2-Phase Closed-Loop Stepper Motor (for AC driver)

■ Features

- Non-excitation electromagnetic brake integrated motor (built-in brake type)
- Minimal heat generating, high torque motor
- Higher cost-efficiency compared to servo motors
- Frame size 60mm, 86mm supported

⚠ Please read "Safety Considerations" in the instruction manual before using.

CE

Frame size 60mm

86mm

■ Ordering Information

Ai A - M - 60 M A - M

Brake	**No mark**	Standard type
	B	Built-in brake type
Encoder resolution	**A**	10,000 PPR(2,500 PPR×4-multiply)
Motor axial length	**M**	48 mm
	L	69 mm
Motor frame size	**M**	60 mm
	L	75 mm
Item	**M**	**M**otor
Voltage	**A**	**A**C power
Series	**Ai**	**A**rtificial **i**ntelligence

60	60×60 mm
86	86×86 mm

▣ Specifications

◎ Motor

Model※1		AiA-M-60MA(-B)	AiA-M-60LA(-B)	AiA-M-86MA(-B)	AiA-M-86LA(-B)
Max. holding torque※2		1.1 N m	2.2 N m	2.8 N m	4.0 N m
Rotor moment of inertia		240 g·cm^2 (240×10^{-7} kg·m^2)	490 g·cm^2 (490×10^{-7} kg·m^2)	1,100 g·cm^2 (1,100×10^{-7} kg·m^2)	1,800 g·cm^2 (1,800×10^{-7} kg·m^2)
Rated current		2.0 A/Phase			
Resistance ±10%		1.5 Ω/Phase	2.4 Ω/Phase	2.3 Ω/Phase	1.9 Ω/Phase
Inductance ±20%		3.9 mH/Phase	8.5 mH/Phase	11.5 mH/Phase	16.2 mH/Phase
Weight※3	Standard type	Approx. 0.95 kg (approx. 0.75 kg)	Approx. 1.35 kg (approx. 1.15 kg)	Approx. 2.00 kg (approx. 1.70 kg)	Approx. 2.60 kg (approx. 2.30 kg)
	Built-in brake type	Approx. 1.53 kg (approx. 1.35 kg)	Approx. 1.90 kg (approx. 1.75 kg)	Approx. 2.76 kg (approx. 2.50 kg)	Approx. 3.36 kg (approx. 3.10 kg)

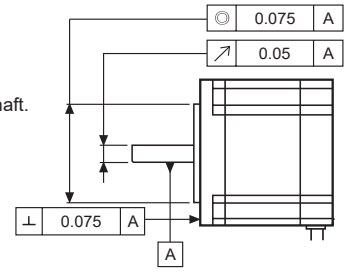
※1: The model name indicates motor type. (none: standard type, B: built-in brake type)
※2: Max. holding torque is maintenance torque of stopping the motor when supplying the rated current (2-phase excitation) and is the standard for comparing the performance of motors.
※3: The weight includes packaging. The weight in parenthesis is for unit only.

● Common specifications

Standard step angle		1.8°/0.9° (Full/Half step)
Motor phase		2-phase
Run method		Bipolar
Insulation class		B type (130℃)
Insulation resistance		Over 100 MΩ (at 500 VDC⎓ megger), between motor coil-case
Dielectric strength		500 VAC～ 50/60 Hz for 1 min between motor coil-case
Vibration		1.5 mm amplitude at frequency 10 to 55 Hz (for 1 min) in each X, Y, Z direction for 2 hours
Shock		Approx. max. 50 G
Environment	Ambient temperature	● Standard type: 0 to 50 ℃, storage: -20 to 70 ℃ ● Built-in brake type: 0 to 40 ℃, storage: -20 to 70 ℃
	Ambient humidity	20 to 85%RH, storage: 15 to 90%RH
Approval		CE
Protection structure		IP30 (IEC34-5 standard)
Stop angle error※1		±0.09°
Shaft vibration※2		0.03 mm T.I.R.
Radial Movement※3		Max. 0.025 mm (load 25 N)
Axial Movement※4		Max. 0.01 mm (load 50 N)
Concentricity for shaft of setup in-low		0.05 mm T.I.R.
Perpendicularity of set-up plate shaft		0.075mm T.I.R.

※1: Specifications are for full-step angle, without load. (Values may vary by load size)
※2: T.I.R. (Total Indicator Reading)
- Indicates total quantity of dial gauge in case of 1 rotation of measuring part around the reference point.

※3: Amount of radial shaft displacement when adding a radial load (25N) to the tip of the motor shaft.
※4: Amount of axial shaft displacement when adding a axial load (50N) to the shaft.
※Environment resistance is rated at no freezing or condensation.



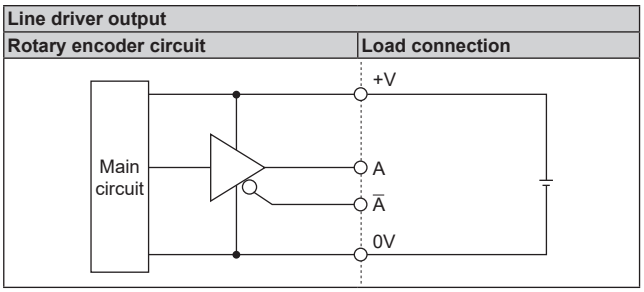
◎ Encoder

Item			Incremental rotary encoder
Resolution			10,000 PPR (2,500 PPR×4-multiply)
Electrical specification	Output phase		A, $\overline{A}$, B, $\overline{B}$, Z, $\overline{Z}$ phase
	Output duty rate		$\frac{T}{2} \pm \frac{T}{4}$ (T=1 cycle of A phase)
	Phase difference of output		Output between A and B phase: $\frac{T}{4} \pm \frac{T}{8}$ (T=1 cycle of A phase)
	Control output	Line driver output	• [Low] - Load current: max. 20mA, residual voltage: max. 0.5 VDC⎓ • [High] - Load current: max. -20mA, output voltage: min. 2.5 VDC⎓
	Response time (rise, fall)		Max. 0.5 μs (cable length: 2 m, I sink = 20 mA)
	Max. response frequency		300 kHz
	Power supply		5 VDC⎓ ±5% (ripple P-P: max. 5%)
	Current consumption		Max. 50 mA (disconnection of the load)

◎ Brake

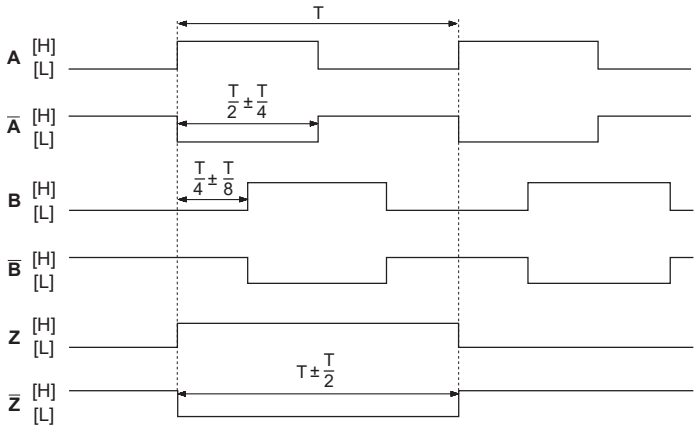
Motor frame size	**Frame size 60 mm**	**Frame size 86 mm**
Rated excitation voltage	24 VDC⎓ ± 10%	
Rated excitation current	0.275 A	0.479 A
Static friction torque	0.75 N m	2.6 N m
Rotation part inertia moment	19 g·cm^2 (1.9 × 10^{-6} kg·m^2)	120 g·cm^2 (12 × 10^{-6} kg·m^2)
Insulation class	B type (130 ℃)	
B type brake	Power ON: brake is released, Power OFF: brake is locked	
Operating time	30 ms	40 ms
Releasing time	10 ms	25 ms

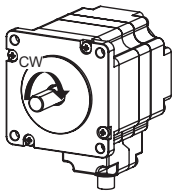
▣ Encoder Control Output Diagram



※All output circuits of A, Ā, B, B̄, Z, Z̄ phase are the same.

▣ Encoder Output Waveforms

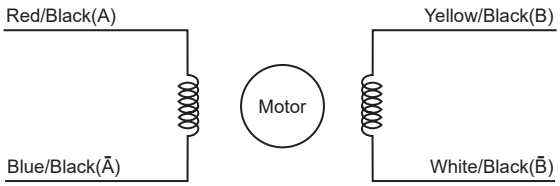




→ Clockwise (CW) ※T=1 cycle of A, B phase

▣ Connection Diagram

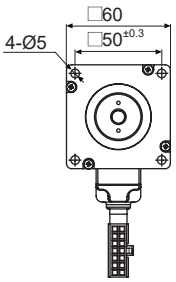
Autonics 2-phase closed-loop stepper motors take bipolar wiring methods.
The wiring colors for each phase and lead-wire are as the followings:



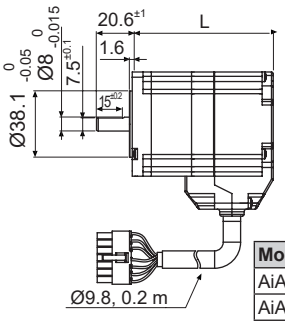
▣ Dimensions

◎ Frame size 60mm

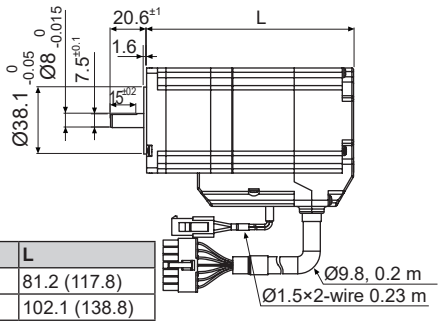
(Unit: mm)



Standard type

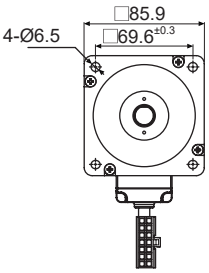


Built-in brake type

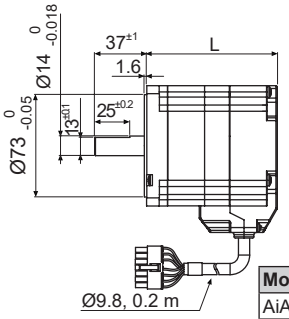


Model	L
AiA-M-60MA(-B)	81.2 (117.8)
AiA-M-60LA(-B)	102.1 (138.8)

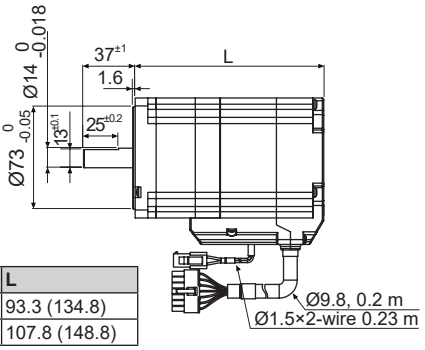
◎ Frame size 86 mm



Standard type



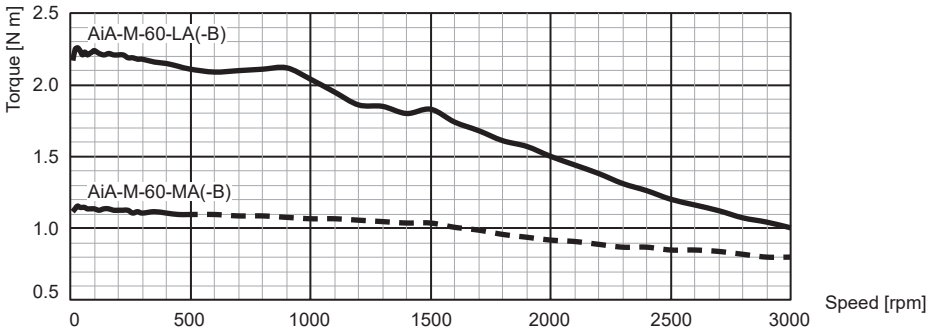
Built-in brake type



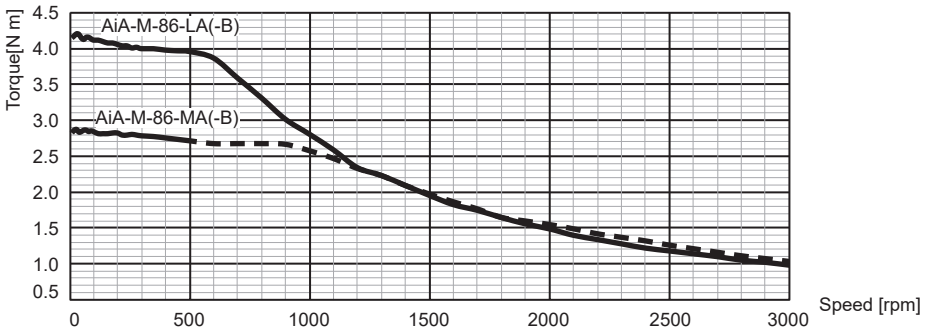
Model	L
AiA-M-86MA(-B)	93.3 (134.8)
AiA-M-86LA(-B)	107.8 (148.8)

▣ Motor Characteristics

◎ Frame size 60mm

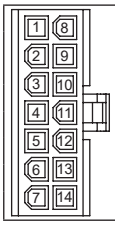


◎ Frame size 86mm



■ Motor Connectors

◎ CN1: Motor+Encoder connector



Pin No.	Function	Pin No.	Function
1	GND	8	+5VDC
2	Encoder A	9	Encoder $\overline{A}$
3	Encoder B	10	Encoder $\overline{B}$
4	Encoder Z	11	Encoder $\overline{Z}$
5	PE	12	N·C
6	Motor A	13	Motor B
7	Motor $\overline{A}$	14	Motor $\overline{B}$

◎ CN2: Brake connector

Pin No.	Function
1	Brake +
2	Brake -

※ Corresponding connector is for built-in brake type only.

[Connector specifications]

Type		Specifications			Manufacture
		Connector	Connector terminal	Housing	
CN1	Motor+Encoder	5557-14R	5556T	—	Molex
CN2	Brake	CHD1140-02	—	—	Dinkle

※Above connector is suitable for AiA-M Series.

◎ Cable (sold separately)

Type	Model	
Motor+Encoder cable	Normal	Moving
	C1D14M-□※1	C1DF14M-□※1

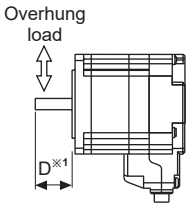
※1: □ indicates cable length (1, 2, 3, 5, 7, 10).
E.g.) C1DF14M-10: 10m moving type motor+encoder cable.

■ Motor Installation

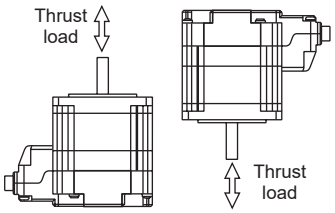
1. Mounting direction

Motor can be mounted in any directions-facing up, facing down and side ways.
No matter which direction motors to be mounted, make sure not to apply overhung or thrust load on the shaft.
Refer to the table below for allowable shaft overhung load / thrust load.

Side ways



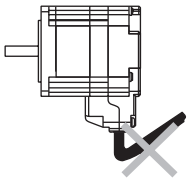
Facing up, down



※1: The distance from the shaft in front (mm)

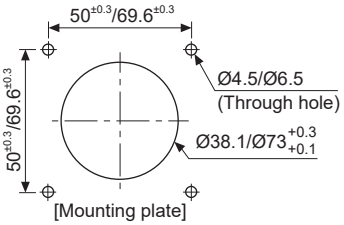
Motor size	The distance from the shaft in front (mm), Allowable overhung load [N]				Allowable thrust load
	D = 0	D = 5	D = 10	D = 15	
Frame size 60 mm	54	67	89	130	Under the load of motor
Frame size 86 mm	260	290	340	390	

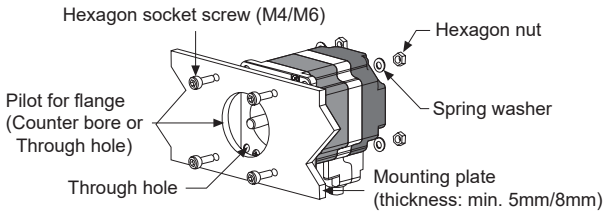
Do not apply excessive force to motor cable when mounting motors.
Do not forcibly pull or insert the cable. It may cause poor connection or disconnection of the cable by force.
In case of frequent cable movement required application, proper safety countermeasures must be ensured.

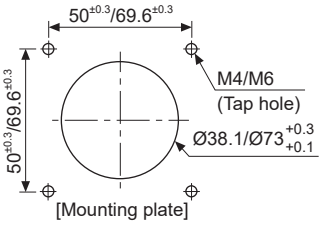


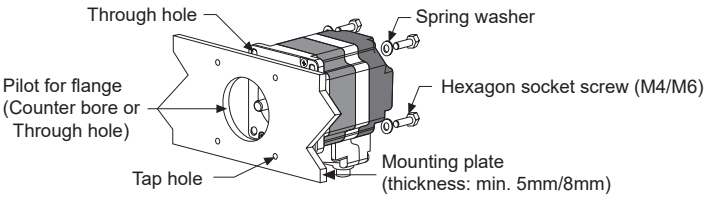
2. Mounting method

◎ **Frame size 60mm/86mm**





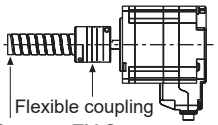
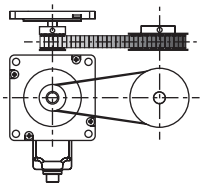
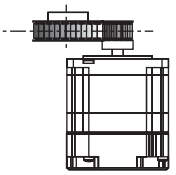




With considering heat radiation and vibration isolation, mount the motor as tight as possible against a metal panel having high thermal conductivity such as iron or aluminum.
When mounting motors, use hexagon socket screws, hexagon nuts, spring washers and flat washers.
Refer to the table below for allowable thickness of mounting plate and using bolt.
Do not draw the wire with over strength 30 N after wiring the encoder.

3. Connection with load

When connecting the load, be sure of the center, tension of the belt, and parallel of the pulley.
When connecting the load such as a pulley, a belt, be sure of the allowable thrust load, radial load, and shock.
Tighten the screw for a coupling or a pulley not to be unscrewed.
When connecting a coupling or a pulley on the motor shaft, be sure of damage of the motor shaft and the motor shaft bearing.
Do not disassemble or modify the motor shaft to connect with the load.

Direct load connection with coupling	Load connection with pulley, belt, and wire	Load connection with gear
 Flexible coupling Ball Screw or TM Screw ※Use Autonics flexible coupling (ERB Series).		
When connecting the load directly (ball screw, TM screw, etc) to the motor shaft, use a flexible coupling as shown in the above figure. If the center of the load is not aligned with that of shaft, it may cause severe vibration, shaft damage or shorten life cycle of the shaft bearing.	The motor shaft and the load shaft should be parallel. Connect the motor shaft and the line which connects the center of two pulleys to a right angle.	The motor shaft and the load shaft should be parallel. Connect the motor shaft to the center of gear teeth side to be interlocked.

4. Installation condition

Install the motor in a place that meets certain conditions specified below.
It may cause product damage if it is used out of following conditions.
① Inside of the housing which is installed indoors
(This unit is manufactured for the purpose of attaching to equipment. Install a ventilation device.)
② Within 0 to 50 ℃ (at non-freezing status) of ambient temperature
③ Within 20 to 85%RH (at non-dew status) of ambient humidity
④ The place without explosive, flammable and corrosive gas
⑤ The place without direct ray of light
⑥ The place where dust or metal scrap does not enter into the unit
⑦ The place without contact with water, oil, or other liquid
⑧ The place without contact with strong alkali or acidity
⑨ The place where easy heat dissipation could be made
⑩ The place without continuous vibration or severe shock
⑪ The place with less salt content
⑫ The place with less electronic noise occurs by welding machine, motor, etc.
⑬ The place where no radioactive substances and magnetic fields exist. It shall be no vacuum status as well.

■ Troubleshooting

Malfunction	Troubleshooting
When motor does not excite	Check the connection status between controller and driver, and pulse input specifications (voltage, width).
	Check the pulse and direction signal are connected correctly.
When motor rotates to the opposite direction of the designated direction	When RUN mode is 1-pulse input method, CCW input [H] is for forward, [L] is for backward. When RUN mode is 2-pulse input method, check CW and CCW pulse input are changed or
When motor drive is unstable	Check that driver and motor are connected correctly.
	Check the driver pulse input specifications (voltage, width).

■ Proper Usage

- Follow instructions in 'Proper Usage'.
  Otherwise, it may cause unexpected accidents.
- Using motors at low temperature may cause reducing ball bearing's grease consistency and friction torque is increased.
  Start the motor in a steady manner since motor's torque is not to be influenced.
- If wiring encoder cable, separate it from high voltage line or power cable for preventing surge and inductive noise. The cable length should be as short as possible.
  Failure to follow this instruction may result in raised cable resistance, residual voltage, and output waveform noise.
- Must connect the encoder shield cable to the F.G. terminal.
- For using motor, it is recommended to maintenance and inspection regularly.
  ① Unwinding bolts and connection parts for the unit installation and load connection
  ② Strange sound from ball bearing of the unit
  ③ Damage and stress of lead cable of the unit
  ④ Connection error with driver
  ⑤ Inconsistency between the axis of motor output and the center, concentric (eccentric, declination) of the load, etc.
- This unit may be used in the following environments.
  ① Indoors (in the environment condition rated in 'Specifications')
  ② Altitude max. 2,000 m
  ③ Pollution degree 2
  ④ Installation category II