

# Autonics 2-Phase Closed-Loop Stepper Motor AiA-M SERIES

## INSTRUCTION MANUAL

Thank you for choosing our Autonics product.  
Please read the following safety considerations before use.

### ■ Safety Considerations

- ※ Please observe all safety considerations for safe and proper product operation to avoid hazards.
- ※ ⚠ Symbol represents caution due to special circumstances in which hazards may occur.
- ⚠ Warning** Failure to follow these instructions may result in serious injury or death.
- ⚠ Caution** Failure to follow these instructions may result in personal injury or product damage.

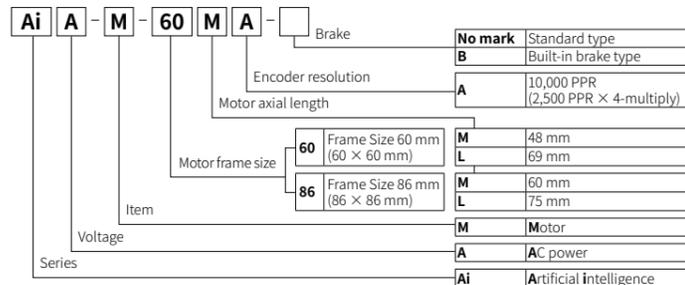
### ⚠ Warning

- Fail-safe device must be installed when using the unit with machinery that may cause serious injury or substantial economic loss.** (e.g. nuclear power control, medical equipment, ships, vehicles, railways, aircraft, combustion apparatus, safety equipment, crime/disaster prevention devices, etc.)  
Failure to follow this instruction may result in personal injury, economic loss or fire.
- Do not use the unit in the place where flammable/explosive/corrosive gas, high humidity, direct sunlight, radiant heat, vibration, impact, or salinity may be present.**  
Failure to follow this instruction may result in explosion or fire.
- Do not use the brake for safety.**  
Failure to follow this instruction may result in personal injury or product and ambient equipment damage.
- Fix the unit on the metal plate.**  
Failure to follow this instruction may result in personal injury, or product and ambient equipment damage.
- Do not connect, repair, or inspect the unit while connected to a power source.**  
Failure to follow this instruction may result in fire.
- Install the unit after considering counter plan against power failure.**  
Failure to follow this instruction may result in personal injury or economic loss or fire.
- Check 'Connections' before wiring.**  
Failure to follow this instruction may result in fire.
- Do not disassemble or modify the unit.**  
Failure to follow this instruction may result in fire or electric shock.
- Install the motor in the housing or ground at the rear ground (⊕) point.**  
Failure to follow this instruction may result in personal injury, fire or electric shock.
- Make sure to install covers on motor rotating components.**  
Failure to follow this instruction may result in personal injury.
- Do not touch the unit during or after operation for a while.**  
Failure to follow this instruction may result in burn due to high temperature of the surface.
- Turn OFF the power directly when error occurs.**  
Failure to follow this instruction may result in personal injury, fire or electric shock.

### ⚠ Caution

- Use the unit within the rated specifications.**  
Failure to follow this instruction may result in fire or product damage.
- Brake is non-polar. When connecting the brake, use AWG 24 (0.2 mm<sup>2</sup>) cable or over.**  
Failure to follow this instruction may result in fire or malfunction due to contact failure.
- Use the unit within the rated specifications**  
Failure to follow this instruction may result in fire or product damage.
- Use dry cloth to clean the unit, and do not use water or organic solvent.**  
Failure to follow this instruction may result in fire.
- The motor may overheat depending on the environment.**  
**Install the unit at the well-ventilated environment and forced cooling with a cooling fan.**  
Failure to follow this instruction may result in product damage and degradation by heat.

### ■ Ordering Information



### ■ Cautions during Use

- Follow instructions in 'Cautions during Use'. 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.
  - Unwinding bolts and connection parts for the unit installation and load connection
  - Strange sound from ball bearing of the unit
  - Damage and stress of lead cable of the unit
  - Connection error with driver
  - 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.
  - Indoors (in the environment condition rated in 'Specifications')
  - Altitude max. 2,000 m
  - Pollution degree 2
  - Installation category II

※ The above specifications are subject to change and some models may be discontinued without notice.  
※ Be sure to follow cautions written in the instruction manual and the technical descriptions (catalog, website).

### ■ Specifications

#### ⊙ Motor

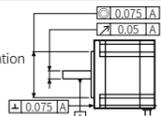
Model <sup>※1</sup>	AiA-M-60MA(-B)	AiA-M-60LA(-B)	AiA-M-86MA(-B)	AiA-M-86LA(-B)
Max. holding torque <sup>※2</sup>	1.1 N m	2.2 N m	2.8 N m	4.0 N m
Rotor moment of inertia	240 g·cm <sup>2</sup> (240×10 <sup>-7</sup> kg·m <sup>2</sup> )	490 g·cm <sup>2</sup> (490×10 <sup>-7</sup> kg·m <sup>2</sup> )	1,100 g·cm <sup>2</sup> (1,100×10 <sup>-7</sup> kg·m <sup>2</sup> )	1,800 g·cm <sup>2</sup> (1,800×10 <sup>-7</sup> kg·m <sup>2</sup> )
Rated current	2.0 A/Phase	2.4 A/Phase	2.3 A/Phase	1.9 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 <sup>※3</sup>	Standard type (approx. 0.75 kg)	Approx. 0.95 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. 1.75 kg)	Approx. 2.76 kg (approx. 2.50 kg)	Approx. 3.36 kg (approx. 3.10 kg)

- ※1: The model name indicates driver 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°C)
Insulation resistance	Over 100 MΩ (at 500 VDC = megger) between motor coil-case
Dielectric strength	1,000 VAC ~ 50/60 Hz for 1 min between motor coil-case
Vibration	1.5 mm amplitude at frequency of 10 to 55 Hz (for 1 min) in each X, Y, Z direction for 2 hours
Shock	Approx. max. 50 G
Environment	Ambient temperature
	Ambient humidity
Sold separately	Motor+encoder cable - normal C1DF14M-□ <sup>※1</sup> / moving: C1DF14M-□ <sup>※1</sup>
Approval	CE
Protection structure	IP30 (IEC34-5 standard)
Stop angle error <sup>※2</sup>	±0.09°
Shaft vibration <sup>※3</sup>	0.03 mm T.I.R.
Radial movement <sup>※4</sup>	Max. 0.025 mm (load 25 N)
Axial movement <sup>※5</sup>	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	0.075 mm T.I.R.

- ※1: □ of model name indicates cable length (1, 2, 3, 5, 7, 10, 15, 20).  
E.g.) C1DF14M-10: 10 m moving type motor+encoder cable
- ※2: Specifications are for full-step angle, without load. (Values may vary by load size.)
- ※3: T.I.R. (Total Indicator Reading) - Indicates total quantity of dial gauge in case of 1 rotation of measuring part around the reference point.
- ※4: Amount of radial shaft displacement when adding a radial load (25 N) to the tip of the motor shaft.
- ※5: Amount of axial shaft displacement when adding an axial load (50 N) to the shaft.
- ※ Environment resistance is rated at no freezing or condensation.



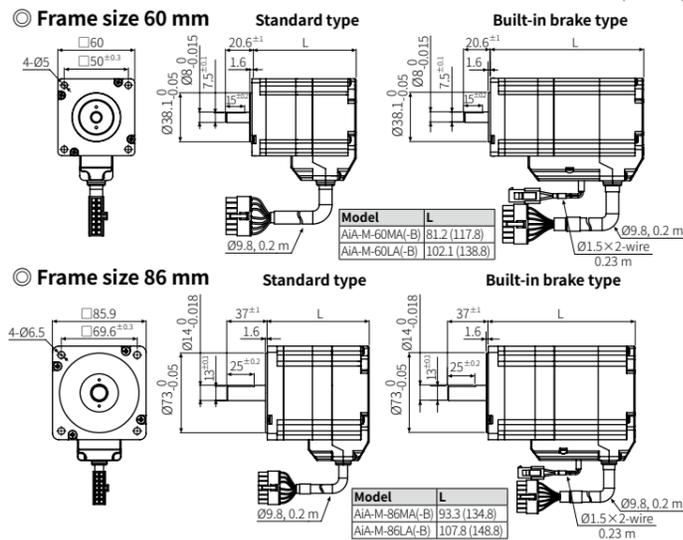
#### ⊙ Encoder

Item	Incremental rotary encoder
Resolution	10,000 PPR (2,500 PPR × 4-multiply)
Output phase	A, Ā, B, B̄, Z, Z̄ 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
Response time (rise, fall)	[Low] - Load current: max. 20 mA, Residual voltage: max. 0.5 VDC = [High] - Load current: max. 20 mA, Output voltage: min. 2.5 VDC =
Max. response frequency	300 kHz
Power supply	5 VDC = ±5% (ripple P-P: max. 5%)
Current consumption	Max. 50 mA (without 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 <sup>2</sup> (1.9 × 10 <sup>-6</sup> kg·m <sup>2</sup> )	120 g·cm <sup>2</sup> (12 × 10 <sup>-6</sup> kg·m <sup>2</sup> )
Insulation class	B type (130 °C)	
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

### ■ Dimensions



### ■ Connection Connectors of Motor

#### ⊙ CN1: Motor+Encoder connector ⊙ CN2: Brake connector

Pin	Function	Pin	Function
1	GND	8	+5 VDC =
2	Encoder A	9	Encoder Ā
3	Encoder B	10	Encoder B̄
4	Encoder Z	11	Encoder Z̄
5	PE	12	N·C
6	Motor A	13	Motor B
7	Motor Ā	14	Motor B̄

Pin	Function
1	Brake +
2	Brake -

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

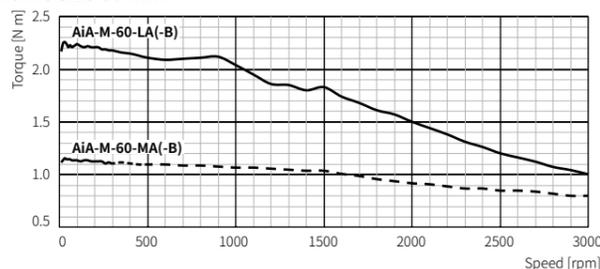
#### [Connector specifications]

Type	Specifications	Manufacture
CN1	Motor+Encoder 5559-14P (connector terminal: 5556T)	Molex
CN2	Brake CHD1140-02	Dinkle

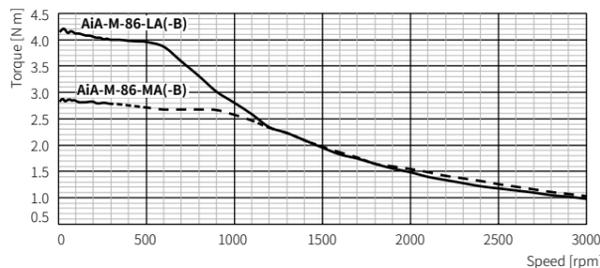
※ Above connectors are suitable for AiA-M(-B) Series.

### ■ Motor Characteristics

#### ⊙ Frame size 60 mm

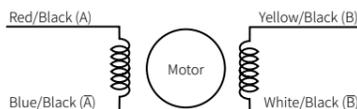


#### ⊙ Frame size 86 mm

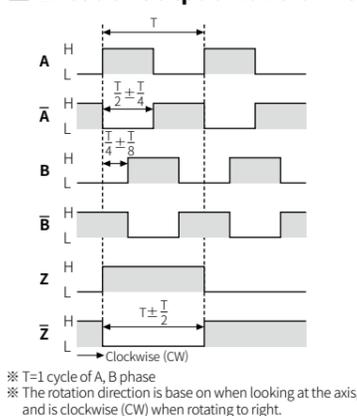


### ■ Connection Diagram

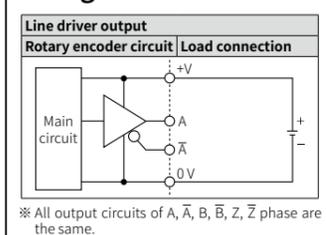
Autonics 2 phase closed-loop stepper motors take bipolar wiring method.  
The wiring colors for each phase and lead-wire are as the followings:



### ■ Encoder Output Waveforms



### ■ Encoder Control Output Diagram



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

- ※ T=1 cycle of A, B phase
- ※ The rotation direction is base on when looking at the axis, and is clockwise (CW) when rotating to right.

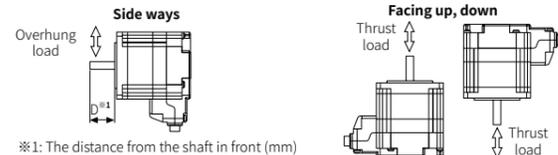
### ■ Troubleshooting

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.
When motor drive is unstable	Check that driver and motor are connected correctly. Check the driver pulse input specifications (voltage, width).

### ■ 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.

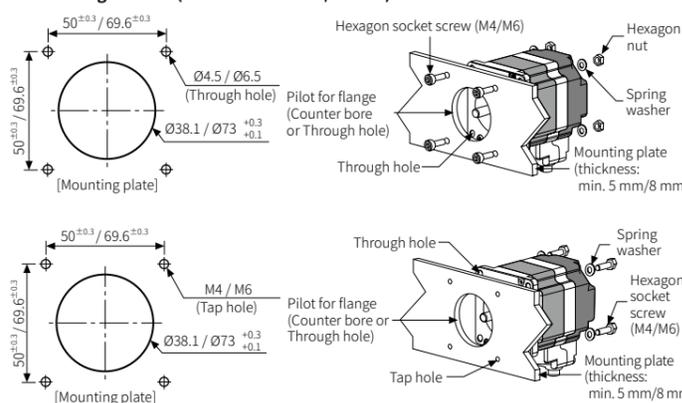


※1: The distance from the shaft in front (mm)

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 60 mm/86 mm)



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