AiA-M Series

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

▣ Features

- Minimal heat generating, high torque motor
- Higher cost-efficiency compared to servo motors
- Frame size 60mm, 86mm supported

<div>
⚠ **Please read "Safety Considerations"**
in the instruction manual before using.
</div>

C E

Frame size
60mm

86mm

▣ Ordering Information

| Ai | A | – | M | – | 60 | M | A |

Encoder resolution	**A**	10,000PPR (2,500PPR×4-multiply)

Motor length

Motor frame size	**60**	60×60mm	**M**	82.8mm
			L	103.8mm
	86	86×86mm	**M**	94.9mm
			L	109.4mm

Item	**M**	Motor
Voltage	**A**	AC power
Series	**Ai**	Artificial intelligence

2-Phase Closed-Loop Stepper Motor

■ Specifications

◎ Motor

Model	AiA-M-60MA	AiA-M-60LA	AiA-M-86MA	AiA-M-86LA
Max. holding torque[1]	11.22kgf·cm (1.1N·m)	22.43kgf·cm (2.2N·m)	28.56kgf·cm (2.8N·m)	40.8kgf·cm (4.0N·m)
Rotor moment of inertia	$240g·cm^2$ $(240×10^{-7}kg·m^2)$	$490g·cm^2$ $(490×10^{-7}kg·m^2)$	$1,100g·cm^2$ $(1,100×10^{-7}kg·m^2)$	$1,800g·cm^2$ $(1,800×10^{-7}kg·m^2)$
Rated current	2.0A/Phase			
Resistance ±10%	1.5Ω/Phase	2.4Ω/Phase	2.3Ω/Phase	1.9Ω/Phase
Inductance ±20%	3.9mH/Phase	8.5mH/Phase	11.5mH/Phase	16.2mH/Phase
Weight[2]	Approx. 0.95kg (approx. 0.75kg)	Approx. 1.35kg (approx. 1.15kg)	Approx. 2.00kg (approx. 1.70kg)	Approx. 2.60kg (approx. 2.30kg)

※1: 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.
※2: 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 100MΩ (at 500VDC megger), between motor coil-case
Dielectric strength	500VAC 50/60Hz for 1 min between motor coil-case
Vibration	1.5mm amplitude at frequency 10 to 55Hz (for 1 min) in each X, Y, Z direction for 2 hours
Shock	Approx. max. 50G
Environment — Ambient temperature	0 to 50℃, storage: -20 to 70℃
Environment — 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]	0.03mm T.I.R.
Radial Movement[3]	Max. 0.025mm (load 25N)
Axial Movement[4]	Max. 0.01mm (load 50N)
Concentricity for shaft of setup in-low	0.05mm 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)
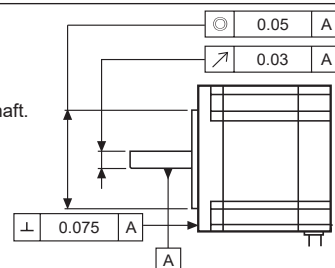※2: T.I.R. (Total Indicator Reading)
  - Indicates total quantity of dial gauge in case of 1 rotation of measuring part around the reference point.
※3: Amount of radial shaft displacement when adding a radial load (25N) to the tip of the motor shaft.
※4: Amount of axial shaft displacement when adding a axial load (50N) to the shaft.
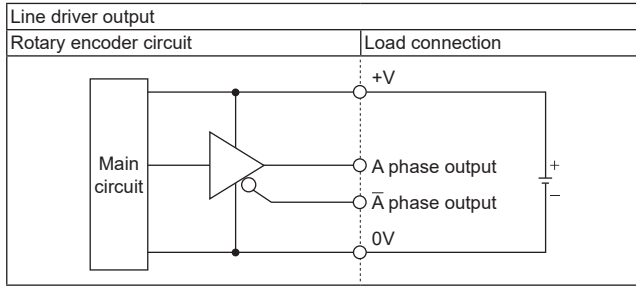※Environment resistance is rated at no freezing or condensation.

(Y)
Closed Loop
Stepper System

(Z)
Stepper Motors

(AA)
Drivers

(AB)
Motion
Controllers

◎ Encoder

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

AiA-M Series

▣ Encoder Control Output Diagram

Line driver output	
Rotary encoder circuit	Load connection

Main circuit

+V

A phase output

$\overline{A}$ phase output

0V

$+$
$-$

※All output circuits of A, $\overline{A}$, B, $\overline{B}$, Z, $\overline{Z}$ phase are the same.

▣ Encoder Output Waveforms

T

A phase [H] [L]

$\overline{A}$ phase [H] [L]

$\dfrac{T}{2} \pm \dfrac{T}{4}$

B phase [H] [L]

$\dfrac{T}{4} \pm \dfrac{T}{8}$

$\overline{B}$ phase [H] [L]

Z phase [H] [L]

$\overline{Z}$ phase [H] [L]

$T \pm \dfrac{T}{2}$

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

CW
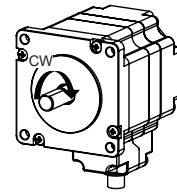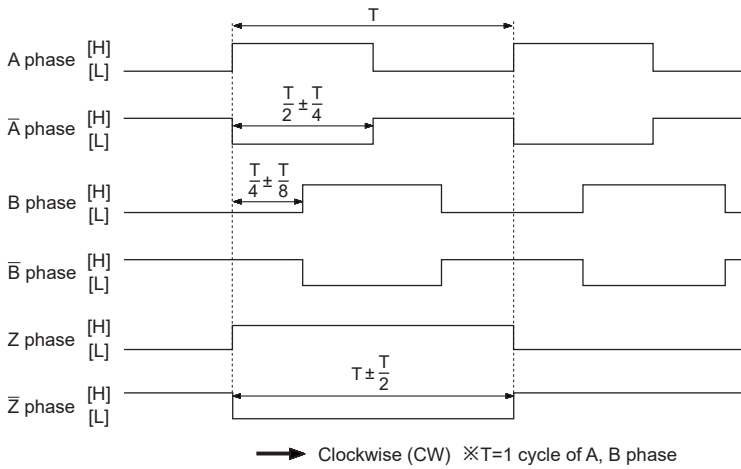
▣ Connection Diagram

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

Red/Black(A)

Yellow/Black(B)

Motor

Blue/Black($\overline{A}$)

White/Black($\overline{B}$)
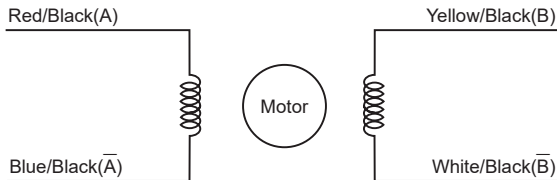
2-Phase Closed-Loop Stepper Motor

▣ Dimensions

◎ **Frame size 60mm**
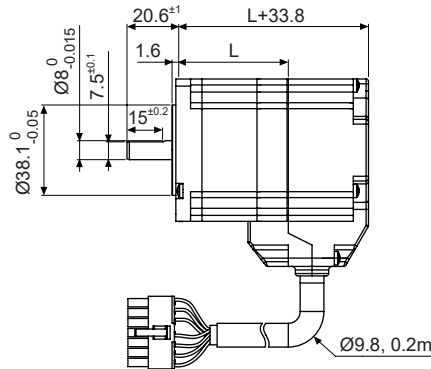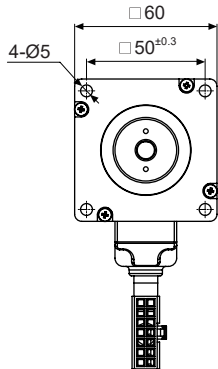
Model	L
AiA-M-60MA	47.4
AiA-M-60LA	68.3

◎ **Frame size 86mm**
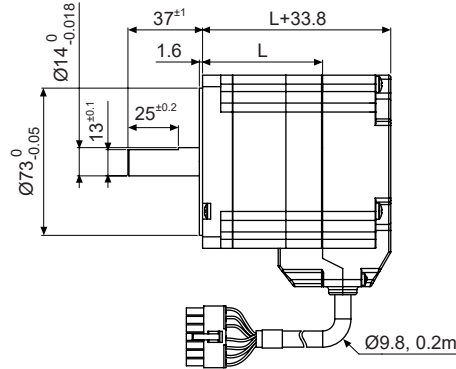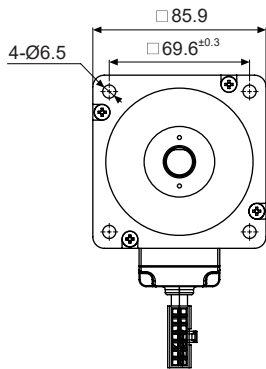
Model	L
AiA-M-86MA	59.5
AiA-M-86LA	74

SENSORS
CONTROLLERS
MOTION DEVICES
SOFTWARE

(Y) Closed Loop Stepper System
(Z) Stepper Motors
(AA) Drivers
(AB) Motion Controllers

▣ Motor Characteristics

◎ **Frame size 60mm**
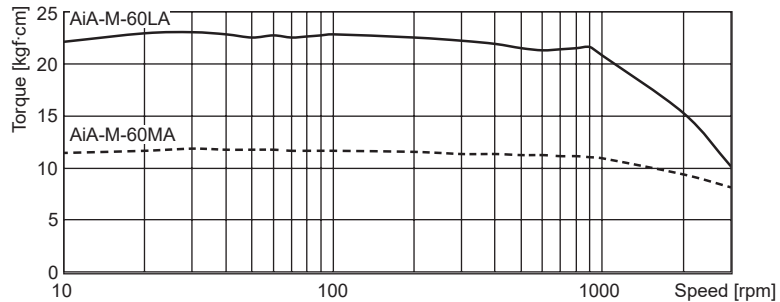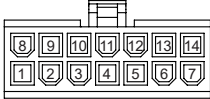
◎ **Frame size 86mm**
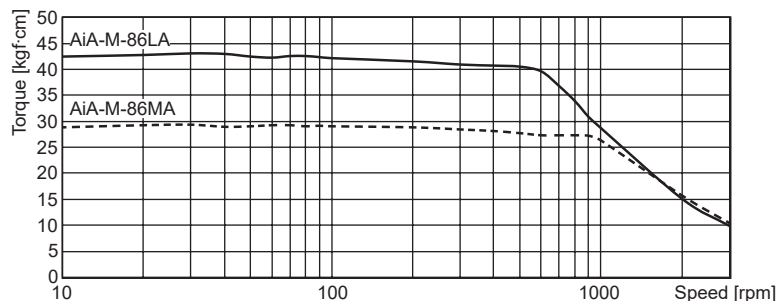
AiA-M Series

■ Motor Connectors

◎ CN1: Motor+Encoder connector

Pin arrangement	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 $\overline{B}$

Type		Specifications			Manufacture
		Connector	Connector terminal	Housing	
CN1	Motor+Encoder	5557-14R	5556T	───	Molex

※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.
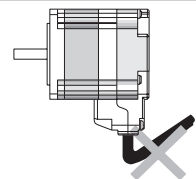Refer to the table below for allowable shaft overhung load / thrust load.

Side ways   **Facing up, down**
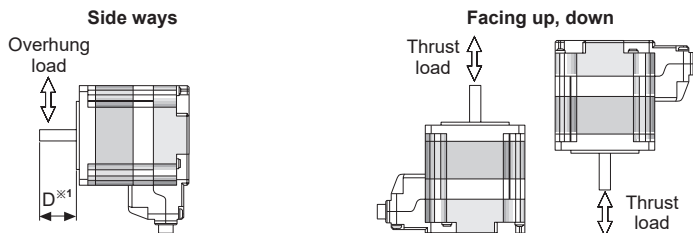
※1: The distance from the shaft in front (mm)

Motor size	The distance from the shaft in front (mm), Allowable overhung load [kgf (N)]				Allowable thrust load
	D=0	D=5	D=10	D=15	
Frame size 60mm	5.5 (54)	6.8 (67)	9.1 (89)	13.3 (130)	Under the load of motor
Frame size 86mm	26.5 (260)	29.5 (290)	34.6 (340)	39.7 (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.
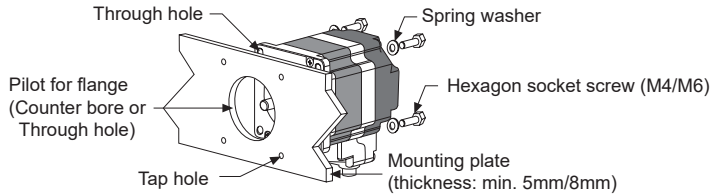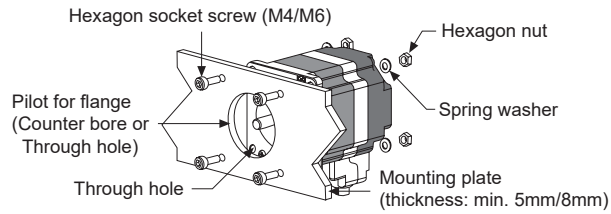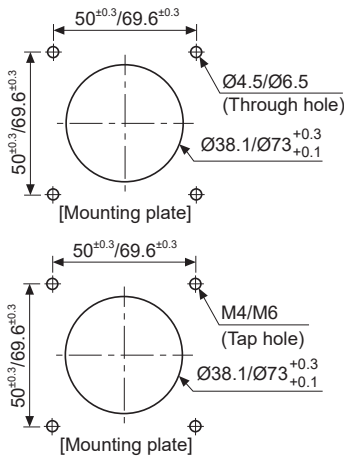In case of frequent cable movement required application, proper safety countermeasures must be ensured.

2. Mounting method

◎ Frame size 60mm/86mm

[Mounting plate]

50±0.3/69.6±0.3
50±0.3/69.6±0.3
Ø4.5/Ø6.5 (Through hole)
Ø38.1/Ø73 +0.3/+0.1

Hexagon socket screw (M4/M6)
Hexagon nut
Pilot for flange (Counter bore or Through hole)
Spring washer
Through hole
Mounting plate (thickness: min. 5mm/8mm)

[Mounting plate]

50±0.3/69.6±0.3
50±0.3/69.6±0.3
M4/M6 (Tap hole)
Ø38.1/Ø73 +0.3/+0.1

Through hole
Spring washer
Pilot for flange (Counter bore or Through hole)
Hexagon socket screw (M4/M6)
Tap hole
Mounting plate (thickness: min. 5mm/8mm)

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 30N 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.
①Inside of the housing which is installed indoors
  (This unit is manufactured for the purpose of attaching to equipment. Install a ventilation device.)
②Within 0 to 50℃ (at non-freezing status) of ambient temperature
③Within 20 to 85%RH (at non-dew status) of ambient humidity
④The place without explosive, flammable and corrosive gas
⑤The place without direct ray of light
⑥The place where dust or metal scrap does not enter into the unit
⑦The place without contact with water, oil, or other liquid
⑧The place without contact with strong alkali or acidity
⑨The place where easy heat dissipation could be made
⑩The place without continuous vibration or severe shock
⑪The place with less salt content
⑫The place with less electronic noise occurs by welding machine, motor, etc.
⑬The place where no radioactive substances and magnetic fields exist. It shall be no vacuum status as well.

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AiA-M Series

▣ Troubleshooting

1. When motor does not rotate
①Check the connection status between controller and driver, and pulse input specifications (voltage, width).
②Check the pulse and direction signal are connected correctly.

2. When motor rotates to the opposite direction of the designated direction
①When RUN mode is 1-pulse input method, CCW input [H] is for forward, [L] is for backward.
②When RUN mode is 2-pulse input method, check CW and CCW pulse input are changed or not.

3. When motor drive is unstable
①Check that driver and motor are connected correctly.
②Check 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.
  ①Unwinding bolts and connection parts for the unit installation and load connection
  ②Strange sound from ball bearing of the unit
  ③Damage and stress of lead cable of the unit
  ④Connection error with driver
  ⑤Inconsistency 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.
  ①Indoors (in the environment condition rated in 'Specifications')
  ②Altitude max. 2,000m
  ③Pollution degree 2
  ④Installation category II