GE Fanuc Automation Europe

Computer Numerical Controls

AC SERVO MOTOR α series

Descriptions

B-65142EN/04

TECHNOLOGY AND MORE

The export of this product is subject to the authorization of the government of the country from where the product is exported.

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

FANUC SERVO MOTOR series

SAFETY PRECAUTIONS

This ”Safety Precautions” section describes the precautions which must be observed to ensure safety when using FANUC servo motors (including spindle motors). Users of any servo motor model are requested to read this manual carefully before using the servo 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 the ”Safety Precautions.” They are invited to ask FANUC previously about what behavior or action is prohibited.

Contents

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.**

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.**

  Motors are heavy. When moving them, use a crane or lift as required. (For the weight of motors, refer to their respective specification manuals.)
  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. When moving a motor, be careful not to apply excessive force to its windings as the windings may break and/or their insulation may deteriorate.

- **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 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.

- **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.

- **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 changeover. Refer to their respective motor specification manuals for details.

WARNING

- **Connect power wires securely so that they will not get loose.**

  A failure to observe this caution may cause a wire to be disconnected, resulting in a ground fault, short circuit, or electric shock.

- **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.

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

  A rotating part may catch your cloths or fingers. Before starting a motor, ensure that there is no stuff that can fly away (such as a key) on the motor.

- **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.

- **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.

3 CAUTION

CAUTION

- **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.

- **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.

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 detector.**

  Such a test can damage elements in the detector.

- **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.

NOTE

- **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.

- **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

This manual describes the specifications and characteristics of the α series servo motors. The manual consists of the following chapters:

I. SPECIFICATIONS FOR THE α series

This chapter provides general notes on the use of the α series and explains how to select the optimum motor for a given application. This chapter also provides the specifications common to each model of the α series, concerning the detectors, internal brakes, plug connectors, and so forth.

II. FANUC AC SERVO MOTOR α series

This chapter explains how to specify a certain α series servo motor and provides specifications, dimensions, and data sheets for the entire range of α series servo motors.

III. FANUC AC SERVO MOTOR αM series

This chapter explains how to specify a certain αM series servo motor and provides specifications, dimensions, and data sheets for the entire range of αM series servo motors.

IV. FANUC AC SERVO MOTOR αL series

This chapter explains how to specify a certain αL series servo motor and provides specifications, dimensions, and data sheets for the entire range of αL series servo motors.

V. FANUC AC SERVO MOTOR αC series

This chapter explains how to specify a certain αC series servo motor and provides specifications, dimensions, and data sheets for the entire range of αC series servo motors.

VI. FANUC AC SERVO MOTOR α(HV) series

This chapter explains how to specify a certain α(HV) series servo motor and provides specifications, dimensions, and data sheets for the entire range of α(HV) series servo motors.

VII. FANUC AC SERVO MOTOR αM(HV) series

This chapter explains how to specify a certain α(HV) series servo motor and provides specifications, dimensions, and data sheets for the entire range of α(HV) series servo motors.

VIII. SUPPLEMENT

This supplement explains how to increase the maximum allowable speed of AC servo motors.

Although this manual provides information on detector signal outputs, it does not describe connection to a servo amplifier or NC. For details of these connections, refer to the “FANUC SERVO MOTOR α series Maintenance Manual” (B–65165E).

Related manuals

The following six kinds of manuals are available for FANUC SERVO MOTOR α series. In the table, this manual is marked with an asterisk (*).

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I. DESCRIPTIONS FOR THE α series

1 GENERAL

The FANUC AC servo motor α series has been designed for machine tool feed axis applications. This servo motor α series has the following features:

Smooth rotation

The special magnetic pole shape minimizes torque ripples which, when combined with precise current control and accurate pulse coder feedback, enables extremely smooth motor rotation.

Excellent acceleration

The use of a special rotor shape results in motors that are smaller and lighter than previous models, but which can develop a high level of torque. These motors, therefore, provide excellent acceleration characteristics.

High reliability

A totally–enclosed, friction–free brushless design is used. This allows the servo motors to be used in demanding environments with no need for special checks or maintenance.

Built–in, high–precision detector

A low–indexing–error optical encoder (pulse coder) is built into the motors. This pulse coder enables precise positioning.
Pulse coders that output 65,536, or 1,000,000 pulses per rotation are available. As such, the α series motors can be used for positioning applications ranging from simple positioning to those requiring a high degree of precision. (Available pulse coders vary with the series and model of the motor being used.)

The FANUC AC servo motor α series consists of the α , αM, αC, α (HV) series, and αM (HV), all of which are suitable general machine tool, control applications, and the αL series, designed for controlling machine tools that require frequent positioning operations, such as punch presses and PCB drilling machines.
Each of these series is further divided into the following models:

- **α series**
  α1/3000, α2/2000, α2/3000, α3/3000, α6/2000, α6/3000, α12/2000, α12/3000, α22/1500, α22/2000, α22/3000, α30/1200, α30/2000, α30/3000, α40/2000, α40/2000 (with fan), α65/2000, α100/2000, α150/2000, α300/2000, α400/2000

- **αM series**
  αM2/3000, αM2.5/3000, αM6/3000, αM9/3000, αM22/3000, αM30/3000, αM40/3000, αM40/3000 (with fan)

- **αL series**
  αL6/3000, αL9/3000, αL25/3000, αL50/2000

- **αC series**,
  αC3/2000, αC6/2000, αC12/2000, αC22/1500

- **α(HV) series**
  α3/3000HV, α6/3000HV, α12/3000HV, α22/3000HV, α30/3000HV, α40/2000HV, α1000/2000HV

- **αM(HV) series**
  αM6/3000 (HV), αM9/3000 (HV), αM22/3000 (HV), αM30/3000 (HV), αM40/3000 (HV)

2 PRECAUTIONS ON USE

2.1 APPLICABLE AMPLIFIERS

2.1.1 Applicable Amplifiers

The FANUC α series AC servo motors can be driven using FANUC α series servo amplifiers.

Servo motor		Servo amplifier module (SVM)/ Servo amplifier unit (SVU)		
Model name	**Specification**	**Model name**	**Specification**	**Connection axis**
α1/3000 α2/2000 α2/3000	A06B–0371–B*** A06B–0372–B*** A06B–0373–B***	SVM1–12	A06B–6079–H101 A06B–6096–H101	
		SVM2–12/12	A06B–6079–H201 A06B–6096–H201	L and M axes
		SVM2–12/20	A06B–6079–H202 A06B–6096–H202	L axis
		SVM2–12/40	A06B–6079–H204 A06B–6080–H204	L axis
		SVM3–12/12/12	A06B–6079–H301 A06B–6080–H301 A06B–6096–H301	L, M and N axes
		SVM3–12/12/20	A06B–6079–H302 A06B–6080–H302 A06B–6096–H302	L and M axes
		SVM3–12/20/20	A06B–6079–H303 A06B–6080–H303 A06B–6096–H303	L axis
		SVM3–12/12/40	A06B–6079–H305 A06B–6080–H305 A06B–6096–H305	L and M axes
		SVM3–12/20/40	A06B–6079–H306 A06B–6080–H306 A06B–6096–H306	L axis
		SVU1–12	A06B–6089–H101	L and M axes
		SVU2–12/12	A06B–6089–H201	L axis
		SVU2–12/20	A06B–6089–H202	L axis
		SVU2–12/40	A06B–6089–H204	L axis
		SVU3–12/12/12	A06B–6089–H301	L, M and N axes
		SVU3–12/12/20	A06B–6089–H302	L and M axes
		SVU3–12/20/20	A06B–6089–H303	L axis

Servo motor		Servo amplifier module (SVM)/ Servo amplifier unit (SVU)		
Model name	Specification	Model name	Specification	Connection axis
αM2/3000 αM2.5/3000 αC3/2000 αC6/2000	A06B–0376–B*** A06B–0377–B*** A06B–0121–B*** A06B–0126–B***	SVM1–20	A06B–6079–H102 A06B–6096–H102	
		SVM2–12/20	A06B–6079–H202 A06B–6096–H202	M axis
		SVM2–20/20	A06B–6079–H203 A06B–6096–H203	L and M axes
		SVM2–20/40	A06B–6079–H205 A06B–6096–H205	L axis
		SVM3–12/12/20	A06B–6079–H302 A06B–6080–H302 A06B–6096–H302	N axis
		SVM3–12/20/20	A06B–6079–H303 A06B–6080–H303 A06B–6096–H303	M and N axes
		SVM3–20/20/20	A06B–6079–H304 A06B–6080–H304 A06B–6096–H304	L, M and N axes
		SVM3–12/20/40	A06B–6079–H306 A06B–6080–H306 A06B–6096–H306	M axis
		SVM3–20/20/40	A06B–6079–H307 A06B–6080–H307 A06B–6096–H307	L and M axes
		SVU1–20	A06B–6089–H102	
		SVU2–12/20	A06B–6089–H202	M axis
		SVU2–20/20	A06B–6089–H203	L and M axes
		SVU2–20/40	A06B–6089–H205	L axis
		SVU3–12/12/20	A06B–6089–H302	N axis
		SVU3–12/20/20	A06B–6089–H303	M and N axes
		SVU3–20/20/20	A06B–6089–H304	L, M and N axes

Servo motor		Servo amplifier module (SVM)/ Servo amplifier unit (SVU)		
Model name	Specification	Model name	Specification	Connection axis
α3/3000 α6/2000	A06B–0123–B*** A06B–0127–B***	SVM1–40S	A06B–6079–H103 A06B–6096–H103	
		SVM2–12/40	A06B–6079–H204 A06B–6096–H204	M axis
		SVM2–20/40	A06B–6079–H205 A06B–6096–H205	M axis
		SVM2–40/40	A06B–6079–H206 A06B–6096–H206	L axis
		SVM2–40/80	A06B–6079–H207 A06B–6096–H207	L axis
		SVM2–40L/40L	A06B–6079–H209 A06B–6096–H209	L and M axes
		SVM3–12/12/40	A06B–6079–H305 A06B–6080–H305 A06B–6096–H305	N axis
		SVM3–12/20/40	A06B–6079–H306 A06B–6080–H306 A06B–6096–H306	N axis
		SVM3–20/20/40	A06B–6079–H307 A06B–6080–H307 A06B–6096–H307	N axis
		SVU1–40	A06B–6089–H104	
		SVU2–12/40	A06B–6089–H204	M axis
		SVU2–20/40	A06B–6089–H205	M axis
		SVU2–40/40	A06B–6089–H206	L and M axes
		SVU2–40/80	A06B–6089–H207	L axis

Servo motor		Servo amplifier module (SVM)/ Servo amplifier unit (SVU)		
Model name	**Specification**	**Model name**	**Specification**	**Connection axis**
α12/2000 αC22/1500 (The SVU2 is unapplicable to the αC22/1500.)	A06B–0142–B*** A06B–0145–B***	SVM1–40L	A06B–6079–H104 A06B–6096–H104	
		SVM2–12/40	A06B–6079–H204 A06B–6096–H204	M axis
		SVM2–20/40	A06B–6079–H205 A06B–6096–H205	M axis
		SVM2–40/40	A06B–6079–H206 A06B–6096–H206	L axis
		SVM2–40/80	A06B–6079–H207 A06B–6096–H207	L axis
		SVM2–40L/40L	A06B–6079–H209 A06B–6096–H209	L and M axes
		SVM3–12/12/40	A06B–6079–H305 A06B–6080–H305 A06B–6096–H305	N axis
		SVM3–12/20/40	A06B–6079–H306 A06B–6080–H306 A06B–6096–H306	N axis
		SVM3–20/20/40	A06B–6079–H307 A06B–6080–H307 A06B–6096–H307	N axis
		SVU1–40	A06B–6089–H104	
		SVU2–12/40	A06B–6089–H204	M axis
		SVU2–20/40	A06B–6089–H205	M axis
		SVU2–40/40	A06B–6089–H206	L and M axes
		SVU2–40/80	A06B–6089–H207	L axis
α22/1500	A06B–0146–B***	SVM1–40L	A06B–6079–H104 A06B–6096–H104	
		SVM2–40/80	A06B–6079–H207 A06B–6096–H207	L axis
		SVM2–40L/40L	A06B–6079–H209 A06B–6096–H209	L, M axes
		SVU1–40	A06B–6089–H104	

Servo motor		Servo amplifier module (SVM)/ Servo amplifier unit (SVU)		
Model name	Specification	Model name	Specification	Connection axis
α6/3000 αM6/3000	A06B–0128–B*** A06B–0162–B***	SVM1–80	A06B–6079–H105 A06B–6096–H105	
		SVM2–40/80	A06B–6079–H207 A06B–6096–H207	M axis
		SVM2–80/80	A06B–6079–H208 A06B–6096–H208	L and M axes
		SVU1–80	A06B–6089–H105	
		SVU2–40/80	A06B–6089–H207	M axis
		SVU2–80/80	A06B–6089–H208	L and M axes
		SVU2–12/80	A06B–6089–H209	M axis
		SVU2–20/80	A06B–6089–H210	M axis
α12/3000 α22/2000 α30/1200 αM9/3000 αL6/3000 αL9/3000	A06B–0143–B*** A06B–0148–B*** A06B–0151–B*** A06B–0163–B*** A06B–0562–B*** A06B–0564–B***	SVM1–80	A06B–6079–H105 A06B–6096–H105	
		SVM2–40/80	A06B–6079–H207 A06B–6096–H207	M axis
		SVM2–80/80	A06B–6079–H208 A06B–6096–H208	L and M axes
		SVU1–80	A06B–6089–H105	
α22/3000 α30/2000 α30/3000 α40/2000 α40/2000 (with FAN) αM22/3000 αM30/3000 αL25/3000 αL50/2000	A06B–0148–B*** A06B–0152–B*** A06B–0153–B*** A06B–0157–B*** A06B–0158–B*** A06B–0165–B*** A06B–0166–B*** A06B–0571–B*** A06B–0572–B***	SVM1–130	A06B–6079–H106 A06B–6096–H106	
		SVU1–130	A06B–6089–H106	
αM40/3000	A06B–0169–B***	SVM1–130 SVU1–130	A06B–6079–H106 (Note 7) A06B–6096–H106 (Note 7) A06B–6089–H106 (Note 8)	
α65/2000	A06B–0331–B***	SVM1–240	A06B–6079–H107 A06B–6096–H107	
αM40/3000 (with fan) α100/2000 α150/2000	A06B–0170–B*** A06B–0332–B*** A06B–0333–B***	SVM1–360	A06B–6079–H108 A06B–6096–H108	
α300/2000 α400/2000	A06B–0137–B*** A06B–0138–B***	SVM1–360 2 modules /1motor	A06B–6079–H108 or A06B–6096–H108	

Servo motor		Servo amplifier module (SVM)/ Servo amplifier unit (SVU)		
Model name	**Specification**	**Model name**	**Specification**	**Connection axis**
α3/3000HV α6/3000HV	A06B–0171–B*** A06B–0172–B***	SVM1–20HV	A06B–6085–H102 A06B–6097–H102	
		SVM2–20/20HV	A06B–6085–H201 A06B–6097–H201	L and M axes
		SVM2–20/40HV	A06B–6085–H202 A06B–6097–H202	L axis
		SVM2–20/60HV	A06B–6085–H203 A06B–6097–H203	L axis
α12/3000HV αM6/3000HV αM9/3000HV	A06B–0176–B*** A06B–0182–B*** A06B–0183–B***	SVM1–40HV	A06B–6085–H103 A06B–6097–H103	
		SVM2–20/40HV	A06B–6085–H202 A06B–6097–H202	M axis
		SVM2–40/40HV	A06B–6085–H204 A06B–6097–H204	L and M axes
		SVM2–40/60HV	A06B–6085–H205 A06B–6097–H205	L axis
α22/3000HV α30/3000HV αM22/3000HV αM30/3000HV	A06B–0177–B*** A06B–0178–B*** A06B–0185–B*** A06B–0186–B***	SVM1–60HV	A06B–6085–H104 A06B–6097–H104	
		SVM2–20/60HV	A06B–6085–H203 A06B–6097–H203	M axis
		SVM2–40/60HV	A06B–6085–H205 A06B–6097–H205	M axis
		SVM2–60/60HV	A06B–6085–H207 A06B–6097–H207	L and M axes
α40/2000HV	A06B–0179–B***	SVM1–80HV	A06B–6097–H105	(Note 9)
αM40/3000HV	A06B–0189–B***	SVM1–80HV	A06B–6097–H105	(Note 9)
α1000/2000HV	A06B–0131–B***	SVM1–320HV 2 modules /1motor	A06B–6097–H107 (FSSB interface)	

Servo motor		Dynamic Brake modules(DBM)	
Model name	**Specification**	**Model name**	**Specification**
α300/2000 α400/2000	A06B–0137–B*** A06B–0138–B***	DBM 2 modules /1motor	A06B–6079–H401
α1000/2000HV	A06B–0131–B***	DBM 2 modules /1motor	A06B–6079–H401

CAUTION

1 If a motor is used in a combination other than those listed above, it may become broken.
2 For details on the servo amplifier module (SVM), refer to “FANUC Servo Amplifier α series Descriptions” (B-65162E).
3 For details on the servo amplifier unit (SVU), refer to “FANUC Servo Amplifier α series Descriptions” (B-65162E).
4 When using the α series servo amplifier modules for three axes (SVM3) on the B type interface CNC such as FS20 and FS21 series, the specification varies from one NC to another. Refer to “FANUC Control Servo Amplifier α series Descriptions” (B-65162E).
5 When the SVM-130 is used to drive the α22/3000, α30/3000, α40/2000 (with fan), αM22/3000, αM30/3000, αL25/3000, or αL50/2000, it must be cooled by forced air flow.
6 When using C series servo amplifiers, consult with our service person.
7 The fan adapter (A06B–6078–K002) is necessary for each servo motor amplifier. Refer to “FANUC Servo Motor Amplifier α series Descriptions (B–65162E)”.
8 SVU1–130 can be connected to NC through only TYPE A I/F or TYPE B I/F, and FSSB I/F is not available.
9 SVU1–80HV can be connected to NC through only FSSB I/F.

2.1.2 Data for Selecting PSM

Motor model	Rating output	Maximum output at accelerating	
		Case 1	Case 2
αM40/3000	3.0kW	18.4kW	20.7kW
αM40/3000 (with fan)	10kW	30.2kW	34.0kW
α300/2000	37kW	82kW	94kW
α400/2000	40kW	84kW	96kW
α40/2000HV	5.9kW	16.7kW	18.8kW
αM40/3000HV	3.0kW	21.4kW	24.0kW
α1000/2000HV	100kW	168kW	189kW

For Cases 1 and 2, refer to motor power output list for selecting the power supply of the FANUC SERVO AMPLIFIER α series DESCRIPTIONS (B–65162E).

CAUTION
These data is only for selecting the PSM and it does not guarantee the power of motors.

When the one motor driven in the α300/2000, α400/2000, or α1000/2000HV, the selection is as follows.

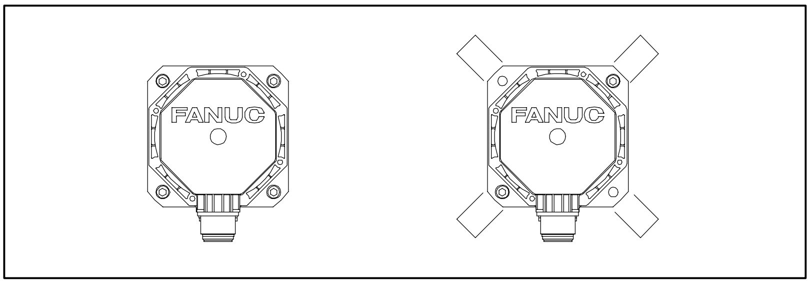
Motor Model	Case 1	Case 2	Case (high frequency)(*)
α300/2000	PSM30 × 2	PSM30 × 2	PSM37 × 2
α400/2000	PSM30 × 2	PSM30 × 2	PSM37 × 2
α1000/2000HV	PSM75HV × 2	PSM75HV × 2	PSM75HV × 2

CAUTION
(*) In the case of high frequently positioning such as press machine or positioning over 30 times per minute, the PSM should be selected with the following condition. “The continuous rating of the PSM should be under the 1.5 times to the amount of acceleration maximum of the same time moving axis”.

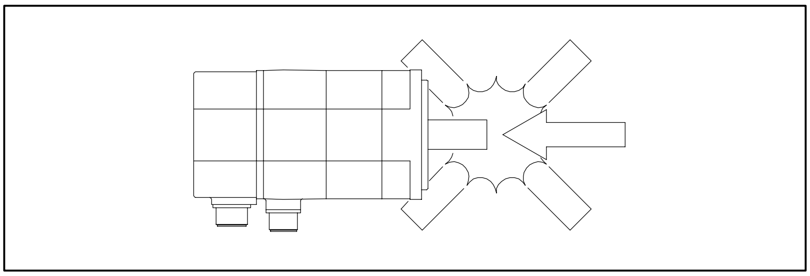
2.2 INSTALLATION

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

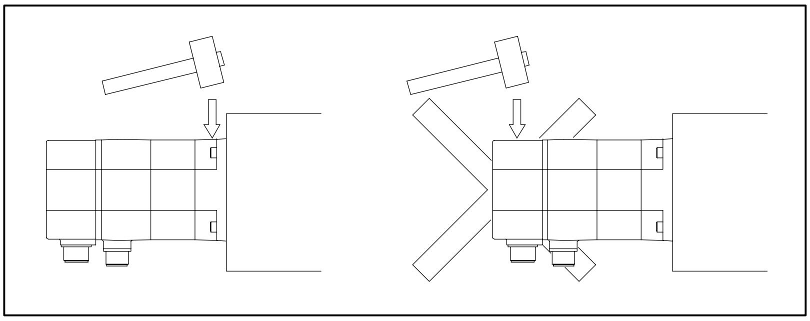
- Secure the servo motor uniformly using four bolt holes provided on the front flange.



- Ensure that the surface on which the machine is mounted is sufficiently flat.
- When mounting on the machine, take care not to apply a shock to the motor.



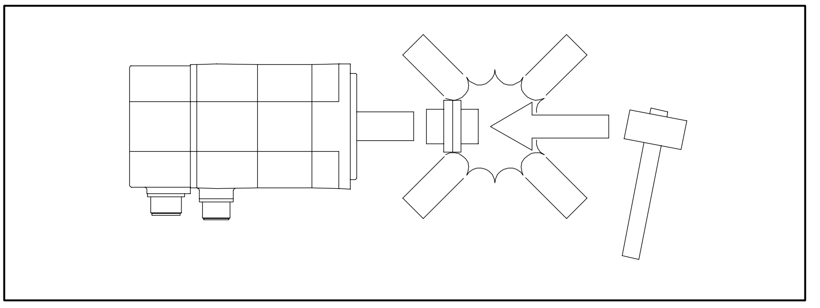
- When it is unavoidable to tap the motor for adjusting the position, etc., use a plastic hammer and tap only the front flange if possible.



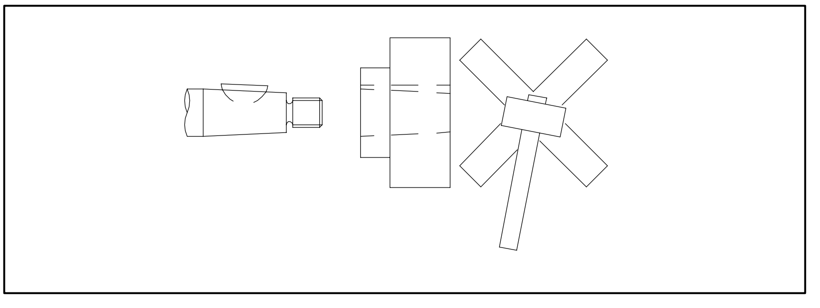
2.3 COUPLING

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

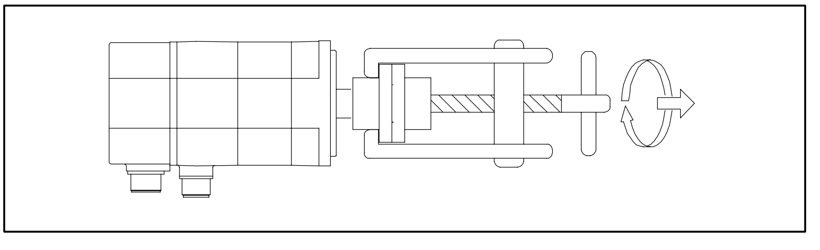
- When connecting the power transmission elements such as a gear, a pulley and a coupling to the shaft, take care not to apply a shock to the shaft.



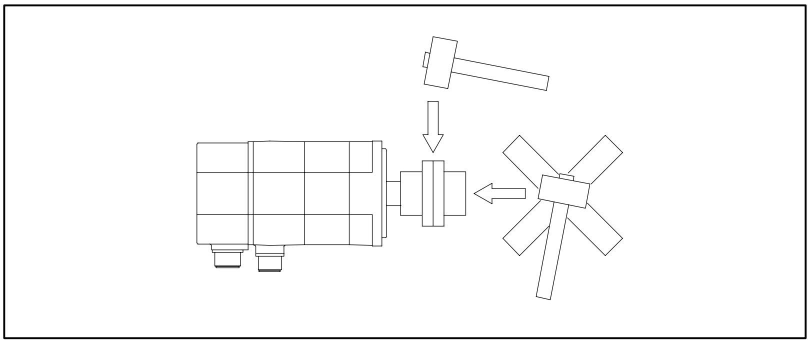
- Generally, in the case of straight shaft, use a span ring for connection with the shaft.
- In the case of tapered shaft, match the tapered surface with the power transmission element and fix by tightening the screw at the end. When the woodruff key is too tight, don't tap it with a hammer. Use the woodruff key mainly for positioning, and use the tapered surface for torque transmission. Machine the tapered surface of the power transmission element so that over 70% of the whole surface is contacted.



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



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



- Suppress the rotary unbalance of the connected power transmission element to the level as low as possible. It is usually believed that there is no problem in the symmetrical form . Be careful when rotating continuously the asymmetrical different form power transmission element. Even if the vibration caused by the unbalance is as small as 0.5G, it may damage the motor bearing or the detector.

An exclusive large oil seal is used in the front flange of the models α3 to α40.
The oil seal surface is made of steel plate. Take care not to apply a force to the oil seal when installing the motor or connecting the power transmission elements.

2.4 AXIS LOAD

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

Motor model	Radial load	Axial load	Front bearing (reference)
α1/2 αM2/2.5	25 [kgf]	8 [kgf]	6003
α3/6 αM6/9 αL6/9 αC3/6 α3/6HV αM6/9HV	70 [kgf]	20 [kgf]	6205
α12/22/30/40 αM22/30/40/40 (with fan) αL25/50 αC12/22 α12/22/30/40HV αM22/30/40HV	450 [kgf]	135 [kgf]	6208
α65/100/150	900 [kgf]	250 [kgf]	6312
α300/400	1200 [kgf]	200 [kgf]	NU2214
α1000	1400 [kgf]	200 [kgf]	6317 Combination bearing

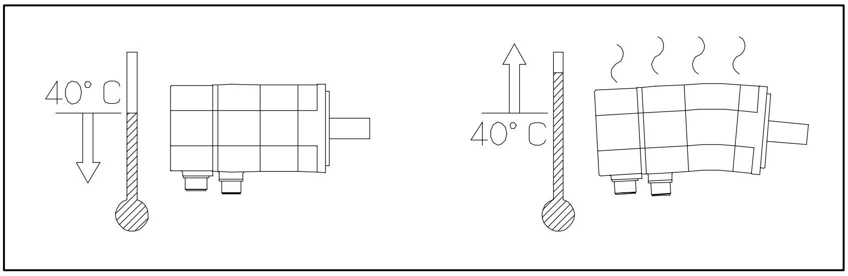
The above values are the reference assuming the use as a feed axis on the typical machine tool.

- The allowable radial load is the value when a load is applied to the shaft end. It indicates the total continuous force applied to the shaft in some methods of mounting (e.g, belt tension) and the force by load torque (e.g., moment/pulley radius).
- The belt tension is critical particularly when a timing belt is used. Too tight belt causes breakage of the shaft or other fault.
  Belt tension must be controlled so as not to exceed the limits calculated from the permissible radial load indicated above.
- In some operation conditions, the pulley diameter and the gear size need to be checked. For example, when using the model α3 with a pulley/gear with the radius of 2.5cm or less, the radial load at the occurrence of 180kg·cm torque will exceed 70kg. In the case of timing belt, as the belt tension is added to this value, it is thus necessary to support the shaft end.
- Actually, when using a timing belt, a possible fault like a broken shaft can be prevented by positioning the pulley as close to the bearing as possible.
- When there is a possibility of a large load, the machine tool builder needs to examine the life by referring to the shaft diameter, bearing, etc.
- Since the standard single row deep groove ball bearing is used for the motor bearing, a very large axial load can not be used. Particularly, when using a worm gear and a helical gear, it is necessary to provide another bearing.
- The motor bearing is generally fixed with a C-snap ring, and there is a small play in the axial direction. When this play influences the positioning in the case of using a worm gear and a helical gear, for example, it is necessary to fix it with another bearing.

2.5 ENVIRONMENT

Ambient temperature

The ambient temperature should be 0°C to 40°C. When operating the machine at a higher temperature, it is necessary to lower the output power so that the motor temperature does not exceed the specified constant value. (The values in the data sheet are determined for an ambient temperature of 20°C.)



Vibration

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

Installation height

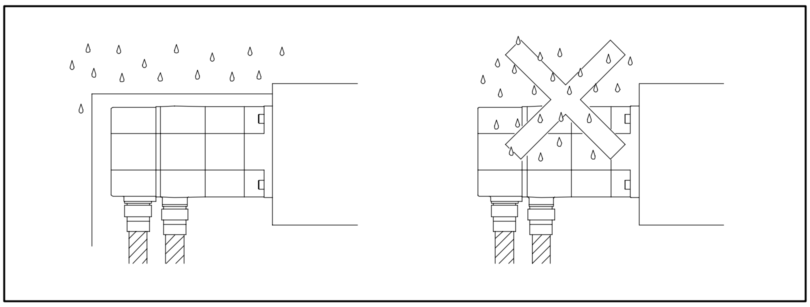
Up to 1,000 meters above the sea level requires, no particular provision for attitude. When operating the machine at a higher level, special care is unnecessary if the ambient temperature is lowered 1°C at every 100m higher than 1,000m. For example, when the machine is installed at a place of 1,500 meters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

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

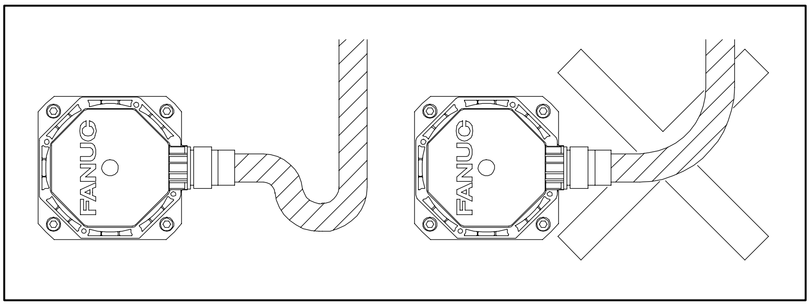
Drip–proof environment

The level of motor protection is such that a single motor unit can satisfy IP65 of the IEC standard. (The connector section for the fan of fan–equipped models is excluded.) However, this standard relates only to short–term performance. So, note the following when using the motor in actual applications:

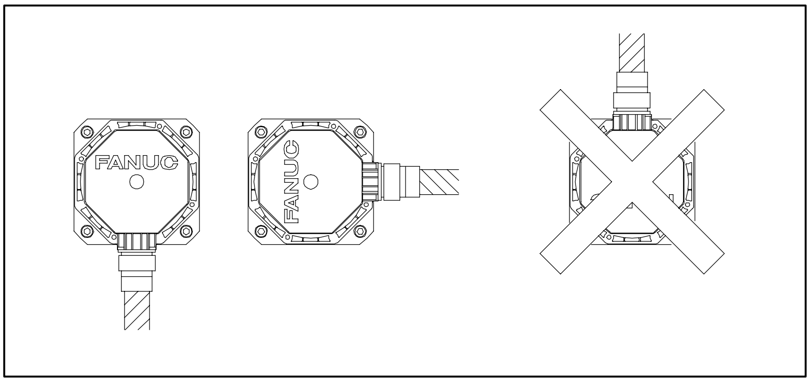
- Protect the motor surface from the cutting fluid or lubricant. Use a cover when there is a possibility of wetting the motor surface. Only the telescopic cover of the sliding part can not completely prevent leakage of the cutting fluid. Pay attention to the drop along the structure body, too.



- Prevent the cutting fluid from being led to the motor through the cable. When the motor connector is used in the up position, put a drip loop in the cable.



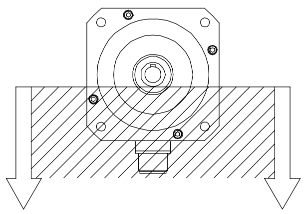
- When the motor connector is up, the cutting fluid is collected in the cable connector through the cable. Turn the motor connector sideways or downward as far as possible. Most of the defects caused by the cutting fluid have occurred in the cable connector.
  The standard receptacle on the motor side is waterproof. If the cable connector will be subjected to moisture, it is recommended that an R class or waterproof plug be used. Suitable plugs are listed in the cable plug combination recommendations in Chapter 8. (The standard MS plug is not waterproof; water is liable to enter the pin section.)



Shaft attachment section requirements

The motor shaft is sealed to prevent penetration of oil into the motor housing. However, sealing may not be perfect under severe working conditions.

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



The motor shaft oil seal diameter is as shown below.

Motor mode	Oil seal diameter
α1/2 αM2/2.5	ϕ 15 [mm]
α3/6 αM6/9 αL6/9 αC3/6 α3/6HV αM6/9HV	ϕ 24 [mm]
α12/22/30/40 αM22/30/40 αL25/50 αC12/22 α12/22/30/40HV αM22/30/40HV	ϕ 35 [mm]
α65/100/150	ϕ 60 [mm]
α300/400	ϕ 70 [mm]
α1000HV	ϕ 85 [mm]

2.6 ACCEPTANCE AND STORAGE

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

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

FANUC servo motors are completely checked before shipment, and the inspection at acceptance is normally unnecessary. When an inspection is required, check the specifications (wiring, current, voltage, etc.) of the motor and detector.
Store the motor indoors. The storage temperature is -20°C to +60°C. Avoid storing in the following places.

- Place with high humidity so condensation will form.
- Place with extreme temperature changes.
- Place always exposed to vibration.
  (The bearing may be damaged.)
- Place with much dust.

3 INSTRUCTIONS

3.1 DRIVE SHAFT COUPLING

There are four methods for connecting the motor shaft to the ball screw:

- Direct connection through a flexible coupling
- Direct connection through a rigid coupling
- Connection through gears
- Connection through timing belts

It is important to understand the advantages and disadvantages of each method, and select one that is most suitable for the machine.

Direct connection using a flexible coupling

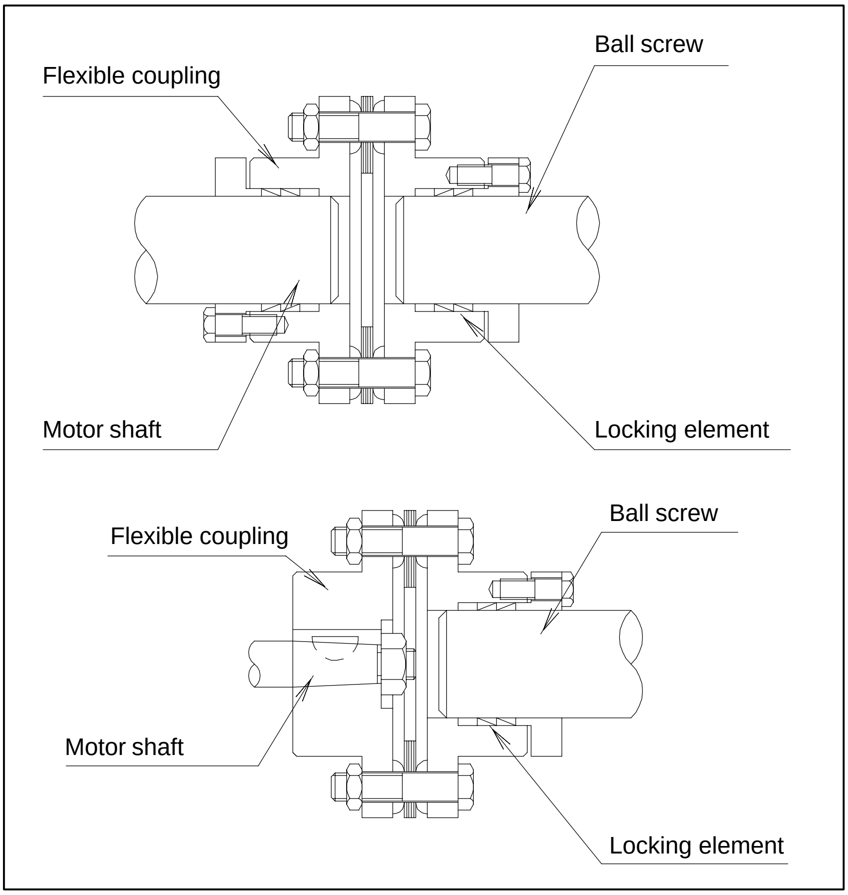
Direct connection by a flexible coupling has the following advantages over connection using gears:

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

However, this method has the following disadvantages:

- The motor shaft and the ball screw must not slide from each other in the radial direction (for single coupling).
- Loose assembly may result in lower rigidity.

When the motor shaft needs to be connected directly to the ball screw, connecting them using a flexible coupling facilitates adjustment and installation of the motor.
To use a single coupling, the machine needs to be designed so that the centers of the motor shaft and the ball screw are aligned. (In the same way as with a rigid coupling, the use of a single coupling demands that there be almost no relative eccentricity between the axes.)
If it is difficult to align the centers, a double coupling needs to be employed.



Direct connection using a rigid coupling

Direct connection using a rigid coupling has the following advantages over direct connection using a flexible coupling:

- More economical
- The coupling rigidity can be increased.
- If the rigidity is the same as with a flexible coupling, the inertia can be reduced.

However, this method has the following disadvantages:

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

For this reason, a rigid coupling needs to be mounted very carefully.
It is desirable that the run-out of the ball screw is 0.01 mm or less. When a rigid coupling is used on the motor shaft, the run-out of the hole for the ball screw must be set to 0.01 mm or less by adjusting the tightness of the span ring.
The run-out of the motor shaft and the ball screw in the radial direction can be adjusted or compensated to a certain extent by deflection. Note, however, that it is difficult to adjust or measure changes in the angle. Therefore, the structure of the machine should be such that precision can be fully guaranteed.

Gears

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

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

Timing belt

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

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

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

Connection between the straight shaft and a connecting element

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

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

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

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

3.2 MACHINE MOVEMENT PER 1 REVOLUTION OF MOTOR SHAFT

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

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

4 SELECTING A MOTOR

When selecting an applicable motor, the load, rapid traverse feedrate, increment system, and other conditions must be considered. This section describes how to calculate the load and other conditions, showing an example of a table with a horizontal axis.

Motors are subjected to two types of torque: constant load torque (including friction), and cutting power and acceleration/deceleration torque. Calculate the two loads accurately and select a motor that satisfies the following conditions:

Condition 1

When the machine is operating without any load, the torque is within about 70% of the continuous torque rating.

When the machine tool is stopped, the motor is generating torque in a balanced state with the friction–induced load. If acceleration/ deceleration torque required for actual operation is added when this value is close to the rated torque, the rated torque may be exceeded as the average torque, and the motor is more likely to overheat.

This figure of “within 70% of the continuous torque rating” is for reference only. Determine the appropriate torque based upon actual machine tool conditions.

Condition 2

Acceleration can be made with a desired time constant.

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

Condition 3

The frequency of positioning in rapid traverse is set to a desired value. The greater the frequency of positioning in rapid traverse, the greater the ratio of acceleration time to the entire operation time. This may overheat the motor. When the acceleration time constant is increased according to the rapid traverse feedrate and positioning frequency constant, the amount of produced heat decreases in inverse proportion to the acceleration time constant.

Condition 4

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

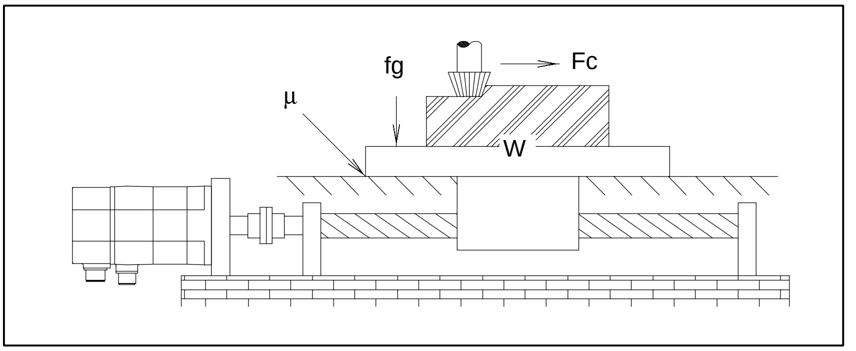
Condition 5

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

The procedure for selecting a motor is described below:

4.1 CALCULATING CONDITIONS FOR SELECTING A MOTOR

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



Sample mechanical specifications of the table and workpiece

W : Weight of movable parts (table and workpiece) = 1000 (kgf) = 98000 (N)

w : Weight of movable parts (table and workpiece) = 1000 (kg)

μ : Friction coefficient of the sliding surface = 0.05

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

fg : Gib fastening force (kgf) = 50 (kgf) = 490 (N)

Fc : Thrust counter force caused by the cutting force (kgf) = 100 (kgf) = 980 (N)

Fcf : Force by which the table is pressed against the sliding surface, caused by the moment of cutting force = 30 (kgf) = 294 (N)

Z_1/Z_2 : Gear reduction ratio = 1/1

Sample specifications of the feed screw (ball screw)

Db : Shaft diameter = 32 (mm) = 32×10^{-3} (m)

Lb : Shaft length = 1000 (mm) = 1 (m)

P : Pitch = 8 (mm) = 8×10^{-3} (m)

Sample specifications of the operation of the motor shaft

Ta : Acceleration torque (kgf·cm) (Nm)

Vm : Motor speed in rapid traverse = 3000 (min^{-1}) = 50 (s^{-1})

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

J_M : Motor inertia ($kgf{\cdot}cm{\cdot}sec^2$) ($kg{\cdot}m^2$)

J_L : Load inertia ($kgf{\cdot}cm{\cdot}sec^2$) ($kg{\cdot}m^2$)

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

4.1.1 Calculating the Load Torque and Load Inertia

Calculating the load torque

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

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

Tm : Load torque applied to the motor shaft
F : Force required to move a movable part (table or tool post) along the axis
L : Traveling distance of the machine tool per revolution of the motor = P × (Z1/Z2)
Tf : Friction torque of the nut of the ball screw or bearing applied to the motor shaft (input if necessary)

F depends on the weight of the table, friction coefficient, whether cutting is in progress, and whether the axis is horizontal or vertical. If the axis is vertical, F also depends on the presence of a counterbalance. For a table with a horizontal axis, F is calculated as follows:
When Tf = 2 (kgf·cm) = 0.2 (Nm)

When cutting is not executed:

F = μ (W + fg)

Example)

F = 0.05 × (1000 + 50) = 52.5 (kgf) = 514.5 (N)
Tm = (52.5 × 0.8)/(2 × π × 0.9) + 2 = 9.4 (kgf·cm) = 0.92 (Nm)

When cutting is in progress:

F = Fc + μ (W + fg + Fcf)

Example)

F = 100 + 0.05 × (1000 + 50 + 30) = 154 (kgf·cm) = 1509 (N)
Tmc = (154 × 0.8)/(2 × π × 0.9) + 2 = 23.8 (kgf·cm) = 2.3 (Nm)

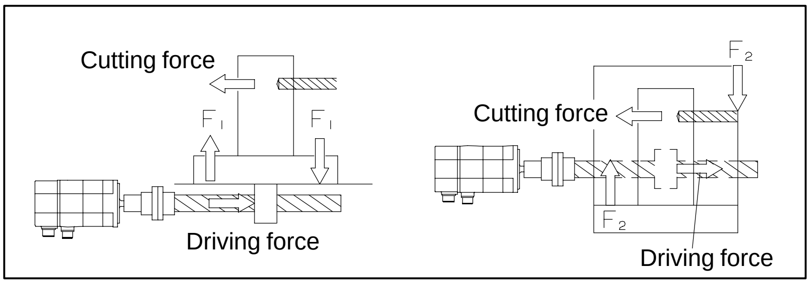
To satisfy condition 1, check the data sheet and select a motor whose load torque (rated torque at stall) when cutting is not executed is 0.92 (Nm) or higher and the maximum speed is 3000 (min^{-1}) or higher. Considering the acceleration/deceleration conditions, provisionally select α2/3000 (rated torque at stall is 2.0 (Nm)).

• Cautions

When calculating the torque, take the following precautions:

- Allow for the friction torque caused by the gib fastening force (fg). The torque calculated only from the weight of a movable part and the friction coefficient is generally quite small. The gib fastening force and precision of the sliding surface may have a great effect on the torque.
- The pre–load of the bearing or nut of the ball screw, pre–tension of the screw, and other factors may make Tc of the rolling contact considerable. In a small, lightweight machine tool, the friction torque will greatly affect the entire torque.

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

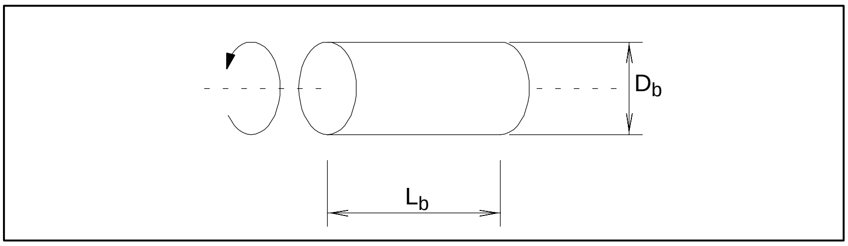


- The feedrate may cause the friction torque to vary greatly. Obtain an accurate value by closely examining variations in friction depending on variations in speed, the mechanism for supporting the table (sliding contact, rolling contact, static pressure, etc.), material of the sliding surface, lubricating system, and other factors.
- The friction torque of a single machine varies widely due to adjustment conditions, ambient temperature, and lubrication conditions. Collect a great amount of measurement data of identical models so that a correct load torque can be calculated. When adjusting the gib fastening force and backlash, monitor the friction torque. Avoid generating an unnecessarily great torque.

Calculating the load inertia

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

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



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

$$J_b = \frac{\pi \gamma_b}{32 \times 980} D_b^{\,4} L_b \quad (\text{kgf·cm·s}^2)$$

J_b : Inertia (kgf·cm·s^2)
γ_b : Weight of the object per unit volume (kg/cm^3)
D_b : Diameter of the object (cm)
L_b : Length of the object (cm)

SI unit

$$J_b = \frac{\pi \gamma_b}{32} D_b^{\,4} L_b \quad (\text{kgf·m}^2)$$

J_b : Inertia (kgf·m^2)
γ_b : Weight of the object per unit volume (kg/cm^3)
D_b : Diameter of the object (m)
L_b : Length of the object (m)

Example)

When the shaft of a ball screw is made of steel (g = 7.8×10^3 (kg/m^3)), inertia J_b of the shaft is calculated as follows:

$J_b = 7.8 \times 10^3 \times \pi \div 32 \times 0.032^4 \times 1 = 0.0008$ [kg·m^2]
(=0.0082 [kg·cm·s^2])

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

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

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

SI unit

$$J = W \times \left(\frac{L}{2\pi}\right)^2 \quad (\text{kgf·cm·s}^2)$$

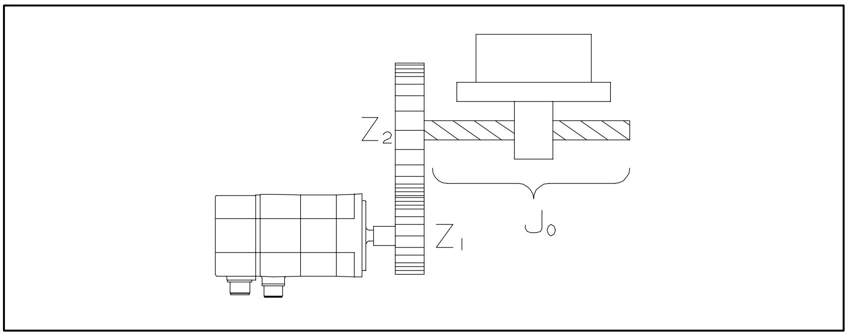
W : Weight of the object moving along a straight line (kg)
L : Traveling distance along a straight line per revolution of the motor (cm)

Example)

When W is 1000(kg) and L is 8(mm), Jw of a table and workpiece is calculated as follows:

Jw = $1000 \times (0.008 \div 2 \div \pi)^2 = 0.00162$ (kg·m^2) = 0.0165 (kgf·cm·s^2)

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



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

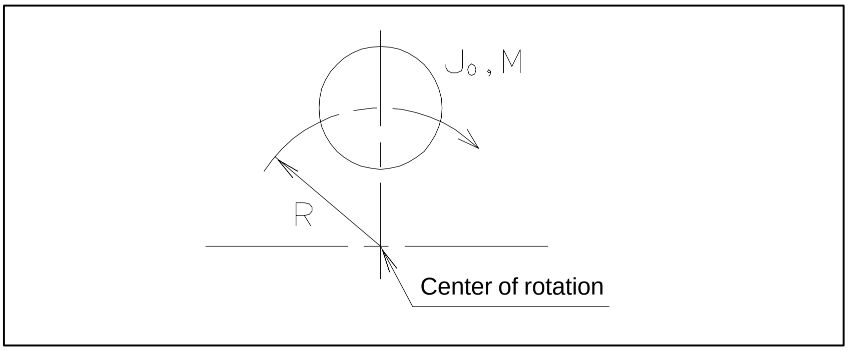
$$J = \left(\frac{Z_1}{Z_2}\right)^2 \times J_o$$ (Z_1, Z_2 : Number of teeth when the gear connection)

or

$$J = \left(\frac{1}{Z}\right)^2 \times J_o$$ ($\frac{1}{Z}$: Deceleration ratio)

J_0: Inertia before the speed is changed

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



$$J = J_o + MR^2$$ (kgf·cm·s²)

J_0 : Inertia around the center of the object
M : Weight of the object
R : Radius of rotation

The above equation is used to calculate the inertia of, for example, a large gear which is hollowed out in order to reduce the inertia and weight.
The sum of the inertia values calculated above is J (load inertia) for accelerating the motor.
In this example, the sum of Jb and Jw obtained in above is load inertia JL.
J_L = 0.000803 + 0.00162 = 0.00242 (kgf·m^2)

● Note Limitations on load inertia

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

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

When the load inertia is greater than the rotor inertia by a factor of more than 3 to 5, the controllability of the motor will be adversely affected. If the load inertia much larger than three times the rotor inertia, an adjustment in the normal range may be insufficient. Avoid using a machine with such a great load inertia.

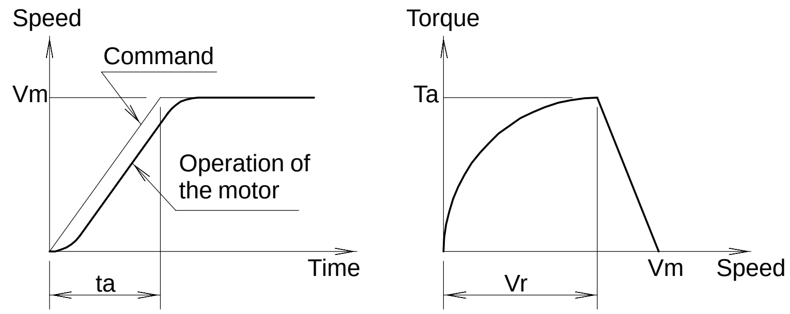
4.1.2 Calculating the Acceleration Torque

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

Calculating acceleration torque : Procedure 1

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

- **In linear acceleration/deceleration**



Speed variation

Acceleration required to achieve the speed

$$Ta = Vm \times 2\pi \times \frac{1}{ta} \times J_M \times (1-e^{-ks \cdot ta}) + Vm \times 2\pi \times \frac{1}{ta} \times J_L \times (1-e^{-ks \cdot ta}) \div \eta$$

$$Vr = Vm \times \{1-\frac{1}{ta \cdot ks}(1-e^{-ks \cdot ta})\}$$

Ta : Acceleration torque
Vm : Motor speed in rapid traverse
ta : Acceleration time
J_M : Motor inertia
J_L : Load inertia
Vr : Point from which the acceleration torque starts to decrease
ks : Servo position loop gain
η : Machine tool efficiency

Example)

Try to perform linear acceleration/deceleration under the following condition.

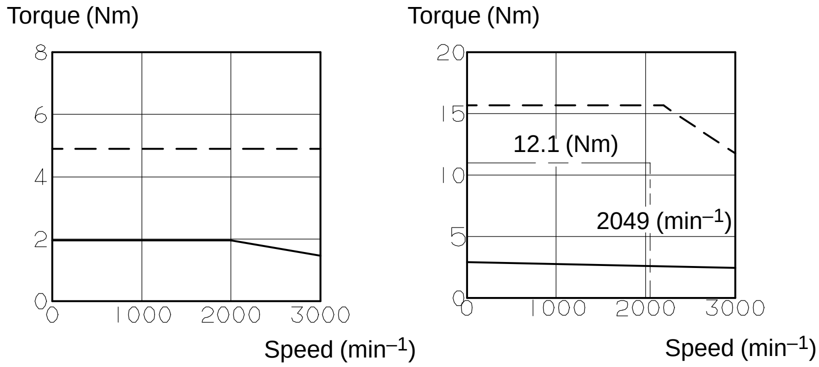
$V_m = 3000\ (\mathrm{min}^{-1}) = 50\ (\mathrm{s}^{-1})$, $ta = 0.1\ (\mathrm{s})$, $ks = 30\ (\mathrm{s}^{-1})$,

$J_L = 0.0247\ (\mathrm{kgf{\cdot}cm{\cdot}s^2})$

Select α2/3000, and calculate its acceleration torque.

J_M motor inertia is 0.0056 (kgf·cm·s^2) when α2/3000 is selected, so the load inertia is calculated as follows:

$$\begin{aligned} Ta &= 50 \times 2\pi \times 1/0.1 \times 0.0056 \times (1 - e^{-30 \times 0.1}) \\ &\quad + 50 \times 2\pi \times 1/0.1 \times 0.0247 \times (1 - e^{-30 \times 0.1}) \div 0.9 \\ &= 98.6\ (\mathrm{kgf{\cdot}cm}) = 9.67\ (\mathrm{Nm}) \end{aligned}$$



Speed–torque characteristics of α2/3000 **Speed–torque characteristics of α3/3000**

The speed–torque characteristics of α2/3000 show that the acceleration torque of 9.67 (Nm) is beyond the intermittent operating zone of α2/3000 (see the characteristic curve above and data sheet). (The torque is insufficient for α2/3000.)

If the operation specifications of the shaft (for instance, the acceleration time) cannot be changed, a larger motor must be selected. Select an α3/3000 (J_M is 0.014 (kgf·cm·s^2)) and calculate the acceleration torque again.

Ta = 123.7 (kg·cm) = 12.1 (Nm)

Vr = 2050 (min^{-1})

In acceleration, an acceleration torque of 12.1 (Nm) is required at 2050 (min^{-1}). The speed–torque characteristic curve shown above shows that the acceleration is possible with α3/3000.

As α2/3000 is changed to α3/3000, the size of the attachment flange is increased from 90 mm × 90 mm to 130 mm × 130 mm. If the machine tool does not allow a larger motor, the specifications must be changed. For example, the acceleration time must lengthen.

Calculating acceleration torque : Procedure 2

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

$$T = Ta + Tm$$

T=12.1(Nm)+0.9(Nm)=13.0(Nm)

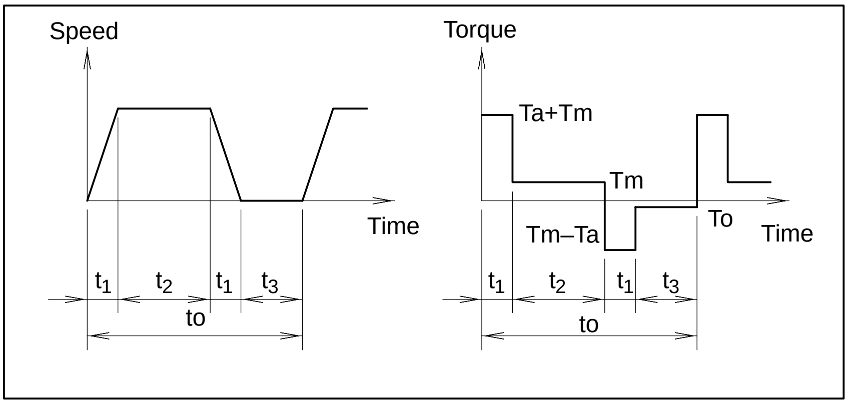
Calculating acceleration torque : Procedure 3

Check that T obtained in Procedure 2 above is smaller than or equal to the maximum torque. Using the speed–torque characteristic curve on the data sheet of the corresponding motor, check that T obtained in Procedure 1 above is within the intermittent operating zone at Vr.
As Vr is 2050 (min^{-1}) and T is 13.0 (Nm), the acceleration is possible with the specified time constant (condition 2).

4.1.3 Calculating the Root–mean–square Value of the Torques

Calculating the frequency of positioning in rapid traverse

Generate an operation cycle which includes rapid traverse. Write the time–speed graph and time–torque graph as shown below.
In a common cutting machine, the frequency of positioning in rapid traverse will cause no problems. In a special machine tool which frequently executes rapid traverse, however, the motor must be checked to see whether it is overheated by the current required for acceleration or deceleration.



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

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

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

If Trms is smaller than or equal to 90% of the rated torque at stall (Ts), the motor is judged to be usable.
(A margin including the overall thermal efficiency is considered.)

Example)
When an α3/3000 (Ts = 31 (kgf·cm) = 3.0 (Nm)) is used under the following conditions: Ta = 12.1 (Nm), Tm = To = 0.9 (Nm), t1 = 0.1 (s), t2 = 1.8 (s), t3 = 7.0 (s)

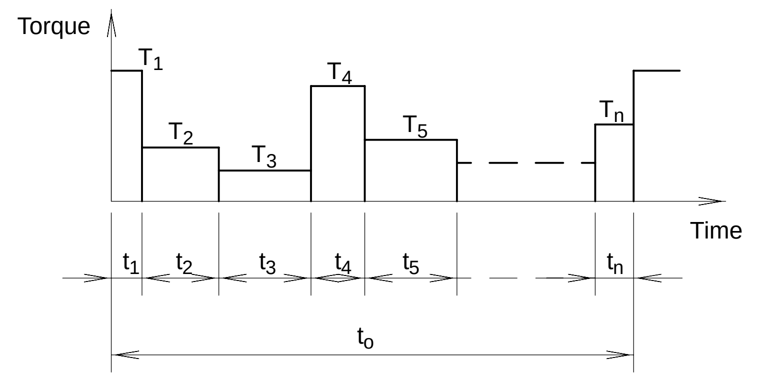
$$Trms = \sqrt{\frac{(12.1 + 0.9)^2 \times 0.1 + 0.9^2 \times 1.8 + (12.1-0.9)^2 \times 0.1 + 0.9^2 \times 7}{t_O}}$$

$$= 20.2(Nm) < Ts \times 0.9 = 2.9 \times 0.9 = 2.61(Nm)$$

The α3/3000 can be used for operation. (Condition 3)

Calculating the torque in a cycle in which the load varies

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



$$Trms = \sqrt{\frac{T_1^2 t_1 + T_2^2 t_2 + T_3^2 t_3 + \ldots + T_n^2 t_n}{t_o}}$$

$to = t_1 + t_2 + \ldots + Tn$

NOTE

When the motor is being operated at high speed for a comparatively large proportion of the time, you must take the rotating speed of the motor into consideration and evaluate whether output can be specified in terms of a continuous operation torque.

4.1.4 Calculating the Percentage Duty Cycle with the Maximum Cutting Torque

Check that the time for which the table can be moved with the maximum cutting torque, Tmc, (percentage duty cycle and ON time) is within a desired range of cutting time. (Condition 5)
If Tmc (maximum load torque) applied to the motor shaft during cutting, which is obtained in Subsec. 4.1.1, is smaller than the product of rated torque at stall of the motor (Tc) and α (thermal efficiency), the motor can be used in continuous cutting. If Tmc is greater than the product (Tmc > Tc _ α), follow the procedure below to calculate the percentage ratio of time (t_{ON}) Tmc can be applied to the motor to total time (t) of a single cutting cycle. (α is assumed to be 0.9. Calculate the percentage considering the specifications of the machine.)

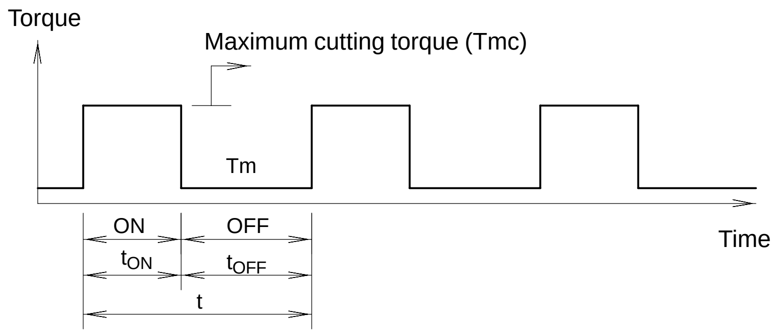
$Tmc < Tc \times \alpha$ ...	Operation can be continued with the maximum cutting torque. (The percentage duty cycle with the maximum cutting torque is 100%.)
$Tmc > Tc \times \alpha$ ...	Calculate the percentage duty cycle, according to the following figure and expressions.

Example)

As calculated in Subsec. 4.1.1,
Tmc = 21.8 (kgf·cm) = 2.1 (Nm)
α3/3000: Tc = 31 (kgf·cm) = 3.0 (Nm)
Tc × α = 3.0 × 0.9 = 2.7 (Nm) > Tmc = 2.1 (Nm)

No problems will occur in continuous cutting.

Calculating the percentage duty cycle with the maximum cutting torque



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

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

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

Example)

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

$$\sqrt{\frac{4.0^2 \times t_{ON} + 0.9^2 \times t_{OFF}}{t_{ON} + t_{OFF}}} < 2.7(Nm)$$ (90% of rated torque of α3/3000)

Therefore,

$$\frac{t_{ON}}{t_{OFF}} < \frac{1}{1.3}$$

The ratio of non–cutting time to cutting time must be 1.3 or greater.

The percentage duty cycle is calculated as follows:

$$\frac{t_{ON}}{t_{ON} + t_{OFF}} \times 100 = 43.5\%$$

Finally, the α3/3000 that satisfies conditions 1 to 5 is selected.

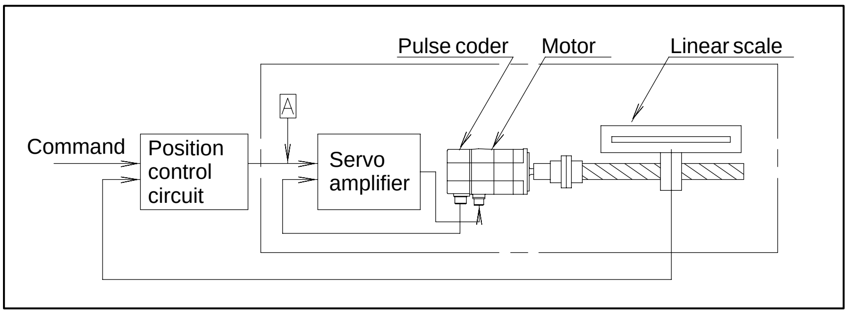
- **Limitations on ON time**

The period during which continuous operation under an overload is allowed is also restricted by the OVC alarm level and overload duty cycle characteristics.

4.2 PRECAUTIONS FOR USING LINEAR SCALE

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

Machine system natural frequency



This method is shown in the figure above by block diagram. The response of this control system is determined by the adjustment value (position loop gain) of the position control circuit. In other words, the position loop gain is determined by the specified response time of the control system. In the diagram above, the section enclosed by the broken line is called the velocity loop. Unless the response time of this section where position signal is detected is sufficiently shorter than the response time determined by the position loop gain, the system does not operate properly. In other words, when a command signal is put into point A, response time of the machine where position signals are detected must be sufficiently shorter than the response time defined by the position loop gain.
When the response of the detector section is slow, the position loop gain must be reduced to have the system operate normally, and as a result, the response of the whole system is slow. The same problem is caused when inertia is great (see Subsec. 4.1.1)).
The main causes for slow response are the mass of the machine and the elastic deformation of the machine system. The larger the volume, and the greater the elastic deformation, the slower the response becomes.
As an index for estimating the response of this machine system, the natural frequency of the machine is used, and this is briefly calculated by the following equation.

$$Wm = \frac{1}{2\pi} \times \sqrt{\frac{Km}{JL}}$$

Wm : Natural frequency

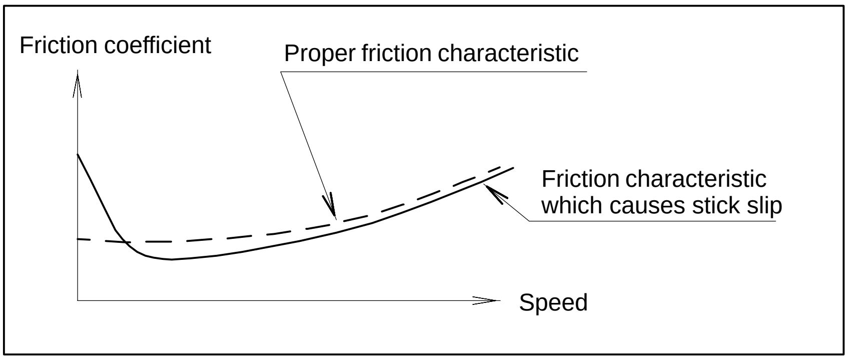
JL : Load inertia reflected to motor shaft

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

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

Stick slip

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



Value of machine overrun (Damping coefficient of machine system)

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

4.3 HOW TO FILL IN THE SERVO MOTOR SELECTION DATA TABLE

Select a suitable motor according to load conditions, rapid traverse rate, increment system and other factors. To aid in selecting the correct motor, we recommend filling in the “Servo Motor Selection Data Table” on the following page.

This section describes the items to fill in the Servo Motor Selection Data Table.

Servo Motor Selection Data Table

Machine		**Type**	
NC model	FS Power Mate	**Spindle motor**	

Item / **Axis**								
Specifications of moving object								
*	Axis movement direction (horizontal, vertical, rotation, slant _ degree)							
*	Weight of moving object (including workpiece, etc.)	kgf						
*	Counterbalance	kgf						
*	Table support (sliding, rolling, static pressure) or friction coefficient							
*	Ball screw	Diameter	mm					
		Pitch	mm					
		Length	mm					
		Rack and pinion (diameter of pinion, traveling distance of the machine tool per revolution of the pinion)						
		Other						
*	Total gear ratio							
Mechanical specifications								
	Traveling distance of the machine tool per revolution of the motor	mm						
	Least input increment of NC (resolution)	mm						
*	Maximum rapid traverse feedrate	mm/min						
	Motor speed in rapid traverse	min^{-1}						
*	Cutting rapid traverse	mm/min						
*1	Motor shaft converted load inertia	$kgf\cdot cm\cdot s^2$						
	Inertia of coupling, reduction gear and pulley	$kgf\cdot cm\cdot s^2$						
*2	Steady–state load torque	kgf·cm						
*	Cutting thrust	kgf						
	Maximum cutting torque (including steady–state load)	kgf·cm						
	Maximum cutting duty/ON time	%/min						
	Positioning distance	mm						
*3	Required positioning time	sec						
	In–position set value	µm						
	Rapid traverse positioning frequency (continuous, intermittent)	times/min						
	Machine tool efficiency							

Item \ Axis					
Motor specifications and characteristics					
	Motor type (desired size and output)				
	Feedback type (when an absolute, incremental or pulse position detector is required)				
	Options (when a brake, non–standard shaft, etc. is required)				
	Separate type pulse coder (yes/no)				
	Acceleration/deceleration time in rapid traverse msec				
	Acceleration/deceleration time in cutting feed msec				
	Feed–forward during rapid traverse (yes/no)				
	Position loop gain 1/sec				
	Dynamic brake stop distance mm				
Note	Be sure to fill in units other than the above if used. (Sometimes “deg” is used instead of “mm” for the rotary axis.) * Note required values for selecting the motor. *1 If possible enter the total load inertia. If you enter the inertia of coupling, reduction gear and pulley (motor shaft conversion) in the next item, you can also calculate the total load inertia by adding the weight of the moving object and ball screw values by logical calculation in the case of a linear shaft. *2 Steady–state load torque refers to the steady–state components such as friction (holding torque is included in the case of a gravity shaft) when the motor is rotating at a fixed speed. Enter the state–state load torque as far as possible. If details are unknown, use a value calculated logically from the weight and friction coefficient. Enter the steady–state load torque of the rotary axis in the same way as for load inertia as it cannot be calculated logically. You need not enter the torque required for acceleration/deceleration. *3 Servo delay and setting times must also be taken into consideration in the positioning time.				
Operating patterns/ Remarks	Enter typical operating patterns (time in horizontal column and torque and speed in vertical column, etc.) if they are already known. In cases where the machine tool makes special movements or the motor is rotated continuously, enter as many details as possible. Feel free to enter any other comments.				

4.3.1 Title

Kind of machine tool

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

Type of machine tool

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

CNC equipment

Fill in this blank with the name of CNC (16*i*–MA, 21*i*–TA, PM*i*–D, etc.) employed.

Spindle motor output

Enter the specifications and output of the spindle motor. (This item is needed when selecting PSM.)

Axis

Fill in this blank with names of axes practically employed in CNC command. If the number of axes exceeds 4 axes, enter them in the second sheet.

4.3.2 Data

Specifications of moving object

Be sure to enter data in this row. Data entered here is needed for determining the approximate motor load conditions (inertia, load torque).

- **Axis movement direction**

  Enter the movement directions of driven parts such as the table and tool post (e.g. horizontal, vertical). Write their angle from the horizontal level if their movement directions are slant (e.g. slant 60°).

- **weight of driven parts**

  Enter the weight of driven parts, such as table, tool post, etc. by the maximum value including the weight of workpiece, jig, and so on. Do not include the weight of the counter balance in the next item in this item.

- **Counter balance**

  Enter the weight of the counter balance in the vertical axis, if provided. Enter whether the counter balance is made by a weight or force as this influences inertia.

- **Table support**

  Enter the type of table slide (e.g. rolling, sliding or static pressure).
  Enter a special slide way material like Turcite, if used. Also enter the friction coefficient value. This item is significant in estimating the friction coefficient for calculating mainly the load torque.

- **Feed screw**

  Enter the diameter, pitch, and axial length of the lead screw in order.
  If a rack and pinion or other mechanism is used, also enter the traveling distance of the machine tool per revolution of the pinion.

- **Total gear ratio**

  Enter the gear ratio between the ball screw and the servo motor, gear ratio between the final stage pinion and the servo motor in case of the rack pinion drive, or gear ratio between the table and the motor in case of rotary table.

Mechanical specifications

Enter basic data that is required for selecting the motor.
For details on how to calculate each of the items, see 4.1 to 4.2.
Pay special attention to the unit for calculating and expressing torque.

- **Movement per rotation of motor**

  Enter the movement of the machine tool when the motor rotates one turn.

  Example

  - When the pitch of ball screw is 12 mm and the gear ratio is 2/3,
    $12 \times 2/3 = 8$ mm
  - When the gear ratio is 1/72 in rotary table ;
    $360 \times 1/72 = 5$ deg

- **Least input increment CNC**

  Enter the least input increment of NC command. (The standard value is 0.001 mm.)

- **Rapid traverse rate**

  Enter the rapid traverse rate required for machine tool specifications.

- **Motor speed in rapid traverse**

  Enter the motor speed during rapid traverse.

- **Cutting rapid traverse**

  Enter the rapid traverse rate required for machine tool specifications.

- **Motor shaft converted load inertia**

  Enter a load inertia applied by the moving object reflected on the motor shaft. Do not include the inertia of the motor proper in this value. For details on this calculation, see 4.1.1.
  In the case of a linear shaft, enter the load inertia calculated by logical calculation if you enter the next item. In the case of a rotary shaft, however, the load inertia cannot be calculated by logical calculation.

- **Inertia of coupling, reduction gear and pulley**

Enter values to two digits past the decimal point. (e.g. 0.2865 → 0.29)

- **Steady–state load torque**

Enter load inertia applied on transfer mechanisms other than couplings, moving objects and ball screw.

Enter the torque obtained by calculating the force applied for moving the machine tool and state–state components such as friction (including holding torque in the case of a gravity shaft) reflected on the motor shaft when it is rotating at a fixed speed. (Do not include any torque required for acceleration/deceleration in this item.) If details are unknown, use a value calculated logically from the weight and friction coefficient. Enter the steady–state load torque of the rotary axis in the same way as for load inertia as it cannot be calculated logically.

If the load torque values differ during lifting and lowering in the vertical axis, enter both values. Also, if the load torque values differ during rapid traverse and cutting feed, enter a notice to that effect.
Since torque produced in low speed without cutting may be applied even when the motor has stopped, a sufficient allowance is necessary as compared with the continued rated torque of the motor. Suppress this load torque so that it is lower than 70% of the rated torque.

- **Cutting thrust**

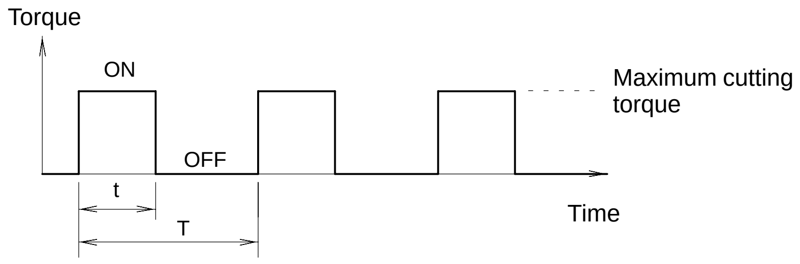
Enter the maximum value of the force applied during cutting by the force in the feed axis direction.

- **Maximum cutting torque**

Enter the torque value on the motor shaft corresponding to the maximum value of the above cutting thrust. When you enter this value, add the steady–state load to the motor shaft converted value for the cutting thrust. Since the torque transfer efficiency may substantially deteriorate to a large extent due to the reaction from the slideway, etc. produced by the cutting thrust, obtain an accurate value by taking measured values in similar machine tools and other data into account.

- **Maximum cutting duty / ON time**

Enter the duty time and ON time with the maximum cutting torque in the above item applied.



ON : Time that the maximum cutting torque is applied
OFF : Time when cutting torque is not applied
Duty : (t/T) × 100 (%)
ON time = t (min)

- **Positioning distance**

Enter the distance as a condition required for calculating the rapid traverse positioning frequency.
When an exclusive positioning device is used, enter this value together with the desired positioning time below.

- **Required positioning time**

Enter the required positioning time when an exclusive positioning device is used.
When the device is actually attached on the machine tool, note that servo delay and setting times must also be taken into consideration in the positioning time.

- **In–position set value**

Enter the in–position set value as a condition required for calculating the above positioning times when an exclusive positioning device is used. Note that the positioning time changes according to this value.

- **Rapid traverse positioning frequency**

Enter the rapid traverse positioning frequency by the number of times per minute. Enter whether the value is for continuous positioning over a long period of time or for intermittent positioning within a fixed period of time. (This value is used to check the OVC alarm and whether the motor is overheated or not by a flowing current during acceleration/deceleration, or to check the regenerative capacity of the amplifier.)

- **Machine tool efficiency**

This value is used for calculating the transfer efficiency of motor output on a machine tool. (Standard value is 0.9.)
Generally, a drop in transfer efficiency is expected if a reduction gear having a large deceleration rate is used.

Motor specifications and characteristics

- **Motor type**

Enter the motor type, if desired.

- **Feedback type**

Enter the specifications (absolute/increment or number of pulses: 65,536 or 10,000) of the feedback detector (pulse coder) built into the motor.

- **Options**

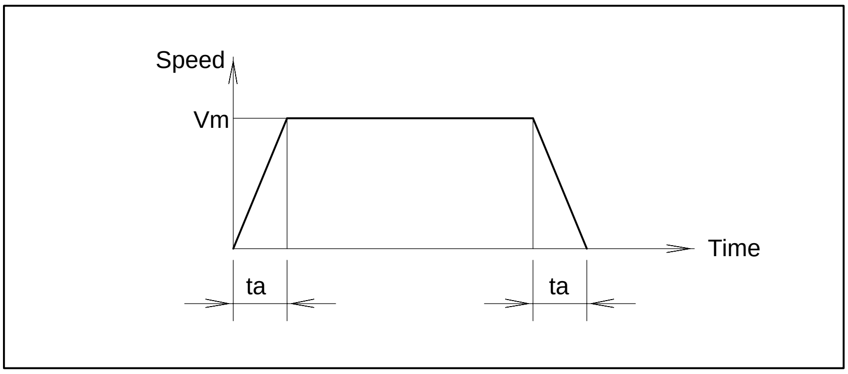
Enter options such as a motor brake and non–standard shaft, if required.

- **Separate type pulse coder**

Enter the name of the separate type pulse coder, if used.

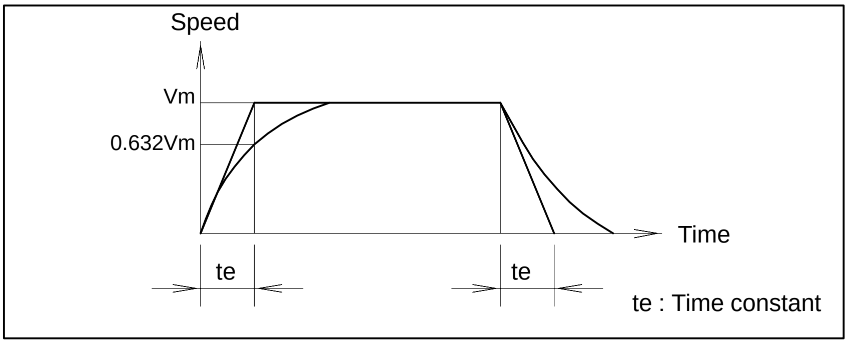
- **Acceleration / deceleration time constant at rapid traverse**

The acceleration/deceleration time is determined according to the load inertia, load torque, motor output torque, and working speed. For details of calculations, refer to Subsec. 4.1.2 and 4.1.3.
The acceleration/deceleration mode at rapid traverse is generally linear acceleration/deceleration in FANUC's CNC.



- **Acceleration/ deceleration time constant at cutting feed**

The acceleration/deceleration at cutting feed is exponential acceleration /deceleration in general. This blank is filled in with its time constant



- **Feed–forward during rapid traverse**

Enter whether or not feed–forward control is used.
Generally, feed–forward control can reduce the delay time in executing servo commands. However, overheating of the motor is more likely to occur as a higher torque is required for acceleration/deceleration. Since mechanical shock increases by only the No.1 time constant, generally also set the No.2 acceleration/deceleration time constant or FAD time constant when using feed–forward control.

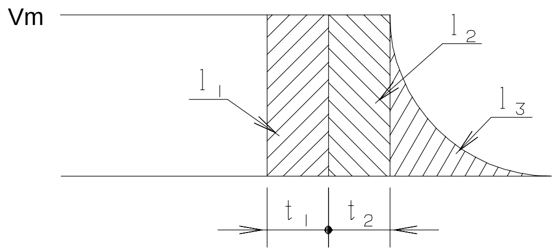
- **Position loop gain**

Fill in this blank with a value which is considered to be settable judging it from the inertia value based on experiences.
Since this value is not always applicable due to rigidity, damping constant, and other factors of the machine tool, it is usually determined on the actual machine tool. If the position detector is mounted outside the motor, this value is affected by the machine tool rigidity, backlash amount, and friction torque value. Enter these values without fail.

- **Dynamic brake stop distance**

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

There are two ways of shortening this dynamic brake stop distance, the emergency stop distance shortening function, and the emergency stop distance shortening function (additional hardware is required) effective during power interruptions.



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

l_1 : Coasting distance due to delay time t_1 of receiver

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

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

(t_1+t_2) is usually about 0.05 seconds.

Coasting distance(mm or deg)

$$= Vm \times (t_1 + t_2) + (J_m + J_1) \times (A \times No + B \times No^3) \times L$$

Jm : Motor inertia (kg·cm·s^2)

J : Load inertia (kg·cm·s^2)

No : Motor speed at rapid traverse (rpm)

L : Machine movement on one–rotation of motor (mm or deg) (No × L=Vm)

A: Coefficient A for calculating the dynamic brake stop distance

B: Coefficient B for calculating the dynamic brake stop distance

For details, see the table on the following page.

Coefficients for calculating the dynamic brake stopping distance

Model	A	B	Jm (kgf·cm·s^2)
α series			
α1/3000	4.4×10^{-2}	1.7×10^{-8}	0.0031
α2/2000	1.5×10^{-2}	6.6×10^{-9}	0.0056
α2/3000	1.5×10^{-2}	6.5×10^{-9}	0.0061
α3/3000	3.1×10^{-2}	3.3×10^{-9}	0.014
α6/2000	1.1×10^{-2}	2.1×10^{-9}	0.027
α6/3000	2.4×10^{-2}	1.0×10^{-9}	0.027
α12/2000	7.0×10^{-3}	3.0×10^{-9}	0.064
α12/3000	1.4×10^{-2}	1.5×10^{-9}	0.064
α22/1500	3.8×10^{-3}	1.3×10^{-9}	0.12
α22/2000	6.1×10^{-3}	8.1×10^{-10}	0.12
α22/3000	7.3×10^{-3}	6.8×10^{-10}	0.12
α30/1200	1.6×10^{-3}	1.3×10^{-9}	0.17
α30/2000	1.8×10^{-3}	1.2×10^{-9}	0.17
α30/3000	4.3×10^{-3}	4.9×10^{-10}	0.17
α40/2000	1.8×10^{-3}	6.3×10^{-10}	0.23
α65/2000	1.7×10^{-3}	4.2×10^{-10}	0.19
α100/2000	1.3×10^{-3}	2.4×10^{-10}	0.27
α150/2000	1.0×10^{-3}	1.7×10^{-10}	0.35
α300/2000	3.3×10^{-4}	1.0×10^{-10}	0.80
α400/2000	1.9×10^{-4}	1.0×10^{-10}	1.05
αM series			
αM3/3000	2.0×10^{-2}	7.8×10^{-9}	0.0030
αM2.5/3000	7.0×10^{-3}	4.8×10^{-9}	0.0053
αM3/3000	4.4×10^{-2}	3.7×10^{-9}	0.008
αM6/3000	1.8×10^{-2}	1.5×10^{-9}	0.014
αM9/3000	1.2×10^{-2}	4.8×10^{-10}	0.026
αM22/3000	6.2×10^{-3}	6.8×10^{-10}	0.059
αM30/3000	3.0×10^{-3}	3.2×10^{-10}	0.11
αM40/3000	2.2×10^{-3}	6.7×10^{-11}	0.12
αM40/3000 (with fan)	1.3×10^{-3}	1.2×10^{-10}	0.12
αL series			
αL6/3000	2.7×10^{-2}	5.5×10^{-9}	0.0050
αL9/3000	2.4×10^{-2}	8.7×10^{-10}	0.010
αL25/3000	6.3×10^{-3}	9.1×10^{-10}	0.055
αL50/2000	3.0×10^{-3}	6.2×10^{-10}	0.10
αC series			
αC3/2000	8.1×10^{-3}	1.3×10^{-8}	0.014
αC6/2000	2.9×10^{-3}	8.2×10^{-9}	0.027
αC12/2000	1.6×10^{-3}	1.3×10^{-8}	0.064
αC22/2000	3.8×10^{-3}	1.3×10^{-9}	0.12

Model	A	B	Jm (kgf·cm·s^2)
α (HV) series			
α3/3000HV	3.4×10^{-2}	3.0×10^{-9}	0.014
α6/3000HV	1.3×10^{-2}	1.8×10^{-9}	0.027
α12/3000HV	1.4×10^{-2}	1.5×10^{-9}	0.064
α22/3000HV	7.8×10^{-3}	6.4×10^{-10}	0.12
α30/3000HV	4.3×10^{-3}	5.0×10^{-10}	0.17
α40/2000HV	5.9×10^{-3}	2.0×10^{-10}	0.23
α1000/2000HV	4.7×10^{-5}	7.6×10^{-11}	4.25
αM (HV) series			
αM6/3000HV	1.4×10^{-2}	1.9×10^{-9}	0.014
αM9/3000HV	1.1×10^{-2}	5.2×10^{-10}	0.026
αM22/3000HV	8.6×10^{-3}	3.1×10^{-10}	0.059
αM30/3000HV	6.8×10^{-3}	6.4×10^{-11}	0.11
αM40/3000HV	5.8×10^{-3}	5.0×10^{-11}	0.12

The values of A and B are calculated by assuming that the resistance of the power line is 0.05 Ω per phase. The values will vary slightly according to the resistance value of the power line.
The coefficient above values are applicable when the α series servo amplifier is being used. The coefficient may change, depending on the type of the servo amplifier. Contact FANUC when using the C series amplifier.

4.4 CHARACTERISTIC CURVE AND DATA SHEET

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

4.4.1 Performance Curves

The typical characteristic curves consist of the following.

Speed–torque characteristics

These are known as operating curves and describe the relationship between the output torque and speed of the motor. The motor can be operated continuously at any combination of speed and torque within the prescribed continuous operating zone. Outside of this zone, the motor must be operated on an intermittent basis using the duty cycle curves. The limit of continuous operating zone is determined under the following conditions. And this zone may be limited by the thermal protection of mounted precision instrument. (pulse coder)

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

The limit of intermittent operating zone is determined by input voltage to the motor.
Actual operation is limited by the current limit of servo unit.
Due to the negative temperature coefficient of the magnetic material, continuous operating zone must be derated at the rate of 0.19% per degree centigrade rise of magnets. (i.e. for ambient temperature above 20° derate 0.19% for each degree over)

Overload duty characteristic

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

4.4.2 Data Sheet

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

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

Important parameters on the data sheet are defined as follows :

Continuous RMS current at stall TENV : Is (Arms)

Maximum effective current that allows continuous motor operation

Torque constant : Kt (kgf·cm/Arms) (Nm/Arms)

This is known as torque sensitivity and represents the torque developed per ampere of phase current. This value is a motor–specific constant, and is calculated by the flux distribution and location of coils in the armature, and the dimensions of the motor.

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

The back EMF constant indicates the strength of the permanent magnetic field. It is the value of the generated voltage at a specified speed when the rotor is rotated mechanically. Back EMF is a motor–specific constant, and is also calculated by the flux distribution and location of coils in the armature, and the dimensions of the motor. Expressed in [min^{-1}] units, back EMF has the dimensions of [$\mathrm{Vrms/min}^{-1}$]. The relationship can be given as:

$(\mathrm{Vrms{\cdot}sec}^{-1}/\mathrm{rad}) = (9.55 \times \mathrm{Vrms/min}^{-1})$

The back EMF constant is indicated as the RMS voltage per phase, so multiple by $\sqrt{3}$ to obtain the actual terminal voltage.

$$\boldsymbol{Kt\ (kgf \cdot cm/Arms) = 30.6Kv\ (Vrms \cdot \sec/rad)}$$

SI unit

$$\boldsymbol{Kt\ (Nm/Arms) = 3Kv\ (Vrms \cdot \sec/rad)}$$

For this reason, when back EMF constant drops lower than the demagnetization of the magnet, the torque constant also drops by the same ratio.

Mechanical time constant : tm (sec)

This is a function of the initial rate of rise in velocity when a step voltage is applied. It is calculated from the following relationship.

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

Jm : Rotor inertia ($\mathrm{kgf{\cdot}m^2}$)

Ra : Resistance of the armature (Ω)

Thermal time constant : t_t (min)

This is a function of the initial rate of rise of winding temperature at rated current. It is defined as the time required to attain 63.2 percent of the final temperature rise.

Static friction : Tf (kgf·cm) (Nm)

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

4.4.3 How to Use Duty Cycle Curves

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

1 Calculate Torque percent by formula (b) below.

2 Motor can be operated at any point on and inside the curve corresponding to the given over load conditions obtained form **1**.

3 Calculate t_F by formula (a)

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

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

t_F : “OFF” time
t_R : “ON” time

The values of t_R and t_F obtained form the above mentioned procedure shows the ones limited by motor thermal conditions.
Note that thermal protection devices such as a circuit breaker and thermal circuit are incorporated into the drive amplifier. These devices also impose a restriction on motor usage.
When the motor is overloaded, the software (OVC alarm) imposes an additional restriction on motor drive duration.

5 CONDITIONS FOR APPROVAL RELATED TO THE IEC34 STANDARD

5.1 APPLICABLE MOTORS

This chapter describes the conditions the following FANUC α, series AC servo motors must clear before they can be approved for the IEC34 standard.
For details on EMC compliance authorization, refer to the separate manual “Compliance with EMC Directives”

5.1.1 200 VAC Input Types

The following FANUC AC servo motor α series can comply with the IEC34 standard if you follow the descriptions in this chapter. The TÜV mark is printed on the nameplates of the following motors.
(α series motors produced before March 1995 comply with the IEC34 standard only on condition that “#T” or “#U” is designated at the end of the specification code indicated on the nameplate.)

α series

Model name	Motor specification number
α1/3000	A06B–0371–Bxxx
α2/2000	A06B–0372–Bxxx
α2/3000	A06B–0373–Bxxx
α3/3000	A06B–0123–Bxxx
α6/2000	A06B–0127–Bxxx
α6/3000	A06B–0128–Bxxx
α12/2000	A06B–0142–Bxxx
α12/3000	A06B–0143–Bxxx
α22/1500	A06B–0146–Bxxx
α22/2000	A06B–0147–Bxxx
α22/3000	A06B–0148–Bxxx
α30/1200	A06B–0151–Bxxx
α30/2000	A06B–0152–Bxxx
α30/3000	A06B–0153–Bxxx
α40/2000	A06B–0157–Bxxx
α40/2000 (with fan)	A06B–0158–Bxxx
α65/2000	A06B–0331–Bxxx
α100/2000	A06B–0332–Bxxx
α150/2000	A06B–0333–Bxxx
α300/2000	A06B–0137–Bxxx
α400/2000	A06B–0138–Bxxx

α M series

Mode name	Motor specification number
αM2/3000	A06B–0376–Bxxx
αM2.5/3000	A06B–0377–Bxxx
αM6/3000	A06B–0162–Bxxx
αM9/3000	A06B–0163–Bxxx
αM22/3000	A06B–0165–Bxxx
αM30/3000	A06B–0166–Bxxx
αM40	A06B–0169–Bxxx
αM40 (with fan)	A06B–0170–Bxxx

α L series

Model name	Motor specification number
αL6/3000	A06B–0562–Bxxx
αL9/3000	A06B–0564–Bxxx
αL25/3000	A06B–0571–Bxxx
αL50/3000	A06B–0572–Bxxx

α C series

Mode name	Motor specification number
αC3/2000	A06B–0121–Bxxx
αC6/2000	A06B–0126–Bxxx
αC12/2000	A06B–0141–Bxxx
αC22/1500	A06B–0145–Bxxx

5.1.2 400 VAC Input Types

The following FANUC AC servo motor αHV series can comply with the IEC34 standard if you follow the descriptions in this chapter. The TÜV mark is printed on the nameplates of the following motors.
(α series motors produced before March 1995 comply with the IEC34 standard only on condition that “#T” or “#U” is designated at the end of the specification code indicated on the nameplate.)

α(HV) series

Model name	Motor specification number
α3/3000HV	A06B–0171–Bxxx
α6/3000HV	A06B–0172–Bxxx
α12/3000HV	A06B–0176–Bxxx
α22/3000HV	A06B–0177–Bxxx
α30/3000HV	A06B–0178–Bxxx
α40/2000HV	A06B–0179–Bxxx
α1000/2000HV	A06B–0131–Bxxx

αM(HV) series

Model name	Motor specification number
αM6/3000HV	A06B–0182–Bxxx
αM9/3000HV	A06B–0183–Bxxx
αM22/3000HV	A06B–0185–Bxxx
αM30/3000HV	A06B–0186–Bxxx
αM40/3000HV	A06B–0189–Bxxx

5.2 DRIVES

5.2.1 200 VAC Input Types

The FANUC α , αM, αL, and αC series AC servo motors can be driven only by the FANUC servo amplifiers for 200 to 230 VAC.

5.2.2 400 VAC Input Types

The FANUC α (HV) series and αM(HV) series AC servo motors can be driven only by the FANUC servo amplifiers for 400 to 460 VAC.

5.3 POWER CABLE CONNECTORS

5.3.1 Models α1 and α2

The motor power cable must be connected using the following specified connectors.

Model Name	Connector Kit Specification [FANUC Specification]		Dedicated Tools Specification [FANUC Specification]
α1/3000 α2/2000 α2/3000 αM2/3000 αM2.5/3000	Connector kit w/ contacts	176346–8 (AMP Japan) [A06B–6050–K121]	Crimping tool 914596–3 (AMP Japan) [A97L–0200–0979/L]
	Connector kit w/out contacts	176346–7 (AMP Japan) [contacts not provided]	Extractor 914677–1 (AMP Japan) [A97L–0200–0980/D3]

* Also, see “8. Connectors.”

Section 8.2.3 of IEC204–1 (EN60204–1), which must be met to acquire CE marking approval, stipulates that all exposed live conductors of electric equipment and machines be connected to a protection link circuit. In order to comply with this stipulation, sufficient care must be paid when using the above connector kits.

- When connecting the connector kit assembly, connect the metal shell of the connectors shown below to the protection link circuit.
- Use leads that meet the following specifications:

Brake	Number of Cores	Cable Size	Insulation O.D.	Sheath O.D. (*)
W/out brake	5 or more	AWG18 to 16 (0.85 to 1.25 mm^2)	ϕ1.8 to 2.8 mm	ϕ10.4 to 11.4 mm
W/ brake	7 or more			

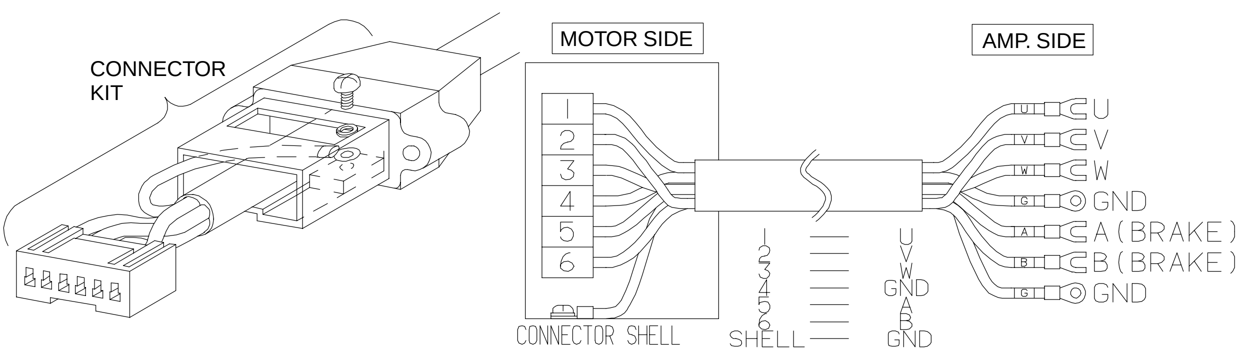
(*) Note that water–proof performance may be impaired if a sheath of inappropriate O.D. is used.

- An earth lead for the connector shell is also required in addition to the motor earth. Connect each of these to the GND terminal on the amplifier.

FANUC can also provide cable assemblies that use IEC–compliant leads. The following are FANUC specifications:

❑ Cable assembly (14 m as standard)
Model with no brake: A06B–6080–K824
Model with built–in brake: A06B–6080–K825

Connecting the Connector Shell Grounding Wire



5.3.2 Models α3 and Higher

The motor power cable and brake fan unit must be connected using the connectors and cable clamps specified below.

Cable Type	Motor model name	Plug connector maker specification [FANUC specification]		Cable clamp specification and connector maker name
For Power	α3/3000, α6/2000, α6/3000, αM6/3000, αM9/3000 αL6/ 3000, αL9/3000, αC3/2000, αC6/2000, α3/ 3000HV, α6/3000HV, αM6/3000HV, αM9/3000HV	Straight type	H/MS3106A18–10S–D–T (10) [A63L–0001–0648/ 61810SH]	H/MS3057–10A (10) [A63L–0001–0592/ 10AK] Hirose Electric
		L–shape type	H/MS3108B18–10S–D–T (10) [A63L–0001–0648/ 81810SH]	
	α12/2000, α12/3000, α22/1500, α22/2000, α30/1200, αC12/2000, αC22/1500, α12/3000HV, α22/3000HV, α30/3000HV, αM22/3000HV, αM30/3000HV	Straight type	JL04V–6A22–22SE–EB [A63L–0001–0648/ 62222SJ]	JL04–2022CK–(14) [A63L–0001–0653/ 12A] Japan Aviation Electronics Industry
		L–shape type	JL04V–8A22–22SE–EB [A63L–0001–0648/ 82222SJ]	
	α22/3000, α30/2000, α30/3000, α40/2000, α40/2000FAN αM22/3000, αM30/3000, αL25/3000, αL50/2000	Straight type	JL04V–6A24–10SE (G)–EB [A63L–0001–0648/ 62410SJ]	JL04–2428CK–(17) [A63L–0001–0653/ 16A] Japan Aviation Electronics Industry
		L–shape type	JL04V–8A24–10SE (G)–EB [A63L–0001–0648/ 82410SJ]	
90V brake fan unit connection	Common to all models exclud-ing α (HV) series	Straight type	JL04V–6A10SL–3SE –EB [A63L–0001–0648/ 610SL3SJ]	JL04–1012CK–(05) [A63L–0001–0653/ 04A] Japan Aviation Electronics Industry
		L–shape type	JL04V–8A10SL–3SE –EB [A63L–0001–0648/ 810SL3SJ]	

- Also see Section 8.
- The power cable for the α22/3000, α30/2000, α30/3000, α40/2000, α40/2000FAN, αM22/3000, αM30/3000, αL25/3000, and αL50/2000 has 7 conductors. Its grounding wire (one conductor) must have a cross section not less than that for the U, V, or W line (two conductors). For the grounding wire for the other connectors, its cross section must not be less than that for the U, V, or W line.
- TUV have certified that the plug connector and cable clamp mentioned above, when combined with the FANUC α series servo motors, satisfy the VDE0627 safety standard. As indicated in the table below, several manufacturers offer other plug connectors. For information about whether the plug connectors satisfy the safety standard when combined with the FANUC α series servo motors, contact the corresponding manufacturer. Contact the manufacturers if you require details of their products.

Manufacturer	Product series name
Hirose Electric (HRS)	H/MS310 TUV–conforming series
Japan Aviation Electronics Industry (JAE)	JL04V series
DDK Ltd. (DDK)	CE05 series

- If a cable or conduit hose seal adapter is used, consult an appropriate connector maker.

5.4 APPROVED SPECIFICATIONS

The following specifications are approved for the IEC34 standard.

5.4.1 Motor Speed (IEC34–1)

The allowable maximum speeds of motors are as listed below.

The allowable maximum speeds are specified in such a way that the approval conditions of the IEC34 standard, as they relate to rotational speed, are satisfied. When the allowable maximum speeds are used, the characteristics are not guaranteed. For the maximum speed that each motor can support, refer to the respective data sheet.

Motor model	Rated–output speed [min^{-1}]	Allowable maximum speed [min^{-1}]
α1/3000, α2/3000, α3/3000, α6/3000, αM2/3000, αM2.5/3000 αM6/3000, αM9/3000, αL6/3000, αL9/3000 α3/3000HV α6/3000HV αM6/3000HV, αM9/3000HV α12/3000, α22/3000, α30/3000, αM22/3000 αM30/3000 αL25/3000, α12/3000HV, α22/3000HV, α30/3000HV, αM22/3000HV, αM30/3000HV	3000	4000
α2/2000, α6/2000, α12/2000, α22/2000, α30/2000, α40/2000, αC3/2000, αC6/2000, αC12/2000, αL50/2000	2000	2500
α22/1500, αC22/1500	1500	2000
α30/1200	1200	1500
α65/2000, α100/2000, α150/2000	2000	2500
αM40/3000	1000	3000
αM40/3000 (with fan)	3000	3000
αM40/2000HV, α300/2000, α400/2000, α1000/2000HV	2000	2000
αM40/3000HV	1000	3000

5.4.2 Output (IEC34–1)

The rated output is guaranteed as continuous output only for the rated–output speed. The output in an intermittent operation range is not specified. When rated output increases due the use of an external fan (excluding models with cooling fan), the servo motor does not comply with the IEC34 standard. Note, however, that this poses no problem if the fan is used for the purpose of cooling, and the motor is used with output held at the current output rating. The approved output of each model is as listed in II to VII.3, "Specifications and Characteristics" (described later).

5.4.3 Protection Type (IEC34–5)

Motor protection confirms to IP65.

Note that on models with built–in fan, the fan connector is IP00. On models where the power cable is connected to the terminal box, you must pay attention to the cable routing port, for example, by using a conduit that complies with IP65.

IP6x: Completely dust–proof machine

This structure completely prevents dust from entering the machine.

IPx5: Sprinkle–proof machines

A sprinkle–proof machine shall not suffer inadvertent influence when they are exposed to water sprinkled from nozzles at any angle to the machine.

The conditions of the IPx5 type test are as follows:

Nozzle inside diameter:	6.3 (mm)
Amount of sprinkled water:	12.5 (liters/minute)
Water pressure at the nozzle:	30 (kPa)
Sprinkle time per a surface of 1 m^2:	1 (minute)
Minimum required time:	3 (minutes)
Distance between the nozzle and machine:	Approximately 3 m

CAUTION

IPx5 evaluates machines for waterproofness in a short–term test as described above, allowing chances that the machines may get dry after the test. If a machine is exposed to liquids other than water or so continuously to water that it cannot get dry, it may suffer inadvertent influence even if the degree of exposure is low.

5.4.4 Cooling Method (ICE34–6)

The motor cooling methods are as listed below.

Motor model	IC code	Method
α40/2000 with fan	IC416	Fully closed; cooled by an external independent fan
Other models	IC410	Fully closed; cooled by a natural air flow

5.4.5 Mounting Method (IEC34–7)

The motors can be mounted by the following methods.

IMB5: Flange mounting with the shaft facing sideways (from the rear)
IMV1: Flange mounting with the shaft facing upward (from the rear)
IMV3: Flange mounting with the shaft facing downward (from the rear)

5.4.6 Heat Protection (IEC34–11)

The heat protection type is as listed below:

T P 2 1 1

1: Temperature rise limit category 1 for heat protection
2: Stop only at stage 1 (no warning)
2: Protection for gradual and abrupt overload

Remarks

For details on EMC compliance authorization, refer to the separate manual “Compliance with EMC Directives”

6 FEEDBACK DETECTOR

6.1 BUILT–IN DETECTOR

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

Pulse coder type	Resolution Division/rev	Absolute/ incremental	Applicable motor
Pulse coder αA64	65,536	Absolute	All models
Pulse coder αI64	65,536	Incremental	All models
Pulse coder αA1000	1,000,000	Absolute	All models except αC series

6.2 PULSE CODER RESOLUTION AND CONTROL RESOLUTION

65,536 divisions/revolution

With the NC's flexible feed gear function, 1–μm control can be performed for feed pitches of up to 30 mm per motor revolution.

1,000,000 divisions/revolution

With the NC's flexible feed gear function 0.1–μm control (up to 100 mm/revolution) and 0.01–μm control (up to 10 mm/revolution) can be performed.
Increasing the speed loop gain as far as possible is effective. This can be easily achieved by increasing the resolution

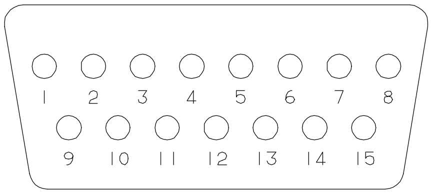
6.3 ABSOLUTE–TYPE PULSE CODER

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

6.4 DETECTOR INPUT/OUTPUT SIGNALS

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

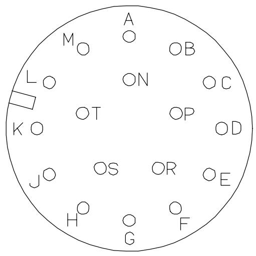
Models
α1/3000, α2/2000, α2/3000, αM2/3000, αM2.5/3000



D–SUB 15P

Signal name	Pin No.	
	αA64 αA1000	αI64
SD *SD	12 13	12 13
REQ *REQ	5 6	5 6
+5V 0V Shield +6VA 0VA	8, 15 1, 2, 3 4 14 10	8, 15 1, 2, 3 4 – –

Models
α3/3000 to α400/1200
α3/3000HV to α1000/2000HV
αC3/2000 to αC22/1500
αM3/3000 to αM40/3000, αM40/3000 (with fan)
αM6/3000HV to αM40/3000HV
αL3/3000 to αL50/3000



3102A 20–29PW

Signal name	Pin No.	
	αA64 αA1000	αI64 αI8
SD *SD	A D	A D
REQ *REQ	F G	F G
+5V 0V Shield +6VA 0VA	J, K N, T H R S	J, K N, T H – –

6.5 SEPARATE TYPE POSITION DETECTOR

For detecting a position by attaching directly to a ball screw or a machine, use a separate type position detector. Pay attention to the following items when using the separate type position detector.

- Increase the machine rigidity between the servo motor and the position detector to minimize mechanical vibration. If the machine rigidity is low or the structure vibrates, poor performance, over shoot is likely to occur.
- Generally, when the separate type detector is used, the influence of gear, ball screw pitch error or table inclination is decreased and the positioning accuracy and geometrical accuracy (roundness, etc.) are increased, but the smoothness may deteriorate due to the elasticity in the machine between the servo motor and the position detector.
- It is necessary to use the built-in pulse coder with a resolution equal to or finer than that of the separate type position detector.

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

6.5.1 Separate Type Pulse Coder Type and Specifications

Four types of separate type pulse coder are available. Features and rapid traverse–related limitations are the same as the built–in pulse coder.

- **Pulse coder αA1000S**

A860–0372–T001

1,000,000 P/rev (Up to 4000 min^{-1})

- **Incremental pulse coder unit**

A860–0301–T0□□

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

- **Absolute pulse coder unit**

A860–0324–T1□□

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

- **High–speed high resolution pulse coder unit**

A860–0314–T1□□

□□
11 : 2000P/rev (Up to 3000min $^{-1}$)
12 : 2500P/rev (Up to 2400min $^{-1}$)
13 : 3000P/rev (Up to 2000min $^{-1}$)

The following signal conversion circuits are required for connecting high–speed high resolution pulse coder units to the NC.
Signal conversion circuit: **A06B–6061–J0□□**

□□
01 : For two systems
02 : For four systems

6.5.2 Separate Type Pulse Coder Specifications

Pulse coder αA1000S

Item		Specification
Power voltage		5 (V) ± 5%
Current consumption		Up to 0.3 (A)
Working temperature range		0 to +60 (°C)
Resolution		1,000,000 (/rev.)
Maximum speed of rotation		4000 (min^{-1})
Input shaft inertia		Up to 1×10^{-4} (kg·m^2)
Input shaft startup torque		Up to 0.1 (Nm)
Rated loads	Radial	2.0 (N)
	Axial	1.0 (N)
Shaft diameter runout		0.02×10^{-3} (m)
Structure		Dust–proof, drip–proof (IP55 or equivalent: when water–proof connector is fitted)
Vibration resistance acceleration		5 (G) (50 to 2,000 (Hz))
Weight		Approx. 0.75 (kg)

Incremental pulse coder unit

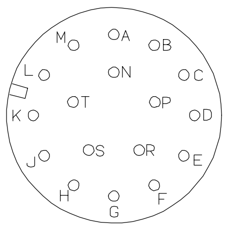
Absolute pulse coder unit

High–speed and high–resolution pulse coder unit

Item		Specification
Power voltage		5 (V) ± 5%
Current consumption		Up to 0.35 (A)
Working temperature range		0 to +60 (°C)
Maximum response frequency		100×10^{3} (Hz)
Input shaft inertia		Up to 5×10^{-3} (kg·m^{2})
Input shaft startup torque		Up to 0.8 (Nm)
Rated loads	Radial	20 (N)
	Axial	10 (N)
Shaft diameter runout		0.02×10^{-3} (m)
Weight		Approx. 2.0 (kg)

6.5.3 Input Signals and Layout of Connector Pins of Separate Type Pulse Coder

Pulse coder αA1000S

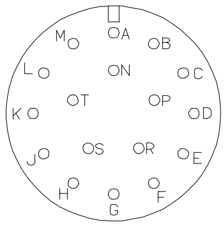


3102A20–29PW

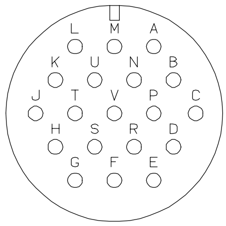
Signal name	Pin No. αA1000S 3102A20–29P
SD *SD	A D
REQ *REQ	F G
+5V 0V	J, K N, T
Shield	H
+6VA 0VA	R S

Incremental pulse coder unit

Absolute pulse coder unit



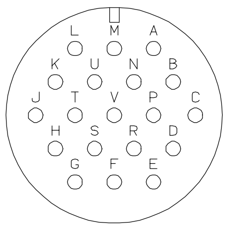
Incremental
3102A20–29P



Absolute
3102A22–14P

Signal name	Pin No.	
	Incremental 310A20-29P	**Absolute 3102A22-14P**
A *A	A D	A B
B *B	B E	C D
Z *Z	F G	E F
C1 C2 C4 C8	– – – –	G H J K
+5V 0V	C, J, K N, P, T	L M
Shield	H	N
OH1 OH2		– –
REQ		S
+6VA 0VA		T U

High–speed and high–resolution pulse coder unit



3102A22–14P

Signal name	Pin No
	High–speed and high–resolution 3102A22-14P
A *A	A B
B *B	C D
Z *Z	E F
C1 C2 C4 C8	G H J K
+5V 0V	L, T M, U
Shield	N
OH1 OH2	– –

6.5.4 External Dimensions of Separate Type Pulse Coder

Separate Type Pulse Coder Name	Dwg. No.
Pulse coder αA1000S	Fig. 6.5.4 (a)
Incremental pulse coder unit	Fig. 6.5.4 (b)
Absolute pulse coder unit High–speed and high–resolution pulse coder unit	Fig. 6.5.4 (c)

Fig. 6.5.4 (a) Pulse coder αA1000S

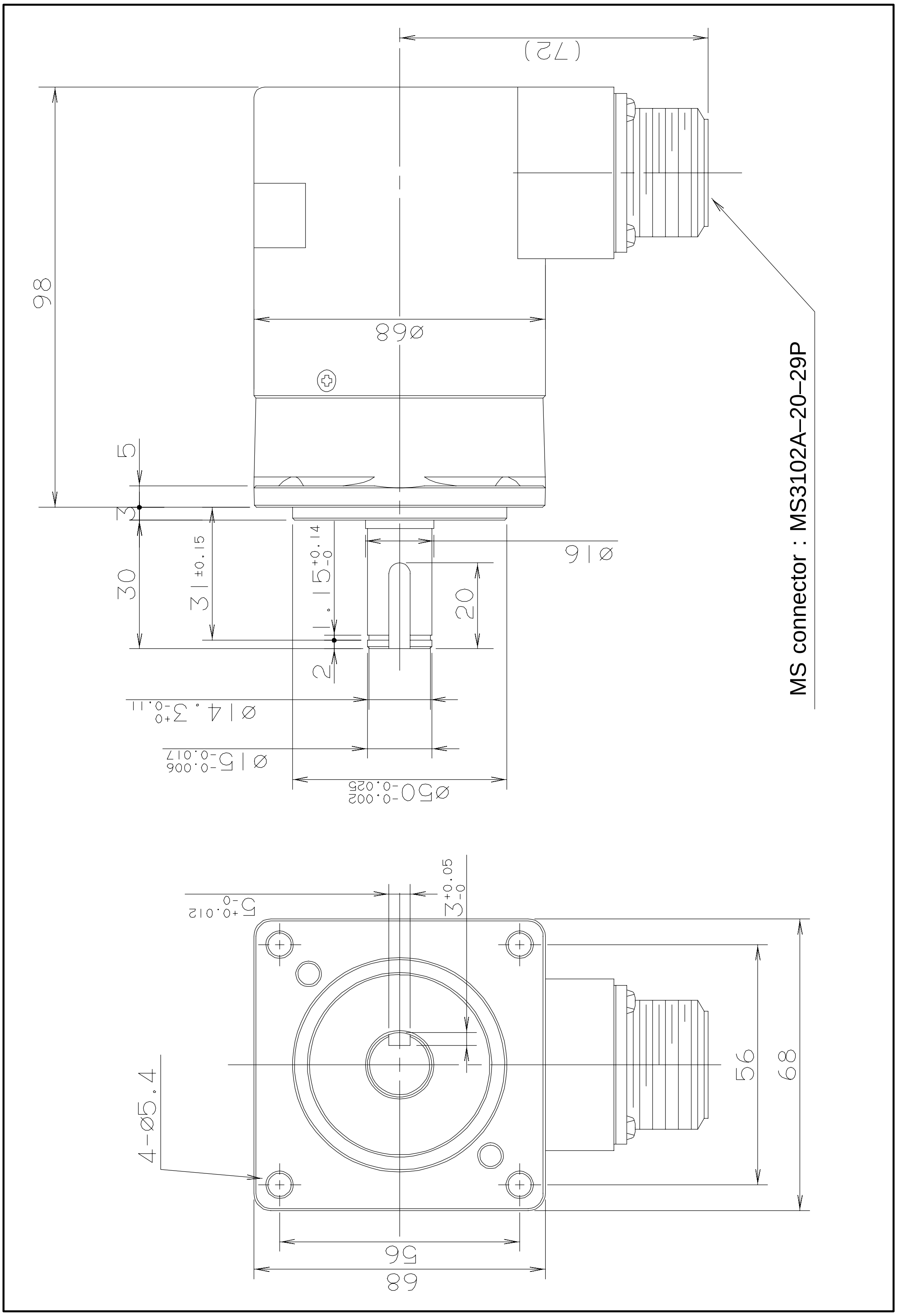


Fig. 6.5.4 (b) Incremental pulse coder unit

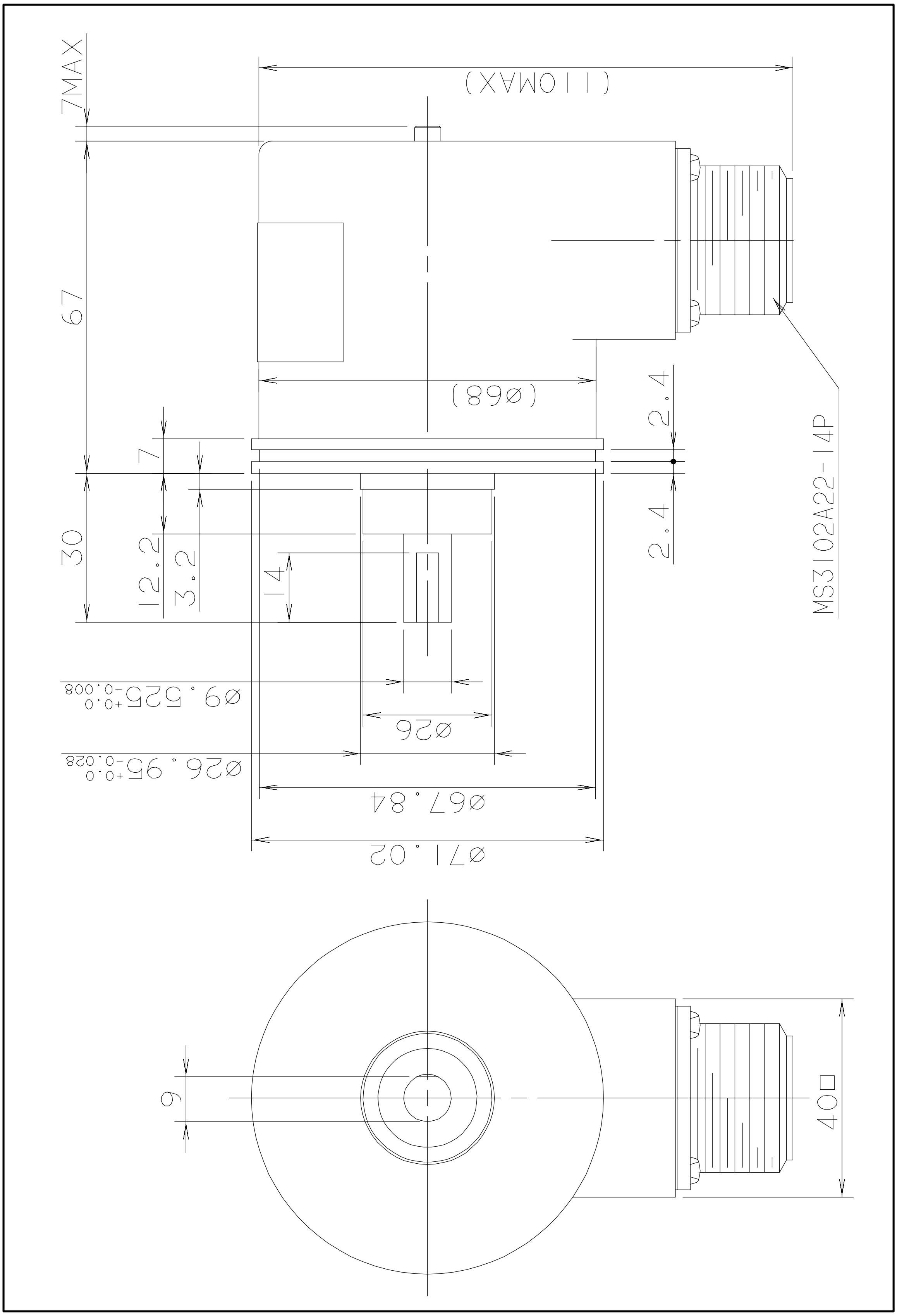
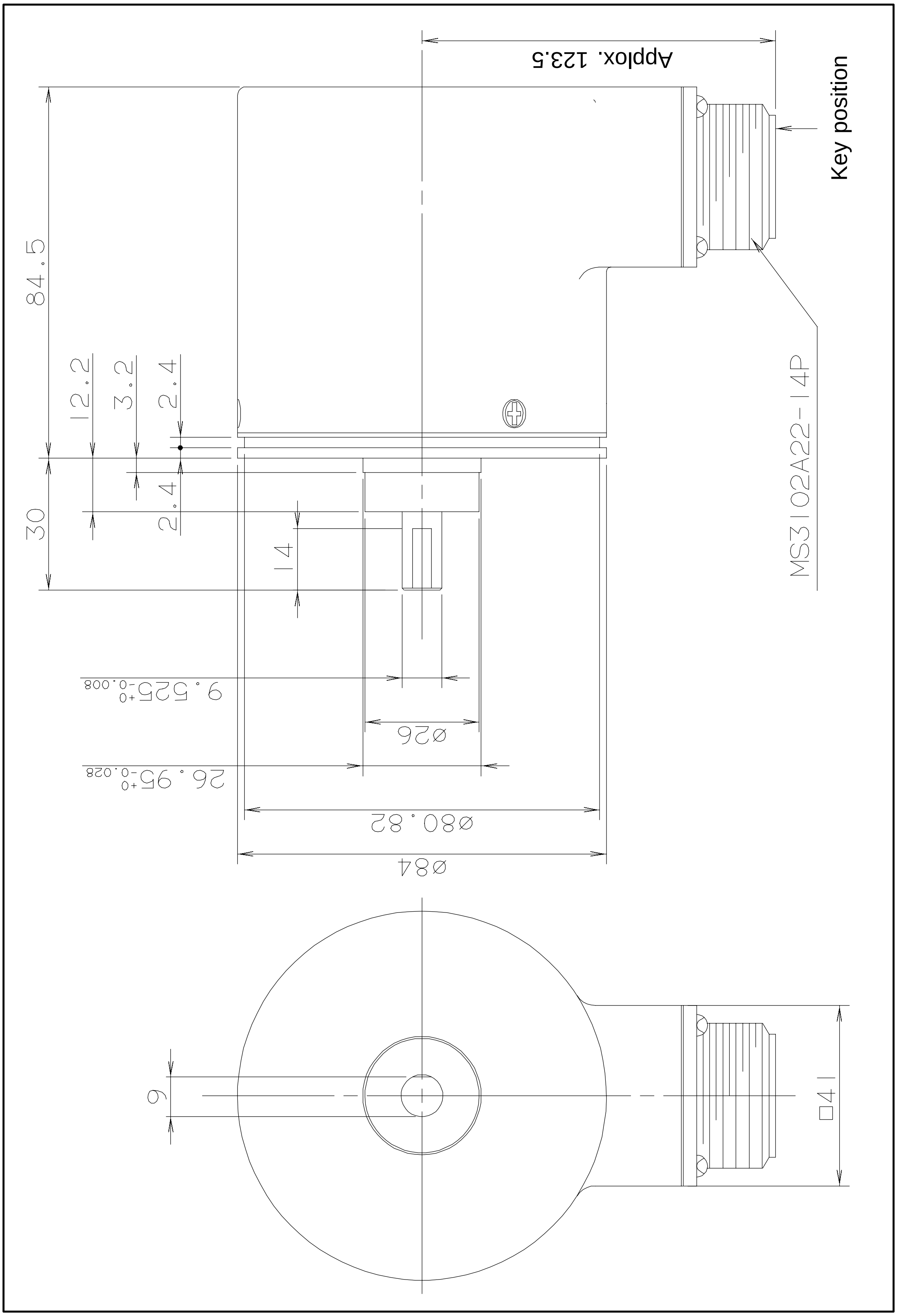


Fig. *6.5.4 (c)* **Absolute pulse coder unit/High–speed and high–resolution pulse coder unit**



7 BUILT–IN BRAKE

Some of the α, α(HV), αC, αM, and αL series Models use motors that contain a holding brake to prevent falling along a vertical axis.
Motors with a built-in brake have different outlines and weight from other types of motors. For their outlines, refer to appropriate outline drawings.

7.1 BRAKE SPECIFICATIONS

The specifications of built–in brakes are listed below.

Motor model		Unit	α1 α2 αM2 αM2.5	α3 α6 αM6 αM9 αC3 αC6	α12 α22 α30 αC12 αC22 αM22 αM30 αM40 αM40 (with fan)	α40	α65 α100 α150
Brake torque		Nm kgf·cm	2 20	8 82	35 357	35 357	100 1020
Response time	Release	msec	60	70	120	120	180
	Brake	msec	20	30	30	30	60
Supply voltage Current		VDC (±10%) A	90 0.2 or less	90 0.4 or less	90 0.5 or less	90 0.6 or less	90 1.0 or less
Weight increase		kg	Approx. 1.3	Approx. 2.3	Approx. 6.3	Approx. 10	Approx. 15
Inertia increase		$kg{\cdot}m^2$ $kgf{\cdot}cm{\cdot}s^2$	0.00002 0.0002	0.00007 0.0007	0.0006 0.006	0.0010 0.010	0.0010 0.010
Resistance value		Ω	516	295	220	220	99

Motor model		Unit	αL6 αL9	αL25 αL50	
Brake torque		Nm kgf·cm	8 82	18 184	40 408
Response time	Release	msec	70	100	120
	Brake	msec	30	70	30
Supply voltage Current		VDC (±10%) A	90 0.4 or less	90 0.5 or less	90 0.5 or less
Weight increase		kg	Approx. 2.3	Approx. 6.0	Approx. 6.0
Inertia increase		$kg{\cdot}m^2$ $kgf{\cdot}cm{\cdot}s^2$	0.00007 0.0007	0.0006 0.006	0.0006 0.006
Resistance value		Ω	295	220	220

Motor model		Unit	α3HV α6HV αM6HV αM9HV	α12HV α22HV α30HV α40HV αM22HV αM30HV αM40HV
Brake torque		Nm kgf·cm	8 82	35 357
Response time	Release	msec	70	120
	Brake	msec	30	30
Supply voltage Current		VDC (±10%) A	24 1.5 or less	24 2.0 or less
Weight increase		kg	Approx. 2.3	Approx. 6.3
Inertia increase		$kg{\cdot}m^2$ $kgf{\cdot}cm{\cdot}s^2$	0.00007 0.0007	0.0006 0.006
Resistance value		Ω	21	16

The values shown above are standard values at 20°C.

7.2 CAUTIONS

CAUTION

Pay attention to the following points when motors with brakes are used.

1 Configure the brake circuit referring to the brake wiring diagrams and recommended parts described in the following items.

2 For the α, αM, αL and αC brake power supplies, use the full–wave rectified 100 VAC or 90 VDC power supplies. The allowable voltage fluctuation for both of these power supplies is ±10%. Do not use a half–wave rectified 200 VAC power supply. Doing so will damage the surge absorber.

3 For the α(HV) and αM(HV), use the 24 VDC power supply. The allowable voltage fluctuation for this power supply is ±10%.

4 The brake in the motor is used to hold the machine when the servo motor control is OFF. It is possible to brake the machine by turning OFF the brake power in an emergency stop or during a power interruption. However, it is impossible to use this brake to reduce the stop distance in normal operation.

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

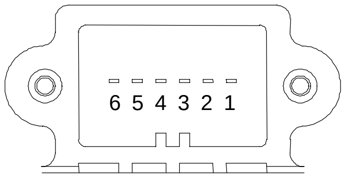
6 Models α40/2000 are longer because they contain a brake. If an excessive load is applied to the opposite side of the flange, the flange may be damaged. Do not apply any load to the opposite side of the flange. Do not subject the motor to excessive force.

7 Motor brake connectors do not have polarity.

7.3 CONNECTOR SHAPES

The following shows the shape and pin arrangement of the brake connectors.

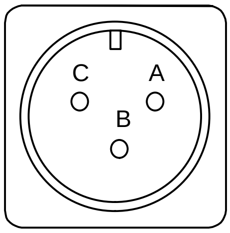
Models α1, α2, αM2, αM2.5



Connections: 5=BK, 6=BK (Connect to inside of power connector.)

176339–2
(AMP Japan)

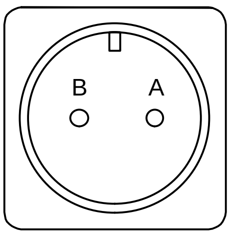
Models α3 to α150, αM, αL, αC



Connections: A=BK, B=BK, C=GND

JL04V–2E10SL–3PE–B
(Japan Aviation Electronics Industry)

Models α(HV), αM(HV)



Connections: A=BK, B=BK

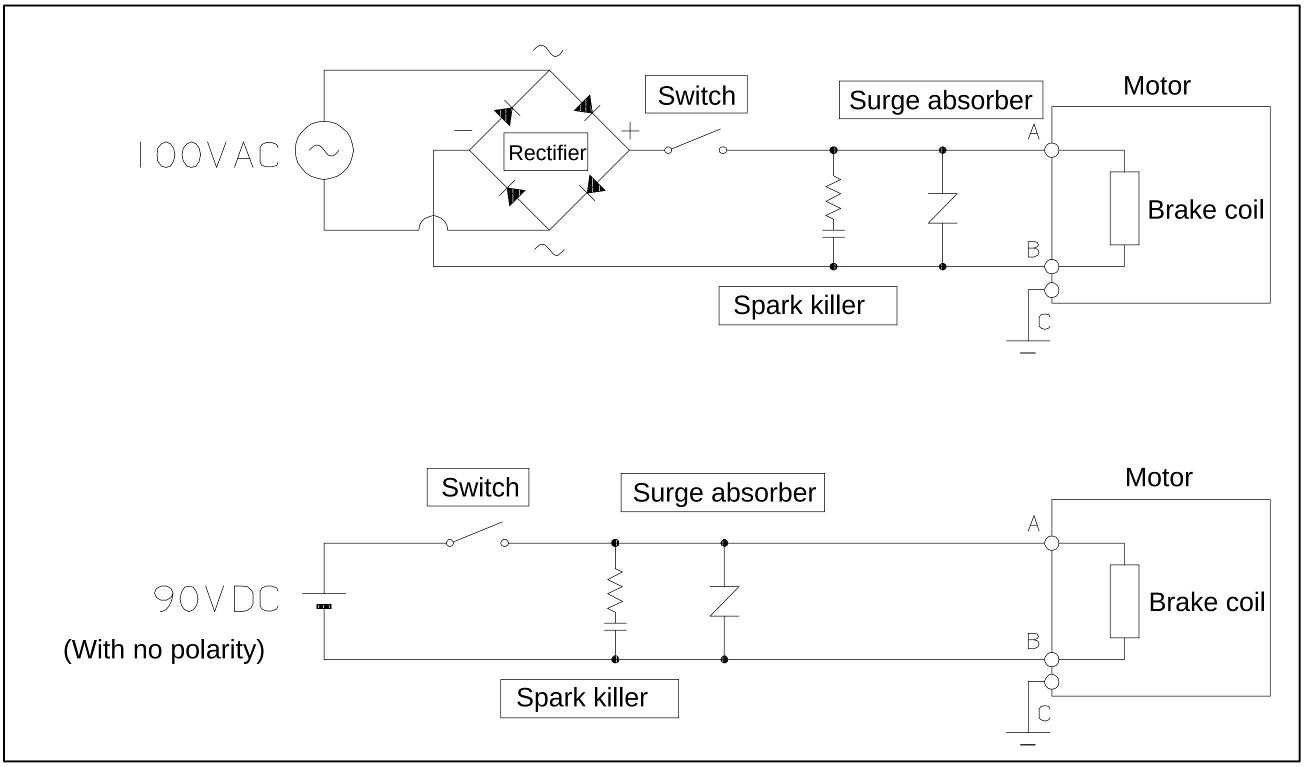
H/MS3102A10SL–4P
(Hirose Electric)

* "BK" stands for the brake signal.

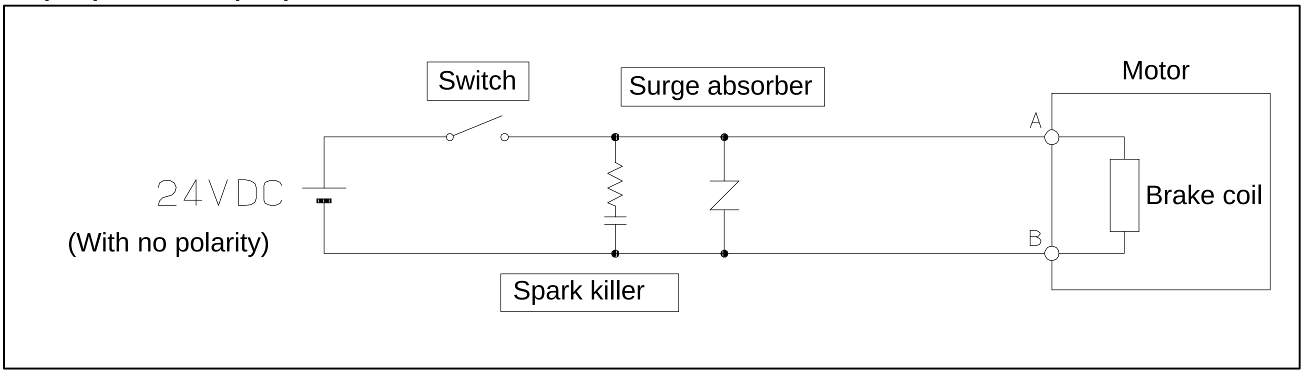
7.4 CONNECTION OF THE BRAKES

The following shows example of brake connections.

Models
α, αM, αL, αC



Models
α(HV) and αM(HV)



7.5 RECOMMENDED PARTS IN BRAKE CIRCUITS

Name	Model No.	Name of Manufacturer	Q'ty	Required Specifications	Order Dwg. No. (FANUC Procurement Dwg. No.)
Rectifier	D3SB60	SHINDENGEN ELECTRIC MFG. CO., LTD.	1	Withstand voltage 400 V min.	A06B–6050–K112
Switch	—	—	1	Rated control capacity 500VAC, 5A	—
Spark killer	S2–A–0	OKAYA ELECTRIC IND. CO., LTD.	1	500Ω/0.2μF Withstand voltage 400 V min.	—
Surge absorber	ERZV20D221	Matsusihita Electric Industrial Co., Ltd.	1	Varister voltage 220V Max. allowable circuit voltage 140VAC	A06B–6050–K113

7.6 BRAKE CABLE (TUV/EMC COMPATIBLE)

Motor Type	Brake Power Voltage	Connector Shape	Cable Dwg. No.	
			Straight	Elbow
α1,α2 αM2, α2.5	90VDC	Packaged inside power connector	A06B–6080–K825	—
α3 to α150 αM3 to α30 αL, αC	90VDC	3 pins	—	A06B–6080–K806
α(HV) αM(HV)	24VDC	2 pins	—	A06B–6080–K807

Use a cable of maximum length 14 m and minimum conductor cross–section area of 0.5 mm^2 per lead.

7.7 REDUCING THE BRAKE SHAFT FALL AMOUNT

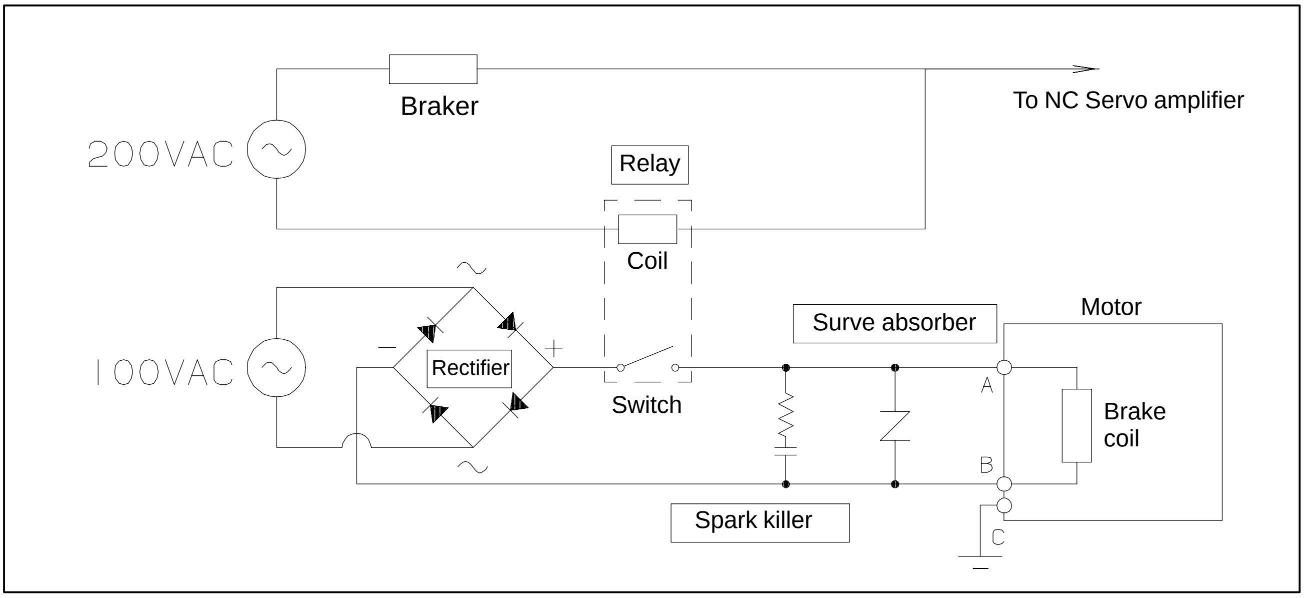
When a motor with brake is applied to gravity shafts, the fall amount of the shaft in a power interruption or an emergency stop, or when the CNC is turned OFF may be a problem. The following describes an effective way of minimizing this fall amount.

(1) Provide a control switch or relay on the DC side (see position in figure below) of the brake circuit to quickly activate the brake.

(2) It is essential that this switch or relay be disconnected as quickly as possible to shorten the fall amount in the vertical axis.

(3) Taking the power supply for actuating the relay directly from the mains power supply (mainly 200 VAC in Japan) is effective for quickly disconnecting the relay in a power interruption.

(4) To prevent the shaft from falling during an emergency stop, it is sometimes effective to use the “brake control function” in the servo software. This function enables continuous excitation of the motor until the motor built–in brake operates.
For details, see Parameter Manual B–65150E.



8 CONNECTORS

8.1 CONNECTOR ON THE MOTOR SIDE

The FANUC α series AC servo motors use TÜV–approved connectors on the power cable and brake/fan unit in order to comply with the IEC34 standard. Dripproof receptacle connectors are used as standard for all cables including those for signals (except for the α1, and α2 series). These connectors are dripproof even when not engaged.

Strictly speaking, the IEC34 for connectors is different from the MS standard with respect to the connector disengaged–state waterproof function and appearance (black in color). However, the TÜV–approved connectors are compatible with the MS–standard round connectors in size and shape. So, MS–standard plug connectors other than those recommended below are also usable. (The waterproof plug connectors recommended in Sections 8.3.1 and 8.3.2 should be used if it is necessary to keep the whole system waterproof.)

8.1.1 Specifications of Connectors on the Motor Side

Connectors for α1 and α2

Motor Type	For Power	For Signal	For Brake
α1/3000 α2/2000, α2/3000 αM2/3000 αM2.5/3000	176339–2 (AMP Japan)	SDAB–15P (Hirose Electric)	Power connectors are used. For details, see chapter “7. Brakes.”

Connectors for α3 to α40

<table>
<tr><th>Motor Type</th><th>For Power</th><th>For Signal</th><th>For Brake</th></tr>
<tr><td>α3/3000, α6/2000
α6/3000
αM6/3000, αM9/3000,
αL6/3000, αL9/3000,
αC3/2000, αC6/2000</td><td rowspan="2">H/MS3102A18–10P–D–T (10)
(Hirose Electric)</td><td rowspan="5">H/MS3102A20–29PCW4 (10)
(Hirose Electric)</td><td>JL04V–2E10SL–3PE–B
(Japan Aviation Electronics Industry)</td></tr>
<tr><td>α3/3000HV
α6/3000HV
αM6/3000HV
αM9/3000HV</td><td>H/MS3102A10SL–4P
(Hirose Electric)</td></tr>
<tr><td>α12/2000, α12/3000
α22/1500, α22/2000
α30/1200
αC12/2000, αC22/1500</td><td rowspan="2">JL04HV–2E22–22PE–B
(Japan Aviation Electronics Industry)</td><td>JL04V–2E10SL–3PE–B
(Japan Aviation Electronics Industry)</td></tr>
<tr><td>α12/3000HV,
α22/3000HV
α30/3000HV
α40/2000HV
αM22/3000HV
αM30/3000HV
αM40/3000HV</td><td>H/MS3102A10SL–4P
(Hirose Electric)</td></tr>
<tr><td>α22/3000, α30/2000
α30/3000, α40/2000
α40/2000FAN
αM22/3000, αM30/3000,
αM40/3000,
αM40/3000FAN,
αL25/3000, αL50/2000</td><td>JL04V–2E24–10PE(G)–B
(Japan Aviation Electronics Industry)</td><td>JL04V–2E10SL–3PE–B
(Japan Aviation Electronics Industry)</td></tr>
</table>

Fan connectors

Motor Type	For Fan
α40/2000FAN αM40/3000FAN	JL04V–2E10SL–3PE–B (Japan Aviation Electronics Industry)
α300, α400	H/MS3102A18–10P–D–T(10) (Hirose Electric)

CAUTION

1 The motors should be installed with their connector facing downward as long as possible. When it is impossible to install a motor in this position, allow slack in the cable to keep liquids such as a dielectric fluid from going along the cable into the cable or motor. If there is a possibility that the motors and connectors get wet, provide a cover to protect them.

2 If a motor is not connected to the earth ground through the machine (frame), connect the motor grounding point and the amplifier grounding point to absorb noise using a 1.25 mm^2 or larger conductor other than the grounding conductor in the power cable. Keep the grounding conductor as far from the power cable as possible.

8.2 CONNECTORS ON THE CABLE SIDE (MODELS α1 AND α2)

FANUC can provide TÜV–approved connectors for models α1, and α2. The table below lists the specifications of connector kits. The connectors used in models α1 and α2 are dripproof in an engaged position.

8.2.1 Connector Kit Specifications

Motor model	Power cable	Signal cable (straight type)	
Connector kit specifications	176346–8 (AMP Japan) A06B–6050–K121 (FANUC specification)	HDAB–15S [connector] HDAW–15–CV [waterproof cover] (Hirose Electric) A06B–6050–K115 (FANUC specification)	
Applicable wire size (Note1)	AWG#18 to AWG#16	AWG#20 (maximum)	
Insulation external diameter (Note 2)	ϕ1.8 to 2.8	Not specified	
Compatible cable O.D.	ϕ10.4 to 11.4	ϕ8.4 to 9.2	Water proof: ϕ10.4 to 11.2

CAUTION

1 AMP Japan connector contacts used in the power cable for the α1 and α2 are crimp type. Be careful about the applicable wire. The size of conductors used must meet the following requirements so that they carry the required current.
α1 and 2 power cables: AWG#18 to 16
α1 and α2 signal cables: AWG#20 for +5V, 0V, 6VA, and 0VA, and AWG#24 or greater for the others

2 For α1 and α2 power cables, select the external diameter that matches the cable clamp applicable range (10.4 to 11.4 mm^2) in order to secure TUV approval and waterproof performance. (See above table)

NOTE

For crimp contacts, insulations as well as wires are crimped. So, they must meet the size requirements listed above. An insulation smaller than those listed here may also be used depending on the wire and tool used. Contact AMP Japan for details.

The following dedicated tools are required to insert and remove the contacts. They should be prepared separately from the connector kit.

Crimping tool specification (power connector for α1 and α2):
914596–3 (AMP Japan)
A97L–0200–0979/L (FANUC)

Extractor specification (power connector for α1, and α2):
914677–1 (AMP Japan)
A97L–0200–0980/D3 (FANUC)

8.2.2 Cable Assembly Specifications (14m Standard) (for α1 and α2)

The following cables for α1 and 2 are provided by FANUC.

Motor Type	For Power	For Power (for model with brake)	For Signal
α1/3000 α2/2000 α2/3000 αM2/3000 αM2.5/2000	A06B–6080–K824 (w/ shielded leads)	A06B–6080–K825 (w/ shielded leads)	A06B–6080–K841 (w/ double–shielded leads)

* All cables in the above table are EMC–compliant.

* The cable assembly for signals is usable when the NC is Series 16, Series 18–A, Series 15–B, Series 21–TA, Power Mate MODEL D, F (TYPE A I/F), Series 16–B, Series 18–B, Series 20, Series 21–GA, Series 21–TB, or Power Mate MODEL H (TYPE B I/F).

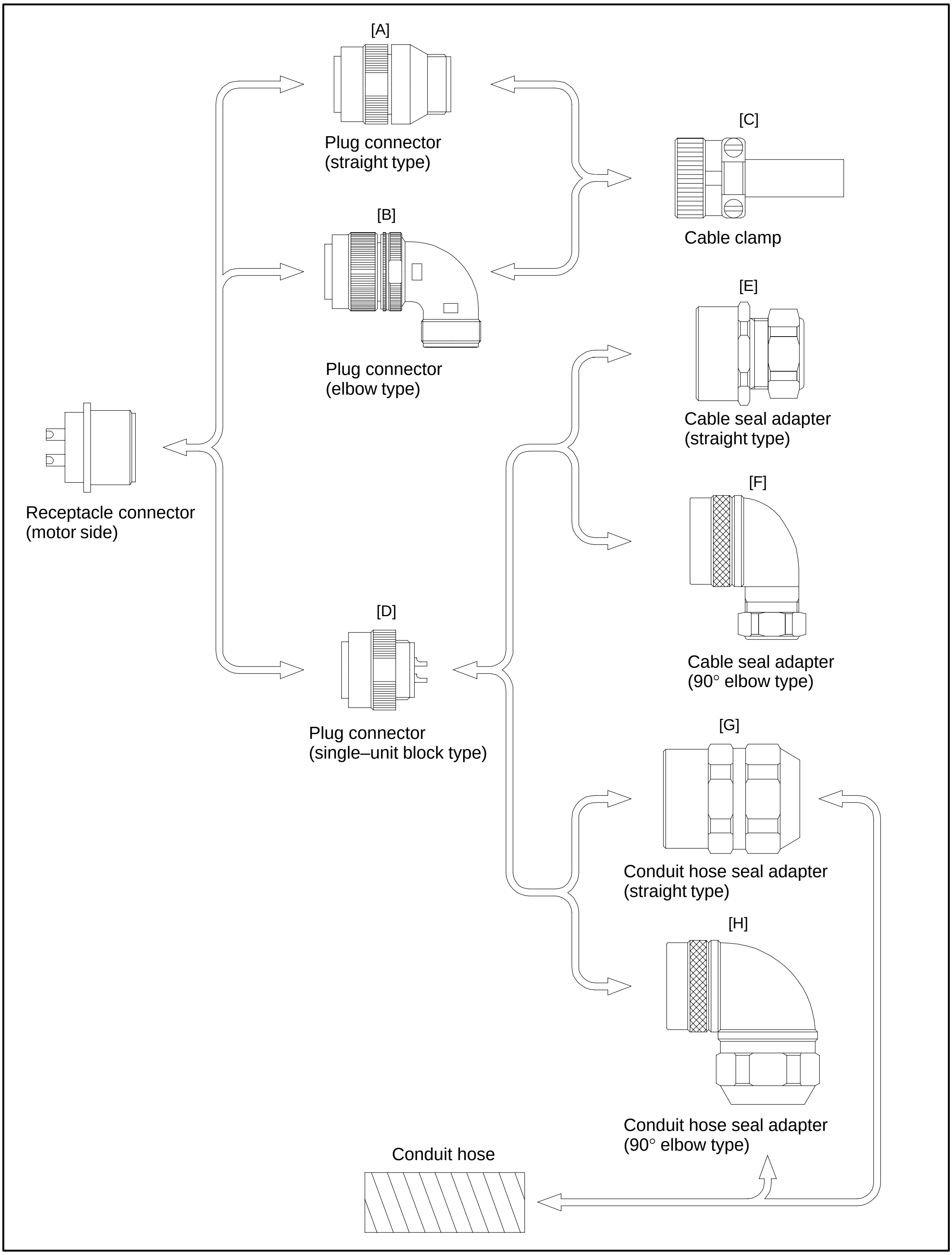
8.3 SPECIFICATIONS OF THE CONNECTORS ON THE CABLE SIDE (MODELS α3 AND HIGHER)

To meet the IEC34 standard, TÜV–approved plug connectors and cable clamps should be used in connecting the power cable and brake/fan unit. To meet the IEC34 standard by using a cable or conduit hose seal adaptor, contact the manufacturer for details.

FANUC can provide TÜV–approved types (waterproof) and waterproof types as plug connectors on the cable side for the FANUC α series AC servo motors; all these connectors are black. Of course, conventional plug connectors may be used, because they are MS–compatible.

The specifications of each connector are explained based on the examples shown below.

Example of connector connection



8.3.1 Specifications of Plug Connectors on the Cable Side (Waterproof TÜV–approved Type)

Model Name	[A] Straight Type Plug Connector	[B] Elbow Type Plug Connector	[C] Cable Clamp	[D] Single Block Type Plug Connector
For Power				
α3/3000, α6/2000 α6/3000, αM6/3000, αM9/3000 αL6/3000, αL9/3000 αC3/2000, αC6/2000 α3/3000HV α6/3000HV αM6/3000HV αM9/3000HV	H/MS3106A18–10S–D–T(10) (Hirose Electric)	H/MS3108A18–10S–D–T(10) (Hirose Electric)	H/MS3057–10A(10) (Hirose Electric)	H/MS3106A18–10S–D–T(13) (Hirose Electric)
α12/2000, α12/3000 α22/1500, α22/2000 α30/1200 αC12/2000, αC22/1500 α12/3000HV α22/3000HV α30/3000HV α40/2000HV αM22/3000HV αM30/3000HV αM40/3000HV	JL04V–6A22–22SE–EB (Japan Aviation Electronics Industry)	JL04V–8A22–22SE–EB (Japan Aviation Electronics Industry)	JL04–2022CK–(14) (Japan Aviation Electronics Industry)	JL04V–6A22–22SE (Japan Aviation Electronics Industry)
α22/3000, α30/2000 α30/3000, α40/2000 α40/2000FAN (*1) αM22/3000 αM30/3000 αM40/3000 αM40/3000FAN (*1) αL25/3000 αL50/2000	JL04V–6A24–10SE(G)–EB (Japan Aviation Electronics Industry)	JL04V–8A24–10SE(G)–EB (Japan Aviation Electronics Industry)	JL04–2428CK–(17) (Japan Aviation Electronics Industry)	JL04V–6A24–10SE(G) (Japan Aviation Electronics Industry)
For Signal				
Common to all models	Not subject to IEC34 standard (Select from the water–proof connectors in the following item.)			
For Brake				
Common to all models (excluding αHV series) (*1)	JL04V–6A10SL–3SE–EB (Japan Aviation Electronics Industry)	JL04V–8A10SL–3SE–EB (Japan Aviation Electronics Industry)	JL04–1012CK–(05) (Japan Aviation Electronics Industry)	JL04V–6A10SL–3SE (Japan Aviation Electronics Industry)
αHV series	Not subject to IEC34 standard (Select from the water–proof connectors in the following item.)			

*1 The connector for the α40 fan and αM40 fan is the same connector used on a standard brake.

NOTE

1 You must pay attention when selecting connectors made by manufacturers not listed in the table above.
For details, “5. IEC34 Standard Compliance Authorization Conditions.”
2 When connector type [D] is used, and a seal adapter must be used for compliance with the IEC34 standard, consult the contact manufacturer separately.
3 Signal connectors and brake connectors for the αHV series are not subject to the IEC34 standard. Select from the water–proof connectors in the following item.

8.3.2 Specifications of Plug Connectors on the Cable Side (Waterproof Type)

Model Name	[A] Straight Type Plug Connector	[B] Elbow Type Plug Connector	[C] Cable Clamp	[D] Single Block Type Plug Connector
For Power				
α3/3000, α6/2000 α6/3000, αM6/3000, αM9/3000 αL6/3000, αL9/3000 αC3/2000, αC6/2000 α3/3000HV α6/3000HV αM6/3000HV αM9/3000HV	JA06A–18–10S–J1–EB (Japan Aviation Electronics Industry) H/MS3106A18–10S(10) (Hirose Electric) MS3106A18–10S–B–BSS (DDK Ltd.)	JA08A–18–10S–J1–EB (Japan Aviation Electronics Industry) H/MS3108A18–10S(10) (Hirose Electric) MS3108A18–10S–B–BAS (DDK Ltd.)	JL04–18CK(13) (Japan Aviation Electronics Industry) H/MS3057–10A(10) (Hirose Electric) CE3057–10A–1(D265) (DDK Ltd.)	JA06A–18–10S–J1–(A72) (Japan Aviation Electronics Industry) H/MS3106A18–10S(13) (Hirose Electric) MS3106A18–10S–B (D190) (DDK Ltd.)
α12/2000, α12/3000 α22/1500, α22/2000 α30/1200 αC12/2000, αC22/1500 α12/3000HV α22/3000HV α30/3000HV α40/2000HV αM22/3000HV αM30/3000HV αM40/3000HV	JA06A–22–22S–J1–EB (Japan Aviation Electronics Industry) H/MS3106A22–22S(10) (Hirose Electric) MS3106A22–22S–B–BSS (DDK Ltd.)	JA08A–22–22S–J1–EB (Japan Aviation Electronics Industry) H/MS3108B22–22S(10) (Hirose Electric) MS3108A22–22S–B–BAS (DDK Ltd.)	JL04–2022CK–(14) (Japan Aviation Electronics Industry) H/MS3057–12A(10) (Hirose Electric) CE3057–12A–1(D265) (DDK Ltd.)	JA06A–22–22S–J1–(A72) (Japan Aviation Electronics Industry) H/MS3106A22–22S(13) (Hirose Electric) MS3106A22–22S–B (D190) (DDK Ltd.)
α22/3000, α30/2000 α30/3000, α40/2000 α40/2000FAN (*1) αM22/3000 αM30/3000 αM40/3000 αM40/3000HVFAN (*1) αL25/3000 αL50/2000	JA06A–24–10S–J1–EB (Japan Aviation Electronics Industry) H/MS3106A24–10S(10) (Hirose Electric) MS3106A24–10S–B–BSS (DDK Ltd.)	JA08A–24–10S–J1–EB (Japan Aviation Electronics Industry) H/MS3108B24–10S(10) (Hirose Electric) MS3108A24–10S–B–BAS (DDK Ltd.)	JL04–2428CK–(17) (Japan Aviation Electronics Industry) H/MS3057–16A(10) (Hirose Electric) CE3057–16A–1(D265) (DDK Ltd.)	JA06A–24–10S–J1–(A72) (Japan Aviation Electronics Industry) H/MS3106A24–10S(13) (Hirose Electric) MS3106A24–10S–B (D190) (DDK Ltd.)

Model Name	[A] Straight Type Plug Connector	[B] Elbow Type Plug Connector	[C] Cable Clamp	[D] Single Block Type Plug Connector
For Signal				
Common to all models	JA06A–20–29SW–J1–EB (Japan Aviation Electronics Industry) H/MS3106A20–29SW(11) (Hirose Electric) MS3106A20–29SW–B–BSS (DDK Ltd.)	JA08A–20–29SW–J1–EB (Japan Aviation Electronics Industry) H/MS3108B20–29SW(11) (Hirose Electric) MS3108A20–29SW–B–BAS (DDK Ltd.)	JL04–2022CK–(14) (Japan Aviation Electronics Industry) H/MS3057–12A(10) (Hirose Electric) CE3057–12A–1(D265) (DDK Ltd.)	JA06A–20–29SW–JA–(A72) (Japan Aviation Electronics Industry) H/MS3106A20–29SW(14) (Hirose Electric) MS3106A20–29SW–B(D190) (DDK Ltd.)
For Brake				
Common to all models (excluding αHV series)*1	JA06A–10SL–3S–J1–EB (Japan Aviation Electronics Industry) H/MS3106A10SL–3S(10) (Hirose Electric) MS3106A10SL–3S–B–BSS (DDK Ltd.)	JA08A–10SL–3S–J1–EB (Japan Aviation Electronics Industry) H/MS3108B10SL–3S(10) (Hirose Electric) MS3108A10SL–3S–B–BAS (DDK Ltd.)	JA04–1012CK–(06) (Japan Aviation Electronics Industry) H/MS3057–4A1(10) (Hirose Electric) CE3057–4A–1(D265) (DDK Ltd.)	JA06A–10SL–3S–J1–(A72) (Japan Aviation Electronics Industry) H/MS3106A10SL–3S(13) (Hirose Electric) MS3106A10SL–3S–B–(D190) (DDK Ltd.)
αHV series	JA06A–10SL–4S–J1–EB (Japan Aviation Electronics Industry) H/MS310610SL–4S(10) (Hirose Electric) MS3106A10SL–4S–B–BSS (DDK Ltd.)	JA08A–10SL–4S–J1–EB (Japan Aviation Electronics Industry) H/MS3108B10SL–4S(10) (Hirose Electric) MS3108A10SL–4S–B–BAS (DDK Ltd.)	JL04–1012CK–(06) (Japan Aviation Electronics Industry) H/MS3057–4A1(10) (Hirose Electric) CE3057–4A–1(D265) (DDK Ltd.)	JA06A–10SL–4S–J1–(A72) (Japan Aviation Electronics Industry) H/MS3106A10SL–4S(13) (Hirose Electric) MS3106A10SL–4S–B–(D190) (DDK Ltd.)

*1 The connector for the α40 fan or αM40 fan is the same connector used on a standard brake.

Cable–side plug connector specification (waterproof/seal adapter specification)

Model Name	[E] Cable Seal Adapter Straight Type	[F] Cable Seal Adapter Elbow Type	[G] Conduit Hose Seal Adapter Straight Type	[H] Conduit Hose Seal Adapter Elbow Type
For Power				
α3/3000, α6/2000 α6/3000, αM6/3000, αM9/3000 αL6/3000, αL9/3000 αC3/2000, αC6/2000 α3/3000HV α6/3000HV αM6/3000HV αM9/3000HV	YSO 18–12–14 (DAIWA DENGYOU CO., LTD.) ACS–12RL–MS18F (NIPPON FLEX CO., LTD.) CKD12–18 (SANKEI MANUFACTURING CO., LTD.)	YLO 18–12–14 (DAIWA DENGYOU CO., LTD.) ACA–12RL–MS18F (NIPPON FLEX CO., LTD.) C90° KD12–18 (SANKEI MANUFACTURING CO., LTD.)	MSA 16–18 (DAIWA DENGYOU CO., LTD.) RCC–104RL–MS18F (NIPPON FLEX CO., LTD.) KKD16–18 (SANKEI MANUFACTURING CO., LTD.)	MAA 16–18 (DAIWA DENGYOU CO., LTD.) RCC–304RL–MS18F (NIPPON FLEX CO., LTD.) K90° KD16–18 (SANKEI MANUFACTURING CO., LTD.)
α12/2000, α12/3000 α22/1500, α22/2000 α30/1200 αC12/2000, αC22/1500 α12/3000HV α22/3000HV α30/3000HV α40/2000HV αM22/3000HV αM30/3000HV αM40/3000HV	YSO 22–12–14 (DAIWA DENGYOU CO., LTD.) ACS–16RL–MS22F (NIPPON FLEX CO., LTD.) CKD16–22 (SANKEI MANUFACTURING CO., LTD.)	YLO 22–12–14 (DAIWA DENGYOU CO., LTD.) ACA–16RL–MS22F (NIPPON FLEX CO., LTD.) C90° KD16–22 (SANKEI MANUFACTURING CO., LTD.)	MSA 22–22 (DAIWA DENGYOU CO., LTD.) RCC–106RL–MS22F (NIPPON FLEX CO., LTD.) KKD22–22 (SANKEI MANUFACTURING CO., LTD.)	MAA 22–22 (DAIWA DENGYOU CO., LTD.) RCC–306RL–MS22F (NIPPON FLEX CO., LTD.) K90° KD22–22 (SANKEI MANUFACTURING CO., LTD.)

Model Name	[E] Cable Seal Adapter Straight Type	[F] Cable Seal Adapter Elbow Type	[G] Conduit Hose Seal Adapter Straight Type	[H] Conduit Hose Seal Adapter Elbow Type
α22/3000, α30/2000 α30/3000, α40/2000 α40/2000FAN (*1) αM22/3000 αM30/3000 αM40/3000 αM40/3000FAN (*1) αL25/3000 αL50/2000	YSO 24–15–17 (DAIWA DENGYOU CO., LTD.) ACS–20RL–MS24F (NIPPON FLEX CO., LTD.) CKD20–24 (SANKEI MANUFACTURING CO., LTD.)	YLO 24–15–17 (DAIWA DENGYOU CO., LTD.) ACS–20RL–MS24F (NIPPON FLEX CO., LTD.) C90° KD20–24 (SANKEI MANUFACTURING CO., LTD.)	MSA 22–24 (DAIWA DENGYOU CO., LTD.) RCC–106RL–MS24F (NIPPON FLEX CO., LTD.) KKD22–24 (SANKEI MANUFACTURING CO., LTD.)	MAA 22–24 (DAIWA DENGYOU CO., LTD.) RCC–306RL–MS24F (NIPPON FLEX CO., LTD.) K90° KD22–24 (SANKEI MANUFACTURING CO., LTD.)
For Signal				
Common to all models	YSO 20–9–11 (DAIWA DENGYOU CO., LTD.) ACS–12RL–MS20F (NIPPON FLEX CO., LTD.) CKD12–20 (SANKEI MANUFACTURING CO., LTD.)	YLO 20–9–11 (DAIWA DENGYOU CO., LTD.) ACA–12RL–MS20F (NIPPON FLEX CO., LTD.) C90° KD12–20 (SANKEI MANUFACTURING CO., LTD.)	MSA 16–20 (DAIWA DENGYOU CO., LTD.) RCC–104RL–MS20F (NIPPON FLEX CO., LTD.) KKD16–20 (SANKEI MANUFACTURING CO., LTD.)	MAA 16–20 (DAIWA DENGYOU CO., LTD.) RCC–304RL–MS20F (NIPPON FLEX CO., LTD.) K90° KD16–20 (SANKEI MANUFACTURING CO., LTD.)
For Brake				
Common to all models (*1)	YSO 10–5–8 (DAIWA DENGYOU CO., LTD.) CKD8–10 (SANKEI MANUFACTURING CO., LTD.)	YLO 10–5–8 (DAIWA DENGYOU CO., LTD.) C90° KD8–10 (SANKEI MANUFACTURING CO., LTD.)	MSA 10–10 (DAIWA DENGYOU CO., LTD.) KKD10–10 (SANKEI MANUFACTURING CO., LTD.)	MAA 10–10 (DAIWA DENGYOU CO., LTD.) K90° KD10–10 (SANKEI MANUFACTURING CO., LTD.)

*1 The connector for the α40 fan or αM40 fan is the same connector used on a standard brake.

Water–proofing performance can be improved by using a [D] single block type connector in combination with an [E] to [H] seal adapter. The above table is for reference only. Consult the respective manufacturer for details.

8.3.3 Specifications of Plug Connectors on the Cable Side (Non–waterproof Type)

Model Name	[A] Straight Type Plug Connector	[B] Elbow Type Plug Connector	[C] Cable Clamp
For Power			
α3/3000, α6/2000 α6/3000, αM6/3000, αM9/3000 αL6/3000, αL9/3000 αC3/2000, αC6/2000 α3/3000HV α6/3000HV αM6/3000HV αM9/3000HV	MS3106B18–10S–(A72) (Japan Aviation Electronics Industry) H/MSA3106A18–10S(10) (Hirose Electric) MS3106B18–10S–B (DDK Ltd.)	MS3108B18–10S–(A72) (Japan Aviation Electronics Industry) H/MSA3108B18–10S(10) (Hirose Electric) MS3108B18–10S–B (DDK Ltd.)	MS3057–10A–(A72) (Japan Aviation Electronics Industry) H/MSA3057–10A(10) (Hirose Electric) MS3057–10A(D265) (DDK Ltd.)

Model Name	[A] Straight Type Plug Connector	[B] Elbow Type Plug Connector	[C] Cable Clamp
α12/2000, α12/3000 α22/1500, α22/2000 α30/1200 αC12/2000, αC22/1500 α12/3000HV α22/3000HV α30/3000HV α40/2000HV αM22/3000HV αM30/3000HV αM40/3000HV	MS3106B22–22S–(A72) (Japan Aviation Electronics Industry) H/MSA3106A22–22S(10) (Hirose Electric) MS3106B22–22S–B (DDK Ltd.)	MS3108B22–22S–(A72) (Japan Aviation Electronics Industry) H/MSA3108B22–22S(10) (Hirose Electric) MS3108B22–22S–B (DDK Ltd.)	MS3057–12A–(A72) (Japan Aviation Electronics Industry) H/MSA3057–12A(10) (Hirose Electric) MS3057–12A(D265) (DDK Ltd.)
α22/3000, α30/2000 α30/3000, α40/2000 α40/2000FAN (*1) αM22/3000 αM30/3000 αM40/3000 αM40/3000FAN (*1) αL25/3000 αL50/2000	MS3106B24–10S–(A72) (Japan Aviation Electronics Industry) H/MSA3106A24–10S(10) (Hirose Electric) MS3106A24–10S–B (DDK Ltd.)	MS3108B24–10S–(A72) (Japan Aviation Electronics Industry) H/MSA3108B24–10S(10) (Hirose Electric) MS3108B24–10S–B (DDK Ltd.)	MS3057–16A–(A72) (Japan Aviation Electronics Industry) H/MSA3057–16A(10) (Hirose Electric) MS3057–16A(D265) (DDK Ltd.)
For Signal			
Common to all models	MS3106B20–29SW–(A72) (Japan Aviation Electronics Industry) H/MSA3106A20–29SW(11) (Hirose Electric) MS3106A20–29SW–B (DDK Ltd.)	MS3108B20–29SW–(A72) (Japan Aviation Electronics Industry) H/MSA3108B20–29SW(11) (Hirose Electric) MS3108B20–29SW–B (DDK Ltd.)	MS3057–12A–(A72) (Japan Aviation Electronics Industry) H/MSA3057–12A(10) (Hirose Electric) MS3057–12A(D265) (DDK Ltd.)
For Brake			
Common to all models (excluding αHV series)*1	MS3106B10SL–3S–(A72) (Japan Aviation Electronics Industry) H/MSA3106A10SL–3S(10) (Hirose Electric) MS3106A10SL–3S–B (DDK Ltd.)	MS3108B10SL–3S–(A72) (Japan Aviation Electronics Industry) H/MSA3108B10SL–3S(10) (Hirose Electric) MS3108A10SL–3S–B (DDK Ltd.)	MS3057–4A–(A72) (Japan Aviation Electronics Industry) H/MSA3057–4A(10) (Hirose Electric) MS3057–4A(D265) (DDK Ltd.)
αHV series	MS3106B10SL–4S–(A72) (Japan Aviation Electronics Industry) H/MSA3106A10SL–4S(10) (Hirose Electric) MS3106A10SL–4S–B (DDK Ltd.)	MS3108B10SL–4S–(A72) (Japan Aviation Electronics Industry) H/MSA3108B10SL–4S(10) (Hirose Electric) MS3108A10SL–4S–B (DDK Ltd.)	MS3057–4A–(A72) (Japan Aviation Electronics Industry) H/MSA3057–4A(10) (Hirose Electric) MS3057–4A(D265) (DDK Ltd.)

*1 The connector for the α40 fan or αM40 fan is the same connector used on a standard brake.

The table only examples. Contact each manufacturer for details.

8.3.4 Cable Assembly Specifications (α3 or Above) (14m Standard)

The following cables for α3 and above are provided by FANUC.

<table>
<tr><th>Motor Type</th><th>For Power (top row: straight type, bottom row: elbow type)</th><th>For Signal (top row: straight type, bottom row: elbow type)</th><th>For Brake and Fan (elbow type only)</th></tr>
<tr><td>α3/3000, α6/2000
α6/3000,
αM6/3000, αM9/3000
αL6/3000, αL9/3000
αC3/2000, αC6/2000</td><td rowspan="2">A06B–6080–K800
A06B–6080–K801</td><td rowspan="5">A06B–6080–K842
A06B–6080–K843</td><td>A06B–6080–K806</td></tr>
<tr><td>α3/3000HV
α6/3000HV
αM6/3000HV
αM9/3000HV</td><td>A06B–6080–K807</td></tr>
<tr><td>α12/2000, α12/3000
α22/1500, α22/2000
α30/1200
αC12/2000, αC22/1500</td><td rowspan="2">A06B–6080–K802
A06B–6080–K803</td><td>A06B–6080–K806</td></tr>
<tr><td>α12/3000HV
α22/3000HV
α30/3000HV
α40/2000HV
αM22/3000HV
αM30/3000HV
αM40/3000HV</td><td>A06B–6080–K807</td></tr>
<tr><td>α22/3000, α30/2000
α30/3000, α40/2000
α40/2000FAN (*2)
αM22/3000
αM30/3000
αM40/3000
αM40/3000FAN (*2)
αL25/3000
αL50/2000</td><td>A06B–6080–K804
A06B–6080–K805</td><td>A06B–6080–K806</td></tr>
</table>

*1 All cables in the above table are EMC–compliant.

*2 Cable for fan of the α40/2000 fan and αM40/3000 fan is A06B–6080–K806.

9 COOLING FAN

Models α40, αM40, α300, α400, and α1000 can be fitted with an optional cooling fan. The cooling fan requires a single–phase 200 VAC or three–phase 200VAC power supply.
The specifications and connection diagram are given below. Use fuses or a circuit breaker in the power magnetics cabinet.

9.1 COOLING FAN SPECIFICATIONS

Motor Type	α40 with Fan	
Input Voltage [V]	Single–phase 200 VAC	Single–phase 230 VAC
Rated Current [A]	0.64 ± 0.06	0.74 ± 0.06
Surge Current [A]	1.06 ± 0.1	1.22 ± 0.1
Protection Circuit Setting Temperature [°C]	135	
Protection Type (IEC34–5)	IP00	

Motor Type	Input voltage	Rated current(Arms)	
		50Hz	60Hz
αM40/3000 (with fan)	200V (Single–phase)	0.25 Arms	0.23Arms
α300/2000 α400/2000	200V (Three–phase)	0.25 Arms	0.35Arms
α1000/2000HV	200V (Three–phase)	0.75 Arms	0.75Arms

9.2 MOTOR CONNECTOR SPECIFICATIONS

Motor Type	Receptacle Connector
α40 with Fan	JL04V–2E10SL–3PE–B (Japan Aviation Electronics Industry)
α300, α400	H/MS3102A18–10P–D–T(10) (Hirose Electric)

* 1 Standard brake connectors are used as fan connectors for the α40/αM40.
* 2 α3–class power connectors are used as fan connectors for the α300/α400.

9.3 ABOUT CONNECTOR CABLES

α40/2000 with fan, αM40/3000 with fan, α300/2000, α400/2000, α1000/2000HV

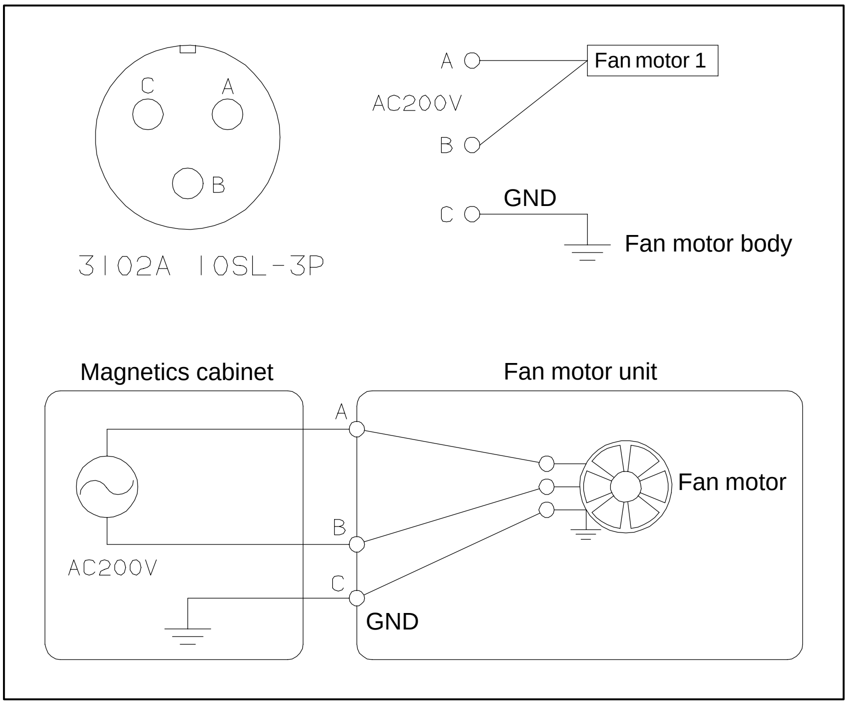
The user must prepare connector cables referring to the following specifications.

Item	Specification
Cable plug connector	For details, see the brake and fan connector specifications in “8.3 Cable Connector Specifications.”
Recommend Lead Diameter (conductor diameter)	1 mm^2 (AWG18 or equivalent) max.

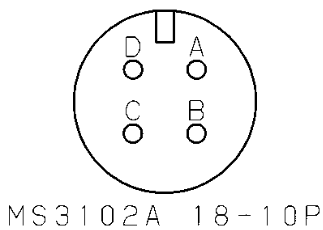
9.4 WIRING DIAGRAM

α40/2000 with fan
αM40/3000 with fan

The following shows the wiring diagram for connection to the fan unit.

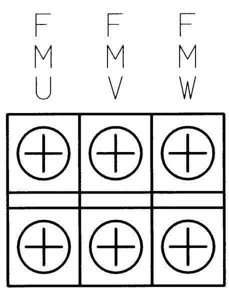


α300/2000
α400/2000



PIN NAME	TERM. NAME
A	R
B	S
C	T
D	EARTH

α1000/2000HV



PIN NAME	TERM. NAME
FMU	R
FMV	S
FMW	T

II. FANUC AC SERVO MOTOR α series

1 GENERAL

The FANUC AC servo motor α series consists of a range of servo motors that are suitable for the feed axes of machine tools. They have the following features:

Excellent acceleration characteristics

The rotor inertia has been reduced without sacrificing maximum output torque. As a result, the motors offer excellent acceleration characteristics.

Compact

The use of the latest ferrite magnet, combined with an optimized mechanical design, reduces both the overall length and weight. The result is compact, lightweight servo motors.

Excellent waterproofing

The use of waterproof connectors and FANUC's unique stator seal provide excellent waterproofing, ensuring that no liquid, such as coolant, can enter the motor.

Extended continuous–operation

The use of the latest servo software minimizes the heat generated by high–speed rotation, allowing continuous operation over a wide range.

Smooth rotation

Further improvements have been made to the unique magnetic pole shape to minimize torque ripple. The result is extremely smooth rotation.

Controllability

The use of the latest servo software maintains controllability even when a disturbance occurs.

High–performance detector

The high–resolution pulse coder model αA1000, αA64 or αI64 is provided as standard. This pulse coder allows precise positioning.

Powerful brake

A powerful brake with an increased holding torque is available as an option. The brake uses an asbestos–free design.

2 TYPES OF MOTORS AND DESIGNATION

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

Models α1/3000, α2/2000, and α2/3000

A06B–03□□–B☆ ○○

□□
- **71** : Model α1/3000
- **72** : Model α2/2000
- **73** : Model α2/3000

☆
- **0** : Taper shaft (standard)
- **1** : Taper shaft with the brake (2Nm)
- **5** : Straight shaft
- **6** : Straight shaft with the brake (2Nm)

○○
- **75** : Pulse coder αA64
- **77** : Pulse coder αI64
- **88** : Pulse coder αA1000

The standard shafts used for models α1/3000, α2/2000, and α2/3000 are taper shafts. Use a taper shaft as far as circumstances, such as the delivery time and maintenance, permit.

Models α3/3000, α6/2000, and α6/3000

A06B–01□□–B☆ ○○

□□
- **23** : Model α3/3000
- **27** : Model α6/2000
- **28** : Model α6/3000

☆
- **0** : Taper shaft (standard)
- **1** : Taper shaft with the brake (8Nm)
- **5** : Straight shaft
- **6** : Straight shaft with the brake (8Nm)

○○
- **75** : Pulse coder αA64
- **77** : Pulse coder αI64
- **88** : Pulse coder αA1000

The standard shafts used for models α3/3000, α6/2000, and α6/3000 are taper shafts. Use a taper shaft as far as circumstances, such as the delivery time and maintenance, permit.

Models α12/2000, α12/3000, α22/1500, α22/2000, α22/3000, α30/1200, α30/2000, α30/3000, α40/2000, and α40/2000 (with fan)

A06B–01□□–B☆ ○○

□□

42 : Model α12/2000
43 : Model α12/3000
46 : Model α22/1500
47 : Model α22/2000
48 : Model α22/3000
51 : Model α30/1200
52 : Model α30/2000
53 : Model α30/3000
57 : Model α40/2000
58 : Model α40/2000 (with fan)

☆

0 : Straight shaft (standard)
1 : Straight shaft with the brake (35Nm)
5 : Taper shaft
6 : Taper shaft with the brake (35Nm)

○○

75 : Pulse coder αA64
77 : Pulse coder αI64
88 : Pulse coder αA1000

A straight shaft is fitted as the standard shaft for models α12 to α40. When early delivery and case–of–maintenance are important, a straight shaft should be used. For model α40, a tapered shaft is not available.

Models α65/2000, α100/2000, and α150/2000

A06B–03□□–B☆ ○○

□□

31 : Model α65/2000
32 : Model α100/2000
33 ; Model α150/2000

☆

0 : Taper shaft (standard)
2 : Taper shaft with the brake (100Nm)

○○

75 ; Pulse coder αA64
77 : Pulse coder αI64
88 : Pulse coder αA1000

Models α300/2000, α400/2000

A06B–013□–B0 ○○

□

7 : Model α300/2000
8 : Model α400/2000

○○

75 ; With the pulse coder αA64
77 : With the pulse coder αI64
88 : With the pulse coder αA1000

- For these models, a tapered shaft is standard. a straight shaft is not available.
- For these models,a brake option is not available.

3 SPECIFICATIONS AND CHARACTERISTICS

3.1 TYPE OF MOTORS AND SPECIFICATIONS

Item		Unit	α1/3000	α2/2000 α2/3000
Output		kw	0.3	0.4 0.5
		HP	0.4	0.5 0.6
Rated torque at stall		Nm	1.0	2.0
		kgf·cm	10	20
Rating rotation speed		min^{-1}	3000	2000 3000
Rotor inertia		kg·m^2	0.00030	0.00055
		kgf·cm·s^2	0.0031	0.0056
Mass		kg	2.8	4.3

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

Item		Unit	α3/3000	α6/2000 α6/3000
Output		kw	0.9	1.0 1.4
		HP	1.3	1.4 1.9
Rated torque at stall		Nm	3.0	6.0
		kgf·cm	31	61
Rating rotation speed		min^{-1}	3000	2000 3000
Rotor inertia		kg·m^2	0.0014	0.0026
		kgf·cm·s^2	0.014	0.027
Mass		kg	8	13

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

Item	Unit	α12/2000 α12/3000	α22/1500 α22/2000 α22/3000	α30/1200 α30/2000 α30/3000	α40/2000	α40/2000 (with fan)
Output	kw	2.1 2.8	3.0 3.8 4.4	3.3 4.5 4.8	5.9	7.3
	HP	2.8 3.8	4.0 5.0 5.9	4.4 6.0 6.4	7.8	9.8
Rated torque at stall	Nm	12	22	30	38	56
	kgf·cm	122	225	306	387	571
Rating rotation speed	min^{-1}	2000 3000	1500 2000 3000	1200 2000 3000	2000	2000
Rotor inertia	$kg{\cdot}m^2$	0.0062	0.012	0.017	0.022	0.022
	$kgf{\cdot}cm{\cdot}s^2$	0.064	0.12	0.17	0.23	0.23
Mass	kg	18	29	41	52	55

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

Item	Unit	α65/2000	α100/2000	α150/2000	α40/2000HV	αM40/3000HV
Output	kw	8.2	10	12	37	40
	HP	11	14	16	50	54
Rated torque at stall	Nm	65	100	150	300	390
	kgf·cm	663	1019	1529	3060	3980
Rating rotation speed	min^{-1}	2000	2000	2000	2000	2000
Rotor inertia	$kg{\cdot}m^2$	0.019	0.026	0.034	0.079	0.103
	$kgf{\cdot}cm{\cdot}s^2$	0.19	0.27	0.35	0.80	1.05
Mass	kg	80	100	120	180	220

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

3.2 CHARACTERISTIC CURVE AND DATA SHEET

Speed–torque characteristics

The intermittent operation zone is determined by the input voltage applied to the drive amplifier. The curve shown is the value for the rated input voltage (200V).
On models α1 to 6, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item.

Overload duty characteristic

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

Data sheet

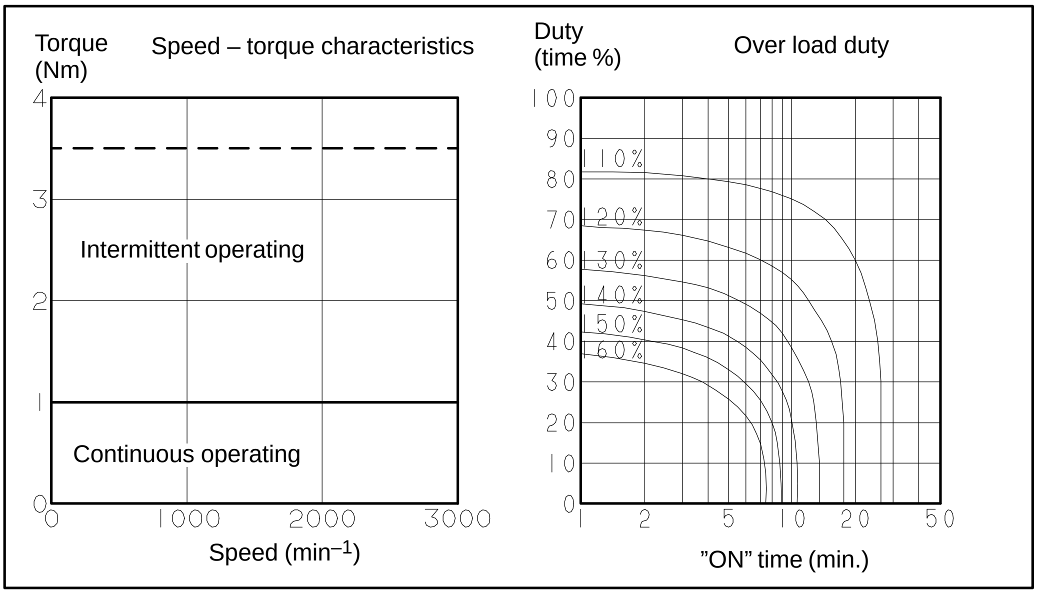
The parameters given in the data sheet are representative values for an ambient temperature of 20°C. They are subject to an error of +10%.
The indicated logical values are threshold values for the single motor unit (when the motor is not restricted by the control system).
The maximum torque that can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

Example : α3/3000

- Motor torque constant = 0.65 (Nm/Arms)
- Amplifier limit value = 40 Apeak
- Maximum torque value
  = $\underline{40 \times 0.707}$ x 0.65
  (Converted to an effective value)
  = 18.4 Nm

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

Model α1/3000 Specification : A06B–0371–B□□□



Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	1.0 10			Nm kgfcm
Rotor inertia	Jm	0.00030 0.0031			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	2.3			A (rms)
Torque constant (*)	Kt	0.44 4.5			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	15.5 0.15			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	1.73			Ω
Mechanical time constant (*)	tm	0.010			s
Thermal time constant	tt	15			min
Static friction	Tf	0.10 1			Nm kgfcm
Mass		2.8			kg

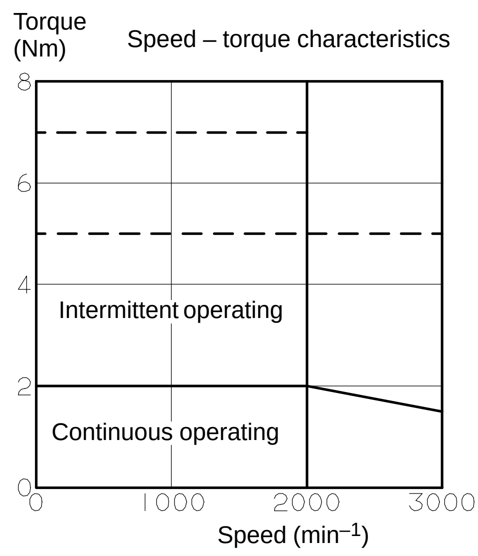
(*) The values are the standard values at 20°C and the tolerance is ±10%.

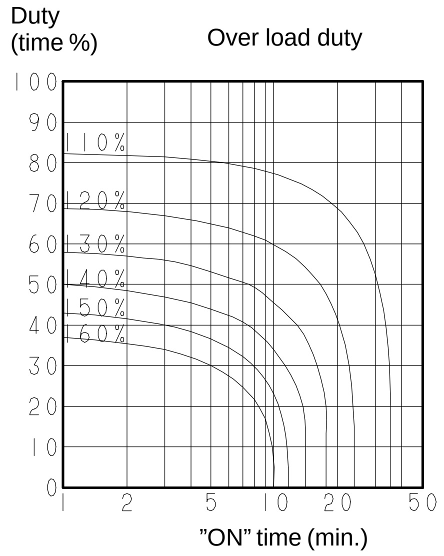
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.) These values may be changed without prior notice.

On model α1, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item.

Model α2/2000 Specification : A06B–0372–B□□□

Model α2/3000 Specification : A06B–0373–B□□□





Data sheet

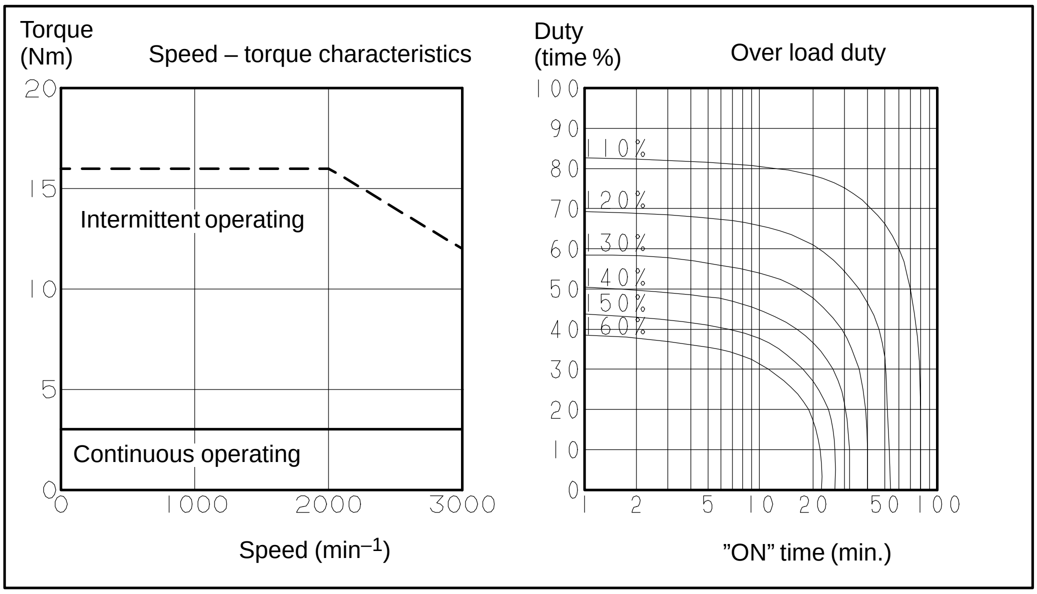
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000	3000		min^{-1}
Rated torque at stall (*)	Ts	2.0 20	2.0 20		Nm kgfcm
Rotor inertia	Jm	0.00055 0.0056	0.00055 0.0056		kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	2.2	3.0		A (rms)
Torque constant (*)	Kt	0.90 9.2	0.67 6.9		Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	31.3 0.30	23.5 0.22		V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	2.44	1.38		Ω
Mechanical time constant (*)	tm	0.005	0.005		s
Thermal time constant	tt	20	20		min
Static friction	Tf	0.15 1.5	0.15 1.5		Nm kgfcm
Mass		4.3	4.3		kg

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

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

On model α2, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item.

Model α3/3000 Specification : A06B–0123–B□□□



Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	3.0 31			Nm kgfcm
Rotor inertia	Jm	0.0014 0.014			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	4.6			A (rms)
Torque constant (*)	Kt	0.65 6.6			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	 Ke Kv	 23 0.22			 V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.57			Ω
Mechanical time constant (*)	tm	0.006			s
Thermal time constant	tt	45			min
Static friction	Tf	0.3 3			Nm kgfcm
Mass		8.0			kg

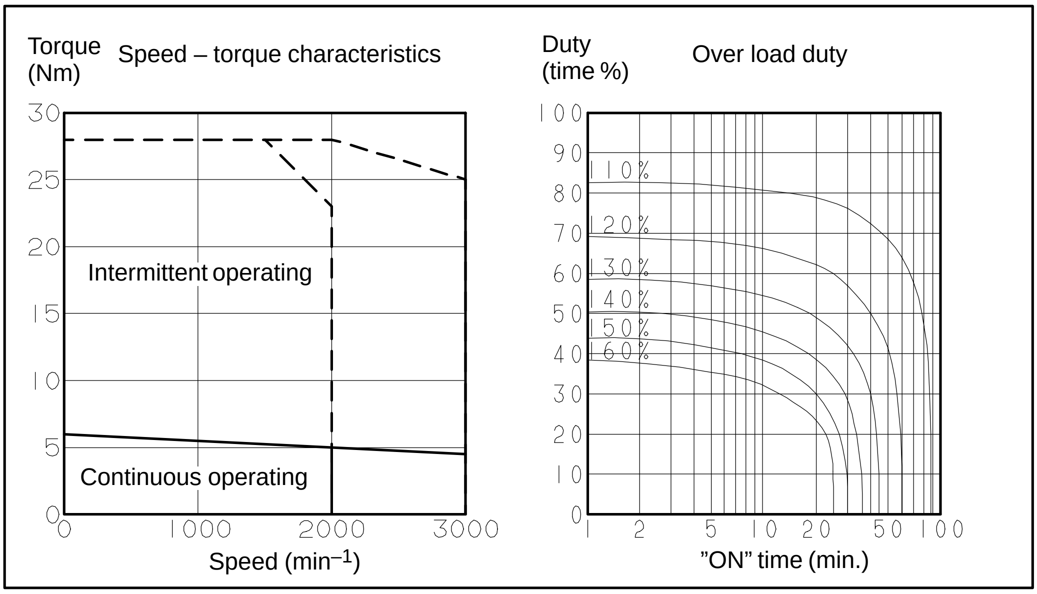
(*) The values are the standard values at 20°C and the tolerance is ±10%.

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

On model α3, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item.

Model α6/2000 Specification : A06B–0127–B□□□

Model α6/3000 Specification : A06B–0128–B□□□



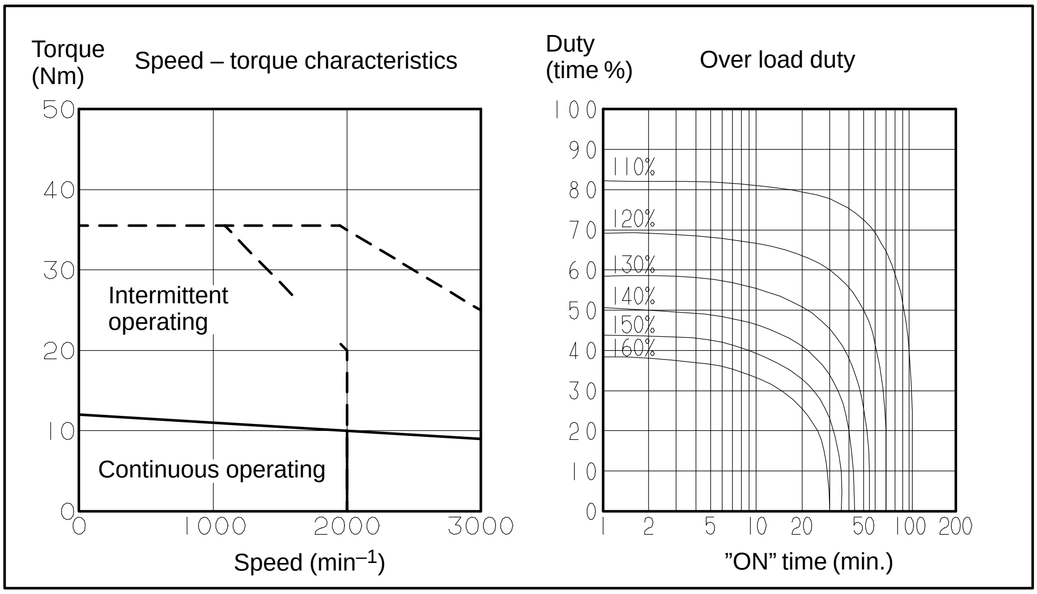
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000	3000		min^{-1}
Rated torque at stall (*)	Ts	6.0 61	6.0 61		Nm kgfcm
Rotor inertia	Jm	0.0026 0.027	0.0026 0.027		kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	5.6	10.0		A (rms)
Torque constant (*)	Kt	1.08 11. 0	0.60 6.1		Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	38 0.36	21 0.20		V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.65	0.18		Ω
Mechanical time constant (*)	tm	0.004	0.004		s
Thermal time constant	tt	50	50		min
Static friction	Tf	0.3 3	0.3 3		Nm kgfcm
Mass		13	13		kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.) These values may be changed without prior notice.
On model α6, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item.

Model α12/2000 Specification : A06B–0142–B□□□

Model α12/3000 Specification : A06B–0143–B□□□



Data sheet

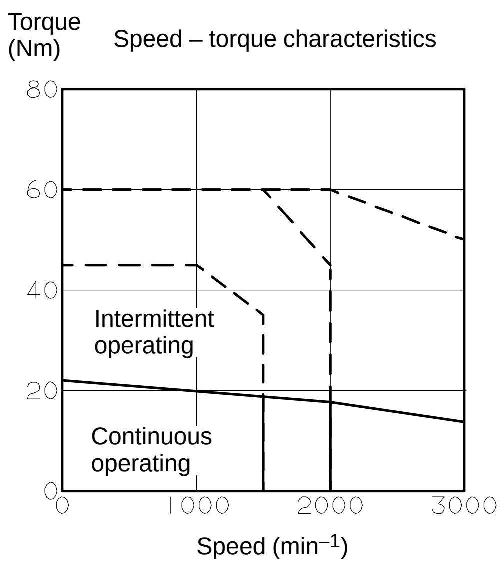
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000	3000		min^{-1}
Rated torque at stall (*)	Ts	12 122	12 122		Nm kgfcm
Rotor inertia	Jm	0.0062 0.064	0.0062 0.064		kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	8.8	15.5		A (rms)
Torque constant (*)	Kt	1.36 13.8	0.77 7.9		Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	47 0.45	27 0.26		V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.49	0.17		Ω
Mechanical time constant (*)	tm	0.005	0.005		s
Thermal time constant	tt	60	60		min
Static friction	Tf	0.8 8	0.8 8		Nm kgfcm
Mass		18	18		kg

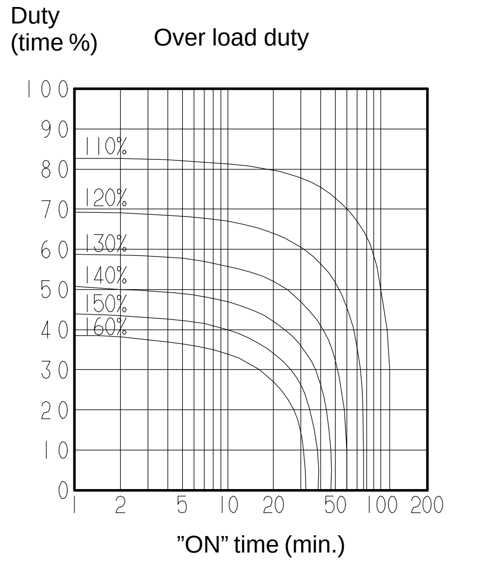
(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.) These values may be changed without prior notice.

Model α22/1500 Specification : A06B–0146–B□□□

Model α22/2000 Specification : A06B–0147–B□□□

Model α22/3000 Specification : A06B–0148–B□□□





Data sheet

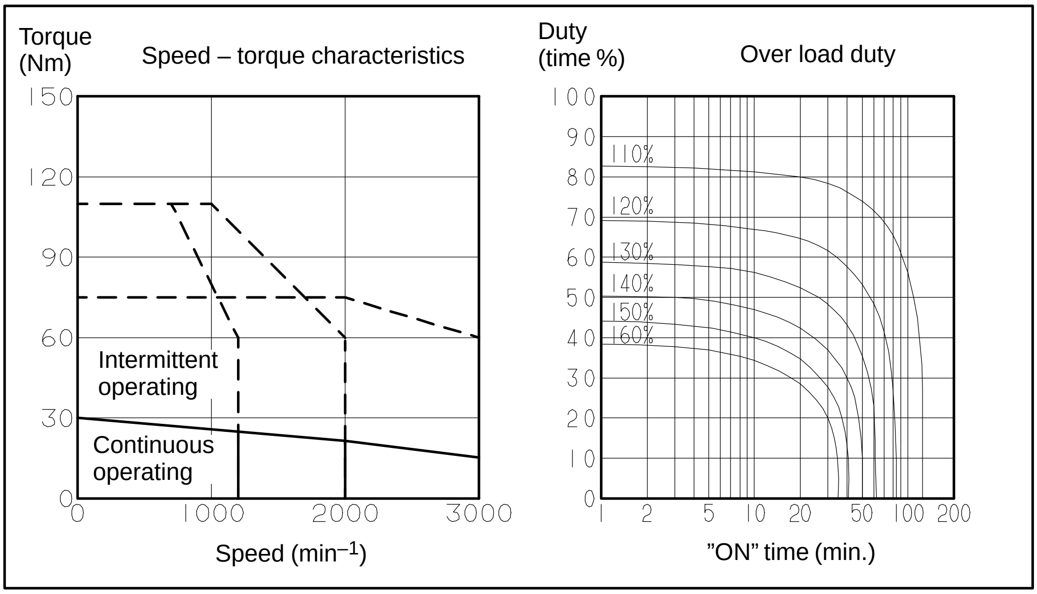
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	1500	2000	3000	min^{-1}
Rated torque at stall (*)	Ts	22 224	22 224	22 224	Nm kgfcm
Rotor inertia	Jm	0.012 0.12	0.012 0.12	0.012 0.12	kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	12.5	18.7	32.1	A (rms)
Torque constant (*)	Kt	1.76 18.0	1.17 12.0	0.68 7.0	Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	62 0.59	41 0.39	24 0.23	V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.315	0.140	0.049	Ω
Mechanical time constant (*)	tm	0.004	0.004	0.004	s
Thermal time constant	tt	65	65	65	min
Static friction	Tf	1.2 12	1.2 12	1.2 12	Nm kgfcm
Mass		29	29	29	kg

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

Model α30/1200 Specification : A06B–0151–B□□□

Model α30/2000 Specification : A06B–0152–B□□□

Model α30/3000 Specification : A06B–0153–B□□□



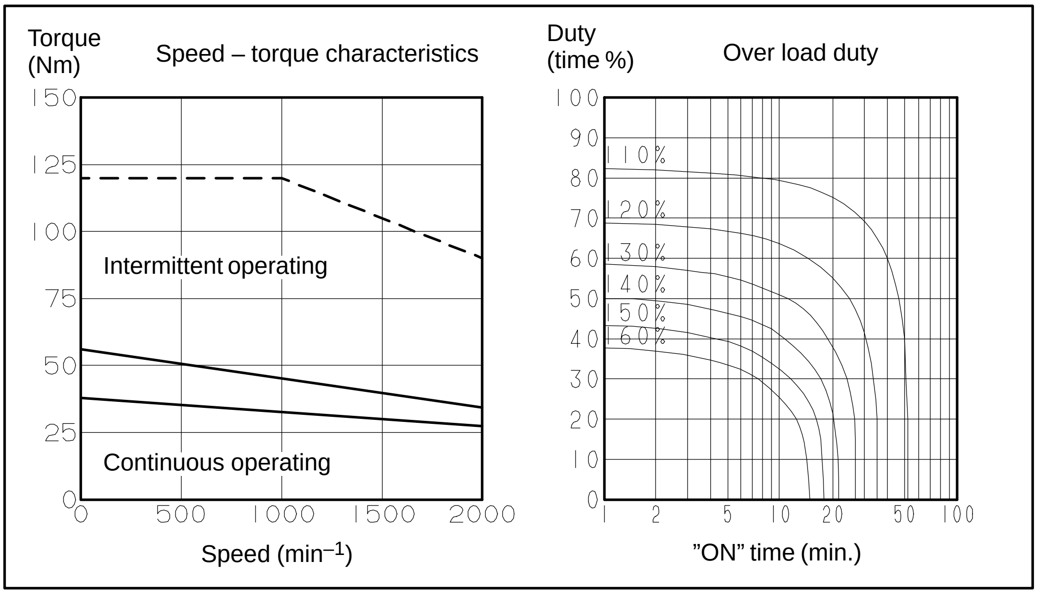
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	1200	2000	3000	min $^{-1}$
Rated torque at stall (*)	Ts	30 306	30 306	30 306	Nm kgfcm
Rotor inertia	Jm	0.017 0.17	0.017 0.17	0.017 0.17	kgm ^{2} kgfcms ^{2}
Continuous RMS current at stall (*)	Is	12.6	20.2	33.7	A (rms)
Torque constant (*)	Kt	2.37 24.2	1.48 15.1	0.89 9.1	Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	83 0.79	52 0.49	31 0.30	V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.34	0.13	0.046	Ω
Mechanical time constant (*)	tm	0.003	0.003	0.003	s
Thermal time constant	tt	70	70	70	min
Static friction	Tf	1.8 18	1.8 18	1.8 18	Nm kgfcm
Mass		41	41	41	kg

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

Model α40/2000 Specification : A06B–0157–B0□□

Model α40/2000(with fan) Specification : A06B–0158–B0□□

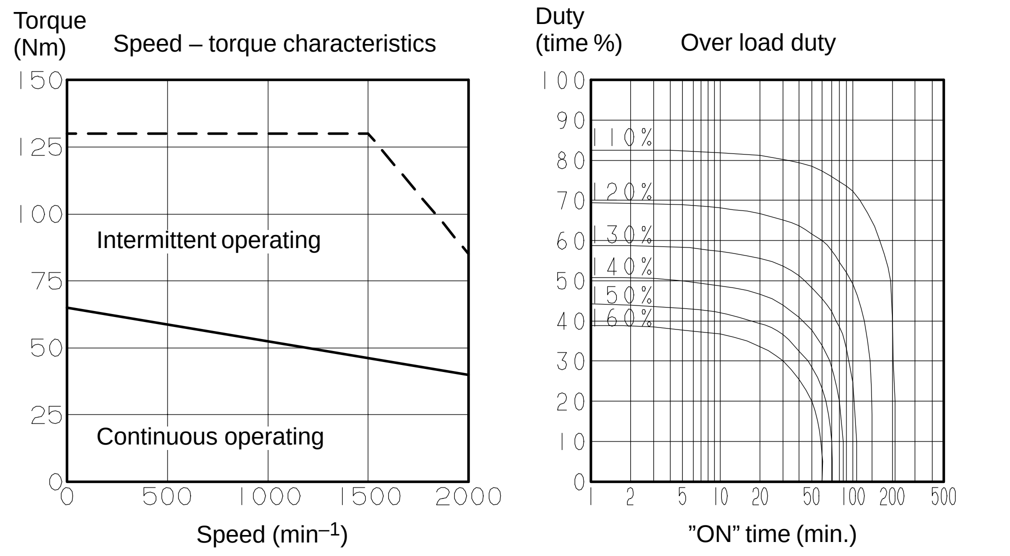


Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000	2000 (with fan)		min $^{-1}$
Rated torque at stall (*)	Ts	38 390	56 570		Nm kgfcm
Rotor inertia	Jm	0.022 0.23	0.022 0.23		kgm^2 kgfcms^2
Continuous RMS current at stall (*)	Is	27.0	40.1		A (rms)
Torque constant (*)	Kt	1.40 14.3	1.40 14.3		Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	49 0.47	49 0.47		V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.080	0.080		Ω
Mechanical time constant (*)	tm	0.003	0.003		s
Thermal time constant	tt	75	30		min
Static friction	Tf	1.8 18	1.8 18		Nm kgfcm
Mass		52	55		kg

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

Model α65/2000 Specification : A06B–0331–B□□□

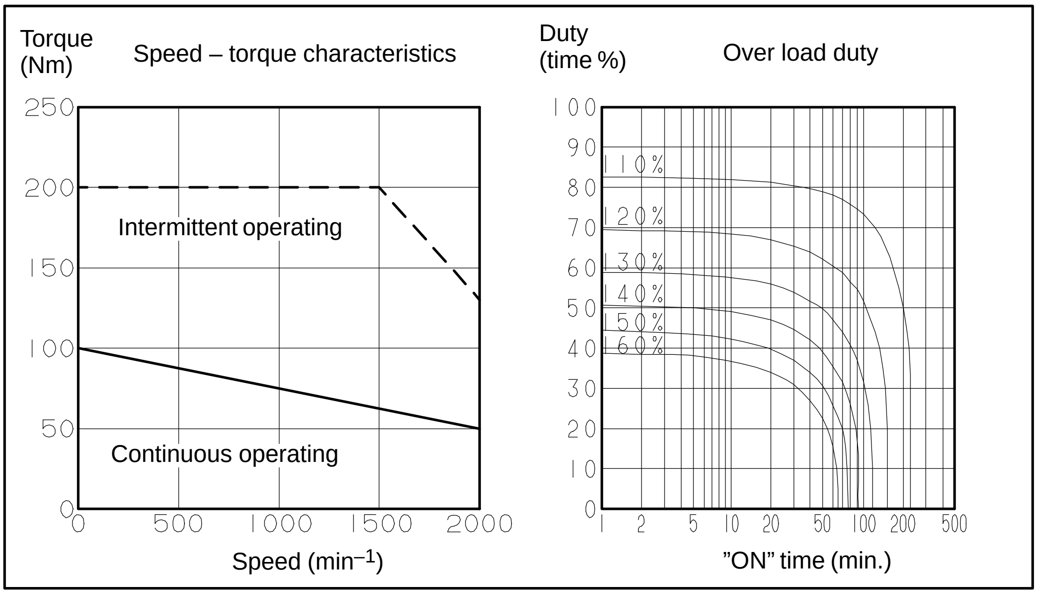


Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000			min^{-1}
Rated torque at stall (*)	Ts	65 660			Nm kgfcm
Rotor inertia	Jm	0.019 0.19			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	62			A (rms)
Torque constant (*)	Kt	1.04 10.6			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	36 0.35			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.020			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	70			min
Static friction	Tf	3.7 38			Nm kgfcm
Mass		80			kg

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

Model α100/2000 Specification : A06B–0332–B□□□

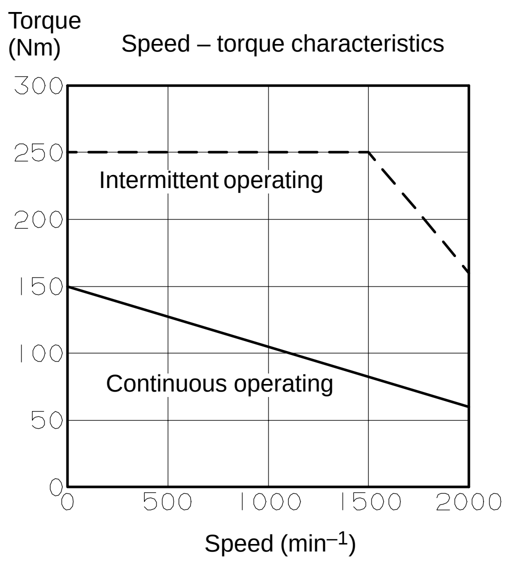


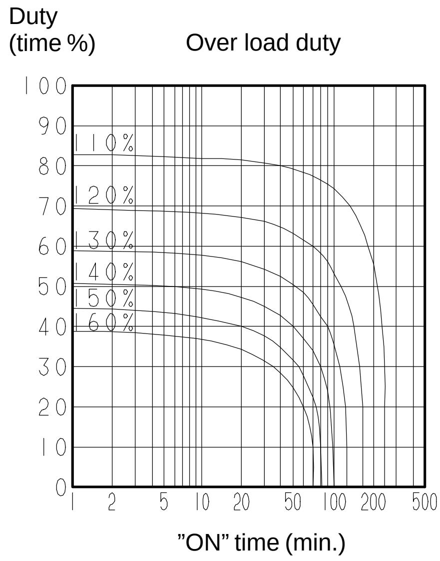
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000			min $^{-1}$
Rated torque at stall (*)	Ts	100 1020			Nm kgfcm
Rotor inertia	Jm	0.026 0.27			kgm^2 kgfcms^2
Continuous RMS current at stall (*)	Is	85			A (rms)
Torque constant (*)	Kt	1.17 12.0			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	41 0.39			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.014			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	80			min
Static friction	Tf	5.5 56			Nm kgfcm
Mass		100			kg

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

Model α150/2000 Specification : A06B–0333–B□□□



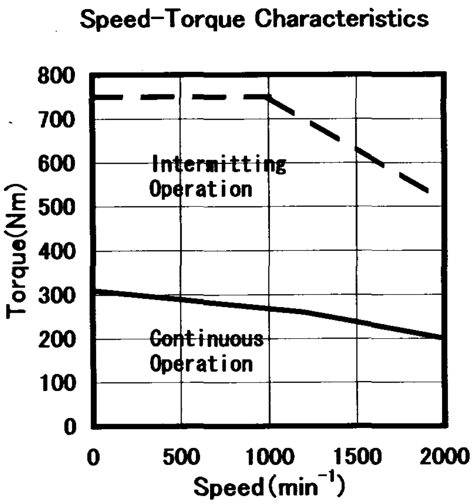


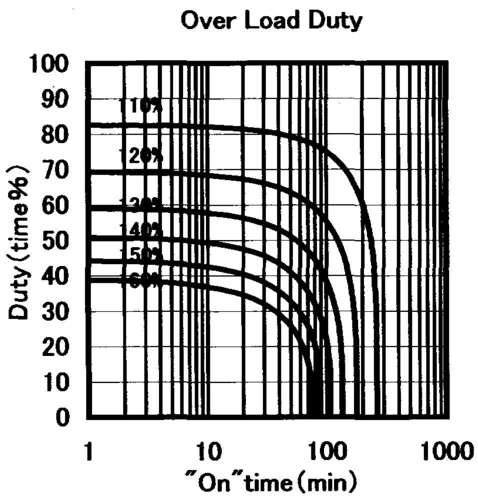
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000			min $^{-1}$
Rated torque at stall (*)	Ts	150 1530			Nm kgfcm
Rotor inertia	Jm	0.034 0.35			kgm^2 kgfcms^2
Continuous RMS current at stall (*)	Is	113			A (rms)
Torque constant (*)	Kt	1.31 13.3			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	46 0.44			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.011			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	90			min
Static friction	Tf	7.4 75			Nm kgfcm
Mass		120			kg

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

Model α300/2000 Specification : A06B–0137–B□□□



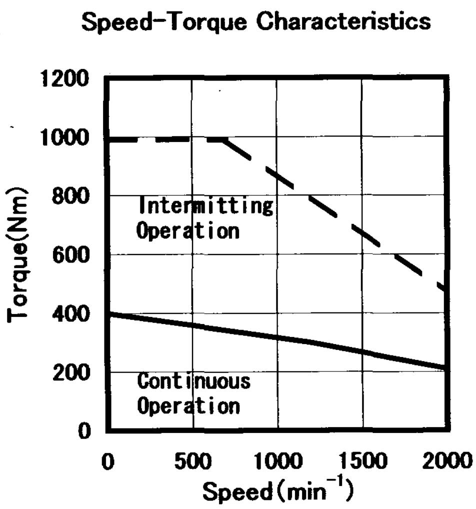


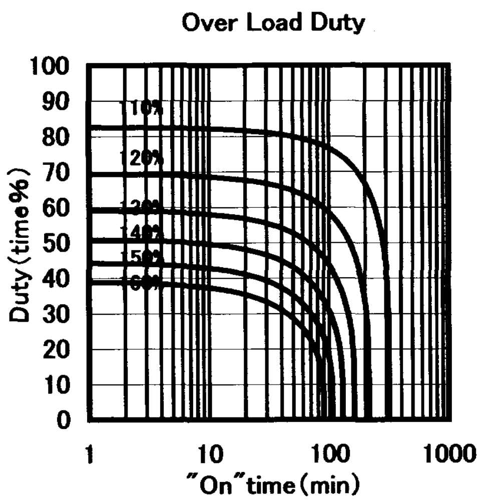
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000			min $^{-1}$
Rated torque at stall (*)	Ts	300 3060			Nm kgfcm
Rotor inertia	Jm	0.079 0.80			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	187			A (rms)
Torque constant (*)	Kt	1.55 15.9			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	54 0.52			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.012			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	150			min
Static friction	Tf	2 20			Nm kgfcm
Weight		180			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)

Model α400/2000 Specification : A06B–0138–B□□□





Data sheet

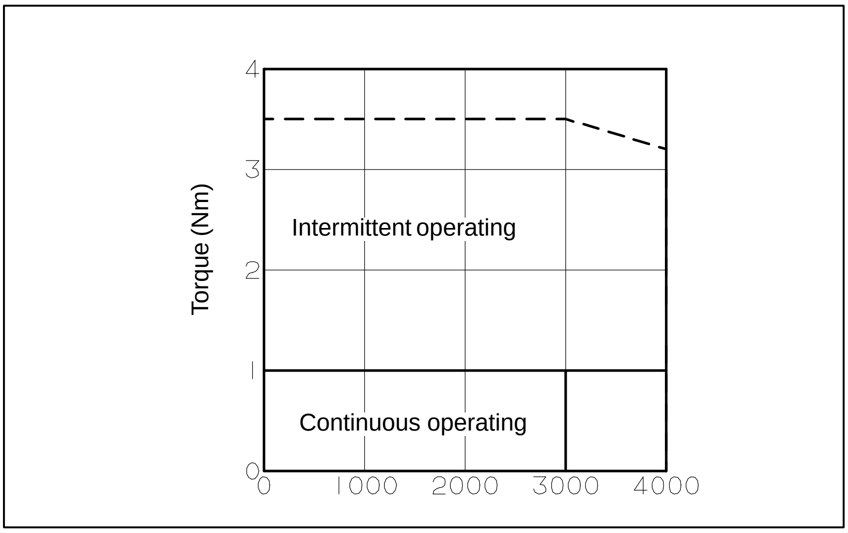
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000			min $^{-1}$
Rated torque at stall (*)	Ts	390 3980			Nm kgfcm
Rotor inertia	Jm	0.103 1.05			kgm^2 kgfcms^2
Continuous RMS current at stall (*)	Is	183			A (rms)
Torque constant (*)	Kt	2.07 21.2			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	 Ke Kv	 72 0.69			 V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.014			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	180			min
Static friction	Tf	2 20			Nm kgfcm
Weight		220			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)

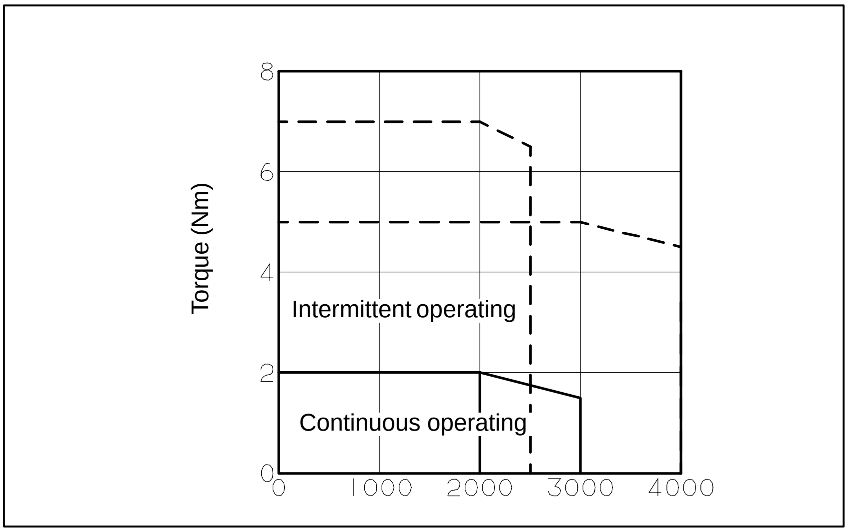
Speed-torque characteristics (HRV control)

On the following models, the intermittent operating zone can be extended by using HRV control.

- **α1/3000**

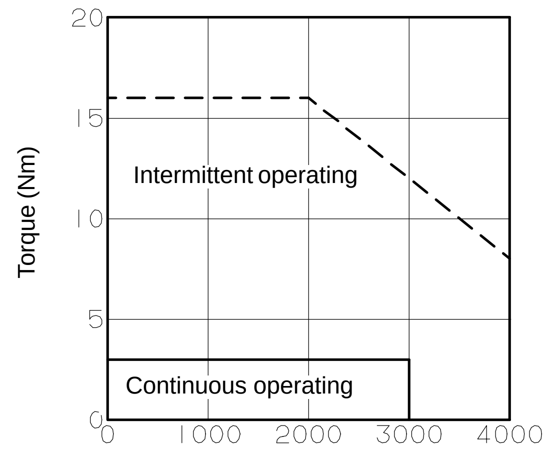


- **α2/2000 and α2/3000**

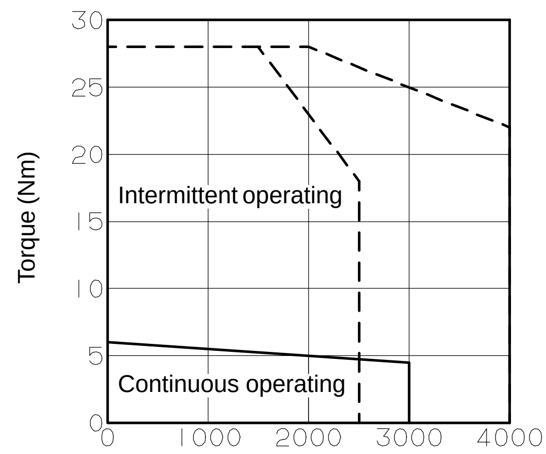


NOTE
HRV control sometimes cannot be used depending on the CNC system. Using HRV control increases the intermittent operating zone at high motor operating speeds. The continuous operating zone, however, is the same as when conventional control methods are used.

- **α3/3000**



- **α6/2000 and α6/3000**

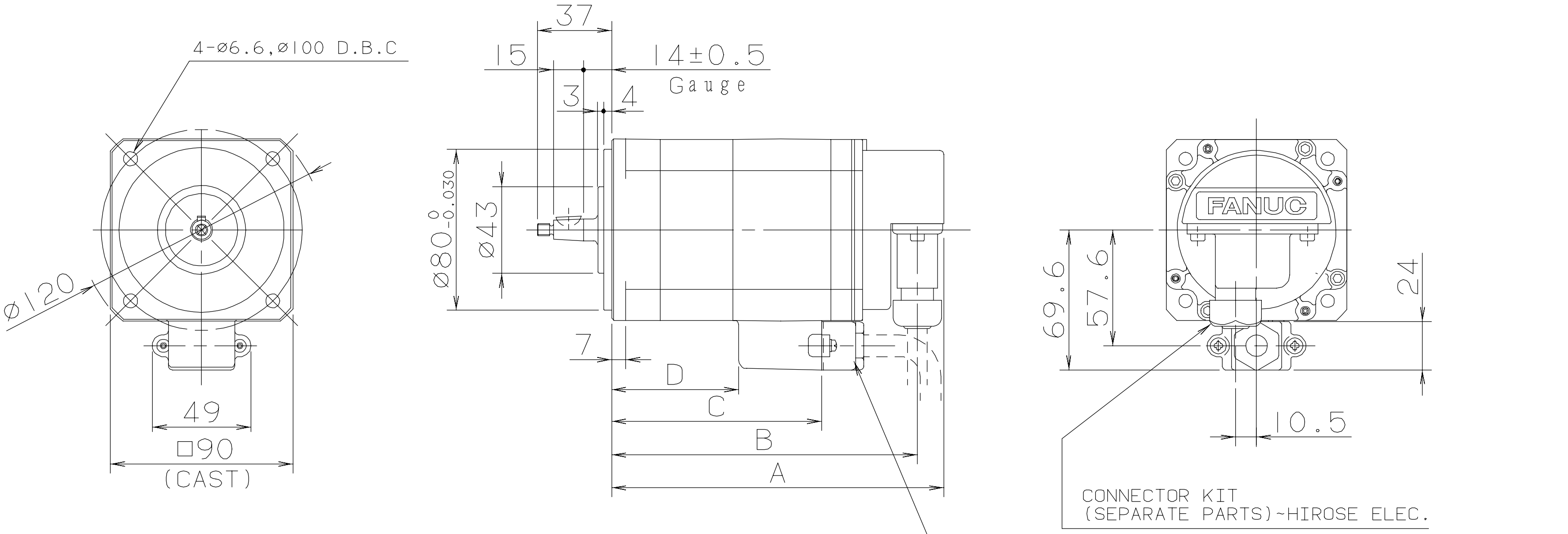


NOTE
HRV control sometimes cannot be used depending on the CNC system. Using HRV control increases the intermittent operating zone at high motor operating speeds. The continuous operating zone, however, is the same as when conventional control methods are used.

3.3 OUTLINE DRAWINGS

Model	Fig. No.
Models α1 and α2	Fig. 3.3(a)
Models α1 and α2 (with the brake)	Fig. 3.3(b)
Models α1 and α2 (shaft option)	Fig. 3.3(c)
Models α3 and α6	Fig. 3.3(d)
Models α3 and α6 (with the brake)	Fig. 3.3(e)
Models α3 and α6 (shaft option)	Fig. 3.3(f)
Models α12, α22, α30 and α40	Fig. 3.3(g)
Models α12, α22, α30 and α40 (with the brake)	Fig. 3.3(h)
Models α12, α22, α30 and α40 (shaft option)	Fig. 3.3(i)
Model α40 (with fan)	Fig. 3.3(j)
Model α40 (with fan) (with the brake)	Fig. 3.3(k)
Models α65, α100 and α150	Fig. 3.3(l)
Models α65, α100 and α150 (with the brake)	Fig. 3.3(m)
Models α300 and α400	Fig. 3.3(n) (o)

Fig. 3.3 (a) Models α1 and α2

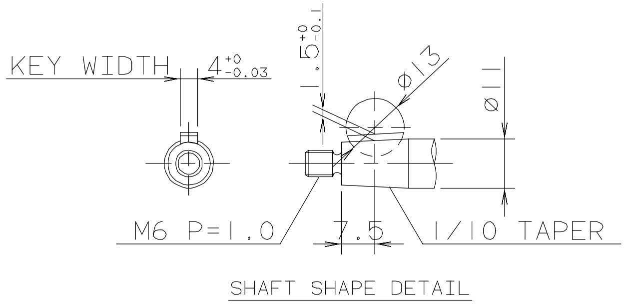


NOTE 1)SHAFT DIA.RUNOUT MAX.0.02mm
RABBET DIA.ECCENTRICITY MAX.0.04mm
MOUNTING FACE RUNOUT MAX.0.06mm
RATED LOADS RADIAL 245N(25kgf)

MODEL	A	B	C	D
α1	165	152	104	60
α2	201	188	140	96

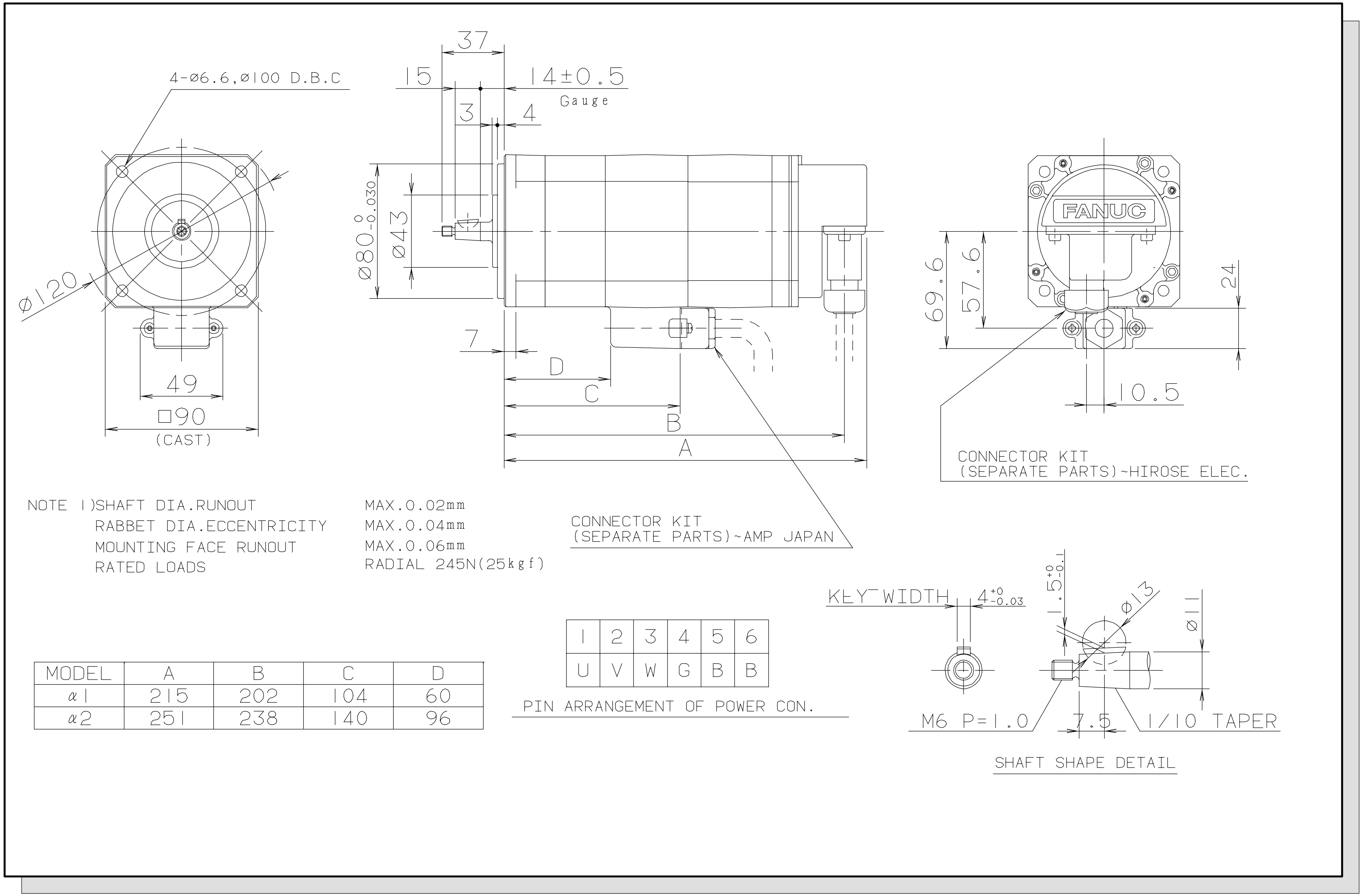
1	2	3	4	5	6
U	V	W	G		

PIN ARRANGEMENT
OF POWER CON.



SHAFT SHAPE DETAIL

Fig. 3.3 (b) Models α1 and α2 (with the brake)

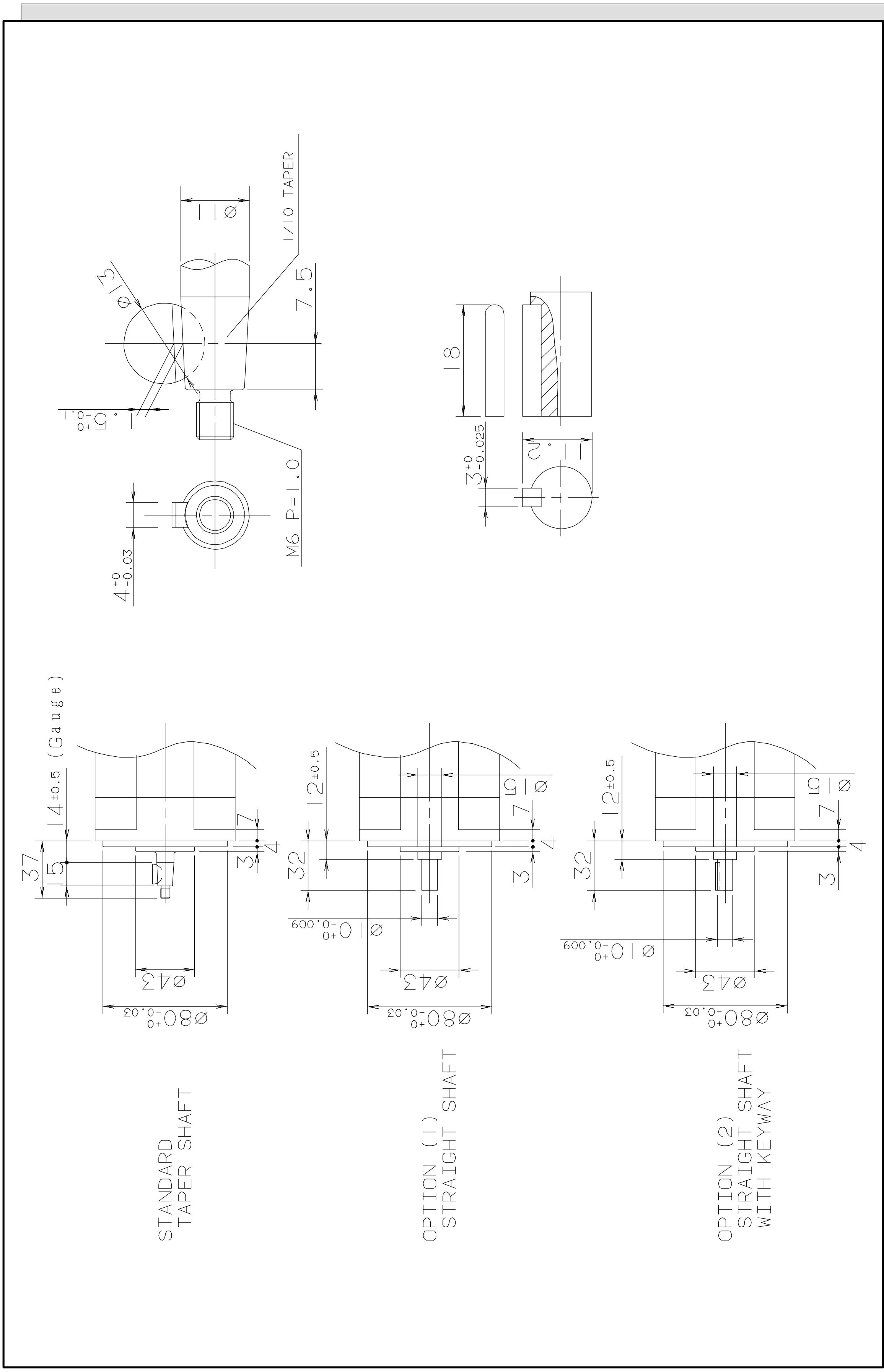


MODEL	A	B	C	D
α1	215	202	104	60
α2	251	238	140	96

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

PIN ARRANGEMENT OF POWER CON.

Fig. 3.3 (c) Models α1 and α2 (shaft option)



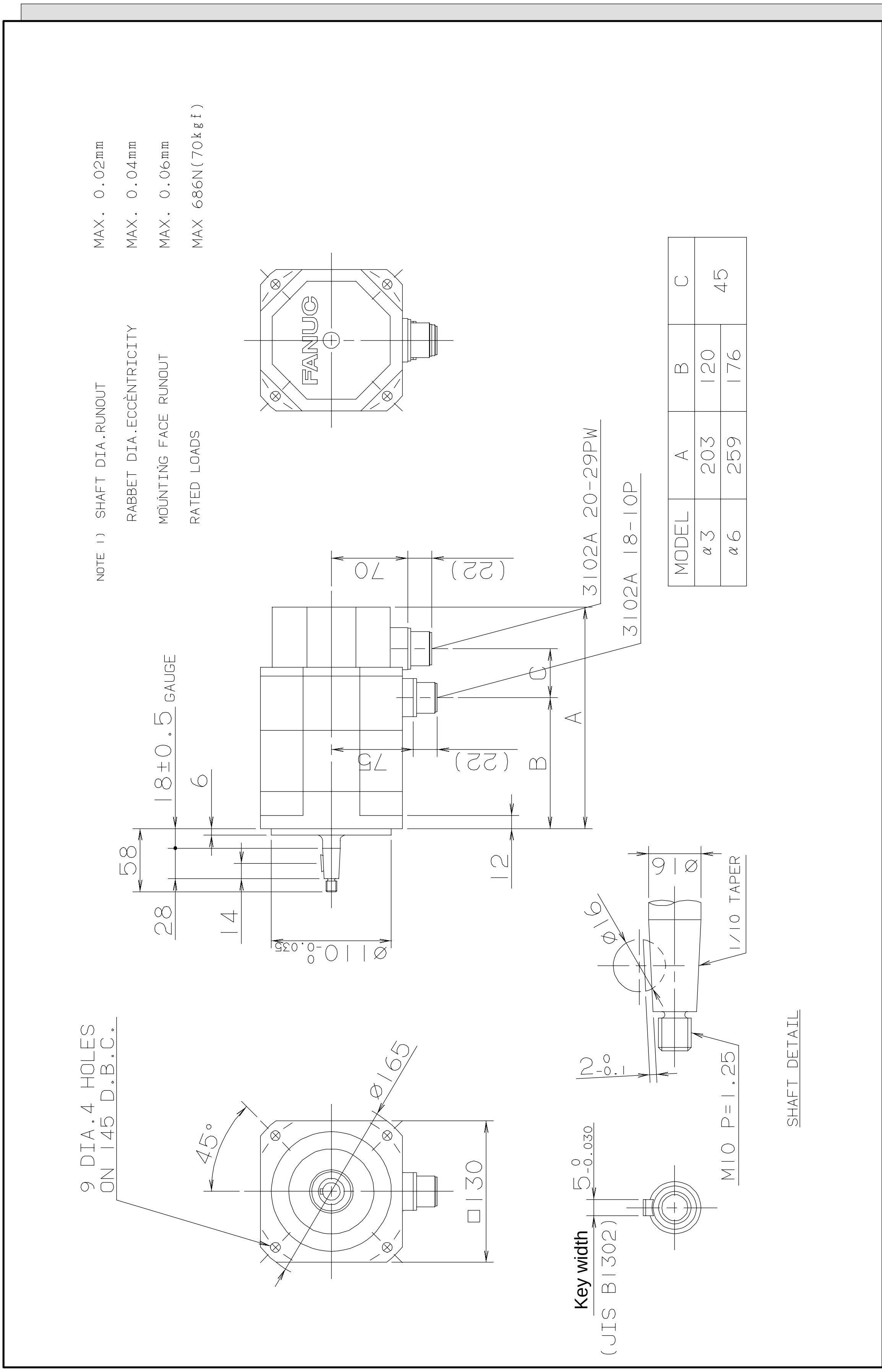


Fig. 3.3 (d) Models α3 and α6

Fig. 3.3 (e) Models α3 and α6 (with the brake)

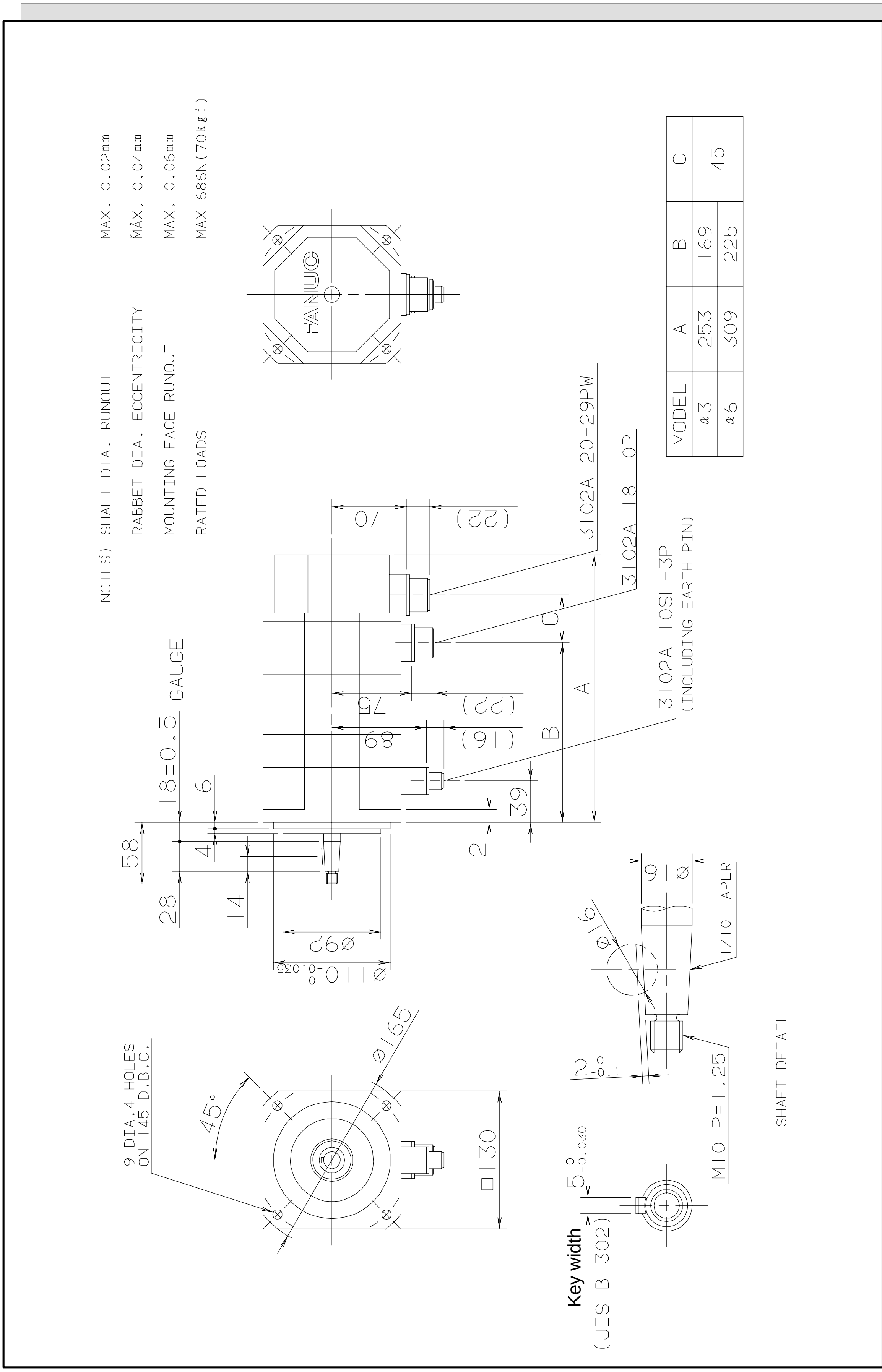


Fig. 3.3 (f) Models α3 and α6 (shaft option)

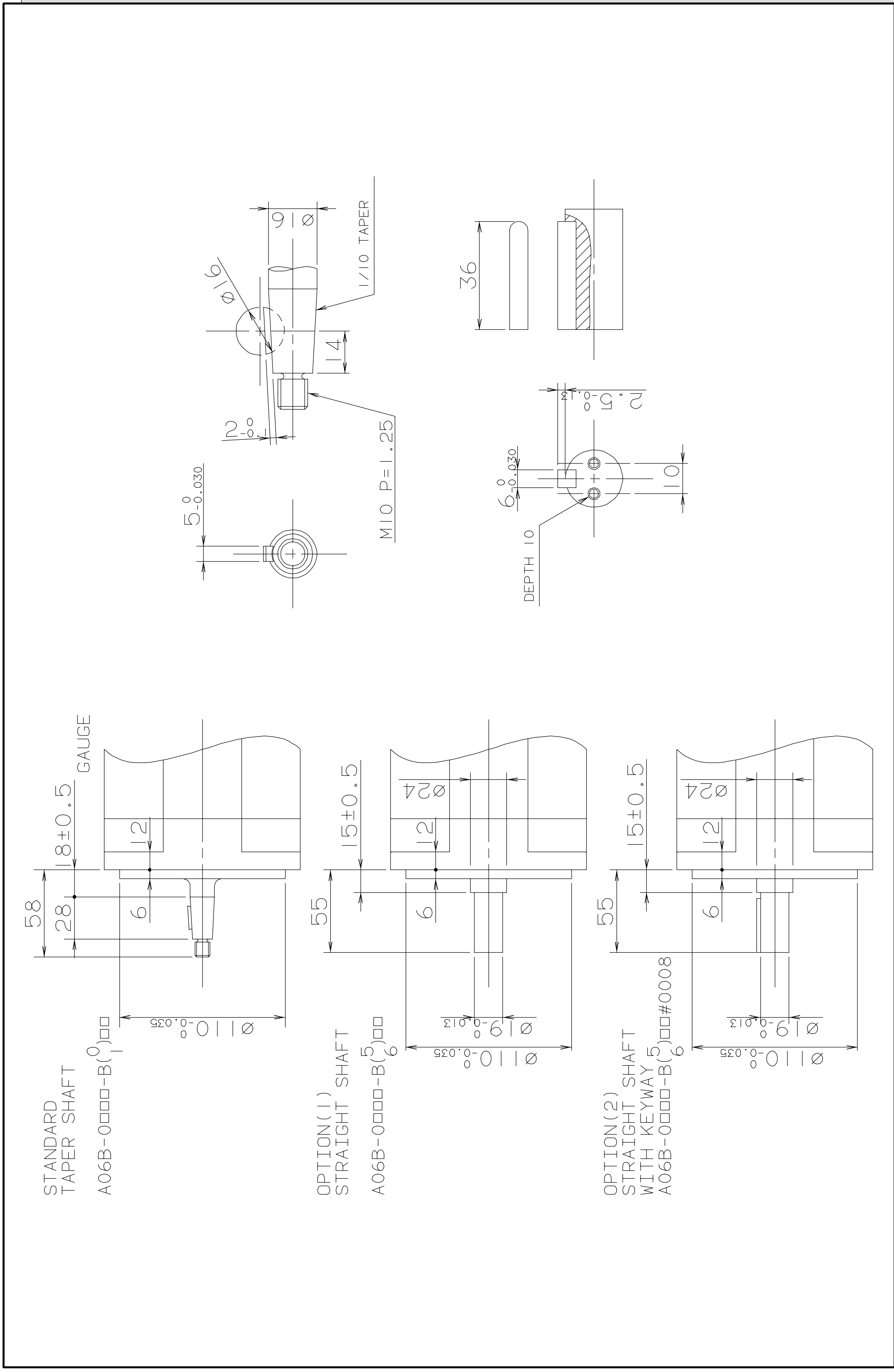
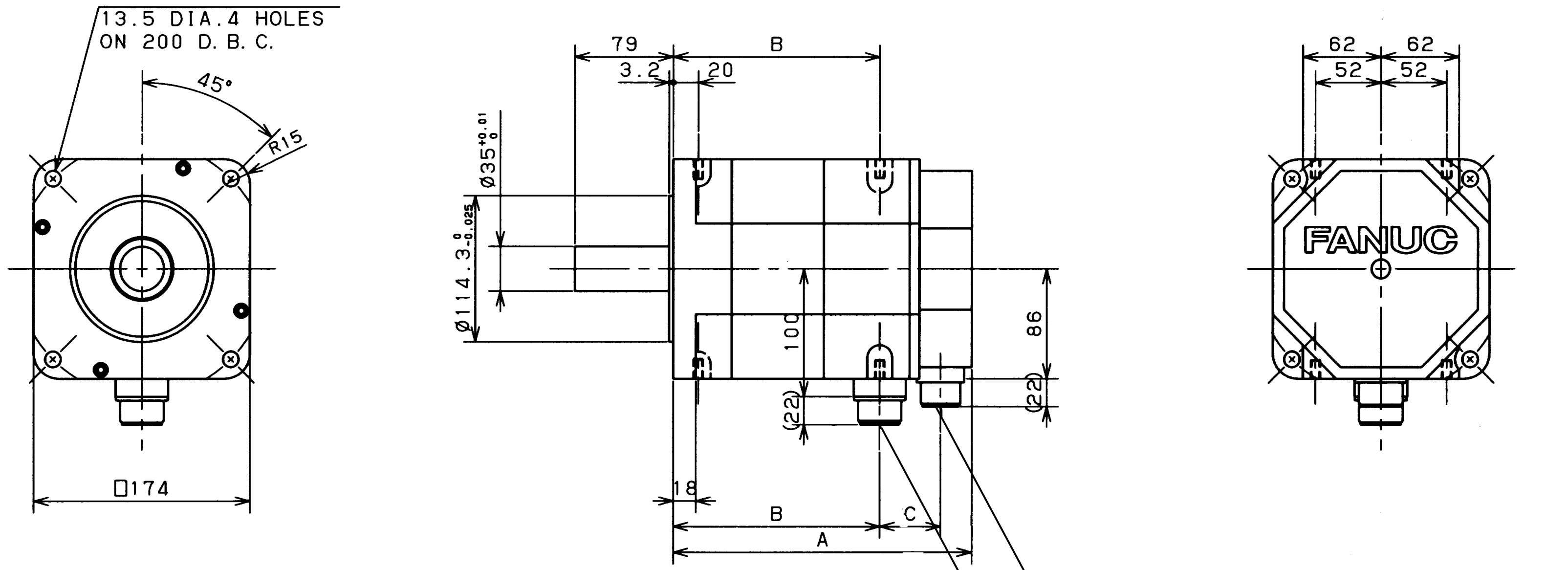


Fig. 3.3 (g) Models α12, α22, α30, and α40



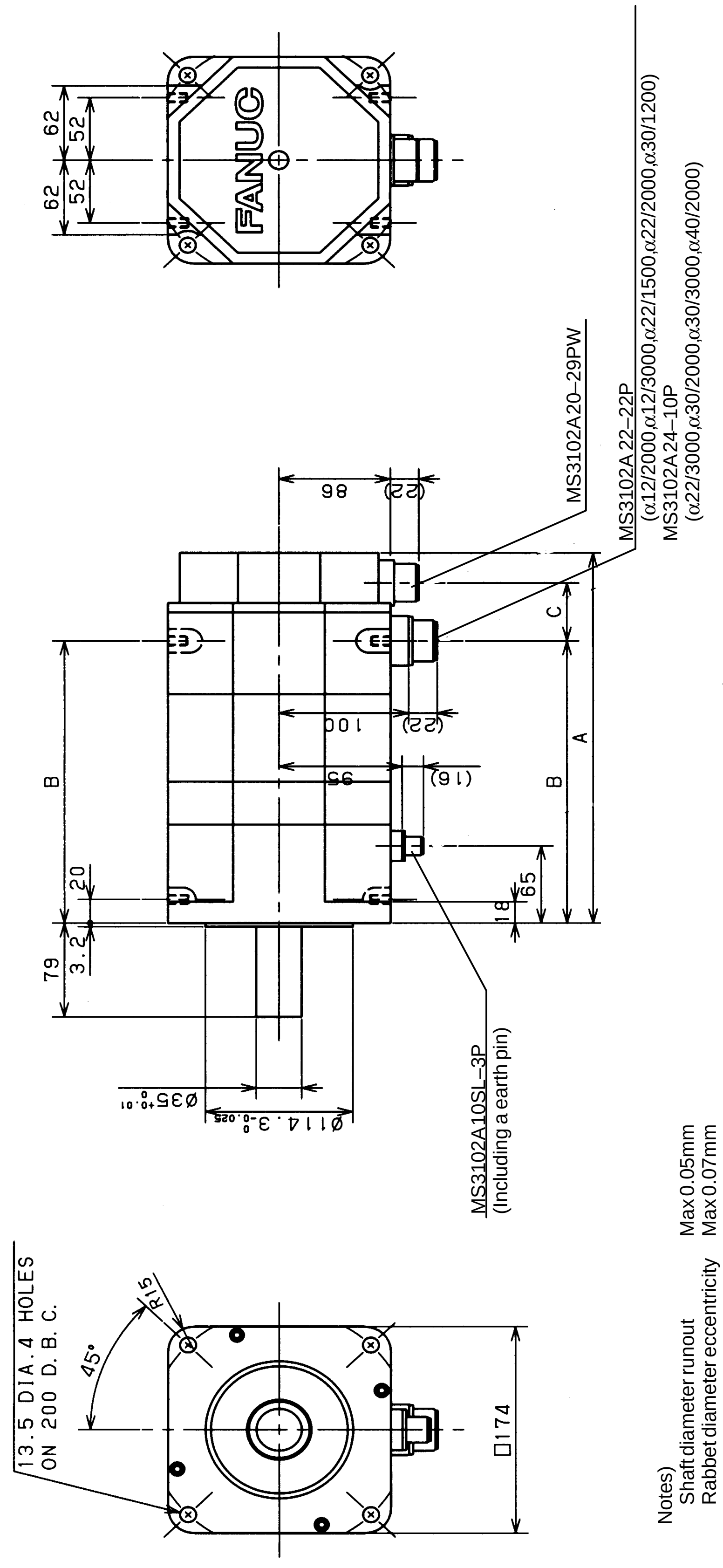
Notes)

Shaft diameter runout	Max 0.05mm
Rabbet diameter eccentricity	Max 0.07mm
Mounting face runout	Max 0.10mm
Rated load	4410N(450kgf)

Taps for eyebolt : M8 depth 15^{+1}
Eyebolts are not attached

MODEL	A	B	C
α12	240	166	49
α22	314	240	
α30	388	314	
α40	462	388	

Fig. 3.3 (h) Models α12, α22, α30, and α40 (with the brake)



Taps for eyebolt : M8 depth 15+1
Eyebolts are not attached

MODEL	A	B	C
α12	312	238	49
α22	386	312	
α30	460	386	
α40	548	474	

Notes)

Shaft diameter runout	Max 0.05mm
Rabbet diameter eccentricity	Max 0.07mm
Mounting face runout	Max 0.10mm
Rated load	4410N(450kgf)

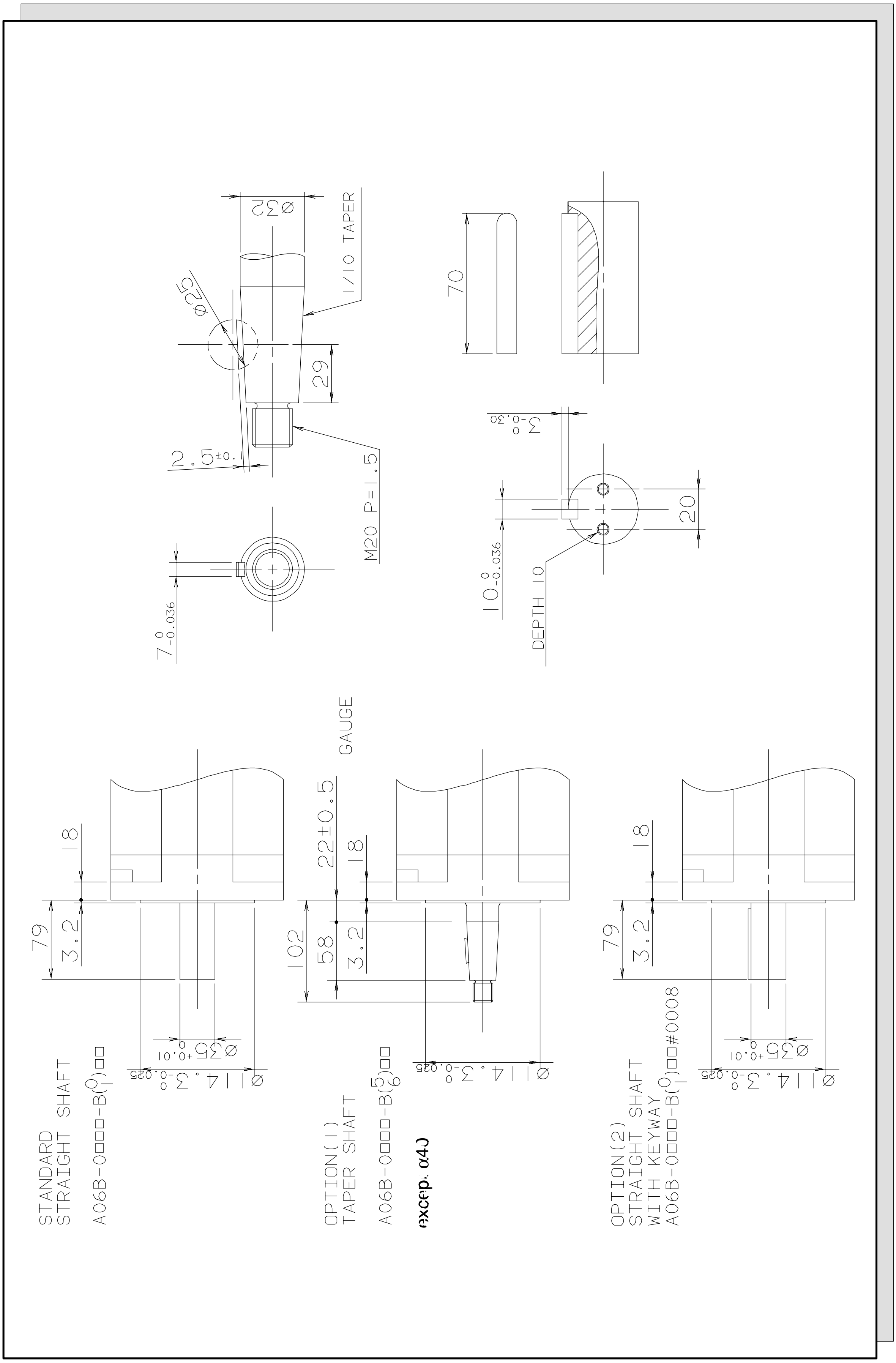
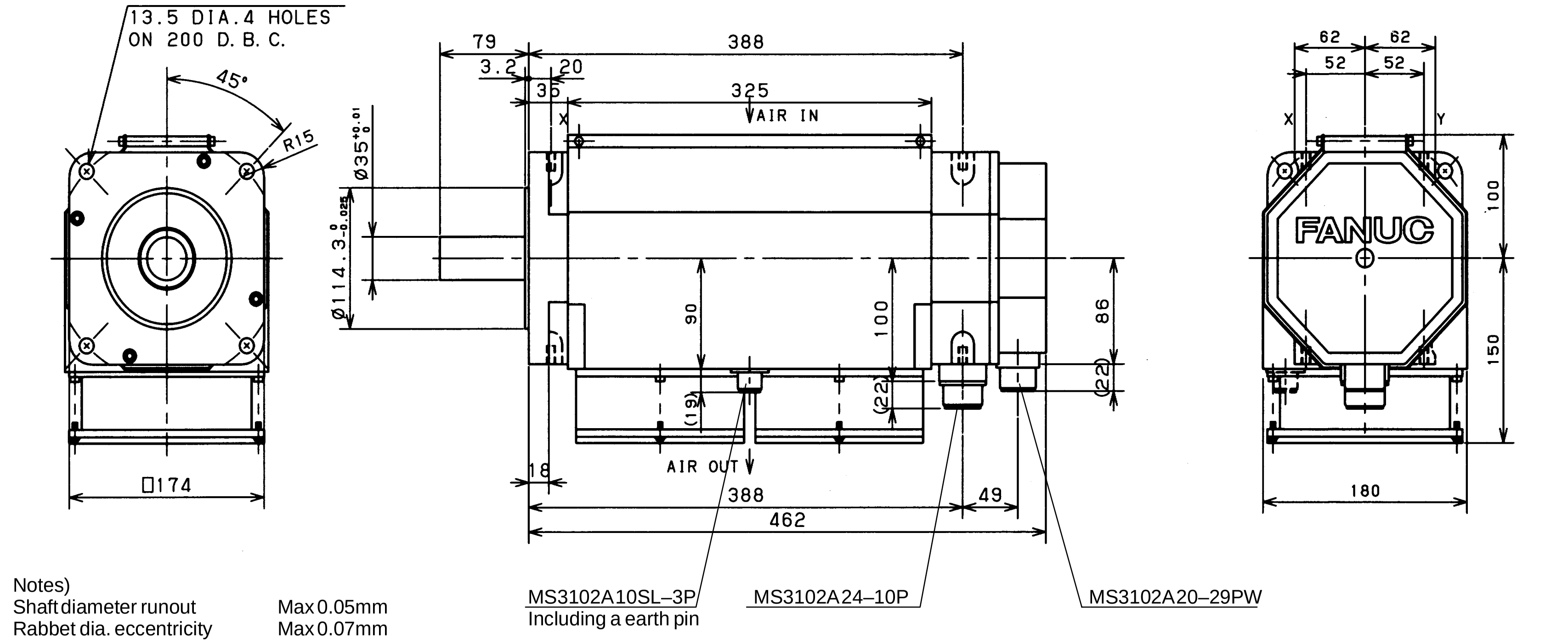


Fig. 3.3 (i) Models α12, α22, α30, and α40 (shaft option)

Fig. 3.3 (j) Model α40 (with fan)



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

Taps for eyebolt : M8 depth 15^{+1}
Eyebolts are not attached
No weight more than 100kg
No acceleration more than 1G
Direction of the air flow is downward only

Fan Motor Specification

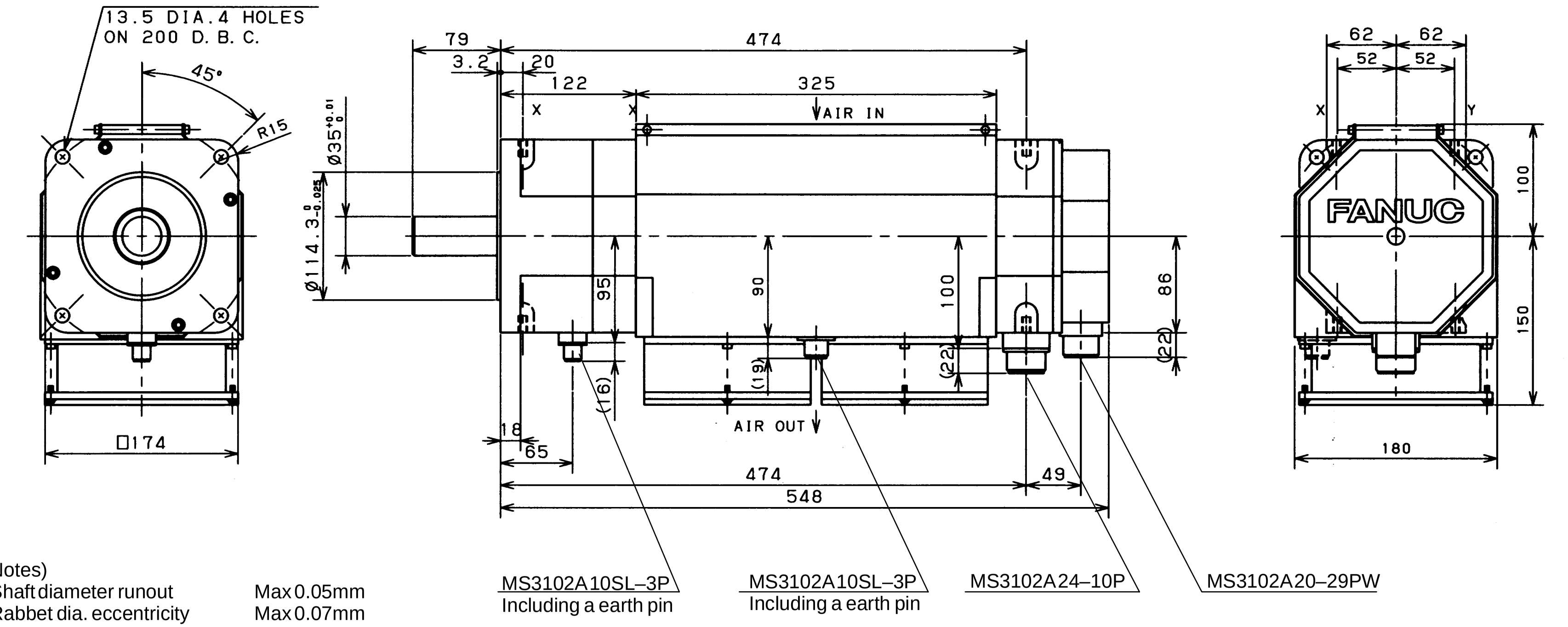
Input Voltage	200 V	
Frequency	50 Hz	60 Hz
Input	40 W	40 W
Speed	2700min^{-1}	2900min^{-1}

This chart is spec. for one fan motor.
Prepare a protect fuse in power supply.

Fan Connector

Pin	Note
A	Single phase 200Vac 2 fans in parallel
B	
C	Earth

Fig. 3.3 (k) Model α40 (with fan) (with the brake)



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

Taps for eyebolt : M8 depth 15^{+1}
Eyebolts are not attached
No weight more than 100kg
No acceleration more than 1G
Direction of the air flow is downward only

Fan Motor Specification

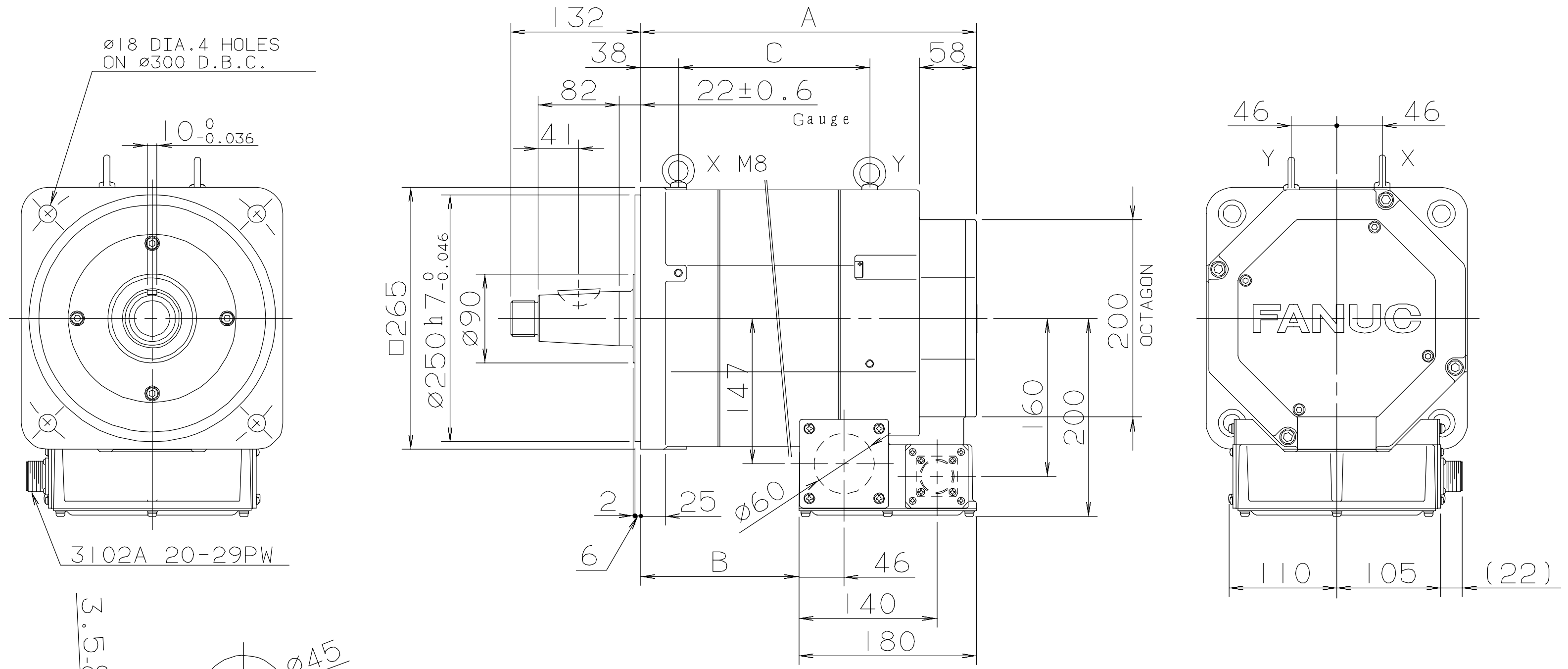
Input Voltage	200 V	
Frequency	50 Hz	60 Hz
Input	40 W	40 W
Speed	2700min^{-1}	2900min^{-1}

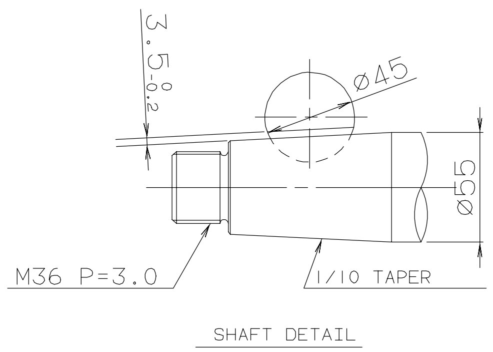
This chart is spec. for one fan motor.
Prepare a protect fuse in power supply.

Fan Connector

Pin	Note
A	Single phase 200Vac 2 fans in parallel
B	
C	Earth

Fig. 3.3 (l) Models α65, α100, and α150





MODEL	A	B	C
α65	341	160	194
α100	401	220	254
α150	461	280	314

NOTES)
SHAFT DIA. RUNOUT Max. 0.03mm
RABBET DIA. ECCENTRICITY Max. 0.06mm
MOUNTING FACE RUNOUT Max. 0.08mm
RATED LOADS Radial 8820N(900kgf)

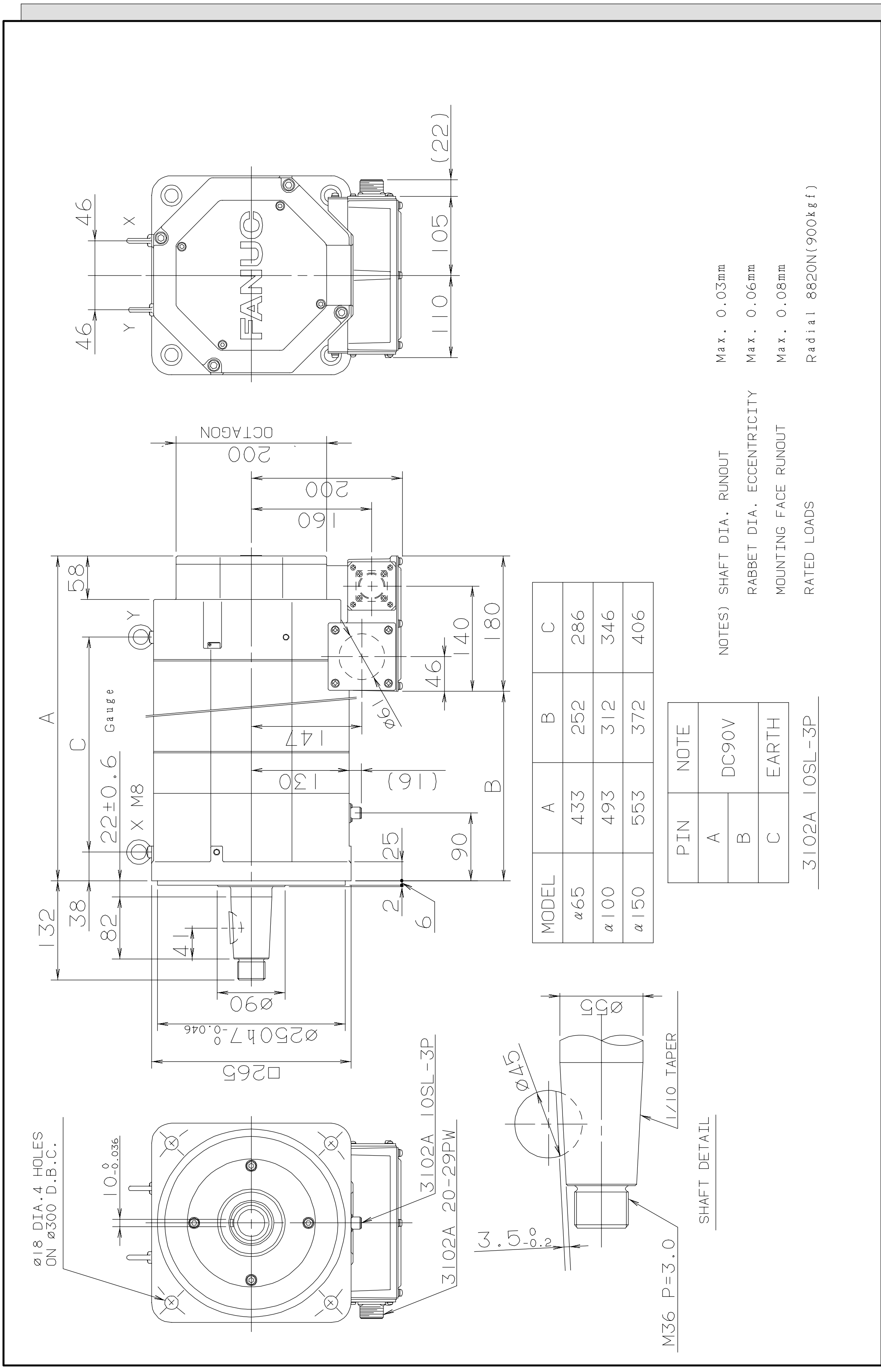
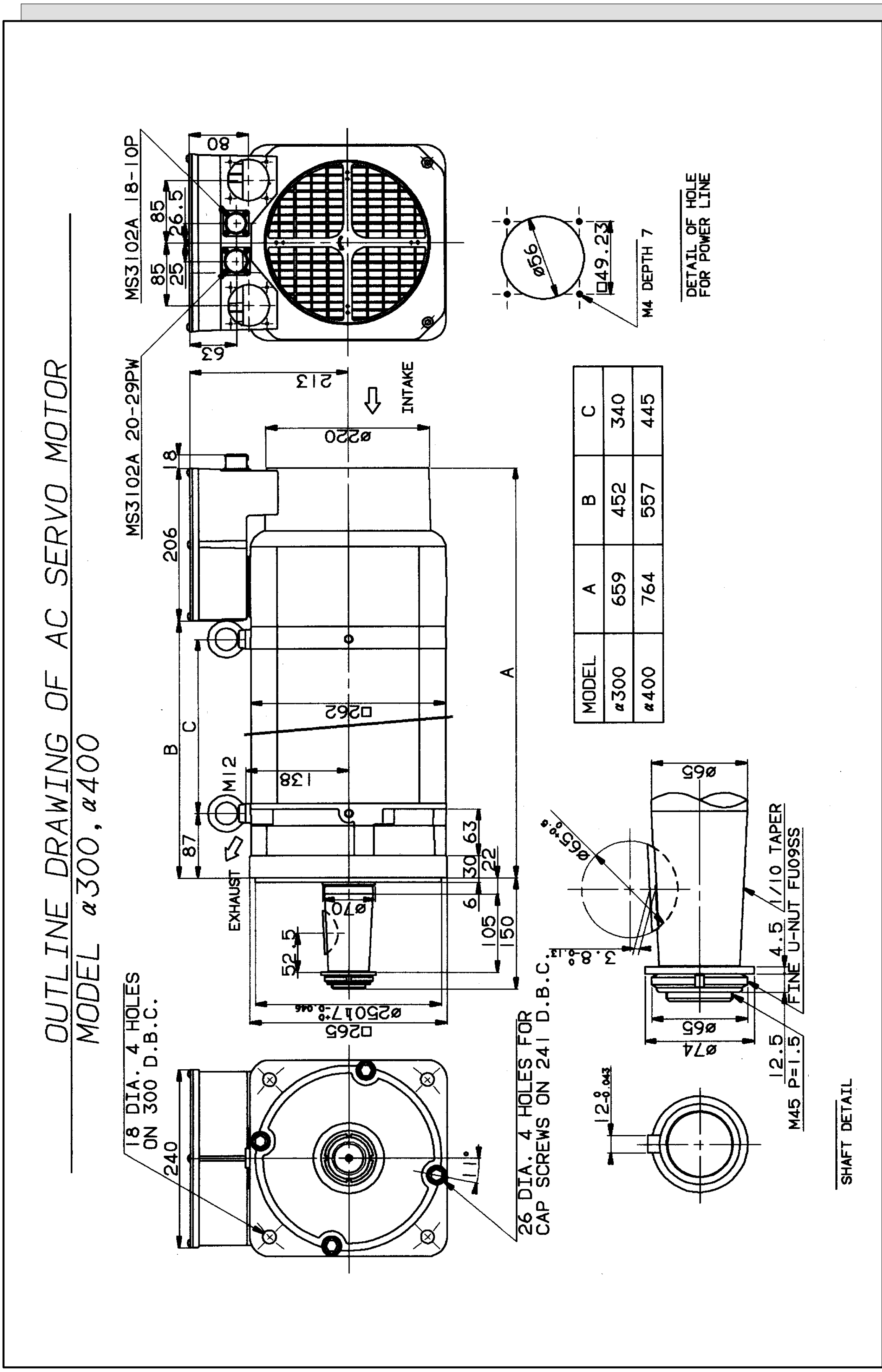


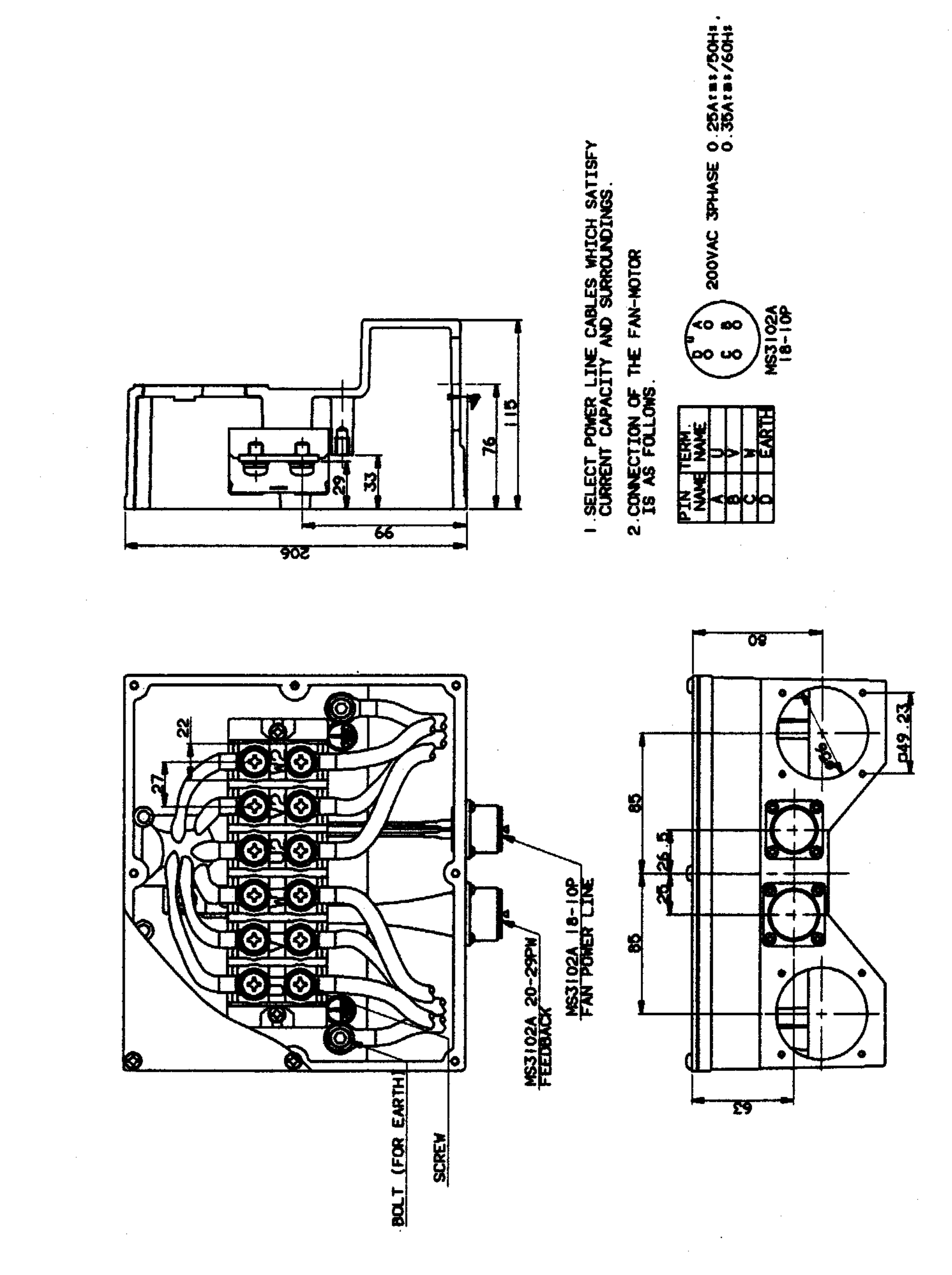
Fig. 3.3 (m) Models α65, α100, and α150 (with the brake)

Fig. 3.3 (*n*) Models α300/2000 and α400/2000



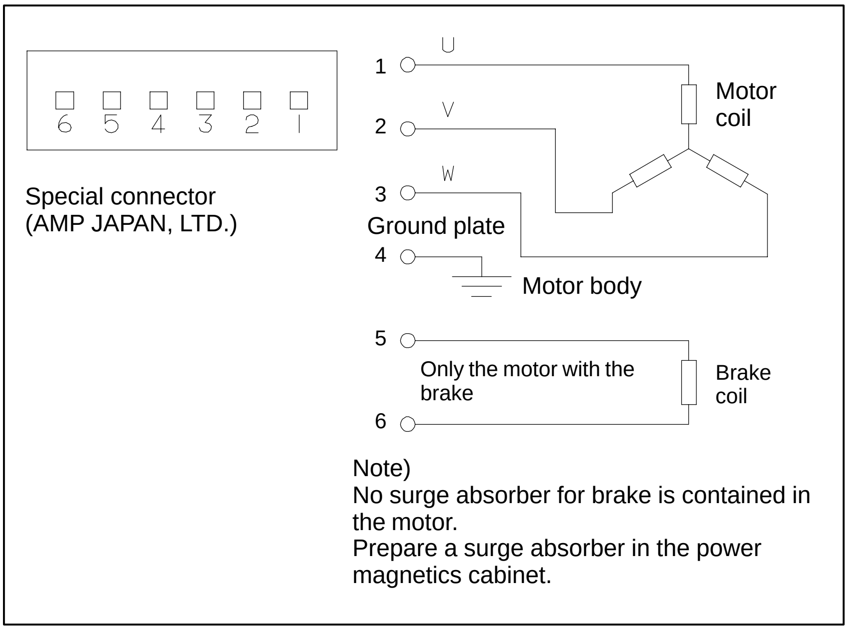
MODEL	A	B	C
α300	659	452	340
α400	764	557	445

Fig. 3.3 (o) Models α300/2000 and α400/2000 (terminal box)

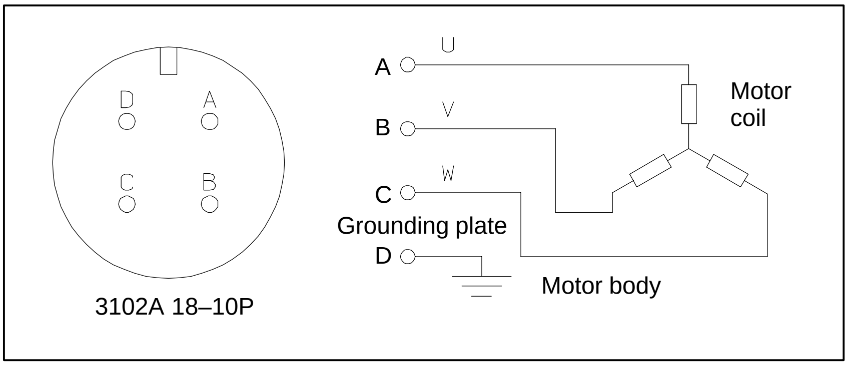


3.4 CONNECTION OF POWER LINE

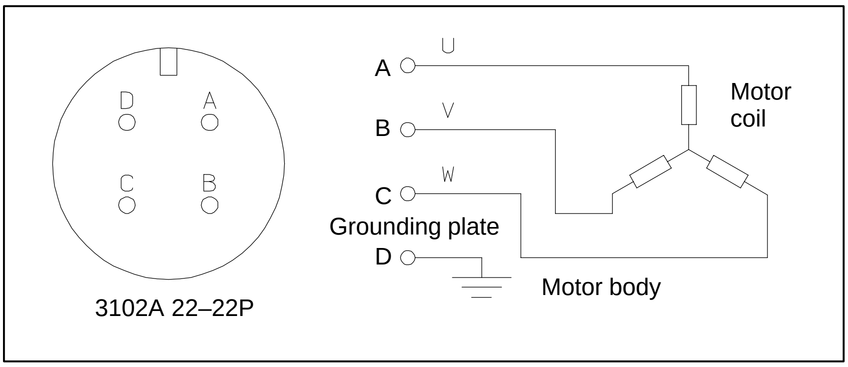
Models α1/3000, α2/2000, and α2/3000



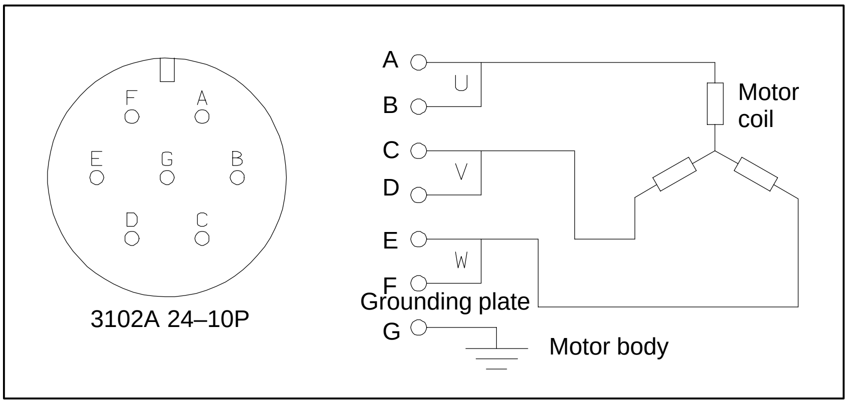
Models α3/3000, α6/2000, and α6/3000



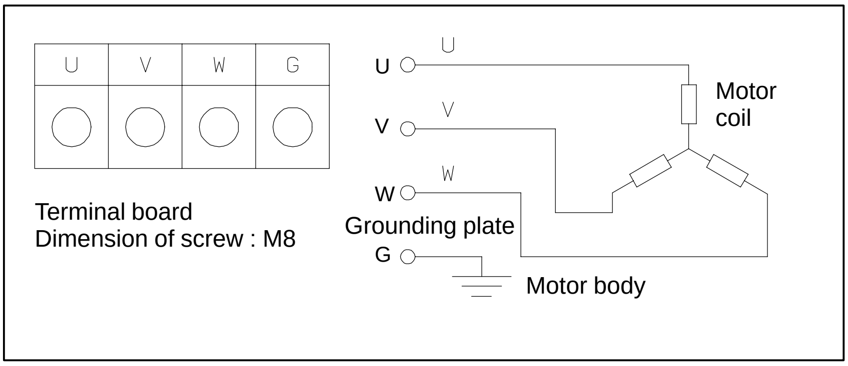
Models α12/2000, α12/3000, α22/1500, α22/2000, and α30/1200



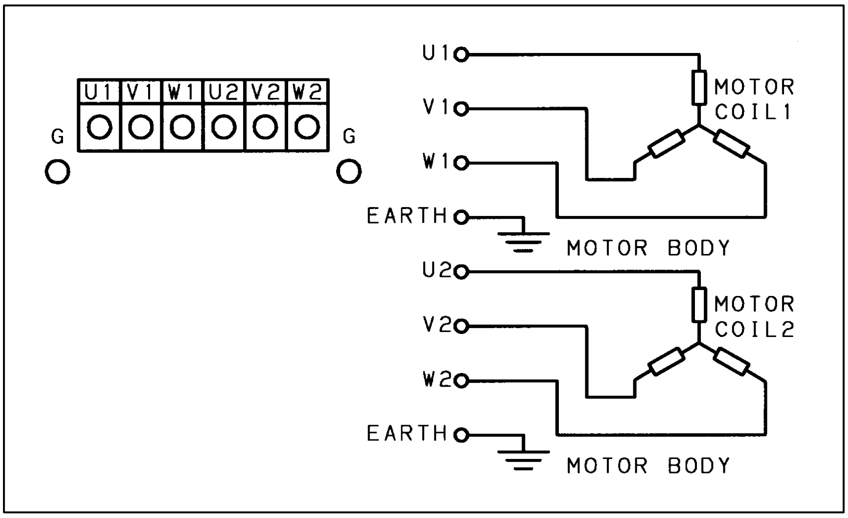
Models
α22/3000, α30/2000, α30/3000, and α40/2000



Models
α65/2000, α100/2000, and α150/2000



Models
α40/2000 and α400/2000



CAUTION

1 The motors should be installed with their connector facing downward as long as possible. When it is impossible to install a motor in this position, allow slack in the cable to keep liquids such as a dielectric fluid from going along the cable into the cable or motor. If there is a possibility that the motors and connectors get wet, provide a cover to protect them.

2 If a motor is not connected to the earth ground through the machine (frame), connect the motor grounding point and the amplifier grounding point to absorb noise using a 1.25 mm^2 or larger conductor other than the grounding conductor in the power cable. Keep the grounding conductor as far from the power cable as possible.

III. FANUC AC SERVO MOTOR αM series

1 GENERAL

The FANUC AC servo motor αM series is suitable for application to the feed axes of small machine tools. It has the following features:

Excellent acceleration characteristics

A high maximum output torque and intermediate rotor inertia result in excellent acceleration characteristics.

Compact

The use of the latest neodymium ferrite magnet further reduces the size and weight of the servo motors. This produces a servo motor that is sufficiently compact to allow its use in small machine tools.

Excellent waterproofing

The use of waterproof connectors and FANUC's unique stator seal provide excellent waterproofing, ensuring that no liquid, such as coolant, can enter the motor.

Extended continuous–operation

The use of the latest servo software minimizes the heat generated by high–speed rotation, allowing continuous operation over a wide range.

Smooth rotation

Further improvements have been made to the unique magnetic pole shape to minimize torque ripple. The result is extremely smooth rotation.

Controllability

The use of the latest servo software maintains controllability even when a disturbance occurs.

High–performance detector

High–resolution pulse coder αA1000, αA64, αI64 is used in the standard configuration, enabling precise positioning.

Powerful brake

A powerful brake with an increased holding torque is available as an option. The brake uses an asbestos–free design.

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

The αM series includes the following models:

- Models αM2 and αM2.5 (excluding shaft type models) that are compatible with the installation dimensions of the α series models α1 and 2.
- Models αM3, αM6, and αM9 that are compatible with the installation dimensions of the α series models α3 and 6.
- Models αM22 and αM30 that are compatible with the installation dimensions of the α series models α12, 22, and 30.

2 TYPES OF MOTORS AND DESIGNATION

Models
αM2/3000, αM2.5/3000

A06B–03□□–B☆ ○○

□□
76 : Model αM2/3000
77 : Model αM2.5/3000

☆
0 : Taper shaft (standard)
1 : Taper shaft with the brake (2Nm)
5 : Straight shaft
6 : Straight shaft with the brake (2Nm)

○○
75 : Pulse coder αA64
77 : Pulse coder αI64
88 : Pulse coder αA1000

The standard shafts used for αM2/3000 and αM2.5/3000 are taper shafts. Use a taper shaft as far as circumstances, such as the delivery time and maintenance, permit.

Models
αM6/3000, αM9/3000

A06B–01□□–B☆ ○○

□□
62 : Model αM6/3000
63 : Model αM9/3000

☆
0 : Taper shaft (standard)
1 : Taper shaft with the brake (8Nm)
5 : Straight shaft
6 : Straight shaft with the brake (8Nm)

○○
75 : Pulse coder αA64
77 : Pulse coder αI64
88 : Pulse coder αA1000

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

Models
αM22/3000, αM30/3000

A06B–01□□–B☆ ○○

□□

- **65** : Model αM22/3000
- **66** : Model αM30/3000

☆

- **0** : Taper shaft (standard)
- **1** : Taper shaft with the brake (35Nm)
- **5** : Straight shaft
- **6** : Straight shaft with the brake (35Nm)

○○

- **75** : Pulse coder αA64
- **77** : Pulse coder αI64
- **88** : Pulse coder αA1000

The standard shafts used for αM22/3000 and αM30/3000 are straight shafts. Use a taper shaft as far as circumstances, such as the delivery time and maintenance, permit.

Models
αM40/3000 and
αM40/3000 with FAN

A06B–01□□–B☆ ○○

□□

- **69** : Model αM40/3000
- **70** : Model αM40/3000 with fan

☆

- **0** : Straight shaft (standard)
- **1** : Straight shaft with the brake (35Nm)

○○

- **75** : With the pulse coder αA64
- **77** : With the pulse coder αI64
- **88** : With the pulse coder αA1000

For these models, a tapered shaft is not available.

3 SPECIFICATIONS AND CHARACTERISTICS

3.1 TYPES OF MOTORS AND SPECIFICATIONS

Item	Unit	αM2/3000	αM2.5/3000	αM6/3000
Output	kw	0.5	0.5	1.4
	HP	0.7	0.7	1.9
Rated torque at stall	Nm	2	2.5	6.0
	kgf·cm	20	26	61
Rating rotation speed	min^{-1}	3000	3000	3000
Rotor inertia	$kg·m^2$	0.00026	0.00051	0.0013
	$kgf·cm·s^2$	0.0027	0.0052	0.014
Mass	kg	2.8	4.3	8

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

Item	Unit	αM9/3000	αM22/3000	αM30/3000	αM40/3000	αM40/3000 with fan
Output	kw	1.8	3.8	3.8	3.0	10
	HP	2.4	5.1	5.1	4.1	14
Rated torque at stall	Nm	9.0	20	30	40	70
	kgf·cm	92	204	306	408	714
Rating rotation speed	min^{-1}	3000	3000	2000 (S1) 3000 (S3–60%)	1000	2000
Rotor inertia	$kg·m^2$	0.0025	0.0058	0.011	0.012	0.012
	$kgf·cm·s^2$	0.026	0.059	0.11	0.12	0.12
Mass	kg	12	18	30	41	43

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

3.2 CHARACTERISTIC CURVE AND DATA SHEET

Speed–torque characteristics

The intermittent operation zone is determined by the input voltage applied to the drive amplifier. The curve shown is the value for the rated input voltage (200V).

“Intermittent operating zone (S3)” in the speed-torque characteristics refers to the intermittent cycle operating zone in the IEC34-1 standard. In this zone, ON operation of six minutes and OFF operation of four minutes in a 10-minute cycle is possible.

On models αM40/3000 and αM40/3000 with fan “Intermittent operating (S3–25%)” in the “Speed–torque characteristics is permitting operating zone in IEC34–1, and it enables to operate 2.5min ON and 7.5min OFF in 10min cycle time.

Equally, (S3–60%)” in the “Speed–torque characteristics enables to operate 6min ON and 4min OFF in 10min cycle time.

On models αM2 to M9, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item.

Overload duty characteristic

The overload duty characteristic curves are determined based on the temperature restriction for the single motor unit (the temperature is restricted by means of a thermal trip built into the motor). The curves are determined by assuming that the temperature increases gradually under certain overload conditions. Therefore, the curves do not apply to the rapid temperature rise which occurs, for example, when the motor shaft is locked. (An overcurrent flows in the motor windings until the thermal trip operates. The temperature rises momentarily.)

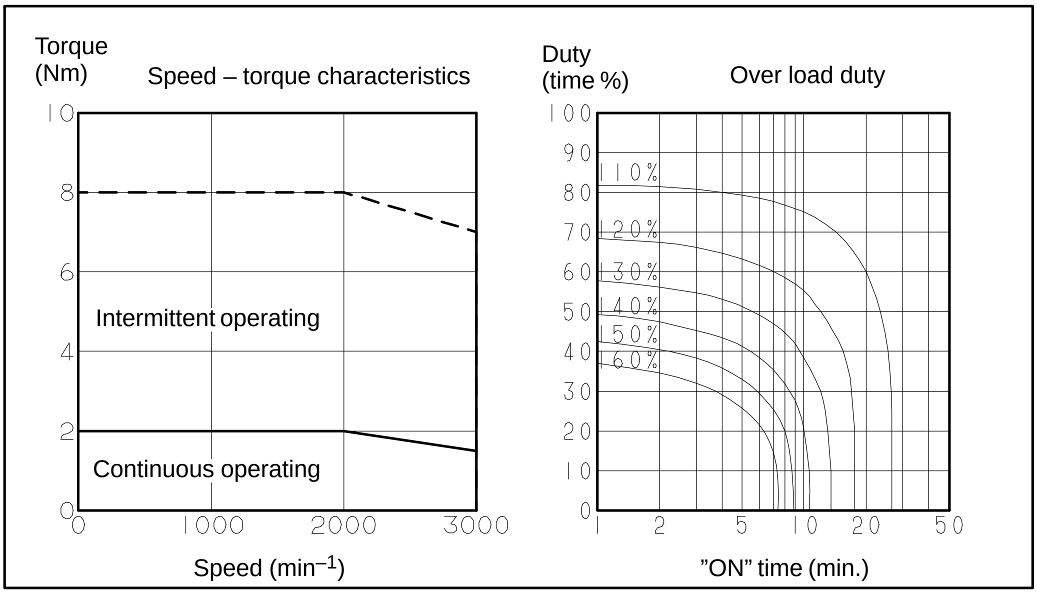
To detect such an abrupt temperature rise, the FANUC digital servo system provides a software thermal function that uses servo software to observe the current. During operation that is characterized by frequent acceleration/deceleration cycles, control is imposed by the software thermal function.

Driving units (such as amplifiers) and built–in detectors contain their own overheating protection devices. Therefore, note that control may be imposed according to how the equipment is being used.

Data sheet

The parameters given in the data sheet are representative values for an ambient temperature of 20°C. They are subject to an error of ±10%.
The indicated logical values are threshold values for the single motor unit (when the motor is not restricted by the control system).
The maximum torque that can be produced during acceleration or deceleration in actual use is calculated as the approximate product of the motor torque constant and the current limit value of the amplifier.
This value is for reference only. The actual value will vary depending on changes in the power supply, as well as variations in motor parameters and amplifier limit values.
In some models, if the maximum current flows in the motor, the actual maximum torque is affected by, for example, magnetic saturation. As a result, the actual maximum torque will be lower than the calculated value.
The intermittent operation area (maximum torque value) indicated in the speed to torque characteristics is the effective value, determined according to the combination with the amplifier.

Model αM2/3000 Specification : A06B–0376–B□□□

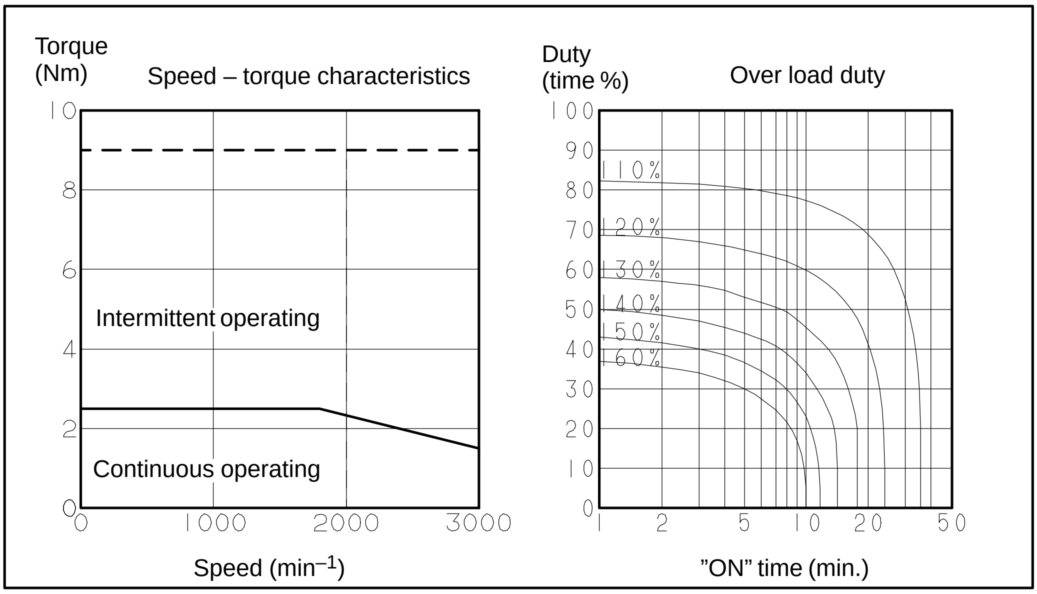


Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	2.0 20			Nm kgfcm
Rotor inertia	Jm	0.00027 0.0028			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	3.0			A (rms)
Torque constant (*)	Kt	0.67 6.8			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	23 0.22			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	1.73			Ω
Mechanical time constant (*)	tm	0.003			s
Thermal time constant	tt	15			min
Static friction	Tf	0.15 1.5			Nm kgfcm
Mass		2.8			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.) These values may be changed without prior notice.
On model αM2, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item

Model αM2.5/3000 Specification : A06B–0377–B□□□



Data sheet

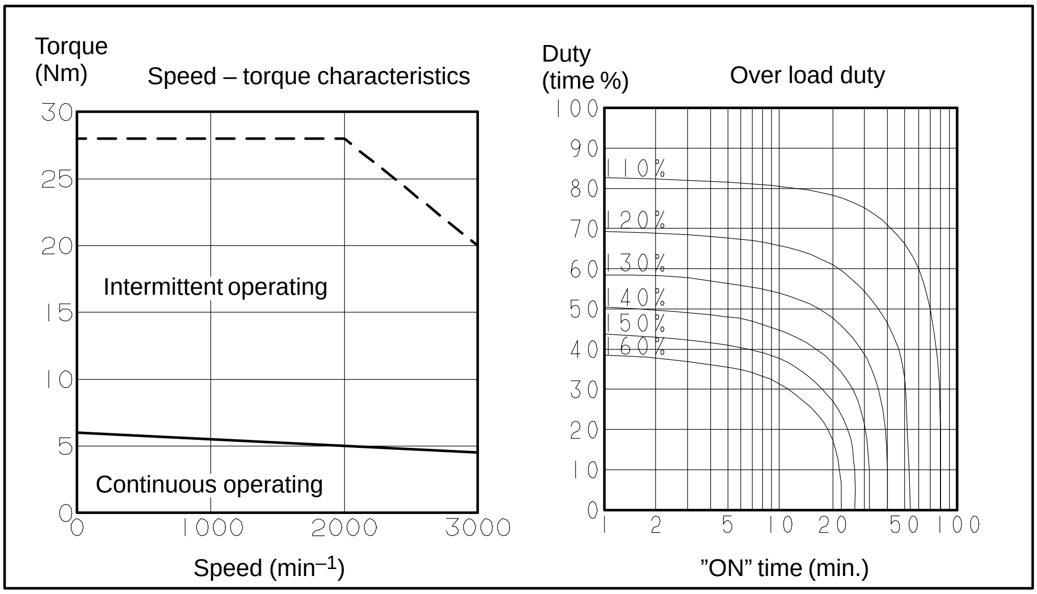
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min $^{-1}$
Rated torque at stall (*)	Ts	2.5 26			Nm kgfcm
Rotor inertia	Jm	0.00052 0.0053			kgm^2 kgfcms^2
Continuous RMS current at stall (*)	Is	3.7			A (rms)
Torque constant (*)	Kt	0.67 6.8			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	23 0.22			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.59			Ω
Mechanical time constant (*)	tm	0.002			s
Thermal time constant	tt	20			min
Static friction	Tf	0.2 2			Nm kgfcm
Mass		4.3			kg

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

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

On model αM2.5, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item

Model αM6/3000 Specification : A06B–0162–B□□□



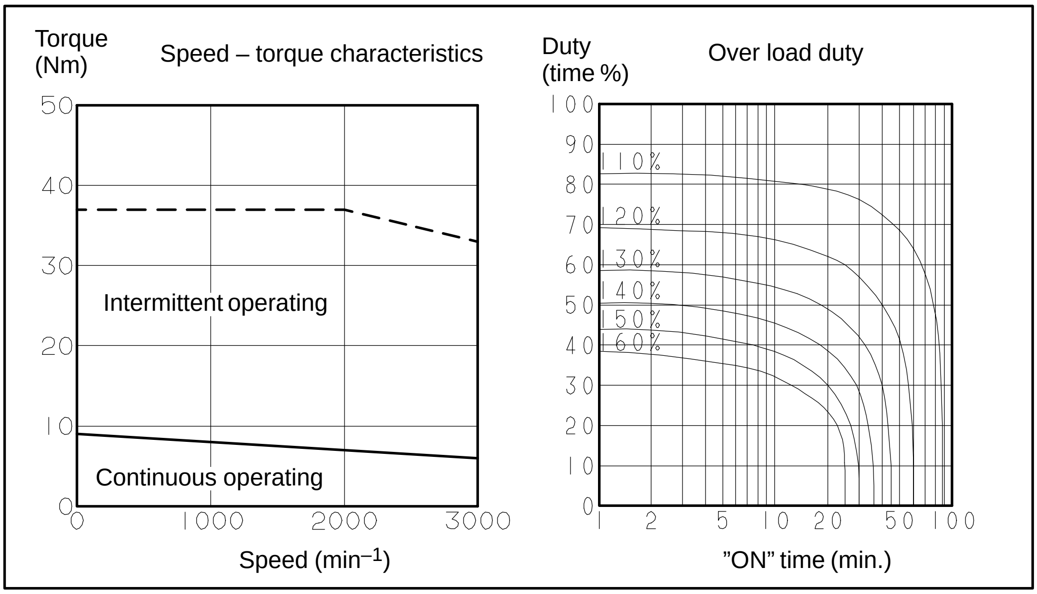
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	6.0 61			Nm kgfcm
Rotor inertia	Jm	0.0013 0.014			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	8.0			A (rms)
Torque constant (*)	Kt	0.75 7.6			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	26 0.25			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.463			Ω
Mechanical time constant (*)	tm	0.003			s
Thermal time constant	tt	45			min
Static friction	Tf	0.3 3			Nm kgfcm
Mass		8			kg

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

Model αM9/3000

Specification : A06B–0163–B□□□

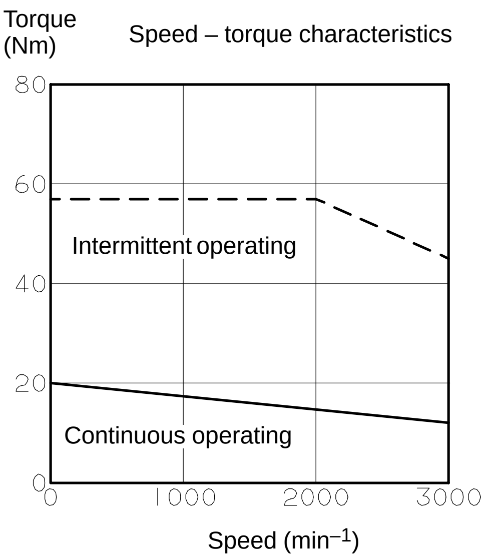


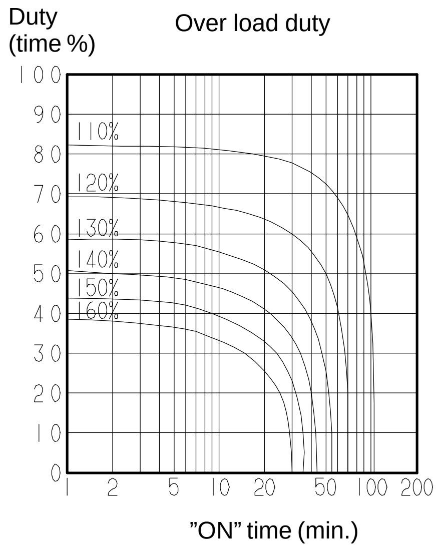
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	9.0 92			Nm kgfcm
Rotor inertia	Jm	0.0025 0.026			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	10.4			A (rms)
Torque constant (*)	Kt	0.86 8.8			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	30 0.29			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.181			Ω
Mechanical time constant (*)	tm	0.002			s
Thermal time constant	tt	50			min
Static friction	Tf	0.3 3			Nm kgfcm
Mass		12			kg

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

Model αM22/3000 Specification : A06B–0165–B□□□



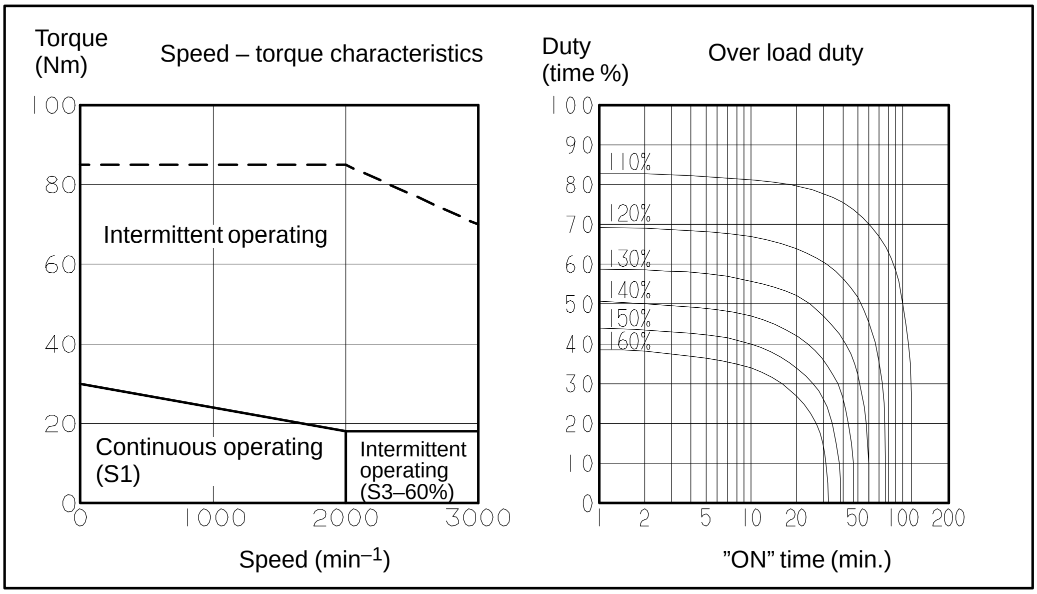


Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min $^{-1}$
Rated torque at stall (*)	Ts	20 204			Nm kgfcm
Rotor inertia	Jm	0.0058 0.059			kgm^2 kgfcms^2
Continuous RMS current at stall (*)	Is	26.5			A (rms)
Torque constant (*)	Kt	0.75 7.7			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	26 0.25			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.07			Ω
Mechanical time constant (*)	tm	0.002			s
Thermal time constant	tt	60			min
Static friction	Tf	0.8 8			Nm kgfcm
Mass		18			kg

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

Model αM30/3000 Specification : A06B–0166–B□□□



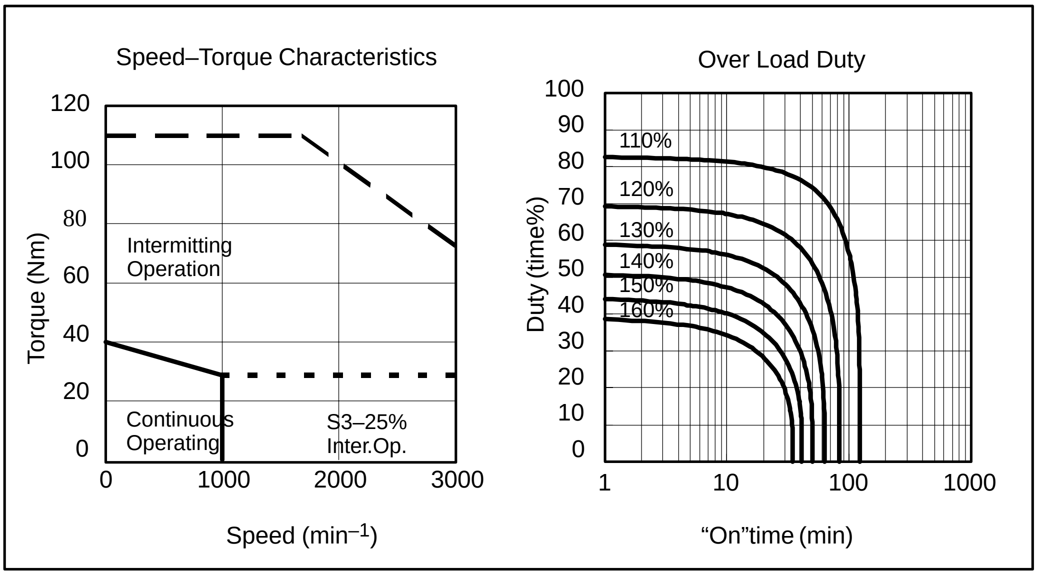
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000 (S1) 3000 (S3–60%)			min^{-1}
Rated torque at stall (*)	Ts	30 306			Nm kgfcm
Rotor inertia	Jm	0.011 0.11			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	27.9			A (rms)
Torque constant (*)	Kt	1.08 11.0			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	38 0.36			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.05			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	65			min
Static friction	Tf	1.2 12			Nm kgfcm
Mass		30			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.) These values may be changed without prior notice.
The 2000 to 3000 rpm range of this servo motor is the intermittent operation range, and is used mainly for positioning. In the intermittent operation range (S3 to 60%), ON operation of six minutes and OFF operation of four minutes in a 10-minute cycle is possible.

Model αM40/3000

Specification : A06B–0169–B□□□

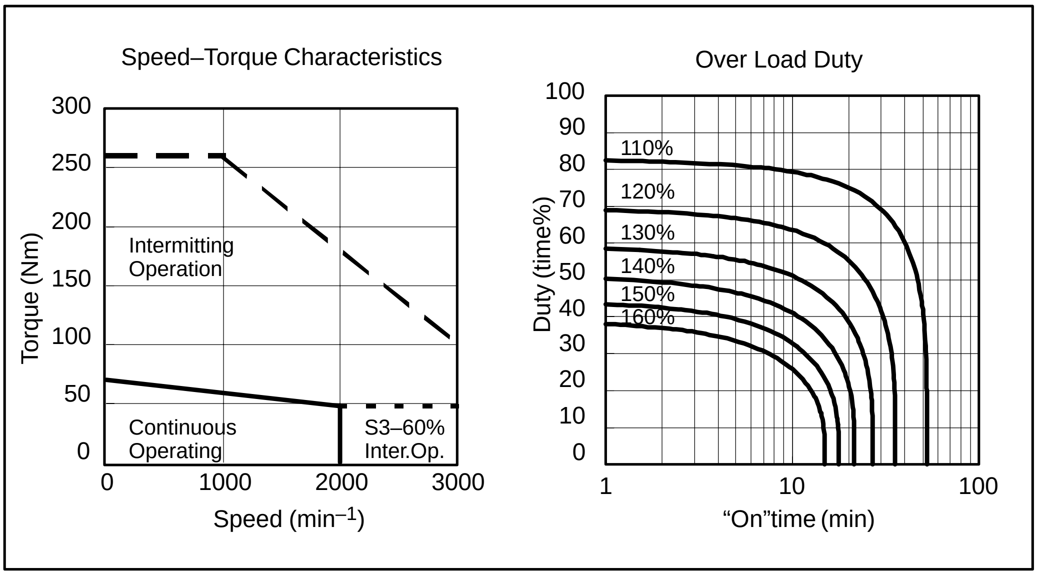


Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	1000			min $^{-1}$
Rated torque at stall (*)	Ts	40 408			Nm kgfcm
Rotor inertia	Jm	0.012 0.12			kgm^2 kgfcms^2
Continuous RMS current at stall (*)	Is	32.3			A (rms)
Torque constant (*)	Kt	1.24 12.6			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	43 0.41			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.05			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	70			min
Static friction	Tf	1.8 18			Nm kgfcm
Weight		41			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
S3 to 25% intermittent operating zone shows 2.5 min continuous operating zone in 10 min cycle.

Model αM40/3000FAN Specification : A06B–0170–B□□□



Data sheet

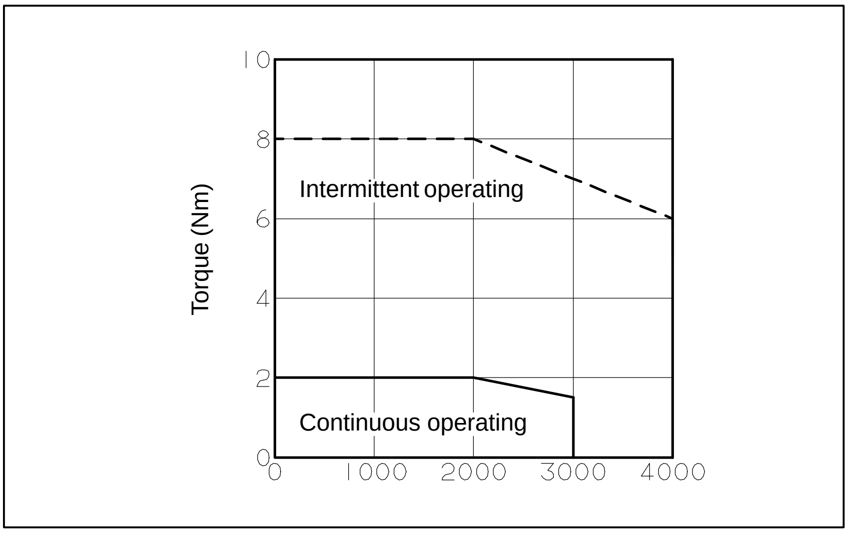
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000			min $^{-1}$
Rated torque at stall (*)	Ts	70 714			Nm kgfcm
Rotor inertia	Jm	0.012 0.12			kgm^2 kgfcms^2
Continuous RMS current at stall (*)	Is	56.5			A (rms)
Torque constant (*)	Kt	1.24 12.6			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	43 0.41			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.05			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	30			min
Static friction	Tf	1.8 18			Nm kgfcm
Weight		43			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)
S3 to 60% intermitting operating zone shows 6 min continuous operating zone in 10 min cycle.

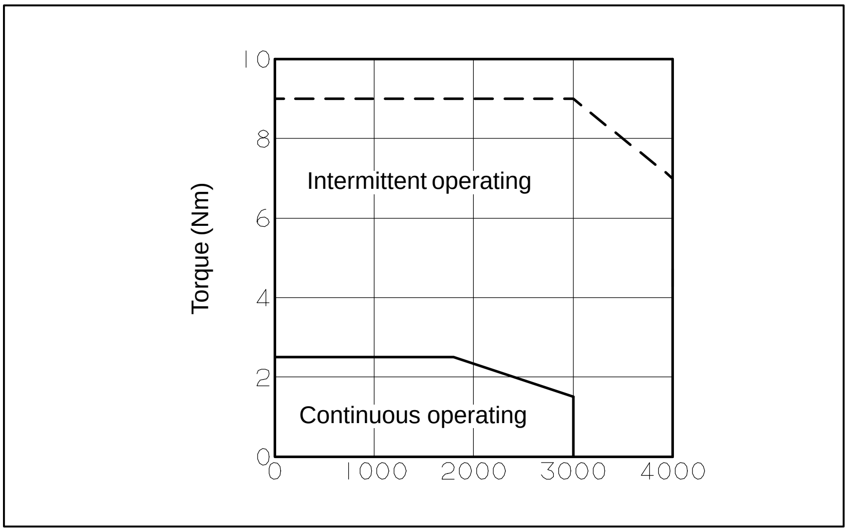
Speed-torque characteristics (HRV control)

On the following models, the intermittent operating zone can be extended by using HRV control.

- **αM2/3000**

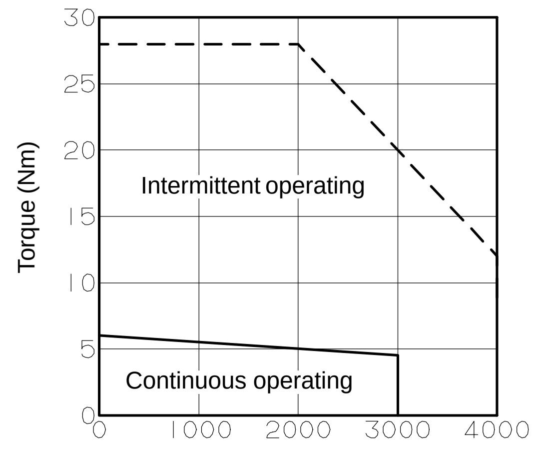


- **αM2.5/3000**

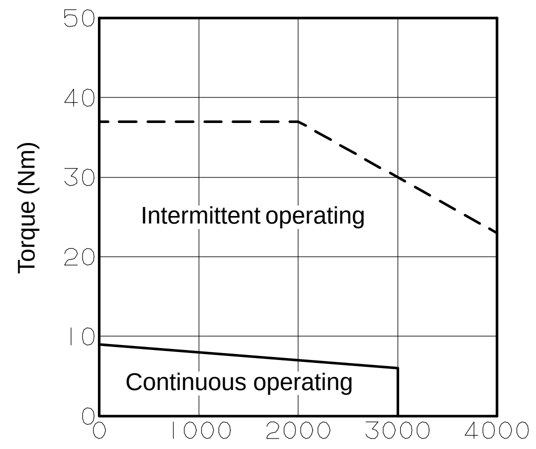


> **NOTE**
> HRV control sometimes cannot be used depending on the CNC system. Using HRV control increases the intermittent operating zone at high motor operating speeds. The continuous operating zone, however, is the same as when conventional control methods are used.

- **αM6/3000**



- **αM9/3000**

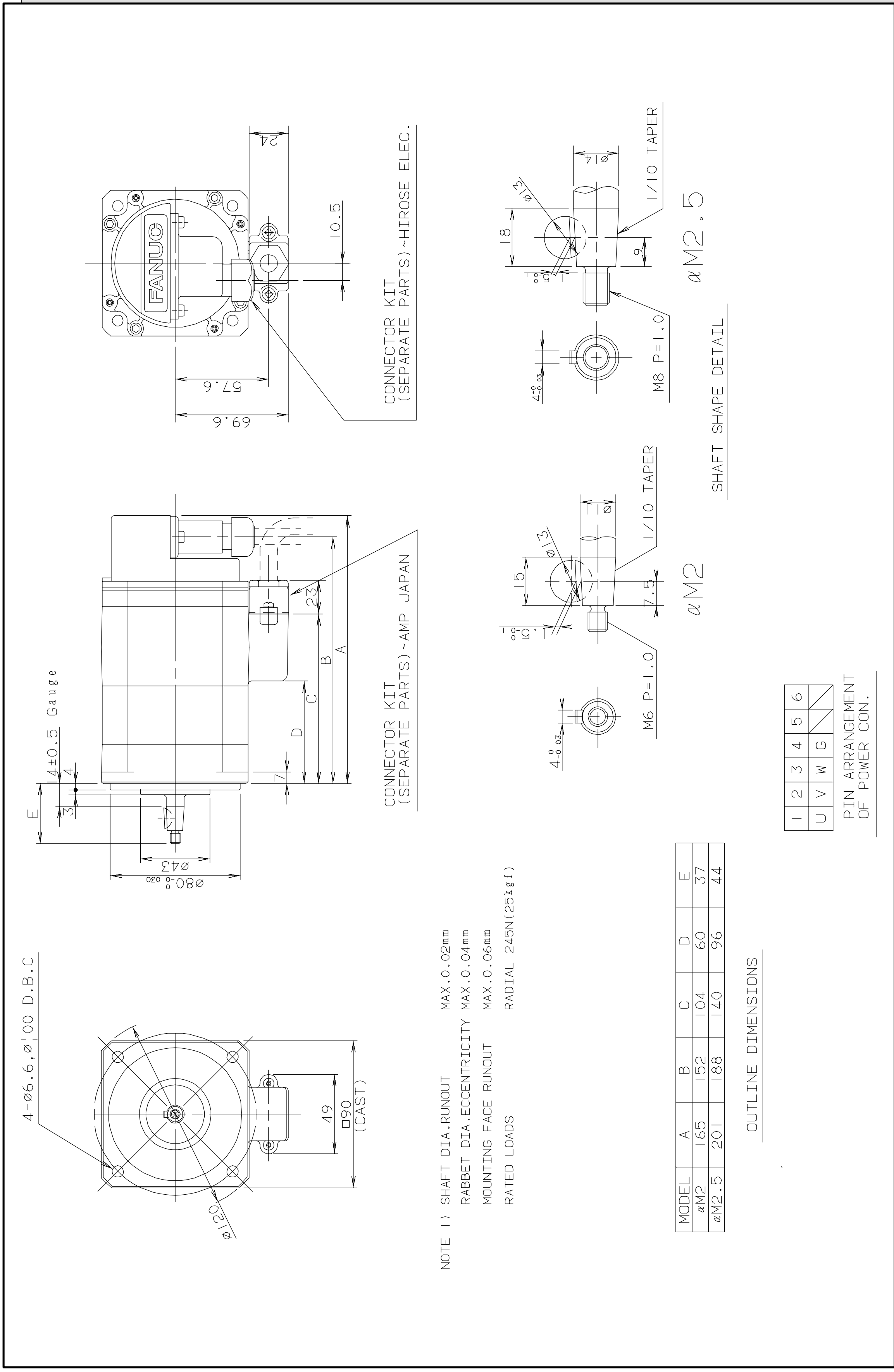


NOTE
HRV control sometimes cannot be used depending on the CNC system. Using HRV control increases the intermittent operating zone at high motor operating speeds. The continuous operating zone, however, is the same as when conventional control methods are used.

3.3 OUTLINE DRAWINGS

Model	Fig. No.
Models αM2/3000 and αM2.5/3000 (standard)	Fig. 3.3 (a)
Models αM2/3000 and αM2.5/3000 (with the brake)	Fig. 3.3 (b)
Model αM2/3000 (shaft option)	Fig. 3.3 (c)
Model αM2.5/3000 (shaft option)	Fig. 3.3 (d)
Models αM6/3000 and αM9/3000 (standard)	Fig. 3.3 (e)
Models αM6/3000 and αM9/3000 (with the brake)	Fig. 3.3 (f)
Model αM6/3000 (shaft option)	Fig. 3.3 (g)
Model αM9/3000 (shaft option)	Fig. 3.3 (h)
Models αM22/3000 to αM40/3000 (standard)	Fig. 3.3 (i)
Models αM22/3000 to αM40/3000 (with the brake)	Fig. 3.3 (j)
Models αM22/3000 to αM40/3000 (shaft option)	Fig. 3.3 (k)
Model αM40/3000 (with fan)	Fig. 3.3 (l)
Model αM40/3000 (with fan) (with the brake)	Fig. 3.3 (m)

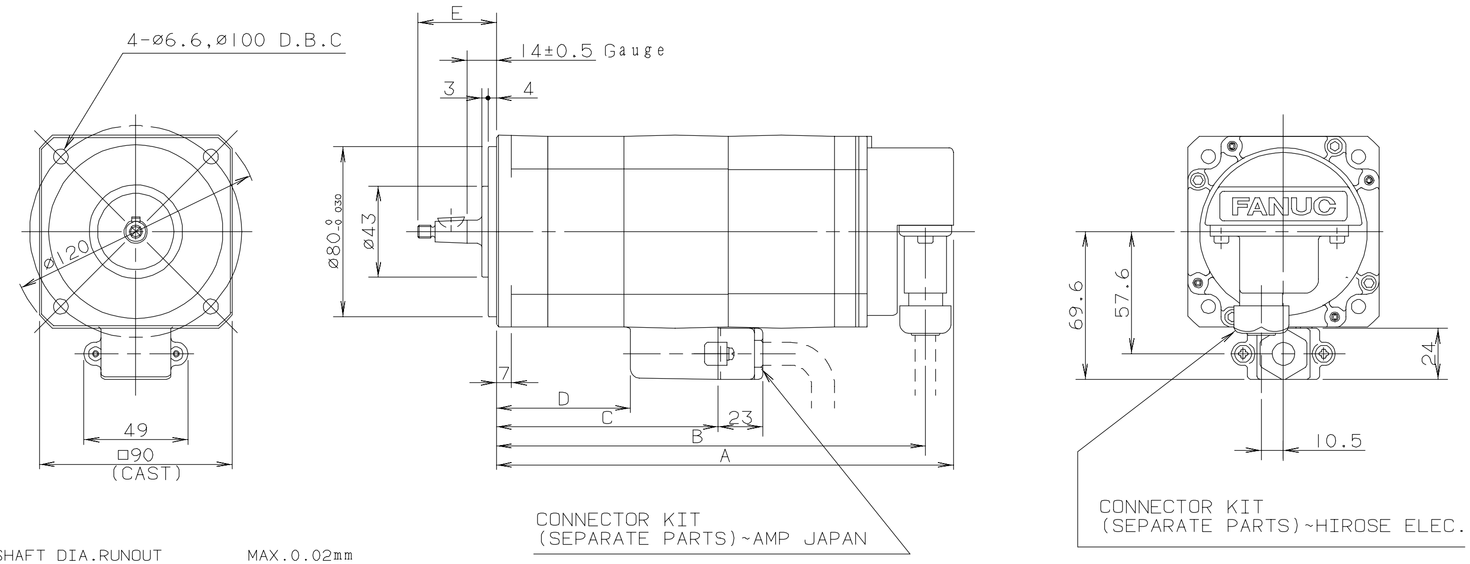
Fig. 3.3 (a) Models αM2/3000 and αM2.5/3000 (standard)



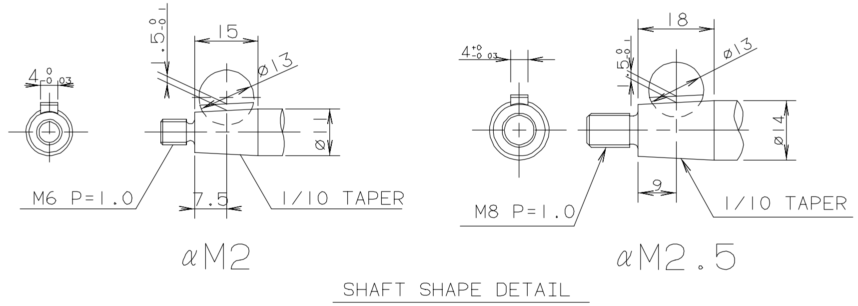
MODEL	A	B	C	D	E
αM2	165	152	104	60	37
αM2.5	201	188	140	96	44

1	2	3	4	5	6
U	V	W	G		

Fig. 3.3 (b) Models αM2/3000 and αM2.5/3000 (with the brake)



NOTE 1) SHAFT DIA.RUNOUT MAX.0.02mm
RABBET DIA.ECCENTRICITY MAX.0.04mm
MOUNTING FACE RUNOUT MAX.0.06mm
RATED LOADS RADIAL 245N(25kgf)



MODEL	A	B	C	D	E
αM2	215	202	104	60	37
αM2.5	251	238	140	96	44

OUTLINE DIMENSIONS

BRAKE SPECIFICATION

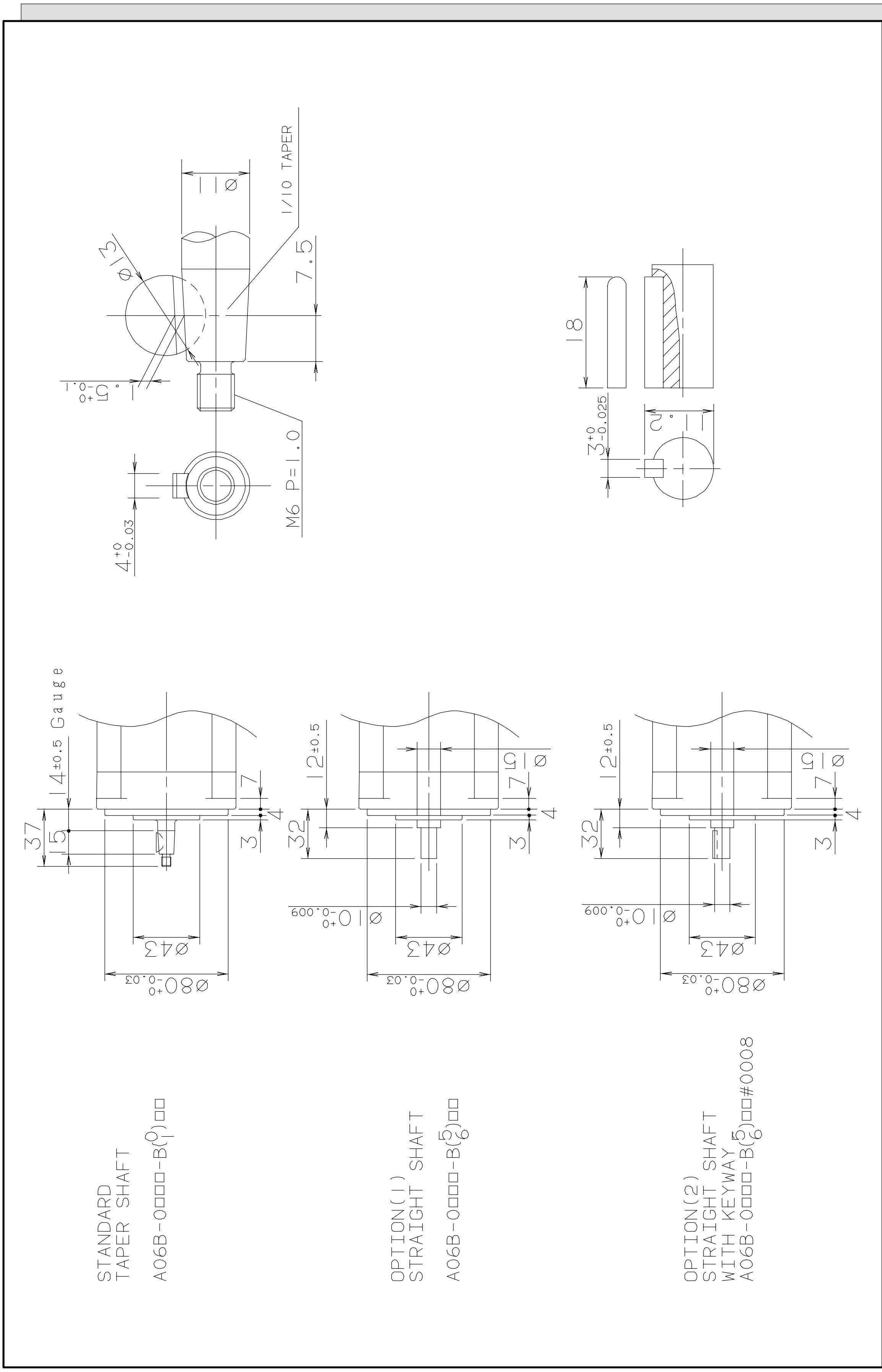
BRAKE TORQUE	20kgcm
POWER SUPPLY	DC90V
RATED CURRENT	LESS THAN 0.2A

SURGE ABSORBER IS NOT INCLUDED
WITH MOTOR. PREPARE TO POWER SUPPLY.
(SPEC. A70L-0001-0015/20DK221;
MATSUSITA ELEC.)

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

PIN ARRANGEMENT OF POWER CON.

Fig. 3.3 (c) Model αM2/3000 (shaft option)



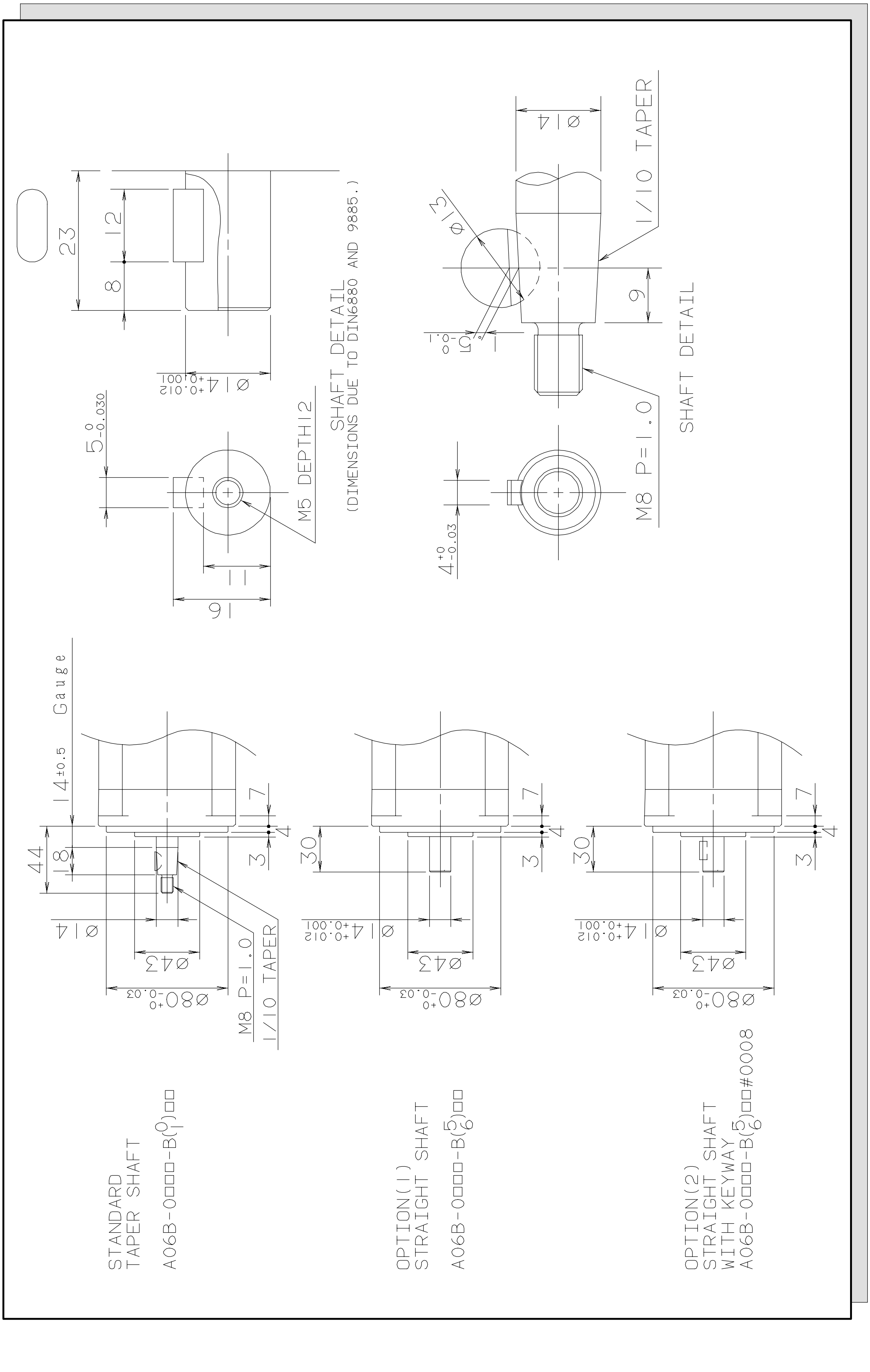


Fig. 3.3 (d) Model αM2.5/3000 (shaft option)

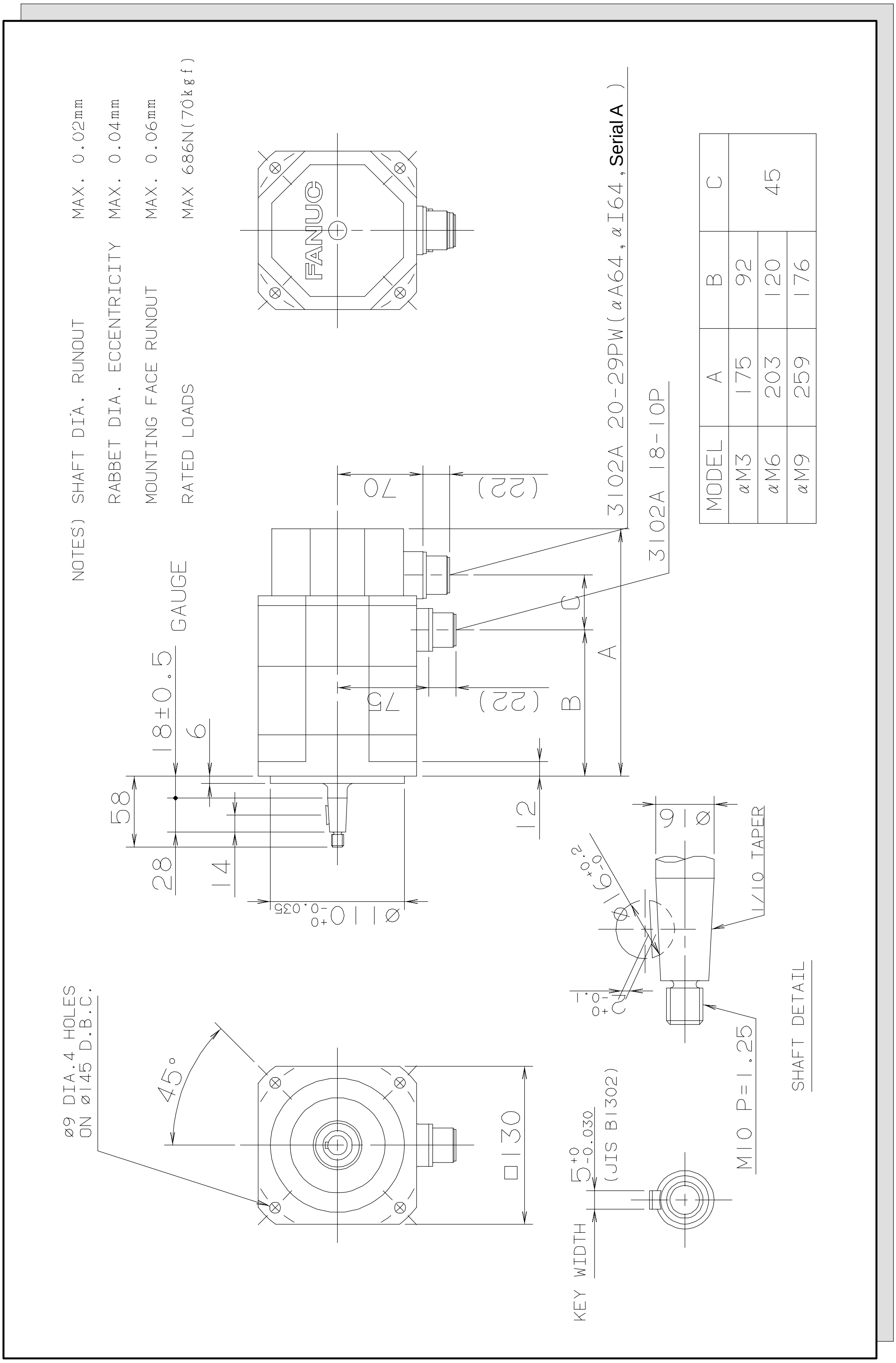
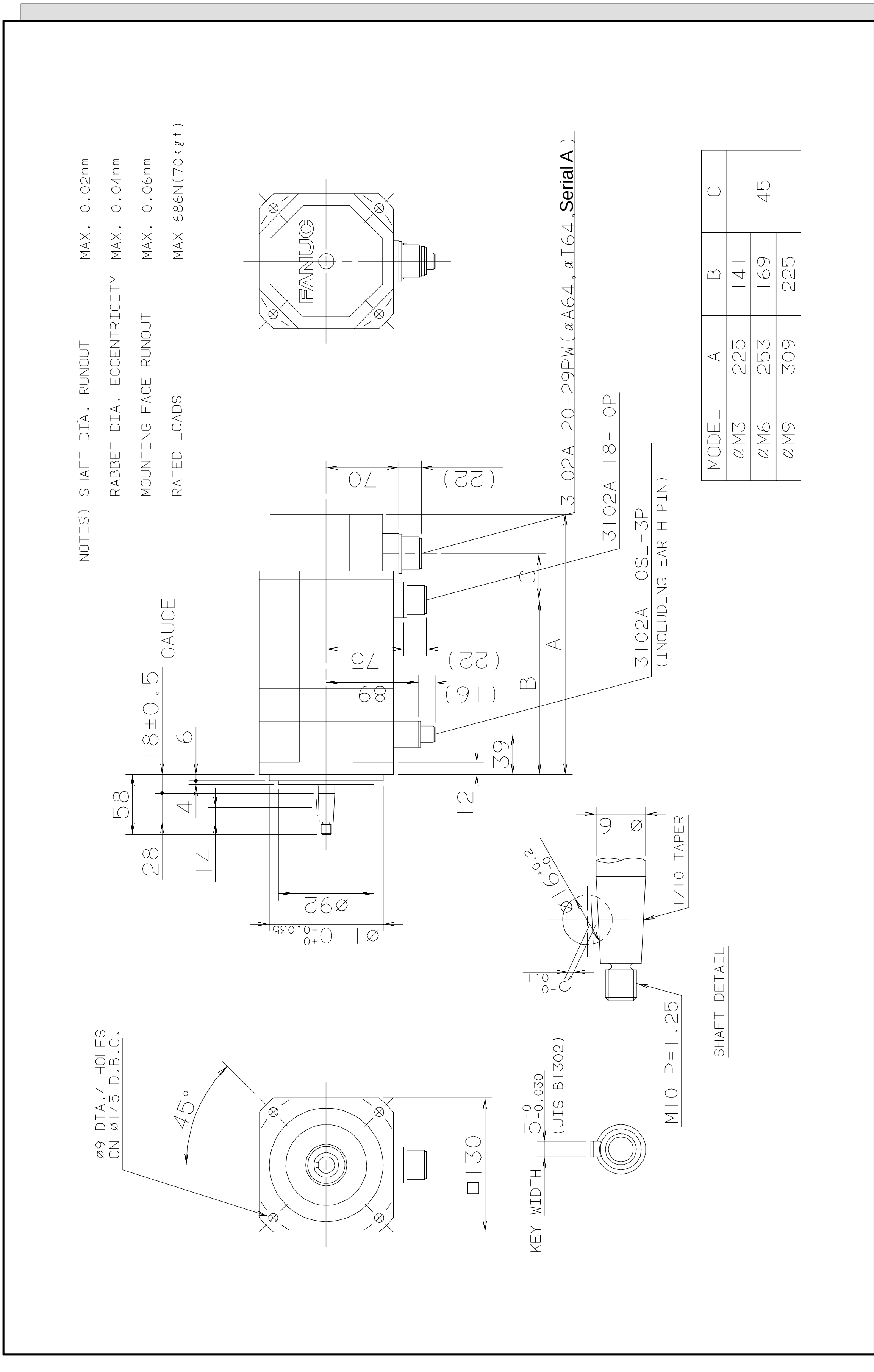


Fig. 3.3 (e) Models αM6/3000 and αM9/3000 (standard)

Fig. 3.3 (f) Models αM6/3000 and αM9/3000 (with the brake)



MODEL	A	B	C
αM3	225	141	45
αM6	253	169	
αM9	309	225	

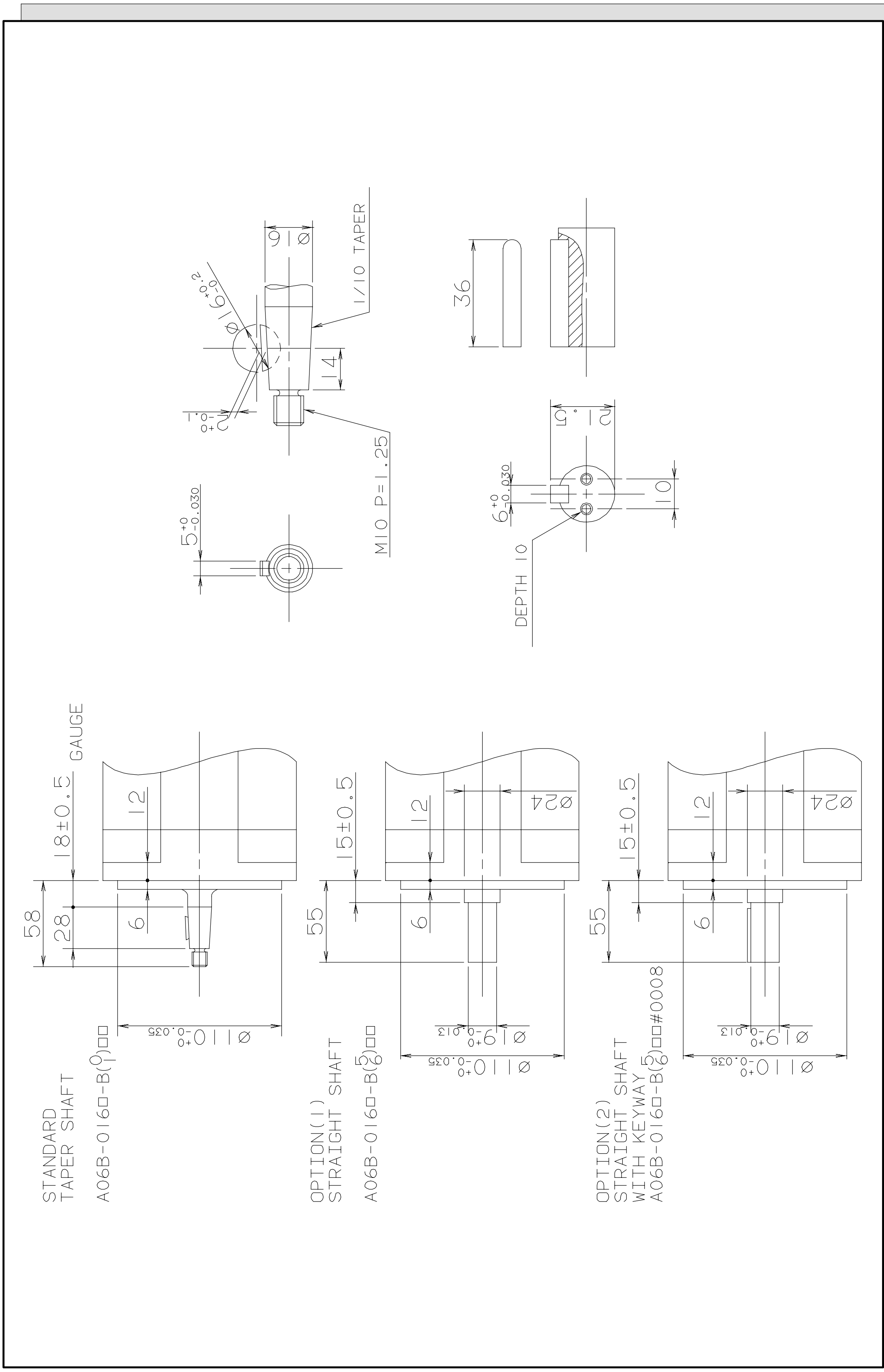


Fig. 3.3 (g) Models αM6/3000 (shaft option)

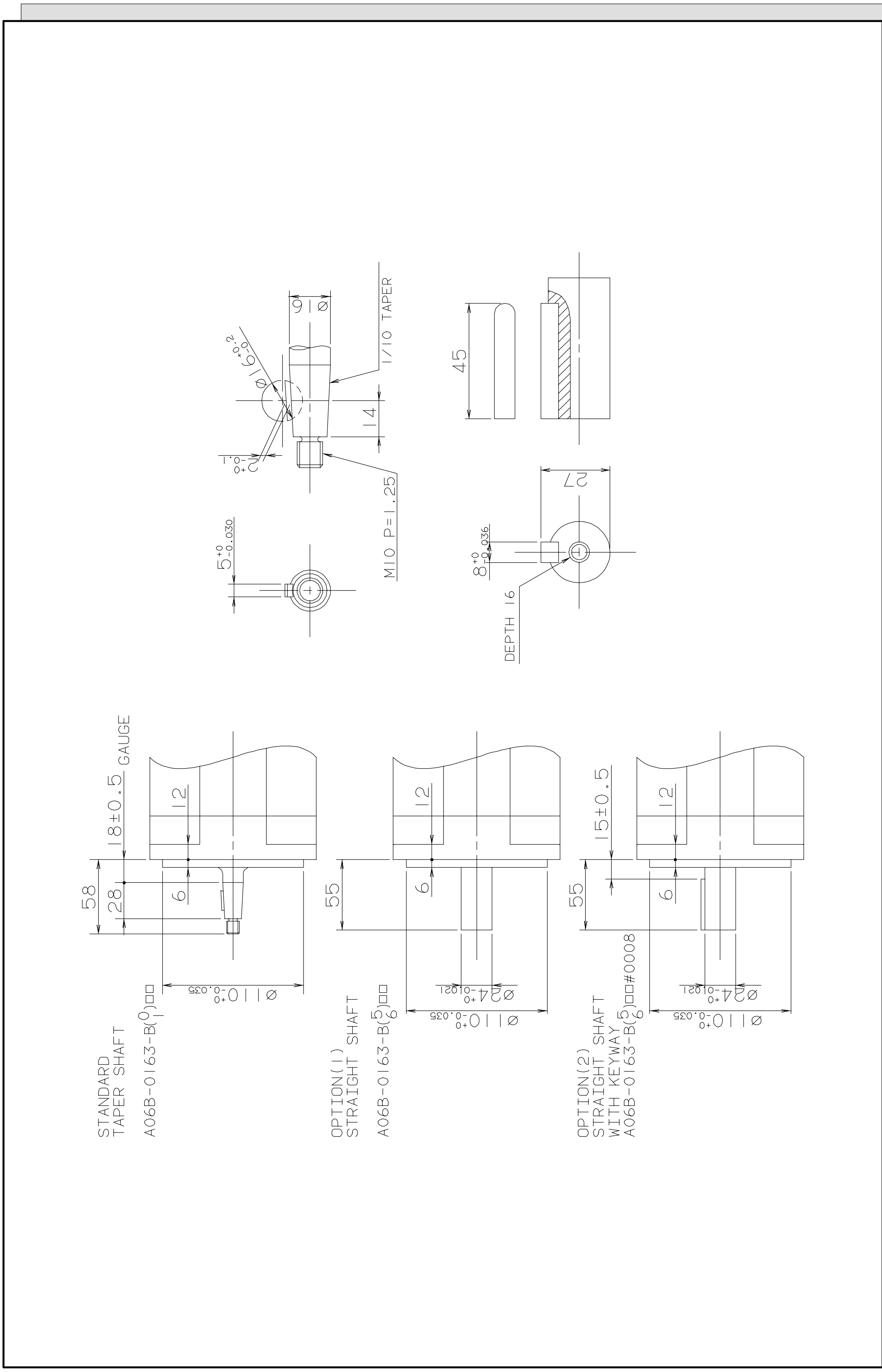
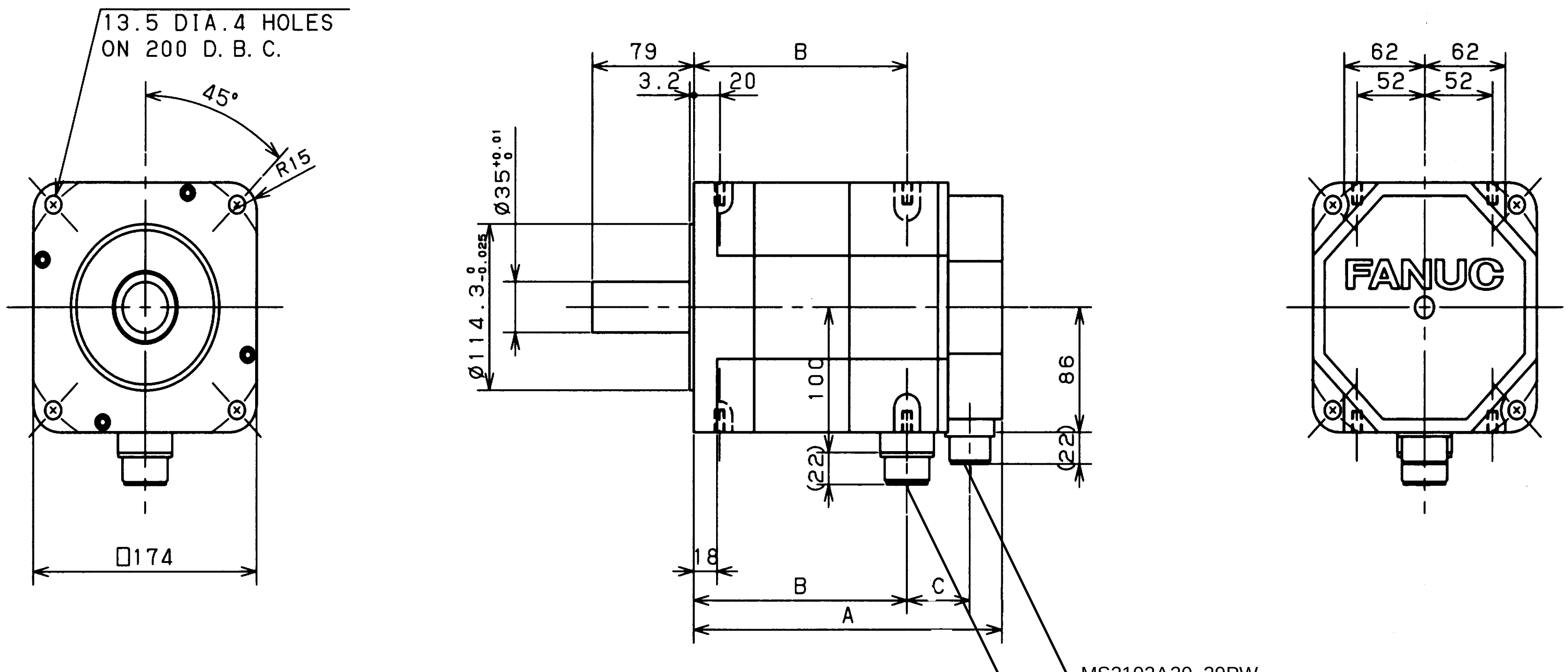


Fig. 3.3 (h) Model αM9/3000 (shaft option)

Fig. 3.3 (i) Models αM22/3000 to αM40/3000 (standard)



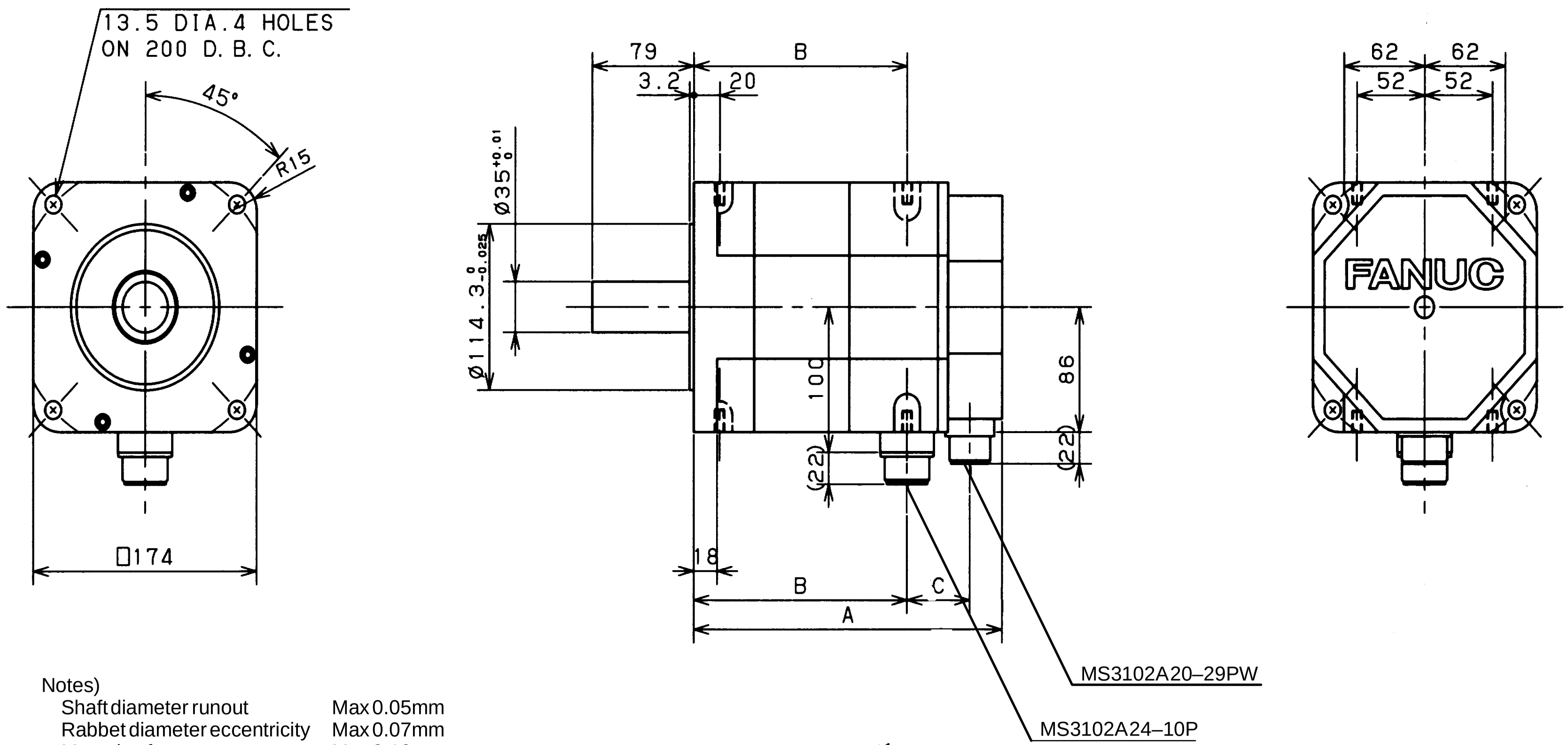
Notes)

Shaft diameter runout	Max 0.05mm
Rabbet diameter eccentricity	Max 0.07mm
Mounting face runout	Max 0.10mm
Rated load	4410N(450kgf)

Taps for eyebolt : M8 depth 15^{+1}
Eyebolts are not attached

MODEL	A	B	C
αM22	240	166	49
αM30	314	240	
αM40	388	314	

Fig. 3.3 (j) Models αM22/3000 to αM40/3000 (with the brake)



Notes)

Shaft diameter runout	Max 0.05mm
Rabbet diameter eccentricity	Max 0.07mm
Mounting face runout	Max 0.10mm
Rated load	4410N(450kgf)

Taps for eyebolt : M8 depth 15^{+1}
Eyebolts are not attached

MODEL	A	B	C
αM22	240	166	49
αM30	314	240	
αM40	388	314	

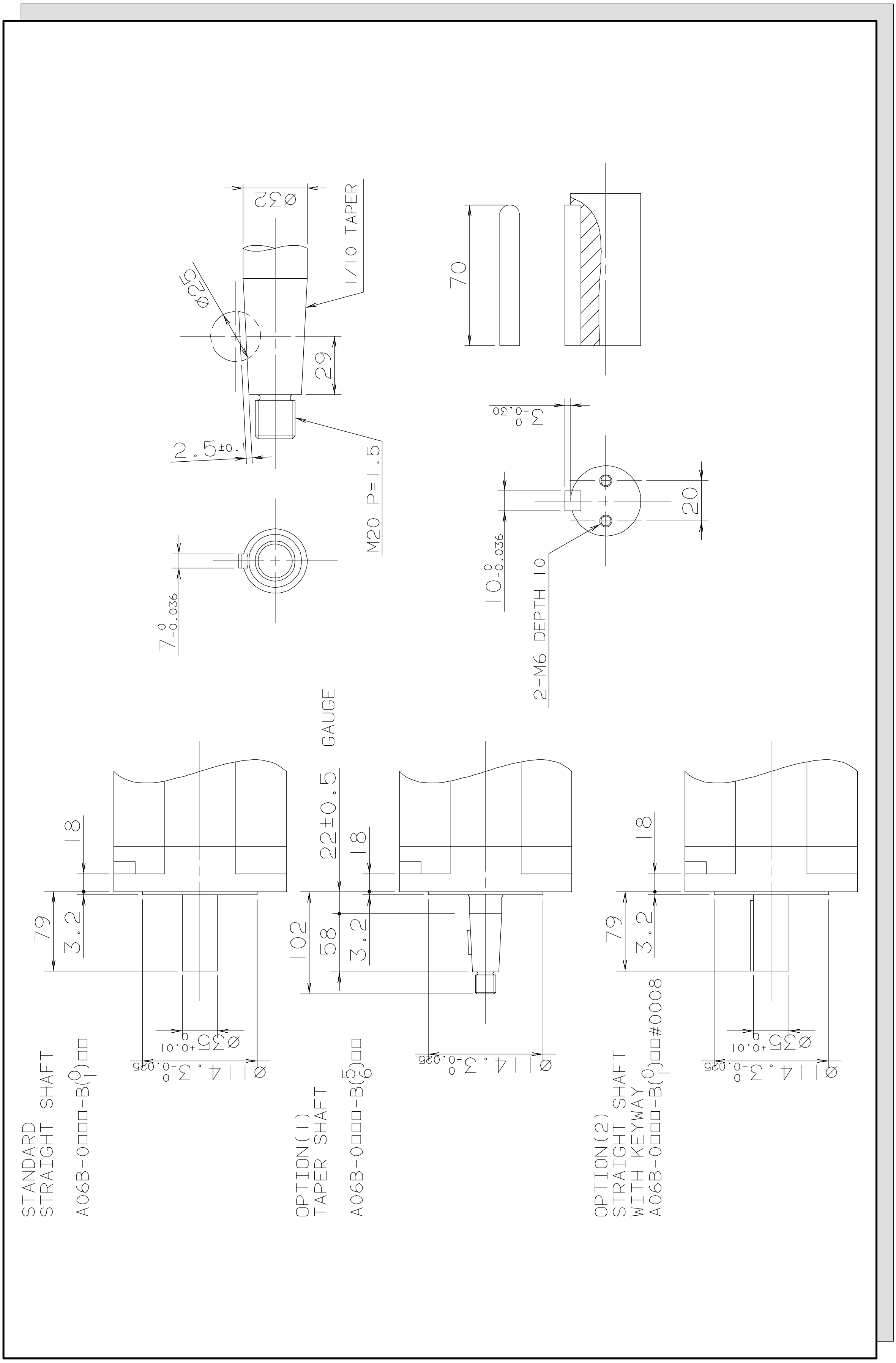
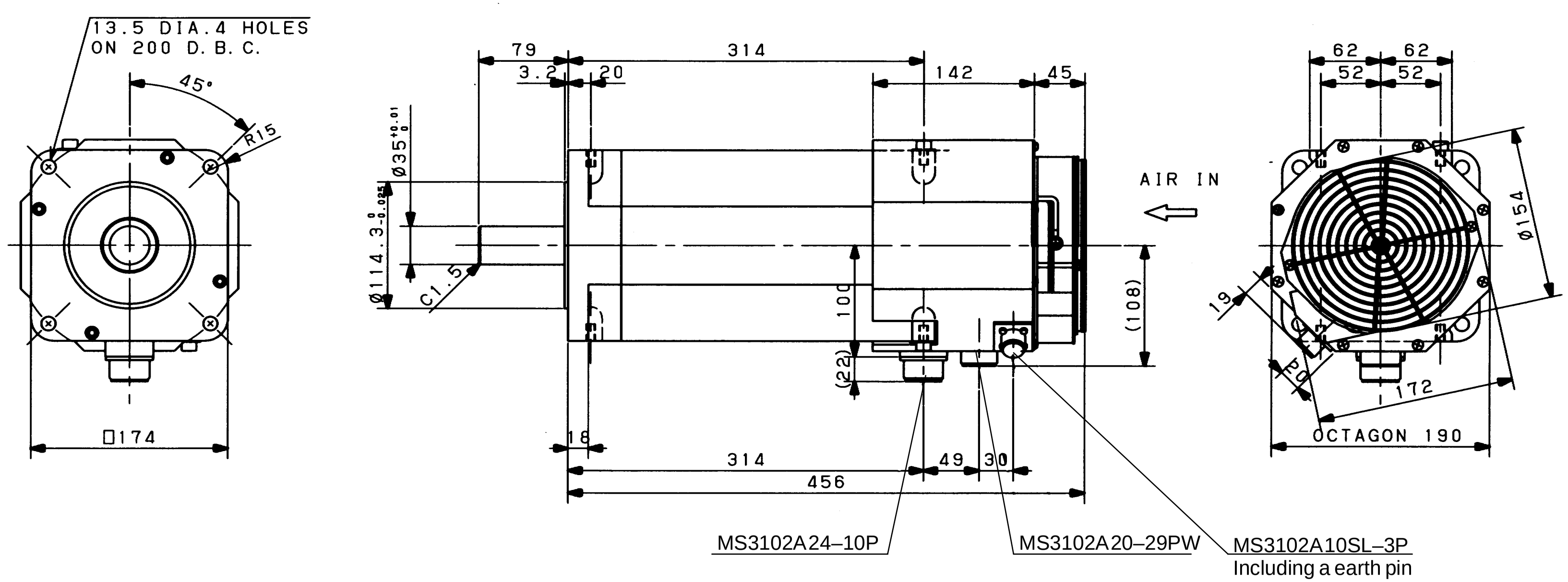


Fig. 3.3 (k) Models αM22/3000 to αM40/3000 (shaft option)

Fig. 3.3 (l) Model αM40/3000 (with fan)



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

Taps for eyebolt : M8 depth 15^{+1}
Eyebolts are not attached
No weight more than 100kg
No acceleration more than 1G
Direction of the air flow is downward only

Fan Motor Specification

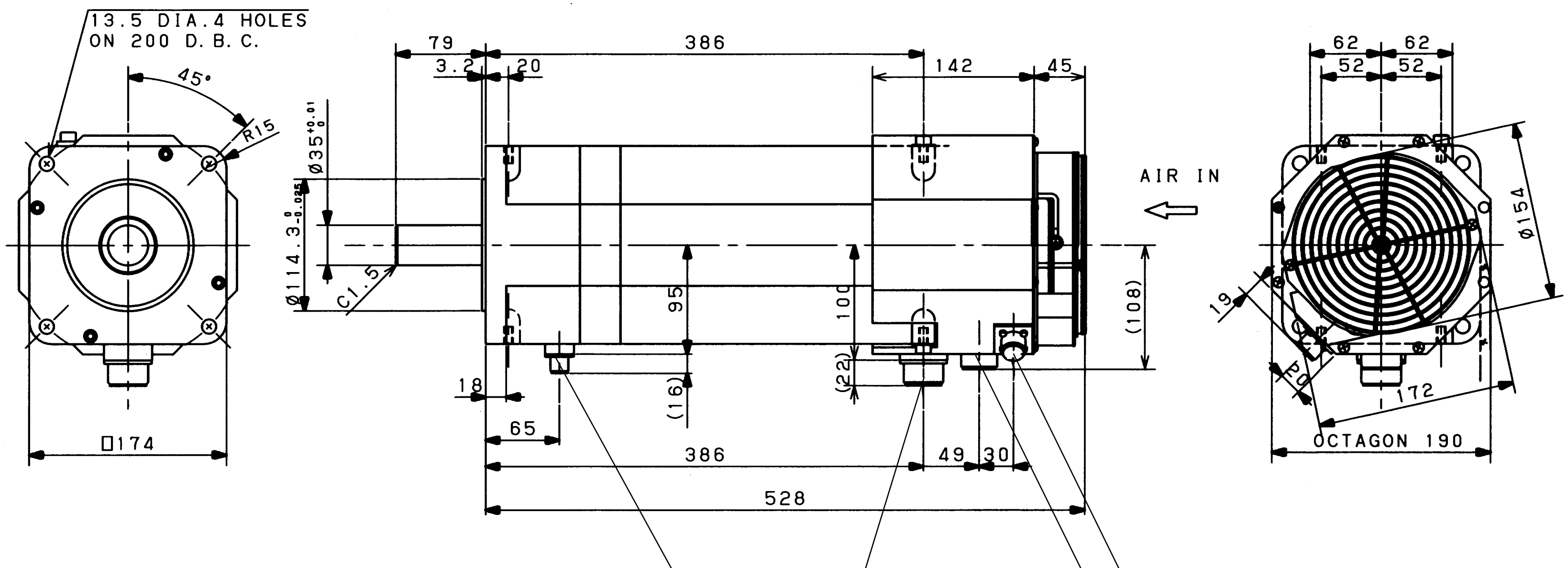
Input Voltage	200 V	
Frequency	50 Hz	60 Hz
Input	40 W	40 W
Speed	2700 min^{-1}	2900 min^{-1}

This chart is spec. for one fan motor.
Prepare a protect fuse in power supply.

Fan Connector

Pin	Note
A	Single phase 200VAC
B	
C	Earth

Fig. 3.3 (m) Models αM40/3000 (with fan) (with the brake)



Notes)

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

Taps for eyebolt : M8 depth 15^{+1}
Eyebolts are not attached
No weight more than 100kg
No acceleration more than 1G
Direction of the air flow is downward only

Fan Motor Specification

Input Voltage	200 V	
Frequency	50 Hz	60 Hz
Input	40 W	40 W
Speed	2700 min^{-1}	2900 min^{-1}

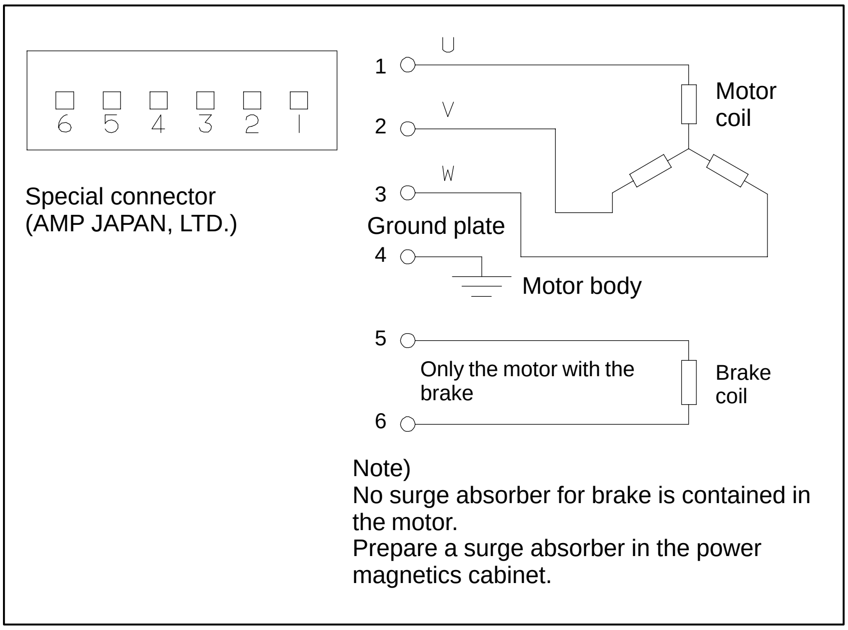
This chart is spec. for one fan motor.
Prepare a protect fuse in power supply.

Fan Connector

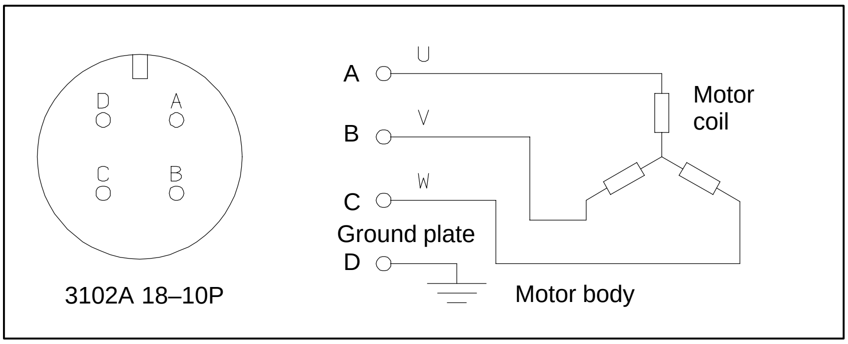
Pin	Note
A	Single phase 200VAC 2 fans in parallel
B	
C	Earth

3.4 CONNECTION OF POWER LINE

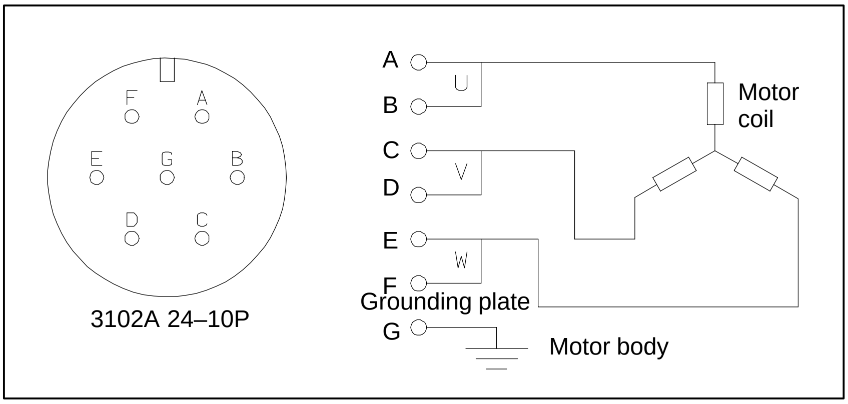
Models αM2/3000, αM2.5/3000



Models αM6/3000, αM9/3000



Models αM22/3000, αM30/3000, αM40/3000, αM40/3000 (with fan)



IV. FANUC AC SERVO MOTOR αL series

1 GENERAL

The FANUC AC servo motor αL series is suitable for high–speed positioning. It has the following features:

Excellent acceleration characteristics

The latest neodymium ferrite magnet is employed, and the rotor inertia is minimized. The result is a motor that offers excellent acceleration.

Excellent waterproofing

The use of waterproof connectors and FANUC's unique stator seal provide excellent waterproofing, ensuring that no liquid, such as coolant, can enter the motor.

Extended continuous–operation

The use of the latest servo software minimizes the heat generated by high–speed rotation, allowing continuous operation over a wide range.

Smooth rotation

Further improvements have been made to the unique magnetic pole shape to minimize torque ripple. The result is extremely smooth rotation.

Controllability

The use of the latest servo software maintains controllability even when a disturbance occurs.

High–performance detector

High–resolution pulse coder αA1000, αA64, αI64 is used in the standard configuration, enabling precise positioning.

Powerful brake

A powerful brake with an increased holding torque is available as an option. The brake uses an asbestos–free design.

The L series models αL6, and αL9, all of which are compatible with series models α3 and α6 in their installation size, and models αL25 and αL50, which are compatible with series models α12 and α22 in their installation size. All these αL series models are compatible with the conventional FANUC AC servo motor αL series in their installation size.

2 TYPES OF MOTORS AND DESIGNATION

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

Models αL3/3000, αL6/3000, and αL9/3000

A06B–05□□–B☆ ○○

□□
- **62** : Model αL6/3000
- **64** : Model αL9/3000

☆
- **0** : Taper shaft (standard)
- **1** : Taper shaft with the brake (8Nm)

○○
- **75** : Pulse coder αA64
- **77** : Pulse coder αI64
- **88** : Pulse coder αA1000

Models αL25/3000 and αL50/2000

A06B–05□□–B☆ ○○

□□
- **71** : Model αL25/3000
- **72** : Model αL50/2000

☆
- **0** : Taper shaft (standard)
- **2** : Taper shaft with the brake (18Nm)
- **3** : Taper shaft with the brake (40Nm)

○○
- **75** : Pulse coder αA64
- **77** : Pulse coder αI64
- **88** : Pulse coder αA1000

3 SPECIFICATIONS AND CHARACTERISTICS

3.1 TYPES OF MOTORS AND SPECIFICATIONS

Item	Unit	αL6/3000	αL9/3000	αL25/3000	αL50/2000
Output	kw	1.4	2.0	3.5	6.0
	HP	1.8	2.7	4.7	8.0
Rated torque at stall	Nm	6.0	9.0	25	50
	kgf·cm	61	92	255	510
Rating rotation speed	min^{-1}	3000	3000	3000	2000
Rotor inertia	kg·m^2	0.00049	0.00098	0.0054	0.0098
	kgf·cm·s^2	0.0050	0.010	0.055	0.10
Mass	kg	11	17	25	42

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

3.2 CHARACTERISTIC CURVE AND DATA SHEET

Speed–torque characteristics

The intermittent operation zone is determined by the input voltage applied to the drive amplifier. The curve shown is the value for the rated input voltage (200V).

On models αL6 to αL9, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item

Overload duty characteristic

The overload duty characteristic curves are determined based on the temperature restriction for the single motor unit (the temperature is restricted by means of a thermal trip built into the motor). The curves are determined by assuming that the temperature increases gradually under certain overload conditions. Therefore, the curves do not apply to the rapid temperature rise which occurs, for example, when the motor shaft is locked. (An overcurrent flows in the motor windings until the thermal trip operates. The temperature rises momentarily.)

To detect such an abrupt temperature rise, the FANUC digital servo system provides a software thermal function that uses servo software to observe the current. During operation that is characterized by frequent acceleration/deceleration cycles, control is imposed by the software thermal function.

Driving units (such as amplifiers) and built–in detectors contain their own overheating protection devices. Therefore, note that control may be imposed according to how the equipment is being used.

Data sheet

The parameters given in the data sheet are representative values for an ambient temperature of 20°C. They are subject to an error of ±10%.

The indicated logical values are threshold values for the single motor unit (when the motor is not restricted by the control system).

The maximum torque that can be produced during acceleration or deceleration in actual use is calculated as the approximate product of the motor torque constant and the current limit value of the amplifier.

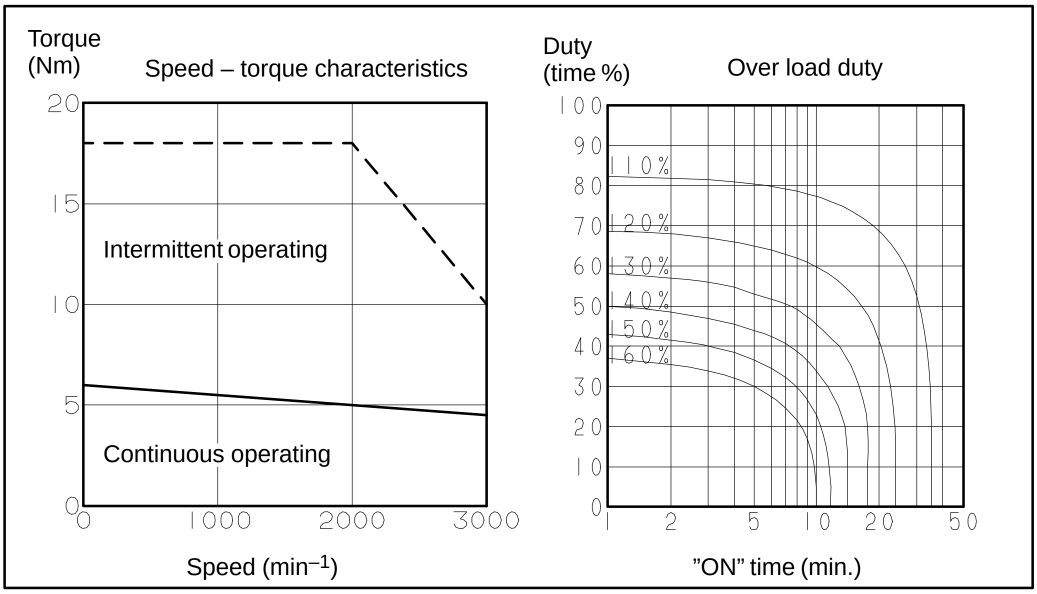
This value is for reference only. The actual value will vary depending on changes in the power supply, as well as variations in motor parameters and amplifier limit values.

In some models, if the maximum current flows in the motor, the actual maximum torque is affected by, for example, magnetic saturation. As a result, the actual maximum torque will be lower than the calculated value.

The intermittent operation area (maximum torque value) indicated in the speed to torque characteristics is the effective value, determined according to the combination with the amplifier.

Model αL6/3000

Specification : A06B–0562–B□□□



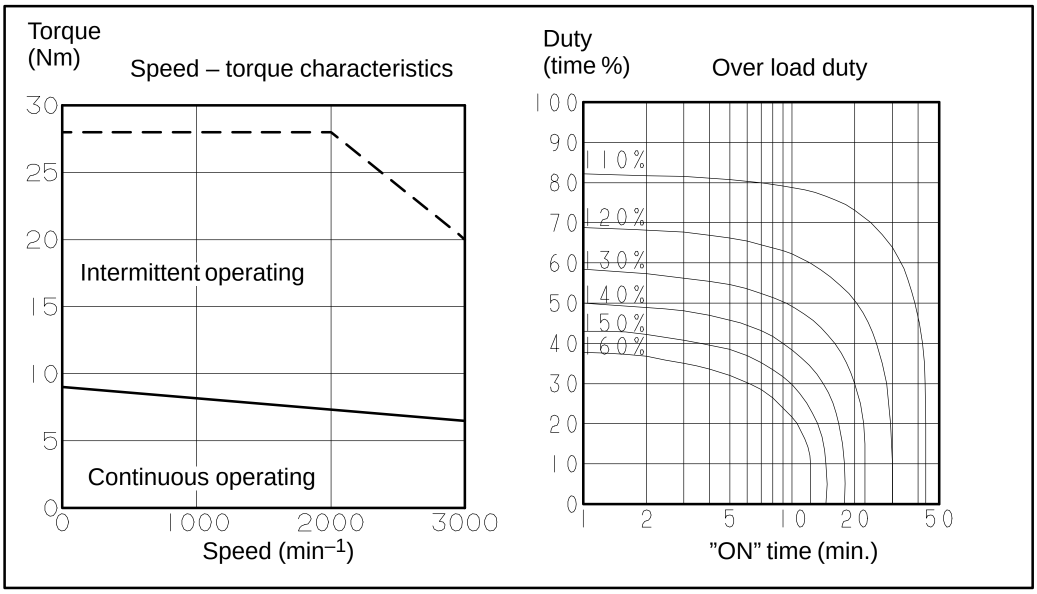
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	6.0 61			Nm kgfcm
Rotor inertia	Jm	0.00049 0.0050			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	11.4			A (rms)
Torque constant (*)	Kt	0.52 5.3			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	18 0.17			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.275			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	25			min
Static friction	Tf	0.5 5			Nm kgfcm
Mass		11			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.) These values may be changed without prior notice.
On model αL6, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item

Model αL9/3000

Specification : A06B–0564–B□□□



Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	9.0 92			Nm kgfcm
Rotor inertia	Jm	0.00098 0.010			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	16.9			A (rms)
Torque constant (*)	Kt	0.52 5.3			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	18 0.17			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.110			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	45			min
Static friction	Tf	0.9 9			Nm kgfcm
Mass		17			kg

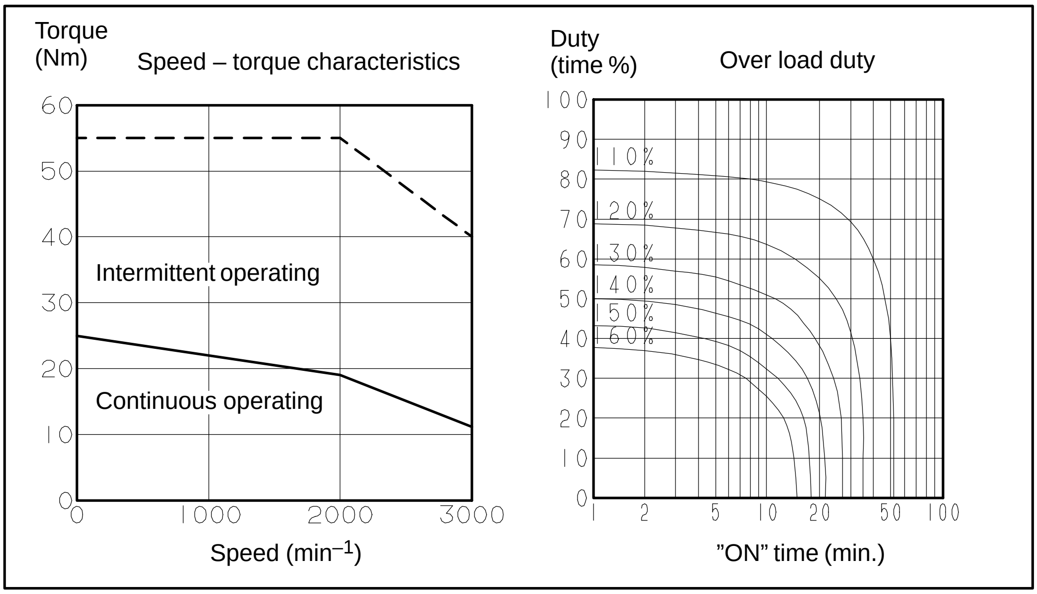
(*) The values are the standard values at 20°C and the tolerance is ±10%.

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

On model αL9, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item

Model αL25/3000

Specification : A06B–0571–B□□□

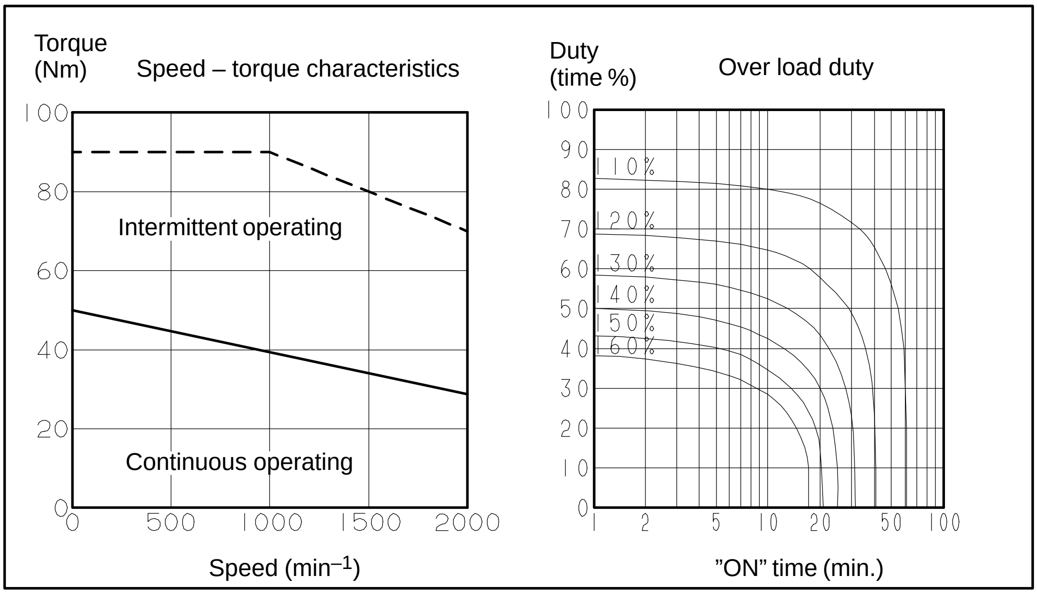


Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min $^{-1}$
Rated torque at stall (*)	Ts	25 255			Nm kgfcm
Rotor inertia	Jm	0.0054 0.055			kgm^2 kgfcms^2
Continuous RMS current at stall (*)	Is	37			A (rms)
Torque constant (*)	Kt	0.66 6.8			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	23 0.22			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.049			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	45			min
Static friction	Tf	1.2 12			Nm kgfcm
Mass		25			kg

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

Model αL50/2000 Specification : A06B–0572–B□□□



Data sheet

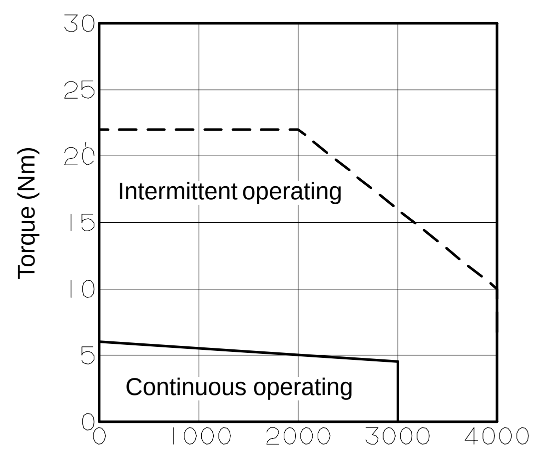
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000			min^{-1}
Rated torque at stall (*)	Ts	50 510			Nm kgfcm
Rotor inertia	Jm	0.0098 0.10			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	51			A (rms)
Torque constant (*)	Kt	0.96 9.8			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	33 0.32			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.038			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	70			min
Static friction	Tf	1.8 18			Nm kgfcm
Mass		42			kg

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

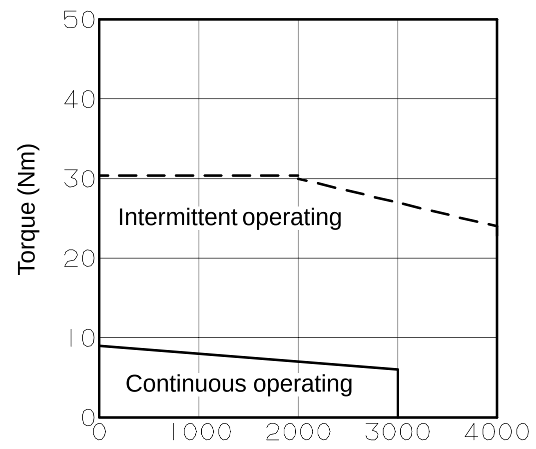
(Remarks) Speed–torque characteristics (HRV control)

On the following models, the intermittent operating zone can be extended by using HRV control.

- **αL6/3000**



- **αL9/3000**

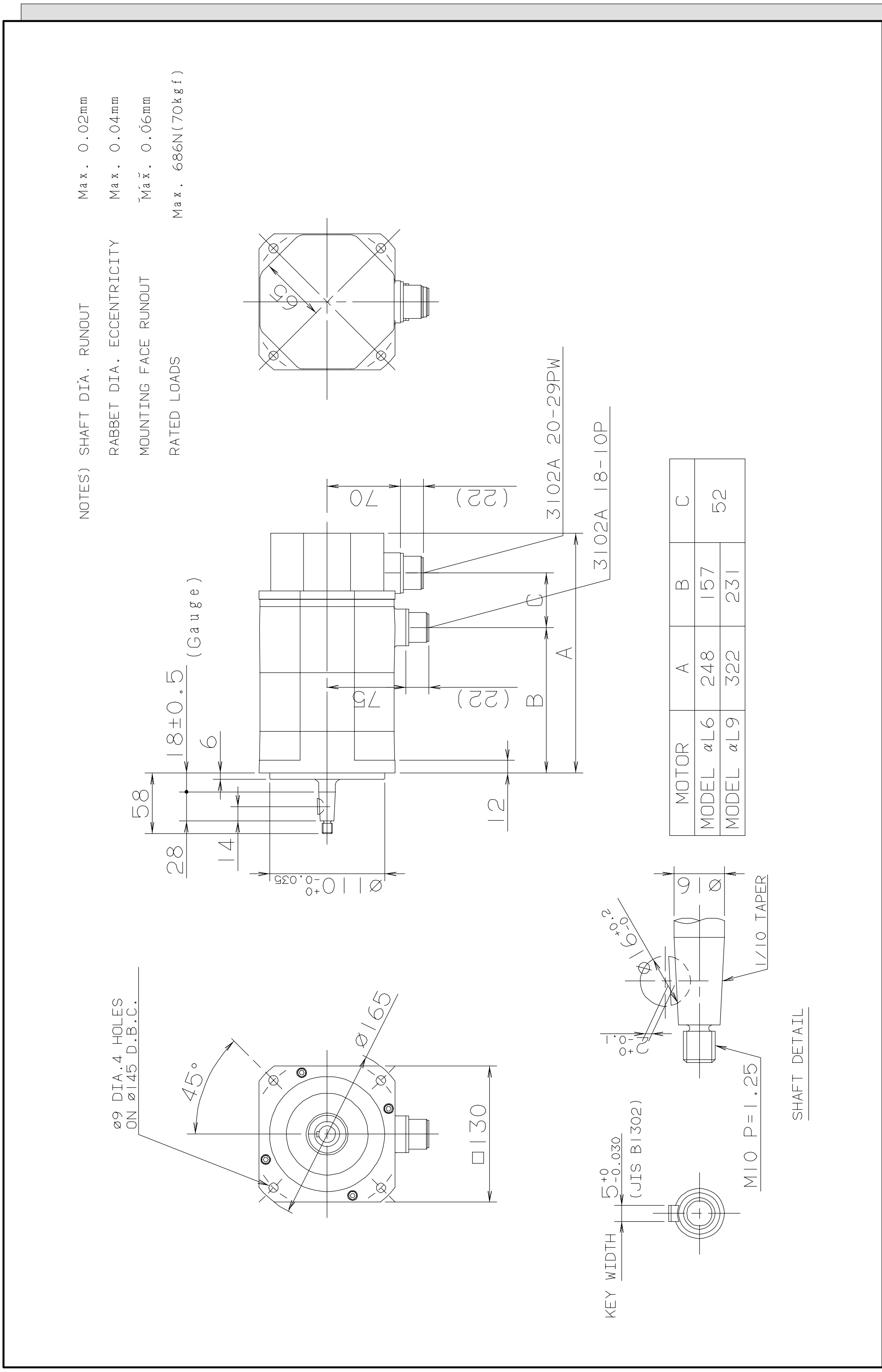


> **NOTE**
> HRV control sometimes cannot be used depending on the CNC system. Using HRV control increases the intermittent operating zone at high motor operating speeds. The continuous operating zone, however, is the same as when conventional control methods are used.

3.3 OUTLINE DRAWINGS

Model	Fig. No.
Models αL6/3000 and αL9/3000	Fig. 3.3 (a)
Models αL6/3000 and αL9/3000 (with the brake)	Fig. 3.3 (b)
Models αL25/3000 and αL50/2000	Fig. 3.3 (c)
Models αL25/3000 and αL50/2000 (with the brake)	Fig. 3.3 (d)

Fig. 3.3 (a) Models αL6/3000 and αL9/3000



MOTOR	A	B	C
MODEL αL6	248	157	52
MODEL αL9	322	231	

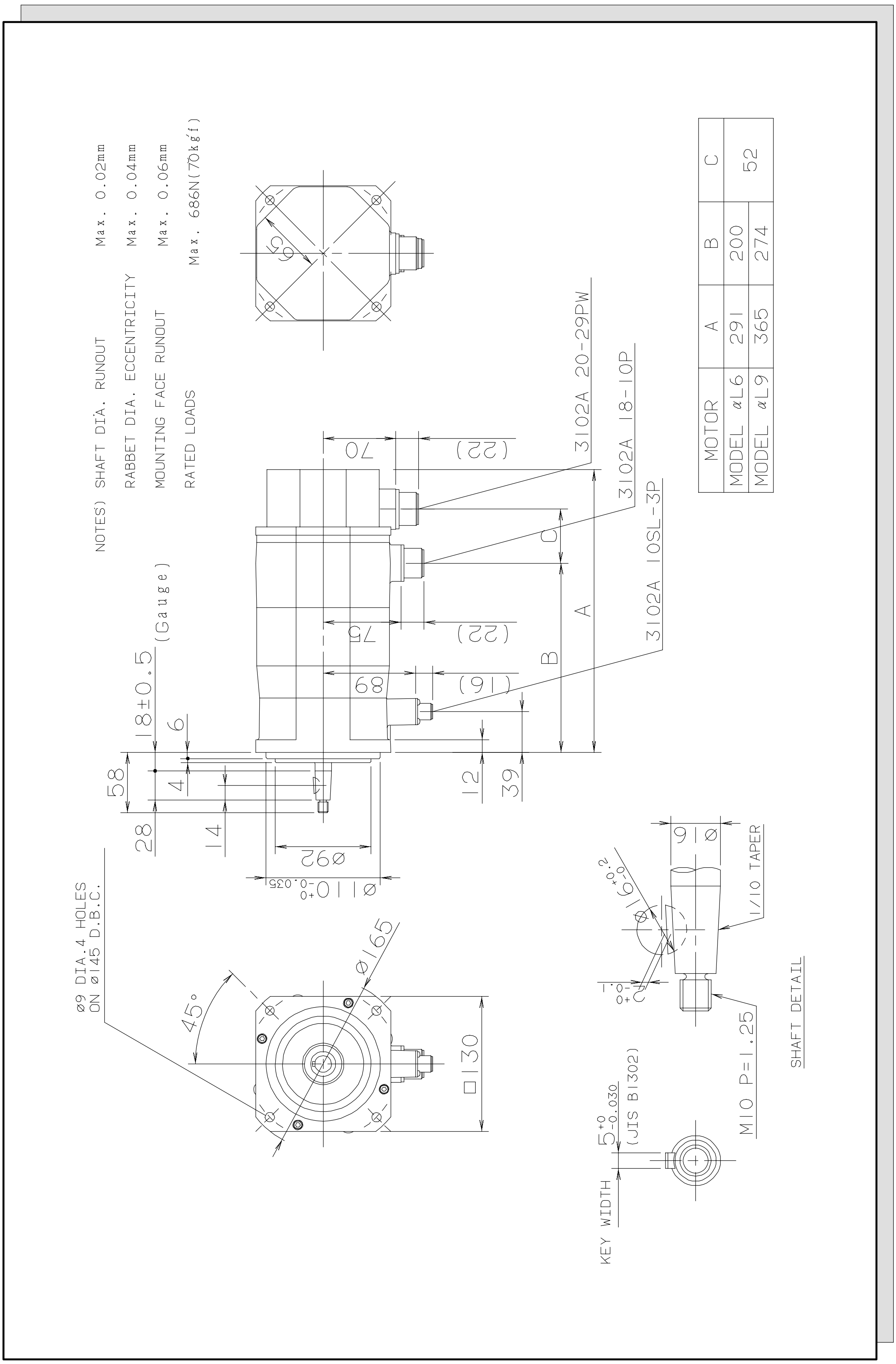


Fig. 3.3 (b) Models αL6/3000 and αL9/3000 (with the brake)

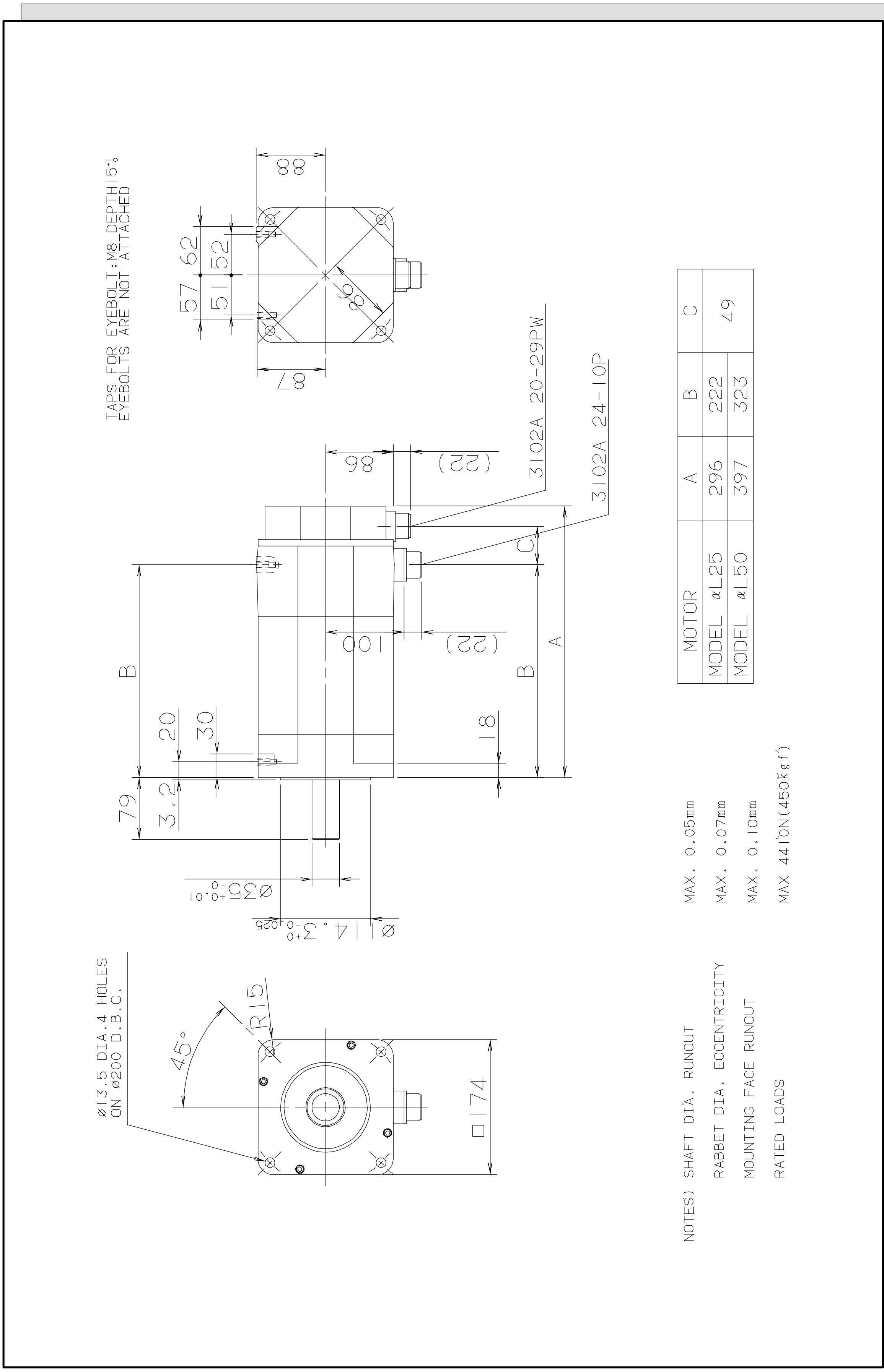
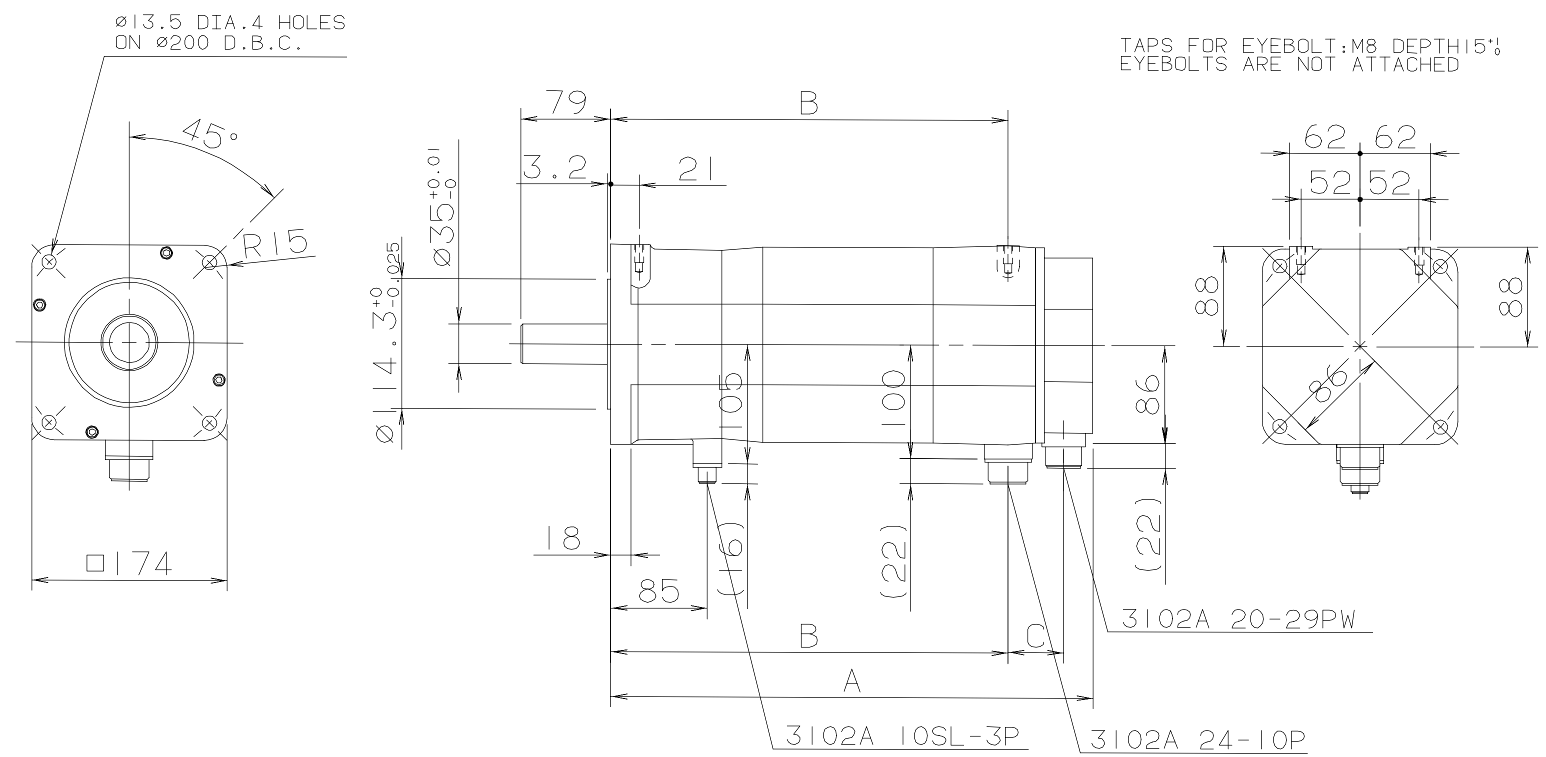


Fig. 3.3 (c) Models αL25/3000 and αL50/2000

Fig. 3.3 (d) Models αL25/3000 and αL50/2000 (with the brake)

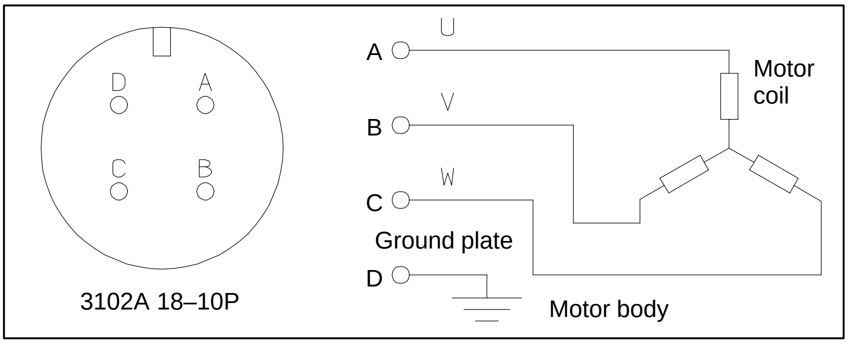


MOTOR	A	B	C
MODEL αL25	376	301	49
MODEL αL50	477	402	

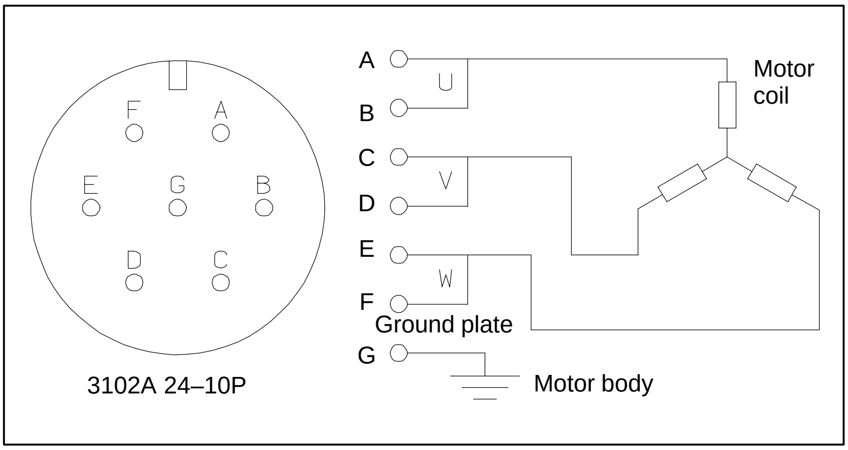
NOTES) SHAFT DIA. RUNOUT MAX. 0.05mm
RABBET DIA. ECCENTRICITY MAX. 0.01mm
MOUNTING FACE RUNOUT MAX. 0.10mm
RATED LOADS MAX 4410N(450kgf)

3.4 CONNECTION OF POWER LINE

Models αL6/3000 and αL9/3000



Models αL25/3000 and αL50/2000



V. FANUC AC SERVO MOTOR αC series

1 GENERAL

The FANUC AC servo motor αC series is suitable for application to the feed axes of machine tools. These motors have the following features:

High cost–effectiveness

High cost–effectiveness has been achieved. Although a low–power amplifier is used, high acceleration is offered.

Compact

The use of the latest ferrite magnet, combined with an optimized mechanical design, reduces both the overall length and weight. The result is compact, lightweight servo motors.

Excellent waterproofing

The use of waterproof connectors and FANUC's unique stator seal provide excellent waterproofing, ensuring that no liquid, such as coolant, can enter the motor.

Smooth rotation

Further improvements have been made to the unique magnetic pole shape to minimize torque ripple. The result is extremely smooth rotation.

Controllability

The use of the latest servo software maintains controllability even when a disturbance occurs.

High–performance detector

High–resolution pulse coder αA1000, αA64, αI64 is used in the standard configuration, enabling precise positioning.

Powerful brake

A powerful brake with an increased holding torque is available as an option. The brake uses an asbestos–free design.

The αC series includes models αC3 and αC6, both of which are compatible with α series models α3 and α6 in their installation size, and models αC12 and αC22, which are compatible with series models α12 and α22 in their installation size.

2 TYPES OF MOTORS AND DESIGNATION

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

Models αC3/2000 and αC6/2000

A06B–01□□–B☆ ○○

□□
- **21** : Model αC3/2000
- **26** : Model αC6/2000

☆
- **0** : Taper shaft (standard)
- **1** : Taper shaft with the brake (8Nm)
- **5** : Straight shaft
- **6** : Straight shaft with the brake (8Nm)

○○
- **75** : Pulse coder αA64
- **77** : Pulse coder αI64

The standard shafts used for models αC3/2000 and αC6/2000 are taper shafts. Use a taper shaft as far as circumstances, such as the delivery time and maintenance, permit.

Models αC12/2000 and αC22/1500

A06B–01□□–B☆ ○○

□□
- **41** : Model αC12/2000
- **45** : Model αC22/1500

☆
- **0** : Straight shaft (standard)
- **1** : Straight shaft with the brake (35Nm)
- **5** : Taper shaft
- **6** : Taper shaft with the brake (35Nm)

○○
- **75** : Pulse coder αA64
- **77** : Pulse coder αI64

A straight shaft is fitted as the standard shaft for models αC12/2000 and αC22/1500. When early delivery and case–of–maintenance are important, a straight shaft should be used.

> **NOTE**
> For the αC series, pulse coder αA1000 cannot be used.

3 SPECIFICATIONS AND CHARACTERISTICS

3.1 TYPES OF MOTORS AND SPECIFICATIONS

Item	Unit	αC3/2000	αC6/2000	αC12/2000	αC22/1500
Output	kw	0.3	0.6	1.0	1.5
	HP	0.4	0.8	1.4	2.1
Rated torque at stall	Nm	3.0	6.0	12	22
	kgf·cm	31	61	122	224
Rating rotation speed	min^{-1}	2000	2000	2000	1500
Rotor inertia	$kg \cdot m^2$	0.0014	0.0026	0.0062	0.012
	$kgf \cdot cm \cdot s^2$	0.014	0.027	0.064	0.12
Mass	kg	8	13	18	29

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

3.2 CHARACTERISTIC CURVE AND DATA SHEET

Speed–torque characteristics

The intermittent operation zone is determined by the input voltage applied to the drive amplifier. The curve shown is the value for the rated input voltage (200V).

Overload duty characteristic

The overload duty characteristic curves are determined based on the temperature restriction for the single motor unit (the temperature is restricted by means of a thermal trip built into the motor). The curves are determined by assuming that the temperature increases gradually under certain overload conditions. Therefore, the curves do not apply to the rapid temperature rise which occurs, for example, when the motor shaft is locked. (An overcurrent flows in the motor windings until the thermal trip operates. The temperature rises momentarily.)

To detect such an abrupt temperature rise, the FANUC digital servo system provides a software thermal function that uses servo software to observe the current. During operation that is characterized by frequent acceleration/deceleration cycles, control is imposed by the software thermal function.

Driving units (such as amplifiers) and built–in detectors contain their own overheating protection devices. Therefore, note that control may be imposed according to how the equipment is being used.

Data sheet

The parameters given in the data sheet are representative values for an ambient temperature of 20°C. They are subject to an error of +10%.

The indicated logical values are threshold values for the single motor unit (when the motor is not restricted by the control system).

The maximum torque that can be produced during acceleration or deceleration in actual use is calculated as the approximate product of the motor torque constant and the current limit value of the amplifier.

Example : αC3/2000

- Motor torque constant = 1.06 (Nm/Arms)
- Amplifier limit value = 20 Apeak
- Maximum torque value
  = $\underline{20 \times 0.707}$ x 1.06
  (Converted to an effective value)
  = 14.9 Nm

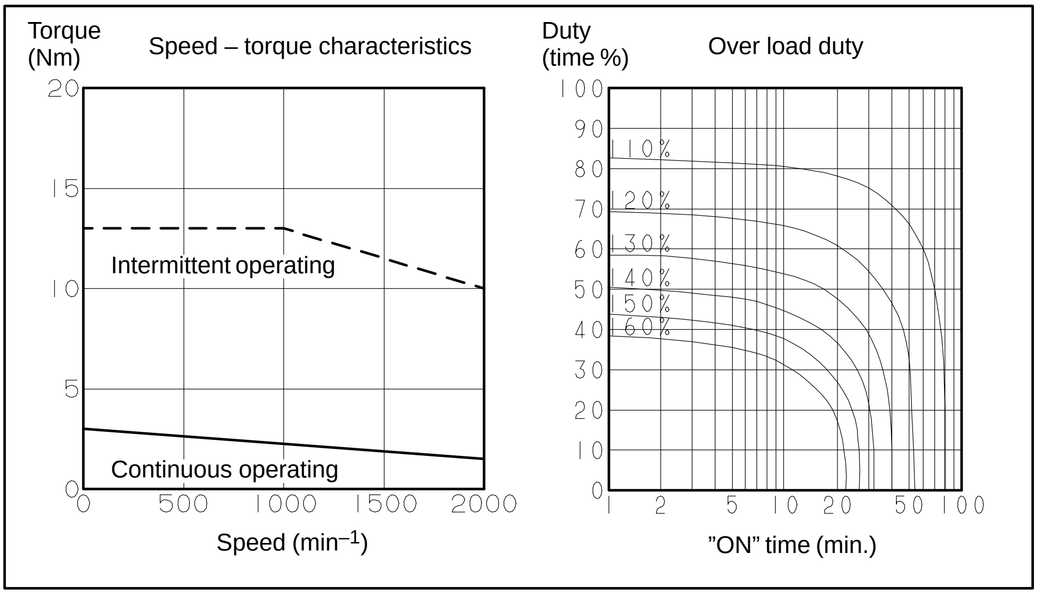
This value is for reference only. The actual value will vary depending on changes in the power supply, as well as variations in motor parameters and amplifier limit values.

In some models, if the maximum current flows in the motor, the actual maximum torque is affected by, for example, magnetic saturation. As a result, the actual maximum torque will be lower than the calculated value.

The intermittent operation area (maximum torque value) indicated in the speed to torque characteristics is the effective value, determined according to the combination with the amplifier.

Model αC3/2000

Specification : A06B–0121–B□□□



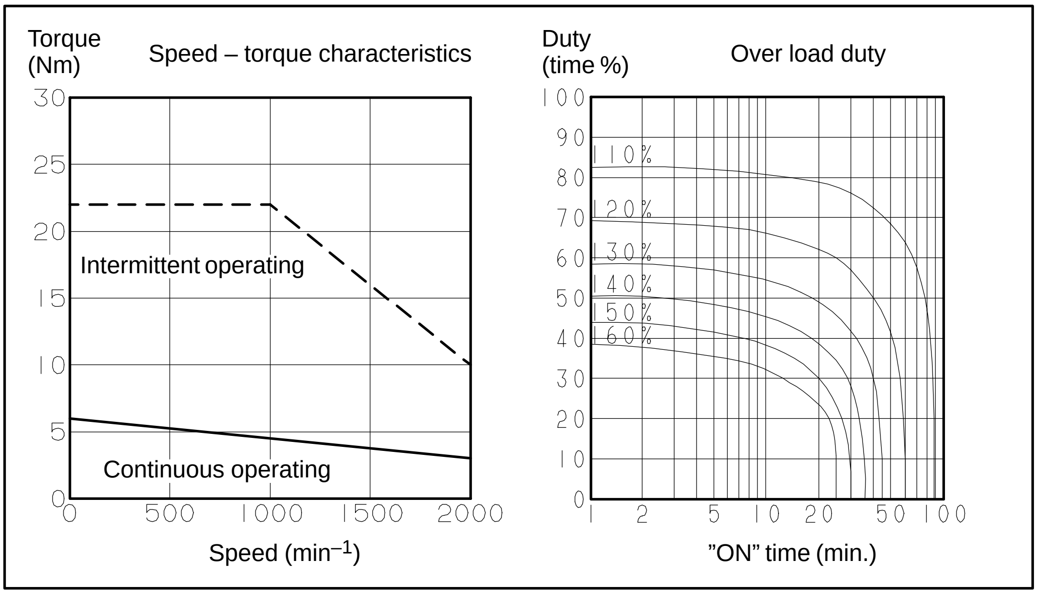
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000			min^{-1}
Rated torque at stall (*)	Ts	3.0 31			Nm kgfcm
Rotor inertia	Jm	0.0014 0.014			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	2.8			A (rms)
Torque constant (*)	Kt	1.06 10.8			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	37 0.35			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	1.85			Ω
Mechanical time constant (*)	tm	0.006			s
Thermal time constant	tt	45			min
Static friction	Tf	0.3 3			Nm kgfcm
Mass		8			kg

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

Model αC6/2000

Specification : A06B–0126–B□□□



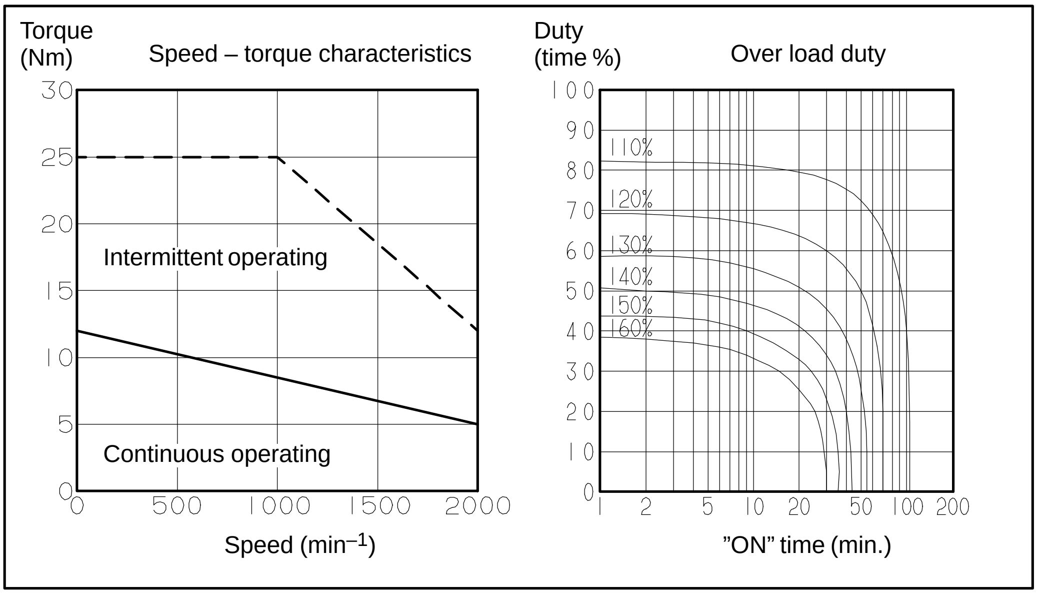
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000			min^{-1}
Rated torque at stall (*)	Ts	6.0 61			Nm kgfcm
Rotor inertia	Jm	0.0026 0.027			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	3.6			A (rms)
Torque constant (*)	Kt	1.68 17.1			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	59 0.56			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	1.52			Ω
Mechanical time constant (*)	tm	0.004			s
Thermal time constant	tt	50			min
Static friction	Tf	0.3 3			Nm kgfcm
Mass		13			kg

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

Model αC12/2000

Specification : A06B–0141–B□□□



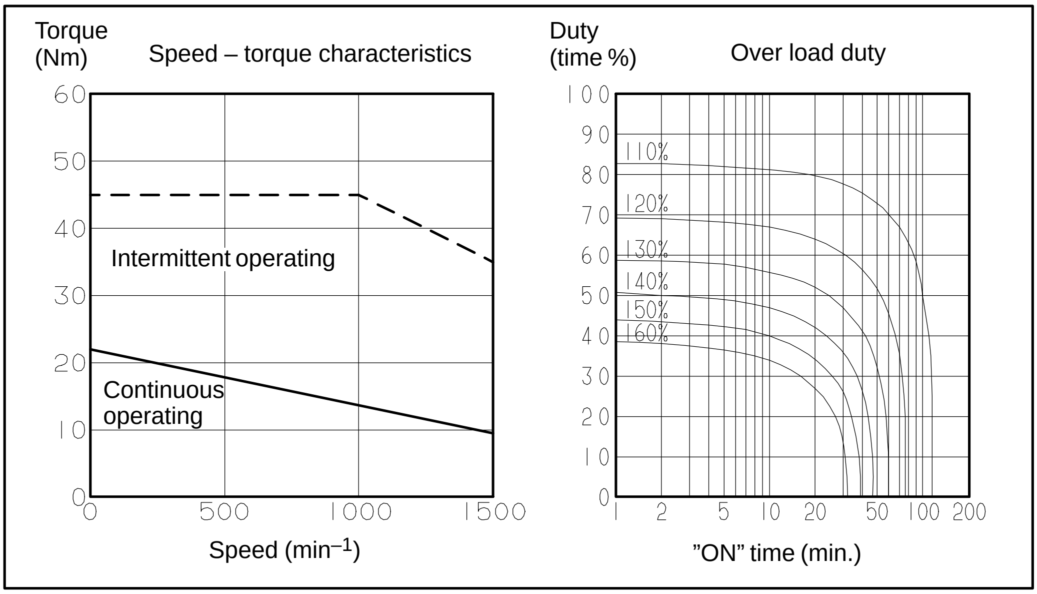
Data sheet

Parameter	Symbol	Value	Unit
Rating rotation speed	Nmax	2000	min^{-1}
Rated torque at stall (*)	Ts	12 122	Nm kgfcm
Rotor inertia	Jm	0.0062 0.064	kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	5.9	A (rms)
Torque constant (*)	Kt	2.04 20.8	Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	71 0.68	V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	1.10	Ω
Mechanical time constant (*)	tm	0.005	s
Thermal time constant	tt	60	min
Static friction	Tf	0.8 8	Nm kgfcm
Mass		18	kg

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

Model αC22/1500

Specification : A06B–0145–B□□□



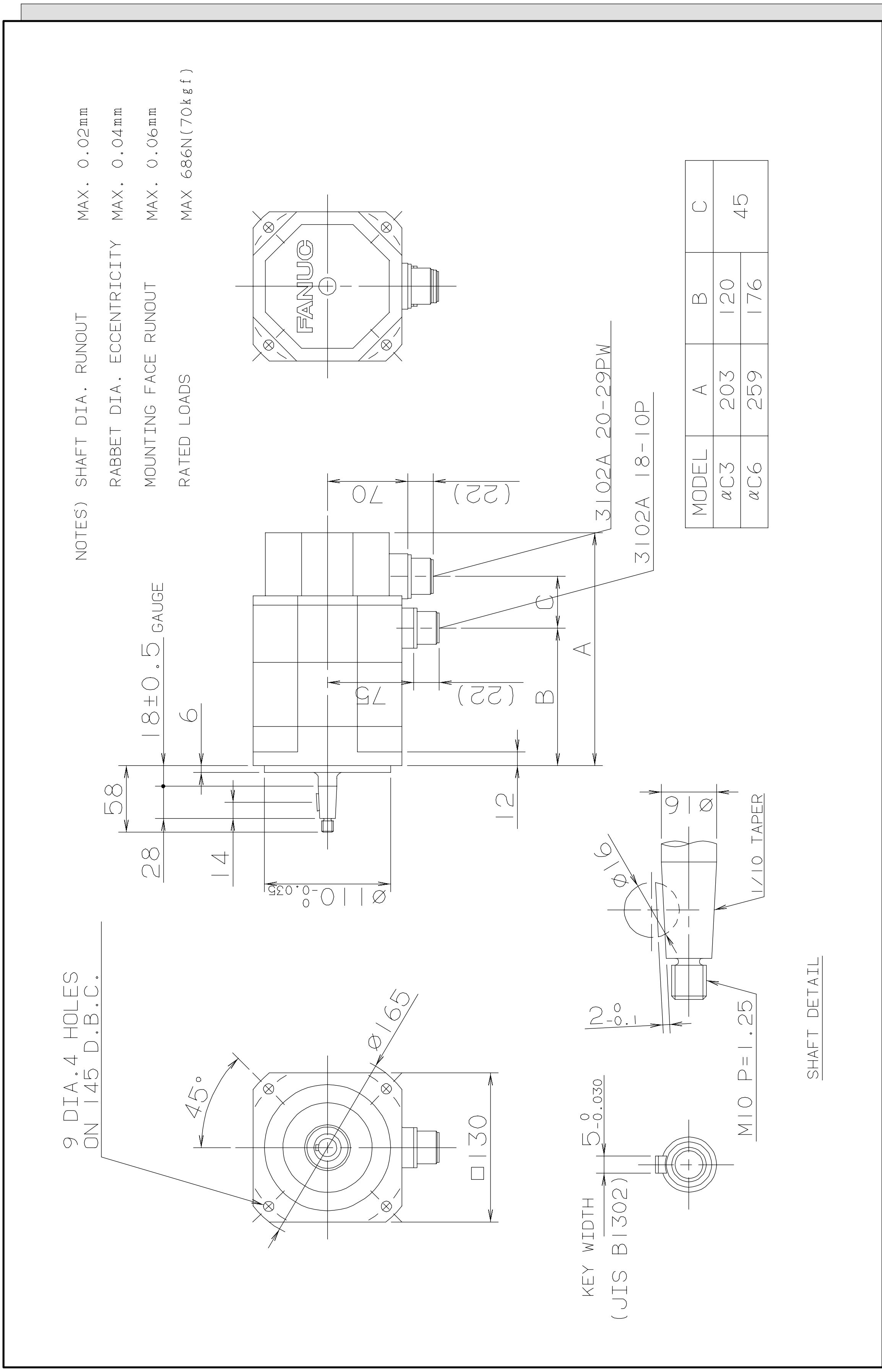
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	1500			min^{-1}
Rated torque at stall (*)	Ts	22 224			Nm kgfcm
Rotor inertia	Jm	0.012 0.12			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	12.5			A (rms)
Torque constant (*)	Kt	1.76 18.0			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	62 0.59			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.32			Ω
Mechanical time constant (*)	tm	0.003			s
Thermal time constant	tt	65			min
Static friction	Tf	1.2 12			Nm kgfcm
Mass		29			kg

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

3.3 OUTLINE DRAWINGS

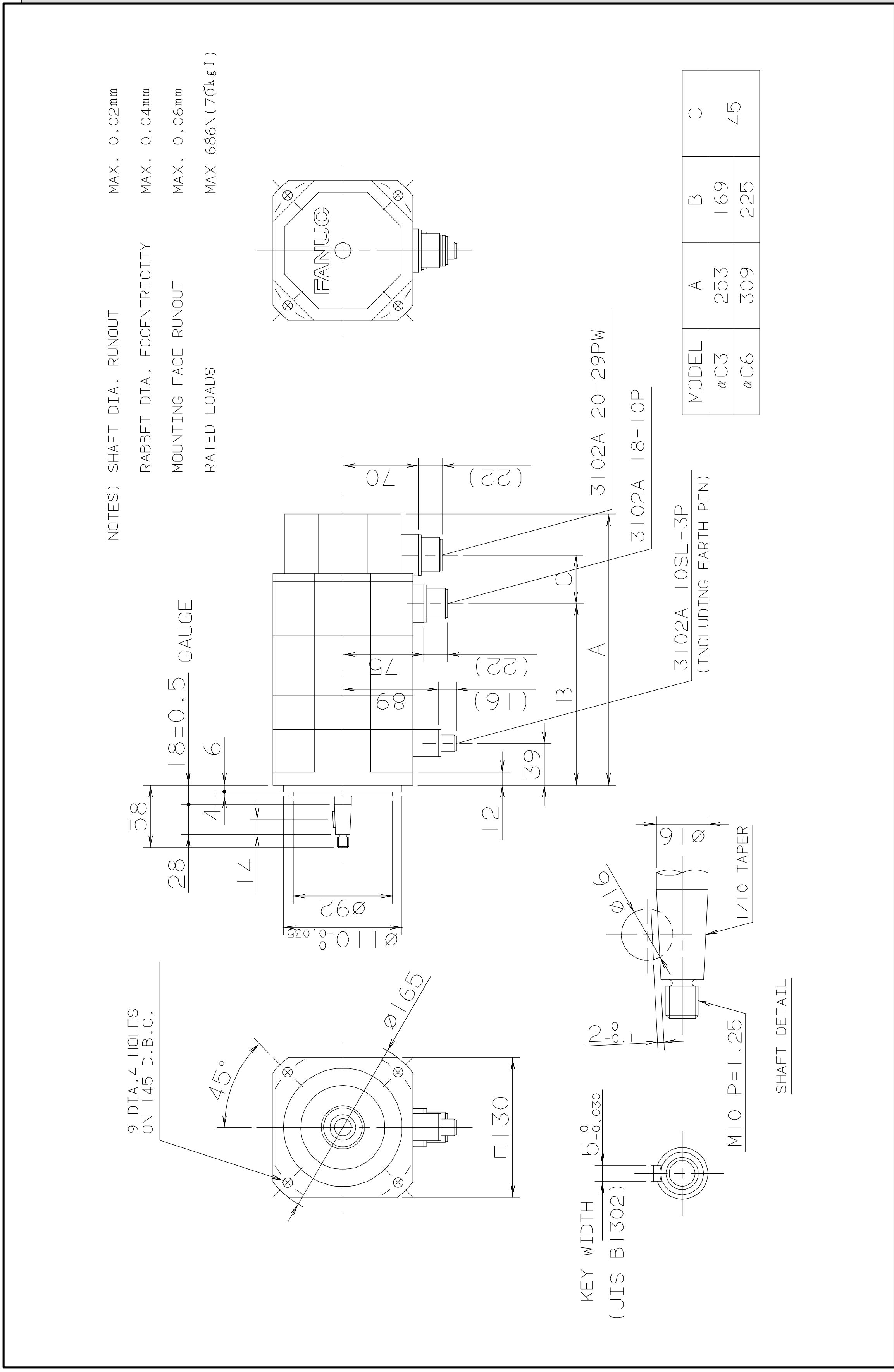
Model	Fig. No.
Models αC3/2000 and αC6/2000	Fig. 3.3(a)
Models αC3/2000 and αC6/2000 (with the brake)	Fig. 3.3(b)
Models αC3/2000 and αC6/2000 (shaft option)	Fig. 3.3(c)
Models αC12/2000 and αC22/1500	Fig. 3.3(d)
Models αC12/2000 and αC22/1500 (with the brake)	Fig. 3.3(e)
Models αC12/2000 and αC22/1500 (shaft option)	Fig. 3.3(f)



MODEL	A	B	C
αC3	203	120	45
αC6	259	176	

Fig. 3.3 (a) Models αC3/2000 and αC6/2000

Fig. 3.3 (b) Models αC3/2000 and αC6/2000 (with the brake)



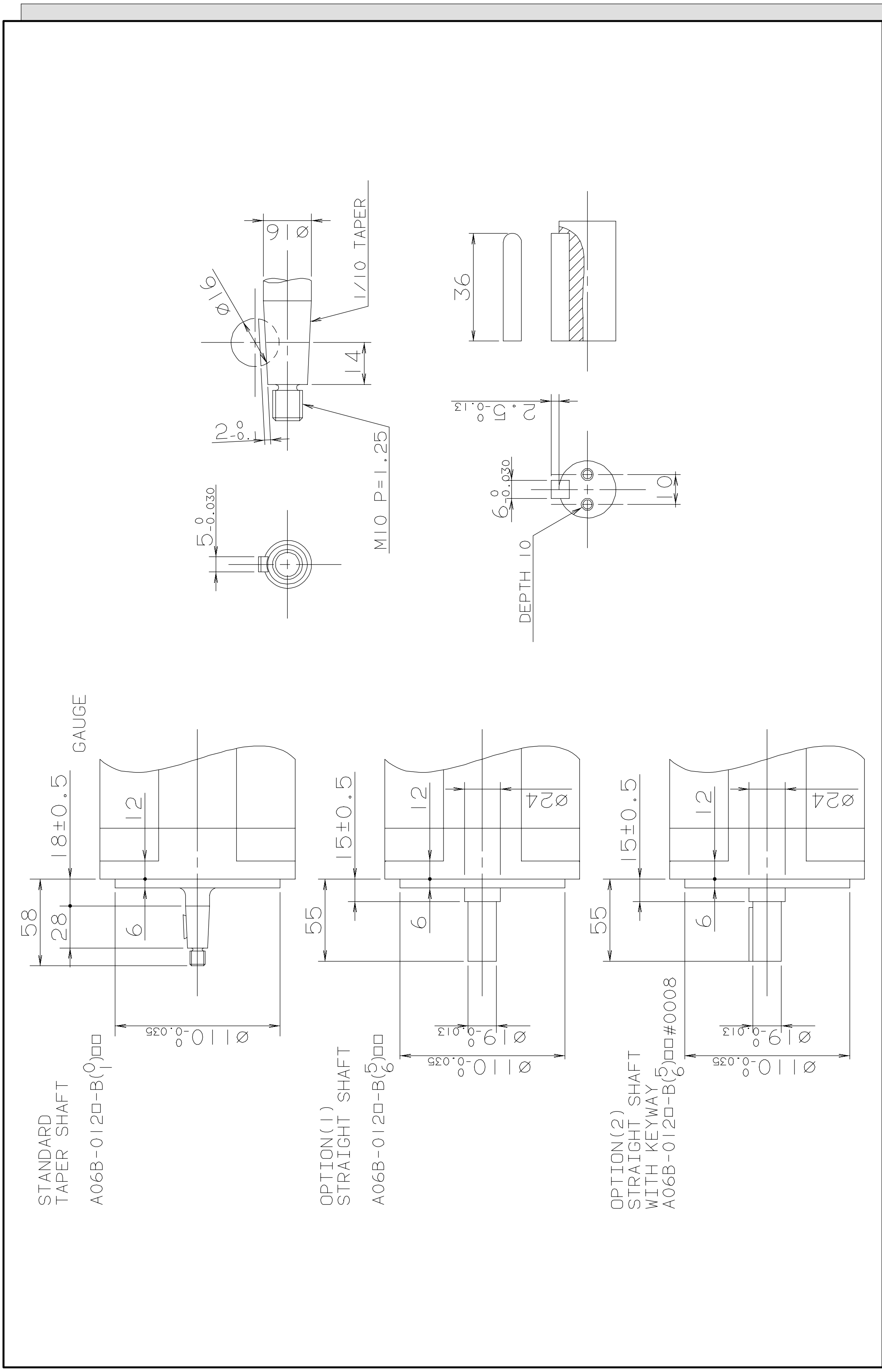
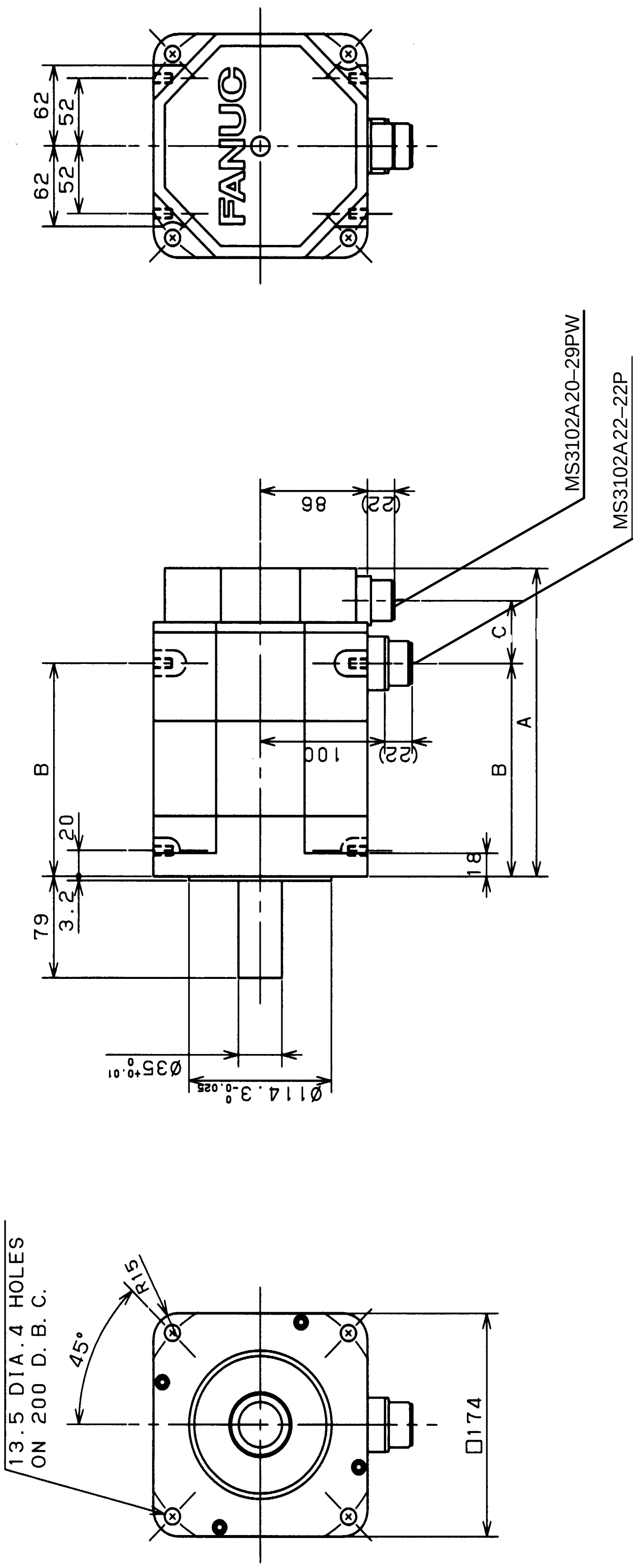


Fig. 3.3 (c) Models αC3/2000 and αC6/2000 (shaft option)

Fig. 3.3 (d) Models αC12/2000 and αC22/1500

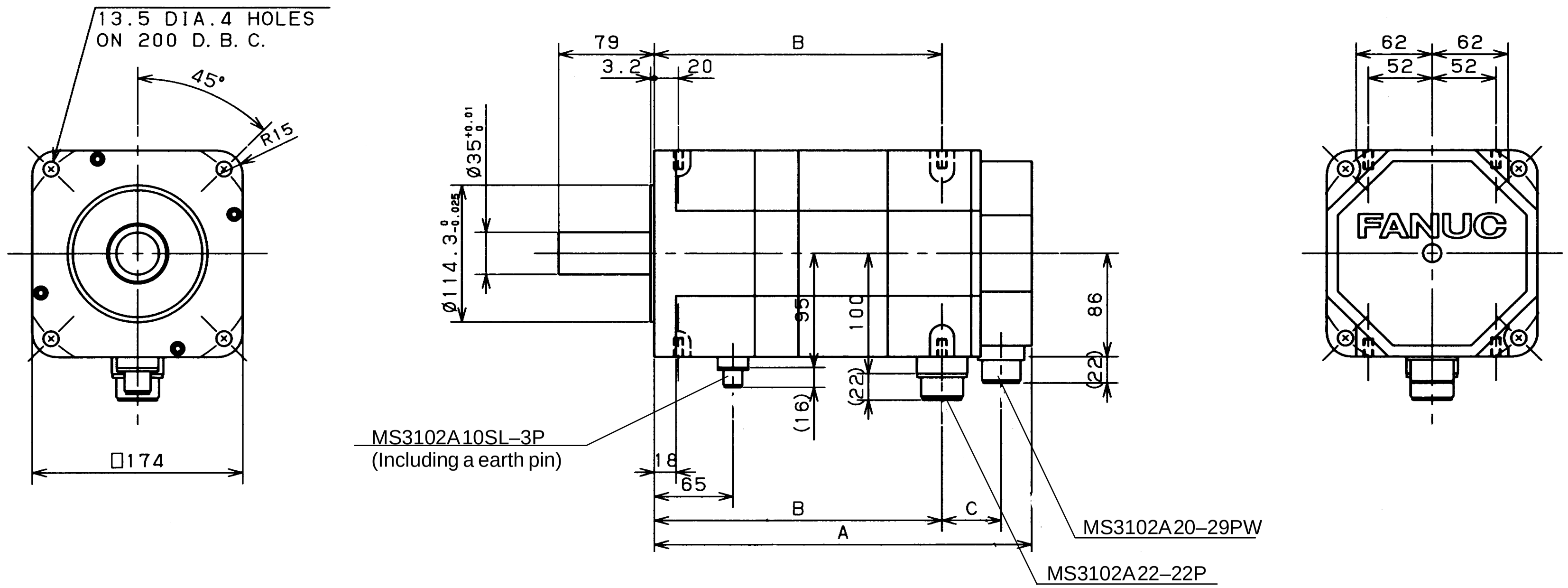


Notes)
Shaft diameter runout Max 0.05mm
Rabbet diameter eccentricity Max 0.07mm
Mounting face runout Max 0.10mm
Rated load 4410N(450kgf)

Taps for eyebolt : M8 depth 15^{+1}
Eyebolts are not attached

MODEL	A	B	C
αC12	240	166	49
αC22	314	240	

Fig. 3.3 (e) Models αC12/2000 and αC22/1500 (with the brake)

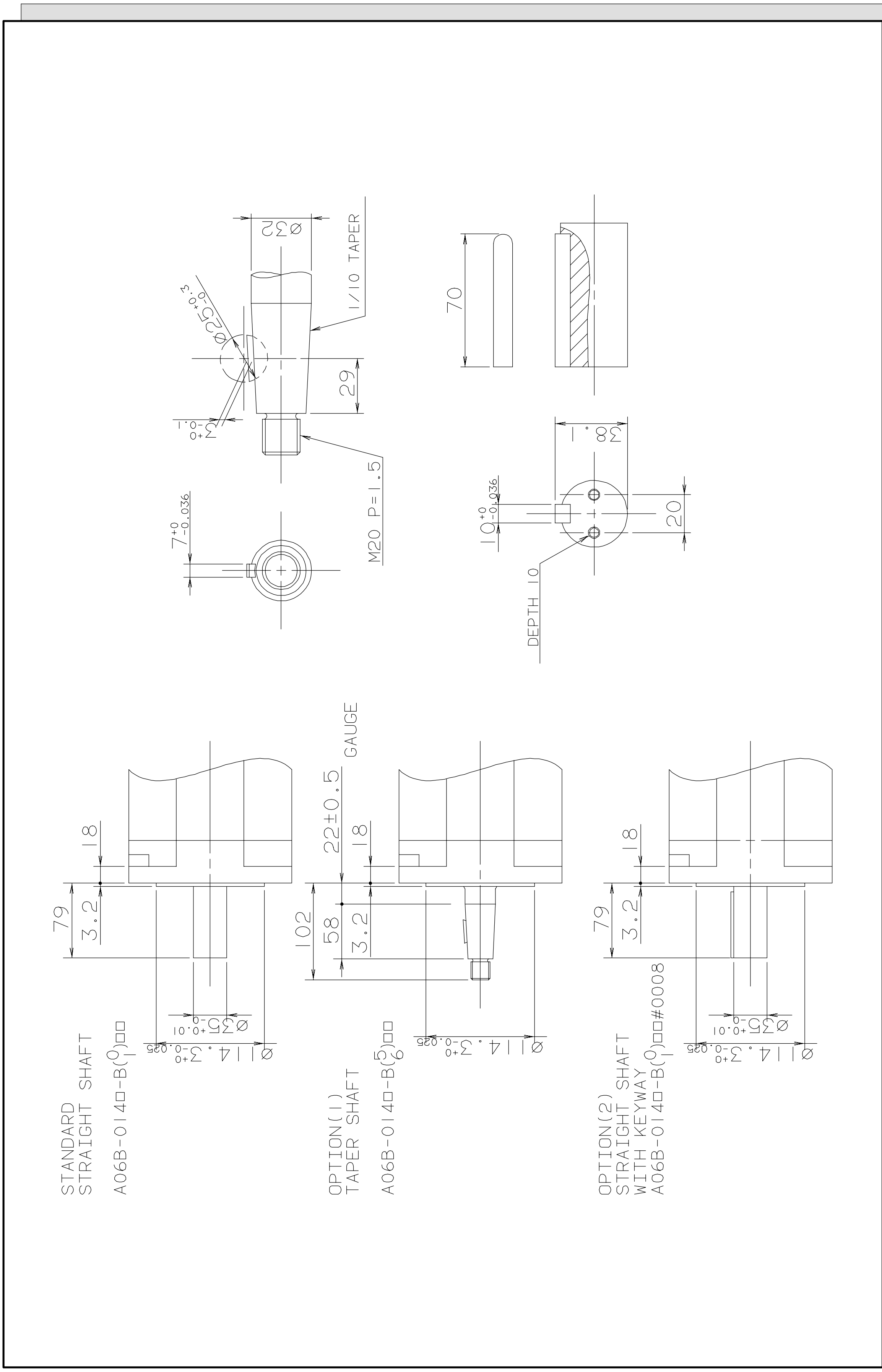


Notes)
Shaft diameter runout Max 0.05mm
Rabbet diameter eccentricity Max 0.07mm
Mounting face runout Max 0.10mm
Rated load 4410N(450kgf)

Taps for eyebolt : M8 depth 15^{+1}
Eyebolts are not attached

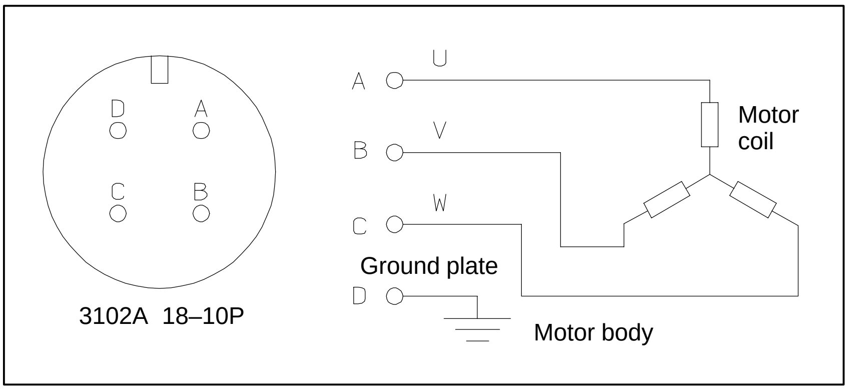
MODEL	A	B	C
αC12	312	238	49
αC22	386	312	

Fig. 3.3 (f)   Models αC12/2000 and αC22/1500 (shaft option)

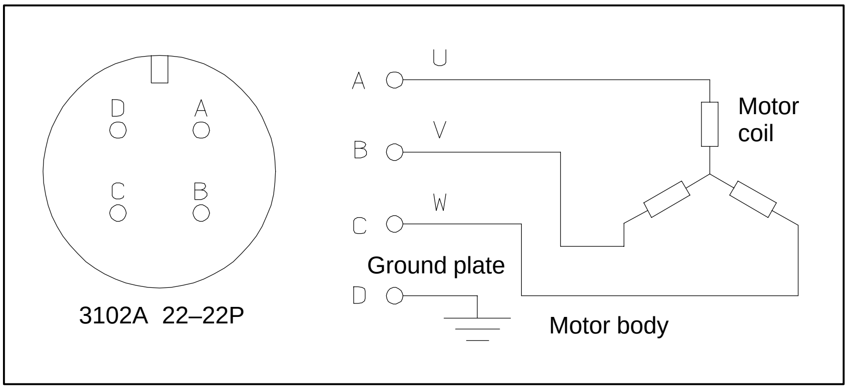


3.4 CONNECTION OF POWER LINE

Models αC3/2000 and αC6/2000



Models αC12/2000 and αC22/1500



CAUTION

1 The motors should be installed with their connector facing downward as long as possible. When it is impossible to install a motor in this position, allow slack in the cable to keep liquids such as a dielectric fluid from going along the cable into the cable or motor. If there is a possibility that the motors and connectors get wet, provide a cover to protect them.

2 If a motor is not connected to the earth ground through the machine (frame), connect the motor grounding point and the amplifier grounding point to absorb noise using a 1.25 mm^2 or larger conductor other than the grounding conductor in the power cable. Keep the grounding conductor as far from the power cable as possible.

VI. FANUC AC SERVO MOTOR α (HV) series

1 GENERAL

The FANUC AC servo motor α(HV) series is suitable for application to the feed axes of machine tools. These motors have the following features:

Direct connection to a 400V power source

A 400V power source can be connected directly without using a transformer.

Compact

The use of the latest ferrite magnet, combined with an optimized mechanical design, reduces both the overall length and weight. The result is compact, lightweight servo motors.

Excellent waterproofing

The use of waterproof connectors and FANUC's unique stator seal provide excellent waterproofing, ensuring that no liquid, such as coolant, can enter the motor.

Smooth rotation

Further improvements have been made to the unique magnetic pole shape to minimize torque ripple. The result is extremely smooth rotation.

Controllability

The use of the latest servo software maintains controllability even when a disturbance occurs.

Built–in high–performance detector

A high–resolution pulse coder αA1000, αA64, αI64 is provided as standard, assuring accurate positioning.

Powerful brake

A powerful brake with an increased holding torque is available as an option. The brake uses an asbestos–free design.

The α(HV) series includes models α3HV and α6HV, both of which are compatible with α series models α3 and α6 in their installation size, and models α12HV, α22HV, α30HV, and α40HV, which are compatible with series models α12, α22, α30 and α40 in their installation size.

2 TYPES OF MOTORS AND DESIGNATION

The types and specifications of α(HV) series servo motors are described as follows.

Models α3/3000HV and α6/3000HV

A06B–01□□–B☆ ○○

□□
- **71** : Model α3/3000HV
- **72** : Model α6/3000HV

☆
- **0** : Taper shaft (standard)
- **2** : Taper shaft with the brake (8Nm/24VDC)
- **5** : Straight shaft
- **7** : Straight shaft with the brake (8Nm/24VDC)

○○
- **75** : Pulse coder αA64
- **77** : Pulse coder αI64
- **88** : Pulse coder αA1000

The standard shafts used for models α3/3000HV and α6/3000HV are taper shafts. Use a taper shaft as far as circumstances, such as the delivery time and maintenance, permit.

Models α12/3000HV, α22/3000HV and α30/3000HV

A06B–01□□–B☆ ○○

□□
- **76** : Model α12/3000HV
- **77** : Model α22/3000HV
- **78** : Model α30/3000HV

☆
- **0** : Straight shaft (standard)
- **2** : Straight shaft with the brake (35Nm/24VDC)
- **5** : Taper shaft
- **7** : Taper shaft with the brake (35Nm/24VDC)

○○
- **75** : Pulse coder αA64
- **77** : Pulse coder αI64
- **88** : Pulse coder αA1000

A straight shaft is fitted as the standard shaft for models α12/3000HV, α22/3000HV and α30/3000HV. When early delivery and case–of–maintenance are important, a straight shaft should be used.

Models α40/2000HV

A06B–0179–B☆ ○○

☆
- **0** : Straight shaft (standard)
- **2** : Straight shaft with the brake (35Nm 24VDC)

○○
- **75** : With the pulse coder αA64
- **77** : With the pulse coder αI64
- **88** : With the pulse coder αA1000

This model, a tapered shaft is not available.

Models α1000/2000HV

A06B–0131–B0 ○○

○○
- **75** : With the pulse coder αA64
- **77** : With the pulse coder αI64
- **88** : With the pulse coder αA1000

This model, a tapered shaft is standard, a straight shaft is not available.
This model, a brake option is not available.

3 SPECIFICATIONS AND CHARACTERISTICS

3.1 TYPES OF MOTORS AND SPECIFICATIONS

Item	Unit	α3/3000HV	α6/3000HV
Output	kw	0.9	1.4
	HP	1.3	1.9
Rated torque at stall	Nm	3.0	6.0
	kgf·cm	31	61
Rating rotation speed	min^{-1}	3000	3000
Rotor inertia	$kg{\cdot}m^2$	0.0014	0.0026
	$kgf{\cdot}cm{\cdot}s^2$	0.014	0.027
Mass	kg	8	13

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

Item	Unit	α12/3000HV	α22/3000HV	α30/3000HV	α40/2000HV	α1000/2000HV
Output	kw	2.8	4.4	4.8	5.9	100
	HP	3.8	5.9	6.4	7.9	136
Rated torque at stall	Nm	12	22	30	38	900
	kgf·cm	122	224	306	390	9180
Rating rotation speed	min^{-1}	3000	3000	3000	2000	2000
Rotor inertia	$kg{\cdot}m^2$	0.0062	0.012	0.017	0.022	0.417
	$kgf{\cdot}cm{\cdot}s^2$	0.064	0.12	0.17	0.23	4.25
Mass	kg	18	29	41	52	470

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

3.2 CHARACTERISTIC CURVE AND DATA SHEET

Speed–torque characteristics

The intermittent operation zone is determined by the input voltage applied to the drive amplifier. The curve shown is the value for the rated input voltage (400V).
On models α3HV to α6HV, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item

Overload duty characteristic

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

Data sheet

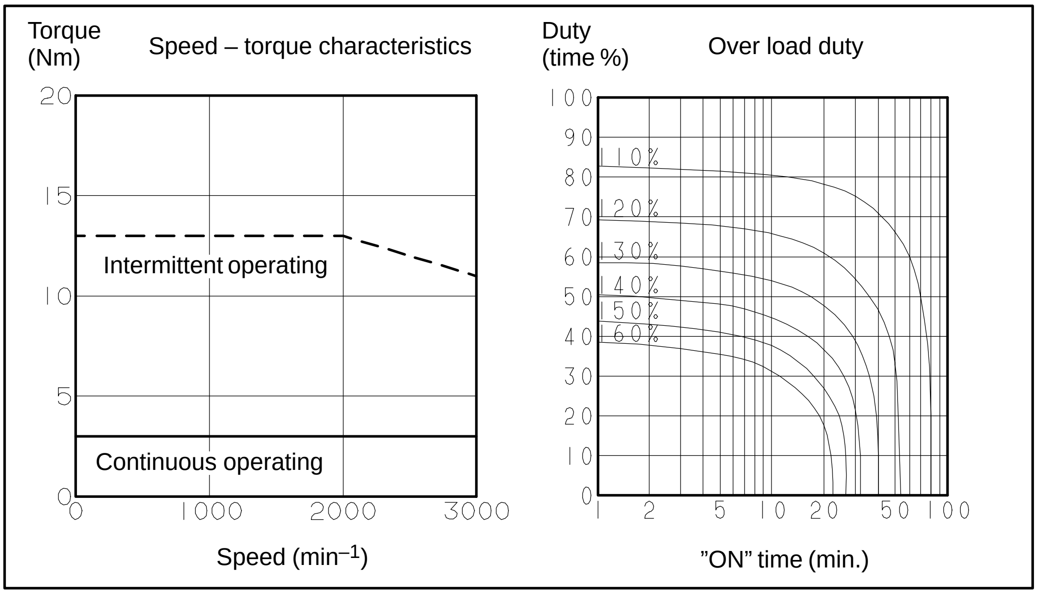
The parameters given in the data sheet are representative values for an ambient temperature of 20°C. They are subject to an error of +10%.
The indicated logical values are threshold values for the single motor unit (when the motor is not restricted by the control system).
The maximum torque that can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

Example : α3/3000HV

- Motor torque constant = 1.06 (Nm/Arms)
- Amplifier limit value = 20 Apeak
- Maximum torque value
  $= \underline{20 \times 0.707} \times 1.06$
  (Converted to an effective value)
  = 14.9 Nm

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

Model α3/3000HV Specification : A06B–0171–B□□□

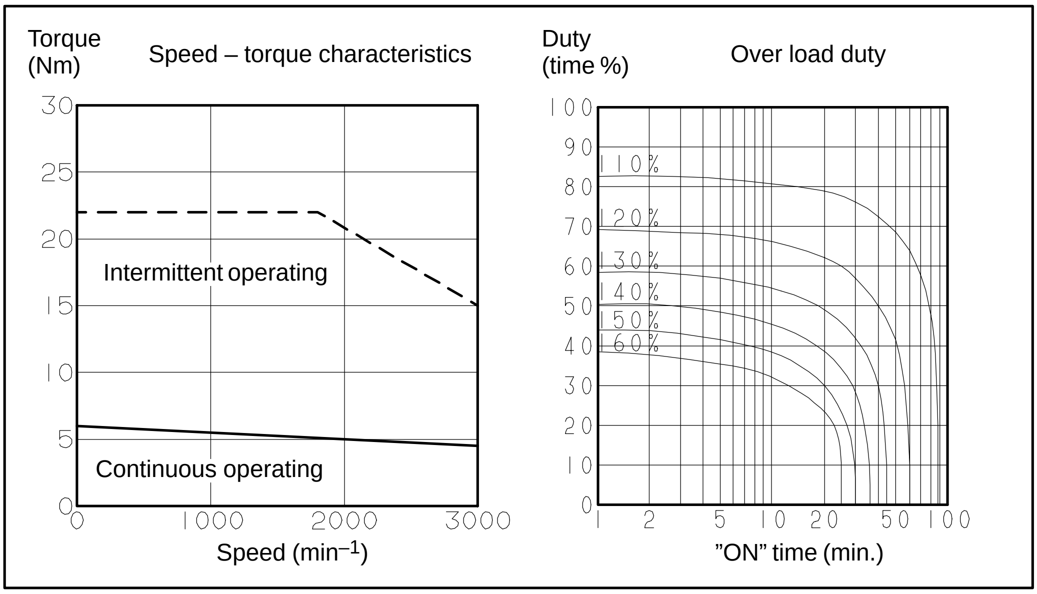


Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	3.0 31			Nm kgfcm
Rotor inertia	Jm	0.0014 0.014			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	2.8			A (rms)
Torque constant (*)	Kt	1.06 10.8			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	 Ke Kv	 37 0.35			 V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	1.85			Ω
Mechanical time constant (*)	tm	0.006			s
Thermal time constant	tt	45			min
Static friction	Tf	0.3 3			Nm kgfcm
Mass		8			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.) These values may be changed without prior notice.
On model α3HV, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item

Model α6/3000HV Specification : A06B–0172–B□□□



Data sheet

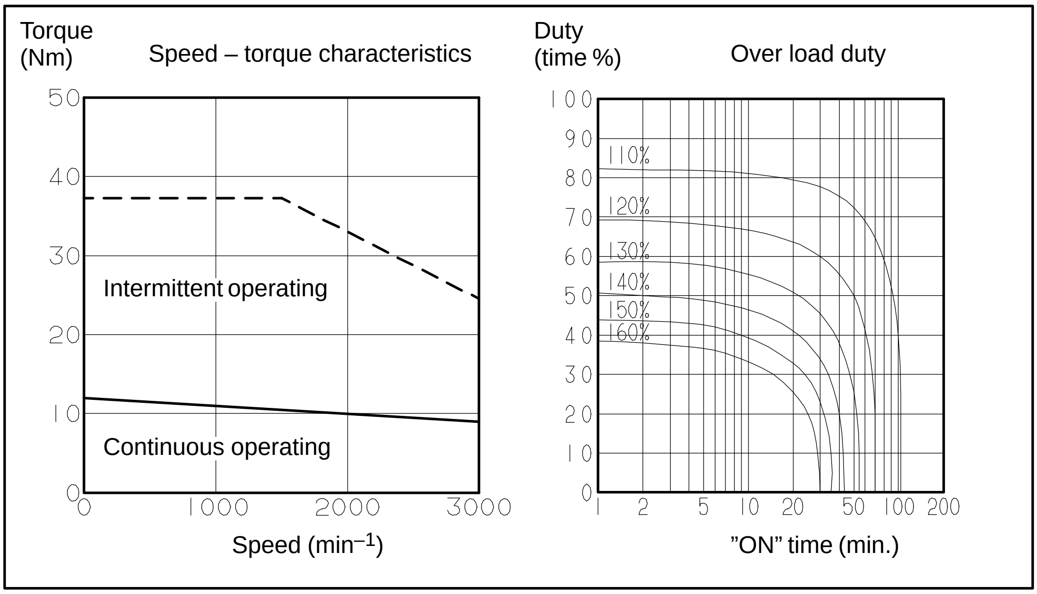
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	6.0 61			Nm kgfcm
Rotor inertia	Jm	0.0026 0.027			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	3.6			A (rms)
Torque constant (*)	Kt	1.68 17.1			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	59 0.56			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	1.52			Ω
Mechanical time constant (*)	tm	0.004			s
Thermal time constant	tt	50			min
Static friction	Tf	0.3 3			Nm kgfcm
Mass		13			kg

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

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

On model α6HV, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item

Model α12/3000HV Specification : A06B–0176–B□□□



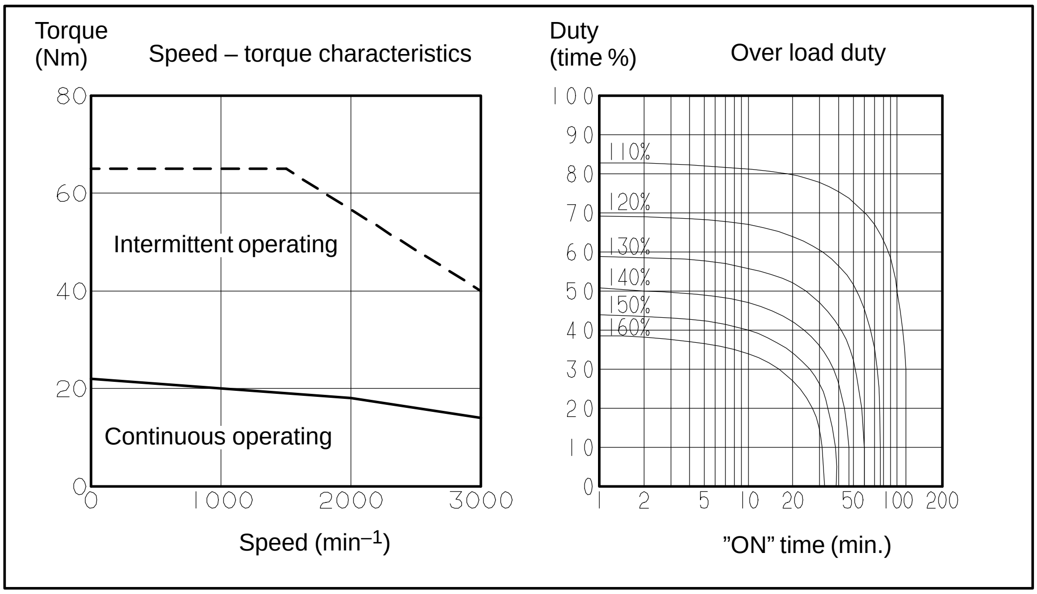
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	12 122			Nm kgfcm
Rotor inertia	Jm	0.0062 0.064			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	8.8			A (rms)
Torque constant (*)	Kt	1.36 13.8			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	47 0.45			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.49			Ω
Mechanical time constant (*)	tm	0.005			s
Thermal time constant	tt	60			min
Static friction	Tf	0.8 8			Nm kgfcm
Mass		18			kg

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

Model α22/3000HV

Specification : A06B–0177–B□□□



Data sheet

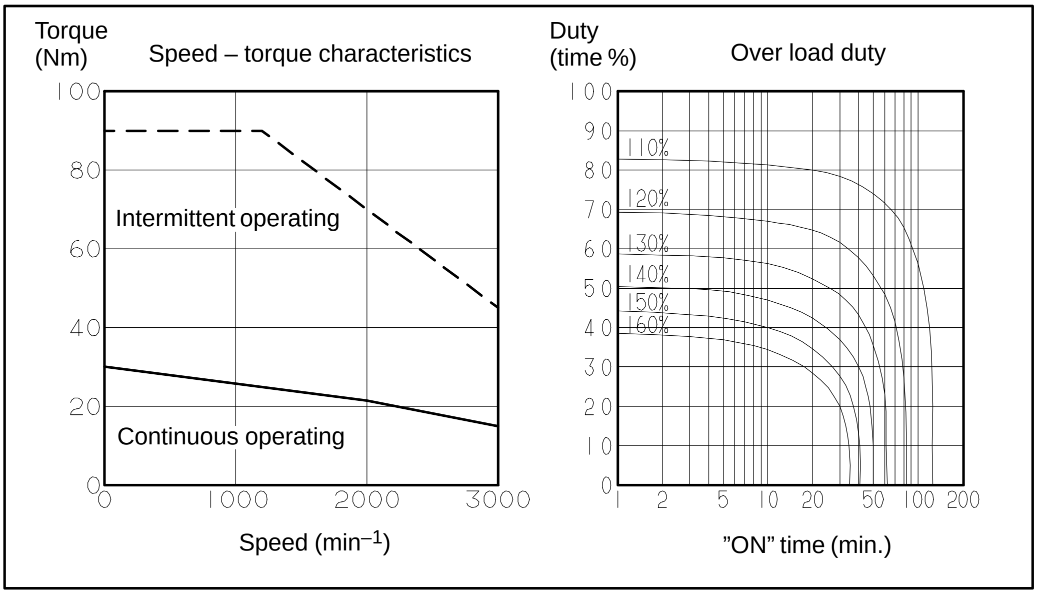
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	22 224			Nm kgfcm
Rotor inertia	Jm	0.012 0.12			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	12.5			A (rms)
Torque constant (*)	Kt	1.76 18.0			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	62 0.59			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.32			Ω
Mechanical time constant (*)	tm	0.003			s
Thermal time constant	tt	65			min
Static friction	Tf	1.2 12			Nm kgfcm
Mass		29			kg

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

The characteristics graphs above show the characteristics of the motor when combined with the 60HV servo amplifier. (For the specification of the servo amplifier, see Section 2.1 in Chapter 1.)

Model α30/3000HV

Specification : A06B–0178–B□□□



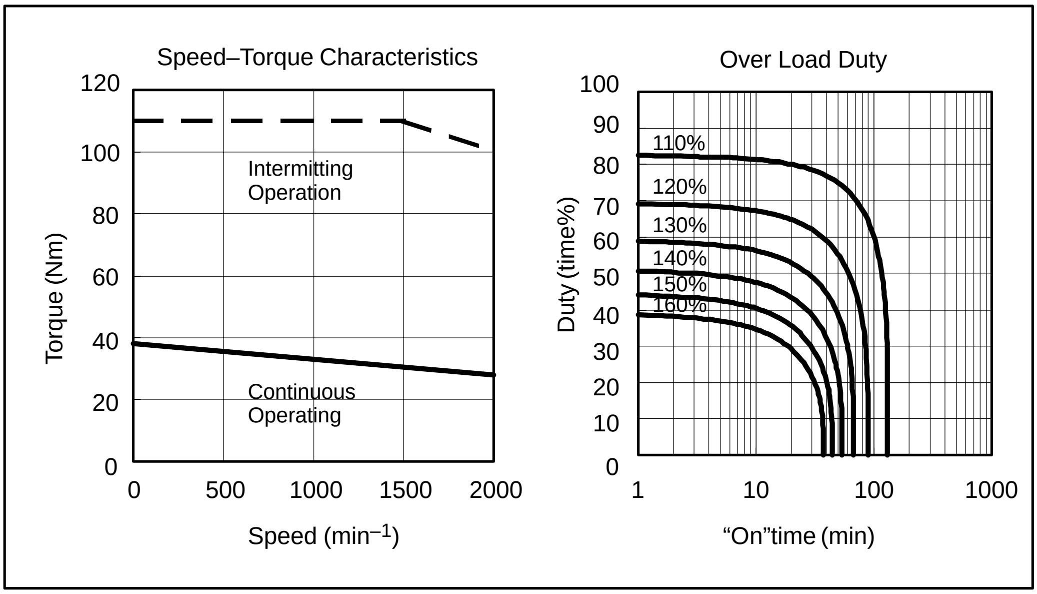
Data sheet

Parameter	Symbol	Value	Unit
Rating rotation speed	Nmax	3000	min^{-1}
Rated torque at stall (*)	Ts	30 306	Nm kgfcm
Rotor inertia	Jm	0.017 0.17	kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	12.6	A (rms)
Torque constant (*)	Kt	2.37 24.2	Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	83 0.79	V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.34	Ω
Mechanical time constant (*)	tm	0.003	s
Thermal time constant	tt	70	min
Static friction	Tf	1.8 18	Nm kgfcm
Mass		41	kg

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

The characteristics graphs above show the characteristics of the motor when combined with the 60HV servo amplifier. (For the specification of the servo amplifier, see Section 2.1 in Chapter 1.)

Model α40/2000HV Specification : A06B–0179–B□□□

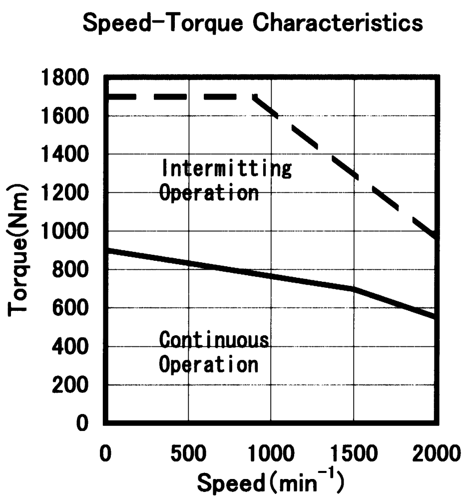


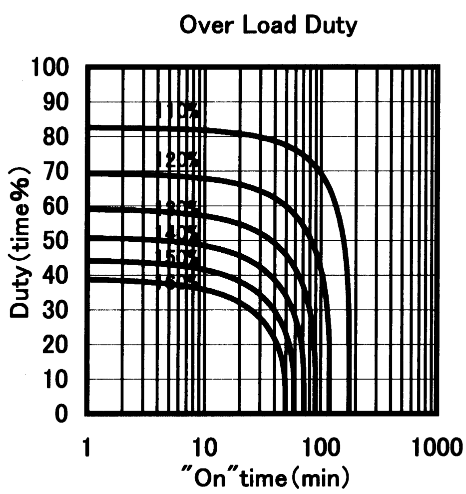
Data sheet

Parameter	Symbol	Value			Unit
Rating speed	Nmax	2000			min $^{-1}$
Rated torque at stall (*)	Ts	38 390			Nm kgfcm
Rotor inertia	Jm	0.022 0.23			kgm ^{2} kgfcms ^{2}
Continuous RMS current at stall (*)	Is	19.2			A (rms)
Torque constant (*)	Kt	1.98 20.2			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	69 0.66			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.16			Ω
Mechanical time constant (*)	tm	0.003			s
Thermal time constant	tt	75			min
Static friction	Tf	1.8 18			Nm kgfcm
Weight		52			kg

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

Model α1000/2000HV Specification : A06B–0131–B□□□





Data sheet

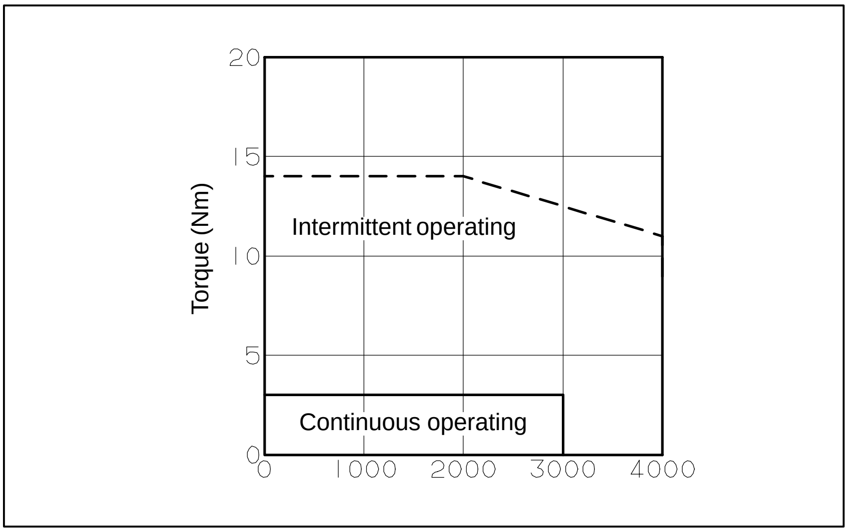
Parameter	Symbol	Value			Unit
Rating speed	Nmax	2000			min $^{-1}$
Rated torque at stall (*)	Ts	900 9180			Nm kgfcm
Rotor inertia	Jm	0.417 4.25			kgm^2 kgfcms^2
Continuous RMS current at stall (*)	Is	220			A (rms)
Torque constant (*)	Kt	4.09 41.7			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	142.7 1.36			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.011			Ω
Mechanical time constant (*)	tm	0.0008			s
Thermal time constant	tt	100			min
Static friction	Tf	4 40			Nm kgfcm
Weight		470			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo motor. (The above figures show average values.)

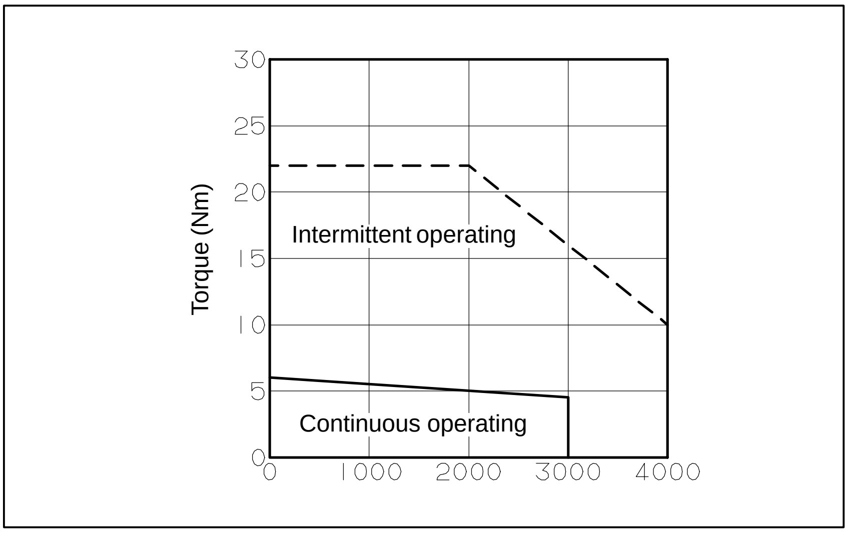
(Remarks) Speed–torque characteristics (HRV control)

On the following models, the intermittent operating zone can be extended by using HRV control.

- **α3/3000HV**



- **α6/3000HV**



CAUTION
HRV control sometimes cannot be used depending on the CNC system. Using HRV control increases the intermittent operating zone at high motor operating speeds. The continuous operating zone, however, is the same as when conventional control methods are used.

3.3 OUTLINE DRAWINGS

Model	Fig. No.
Models α3/3000HV and α6/3000HV	Fig. 3.3 (a)
Models α3/3000HV and α6/3000HV (with the brake)	Fig. 3.3 (b)
Models α3/3000HV and α6/3000HV (shaft option)	Fig. 3.3 (c)
Models α12/3000HV, α22/3000HV, and α30/3000HV	Fig. 3.3 (d)
Models α12/3000HV, α22/3000HV, and α30/3000HV (with the brake)	Fig. 3.3 (e)
Models α12/3000HV, α22/3000HV, and α30/3000HV (shaft option)	Fig. 3.3 (f)
Models α40/2000HV	Fig. 3.3 (g)
Models α40/2000HV (with the brake)	Fig. 3.3 (h)
Models α1000/2000HV	Fig. 3.3 (i) (j)

Fig. 3.3 (a) Models α3/3000HV and α6/3000HV

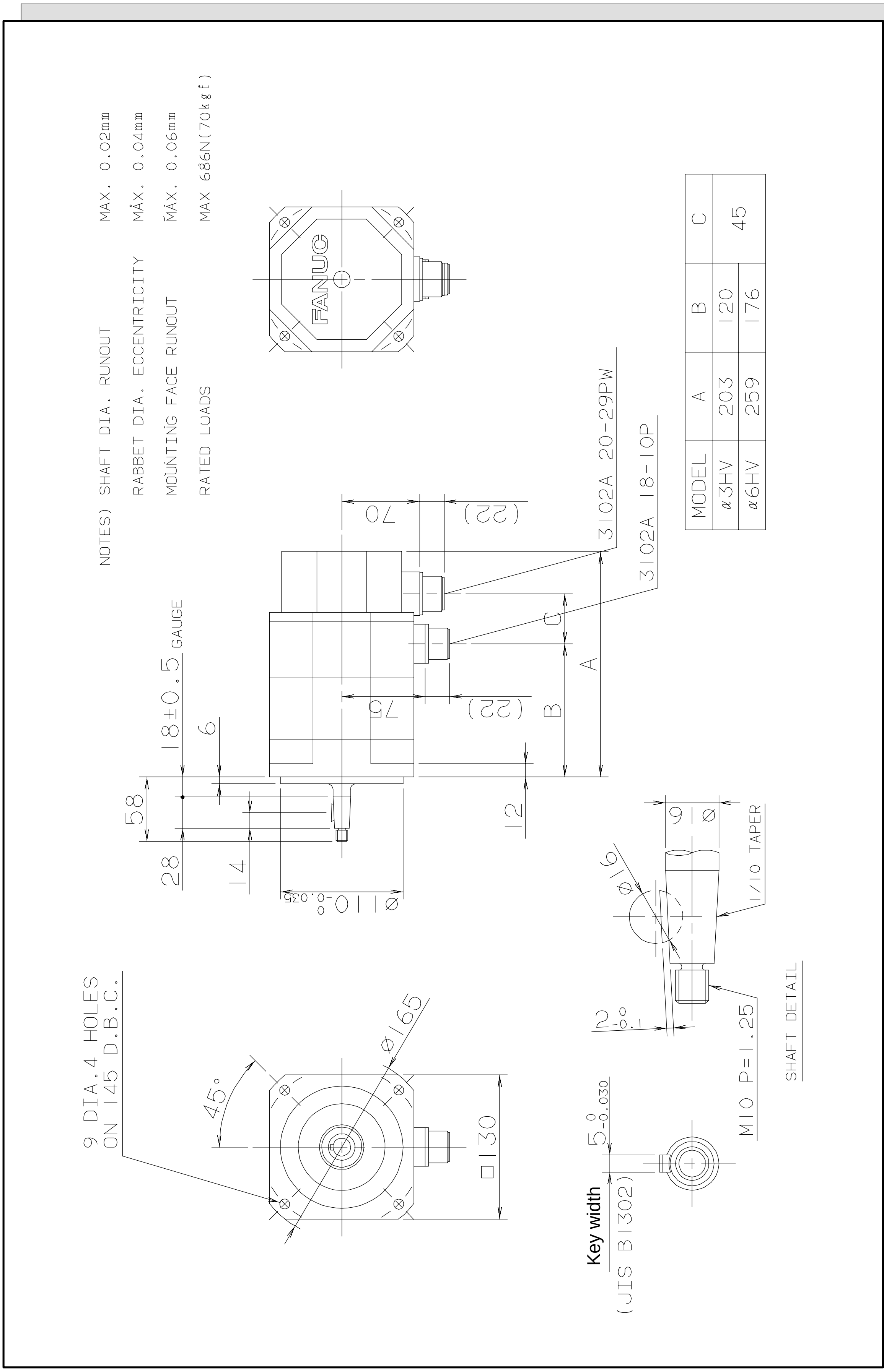
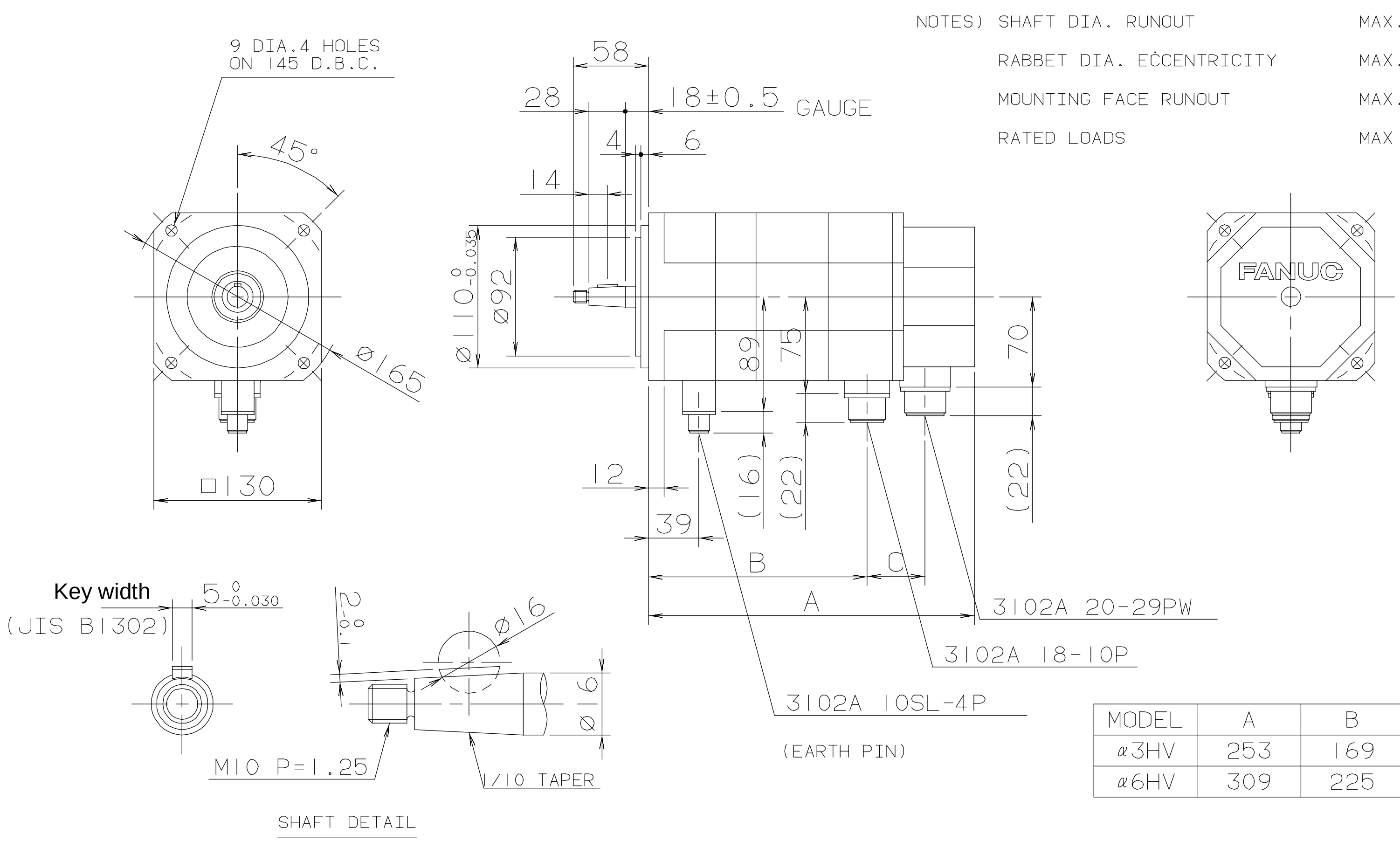


Fig. 3.3 (b) Models α3/3000HV and α6/3000HV (with the brake)



NOTES) SHAFT DIA. RUNOUT MAX. 0.02mm
RABBET DIA. ECCENTRICITY MAX. 0.04mm
MOUNTING FACE RUNOUT MAX. 0.06mm
RATED LOADS MAX 686N(70kgf)

MODEL	A	B	C
α3HV	253	169	45
α6HV	309	225	

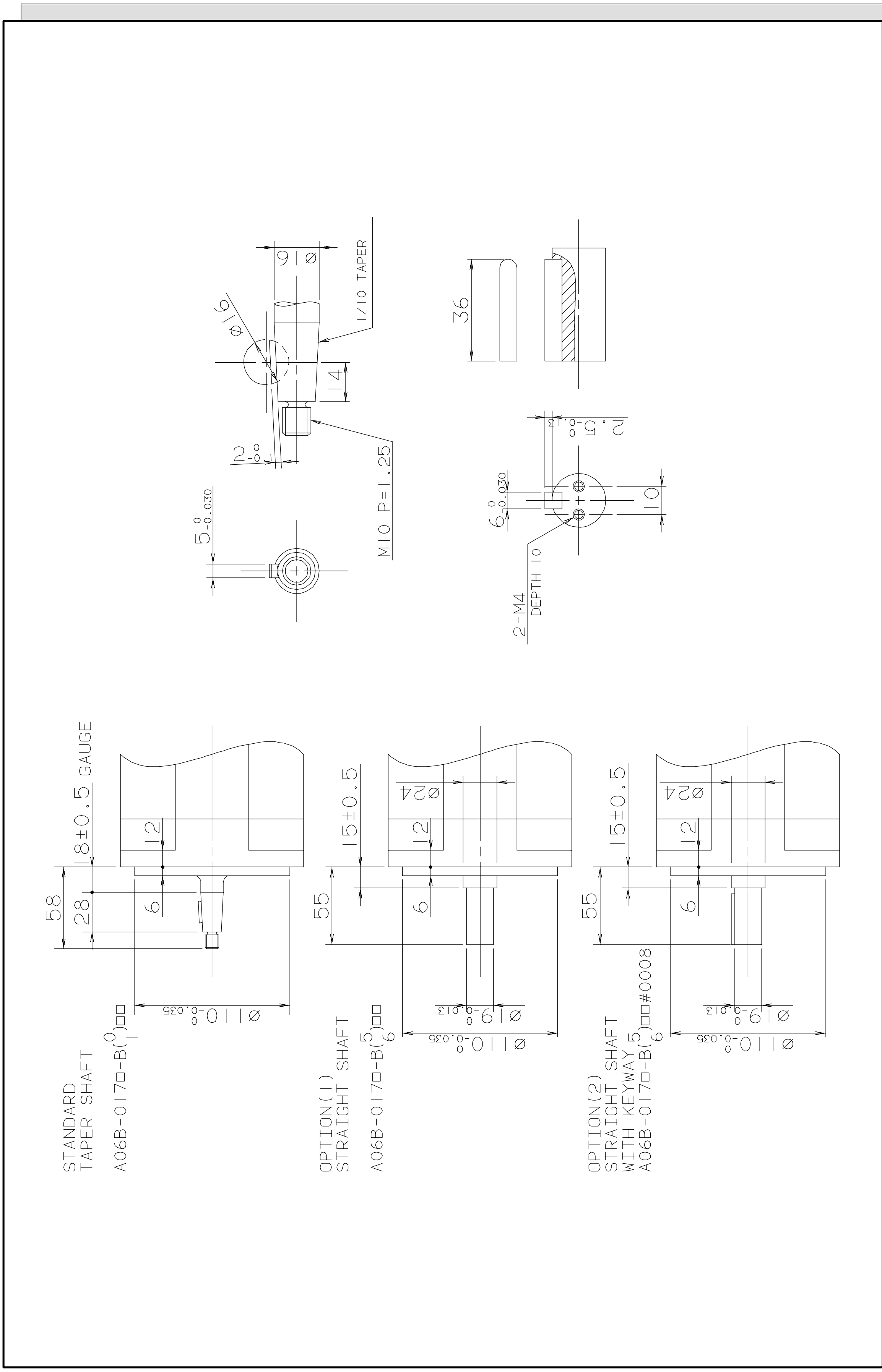
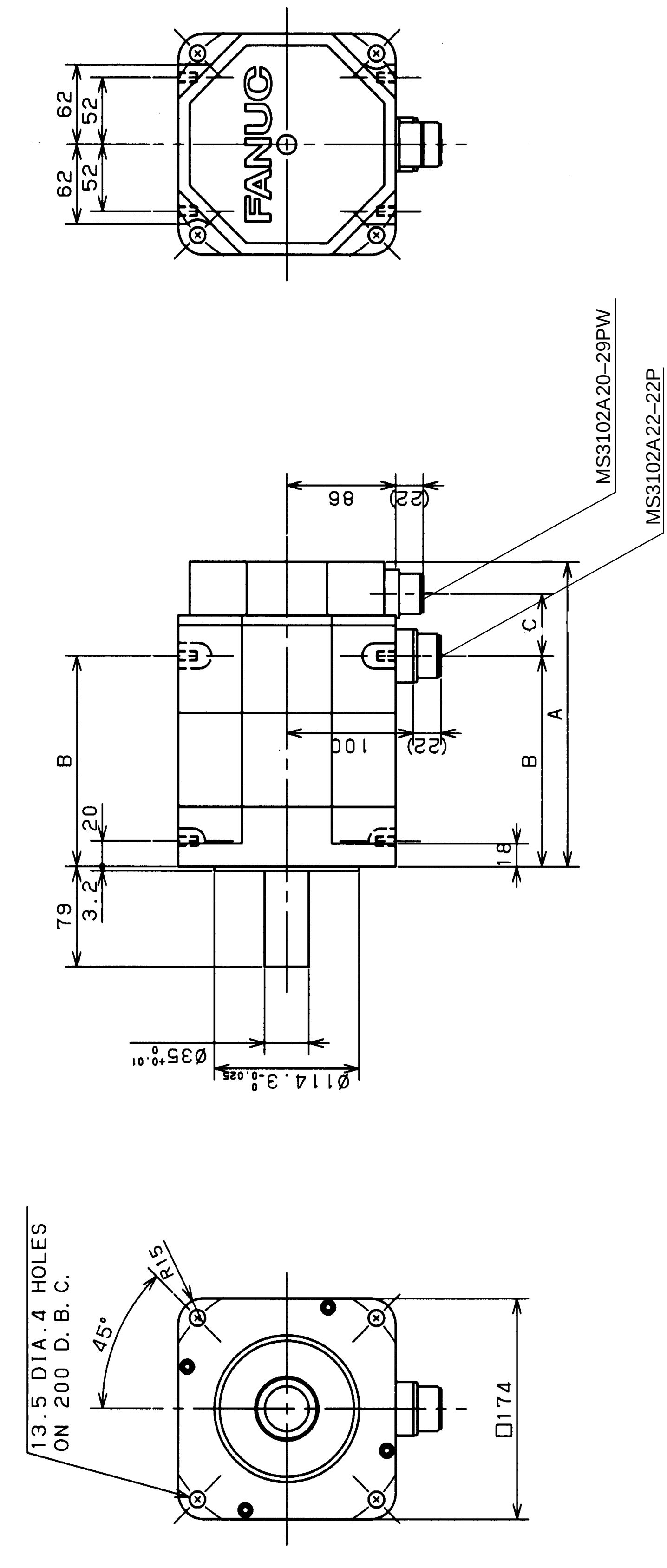


Fig. 3.3 (c) Models α3/3000HV and α6/3000HV (shaft option)

Fig. 3.3 (d) Models α12/3000HV, α22/3000HV and α30/3000HV



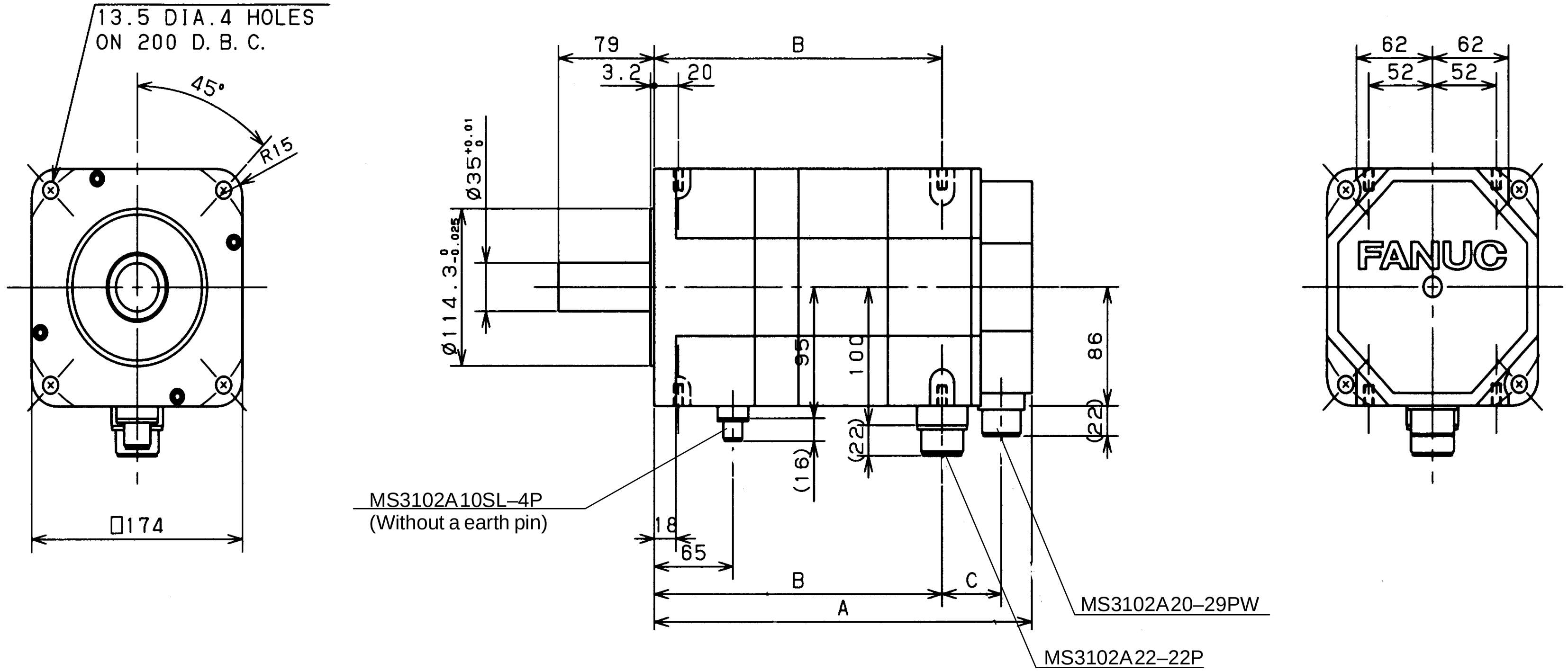
Taps for eyebolt : M8 depth 15 +1
Eyebolts are not attached

MODEL	A	B	C
α12HV	240	166	49
α22HV	314	240	
α30HV	388	314	

Notes)

Shaft diameter runout	Max 0.05mm
Rabbet diameter eccentricity	Max 0.07mm
Mounting face runout	Max 0.10mm
Rated load	4410N(450kgf)

Fig. 3.3 (e) Models α12/3000HV, α22/3000HV and α30/3000HV (with the brake)



Notes)

Shaft diameter runout	Max 0.05mm
Rabbet diameter eccentricity	Max 0.07mm
Mounting face runout	Max 0.10mm
Rated load	4410N(450kgf)

Taps for eyebolt : M8 depth 15^{+1}
Eyebolts are not attached

MODEL	A	B	C
α12HV	312	238	49
α22HV	386	312	
α30HV	460	386	

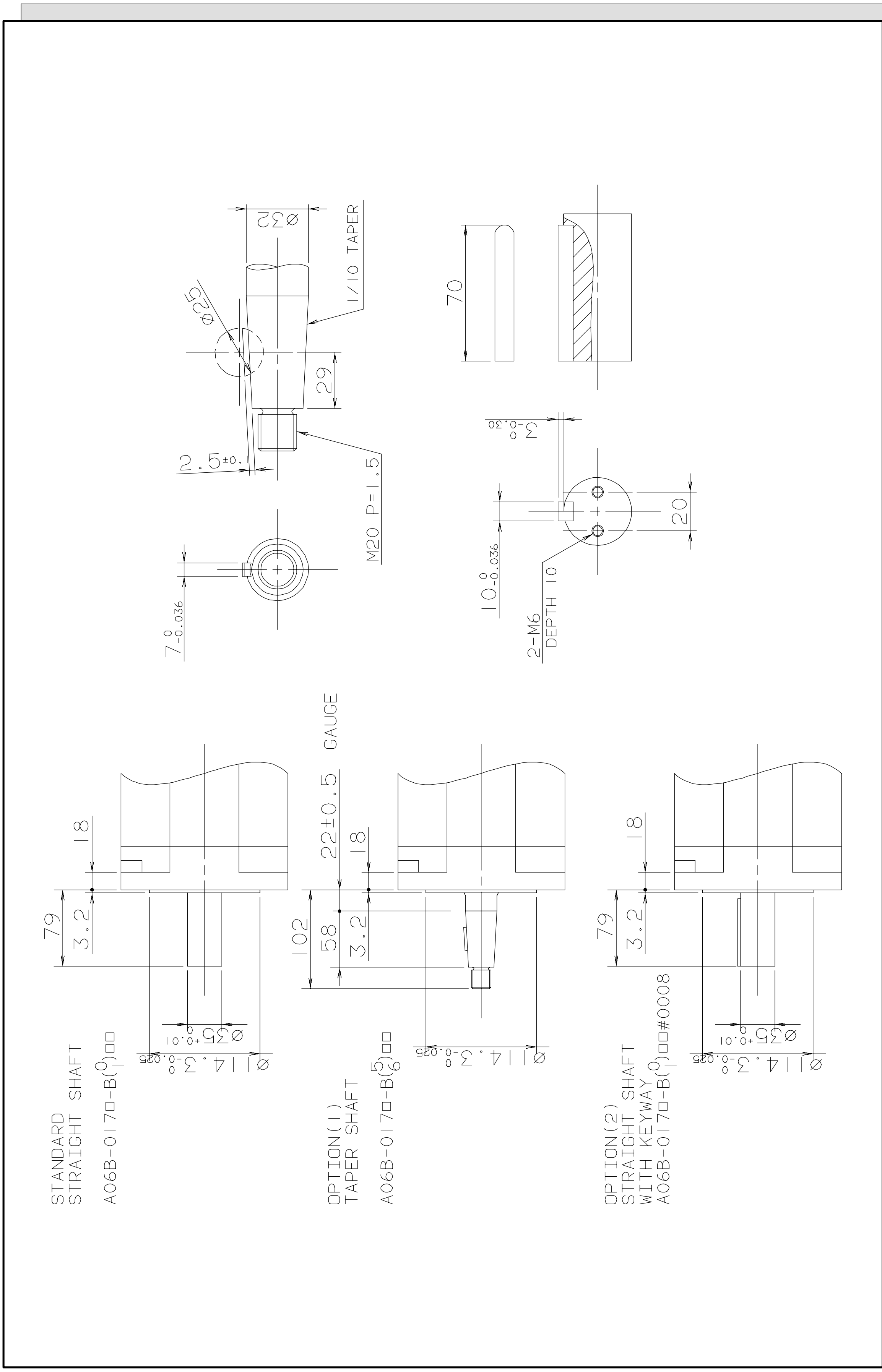
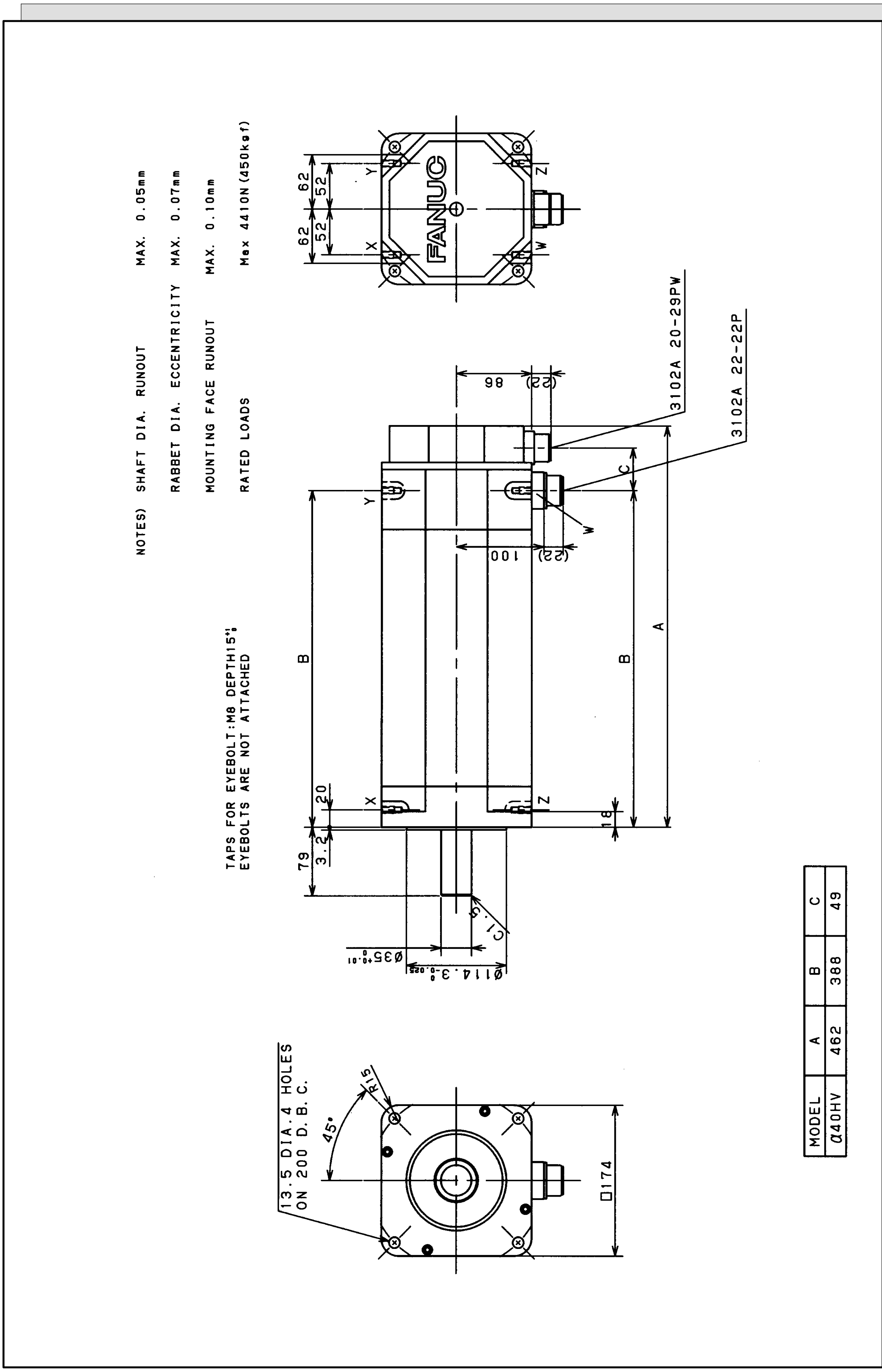


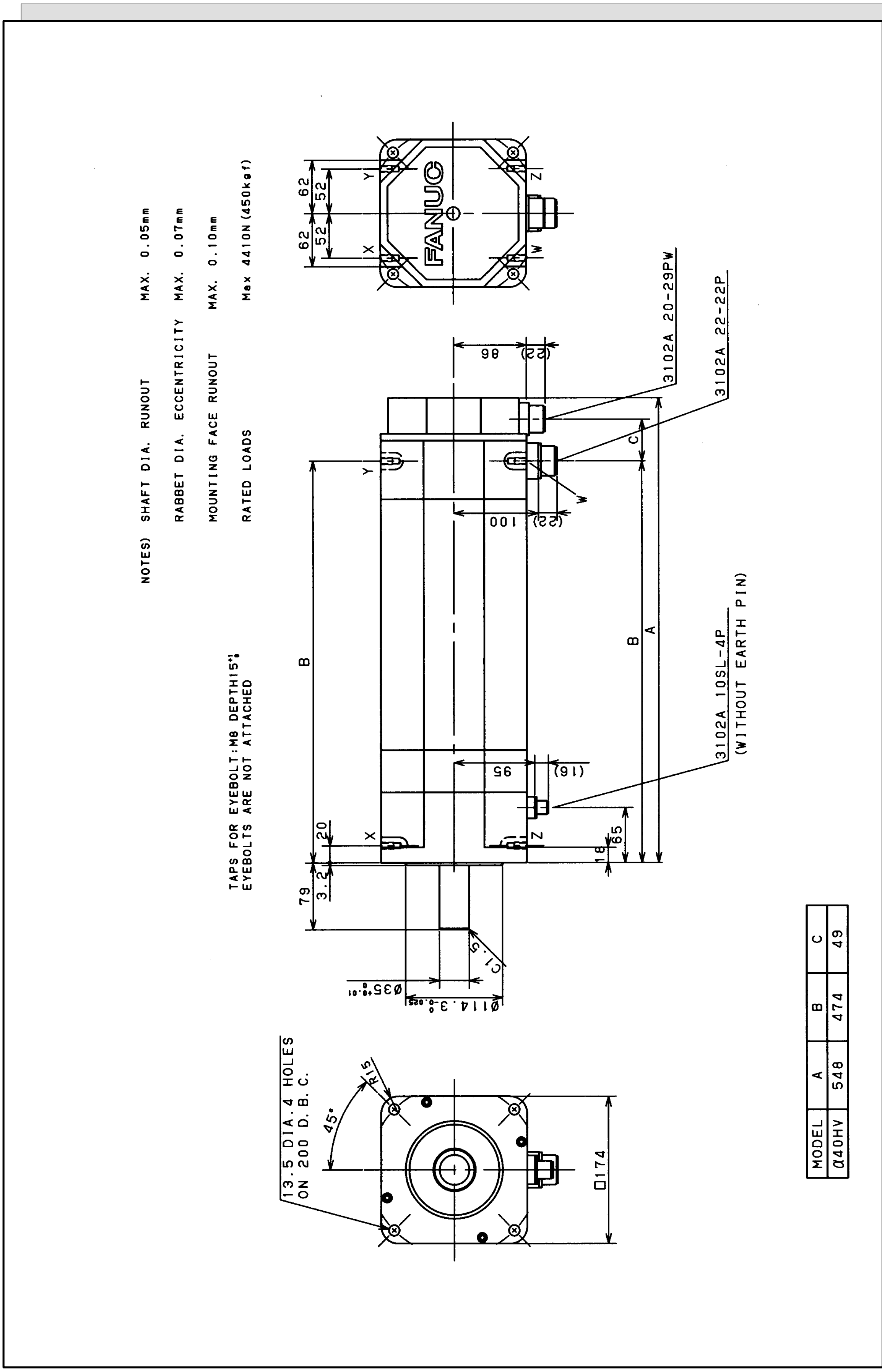
Fig. 3.3 (f) Models α12/3000HV, α22/3000HV and α30/3000HV (shaft option)



MODEL	A	B	C
α40HV	462	388	49

Fig. 3.3 (g) Model α40/2000HV

Fig. 3.3 (h) Model α40/2000HV (with the brake)



MODEL	A	B	C
α40HV	548	474	49

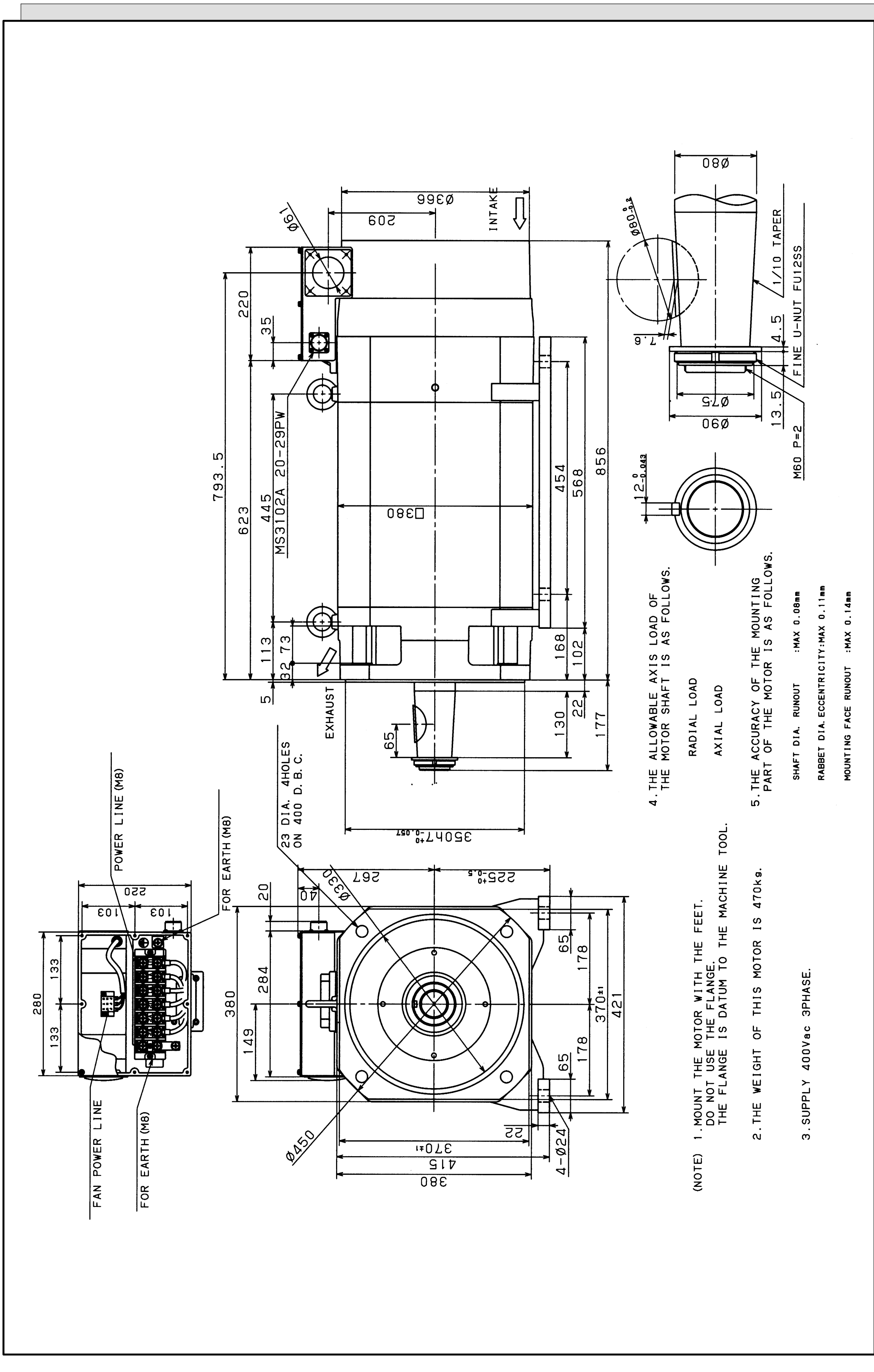
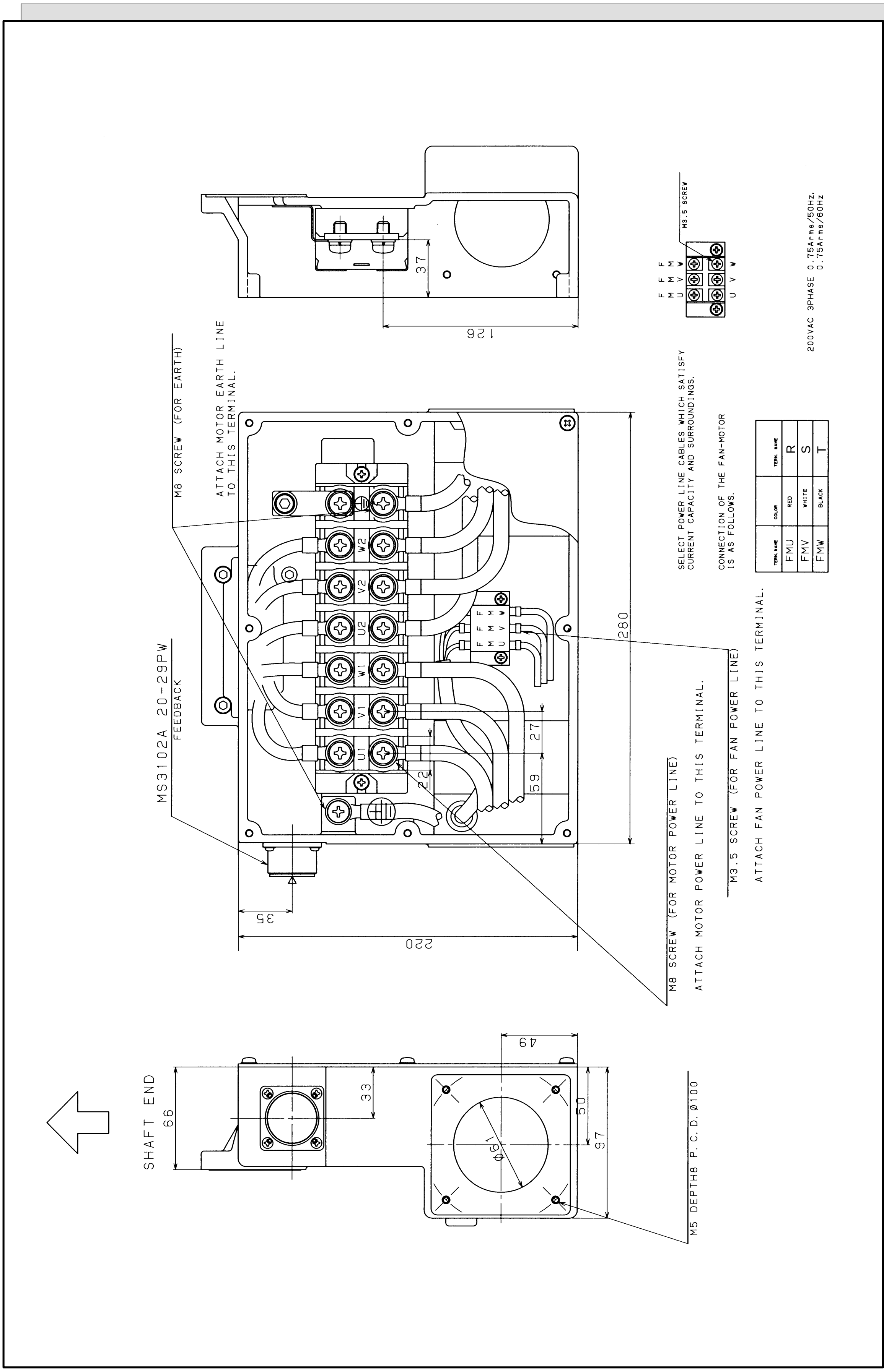


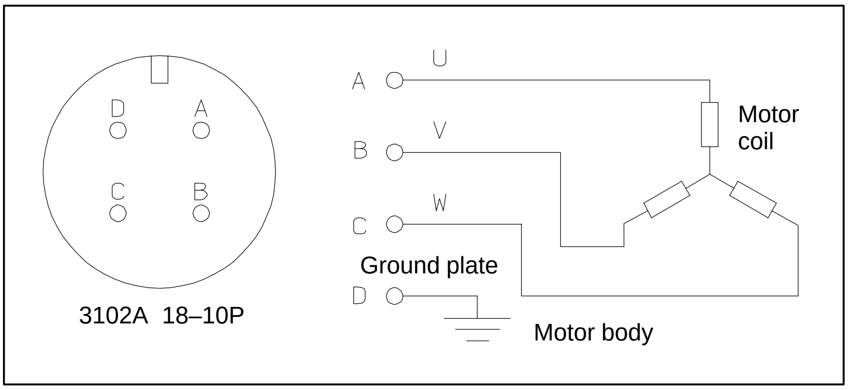
Fig. 3.3 (i) Model α1000/2000HV

Fig. 3.3 (j)   Model α1000/2000HV (terminal box)

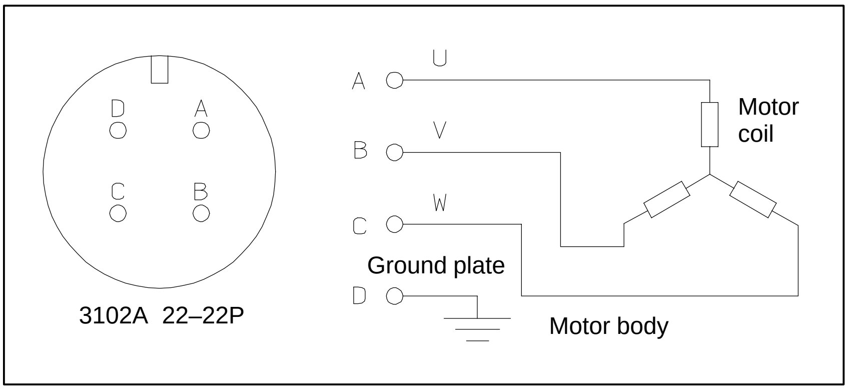


3.4 CONNECTION OF POWER LINE

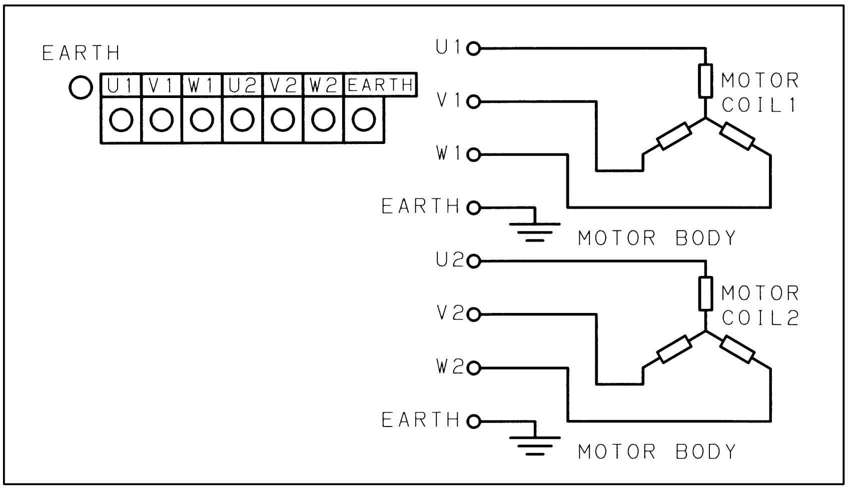
Models α3/3000HV and α6/3000HV



Models α12/3000HV, α22/3000HV, α30/3000HV, and α40/3000HV



Models α1000/2000HV



CAUTION

1 The motors should be installed with their connector facing downward as long as possible. When it is impossible to install a motor in this position, allow slack in the cable to keep liquids such as a dielectric fluid from going along the cable into the cable or motor. If there is a possibility that the motors and connectors get wet, provide a cover to protect them.

2 If a motor is not connected to the earth ground through the machine (frame), connect the motor grounding point and the amplifier grounding point to absorb noise using a 1.25 mm^2 or larger conductor other than the grounding conductor in the power cable. Keep the grounding conductor as far from the power cable as possible.

VII. FANUC AC SERVO MOTOR αM (HV) series

1 GENERAL

The FANUC AC servo motor αM(HV) series is ideal for the feed shafts of small machine tools. The features of this servo motor are as follows:

Direct connection to a 400V power source

A 400V power source can be connected directly without using a transformer.

Excellent acceleration characteristics

A high maximum output torque and intermediate rotor inertia result in excellent acceleration characteristics.

Compact

The use of the latest ferrite magnet, combined with an optimized mechanical design, reduces both the overall length and weight. The result is compact, lightweight servo motors.

Excellent waterproofing

The use of waterproof connectors and FANUC's unique stator seal provide excellent waterproofing, ensuring that no liquid, such as coolant, can enter the motor.

Wide continuous operating zone

The latest servo software minimizes heat generation at high operating speeds, and extends the continuous operating zone.

Smooth rotation

Further improvements have been made to the unique magnetic pole shape to minimize torque ripple. The result is extremely smooth rotation.

Controllability

The use of the latest servo software maintains controllability even when a disturbance occurs.

High–performance detector

High–resolution pulse coder αA1000, αA64, αI64 is used in the standard configuration, enabling precise positioning.

Powerful brake

A powerful brake with an increased holding torque is available as an option. The brake uses an asbestos–free design.

The αM (HV) series includes the following models:

- Models αM6HV and αM9HV that are compatible with the installation dimensions of the α series models α3 and α6
- Models αM22HV, αM30HV, and αM40HV that are compatible with the installation dimensions of the α series models α12, α22, α30, and α40

2 TYPES OF MOTORS AND DESIGNATION

Models αM6/3000HV and αM9/3000HV

A06B–01□□–B☆ ○○

□□
- **82** : Model αM6/3000HV
- **83** : Model αM9/3000HV

☆
- **0** : Taper shaft (standard)
- **2** : Taper shaft with the brake (8Nm/24VDC)
- **5** : Straight shaft
- **7** : Straight shaft with the brake (8Nm/24VDC)

○○
- **75** : Pulse coder αA64
- **77** : Pulse coder αI64
- **88** : Pulse coder αA1000

The standard shafts used for models αM6/3000HV and αM9/3000HV are taper shafts. Use a taper shaft as far as circumstances, such as the delivery time and maintenance, permit.

Models αM22/3000HV and αM30/3000HV

A06B–01□□–B☆ ○○

□□
- **85** : Model αM22/3000HV
- **86** : Model αM30/3000HV

☆
- **0** : Straight shaft (standard)
- **2** : Straight shaft with the brake (35Nm/24VDC)
- **5** : Taper shaft
- **7** : Taper shaft with the brake (35Nm/24VDC)

○○
- **75** : Pulse coder αA64
- **77** : Pulse coder αI64
- **88** : Pulse coder αA1000

A straight shaft is fitted as the standard shaft for models αM22/3000HV and αM30/3000HV. When early delivery and case–of–maintenance are important, a straight shaft should be used.

Models
αM40/3000HV

A06B–0189–☆ ○○

☆

0 : Straight shaft (standard)
2 : Straight shaft with the brake (35Nm 24VDC)

○○

75 : With the pulse coder αA64
77 : With the pulse coder αI64
88 : With the pulse coder αA1000

This model, a tapered shaft is not available.

3 SPECIFICATIONS AND CHARACTERISTICS

3.1 TYPES OF MOTORS AND SPECIFICATIONS

Item	Unit	αM6/ 3000HV	αM9/ 3000HV	αM22/ 3000HV	αM30/ 3000HV	αM40/ 3000HV
Output	kw	1.4	1.8	3.8	3.8	3.0
	HP	1.9	2.4	5.1	5.1	4.0
Rated torque at stall	Nm	6	9	20	30	40
	kgf·cm	61	92	204	306	408
Rating rotation speed	min^{-1}	3000	3000	3000	2000(S1) 3000(S3–60%)	1000
Rotor inertia	$kg \cdot m^2$	0.0013	0.0025	0.0058	0.011	0.012
	$kgf \cdot cm \cdot s^2$	0.014	0.026	0.059	0.11	0.12
Mass	kg	7.5	12	29	41	41

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

3.2 CHARACTERISTIC CURVE AND DATA SHEET

Speed–torque characteristics

The intermittent operation zone is determined by the input voltage applied to the drive amplifier. The curve shown is the value for the rated input voltage (400V).
On model αM40/3000HV, “Intermittent operating (S3 to 25%)” in the “Speed–torque characteristics” is permitting operating zone in IEC34–1, and it enables to operate 2.5 min ON and 7.5 min OFF in 10 min cycle time.
Equally, (S3 to 60%)” in the “Speed–torque characteristics” enables to operate 6 min ON and 4 min OFF in 10 min cycle time.
On models αM6HV to αM9HV, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item

Overload duty characteristic

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

Data sheet

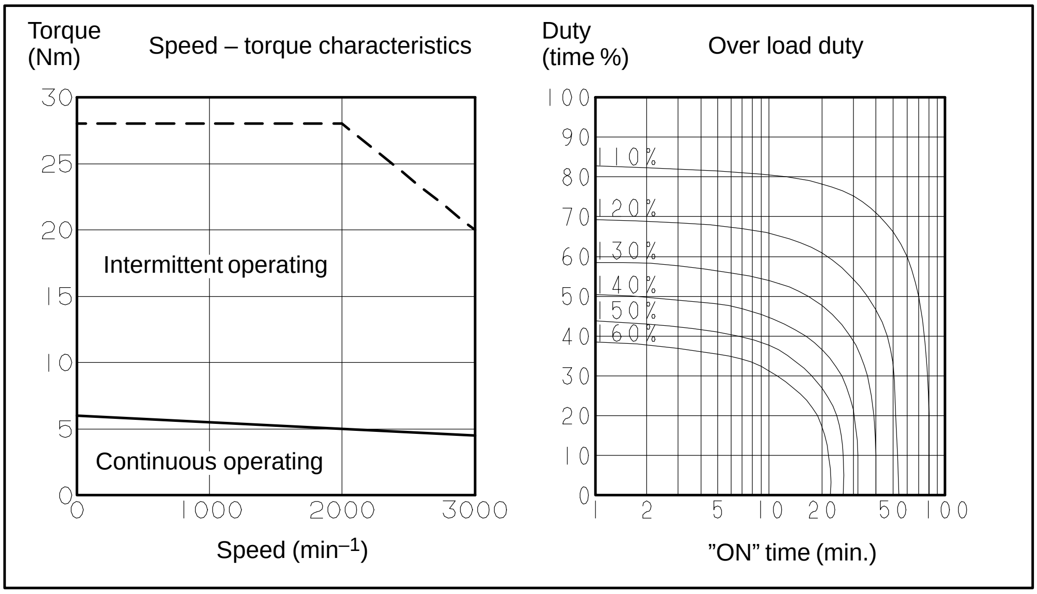
The parameters given in the data sheet are representative values for an ambient temperature of 20°C. They are subject to an error of +10%.
The indicated logical values are threshold values for the single motor unit (when the motor is not restricted by the control system).
The maximum torque that can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

Example : αM6/3000HV

- Motor torque constant = 1.50 (Nm/Arms)
- Amplifier limit value = 40 (Apeak)
- Maximum torque value
  $= \underline{40 \times 0.707} \times 1.50$ (Nm)
  (Converted to an effective value)

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

Model αM6/3000HV Specification : A06B–0182–B□□□



Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	6 61			Nm kgfcm
Rotor inertia	Jm	0.0013 0.014			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	4.0			A (rms)
Torque constant (*)	Kt	1.50 15.3			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	52 0.50			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	1.80			Ω
Mechanical time constant (*)	tm	0.003			s
Thermal time constant	tt	45			min
Static friction	Tf	0.3 3			Nm kgfcm
Maximum allowable current	Im	60			A (peak)
Mass		7.5			kg

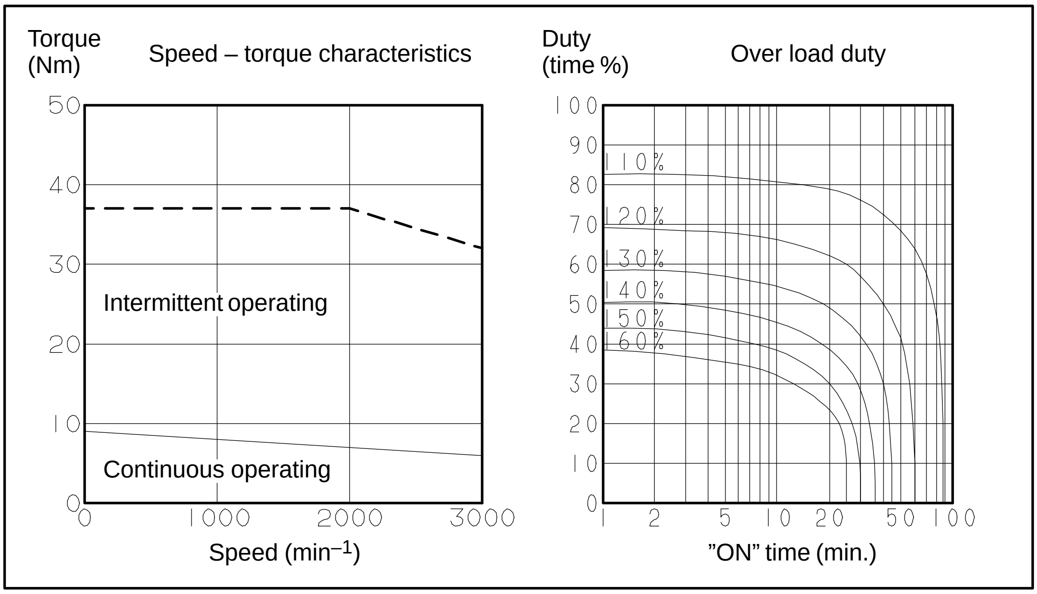
(*) The values are the standard values at 20°C and the tolerance is ±10%.

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

On model αM6HV, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item

Model αM9/3000HV

Specification : A06B–0183–B□□□



Data sheet

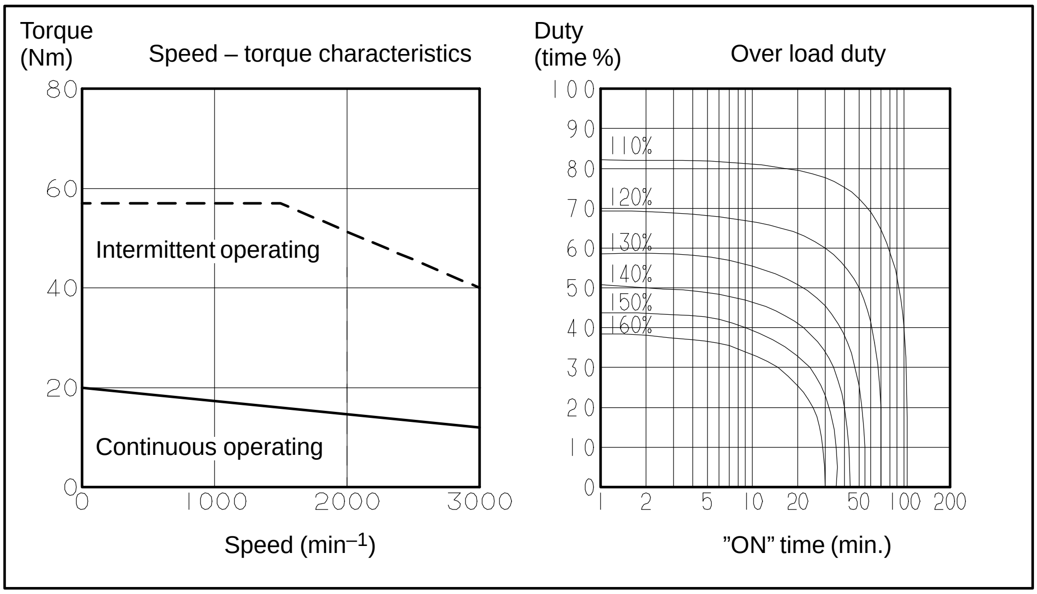
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	9 92			Nm kgfcm
Rotor inertia	Jm	0.0025 0.026			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	5.8			A (rms)
Torque constant (*)	Kt	1.56 15.9			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	54 0.52			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.67			Ω
Mechanical time constant (*)	tm	0.002			s
Thermal time constant	tt	50			min
Static friction	Tf	0.3 3			Nm kgfcm
Maximum allowable current	Im	120			A (peak)
Mass		12			kg

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

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

On model αM9HV, the maximum speed of rotation is increased by using HRV control. The speed-torque characteristics for when HRV control is used are described at the end of this item

Model αM22/3000HV Specification : A06B–0185–B□□□



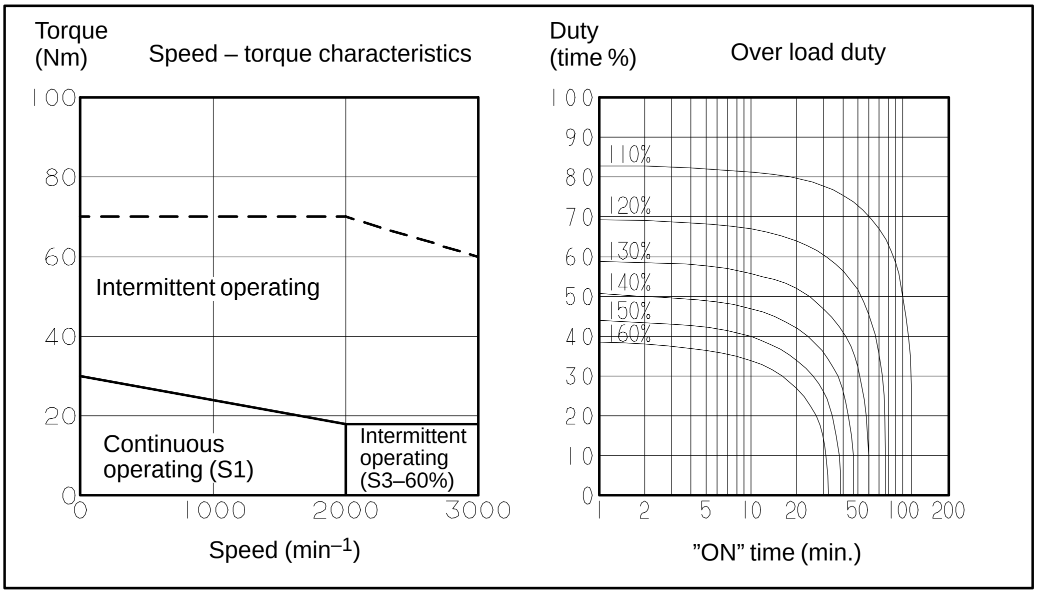
Data sheet

Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	3000			min^{-1}
Rated torque at stall (*)	Ts	20 204			Nm kgfcm
Rotor inertia	Jm	0.0058 0.059			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	12.1			A (rms)
Torque constant (*)	Kt	1.66 16.9			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	58 0.55			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.26			Ω
Mechanical time constant (*)	tm	0.002			s
Thermal time constant	tt	60			min
Static friction	Tf	0.8 8			Nm kgfcm
Maximum allowable current	Im	90			A (peak)
Mass		18			kg

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

Model αM30/3000HV

Specification : A06B–0186–B□□□



Data sheet

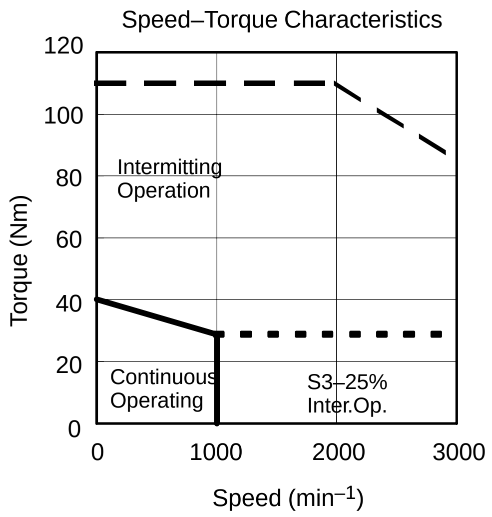
Parameter	Symbol	Value			Unit
Rating rotation speed	Nmax	2000 (S1) 3000 (S3–60%)			min^{-1}
Rated torque at stall (*)	Ts	30 306			Nm kgfcm
Rotor inertia	Jm	0.011 0.11			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	16.3			A (rms)
Torque constant (*)	Kt	1.85 18.8			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	64 0.64			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.16			Ω
Mechanical time constant (*)	tm	0.002			s
Thermal time constant	tt	65			min
Static friction	Tf	1.2 12			Nm kgfcm
Maximum allowable current	Im	160			A (peak)
Mass		30			kg

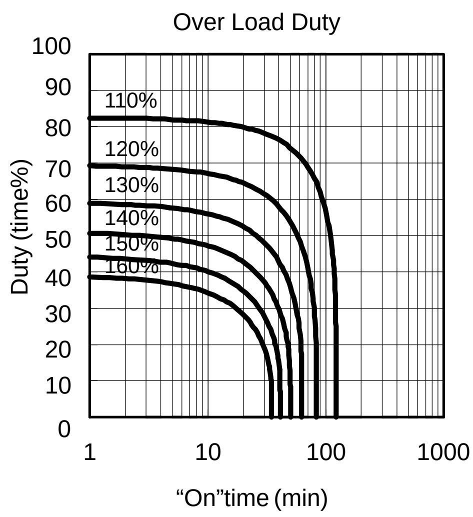
(*) The values are the standard values at 20°C and the tolerance is ±10%.

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

The 2000 to 3000 min^{-1} range of this servo motor is the intermittent operation range, and is used mainly for positioning. In the intermittent operation range (S3 to 60%), ON operation of six minutes and OFF operation of four minutes in a 10-minute cycle is possible.

Model αM40/3000HV Specification : A06B–0189–B□□□





Data sheet

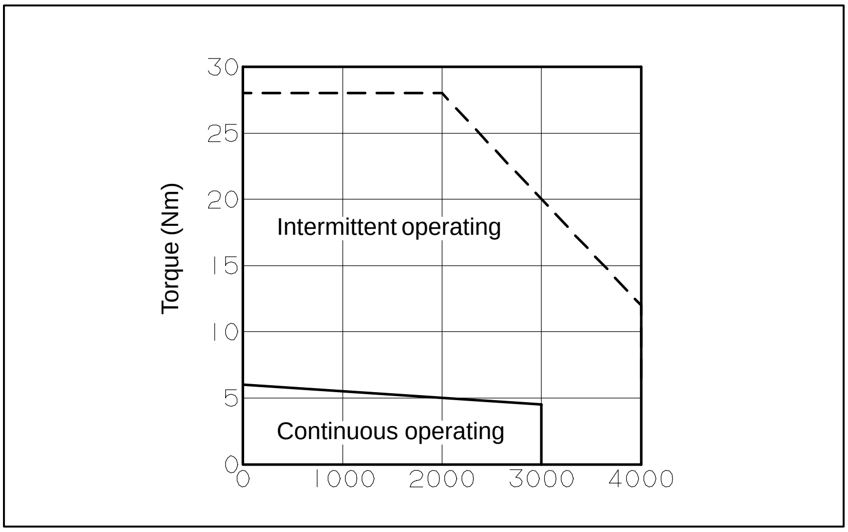
Parameter	Symbol	Value			Unit
Rating speed	Nmax	1000			min^{-1}
Rated torque at stall (*)	Ts	40 408			Nm kgfcm
Rotor inertia	Jm	0.012 0.12			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	20.2			A (rms)
Torque constant (*)	Kt	1.98 20.2			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	69 0.66			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.13			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	70			min
Static friction	Tf	1.8 18			Nm kgfcm
Weight		41			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo software. (The above figures show average values.)
These values may be changed without prior notice.
S3 to 25% intermitting operating zone shows 2.5 min continuous operating zone in 10 min cycle.

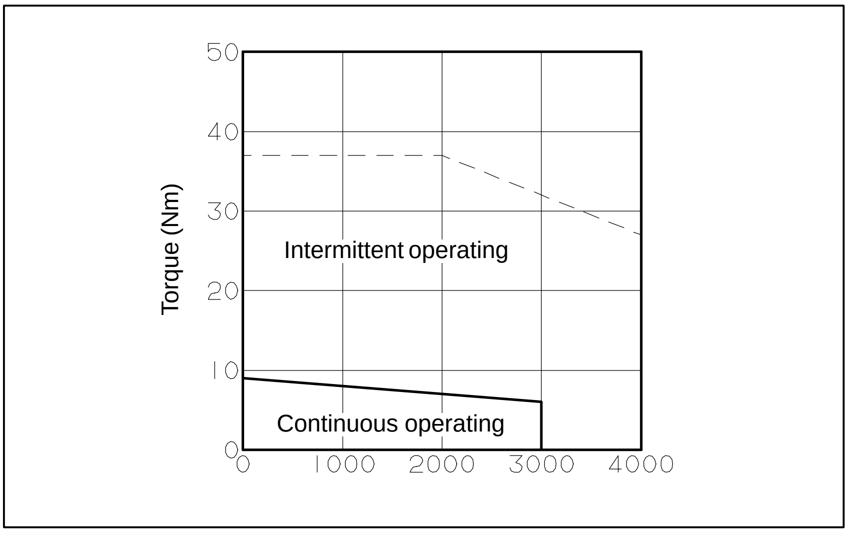
(Remarks) Speed–torque characteristics (HRV control)

On the following models, the intermittent operating zone can be extended by using HRV control.

- **αM6/3000HV**



- **αM9/3000HV**

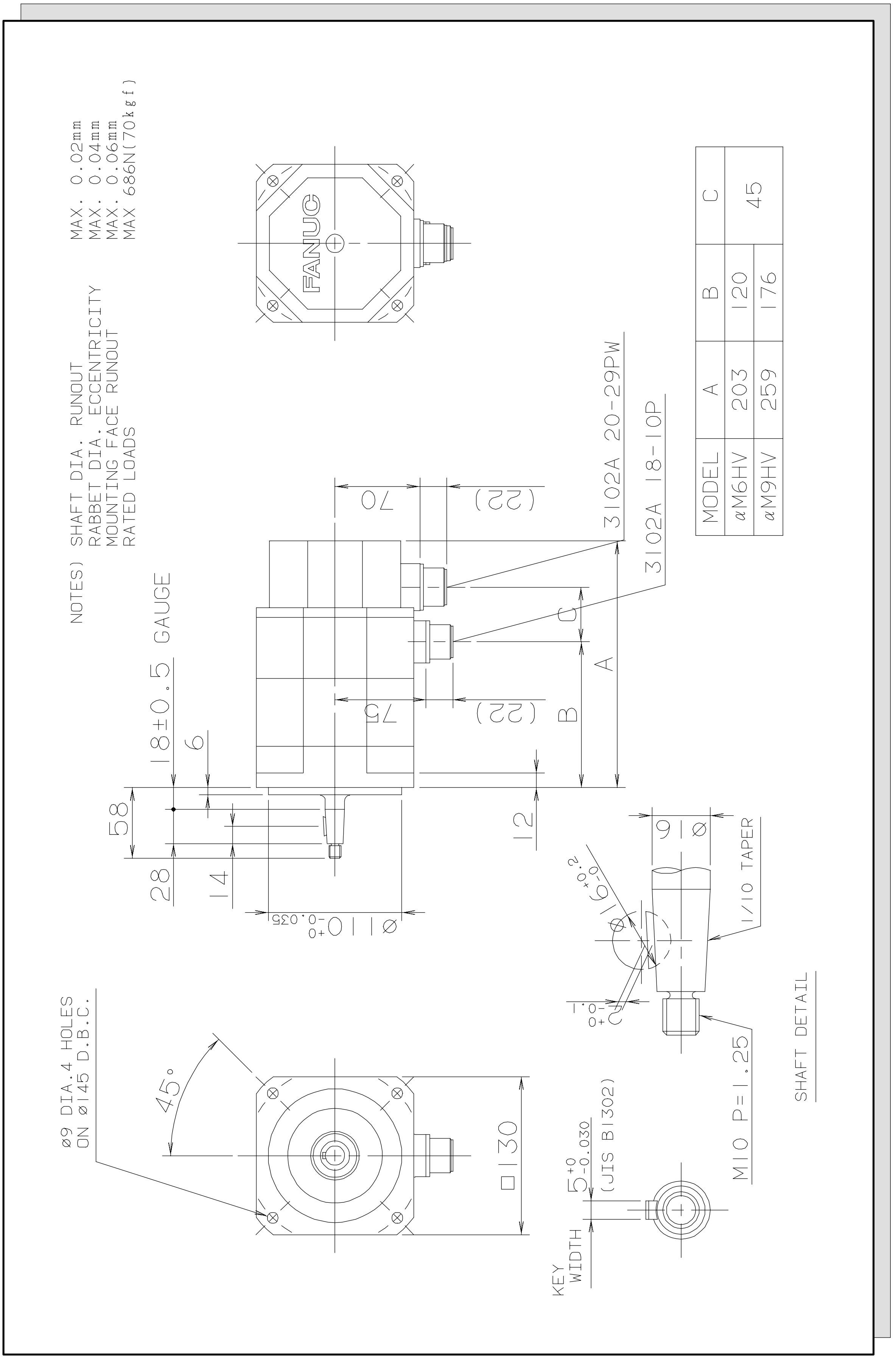


> **NOTE**
> HRV control sometimes cannot be used depending on the CNC system. Using HRV control increases the intermittent operating zone at high motor operating speeds. The continuous operating zone, however, is the same as when conventional control methods are used.

3.3 OUTLINE DRAWINGS

Model	Fig. No.
Models αM6/3000HV and αM9/3000HV (standard)	Fig. 3.3 (a)
Models αM6/3000HV and αM9/3000HV (with the brake)	Fig. 3.3 (b)
Models αM6/3000HV (shaft option)	Fig. 3.3 (c)
Models αM9/3000HV (shaft option)	Fig. 3.3 (d)
Models αM22/3000HV and αM30/3000HV (standard)	Fig. 3.3 (e)
Models αM22/3000HV and αM30/3000HV (with the brake)	Fig. 3.3 (f)
Models αM22/3000HV and αM30/3000HV (shaft option)	Fig. 3.3 (g)
Model αM40/3000HV	Fig. 3.3 (h)
Model αM40/3000HV (with the brake)	Fig. 3.3 (i)

Fig. 3.3 (a) Models αM6/3000HV and αM9/3000HV (standard)



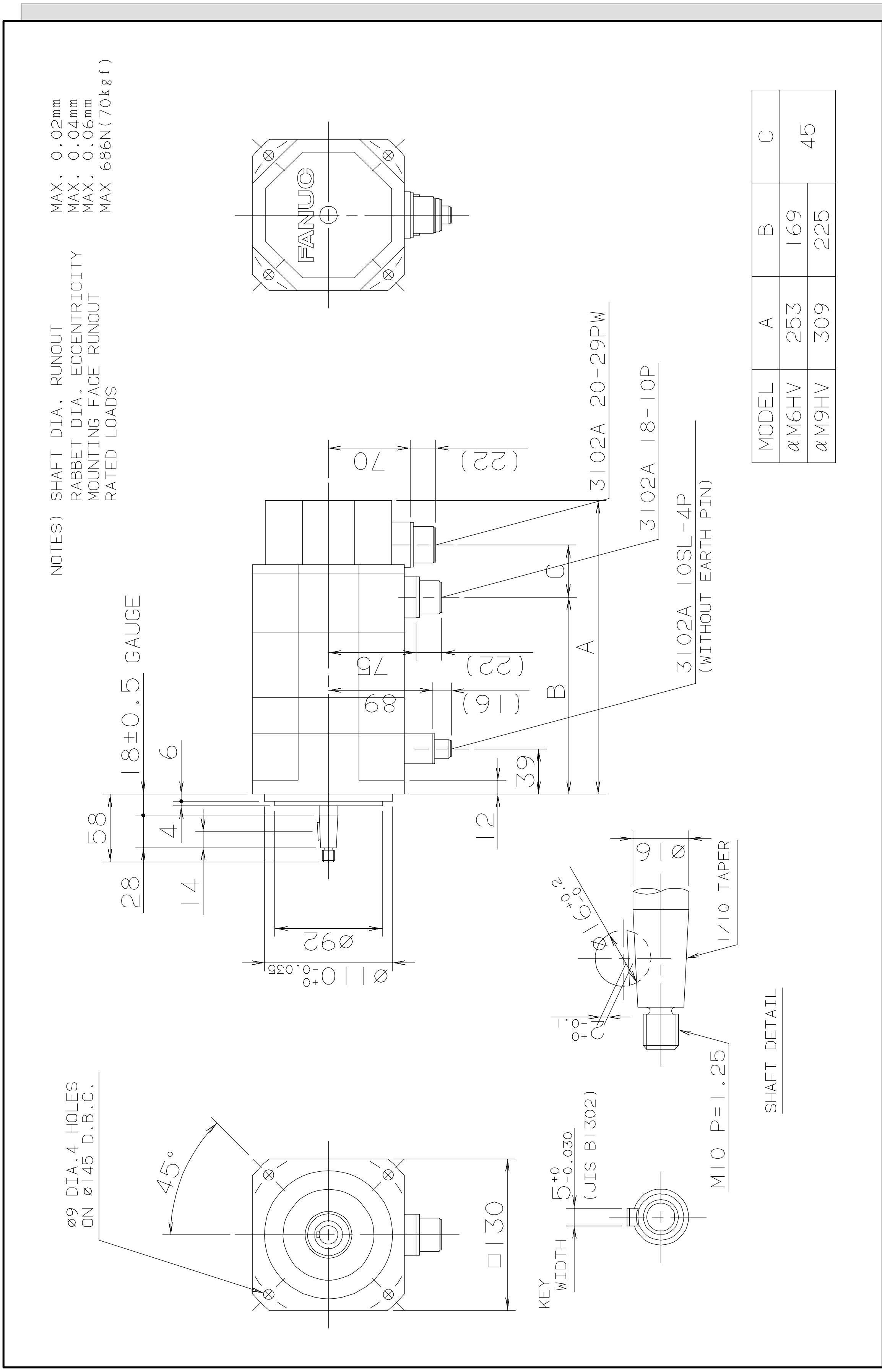


Fig. 3.3 (b) Models αM6/3000HV and αM9/3000HV (with the brake)

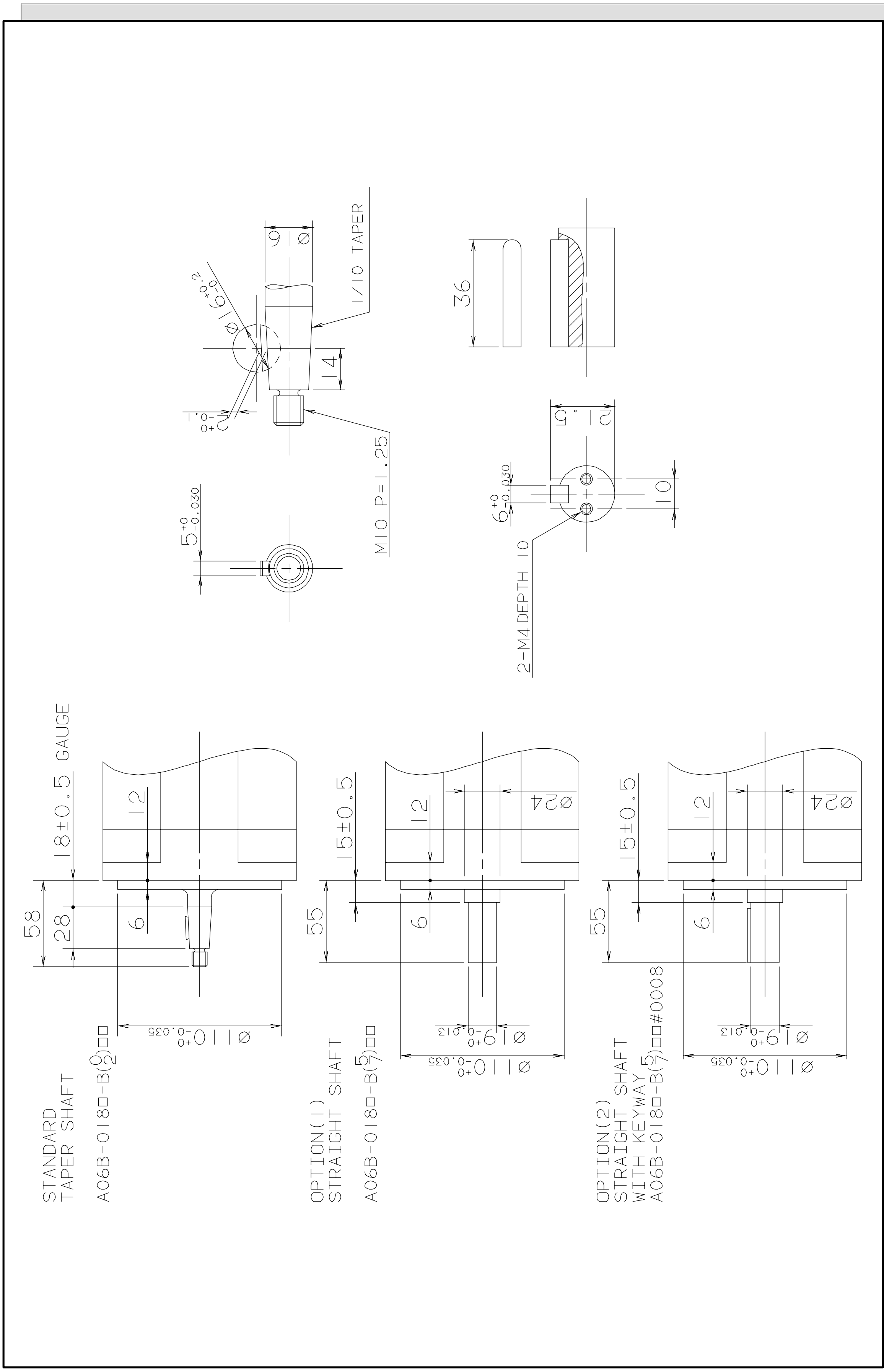


Fig. 3.3 (c) Models αM6/3000HV (shaft option)

Fig. 3.3 (d) Models αM9/3000HV (shaft option)

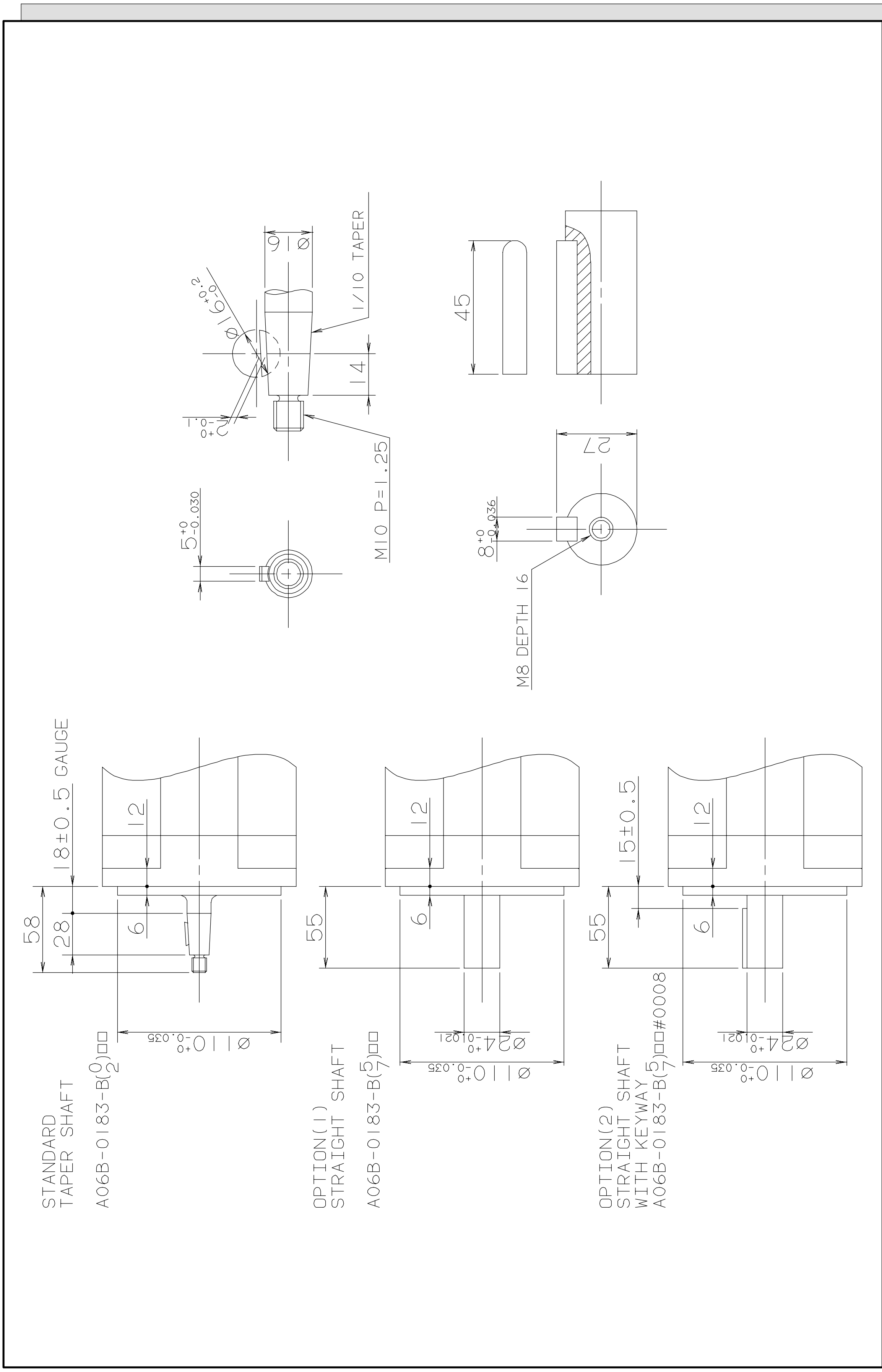
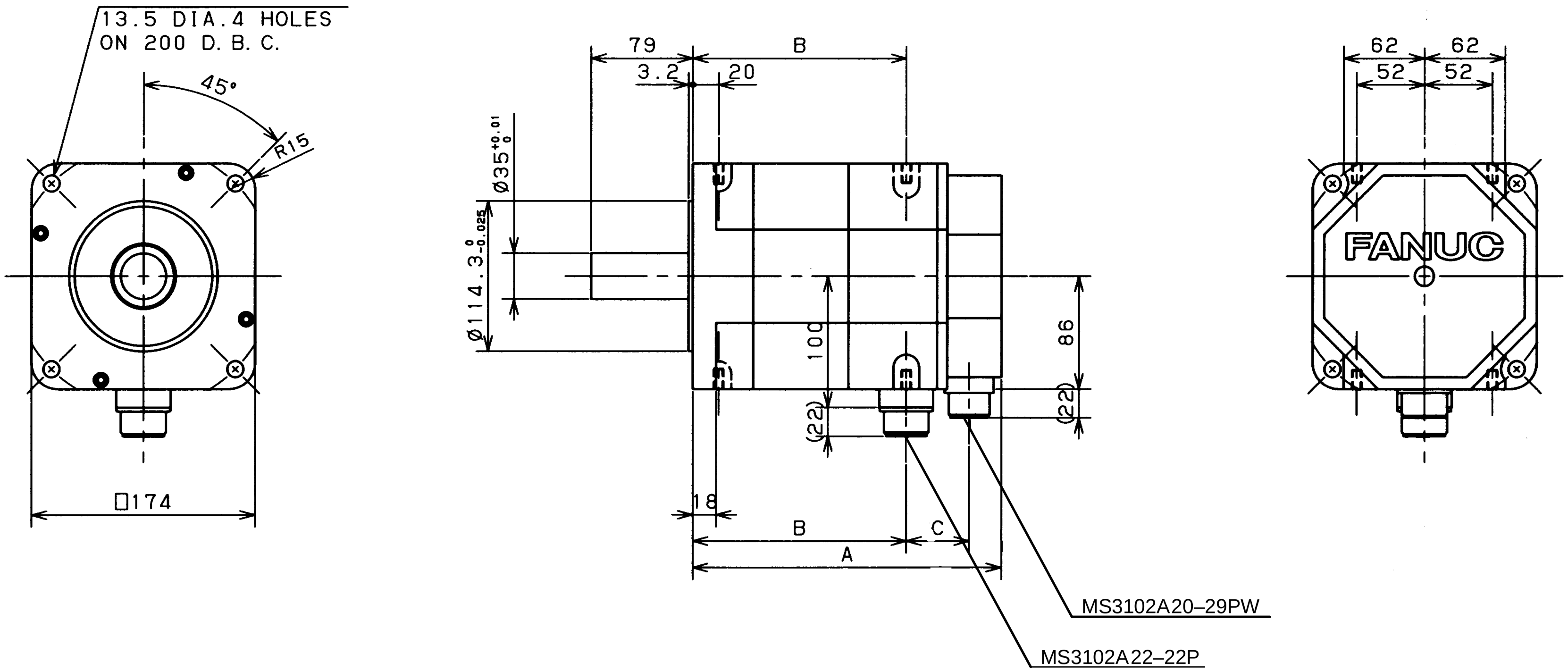


Fig. 3.3 (e) Models αM22/3000HV and αM30/3000HV (standard)



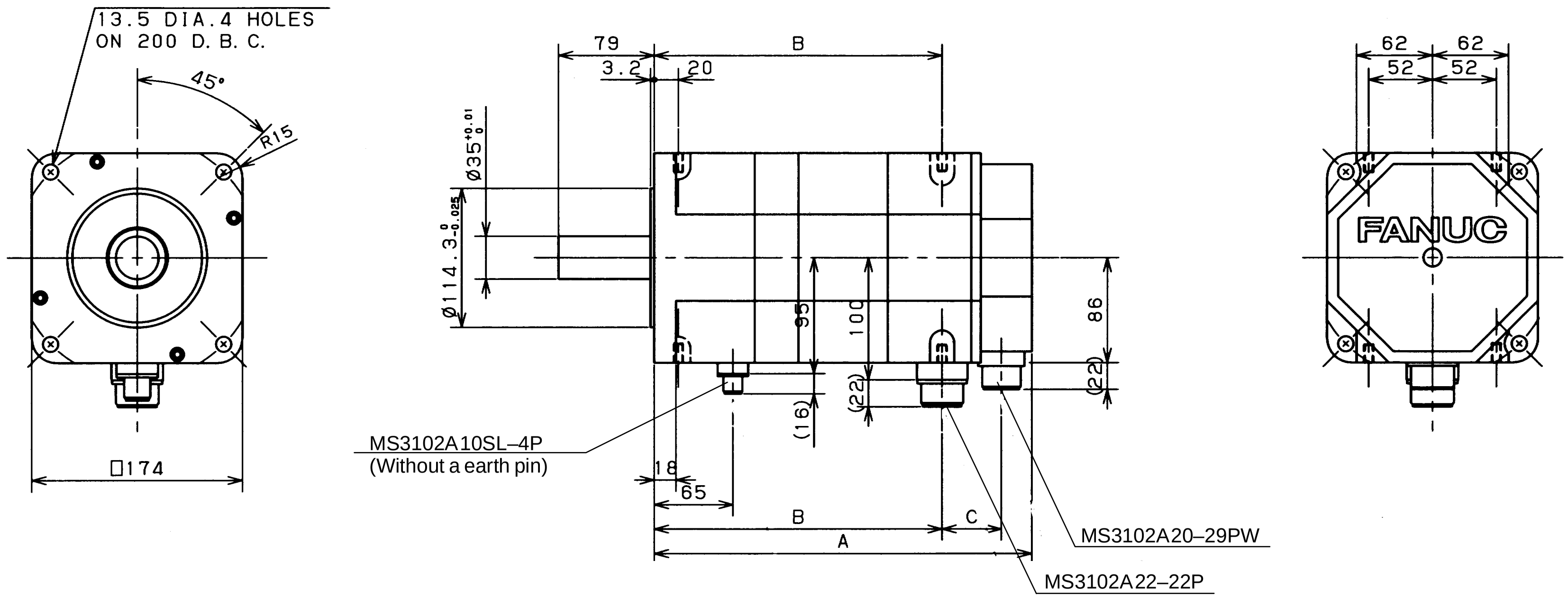
Notes)

Shaft diameter runout	Max 0.05mm
Rabbet diameter eccentricity	Max 0.07mm
Mounting face runout	Max 0.10mm
Rated load	4410N(450kgf)

Taps for eyebolt : M8 depth 15^{+1}
Eyebolts are not attached

MODEL	A	B	C
αM22HV	240	166	49
αM30HV	314	240	

Fig. 3.3 (f) Models αM22/3000HV and αM30/3000HV (with the brake)



Notes)
Shaft diameter runout Max 0.05mm
Rabbet diameter eccentricity Max 0.07mm
Mounting face runout Max 0.10mm
Rated load 4410N(450kgf)

Taps for eyebolt : M8 depth 15^{+1}
Eyebolts are not attached

MODEL	A	B	C
αM22HV	312	238	49
αM30HV	386	312	

Fig. 3.3 (g) Models αM22/3000HV and αM30/3000HV (shaft option)

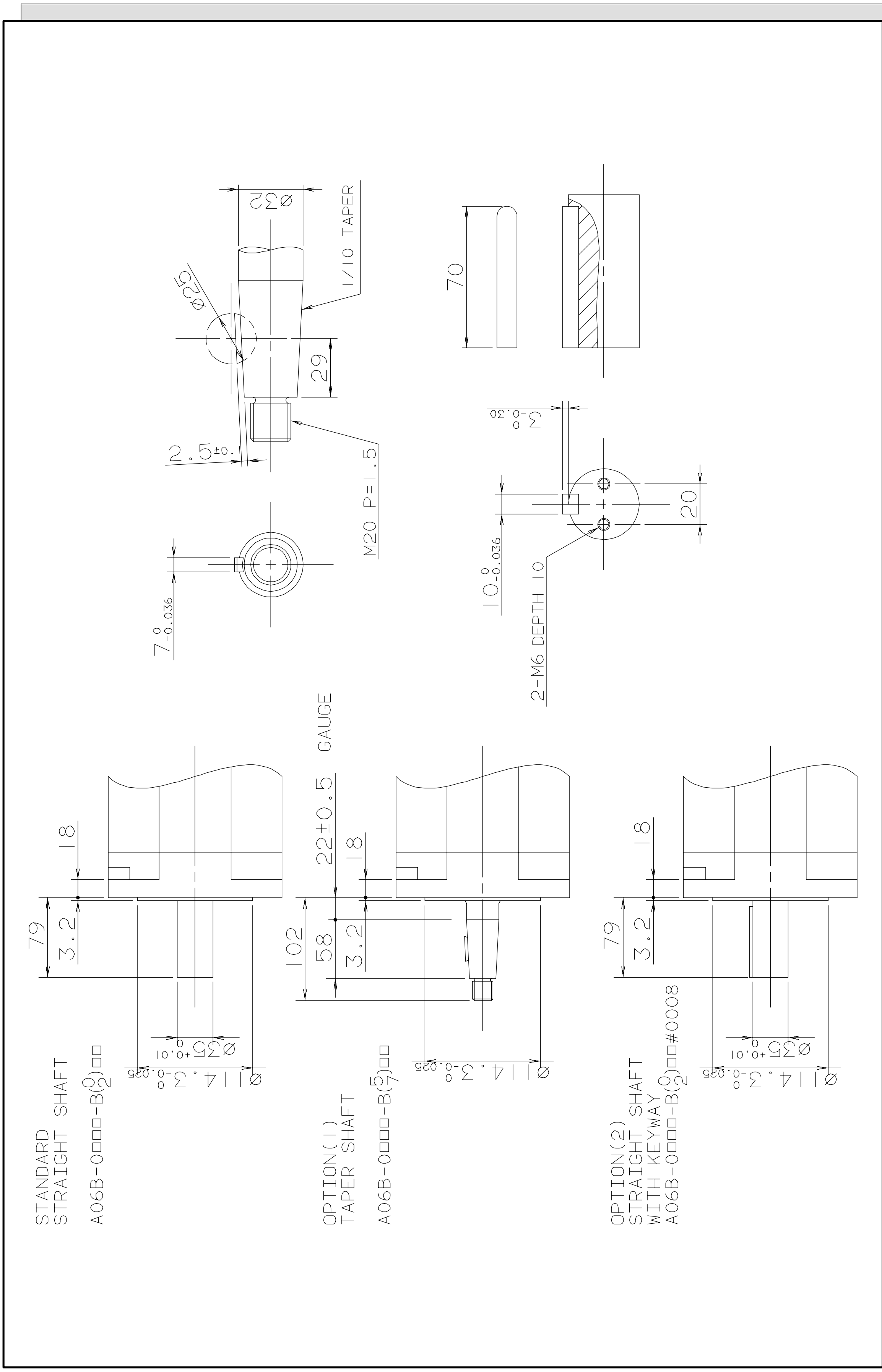
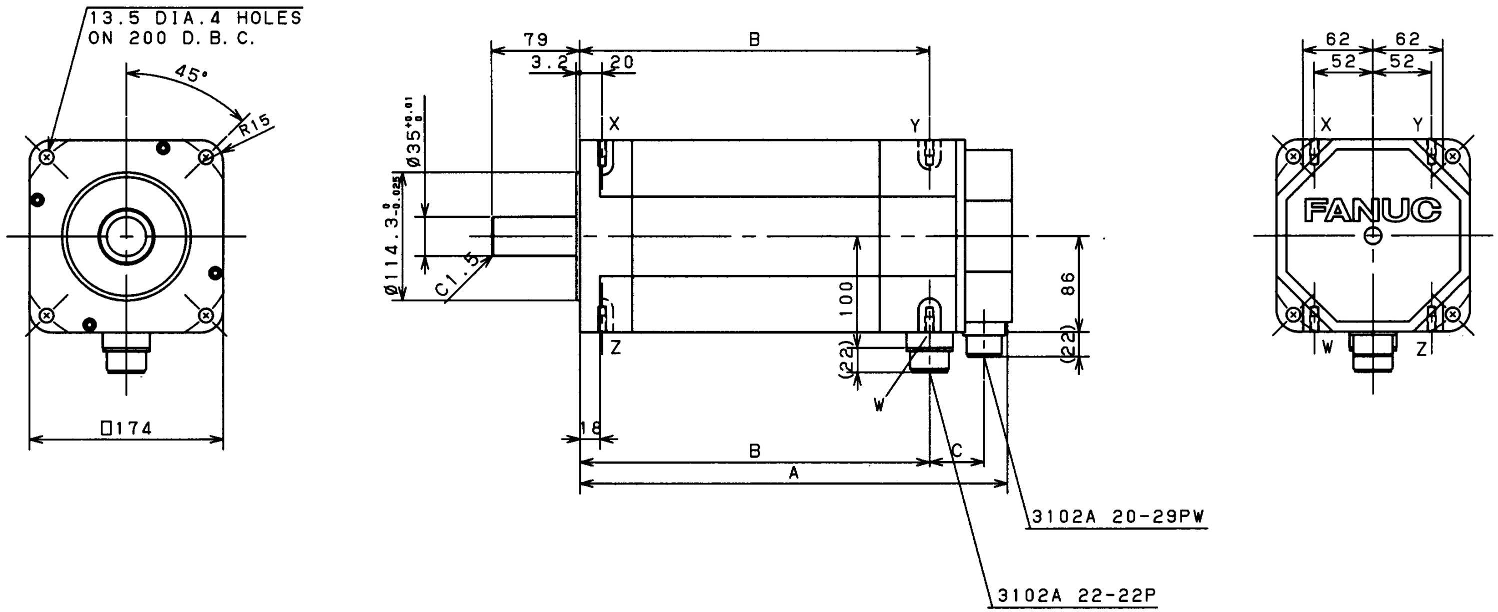


Fig. 3.3 (h) **Model αM40/2000HV (standard)**

NOTES) SHAFT DIA. RUNOUT MAX. 0.05mm
RABBET DIA. ECCENTRICITY MAX. 0.07mm
MOUNTING FACE RUNOUT MAX. 0.10mm
RATED LOADS Max 4410N (450kgf)

TAPS FOR EYEBOLT:M8 DEPTH15$^{+1}_{0}$
EYEBOLTS ARE NOT ATTACHED



MODEL	A	B	C
αM40HV	388	314	49

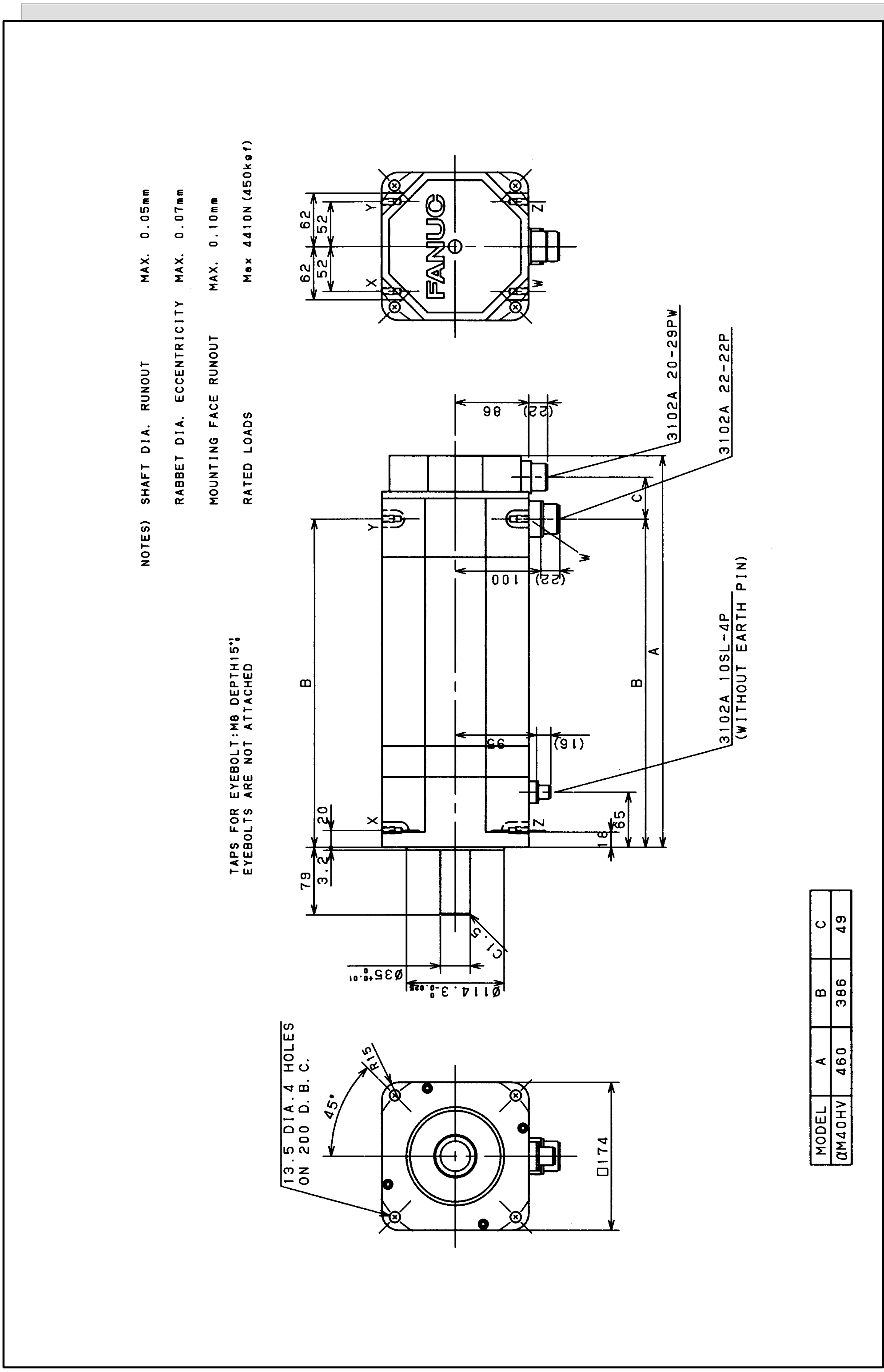
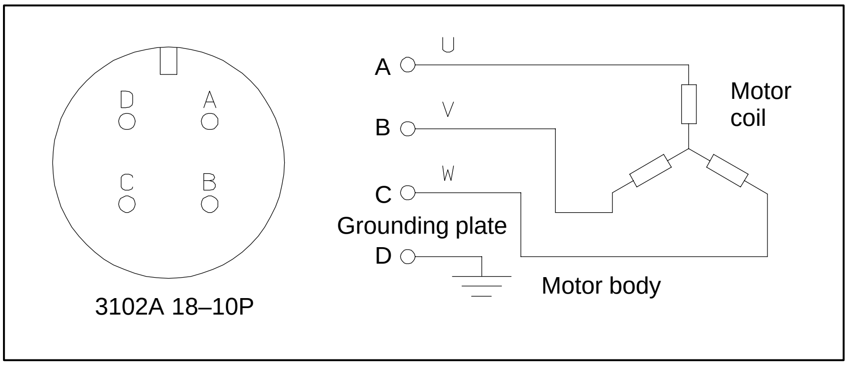


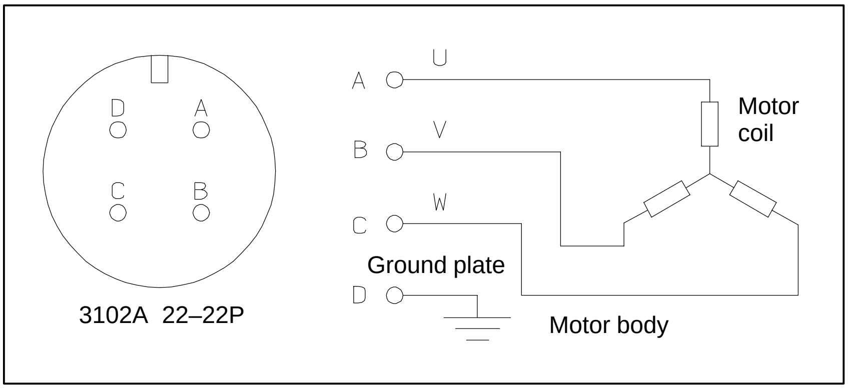
Fig. 3.3 (i) Model αM40/2000HV (with the brake)

3.4 CONNECTION OF POWER LINE

Models αM6/3000HV and αM9/3000HV



Models αM22/3000HV, αM30/3000HV, and αM40/3000HV



VIII. SUPPLEMENT

(Following AC servo motors are extended the allowable maximum speed.)

1 REQUIRED CONDITIONS

Servo Motor	• The following table shows the applied motors and their allowable maximum speed. • The specification numbers of Servo Motor for order are same as before. • Some motors need the manufacture date since January ’99.
Servo Software	• It is necessary to use 90A0 or later series software and HRV2 (LEVEL–UP HRV) control.
Servo Parameters	• It is necessary to change the parameters.
Servo Amplifier (SVM, SVU)	• It is not necessary to change.
Power supply module (PSM)	• It may be necessary to select again depending on the situation.

2 SERVO MOTOR

- The following table shows the applied motors and their allowable maximum speed.
- The specification numbers of Servo Motor for order are same as before.
- Some motors need the manufacture date since January ’99.

	Allowable maximum speed		Applicable manufacture date
	Before	After	
α12/3000	$3000min^{-1}$	$4000min^{-1}$	since Jan. 1999
α22/3000	$3000min^{-1}$	$4000min^{-1}$	since Jan. 1999
α30/3000	$3000min^{-1}$	$4000min^{-1}$	since Jan. 1999
α40/2000	$2000min^{-1}$	$2500min^{-1}$	– not required
α40/2000 with fan	$2000min^{-1}$	$2500min^{-1}$	– not required
α65/2000	$2000min^{-1}$	$2500min^{-1}$	– not required
α100/2000	$2000min^{-1}$	$2500min^{-1}$	– not required
α150/2000	$2000min^{-1}$	$2500min^{-1}$	– not required
αM22/3000	$3000min^{-1}$	$4000min^{-1}$	– not required
αM30/3000	$3000min^{-1}$	$4000min^{-1}$	– not required
α12/3000HV	$3000min^{-1}$	$4000min^{-1}$	since Jan. 1999
αM22/3000HV	$3000min^{-1}$	$4000min^{-1}$	– not required
αM30/3000HV	$3000min^{-1}$	$4000min^{-1}$	– not required

NOTE
α22/3000HV and α30/3000HV are not extend the maximum allowable speed for the moment.

3 SERVO SOFTWARE

It is necessary for 90A0 or later series servo software and the control to be HRV2 (LEVEL–UP HRV) control.
Refer to “FANUC AC SERVO MOTOR α series PARAMETER MANUAL (B–65150E /after edition 03)” as 90A0 series servo software and its edition for HRV2 (LEVEL–UP HRV) control.

4 SERVO PARAMETER

- The parameters for extended the maximum allowable speed are the following.

  1) α12/3000, α22/3000, α30/3000, α40/2000, α40/2000 (with fan), α65/2000, α100/2000, α150/2000, α12/3000HV
     1. Download the parameter in 90A0–001U and after.
     2. Set up the LEVEL–UP HRV control.

        No.1809 / 2004 00000011

        No.1852 / 2040 Multiply normal parameter by 0.8

        No.1853 / 2041 Multiply normal parameter by 1.6

  2) αM22/3000, αM30/3000, (αM40/3000, αM40/3000 (with fan)), αM22/3000HV, αM30/3000HV
     1. Download the parameter in 90A0–001U and after.
     2. Change the parameter as Table 4.

Table 4 Parameter for changing (inside the bold flame)

		Model	αM22/3000	αM30/3000	αM22/3000HV	αM30/3000HV	αM40/3000 (with fan)	αM40/3000
		Spec. No.	0165	0166	0185	0186	0170	0169
99.11.2		ID No.	100	101	106	107	108	110
Symbol	Parameter No.							
	FS15	FS16,18						
	1809	2004	00000011	00000011	00000011	00000011	01000011	00000011
PK1	1852	2040	670	1030	1120	1059	2017	1197
PK2	1853	2041	–4054	–5246	–4755	–4117	–8287	–5048
PVPA	1869	2057	–7695	–5129	–5135	–6422	–3848	–3865
PALPH	1870	2058	–2700	–1680	–2000	–3226	–1144	–3168
AALPH	1967	2074	12288	0	28672	8192	20480	0
MFWKCE	1736	2128	0	8000	0	1000	2000	2000
PHDLY1	1756	2133	0	0	0	0	0	0
PHDLY2	1757	2134	0	0	0	0	0	0

1 Although the αM40/3000 and αM40/3000 (with fan) are not intended for higher speeds, parameters best suited to LEVEL–UP HRV are available to them.
2 See the Parameter Manual (B–65150E) for details of servo software 90A0 001U.
3 See the Section 4.3 “LEVEL–UP HRV control” of the Parameter Manual (B–65150E) for details of setting the LEVEL–UP HRV control.
4 The parameter in Table 4 is the best–tuned parameter for LEVEL–UP HRV control. If the speed is not extended, it has better controllability with this parameter.
5 See the Parameter Manual (B–65150E edition 03 or later) for details of servo parameters.

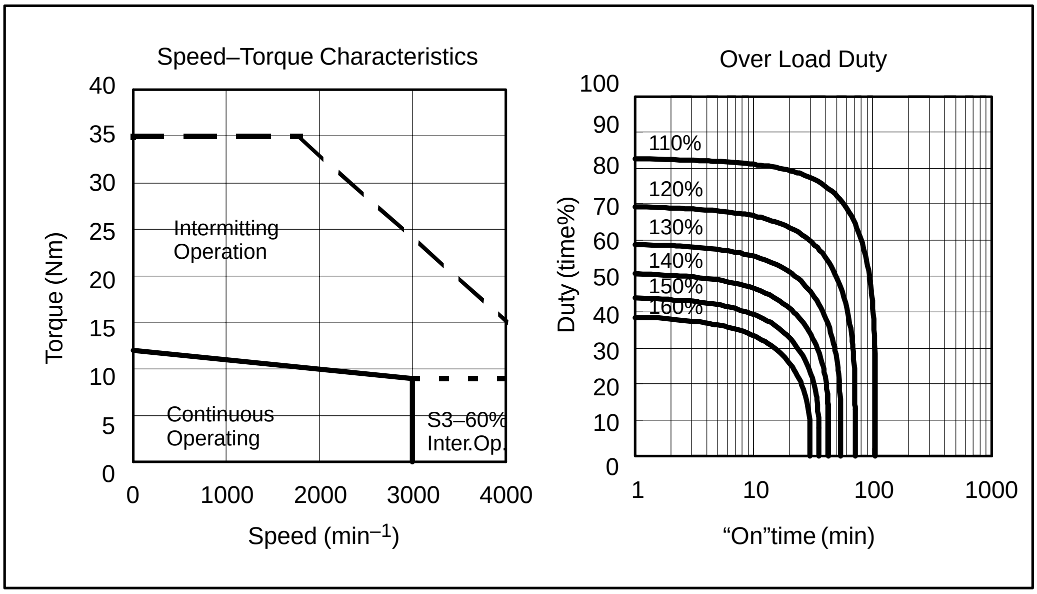
5 SELECTING PSM

In case of the using motors with extended speed, it is necessary to use “Case 2” for accelerating maximum output in “FANUC SERVO AMPLIFIER α series DESCRIPTIONS (B–65162/after edition 03)”
Refer to FANUC SERVO AMPLIFIER α series DESCRIPTIONS (B–65162/after edition 03)” as the details.

6 “CHARACTERISTICS CURVE” AND “DATA SHEET”

“Characteristics Curve” and “Data sheet” are shown in following pages.

Model α12/3000 Specification : A06B–0143–B□□□



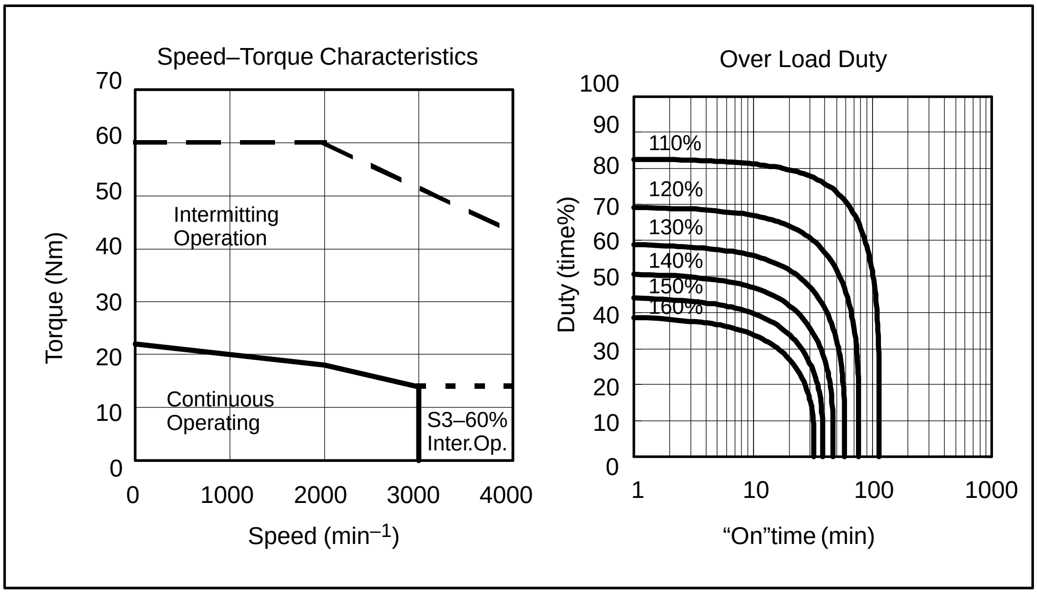
Data sheet

Parameter	Symbol	Value			Unit
Rating speed	Nmax	3000			min $^{-1}$
Maximum speed	Nlim	4000			min $^{-1}$
Rated torque at stall (*)	Ts	12 122			Nm kgfcm
Rotor inertia	Jm	6.2E–3 6.4E–2			kgm^2 kgfcms^2
Continuous RMS current at stall (*)	Is	15.5			A (rms)
Torque constant (*)	Kt	0.77 7.9			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	27.1 0.26			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.18			Ω
Mechanical time constant (*)	tm	0.006			s
Thermal time constant	tt	60			min
Static friction	Tf	0.8 8			Nm kgfcm
Weight		18			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo software. (The above figures show average values.)
These values may be changed without prior notice.
S3 to 60% intermitting operating zone shows 6 min "ON" and 4 min "OFF" in 10 min cycle.

Model α22/3000

Specification : A06B–0148–B□□□

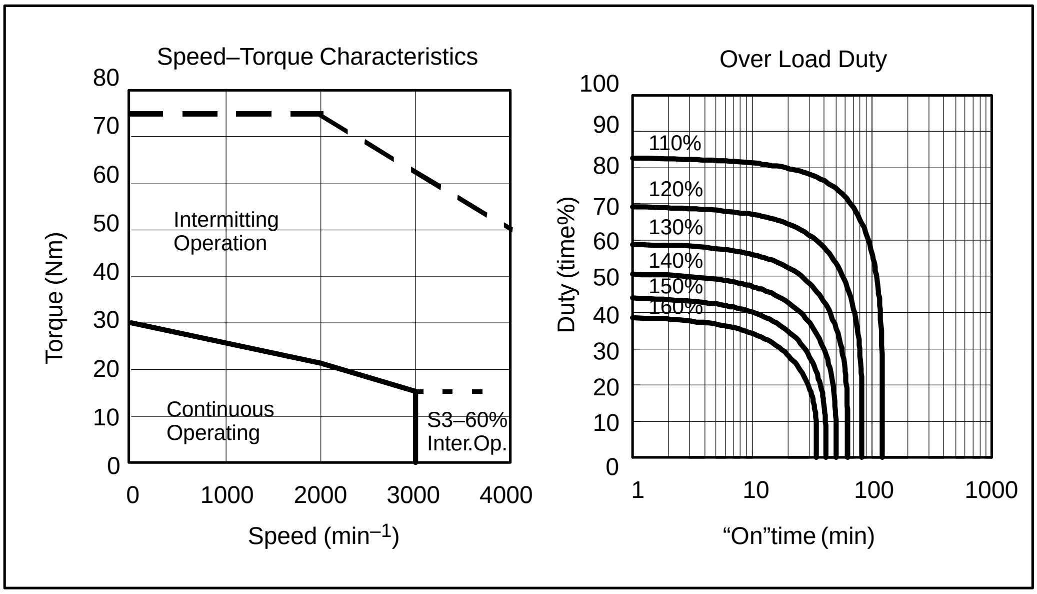


Data sheet

Parameter	Symbol	Value			Unit
Rating speed	Nmax	3000			min^{-1}
Maximum speed	Nlim	4000			min^{-1}
Rated torque at stall (*)	Ts	22 224			Nm kgfcm
Rotor inertia	Jm	1.2E–2 1.2E–1			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	32.1			A (rms)
Torque constant (*)	Kt	0.68 7.0			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	23.9 0.23			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.05			Ω
Mechanical time constant (*)	tm	0.004			s
Thermal time constant	tt	65			min
Static friction	Tf	1.2 12			Nm kgfcm
Weight		30			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo software. (The above figures show average values.)
These values may be changed without prior notice.
S3 to 60% intermitting operating zone shows 6 min “ON” and 4 min “OFF” in 10 min cycle.

Model α30/3000 Specification : A06B–0153–B□□□

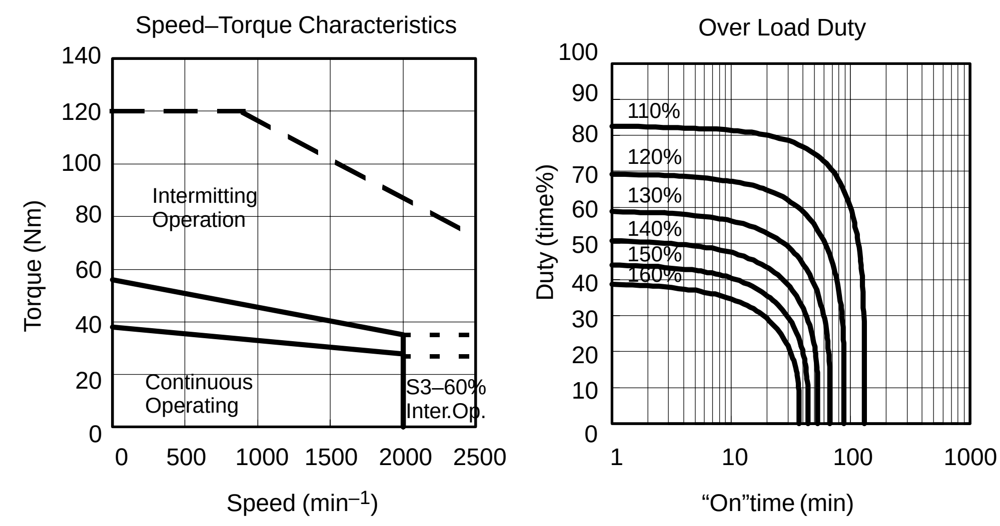


Data sheet

Parameter	Symbol	Value			Unit
Rating speed	Nmax	3000			min $^{-1}$
Maximum speed	Nlim	4000			min $^{-1}$
Rated torque at stall (*)	Ts	30 306			Nm kgfcm
Rotor inertia	Jm	1.7E–2 1.7E–1			kgm ^{2} kgfcms ^{2}
Continuous RMS current at stall (*)	Is	33.7			A (rms)
Torque constant (*)	Kt	0.89 9.1			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	31.1 0.30			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.05			Ω
Mechanical time constant (*)	tm	0.003			s
Thermal time constant	tt	70			min
Static friction	Tf	1.8 18			Nm kgfcm
Weight		41			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo software. (The above figures show average values.)
These values may be changed without prior notice.
S3 to 60% intermitting operating zone shows 6 min “ON” and 4 min “OFF” in 10 min cycle.

Model α40/2000 Specification : A06B–0157–B□□□
Model α40/2000FAN Specification : A06B–0158–B□□□

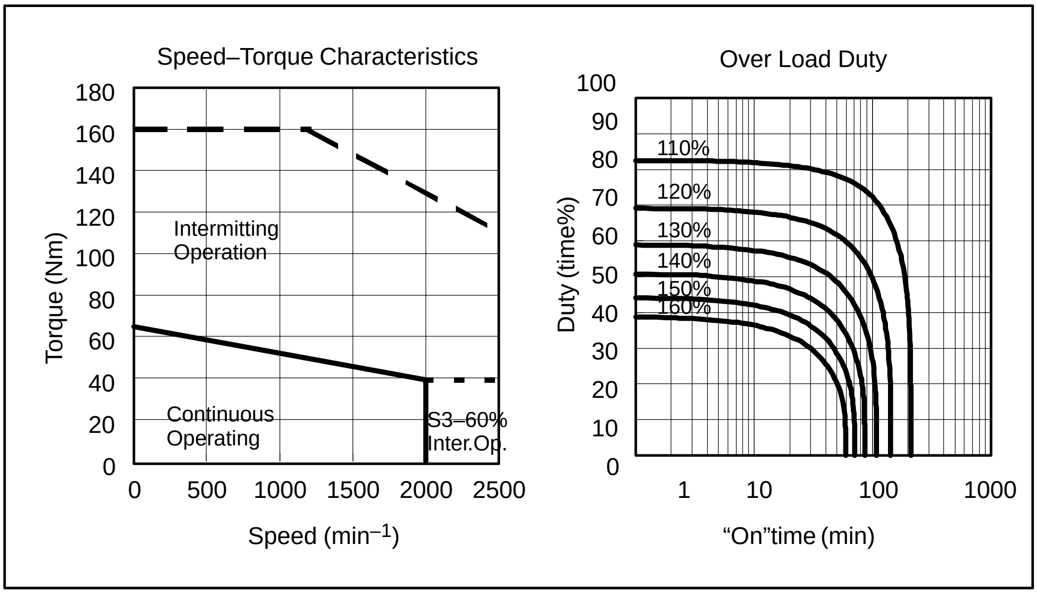


Data sheet

Parameter	Symbol	Value			Unit
Rating speed	Nmax	2000	2000		min^{-1}
Maximum speed	Nlim	2500	2500		min^{-1}
Rated torque at stall (*)	Ts	38 388	56 571		Nm kgfcm
Rotor inertia	Jm	2.2E–2 2.3E–1	2.2E–2 2.3E–1		kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	27.2	40.1		A (rms)
Torque constant (*)	Kt	1.40 14.3	1.40 14.3		Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	48.8 0.47	48.8 0.47		V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.08	0.08		Ω
Mechanical time constant (*)	tm	0.003	0.003		s
Thermal time constant	tt	75	30		min
Static friction	Tf	1.8 18	1.8 18		Nm kgfcm
Weight		52	55		kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo software. (The above figures show average values.)
These values may be changed without prior notice.
S3 to 60% intermitting operating zone shows 6 min “ON” and 4 min “OFF” in 10 min cycle.

Model α65/2000 Specification : A06B–0331–B□□□

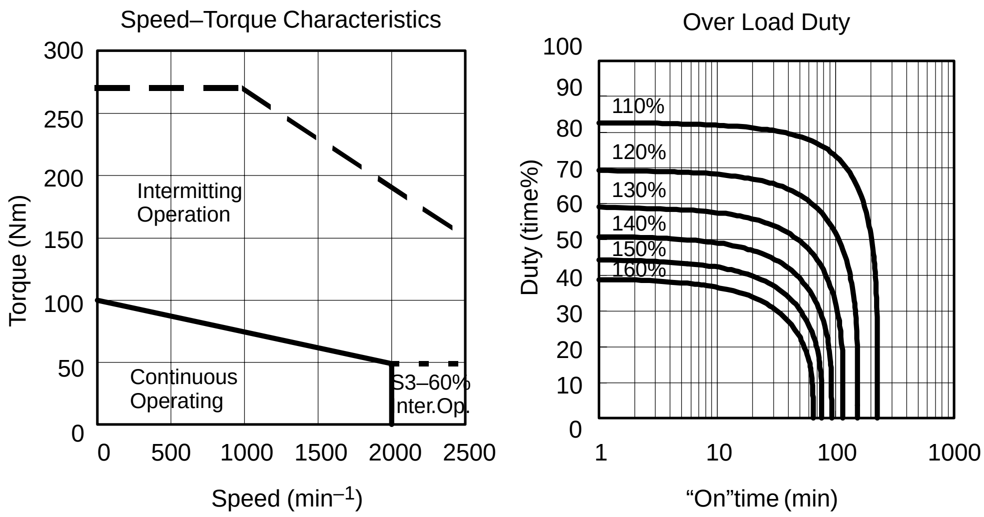


Data sheet

Parameter	Symbol	Value			Unit
Rating speed	Nmax	2000			min $^{-1}$
Maximum speed	Nlim	2500			min $^{-1}$
Rated torque at stall (*)	Ts	65 663			Nm kgfcm
Rotor inertia	Jm	1.8E–2 1.9E–1			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	62.5			A (rms)
Torque constant (*)	Kt	1.04 10.6			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	36.3 0.35			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.02			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	120			min
Static friction	Tf	3.7 38			Nm kgfcm
Weight		80			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo software. (The above figures show average values.)
These values may be changed without prior notice.
S3 to 60% intermitting operating zone shows 6 min "ON" and 4 min "OFF" in 10 min cycle.

Model α100/2000 Specification : A06B–0332–B□□□



Data sheet

Parameter	Symbol	Value			Unit
Rating speed	Nmax	2000			min^{-1}
Maximum speed	Nlim	2500			min^{-1}
Rated torque at stall (*)	Ts	100 1020			Nm kgfcm
Rotor inertia	Jm	2.6E–2 2.7E–1			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	85.3			A (rms)
Torque constant (*)	Kt	1.17 12.0			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	40.9 0.39			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.01			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	130			min
Static friction	Tf	5.5 56			Nm kgfcm
Weight		100			kg

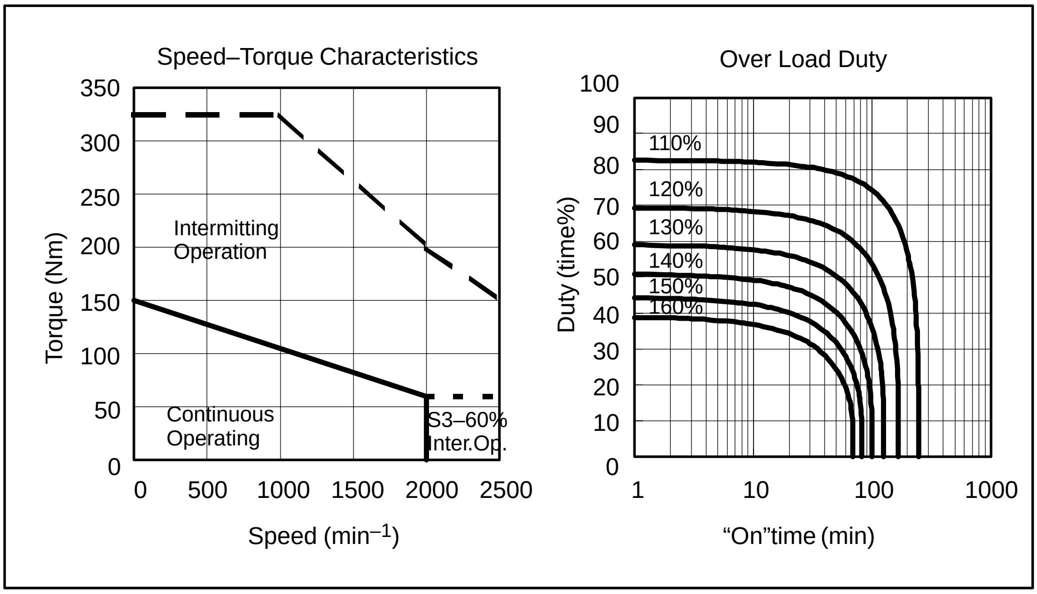
(*) The values are the standard values at 20°C and the tolerance is ±10%.

The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo software. (The above figures show average values.)

These values may be changed without prior notice.

S3 to 60% intermitting operating zone shows 6 min "ON" and 4 min "OFF" in 10 min cycle.

Model α150/2000 Specification : A06B–0333–B□□□

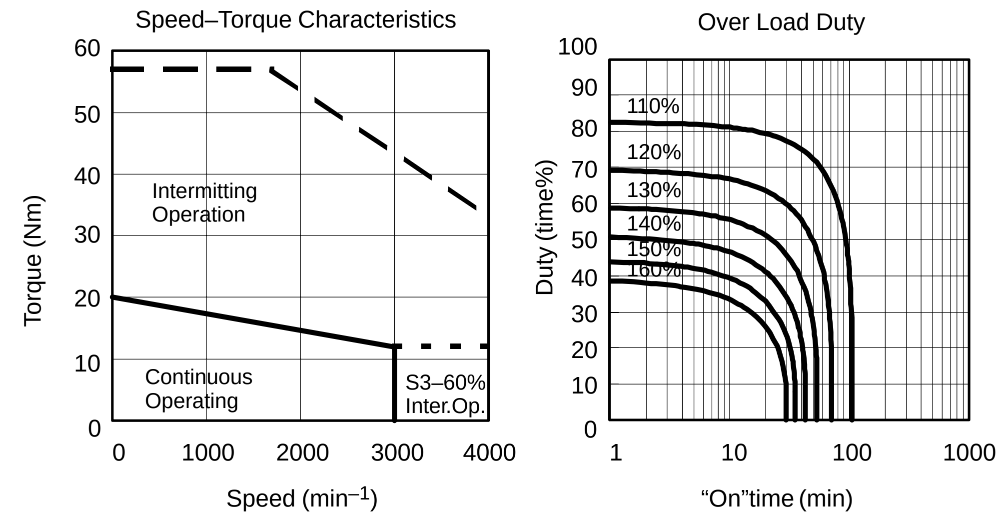


Data sheet

Parameter	Symbol	Value			Unit
Rating speed	Nmax	2000			min $^{-1}$
Maximum speed	Nlim	2500			min $^{-1}$
Rated torque at stall (*)	Ts	150 1531			Nm kgfcm
Rotor inertia	Jm	3.4E–2 3.5E–1			kgm ^{2} kgfcms ^{2}
Continuous RMS current at stall (*)	Is	114.9			A (rms)
Torque constant (*)	Kt	1.30 13.3			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	45.6 0.44			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.01			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	140			min
Static friction	Tf	7.4 75			Nm kgfcm
Weight		120			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo software. (The above figures show average values.)
These values may be changed without prior notice.
S3 to 60% intermitting operating zone shows 6 min “ON” and 4 min “OFF” in 10 min cycle.

Model αM22/3000 Specification : A06B–0165–B□□□



Data sheet

Parameter	Symbol	Value			Unit
Rating speed	Nmax	3000			min^{-1}
Maximum speed	Nlim	4000			min^{-1}
Rated torque at stall (*)	Ts	20 204			Nm kgfcm
Rotor inertia	Jm	5.8E–3 5.9E–2			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	26.5			A (rms)
Torque constant (*)	Kt	0.75 7.7			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	26.3 0.25			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.07			Ω
Mechanical time constant (*)	tm	0.002			s
Thermal time constant	tt	60			min
Static friction	Tf	0.8 8			Nm kgfcm
Weight		18			kg

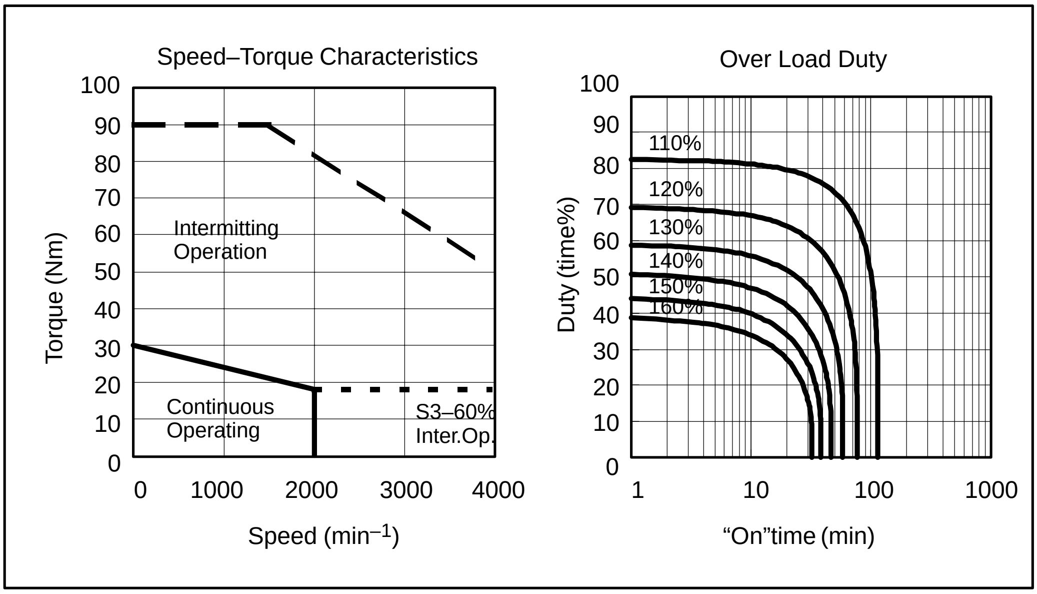
(*) The values are the standard values at 20°C and the tolerance is ±10%.

The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo software. (The above figures show average values.)

These values may be changed without prior notice.

S3 to 60% intermitting operating zone shows 6 min “ON” and 4 min “OFF” in 10 min cycle.

Model αM30/3000 Specification : A06B–0166–B□□□

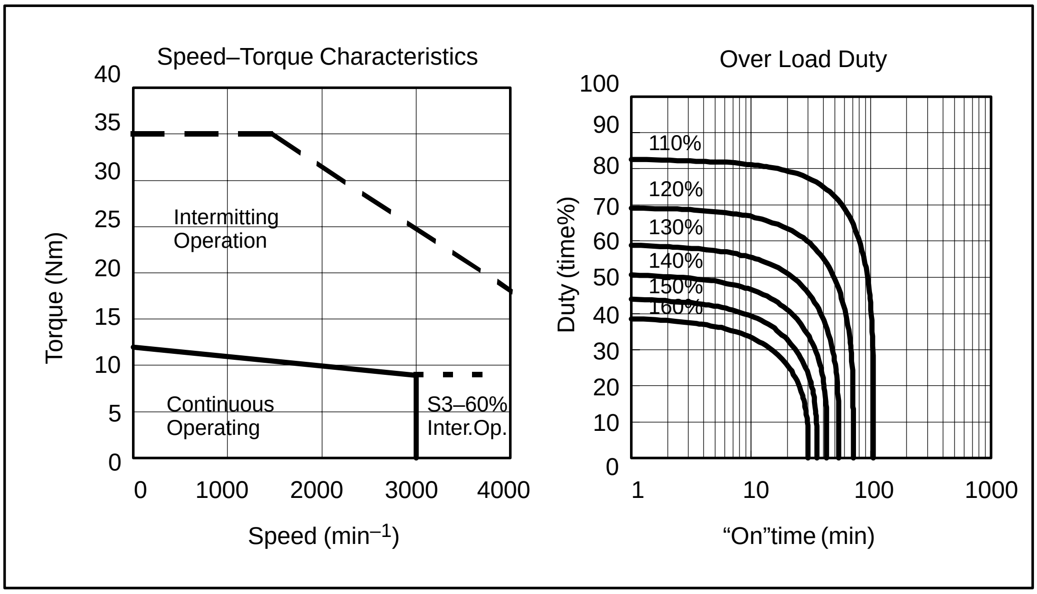


Data sheet

Parameter	Symbol	Value			Unit
Rating speed	Nmax	2000			min^{-1}
Maximum speed	Nlim	4000			min^{-1}
Rated torque at stall (*)	Ts	30 306			Nm kgfcm
Rotor inertia	Jm	1.1E–2 1.1E–1			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	27.9			A (rms)
Torque constant (*)	Kt	1.08 11.0			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	37.6 0.36			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.05			Ω
Mechanical time constant (*)	tm	0.001			s
Thermal time constant	tt	65			min
Static friction	Tf	1.2 12			Nm kgfcm
Weight		30			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo software. (The above figures show average values.)
These values may be changed without prior notice.
S3 to 60% intermitting operating zone shows 6 min “ON” and 4 min “OFF” in 10 min cycle.

Model α12/3000HV Specification : A06B–0176–B□□□



Data sheet

Parameter	Symbol	Value			Unit
Rating speed	Nmax	3000			min^{-1}
Maximum speed	Nlim	4000			min^{-1}
Rated torque at stall (*)	Ts	12 122			Nm kgfcm
Rotor inertia	Jm	6.2E–3 6.4E–2			kgm^2 kgfcms^2
Continuous RMS current at stall (*)	Is	8.8			A (rms)
Torque constant (*)	Kt	1.36 13.8			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	47.4 0.45			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.56			Ω
Mechanical time constant (*)	tm	0.006			s
Thermal time constant	tt	60			min
Static friction	Tf	0.8 8			Nm kgfcm
Weight		18			kg

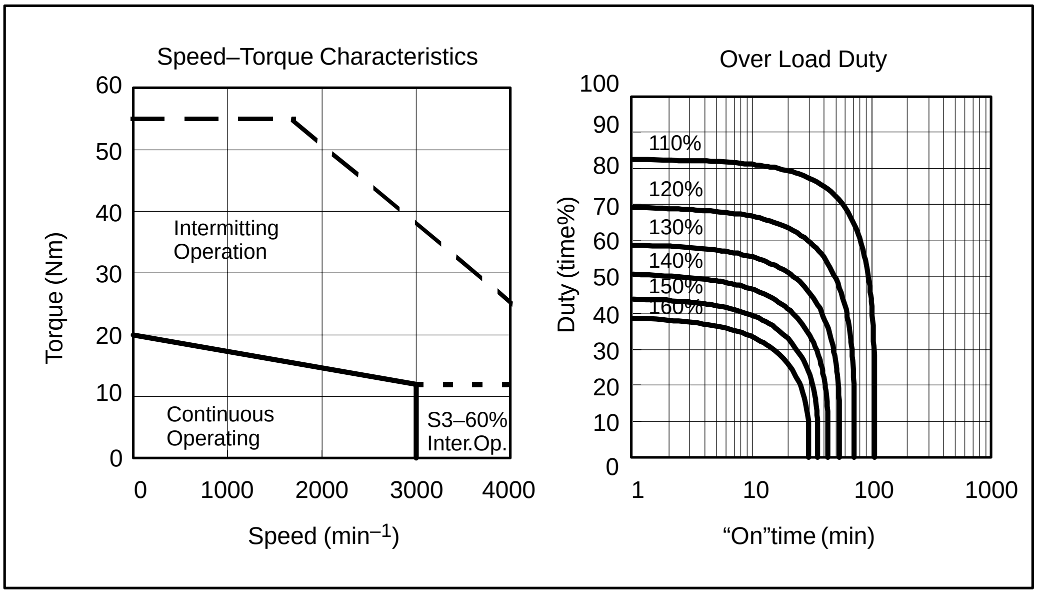
(*) The values are the standard values at 20°C and the tolerance is ±10%.

The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo software. (The above figures show average values.)

These values may be changed without prior notice.

S3 to 60% intermitting operating zone shows 6 min “ON” and 4 min “OFF” in 10 min cycle.

Model αM22/3000HV Specification : A06B–0185–B□□□

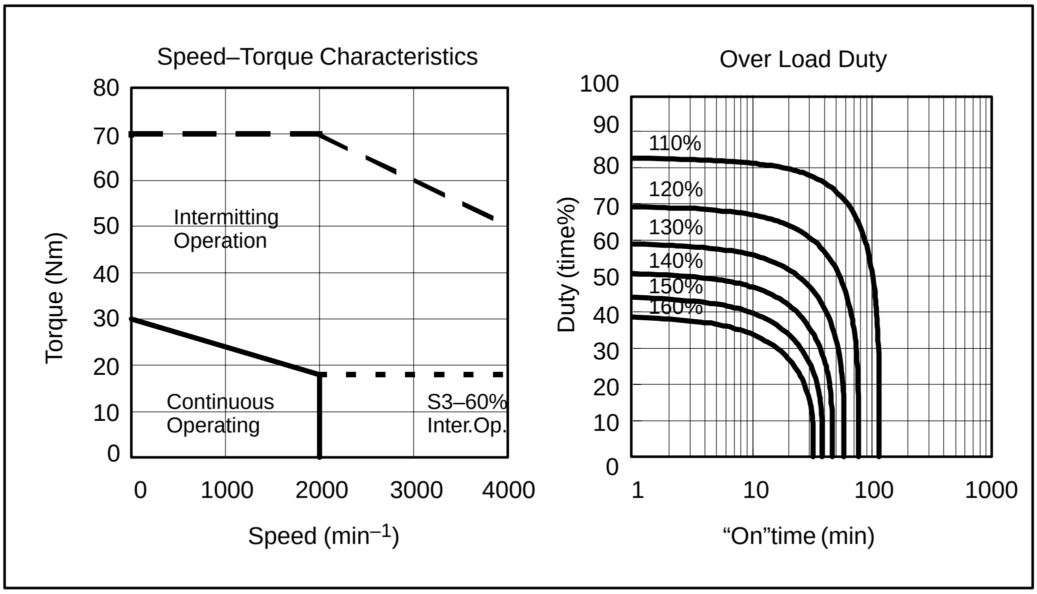


Data sheet

Parameter	Symbol	Value			Unit
Rating speed	Nmax	3000			min $^{-1}$
Maximum speed	Nlim	4000			min $^{-1}$
Rated torque at stall (*)	Ts	20 204			Nm kgfcm
Rotor inertia	Jm	5.8E–3 5.9E–2			kgm^2 kgfcms^2
Continuous RMS current at stall (*)	Is	12.1			A (rms)
Torque constant (*)	Kt	1.66 16.9			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	57.9 0.55			V (rms)/1000min $^{-1}$ V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.26			Ω
Mechanical time constant (*)	tm	0.002			s
Thermal time constant	tt	60			min
Static friction	Tf	0.8 8			Nm kgfcm
Weight		18			kg

(*) The values are the standard values at 20°C and the tolerance is ±10%.
The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo software. (The above figures show average values.)
These values may be changed without prior notice.
S3 to 60% intermitting operating zone shows 6 min “ON” and 4 min “OFF” in 10 min cycle.

Model αM30/3000HV Specification : A06B–0186–B□□□



Data sheet

Parameter	Symbol	Value			Unit
Rating speed	Nmax	3000			min^{-1}
Maximum speed	Nlim	4000			min^{-1}
Rated torque at stall (*)	Ts	30 306			Nm kgfcm
Rotor inertia	Jm	1.1E–2 1.1E–1			kgm^2 $kgfcms^2$
Continuous RMS current at stall (*)	Is	16.3			A (rms)
Torque constant (*)	Kt	1.85 18.8			Nm/A (rms) kgfcm/A (rms)
Back EMF constant (1–phase) (*) (*)	Ke Kv	64.5 0.62			V (rms)/1000min^{-1} V (rms)·sec/rad
Armature resistance (1–phase) (*)	Ra	0.16			Ω
Mechanical time constant (*)	tm	0.002			s
Thermal time constant	tt	65			min
Static friction	Tf	1.2 12			Nm kgfcm
Weight		30			kg

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

The speed–torque characteristics very depending on the type of software, parameter setting, and input voltage of the digital servo software. (The above figures show average values.)

These values may be changed without prior notice.

S3 to 60% intermitting operating zone shows 6 min “ON” and 4 min “OFF” in 10 min cycle.

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Revision Record

FANUC AC SERVO MOTOR α series DESCRIPTIONS (B–65142E)

04	Feb., 2001	Addition of models αM40, αM40 with fan, α40/2000HV, αM40/3000HV, α300/2000, α400/2000, and α1000/2000HV Addition of “VIII. SUPPLEMENT” Correction of errors			
03	Dec., 1998	Addition of “VII. FANUC AC SERVO MOTOR αM(HV) series”			
02	Mar., 1995	Addition of “5. CONDITIONS FOR APPROVAL RELATED TO THE IEC34 STANDARD” in Part I Addition of “8. CONNECTORS” in Part I Addition of “III. FANUC AC SERVO MOTOR α(HV) series”			
01	Mar., 1994	——————————			
Edition	Date	Contents	Edition	Date	Contents

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