GE Fanuc Automation

Computer Numerical Control Products

AC Spindle Motor αi Series

Descriptions

GFZ-65272EN/04 March 2003

Warnings, Cautions, and Notes as Used in this Publication

Warning

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

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

Caution

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

Note

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

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

1.1 DEFINITION OF WARNING, CAUTION, AND NOTE

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

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

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

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

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

1.2 WARNING

⚠ WARNING

- Be safely dressed when handling a motor.

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

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

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

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.

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

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

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

1.3 CAUTION

⚠ **CAUTION**

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

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

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

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

- 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.

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

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

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

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

- Be sure to connect motor cables correctly.

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

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

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

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

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

⚠ 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.

1.4 NOTE

NOTE

- Do not step or sit on a motor.

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

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

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

- Do not remove a nameplate from a motor.

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

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

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

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

Such a test can damage elements in the sensor.

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

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

- Do not disassemble a motor.

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

- Do not modify a motor.

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

- Use a motor under an appropriate environmental condition.

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

NOTE

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

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

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

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

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

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

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

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

MOTOR INSULATION RESISTANCE MEASUREMENT

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

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* series	α0.5/10000*i*, α1/10000*i*, α1.5/10000*i*, α2/10000*i*, α3/10000*i*, α6/10000*i*, α8/8000*i*, α12/7000*i*, α15/7000*i*, α18/7000*i*, α22/7000*i*, α30/6000*i*, α40/6000*i*, α50/4500*i*, α1/15000*i*, α1.5/15000*i*, α2/15000*i*, α3/12000*i*, α6/12000*i*, α8/10000*i*, α12/10000*i*, α15/10000*i*, α18/10000*i*, α22/10000*i*
α*i*P series	α12/6000*i*P, α15/6000*i*P, α18/6000*i*P, α22/6000*i*P, α30/6000*i*P, α40/6000*i*P, α50/6000*i*P, α60/4500*i*P, α12/8000*i*P, α15/8000*i*P, α18/8000*i*P, α22/8000*i*P
α*i*T series	α1.5/15000*i*T, α2/15000*i*T, α3/12000*i*T, α6/12000*i*T, α8/12000*i*T, α8/15000*i*T, α15/10000*i*T, α15/12000*i*T, α22/10000*i*T
α*i*L series	α8/20000*i*L, α15/15000*i*L, α26/15000*i*L
α(HV)*i* series	α0.5/10000HV*i*, α1/10000HV*i*, α1.5/10000HV*i*, α2/10000HV*i*, α3/10000HV*i*, α6/10000HV*i*, α8/8000HV*i*, α12/7000HV*i*, α15/7000HV*i*, α22/7000HV*i*, α30/6000HV*i*, α40/6000HV*i*, α60/4500HV*i*, α100/4000HV*i*
α(HV)*i*P series	α15/6000HV*i*P, α22/6000HV*i*P, α40/6000HV*i*P, α50/6000HV*i*P, α60/4500Hv*i*P
α(HV)*i*T series	α1.5/15000HV*i*T, α2/15000HV*i*T, α3/12000HV*i*T, α6/12000HV*i*T, α8/12000HV*i*T, α8/15000HV*i*T, α15/10000HV*i*T, α15/12000HV*i*T, α22/10000Hv*i*T
α(HV)*i*L series	α8/20000HV*i*L, α15/15000HV*i*L, α26/15000HV*i*L

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IX. FANUC AC SPINDLE MOTOR α(HV)*i*L SERIES

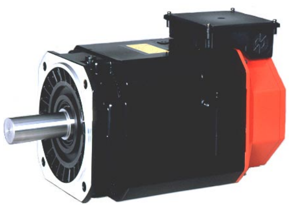
I. DESCRIPTIONS FOR THE αi SERIES

1 GENERAL

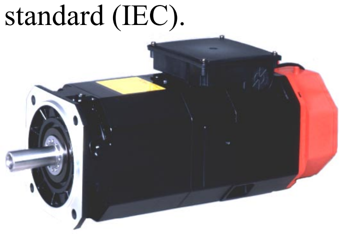
As motors for driving the spindle of a CNC machine tool, the FANUC AC Spindle Motor α*i* series has incorporated accumulated technologies and employs the latest design and manufacturing techniques to provide the features listed below.

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 α*i* 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 α*i*P 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 α*i* series, the cooling air path is optimized to further improve cooling performance.
- Two types of speed sensors built into the motor are available: M*i* sensor based on the A/B-phase signal and MZ*i* 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).



α*i* series

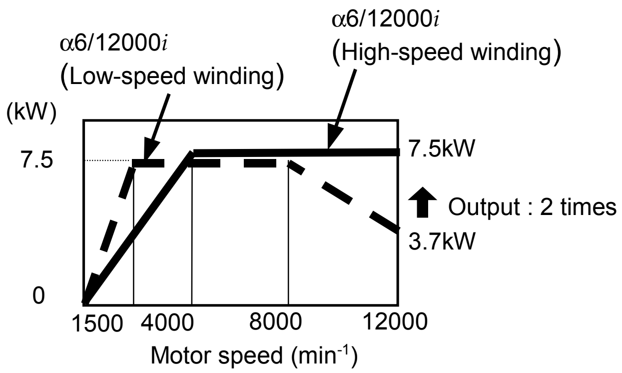


α*i*T series

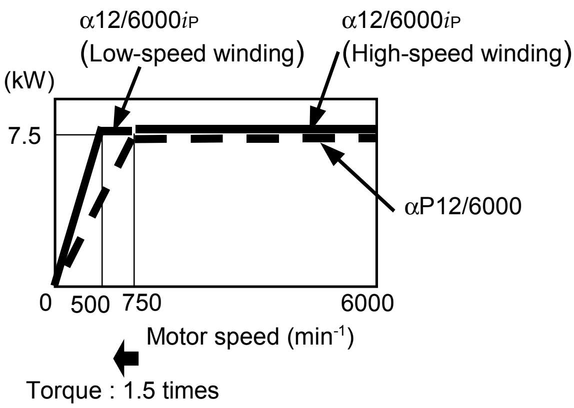
Features of αi

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

αi, αiT : Remarkable output increase in the high-speed area by employing a high-speed winding.
→ Enables highly efficient cutting and acceleration time reduction



αiP: 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.

Feature

Series	Rated output	Feature	Example of applicable machine
αi	0.55 to 45	Standard motors for machine-tool spindles	For Lathe and Machining center
αiP	5.5 to 30	Motors with constant output over a wide range, which require no reduction units	
α(HV)i	0.55 to 100	αi series directly connectable to a 400 V power supply	
αiT	1.5 to 22	Model for direct spindle connection used with machining centers	For Machining center
αiL	7.5 to 30	Liquid-cooled model for direct spindle connection used with high precision machining centers	

Lineup for αi series spindle motor

Continuous rated output	αi		αiP	αiT	αiL	α(HV)i	α(HV)iP	α(HV)iT	α(HV)iL
0.55	**α0.5/ 10000i**					**α0.5/ 10000HVi**			
1.1	**α1/ 10000i**	α1/ 15000i				**α1/ 10000HVi**			
1.5	**α1.5/ 10000i**	α1.5/ 15000i		α1.5/ 15000iT		**α1.5/ 10000HVi**		α1.5/ 15000HViT	
2.2	**α2/ 10000i**	α2/ 15000i		α2/ 15000iT		**α2/ 10000HVi**		α2/ 15000HViT	
3.7	**α3/ 10000i**	α3/ 12000i		α3/ 12000iT		**α3/ 10000HVi**		α3/ 12000HViT	
5.5	**α6/ 10000i**	α6/ 12000i	α12/ 6000iP	α6/ 12000iT		**α6/ 10000HVi**		α6/ 12000HViT	
7.5	**α8/ 8000i**	**α8/ 10000i**	α15/ 6000iP	α8/ 12000iT	α8/ 20000iL	**α8/ 8000HVi**	α15/ 6000HViP	α8/ 12000HViT	α8/ 20000HViL
9			α18/ 6000iP						
11	**α12/ 7000i**	**α12/ 10000i**	α22/ 6000iP			**α12/ 7000HVi**	α22/ 6000HViP		
15	**α15/ 7000i**	**α15/ 10000i**	**α30/ 6000iP**	α15/ 12000iT	α15/ 15000iL	**α15/ 7000HVi**		α15/ 12000HViT	α15/ 15000HViL
18.5	**α18/ 7000i**	**α18/ 10000i**	**α40/ 6000iP**				α40/ 6000HViP		
22	**α22/ 7000i**	**α22/ 10000i**	**α50/ 6000iP**	α22/ 10000iT		**α22/ 7000HVi**	α50/ 6000HViP	α22/ 10000HViT	
30	**α30/ 6000i**		α60/ 4500iP		α26/ 15000iL	**α30/ 6000HVi**	α60/ 4500HViP		α26/ 15000HViL
37	α40/ 6000i					α40/ 6000HVi			
45	α50/ 4500i								
60						α60/ 4500HVi			
100						**α100/ 4000HVi**			

15000 Highest-speed upgraded model   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	M*i* 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 Module (SPM)” in the SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN)
	MZ*i* 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:

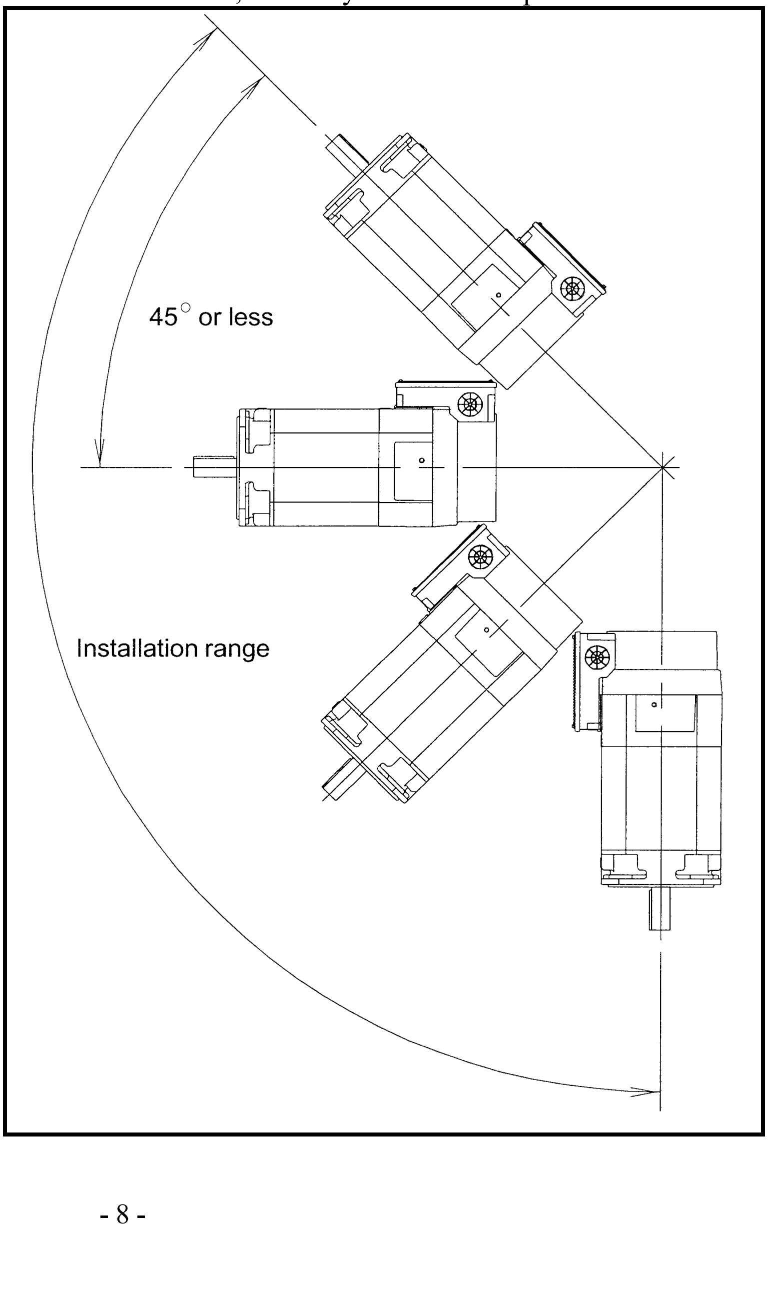
⚠ WARNING

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 single motor, (gear and pulley may be attached).

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

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

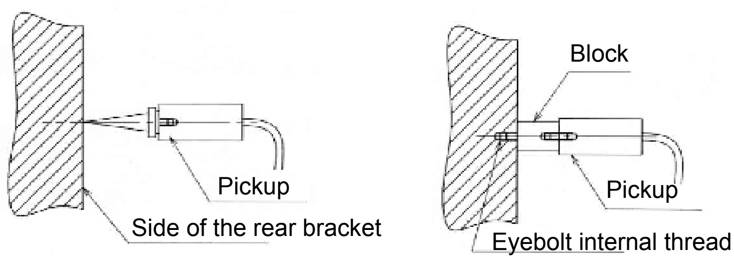
10 to 1000 Hz

Criteria: 0.5 G (4.9 m/s^2) or less at the rear bracket

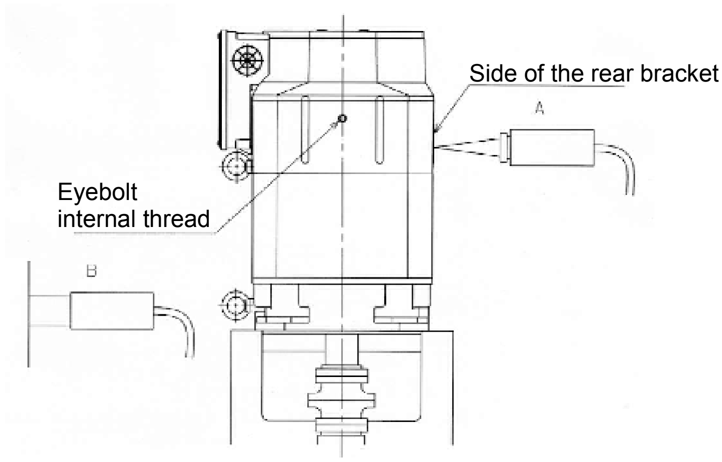
1. Using a pickup

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

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



2. Vibration measurement position (rear bracket)



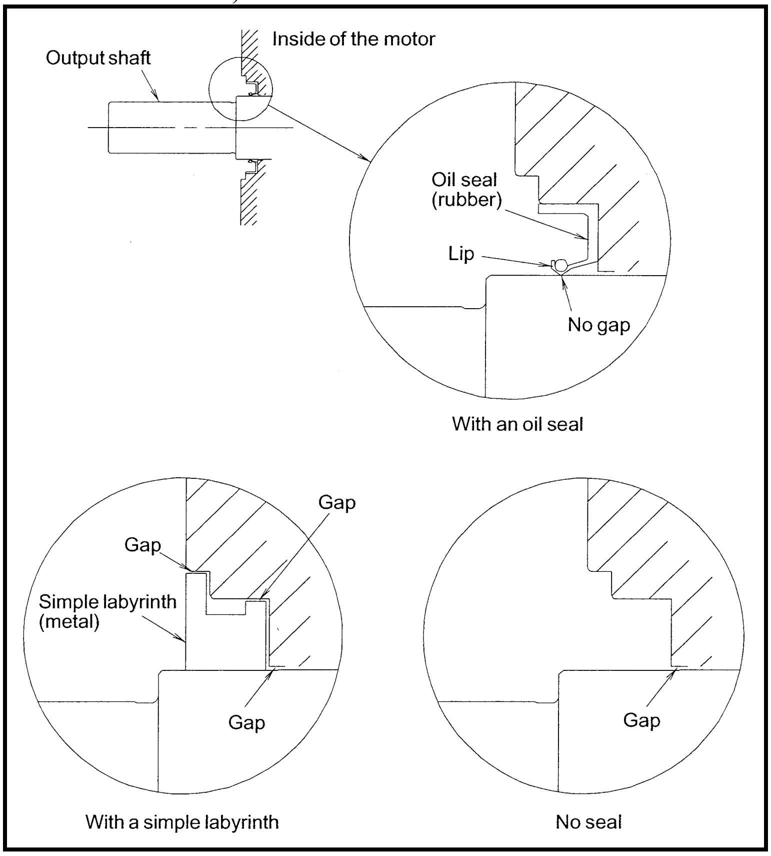
6 Dynamic balance
During high-speed operation, a small imbalance may cause a large vibration, resulting in an unusual sound, premature bearing damage, or some other abnormality.
Therefore, reduce the amount of the imbalance with the dynamic balance of the other rotation shafts, as well as the gear and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

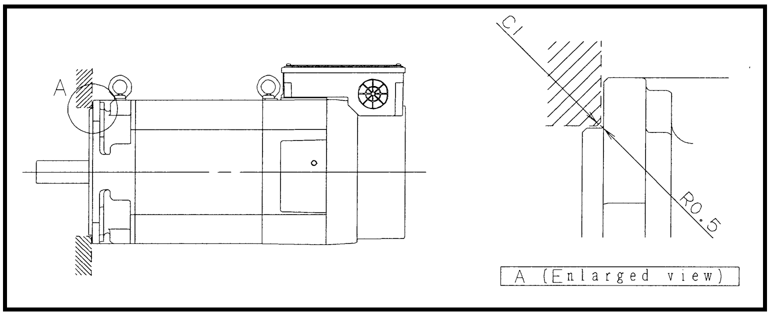


For those models with an oil seal, ensure that the surface of the lubricant is below the lip of the oil seal.

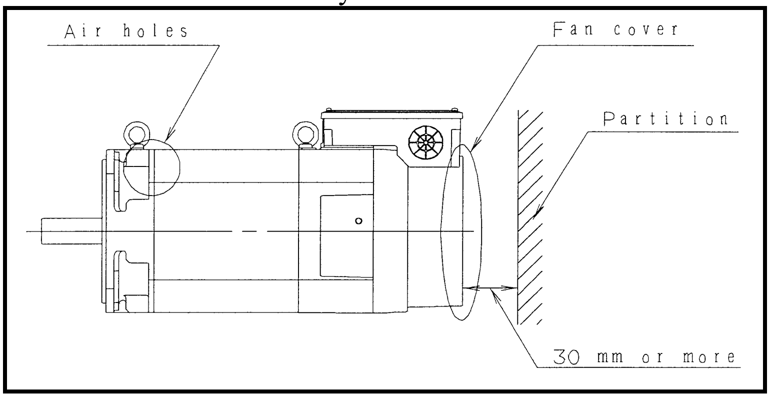
If a simple labyrinth is used as the output shaft seal (high-speed model) or if no seal is provided (foot mounting type), ensure that lubricant does not splash onto the flange surface. (If such a motor is directly mounted on a gear box, the lubricant may gradually penetrate inside the motor even when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

8 The lid of the terminal box is provided with rubber gasket to make it waterproof.
Check that the lid has this gasket, then mount it on the terminal box.

9 The edge of the fauset joint to mount the flange mounting type motor should be chamfered about C1.



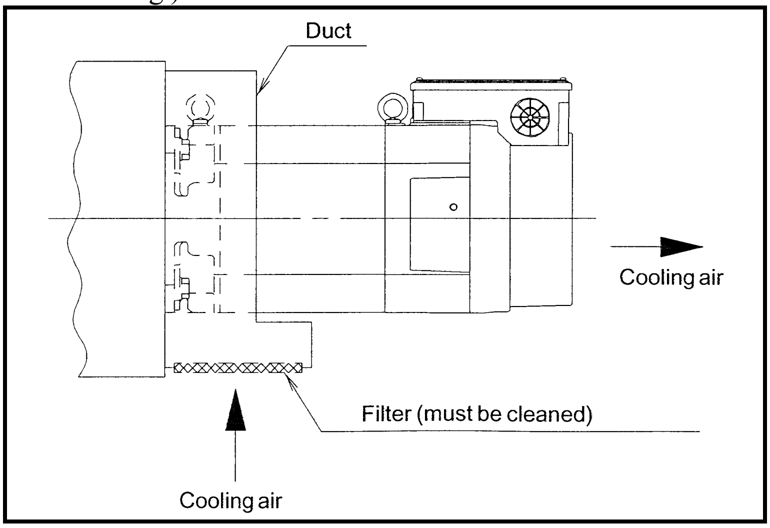
10 Please space 30 mm or more between the fan cover and the partition to keep the cooling ability well.
We recommend to take a structure such as you can clean air holes and the fan cover easily.



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

Example)

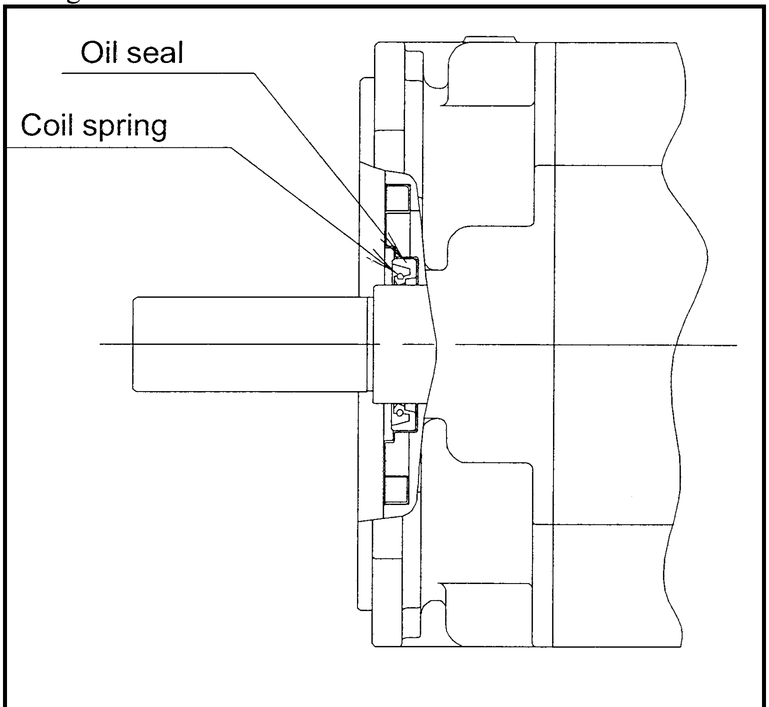
When a duct with a filter is installed on a flange mounting type motor with a rear exhaust (The filter requires periodic cleaning.)



NOTE

1 A foot mounting type motor has no oil seal. When an oil seal is required, add #0002 to the drawing number of the motor. An oil seal cannot be attached to any high-speed model, however. For details, refer to "Order List" (B-65271EN).
Example)
Model α12/7000*i* (foot mounting type, with no key, rearward exhaust)
A06B-1408-B200
A06B-1408-B200#0002 (with oil seal)

2 When the oil seal is not exposed to lubricant, remove the coil spring of the oil seal to decrease the friction between the lip and shaft.
There is no problem with dry dust sealing.
If the motor is turned at high speed with the contact section between the oil seal and shaft being dry, the contact section can make an abnormal sound (interfering sound), or the lip can be damaged.



Oil seal section

3 Cable wiring

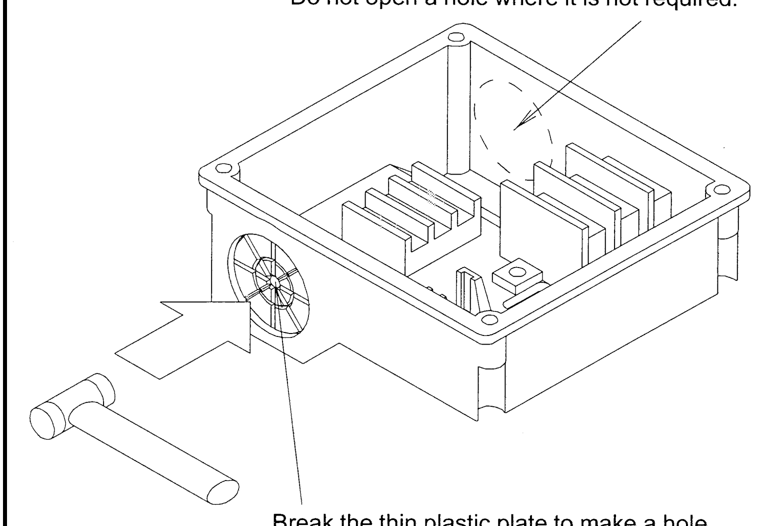
Follow the procedure below to install the cable.

(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.
Do not open a hole where it is not required.
Break the thin plastic plate to make a hole.

Model	Ordering number
α1*i* to α15*i* , α12*i*P to α22*i*P α1.5/15000*i*T to α15/10000*i*T α6HV*i* to α22HV*i* α15HV*i*P , α22HV*i*P α1.5/15000HV*i*T to α22/10000HV*i*T α8/20000*i*L , α8/20000HV*i*L	A06B-0754-K001
α18*i*, α22*i*, α30*i*P, α40*i*P, α50*i*P α40HV*i*P , α50HV*i*P α15/12000*i*T, α22/10000*i*T α15/15000*i*L, α26/15000*i*L α15/15000HV*i*L, α26/15000HV*i*L	A06B-0731-K001

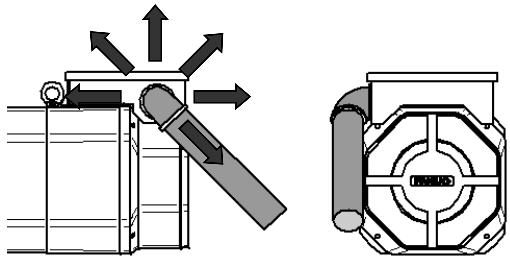
High-speed models are same as above.

*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.)

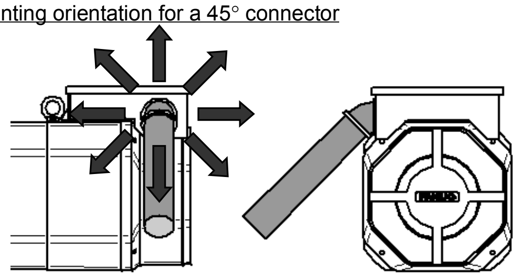
Applicable models :

α12*i* to α15*i*, α12*i*P to α22*i*P, α15/10000*i*T,
α12HV*i* to α22HV*i*, α15/6000HV*i*P to α22/6000HV*i*P,
α15/10000HV*i*T, α15/12000HV*i*T, α22/10000HV*i*T

Conduit mounting orientation for a 90° connector



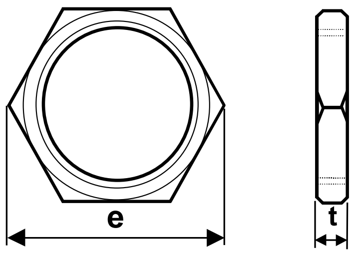
Conduit mounting orientation for a 45° connector



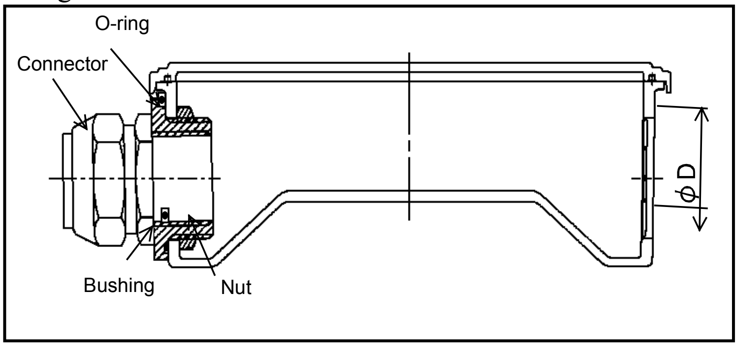
*2 The nut used to fasten the connector to the terminal box must be smaller than the size listed below. (Any larger nut interferes with the terminal box.) For the diameter of the cable hole in each model, refer to the outside dimension drawing of the respective models.

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)

Outside dimensions of the conduit-connector retaining nut



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

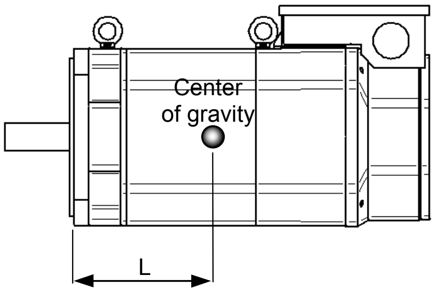


Cable hole diameter φD	O-ring code	
	JIS B 2401	ISO 3601-1
φ42.5 mm	P46	C0462G
φ61 mm	P65	C0650G

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

4 Center of gravity

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



α*i* series	α*i*P series	α (HV)*i* series	α(HV)*i*P series	Center of gravity [mm]
α0.5/10000*i*	-	α0.5/10000HV*i*	-	95±5
α1/10000*i* α1/15000*i*	-	α1/10000HV*i*	-	125±5
α1.5/10000*i* α1.5/15000*i*	-	α1.5/10000HV*i*	-	145±5
α2/10000*i* α2/15000*i*	-	α2/10000HV*i*	-	125±5
α3/10000*i* α3/12000*i*	-	α3/10000HV*i*	-	170±5
α6/10000*i* α6/12000*i*	-	α6/10000HV*i*	-	150±5
α8/8000*i* α8/10000*i*	-	α8/8000HV*i*	-	185±5
α12/7000*i* α12/10000*i*	α12/6000*i*P α12/8000*i*P	α12/7000HV*i*	-	160±5
α15/7000*i* α15/10000*i*	α15/6000*i*P α15/8000*i*P	α15/7000HV*i*	α15/6000HV*i*P	
α18/7000*i* α18/10000*i*	α18/6000*i*P α18/6000*i*P	-	-	
α22/7000*i* α22/10000*i*	α22/6000*i*P α22/8000*i*P	α22/7000HV*i*	α22/6000HV*i*P	
α30/6000*i*	α30/6000*i*P	α30/6000HV*i*	-	
α40/6000*i*	α40/6000*i*P	α40/6000HV*i*	α40/6000HV*i*P	
-	α50/4500*i*P	-	α50/6000HV*i*P	
α50/4500*i*	-	-	-	
-	α60/4500*i*P	α60/4500HV*i*	α60/4500HV*i*P	
-	-	α100/4000HV*i*	-	

4.2 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 α15/12000*i*T and α*i*L series motors).

   The output switching type motors in the α*i* series, α*i*P series, and α(HV)*i*P series come standard with jumpers in the terminal box. If you want to any other output switching type motor, place an order for jumpers according to the following list.

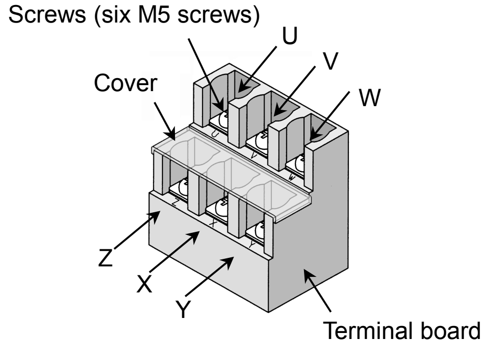
Terminal size	Specification of the winding to be used	Ordering number	Required quantity
M5	Low-speed winding	A65L-0001-0630/SS	1
M5	High-speed winding	A65L-0001-0630/SD	3
M6	Low-speed winding	A290-1410-X416	1
M6	High-speed winding	A290-1410-X417	3

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**

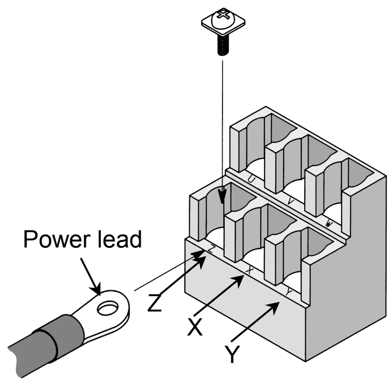
The terminal board has two rows. The U-, V-, and W-phase leads can be connected to the upper row, while the Z-, X-, and Y-phase wires can be connected to the lower row.



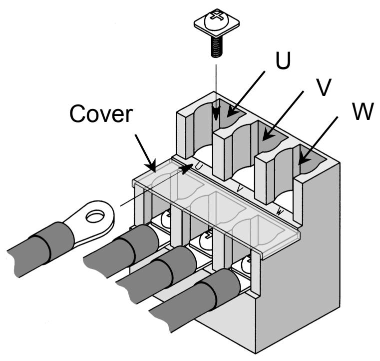
1) Using the motor by switching its output
To use the motor by switching its output, connect the six power leads (the U-, V-, W-, X-, Y-, and Z-phase wires) respectively to the terminal board screws marked U, V, W, X, Y, and Z.
(For the α15/12000iT and αiL series motors, the terminal board screws are 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.



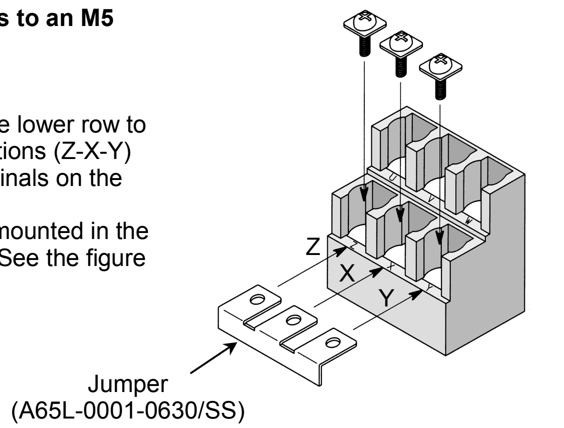
<2> Attaching power leads to the upper row
After putting the cover on the lower row, attach the U-, V-, and W-phase power leads to the upper row and fasten them with the



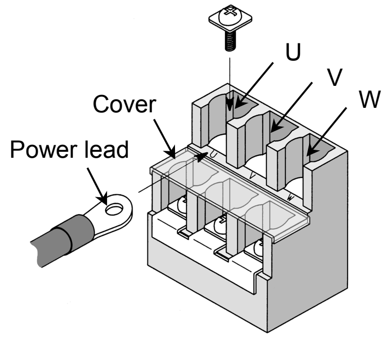
2) Using the motor by energizing it only with the low-speed winding (Y connection) rather than switching its output

• **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.
The jumper must be mounted in the specified orientation. See the figure at the right.

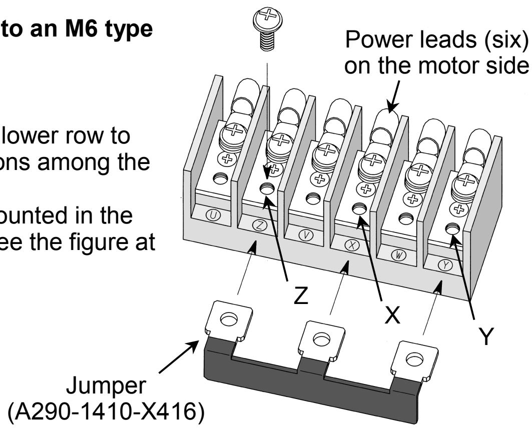


<2> Attaching power leads
After putting the cover on the lower row, attach the U-, V-, and W-phase power leads to the upper row and fasten them with the screws.

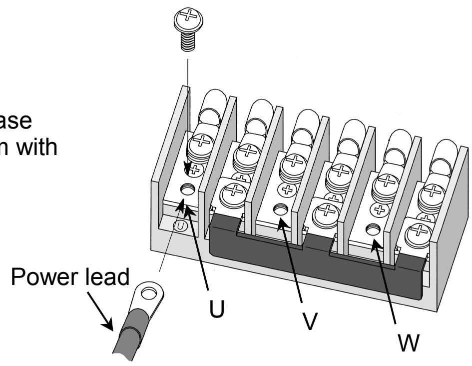


• **Connecting power leads to an M6 type terminal board**

<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.



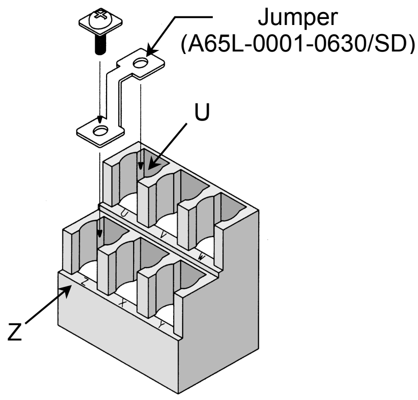
<2> Attaching power leads
Attach the U-, V-, and W-phase power leads and fasten them with the screws.



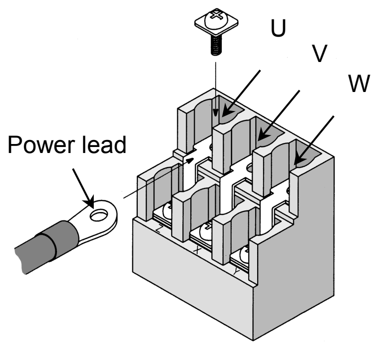
3) Using the motor by energizing it only with the high-speed winding (Δ connection) rather than switching its output

• 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.
The jumpers must be mounted in the specified orientation. See the figure at the right.

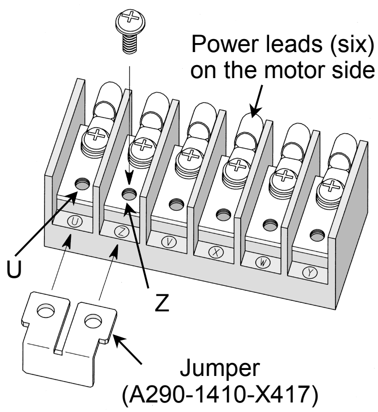


<2> Attaching power leads
Attach the U-, V-, and W-phase power leads to the upper row and fasten them with the screws.
No cover need be put on the lower row.

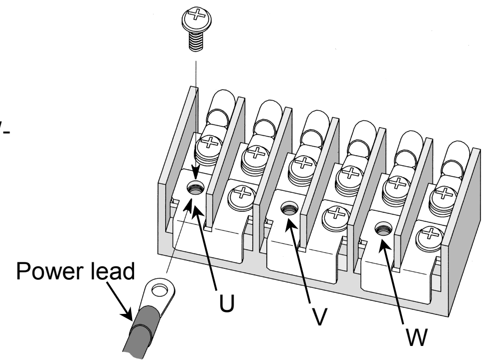


• Connecting power leads to an M6 type terminal board

<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.



4.3 FAN MOTOR CONNECTION

αi, αiP, αiT series spindle motor models	50Hz Rated voltage [V]	50Hz Rated current [A]	50Hz Surge current [Ap-p]	60Hz Rated voltage [V]	60Hz Rated current [A]	60Hz Surge current [Ap-p]
α1i, α1.5i, α1.5iT	240	0.15	0.47	240	0.12	0.48
α2i, α3i, α2iT, α3iT	200	0.10	0.41	200	0.10	0.40
α6i, α8i, α6iT, α8iT	200	0.13	0.50	200	0.14	0.51
α12i to α22i, α12iP to α22iP, α15iT, α22iT	200	0.22	1.15	200	0.32	1.10
α30i, α40i, α30iP, α40iP, α50iP	200	0.65	3.12	200	0.8	3.06
α50i, α60i, α60iP	200	0.75	3.96	200	0.75	3.68

α(HV)i, α(HV)iP, α(HV)iT series spindle motor models	50Hz Rated voltage [V]	50Hz Rated current [A]	50Hz Surge current [Ap-p]	60Hz Rated voltage [V]	60Hz Rated current [A]	60Hz Surge current [Ap-p]
α1HVi, α1.5HVi, α1.5HViT	200	0.09		230	0.11	
α2HVi, α3HVi, α2HViT, α3HViT	200	0.11		230	0.13	
α6HVi, α8HVi, α6HViT, α8HViT	400	0.07	0.31	480	0.08	0.37
α12HVi to α22HVi, α15HViP, α22HViP, α15HViT, α22HViT	400	0.20	0.97	480	0.24	1.22
α30HVi, α40HVi, α100HVi (circumference fan), α40HViP, α50HViP	380	0.30	1.86	380	0.35	1.82
α60HVi, α60HViP	380	0.30	2.18	380	0.30	1.98
α100HVi (back fan)	400	0.30		400	0.36	

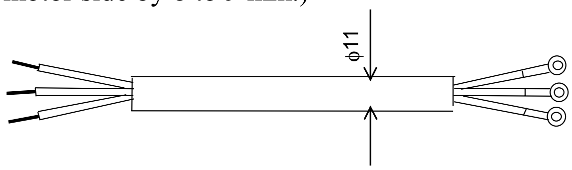
NOTE
1 The term "surge current" represents a peak-to-peak current that flows when the power is turned on.
2 The values listed below are a rough standard. They are not guaranteed.

Cable for the fan motor

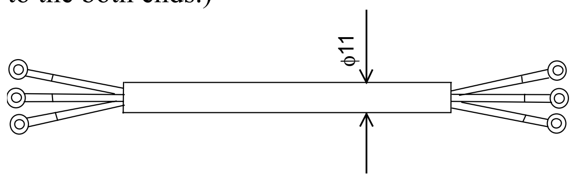
The machine tool builder is to prepare the following cable for the fan motor:

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

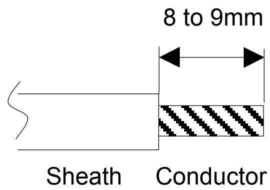
<1> For a non-screw terminal block (Peel off each wire sheath on the motor side by 8 to 9 mm.)



<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

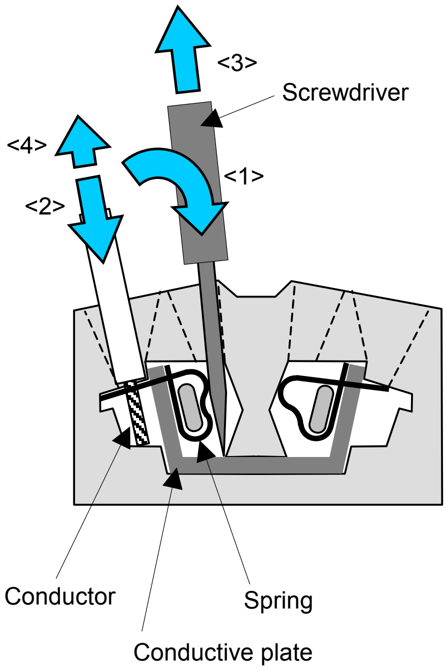


Peel-off length of a wire sheath

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.

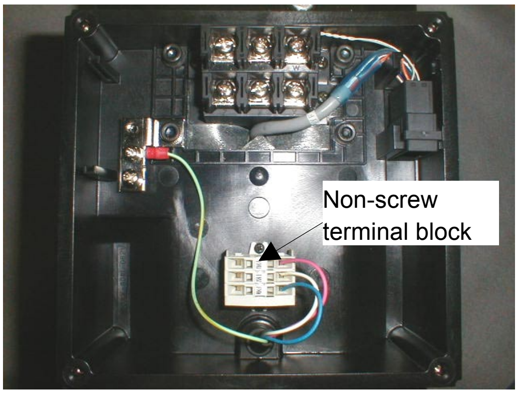
<2> Check the peel-off length (8 to 9 mm), then insert the wire into the wire insertion slot (large rectangular hole) until it stops, by sliding the wire along the outer side of the hole slowly so that the conductor does not become loose. Be careful not to push a thin wire excessively.

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

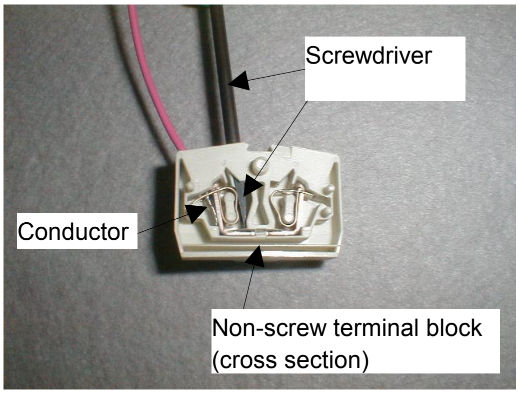
<4> By slightly pulling the wire, check that the wire is connected firmly. The wire need not be pulled intensely.

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

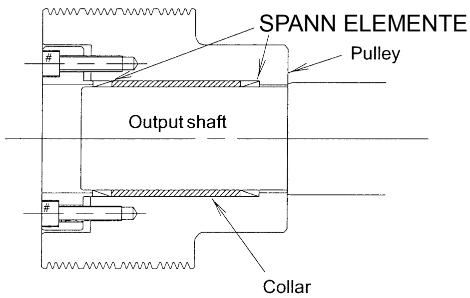
4.4 WHEN A MOTOR IS CONNECTED TO A SPINDLE VIA A BELT

⚠ CAUTION

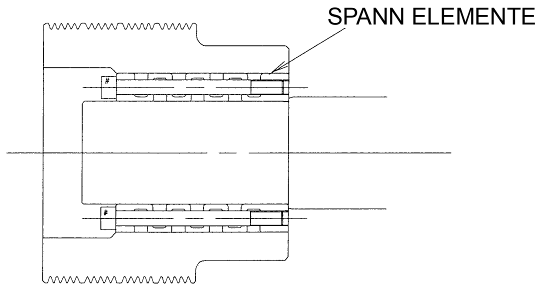
1 Mounting the pulley
- The gap between the inner surface of the motor pulley and output shaft should be 10μm to 15μm.
- If the gap is large when the high-speed rotation (4500 min^{-1}), fretting produced at the gap causes a large vibration, resulting in damage to the motor bearing.
- As the vibration 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.

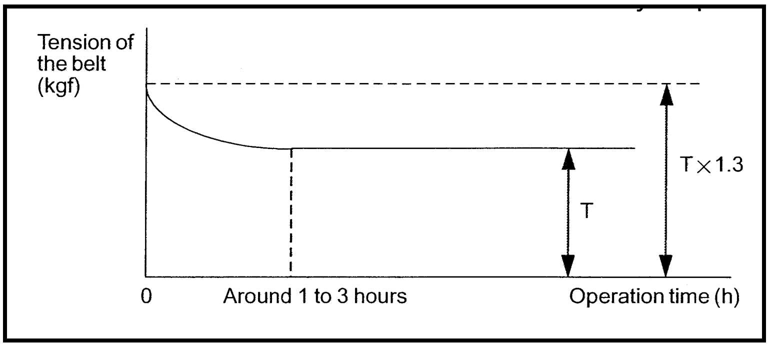


2 After attaching a pulley to the motor, adjust the vibration of the belt groove to within 20 μm (T.I.R).

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.



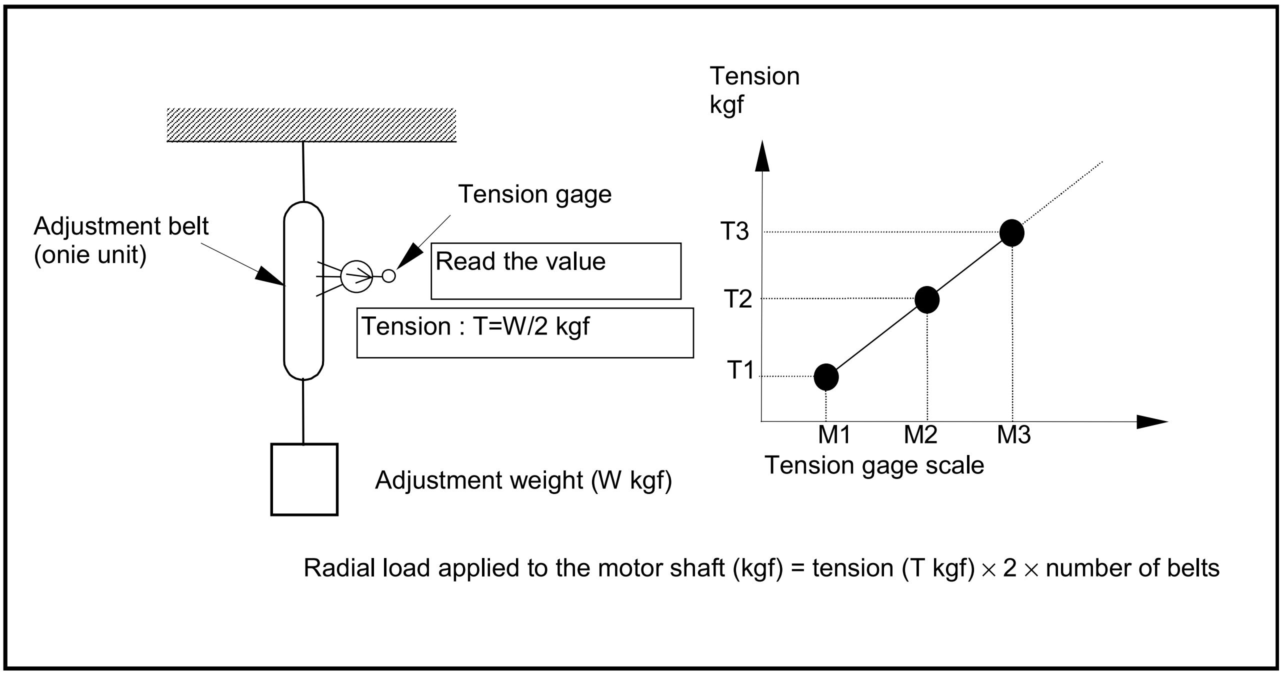
Recommended belts:

Ribace manufactured by BANDO.

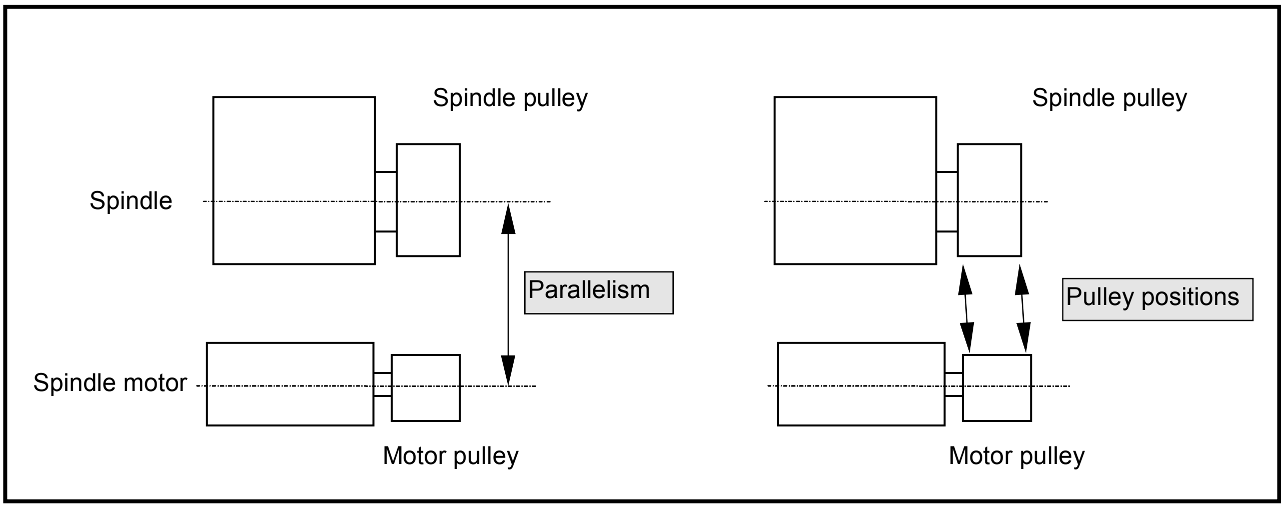
Ribstar manufactured by MITSUBOSHI.

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.



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

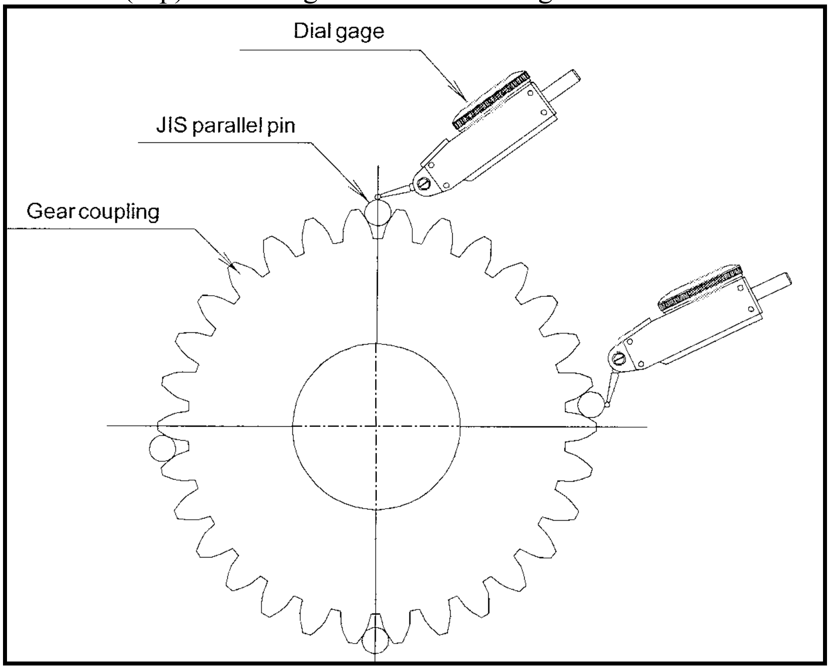
⚠ CAUTION

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.

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

⚠ CAUTION

1 Use a coupling which can absorb thermal expansion in the axial direction of the motor mating shaft so that no load is applied in the motor axial direction.
(Examples)
- Diaphragm coupling (EAGLE INDUSTRY CO., LTD.)
- Oldham's coupling
- Gear coupling

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

3 It is important to perform centering and obtain parallelism to avoid having to recourse to the flexibility of the coupling.
At high speeds, any eccentricity may cause the bearing to fail prematurely.

4 Check all machines before shipping to confirm that the vibration acceleration is 0.5 G or less when measured using the method described in CAUTION 4 of Section 4.1.

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.

⚠ CAUTION

1 After a continuous and long operation, the temperature of model $\alpha 0.5i$ 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.

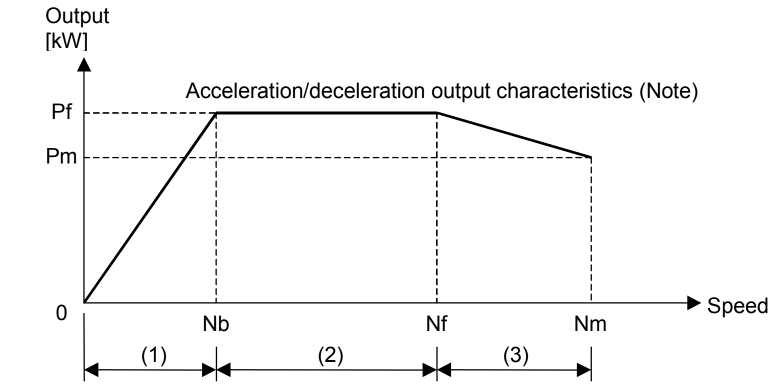
3 Cooling
Clean off dust from the cooling air inlet and outlet of the stator every year, and check the flow of air carefully.

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.
- When an αCi series motor is used or if the machine load torque is high, use the 30-minute rated output as is.
- 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)

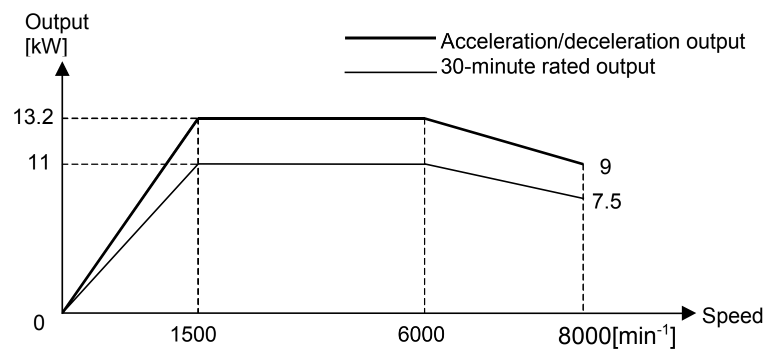
$$t3=0.10754\times\frac{(JL+Jm)\times(Nm-Nf)}{(Pm-Pf)\times 1000}\times\{(Nm-Nf)-\frac{Pf\ Nm-Pm\ Nf}{Pm-Pf}\times Ln(Pm/Pf)\}\ [sec]$$

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 α8/8000*i* 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 α8/8000*i* 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**
> For all models, these are not guaranteed values but guidelines. In case of αC*i* series, use 30 min rated output for Pf and Pm (10 min or 15 min rated output for some models) must be adjusted. 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·m·sec^2]. Then the acceleration times are as follows:

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

$$t1=0.10754\times\frac{(0.0056+0.0028)\times 1500^2}{13.2\times 1000}=0.154[\mathrm{sec}]$$

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

$$t2=0.10754\times\frac{(0.0056+0.0028)\times(6000^2-1500^2)}{2\times 13.2\times 1000}$$
$$=1.155[\mathrm{sec}]$$

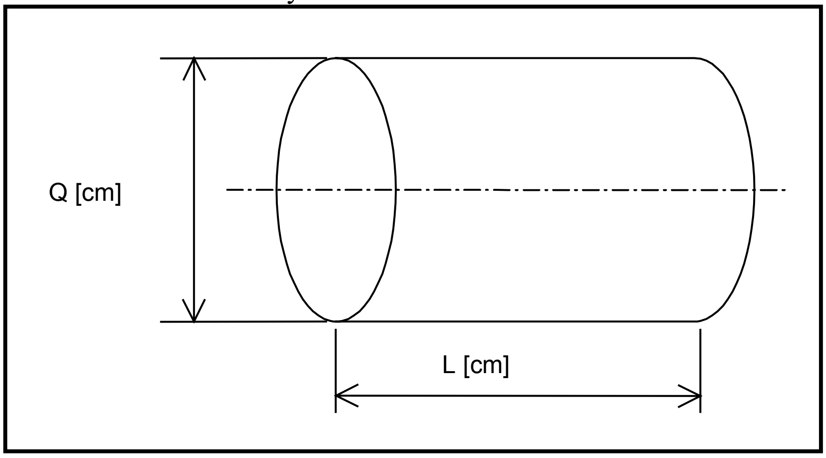
- Acceleration time (t3) in the decreasing-output range (Nf to Nm)

$$t3=0.10754\times\frac{(0.0056+0.0028)\times(8000-6000)}{(9-13.2)\times 1000}$$
$$\times\{(8000-6000)-\frac{13.2\times 8000-9\times 6000}{9-13.2}\times \mathrm{Ln}(9/13.2)\}$$
$$=1.164[\mathrm{sec}]$$

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.



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

When steel (γ=7.8×10^{-3} kgf/cm^3) is used, the approximate inertia is obtained from the following equation.

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

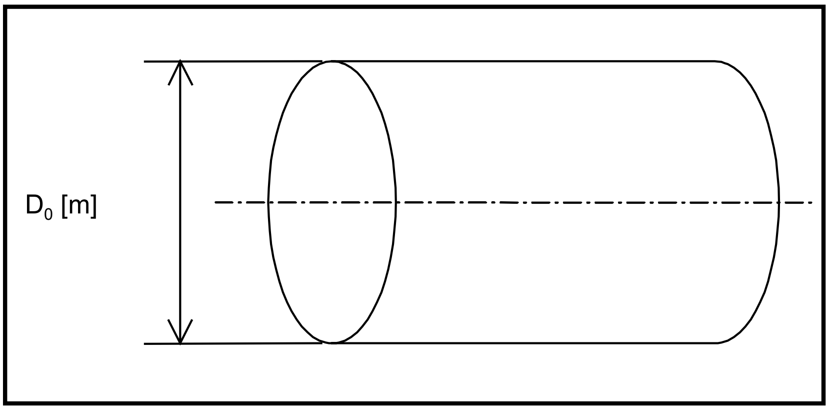
When the unit for J is changed.

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

Reference 2

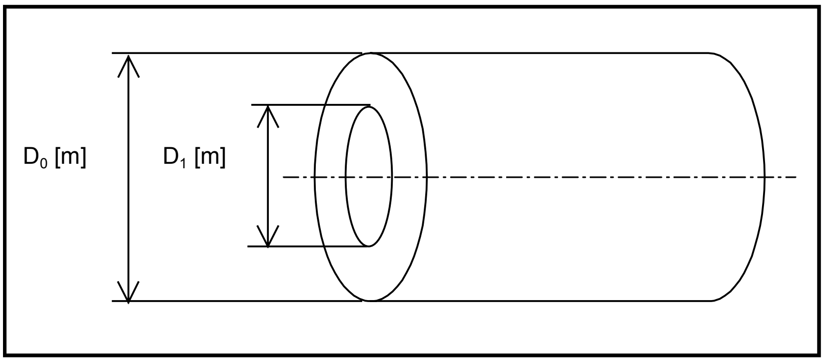
To obtain the value GD^2 [kgf·m^2] for cylinder, get the value of G from its weight in kilograms and use the following equation to get the value of D^2.

- 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]

$$
\begin{aligned}
J[\text{kgf·cm·sec}^2] &= GD^2\ [\text{kgf·m}^2]/4/g\times 100\\
&= GD^2\ [\text{kgf·m}^2]/4/9.8\times 100\\
&= GD^2\ [\text{kgf·m}^2]\times 2.55
\end{aligned}
$$

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:

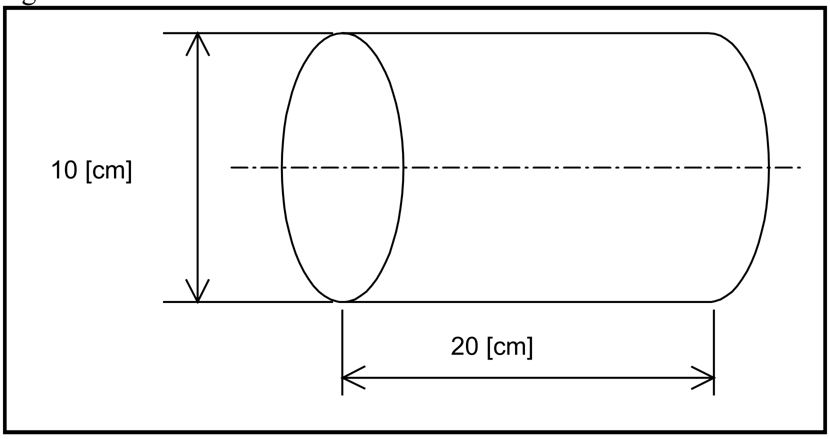
J[kgf·cm·sec^2] = GD^2 [kgf·m^2]/4/g×100
= I [kg·m^2]/g×100
= I [kg·m^2]/9.80×100
= I [kg·m^2] ×10.2

> **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 = $\pi\gamma$ /(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]

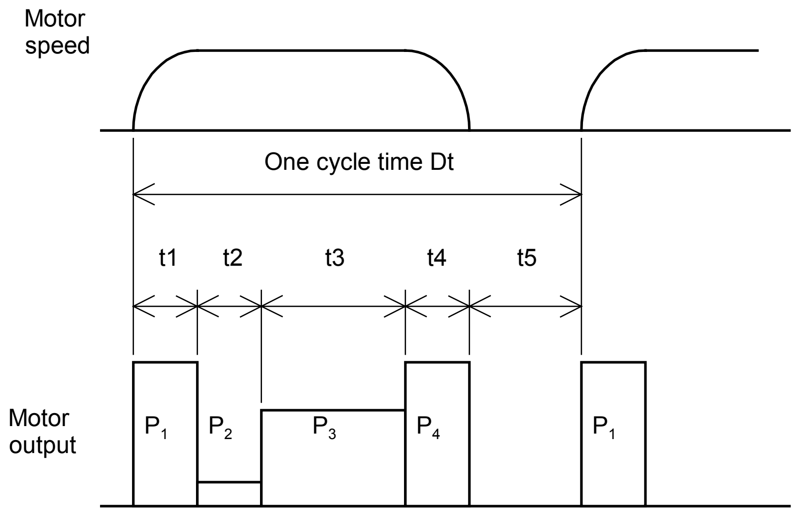
D^2 = D$_0^2$/2
= 0.1^2/2
= 0.005[m^2]

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].

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

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

Example)

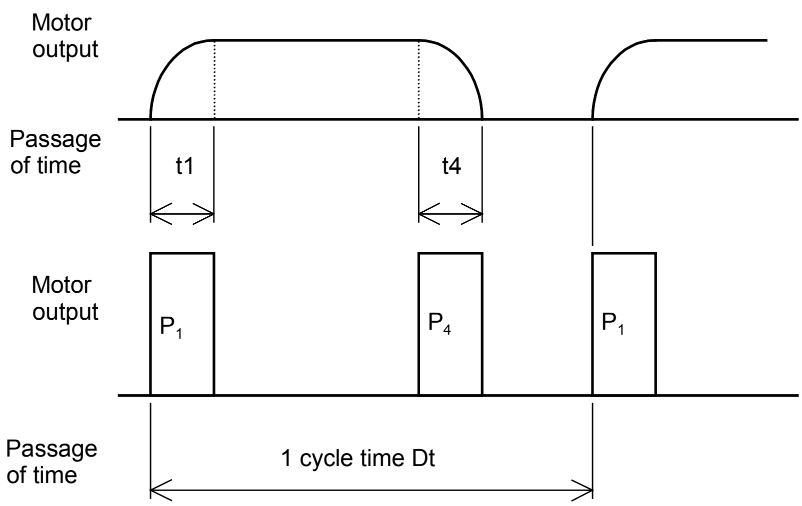
To obtain the allowable duty cycle when model $\alpha 3i$ accelerates and decelerates repeatedly without load ($P_2=P_3=0$).

- 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 $\alpha 3i$ accelerates and decelerates repeatedly, the allowable duty cycle time is 19 seconds.

Allowable duty cycle time Dt for repeated acceleration/deceleration



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

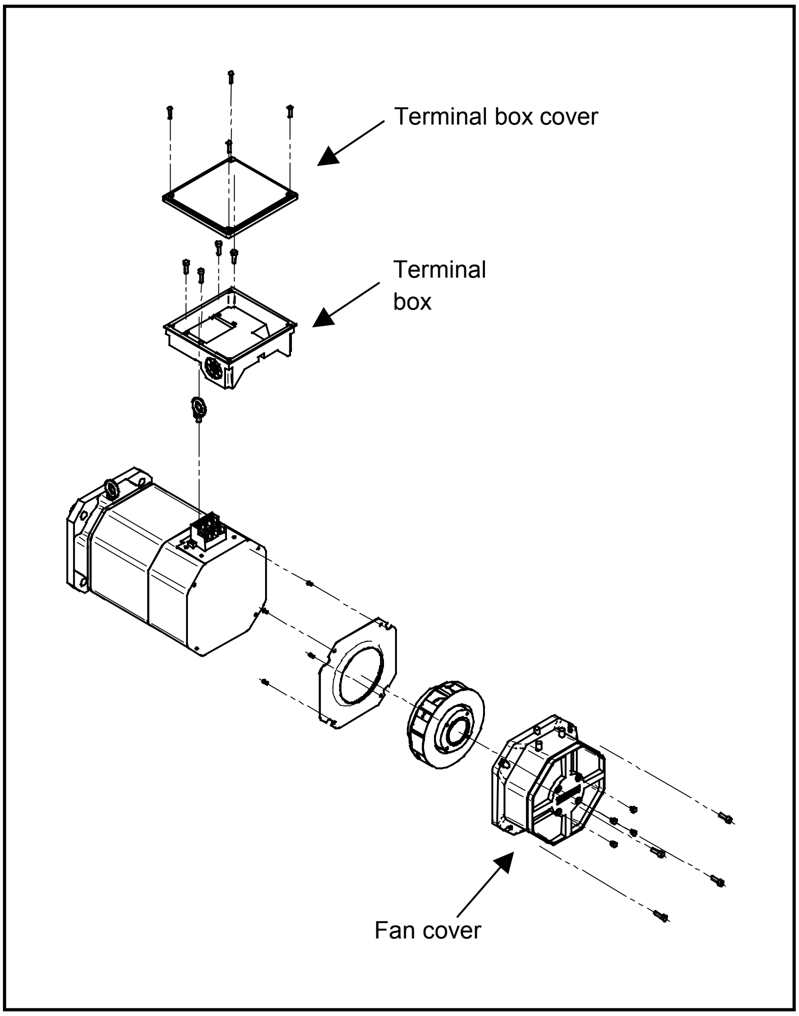
P_{cont} : Continuous rated output
P_{30min} : 30-minute rated output
t1+t4 : Sum of the acceleration and deceleration time

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 αi SERIES

1 GENERAL

The FANUC AC spindle motor αi series 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 M*i* sensor or MZ*i* 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		αi series		
Item / Model		**α0.5/10000*i***	**α1/10000*i***	**α1.5/10000*i***
Output (*2)	Cont. rated kW (HP)	0.55 (0.74)	1.5 (2.0)	1.1 (1.5)
	30 min rated [15 min, 10min] (*3) kW (HP)	1.1 (1.5)	2.2 (3.0)	3.7 (5.0)
	S3 60% [40%,25%] (*4)(*5) kW (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 (*3) S3 60% (*4)	11	13	28
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	17	
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		M*i* sensor or MZ*i* sensor		
Type of thermal protection (*10)		TP211		
Resolution of the MZ*i* 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 module		SPM-2.2*i*		SPM-5.5*i*
Model		α0.5/10000*i*	α1/10000*i*	α1.5/10000*i*

Series		αi series			
Item / Model		α2/10000*i*	α3/10000*i*	α6/10000*i*	α8/8000*i*
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 (*3) S3 60% (*4)	27	29	49	53
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		17		20	
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		M*i* sensor or MZ*i* sensor			
Type of thermal protection (*10)		TP211			
Resolution of the MZ*i* 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 module		SPM-5.5*i*		SPM-11*i*	
Model		α2/10000*i*	α3/10000*i*	α6/10000*i*	α8/8000*i*

Series		αi series			
Item	Model	**α12/7000*i***	**α15/7000*i***	**α18/7000*i***	**α22/7000*i***
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 (*3) S3 60% (*4)	64	82	95	111
Speed min^{-1}	Base speed	1500	1500	1500	1500
	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 (*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		M*i* sensor or MZ*i* sensor			
Type of thermal protection (*10)		TP211			
Resolution of the MZ*i* 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	26.4	31.2
Applicable spindle amplifier module		SPM-15*i*	SPM-22*i*		SPM-26*i*
Model		α12/7000*i*	α15/7000*i*	α18/7000*i*	α22/7000*i*

Series		αi series		
Item \ Model		**α30/6000*i***	**α40/6000*i***	**α50/4500*i***
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 (*3) S3 60% (*4)	155	185	236
Speed min^{-1}	Base speed	1150	1500	1150
	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 (*7)		Totally enclosed and fan cooled IC0A6		
Cooling fan W		84		90
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		M*i* sensor or MZ*i* sensor		
Type of thermal protection (*10)		TP211		
Resolution of the MZ*i* sensor /rev.		4096		
Number of detected gear teeth per rotation λ/rev.		256		
Bearing lubrication		Grease		
Maximum output during acceleration(*11) kW		44.4	54.0	66.0
Applicable spindle amplifier module		SPM-45*i*		SPM-55*i*
Model		α30/6000*i*	α40/6000*i*	α50/4500*i*

Series		αi series			
Item \ Model		**α1/15000*i***	**α1.5/15000*i***	**α2/15000*i***	**α3/12000*i***
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	15000	15000	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 (*7)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		17			
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		MZ*i* sensor (*12)			
Type of thermal protection (*10)		TP211			
Resolution of the MZ*i* sensor /rev.		2048			
Number of detected gear teeth per rotation λ/rev.		128			
Bearing lubrication		Grease			
Maximum output during acceleration(*11) kW		5.6	13	20	13
Applicable spindle amplifier module		SPM-5.5*i*	SPM-15*i*	SPM-22*i*	SPM-11*i*
Model		α1/15000*i*	α1.5/15000*i*	α2/15000*i*	α3/12000*i*

Series		αi **series**			
		α6/12000*i*(*1)		**α8/10000*i*(*1)**	
Item / **Model**		**Low-speed winding**	**High-speed winding**	**Low-speed winding**	**High-speed winding**
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 (*7)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		20			
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		M*i* sensor or MZ*i* sensor			
Type of thermal protection (*10)		TP211			
Resolution of the MZ*i* sensor /rev.		4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Maximum output during acceleration(*11) kW		9		13.2	
Applicable spindle amplifier module		SPM-11*i*			
Model		α6/12000*i*		α8/10000*i*	

Series		αi series			
Item / Model		**α12/10000*i*(*1)**		**α15/10000*i*(*1)**	
		Low-speed winding	**High-speed winding**	**Low-speed winding**	**High-speed winding**
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	10000	10000	10000
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		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		M*i* sensor or MZ*i* sensor			
Type of thermal protection (*10)		TP211			
Resolution of the MZ*i* 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	
Applicable spindle amplifier module		SPM-15*i*		SPM-22*i*	
Model		α12/10000*i*		α15/10000*i*	

Series		αi series			
Item / Model		α18/10000i(*1)		α22/10000i(*1)	
		Low-speed winding	High-speed winding	Low-speed winding	High-speed winding
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	10000	10000	10000
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		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		Mi sensor or MZi sensor			
Type of thermal protection (*10)		TP211			
Resolution of the MZi sensor /rev.		4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Maximum output during acceleration(*11) kW		26.4		31.2	
Applicable spindle amplifier module		SPM-22i		SPM-26i	
Model		α18/10000i		α22/10000i	

(*1) For α6/12000*i*, α8/10000*i*, α12/10000*i*, α15/10000*i*, α18/10000*i*, and α22/10000*i*, 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 α0.5/10000*i*, α1/10000*i*, α2/10000*i*, α1/15000*i*, α1.5/15000*i*, or α2/15000*i* is 15 min rated. That for α1.5/10000*i* is 10 min rated.

(*4) S3 40% for α0.5/10000*i*, α30/6000*i*, α50/4500*i*, α1/15000*i*, α1.5/15000*i*, or α2/15000*i*, S3 25% for α1.5/10000*i*.

(*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. When using α1/15000*i*, α1.5/15000*i*, or α2/15000*i*, the output shaft must be placed horizontally or vertically downward (IMB5, IMV1).

(*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 α0.5/10000*i*, α1/10000*i*, α2/10000*i*, α1/15000*i*, α1.5/15000*i*, or α2/15000*i* and 120% of 10 min rated for α1.5/10000*i*.

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

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

(*12) There is another type of α3/12000*i* that has a built-in M*i* sensor.

(*13) 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.

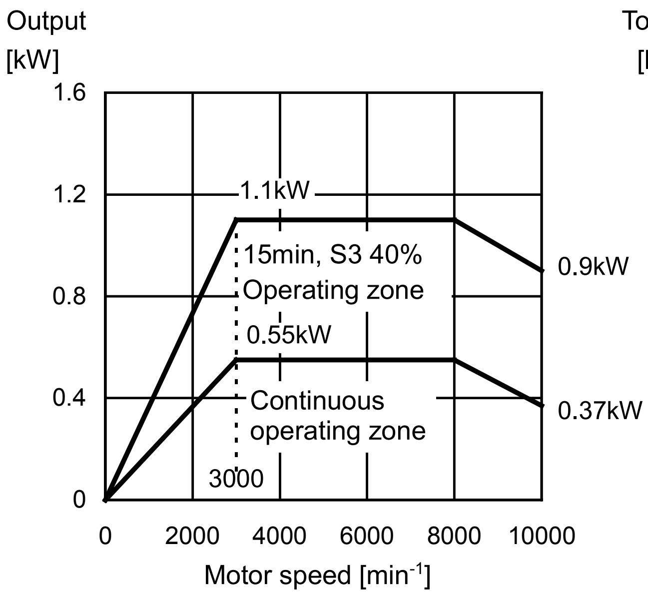
T[N·m]=P[kW]×1000/0.1047/N[min^{-1}]

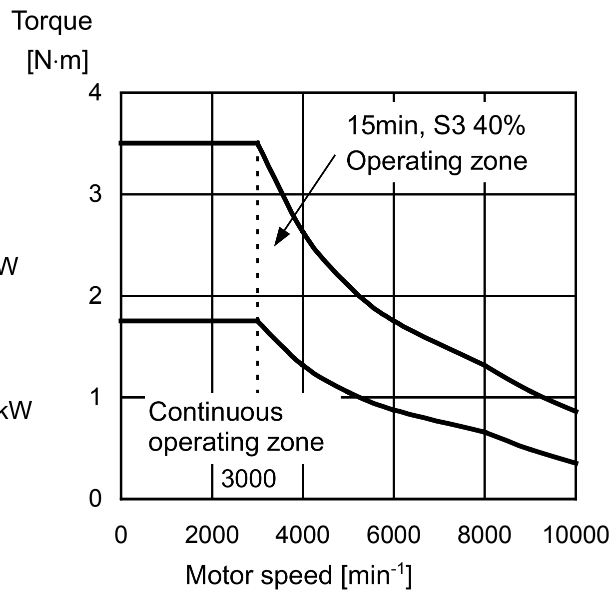
P[kW]: Motor output

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

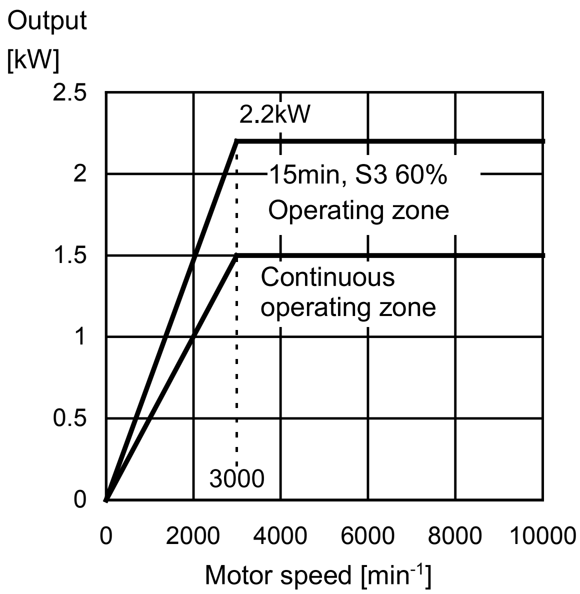
When the unit of T is [kgf·m],
T[kgf·m]=P[kW]×1000/1.0269/N[min^{-1}]

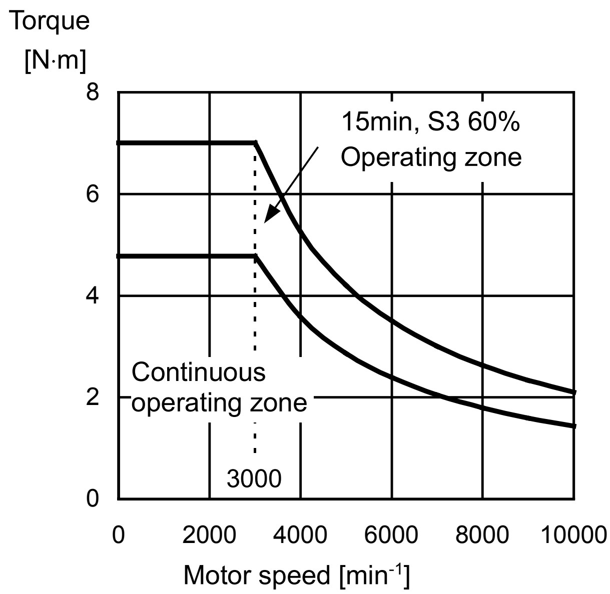
3.1 MODEL α0.5/10000i



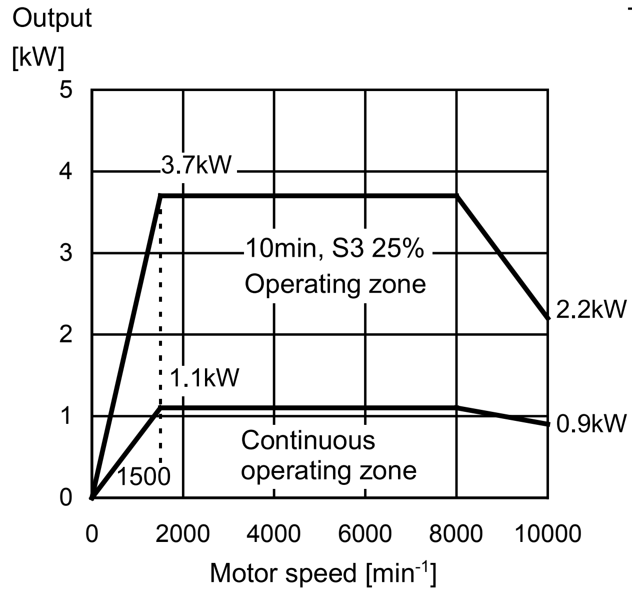


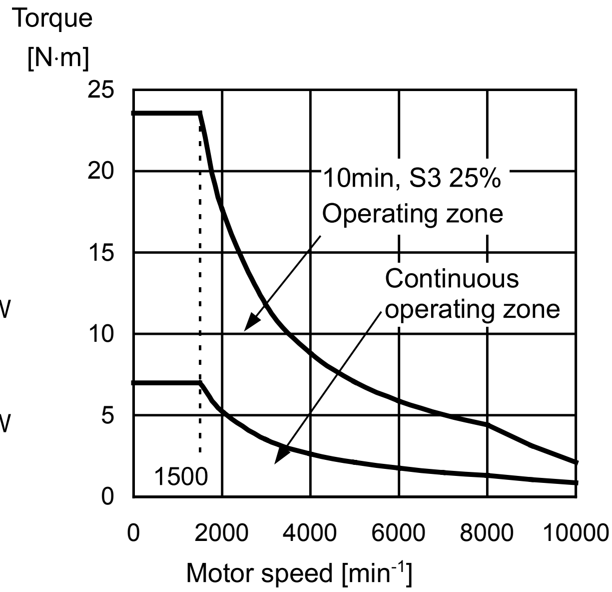
3.2 MODEL α1/10000i



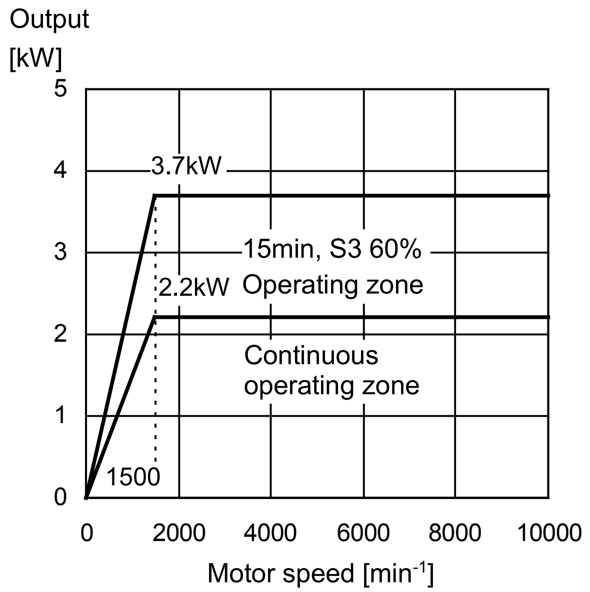


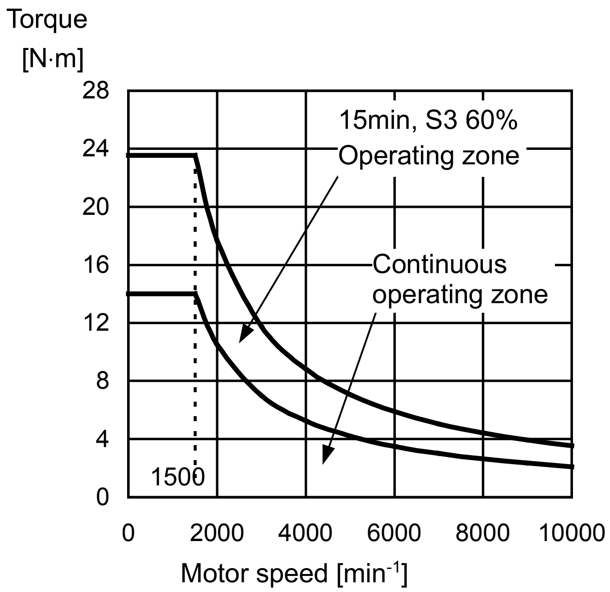
3.3 MODEL α1.5/10000i



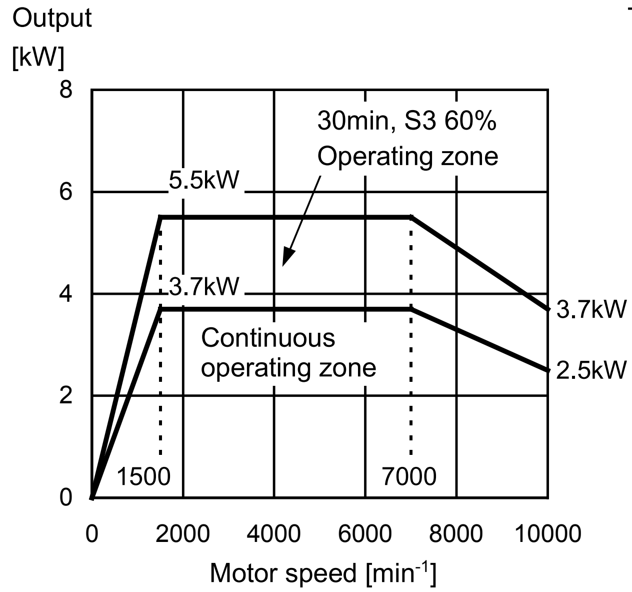


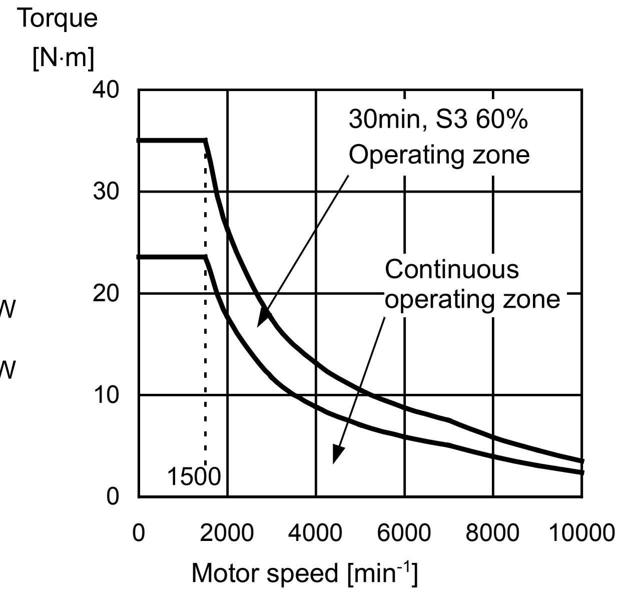
3.4 MODEL α2/10000i



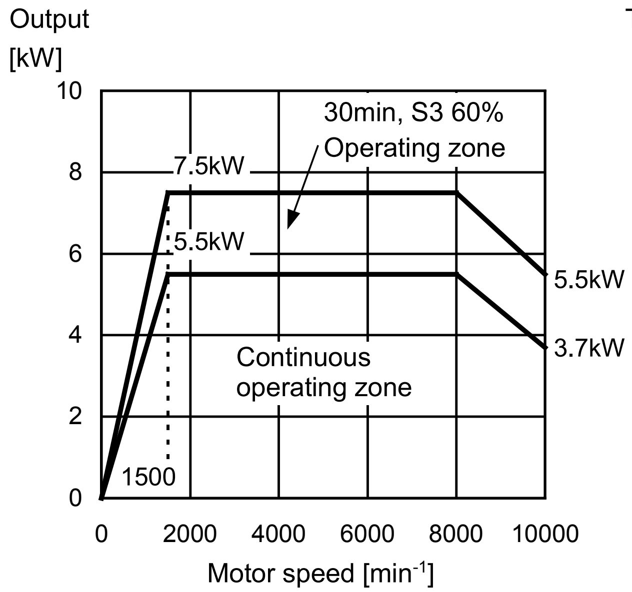


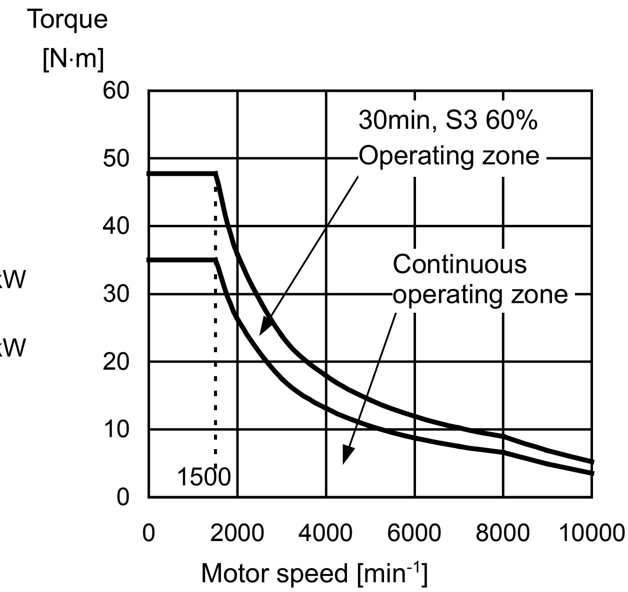
3.5 MODEL α3/10000*i*



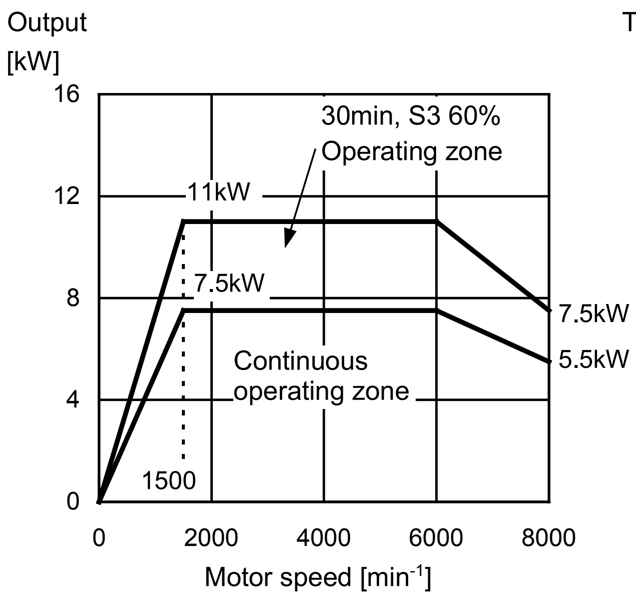


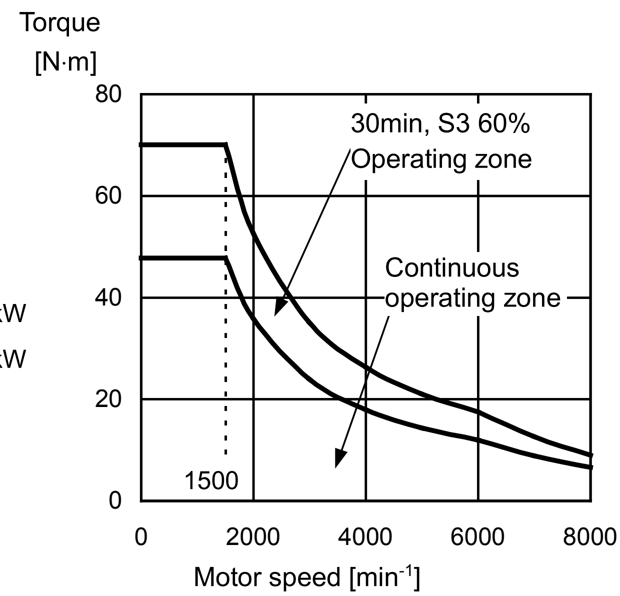
3.6 MODEL α6/10000*i*



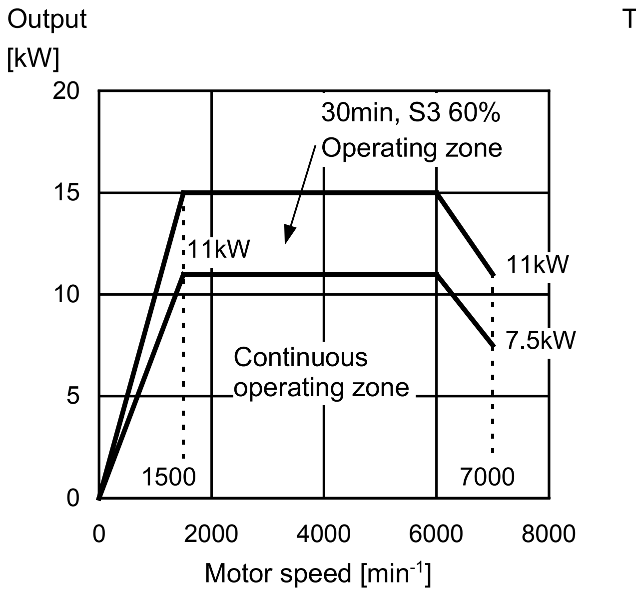


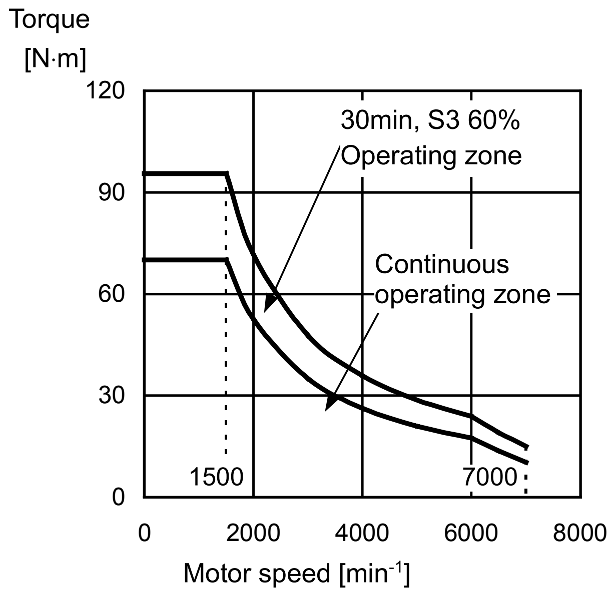
3.7 MODEL α8/8000*i*



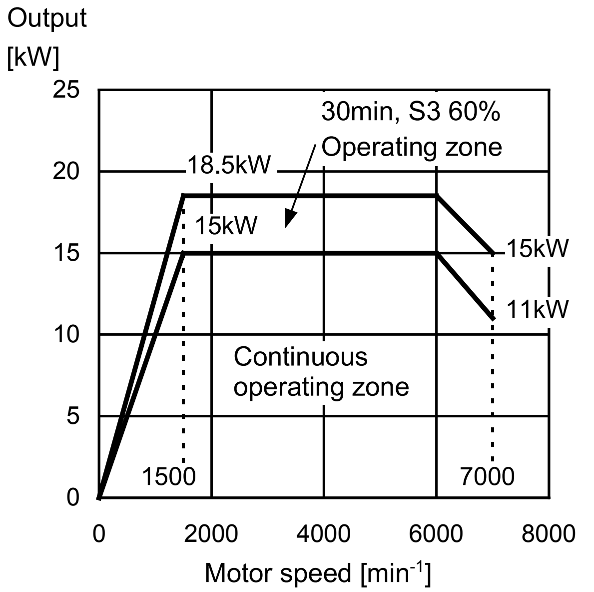


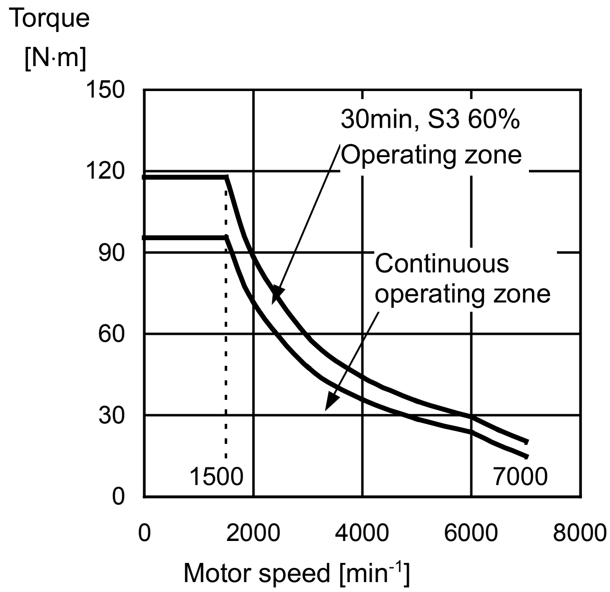
3.8 MODEL α12/7000*i*



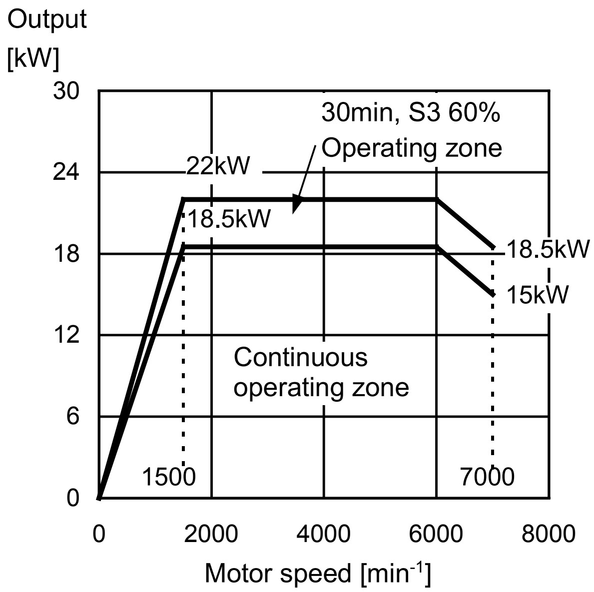


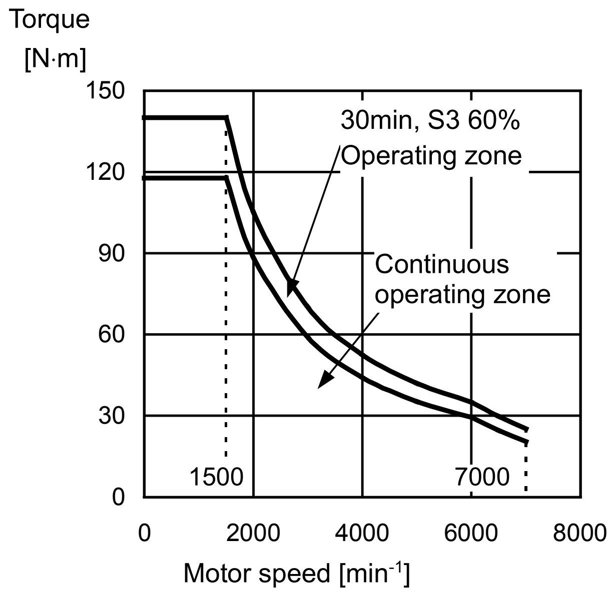
3.9 MODEL α15/7000*i*



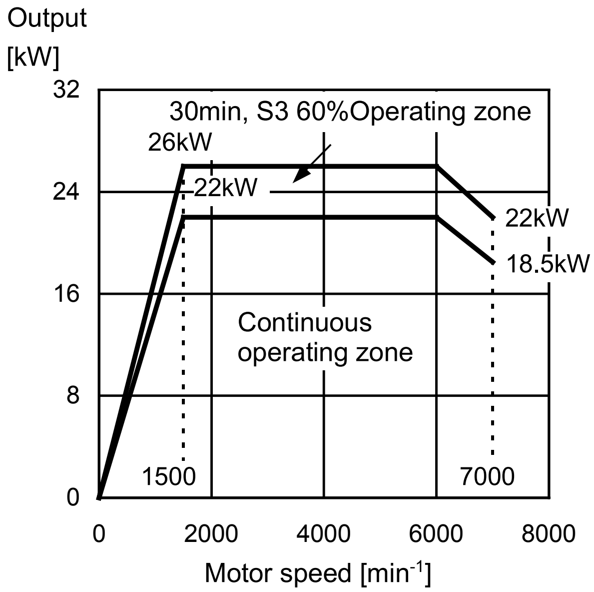


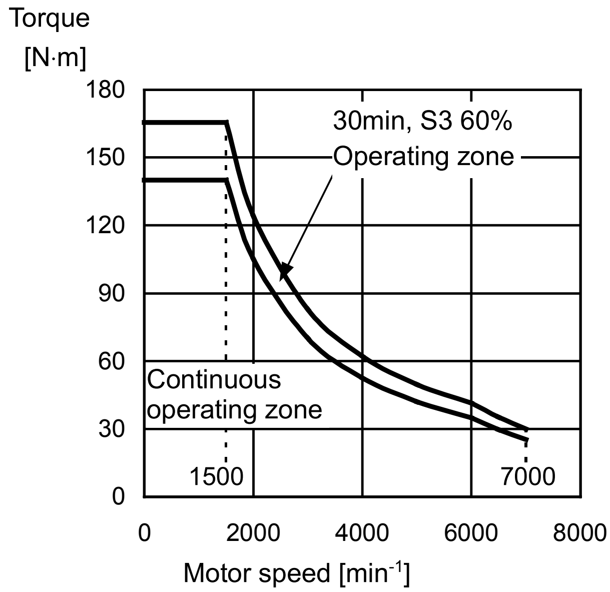
3.10 MODEL α18/7000*i*



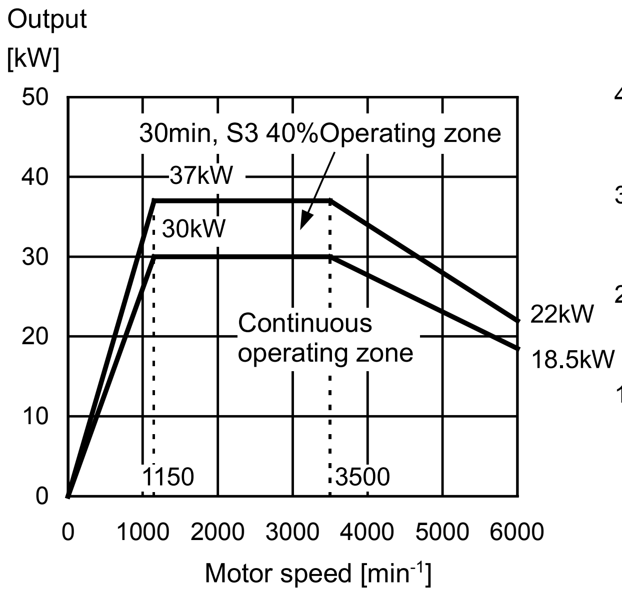


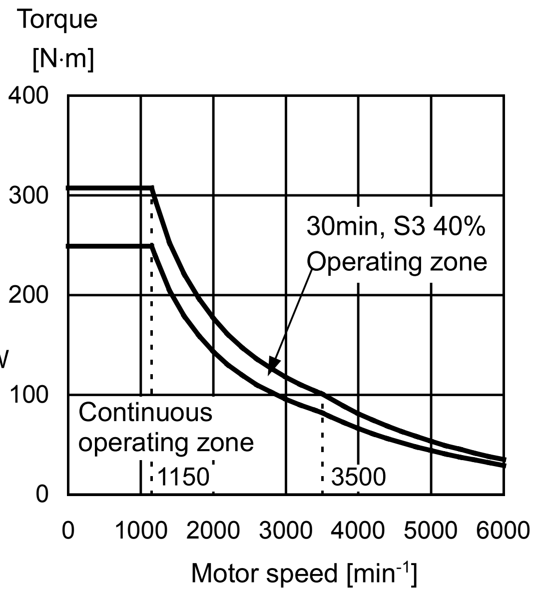
3.11 MODEL α22/7000i





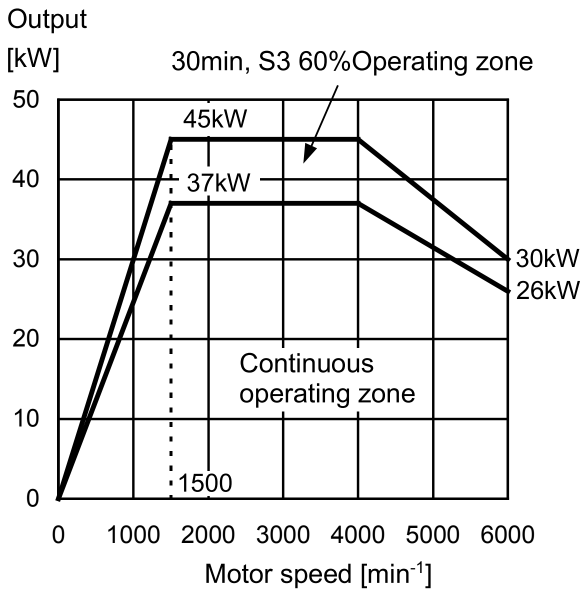
3.12 MODEL α30/6000i

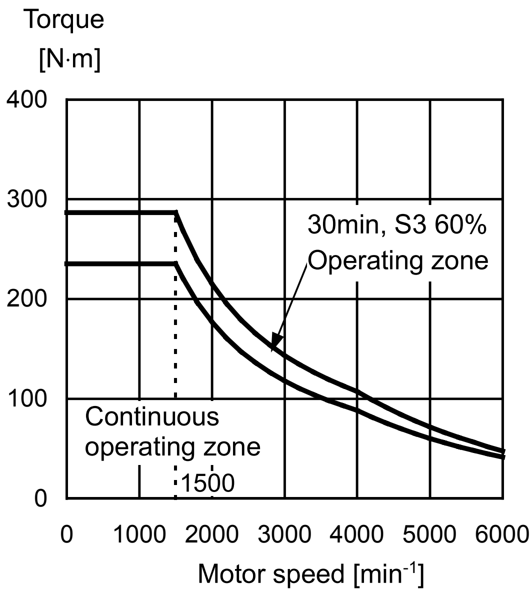




3.13 MODEL α40/6000*i*

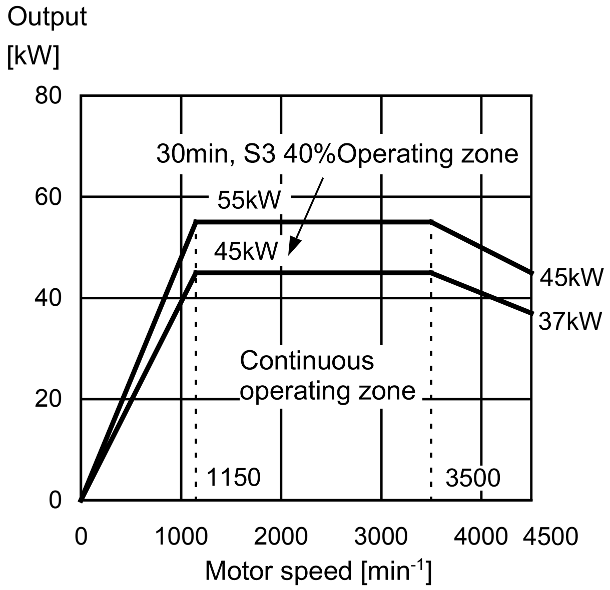
Applicable amplifier SPM-45*i*

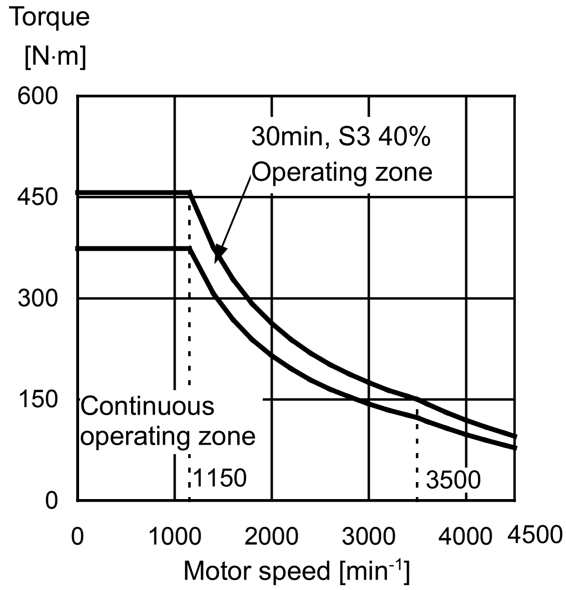




3.14 MODEL α50/4500*i*

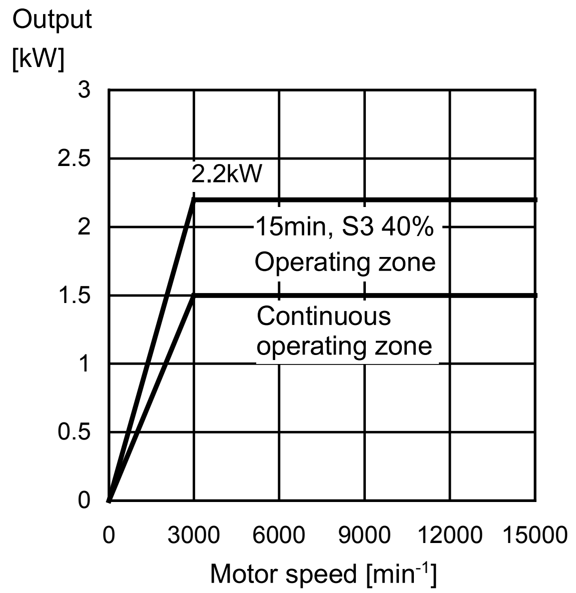
Applicable amplifier SPM-55*i*

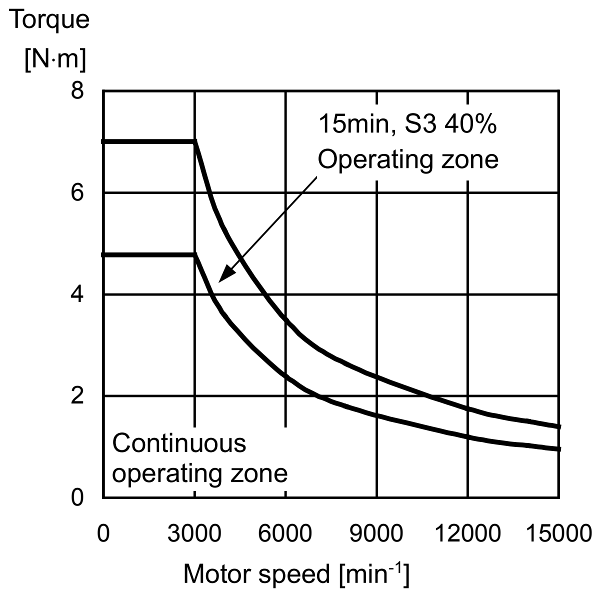


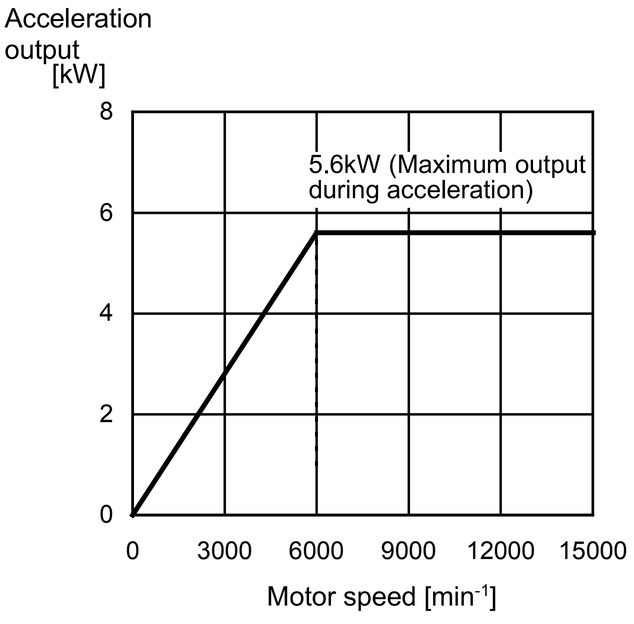


3.15 MODEL α1/15000*i*

Applicable amplifier SPM-5.5*i*





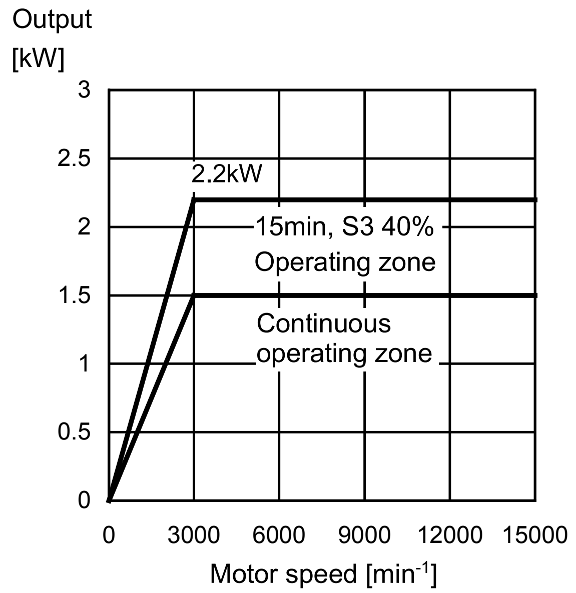


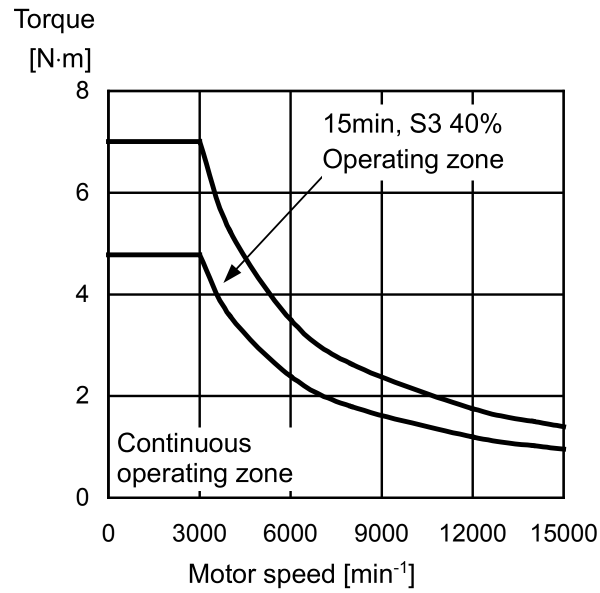
NOTE

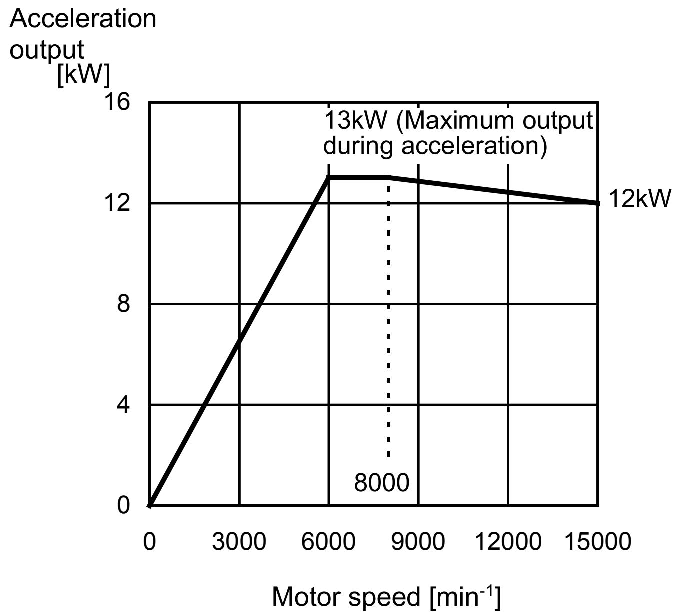
Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

3.16 MODEL α1.5/15000*i*

Applicable amplifier SPM-15*i*



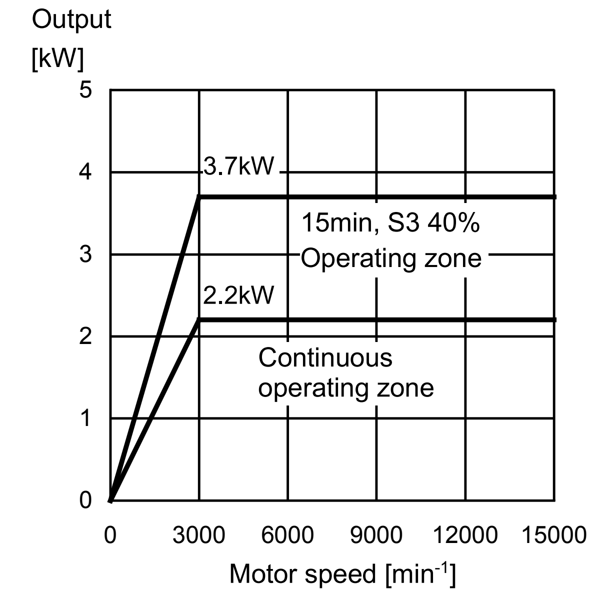


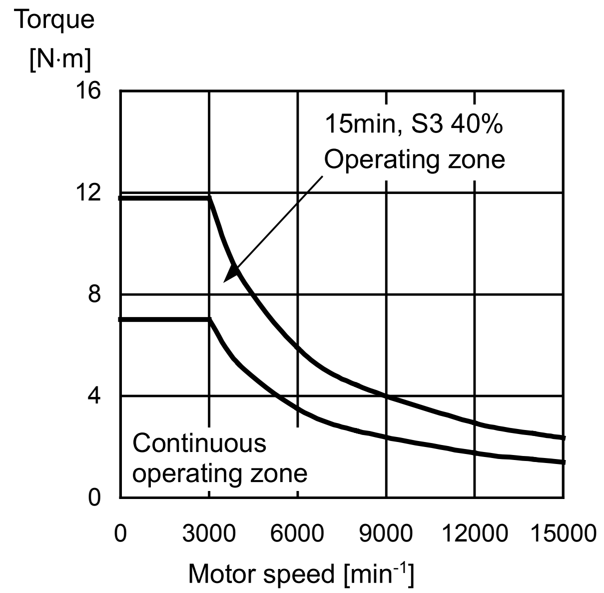


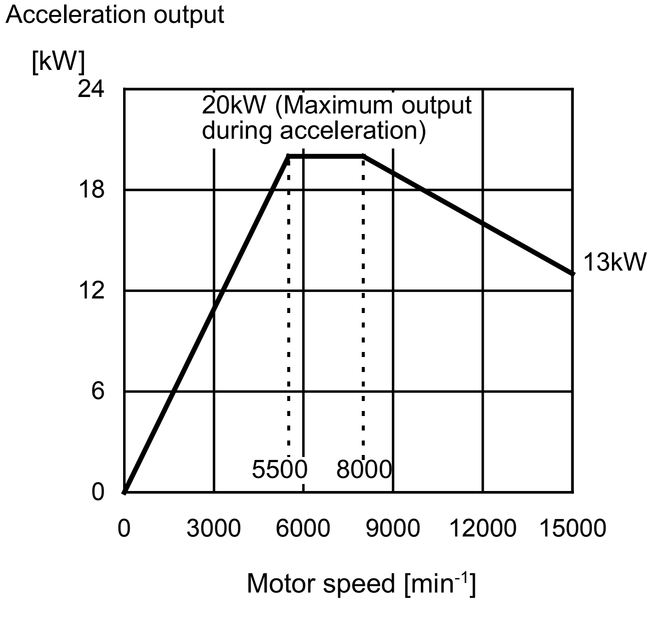
> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

3.17 MODEL α2/15000*i*

Applicable amplifier SPM-22*i*





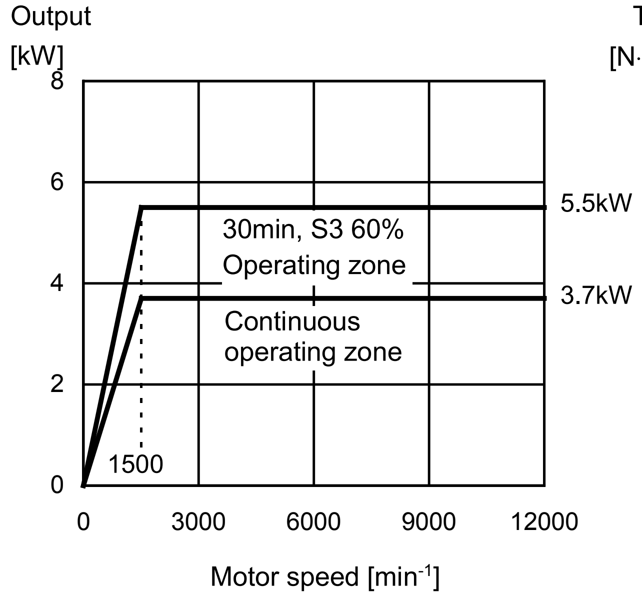


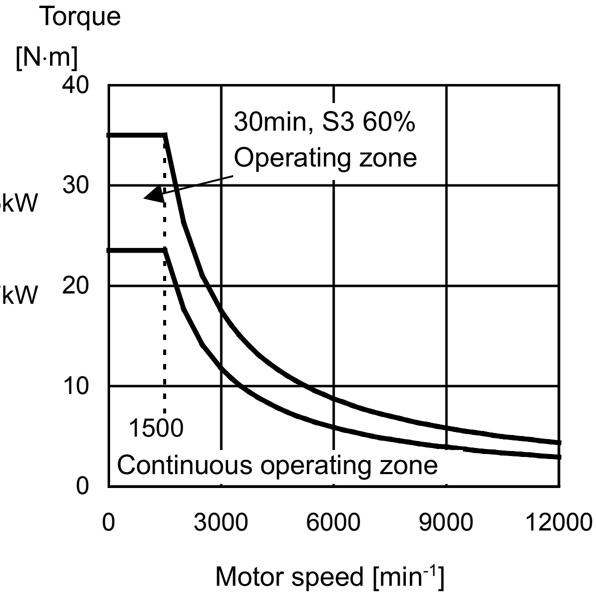
NOTE

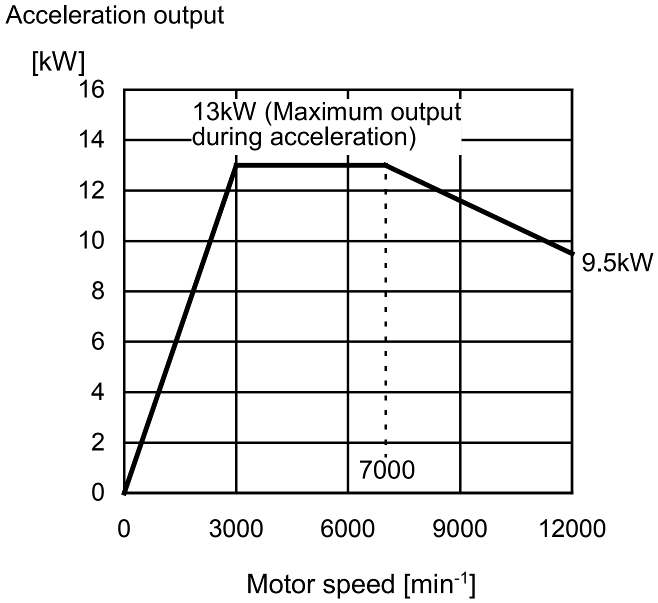
Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

3.18 MODEL α3/12000*i*

Applicable amplifier SPM-11*i*



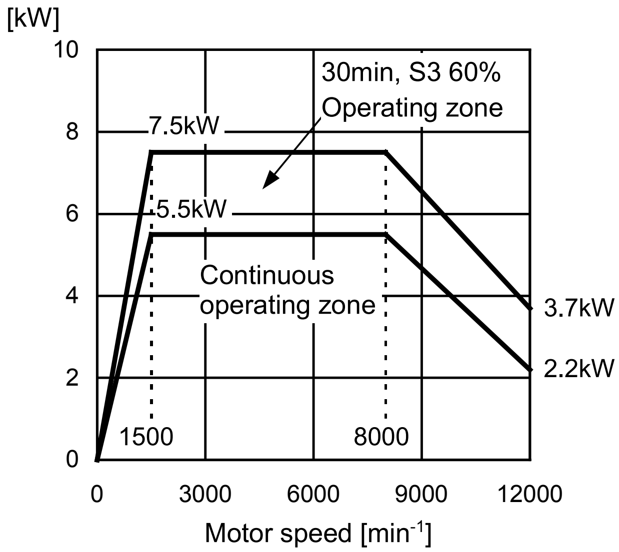




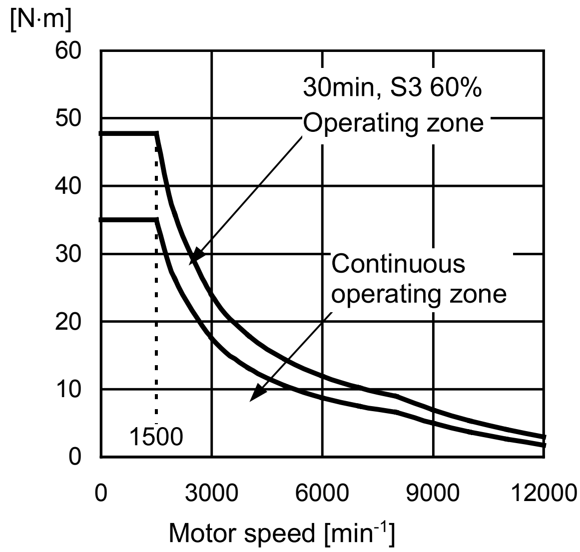
> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time.
> Acceleration output is not an assured value.

3.19 MODEL α6/12000*i*

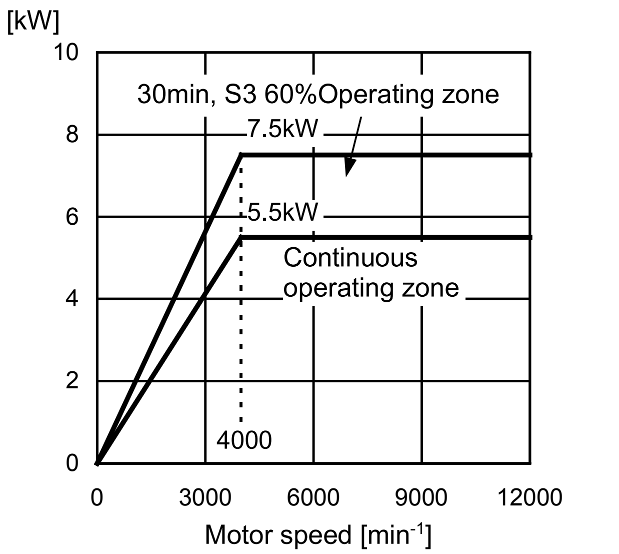
Low-speed winding output (Y connection)



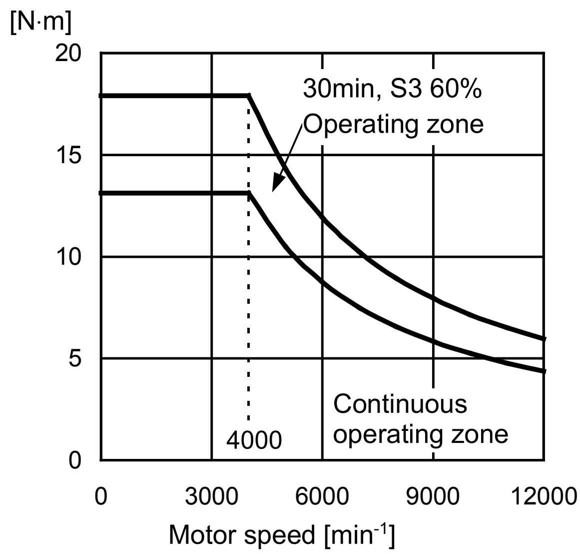
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

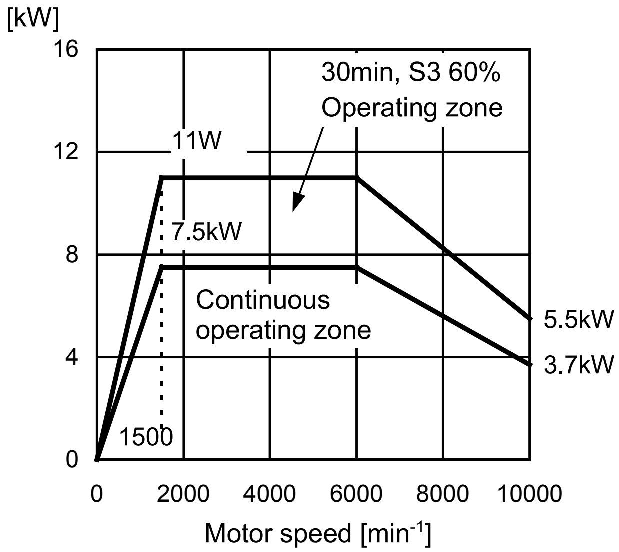


High-speed winding output (Δ connection)

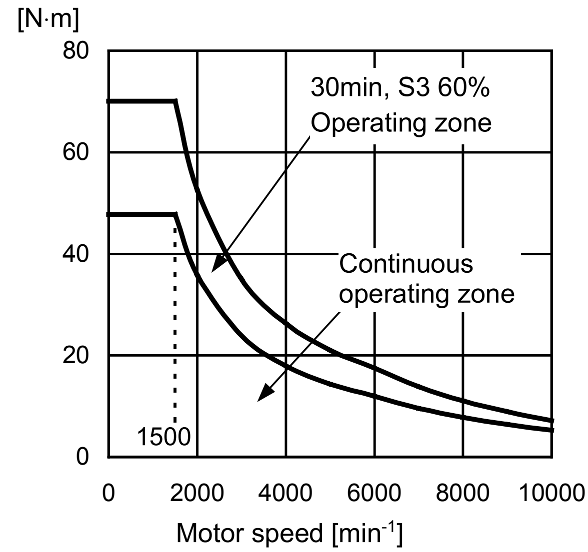


3.20 MODEL α8/10000i

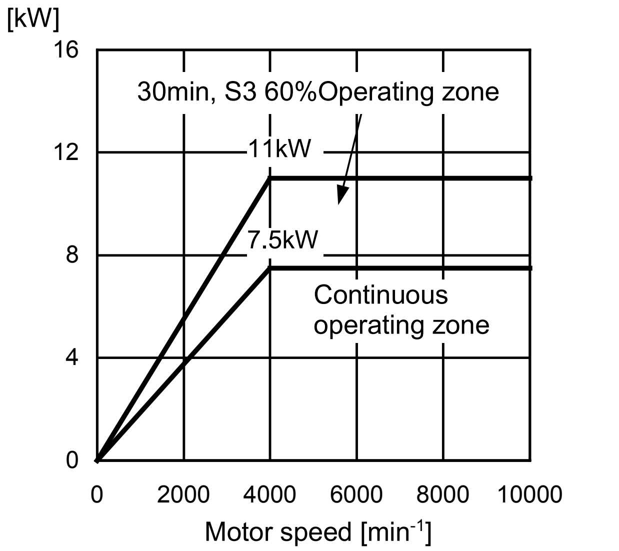
Low-speed winding output (Y connection)



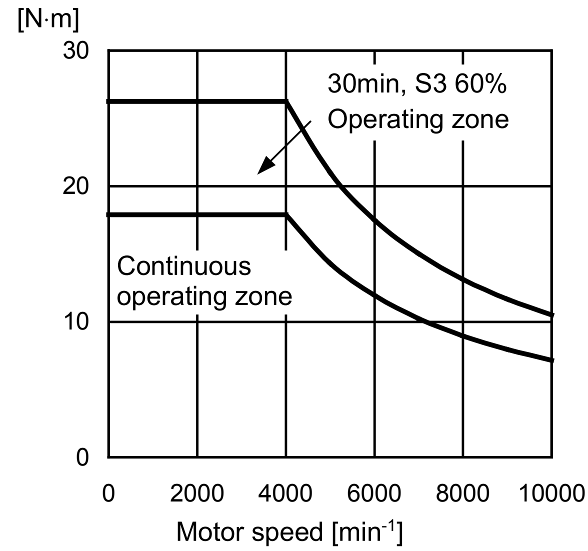
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

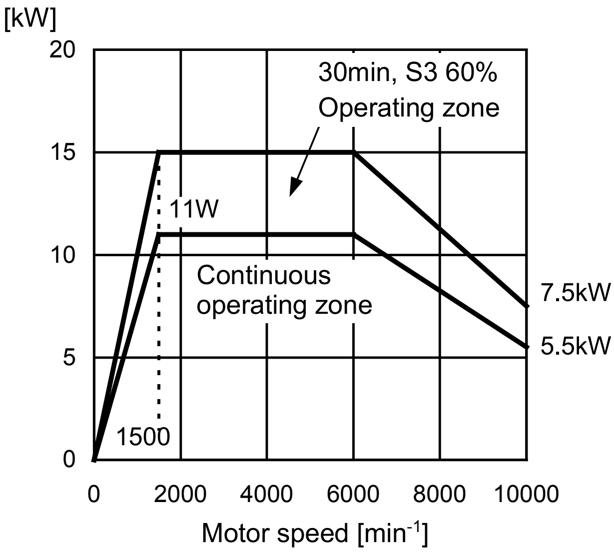


High-speed winding output (Δ connection)

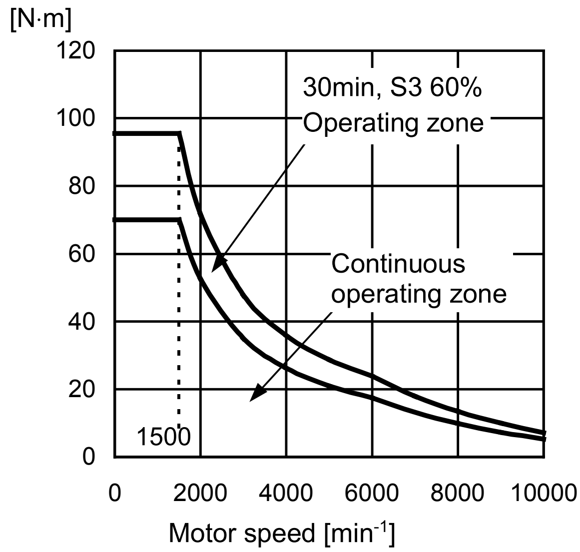


3.21 MODEL α12/10000*i*

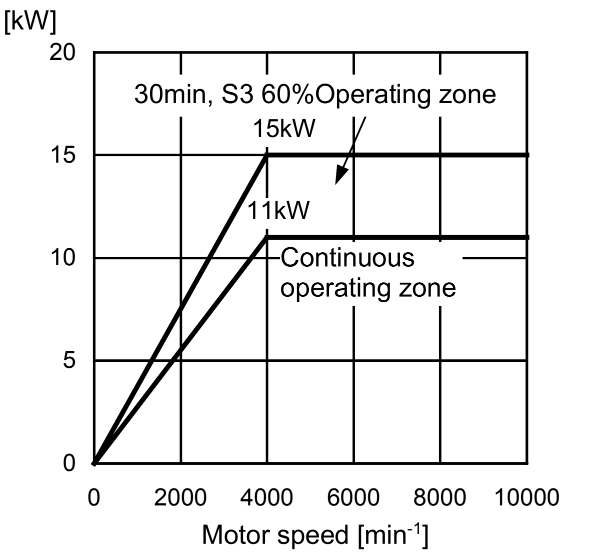
Low-speed winding output (Y connection)



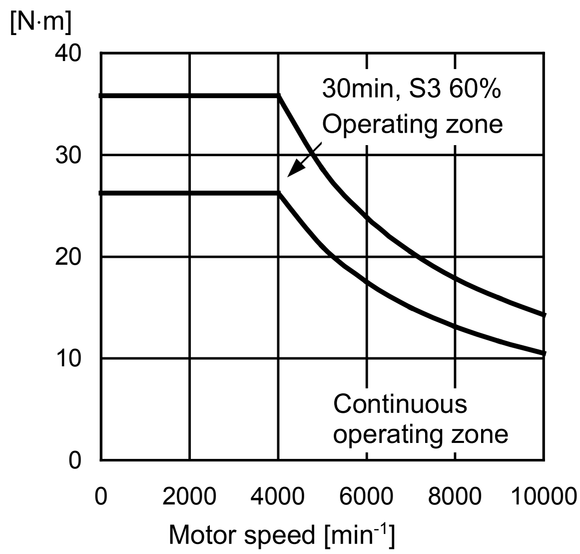
Low-speed winding torque (Y connection)



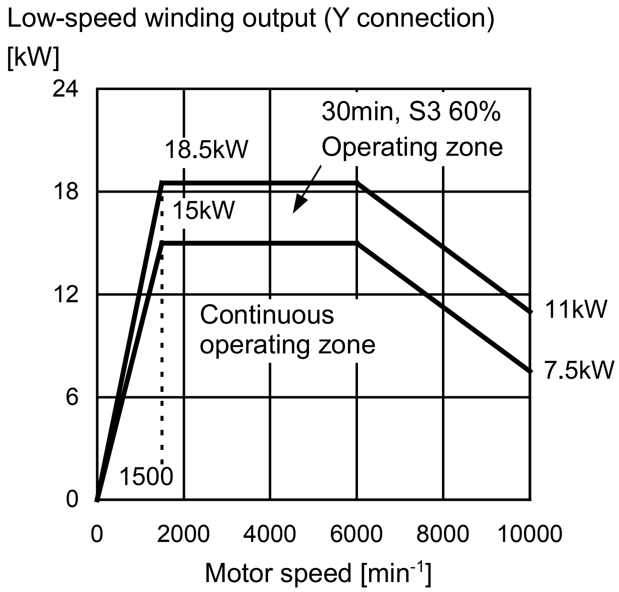
High-speed winding output (Δ connection)

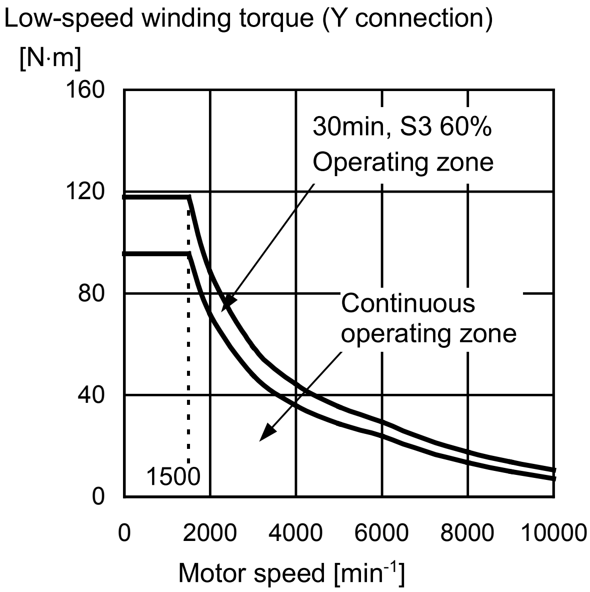


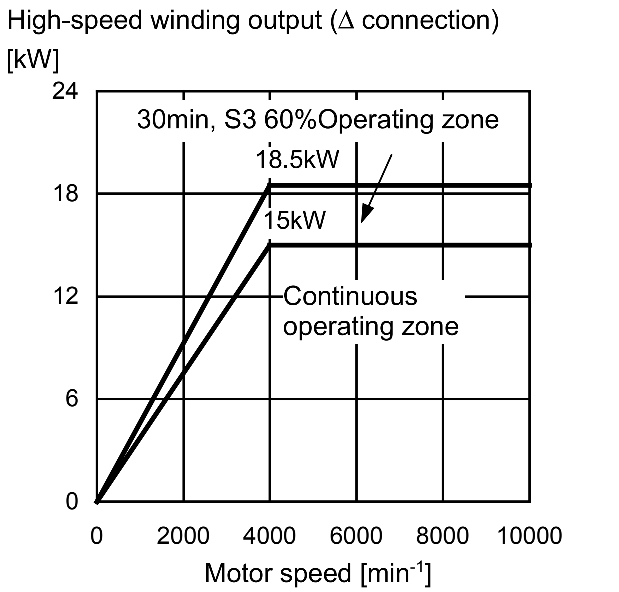
High-speed winding output (Δ connection)

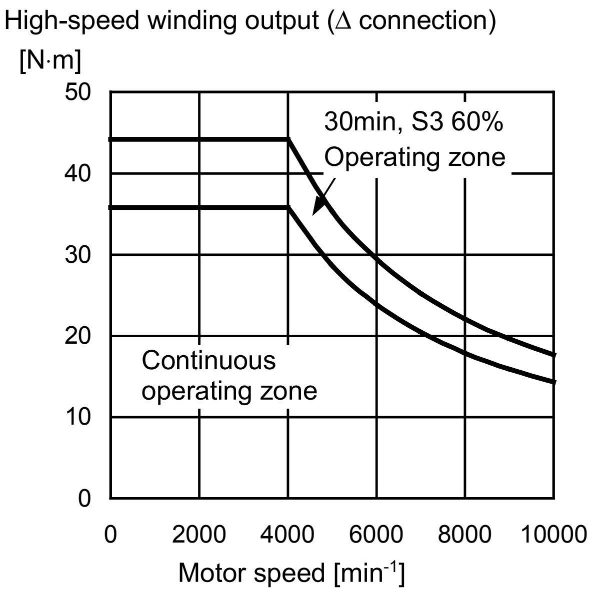


3.22 MODEL α15/10000*i*

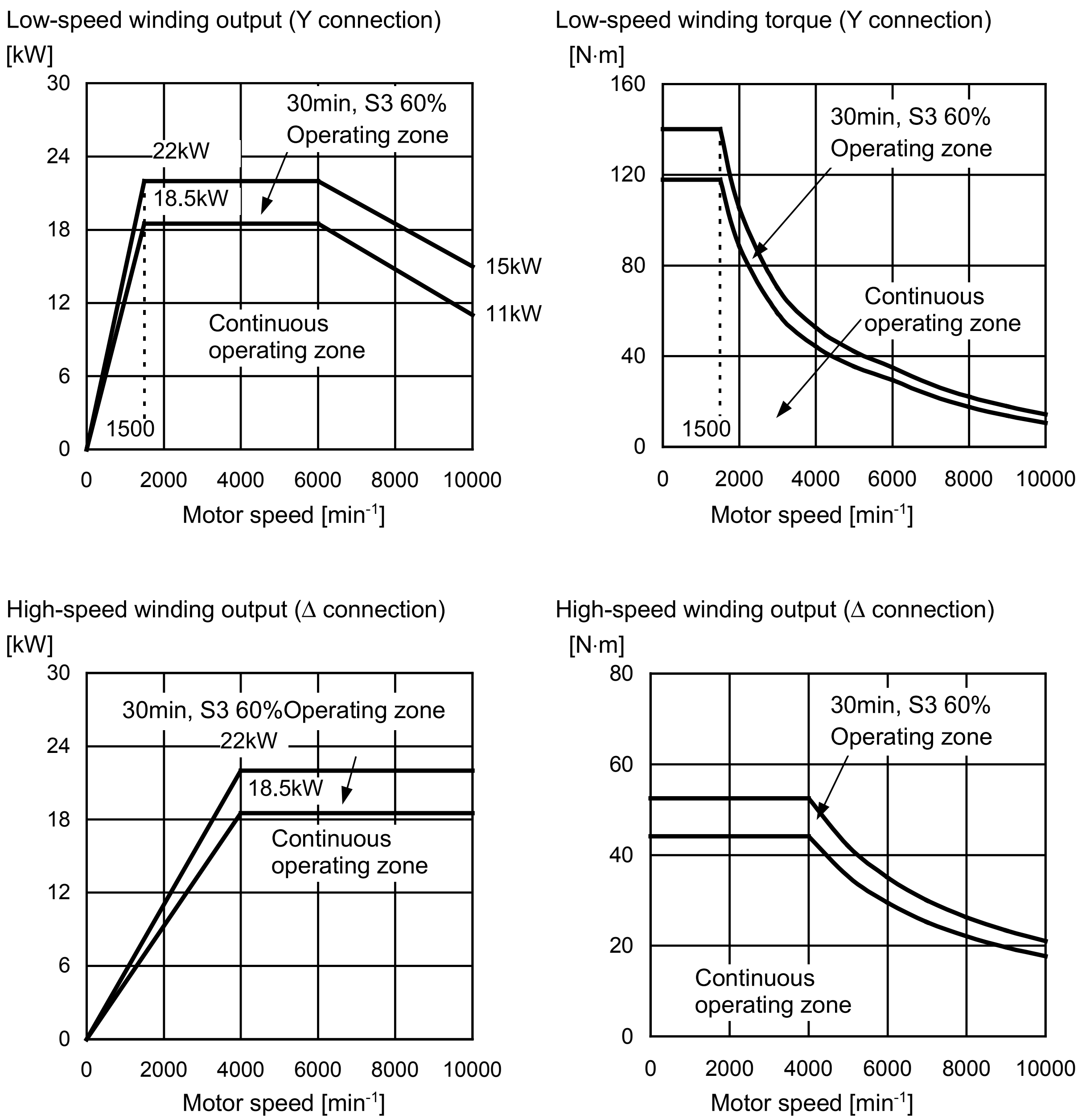






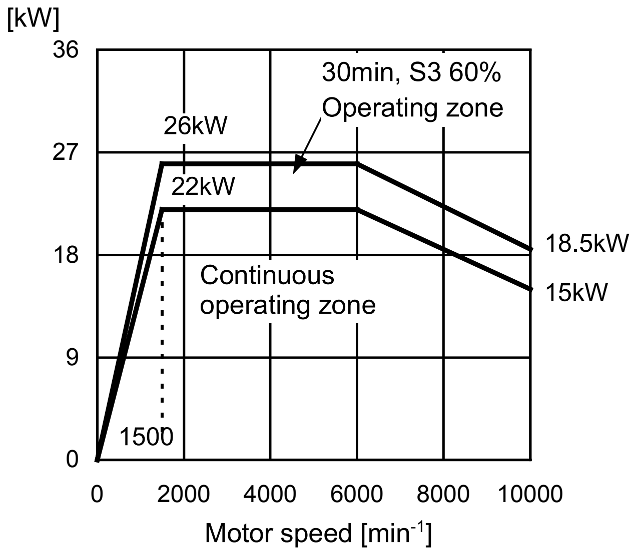


3.23 MODEL α18/10000i

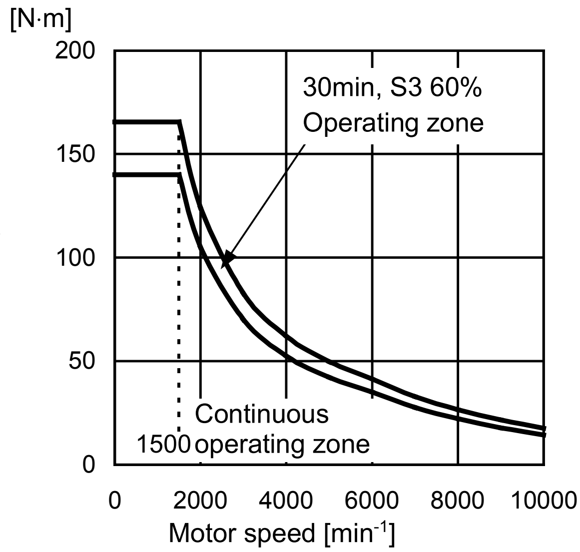


3.24 MODEL α22/10000*i*

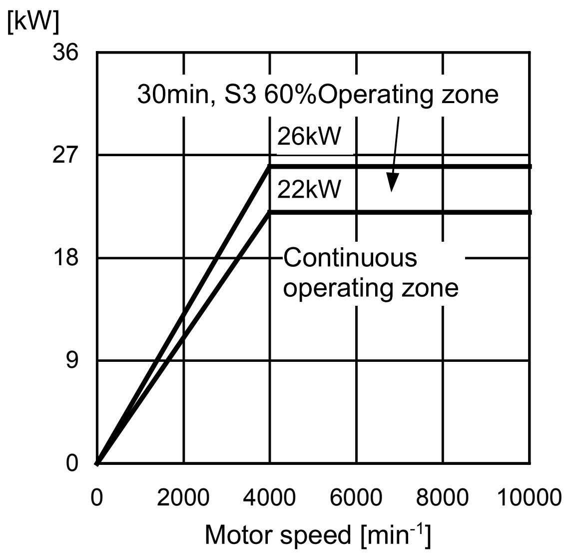
Low-speed winding output (Y connection)



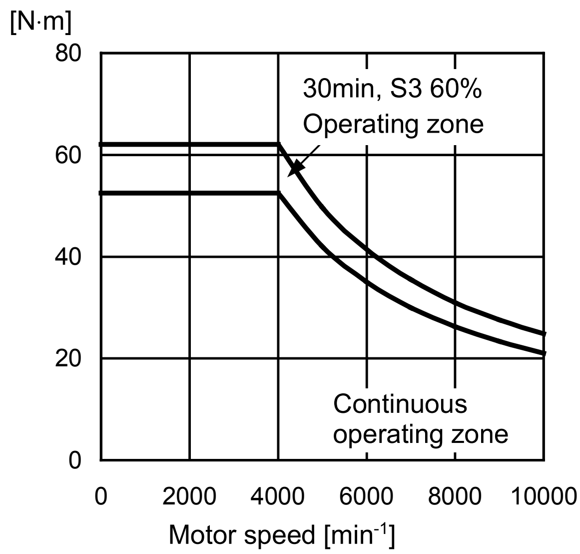
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



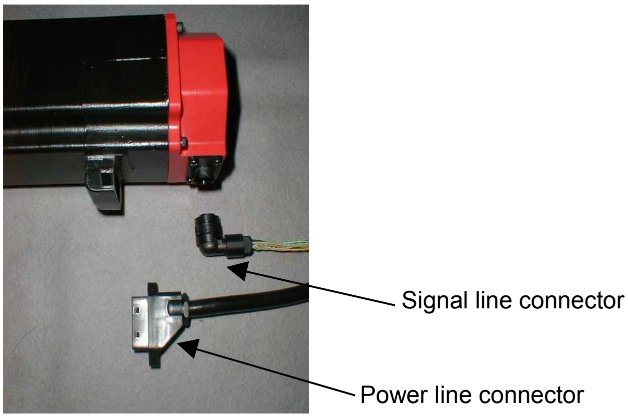
High-speed winding output (Δ connection)



4 CONNECTIONS

4.1 MODEL α0.5/10000i

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

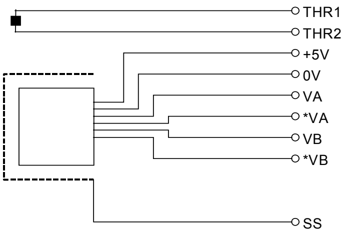
NOTE
If the outer sheath diameter is inadequate, the waterproofness can degrade.

Connector pins arrangement

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

Connection of signal lead

- For type with M*i* sensor



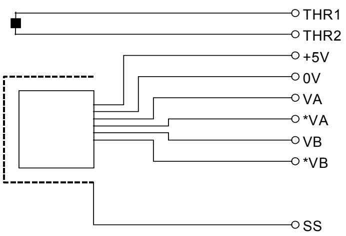
Connector parts related to cable side

	Japan Aviation Electronics Industry specification
Connector	JN1xS10SL1: Applicable sheath diameter ϕ5.7 to 7.3 JN1xS10SL2: Applicable sheath diameter ϕ6.5 to 8.0 ↑ D: Straight plug F: Elbow plug
Terminal	JN1-22-22S

Connector pins arrangement

	1	2	3
	RA	RB	-
4	5	6	7
PA	PB	-	0V
	8	9	10
	+5V	THR1	THR2

- For type with MZ*i* sensor



Connector parts related to cable side

	Japan Aviation Electronics Industry specification
Connector	JN1xS10SL1: Applicable sheath diameter ϕ5.7 to 7.3 JN1xS10SL2: 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 α1/10000*i* TO α50/4500*i*

Cables for power lead and fan motor are connected to the terminal block.
M*i* sensor or MZ*i* 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 U,V,W,G	Power lead X,Y,Z	Fan motor FMU,FMV,FMW
α1/10000*i*, α1.5/10000*i*	M5	-	M4
α2/10000*i* to α15/7000*i*	M5	-	Screw-less terminal block
α18/7000*i* to α22/7000*i*	M6	-	Screw-less terminal block
α30/6000*i* to α40/6000*i*	M10	-	Screw-less terminal block
α50/4500*i*	M8	-	Screw-less terminal block
α1/15000*i*, α1.5/15000*i*	M5	-	M4
α2/15000*i*, α3/12000*i*	M5	-	Screw-less terminal block
α6/12000*i* to α15/10000*i*	M5	M5	Screw-less terminal block
α18/10000*i* to α22/10000*i*	M6	M6	Screw-less terminal block

Cable for the power lead

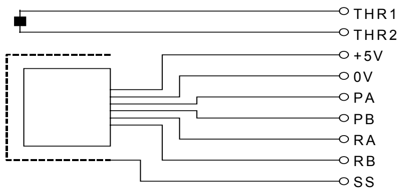
For the power lead cable specification, refer to "FANUC SERVO AMPLIFIER αi series DESCRIPTIONS (B-65282EN)".

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.

4.3 CONNECTION OF SIGNAL LEAD

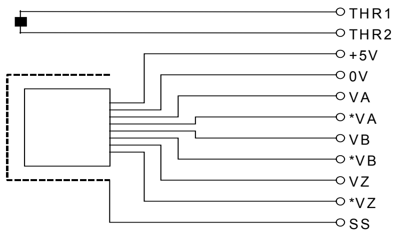
Connector attachment for a motor with a built-in M*i* sensor



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		RA	RB		0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	PA	PB		SS	THR1

Connector attachment for a motor with a built-in MZ*i* 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

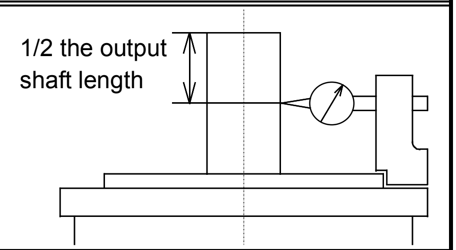
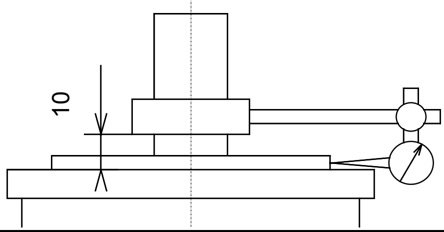
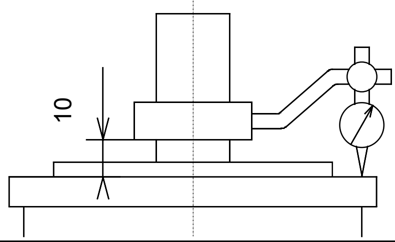
Use the motor output shaft below the allowable radial loads shown in the table below.

Model	Allowable radial load (kgf)	
	At output shaft end	At output shaft center
α0.5/10000i	294N (30kgf)	323N (33kgf)
α1/10000i	392N (40kgf)	441N (45kgf)
α1.5/10000i	882N (90kgf)	980N (100kgf)
α2/10000i	882N (90kgf)	999N (102kgf)
α3/10000i	1470N (150kgf)	1607N (164kgf)
α6/10000i	1960N (200kgf)	2205N (225kgf)
α8/8000i	2940N (300kgf)	3371N (344kgf)
α12/7000i, α15/7000i	2940N (300kgf)	3410N (348kgf)
α18/7000i, α22/7000i	4410N (450kgf)	4988N (509kgf)
α30/6000i, α40/6000i	5390N (550kgf)	6134N (626kgf)
α50/4500i	1078N (1100 kgf)	1230N (1255 kgf)
α1/15000i, α1.5/15000i	Direct connection to the spindle	
α2/15000i		
α3/12000i	980N (100kgf)	1068N (109kgf)
α6/12000i	1470N (150kgf)	1656N (169kgf)
α8/10000i	1960N (200kgf)	2244N (229kgf)
α12/10000i, α15/10000i	2450N (250kgf)	2842N (290kgf)
α18/10000i, α22/10000i	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

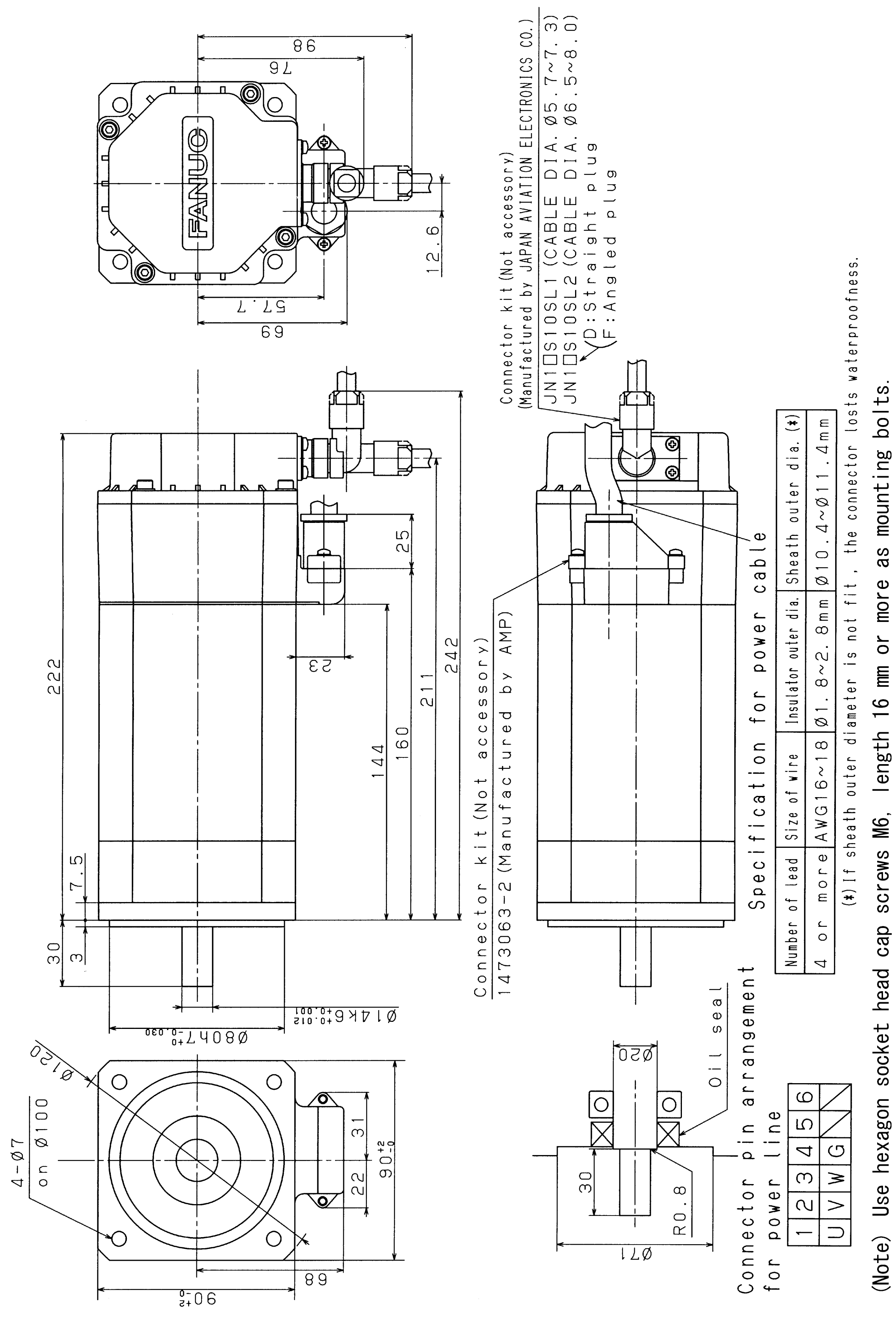
Item \ Model	α0.5*i* to α22*i*	α30*i* to α50*i*	α1/15000*i* to α2/15000*i*	Measuring method
Run-out at the end of the output shaft	20μm or less	20μm or less	10μm or less	
Run-out of the faucet joint for mounting the flange against the core of the shaft (only for flange type)	40μm or less	60μm or less	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 α1/15000*i* to α2/15000*i*, the assembling accuracies of high-speed models are the same as those of the standard models shown above.

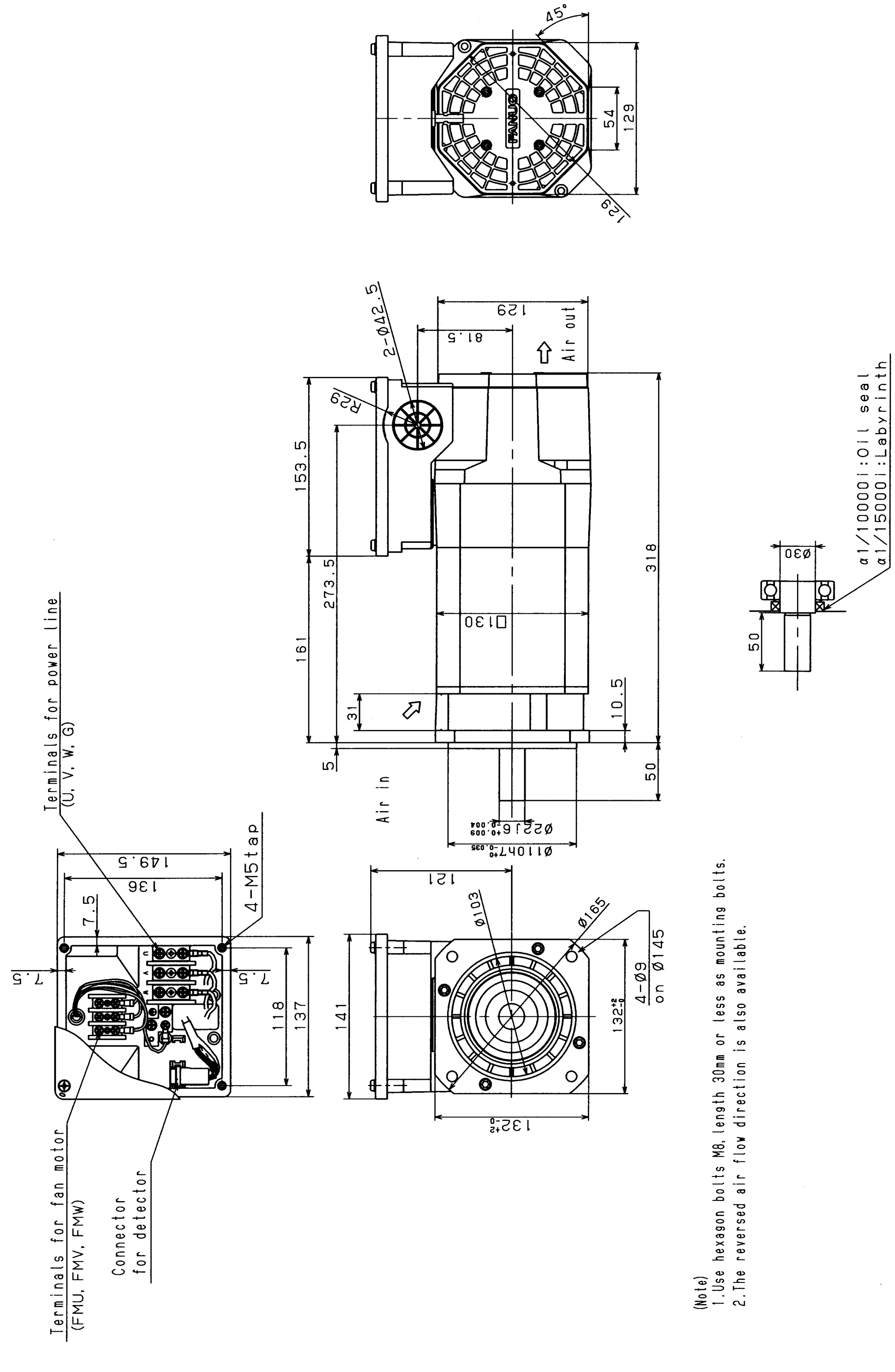
7 EXTERNAL DIMENSIONS

Model name	Section
Model α0.5/10000i (flange mounting type)	7.1
Models α1/10000i and α1/15000i (flange mounting type)	7.2
Model α1/10000i (foot mounting type)	7.3
Model α1.5/10000i (flange mounting type)	7.4
Model α1.5/15000i (flange mounting type)	7.5
Model α1.5/10000i (foot mounting type)	7.6
Model α2/10000i (flange mounting type)	7.7
Model α2/15000i (flange mounting type)	7.8
Model α2/10000i (foot mounting type)	7.9
Models α3/10000i and α3/12000i (flange mounting type)	7.10
Model α3/10000i (foot mounting type)	7.11
Models α6/10000i and α6/12000i (flange mounting type)	7.12
Model α6/10000i (foot mounting type)	7.13
Models α8/8000i and α8/10000i (flange mounting type)	7.14
Model α8/8000i (foot mounting type)	7.15
Models α12/7000i and α12/10000i (flange mounting type)	7.16
Model α12/7000i (foot mounting type)	7.17
Models α15/7000i and α15/10000i (flange mounting type)	7.18
Model α15/7000i (foot mounting type)	7.19
Models α18/7000i and α18/10000i (flange mounting type)	7.20
Model α18/7000i (foot mounting type)	7.21
Models α22/7000i and α22/10000i (flange mounting type)	7.22
Model α22/7000i (foot mounting type)	7.23
Model α30/6000i (flange mounting type)	7.24
Model α30/6000i (foot mounting type)	7.25
Model α40/6000i (flange mounting type)	7.26
Model α40/6000i (foot mounting type)	7.27
Model α50/4500i (flange mounting type)	7.28
Model α50/4500i (foot mounting type)	7.29

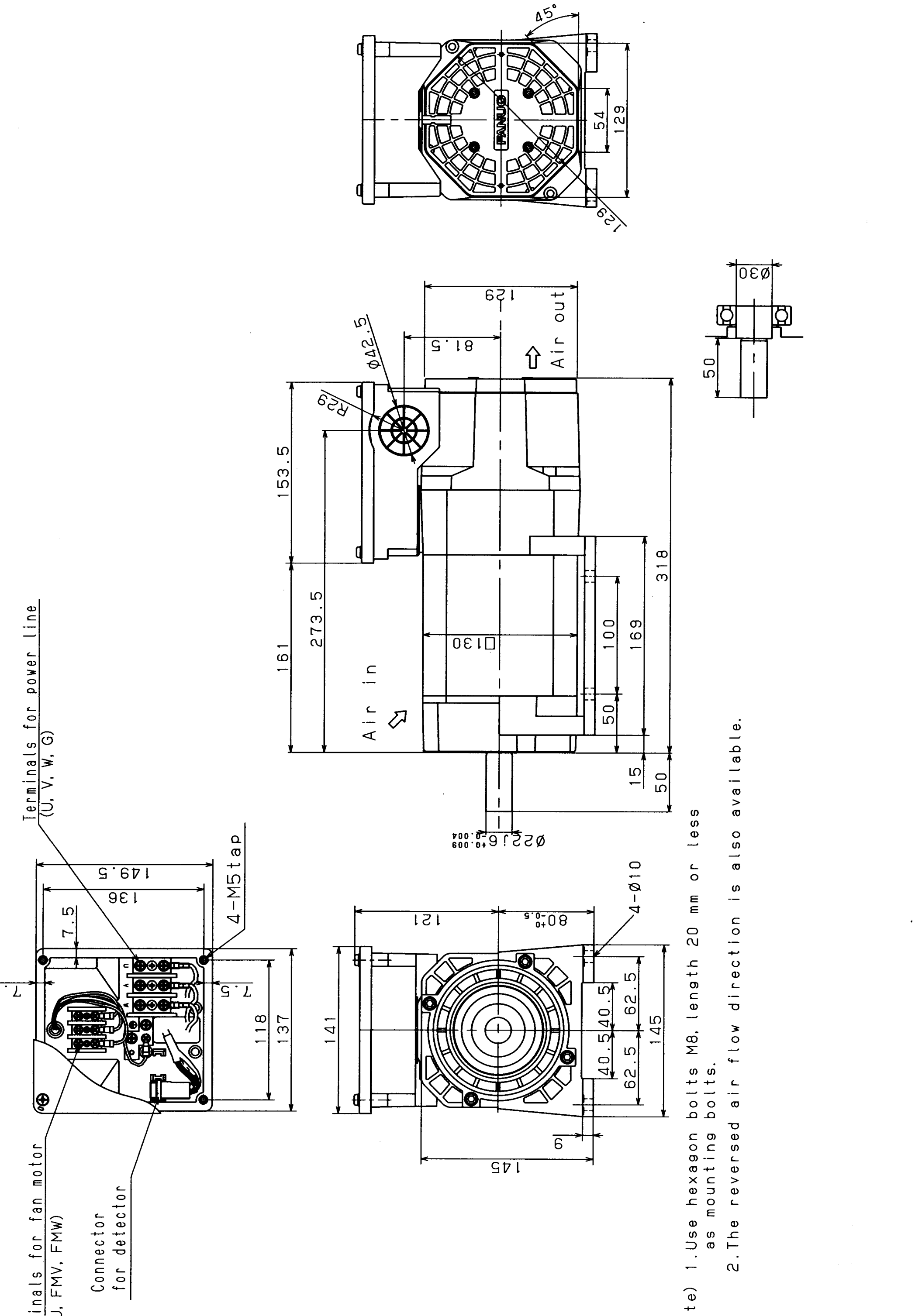
7.1 MODEL α0.5/10000i (FLANGE MOUNTING TYPE)



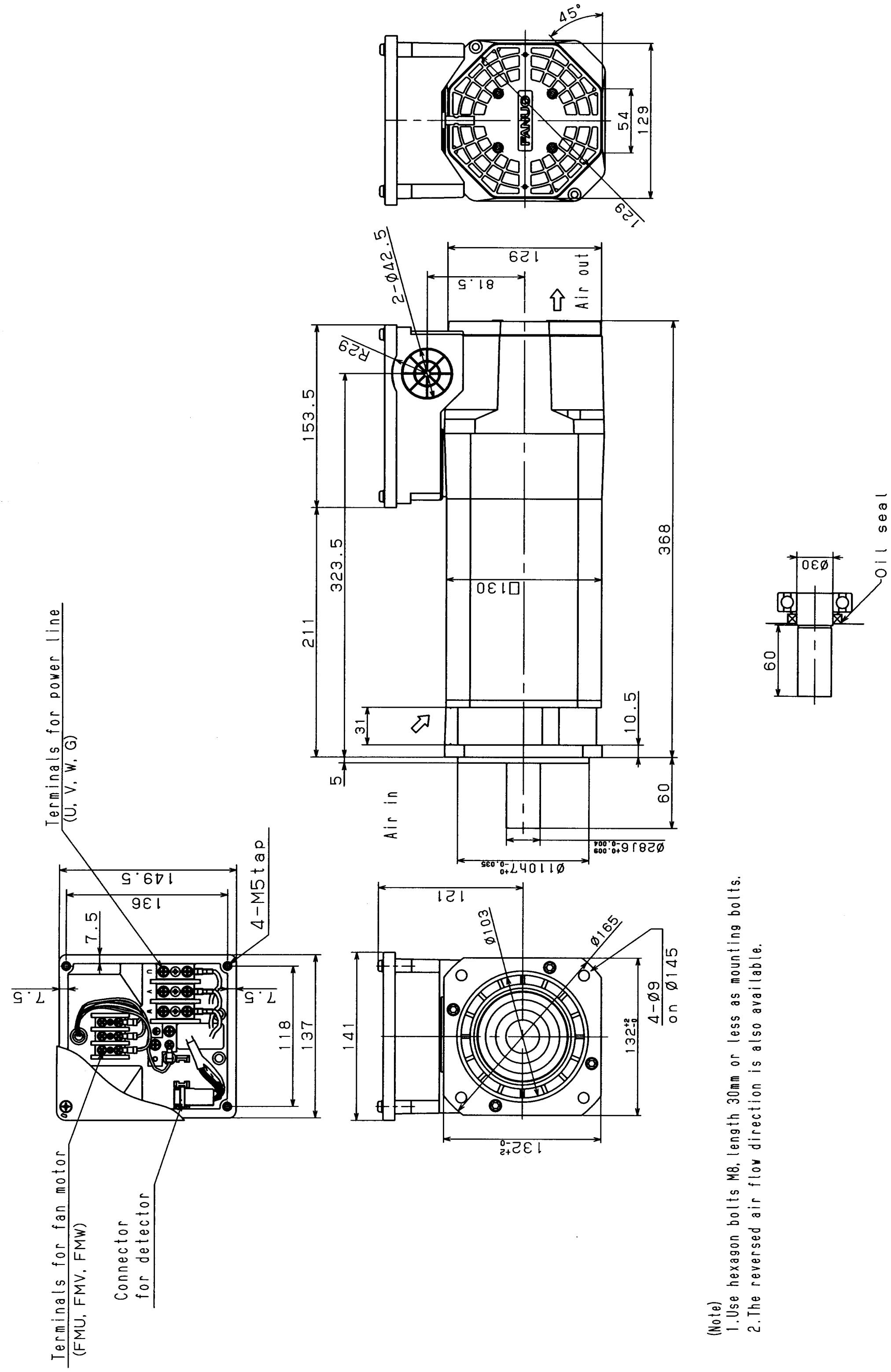
7.2 MODELS α1/10000i AND α1/15000i (FLANGE MOUNTING TYPE)



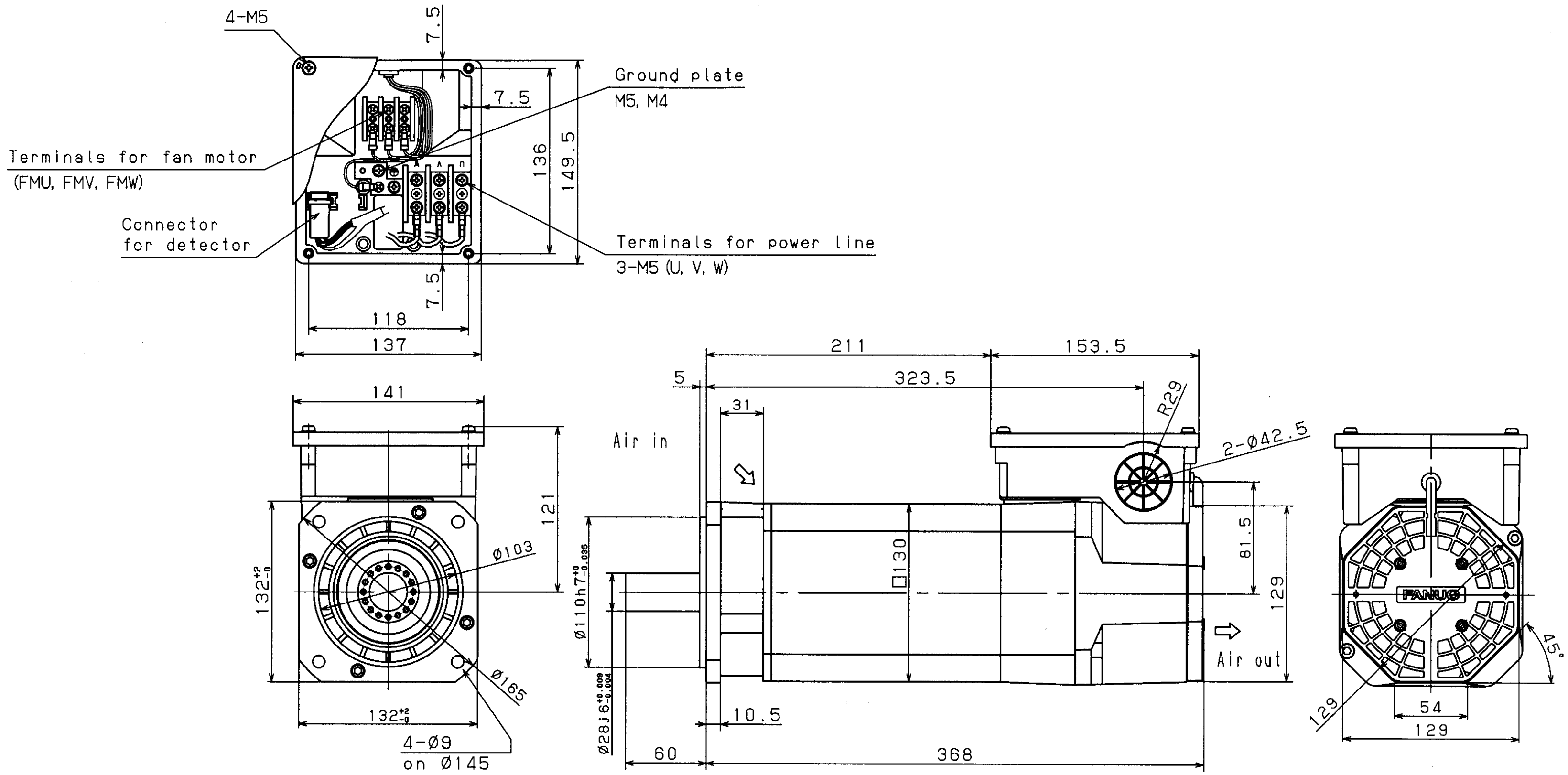
7.3 MODEL α1/10000i (FOOT MOUNTING TYPE)

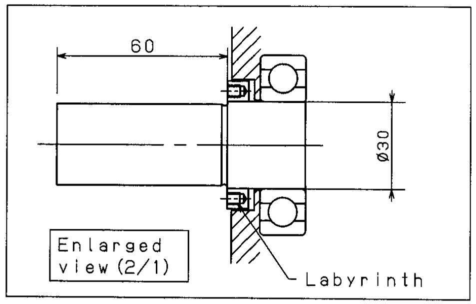


7.4 MODEL α1.5/10000i (FLANGE MOUNTING TYPE)



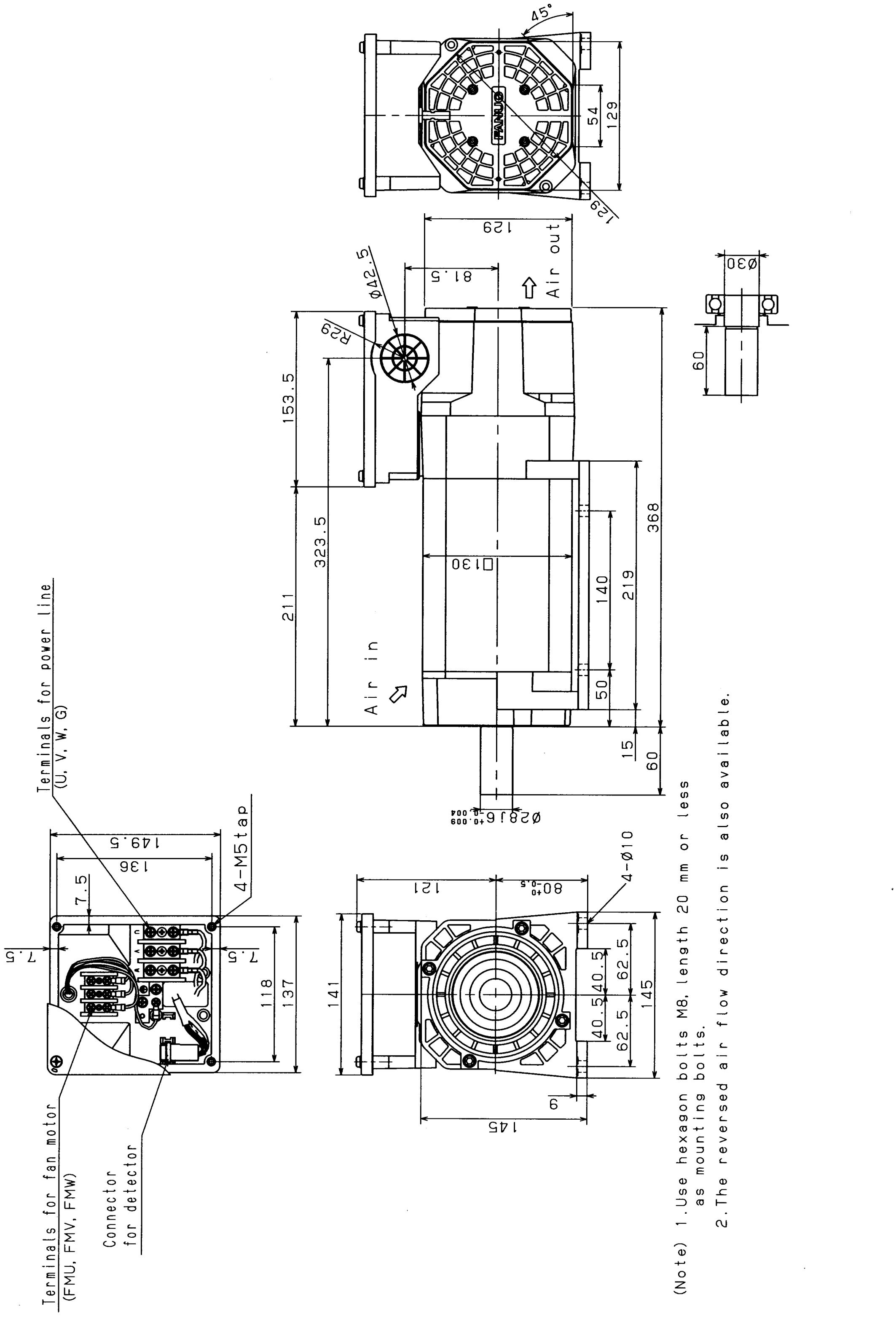
7.5 MODEL α1.5/15000*i* (FLANGE MOUNTING TYPE)



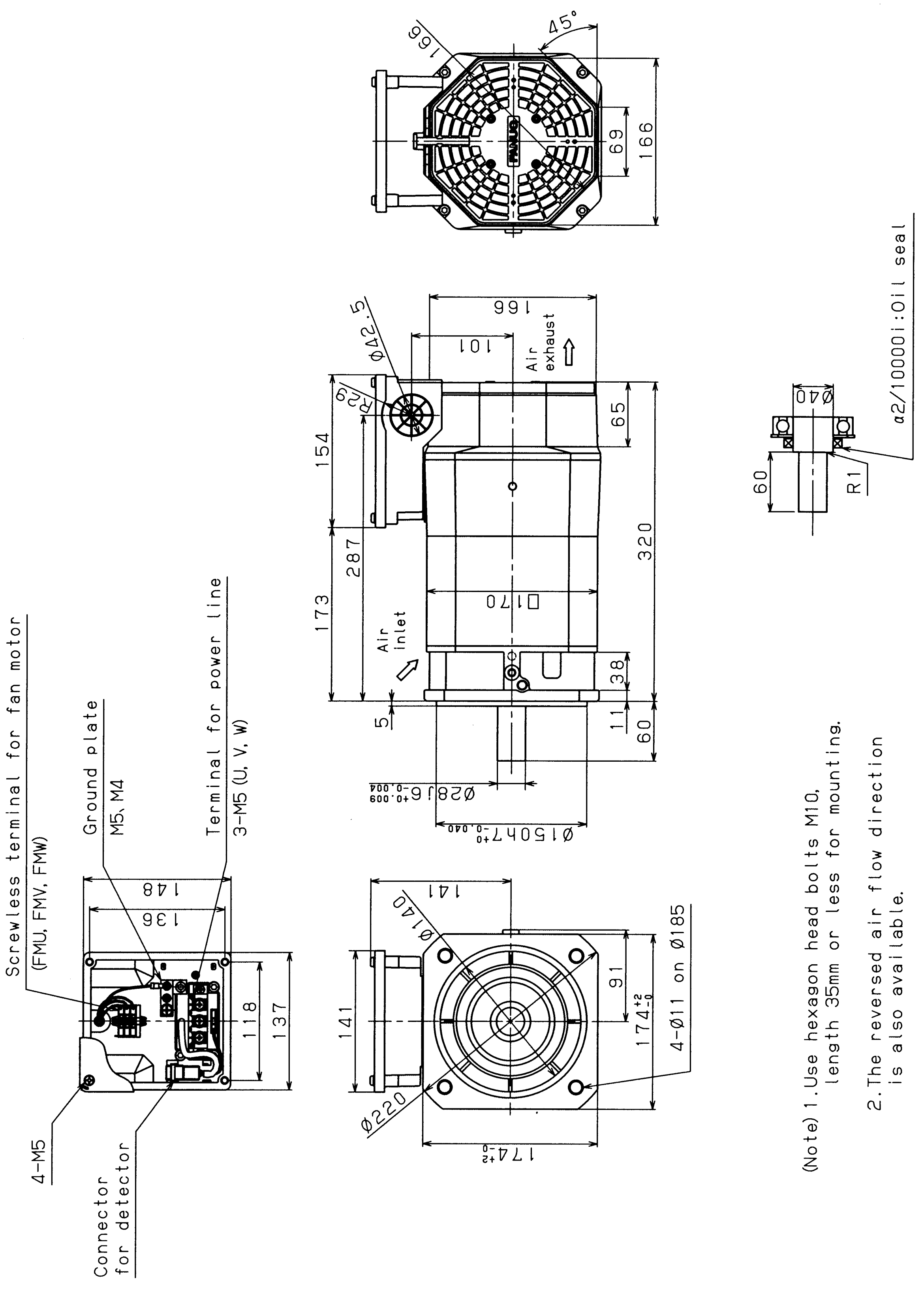


(Note)
1.Direct connection to the spindle shaft.
2.The output shaft should be horizontal or vertical downward.
3.This motor should be used under that the vibration is less than 0.5G. (the measuring frequency:10~1000Hz)
You should center between motor shaft and spindle, installing this motor to the machine, 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.

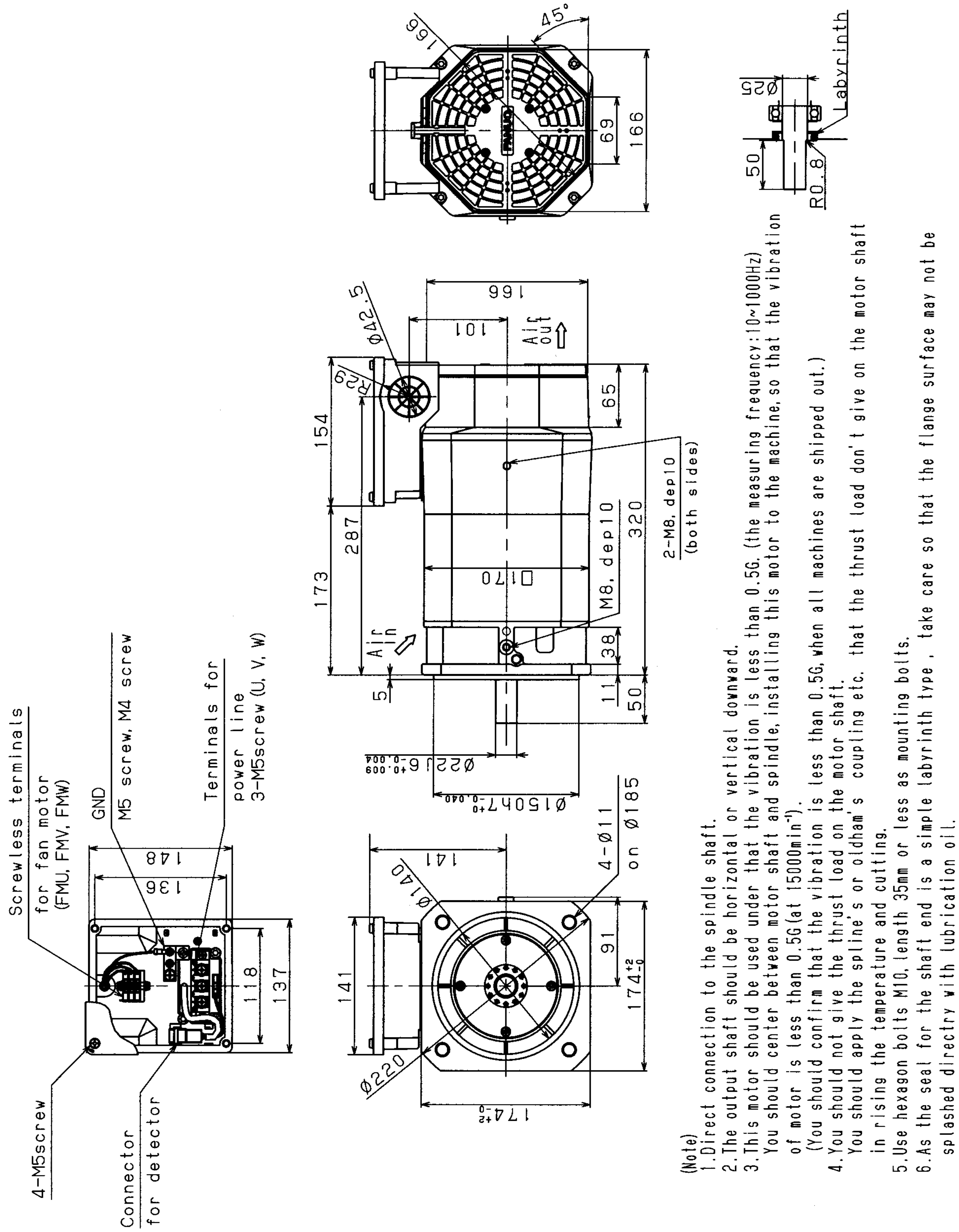
7.6 MODEL α1.5/10000*i* (FOOT MOUNTING TYPE)



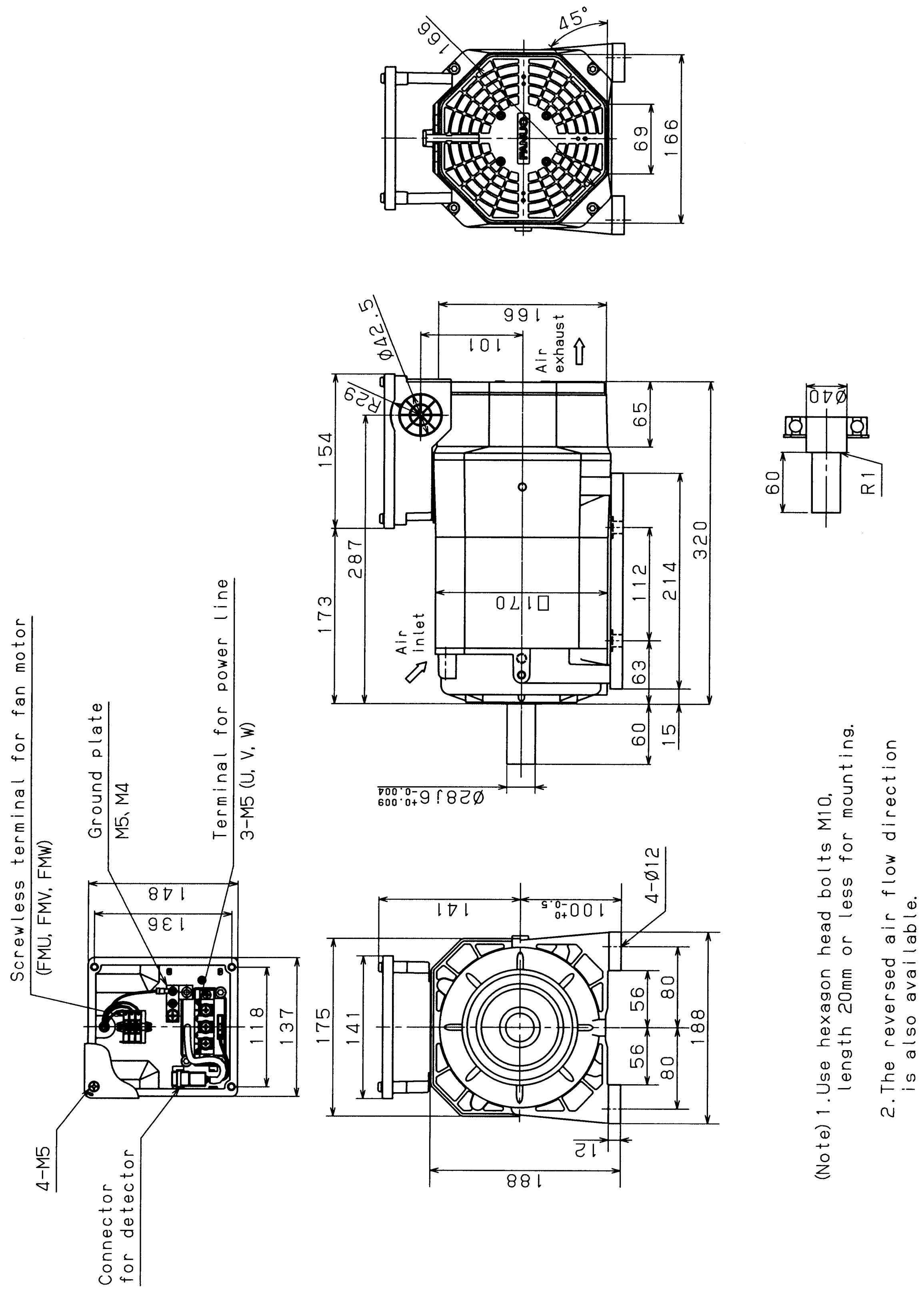
7.7 MODEL α2/10000i (FLANGE MOUNTING TYPE)



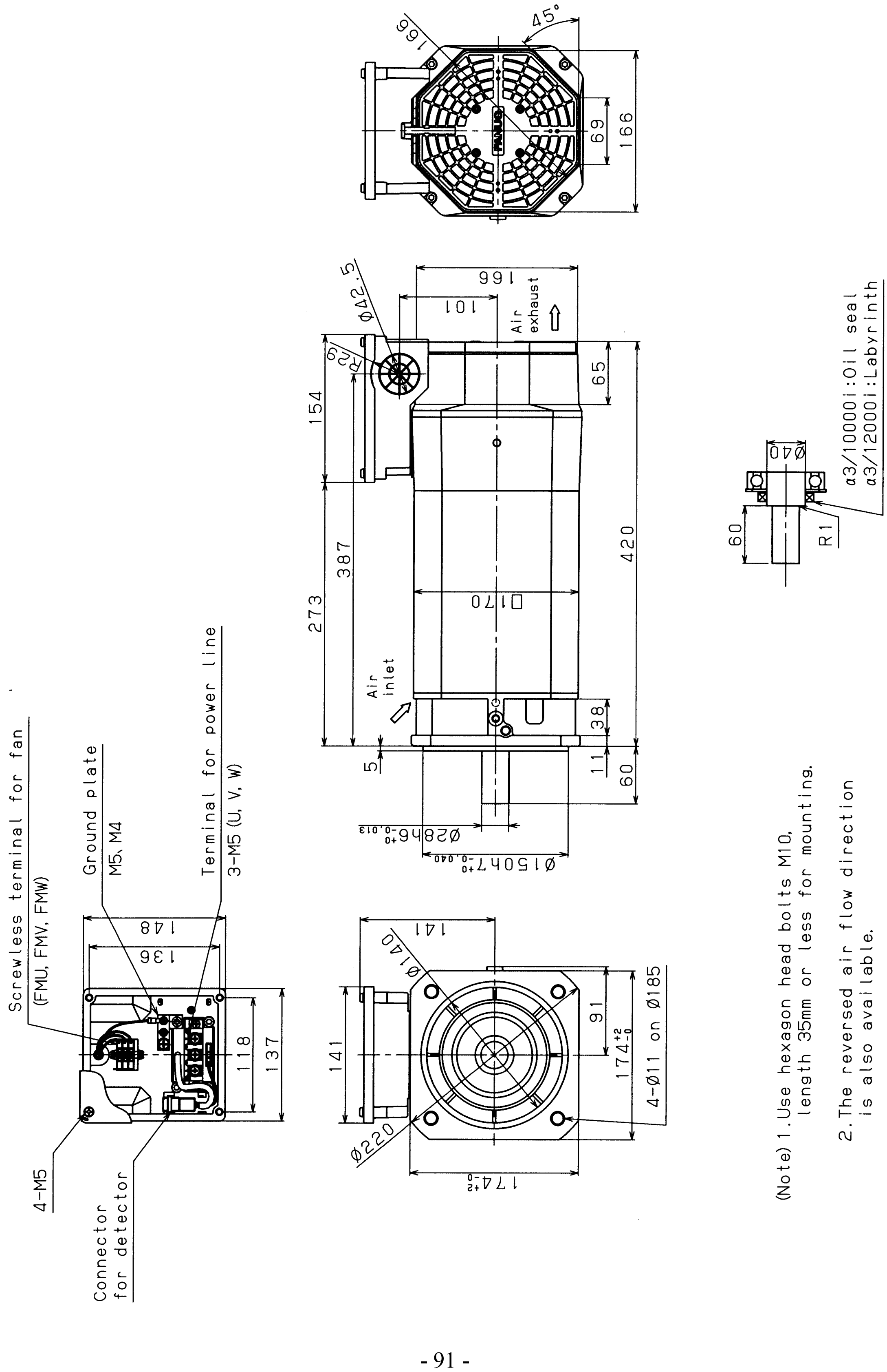
7.8 MODEL α2/15000*i* (FLANGE MOUNTING TYPE)



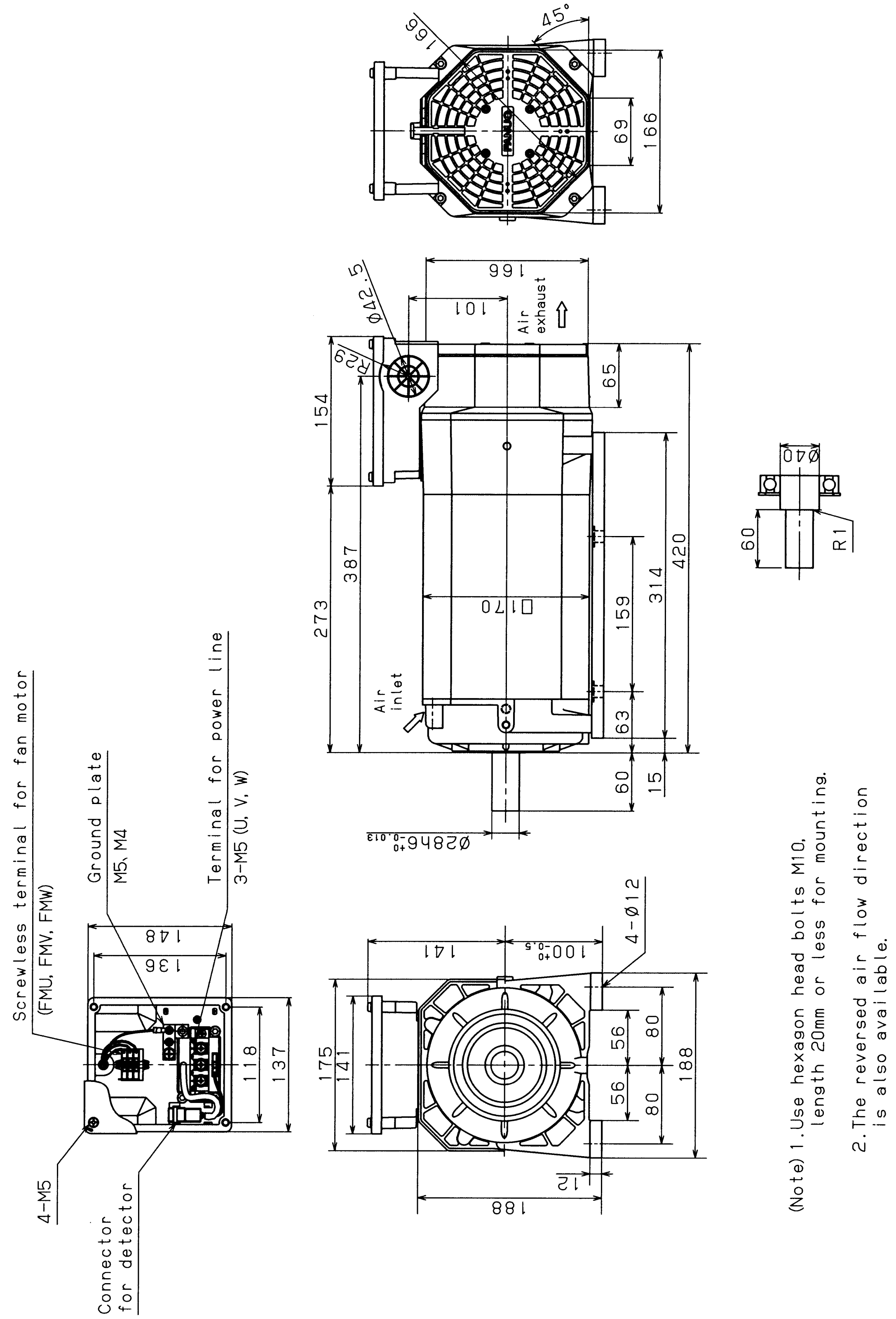
7.9 MODEL α2/10000*i* (FOOT MOUNTING TYPE)



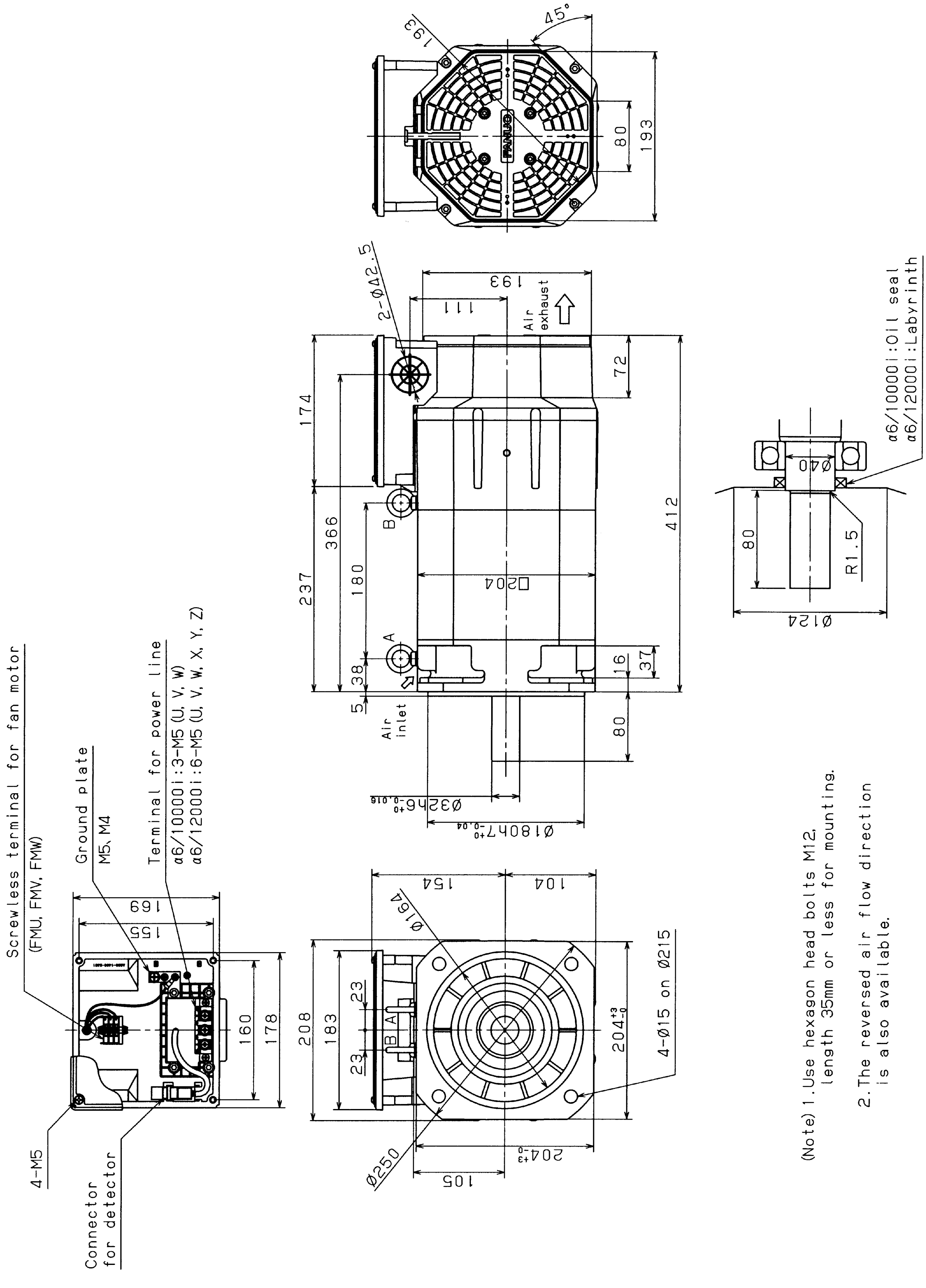
7.10 MODELS α3/10000*i* AND α3/12000*i* (FLANGE MOUNTING TYPE)



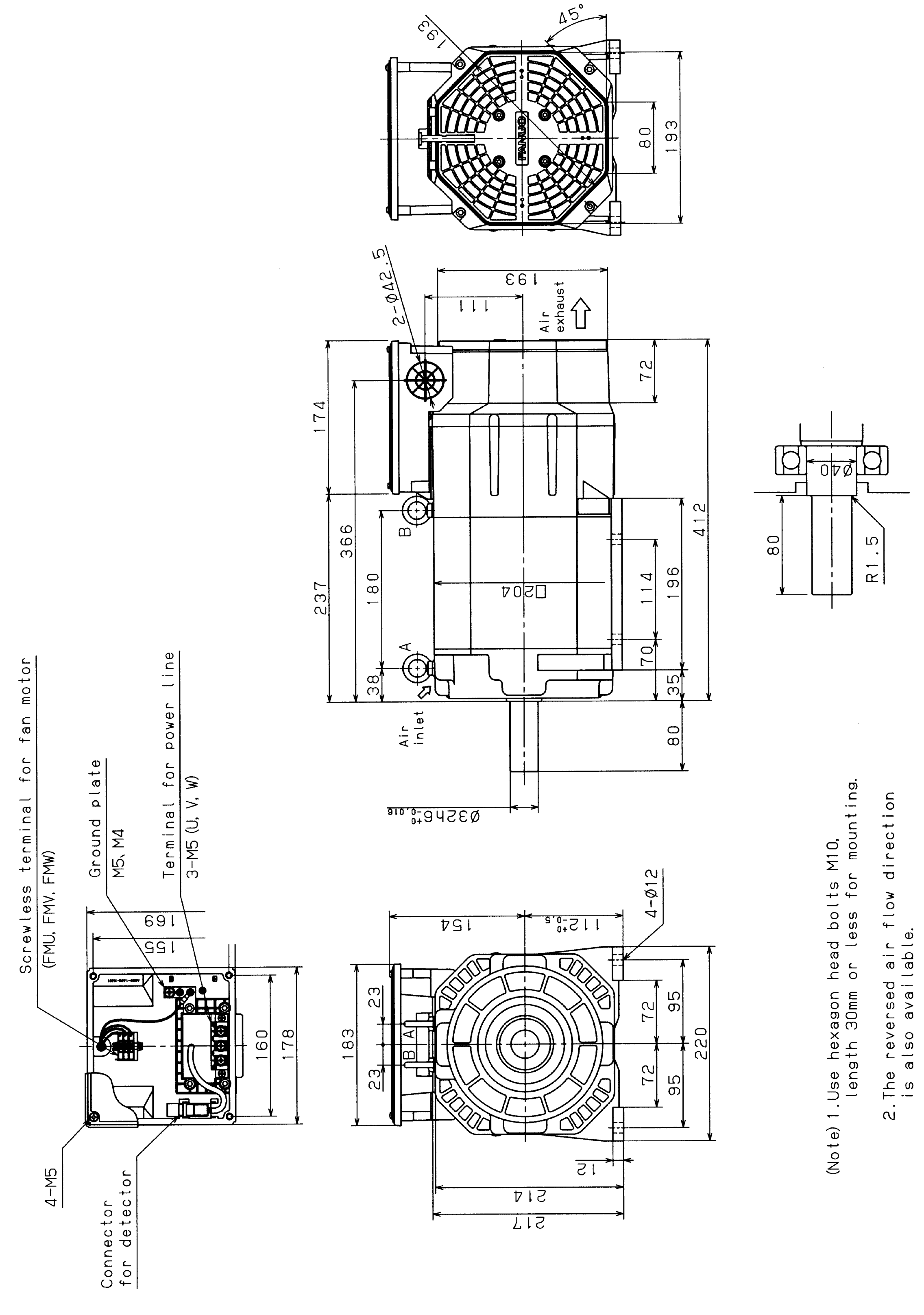
7.11 MODEL α3/10000*i* (FOOT MOUNTING TYPE)



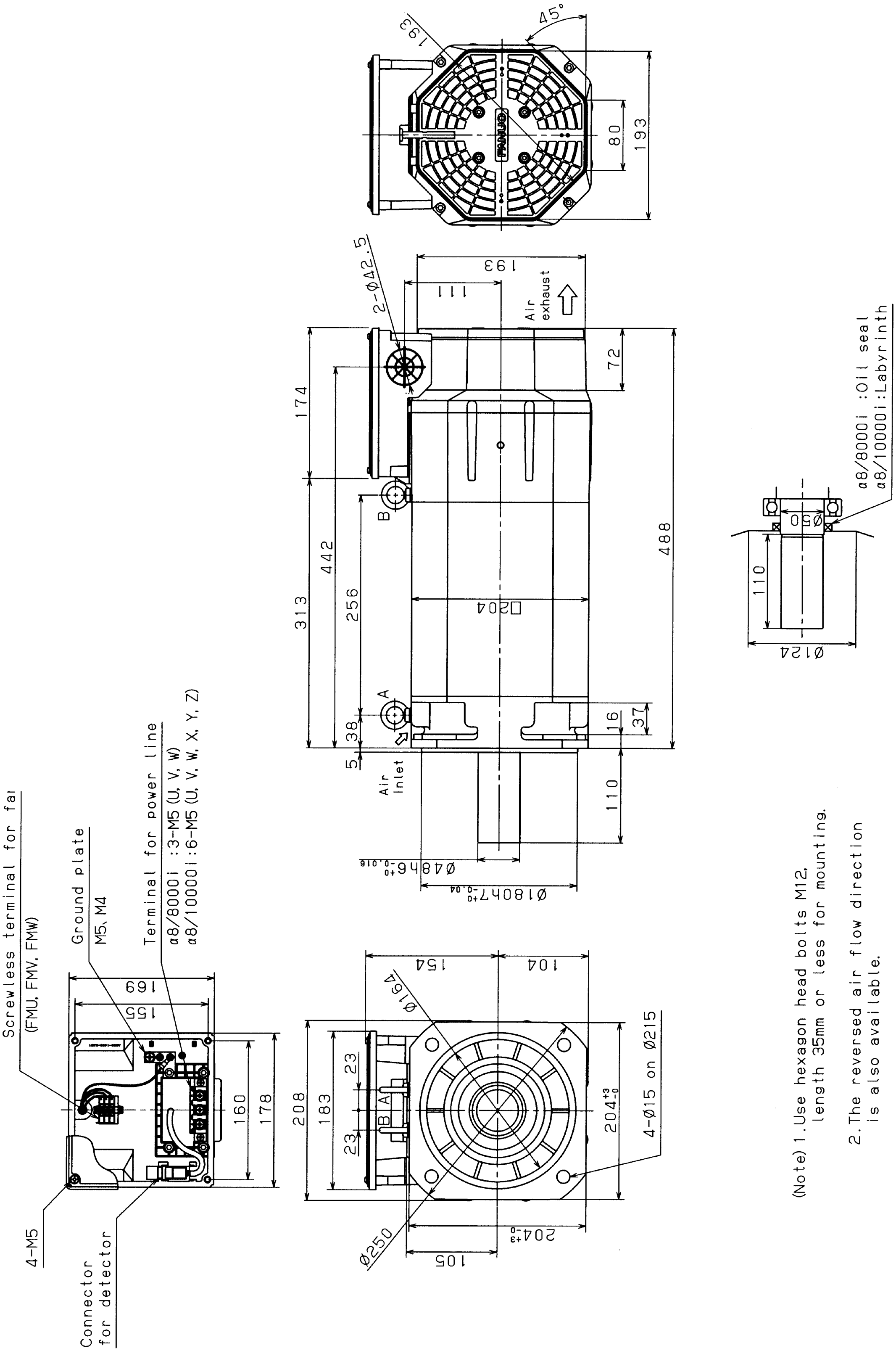
7.12 MODELS α6/10000*i* AND α6/12000*i* (FLANGE MOUNTING TYPE)



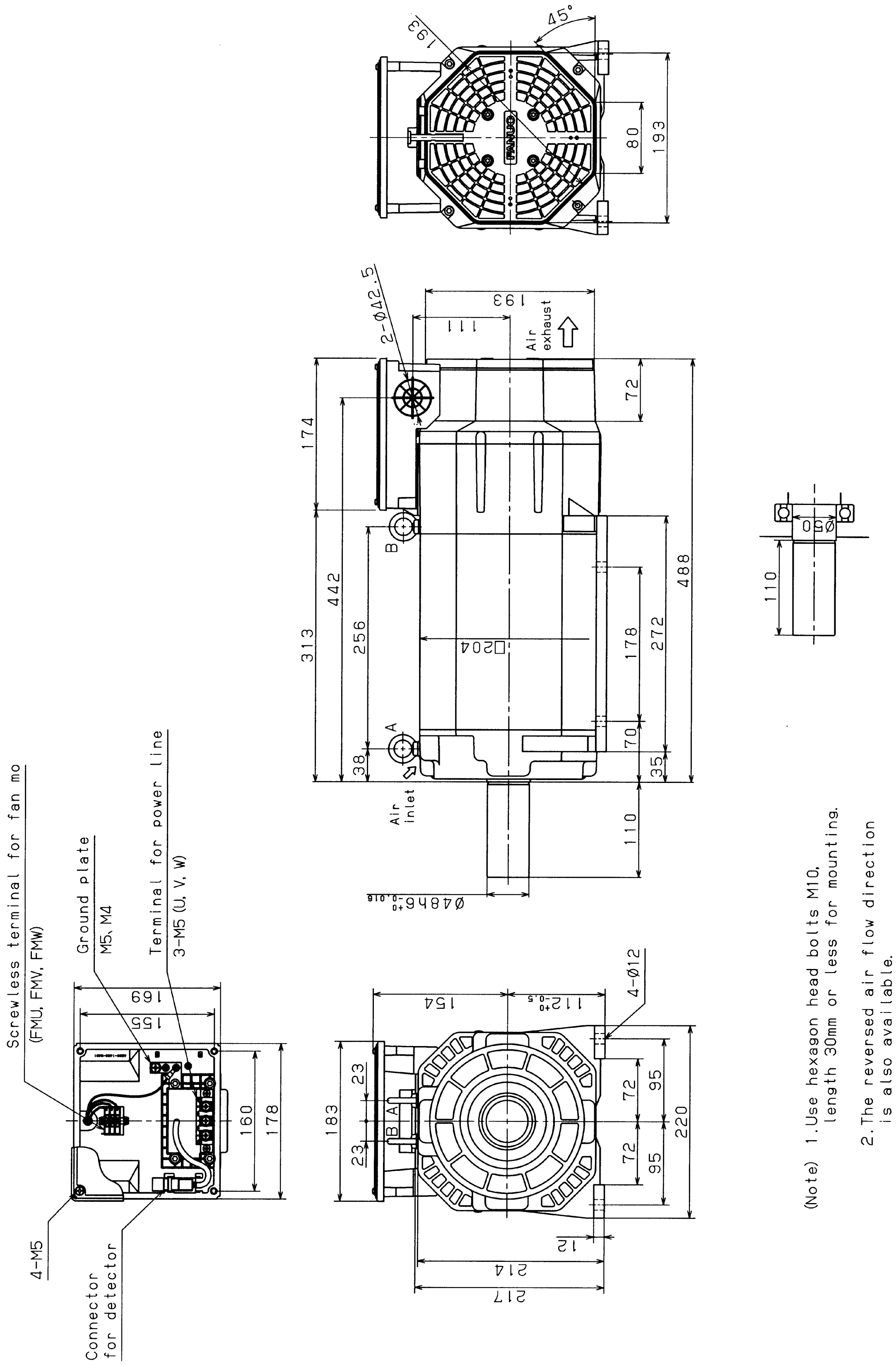
7.13 MODEL α6/10000*i* (FOOT MOUNTING TYPE)



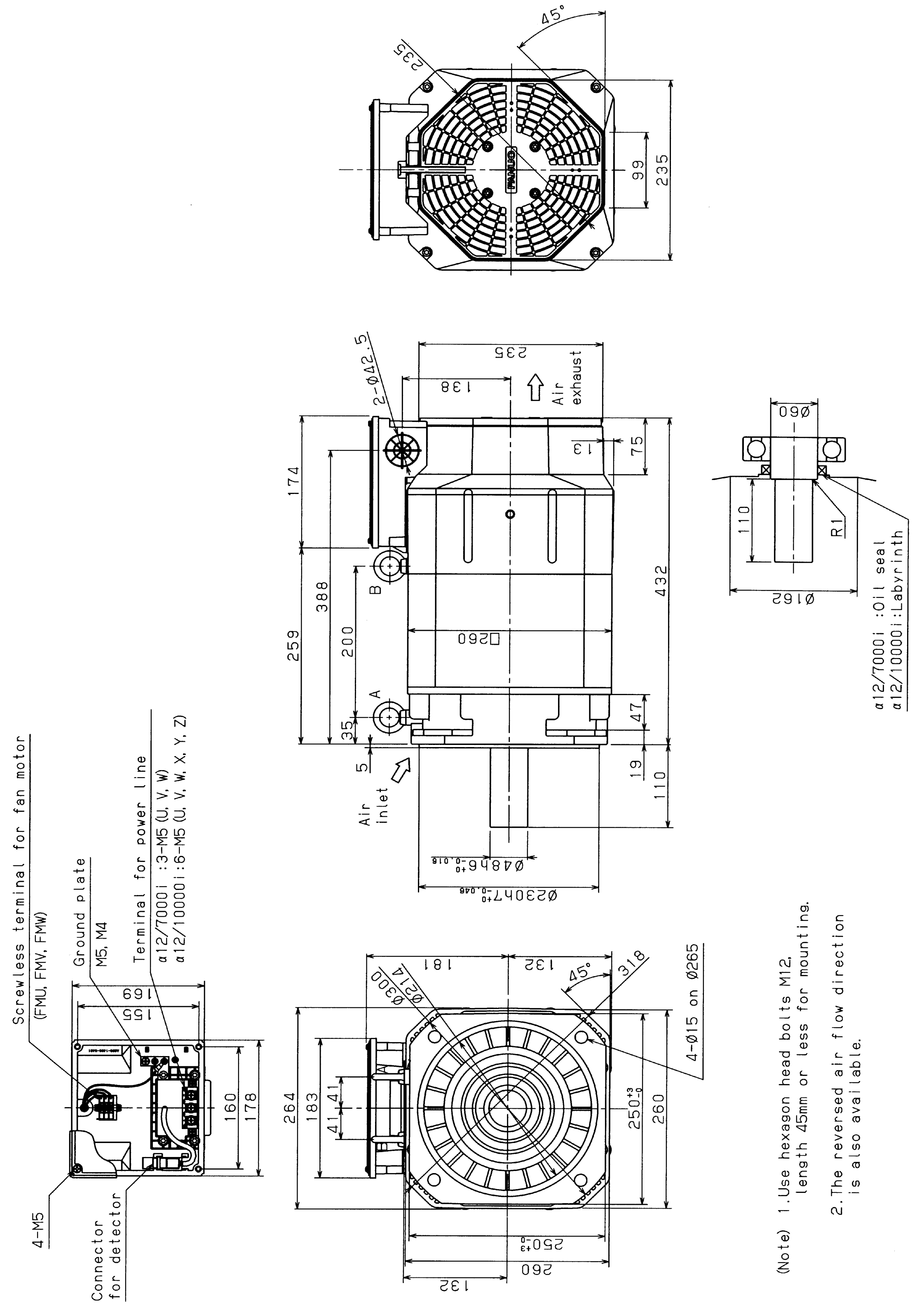
7.14 MODELS α8/8000*i* AND α8/10000*i* (FLANGE MOUNTING TYPE)



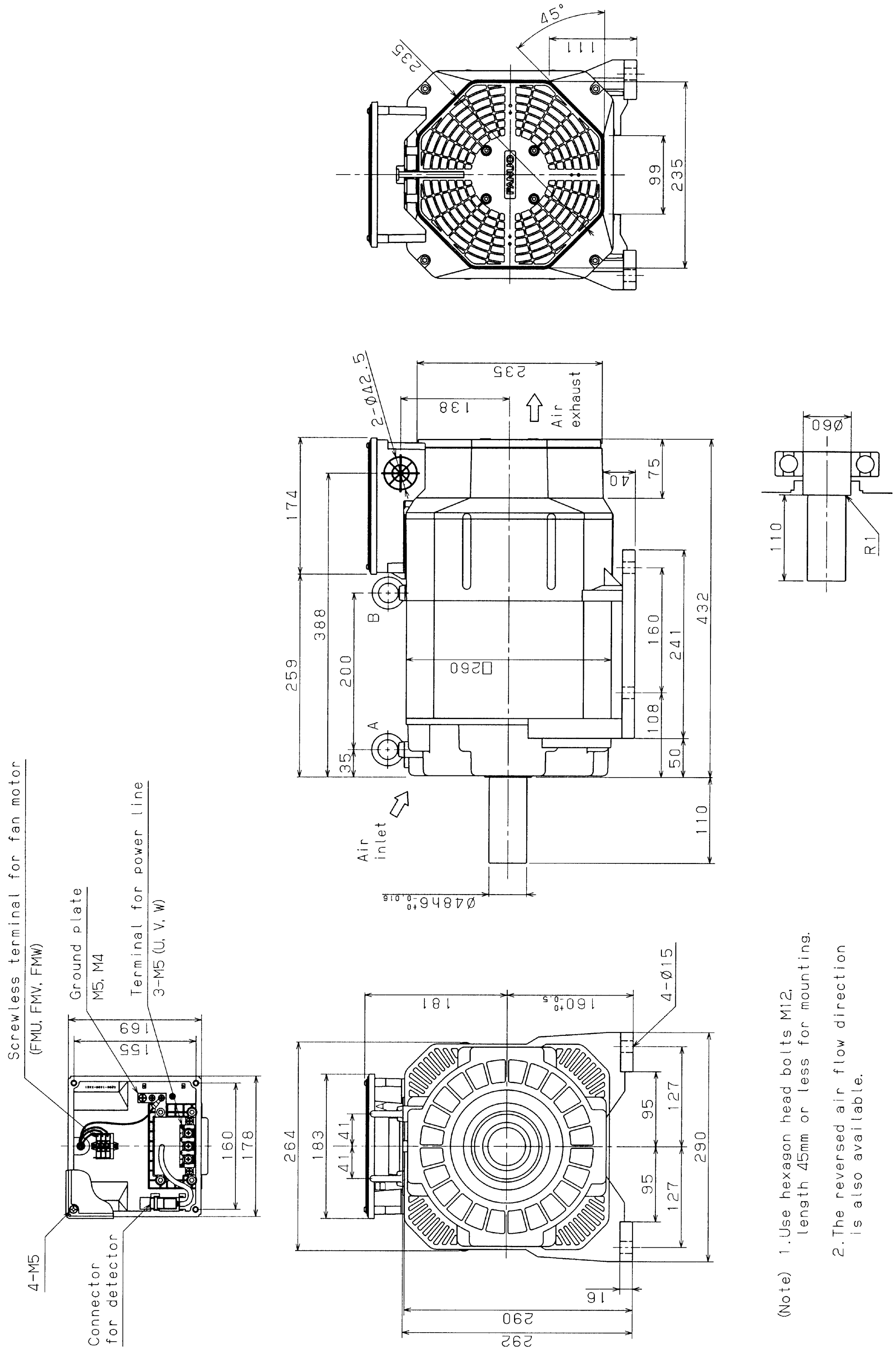
7.15 MODEL α8/8000i (FOOT MOUNTING TYPE)



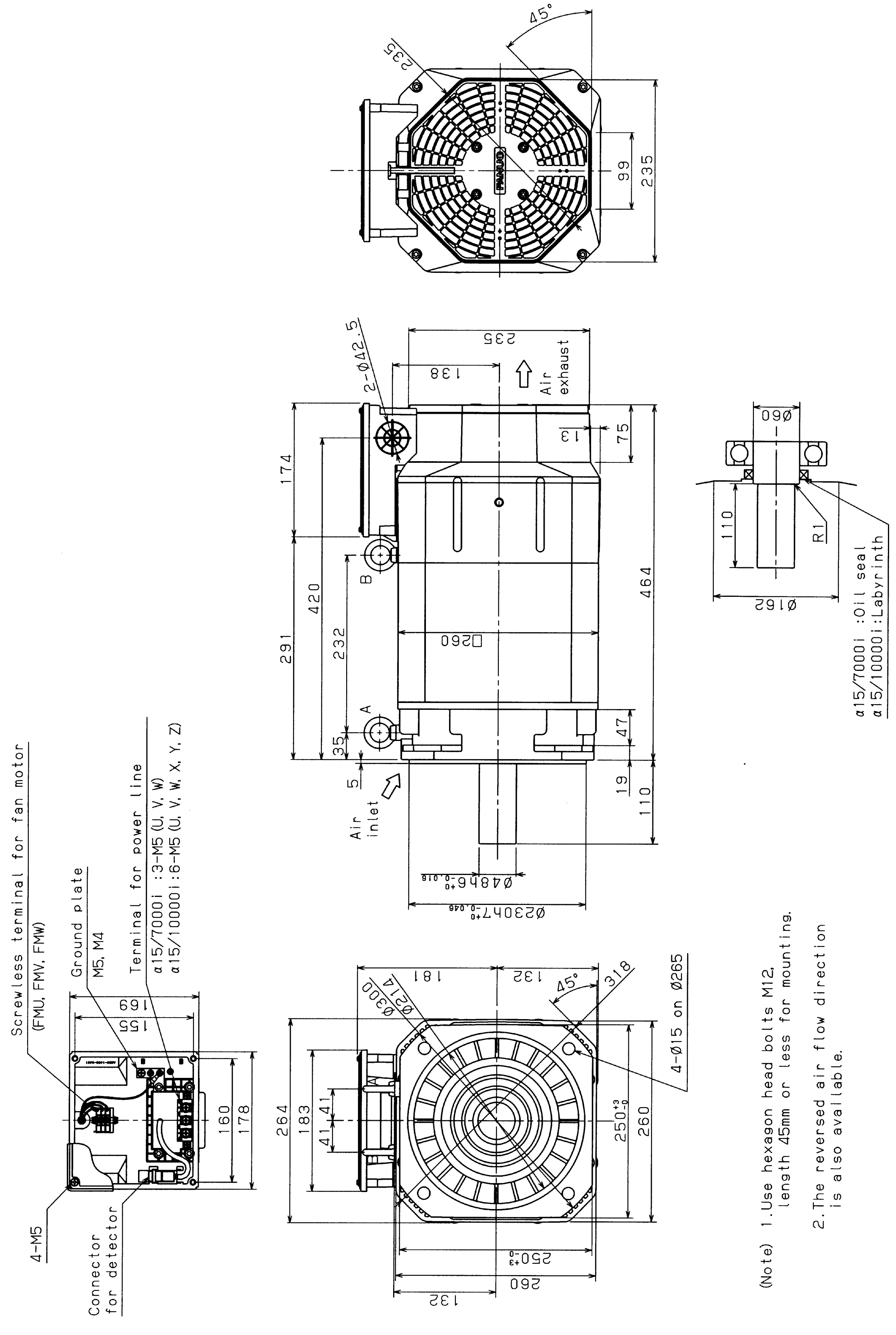
7.16 MODELS α12/7000*i* AND α12/10000*i* (FLANGE MOUNTING TYPE)



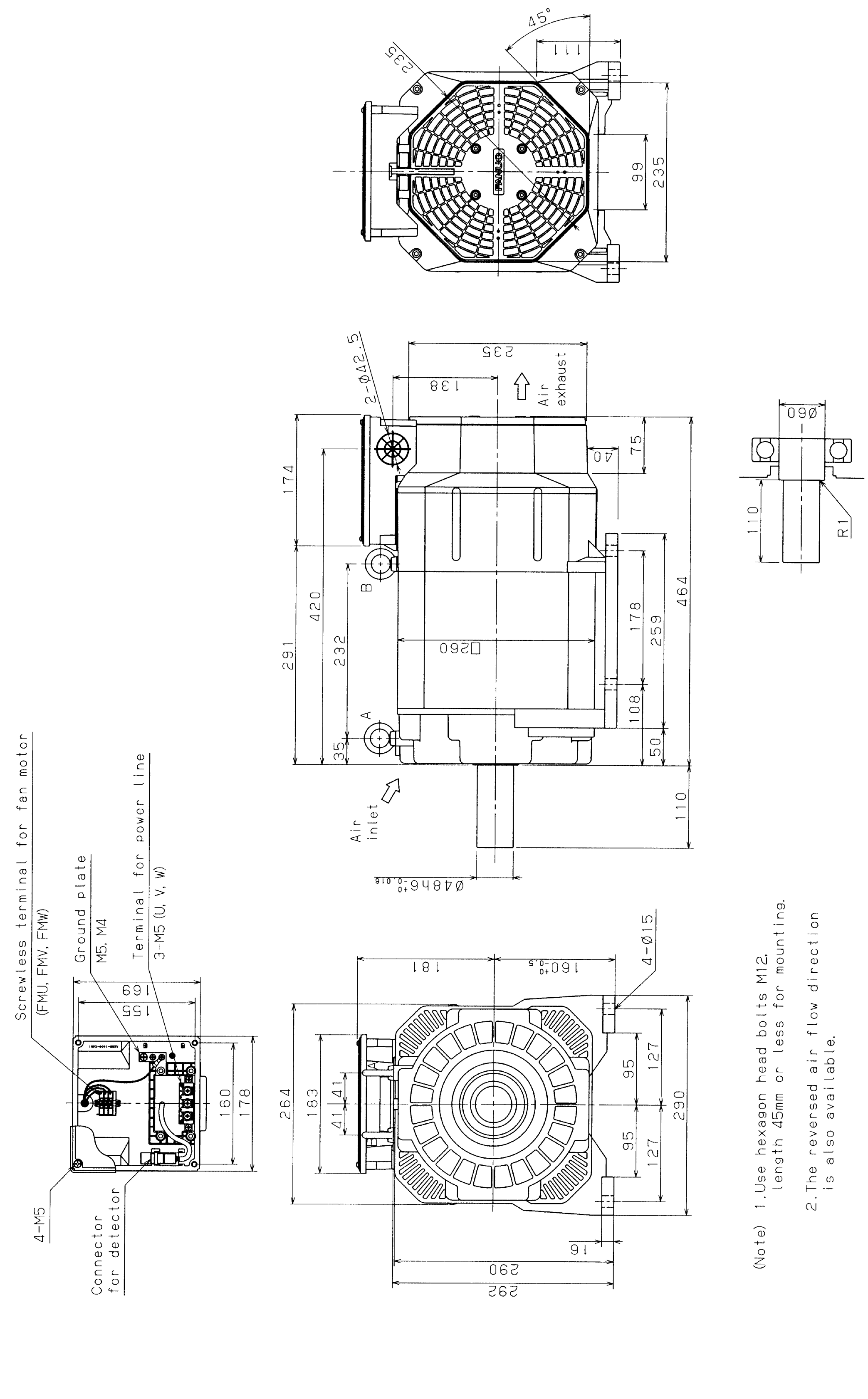
7.17 MODEL α12/7000i (FOOT MOUNTING TYPE)



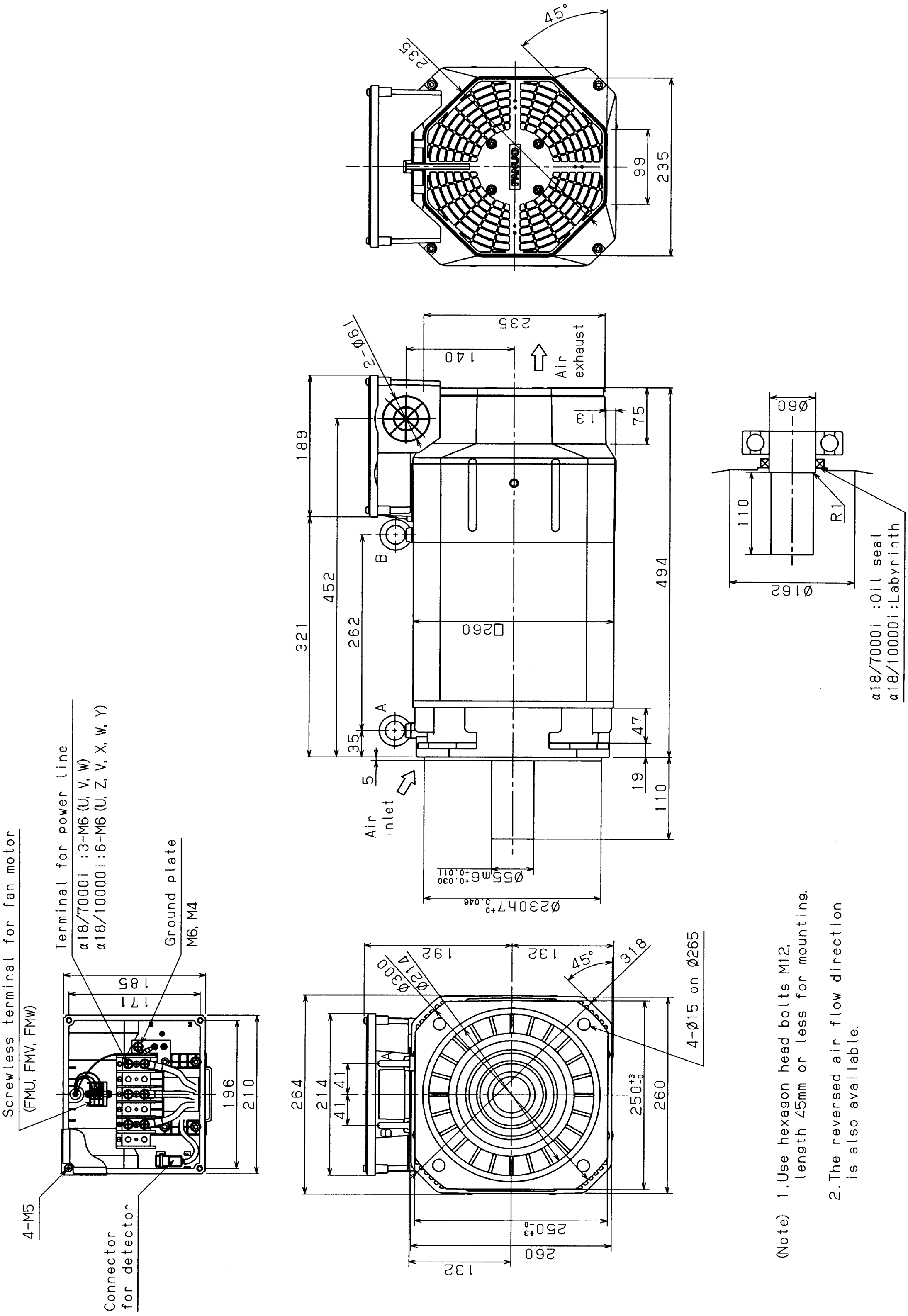
7.18 MODELS α15/7000*i* AND α15/10000*i* (FLANGE MOUNTING TYPE)



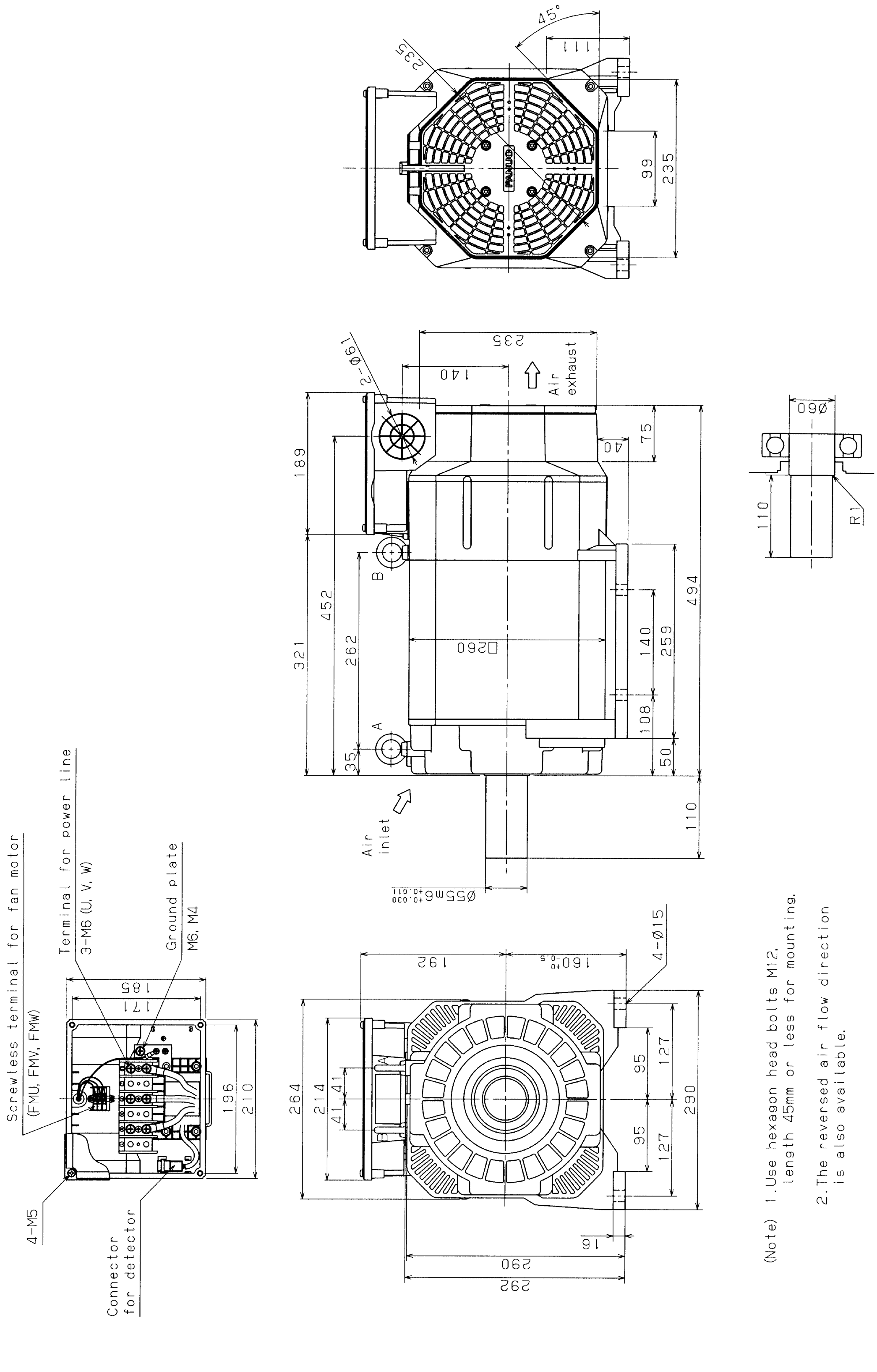
7.19 MODEL α15/7000i (FOOT MOUNTING TYPE)



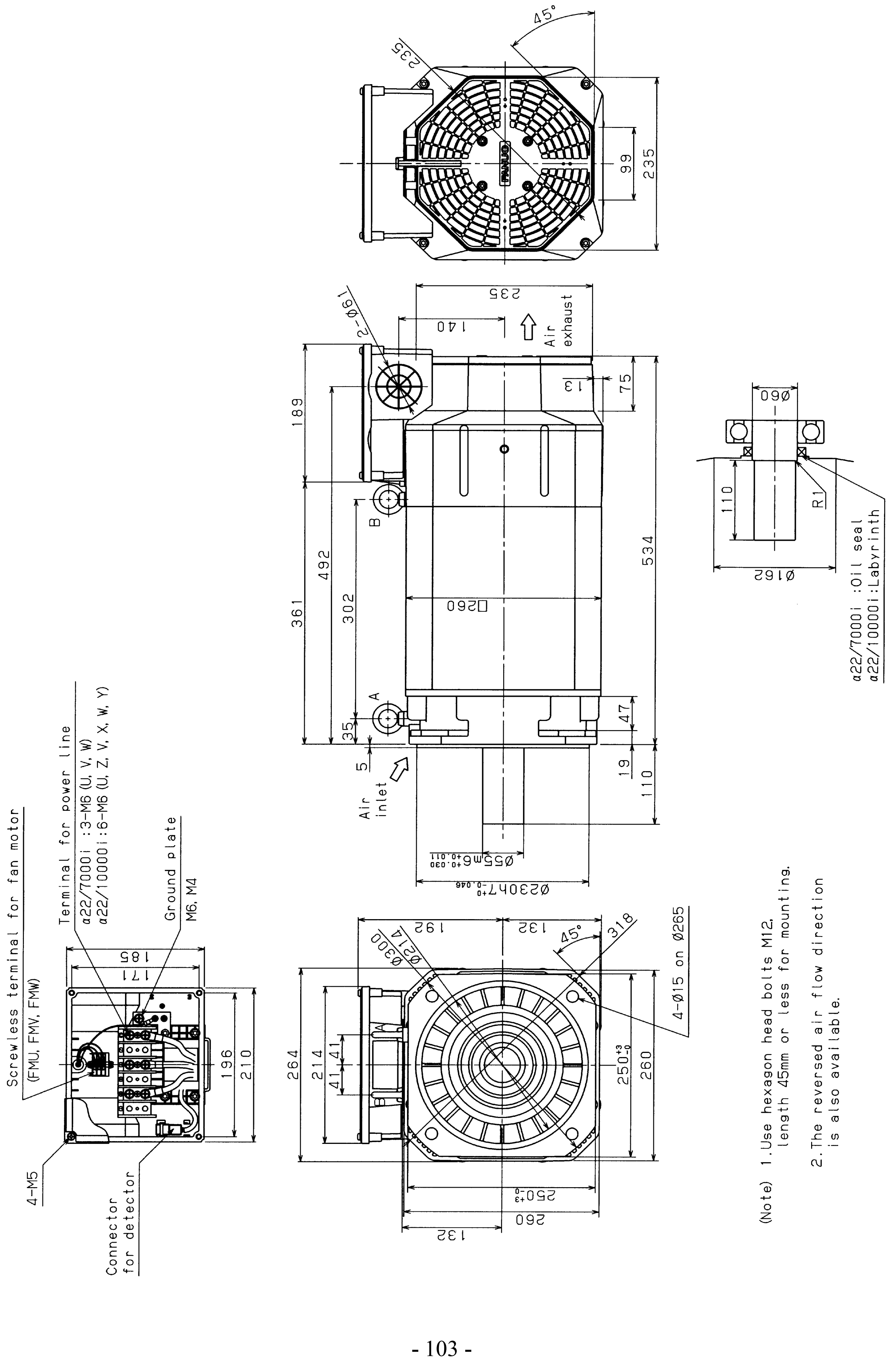
7.20 MODELS α18/7000*i* AND α18/10000*i* (FLANGE MOUNTING TYPE)



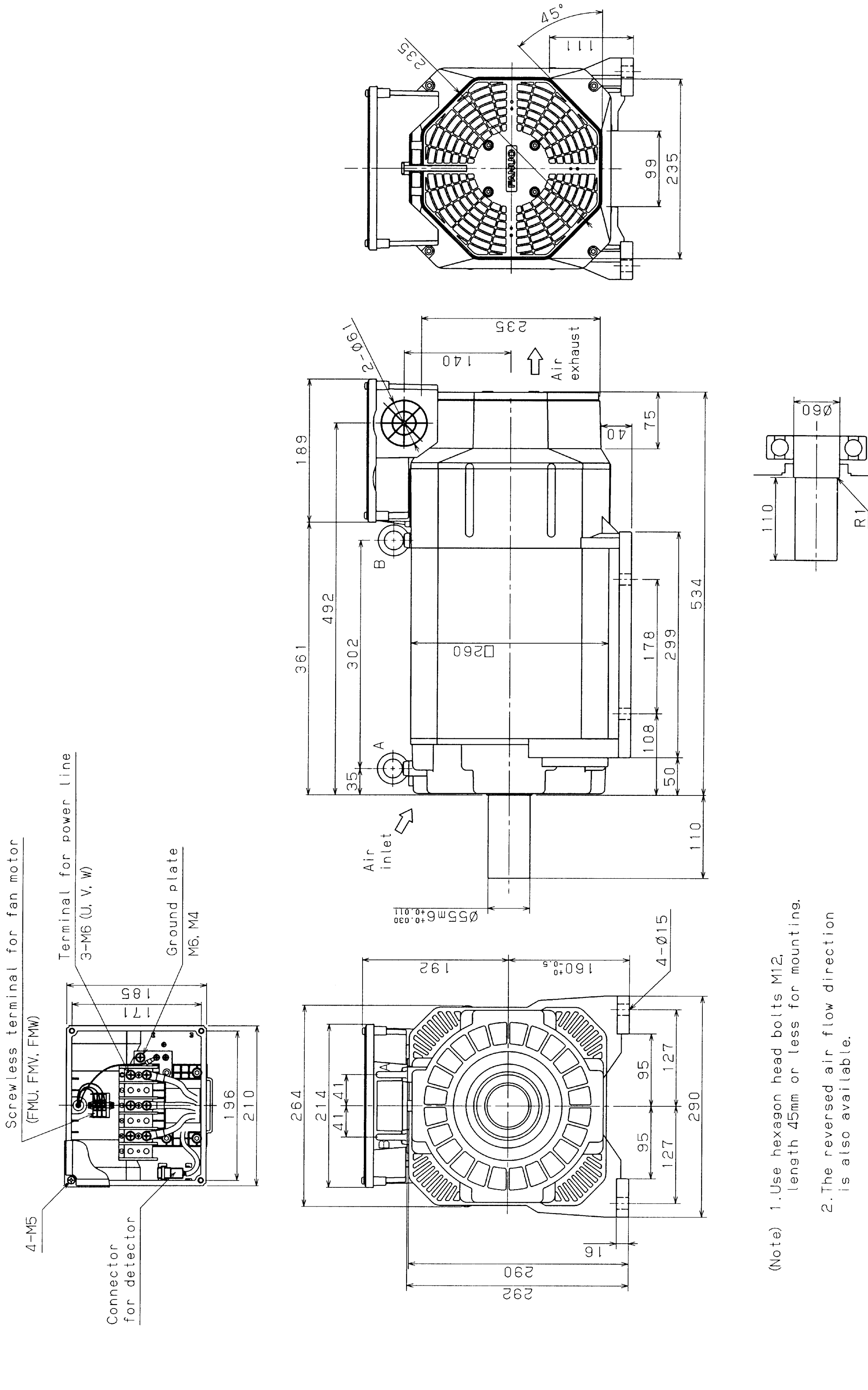
7.21 MODEL α18/7000i (FOOT MOUNTING TYPE)



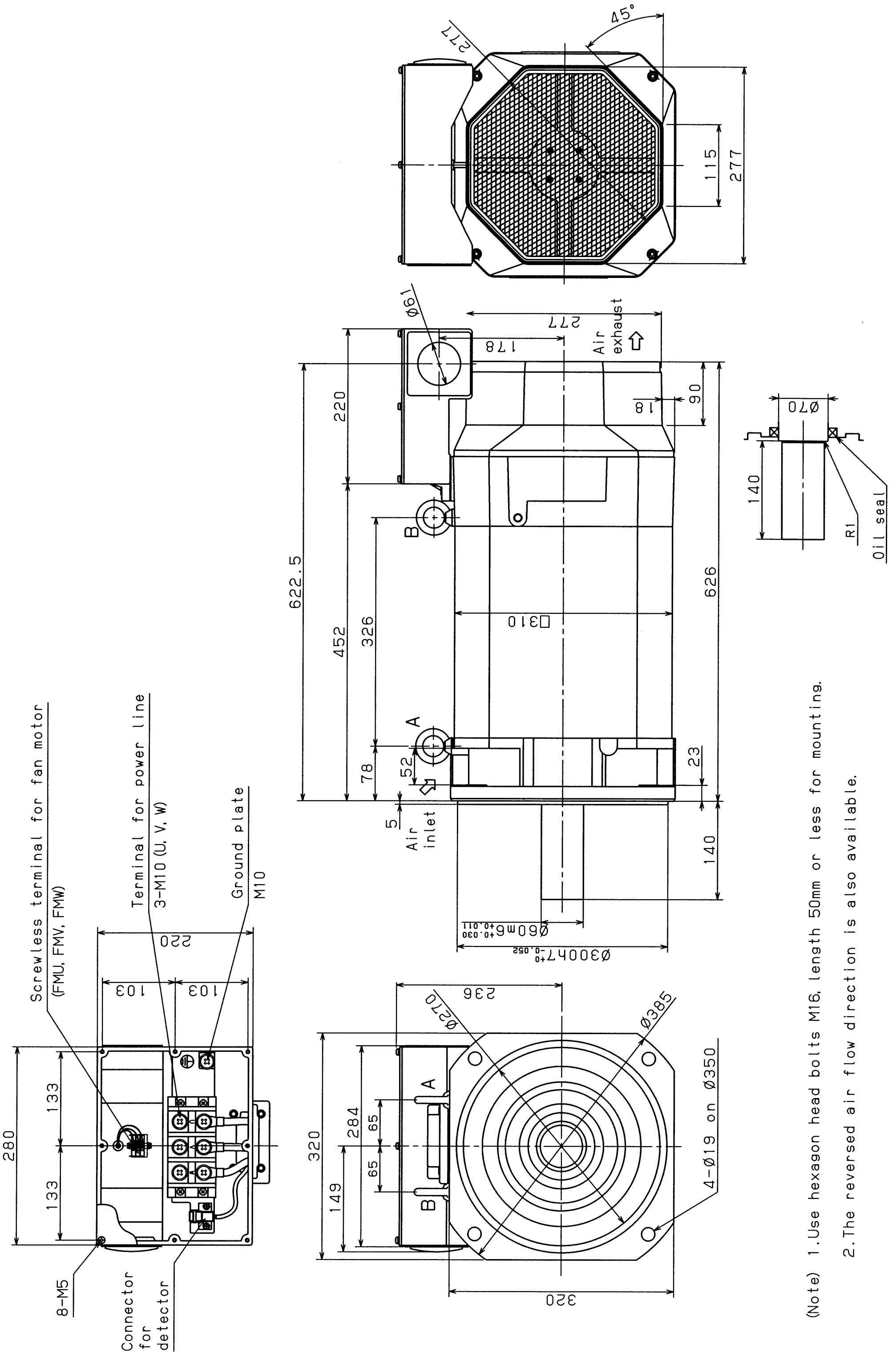
7.22 MODELS α22/7000i AND α22/10000i (FLANGE MOUNTING TYPE)



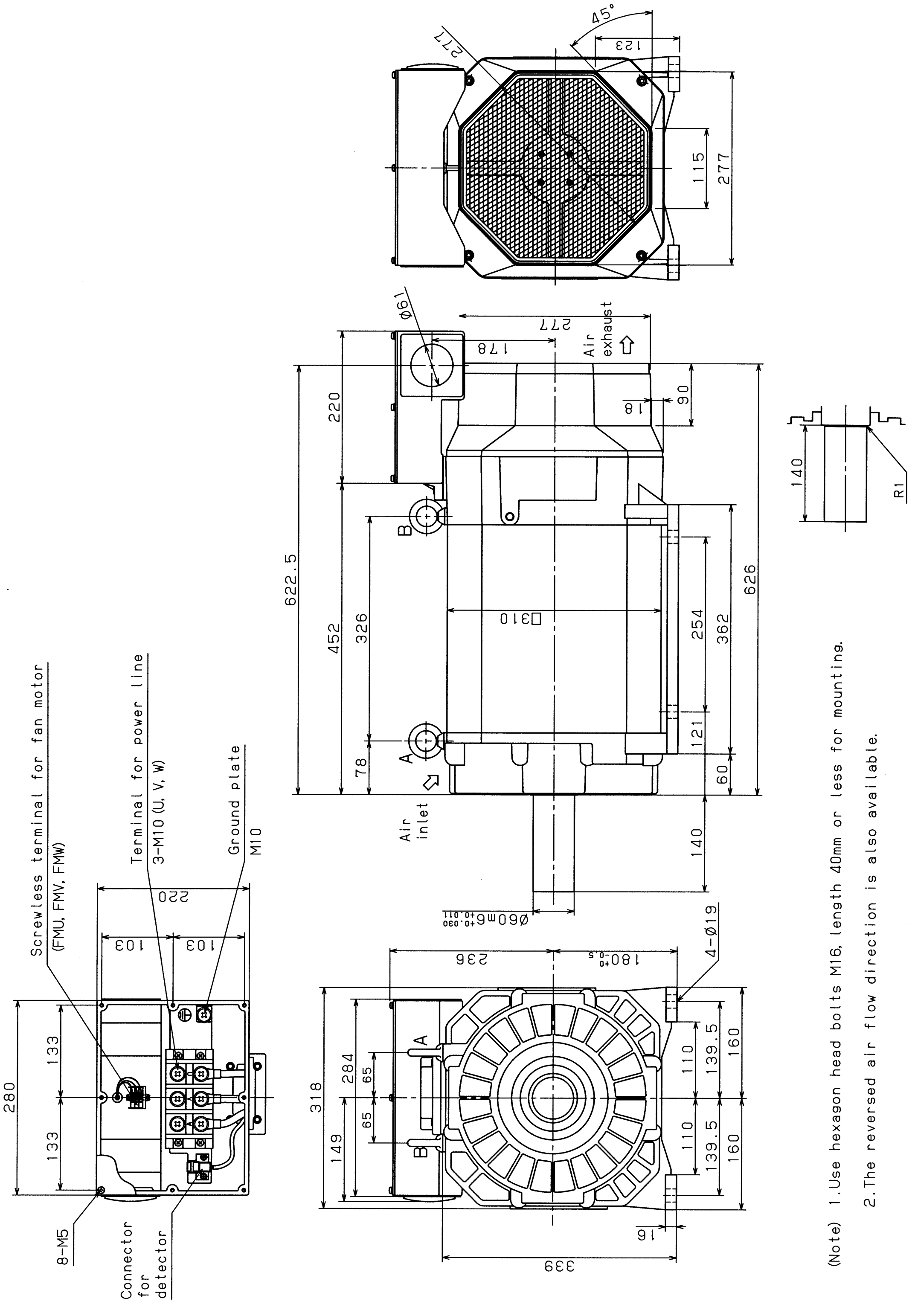
7.23 MODEL α22/7000i (FOOT MOUNTING TYPE)



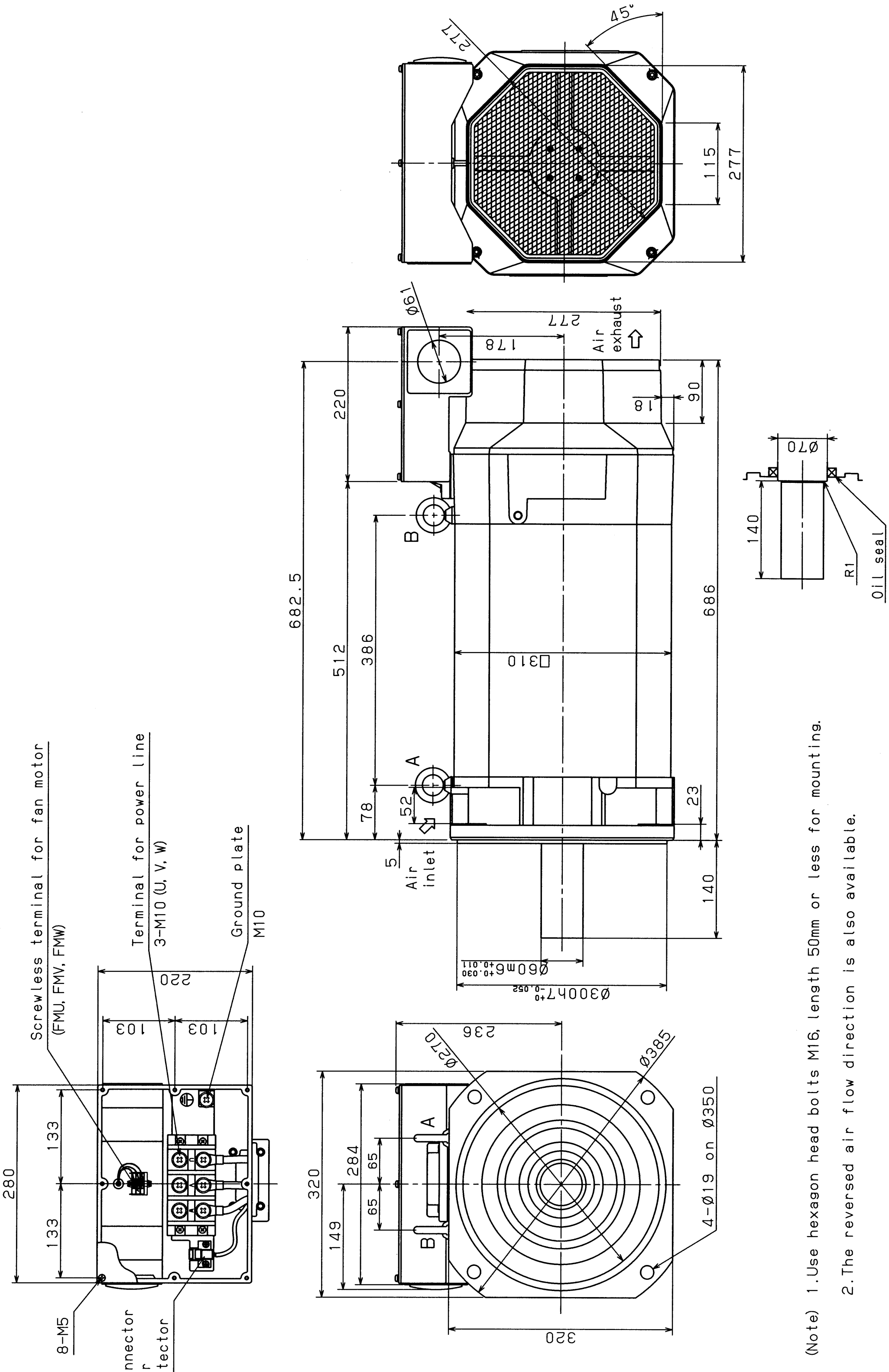
7.24 MODEL α30/6000*i* (FLANGE MOUNTING TYPE)



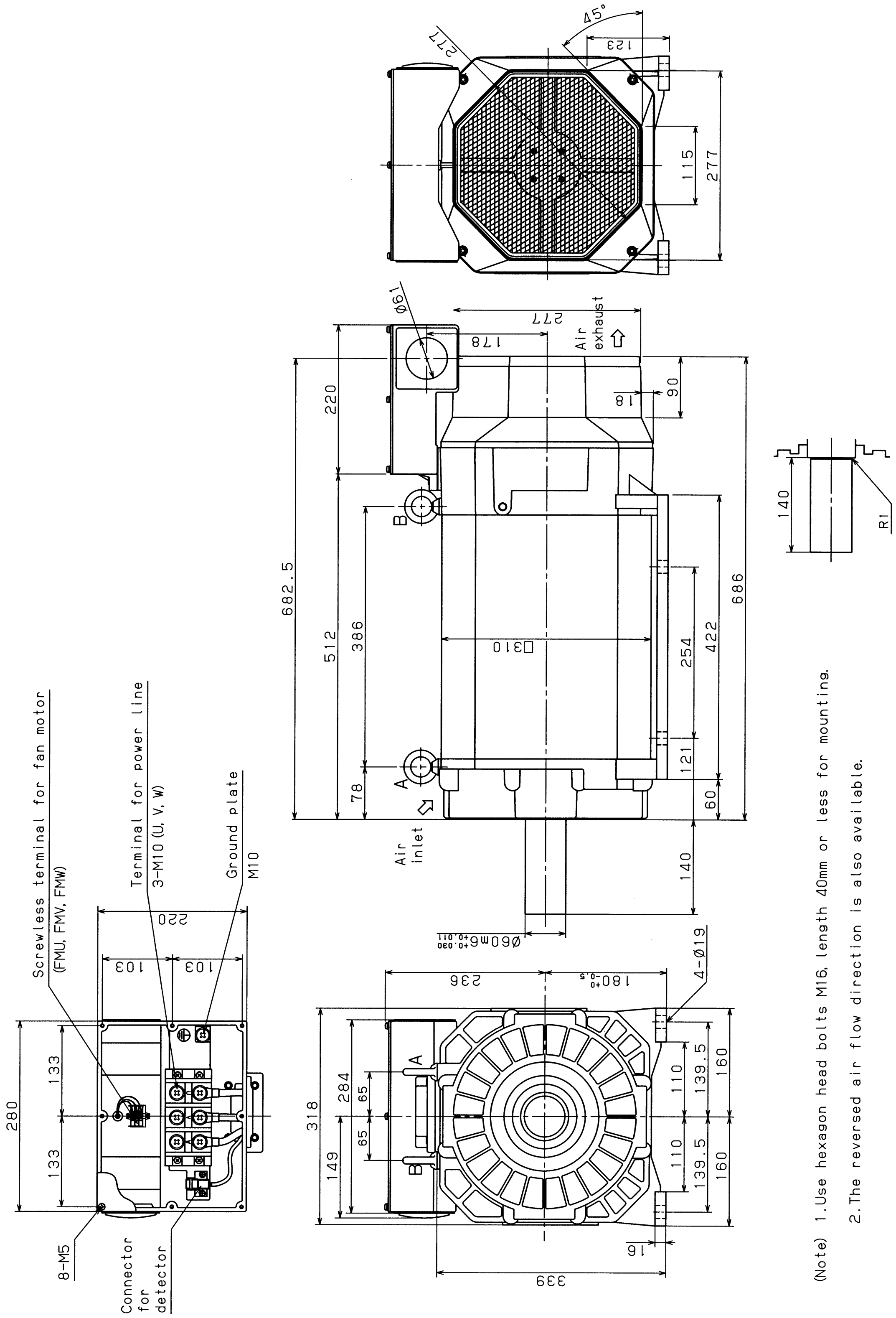
7.25 MODEL α30/6000i (FOOT MOUNTING TYPE)



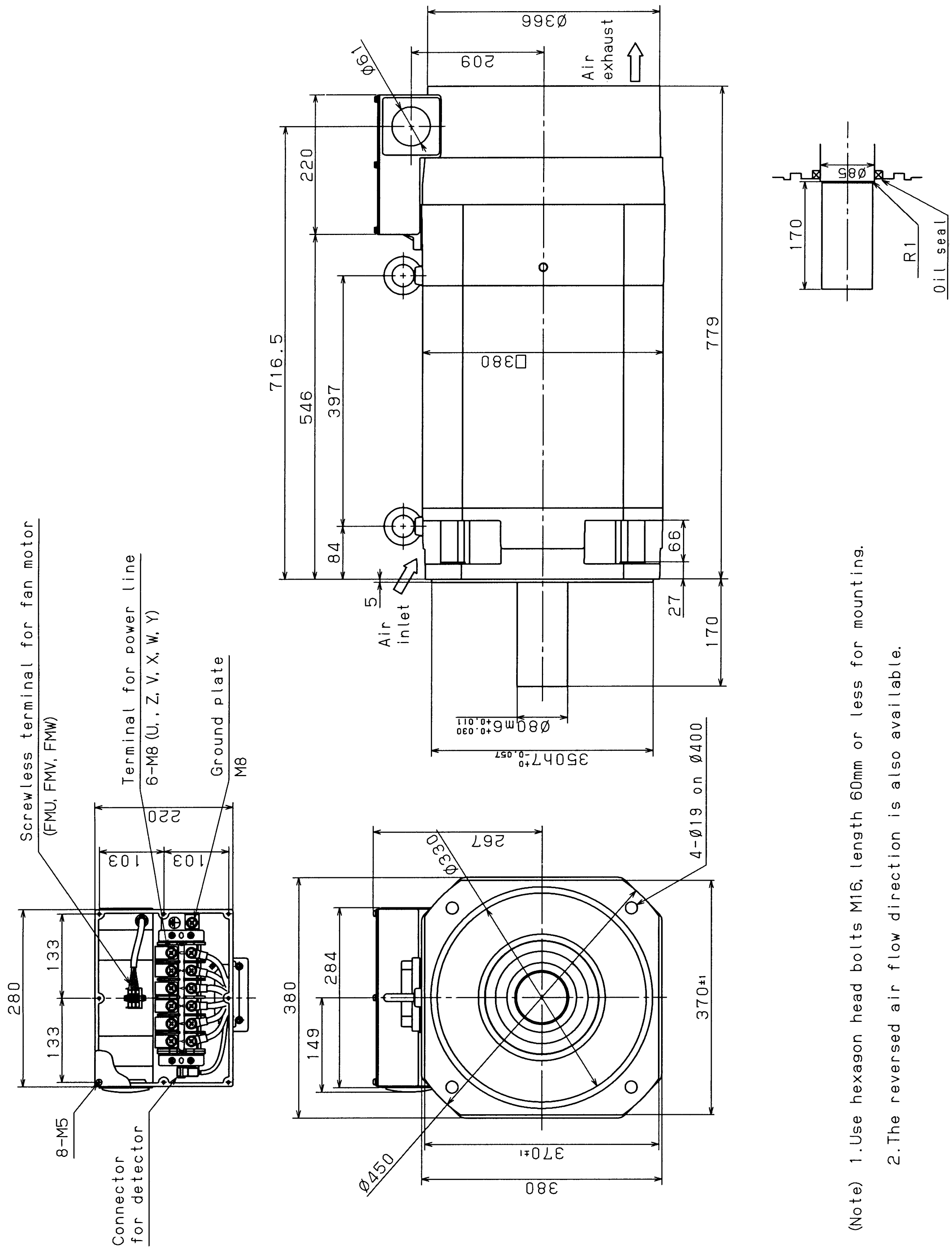
7.26 MODEL α40/6000i (FLANGE MOUNTING TYPE)



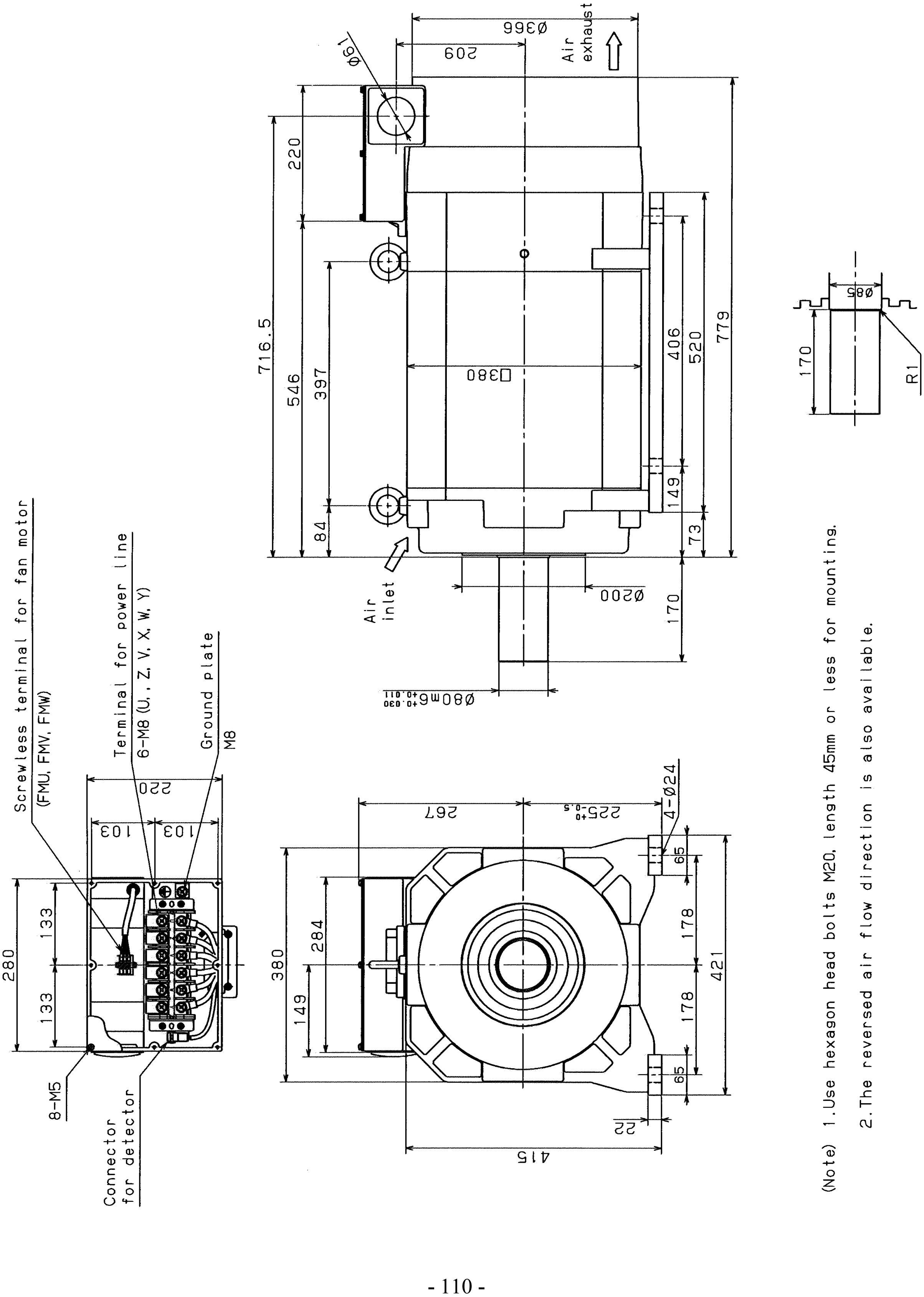
7.27 MODEL α40/6000i (FOOT MOUNTING TYPE)



7.28 MODEL α50/4500*i* (FLANGE MOUNTING TYPE)



7.29 MODEL α50/4500i (FOOT MOUNTING TYPE)



(Note) 1. Use hexagon head bolts M20, length 45mm or less for mounting.
2. The reversed air flow direction is also available.

III. FANUC AC SPINDLE MOTOR αiP SERIES

1 GENERAL

FANUC AC spindle motor αiP series 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*P series			
Item / Model		α12/6000*i*P α12/8000*i*P		α15/6000*i*P α15/8000*i*P	
		Low-speed winding	**High-speed winding**	**Low-speed winding**	**High-speed winding**
Output (*2)	Cont. rated kW (HP)	3.7 (4.9)	5.5 (7.4)	5 (6.6)	7.5 (10)
	30 min rated kW [15 min] (*3) (HP)	7.5 (10)	7.5 (10)	9 (12)	9 (12)
	S3 60% kW [15%] (*4)(*5) (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·m^2	0.07		0.09	
	kgf·cm·s^2	0.77		0.93	
Weight kgf		95		110	
Vibration		V5 (option V3)			
Noise		75 dB (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		M*i* sensor or MZ*i* sensor			
Type of thermal protection (*10)		TP211			
Resolution of the MZ*i* 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		SPM-11*i*		SPM-15*i*	
Model		α12/6000*i*P		α15/6000*i*P	

Series		α*i*P series			
Item	Model	**α18/6000*i*P** **α18/8000*i*P**		**α22/6000*i*P** **α22/8000*i*P**	
		Low-speed winding	**High-speed winding**	**Low-speed winding**	**High-speed winding**
Output (*2)	Cont. rated kW (HP)	6 (8)	9 (12)	7.5 (10)	11 (14.7)
	30 min rated kW [15 min] (*3) (HP)	11 (14.7)	11 (14.7)	15 (20.1)	15 (20.1)
	S3 60% kW [15%] (*4)(*5) (HP)	11 (14.7)	11 (14.7)	15 (20.1)	15 (20.1)
Rated current A (*6)	Cont. rated	32	55	43	69
	30 min rated (*3) S3 60%, 15% (*4)	53	63	80	88
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)		114.6 (1169)	114.6 (1169)	143.2 (1461)	140 (1428)
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		V5 (option V3)			
Noise		75 dB (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		M*i* sensor or MZ*i* sensor			
Type of thermal protection (*10)		TP211			
Resolution of the MZ*i* sensor /rev.		4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Maximum output during acceleration (*11) kW		15.1		20.0	
Applicable spindle amplifier		SPM-15*i*		SPM-22*i*	
Model		α18/6000*i*P		α22/6000*i*P	

Series		αiP series			
Item / Model		α30/6000iP		α40/6000iP	
		Low-speed winding	High-speed winding	Low-speed winding	High-speed winding
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		75 dB (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		Mi sensor or MZi sensor			
Type of thermal protection (*10)		TP211			
Resolution of the MZi 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		SPM-22i		SPM-26i	
Model		α30/6000iP		α40/6000iP	

Series		α*i*P series			
Item / Model		α50/6000*i*P		α60/4500*i*P	
		Low-speed winding	High-speed winding	Low-speed winding	High-speed winding
Output (*2)	Cont. rated kW (HP)	22 (29.5)	22 (29.5)	18.5 (24.8)	22 (29.5)
	30 min rated [15 min] (*3) kW (HP)	30 (40.2)	30 (40.2)	30 (40.2)	30 (40.2)
	S3 60% [15%] (*4)(*5) kW (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		75 dB (A) or less		80 dB (A) or less	
Cooling system (*7)		Totally enclosed and fan cooled IC0A6			
Cooling fan W		84		90	
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		M*i* sensor or MZ*i* sensor			
Type of thermal protection (*10)		TP211			
Resolution of the MZ*i* 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		SPM-26*i*		SPM-30*i*	
Model		α50/6000*i*P		α60/4500*i*P	

(*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 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 low-speed winding models other than α50/6000*i*P and α60/4500*i*P is 15 min rated.

(*4) S3 15% for low-speed winding models other than α50/6000*i*P and α60/4500*i*P
S3 25% for low-speed winding of α50/6000*i*P and α60/4500*i*P

(*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 module and are not guaranteed.

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

3 OUTPUT/TORQUE CHARACTERISTICS

Reference
Calculation for torque

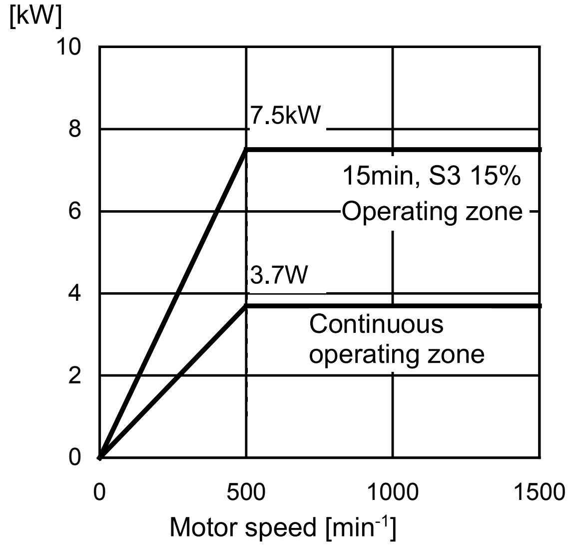
Torque T can be obtained by the following equation.

T[N·m]=P[kW]×1000/0.1047/N[min^{-1}]
- P[kW]: Motor output
- N[min^{-1}]: Motor speed

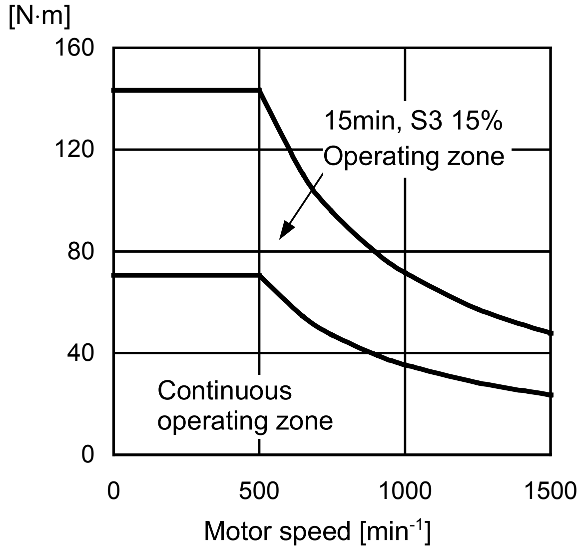
When the unit of T is [kgf·m],
T[kgf·m]=P[kW]×1000/1.0269/N[min^{-1}]

3.1 MODEL α12/6000*i*P

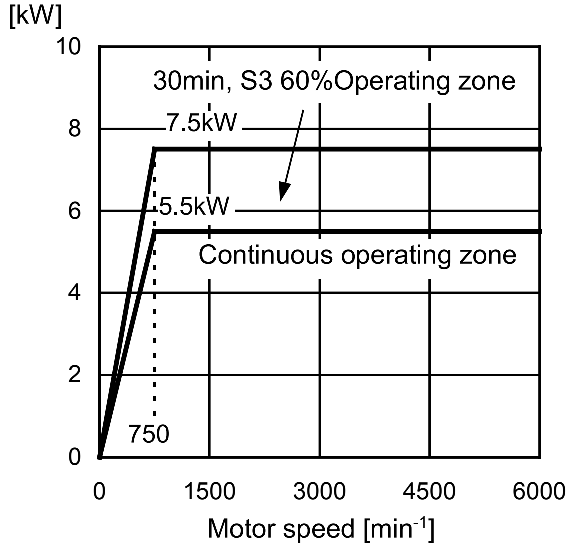
Low-speed winding output (Y connection)



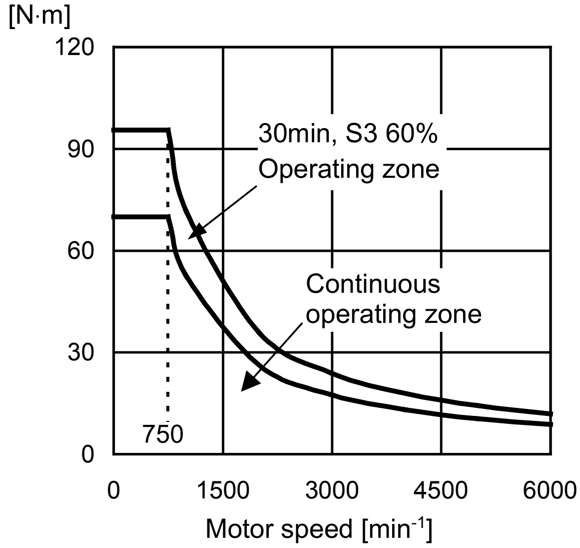
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

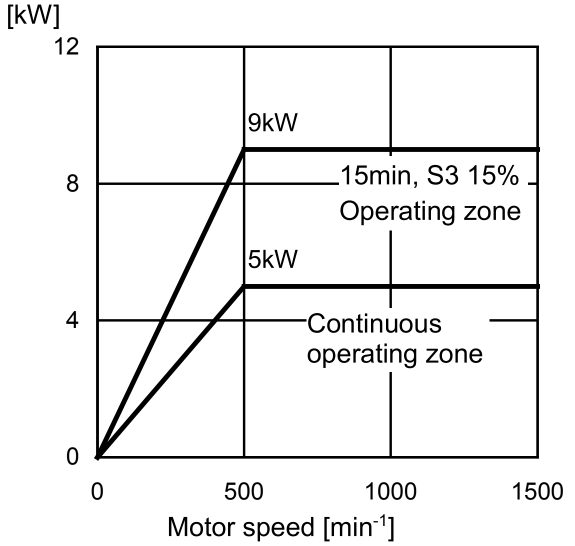


High-speed winding output (Δ connection)

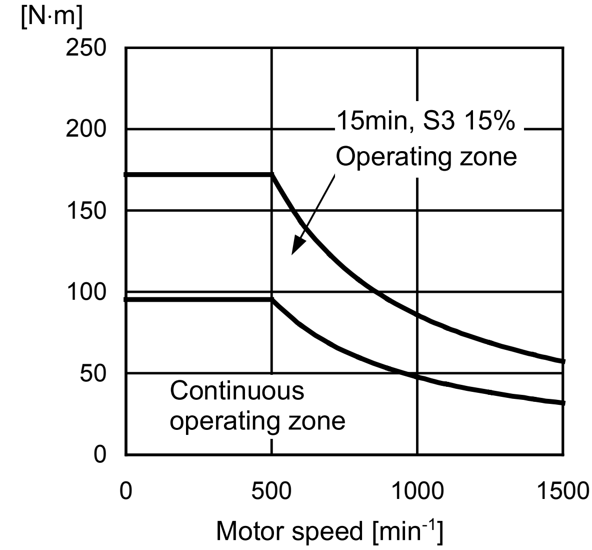


3.2 MODEL α15/6000*i*P

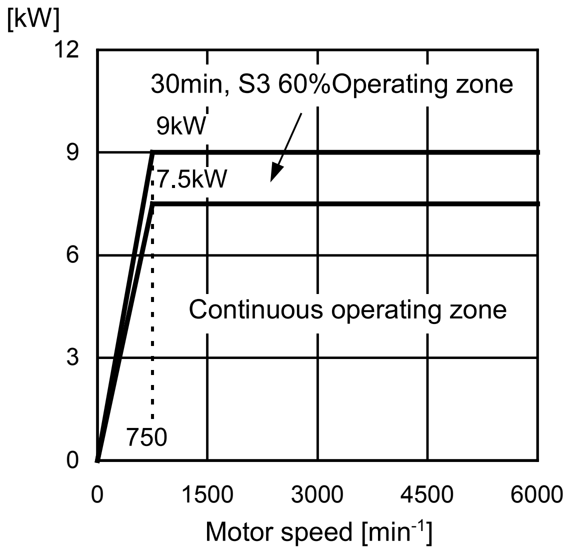
Low-speed winding output (Y connection)



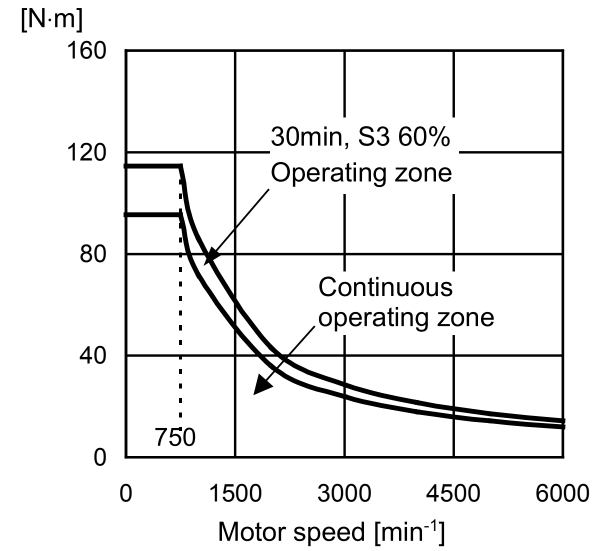
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

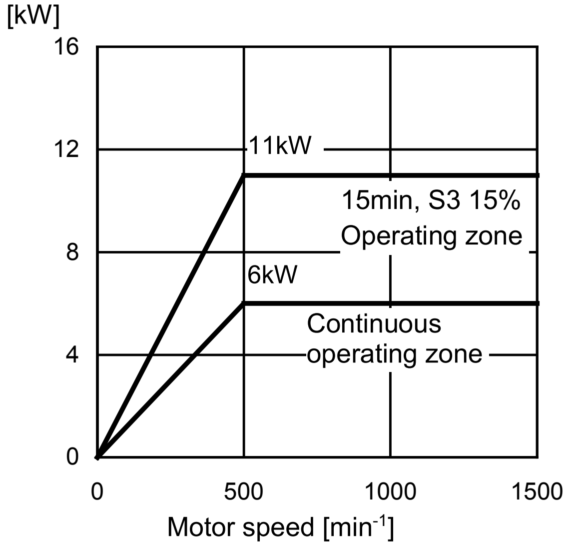


High-speed winding output (Δ connection)

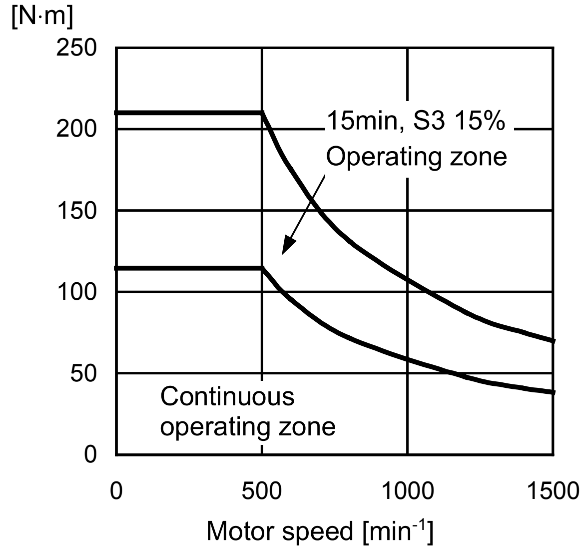


3.3 MODEL α18/6000*i*P

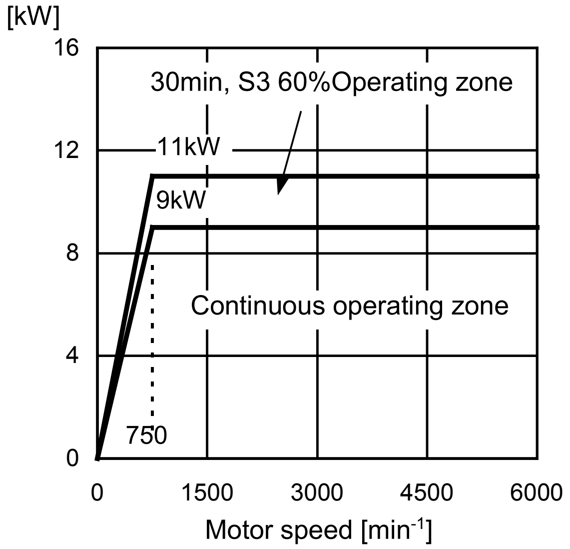
Low-speed winding output (Y connection)



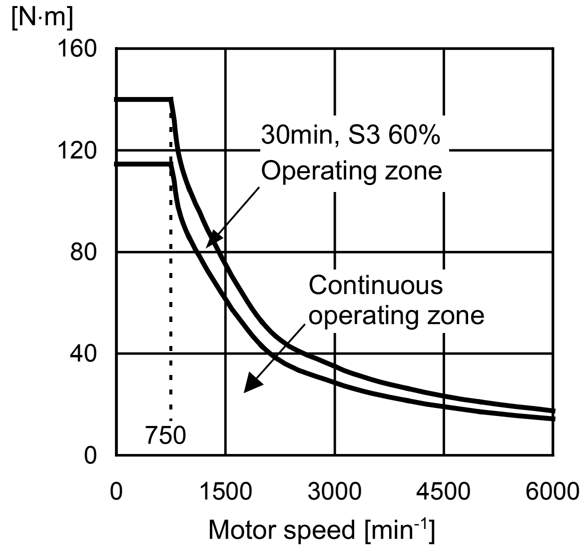
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

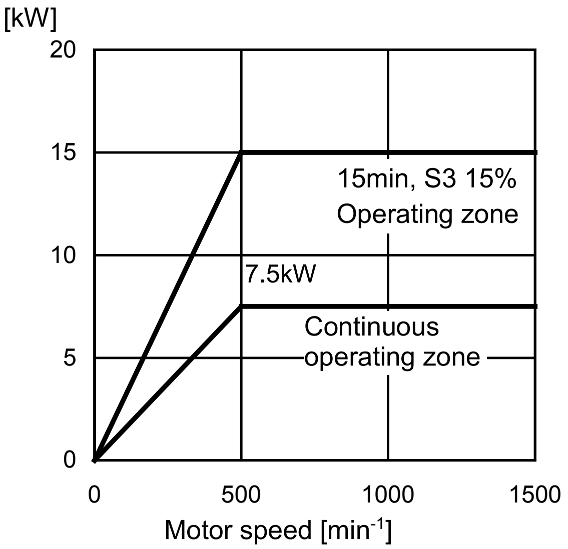


High-speed winding output (Δ connection)

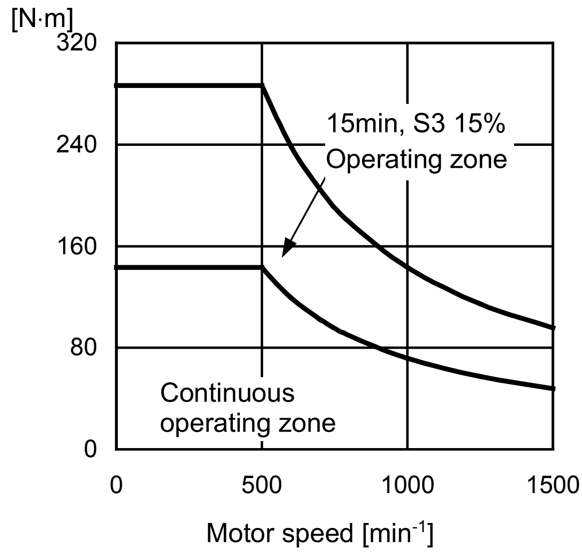


3.4 MODEL α22/6000iP

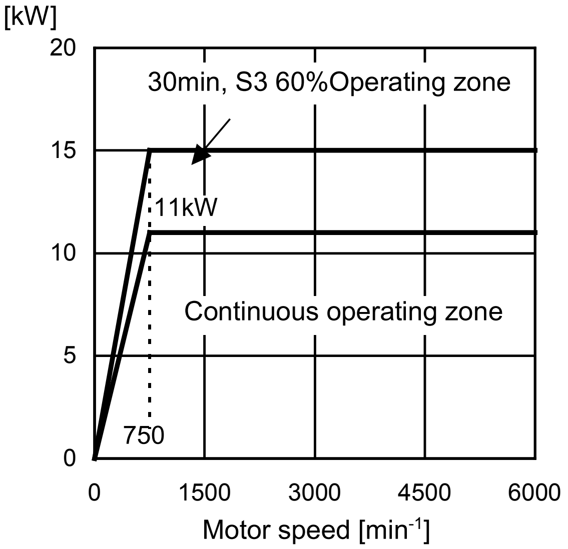
Low-speed winding output (Y connection)



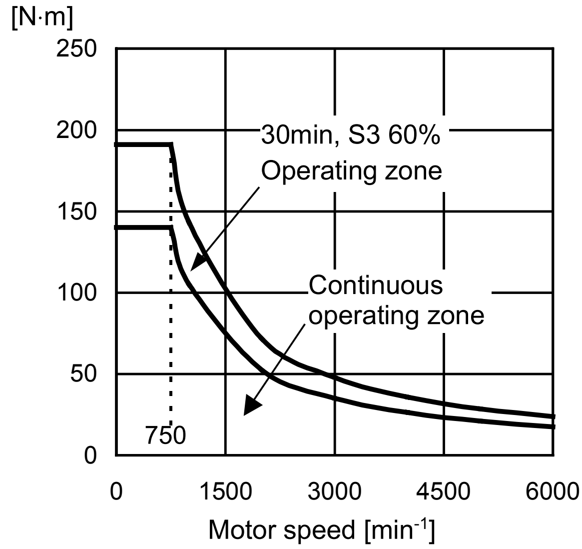
Low-speed winding torque (Y connection)



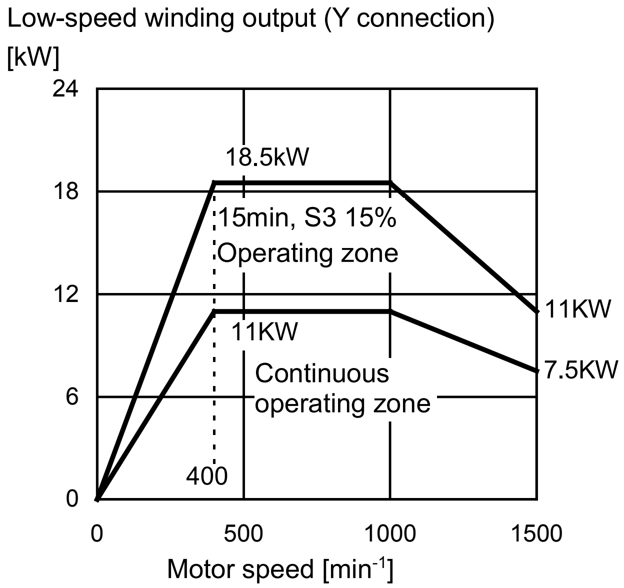
High-speed winding output (Δ connection)

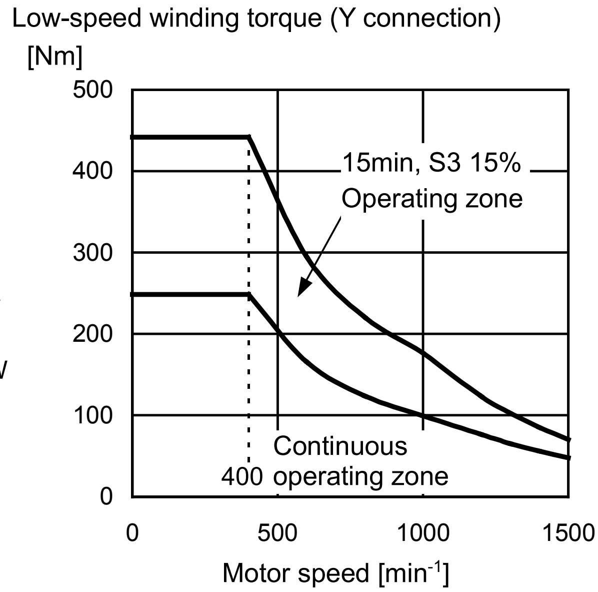


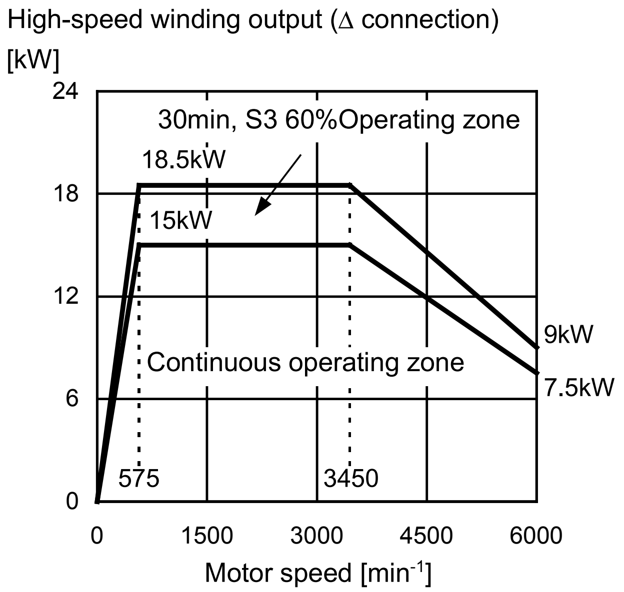
High-speed winding output (Δ connection)

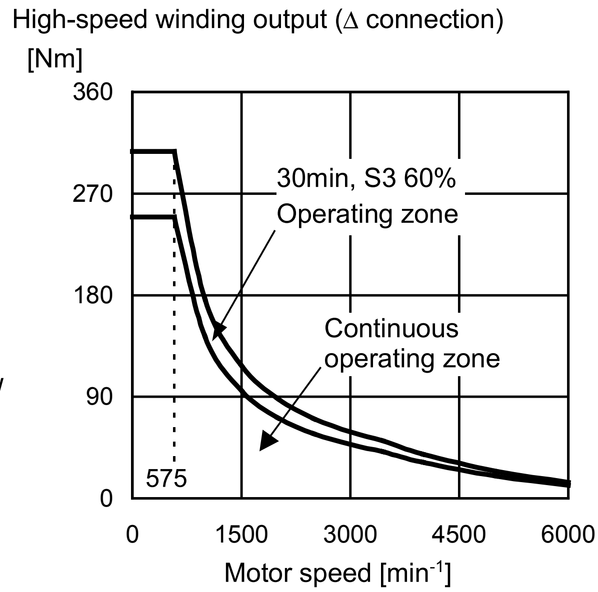


3.5 MODEL α30/6000*i*P

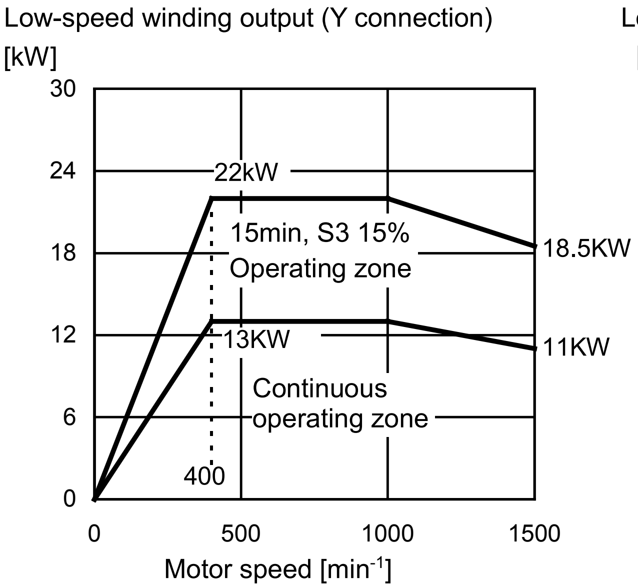


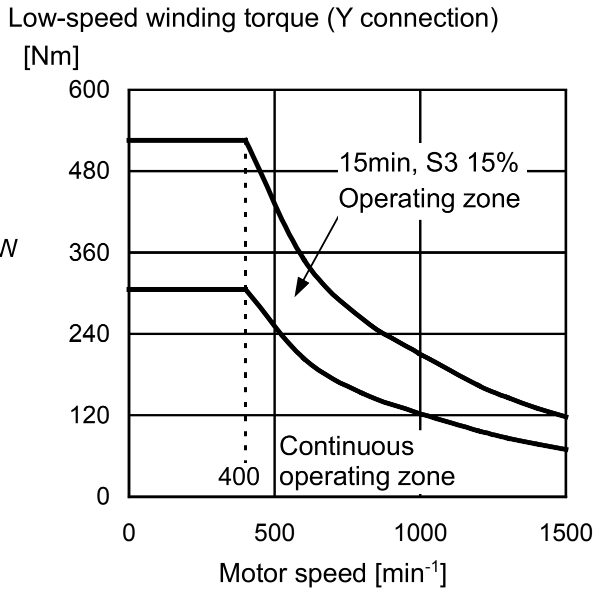


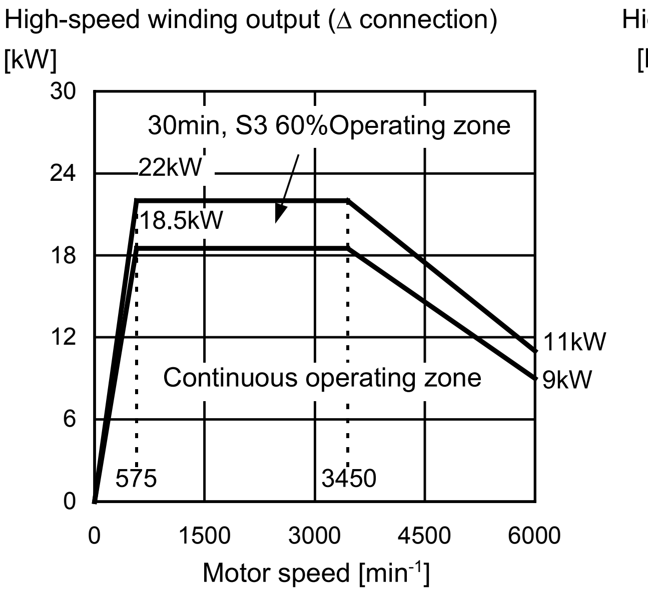


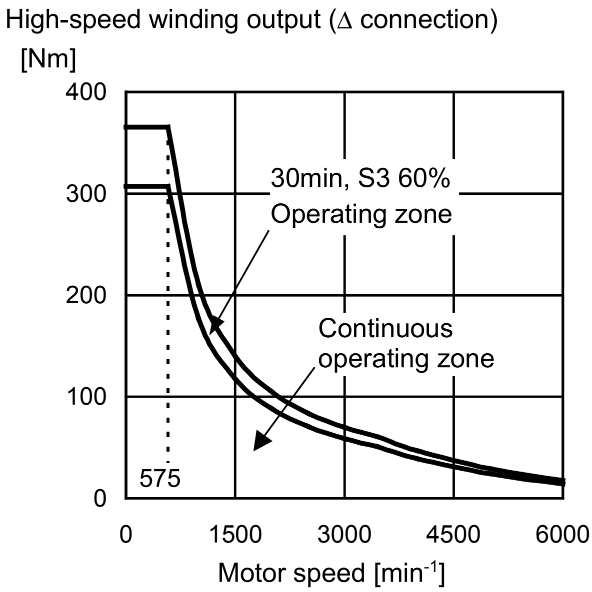


3.6 MODEL α40/6000*i*P



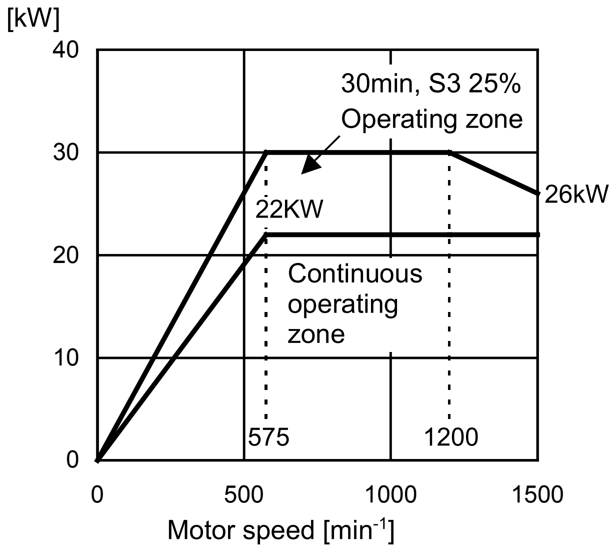




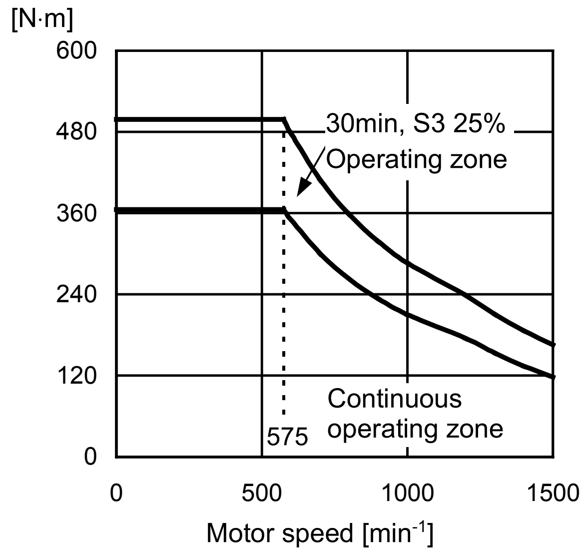


3.7 MODEL α50/6000iP

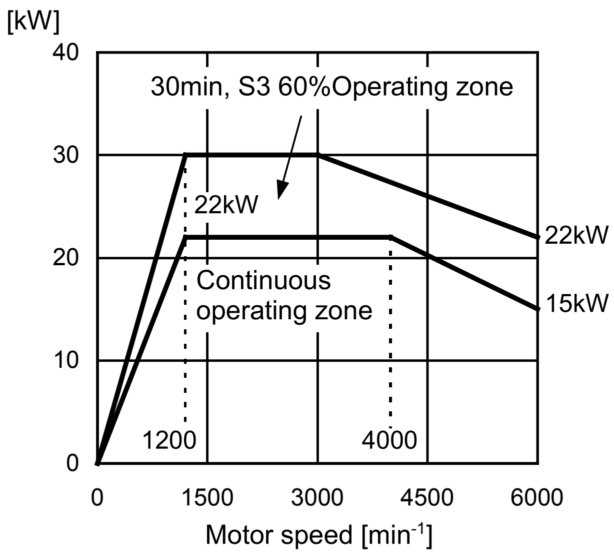
Low-speed winding output (Y connection)



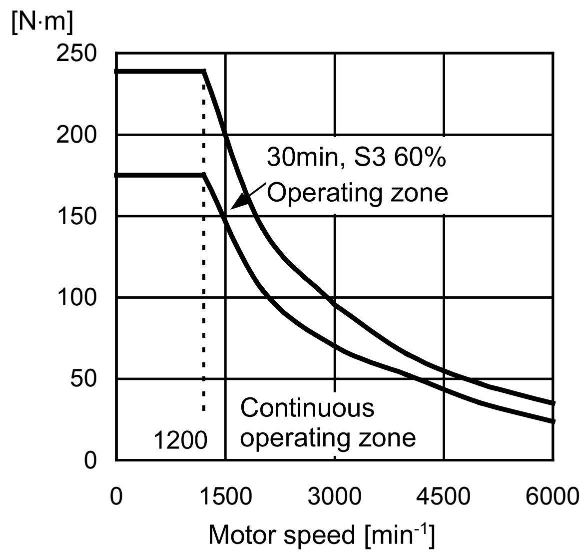
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

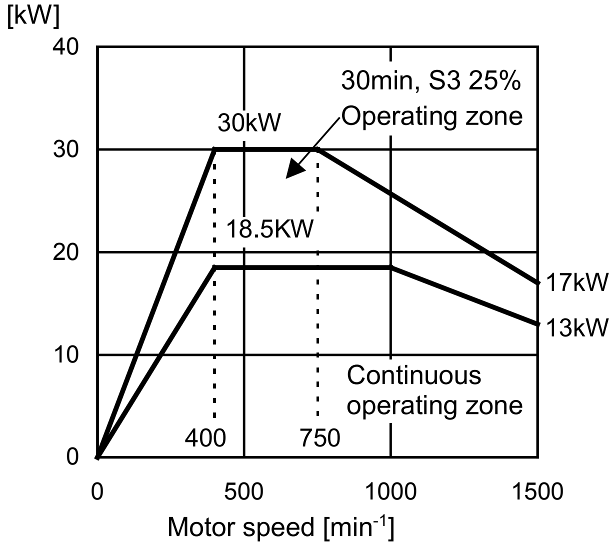


High-speed winding output (Δ connection)

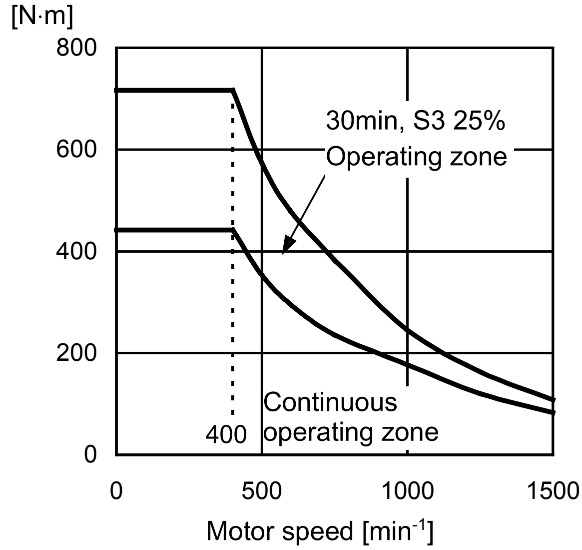


3.8 MODEL α60/4500*i*P

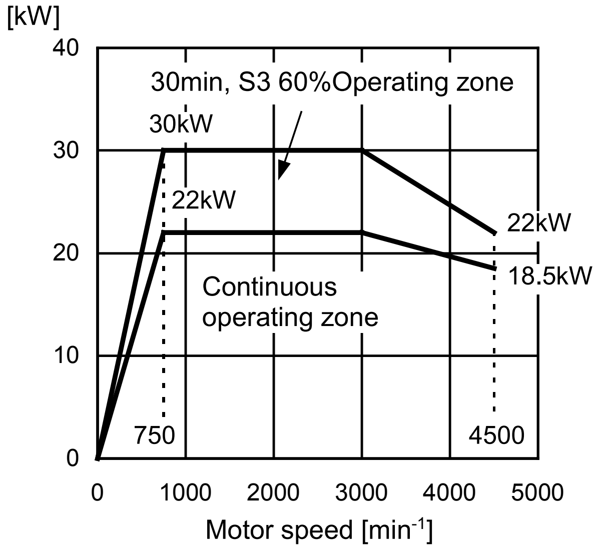
Low-speed winding output (Y connection)



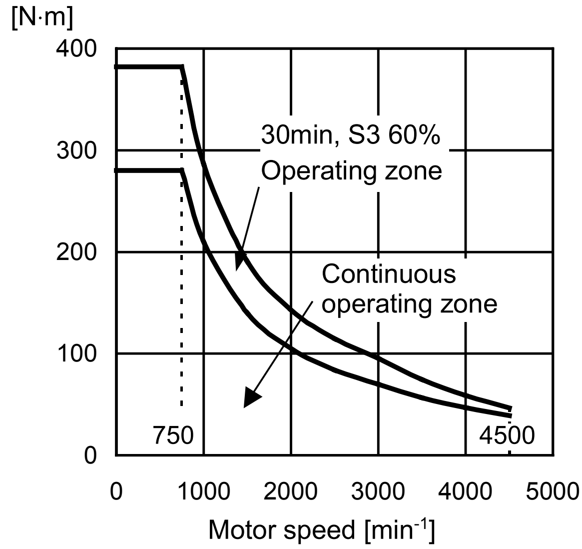
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

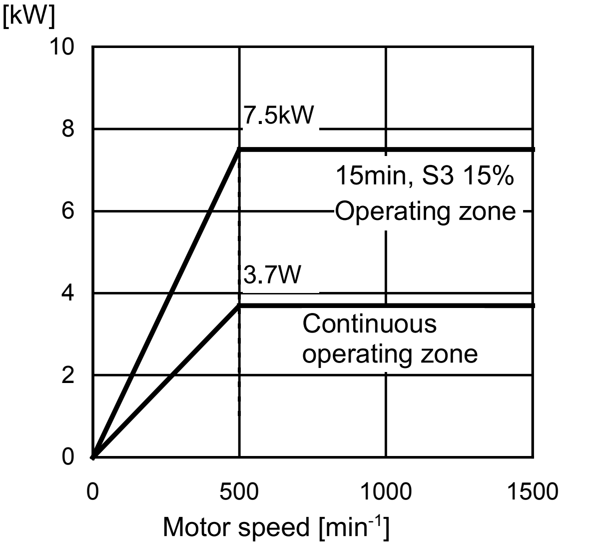


High-speed winding output (Δ connection)

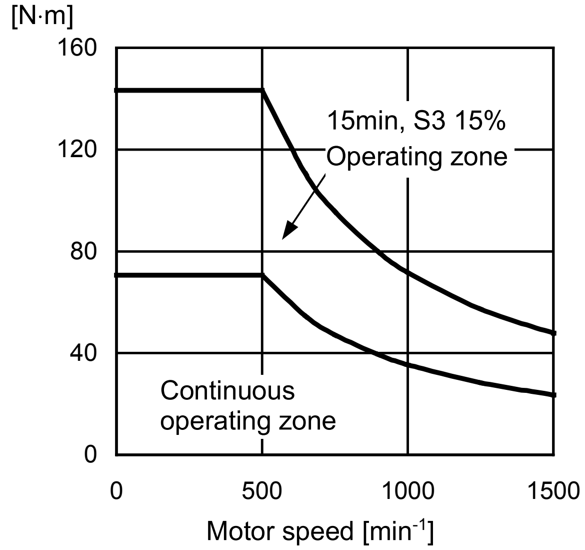


3.9 MODEL α12/8000*i*P

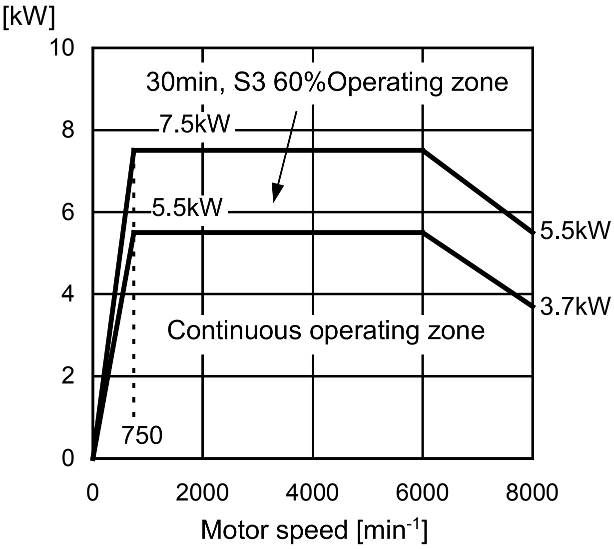
Low-speed winding output (Y connection)



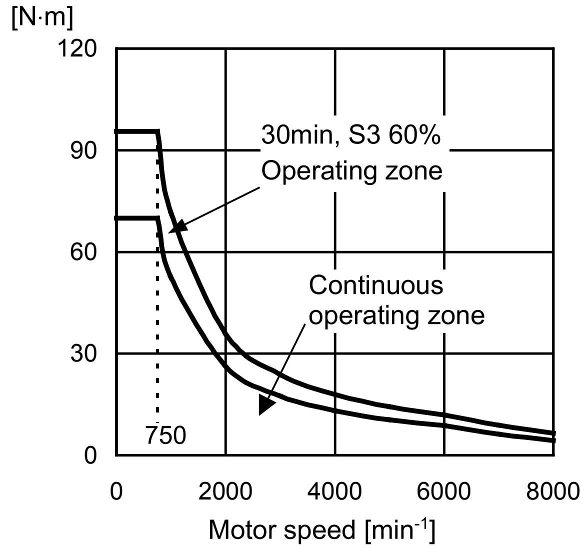
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

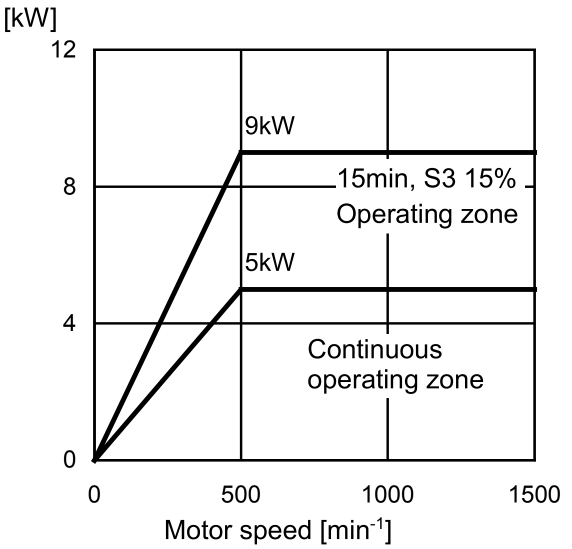


High-speed winding output (Δ connection)

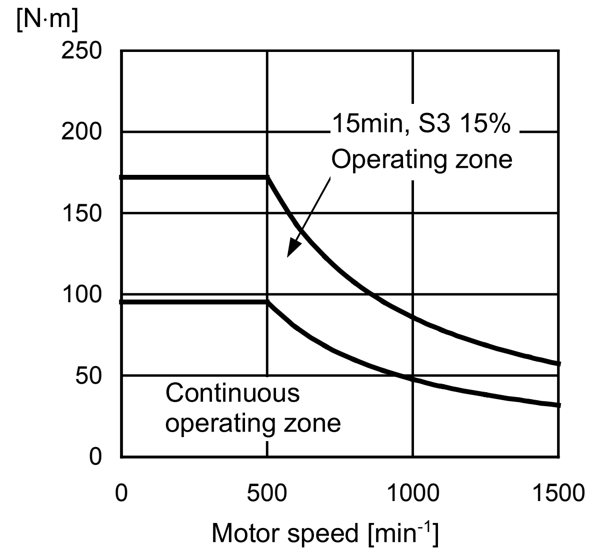


3.10 MODEL α15/8000*i*P

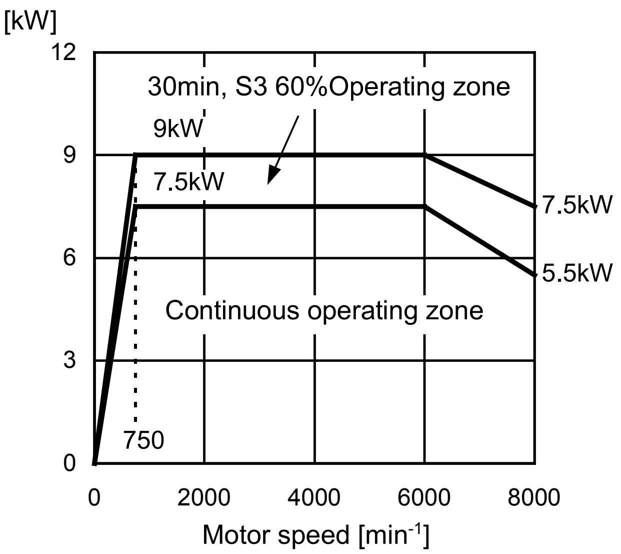
Low-speed winding output (Y connection)



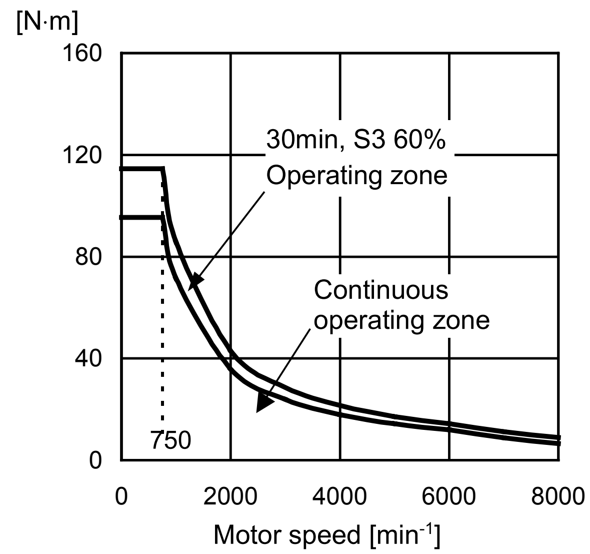
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

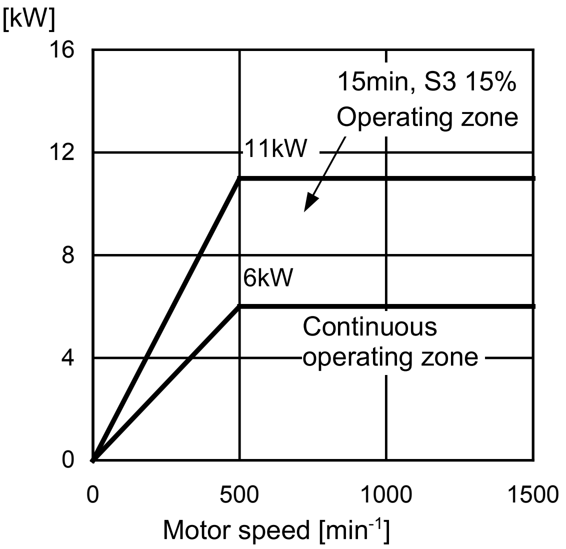


High-speed winding output (Δ connection)

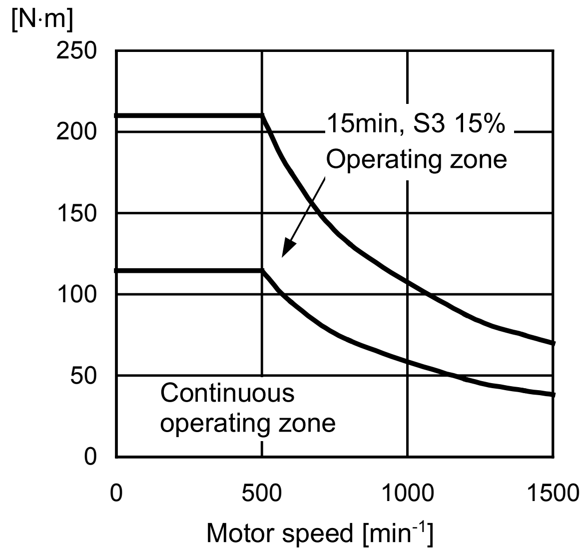


3.11 MODEL α18/8000*i*P

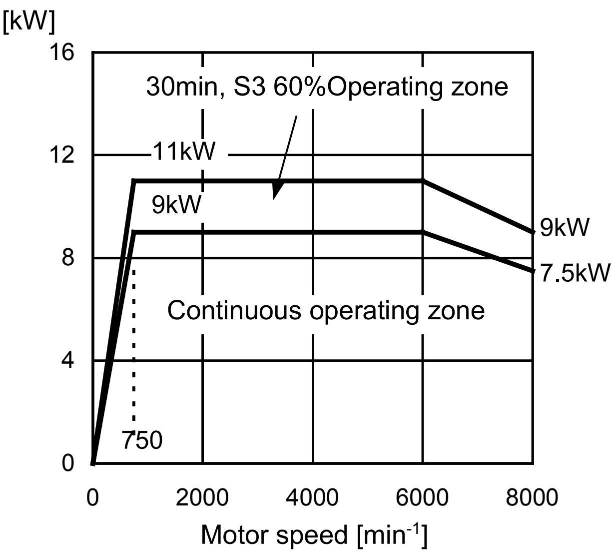
Low-speed winding output (Y connection)



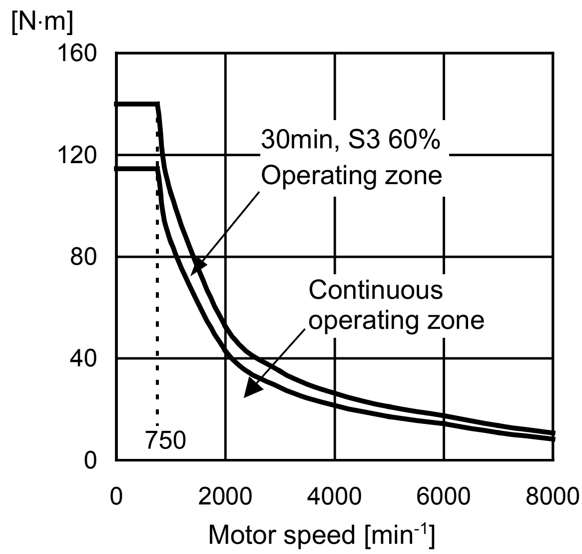
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)

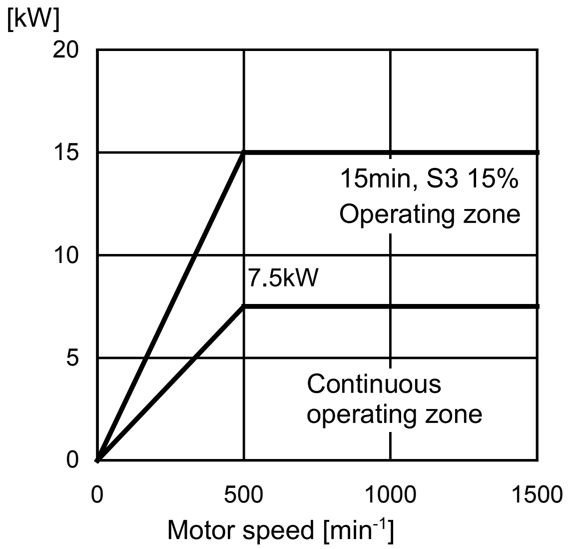


High-speed winding output (Δ connection)

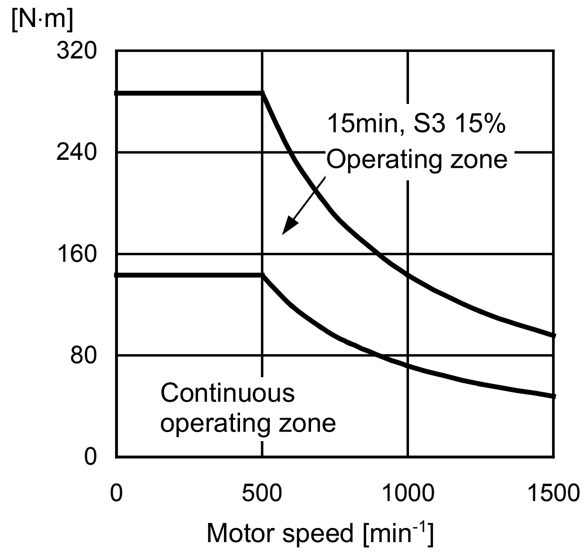


3.12 MODEL α22/8000iP

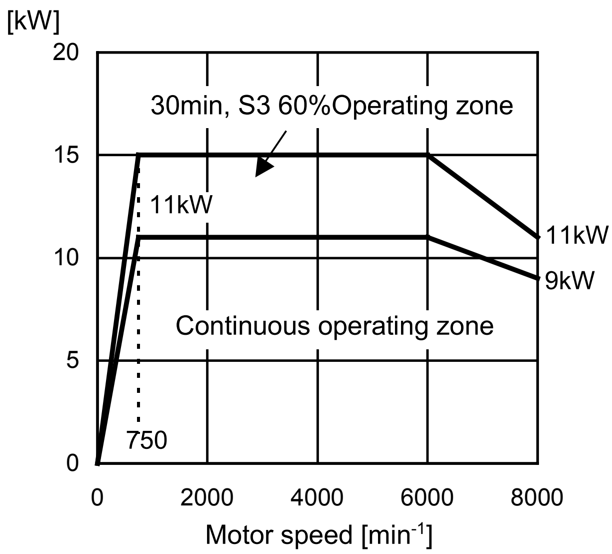
Low-speed winding output (Y connection)



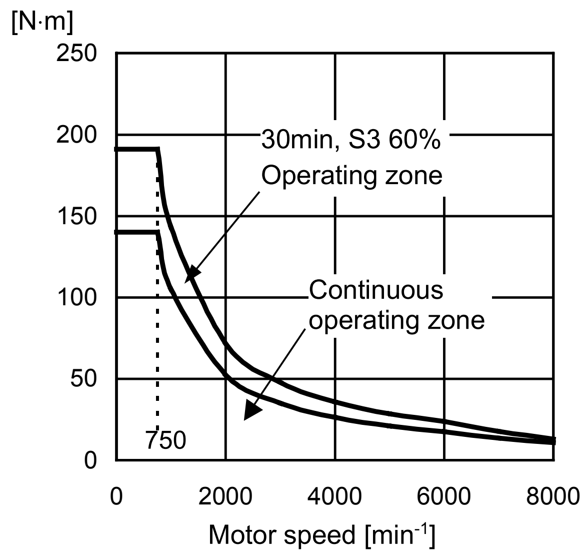
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



High-speed winding output (Δ connection)



4 CONNECTIONS

4.1 MODELS α12/6000*i*P TO α60/4500*i*P

Cables for power lead and fan motor are connected to the terminal block.
M*i* sensor or MZ*i* 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		Fan motor
	U,V,W,G	X,Y,Z	FMU,FMV,FMW
α12/6000*i*P to α22/6000*i*P	M5	M5	Screw-less terminal block
α30/6000*i*P to α50/6000*i*P	M6	M6	Screw-less terminal block
α60/4500*i*P	M8	M8	M3.5

Cable for the power lead

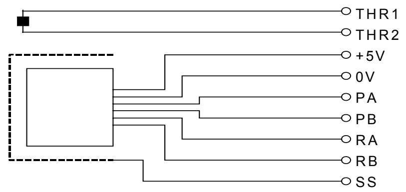
For the power lead cable specification, refer to "FANUC SERVO AMPLIFIER α*i* series DESCRIPTIONS (B-65282EN)".

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

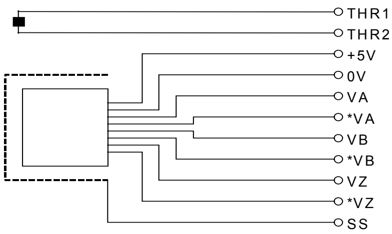
Connector attachment for a motor with a built-in M*i* sensor



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		RA	RB		0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	PA	PB		SS	THR1

Connector attachment for a motor with a built-in MZ*i* 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

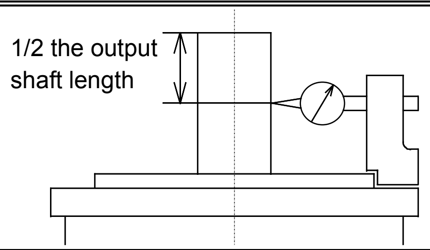
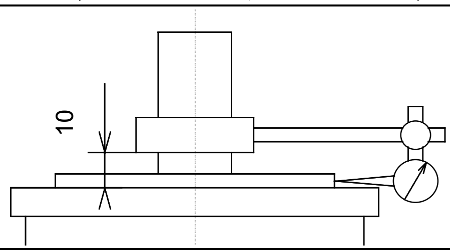
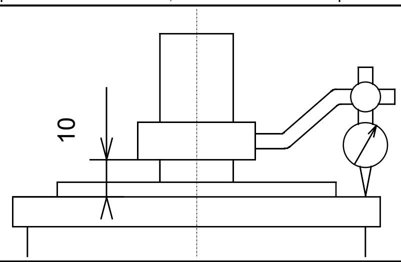
Use the motor output shaft below the allowable radial loads shown in the table below.

Model	Allowable radial load (kgf)	
	At output shaft end	At output shaft center
α12/6000*i*P, α15/6000*i*P	2940N (300kgf)	3410N (348kgf)
α18/6000*i*P, α22/6000*i*P	4410N (450kgf)	4988N (509kgf)
α30/6000*i*P, α40/6000*i*P, α50/6000*i*P	5390N (550kgf)	6134N (626kgf)
α60/4500*i*P	-	19600N (2000kgf)
α12/8000*i*P, α15/8000*i*P	2450N (250kgf)	2842N (290kgf)
α18/8000*i*P, α22/8000*i*P	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

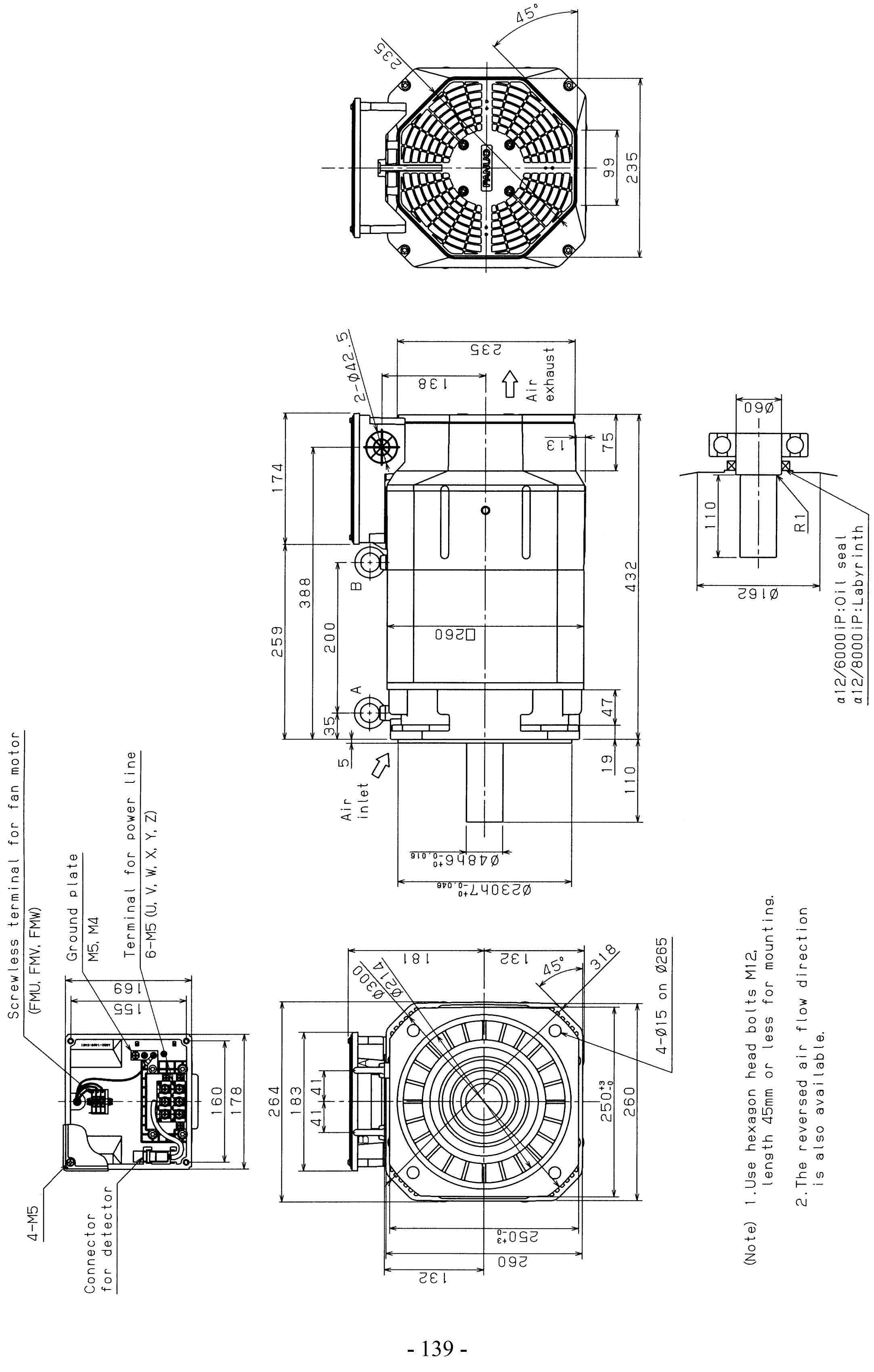
Item \ Model	α12*i*P to α22*i*P	α30*i*P to α60*i*P	Measuring method
Run-out at the end of the output shaft	20µm or less	20µm or less	
Run-out of the faucet joint for mounting the flange against the core of the shaft (only for flange type)	40µm or less	60µm or less	
Run-out of the flange mounting surface 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.

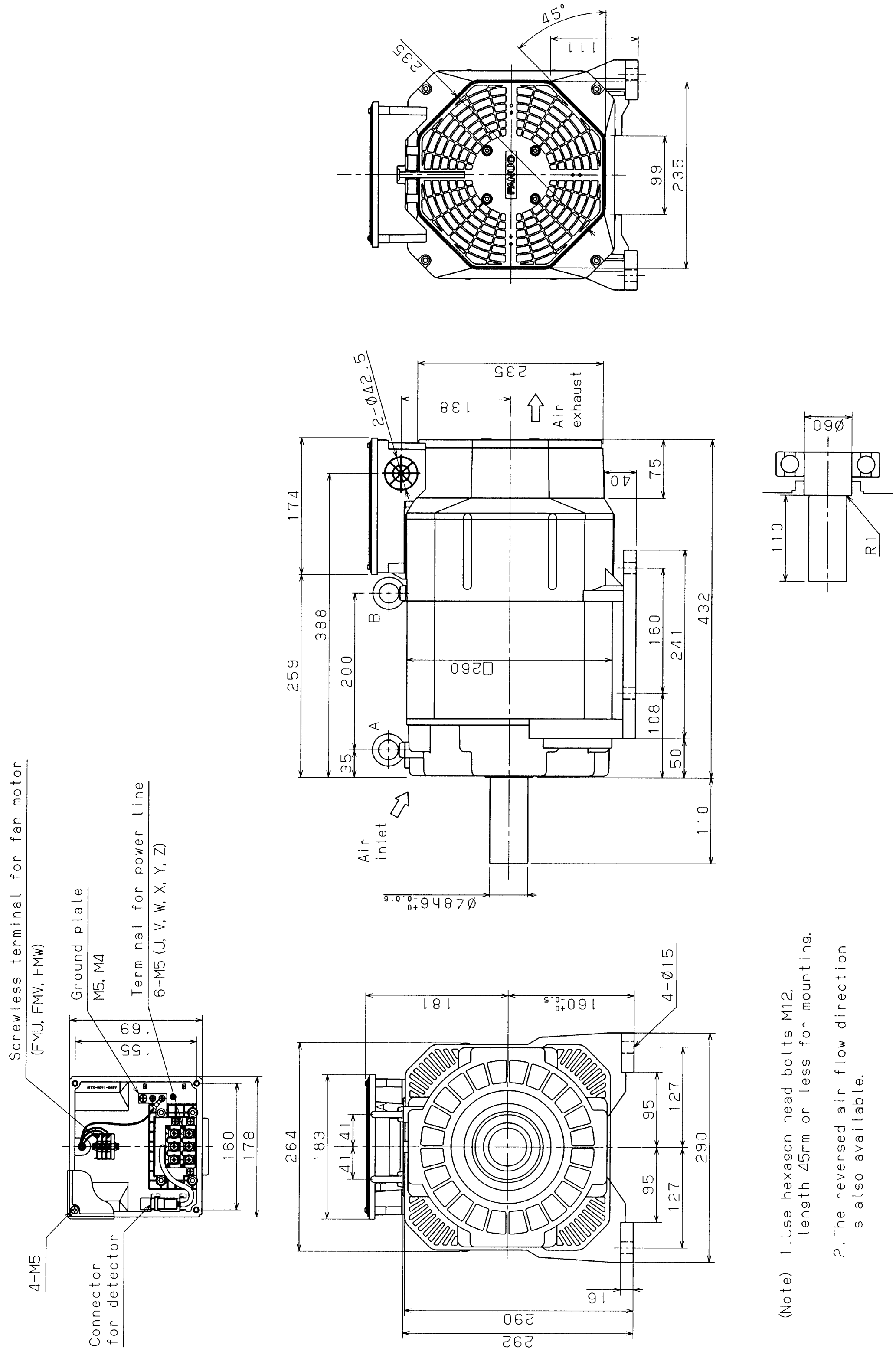
7 EXTERNAL DIMENSIONS

Model name	Section
Models α12/6000*i*P and α12/8000*i*P (flange mounting type)	7.1
Model α12/6000*i*P (foot mounting type)	7.2
Models α15/6000*i*P and α15/8000*i*P (flange mounting type)	7.3
Model α15/6000*i*P (foot mounting type)	7.4
Models α18/6000*i*P and α18/8000*i*P (flange mounting type)	7.5
Model α18/6000*i*P (foot mounting type)	7.6
Models α22/6000*i*P and α22/8000*i*P (flange mounting type)	7.7
Model α22/6000*i*P (foot mounting type)	7.8
Models α30/6000*i*P and α40/6000*i*P (flange mounting type)	7.9
Models α30/6000*i*P and α40/6000*i*P (foot mounting type)	7.10
Model α50/6000*i*P (flange mounting type)	7.11
Model α50/6000*i*P (foot mounting type)	7.12
Model α60/4500*i*P (flange mounting type)	7.13
Model α60/4500*i*P (foot mounting type)	7.14

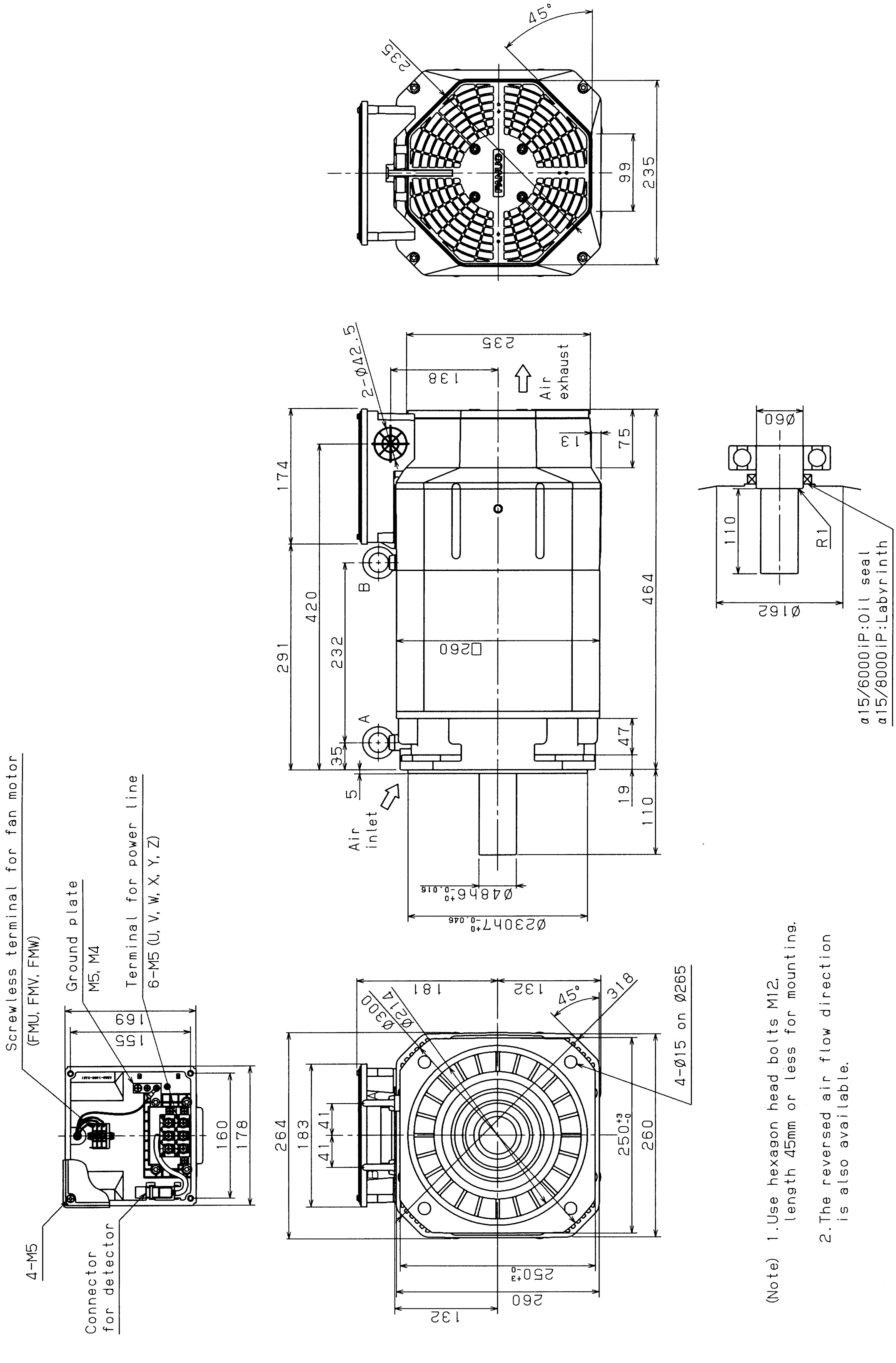
7.1 MODELS α12/6000*i*P AND α12/8000*i*P (FRANGE MOUNTING TYPE)



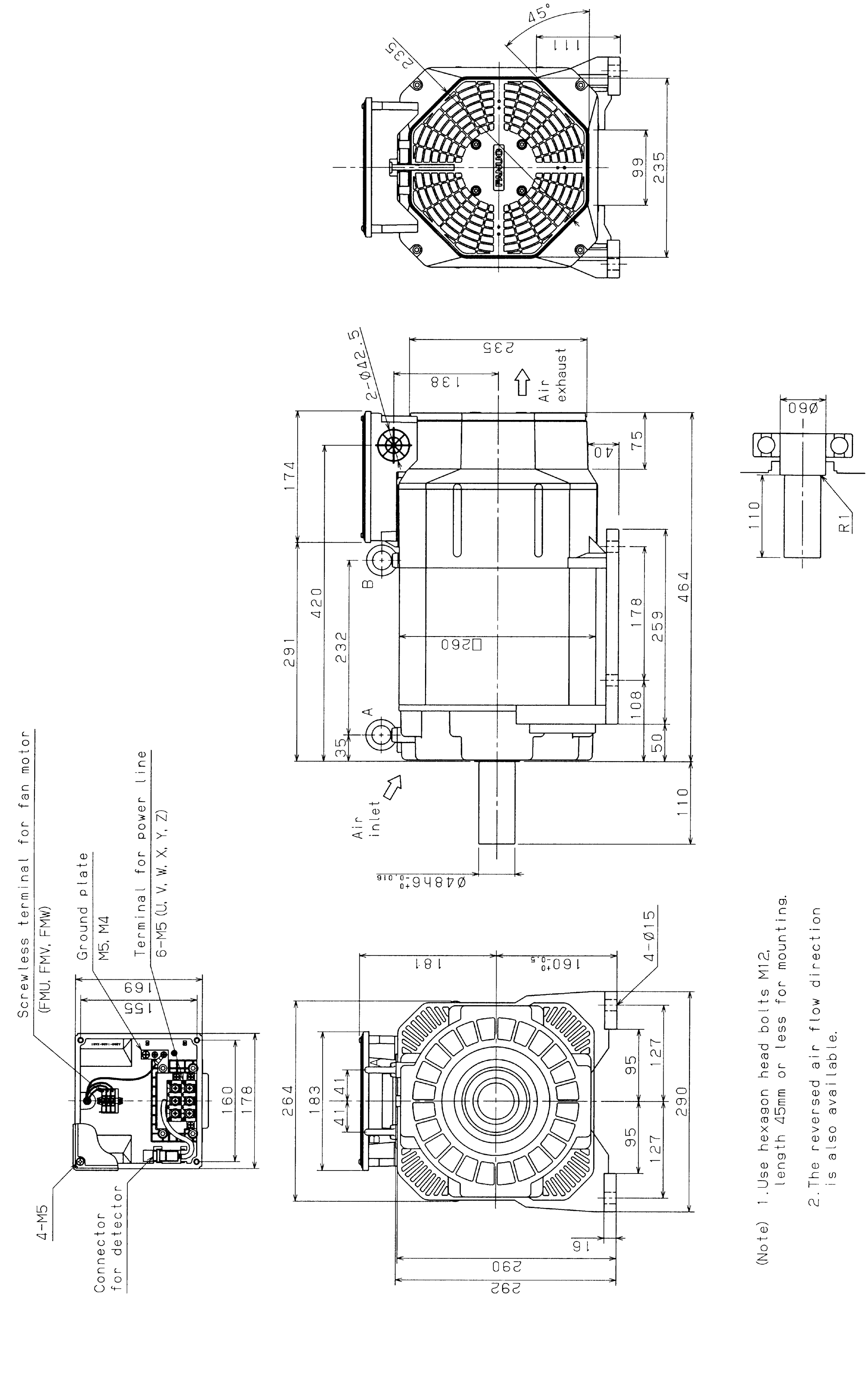
7.2 MODEL α12/6000*i*P (FOOT MOUNTING TYPE)



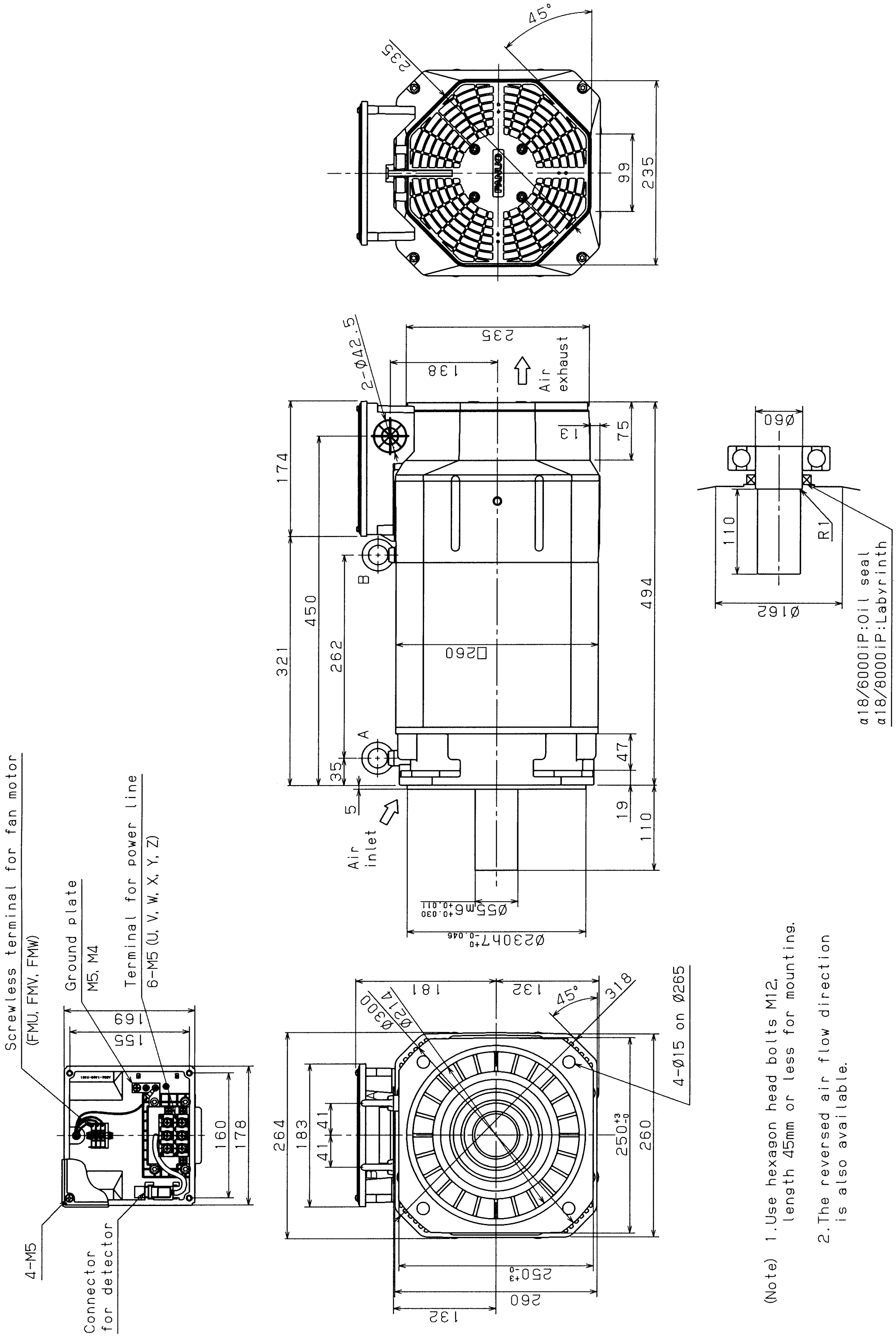
7.3 MODELS α15/6000*i*P AND α15/8000*i*P (FRANGE MOUNTING TYPE)



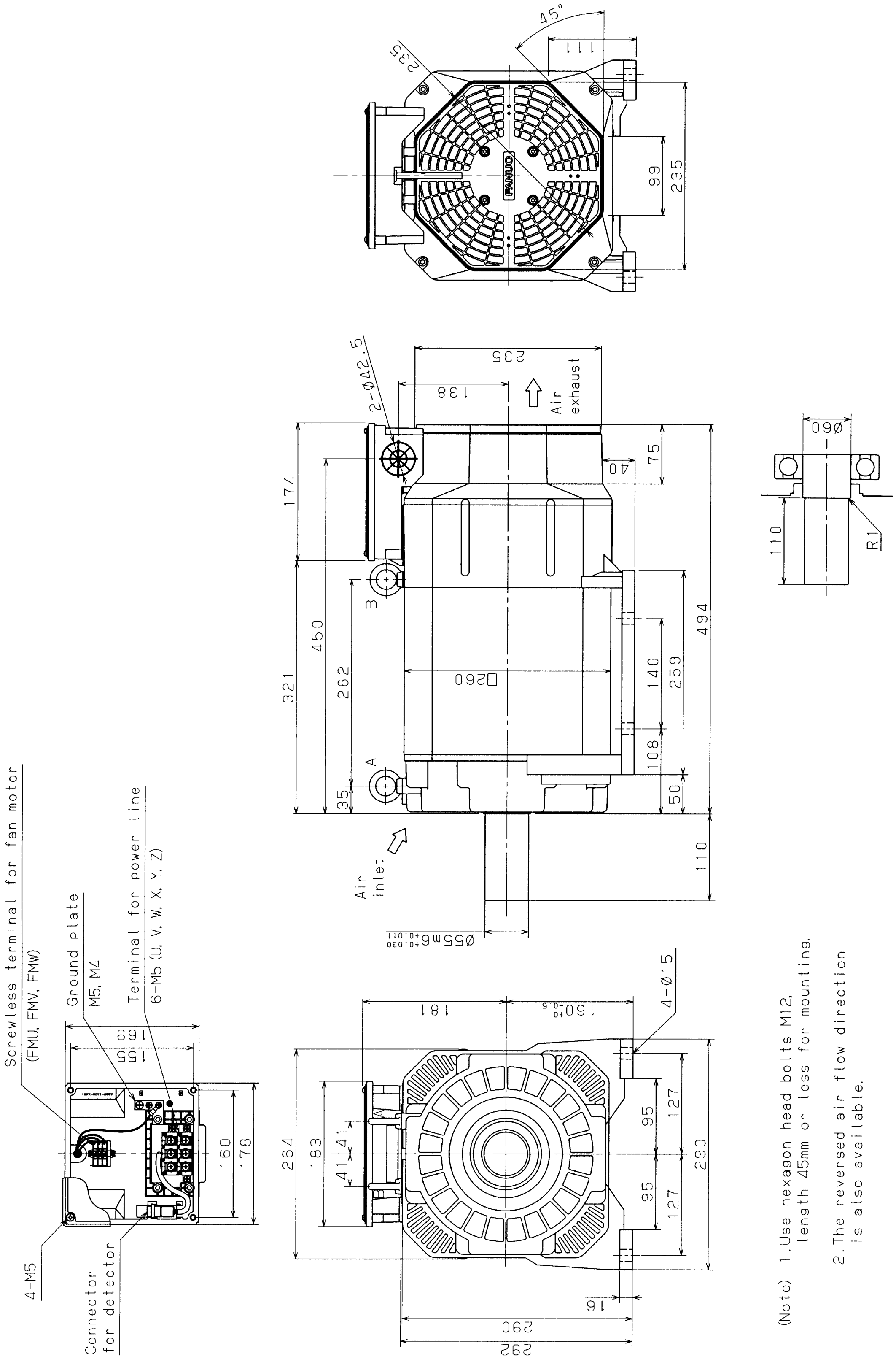
7.4 MODEL α15/6000*i*P (FOOT MOUNTING TYPE)



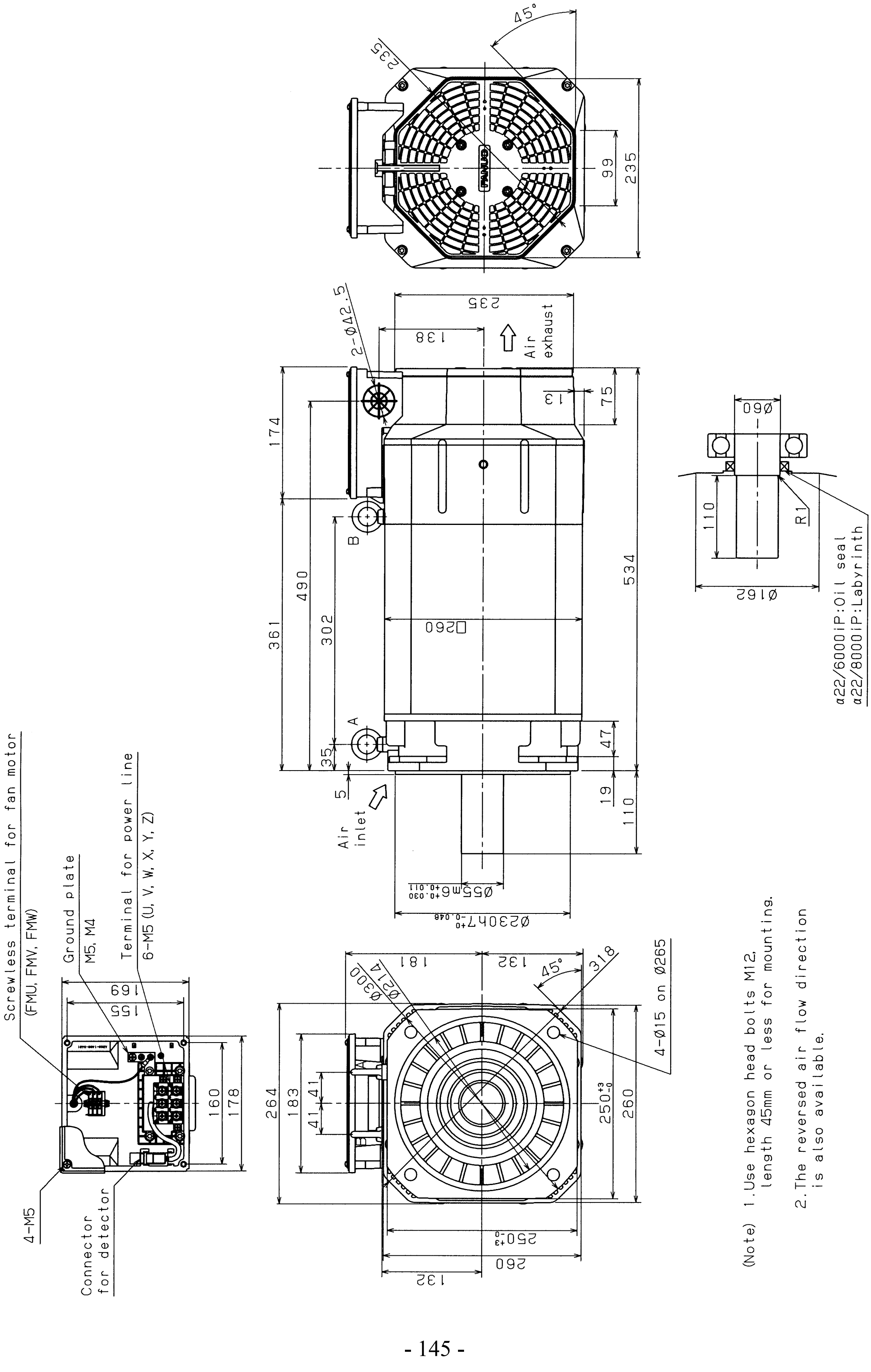
7.5 MODELS α18/6000*i*P AND α18/8000*i*P (FRANGE MOUNTING TYPE)



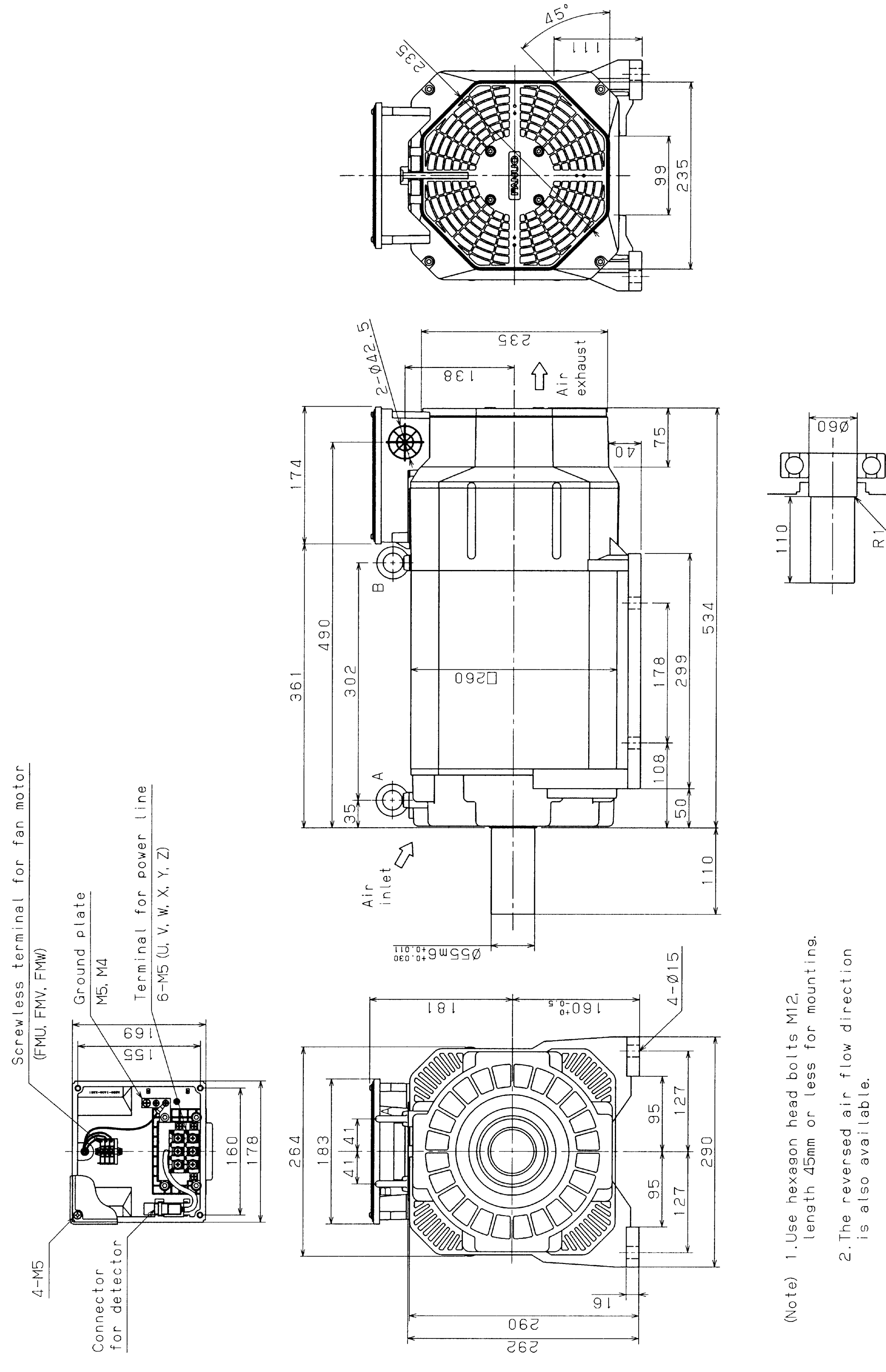
7.6 MODEL α18/6000*i*P (FOOT MOUNTING TYPE)



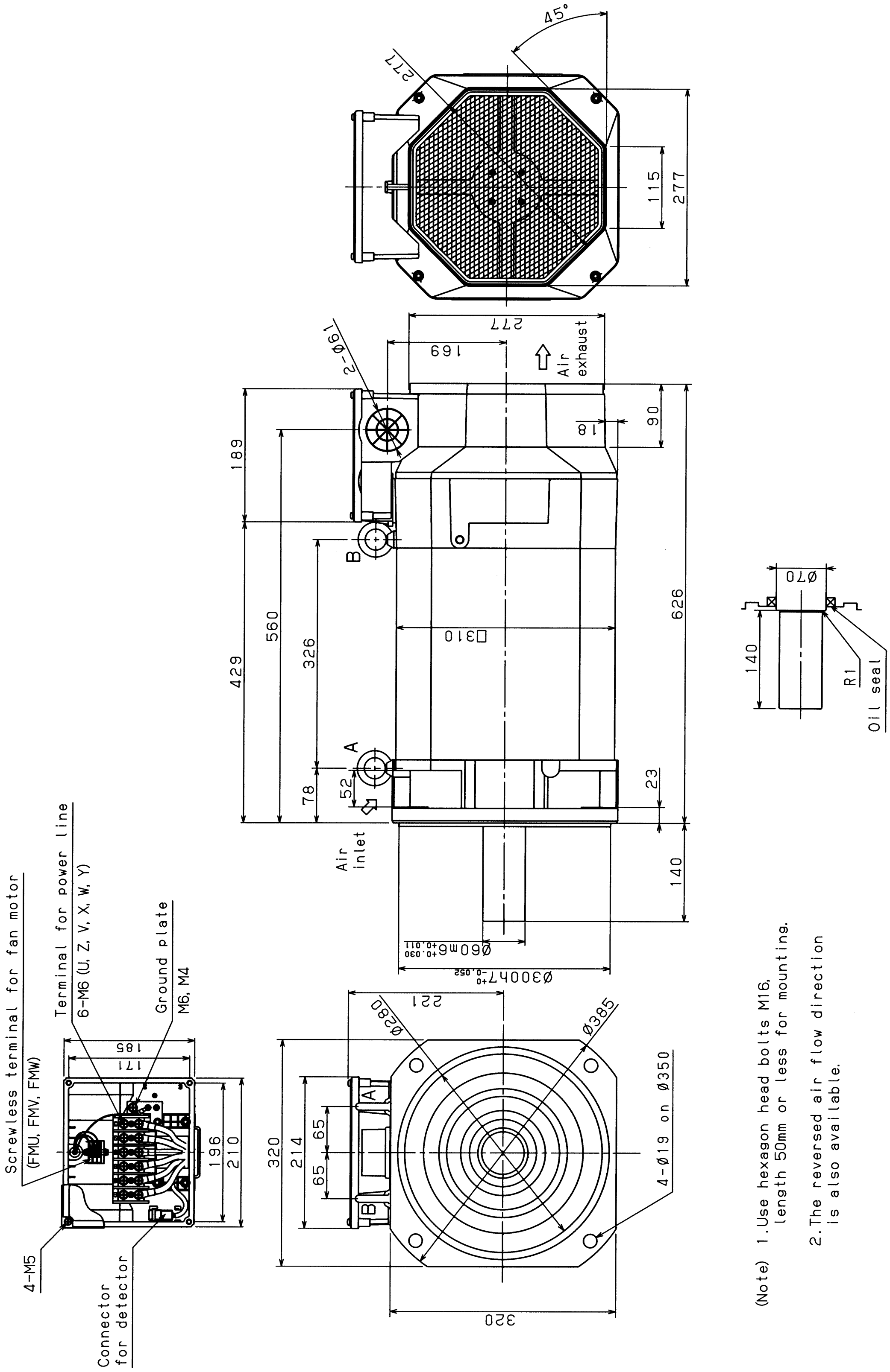
7.7 MODELS α22/6000*i*P AND α22/8000*i*P (FRANGE MOUNTING TYPE)



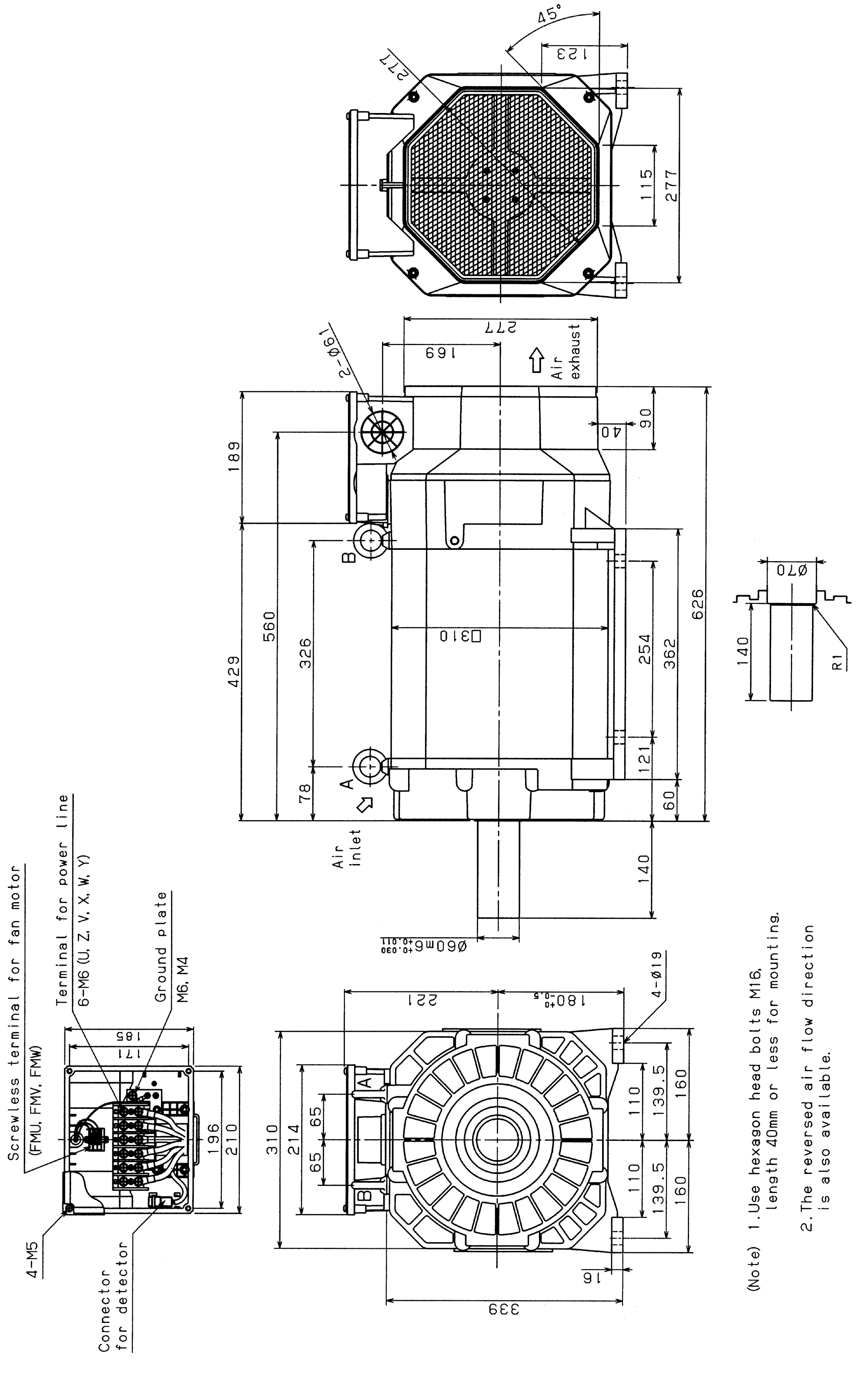
7.8 MODEL α22/6000*i*P (FOOT MOUNTING TYPE)



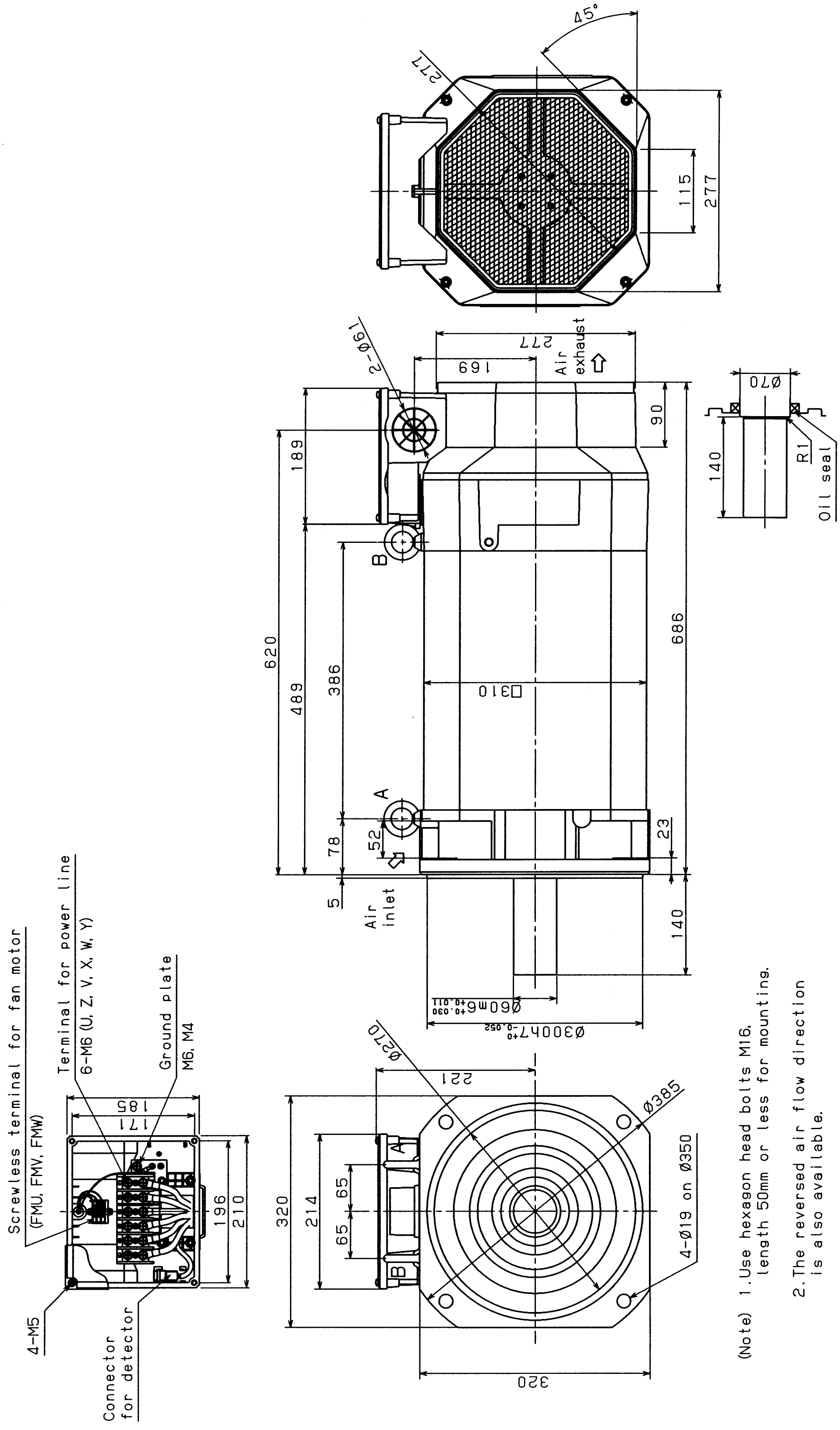
7.9 MODELS α30/6000*i*P AND α40/6000*i*P (FRANGE MOUNTING TYPE)



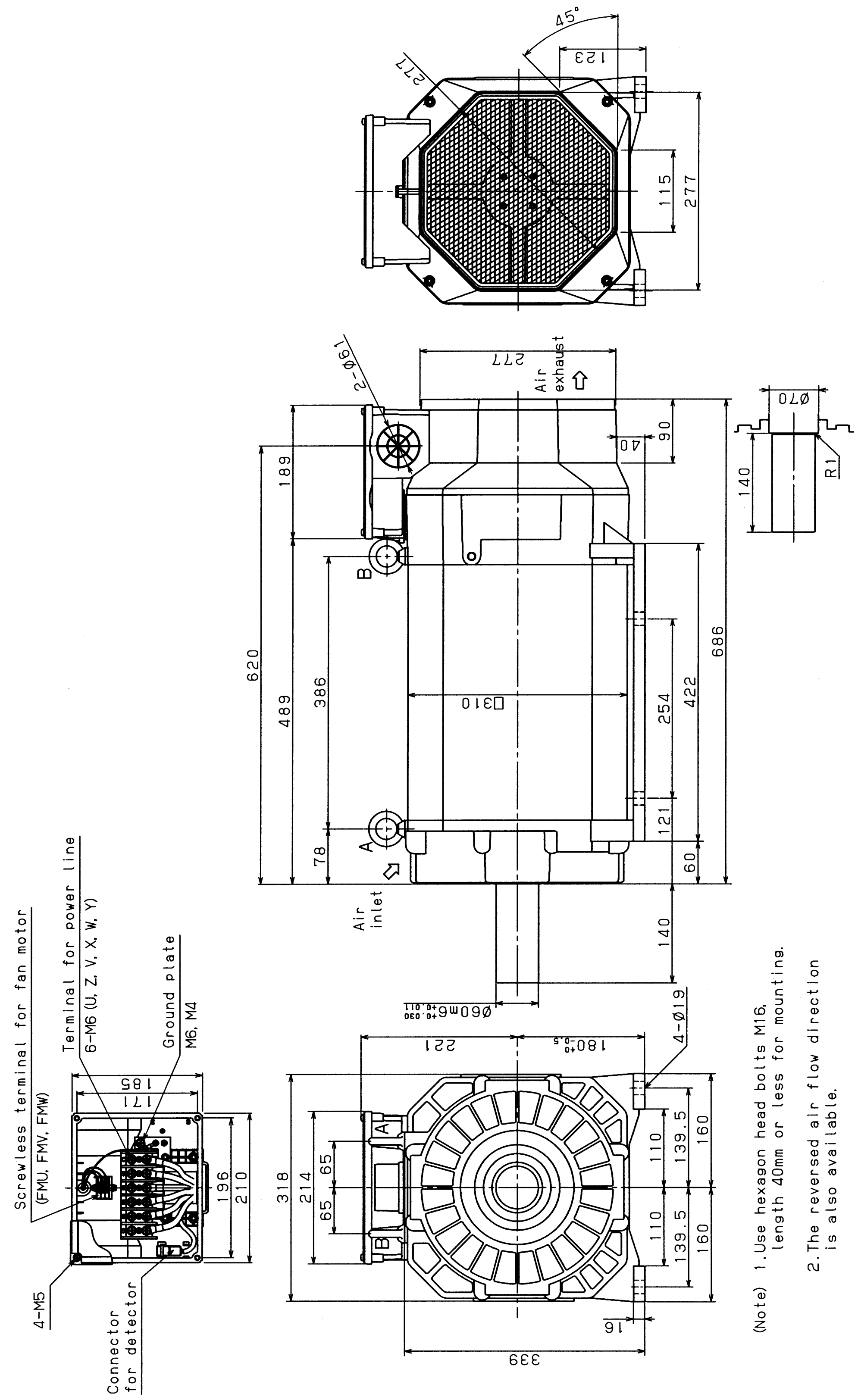
7.10 MODELS α30/6000*i*P AND α40/6000*i*P (FOOT MOUNTING TYPE)



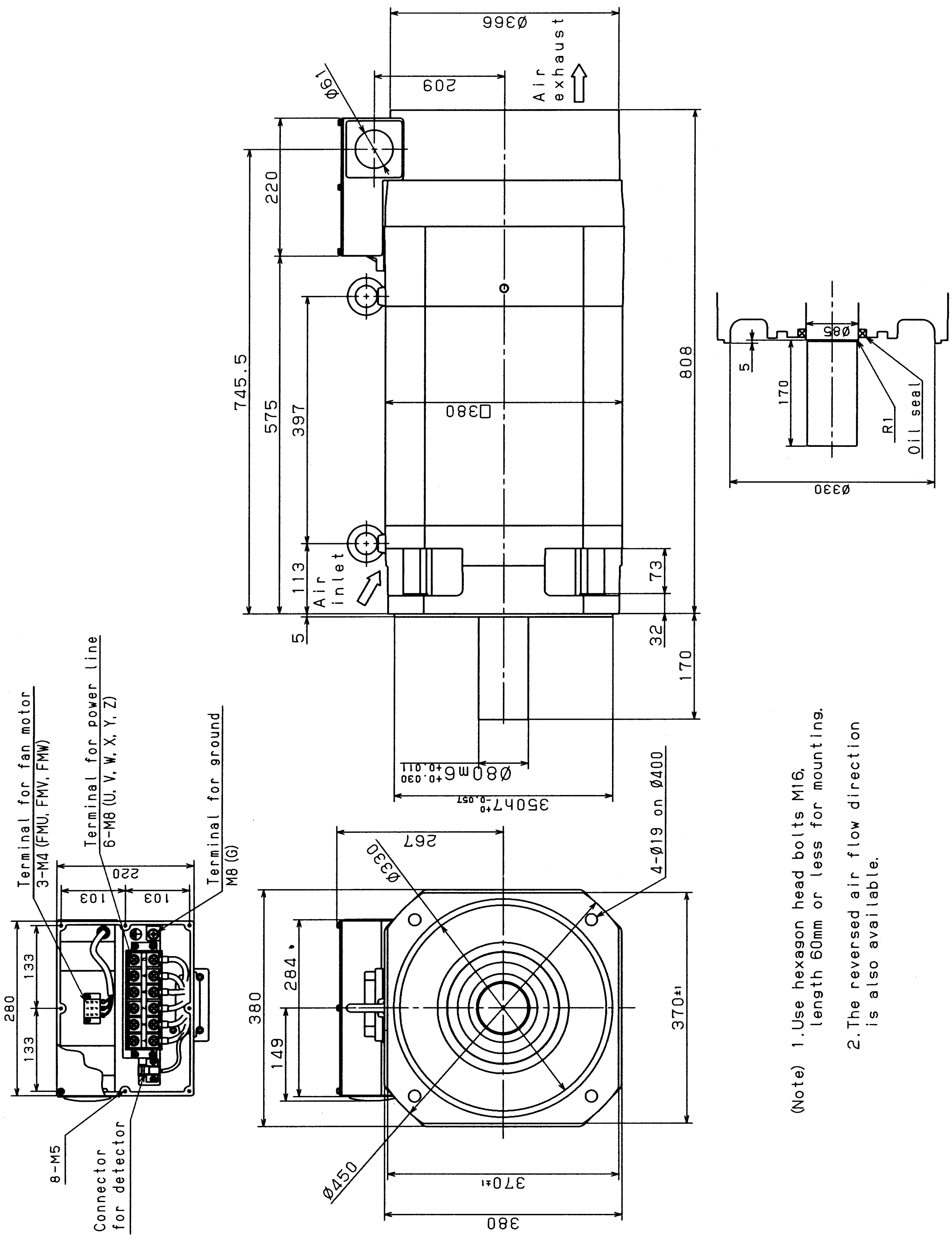
7.11 MODEL α50/6000*i*P (FRANGE MOUNTING TYPE)



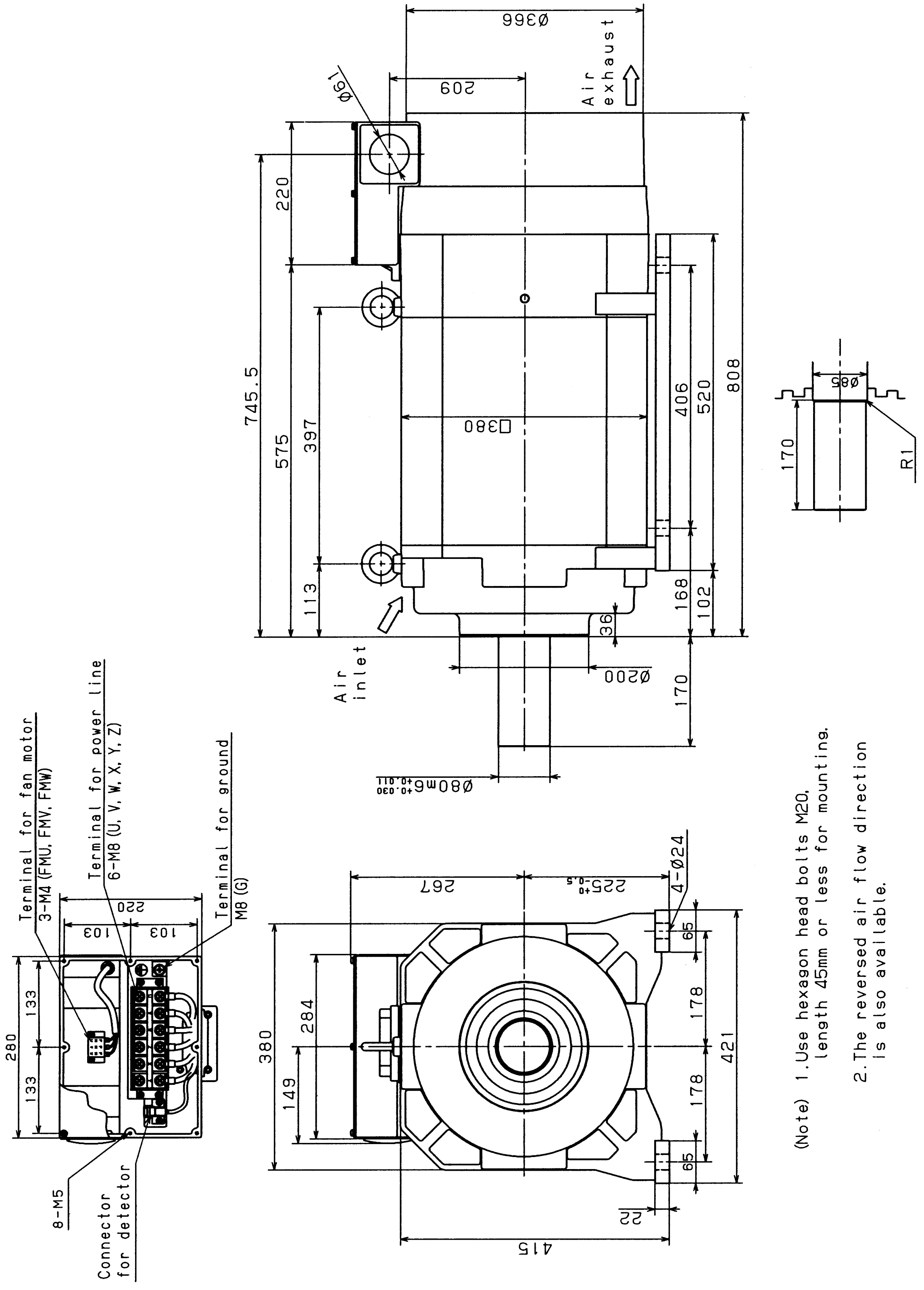
7.12 MODEL α50/6000*i*P (FOOT MOUNTING TYPE)



7.13 MODEL α60/4500*i*P (FRANGE MOUNTING TYPE)



7.14 MODEL α60/4500*i*P (FOOT MOUNTING TYPE)



IV. FANUC AC SPINDLE MOTOR αiT SERIES

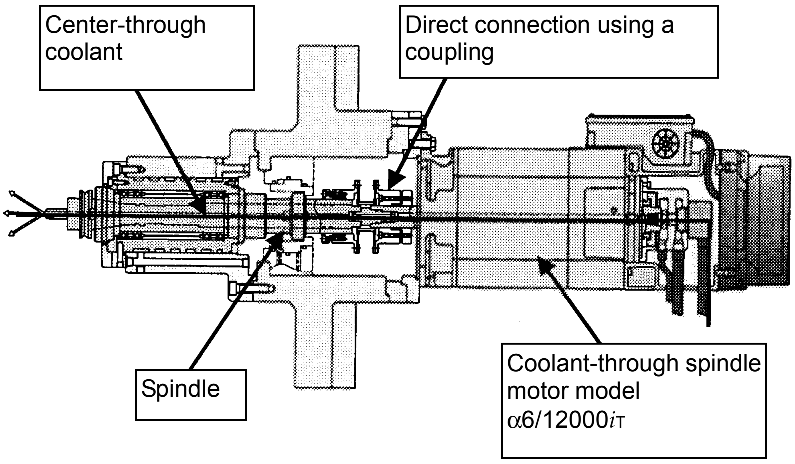
1 GENERAL

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



Features of a spindle of direct motor connection type

<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.

Important

(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		α1.5/15000*i*T	α2/15000*i*T	α3/12000*i*T
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	15,000	15,000	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 MZ*i* 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 module		SPM-15*i*	SPM-22*i*	SPM-11*i*

* See Page 162 for Cautions and limitations.

Item \ Model		α6/12000*i*T		α8/12000*i*T	
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 MZ*i* 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 module		SPM-15*i*		SPM-15*i*	

* See Page 162 for Cautions and limitations.

Item		α8/15000*i*T		α15/10000*i*T	
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 MZ*i* 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 module		SPM-26*i*		SPM-22*i*	

* See Page 162 for Cautions and limitations.

Item \ Model		α15/12000*i*T		α22/10000*i*T	
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% (*3)(*4) kW (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	12,000	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 MZ*i* 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 module		SPM-30*i*		SPM-26*i*	

* See Page 162 for Cautions and limitations.

Cautions and limitations

(*1) The rated output is guaranteed at the rated voltage.
(Amplifier input: 200 to 230VAC)
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 α1.5/15000*i*T and α2/15000*i*T is 15 min rated.

(*3) 40% for α1.5/15000*i*T, α2/15000*i*T and α22/10000*i*T

(*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 a gear coupling or 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 module 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 α*i* 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

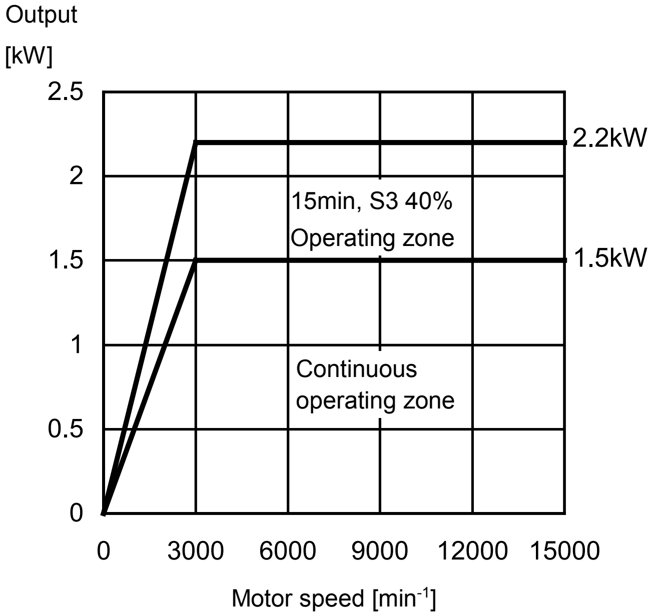
$N[min^{-1}]$: Motor speed

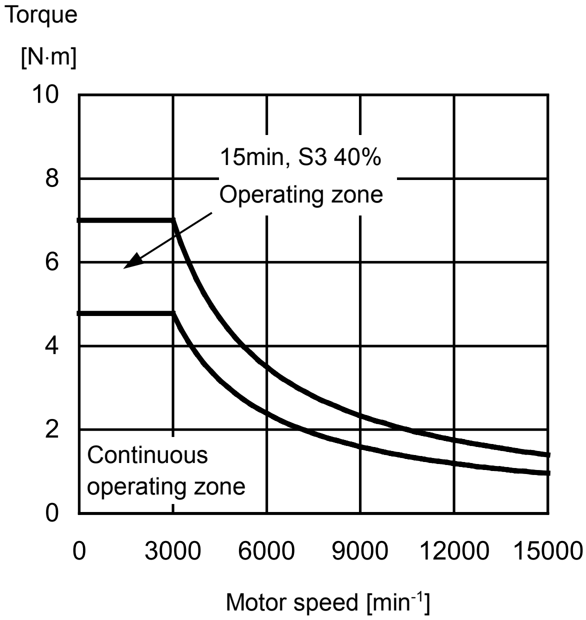
When the unit of T is [kgf·m],

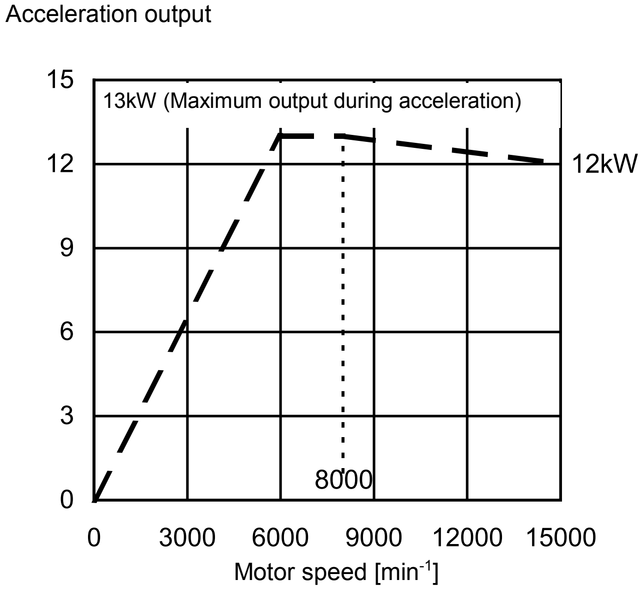
$T[kgf\cdot m]=P[kW]\times 1000/1.0269/N[min^{-1}]$

3.1 MODEL α1.5/15000iT

Applicable amplifier SPM-15i





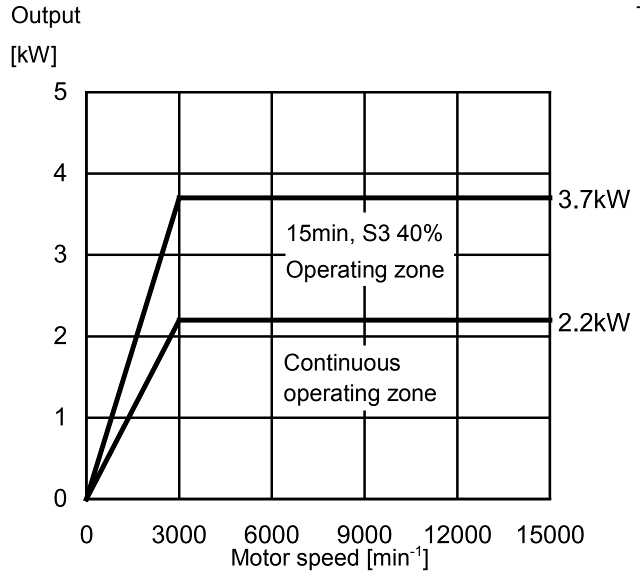


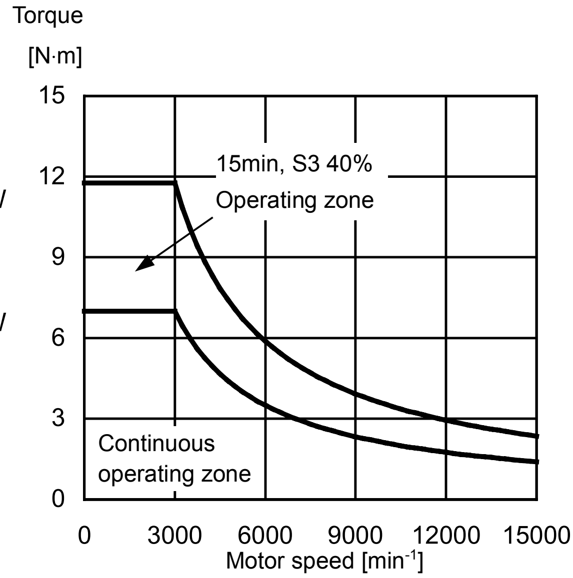
NOTE

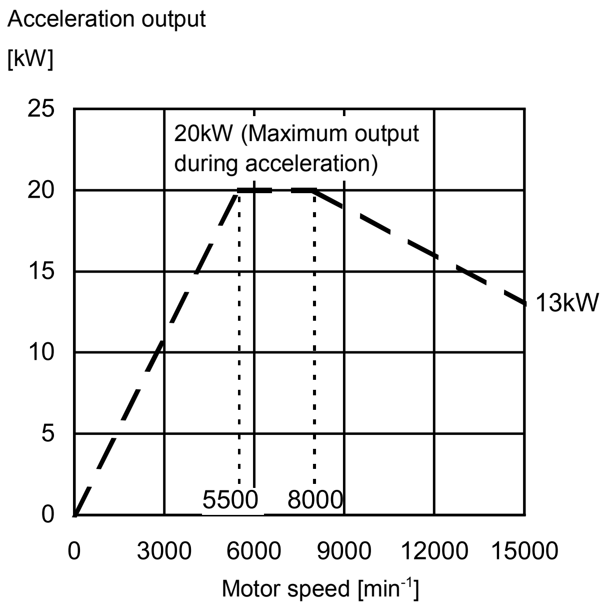
Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

3.2 MODEL α2/15000*i*T

Applicable amplifier SPM-22*i*



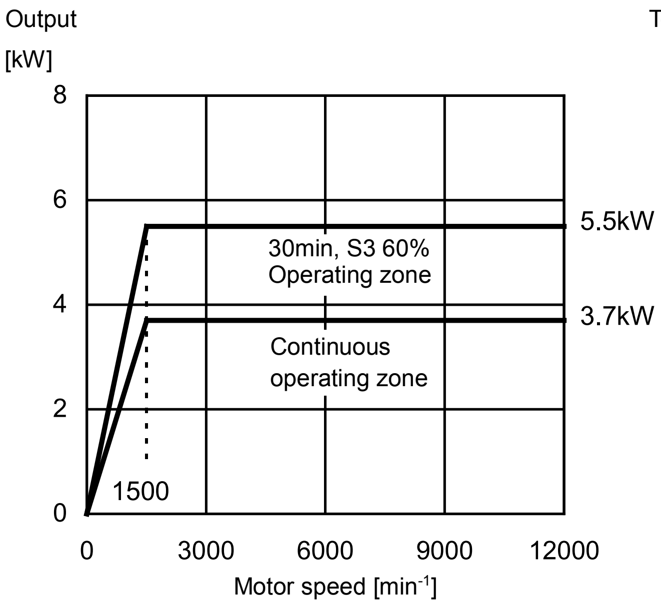


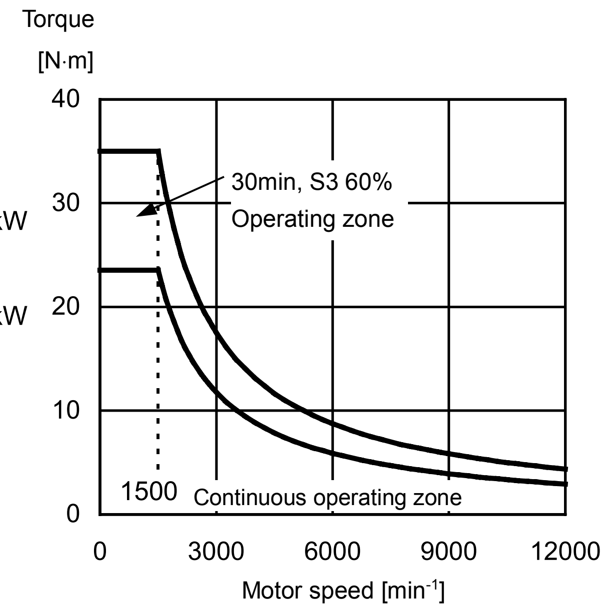


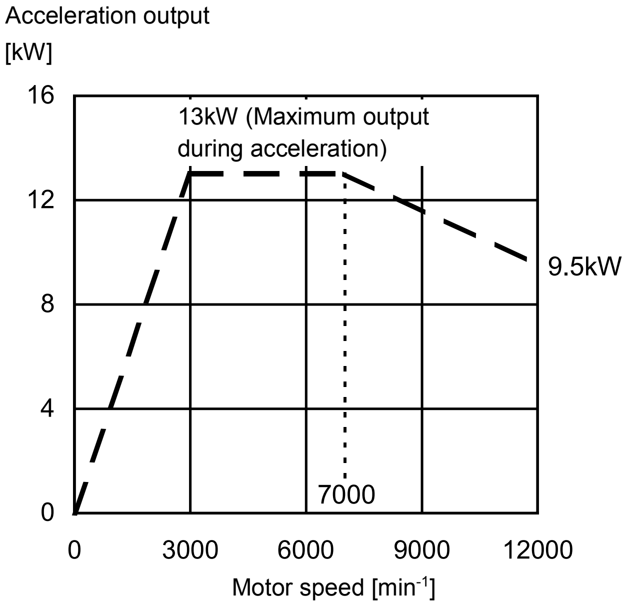
> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

3.3 MODEL α3/12000*i*T

Applicable amplifier SPM-11*i*





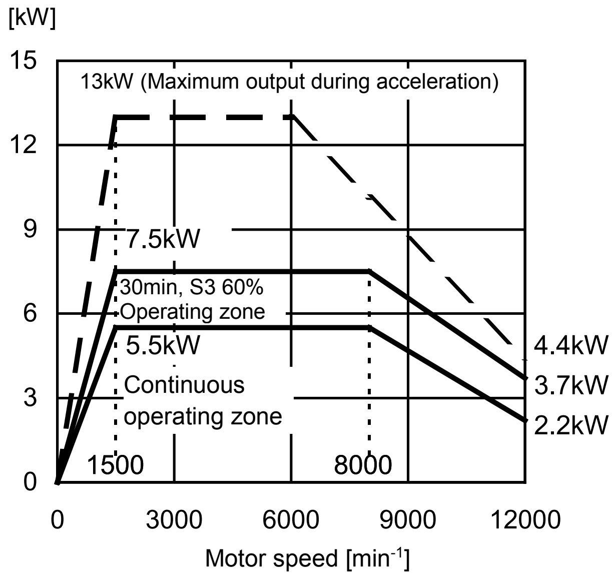


> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

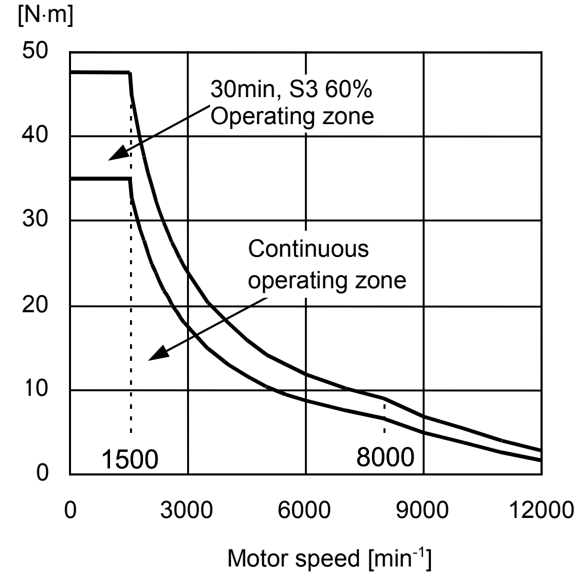
3.4 MODEL α6/12000iT

Applicable amplifier SPM-15i

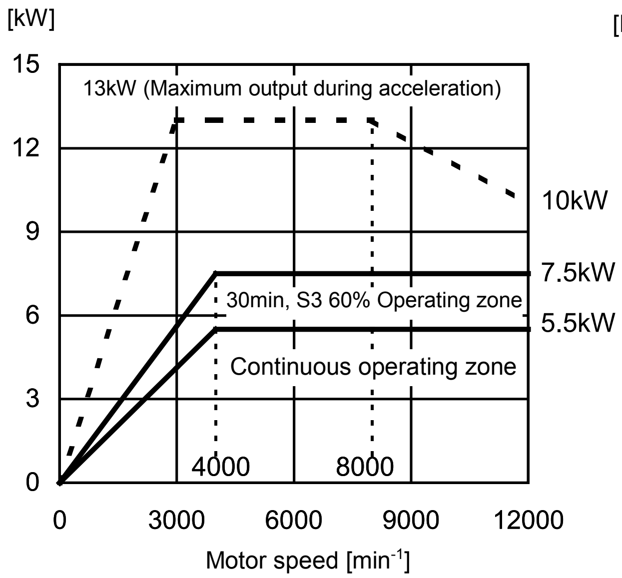
Low-speed winding output (Y connection)



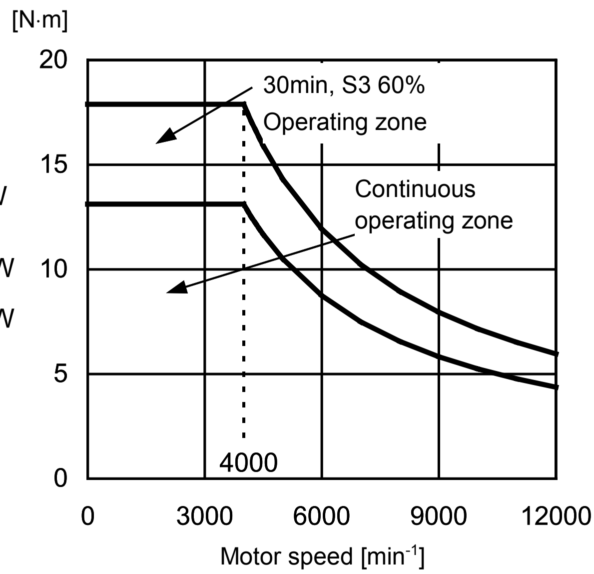
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



High-speed winding output (Δ connection)



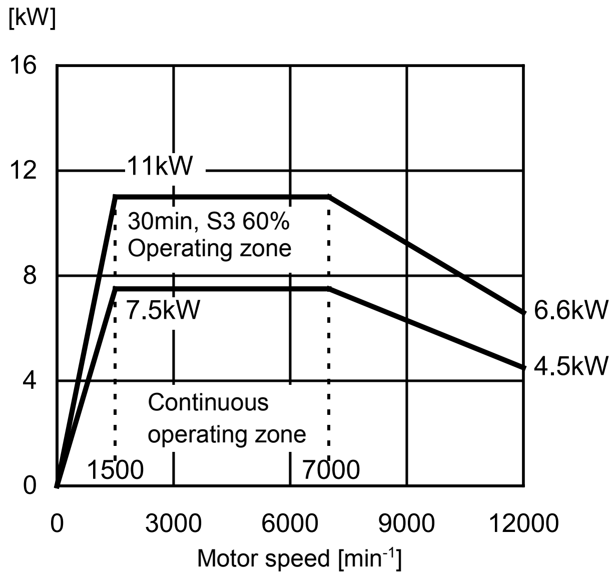
NOTE

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

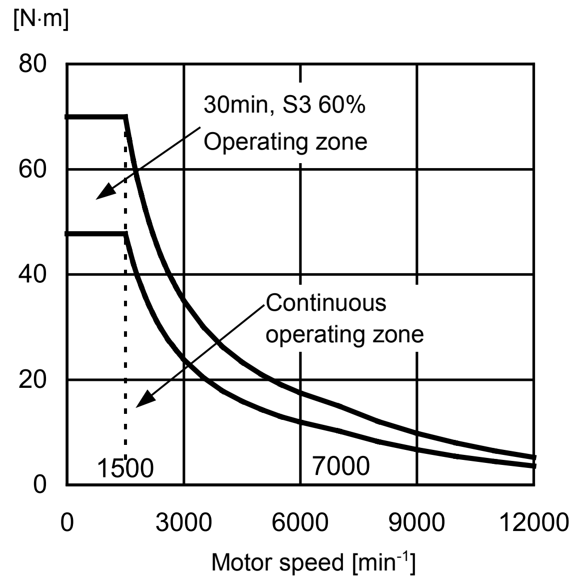
3.5 MODEL α8/12000*i*T

Applicable amplifier SPM-15*i*

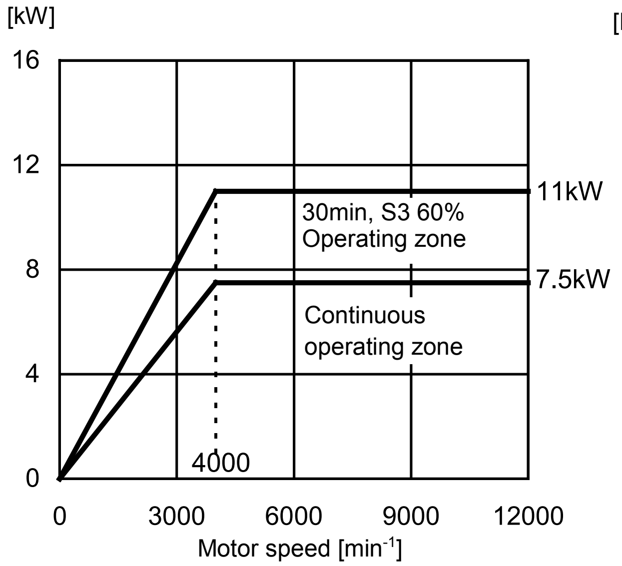
Low-speed winding output (Y connection)



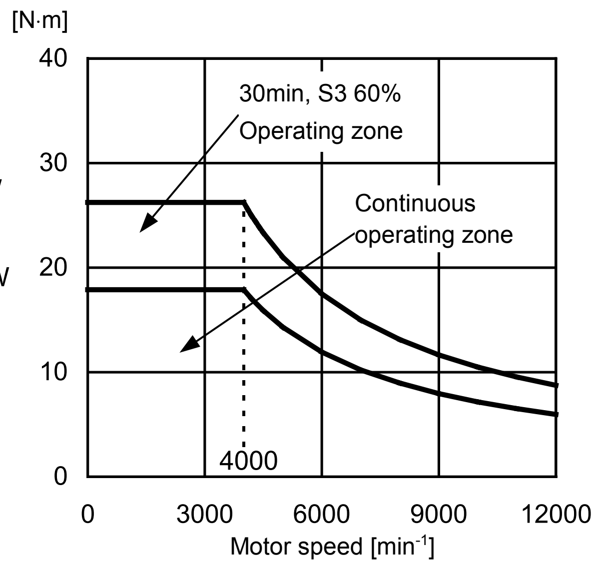
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



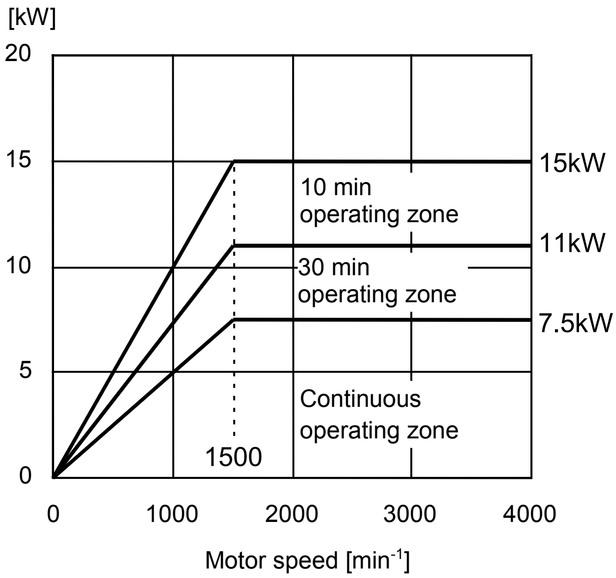
High-speed winding output (Δ connection)



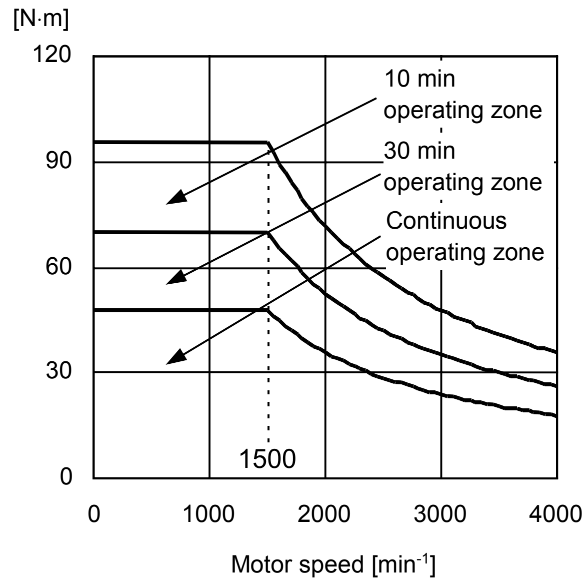
3.6 MODEL α8/15000iT

Applicable amplifier SPM-26i

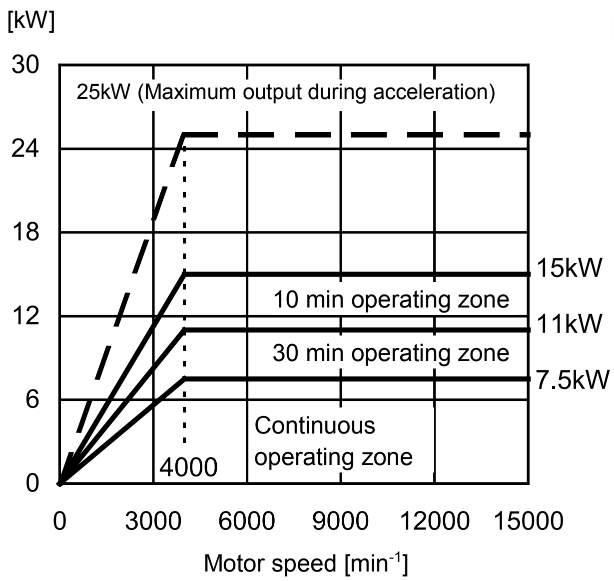
Low-speed winding output (Y connection)



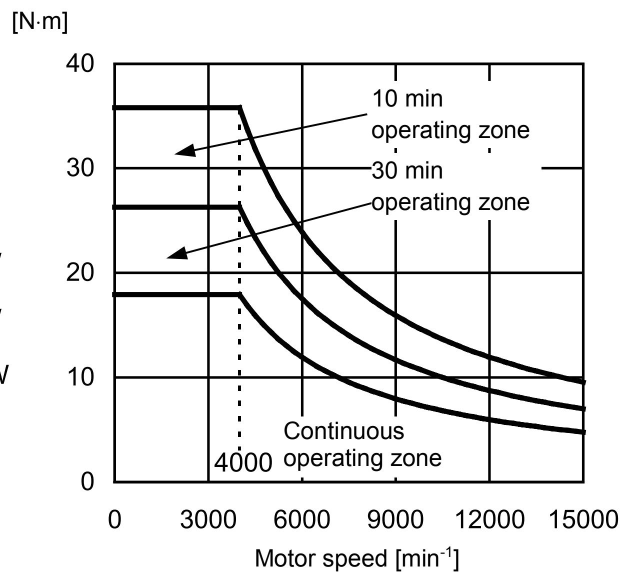
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



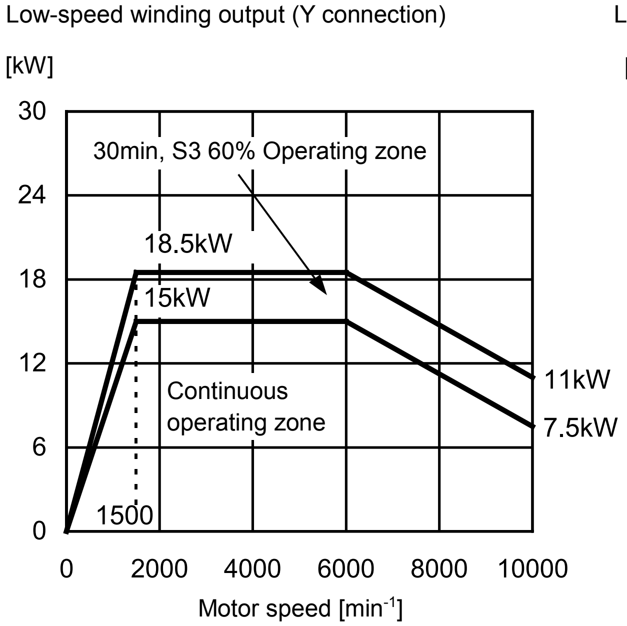
High-speed winding output (Δ connection)

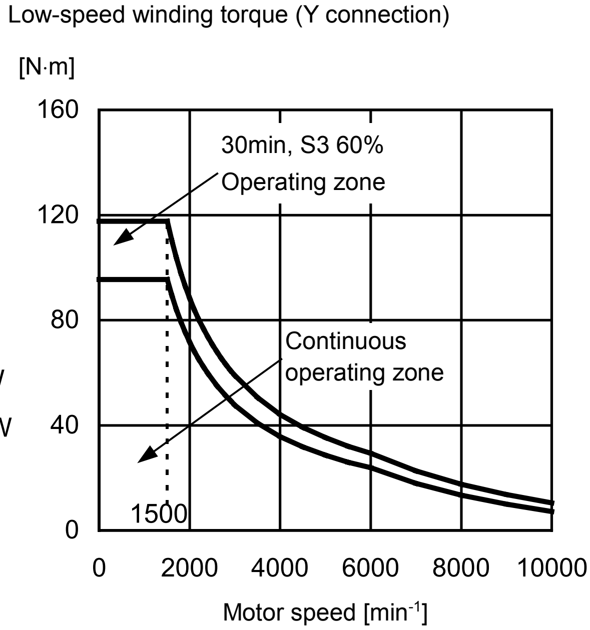


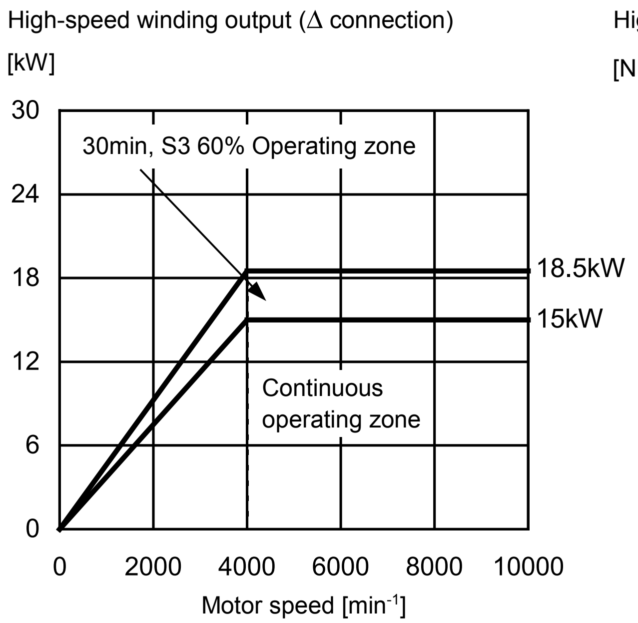
> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

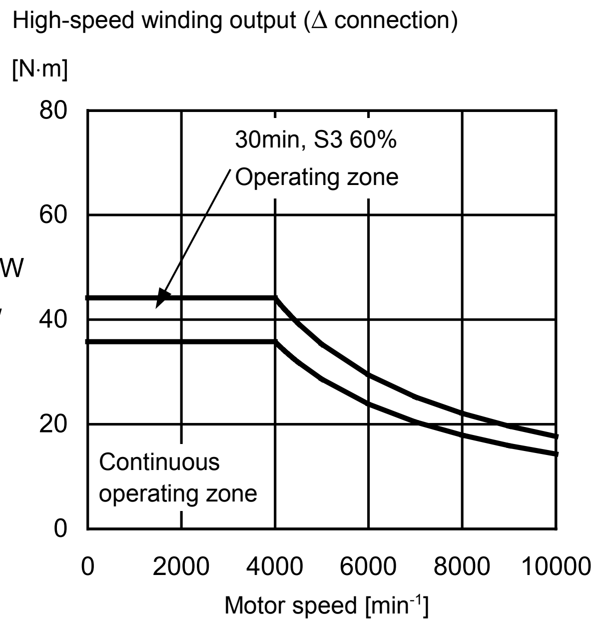
3.7 MODEL α15/10000*i*T

Applicable amplifier SPM-22*i*





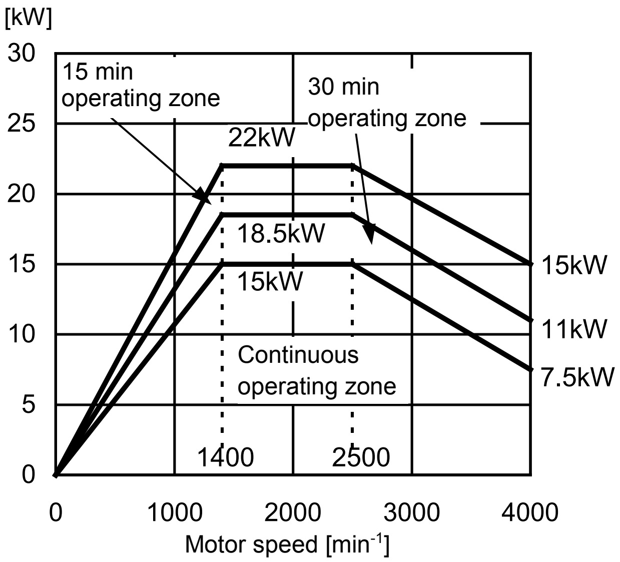




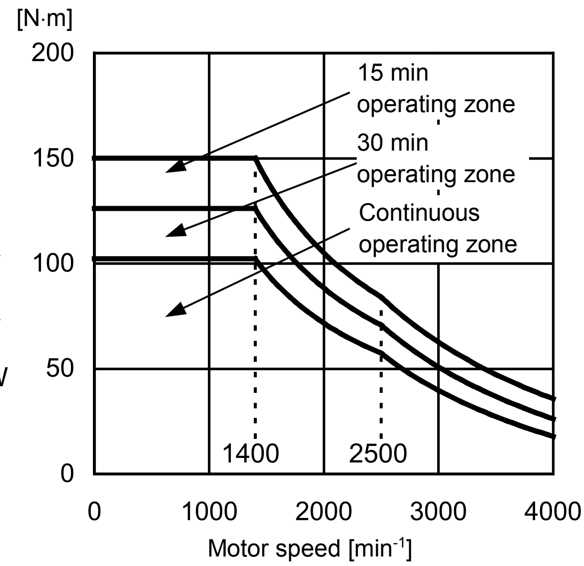
3.8 MODEL α15/12000*i*T

Applicable amplifier SPM-30*i*

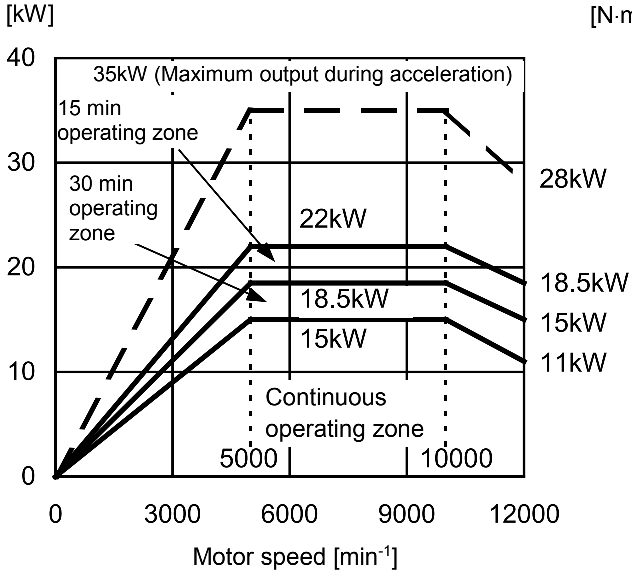
Low-speed winding output (Y connection)



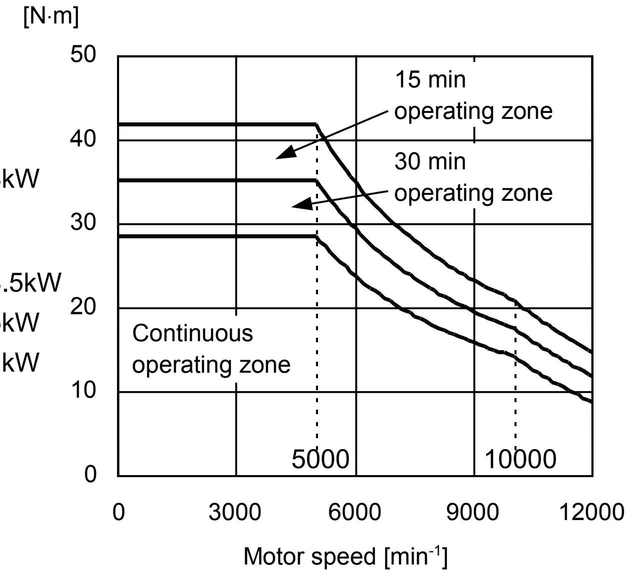
Low-speed winding torque (Y connection)



High-speed winding output (Y connection)



High-speed winding output (Y connection)

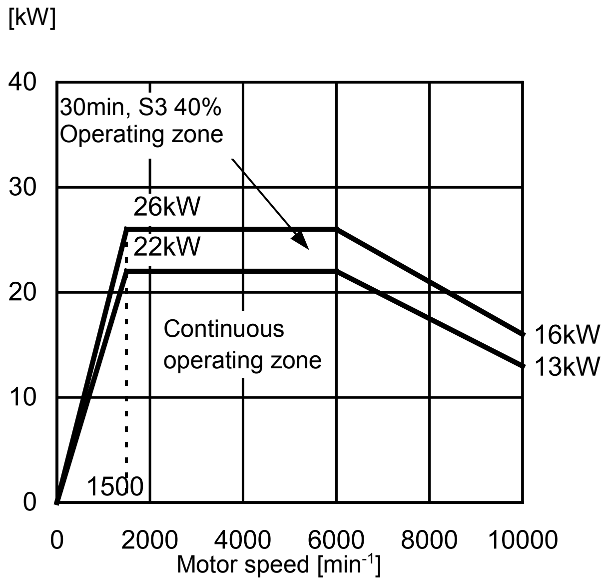


> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

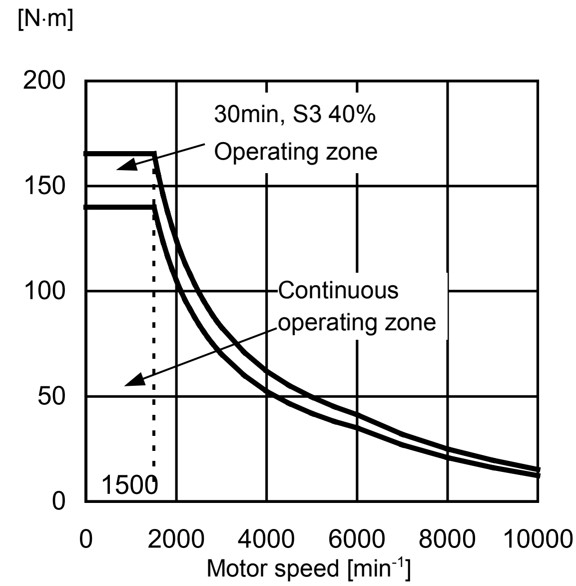
3.9 MODEL α22/10000*i*T

Applicable amplifier SPM-26*i*

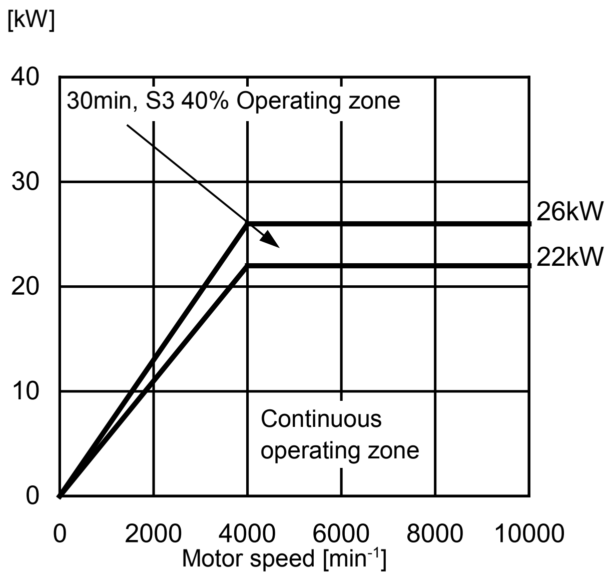
Low-speed winding output (Y connection)



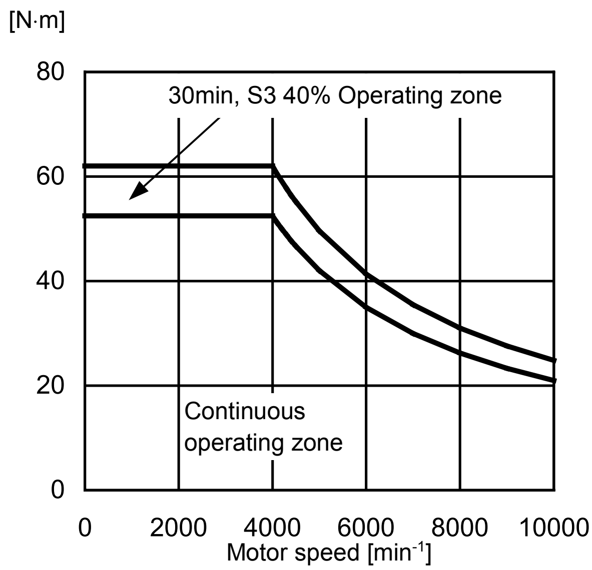
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



High-speed winding output (Δ connection)

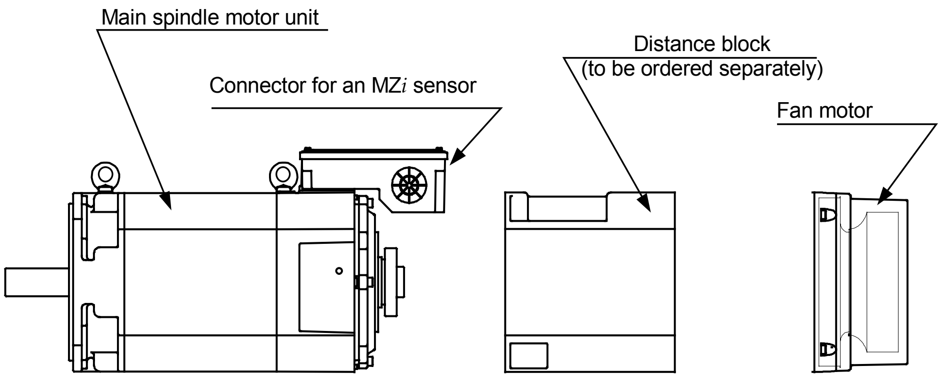


4 CONFIGURATION AND ORDERING NUMBER

4.1 CONFIGURATION

The α*i*T series motor 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 MZ*i* 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
α1.5/15000*i*T	A06B-1463-B123#0021	SPM-15*i*	- Flange mounting type - Hollow shaft (with no key) - Labyrinth - Built-in with MZ*i* sensor
α2/15000*i*T	A06B-1464-B123#0021	SPM-22*i*	
α3/12000*i*T	A06B-1465-B123#0021	SPM-11*i*	
α6/12000*i*T	A06B-1466-B123#0021	SPM-15*i*	
α8/12000*i*T	A06B-1467-B123#0021	SPM-15*i*	
α8/15000*i*T	A06B-1477-B133#0121	SPM-26*i*	
α15/10000*i*T	A06B-1469-B123#0021	SPM-22*i*	
α15/12000*i*T	A06B-1479-B133#0121	SPM-30*i*	
α22/10000*i*T	A06B-1471-B123#0021	SPM-26*i*	

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.

Name	Ordering number	Remarks
Type 1.5*i*T	A06B-1463-K560	For α1.5*i*T
Type 2*i*T	A06B-1464-K560	For α2*i*T and α3*i*T
Type 6*i*T	A06B-1466-K560	For α6*i*T and α8*i*T

5 CONNECTIONS

5.1 CONNECTION OF THE POWER, FAN MOTOR, AND MZ*i* SENSOR SIGNAL LEADS

Cables for power lead and fan motor are connected to the terminal block.
MZ*i* 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		Cooling fan
	U,V,W,G	X,Y,Z	FMU,FMV,FMW
α1.5/15000*i*T	M5	-	M4
α2/15000*i*T	M5	-	Screw-less terminal block
α3/12000*i*T	M5	-	Screw-less terminal block
α6/12000*i*T	M5	M5	Screw-less terminal block
α8/12000*i*T	M5	M5	Screw-less terminal block
α8/15000*i*T	M5	M5	Screw-less terminal block
α15/10000*i*T	M5	M5	Screw-less terminal block
α15/12000*i*T	M6	M6	Screw-less terminal block
α22/10000*i*T	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
α1.5/15000*i*T	M5	M5	-	8.0
α2/15000*i*T	M5	M6	-	8.0
α3/12000*i*T	M5	M5	5.5	-
α6/12000*i*T	M5	M5	8	-
α8/12000*i*T	M5	M5	8	-
α8/15000*i*T	M5	M6	14	-
α15/10000*i*T	M5	M6	14	-
α15/12000*i*T	M6	M6	22	-
α22/10000*i*T	M6	M6	22	-

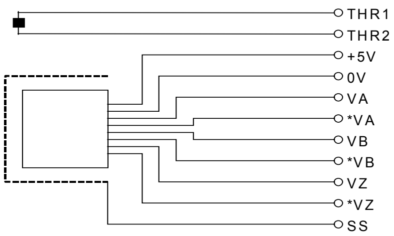
NOTE
1 LMFC power lead: Fire-retardant Polyflex power cable (Heat resistance: 105°C)
2 Flonlex power lead: Manufactured by HITACHI CABLE, Ltd. (Heat resistance: 200°C)

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

MZ*i* 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

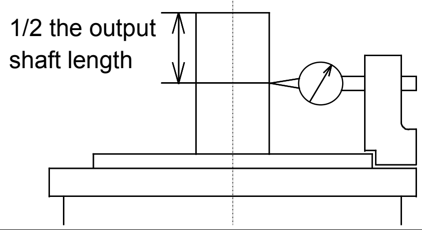
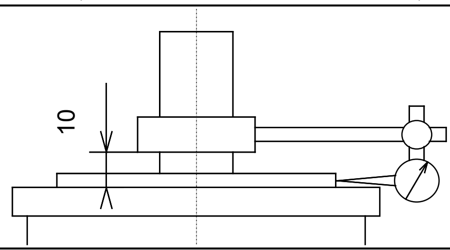
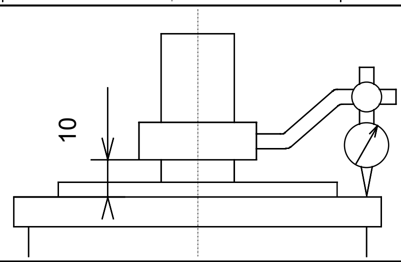
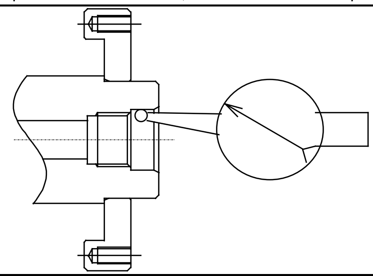
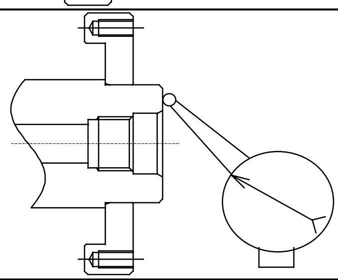
	Motor side		Cable side	
	FANUC specification	Manufacture specification	FANUC specification	Manufacture specification
Housing	A63L-0001-0535/121KDF	178964-6	A63L-0001-0460/121KD	178289-6
Contact	A63L-0001-0456/ASMT	175288-2	A63L-0001-0456/ASM	1-175217-2

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).

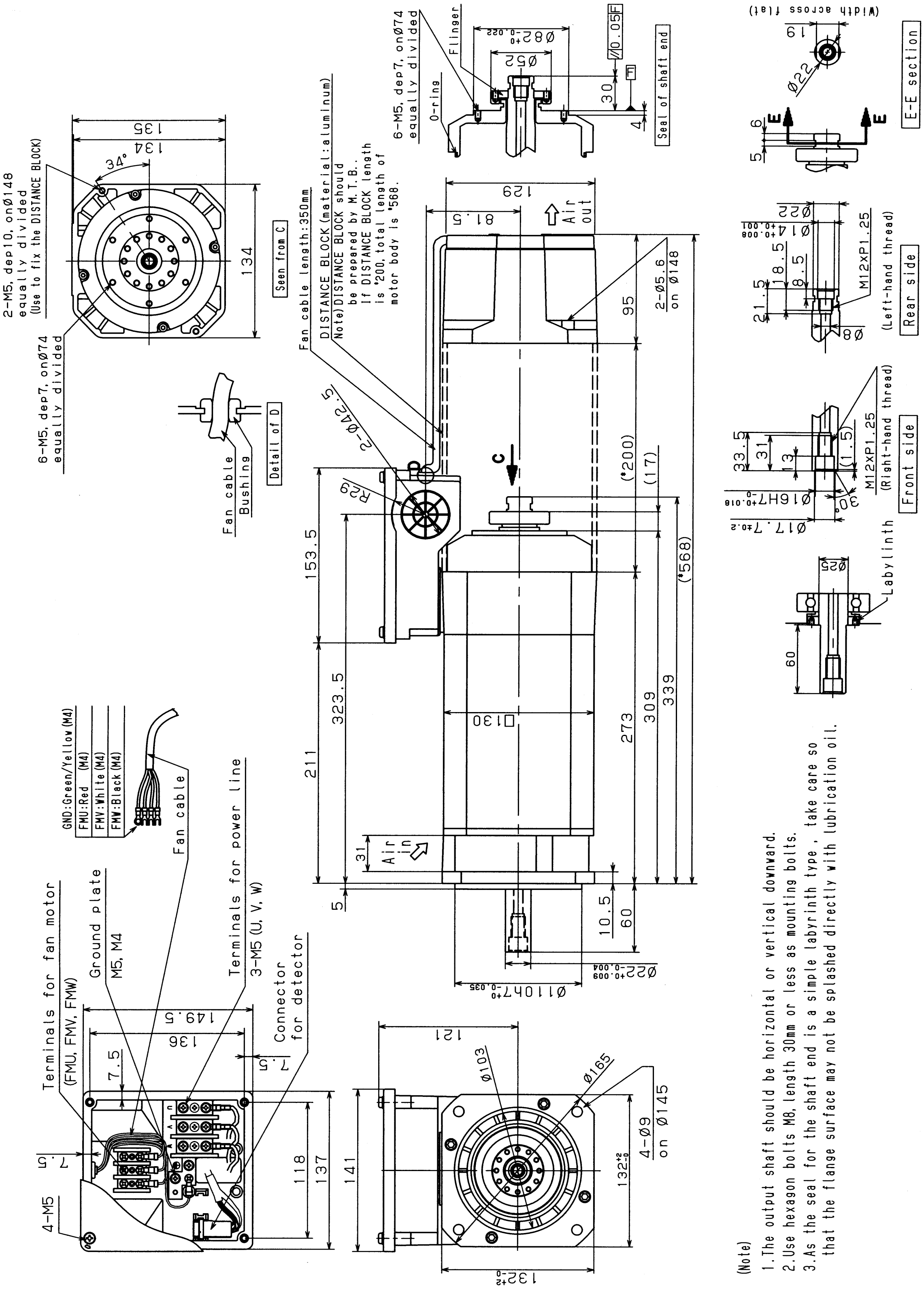
6 ASSEMBLING ACCURACY

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	

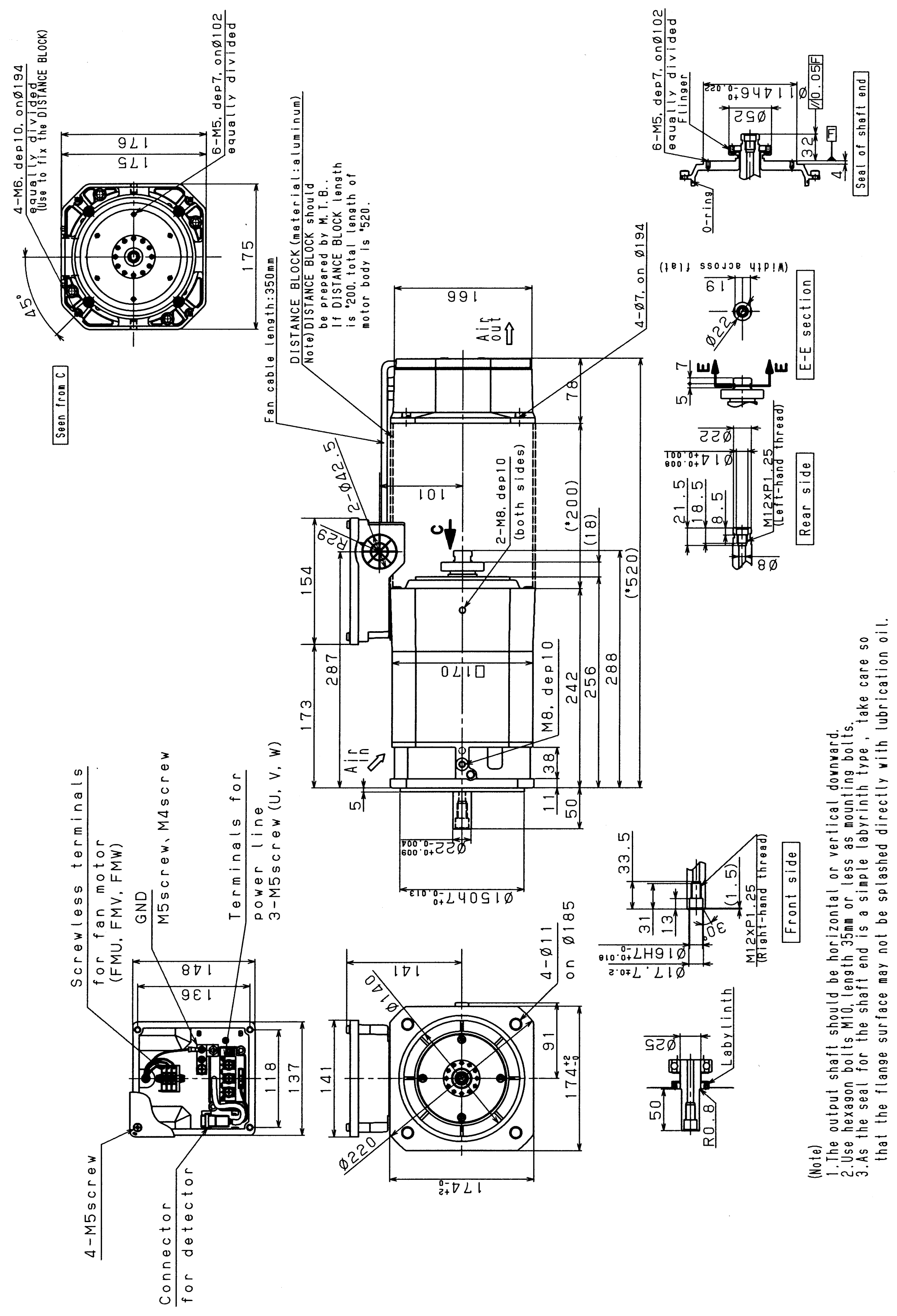
7 EXTERNAL DIMENSIONS

Model name	Section
Model α1.5/15000iT	7.1
Model α2/15000iT	7.2
Model α3/12000iT	7.3
Model α6/12000iT	7.4
Models α8/12000iT and α8/15000iT	7.5
Model α15/10000iT	7.6
Model α15/12000iT	7.7
Model α22/10000iT	7.8
Distance block Type 1.5iT	7.9
Distance block Type 2iT	7.10
Distance block Type 6iT	7.11
Distance block Type 15iT	7.12

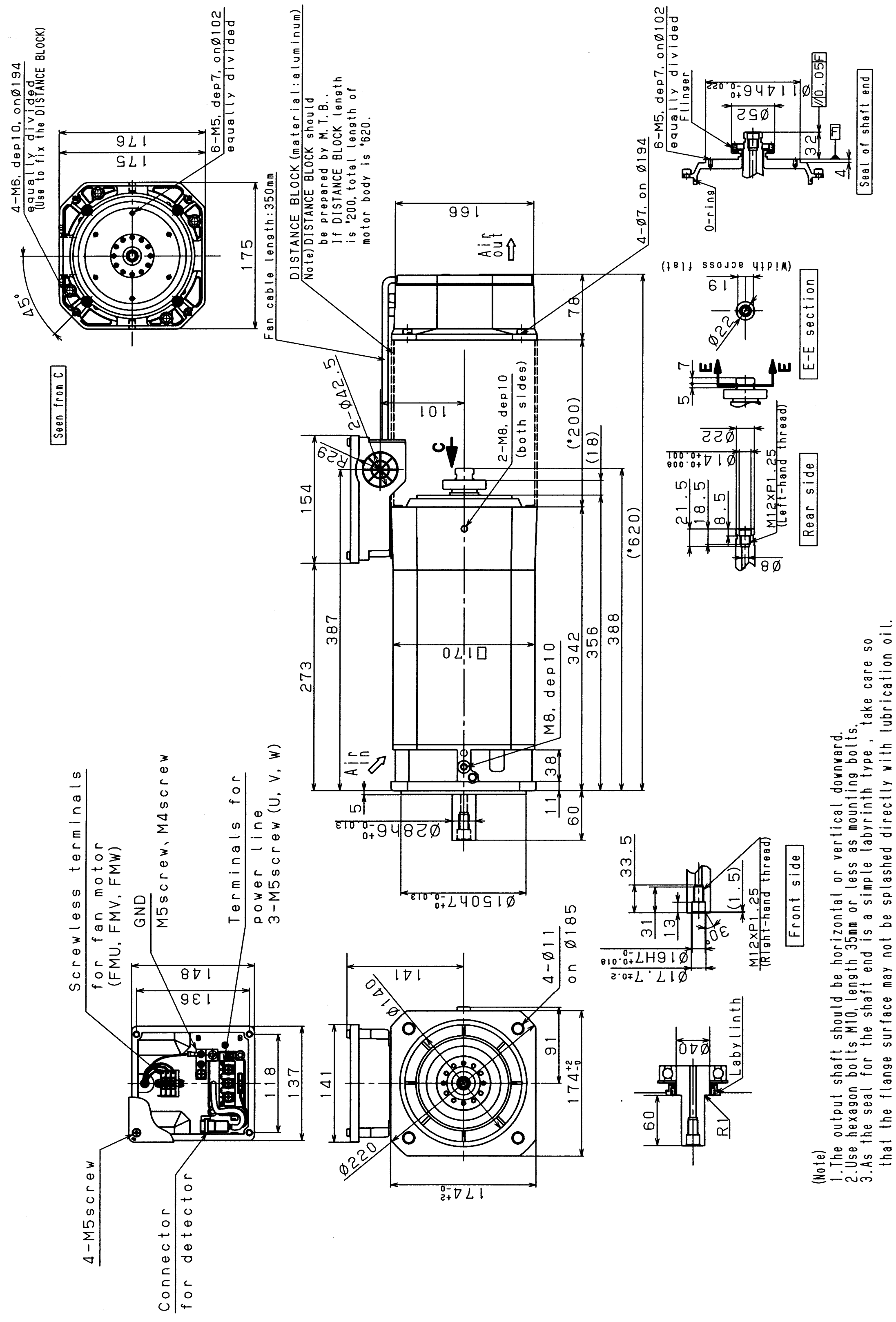
7.1 MODEL α1.5/15000*i*T



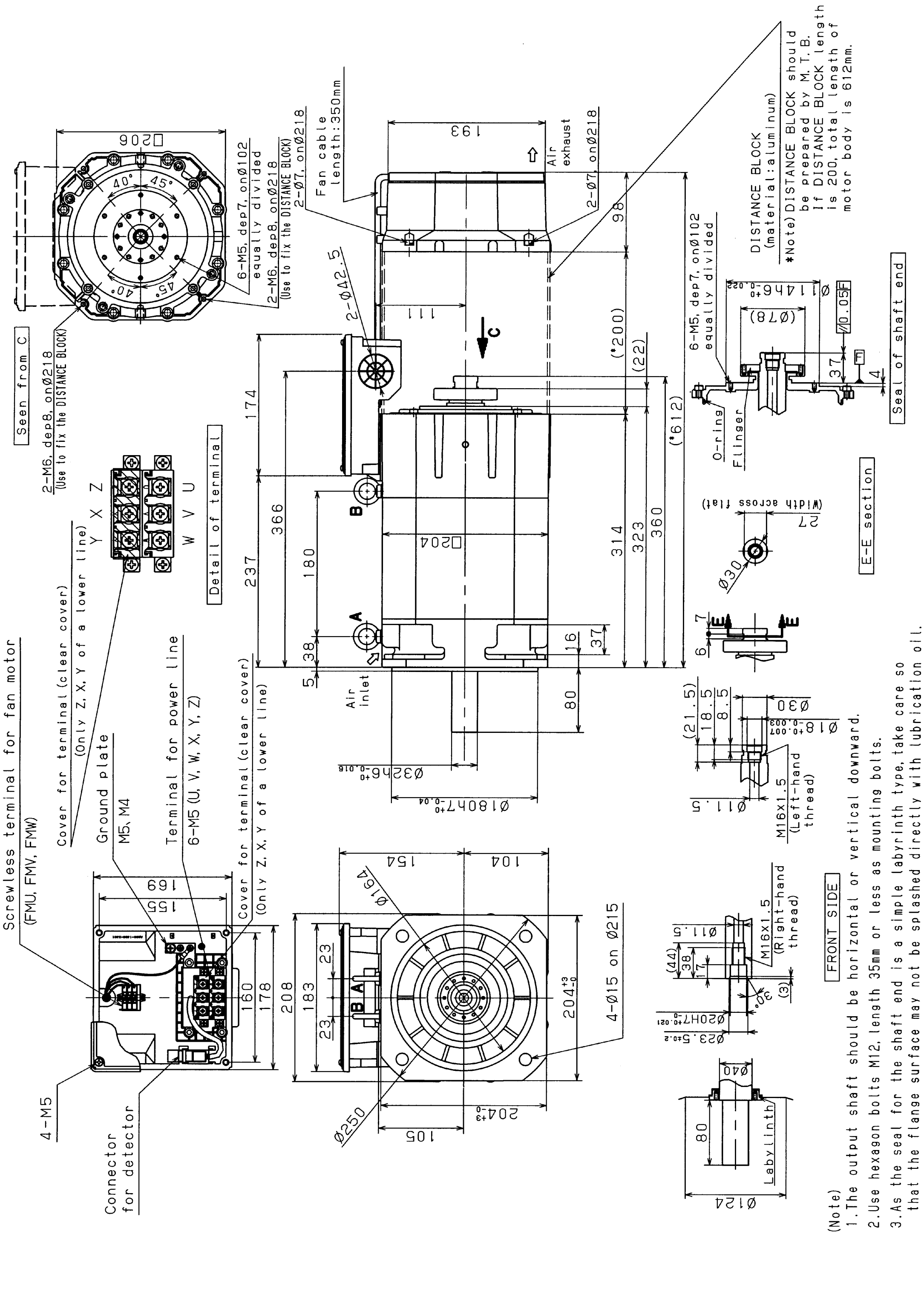
7.2 MODEL α2/15000iT



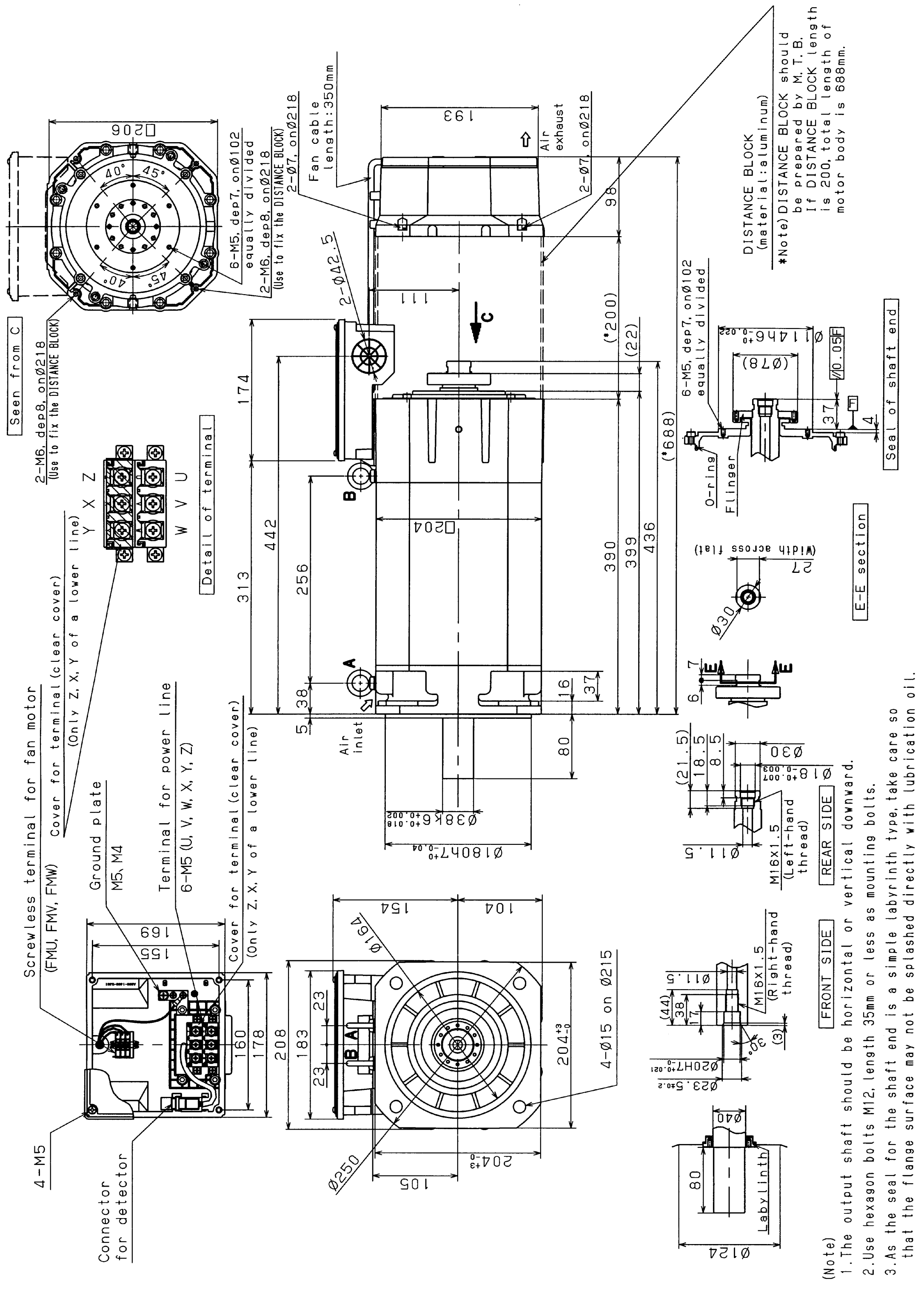
7.3 MODEL α3/12000*i*T



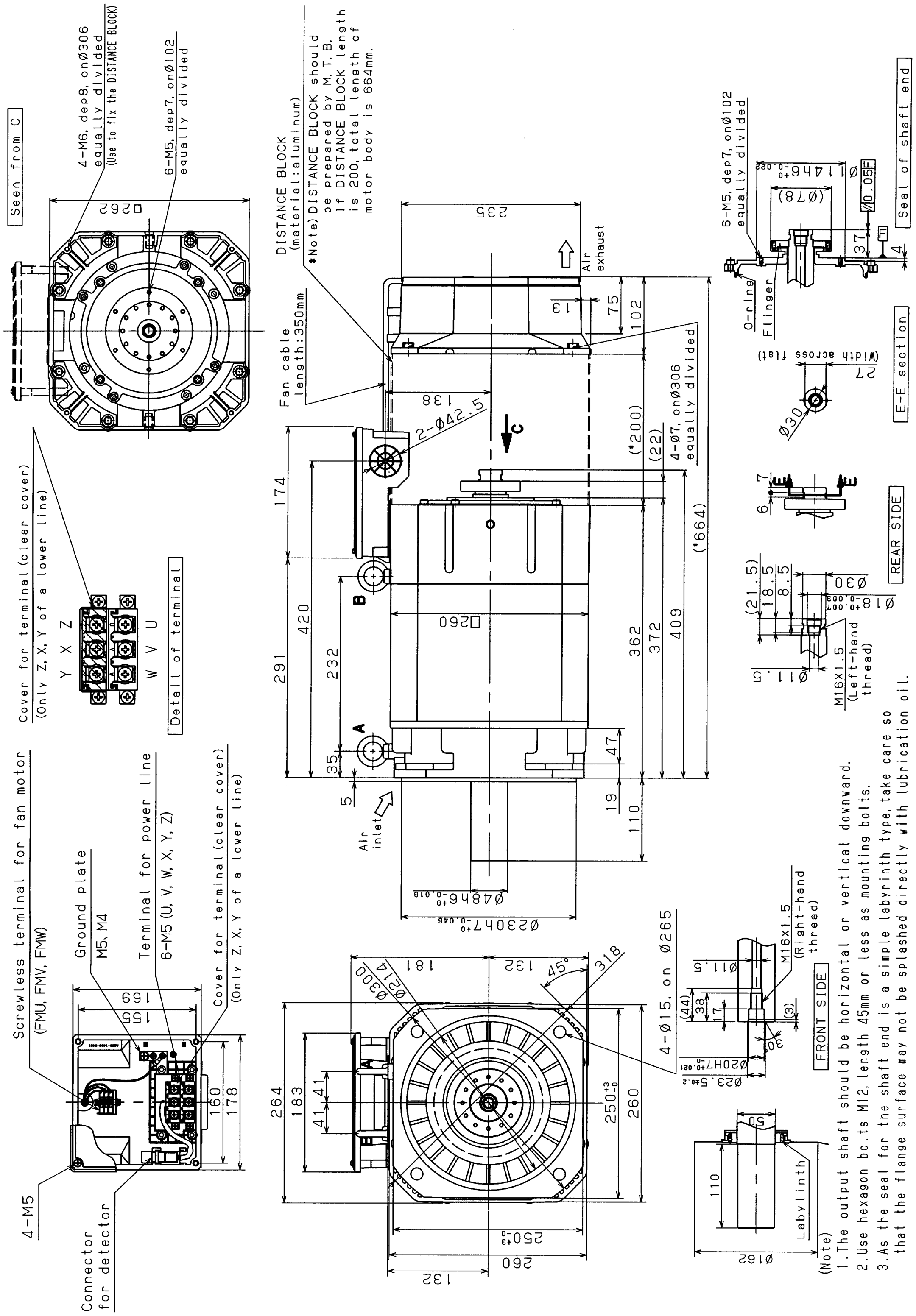
7.4 MODEL α6/12000*i*T



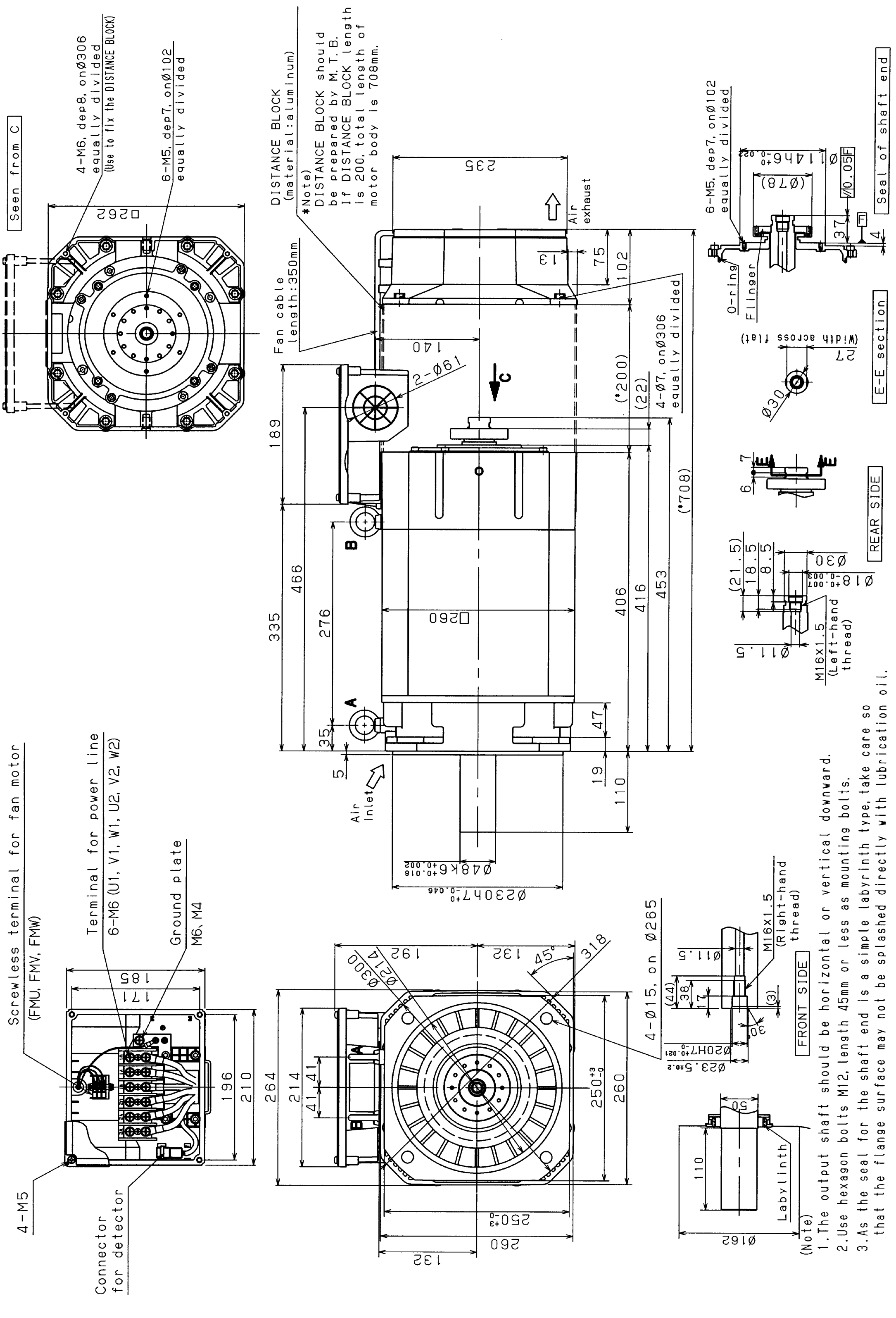
7.5 MODELS α8/12000*i*T AND α8/15000*i*T



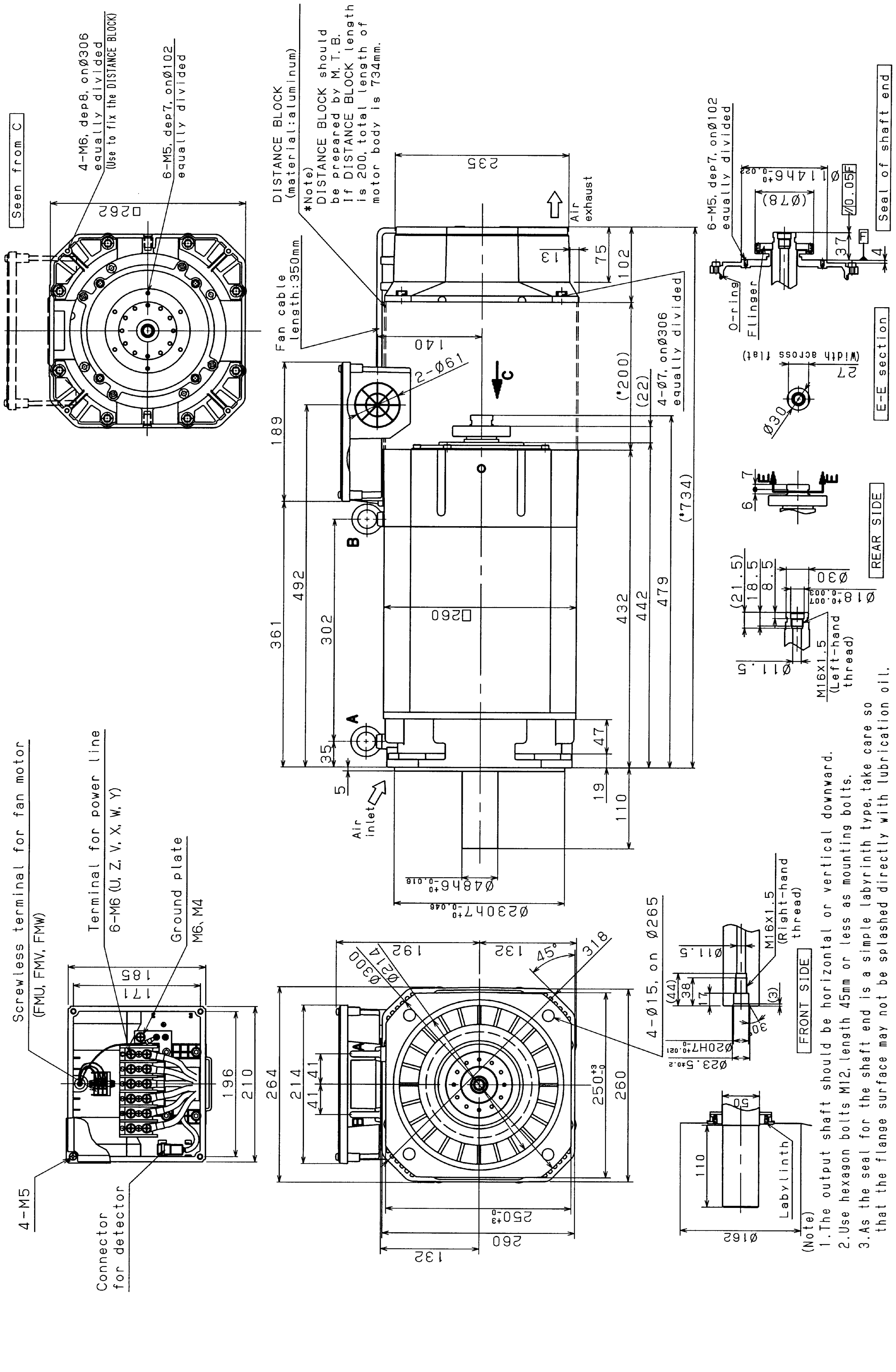
7.6 MODEL α15/10000iT



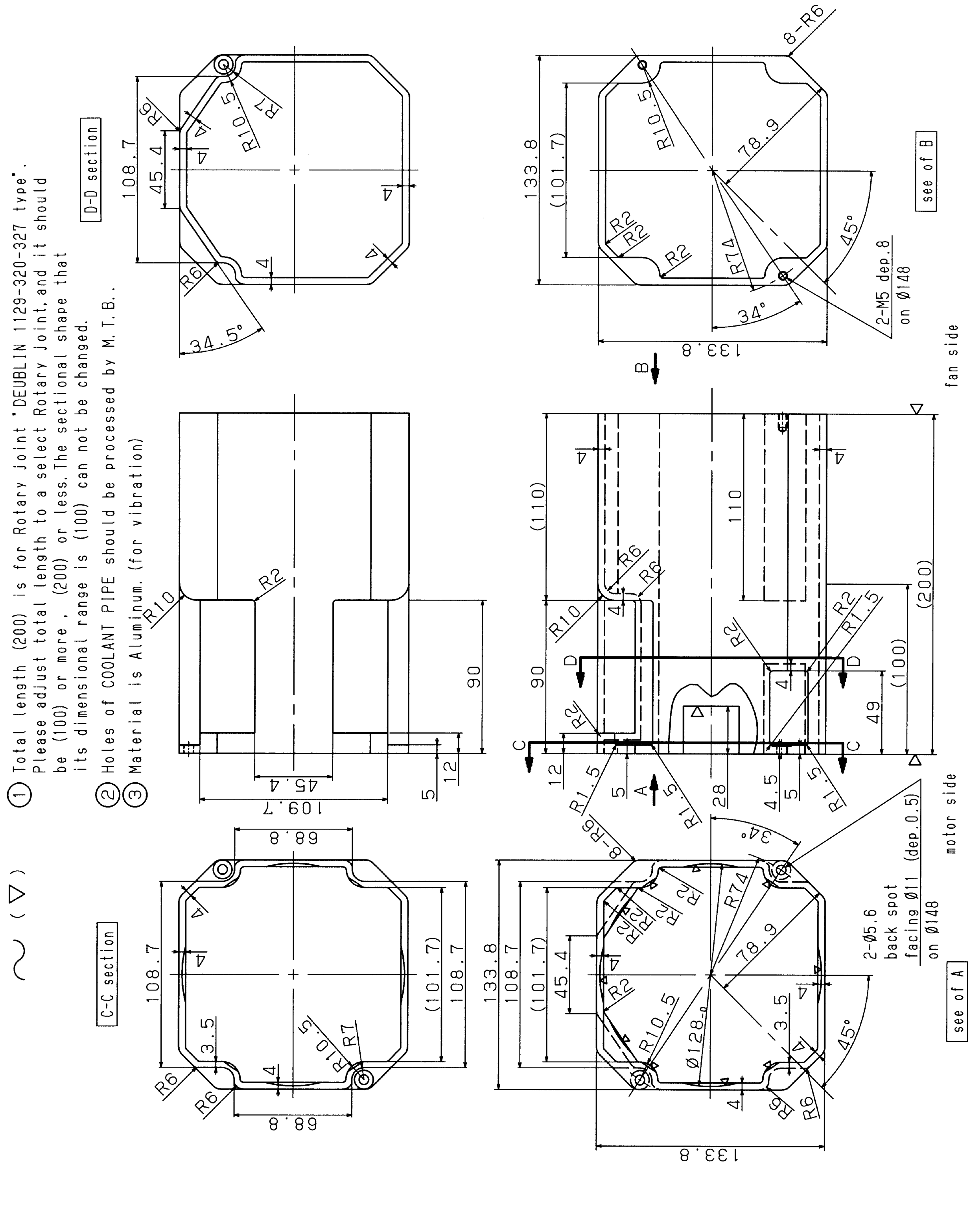
7.7 MODEL α15/12000*i*T



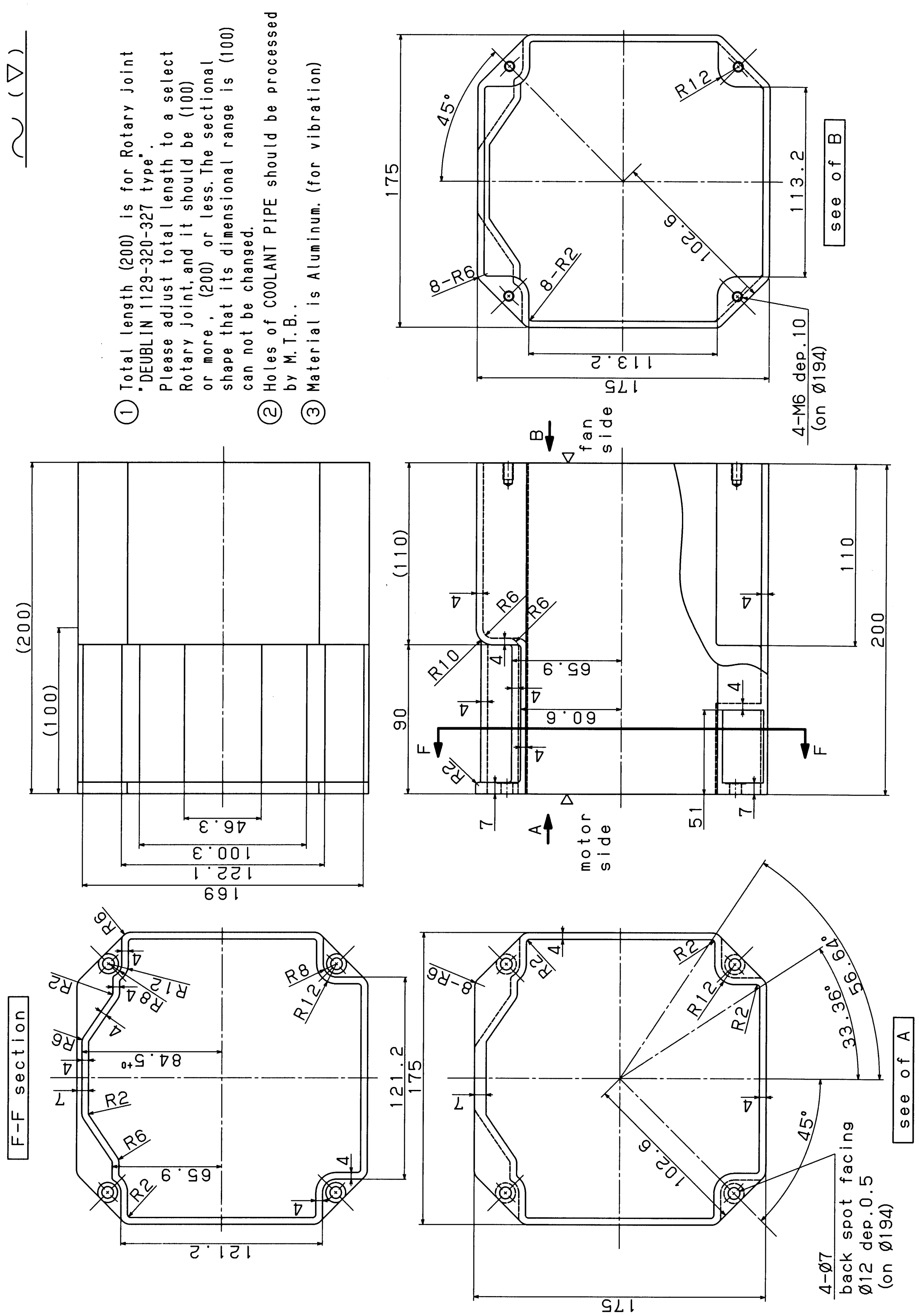
7.8 MODEL α22/10000*i*T



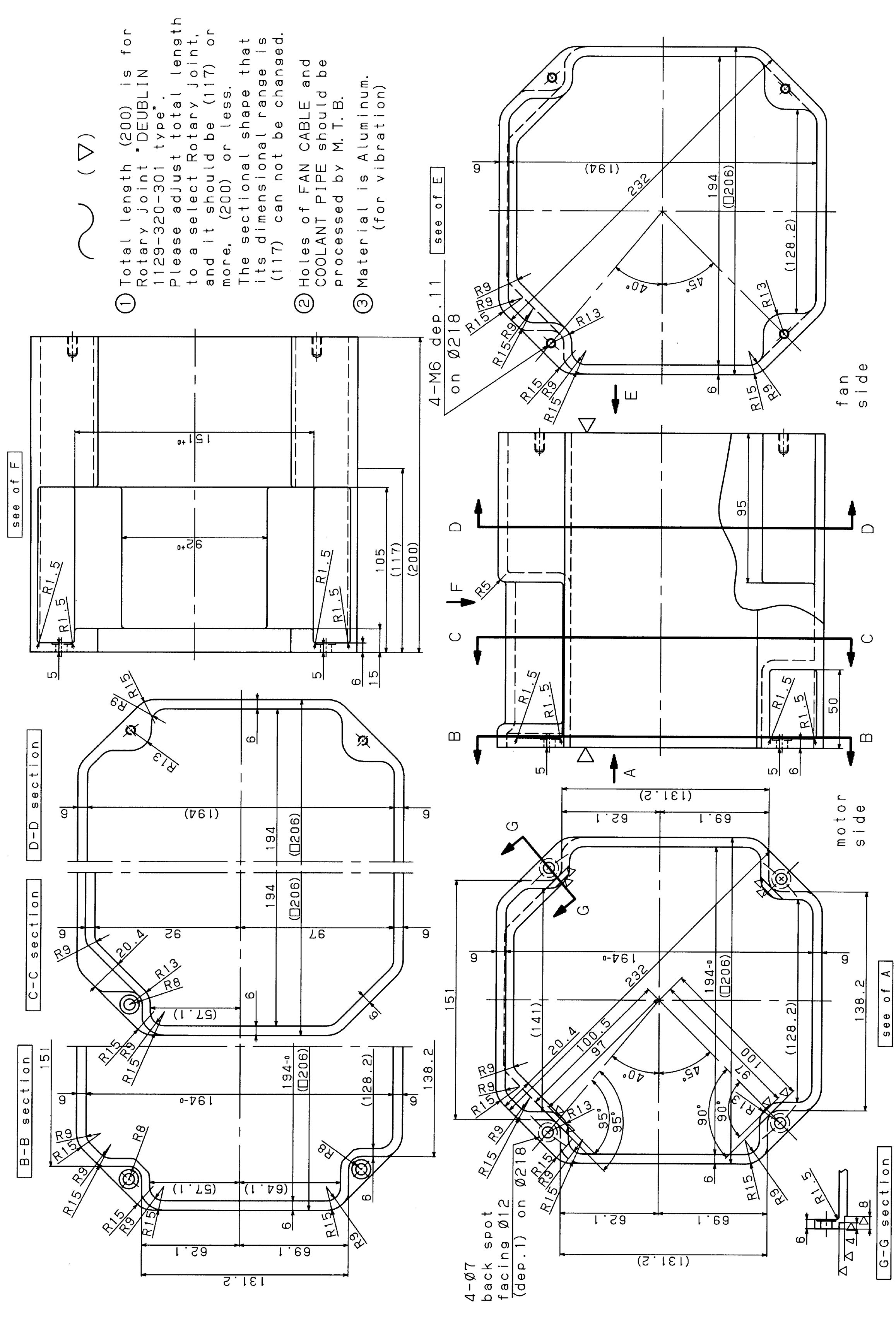
7.9 DISTANCE BLOCK TYPE 1.5*i*T



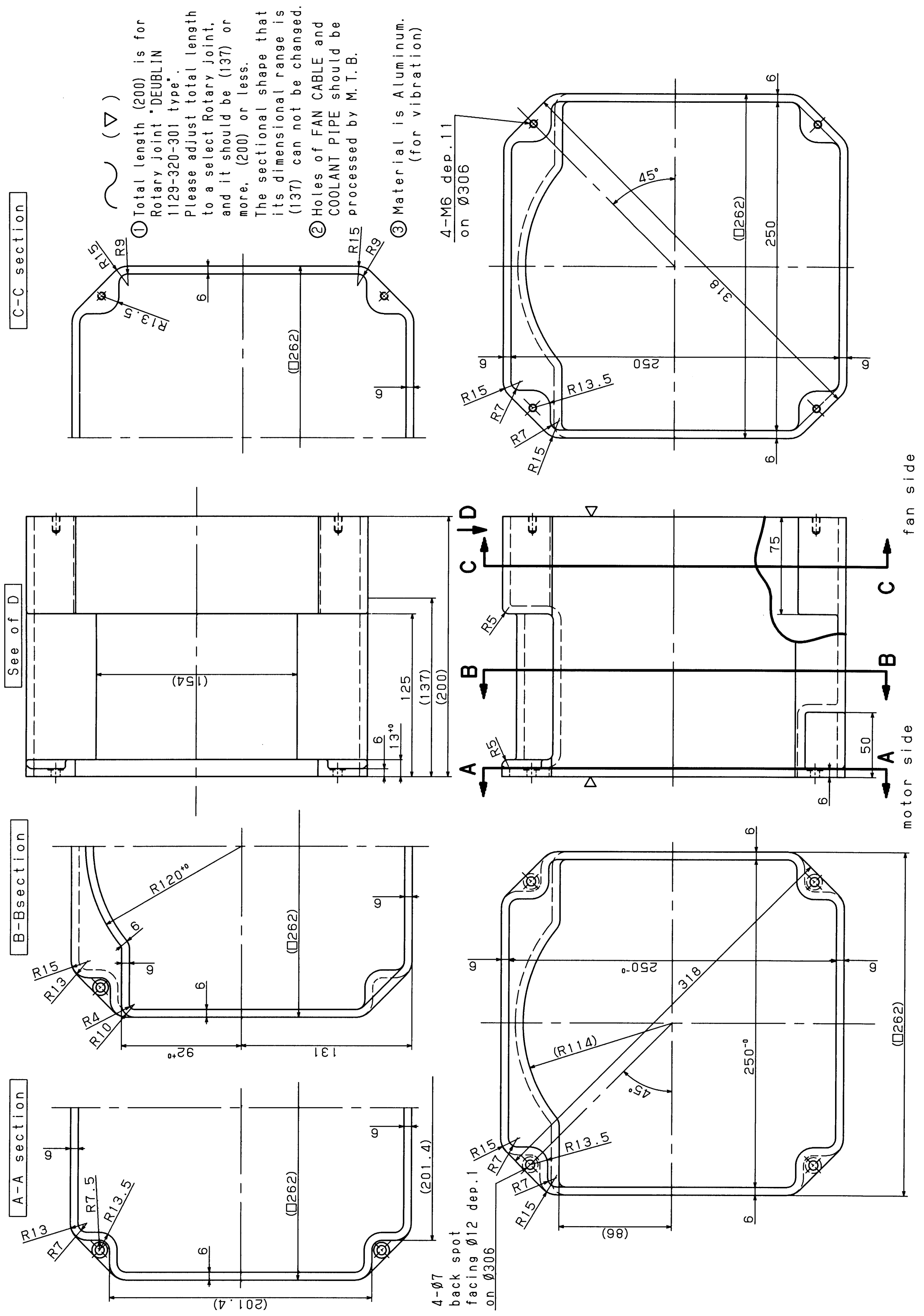
7.10 DISTANCE BLOCK TYPE 2*i*T



7.11 DISTANCE BLOCK TYPE 6*i*T

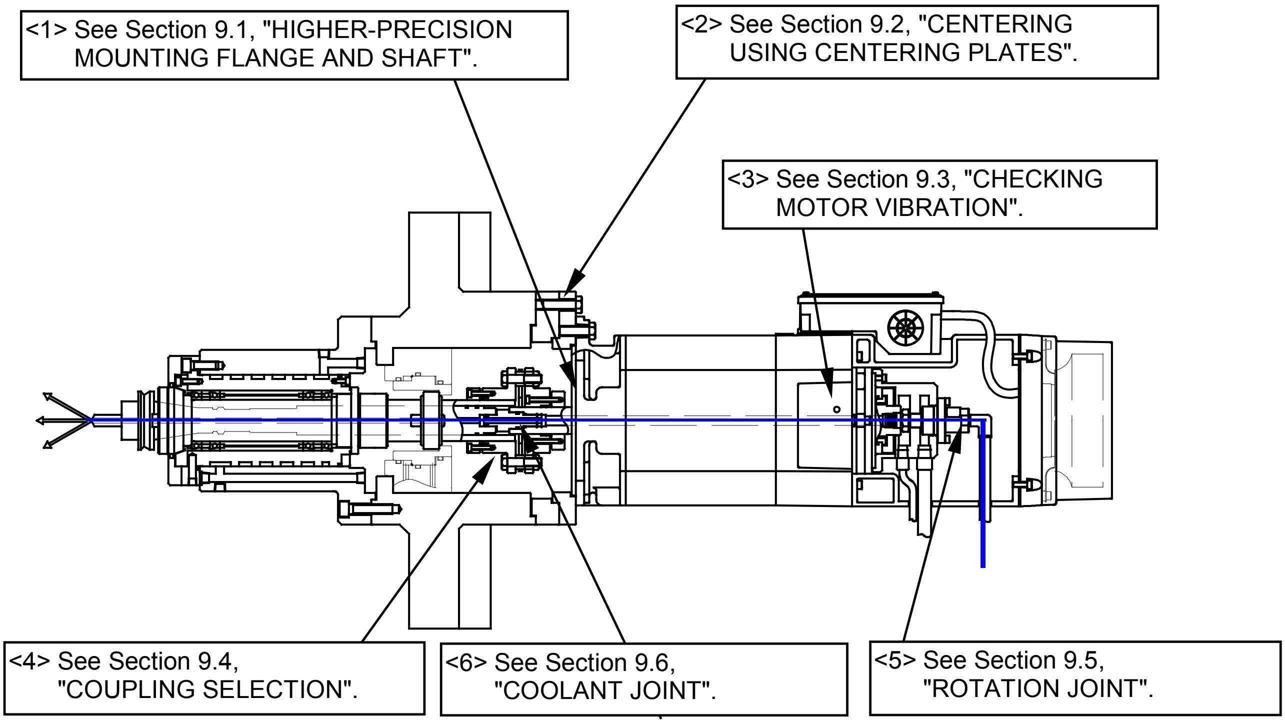


7.12 DISTANCE BLOCK TYPE 15*i*T



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

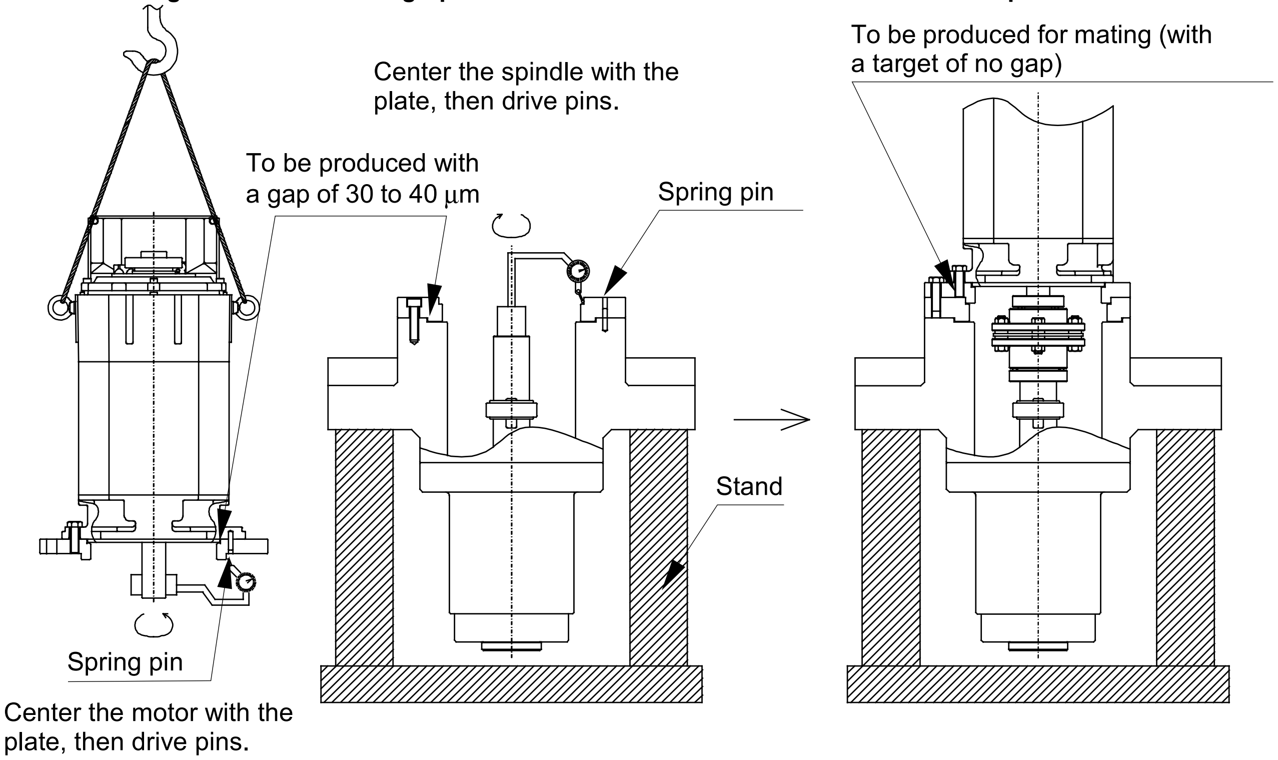
With the α*i*T series, a mounting flange and shaft are assembled with higher precision for direct connection with the spindle. For details, see Chapter 6, "ASSEMBLY PRECISION".

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.)

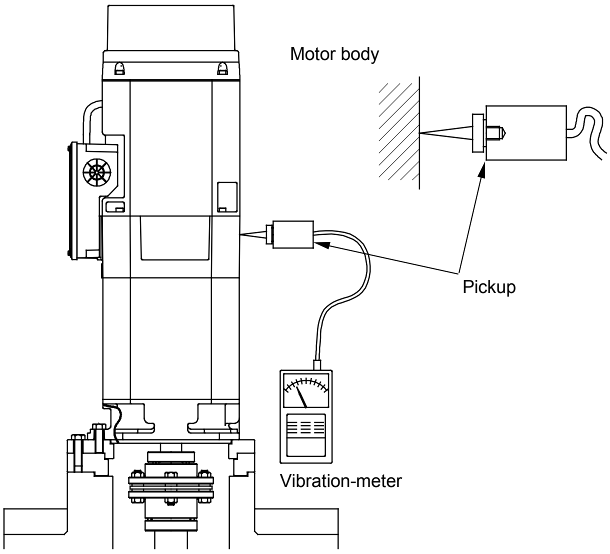
This centering structure allows high-precision installation even in the case of motor replacement in the field.



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:

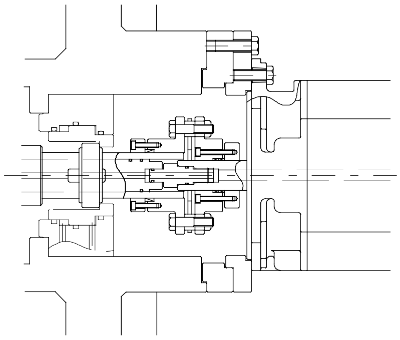
Name: Anavibro
Model: VM-3304
Manufacturer: IMV Corporation (TEL : 03-3262-6311)
Features: Since a pickup of moving-coil (velocity) type is employed, the need for complicate setting is eliminated to allow an easy measurement.
The frequency range is 10 to 1000 Hz, so that this vibration-meter is suitable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

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. When attaching a coupling to the motor shaft, do not strike the coupling so that no shock load is applied to the bearing.

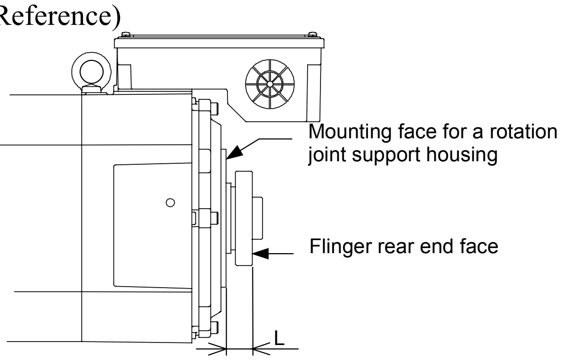
(Example of using a disk coupling)



NOTE

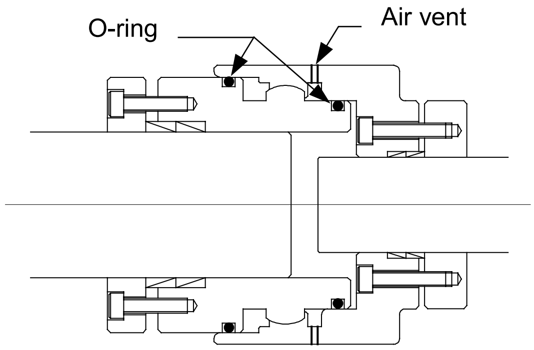
If a gear coupling or Oldham coupling is used, the motor shaft can be left pushed into the inside of the motor when the motor shaft is inserted into the spindle. So, measure the distance (L in the figure below) between the mounting face for a rotation joint support housing and the flinger rear end face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

(Reference)



Motor model	End face distance L
α1.5iT	(17)
α2iT to α3iT	(18)
α6iT to α22iT	(22)

(Example of an air vent on a gear coupling)



(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 α3iT to α22iT.
TYPE 67E304-30-ZZ (EAGLE INDUSTRY)

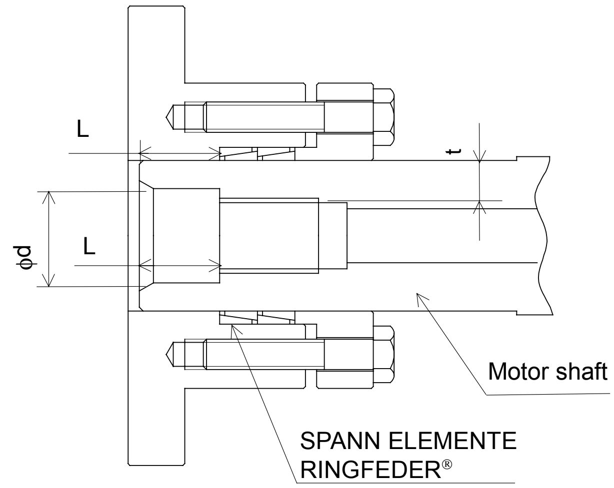
NOTE

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 α1.5/15000iT and α2/15000iT, 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 α1.5/15000iT, α2/15000iT, α8/15000iT, and α15/12000iT, 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 α1.5/15000*i*T and α2/15000*i*T have a less thickness (t).

↓

[Stress applied to motor shaft] ≤ [Motor shaft yield point (490 N/mm²)]

Model	α1.5/15000*i*T α2/15000*i*T α3/12000*i*T	α6/12000*i*T α8/12000*i*T α8/15000*i*T α15/10000*i*T α15/12000*i*T α22/10000*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 α2/15000*i*T 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/mm²]) 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 α2/15000*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/mm²]) From the produced surface pressure P (170.7 [N/mm²]) and the transferable torque (128.2 [N·m]), stress σ applied onto the motor shaft is calculated as σ = 453.1 [N/mm²]. Accordingly, the following is obtained: 453.1 ≤ 490

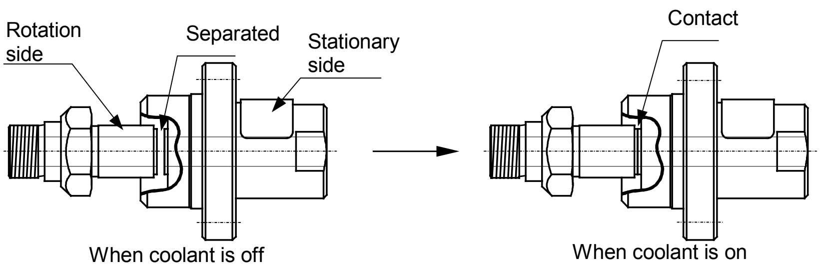
*2 This data is calculated from a maximum output at acceleration time used as a guideline for power supply module selection and from the motor base speed, and is not a guaranteed value.

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 αiT 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	α1.5*i*T to α3*i*T		α6*i*T to α22*i*T	
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	1129-320-327	1129-014-327	1129-320-301	1129-014-301
Specification of Rix	ESX20M-6793	ESX20M-7248	ESX20M-6902	ESX20M-7308
Function(Caution)	Spindle-through coolant during rotation or stopping Air-through during stopping (Air-through disabled during rotation)			

> **⚠ CAUTION**
> For details of the rotation joint function, the method of attaching rotation joints, and rotation joints capable of air-through during rotation, contact the following company:
>
> For rotation joints and support housings, contact:
> Deublin Japan Corporation TEL: 0727-57-0099
> Rix corporation TEL: 092-472-7312, E-mail : intl-trade@rix.co.jp

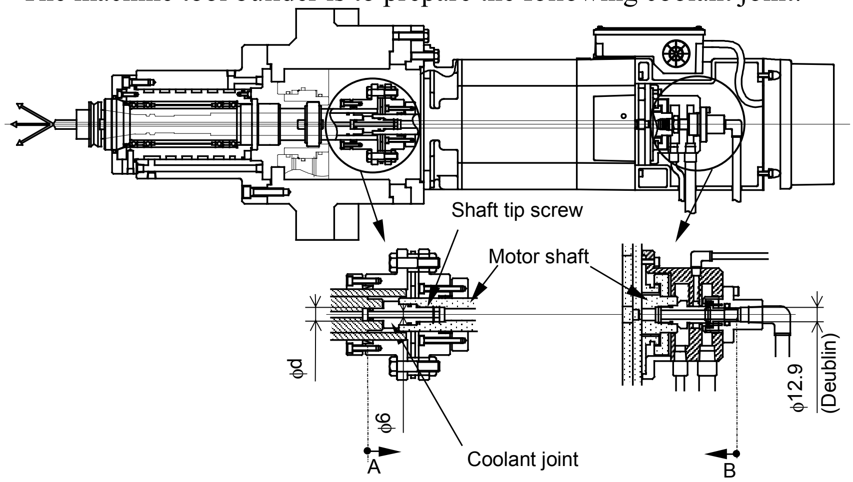


Example of rotation joint (separate external support type)

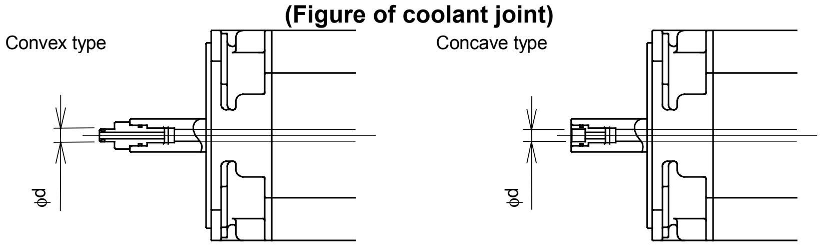
* Before attaching a rotation joint to the motor shaft, apply screw locking adhesive.

9.6 COOLANT JOINT

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



(Figure of coolant joint)



<1> When spindle-through coolant is used, a thrust load acts at positions A and B between the spindle and motor and between the motor and rotation joint. By setting a thrust load at position B slightly higher than a thrust load at position A, the operation of the motor can be made stable relative to the pulsation of the coolant pump.

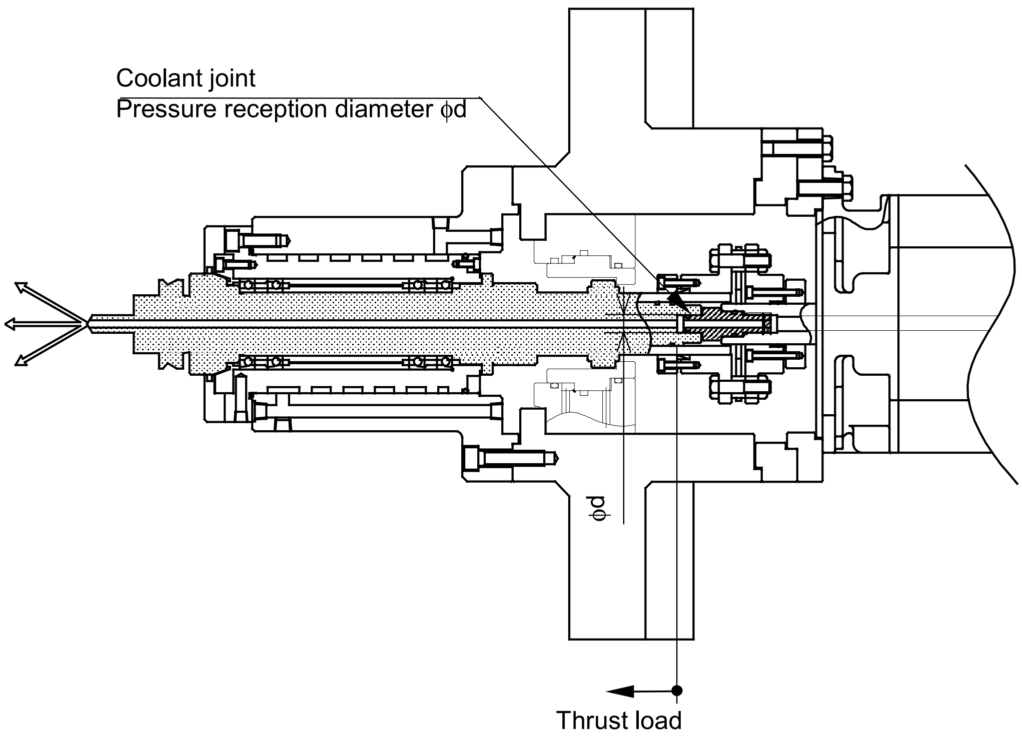
<2> When a rotation joint described in Section 9.5 is used, the pressure reception diameter on the rotation joint side is φ12.9(Deublin) or φ12.6(Rix). So, ensure that the pressure reception diameter (d) on the side of a coolant joint attached to the motor shaft tip follows the table below.

* 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
α1.5*i*T to α3*i*T	Deublin	1129-320-327 1129-014-327	φ12.5	M12
	Rix	ESX20M-6793 ESX20M-7248	φ12.2	
α6*i*T to α22*i*T	Deublin	1129-320-301 1129-014-301	φ12	M16
	Rix	ESX20M-6902 ESX20M-7308	φ11.7	

* Before attaching a coolant joint, apply screw locking adhesive. Be sure to use a motor shaft tip screw when attaching a coolant joint.

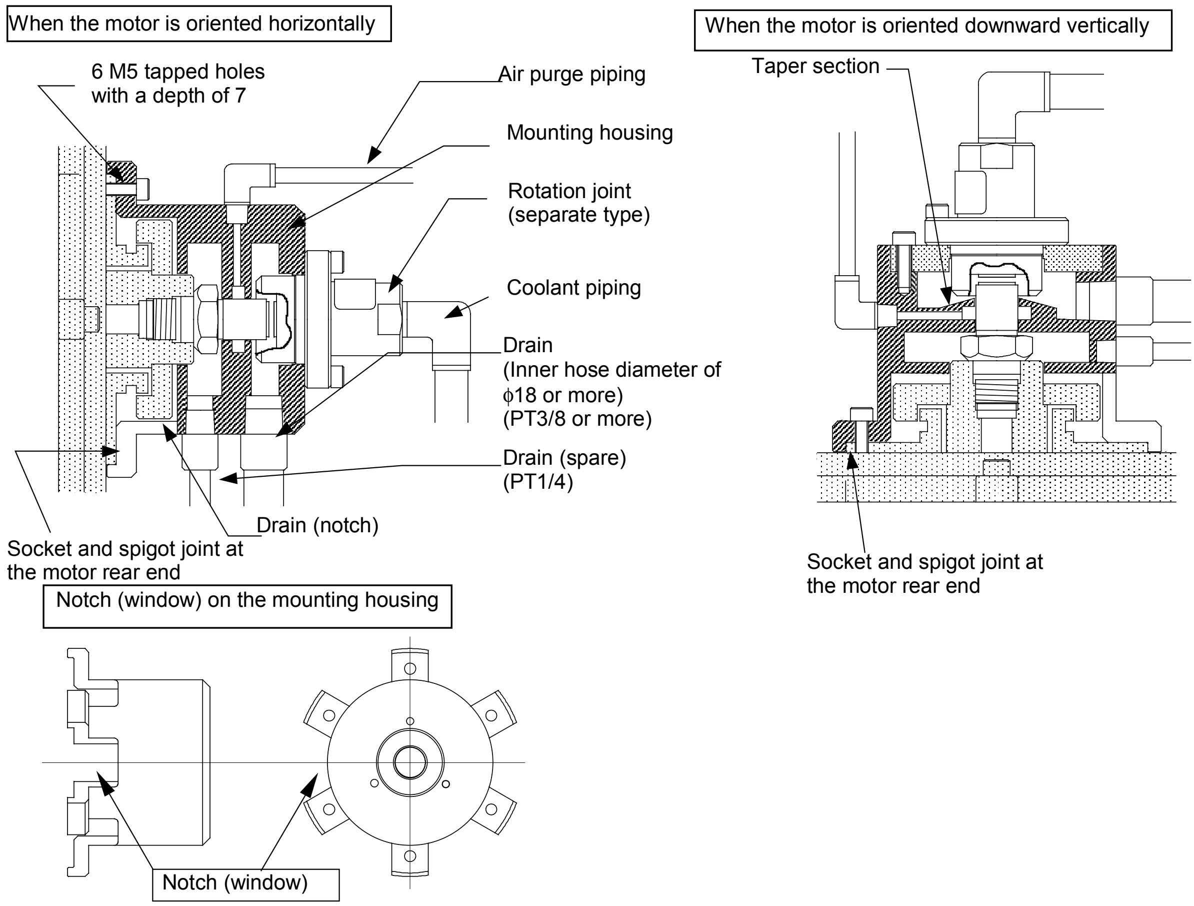
<3> Method of calculating a thrust load imposed on the motor when a coolant pressure of 70 kgf/cm^2 is applied
(Example)
When the pressure reception diameter (d) of a coolant joint is ϕ12 and rotation joint is Deublin.
The pressure reception areas are calculated as follows:
Position A : 1.13cm^2(ϕ12)-0.28cm^2(ϕ6)=0.85cm^2
Position B : 1.31cm^2 (ϕ12.9)-0.28cm^2(ϕ6)=1.03cm^2
So, the thrust load imposed on position A is 59.5 kgf, and the thrust load imposed on position B is 72.1 kgf. Accordingly, the thrust load <u>12.6 kgf</u> (72.1 kgf - 59.5 kgf) acts in the direction for pushing the motor shaft forward.
When pressure reception diameter d = ϕ12.5, a similar calculation can be made to find a thrust load of <u>5.6 kgf</u>.



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, coolant 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 coolant 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 coolant 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)



V. FANUC AC SPINDLE MOTOR αiL SERIES

1 GENERAL

The FANUC AC spindle motor αiL series is liquid-cooled motors. They feature low temperature rise, high-speed, high torque at low speed, and low vibration.
Coupling an αiL series 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 MZ*i* 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 αiT 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		α8/20000iL		α15/15000iL		α26/15000iL	
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 ratedkW (HP)	-	-	-	22 (29.5)	-	30 (40.2)
	(S2) 15 min ratedkW (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		
	(S2),(S3) A	119	121	121	96		
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 MZ*i* 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 module		SPM-30*i*		SPM-30*i*		SPM-30*i*	

* See Page 212 for Cautions and limitations.

Cautions and limitations

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

(*2) The rated output is guaranteed at the rated voltage.
(Amplifier input: 200 to 230VAC)
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 a gear coupling or 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 IV.)

(*11)These values are to be used only as guidance for selecting a power supply module 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

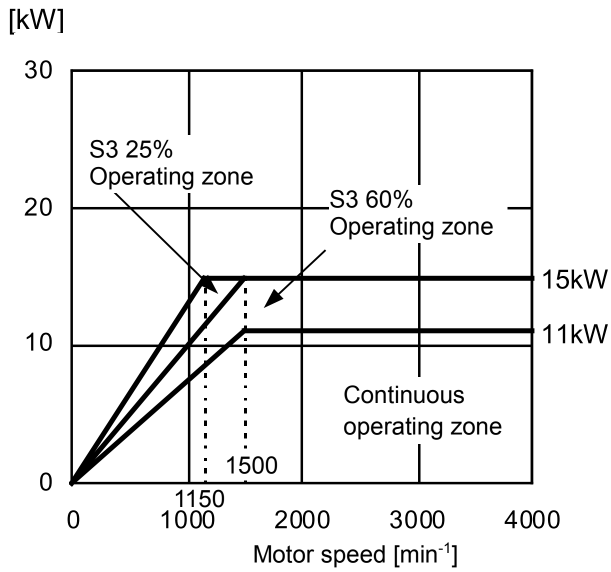
When the unit of T is [kgf·m],

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

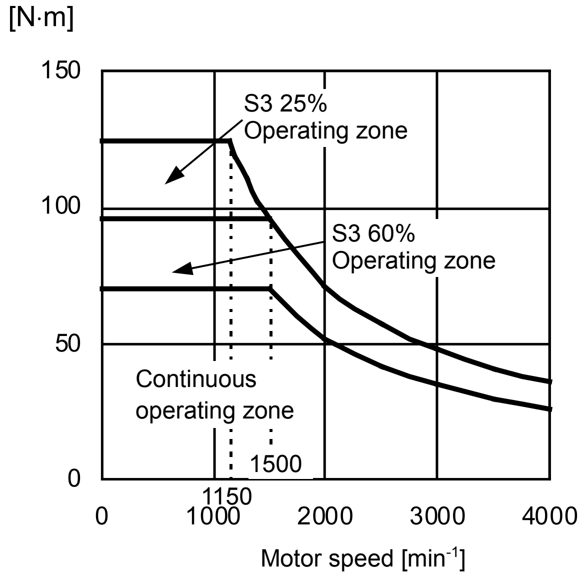
3.1 MODEL α8/20000*i*L

Applicable amplifier SPM-30*i*
Cooler capacity 2.9kW (2500kcal/h)

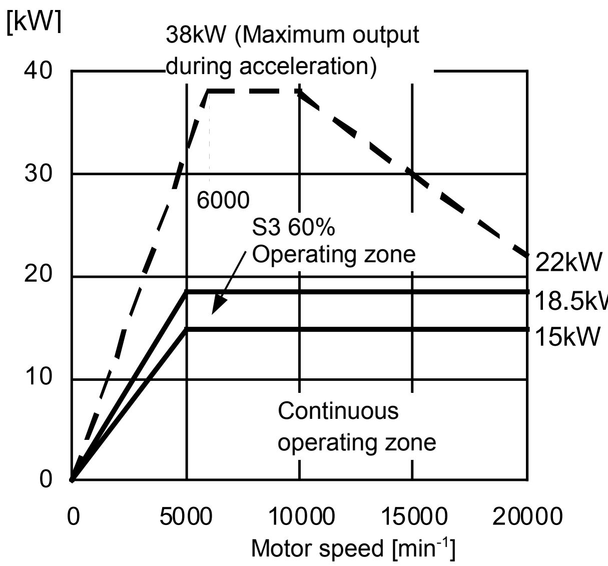
Low-speed winding output (Y connection)



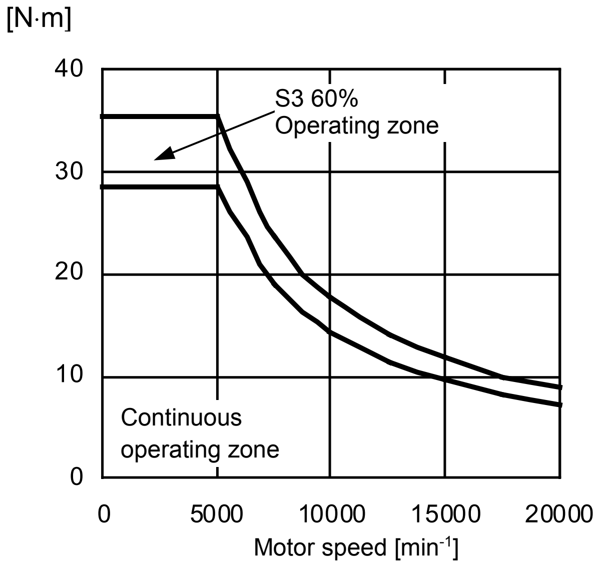
Low-speed winding torque (Y connection)



Low-speed winding output (Y connection)



Low-speed winding torque (Y connection)

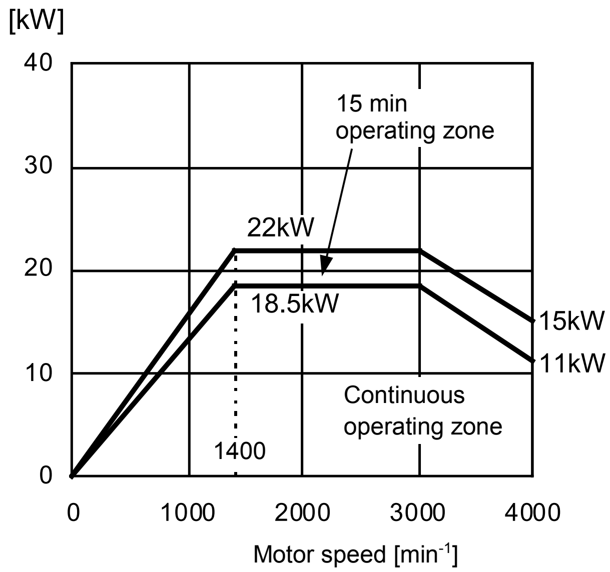


> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

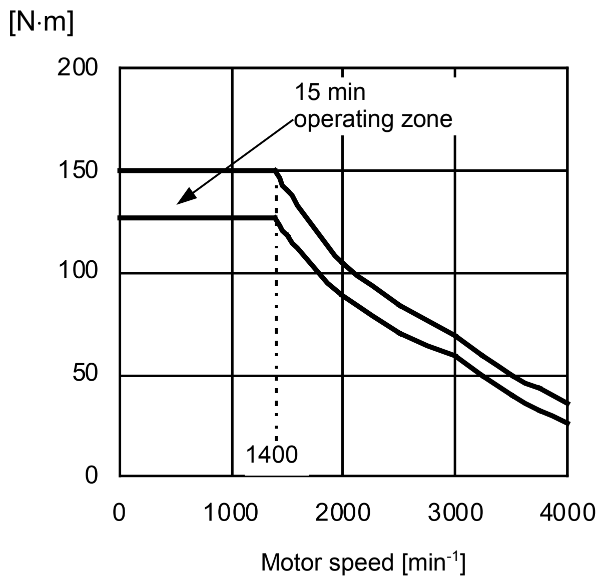
3.2 MODEL α15/15000*i*L

Applicable amplifier SPM-30*i*
Cooler capacity 3.5kW (3000kcal/h)

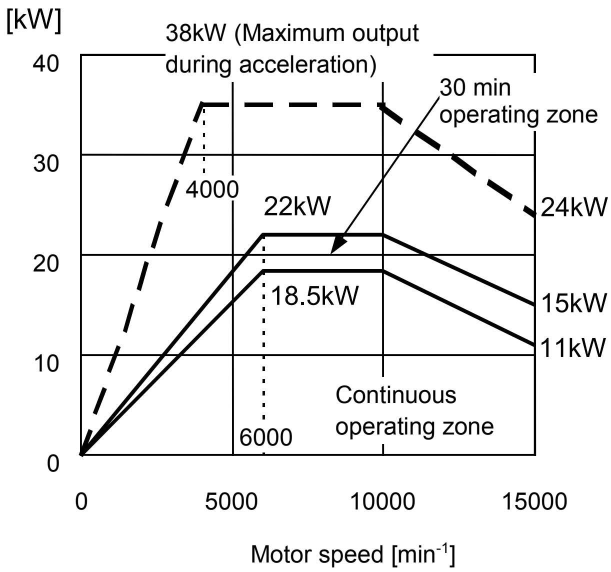
Low-speed winding output (Y connection)



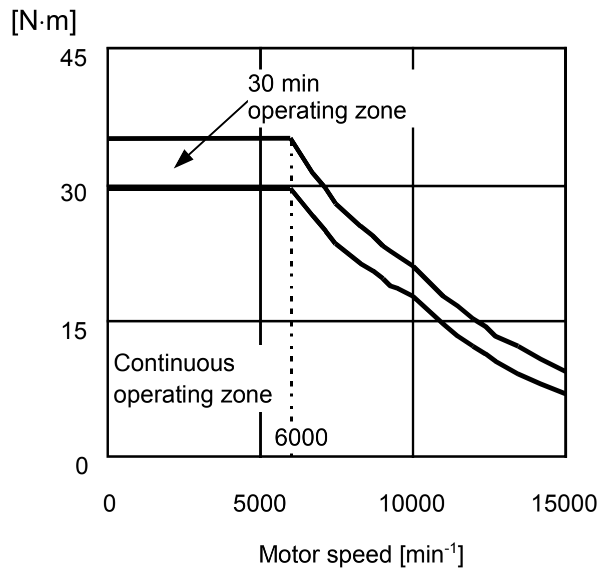
Low-speed winding torque (Y connection)



Low-speed winding output (Y connection)



Low-speed winding torque (Y connection)

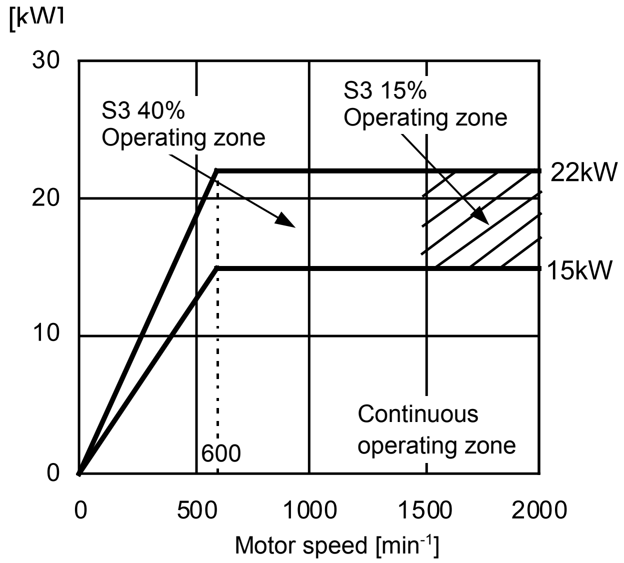


NOTE
Acceleration output is used as a measure to calculate the acceleration or deceleration time.
Acceleration output is not an assured value.

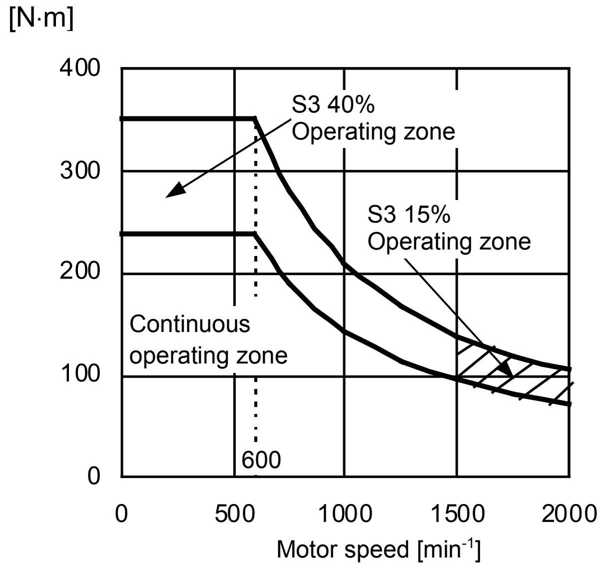
3.3 MODEL α26/15000*i*L

Applicable amplifier SPM-30*i*
Cooler capacity 4.1kW (3500kcal/h)

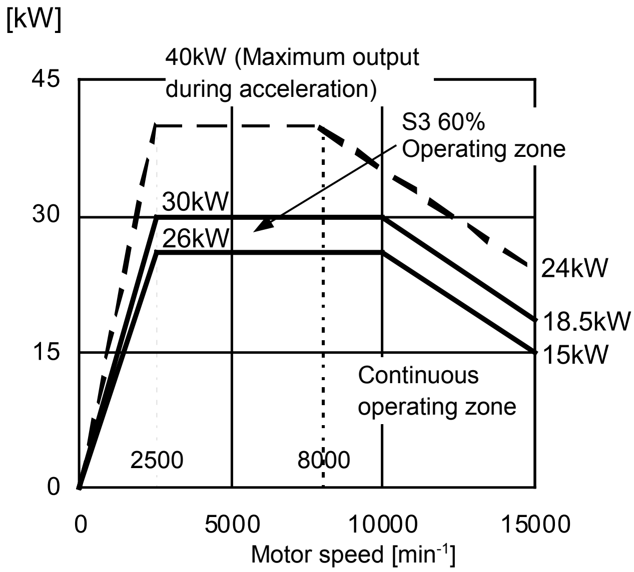
Low-speed winding output (Y connection)



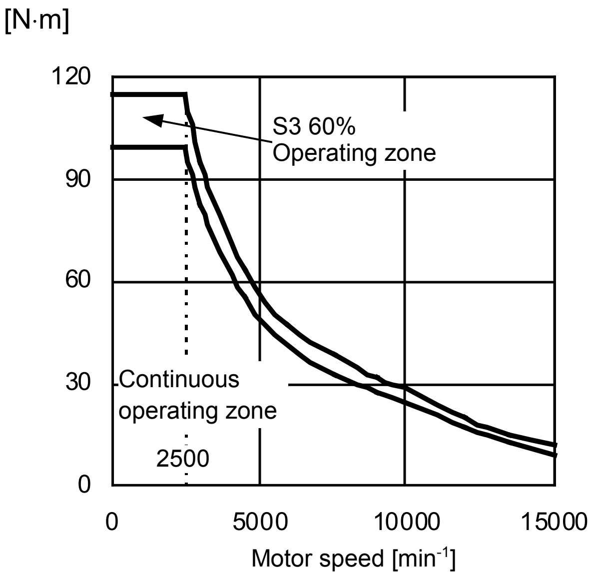
Low-speed winding torque (Y connection)



Low-speed winding output (Y connection)



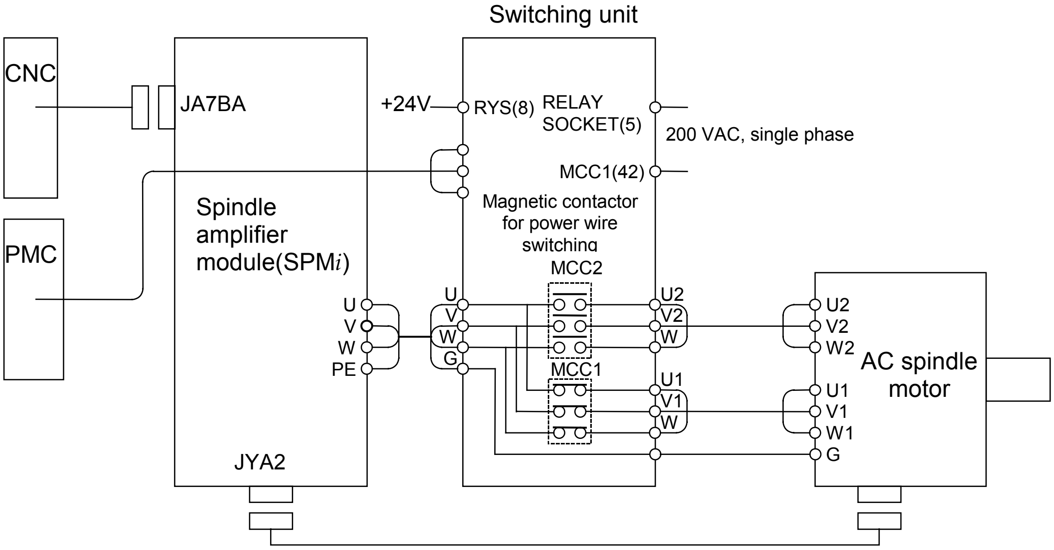
Low-speed winding torque (Y connection)



> **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.

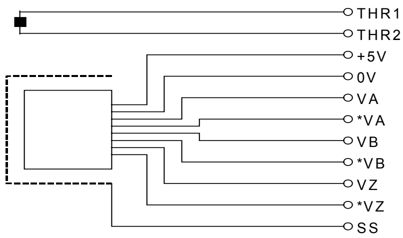
Motor model	Crimp terminal size		Applicable power lead size (mm^2)	
	Motor side	Amplifier side	(*1) LMFC	(*2) Flonlex power cable
α8/20000iL	M5	M6	22	14
α15/15000iL	M6	M6	22	14
α26/15000iL	M6	M6	22	14

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

MZ*i* 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		α8/20000iL	α15/15000iL	α26/15000iL
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.

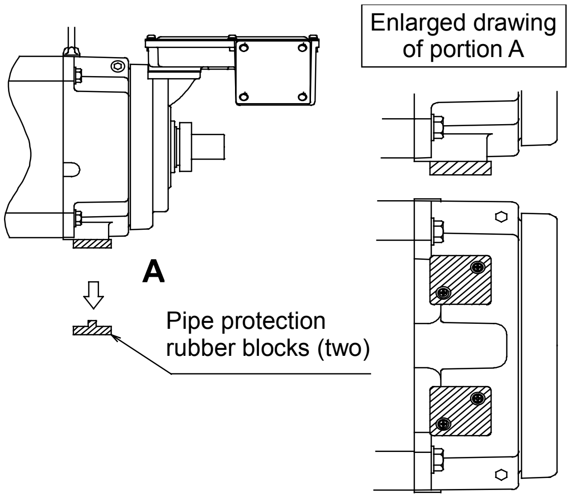
(*3) If the temperature of the liquid coolant is lower than the room temperature as measured at the cooling pipe inlet, it is likely that condensation may occur in the motor. Be sure to strictly observe the specified temperature.

Liquid coolant piping

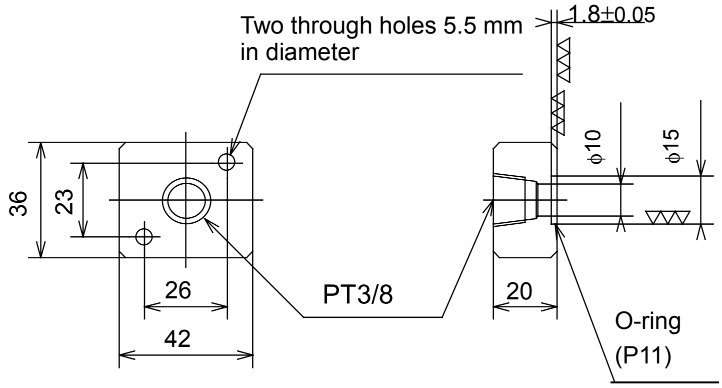
This motor series needs cooling based on liquid coolant.

- Factory-setting

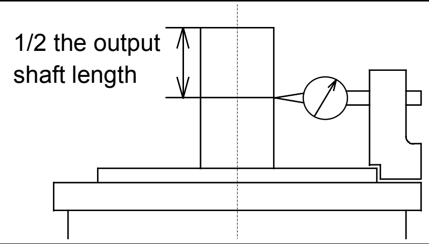
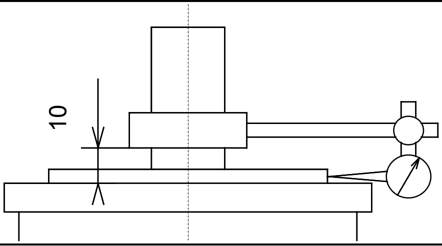
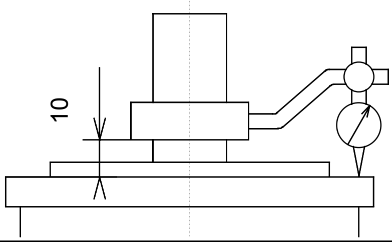
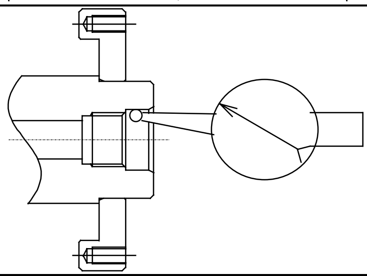
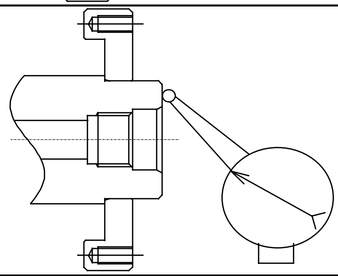
The motor comes with rubber blocks for pipe protection.
The machine tool builder is requested to prepare a pipe block according to the following drawing.



- Example of a pipe block



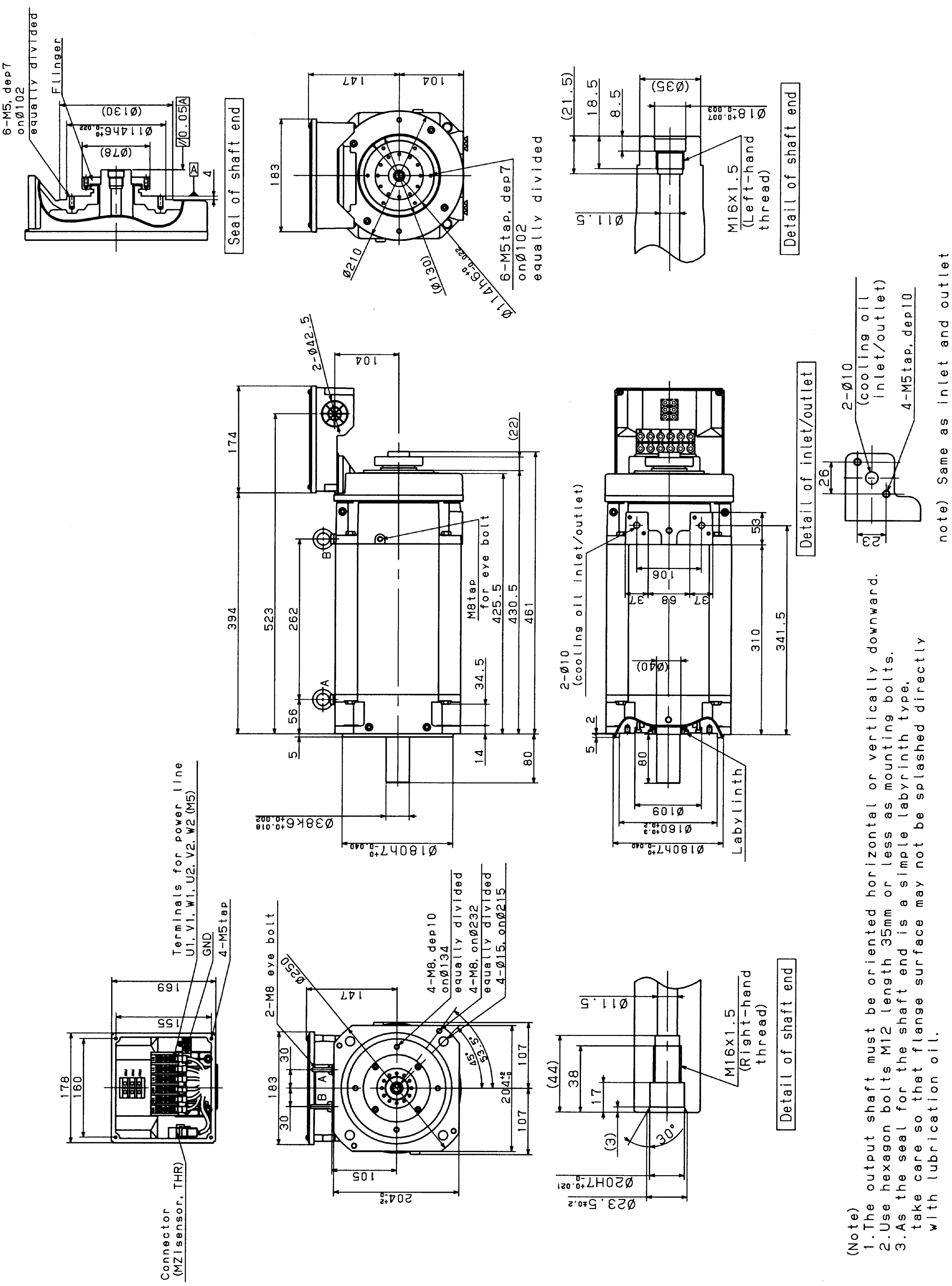
5 ASSEMBLING ACCURACY

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	

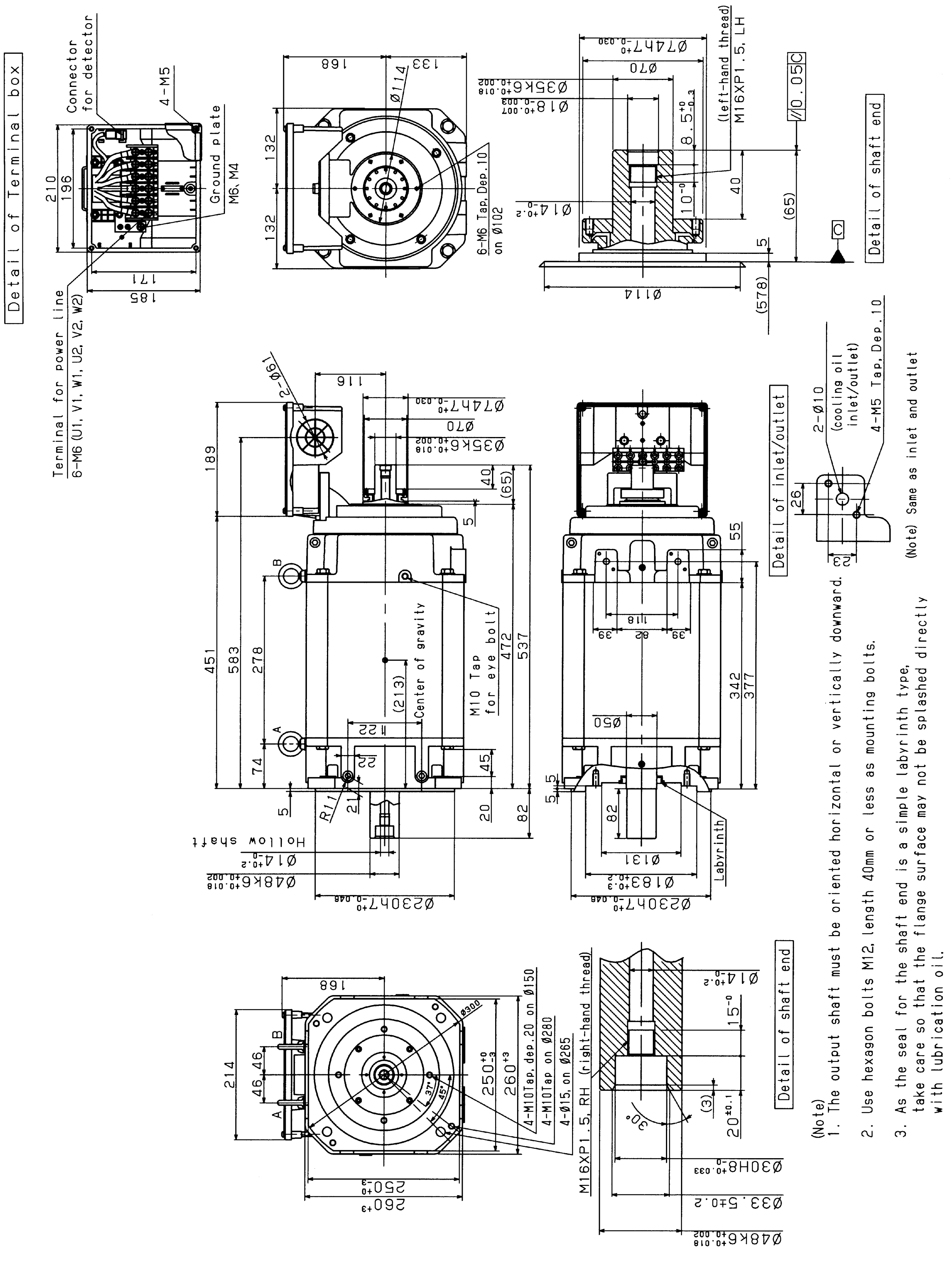
6 EXTERNAL DIMENSIONS

Model name	Section
Model α8/20000*i*L	6.1
Model α15/15000*i*L	6.2
Model α26/15000*i*L	6.3

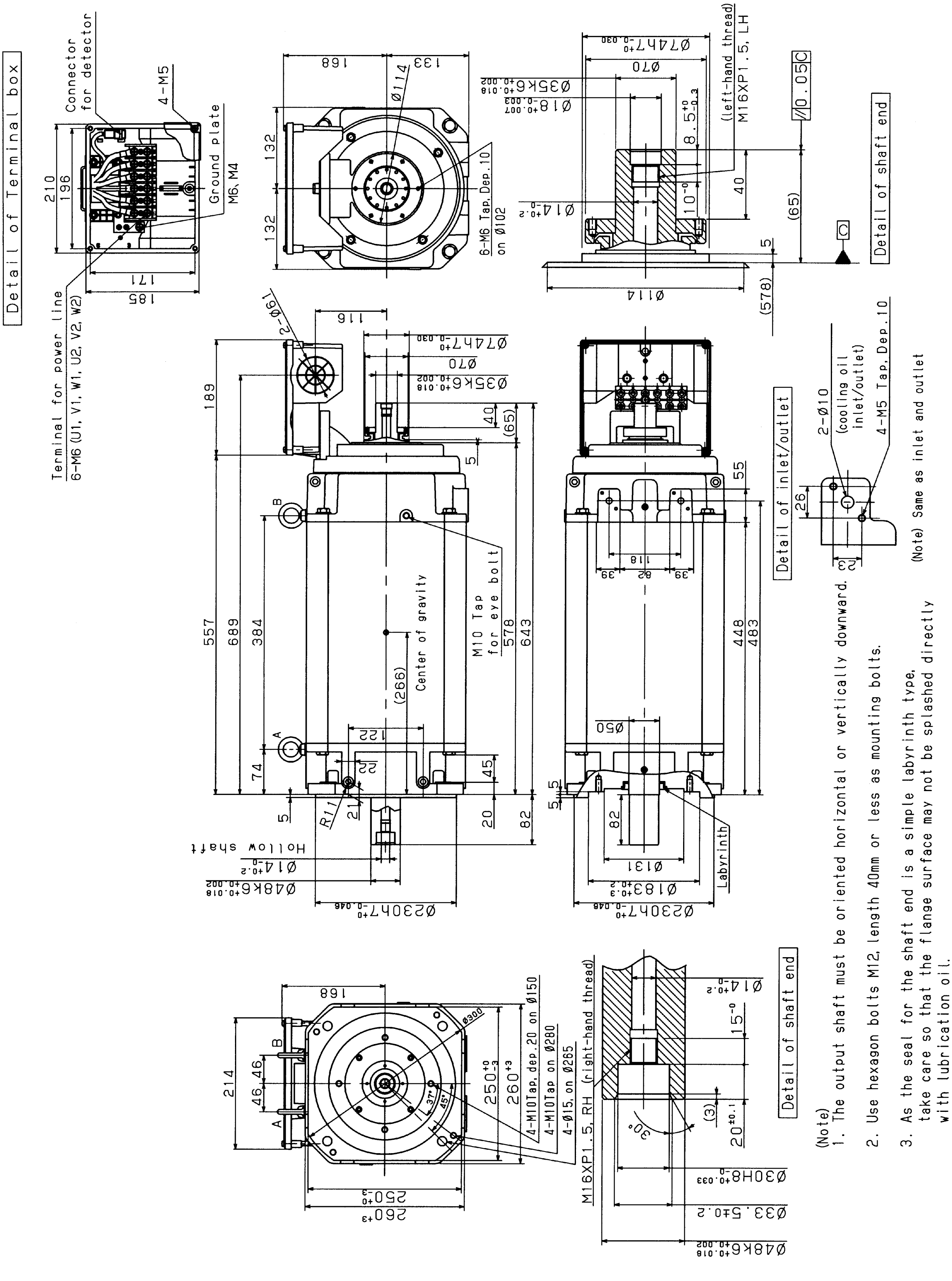
6.1 MODEL α8/20000*i*L



6.2 MODEL α15/15000*i*L



6.3 MODEL α26/15000*i*L



VI. FANUC AC SPINDLE MOTOR α(HV)i SERIES

1 GENERAL

The FANUC AC Spindle Motor α(HV)*i* series 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 α1HV*i*, α1.5HV*i*, α2HV*i*, and α3HV*i*, 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 M*i* sensor or MZ*i* 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(HV)*i* series		
Item \ Model		**α0.5/10000HV*i***	**α1/10000HV*i***	**α1.5/10000HV*i***
Output (*2)	Cont. rated kW (HP)	0.55 (0.74)	1.5 (2.0)	1.1 (1.5)
	30 min rated [15 min, 10min] (*3) kW (HP)	1.1 (1.5)	2.2 (3.0)	3.7 (5.0)
	S3 60% [40%,25%] (*4)(*5) kW (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	$kg·m^2$	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 (*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		M*i* sensor or MZ*i* sensor		
Type of thermal protection (*10)		TP211		
Resolution of the MZ*i* 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 module		SPM-5.5HV*i*		
Model		α0.5/10000HV*i*	α1/10000HV*i*	α1.5/10000HV*i*

Series		α(HV)*i* series			
Item / Model		**α2/10000HV*i***	**α3/10000HV*i***	**α6/10000HV*i***	**α8/8000HV*i***
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·m^2	0.0078	0.0148	0.0179	0.0275
	kgf·cm·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		M*i* sensor or MZ*i* sensor			
Type of thermal protection (*10)		TP211			
Resolution of the MZ*i* 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 module		SPM-5.5HV*i*		SPM-11HV*i*	
Model		α2/10000HV*i*	α3/10000HV*i*	α6/10000HV*i*	α8/8000HV*i*

Series		α(HV)*i* series			
Item \ Model		**α12/7000HV*i***	**α15/7000HV*i***	**α22/7000HV*i***	**α30/6000HV*i***
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		M*i* sensor or MZ*i* sensor			
Type of thermal protection (*10)		TP211			
Resolution of the MZ*i* 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 module		SPM-15HV*i*	SPM-30HV*i*		SPM-45HV*i*
Model		α12/7000HV*i*	α15/7000HV*i*	α22/7000HV*i*	α30/6000HV*i*

Series		α(HV)*i* series			
Item \ Model		α40/6000HV*i*	α60/4500HV*i*	α100/4500HV*i* (*1) Low-speed winding	α100/4500HV*i* (*1) High-speed winding
Output (*2)	Cont. rated kW (HP)	37 (49.6)	60 (80.4)	100 (134.0)	100 (134.0)
	30 min rated kW [15 min, 10min] (*3) (HP)	45 (60.3)	75 (100.5)	-	-
	S3 60% kW [40%,25%] (*4)(*5) (HP)	45 (60.3)	75 (100.5)	-	-
Rated current A (*6)	Cont. rated	84	138	159	170
	30 min rated (*3) S3 60% (*4)	97	163	-	-
Speed min^{-1}	Base speed	1500	1150	1000	2000
	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	$kg \cdot m^2$	0.355	0.49	0.98	
	$kgf \cdot cm \cdot s^2$	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				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		M*i* sensor or MZ*i* sensor		MZ*i* sensor	
Type of thermal protection (*10)		TP211			
Resolution of the MZ*i* sensor /rev.		4096			
Number of detected gear teeth per rotation λ/rev.		256			
Bearing lubrication		Grease			
Maximum output during acceleration(*11) kW		90	90	117	
Applicable spindle amplifier module		SPM-75HV*i*	SPM-75HV*i*	SPM-75HV*i*	
Model		α40/6000HV*i*	α60/4500HV*i*	α100/4000HV*i*	

(*1) For α100/4000HV*i*, 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:
α100/4000HV*i* : 460/480VAC +10% -0%, 50/60 Hz ±1Hz
Models except α100/4000HV*i* : 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 α0.5/10000HV*i*, α1/10000HV*i*, or α2/10000HV*i* is 15 min rated. That for α1.5/10000HV*i* is 10 min rated.
(*4) S3 40% for α0.5/10000HV*i* or α30/6000HV*i*, S3 25% for α1.5/10000HV*i*.
(*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 α0.5/10000HV*i*, α1/10000HV*i*, or α2/10000HV*i* , 120% of 10 min rated for α1.5/10000*i*, and 120% of continuous rated for α100/4000HV*i*.
(*10) Type conforms to IEC 34-11.
(*11) These values are to be used only as guidance for selecting a power supply module and are not guaranteed.
(*12) Degree of protection: with oil seal:IP54, without oil seal:IP40.
Degree of protection (α100/4000HV*i*): with oil seal:IP40.
(*13) Input power supply voltage of a fan motor for α1/10000HV*i*, α1.5/10000HV*i*, α2/10000HV*i*, or α3/10000HV*i* 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

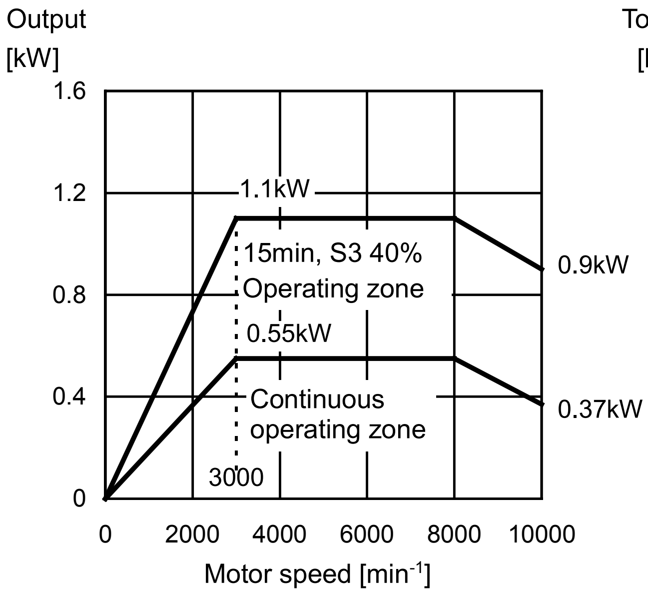
$N[min^{-1}]$: Motor speed

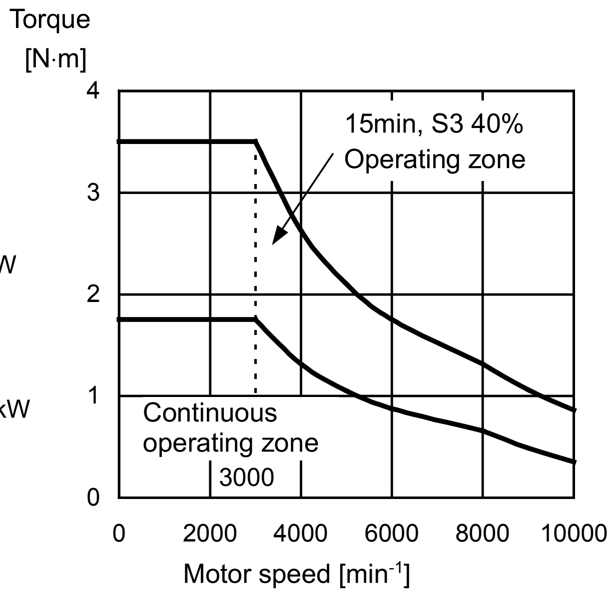
When the unit of T is [kgf·m],

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

3.1 MODEL α0.5/10000HV*i*

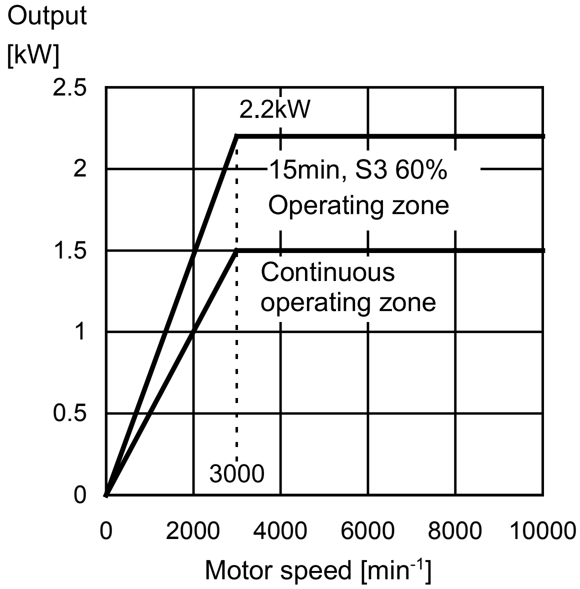
Applicable amplifier SPM-5.5HV*i*

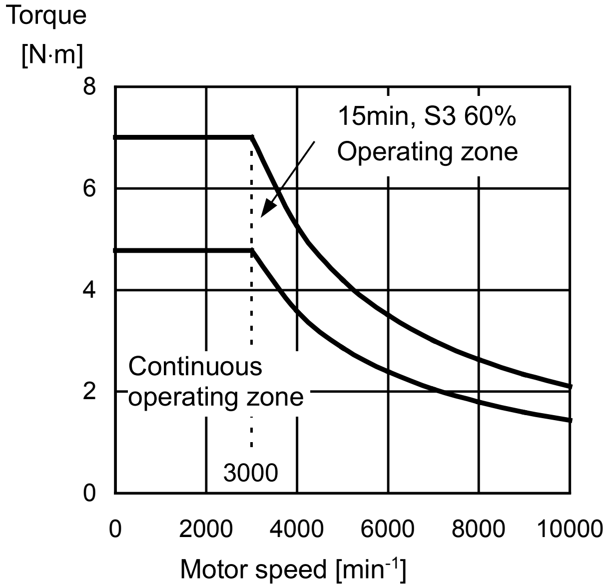




3.2 MODEL α1/10000HV*i*

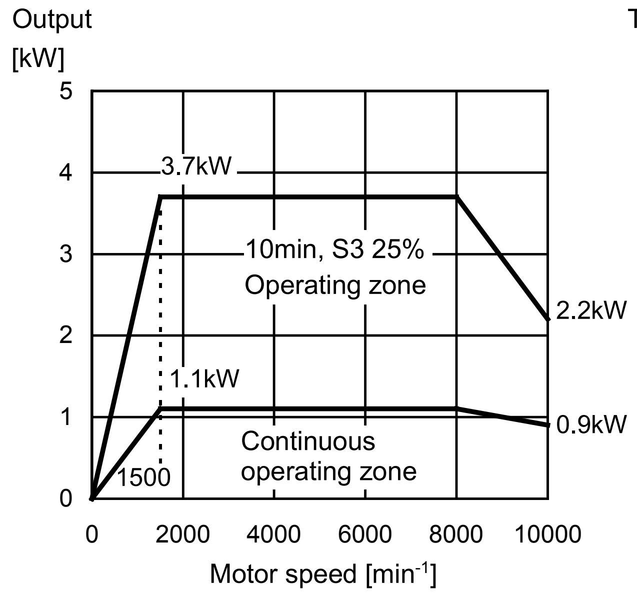
Applicable amplifier SPM-5.5HV*i*

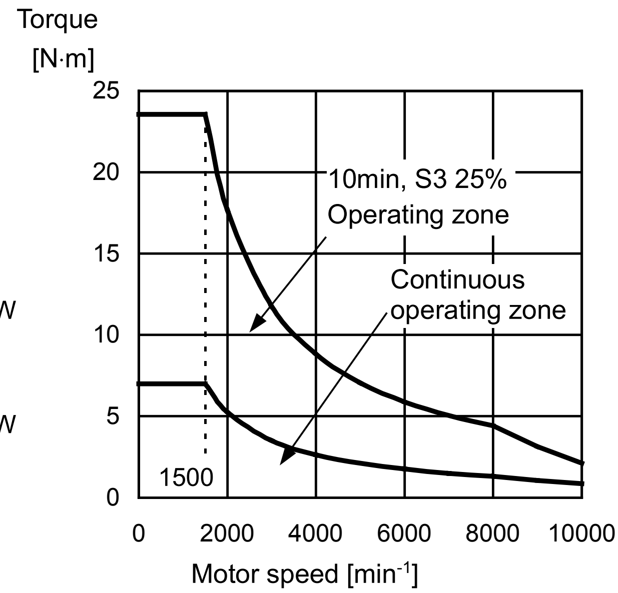




3.3 MODEL α1.5/10000HV*i*

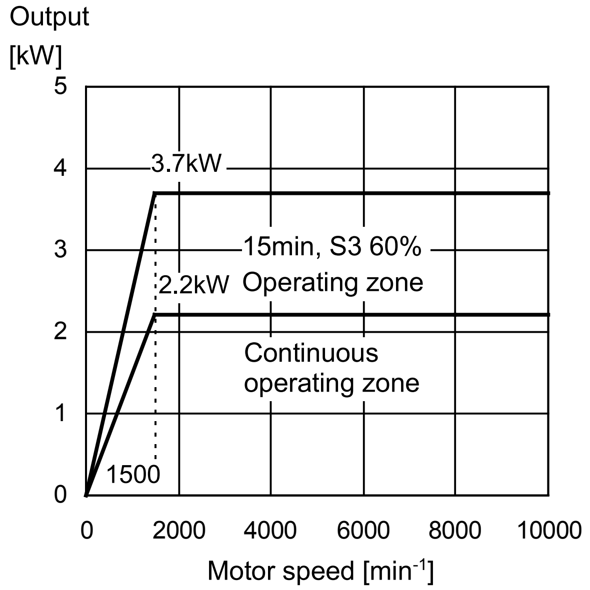
Applicable amplifier SPM-5.5HV*i*

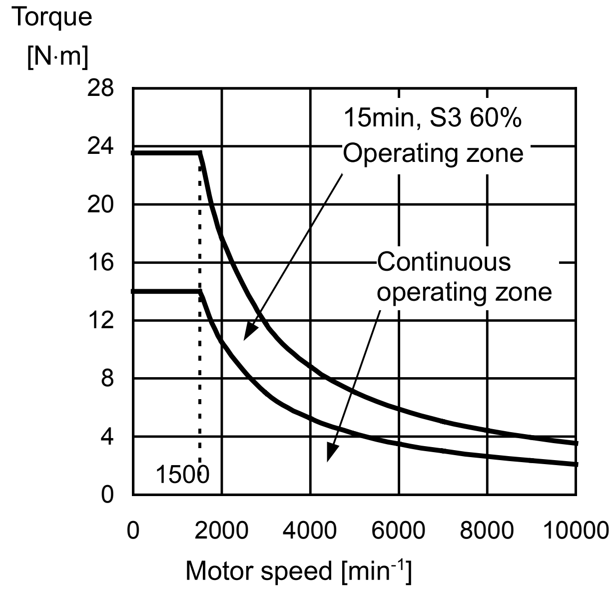




3.4 MODEL α2/10000HV*i*

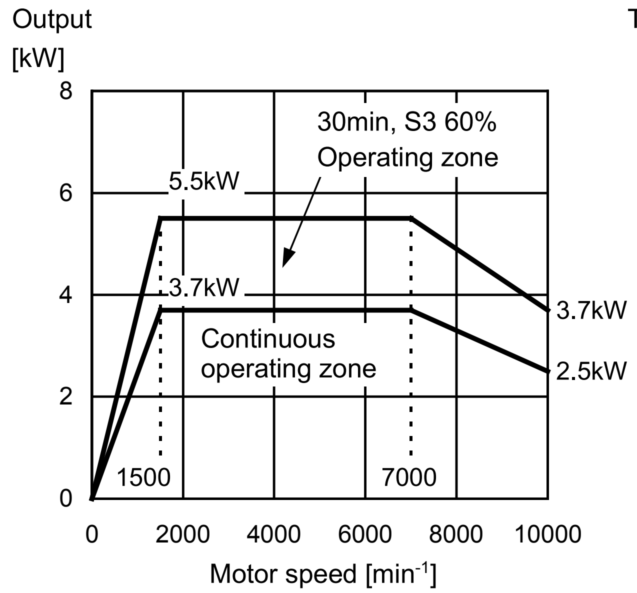
Applicable amplifier SPM-5.5HV*i*

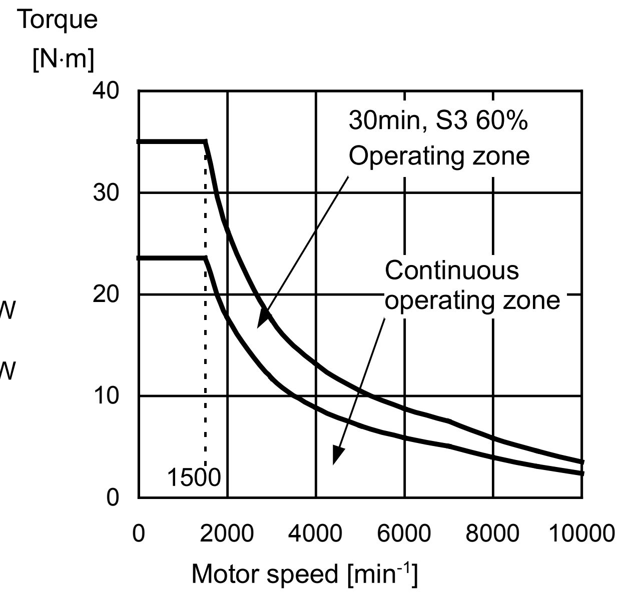




3.5 MODEL α3/10000HV*i*

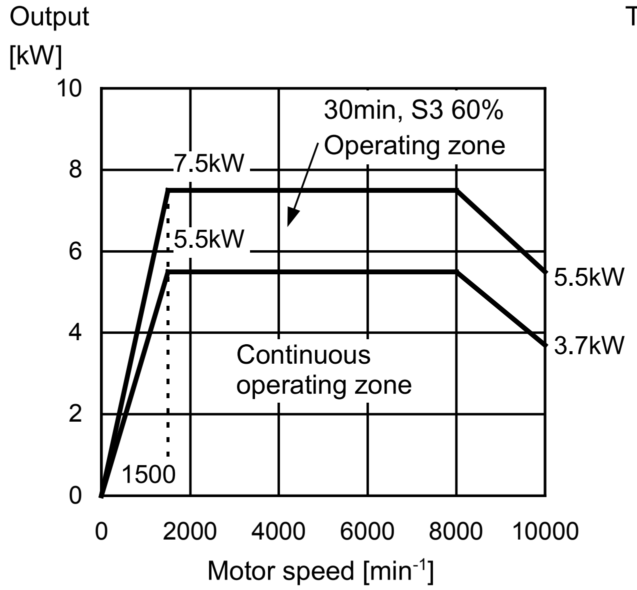
Applicable amplifier SPM-5.5HV*i*

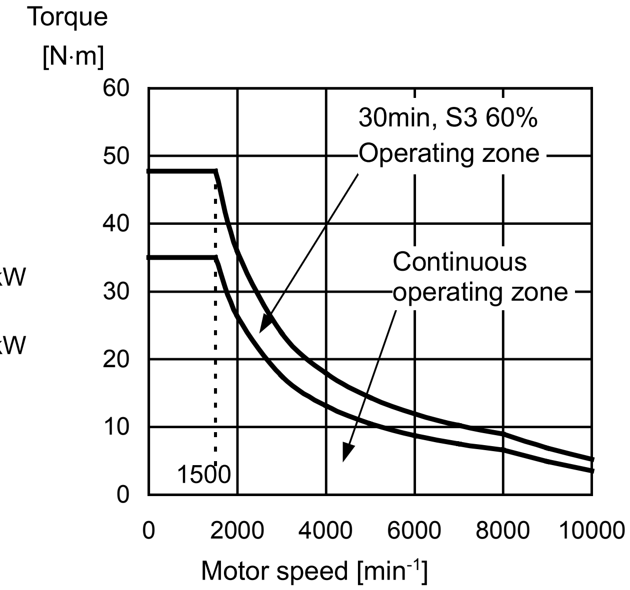




3.6 MODEL α6/10000HV*i*

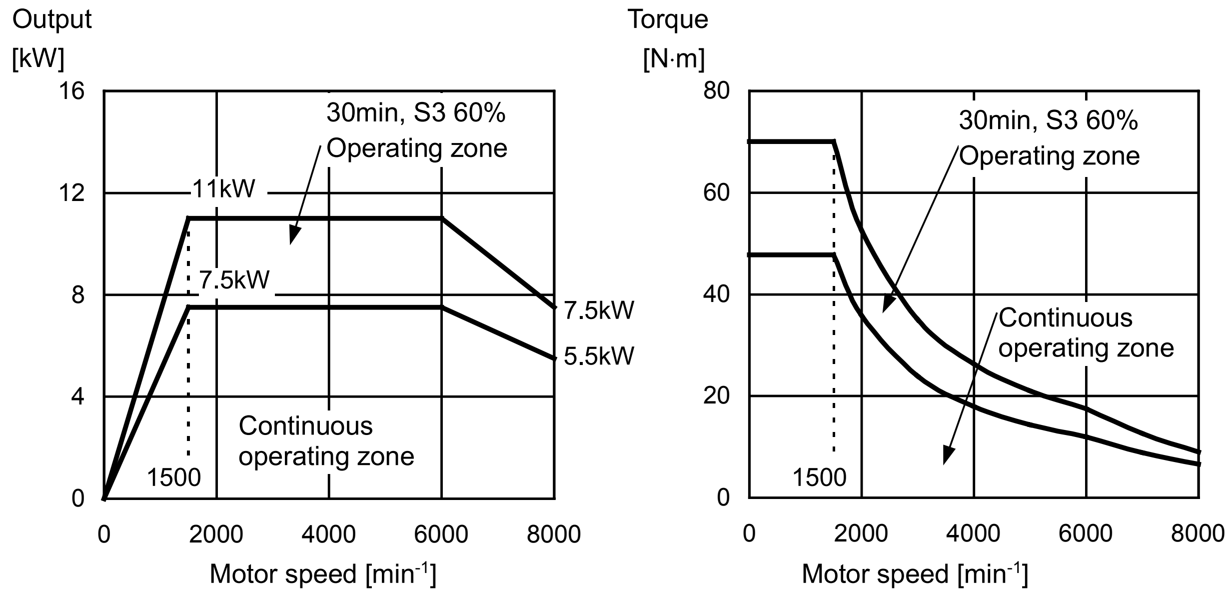
Applicable amplifier SPM-11HV*i*





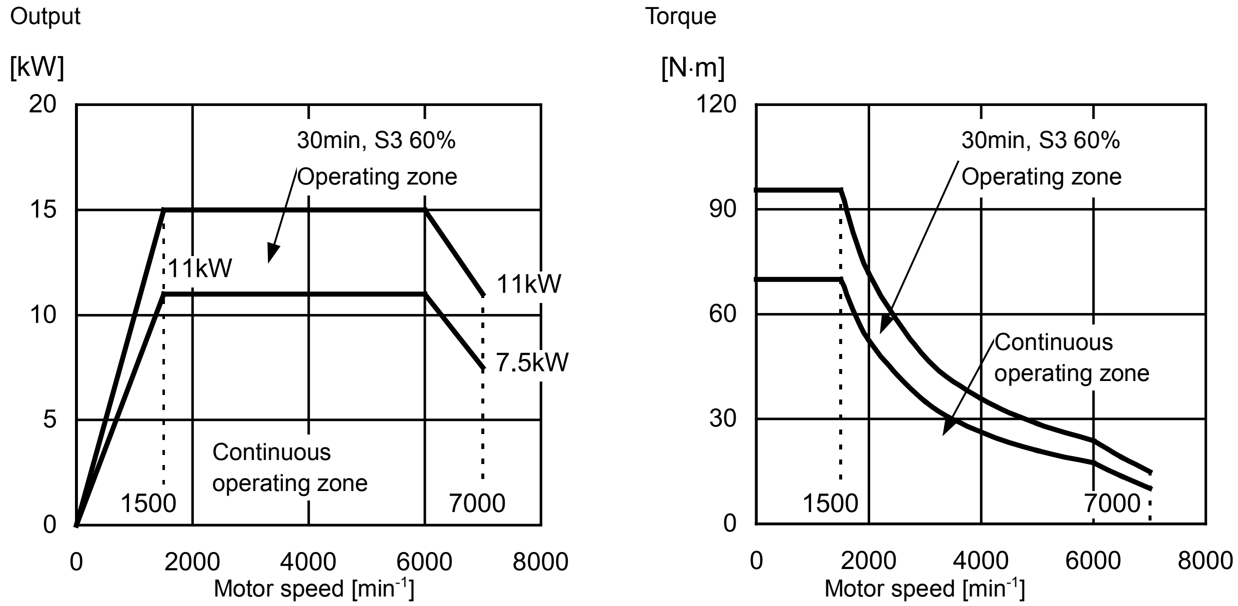
3.7 MODEL α8/8000HV*i*

Applicable amplifier SPM-11HV*i*



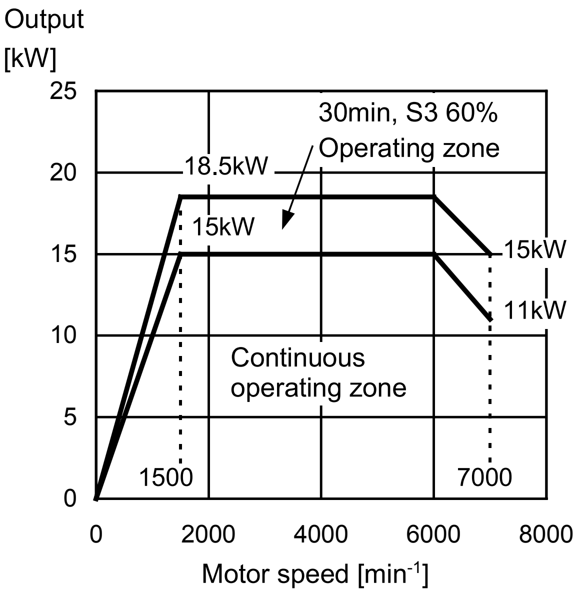
3.8 MODEL α12/7000HV*i*

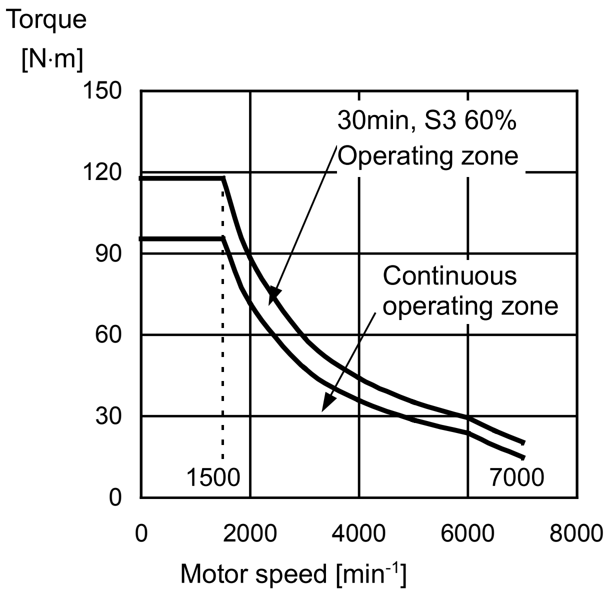
Applicable amplifier SPM-15HV*i*



3.9 MODEL α15/7000HV*i*

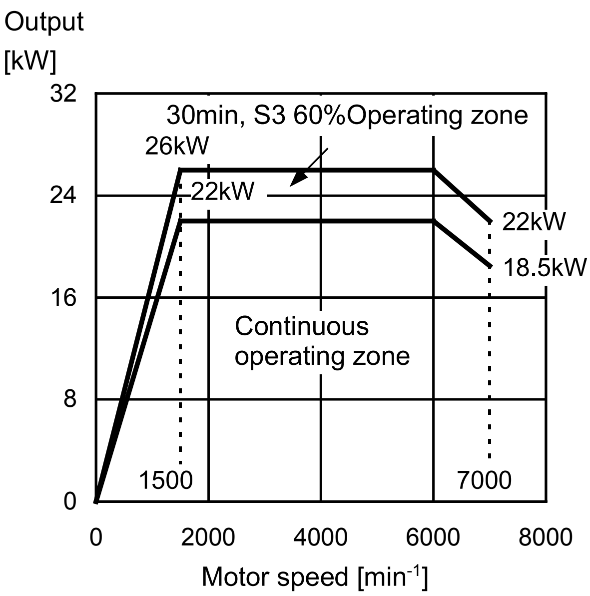
Applicable amplifier SPM-30HV*i*

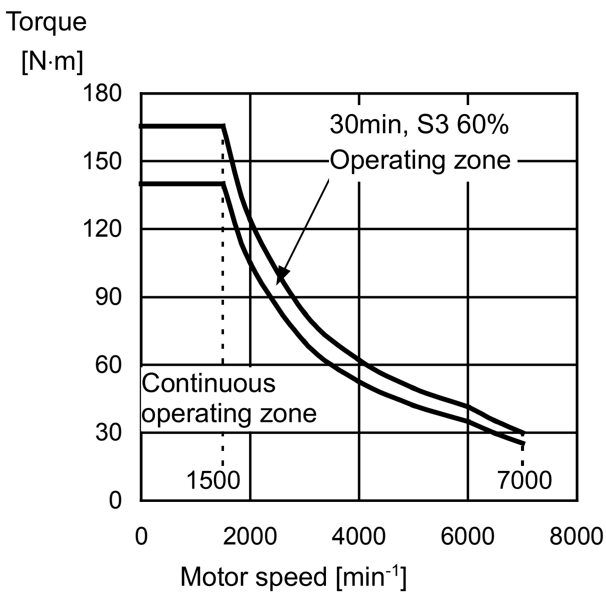




3.10 MODEL α22/7000HV*i*

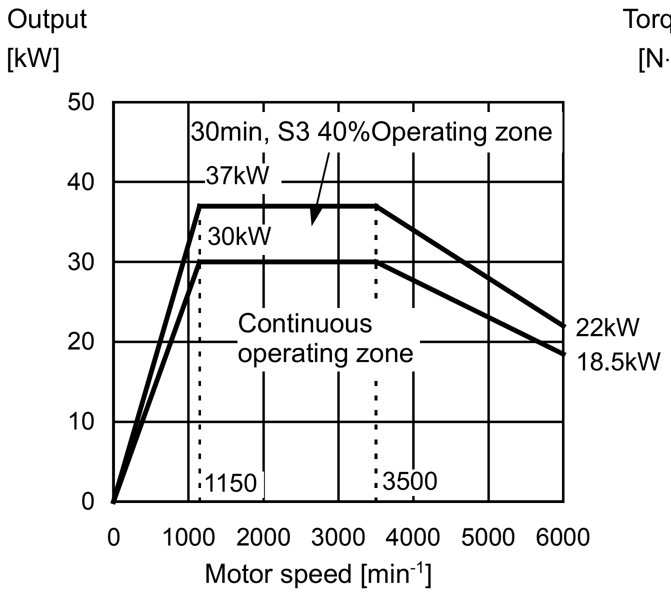
Applicable amplifier SPM-30HV*i*

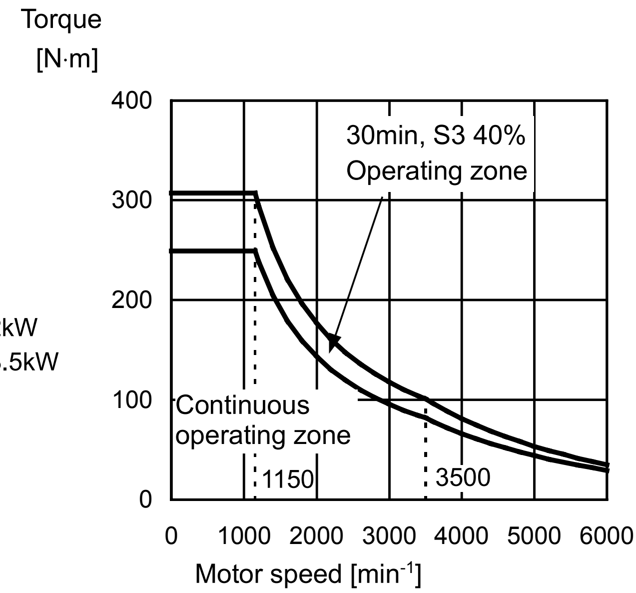




3.11 MODEL α30/6000HV*i*

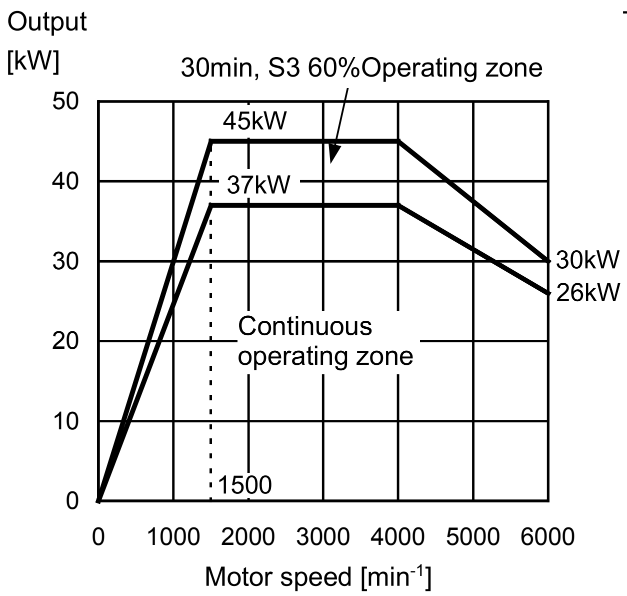
Applicable amplifier SPM-45HV*i*

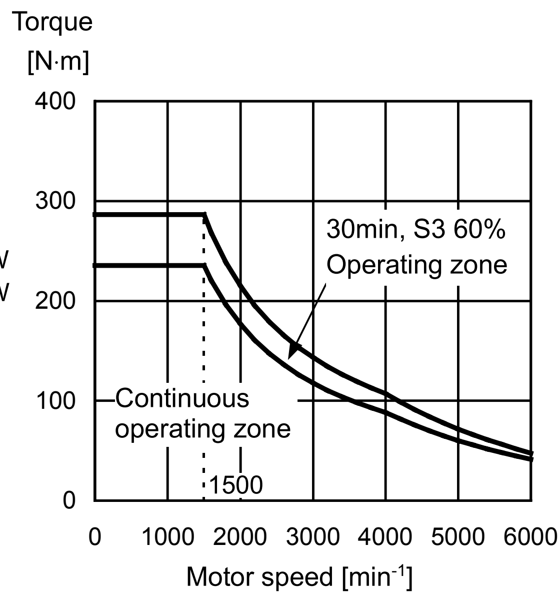




3.12 MODEL α40/6000HV*i*

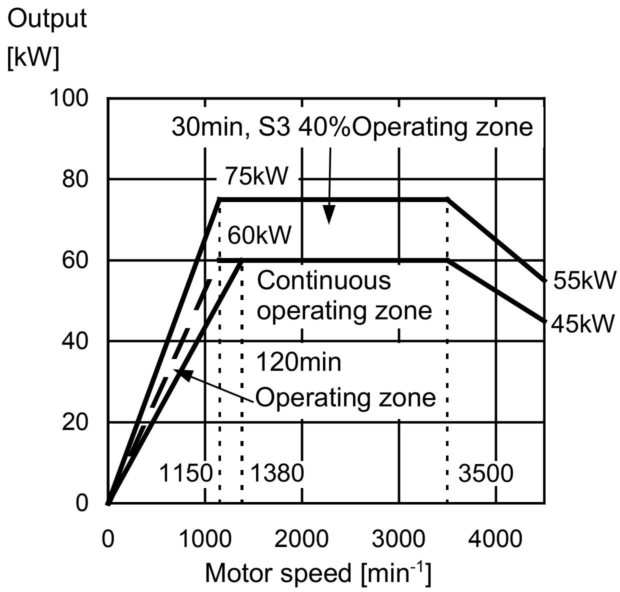
Applicable amplifier SPM-45HV*i*

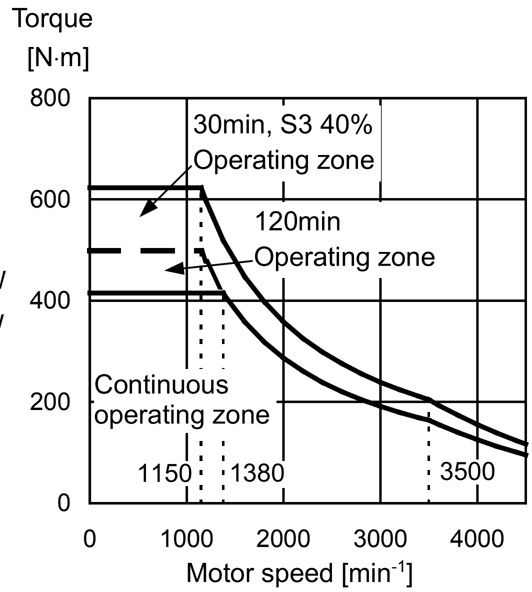




3.13 MODEL α60/4500HV*i*

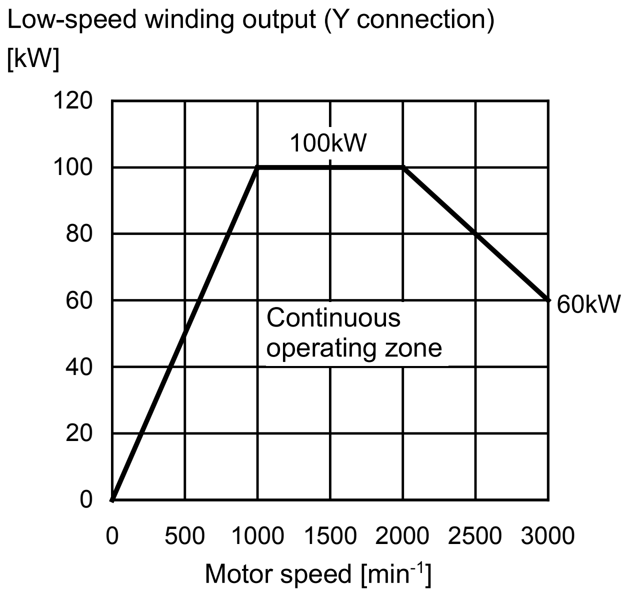
Applicable amplifier SPM-75HV*i*

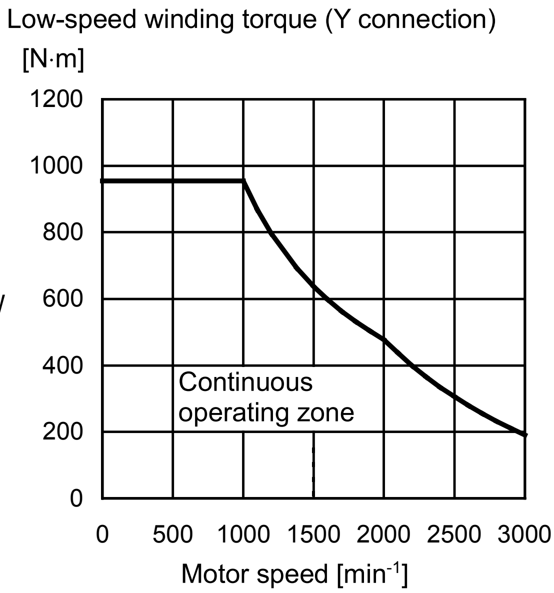


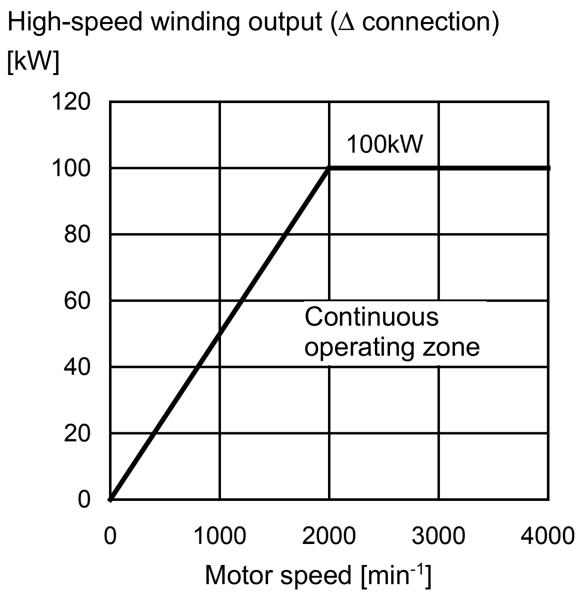


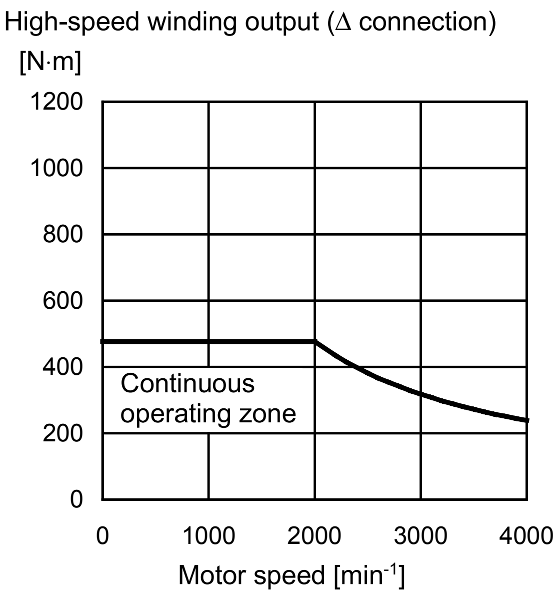
3.14 MODEL α100/4000HV*i*

Applicable amplifier SPM-75HV*i*





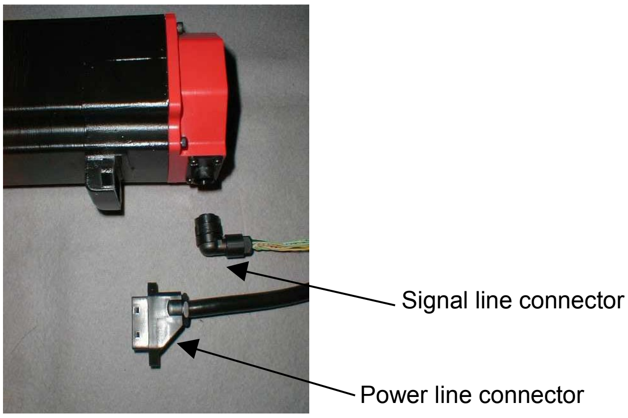




4 CONNECTIONS

4.1 MODEL α0.5/10000HV*i*

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

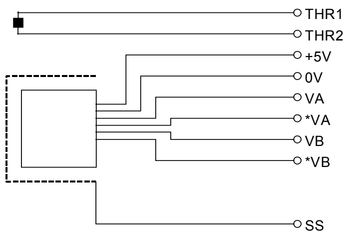
NOTE
If the outer sheath diameter is inadequate, the waterproofness can degrade.

Connector pins arrangement

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

Connection of signal lead

- For type with M*i* sensor



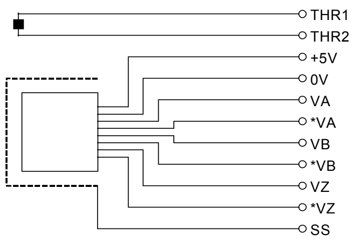
Connector parts related to cable side

	Japan Aviation Electronics Industry specification
Connector	JN1xS10SL1: Applicable sheath diameter φ5.7 to 7.3 JN1xS10SL2: Applicable sheath diameter φ6.5 to 8.0 ↑ D:Straight plug F:Elbow plug
Terminal	JN1-22-22S

Connector pins arrangement

1	2	3	
RA	RB	-	
4	5	6	7
PA	PB	-	0V
8	9	10	
+5V	THR1	THR2	

- For type with MZ*i* sensor



Connector parts related to cable side

	Japan Aviation Electronics Industry specification
Connector	JN1xS10SL1: Applicable sheath diameter φ5.7 to 7.3 JN1xS10SL2: 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 α1/10000HV*i* TO α100/4000HV*i*

Cables of primary winding and fan motor are connected to the terminal block.
M*i* sensor or MZ*i* sensor signal or thermistor 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		Fan motor	Fan motor
	U,V,W,G	X,Y,Z	FMU,FMV,FMW	FMU,FMV
α1/10000HV*i* to α1.5/10000HV*i*	M5	-	-	M4
α2/10000HV*i* to α3/10000HV*i*	M5	-	-	Screw-less terminal block
α6/10000HV*i* to α22/7000HV*i*	M5	-	Screw-less terminal block	-
α30/6000HV*i* to α40/6000HV*i*	M10	-	Screw-less terminal block	-
α60/4500HV*i*	M10	-	M3.5	-
α100/4000HV*i*	M8	M8	M3.5	-

Cable for the power lead

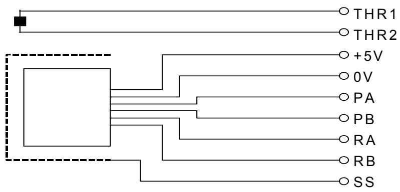
For the power lead cable specification, refer to "FANUC SERVO AMPLIFIER α*i* series DESCRIPTIONS (B-65282EN)".

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

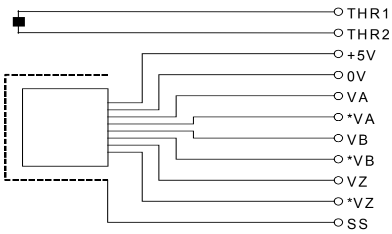
Connector attachment for a motor with a built-in M*i* sensor



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		RA	RB		0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	PA	PB		SS	THR1

Connector attachment for a motor with a built-in MZ*i* 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

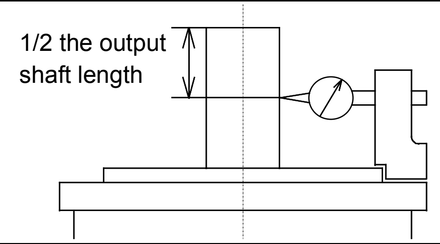
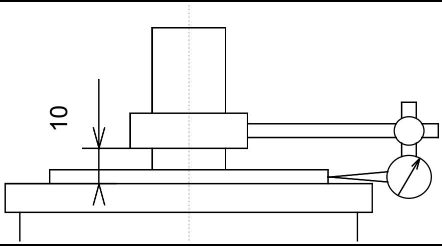
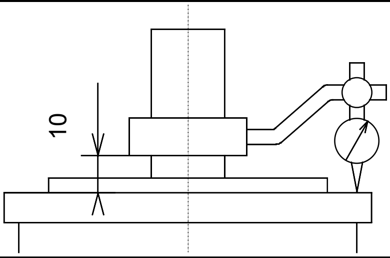
Use the motor output shaft below the allowable radial loads shown in the table below.

Model	Allowable radial load (kgf)	
	At output shaft end	At output shaft center
α0.5/10000HV*i*	294N (30kgf)	323N (33kgf)
α1/10000HV*i*	392N (40kgf)	441N (45kgf)
α1.5/10000HV*i*	882N (90kgf)	980N (100kgf)
α2/10000HV*i*	882N (90kgf)	999N (102kgf)
α3/10000HV*i*	1470N (150kgf)	1607N (164kgf)
α6/10000HV*i*	1960N (200kgf)	2205N (225kgf)
α8/8000HV*i*	2940N (300kgf)	3371N (344kgf)
α12/7000HV*i*, α15/7000HV*i*	2940N (300kgf)	3410N (348kgf)
α22/7000HV*i*	4410N (450kgf)	4988N (509kgf)
α30/6000HV*i*, α40/6000HV*i*	5390N (550kgf)	6134N (626kgf)
α60/4500HV*i*	-	19600N (2000kgf)
α100/4000HV*i*	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.

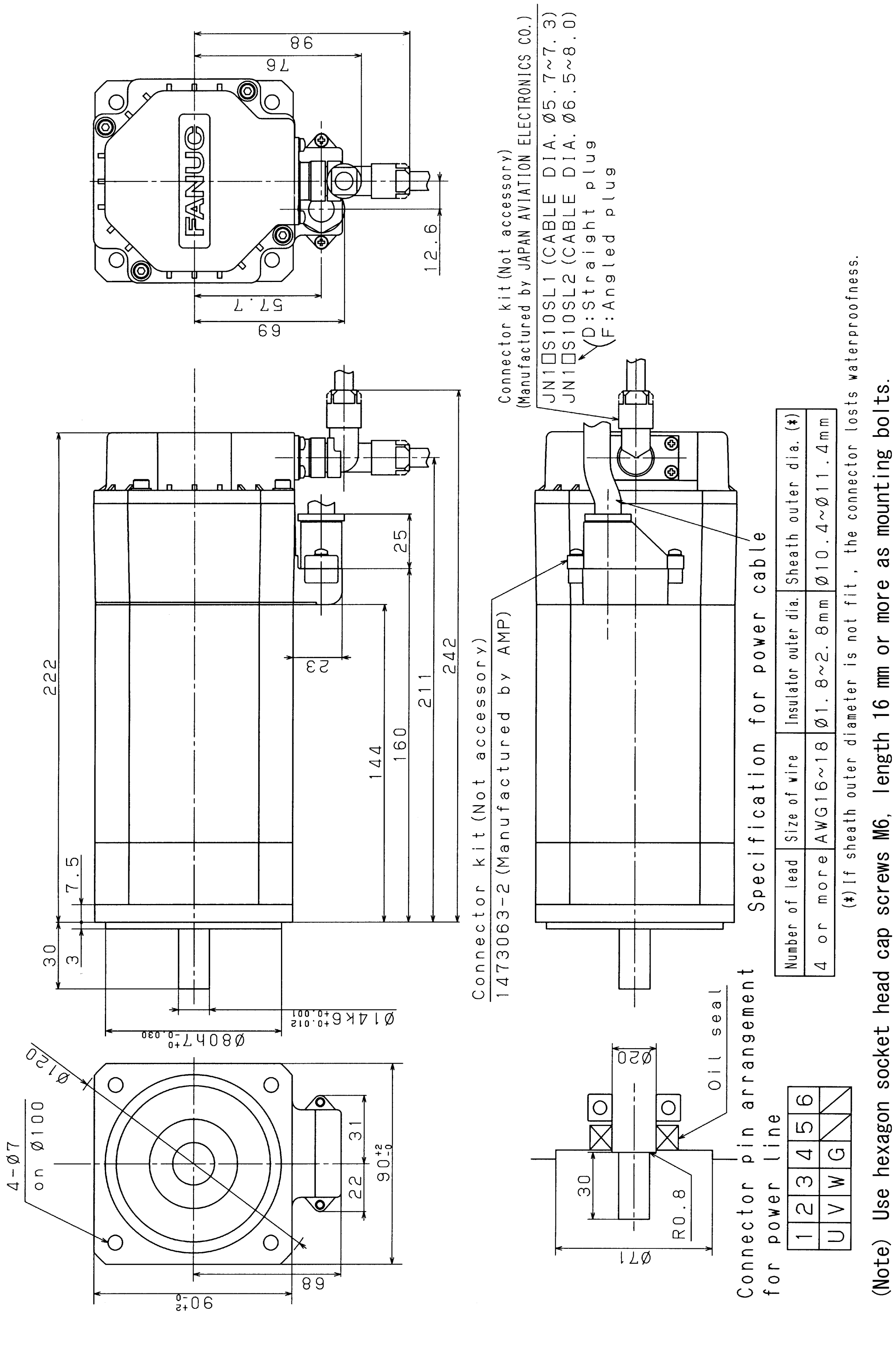
6 ASSEMBLING ACCURACY

Item \ Model	α0.5HV*i* to α22HV*i*	α30HV*i* to α60HV*i*	α100HV*i*	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	

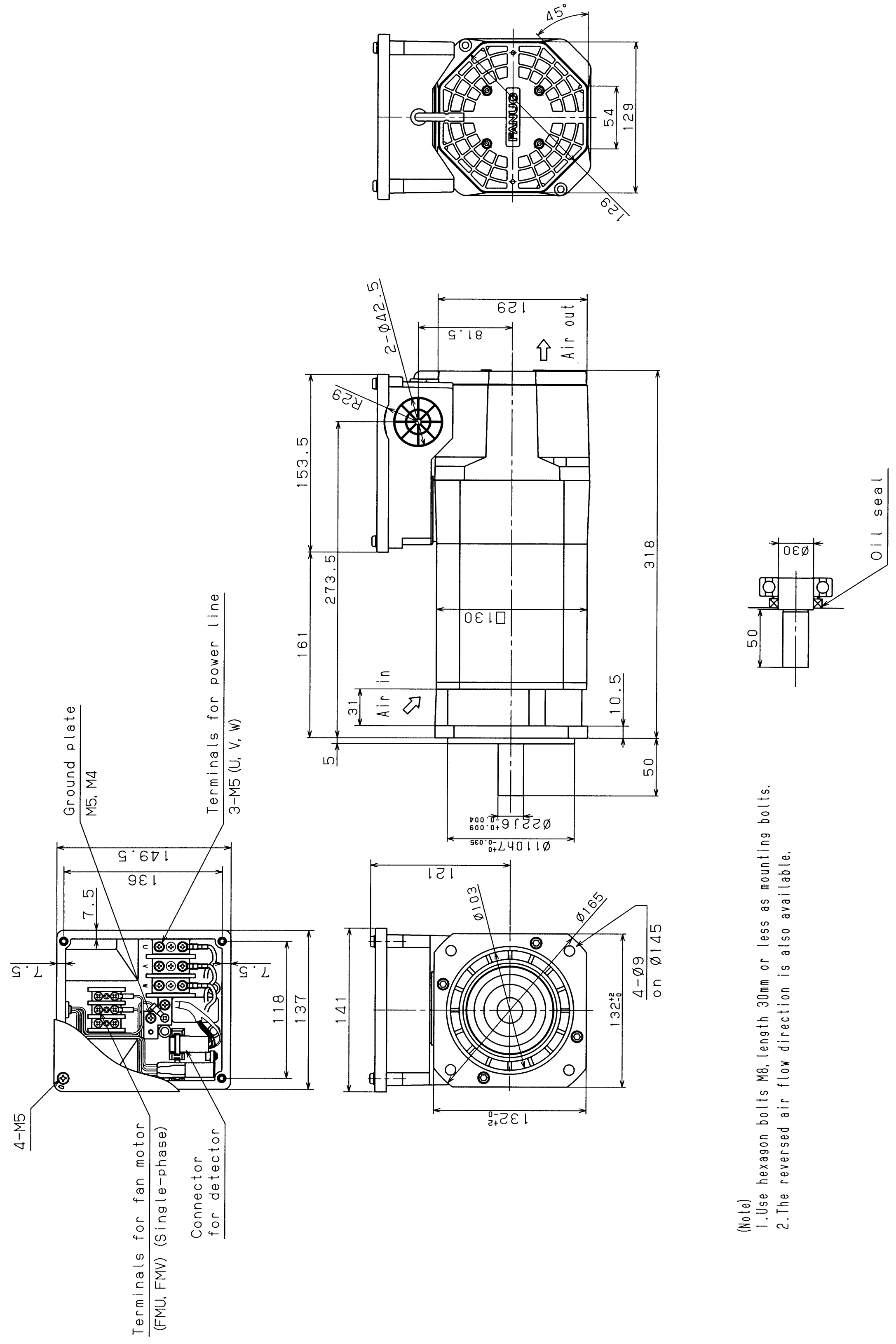
7 EXTERNAL DIMENSIONS

Model name	Section
Model α0.5/10000HV*i* (flange mounting type)	7.1
Model α1/10000HV*i* (flange mounting type)	7.2
Model α1/10000HV*i* (foot mounting type)	7.3
Model α1.5/10000HV*i* (flange mounting type)	7.4
Model α1.5/10000HV*i* (foot mounting type)	7.5
Model α2/10000HV*i* (flange mounting type)	7.6
Model α2/10000HV*i* (foot mounting type)	7.7
Model α3/10000HV*i* (flange mounting type)	7.8
Model α3/10000HV*i* (foot mounting type)	7.9
Model α6/10000HV*i* (flange mounting type)	7.10
Model α6/10000HV*i* (foot mounting type)	7.11
Model α8/8000HV*i* (flange mounting type)	7.12
Model α8/8000HV*i* (foot mounting type)	7.13
Model α12/7000HV*i* (flange mounting type)	7.14
Model α12/7000HV*i* (foot mounting type)	7.15
Model α15/7000HV*i* (flange mounting type)	7.16
Model α15/7000HV*i* (foot mounting type)	7.17
Model α22/7000HV*i* (flange mounting type)	7.18
Model α22/7000HV*i* (foot mounting type)	7.19
Model α30/6000HV*i* (flange mounting type)	7.20
Model α30/6000HV*i* (foot mounting type)	7.21
Model α40/6000HV*i* (flange mounting type)	7.22
Model α40/6000HV*i* (foot mounting type)	7.23
Model α60/4500HV*i* (flange mounting type)	7.24
Model α60/4500HV*i* (foot mounting type)	7.25
Model α100/4000HV*i* (foot flange mounting type)	7.26

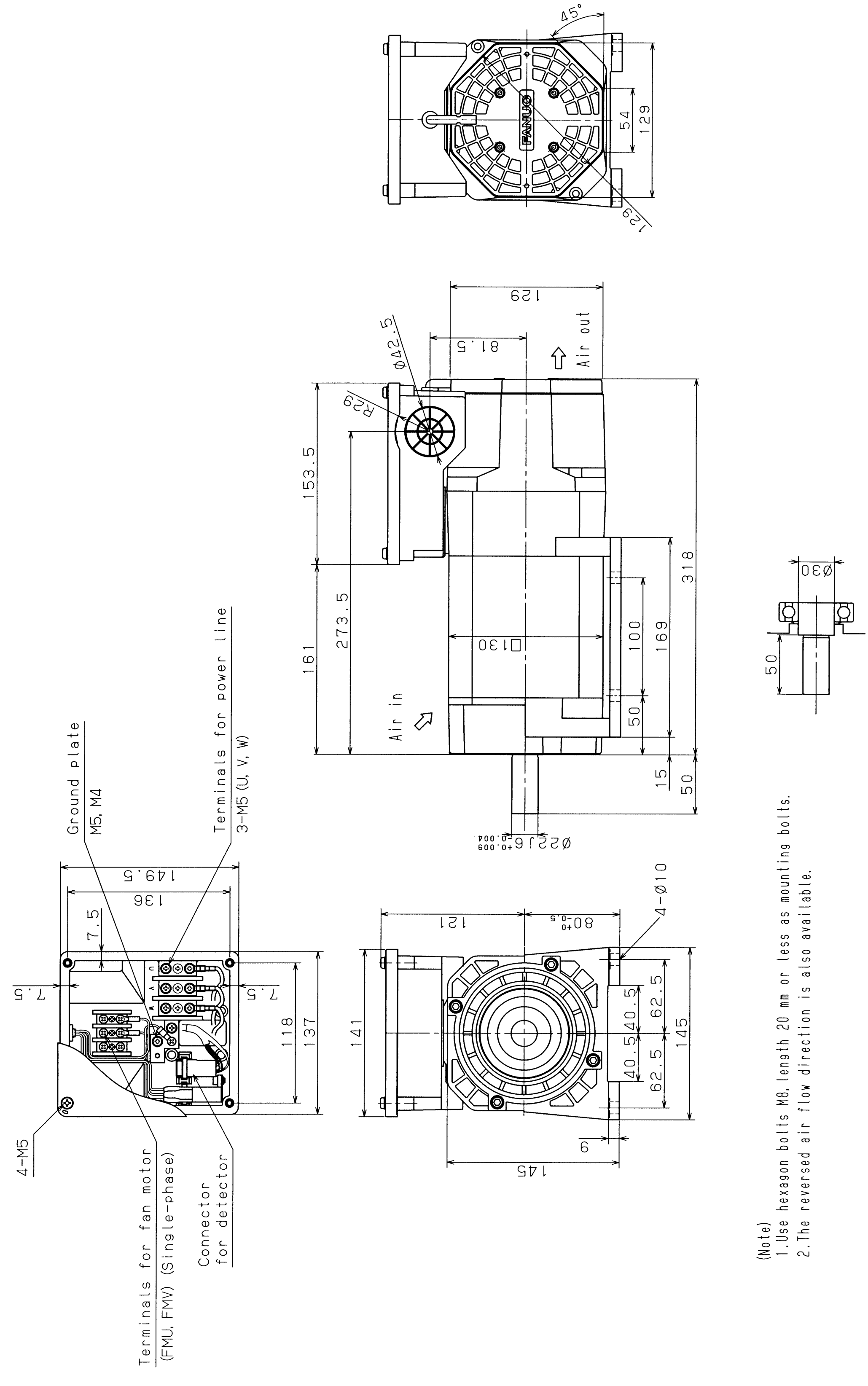
7.1 MODEL α0.5/10000HV*i* (FLANGE MOUNTING TYPE)



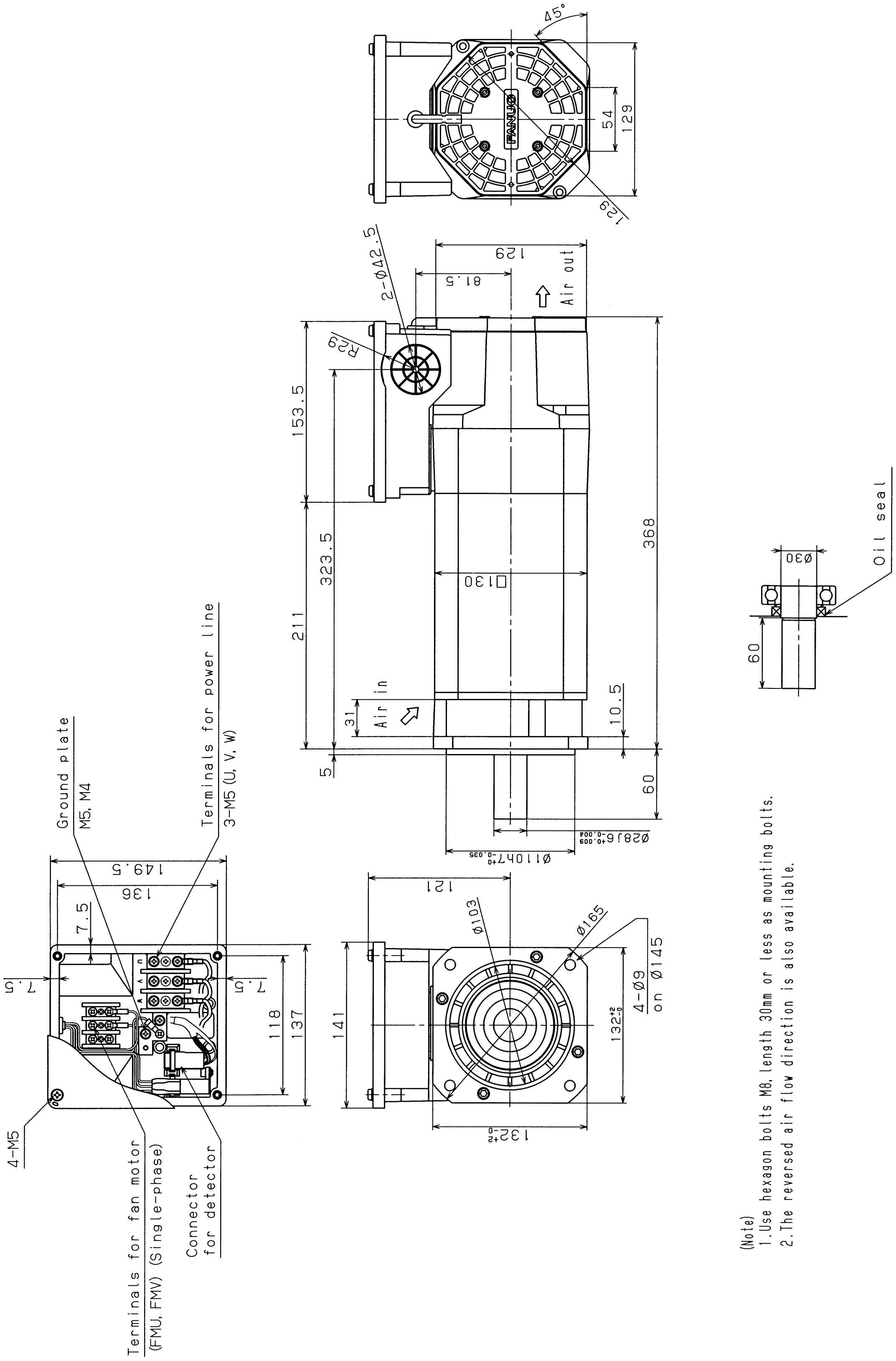
7.2 MODEL α1/10000HV*i* (FLANGE MOUNTING TYPE)



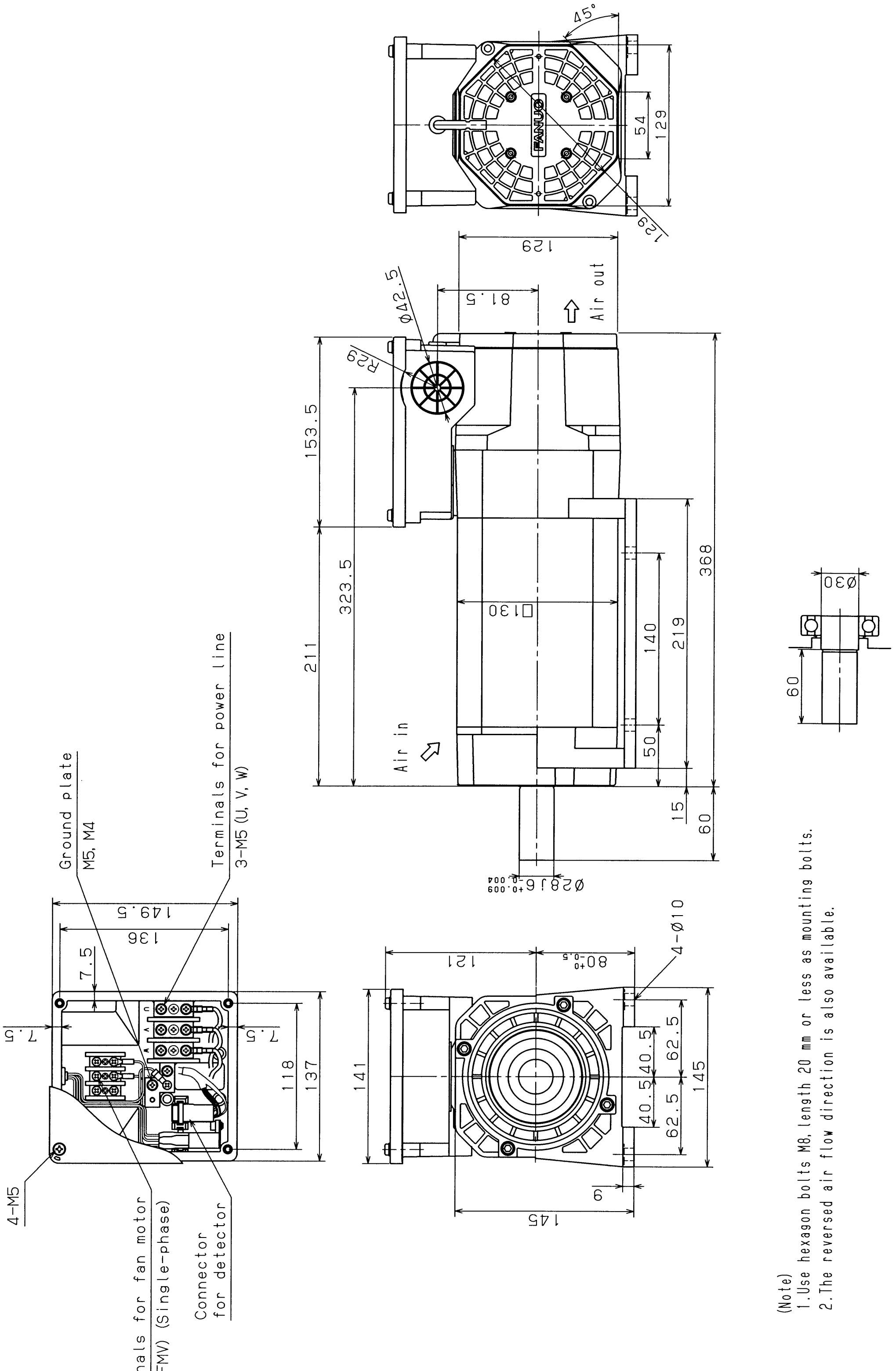
7.3 MODEL α1/10000HVi (FOOT MOUNTING TYPE)



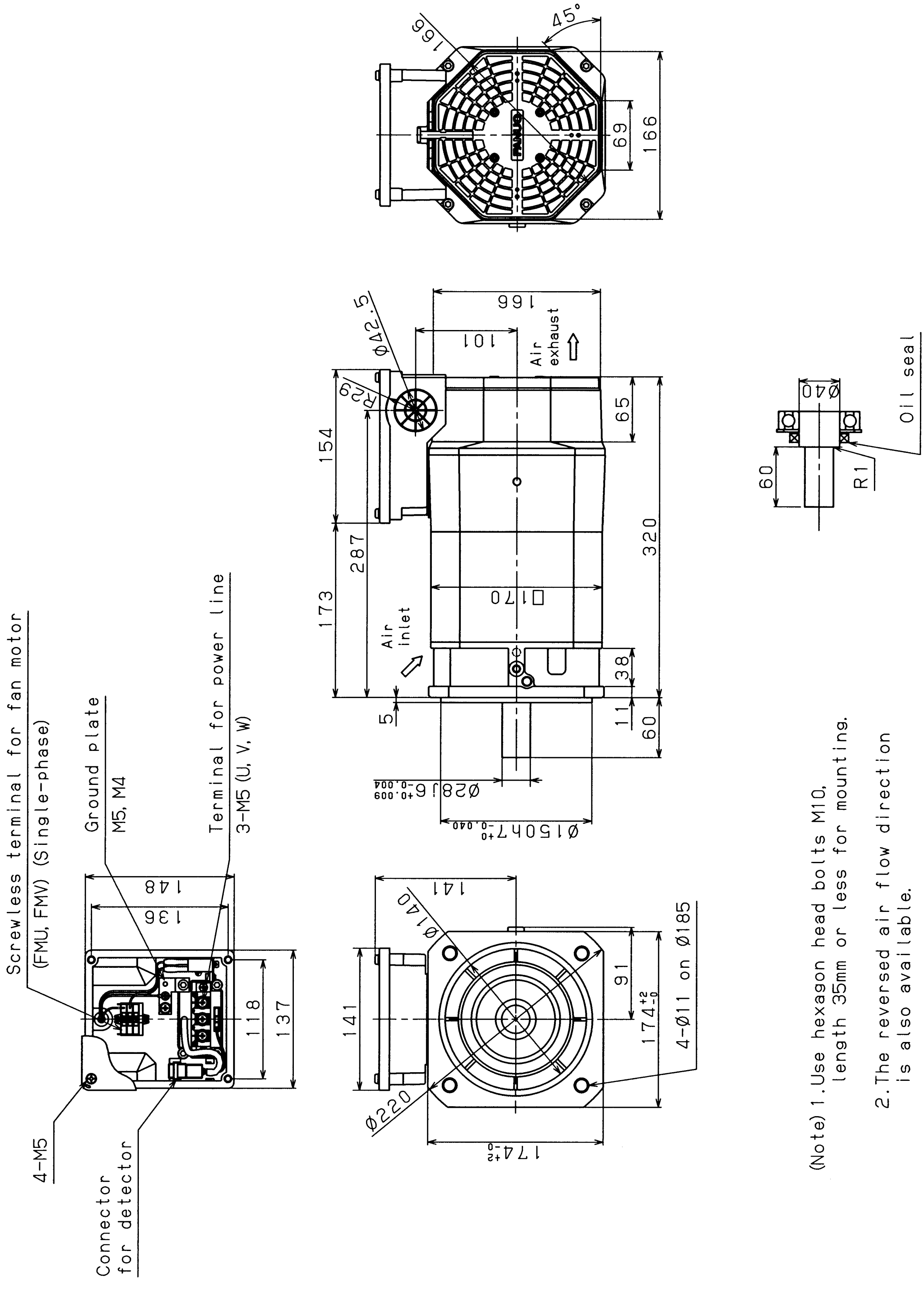
7.4 MODEL α1.5/10000HV*i* (FLANGE MOUNTING TYPE)



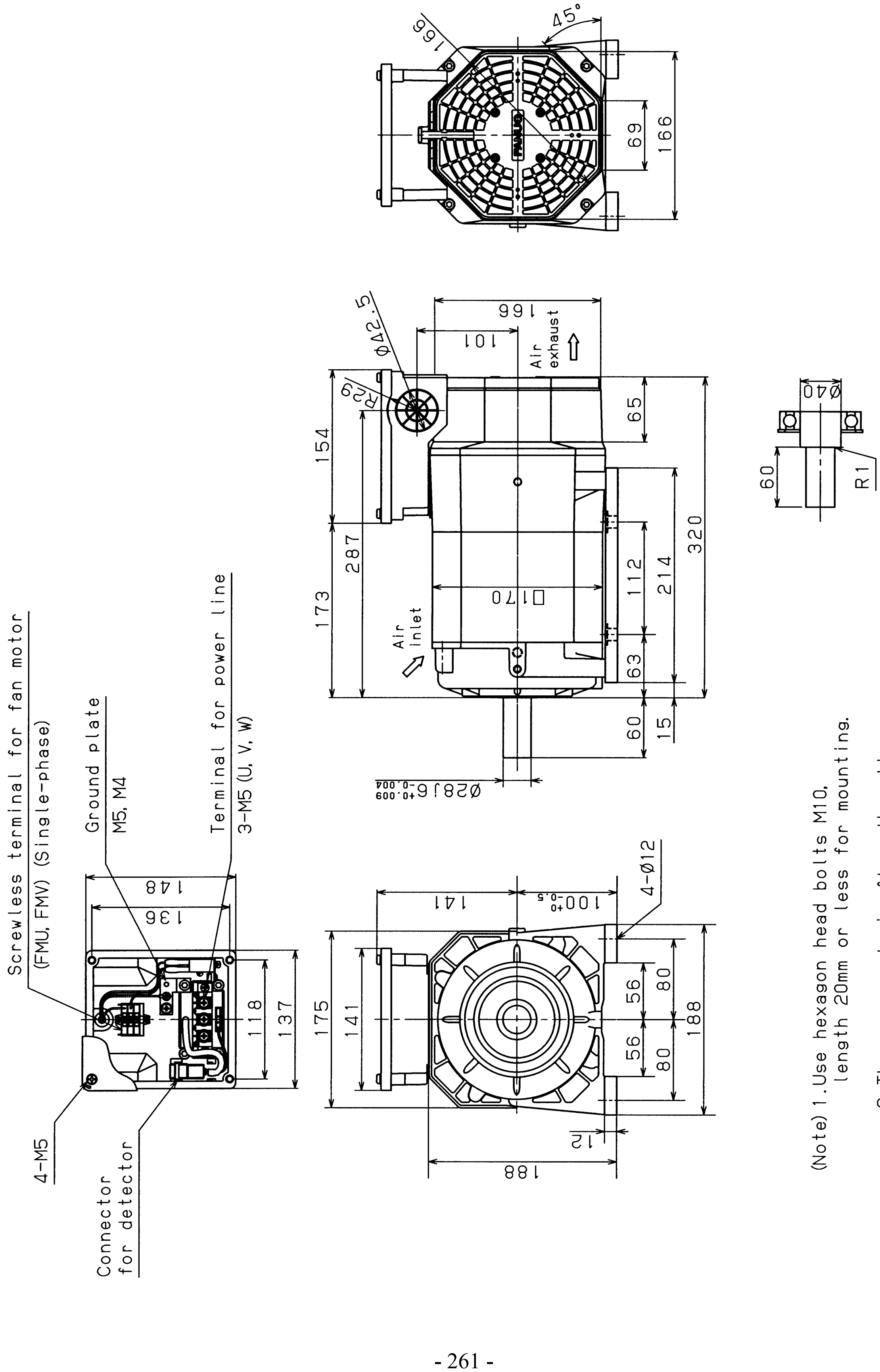
7.5 MODEL α1.5/10000HV*i* (FOOT MOUNTING TYPE)



7.6 MODEL α2/10000HV*i* (FLANGE MOUNTING TYPE)

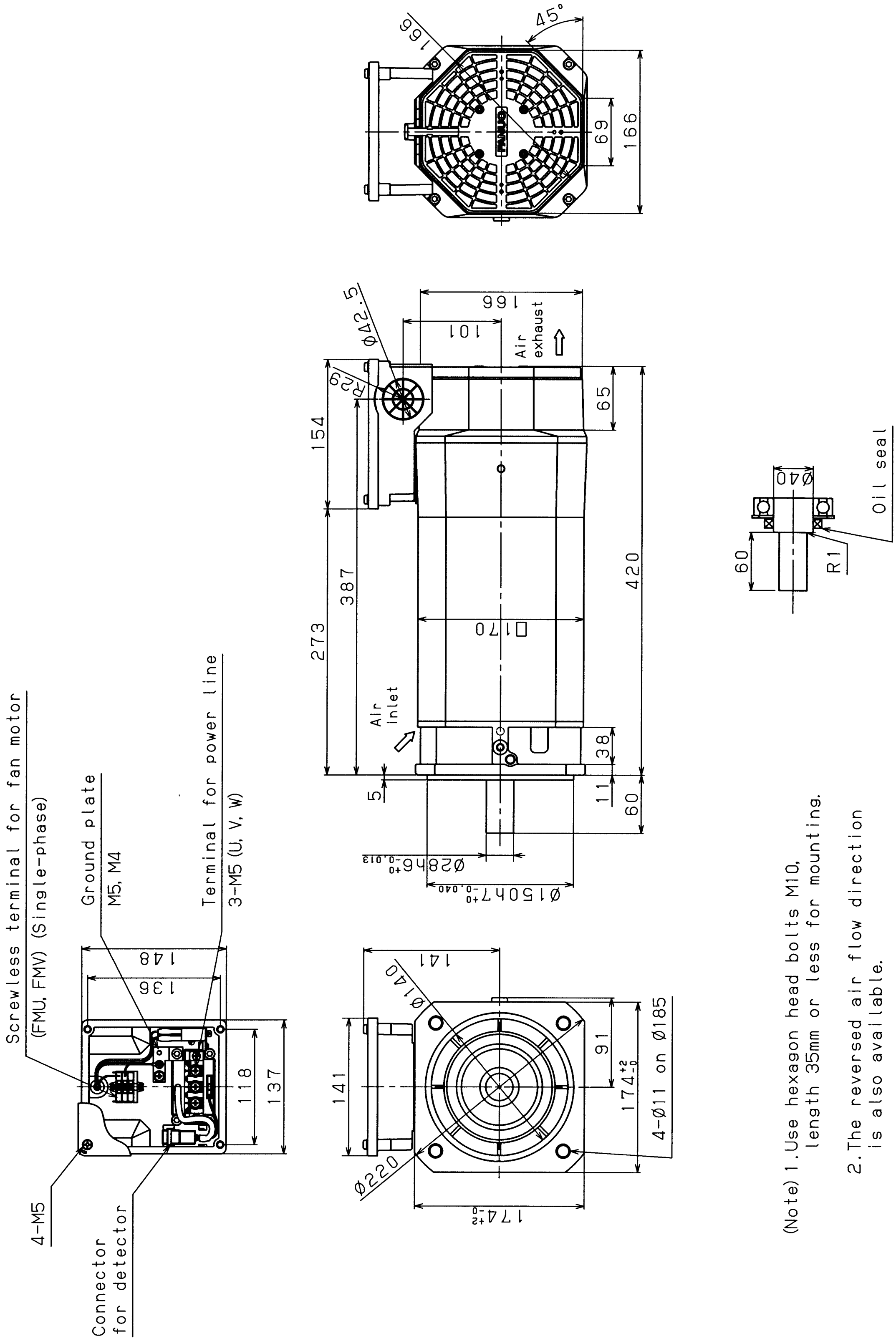


7.7 MODEL α2/10000HVi (FOOT MOUNTING TYPE)

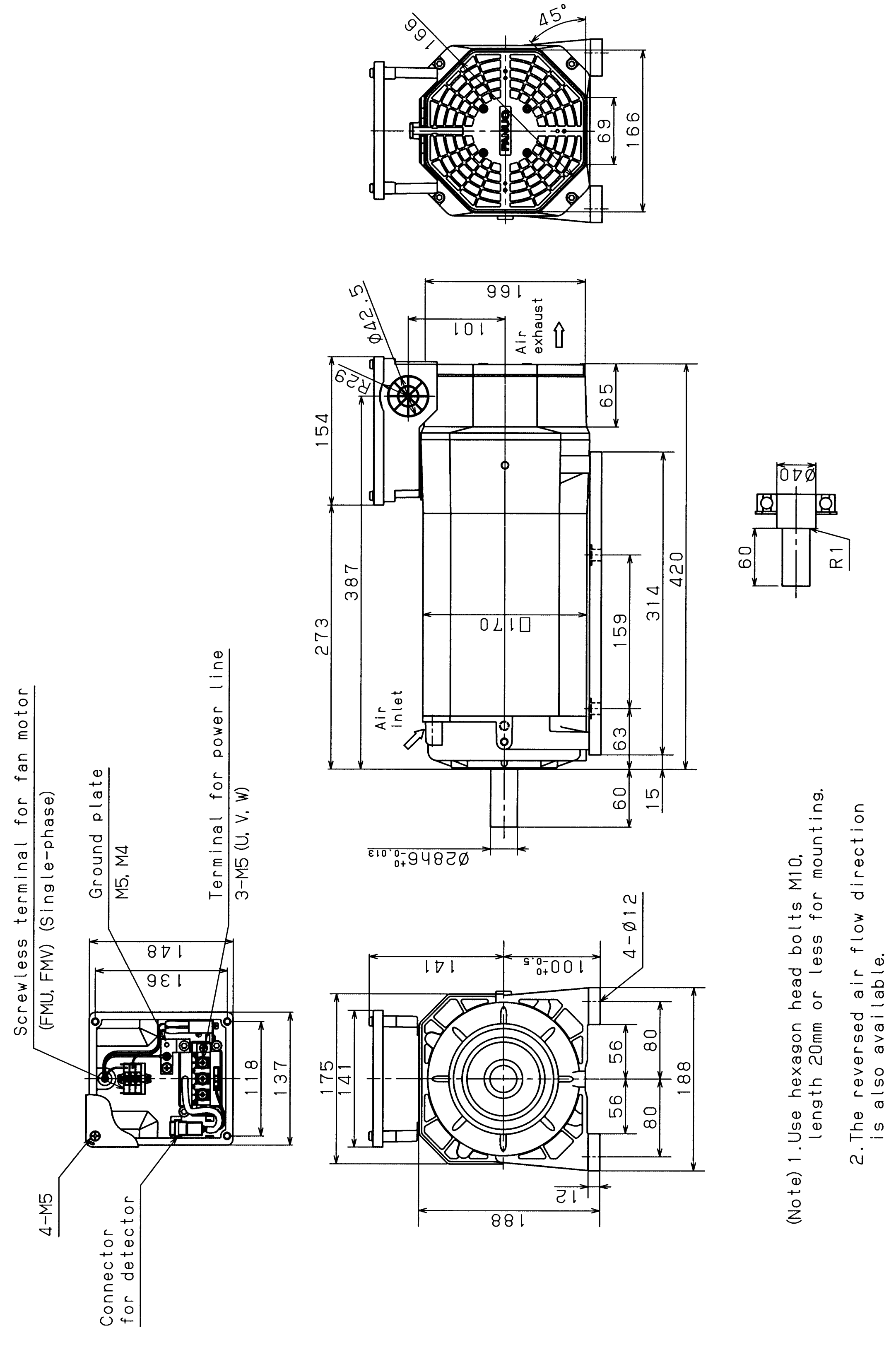


(Note) 1.Use hexagon head bolts M10, length 20mm or less for mounting.
2.The reversed air flow direction is also available.

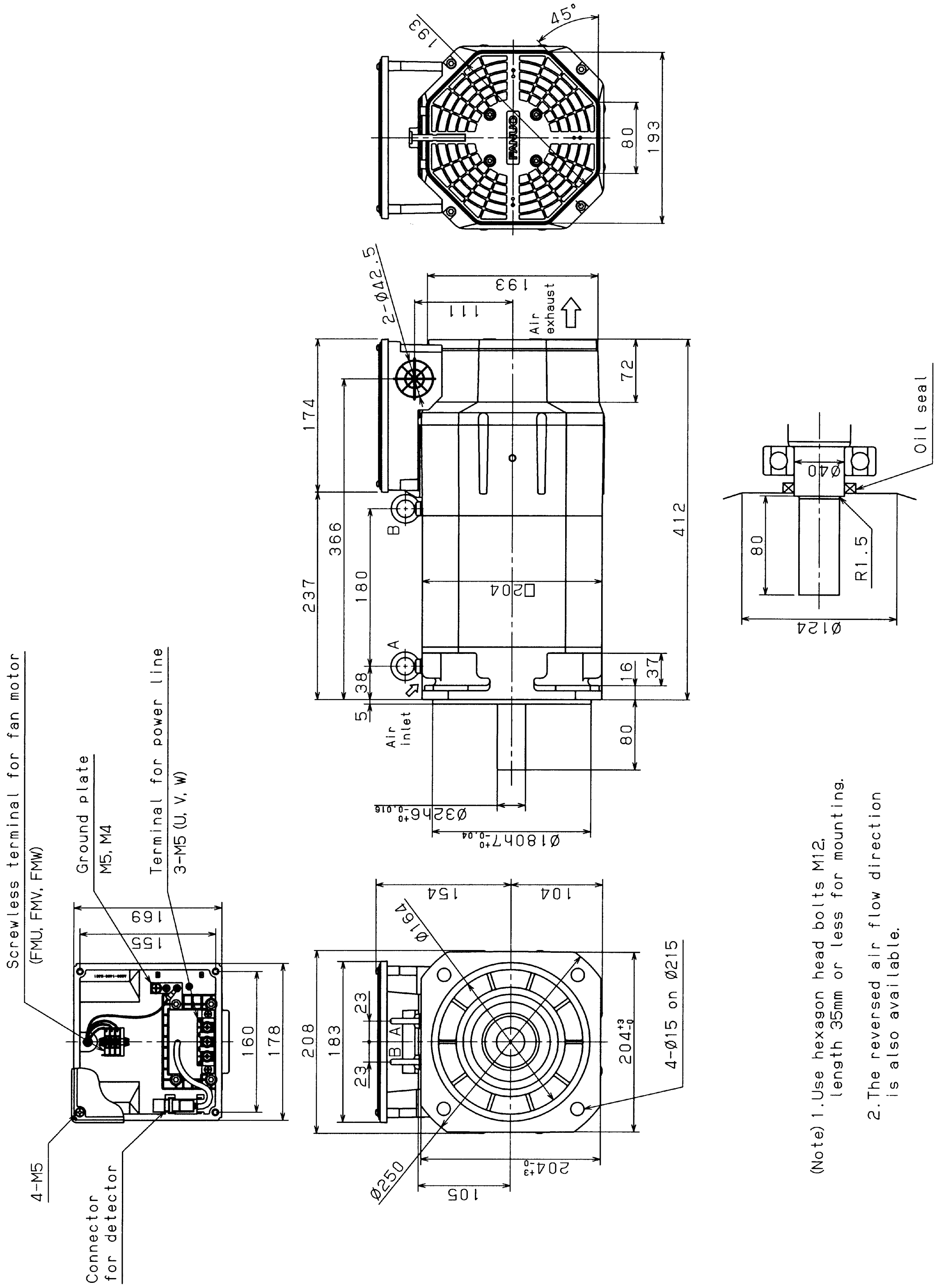
7.8 MODEL α3/10000HVi (FLANGE MOUNTING TYPE)



7.9 MODEL α3/10000HVi (FOOT MOUNTING TYPE)

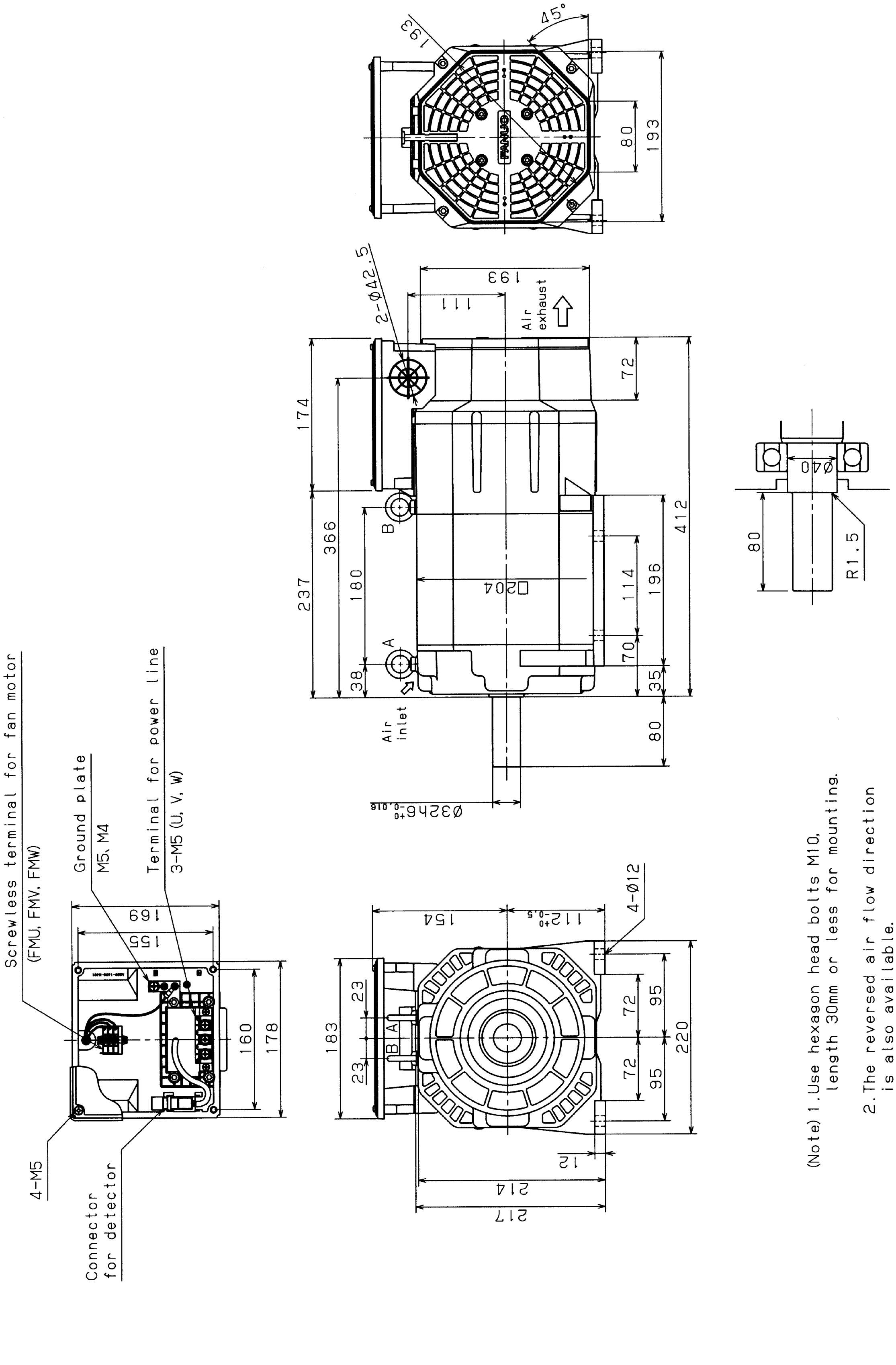


7.10 MODEL α6/10000HV*i* (FLANGE MOUNTING TYPE)

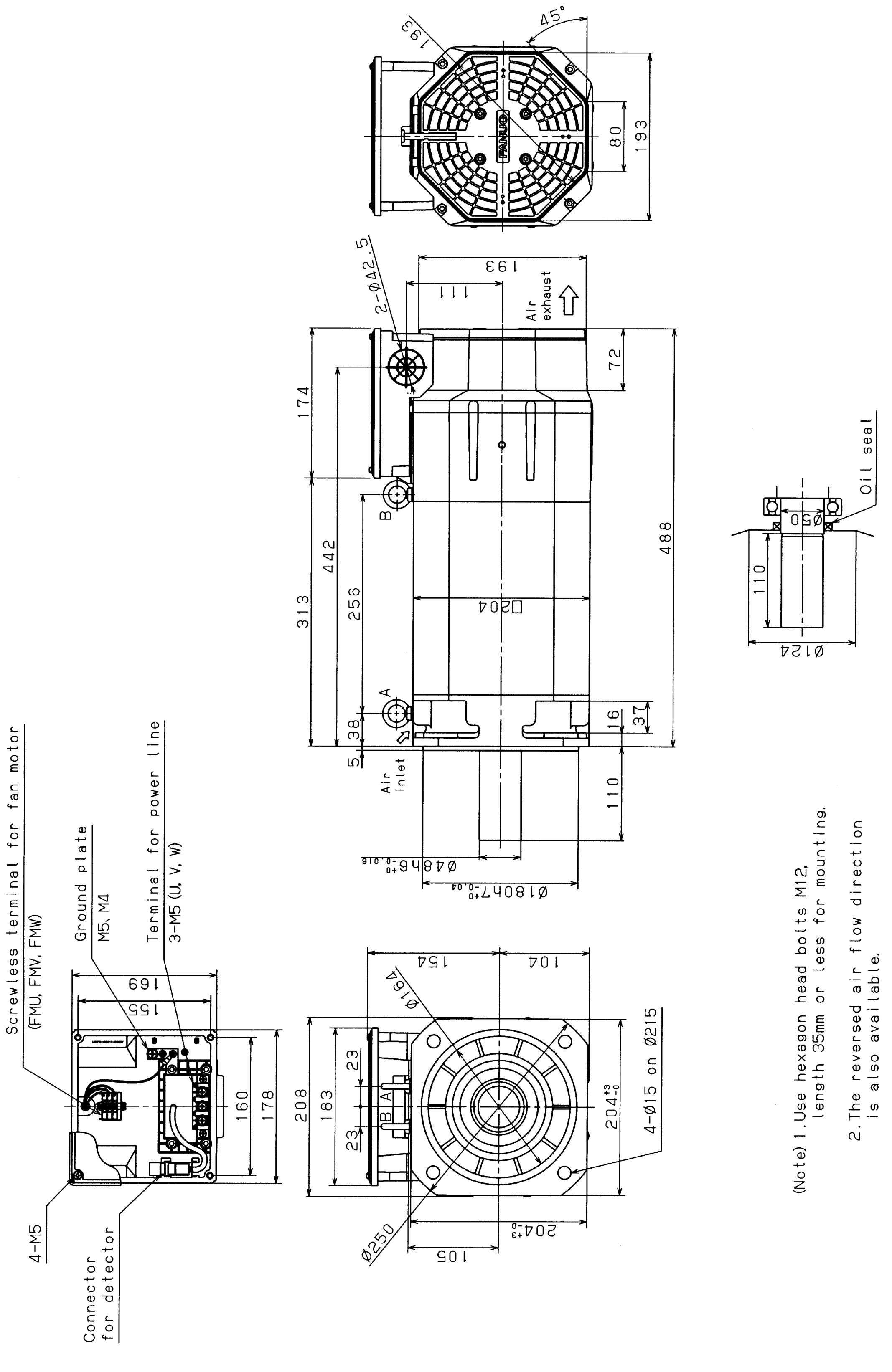


(Note) 1. Use hexagon head bolts M12, length 35mm or less for mounting.
2. The reversed air flow direction is also available.

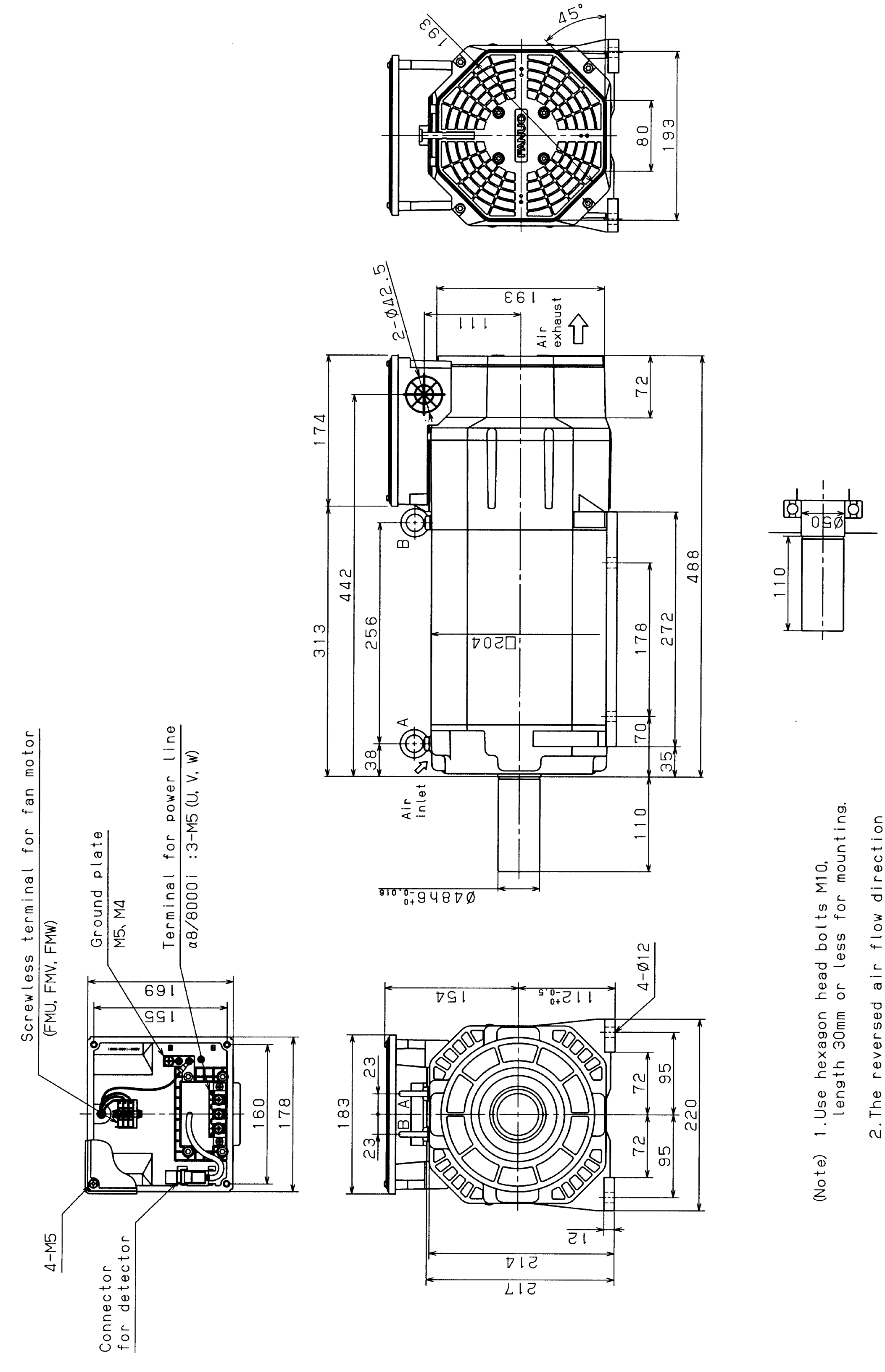
7.11 MODEL α6/10000HVi (FOOT MOUNTING TYPE)



7.12 MODEL α8/8000HV*i* (FLANGE MOUNTING TYPE)

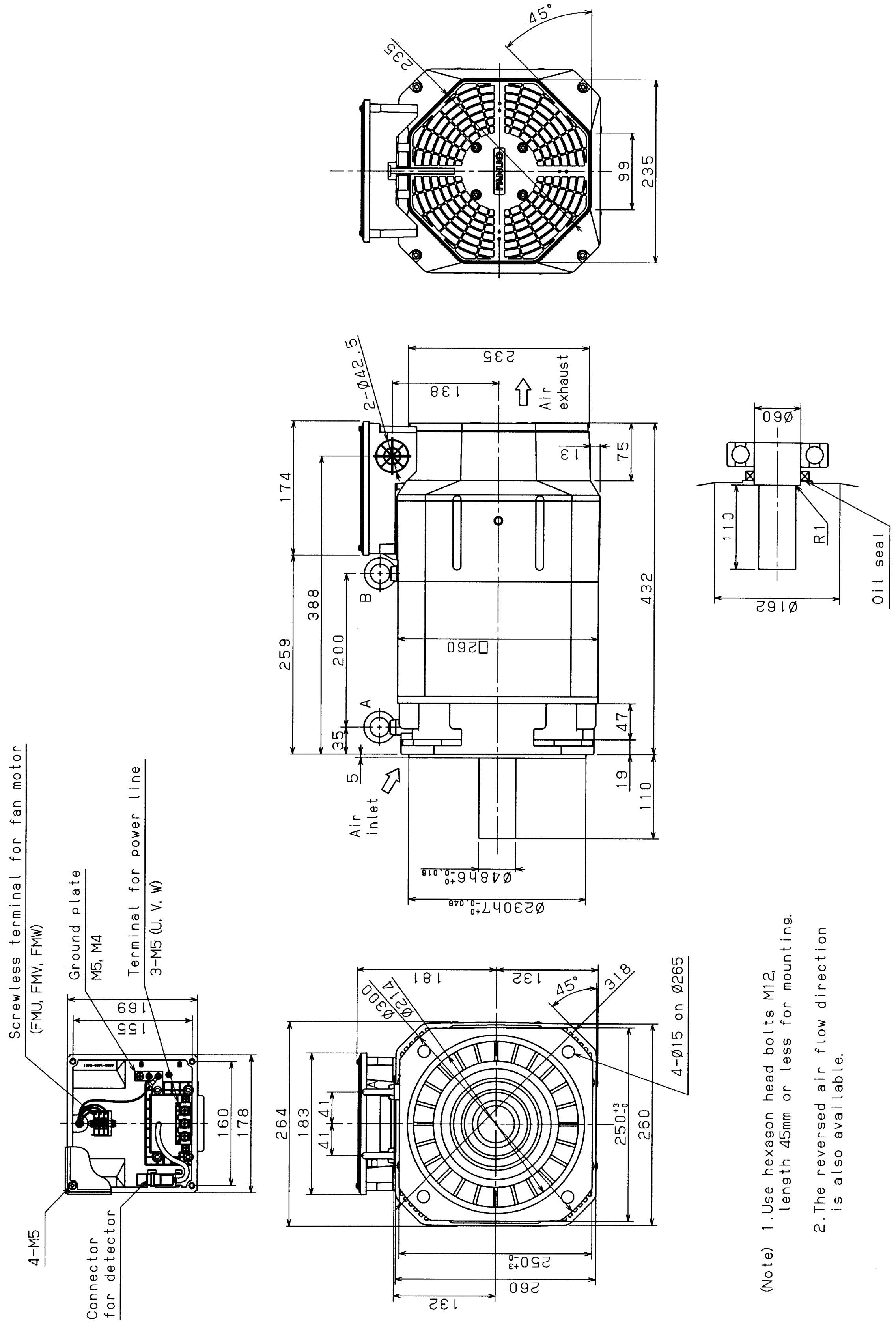


7.13 MODEL α8/8000HV*i* (FOOT MOUNTING TYPE)

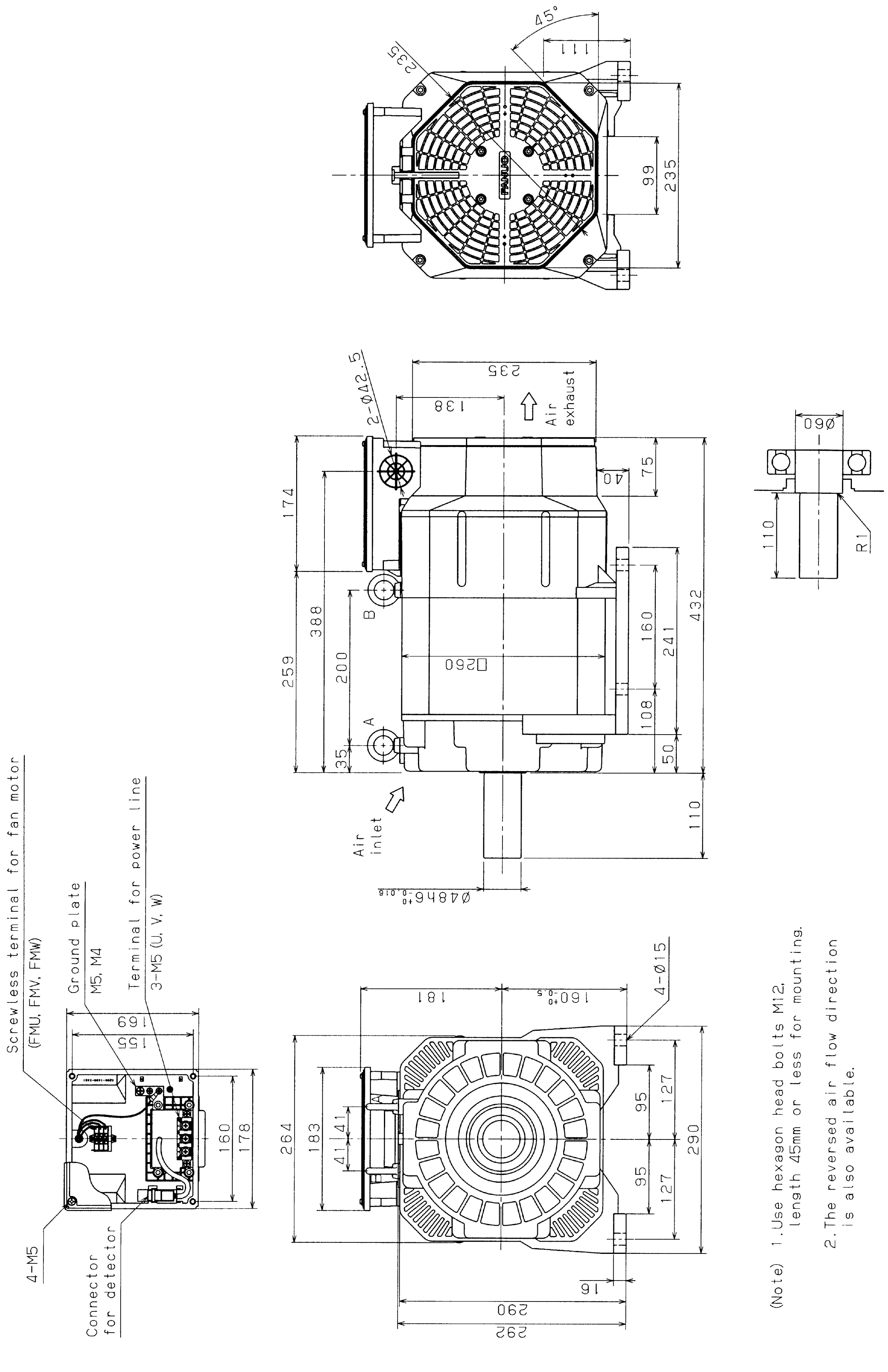


(Note) 1. Use hexagon head bolts M10, length 30mm or less for mounting.
2. The reversed air flow direction is also available.

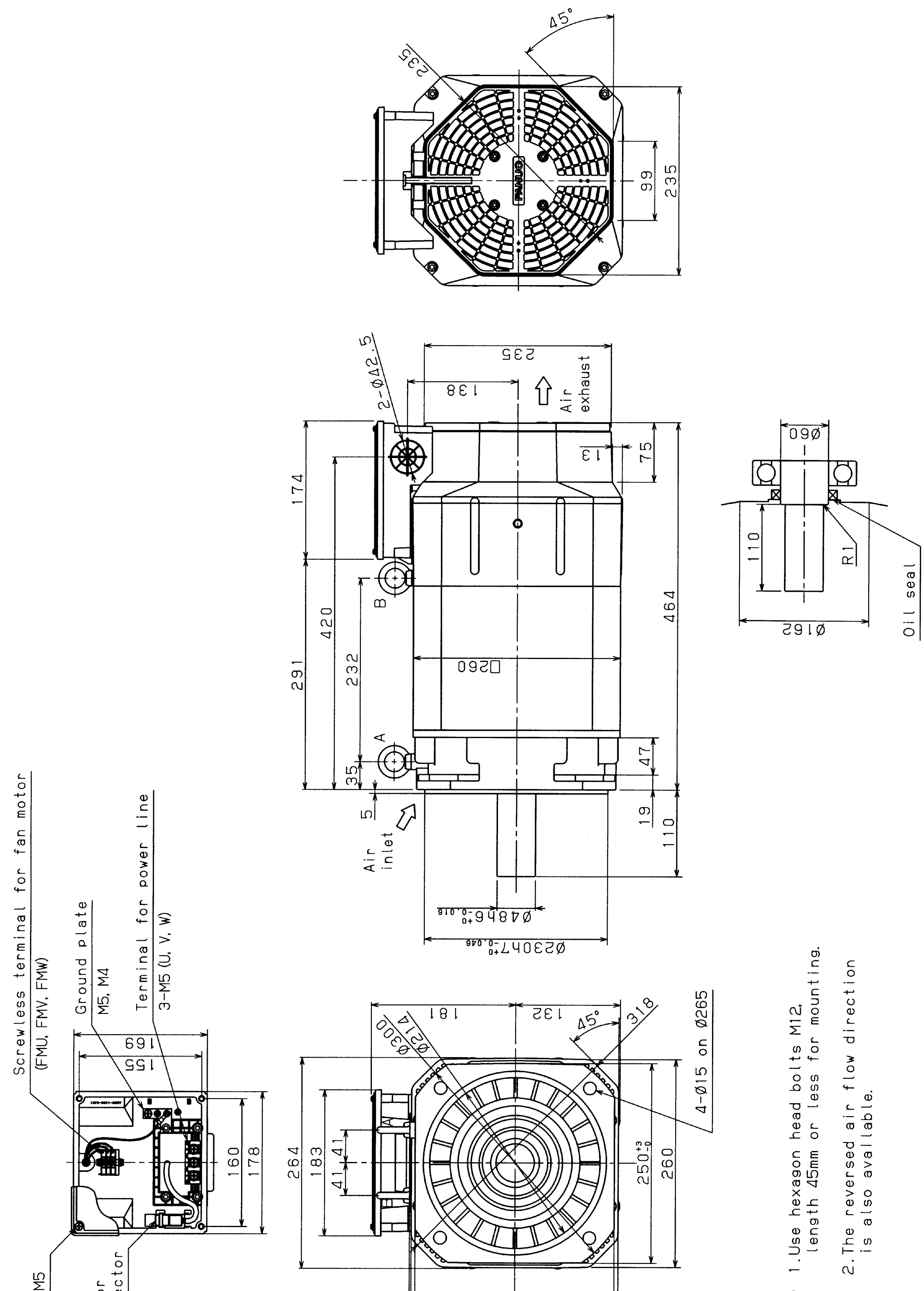
7.14 MODEL α12/7000HV*i* (FLANGE MOUNTING TYPE)



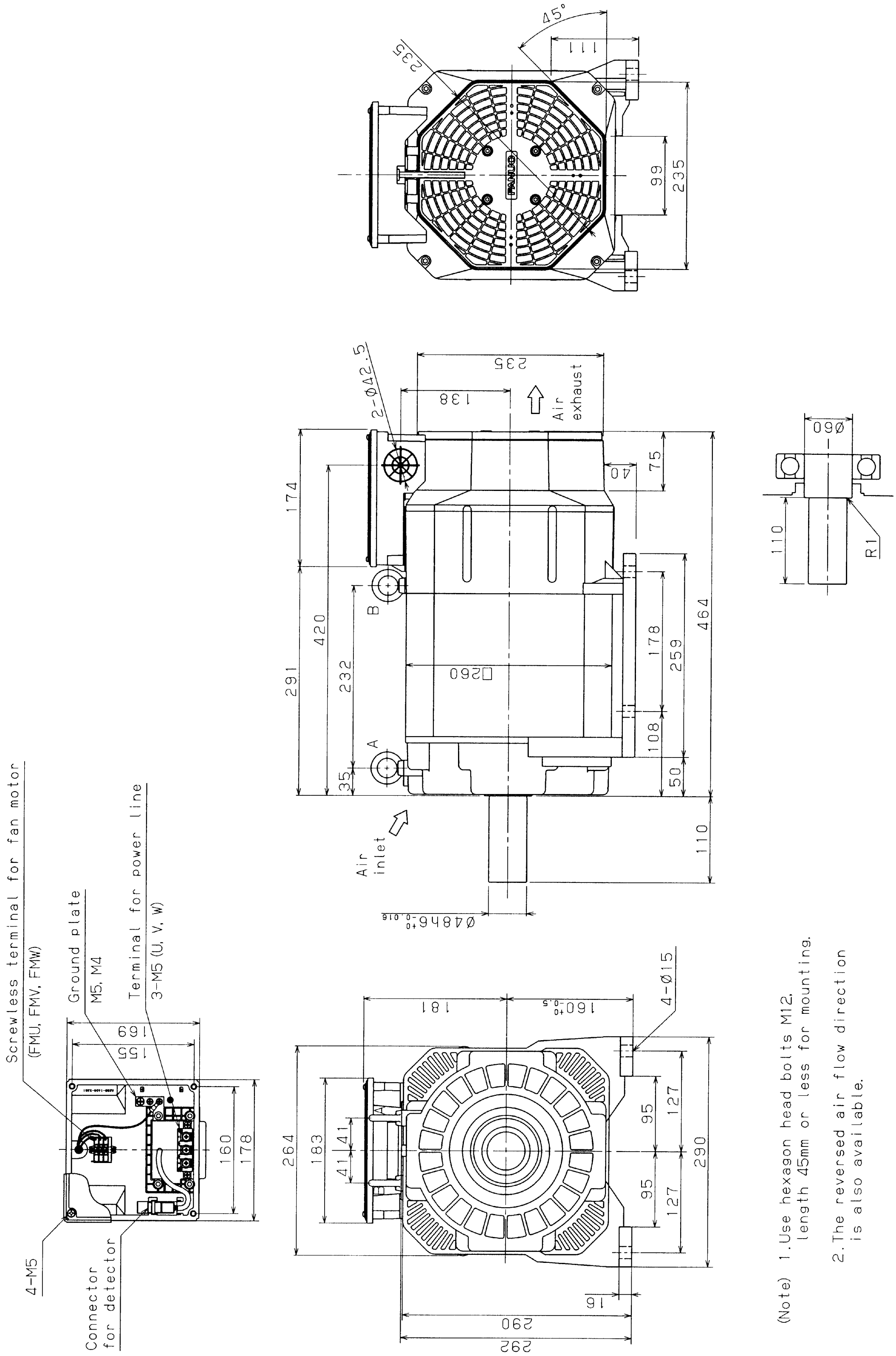
7.15 MODEL α12/7000HV*i* (FOOT MOUNTING TYPE)



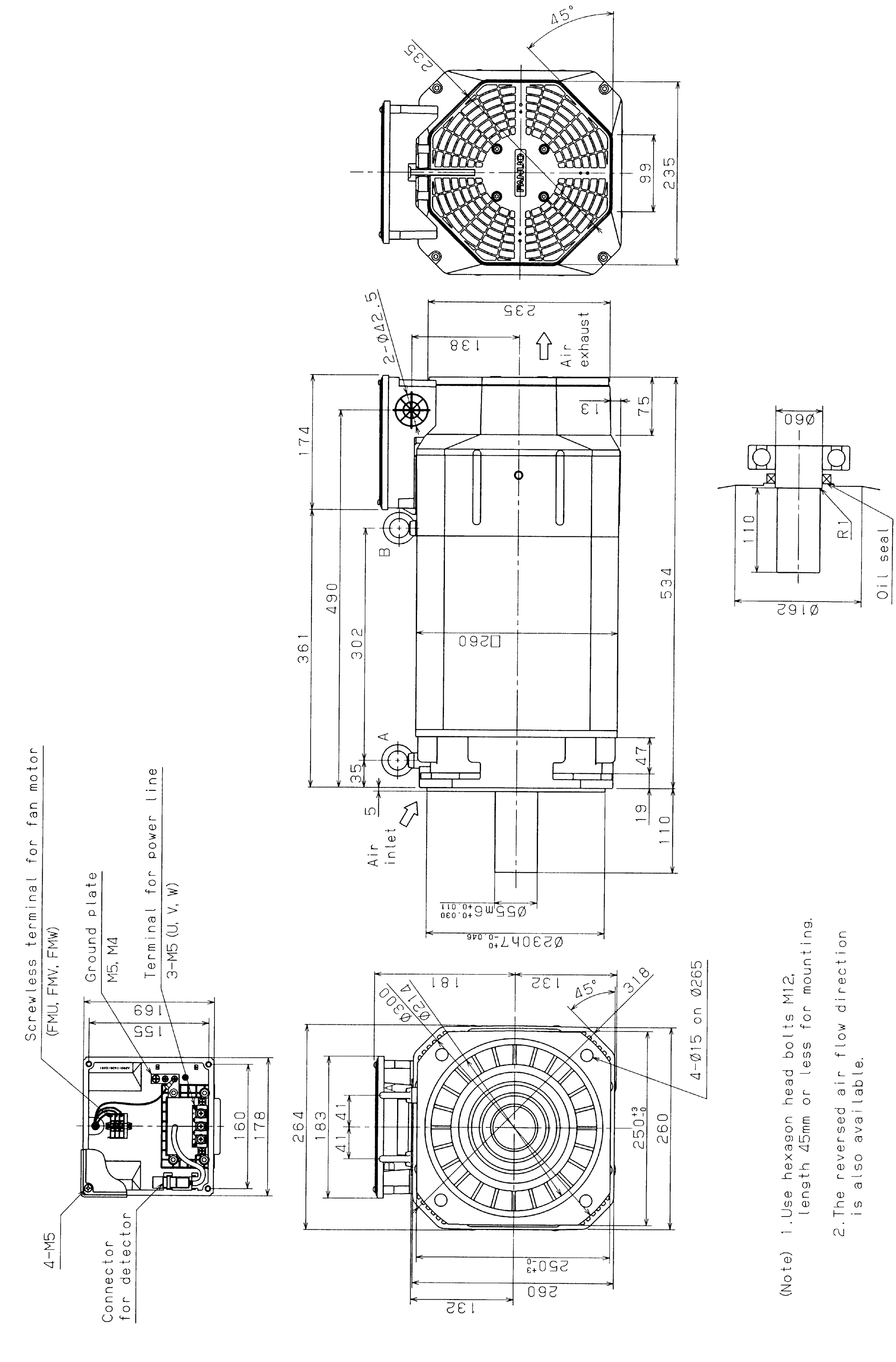
7.16 MODEL α15/7000HV*i* (FLANGE MOUNTING TYPE)



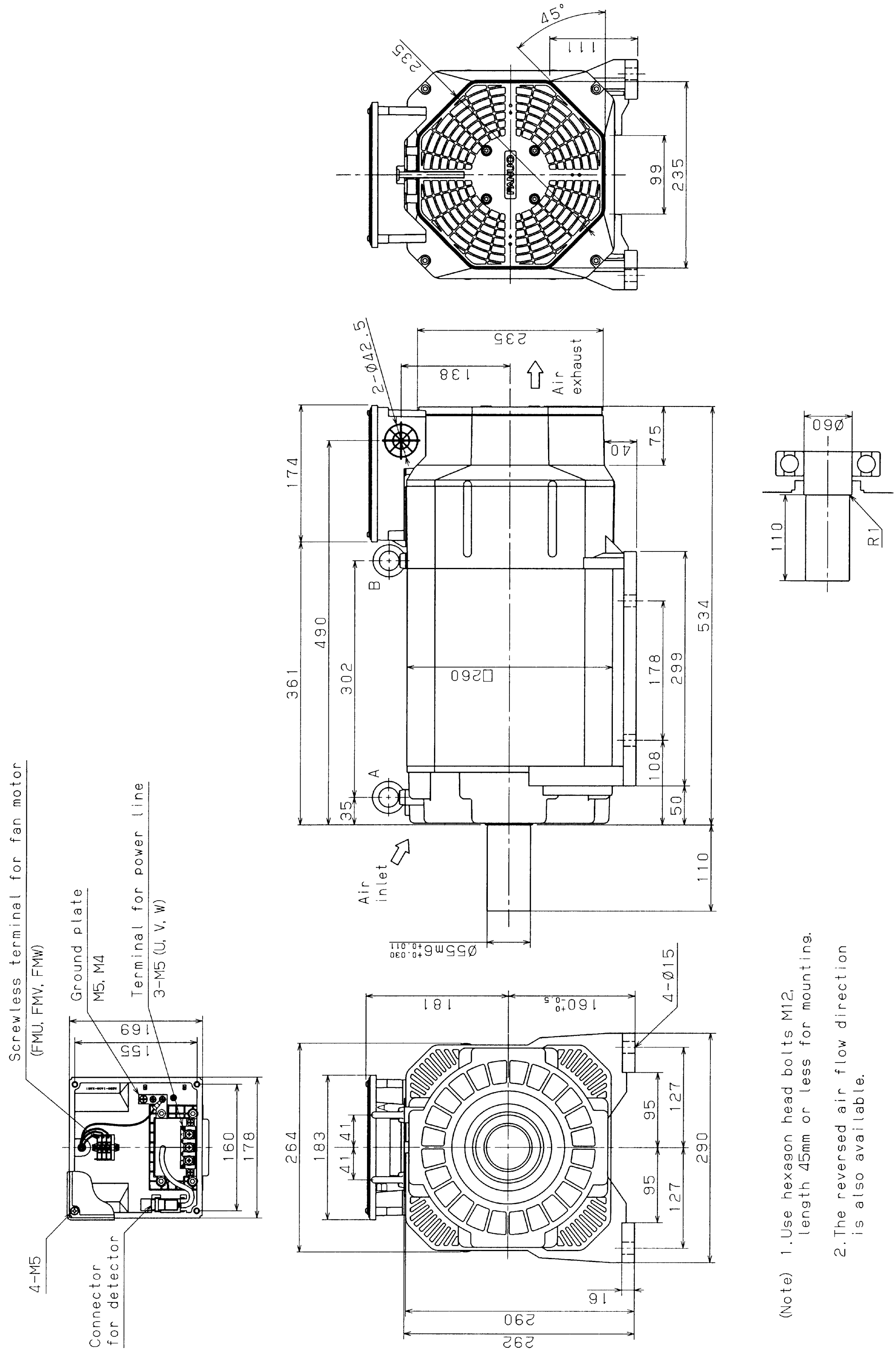
7.17 MODEL α15/7000HVi (FOOT MOUNTING TYPE)



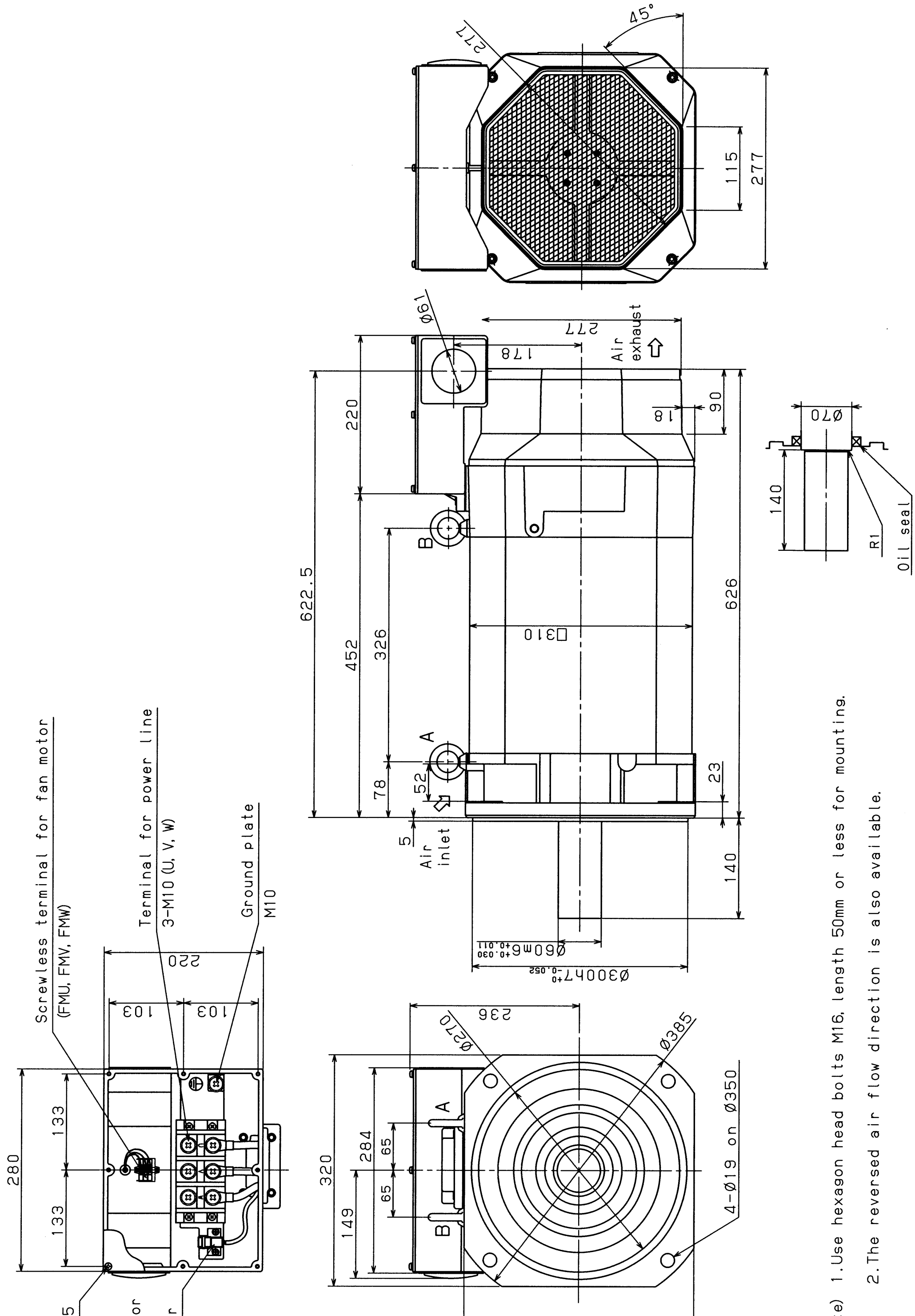
7.18 MODEL α22/7000HV*i* (FLANGE MOUNTING TYPE)



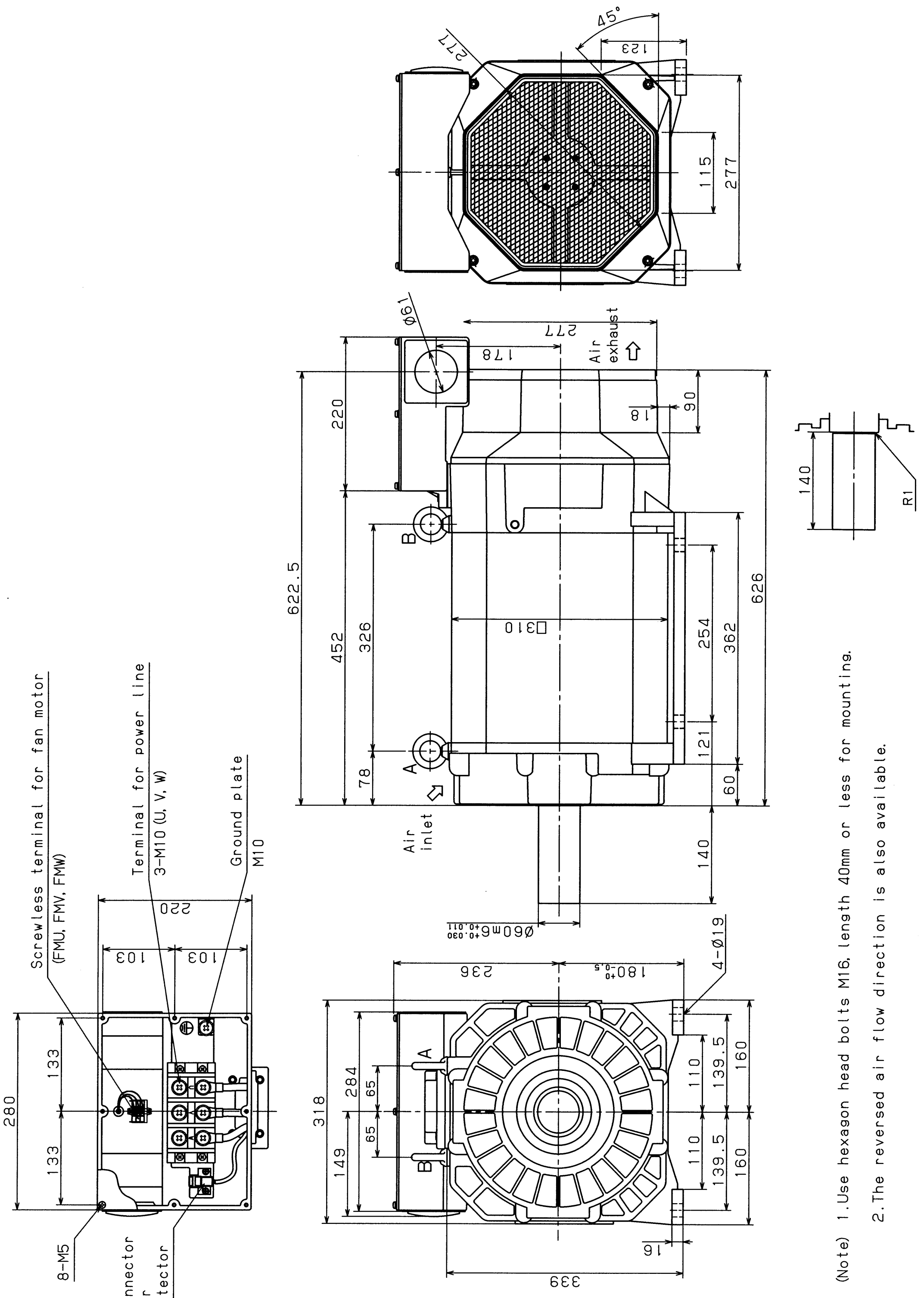
7.19 MODEL α22/7000HVi (FOOT MOUNTING TYPE)



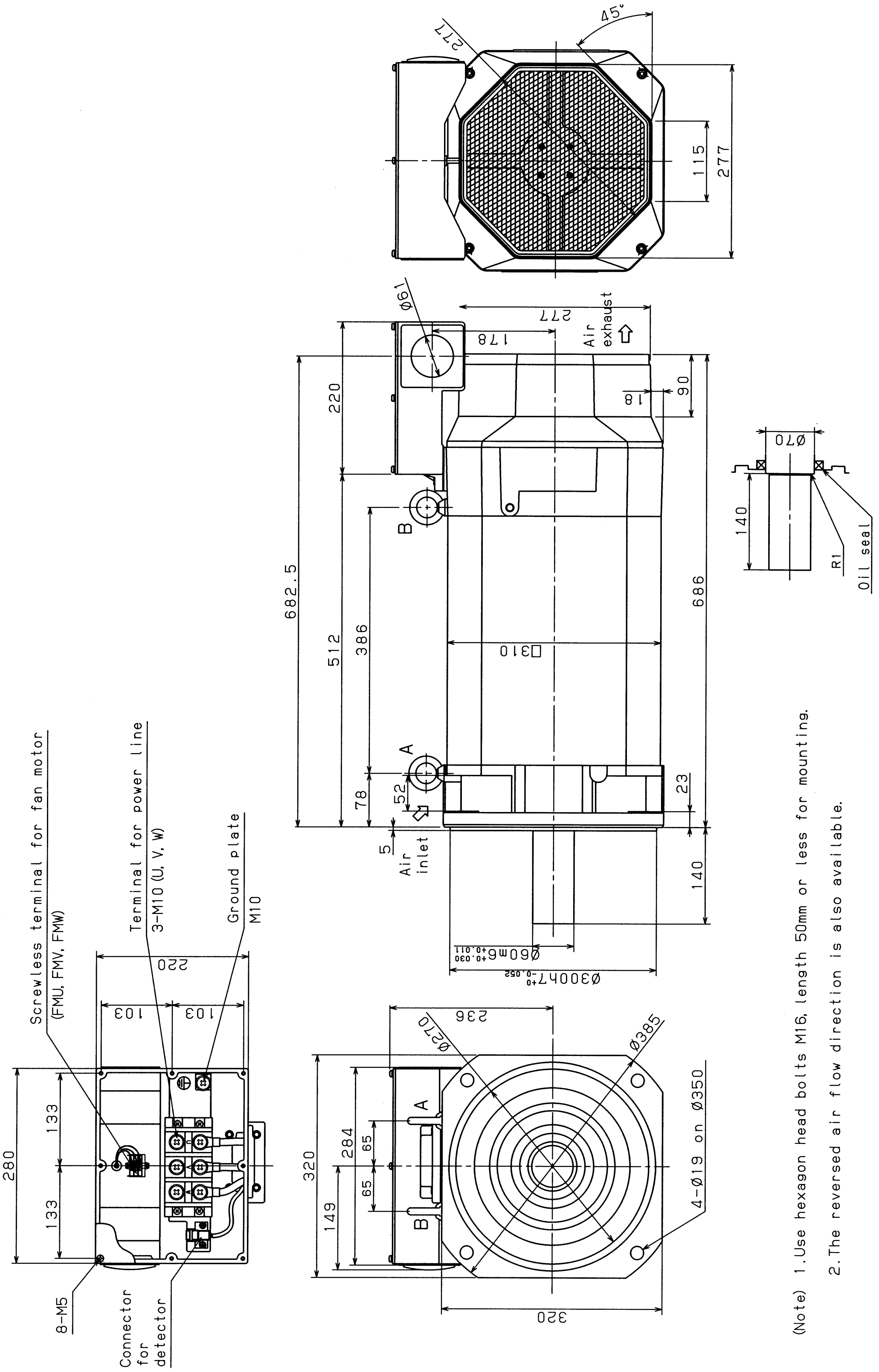
7.20 MODEL α30/6000HV*i* (FLANGE MOUNTING TYPE)



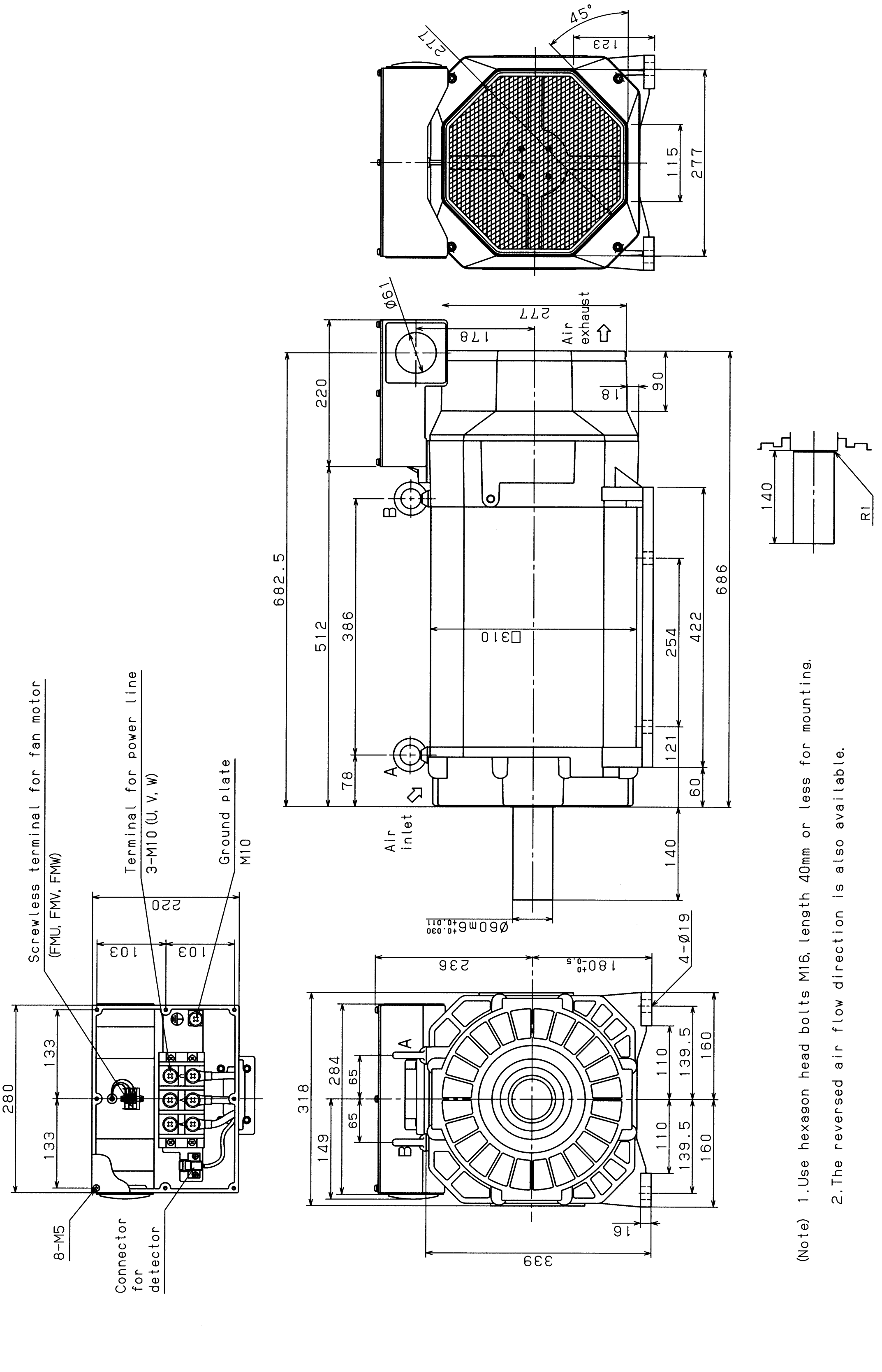
7.21 MODEL α30/6000HV*i* (FOOT MOUNTING TYPE)



7.22 MODEL α40/6000HV*i* (FLANGE MOUNTING TYPE)

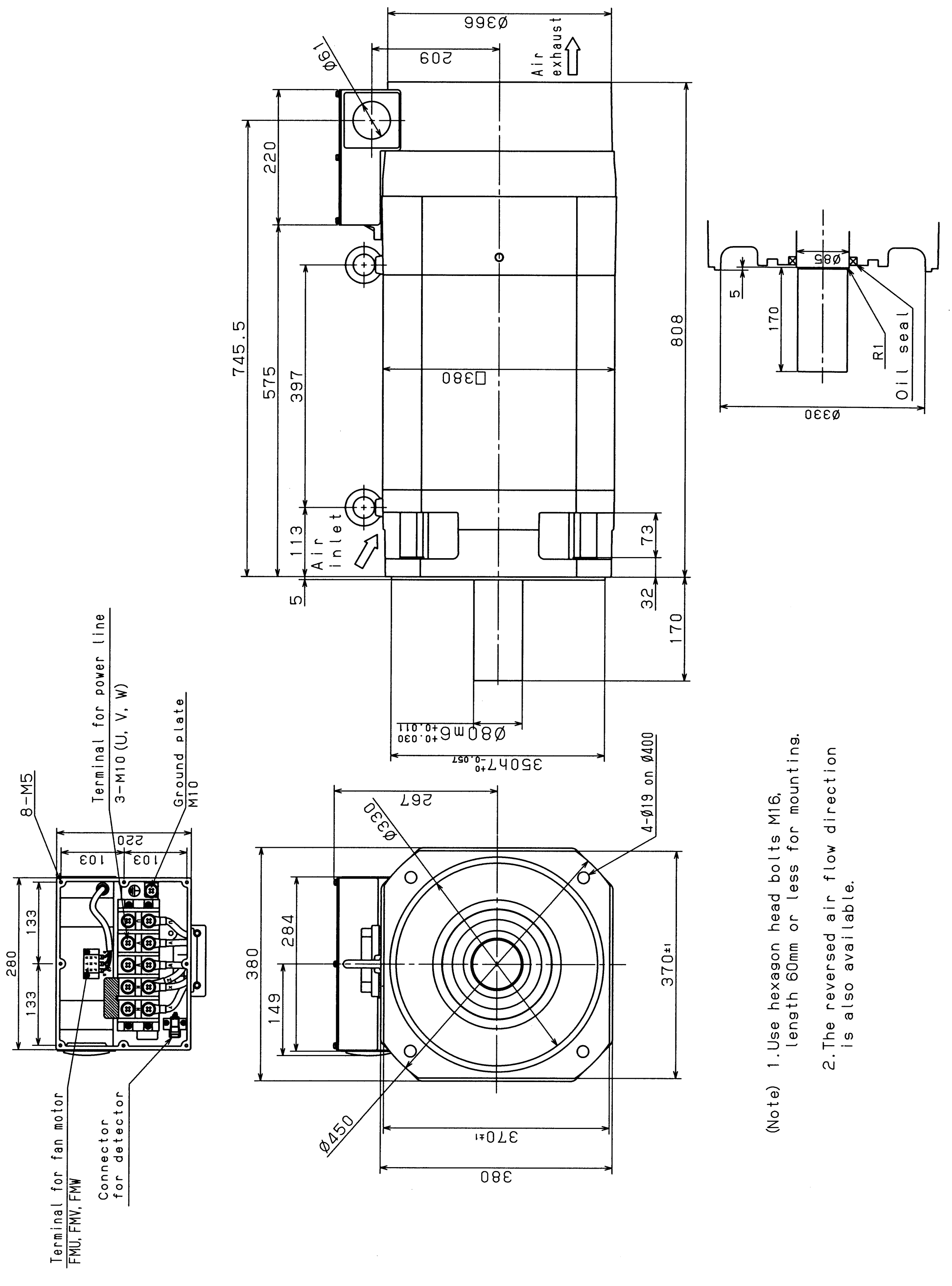


7.23 MODEL α40/6000HV*i* (FOOT MOUNTING TYPE)

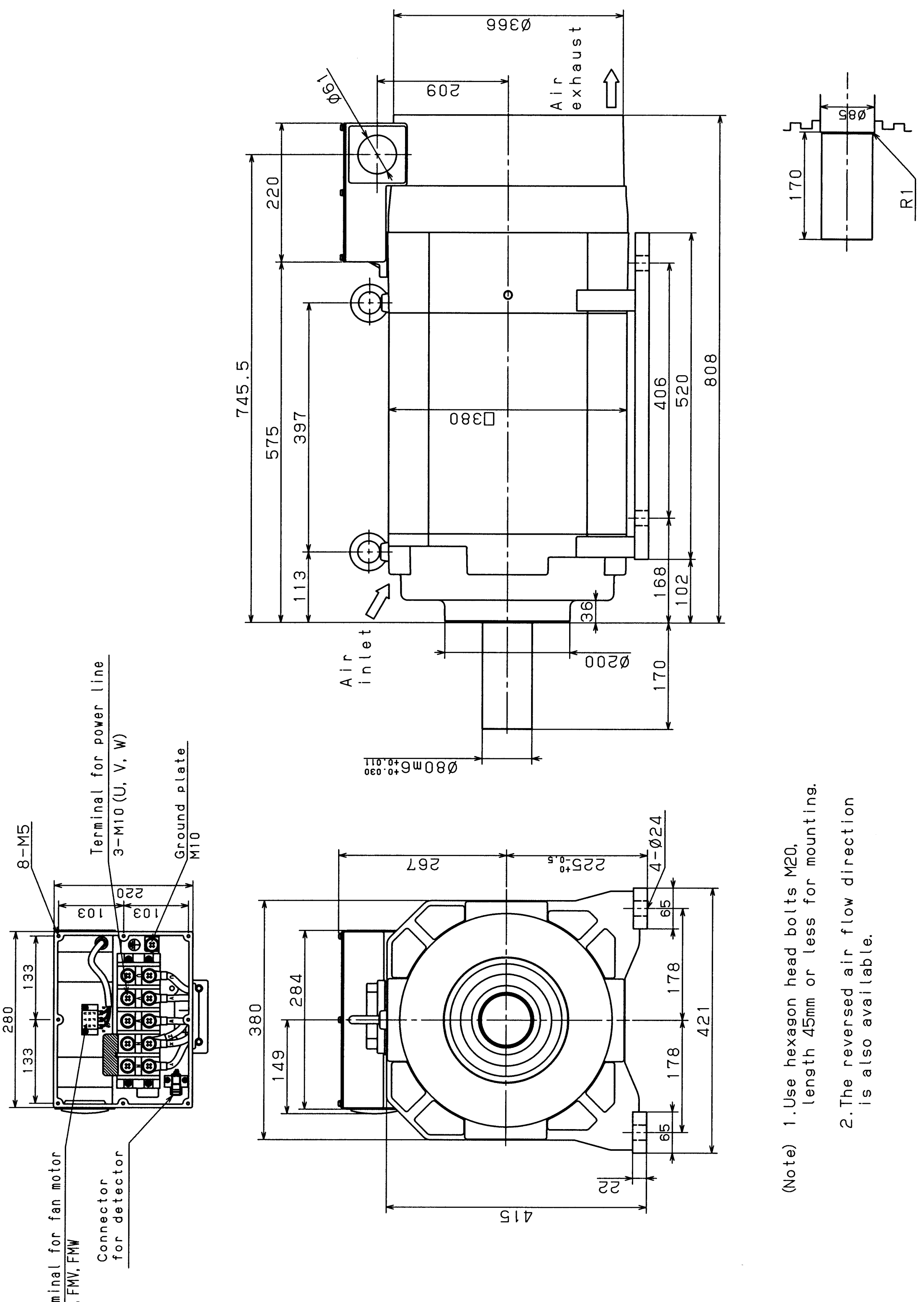


(Note) 1.Use hexagon head bolts M16, length 40mm or less for mounting.
2.The reversed air flow direction is also available.

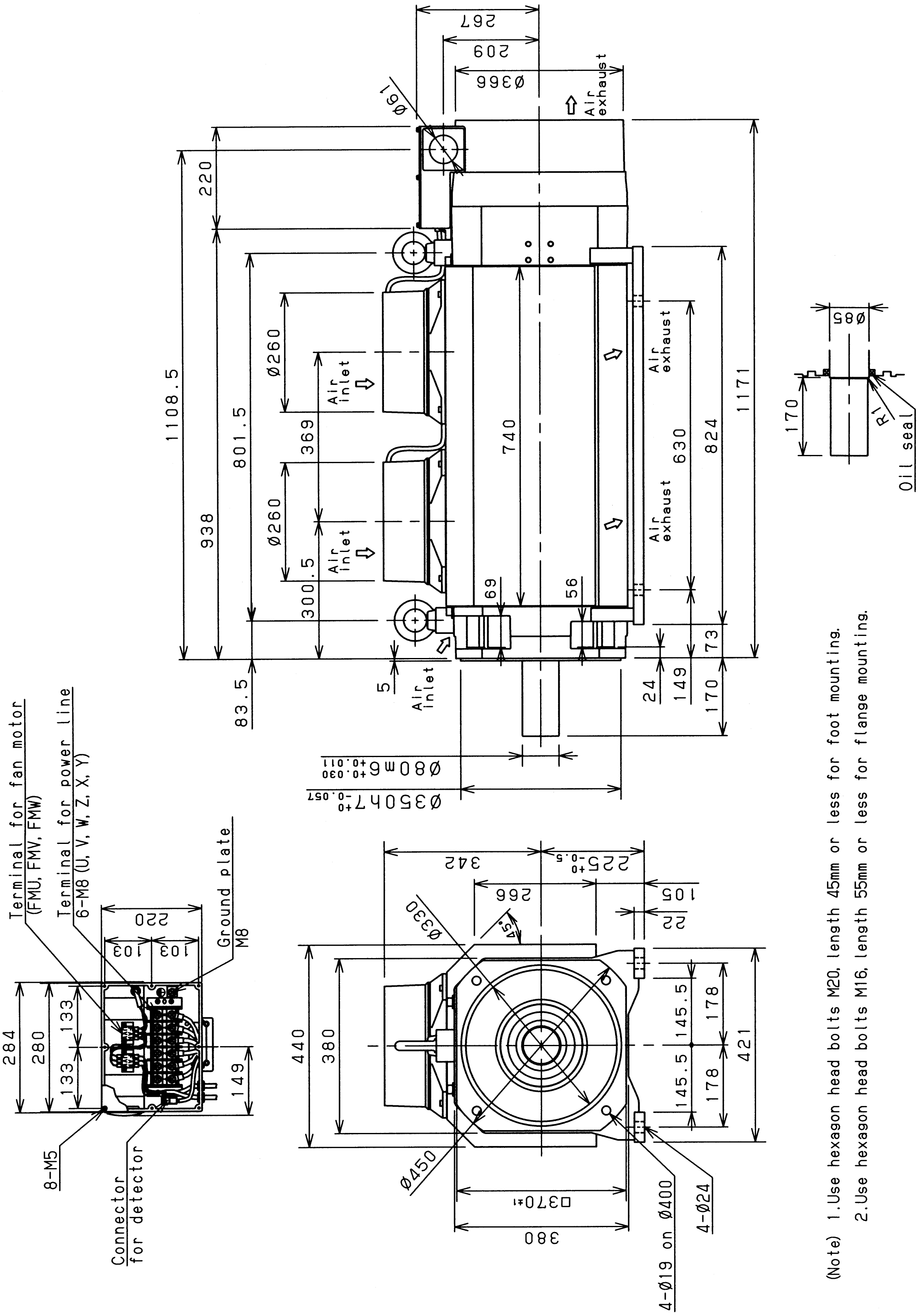
7.24 MODEL α60/4500HV*i* (FLANGE MOUNTING TYPE)



7.25 MODEL α60/4500HVi (FOOT MOUNTING TYPE)



7.26 MODEL α100/4000HVi (FOOT FLANGE MOUNTING TYPE)



VII. FANUC AC SPINDLE MOTOR α(HV)*i*P SERIES

1 GENERAL

FANUC AC spindle motor α(HV)*i*P series 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(HV)*i*P series			
Item / Model		α15/6000HV*i*P		α22/6000HV*i*P	
		Low-speed winding	High-speed winding	Low-speed winding	High-speed winding
Output (*2)	Cont. rated kW (HP)	5 (6.6)	7.5 (10)	7.5 (10)	11 (14.7)
	30 min rated [15 min] (*3) kW (HP)	9 (12)	9 (12)	15 (20.1)	15 (20.1)
	S3 60% [15%] (*4)(*5) kW (HP)	9 (12)	9 (12)	15 (20.1)	15 (20.1)
Rated current A (*6)	Cont. rated		25		35
	30 min rated (*3) S3 60%, 15% (*4)		29		43
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	$kg·m^2$	0.09		0.128	
	$kgf·cm·s^2$	0.93		1.29	
Weight kgf		110		143	
Vibration		V5 (option V3)			
Noise		75 dB (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		M*i* sensor or MZ*i* sensor			
Type of thermal protection (*10)		TP211			
Resolution of the MZ*i* 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		SPM-15HV*i*		SPM-30HV*i*	
Model		α15/6000HV*i*P		α22/6000HV*i*P	

Series		α(HV)*i*P series			
Item / Model		α40/6000HV*i*P		α50/6000HV*i*P	
		Low-speed winding	High-speed winding	Low-speed winding	High-speed winding
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		75 dB (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		M*i* sensor or MZ*i* sensor			
Type of thermal protection (*10)		TP211			
Resolution of the MZ*i* 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		SPM-30HV*i*		SPM-30HV*i*	
Model		α40/6000HV*i*P		α50/6000HV*i*P	

Series		α(HV)*i*P series	
Item / Model		α60/4500HV*i*P	
		Low-speed winding	High-speed winding
Output (*2)	Cont. rated kW (HP)	18.5 (24.8)	22 (29.5)
	30 min rated [15 min] (*3) kW (HP)	30 (40.2)	30 (40.2)
	S3 60% [15%] (*4)(*5) kW (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		80 dB (A) or less	
Cooling system (*7)		Totally enclosed and fan cooled IC0A6	
Cooling fan W		90	
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		M*i* sensor or MZ*i* sensor	
Type of thermal protection (*10)		TP211	
Resolution of the MZ*i* 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		SPM-30HV*i*	
Model		α60/4500HV*i*P	

(*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 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: 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 α50/6000HV*i*P and α60/4500HV*i*P is 15 min rated.

(*4) S3 15% for low-speed winding models other than α50/6000HV*i*P and α60/4500HV*i*P.
S3 25% for low-speed winding of α50/6000HV*i*P and α60/4500HV*i*P

(*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 module 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.

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

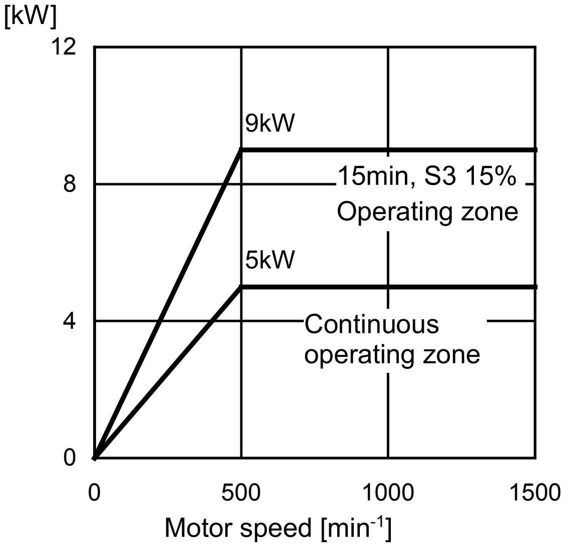
- P[kW]: Motor output
- $N[min^{-1}]$: Motor speed

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

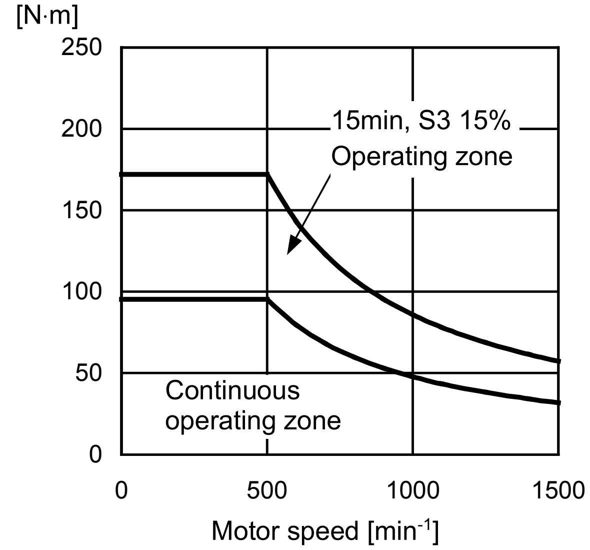
3.1 MODEL α15/6000HV*i*P

Applicable amplifier SPM-15HV*i*

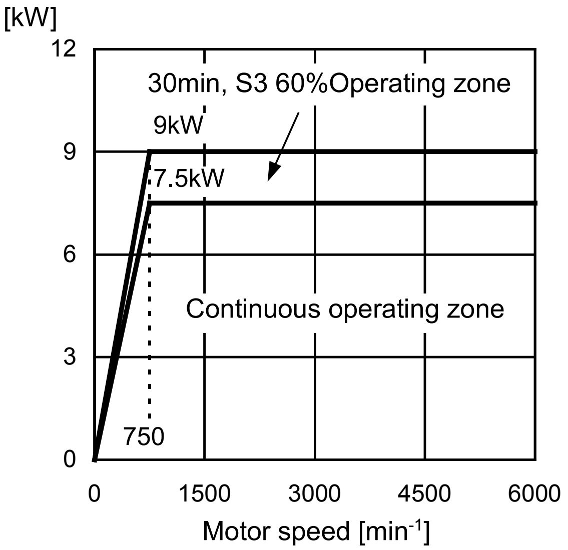
Low-speed winding output (Y connection)



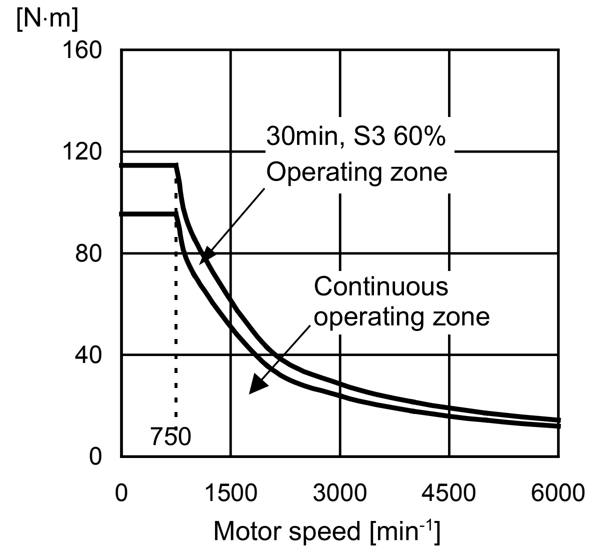
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



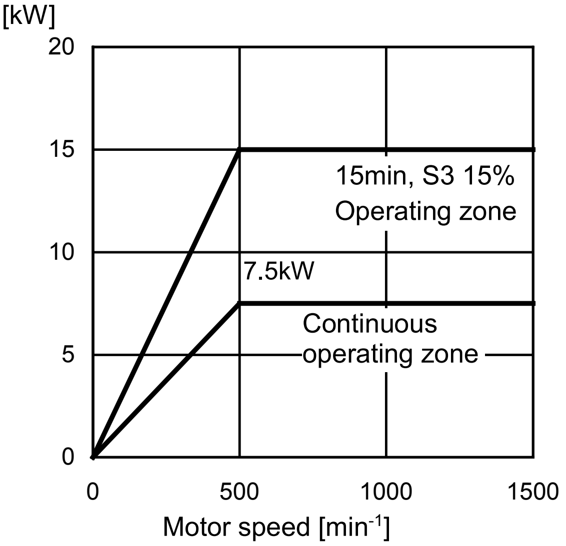
High-speed winding output (Δ connection)



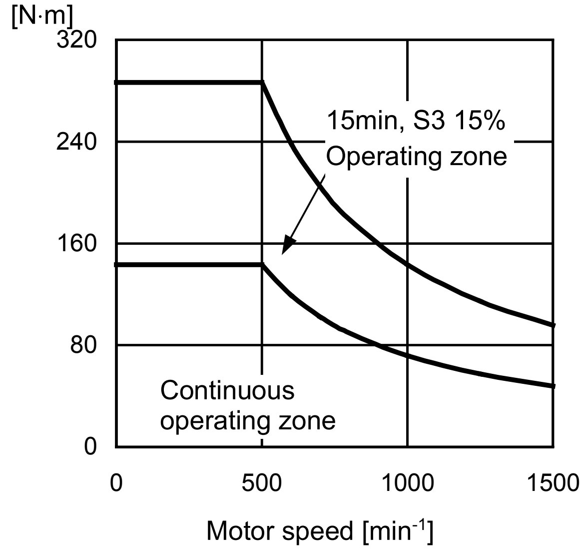
3.2 MODEL α22/6000HV*i*P

Applicable amplifier SPM-30HV*i*

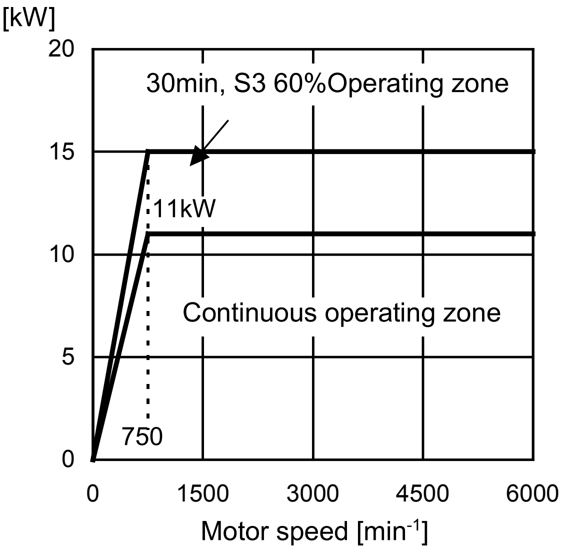
Low-speed winding output (Y connection)



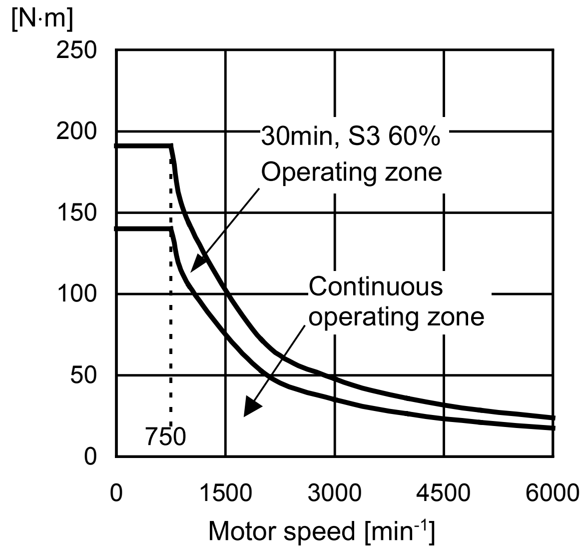
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



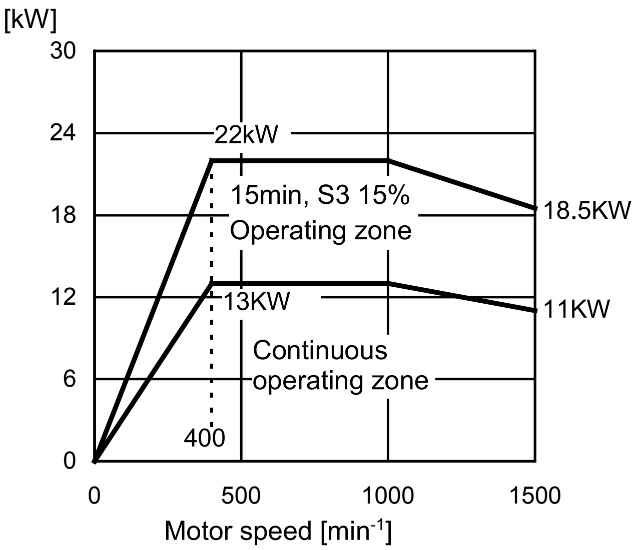
High-speed winding output (Δ connection)



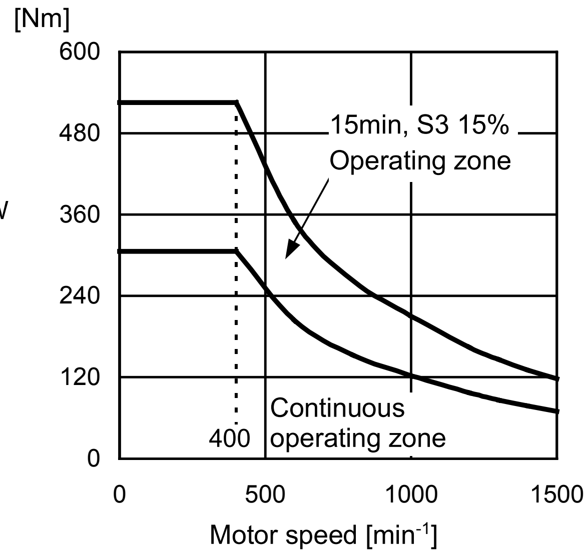
3.3 MODEL α40/6000HV*i*P

Applicable amplifier SPM-30HV*i*

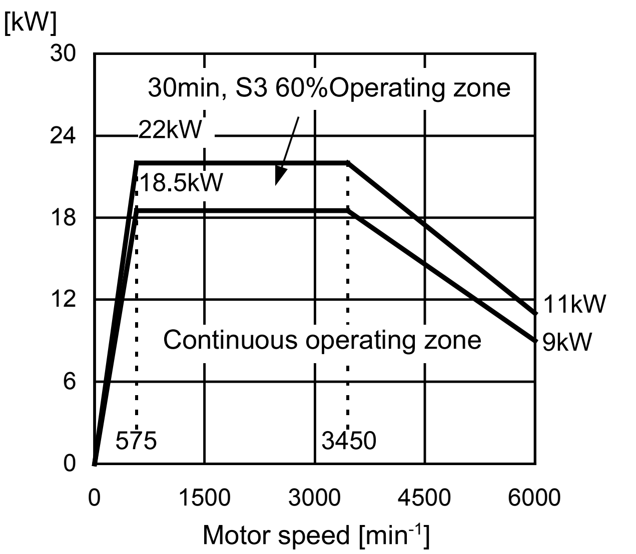
Low-speed winding output (Y connection)



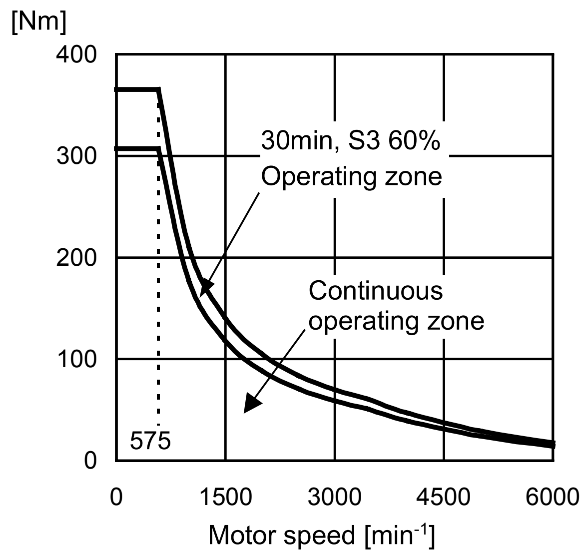
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



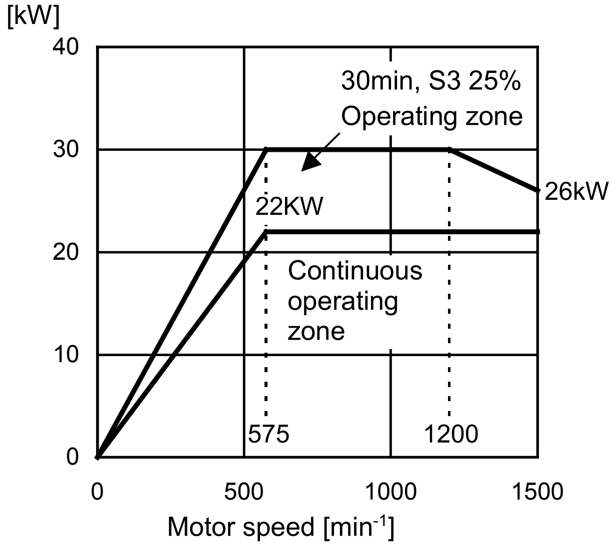
High-speed winding output (Δ connection)



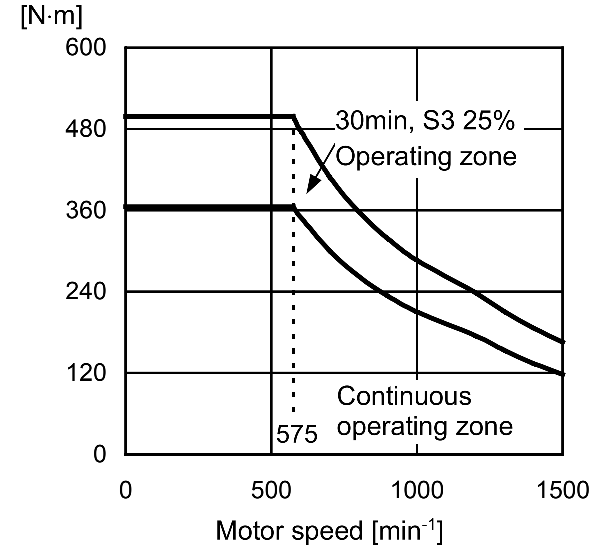
3.4 MODEL α50/6000HV*i*P

Applicable amplifier SPM-30HV*i*

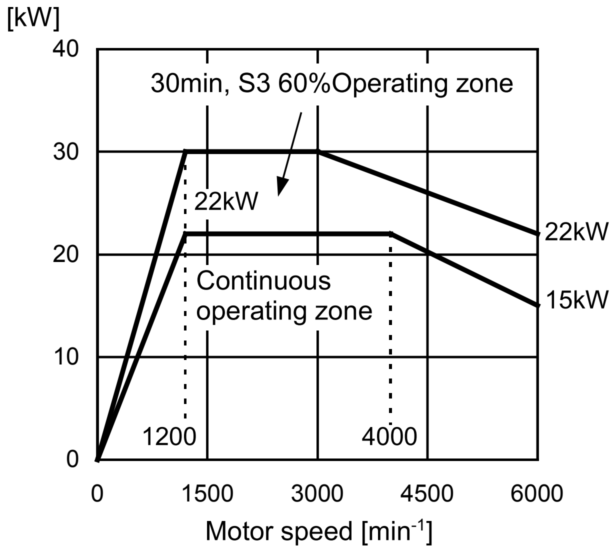
Low-speed winding output (Y connection)



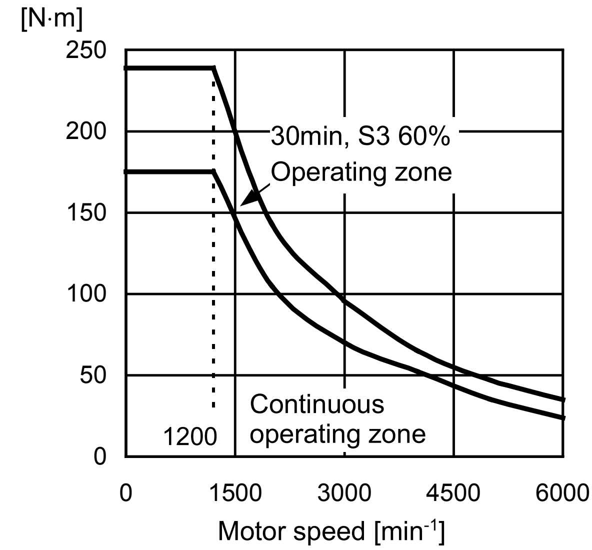
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



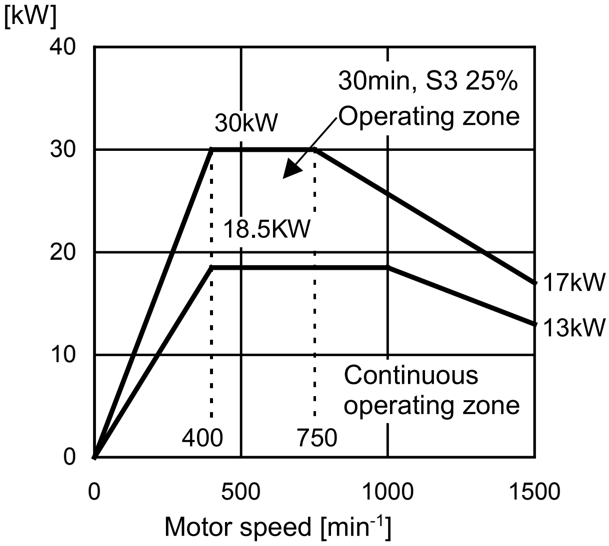
High-speed winding output (Δ connection)



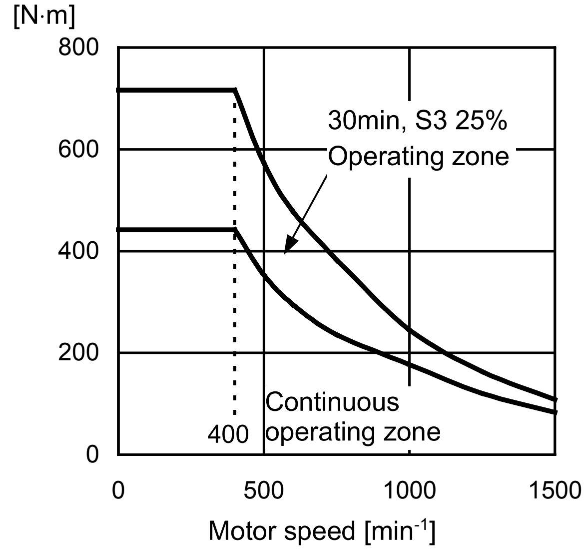
3.5 MODEL α60/4500HV*i*P

Applicable amplifier SPM-30HV*i*

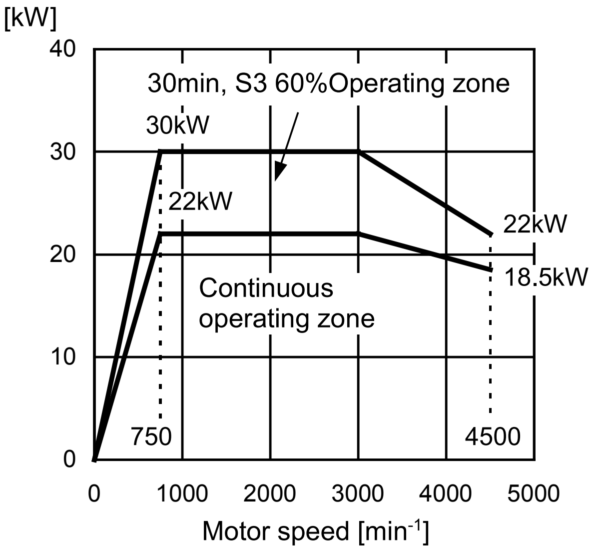
Low-speed winding output (Y connection)



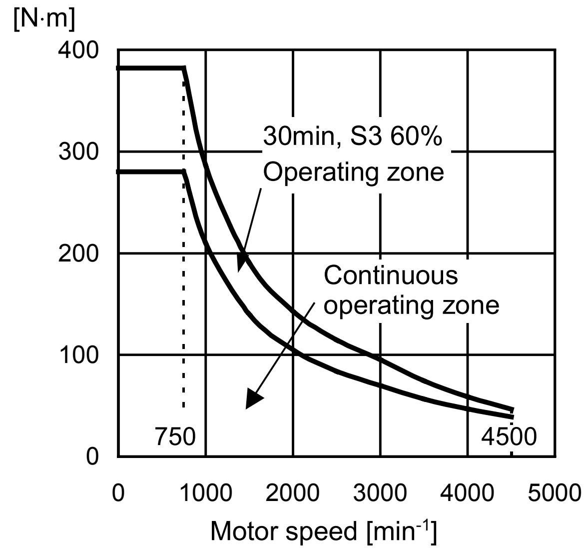
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



High-speed winding output (Δ connection)



4 CONNECTIONS

4.1 MODELS α15/6000HV*i*P TO α60/4500HV*i*P

Cables for the power lead and fan motor are connected to the terminal block.
M*i* sensor or MZ*i* 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
α15/6000HV*i*P, α22/6000HV*i*P	M5	M5	Screw-less terminal block
α40/6000HV*i*P, α50/6000HV*i*P	M6	M6	Screw-less terminal block
α60/4500HV*i*P	M8	M8	M3.5

Cable for the power lead

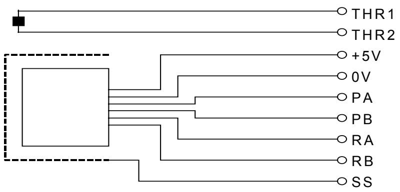
For the power lead cable specification, refer to "FANUC SERVO AMPLIFIER α*i* series DESCRIPTIONS (B-65282EN)".

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

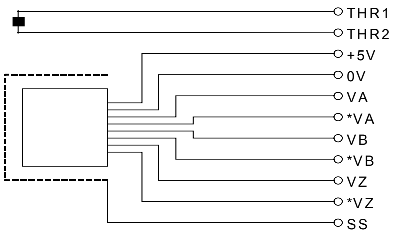
Connector attachment for a motor with a built-in M*i* sensor



Connector pins arrangement

Number	B1	B2	B3	B4	B5	B6
Color						
Signal		RA	RB		0V	THR2
Number	A1	A2	A3	A4	A5	A6
Color						
Signal	+5V	PA	PB		SS	THR1

Connector attachment for a motor with a built-in MZ*i* 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

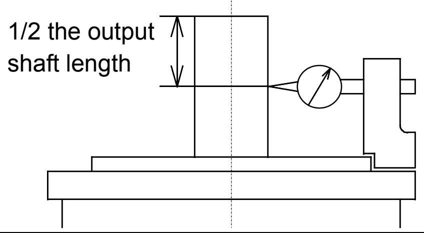
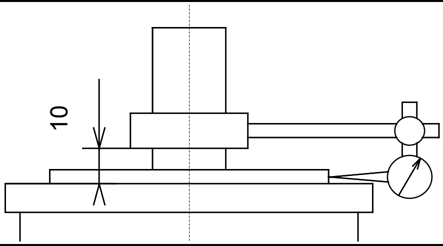
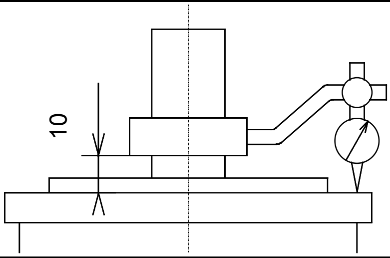
Use the motor output shaft below the allowable radial loads shown in the table below.

Model	Allowable radial load (kgf)	
	At output shaft end	At output shaft center
α15/6000HV*i*P	2940N (300kgf)	3410N (348kgf)
α22/6000HV*i*P	4410N (450kgf)	4988N (509kgf)
α40/6000HV*i*P, α50/6000HV*i*P	5390N (550kgf)	6134N (626kgf)
α60/4500HV*i*P	-	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.

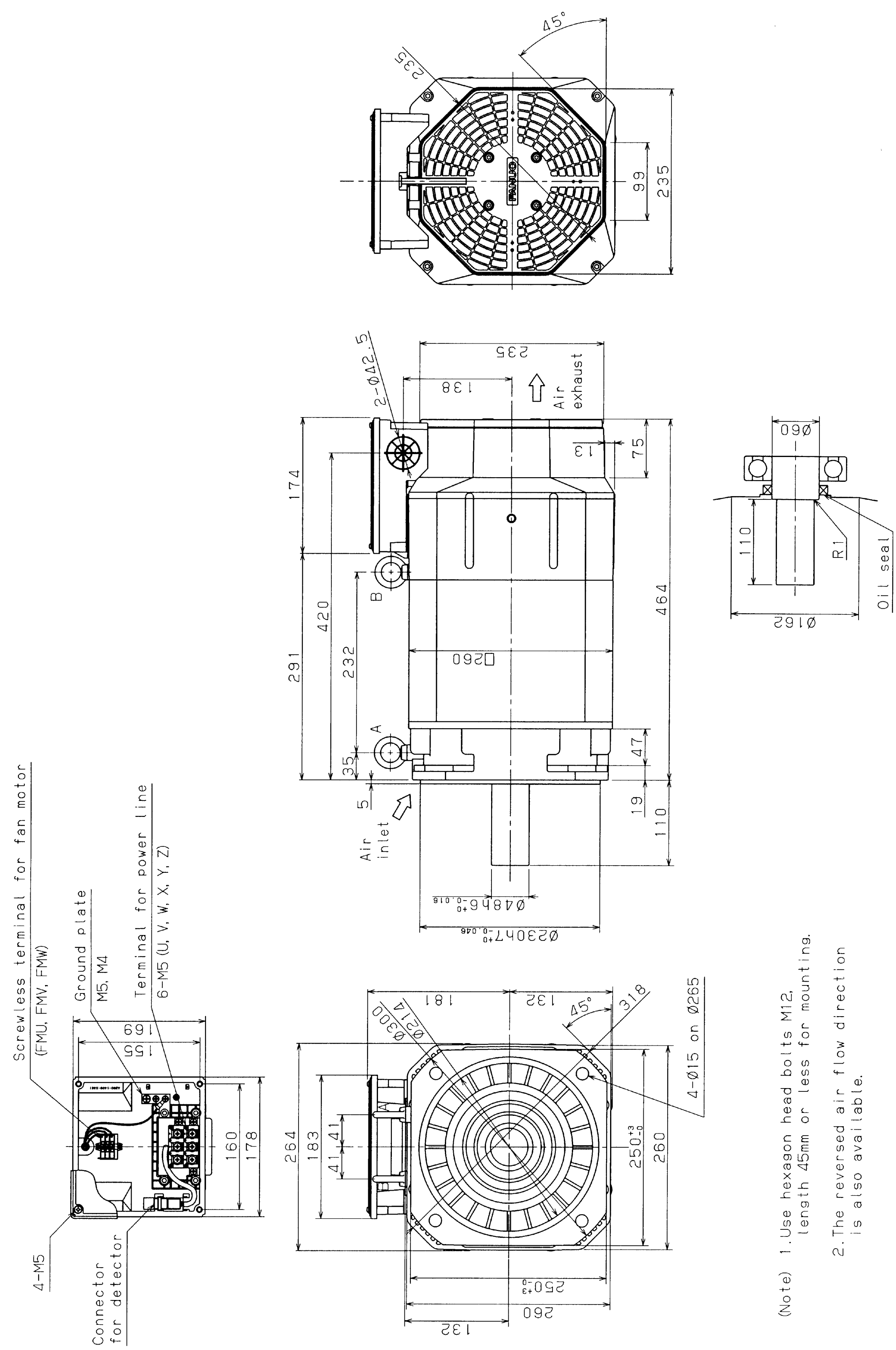
6 ASSEMBLING ACCURACY

Item \ Model	α15HV*i*P, α22Hv*i*P	α40HV*i*P to α60HV*i*P	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	

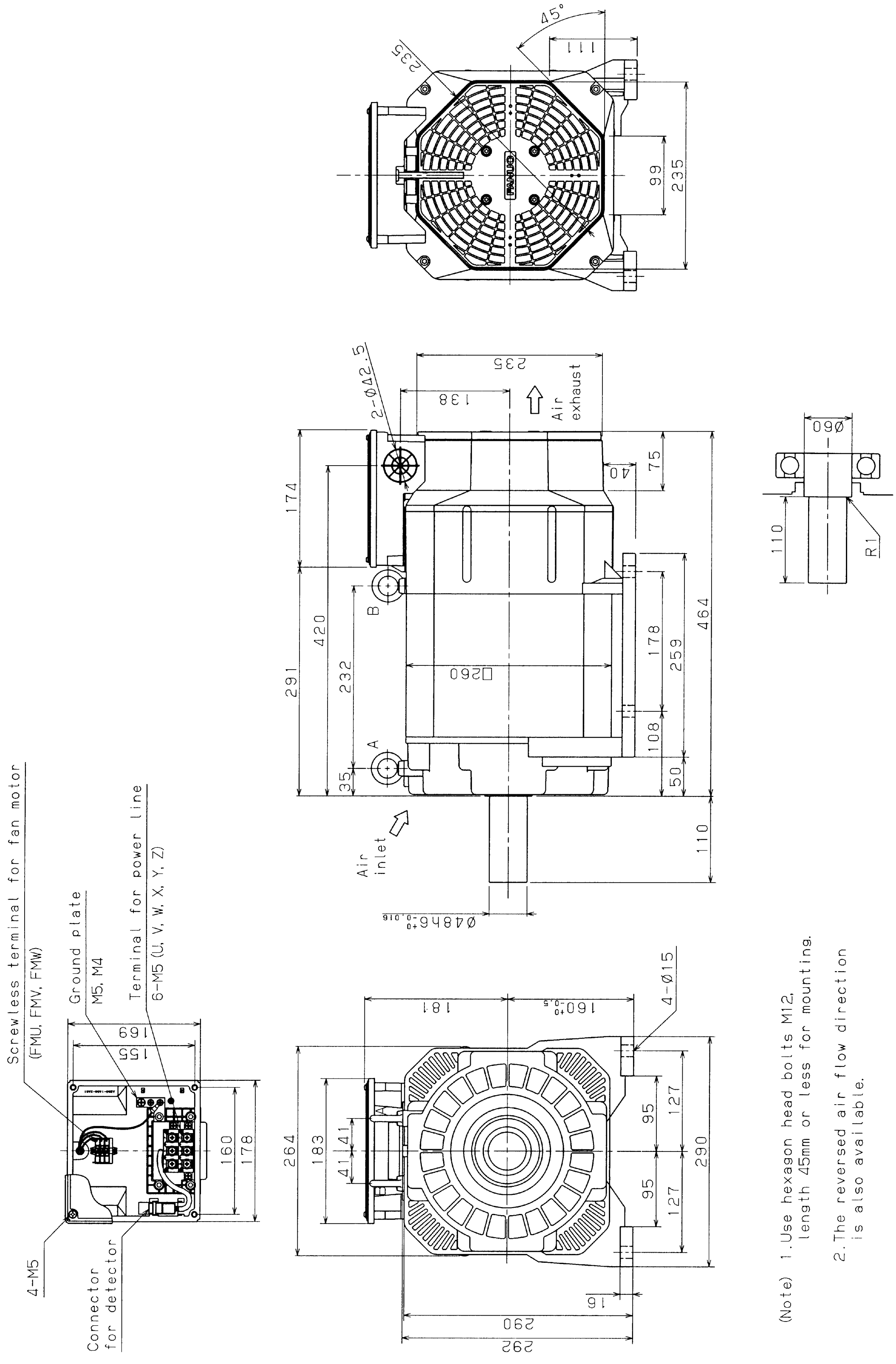
7 EXTERNAL DIMENSIONS

Model name	Section
Model α15/6000HV*i*P (flange mounting type)	7.1
Model α15/6000HV*i*P (foot mounting type)	7.2
Model α22/6000HV*i*P (flange mounting type)	7.3
Model α22/6000HV*i*P (foot mounting type)	7.4
Model α40/6000HV*i*P (flange mounting type)	7.5
Model α40/6000HV*i*P (foot mounting type)	7.6
Model α50/6000HV*i*P (flange mounting type)	7.7
Model α50/6000HV*i*P (foot mounting type)	7.8
Model α60/4500HV*i*P (flange mounting type)	7.9
Model α60/4500HV*i*P (foot mounting type)	7.10

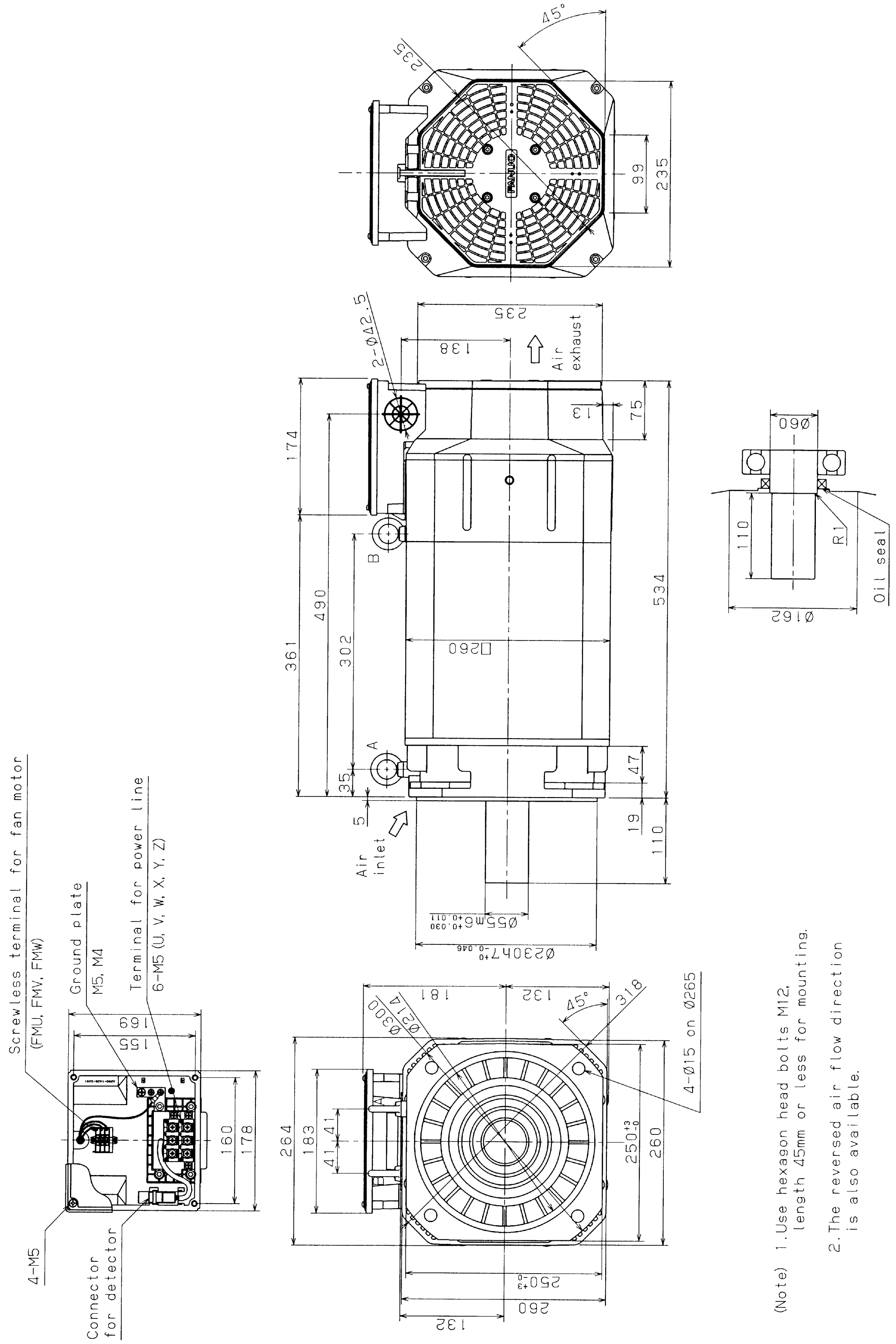
7.1 MODEL α15/6000HV*i*P (FLANGE MOUNTING TYPE)



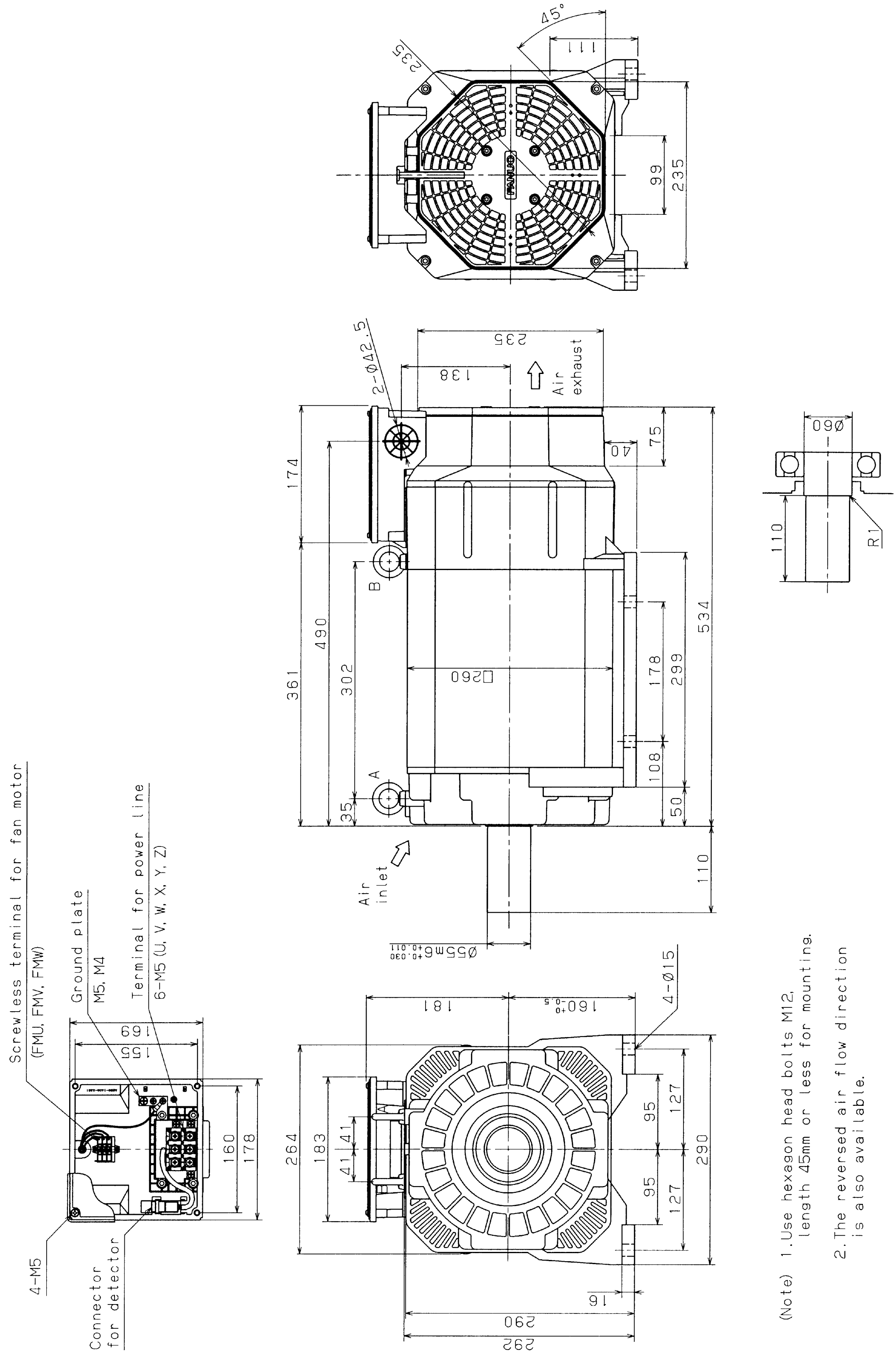
7.2 MODEL α15/6000HV*i*P (FOOT MOUNTING TYPE)



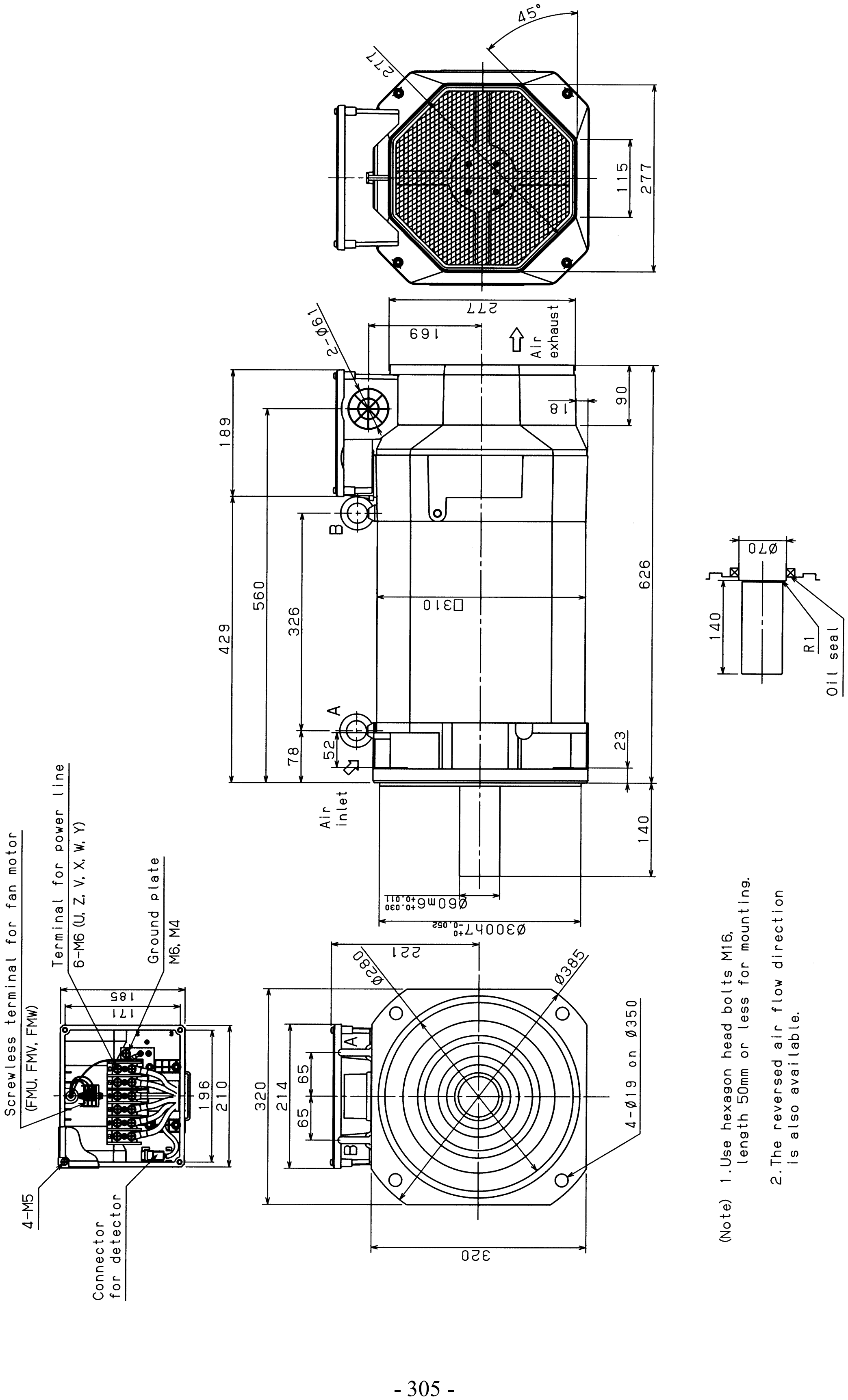
7.3 MODEL α22/6000HV*i*P (FLANGE MOUNTING TYPE)



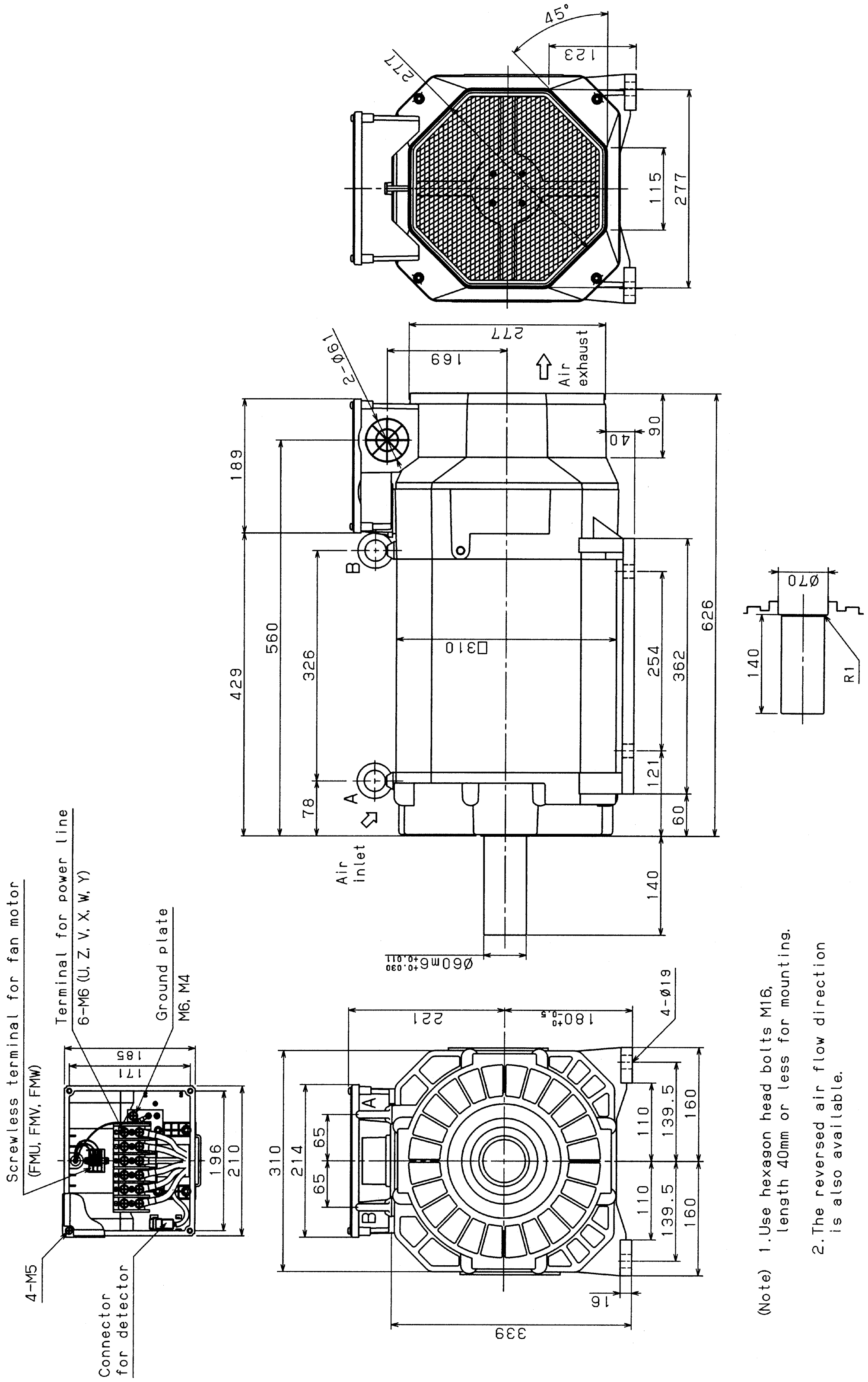
7.4 MODEL α22/6000HV*i*P (FOOT MOUNTING TYPE)



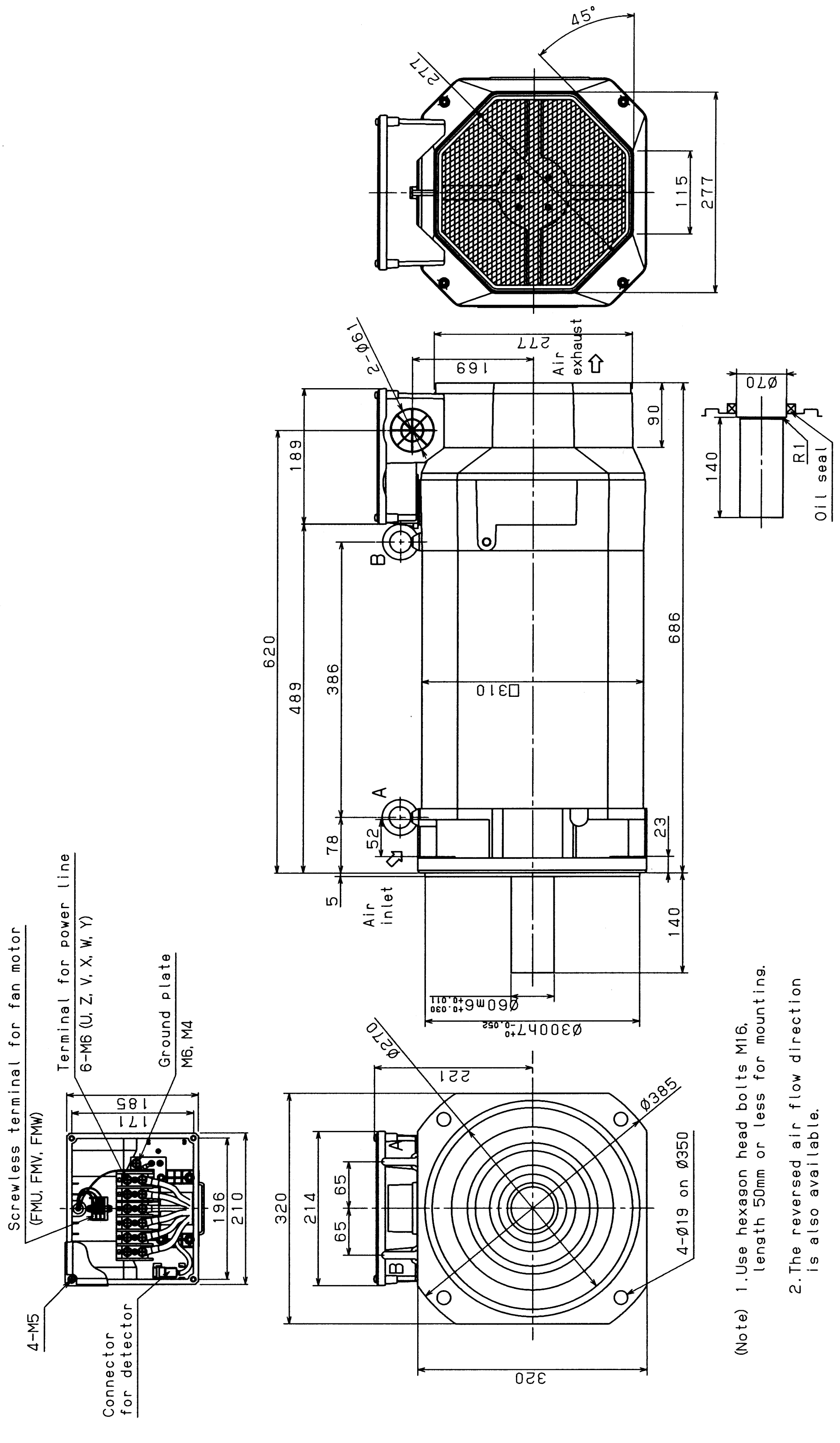
7.5 MODEL α40/6000HV*i*P (FLANGE MOUNTING TYPE)



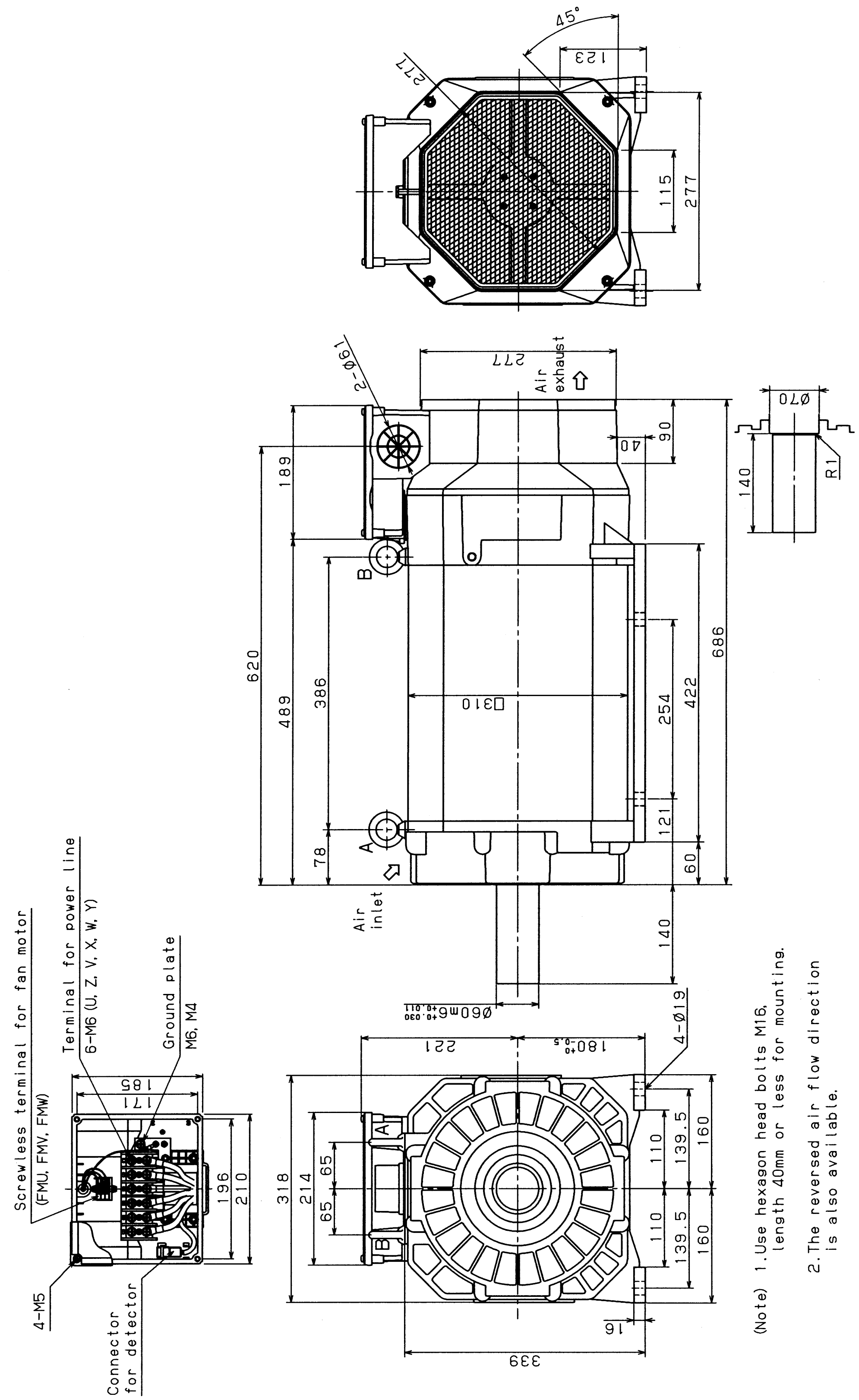
7.6 MODEL α40/6000HV*i*P (FOOT MOUNTING TYPE)



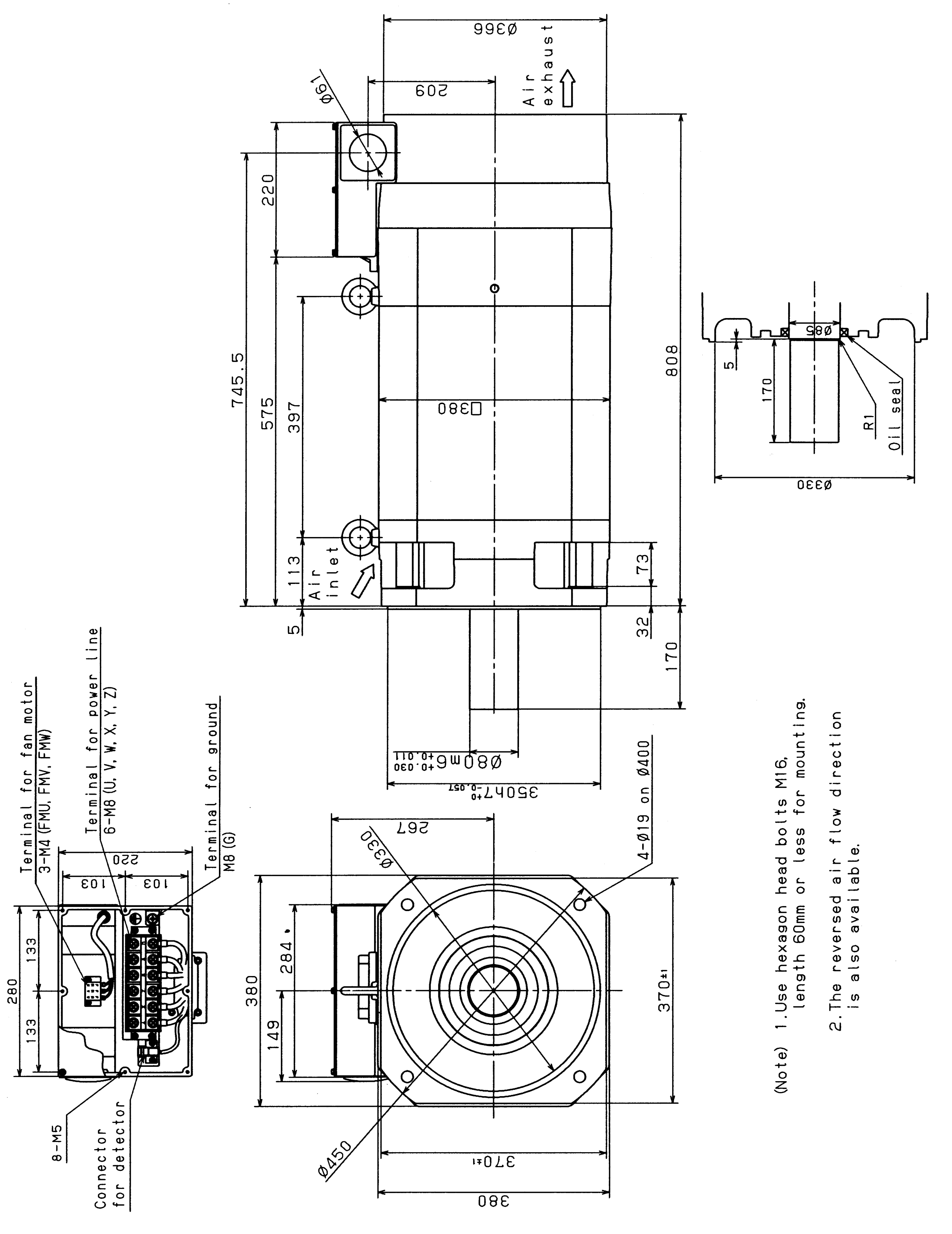
7.7 MODEL α50/6000HV*i*P (FLANGE MOUNTING TYPE)



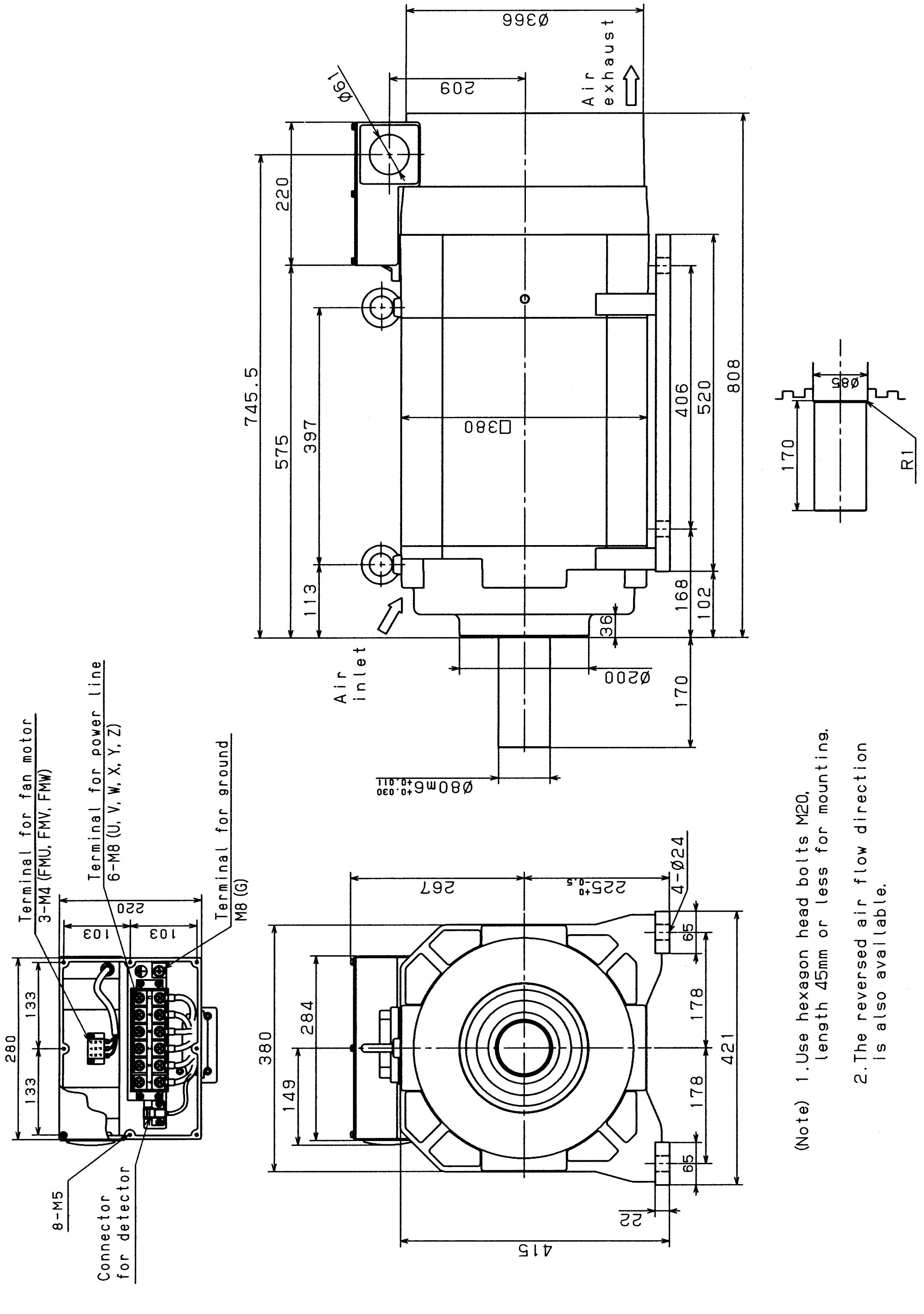
7.8 MODEL α50/6000HV*i*P (FOOT MOUNTING TYPE)



7.9 MODEL α60/4500HV*i*P (FLANGE MOUNTING TYPE)



7.10 MODEL α60/4500HV*i*P (FOOT MOUNTING TYPE)



VIII. FANUC AC SPINDLE MOTOR α(HV)iT SERIES

1 GENERAL

The FANUC AC Spindle Motor α(HV)*i*T series includes spindle motors (hollow shaft), which can be driven by 400 to 480VAC without a step-down transformer(*1).

(*1) For models α1.5HV*i*T, α2HV*i*T, and α3HV*i*T, 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 α*i*T series section.

2 SPECIFICATIONS

Item \ Model		α1.5/15000HV*i*T	α2/15000HV*i*T	α3/12000HV*i*T
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	15,000	15,000	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 MZ*i* 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 module		SPM-15HV*i*	SPM-30HV*i*	SPM-11HV*i*

* See Page 319 for Cautions and limitations.

Item	Model	α6/12000HV*i*T		α8/12000HV*i*T	
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 MZ*i* 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 module		SPM-15HV*i*		SPM-15HV*i*	

* See Page 319 for Cautions and limitations.

Item \ Model		α8/15000HV*i*T		α15/10000HV*i*T	
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 MZ*i* 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 module		SPM-30HV*i*		SPM-30HV*i*	

* See Page 319 for Cautions and limitations.

Item \ Model		α15/12000HV*i*T		α22/10000HV*i*T	
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% (*3)(*4) kW (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	12,000	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 MZ*i* 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 module		SPM-30HV*i*		SPM-30HV*i*	

* See Page 319 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 α1.5/15000HV*i*T and α2/15000HV*i*T is 15 min rated.

(*3) 40% for α1.5/15000HV*i*T, α2/15000HV*i*T, and α22/10000HV*i*T

(*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 a gear coupling or 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 module 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 α*i* 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 α1.5/15000HV*i*T, α2/15000HV*i*T, or α3/15000HV*i*T 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.

$T[N{\cdot}m]=P[kW]\times1000/0.1047/N[min^{-1}]$

P[kW]: Motor output

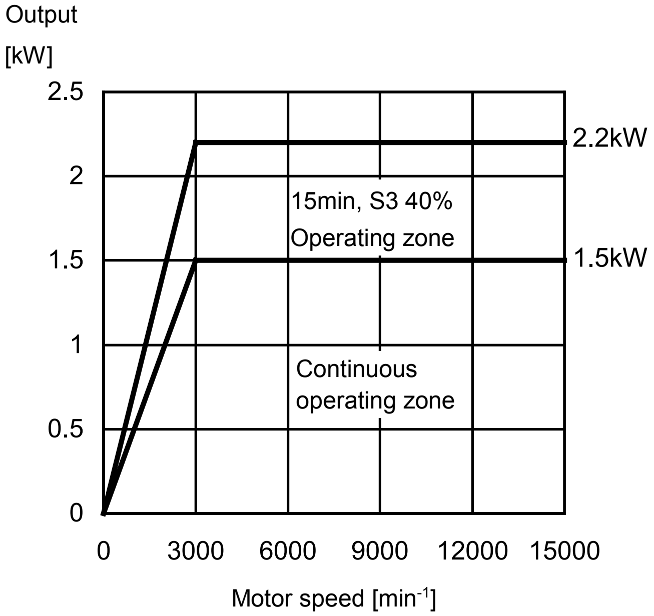
$N[min^{-1}]$: Motor speed

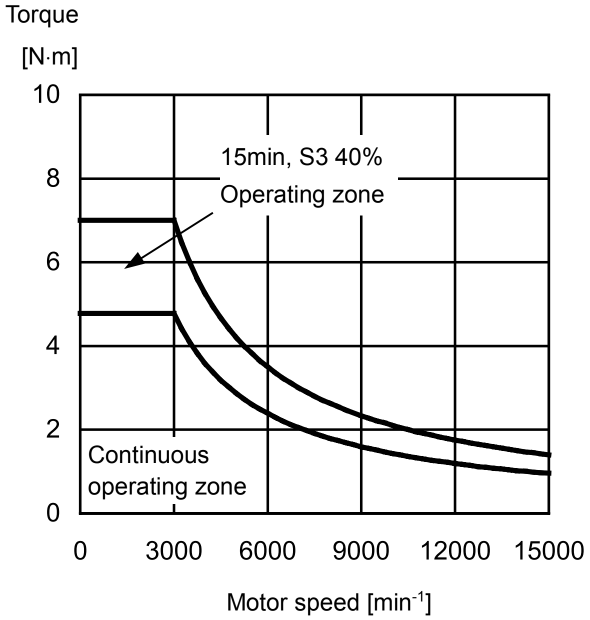
When the unit of T is [kgf·m],

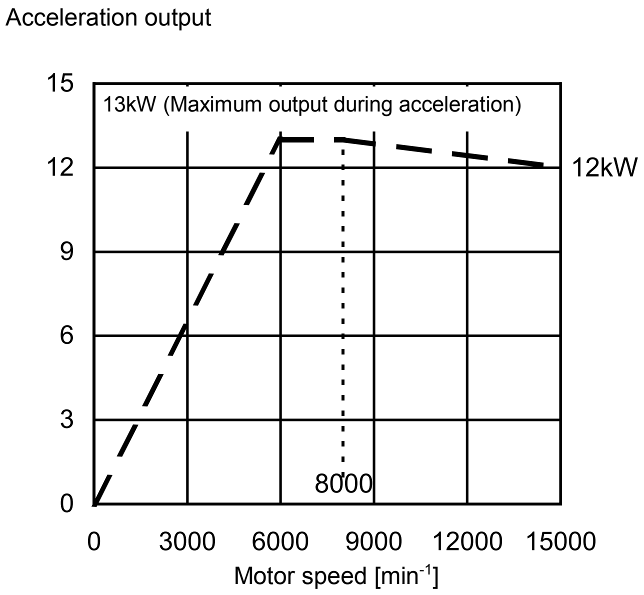
$T[kgf{\cdot}m]=P[kW]\times1000/1.0269/N[min^{-1}]$

3.1 MODEL α1.5/15000HV*i*T

Applicable amplifier SPM-15HV*i*



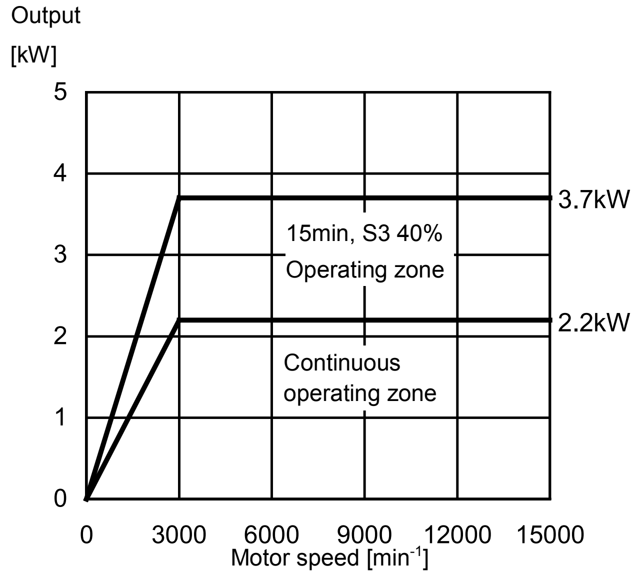


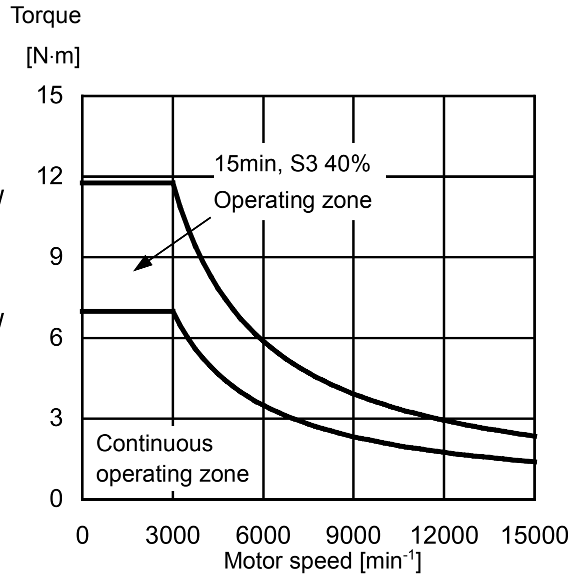


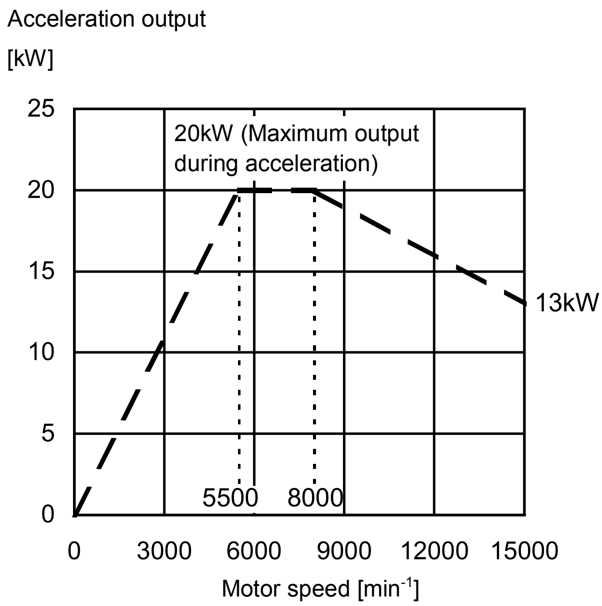
> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

3.2 MODEL α2/15000HV*i*T

Applicable amplifier SPM-30HV*i*



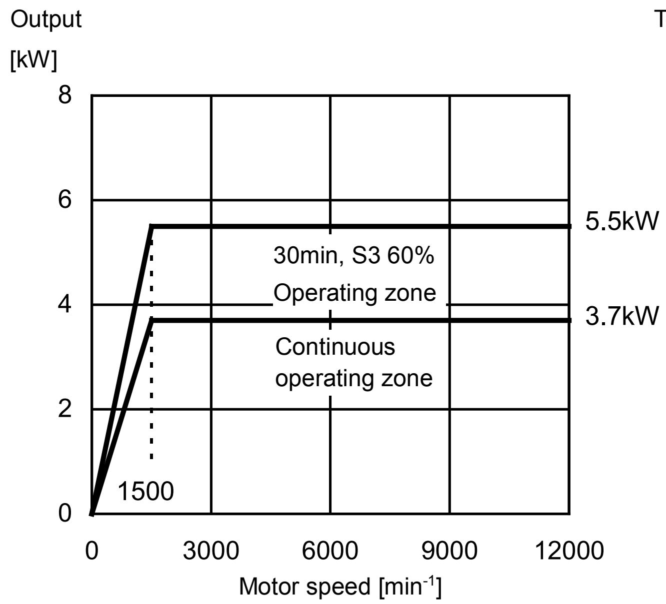


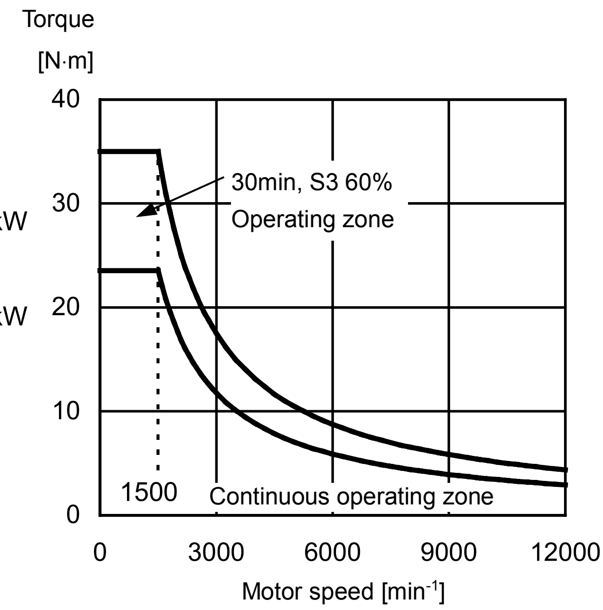


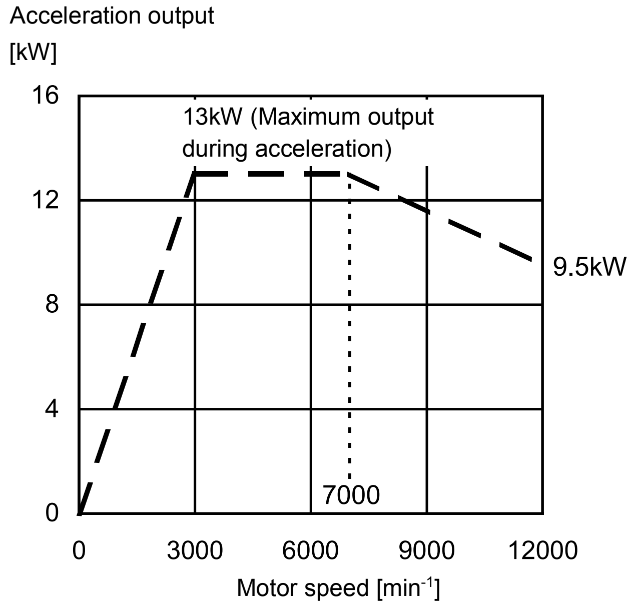
NOTE
Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

3.3 MODEL α3/12000HV*i*T

Applicable amplifier SPM-11HV*i*







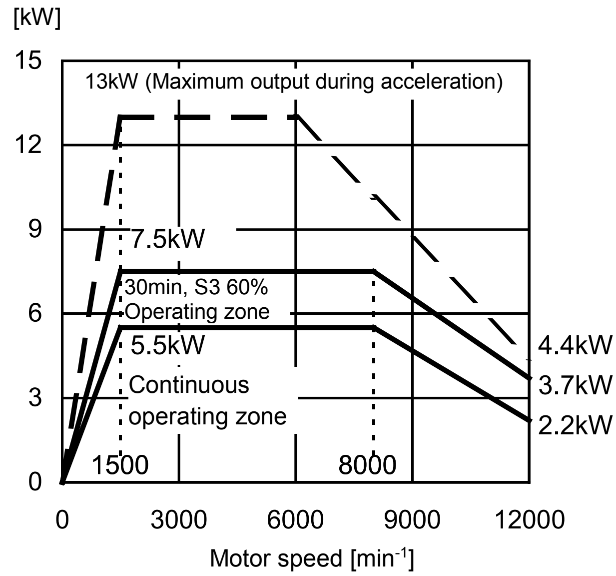
NOTE

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

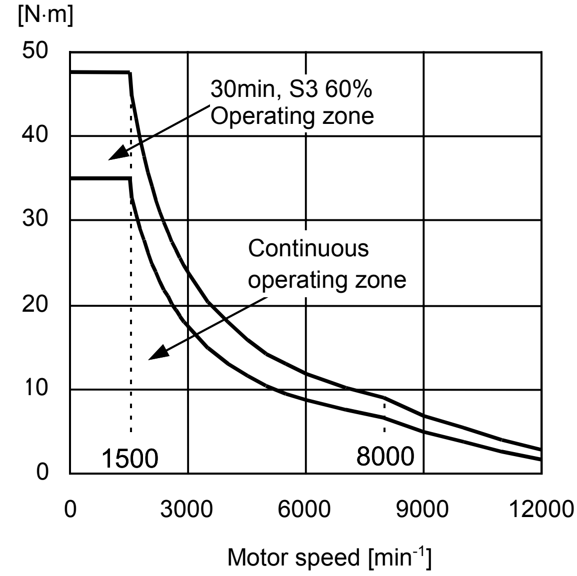
3.4 MODEL α6/12000HV*i*T

Applicable amplifier SPM-15HV*i*

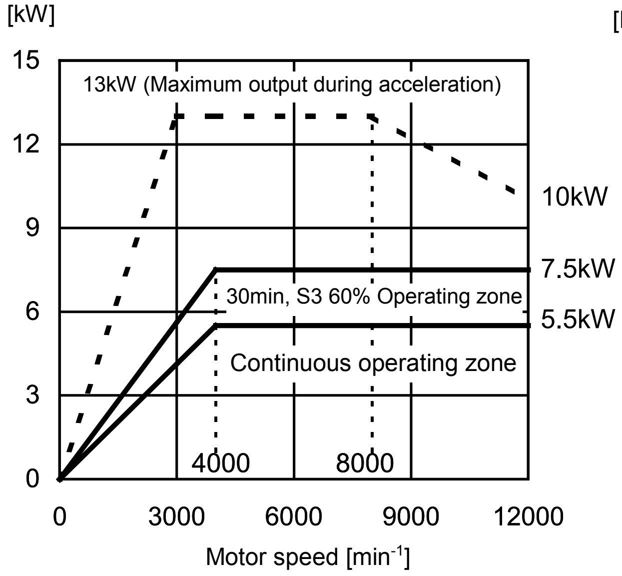
Low-speed winding output (Y connection)



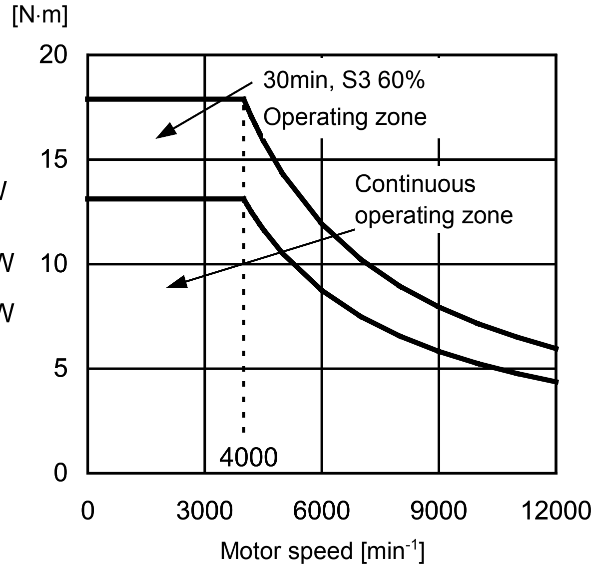
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



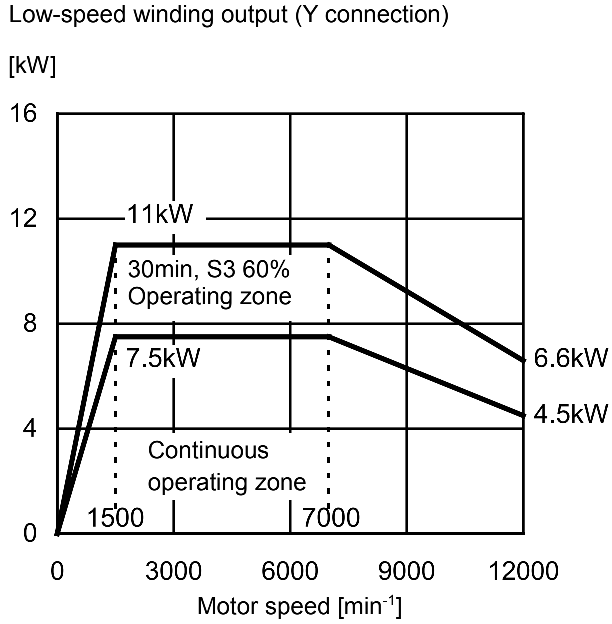
High-speed winding output (Δ connection)

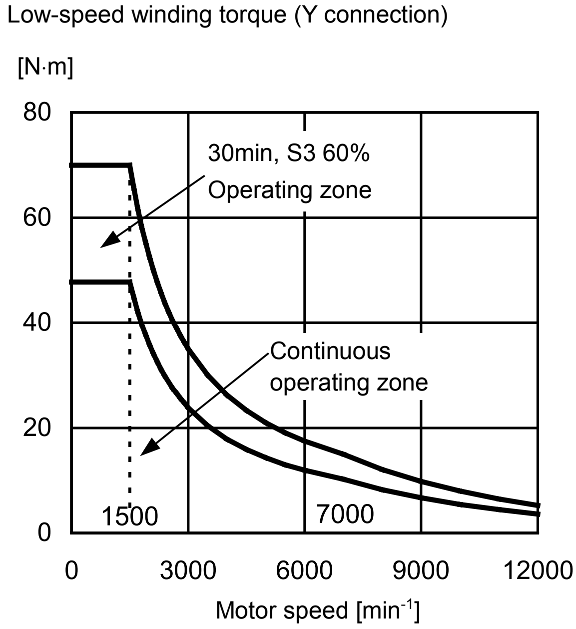


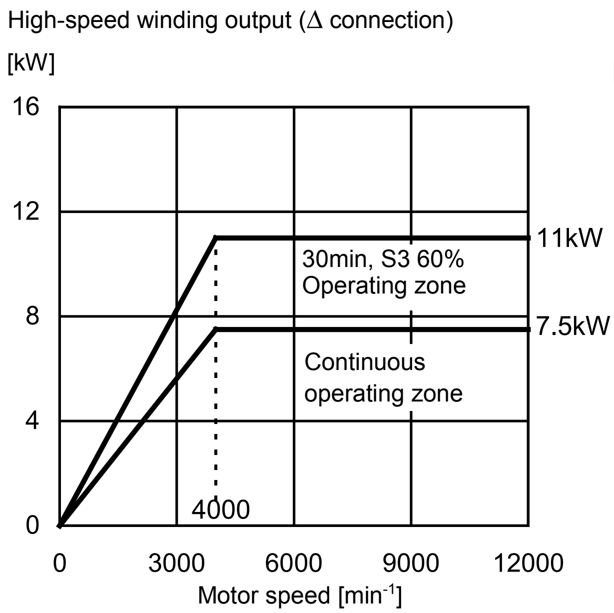
> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

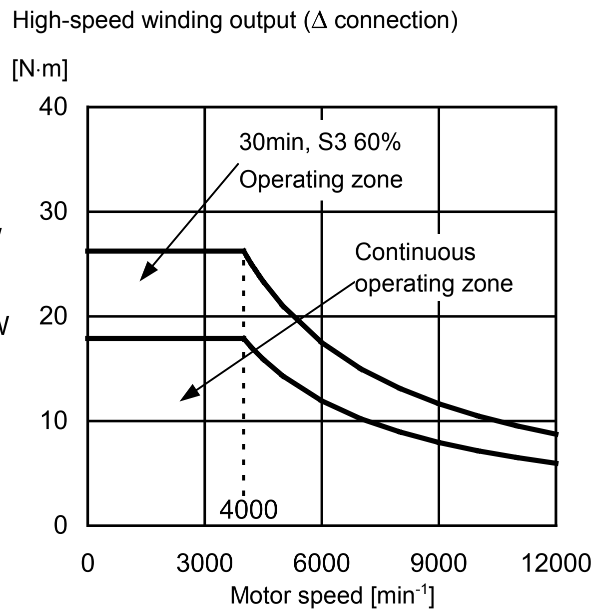
3.5 MODEL α8/12000HV*i*T

Applicable amplifier SPM-15HV*i*





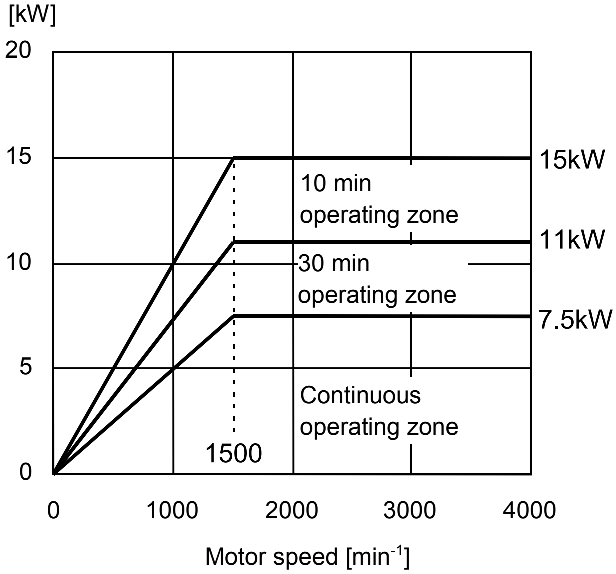




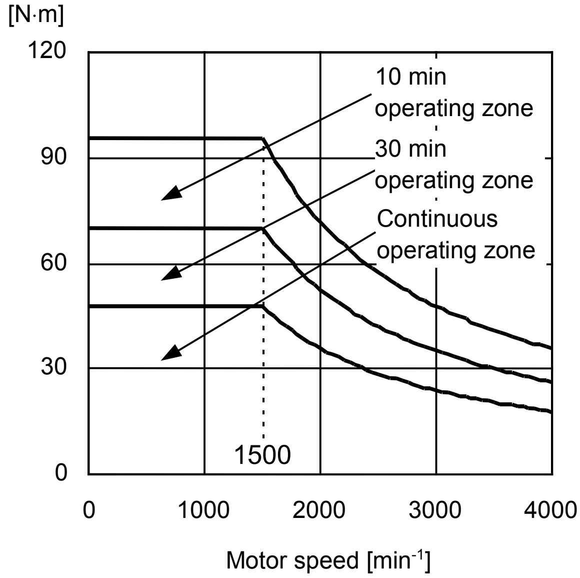
3.6 MODEL α8/15000HV*i*T

Applicable amplifier SPM-30HV*i*

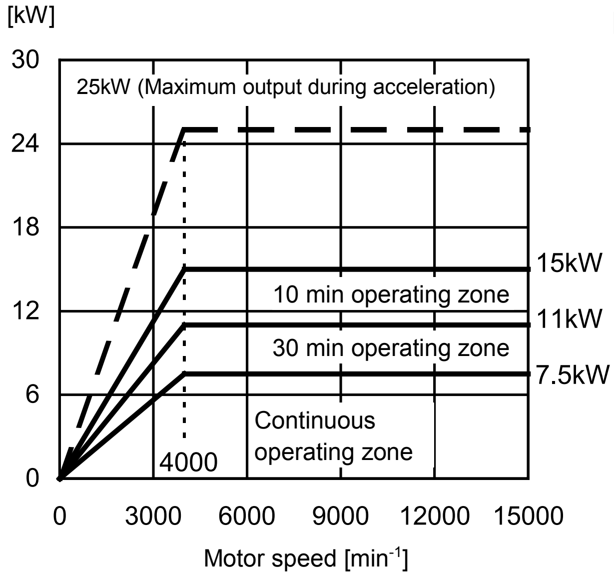
Low-speed winding output (Y connection)



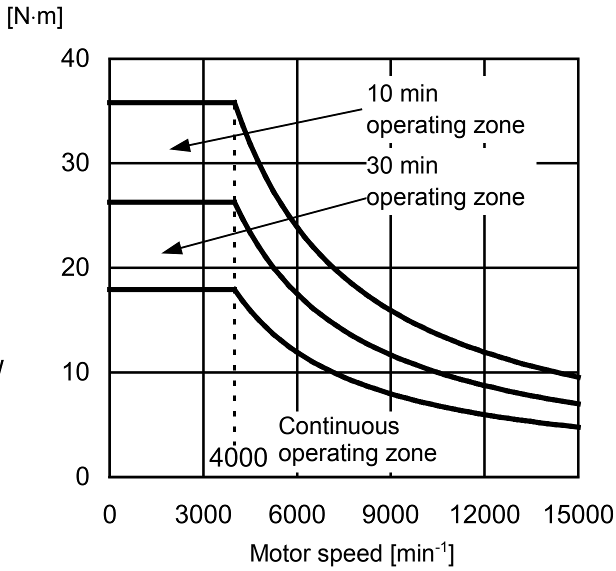
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



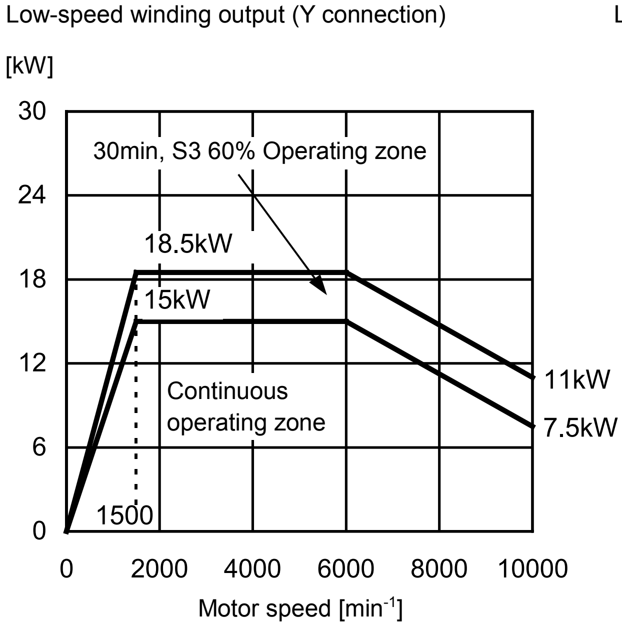
High-speed winding output (Δ connection)

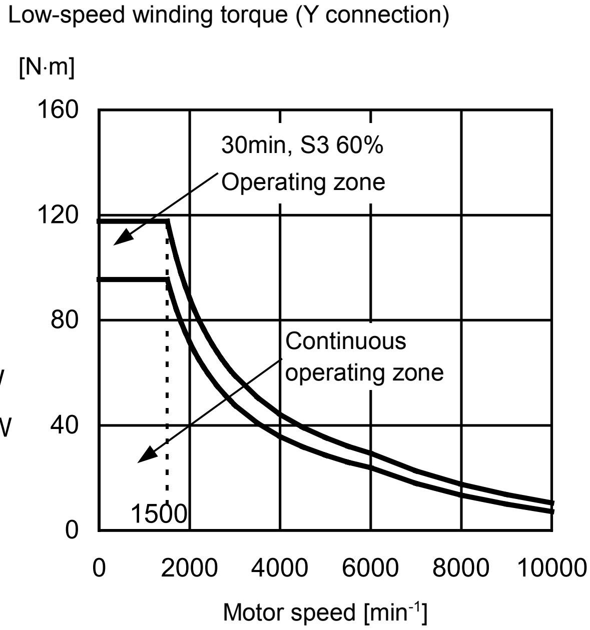


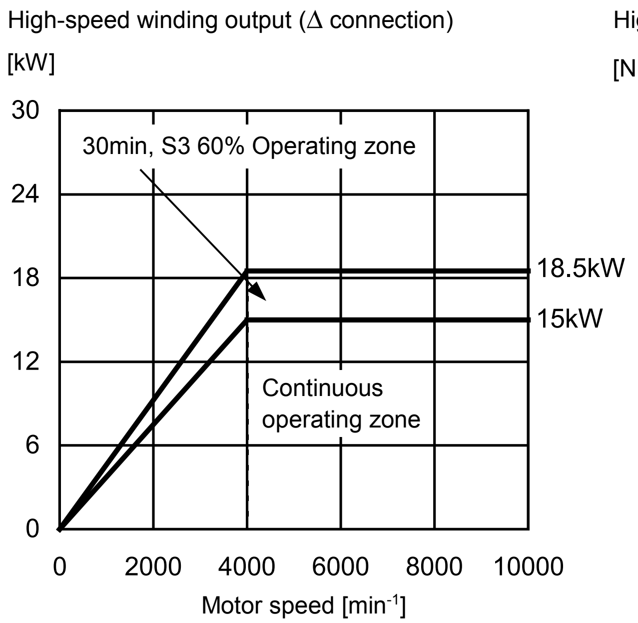
> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

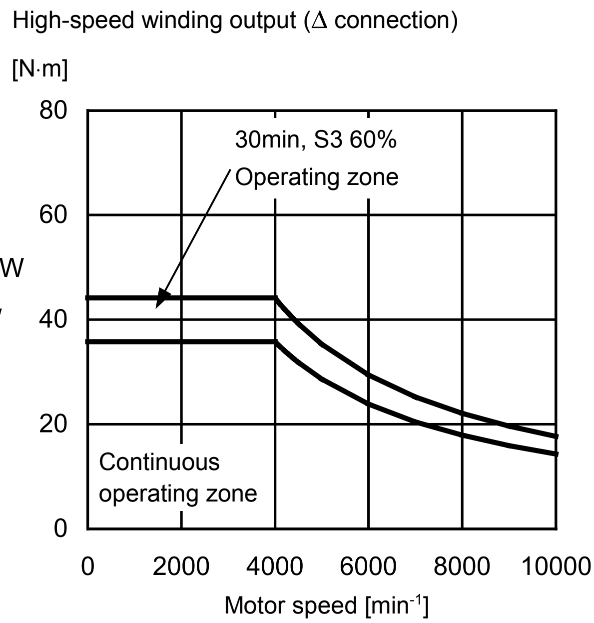
3.7 MODEL α15/10000HV*i*T

Applicable amplifier SPM-30HV*i*





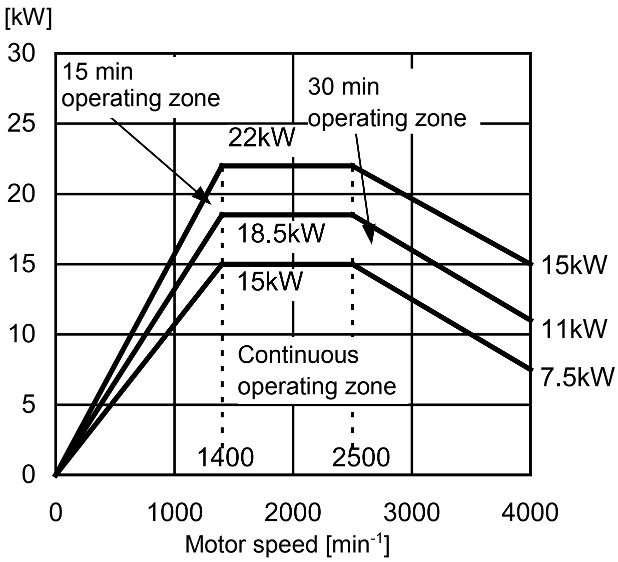




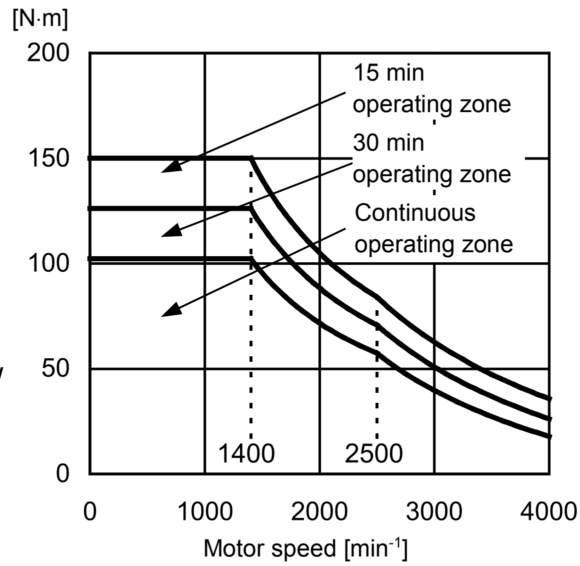
3.8 MODEL α15/12000HV*i*T

Applicable amplifier SPM-30HV*i*

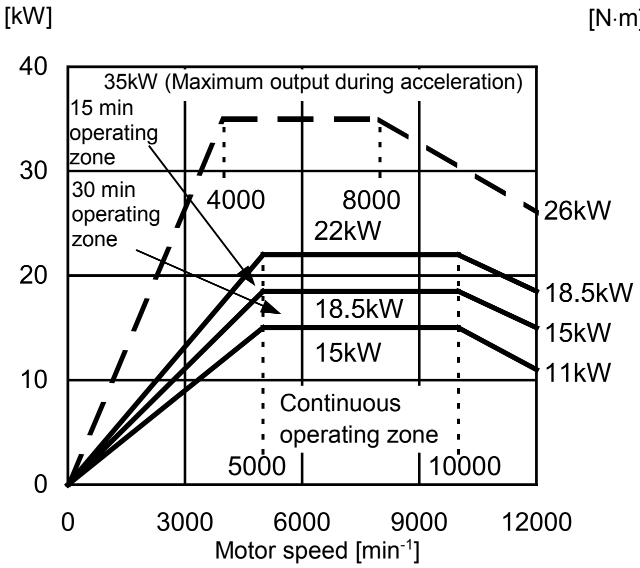
Low-speed winding output (Y connection)



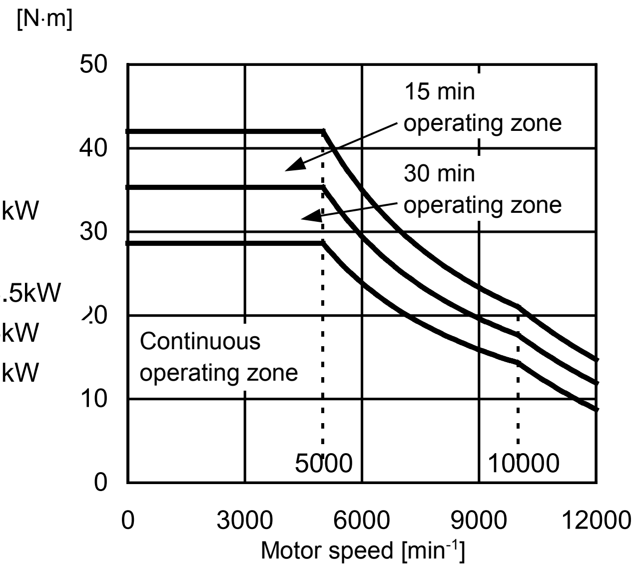
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



High-speed winding output (Δ connection)



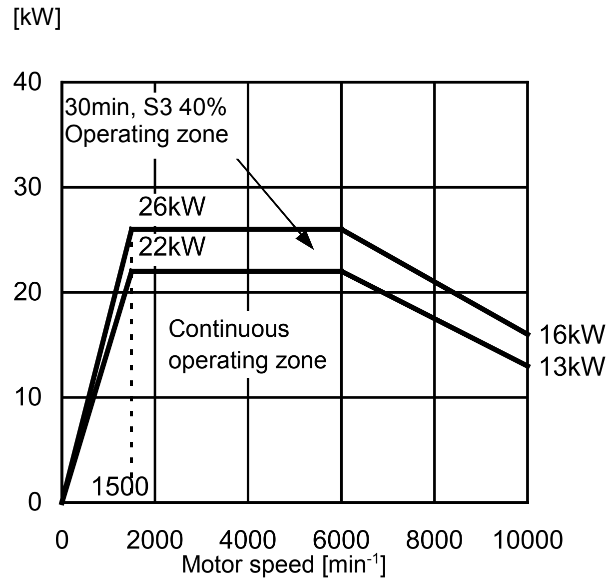
NOTE

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

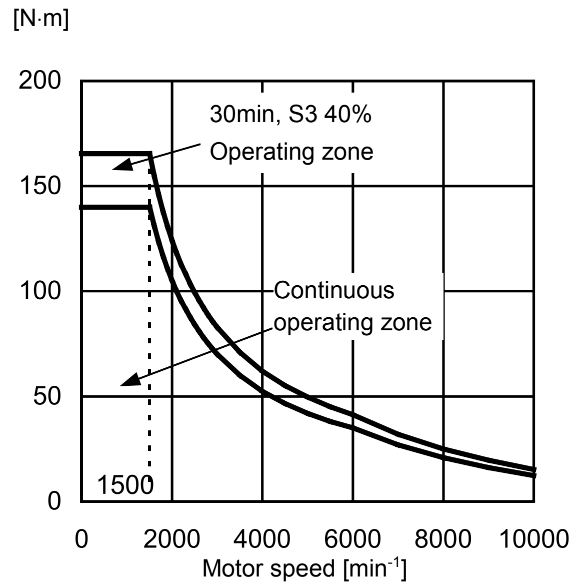
3.9 MODEL α22/10000HV*i*T

Applicable amplifier SPM-30HV*i*

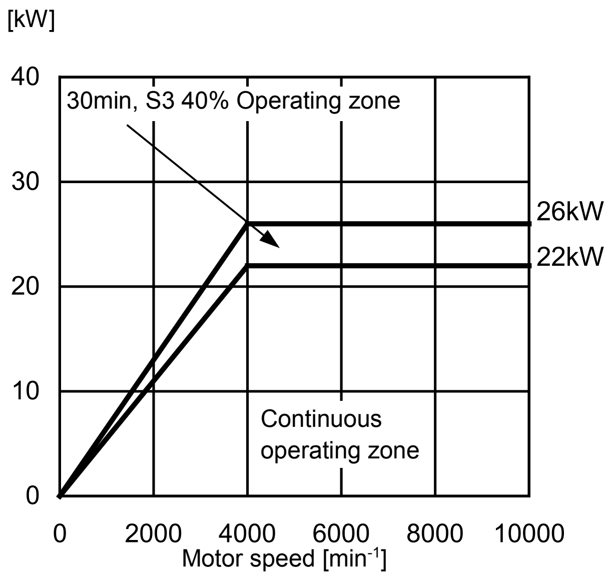
Low-speed winding output (Y connection)



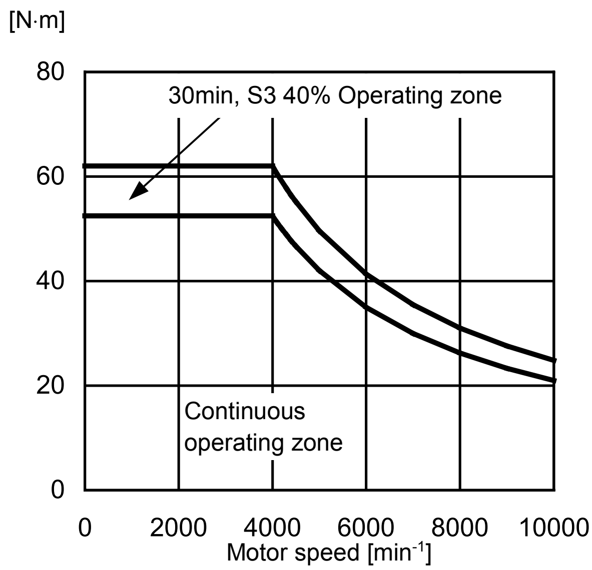
Low-speed winding torque (Y connection)



High-speed winding output (Δ connection)



High-speed winding output (Δ connection)

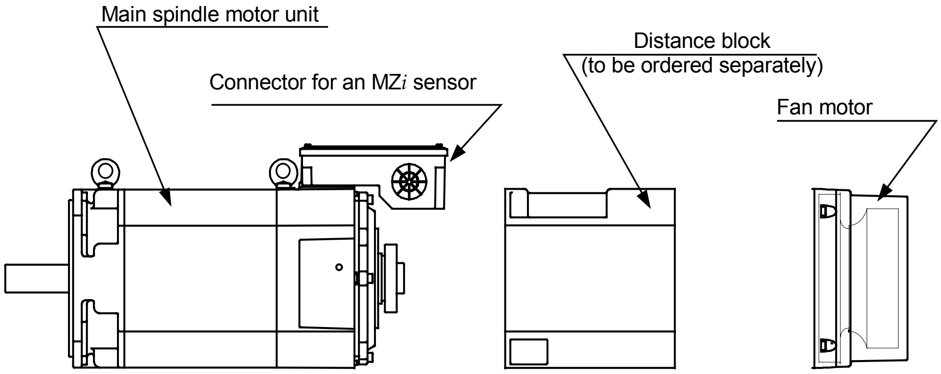


4 CONFIGURATION AND ORDERING NUMBER

4.1 CONFIGURATION

The α(HV)*i*T series motor 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 MZ*i* 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
α1.5/15000HV*i*T	A06B-1563-B123#0021	SPM-15HV*i*	- Flange mounting type - Hollow shaft (with no key) - Labyrinth - Built-in with MZ*i* sensor
α2/15000HV*i*T	A06B-1564-B123#0021	SPM-30HV*i*	
α3/12000HV*i*T	A06B-1565-B123#0021	SPM-11HV*i*	
α6/12000HV*i*T	A06B-1566-B123#0021	SPM-15HV*i*	
α8/12000HV*i*T	A06B-1567-B123#0021	SPM-15HV*i*	
α8/15000HV*i*T	A06B-1577-B133#0121	SPM-30HV*i*	
α15/10000HV*i*T	A06B-1569-B123#0021	SPM-30HV*i*	
α15/12000HV*i*T	A06B-1579-B133#0121	SPM-30HV*i*	
α22/10000HV*i*T	A06B-1571-B123#0021	SPM-30HV*i*	

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.

Name	Ordering number	Remarks
Type 1.5*i*T	A06B-1463-K560	For α1.5HV*i*T
Type 2*i*T	A06B-1464-K560	For α2HV*i*T and α3HV*i*T
Type 6*i*T	A06B-1466-K560	For α6HV*i*T and α8HV*i*T
Type 15*i*T	A06B-1469-K560	For α15HV*i*T and α22HV*i*T

5 CONNECTIONS

5.1 CONNECTION OF THE POWER, FAN MOTOR, AND MZ*i* SENSOR SIGNAL LEADS

Cables for power lead and fan motor are connected to the terminal block.
MZ*i* 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
α1.5/15000HV*i*T	M5	-	M4	M4
α2/15000HV*i*T	M5	-	-	Screw-less terminal block
α3/12000HV*i*T	M5	-	-	Screw-less terminal block
α6/12000HV*i*T	M5	M5	Screw-less terminal block	-
α8/12000HV*i*T	M5	M5	Screw-less terminal block	-
α8/15000HV*i*T	M5	M5	Screw-less terminal block	-
α15/10000HV*i*T	M5	M5	Screw-less terminal block	-
α15/12000HV*i*T	M5	M5	Screw-less terminal block	-
α22/10000HV*i*T	M5	M5	Screw-less terminal block	-

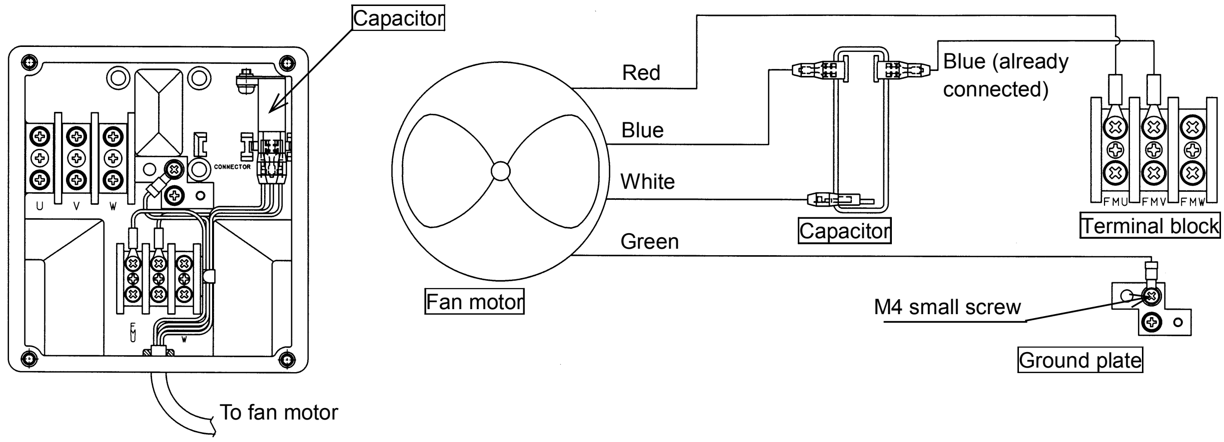
Cable for the fan motor

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

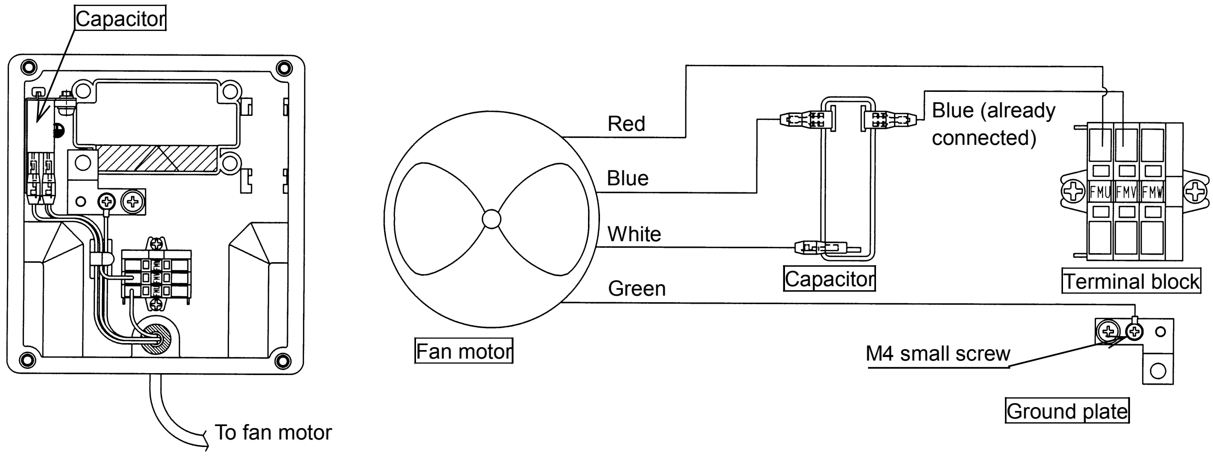
5.2 CONNECTION OF A SINGLE-PHASE FAN MOTOR

The input power requirements of the fan motor for α1.5/15000HV*i*T, α2/15000HV*i*T, or α3/15000HV*i*T are: 200/230VAC +10% -15%, single-phase, and 50/60 Hz±1Hz.

For α1.5/15000HV*i*T

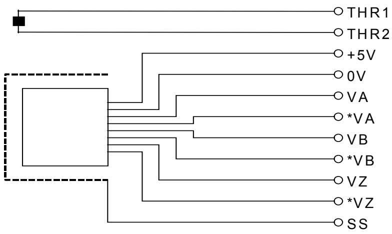


For α2/15000HV*i*T and α3/12000HV*i*T



5.3 CONNECTION OF SIGNAL LEAD

MZ*i* 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

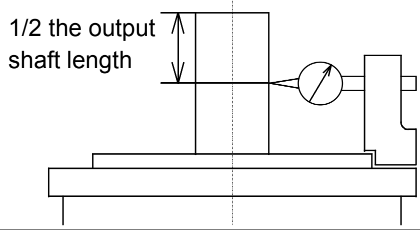
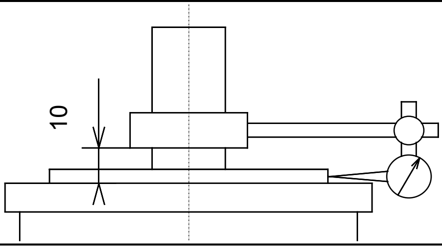
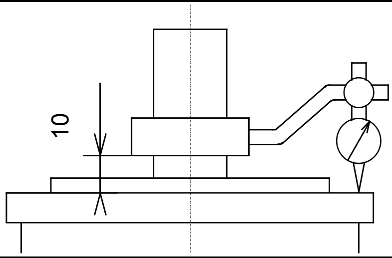
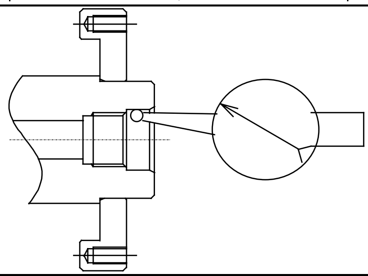
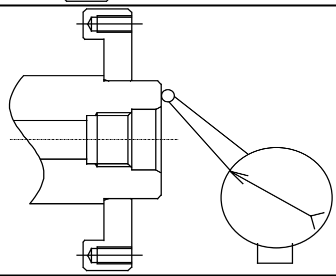
	Motor side		Cable side	
	FANUC specification	Manufacture specification	FANUC specification	Manufacture specification
Housing	A63L-0001-0535/121KDF	178964-6	A63L-0001-0460/121KD	178289-6
Contact	A63L-0001-0456/ASMT	175288-2	A63L-0001-0456/ASM	1-175217-2

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

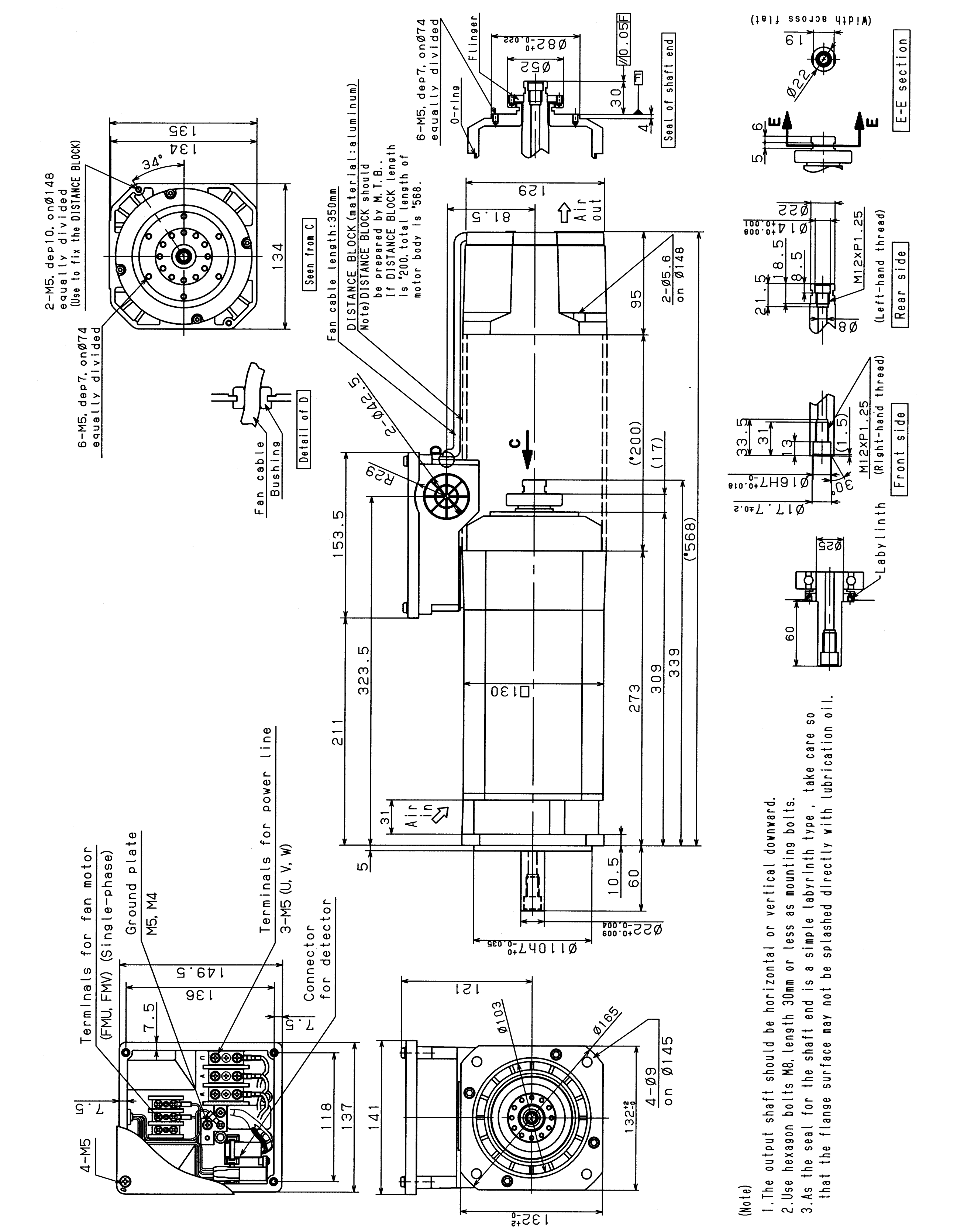
Item	Accuracy	Measuring method
Run-out at the end of the output shaft	10μm or less	
Run-out of the faucet joint for mounting the flange against the core of the shaft	30μm or less	
Run-out of the flange mounting surface against the core of the shaft	40μm or less	
Front shaft end through hole inlet Rear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

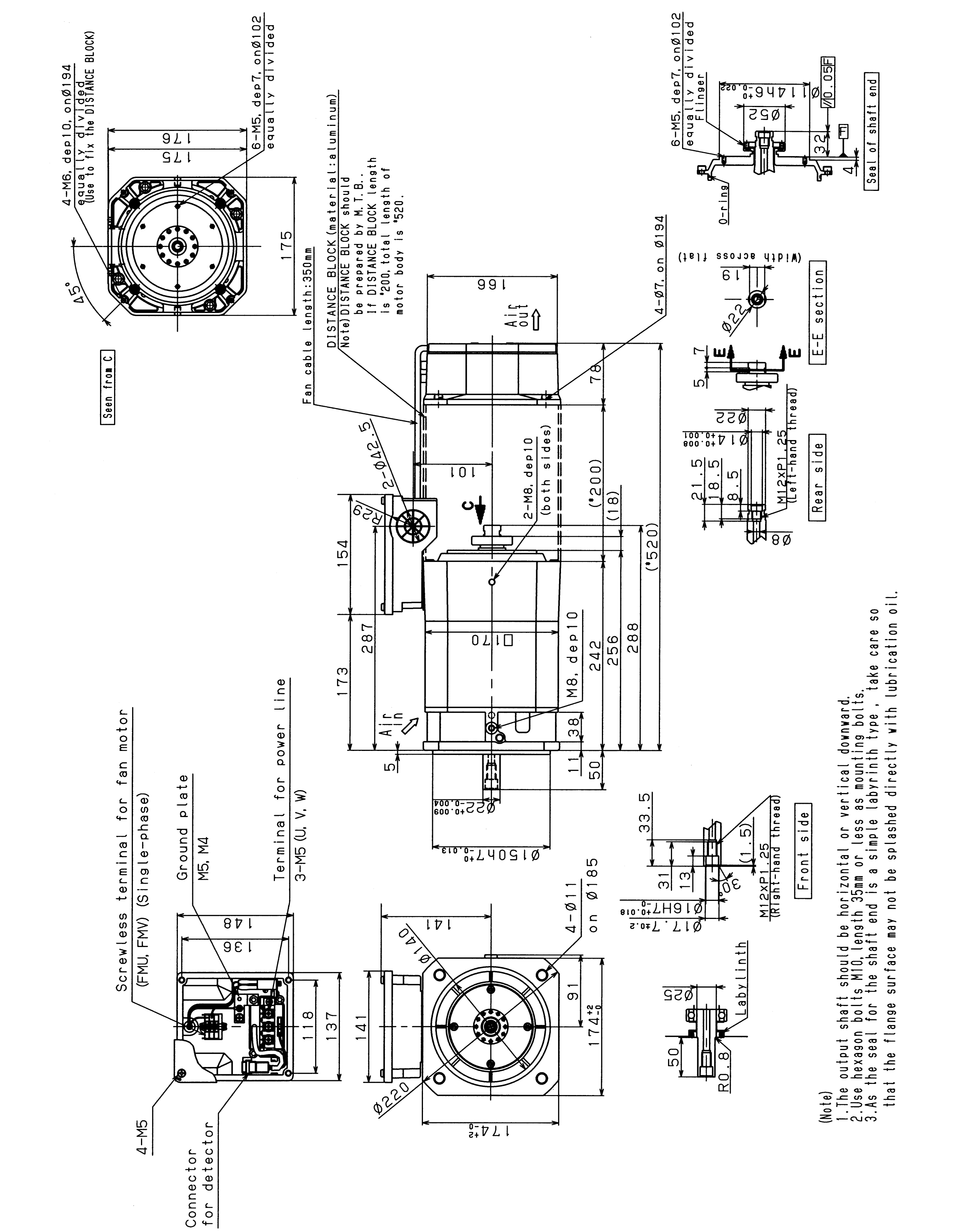
Model name	Section
Model α1.5/15000HV*i*T	7.1
Model α2/15000HV*i*T	7.2
Model α3/12000HV*i*T	7.3
Model α6/12000HV*i*T	7.4
Models α8/12000HV*i*T and α8/15000HV*i*T	7.5
Model α15/10000HV*i*T	7.6
Model α15/12000HV*i*T	7.7
Model α22/10000HV*i*T	7.8

* For a distance block, see the α*i*T series section.

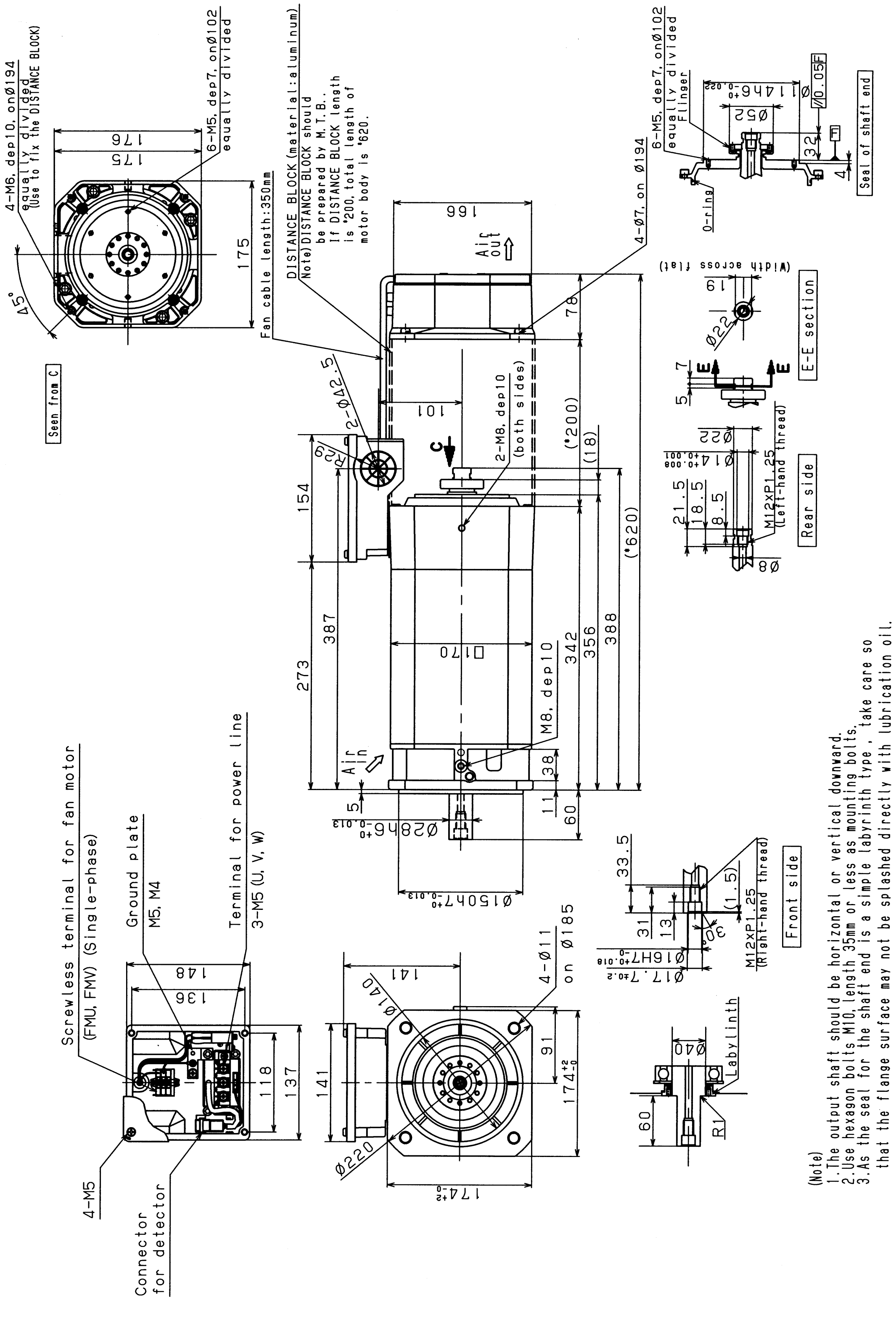
7.1 MODEL α1.5/15000HV*i*T



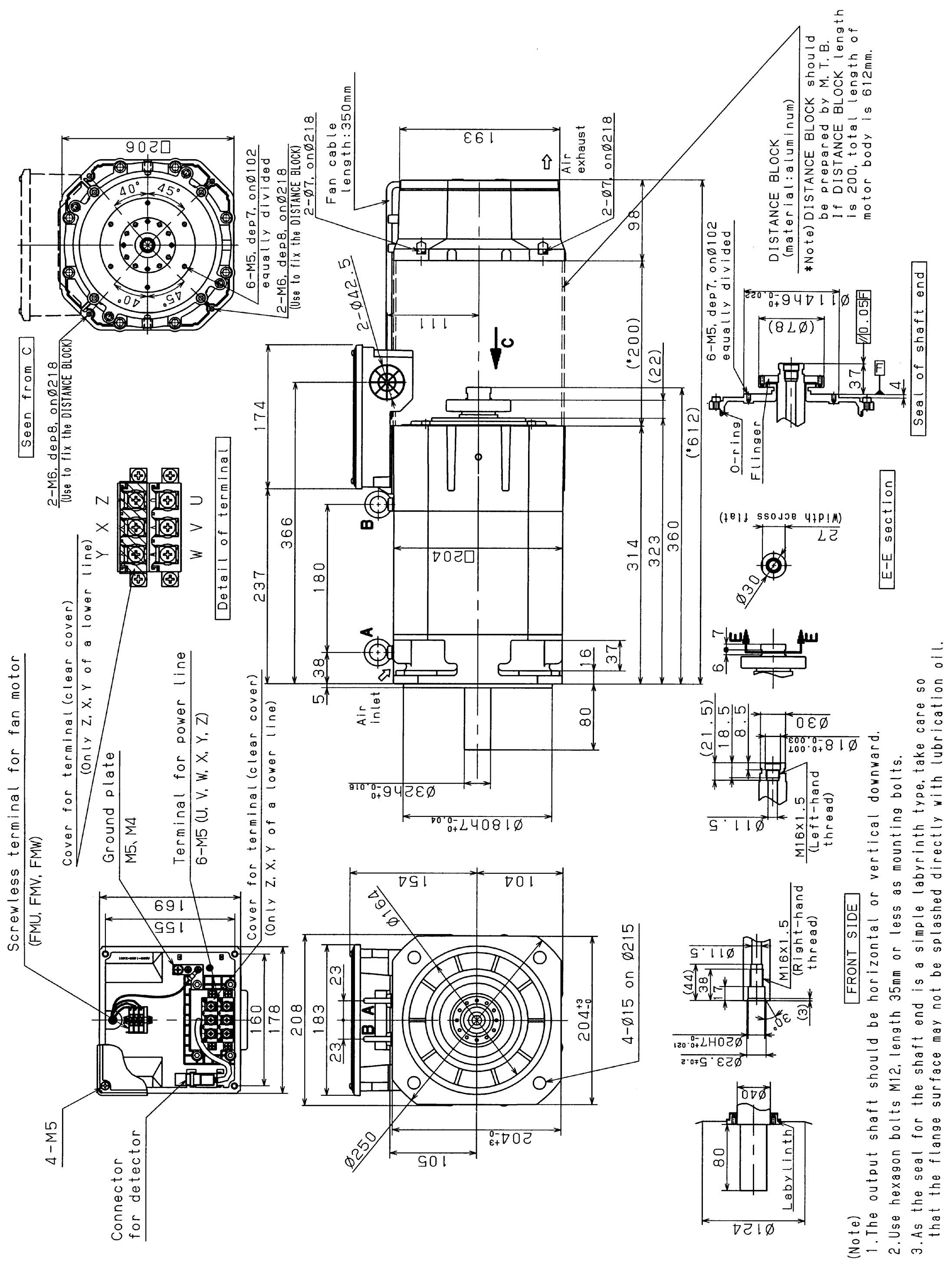
7.2 MODEL α2/15000HV*i*T



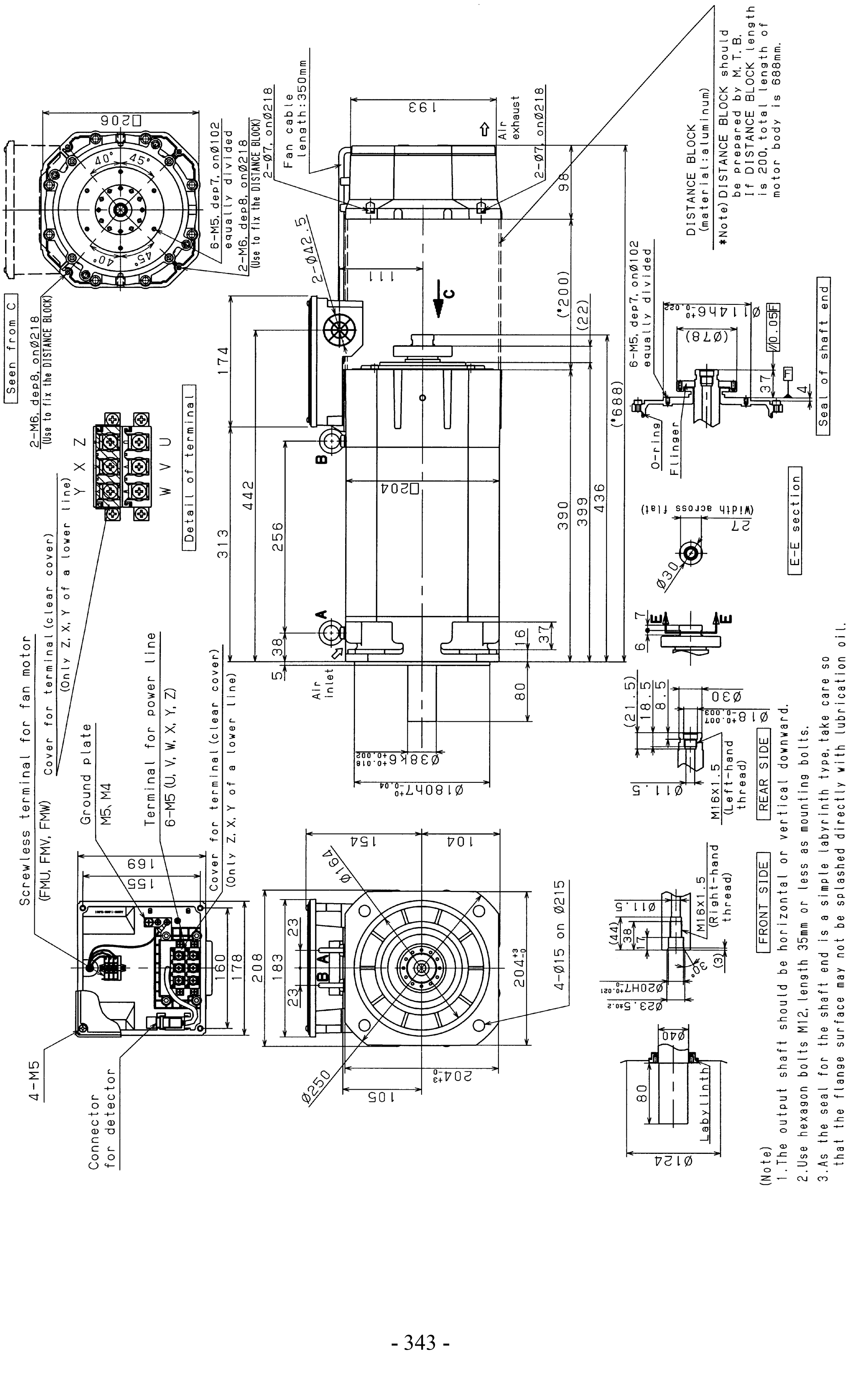
7.3 MODEL α3/12000HV*i*T



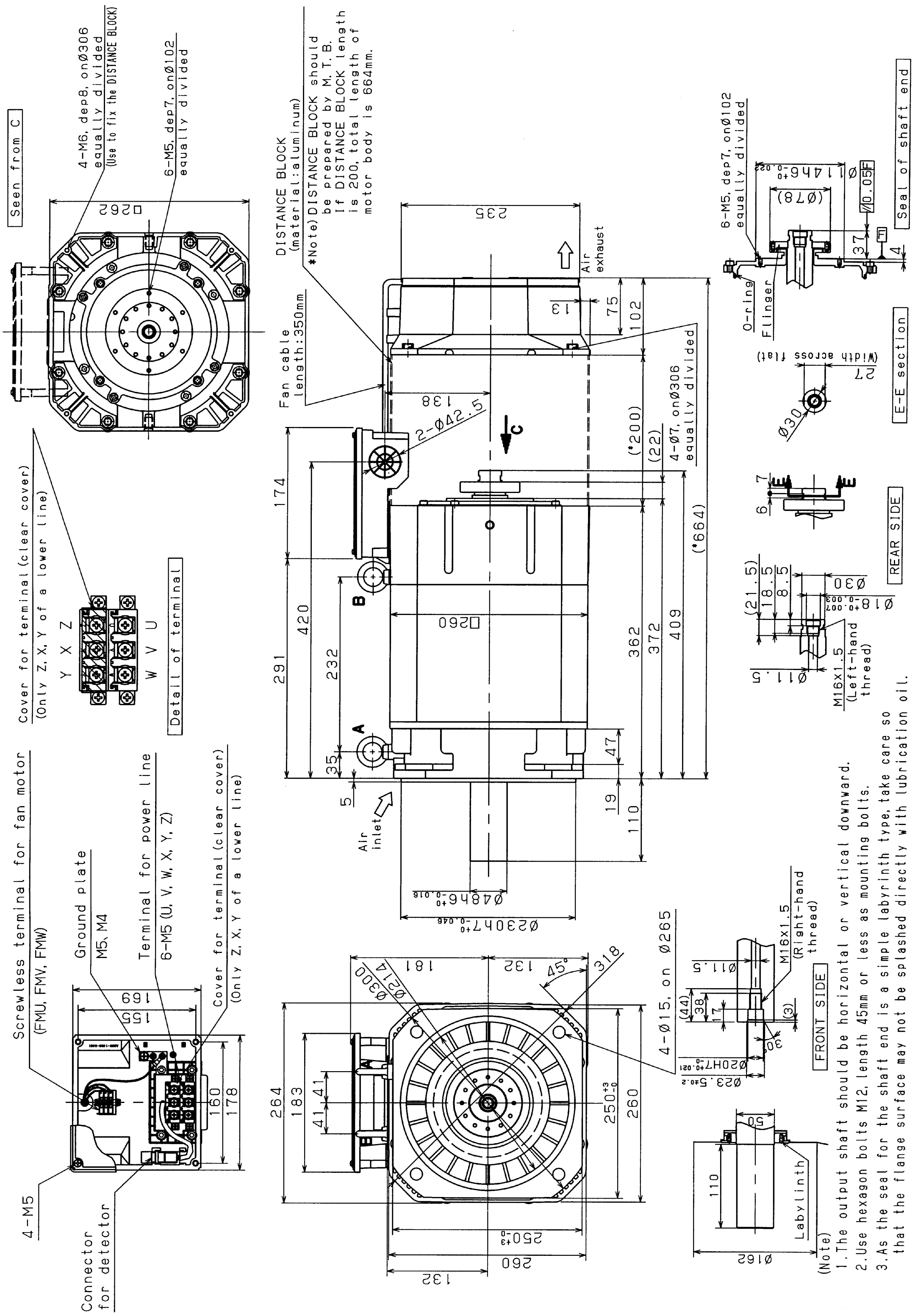
7.4 MODEL α6/12000HV*i*T



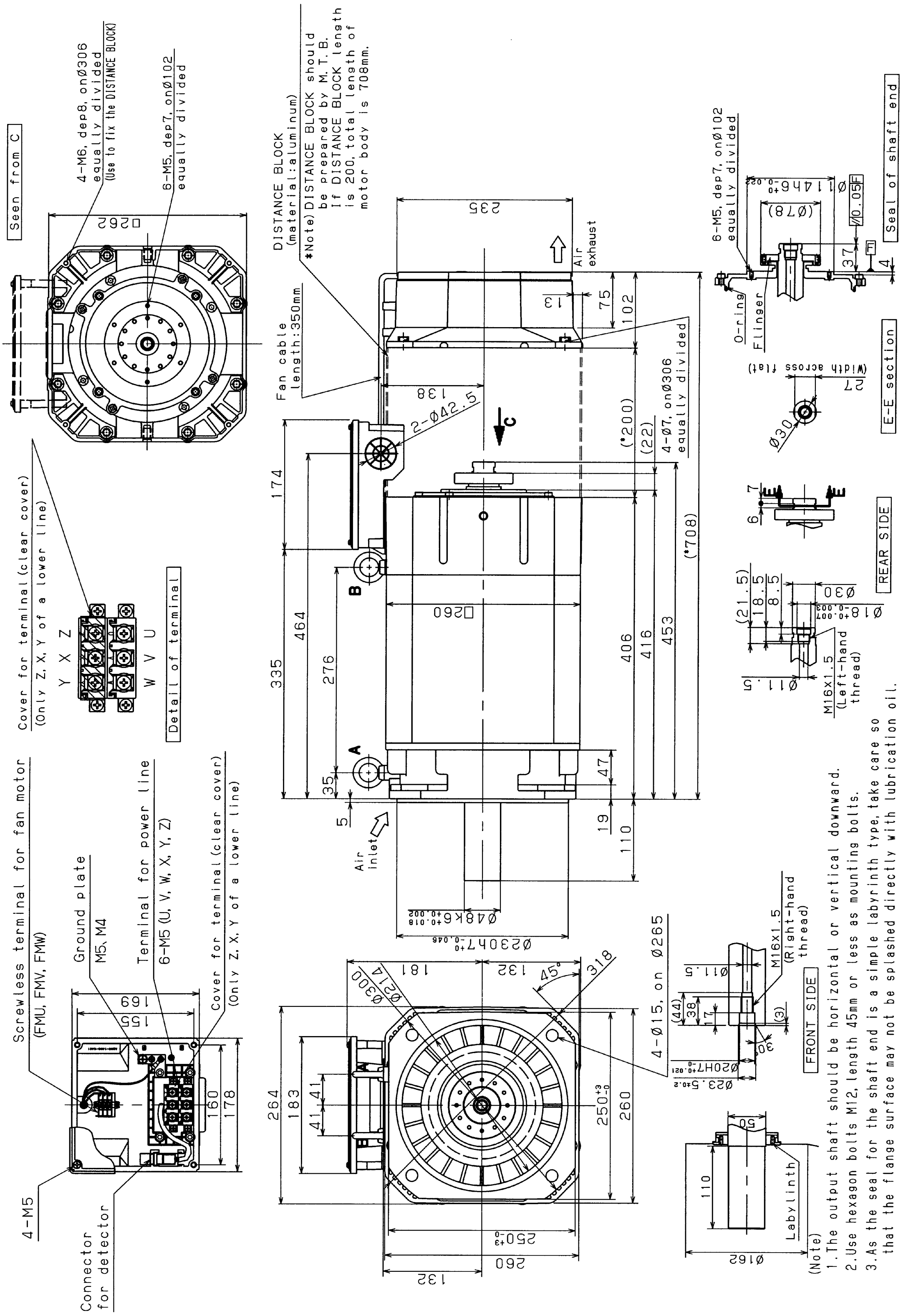
7.5 MODELS α8/12000HV*i*T AND α8/15000HV*i*T



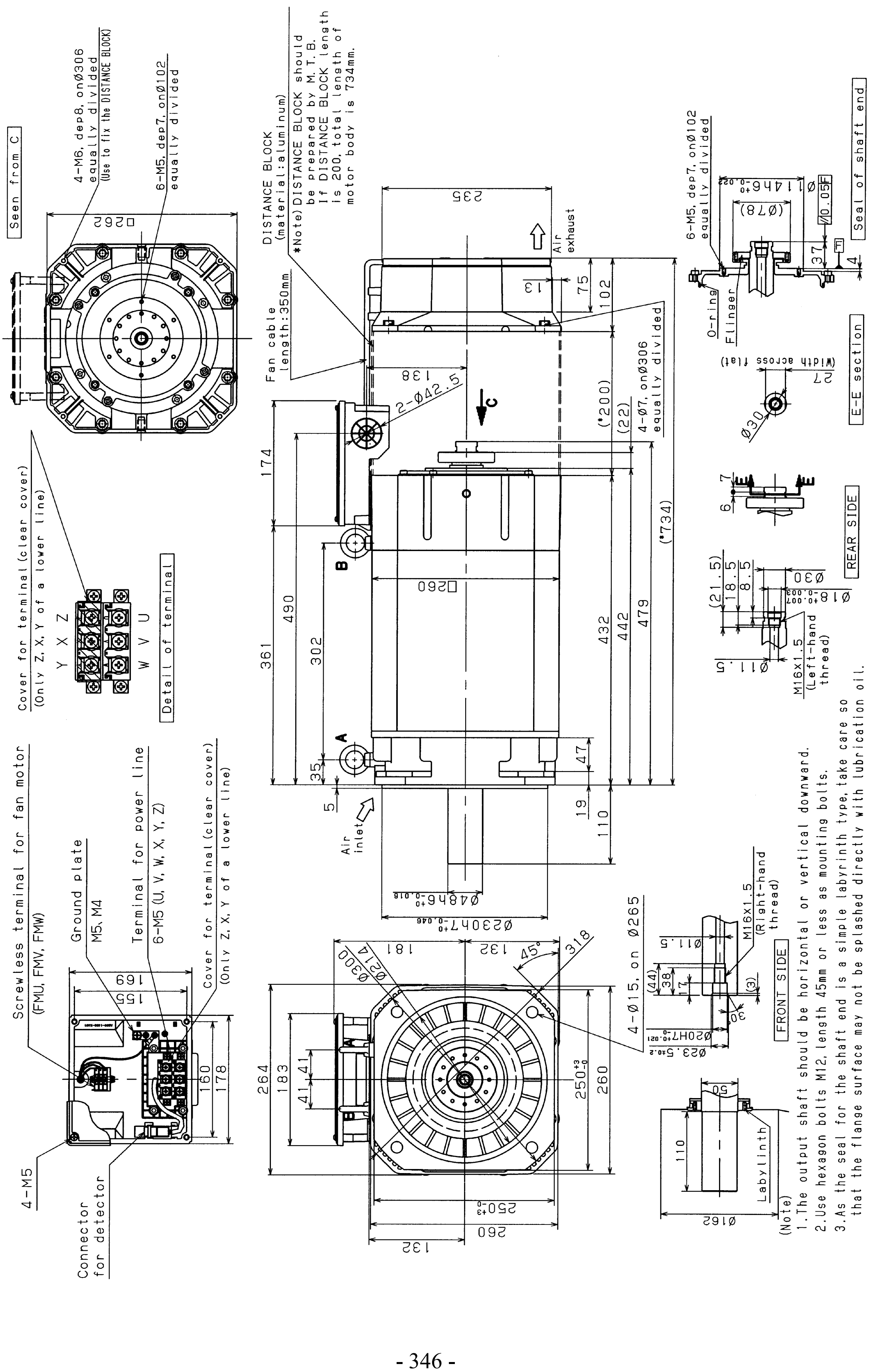
7.6 MODEL α15/10000HV*i*T



7.7 MODEL α15/12000HV*i*T



7.8 MODEL α22/10000HV*i*T



IX. FANUC AC SPINDLE MOTOR α(HV)iL SERIES

1 GENERAL

The FANUC AC spindle motor α(HV)*i*L series 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(HV)*i*L series 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 MZ*i* 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*T 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		α8/20000HV*i*L		α15/15000HV*i*L		α26/15000HV*i*L	
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						
	(S2),(S3) A						
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 MZ*i* 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 module		SPM-45HV*i*		SPM-45HV*i*		SPM-45HV*i*	

* See Page 352 for Cautions and limitations.

Cautions and limitations

(*1) The power wire switching method is Y-Δ switching. Refer to FANUC SERVO AMPLIFIER α*i* 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.
<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 a gear coupling or 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 IV.)

(*11) These values are to be used only as guidance for selecting a power supply module 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.

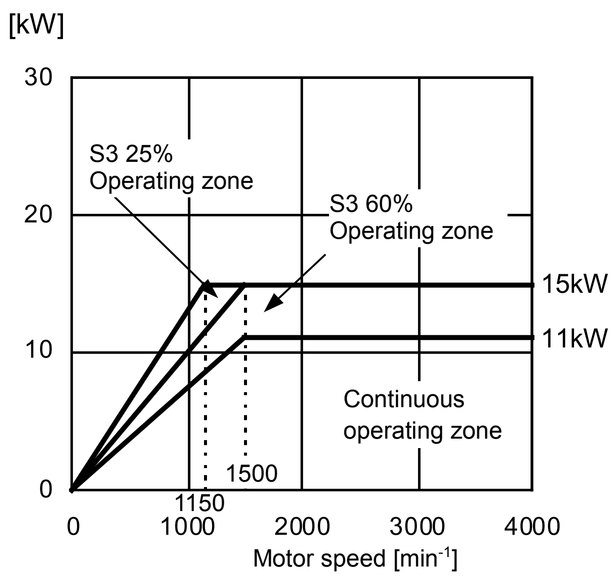
$T[N\cdot m]=P[kW]\times 1000/0.1047/N[min^{-1}]$
- P[kW]: Motor output
- $N[min^{-1}]$: Motor speed

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

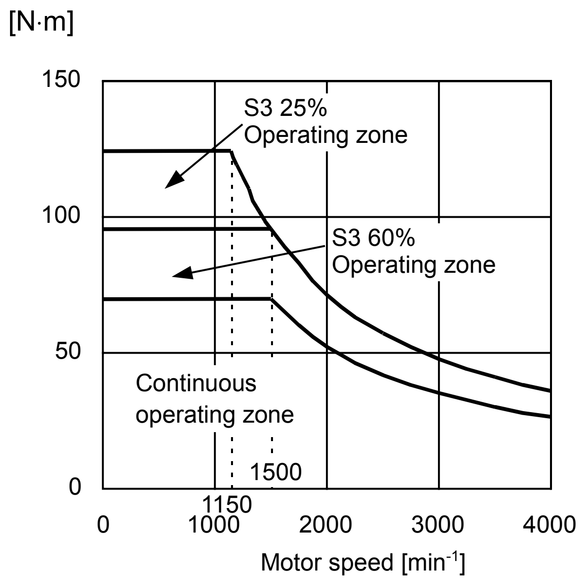
3.1 MODEL α8/20000HV*i*L

Applicable amplifier SPM-45HV*i*
Cooler capacity 2.9kW (2500kcal/h)

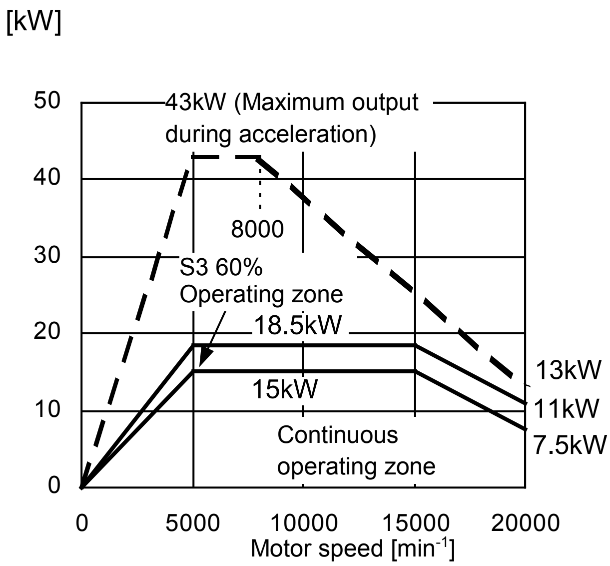
Low-speed winding output (Y connection)



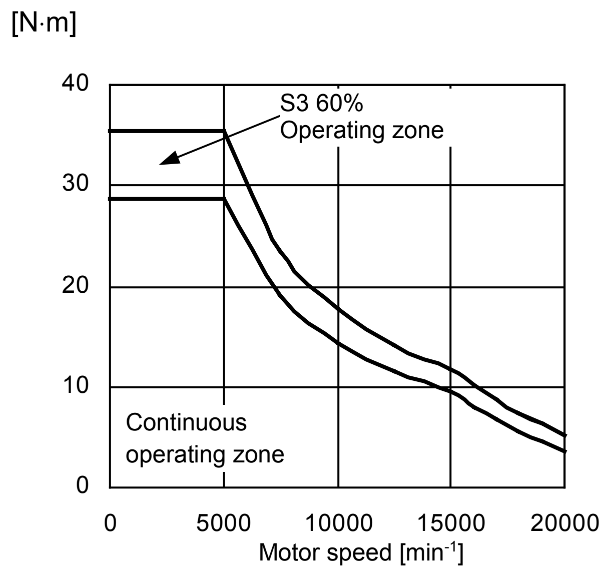
Low-speed winding torque (Y connection)



Low-speed winding output (Δ connection)



Low-speed winding torque (Δ connection)

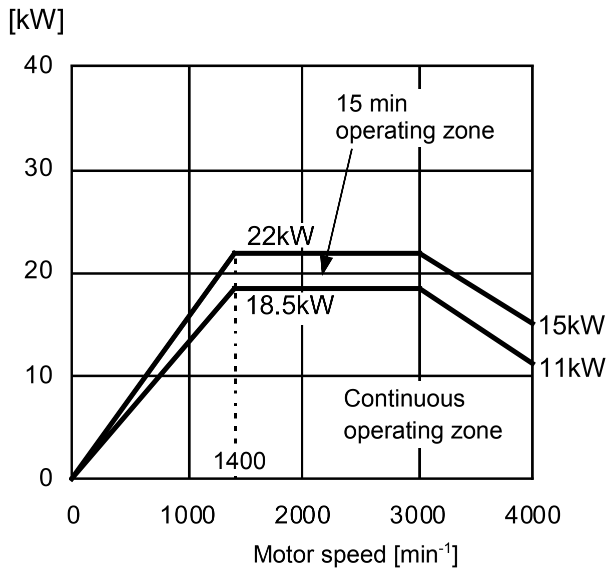


NOTE
Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

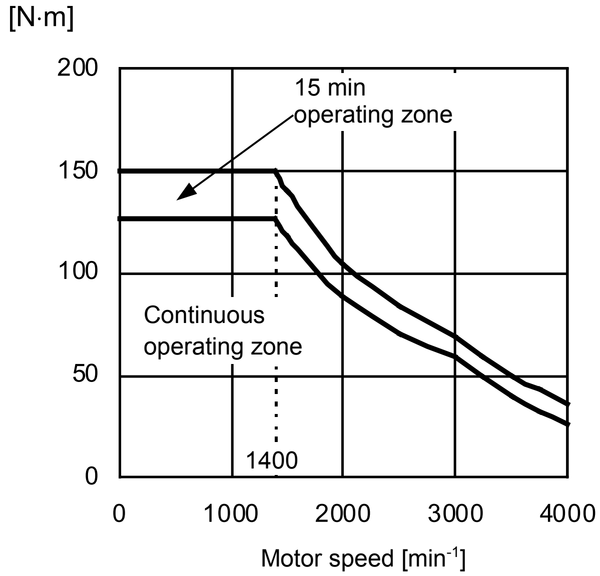
3.2 MODEL α15/15000HV*i*L

Applicable amplifier SPM-45HV*i*
Cooler capacity 3.5kW (3000kcal/h)

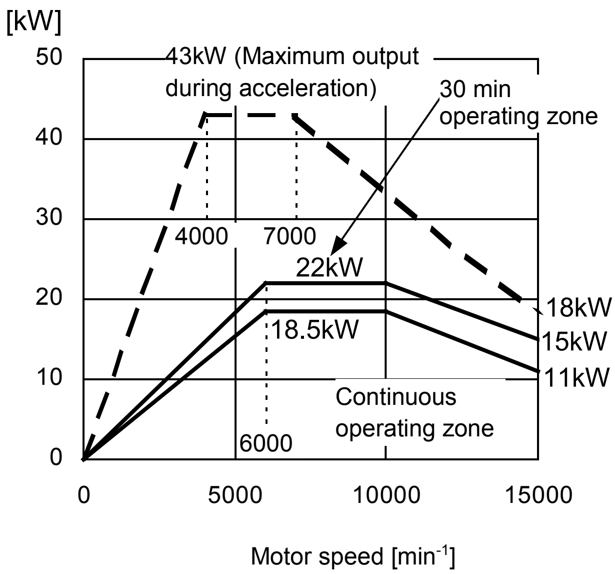
Low-speed winding output (Y connection)



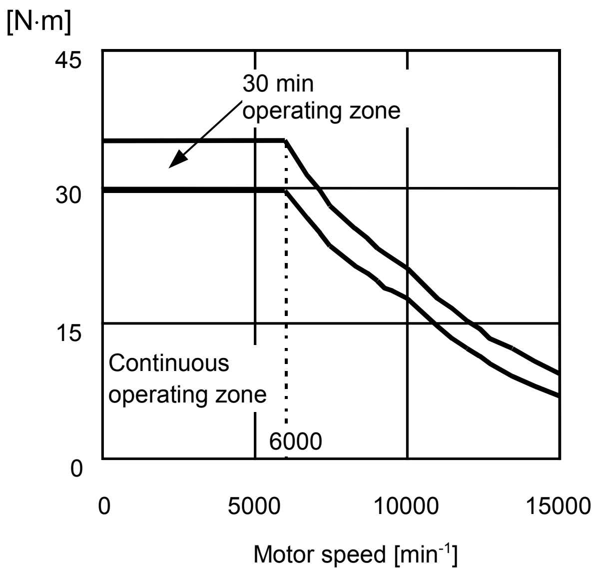
Low-speed winding torque (Y connection)



Low-speed winding output (Δ connection)



Low-speed winding torque (Δ connection)

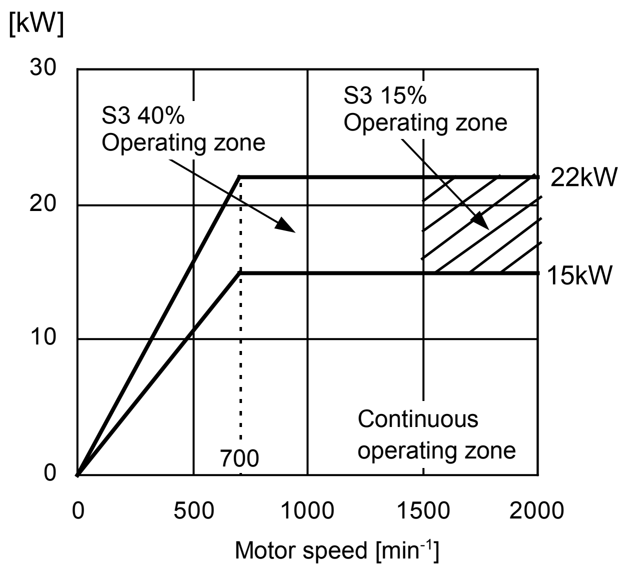


> **NOTE**
> Acceleration output is used as a measure to calculate the acceleration or deceleration time. Acceleration output is not an assured value.

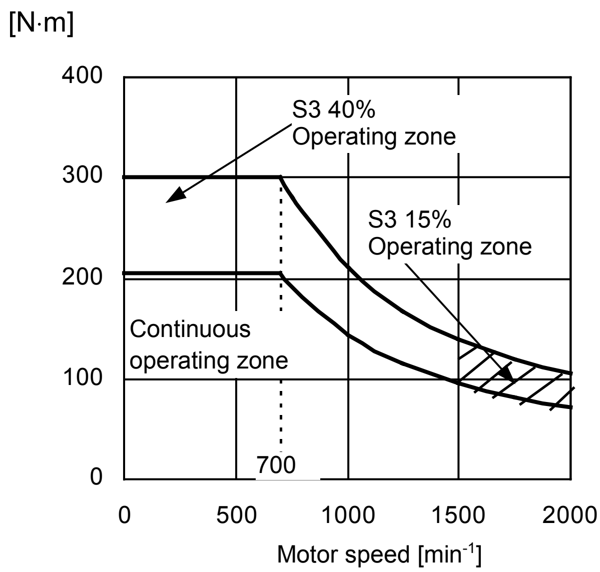
3.3 MODEL α26/15000HV*i*L

Applicable amplifier SPM-45HV*i*
Cooler capacity 4.1kW (3500kcal/h)

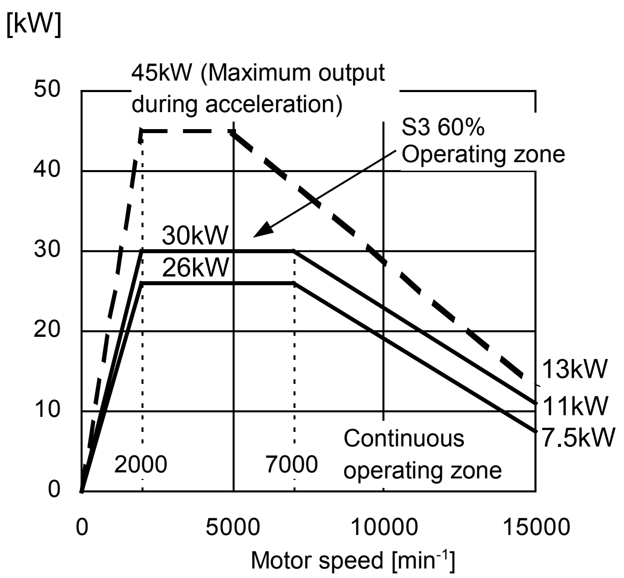
Low-speed winding output (Y connection)



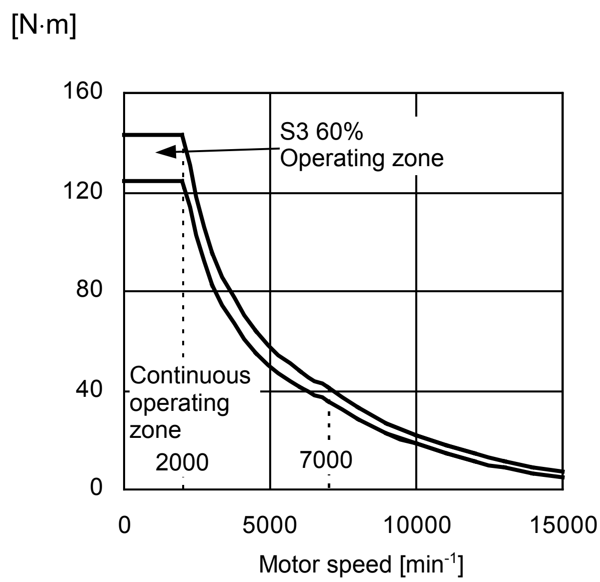
Low-speed winding torque (Y connection)



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

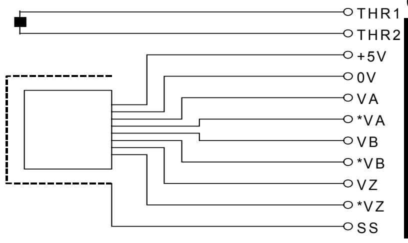
4.1 POWER WIRE CRIMP TERMINAL SIZE

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

Motor model	Crimp terminal size	
	Motor side	Amplifier side
α8/20000HV*i*L	M5	M6
α15/15000HV*i*L	M6	M6
α26/15000HV*i*L	M6	M6

4.2 CONNECTION OF SIGNAL LEAD

MZ*i* 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		α8/20000HV*i*L	α15/15000HV*i*L	α26/15000HV*i*L
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.

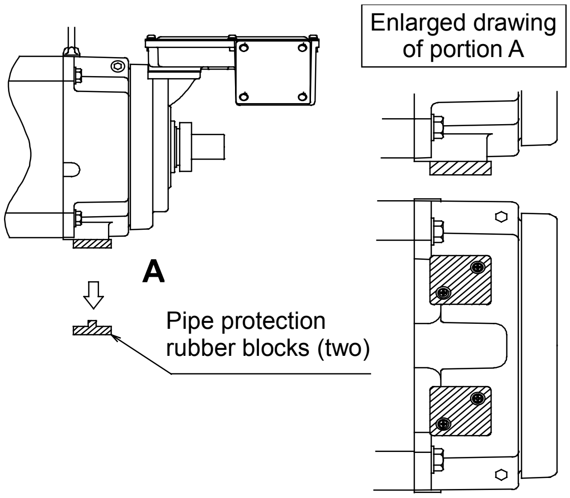
(*3) If the temperature of the liquid coolant is lower than the room temperature as measured at the cooling pipe inlet, it is likely that condensation may occur in the motor. Be sure to strictly observe the specified temperature.

Liquid coolant piping

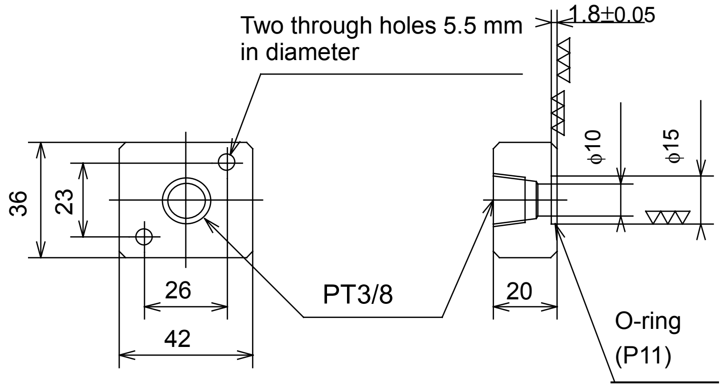
This motor series needs cooling based on liquid coolant.

- Factory-setting

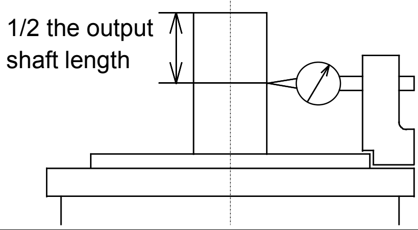
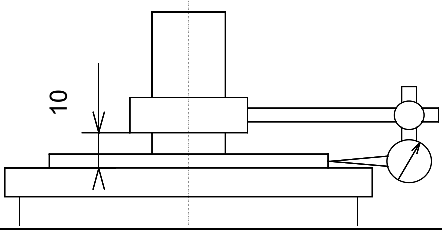
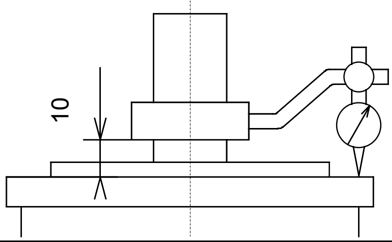
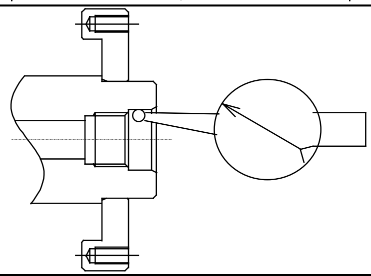
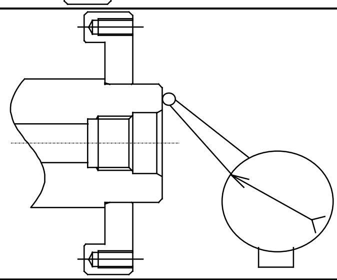
The motor comes with rubber blocks for pipe protection.
The machine tool builder is requested to prepare a pipe block according to the following drawing.



- Example of a pipe block



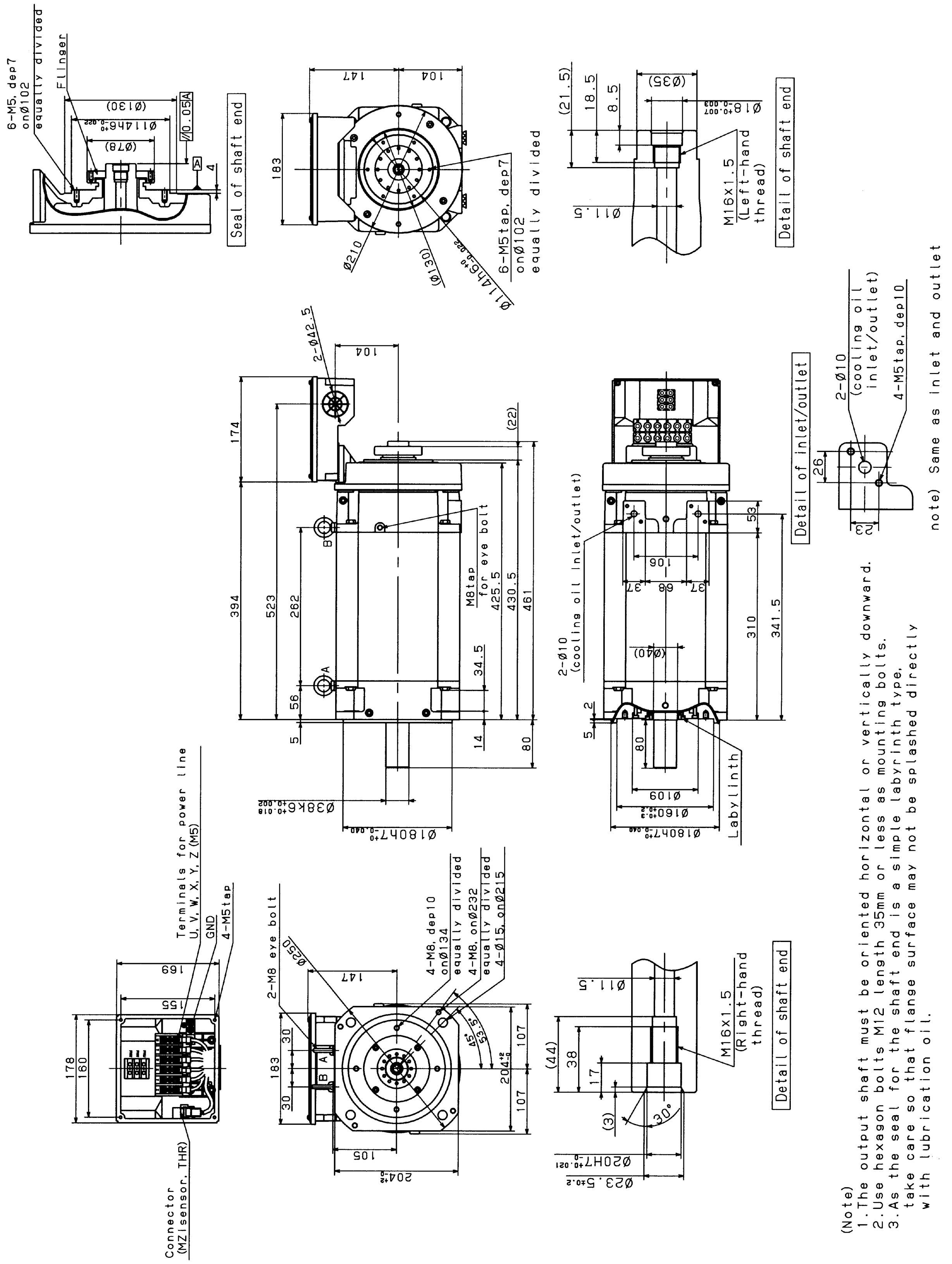
5 ASSEMBLING ACCURACY

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

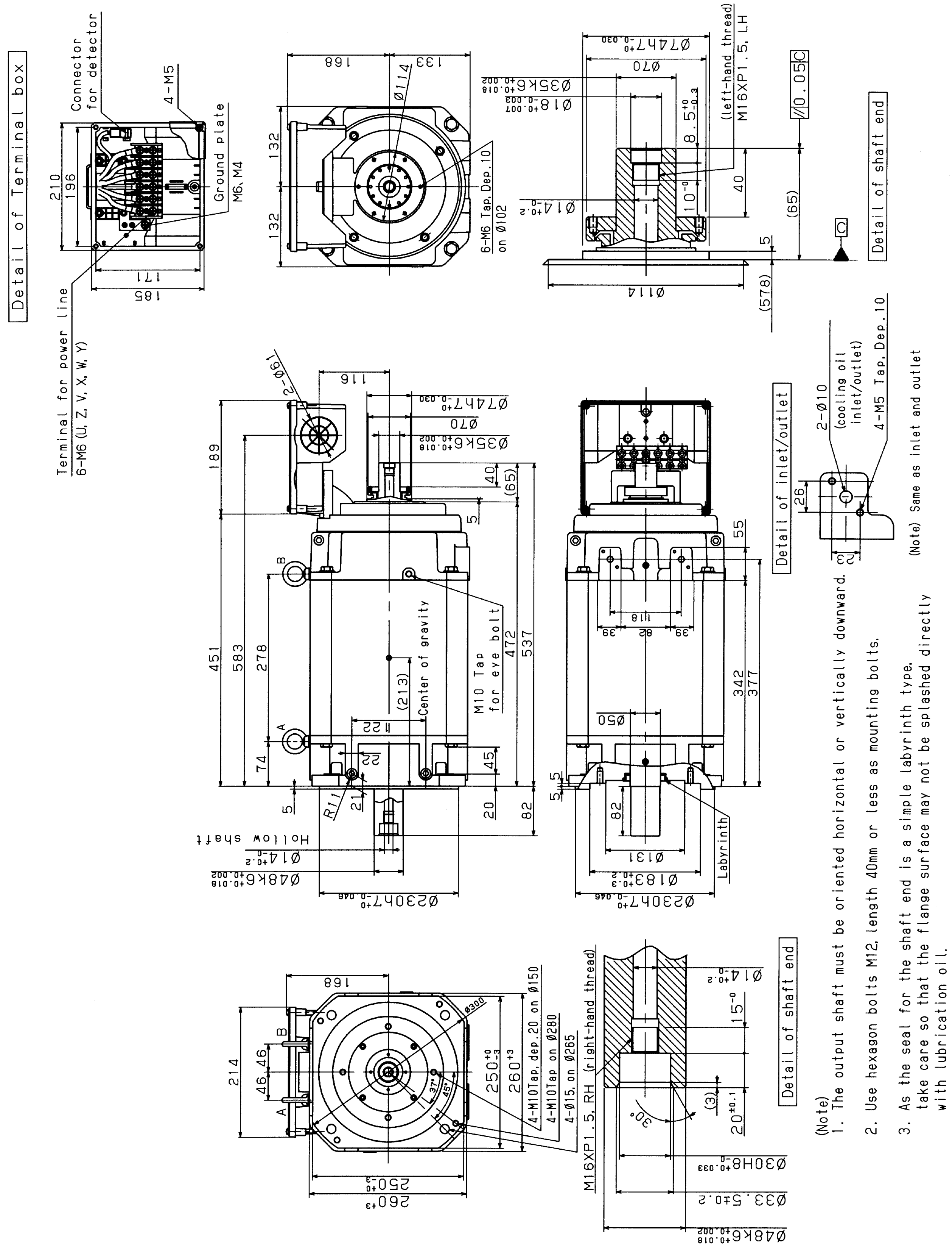
Model name	Section
Model α8/20000HV*i*L	6.1
Model α15/15000HV*i*L	6.2
Model α26/15000HV*i*L	6.3

6.1 MODEL α8/20000HV*i*L

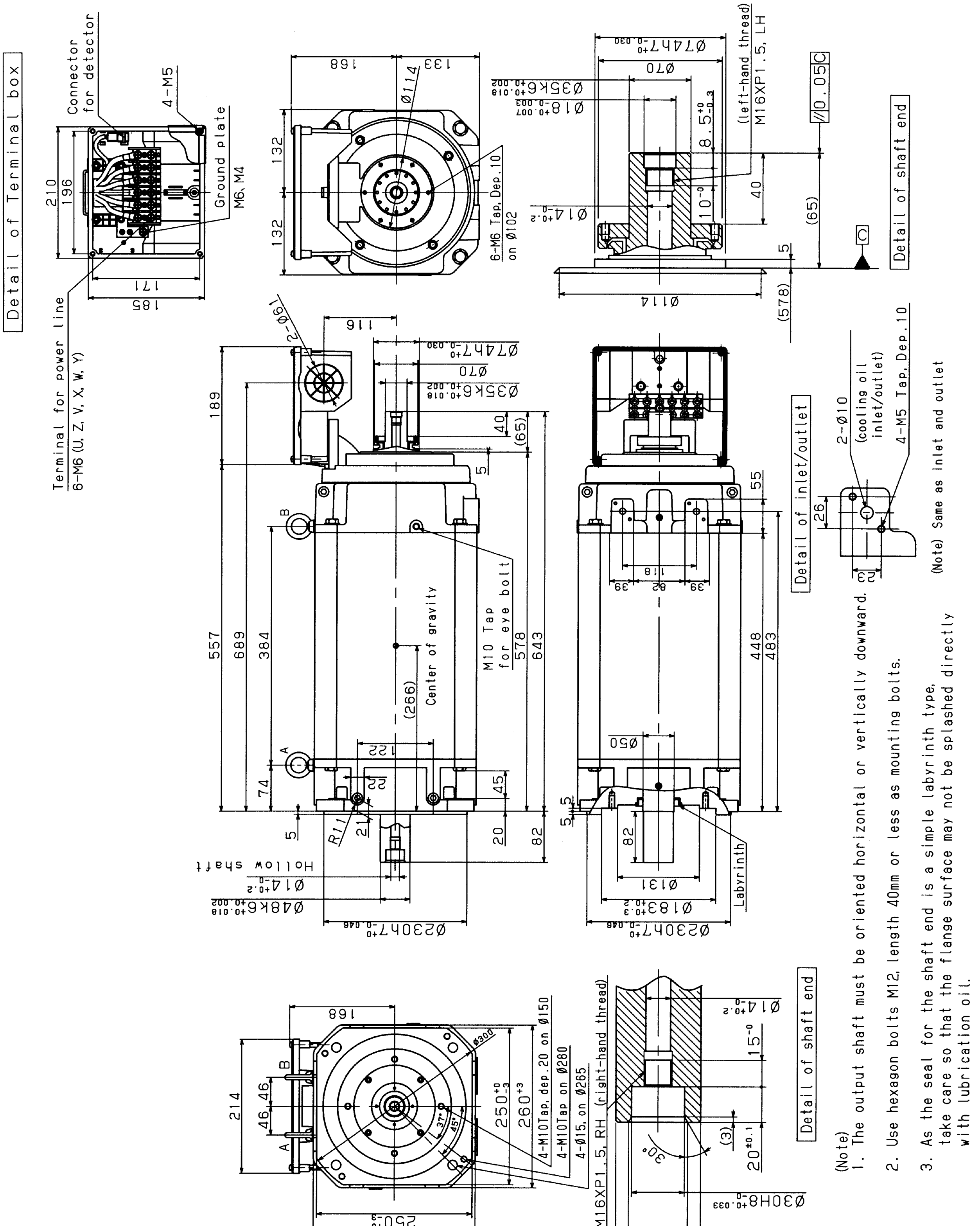


(Note)
1.The output shaft must be oriented horizontal or vertically downward.
2.Use hexagon bolts M12 length 35mm or less as mounting bolts.
3.As the seal for the shaft end is a simple labyrinth type, take care so that flange surface may not be splashed directly with lubrication oil.

6.2 MODEL α15/15000HViL



6.3 MODEL α26/15000HV*i*L



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Revision Record

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

Edition	Date	Contents	Edition	Date	Contents
04	Feb., 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	————————			