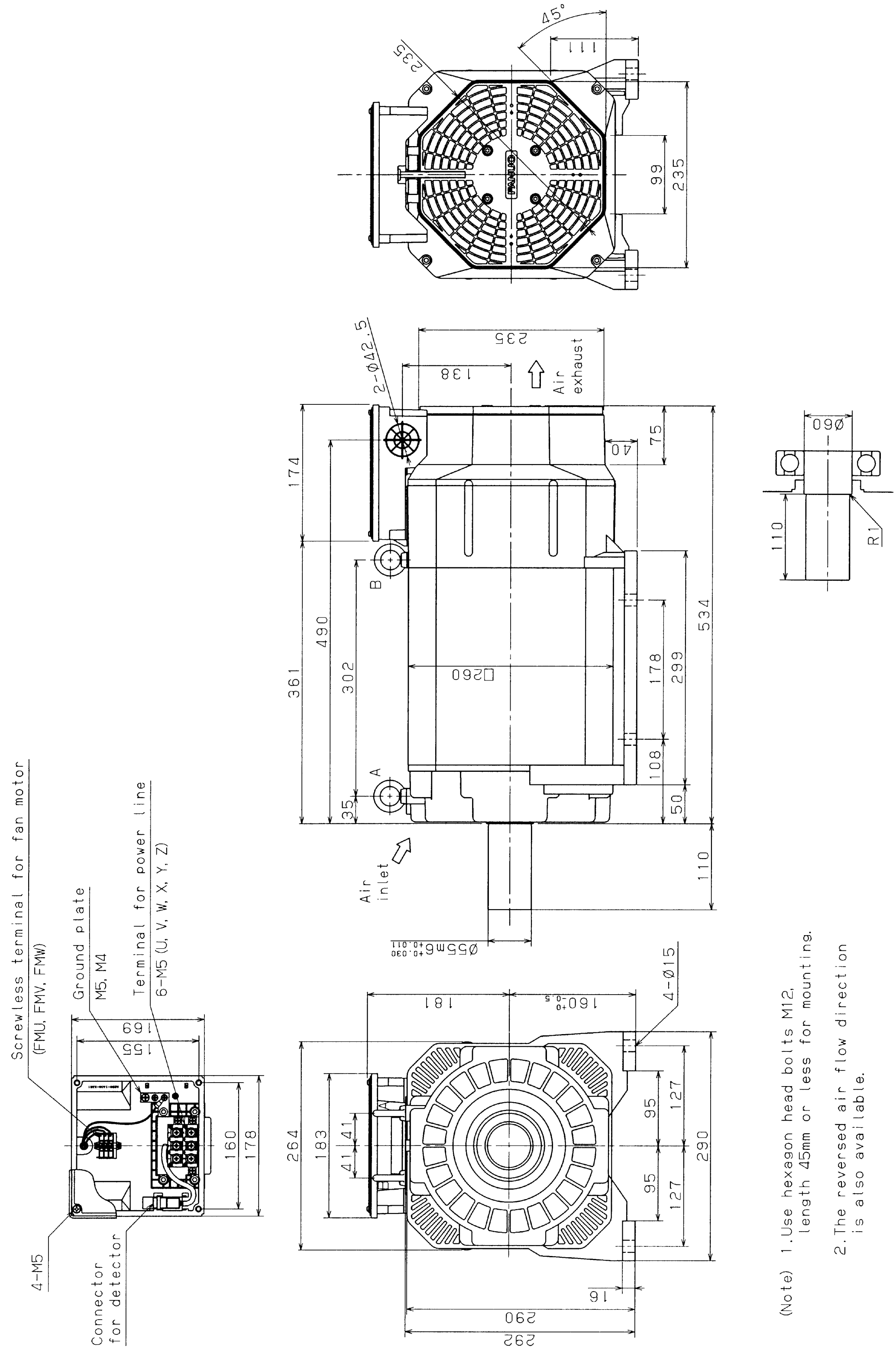
7.6 MODEL αiIP 18/6000 (FOOT MOUNTING TYPE)



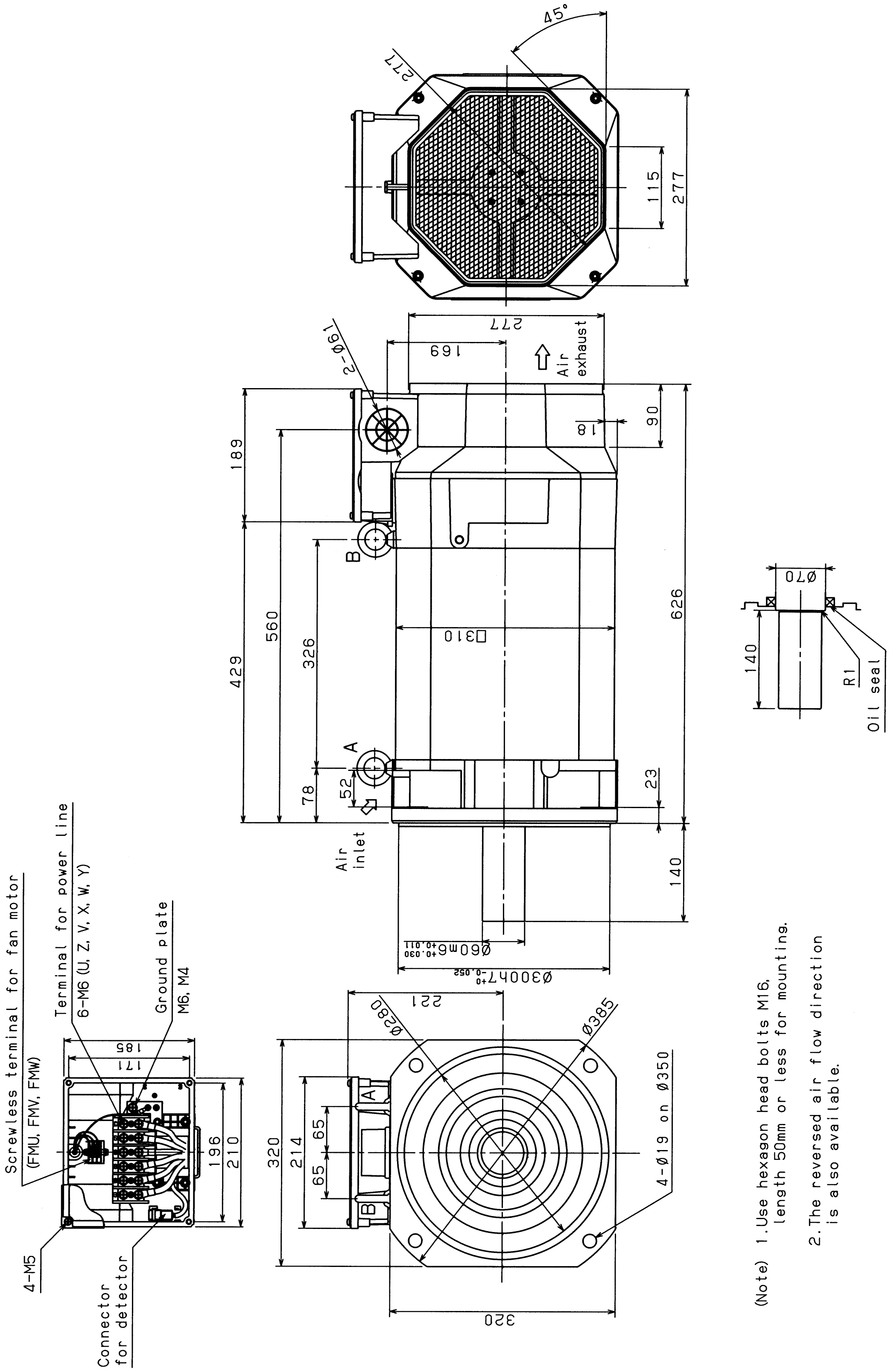
7.7 MODELS αiIP 22/6000 AND αiIP 22/8000 (FLANGE MOUNTING TYPE)



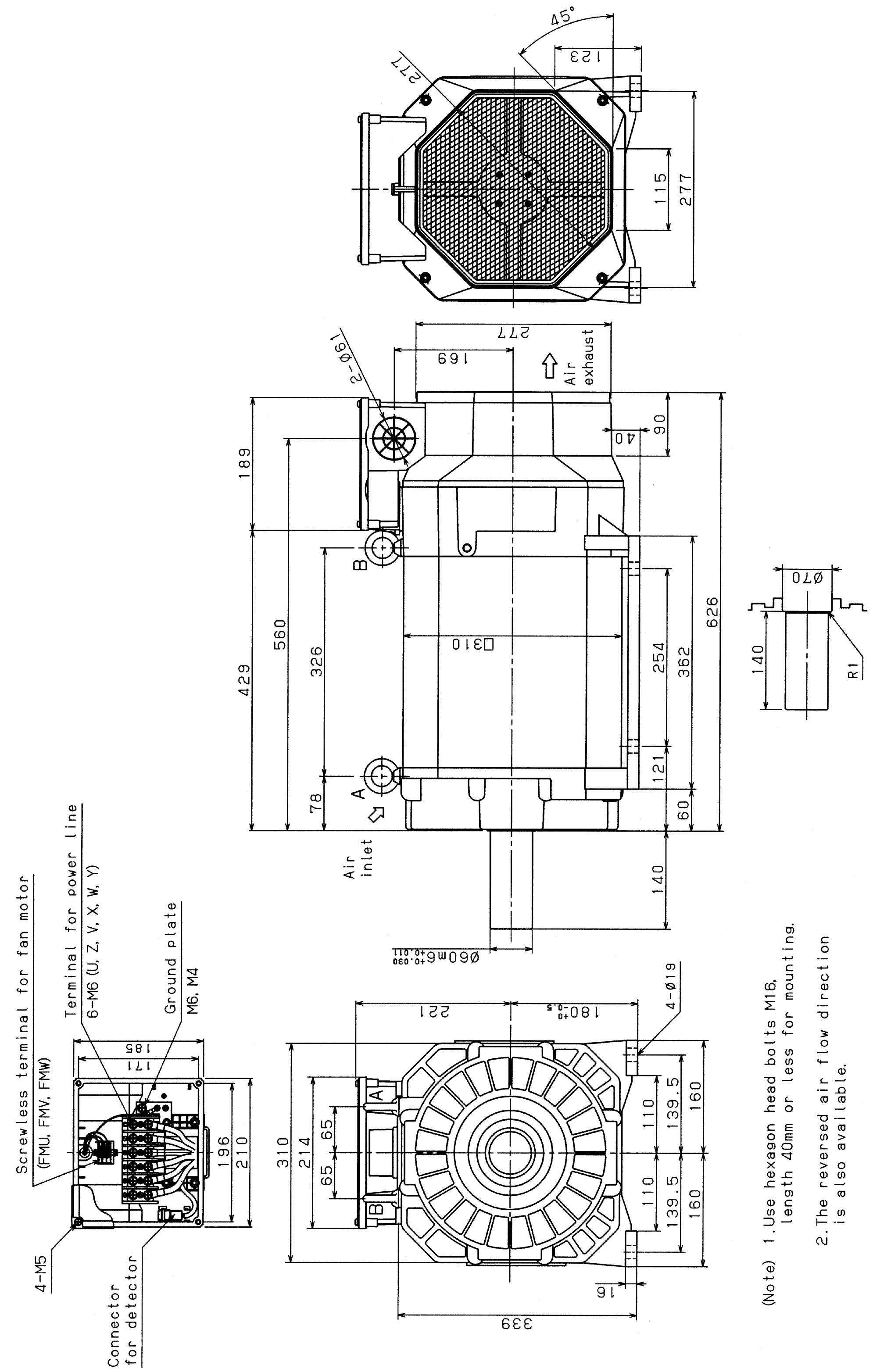
7.8 MODEL αiIP 22/6000 (FOOT MOUNTING TYPE)



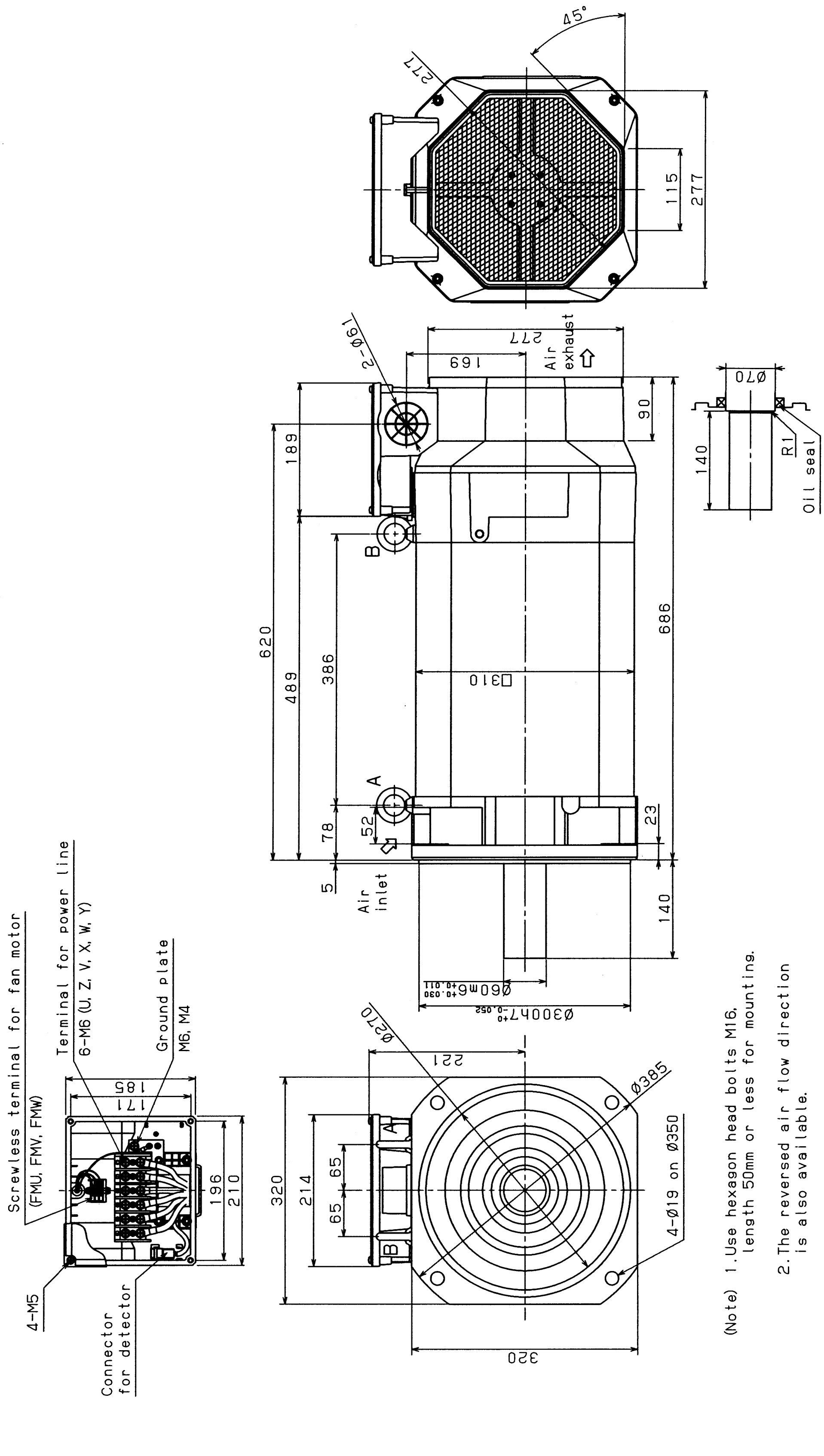
7.9 MODELS αiIP 30/6000 AND αiIP 40/6000 (FLANGE MOUNTING TYPE)



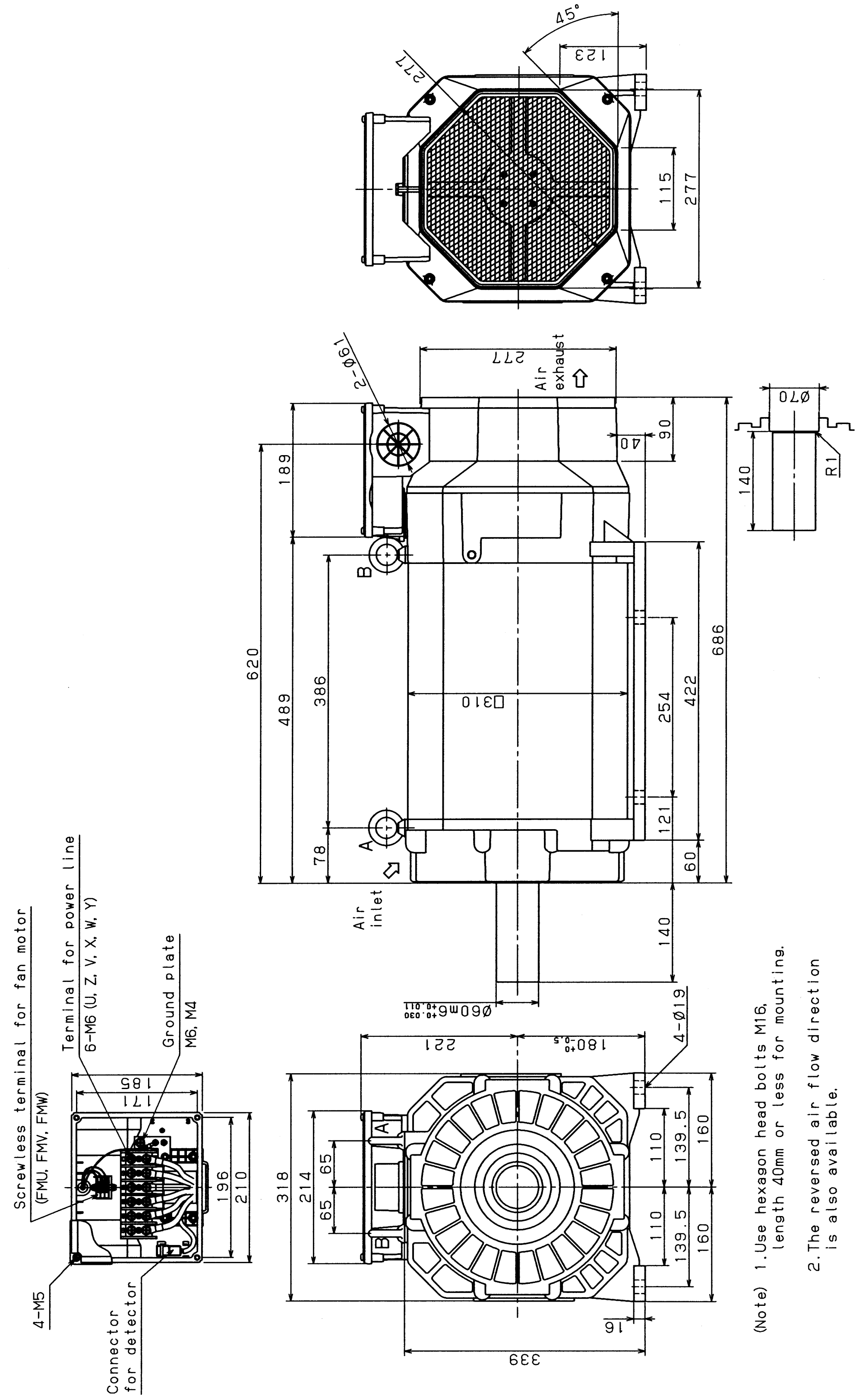
7.10 MODELS αiIP 30/6000 AND αiIP 40/6000 (FOOT MOUNTING TYPE)



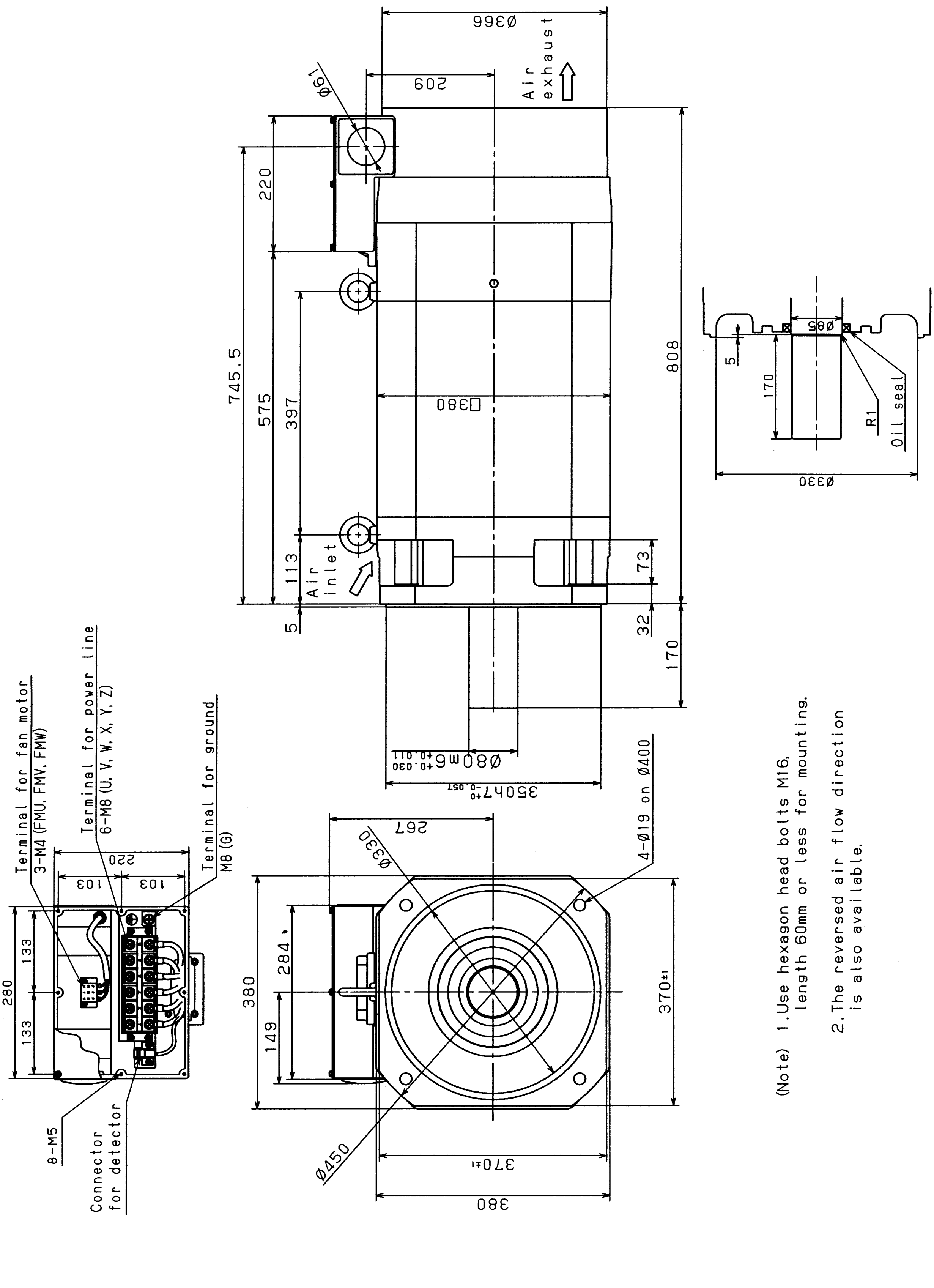
7.11 MODEL αiIP 50/6000 (FLANGE MOUNTING TYPE)



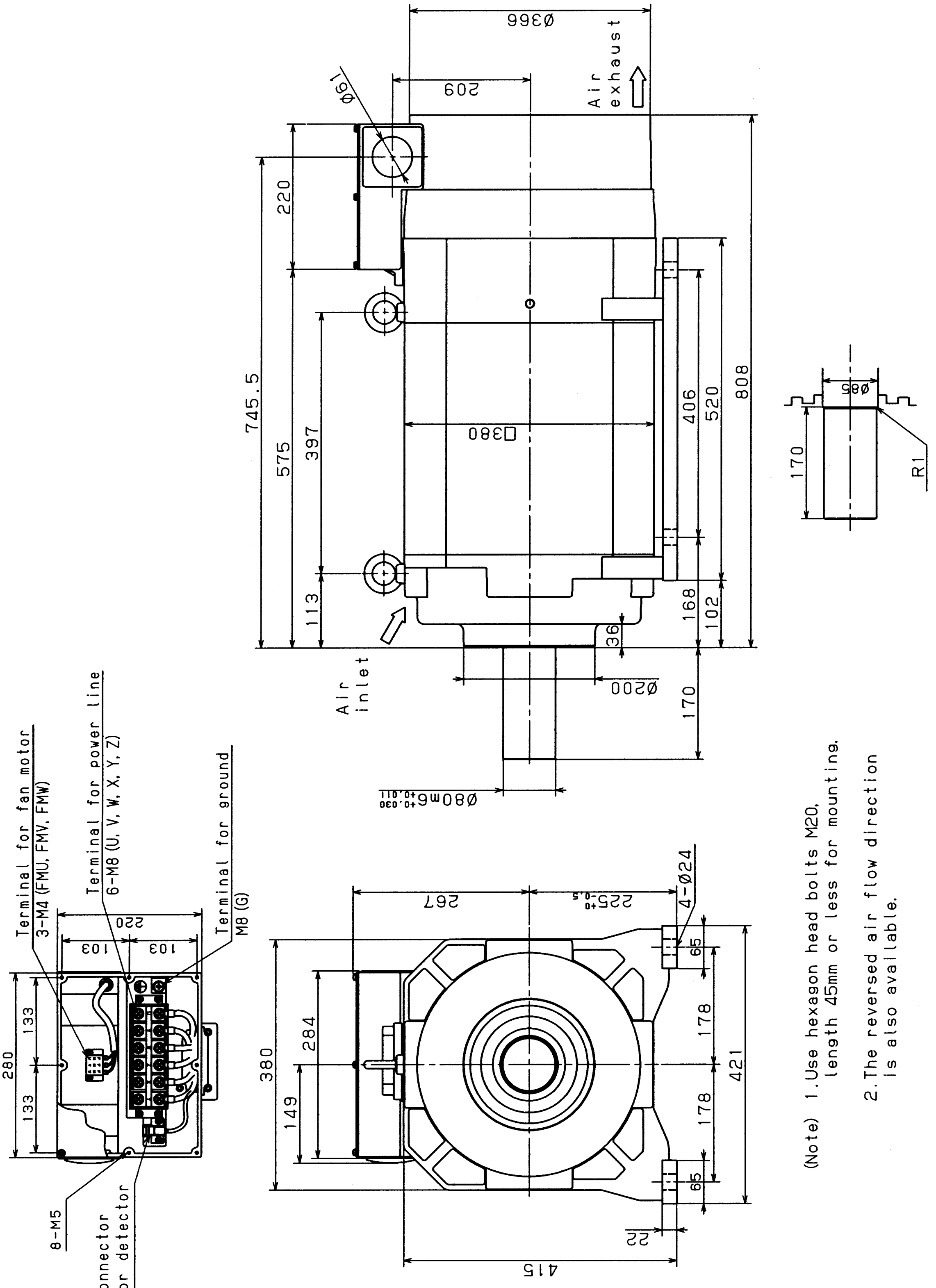
7.12 MODEL αiIP 50/6000 (FOOT MOUNTING TYPE)



7.13 MODEL αiIP 60/4500 (FLANGE MOUNTING TYPE)



7.14 MODEL αiIP 60/4500 (FOOT MOUNTING TYPE)



V. FANUC AC SPINDLE MOTOR αiIP series 400V type

1 GENERAL

FANUC AC spindle motor αiIP series 400V type is suitable for structural simplification by eliminating the machine spindle gear box.

Features

- As the rated output range is wide from 1:10 to 1:16 , a gear box structure for speed change is not required, thereby allowing the structure of the machine to be simplified.
  Accordingly, vibration and noise caused by the gear box structure is also eliminated.
- Improvement in efficiency of construction equipment
  Unnecessary use of time is reduced because it is not necessary to stop the spindle when switching the gear.
- Despite a compact configuration, a large low-speed torque can be obtained.
- The method of fan exhaust can be selected from either a exhaust front type or exhaust rear type, thus preventing heat deformation of the machine.
- 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

Series		α*i*IP series 400V type			
Item	Model	α*i*IP 15/6000HV		α*i*IP 22/6000HV	
		Low-speed winding (Y connection)	High-speed winding (Δ connection)	Low-speed winding (Y connection)	High-speed winding (Δ connection)
Output (*2)	Cont. rated kW (HP)	5 (6.6)	7.5 (10)	7.5 (10)	11 (14.7)
	30 min rated kW [15 min] (*3) (HP)	9 (12)	9 (12)	15 (20.1)	15 (20.1)
	S3 60% kW [15%] (*4)(*5) (HP)	9 (12)	9 (12)	15 (20.1)	15 (20.1)
Rated current A (*6)	Cont. rated		25	25	38
	30 min rated (*3) S3 60%, 15% (*4)		29	45	49
Speed min^{-1}	Base speed	500	750	500	750
	Max. speed	1500	6000, 8000	1500	6000, 8000
Cont. rated torque at const. rated torque range N·m (kgf·cm)		95.5 (974)	95.5 (974)	143.2 (1461)	140 (1428)
Rotor inertia	$kg \cdot m^2$	0.09		0.128	
	$kgf \cdot cm \cdot s^2$	0.93		1.29	
Weight kgf		110		143	
Vibration		V5 (option V3)			
Noise		75dB(A) or less			
Cooling system (*7)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		56			
Installation (*8)		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			
Allowable overload capacity (1 min) (*9)		120 % of 30 min rated output			
Insulation		Class H			
Ambient temperature		0 to 40 °C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Sensor		α*i*M sensor or α*i*MZ sensor			
Type of thermal protection (*10)		TP211			
Resolution of the α*i*MZ sensor /rev.		4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Maximum output during acceleration (*11) kW		13.5		20.0	
Applicable spindle amplifier		α*i*SP 15HV		α*i*SP 30HV	
Model		α*i*IP 15/6000HV		α*i*IP 22/6000HV	

Series		αiP series 400V type			
Item / Model		αiP 40/6000HV		αiP 50/6000HV	
		Low-speed winding (Y connection)	**High-speed winding (Δ connection)**	**Low-speed winding (Y connection)**	**High-speed winding (Δ connection)**
Output (*2)	Cont. rated kW (HP)	13 (17.3)	18.5 (24.8)	22 (29.5)	22 (29.5)
	30 min rated kW [15 min] (*3) (HP)	22 (29.5)	22 (29.5)	30 (40.2)	30 (40.2)
	S3 60% kW [15%] (*4)(*5) (HP)	22 (29.5)	22 (29.5)	30 (40.2)	30 (40.2)
Rated current A (*6)	Cont. rated	34	53	48	47
	30 min rated (*3) S3 60%, 15% (*4)	54	61	59	59
Speed min^{-1}	Base speed	400	575	575	1200
	Max. speed	1500	6000	1500	6000
Cont. rated torque at const. rated torque range N·m (kgf·cm)		310 (3165)	307 (3133)	365 (3726)	175 (1785)
Rotor inertia	$kg{\cdot}m^2$	0.295		0.355	
	$kgf{\cdot}cm{\cdot}s^2$	3.0		3.6	
Weight kgf		250		290	
Vibration		V5 (option V3)			
Noise		75dB(A) or less			
Cooling system (*7)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		84			
Installation (*8)		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			
Allowable overload capacity (1 min) (*9)		120 % of 30 min rated output			
Insulation		Class H			
Ambient temperature		0 to 40 °C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Sensor		αiM sensor or αiMZ sensor			
Type of thermal protection (*10)		TP211			
Resolution of the αiMZ sensor /rev.		4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Maximum output during acceleration (*11) kW		29.0		35.4	
Applicable spindle amplifier		αiSP 30HV		αiSP 30HV	
Model		αiP 40/6000HV		αiP 50/6000HV	

Series		αiIP series 400V type	
Item / Model		αiIP 60/4500HV	
		Low-speed winding (Y connection)	High-speed winding (Δ connection)
Output (*2)	Cont. rated kW (HP)	18.5 (24.8)	22 (29.5)
	30 min rated kW [15 min] (*3) (HP)	30 (40.2)	30 (40.2)
	S3 60% kW [15%] (*4)(*5) (HP)	30 (40.2)	30 (40.2)
Rated current A (*6)	Cont. rated	44	53
	30 min rated (*3) S3 60%, 15% (*4)	67	66
Speed min^{-1}	Base speed	400	750
	Max. speed	1500	4500
Cont. rated torque at const. rated torque range N·m (kgf·cm)		442 (4504)	280 (2850)
Rotor inertia	$kg \cdot m^2$	0.49	
	$kgf \cdot cm \cdot s^2$	5.0	
Weight kgf		468	
Vibration		V10 (option V5)	
Noise		80dB(A) or less	
Cooling system (*7)		Totally enclosed and fan cooled IC0A6	
Cooling fan W		180	
Installation (*8)		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	
Allowable overload capacity (1 min) (*9)		120 % of 30 min rated output	
Insulation		Class H	
Ambient temperature		0 to 40 °C	
Altitude		Height above sea level not exceeding 1000m	
Painting color		Munsell system N2.5	
Sensor		αiM sensor or αiMZ sensor	
Type of thermal protection (*10)		TP211	
Resolution of the αiMZ sensor /rev.		4096	
Number of detected gear teeth per rotation λ/rev.		256	
Bearing lubrication		Grease	
Maximum output during acceleration (*11) kW		36	
Applicable spindle amplifier		αiSP 30HV	
Model		αiIP 60/4500HV	

(*1) When the output switch function is used, the CNC soft option and switching magnetic contactor unit associated with the output switch function (Y-Δ switch) are required.
See FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN) for details of the output switch control.

(*2) The rated output is guaranteed at the rated voltage.
(Amplifier input: 400/480VAC +10% -15%, 50/60 Hz ±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.

(*3) The output for low-speed winding models other than αiP 50/6000HV and αiP 60/4500HV is 15 min rated.

(*4) S3 15% for low-speed winding models other than αiP 50/6000HV and αiP 60/4500HV.
S3 25% for low-speed winding of αiP 50/6000HV and αiP 60/4500HV

(*5) The cycle time is 10 minutes, S3 60%: ON 6 minutes, OFF 4 minutes, S3 25%: ON 2.5 minutes, OFF 7.5 minutes and S3 15%: ON 1.5 minutes, OFF 8.5 minutes.

(*6) The rated current is not a guaranteed value but a guideline for the maximum current at each rated output.

(*7) IC code conforms to IEC 34-6.

(*8) IM code conforms to IEC 34-7.

(*9) This is not a guaranteed value but a guideline for the maximum motor output at a rated supply voltage.

(*10) Type conforms to IEC 34-11.

(*11) These values are to be used only as guidance for selecting a power supply (αiPS) and are not guaranteed.

(*12) Degree of protection:
with oil seal: IP54, without oil seal: IP40.

3 OUTPUT/TORQUE CHARACTERISTICS

Reference
Calculation for torque

Torque T can be obtained by the following equation.

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

P[kW]: Motor output

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

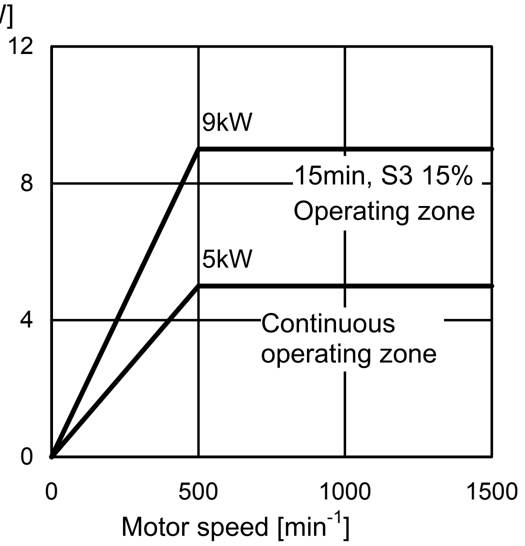
When the unit of T is [kgf·m],

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

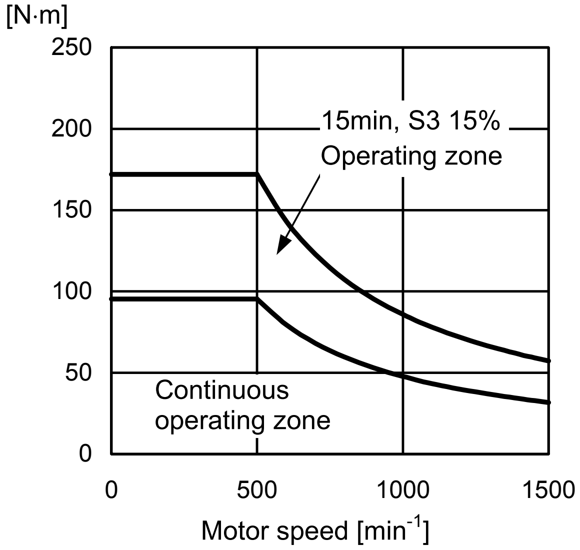
3.1 MODEL αiIP 15/6000HV

Applicable amplifier αiSP 15HV

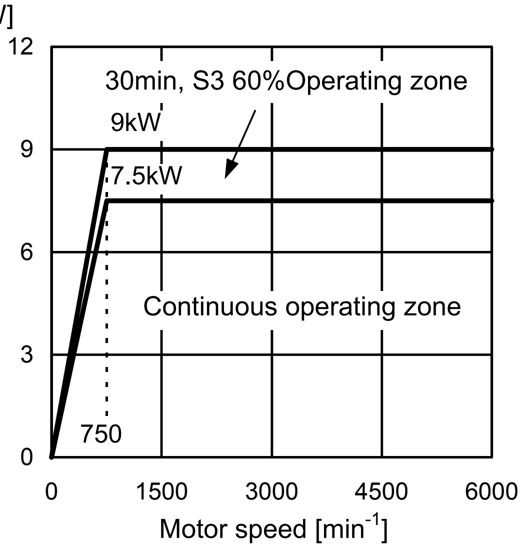
Low-speed winding output (Y connection)



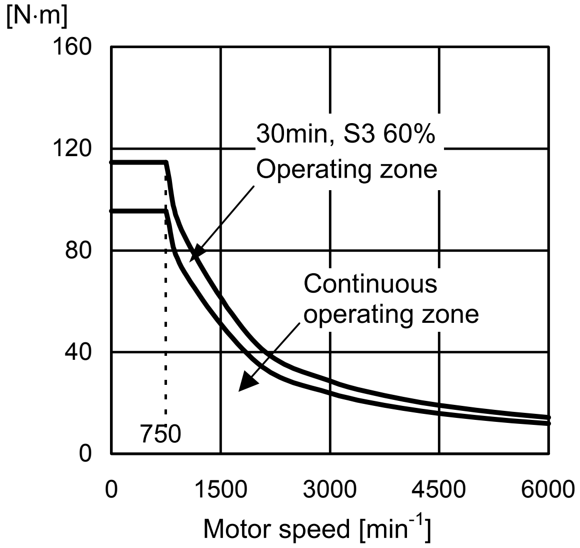
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



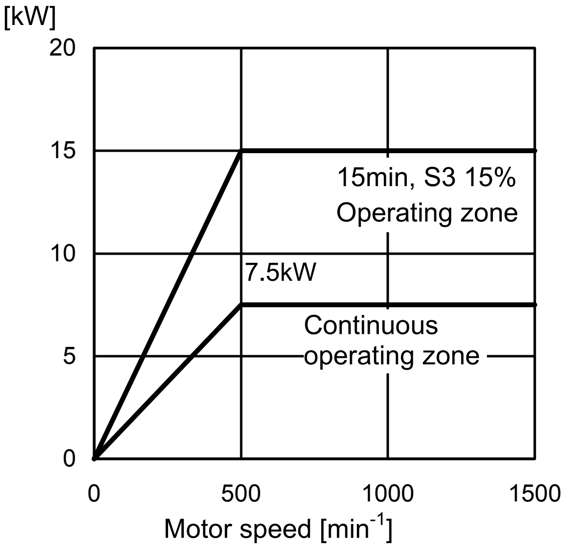
High-speed winding torque (Δ connection)



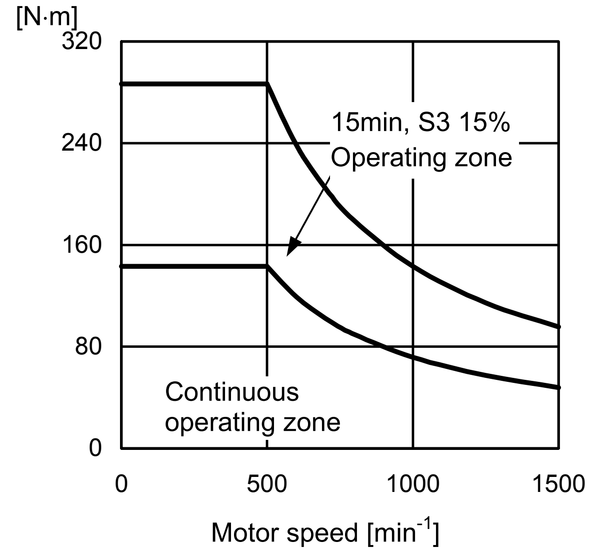
3.2 MODEL αiIP 22/6000HV

Applicable amplifier αiSP 30HV

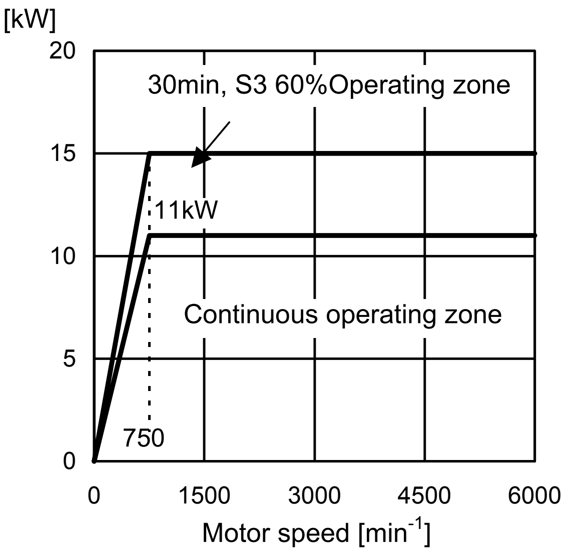
Low-speed winding output (Y connection)



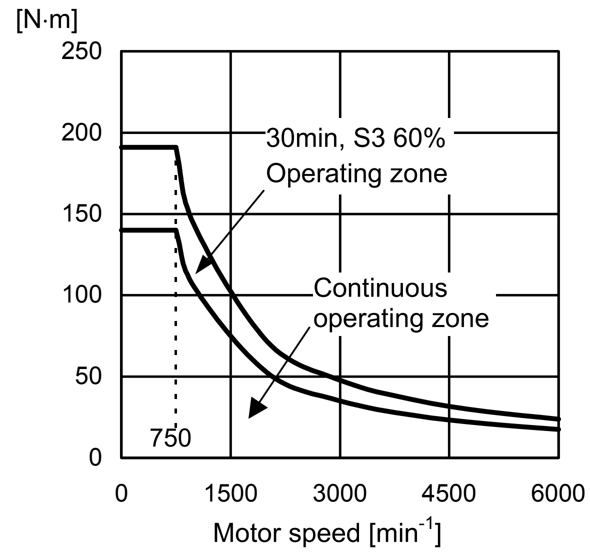
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

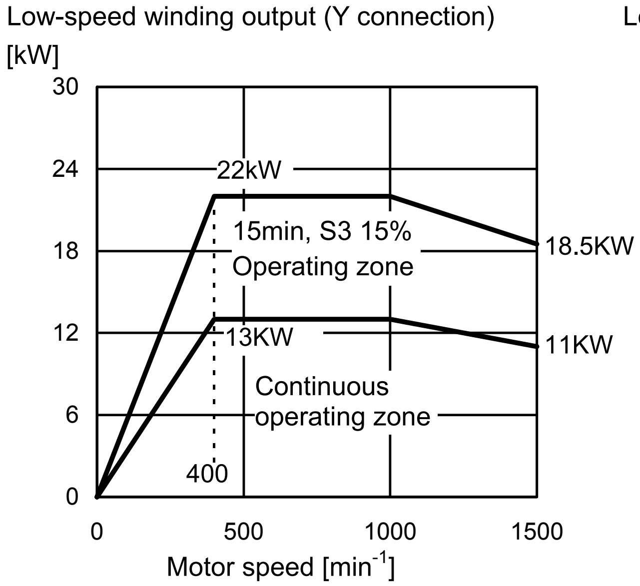


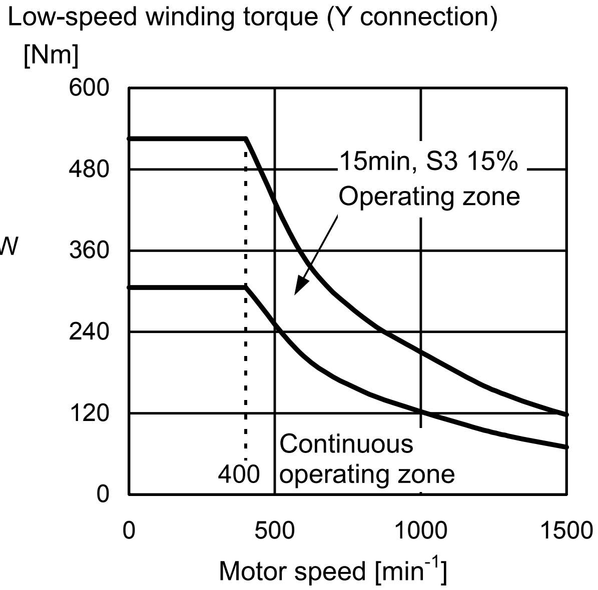
High-speed winding torque (Δ connection)

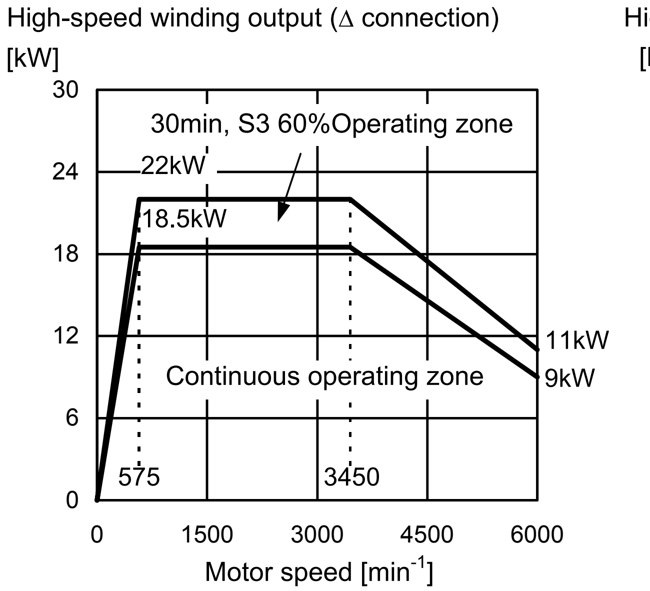


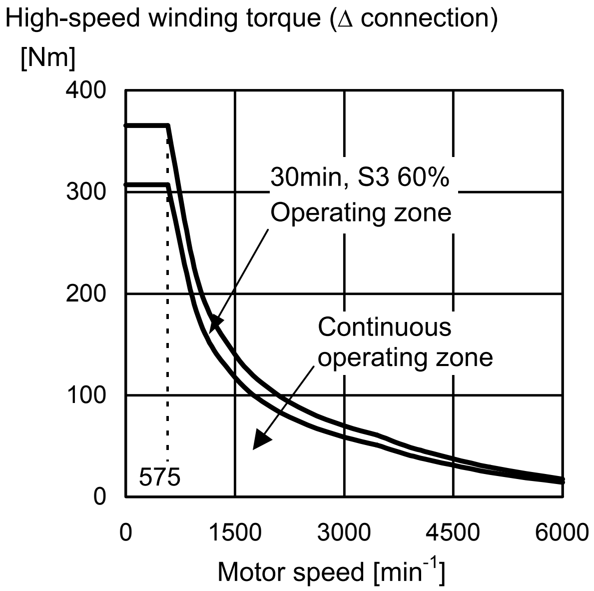
3.3 MODEL α*i*IP 40/6000HV

Applicable amplifier α*i*SP 30HV





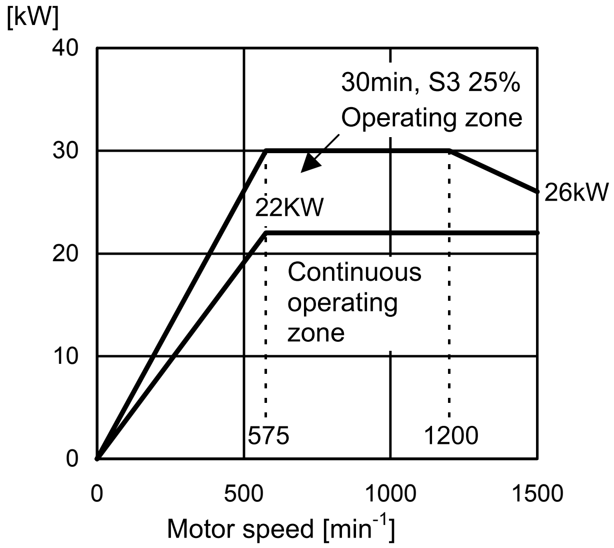




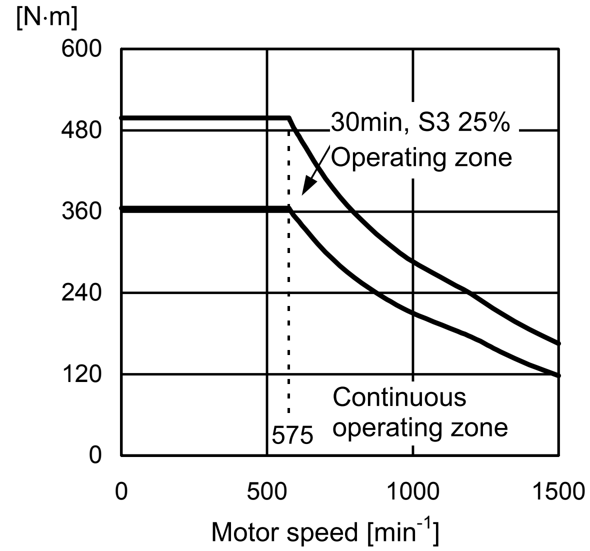
3.4 MODEL αiIP 50/6000HV

Applicable amplifier αiSP 30HV

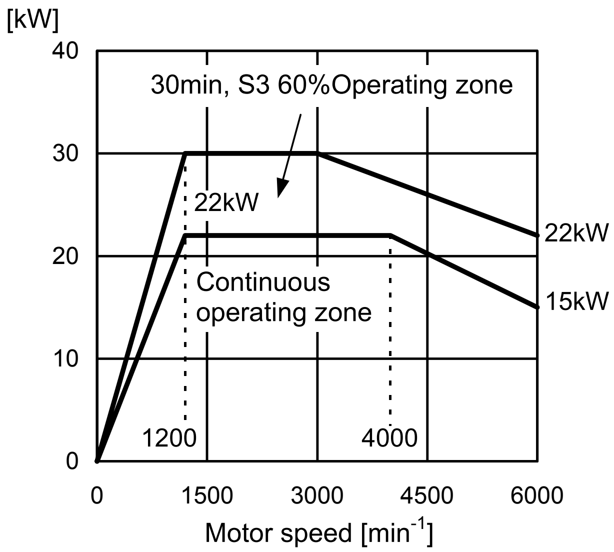
Low-speed winding output (Y connection)



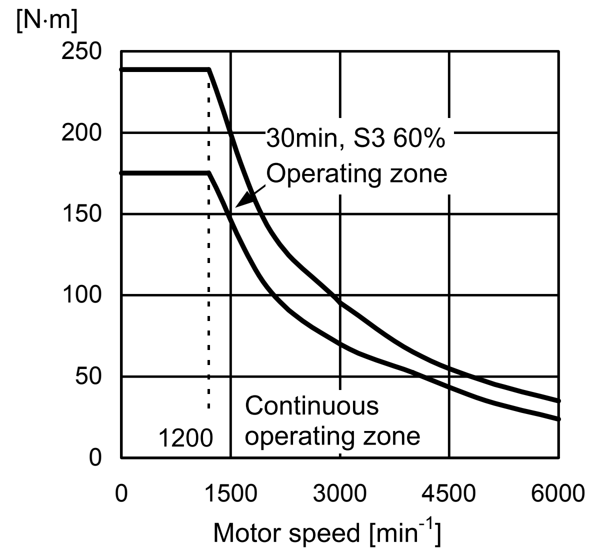
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



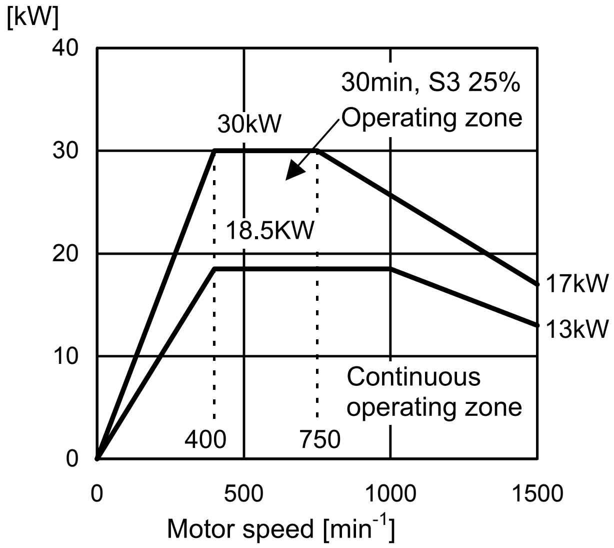
High-speed winding torque (Δ connection)



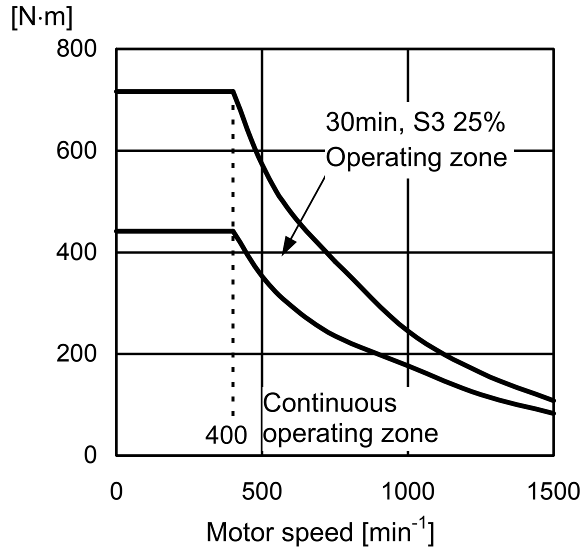
3.5 MODEL α*i*IP 60/4500HV

Applicable amplifier α*i*SP 30HV

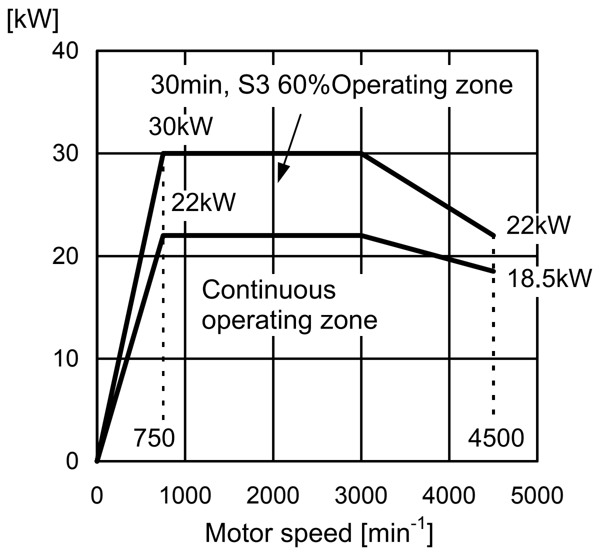
Low-speed winding output (Y connection)



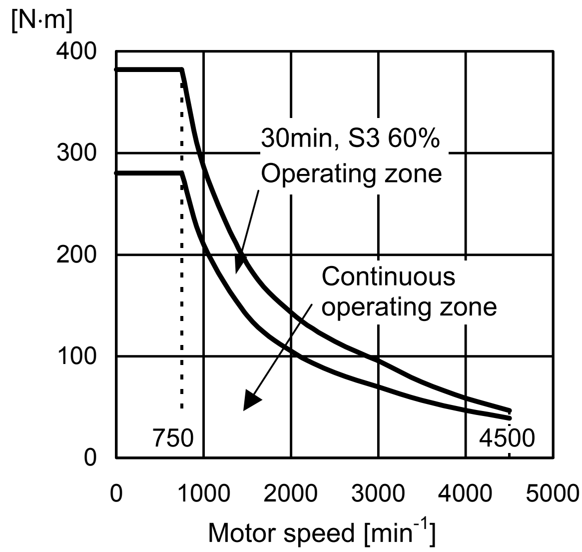
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



High-speed winding torque (Δ connection)



4 CONNECTIONS

4.1 MODELS αiIP 15/6000HV TO αiIP 60/4500HV

Cables for the power lead and fan motor are connected to the terminal block.

αiM sensor or αiMZ sensor signal or thermo stat signal use a connector manufactured by Tyco Electronics AMP.
The connector housing and the connector are attached to the motor.

Size of screws used in the terminal block / Model	Power lead		Fan motor
	U,V,W,G	X,Y,Z	FMU,FMV,FMW
αiIP 15/6000HV αiIP 22/6000HV	M5	M5	Screw-less terminal block
αiIP 40/6000HV αiIP 50/6000HV	M6	M6	Screw-less terminal block
αiIP 60/4500HV	M8	M8	M3.5

Cable for the power lead

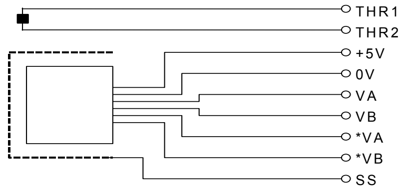
For the power lead cable specification, refer to "FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN)".

Cable for the fan motor

For the fan motor current value and cable specifications, refer to Section I.4.3, “FAN MOTOR CONNECTION” in this manual.

4.2 CONNECTION OF SIGNAL LEAD

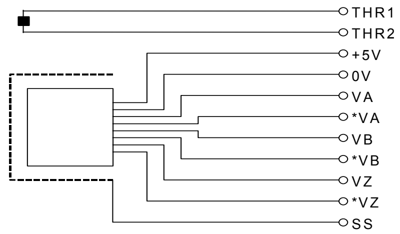
Connector attachment for a motor with a built-in αiM sensor



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		*VA	*VB		0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	VA	VB		SS	THR1

Connector attachment for a motor with a built-in αiMZ sensor



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		*VA	*VB	*VZ	0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	VA	VB	VZ	SS	THR1

- Connector housing and contact specifications

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

	Motor side		Cable side	
	FANUC specification	Manuafacture specification	FANUC specification	Manuafacture 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 kΩ as measured at room temperature (20°C to 30°C).

5 ALLOWABLE RADIAL LOAD

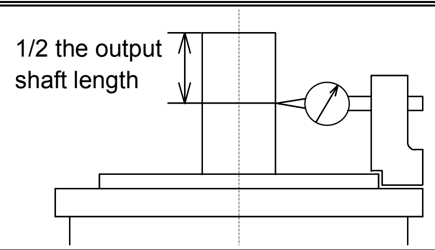
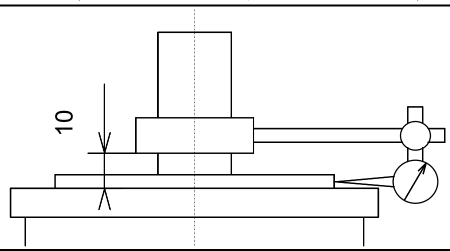
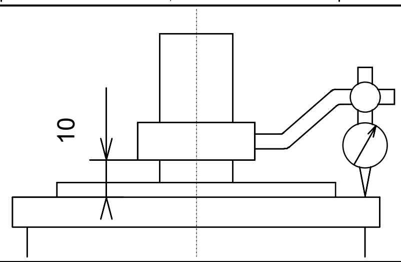
Use the motor output shaft below the allowable radial loads shown in the table below.

Model	Allowable radial load (kgf)	
	At output shaft end	At output shaft end
αiIP 15/6000HV	2940N (300kgf)	3410N (348kgf)
αiIP 22/6000HV	4410N (450kgf)	4988N (509kgf)
αiIP 40/6000HV, αiIP 50/6000HV	5390N (550kgf)	6134N (626kgf)
αiIP 60/4500HV	—	19600N (2000kgf)

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. If a thrust load is applied when a helical gear is used, the shaft moves in the direction of the thrust. So, as a general rule, never apply a thrust load.

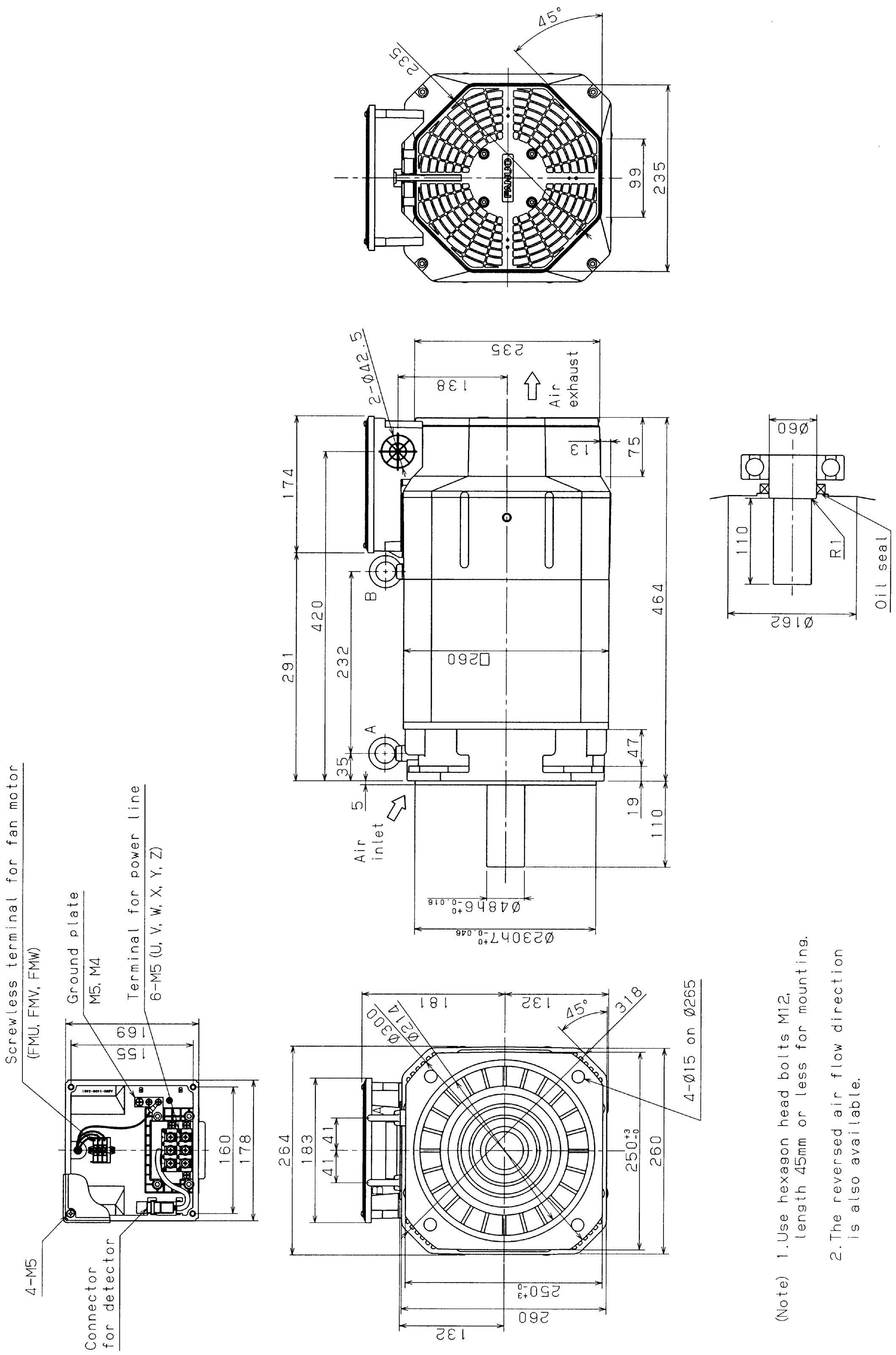
6 ASSEMBLING ACCURACY

Item \ Model	**αiIP 15HV** **αiIP 22HV**	**αiIP 40HV to** **αiIP 60HV**	**Measuring method**
Run-out at the end of the output shaft	20μm or less	20μm or less	
Run-out of the faucet joint for mounting the flange against the core of the shaft (only for flange type)	40μm or less	60μm or less	
Run-out of the flange mounting surface against the core of the shaft (only for flange type)	80μm or less	100μm or less	

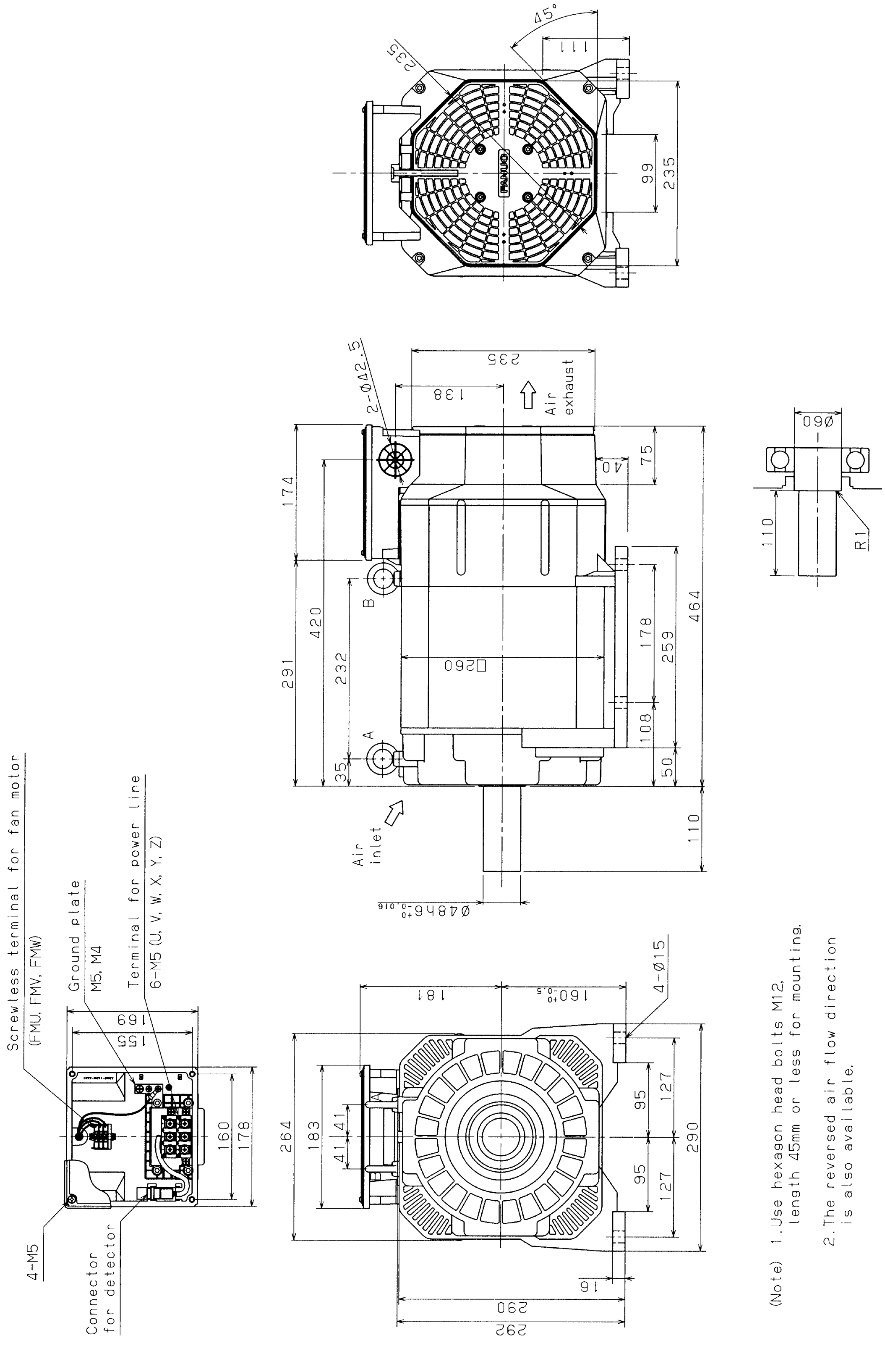
7 EXTERNAL DIMENSIONS

Model name	Section
Model αiIP 15/6000HV (flange mounting type)	7.1
Model αiIP 15/6000HV (foot mounting type)	7.2
Model αiIP 22/6000HV (flange mounting type)	7.3
Model αiIP 22/6000HV (foot mounting type)	7.4
Model αiIP 40/6000HV (flange mounting type)	7.5
Model αiIP 40/6000HV ((oot mounting type)	7.6
Model αiIP 50/6000HV (flange mounting type)	7.7
Model αiIP 50/6000HV (foot mounting type)	7.8
Model αiIP 60/4500HV (flange mounting type)	7.9
Model αiIP 60/4500HV (foot mounting type)	7.10

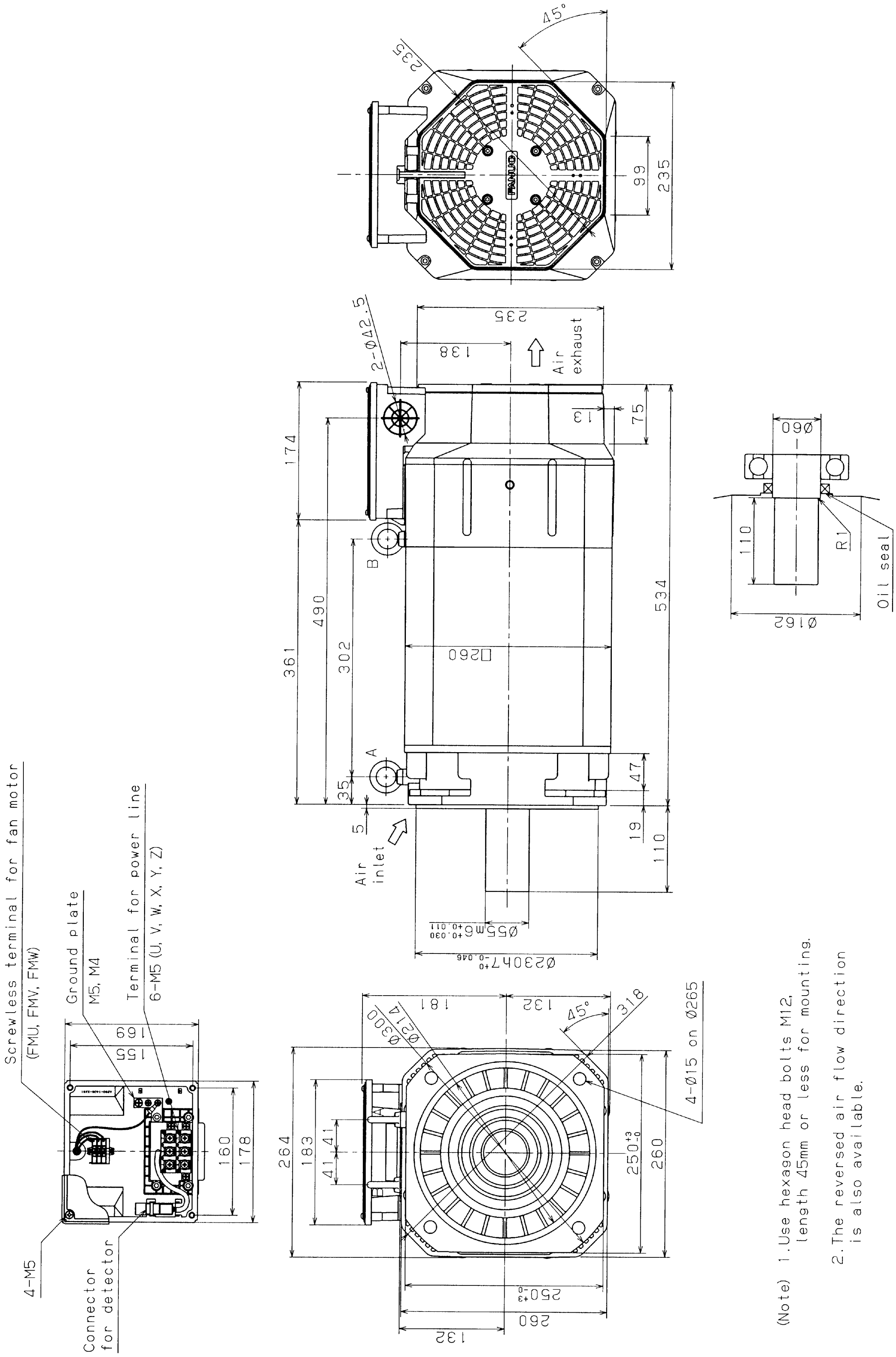
7.1 MODEL αiIP 15/6000HV (FLANGE MOUNTING TYPE)



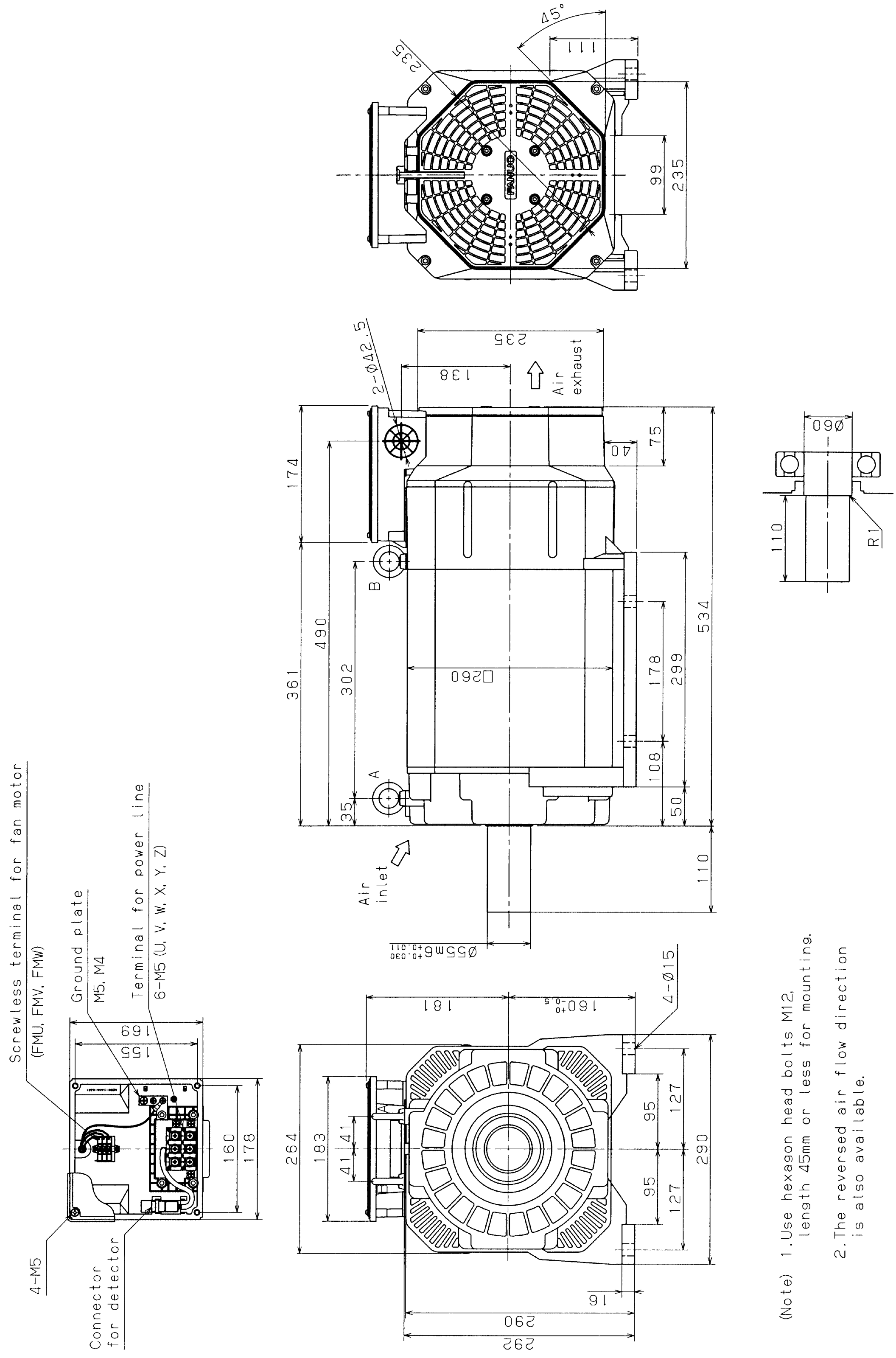
7.2 MODEL αiIP 15/6000HV (FOOT MOUNTING TYPE)



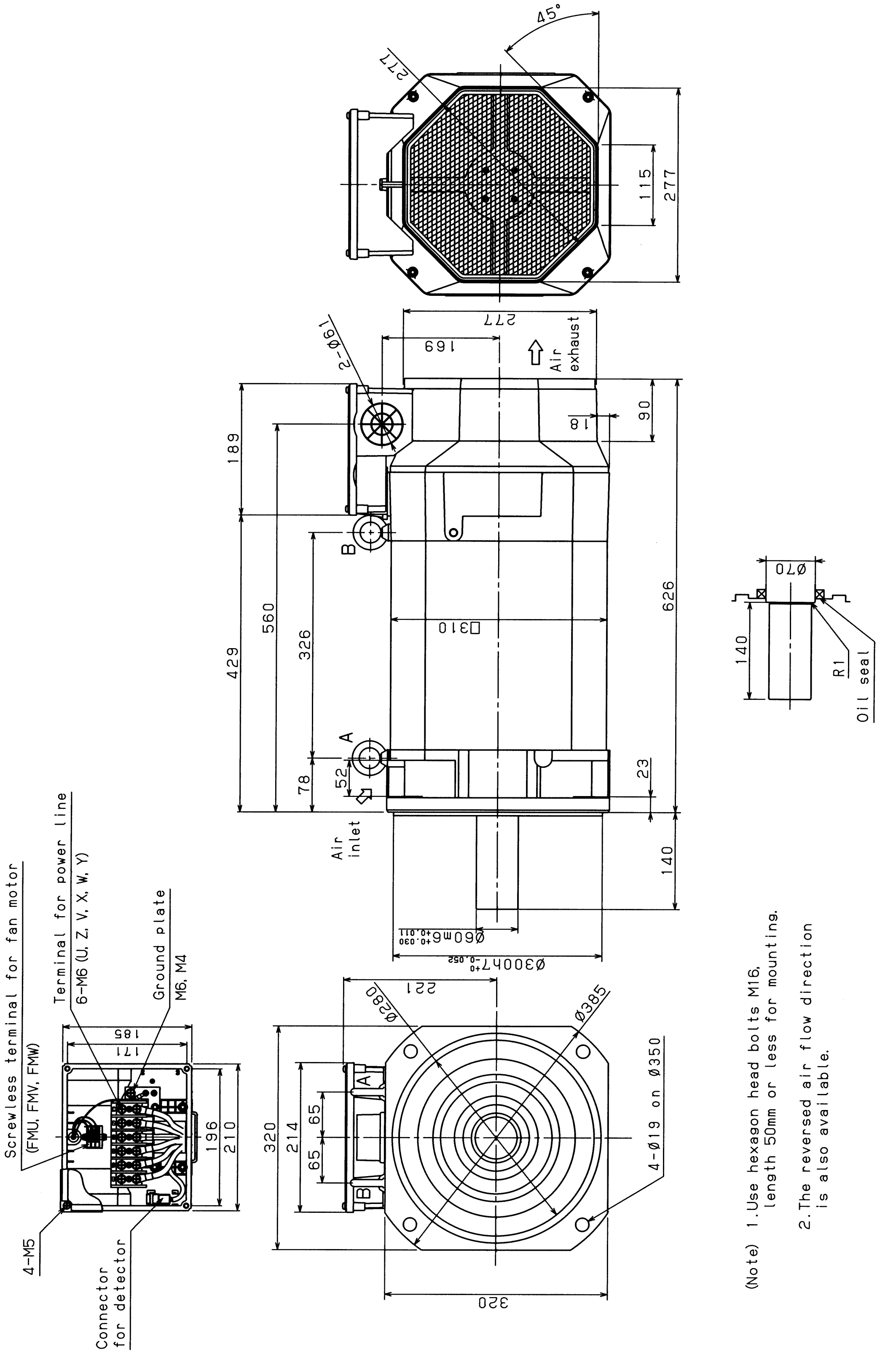
7.3 MODEL αiIP 22/6000HV (FLANGE MOUNTING TYPE)



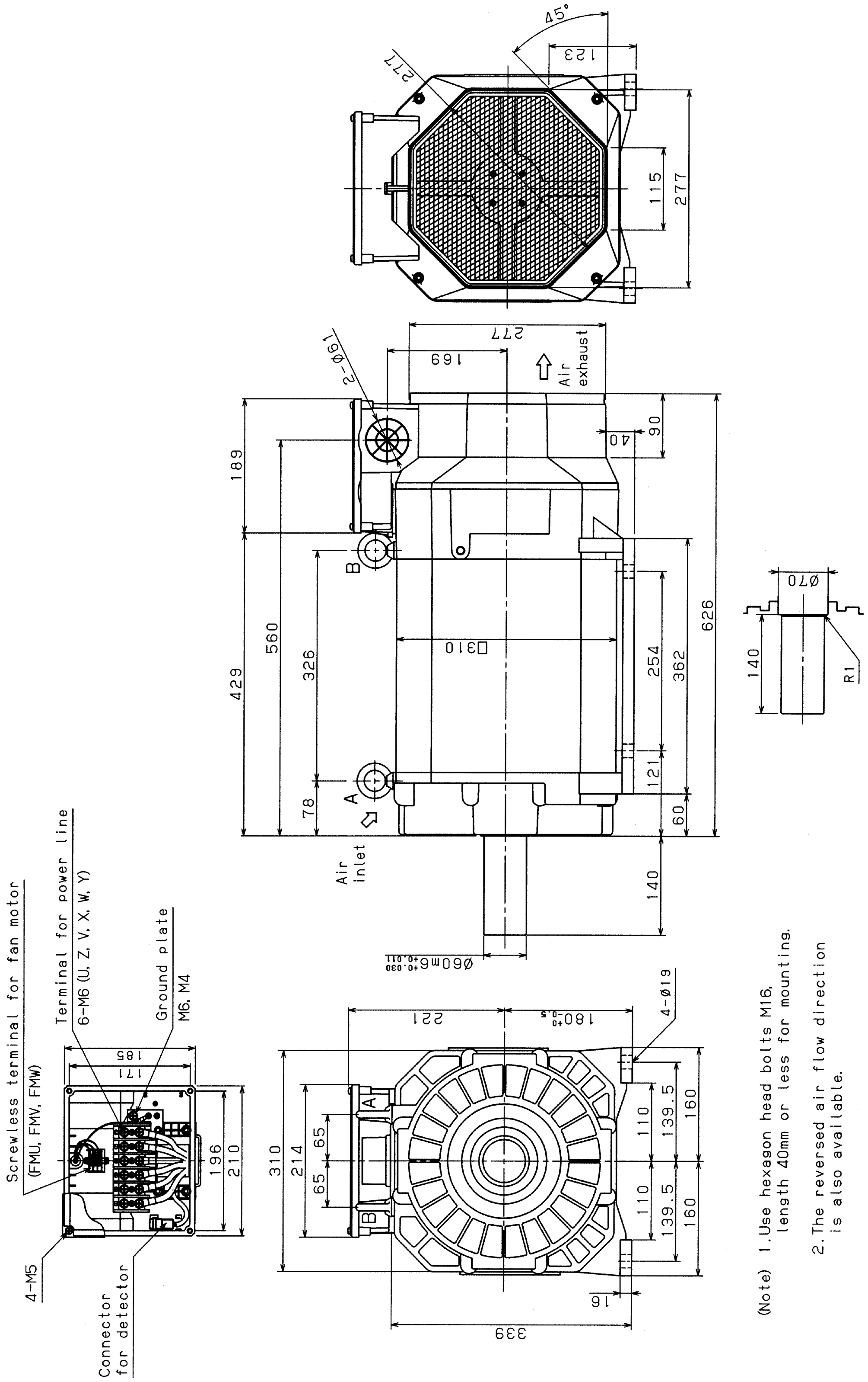
7.4 MODEL αiIP 22/6000HV (FOOT MOUNTING TYPE)



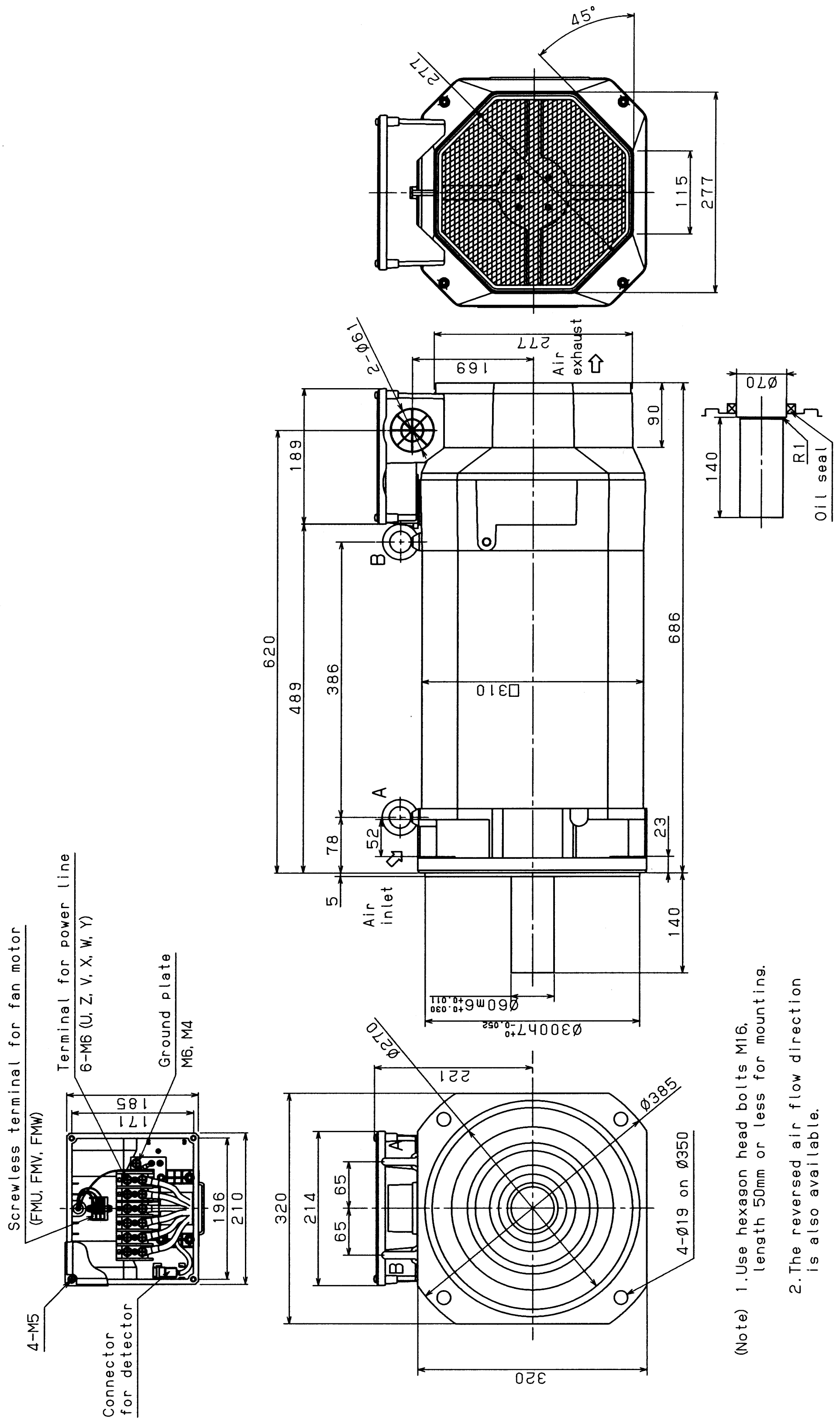
7.5 MODEL αiIP 40/6000HV (FLANGE MOUNTING TYPE)



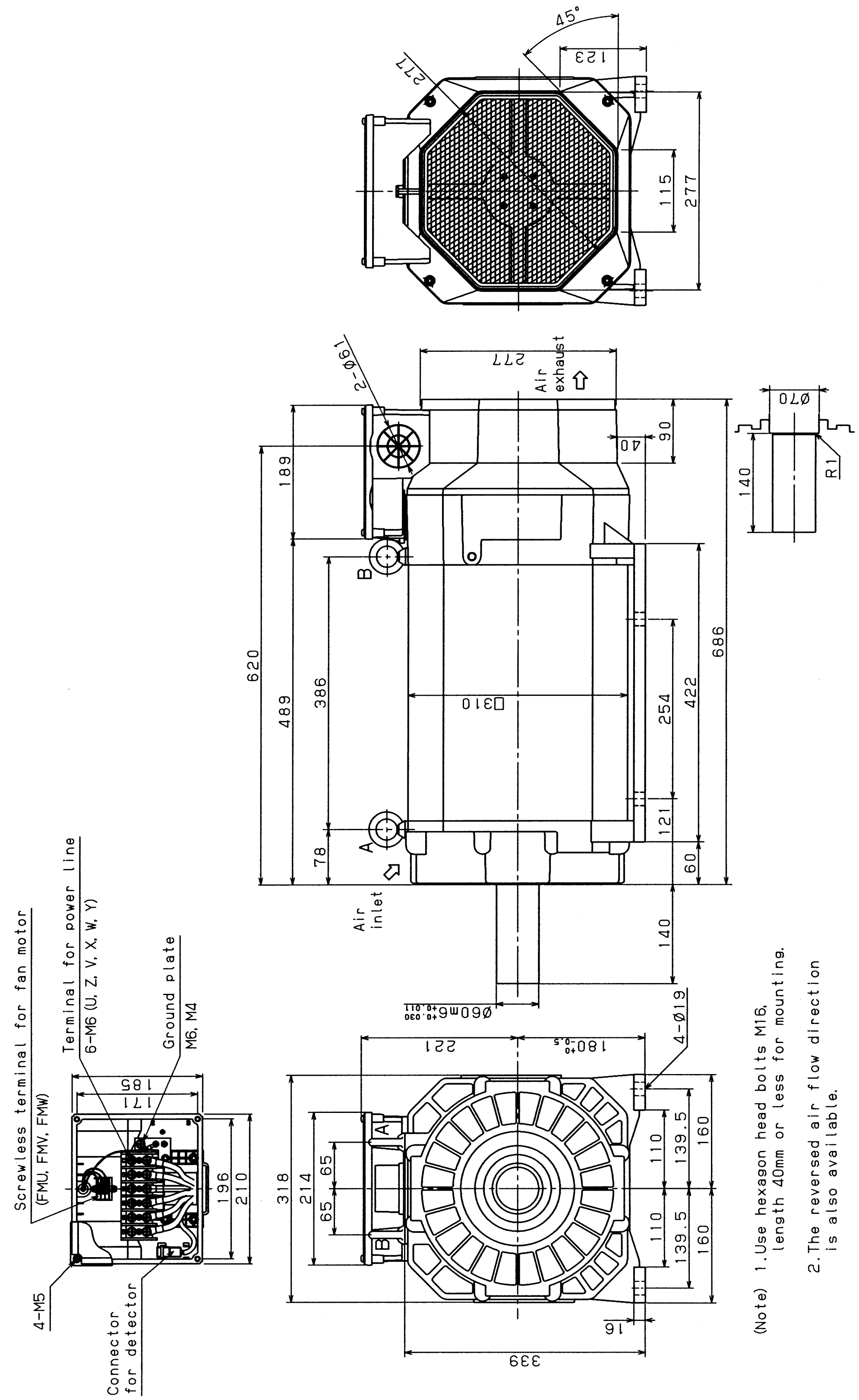
7.6 MODEL αiIP 40/6000HV ((OOT MOUNTING TYPE)



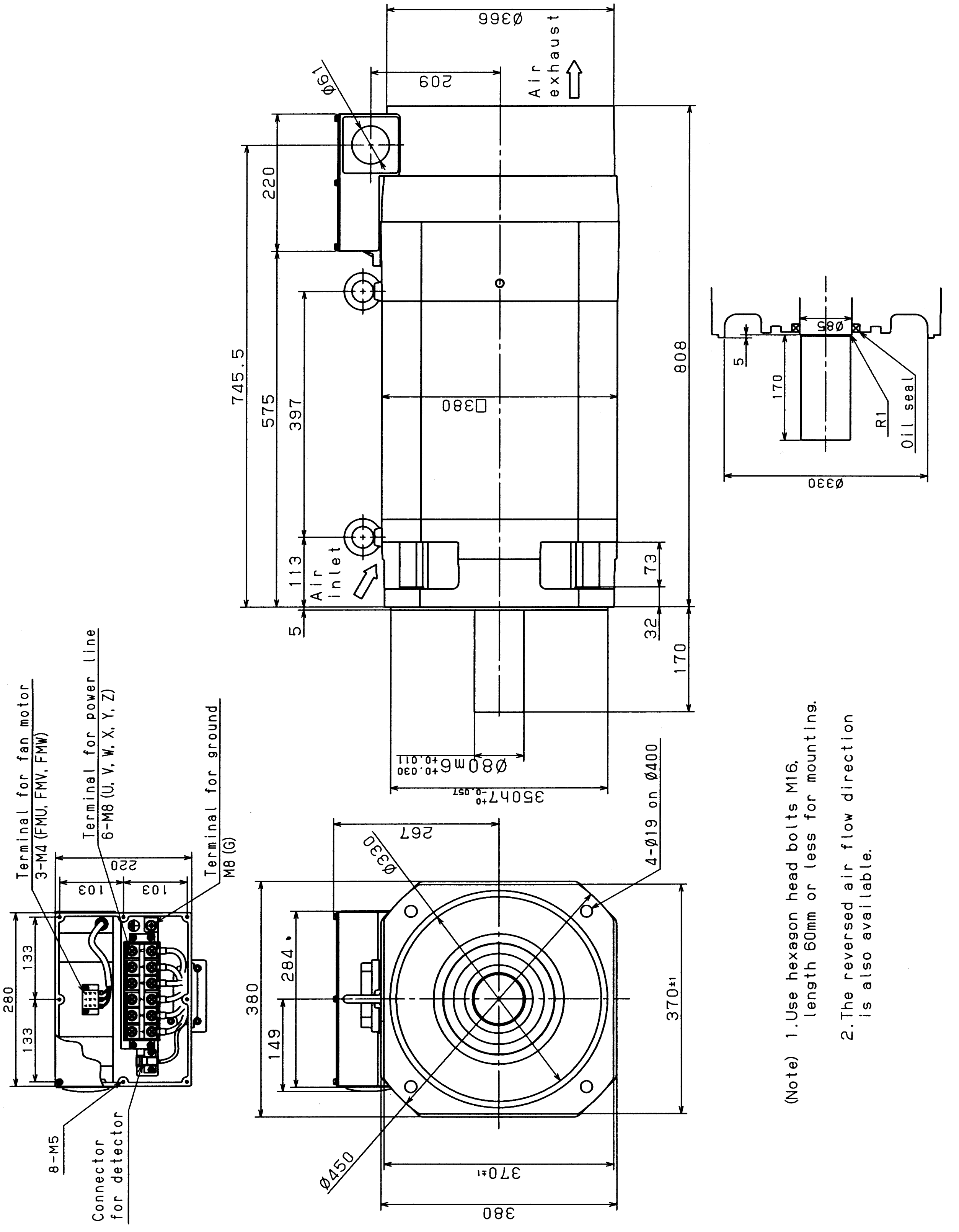
7.7 MODEL αiIP 50/6000HV (FLANGE MOUNTING TYPE)



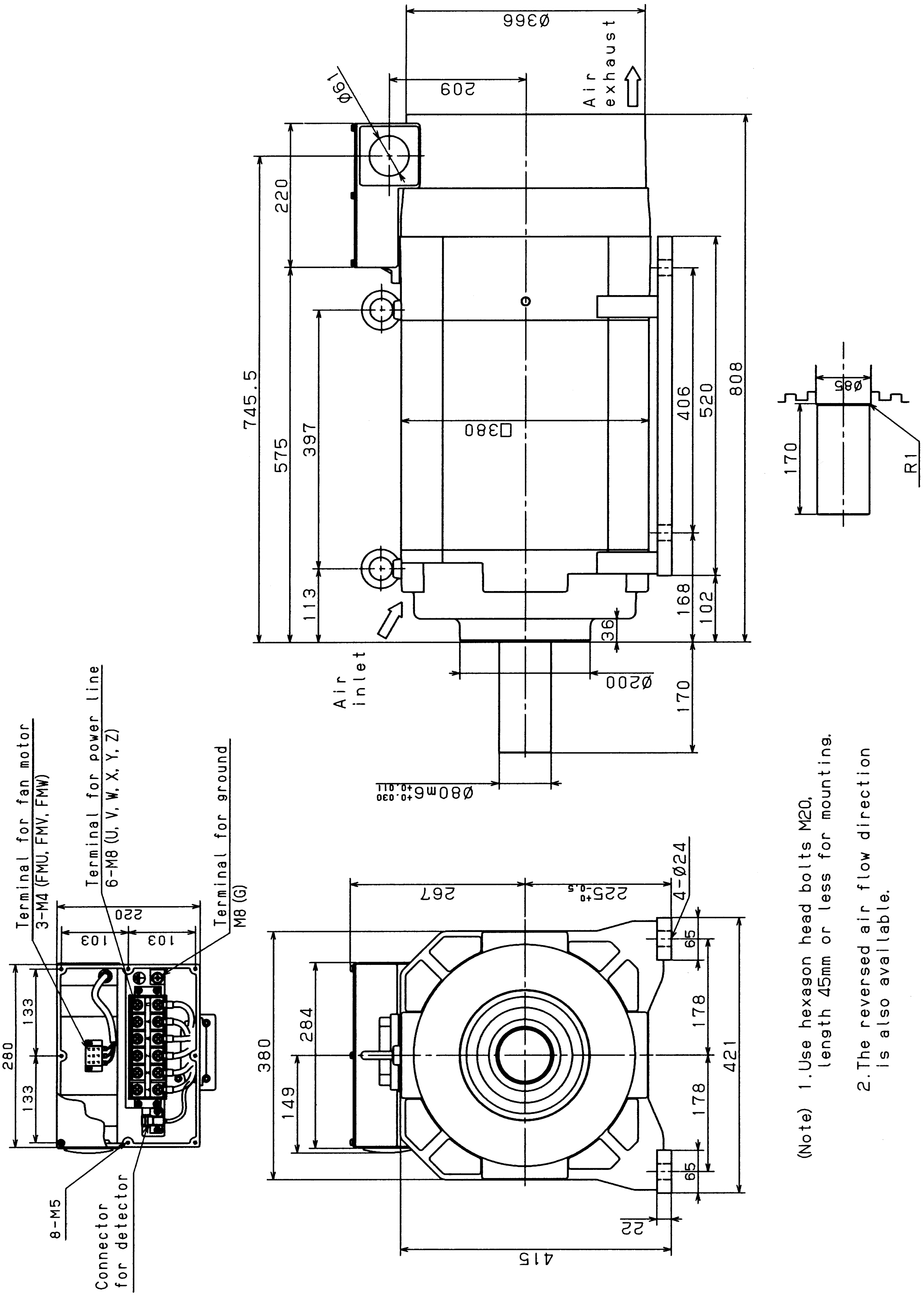
7.8 MODEL αiIP 50/6000HV (FOOT MOUNTING TYPE)



7.9 MODEL αiIP 60/4500HV (FLANGE MOUNTING TYPE)



7.10 MODEL αiIP 60/4500HV (FOOT MOUNTING TYPE)



VI. FANUC AC SPINDLE MOTOR αiIT series 200V type

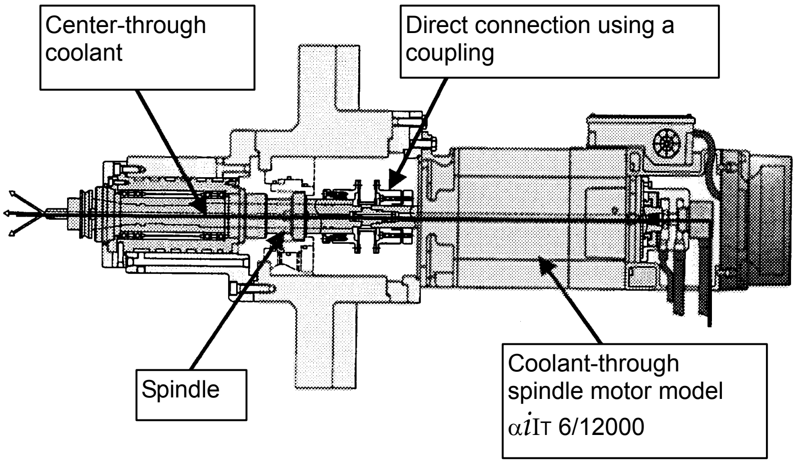
1 GENERAL

Features

By directly connecting the spindle with a spindle motor (hollow shaft), higher-speed spindle rotation and highly efficient center-through coolant machining are enabled. A spindle of direct motor connection type is connected with a motor by using a coupling, so that this type of spindle has several advantages. For example, transfer of heat produced by the motor to the spindle is minimized, and each of the motor and spindle can be maintained separately.

Item of comparison	**Belt driving, gear driving**	**Direct motor connection**
Sindle rotation speed	-	Higher
Spindle vibration	-	Lower
Spindle heat-up	-	Lower

Example of spindle of direct motor connection structure



<u>Features of a spindle of direct motor connection type</u>

<1> Higher-speed spindle rotation can be achieved.
<2> Transfer of heat produced by the motor to the spindle is minimized.
<3> Each of the motor and spindle can be maintained separately.

Caution

(1) For attachment of this type of motor to a spindle, only coupling-based direct connection with the spindle is allowed. When a spindle of direct motor connection type is used, fretting can occur with the motor shaft in a short-time operation, or the bearing of the spindle or motor can be damaged if the spindle and motor are not aligned precisely. As the method of quantitatively determining whether a spindle and motor are aligned precisely, FANUC recommends the user to measure the vibration (acceleration G) of the motor after being connected with the spindle. For details, see Section 9.3, "CHECKING MOTOR VIBRATION" in this manual.

(2) Do not apply a thrust load onto the motor shaft. Select a coupling that does not apply a thrust load onto the motor shaft for a cause such as coolant pressure when the temperature rises or cutting is performed.

2 SPECIFICATIONS

Item \ Model		αiIT 1.5/20000	αiIT 2/20000	αiIT 3/12000
Output (*1)	(S1)Cont. rated kW (HP)	1.5 (2.0)	2.2 (3.0)	3.7 (5.0)
	(S2)30 min rated kW [15 min](*2)(HP)	2.2 (3.0)	3.7 (5.0)	5.5 (7.4)
	(S3)60%[40%]kW (*3) (*4) (HP)	2.2 (3.0)	3.7 (5.0)	5.5 (7.4)
Rated current (*5)	(S1) A	28	41	36
	(S2),(S3) A	33	53	46
Speed min^{-1}	Base speed	3,000	3,000	1,500
	Max. speed	20,000	20,000	12,000
Cont. rated torque at const. rated torque range N·m (kgf·cm)		4.77 (48.7)	7.0 (71.5)	23.5 (240)
Rotor inertia $kg{\cdot}m^2$ $(kgf{\cdot}cm{\cdot}s^2)$		0.0043 (0.04)	0.0078 (0.08)	0.0148 (0.15)
Weight kgf		24	27	46
Vibration		V3 (rotation component)		
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 the horizontally to vertically downwards. (IMB5,IMV1)		
Allowable overload capacity (1 min) (*8)		120% of (S2)		
Insulation		Class H		
Ambient temperature		0°C to 40°C		
Altitude		Height above sea level not exceeding 1000m		
Painting color		Munsell system N2.5		
Type of thermal protection (*9)		TP211		
Resolution of the built-in sensor p/rev		Built-in with αiMZ sensor 2048		
Number of detected gear teeth per rotation λ/rev.		128		
Bearing lubrication		Grease		
Shaft end seal, protection format (IEC34)		Simplified labyrinth: IP40		
Method of connection with the spindle (*10)		To be directly connected with the spindle		
Allowable thrust load (*11)kgf		6		
Maximum output during acceleration (*12) kW		13.0	20.0	13.0
Applicable spindle amplifier		αiSP 15	αiSP 22	αiSP 11

* See Page 260 for Cautions and limitations.

Item \ Model		αiIT 6/12000		αiIT 8/12000	
Connection (*13)		Low-speed winding (Y connection)	High-speed winding (Δ connection)	Low-speed winding (Y connection)	High-speed winding (Δ connection)
Output (*1)	(S1)Cont. rated kW (HP)	5.5 (7.4)	5.5 (7.4)	7.5 (10)	7.5 (7.5)
	(S2)30 min rated kW (HP)	7.5 (10)	7.5 (10)	11 (14.7)	11 (14.7)
	(S3)60% (*4) kW (HP)	7.5 (10)	7.5 (10)	11 (14.7)	11 (14.7)
Rated current (*5)	(S1) A	37	38	49	51
	(S2),(S3) A	47	45	61	62
Speed min^{-1}	Base speed	1,500	4,000	1,500	4,000
	Max. speed	12,000	12,000	12,000	12,000
Switching speed min^{-1}		4,000		4,000	
Cont. rated torque at const. rated torque range N·m (kgf·cm)		35.0 (357)	13.2 (134)	47.7 (487)	17.9 (182.7)
Rotor inertia	$kg{\cdot}m^2$ ($kgf{\cdot}cm{\cdot}s^2$)	0.0179 (0.18)		0.0275 (0.28)	
Weight kgf		51		80	
Vibration		V3 (rotation component)			
Noise		75dB(A) or less			
Cooling system (*6)		Totally enclosed and fan cooled (IC0A6)			
Cooling fan W		20			
Installation (*7)		Mount the motor so that the output shaft points in a direction ranging within the horizontally to vertically downwards. (IMB5,IMV1)			
Allowable overload capacity (1 min) (*8)		120% of (S2)			
Insulation		Class H			
Ambient temperature		0°C to 40°C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Type of thermal protection (*9)		TP211			
Resolution of the built-in sensor p/rev		Built-in with αiMZ sensor 4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Shaft end seal, protection format (IEC34)		Simplified labyrinth: IP40			
Method of connection with the spindle (*10)		To be directly connected with the spindle			
Allowable thrust load (*11) kgf		13			
Maximum output during acceleration (*12) kW		13.0		13.2	
Applicable spindle amplifier		αiSP 15		αiSP 15	

* See Page 260 for Cautions and limitations.

Item \ Model		αiIT 8/15000		αiIT 15/10000	
Connection (*13)		Low-speed winding (Y connection)	High-speed winding (Δ connection)	Low-speed winding (Y connection)	High-speed winding (Δ connection)
Output (*1)	(S1)Cont. rated kW (HP)	7.5 (10)	7.5 (10)	15 (20.1)	15 (20.1)
	(S2)30 min rated kW (HP)	11 (14.7)	11 (14.7)	18.5 (24.8)	18.5 (24.8)
	(S2) 10 min rated kW (HP)	15.0 (20.1)	15.0 (20.1)	-	-
	(S3)60% (*4) kW (HP)	-	-	18.5 (24.8)	18.5 (24.8)
Rated current (*5)	(S1) A	70	74	70	71
	(S2),(S3) A	108	107	82	81
Speed min^{-1}	Base speed	1,500	4,000	1,500	4,000
	Max. speed	4,000	15,000	10,000	10,000
Switching speed min^{-1}		4,000		4,000	
Cont. rated torque at const. rated torque range N·m (kgf·cm)		47.7 (487)	17.9 (182)	95.4 (974)	35.8 (365)
Rotor inertia	$kg\cdot m^2$ ($kgf\cdot cm\cdot s^2$)	0.0275 (0.28)		0.09 (0.93)	
Weight kgf		80		110	
Vibration		V3 (rotation component)			
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 the horizontally to vertically downwards. (IMB5,IMV1)			
Allowable overload capacity (1 min) (*8)		120% of (S2)			
Insulation		Class H			
Ambient temperature		0°C to 40°C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Type of thermal protection (*9)		TP211			
Resolution of the built-in sensor p/rev		Built-in with αiMZ sensor 4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Shaft end seal, protection format (IEC34)		Simplified labyrinth: IP40			
Method of connection with the spindle (*10)		To be directly connected with the spindle			
Allowable thrust load (*11) kgf		13			
Maximum output during acceleration (*12) kW		28.0		22.2	
Applicable spindle amplifier		αiSP 26		αiSP 22	

* See Page 260 for Cautions and limitations.

Item \ Model		αiIT 15/15000		αiIT 22/10000	
Connection (*13)		Low-speed winding (Y connection)	High-speed winding (Y connection)	Low-speed winding (Y connection)	High-speed winding (Δ connection)
Output (*1)	(S1)Cont. rated kW (HP)	15 (20.1)	15 (20.1)	22 (29.5)	22 (29.5)
	(S2)30 min rated kW (HP)	18.5 (24.8)	18.5 (24.8)	26 (34.9)	26 (34.9)
	(S2) 15 min rated kW (HP)	22 (29.5)	22 (29.5)	-	-
	(S3)40% kW (*3)(*4) (HP)	-	-	26 (34.9)	26 (34.9)
Rated current (*5)	(S1) A	76	86	100	101
	(S2),(S3) A	104	108	111	112
Speed min^{-1}	Base speed	1,400	5,000	1,500	4,000
	Max. speed	4,000	15,000	10,000	10,000
Switching speed min^{-1}		3,500		4,000	
Cont. rated torque at const. rated torque range N·m (kgf·cm)		102.2 (1043.3)	28.6 (292.1)	140 (1428)	52.5 (536)
Rotor inertia $kg \cdot m^2$ ($kgf \cdot cm \cdot s^2$)		0.055 (0.56)		0.128 (1.29)	
Weight kgf		121		143	
Vibration		V3 (rotation component)			
Noise		75dB(A) or less			
Cooling system (*6)		Totally enclosed and fan cooled (IC0A6)			
Cooling fan W		56			
Installation (*7)		Mount the motor so that the output shaft points in a direction ranging within the horizontally to vertically downwards. (IMB5,IMV1)			
Allowable overload capacity (1 min) (*8)		120% of (S2)			
Insulation		Class H			
Ambient temperature		0°C to 40°C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Type of thermal protection (*9)		TP211			
Resolution of the built-in sensor p/rev		Built-in with αiMZ sensor 4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Shaft end seal, protection format (IEC34)		Simplified labyrinth: IP40			
Method of connection with the spindle (*10)		To be directly connected with the spindle			
Allowable thrust load (*11) kgf		13			
Maximum output during acceleration (*12) kW		38		31.2	
Applicable spindle amplifier		αiSP 30		αiSP 26	

* See Page 260 for Cautions and limitations.

Cautions and limitations

(*1) The rated output is guaranteed at the rated voltage.
(Amplifier input: 200/220/230VAC +10% -15%, 50/60Hz±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 αiIT 1.5/20000 and αiIT 2/20000 is 15 min rated.

(*3) 40% for αiIT 1.5/20000, αiIT 2/20000, and αiIT 22/10000.

(*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 the maximum current for each rated output.

(*6) IC code conforms to IEC 34-6.

(*7) IM code conforms to IEC 34-7.

(*8) This is not a guaranteed value but a guideline for the maximum motor output at a rated supply voltage.

(*9) Type conforms to IEC 34-11.

(*10)When assembling a motor with the machine, align the motor shaft with the spindle so that the vibration acceleration of the motor does not exceed 0.5 G (at maximum speed).
(Before shipping machines, check that the vibration acceleration is 0.5 G or less for all motors.)

(*11)Select a coupling that does not apply a thrust load onto the motor shaft for a cause such as coolant pressure when the temperature rises.
Note that in the direction in which the motor shaft is pushed toward the inside of the motor, the allowable load is 0 kgf.
(If an Oldham coupling is used, the motor shaft can be left pushed into the inside of the motor when the motor shaft is inserted into the spindle. So, measure the distance between the mounting face for a rotation joint support housing and the flinger rear end face before and after insertion, and check that the two measured values are identical.
For details, see Section 9.4 "COUPLING SELECTION".)

(*12)These values are to be used only as guidance for selecting a power supply (αiPS) and are not guaranteed.

(*13)Switching methods of power lead are two types (Y-Δ switching and Y-Y switching).
Required are the CNC software option related to the output switching function and the switching magnetic connection unit.
Refer to FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN) for output switching control.

(*14)The protection grade (IEC34-5) is IP40. However, the grade is IP54 when the labyrinth seal on the front side of the output axis and the flinger seal on the rear side are excluded.
Ensure that the labyrinth seal and flinger seal are not directly exposed to coolant and mist.

3 OUTPUT/TORQUE CHARACTERISTICS

Reference
Calculation for torque

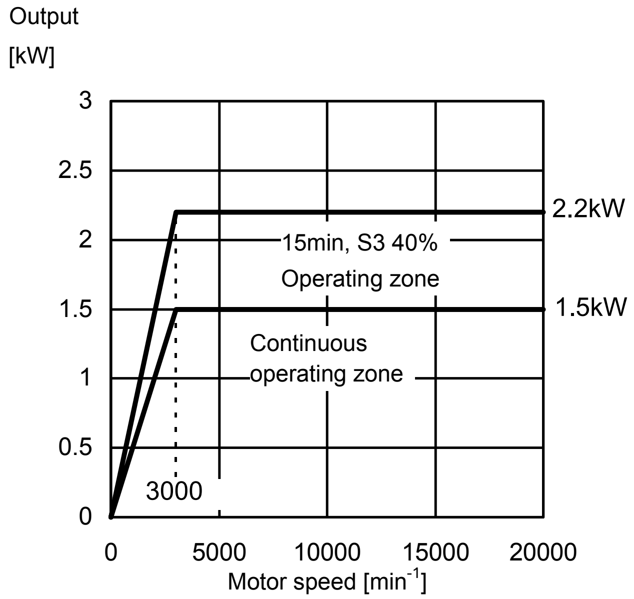
Torque T can be obtained by the following equation.

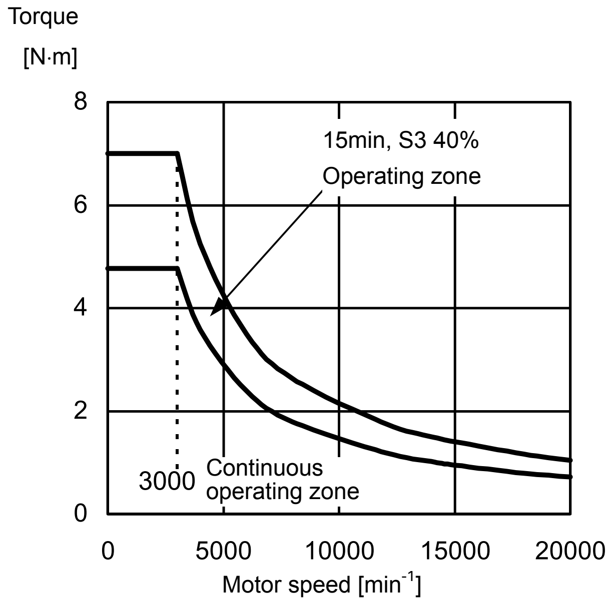
$T[N\cdot m]=P[kW]\times 1000/0.1047/N[min^{-1}]$
P[kW]: Motor output
$N[min^{-1}]$: Motor speed

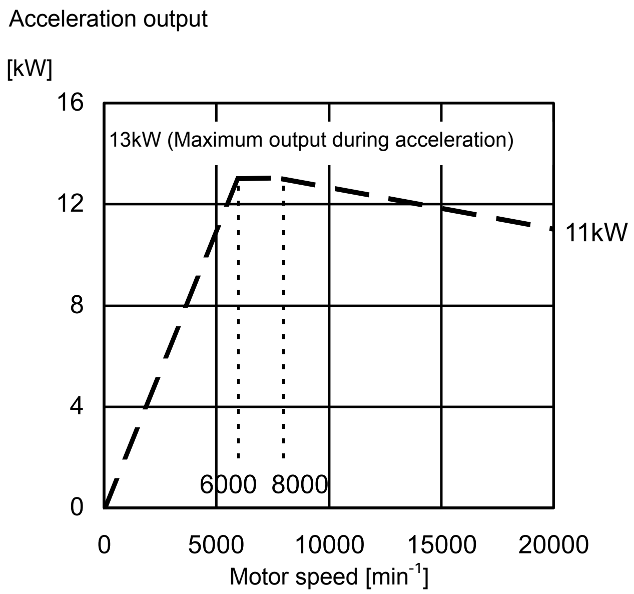
When the unit of T is [kgf·m],
$T[kgf\cdot m]=P[kW]\times 1000/1.0269/N[min^{-1}]$

3.1 MODEL αiIT 1.5/20000

Applicable amplifier αiSP 15





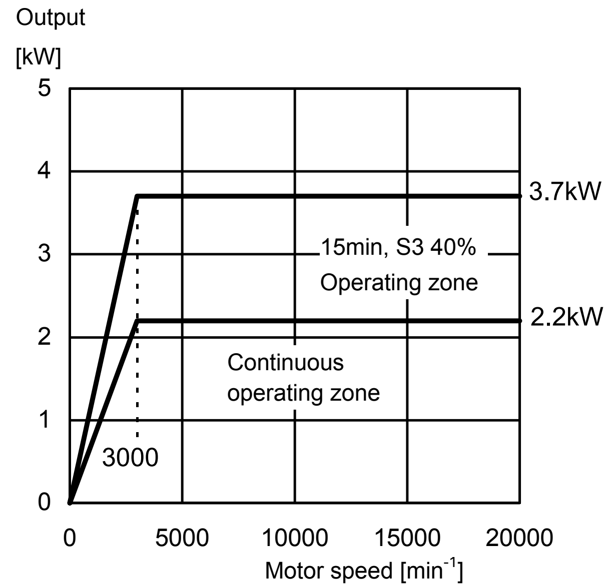


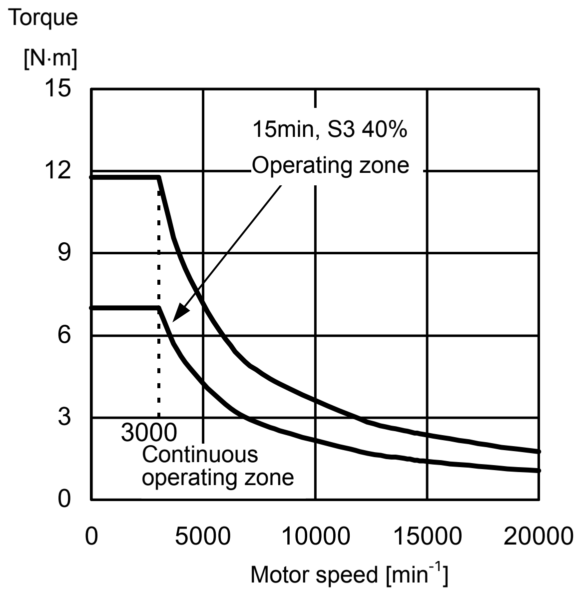
NOTE

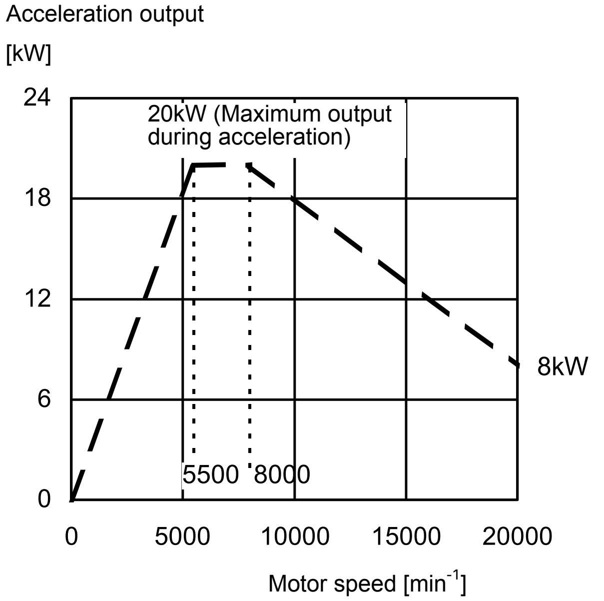
Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

3.2 MODEL αiIT 2/20000

Applicable amplifier αiSP 22



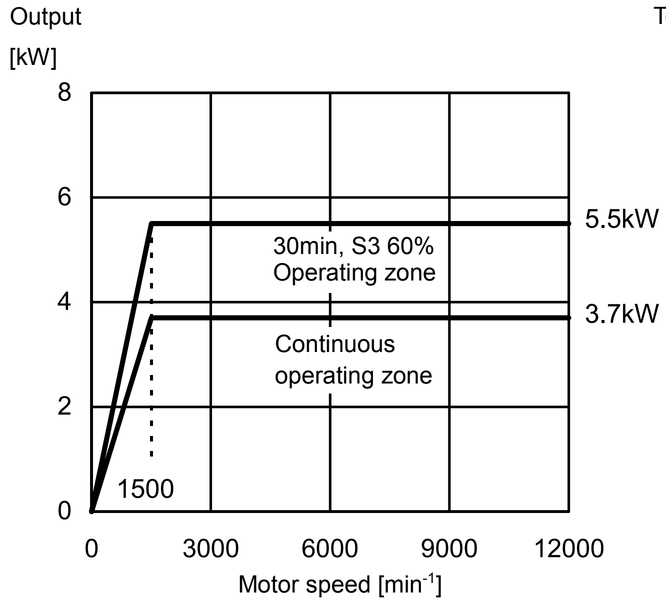


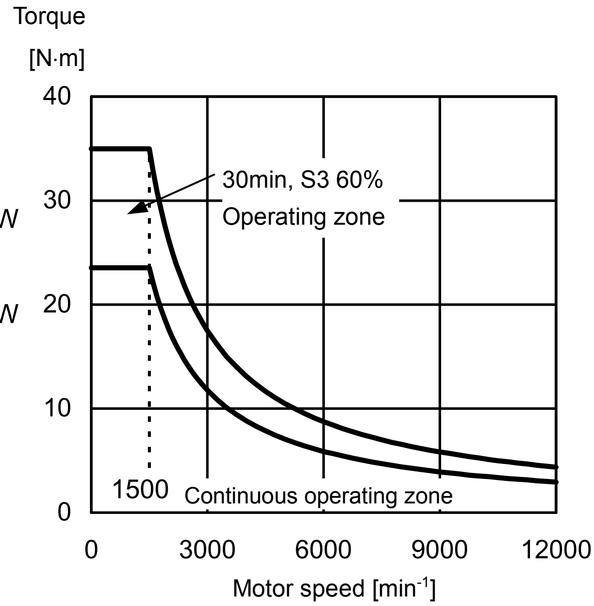


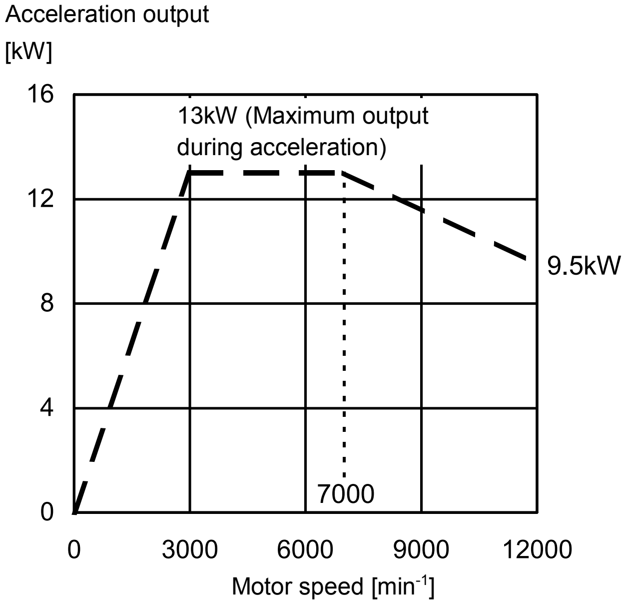
> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

3.3 MODEL αiIT 3/12000

Applicable amplifier αiSP 11







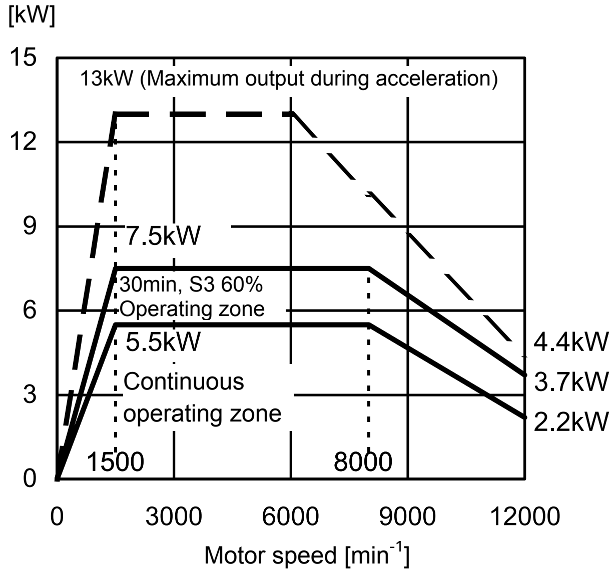
NOTE

Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

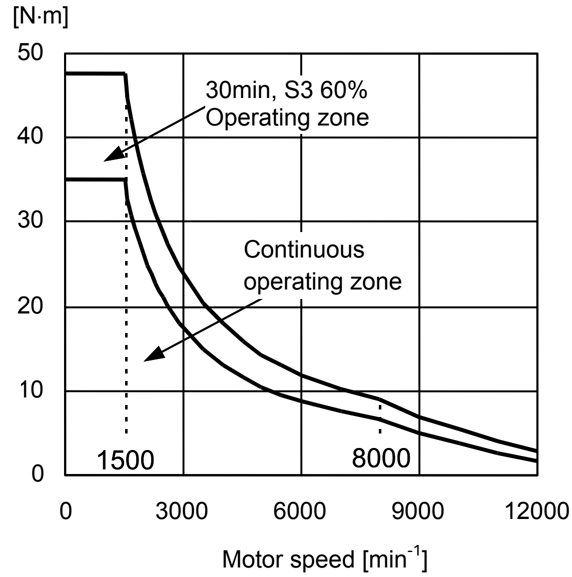
3.4 MODEL αiIT 6/12000

Applicable amplifier αiSP 15

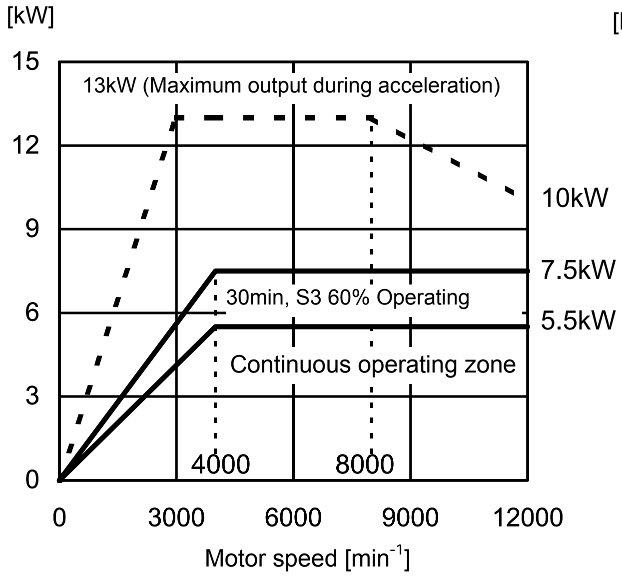
Low-speed winding output (Y connection)



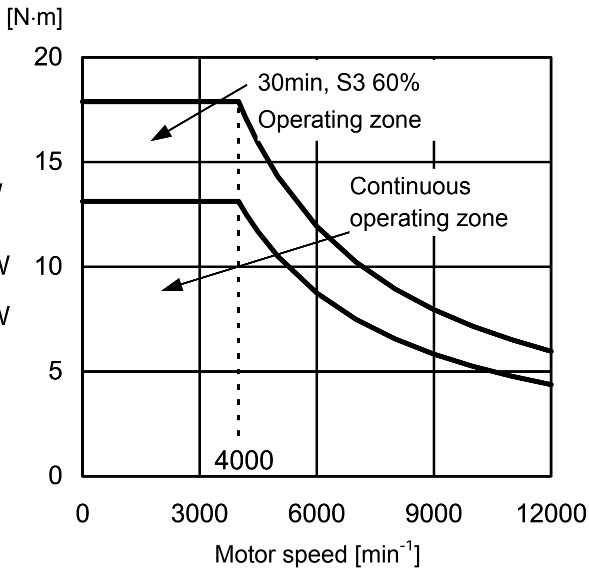
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



High-speed winding torque (Δ connection)



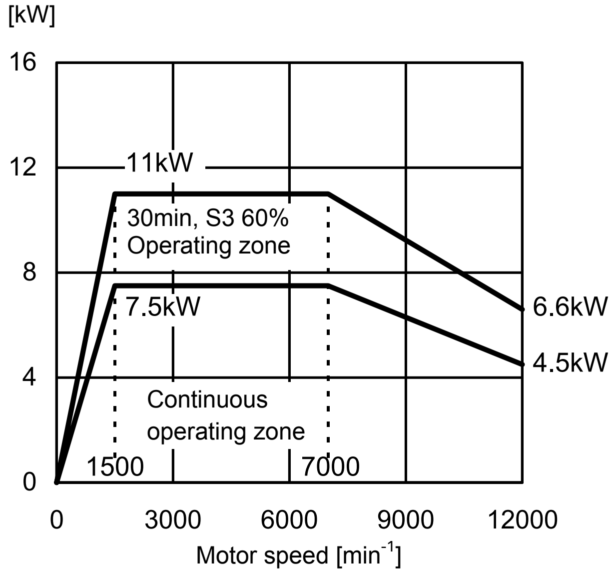
NOTE

Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

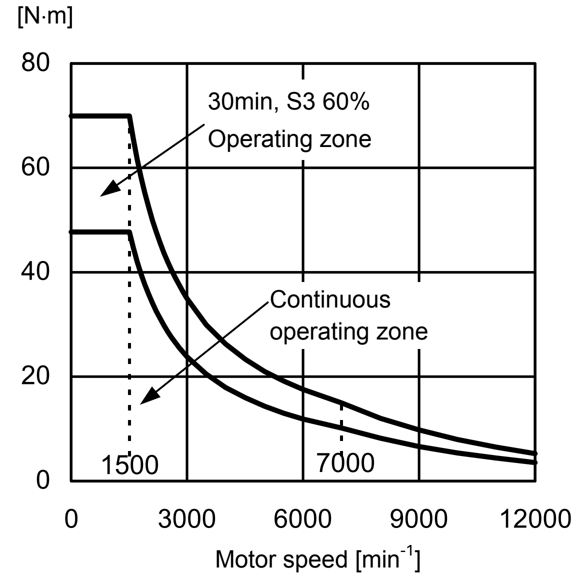
3.5 MODEL αiIT 8/12000

Applicable amplifier αiSP 15

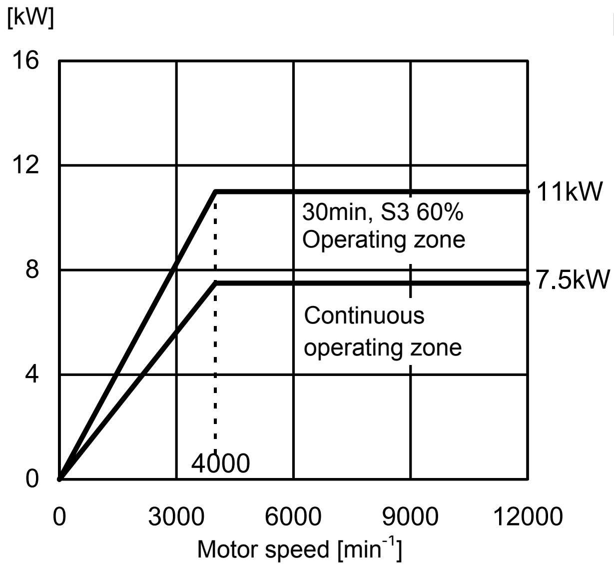
Low-speed winding output (Y connection)



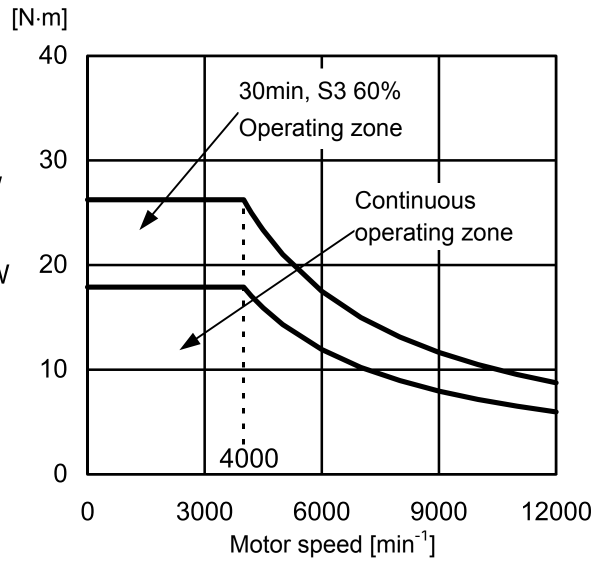
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



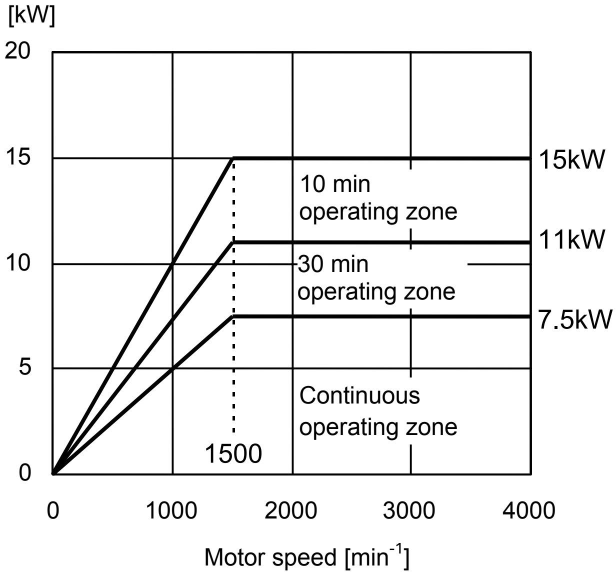
High-speed winding torque (Δ connection)



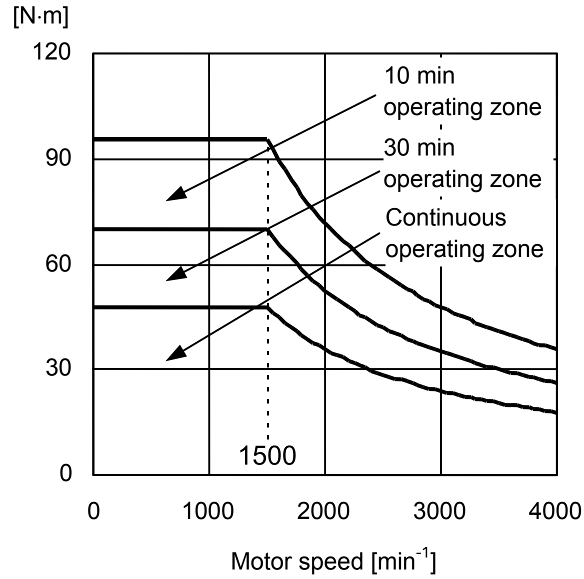
3.6 MODEL αiIT 8/15000

Applicable amplifier αiSP 26

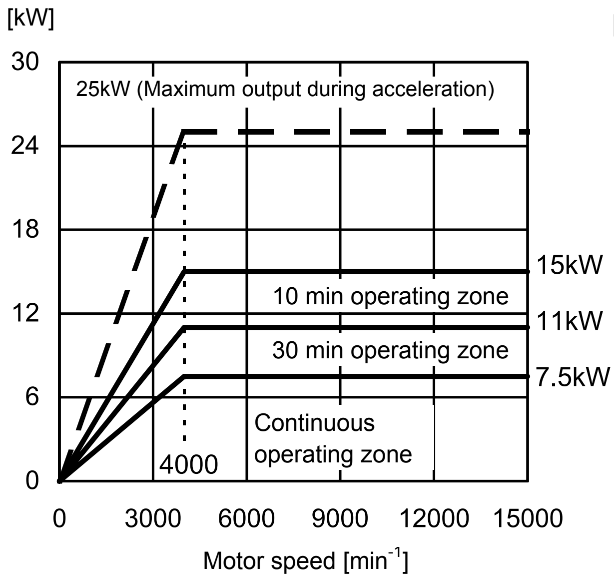
Low-speed winding output (Y connection)



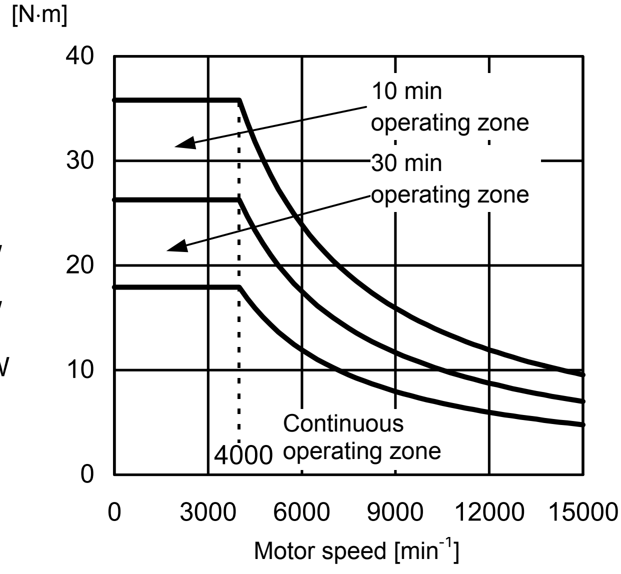
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



High-speed winding torque (Δ connection)



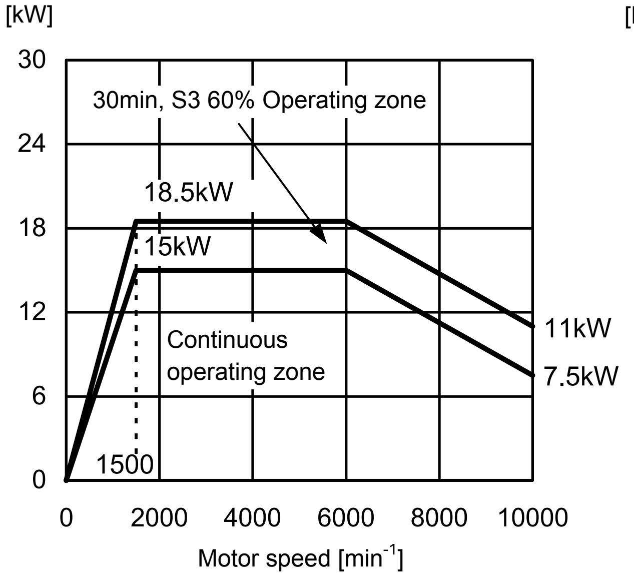
NOTE

Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

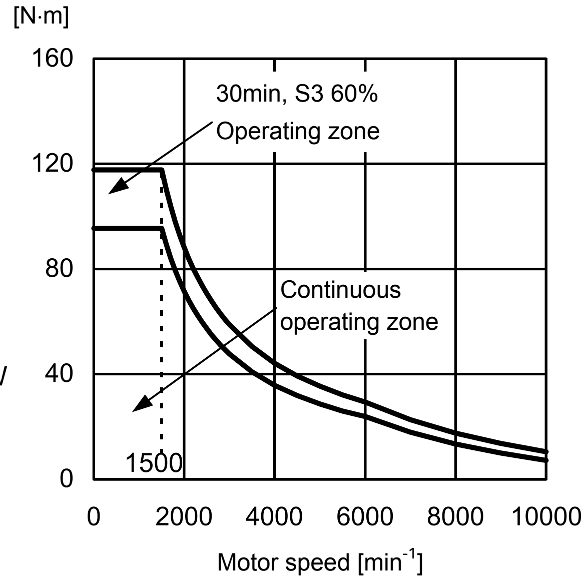
3.7 MODEL αiIT 15/10000

Applicable amplifier αiSP 22

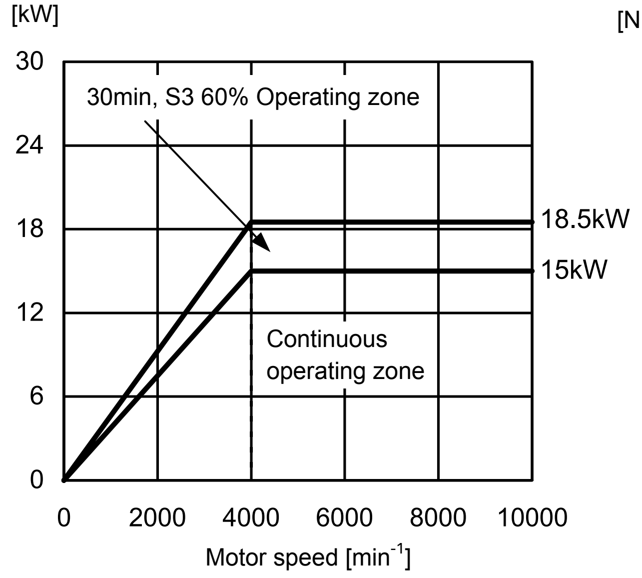
Low-speed winding output (Y connection)



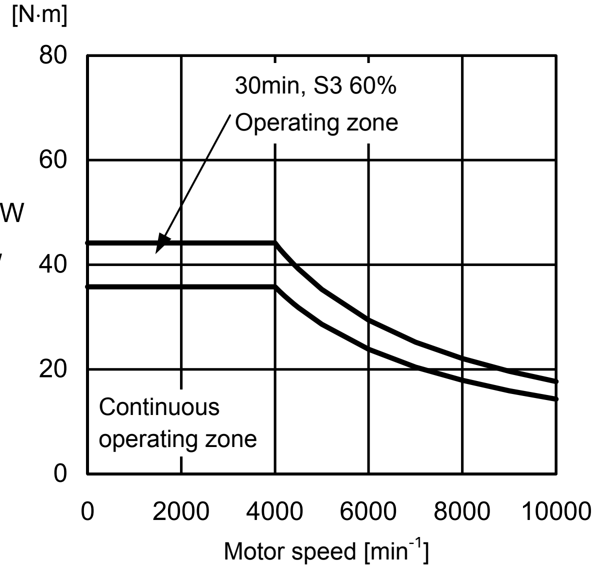
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



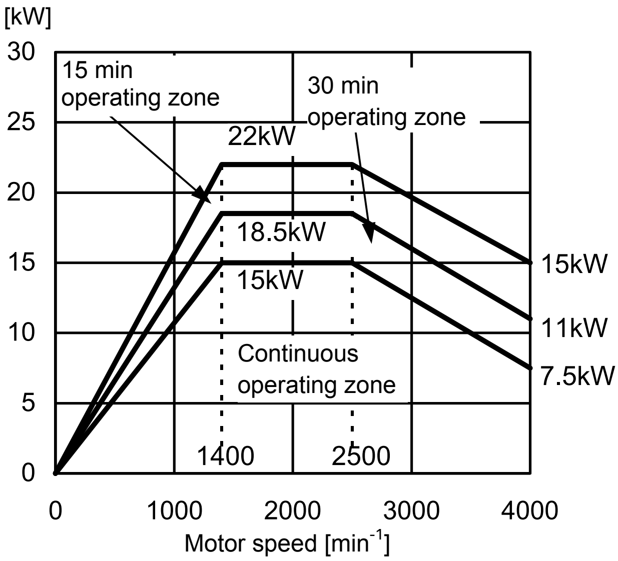
High-speed winding torque (Δ connection)



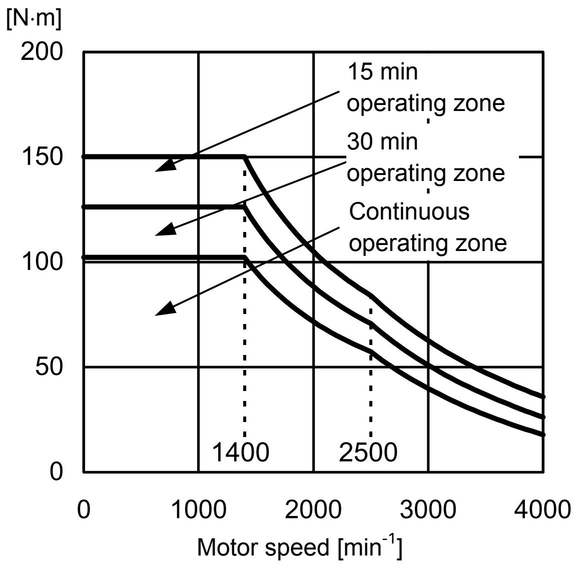
3.8 MODEL αiIT 15/15000

Applicable amplifier αiSP 30

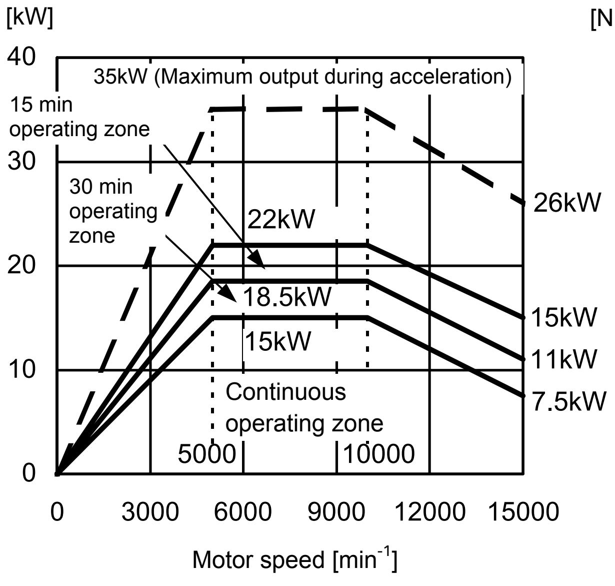
Low-speed winding output (Y connection)



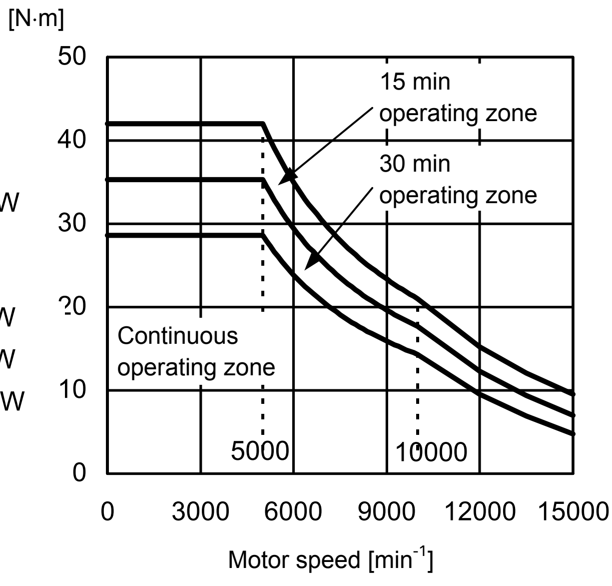
Low-speed winding torque (Y connection)



High-speed winding output (Y connection)



High-speed winding torque (Y connection)

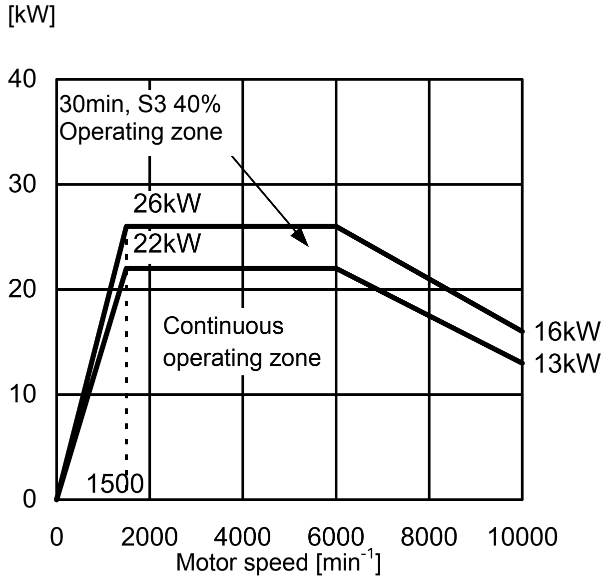


> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

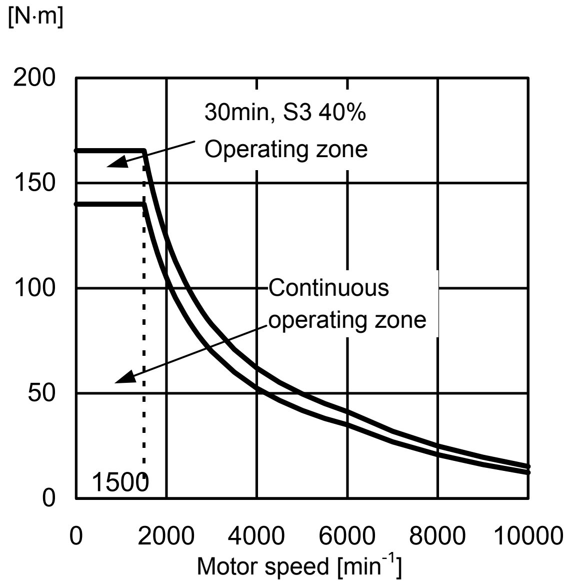
3.9 MODEL αiIT 22/10000

Applicable amplifier αiSP 26

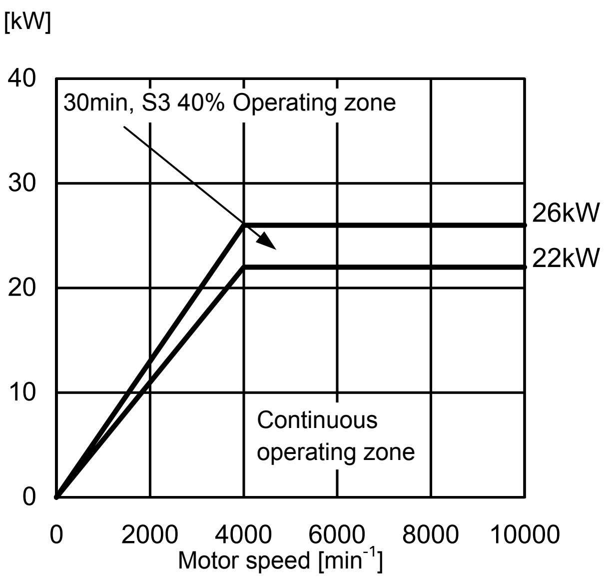
Low-speed winding output (Y connection)



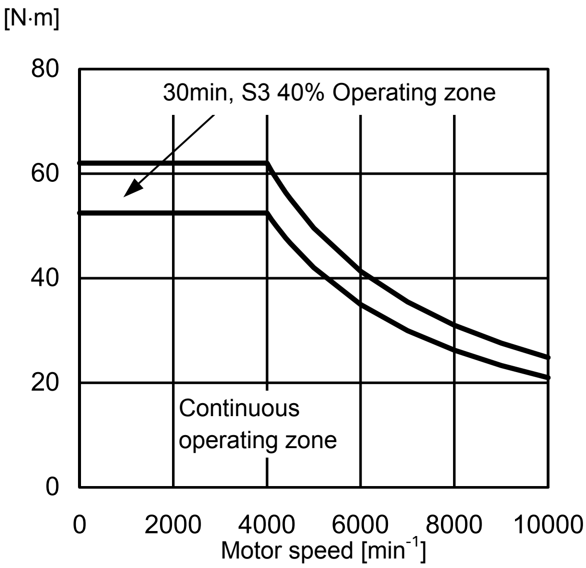
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



High-speed winding torque (Δ connection)

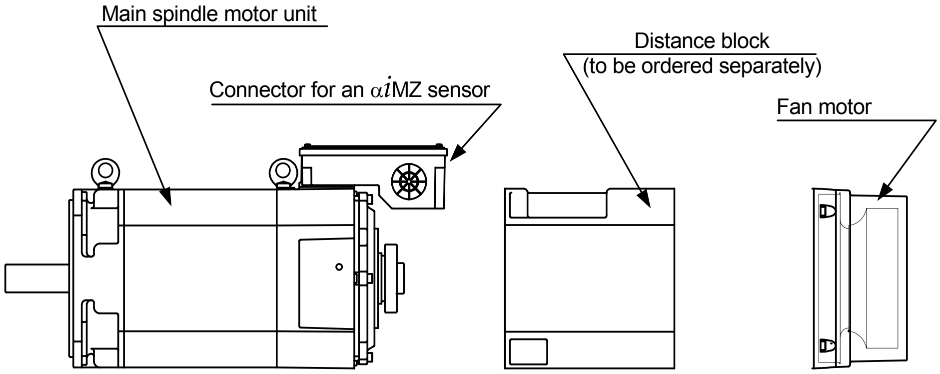


4 CONFIGURATION AND ORDERING NUMBER

4.1 CONFIGURATION

The αiIT series motor 200V type consists of the following items:

(1) Main spindle motor unit
(2) Fan motor (Exhaust on the side opposite to the load axis. Packed separately.)
(3) Connector (housing, contact) for an αiMZ sensor
The connector is contained in the terminal block.
(4) Distance block (Separately packed. To be ordered separately in addition to the main motor unit.)



4.2 ORDERING NUMBER

Motor (including a cooling fan)

Model	Ordering number	SPM	Remarks
αiIT 1.5/20000	A06B-1463-B123#0121	αiSP 15	- Flange mounting type - Hollow shaft (with no key) - Labyrinth - Built-in with αiMZ sensor
αiIT 2/20000	A06B-1464-B123#0121	αiSP 22	
αiIT 3/12000	A06B-1465-B123#0021	αiSP 11	
αiIT 6/12000	A06B-1466-B123#0021	αiSP 15	
αiIT 8/12000	A06B-1467-B123#0021	αiSP 15	
αiIT 8/15000	A06B-1477-B133#0121	αiSP 26	
αiIT 15/10000	A06B-1469-B123#0021	αiSP 22	
αiIT 15/15000	A06B-1479-B133#0221	αiSP 30	
αiIT 22/10000	A06B-1471-B123#0021	αiSP 26	

Distance block

* Please prepare Distance-block by the machine tool builder. The distance blocks indicated in the table below are available from FANUC as separate items.

- Distance block

Name	Ordering number	Remarks
Type αiIT 1.5	A06B-1463-K560	For αiIT 1.5
Type αiIT 2	A06B-1464-K560	For αiIT 2 and αiIT 3
Type αiIT 6	A06B-1466-K560	For αiIT 6 and αiIT 8
Type αiIT 15	A06B-1469-K560	For αiIT 15 and αiIT 22

- Distance block with windows

Name	Ordering number	Remarks
Type αiIT 2	A06B-1464-K580	For αiIT 2 and αiIT 3
Type αiIT 6	A06B-1466-K580	For αiIT 6 and αiIT 8
Type αiIT 15	A06B-1469-K580	For αiIT 15 and αiIT 22

5 CONNECTIONS

5.1 CONNECTION OF THE POWER, FAN MOTOR, AND αiMZ SENSOR SIGNAL LEADS

Cables for power lead and fan motor are connected to the terminal block.

αiMZ sensor signal or thermo stat signal use a connector manufactured by Tyco Electronics AMP.

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

Model \ Size of screws used in the terminal block	Power lead		Cooling fan
	U,V,W,G	X,Y,Z	FMU,FMV,FMW
αiIT 1.5/20000	M5	-	M4
αiIT 2/20000	M5	-	Screw-less terminal block
αiIT 3/12000	M5	-	Screw-less terminal block
αiIT 6/12000	M5	M5	Screw-less terminal block
αiIT 8/12000	M5	M5	Screw-less terminal block
αiIT 8/15000	M5	M5	Screw-less terminal block
αiIT 15/10000	M5	M5	Screw-less terminal block
αiIT 15/15000	M6	M6	Screw-less terminal block
αiIT 22/10000	M6	M6	Screw-less terminal block

Size of power lead

Observe the sizes indicated below when using power leads to be used between the amplifier and motor, and crimp terminals.

Motor model	Crimp terminal size		Applicable power lead size (mm^2)	
	Motor side	Amplifier side	(*1) LMFC	(*2) Flonlex power cable
αiIT 1.5/20000	M5	M5	-	8.0
αiIT 2/20000	M5	M6	-	8.0
αiIT 3/12000	M5	M5	5.5	-
αiIT 6/12000	M5	M5	8	-
αiIT 8/12000	M5	M5	8	-
αiIT 8/15000	M5	M6	14	-
αiIT 15/10000	M5	M6	14	-
αiIT 15/15000	M6	M6	22	-
αiIT 22/10000	M6	M6	22	-

NOTE

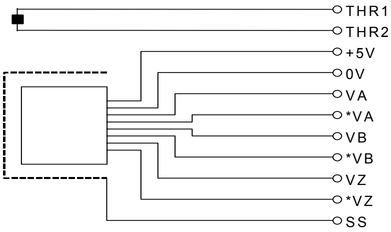
1. LMFC power lead: Fire-retardant Polyflex power cable (Heat resistance: 105°C)
2. Flonlex power lead: Manufactured by HITACHI CABLE, Ltd. (Heat resistance: 200°C)

Cable for the fan motor

For the fan motor current value and cable specifications, refer to Section I.4.3, “FAN MOTOR CONNECTION” in this manual.

5.2 CONNECTION OF SIGNAL LEAD

αiMZ sensor signal or overheat signal use a connector manufactured by Tyco Electronics AMP.
The connector housing and the connector are attached to the motor.



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		*VA	*VB	*VZ	0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	VA	VB	VZ	SS	THR1

Connector housing and contact specifications

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

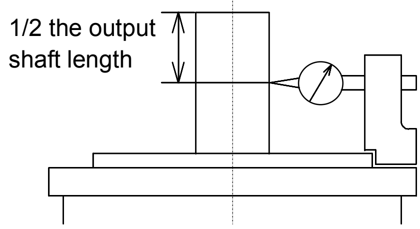
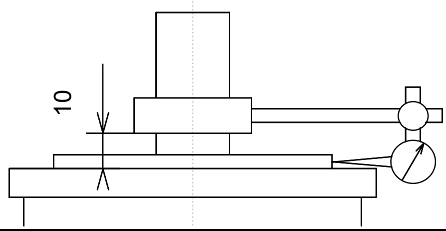
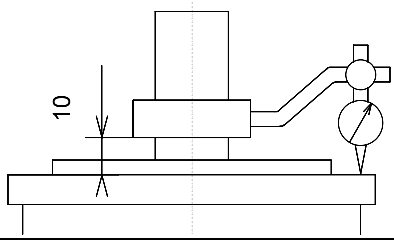
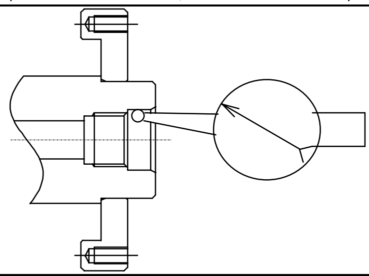
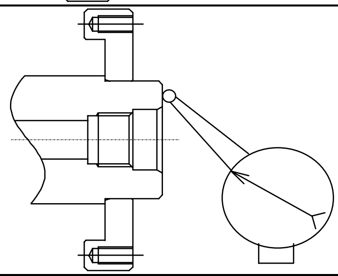
	Motor side		**Cable side**	
	FANUC specification	**Manufacture specification**	**FANUC specification**	**Manufacture specification**
Housing	A63L-0001-0535/121KDF	178964-6	A63L-0001-0460/121KD	178289-6
Contact	A63L-0001-0456/ASMT	175288-2	A63L-0001-0456/ASM	1-175217-2

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 kΩ as measured at room temperature (20°C to 30°C).

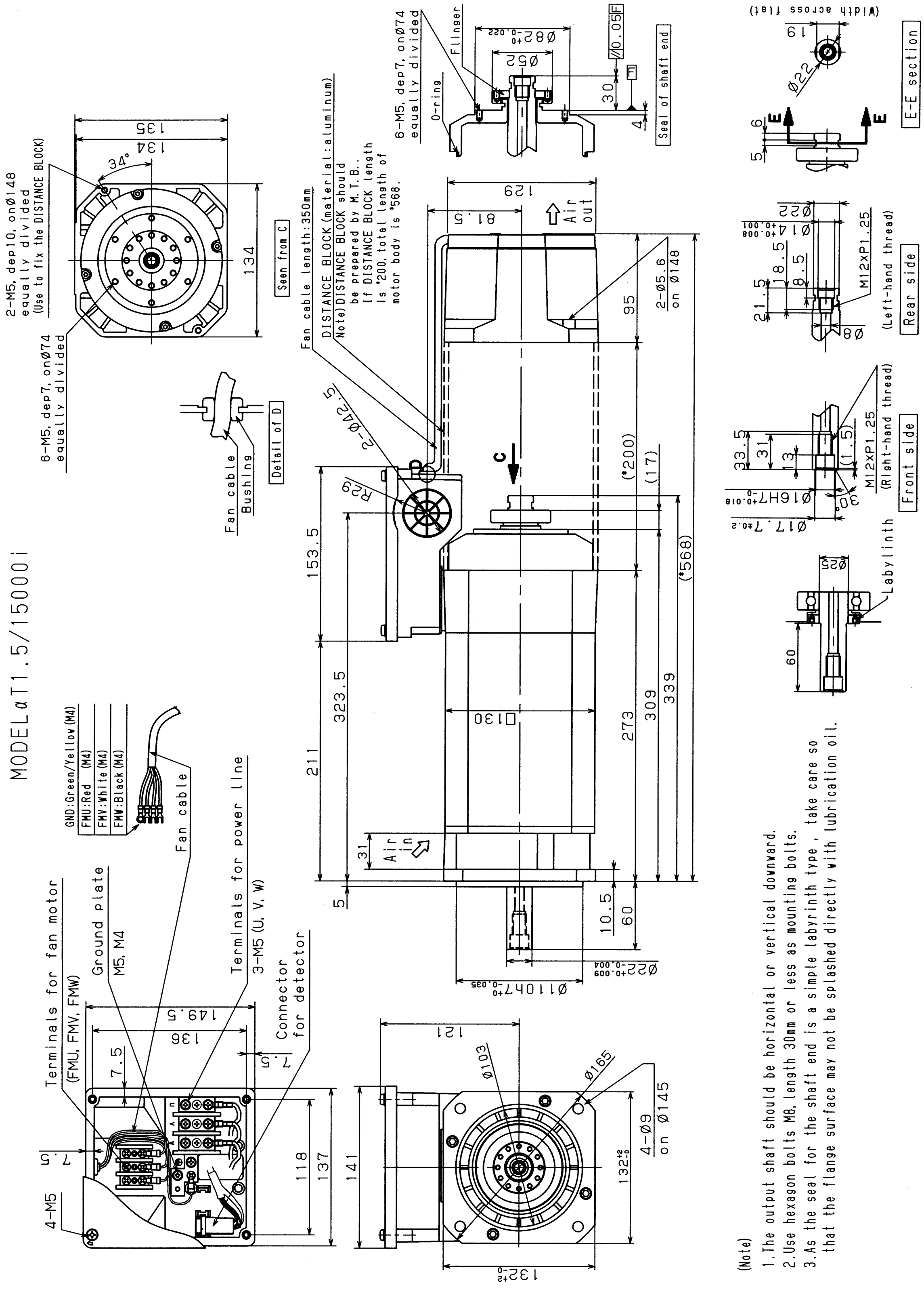
6 ASSEMBLING ACCURACY

Item	Accuracy	Measuring method
Run-out at the end of the output shaft	10μm or less	
Run-out of the faucet joint for mounting the flange against the core of the shaft	30μm or less	
Run-out of the flange mounting surface against the core of the shaft	40μm or less	
Front shaft end through hole inlet Rear shaft end through hole inlet Run-out of socket and spigot joint	20μm or less	
Run-out of front shaft end face Run-out of rear shaft end face	10μm or less	

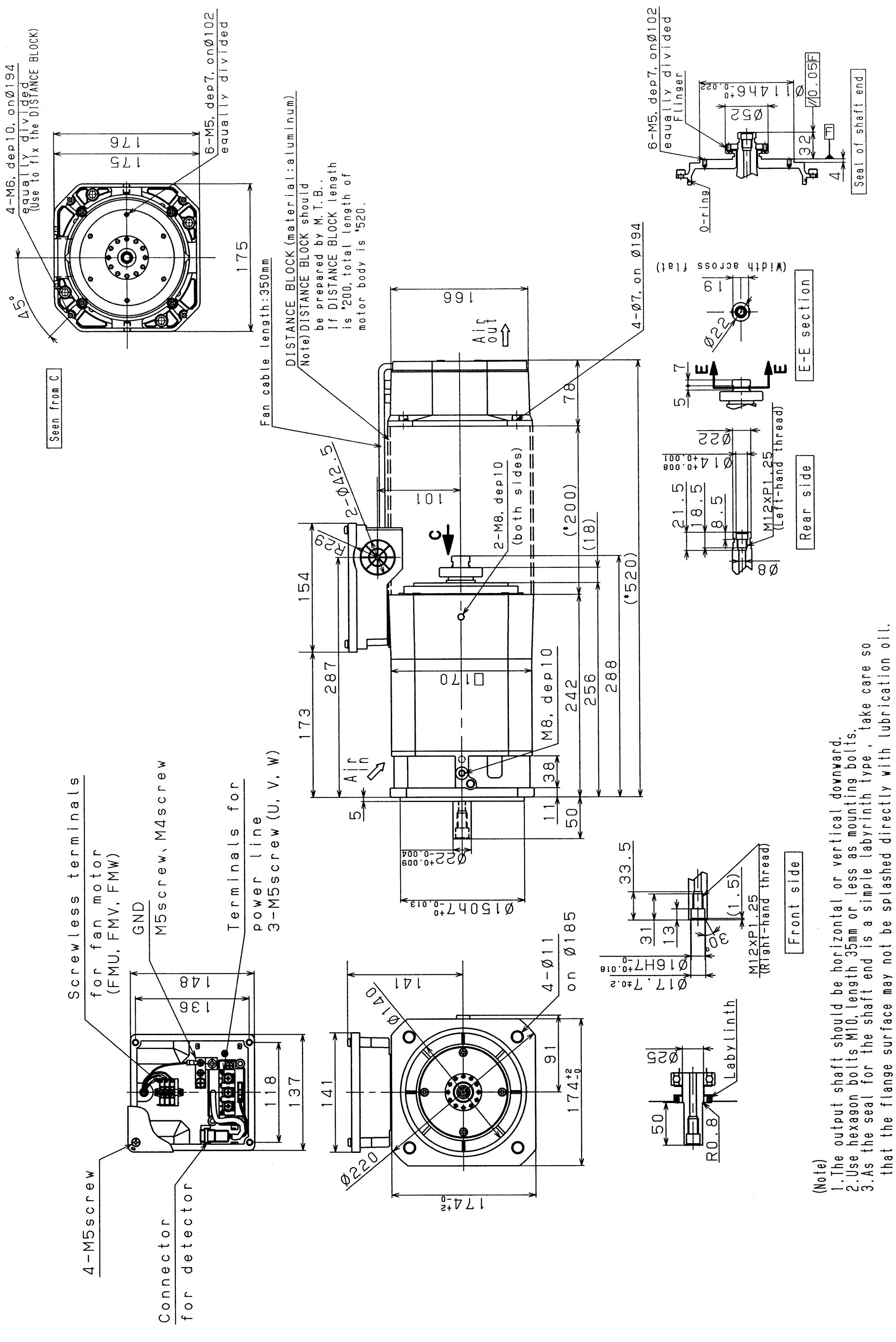
7 EXTERNAL DIMENSIONS

Model name	Section
Model αiIT 1.5/20000	7.1
Model αiIT 2/20000	7.2
Model αiIT 3/12000	7.3
Model αiIT 6/12000	7.4
Models αiIT 8/12000 and αiIT 8/15000	7.5
Model αiIT 15/10000	7.6
Model αiIT 15/15000	7.7
Model αiIT 22/10000	7.8
Distance block Type αiIT 1.5	7.9
Distance block Type αiIT 2	7.10
Distance block Type αiIT 6	7.11
Distance block Type αiIT 15	7.12
Distance block with windows Type αiIT 2	7.13
Distance block with windows Type αiIT 6	7.14
Distance block with windows Type αiIT 15	7.15

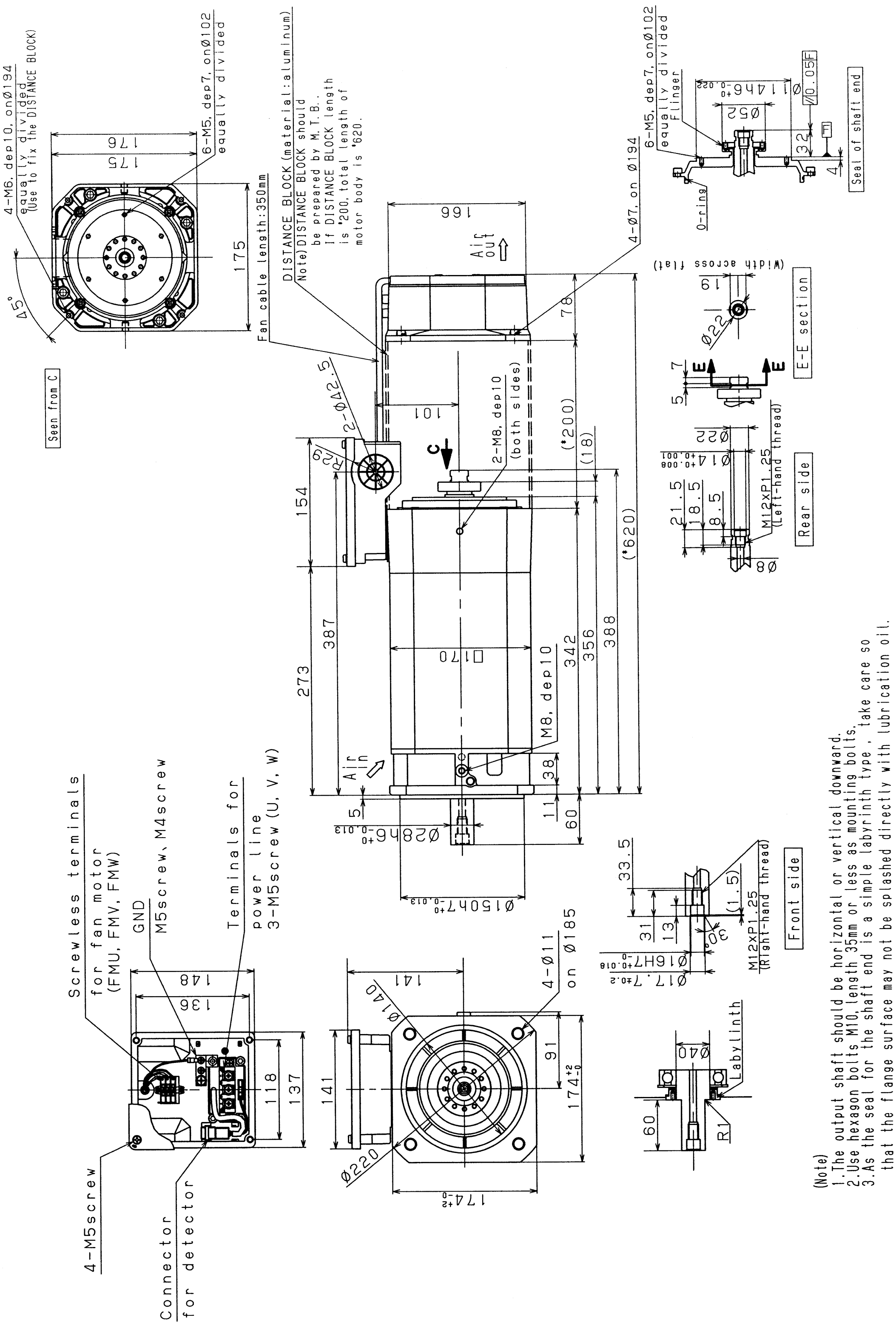
7.1 MODEL αiIT 1.5/20000



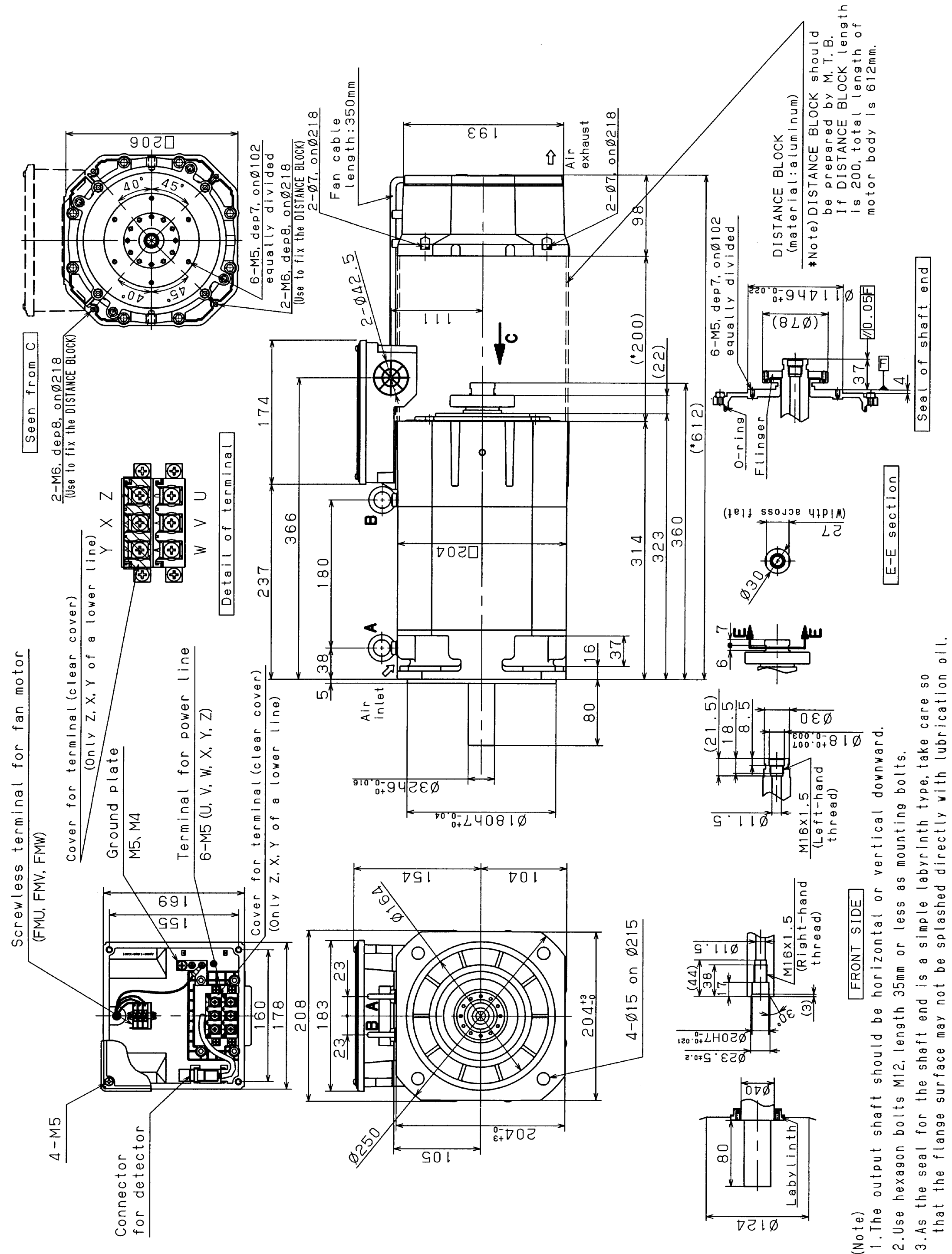
7.2 MODEL α*i*IT 2/20000



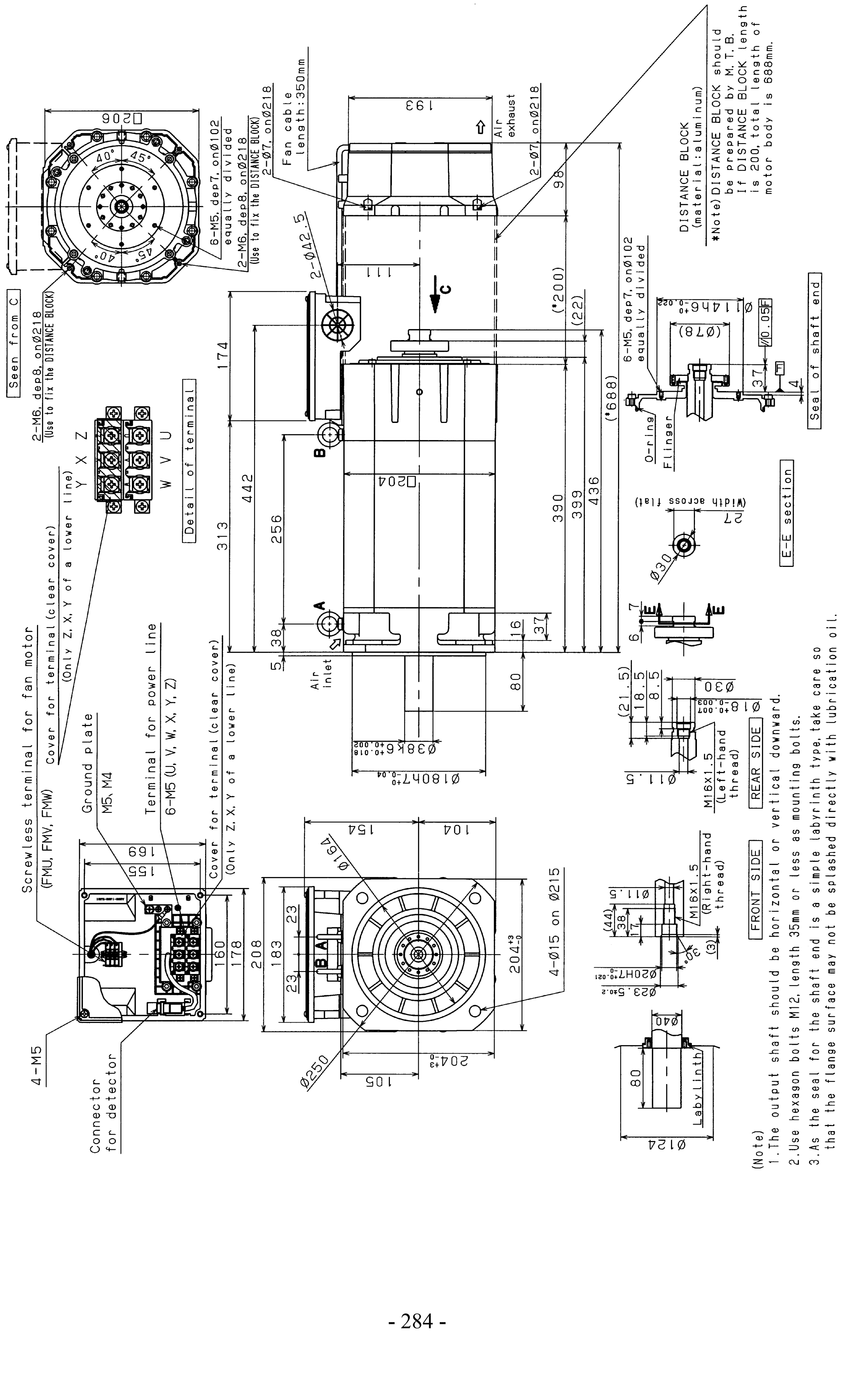
7.3 MODEL αiIT 3/12000



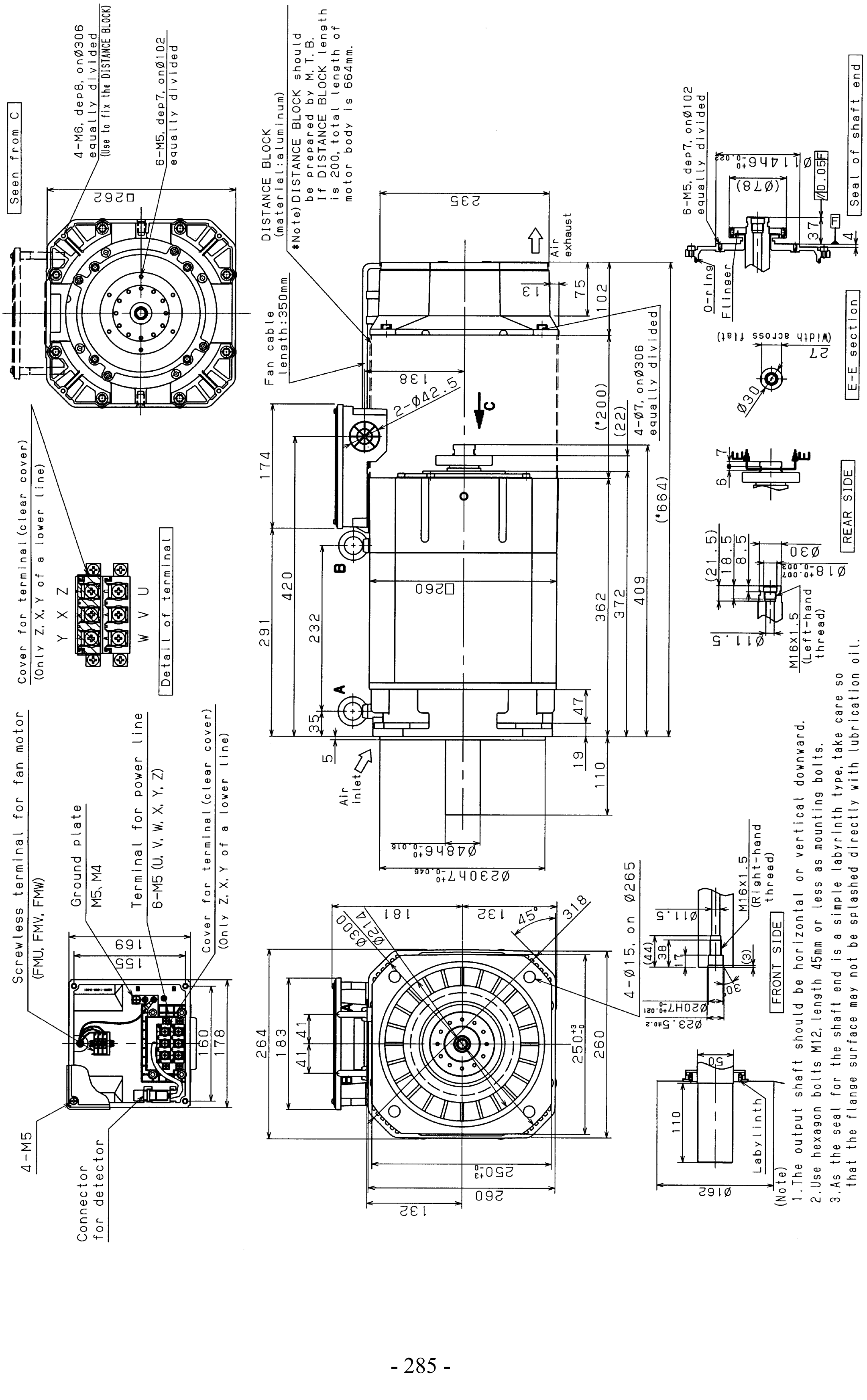
7.4 MODEL αiIT 6/12000



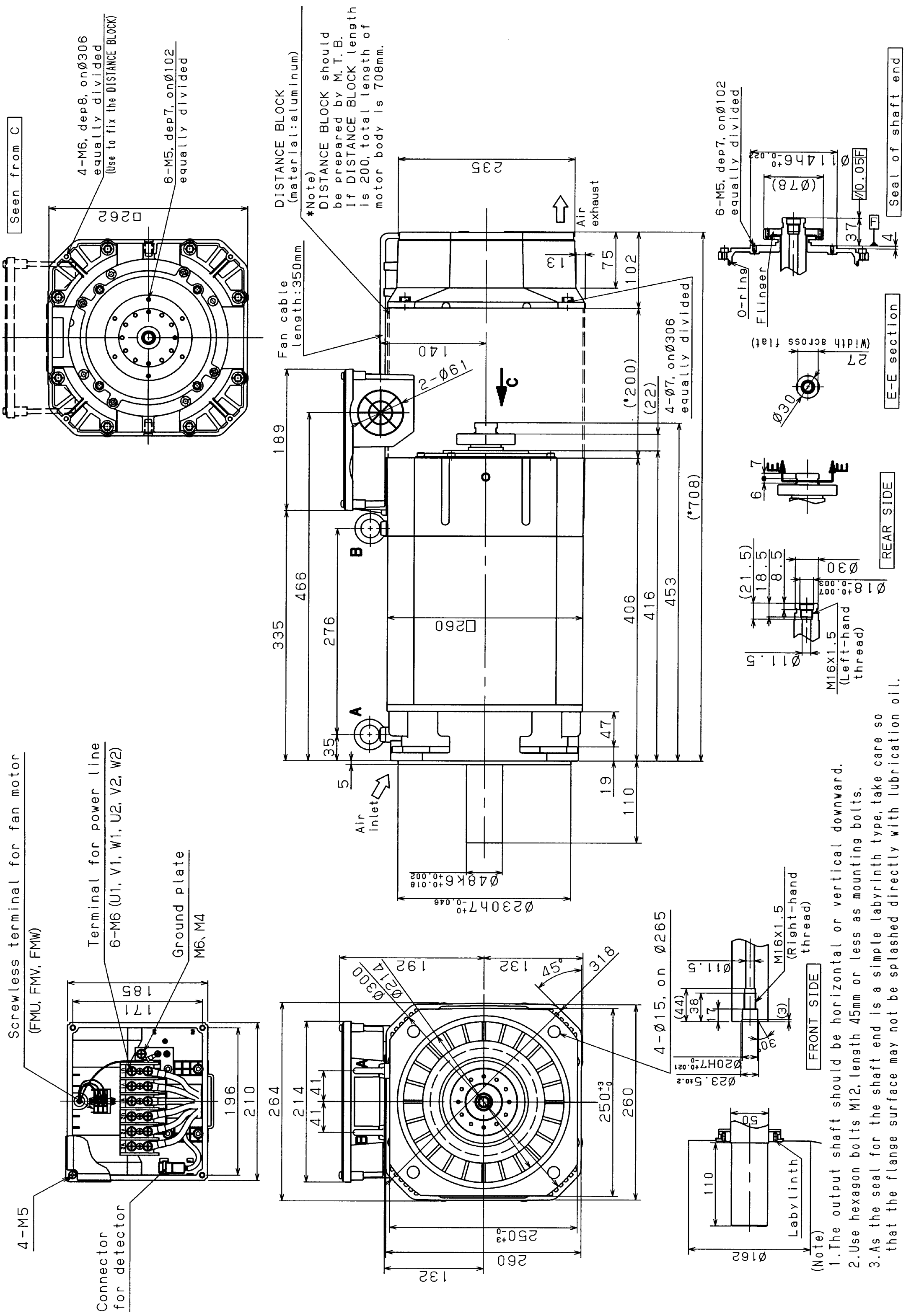
7.5 MODELS αiIT 8/12000 AND αiIT 8/15000



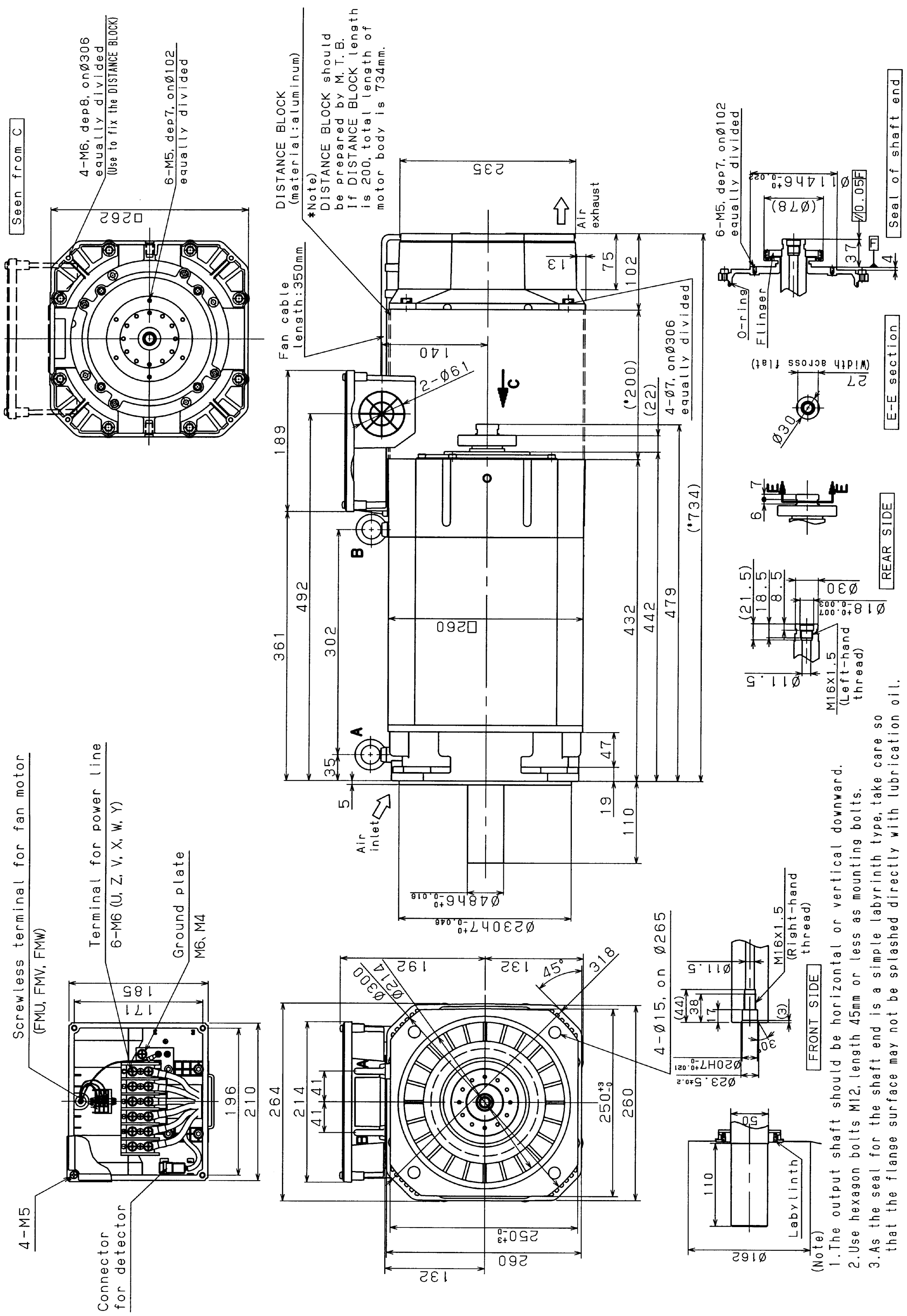
7.6 MODEL αiIT 15/10000



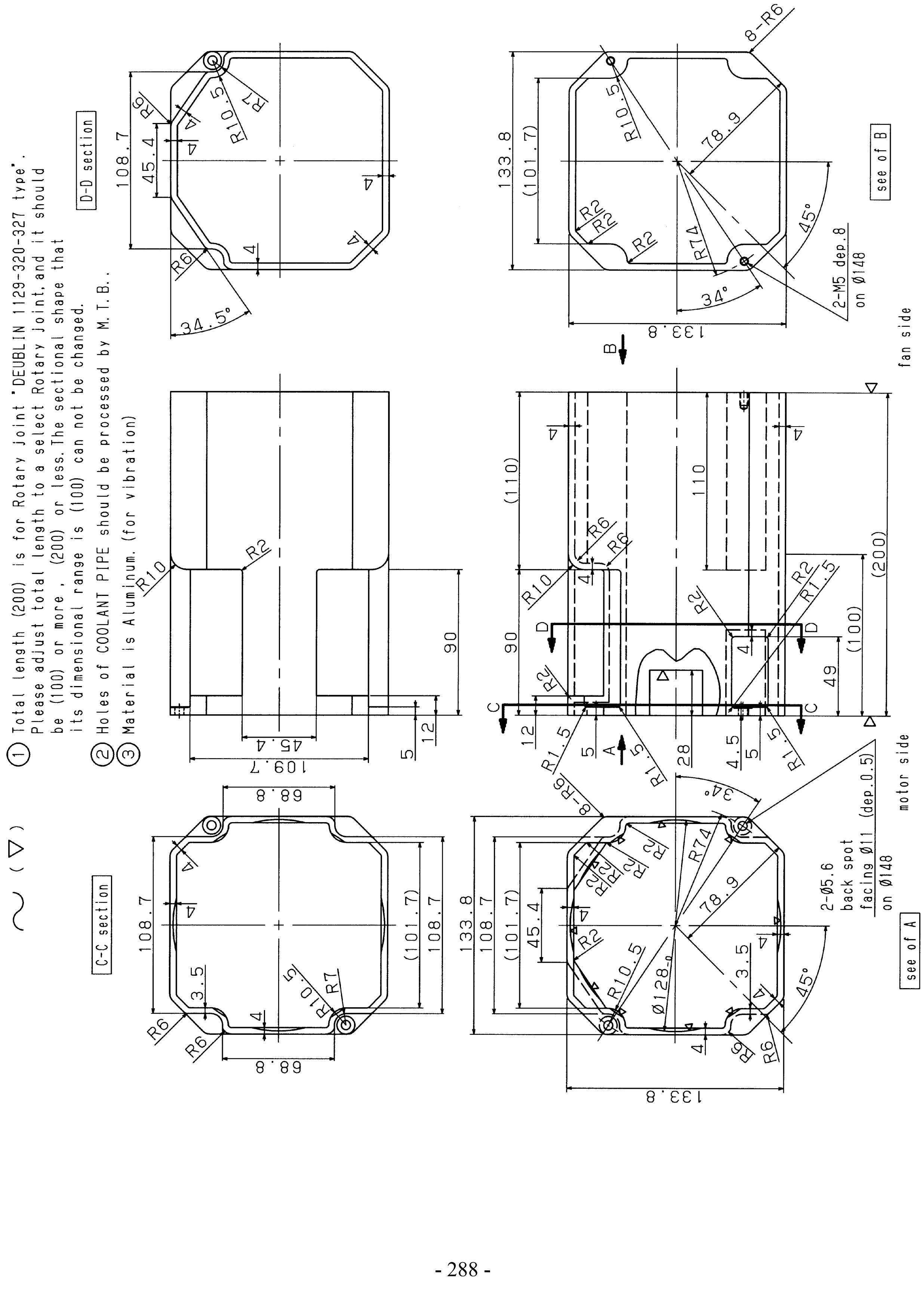
7.7 MODEL αiIT 15/15000



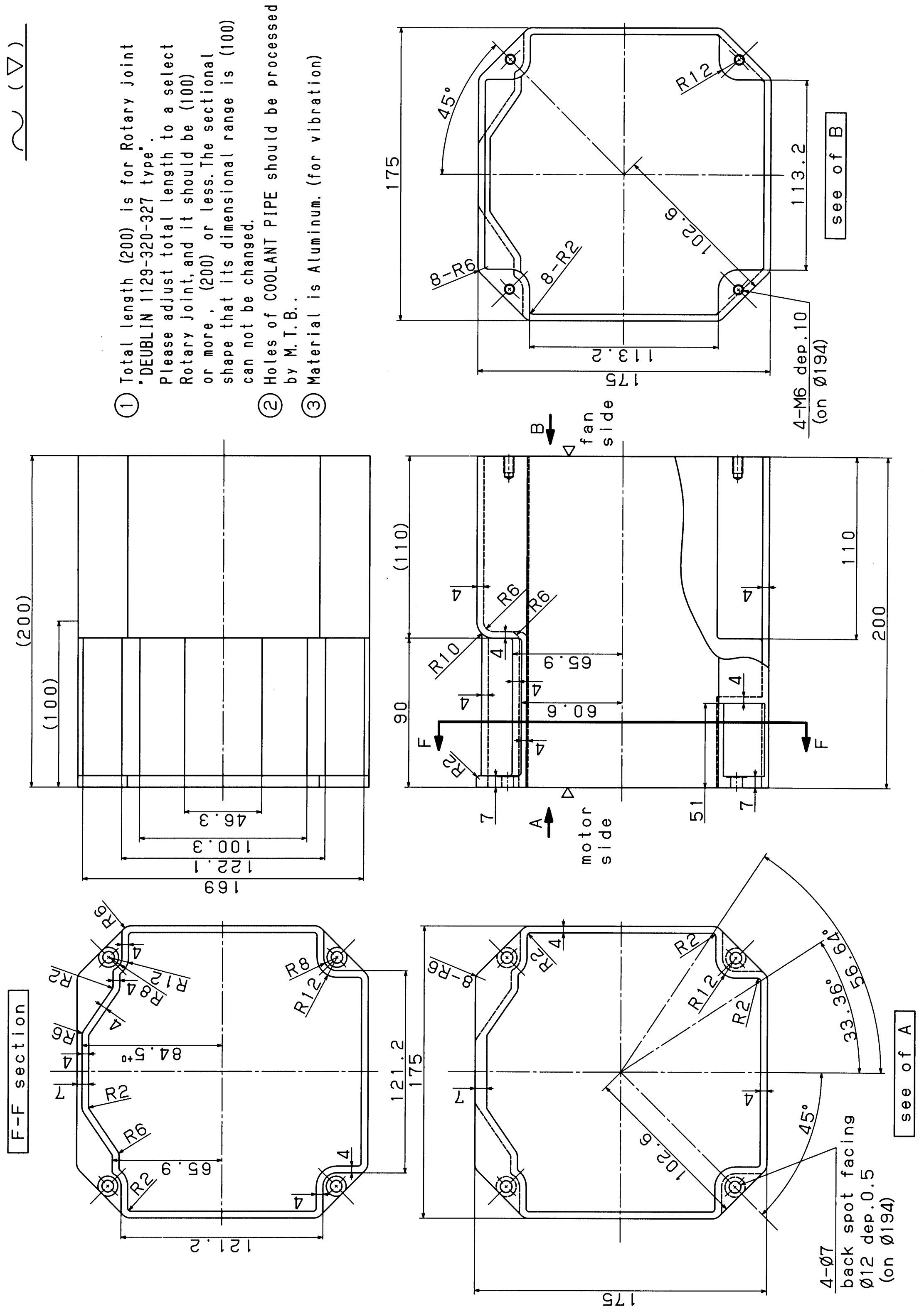
7.8 MODEL αiIT 22/10000



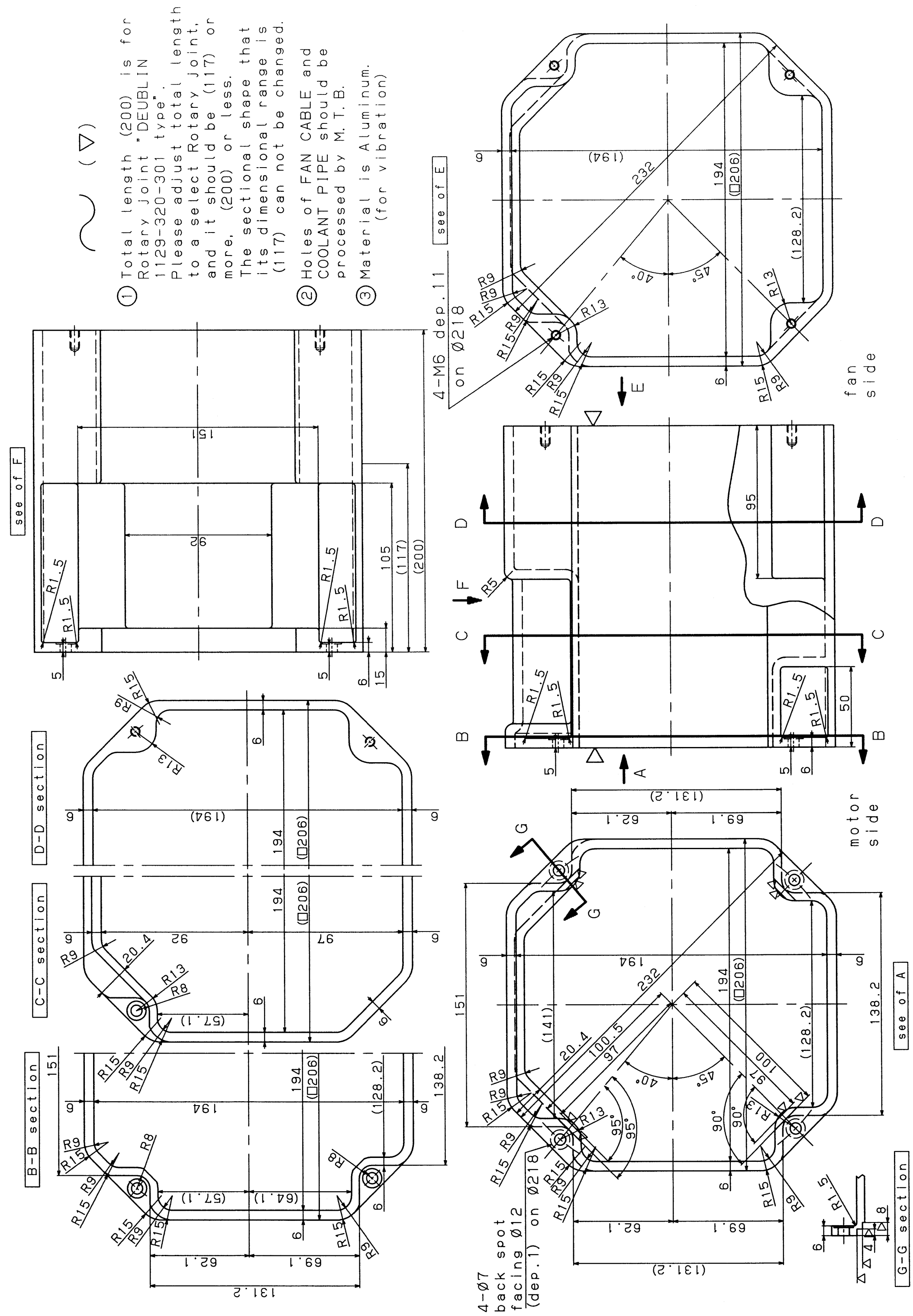
7.9 DISTANCE BLOCK TYPE αiIT 1.5



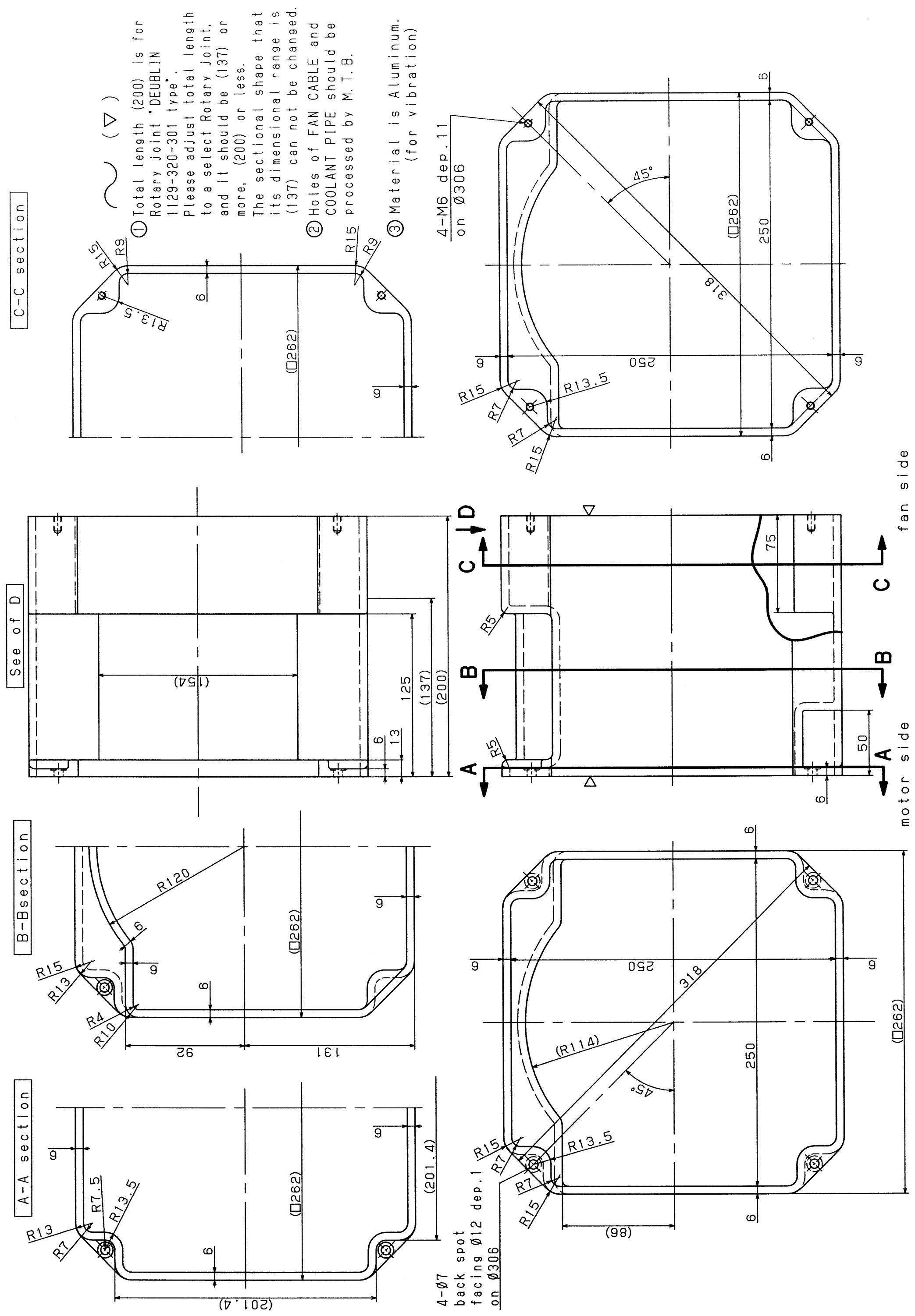
7.10 DISTANCE BLOCK TYPE αiIT 2



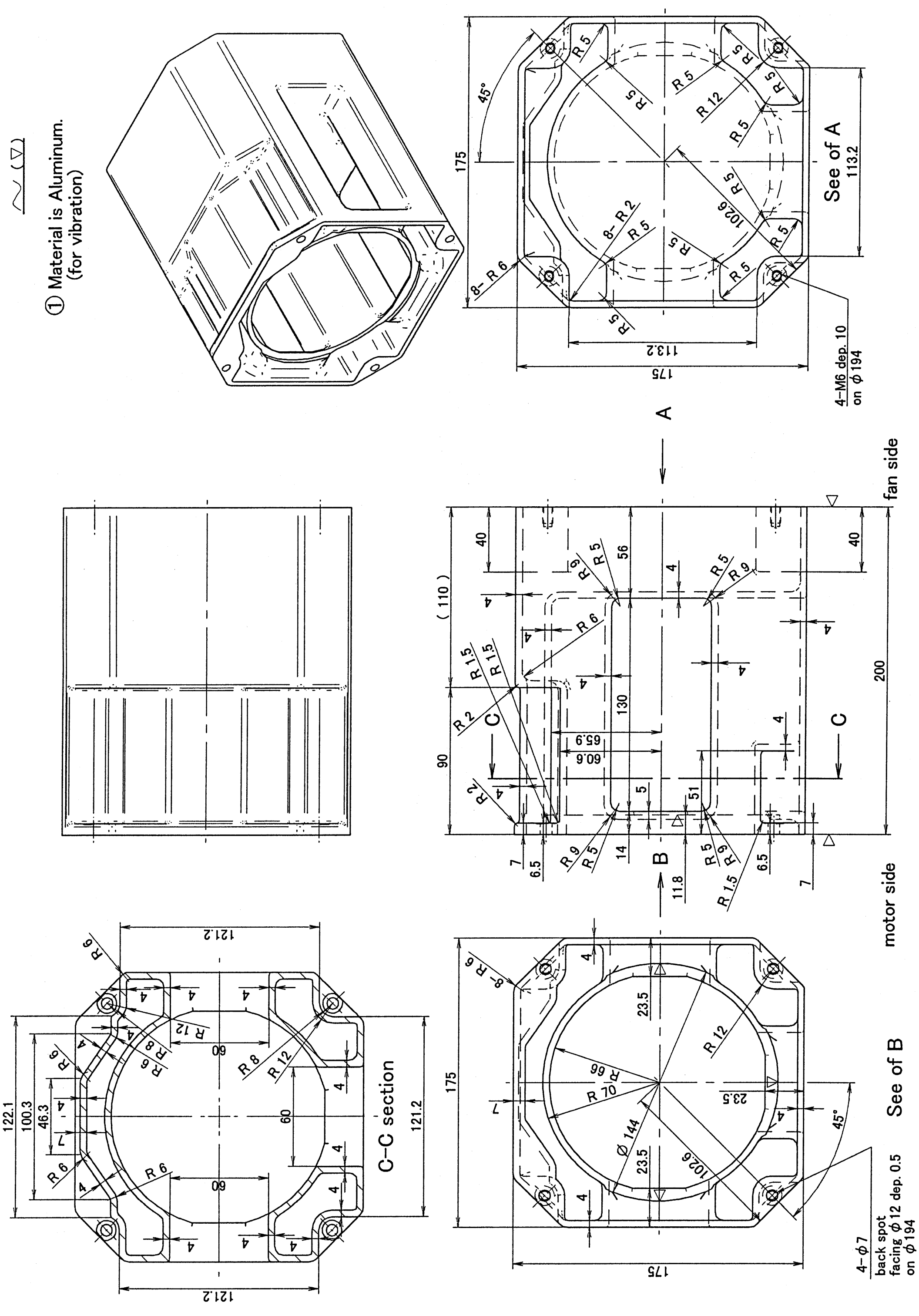
7.11 DISTANCE BLOCK TYPE αiIT 6



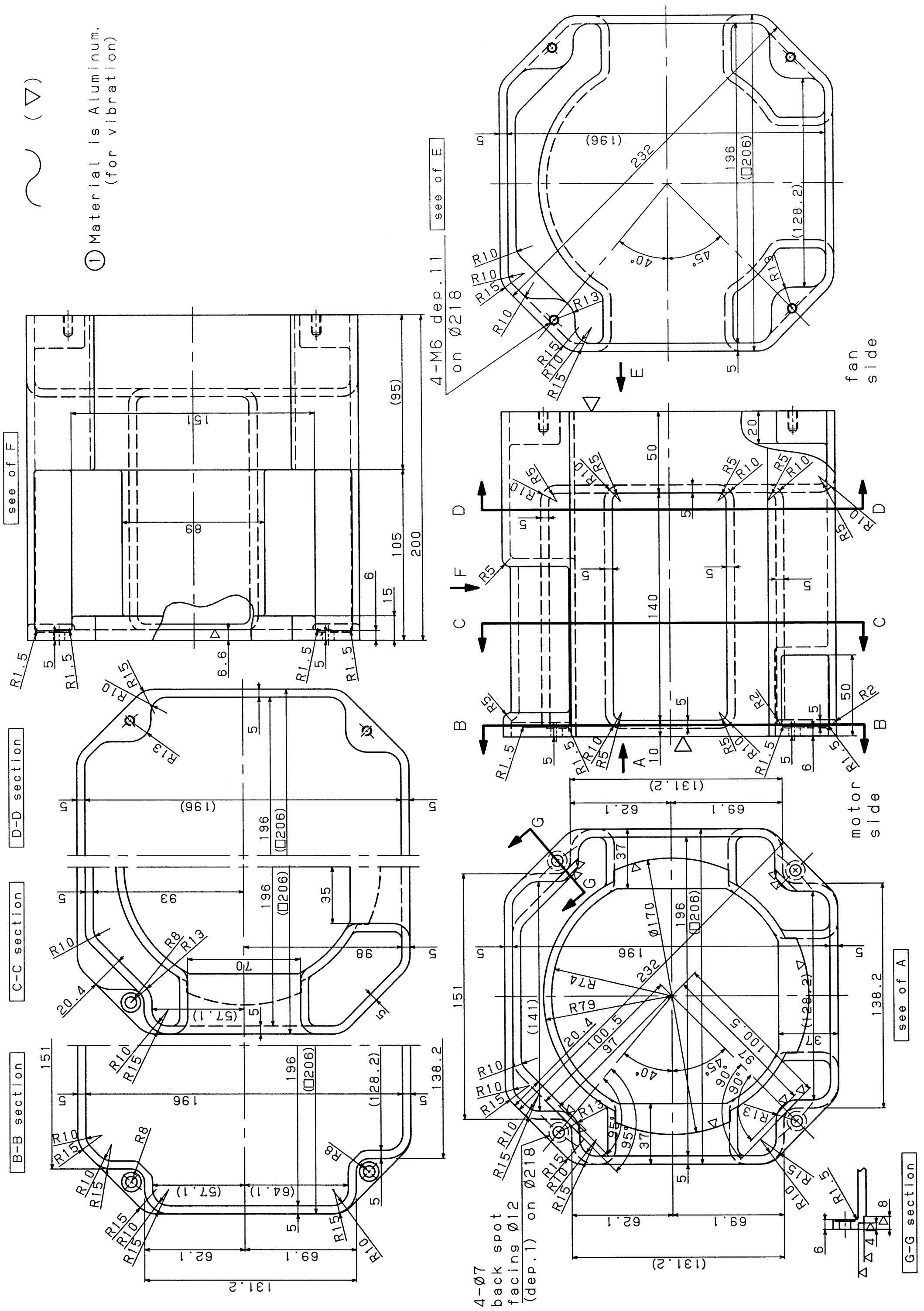
7.12 DISTANCE BLOCK TYPE αiIT 15



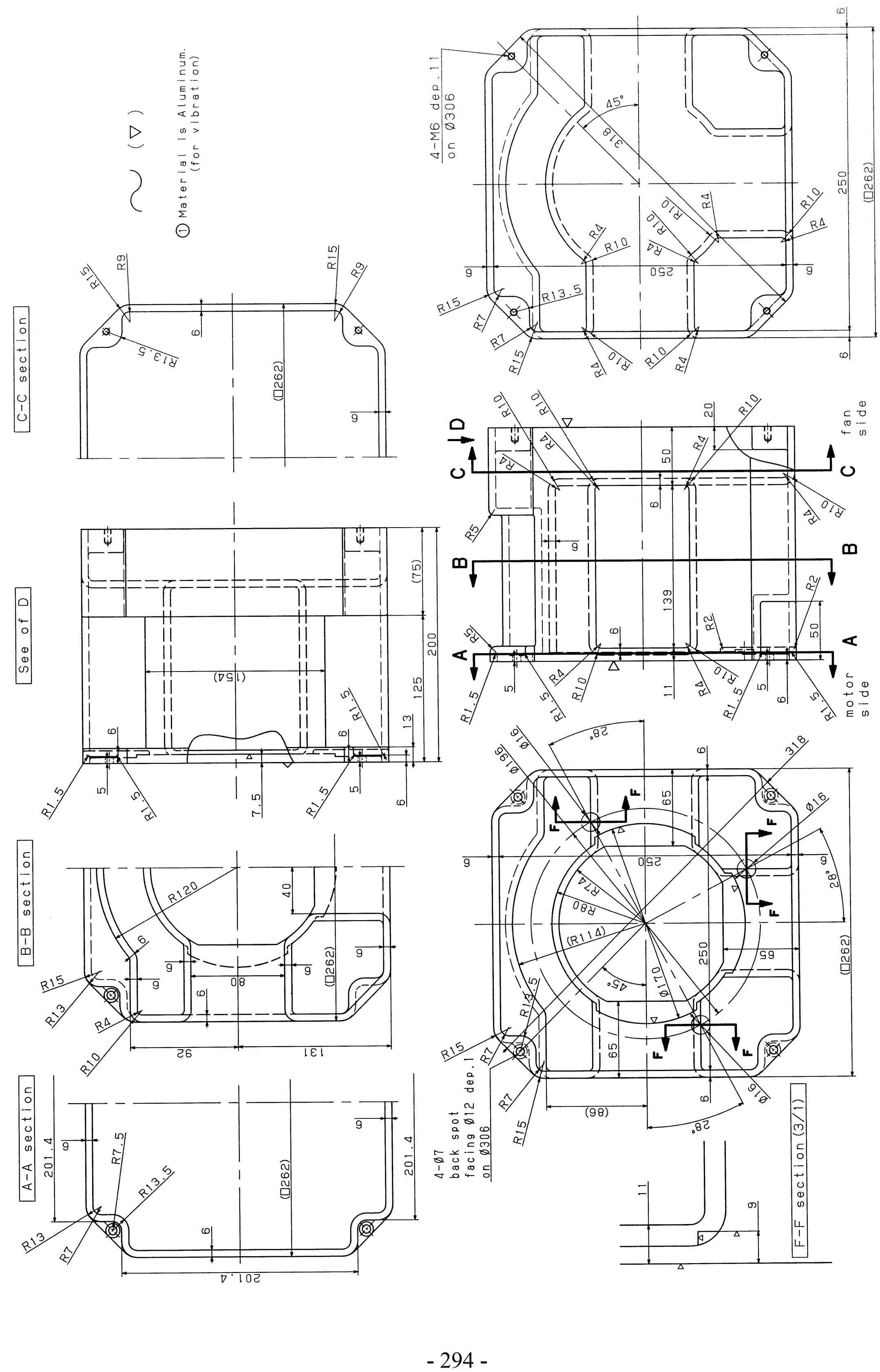
7.13 DISTANCE BLOCK WITH WINDOWS TYPE αiIT 2



7.14 DISTANCE BLOCK WITH WINDOWS TYPE αiIT 6

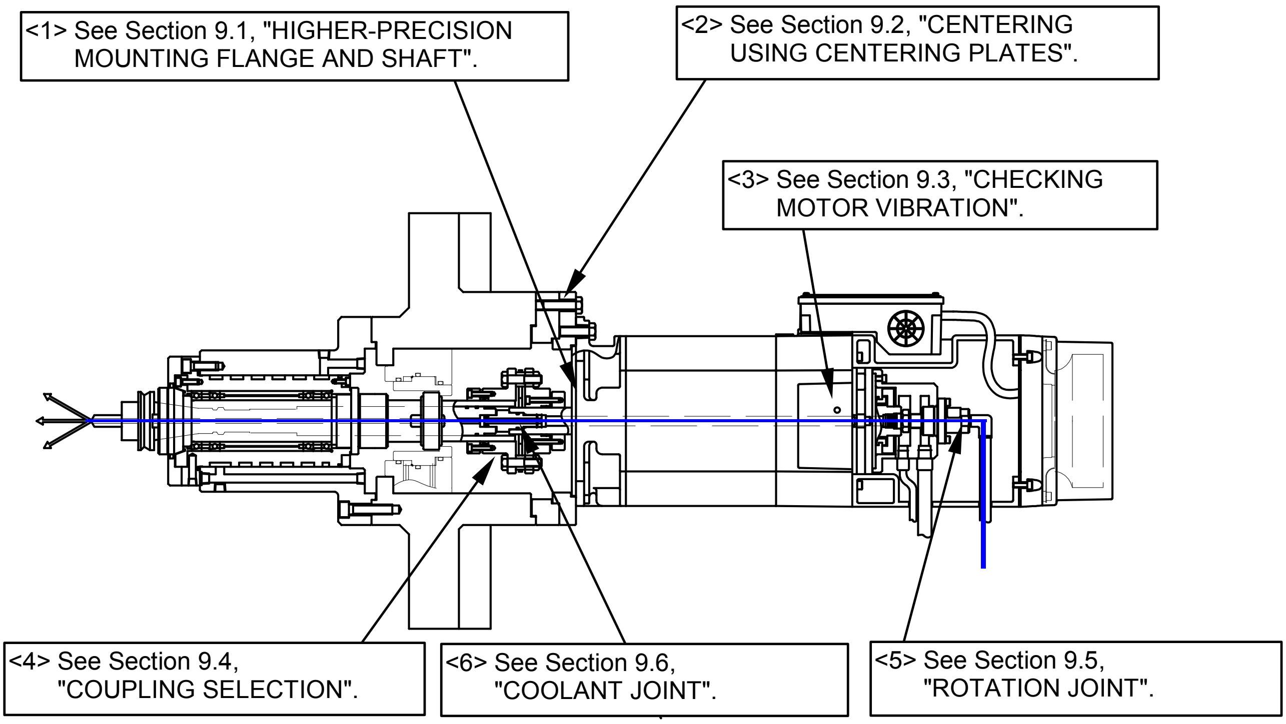


7.15 DISTANCE BLOCK WITH WINDOWS TYPE αiIT 15



8 POINTS ABOUT DIRECT CONNECTION STRUCTURE

If the motor shaft and spindle are not centered precisely when the spindle motor is directly connected to the spindle, fretting can occur with the motor shaft in a short-time operation, or the bearing of the motor can be damaged because of vibration occurring at the joint. Six important points for high-speed rotation with low vibration in a direct motor connection structure are described below.



9 NOTES ON MOTOR INSTALLATION

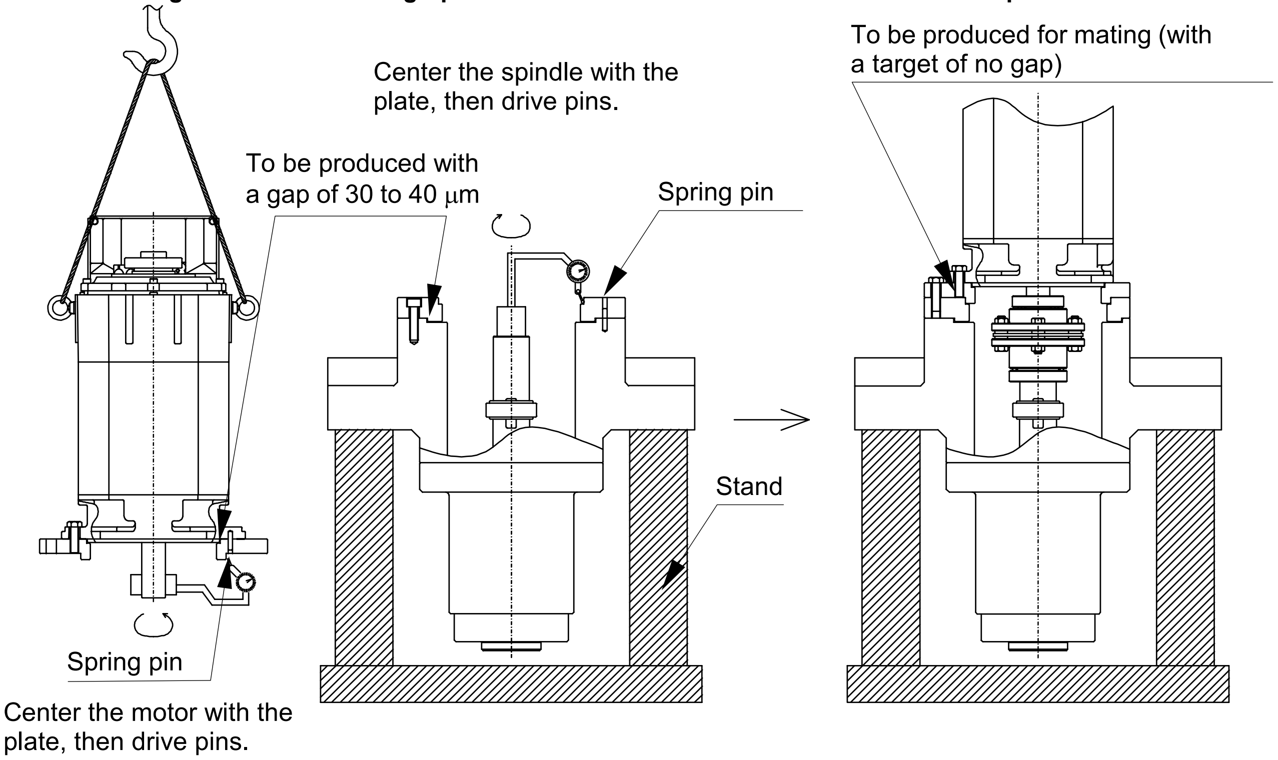
9.1 HIGHER-PRECISION MOUNTING FLANGE AND SHAFT

With the αiIT series, a mounting flange and shaft are assembled with higher precision for direct connection with the spindle. For details, see Chapter 6, "ASSEMBLY PRECISION".

9.2 CENTERING USING CENTERING PLATES

When connecting the spindle with the motor shaft, make centering with a target concentricity of 5μm. If centering accuracy measurement is difficult, it is recommended to use centering plates between the spindle head and motor.
Prepare two centering plates: one for the motor and the other for the spindle head. Mate the socket and spigot joint of the plate for the motor with the socket and spigot joint of the plate for the spindle head (with a target of no gap). After centering of the plate for the motor with the motor, center the plate for the spindle head with the spindle head. Then, attach the motor with the plate to the plate for the spindle head. (For plate centering, the user should prepare a stand and orient the spindle upward.)

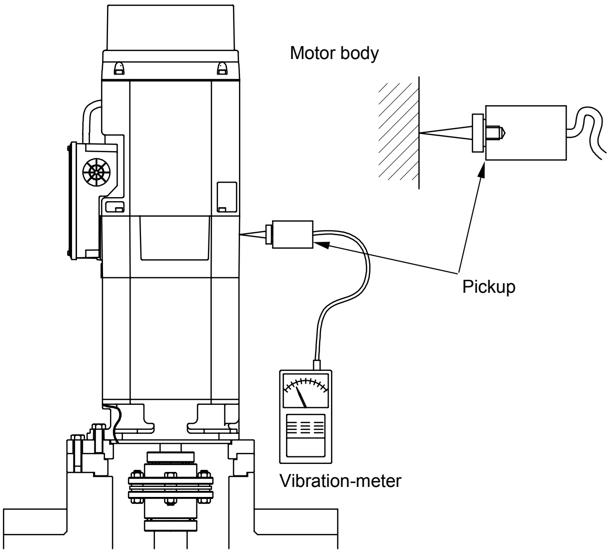
This centering structure allows high-precision installation even in the case of motor replacement in the field.



9.3 CHECKING MOTOR VIBRATION (TO SEE WHETHER CENTERING IS SUCCESSFUL)

To check whether the spindle is centered with the motor successfully, measure the vibration acceleration of the motor.
Center the motor shaft with the spindle so that the vibration acceleration of the motor does not exceed 0.5 G (at maximum speed). (Frequency range: 10 to 1000 Hz)
Before shipping machines, check that the vibration acceleration is 0.5 G or less for all motors.

Method of motor vibration measurement



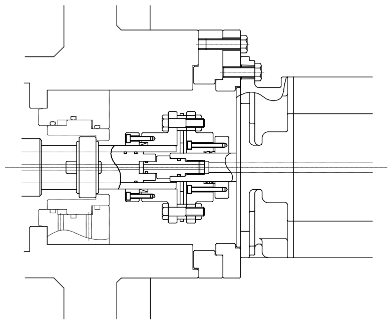
(Recommended vibration-meter) Use the following vibration-meter or an equivalent:

Name:	Anavibro
Model:	VM-3304
Manufacturer:	IMV Corporation (TEL : 03-3262-6311)
Features:	Since a pickup of moving-coil (velocity) type is employed, the need for complicate setting is eliminated to allow an easy measurement. The frequency range is 10 to 1000 Hz, so that this vibration-meter is suitable for measurement of motor rotation components.

* FANUC does not recommend a charge vibration-meter using a piezoelectric acceleration type pickup because it requires complicate setting for use.

9.4 COUPLING SELECTION

1 When connecting the spindle and motor shaft, be sure to use a flexible coupling.
(Flexible coupling examples)
- Diaphragm coupling (EAGLE INDUSTRY CO., LTD.)
- Oldham's coupling
- Gear coupling (MIKI PULLEY)



Example of disk coupling

Flexible coupling has three tolerances of degree of freedom: eccentricity, declination, and axial displacement. This enables coupling with less vibration and less noise to achieve high-speed rotation.

- Tolerances of eccentricity and declination: Slight eccentricity and declination that could not be absorbed by centering are absorbed.
- Tolerance of axial displacement: Extension of the spindle and motor shaft due to temperature increase is absorbed.

(Caution)

- These tolerances are criteria for preventing the coupling from being damaged, not criteria for preventing load from being applied to the spindle and motor bearings. Therefore, to peform rotation with low vibration and low noise before high-speed rotation is achieved, the spindle and motor shaft must be centered.
- FANUC has confirmed that with a coupling (disk coupling) that permits only the degrees of freedom of declination and axial displacement, rotation can take place properly if centering has been pereformed with a concentricity of 5 μm.

2 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.

3 Use a coupling in which thrust load is not applied to the motor shaft by, for example, an increased temperature, cutting operation, or coolant pressure.

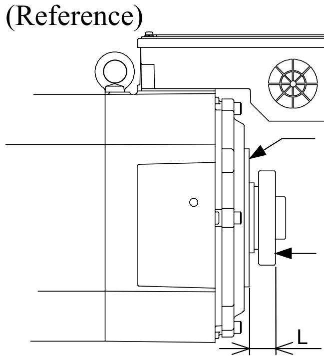
4 Set the torsional rigidity of the coupling to an appropriate high value. If the torsional rigidity is low, vibration may be produced during orientation.

5 When attaching the coupling to the motor shaft, never use a hammer or the like; otherwise, impact load is applied to the bearing.

NOTE

If an Oldham coupling is used, the motor shaft can be left pushed into the inside of the motor when the motor shaft is inserted into the spindle. So, measure the distance (L in the figure below) between the mounting face for a rotation joint support housing and the flinger rear end face before and after insertion, and check that the two measured values are identical.

(Reference)



Motor model	End face distance L
αiIT 1.5	(17)
αiIT 2 to αiIT 3	(18)
αiIT 6 to αiIT 22	(22)

(Reference) Contact points for couplings

Manufacturer	Type of coupling	Point of contact	Applicable maximum speed (*)
EAGLE INDUSTRY CO., LTD	Diaphragm	03-3438-1390	20,000 min^{-1}
MIKI PULLEY CO., LTD	Disk	044-733-5151	12,000 min^{-1}

* FANUC recommends diaphragm coupling for high-speed which is more than 12,000 min^{-1} and high-torque motor.
Because diaphragm coupling has three degrees of freedom (parallel offset, angular misalignment and axial movement) and will realize high-speed rotation under low vibration and low noise.

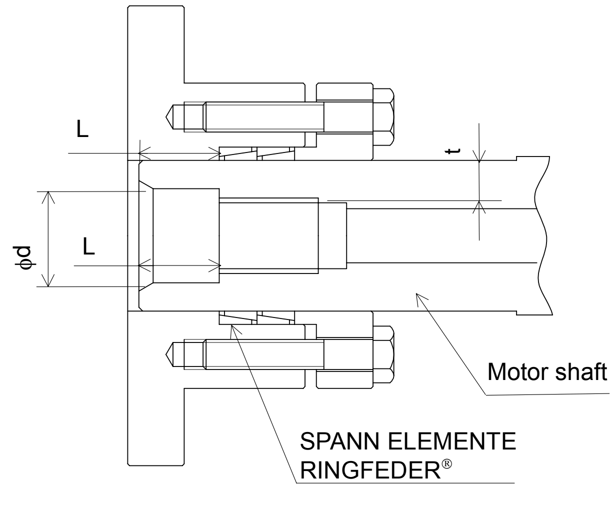
* Example of diaphragm coupling for αiIT 3 to αiIT 22.
TYPE 67E304-30-ZZ (EAGLE INDUSTRY)

NOTE

Select SPANN ELEMENTE that can withstand a torque(*1) 3.6 times greater than the S3 rated torque to protect against slippage in intermittent cutting.
With the models αiIT 1.5/20000 and αiIT 2/20000, however, the motor shaft to which a SPANN ELEMENTE is fastened is thin. So, select SPANN ELEMENTE and a fastening method so that the stress applied to the motor shaft does not exceed the yield point of the motor shaft (490 N/mm^2). As shown below, provide a space of L mm or more between the SPANN ELEMENTE and the tip of the motor shaft.

*1 With the high-acceleration type models αiIT 1.5/20000, αiIT 2/20000, αiIT 8/15000, and αiIT 15/15000, select SPANN ELEMENTE that can withstand a torque 3 times greater than the maximum torque at acceleration time.

See the example of SPANN ELEMENTE selection shown below. For the method of calculation and the location of fastening to the motor shaft, contact the following company:
TAKEDA TRADE CO., LTD. (RINGFEDER®)
Tel: 06-6441-1503, 03-3815-6501



The models αiIT 1.5/20000 and αiIT 2/20000 have a less thickness (t).

↓

[Stress applied to motor shaft] ≤ [Motor shaft yield point (490 N/mm^2)]

Model	α*i*IT 1.5/20000*i*T α*i*IT 2/20000*i*T α*i*IT 3/12000*i*T	α*i*IT 6/12000*i*T α*i*IT 8/12000*i*T α*i*IT 8/15000*i*T α*i*IT 15/10000*i*T α*i*IT 15/15000*i*T α*i*IT 22/10000*i*T
ϕd	$\phi 16^{+0.018}_{-0}$	$\phi 20^{+0.021}_{-0}$
L	13	17

An example of SPANN ELEMENTE selection for the model α*i*IT 2/20000 is given below.

[Example of selection]

Condition 1: Two sets of SPANN ELEMENTE RfN8006 22 × 26 (inner diameter × outer diameter) are used.
Condition 2: Four M5 bolts (strength class: 12.9) are tightened by a tightening torque of 10.0 [N·m].

Surface pressure P (170.7 [N/mm^2]) is produced on the motor shaft, and torque T (128.2 [N·m]) becomes transferable.

Checking transferable torque T
[Check]: Transferable torque T ≥ 3 times maximum torque at motor acceleration time
The maximum torque at acceleration time of the model α2/20000*i*T is 34.8 [N·m][*2]. Accordingly, the following transferable torque is obtained:
128.2 ≥ 3 × 34.8

From the produced surface pressure P and the transferable torque T, check stress σ applied onto the motor shaft.
[Check]: Stress σ applied onto the motor shaft ≤ Motor shaft yield point (490 [N/mm^2])
From the produced surface pressure P (170.7 [N/mm^2]) and the transferable torque (128.2 [N·m]), stress σ applied onto the motor shaft is calculated as σ = 453.1 [N/mm^2]. Accordingly, the following is obtained:
453.1 ≤ 490

*2 This data is calculated from a maximum output at acceleration time used as a guideline for power supply (α*i*PS) selection and from the motor base speed, and is not a guaranteed value.

9.5 ROTATION JOINT

When coolant is flown through the through hole of the motor shaft, a coolant pressure acts on the end face of the coolant joint attached to the shaft front end, thus producing a thrust load that pushes the motor shaft backward. (See Section 9.6.)
If a rotation joint of separate external support type is attached to the motor shaft rear end, a coolant pressure acts also on the rotation joint to push the motor shaft forward, and therefore the thrust load can be canceled.
The $\alpha i I_T$ series is designed assuming that a rotation joint indicated in the table below is attached to the shaft rear end:
Rotation joints of separate external support type manufactured by Deublin or Rix.

Motor model	$\alpha i I_T$ 1.5 to $\alpha i I_T$ 3		$\alpha i I_T$ 6 to $\alpha i I_T$ 22	
Mounting screw size	M12 × 1.25 (left-hand screw)		M16 × 1.5 (left-hand screw)	
Piping direction	Straight type	Elbow type	Straight type	Elbow type
Specification of Deublin	1129-036-327	1129-033-327	1129-036-301	1129-033-301
Specification of Rix	ESX20M-S012	ESX20M-E012	ESX20M-S016	ESX20M-E016
Function(Caution)	Spindle-through coolant during rotation or stopping Air-through during stopping (Air-through disabled during rotation)			

⚠ CAUTION

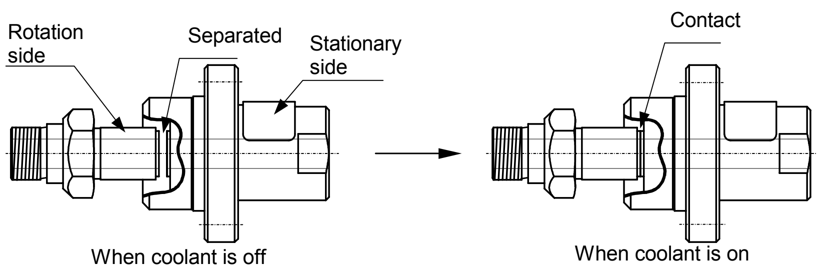
When selecting a rotation joint, if the coolant-through frequency during the machine cycle is high (use in a dedicated machine or line machine), be sure to contact the rotation joint manufacturer.

NOTE

Inquire the following of the rotation joint manufacturer:

- Details of features of the rotation joint and its installation
- Type for enabling air-through during rotation

For rotation joints and support housings, contact:
Deublin Japan Ltd. TEL 072-757-0099
Rotation Joint Div., RIX CORPORATION Co., LTD. TEL 092-935-8913

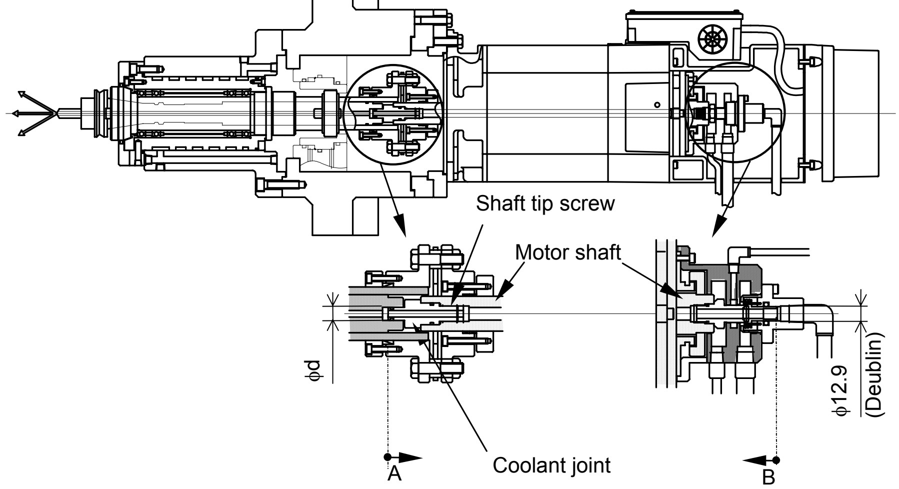


Example of rotation joint (separate external support type)

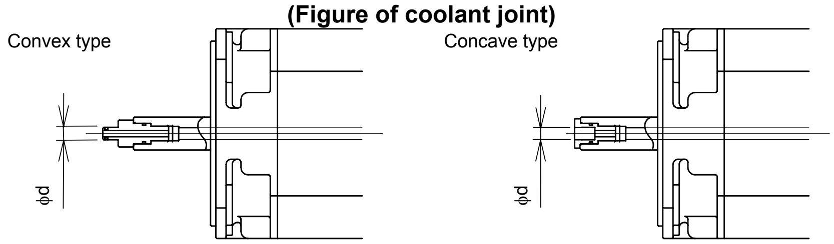
* Before attaching a rotation joint to the motor shaft, apply screw locking adhesive.

9.6 COOLANT JOINT

The machine tool builder is to prepare the following coolant joint:



(Figure of coolant joint)



* • when installing the coolant joint, apply thread-locking adhesive to the joint, and be sure to use the screw used at the end of the motor shaft.
• Press the coolant joint against the shaft end face.

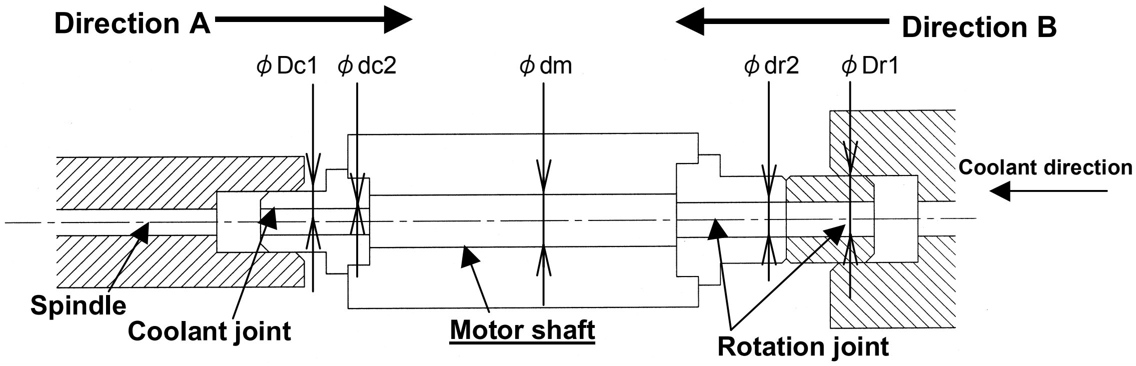
(1) When center-through coolant is used, thrust load due to coolant is applied between the spindle and motor and between the motor and rotation joint. The motor can be made stable without affecting impacts such as pulsation of the coolant pump by setting a slightly larger thrust load in direction B in the above figure than a thrust load in direction A.

(2) When a rotation joint described in Section 9.5 is used, the pressure reception diameter on the rotation joint side is φ12.9(Deublin) or φ12.6(Rix). So, ensure that the pressure reception diameter (φd) on the side of a coolant joint attached to the motor shaft tip follows the table below.
* When the coolant pressure is 70 kgf/cm^2 or less (For a coolant pressure of more than 70 kgf/cm^2, consult with FANUC.)

Motor model	Manufacturer	Rotation joint specification	Pressure reception diameter φd on coolant joint side	Shaft tip screw size
αiIT 1.5 to αiIT 3	Deublin	1129-036-327 1129-033-327	φ12.5	M12
	Rix	ESX20M-S012 ESX20M-E012	φ12.2	

Motor model	Manufacturer	Rotation joint specification	Pressure reception diameter ϕd on coolant joint side	Shaft tip screw size
αiIT 6 to αiIT 22	Deublin	1129-036-301 1129-033-301	ϕ12.0	M16
	Rix	ESX20M-S016 ESX20M-E016	ϕ11.7	

(3) Concept of thrust load applied to the motor



<1> In the above figure, calculate the thrust load applied to the motor.

Coolant pressure: P

Outside diameter of coolant joint: ϕDc1, outside area: Sc1

Inside diameter of coolant joint: ϕdc2, inside area: Sc2

Inside diameter of motor shaft: ϕdm, inside area: Sm

Outside diameter of rotation joint: ϕDr1, outside area: Sr1

Inside diameter of rotation joint: ϕdr2, inside area: Sr2

- Thrust load applied to the motor in direction A: $F_A=P(Sc1-Sc2)+P(Sm-Sr2)$
- Thrust load applied to the motor in direction B: $F_B=P(Sr1-Sr2)+P(Sm-Sc2)$
- Total thrust load applied to the motor:
  $F=F_B-F_A=$
  $P(Sr1-Sr2)+P(Sm-Sc2)-(P(Sc1-Sc2)+P(Sm-Sr2))$
  $=P(Sr1-Sc1)=P(\pi(\phi Dr1)^2/4-\pi(\phi Dc1)^2/4)$

<u>Therefore, only the coolant pressure, the outside diameter of the rotation joint (ϕDr1), and the outside diameter of the coolant joint (ϕDc1) are related to the calculation of the thrust load applied to the motor.</u>

<2> Example for calculating the thrust load

Assume that the coolant pressure is 70 kgf/cm^2, the pressure reception diameter is ϕDc1=ϕ12.

Also assume that the rotation joint is manufactured by Deublin (ϕDr1=ϕ12.9).

The thrust load applied to the motor is then calculated as follows:

$F=70kgf/cm^2 \times (1.31cm^2\ (\phi 12.9)-\ 1.13cm^2(\phi 12))=\underline{\ 12.6kgf}$

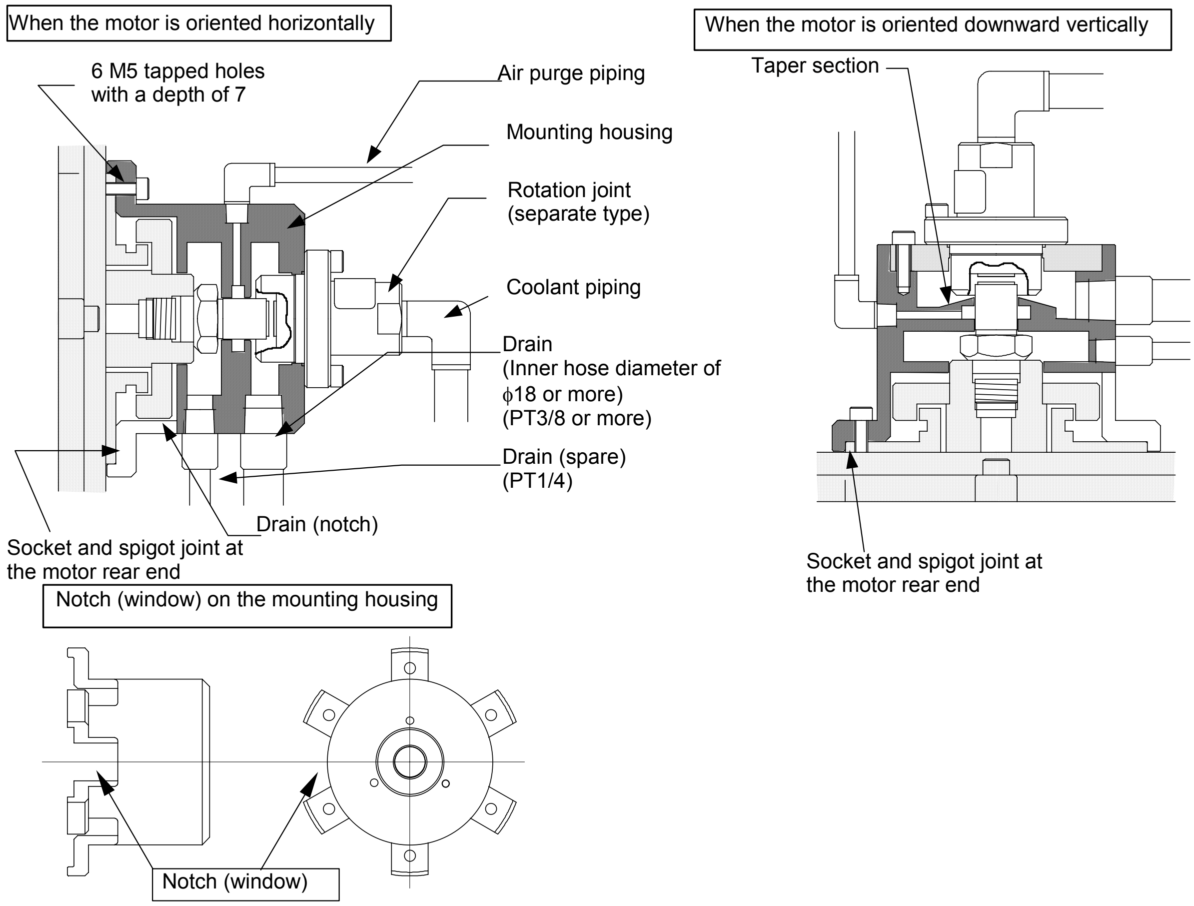
A thrust load of 12.6 kgf is applied in such a direction that it presses the motor shaft forward.

Also when the pressure reception diameter is ϕDc1=ϕ12.5, a thrust load of 5.6 kgf can be obtained by similar calculation.

9.7 ROTATION JOINT SUPPORT HOUSING

The machine tool builder is to prepare a rotation joint support housing. To secure a housing, use a socket and spigot joint and six M5 tapped holes at the motor rear end. Prepare six M5 bolts to secure a housing.
When a rotation joint of separate external support type is used, cutting fluid leaks from the sealing section (contact section between the stationary side and rotation side). So, be sure to provide a drain on the housing for the rotation joint. A drain of PT3/8 or more is required, and a hose with an inner diameter of ϕ12 mm or more is required.
(To determine the final figure of a drain, be sure to contact the manufacturer of a rotation joint.)
A housing of labyrinth structure for preventing cutting fluid from penetrating into the inside of the motor is required. Particularly when the motor is oriented downward vertically, enhance drainage by means such as air purging.
When the rotation joint is damaged, a large amount of cutting fluid can leak. So, provide many notches on the housing. Moreover, attach a flow rate sensor to the drain to perform periodic flow rate management. For details, refer to the specifications of each rotation joint.

(Example of rotation joint support housing)



VII. FANUC AC SPINDLE MOTOR αiIT series 400V type

1 GENERAL

The FANUC AC spindle motor αiIT series 400V type includes spindle motors (hollow shaft), which can be driven by 400 to 480VAC without a step-down transformer(*1).

(*1) For models αiIT 1.5HV, αiIT 2HV, and αiIT 3HV, however, a single-phase step-down transformer for fan motors is required when 480VAC is applied.

Features

- For features of a spindle that is directly connected to a motor, see the αiIT series 200V type section.

2 SPECIFICATIONS

Item \ Model		αiIT 1.5/20000HV	αiIT 2/20000HV	αiIT 3/12000HV
Output (*1)	(S1)Cont. rated kW (HP)	1.5 (2.0)	2.2 (3.0)	3.7 (5.0)
	(S2)30 min rated kW [15 min](*2)(HP)	2.2 (3.0)	3.7 (5.0)	5.5 (7.4)
	(S3)60%[40%]kW (*3) (*4) (HP)	2.2 (3.0)	3.7 (5.0)	5.5 (7.4)
Rated current (*5)	(S1) A	13	21	18
	(S2),(S3) A	16	28	23
Speed min^{-1}	Base speed	3,000	3,000	1,500
	Max. speed	20,000	20,000	12,000
Cont. rated torque at const. rated torque range N·m (kgf·cm)		4.77 (48.7)	7.0 (71.5)	23.5 (240)
Rotor inertia $kg \cdot m^2$ ($kgf \cdot cm \cdot s^2$)		0.0043 (0.04)	0.0078 (0.08)	0.0148 (0.15)
Weight kgf		24	27	46
Vibration		V3 (rotation component)		
Noise		75dB(A) or less		
Cooling system (*6)		Totally enclosed and fan cooled (IC0A6)		
Cooling fan W		(*15)		
Installation (*7)		Mount the motor so that the output shaft points in a direction ranging within the horizontally to vertically downwards. (IMB5,IMV1)		
Allowable overload capacity (1 min) (*8)		120% of (S2)		
Insulation		Class H		
Ambient temperature		0°C to 40°C		
Altitude		Height above sea level not exceeding 1000m		
Painting color		Munsell system N2.5		
Type of thermal protection (*9)		TP211		
Resolution of the built-in sensor p/rev		Built-in with αiMZ sensor 2048		
Number of detected gear teeth per rotation λ/rev.		128		
Bearing lubrication		Grease		
Shaft end seal, protection format (IEC34)		Simplified labyrinth: IP40		
Method of connection with the spindle (*10)		To be directly connected with the spindle		
Allowable thrust load (*11)kgf		6		
Maximum output during acceleration (*12) kW		13.0	20.0	13.0
Applicable spindle amplifier		αiSP 15HV	αiSP 30HV	αiSP 11HV

* See Page 317 for Cautions and limitations.

Item \ Model		αiIT 6/12000HV		αiIT 8/12000HV	
Connection (*13)		Low-speed winding (Y connection)	High-speed winding (Δ connection)	Low-speed winding (Y connection)	High-speed winding (Δ connection)
Output (*1)	(S1)Cont. rated kW (HP)	5.5 (7.4)	5.5 (7.4)	7.5 (10)	7.5 (7.5)
	(S2)30 min rated kW (HP)	7.5 (10)	7.5 (10)	11 (14.7)	11 (14.7)
	(S3)60% (*4) kW (HP)	7.5 (10)	7.5 (10)	11 (14.7)	11 (14.7)
Rated current (*5)	(S1) A	18	18	23	25
	(S2),(S3) A	22	24	29	30
Speed min^{-1}	Base speed	1,500	4,000	1,500	4,000
	Max. speed	12,000	12,000	12,000	12,000
Switching speed min^{-1}		4,000		4,000	
Cont. rated torque at const. rated torque range N·m (kgf·cm)		35.0 (357)	13.2 (134)	47.7 (487)	17.9 (182.7)
Rotor inertia	$kg \cdot m^2$ ($kgf \cdot cm \cdot s^2$)	0.0179 (0.18)		0.0275 (0.28)	
Weight kgf		51		80	
Vibration		V3 (rotation component)			
Noise		75dB(A) or less			
Cooling system (*6)		Totally enclosed and fan cooled (IC0A6)			
Cooling fan W					
Installation (*7)		Mount the motor so that the output shaft points in a direction ranging within the horizontally to vertically downwards. (IMB5,IMV1)			
Allowable overload capacity (1 min) (*8)		120% of (S2)			
Insulation		Class H			
Ambient temperature		0°C to 40°C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Type of thermal protection (*9)		TP211			
Resolution of the built-in sensor p/rev		Built-in with αiMZ sensor 4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Shaft end seal, protection format (IEC34)		Simplified labyrinth: IP40			
Method of connection with the spindle (*10)		To be directly connected with the spindle			
Allowable thrust load (*11) kgf		13			
Maximum output during acceleration (*12) kW		13.0		13.2	
Applicable spindle amplifier		αiSP 15HV		αiSP 15HV	

* See Page 317 for Cautions and limitations.

Item \ Model		αiIT 8/15000HV		αiIT 15/10000HV	
Connection (*13)		Low-speed winding (Y connection)	High-speed winding (Δ connection)	Low-speed winding (Y connection)	High-speed winding (Δ connection)
Output (*1)	(S1)Cont. rated kW (HP)	7.5 (10)	7.5 (10)	15 (20.1)	15 (20.1)
	(S2)30 min rated kW (HP)	11 (14.7)	11 (14.7)	18.5 (24.8)	18.5 (24.8)
	(S2) 10 min rated kW (HP)	15.0 (20.1)	15.0 (20.1)	-	-
	(S3)60% (*4) kW (HP)	-	-	18.5 (24.8)	18.5 (24.8)
Rated current (*5)	(S1) A	35	37	37	36
	(S2),(S3) A	55	53	45	41
Speed min^{-1}	Base speed	1,500	4,000	1,500	4,000
	Max. speed	4,000	15,000	10,000	10,000
Switching speed min^{-1}		4,000		4,000	
Cont. rated torque at const. rated torque range N·m (kgf·cm)		47.7 (487)	17.9 (182)	95.4 (974)	35.8 (365)
Rotor inertia $kg{\cdot}m^2$ ($kgf{\cdot}cm{\cdot}s^2$)		0.0275 (0.28)		0.09 (0.93)	
Weight kgf		80		110	
Vibration		V3 (rotation component)			
Noise		75dB(A) or less			
Cooling system (*6)		Totally enclosed and fan cooled (IC0A6)			
Cooling fan W					
Installation (*7)		Mount the motor so that the output shaft points in a direction ranging within the horizontally to vertically downwards. (IMB5,IMV1)			
Allowable overload capacity (1 min) (*8)		120% of (S2)			
Insulation		Class H			
Ambient temperature		0°C to 40°C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Type of thermal protection (*9)		TP211			
Resolution of the built-in sensor p/rev		Built-in with αiMZ sensor 4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Shaft end seal, protection format (IEC34)		Simplified labyrinth: IP40			
Method of connection with the spindle (*10)		To be directly connected with the spindle			
Allowable thrust load (*11) kgf		13			
Maximum output during acceleration (*12) kW		28.0		22.2	
Applicable spindle amplifier		αiSP 30HV		αiSP 30HV	

* See Page 317 for Cautions and limitations.

Item \ Model		αiIT 15/15000HV		αiIT 22/10000HV	
Connection (*13)		Low-speed winding (Y connection)	High-speed winding (Δ connection)	Low-speed winding (Y connection)	High-speed winding (Δ connection)
Output (*1)	(S1)Cont. rated kW (HP)	15 (20.1)	15 (20.1)	22 (29.5)	22 (29.5)
	(S2)30 min rated kW (HP)	18.5 (24.8)	18.5 (24.8)	26 (34.9)	26 (34.9)
	(S2) 15 min rated kW (HP)	22 (29.5)	22 (29.5)	-	-
	(S3)40% kW (*3)(*4) (HP)	-	-	26 (34.9)	26 (34.9)
Rated current (*5)	(S1) A	48	41	46	47
	(S2),(S3) A	67	56	54	53
Speed min^{-1}	Base speed	1,400	5,000	1,500	4,000
	Max. speed	4,000	15,000	10,000	10,000
Switching speed min^{-1}		3,500		4,000	
Cont. rated torque at const. rated torque range N·m (kgf·cm)		102.2 (1043.3)	28.6 (292.1)	140 (1428)	52.5 (536)
Rotor inertia	$kg{\cdot}m^2$ ($kgf{\cdot}cm{\cdot}s^2$)	0.055 (0.56)		0.128 (1.29)	
Weight kgf		121		143	
Vibration		V3 (rotation component)			
Noise		75dB(A) or less			
Cooling system (*6)		Totally enclosed and fan cooled (IC0A6)			
Cooling fan W					
Installation (*7)		Mount the motor so that the output shaft points in a direction ranging within the horizontally to vertically downwards. (IMB5,IMV1)			
Allowable overload capacity (1 min) (*8)		120% of (S2)			
Insulation		Class H			
Ambient temperature		0°C to 40°C			
Altitude		Height above sea level not exceeding 1000m			
Painting color		Munsell system N2.5			
Type of thermal protection (*9)		TP211			
Resolution of the built-in sensor p/rev		Built-in with αiMZ sensor 4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Shaft end seal, protection format (IEC34)		Simplified labyrinth: IP40			
Method of connection with the spindle (*10)		To be directly connected with the spindle			
Allowable thrust load (*11) kgf		13			
Maximum output during acceleration (*12) kW		38		31.2	
Applicable spindle amplifier		αiSP 30HV		αiSP 30HV	

* See Page 317 for Cautions and limitations.

Cautions and limitations

(*1) The rated output is guaranteed at the rated voltage.
(Amplifier input: 400/480VAC +10%, -15%, 50/60Hz±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 αiIT 1.5/20000HV and αiIT 2/20000HV is 15 min rated.

(*3) 40% for αiIT 1.5/20000HV, αiIT 2/20000HV, and αiIT 22/10000HV

(*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 the maximum current for each rated output.

(*6) IC code conforms to IEC 34-6.

(*7) IM code conforms to IEC 34-7.

(*8) This is not a guaranteed value but a guideline for the maximum motor output at a rated supply voltage.

(*9) Type conforms to IEC 34-11.

(*10) When assembling a motor with the machine, align the motor shaft with the spindle so that the vibration acceleration of the motor does not exceed 0.5 G (at maximum speed).
(Before shipping machines, check that the vibration acceleration is 0.5 G or less for all motors.)

(*11) Select a coupling that does not apply a thrust load onto the motor shaft for a cause such as coolant pressure when the temperature rises.
<u>Note that in the direction in which the motor shaft is pushed toward the inside of the motor, the allowable load is 0 kgf.</u>
(If an Oldham coupling is used, the motor shaft can be left pushed into the inside of the motor when the motor shaft is inserted into the spindle. So, measure the distance between the mounting face for a rotation joint support housing and the flinger rear end face before and after insertion, and check that the two measured values are identical.
For details, see Section V-9.4 "COUPLING SELECTION".)

(*12) These values are to be used only as guidance for selecting a power supply (αiPS) and are not guaranteed.

(*13) Switching method of power lead is Y-Δ switching.
Required are the CNC software option related to the output switching function and the switching magnetic connection unit.
Refer to FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN) for output switching control.

(*14) The protection grade (IEC34-5) is IP40. However, the grade is IP54 when the labyrinth seal on the front side of the output axis and the flinger seal on the rear side are excluded.
Ensure that the labyrinth seal and flinger seal are not directly exposed to coolant and mist.

(*15) The input power requirements of the fan motor for αiIT 1.5/20000HV, αiIT 2/20000HV, or αiIT 3/12000HV are: 200/230VAC +10% -15%, single-phase, and 50/60 Hz±1Hz.

3 OUTPUT/TORQUE CHARACTERISTICS

Reference
Calculation for torque

Torque T can be obtained by the following equation.

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

P[kW]: Motor output

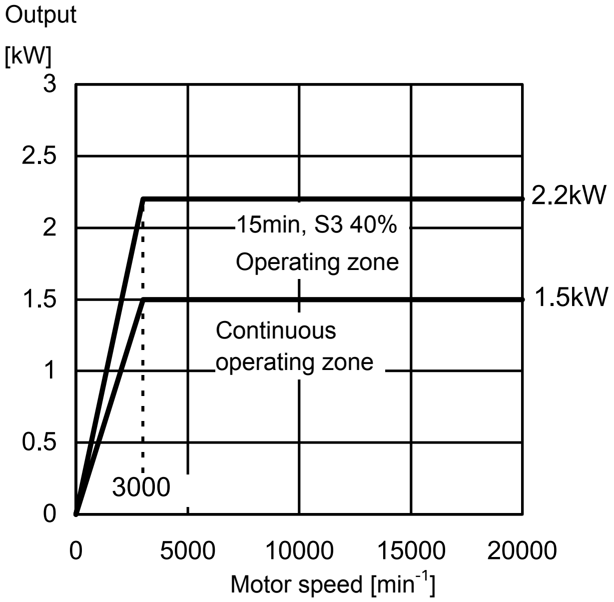
$N[min^{-1}]$: Motor speed

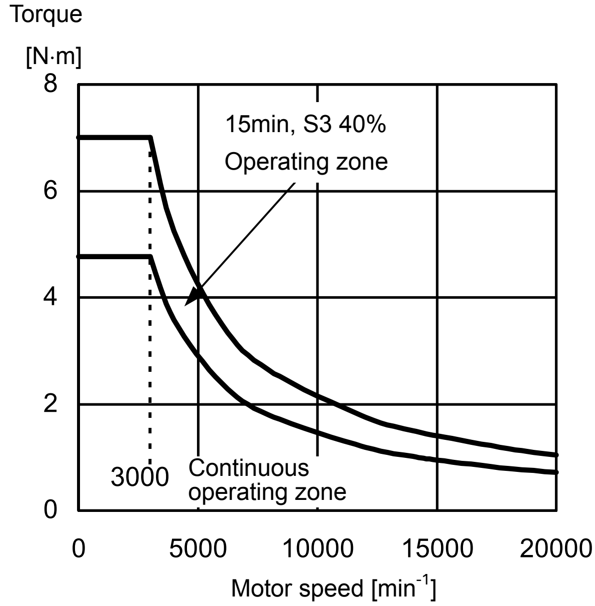
When the unit of T is [kgf·m],

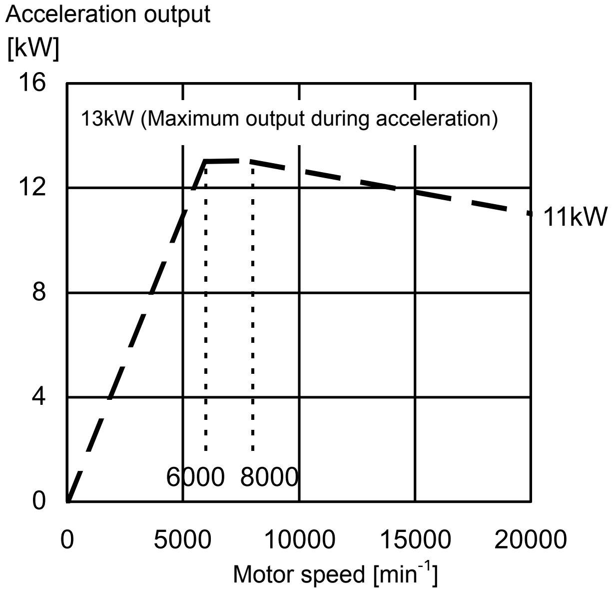
$T[kgf \cdot m] = P[kW] \times 1000 / 1.0269 / N[min^{-1}]$

3.1 MODEL αiIT 1.5/20000HV

Applicable amplifier αiSP 15HV





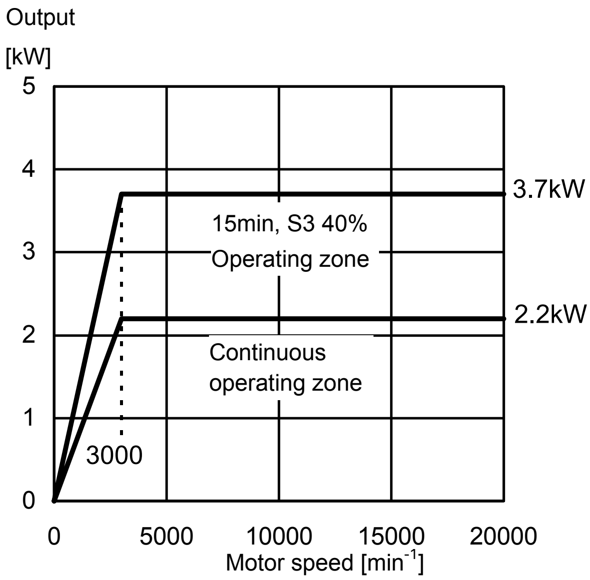


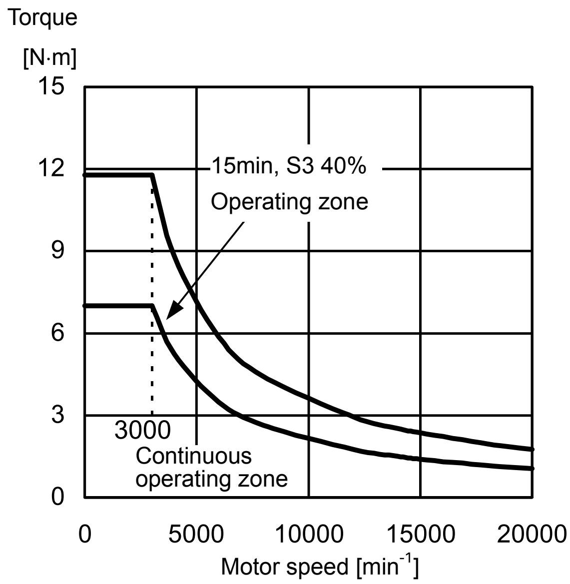
NOTE

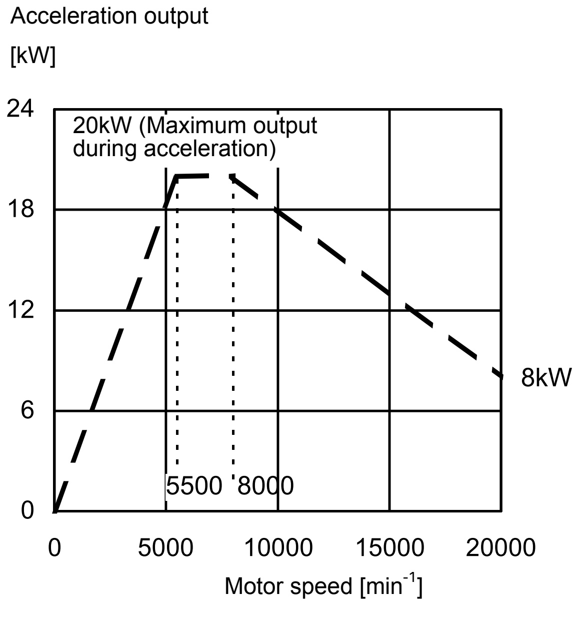
Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

3.2 MODEL αiIT 2/20000HV

Applicable amplifier αiSP 30HV





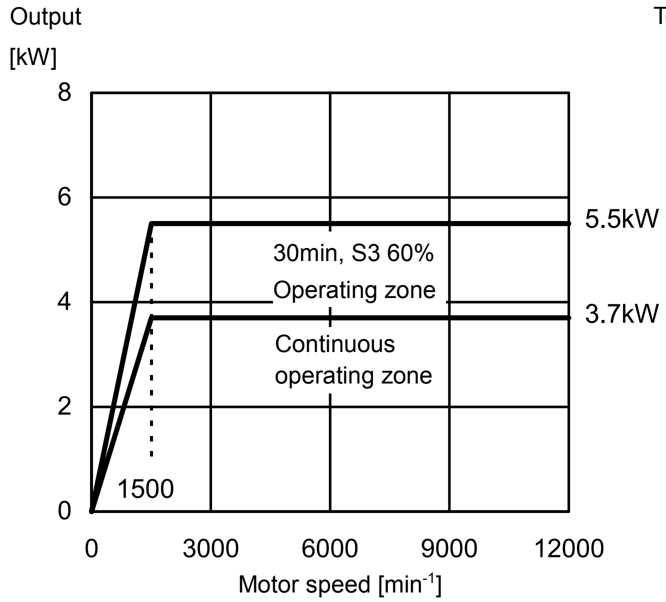


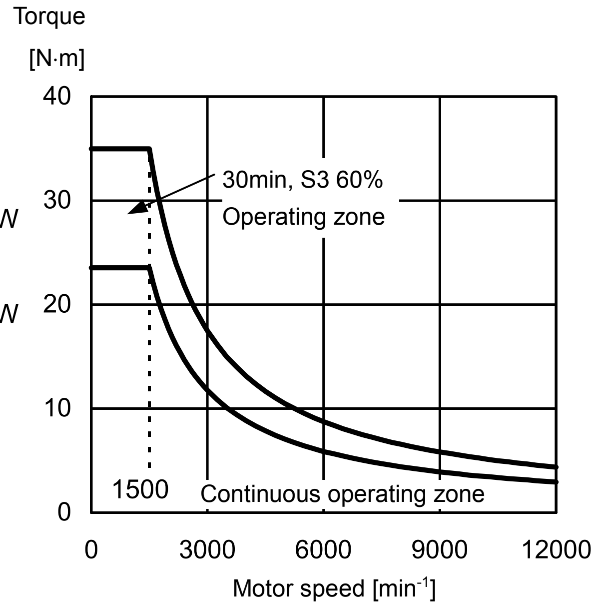
NOTE

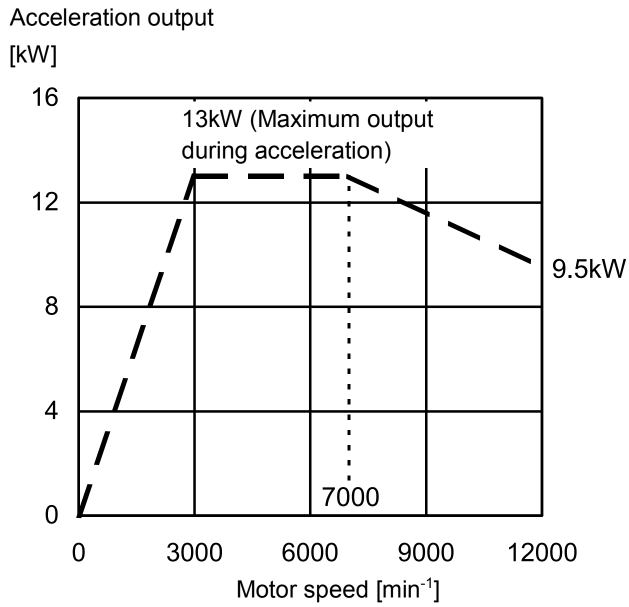
Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

3.3 MODEL αiIT 3/12000HV

Applicable amplifier αiSP 11HV





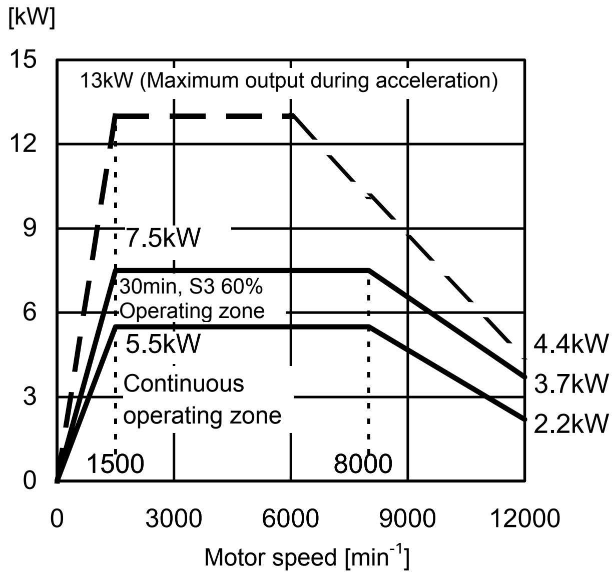


NOTE
Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

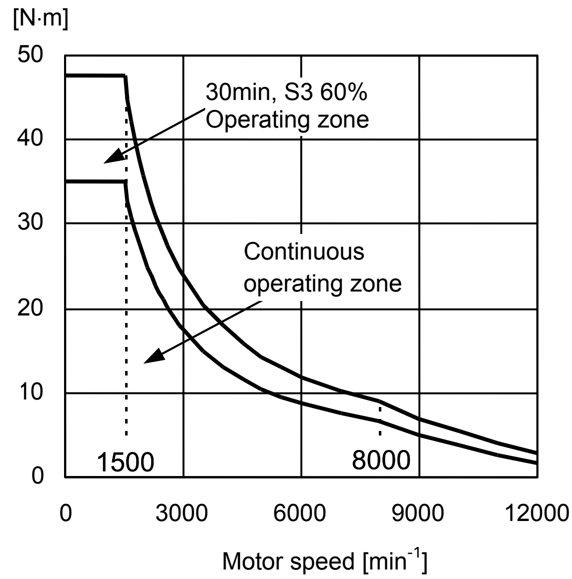
3.4 MODEL αiIT 6/12000HV

Applicable amplifier αiSP 15HV

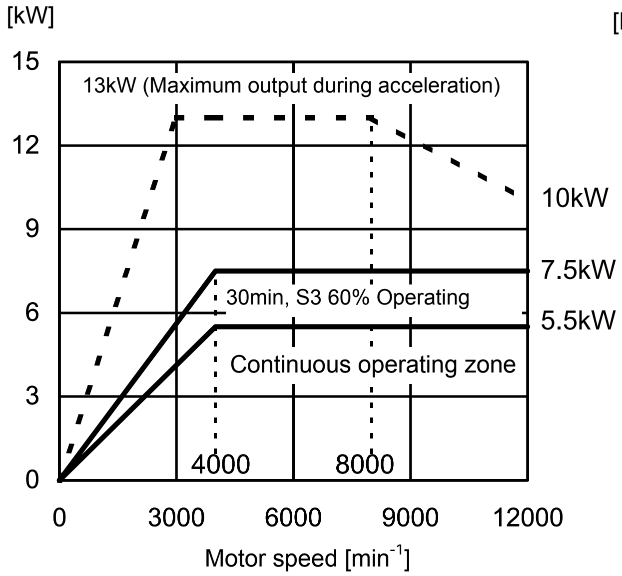
Low-speed winding output (Y connection)



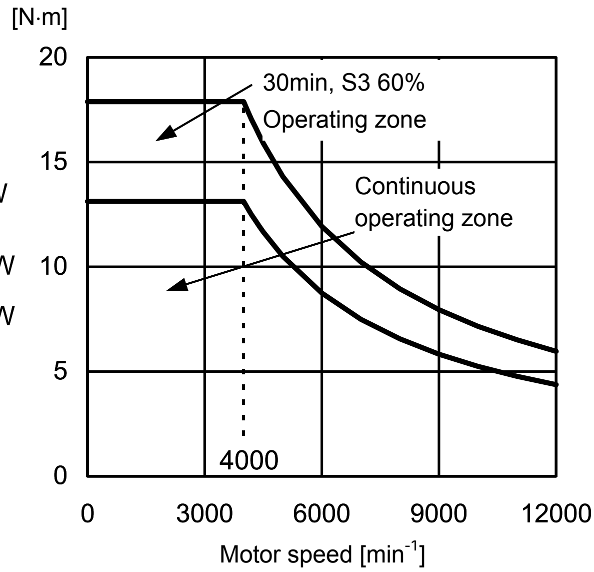
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



High-speed winding torque (Δ connection)



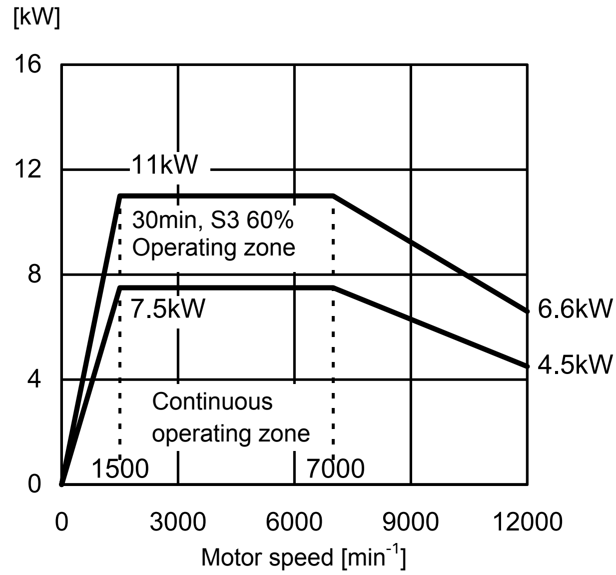
NOTE

Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

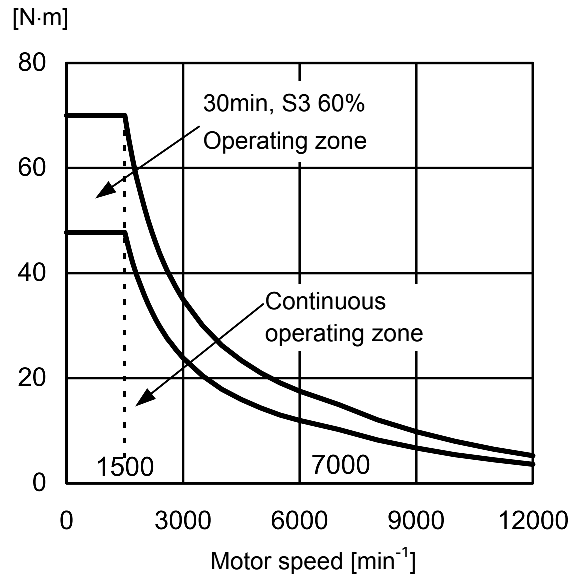
3.5 MODEL αiIT 8/12000HV

Applicable amplifier αiSP 15HV

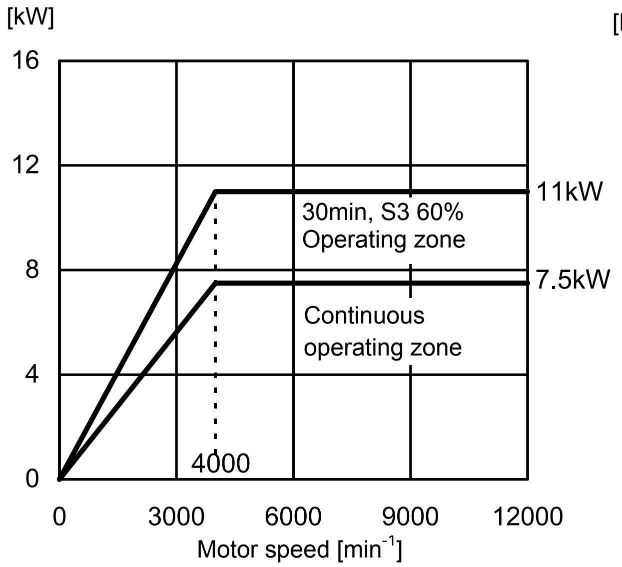
Low-speed winding output (Y connection)



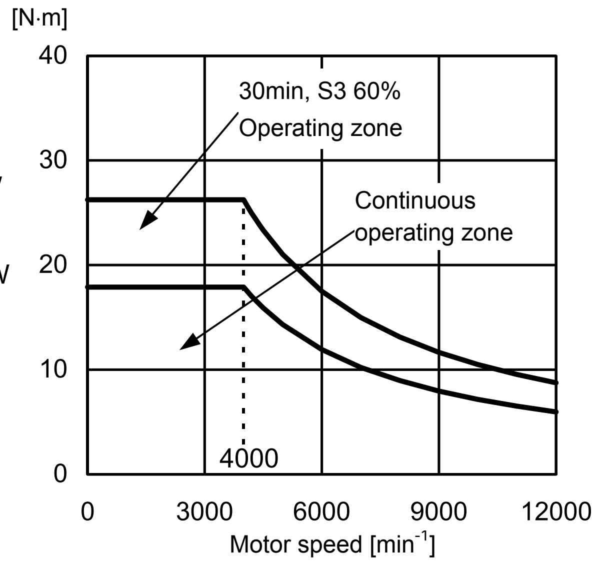
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

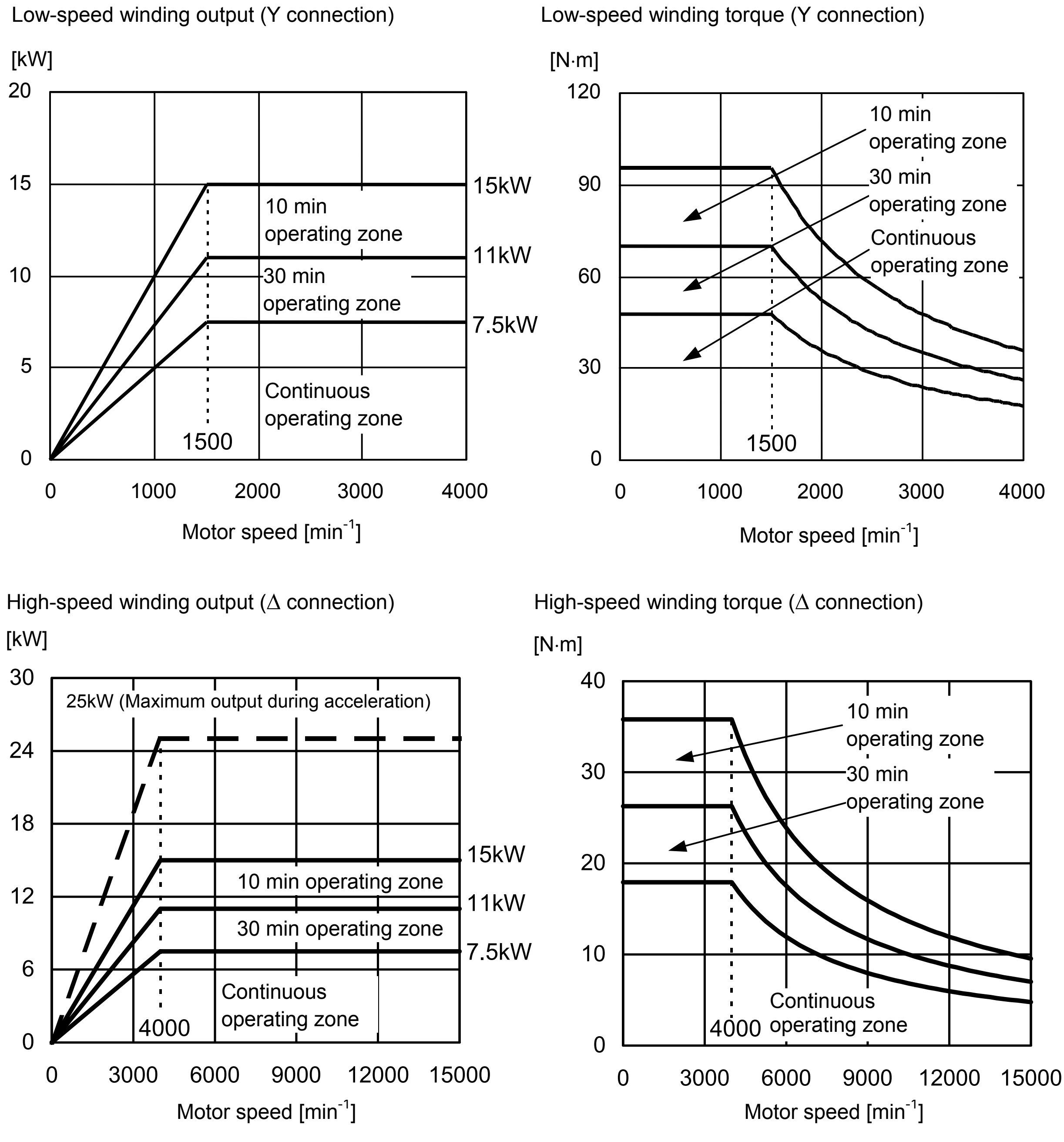


High-speed winding torque (Δ connection)



3.6 MODEL αiIT 8/15000HV

Applicable amplifier αiSP 30HV



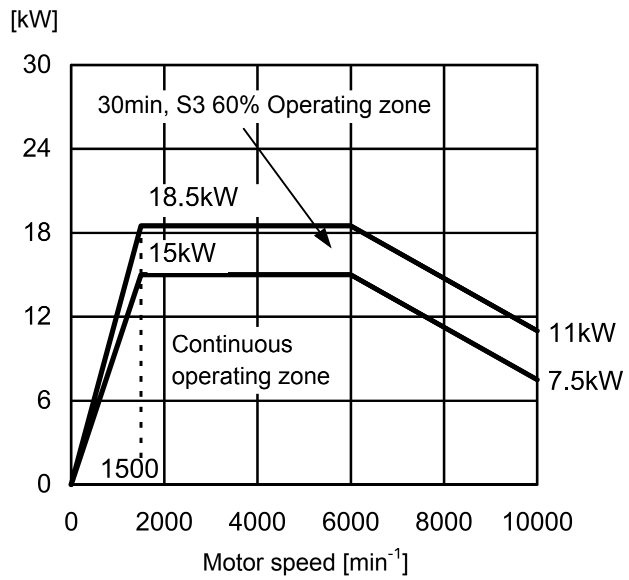
NOTE

Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

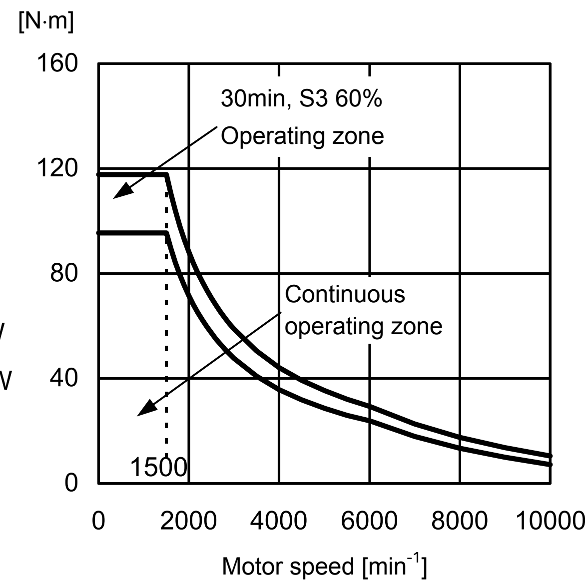
3.7 MODEL αiIT 15/10000HV

Applicable amplifier αiSP 30HV

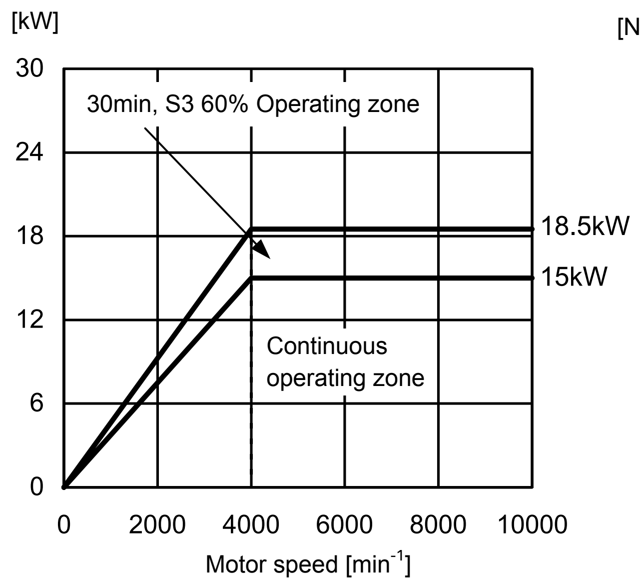
Low-speed winding output (Y connection)



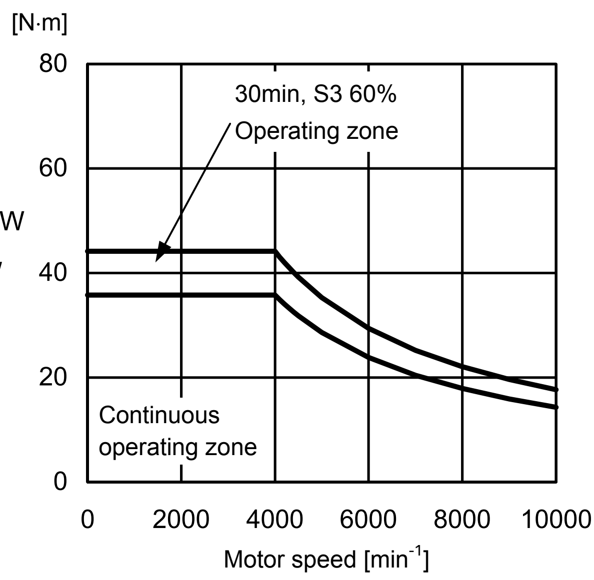
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

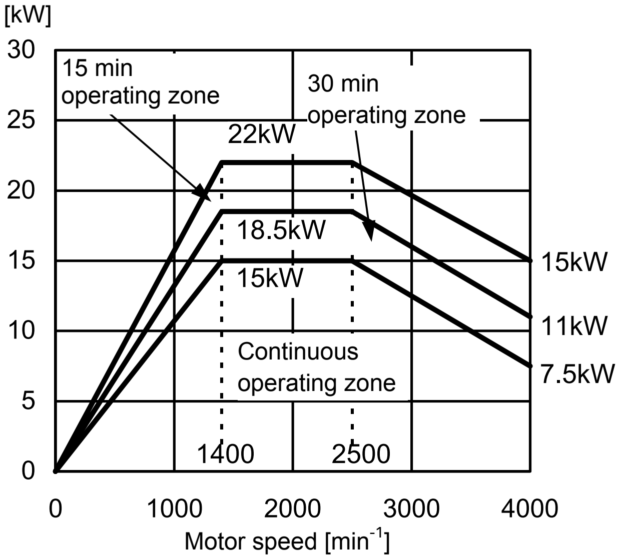


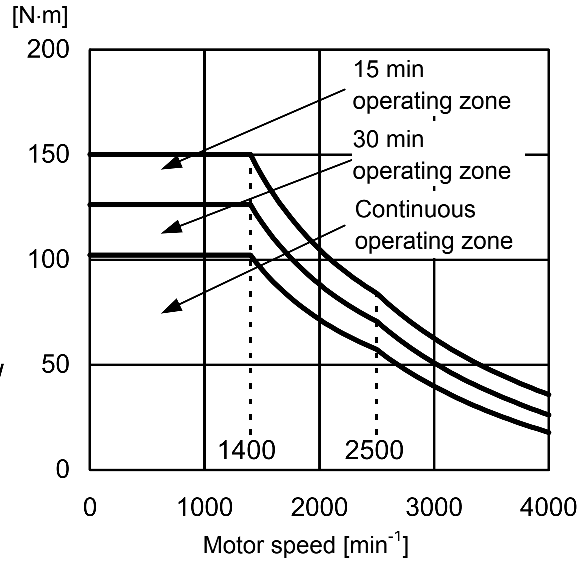
High-speed winding torque (Δ connection)

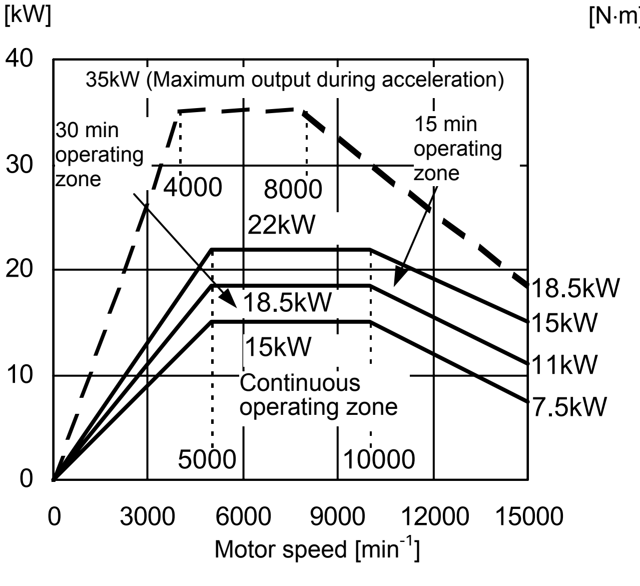


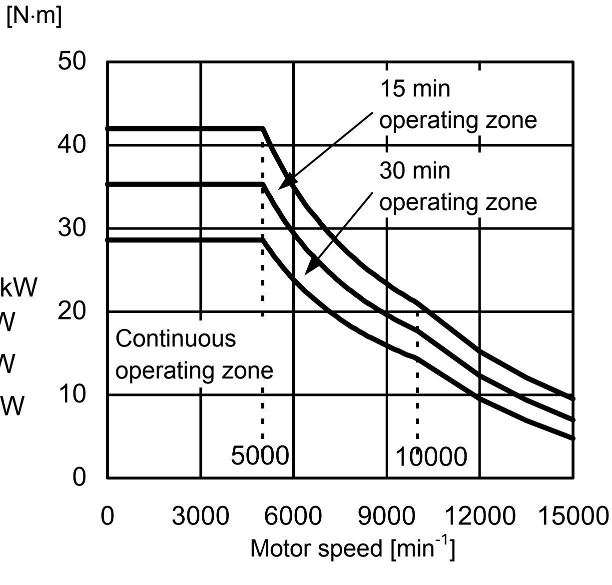
3.8 MODEL αiIT 15/15000HV

Applicable amplifier αiSP 30HV







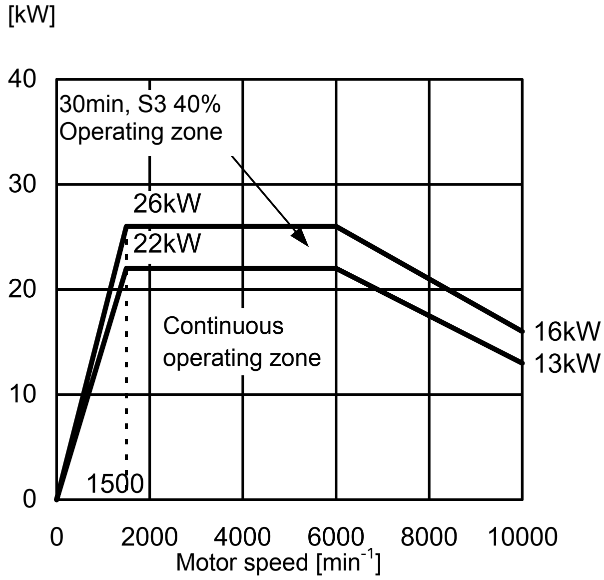


> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

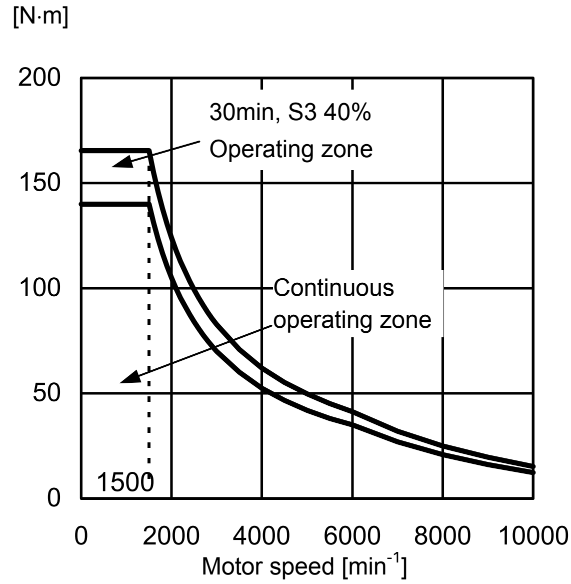
3.9 MODEL αiIT 22/10000HV

Applicable amplifier αiSP 30HV

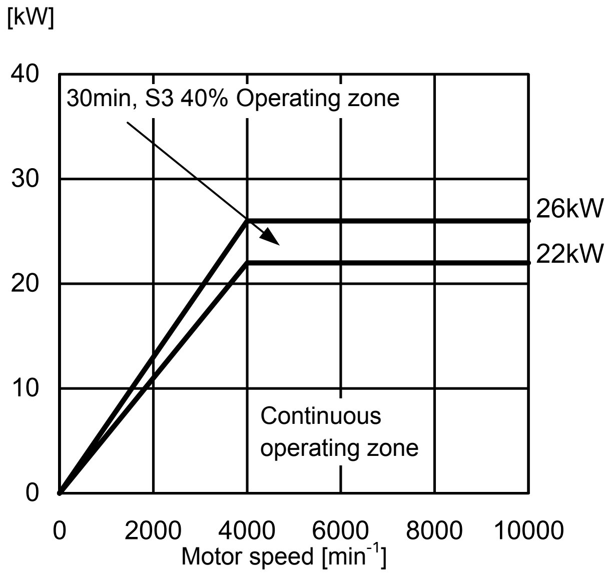
Low-speed winding output (Y connection)



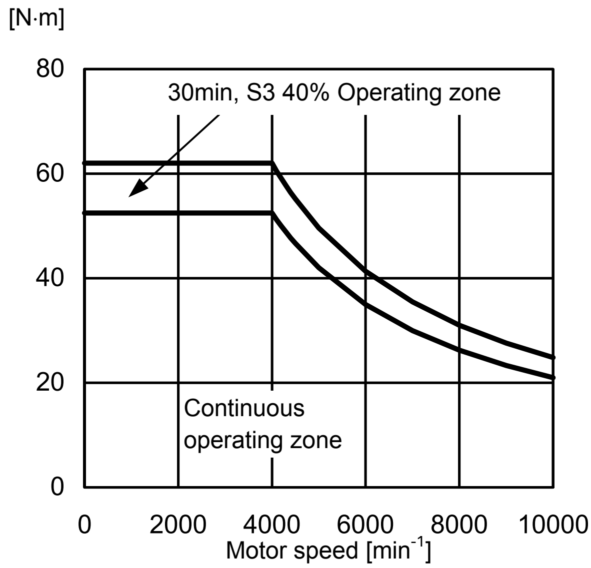
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



High-speed winding torque (Δ connection)



NOTE

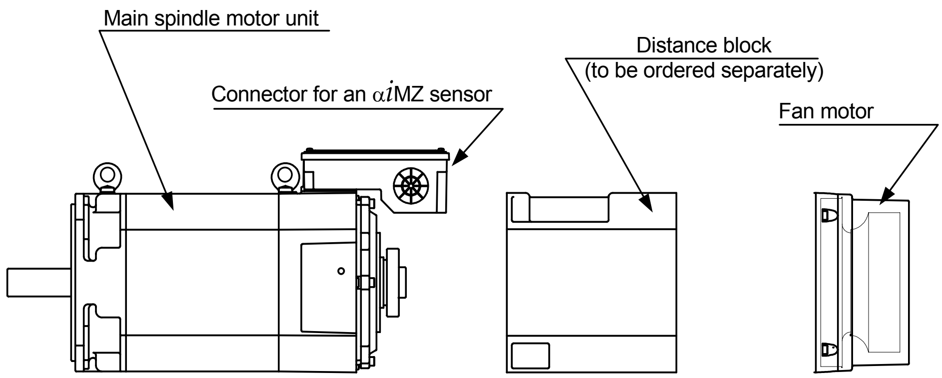
Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

4 CONFIGURATION AND ORDERING NUMBER

4.1 CONFIGURATION

The αiIT series motor 400V type consists of the following items:

(1) Main spindle motor unit
(2) Fan motor (Exhaust on the side opposite to the load axis. Packed separately.)
(3) Connector (housing, contact) for an αiMZ sensor
The connector is contained in the terminal block.
(4) Distance block (Separately packed. To be ordered separately in addition to the main motor unit.)



4.2 ORDERING NUMBER

Motor (including a cooling fan)

Model	Ordering number	SPM	Remarks
αiIT 1.5/20000HV	A06B-1563-B123#0121	αiSP 15HV	- Flange mounting type - Hollow shaft (with no key) - Labyrinth - Built-in with αiMZ sensor
αiIT 2/20000HV	A06B-1564-B123#0121	αiSP 30HV	
αiIT 3/12000HV	A06B-1565-B123#0021	αiSP 11HV	
αiIT 6/12000HV	A06B-1566-B123#0021	αiSP 15HV	
αiIT 8/12000HV	A06B-1567-B123#0021	αiSP 15HV	
αiIT 8/15000HV	A06B-1577-B133#0121	αiSP 30HV	
αiIT 15/10000HV	A06B-1569-B123#0021	αiSP 30HV	
αiIT 15/15000HV	A06B-1579-B133#0221	αiSP 30HV	
αiIT 22/10000HV	A06B-1571-B123#0021	αiSP 30HV	

Distance block

* Please prepare Distance-block by the machine tool builder.
The distance blocks indicated in the table below are available from FANUC as separate items.

- Distance block

Name	Ordering number	Remarks
Type αiIT 1.5	A06B-1463-K560	For αiIT 1.5HV
Type αiIT 2	A06B-1464-K560	For αiIT 2HV and αiIT 3HV
Type αiIT 6	A06B-1466-K560	For αiIT 6HV and αiIT 8HV
Type αiIT 15	A06B-1469-K560	For αiIT 15HV and αiIT 22HV

- Distance block with windows

Name	Ordering number	Remarks
Type αiIT 2	A06B-1464-K580	For αiIT 2HV and αiIT 3HV
Type αiIT 6	A06B-1466-K580	For αiIT 6HV and αiIT 8HV
Type αiIT 15	A06B-1469-K580	For αiIT 15HV and αiIT 22HV

5 CONNECTIONS

5.1 CONNECTION OF THE POWER, FAN MOTOR, AND αiMZ SENSOR SIGNAL LEADS

Cables for power lead and fan motor are connected to the terminal block.

αiMZ sensor signal or thermostat signal use a connector manufactured by Tyco Electronics AMP.

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

Size of screws used in the terminal block / Model	Power lead		Cooling fan	
	U,V,W,G	X,Y,Z	FMU,FMV,FMW	FMU,FMV
αiIT 1.5/20000HV	M5	-	M4	M4
αiIT 2/20000HV	M5	-	-	Screw-less terminal block
αiIT 3/12000HV	M5	-	-	Screw-less terminal block
αiIT 6/12000HV	M5	M5	Screw-less terminal block	-
αiIT 8/12000HV	M5	M5	Screw-less terminal block	-
αiIT 8/15000HV	M5	M5	Screw-less terminal block	-
αiIT 15/10000HV	M5	M5	Screw-less terminal block	-
αiIT 15/15000HV	M5	M5	Screw-less terminal block	-
αiIT 22/10000HV	M5	M5	Screw-less terminal block	-

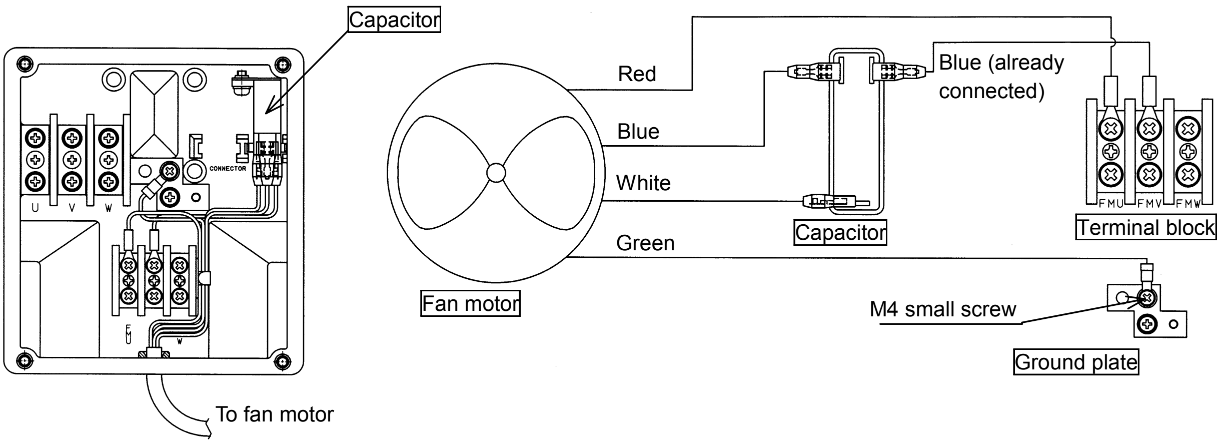
Cable for the fan motor

For the fan motor current value and cable specifications, refer to Section I.4.3, “FAN MOTOR CONNECTION” in this manual.

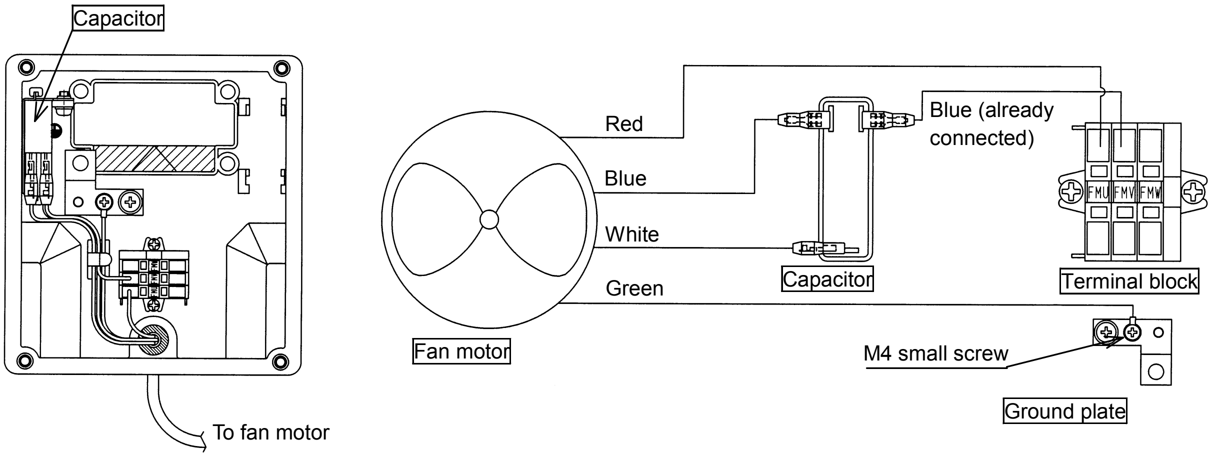
5.2 CONNECTION OF A SINGLE-PHASE FAN MOTOR

The input power requirements of the fan motor for αiIT 1.5/20000HV, αiIT 2/20000HV, or αiIT 3/12000HV are: 200/230VAC +10% -15%, single-phase, and 50/60 Hz±1Hz.

For αiIT 1.5/20000HV

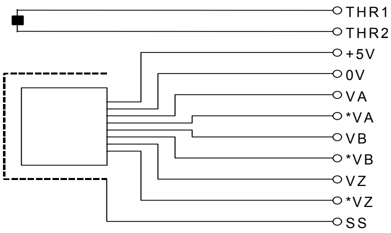


For αiIT 2/20000HV and αiIT 3/12000HV



5.3 CONNECTION OF SIGNAL LEAD

αiMZ sensor signal or overheat signal use a connector manufactured by Tyco Electronics AMP .
The connector housing and the connector are attached to the motor.



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		*VA	*VB	*VZ	0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	VA	VB	VZ	SS	THR1

Connector housing and contact specifications

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

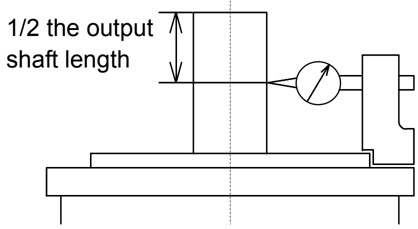
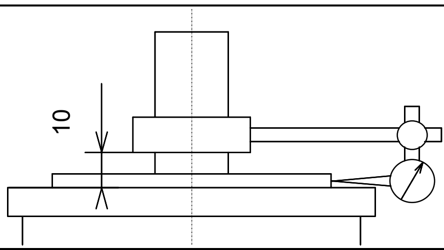
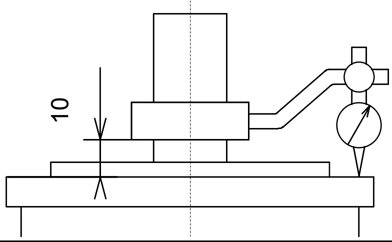
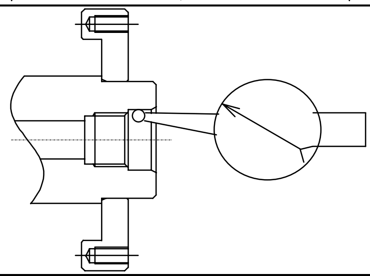
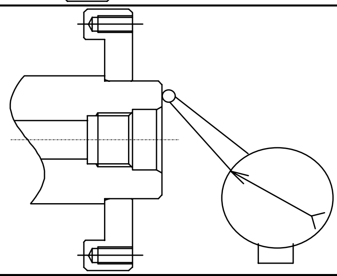
	Motor side		Cable side	
	FANUC specification	**Manufacture specification**	**FANUC specification**	**Manufacture specification**
Housing	A63L-0001-0535/121KDF	178964-6	A63L-0001-0460/121KD	178289-6
Contact	A63L-0001-0456/ASMT	175288-2	A63L-0001-0456/ASM	1-175217-2

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 kΩ as measured at room temperature (20°C to 30°C).

6 ASSEMBLING ACCURACY

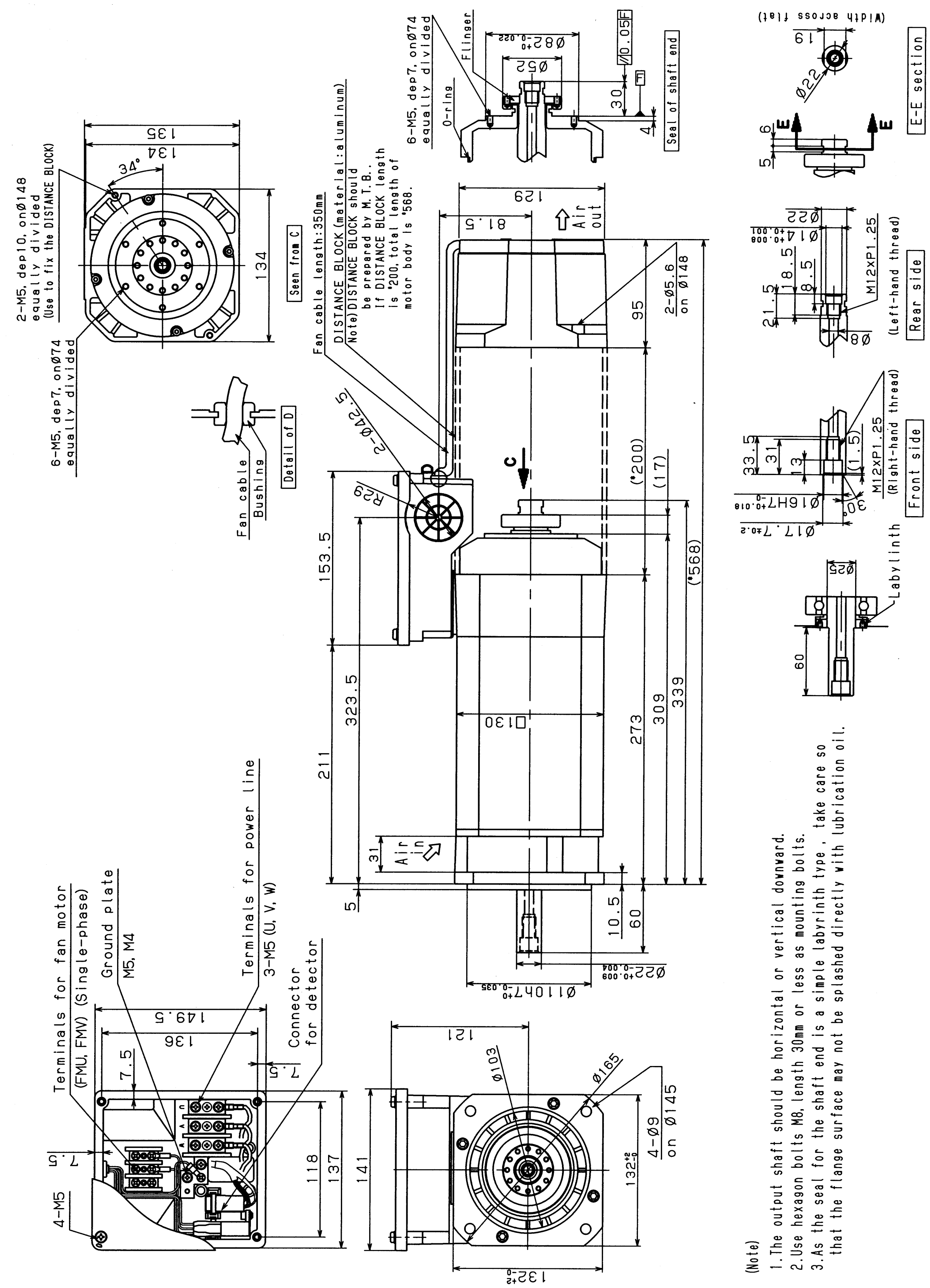
Item	Accuracy	Measuring method
Run-out at the end of the output shaft	10µm or less	
Run-out of the faucet joint for mounting the flange against the core of the shaft	30µm or less	
Run-out of the flange mounting surface against the core of the shaft	40µm or less	
Front shaft end through hole inlet Rear shaft end through hole inlet Run-out of socket and spigot joint	20µm or less	
Run-out of front shaft end face Run-out of rear shaft end face	10µm or less	

7 EXTERNAL DIMENSIONS

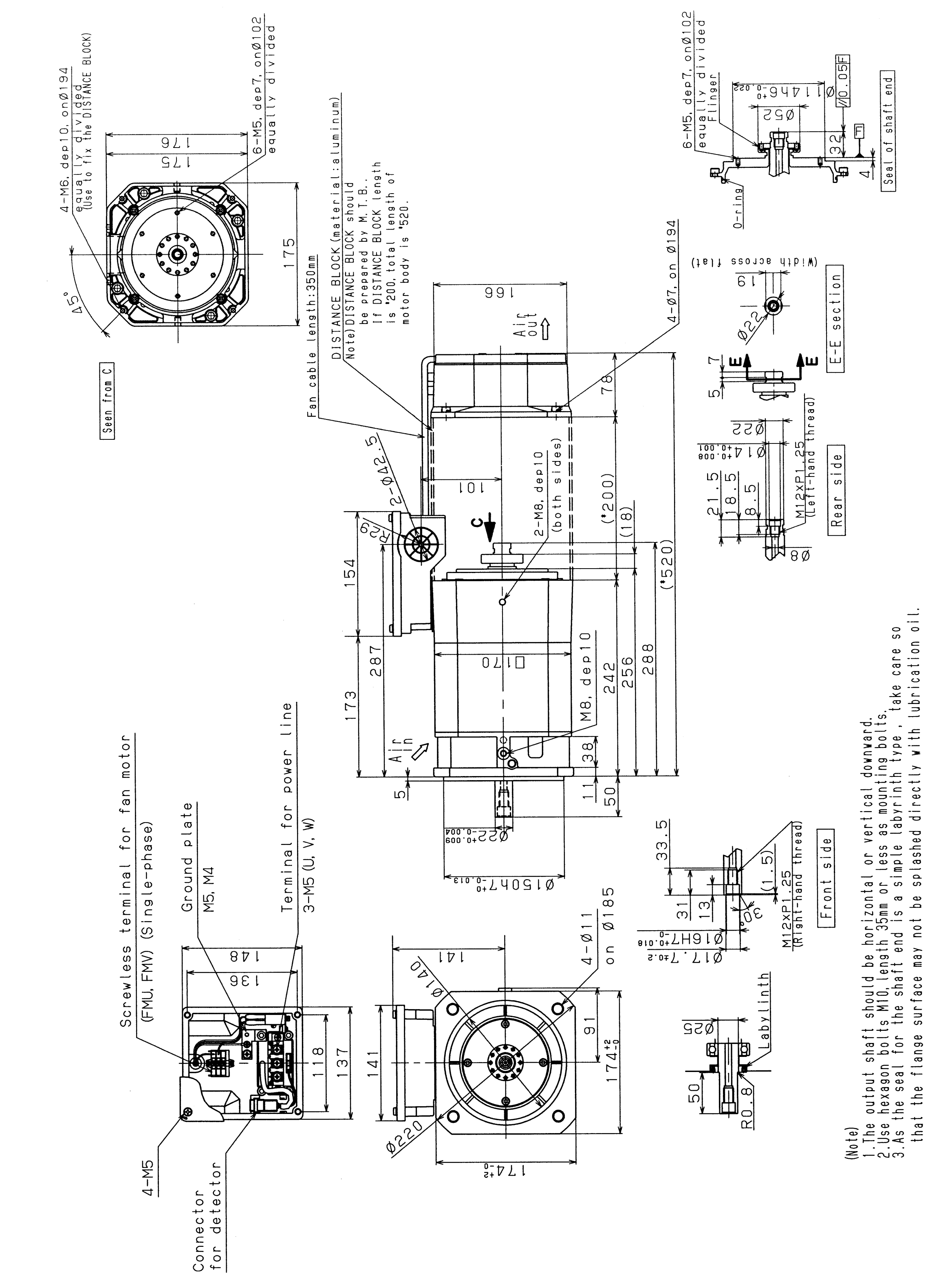
Model name	Section
Model αiIT 1.5/20000HV	7.1
Model αiIT 2/20000HV	7.2
Model αiIT 3/12000HV	7.3
Model αiIT 6/12000HV	7.4
Models αiIT 8/12000HV and αiIT 8/15000HV	7.5
Model αiIT 15/10000HV	7.6
Model αiIT 15/15000HV	7.7
Model αiIT 22/10000HV	7.8

* For a distance block, see the αiIT series 200V type section.

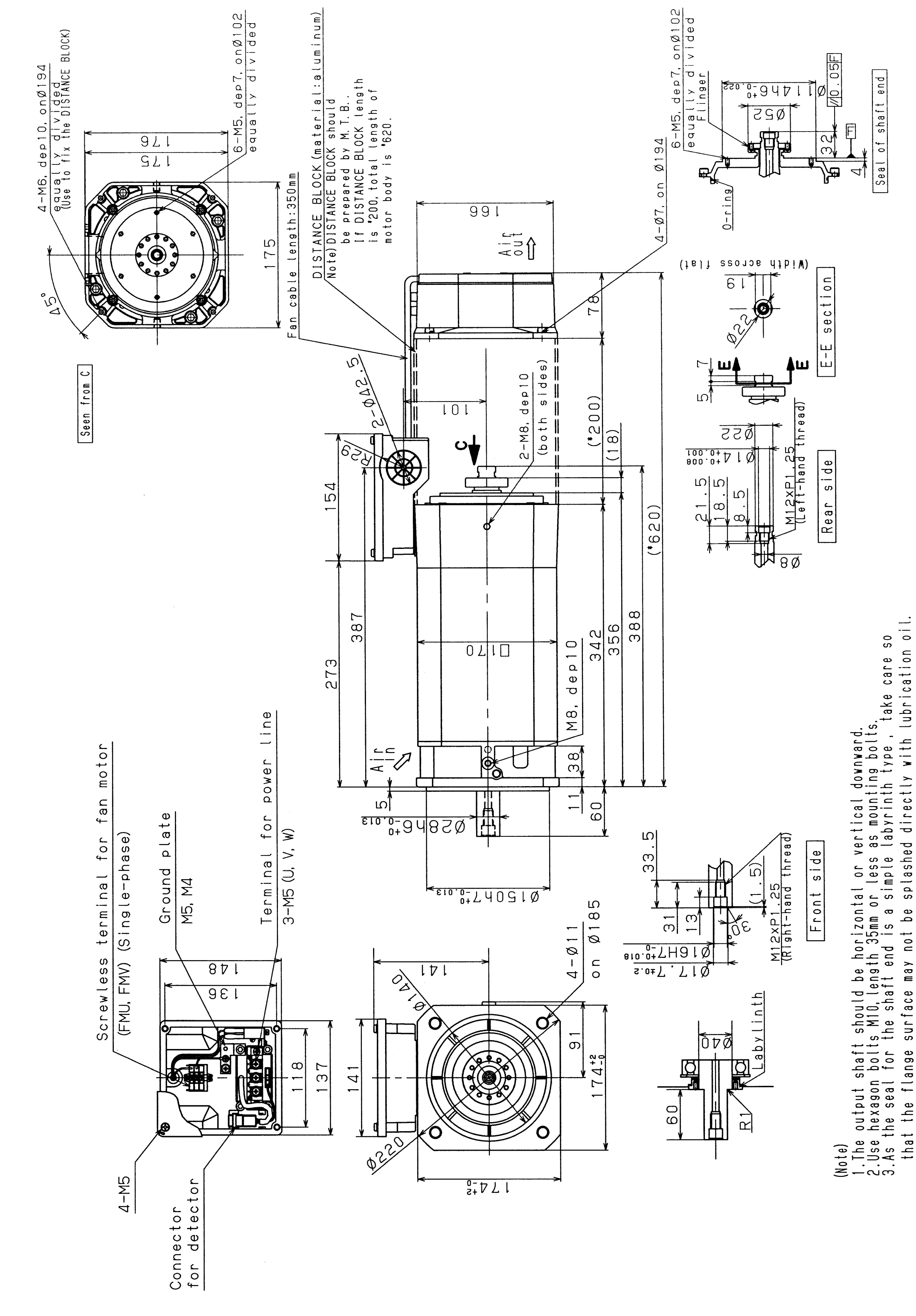
7.1 MODEL αiIT 1.5/20000HV



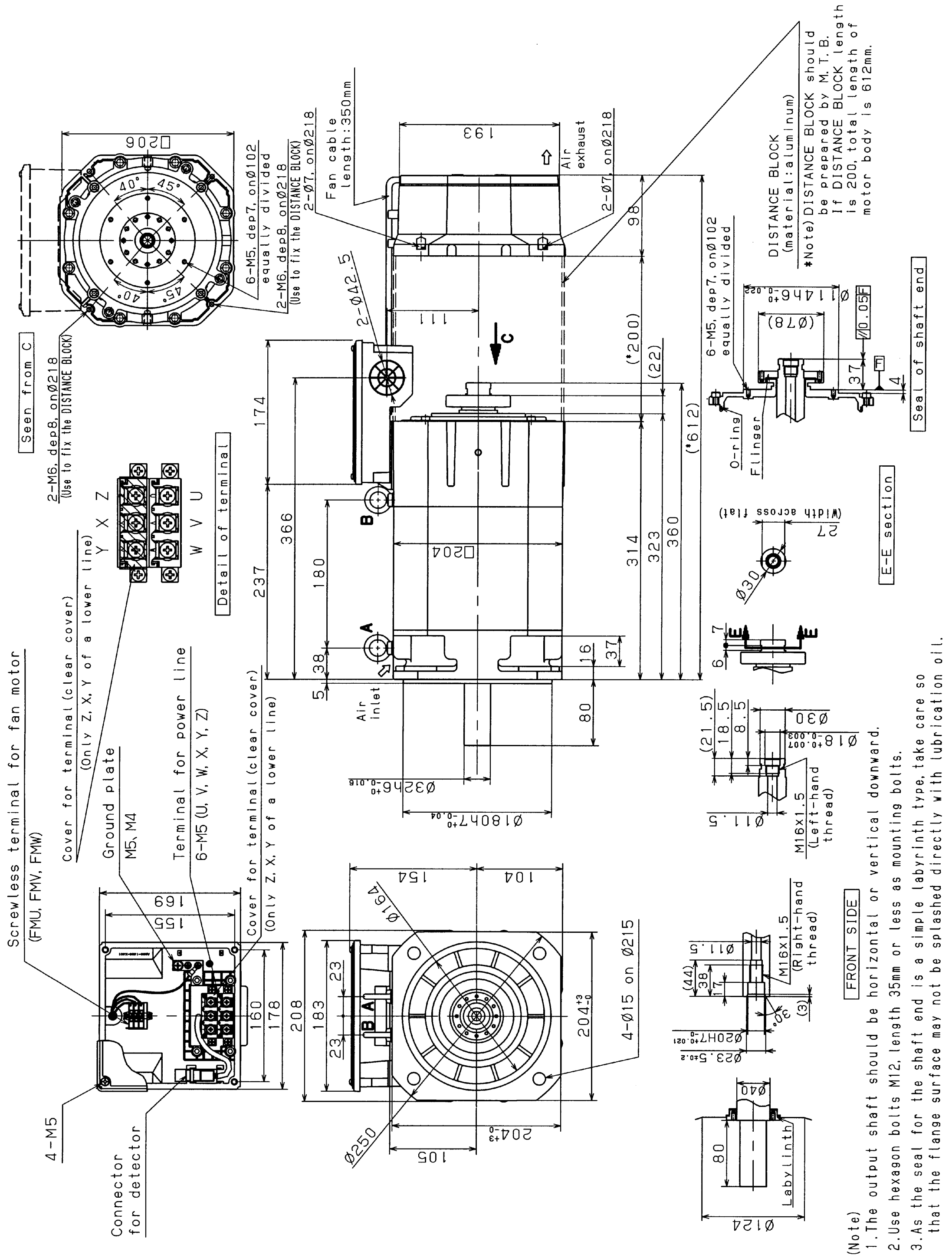
7.2 MODEL αiIT 2/20000HV



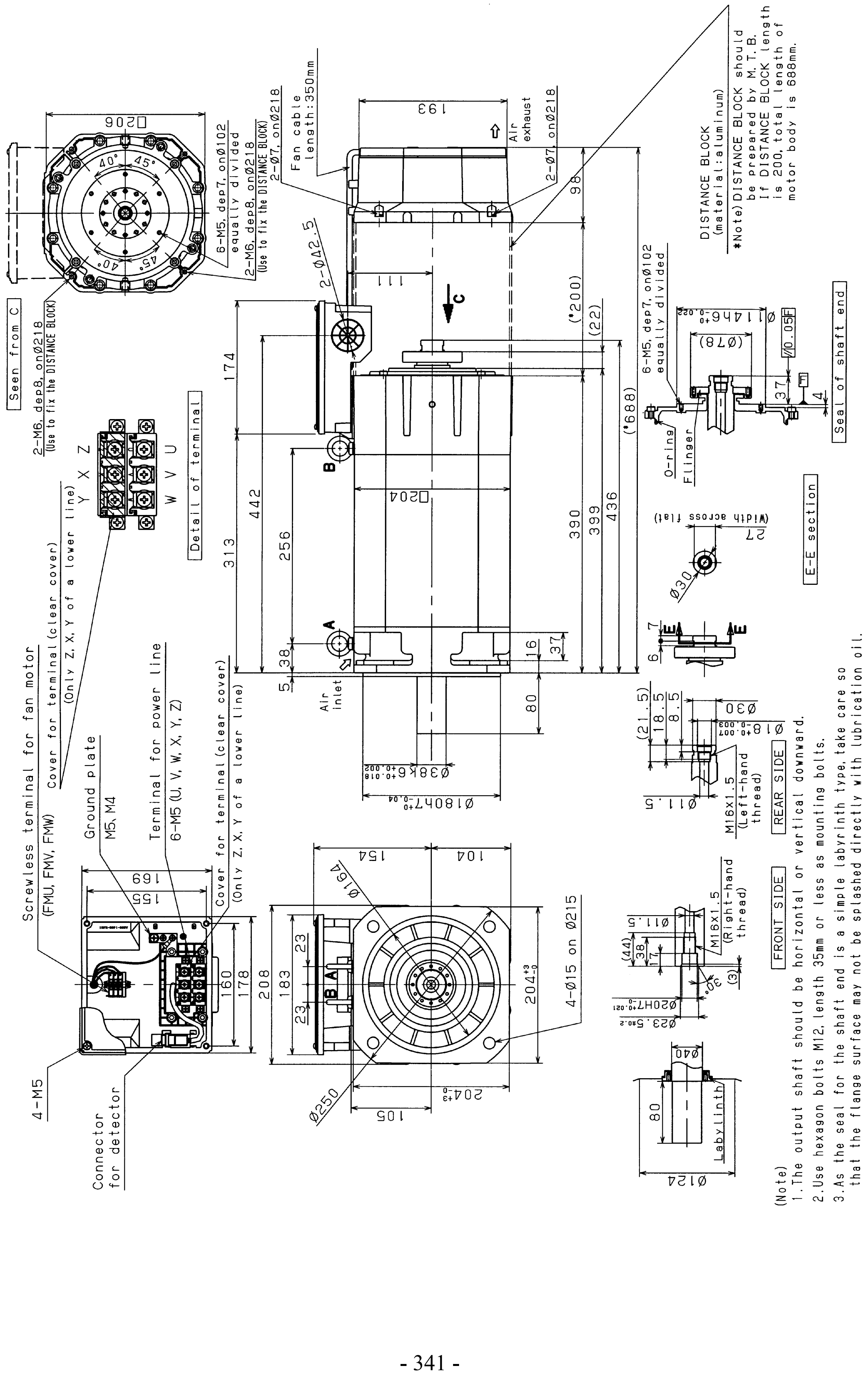
7.3 MODEL αiIT 3/12000HV



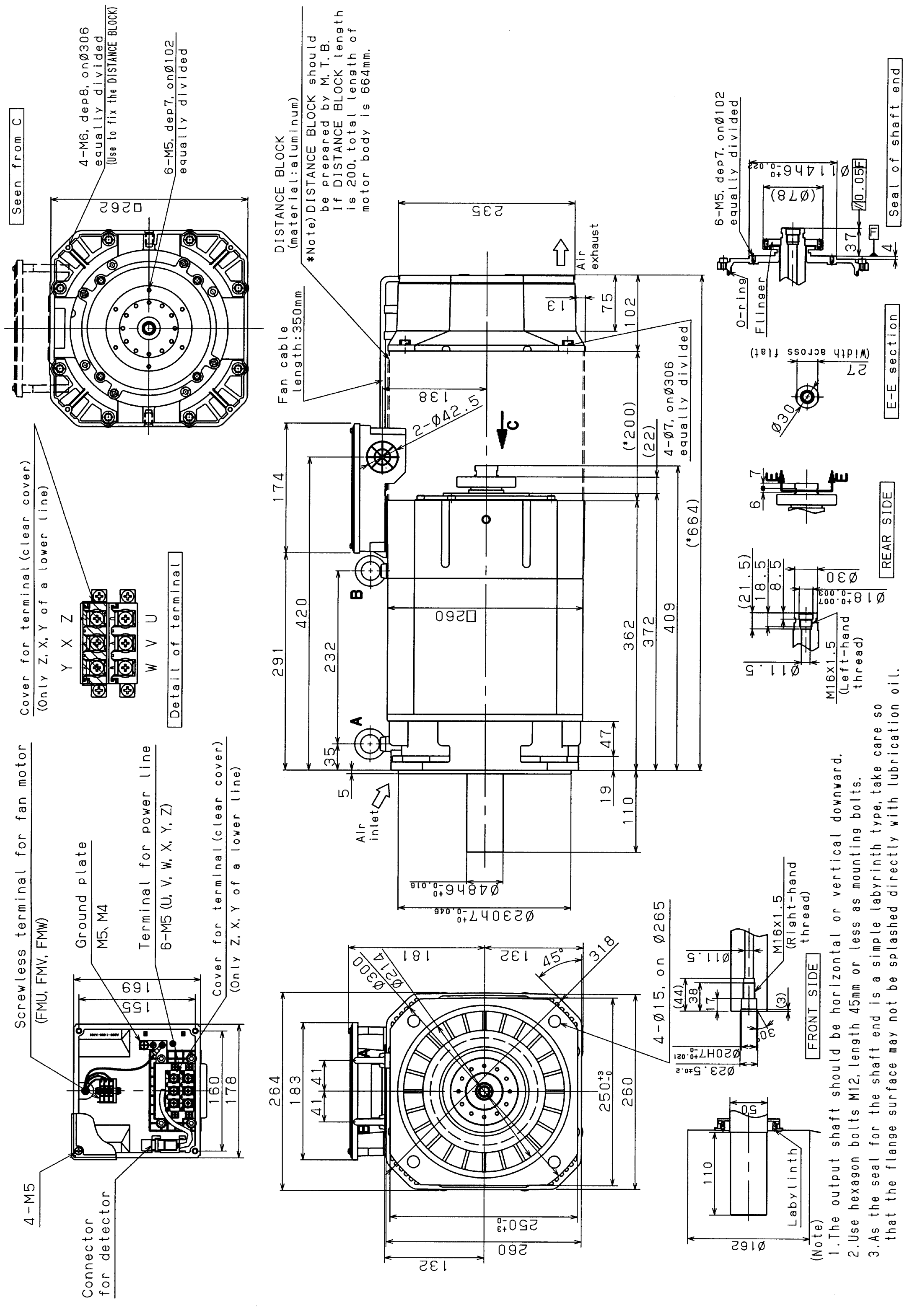
7.4 MODEL αiIT 6/12000HV



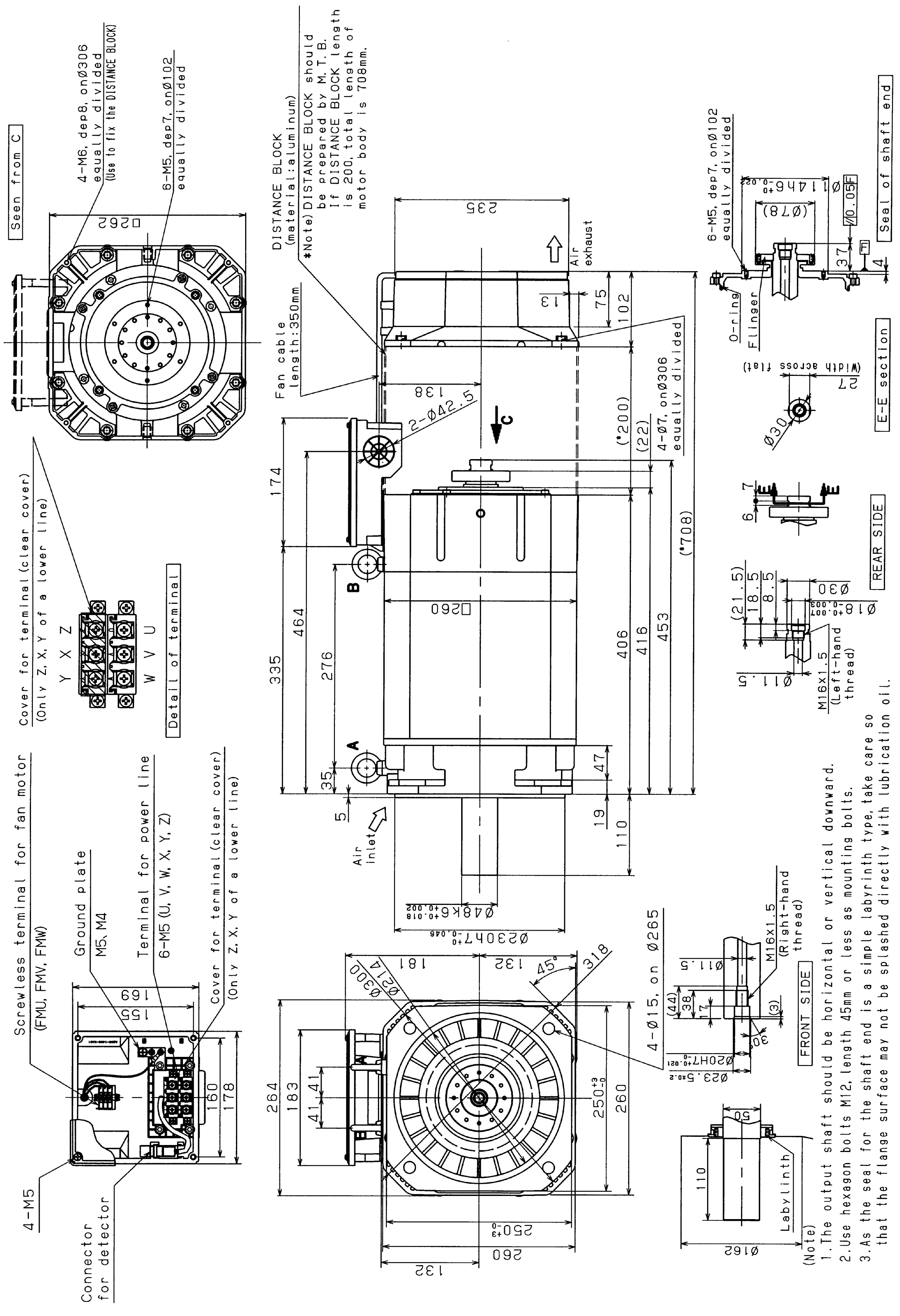
7.5 MODELS αiIT 8/12000HV AND αiIT 8/15000HV



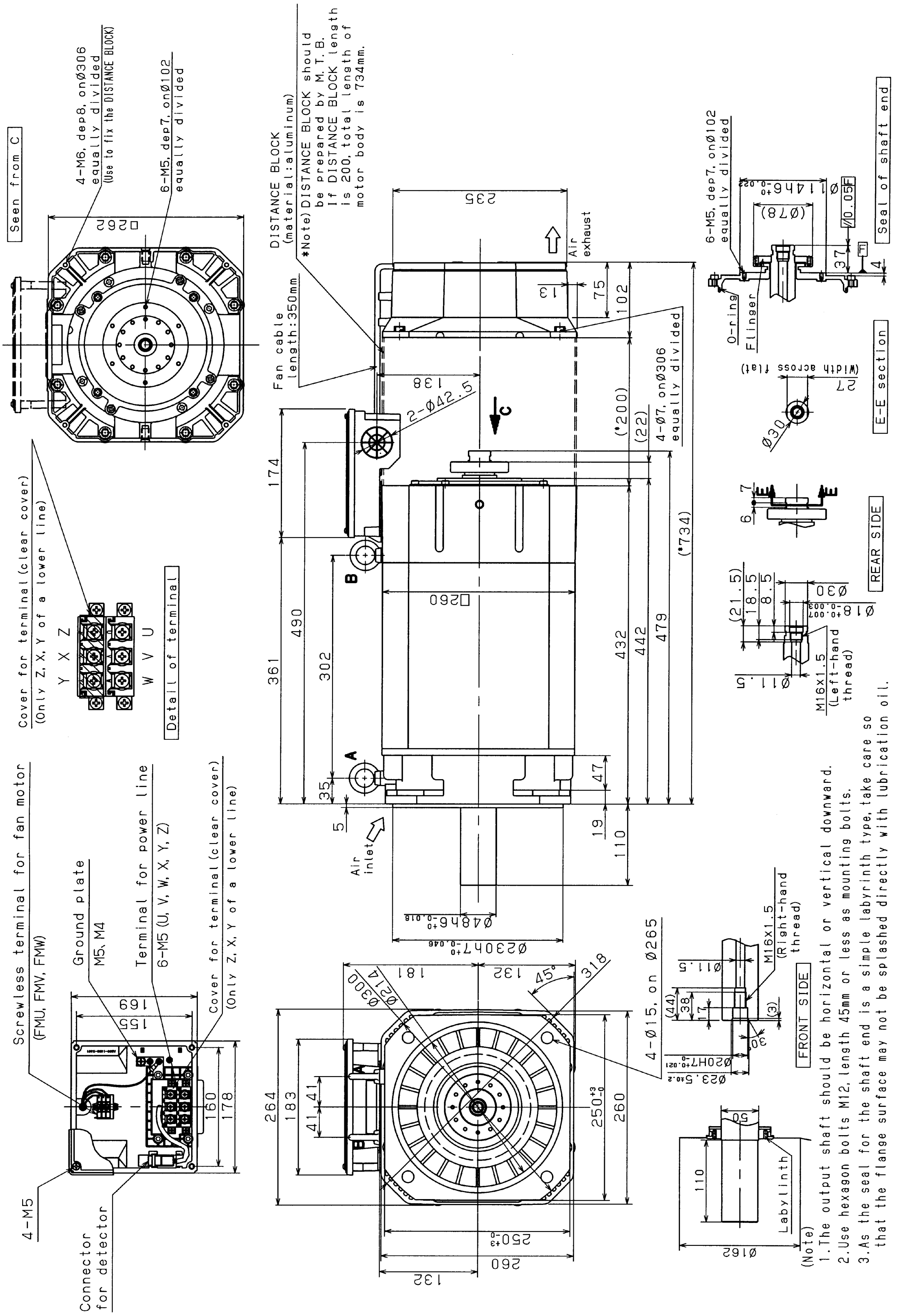
7.6 MODEL αiIT 15/10000HV



7.7 MODEL αiIT 15/15000HV



7.8 MODEL αiIT 22/10000HV



VIII. FANUC AC SPINDLE MOTOR αiIL series 200V type

1 GENERAL

The FANUC AC spindle motor αiIL series 200V type is liquid-cooled motors. They feature low temperature rise, high-speed, high torque at low speed, and low vibration.

Coupling an αiIL series 200V type motor directly to the spindle of a machining center makes it possible to realize gear-less, high-precision operation.

The motor shaft has a through hole, through which center-through coolant can be passed.

Features

(1) Thermal conduction to the spindle head and heat radiation to the machine column are reduced by cooling the front flange and motor case with a unique conduit structure (granted Japanese patent No. 2105-445 and US patent No. 5,084,642).

(2) A high torque at low rotation speed is realized by achieving high-efficient cooling based on liquid coolant and employing an output switching function (Y-Y switching).

(3) High-speed rotation is supported with grease-based lubrication.

(4) A vibration class of V3 (rotation component) is attained by strict rotor balance adjustments.

(5) The motor shaft is provided with a through hole for center-through coolant.

(6) The αiMZ sensor signal incorporated in the motor can be used in performing orientation and rigid tapping, so there is no need to mount a detector on the machine tool.

- See descriptions about the αiIT series for the features of the spindle coupled directly to the motor, the points of the direct coupling structure, and cautions for mounting the motor.

2 SPECIFICATIONS

Item		Model α*i*IL 8/20000		α*i*IL 15/15000		α*i*IL 26/15000	
Connection (*1)		Low-speed winding (Y connection)	High-speed winding (Y connection)	Low-speed winding (Y connection)	High-speed winding (Y connection)	Low-speed winding (Y connection)	High-speed winding (Y connection)
Rated output (*2)	(S1) Cont. rated kW (HP)	11 (14.7)	15 (20.1)	18.5 (24.8)	18.5 (24.8)	15 (20.1)	26 (34.9)
	(S2) 30 min rated kW (HP)	-	-	-	22 (29.5)	-	30 (40.2)
	(S2) 15 min rated kW (HP)	-	-	22 (29.5)	-	-	-
	(S3)60% (*3) kW (HP)	15 (20.1)	18.5 (24.8)	-	-	-	30 (40.2)
	(S3)40% (*3) kW (HP)	-	-	-	-	22 (29.5)	-
	(S3)25% (*3) kW (HP)	15 (20.1)	-	-	-	-	-
Rated current (*4)	(S1) A	76	107	103	84	79	107
	(S2),(S3) A	119	121	121	96	108	133
Speed min^{-1}	Base speed	1,500	5,000	1,400	6,000	600	2,500
	Max. speed	4,000	20,000	4,000	15,000	2,000	15,000
Switching speed min^{-1}		4,000		4,000		1,800	
Cont. rated torque at const. rated torque range N·m (kgf·cm)		70.0 (715)	28.6 (292)	126.1 (1286)	29.4 (300)	238.8 (2435)	99.3 (1013)
Rotor inertia $kg\cdot m^2$ ($kgf\cdot cm\cdot s^2$)		0.0275 (0.28)		0.055 (0.56)		0.167 (1.70)	
Weight kgf		80		140		170	
Vibration		V3 (rotation component)					
Noise		75dB(A) or less					
Cooling system (*5)		Liquid-cooling method (IC9U7A7)					
Installation (*6)		Mount the motor so that the output shaft points in a direction ranging within the horizontally to vertically downwards. (IMB5,IMV1)					
Allowable overload capacity (1 min) (*7)		120% of (S2) or (S3)					
Insulation		Class H					
Ambient temperature		0°C to 40°C					
Altitude		Height above sea level not exceeding 1000m					
Painting color		Munsell system N2.5					
Type of thermal protection (*8)		TP211					
Resolution of the built-in sensor p/rev		Built-in with α*i*MZ sensor 2048					
Number of detected gear teeth per rotation λ/rev		128					
Bearing lubrication		Grease					
Shaft end seal, protection format (IEC34)		Simplified labyrinth: IP40					
Method of connection with the spindle (*9)		To be directly connected with the spindle					
Allowable thrust load (*10) kgf		6		13			
Maximum output during acceleration (*11) kW		41		41		43	
Applicable spindle amplifier		α*i*SP 30		α*i*SP 30		α*i*SP 30	

* See Page 350 for Cautions and limitations.

Cautions and limitations

(*1) The power wire switching method is Y-Y switching. Refer to FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN) for explanations about output switching control.

(*2) The rated output is guaranteed at the rated voltage.
(Amplifier input: 200/220/230VAC +10% -15%, 50/60Hz±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.

(*3) The cycle time is 10 minutes, S3 60%: ON 6 minutes, OFF 4 minutes, S3 40%: ON 4 minutes, OFF 6 minutes, S3 25%: ON 2.5 minutes, OFF 7.5 minutes

(*4) The rated current is the maximum current for each rated output.

(*5) IC code conforms to IEC 34-6. Apply cooling conditions stipulated elsewhere.

(*6) IM code conforms to IEC 34-7.

(*7) This is not a guaranteed value but a guideline for the maximum motor output at a rated supply voltage.

(*8) Type conforms to IEC 34-11.

(*9) When assembling a motor with the machine, align the motor shaft with the spindle so that the vibration acceleration of the motor does not exceed 0.5 G (at maximum speed).
(Before shipping machines, check that the vibration acceleration is 0.5 G or less for all motors.)

(*10)Select a coupling that does not apply a thrust load onto the motor shaft for a cause such as coolant pressure when the temperature rises.
<u>Note that in the direction in which the motor shaft is pushed toward the inside of the motor, the allowable load is 0 kgf.</u>
(If an Oldham coupling is used, the motor shaft can be left pushed into the inside of the motor when the motor shaft is inserted into the spindle. So, measure the distance between the mounting face for a rotation joint support housing and the flinger rear end face before and after insertion, and check that the two measured values are identical.
For details, see Section 9.4 "COUPLING SELECTION" in Part VI.)

(*11)These values are to be used only as guidance for selecting a power supply (αiPS) and are not guaranteed.

(*12)The protection grade (IEC34-5) is IP40. However, the grade is IP54 when the labyrinth seal on the front side of the output axis and the flinger seal on the rear side are excluded.
Ensure that the labyrinth seal and flinger seal are not directly exposed to coolant and mist.

3 OUTPUT/TORQUE CHARACTERISTICS

Reference
Calculation for torque

Torque T can be obtained by the following equation.

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

P[kW]: Motor output

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

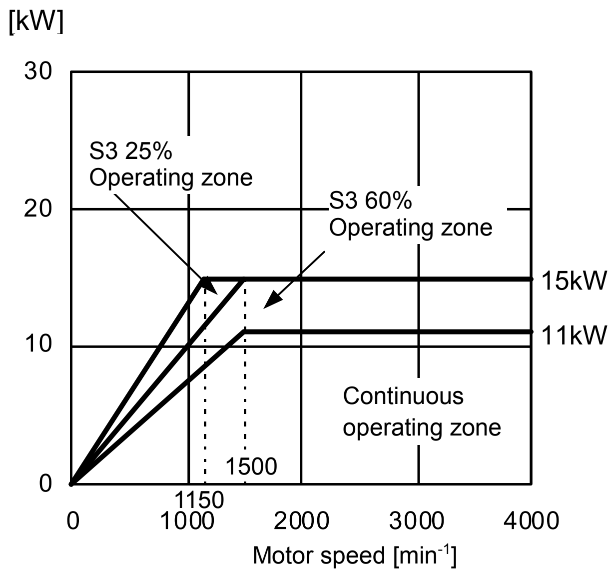
When the unit of T is [kgf·m],

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

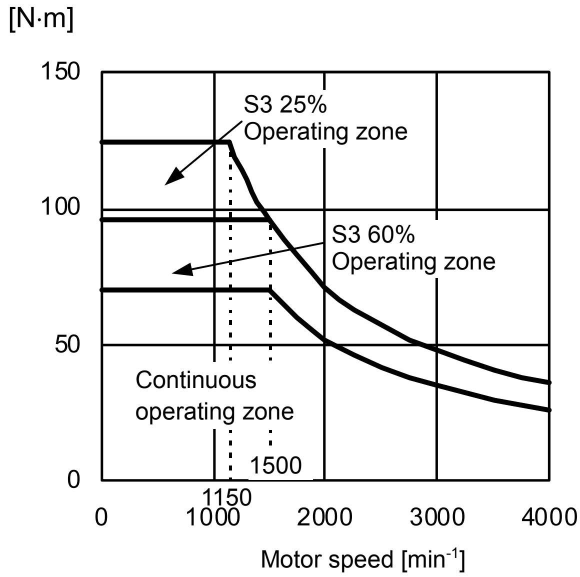
3.1 MODEL αiIL 8/20000

Applicable amplifier αiSP 30
Cooler capacity 2.9kW (2500kcal/h)

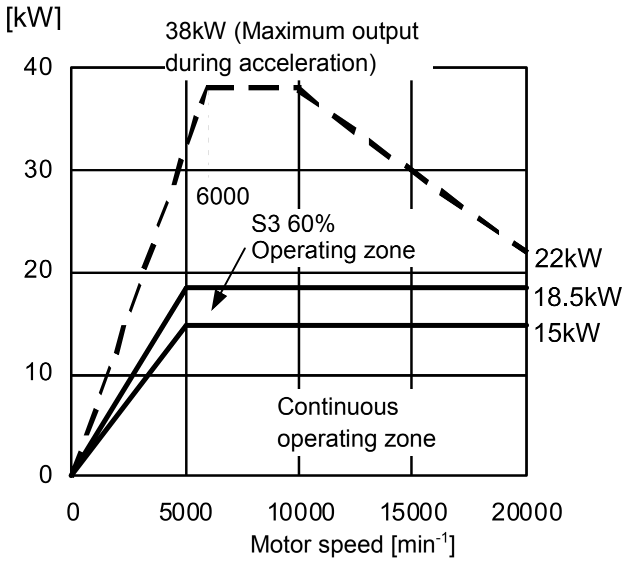
Low-speed winding output (Y connection)



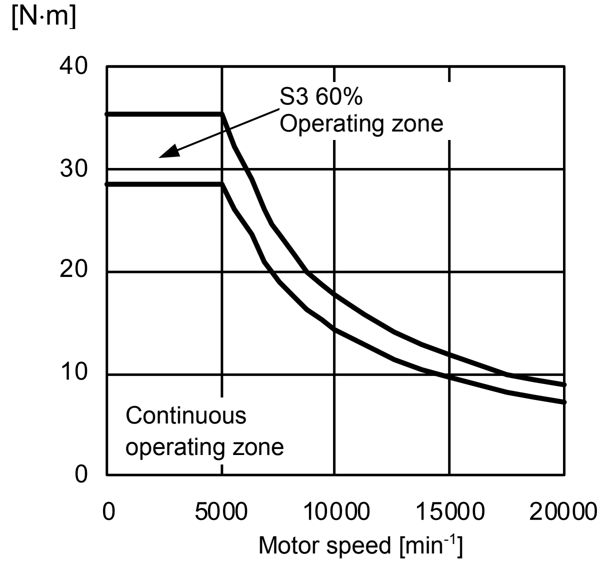
Low-speed winding torque (Y connection)



Low-speed winding output (Y connection)



Low-speed winding torque (Y connection)

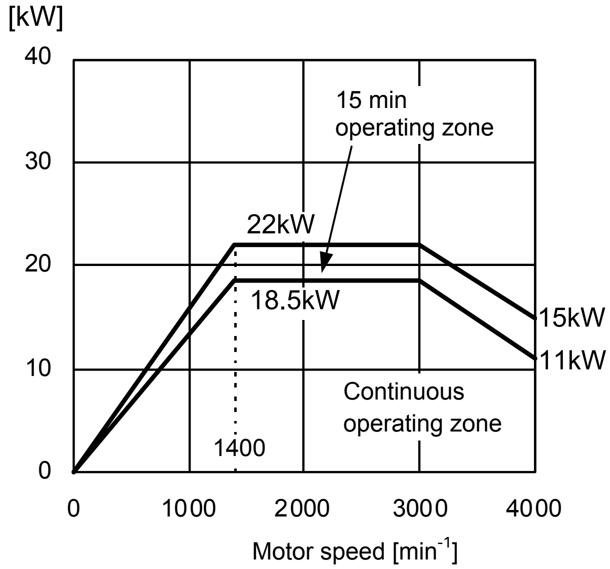


> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

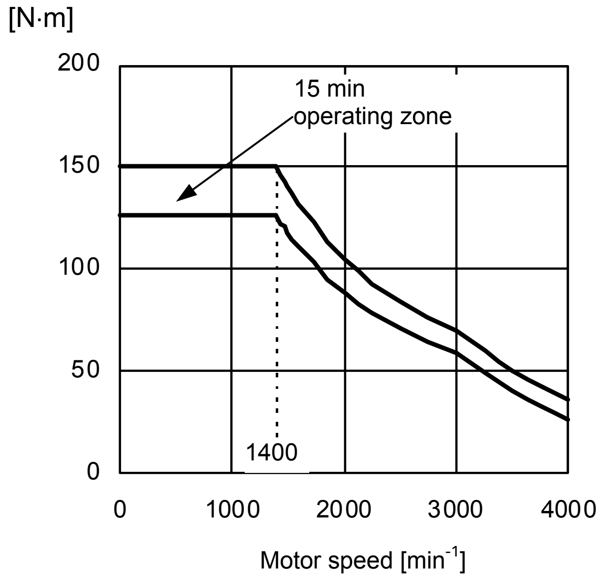
3.2 MODEL αiIL 15/15000

Applicable amplifier αiSP 30
Cooler capacity 3.5kW (3000kcal/h)

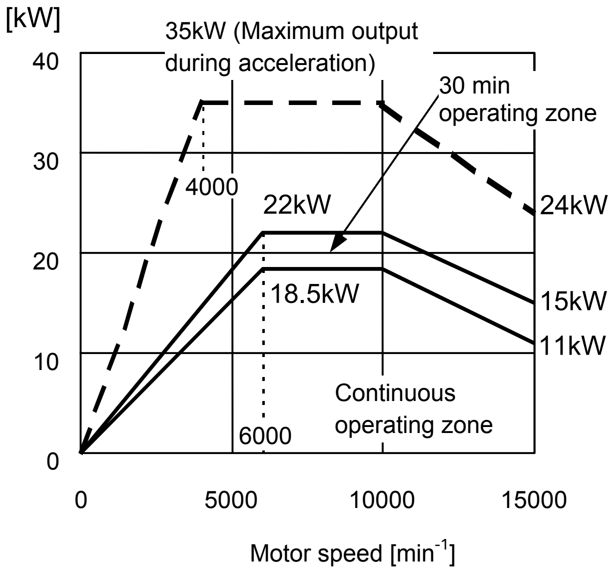
Low-speed winding output (Y connection)



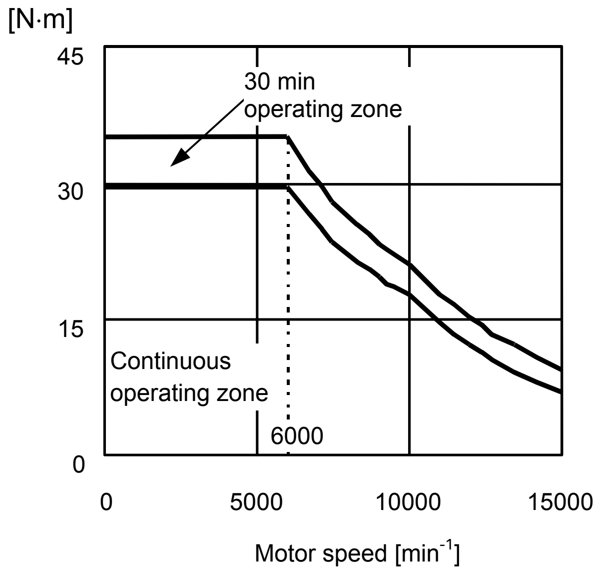
Low-speed winding torque (Y connection)



Low-speed winding output (Y connection)



Low-speed winding torque (Y connection)



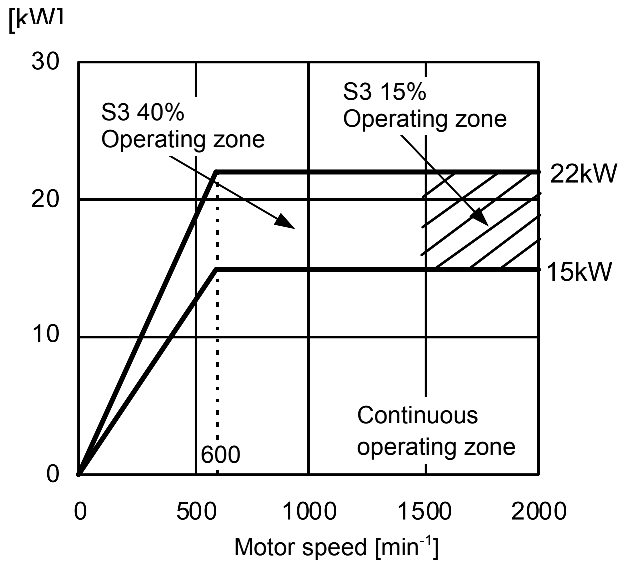
NOTE

Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

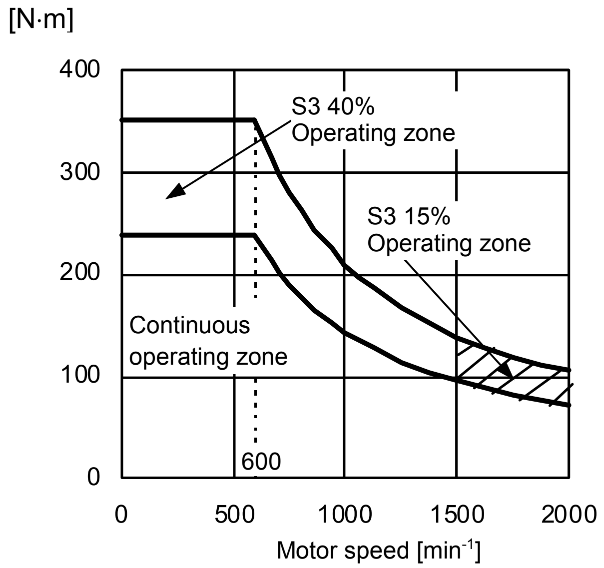
3.3 MODEL αiIL 26/15000

Applicable amplifier αiSP 30
Cooler capacity 4.1kW (3500kcal/h)

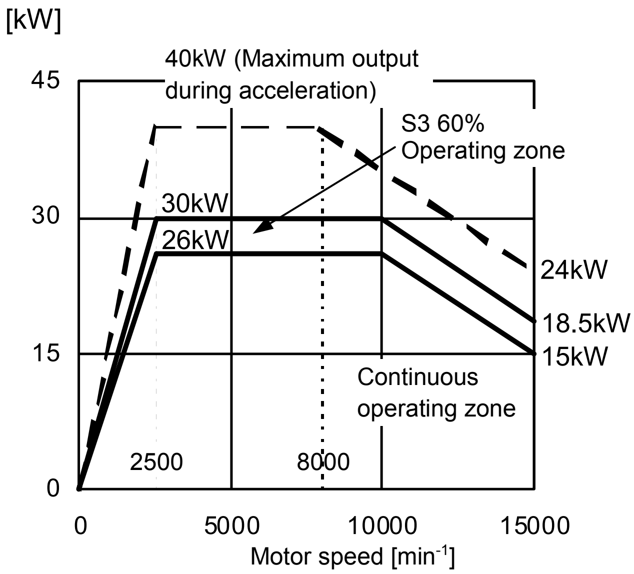
Low-speed winding output (Y connection)



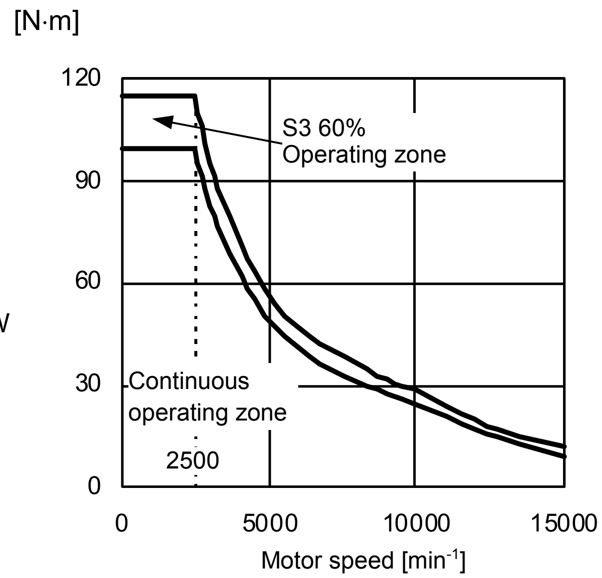
Low-speed winding torque (Y connection)



Low-speed winding output (Y connection)



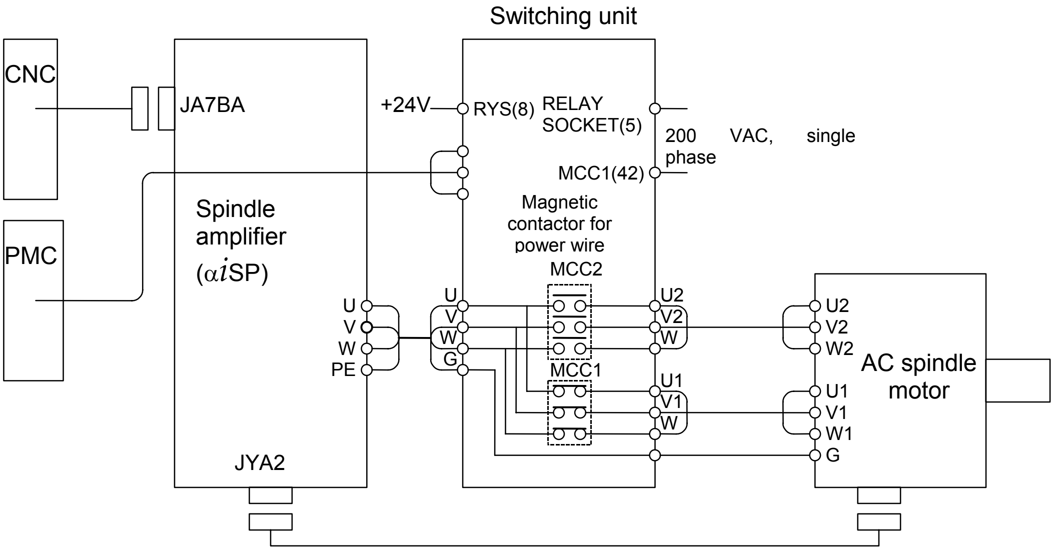
Low-speed winding torque (Y connection)



> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

4 CONNECTIONS

4.1 TOTAL CONNECTION DIAGRAM



NOTE

1. The machine tool builder is requested to prepare cables for any equipment other than the spindle amplifier module, switching unit, or AC spindle motor, which are enclosed within the heavy-line frame.
2. Refer to FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN) for explanations about the switching unit and the low-/high-speed winding switching sequence.
3. The power wire switching method is Y-Y switching.
4. The relationships between the magnetic contactor in the switching unit and the winding state are listed below:

State	MCC1	MCC2
Low-speed winding	ON	OFF
High-speed winding	OFF	ON

4.2 SIZE OF POWER LEAD

When connecting power wires to the amplifier, switching unit, and motor, use the wire size and crimp terminal listed below or equivalents.

Motor model	Crimp terminal size		Applicable power lead size (mm^2)	
	Motor side	Amplifier side	(*1) LMFC	(*2) Flonlex power cable
αiIL 8/20000	M5	M6	22	14
αiIL 15/15000	M6	M6	22	14
αiIL 26/15000	M6	M6	22	14

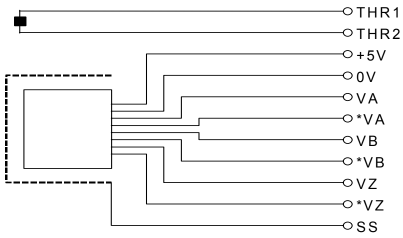
NOTE

1 LMFC power lead: Fire-retardant Polyflex power cable (Heat resistance: 105°C)

2 Flonlex power lead: Manufactured by HITACHI CABLE, Ltd. (Heat resistance: 200°C)

4.3 CONNECTION OF SIGNAL LEAD

αiMZ sensor signal or overheat signal use a connector manufactured by Tyco Electronics AMP.
The connector housing and the connector are attached to the motor.



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		*VA	*VB	*VZ	0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	VA	VB	VZ	SS	THR1

Connector housing and contact specifications

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

	Motor side		Cable side	
	FANUC specification	Manufacture specifica-tion	FANUC specification	Manufacture 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 kΩ as measured at room temperature (20°C to 30°C).

4.4 COOLING

Cooling conditions

Item		αiIL 8/20000	αiIL 15/15000	αiIL 26/15000
Cooler capacity	kw (kcal/h)	2.3 to 3.5(*1) (2000 to 3000)	2.9 to 3.5(*1) (2500 to 3000)	2.9 to 4.1(*1) (2500 to 3500)
Liquid coolant		1. Liquid 2. Liquid additive (example: 2% SHELL DONAX CC) (*2)		
Liquid coolant flow	L/min	10 or more		
Liquid coolant pressure	kPa(kgf/cm^2)	490 or lower (5 or lower) (as measured at the cooling pipe inlet)		
Liquid coolant viscosity	m^2/sec(cSt)	1.0×10^{-5} or lower (10 or lower)		
Liquid coolant specific heat	J/g·K	1.87		
Liquid coolant density	g/cm^3	0.78		
Liquid coolant temperature	(*3)	Room temperature +0°C to +10°C (as measured at the cooling pipe inlet)		

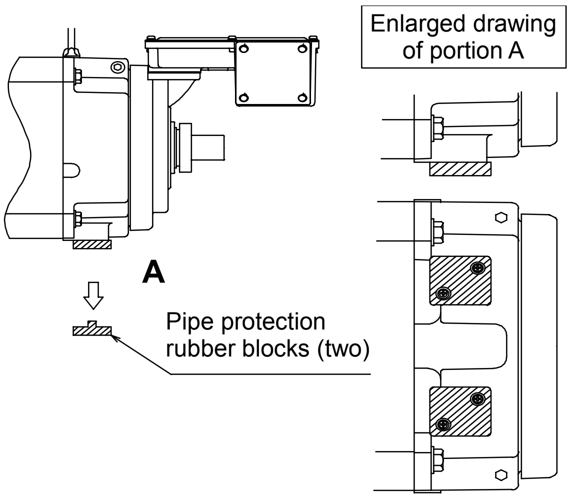
(*1) This cooler capacity meets the corresponding CE marking standard.
(*2) It has been confirmed that a dilute solution with 2% of "SHELL DNAX CC" made by SHELL is usable for cooling.
(*3) If the temperature of the liquid coolant is lower than the room temperature as measured at the cooling pipe inlet, it is likely that condensation may occur in the motor. Be sure to strictly observe the specified temperature.

Liquid coolant piping

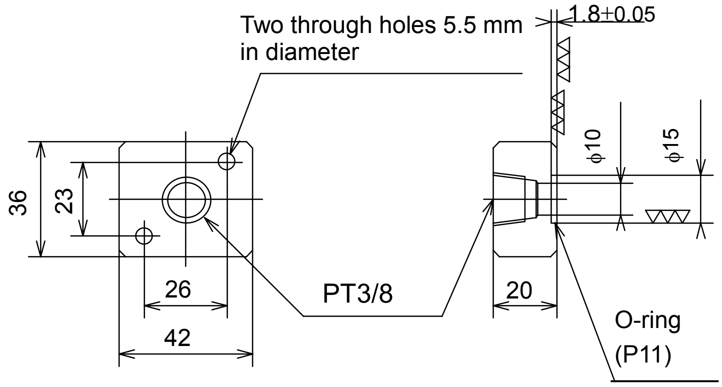
This motor series needs cooling based on liquid coolant.

- Factory-setting

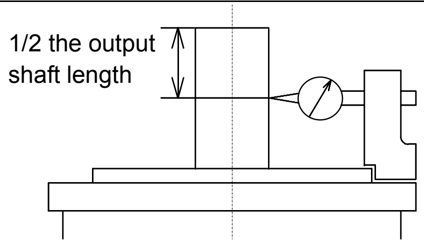
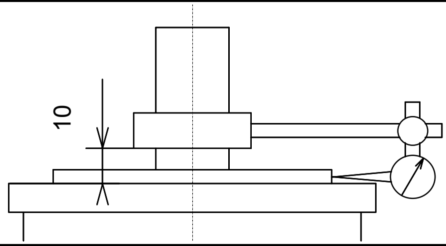
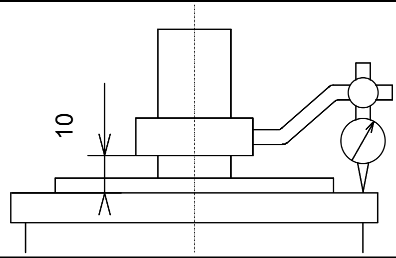
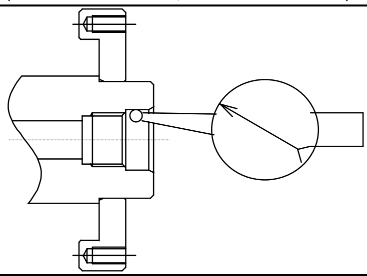
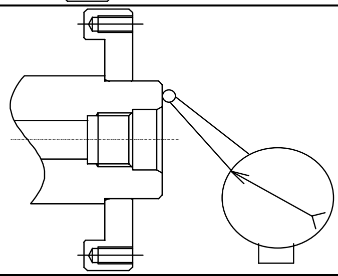
The motor comes with rubber blocks for pipe protection.
The machine tool builder is requested to prepare a pipe block according to the following drawing.



- Example of a pipe block



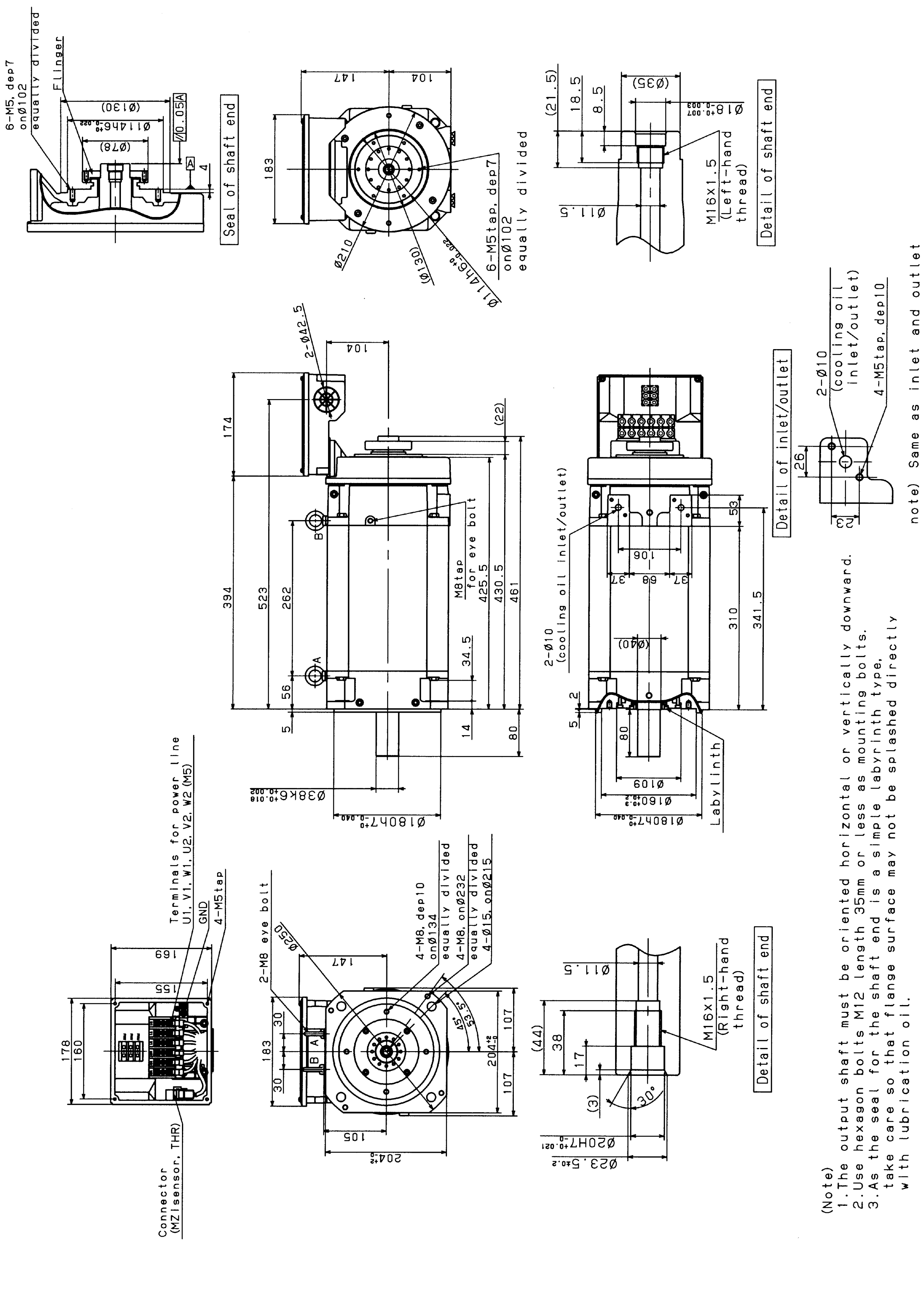
5 ASSEMBLING ACCURACY

Item	Accuracy	Measuring method
Run-out at the end of the output shaft	10μm or less	
Run-out of the faucet joint for mounting the flange against the core of the shaft	30μm or less	
Run-out of the flange mounting surface against the core of the shaft	40μm or less	
Front shaft end through hole inlet Rear shaft end through hole inlet Run-out of socket and spigot joint	20μm or less	
Run-out of front shaft end face Run-out of rear shaft end face	10μm or less	

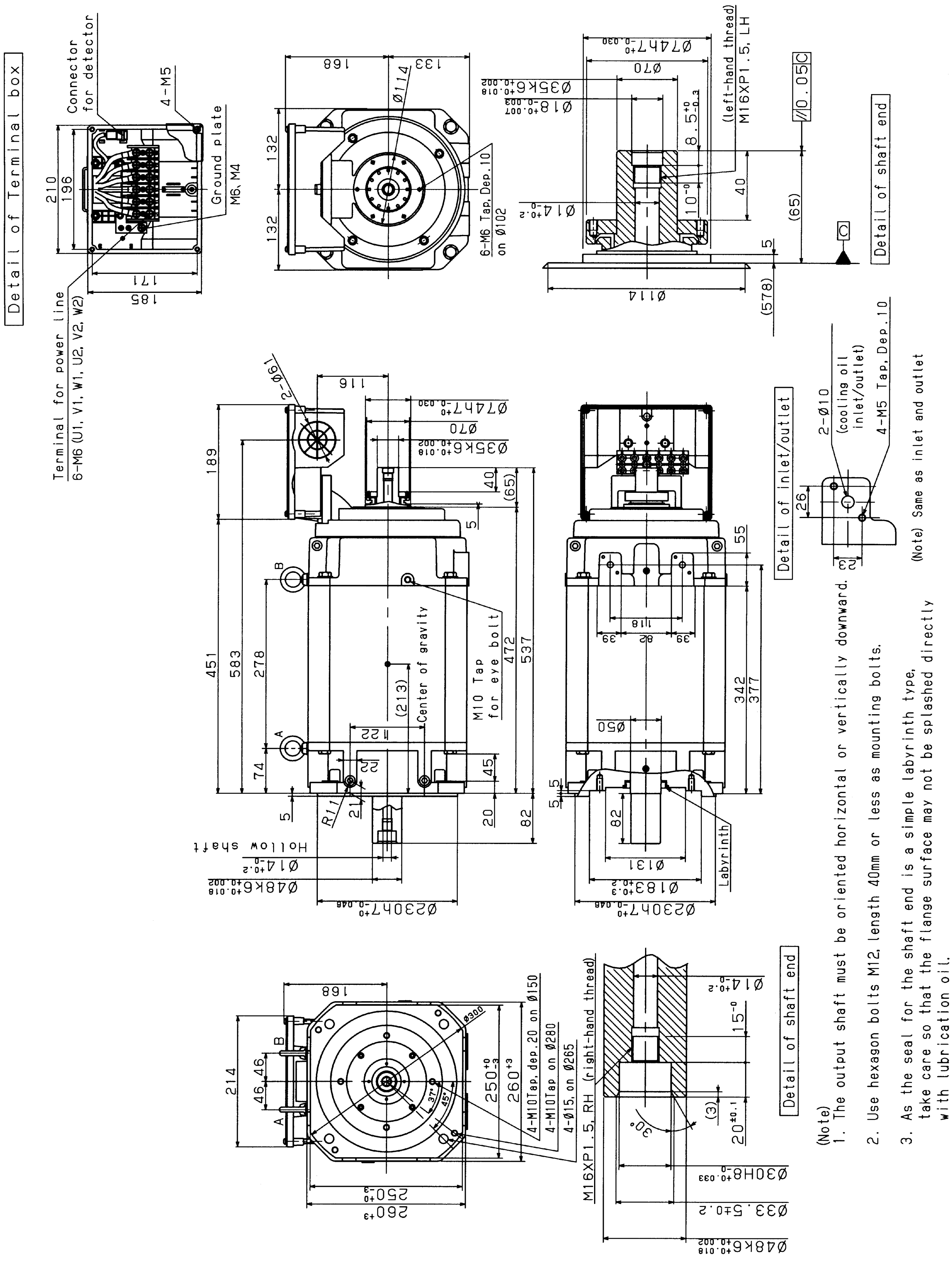
6 EXTERNAL DIMENSIONS

Model name	Section
Model αiIL 8/20000	6.1
Model αiIL 15/15000	6.2
Model αiIL 26/15000	6.3

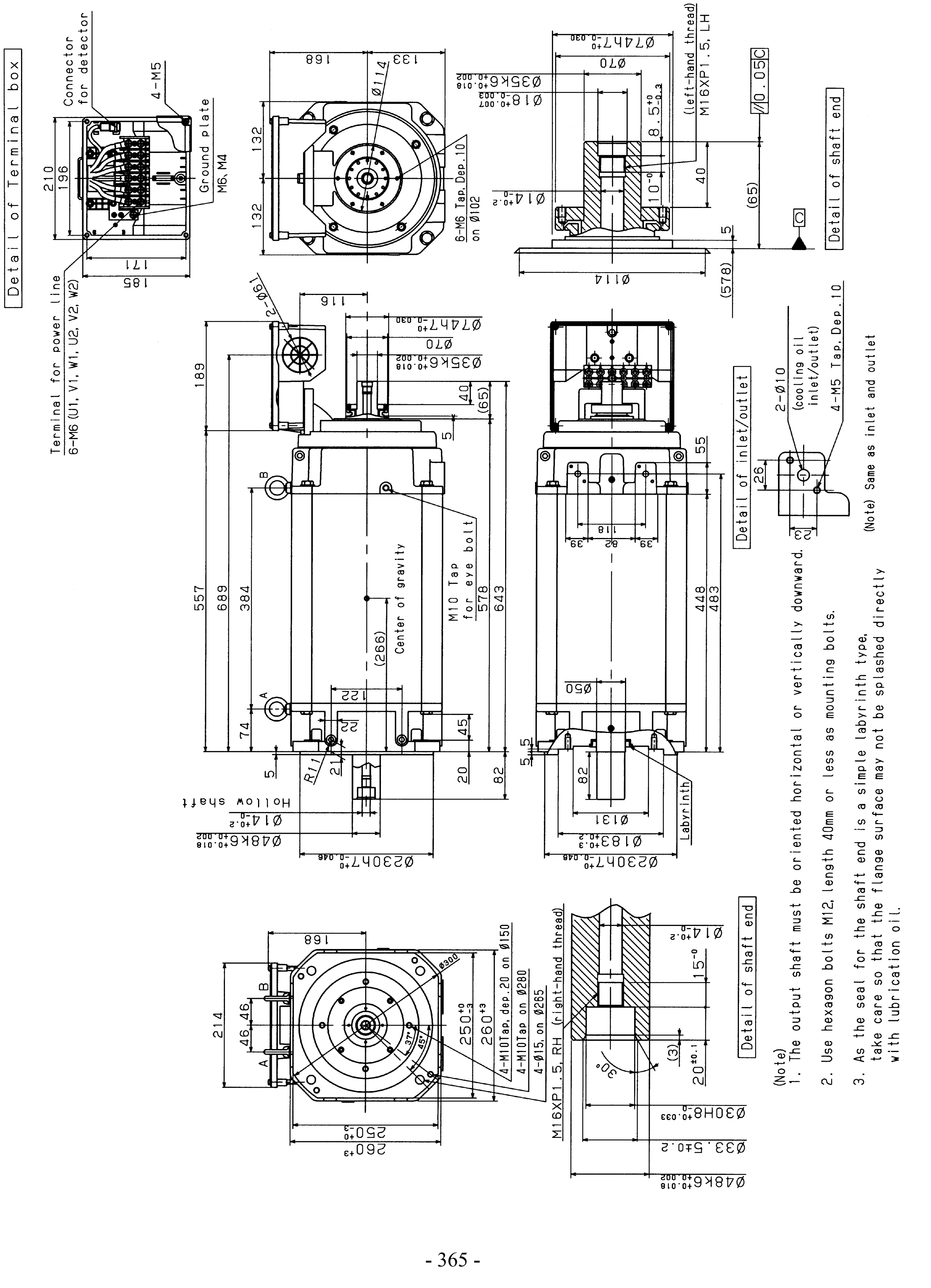
6.1 MODEL αiIL 8/20000



6.2 MODEL αiIL 15/15000



6.3 MODEL α*i*L 26/15000



IX. FANUC AC SPINDLE MOTOR αiIL series 400V type

1 GENERAL

The FANUC AC spindle motor α*i*IL series 400V type is liquid-cooled motors that can be energized at 400 to 480 V without using a step-down transformer. They feature low temperature rise, high-speed, high torque at low speed, and low vibration.

Coupling an α*i*IL series 400V type motor directly to the spindle of a machining center makes it possible to realize gear-less, high-precision operation.

The motor shaft has a through hole, through which center-through coolant can be passed.

Features

(1) Thermal conduction to the spindle head and heat radiation to the machine column are reduced by cooling the front flange and motor case with a unique conduit structure (granted Japanese patent No. 2105-445 and US patent No. 5,084,642).

(2) A high torque at low rotation speed is realized by achieving high-efficient cooling based on liquid coolant and employing an output switching function (Y-Δ switching).

(3) High-speed rotation is supported with grease-based lubrication.

(4) A vibration class of V3 (rotation component) is attained by strict rotor balance adjustments.

(5) The motor shaft is provided with a through hole for center-through coolant.

(6) The α*i*MZ sensor signal incorporated in the motor can be used in performing orientation and rigid tapping, so there is no need to mount a detector on the machine tool.

- See descriptions about the α*i*IT series for the features of the spindle coupled directly to the motor, the points of the direct coupling structure, and cautions for mounting the motor.

2 SPECIFICATIONS

Item	Model	αiL 8/20000HV		αiL 15/15000HV		αiL 26/15000HV	
Connection (*1)		Low-speed winding (Y connection)	High-speed winding (Δ connection)	Low-speed winding (Y connection)	High-speed winding (Δ connection)	Low-speed winding (Y connection)	High-speed winding (Δ connection)
Rated output (*2)	(S1) Cont. rated kW (HP)	11 (14.7)	15 (20.1)	18.5 (24.8)	18.5 (24.8)	15 (20.1)	26 (34.9)
	(S2) 30 min rated kW (HP)	-	-	-	22 (29.5)	-	30 (40.2)
	(S2) 15 min rated kW (HP)	-	-	22 (29.5)	-	-	-
	(S3)60% (*3) kW (HP)	15 (20.1)	18.5 (24.8)	-	-	-	30 (40.2)
	(S3)40% (*3) kW (HP)	-	-	-	-	22 (29.5)	-
	(S3)25% (*3) kW (HP)	15 (20.1)	-	-	-	-	-
Rated current (*4)	(S1) A	48	47	66	53	51	54
	(S2),(S3) A	75	53	77	63	75	62
Speed min^{-1}	Base speed	1,500	5,000	1,400	6,000	700	2,000
	Max. speed	4,000	20,000	4,000	15,000	2,000	15,000
Switching speed min^{-1}		4,000		4,000		1,500	
Cont. rated torque at const. rated torque range	N·m (kgf·cm)	70.0 (715)	28.6 (292)	126.1 (1286)	29.4 (300)	204.7 (2088)	124.2 (1267)
Rotor inertia	$kg{\cdot}m^2$ ($kgf{\cdot}cm{\cdot}s^2$)	0.0275 (0.28)		0.055 (0.56)		0.167 (1.70)	
Weight	kgf	80		140		170	
Vibration		V3 (rotation component)					
Noise		75dB(A) or less					
Cooling system (*5)		Liquid-cooling method (IC9U7A7)					
Installation (*6)		Mount the motor so that the output shaft points in a direction ranging within the horizontally to vertically downwards. (IMB5,IMV1)					
Allowable overload capacity (1 min) (*7)		120% of (S2) or (S3)					
Insulation		Class H					
Ambient temperature		0°C to 40°C					
Altitude		Height above sea level not exceeding 1000m					
Painting color		Munsell system N2.5					
Type of thermal protection (*8)		TP211					
Resolution of the built-in sensor	p/rev	Built-in with αiMZ sensor 2048					
Number of detected gear teeth per rotation	λ/rev	128					
Bearing lubrication		Grease					
Shaft end seal, protection format (IEC34)		Simplified labyrinth: IP40					
Method of connection with the spindle (*9)		To be directly connected with the spindle					
Allowable thrust load (*10)	kgf	6		13			
Maximum output during acceleration (*11)	kW	48		48		50	
Applicable spindle amplifier		αiSP 45HV		αiSP 45HV		αiSP 45HV	

* See Page 372 for Cautions and limitations.

Cautions and limitations

(*1) The power wire switching method is Y-Δ switching. Refer to FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN) for explanations about output switching control.

(*2) The rated output is guaranteed at the rated voltage.
(Amplifier input:400/480VAC+10%-15%, 50/60Hz±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.

(*3) The cycle time is 10 minutes, S3 60%: ON 6 minutes, OFF 4 minutes, S3 40%: ON 4 minutes, OFF 6 minutes, S3 25%: ON 2.5 minutes, OFF 7.5 minutes

(*4) The rated current is the maximum current for each rated output.

(*5) IC code conforms to IEC 34-6. Apply cooling conditions stipulated elsewhere.

(*6) IM code conforms to IEC 34-7.

(*7) This is not a guaranteed value but a guideline for the maximum motor output at a rated supply voltage.

(*8) Type conforms to IEC 34-11.

(*9) When assembling a motor with the machine, align the motor shaft with the spindle so that the vibration acceleration of the motor does not exceed 0.5 G (at maximum speed).
(Before shipping machines, check that the vibration acceleration is 0.5 G or less for all motors.)

(*10)Select a coupling that does not apply a thrust load onto the motor shaft for a cause such as coolant pressure when the temperature rises.
Note that in the direction in which the motor shaft is pushed toward the inside of the motor, the allowable load is 0 kgf.
(If an Oldham coupling is used, the motor shaft can be left pushed into the inside of the motor when the motor shaft is inserted into the spindle. So, measure the distance between the mounting face for a rotation joint support housing and the flinger rear end face before and after insertion, and check that the two measured values are identical.
For details, see Section 9.4 "COUPLING SELECTION" in Part VI.)

(*11)These values are to be used only as guidance for selecting a power supply (αiPS) and are not guaranteed.

(*12)The protection grade (IEC34-5) is IP40. However, the grade is IP54 when the labyrinth seal on the front side of the output axis and the flinger seal on the rear side are excluded.
Ensure that the labyrinth seal and flinger seal are not directly exposed to coolant and mist.

3 OUTPUT/TORQUE CHARACTERISTICS

Reference
Calculation for torque

Torque T can be obtained by the following equation.

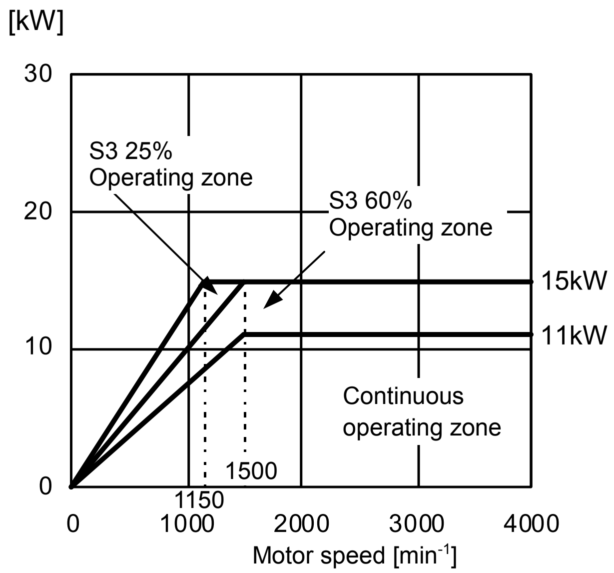
$T[N\cdot m]=P[kW]\times 1000/0.1047/N[min^{-1}]$
P[kW]: Motor output
$N[min^{-1}]$: Motor speed

When the unit of T is [kgf·m],
$T[kgf\cdot m]=P[kW]\times 1000/1.0269/N[min^{-1}]$

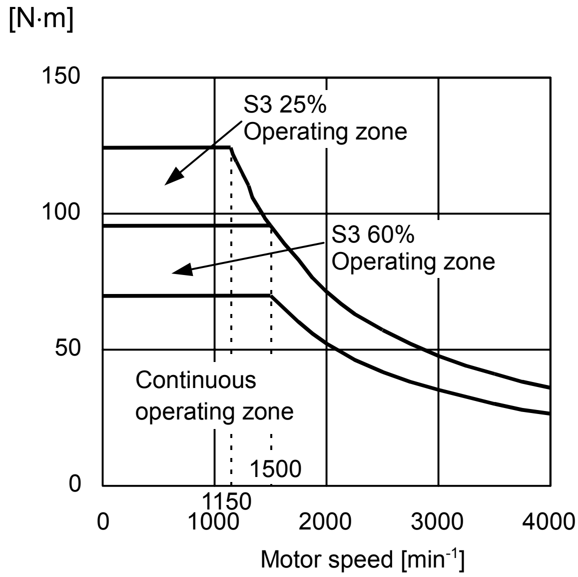
3.1 MODEL αiL 8/20000HV

Applicable amplifier αiSP 45HV
Cooler capacity 2.9kW (2500kcal/h)

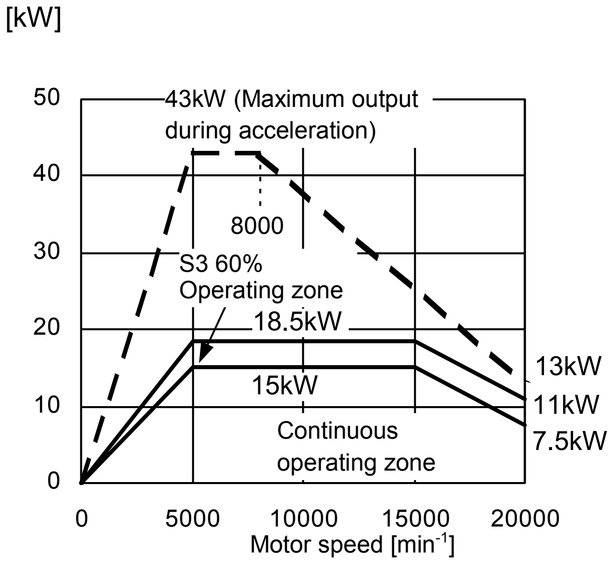
Low-speed winding output (Y connection)



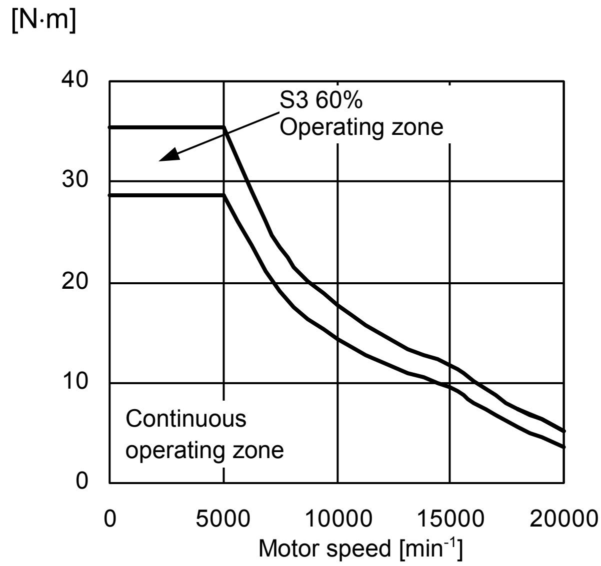
Low-speed winding torque (Y connection)



Low-speed winding output (Δ connection)



Low-speed winding torque (Δ connection)

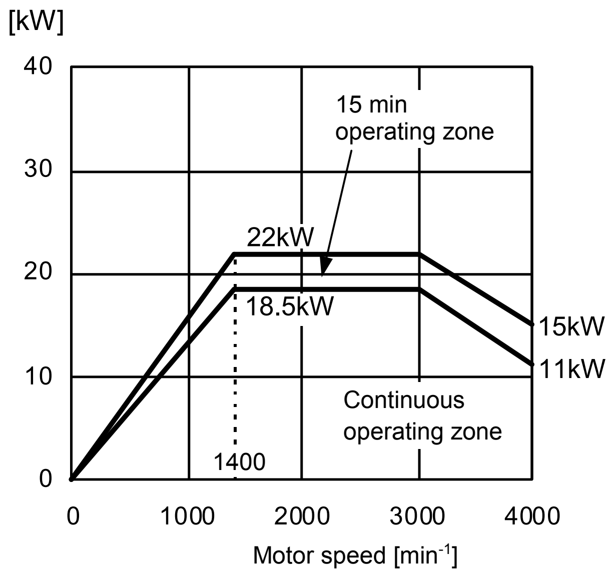


NOTE
Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

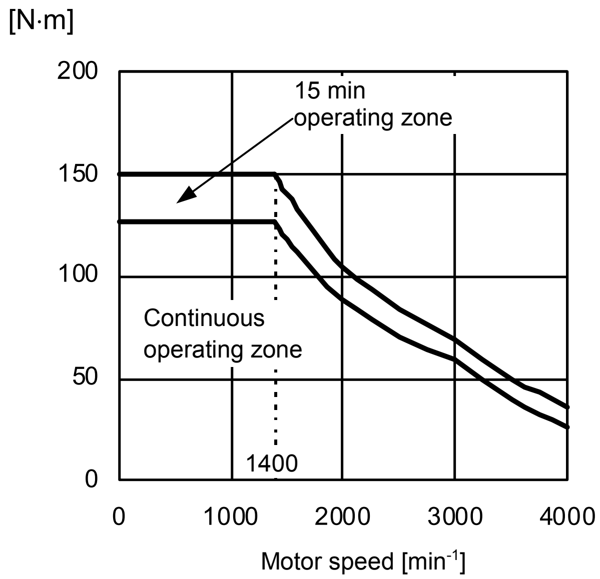
3.2 MODEL αiL 15/15000HV

Applicable amplifier αiSP 45HV
Cooler capacity 3.5kW (3000kcal/h)

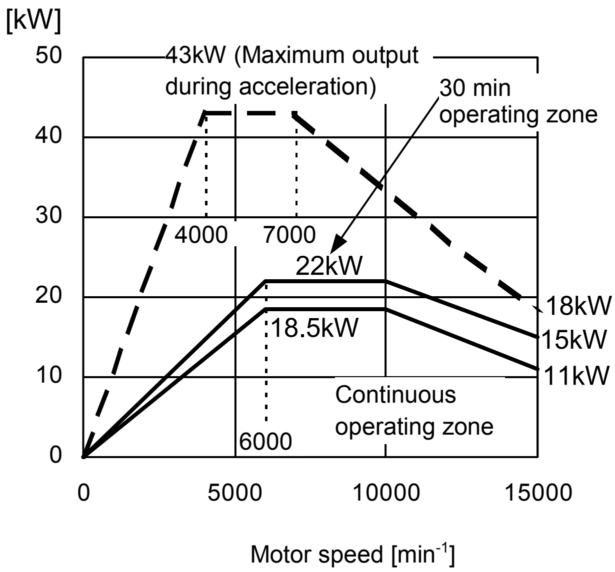
Low-speed winding output (Y connection)



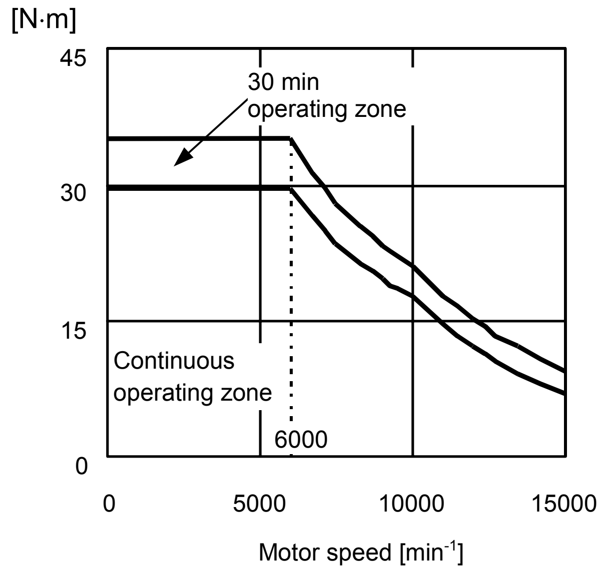
Low-speed winding torque (Y connection)



Low-speed winding output (Δ connection)



Low-speed winding torque (Δ connection)

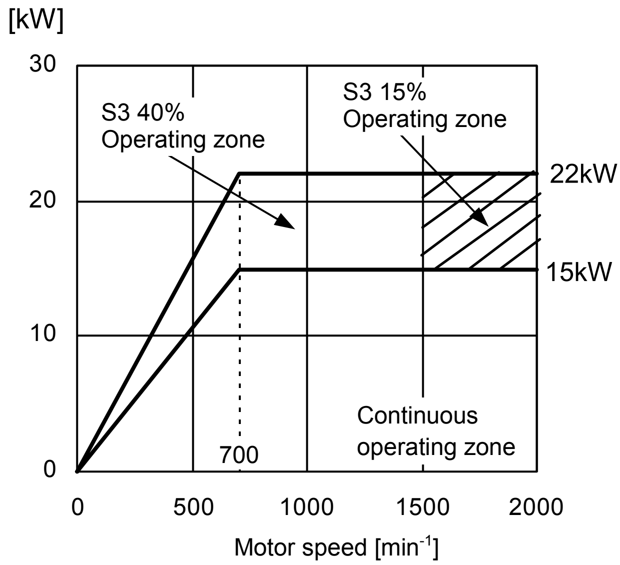


> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

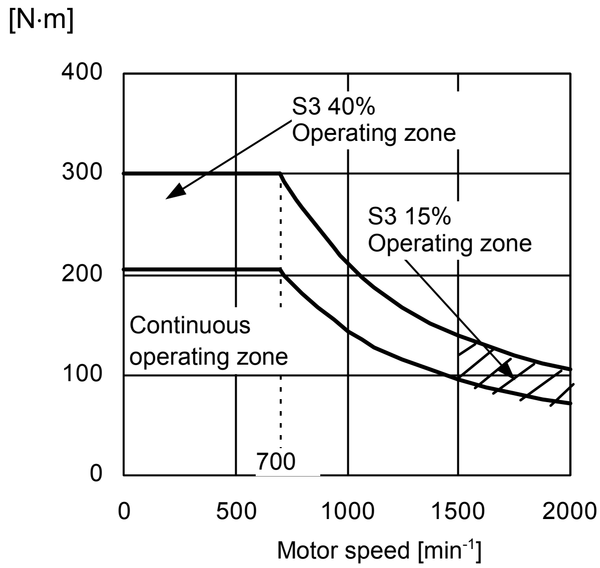
3.3 MODEL αiIL 26/15000HV

Applicable amplifier αiSP 45HV
Cooler capacity 4.1kW (3500kcal/h)

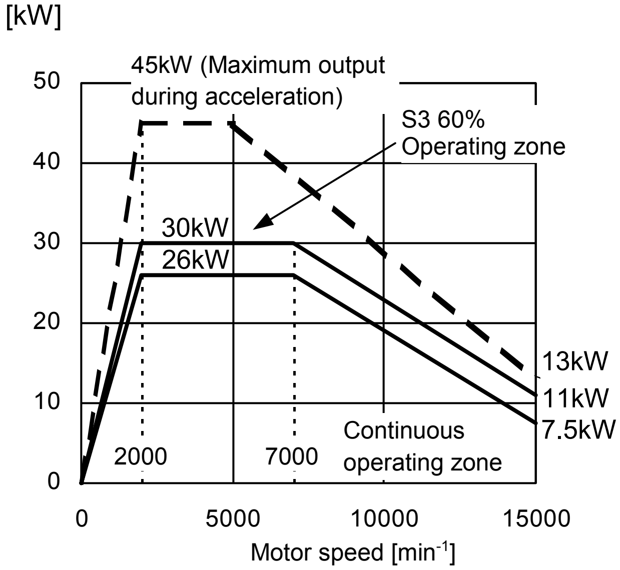
Low-speed winding output (Y connection)



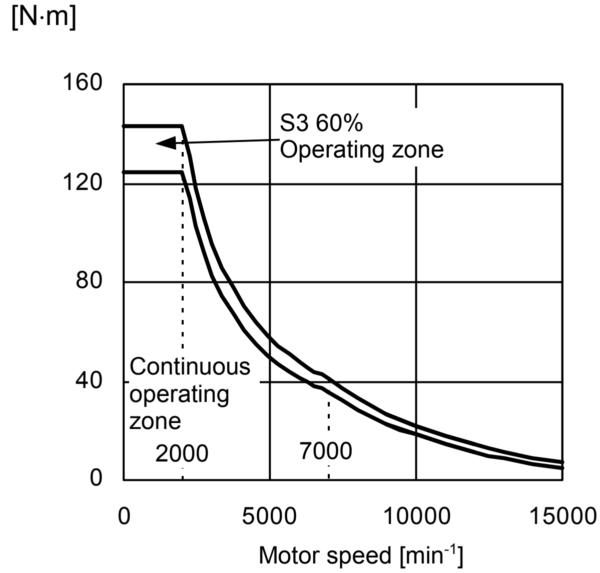
Low-speed winding torque (Y connection)



Low-speed winding output (Δ connection)



Low-speed winding torque (Δ connection)



NOTE
Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

4 CONNECTIONS

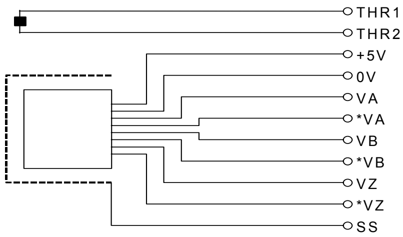
4.1 POWER WIRE CRIMP TERMINAL SIZE

For the power wires, use the crimp terminals listed below or equivalents.

Motor model	**Crimp terminal size**	
	Motor side	**Amplifier side**
αiIL 8/20000HV	M5	M6
αiIL 15/15000HV	M6	M6
αiIL 26/15000HV	M6	M6

4.2 CONNECTION OF SIGNAL LEAD

αiMZ sensor signal or overheat signal use a connector manufactured by Tyco Electronics AMP.
The connector housing and the connector are attached to the motor.



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		*VA	*VB	*VZ	0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	VA	VB	VZ	SS	THR1

Connector housing and contact specifications

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

	Motor side		Cable side	
	FANUC specification	Manufacture specification	FANUC specification	Manufacture 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 kΩ as measured at room temperature (20°C to 30°C).

4.3 COOLING

Cooling conditions

Item		αiL 8/20000HV	αiL 15/15000HV	αiL 26/15000HV
Cooler capacity	kw (kcal/h)	2.3 to 3.5 (*1) (2000 to 3000)	2.9 to 3.5 (*1) (2500 to 3000)	2.9 to 4.1 (*1) (2500 to 3500)
Liquid coolant		1. Liquid 2. Liquid additive (example: 2% SHELL DONAX CC) (*2)		
Liquid coolant flow	L/min	10 or more		
Liquid coolant pressure	kPa(kgf/cm^2)	490 or lower (5 or lower) (as measured at the cooling pipe inlet)		
Liquid coolant viscosity	m^2/sec(cSt)	1.0×10^{-5} or lower (10 or lower)		
Liquid coolant specific heat	J/g·K	1.87		
Liquid coolant density	g/cm^3	0.78		
Liquid coolant temperature (*3)		Room temperature +0°C to +10°C (as measured at the cooling pipe inlet)		

(*1) This cooler capacity meets the corresponding CE marking standard.

(*2) It has been confirmed that a dilute solution with 2% of "SHELL DNAX CC" made by SHELL is usable for cooling.

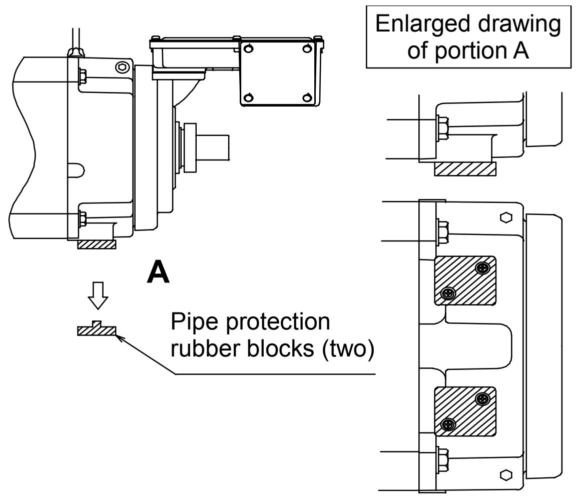
(*3) If the temperature of the liquid coolant is lower than the room temperature as measured at the cooling pipe inlet, it is likely that condensation may occur in the motor. Be sure to strictly observe the specified temperature.

Liquid coolant piping

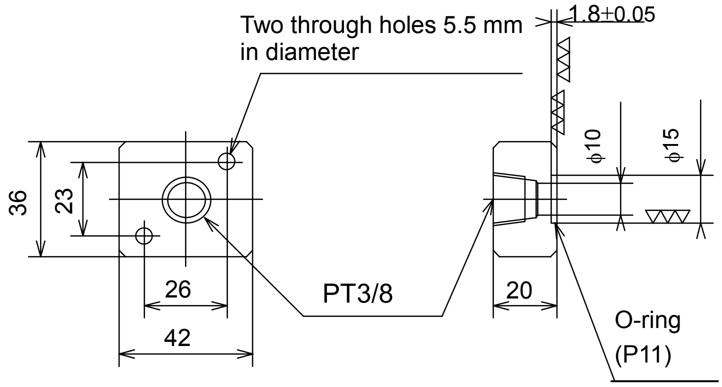
This motor series needs cooling based on liquid coolant.

- Factory-setting

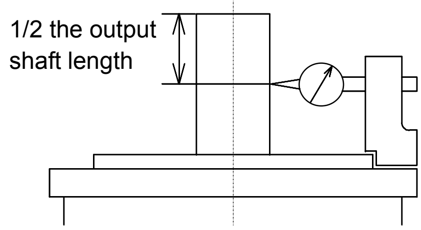
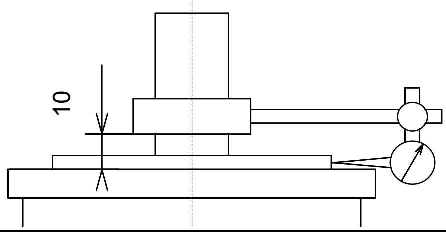
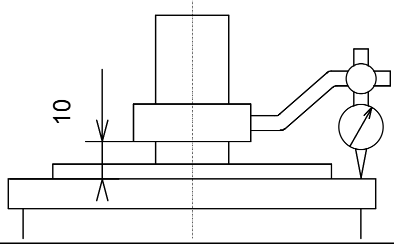
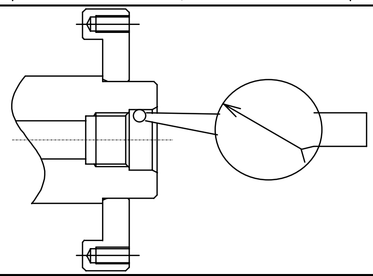
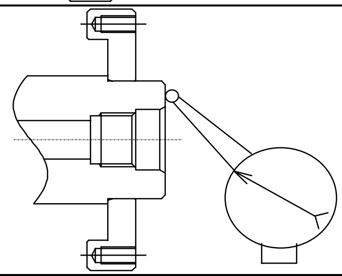
The motor comes with rubber blocks for pipe protection.
The machine tool builder is requested to prepare a pipe block according to the following drawing.



- Example of a pipe block



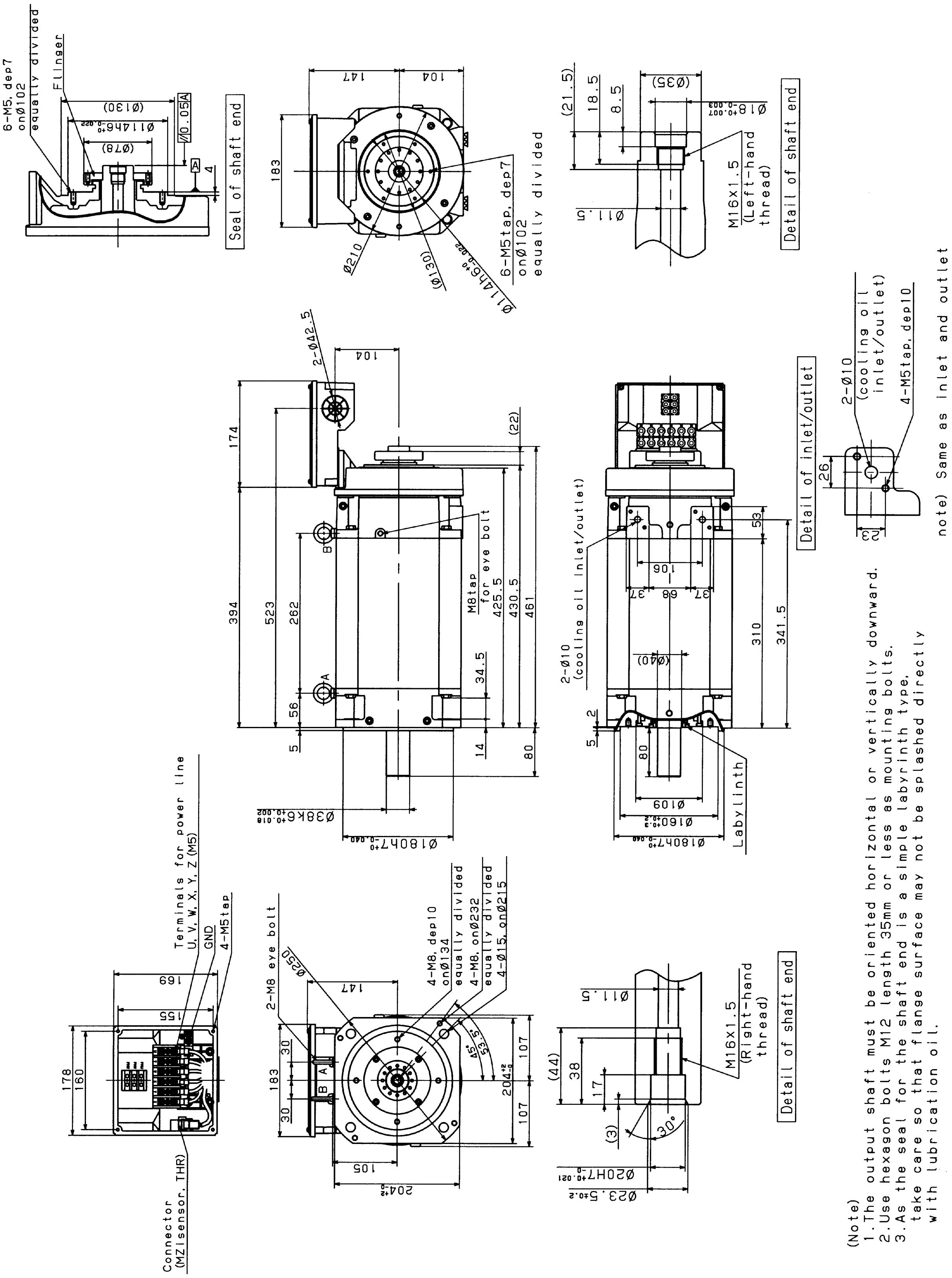
5 ASSEMBLING ACCURACY

Item	Accuracy	Measuring method
Run-out at the end of the output shaft	10μm or less	
Run-out of the faucet joint for mounting the flange against the core of the shaft	30μm or less	
Run-out of the flange mounting surface against the core of the shaft	40μm or less	
Front shaft end through hole inlet Rear shaft end through hole inlet Run-out of socket and spigot joint	20μm or less	
Run-out of front shaft end face Run-out of rear shaft end face	10μm or less	

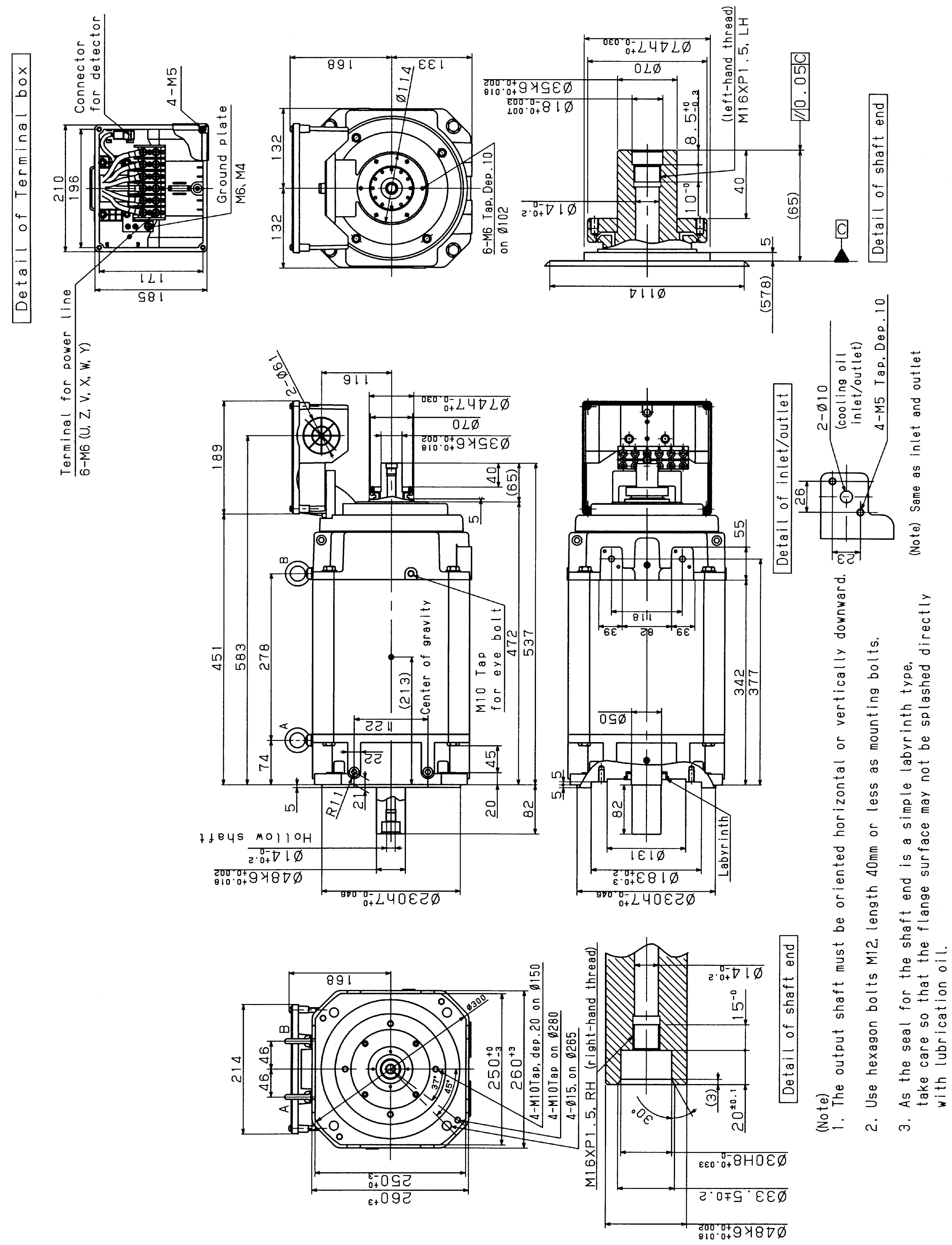
6 EXTERNAL DIMENSIONS

Model name	Section
Model αiIL 8/20000HV	6.1
Model αiIL 15/15000HV	6.2
Model αiIL 26/15000HV	6.3

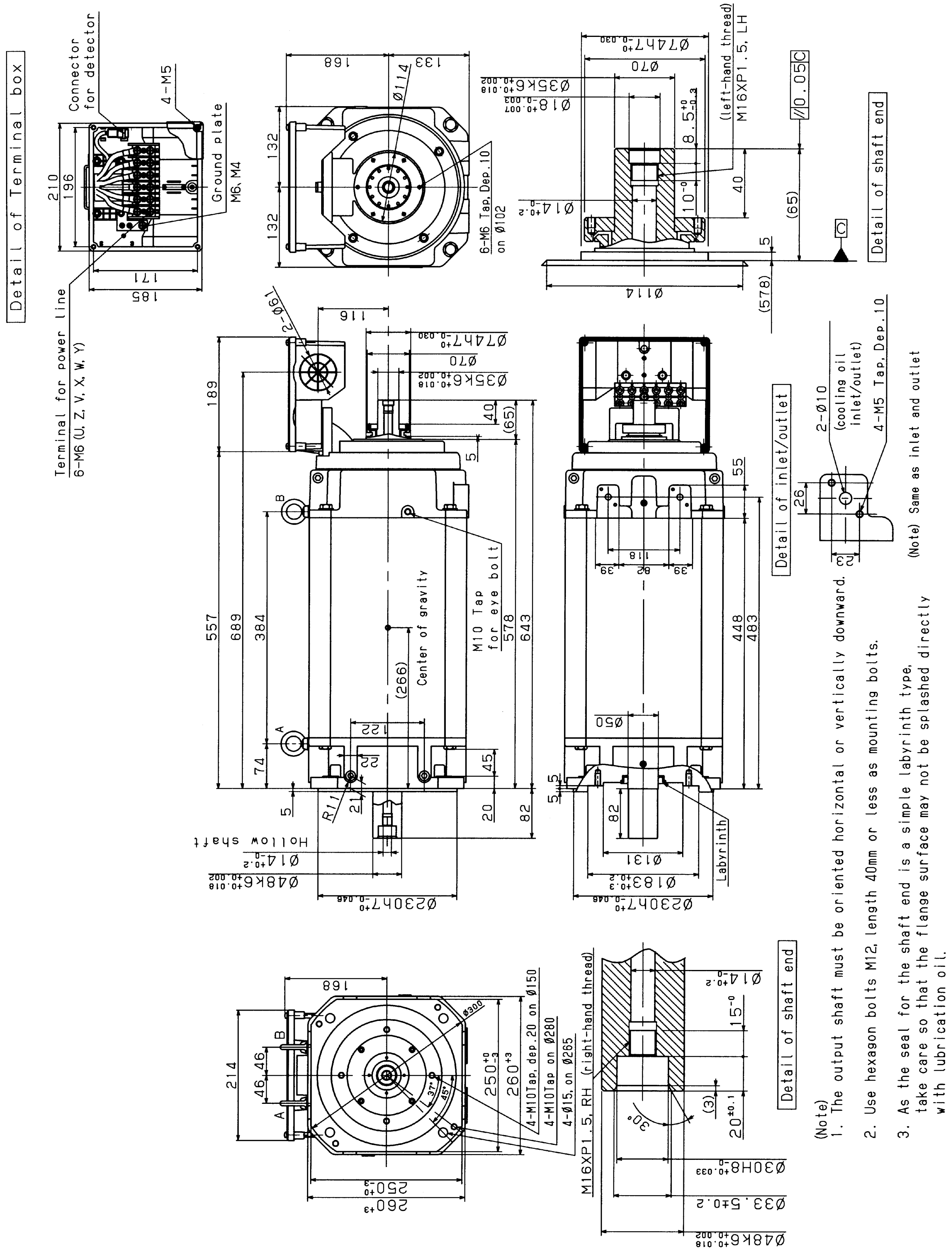
6.1 MODEL αiIL 8/20000HV



6.2 MODEL αiIL 15/15000HV



6.3 MODEL αiIL 26/15000HV



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Revision Record

FANUC AC SPINDLE MOTOR αi series DESCRIPTIONS (B-65272EN)

Edition	Date	Contents	Edition	Date	Contents
05	Sep., 2006	Changing of model names of following series αiI series, αiIP series, αiIT series, and αiIL series Increase of torque of short-time rating at low speed in αiI series			
04	Mar., 2003	Changing of model names of following series αiP series, αiT series, αiL series, α(HV)iP, α(HV)iT, and α(HV)iL series Deleting of αCi series			
03	Sep., 2002	Addition of following series αLi series and αL(HV)i series			
02	Dec., 2001	Addition of following series Large type of αi series, αCi series, α(HV)i series, αP(HV)i series, and αT(HV)i series			
01	Jul., 2001	————			